MANITOBA DROUGHT MANAGEMENT STRATEGY

Part of:
TOMORROW NOW
Manitoba's GREEN Plan

Manitoba

TOMORROW NOW

Manitoba's **GREEN** Plan

This document is part of "TomorrowNow-Manitoba's Green Plan", an eight-year strategic action plan for mobilizing Manitobans to work together to protect the environment while ensuring a prosperous and environmentally-conscious economy. In addition to the actions outlined in this plan, the province has other initiatives underway to ensure we protect the environment and sustainably manage our natural resources now, for tomorrow.

Manitoba's goal is to be one of the most sustainable places to live on earth.

WHAT IS THIS ALL ABOUT?

UNDERSTANDING DROUGHT IN THE PAST, PRESENT, AND FUTURE

"TomorrowNow-Manitoba's Green Plan" is an eight-year strategic action plan to protect the environment while ensuring a prosperous and environmentally-conscious economy for Manitoba. Under the umbrella of TomorrowNow are several key strategies to safeguard our water, including the Surface Water Management Strategy, Wetland Strategy, Climate Change Adaptation Pathway, and Towards Sustainable Drainage, among others. Manitoba Conservation and Water Stewardship released Manitoba's Surface Water Management Strategy to provide Manitoba with the vision for a balanced approach to sustainable surface water management into the future.

The Surface Water Management Strategy's three pillars are improving and protecting water quality, preparing for extreme events, and co-ordination and awareness. Within the context of the second pillar on preparing for extreme events, such as flood and drought, the Surface Water Management Strategy calls for the preparation of a drought strategy for Manitoba. The Manitoba Drought Management Strategy provides a framework of an integrated and action orientated approach to minimize the impacts of drought on Manitoba's people, economy and environmental resources. The strategy improves our understanding of drought occurring in the past, present, and future.

ACTION ORIENTATED

A number of action items have been included in the Manitoba Drought Management Strategy. These initiatives will be implemented to increase Manitoba's resiliency to drought and minimize the impact of future droughts.

- Undertake studies on the long-term effects of climate change on water supply and demand for river basins.
- Establish drought committees to enable efficient information sharing and co-ordination of province-wide drought management efforts.
- Collaborate with Manitoba Emergency Measures Organization to enhance the Manitoba Emergency Plan to include specific guidance for drought-related emergencies.
- Prepare regular water availability and drought conditions reports which include drought indicators for each major river basin.
- Determine drought preparedness levels for each river basin.
- Combine preparedness levels with drought condition information to determine drought stages. Implement the four color-coded drought stages to monitor drought in Manitoba.
- Establish a "Manitoba Drought Monitor" website with up to date drought information.
- Evaluate and enhance meteorological, hydrometric, soil moisture, groundwater and other networks used for drought monitoring.
- Undertake research to develop drought forecasting tools for Manitoba.
- Undertake studies related to water supply dams and reservoirs.
- Participate in trans-boundary collaborations to better manage trans-boundary waters during drought.
- Implement and promote drought mitigation strategies to increase drought resiliency and reduce long-term drought impacts.
- Prepare information and awareness materials regarding drought, water supply management and water efficiency.
- Periodically evaluate the Manitoba Drought Management Strategy to identify any gaps and update the strategy to incorporate new scientific methods and technologies.

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1. OVERVIEW

1.1. CONTEXT OF THE STRATEGY

In the 20th century, billions of dollars of damages have occurred as a result of droughts across the Canadian Prairies. Droughts can occur over large areas and can last for months or even years. The economic losses caused by severe drought make drought one of Canada's most costly hazards (Institute for Catastrophic Loss Reduction, 2010). While droughts can occur anywhere in Canada, the most severe and widespread droughts occur on the prairies. The worst recorded droughts on the prairies occurred in the 1930s, 1960s, 1980s and 2000s (Alberta Environment, 2004). At least 40 long-term droughts have occurred in western Canada during the past two centuries (Environment Canada, 2005). In southern regions of Alberta, Saskatchewan and Manitoba, multi-year droughts were observed in the 1890s, 1930s and 1980s. Almost every year, parts of Manitoba, most commonly in the western and south-western areas, are affected by drought. Ironically, many of these areas are also prone to significant flooding.

All living things require water for life. As reliable and adequate water supplies are required to maintain healthy environments for people and ecosystems, the presence of any kind of drought or water shortage may cause a serious threat in Manitoba. Water shortages stress water supplies, deplete soil moisture reserves, reduce stream-flows, lower lake and reservoir levels and diminish groundwater supplies. Droughts extending over a broad area can have significant effects on a wide range of water sensitive sectors, including agriculture, irrigation, power generation, fisheries, forestry, drinking water supplies, manufacturing and recreation, as well as on wildlife and aquatic ecosystems. For example, significant droughts in the Churchill/Nelson Basin in 1988 to1990 and in 2002 to 2003 resulted in multi-million dollar losses in hydroelectric production.

Droughts also have major environmental implications, such as contributing to declining water quality, wetland loss, soil erosion and degradation, and ecological habitat destruction. Droughts increase the frequency and severity of forest fires leading to increased firefighting costs, financial losses in the forestry industry, and health issues related to widespread smoke. Manitoba has a multi-million dollar commercial and recreational fisheries industry which could face a significant loss due to extended drought conditions.

The challenge of drought management is compounded by increased demand for the use of limited water resources and uncertainties in climate change projections of future water availability. Differences in climate projections reflect uncertainties in climate modelling, mask the climate change signal and create challenges for future planners. Although there is some variation between model projections, future projections for the prairie provinces region include lower summer stream-flows, falling lake levels, retreating glaciers, and increasing soil

"TomorrowNow-Manitoba's Green Plan" is an eight-year strategic action plan for mobilizing Manitobans to work together to protect the environment while ensuring a prosperous and environmentally-conscious economy. The Surface Water Management Strategy is a key component of "TomorrowNow - Manitoba's Green Plan", and is linked to other provincial initiatives, such as the Lake Friendly Accord and the Stewards Alliance, the Protected Areas Strategy, the Climate Change Adaptation Pathway and the Manitoba Imagery Strategy to name just a few. New initiatives coming out of this strategy include the new Drainage and Water Retention Regulation that is currently being developed, as well as the Drought Management Strategy and the Wetland Strategy."

and surface water deficits. The Canadian Prairies have been identified as specifically sensitive to climate changes, with potential for increased aridity as well as increased flooding. The Natural Resources Canada report entitled "From Impacts to Adaptation: Canada in a Changing Climate 2007 - Prairies" states that "increases in water scarcity represents the most serious climate risk" (Natural Resources Canada, 2007). More severe, longer term droughts occurring with increased frequency and resulting in increased water shortages in prairie regions were projected by a recent report on the long term effects of climate change in Canada prepared by the National Round Table on the Environment and the Economy (National Round Table on the Environment and the Economy , 2010). Spatial variability in climate projections further complicate drought issues, as decreased water supply in one area may be offset by increased water supply in another area. Since Manitoba receives water from Alberta, Saskatchewan, northern Ontario and multiple American states, a better understanding of spatial variability in future water supply is required for robust decision making and planning.

Drought conditions do not develop over a few hours or days, but build up over a number of weeks or months. The time factor, in conjunction with good monitoring data and analysis, can allow for some advance preparation for drought and enables co-ordinated planning at the federal, provincial, and local levels. Manitoba has generally responded to drought on an informal basis. However, it is a priority of the Manitoba government to develop a more formal drought management and mitigation strategy and an enhanced monitoring system.

There are various types of droughts that can occur at any time including over the short, medium and long term and with a range of intensities. Droughts can occur in either a local area or on a regional scale. Without sufficient planning and preparation, a drought that extends over months or years can have significant impacts on the economy, people, animals and the environment.

Activities such as monitoring and preparation for drought requires co-ordination between governments and non-government organizations at federal, provincial, and local levels. Manitoba Conservation and Water Stewardship will play a lead role in developing and implementing drought management and mitigation for the province, as the minister of Manitoba Conservation and Water Stewardship is responsible for administering *The Water Protection Act*.

Under the authority of *The Water Protection Act* (Sections 11 (1) and 11 (2)) the minister has the authority to declare a serious water shortage for all or portions of Manitoba and the authority to end the declaration. The act also authorizes the minister to take any actions, make any regulations, or issue any order to prevent, minimize, or alleviate water shortages under a declaration of water shortage.

A comprehensive drought management strategy enables a straightforward, science based, co-ordinated process for the declaration of drought and ongoing drought management.

1.2. PURPOSE AND SCOPE

The purpose of the Manitoba Drought Management Strategy is to provide a framework for an integrated approach to managing drought, with the goal of minimizing the environmental, social and economic impacts of drought on Manitoba's residents, economy and environmental resources. The Manitoba Drought Management Strategy provides a history and overview of drought on the Canadian Prairies, characterizes the different types of drought, and outlines strategies for drought preparedness, reporting, monitoring, action and mitigation.

An action resulting from the Manitoba Drought Management Strategy is the formation of two types of drought committees. The first is an inter-agency committee with representatives from various government departments and agencies. This committee will provide high level oversight, direction and input into the areas of drought monitoring, reporting and management for the province. The second type of committee is made up of stakeholder organizations with representatives from the major river basins across Manitoba. These groups will provide local knowledge and information to supplement provincial drought management activities. A communication framework between agencies and committees is outlined in the Manitoba Drought Management Strategy and will guide province-wide drought management efforts.

A process for declaration of drought stage and response is also outlined. This includes suggested actions to various stages of drought, in addition to identification of key drought mitigation strategies to be implemented over time. The Manitoba Drought Management Strategy is intended to be a living document that can be improved on and adapted to changing conditions. Updates will incorporate new scientific methods and information as well as new technologies.

The Manitoba Drought Management Strategy is not intended to replace or describe emergency measures co-ordinated by the Emergency Measures Organization. The Emergency Measures Organization is responsible for preparing, maintaining and implementing policies and procedures relating to preparedness, response and recovery from emergencies and disasters such as severe drought in Manitoba. Manitoba Conservation and Water Stewardship will collaborate with the Emergency Measures Organization to enhance the Manitoba Emergency Plan to include specific guidance for drought-related emergencies.

1.3. OBJECTIVES

The Manitoba Drought Management Strategy has several key objectives:

i. To establish definitions and indicators of drought that are appropriate for Manitoba.

ii. To define the stages of drought and provide action protocols related to each stage.

iii. To establish drought reporting and monitoring systems for Manitoba.

iv. To provide a communication framework for all levels of government to coordinate drought management efforts.

v. To aid stakeholders and the public in understanding and mitigating drought effects.

vi. To make the public, local governments, landowners and businesses aware of their role in water demand reduction and efficiency on a regular basis, not only when a water supply deficiency occurs.

vii. To consider the consequences of future climate change and its direct and indirect impacts on society and the economy with respect to drought.

1.4. GUIDING PRINCIPLES

The development of this strategy is guided by the following principles:

Partnership

Collaborative and respectful working relationships between federal, provincial and local government departments and agencies, Aboriginal organizations, international governments, non-governmental organizations and the public shall be fostered to uphold effective and co-ordinated drought action, management and mitigation.

Science and Knowledge

Sound science and knowledge combined with education, awareness and state-of-the art technology, are the means for adapting to changing climatic, environmental and social conditions. The most critical need for science and knowledge is before and during a drought.

Communication and Co-ordination

Effective communication and co-ordination amongst all agencies and stakeholders is essential for drought management. Exchange of current information and clarity over roles and responsibilities enables efficient co-ordination among all agencies and stakeholders involved in drought management.

Stewardship/Ownership

All Manitobans are responsible for preserving our natural water resources to maintain an abundance of clean water to meet present and future needs for our environmental, economic and social well-being. The cooperation of all Manitobans to reduce water consumption and use water efficiently during drought is very important.

Proactive Approach

Proactive communication and actions are essential for managing a drought. Communication with the public, industry and agricultural sectors can result in voluntary actions that may lessen the impacts of drought.

2. UNDERSTANDING DROUGHT

2.1 HISTORY OF DROUGHT ON THE CANADIAN PRAIRIES

In the last 100 years, geographically extensive, multi-year droughts with severe impacts were observed in the 1930s, 1960s, 1980s, and most recently in the early 2000s. In fact, according to the Institute for Catastrophic Loss Reduction's *Canadians at Risk* report (2010), droughts are responsible for five out of the top ten most expensive Canadian natural disasters on record.

Drought in the 1800s

Although not as well documented as the droughts of the 1900s, there were also many severe droughts that occurred in the 1800s. The Institute for Catastrophic Loss Reduction (Institute for Catastrophic Loss Reduction, 2010) lists impacts such as scorched potato crops in the Red River Valley in 1805, continuous drought and hordes of grasshoppers across the prairies from 1816 to 1819, complete failure on the 1846 crop in the Red River Valley, crop failures and grasshopper plague in 1868, and nine years of continuous drought across the prairies in the 1890s.

1930s Drought - The Dirty Thirties

Although droughts in the latter half of the 19th century may have been more severe in some areas, the drought of the 1930s was the drought with the largest impact on Manitoba and the Canadian Prairies. The drought set in during 1929 and prevailed through to the early 1940s. The drought of the 1930s was made famous by massive dust storms which earned the decade the nickname "the dirty thirties". The multi-year severe drought, combined with the 1929 stock market crash, led to devastating socioeconomic conditions on the prairies. Blowing dust and significantly reduced crop production occurred from the early 1930s to 1939. By the mid-1930s the drought was set in across the North American prairies, including across the

Canadian Prairies and south all the way to Texas in the U.S.A. Poor soil conservation and farming practices contributed to the soil conditions that allowed the dust storms to reach extraordinary proportions. Crop disease and grasshopper infestations added to the agricultural devastation. With low prices for cattle and lack of feed, conditions forced producers to reduce cattle herds by selling at low prices, or in some cases, culling portions of their herd with no return. The 1936 census indicates that 500 farms were abandoned in Manitoba (Dean et al., 1998). Lack of social programs and crop insurance combined with the poor economic conditions exacerbated many socioeconomic drought impacts. The dust and lack of water also caused health impacts on people, livestock, and wildlife. "Dust pneumonia" and other respiratory illnesses caused many deaths.

Failed crops and economic instability of farming operations created severe mental stress for farming families which led to increased suicide rates. Drought conditions finally began to ease in the early 1940s. The Prairie Farm Rehabilitation Administration (PFRA) was established in 1935 by the Federal Government of Canada as a Branch of Agriculture and Agri-food Canada. PFRA's mandate was to mitigate and recover from the drought by delivering various programs on soil erosion and on-farm water supply to support famers and agricultural industries.

Early 1960s Drought

The drought of the early 1960s was not as long in duration as the drought of the 1930s but was one of the most severe droughts on record. In June 1961 there were record low rainfall accumulations coinciding with record mean monthly temperature and bright sunshine hours. Conditions led to wide scale crop failures and famers selling off cattle due to lack of feed and water. Drought conditions in many locations were worse than conditions in the 1930s. Dust storms were prevalent reminding people of the great dust bowl of the 1930s. Although moderate droughts were reported throughout the 1960s, widespread severe drought was limited to 1961.

Drought of the late 1980s

The return of widespread severe drought occurred in the 1980s. The drought had significant economic impacts in Manitoba. The drought peaked in severity in 1988 causing agricultural production in Manitoba to reduce to 60 % of average. There was also an $80 million dollar loss in hydro power exports in 1989 (Simard and Joyce, 2005). Loss of wetland habitat and increase incidence of disease had a negative impact on waterfowl populations and associated recreation opportunities. Despite the severity of impacts, conditions could have been worse if drought preparedness had not been improved since the 1930s. Lessons on soil conservation had been learned from the 1930s and measures such as new tillage techniques, and treed shelter belts greatly reduced the potential for wind erosion of soils. Crop insurance and government subsidies were helpful to reduce socioeconomic impacts.

Drought from 1999 to 2004

The drought that occurred from 1999 to the mid-2000s was a severe multiyear drought that covered a large portion of the Canadian Prairies. It is the drought of record in some areas of Alberta. The drought had impacts across the prairies on agriculture, tourism, health, hydro power generation, and forestry. The Canadian gross domestic product lost $5.8 billion dollars for 2001 and 2002 due to the drought and more than 41,000 jobs were lost (Lawford et al., 2008). There was a $3.6 billion dollar reduction in agricultural production in the 2001/2002 fiscal year (Lawford et al., 2008). The drought also led to a dramatic increase in forest fires and numerous massive dust storms were reported. In fiscal year 2003/04, Manitoba Hydro incurred the largest financial loss in its history of $436 million due to reduced flow in its system (Manitoba Hydro-Electric Board, 2004).

The 2012 Drought

Most recently, drought conditions quickly developed across Manitoba in 2012 after widespread flooding that occurring in 2011. Although short in duration, drought impacts were already noticeable as pasture productivity was reduced and many dugout supplies were inadequate for livestock operations. Wildfires broke out in May near the communities of Badger and Vita leading to the declaration of local states of emergency. In October more wildfires occurred in southeast Manitoba and the Interlake. In the October fires two states of local emergency were declared, approximately 270 people were evacuated including the communities of Vita and Ross, and 14 homes or farm operations were damaged.

Historic Droughts

Tree ring analysis provides insight about the climate on the prairies before human observations started in the early 19th century. Tree rings research provides data that demonstrate the occurrence of wet and dry cycles in prairie rivers for the last 1000 years. A clear multi-decadal cycle between wet and dry cycles exists. Tree rings in the Upper Assiniboine River Watershed provide evidence that the most severe drought on record occurred in the latter half of the 16th century. This drought appears more severe, and much longer, than the drought of the 1930s. Tree rings form the Red River Basin show that the Red River was also in a severe multi-decade drought in the mid- to late-1500s. It is difficult to comprehend the catastrophe that would occur if Manitoba and the rest of the Canadian Prairies were to experience such a severe, multi-decade drought today. It would be the greatest natural disaster the Canadian Prairies has ever experienced.

Future Drought

The history of drought in Manitoba and the rest of the Canadian Prairies demonstrate that the impacts of drought can be extreme and can have consequences from a local to national scale. The historical cycle of wet and dry periods assures that the return of severe drought to Manitoba and the Canadian Prairies is inevitable in the coming decades. Severe multiyear droughts have occurred frequently in each century for the last number of centuries.

The droughts throughout the 20th century have proved that increased capacity (preparedness) through a variety of methods can help reduce the impacts of drought. The best way to protect Manitoba from the harsh impacts of drought is to prepare as best as possible before severe drought occurs. The Manitoba Drought Management Strategy will enhance Manitoba's understanding of drought and as action items are implemented, increase Manitoba's resilience to drought.

2.2. DEFINITION AND TYPES OF DROUGHT

Definition of Drought

There is no common definition of drought as drought is generally location specific and related to climatic and soil moisture conditions. For the purpose of this strategy, drought is defined as follows:

***Drought** is a natural hazard caused by a shortage of water resulting in direct effects on both human and environmental wellbeing, for a given period of time, for any location(s) where natural or managed water systems fail to meet the typical water demand for human and environmental uses.*

Types of Drought

The following types of drought are based on the definitions developed by the working groups of the Western Water Stewardship Council Technical Workshop on Drought Preparedness held in Calgary in May, 2009.

Meteorological Drought is generally defined by comparing the rainfall in a particular place and at a particular time with the average rainfall for that place. Meteorological drought leads to a depletion of soil moisture and this almost always has an impact on agricultural production. Meteorological drought only refers to the reduction in precipitation amount, and does not take into account the effects of the lack of precipitation on water levels and flows, human needs, or agriculture. A meteorological drought can occur without immediately impacting stream-flow, groundwater, or human needs. If a meteorological drought continues, it will eventually begin to affect water resources.

Agricultural Drought occurs when there is not enough water available for a particular crop to grow at a particular time. Agricultural drought depends on the amount of rainfall, prevailing soil moisture conditions, evaporation, and transpiration, among other factors. An important aspect of agricultural drought is the changing vulnerability of crops to moisture shortages during the different stages of their development. Agricultural droughts are typically detected after meteorological drought but before a hydrological drought.

Hydrological Drought is associated with the effect of low rainfall on water levels in rivers, reservoirs, lakes and aquifers. Hydrological droughts are usually noticed some time after meteorological droughts. First, precipitation decreases and after some time, water levels in rivers and lakes drop. Hydrological drought affects uses that depend on water levels. Changes in water levels affect ecosystems, hydroelectric power generation, and recreational, industrial and urban water use. A minor drought may affect small streams causing low stream-flows or drying. A major drought could affect surface storage, lakes and reservoirs thereby affecting water quality and causing municipal and agricultural water supply problems.

Rainfall recharges aquifers through infiltration and contributes run-off into streams and rivers. Once groundwater and surface waters are significantly affected by lack of precipitation, a hydrologic drought occurs. Aquifer declines occur naturally and the affects of a lack of recharge can be rapid in shallow aquifers or may extend over several years if recharge is lacking. A decline in water levels may impact shallow wells and farm dugouts and contribute to changes to ground water quality.

Socioeconomic Drought occurs when the supply fails to meet the demand for an economic good(s) such as domestic water supplies, hay/forage, food grains, fish, and hydroelectric power, due to weather related water supply shortages from one or both of natural or managed water systems. At any time during hydrological or agricultural droughts, a socioeconomic drought can occur.

2.3. POTENTIAL DROUGHT EFFECTS

The effects associated with drought may be economic, environmental or social (Institute for Catastrophic Loss Reduction, 2010; National Drought Mitigation Centre, 2014). Drought conditions can affect communities, agriculture, industry, individuals, animals and ecosystems in many different ways. For example, drought can lead to reduced water supplies for irrigation, drinking water, fisheries, forestry, municipal use, industrial use, hydroelectric generation and both land and aquatic ecosystems. If adequate water is not available in a community, drought may also lead to insufficient supplies for fire-fighting. The effects of droughts may differ in irrigated and non-irrigated agricultural areas. In regions that rely on irrigation, the effects of short-lived agricultural droughts are usually lower than in regions where crops are not irrigated.

Economic Effects

Economic effects cost people or businesses financial hardship, either directly or indirectly.

Drought events can devastate cropped lands and grasslands, resulting in farmers having poor or no crop production and therefore lost income. Ranchers may have to purchase feed for their livestock at increased costs. Livestock may require new watering systems should usual watering areas become dry. Farmers may have to spend more money on irrigation, drilling new wells or hauling water if regular water supplies become inadequate.

Companies reliant on water for manufacturing or production may have to spend money on new or additional water supplies or further water conservation, thereby increasing the cost of such goods. Significant water shortages can raise the cost of food. Businesses that depend on farming, such as companies that manufacture farm implements or process agricultural products, may lose business when drought damages crops or livestock. Small businesses in local communities

could feel the effects almost immediately, as consumer spending will be sharply reduced.

Companies that normally rely on hydroelectric power may have to spend more money on other energy sources if drought significantly reduces hydroelectric generation. If drought occurs, Manitoba Hydro must use its thermal generating plants or purchase power from neighbouring markets, both at a higher cost, to supply its electrical energy demand. Lower water supplies generally result in lower export revenues and higher purchase costs for Manitoba Hydro. Prolonged drought conditions can eventually lead to electricity rate increases for Manitoba residents and businesses.

When drought conditions exist, wildfires become increasingly common. The cost to fight forest fires rises dramatically and fires can destroy stands of timber and impact the forestry industry.

Droughts can also affect the tourism and recreation industry. As one example, when lakes and other water sources become low or dry, businesses that sell boats and fishing equipment, tourism packages or rely on tourism may not be able to sell some of their goods. Navigation of major waterways may be impeded due to low water levels, which will affect businesses that depend on water for transportation or tourism and recreation.

Manitoba has multi-million dollar commercial and recreational fisheries that could face a significant loss due to extended drought

conditions. Fish kills could occur due to low water coupled with high temperature. Significant fish kills could result in lost revenue for the commercial and recreational fishing industries. Some commercial fishers' incomes are not sufficient to withstand losses in revenue.

Environmental Effects

Drought also affects the environment in many different ways. Limited stream-flow may not provide adequate habitat and water quality to support fish during spawning or other life stages. Environmental effects may also include reduction of water supply for land animals, water fowl and plants. During long periods of drought, terrestrial and aquatic wildlife could face serious shortages of food which may cause migration of wildlife, destruction of aquatic life, soil erosion and poor soil quality. Wildfires also cause destruction of forest and grassland habitat.

Social Effects

Social effects of drought are the way in which a drought affects the health and safety of people. Social effects include public safety, human and animal health and changes in lifestyle and social interaction. Drought may negatively affect the mental health of individuals by inducing anxiety or depression over economic losses caused by drought and increased health problems. Food security and diet concerns may also develop due to reduction in crops, gardens, fishing and trapping, and increased cost of food. The 1930s drought resulted in many well documented health issues in the Canadian Prairies. Health problems could be related to low water flows, access to potable water, poor water quality, and increased air borne particles such as dust and smoke. During drought there is a significantly increased threat to public safety from an increased number of forest and range fires. Remote northern communities are most at risk to forest fires and smoke. Public safety and health issues could result in loss of life.

Significant or prolonged drought can create conflicts between people when there is not enough water to go around, disrupting social norms. Trans-boundary issues may develop if the water supply cannot meet apportionment agreements between jurisdictions.

2.4. WATER ALLOCATION UNDER *THE WATER RIGHTS ACT*

The Water Use Licensing Section of Manitoba Conservation and Water Stewardship is responsible for issuing water rights licences in Manitoba. Any individual or corporation who wishes to use water for agricultural, municipal, industrial, irrigation or other purposes must first obtain a licence under *The Water Rights Act*. Domestic use less than 25,000 litres per day is not licensed. Licences are categorized by the type of source, either groundwater or surface water, and the purpose of use: agricultural, domestic, irrigation, municipal, industrial or other. A licence is obtained by submitting an application to Manitoba Conservation and Water Stewardship. The application is reviewed to assess the effects the withdrawal will have on the water source and determine the remaining water available for allocation. A separate licence is generally required for each source or location from which water is to be obtained. The minister may refuse to issue a licence if, in the opinion of the minister, the action authorized by the licence would negatively affect an aquatic ecosystem.

Upon approval of an application by Manitoba Conservation and Water Stewardship, a water rights licence will be issued. The licence is issued for a time period deemed appropriate by Manitoba Conservation and Water Stewardship, up to a maximum of 20 years. To monitor user compliance with licensed volumes, Manitoba Conservation and Water Stewardship requires licensees to have a metering device and record and report their water use. Licences issued over the last 20 years or more have included such conditions. Information received from licensees is checked for compliance then filed.

Manitoba's water rights licensing is based on western water law where the precedence of licences is determined by the submission date of the licence application. This is commonly referred to as the principle of first-in-time, first-in-right. During a situation where the water supply is not able to meet the required demand for all water use licences, the most junior licence would be restricted first, followed by the next most junior licence and so on. However, during a serious water shortage, *The Water Protection Act* prevails over *The Water Rights Act*. Under *The Water Protection Act*, the minister can declare a serious water shortage and take any action, make any regulation, or issue any order to prevent, minimize, or alleviate the water shortage. The minister could use *The Water Protection Act* to make allocation decisions based on the best use of water in the public's best interest. For example, under Section 9 of *The Water Rights Act*, the following uses are listed in order of "priority of purpose" starting with the highest priority first: domestic purposes, municipal purposes, agricultural purposes, industrial purposes, irrigation purposes and other purposes.

2.5. CLIMATE CHANGE EFFECTS ON DROUGHT

The Intergovernmental Panel on Climate Change (IPCC) recently published their fifth assessment report (IPCC, 2014), indicating with very high confidence that global warming is very likely to lead to more frequent heat events, low-snow years, and daily precipitation extremes over most of North America. These climate stresses may result in more frequent and intense droughts, which will compound with the natural multi-decadal wet-dry cycle observed in historical records. Several studies assessing how climate change will affect the occurrence of drought events across the Canadian Prairies echo the findings of the IPCC, suggesting there is strong potential for the occurrence of more regular and persistent droughts, with greater severity than those observed over the 20th century (Bonsal et al., 2012).

As a part of the Prairie Regional Adaption Collaborative, Manitoba Conservation and Water Stewardship in collaboration with Manitoba Agriculture, Food and Rural Development and Manitoba Infrastructure and Transportation undertook two preliminary studies on the Assiniboine River and the Icelandic River watersheds in southern Manitoba.

The study on the Assiniboine River Basin assessed the impact on water supply and demand with and without climate change (Manitoba Conservation and Water Stewardship and GENIVAR, 2012). Temperature and precipitation data from a regional climate model were analyzed for the time horizons of the 2020s, 2050s and 2080s. Due to scope limitations, multiple combinations of climate models and emission scenarios were not able to be assessed and as such, the results do not account for the range in climate change related uncertainties. Results from this study projected increased temperature and seasonal variations in precipitation changes. Reduced summer precipitation, coupled with increased temperatures resulted in the potential for increased summer droughts. The water demand portion of the study indicated increases in water demand, with greater uncertainty further into the future. The study demonstrates the need for continued water supply and demand management on the Assiniboine River and the importance of long-term planning to account for future uncertainty.

The anticipated impacts of climate change on future drought events further reinforce the need for a drought management strategy for Manitoba. To account for uncertainty in projections and spatial variation of impacts throughout Manitoba, more comprehensive studies on the long-term impacts of climate change on water supply and demand are required. These studies should not be constrained within the provincial boundary of Manitoba but should also consider the upstream jurisdictions which contribute waters to Manitoba.

ACTION ITEM:
Undertaking studies on long-term effects of climate change on water supply and demand for river basins.

3. DROUGHT COMMITTEES

In the spring of 2008, Manitoba Conservation and Water Stewardship established a departmental drought committee. An inter-departmental drought committee was also established in 2008 with representation from the provincial departments most directly involved in drought management along with the federal department of Agriculture and Agri-Food Canada. Through the agencies involved in the two committees, informal updates are provided on water availability and drought conditions in Manitoba. In 2010, the role of the Manitoba Conservation and Water Stewardship Drought Committee was redefined to oversee and provide direction for the development of a drought management strategy for Manitoba.

Co-ordinated monitoring, reporting and response to drought are required between stakeholders and the federal, provincial and local governments. Therefore, a Manitoba Drought Assessment Committee and a Basin Drought Assessment Groups will be formed to facilitate the required co-ordination of drought management activities throughout the province.

ACTION ITEM:
Establish drought committees to enable efficient information sharing and co-ordination of province-wide drought management efforts.

3.1. MANITOBA DROUGHT ASSESSMENT COMMITTEE

The Manitoba Drought Assessment Committee will be an inter-agency committee with representatives from various government departments and agencies. The committee will provide high level oversight, direction, and input into the areas of drought monitoring, reporting and management for the province. The Manitoba Drought Assessment Committee will meet regularly during a drought or when a drought appears to be developing. Each member of the committee represents their own department/agency and provides a departmental/agency update to the committee about drought monitoring, reporting and management, and will provide information from the committee back to their department/agency.

The Manitoba Drought Assessment Committee will report to the minister responsible for *The Water Protection Act* and will provide advice to the minister and the Manitoba government on actions that are necessary to monitor, report and manage the effects of drought. The committee will be chaired by the manager of the Surface Water Management Section (Manitoba Conservation and Water Stewardship). Technical secretariat support will be provided by the Surface Water Management Section. The committee will be encouraged to work where possible to raise public awareness regarding drought impacts and to support educational programs for water conservation and drought management.

Membership

The Manitoba Drought Assessment Committee will be made up of members representing:

- Manitoba Conservation and Water Stewardship, Surface Water Management Section (Chair and Technical Secretariat)
- Manitoba Conservation and Water Stewardship (other branches/sections)
- Manitoba Agriculture, Food and Rural Development
- Manitoba Agricultural Services Corporation
- Manitoba Infrastructure and Transportation
- Manitoba Water Council
- Manitoba Municipal Government

- Manitoba Health
- Manitoba Aboriginal and Northern Affairs
- Manitoba Hydro
- Manitoba Water Services Board
- Agriculture and Agri-Food Canada

Other provincial, aboriginal, and federal agencies, such as Environment Canada, will be engaged as appropriate.

Roles and Responsibilities

The Manitoba Drought Assessment Committee will have the following roles and responsibilities:

- to co-ordinate and provide input to drought assessment and reporting
- to consult with stakeholders to verify drought indicators and conditions
- to educate Manitobans regarding drought and drought mitigation efforts
- to make recommendations to the minister responsible for *The Water Protection Act* regarding the declaration of drought stage, water conservation, and drought mitigation strategies
- to provide input to the minister responsible for *The Water Protection Act* regarding the declaration of serious water shortages and water management during serious and/or extreme droughts
- to review and provide ongoing direction on the implementation of the Manitoba Drought Management Strategy
- to implement programs and policies regarding drought and water supply management in Manitoba
- to provide direction for co-ordinated drought assessment and research to the benefit of all Manitobans

3.2. BASIN DROUGHT ASSESSMENT GROUPS

The Basin Drought Assessment Groups will be made up of stakeholder organizations with representatives from the major river basins across Manitoba (Figure 3.1). Basin Drought Assessment Groups will use their local knowledge of the basin and current observations to provide verification of drought conditions and report any drought impacts. The Manitoba Drought Assessment Committee will use this information when determining drought stage and appropriate actions for drought management. The groups will be encouraged to raise public awareness regarding drought and to support educational programs for water conservation and drought management.

Active involvement of the Basin Drought Assessment Groups is envisioned, but will be dependent upon drought conditions. The engagement of Basin Drought Assessment Groups will be most intensive during severe or extreme drought stages and less active during normal conditions.

Membership

The Basin Drought Assessment Groups could be comprised of members representing, but not limited to, the following:

- Manitoba Conservation Districts Association
- Association of Manitoba Municipalities
- Manitoba Water Council
- local governments including rural municipalities/cities/towns/villages
- agricultural organizations and producer groups such as the Manitoba Beef Producers Association, Keystone Agricultural Producers, the Forage Seed Association, and the Manitoba Pork Council
- aboriginal governments and organizations such as the Manitoba Metis Federation
- Manitoba cottage associations

Roles and Responsibilities

The Basin Drought Assessment Groups will have the following roles and responsibilities:

- to provide input to drought monitoring and reporting
- to provide input to the Manitoba Drought Assessment Committee regarding drought issues including, but not limited to, drought stage, declaration of serious water shortages, water conservation, and drought mitigation
- to educate basin residents regarding drought and drought mitigation efforts
- to implement, within their organizations, programs and policies regarding drought and water supply management
- to review and provide input to the ongoing evaluation of the Manitoba Drought Management Strategy

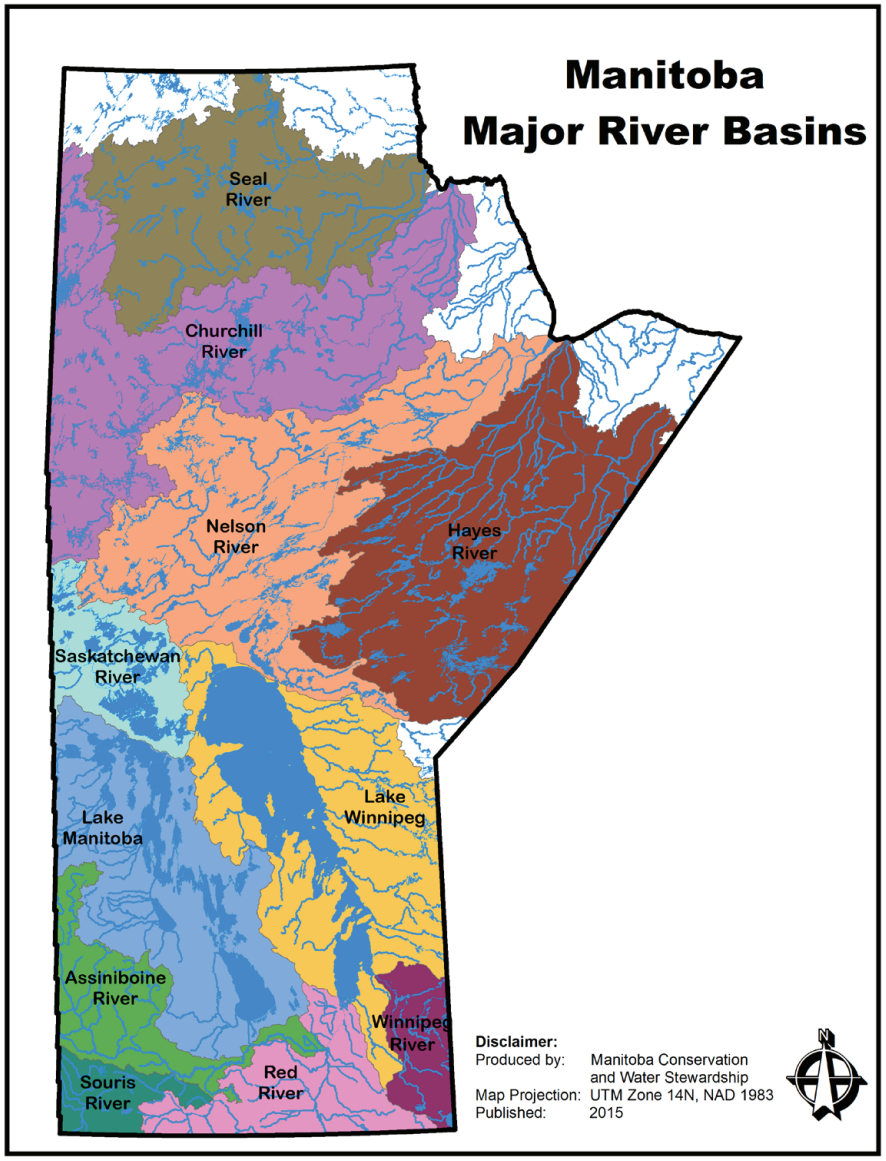


Figure 3.1 Manitoba Major River Basins

3.3. INVOLVEMENT OF DEPARTMENTS AND AGENCIES

Federal, provincial and local governments play an important role in drought management including monitoring and reporting. Every individual in Manitoba plays a role in drought management and mitigation through their everyday choices regarding water efficiency and reducing water consumption. The success of the Manitoba Drought Management Strategy depends on the co-ordinated action of federal, provincial, and local governments, as well as stakeholder and public involvement and awareness.

Manitoba Conservation and Water Stewardship, the Manitoba Drought Assessment Committee and the Basin Drought Assessment Groups will work with the various government agencies and stakeholders that play a role in drought monitoring, reporting and management to ensure timely information sharing, efficient communication and co-ordinated management of drought in Manitoba.

Under the Manitoba Drought Management Strategy, the minister of Manitoba Conservation and Water Stewardship (with responsibility for *The Water Protection Act*) is responsible for declaring drought stages and, along with department staff, the Manitoba Drought Assessment Committee and the Basin Drought Assessment Groups, would co-ordinate drought monitoring, reporting and management. The minister responsible for the Emergency Measures Organization will continue to be responsible for overseeing and co-ordinating the actions required during water shortage emergencies and when local governments declare states of emergency. Manitoba Conservation and Water Stewardship will collaborate with the Emergency Measures Organization to enhance the Manitoba Emergency Plan to include specific guidance for drought-related emergencies.

ACTION ITEM:
Collaborate with the Emergency Measures Organization to enhance the Manitoba Emergency Plan to include specific guidance for drought-related emergencies.

4. DETERMINING DROUGHT

4.1. DROUGHT INDICATORS

Drought indicators enable the description of drought in a consistent way across different times and places and allow for the effective management of droughts at various stages. Drought indicators detect and characterize drought conditions where drought thresholds define and activate the level of response to drought. Drought indicators and thresholds are important for several reasons:

- to detect and monitor drought conditions
- to determine the timing and level of drought response
- to characterize and compare drought events

Operationally, drought indicators are the backbone of a drought management strategy, tying together levels of drought severity with drought preparedness and drought response.

Drought indicators describe the magnitude, duration, severity and spatial extent of drought. Typical indicators are based on meteorological and hydrological variables such as precipitation, stream-flow, soil moisture, reservoir storage and groundwater levels. Precipitation and stream-flow indicators are commonly used in other jurisdictions for drought management.

Considering data availability in Manitoba and practices in place elsewhere, precipitation (median and percentiles) and stream-flow (percentiles) are selected as the primary indicators for Manitoba. Specific precipitation and stream-flow indicators have been developed to reflect Manitoba conditions. Groundwater levels, the Standard Precipitation Index, the Palmer Drought Index, soil moisture information, and other datasets will be used as secondary indicators to evaluate overall basin conditions prior to entering into a drought stage. Secondary indicators will be computed based on available data or provided from federal and provincial agencies.

The coverage and accuracy of drought indicators are limited in part by data availability and quality. The existing meteorological, hydrometric, soil moisture, groundwater and other networks used to monitor drought will be evaluated, and enhanced where possible, to improve Manitoba's drought monitoring capability.

Drought indictors will be analyzed and monitored on a regular basis as input into the determination of drought stage. The Surface Water Management Section will maintain a database to determine drought indicators. When required, assistance from other sections and departments will be sought for collection of additional data and assessment of secondary indicators. As drought severity increases, so too will the frequency of indicator evaluation.

Drought thresholds are trigger values of an indicator that distinguish between drought levels and are indicative of the specific management actions required. Indicator thresholds are selected for each indicator by comparing historical recorded drought and non-drought events with possible combinations of thresholds. The thresholds are selected for Manitoba based on recorded drought events. A summary of the primary and secondary indicators is provided below.

4.1.1. PRIMARY INDICATORS

Precipitation Indicators

For precipitation, two types of indicators have been developed – one based on the per cent of historical median precipitation and a second based on the percentiles of precipitation. Medians and the percentiles are developed by analyzing historical precipitation records available at weather stations within each major watershed across Manitoba. A long-term period of record is required to calculate the indicators, as the indicator computation compares recent conditions to long-term values at given location. Currently, 38 stations have sufficient data to determine the precipitation indicators.

A. Per Cent of Median Precipitation

The per cent median of precipitation indicator is calculated at three different time scales (one-month, three-months, and 12-months) to evaluate both short- and long-term drought conditions. The one-month and three-month indicators are more sensitive to monthly or seasonal precipitation changes, reflecting meteorological and agricultural drought conditions. The 12-month median precipitation indicator provides an assessment of longer-term hydrological drought conditions.

To calculate the indicator, the total precipitation received over the selected time scale (one-month, three-months, or 12-months) is compared to the median historical precipitation for the same time scale. An example of the three-month median precipitation calculation is shown below:

$$\text{Per cent (\%) median precipitation (three months)} = \frac{\text{precipitation received in three months}}{\text{median three month historical precipitation}} \times 100$$

The per cent of median precipitation is then compared to the indicator thresholds to determine drought condition:

Normal: precipitation received in three months is greater than 80 per cent of the historical three-month median precipitation

Moderately Dry: precipitation received in three months is between 60 per cent and 80 per cent of the historical three-month median precipitation

Severely Dry: precipitation received in three months is between 40 per cent and 60 per cent of the historical three-month median precipitation

Extremely Dry: precipitation received in three months is less than 40 per cent of the historical three-month median precipitation

The median precipitation indicator analysis is shown on Figure 4.1 for Winnipeg. For each year, the median three-month historical precipitation is compared to the actual precipitation received over a three month period. This is repeated for each three month period in each year (ex. January, February and March; February, March and April; March, April, and May; etc.). In most years, conditions are generally normal (79 per cent of the time) but moderately dry, severely dry and extremely dry conditions did occur throughout the period between 1938 and 2011. Moderate conditions are observed 14 per cent of the time, severe conditions are observed six per cent of the time, and extreme conditions are observed one per cent of the time.

The calculations are then repeated to develop the one-month and 12-month median precipitation indicators. In each case, the median historical precipitation received over the selected time scale is compared to the actual precipitation received over the month(s) in question.

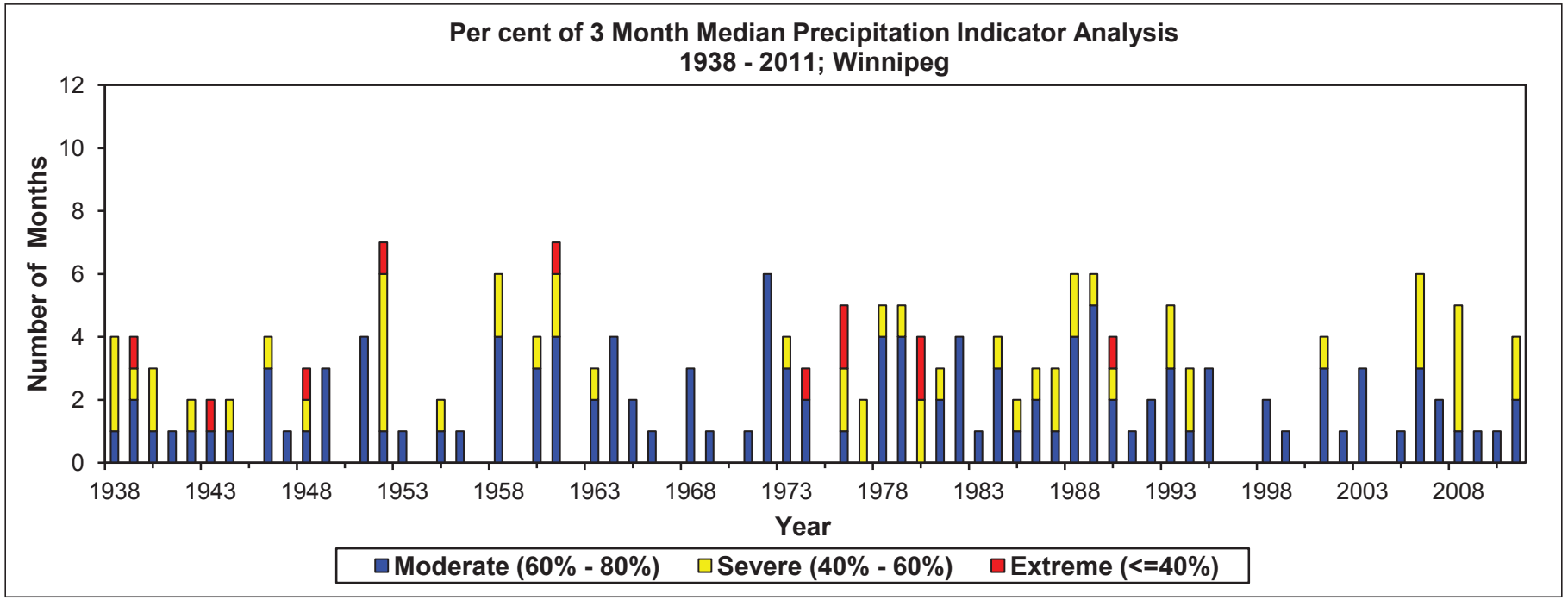


Figure 4.1 Per cent of Median Precipitation Indicator Analysis for Winnipeg

B. Precipitation Percentile Indicator

At each of the 38 weather gauges with sufficient precipitation data, the historical records are used to calculate the fifth, 20th and 35th percentiles of precipitation for each month of the year. For example, the fifth percentile is the precipitation amount that occurs less than or equal to five per cent of time or, in other words, is the precipitation amount that is exceeded 95 per cent of the time. To calculate the indicator, the total precipitation received over the month in question is compared to the historical monthly fifth, 20th and 35th percentiles with the following thresholds:

Normal: actual monthly precipitation is greater than the historical 35th percentile

Moderately Dry: actual monthly precipitation is between the historical 35th and 20th percentiles

Severely Dry: actual monthly precipitation is between the historical 20th and fifth percentiles

Extremely Dry: actual monthly precipitation is less than or equal to the historical fifth percentile

The precipitation percentile indicator analysis is shown on Figure 4.2 for Winnipeg. For each year, the actual precipitation received in a month is compared to the historical fifth, 20th and 35th percentiles. This calculation is repeated for each month in each year between 1938 and 2011. In most years, conditions are mostly normal (87 per cent of the time) but moderately dry, severely dry and extremely dry conditions did occur throughout the period. Moderate conditions are observed six per cent of the time, severe conditions are observed five per cent of the time, and extreme conditions are observed two per cent of the time.

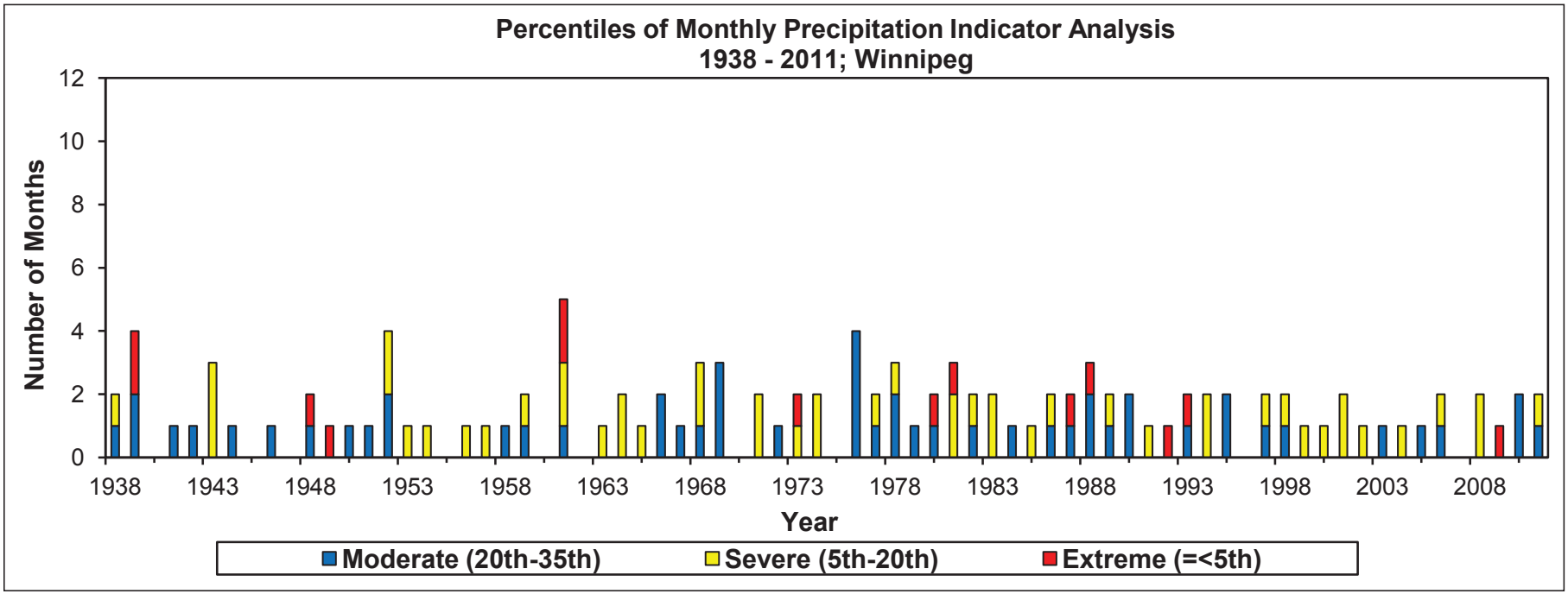


Figure 4.2 Precipitation Percentile Indicator Analysis for Winnipeg

Stream-flow Percentile Indicator

A stream-flow indicator has been developed based on the monthly 10th, 20th and 35th percentiles of stream-flow. The percentiles are calculated at 29 gauging stations across Manitoba through analysis of long-term historical stream-flow records.

An approach similar to the precipitation percentile indicator is applied to determine the stream-flow percentile indicator. At each gauging station, the historical record is used to calculate the 10th, 20th and 35th percentiles of stream-flow for each month of the year. For example, the 10th percentile is the stream-flow amount that occurs less than or equal to 10 per cent of time or, in other words, is the stream-flow amount that is exceeded 90 per cent of the time. Because stream-flow displays clear seasonal patterns, the monthly percentiles are compared seasonally to determine the lowest 10th, 20th and 35th percentiles across each season.

To calculate the indicator, the average stream-flow received over the month in question is compared to the respective seasonal 10th, 20th and 35th percentiles with the following thresholds:

Normal: average monthly flow is greater than the historical 35th percentile

Moderately Dry: average monthly flow is between the historical 35th and 20th percentiles

Severely Dry: Average monthly flow is between the historical 20th and 10th percentiles

Extremely Dry: Average monthly flow is less than or equal to the historical 10th percentile

The stream-flow percentile indicator analysis is shown on Figure 4.3 for the Red River at Emerson. For each year, the actual stream-flow in each month is compared to the historical 10th, 20th and 35th percentiles for that season. This is repeated for each month in each year between 1912 and 2011. In most years, conditions are mostly normal (78 per cent of the time) but moderately dry, severely dry and extremely dry conditions did occur throughout the period. Moderate conditions are observed nine per cent of the time, severe conditions are observed seven per cent of the time, and extreme conditions are observed six per cent of the time. The primary indicators are summarized in Table 4.1.

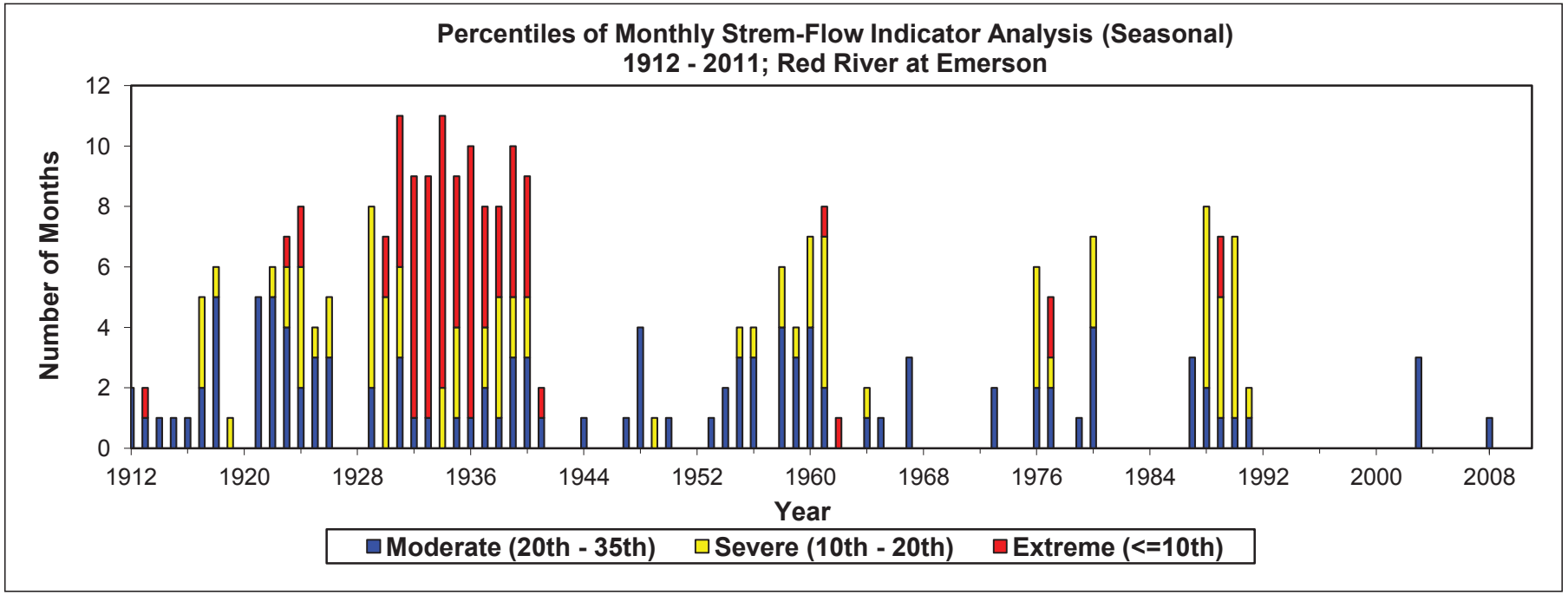


Figure 4.3 Stream-flow Percentile Indicator Analysis for the Red River at Emerson

Table 4.1 Summary of Primary Indicator Thresholds

Drought Condition	Indicator Thresholds		
	Per cent of median precipitation indicator	**Precipitation percentile indicator**	**Stream-flow percentile indicator**
	Actual precipitation compared to per cent of median for one, three or twelve months	Actual monthly precipitation compared to historical 5^{th}, 20^{th} and 35^{th} percentiles	Actual monthly streamflow compared to historical 10^{th}, 20^{th}, and 35^{th} percentiles for each season
Normal	>80% of median	> 35^{th}	> 35^{th}
Moderately dry	60% - 80% of median	20^{th} – 35^{th}	20^{th} – 35^{th}
Severely dry	40% - 60% of median	5^{th} – 20^{th}	10^{th} – 20^{th}
Extremely dry	<40% of median	≤ 5^{th}	≤ 10^{th}

4.1.2. SECONDARY INDICATORS

Secondary indicators will be used to assist in assessing basin conditions, thereby complementing the primary indicators. Some of the secondary indicators such as the Standard Precipitation Index and the Palmer Drought Severity Index are calculated and made available through other sources such as Agriculture and Agri-Food Canada.

Groundwater Percentile Indicator

Groundwater is the primary water supply for many water users across the province. Although the groundwater indicator is listed as a secondary indicator, this does not suggest it is of secondary importance. However, for use as a drought indicator, groundwater reacts slowly to changes in precipitation and can often lag several months or years behind changes seen in streams and lakes. Precipitation and stream-flow indicators are much better at capturing the onset of drought and monitoring moderate droughts. Groundwater indicators will be more important during severe, long-term droughts and could be used as a primary indicator during these events.

The groundwater indicator has been developed based on groundwater level percentiles. The percentiles are based on an analysis of historical groundwater records available at five groundwater monitoring stations located throughout the major aquifers across southern Manitoba.

An approach similar to the precipitation and stream-flow percentile indicators is applied to determine the groundwater percentile indicator. The historical one tenth, fifth, and 25th percentiles of groundwater level are computed for each month of the year. For example, the one tenth percentile is the water level that occurs less than or equal to one tenth per cent of the time or, in other words, is the water level amount that is exceeded 99.9 per cent of the time. In calculating the indicator, the average water level of the month in question is compared to the one tenth, fifth, and 25th percentiles with the following thresholds:

Normal: average monthly groundwater level is greater than the historical 25th percentile

Moderately Dry: average monthly groundwater level is between the historical 25th and fifth percentiles

Severely Dry: average monthly groundwater level is between the historical fifth and one tenth percentiles

Extremely Dry: average monthly groundwater level is less than or equal to the historical one tenth percentile

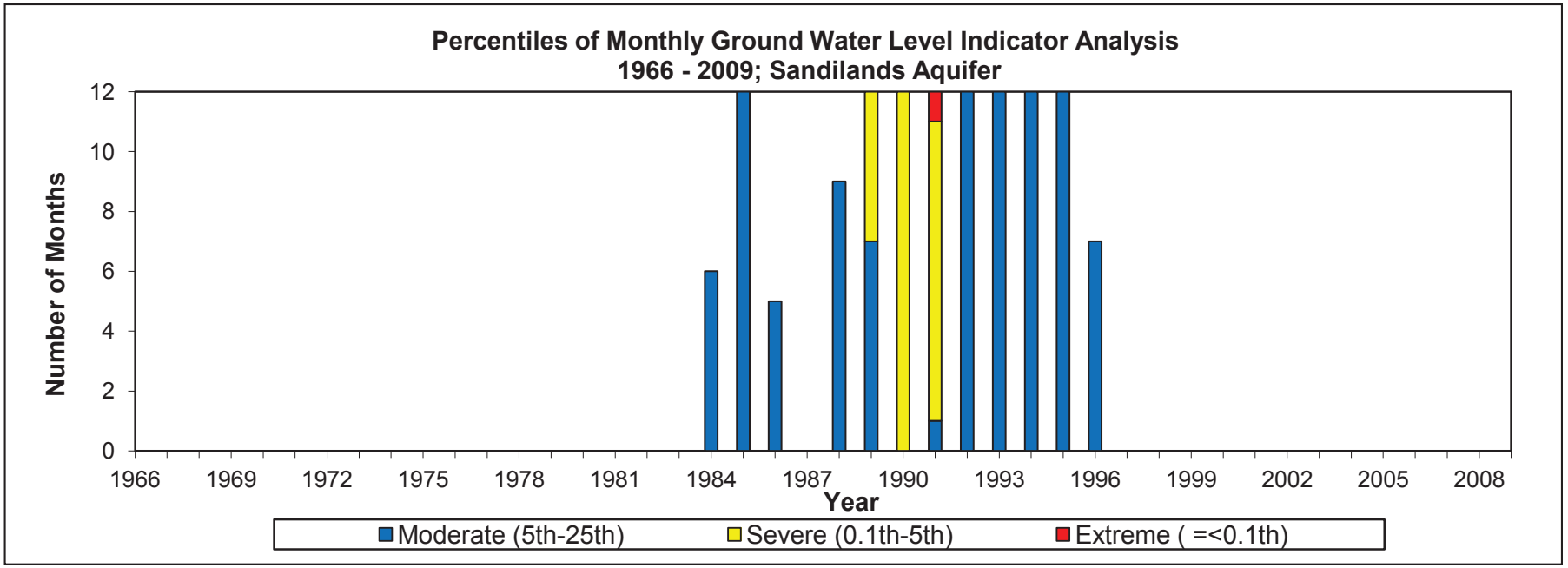


Figure 4.4 Groundwater Level Percentile Indicator Analysis for the Sandilands Aquifer

The groundwater percentile indicator analysis is shown on Figure 4.4 for the Sandilands aquifer. For each year, the actual average water level in each month is compared to the historical monthly one tenth, fifth and 25th percentiles. This is repeated for each month in each year between 1966 and 2009. In most years, conditions are mostly normal (76 per cent of the time) but moderately dry, severely dry and extremely dry conditions did occur throughout the period. Moderate conditions are observed 18 per cent of the time, severe conditions are observed five per cent of the time, and extreme conditions are observed less than one per cent of the time. The groundwater indicator is summarized in Table 4.2.

Table 4.2 Summary of Groundwater Level Indicator Thresholds

Drought Condition	**Indicator Thresholds**
	Groundwater percentile indicator
	Actual monthly level compared to historical 0.1th, 5th and 25th percentiles
Normal	> 25th
Moderately dry	5th – 25th
Severely dry	0.1th – 5th
Extremely dry	≤ 0.1th

Standard Precipitation Index

The Standard Precipitation Index (SPI) was developed in 1993 (McKee et al., 1993) and is designed to quantify the precipitation deficit for multiple time scales for the detection of drought. It is based on the probability of precipitation for a given time period where data are normalized to fit into a normal probability distribution.

Standard Precipitation Index thresholds are measured on a scale of negative and positive values where negative values indicate less than median precipitation (ex: dry) and positive values indicate greater than median (ex. wet). Near normal conditions range between +1 and -1 and extremely dry and wet conditions are below -2 and above +2, respectively.

Palmer Drought Severity Index

The Palmer Drought Severity Index was developed in 1965 (Palmer, 1965) to measure the soil moisture deficit by providing a number to classify drought severity. Precipitation, air temperature and soil moisture data are generally used to calculate the Palmer Drought Severity Index over different time scales. The limitation of this indicator is that Palmer values may lag emerging droughts by several months which is not suitable for near real-time monitoring. The index has proven most effective in determining severity of long-term droughts.

Palmer Drought Severity Index thresholds are measured on a scale of negative and positive values where negative values indicate dry and positive values indicate wet. Near normal conditions range between +0.5 and -0.5 and extremely dry and wet conditions are below -4 and above +4, respectively.

Canadian Forest Fire Weather Index System Drought Code

Manitoba Conservation and Water Stewardship's Fire Program uses the Drought Code of the Canadian Forest Fire Weather Index System (Natural Resources Canada, 2008; Girardin and Wotton, 2009) to prepare fire hazard maps to forecast fire danger. The Drought Code could be used as a secondary indictor to assess the risk of wildfire. The Canadian Forest Fire Weather Index System defines the Drought Code as a numeric rating of the average moisture content of deep, compact organic layers. This code is a useful indicator of seasonal drought effects on forest fuels and the amount of smoldering in deep duff layers and large logs. It is an index of soil moisture variation in the deep layer of the forest floor (about 20 cm deep on average) or other heavy (large diameter) fuels and is a good indicator of fire conductive droughts.

Other Secondary Indicators

Other possible secondary indicators based on data such as soil moisture content, snow pack information, and lake and reservoir levels are used less frequently in Canada and some are still in the development stage. These indicators will be considered as they become more readily available for drought monitoring in Manitoba. In particular, the implementation of a soil moisture-based indicator and use of composite or blended indices, such as those provided by the Canadian Drought Monitor, would be beneficial for the assessment of drought in Manitoba.

4.2. DATA ANALYSIS

Assessing drought indicators will require collecting and analyzing information from various sources, managing these data and preparing communication tools. Manitoba Conservation and Water Stewardship's Surface Water Management Section will be responsible for collecting, analyzing and managing this information, assessing indicators and preparing indicator maps. Given that data required for assessment of drought indicators will come from a number of sources, the section will collaborate with other sections and departments in both the provincial and federal governments.

Information on the various primary and secondary drought indicators will need to be consolidated for determining drought stage (see Section 5). The Surface Water Management Section will take the lead on consolidating these indicators and reporting this information to the Manitoba Drought Assessment Committee, Basin Drought Assessment Groups, stakeholders, and the public. During moderate, severe and extreme droughts, other agencies that collect data and assess drought indicators will have greater involvement, through the Manitoba Drought Assessment Committee, in determining the drought stage.

4.3. PREPAREDNESS

Drought conditions develop gradually over a number of weeks, months or even years. The gradual progression of drought allows for preparation at federal, provincial and local levels. Preparedness is the level of a basin's resiliency to withstand a drought. Drought preparedness includes monitoring networks, structural and non-structural measures and strategies for mitigating drought, and communication networks between drought committees, governments, stakeholders and the public. Being prepared for the onset of drought is the most desirable and proactive means to manage drought.

Over the next five to ten years, preparedness will be assessed in basins across Manitoba by considering variables such as water sources and their reliability, current management of water supply infrastructure, socioeconomic conditions, drought mitigation strategies currently in place and existing communication networks. A promising mechanism to collect this information and assess basin preparedness is the consideration of drought within the integrated watershed management planning process. Integrated watershed management planning is a collaborative effort between government, watershed residents and stakeholders in which a long-term plan is created to manage water, land and other resources for a particular watershed.

Once compiled, drought preparedness information will be evaluated to assess specific vulnerabilities to drought within each basin. The culmination of each basin preparedness assessment is a suggestion of the current drought preparedness level (none, low, medium and high). This information, alongside drought indicator data, will be used to determine the drought stage for each major basin.

Where drought indicators suggest moderately dry, severely dry or extremely dry conditions, the Manitoba Drought Assessment Committee will work closely with the Basin Drought Assessment Groups to obtain up to date information on observed conditions and any impacts. An accurate assessment of preparedness level is critical to determining drought stage and the appropriate drought management response.

ACTION ITEM:
Determine drought preparedness levels for each basin.

5. DROUGHT STAGE AND DECLARATION

5.1. DROUGHT STAGE

Drought stage denotes the severity and extent of drought for a geographic area. The drought stage for each basin will be determined by combining the drought condition, as derived from the science-based drought indicators discussed in Section 3.1, and the preparedness level of the basin (Section 4.3). Table 5.1 demonstrates how the information is combined to determine the drought stage. The proposed drought stages are: Normal Drought Stage, Moderate Drought Stage, Severe Drought Stage and Extreme Drought Stage. The stages are color coded green, blue, yellow, and red, respectively.

Table 5.1 Drought Stage as Determined Based on Drought Condition and Preparedness

Drought Condition	Preparedness Level			
	None	Low	Medium	High
Normal	Normal	Normal	Normal	Normal
Moderately dry	Moderate	Moderate	Moderate	Normal
Severely dry	Severe	Severe	Severe	Moderate
Extremely dry	Extreme	Extreme	Severe	Moderate

A combination of the primary and secondary drought indicators considered the most applicable will be used to characterize the drought condition for each major basin. The assessment of a basin's drought condition will consider water usage within all major water sectors, placing increased emphasis on the drought indicators best describing the most significant sectors within the basin. For example, if a basin is very reliant on a particular groundwater source for domestic and municipal water supply, the groundwater indicator will be a significant component in the drought condition assessment for that basin. In addition, a combination of other indices that assess long term drought conditions such as the 12-month per cent of median precipitation indicator and the Palmer Drought Severity Index will be used to further evaluate the drought condition for this basin and its groundwater supply. This assessment of drought condition along with observed impacts and/or the level of preparedness (where available) will be used to determine drought stage for a basin.

Normal (Green) Stage indicates there are no anticipated water supply shortages or problems and that all functions of a basin work properly for water management. Monthly updates on water availability and drought indicators are recommended during this stage to assist with identifying emerging droughts and managing potential impacts.

Moderate (Blue) Stage indicates a mild or modest drought and is the first indication of a potential water supply shortage in a basin. Monthly updates on water availability and drought indicators are recommended to provide ongoing information on drought status with more frequent updates when necessary.

Severe (Yellow) Stage indicates a severe or serious drought and a potentially serious water supply shortage in a basin. Updates on water availability and drought conditions every two weeks are recommended to provide ongoing information on drought status with more frequent updates when necessary.

Extreme (Red) Stage indicates an extreme or intense drought and indicates a major water supply shortage in a basin. In an extreme drought, water supplies will fail to meet demand causing increasingly more serious and widespread socioeconomic effects. In this stage, a serious water shortage may be declared. Weekly updates on water availability and drought conditions are recommended to provide ongoing information on drought status with more frequent updates when necessary.

ACTION ITEM:
Combine preparedness levels with drought condition information to determine drought stages. Implement the four colour-coded drought stages to monitor drought in Manitoba.

5.2. DROUGHT STAGE DECLARATION/CONFIRMATION

Manitoba Conservation and Water Stewardship is responsible for declaring a drought at any stage (moderate, severe or extreme). The department is also responsible for withdrawing a drought stage or changing the drought stage. The department's decision will be based on advice received from the Manitoba Drought Assessment Committee which will incorporate input from the Basin Drought Assessment Groups. The committee's recommendations will be based on the drought indicators as well as appropriate information from the basin on preparedness level and potential impacts. Ideally, transition from one drought stage to another will be sequential. For the extreme drought stage, the committee will need to provide two recommendations to the department: (i) for declaring/confirming an extreme drought stage and (ii) for declaring serious water shortages under *The Water Protection Act.*

6. RESPONSE TO DROUGHT

The response in Manitoba to changes in drought stage would occur on several levels. At the provincial and local level, the response to change would occur in part through the Manitoba Drought Assessment Committee and the Basin Drought Assessment Groups. Under normal, moderate and severe conditions, the Manitoba Drought Assessment Committee would co-ordinate drought monitoring and reporting, water supply and demand management, education and water conservation with primary support from Manitoba Conservation and Water Stewardship. Individual departments, agencies, local government and stakeholders will also have a role to play in the response to drought. In extreme droughts, appropriate departments and local governments would be engaged to manage serious water shortages. Provincial co-ordination of the response to an emergency caused by extreme drought would be the responsibility of the Emergency Measures Organization.

A brief description of the response required at each drought stage is described below:

Normal (Green) Stage

During normal (green) stage, it is anticipated that there are no water shortages and that the water management demands within a basin will be met.

- Provincial, federal and municipal departments along with local stakeholder groups would provide appropriate direction to promote water efficiency and undertake programs regarding watershed management planning, education and awareness.
- All levels of government would carry out their programs to minimize the effects of drought and water supply shortages and provide updates through the Manitoba Drought Assessment Committee.
- The Manitoba Drought Assessment Committee would analyze available information including indicators and make recommendations if the potential for a moderate drought exists.
- Basin Drought Assessment Groups will be engaged as necessary to provide input into the potential for a moderate drought.

Moderate (Blue) Stage

In the moderate stage, it is anticipated that there may be modest water shortages in all or parts of the basin, where some demands for human, agriculture, industrial, and ecosystem needs may not be fully met.

- Basin Drought Assessment Groups would be engaged as necessary to provide information on local conditions.
- The Manitoba Drought Assessment Committee and Basin Drought Assessment Groups would analyze available information including concerns over any water shortages and potential changes in the drought stage.
- The Manitoba Drought Assessment Committee would prioritize actions necessary to minimize drought impacts and would recommend actions for departments/agencies and stakeholders including Manitoba Conservation and Water Stewardship.
- All levels of government would carry out their programs to minimize the impacts of drought and provide updates through the Manitoba Drought Assessment Committee.

Severe (Yellow) Drought Stage

In the severe stage, it is anticipated that there will be serious water shortages in all or parts of the basin, where demands for human, agriculture, industrial and ecosystem needs may not be fully met.

- Basin Drought Assessment Groups would be engaged as necessary to provide information on local conditions.
- The Manitoba Drought Assessment Committee and Basin Drought Assessment Groups would analyze available information including concerns over any water shortages and potential changes in the drought stage.
- The Manitoba Drought Assessment Committee would prioritize actions necessary to minimize drought impacts and would recommend actions for departments/agencies and stakeholders including Manitoba Conservation and Water Stewardship.
- All levels of government would carry out their programs to minimize the impacts of drought and provide updates through the Manitoba Drought Assessment Committee.

Extreme (Red) Drought Stage

In the extreme stage, it is anticipated that there will be major water shortages in all or parts of the basin, where supply fails to meet the demand for human, agriculture, industrial, commercial and ecosystem needs resulting in increasingly more serious and widespread socioeconomic effects.

- Basin Drought Assessment Groups would be engaged as necessary to provide information on local conditions.
- The Manitoba Drought Assessment Committee and Basin Drought Assessment Groups would analyze available information including concerns over any water shortages and potential changes in the drought stage.
- The Manitoba Drought Assessment Committee would prioritize actions necessary to minimize drought impacts and would recommend actions for departments/agencies and stakeholders including Manitoba Conservation and Water Stewardship.
- In the event of an emergency or disaster caused by extreme drought, the Emergency Measures Organization would assume responsibility for response co-ordination.
- At this stage, the minister of Manitoba Conservation and Water Stewardship might declare a serious water shortage under *The Water Protection Act* for affected areas. The Manitoba Drought Assessment Committee would provide advice regarding such a declaration. Departments may implement other relevant acts to reduce water consumption.
- All levels of government would carry out their programs to minimize the impacts of drought, including serious water supply shortages, and provide updates through the Manitoba Drought Assessment Committee.

7. DROUGHT MONITORING, REPORTING, AND FORECASTING

7.1. DROUGHT MONITORING

Regular monitoring of basin conditions is essential to detecting the onset of a drought and managing the impacts of drought. The monitoring process, including communicating and sharing information with different levels of government and stakeholders, helps evaluate preparedness, drought severity and the extent of drought effects. Monitoring also helps organizations involved in drought management to prioritize actions that are required to minimize drought impacts.

The meteorological, hydrometric, soil moisture, groundwater and other networks used to monitor drought will be evaluated, and enhanced where possible, to improve Manitoba's drought monitoring capability. Making sure necessary data are available and in real-time is critical for the timely detection and on-going response to drought.

ACTION ITEM:
Evaluate and enhance meteorological, hydrometric, soil moisture, groundwater and other networks used for drought monitoring.

7.2. DATA COMMUNICATION AND SHARING

Data communication and sharing maintains a flow of data and information for drought monitoring and management amongst the relevant departments and agencies including the Manitoba Drought Assessment Committee and Basin Drought Assessment Groups. Manitoba Conservation and Water Stewardship's Surface Water Management Section will collect and analyze data from various sources and would disseminate drought information to the Manitoba Drought Assessment Committee, Basin Drought Assessment Groups, stakeholders, and the public. The process is shown on Figure 7.1.

7.3. REPORTING ON WATER AVAILABILITY AND DROUGHT CONDITIONS

Regular monitoring of water supply conditions is a key tool for drought preparedness. Reporting on water availability and drought conditions is important for drought management and to communicate with stakeholders and the public about the status of water supply and drought conditions across the province. Establishment of a Manitoba Drought Monitor website will enable access to drought information including reports on current conditions, monitoring and assessment tools and other resources.

ACTION ITEM:
Establish a "Manitoba Drought Monitor" website with up to date drought information.

Manitoba Conservation and Water Stewardship's Surface Water Management Section routinely (as determined by drought stage) prepares and disseminates water availability and drought conditions reports. Reports are posted on the Manitoba Drought Monitor website for public access and will be circulated within the Manitoba Drought Assessment Committee and Basin Drought Assessment Groups.

The Water Availability and Drought Conditions Report focuses on a summary of the indicator analysis and drought conditions and includes available information on water supplies, potential and observed impacts, and Environment Canada's weather outlook. Relevant information available from other departments and agencies is incorporated into the report where possible.

The Surface Water Management Section will also develop and update a drought stage map to report on current drought status for all river basins across the province. The map will be included as part of the Water Availability and Drought Conditions Report. The section will also maintain a log of drought declarations as well as changes in drought stage. The drought stage map and the log will be posted on the Manitoba Drought Monitor website.

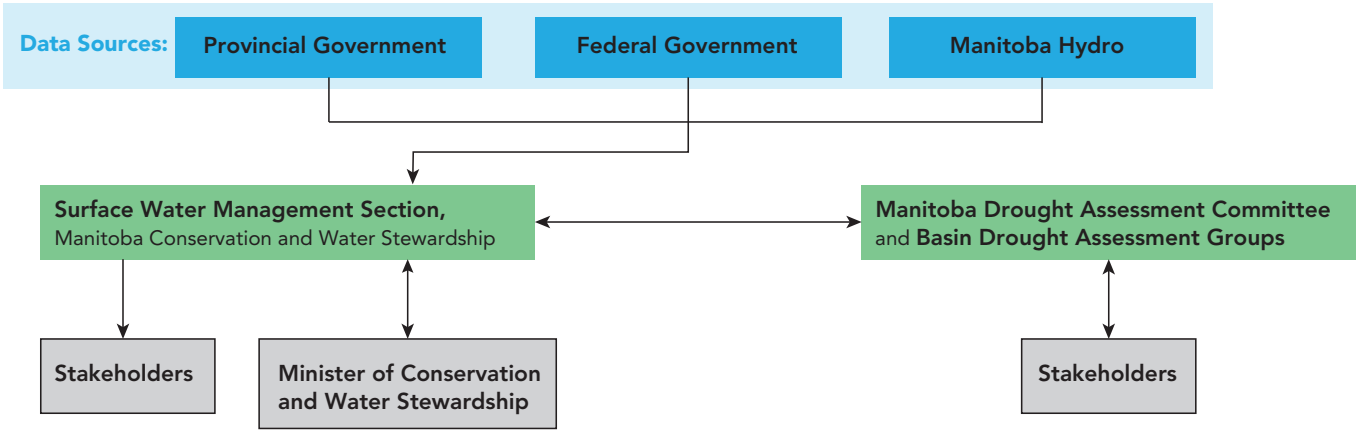
ACTION ITEM:
Prepare regular water availability and drought conditions reports which include drought indicators for each major river basin.

7.4. DROUGHT FORECASTING

Current methods to forecast drought conditions are limited. The ability to forecast the increasing severity of dryness in a basin would be an important development in drought management. Drought forecasting tools for Manitoba will be researched and developed. This will be challenging and require collaboration with the research community. The Manitoba Drought Assessment Committee will play a role in these efforts by providing direction and encouraging research on drought forecasting.

ACTION ITEM:
Undertake research to develop drought forecasting tools for Manitoba.

Figure 7.1 Data Communication and Sharing Process



Data Sources:

- **Provincial government** to supply the following information:
  - » precipitation, temperature, stream-flows and levels, groundwater levels, lake and reservoir levels, forest fire status, water allocation and uses, snow depth, soil moisture, farm water supply, vegetation index, crop reports, drought proofing infrastructure, impending drought impacts
- **Federal government** to supply the following information:
  - » precipitation, temperature, stream-flows and levels; remotely sensed data products, Standard Precipitation Index, Palmer Drought Severity Index, and other blended indices
- **Manitoba Hydro** to supply the following information:
  - » precipitation, lake levels, stream-flows and levels

Drought information will be available online at the Manitoba Drought Monitor website:

- » indicator maps
- » confirmed drought stage maps
- » water supply and drought conditions reports
- » resources to learn more about drought

- **Surface Water Management Section**, Manitoba Conservation and Water Stewardship collects/receives all the aforementioned data products and is then responsible to:
  - » manage hydrological database
  - » analyze all relevant data sources, prepare drought indicators and information products
  - » provide current drought information to drought committees
  - » prepare and disseminate Water Availability and Drought Conditions reports
  - » manage the Manitoba Drought Monitor website
- **Manitoba Drought Assessment Committee** and **Basin Drought Assessment Groups** are responsible for coordinating data and information sharing with the departments, agencies, and stakeholders they represent. See Section 3 for details regarding roles and responsibilities of the Manitoba Drought Assessment Committee and Basin Drought Assessment Groups.

8. DROUGHT MITIGATION STRATEGIES

Actions before and during drought are essential to reduce long term drought effects. Well-planned physical infrastructure, water control operations and non-structural management tools such as policies, programs and plans, can improve drought preparedness levels. Several of the tools noted below can be used in various combinations to mitigate drought impacts.

ACTION ITEM:
Implement and promote drought mitigation strategies to increase drought resiliency and reduce long-term drought impacts.

8.1. INFRASTRUCTURE PLANNING AND DESIGN

After the onset of drought, it is difficult to quickly implement major infrastructure additions or modifications in time to mitigate the drought. The planning, design, permitting and construction of water management related infrastructure can take years or decades, certainly much longer than drought forecasting lead times. For this reason, water management infrastructure must be planned and designed in advance to manage drought. One example of infrastructure is water supply intakes, where intake levels must be sufficient to allow the drawing of supply water under low reservoir or river level conditions. Another example is the design of a hydroelectric system. Manitoba Hydro designs its system of reservoirs, generating stations and interconnections such that firm electrical load can be supplied even under the worst drought conditions on record.

8.2. USE AND OPERATION OF WATER RETENTION STRUCTURES

Structures such as dams and reservoirs provide opportunities for storing water and releasing it later during water shortages. Provincial dams and reservoirs typically serve multiple purposes including water supply, flood protection, and recreation. These structures, shown on the appended map, are located mostly in southern and western Manitoba (Appendix A: Figure A1).

In northern Manitoba and on the Winnipeg River, most dams are owned and operated by Manitoba Hydro for the purposes of hydro-power production. These facilities are also operated to manage floods and droughts. Outflow from Lake Winnipeg, the largest lake in Manitoba, is regulated for multiple purposes including power production, flood relief and drought support.

Dams and reservoirs play a vital role in ensuring adequate water supplies for many cities, towns, and rural areas. Forecasting levels and monitoring the operation of water supply dams and reservoirs is necessary to ensure there is adequate water supply and stream-flow augmentation for human use and basic ecosystem functions. About 50 per cent of the reservoirs in Manitoba are small and have a capacity of less than 500 acre-ft (615 dam^3). In contrast, the storage capacity of Shellmouth Reservoir on the upper Assiniboine River near Russell is about 80 per cent of the total storage capacity of all the provincial water supply reservoirs in the province. During drought, some of the reservoirs created by small dams may dry out, resulting in water shortages. Therefore, it is crucial to monitor water levels in reservoirs and to manage their water supply to minimize drought impacts. The management of dams and reservoirs for water supply should be aligned with local and provincial plans. If it is possible for private dam owners to do so, they may be asked to manage their dams according to the provincial and local drought plans during

periods of drought. For efficient management of water supply dams and reservoirs it is desirable to development and implement real-time monitoring and data management systems, as well as forecasting and decision support systems.

As part of the drought preparedness assessments, studies related to water retention structures will be undertaken and their results included in future updates to the Manitoba Drought Management Strategy.

- Review the efficiency and effectiveness of existing water supply dams and reservoirs in regards to future economic growth, climate change and drought conditions.
- Review and update, if necessary, existing operational rules/ guidelines for dams and reservoirs to meet future water demands. When appropriate, the impacts of climate change should be included.
- Identify options for augmenting water supply and streamflows to meet future demand and for drought proofing.

ACTION ITEM:
Undertake studies related to water supply dams and reservoirs.

8.3. DROUGHT PROOFING PROGRAMS

In 1987 and1989, Manitoba Water Sourcing Studies (Phase I and II) conducted by Prairie Farm Rehabilitation Administration (PFRA), Agriculture and Agri-food Canada, identified chronic on farm water deficits areas in Manitoba (Agriculture and Agri-food Canada, PFRA, 1989). Based on these studies, a number of drought proofing programs were undertaken by Agriculture and Agri-food Canada, the Manitoba Water Services Board and private water co-ops. Drought proofing programs, such as the one offered by the Manitoba Water Services Board to extend rural water supplies, help to provide alternate water supplies in drought prone areas.

8.4. MANAGEMENT OF GROUNDWATER

Management of groundwater can be used to mitigate the effects of water shortages and drought. Groundwater can be used to supplement surface water sources when the surface water source does not meet the demands. Groundwater is an important source of municipal, industrial, agricultural, irrigation, and domestic water supplies in Manitoba. Groundwater also feeds a number of rivers, augmenting flows. In Manitoba, groundwater is available from sand and gravel and bedrock aquifers, as shown in Appendix B (Figures B1 and B2). Groundwater sources, shallow aquifers in particular, may be at risk in a drought.

Manitoba Conservation and Water Stewardship monitors groundwater levels on a regular basis with monitoring wells located in, but not limited to, the Winnipeg and Interlake Carbonate Aquifer, the Assiniboine Delta Aquifer, the Oak Lake Aquifer and the Winkler Aquifer. The use of groundwater in Manitoba (when it exceeds 25,000 litres per day) is regulated by the province and licences have been issued for municipal, livestock, irrigation, industrial, and other purposes (ex: air cooling, heating and recreation). As Manitoba has a good

reserve of groundwater in the major aquifers, groundwater could be used in some parts of the province as a supplementary supply to minimize the shortage of surface water, particularly in the south and western half of the province. However, groundwater supply may be reduced when drought conditions exist for a significant period of time.

8.5. DROUGHT TOLERANT AGRICULTURE

Adopting drought-tolerant cropping practices mitigates crop loss due to drought. A long-term research goal of Manitoba Agriculture, Food and Rural Development is to investigate newer plant breeding technologies so drought-tolerant crops can provide food production security and save water through reduced irrigation. Current crop production studies that examine water use efficiency to determine how crops respond to available nutrients and inputs over a range of climate conditions are expected to provide guidance to implementation of future programs on drought-tolerant crops.

8.6. RESTORATION OF WETLANDS

Wetlands have an important role in the water cycle, including acting as groundwater recharge areas when groundwater levels are low. Recharge areas provide the primary means of replenishing groundwater supplies. By creating new or restoring abandoned or modified wetlands and dugouts, farm water supplies could be increased and groundwater and/or soil moisture could be recharged.

Degradation of wetlands occurs in Manitoba due to human activities. Wetland preservation is a good tool to reduce drought impacts on aquatic habitats/waterfowl and other wildlife species. A comprehensive wetland policy will help to restore and conserve wetlands to increase drought resilience in Manitoba. Manitoba's Surface Water Management Strategy provides direction on the protection and restoration of wetlands through initiatives such as the Save Lake Winnipeg Act and the Peatlands Stewardship Strategy, among others.

8.7. TRANSBOUNDARY DROUGHT MANAGEMENT

Transboundary water management is essential as water use in one jurisdiction can impact water availability in downstream jurisdictions. To ensure water is shared equitably, the management of transboundary water is often set out in agreements between jurisdictions. Manitoba receives approximately 70 per cent of its water from upstream jurisdictions. Therefore, it is imperative that Manitoba works co-operatively with provincial, state and federal jurisdictions regarding the management of transboundary waters.

The Prairie Provinces Water Board developed the Master Agreement on Apportionment in 1969 for eastward flowing waters between Alberta, Saskatchewan and Manitoba (Prairie Provinces Water Board, 1969). The purpose of the Master Agreement on Apportionment is to apportion or share water equitably between the Prairie Provinces and

to protect transboundary surface water quality and groundwater aquifers. Under Schedule A of the Master Agreement on Apportionment, Alberta is entitled to 50 percent of the natural flow of an interprovincial river before it enters Saskatchewan. Under Schedule B of the Master Agreement on Apportionment, Saskatchewan must deliver to Manitoba 50 percent of the water which enters the province from Alberta (Schedule A) and 50 percent of the flow arising within its border. This formula is based on flow occurring over each year. The agreement between Saskatchewan and Manitoba applies on eastward flowing streams including the Churchill, Saskatchewan, Carrot, Red Deer, Assiniboine, Qu'Appelle Rivers, and Pipestone Creek.

Apportionment of the Souris River is overseen by the International Joint Commission through the International Souris River Board. Under the agreement between Canada and the U.S.A. (International Souris River Board, 1959), Manitoba receives regulated flows from North Dakota at a minimum flow of 20 cubic feet per second (0.566 cubic meters per second) from June to October. During periods of severe drought, when it becomes impracticable for North Dakota to deliver the regulated flow of 20 cubic feet per second (0.566 cubic meters per second), North Dakota can petition the International Souris River Board to limit the flows to Manitoba to provide only such flows as the board determines to be practicable and in accordance with the objective of making water available for human and livestock consumption.

There is no agreement between Canada and the United States for the apportionment or sharing of flows in the Red River. International collaboration between Canada and the United States on drought and other water issues is occurring through international groups such as the Red River Basin Commission and the International Red River Board of the International Joint Commission. Apportionment on the Red River is challenging due to the fact that there may be very limited or no flow to apportion during severe drought. The Red River basin lacks major water supply reservoirs that exist in other basins, such as Lake Diefenbaker or Lake of the Woods, that are capable of augmenting flows during drought. However, the need for an agreement has been recognized. Manitoba is working though these international groups to determine how to best manage low flows on the Red River.

Similar to the Red River, there is no agreement between Manitoba and Ontario for the apportionment of flows in the Winnipeg River. However, the Lake of the Woods Control Board, which includes representation from Manitoba, manages the waters of Lake of the Woods, Lac Seul and the Winnipeg and English Rivers between the outlets of these lakes and their junction. The board's mandate ends at the junction of the English and Winnipeg Rivers, just east of the Manitoba/Ontario provincial boundary. However, as the levels and flows on the Winnipeg River in Manitoba are significantly affected by the board's regulation of Lac Seul and Lake of the Woods, the board considers Manitoba's interests when making its decisions.

Collectively, these transboundary water management organizations provide some assurance of stream-flows in Manitoba during droughts. However, due to Manitoba's downstream geographic location in these transboundary river basins, a vital part of Manitoba's drought management strategy is to continue to work in partnership with upstream jurisdictions.

8.8. DROUGHT INSURANCE/DROUGHT ASSISTANCE FUND

Drought is a natural hazard that can be detrimental to our environment, society, and economy. Crop and livestock producers and other industries contribute to the healthy economy of the Province. Occurrence of a drought during seeding and growing seasons may cause a significant loss in crop production and feed shortages for livestock. Significant economic loss may also occur due to wildfires that may increase in frequency during drought.

In the future, federal and provincial governments will need to work together to explore options for disaster assistance programs for those who are significantly affected by drought and water supply shortages. The Manitoba Agricultural Services Corporation will also play a role in enhancing resiliency in rural Manitoba in the face of droughts. This will be accomplished by providing on-going agricultural insurance programming that mitigates drought risk for Manitoba crop and livestock producers and by maintaining a service infrastructure that can be quickly adapted to deliver drought related emergency and recovery services for government in rural Manitoba. In the future, there is opportunity to evaluate how the existing agricultural insurance programming lessens the financial impacts of drought, and assess what changes can be made to further improve the program.

8.9. DEMAND MANAGEMENT - WATER EFFICIENCY AND REDUCED CONSUMPTION

Demand management and water efficiency does not just mean using less water through restrictions. Rather, it is about wise management of water supplies, reducing water demands and the use of water efficient technologies.

Increasing efficient water use and reducing water consumption increases sustainability of this natural resource and will help mitigate the effects of drought. Efforts to reduce water consumption should occur at all levels and by all Manitobans. Domestic, municipal, agricultural, irrigation, industrial and business users can lower demands on the water supply by reducing consumption and losses while increasing supply efficiency.

The Water Protection Act (Section 16(1)) notes that watershed management plans must identify issues and provide recommendations for water demand management, water use practices and priorities, the conservation of water supplies and the reduction of water use and consumption during droughts and other periods of water shortages. Recommendations from watershed management plans regarding water efficiency and reducing consumption should be followed during water shortages.

Community-level water supply infrastructure and water management practices have a vital role in conserving water and reducing water usage. Manitoba has several water-efficiency initiatives such as WaterSmart, Lower Income Energy and Water Efficiency Program and SoftPath to help communities and households reduce water consumption. The Manitoba Water Council is currently preparing advice for the Minister of Conservation and Water Stewardship with respect to water conservation and efficiency.

During moderate and severe droughts, voluntary water efficiency measures should be implemented wherever possible to reduce water consumption. For severe and extreme droughts, regulatory reductions in water consumption may be required along with voluntary measures.

Voluntary water efficiency and reduced consumption can include: reducing water use for gardening, car washing and lawn watering; adapting suitable technology for recycling grey water; reducing water losses due to leakages in municipal water infrastructure and irrigation systems; rainwater harvesting; efficient use of dishwashers and washing machines; and other changes in routine practices. The success of demand management initiatives is highly dependent on variables such as public and political acceptability, public education and awareness, availability of funds, water-saving instruments and institutional capability.

Mandatory water conservation may become necessary in a severe drought. A municipal government could use legislation and bylaws to limit or restrict water use to reduce unnecessary water consumption.

8.10. INNOVATIVE WATER TECHNOLOGY

There are various innovative water reduction technologies and strategies available worldwide. However, many have not been considered for application in Manitoba. Additional research should be encouraged and supported in regards to developing appropriate, sustainable, and innovative water technologies for use in Manitoba. Market development tools encourage research by providing support for innovative water technology. Innovative technology will reduce overall daily consumption and lessen the impacts of water shortages during drought. Such technologies have also reduced costs for businesses, commercial operations, and municipalities.

8.11. LIMITING WATER LICENSING/PERMITS

Suspending or cancelling water allocation licences and permits can be used to reduce water consumption during water shortages. The minister has the authority to portion water by revoking licences or limiting allocations during serious water shortages. During drought, the minster will provide appropriate direction in accordance with legislation such as *The Water Protection Act* and *The Water Rights Act* to achieve suitable targets for reducing water consumption.

8.12. EDUCATION AND AWARENESS

Promoting awareness regarding drought and water shortages, water efficiency and reducing water consumption is important to the successful implementation of a drought management strategy. The successful management of water supplies during drought is highly dependent on the public's level of awareness and understanding. Additional information and awareness materials regarding drought, water supply management and water efficiency will be prepared by Manitoba Conservation and Water Stewardship and partner agencies and made available to all Manitobans though the Manitoba Drought Monitor website. An action plan related to the health impacts of drought will be included during emergency response planning with the Emergency Measures Organization.

ACTION ITEM:
Prepare information and awareness materials regarding drought, water supply management and water efficiency.

8.13. SUPPORT FOR HUMAN HEALTH

Providing information and supports to the public during drought and water shortages can assist people in maintaining their health. Information on air quality and the measures that can be taken if the dust or smoke levels are high can help to reduce the risk of respiratory and other illnesses. Mental health supports are expected to be necessary during a prolonged drought. Information on accessing or maintaining potable water may be necessary.

9. STRATEGY IMPLEMENTATION, ASSESSMENT, AND UPDATES

Manitoba Conservation and Water Stewardship will be responsible for ensuring the implementation of the Manitoba Drought Management Strategy. Manitoba Conservation and Water Stewardship will work co-operatively with the Manitoba Drought Assessment Committee, Basin Drought Assessment Groups, local governments and the public to complete the action items included in the strategy. The success of the strategy is highly dependent on communication and awareness between all stakeholders including within the provincial government, with other levels of government, other agencies, committees and individual Manitobans.

The Manitoba Drought Management Strategy is a living document and will be updated periodically. Updates to the Manitoba Surface Water Strategy will be reflected by making corresponding updates within the Manitoba Drought Management Strategy. Regular review and evaluation of the Manitoba Drought Management Strategy will be essential to providing the best co-operative mitigation of drought impacts. The department will periodically assess the document in association with the Manitoba Drought Assessment Committee and the Basin Drought Assessment Groups to identify strengths, weaknesses and gaps. Updates will incorporate appropriate new scientific methods and information, as well as appropriate new technologies.

ACTION ITEM:
Periodically evaluate the Manitoba Drought Management Strategy to identify any gaps and update the strategy to incorporate new scientific methods and technologies.

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PHOTO LABELS AND CAPTIONS

Page 5
1988 drought, near Pipestone, Manitoba, June, 1988.
(Courtesy: Agriculture and Agri-food Canada)

Page 7
Seven Sisters Hydro Dam on the Winnipeg River, Manitoba, September, 2006. (Courtesy: Manitoba Hydro)

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Near Rossendale west of Portage la Prairie, Manitoba, 2011.

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Drifted soil near Cadillac, Saskatchewan, 1937.

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Red River at Fargo, North Dakota, July, 1936.

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Spilt Lake, Nelson River Basin, Manitoba, July 2003.
(Courtesy: Manitoba Hydro)

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Dugouts in the Interlake Region, Manitoba, 2012.

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1988 drought near Pipestone, Manitoba, June, 1988.
(Courtesy: Agriculture and Agri-food Canada)

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Near Manitoba Escarpment, October, 2003.

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Assiniboine Rivet at Southport Bridge, Manitoba, June, 2002.

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Ground Water Monitoring Well, Assiniboine Delta Aquifer, near Carberry, Manitoba.

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Cracked Soil in Morris, Manitoba, April 2012.

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Hydrometric station at Mary Jane Reservoir near Manitou, Manitoba.

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Aerial view of Shellmouth Dam from downstream, summer, 2002.

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Potato crop irrigated from Assiniboine Delta Aquifer near Carberry, Manitoba, 2005.

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Pembina River near PTH 31 near Windygates, Manitoba, July, 2000.

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Spilt Lake, Nelson River Basin, June, 2003.
(Courtesy: Manitoba Hydro)

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Oak Hammock Marsh, near Stonewall, Manitoba.

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Stephenfield Reservoir near Carman, Manitoba.

Last cover page
Winnipeg River at downstream of Seven Sisters Hydro Dam, June, 2010.

APPENDIX A

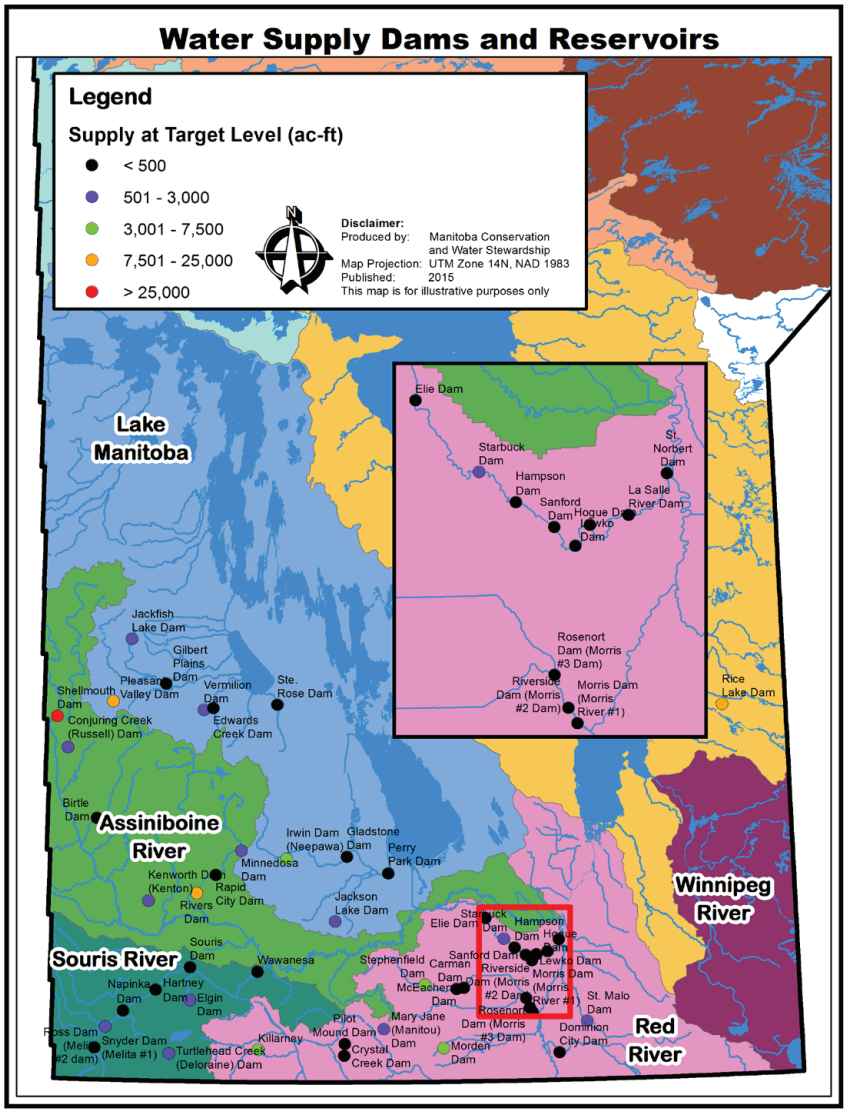

Figure A1. Water Supply/Conservation Dams and Reservoirs in Manitoba

APPENDIX B

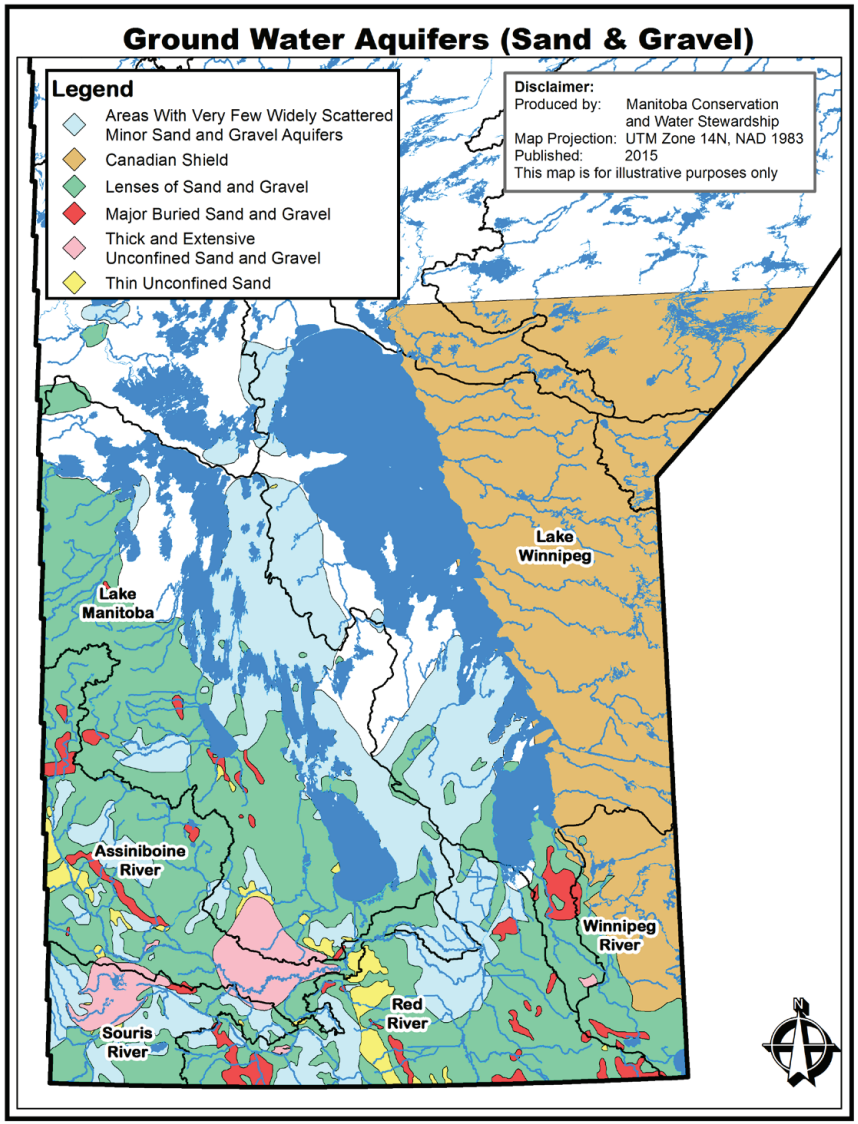

Figure B1. Manitoba Groundwater Aquifers (Sand and Gravel)

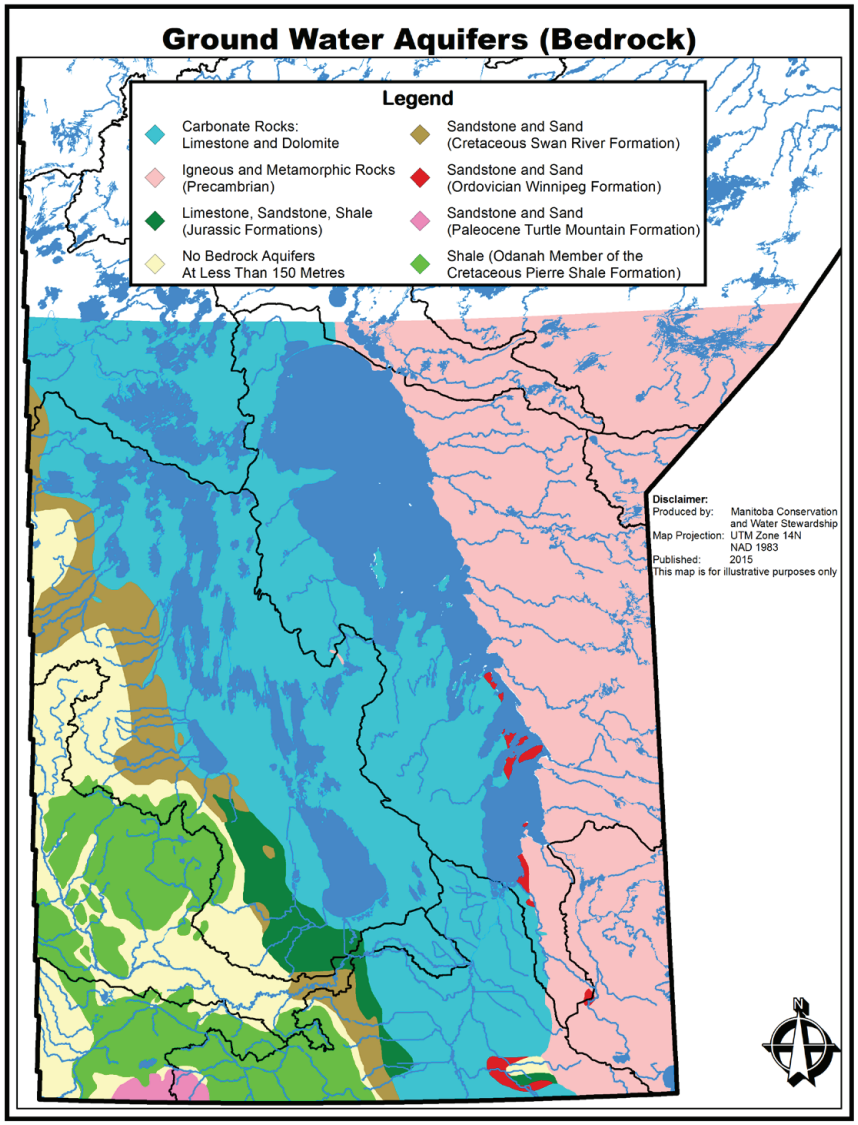

Figure B2. Manitoba Groundwater Aquifers (Bedrock)