RESPONSES

SURVEY TO IDENTIFY REGIONAL WATER RESEARCH PRIORITIES

1. What are the current top five water related research areas listed in order of priority within your organization?

1) No response

2) Investigation of sources of Giardia and Cryptosporidium in the NSR watershed. Determining water treatment required for good control of protozoan risk. Complying with probable new CEPA-toxic requirements (chloramines, ammonia). Developing overall watershed plans for major basins and sub-basins. Determining the risk from contaminant spills.

3) Surface water quality and quantity as affected by agriculture management. Subsurface water quality and quantity as affected by agriculture management. Soil salinity as affected by agriculture management. Climate change and water resources for agriculture.

4) Irrigation, crop diversification. Improving crop production per unit of water. Water conservation – methodology. Fate of agro chemicals in an environment under irrigation. Irrigation sustainability.

5) The City of Medicine Hat does not have research capability; however, we have undertaken one or two internal studies that serve specific departments. For example, our Interpretive Program (contracted to the Grasslands Naturalists, a volunteer environmental education and advocacy group has undertaken various minor studies on avian populations, cottonwood forest, urban streams monitoring – all for the benefit of various City departments.

6) **Non-Irrigation** Water treatment systems research. Emerging waterborne pathogens (i.e. cryptospordium and giardia) and their relationship to the agriculture industry. Surface and groundwater quality assessments and vulnerability to contamination (i.e. watershed scale). Beneficial management practices evaluation for water quality (integration with soil and air quality would be useful). Manure (nitrogen and phosphorus) management and ground and surface water quality including phosphorus mobility and establishing benchmarks and developing ways to measure changes in water quality. **Irrigation** Development of phosphorus standards and a phosphorus index for manure and nutrient management to protect surface water quality. Irrigation water requirements in th3e South Saskatchewan River Basin. Manure and nutrient management to minimize nitrate contamination of groundwater. Effects of food processing wastewater irrigation on soil and water quality. New technology for increasing on-farm irrigation water use efficiency.

7) Environmental effects of industrial discharge (P&P, Petroleum…). LRTAP/POP's – particularly the north. Aquatic ecosystem health. Acid rain. Ecosystem impacts of UV-B

8) Surface water treatment issues. Wastewater treatment. Storm water.

9) No response

10) Aquatic ecological effects of toxic chemicals. Land and water use impacts on water quality (e.g. dams, nutrient enrichment, etc.) Indicators of aquatic health. Aquatic health monitoring protocols. Climate change impacts.

11) Status and recruitment of Big Mouth Buffalo in Qu'Appelle system. Sturgeon recovery in the Sask. River. Diversity of fish populations related to habitat and habitat fragmentation in the Qu'Appelle River system. Population status and movement of fish: walleye in Lake Diefenbaker; walleye at Candle Lake; fish populations and utilization in Wakaw Lake. Gap analysis of controls on import of non-native fish introductions and ecological risk associated with such imports.

12) Production of Algal Toxin in lakes and rivers; factors affecting the growth of blue green algae; model to predict the production of algal toxin; developing management guidelines to reduce its risk of algal toxins to public and animals. Impact of acid precipitation from Alberta and Manitoba on the lakes and rivers of West Boreal and Shield EcoRegions. Developing policy and guidelines for determining the required widths of buffer strips in the riparian zones for the protection of water quality, fisheries and many other uses both in forested and agricultural areas. Impacts of drainage of wetlands and channelization of creeks on water quality and integrity of aquatic ecosystems. Impact of deep reservoirs on the levels of dissolved oxygen and sulphide in waters coming out of the electric hydro electric stations and selecting appropriate methods to correct the problem.

13) No response

14) No response

15) Sustainable water supply systems (surface and groundwater. Water quality/treatment (from well rehabilitation to small scale low-tech water treatment systems suitable for use by the agriculture and agri-food sector in rural areas. Agricultural impacts and water (best management practices for the agriculture and agri-food sector can reduce its impact on water quality). Decision support systems (GIS). Climate change.

16) **Response #1**. Speciation (identification of chemical state) of As, Se, Cr, Hg by chromatography – ICP-MS. Analysis of specialized samples – sample prep methods. Contaminating species from hydrogeological sources. **Response #2**. Industrial process water recycling. Wastewater pretreatment. Small drinking water systems (process development). Impact of industrial discharge or water quality. Disinfection by-products. **Response #3**. Treating water for reuse. Treating surface waters to remove organic carbon and precursors to disinfection by-products. Removing arsenic from drinking water supplies. Developing robust ezonation systems for small communities water treatment: disinfection, taste and odor issues. Treating wastewater from the food processing industry.

17) A key broad research priority is improved projections of the impact of Climate Change on water. The Branch needs to know whether or expect changes in stream flows, levels in water bodies and groundwater flow and storage, and the quality of these waters. This information is essential for us to properly assess the potential impacts from municipal, industrial and other discharges, as well as from irrigation projects. Further, it will improve the quality of our environmental impact assessment advice on future projects. Specific uses for this information could include: implications for wastewater discharges; dilution/assimilation calculations; wastewater strength calculation; need for effective, stringent sewer bylaws (including stormwater); need for alternative ways to treat and dispose of wastewater (including stormwater); need for ways to reduce amount of water needed/used – municipal, industrial; opportunities for more processes, equipment and

appliances; implications for water supply-municipal, industrial; need for alternative ways to treat, distribute and store water; need to maintain fire fighting capacities from the safety and insurance perspectives; implications for irrigation water demand and use; more efficient transport, storage and use; opportunities for equipment and crop changes; development of alternate sources and related transport; implications of demands for inter-basin transfers – domestic and international; forecasts of future precipitation and climate would support consideration of: implications of changes in agricultural practices, equipment, crops, chemicals; implications of changes in livestock operations, e.g. further concentrations, expanded possibilities for ranching and farming operations; implications of expanded areas for irrigation and related water demand and use.

Another priority is associated with the growing risk to human health from antimicrobial resistance, which has been identified by the World Health Organization (WHO), the U.S. Laboratory Centre for Disease Control (LCDC) and Health Canada. Antibiotic resistant organisms are widespread from overuse in health care and in agriculture, as growth promoters and disease treatment in animals. Compounding this problem is the fact that bacteria have multiple drug resistance and the ability to transfer this antibiotic resistance to other bacteria (R factor). Sewage and water have been identified as reservoirs of enteric bacteria and responsible for the spread of R factors. Direct and indirect exposure to contaminated water supplies and more recently washing fruits and vegetables has led to disease outbreaks. Public health assessments must now not only include the safety of water for human use, but for animal consumption and agricultural use. So-called harmless bacterial indicators can no longer be considered harmless.

18) Increased salinity – climate change issues. Water quality monitoring. Water levels. Pesticide drift in watershed. Land use change.

19) No response

20) Trans boundary quantity and quality. Developmental effects on aquatic systems (quality and quantity). Effects of waste on aquatic systems – bulk water removal.

21) Flood control management. Hydro-Power generation. Global water balance simulation. Water quality. Human interaction with the Hydrological cycle.

22) Climate change effects. Water quantity issues. Forestry effects. Resource exploitation by fish?????

23) Water supply, water quality, use and allocation, flooding and drainage, education and public awareness.

24) No response

25) Municipal water and sewage treatment. Watershed/rainwater protection and management. Groundwater hydrology. Aquifer protection. Landfill processes.

26) No response

27) No response

28) Biological nutrient removal. Urban stormwater runoff quality. Effectiveness of wet ponds and wetlands for improving the urban runoff quality. Effectiveness of small scale treatment devices for improving stormwater quality. BMP’s for water quality improvement.

29) Hazard management (e.g. collection and assessment of hydroclimatic information related to the tracking, forecasting and

notification of floods and ice jams and for the operation of mitigative structures). Resource management (i.e. collection and assessment of information on the quantity and quality of surface and groundwater resources for the quantification, management and sustainability of the resource). Cumulative effects monitoring and assessment (identification, quantification and mitigation of effects from multiple point and non-point sources on aquatic ecosystems). Non-point source impacts on water resources from various individual land uses (i.e. forestry, agriculture, mining, oil and gas industry, urban and rural development). Impacts of climate changes on water resource availability and quality.

30) N/A

31) No response

32) Hydrologic impact of wetland drainage. Instream flow needs. Groundwater/acquifer source delineation. Effluent treatment. Developing and improving small scale water treatment systems.

33) No response

34) Below are listed the five main research areas in which our organization is involved at the present time. Please note that the research areas are not listed in order of importance. Priorities often change or have to be adjusted over time as new issues develop; as such it is difficult to designate one area as having priority over others: Effects of livestock manure run-off on surface water quality. Municipal wastewater impacts to surface water. Watershed protection and rehabilitation studies. Nutrient impact studies. Impacts of industry on surface water quality.

35) No response

36) Effectiveness of municipal wastewater treatment processes. A Center of Excellence is being established at Gold Bas Wastewater Treatment Plant (GBWWTP) to facilitate the research and development of new equipment. Impacts of combined sewer overflow discharges on the North Saskatchewan River. Methods of stormwater quality improvement (source control; spill containment; education). Effectiveness of constructed wetlands.

37) Water quality of South Nahanni River-baseline info. Water quality of South Nahanni River – west specific monitoring (potential mining contamination). Limnology of Nahanni NPR Lakes – water quality, toxics, climate change.

38) No response

2. What are the anticipated top five regional water related research priorities listed in order of priority?

1) No response

2) Sources of Giardia and Cryptosporidium in general (agriculture, wildlife or sewage). Complying with probably new CEPA-toxic requirements (chloramines, ammonia). Developing overall watershed plans for major basins and sub-basins. Improve public awareness/involvement in water quality issues. What is the prevalence of exposure to waterborne disease in all communities, and is it significant?

3) a) b) and d) from previous answer generalized to involve all man’s uses of water. Recovering polluted water resources. Flood protection.

4) No response

5) The City of Medicine Hat does not have research capability; however, we have undertaken one or two internal studies that serve specific departments. For example, our Interpretive Program

(contracted to the Grasslands Naturalists, a volunteer environmental education and advocacy group has undertaken various minor studies on avian populations, cottonwood forest, urban streams monitoring – all for the benefit of various City departments.

6) Pesticides (synergistic and cumulative effects). Other endocrine disrupting chemicals (e.g. hormones). Groundwater contamination (nutrients, pesticides, bacteria). Manpower and training support (knowledge and information management) to get the message out and on farm management based solutions (practices) i.e. precision farming, riparian and grazing management. Co-ordination among all water users to set water quality targets and ensure water is managed to meet water quality targets.

7) Climate change. Agricultural impacts on ecosystems. LRTAP/POP's. Environmental effects of industrial discharges. Aquatic ecosystem health.

8) Watershed management's. Storm water treatment. Potable water pathogens.

9) No response

10) Same as for the most part but wetland/riparian habitat will likely emerge in context of both water quality/quantity as will carbon cycline.

11) Determining ecological integrity, or loss of, in aquatic ecosystems. Determining in stream flow needs. Pesticides in water, fate of biomagnification and ecological affects. Effect of climate change on aquatic systems. Biodiversity and species loss.

12) Developing land use management guidelines for new and existing developments over important aquifers. Developing approaches to avoid or reduce the use of water softening salts and it's impacts on the aquatic ecosystem.

13) No response

14) No response

15) Same as question 1.

16) **Response #1**. Agricultural run-off. Mining industry run-off. Forestry related run-off. Integration of the above data into a land management system. **Response #2**. Impact of land use. Impact of industrial development. Multiple use impacts recreation, water supply, waste disposal. **Response #3**. Providing adequate disinfection and by-products control for small (rural) water treatment utilities. Preventing nutrient and chemical discharge to surface waters used as drinking water sources. Preventing groundwater contamination. Recovering nutrients and other resources from efficient streams. Treating and finding applications for saline waters (e.g. produced water from the oil industry.)

17) A key broad research priority is improved projections of the impact of Climate Change on water. The Branch needs to know whether or expect changes in stream flows, levels in water bodies and groundwater flow and storage, and the quality of these waters. This information is essential for us to properly assess the potential impacts from municipal, industrial and other discharges, as well as from irrigation projects. Further, it will improve the quality of our environmental impact assessment advice on future projects. Specific uses for this information could include: implications for wastewater discharges; dilution/assimilation calculations; wastewater strength calculation; need for effective, stringent sewer bylaws (including stormwater); need for alternative

ways to treat and dispose of wastewater (including stormwater); need for ways to reduce amount of water needed/used – municipal, industrial; opportunities for more processes, equipment and appliances; implications for water supply-municipal, industrial; need for alternative ways to treat, distribute and store water; need to maintain fire fighting capacities from the safety and insurance perspectives; implications for irrigation water demand and use; more efficient transport, storage and use; opportunities for equipment and crop changes; development of alternate sources and related transport; implications of demands for inter-basin transfers – domestic and international; forecasts of future precipitation and climate would support consideration of: implications of changes in agricultural practices, equipment, crops, chemicals; implications of changes in livestock operations, e.g. further concentrations, expanded possibilities for ranching and farming operations; implications of expanded areas for irrigation and related water demand and use.

Another priority is associated with the growing risk to human health from antimicrobial resistance, which has been identified by the World Health Organization (WHO), the U.S. Laboratory Centre for Disease Control (LCDC) and Health Canada. Antibiotic resistant organisms are widespread from overuse in health care and in agriculture, as growth promoters and disease treatment in animals. Compounding this problem is the fact that bacteria have multiple drug resistance and the ability to transfer this antibiotic resistance to other bacteria (R factor). Sewage and water have been identified as reservoirs of enteric bacteria and responsible for the spread of R factors. Direct and indirect exposure to contaminated water supplies and more recently washing fruits and vegetables has led to disease outbreaks. Public health assessments must now not only include the safety of water for human use, but for animal consumption and agricultural use. So-called harmless bacterial indicators can no longer be considered harmless.

18) Contaminant measurement. Land use change and its effects.
19) No response
20) As in #1.
21) Same as #1.
22) As in #1.
23) No response
24) No response
25) No response
26) No response
27) No response
28) Quantification of non-point source pollutants that impacts river water quality. Impacts of non-point source pollutants on water quality of receiving stream. Impacts of non-point source pollutants on the quality of groundwater. Impacts of non-point source pollutants on the ecological system. Assimilative capacity of the river reaches.
29) Impact of retreating glaciers on the long-term base flow of Alberta’s rivers. Impact of oil and gas exploration and exploitation on groundwater quality and quantity. Impact of acid deposition from oil sands activities on northern rivers and lakes. Impact on water quality and quantity of forestry activities in northern Alberta and agricultural activities in the white zone. Sources and fate and impact of organic and inorganic contaminants in aquatic ecosystems.

30) N/A

31) No response

32) We are unfamiliar with others' research needs and therefore offer no comment.

33) No response

34) Anticipated areas of water related research for the future includes the following (again, these have not been prioritized): Watershed management and rehabilitation. Eutrophication of streams and rivers. Livestock manure impacts on groundwater. Water quality monitoring/research on Lake Winnipeg (south basin). Emerging issues such as the introduction of foreign biota, and the occurrence of endocrine disrupters and Giardia and Cryptosperidium in aquatic systems.

35) No response

36) River basin planning to protect drinking water source water and other downstream uses. Need for disinfection of wastewater discharges during winter. Water quality based ammonia discharge limits.

37) Mackenzie River Forecast, Water Quality – Mining Impacts.

38) No response

3. Does your agency have the technical expertise available to address these priorities? Please explain.

1) No response

2) We can do our own Giardia/Cryptosporidium testing and can pilot the effects of different disinfectants on the treatment process as a whole, but we need to co-operate with other researchers to investigate issues such a finding the best disinfectant for inactivation of Cryptosporidium, the prevalence of waterborn disease in communities, and improved methods for protozoan analysis. We are installing some online continuous monitors which we hope with be able to pick up spills of contaminants to the river (a UV monitor, and a Microtox toxicity monitor). We need help from other agencies in the implementation of best-management-practices for control of contaminants.

3) Only those areas listed in a).

4) Our agency has some but certainly not all the expertise to address these priorities.

5) The City of Medicine Hat does not have research capability; however, we have undertaken one or two internal studies that serve specific departments. For example, our Interpretive Program (contracted to the Grasslands Naturalists, a volunteer environmental education and advocacy group has undertaken various minor studies on avian populations, cottonwood forest, urban streams monitoring – all for the benefit of various City departments.

6) AAFRD has a network of expertise. It is important that teams with the necessary diverse skill set is developed to insure an integrated approach is used. Requirement for toxicologist expertise (pesticides and/or endocrine disrupting chemicals, etc.) or promote further training of existing specialists.

7) a) and b) – No; c) to e) - Yes

8) No, we depend more on tech journals, consultants and seminars than on in-house expertise. Also the internet is becoming more of a tool.

9) No response

10) Yes, but limited by capacity.

11) Fish populations. Aquatic habitat.

12) Yes to some of the problems and not to others. We are also handicapped by the lack of resources to undertake some of the required research.

13) No response

14) No response

15) Yes. Experienced scientists and engineers form a significant part of the staff compliment. Knowledge is brought in from joint venture-ship with government and non-government agencies, universities, private sector, intellectual networks of interested scientists and acquisition of in-house expertise. To a large extent, we have the expertise, or are developing it through partnering.

16) **Response #1**. Yes – we have all required analytical instrumental equipment – research required to establish methodologies. **Response #2**. Yes – chemists, biologists, engineers, agrologists for multi-disciplinary studies. **Response #3**. Yes – for first four priorities in question 2. The second two issues are primarily regulatory; we could address technical aspects. The fifth issue would involve a "learning curve".

17) No response

18) Support services only.

19) No response

20) Not in all areas.

21) Yes. We do provide graduate training, research and continuing education in the field of water resource management.

22) Yes – active research related to #1.

23) No. Board members comprised primarily of non-professional people.

24) No response

25) Buffalo Pound Water Treatment Plant has some research aspects. The City has a partnership with the University of Regina for solid waste research.

26) No response

27) No response

28) These research projects are conducted in co-operation with the consulting industries, the University of Calgary and Provincial Government.

29) In most areas technical expertise is available, however, time and other resources are limited.

30) N/A

31) No response

32) Yes, although our research expertise lies in specific areas. Research outside these areas would require a consultant.

33) No response

34) Our agency has three core technical expertise required to address these research areas. However, because of staff numbers and limited analytical resources, we are usually restricted to localized projects and/or specific aspects within the broad research categories listed above.

35) No response

36) Research is not a primary function of our organization. We therefore have only a partial capability in addressing these issues. We have one Research & Development Scientist position at

our GBWWTP laboratory. There are also several environment engineer positions within Drainage Services.

37) Nahanni NPR does carry out water quality monitoring with assistance of EC-AEB.

38) No response

4. Who are the primary users of your research findings? (Identify up to three): Environmental Groups, General Public, Government Policy Makers, Industry, Other Scientists, Other (please explain).

1) No response

2) Our own water utility, the water industry in general and drinking water regulators (Alberta Environment, Health Canada)

3) Industry, Other scientists.

4) General Public, Industry (farmers, agri business), Other Scientists

5) The City of Medicine Hat does not have research capability; however, we have undertaken one or two internal studies that serve specific departments. For example, our Interpretive Program (contracted to the Grasslands Naturalists, a volunteer environmental education and advocacy group has undertaken various minor studies on avian populations, cottonwood forest, urban streams monitoring – all for the benefit of various City departments.

6) Municipalities and industry (including producers whose practices can make a difference, if there is a problem). General Public. Government policy makers.

7) Government Policy Makers, Industry, Other Scientists

8) Government Policy Makers.

9) No response

10) General Public, Government Policy Makers, Other Scientists.

11) Government policy makers. Regional biologists. Fisheries stakeholder groups. SWCC. Conservation officers.

12) Government policy makers. Sask. Water. SWCC. General public. Industry. Environmental groups. Fish and Wildlife. Water users including: municipalities, cottage owners, tourist outfitters, fishermen. Livestock operators, lodge owners and general public.

13) No response

14) No response

15) Industry, Government policy makers, other scientists.

16) **Response #1**. Government policy makers. **Response #2**. Government policy makers, industry. **Response #3**. Government policy makers, industry, other scientists.

17) No response

18) Environmental groups, general public, other scientists.

19) No response

20) Environmental groups, general public, government policy makers, industry, other scientists.

21) Government policy makers, industry, other scientists.

22) General public, government policy makers, industry.

23) No response

24) No response

25) No response

26) No response

27) No response

28) Government policy makers, industry, other scientists.
29) General public
30) N/A
31) No response
32) General public, government policy makers, other scientists.
33) No response
34) It has been our experience that all of the groups listed above use our research findings to some degree. We do not have any records that would indicate who the primary users are, but I would speculate that the general public, other scientists (including academia and other government agencies), and policy makers are major beneficiaries of our research results.
35) No response
36) Government policy makers. Industry. General public.
37) Government Policy Makers and other scientists.
38) No response

5. What are the key regional water resource management questions, and what kind of research is needed to resolve these?

1) Availability of water – What can we use over the long term? Water allocation in times of shortage.
2) No response
3) No response
4) No response
5) As is the case with all water issues, the fundamental questions are water quantity and quality as they apply to appropriate apportionment to human, agricultural, industrial and ecosystem needs on a sustainable basis. Research needed includes: complete in-stream needs assessments to determine minimum flows that will sustain riparian ecosystems, species and aesthetic values; appropriate apportionment guidelines and management strategies and/or legislative framework; research is needed to establish well defined baselines on point sources of nutrients and pollutants and subsequently end of pipe limits for all point sources. Of course, such research would also need to study the effects of stream side and on-stream use on all users: human, agricultural, industrial, recreational and most importantly, the riparian ecosystem; the effect of intensive livestock and agricultural processing operations on groundwater and in-stream water quality needs to be studied. Air and soil quality also become part of the concern and perhaps should require a more holistic study including land planning, health and aesthetic considerations. Research must lead to strategic planning and management directions within public policy and legislation. On this issue, knowledge without political will is just fodder for parlor debate.
6) Water supply issue in Southern and Eastern Alberta. Water quality for drinking water, agricultural and recreational uses. What are the impacts of agricultural practices on water quality? In the contest of source apportionment, what are the sources of materials (substances) that may be having adverse effect on water quality. Can only know the agricultural portion by knowing all other sources too in order to distinguish. Practical management solutions – effectiveness of minimizing impact (i.e. precision farming, riparian management). pesticide management and transport, efficacy, persistence. Water management programs (i.e. drainage vs. riparian management). Setting common targets for all water

users and developing a co-ordinated approach to management within each watershed. To what extent can Alberta's irrigation districts expand using available water resources in the South Saskatchewan River Basin and what is the economic impact of water shortages under various development scenarios? What are the most appropriate rates for land application of manure, fertilizer and food processing wastewater to minimize adverse impacts on surface and groundwater quality?

7) No response

8) See #1, our research is not direct for the most park.

9) Water quality. Water quantity. Water sheds in the Sahtu Region of the Northwest Territories. Water concerns regarding fish and wildlife (Aquatics Effects Monitoring). Permafrost. Groundwater.

10) What is capacity of system to assimilate waste(s). What level and type of pollution control is required to protect fish (their uses) from nutrient enrichment, pesticides. How does climate change affect wetlands, water quality.

11) Maintaining or restoring aquatic ecosystem integrity, measuring and steps to do so. Effects of pesticides and other toxic substances in water. Effect of climate change on aquatic ecosystems. Maintaining biodiversity in aquatic ecosystems. Maintaining adequate in stream flows to support fish populations and maintain biodiversity.

12) No response

13) Key questions: What is an appropriate model for simulating the hydrology of the Canadian prairies? What are the appropriate design criteria for effective flood control works and floodproofing, particularly in light of potential impacts from climate change? What are the firm water supplies for allocation and licensing? What are the critical instream flows associated with a "healthy river"? The NHRI has developed a SLURP model. Work with this model in the upper Assiniboine Basin is promising, but more work is needed, particularly in the areas of the Blowing Snow, Frozen Soil Infiltration, and Winter Evaporation and Soil Drainage. The study has also identified other improvements that are needed. The climate change issue may be addressed by PFRA's recent initiative.

14) Key questions are relative to hydrology and the performance of water relative to the bank. I need research that is integrated and applied. Always can use information on communications to general public or interested groups.

15) How much water is available and how much/what kinds of development will this support? Research is needed: to develop assessments (groundwater vs. surface water), to develop effective monitoring, to assess impacts respecting climate change, to assess threats to water quality.

16) No response

17) No response

18) Water quality monitoring. Water levels (declining). Pesticide drift in watershed. Land use change.

19) Is the forestry industry detrimentally affecting the quality and consistency of our water supply?

20) Concerns about Trans boundary quality and quantity. Bulk water removal. Effect of waste matter. Developmental activity effects. Wider use.

21) No response

22) No response

23) Projecting future demand? Full-cost accounting of water supply options? Water quality standards? Institutional requirements? Conservation and public education practices?

24) No response

25) Watershed protection. Action is needed to assure continued protection and improvement of water quality in the upper Qu'Appelle River. Aquifer Protection. There is a lack of sound technical basis for decisions regarding land use decision as they relate to aquifer protection on a regional scale. Decisions are often project specific.

26) Impacts on ?????/fresh water bodies due to open burning of waste "atmospheric fallout". ????? and baseline information associated with industrial/mining activities, w.r.t. pre-exploration phase. Funding issues related to accumulation of baseline data, non members of responsible authority.

27) State of the aquatic ecosystem. Monitoring contaminants – tox sphere, mining related.

28) No response

29) Design and implementation of basin-specific plans for the sustainable use of water quantity and quality in surface and groundwaters. This implies that several information/research needs are to be met, including the following: Existing point and non-point sources are identified and their effect on water resources is quantified and understood; natural background contributions are described and they dynamics are quantified and understood with regard to hydrology and material movement; sources, pathways and fate of organic and inorganic contaminants such as nutrients, metals, PCBs, pesticides are quantified and understood; reach or water body-specific water quality objectives have been set for relevant water quality attributes; realistic projections are made regarding future pressures on the water resource (population, industrial, agricultural growth) and implications of global changes have been considered; dynamic and/or empirical models are available to describe, in a predictive manner, what influence changes in water allocation or point sources or non-point sources material contributions will have on surface and groundwater quality and quantity given specific water availability scenarios; contingency plans are being developed to reduce loading from point source and non-point sources; and contingency plans are being developed to encourage or enforce water conservation. Define, quantify and mediate individual and cumulative non-point source effects from forestry, agriculture, mining, oil and gas industry, and urban and rural development on ground and surface water quality and hydrology. This implies that several information/ research needs are to be met, including the following: regional and basin-specific dynamics for natural, background conditions are described and understood (i.e. 'natural variability' in hydrology, chemistry processes, and transport of materials); regional and basin-specific effects from man-made non-point sources are defined, their dynamics are documented, and their influence on 'natural variability' is understood; and a concerted effort is being made to determine, and implement sustainable methods of land management. Sources, pathways and fate of contaminants such as nutrients, PCB's, Hg, pesticides need to be determined, quantified and, where appropriate, target-loading objectives need to be defined. Implies that several basin specific and general provincial issues are to be addressed: PCB contamination in northern rivers; selenium

contamination issue in coal mines; target loading and acidification mechanism of S and N emissions, particularly in oil sands areas; relative contributions of pesticides to surface waters from atmospheric loading and surface runoff to surface waters are defined, especially, but not exclusively in agricultural areas; contaminant levels in aquatic life, particularly fish tissue needs to be defined on a regional or basin-specific basis; the chronic toxicity of ambient concentrations of single or multiple, frequently co-occurring contaminants needs to be defined for the most sensitive forms and stages of native aquatic species. This refers in particular to pesticides, but also to other organic compounds such as napthemic acids; analytical methods need to be developed and adequate analytical support needs to be acquired to quantify ambient levels of contaminants. Pesticides are of particular concern because of their widespread use in the environment and the very dynamic nature of their marketing; and guidelines for all designated uses are needed for all man-made compounds approved for use in Canada and which have the potential of entering surface or groundwater. Specific hydrological research needs include: the minimum predictable recurrence interval between major storm needs to be defined. This has significant implications on the operation of reservoirs in Alberta, which require that a flood storage pool is available to safely pass a major flood event; a better understanding of snowmelt processes is needed for the prairies and a reliable snowmelt model is required for meaningful flood forecast and early warning; sublimation of snow represents a water loss for the basin; the process needs to be understood better and modeled to develop reliable water supply forecasts for Alberta. The forecasted changes of global climate will potentially have impacts on quantity and quality of surface and groundwater water resources. This highlights the need for information and research in the following areas; glacier retreat needs to be researched to determine at what point, under global warming scenarios, glaciers would no longer contribute significantly to flows in major rivers. More specifically, glacier wastewater in the Bow Basin has been shown to account for 2.5 percent of the annual flow at Banff. During low runoff years however, the contribution for the month of August was shown to be as high as 47 percent; water supply scenarios that could evolve from global changes in climate need to be developed; implications of global climate changes on water quality need to be defined; and contingency/ management plans need to be developed. Groundwater resources: much basic research is needed. An inventory of existing data is needed to identify data gaps and produce detailed maps. The vulnerability of aquifers to pollutants from point and non-point sources needs to be defined. Existing impacts (especially from non-point sources such as oil and gas development, agriculture) should be defined. The recharge potential of aquifers should be defined. Trans-boundary aquifers require special attention with regard to the above points.

30) Water policy (eg. Community involvement), Board approach to management (PPWB, Mackenzie River Basin), agricultural drainage, water quality (eg. Drinking water), agricultural impacts, climate change – impacts on water management, groundwater (quality, identification).

31) Cumulative impacts of drainage and irrigation projects. Impacts of industrial, agriculture and domestic discharge and runoff in regional watersheds (e.g. Lake Winnipeg). Groundwater contamination. Impacts of forestry practices on waterways.

32) Instream flows/needs analysis-requires stream and riparian habitat and aquatic species inventories. Regional hydrology modeling-requires development of a hydrology model to deal with Canadian prairie hydrologic processes to include frozen soil infiltration, blowing snow, and variable contributing drainage areas. Aquifer sensitivity mapping to determine potential for acquifer contamination. Environmental studies, e.g., effects of developments within and adjacent to streams and fish. Wetlands evaluation- agricultural land development and conflicts with habitat retention. Economic studies ("costs of drainage")-requires soil erosion, water quality, etc. studies. Roles of wetlands in groundwater recharge. Impact of changing land use practices on runoff characteristics and basin yield. Impact of agricultural drainage on runoff potential. Potential impact of climate change on glaciers in the eastern slopes of the Rocky Mountains. Forecasting on the basis of snow water equivalent and soil moisture determinations. Application of remote sensing technology to water resource management. Evaporation mechanisms, accuracy of evaporation estimates and evaporation suppression. Contamination of groundwater resources from pesticide use and industrial activities.

33) State of the aquatic ecosystem. Monitoring contaminants – toxcphene, mining related.

34) No response

35) Ensure the protection of groundwater sources – relationship between fertilizer, manure and pesticide use on groundwater quality. Ensure the quality of surface water sources – relationship between fertilizer and pesticide use, livestock management activities, tillage and erosion on surface water quality. Impact of inter basin water transfer and aquifer recharge as a means of providing water supplies. Impact of irrigation management and subsurface drainage on soil salinity and redistribution via discharge of salts, nutrients and pesticides. Irrigation scheduling, technology and equipment to ensure efficient water use. Definition of baseflow requirements of streams and rivers relative to allocatable water supplies.

36) River water quality issues, including need to integrate water quality and water quantity. Establishment of site-specific discharge limits (e.g. ammonia in wastewater). Human activity within a watershed ultimately determines the water quality in that basin. How best do you incorporate this into land use bylaws and regional plans?

37) No response

38) Effects on water resources of land use change, eg. Forestry/agricultural practices, drainage, road construction, etc.

6. How does your agency access or acquire the required research information?

1) Work very closely with Alberta Environment and Alberta Agriculture, Rood and Rural Development researchers.

2) No response

3) No response

4) No response

5) The City accesses most of our immediate and short-term information through provincial government agencies, private testing of local water quality, consultant reports – all on a specific need

basis. Long-term issues, planning and management are very rarely addressed by provincial agencies.

6) AAFRD acquires information primarily through applied research conducted by line-division staff in partnership with industry, other government agencies, and private consultants. The department also adapts and packages information obtained from research conducted elsewhere for Alberta conditions.

7) No response

8) See #3.

9) Water License and Land Use Permit Applications. Technical workshops. Traditional environmental knowledge.

10) No response

11) Personal contact. Internet. Libraries. Journals. Conferences and workshops.

12) Personal contact. Internet. Libraries. Journals. Conferences and workshops.

13) By inter-agency studies mainly, with input from NHRC. Through literature published by research agencies, consultants, etc.

14) Close contact with University of Saskatchewan, NHRI, CWRA, Partners. Occasionally commission our own.

15) In-house expertise, consultant studies, joint partnerships with private sector groups and universities and with other federal departments that have complimentary resources.

16) No response

17) No response

18) Through science advisory committee made up of research agencies.

19) Through magazines.

20) Consultants. Federal Government assistance.

21) No response

22) No response

23) Networking with professional staff and others.

24) No response

25) Participation with other agencies. Literature review/internet. Partnerships with the University of Regina.

26) Stakeholders, ?????, federal government agencies.

27) Federal government, consultant reports, provincial governments.

28) No response

29) Review of literature published in scientific journals (libraries, internet). Review of reports produced by government and non-government agencies, primarily, but not exclusively, from North America (libraries, internet. Attend professional meetings, conferences, workshops, seminars. Personal professional contacts. Specific research topics are being addressed internally. Others require co-operation with other agencies, including research agencies.

30) Have representation on Board of Directors, and support from all agencies.

31) We refer to government or university sources, and to NGO

32) Liaise with other agencies, hire consultants, use of basic research techniques-libraries, journals, Internet, etc. Attendance at conferences, workshops and symposiums and review of publications in technical journals and appropriate follow-up with researchers.

33) Federal government, provincial governments, consultant reports.
34) No response
35) Personal communication. Scientific conferences, workshops, etc. Research reports in the literature and via the internet.
36) Through technical publications, reports, industry contacts, professional associations and their conferences, contacts in all levels of government and from universities.
37) No response
38) Discussion with research scientist.

7. Identify those agencies that in your opinion have the expertise that could assist in addressing your research needs.

1) See #6.
2) No response
3) No response
4) No response
5) Alberta Environment
6) Alberta universities, University of Saskatchewan, Montana State University, Alberta Environment, Alberta Health and Wellness, Alberta Agriculture, Food and Rural Development, EPCOR Water Services Inc., Agriculture and Agri-Food Canada, Environment Canada, Health Canada, Statistics Canada, Alberta Irrigation Projects Association, Private Consultants, Safe Drinking Water Foundation (Dr. Hans Peterson et. al.), Alberta Research Council in Vegreville, Cows and Fish, Intensive Livestock Working Group (ILWG)
7) No response
8) No response
9) Environment Canada. Fisheries and Oceans. Indian Affairs and Northern Development. National Energy Board. Government of the Northwest Territories. Resources Wildlife and Economic Development. Sahtu Renewable Resources Board.
10) No response
11) DFO. Environment Canada. Sask. Water. Other provincial environment departments. Universities.
12) DFO. Environment Canada. Sask. Water. Other provincial environment departments. Universities.
13) I doubt if any one agency has all of the required expertise. However, NHRC, CICS, EC, USACE, USGS all have some expertise. They should also collaborate with provincial operational agencies to make sure the research remains focussed.
14) As in #6. Environment Canada. Perhaps SRC, Canadian Research Council, Partners FOR the Saskatchewan River Basin.
15) Agriculture and Agri-Food Canada, NHRI, NRCan, private sector industry groups.
16) No response
17) No response.
18) Canadian Wildlife Service, National Water Research Institute, Sask. Water, Saskatchewan Environment and Assessment Monitoring, University of Saskatchewan, Environment Canada, Ducks Unlimited, PFRA, Saskatchewan Wetlands Conservation Corporation, Woodlands College, Saskatchewan Research Council, National Research Council.
19) ?
20) Federal government. Provincial/???????. Consultants.
21) No response

22) No response
23) Collaborative approach by university, government and private sector research interests. Research focus should be focused and specific to particular management needs.
24) No response
25) SRC, NHRC
26) Environment Canada, DFO
27) DIAND, DOE, NWRI, Mackenzie River Basin Board, Northern Rivers Ecosystem Initiative
28) No response
29) Universities, Federal research agencies, Alberta Research Council
30) Ducks Unlimited, SRC, PFRA, consultants, Environment Canada, Universities, Sask Water, SERM, etc.
31) Freshwater Institute
32) National Water Research Institute, Saskatchewan Research Council, Geological Survey of Canada, Agriculture Canada, Ducks Unlimited
33) MacKenzie River Basin Board, Northern Rivers Ecosystem Initiative, DIAND, DOE, NWRI
34) No response
35) Universities, Agriculture and Agri-Food Canada, Research Branch, Freshwater Institute, Fisheries and Oceans Canada.
36) National Water Research Institute, Environment Canada, Canadian Council of Ministers of the Environment, Alberta Environment, Water Environment Association, University of Alberta
37) No response
38) Environment Canada, Natural Resources Canada, National Research Council, Universities

8. What are the impediments (other than resources) to ensuring that adequate research is directed toward the water priorities that you have identified?

1) Few people involved in irrigation industry (a small voice).
2) There are many demands on funding sources; the difficulty in sorting out which problems should have priority is a common problem. Some issues require some initial investigation to highlight the existence of problems, which can then result in extended funding. Getting stakeholders together to agree on areas of concern is often difficult.
3) Lack of co-ordination.
4) A co-ordinated effort. Qualified staff.
5) The economic “market-driven” approach to issues: i.e. The clichéd “bottom line” thinking of governments. Shifting of environmental and water resource agencies from department to department and ministerial portfolio to ministerial portfolio. Nobody has any certainty or direction at the administrative level. Projects initiated and not completed create cynicism and futility at the local level. Even small successes would help. As it is, good intentions and effort are squandered because of uncertainty of direction and little political will. There are too many conflicting jurisdictional interests, e.g. provinces, federal government, rural/urban municipalities, irrigation districts, etc.
6) Lack of sufficient planning to ensure the right work is being done. Decision makers acting on need a framework or priority setting which provides a relative ranking of issues to guide

resource allocation. The extent to which the criteria reflect society's interests and what they think is important, will be the extent to which society is satisfied with the results. The lack of information sharing and co-ordination among agencies with an interest in water quality. The lack of water quality monitoring data at different scales to determine the source(s) of water quality problems. Lack of industry stakeholders involvement in determining water issue priorities that could be used to develop and research framework.

7) Expertise (knowledge) and appropriate indicator species of ecosystem health.

8) No response

9) Geological location. No real concern about the north, as not much development has taken place. Large number of water bodies in which to study.

10) Turf protection. Partnerships (cost sharing). Modeling capacity. A sound priority setting system.

11) Accessible databases.

12) Accessible and compatible databases. Technology transfer.

13) Jurisdictional conflicts. Lack of will. Failure to recognize the importance. Lack of good data. Lack of sufficient knowledge of the processes.

14) Too much is not locally focussed. We need direct application results, not theory.

15) Turf I (jurisdiction). The differing organizational focus amongst research groups resulting in different priorities and modes of work.

16) **Response #1 – None. Response #2**. Large term studies necessary to note changes and baselines. Statistical evaluation during design often not considered. Poorly defined goals. **Response #3**. Time: Some fundamental research is required to address some of the issues adequately. Everyone needs a quick fix. Politics: Barriers between research groups, within and between organizations.

17) No response

18) Communication, infrastructure, profile, facilities.

19) Apathy

20) Very important. Manpower and resources.

21) Government priorities. Distribution of resources.

22) Lack of resources ($) far outweighs any other impediment. Distant second is a reluctance of federal scientists to truly work with other non-federal, non-university researchers.

23) Lack of clear understanding of research requirements. Failure to identify leaders and accountability sectors for undertaking. Failure to define the appropriate institutional framework to manage the undertakings.

24) No response

25) Economic and social (small and large "p" politics) often divert attention away from causes and long term solutions and towards expedient solutions.

26) Spatial, area of responsibility vast

27) No response

28) Inadequate data. Appropriate comp8ter models.

29) Funding. Specialised staff cannot be dedicated to specific issues only. Lack of adequately equipped research facilities. Research needs require expertise in diverse areas, some areas of

expertise may not be available internally and time constraints exist because of the urgency of obtaining answers. However, some impediments are science-based. Difficulties exist in evaluating the significance of 'subtle' impacts from diffuse (e.g. land-use) or even point source impacts. Insufficient data to capture long-term variability in water resources (hydrology, chemistry, and biology) complicate the assessment of current impacts as well as the prediction of future impacts; and many researchers are unwilling to commit to directed, problem-oriented research.

30) Expertise, demographics, weak link between policy decision making and science, lack of awareness/priority setting, organizational structure.

31) Political will. Interest of corporations and other big players

32) Insufficient interaction between researchers and practitioners. Need improved communications with other resource management agencies. Mandate questions-which agencies should do the work?

33) No response

34) Inadequate communication and consultation between government agencies and other interested parties can impede research. Changes in Government policy may necessitate a shift in research priorities from time to time. Because we deal with environmental issues, some of our research areas require long-term commitments. Lack of a long-term commitment to a research project can negatively effect the applicability of research results.

35) Identification of specific research requirements.

36) Lack of site-specific knowledge/criteria. Lack of sharing of information (too long a process for publication of research findings).

37) Logistics of accessing remote sites.

38) Disconnect between researchers and operational units. University "research" is not always original, government research is too short term.

9. In which of the Provinces or Territories does your organization focus its mandate?

1) Alberta

2) Primarily the Edmonton region, but our mandate now has us running water utilities or investigating water system problems across Alberta and the rest of Western Canada.

3) Specific Saskatoon – Alberta and Saskatchewan, organization – all provinces.

4) Western Canada, primarily Saskatchewan.

5) Alberta

6) Alberta

7) We are a national facility.

8) Alberta

9) Sahtu settlement region of the Northwest Territories.

10) Prairies, NWT (Nunavit)

11) Saskatchewan

12) Saskatchewan

13) Manitoba

14) Saskatchewan

15) Prairie provinces and B.C. Peace River region.

16) **Response #1**. Alberta. **Response #2**. Alberta. **Response #3**. Alberta first, but the focus is global.
17) Prairie and Northern Region
18) Saskatchewan
19) Saskatchewan
20) Nunavit
21) Manitoba. However, national exposure is also present.
22) Saskatchewan, Northwest Territories
23) Manitoba
24) Prairies
25) Saskatchewan
26) Nunavit
27) NWT
28) Alberta
29) Alberta
30) Saskatchewan
31) Manitoba
32) Saskatchewan
33) NWT
34) Manitoba
35) Manitoba
36) Alberta
37) Northwest Territories
38) Western Provinces

10. Please identify your affiliation: Federal Government, Provincial Government, Consultant, Business (please specify type of business), Municipal Government, Academic/University, NGO (please specify area of interest), Other (please specify.

1) Provincial Government
2) EPCOR is a Power/Water/ Gas Utility, which is set up as a separate corporation with a separate Board, and able to do work outside of the parent municipality, but is still wholly owned by the City of Edmonton (as the single shareholder).
3) Federal Government
4) Federal Government
5) Municipal government
6) Provincial Government
7) Federal Government
8) Municipal Government
9) We are an institute of Public Government set up under the Sahtu Dene Metis Comprehensive Land Claim Agreement and proclaimed under the Mackenzie Valley Resource Management Act.
10) Federal Government
11) Provincial Government
12) Provincial Government
13) Provincial Government
14) NGO – river valley
15) Federal Government
16) **Response #1**. Provincial Government **Response #2 – None. Response #3**. Other – Crown Corporation.
17) Federal Government
18) NGO, World Biosphere Reserve

19) Municipal Government
20) Territorial Government.
21) Academic/University
22) Provincial Government (Drown Corporation, Academic/University – U of S Engineering
23) Provincial government.
24) Academic/University
25) Municipal Government
26) Self-Government Nunavit Board
27) GNWT
28) Municipal Government
29) Provincial Government
30) NGO
31) NGO – General
32) Provincial government
33) Other – GNNT
34) Provincial Government
35) Provincial Government
36) Municipal government.
37) Federal Government – Parks Canada
38) Consultant

11. What is the predominant area of expertise in your agency? (engineer, biologist, hydrologist, etc.)?

1) Irrigation Engineering
2) Our company has expertise in engineering, chemistry, and microbiology.
3) Engineer
4) Agronomy/soil science/ water
5) Municipal water and wastewater treatment and operation (chemistry and engineering), parks, land planning, public health.
6) In discussion with Richard Kellow it was suggested names of appropriate contact people should be included. Use the same address as for R. David Neilson listed above. Biologist –Sandra Cooke, Data integration and information development – Tim Martin, Economics – Tamara Lewis, Hydrology/Irrigation – David Neilson/Wally Chinn, Engineering – Murray Tenove, Hydro geology – John Rodvang, Climatology – Peter Dzikowski, Soil Science – Leon Marciak, Rod Bennett, Technology Transfer Agents – Carol Bettac, Land management/ cropping practice/nutrient management/pesticide chemistry and application/ plant genetics – Dan Heaney, Animal management – Dale Engstrom.
7) Ecologists
8) Engineering
9) Environmental Engineer, Land/Resource Geographer.
10) Biologist
11) Biologists. Conservation Officers. Engineers.
12) Ecologists. Conservation Officers. Engineers.
13) Engineering, hydrology
14) Planners/biologists/ education
15) Engineer

16) **Response #1**. My sub-area-chemical analysis. **Response #2**. Industrial Chemist. **Response #3**. Engineering, water chemistry.
17) No response
18) Project support – infrastructure.
19) Engineer
20) Toxologist, biologist, engineering.
21) Interdisciplinary including engineers, social and natural scientists. (Hydrologist, geographers, anthropologist, zoologist, biologist).
22) Ecologist, some climatology, hydrology, geomorphology.
23) Engineers/non-professional
24) Agricultural engineering
25) The City of Regina addresses a wide range of topics. This response is from the Municipal Engineering Department.
26) Engineer, scientist
27) Renewable and on-renewable resource management
28) Engineer, hydrologist, chemist
29) Engineers, hydrologists, biologists, hydrogeologists.
30) Multidisciplinary
31) Communication
32) Engineering, water resource management, hydrology, agrology.
33) Renewable & Non-Renewable Resource Management
34) The major areas of expertise held by staff in our agency include limnology, biology, plant and animal ecology, botany, groundwater hydrology, geology, entomology, and zoology.
35) Agronomist, Agricultural Engineer
36) Engineers.
37) 1 Biologist on staff, 3 full time, 2 seasonal wardens (perform research tech. Functions as part of job duties).
38) Water resources engineering and planning.

12. Please identify research interests or areas of concern not captured in the preceding questions.

1) N/A
2) There is a need to try and co-ordinate action plans for improvement with all of the stakeholders involved (federal, provincial, industry, agriculture, environment, health, NGOs, etc.) because solutions to many of the problems will require co-operative efforts to minimize impacts.
3) Wetlands and greenhouse gas balance. Biodiversity in water bodies.
4) No response
5) By pelicans, cormorants, waterfowl, raptors, shorebirds.
6) Environmentally sustainable agriculture, of which water quality is a subsidiary benefit. Pesticides guidelines development. Research and test the methodology for comparing Alberta’s level of pollution to national and international competitors.
7) No response
8) No response
9) Our Board is the regulatory authority to issue, amend and suspend water licenses and land use permits in the Sahtu region of the Northwest Territories. In doing so, we require applicants to

gather information in their applications for a water license or land use permit that will lessen or eliminate the impact to the environment. Not all information that we require can be supplied by the applicant as it is not cost effective for them to do any research. Background data on water bodies in the Sahtu Region is non-existent. This data would benefit us by allowing our Board to determine if there will be any cumulative impacts or to determine the level in which to restore the area.

10) Early warning systems. Wetland remediation. Aquatic biodiversity. Aquatic exotica. Pollution prevention. Cumulative effects. Predictive/integrative models. SOE – aquatic reparting.

11) Mapping program for important aquatic habitats; Good Spirit, Turtle, Rafferty and Candle. Development of a strategy to monitor ecological integrity by watershed. Status of invertebrates in the South Saskatchewan River. Assessment of potential to further develop the commercial fishery. Comparative study of two streams in Cypress Hills with and without exotic introductions to determine effect on vertebrate and invertebrate assemblages. Refine tetracycline process to validate stocking success, and contributions to species recruitment. Development and verification of techniques for rapid biological assessment of ecological affects in aquatic ecosystems.

12) Aquatic Ecosystem Classification: There are some models available to describe some features and functions of some aquatic ecosystems such as wetlands and gamefish-bearing waters. What is required for long term management are models which address: ecological structures and functions of the aquatic system (e.g. physical aquatic habitat, benthic structure and functions, nutrient and material processing, biodiversity, etc.) as has been done for the terrestrial ecosystem; addresses whole ecosystem and not just single species or single water uses; addresses ecological features of various scales (niche, site, waterbody, watershed, basin etc.); addresses the interrelationships of aquatic and terrestrial ecosystems. **Riparian Area Management Guidelines.** There is a sufficient body of scientific literature to justify the conservation and protection of riparian areas but considerable controversy over the physical dimensions of the riparian area that needs to be protected or managed to sustain ecological structure and function of this ecotone and its associated aquatic ecosystems. There are sound models to define the physical boundaries of riparian areas to achieve particular uses or values but models defining the boundaries so that whole ecological values and functions are sustained remains to be developed. There is also considerable debate over the types and extent of resource harvest or land use activities which could be considered allowable within riparian areas without significantly impairing ecological functions. There is also the need to address riparian areas at various scales from niche to watershed/basin since the impacts of damaging riparian areas is cumulative. Particular attention needs to be given to headwater and intermittent streams and wetlands because of their relatively more significant role in influencing the physical, chemical and biological quality of lower portions of watersheds. **Minimum Flow and Elevation Criteria**. There is much expertise and well developed management criteria available to manage water flows and waterbody surface elevations to meet specific water/land use needs or to control/prevent flooding. There is, however, very little knowledge or management activity related to maintenance of precise water flows/elevations which are required to sustain properly functioning aquatic ecosystems,

riparian areas, or floodplains. There are models available for determining the minimum flow requirements for various fisheries but few which deal with sustaining the complex array of ecological functions of lentic and lotic ecosystems, or which address concerns related to various scales (e.g. niche, site, waterbody, watershed, basins.)

13) Method of assessing flood risk. Perhaps we put too much faith in log-paper and should be looking at the problem from the causal side. Perhaps some more research could be done on the underlying theories to determine validity for extreme value analysis.

14) The basis of support is the community. What do they know? Believe? Anything that helps provide information on this is useful.

15) No comment.

16) **Response #1**. None **Response #2**. Biodiversity. Nutrient and carbon budgets. Sustainable land use. **Response #3**. Ice management. Water treatment residual management. Sludge dewatering. Iron, manganese and sulphate removal from groundwater supplies. Discharge dispersion models and proper river sampling. Re-circulating water treatment systems for aquaculture.

17) No response

18) How to deal with scientific uncertainty within the need to make complex management decisions. Issue identification at public/land user level within the community.

19) No response

20) No response

21) We are doing a serious work in applying systems view to the management of water resources (mathematical modeling – simulation and optimisation; decision support systems development).

22) No response

23) Perhaps attention to a new approach to water management in the future (new institutional mechanisms, partnerships, etc.) as a way of doing business deserves the focus of attention. Research requirements would flow from this new direction.

24) Air quality, agricultural systems

25) No response

26) Atmospheric fallout in Arctic.

27) No response

28) How to reduce the pollution in the river system? Pollution trading.

29) Following issues are already being addressed as part of provincial or federal government programs or are emerging issues: aquatic biodiversity, occurrence and significant of hormones and drugs in wastewaters and receiving waters, cyanotoxins in surface water: control and management, and Giardia, cryptosporidium and other pathogens in surface waters: control and management.

30) Communications/Education; need for outreach and information dissemination; mentoring for water management professionals.

31) Pesticide run-off (urban and rural, especially on the topic of suspected endocrine disrupters) - Drinking water issues (chlorination by-products) and especially Flouridation impacts.

32) None

33) No response

34) No response

35) Local and area wide surface drainage – economic feasibility and down stream impacts. Integrated Watershed Management.

36) Harmonization of provincial and federal water related regulations and the communication of issues and resolutions of issues to municipalities.

37) Impact of river travellers on water quality, habitat quality.

38) Trans boundary issues, communication of research findings, climate change.

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