



**INTERNATIONAL RED RIVER BOARD
CONSEIL INTERNATIONAL DE LA RIVIÈRE ROUGE**

FLOOD PREPAREDNESS AND MITIGATION IN THE RED RIVER BASIN

**R. A. HALLIDAY
R. HALLIDAY & ASSOCIATES LTD.
SASKATOON, SK**

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EXECUTIVE SUMMARY

It is futile to assume that Red River shall never again overflow its banks. Man is utterly powerless to prevent its occurring periodically, and whenever it occurs the disastrous consequences will be intensified in proportion to the increased number of inhabitants within the submerged district.

Sir Sandford Fleming, 1880

In its November 2000 report, *Living with the Red*, the International Joint Commission (IJC) made a number of recommendations to governments aimed at reducing, mitigating, and preventing harm from future flooding in the Red River basin. The IJC noted that there is no single solution to the challenge and that comprehensive, integrated, binational approaches must be pursued and implemented.

Since the 1997 flood, governments at all levels have made changes in flood-related policies, funded new programs and changes to existing ones, invested in research into many aspects of flooding, and supported the establishment of new institutions such as the Red River Basin Commission. Not only major floods such as that of 1997, but also smaller tributary floods have been the focus for attention.

In June 2001, the United States and Canada directed the IJC and the newly created International Red River Board to monitor progress by governments in implementing the recommendations contained in *Living with the Red*, and to provide encouragement for continued cooperative, innovative, and integrated watershed management approaches. In January 2003 the Commission specifically requested the Board to provide a written report on progress. Also, as it is now almost six years since the Red River flood, this would seem an opportune time to take stock of what has been achieved.

A consultant was engaged to carry out the stock-taking. The approach used was to circulate an invitation to respond to a survey to key agencies and organizations having an interest in Red River flooding. The Survey consisted of a four-part questionnaire. The questionnaire was placed on a website so that it could be answered on-line or printed. One hundred ten letters were distributed and twenty-six responses received. The response rate of 24 percent is considered above-normal for this type of survey.

The International Joint Commission made 28 recommendations to government and endorsed another 30 recommendations of its International Red River Basin Task Force without change. It would be fair to say that the expenditures since 1997 relating to the IJC recommendations are in the order of hundreds of millions of dollars and that similar amounts will be spent in the next five years. No

recommendations have been formally rejected although a few are unlikely to be implemented. The responses received to the IRRB survey indicate that considerable progress has been made in increasing preparedness for major floods and mitigating potential harm from future floods.

Some of the key achievements and deficiencies can be summarized under headings of policy, legislation and institutions; preparedness; mitigation; and environment.

Policies, Legislation and Institutions. Changes in data policies by the Canadian federal government, particularly Environment Canada, and by the Manitoba government have had a number of benefits and are leading to a better-informed public.

Manitoba has introduced a new designated flood area regulation. The associated elevation and inspection requirements for new structures will reduce future flood damages.

In the United States, policy changes by the Army Corps of Engineers are aimed at a more integrated basin-wide consideration of projects. Activity by the Minnesota Red River Watershed Management Board and its North Dakota counterpart, the Red River Joint Water Resource District, also seeks more integrated approaches.

Key institutional developments include the formation of the International Joint Commission's International Red River Basin Board, the Red River Basin Commission and the Red River Basin Institute.

Preparedness. Cities such as Winnipeg and Grand Forks have upgraded detailed emergency plans and other centers are also doing so. Some of these plans will be tested in exercises in 2004.

Another major development is the significant improvements to flood forecasting. Major improvements have been made to data networks; data collection that supports forecasting, such as topographic data; model development; and communication of forecasts. These have occurred in both countries.

Mitigation. Many structural measures aimed at protecting both rural and urban floodplain residents have been built, are under construction or are in advanced planning stages. Rural protection efforts are nearing completion, major levees such as those for Grand Forks and East Grand Forks are well in hand, and expansion of the Red River Floodway (Winnipeg) is moving ahead.

With regard to non-structural measures, the identification of areas at risk in the United States, based in part on information from the 1997 flood, is proceeding, albeit slowly. This is a negotiated process among several agencies. At the same

time, there are some indications of attempts to initiate floodplain developments in the United States ahead of new definitions of the area at risk.

Several agencies are collaborating with the Red River Basin Commission and the Red River Basin Institute on the development of complex hydraulic models for the basin. By 2004 it is anticipated that there will be a single one-dimensional hydrodynamic model of the Red River mainstem extending from Lake Traverse in the headwaters to Breezy Point near Lake Winnipeg. This model development will be useful in planning future flood mitigation work. It also has potential application in flood forecasting.

Current activity appears focussed on the mainstem of the Red River, also the focus of the IJC investigation. More work is needed on tributary flooding, ice jam flooding and summer floods.

Environment. The IJC made recommendations concerning biota transfer, groundwater contamination and storage of hazardous goods. Some work is being accomplished in these areas, but more needs to be done. An area of considerable activity that also arose during the International Flood Mitigation Initiative concerns riparian zones. Programs are underway aimed at establishing riparian conservation reserves and developing a greenway on the Red

In summary, the recommendations that have achieved the most success are those that involve construction of a structural measure identified in the IJC report, even if that work requires collaboration at the federal, state or province, and local level. A second group of successful recommendations relate to specific recommendations aimed at a specific agency. The significant improvements to flood-forecasting are an example.

There are some causes for concern nonetheless. The recommendations that have achieved relatively little success are those that involve multiple agencies and, perhaps, multiple objectives. It may be that these sorts of tasks could be deemed to be more difficult and could naturally be expected to take longer. It may be that public expectation for structural measures supercede all other post-flood pressures and that those expectations need to be met before proceeding with "softer" projects.

One could say that a sort of collective unilateralism has been in play and that this has led to some worthwhile results. Another way of describing progress thus far is to say that there has been considerable success in projects and programs that keep water away from people and less success in programs that keep people away from water. This is not to say that the up to 40-km wide 100-year floodplain of the Red River mainstem should become some sort of "no-go" zone. Rather the policy objective should be to allow people to occupy the floodplain while minimizing risk to life and property.

It will still take considerable effort to achieve the level of integration and cohesion on flood management that the IJC envisaged. This needs to be pursued with some urgency before other priorities begin to compete for attention, or indeed, before another major flood occurs elsewhere. Significant interagency and intergovernmental cooperation will be needed before the long-term resiliency of the basin can be assured. Extensive public processes that cover a short list of issues could be required.

Sir Stanford Fleming's observation regarding Red River flooding remains as true today as it did over a century ago. It is fortunate that residents of the basin and their political leaders are still seized by the flooding issue. In other circumstances complacency could have already set in and flooding concerns could have disappeared.

In considering the way forward, the International Joint Commission and its International Red River Basin Board may wish to concentrate on a short list of matters concerning Red River flooding. This would include: matters pertaining to the transboundary area, in particular the Roseau and Pembina Rivers; matters relating to flooding and the environment, such as invasive species, effects on Lake Winnipeg, and storage of hazardous goods; and the development of indicators of basin resiliency.

The apocryphal quote that the Red River basin has two problems, "too much water and too little", has a firm foundation in reality. In attempting to deal with concerns related to flooding, it is important to determine the consequences of any proposed measures during times of drought. Integrated water resources planning should be the overarching goal for the basin.

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INTRODUCTION

In its November 2000 report, *Living with the Red*, (IJC, 2000) the International Joint Commission made a number of recommendations to governments aimed at reducing, mitigating, and preventing harm from future flooding in the Red River basin. The IJC noted that there is no single solution to the challenge and that comprehensive, integrated, binational approaches must be pursued and implemented. In the course of its work, the IJC had also initiated the development of products of continuing utility to the basin, including hydraulic models, high resolution topographic and land use data for flood-prone areas, and a virtual network to link people, information, and the decision-making process.

Since the 1997 flood, and in response to the IJC recommendations and others such as those arising from the International Flood Mitigation Initiative, significant investments have been made in the basin to better understand flooding along the Red River, to protect communities, and to develop partnerships amongst governments, the private sector, and non-profit organizations to address flood damage and mitigation concerns. Governments at all levels have made changes in flood-related policies, new programs and changes to existing ones have been established, research continues into many aspects of flooding, and new institutions such as the Red River Basin Commission have been established. Not only major floods such as that of 1997, but also smaller tributary floods have been the focus for attention.

In June 2001, the United States and Canada directed the IJC and its newly formed International Red River Board to monitor progress by governments in implementing the recommendations contained in *Living with the Red*, and to provide encouragement for continued cooperative, innovative, and integrated watershed management approaches. In January 2003 the IJC requested that the IRRB provide a written report on what has been accomplished. As it is now almost six years since the Red River flood, this would seem an opportune time to take stock of what has been achieved.

One approach to this stock-taking was to conduct a survey of agencies having an interest in flood preparedness and mitigation in the Red River basin. The survey was aimed at providing a consolidated overview of the nature and extent of flood related activities since 1997. In this way the International Red River Board could lend its support and influence towards continued preparedness and mitigation activities in the basin.

The survey was conducted for the International Joint Commission's International Red River Board by R. Halliday & Associates Ltd. in co-operation with the Canadian Water Resources Association. Funding for the work was made available by the Canadian Departments of Western Economic Diversification and of the Environment.

This report describes the survey and the results achieved. It also makes recommendations for future work in the basin.

Acronyms and abbreviations used in this report are defined when they first appear. A complete listing can be found in Appendix One.

THE SURVEY

A survey instrument, displayed in Appendix Two, was designed in collaboration with the International Red River Board Secretariat. The Survey consisted of a four-part questionnaire. The first part requested the name of the organization responding and the geographic scope of its activity. The second part examined policy, legislation and institutional development in the basin since the 1997 flood. The third part dealt with programs since the flood using the emergency management cycle as a framework. The final section consisted of open-ended questions pertaining primarily to gaps and deficiencies.

The questionnaire was placed on a website so that it could be answered on-line, printed as a .pdf file or downloaded as a Word file. The website also provided background information and contact addresses for the secretariat and the consultant. The respondents were assured that their individual responses would be kept confidential and the website was set up so that responses were anonymous. The website also contained an invitation to respond in French.

About 110 letters were sent out to individuals in key agencies and organizations inviting them to respond. The letters to US agencies were distributed with the assistance of the Red River Basin Commission. As well, a message was broadcast using the Red River Basin Disaster Information Network (RRBDIN) inviting additional input.

The letter to key individuals gave an approximately two-week response time. Many respondents felt this was insufficient. The number of returns by the specified due date was small (about 10%) but several agencies who replied by the due date indicated they required more time to complete the questionnaire. Follow up telephone calls to other agencies led to a greater response.

Of the 110 letters sent out, 13 agencies responded on-line, 9 by email, 2 by fax, and 2 by mail (See Table 1). There were no responses from private sector organizations and few from the university community. Judging by the 24 percent return (considered above-normal for surveys of this type) using an Internet-based questionnaire, as opposed to a mail-out, was reasonably effective. It was clear from the responses that some individuals went to considerable effort to produce a consolidated agency response. Although not requested to do so, a few respondents provided their names for follow-up.

Table 1: Origin of responses and method of responding

	General	US Fed.	CA Fed.	MN	ND	MB
On-line	2	1	1	2	5	2
Email	1	2	1	1	2	2
Fax			1	1		

	General	US Fed.	CA Fed.	MN	ND	MB
Mail		1			1	

All responses were in English. One recipient misinterpreted a question and took exception to the misinterpretation; the question was modified to improve clarity. One response had no information content and was likely from a curious student who happened on the site.

The writer also communicated directly with a number of individuals to clarify points made and to obtain additional information on some projects.

SURVEY RESULTS

The results that follow are generally organized on the basis of the questionnaire. In the course of its work the IJC drew 7 conclusions, made 28 recommendations, and endorsed 2 conclusions and 30 recommendations of the International Red River Basin Task Force Report (IRRBTF 2000) without re-statement. All conclusions and recommendations are presented in the discussion section of this report.

The IJC recommendations are cross-referenced to the survey findings in this report. In addition the recommendations of the IJC's International Red River Basin Task Force that were endorsed, but not restated, by the IJC are cross-referenced. Some conclusions and recommendations are referenced more than once.

Although the survey was aimed primarily at the response to the recommendations arising from the IJC study, respondents were encouraged to report on other related flood matters as well. Those contributions will be covered in this report as well. The level of detail in the survey results varies among jurisdictions and subject areas. This is a consequence of assimilating input from many sources.

The spatial extent of the report is confined to the Red River basin as defined in the IJC study. That is, the Assiniboine River and the Devils Lake subbasin are not included. The Assiniboine River, in particular its Souris River tributary, is not covered in the mandate of the IRRB. Although the Devils Lake basin is part of the Red River basin (and falls within the geographic mandate of the IRRB) there has been no hydraulic connection to the Red in the last millenium.

Although it is technically incorrect, this report uses the expression Red River valley to denote the flat central portion of the Red River basin that takes in the Red River mainstem. For the most part, this is the portion of the basin that appears flooded in 1997 satellite images.

All financial figures are expressed as Canadian dollars for Canada and US dollars for the United States. One Canadian dollar is about 76 cents in US currency.

POLICY, LEGISLATION AND INSTITUTIONS

IJC Conclusions	IJC Recommendations	TF Recommendations
1, 5, 7	1,2,10-14,17-21,23,25-28	15-17,21,26,28,

Part B of the questionnaire requested information concerning policy changes, legislation and institutional development since the 1997 flood. Relatively few respondents reported activity in these areas. The responses are summarized in Table 2.

Table 2: Summary of Policy, Legislation, and Institutional Changes

	General	USA	Canada	MN	ND	MB
Policy		X	X	X		X
Legislation						
Zoning						X
Dike const.		X		X	X	
Institutions						
IRRB	X					
RRBC	X					
RRBDIN	X					
RRBI				X	X	
GRT				X	X	X

Policies. In general, one could say that current policies related to floodplain occupancy are unchanged from those of 1997 and that respondents see no particular reasons for change. Where changes have been deemed necessary, this has been accomplished through legislative means rather than by modifying policies.

There is however heightened awareness of flood risk throughout the basin, which has led to increased utilization of existing statutory flood mitigation and floodplain management programs in the United States. Positive actions such as buy-outs of at-risk structures and measures to reduce sewer back-flow in Grand Forks were identified. Some of the new commercial buildings in that city have incorporated flood proofing measures such as installing heating plants above the 1997 flood line.

A national policy change within the US Army Corps of Engineers (USACE) places a greater emphasis on integrated basin studies. The policy is designed to deal with problems and solutions from a holistic perspective and to ensure that all interests are engaged in the effort.

Minnesota has used the services of a professional mediation firm to resolve the gridlock in permitting of projects initiated by Red River watershed districts. The resulting Mediation Agreement provides a framework for moving forward.

One problem identified by the IJC was the difficulty in obtaining flood-related data from Canadian sources. On account of budget cutbacks, Canadian agencies, both federal and provincial, saw cost-recovery for provision of data as a means of meeting budget targets. Recent policy changes in, for example Environment Canada and Manitoba Conservation, have seen the provision of data move from a cost-recovery mode to a public good mode. Environment Canada now provides historic streamflow and climate data as well as current water level data on line. Manitoba Conservation has also made much more of its point and spatial data available on line.

Legislation. There have been no changes to Canadian federal legislation arising from the 1997 flood. In response to the flood, Manitoba took a legislative initiative that will clearly affect the security of floodplain occupancy. The province introduced a *Designated Flood Area Regulation* under its *Water Resources Administration Act* that identifies the static water level reached in 1997 (roughly a 100-year flood elevation) as a Red River Valley Designated Flood Area (DFA). New structures built in this area must be protected to the 1997 flood level plus 0.6 m (two feet) and hazardous goods must be stored above this level.

To deal with a problem identified following the 1997 flood, where many structures built following the 1979 flood did not conform to post-flood regulations, a two-stage building permit approach for the DFA is identified in both the Act and Regulation. The first stage of the permit allows completion of a foundation or footings; the second stage allows completion of the structure once inspection has confirmed flood-proofing criteria have been met.

The city of Winnipeg is governed by its own provincial statute. The new city of Winnipeg Charter, which came into effect on January 1, 2003, states "The City may do everything that council considers possible, practicable and within the means of the city to reduce the consequences to persons and property within the city of floods or other disasters and to provide continuity of local government."

Although much of the city of Winnipeg is protected by the Red River Floodway, some low-lying communities are protected by secondary dikes. The city enacted a bylaw aimed at first, protecting existing secondary dikes from being removed or altered, and secondly, regulating construction that would be detrimental either to the timely and secure construction of secondary dikes, or to the augmentation of existing secondary dikes.

In the United States, *The National Flood Insurance Act* of 1968 was re-authorized (H.R. 11) by unanimous consent of the U.S. Senate on January 9th, 2003. The reauthorization was retroactive to December 31, 2002 thus ensuring

uninterrupted application of policies. The Act seeks to reduce federal spending on disaster assistance and provides government supported flood insurance for floodplain residents. The Act is administered by the Federal Emergency Management Agency (FEMA).

In response to support from an array of State and local authorities, Red River regional organizations, and environmental groups, the 106th Congress provided funding for a Red River Reconnaissance Study in 2001. The study report, approved in 2002, is the vehicle for a series of spin-off feasibility studies that will focus on portions of the basin facing serious flood threats, needing ecosystem restoration measures, or experiencing other water resources needs and opportunities. The Wild Rice River Feasibility Study, which started in 2003 and which is focused on flood damage reduction and environmental rehabilitation in the lower Wild Rice watershed, is the first such spin-off to get underway. The Fargo-Moorhead & Upstream Subbasin Feasibility Study and Roseau River Feasibility Study are expected to begin in the near future.

Other legislative initiatives in the United States have been directed almost exclusively at providing funding for dike construction. The US Army Corps of Engineers (USACE) has the authority under the *Flood Control Act* of 1948 to construct small flood mitigation projects but requires congressional authorization and annual budget appropriations to construct major works. Since the 1997 flood a number of projects, such as the Grand Forks and East Grand Forks dikes, have been authorized and funded, at least in part, under federal legislation. As well, Minnesota and North Dakota have legislated state contributions to a portion of the local cost share of some Corps projects. (The non-federal share of a project's cost is typically in the order of one-third the total cost.)

Institutions. A key development in 2000 was the restructuring of the IJC boards in the Red River basin. This involved combining the mandates of the former International Souris-Red Rivers Engineering Board and the International Red River Pollution Board to create the International Red River Board (IRRB). The IRRB Directive, Appendix Three, section 5G, assigns responsibilities for monitoring and reporting on flood preparedness and mitigation activities arising from the IJC Reference on the 1997 Red River Flood to the Board.

In March 2002 the Red River Basin Board (RRBB), The International Coalition (TIC), and the Red River Water Resources Council (RRWRC) formally agreed to merge to become the Red River Basin Commission (RRBC). The mission of the RRBC will be to build basin-wide consensus and commitment to comprehensive, integrated watershed stewardship and management, and to speak with a unified voice for the Red River Basin. The RRBC has been asked by the IJC to put together a framework plan for floodplain management. This plan will be discussed by political leaders.

The Red River Basin Decision Information Network (RRBDIN) was initiated under the IJC Study to provide an online resource where people can locate information and data relating to the water and natural resource management issues in the Red River Basin. The vision was to have the RRBDIN become a trusted and dependable resource for informed decision making built upon and maintained by a strong network of cooperating agencies, organizations, and individuals. These tools would be designed to enhance and facilitate interaction with one another and make possible the direct exchange of information and ideas between people in the basin on a continual basis. RRBDIN has been maintained since, primarily with funding provided by the USACE, but does not have continuing funding.

The Red River Basin Institute (RRBI) was established under the auspices of the Tri-Colleges in Fargo-Moorhead (Concordia, Minnesota State University and North Dakota State University) as a forum for research, public education, training and information disseminating relating to flood or damage reduction and natural resource protection and enhancement in the Red River Basin. The RRBI consists of a Water Education Center and a Center for Flood Damage Reduction and Natural Resource Studies and has a Management Board with representatives from federal, state, provincial and local interests.

The International Flood Mitigation Initiative (IFMI) was a project conducted by the North Dakota Consensus Council, with financial support from the US Environmental Protection Agency and the province of Manitoba. This project was aimed at developing an integrated strategy for flood damage reduction in the basin. A group of people representing many interests came together and developed a shared understanding of mitigation needs and priorities.

One initiative identified (IFMI, 2000) during the IFMI process was the concept of a Greenway on the Red, a 960-km (600-mile) long continuous greenway from Lake Traverse in South Dakota to Lake Winnipeg in Manitoba, linking the U. S. North Country Trail to the Trans-Canada Trail. As a means of facilitating this development the not-for-profit Greenway on the Red Trust (GRT) was established.

PROGRAMS

Many projects and programs have been instituted in the Red River basin since the 1997 flood. Part C of the questionnaire invited respondents to identify their organization's work. The questions were organized for the most part around the Emergency Management Cycle and the results will be summarized in the same way. Some people may place some activities under different headings.

Flood Preparedness

IJC Conclusions	IJC Recommendations	TF Recommendations
1,6,7	8,17-19,22,26	2,16-19,26,30,35-40,44,46,48,50

Flood preparedness includes developing a plan for emergency operations, identifying available resources which can be tapped during a disaster, delivering an integrated training programs and exercises, and practicing the actions outlined in national, regional or local emergency operations plans.

A key element is a detailed Emergency Preparedness and Response Plan. Such a plan covers all aspects of the emergency management cycle. The plans tend to be 'all-hazard' plans rather than simply focussing on one hazard such as flooding as lines of authority and required actions during an emergency may be similar.

In both the United States and Canada the first response to an emergency is at the local level then, as the severity of the event increases, state or provincial then federal efforts are brought to bear. The preparation of emergency preparedness plans is therefore a local responsibility with support and advice being provided at the state or provincial levels.

In Canada OCIPEP administers the Joint Emergency Preparedness Program (JEPP) to assist communities in improving their readiness and response capabilities for all types of emergencies. Since 1997, OCIPEP has provided funding through the JEPP to enhance "all hazards" response capabilities of several Red River Basin communities.

Flood forecasting capability and development of databases to support that capability are a fundamental requirement of flood preparedness. In Manitoba, the Department of Conservation is the lead agency in operating forecast systems and issuing flood outlooks and warnings. Other agencies play a significant role, however. The Meteorological Service of Environment Canada issues severe weather predictions and warnings and its Water Survey of Canada division collects water level and streamflow data for use in forecasts.

In the United States, the National Weather Service (USNWS) is the flood forecasting entity. Significant roles are played as well by data collection organizations such as the US Geological Survey, Water Resources Division and reservoir operators including the US Army Corps of Engineers, Minnesota Department of Conservation and the North Dakota State Water Commission.

A binational body known as the Prairie Region Emergency Management Advisory Committee (PREMAC) is one of several United States-Canada committees that meet to consider emergency management issues of common interest. The committees are led by Federal Emergency Management Agency (FEMA) and OCIPEP but, unfortunately for the Red River basin, FEMA Region Five and Minnesota are not represented on PREMAC. There has been no FEMA-OCIPEP consultation on civil emergency planning and management pertaining to natural hazards since a meeting of PREMAC in December 2001.

Table 3 summarizes developments in the basin with respect to flood preparedness. Improvements to flood preparedness occurred with respect to development of emergency plans, databases and flood forecasting.

Table 3: Summary of Flood Preparedness Developments

	General	USA	Canada	MN	ND	MB
Emer. Plan						
City/town		X			X	X
County/RM		X		X	X	X
Databases		X	X	X	X	X
Fld Forecast		X	X			X

Emergency Plans. Following the 1997 flood North Dakota passed legislation specifically requiring cities, townships and counties to address natural and man-made hazards in their comprehensive emergency plans. Minnesota has similar requirements.

Flood preparedness meetings are conducted in late winter with state and local officials to update local, state, and USACE Flood Response Plans. These meetings review how flood response is coordinated through the county to the respective State Division of Emergency Management for the allocation of state and USACE flood response resources.

The United States Emergency Protection Agency (USEPA) has provided funding for emergency response planning efforts. The North Dakota Division of Emergency Management (DEM) with assistance from EPA has been engaged with municipal and county emergency planning coordinators in developing integrated emergency operations plans instead of having three separate contingency plans for emergency operations, hazardous materials, and floods. These plans also include provisions for risk reduction assessments for hazardous

materials, public awareness, and potential land-use restrictions. DEM continues to support the City of Grand Forks as a pilot project and have undertaken several joint exercises. An exercise involving North Dakota, Minnesota and Manitoba is scheduled for February 2004, and another exercise at the local level within the Red River Valley is also being scheduled for 2004. This exercise will test the US/Canada cross-border capability of response crews.

The Manitoba Emergency Management Organization (MEMO) is responsible for administering the Manitoba Emergency Management Plan. This Plan is designed to provide direction and guidance, ranging from a single departmental response to the fully coordinated, collective emergency response of many or all departments. It may be implemented in whole or in part, depending on the particular requirements of the situation. The Plan also provides guidance to municipal authorities with respect to their responsibilities for emergency planning at the local level.

The city of Grand Forks has established a Flood Protection Committee and conducts an annual review of its flood fight plan. The June 2002 floods in the Roseau River basin have also led to improvements in preparedness in that basin and, in general, there is a feeling that local government is now better prepared.

The city of Winnipeg has developed a comprehensive flood emergency manual. The manual uses the City's Geographic Information System as a base, but has several associated programs, such as a hydraulic river model, and a sandbag "calculator" and it contains .pdf files of drawings, protocols, operational instructions, and other documents. The manual consolidates all the flood activity information on the City's sewer and flood protection facilities, including gates, permanent and temporary pumping facilities, primary dikes, and secondary dikes, for a flood water level equivalent to the legislated Flood Protection Level. Trial runs of the manual have been undertaken in both the 2002 and 2003 spring runoff events, although these were fairly minor events.

Databases. There have been many initiatives related to database development in the basin. In Canada, an accurate Digital Elevation Model of the topography of the entire Red River valley from the international boundary to Lake Winnipeg has been developed using Light Detection And Ranging (Lidar) technology. This built on work initiated during the IJC studies. Lidar databases have also been developed for key areas in the United States, including the lower Pembina basin (completed during the IJC studies), the Buffalo and Wild Rice Water districts, and the area south of Fargo.

About 70 percent of all individual residences and businesses in the Canadian portion of the basin have been geo-referenced using Global Positioning System (GPS) technology and the nature of their flood protection works entered into a database. This database does not include structures within ring-diked communities. As well, all groundwater wells (including abandoned wells) in the valley have been inventoried and geo-referenced.

The USGS National Water Information System provides water data via the Internet for all states using a single connection point. Backup systems have been implemented to provide access to local data even in the event of a failure of the local system.

Through the RRBDIN, several tools have been implemented to provide better access to information for people in the Basin. These include a DataViewer to easily access a variety of hydrometeorological datasets (stage, discharge, runoff, water quality, ice jams, forecasts, etc.) and a BasinViewer to allow viewing and querying spatial data from a variety of sources throughout the basin (features such as water, transportation, ecological, political, aerial photos, etc.). Other available data sources include available Lidar topographic data in the basin with associated metadata and an Inventory of Water Resource Models generated for various studies throughout the basin. Some respondents saw a need to examine the status of RRBDIN from a binational perspective and in the context of materials available on agency-specific websites.

A CD-ROM for Red River Subarea Contingency Plan, *Inland Sensitivity Atlas for the Red River of the North*, was prepared as a joint product of USEPA Regions 8 and 5, The Great Lakes Commission, Upper Mississippi River Basin Association, and USGS Upper Midwest Environmental Sciences Center. This CD-ROM provides geographic information system products about sensitive environmental, economic, and cultural resources, potential spill sources, and response resources for spill preparedness and response for the basin.

The Pembina and Roseau watersheds were the focus of a joint US/Canada project to study geospatial framework data issues and uses in the Red River basin, a transboundary area of considerable interest to both countries. The project was funded by the US Federal Geographic Data Committee and the Canadian Geoconnections Secretariat was aimed at continuing the work begun by the International Joint Commission. (Vantage Point *et al.*, 2002)

During the IJC study there was a marked difference in data availability between Canada and the United States. Since then, Environment Canada has made its historical hydrometric and climate data available for download via the Internet. Current water level data from 1200 sites are now available in real time and streamflow data will be available soon. Manitoba has also taken steps to make its data more readily available, with the Internet being the preferred method of distribution.

Flood Forecasting. The US National Weather Service has implemented significant changes in its flood forecasting methodology since the 1997 flood. A sophisticated set of improvements to their Sacramento model have been implemented based on the Advanced Hydrologic Prediction System (AHPS). By better quantifying the risks, AHPS has the potential of providing more effective early protection, reducing the number of emergency actions that weren't needed,

decreasing the chance of missing emergency actions that are needed, and assisting the USACE with emergency levee freeboard design. The AHPS includes:

- advanced dynamic routing procedures to account for the complex hydraulics of the entire Red River in the United States,
- a method to explicitly account for ponded meltwater in the flat terrain of the Red River,
- physically-based methods to model unusual flow pathways at very high flood levels,
- a longer time horizon forecasting methodology that explicitly accounts for forecasting uncertainty and allows for objective risk-based decision making, and
- web-based graphical presentation of forecasts

In addition, the US Geological Survey has flood-hardened the Red River mainstem gages at Wahpeton, Hickson, Fargo, Halstad, and Grand Forks. All streamflow gages in the basin have been telemetered and are available from the USGS North Dakota web page. New or reactivated gages have been installed on the Red River at Thompson, Red Lake River at Fisher, Antelope near Dwight, Little South Pembina River near Walhalla, and Pembina River at Walhalla. And, a stage only gage has been installed on the Red River at Pembina. An acoustic doppler velocity meter was installed on the Red River at Grand Forks allowing more accurate display of real time discharge data. The North Dakota district also has purchased two acoustic doppler current profilers for making streamflow measurements faster, safer, and at sites where conventional methods cannot be used, such as at bridges with a lot of debris or ice.

The USACE is developing quasi-distributed hydrologic models (HMS) for areas upstream of its reservoirs in the Red River Basin. These models are coupled with Unsteady Flow HEC-RAS models and Reservoir Simulation models and incorporate a distributed snowmelt process model. Output from those models will be shared with the National Weather Service.

During the IJC studies, the USACE developed a UNET hydrodynamic model of the Red River mainstem extending from the headwaters to Letellier, MB while another similar model (Mike-11) extending from Grand Forks, ND to Selkirk was developed for Manitoba. The latter model was updated by incorporating the Lidar topography mentioned earlier in this report and has been incorporated into Manitoba's flood forecasting procedures. Manitoba has also made improvements in existing hydrological procedures.

The end result is that residents in the Manitoba portion of the Red River valley can obtain a personalized forecast of spring flood elevations and emergency measures that are required to protect property. (Bowering *et al.*, 2002) This is accomplished through a decision support website geoapp.gov.mb.ca/website/rvfp. Landowners can log on to the site to see the

predicted water level at their locations, compare the water levels to current flood protection levels and perform a calculation of the number of sandbags required to raise the flood protection level.

Improvements to the hydrometeorological networks used in flood forecasting for Manitoba were undertaken. Under a federal-provincial agreement 47 Water Survey of Canada gauging stations were upgraded, primarily through the addition of telemetry, and 37 new stations added to the network. In addition, a significant addition to the climatological network was completed. Some 165 stations gather temperature, precipitation and soil moisture data in southern Manitoba and make the data available in real time for forecast and other purposes. At the same time however, Environment Canada is making large reductions in its volunteer observer climate network.

The Canada Centre for Remote Sensing, Natural Resources Canada, and the National Water Research Institute, Environment Canada, are developing new methodologies for the application of remotely sensed, GIS and *in situ* data to flood forecasting. They have been using remotely sensed data from the Canadian Radarsat, the European Space Agency's Envisat, and US Landsat satellites to estimate soil moisture conditions as an input to hydrological modelling. Multiple Radarsat and Envisat data collected over the Roseau River watershed for the period of September 2002 through June 2003 are being analyzed in relation to ground observations and meteorological conditions.

Mitigation

IJC Conclusions	IJC Recommendations	TF Recommendations
2-5,	2-7,9,10,11,12,13,14,16	3-7,10-12,15,23,29

Mitigation can be defined as sustained action that reduces or eliminates long-term risk to people and property from natural hazards and their effects. It encompasses a suite of activity by government and non-government organizations, as well as by individuals, aimed at reducing the occurrence or the effects of a disaster.

In a flood plain management context, policies and regulations identify the flood plain and determine what may be constructed in a flood plain and under what circumstances. Policies and regulations may also cover the construction of flood mitigation measures aimed at reducing flooding or the effects of flooding. They may therefore be structural or non-structural in their application.

Table 4: Summary of Mitigation Measures

	General	USA	Canada	MN	ND	MB
Structural						
Individual			X		X	X
Community		X	X	X	X	X
Storage		X			X	X
Non-struct.					X	X
Regulations				X	X	X
Models	X		X	X	X	X

Structural Measures. Many structural measures have been undertaken in all parts of the basin since 1997. In Manitoba south of Winnipeg 13 community dikes were constructed and 1742 homes, farmsteads or businesses were raised, diked or relocated under the terms of a federal-provincial agreement. This is roughly 70 to 75 percent of the eligible structures. Fifty-six of the most vulnerable structures were purchased from owners and removed from high hazard areas.

The city of Winnipeg had an extremely close call in 1997. Since that time the Red River Floodway inlet control structure has been refurbished and two notches opened in the east embankment to improve the hydraulic characteristics at the Floodway entrance. A preferred option (Floodway expansion) for reducing Winnipeg's vulnerability to rare floods has been identified and \$240 million funding allocated to conduct detailed engineering and environmental studies, final designs and tender documents, and construction of the highest priority phases/components of the overall project. A Floodway Expansion Management Authority is in the process of being established to execute the project. The overall project will cost \$660 million and provide protection against the 700-year flood.

Some secondary dikes within Winnipeg have been refurbished and new ones constructed. The City has implemented over \$10 million worth of flood protection infrastructure works, and budgeted an additional amount of almost \$25 million through to 2008. There is a requirement for an additional \$110 million in expenditures to improve the reliability of the City's internal flood protection system and to protect to a water level associated with the legislated Flood Protection Level. This \$110 million is included in the \$660 million cost, mentioned earlier, of protecting Winnipeg against the 700-year flood. (Measures underway to add additional storage at Shellmouth Reservoir on the Assiniboine River will also, under some flooding conditions, provide additional protection for Winnipeg.)

In the United States efforts have been directed to increasing storage in the upper basin and diking. A co-operative storage project with the USACE, North Dakota State Water Commission and local interests for increasing storage at Baldhill Dam on the Sheyenne River is underway. A State-sponsored project for

construction of a dry dam on the Maple River is going through the federal regulatory process. In North Dakota urban dikes at Grand Forks and Wahpeton are under construction while projects are being developed at Fargo/Ridgewood, Drayton and Grafton. The Grand Forks/East Grand Forks dikes to be completed in 2006 will provide protection against the 250-year flood and cost about \$393 million. A Natural Resources Conservation Service PL-566 project will increase storage upstream of Grafton, ND by a dam on the Middle Branch of the Park River.

Rural diking projects aimed at protecting individual land holdings are underway in several water resources districts in North Dakota. Several communities along the Red River (including Pembina, Drayton, Grand Forks, Fargo, Briarwood, Oxbow, and Wahpeton) took advantage of Hazard Mitigation Grant Program funding following the 1997 flood to purchase and remove homes from the flood plain.

Significant projects have been completed or are underway in virtually all of the flood prone communities in the Minnesota portion of the basin. Specifically, USACE projects in East Grand Forks, Breckenridge, and Crookston are underway. Studies and design work are underway for Ada and Roseau. Additionally, there are a number of ecosystem restoration projects that will be completed through the Red River mediation process--North Ottawa impoundment, Aggasiz impoundment, and Hay Creek - that have incidental flood damage reduction benefits. A Natural Resources Conservation Service PL-566 project, sponsored by the city of Warren and the Middle-Snake-Tamarac Rivers Watershed District, will protect Warren, MN against the 100-year flood by means of an excavated Floodway and off-stream storage. Minnesota is committed to acquiring and removing flood damaged or flood prone structures from the flood plain and to protecting remaining structures. Some \$2.35 million has been made available on a 50 percent cost share basis for the construction of farmstead ring dikes.

The Red River Reconnaissance Study report, approved in 2002, is the vehicle for a series of spin-off feasibility studies that will focus on portions of the basin facing serious flood threats, needing ecosystem restoration measures, or experiencing other water resources needs and opportunities. The Wild Rice River Feasibility Study, which started in 2003 and which is focused on flood damage reduction and environmental rehabilitation in the lower Wild Rice watershed, is the first such spin-off to get underway. The Fargo-Moorhead & Upstream Subbasin Feasibility Study and Roseau River Feasibility Study are expected to begin in the near future. Additional feasibility studies, hopefully leading to Federal assistance with project implementation, will be initiated as local and Federal resources become available.

Non-Structural Measures. In its study of Red River flooding, the IJC observed that, unlike the United States, Canada has no continuing mitigation policies or

programs. Currently the Canadian Federal Office of Critical Infrastructure Protection and Emergency Preparedness (OCIPEP) is leading the development of a National Disaster Mitigation Strategy (NDMS). In spring 2002, OCIPEP undertook consultations with provinces and territories, the private sector and non-governmental organizations, and federal departments and agencies to develop a NDMS which seeks to determine the scope, policies and mechanisms to address the gaps and priority areas for action on mitigation. Since then, OCIPEP has developed, in concert with provinces and territories, a draft goal and principles which, if approved, would enable provinces and territories to pursue respective mitigation-related priorities. A NDMS framework and associated funding are yet to be approved.

A key element of non-structural approaches to floodplain management is the definition of a regulatory floodplain and the institution of regulations for the occupancy of that floodplain. In Manitoba the regulatory floodplain is legislated as that occupied by the 1997 flood, which was approximately a 100-year flood. The safe building elevation adds 0.6 m (two feet) of freeboard. In North Dakota and Minnesota the regulatory floodplain is that of the 100-year flood plus one foot (0.3 m) of freeboard for residential structures. (It should be noted that in Manitoba the 100-year floodplain is up to 40 km (25 miles) wide. Extra provision for wave action is justified.) All jurisdictions have removed at least some severely at-risk structures from the floodplain.

There is a remaining problem in the United States in that the calculations of the 100-year flood post-1997 throughout the basin are incomplete. One example of the problem is in Fargo-Moorhead. The new 100-year flood elevation is 1.8 ft. (0.5 m) higher than the previously defined elevation but this new level has not been promulgated. Flood frequency calculations are complex and different specialists will obtain differing results. The practice in the United States is to seek administrative agreements on the regulatory flood. The lack of such an agreement does not preclude the USACE from designing a flood control project but the design would be based on its flood frequency analysis.

One response to the lack of an agreed regulatory flood is an attempt by some property developers to move ahead on developments that would be unlikely to meet future flood-proofing requirements. Respondents identified the Oakport Estates Subdivision in Moorhead as an example.

North Dakota defines a regulatory floodway within which no encroachment on the river channel is permitted. Developments in the floodway fringe must meet a one-foot rise criterion.

The Red River Joint Water Resources District is proposing to develop a flood mitigation plan for the North Dakota portion of the watershed. Their effort would mainly consist of detention sites. It is anticipated that this information would be combined with other mitigation efforts in North Dakota and the rest of the

watershed in the effort to develop a comprehensive plan for the watershed. A coordinator has been hired to assist in this process. The District, however, does not have the authority to move forward on its recommendations.

Another non-structural measure currently underway is a project by the Red River Basin Commission, with cost sharing from the Red River Basin Institute, Province of Manitoba, ND Red River Joint Water Resources District, ND State Water Commission, and MN Red River Watershed Management Board aimed at implementing a single Mike-11 unsteady flow model from the headwaters of the Red at Lake Traverse to Lake Winnipeg. Under a contract for the RRBC, a consultant is developing an unsteady Mike-11 model of the Red River main stem from the headwaters on the Bois de Sioux River at Lake Traverse to St Jean Baptiste in Manitoba. The model has been calibrated for the 1997 flood. The floods of 1989, 1996, and 2001 will be used for verification. The new Mike-11 model overlaps with an existing Mike-11 model that extends from Grand Forks in North Dakota to Breezy Point near Lake Winnipeg. In 2004 the two models will be coupled to provide a continuous Mike-11 model for the entire main stem of the Red River plus some of the major tributaries such as the Pembina River and Red Lake River. The Mike-11 model is one of several proprietary models developed by the Danish Hydraulics Institute.

An unsteady HEC-RAS model of the Red River main stem is also being developed by the same consultant. That model will extend from Fargo to Emerson and will link with upstream HEC-RAS models being developed by the US Army Corps of Engineers. The HEC-RAS model was developed by the USACE and is widely used in both the US and Canada in its steady flow version.

Under a federal-provincial agreement, a more complex unsteady flow model was developed to examine wind set-up and wave uprush in the "Red Sea". The Telemac-2D model extends from the international boundary to Winnipeg. It was used to calculate the effects of wind and waves at the Red River Floodway inlet control structure and the effects of existing dikes on local water levels.

These models may be used for planning studies for flood control projects. The effects of tributary storage on main stem flood levels will be a primary application. Such models allow an analysis of tributary peak timing on mainstem water levels, analysis of the effects of various structural measures such as dikes on local water levels, and a determination of the increase in water levels due to encroachment on the floodplain by, say, fill for residential construction.

Response/Recovery

IJC Conclusions	IJC Recommendations	TF Recommendations
	15	25

Response involves the coordinated actions taken during or immediately following a flood when people may have been injured or lives lost, major damage has occurred to public and private property, and essential utilities and supply sources are disrupted. Emergency response takes place at the level appropriate to the emergency. The first line of response is local government, then provincial, then federal.

Following a disaster, the recovery phase attempts to restore all systems to normal or near normal condition. Long-term recovery from a disaster may go on for years until the entire disaster area is completely redeveloped; either as it was in the past or for entirely new purposes that are less vulnerable to disaster. The cornerstone of the recovery process is disaster financial assistance. This alleviates an unreasonable financial burden and is generally provided to help local governments, individuals, full-time farmers, small businesses and some non-profit organizations. There is, off course, a human cost in all disasters and the focus of any recovery program must be to promote community resiliency so that individuals and communities are better able to cope with the next disaster.

For the most part, agencies charged with response and recovery, have not made changes as a direct result of the 1997 flood. Some specific areas of activity are summarized in Table 5.

Table 5: Summary of Response/Recovery Measures

	General	USA	Canada	MN	ND	MB
Planning		X		X	X	X

The Minnesota Recovers Task Force, which coordinates the responses and recovery efforts of State and Federal agencies when disasters occur in Minnesota meets weekly, frequently with representatives of local government units (LGUs) in attendance or teleconferencing, and reviews requests to determine which agencies' programs can assist a particular short- or long-term recovery effort. The USACE can follow up disaster recovery efforts via its cost-shared Continuing Authorities Program to address permanent solutions to flood threats, riverbank erosion problems, etc. Alternatively, a local government unit may contact its Congressional delegation to request a specifically-authorized project.

By November 2003, the Minnesota Division of Emergency Management is scheduled to complete an enhanced State Hazard Mitigation Plan. One element of this plan is review by an interagency team comprising local, state, and federal representation.

The St. Paul District Temporary Housing Planning and Response Team is one of five across the USACE that specialize in providing temporary housing after a disaster. Working for FEMA, the Corps has installed travel trailers at private

residences and constructed mobile home parks. The St. Paul team has participated in several missions nationwide, including the summer 2002 flood in Roseau, Minnesota, following which 160 travel trailers were installed and a mobile home park with a capacity of 120 units was designed and constructed.

There has been no Canada-United States consultation on civil emergency planning and management pertaining to natural hazards since a meeting of the Prairie Region Emergency Management Advisory Committee (PREMAC) in December 2001.

Winnipeg has completed a recovery/reentry plan for a catastrophic event such as the 1997 flood. This involved investigating similar plans in many other jurisdictions.

Environment

IJC Conclusions	IJC Recommendations	TF Recommendations
4	23,	32,34

Although they make a contribution to public health, safety and security, there are a number of achievements since the 1997 flood that also have a bearing on environment and aquatic ecosystems. These cover a wide range of subjects. These are summarized in Table 6.

Table 6: Summary of Environmental Measures

	General	USA	Canada	MN	ND	MB
L. Traverse		X				
Grnd. water			X			X
Hrzds good		X			X	X
L. Winnipeg						X
Lagoons						X
Greenway	X	X		X	X	X
Cons Res.		X		X	X	X

Lake Traverse. The risk of biota transfer through the hydraulic connection between the Little Minnesota River and Red River systems at Lake Traverse continues. This is a high priority item for the IRRB. The USACE dam safety reconnaissance study for the White Rock Dam, which controls the pool elevation of Lake Traverse during large flood events, has considered the potential for inter-basin flows. This issue also may be addressed as part of the Minnesota River Reconnaissance Study, which is being organized.

Ground Water. The IJC identified a problem with the contamination of groundwater wells in Manitoba. Since the 1997 flood, an inventory of active and

abandoned wells in Manitoba was completed and the wells subject to surface flooding were sealed. Minnesota had regulations concerning abandoned wells in place prior to 1997.

Hazardous Goods. Storage of hazardous goods, even banned substances, in the floodplain was another issue of concern after the 1997 flood. Manitoba is undertaking consultations concerning on-farm storage of hazardous chemicals and safe disposal of household hazardous waste. The province maintains inventories of many types of contaminants and intends to consolidate these into a single database.

Prior to the 1997 flood Manitoba based its regulations concerning dikes around sewage lagoons and other hazards on the 100-year flood. Since the 1997 was in the order of a hundred year event - if anything slightly rarer than a hundred year event - the regulations are now based on the area inundated in 1997.

The ND Division of Emergency Management (DEM) has had discussions, meetings and presentations for the North Dakota-based chemical industry with emphasis on awareness of the inventory of hazardous chemicals in the floodplain, encourage reduction of chemical inventory in the floodplain, encourage flood protection efforts, and encourage relocation of hazardous chemicals in anticipation of flood events. DEM has coordinated with ND Department of Agriculture to hold periodic collection and disposal efforts for getting rid of banned and obsolete chemicals in flood-prone areas. A brochure has also been produced on flood-proofing of above-ground storage tanks.

Lake Winnipeg. The 1997 flood led to a significant loading of nutrients into Lake Winnipeg. The province of Manitoba has since announced a Lake Winnipeg Action Plan which commits the province to reducing nutrient fluxes to the Lake to levels below those of the 1970s. This will require reductions from both point and non-point sources. The province is developing new nutrient management zones based on soil classification and topographical features to identify areas more vulnerable to nutrient loss to ground and surface water. Zones will be defined and described in one of four categories with requirements attached to each zone.

Riparian Zones. The IFMI process has led to a renewed interest in preserving and enhancing riparian zones. Several developments throughout the basin are pertinent. A Greenway on the Red Trust has been organized to "promote the development of a greenway system on the Red River of the North and its tributaries that mitigates floods and protects people through education and partnerships that enhance the economy, environment and communities of the Red River Basin."

The Greenway will provide multiple on-the-ground benefits through riparian restoration; water quality enhancement; farmer/landowner incentives; community strengthening; and increased recreation, tourism, and economic development.

The Greenway project is supported in the United States by, among others, grants from the USEPA and FEMA. Winnipeg has an on-going program to acquire riverbank property for linear greenway and park purposes. This sometimes involves the removal of structures (houses and businesses) from the floodplain.

The USACE is pursuing several environmental and flood damage reduction projects that protect or enhance the floodplain environment. These include fish passage over existing dams on the Red River and several tributaries, partial restoration of hydrologic and floodplain conditions along the lower reaches of Hay Creek in Roseau County, establishment of the Greenway with the construction of the Grand Forks/East Grand Forks flood control project, and the restoration/ enhancement of floodplain functions along 15 miles (24 km) of the Wild Rice River below Ada through the setback of existing agricultural protection levees and re-meandering of the channelized river.

The Red River Basin Commission is assisting various groups in Minnesota and North Dakota in developing a Red River Conservation Reserve Enhancement Program (CREP). Measures such as buffer strips, wetland restoration, river corridor restoration and setback levees are contemplated. Respondents in the United States felt that Minnesota was much more supportive of these types of programs than North Dakota.

The Minnesota Mediation Agreement is the product of eight months of consensus-based, mediated negotiations by the Red River Basin Flood Damage Reduction Work Group. The Agreement is intended as the framework for a new, collaborative approach to implementing both flood damage reduction and natural resource protection and enhancement in the Red River Basin in ways that will benefit all Minnesota's citizens. The keys to this new approach are clearly identified goals, comprehensive watershed planning, early consultation and collaboration on flood damage reduction projects among stakeholders, and a cooperative approach to state-level permitting of those projects.

The Red River Basin Riparian Project, funded by a USEPA grant, is a land management and water quality project that seeks to improve riparian areas through influencing land management decisions. Eight demonstration sites are being established in the basin. Manitoba has also announced tax reduction measures for land owners in riparian zones as a water quality improvement measure aimed at reducing agricultural runoff.

The Louisville/Parnell Impoundment project in the Red Lake Watershed District controls breakout flows and assists wetland restoration. The project consists of an earthfill structure and three wetlands units.

Winnipeg's standard tender document requires adherence to proscribed environmental protection measures, as well as best management practices for such things as fuel handling and storage, waste handling and disposal,

dangerous goods, emergency spill response, protection of trees, sediment control, etc. Re-vegetation of riverbank and construction of pool and rifle structures on streams are two examples of the types of “compensation” works that are undertaken to meet the requirements of the federal Department of Fisheries and Oceans (DFO) for flood protection works and associated riverbank works that are considered as “harmful alteration, disruption or destruction of fish habitat”.

Databases. The MN Red River Watershed Management Board funds water quality studies aimed at increasing understanding of land use and water quality issues.

Education

IJC Conclusions	IJC Recommendations	TF Recommendations
	26	

A key challenge in floodplain management is informing members of the public of the risks they are exposed to and the feasible measures available to reduce those risks. Educational initiatives play a key role in this. Table 7 summarizes a number of educational initiatives.

Table 7: Summary of Educational Initiatives

	General	USA	Canada	MN	ND	MB
K-12						
Proj. WET		X		X	X	X
RRBI	X					
Coll/Univer						
RRBI		X		X	X	X
U of M			X			X
Adult						
RiverWatch				X	X	X

Schools. At the K-12 level, Project WET is in operation in Minnesota, North Dakota and Manitoba. This Project provides opportunities in a broad range of water topics, but some material related to flooding has been developed and incorporated into Red River basin programs. As well, USEPA is funding development of *Discover a Watershed: The Red River*. This activity booklet, scheduled for completion this year, will be distributed through International Project WET in the US and Canada.

The Red River Basin Institute (RRBI) is developing a Water Education Center that provides specific hands-on educational opportunities and conducts teacher

institutes. (RRBI, 2003) The Center is working with Minnesota RiverWatch personnel to extend this student surface water monitoring project to the entire basin. Also the Center has committed to hosting an annual teacher institute in various parts of the basin.

Colleges/Universities. The Center for Flood Damage Reduction and Natural Resource Studies the Red River Basin Institute in co-operation with the Tri-Colleges will help increase educational opportunities. (RRBI, 2003) The RRBI has a Management Advisory Board and Technical Advisory Group drawn from organizations throughout the basin, including Manitoba. The RRBI issues grants for research proposals that address flood damage reduction and natural resources. One of the requirements for proposals is that the study include an educational component, e.g., facilitate a cooperative network between research staff from higher education institutions, etc. and to provide opportunities for students to gain research experience and prepare for future employment in these areas.

In Canada, the federal research granting councils, the Natural Sciences and Engineering Research Council and the Social Sciences and Humanities Research Council, have provided some grants to examine physical and social science topics related to flooding. OCIEP's Research and Development Directorate provides annual funding, advice and interpretation of scientific issues pertaining to emergency management and the protection of Canada's critical infrastructure. Since 1997, OCIEP has supported research into the social, economic and health impacts of flooding on Red River Basin residents. OCIEP continues to provide funding for, and publish research that addresses disaster mitigation and flood risk management strategies that are applicable to the Red River Basin. OCIEP's research reports are available on-line.

As well, the OCIEP Canadian Disaster Database contains historical information on Canadian disasters that have occurred over the past century. The on-line database describes where and when a disaster occurred, who was affected, and provides a rough estimate of the direct costs.

The University of Manitoba, Natural Resources Institute, has developed new courses related to hazard management and water resources. A research project by the University of Manitoba (partnered with the city of Winnipeg, the Province of Manitoba and the Federal Government) to assess the reliability and understand the behavior of temporary sandbag dikes. The main objectives of the research project are: 1) to quantitatively assess the stability of sandbag structures of varying heights constructed according to the design cross-section developed by the City of Winnipeg; 2) to develop a measure of reliability for the existing method of construction and identify height limits based on acceptable probabilities of failure; 3) to evaluate new design cross-sections and/or methods of construction, if necessary; and, 4) to produce a video that demonstrates how to construct a sandbag dike.

As well, several of the studies performed for the IJC have now been reported in peer-reviewed publications thus making the results more accessible to graduate students. Natural Resources Canada has produced a compilation of all its scientific work related to Red River flooding. (Brooks *et al.* 2003) Some 36 NRCan publications are available in CD-ROM form or via the Internet.

Many agencies in the basin provide university, college, vocational-technical, and high school students with part- and full-time work opportunities particularly in the areas of flood damage reduction and environmental restoration.

Public. Websites operated by federal, state or provincial, and other organizations provide information to the public. Some, such as the Manitoba decision support site and the RRBDIN site, provide specific technical information to assist flood managers and landowners. Others such as the RiverWatch site, developed in collaboration with Prairie Public Television provide background information. Similarly, federal, state and provincial agencies have developed a host of printed materials, some technical, others more general, to inform the public of flooding issues.

In Canada Emergency Preparedness Week (first week in May) is an annual event aimed at building the public's awareness and preparedness for emergencies and disasters. Since 1997, disaster mitigation has featured prominently during nationally and provincially coordinated Emergency Preparedness Week activities.

GAPS AND DEFICIENCIES

The broad consensus of the respondents was that the Red River basin is unquestionably in a better position to withstand a flood like the 1997 event now than it was at the time of the flood. Agencies are proud of what they have achieved but realize there is still room for additional work.

The 2002 Roseau River flood was a recent reminder that the Red River basin is vulnerable to many kinds of floods. The work that the IJC carried out related to rare basin-wide floods by no means addresses all the issues. Although no flood caused by summer rains has led to the Red River leaving its channel, summer floods have caused considerable problems in urban centers and on Red River tributaries such as the Roseau. Furthermore, even relatively frequent summer floods can cause significant agricultural and infrastructure damage. The databases developed following the 1997 flood can be helpful in examining summer flooding, but models calibrated to summer conditions are required.

In addition, although the IJC study touched on ice-jam floods and made some general recommendations in that regard, mitigation of such floods is still a major concern. Selkirk, MB experienced an ice jam flood in 1996 and ice jams in that area are noted in historical records. Crookston, MN is also subject to ice jam flooding from the Red Lake River. The Sheyenne, Pembina and Assiniboine Rivers also experience ice jamming.

A gap remains related to nature of flooding.

There is a tendency following a major flood to embark on a series of structural measures as the primary means of protecting property from harm and making communities more resilient. While these measures may be economically justified they do obligate the owner to commit funds for long-term maintenance. They also may at some future time serve as a fatal trap by encouraging further development on flood-prone lands, development that could well be destroyed during some even larger event.

Non-structural approaches, which identify the vulnerabilities related to the floodplain and seek to reduce those vulnerabilities over time, are the preferred alternative. Yet implementing such approaches meets with limited success. Efforts have been made to update regulatory flood stages in US communities at risk. However, because agencies use different methodologies and generate conflicting results, it becomes necessary to compromise with an administrative agreement on the 100-year discharge and stage. This process takes time.

Furthermore, a community may resist adopting higher regulatory elevations because it puts more of the community into a zone requiring flood insurance or adherence to flood-proofing building codes; it increases the top elevation (hence, the cost) of flood works; and existing flood works might lose their certification,

i.e., a community previously certified as out of the regulatory floodplain would find itself back in the floodplain.

Respondents identified the problem related to compensation for those individuals who may be deliberately flooded for the common good. This is particularly a concern in the area south of Winnipeg when the Floodway is operated beyond its design capacity, as it was in 1997.

The enticement of persons into new dwellings in a defined floodplain, albeit one protected by a certified dike or other measure, was a concern. In the event of a structural failure the flood damages will exceed pre-project damages.

There is another gap related to non-structural approaches.

Some respondents identified institutional gaps. The Red River being the divide between US federal regions Five and Eight poses a problem for seamless application of federal programs in the US portion of the basin. This appears to be particularly a problem for FEMA. The suggestion was to designate a lead region for the entire basin during a major disaster.

As a result of the modelling performed during the IJC studies, North Dakota and Manitoba agreed to cost share the enlargement of the two most easterly of the four South Buffalo drains in the lower Pembina basin. A court case in the United States has also led to many illegal dikes in the Pembina basin being taken down.

One respondent identified a need to initiate a feasibility study of the Pembina River basin in cooperation with the Pembina River Basin Advisory Group and other interests. That study is a necessary first step in the process leading to possible US federal partnership in flood damage reduction measures. However, limited federal resources and competing needs throughout the basin have postponed pursuing that study with local interests.

Some also felt that there is room for improvement in international coordination. A basin-wide entity such as the Red River Basin Commission could provide a service. Generally speaking there was scope for additional watershed planning and interagency cooperation.

On a technical level, a gap related to vertical datums was identified. Although the United States has officially adopted a new vertical datum, NAVD 88, to replace NGVD 29, many jurisdictions continue to use the former official datum or even local datums. This adds to the challenge of doing regional scale analyses. There is a further complexity in that Canada continues to use CGVD 28, which is roughly equivalent to the US NGVD 29, but significantly different from NAVD 88. Natural Resources Canada has developed software that uniformly converts from one datum to the other. Use of that software, however presupposes that the original datum is known.

Other technical gaps included the need to include rural areas in the Lidar mapping of US portion of the 100-year floodplain. The challenge of producing a seamless, best-available digital elevation model for the entire basin remains.

One respondent raised the point that administrative willingness to fund the network of hydrometric and meteorological stations used in flood forecasting and floodplain management may have already peaked in the United States. Budget constraints could lead to network reductions.

Finally, respondents identified gaps related to science needs. An objective analysis of effects of drainage and wetland restoration on floods, both mainstem and tributary, was identified. Similarly, an examination of the potential benefits of micro-storage was identified.

Respondents saw a gap particularly in funding related to social dimensions of flooding. This has application to non-structural measures, communication of flood risk and enhancing the floodplain environment. Questions remain as well concerning access and evacuation issues, and the public response to those issues.

DISCUSSION

The responses received to the IRRB survey indicate that considerable progress has been made in increasing preparedness for major floods and mitigating the potential harm from future floods. The responses can be reviewed in the context of the IJC's Conclusions and Recommendations and those of its Task Force. Such a review provides a snapshot of current status of flood preparedness in the basin.

The following tables represent this writer's interpretation of the results. In framing its recommendations the IJC stated not only what should be done but also who should do it, and sometimes when it should be done. Some recommendations imply acceptance of a certain policy direction before the recommendation can be implemented. An effort has been made to identify those cases where that acceptance is not clear. Also, in reporting on progress the emphasis will be placed on what has been accomplished but, where a task has been accomplished in a manner different than that implied by the IJC recommendation, this will be noted. Making an overall determination of progress on some recommendations is also confounded by, in some cases, differing achievements in each country.

The overall scale used in defining progress on the recommendations is as follows:

- Little or No Progress. This applies to cases where a required policy decision does not appear to have been made, where no discernable progress has been reported, or perhaps where meetings have been held but with little effect.
- Some Progress. This applies where there has been activity to meet the recommendation but significant impediments remain before the recommendations can be completed. This includes cases where policies directions are clear but where substantial financial impediments remain.
- Significant Progress. This applies where the completion of the recommendation can be reasonably foreseen.
- Complete or Ongoing. The recommendation appears to have been accepted and implementation is either complete or continuing (in the case where it will take several years to complete the recommendation).

IJC Conclusions

Conclusions from IJC Report		Status
1	Although the 1997 flood was a rare event, floods of the same size as the 1997 event, or greater, can be expected to occur in the future in the Red River basin. People and property remain at risk	Accepted

Conclusions from IJC Report		Status
	from these floods.	
2	It would be difficult if not impossible to develop enough economically and environmentally acceptable large reservoir storage that alone would reduce substantially the flood peaks for major floods. Storage to reduce flood peaks for more frequent local floods may prove worthwhile and deserves further study.	Accepted
3	Large-scale micro-storage has some potential to reduce flood peaks, perhaps significantly for more frequent local floods, but reliance solely on micro-storage for major flood events would be impracticable and costly. While there are many obstacles to its effective and efficient implementation, the feasibility of micro-storage for flood peak reduction should continue to be analyzed.	Qualified Acceptance
4	Wetland storage can provide an economically and environmentally beneficial method of reducing flood flows for frequent, smaller floods, but wetland storage alone is unlikely to significantly reduce the peaks of large floods on the mainstem of the Red River.	Qualified Acceptance
5	Under flow conditions similar to those experienced in 1997, the risk of a failure of Winnipeg's flood protection infrastructure is high. Public safety requires that the city, province and Canadian federal government focus immediate attention on designing and implementing measures to further protect Winnipeg.	Accepted
6	Further improvement and maintenance of the Red River virtual floodplain management database is required. Federal, state and provincial governments and local authorities must maintain a high level of involvement in further database development and in improving data accessibility.	Accepted
7	Large and small communities throughout the Red River basin will remain at undue risk until a comprehensive binational multi-faceted solution to the full range of flood problems is developed and implemented. Such a solution will require use of all flood mitigation methods, both structural and non-structural, and must take into account potential impacts on the environment.	Qualified Acceptance

Conclusion 1. One of the enduring legacies of the 1997 flood is the realization that large floods are a fact of life in the basin. In fact, it can be said that the 1997 flood transformed the 1826 flood in Canada from one of legend to a very real event. Reconstructions of flooding history in the Canadian portion of the basin by St. George and Neilsen (2003) from 1648 to 1999 indicate significant floods in 1747, 1762, 1826, 1852, 1950, 1979 and 1997. The first two of these were previously unknown. In the United States, one can infer from geological investigations by Bluemle (1991) that conditions in the basin were very wet around 1830 and about 800, 1800, 3200, 3600 and 4500 years before present. The existence of a significant flood hazard as identified in the IJC's first

conclusion is therefore substantiated by scientific research and is widely accepted.

Conclusion 2. Although people see reservoir storage in the United States portion of the basin as providing local benefits to flood reduction on tributaries, there is general acceptance that available reservoir storage is insufficient to reduce damages from a large flood such as that of 1997. The IJC's second recommendation is therefore accepted.

Conclusion 3. The concept of reducing flood peaks through large-scale micro-storage was identified during the first round of IJC hearings following the flood by Kuiper (1997) among others. Several presenters noted the ice-cube tray appearance of the basin in satellite imagery obtained at the time of the flood peak and speculated that water retention on agricultural lands could play a role in reducing peaks. This concept was further developed and popularized as the "waffle plan" by the Energy & Environmental Research Center (EERC) at the University of North Dakota.

In 2002, the EERC received funding for a three-year project to further develop the concept. The initial stages of the project will concentrate on improving the topographic database for the Red River valley in the United States, something that will have numerous beneficiaries. During the course of the project a determination of the willingness of farmers to use their land for water storage will be made.

On this basis it can be said that the IJC recommendation concerning micro-storage has qualified acceptance but that the results of the EERC project are awaited with interest. Those results will help interested persons develop their positions concerning the IJC conclusion.

Conclusion 4. Wetlands play an important role in sustaining healthy ecosystems and loss of wetland storage is frequently cited as a factor in flooding. While acknowledging the environmental importance of wetlands and the role they may play in reducing smaller more frequent floods, the IJC report did not find wetland loss to be a factor in the 1997 flood. The studies conducted by its Task Force in this regard have now appeared in peer-reviewed literature. (Simonovic and Juliano, 2001, Shultz and Leitch, 2003) While there is general acceptance of that conclusion, wetlands interests find it difficult to accept. The underlying question is, if wetland loss was not a factor in the 1997 flood, at what magnitude of flooding do such losses play a role?

Conclusion 5. Winnipeg's vulnerability to the repetition of a 1997 flood and the consequences to the provincial economy in the event of a repeat flood were cause for concern. The federal, provincial and civic governments have embraced the IJC's conclusion, funded further investigative work, identified a

preferred option for increasing the city's flood protection, and allocated almost one-half of the required funding.

Conclusion 6. The IJC studies identified a number of problems in databases for the Red River basin and the dissemination of that data, even when available. Agencies throughout the basin have made a number of improvements since that time. The studies led to the establishment of the Red River Basin Disaster Information Network (RRBDIN). With funding primarily from the USACE, that network continues to develop and provides a useful service for basin residents.

Conclusion 7. The vulnerability of large and small communities in the Red River basin to future flooding has been accepted. In addressing that concern, a large number of structural solutions have been, or are in the process of being, implemented. The structural measures are subject to environmental assessment and environmental values are being incorporated in some measures, for example the Greenway and the Grand Forks dike. On the other hand the solutions tend to be agency driven rather than binational or multi-faceted. As well, with the exception of significant improvements in flood-forecasting, non-structural approaches have not been a major factor.

Task Force Conclusions

The IJC Task Force drew two conclusions that were endorsed but not restated by the IJC.

Conclusions from IJC Task Force Report		Status
7	There is general recognition in the region that flooding in the lower Pembina River has been profoundly affected by the construction of dikes and roads that act as dikes on both sides of the boundary. Rectifying the transboundary consequences of these structures will require action in both countries and there appears to be readiness to take such action.	Accepted
8	Further improvement and maintenance of the [virtual] Red River floodplain management database [initiated by the Task Force] is required. Federal, state and provincial governments and local authorities must maintain a high level of involvement in further database development and in improving data accessibility	Qualified Acceptance

Conclusion 7. The matter of flooding in the lower Pembina River is a complex and long-standing problem. Since the IJC study a number of steps have been taken including the general acceptance of set-back levees as a possible solution, the removal of some levees, and increasing the capacity of trans-boundary culverts. Work is continuing on several fronts to obtain a complete solution.

Conclusion 8. This conclusion pertains primarily to RRBDIN. (See also IJC Conclusion 6.) While there is considerable database development continuing and a number of tools employing the data have been developed by several agencies, broadly-based support for development of a virtual database for the Red River is still required. That said, Minnesota (in particular), North Dakota and Manitoba have all made significant strides in creating searchable databases. These efforts tend to help users access state or provincial databases rather than providing points of entry to distributed data holdings.

IJC Recommendations

The IJC made 28 Recommendations for future work concerning Red River flooding. All have received some attention by governments. In the discussion that follows the table some recommendations have been grouped to avoid repetition.

Recommendations from IJC Report		Status
1	The federal governments should convene a meeting of senior federal, provincial and state officials in 2002 to undertake policy	Little or no

Recommendations from IJC Report		Status
	discussions and an examination of the 1997 flood, with emphasis on review of emergency plans, evacuation procedures and mitigation measures underway.	Progress
2	The design flood used as the standard for flood protection works for Winnipeg should be the highest that can be economically justified or, at a minimum, the flood of record, the 1826 flood.	Complete
3	The city, province and the Canadian federal government should cooperatively develop and finance a long-term flood protection plan for the city that fully considers all social, environmental and human effects of any proposed flood protection measures and respects both the needs of Winnipeg and the interests of those outside the city who might be affected by such a plan.	Some Progress
4	The government of the United States, in cooperation with the cities of Fargo and Moorhead and the states of North Dakota and Minnesota, should expedite the study of flood risk potential and implement plans for flood protection measures for the Fargo–Moorhead area.	Some Progress
5	The government of the United States, in cooperation with the cities of Grand Forks and East Grand Forks and the states of North Dakota and Minnesota, should ensure that the planned flood protection works are promptly and expeditiously completed.	Signif. Progress
6	The government of the United States, in cooperation with the cities of Wahpeton and Breckenridge and the states of North Dakota and Minnesota, should expedite approval and implementation of flood protection plans to reduce the risk of flooding at Wahpeton–Breckenridge.	Signif. Progress
7	The province of Manitoba and city of Selkirk should expedite studies of flood-risk potential in the Selkirk area.	Signif. Progress
8	To improve resiliency in the basin, governments should support enhanced research into the various social dimensions of the flood, including economic, psychological, public health and sociological impacts.	Little Progress
9	Governments at all levels should ensure that in the development of flood mitigation strategies for the basin the needs of small communities, individual isolated farmsteads and agriculture are not overlooked.	Signif. Progress
10	Federal government agencies, in cooperation with the state of North Dakota and the province of Manitoba, should establish a consultative group to work with local interests, including the Pembina River Basin Advisory Board, to resolve the lower Pembina River flooding issue, provide necessary resources for the group, and act to achieve a solution.	Some Progress
11	Governments should develop a binational integrated approach to mitigation initiatives at all political levels, based on a comprehensive mitigation strategy for the entire basin. In the	Little Progress

Recommendations from IJC Report		Status
	United States, the strategy should be integrated within the overall national framework.	
12	The Canadian federal government should establish a national flood mitigation strategy, or a broader disaster mitigation strategy, and support it with comprehensive mitigation programs.	Some Progress
13	Governments should use, at a minimum, the 100-year (1 percent) flood as the basis for floodplain regulations and revise their estimates of the 100-year flood levels based on 1997 and new data that become available.	Signif. Progress
14	State, provincial and other appropriate authorities should review the effectiveness of and compliance with the floodplain management regulations in the basin and take steps as needed to improve enforcement.	Some Progress
15	Within the current context of Canada–United States cooperation for civil emergency planning and management, governments should develop more detailed bilateral emergency planning and management arrangements with specific adaptations to Red River flooding.	Little Progress
16	Development of the digital elevation model for the Red River basin, with high resolution in appropriate high flood risk areas, should be pursued and completed through collaborative initiatives of federal, state, provincial and local governments.	Some Progress
17	Federal, state and provincial governments should develop and implement a binational agreement to establish an appropriate network of hydrological and meteorological stations and data exchange for floodplain management and flood forecasting in the Red River basin.	Little Progress
18	The governments should authorize the Commission to establish a binational Red River Flood Forecasting Liaison Committee under the International Red River Board to improve interjurisdictional coordination and to help ensure that clear, understandable and compatible forecasts are issued to the public.	No Progress
19	As a long term priority, government agencies responsible for flood-forecasting and mitigation measures should develop basin-wide models rather than separate but coordinated models for each country.	Some Progress
20	The Canadian government should review its data and information management policies to ensure that topographic, hydrometeorological, and other flood related data collected under government programs are made available without restrictions or conditions that limit their accessibility.	Signif. Progress
21	Governments should ensure that progress continues in building a binational, virtual network linking the people, data, and models for the Red River basin.	Signif. Progress
22	Federal, state, and provincial governments should work with basin	Signif.

Recommendations from IJC Report		Status
	organizations to complete in a timely manner the development of a prototype decision support system and establish a cooperative mechanism for coordination and funding its further development and implementation.	Progress
23	Governments should take immediate steps to ensure that all banned materials such as toxaphene are removed from the Red River basin. Governments should also ensure that potentially hazardous materials are not stored in the 500-year floodplain, although reasonable quantities of such substances could be maintained in the floodplain for immediate use.	Some Progress
24	Flood protection projects focus not only on reduction of flood damage but also on protection and enhancement of the floodplain environment.	Some Progress
25	Governments immediately take steps, on a binational basis, to begin development of a comprehensive flood damage reduction plan for the Red River basin.	Some Progress
26	Governments at all levels should undertake the following measures: [eight items]	Some Progress
27	Governments should assign the following functions to the International Joint Commission for implementation by the International Red River Board: [eleven items]	Complete
28	The federal governments, in cooperation with the state and provincial governments should work with the Commission and its International Red River Board, as well as with existing and emerging bilateral organizations, to ensure that appropriate arrangements are in place to coordinate and implement measures for flood preparedness and mitigation activities and to implement recommendations of the Commission.	Signif. Progress

Recommendation 1. One result of the IFMI process was to draw governors of Minnesota and North Dakota together with the premier of Manitoba together to discuss matters pertaining to flooding. This led to the signing of a Memorandum of Understanding in November 2000. The RRBC has continued to organize periodic meetings of senior elected officials from the three jurisdictions. While the involvement of the federal governments has been small, the intent of this recommendation has been met in part.

Recommendation 2. This recommendation regarding the level of flood protection for Winnipeg has been met.

Recommendation 3. A flood protection plan for Winnipeg involving expansion of the Red River Floodway has been developed and funded in part. The plan will take into account the interests of those affected but not protected.

Recommendation 4-6. Studies and design work pertaining to flood protection for Fargo are underway. Flood protection projects for Grand Forks, East Grand forks, Wahpeton and Breckenridge are underway. This work is being led by the USACE.

Recommendation 7. Selkirk is downstream from Winnipeg and is vulnerable to ice jam floods. Following the 1997 flood there were concerns regarding the current level of flood protection in the community. The province has since confirmed that current infrastructure provides protection against the 100-year flood.

Selkirk also has concerns about the potential impact of Floodway expansion. The provincial government is committed to ensuring flood risks at Selkirk are not aggravated by Floodway expansion.

Recommendation 8. Although some social and economic studies are being undertaken at universities using government and other funding concerning topics raised by the 1997 flood, the level of funding support, and hence the research effort, is still modest.

Recommendation 9. The particular problems of small communities, isolated dwellings and agricultural producers have been considered in the aftermath of the 1997 flood and programs aimed at meeting those specific needs have been implemented throughout the basin. (One specific objective of a Canada-Manitoba agreement was to flood proof the rural basin to the 1997 level.) This effort is particularly significant along the Red River mainstem and for the areas inundated in 1997. The consequences of summer flooding remain a concern in tributary basins.

Recommendation 10. The Pembina River Advisory Board together with North Dakota and Manitoba assistance is making some progress on the lower Pembina flooding issue. The USACE is prepared to provide some US federal assistance in the future.

Recommendation 11. The Red River Basin Commission has a current project aimed at preparing a flood mitigation framework. The RRBC does have representatives from all levels of government but the process itself is not government led.

Recommendation 12. The Canadian Office of Critical Infrastructure Protection and Emergency Preparedness (OCIPEP) is leading the development of a National Disaster Mitigation Strategy (NDMS). In 2002 OCIPEP undertook consultations to develop a NDMS which seeks to determine the scope, policies and mechanisms to address the gaps and priority areas for action on mitigation. Since then, OCIPEP has developed, in concert with provinces and territories, a draft goal and principles which, if approved, would enable provinces and

territories to pursue mitigation-related priorities. A NDMS framework and associated funding are yet to be approved.

Recommendation 13. Governments throughout the basin are using at least the hundred year floodplain as the basis for regulations. The flood frequency calculations required to develop the hundred-year floodplain definition are not complete and administratively agreed for some urban centers the American portion the basin.

Recommendation 14. Enforcement measures related to new construction in the floodplain have been beefed up in the Red River valley in Canada through a two-step inspection program for new structures. US entities have also improved inspection but there remains a problem since adoption of the state building codes is by local option.

Recommendation 15. There has been no Canada-United States consultation on civil emergency planning and management pertaining to natural hazards since a meeting of the Prairie Region Emergency Management Advisory Committee (PREMAC) in December 2001.

Recommendation 16. Although high resolution topographic data has been obtained for the Red River valley in Manitoba and for several urban centers in the United States, the preparation of a seamless basin-wide digital elevation model has not been undertaken. A reconnaissance study related to this is underway in the United States.

Recommendation 17. The hydrometeorological monitoring network has been improved considerably since 1997 and data are routinely shared between forecast agencies in both countries and with other interests. This activity is not supported by any basin-specific binational agreement, however.

Recommendation 18. This recommendation pertaining to the establishment of a Flood forecasting Liaison committee under the aegis of the IRRB has not been implemented.

Recommendation 19. Basin-wide hydrodynamic models (Mike-11 and HEC-RAS) for the Red River mainstem are being developed under a task led by the Red River Basin Commission. These models can be used for evaluating flood mitigation measures. It is extremely unlikely the flood forecast entities, the National Weather Service and Manitoba Conservation, would support a common forecast model on account of the administrative complexities and the need to demonstrate due diligence to their respective governments.

Recommendation 20. This recommendation was directed at Canadian data management policies. Policy decisions have now been taken by the Canadian and Manitoba governments that will lead to unfettered access to Canadian data.

Administrative arrangements have already been completed by both governments to improve access and these will continue. Some data holdings are already much more accessible than they were at the time of the IJC report.

Recommendation 21. Several measures have been introduced to continue the work on a binational virtual network linking people, data and models for the Red River basin. A key element has been the RRDDIN project supported for the most part by the USACE. There have also been significant agency-level initiatives aimed at making data, tools and model output more available.

Recommendation 22. As indicated for the previous recommendation there have been developments related to decision support systems. Binational interagency approaches are lacking however.

Recommendation 23. The question of storage of banned substances in the floodplain is being considered as part of the broader issue of storage of hazardous substances. Administrative and public discussions are continuing.

Recommendation 24. In addition to building flood mitigation projects in conformance with federal, state or provincial laws, there have been developments that provided additional environmental values as part of a mitigation project. Examples are greenway development in Grand Forks and Winnipeg and the interest in set-back levees for the lower Pembina River. In general there is considerable attention being paid to riparian ecosystems along the Red.

Recommendation 25. There has been almost no attention devoted to a comprehensive flood damage reduction plan by government agencies. The work currently being undertaken by the RRBC (Recommendation 19 above) will contribute to such a plan, however.

Recommendation 26. This recommendation directed eight measures to governments for action. All are long-term and will require sustained activity over many years. Some of the work already initiated meets the intent of the recommendation but it is too early to evaluate the effectiveness.

Recommendation 27. This recommendation identified 11 flood-related functions that the IRRB should be asked to perform on behalf of the IJC. These are included in the directive to the Board.

Recommendation 28. There is activity on a number of fronts related to preparedness and mitigation but no cohesive binational approach

Task Force Recommendations

The IJC's Task Force made 50 Recommendations. Thirty of these were endorsed but not re-stated in the IJC Report. The status of these recommendations is summarized in the following table and a more detailed discussion follows the table. As is the case with the IJC recommendations, the Task Force recommendations are in several parts, indicating what should be done, who should do it and when. In some cases it is difficult to make a clear evaluation of the degree to which the recommendation has been implemented.

Recommendations from IJC Task Force		Status
2	Future ice jam information from the entire basin should be incorporated into the CRREL Ice Jam Database so that ice problems in the basin can be analyzed further. Where feasible, historic ice jams from the Canadian portion of the basin should be entered.	Little Progress
3	Communities in the United States portion of the Red River basin should ensure that community-built flood damage reduction projects are certified by FEMA for 100-year or greater protection, or should participate in the Non-Federal Flood Control Works Inspection Program.	Some Progress
5	Based on results from hydraulic model studies, modify the east embankment of the Floodway to improve the performance of the Floodway entrance to lower upstream water levels and increase capacity.	Complete
6	The west dike should be raised to allow a water level elevation of 778 feet at the Floodway inlet structure with appropriate freeboard.	Signif. Progress
7	The primary diking system should be raised where economically feasible to the elevation specified in existing legislation.	Some Progress
10	Modifications to the sewer and land drainage systems should be optimized and undertaken once the overall plan for Winnipeg flood protection is determined.	Signif. Progress
11	The City of Winnipeg should give immediate high priority to the preparation of a detailed emergency preparedness and response manual.	Complete
12	Operating rules for new flood control measures should be designed to accommodate all flow regimes, even those beyond design capacity. The public should be consulted on any proposed new operating rules.	Some Progress
15	The 500-year flood (0.2 percent flood) should be defined throughout the Red River basin and used to inform the public of the potential risks of flooding from rare events, including the need to buy flood insurance in the United States, and as the basis of regulations for siting and floodproofing critical facilities.	Little Progress
16	Both North Dakota and Minnesota should consider adopting the new International Building Code that includes requirements for design and construction in flood hazard areas.	Complete

Recommendations from IJC Task Force		Status
17	The National Building Code of Canada should specify design and construction standards for buildings in flood hazard areas such as the Red River basin. Floodplain construction requirements should be incorporated into the Manitoba code when available.	No Progress
18	Federal, state, provincial and local governments in the Red River Basin, in conjunction with the private sector, should continue to develop, refine and implement effective strategies to improve the disaster resiliency in both communities. Efforts should be made to increase public awareness of flood risks throughout the basin.	Some Progress
21	The Canadian federal government should include in the Disaster Financial Assistance Arrangements provisions to allow for the permanent removal of structures in areas subject to repeated flooding.	No Progress
25	Recovery, rebuilding, and mitigation expertise and information should be widely shared across the border in advance of flooding.	Little Progress
26	Measures of flood resilience should be developed, and a system should be established to monitor resilience in the Red River basin.	Little Progress
28	Given the transboundary nature of the basin and the potential for federal involvement in funding and monitoring any agreement, federal agencies from both countries should be engaged in this process as well	Some Progress
29	Changes in the road network and diking system in the Lower Pembina Basin should be modeled by the hydrodynamic model prior to implementation of any plan to ensure that there are no unintended consequences.	Some Progress
30	The virtual database and decision support system prototype that the Task Force has begun to develop for the Pembina Basin should be continued by relevant agencies in Canada and the United States.	Some Progress
32	Any modification to existing operating plans or physical structures associated with Lake Traverse that could increase pool elevation must be accompanied by features that eliminate the southward movement of water into the Little Minnesota River.	Some Progress
34	Governments should continue to monitor toxaphene in the Lake Winnipeg ecosystem until concentrations decline to pre-1997 levels.	Ongoing
35	Hydrometric and meteorological data networks necessary for flood forecasting should be improved and maintained in a state of readiness to forecast future floods.	Signif. Progress
36	New geographically related data collection in the United States should be in accord with the North American Vertical Datum of 1988.	Some Progress
37	For consistency and accuracy data used in models should take into account the differences in data at the border. Because datum conversions can affect data accuracy, any conversions between	Some Progress

Recommendations from IJC Task Force		Status
	standards should be noted and reported along with the data.	
38	U.S. National Geodetic Survey and the Geodetic Survey of Canada should convene a forum of datum experts in the year 2000 to discuss Red River Basin datum issues and develop a long-term transition plan.	No Progress
39	All key data providers in Canada should make available at no cost and with no restriction the data sets necessary for the Red River floodplain management and emergency response, and regional or basin-wide modeling activities.	Signif. Progress
40	Data providers should remain responsible for maintaining and replicating the data sets.	Accepted
44	The U.S. National Weather Service should implement its Advanced Hydrologic Prediction System in the Red River basin as an early priority.	Complete
46	Confirm the flood peak reduction findings of Chapter 3 for large floods and examine reductions for smaller floods by implementing distributed models on tributaries such as the Mistinka, Wild Rice and Maple Rivers.	Some Progress
48	Conduct surveys of secondary roads, particularly in the central portion of the basin, with differential global positioning systems, and incorporate the results into the hydraulic models.	Some Progress
50	Measures should be taken to ensure that data supporting the operation of the hydraulic models and model outputs can be made widely available.	Signif. Progress

Recommendation 2. There have been no significant ice jam floods in the Red River basin since 1997 but no historic floods have been added to the CRREL database since that time.

Recommendation 3. The US Non-Federal Flood Control Works Inspection Program is now known as the Rehabilitation Inspection Program (RIP). Most communities in the basin with non-federal levees do not participate in the program. Thus far ten communities have applied, six met requisite engineering and maintenance standards, and three rehabilitation projects have been completed.

Recommendation 5. This work on improving the performance of the Floodway inlet is complete. Two notches were cut in the east embankment.

Recommendation 6. A project related to raising of the West Dike (Winnipeg) has been funded and design work is underway. This is a sub-set of IJC Recommendation 3, that is, a \$660 million improvement to Winnipeg's flood protection.

Recommendation 7. Winnipeg has identified \$2.6 million in its capital estimates for 2004-2008 for Primary Dike upgrades. This also is a sub-set of IJC Recommendation 3.

Recommendation 10. Modifications to Winnipeg's sewer and land drainage system have been undertaken (pumping station upgrades are 40% complete) and will continue. This as well is a sub-set of IJC Recommendation 3.

Recommendation 11. A detailed flood emergency manual for the city of Winnipeg has been completed.

Recommendation 12. This recommendation regarding operating rules for mitigation works has been accepted and will be taken into account in Red River Floodway expansion.

Recommendation 15. The 500-year floodplain is being defined in flood frequency analyses conducted by the USACE, but there is little evidence of regulatory agencies incorporating this floodplain into regulations. The 500-year floodplain has not been defined in Manitoba.

Recommendation 16. The North Dakota State Building Code, as of August 1, 2002, uses the 2000 edition of the International Building Code. The new Minnesota Building Code, effective March 31, 2003 is also based on the International Building Code. In both North Dakota and Minnesota, enforcement of the building code is the responsibility of local jurisdictions. Jurisdictions that elect to adopt and enforce a building code must adopt the state building code, but may amend the code further to conform to local needs. In Minnesota such amendments must be more stringent than the state code.

Recommendation 17. No steps have been taken to incorporate flood-proofing information into the Canadian National Building Code.

Recommendation 18. Measures undertaken to mitigate the effects of damaging floods in the Red River basin have undoubtedly led to increased resiliency in the areas flooded in 1997. The continuing discussions of floods and flood risks have increased public awareness.

Recommendation 21. No changes have been made to Canadian Disaster Financial Assistance Arrangements that would allow for payments to remove structures from high risk areas. Some Canadian buy-outs following the 1997 flood were made, however, using a separate arrangement.

Recommendation 25. There is considerable sharing of recovery, mitigation and re-building expertise and information across the international boundary. For the most part, this has been on an informal agency to agency basis.

Recommendation 26. There has been no activity specifically directed to developing measures of flood resilience for the basin.

Recommendation 28. There has been little involvement by federal agencies thus far in achieving solutions to flooding of the lower Pembina River.

Recommendation 29. While there appears to be general acceptance of the hydrodynamic model of the lower Pembina River developed for the IJC and a willingness to use it to review project proposals, other modelling developments are underway. There will be a need to confirm that all models are using the same input and scenarios in order to build confidence in the results.

Recommendation 30. The work on databases and decision support related to the Pembina River is being continued to some extent by the PRAB and RRBDIN. A binational research project also examined some data issues related to the Pembina.

Recommendation 32. The potential for biota transfer at Lake Traverse is being considered as part of the dam safety study at White Rock Dam. This is a high priority issue for the IRRB.

Recommendation 34. Manitoba continues to monitor toxaphene levels in Lake Winnipeg.

Recommendation 35. The task of improving hydrometric and meteorological networks used in flood forecasting has been completed. Maintaining these networks in the long term remains a challenge.

Recommendation 36. Data collected by US federal agencies are being collected using the new US vertical datum (NAVD 1988). This is frequently not the case for city and county entities.

Recommendation 37. There now appears to be a greater likelihood of the datums used in specific projects being reported, but this is not always the case. Natural Resources Canada has developed a conversion algorithm for converting between US and Canadian vertical datums.

Recommendation 38. Natural Resources Canada, together with provincial agencies, is examining issues related to adopting a Canadian vertical datum that is akin to NAVD 1988. NRCan has a goal of converting to a new vertical datum by 2004 and although this has been discussed with the U.S. National Geodetic Survey, there has been no expert binational examination of datum issues specifically related to the Red River basin since the IJC study.

Recommendation 39. Substantial improvements in data availability for both Canadian and American data have been made since the flood. More work in this regard continues to be needed, however.

Recommendation 40. There is general acceptance of the concept of data providers being responsible for maintaining and replicating data sets, as opposed to this being done by third parties.

Recommendation 44. The National Weather Service has implemented the AHPS forecast system for the US portion of the basin.

Recommendation 46. The flood peak reduction analysis performed during the IJC studies can be re-examined once the hydrodynamic model of the entire basin is complete. A distributed hydrologic model for the Mistinka River is being prepared by the USACE. Similar models for the Wild Rice and Maple Rivers have not been developed.

Recommendation 48. As higher resolution digital elevation models are being prepared for the basin, some attention is given to precise surveys of secondary roads.

Recommendation 50. The data supporting the operation of hydraulic models and the output from those models are becoming more widely available. There is a significant need for the preparation of metadata in accordance with a standard such as the FGDC standard to facilitate this process.

Summary

As can be appreciated from the foregoing discussion, there has been significant attention paid to implementing the recommendations to governments made by the IJC in its report, *Living With the Red*. It would be fair to say that the expenditures to date are in the order of hundreds of millions of dollars and that similar amounts will be spent in the next five years. No recommendations have been formally rejected.

The recommendations that have achieved the most success are those that involve construction of a structural measure identified in the IJC report, even if that work requires collaboration at the federal, state or province, and local level. A second group of successful recommendations relate to specific recommendations aimed at a specific agency. The improvements to flood-forecasting are an example.

That said, there are some patterns of activity in response to the recommendations that give cause for concern. The recommendations that have achieved relatively little success are those that involve multiple agencies and,

perhaps, multiple objectives. It could be that these sorts of task could be deemed to be more difficult and could naturally be expected to take longer. It could also be said that public expectations for structural measures supercede all other post-flood needs and that those expectations need to be met before proceeding with "softer" projects.

One could say that a sort of collective unilateralism has been in play and that this has led to some worthwhile results. Another way of describing progress thus far is to say that there has been considerable success in projects and programs that keep water away from people and less success in programs that keep people away from water. This is not to say that the up to 40-km wide 100-year floodplain of the Red River mainstem should become some sort of "no-go" zone. Rather the policy objective should be to allow people to occupy the floodplain while minimizing risk to life and property.

This writer is of the view that it will take considerable effort to achieve the level of integration and cohesion on flood management that the IJC envisaged. This needs to be done with some urgency before complacency sets in. Processes akin to the IFMI process but dealing with a short list of issues could be required. Significant interagency and intergovernmental cooperation will be needed. It is fortunate that residents of the basin and their political leaders are still seized by the flooding issue. In other circumstances flooding could have disappeared from view by this time.

The apocryphal quote that the Red River basin has two problems, "too much water and too little" has a firm foundation in reality. In attempting to deal with concerns related to flooding, it is important to determine the consequences of any proposed measures during times of drought. Integrated water resources planning should be the overarching goal for the basin.

RECOMMENDATIONS

Recommendations arising from this survey can be grouped in a number of ways. This report will use the gaps defined earlier as the basis for recommendations. In addition there will be some recommendations directed specifically at the International Red River Basin Board which has been tasked by the IJC to monitor progress on its recommendations. The Board may wish to conduct another survey in about five year's time.

Nature of Flooding

Activity since the 1997 flood has been understandably focussed on rare floods on the Red River mainstem. Agencies involved in floodplain management issues, while continuing to deal with large rare floods may wish to:

- Identify communities where ice jam flooding is a continuing problem and examine measures to mitigate such flooding.
- Consider the effects of summer floods on Red River tributaries and establish a database of damages caused by such floods.

In particular the IRRB may wish to:

- Facilitate and support the study of the effects of drainage and land use change on the nature and extent of tributary floods.
- Support the implementation of distributed hydrological models for key tributaries.

Non-Structural Measures

Although significant improvements have been made to flood forecasting systems in the basin, for the most part the implementation of non-structural approaches has lagged construction of structural measures.

Agencies may wish to:

- While continuing to complete mitigation projects, provide leadership, technical support and funding to bring non-structural measures into place. This could include, for example, ensuring a regulatory floodplain is in place for the entire basin, building codes are adopted throughout the basin, and potentially hazardous chemicals are stored safely and so on.
- Pursue riparian restoration and improvement projects in the context of protection of public safety and enhancement of ecosystem values.
- Identify and report on the degree to which flood insurance is accepted and employed in the US portions of the basin.

- Draw public attention to good and bad examples of effective floodplain management.

The IRRB, in particular, may wish to:

- Monitor the status of flood forecasting, particularly the hydrometeorological data networks that support the forecasts, and report to governments on that status. Any degradation in forecast systems should be identified.
- Provide attention and support to resolving flooding issues in the Pembina and Roseau subbasins.
- Pay particular attention to issues that require multiple jurisdictions or multiple agencies, or both, for successful implementation and lend its support to their resolution.

Institutional Development

There are a very large number of agencies and organizations active in Red River flooding issues and other water management matters. The geographic and technical scope of their work varies enormously. Efforts have been made to develop more consistent approaches through organizations such as the North Dakota Red River Joint Water Resource District and Minnesota Red River Watershed Management Board but more work is needed in this regard. Agencies may wish to:

- Continue to develop approaches to working together in a more coordinated fashion.
- Provide technical and other support to local organizations.

In particular:

- FEMA may wish to resolve an apparent problem in providing consistent approaches pertaining to Red River flooding for Regions Five and Eight.
- The IRRB may wish to provide institutional support to address flooding in the lower Pembina basin.

Technical Matters

There are a number of technical matters that continue to require attention in the Red River basin. Agencies may wish to:

- Continue development of distributed databases, including provision of searchable metadata, and decision support systems for the basin.

- Develop a seamless best-available digital elevation model for the basin.

The IRRB may wish to:

- Identify particular data deficiencies and priorities for future database development.
- Develop a position on and a means of supporting multi-purpose, multi-agency entities engaged in development of databases and models for the basin.

Research

Research and development conducted in government facilities, universities and elsewhere can play a long-term role in improving community resiliency in the Red River basin. While respondents to the IRRB survey did not see the absence of knowledge as an impediment to moving ahead on IJC and other recommendations, there are certainly issues that would benefit from research effort. Agencies may wish to:

- Promote and support making Red River data and information products widely available to academic and other researchers through the use of searchable databases.
- Assist the development of a research agenda, including priorities, for the Red River basin. This should include physical, biological and socio-economic science. (It is noted that the RRBI has done some work in this regard.)
- Support research grant applications to funding organizations such as foundations and granting councils.

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APPENDIX ONE - ACRONYMS AND ABBREVIATIONS

AHPS	Automated Hydrologic Prediction System (USNWS)
CD-ROM	Compact Disk - Read Only Memory
CREP	Conservation Reserve Enhancement Program
DEM	Digital Elevation Model
DEM	Division of Emergency Management (North Dakota)
DFA	Designated Flood Area (Manitoba)
EERC	Energy & Environmental Research Center (UND)
FEMA	Federal Emergency Management Agency (United States)
FGDC	Federal Geographic Data Committee (United States)
GPS	Global Positioning System
GRT	Greenway on the Red Trust
IFMI	International Flood Mitigation Initiative
IJC	International Joint Commission
IRRB	International Red River Board (IJC)
IRRBTF	International Red River Basin Task Force (IJC)
JEPP	Joint Emergency Preparedness Program (Canada)
Lidar	Light Detection And Ranging
MB	Manitoba
MEMO	Manitoba Emergency Measures Organization
MN	Minnesota
ND	North Dakota
NDMS	National Disaster Mitigation Strategy (Canada)
OCIPEP	Office of Critical Infrastructure Protection and Emergency Preparedness (Canada)
PRAB	Pembina River Advisory Board
PREMAC	Prairie Region Emergency Management Advisory Committee
RRBB	Red River Basin Board (now RRBC)
RRBC	Red River Basin Commission
RRBDIN	Red River Basin Disaster Information Network
RRBI	Red River Basin Institute (Tri-colleges)
RRWRC	Red River Water Resources Council (now RRBC)
TIC	The International Coalition (now RRBC)
UNET	UNsteady NETwork
US	United States of America
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
USNWS	United States National Weather Service
WET	Water Education for Teachers

APPENDIX TWO
SURVEY INSTRUMENT

International Red River Board Questionnaire

A. Background

- 1 Organization:
- 2 Location:
- 3 Location of activity (check all that apply):
 - Manitoba
 - Minnesota
 - North Dakota
 - South Dakota
 - Other United States
 - Other Canada
- 4 Basin resident?
 - Yes
 - No

B. Policy, legislation, institutions

- 1 Please identify any new policies aimed at reducing the social, economic and environmental impacts of Red River flooding that your organization has implemented since 1997.
- 2 Similarly, can you identify any changes in legislation post 1997 aimed at reducing flood impacts.
- 3 As well, please identify any new institutions that your organization has established or taken part in establishing that will address flooding issues on a continuing basis.
- 4 Can you identify further needs for the development of policies, legislation or institutions that would improve our ability to reduce flood impacts in the Red River basin?

C. Programs

Indicate your organization's work in the Red River basin related to subject areas contained in the IJC recommendations to governments or to other subject areas. Skip questions that do not relate to your organization's mandate.

- 1 Flood Preparedness (emergency operations plans to protect communities and residents from flooding and its effects). Briefly list preparedness programs and expected deliverables or outcomes.
- 2 Database Development (collection, archive, distribution). Briefly list databases and related products for improving flood management.
- 3 Flood Forecasting. Briefly identify forecast improvements and expected deliverables or outcomes.
- 4 Other Flood Modelling and Mapping Technologies. Briefly identify applications of technologies new to the Red River basin since 1997.
- 5 Additional Flood Mitigation (sustained actions to reduce or eliminate long term risk of flooding and its effects.) Briefly list structural and other non-structural mitigation projects and expected deliverables or outcomes.
- 6 Transboundary Effects from Flood Mitigation Activities. Briefly list work that applies and

expected deliverables or outcomes.

- 7 *Response and Recovery (actions taken during or immediately following a flood to reduce damages and resume normal activity). Briefly list changes to response and recovery procedures.*
- 8 *Best Management Practices (actions to protect and enhance the floodplain environment). Briefly identify adoption of practices that apply and expected deliverables or outcomes.*
- 9 *Education*
 - a) *Briefly list educational initiatives and expected deliverables or outcomes.*
 - b) *Education level of the initiative (check all that apply):*
 - School*
 - College*
 - University*
 - Adult*
- 1 *Integrating Flood Plain Management (actions to integrate physical, cultural, technological,*
- 0 *and environmental approaches to flood protection and mitigation). Briefly list initiatives and expected deliverables or outcomes.*

D. Deficiencies and Achievements

Identify your perceptions of gaps or deficiencies in existing activities as they relate to the IJC recommendations to governments.

- 1 *What gaps remain in your agency's response to the IJC recommendations?*
- 2 *What is your agency's most significant achievement in response to the recommendations?*
- 3 *What weaknesses do you perceive in your agency's response?*
- 4 *Gaps or deficiencies pertaining to other agencies.*
- 5 *Provide any recommendations to fill gaps and/or correct deficiencies.*
- 6 *List two or three topics that require further investigation before agencies can respond appropriately.*

E. Conclusions

- 1 *One objective of effective floodplain management is to improve the resilience of communities and individuals in the face of disasters. In your considered opinion, has the basin's ability to deal with a flood of the magnitude of that of 1997*
 - Improved?*
 - Stayed the same?*
 - Become worse?*
- 2 *Elaborate if you wish, or provide comments on other Red River basin flooding issues that are important to you.*

This survey is being conducted for the International Joint Commission's International Red River Board by R. Halliday & Associates Ltd., a company based in Saskatoon Canada, in co-operation with the Canadian Water Resources Association.

All individual responses will be kept confidential.

APPENDIX THREE

IRRB DIRECTIVE

DIRECTIVE TO THE INTERNATIONAL RED RIVER BOARD

1. Pursuant to the Boundary Waters Treaty of 1909, responsibilities have been conferred on the Commission under a 1948 Reference from the governments of Canada and the United States with respect to the use and apportionment of the waters along, across, or in the vicinity of the international boundary from the eastern boundary of the Milk River drainage basin on the west up to and including the drainage basin of the Red River on the east, and under the May 1969 authorization from the governments to establish continuous supervision over the quality of the waters crossing the boundary in the Red River and to recommend amendments or additions to the objectives when considered warranted by the International Joint Commission.
2. This directive replaces previous directives and instructions provided by the International Joint Commission to the International Souris-Red Rivers Engineering Board, and in the February 8, 1995 Directive to the International Red River Pollution Board. This Directive consolidates the functions of those two former boards into one board, to be known as the International Red River Board (Board).
3. The Board's mandate is to assist the Commission in preventing and resolving transboundary disputes regarding the waters and aquatic ecosystem of the Red River and its tributaries and aquifers. This will be accomplished through the application of best available science and knowledge of the aquatic ecosystem of the basin and an awareness of the needs, expectations and capabilities of residents of the Red River basin.
4. The geographical scope of the Board's mandate shall be the Red River basin, excluding the Assiniboine and Souris Rivers. The Board's activities shall focus on those factors which affect the Red River's water quality, water quantity, levels and aquatic ecological integrity.
5. The Board's duties shall be to:
 - A. Maintain an awareness of basin-wide development activities and conditions that may affect water levels and flows, water quality and the ecosystem health of the Red River and its transboundary tributaries and inform the Commission about transboundary issues.
 - B. Provide a continuing forum for the identification, discussion and resolution of existing and emerging water-related issues relevant to the Red River basin.
 - C. Recommend appropriate strategies to the Commission concerning water quality, quantity and aquatic ecosystem health objectives in the basin.
 - D. Maintain continuing surveillance and perform inspections, evaluations and assessments, as necessary, to determine compliance with objectives agreed to by governments for water quality, levels and quantity in the Red River basin.
 - E. Encourage the appropriate regulatory and enforcement agencies to take steps to ensure that agreed objectives are met.
 - F. Encourage the appropriate authorities, such as resource and emergency planning agencies, to establish and maintain contingency plans, including early warning

procedures, for appropriate reporting and action on accidental discharges or spills, floods and droughts, discharges or spills, floods and droughts.

- G. Monitor and report on flood preparedness and mitigation activities in the Red River basin and their potential effects on the transboundary aquatic ecosystem, and encourage and facilitate the development and maintenance of flood-related data and information systems and flood forecasting and hydrodynamic models. In carrying out this responsibility, the Board shall:
- i. Monitor progress by the governments (federal, state, provincial, municipal) in implementing the recommendations of the Commission's report on Red River basin flooding, and in maintaining and advancing the work of the Task Force's legacy projects, and to this end provide opportunities for the public to comment on the adequacy of such progress.
 - ii. Encourage governments to develop and promote a culture of flood preparedness in the Red River valley.
 - iii. Encourage government efforts to develop and implement a long-term strategy for flood mitigation and emergency preparedness.
 - iv. Encourage the sharing of accurate and timely transboundary information to support the development of improved flood forecasting techniques and procedures for early flood warnings and to improve communication of flood forecasts.
 - v. Provide through the activities of the Board a forum for the exchange of best practices and for other flood-related information on preparedness, mitigation, response, and recovery, to assist in transboundary problem solving.
 - vi. Promote the application of innovative technologies for supporting flood modeling and mapping.
 - vii. Monitor the adequacy of data and information collection networks (meteorological, hydrometric, water quality) for flood preparedness, forecasting and mitigation, within the larger context of overall water management needs in the basin.
 - viii. Monitor potential transboundary effects of flood mitigation and other works in the basin, and encourage cooperative studies necessary to examine these effects.
 - ix. Encourage governments to integrate floodplain management activities in watershed and basin management.
 - x. Interact with all levels of government to help decision-makers become aware of transboundary flood-related and associated water management issues.
 - xi. Assist in facilitating a consultative process for resolution of the lower Pembina River flooding issue.

- H. Involve the public in the work of the Board, facilitate provision of timely and pertinent information within the basin in the most appropriate manner including electronic information networks, and conduct an annual public meeting in the Red River basin;
 - I. Provide an annual report to the Commission, plus other reports as the Commission may request or the Board may feel appropriate in keeping with this Directive;
 - J. Maintain an awareness of the activities of other agencies and institutions, in the Red River basin.
6. The Board shall continue to report on the non-Red River geographic areas under the responsibility of the former International Souris-Red Rivers Engineering Board, including the Poplar and Big Muddy basins, but excluding the Souris River basin, until the Commission determines otherwise.
 7. The Board shall have an equal number of members from each country. The Commission shall normally appoint each member for a three-year term. Members may serve for more than one term. Members shall act in their personal and professional capacity, and not as representatives of their countries, agencies or institutions. The Commission shall appoint one member from each country to serve as co-chairs of the Board. An alternate member may not act as a co-chair.
 8. At the request of any member, the Commission may appoint an alternate member to act in the place of such member whenever the said member, for any reason, is not available to perform such duties as are required of the member.
 9. The co-chairs of the Board shall be responsible for maintaining proper liaison between the Board and the Commission, and among the Board members. Chairs shall ensure that all members of the Board are informed of all instructions, inquiries, and authorizations received from the Commission and also of activities undertaken by or on behalf of the Board, progress made, and any developments affecting such progress.
 10. Each chair, after consulting the members of the Board, may appoint a secretary. Under the general supervision of the chair(s), the secretary(ies) shall carry out such duties as are assigned by the chairs or the Board as a whole.
 11. The Board may establish such committees and working groups as may be required to discharge its responsibilities effectively. The Commission shall be kept informed of the duties and composition of any committee or working group. Unless other arrangements are made, members of the Board, committees, or working groups will make their own arrangements for reimbursement of necessary expenditures.
 12. The Commission should also be informed of the Board's plans and progress and of any developments or cost impediments, actual or anticipated, which are likely to affect carrying out the Board's responsibilities.
 13. The Commission shall be informed, in advance, of plans for any public meetings or public involvement in the Board deliberations. The Board shall report, in a timely manner, to the Commission on these meetings, including representations made to the board.

14. The Board shall provide the text of media releases and other public information materials to the Secretaries of the Commission for review by the Commission's Public Information Officers, prior to their release.
15. Reports, including annual reports, and correspondence of the Board shall, normally, remain privileged and be available only to the Commission and to members of the Board and its committees until their release has been authorized by the Commission.
16. If, in the opinion of the Board or of any member, any instruction, directive, or authorization received from the Commission lacks clarity or precision, the matter shall be referred promptly to the Commission for appropriate action.
17. In the event of any unresolved disagreement among the members of the Board, the Board shall refer the matter forthwith to the Commission for decision.
18. The Commission may amend existing instructions or issue new instructions to the Board at any time.