8.0 Floodway Operation

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8.0 FLOODWAY OPERATION

8.1 Spring Operation

8.1.1 Objective

The objective of this section is to provide an overall summary of the flood control and protection infrastructure for the City of Winnipeg and the Red River Valley, including a description of existing and expanded Floodway operations in response to a spring flood event, and the effects thereof. Summer Operation is covered separately in sections 8.2 and 8.3 of the Supplementary Filing.

Much of the technical information presented in this section is a summary of more comprehensive analyses and discussions which are contained in the Preliminary Engineering Report that the Environmental Impact Statement was based upon, and is intended to provide a high-level, broad overview to aid in general understanding of the system. Where appropriate, the reader has been referred to the applicable Preliminary Engineering technical document if further detail on that aspect is required.

8.1.2 Major Flood Control Works

The City of Winnipeg and the communities in the Red and Assiniboine River Valleys have a long recorded history of flood events dating back to 1826. Following the 1950 flood, the Government of Canada commissioned a Red River Basin Investigation Authority to report on measures for the reduction of the flood hazard in the Greater Winnipeg area. The authority prepared a comprehensive engineering report on the nature and causes of periodic flooding on the Red and Assiniboine Rivers and submitted preliminary engineering plans for a wide range of flood damage reduction measures. In 1956, the Province of Manitoba appointed the Royal Commission on Flood Cost Benefit to prepare benefit-cost ratios on the various flood damage reduction projects identified by the Investigation Authority.

The Royal Commission reported in 1958 and recommended construction of the following three major flood control projects:

- A Greater Winnipeg Floodway with a capacity of 1700 m^3/s (60,000 cfs).
- A diversion of the Assiniboine River to Lake Manitoba at Portage la Prairie with a capacity of 708 m^3/s (25,000 cfs).
- A storage reservoir on the Assiniboine River near Russell Manitoba (Shellmouth Dam). The reservoir, named Lake of the Prairies has a storage capacity of 480,000 dam^3 (390,000 acre-feet), and reduces the peak flow contribution of the Assiniboine River in Winnipeg by a maximum of 198 m^3/s (7,000 cfs).

All three projects have been built and currently function as part of the major flood control works. The locations of the three projects are shown below on Figure 1. The Floodway was completed in 1968 at a cost of $62.7 million; the Portage Diversion was completed in 1970 at a cost of $20.5 million; and Shellmouth Dam was finished in 1972 at a cost of $10.8 million. Additionally, the City of Winnipeg constructed a permanent dyking system immediately after the 1950 flood to provide flood protection along the Red, Assiniboine and Seine Rivers within the City. After the 1966, 1979 and 1997 floods, ring dykes were been built around most flood-prone communities in the Red River Valley and individual flood-proofing measures have been further applied throughout the rural region. These are discussed in greater detail in Section 8.1.4.

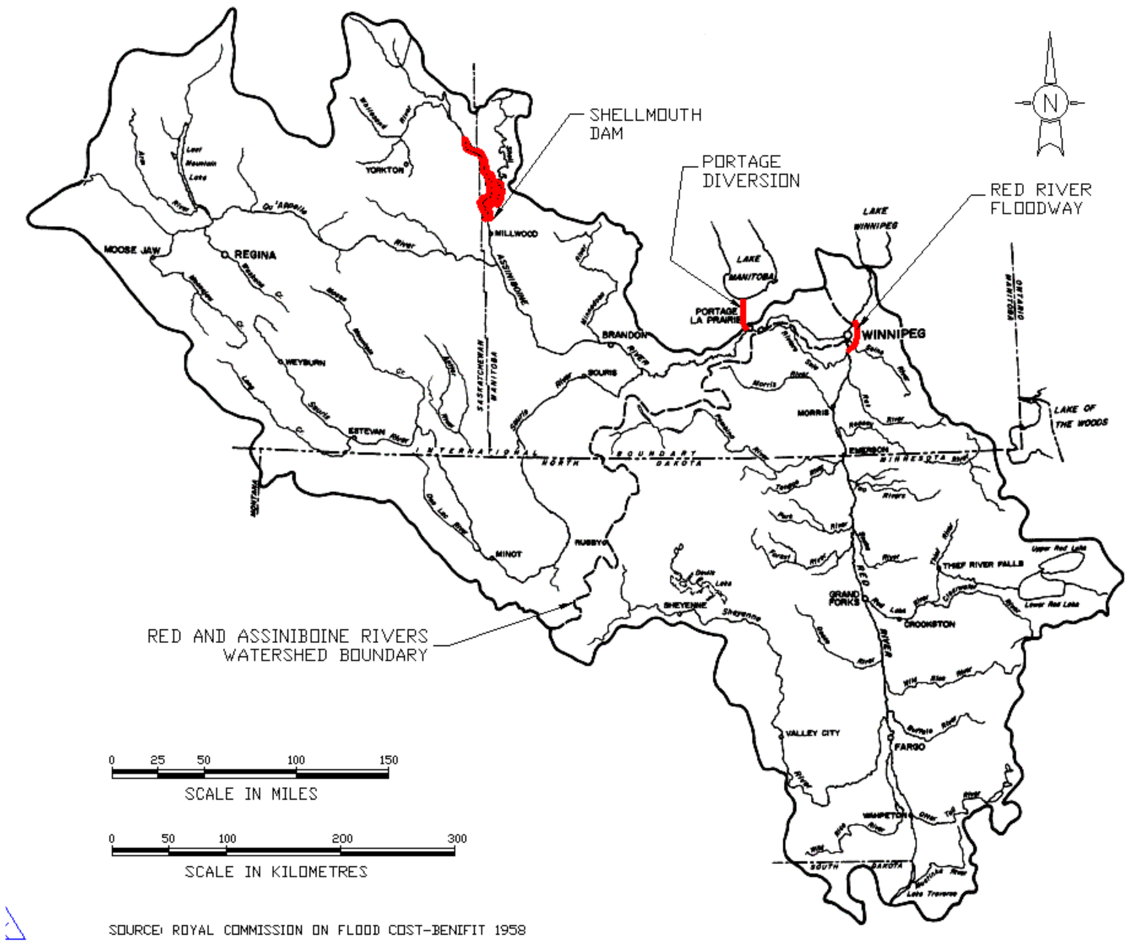


Figure 1: Red River Drainage Basin & Existing Flood Control Works

8.1.3 The Red River Drainage Basin

8.1.3.1 General Characteristics

The Red River originates in north-central United States, some 880 km (550 miles) almost due south of its outlet in Lake Winnipeg. In the City of Winnipeg, it is joined by its major tributary, the Assiniboine River, which drains an area of 153,000 km^2 (59,000 mi^2) to the west. Despite the fact that the area drained by the Red River to the south of Winnipeg is smaller than this, being just 124,000 km^2 (48,000 mi^2), the maximum flows on the Red are much higher than those on the Assiniboine. During the period of record, some 80% of the peak flood flows at Redwood Bridge in Winnipeg originated from the main stem of the Red. Further, a very large portion of these peak flows, some 80% or more, originated in the United States. Of the total drainage area on the Red alone, some 102,000 km^2 (39,360 mi^2) are in the United States and 22,000 km^2 (8,640 mi^2) are in Canada (see Figure 1 and Figure 2).

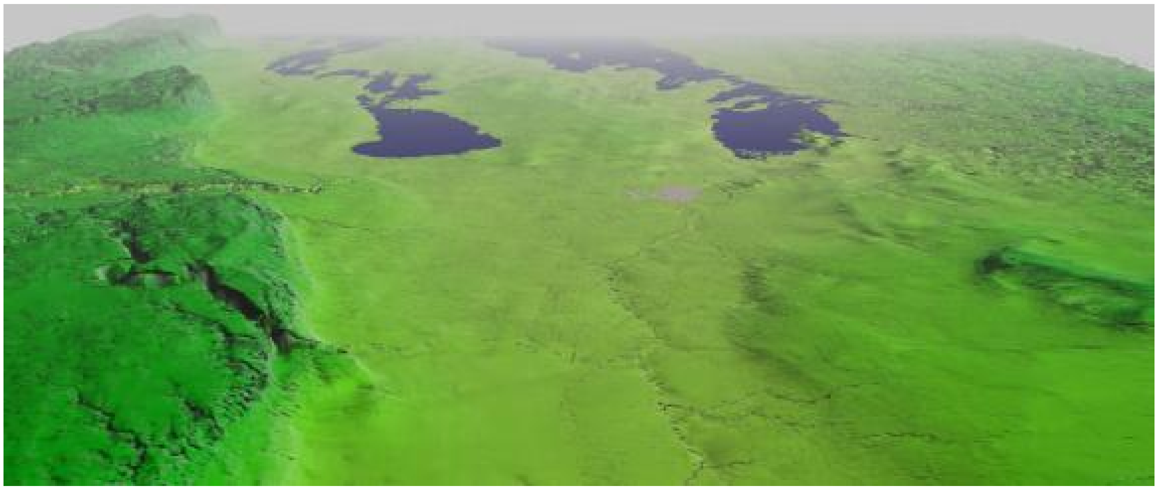


Figure 2: Red River Valley, Looking North from Emerson. Mb.
(Rendered Digital Elevation Model from NASA SRTM Data – City of Winnipeg is shaded Grey)

The drainage area of the Red River has two basic types of topography. The central portion of the area extending east and west of the river is the bed of the former glacial Lake Agassiz. This region is a broad, flat plain with very gentle gradients. As a result, once the river leaves its banks, very extensive areas are subject to flooding. In 1950, for example, an area of 1370 km^2 (530 mi^2) was flooded between Winnipeg and the International Boundary at Emerson. Surrounding the plain is a rougher and higher upland region.

Because of the gentle gradients that characterize this former lakebed, the Red River and the lower end of its tributaries have never developed sufficient velocity to cut channels adequate to carry the higher flows. From its origin to Lake Winnipeg, the river makes a gradual, continuous descent averaging about 10 cm/km (one-half foot per mile). Between Emerson and Winnipeg the slope is especially flat, averaging only about 5 cm/km (one-quarter of a foot per mile).

The soil covering the Red River plains consists of a highly plastic clay which is able to hold large quantities of water and possesses high swelling and shrinking characteristics with changes in moisture content. These qualities make it a very poor foundation material and make the riverbanks in many areas unstable and subject to slides. However, these same qualities make this material ideal for constructing flood protection dykes, due to its low hydraulic conductivity. Underlying these clays at depths of from 1.2 m to 18.3 m (4 ft to 60 ft), is the glacial drift or hardpan, a heterogeneous mass of rock dust, clay, sand, gravel and boulders which, in contrast to the clay, makes excellent foundation material.

8.1.3.2 Flood Hydrology of Red River at Winnipeg

Knowledge of the “state-of-nature” and the controlled Red River flood flows in Winnipeg, as referenced to the James Avenue Pumping Station Datum, are key to the design and operation of both the existing Floodway and the expanded Floodway project. Accordingly, Manitoba Water Stewardship prepared an estimate of hydrometerological parameter generated floods for the Red River for use in the Floodway Expansion Project. The natural flow contributions in the Winnipeg area were estimated by Manitoba Water Stewardship for various Red River flood magnitudes at James Avenue Pumping Station. The estimates were based on recorded data, estimates from the 1826 flood and temporal considerations of contributions from other streams to the Red River peak. A hydrometeorological parameter routed flood (HPRF) was also estimated and used in the assessment of the natural flood flows. The information is contained in a document authored by

A. Warkentin (Mb. Water Stewardship) dated March 2004 and is provided in Annex "B" of Appendix "C" to the Preliminary Engineering Report, entitled "Inlet Control Structure". The key elements are summarized in Figure 3 and itemized by local contributing areas in the following section.

As can be seen from Figure 3, the local uncontrolled flow for the design flood parameters contributes approximately 6% to the natural flood peak in the Red River at James Avenue Pumping Station or 7% of the natural Red River flood peak at the Floodway entrance.

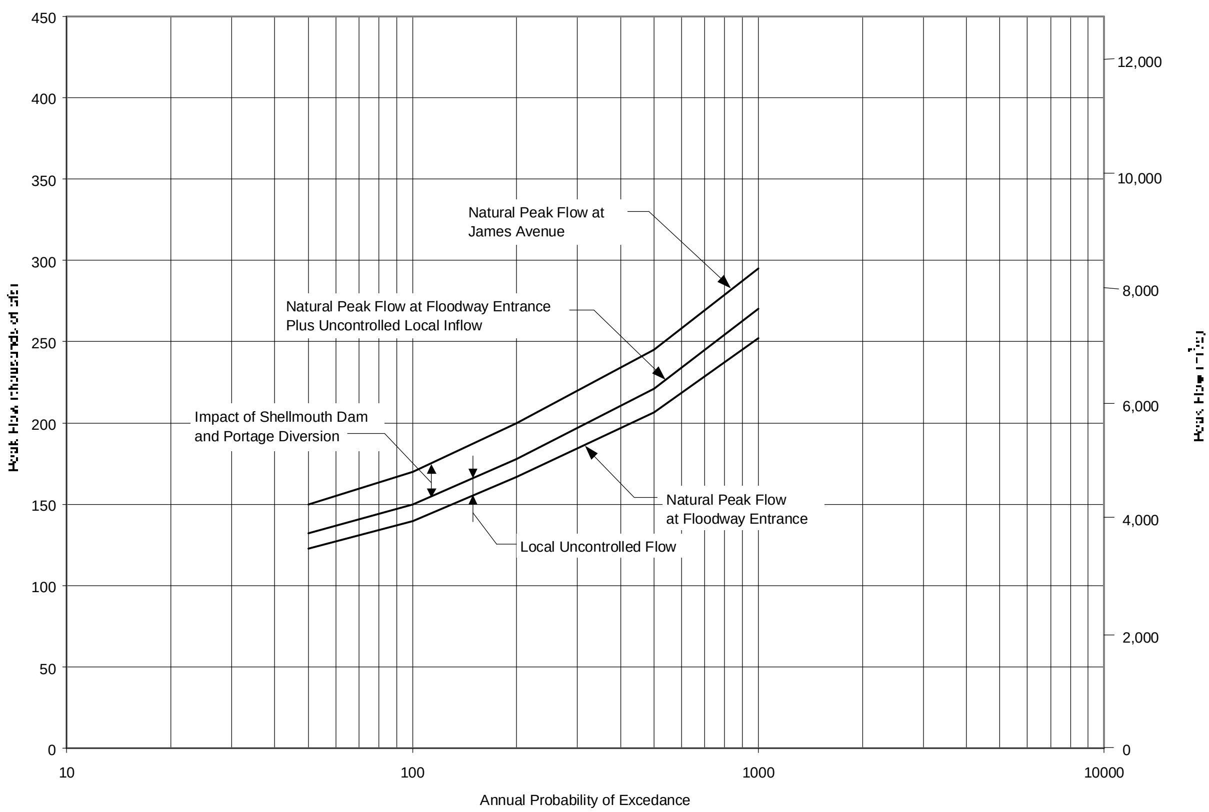


Figure 3 – State of Nature Flood Flows

8.1.3.2.1 Natural Flood Flows

The flow components for the Assiniboine River and smaller streams, as summarized in Table 1, are not necessarily spring flood peaks but rather the estimated contribution to the Red River peak flow at James Avenue Pumping Station for the design flood conditions.

TABLE 1
ESTIMATED NATURAL FLOW CONTRIBUTIONS
FOR RED RIVER DESIGN FLOODS AT JAMES AVENUE PUMPING STATION

Annual Probability of Exceedance	Red River Peak at James Avenue m^3/s (cfs)	Assiniboine River at Headingley m^3/s (cfs)	La Salle River at St. Norbert m^3/s (cfs)	Sturgeon Creek at St. James m^3/s (cfs)	Seine River at Grande Pointe m^3/s (cfs)	Local Runoff in Winnipeg m^3/s (cfs)	Red River at Floodway Entrance m^3/s (cfs)
1 in 1 000	8 353 (295 000)	736 (26 000)	283 (10 000)	85 (3 000)	71 (2 500)	31 (1 100)	7 147 (252 400)
1 in 500	6 938 (245 000)	708 (25 000)	227 (8 000)	71 (2 500)	57 (2 000)	25 (900)	5 850 (206 600)
1 in 200	5 663 (200 000)	680 (24 000)	142 (5 000)	57 (2 000)	42 (1 500)	20 (700)	4 723 (166 800)
1 in 100	4 814 (170 000)	623 (22 000)	127 (4 500)	51 (1 800)	34 (1 200)	17 (600)	3 962 (139 900)
1 in 50	4 248 (150 000)	566 (20 000)	113 (4 000)	45 (1 600)	28 (1 000)	17 (600)	3 477 (122 800)

8.1.3.2.2 Controlled Flood Flows

Operation of Shellmouth Dam, the Seine River Inverted Syphon and, in particular, the Portage Diversion reduce the Red River peak flood flows at James Avenue Pumping Station. However, the contribution of uncontrolled local inflows between the Inlet Control Structure and the Red River at James Avenue Pumping Station is still significant. A summary of flow contributions for the design flood including uncontrolled local inflows is tabulated below in Table 2 and the results shown graphically in Figure 3. Again actual inflows will depend on hydrological conditions within each tributary as well as operation of Shellmouth Dam and Portage Diversion.

TABLE 2
ESTIMATED CONTROLLED FLOW CONTRIBUTIONS
AT JAMES AVENUE PUMPING STATION

	Natural Peak Flows		**Uncontrolled Flow Contribution to Peak Flow at James Avenue Pumping Station**				
Annual Probability of Exceedance	Red River Peak at James Avenue m^3/s (cfs)	*Red River at Floodway Entrance* m^3/s (cfs)	Assiniboine River at Headingley m^3/s (cfs)	La Salle River at St. Norbert m^3/s (cfs)	Sturgeon Creek at St. James m^3/s (cfs)	Seine River at Syphon Outlet m^3/s (cfs)	Local Runoff in Winnipeg m^3/s (cfs)
1 in 1 000	8 353 (295 000)	7 147 (252 400)	99 (3 500)	283 (10 000)	85 (3 000)	6 (200)	31 (1 100)
1 in 700[1]	7 646 (270 000)	6 371 (225 000)	91 (3 200)	249 (8 800)	76 (2 700)	6 (200)	28 (1 000)
1 in 500	6 938 (245 000)	5 850 (206 600)	85 (3 000)	227 (8 000)	71 (2 500)	6 (200)	25 (900)
1 in 200	5 663 (200 000)	4 723 (166 800)	85 (3 000)	142 (5 000)	57 (2 000)	6 (200)	20 (700)
1 in 100	4 814 (170 000)	3 962 (139 900)	85 (3 000)	127 (4 500)	51 (1 800)	6 (200)	17 (600)
1 in 50	4 248 (150 000)	3 477 (122 800)	85 (3 000)	113 (4 000)	45 (1 600)	6 (200)	17 (600)

[1] *1-in-700 year flood interpolated.*

8.1.4 The Existing Floodway And Associated Flood Protection Works

Section 8.1.4 describes the existing Floodway and all other associated flood protection works that, in conjunction with the Shellmouth Dam and Portage Diversion, comprehensively form the flood control and protection infrastructure works for the City of Winnipeg.

The existing Floodway system is based on an open channel around the City of Winnipeg to divert water around the city during major floods. An Inlet Control Structure across the Red River just upstream of Winnipeg limits flow through Winnipeg and diverts the excess water into the open channel under flood conditions. An Outlet Control Structure dissipates the energy from flow in the channel at the Floodway Outlet Structure before it re-enters the Red River downstream of Lockport. A dyking system extending both East and West from the Inlet Control Structure completes the water retaining system.

The basis of the initial design of the flood protection works was to provide protection for the 1-in-160 year flood (*return period based on knowledge of hydrology of the day in the 1960's*) of 4,785 m^3/s (169,000 cfs) at Redwood Bridge, located a short distance downstream from the confluence of the Red and Assiniboine Rivers.

The following discharges and water levels applied to the initial design:

Design Flood (natural)	§ 4785 m^3/s (169,000 cfs)
Return Period	§ 1-in-160 years (1962)
Assiniboine River contribution to peak	§ 1085 m^3/s (38,300 cfs) avg
Portage Diversion	§ 708 m^3/s (25,000 cfs)
Reduction of flow due to Shellmouth Reservoir	§ 198 m^3/s (7,000 cfs)
Redwood Bridge (controlled)	§ El. 229.36 m (752.5 ft)
	§ El. 7.62 m (25 ft) (JAPSD)
Floodway Discharge	§ 1699 m^3/s (60,000 cfs)
Inlet Control Structure Discharge	§ 2002 m^3/s (70,700 cfs)
Controlled Discharge – James Avenue	§ 2180 m^3/s (77,000 cfs)
Water level upstream of Inlet Control Structure for design condition	§ El. 234.77 m (770.25 ft)
Water level upstream of Inlet Control Structure for emergency operation	§ El. 237.13 m (778.0 ft)

The current design flood period, based on knowledge of the hydrology of the Red River, is approximately 1-in-90 years with the design upstream water level.

8.1.4.1 Floodway Channel

The Floodway Channel is approximately 47 km (29 mi) in length with a difference in water surface under design flood conditions, of approximately 5.5 m (18 ft) between the Inlet and the Outlet. It is located in the high plasticity lacustrine clays of glacial Lake Agassiz, which are underlain generally by glacial till. An exception to this is the Birds Hill ridge which is a granular fluvio-glacial deposit from the last glacial age. The soils south and north of Birds Hill are similar but there are differences in the thickness of the lacustrine deposit.

The base width of the channel varies from 115.8 m (380 ft) to 164.6 m (540 ft), and the top widths range from 213.4 m (700 ft) to 304.8 m (1000 ft). The Inlet to the Floodway is located in the east bank of the Red River and consists of a broad-crested earthen weir 213.4 m (700 ft) wide, with a crest elevation of 228.6 m (750 ft). There is a transition section below the weir which widens gradually to the typical Floodway cross section. The crest at el 228.6 m (750 ft ASL) ensures that flows below approximately 1,000 m^3/s (35,000 cfs) pass down the Red River and do not enter the Floodway. This prevents ice from entering the Floodway channel during periods of flow when ice is prevalent on the river.

Prior to 1997, the only major inlet for flow to the Floodway was the entrance opening proper, at the Red River. In 1997, the peak discharge in the Floodway approached its design value of 60,000 cfs. During this event, it was observed that the East Embankment and the Turnbull Drive Dyke each restricted the flood flows as they approached the Floodway entrance. Investigations determined that improvements to the inlet configuration in the vicinity of Grande Point could improve hydraulic conditions and reduce water levels and flooding duration in the area.

Subsequently, two sections of the East Embankment of the Floodway were removed to provide an outlet from Grande Pointe area direct to the Floodway Channel. These two openings, short circuit the flow path of the floodwater from the area thereby lowering local water levels. The most westerly opening is 700 m (2,300 ft) long and the other is approximately 550 m (1,800 ft) long (drawings showing the location of the embankment gaps are located in Appendix “L” to the Preliminary Engineering Report, if required for clarity).

8.1.4.2 Inlet Control Structure

The Floodway Inlet Control Structure is situated in the Red River just downstream from the inlet to the Floodway Channel. The structure consists of reinforced concrete abutments, end piers and a central pier with two large submersible sector gates, each 34.29 m (112.5 ft) wide. The gates normally are in the submerged position below the bottom of the riverbed, with a minimum of 1.83 m (6 ft) (but normally about 2.44 m (8 ft)) of water over them in the summer months. Under these conditions the crest of the Channel Inlet at el. 228.6 m (750 ft) permits flows to enter the Floodway when the Red River discharge exceeds 1,000 m^3/s (35,000 cfs). As the natural river stage increases above 1,000 m^3/s (35,000 cfs) there is a division in flow between the Floodway and the Red River. The purpose of the Floodway Inlet Control Structure is to regulate the division in flow between the Floodway and the Red River. The intent of operating the gates in the Floodway Inlet Control Structure is to maintain an upstream water surface elevation at the level that would have occurred under natural conditions (operating rules are described in greater detail in section 8.1.5 of this section). Gates were chosen to be incorporated into the original project as a means of flow regulation over modifying the Floodway channel to accommodate unregulated flows. Without the gates, the excavation required in the Floodway would have to have been much greater, and would have made the project uneconomic. The structure is founded on limestone bedrock. (Drawings of the Inlet Control Structure are included in Annex “B” of Appendix “C” to the Preliminary Engineering Report, if required for clarity).

8.1.4.3 Floodway Dyking System

Dykes on either side of the Floodway Inlet Control Structure retain the floodwaters upstream of Winnipeg. The dykes together with the Inlet Control Structure define the water retaining system and are an integral part of the Floodway system. East of the Red River, the East Dyke is incorporated into the embankment created by the Floodway channel excavation. The dyke extends parallel to the Floodway to PTH 59S. Beyond PTH 59S, it is identified as the West Embankment.

West of the Red River, the original West Dyke extends a distance of about 32 km (20 miles) in a southern and westerly direction from the Inlet Control Structure up to the point where the natural ground is above the original design flood elevation. The West Dyke contains the floodwaters of the Red River and prevents the flow from passing into the LaSalle River watershed, where it would bypass the Floodway Inlet Control Structure and enter Winnipeg directly. During large floods, the river water level is well above the natural bank level and flooding extends laterally over many kilometers (some 40.2 km (25 miles) in 1997, for example). The original design included the concept of allowing flow past the end of the West Dyke or through breaches in the West Dyke for extreme floods.

Extension of the West Dyke westward along PR 305, to the vicinity of Brunkild was completed in 2001. The West Dyke is now some 70 km (43.5 miles) long and is proposed for further upgrade under the Floodway Expansion Program, primarily for wind setup under extreme floods.

8.1.4.4 Floodway Outlet Structure

The difference in water level over the entire reach of the Floodway Channel from Inlet to Outlet is 5.5 m (18 ft) under design conditions but the corresponding difference of the Red River between those same points is about 9.8 m (32 ft). The purpose of the Outlet Structure therefore is to dissipate the energy in the water at its point of re-entry into the Red River near Lockport, thereby preventing damage and erosion in the river. The Outlet Structure is to be modified to accommodate an increased design flow of 3965 m^3/s (140,000 cfs) with the expanded Floodway.

8.1.4.5 Bridges, Crossings and Other Associated Floodway Structures

There are many structures that cross over and under the Floodway. These include highway bridges, railway bridges, transmission lines, pipelines, communication cables, and the City of Winnipeg water supply aqueducts. There are also drop structures along the south and east side of the Floodway Channel. In addition, the Seine River Inverted Syphon carries flow under the Floodway Channel to meet riparian needs in its natural watercourse through the City. Seine River flood overflows are diverted into the Floodway Channel.

A summary of major structures includes:

- Six highway bridges including the TransCanada Highway.
- Six railway bridges.
- Fourteen overhead power transmission lines, owned by Manitoba Hydro. Additionally, Manitoba Hydro has three underground fibre optic communication cables that cross the Floodway.
- Several Centra Gas and Manitoba Telecom buried crossings.
- Two oil pipelines.
- City of Winnipeg water supply aqueducts.
- Seven local drainage drop structures.
- Seine River Inverted Syphon.

8.1.4.6 Community Ring Dykes and Individual Flood Proofing Efforts

Following the 1997 event, the Governments of Canada and Manitoba jointly invested approximately $110 million in flood protection works in the Red River valley under the “1997 Red River Valley Flood Proofing and Dike Enhancement” agreement. The details of that program and its implementation status are documented in detail in Annex “A1” and “A2” of this section of the Supplementary Filing.

Under this program, 9 additional Red River Valley communities were protected by community dykes: Grande Pointe; Niverville; Gretna; Aubigny; St. Pierre-Jolys; Lowe Farm; Riverside; Rosenfeld; and Ste. Agathe. In addition, 4 more communities upgraded their existing dykes to the new level of protection: Emerson; Dominion City; Rosseau River; and Rosenort. Approximately 1900 residences and business were protected under the community dyking program. Additionally, 22 residences were purchased and removed from the flood plain immediately south of the Floodway along St. Mary’s Road, Greenview Road and Howden Road.

Outside of the major community ring dykes, 2850 applications for financial assistance were received from individual homes and businesses, of which 2576 were determined to be eligible and were incorporated into the flood protection program.

All properties under this program were required to be protected to the 1997 level plus 2' freeboard. The specifications for construction required top-widths of dykes or clear widths on pads that envisaged the ability to build temporary sandbag dykes to further accommodate floods of higher return frequency. Because of this requirement, the communities and individual properties that were protected under the post-1997 program from (and including) Ste. Agathe and upstream could be protected against the 700 year event by supplementing their permanent protection measures with temporary works.

Many properties between Ste Agathe and the Floodway Inlet would likely not be upgradeable to 700 year protection without major modifications, since they lie within the zone of backwater influence of the Inlet Control Structure and would be subject to artificial flooding as a result of Floodway Operation in response to the extreme event. Damages caused to those properties by such artificial flooding would be covered by the compensation legislation discussed in Section 7.0.

8.1.4.7 City of Winnipeg Flood Protection Works

The major components of the City of Winnipeg's Flood Protection Works form an integral and critical component of the overall flood protection system, and include:

- The Primary Dike System
- The Secondary Dike System
- Sewer System Pump Stations and Gate Chambers

The City's flood protection system is described and discussed in greater detail in Section 11.0.

8.1.5 Operation Rules

The Floodway has been operated in response to spring events in 22 years since it was commissioned in 1968. In four of those years, 1974, 1979, 1996 and 1997, the natural Red River peak discharge would have exceeded 2265 m^3/s (80,000 cfs) at James Avenue Pumping Station, the level of protection provided by the current dyking system within Winnipeg (referred to as 24.5 ft JAPSD).

The original policy of operation was established in March 1970 in the document entitled "Red River Floodway Program of Operation", and reads as follows:

> *"The Red River Floodway will be operated to provide maximum protection for the Metropolitan Area of Winnipeg but, at the same time, the interests upstream of the Floodway should not be adversely affected. In order to accomplish this the water levels upstream of the Inlet Control Structure shall be maintained at the elevation which would have obtained under natural conditions except as noted..."*

In an October 1984 update to this document, detailed operating rules were developed to assist in achieving compliance with the policy.

Following the 1997 flood, the Province appointed the Red River Floodway Operation Review Committee to review the present rules and criteria for operation of the Red River Floodway

(Inlet) control structure and recommend changes, if necessary. That committee found that, while the existing rules of the time were appropriate under most circumstances, changes would be appropriate to make allowances for certain forseen exceptional circumstances such as those that occurred in 1997, and to remove ambiguities that existed in the way the rules were currently written.

The changes recommended by the Red River Floodway Operation Review Committee were adopted by the Province in April, 2000 and are summarized as follows:

Rule 1:*Normal Operation:* Maintain “natural” water levels on the Red River at the entrance to the Floodway Channel, until the water surface elevation at the James Avenue gauge reaches el 7.46 m. (24.5 ft), or the river level anywhere along the Red River within the City of Winnipeg reaches two feet (0.61 m) below the Flood Protection Level of el. 8.48 m or 27.83 ft.

Rule 2:*Major Flood Operation:* Once the river levels within Winnipeg reach the limits described in Rule 1, the level in Winnipeg should be held constant while river levels south of the Inlet Control Structure continue to rise. Furthermore, if forecasts indicate that river levels south of Winnipeg will rise more than 0.61m (2 ft) above natural, the City must proceed with emergency raising of the dykes and temporary protection measures on the sewer systems in accordance with the flood level forecasts within Winnipeg. The water levels in Winnipeg should be permitted to rise as construction proceeds, but not so as to encroach on the freeboard of the dykes or compromise the emergency measures undertaken for protecting the sewer systems. At the same time, the Province should consider the possibility of an emergency increase in the height of the Floodway embankments and the West Dyke. At no time will the water level at the Floodway Channel’s entrance be allowed to rise to a level that infringes on the allowable freeboard on the Floodway West Embankment (Winnipeg side) and the West Dyke.

Rule 3:*Extreme Flood Operation:* For extreme floods, where the water level at the Floodway Channel’s entrance reaches the maximum level that can be held by the Floodway West Embankment and the West Dyke, the river level must not be permitted to exceed that level. All additional flows must be passed through Winnipeg.

The Red River Floodway Operation Review Committee also noted that questions arose about the accuracy of the computed “natural” levels above the Floodway. They therefore recommended that the “Natural” water level relationships be recomputed.

The "natural flow" is the flow that would have occurred if flood control projects such as the Shellmouth Dam, Portage Diversion, Assiniboine Dykes and Floodway had not been built. The "natural level" is defined as the level that would have occurred in the absence of flood control works but with the level of urban development in place at time of construction of flood control works.

In December 2002, Acres Manitoba was assigned to recompute the natural water levels associated with the Red River, and their report was filed in April, 2004. A copy of the executive summary of that report is attached to this report as Annex “B”, and the full text of the report is available for download at:

http://www.floodwayauthority.mb.ca/reports_recomp.html

The findings of the Acres study were that:

"The rating table is not a single relationship, due to the variable nature of Assiniboine River contributions. As such, a two dimensional matrix of Red and Assiniboine River discharge was required. The matrix of Red River and Assiniboine River discharges was simulated using the calibrated backwater model... The calculated rating table is presented in the following table and as a stage-discharge rating curve based on 10% flow contribution from the Assiniboine River is shown in the figure below."

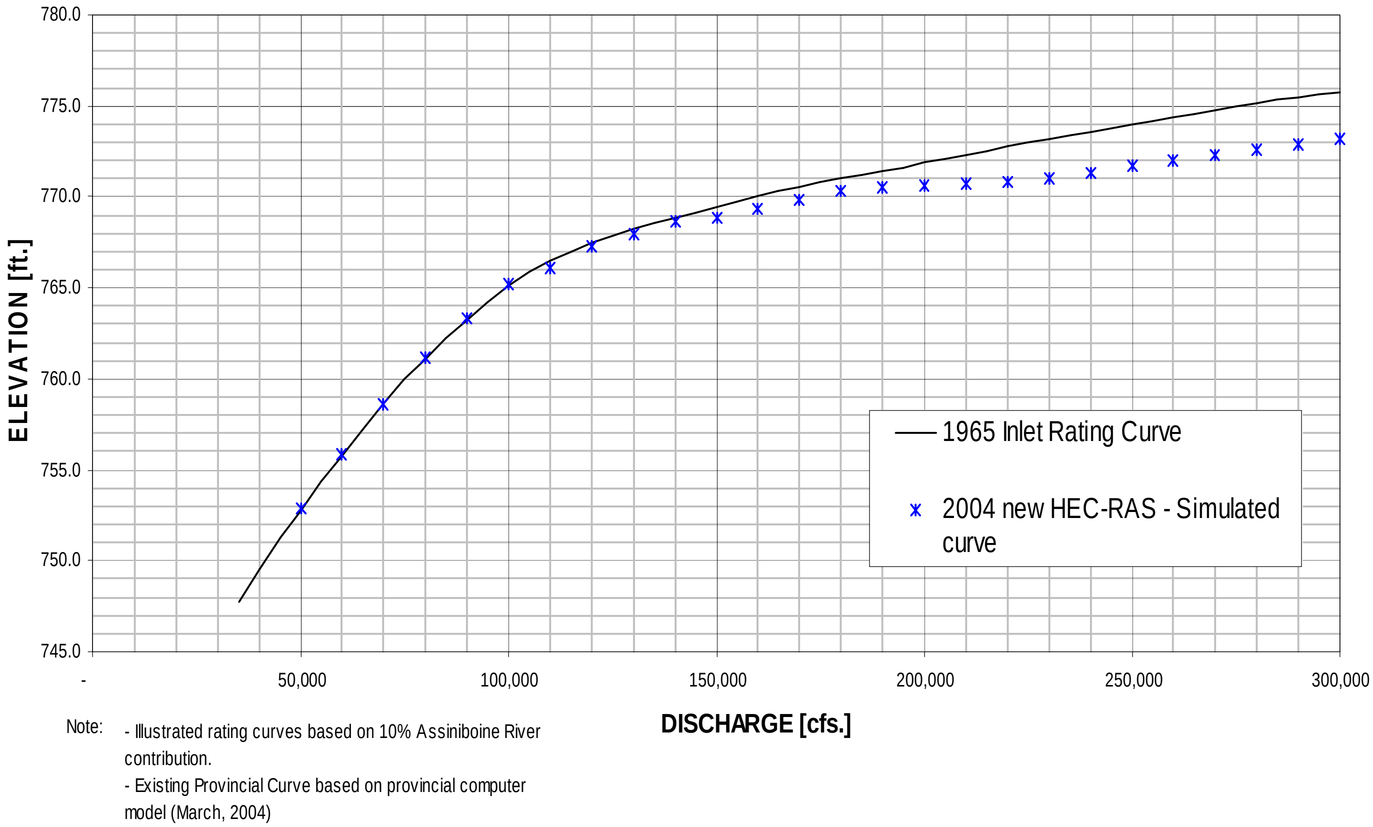


Figure 4: Rating Curve at Inlet Control Structure

Acres further found that:

The rating curve plot shows that the simulated curve begins to diverge from the existing Floodway Inlet curve at about 150,000 cfs and this divergence grows to about a foot lower at 200,000 cfs, and about two feet lower at 250,000 cfs.

The difference in the 'old' vs. 'new' rating curves is attributed to:

1) A better current understanding of the hydrology of the Red River Basin (there are 40+ years of additional data available which can be analyzed to determine hydrological impacts and responses today than what existed when the original Floodway rating curve was developed, and

2) The computerized modeling tools and analysis techniques available today are significantly more refined and accurate than the methods available for analysis of data that existed during the design of the original Floodway

8.1.6 Spring Flood Fighting Operations

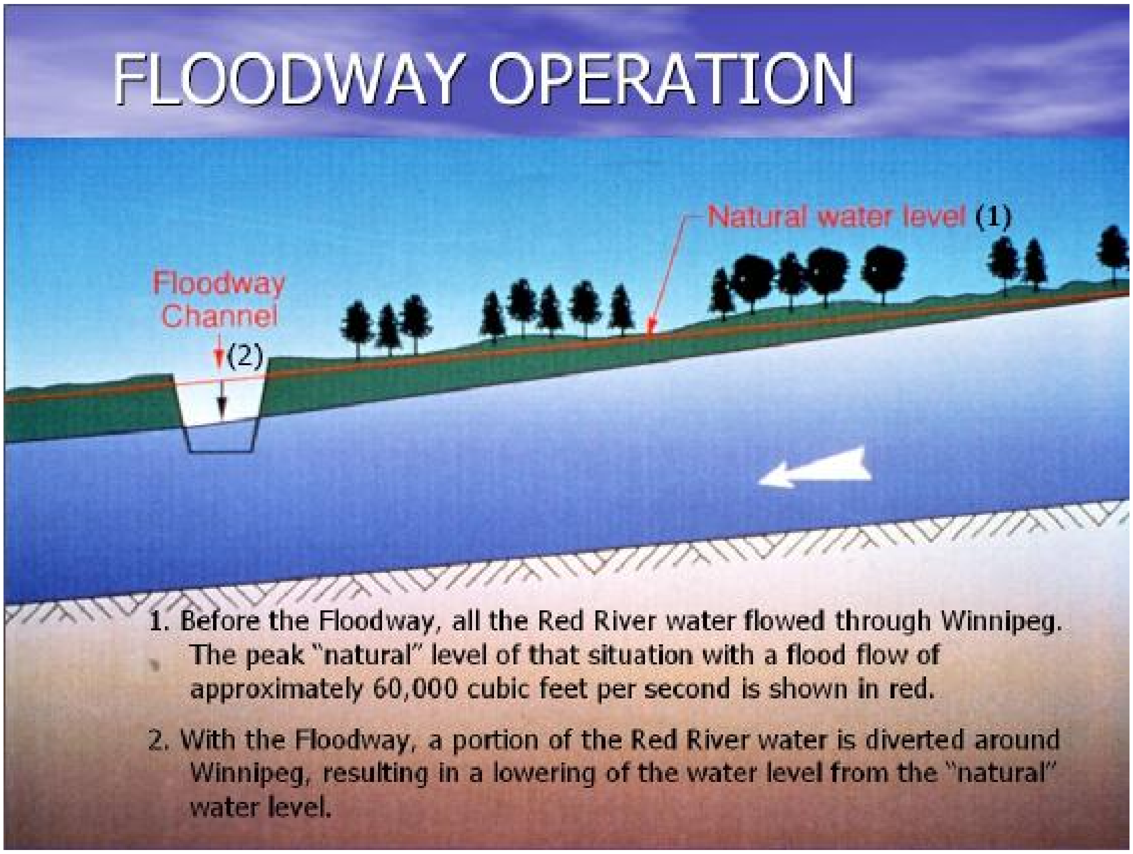
In general, a typical spring flood fighting operation on the Red River begins with the early assessment of flood potential along the river. This assessment, undertaken by Water Stewardship, includes analysis of snowpack and antecedent soil moisture conditions over the entire Red and Assiniboine basins. The long range forecast is usually issued in early March and is followed up if necessary with successive forecasts as the run-off develops. If a significant flood is forecast, information is provided as required to all departments and local governments involved in planning flood fighting activities.

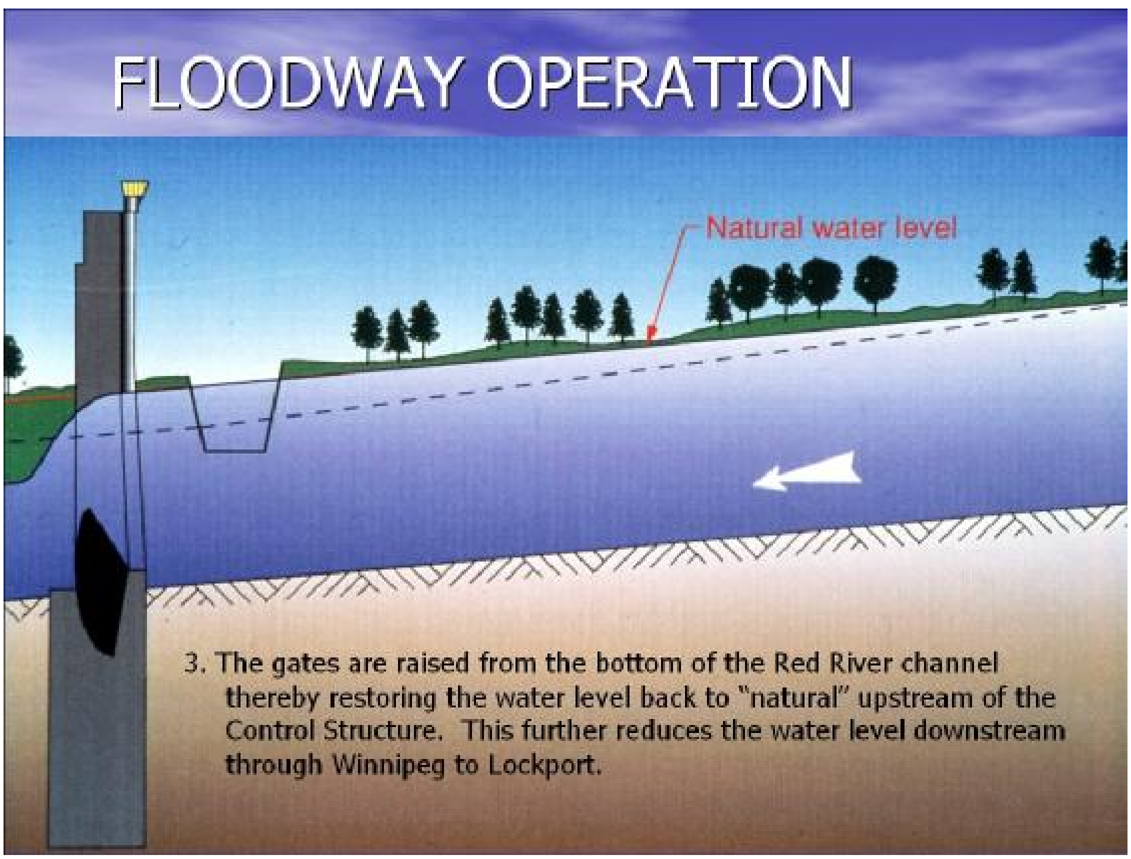
During the flood, Water Stewardship continuously monitors streamflow, provides daily water-levels and forecast peak flows and dates, to all affected Town flood protection facilities and all protected private home sites, etc. along the Red River and its tributaries.
Detailed information on operations in each ring-dyked community should be requested from Water Stewardship, Infrastructure and Operations Division. Detailed information on coordination of overall flood fighting activities should be requested from Manitoba Emergency Management Organization.

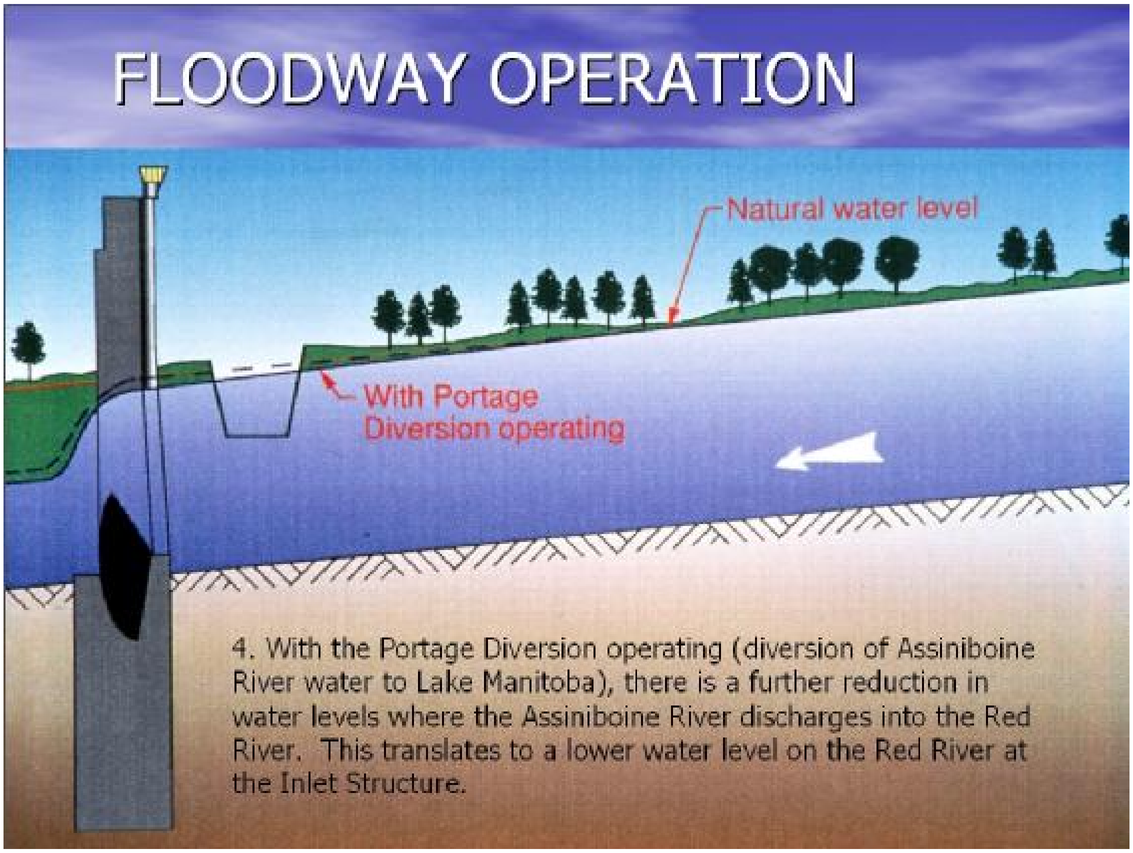
The City of Winnipeg is responsible for operation and maintenance of the Primary Dykes within the City (except for the Primary Dykes on the University of Manitoba Fort Garry Campus). Since 1997 the City has developed a detailed Flood Operations Manual which provides an enhanced level of coordination for comprehensive flood fighting planning and operations activities up to 25.7 feet JAPSD, which is the water level associated with the legislated Flood Protection Level.

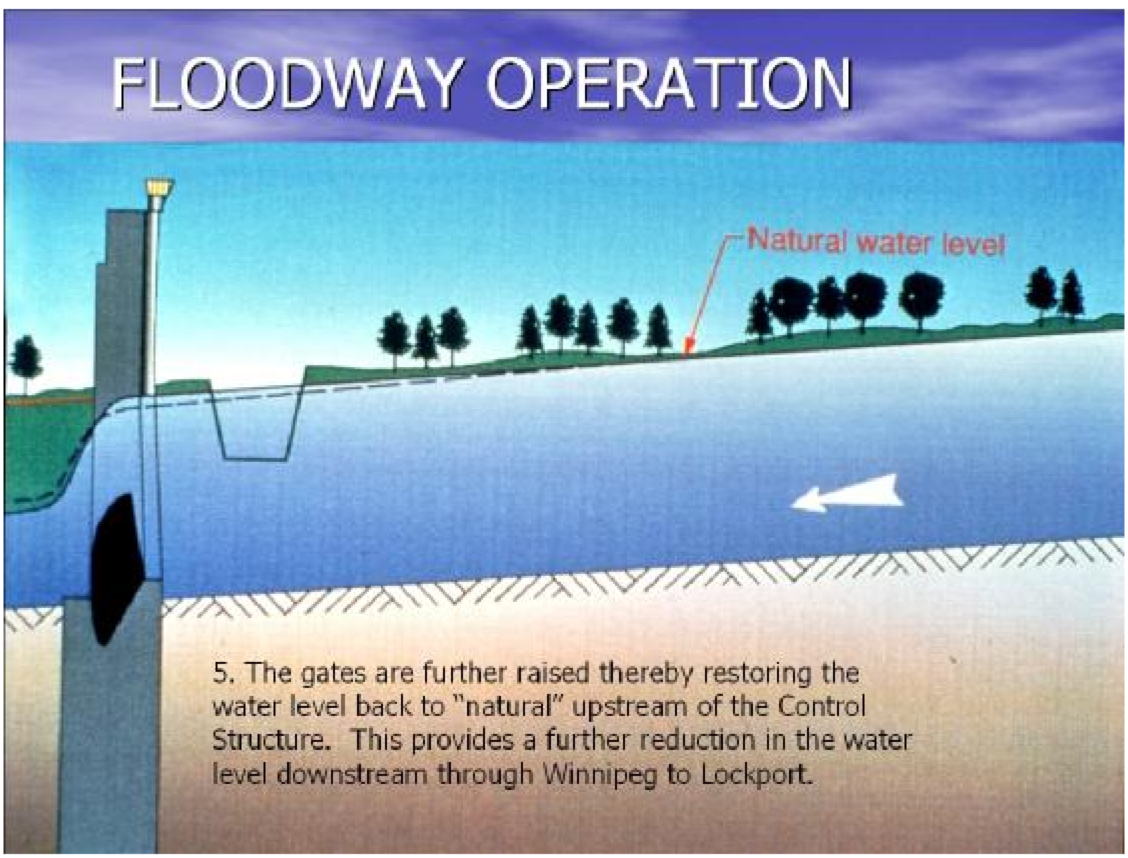
8.1.7 Interaction of Inlet Control Gates, the Floodway Inlet and Other Flood Protection Works

Operation and interaction of the Inlet Control Gates is illustrated and described in the following four graphics:


FLOODWAY OPERATION
Natural water level (1)
Floodway Channel
(2)
1. Before the Floodway, all the Red River water flowed through Winnipeg. The peak "natural" level of that situation with a flood flow of approximately 60,000 cubic feet per second is shown in red.
2. With the Floodway, a portion of the Red River water is diverted around Winnipeg, resulting in a lowering of the water level from the "natural" water level.


FLOODWAY OPERATION
Natural water level
3. The gates are raised from the bottom of the Red River channel thereby restoring the water level back to "natural" upstream of the Control Structure. This further reduces the water level downstream through Winnipeg to Lockport.


FLOODWAY OPERATION
Natural water level
With Portage
Diversion operating
4. With the Portage Diversion operating (diversion of Assiniboine River water to Lake Manitoba), there is a further reduction in water levels where the Assiniboine River discharges into the Red River. This translates to a lower water level on the Red River at the Inlet Structure.


FLOODWAY OPERATION
Natural water level
5. The gates are further raised thereby restoring the water level back to "natural" upstream of the Control Structure. This provides a further reduction in the water level downstream through Winnipeg to Lockport.

The above graphics demonstrate the gate operation for a given natural flow of approximately 60,000 cfs in the Red River, upstream of the Inlet Control Structure.

As shown earlier in Figure 4, there is a specific natural water level upstream of the control structure associated with each discrete flow rate on the Red River. Following the same principals as those illustrated in the graphics above, when operating under Rule 1, the gates would be adjusted as the flow on the Red River varied throughout the duration of the flood event so that the water level upstream equaled the computed “natural” level.

As noted in section 8.1.5, Operating Rules #2 and #3 anticipate that Floodway operations will be undertaken in response to major and extreme floods which cause “unnatural” water levels upstream of the Inlet Control Structure (ie. artificial flooding). Under such operations, the areas which experience unnatural water levels are located in a reach of the river referred to as being within the influence of the ”backwater” effect of the Inlet Control Structure. The extent of this backwater zone, and the effects of both natural and unnatural water levels in this zone is discussed further in section 8.1.10.

In recognition of the damages that can be realized under such operations, the Province has established compensation legislation which applies in the event that Floodway operation causes artificial flooding during spring flooding in the Red River Valley. Details of this legislation, it’s application and conditions attached thereto are discussed in detail in Section 7.0.

8.1.8 Effect of the Floodway Entrance Plug

The original design of the Floodway incorporated a weir at the channel entrance to serve several purposes:

- Minimize use of the Floodway during summer so as to also minimize the frequency of submergence of the channel vegetation that could lead to its irradication and resulting exposure of the channel bed to unpredictable erosion damage

- Minimize the risk of entrance of large volumes of river ice into the Floodway during the spring prior to passage of the ice down-river through Winnipeg. The ice jamming potential at bridges, or at the Floodway Outlet where the channel narrows to about one sixth of the surface width of the Floodway Channel upstream was feared as an uncertainty. It was recognized as a possible cause of channel blockage that could cause unpredictable rises in water level, and risk to the bridges.

The weir is about 200 m wide, has a crest elevation of approximately El 228.6 m (750 ft ASL) and is about 2 m in height above the invert of the Floodway Channel downstream.

The same issues exist today as did during the original planning in the 1960’s. It is possible that some means of prevention of these problems could be devised at a cost to the project, if there were significant benefits to be achieved by eliminating the entrance weir. Figure 5 shows the rating curve of flow through the Floodway as a function of the water level at the Floodway entrance. It also demonstrates how the expanded Floodway would modify this, and further, how it would be changed if the entrance weir were removed in its entirety. This figure demonstrates two points:

- The improvement in flood passage without the entrance weir at upstream water levels that are approaching or exceed the top of the riverbanks at the Inlet would be virtually nil.

- The largest increase in flow that could be provided is approximately 120 m^3/s (4,200 cfs), and would be at a water level of approximately 228.6 m (750 ft).

Combination of the modified Floodway rating curve (Figure 5– no Entrance Plug) with the known hydraulic characteristics of the Red River shows the following:

- With a water level at El 228.6 m (750 ft) and assuming the weir is in place, the river flow would typically be about 1,000 m^3/s (35,000 cfs), and would be at an incipient condition of overflowing the crest of the entrance weir.

- If a similar river flow were to occur and the weir did not exist, the drawdown effect of water entering the Floodway would be approximately 35 cm (14 inches) at the entrance to the Floodway, and would be a similar reduction in water level through most of Winnipeg.

- The reduction in water level would reduce to approximately 18 cm (7 inches) at St. Adolph, and to 7 cm (3 inches) at Ste. Agathe. This is the largest improvement that could be expected.

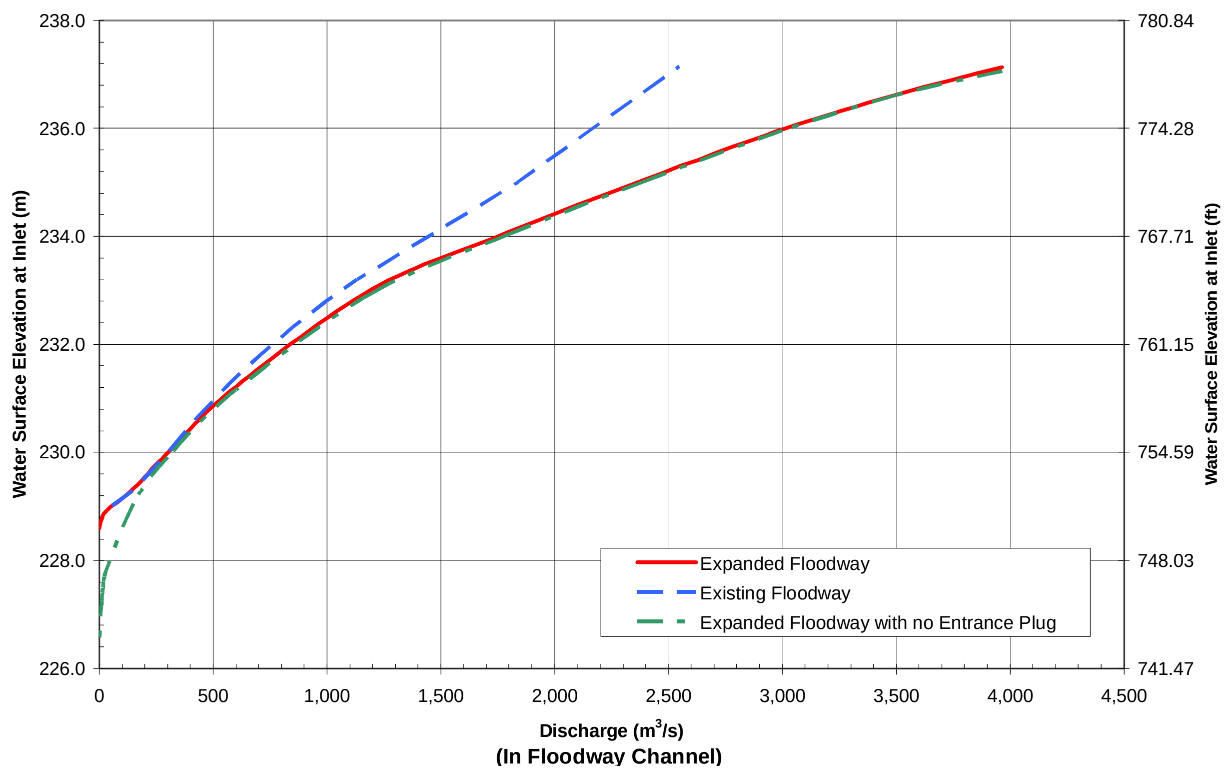


Figure 5 – Rating Curves of Floodway Channel at Floodway Entrance

- At flows that cause the river level to exceed El 230 m (754.5 ft), the elimination of the weir would have no measurable effect. This would be at river flows of about 1 600 m^3/s (56,000 cfs), or greater.

- Similarly, at flows that would cause the river to reach only El 226.5 m (743 ft), the benefit would be zero, as no flow would enter the Floodway either with or without the entrance weir.

These reductions are all at a stage that is well below bank-full stage in the Red River, and the maximum reduction in water level of 35 cm (14 inches) would occur at a water level of about 4 m (12 ft) below the top of bank. Given the small water level reduction, and the fact that that reduction is achieved at a level that is well below bank-full stage upstream, it has no benefit and does not warrant the cost of removing the weir or replacing it with a costly structure to hold back ice while allowing flow into the Floodway channel at less than 750 ASL. Just removing the plug will add exposure of the Floodway to the risks cited above.

8.1.9 Floodway Expansion Project Synopsis

The Floodway Expansion Project is being designed to protect the City of Winnipeg from floods with returns periods up to a 1-in-700 years. The key elements of the expansion project include:

- Increasing the capacity of the Floodway Channel from 1700 m^3/s (60,000 cfs) to 3965 m^3/s (140,000 cfs) primarily through widening of the existing channel.

- Maintaining the previous maximum water level limit of 237.13 m (778.0 ft) at the Floodway Entrance for the 1-in-700 year design condition.

- Limiting the flow through the Inlet Control Structure without considering water levels to exceed the Flood Protection Level of 7.68 m (25.8 ft JAPSD) in Winnipeg.

- Raising the West Dyke, East Dyke and West Embankment of the Floodway to provide protection to the design flood level with sufficient freeboard to withstand the setup and waves generated by the design wind during the flood period.

- Modifying the Outlet Control Structure to provide the energy dissipation required for the increased Floodway flow. This is being accommodated primarily through a new, wider mass-concrete overflow structure.

- Maintaining the current Operation Rule Curves. However, with the expanded Floodway, the transition points between the rules are implemented at higher flows, which reflect the revised discharge capacity (and associated higher levels of protection) of the Floodway Channel.

To summarize the discussions contained in the preceding sections (8.1.5 to 8.1.9), the “State-of-Nature” or “Natural” and the ultimate maximum water levels at the Floodway entrance are graphically depicted below in Figure 6. This figure also illustrates the effect of implementing the Operation Rules for both the existing and expanded Floodway and the effect of the modifications made during the design process. The modifications were based primarily on additional backwater analysis and modified Floodway Channel geometry.

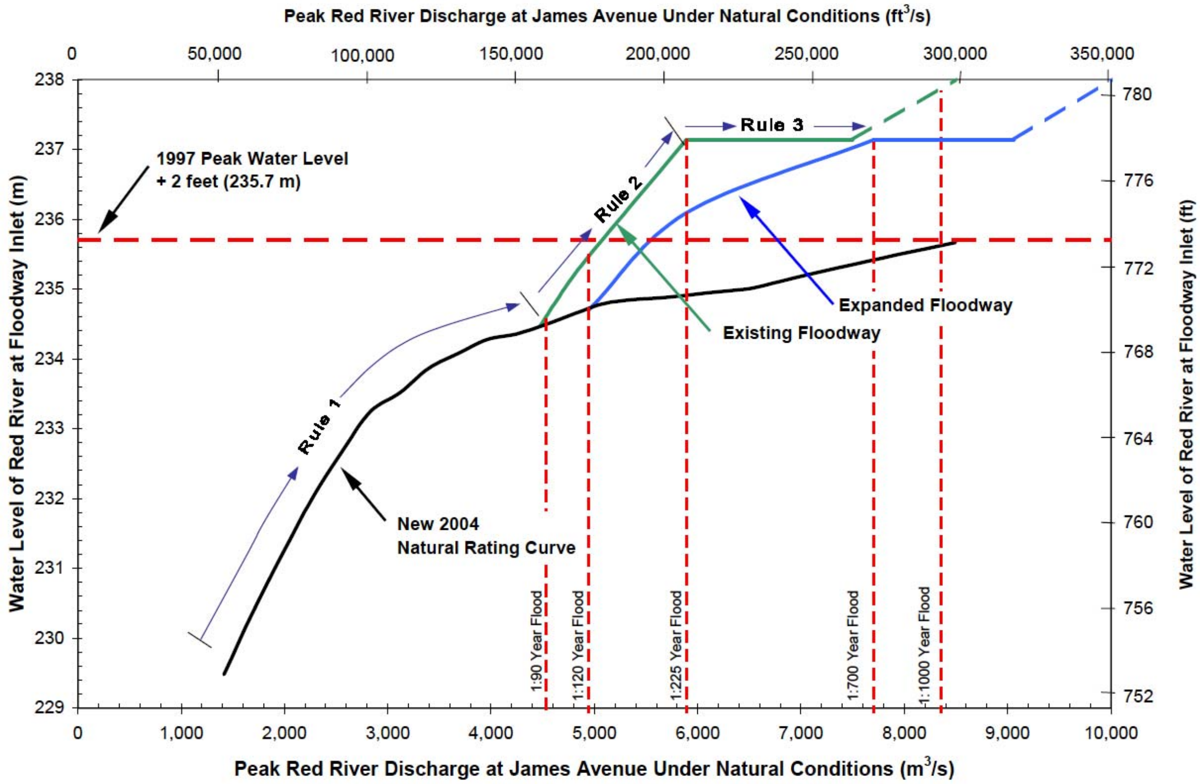


Figure 6 – Rule Curve for Existing and Expanded Floodway
(Showing Elevation at Inlet vs. Flow Event)

8.1.10 Effects of Floodway Operation (Spring Event)

The effects of Floodway Operation in response to a spring flood event are described in this section within the context of four events that have return periods as follows:

- **90 Year** (event at which natural water level is maintained with existing Floodway)
- **120 Year** (event at which natural water level is maintained with expanded Floodway)
- **225 Year** (maximum protection level of existing Floodway at el. 778 – artificial flooding occurs)
- **700 Year** (maximum protection level of expanded Floodway at el. 778 – artificial flooding occurs)

(Although the existing Floodway can pass a maximum of a 225 year flood, it is not reliable due to submerged bridges and inadequate freeboard on the West Dyke.)

During the latter stages of the public consultation process, and through the initial responses received to the Environmental Impact Assessment, it has become apparent that there is a general misconception with respect to the areas inundated by the 700 year event, in the presence of the existing and the expanded Floodway, and how those areas relate to inundation that may have occurred without the Floodway and it's associated works. In particular, some members of the general public incorrectly believe that:

- the West Dyke creates a significant impoundment west of the Red River that would not exist without the dyke, and

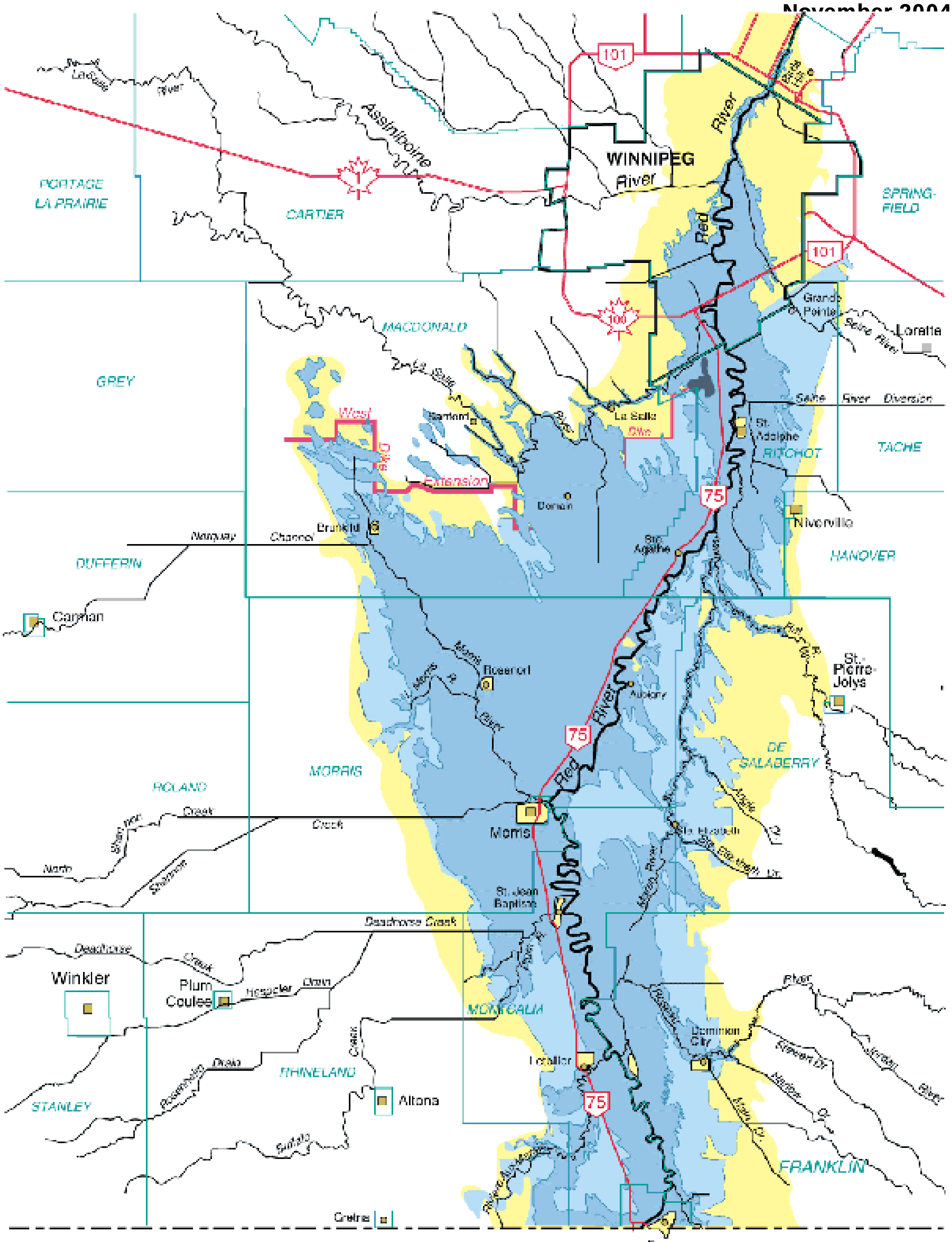
- that areas east of approximately PTH No. 59 would not be part of the floodplain for extreme events if the Floodway and the East Embankment did not exist

These misconceptions can be dispelled by studying the graphic depicted in Figure 7, which illustrates the extents of flooding for various extreme events of record (1826, 1950 and 1997). The extent of flooding for the 1826 and 1950 events as shown were determined by using water levels recorded for those events to develop reasonable flood hydrographs for the events, and simulating those events in a similar way as the design events for the Floodway expansion were modeled to determine the limits of flood propagation. The topography in the inundation models for those events was also modified from existing conditions to represent the state of infrastructure development at those points in time. The 1997 flooded area is based on Radarsat (satellite) imagery captured at the peak of the actual event.

It is apparent that, even in the absence of the West Dyke, Floodway and East Embankment, flood waters in 1950 and 1826 propagated both into the westerly portion of the valley and easterly extent of the floodplain in a similar pattern or 'footprint' as that experienced in 1997 (when the West Dyke and Floodway existed). This is largely due to the natural topography and gradients throughout the valley (to the west, created by the confluence of the Red River valley and the Morris River valley).

Interestingly, to the west, the ultimate extent of flood water propagation in 1826 closely followed the alignment of the (later) West Dyke for much of its length. This is because a good portion of the West Dyke is situated on the watershed boundary, and is simply intended to prevent the floodwaters from the Red River from crossing the boundary into the LaSalle River.

Based on review of the flood extents in 1826, it is clear that areas to the south of the West Dyke and east of PTH 59 near Grande Pointe are part of the natural floodplain that would exist with or without the Floodway and it's associated works. This is not to say that existence of the Floodway causes no impact. As noted in sections 8.1.5 and 8.1.7, beyond approximately the 90 year event, operation following Rule 2 would be undertaken, and unnatural water levels would be created upstream of the Inlet Control Structure in response to a Major Flood, with the existing Floodway. However, the effect in those areas noted above is incremental on an existing condition, not solely related to existence and operation of the Flood Control Works. These effects are further discussed in the following section.



RED RIVER VALLEY FLOODED AREAS

1826 1950 1997

FIGURE 7

Also in the latter stages of the Public Consultation Process, inundation figures were prepared to assist in demonstrating the effects and benefits of the Floodway and the expansion project. However, in some cases, misconceptions existed in interpretation of these figures, particularly when events with varying return periods were presented independently. To clarify these issues, Figures 8.1 and 8.2 were developed showing three distinct conditions overlaid on one graphic:

- <u>The 700 year design event:</u> Shown in Dark Blue, the topographical extent of flooding for this event throughout the valley is independent of Floodway Expansion (ie. with or without expansion, the maximum water elevation at the Floodway Inlet is 778' ASL, and therefore the inundation extends to the same limits). *The total flow associated with this event is 225,000 cfs on the Red River at the Inlet, and is significantly larger than the total flow associated with the 1997 event (138,500 cfs).*

- <u>The actual 1997 flood limits</u>: This is represented by the area in green *combined* with the area in light blue. This is the limit of flooding that actually occurred at the peak of the 1997 event (approximately 90 year return frequency, vs. 700 years as described above).

- <u>The 90 year event after Floodway Expansion:</u> Shown in green, this area represents the extent of flooding that would occur should a hydrologic event similar to the 1997 condition be experienced after Floodway Expansion. The benefits of the expansion project are shown in that the difference between the actual 1997 limits noted above would be <u>reduced</u> by the area in light blue, due to the increased Floodway capacity.

Comparison of Flooding Extents
90 Year (~1997) vs. 700 Year

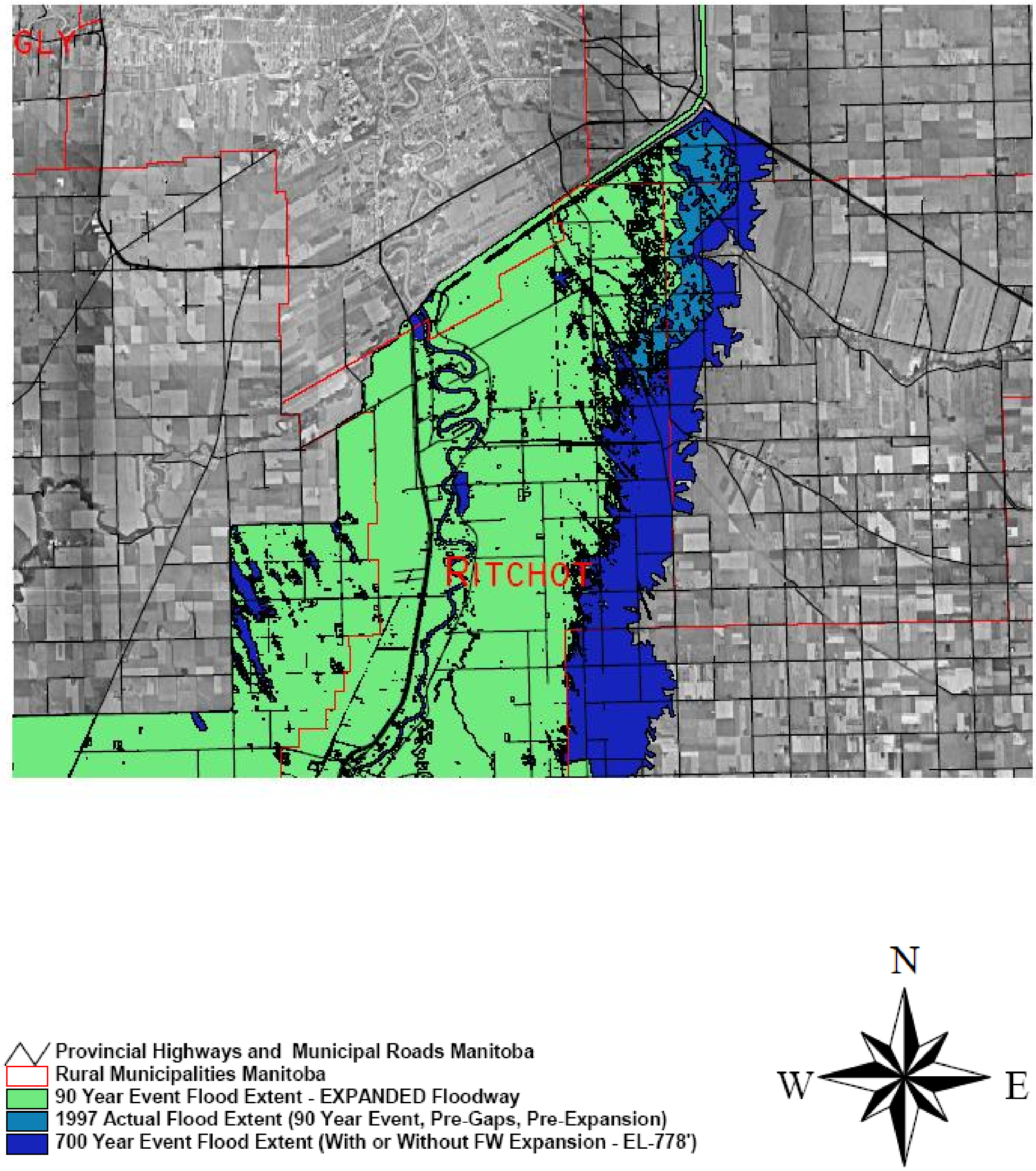


FIGURE 8.1 (Ste. Agathe to Grande Pointe)

Comparison of Flooding Extents
90 Year (~1997) vs. 700 Year

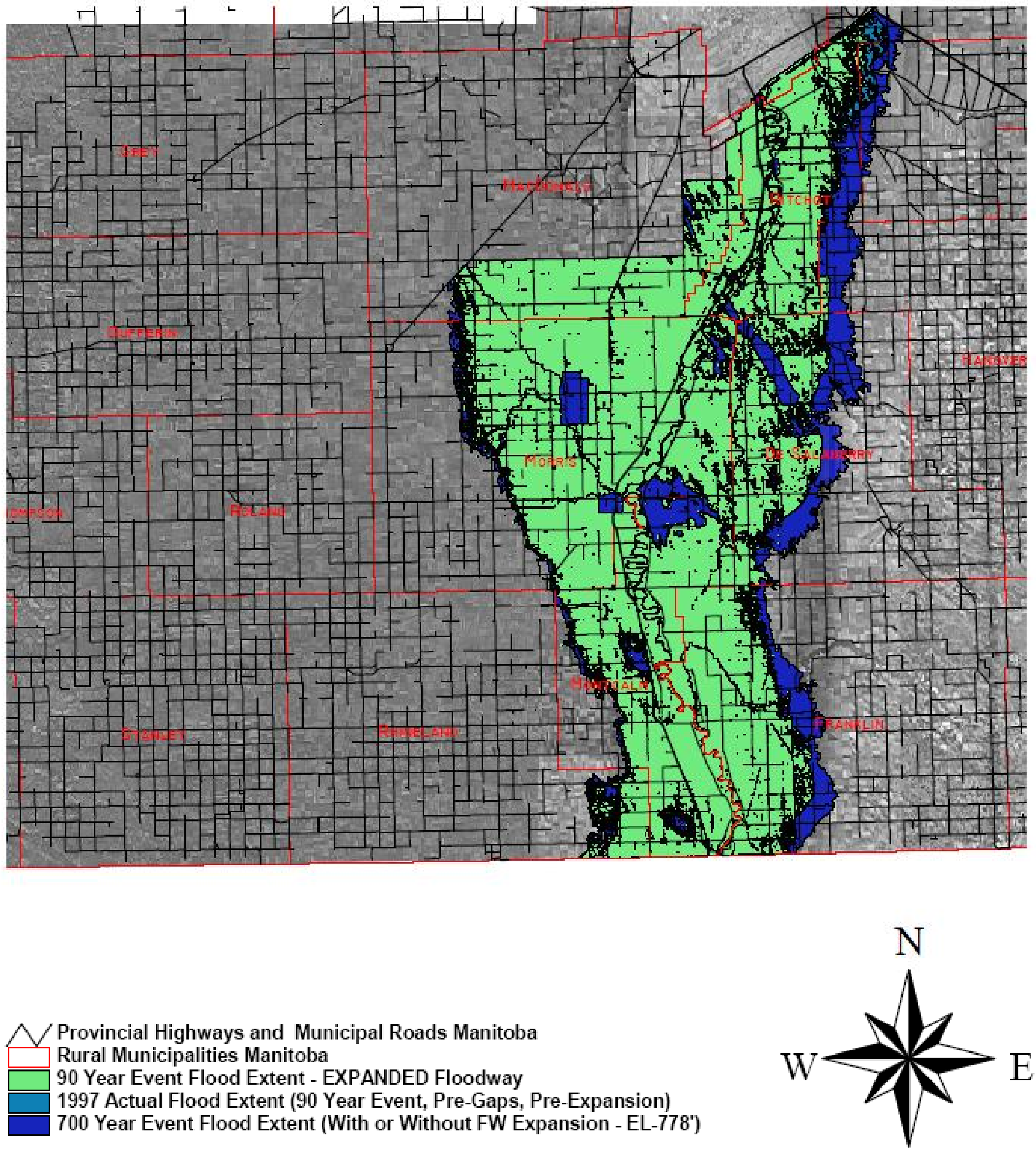


FIGURE 8.2 (Emerson to Winnipeg)

The effects of Floodway operations on water levels along the Red River are evaluated in detail in Appendix "L" to the Preliminary Engineering Report, entitled "Environmental Baseline Studies – Water Regime Effects". A summary of those findings is provided herein to meet the objectives of this section in providing a complete overview of Floodway operations.

Water surface profiles for each of these four events were developed using a combination of 3 industry recognized hydraulic models: HEC-RAS, MIKE11 and TELEMAC-2D. A substantial amount of technical detail regarding model setup, calibration and the simulations carried out are contained in various appendices of the Preliminary Engineering Report, mainly Appendix "L" and Appendix "H".

The following graphical products have been developed since filing of the EIS to aid in understanding of the effects related to existence and operation of the current Floodway, and expansion of the Floodway. These are included as Annexes to this section of the Supplementary Filing:

- Graphs of the water surface profiles for each of these events, depicting conditions for both the existing Floodway and expanded Floodway. These graphics also show the flood protection levels for various communities in relation to the water levels (contained in Annex "C" to this section of the Supplementary Filing - 18 pp)

- A tabulation of water levels at discrete locations for existing and expanded Floodway scenarios (contained in Annex "D" to this section of the Supplementary Filing – 1 page)

- Individual graphical depictions of water levels for the communities referenced in the above table (contained in Annex "E" to this section of the Supplementary Filing – 19 images)

- Additional inundation maps showing the maximum extent of flooding for the design event to be expected south of Winnipeg, within Winnipeg and to the North. (contained in Annex "F" to this section of the Supplementary Filing – 3 pp)

- Cross-sections showing the extent of inundation for the 700 year design event (contained in Annex "G" to this section of the Supplementary Filing – 4 pp) *Note: due to time limitations only one set of cross sections at one location could be prepared for submission with this report. Additional cross sections will be available in December 2004, for the locations that are identified on the inundation maps.*

To summarize the effects of Floodway operation and expansion which are demonstrated in the above noted tables and graphics, a quantitative analysis of total residences that would experience flooding for the four target events was carried out, for both the existing and expanded Floodway scenarios. The results are tabulated below in Table 3:

TABLE: 3 - Estimated Numbers of Flooded Residences With/Without Floodway Expansion

Region of Analysis:	Number of Residences Flooded							
	Existing Floodway				Expanded Floodway			
	1:90 yr	***1:120 yr***	***1:225 yr***	***1:700 yr***	***1:90 yr***	***1:120 yr***	***1:225 yr***	***1:700 yr***
Emerson to Floodway Inlet[1]	1085	1300	2960	3300	1085	1200	2355	3300
Within City of Wpg below Floodway Inlet[1]	0	0	0	144,000	0	0	0	0
North Perimeter Bridge to Floodway Outlet[2]	-[3]	124	143	364	-[3]	124	143	239
Floodway Outlet to Netley Creek[2]	-[3]	73	86	167	-[3]	73	86	174

Notes:

1. Source - "Flood Protection for Winnipeg" - 2001 - KGS Group / InterGroup - Appendix F
(This data represents information as of late1998)

2. Source - "Preliminary Engineering Report" - Appendix L - Acres Manitoba Ltd

3. This flood was not analysed by Acres Manitoba Ltd.

The source of the data in the table is based on the best sampling of information available as of 1998. While the totals represented by the figures may not be explicitly accurate in 2004, differences would be small, and would not affect the economics or benefits of the Floodway Expansion Project, and there are two valid conclusions that can be drawn from the table, irrespective of the date:

- The orders of magnitude represented by the totals in each region are appropriate in comparison to each other, and
- The relative changes shown from existing to expanded Floodway are relatively accurate, and again allow for the comparison and demonstration of project benefits and impacts.

8.1.11 Effects of Floodway Operation and Expansion for Extreme Events (beyond 700 Year Return Period)

8.1.11.1 Upstream of the Inlet

For floods larger than the 1 in 700 year flood, the water level upstream of the Floodway Inlet would be maintained at 237.13 m (778 ft) ASL, therefore the effect on water levels will be the same with or without the expansion project. For a very extreme flood, the water level would rise above 778 ft, earlier with the existing Floodway than with the expanded Floodway.

8.1.11.2 Within Winnipeg

Water levels in Winnipeg would rise above 26.5 ft at James Avenue as additional flow is passed through Winnipeg. If all the primary dykes in Winnipeg cannot be temporarily raised on an emergency basis, flooding will occur in Winnipeg. However, for floods greater than the 1 in 700 year flood, the flooding would be much less extensive in Winnipeg with the Project.

8.1.11.3 Downstream of the Outlet

The incremental flood levels with the Project downstream of the Floodway Outlet should be no greater than the incremental difference for the 1 in 700 year flood (an increase of 0.27 m with the Project at Lockport, tapering to an increase of 0.13 m at Selkirk and 0.05 m at Breezy Point). This is because for floods larger than the 1 in 700 year event, the additional water will go through Winnipeg, as it would with the existing Floodway.

8.1.11.4 Response to Very Extreme Events

For an extreme event of one in 2500 year Flood (9 500 m3/s at James Avenue, approximately 8 500 m3/s at the inlet), the combined capacity of the Expanded Floodway and the Inlet Control Structure in the Red River may be exceeded and may require the removal of part of the West Dyke to allow passage of the flood. At this level, flooding will have occurred on the north side of the West Dyke due to allowing more water to flow through Winnipeg (Rule 3); and the location will be selected as to cause no additional flooding in the region protected by the West Dyke.

8.2 SUMMER WATER LEVEL CONTROL IN THE CITY OF WINNIPEG

Summer water level control in the City of Winnipeg is a planned future action as a separate action from Floodway Expansion. In other words, management of summer water levels in the City of Winnipeg is to be done solely through the operation of the existing Red River Floodway control gates, thereby precluding the requirement for any additional work associated with Floodway Expansion. Therefore, the environmental licence and approvals applications for water level control outside of the existing current program of operation (typically in the spring) are not being put forward at this time and will be sought later as an amendment and/or alteration to the approvals for Floodway Expansion. In the meantime, Manitoba will undertake studies to investigate riverbank stability, fish passage and wildlife. As part of those studies, Manitoba will consult with interested stakeholders.

Manitoba has operated the Floodway in the summer in 2002 and 2004. The reader is referred to Section 8.3 for further discussion on emergency operations outside the existing program of operation.

8.2.1 STUDY OF SUMMER WATER LEVEL CONTROL

In October 2002, Manitoba Conservation engaged KGS Group Consulting Engineers to proceed with a feasibility study of the merits of summer water level control in the City of Winnipeg. This study was initiated following the emergency operation of the Red River Floodway during the summer of 2002 and a preliminary assessment of summer water level control as part of KGS Group's November 2001 report, "Flood Protection Studies for Winnipeg" (KGS Group, 2001).

The scope of work included an assessment of the benefits and costs associated with summer operation of the Floodway including:

§ Benefits to the City of Winnipeg based on avoided flood damages due to sewer backup, and reduced flood pump station maintenance and operation costs.

§ Recreational benefits based on accepted values for increased recreation / tourism and avoided operational costs.

§ Qualitative assessment of the benefits of future tourism / recreation development opportunities.

§ Costs associated with increased flooding upstream of the Floodway Inlet Structure, based on use of KGS Group's flood damage model, topography upstream of the Floodway Inlet and information from the Province regarding summer use of this area.

In addition to these considerations, the study scope included an assessment of the effects of summer water level control on fish passage and summer navigation and the operation of the Floodway for summer water level control in 2002.

The final report is titled "Investigation of the Merits of Management of Red River Summer Water Levels in the City of Winnipeg", and can be found at the following website:

http://www.gov.mb.ca/conservation/watres/study_reports.html.

8.2.2 SUMMARY OF THE STUDY OF SUMMER WATER LEVEL CONTROL

The following sections are taken from the Executive Summary, the Conclusions and the Recommendations from the report "Investigation of the Merits of Management of Red River Summer Water Levels in the City of Winnipeg". This information is provided herein for information purposes only. Manitoba has not adopted or approved the information, conclusions and recommendations of the report but will be using this information as a basis for determining future studies and investigations (see Section 8.2.3 below).

EXECUTIVE SUMMARY

A number of options for summer water level control were considered as a part of the KGS Group study "Flood Protection Studies for Winnipeg" (KGS Group, 2001). The 2001 study concluded that costs to completely eliminate the effects of summer flooding and not raise upstream water levels above the "state-of-nature" would increase the Floodway Expansion costs by over $100 Million. This was deemed not to be practical. For the purpose of the subject study, the option of using the existing Floodway configuration and temporarily raising the upstream water levels above the "state-of-nature" was studied to assess the financial feasibility of summer water level control.

In addition to the merits and costs of summer water level control, this study considered an assessment of the emergency operation of the Floodway that was authorized on June 28, 2002 when the Red River water level was predicted to exceed el. 14 ft JAPSD (James Avenue Pump Station Datum). This decision was based on the risk of basement flooding due to possible heavy rain over the city in combination with high river levels.

To assist with the study direction and provide input to the study, a Steering Committee was established with representatives from Canada, the Province of Manitoba, the City of Winnipeg, as well as upstream and downstream stakeholders. The Steering Committee Members were as follows:

- Rick Bowering (Manitoba Conservation, Chair)
- Eugene Kozera (Manitoba Conservation)
- Rick Hay (Manitoba Conservation)
- Henry Daniels (Manitoba Conservation)
- Maurice Sydor (Environment Canada)
- Doug McNeil (City of Winnipeg)
- Tony Kettler (PFRA)
- Herm Martens (RM of Morris)
- Bob Stefaniuk (RM of Ritchot)
- Val Rutherford (RM of Ritchot)
- Doug Dobrowolski (RM of MacDonald)
- Bud Oliver (Selkirk and District Planning Area Board)
- Cas Booy (Independent Member)

Assessment of Benefits and Costs

The assessment of benefits and costs was based on the effects of summer operation of the Floodway Inlet Control Structure on:

§ Potential basement flood damage and operating costs for flood infrastructure in the City of Winnipeg compared to the existing conditions.

§ Recreation activities that occur during the summer navigation season on the Red River, Assiniboine River and other tributaries that are affected by changes in water levels on the Red River, between the Floodway Inlet and Floodway Outlet.

§ Flood and disruption damages to market gardeners, cereal crops, and uncultivated riverbank land located upstream of the Floodway Inlet Control Structure. Costs associated with these damages were estimated using compensation and buyout approaches. The first approach was based on compensation for losses following each summer operation event, while the buyout approach considers a one time, "upfront", purchase of the affected lands. A potential hybrid solution (i.e. part buyout and part compensation) was also considered.

§ Costs of summer operation and maintenance of the flood control infrastructure.

§ Flood damage and maintenance costs to affected municipal infrastructure upstream of the Floodway Inlet Control Structure such as roads, drains, water intakes, etc.

§ Property tax revenue to upstream municipalities due to buyout of flood prone lands by the Province.

§ Recreational boaters north of Winnipeg.

In addition to quantitative assessment of benefits and costs, additional items were identified which are positively or negatively affected by the summer operation of the Floodway Inlet Control Structure. These include:

§ Bank stability effects of summer operation, upstream and downstream of the Floodway Inlet Control Structure.

§ Environmental considerations, including potential fisheries effects and the requirements of the Department of Fisheries and Oceans, as well as potential effects to the area north of the St. Andrews Lock and Dam, including Selkirk.

Results and Sensitivity Analyses

The analysis of benefits and costs indicate that the optimum target water level is el. 8 ft JAPSD, where both the B/C ratio and net benefits tend to peak. This occurs because the upstream damages increase at a higher rate than the benefits as the summer water level control is reduced to el. 8 ft JAPSD. Furthermore, there are negligible additional recreation/tourism benefits for controlled water levels below el. 8 ft JAPSD.

The inputs considered in the analysis were based on assumptions that are difficult to verify, require substantially greater effort to substantiate, or depend on future conditions that cannot be predicted with certainty. The sensitivity of the results of the analyses was, therefore, assessed for reasonable bounds in the variability of these assumptions.

For the sensitivity assessment, the base case used the “hybrid” (i.e. part buyout and part compensation) approach to calculating upstream damages. A total buyout approach was deemed to be not economically feasible and a total compensation approach was considered to be extremely difficult to implement and carry out into the future. The benefit/cost ratios and net benefits for the base case are 2.7 and $670,000, respectively, when recreation / tourism benefits are included in the assessment. When recreation and tourism benefits are excluded, these values reduce to 1.9 and $340,000 respectively.

The sensitivity of these economic indicators was tested for reasonable upper and lower bounds for the assumptions that could potentially have the most significant effect on the results. The results of the analysis are shown on the Table below.

Sensitivity Analysis to Cost / Damage Input

	Benefit / Cost Ratio		Net benefits	
Scenario	**With High Recreation / Tourism Benefits**	**With No Recreation / Tourism Benefits**	**With High Recreation / Tourism Benefits**	**With No Recreation / Tourism Benefits**
Base Case	2.7	1.9	$ 670,000	$ 340,000
+10% Upstream Damages	2.5	1.7	$ 630,000	$ 295,000
-25% Upstream Damages	3.6	2.5	$ 760,000	$ 430,000
+40% Benefits due to Reduced Basement Flood Damages	3.4	2.6	$ 960,000	$ 625,000
-40% Benefits due to Reduced Basement Flood Damages	2.0	1.1	$ 380,000	$ 45,000
Highest Benefit Scenario -25% Upstream Damages & +40% Benefits due to Reduced Basement Flood Damages	4.6	3.5	$ 1,100,000	$ 720,000
Lowest Benefit Scenario +10% Upstream Damages & -40% Benefits due to Reduced Basement Flood Damages	1.8	1.0	$ 340,000	$ 5,000

Alternate Means to Deal with Elevated Summer Water Levels

During meetings with the Steering Committee and other stakeholders, alternatives to summer flood control were discussed. These included increasing the size of and/or adding additional Flood Pump Stations in the City of Winnipeg. Such actions could theoretically alleviate basement flood damages by allowing the drainage districts to be isolated from high river levels and pumping the rainfall runoff to the river when necessary. Based on a cursory assessment of this alternative, it was concluded that the high costs required to upgrade the Flood Pump Stations make this option not a viable alternative to summer water level control.

Another alternative that could be considered, in conjunction with increased capacity of the Flood Pump Stations or separately, would be to increase the elevation of the river walkways and the associated infrastructure. Although this is technically feasible, it would, however, be costly and regressive to replace these works constructed over the past ten to fifteen years. This is not seen as a viable alternative.

If the Floodway is expanded as currently planned, the frequency of summer flooding will not be affected. The upstream effects of summer water level control will, however, be reduced, due to the larger capacity of the Floodway. Consideration of the effects of an expanded Floodway was excluded from the scope of this study.

Assessment of 2002 Operation of Floodway

As a part of this study, an assessment of the 2002 operation of the Floodway was undertaken. The scope of this assessment included:

§ Review and documentation of the planning phases of 2002 summer Floodway operation.

§ Review of the operation criteria, including

- Initiation levels
- Response to rainfall forecasts
- River level drawdown rates

§ Recommendations for future summer operation

Based on the experiences of 2002 and the analysis of rainfall and river water level response times, it was concluded that it is not practical to operate the Floodway in response to rainfall forecasts. This is due to the short time frame and uncertainty associated with forecasting rainfall and the relatively long response time for water levels to adjust to Floodway gate adjustments. Therefore, if a decision is made to operate the Floodway in the future for summer water level control, it should be done as soon as water levels exceed a predetermined threshold, say elevation 9 feet or 10 feet JAPSD. The control level would then be elevation 8 feet JAPSD based on the costs and benefits analysis. Given the relative response times of the sewer and the river, implementing the Floodway for summer water level control needs to be viewed as purchasing an insurance policy. That is, the costs associated with upstream damages will need to be paid out and depending on the extent of rainfall, there may or may not be avoided damages. In those years when damages do occur they will, however, be substantial. For example in 1993, the total estimated damages of $140 Million could possibly have been reduced by tens of millions of dollars for a cost of summer operation in the order of $1 million.

If the decision is made to control summer levels when water levels exceed the predetermined threshold, it can then be done in a controlled manner, minimizing the concerns associated with the drawdown rate and associated bank stability considerations.

Environmental Considerations

A number of environmental issues will need to be resolved prior to proceeding with the control of summer river levels in Winnipeg. It is assumed that this will be a project requiring a license for a change in the Floodway operation rules and that the environmental issues will be dealt with as a part of the environmental licensing process. These include:

§ Fish passage at the Floodway Inlet Control Structure

§ Assessment of the effects on and compensation requirements for the upstream stakeholders

§ Concerns of downstream stakeholders associated with changed flow regime.

Bank Stability Considerations

The implications of the summer control operation on riverbank stability are complex. Bank stability is controlled by numerous natural and man-made factors. It is anticipated that the incremental impacts on bank performance from the control of the summer flood levels will be relatively minor both upstream and downstream of the Inlet Control Structure relative to the natural factors. Any negative physical impacts that might be realized upstream of the Inlet will be offset by the positive impacts experienced downstream. Based on a comparison of the values of land impacted, the benefit/cost ratio is anticipated to be greater than 1, considering the higher land values within Winnipeg.

An engineering investigation and geotechnical monitoring program is recommended to obtain base-line information on the bank stability conditions prior to implementation of the summer control program, and to determine the influences directly attributed to control of summer water levels. The estimated cost to complete the investigation and installation of the monitoring instrumentation is anticipated to be in the range of $225,000 to $375,000. An additional allowance for monitoring and data interpretation over a 10 year period should also be included for planning purposes.

Assessment of Results

The results of the benefit/cost (B/C) analysis demonstrate that summer water level control is a viable endeavor from a societal perspective. For the base case conditions, benefit/cost ratios of 2.7 and 1.9 with and without tourism/recreation benefits, respectively, have been calculated. Although these B/C ratios are substantially greater than 1, they are not overwhelmingly in support of the summer control initiative. As described above, the B/C ratios are relatively sensitive to reasonable lower and upper bounds associated with the assumptions made for the analysis. When viewed from a lowest reasonable benefit perspective, the B/C ratios are reduced to 1.8 and 1.0 for conditions with and without tourism/recreation benefits, respectively. On the other hand, based on a highest reasonable benefit assessment of the contributing assumptions to the analysis, B/C ratios as high as 4.6 and 3.5 were calculated for conditions with and without recreation benefits, respectively. This would normally be viewed as an attractive project, and justify investment of public funds.

The economic analysis described in this report is based on traditional methods of estimating the expected annual damages (EAD) associated with the status quo (no use of the Floodway in summer season) and with various alternatives of operating the Floodway to reduce summer levels in Winnipeg. In recent years it has become standard policy by the U.S. Army Corps of Engineers to consider risk and uncertainty in the estimation of the EAD. This methodology almost invariably results in computed benefits that exceed the values that would be estimated by traditional, less rigorous means that ignore the existence of uncertainties in the parameters being analyzed. For example, studies of the Floodway Expansion showed an increase of over 25% in the project benefits with proper recognition of the effects of uncertainty. Similar increases in the benefits could be anticipated for this project.

Benefits due to reduced basement flood damages are less than might have been anticipated based on reported basement flood damages in 1993. Although damages were high that year (reported in the order of $140 Million), large portions of these damages were due to significant rainfall events and not necessarily due to the coincident high river levels. That is, substantial portions of these damages would have occurred even if river water levels had been normal. Damages of this type are, therefore, not included with the benefits of summer water level control.

In addition to the benefits that have been quantified, there are a number of intangible benefits of control of summer water levels that should be considered in the assessment of whether or not to proceed.

§ Stress and anxiety levels associated with those Winnipeggers living in areas vulnerable to basement flooding will be high during periods of elevated river levels regardless of whether or not significant rainfall occurs. Alleviating this stress to those living in these areas is a benefit that cannot be quantified. Furthermore, damages associated with disruption, personal and business loss during periods of flooding has not been considered in the assessment of benefits. Increased stress and anxiety should also be considered for those living upstream of the Floodway Inlet Control Structure as well.

§ The potential good will and further establishment of Winnipeg's reputation as the "River City" could bring substantial undefined benefits to the City as a destination and to the citizens for their own use. Reliable stable levels on the Red and Assiniboine Rivers within the City would enhance the well being of all Winnipeggers in a manner that can't be quantified.

Other considerations such as resolving issues associated with fish passage and the concerns of Fisheries and Oceans Canada (DFO) with operation of the Floodway Inlet Control Structure will need to be resolved prior to proceeding. Preliminary discussions with the DFO indicate that this issue can be resolved. Further discussion and analysis is required at the next planning stage.

CONCLUSIONS

Based on the results of the study the following conclusions are presented.

§ Annual benefits due to reduced basement flood damages vary depending on the control level selected for summer control. Estimated annual benefits range from $740,000 to $1,070,000. Estimated benefits that could be achieved by summer water level control for a single extreme event are in the tens of millions of dollars.

§ The benefit due to reduced basement flood damages was calculated using approximate methods and could vary substantially (± 40%). The level of effort to refine these estimates is considerable and not practical at this level of study.

§ In recent years, it has become standard policy of the U.S. Army Corps of Engineers (USACE) to consider the influence of risk and uncertainty in the estimation of the estimated annual damage. The work required to conduct such an analysis is extensive, and beyond the scope of this study, however, using the USACE methodology would likely increase substantially the benefits stated in this report.

§ Annual recreation / tourism benefits vary depending on the control level selected for summer water level control. They have been estimated to be between $140,000 and $320,000 depending on whether low or high estimates are taken.

§ The potential for greater economic, recreational and cultural benefits that could be generated from an integrated and fully developed river system exist in Winnipeg. Although requiring significant investments of time and capital, the benefits could eventually be in the tens of millions of dollars annually. Persistent summer flooding is currently a significant barrier to any such development. Removal of that barrier could open the door to significant economic, recreational and cultural benefits to residents of the area.

§ Three alternate approaches were investigated to assess the magnitude of project costs related to upstream damages. The “hybrid” approach, a combination of purchasing market gardeners property and compensating cereal crop and other landowners was selected as the most appropriate method. It was selected partly because it accounts for the fact that periodic flooding of market gardeners could ruin their businesses even if per-event compensation was provided.

§ Estimated upstream and other damages vary depending on the control level selected for summer water level control. Total estimated average annual damages, including increased operation and other factors, are approximately $500,000.

§ Benefit/cost (B/C) ratios for proceeding with summer water level control were calculated using the “hybrid approach”, based on the best estimate of the benefits and cost. B/C ratios of 2.7 and 1.9 with and without tourism/recreation benefits, respectively, were calculated.

§ The B/C ratios are sensitive to a number of assumptions used in the analysis. Depending on the highest and lowest benefit scenarios considered, the B/C ratios varied from 4.6 to 1.0. Similarly, net benefits ranged from $1,000,000 to $5,000.

§ Bank stability issues upstream of the Floodway are complex and a monitoring program is recommended to obtain baseline information. From a societal perspective, the value of bank stability benefits downstream of the Floodway Inlet Control Structures will exceed the damages upstream.

§ Two alternatives to summer water level control were considered;

i) increasing the capacity of the Flood Pump Stations, and

ii) increasing the elevation of the river walkway elevations.

These are not considered viable alternatives to summer level control.

§ A number of environmental issues will need to be resolved should the summer water level control proceed. These include:

- Department of Fisheries and Oceans' concerns with fish passage at the Floodway Inlet Control Structure during periods of summer water level control

- Compensation issues associated with upstream stakeholders affected by artificial flood levels.

- Concerns that residents downstream of the Floodway Outlet will have with the changed flow regime.

With further study and consultation it is believed that these environmental issues can be resolved.

RECOMMENDATIONS

Based on the results of the study, a number of recommendations have been made.

§ Based on the B/C ratio, summer water level control appears to have merit and Manitoba should proceed to the next level of assessment of the decision to proceed with summer water level control.

§ At the next level of planning, the following issues should be resolved, based on more thorough assessment than was possible in this conceptual study:

- The overall B/C cost ratio required to proceed with the project, with or without tourism and recreation benefits.

- The value of the intangible benefits, especially the potential for greater economic, recreational and cultural benefits associated with an integrated and fully developed river system in Winnipeg.

- The approach to resolving compensation issues for upstream stakeholders. This needs to consider geotechnical issues and crop and other land related damages.

- The approach to deal with the environmental issues should be identified, namely DFO and the downstream stakeholders.

§ An engineering investigation and monitoring program to obtain baseline information should be initiated prior to implementing summer water level control.

§ Further studies should be initiated to refine the estimate of benefits and costs based on the results of this study. Consideration should also be given to using the United States Army Corps of Engineers (USACE) methodology for assessing expected annual damages.

8.2.3 CURRENT AND FUTURE INVESTIGATIONS

Manitoba Water Stewardship and the Manitoba Floodway Authority will be undertaking investigations to resolve the issues and concerns related to: 1) the stability of riverbanks both upstream and downstream of the Floodway Inlet Control Structure; 2) the passage of fish at the Floodway Inlet Control Structure, and; 3) wildlife along the riverbanks and the Floodway channel.

8.2.3.1 Planned Riverbank Investigations

Based on the conclusions and recommendations of the KGS report on summer water level control, an engineering and monitoring program is planned for the next few years. The study is planned to begin in 2005.

8.2.3.1.1 2004 Riverbank Investigation

KGS Group Consulting Engineers was engaged to monitor the performance of select locations along the Red River between the Floodway Inlet Control Structure and Ste. Agathe during and after the 2004 summer flooding of the Red River. The program provides initial data on bank stability performance as related to elevated river conditions. The results will be incorporated into the more rigorous and detailed monitoring program identified in Section 8.2.3.1 above to help evaluate the possible impacts on bank stability that may be attributed to natural and human-made increases in the river levels.

The monitoring program was initiated after the start of the 2004 summer flooding to provide primarily qualitative information on the bank performance during the summer flood. The general scope of work included the following:

- Seven sites were selected for monitoring, representative of the three general types of banks encountered along the river within the primary influence area between the Inlet and Ste. Agathe. The seven sites included three with recent / active deep seated failures, two with steep and high banks that are exposed to active erosion, and two that appeared relatively stable recently but did show evidence of historic movement. No monitoring sites were selected within the City for this initial program.

- Four visual site inspections were performed, with a photographic record and inspection for bank performance (movement of failure scarps, initiation of tension cracks, erosion along exposed bank faces, etc.). The first inspection was performed immediately after award of the project when the flood staging had already started. Two inspections were completed during flood recession, and the final inspection was completed after recession of the flood.

- Monitoring pins were installed in the bank, to allow measurement across the pins and identify possible movement. The pins were installed across existing tension cracks or scarps, as well as on stable ground areas. The pin separation was measured during each inspection as a relatively low-tech means to confirm significant movement, and provide an additional quantitative basis to support the visual inspections.

At the start of the program, the monitoring was intended to provide information related to a natural summer flood. However, after continued rainfall and increased river levels, the Province decided to operate the Floodway to minimize sewer backup in the City of Winnipeg. This increased both the river levels and the duration of flooding upstream from the Inlet. The objectives of the monitoring program remain the same, although the conditions of natural flooding were no longer applicable.

A summary of the preliminary results is as follows:

- For the three sites with deep-seated and recently active evidence of failures, movement during and / or after the flood recession was observed on two of the sites.
- For the two sites that had steep and high bank edges with little to no vegetative cover on the face, no noticeable movement was observed or measured during the monitoring period.
- For the two sites that appeared relatively stable, no evidence of movement was observed from either the visual site inspections or the pin monitoring.

The first site inspection was performed after the flood staging had already begun. Therefore, KGS did not get a chance to inspect or install monitoring pins on the lower portion of the bank prior to flooding.

8.2.3.2 Fish Passage Investigations

As stated in the KGS Report on control of summer water levels, the Federal Department of Fisheries and Oceans has concerns with fish passage at the Floodway Inlet Control Structure during periods of summer water level control. The issue is that operation of the Floodway results in raising the two gates at the Inlet Control Structure from their resting position below the bottom of the Red River. The gate operation potentially blocks fish passage upstream through the structure. The operation of the gates is of particularly concern when the fish are moving upstream to spawn.

Based on discussions with DFO and Manitoba Fisheries Branch, aquatic studies are planned in the next few years. Some studies were initiated in 2004 and the reader is referred to Section 3.0 of this document for more information. Section 3.0 also documents information on how the existing Floodway structure and operation may impair fish passage. The Floodway Expansion Project will not change the operation and therefore not change any baseline effects on fish passage. Manitoba Water Stewardship has adopted a formal rule for emergency operation of the Floodway to reduce the risk of sewer backup in Winnipeg as discussed in Section 8.3. Any future change in the operation to add recreation benefits will require changes to the operating rules.

8.2.3.3 Wildlife Investigations

Operation of the gates beyond the Program of Operation (typically spring) would likely cause flooding above “natural” in areas upstream of the inlets on the Red River as well as more frequent summer flooding in the base of the Floodway channel. An assessment of the terrestrial environment impacts will also be conducted prior to a change in operating rules.

8.2.3.4 Adaptive Management Approach to Assessment

Recognizing that the existing inlet structure and its current and future operation may impact fish passage in the Red River, the Manitoba Floodway Authority (MFA) and Manitoba Water Stewardship (MWS) are committed to undertaking an adaptive management approach. The approach will review potential effects and will develop and test a variety of potential mitigation measures over time while consulting with regulators and the public. A Fish Passage Committee is proposed to direct these studies and would likely include representatives from the following agencies/organizations:

- Manitoba Floodway Authority – own and maintain the facility
- Manitoba Water Stewardship
    - Infrastructure and Operations – operators of the facility
    - Fisheries Branch - responsible for fisheries
- Federal Department of Fisheries and Oceans
- Infrastructure Canada
- Local universities
- External experts, scientists and specialists.

The Fish Passage Committee would advise MFA and MWS on studies to determine the ecological effects of the Inlet Control Structure or any other component of the project on fish passage. In addition, methods will be developed to mitigate fish barriers or hazards. Various options are being considered for review with the Fish Passage Committee such as trapping and moving fish, fish ladders, and potential structural changes to the Inlet Control Structure, to aid fish movement. The various potential strategies will be assessed and evaluated to determine the benefits as well as potential adverse effects of each option.

An adaptive management approach will be used to test some of the options while in operation and to modify the particular option to enhance its ability to mitigate for fish barriers. An overall blueprint for action is envisioned that could include for each action category (management objectives, implementation options, information gathering and evaluation) proposed activities, estimated time allotments and responsible agency.

8.3 EMERGENCY OPERATION TO REDUCE SEWER BACKUP IN WINNIPEG

Emergency summer operation of the Red River Floodway occurred in 2002 and 2004 to reduce the probability of widespread basement flooding in Winnipeg and resulting risk to health and damage to property. The operation lowered levels in the City, but resulted in artificial flooding of up to 1000 acres along the river south of the Inlet Control Structure. After both operations the Province paid compensation to residents impacted by the operation.

Emergency summer operation of the Floodway was not included in the approved program of operation for the Floodway however the action in 2002 and 2004 was taken given the seriousness of the emergencies. After the 2002 operation, the Province commissioned a study of the benefits and costs of emergency summer operation, and the report titled "Investigation of the Merits of Management of Red River Summer Water Levels in the City of Winnipeg" is summarized in Section 8.2. The report concluded that the benefits exceed the costs however the economic analysis did not consider the costs associated with delayed construction if emergency summer operation was to occur during construction of the Floodway expansion project. The report also identified outstanding environmental issues related to riverbank stability and fish passage.

Given that there will be circumstances in the future where emergency operation of the Floodway may be necessary to reduce sewer back-up in Winnipeg, Manitoba Water Stewardship has now adopted a formal rule governing decisions to carry out such operations. Refer to the letter dated November 19, 2004 from Mr. Norm Brandson, Deputy Minister of Water Stewardship to Mr. Ernie Gilroy, CEO, Manitoba Floodway Authority, which also contains copy of the adopted rule (attached in Annex "H" to this section of the Supplementary Filing).

Annex 'A1'-Flood Proofing Program 2002-03 Report

Canada-Manitoba Partnership Agreement on Red River Valley Flood Protection

The Honourable Stephen Owen
Secretary of State
(Western Economic Diversification)
(Indian Affairs and Northern Development)
66 Slater Street, 16th Floor
Ottawa ON K1A 0P4

The Honourable Steve Ashton
Minister of Conservation
Legislative Building
333 – 450 Broadway Avenue
Winnipeg MB R3C 0V8

Dear Sirs,

It is our pleasure and honour to present, herewith, the 2002/2003 Annual Report for the Canada-Manitoba Partnership Agreement on Red River Valley Flood Protection.

Respectfully submitted,

Orville Buffie
Assistant Deputy Minister

Norman B. Brandson
Deputy Minister

Canada

CANADA-MANITOBA PARTNERSHIP AGREEMENT
ON RED RIVER VALLEY FLOOD PROTECTION

Manitoba

CANADA-MANITOBA PARTNERSHIP AGREEMENT ON RED RIVER VALLEY FLOOD PROTECTION

INTRODUCTION

In the spring of 1997 the Red River Basin was subjected to a severe flood north and south of the Canada-United States border with consequent damage to both public and private property. In addition to disaster financial assistance for flood damage restoration, Canada and Manitoba negotiated flood protection agreements to mitigate against future flood events. This annual report is a summary record of program activities carried out during the 2002/2003 fiscal year under the Canada-Manitoba Partnership Agreement on Red River Valley Flood Protection.

AGREEMENTS

In May 1997 Canada and Manitoba committed to an agreement entitled 1997 Red River Valley Flood Proofing and Dike Enhancement which was officially signed on March 25, 1998. This program initially provided $24.0 million to improve permanent diking systems and flood proofing infrastructure. The aim of the program was to prevent or reduce damage from future floods of a magnitude of the 1997 flood. In the summer of 1998, an additional $6.0 million was approved by the two senior levels of government for a total of $30.0 million to be cost-shared equally under this Agreement (hereinafter referred to as Phase I) ending March 31, 1999.

The Canada-Manitoba Partnership Agreement on Red River Valley Flood Protection (hereinafter referred to as Phase II) provides for up to $100.0 million of funding ($50.0 million federal and $50.0 million provincial) over the course of the program which commenced on April 1, 1999 and was to conclude on March 31, 2003. This past year the Agreement was extended for two years to allow for additional construction time of projects with a new termination date of March 31, 2005. The funding allocation for the program remains at $100.0 million. The Phase II Agreement allocated funding to six Program elements as outlined in **Figure 1.0**.

PROGRAM ELEMENT	PROGRAM ALLOCATION (MILLION $) [1]		
	FEDERAL	PROVINCIAL	TOTAL
1. Individual Home & Business	24.9	21.2	46.1
2. Communities	16.6	16.6	33.2
3. City of Winnipeg	5.2	5.2	10.4
4. Environmental Impact Mitigation & Scientific Data	2.5	2.5	5.0
5. Provincial Flood Control Infrastructure	0.0	4.5	4.5
6. Technical Support in Program Management	0.8	0.0	0.8
TOTAL	**$50.0**	**$50.0**	**$100.0**

¡ **Figure 1.0** ¡

AGREEMENT MANAGEMENT

The management structure, which is being used to facilitate implementation of the Agreement, is shown in the attached **Appendix A**. Under the direction of federal and provincial ministers, overall management and administration of the Agreement is

[1] These figures are amended from the original notional allocations of the program as approved by the Agreement Management Committee in November 2002.

being guided by a Management Committee with two members from Manitoba and two members from Canada, supported by one federal ex-officio member and two co-secretaries. This Committee is responsible for, among other things: ensuring that the terms and conditions of the Agreement are adhered to; establishing necessary standards, procedures, and work plans; and establishing implementation committees for each project to guide the development and implementation of initiatives.

During the 2002/2003 fiscal year, the Management Committee formally met once to address management and administrative issues and to ensure agreement implementation was proceeding satisfactorily.

PROJECT DELIVERY

The overall project delivery of the Agreement is guided by the Canada and Manitoba Management Committee members.

Engineering services required for project development and delivery are provided by private sector consultants selected on a request for proposal basis to develop the project elements required for the physical works. Construction of physical work is carried out by contractors selected through a public tender contract-award basis.

To a large extent, third party contracts under Program Elements 1, 2, and 5 (i.e. consultants, contractors, etc.) are entered into and administered through Manitoba Conservation. The City of Winnipeg administers third party contracts under Program Element 3, while administration of activities under Program Element 4 is split between Canada and Manitoba. Program Element 6 provides for Technical and Management support by Canada for administration of the Agreement.

I M P L E M E N T A T I O N P R O G R E S S

Activities in Phase II are a continuation of program elements initiated in Phase I with additional program elements being added to address flood protection within the City of Winnipeg, to conduct environmental impact mitigation and scientific data gathering, and to provide technical support in program management. Phase II Agreement expenditures to March 31, 2002 and for this fiscal year are presented in **Figure 2.0**.

Phase II Program Expenditures

PROGRAM ELEMENT	Program Allocation (million $)	Expenditures to March 31, 2002 (million $)	Expenditures Fiscal Year 2002/2003 (million $)	Expenditures To Date (million $) [2]
1. Individual Home & Business *	46.1	51.6	7.1	58.7
2. Community Ring Dike *	33.2	23.5	8.0	31.5
3. City of Winnipeg *	10.4	3.2	2.9	6.1
4. Environmental Impact Mitigation & Scientific Data	5.0	4.4	0.6	5.0
5. Provincial Infrastructure	4.5	4.5	0.0	4.5
6. Technical Support in Program Management	0.8	0.7	0.1	0.8
TOTAL	**$100.0**	**$87.9**	**18.7**	**$106.6**

* *These are Federal and Provincial costs only and exclude individual and municipal share of total project costs. These are revised allocations as they have been modified from the original notional allocations.*

¡ **Figure 2.0** ¡

[2] Canada's share of the funds under the Canada-Manitoba Partnership Agreement on Red River Valley Flood Protection is to a maximum of $50 million.

I N D I V I D U A L   H O M E   A N D   B U S I N E S S

This program element, which concluded on March 31, 2003, offered financial assistance to protect properties which were subjected to flooding in the spring of 1997. The program was initiated in the summer of 1997 under Phase I, with an amendment introduced in the fall of 1998 which increased the level of government financial assistance from $30,000 to $60,000 per claim. The individual property owner contributed up to $10,000 or 25 percent of expenditures under $70,000 and 100 percent of costs above $70,000 per claim. Inclusive of Phase 1, a total of 2,850 applications were submitted prior to September 1, 1999. Applicants were advised that all projects must be completed and all invoices submitted by March 31, 2003.

As part of this program element, a number of anomaly situations arose which were assessed and considered for assistance on the basis of a proposed “buy-out”. Economic Anomalies were defined as properties whose cost of flood protection would exceed the value of the property. A total of 19 homes were identified as meeting the criteria in this category and qualifying for a “buy-out”. Eighteen homes, including seven of the properties originally purchased for the Ste. Agathe community ring dike, were purchased for a total cost of $2.7 million.

On December 7, 2001 the 4-member Public Review Panel submitted to the Minister of Conservation its final report of recommendations should a future flood proofing program be needed. Specific areas reviewed included: program design, administration, staff training, communications and program deadlines.

Including the Economic Anomalies, the total expended under the Home & Business Flood Proofing Program in Phase 2 was $58.7 million. The status of the Individual Home and Business Program Flood Proofing Program applications is shown in **Figure 3.0** below.

Status as at March 31, 2003	Number of Applications
Ineligible	274
Transferred to City of Winnipeg Flood Proofing Program	163
Protected by Community Ring Dikes	348
Purchased by Community Ring Dike and Physical Anomalies Programs	38
Owners Did Not Proceed	261
Projects Started but Not Complete	6
Flood Proofed	1742
Purchased by Economic Anomalies Initiative	18
Total	**2850**

¡ **Figure 3.0** ¡

COMMUNITY DIKING

Projects approved under this program element are: St. Mary's Road; Grande Pointe; Rosenort; Niverville; Gretna; Aubigny; St. Pierre-Jolys; Lowe Farm; Riverside; Emerson; Rosenfeld; Dominion City; Ste. Agathe; Roseau River and St. Lazare. Project designs, acquisition of regulatory approval, acquisition of land, and construction were the primary activities facilitated through the execution of project implementation agreements by local, provincial, and federal authorities. The construction status of the community ring dike projects is shown in **Figure 4.0**.

Community	Percent Complete	Community	Percent Complete
Aubigny	99	Rosenfeld	99
Dominion City	90	Rosenort	98
Emerson	95	St. Mary's Road	90
Grande Pointe	95	St. Pierre-Jolys	100
Gretna	99	Ste. Agathe	83
Lowe Farm	100	St. Lazare	100
Niverville	75	Roseau River	100
Riverside	98		

¡ **Figure 4.0** ¡

For the most part, Canada and Manitoba equally shared program expenditures associated with the community ring dikes. In addition, municipal governments are required to contribute 10 percent of the total project cost. In the case of the Roseau River community, the project received only federal financial assistance since the project is located on federally owned land. Manitoba, on the other hand, assumed the funding responsibility for the community diking at St. Lazare and for some improvements to existing community ring dikes at Letellier, St. Jean Baptiste, Morris, St. Adolphe, and Brunkild.

A tabulation of Engineering Services Contracts and Construction Contracts with their values is included in **Appendix B** and **Appendix C**.

C I T Y O F W I N N I P E G

A number of homes within the City of Winnipeg, located on the riverside of the Primary Diking System, require emergency diking during flood events. The objective of this program element is to enhance the level of protection and/or integrity of the secondary diking systems (i.e. properties not protected by the Primary Diking System) and to minimize annual costs associated with emergency diking during flood events.

Secondary diking systems were considered for projects that protected multiple properties with a single dike (community ring dikes), multi-family (condominium) developments, individual homes and special cases. Winnipeg City Council approved a priority list of flood protection projects which ranked the community ring dike and multi-family developments based upon their cost-benefit analysis. Individual homes were included on the priority list if they met program criteria, specifically a minimum of four feet to attain flood protection level and a riverbank stability safety factor of 1.3.

The special case projects were ranked on a case-by-case basis that considered the value for money that the project provides.

To comply with Canadian Environmental Assessment Act (CEAA) and the Fisheries Act, fish habitat mapping and environmental assessments were performed for the projects carried out under this program element.

Local Improvement District Initiation by-laws were initiated for the community ring dike projects, as the local improvement process under The City of Winnipeg Act requires City Council to pass a by-law for each initiative. This process allows property owners the opportunity to vote against the local improvement during a public hearing process.

In addition to the Canada-Manitoba Partnership Agreement on Red River Valley Flood Protection being extended, the Canada-Manitoba-Winnipeg Agreement on Secondary Diking Enhancements was also extended with a new termination date to March 31, 2005. This time extension was determined necessary, as construction at six of the project sites could not be completed by the original sunset date due to the requirements of the engineering design. The engineering design on each project is critical to, and precedes the public consultation process, the local improvement process and environmental approvals.

Construction of the upper bank works required for two of the community ring dike projects was completed by the fall of 2002. The lower bank works required for another community ring dike project was completed prior to March 31, 2003.

Numerous individual flood protection projects, including multi-family (condominium) projects were initiated and had attained various stages of completion. These projects, reviewed and approved by the Technical Review Committee, consisted of various flood protection measures; for example, permanent concrete walls, permanent earth reinforced walls, assembly walls and house/property raising.

ENVIRONMENTAL IMPACT MITIGATION AND SCIENTIFIC DATA

The environmental impact mitigation and scientific data gathering program element is aimed at addressing the following flood related issues:

- to protect potable water supplies (mainly on the east side of the river) from the negative effects of surficial flooding as occurred in the spring of 1997;

- to enhance existing databases, topographic information, and monitoring networks required in the planning of future developments and land uses in the Red River Valley and to improve flood preparedness capability;

- to advance the level of knowledge and better understand the various factors contributing to patterns of flooding in the Red River Valley; and

- to undertake a variety of other studies and communications to address flood-related issues under the program.

In addition to the above, additional initiatives were approved for funding over the course of the program.

Groundwater Protection

Refurbishment of the domestic water supply wells within the northeast corner of the flood zone (mainly in the R. M. of Ritchot) proved to be problematic following the 1997 flood. The Canada-Manitoba Partnership Agreement on Red River Valley Flood Protection supports necessary well enhancements to protect the aquifer in the event of future floods. In 2002/2003, the groundwater protection work focused on a number of activities which were directed towards future flood preparedness, aquifer protection and public awareness of water supply protection. A summary of the work activities completed during this fiscal period is provided below.

- Private water wells located within the Red River Valley Designated Flood Area were inventoried and entered into the Provincial well record database to provide an up-to-date record of wells for producing map based information to support an enhanced capability for future flood preparedness. During the inventory process approximately 770 residential farm sites were visited within the rural municipalities of Ritchot, De Salaberry, Franklin, Montcalm, Morris and Macdonald. In total, about 350 water wells were inventoried during the process.

- Abandoned water wells were properly sealed to ensure protection of potable groundwater supplies from future flooding events. In total, 39 abandoned wells were sealed under the program.

- Operational water wells deficient of proper construction or protection were upgraded to flood protection standards to provide a safe source of groundwater and to prevent future flood water contamination of both the well and potable groundwater supply. In total, 35 water wells were upgraded to flood protection standards under the program.

- A Fact Sheet has been developed to provide public awareness and education material on water supply protection. The publication provides a brief overview of water well basics and outlines good practices for protection and maintaining a water well. Information on flood protection standards and flood preparedness for water wells located within areas of overland flooding such as the Red River Valley Designated Flood Area are also provided.

GIS and Topography

The main focus of this initiative was to develop and implement a web-based geographic information system (GIS) that will be able to assist with future flood fighting and response activities in the Red River Valley. This initiative involved the following six components: (a) consultations regarding applications, (b) identification of datasets, (c) data collection, (d) data configuration and formatting, (e) application development, and (f) data and system housing, operation, and maintenance.

During the 2002/2003 fiscal year, a significant amount of the project focussed on the transfer of the system from Canada to the Province of Manitoba. Numerous improvements were made to the site. Also, additional tools and data layers were added to the system over the course of the year. The project area was also expanded to include the area along the Red River north of Winnipeg. The most significant tool added to the system was the road analysis tool, which allows users of the system to assess information on when roads in the Valley would be flooded during a major flood event. Additional Light Imaging Detection and Ranging (LiDAR) surveys were completed for the region north of Winnipeg, and the region from Emerson to Morris in order to complete the digital elevation model (DEM) for the Canadian portion of the Red River Basin. The data was processed and added to the web-based system. Additional work was carried out on the inventory using a mapping grade Geographic Positioning System (GPS) of the individual homes and businesses that were flood protected under the program. Numerous presentations on the GIS decision support system were made to flood fighters, municipal leaders and local residents of the Valley. As well, papers of this project were presented at a number of national and international conferences.

The decision support system was launched on the Internet in August 2002 and can be accessed at geoapp.gov.mb.ca/website/rrvfp/. During the year, experience was gained in managing the web-based system on the provincial internet server. The website is now fully operational and is being maintained by Manitoba Conservation.

Red River Morphology and Flooding Patterns

Natural Resources Canada, in collaboration and partnership with Manitoba Industry, Trade and Mines, carried out a 4-year research program into the long-term history of large flood events on the Red River. The research focused on reconstructing a paleoflood record and examining the long-term geological processes that may be altering the flood hazard.

The project included the integration of research on various fronts, including: (a) the establishment a tree-ring record for identification of past large flood events and reconstruction of past climatic change, (b) stratigraphic and/or biostratigraphic analyses of alluvial deposits along the river banks, at small channel scar lakes, and at the south basin of Lake Winnipeg, (c) historical and instrumental records of hydrological change, and (d) other literature reviews and miscellaneous observations to assess the significance of geologic processes contributing to long-term changes in the flood hazard in the Red River Valley.

This project was completed during the 2002/2003 fiscal year. A final report on the "Geoscientific Insights into Red River Flood Hazards in Manitoba" was submitted to the Agreement Management Committee in March 2003. The report provides a detailed overview of the project results as well as a copy of the scientific papers and reports that have been published on this subject matter. Further information on this study can be found on the Geological Survey of Canada website at sts.gsc.nrcan.gc.ca/ or at the Manitoba Industry, Mines and Trade website at www.gov.mb.ca/itm/index.html.

Other Studies/Program Evaluation/Communications

An evaluation framework for Agreement-related programming was developed and the initial work was undertaken during the 2002/2003 fiscal year. Using this framework a midterm summary has been completed and a draft report has been forwarded to Western Diversification for review and approval. The audit component of this initiative has been substantially completed with audit requirements related to the Agreement extension to be undertaken within the Agreement time frame.

PROVINCIAL INFRASTRUCTURE

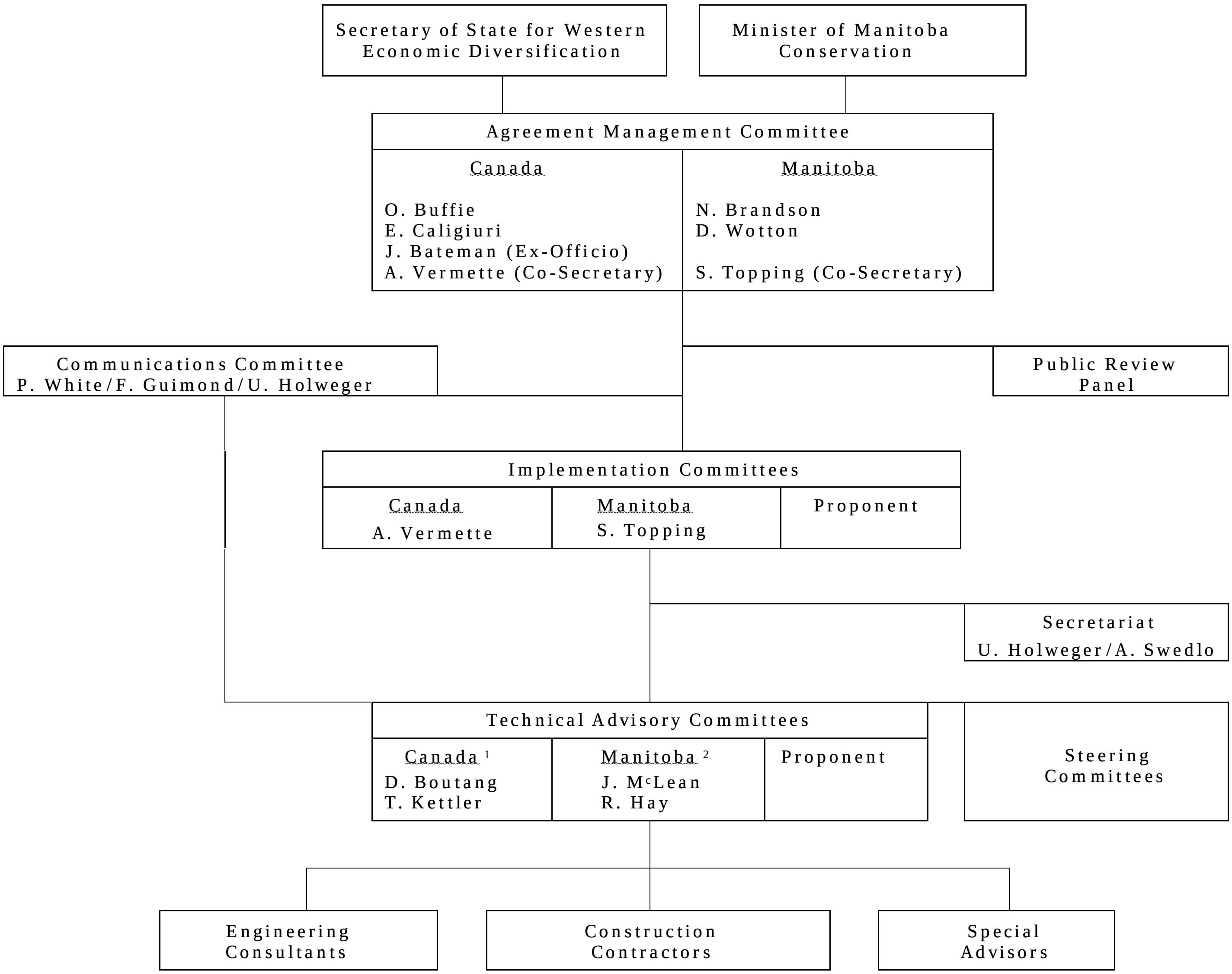
The Provincial Infrastructure program element is aimed at refurbishing a number of provincial flood control facilities. The specific projects included: the West Dike extension (Provincial Road 305); Red River Floodway inlet structure repair; assessment of the Portage Diversion flood control structures and hydraulic analysis of the Assiniboine River from Baie St. Paul to Headingley. These projects were completed in 2001/2002 and no new projects were initiated under this program element in 2002/2003.

TECHNICAL SUPPORT IN PROGRAM MANAGEMENT

The technical support in program management is not a program element. As the lead federal agency responsible for the administration of the Federal-Provincial Agreement, Western Economic Diversification has contracted with Agriculture and Agri-Food Canada's Prairie Farm Rehabilitation Administration (PFRA) to provide the third party technical support on the federal side in the joint management and delivery of the projects and initiatives under the Agreement. The Agreement includes an allocation of $0.8 million federal to cover PFRA's incremental costs associated with this technical support over the course of the 4-year Agreement.

APPENDIX A

CANADA-MANITOBA PARTNERSHIP AGREEMENT ON FLOOD PROTECTION
MANAGEMENT STRUCTURE



[1] D. Boutang serves on the TAC for rural communities. T. Kettler serves on the TAC for the City of Winnipeg and Floodway South Projects.

[2] J. McLean serves as the Project Manager for rural communities (Assistant Project Managers are R. Madder, D. Sexton and R. Kaatz). R. Hay serves on the TAC for the City of Winnipeg.

APPENDIX B

Engineering Services Contracts
Program Element #2 - Community Ring Dikes

Community	Contract Title	Awarded To	Amount of Contract $	Payment to March 31, 2003 $
Aubigny	Design & Supervision	Wardrop Engineering	$ 54,700.00	$ 49,708.51
Emerson	Design & Supervision	Stantec Engineering	76,500.00	74,188.40
Glenlea	Design & Supervision	Stantec Engineering	4,345.00	4,345.00
Grande Pointe	Feasibility Study	Acres Engineering	23,900.00	23,888.28
	Design & Supervision	Acres Engineering	475,000.00	449,578.78
Gretna	Design & Supervision	KGS Group	52,718.00	52,718.00
Landmark	Feasibility Study	Stanley Consultants	4,500.00	4,500.00
	Design & Supervision	J.R. Cousins Consulting	2,055.00	2,055.00
Lowe Farm	Feasibility Study	Stanley Consultants	4,550.00	4,550.00
	Design & Supervision	Stantec Engineering	10,200.00	7,788.08
Niverville	Design & Supervision	Wardrop Engineering	67,050.00	38,528.90
Osborne	Feasibility Study	Stantec Engineering	4,345.00	4,345.00
Riverside	Feasibility Study	Stanley Consultants	5,100.00	5,100.00
	Design & Supervision	Acres Engineering	59,600.00	58,976.76
Rosenfeld	Design & Supervision	Stantec Engineering	28,575.00	28,575.00
Rosenort	Design & Supervision	KGS Group	936,367.00	811,422.24
St. Adolphe	Feasibility Study	Stanley Consultants	22,804.00	22,804.00
St. Lazare	Feasibility Study	Stanley Consultants	4,100.00	4,100.00
	Design & Supervision	Stanley Consultants	34,925.00	34,925.00
St. Mary's Road	Pre Design	Acres Engineering	78,000.00	77,997.85
St. Pierre-Jolys	Feasibility Study	Stanley Consultants	4,550.00	4,550.00
	Design & Supervision	Stantec Engineering	67,150.00	66,000.00
Ste. Agathe	Design & Supervision	KGS Group	499,399.00	434,146.04
Seine River	Feasibility Study	Stefanson Watershed Services	38,900.00	26,204.09
South of Floodway	Feasibility Study	Wardrop Engineering	47,100.00	47,100.00
Roseau River	Design & Supervision	Ayshkum Consulting	732,673.98	732,673.98
	Design & Supervision	SEG Consulting	69,125.00	69,125.00

APPENDIX C

Construction Contracts
Program Element #2 - Community Ring Dikes

Community	Contract Title	Date Awarded	Awarded To	Tendered Amount of Contract	Start Date	Completion Date (Construction)	% Complete as of Mar. 31, 2003 (Project) [3]
Aubigny	Dike Flood Protection Infrastructure	Aug 1, 2002	A. Brunet Construction Ltd.	256,420.00	Aug 1, 2002	Sept 26, 2002	99%
Dominion City	Dike Flood Protection Infrastructure	Sept 19, 2002	Kelvin Kartage	352,803.00	Sept 19, 2002	Spring 2003	90%
Emerson	Dike Flood Protection Infrastructure	July 24, 2002	Edie Construction Ltd.	468,634.48	July 24, 2002	Nov 2002	95%
Grande Pointe	Removal of Embankment & Road Improvement	Dec 19, 2002	Hugh Munro Construction Ltd.	250,000.00	Dec 19, 2002	July 1, 2002	100%
	West Dike Construction	July 24, 2002	Hugh Munro Construction Ltd.	962,810.00	July 24, 2002	Spring 2003	95%
	Seine River Control Structure & 4-Span Bridge	Feb 12, 2002	Main Line Industries Ltd.	961,855.83	Feb 12, 2002	Aug 23, 2002	100%
	Grande Pointe Diversion Outlet Structure	June 24, 2002	M. D. Steele Construction Ltd.	1,906,482.00	June 24, 2002	Oct 15, 2002	100%
Gretna	Dike Flood Protection Infrastructure	Jun 1, 2000	Edie Construction Ltd.	396,080.00	Jun 1, 2000	Nov 20, 2001	99%
Lowe Farm	Dike Flood Protection Infrastructure	Aug 1, 2000	JKW Construction Ltd.	44,820.00	Aug 1, 2000	Oct 1, 2000	100%
Niverville	Dike Flood Protection Infrastructure	July 29, 2002	Specialty Flood Protection Ltd.	1,304,473.42	July 29, 2002	Spring 2003	75%
Riverside	Dike Flood Protection Infrastructure	Aug 1, 2001	Specialty Flood Protection Ltd.	422,509.92	Aug 1, 2001	Oct 31, 2002	98%
Rosenfeld	Dike Flood Protection Infrastructure	Aug 1, 2000	JKW Construction Ltd.	209,945.00	Aug 1, 2000	Oct 1, 2000	99%
Rosenort	Floodway Channel Bridge	Jul 17, 2000	M.D. Steele Construction Ltd.	2,073,536.00	Jul 17, 2000	Apr 9, 2001	100%
	Flood Protection East Dike	Jul 14, 2000	JKW Const. Ltd./A. Brunet Ltd.	1,336,394.00	Jul 14, 2000	Oct 23, 2001	100%
	Floodway Channel & Assoc. Works	Jul 13, 2000	Kelly Panteluk Const. Ltd.	6,059,813.54	Jul 13, 2000	Jul 9, 2002	98%
	Flood Protection Channel Riffles	Mar 3, 2003	Nelson River Construction Inc.	265,210.00	Mar 3, 2003	June 30, 2003	40%
Roseau River	Dike Remediation	Mar 30, 2000	L. Chabot Enterprises	1,410,000.00	Mar 30, 2000		100%
St. Lazare	Dike Flood Protection Infrastructure	Oct 22, 1999	Russell Redi Mix Concrete Ltd.	279,160.00	Oct 22, 1999	Nov 23, 2000	100%
St. Pierre-Jolys	Dike Flood Protection Infrastructure	Jun 28, 2000	E. F. Moon Construction Ltd.	673,805.00	Jun 28, 2000	Dec 15, 2001	100%
Ste. Agathe	West Dike	Nov 18, 1998	H. Baudry Constr. (1980) Ltd.	337,930.00	Nov 18, 1998	Dec 14, 1999	100%
	Utilities Relocation & Clay Cut-off Trench	Jul 17, 2000	Cumming & Dobbie (1986) Ltd.	332,584.00	Jul 17, 2000	Oct 31, 2000	100%
	Rockfill Rip Rap Placement	Mar 6, 2000	Mulder Construction & Materials Ltd.	381,250.00	Mar 6, 2000	Feb 18, 2002	100%
	East Dike & Gravity Outlet Structures	Sept 25, 2002	Taillieu Construction Ltd.	1,248,950.00	Sept 25, 2002	Spring 2003	60%

[3] Post-construction costs include seeding, developing operating manuals, legal surveys and/or required remediation.

Annex 'A2'-Flood Proofing Program 2003-04 Work Plan

Canada-Manitoba Partnership Agreement on Red River Valley Flood Protection

Gathering water data.

Annual Work Plan
2003 - 2004

Canada

CANADA-MANITOBA PARTNERSHIP AGREEMENT
ON RED RIVER VALLEY FLOOD PROTECTION

ENTENTE DE PARTENARIAT CANADA-MANITOBA SUR LA PROTECTION
CONTRE LES INONDATIONS DANS LA VALLÉE DE LA RIVIÈRE ROUGE

Manitoba

CANADA-MANITOBA PARTNERSHIP AGREEMENT ON RED RIVER VALLEY FLOOD PROTECTION

2003-2004 WORK PLAN

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CANADA-MANITOBA PARTNERSHIP AGREEMENT ON RED RIVER VALLEY FLOOD PROTECTION

2003-2004 WORK PLAN

1.0 INTRODUCTION

The Canada-Manitoba Partnership Agreement on Red River Valley Flood Protection (referred to as the "Flood Protection Program") provides for up to $100 million of funding ($50 million federal and $50 million provincial) over the course of the program which commenced on April 1, 1999 and was to conclude on March 31, 2003. The Agreement was amended during the last fiscal year to extend the termination date to March 31, 2005. The aim of the program is to minimize damages in the Red River Valley from future flood events similar in magnitude to that experienced in 1997. This $100 million Agreement is a follow-up to a joint $30 million Red River Flood Proofing and Dike Enhancement Program (1997) - commonly referred to as Phase 1 - which concluded on March 31, 1999.

The federal-provincial Agreement on flood protection calls for a committee structure to be responsible for the overall management of the Flood Protection Program and to oversee the implementation of the various projects and initiatives under the Program. The committee structure under this Agreement is outlined in ***Figure 1****.*

One of Management Committee's responsibilities called for in the Agreement is the preparation and approval of an annual work plan. This document serves as the 2003/2004 Work Plan.

2.0 PROGRAM ELEMENTS

Six elements comprise the overall program. The following sections briefly describe the current status of the projects and initiatives undertaken in each of the program elements and their expected progress over the course of 2003/2004. A summary of the projected expenditures for 2003/2004 of the Agreement is presented in ***Table 3****.*

2.1 Program Element 1: Individual Home and Business

This Program Element, which concluded on March 31, 2003, offered financial assistance toward the protection of those individual homes and businesses which were subject to flooding in the spring of 1997. This portion of the program was initiated in the summer of 1997 under Phase 1, with an amendment introduced in the fall of 1998 which increased the level of Government financial assistance offered under the program from a maximum of $30,000 to $60,000 per claim. The individual property owner contributed up to $10,000 or 25 percent of expenditures under $70,000 and 100 percent of costs above $70,000 per claim.

Individuals were able to submit applications for assistance to the Program until September 1, 1999. Inclusive of Phase 1, a total of 2,850 applications were submitted. Of these, 274 were considered ineligible, 163 were referred to the City of Winnipeg Flood Proofing Program (Program Element 3) and 348 fell within areas that will be protected by community ring dikes. Thirty-eight (38) properties were purchased under the St. Mary's Road Community Ring Dike Program or the Physical Anomalies program, which is administered by MEMO, thus leaving a potential 2,027 applications to administer under this Program Element. Seventeen hundred and forty-two (1,742) projects were completed, 261 approved applicants did not proceed with construction and 6 projects were started but not completed prior to the termination date.

As part of this Program Element, a number of anomaly situations arose which were assessed and considered for assistance on the basis of a proposed "buy-out". Economic Anomalies were defined as properties whose cost of flood protection would exceed the value of the property. A total of 19 homes were identified as meeting the criteria in this category and qualifying for a "buy-out". Eighteen properties were purchased for a total cost of $2.7 million.

Except for one potential anomaly buyout, the home and business program element was concluded on March 31, 2003. All file records for this element are being prepared for storage and/or audit.

Total program expenditures under Phase 2 including the anomalies was $58.8 million as of March 31, 2003.

2.2 Program Element 2: Community Dikes

This Program Element is aimed at implementing or enhancing flood protection infrastructure for rural communities in the Red River Valley that were subject to flooding or the threat of flooding in 1997.

For the most part, both Canada and Manitoba equally cost-share program expenditures associated with the community ring dikes. In addition, municipal governments contribute 10 percent of the project cost. In the case of the Roseau River Community, the project has received federal financial assistance ($1.09 million from this Program). Manitoba, on the other hand, assumed the funding responsibility for the community diking at St. Lazare and for some enhancements to existing community ring dikes at Brunkild, Letellier, Morris, St. Adolphe and St. Jean Baptiste to bring them up to the 1997 flood proofing standard.

Some of the work under this Program Element was initiated under the Phase 1 Agreement which expired March 31, 1999. Construction continues on community dike projects under this Agreement for which $35.0 million has been notionally allocated.

A total of five community dikes were completed in 2000/2001. Construction in 2001/2002 was underway at Rosenort, Grande Pointe, Ste. Agathe and Riverside while planning, right-of-way acquisition, and design activities were underway for Emerson, Niverville, Aubigny and Dominion City. In 2002/2003 construction continued at Rosenort, Emerson, Dominion City, Grande Pointe, Ste. Agathe, Riverside, Niverville and Aubigny and along with building disposition for the St. Mary's Road Project. Completion of all remaining work for this program element is planned for 2003/2004.

The following table provides a more detailed overview of the project activities to date and activities planned for the fiscal year 2003/2004.

Table 1: Community Diking Activity Summary

Project	Progress to Date	2003-2004 Planned Activities
St. Mary's Road	• Completed disposal of some buildings and foundations	• Complete disposal of buildings and foundations • Rehabilitate land for agriculture
Grande Pointe	• East Dike constructed (PTH#59) • Bridge complete • West Dike constructed • Drop structure complete	• East Dike paving to be completed (PTH#59) • West Dike to be shaped and seeded • Operation & Maintenance (O&M) manual to be completed
Ste. Agathe	• East Dike and structures 60% complete	• Complete East Dike and structures • Complete legal survey • O&M manual to be completed
Rosenort	• West Dike complete • Riffle construction awarded and partially complete	• Complete riffle contract • Complete legal survey • O&M manual to be completed
Niverville	• Dike is 75% complete	• Complete dike • O&M manual to be completed
Gretna	• Construction complete	• O&M manual to be completed
Aubigny	• Dike construction complete	• Some minor clean-up at dike and access points • O&M manual to be completed
St. Pierre-Jolys	• Post-construction clean-up complete	• O&M manual to be completed
Lowe Farm	• Completed in 2000/2001	• Legal survey to be completed
Riverside	• 95% complete	• Deficiencies to be completed • Legal survey to be completed • O&M manual to be completed
Emerson	• Earthwork and gravity outlet complete • Pumping station complete	• Pump test to be completed • O&M manual to be completed
Rosenfeld	• Community dike post-construction clean-up complete	• Legal survey to be completed • O&M manual to be completed
Dominion City	• Dike constructed	• Construction of connector dike on expropriated property to be completed • O&M manual to be completed
Seine River Trib. PTH#1	• Deferred	• Deferred
St. Lazare	• Completed in 1999 / 2000	• Legal survey to be completed • O&M manual to be completed
Roseau River	• Completed in 2000 / 2001	• Repair of slide to be completed

2.3 Program Element 3: City of Winnipeg

A number of homes within the City of Winnipeg, located on the riverside of the Primary Diking System, require emergency flood protection during times of flooding. The objective of this program element is to enhance the level of protection and/or integrity of the secondary diking systems (i.e. dikes on the river side of the primary dikes) that protect these homes in order to minimize recurring costs associated with emergency diking during flood events.

A method of prioritizing projects to be accommodated within available funding was developed and adopted by City Council, based on the following criteria:

1) Community Ring Dikes – projects were prioritized using the benefit to cost ratio and the community consultation process.
2) Multi-family (condominium) Projects – projects were prioritized using the benefit to cost ratio.
3) Individual Homes – these projects were not ranked, as the cost to the homeowner could be significant while the maximum cost to the program would not exceed $60,000 per claim.
4) Special Cases - These projects were ranked on a case-by-case basis that considered the value for money that the project provides.

Community Ring Dike Programs – There were six sites prioritized as suitable for community ring dike construction. Two of the sites have been completed except for minor restorations. Two sites elected not to proceed with the works. The other two sites are in the detailed engineering phase and are proceeding through the City of Winnipeg District Local Improvement Process, which assists the property owners by adding their funding contribution to their property taxes.

Multi-family Projects – There were nine multi-family project sites prioritized, three have been completed, two have elected not to proceed with the works, one site is negotiating easements from adjacent property owners and detailed engineering is underway at the remaining three sites.

Individual Homes – Of the 18 individual properties adopted as priorities to date, 10 have been completed, two have elected not to proceed, one project is not proceeding to construction, and five have yet to begin works. The projects have included raising foundations, assembly walls, concrete walls, earth dikes and segmental block walls.

Special Cases – There are six special case projects, two of these projects have been completed and negotiations for property acquisition at three of the other sites has also been initiated. Preliminary engineering on the other special case project has begun.

The termination date of this program has been extended to March 31, 2005. Winnipeg City Council approval for the program project revised priority listings is underway, to ensure optimal utilization of available funding. Once Flood Proofing Agreements and any required easements and approvals are in place, completion of flood proofing measures will be initiated.

Two community ring dike projects are proceeding through the local improvement process, and no objections have been recorded for these projects. Detailed design, tendering, and construction of the works at these sites is scheduled for the summer/fall of 2003.

The flood proofing measures required at the four remaining multi-family project sites can be initiated once Flood Proofing Agreements and all necessary easements are executed during the detailed design phase of the projects. All of these sites are anticipated to have lower bank works initiated during the early winter of 2003. All of the upper bank works will be completed by the sunset date of the program.

Individual and Special Case projects are proceeding, and will be completed by the sunset date of the program.

The following table provides an overview of project activities in 2002-2003 and the planned activities for 2003-2004.

Table 2: City of Winnipeg Flood Proofing Program

Project	2002-2003 Works		Planned 2003-2004 Works	
	Riverbank Works	Dike Works	Riverbank Works	Dike Works
Community Ring Dikes				
Kingston Crescent/Row	Complete	Complete	-	-
North Drive	Complete	-	-	Scheduled for construction
Kilkenny Drive	Complete	Complete	-	-
Lord Avenue	Complete	-	-	Scheduled for construction
Parkwood Place*	-	-	-	-
Multi-Family Projects				
525 Wellington	Complete	Complete	-	-
270 Roslyn Road	Complete	Complete	-	-
29 Roslyn Road	Complete	Complete	-	-
1660 Pembina Highway	-	Agreements required	Scheduled for construction	Scheduled for construction
One/Seven/Eleven Evergreen Place**	-	Agreements required	Scheduled for construction	Scheduled for construction
99/141 Wellington Crescent	-	Agreements required	Scheduled for construction	Scheduled for construction

**** Project not proceeding, pending City Council approval of revised priority list.***
***** Combined Seven and Eleven with One Evergreen, pending City Council approval of revised priority list.***

2.4 Program Element 4: Environmental Impact Mitigation and Scientific Data

The environmental impact mitigation and scientific data gathering program element is aimed at addressing the following flood related issues:

- to protect potable water supplies (mainly on the east side of the river) from the negative effects of surficial flooding as occurred in the spring of 1997;
- to enhance existing data bases, topographic information, and monitoring networks required in the planning of future developments and land uses in the Red River Valley and to improve flood preparedness capability;
- to advance the level of knowledge and better understand the various factors contributing to patterns of flooding in the Red River Valley; and
- to undertake a variety of other studies and communications to address flood-related issues under the Program.

In addition to the above, additional initiatives may be approved for funding over the course of the Program.

a) Groundwater Protection

Refurbishment of the domestic water supply wells within the northeast corner of the flood zone (mainly in the R. M. of Ritchot) proved to be problematic following the 1997 flood. The Flood Protection Program supports necessary well enhancements to protect the aquifer in the event of future floods. In 2002/2003, the groundwater protection work focused on a number of activities which were directed towards future flood preparedness, aquifer protection and public awareness of water supply protection. A summary of the work activities completed during this fiscal period is provided below:

- Private water wells located within the Red River Valley Designated Flood Area were inventoried and entered into the Provincial well record data base to provide an up-to -date record of wells for producing map based information to support an enhanced capability for future flood preparedness. During the inventory process approximately 770 residential farm sites were visited within the rural municipalities of Ritchot, De Salaberry, Franklin, Montcalm, Morris and Macdonald. In total, about 350 water wells were inventoried during the program.
- Abandoned water wells were properly sealed to ensure protection of potable groundwater supplies from future flooding events. In total, 39 abandoned wells were sealed under the Program.
- Operational water wells deficient of proper construction or protection were upgraded to flood protection standards to provide a safe source of groundwater and prevent future flood water contamination of both the well and potable groundwater supply. In total, 35 water wells were upgraded to flood protection standards under the Program.
- A Fact Sheet was developed to provide public awareness and education material on water supply protection. This publication provides a brief overview

of water well basics and outlines good practices for protecting and maintaining a water well. Information on flood protection standards and flood preparedness for water wells located within areas of overland flooding such as the Red River Valley Designated Flood Area are also provided.

- No further activities are planned for 2003/2004 for this program element.

b) GIS and Topography Data

The main focus of this initiative was to develop and implement a web based geographic information system (GIS) that will be able to assist with future flood fighting and response activities in the Red River Valley. This initiative involved the following six components: (i) consultations regarding applications, (ii) identification of datasets, (iii) data collection, (iv) data configuration and formatting, (v) application development, and (vi) data and system housing, operation, and maintenance.

During the 2003/2003 fiscal year, a significant amount of the project focused on the migration of the system to the Province of Manitoba. Numerous improvements were made to the site as well as additional tools and data layers were added to the system over the course of the year. The project area was also expanded to include the area along the Red River north of Winnipeg. The most significant tool added to the system was the road analysis tool which allows users of the system to assess when roads in the valley would be flooded during a major flood event. Additional Light Imaging Detection and Ranging (LIDAR) surveys were completed for the region north of Winnipeg, and the region from Emerson to Morris in order to complete the digital elevation model (DEM) for the Canadian portion of the Red River Basin. The data was processed and added to the web based system. Additional work was carried out on the inventory using a mapping grade Geographic Positioning System (GPS) of the individual homes and businesses that were flood protected under the program. Numerous presentations on the GIS decision support system were made to flood fighters, municipal leaders and local residents of the valley as well as papers of this project were presented at a number of national and international conferences.

The decision support system was launched on the internet in August 2003 and can be accessed at geoapp.gov.mb.ca/website/rrvfp/. During the year experience was gained in managing the web-based system on the provincial internet server. The web site is now fully operational and is being maintained by Manitoba Conservation.

c) Flood Forecasting Network

The objective of this element was to safeguard and enhance the hydrometric and climatological networks used for flood forecasting and water management in the Red River Valley. The total cost for the 3-year project was $1.5 million with $1.2 million allocated to upgrading and flood proofing the water monitoring network in the

Red River Valley, and $0.3 million allocated to enhancing the climatological networks in cooperation with the Agricultural Centre of Excellence in Carman, Manitoba.

Work on this component was completed in 2001/2002.

d) Red River Morphology and Flooding Patterns

Natural Resources Canada, in collaboration and partnership with other agencies, carried out a 4-year research program into the long-term history of large flood events on the Red River. The research focused on reconstructing a paleoflood record and examining the long-term geological processes that may be altering the flood hazard.

The research included: (a) the establishment of a tree ring record for identification of past large flood events and reconstruction of past climatic change; (b) stratigraphic and/or biostratigraphic analyses of alluvial deposits along the river banks, at small channel scar lakes, and at the south basin of Lake Winnipeg; (c) historical and instrumental records of hydrological change; and (d) other literature reviews and miscellaneous observations to assess the significance of geologic processes contributing to long-term changes in the flood hazard in the Red River valley.

This project was completed during the 2002/2003 fiscal year. A final report on the "Geoscientific Insights into Red River Flood Hazards in Manitoba" was submitted to the Agreement Management Committee in March 2003. The report provides a detailed overview of the project results as well as a copy of the scientific papers and reports that have been published on this subject matter. Further information on this study can be found on the Geological Survey of Canada website at sts.gsc.nrcan.gc.ca/ or at the Manitoba Industry, Mines and Trade website at www.gov.mb.ca/itm/index.html.

e) Other Studies

No activities were carried out under other studies funded by the Canada-Manitoba Flood Proofing Agreement in 2002/2003. No activities are planned in 2003/2004.

f) Communications Activities

Communications activities in the 2002/2003 fiscal year include news releases, announcements, web-based information, an annual report, and other related activities. Program concluding notices were also issued for the flood proofing program. No major communication activities are planned for 2003/2004 but news releases and potential announcements may be planned as deemed appropriate by the Agreement Partners.

g) Program Evaluation and Audit

An evaluation framework for Agreement-related programs was developed and the initial work was undertaken in the 2002/2003 fiscal year. Using this framework, a midterm summary has been completed and a draft report has been forwarded to Western Diversification for review and approval.

The audit component of this initiative is substantially complete with audit requirements related to the Agreement extension to be undertaken within the agreement time frame.

2.5 Program Element 5: Provincial Flood Control Infrastructure

The Province of Manitoba identified a number of Provincial Flood Control Infrastructure Projects to be undertaken under this Agreement for a notional allocation of $4.5 million. A list of these projects follows:

a) West Dike Extension

As part of Phase I, Manitoba Conservation completed the enhancements and restoration of borrow areas associated with the emergency raising of the existing west dike during the 1997 Flood. The cost of this work was $1.9 million. Under this program, the permanent west dike works include the extension of the existing west dike along P.R. #305 to Brunkild, Manitoba. Provincial environmental licensing was obtained in mid-March 2000, land acquisition began in April 2000, and material purchase (culverts and traffic gravel) and utility relocation was expedited through the winter of 2000/2001. Grade reconstruction began in the summer/fall of 2001 and was completed in 2001/2002 except for post-construction clean-up. Total costs attributable to this project (Phase 2) are estimated at $2.1 million. The project has been completed and no activities are scheduled for 2003/2004.

b) Red River Floodway Rip Rap

This project consisted of repair to scour holes which had developed in the downstream rip-rap apron of the Red River Floodway Inlet Control Structure at St. Norbert. The work included backfilling the scour holes, re-armoring the river bed surface with a cast-in-place concrete mat and restoring the rock armoring on the river bank and structure abutment slopes. The east half was completed in March 1999 and the west half in January 2000. Actual expenditures totaled $2.4 million for both sides, of which $1.1 million was funded under the flood protection program. No additional costs or activity is planned for 2003/2004 under the Canada-Manitoba Agreement.

c) Red River Floodway Gate

This project involves rehabilitation and refurbishment of the Floodway Inlet Control Structure, specifically the components of the structure below the water line (i.e. the gates and associated elements). This process requires the structure to be cofferdammed and de-watered for access.

Originally, work for the west gate was scheduled to be undertaken during the fall and winter of 2000/2001 and the east gate during the fall and winter of 2001/2002. However, extraordinarily high river flows during the fall and early winter of 2000 resulted in the abandonment of the cofferdammed west gate with the scheduled work having only been partially completed. Work on the west gate was completed during the fall/winter of 2001/2002. Similar servicing of the east gate was carried out during the fall/winter of 2002/2003 which completed this project. The total estimated cost of the work is $3.1 million of which $1.0 million was provided from the Canada-Manitoba Partnership Agreement.

d) Portage Diversion

This project consisted of inspection, assessment and preparation of a comprehensive refurbishment plan for the two flow control structures, which are both nearing 30 years of age, similar to the Red River Floodway. Replacement of the standby electrical generator was performed during the 1999/2000 fiscal year.

An estimated total cost of $2.3 million is projected to be required to complete the refurbishment of both structures. Neither funding sources nor implementation schedules have yet been finalized for the major refurbishment. Total expenditure for this project under the Canada-Manitoba Partnership Agreement was $202,000. No additional activity is planned.

e) Assiniboine River Dikes

The project consists of detailed hydraulic capacity assessment of the Assiniboine River between Baie St. Paul Bridge (P.R. #241) and Headingley.

An engineering consultant was retained to determine further diking requirements sufficient to convey 22,500 cfs through this reach of the Assiniboine River. The analysis was completed in 1999/2000 at a cost of $122,800.

Although the existing channel capacity is insufficient to prevent minor local flooding, the design discharge utilized in the analysis corresponded to a one in 400 year return period, which rendered most supplementary diking schemes economically unfeasible. No activities were undertaken in 2001/2002 and no additional activity is planned for 2003/2004.

2.6 Program Element 6: Technical Support in Program Management

This Program Element is not a program element per se. As the lead federal agency responsible for the administration of the Federal-Provincial Agreement, Western Economic Diversification has contracted with PFRA to provide the third party technical support on the federal side in the joint management and delivery of the projects and initiatives under the Agreement. The Agreement includes an allocation of $0.8 million federal to cover PFRA's incremental costs associated with this technical support over the course of the Agreement. A total of $225,000 was expended in each of 1999/2000, 2000/2001, 2001/2002 and $125,000 in 2002/2003 fiscal year under this program element. No expenditures are anticipated in 2003/2004.

3.0 FUNDING ALLOCATIONS AND EXPENDITURE CASH FLOW

Table 3 provides a summary of expenditures to date and a forecast of remaining funds to be expended to complete all of the Program Elements by the Program termination date of March 31, 2005.

It should be noted that in ***Table 3*** the total expenditures to March 31, 2003 reflects the over-expenditure of funds under Program Element 1 – Individual Home and Business over and above the resources allocated under the terms and conditions of the federal-provincial Agreement. The over-expenditure is displayed in the Provincial column with the actual amount not known until the Community Dikes program element is completed by March 31, 2004. The Agreement Management Committee has agreed to re-allocate any unused funds from Program Element 2 - Community Dikes to Program Element 1 to cover a portion of the over-expenditures under the Individual Home and Business program element. Canada's share of total program funds under the Canada-Manitoba Partnership Agreement on Red River Valley Flood Protection is up to $50 M.

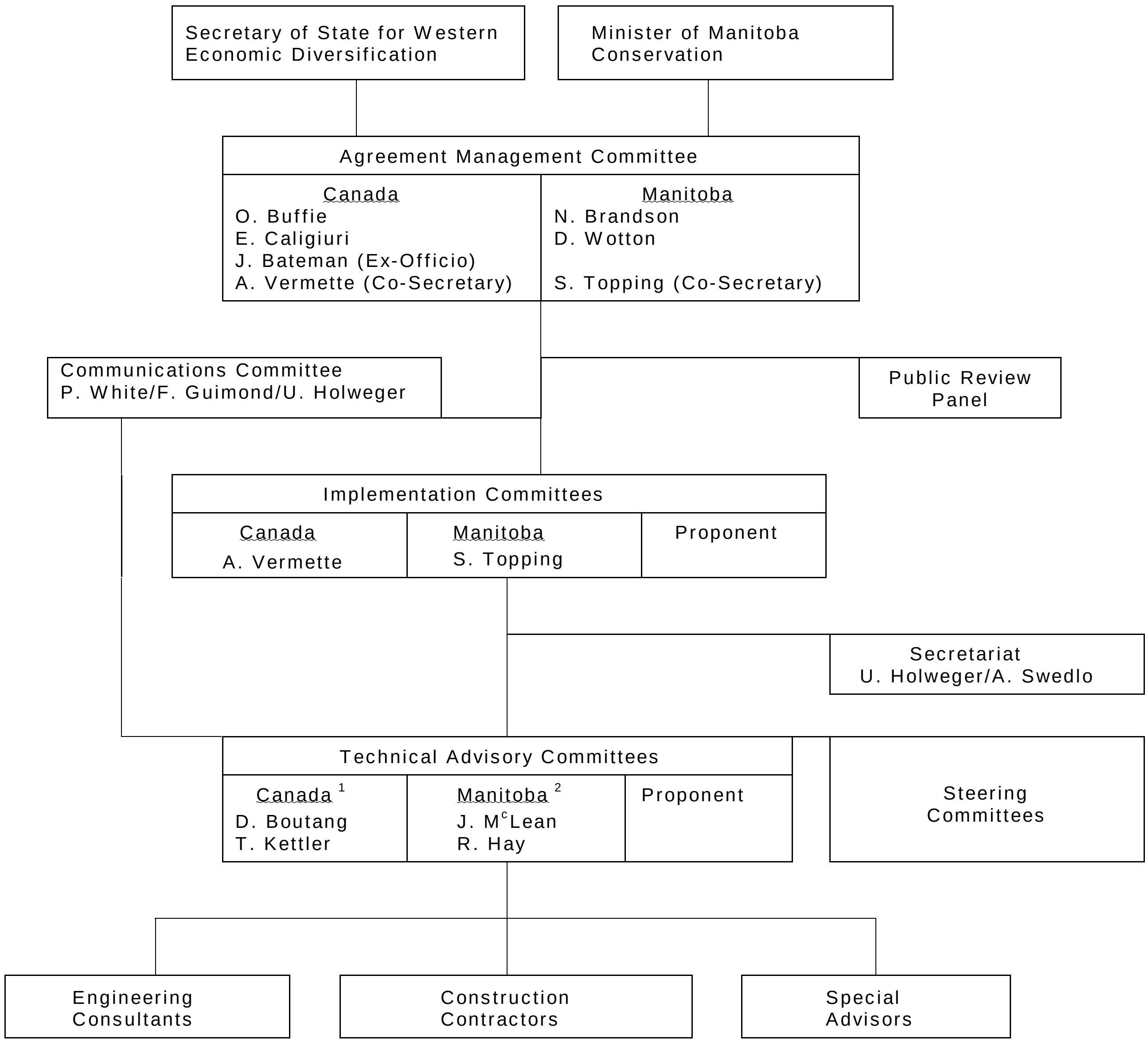
In the Appendix ***Table 4*** is a summary provided as information to show the Program expenditures in Phase 1 and the anticipated total expenditures for Phase 2 including the total Program expenditures as currently compiled from financial records and the forecasted expenditures for 2003/2004 and 2004/2005.

APPROVAL OF THE 2003-2004 WORK PLAN

Pursuant to Section 3.4 (d) of the Agreement, the 2003-2004 Work Plan was hereby approved on June 27, 2003.

O. Buffie, Federal Member Management Committee	N. Brandson, Provincial Member Management Committee
E. Caligiuri, Federal Member Management Committee	D. Wotton, Provincial Member Management Committee

FIGURE 1
CANADA-MANITOBA PARTNERSHIP AGREEMENT ON FLOOD PROTECTION – MANAGEMENT STRUCTURE



[1] D. Boutang serves on the TAC for rural communities. T. Kettler serves on the TAC for the City of Winnipeg and Floodway South Projects.

[2] J. M^c^Lean serves as the Project Manager for rural communities (Assistant Project Managers are R. Madder and D. Sexton).
R. Hay serves on the TAC for the City of Winnipeg.

TABLE 3
CANADA-MANITOBA PARTNERSHIP AGREEMENT
ON RED RIVER VALLEY FLOOD PROTECTION
PHASE 2 EXPENDITURES & PROJECTED CASH FLOW ($X 1000)

Program Elements	Expenditures to March 31, 2003		Forecast 2003/2004		Forecast 2004/2005		Total	
	Fed	Prov	Fed	Prov	Fed	Prov	Fed	Prov
1. Individual Home & Business (1)	24,936.9	33,819.4	0.0	310.2	0.0	0.0	24,936.9	34,129.6
2. Community Dikes (2)	15,759.8	15,779.0	803.3	803.3	0.0	0.0	16,563.1	16,582.3
3. City of Winnipeg (1) & (2)	3,028.5	3,037.1	1,251.0	1,251.0	920.5	911.9	5,200.0	5,200.0
4. Environmental Impact Mitigation & Scientific Data								
A. Groundwater Protection	69.1	170.0	0.0	0.0	0.0	0.0	69.1	170.0
B. GIS & Topography Data	498.5	571.7	0.0	0.0	0.0	0.0	498.5	571.7
C. Flood Forecasting Network	605.0	891.0	0.0	0.0	0.0	0.0	605.0	891.0
D. Red River Morphology & Flooding Patterns	1,000.0	0.0	0.0	0.0	0.0	0.0	1,000.0	0.0
E. Other Studies	327.4	850.4	0.0	0.0	0.0	0.0	327.4	850.4
SUBTOTAL	2,500.0	2,483.1	0.0	0.0		0.0	2,500.0	2,483.1
5. Provincial Flood Control Infrastructure	0.0	4,445.4	0.0	0.0	0.0	0.0	0.0	4,445.4
6. Technical Support in Program Management (PFRA)	800.0	0.0	0.0	0.0	0.0	0.0	800.0	0.0
	47,025.2	59,564.0	2,054.3	2,364.5	920.5	911.9	50,000.0*	62,840.4

(1) excludes individual contribution

(2) excludes municipal contribution

** Canada's share of program funds under the Canada-Manitoba Partnership Agreement on Red River Valley Flood Protection is up to a maximum of $50 M.*

A P P E N D I X

TABLE 4
CANADA-MANITOBA PARTNERSHIP AGREEMENT ON RED RIVER VALLEY FLOOD PROTECTION SUMMARY EXPENDITURES – PHASE 1 AND PHASE 2

PROGRAM ELEMENTS	PHASE 1		PHASE 2		TOTAL	
	CANADA	MANITOBA	CANADA	MANITOBA	CANADA	MANITOBA
INDIVIDUAL HOMES & BUSINESSES [1]						
CLAIMS	10,968,482.16	9,048,166.34	22,786,533.63	31,669,057.73	33,755,015.79	40,717,224.07
ADMINISTRATION	602,419.50	602,419.50	1,179,877.57	1,489,877.57	1,782,097.07	2,092,297.07
ANOMALIES	0.00	0.00	970,662.62	970,662.61	970,662.62	970,662.61
PHASE II REALLOCATION	3,089,716.59	3,089,716.59	0.00	0.00	3,089,716.59	3,089,716.59
SUBTOTAL	14,660,618.25	12,740,302.43	24,936,873.82	34,129,597.91	39,597,492.07	46,869,900.34
COMMUNITY DIKES						
NEW COMMUNITY DIKES [2]	339,381.75	339,381.75	15,468,996.18	15,468,996.18	15,808,377.93	15,808,377.93
ST. LAZARE	0.00	6,750.41	0.00	302,102.42	0.00	308,852.83
EXISTING COMMUNITY DIKES	0.00	0.00	0.00	811,253.46	0.00	811,253.46
ROSEAU RIVER	0.00	0.00	1,094,130.00	0.00	1,094,130.00	0.00
SUBTOTAL	339,381.75	346,132.16	16,563,126.18	16,582,352.06	16,902,507.93	16,928,484.22
CITY OF WINNIPEG						
HOME & BUSINESS CLAIMS & COMMUNITY RING DIKES	0.00	0.00	5,200,000.00	5,200,000.00	5,200,000.00	5,200,000.00
SUBTOTAL	0.00	0.00	5,200,000.00	5,200,000.00	5,200,000.00	5,200,000,00
ENVIRONMENTAL IMPACT MITIGATION & SCIENTIFIC DATA						
A. GROUNDWATER PROTECTION	0.00	0.00	69,135.00	169,976.80	69,135.00	169,976.80
B. GIS & TOPOGRAPHY DATA	0.00	0.00	498,500.00	571,734.76	498,500.00	571,734.76
C. FLOOD FORECASTING NETWORK	0.00	0.00	605,000.00	890,999.97	605,000.00	890,999.97
D. RED RIVER MORPHOLOGY & FLOOD PATTERNS	0.00	0.00	1,000,000.00	0.00	1,000,000.00	0.00
E. OTHER STUDIES	0.00	0.00	0.00	26,147.92	0.00	26,147.92
- Hydraulic Impacts Study	0.00	0.00	0.00	10,249.20	0.00	10,249.20
- Flood Display & Program Brochures	0.00	0.00	1,943.00	0.00	1,943.00	0.00
- Technical Workshop (May 1999)	0.00	0.00	10,548.00	0.00	10,548.00	0.00
- 2-D Modeling by NRC	0.00	0.00	90,408.00	0.00	90,408.00	0.00
- Floodway Embankment Design	0.00	0.00	58,516.00	0.00	58,516.00	0.00
- Rampant Red Project (Heritage Canada)	0.00	0.00	43,065.00	0.00	43,065.00	0.00
- Program Evaluation	0.00	0.00	122,794.00	0.00	122,794.00	0.00
- Pre-Commitment Study [2]	0.00	0.00	0.00	786,111.02	0.00	786,111.02
- CEC Public Meetings	0.00	0.00	0.00	24,379.74	0.00	24,379.74
- Communications & Awareness	0.00	0.00	91.00	3,500.00	91.00	3,500.00
SUBTOTAL	0.00	0.00	2,500,000.00	2,483,099.41	2,500,000.00	2,483,099.41
PROVINCIAL FLOOD CONTROL INFRASTRUCTURE						
WEST DIKE EXTENSION	0.00	1,913,565.41	0.00	1,685,085.40	0.00	3,598,650.81
FLOODWAY INLET STRUCTURE	0.00	0.00	0.00	2,435,343.28	0.00	2,435,343.28
ASSINIBOINE RIVER STUDY (Baie St. Paul to Headingley)	0.00	0.00	0.00	122,747.43	0.00	122,747.43
PORTAGE DIVERSION CONTROL STRUCTURES STUDY	0.00	0.00	0.00	202,207.59	0.00	202,207.59
SUBTOTAL	0.00	1,913,565.41	0.00	4,445,383.70	0.00	6,358,949.11
TECHNICAL SUPPORT IN PROGRAM MANAGEMENT						
PRAIRIE FARM REHABILITATION ADMINISTRATION	0.00	0.00	800,000.00	0.00	800,000.00	0.00
SUBTOTAL	0.00	0.00	800,000.00	0.00	800,000.00	0.00
TOTAL	15,000,000.00	15,000,000.00	50,000,000.00	62,840,433.08	65,000,000.00*	77,840,433.08

(1) *excludes individual contribution*

(2) *excludes municipal contribution*

** Canada's share of program funds under the Phase 1 and 2 Agreements is up to a maximum of $65 M.*

NOTES

Annex 'B'-Recomputation of Natural River Levels (Executive Summary)

Manitoba Water Stewardship
Water Branch

Manitoba
Building for the Future

Re-Computation of Natural Water Levels at the Floodway Inlet

EXECUTIVE SUMMARY

APRIL 2004 **P14533.01** **Acres Manitoba Limited**

ACRES

Executive Summary

INTRODUCTION

After the 1997 flood, the Manitoba Government reconvened the Manitoba Water Commission (MWC) and tasked the Commission to review the operation of the Red River Floodway during the 1997 flood. One of the many issues for the MWC was review of the Floodway's Program of Operation and the determination of what "natural" water levels would have been for the 1997 flood as discussed in their report (Manitoba Water Commission, 1998).One of the many recommendations from the MWC was that the Floodway's Program of Operation should be reviewed by the Province in full consultation with the federal government, the City of Winnipeg and residents in the Valley.

Both the Manitoba Water Commission and the Floodway Operation Review Committee recommend that the procedure for determining "natural" levels be recomputed.

Subsequent to the MWC report, a Floodway Operation Review Committee was formed, with a report being issued in December 1999. One of the recommendations of the Red River Floodway Operation Review Committee (1999) was that:

> *"the 'natural' water level relationship be recomputed. To assure that the relationships receive broad acceptance, the computation should be done under the supervision of a technical working group of representatives from the provincial and federal governments, from the City of Winnipeg, and from the valley south of the Floodway Control Structure"*

In December 2002, Acres Manitoba was awarded the study by Manitoba Water Branch (MWB) to carry out a study to re-compute the "natural" water levels at the Floodway Inlet for a full range of Red River and Assiniboine river flows. In keeping with the recommendations of the Floodway Operation Review Committee report, the Minister set up a Steering Committee, supported by a Technical Sub-committee (TSC). The majority of the members on the TSC were senior technical water resource engineers from either government or the University.

Terms of Reference for Acres study

The primary deliverables for the study were:

1) A table of "natural" water levels at the Floodway Channel Inlet for a combination of Red River (downstream of the confluence with the Assiniboine River) flows and Assiniboine River flows.

2) The hydraulic model used to calculate the "natural" water levels noted in the above paragraph. At the end of the study, the final hydraulic model will be given to the Manitoba Water Branch, and

Branch staff will be trained to run the model in its entirety.

3) A report which will include a discussion of the methodology used, of all inputs to the hydraulic model, of the calibration effort, of all assumptions made, of problems encountered during the development and completion of the deliverables, of the limitations of the hydraulic model, and of any other relevant issues. This report will be presented and explained to the entire Steering Committee and as such must be conducted in non-technical language. This presentation shall be held at 200 Saulteaux Crescent, Winnipeg or, by mutual agreement only, at any other facility including the Contractor's offices.

NATURAL LEVELS

The determination of "natural" levels at the Floodway Inlet is fundamental to the operation of the Floodway. Under the current operating rules the Floodway is to operate to ensure that:

- the water surface elevation at the entrance of the Red River Floodway channel does not rise above "natural", unless the water surface elevation at James Avenue reaches 24.5 ft or the water level along the Red River within the City of Winnipeg reaches two feet below the Flood Protection Level of 27.83 ft (Rule 1); and,

- once the river levels within the City of Winnipeg reach the limits described in Rule 1, the levels in Winnipeg would be held constant and levels upstream of the Floodway would be allowed to rise above natural. If levels are forecast to rise more than 2 ft above natural, the City of Winnipeg must proceed with emergency raising of the dykes and other temporary protection measures (e.g., further closure of their sewer systems from high river levels). The water levels within the City should be permitted to rise as construction proceeds on raising the dykes (Rule 2).

Definition of "natural"

The "natural flow" is the flow that would have occurred if flood proofing projects such as Shellmouth, Portage Diversion, Assiniboine Dykes and Floodway had not been built

The "natural level" is defined as the level that would have occurred in the absence of flood control works and level of urban development in place at time of construction of flood control works.

A rating curve is used to relate the natural flow at James Avenue in downtown Winnipeg to the natural level at the Floodway Inlet in St. Norbert. Backwater analysis was used to determine this relationship.

NUMERICAL BACKWATER ANALYSIS

A numerical backwater study is a common engineering technique for computing water levels within a river reach for a given a flow. The computations start from a downstream location and progress upstream. The inherent assumptions are:

- flow is assumed to be one-directional
- flow through a cross-section can be considered averaged
- flow is assumed to be constant or gradually varied

While some of the preliminary backwater analysis had been carried out by the Red River Basin Investigation (RRBI) in the 1951 to 1953 timeframe, the majority of the detailed hydraulic calculations were made by the Province following the release of the report of the 1958 Royal Commission on Flood Cost-Benefit which recommended construction of a 60,000 cfs capacity floodway around the City of Winnipeg. In the spring of 1959, field investigations were carried out to relocate the Floodway Inlet from a point near the South Perimeter Highway (a recommendation of the Royal Commission) to a point upstream of the Town of St. Norbert, a distance of about 8 kilometres. The final location of the inlet was approved in 1960. Subsequent to this, detailed hydraulic investigations were carried out to determine "natural" conditions at the Floodway Inlet for a range of Red and Assiniboine River flows.

In 1965, the Floodway Inlet Rating Curve was finalized and documented in a 1970 report. The 1965 rating Curve required classifying the Assiniboine River contribution as minimum, average or maximum and then consulting the rating curve to determine what the natural level at the Floodway should be. Based on recommendations of the Manitoba Water Commission in 1980, the above-described 1965 multiple-plot rating curve was converted into a numerical formula and documented in a 1984 MWB report.

Differences between the early 1960's analysis and the Acres analysis

Some of the differences between the Province's early 60's analysis and the current Acres analysis are as follows:

- back in the early 1960's the backwater calculation would have been done by hand using lookup tables and slide rules. At that time the number of scenarios tested would have been limited. For this re-computation analysis the US Army Corps of Engineers River Analysis System, HEC-RAS model (version 3.1.1) was used. This model allows a multitude of scenarios to be tested;

- in the early 1960's, model calibration was solely based on data collected from the 1950 flood. For the current re-computation, data from both the 1950 and 1966 flood was used. Prior to using the 1950 and 1966 data, Acres performed a quality control (QC) review of the data. As outlined in the main report there are QC problems with the 1950 data that were not known at the time of the earlier study;

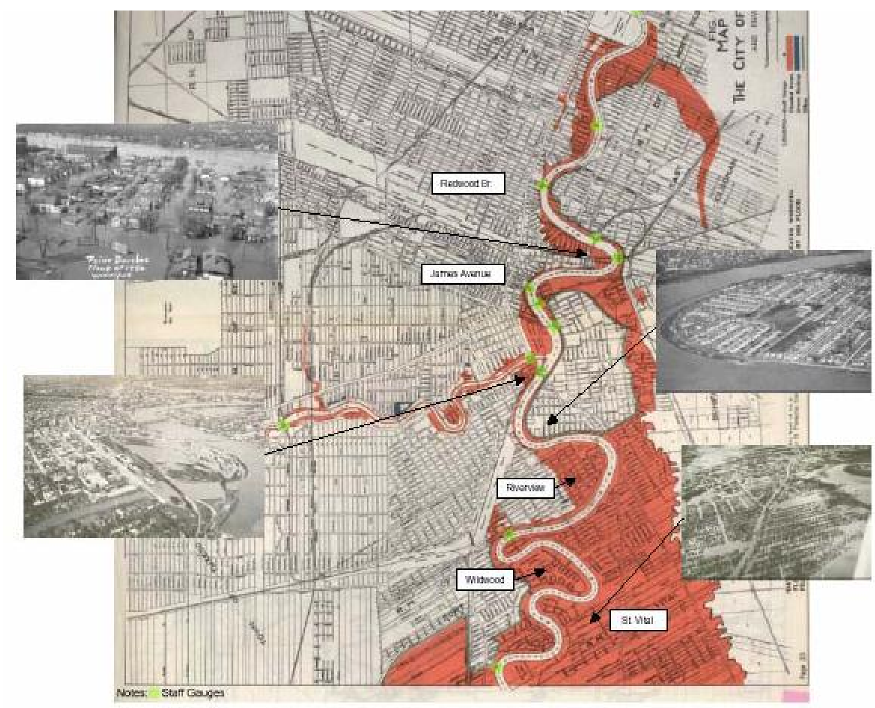
- the modelling done in the early 1960's was based on the available topographical information of the time to define overbank elevation. In the Acres study, detailed topographical information has been generated from a variety of sources to better define the area;

- in this study topographical and backwater modelling was linked to a geographic information system (GIS) to allow the graphical visualization of model construction and results; this type of technology was not available when the original study was done.

REVIEW OF HISTORIC FLOOD DATA

1950 flood

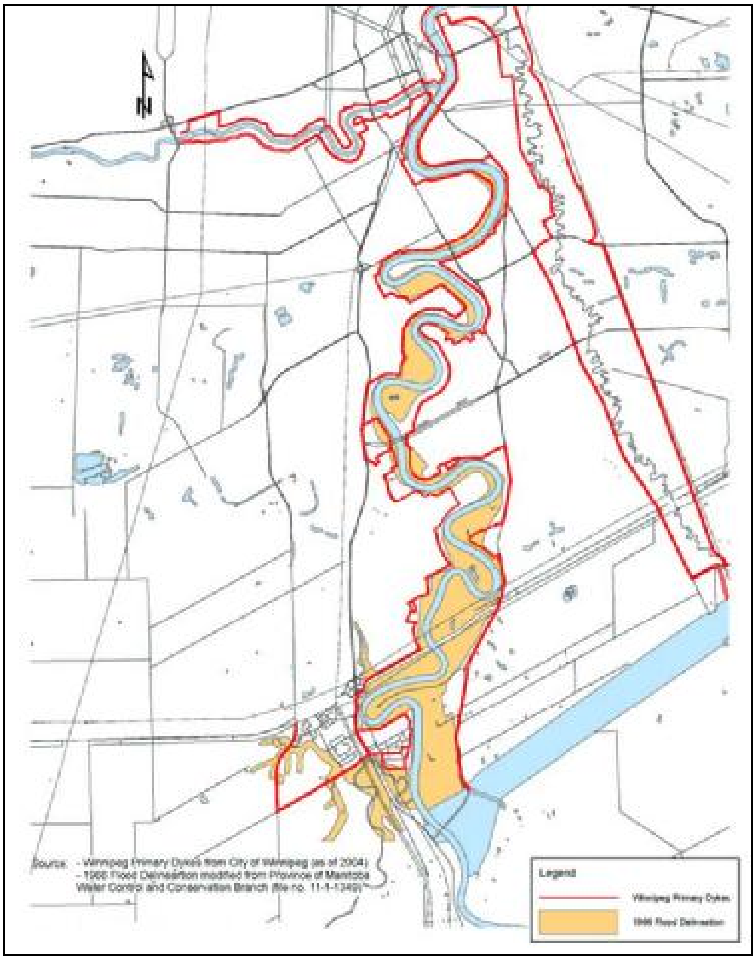
The floods of 1950 and 1966 represent the largest "pre-Floodway" Winnipeg floods in recent record with water levels at the James Ave



1950 Flooded Area – James Ave. 30.3 ft.

Pumping Station in the City of Winnipeg reaching 30.3 ft and 26.2 ft above James Avenue datum (JAD) respectively. Zero for JAD is normal winter ice level or elevation 727.57 ft.. Normal summer water level is 6.5 ft JAD or elevation 734.0 ft. In the summer when the St. Andrews Lock and Dam is in operation water levels in the City are kept relatively constant. Normal flood stage for Winnipeg is generally considered around 18.0 ft. JAD.

1966 flood



1966 flooded Area – James Ave. 26.2 ft.

The 1950 and 1966 flood years also represent years were a significant amount of additional hydraulic information was collected along the rivers, which is why these years were chosen as the focus of this review. With the opening of the Red River Floodway in 1969, spring flood stages typically would only reach a maximum stage of 18 to 20 ft JAD. While the 1997 flood represents the Flood of the Century for the Red River, the diversion of approximately 65,000 cfs around the City via the Red River Floodway saved Winnipeg from significant flooding. In 1997, the river only reached 24.5 ft JAD. However the slope of the river increased going northward to an equivalent water level of 25.0 ft JAD as a result of water backing up from the floodway outlet. Because of the backwater effects in 1997 that year was not used for model calibration.

As discussed in the main report, analysis of the 1950 and 1966 noted several uncertainties in the 1950 flow estimates. Discrepancies were also noted in some in the recorded water level data at select sites. Modelling was used to address these uncertainties.

In 1966, primary dykes protected the City from flooding. In 1950, only temporary dykes existed and many of these failed except for the Lyndale Dyke that protected the St. Boniface area.

BRIDGES AND STRUCTURES

Bridges included in the study

Bridges and structures located along the Red River circa 1950 were also incorporated into the backwater model. The structures may act as constrictions, reducing the flow capacity of the river and creating a drop in water levels from upstream to downstream or a hydraulic loss. This reduction in conveyance area can be due to pier layout (size, shape or number), low bridge decks or loss of cross section area in the abutment region which will result in a measurable head loss under high flow conditions. The bridges included in the analysis are:

- **Elm Park Bridge** - multi-span open truss type structure with minor approaches and minimal constriction on flow;
- **Norwood Bridge (pre 1997)** - multi-span plate girder structure with lift section for boat traffic. Minor approaches with minimal constriction of flow;
- **Provencher Bridge (pre 2003)** - multi-span plate girder structure with lift section for boat traffic. Lower bottom girder relative to other bridges will create losses under higher flows. Minor approaches with minimal constriction of flow;
- **Canadian National Railways - Redditt Subdivision Bridge** - multi-span open truss type structure. The eastern railway embankment is elevated well above prairie level; however a lower section further east can potentially convey flows under larger flood events. The western railway embankment, although high at the bridge, slopes down to prairie level and turns parallel to the river permitting overland flow to pass west of the bridge through downtown Winnipeg during larger flood events;
- **Canadian Pacific Railways - Keewatin Subdivision Bridge** - multi-span open truss type structure with elevated railway embankments which constrict discharge through the bridge opening up to moderate flood events. The railway embankment is

overtopped during large flood events;

- **Louise Bridge** - multi-span open truss type structure with minimal constriction of flow;
- **Redwood Bridge** - multi-span open truss type structure with minimal constriction of flow;
- **Canadian Pacific Railways - Bergen Cutoff Bridge** - multi-span open truss type structure with elevated railway embankments which constrict discharge through bridge opening only during small floods. During large flood events, overland flow can occur beyond the western railway embankment;
- **St Andrews Lock and Dam** - a unique water control structure comprised of multiple spillway bays controlled by removable wooden "curtains". The curtains are used only during low flow open water periods to control water levels upstream through the City of Winnipeg. The curtains are removed during the passage of a flood; and,
- **PR 204 Highway Bridge - Selkirk** - multi-span open truss structure with lift section for boat traffic. Minor approaches with minimal constriction of flow.

RESULTS

1966 Calibration Results

Calibration for 1966 flows

The model was initially calibrated to the spring flood of 1966, the second highest flood on record for the City of Winnipeg. The 1966 flood was modelled using a HEC-RAS dataset which included the primary dykes as they existed in 1966. For correct modelling of the flood in the Kingston Row area, i.e., preventing overland flow across the meander bend the secondary dyke in this area was raised. The dykes used in the HEC-RAS are modelled as levees and elevations were chosen to prevent overtopping of the dykes. From the 1966 observed flood dataset, 7 days were chosen where there was certainty in the recorded flows on the Red River both upstream and downstream of the confluence of the Assiniboine River.

The 1966 dataset covers a flow range from 44,000 to 87,000 cfs (at Redwood Bridge). The overall error in calibration between observed and computed levels is in the range of 0.02 to 0.10 ft for the observed data near the peak (April 15 to April 21). April 24 had the largest calibration error with an overall difference of 0.48 ft.

1950 Calibration Results

Calibration for

The flood of 1950 was the highest flood in recent history for the City of Winnipeg. In 1950, there was substantial overbank flooding in the

1950 flows

south end of the City. During the 1950 flood temporary dyking in Riverview, Wildwood and Crescent Drive areas was overtopped, large areas of St. Vital were flooded as the Red River and Seine River joined. Temporary dyking around Lyndale Crescent and west of the Seine River protected the St. Boniface area from significant flooding. Downstream of the confluence of the Assiniboine the majority of the flow was contained within the river for the most part, except for some overbank flooding along Scotia Street and back flooding into Bunns Creek.

The physical basis for the 1950 HEC-RAS model was the "natural" model without primary dykes except for the Lyndale Dyke and the raising of the west approach to Provencher Bridge to shunt flows through the bridge cross-section and not across the rail yards.

Model used to compute 1950 flows

The first step in the 1950 calibration involved matching for the flow on May 29 (that was similar in levels to the April 15, 1966 peak). Solving for a range of flows from 87,000 to 91,000 cfs it was determined that a flow of 88,000 cfs provided the smallest overall difference in water levels between observed and simulated in the SALD to Norwood Br. section of the river. The adjusted increase in the May 29 flow was 3,400 cfs or about 4%.

The second step in the model calibration was to calibrate for the peak flow from the 1950 flood and to solve for the floodplain n value in the areas in the south part of the city.

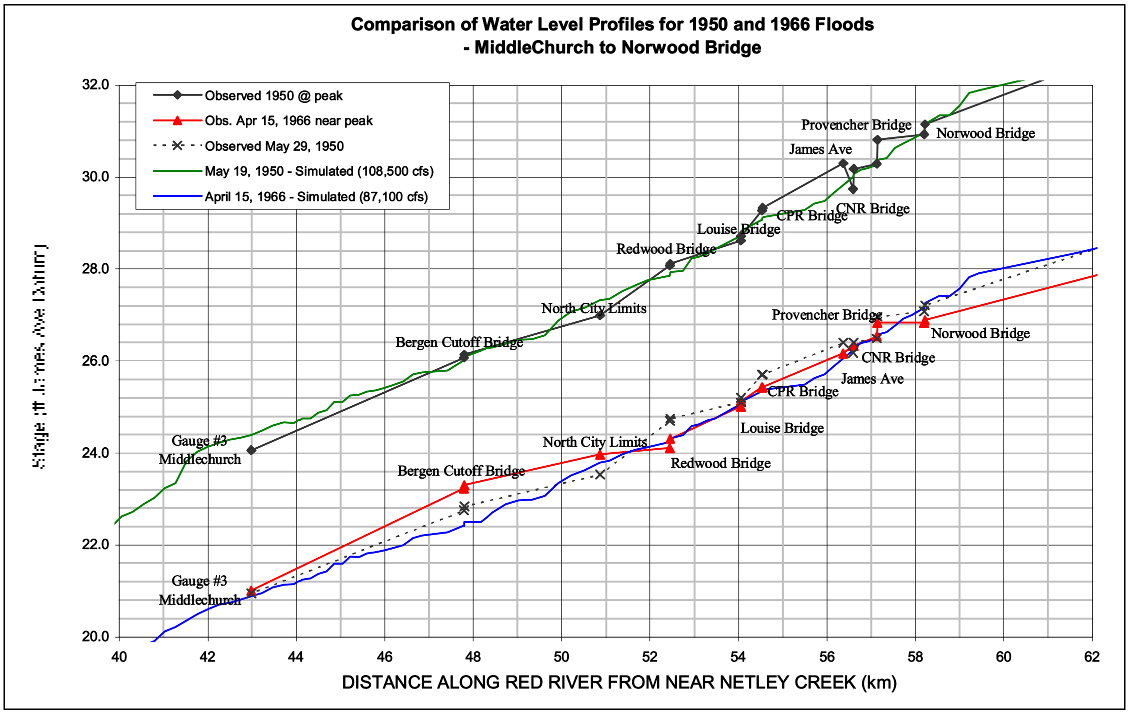
The overall difference in observed versus model calibration is 0.01 feet at the peak.

The following plot shows the modelled versus observed profile in the Middle Church to Norwood section of the river for 1950 and 1966 flows. Examination of the figure yields the following observations:

Assessment of calibration for 1966 and 1950

- The irregularity in the profile line is a result of plotting the "hydraulic" grade line. Inclusion of the variable velocity head component would smooth out the line.
- The 1950 peak simulated profile matches the observed profile reasonably well except in the James Avenue, CNR and Provencher Bridge section of the river. As discussed in the main report there are some anomalies with certain bridges and that the observed losses for these bridges are too high.
- In 1950 at the peak the James Avenue level is high relative to the upstream gauges. Based on modelling this level is incorrect, or

alternatively all other stage data are too low and flows need to be increased to match the James Avenue data. To match the other stage data this study has computed a flow of 108,500 cfs, to match the higher James Avenue stage of 30.3 ft JAD would require a flow in the range of 112,000 cfs.



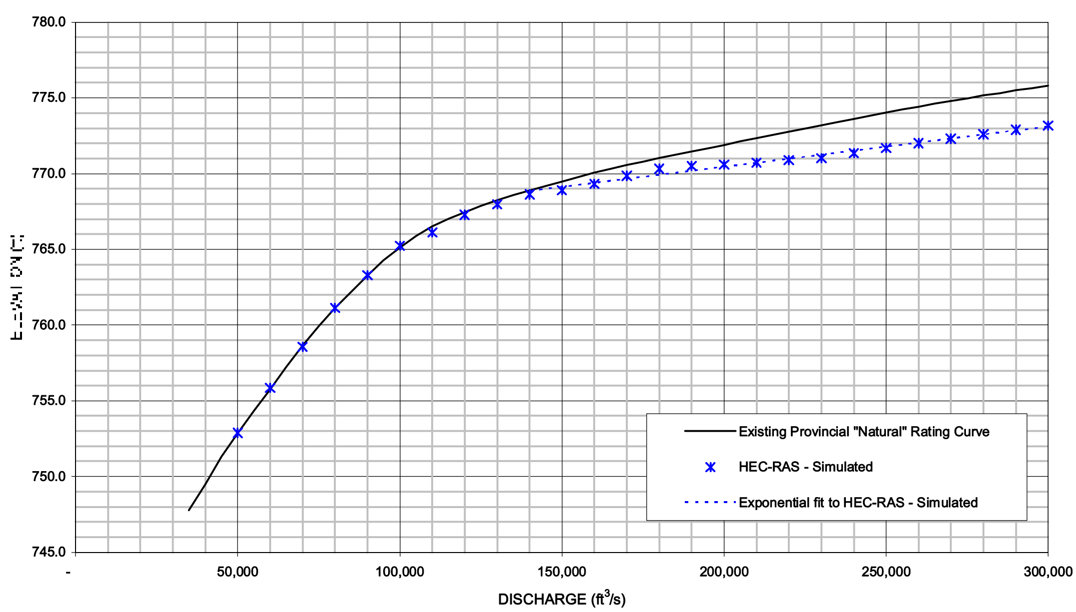
- For the lower-flow profiles, the simulated profile plotted represents the best fit plot for the 1966 data, except for Bergen Cutoff. In 1966, the gauge height for Bergen Cutoff appears to be in error with the level being too high. Long and Wagner (1970) also felt that Bergen Cutoff data was in error based on review of other low flow profiles for 1966. For example as shown in the main report, at the lower flows there is practically no slope on the river in the Bergen to North City limits reach of the river for the May 7 and May 12 profile which would not be expected. To match the 1950 lower-flow profile a slightly higher discharge would be required.

Impact of Dyking on Water Surface Profile and Flooded Area

An assessment of the effect of the primary dykes on water surface profiles was conducted. The primary dykes are for the most part located upstream of the Assiniboine River confluence, therefore the difference in water surface profiles in this reach are the greatest. The maximum difference between the water surface profiles under 1966 flood conditions is 0.10 ft. An additional assessment of the effect of the Lyndale Drive dyke during the peak of the 1950 flood was also conducted. The computed water surface profiles at the peak of the 1950 flood (May 19) is about 0.2 ft.

Floodway Inlet Rating Curve

As discussed in the Introduction the purpose of this study was to derive a new "natural" rating curve(s)/table of water levels at the Floodway inlet. The rating table is not a single relationship, due to the variable nature of Assiniboine River contributions. As such, a two-dimensional matrix of Red and Assiniboine River discharge was required. The matrix of Red River and Assiniboine River discharges was simulated using the calibrated backwater model, with the exception that the Lyndale Drive dike (which existed during the 1950 flood) was removed to reflect pre-1950 flood "natural" conditions. The calculated rating table is presented in the following table and as a stage-discharge rating curve based on 10% flow contribution from the Assiniboine River is shown in the figure below. Note that the Red River discharge corresponds to the combined Red and Assiniboine River discharge at James Avenue.



Notes:
- Ilustrated rating curves based on 10% Assiniboine River contribution.
- Existing Provincial Curve based on provincial computer model (March, 2004)
- File reference: Fig-4_11.xls

Floodway Inlet Rating Curve

RED RIVER DOWNSTREAM OF ASSINIBOINE RIVER CONFLUENCE (cfs)

	ASSINIBOINE RIVER CONTRIBUTION (cfs)										
cfs	0	5,000	10,000	15,000	20,000	25,000	30,000	35,000	40,000	45,000	50,000
20,000	742.4	740.6	738.9	737.5							
30,000	746.8	745.4	744.0	742.7	741.6						
40,000	750.6	749.4	748.2	747.1	746.0	745.0					
50,000	753.9	752.9	751.8	750.8	749.8	748.9	748.0				
60,000	757.0	756.0	755.1	754.2	753.2	752.4	751.5				
70,000	759.8	758.9	758.1	757.2	756.4	755.6	754.8				
80,000	762.3	761.6	760.8	760.1	759.3	758.6	757.8				
90,000		763.8	763.2	762.5	761.9	761.2	760.6	759.9			
100,000		765.5	765.2	764.7	764.1	763.5	762.9	762.3			
110,000		766.6	766.2	765.8	765.4	765.1	764.6	764.1			
120,000		767.5	767.4	767.1	766.7	766.4	766.0	765.6	765.3		
130,000		768.4	768.1	767.9	767.6	767.4	767.2	766.9	766.5		
140,000			768.7	768.6	768.6	768.3	768.0	767.8	767.5	767.3	
150,000			769.0	768.9	768.8	768.7	768.5	768.5	768.4	768.3	
160,000			769.5	769.4	769.2	769.0	768.9	768.7	768.6	768.5	768.4
170,000			770.1	769.9	769.8	769.6	769.4	769.3	769.1	769.0	768.8
180,000			770.5	770.4	770.3	770.1	770.0	769.8	769.7	769.5	769.4
190,000				770.5	770.5	770.5	770.5	770.3	770.2	770.0	769.9
200,000				770.7	770.6	770.5	770.5	770.5	770.5	770.5	770.4
210,000				770.8	770.8	770.7	770.6	T10.5	770.5	770.5	770.5
220,000				771.0	770.9	770.8	770.7	770.7	770.6	770.5	770.5
230,000				771.2	771.1	771.0	770.9	770.8	770.8	770.7	770.6
240,000					771.4	771.3	771.3	771.2	771.1	771.0	770.9
250,000					771.8	771.7	771.6	771.5	771.4	771.4	771.3
260,000					772.1	772.0	771.9	771.9	771.8	771.7	771.6
270,000					772.4	772.3	772.3	772.2	772.1	772.0	771.9
280,000					772.7	772.6	772.6	772.5	772.4	772.4	772.3
290,000					773.0	772.9	772.9	772.8	772.7	772.7	772.6
300,000					773.3	773.2	773.2	773.1	773.0	773.0	772.9

Floodway Inlet “Natural” Rating Table

The simulated rating curve begins to diverge from the existing Floodway Inlet curve at about 150,000 cfs.

The rating curve plot shows that the simulated curve begins to diverge from the existing Floodway Inlet curve at about 150,000 cfs and this divergence grows to about a foot lower at 200,000 cfs, and about two feet lower at 250,000 cfs.

Based on this study Acres computes the natural level for the 1997 flood (for a flow of 162,000 cfs) as 769.3 ft. This level is comparable to Klohn-Crippen study using the Mike11 model (Manitoba Water Commission, 1998) that computed a water level of 769.5 ft for natural conditions for 1997. The Acres level is somewhat lower than the Manitoba Water Stewardship estimate of natural water levels at the Floodway Inlet of 770.1 ft. The MWS estimate of Inlet water levels is based on current procedures in applying the Floodway Inlet Rating Curve. During the 1997 flood, water levels at the Inlet reached 771.5 on May 3, 1997. As discussed in the Manitoba Water Commission (1998) report water levels were raised above natural to keep water levels at James Ave to 24.5 ft JAD.

Sensitivity Analysis and Data Uncertainty

The largest "natural" flood, with corresponding observed water levels, for which the model could be calibrated, was the 1950 flood. The peak discharge during this event (estimated to be 108,500 cfs) was much less than the maximum discharge presented in the rating table. The estimation of water levels well beyond observed conditions can introduce uncertainty with respect to the levels. Determining the uncertainty in the estimated water levels through statistical means is not practical however the uncertainty can be estimated through sensitivity analyses of some of the key hydraulic parameters.

There is some uncertainty in the hydraulic roughness in the overbank areas as limited data exists for calibration

The sensitivity analysis involved the adjustment of the hydraulic roughness in the overbank region of the cross-section, within a reasonable range. The following table shows the values used in the calibration simulations as well as values for the hydraulic roughness within what is considered to be a reasonable range.

Overbank Hydraulic Roughness
for a Reasonable Range of Manning "n" Values

Hydraulic Roughness	Residential/ Commercial Developments	Flood Plain - Undeveloped
Calibrated Values	0.20	0.05
Lower Limit	0.15	0.04
Upper Limit	0.25	0.06

The results of the sensitivity analysis for varying overbank roughness are presented for a range of Red River flows in the following table.

Sensitivity analysis used to address uncertainty in overbank roughness

Sensitivity of Computed Floodway Inlet Water Levels to Overbank Hydraulic Roughness

Scenario	100,000 cfs[1]	200,000 cfs[1]	300,000 cfs[1]
Calibrated Values	765.23 ft	770.59 ft	773.18 ft
Lower Limit	765.16 ft (- 0.07 ft)	770.46 ft (-0.13 ft)	772.21 ft (-0.97 ft)
Upper Limit	765.27ft (+0.04 ft)	770.92 ft (0.33 ft)	773.98 ft (0.80 ft)

[1] Corresponds to Red River Discharge at James Avenue with 10% cfs contribution from the Assiniboine River as illustrated in Floodway Inlet Rating Curve plot.

As shown in the above table the overall uncertainty in the estimated "natural" water levels at the Floodway Inlet varies depending on the discharge. The sensitivity to roughness has been limited to the floodplain/overbank areas, which have a greater influence on computed water levels as the discharge increases and more area is inundated.

- For flood events less than 100,000 cfs, the effect on the estimated "natural" water level at the Floodway Inlet is minimal, with virtually no difference in estimated water levels at the Inlet.

- For larger floods, the estimated uncertainty increases to approximately –0.1 to +0.3 ft at 200,000 cfs, and to -1.0 to +0.8 ft at 300,000 cfs.

The uncertainty in the estimated water levels, although not negligible at the extreme flood discharges is typical of the uncertainty that would be expected in extending any rating curve well beyond metered values. The relative insensitivity of water levels to overbank roughness is due primarily to the flow split between the main channel and the overbank. The approximate flow split between the main channel and the overbank under flows greater than 200,000 cfs, when the overbank is inundated, is approximately 80% and 20% respectively indicating that the dominant conveyance area is still within the main channel.

While the above discussion has focused on the uncertainty of roughness values (Manning's n values) the other uncertainty in modelling is whether the actual physical data used in model calibration is reasonably accurate and representative, this includes: channel cross-sections, flow estimates and recorded water levels at various sites. As discussed in the main report a great deal of attention was spent on ensuring that the flow estimates and water level data were reasonably accurate and where there are anomalies steps have been taken in this study to resolve those differences.

Other uncertainties include accuracy of channel cross-sections and differences in flow meterings during the 1997 flood

Two areas where there is uncertainty in the physical data are in the area of channel cross-section data and metering discrepancies in the 1997 flow data.

- For this study it was assumed that the channel cross-sections surveyed in 1950 by the RRBI have remained relatively the same allowing comparison of water level profiles from various flood years, i.e., 1966 and 1997. As described in the main report, a limited number of RRBI cross-sections have been re-surveyed and no significant changes noted. While it is not expected that the channel cross-sections would change given that morphologically the Red River is relatively stable, there has been a reduction in channel maintenance floods through the City with the construction of the Red River Floodway. Re-surveying of additional RRBI cross-sections on a systematic basis would assess whether there has been any changes in the channel cross-sections.

- The other area of model uncertainty is in the differences in meterings between WSC and the Province during the 1997 flood at the peak. While metering were done at different locations, WSC metering at the Redwood Bridge (a less than ideal site for meterings) and the Provincial meterings at Chief Peguis Bridge just downstream of the Redwood site, the differences in metering of 5,000 cfs represents about a foot on the James Ave rating curve. As discussed in the main report this study has used the WSC metering as the assumed "correct" metering, however it is possible that the Provincial meterings may be more representative of the actual flows. If this is the case then it would reflect on the overall model calibration to 1966 data and adjustments would need to be made. To address this uncertainty it is recommended that a comprehensive data collection program be carried out during the next significant flood which results in James Ave levels exceeding 22 to 23 ft JAD.

MODEL LIMITATIONS

Low Flows

Model not calibrated for flows below 40,000 cfs.

The backwater model has been developed to simulate the Red River under high discharge (>40,000 cfs) conditions and not necessarily to model low flow scenarios. If it is required that water level be accurately predicted for water levels below 40,000 cfs, which reflects "in-channel" conditions, then it is recommended that a separate model that includes all the channel cross-sections be set up and calibrated for this flow range.

Extreme Floods

During extreme floods the hydraulic conveyance area may change

During the passage of an extreme flood, i.e., greater than 200,000 cfs it can be difficult to determine the true extent of flooding, the corresponding flow patterns, or the possibility of overflow/breakout through other depressions and waterways. Two areas of note, which could result in overflow to other waterways through depressions within the topography, are:

- Overflow/breakout from the Red River south of Winnipeg into the Assiniboine River watershed.
- Overflow/breakout from the Red River northwest of Winnipeg into the Netley/Wavey Creek watershed.

Both of these overflows could have the potential for diverting a significant portion of flow outside of the Red River Floodplain under very large flow events. However, based on a review of the water surface profiles and the available topography, neither of these overflows was determined to occur under Red River discharges less than 250,000 cfs. These overflows have therefore not been included in the model, and therefore the upper limit of discharge for the model should not exceed the 300,000 cfs as presented in the rating table. If larger flows are to be simulated in the future, the model may require some modification.

Ice Conditions

Study does not include effects of ice

The backwater model has been developed to simulate the Red River under open water conditions without the presence of an ice cover.

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Long, J. A. 1971 Red River Floods with Particular Reference to the Flood of 1956, 1966 and 1969. Environment Canada Inland Waters Western Region. Winnipeg, Manitoba.

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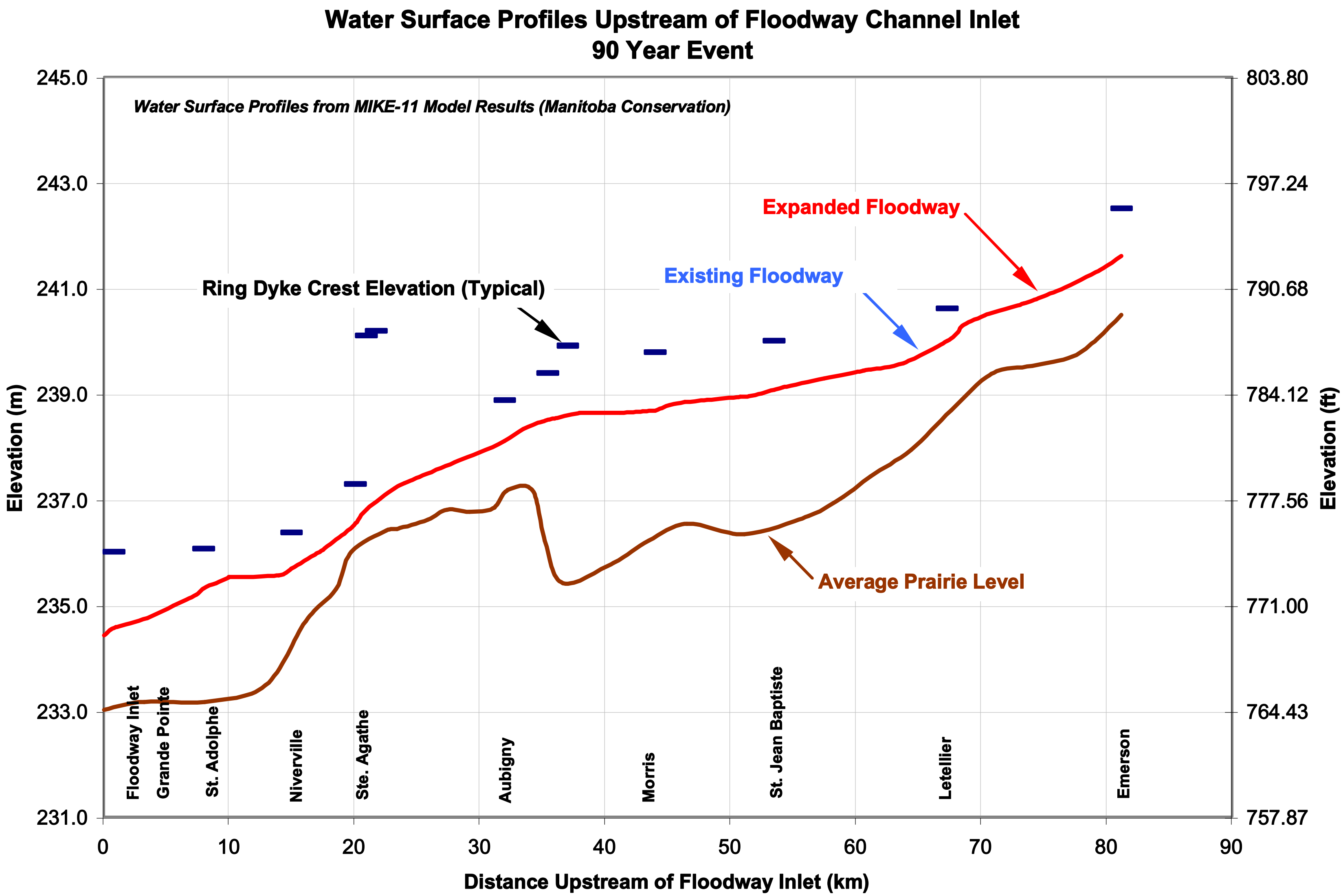
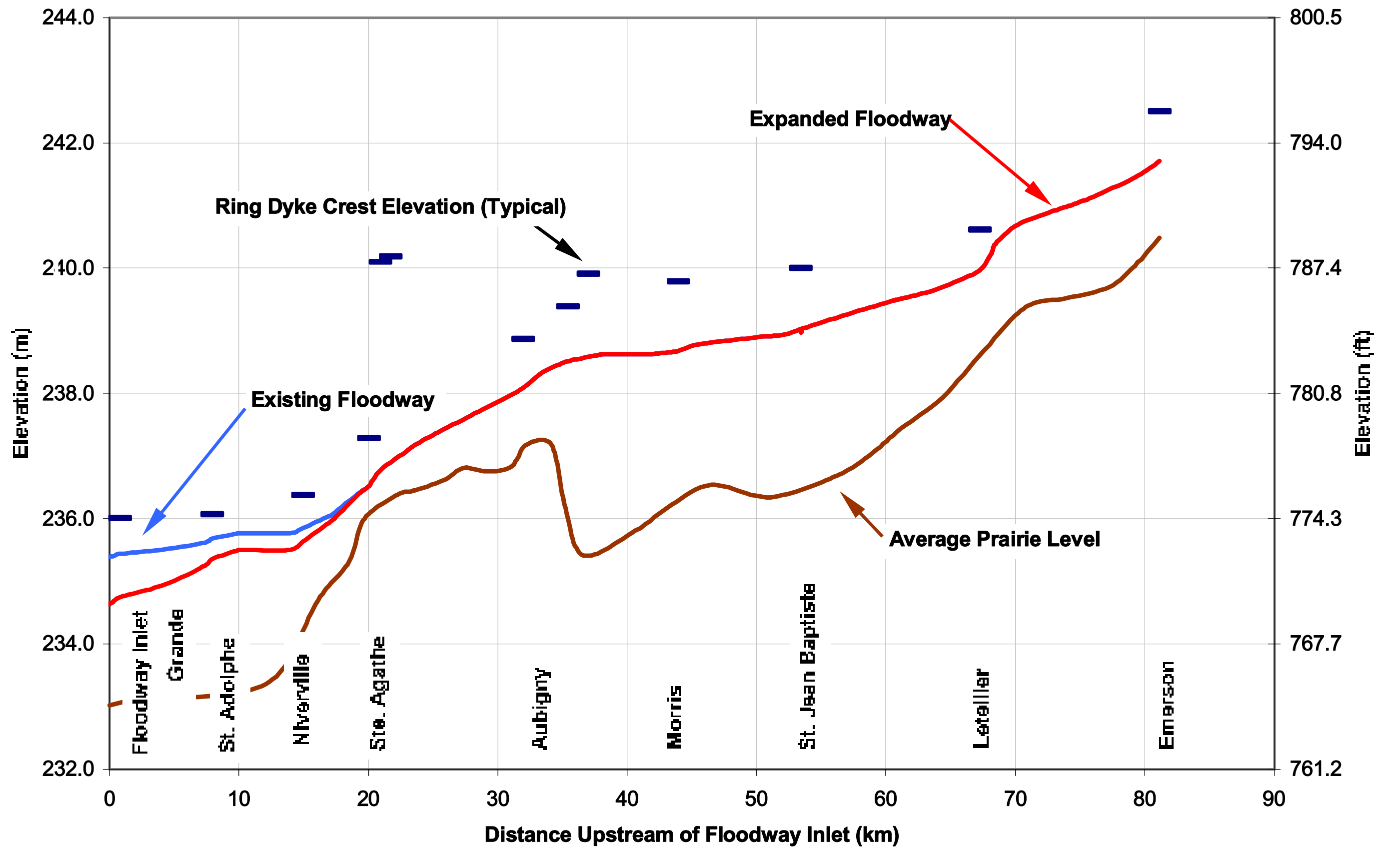
Annex 'C'-Water Surface Profiles (18 pages)

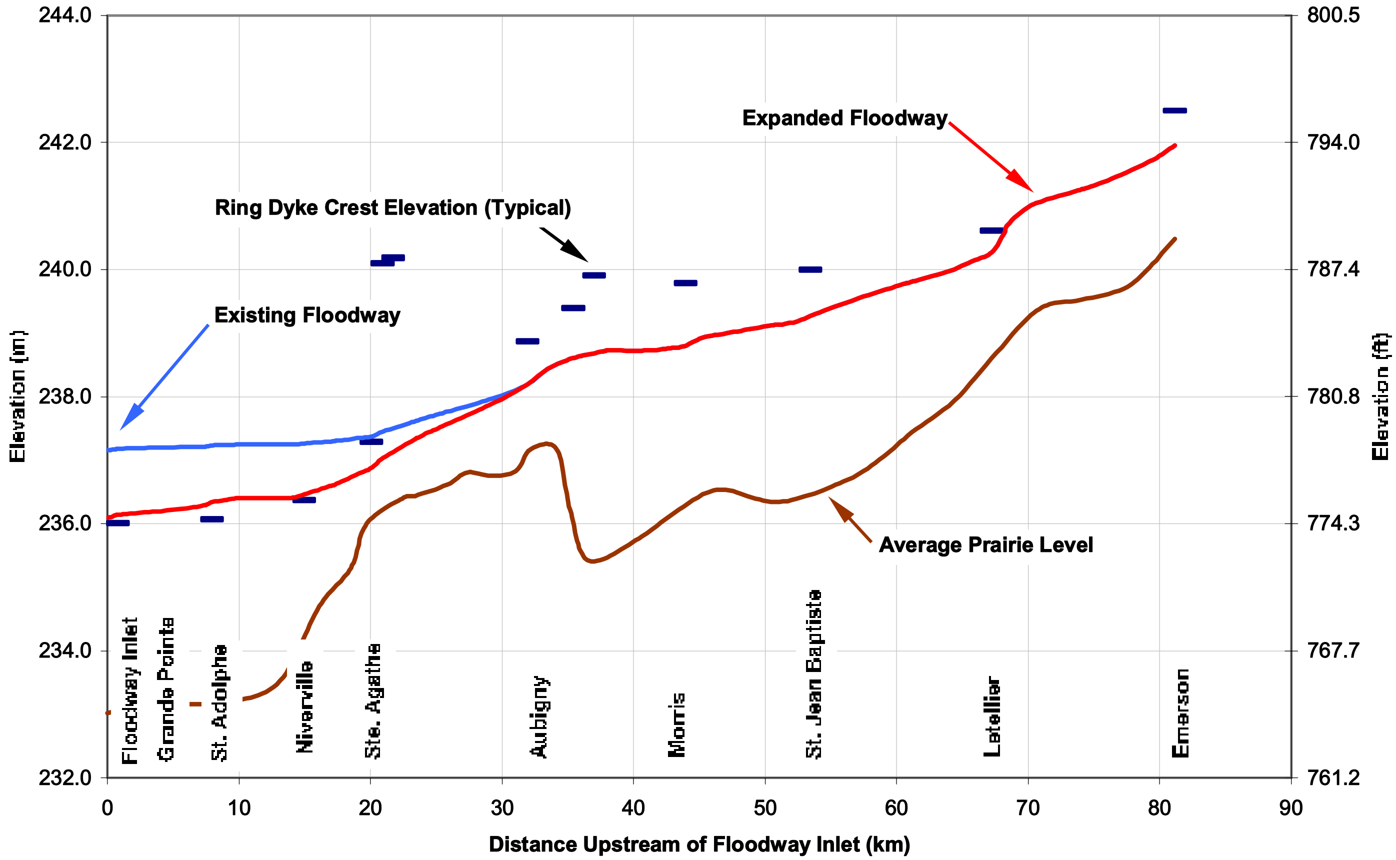


Water Surface Profiles Upstream of Floodway Channel Inlet
90 Year Event
Water Surface Profiles from MIKE-11 Model Results (Manitoba Conservation)
Expanded Floodway
Existing Floodway
Ring Dyke Crest Elevation (Typical)
Average Prairie Level
Elevation (m)
Elevation (ft)
Distance Upstream of Floodway Inlet (km)
245.0
243.0
241.0
239.0
237.0
235.0
233.0
231.0
803.80
797.24
790.68
784.12
777.56
771.00
764.43
757.87
0
10
20
30
40
50
60
70
80
90
Floodway Inlet
Grande Pointe
St. Adolphe
Niverville
Ste. Agathe
Aubigny
Morris
St. Jean Baptiste
Letellier
Emerson



Source: KGS Group (May 2004)

ACRES MANITOBA LTD.	
MANITOBA FLOODWAY EXPANSION AUTHORITY RED RIVER FLOODWAY PDEA-1	
WATER REGIME EFFECTS (WA-264)	
WATER SURFACE PROFILE UPSTREAM OF FLOODWAY INLET FOR THE 120 YEAR FLOOD	
DATE June 2004 PROJECT NO. P15226.00	FIGURE 2-2



Source: KGS Group (May 2004)

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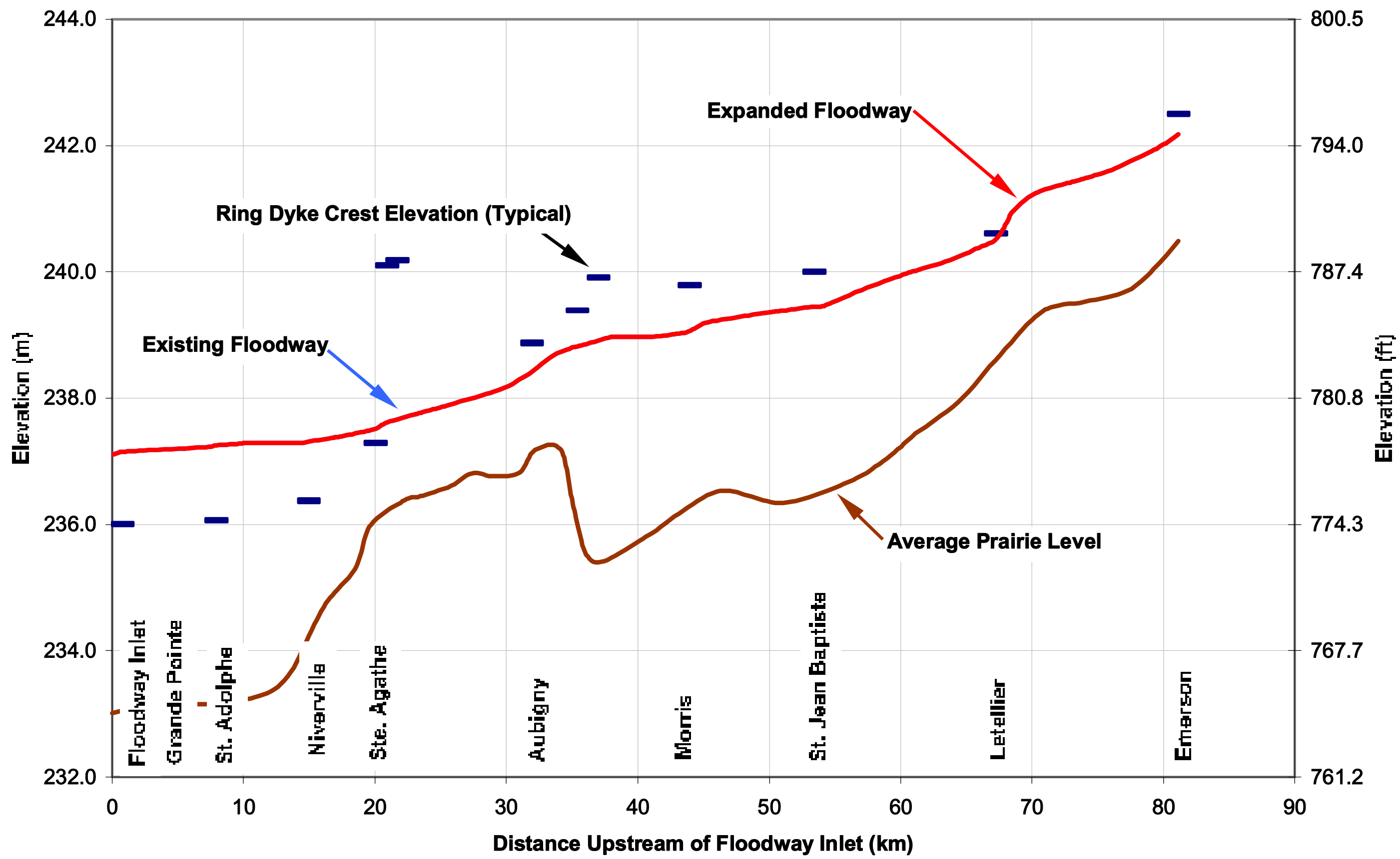
MANITOBA FLOODWAY EXPANSION AUTHORITY
RED RIVER FLOODWAY PDEA-1

WATER REGIME EFFECTS (WA-264)

WATER SURFACE PROFILE UPSTREAM OF FLOODWAY INLET FOR THE 225 YEAR FLOOD

DATE June 2004
PROJECT NO. P15226.00

FIGURE 2-3



Source: KGS Group (May 2004)

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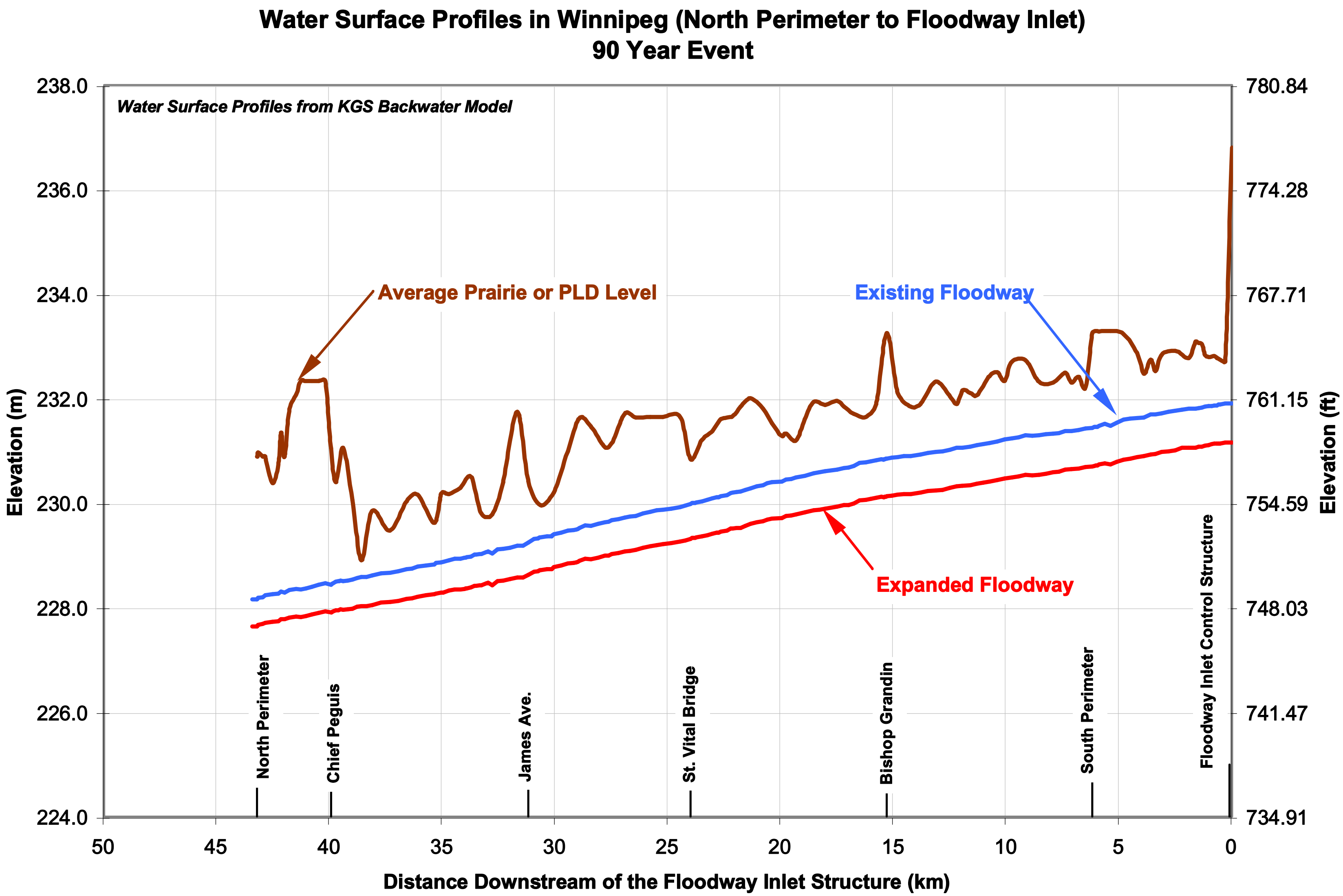
MANITOBA FLOODWAY EXPANSION AUTHORITY
RED RIVER FLOODWAY PDEA-1

WATER REGIME EFFECTS (WA-264)

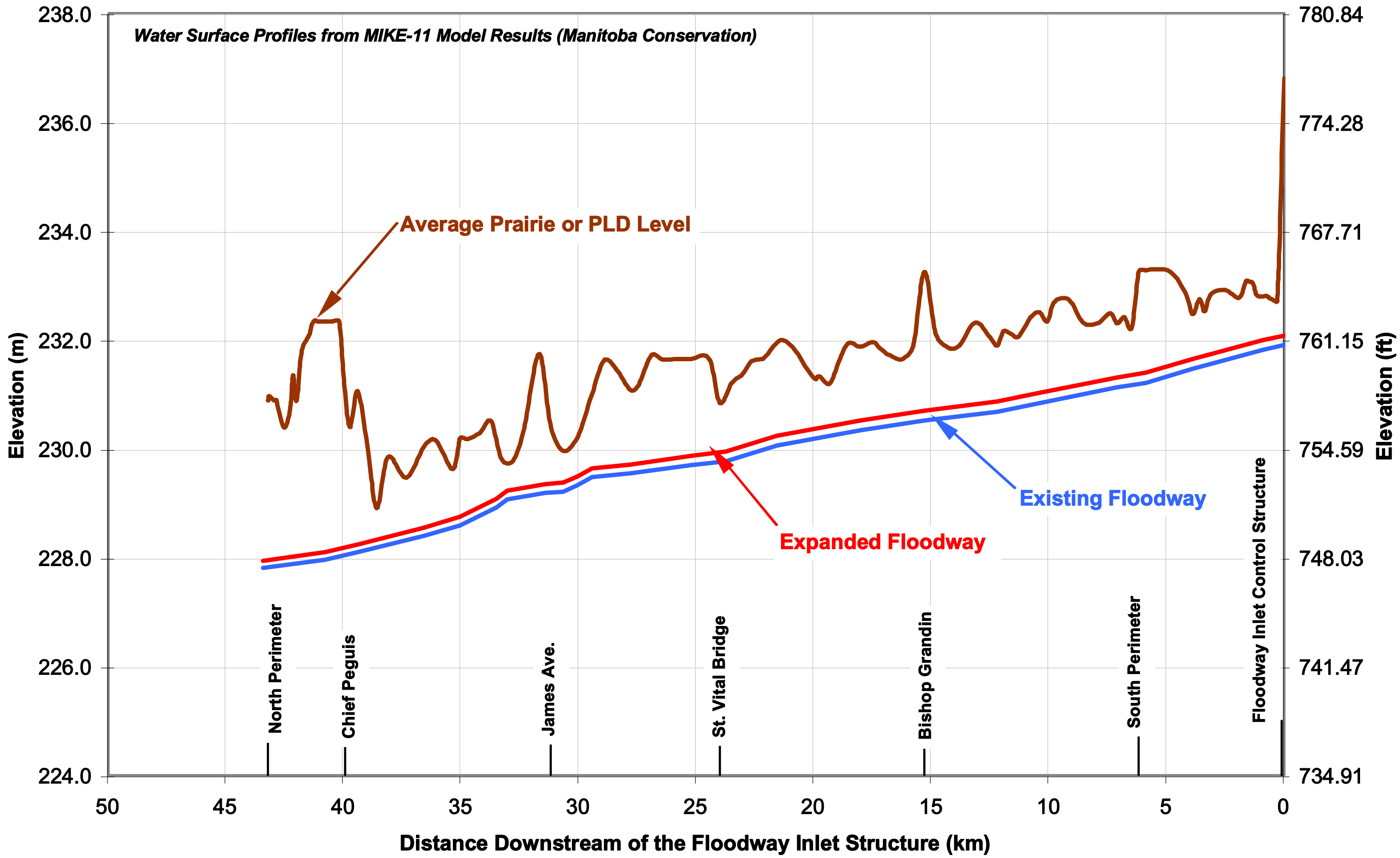
WATER SURFACE PROFILE UPSTREAM OF FLOODWAY INLET FOR THE 700 YEAR FLOOD

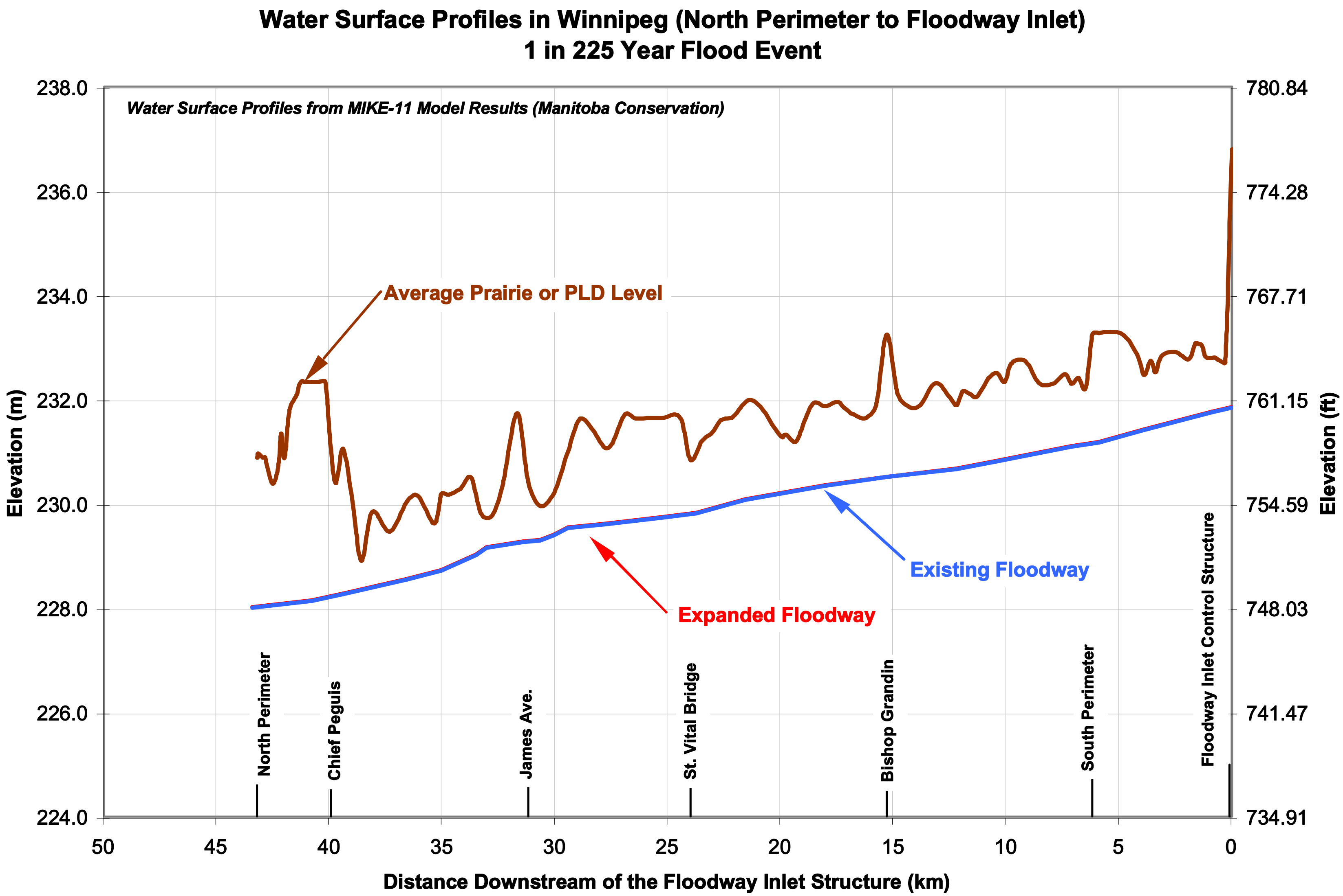
DATE June 2004 PROJECT NO. P15226.00	FIGURE 2-4

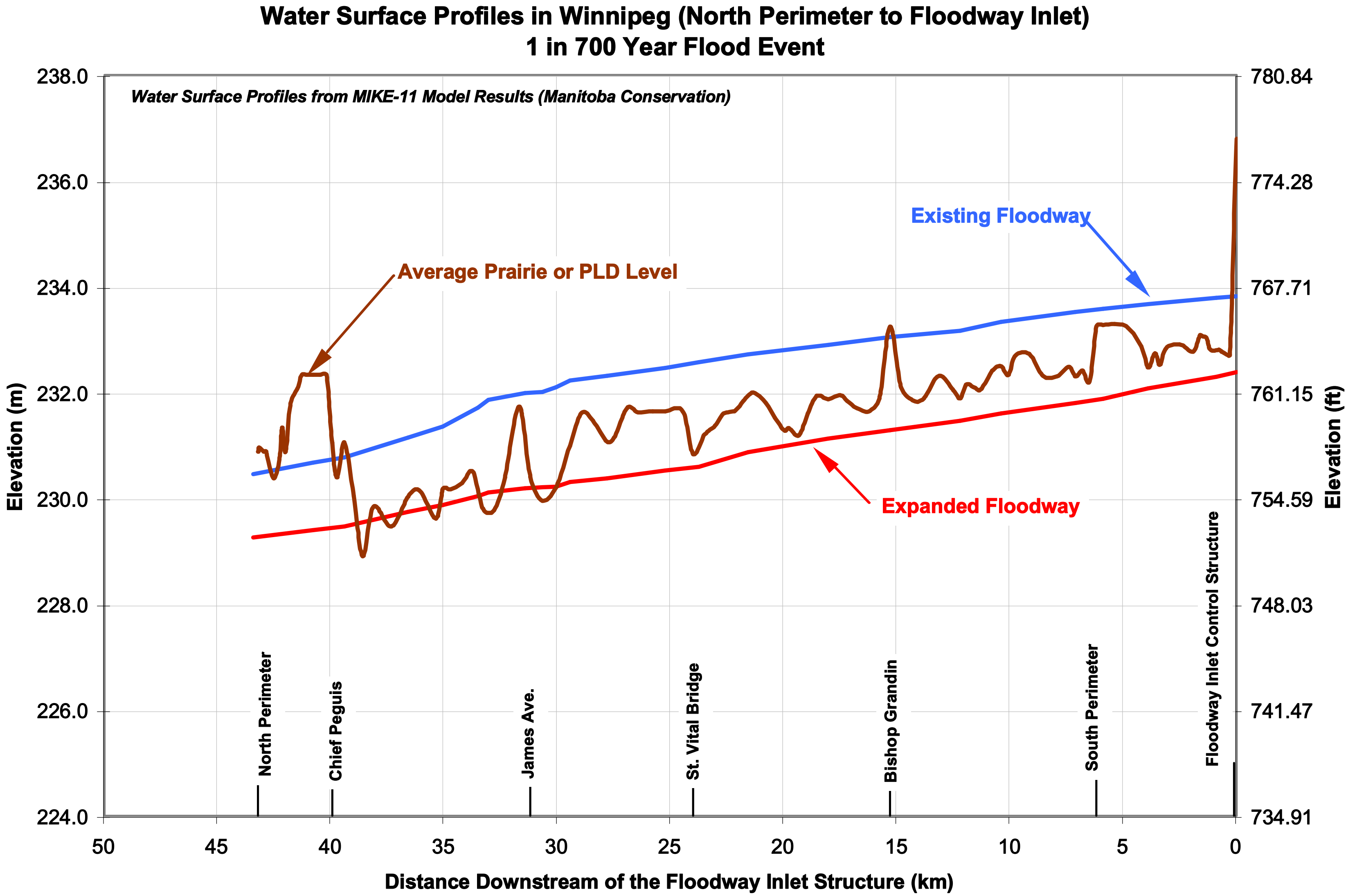


Water Surface Profiles in Winnipeg (North Perimeter to Floodway Inlet)
90 Year Event
Water Surface Profiles from KGS Backwater Model
Average Prairie or PLD Level
Existing Floodway
Expanded Floodway
North Perimeter
Chief Peguis
James Ave.
St. Vital Bridge
Bishop Grandin
South Perimeter
Floodway Inlet Control Structure
Elevation (m)
Elevation (ft)
238.0
236.0
234.0
232.0
230.0
228.0
226.0
224.0
780.84
774.28
767.71
761.15
754.59
748.03
741.47
734.91
50
45
40
35
30
25
20
15
10
5
0
Distance Downstream of the Floodway Inlet Structure (km)

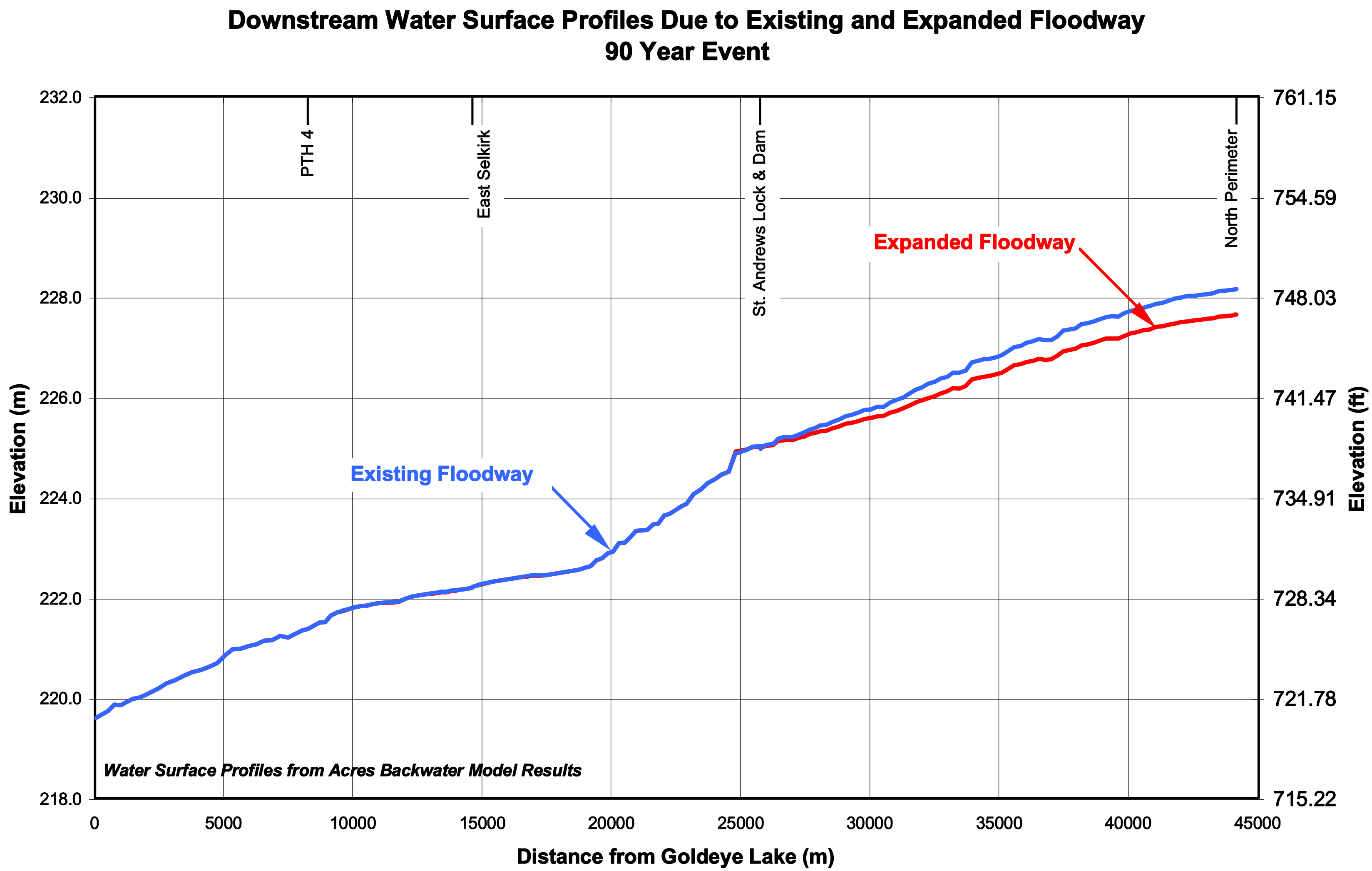
Water Surface Profiles in Winnipeg (North Perimeter to Floodway Inlet)
1 in 120 Year Flood Event

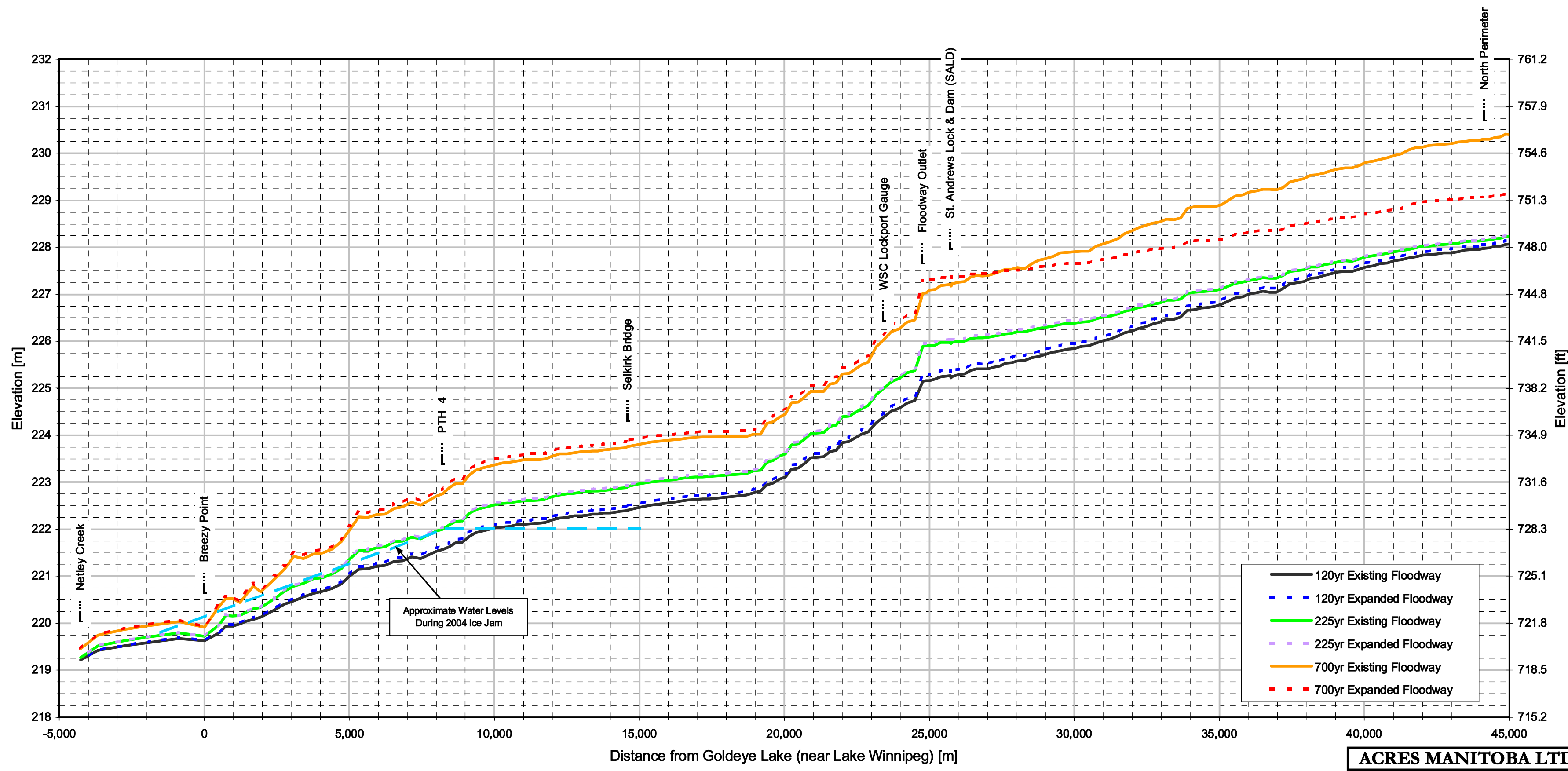



Water Surface Profiles in Winnipeg (North Perimeter to Floodway Inlet)
1 in 225 Year Flood Event
Water Surface Profiles from MIKE-11 Model Results (Manitoba Conservation)
Average Prairie or PLD Level
Existing Floodway
Expanded Floodway
North Perimeter
Chief Peguis
James Ave.
St. Vital Bridge
Bishop Grandin
South Perimeter
Floodway Inlet Control Structure
Elevation (m)
Elevation (ft)
238.0
236.0
234.0
232.0
230.0
228.0
226.0
224.0
780.84
774.28
767.71
761.15
754.59
748.03
741.47
734.91
50
45
40
35
30
25
20
15
10
5
0
Distance Downstream of the Floodway Inlet Structure (km)



Water Surface Profiles in Winnipeg (North Perimeter to Floodway Inlet)
1 in 700 Year Flood Event
Water Surface Profiles from MIKE-11 Model Results (Manitoba Conservation)
Existing Floodway
Average Prairie or PLD Level
Expanded Floodway
Elevation (m)
Elevation (ft)
238.0
236.0
234.0
232.0
230.0
228.0
226.0
224.0
780.84
774.28
767.71
761.15
754.59
748.03
741.47
734.91
North Perimeter
Chief Peguis
James Ave.
St. Vital Bridge
Bishop Grandin
South Perimeter
Floodway Inlet Control Structure
50
45
40
35
30
25
20
15
10
5
0
Distance Downstream of the Floodway Inlet Structure (km)


Downstream Water Surface Profiles Due to Existing and Expanded Floodway
90 Year Event
Elevation (m)
Elevation (ft)
Distance from Goldeye Lake (m)
PTH 4
East Selkirk
St. Andrews Lock & Dam
North Perimeter
Expanded Floodway
Existing Floodway
Water Surface Profiles from Acres Backwater Model Results
232.0
230.0
228.0
226.0
224.0
222.0
220.0
218.0
761.15
754.59
748.03
741.47
734.91
728.34
721.78
715.22
0
5000
10000
15000
20000
25000
30000
35000
40000
45000



Notes:
- Flow Splits from Table 2-4
- Backwater modelling based on Acres (2004) modified HEC-RAS model (Sec. 2.3)

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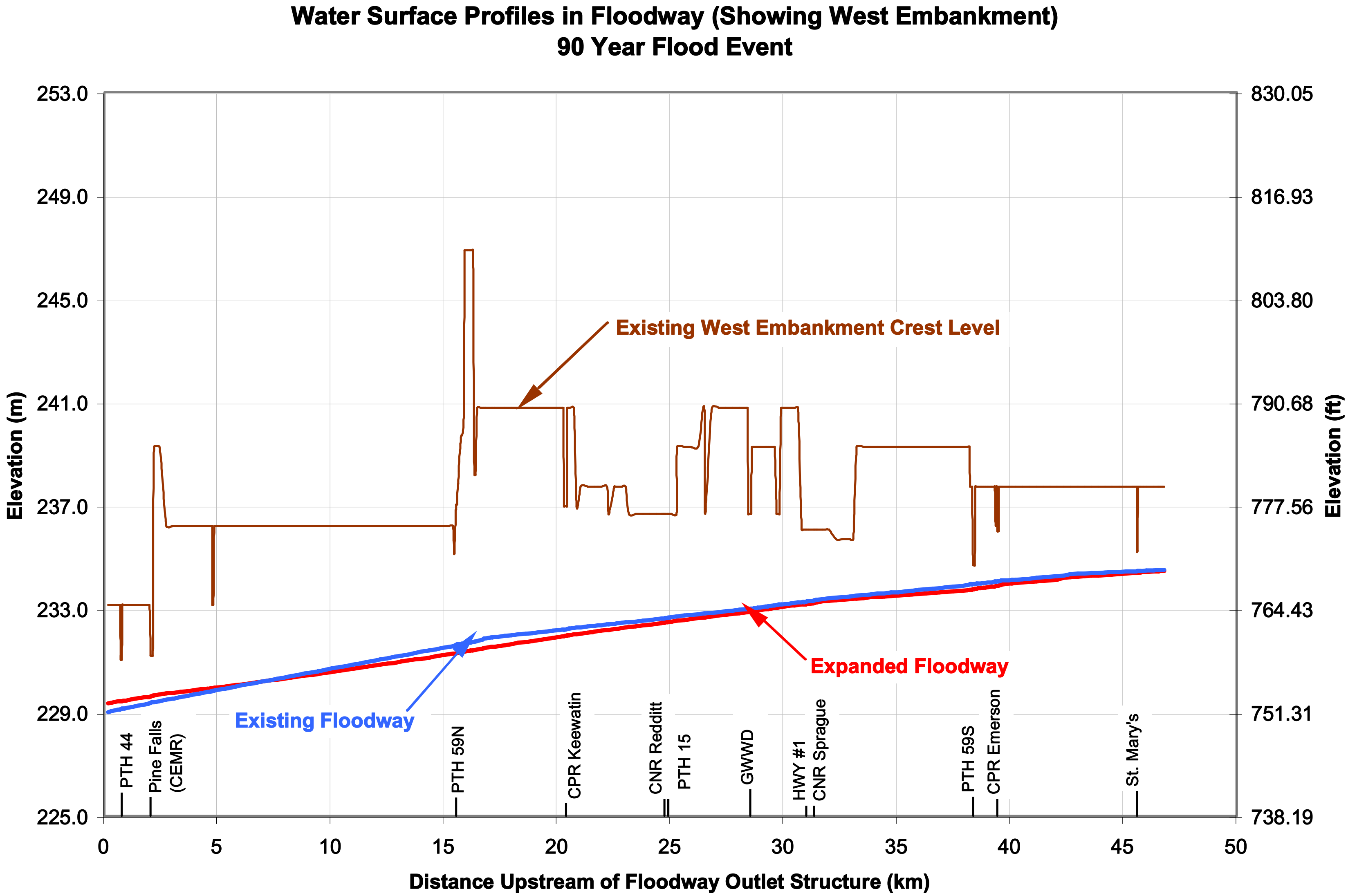
MANITOBA FLOODWAY EXPANSION AUTHORITY
RED RIVER FLOODWAY PDEA-1

WATER REGIME EFFECTS (WA-264)

DOWNSTREAM WATER SURFACE PROFILES DUE TO EXISTING AND EXPANDED FLOODWAY FOR THE 1:120 YEAR TO 1:700 YEAR FLOOD EVENTS

DATE June 2004
PROJECT NO. P15226.00

FIGURE 2-6



Water Surface Profiles in Floodway (Showing West Embankment)
90 Year Flood Event
Elevation (m)
Elevation (ft)
Distance Upstream of Floodway Outlet Structure (km)
Existing West Embankment Crest Level
Expanded Floodway
Existing Floodway
PTH 44
Pine Falls (CEMR)
PTH 59N
CPR Keewatin
CNR Redditt
PTH 15
GWWD
HWY #1
CNR Sprague
PTH 59S
CPR Emerson
St. Mary's
253.0
249.0
245.0
241.0
237.0
233.0
229.0
225.0
830.05
816.93
803.80
790.68
777.56
764.43
751.31
738.19
0
5
10
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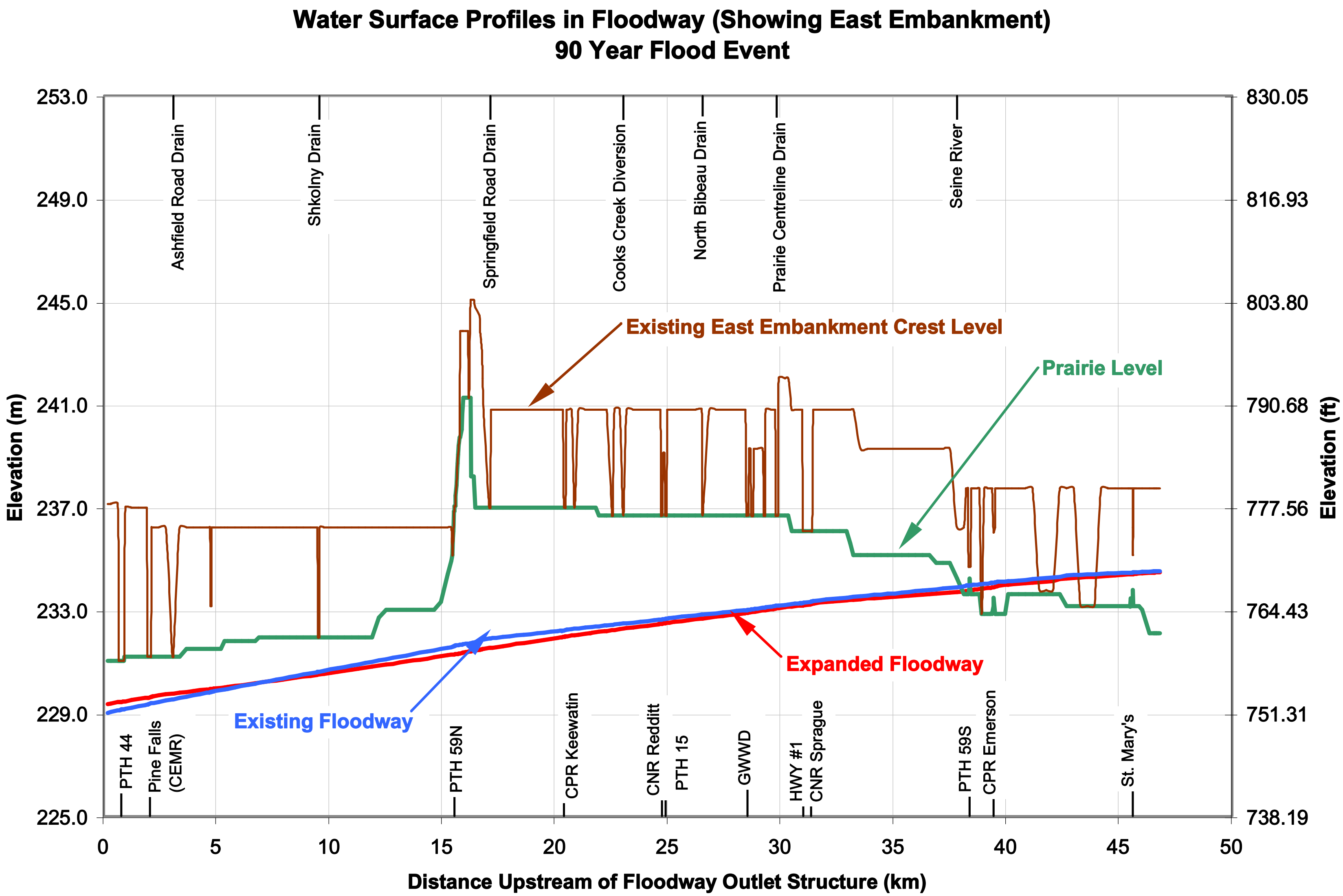
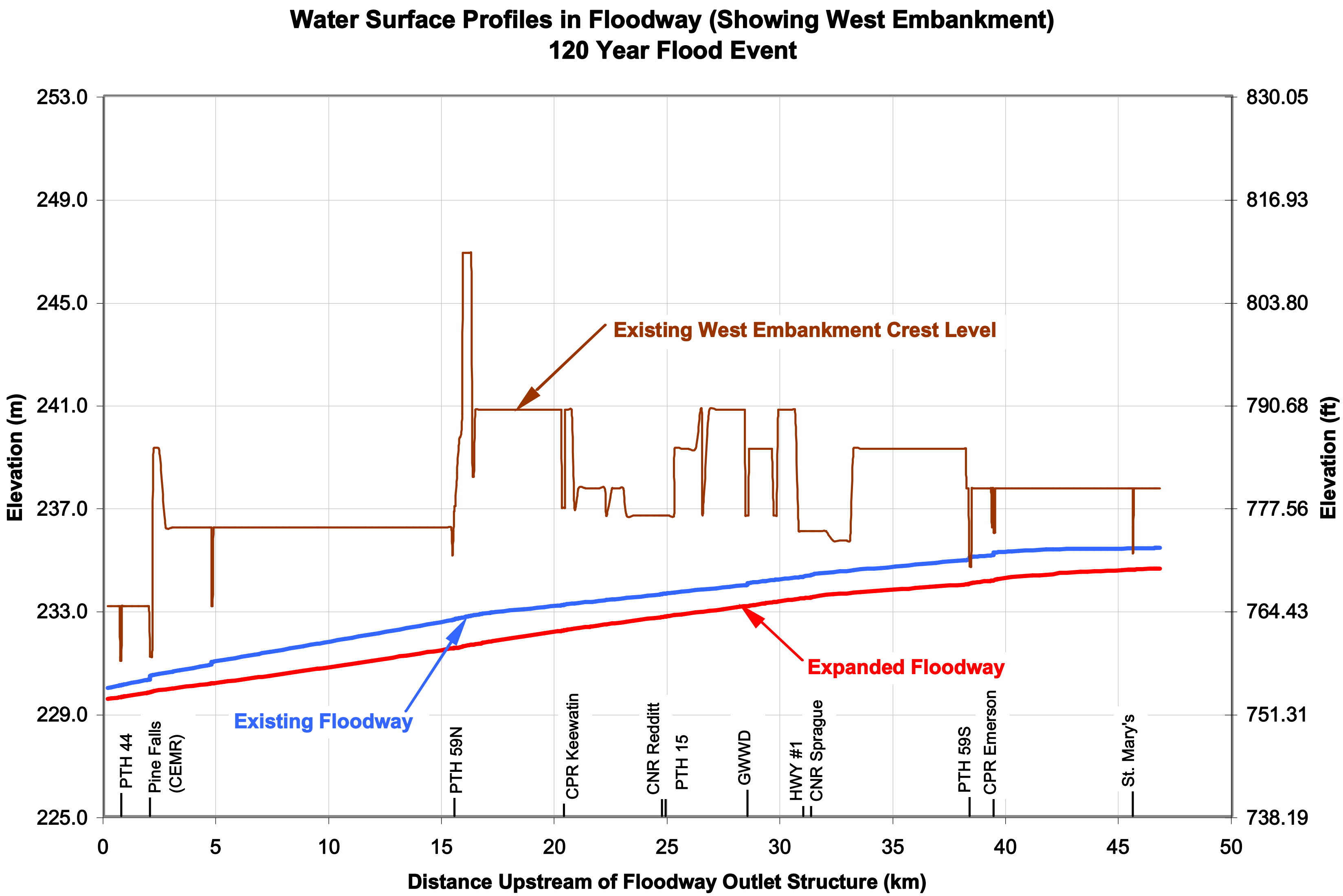
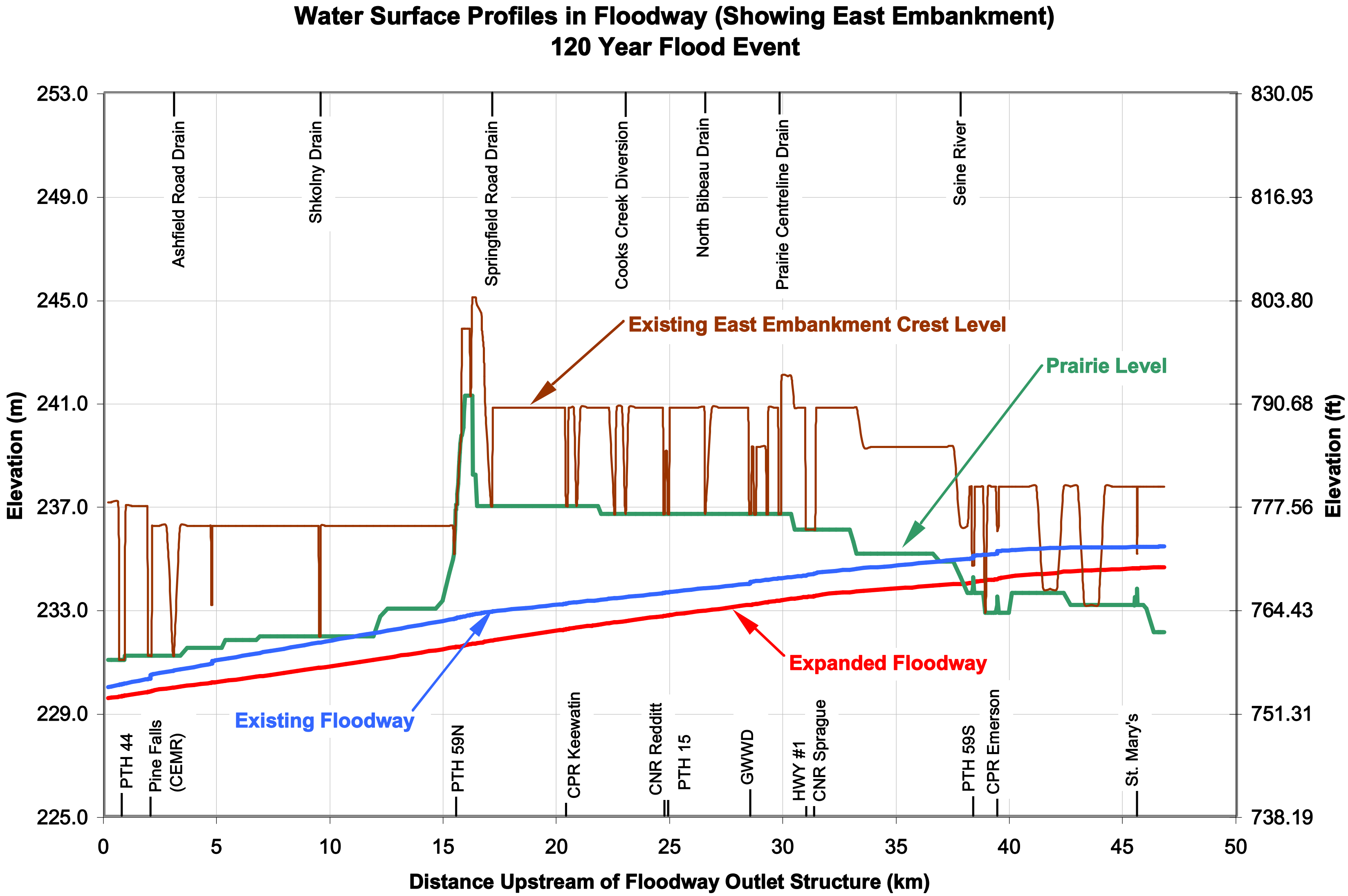
25
30
35
40
45
50

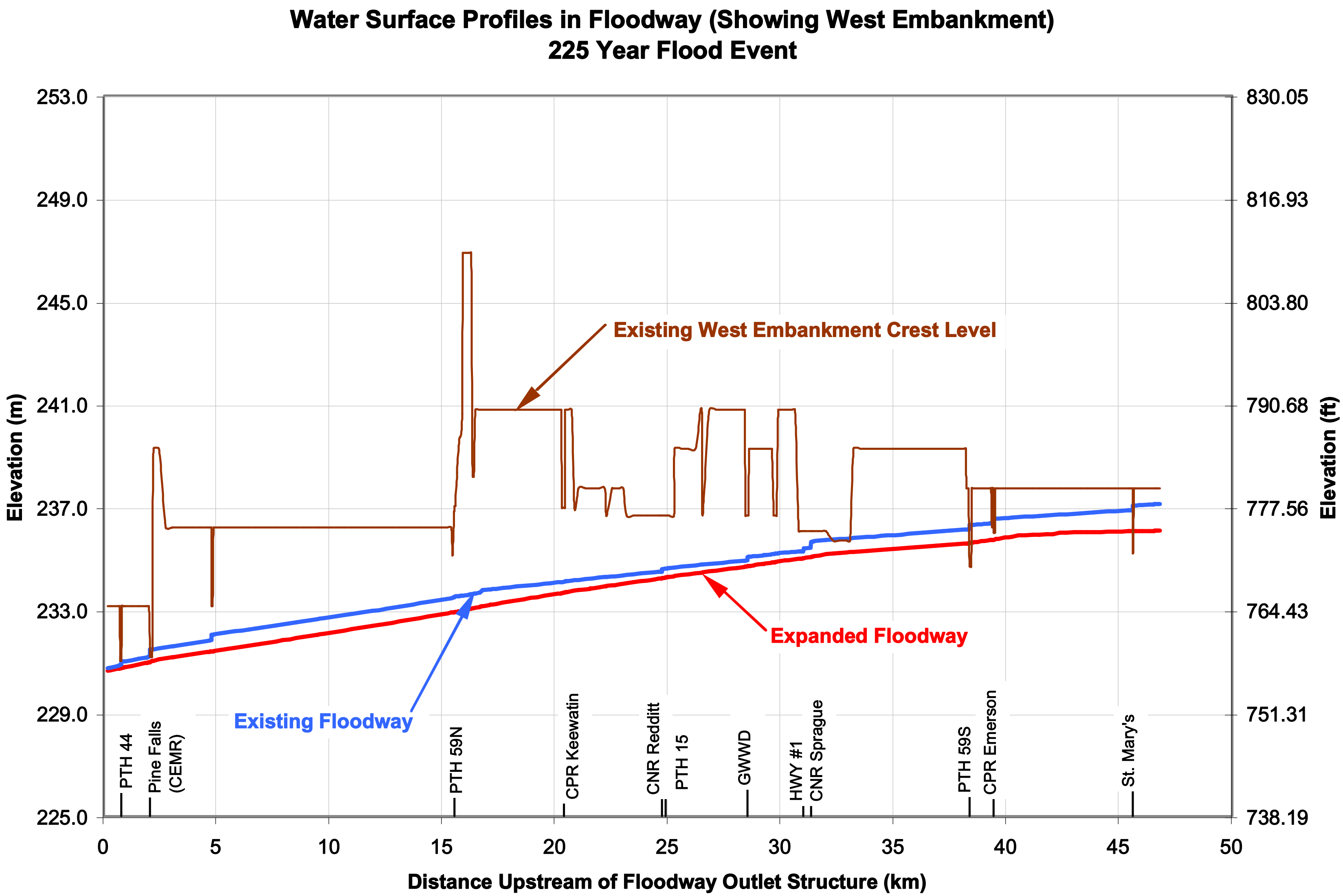

Water Surface Profiles in Floodway (Showing East Embankment)
90 Year Flood Event
Elevation (m)
Elevation (ft)
Distance Upstream of Floodway Outlet Structure (km)
Existing East Embankment Crest Level
Prairie Level
Expanded Floodway
Existing Floodway
Ashfield Road Drain
Shkolny Drain
Springfield Road Drain
Cooks Creek Diversion
North Bibeau Drain
Prairie Centreline Drain
Seine River
PTH 44
Pine Falls (CEMR)
PTH 59N
CPR Keewatin
CNR Redditt
PTH 15
GWWD
HWY #1
CNR Sprague
PTH 59S
CPR Emerson
St. Mary's
253.0
249.0
245.0
241.0
237.0
233.0
229.0
225.0
830.05
816.93
803.80
790.68
777.56
764.43
751.31
738.19
0
5
10
15
20
25
30
35
40
45
50



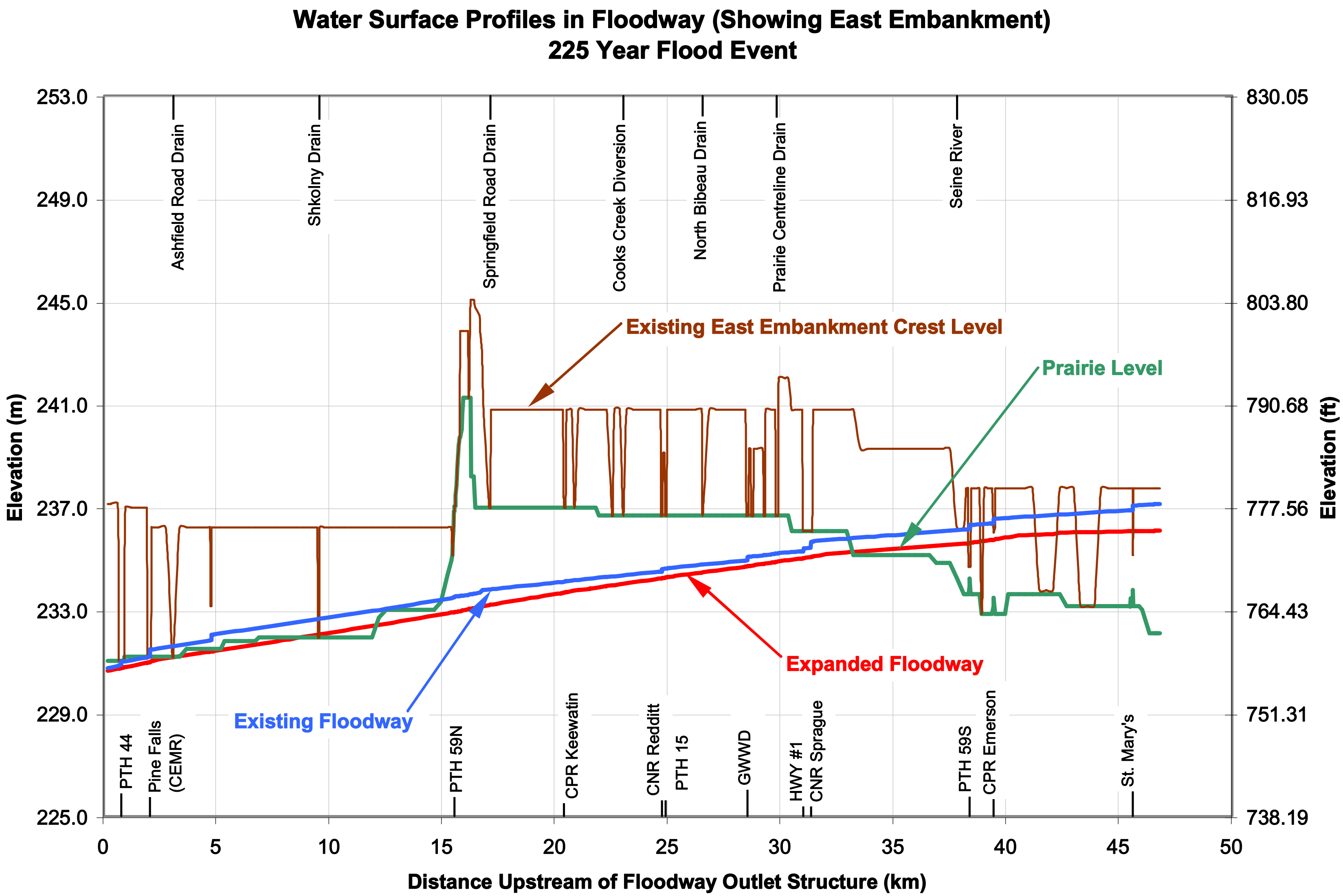
Water Surface Profiles in Floodway (Showing West Embankment)
120 Year Flood Event
Existing West Embankment Crest Level
Expanded Floodway
Existing Floodway
Elevation (m)
Elevation (ft)
Distance Upstream of Floodway Outlet Structure (km)
PTH 44
Pine Falls (CEMR)
PTH 59N
CPR Keewatin
CNR Redditt
PTH 15
GWWD
HWY #1
CNR Sprague
PTH 59S
CPR Emerson
St. Mary's
253.0
249.0
245.0
241.0
237.0
233.0
229.0
225.0
830.05
816.93
803.80
790.68
777.56
764.43
751.31
738.19
0
5
10
15
20
25
30
35
40
45
50



Water Surface Profiles in Floodway (Showing East Embankment)
120 Year Flood Event
Elevation (m)
Elevation (ft)
Distance Upstream of Floodway Outlet Structure (km)
253.0
249.0
245.0
241.0
237.0
233.0
229.0
225.0
830.05
816.93
803.80
790.68
777.56
764.43
751.31
738.19
0
5
10
15
20
25
30
35
40
45
50
Ashfield Road Drain
Shkolny Drain
Springfield Road Drain
Cooks Creek Diversion
North Bibeau Drain
Prairie Centreline Drain
Seine River
Existing East Embankment Crest Level
Prairie Level
Expanded Floodway
Existing Floodway
PTH 44
Pine Falls (CEMR)
PTH 59N
CPR Keewatin
CNR Redditt
PTH 15
GWWD
HWY #1
CNR Sprague
PTH 59S
CPR Emerson
St. Mary's



Water Surface Profiles in Floodway (Showing West Embankment)
225 Year Flood Event
Elevation (m)
Elevation (ft)
253.0
249.0
245.0
241.0
237.0
233.0
229.0
225.0
830.05
816.93
803.80
790.68
777.56
764.43
751.31
738.19
Existing West Embankment Crest Level
Expanded Floodway
Existing Floodway
PTH 44
Pine Falls (CEMR)
PTH 59N
CPR Keewatin
CNR Redditt
PTH 15
GWWD
HWY #1
CNR Sprague
PTH 59S
CPR Emerson
St. Mary's
0
5
10
15
20
25
30
35
40
45
50
Distance Upstream of Floodway Outlet Structure (km)



Water Surface Profiles in Floodway (Showing East Embankment)
225 Year Flood Event
253.0
249.0
245.0
241.0
237.0
233.0
229.0
225.0
830.05
816.93
803.80
790.68
777.56
764.43
751.31
738.19
Elevation (m)
Elevation (ft)
Ashfield Road Drain
Shkolny Drain
Springfield Road Drain
Cooks Creek Diversion
North Bibeau Drain
Prairie Centreline Drain
Seine River
Existing East Embankment Crest Level
Prairie Level
Expanded Floodway
Existing Floodway
PTH 44
Pine Falls (CEMR)
PTH 59N
CPR Keewatin
CNR Redditt
PTH 15
GWWD
HWY #1
CNR Sprague
PTH 59S
CPR Emerson
St. Mary's
0
5
10
15
20
25
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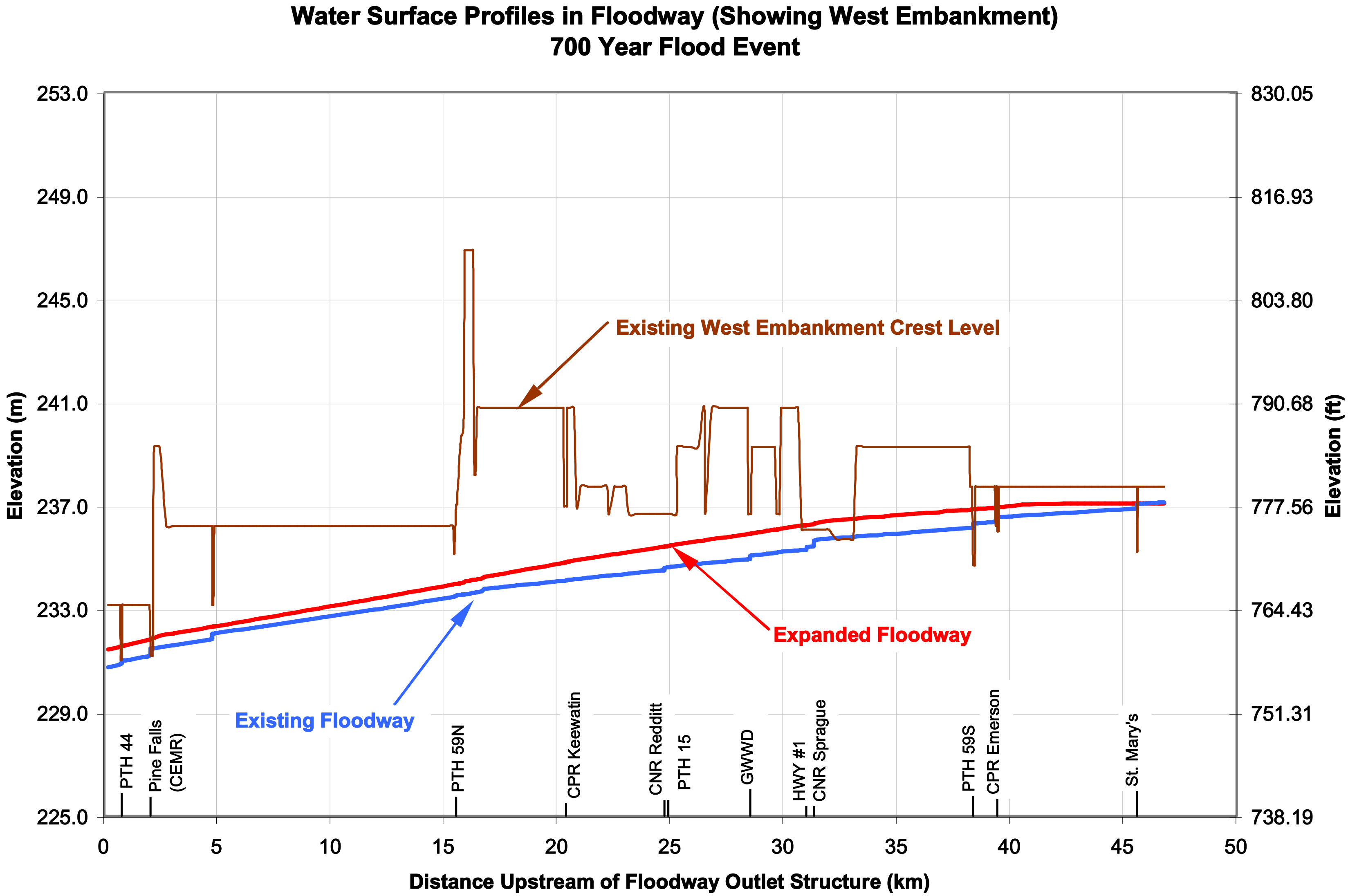
35
40
45
50
Distance Upstream of Floodway Outlet Structure (km)


Water Surface Profiles in Floodway (Showing West Embankment)
700 Year Flood Event
Elevation (m)
Elevation (ft)
Distance Upstream of Floodway Outlet Structure (km)
Existing West Embankment Crest Level
Expanded Floodway
Existing Floodway
PTH 44
Pine Falls (CEMR)
PTH 59N
CPR Keewatin
CNR Redditt
PTH 15
GWWD
HWY #1
CNR Sprague
PTH 59S
CPR Emerson
St. Mary's
253.0
249.0
245.0
241.0
237.0
233.0
229.0
225.0
830.05
816.93
803.80
790.68
777.56
764.43
751.31
738.19
0
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10
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45
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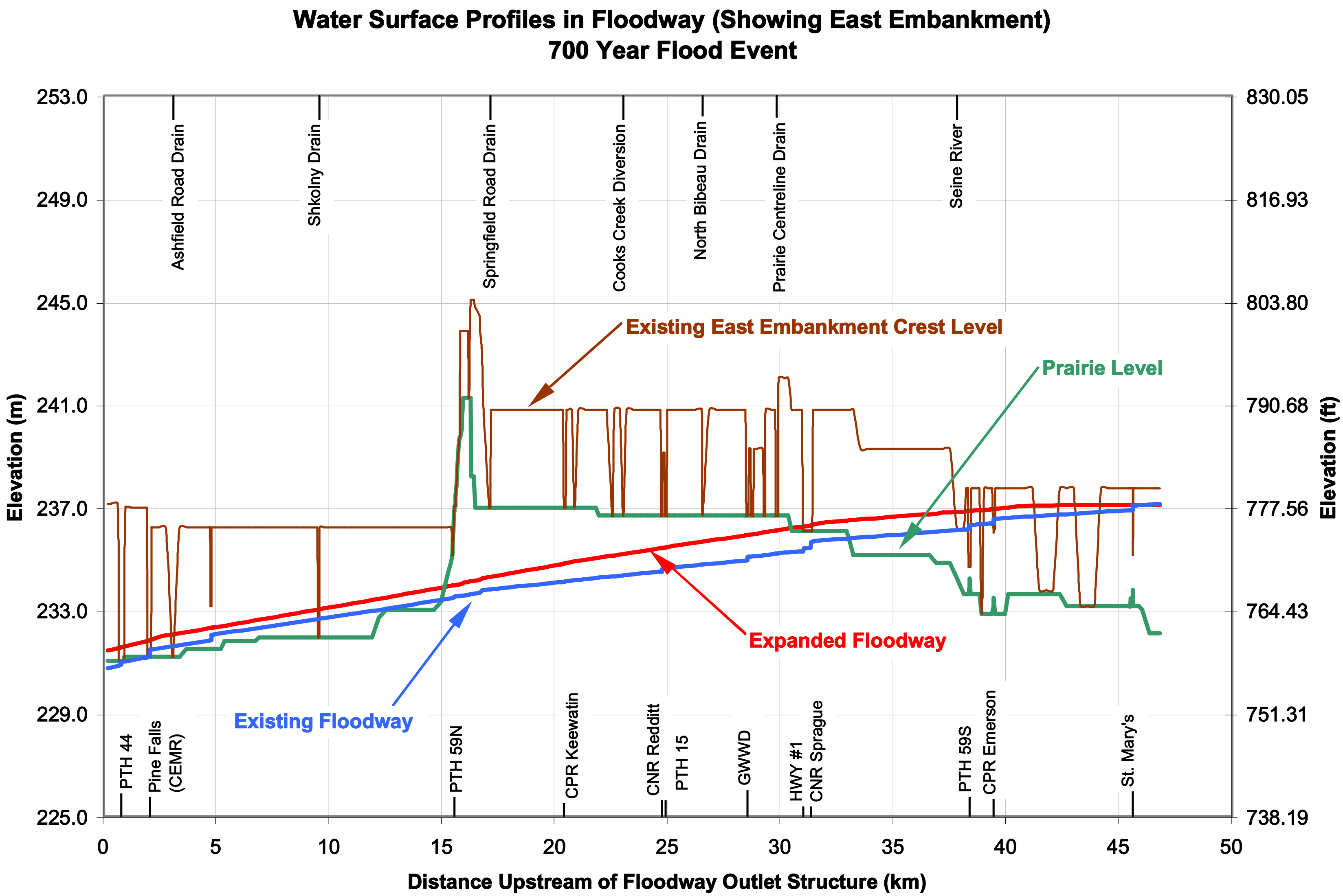
Water Surface Profiles in Floodway (Showing East Embankment)
700 Year Flood Event
Elevation (m)
Elevation (ft)
Distance Upstream of Floodway Outlet Structure (km)
Ashfield Road Drain
Shkolny Drain
Springfield Road Drain
Cooks Creek Diversion
North Bibeau Drain
Prairie Centreline Drain
Seine River
Existing East Embankment Crest Level
Prairie Level
Expanded Floodway
Existing Floodway
PTH 44
Pine Falls (CEMR)
PTH 59N
CPR Keewatin
CNR Redditt
PTH 15
GWWD
HWY #1
CNR Sprague
PTH 59S
CPR Emerson
St. Mary's
253.0
249.0
245.0
241.0
237.0
233.0
229.0
225.0
830.05
816.93
803.80
790.68
777.56
764.43
751.31
738.19
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Annex 'D'-Water Surface Elevations (Tabulation – 1 page)

Summary of Peak Water Levels Along the Red River

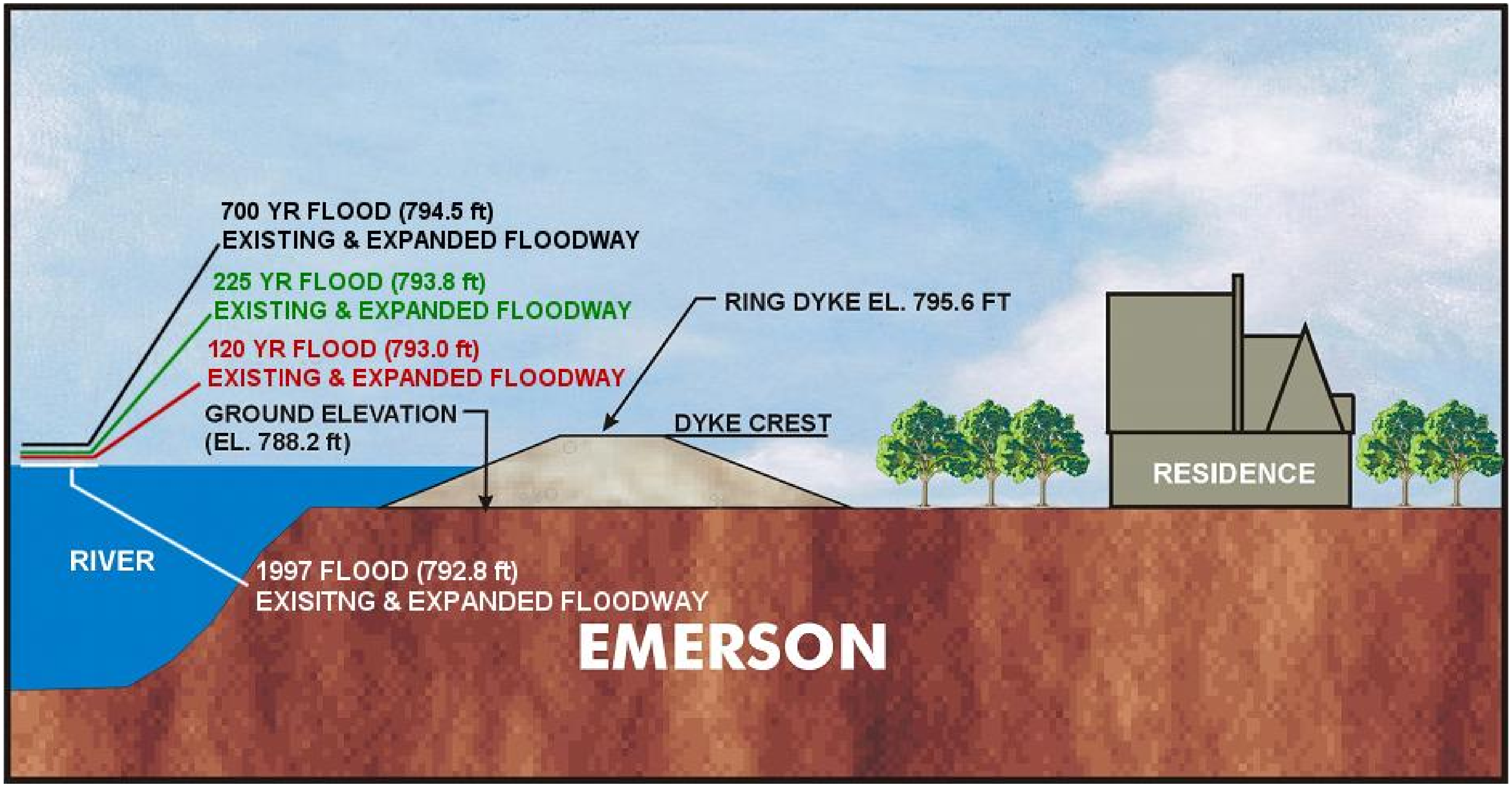
Location		Maximum Water Level (ft): 1 in 100 Yr Flood: Existing Floodway	1 in 100 Yr Flood: Expanded Floodway	1 in 100 Yr Flood: Difference (Exp - Exist)	1 in 120 Yr Flood: Existing Floodway	1 in 120 Yr Flood: Expanded Floodway	1 in 120 Yr Flood: Difference (Exp - Exist)	1 in 225 Yr Flood: Existing Floodway	1 in 225 Yr Flood: Expanded Floodway	1 in 225 Yr Flood: Difference (Exp - Exist)	1 in 700 Yr Flood: Existing Floodway	1 in 700 Yr Flood: Expanded Floodway	1 in 700 Yr Flood: Difference (Exp - Exist)
Emerson	Upstream of Floodway Inlet Structure	792.81	792.81	0.00	793.00	793.00	0.00	793.81	793.81	0.00	794.54	794.54	0.00
Letellier		787.27	787.27	0.00	787.29	787.29	0.00	788.30	788.30	0.00	789.08	789.08	0.00
St. Jean Baptiste		784.37	784.37	0.00	784.04	784.04	0.00	785.00	785.00	0.00	785.59	785.59	0.00
Morris		783.17	783.17	0.00	783.06	783.06	0.00	783.47	783.47	0.00	784.32	784.32	0.00
St. Pierre-Jolys		781.26	781.26	0.00	780.90	780.90	0.00	782.20	782.20	0.00	783.01	783.01	0.00
Rosenort		783.08	783.08	0.00	782.97	782.97	0.00	783.32	783.32	0.00	784.12	784.12	0.00
Aubigny		781.20	781.20	0.00	781.13	781.13	0.00	781.47	781.47	0.00	782.21	782.21	0.00
Brunkild		783.19	783.19	0.00	783.01	783.01	0.00	783.43	783.37	-0.06	784.12	784.12	0.00
Avonlea Corner		778.08	778.02	-0.06	777.74	778.02	0.28	778.79	778.35	-0.44	779.37	779.37	0.00
Ste. Agathe		776.07	776.07	0.00	776.00	776.00	0.00	778.77	777.15	-1.63	779.26	779.26	0.00
Niverville		773.82	773.44	-0.38	773.90	773.38	-0.52	778.42	775.80	-2.62	778.59	778.59	0.00
St. Adolphe		772.59	772.14	-0.46	773.24	772.18	-1.06	778.31	775.40	-2.91	778.38	778.38	0.00
Grande Pointe		770.92	769.75	-1.17	772.38	770.10	-2.28	778.13	774.70	-3.43	778.00	778.00	0.00
Floodway Inlet (Turnbull Dr.)		770.52	769.56	-0.96	772.26	769.80	-2.46	778.07	774.57	-3.50	777.91	777.91	0.00
James Avenue	Through Winnipeg	752.06	750.89	-1.17	751.99	752.27	0.28	752.27	752.30	0.03	760.56	755.30	-5.26
North Perimeter Bridge		748.72	748.10	-0.62	747.97	748.23	0.26	748.52	748.59	0.07	755.58	751.54	-4.04
St. Andrews Church		741.08	740.91	-0.16	740.94	741.31	0.36	742.75	742.91	0.16	747.70	746.92	-0.79
St. Andrews Lock & Dam		738.81	738.91	0.10	739.01	739.44	0.43	741.37	741.57	0.20	745.47	746.00	0.52
Red River at Floodway Outlet		738.42	738.58	0.16	738.68	739.07	0.39	741.11	741.31	0.20	744.82	745.70	0.89
Lower Fort Garry	D/S of FW Outlet	729.53	729.59	0.07	729.66	729.92	0.26	731.27	731.40	0.13	734.06	734.48	0.43
Selkirk Bridge		729.53	729.59	0.07	729.66	729.92	0.26	731.27	731.40	0.13	734.06	734.48	0.43
PTH 4 Bridge		726.67	726.74	0.07	726.80	727.03	0.23	728.22	728.35	0.13	730.68	731.00	0.33
Breezy Point		721.06	721.06	0.00	721.10	721.16	0.07	721.65	721.69	0.03	722.97	723.13	0.16
James Avenue Level (MIKE 11)		24.49	23.32	-	24.42	24.70	-	24.70	24.73	-	32.99	27.73	-
MIKE 11 Run Ref. Number		BA054y2	BA176	-	BJ444	BJ428	-	BJ309ac	BJ315h	-	BH315e4	BH320	-

NOTES:

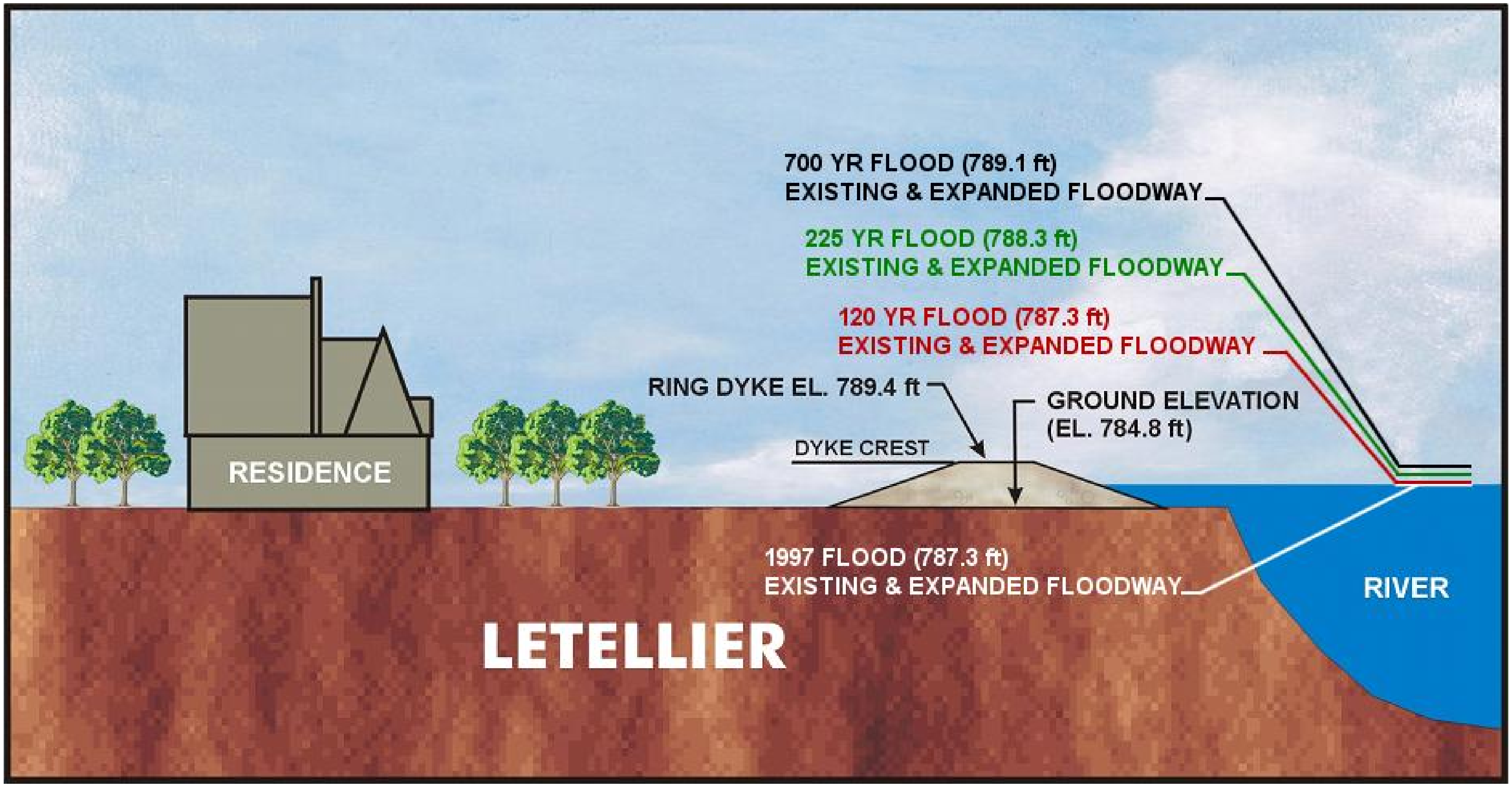
1) Values in blue shading are from MIKE 11 Model results
2) Values in orange shading are from Acres Backwater Model using MIKE 11 Flows
3) James Avenue Level from MIKE 11 model estimated at MIKE 11 cross section 32978
4) Frequency relationships relative to Natural Flow at James Avenue
5) Water Levels upstream of the inlet structure for the 1 in 225 year - existing Floodway are at 237.13 m, however this level upstream of the Inlet carries unacceptable risk to the flood protection works.
6) Water levels in the city for the 1 in 700 year flood - expanded Floodway are controlled at 0.61 m above 7.47 m JAPSD which accounts for either permanent or emergency temporary raising of the Primary Dykes.
7) James Ave. water level for the 1 in 700 year flood - existing Floodway was estimated using the Acres Backwater Model as it more correctly accounts for the overbank flooding that would occur in the city under this condition
8) Refer to Figure 2-1 for existing and expanded Floodway operation rules

Annex 'E'-Water Surface Elevations – Graphical Depictions (19 images)

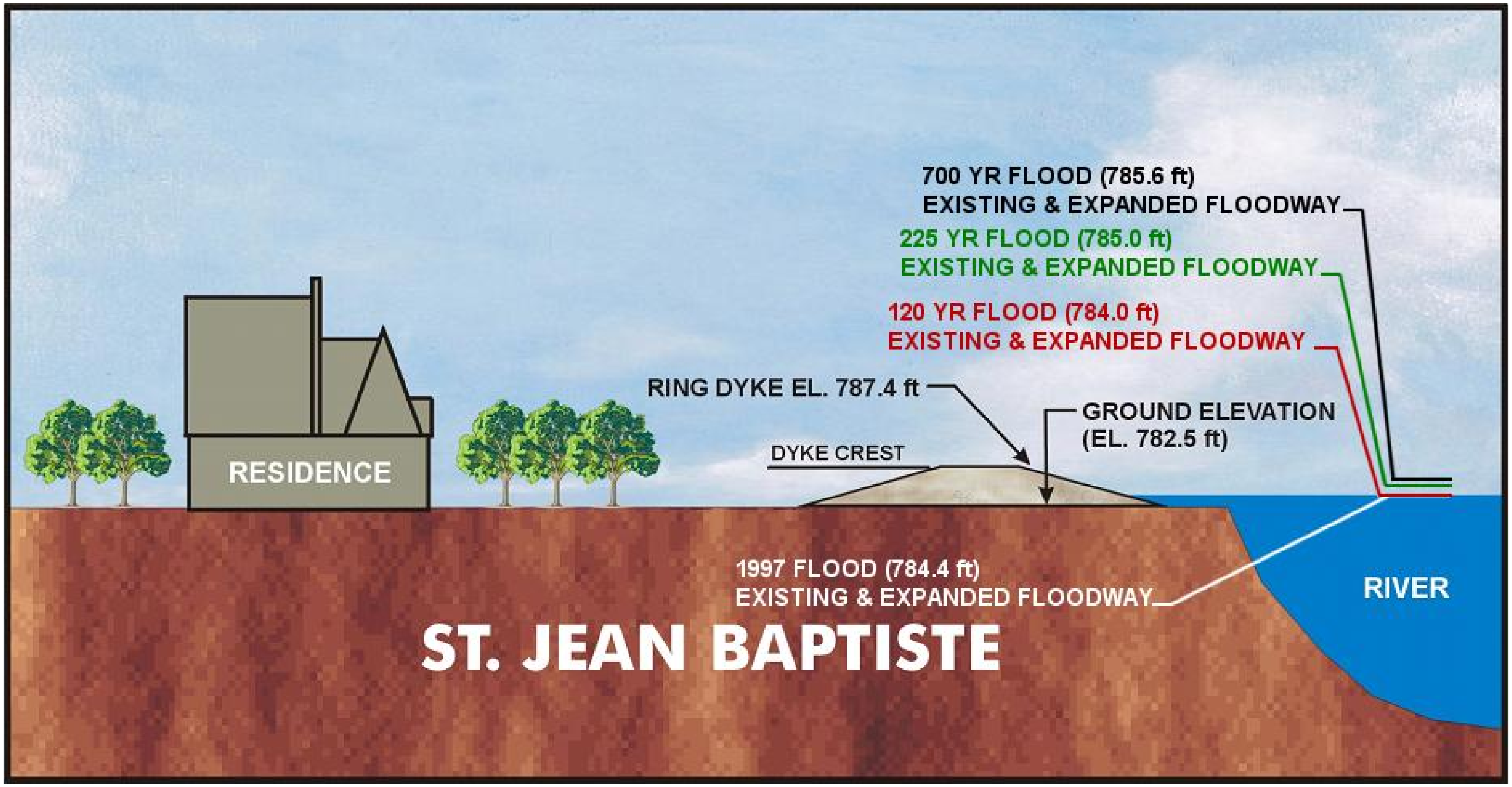
1-emerson.png (938x487x16M png)



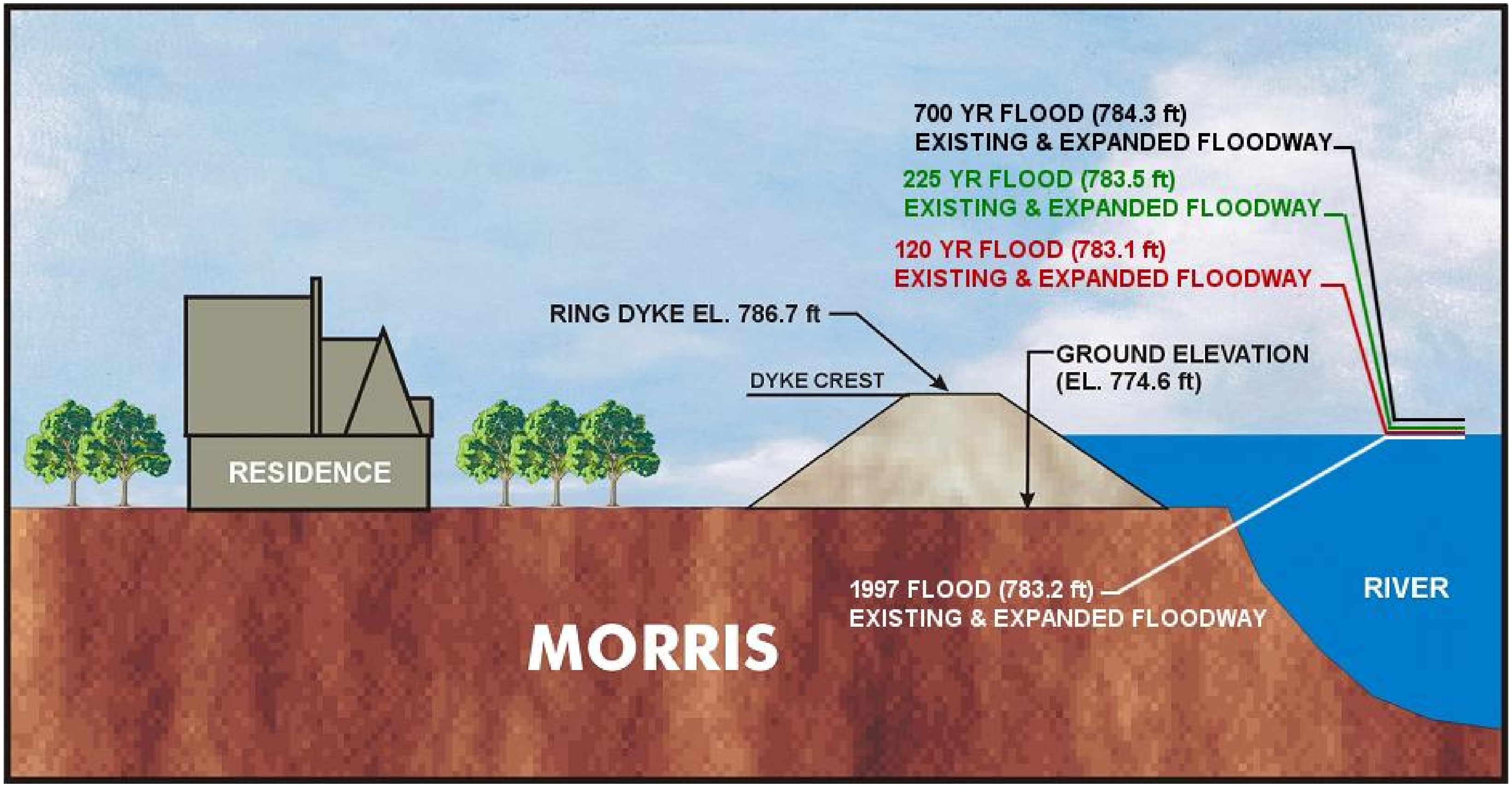
2-letellier.png (938x487x16M png)



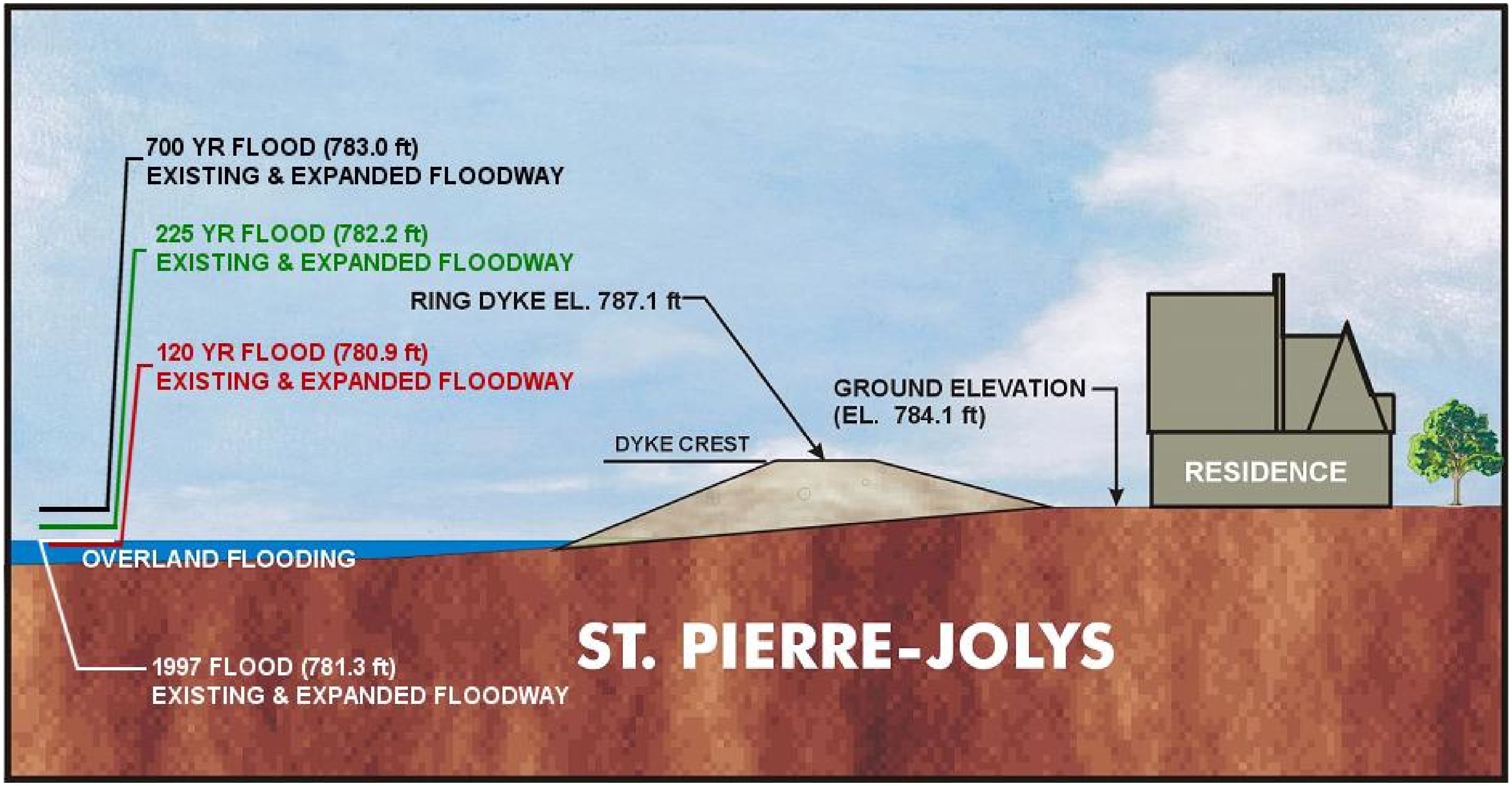
3-st_jean baptiste.png (938x487x16M png)



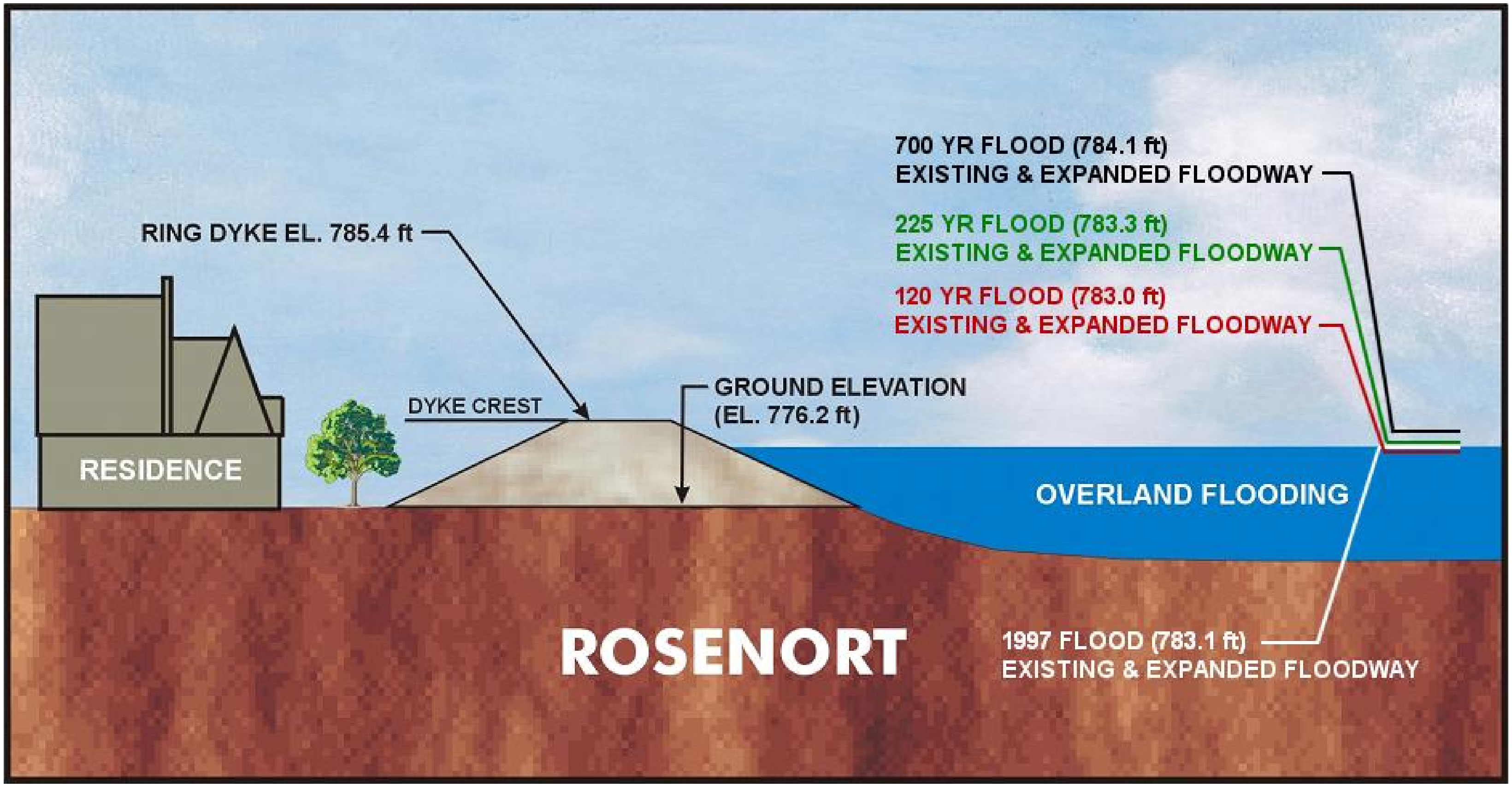
4-morris.png (938x487x16M png)



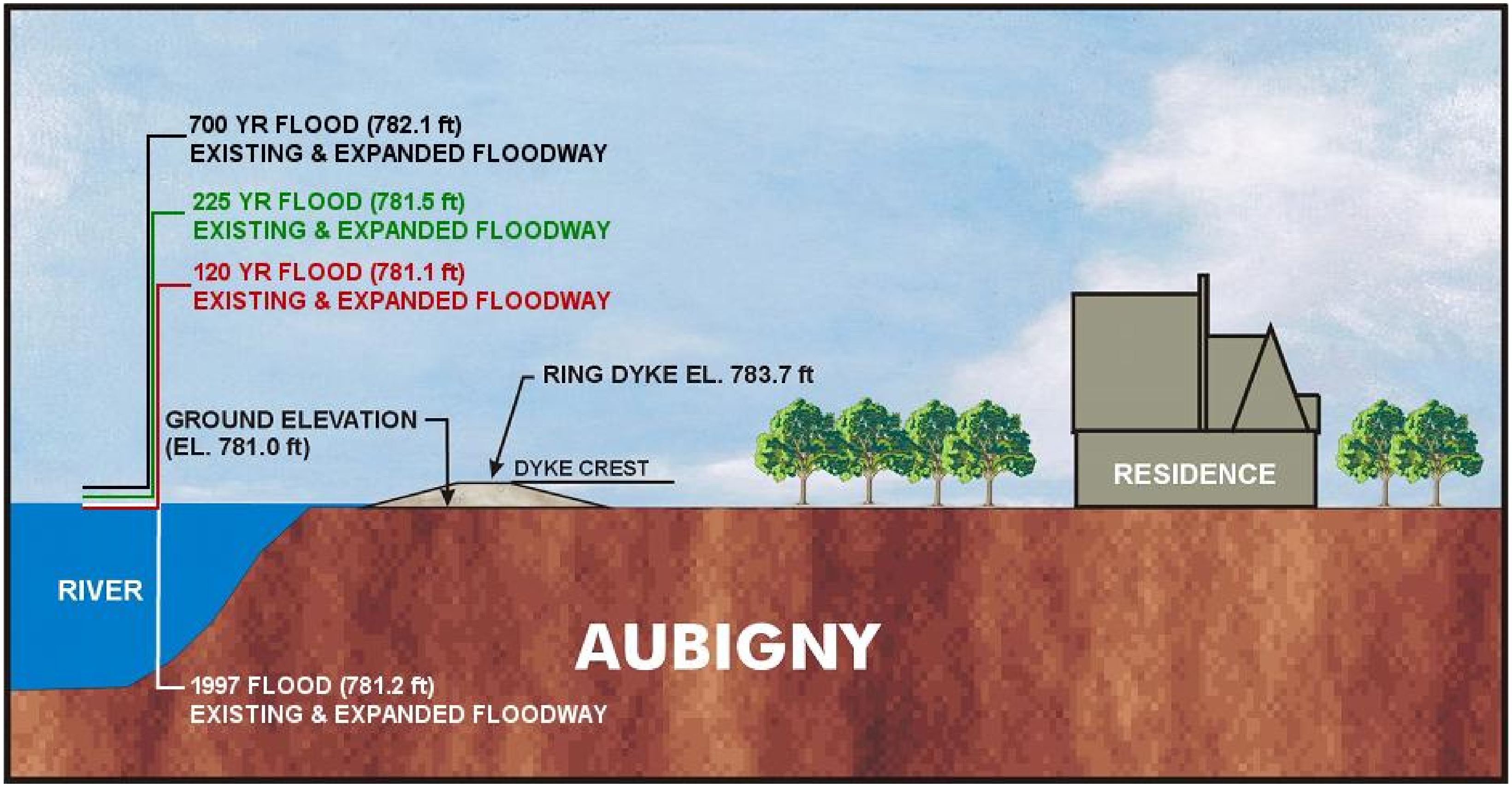
5-st_pierre-jolys.png (938x486x16M png)



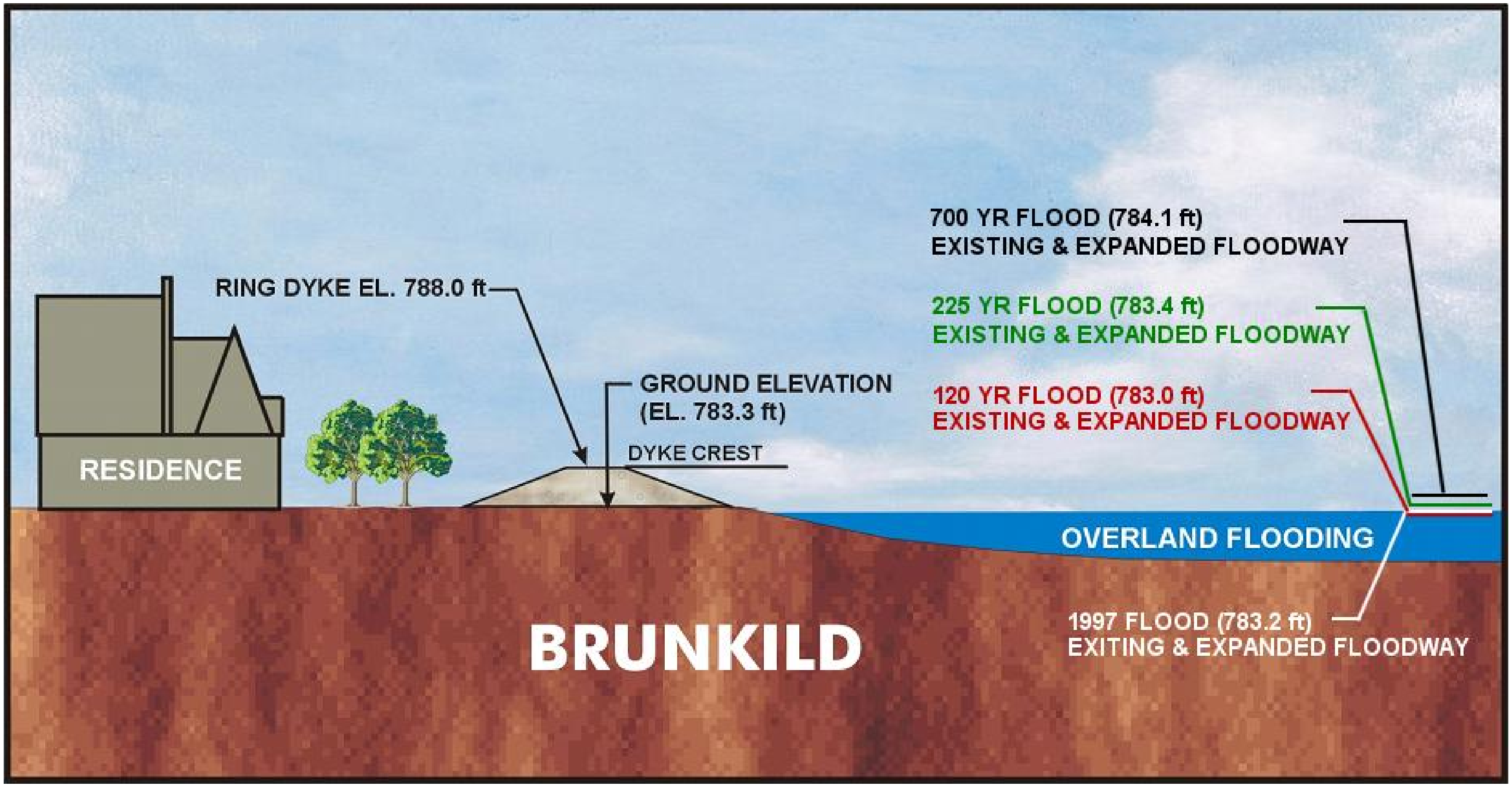
6-rosenort.png (938x487x16M png)



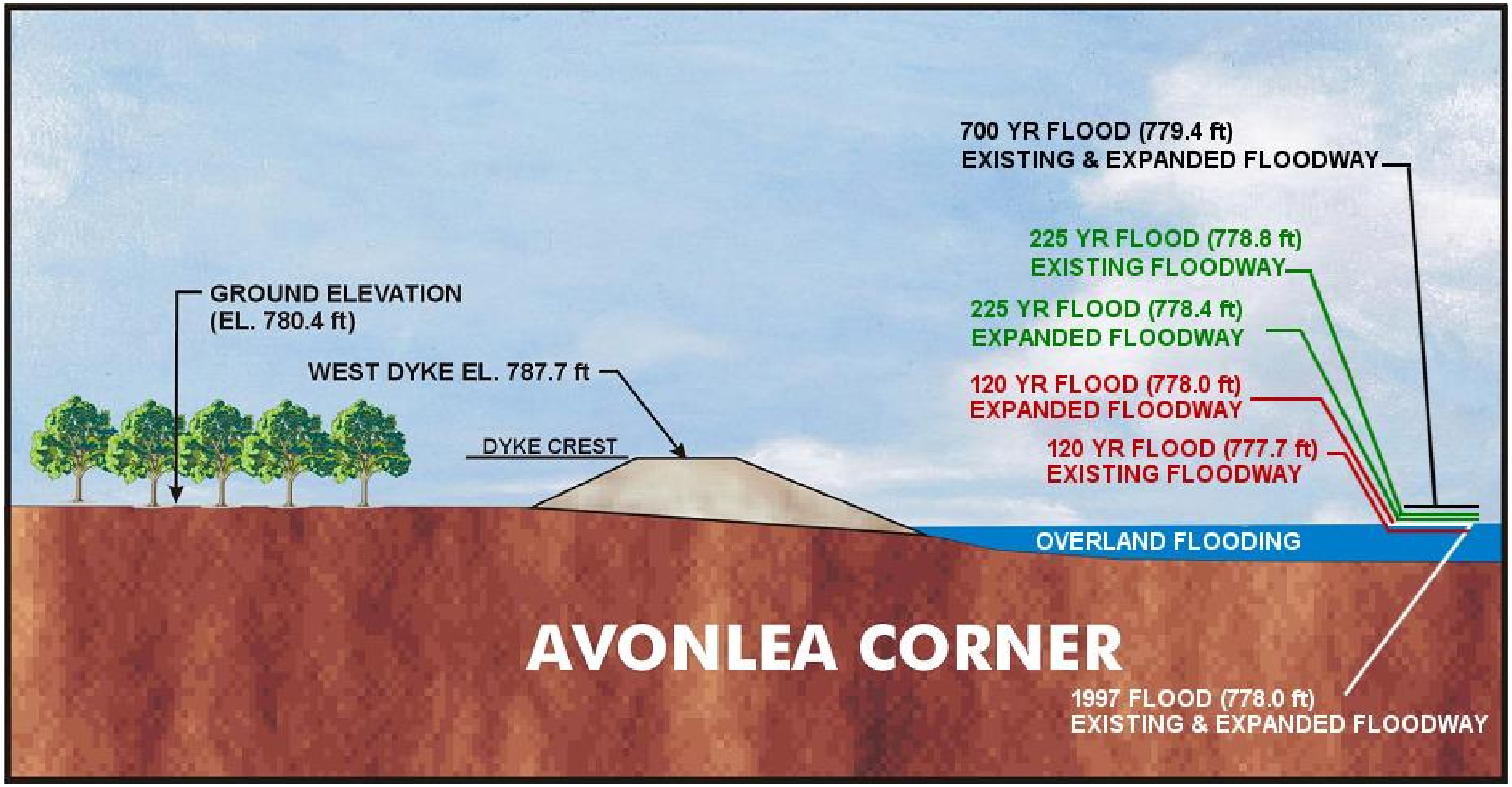
7-aubigny.png (938x487x16M png)



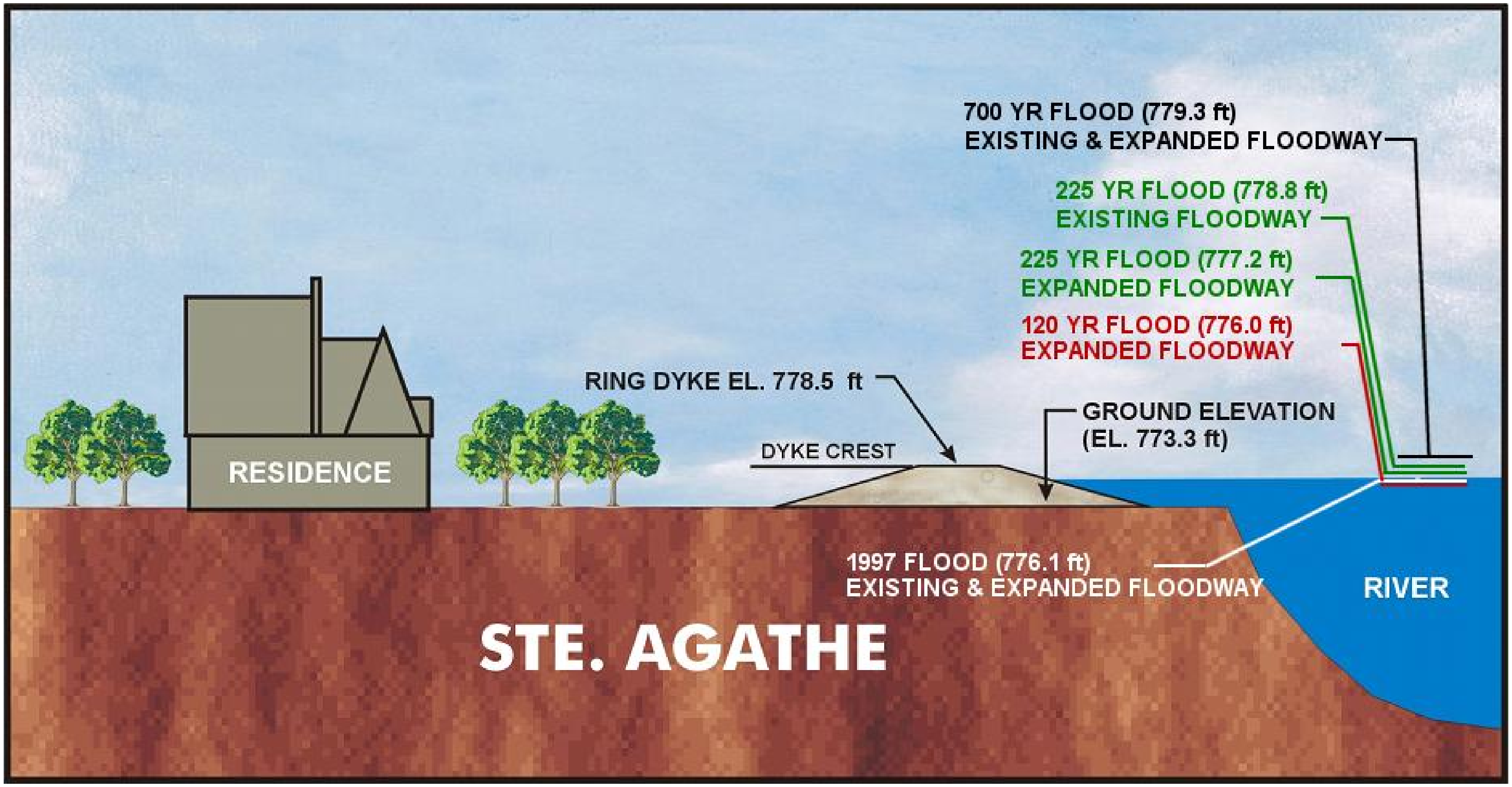
8-brunkild.png (938x487x16M png)



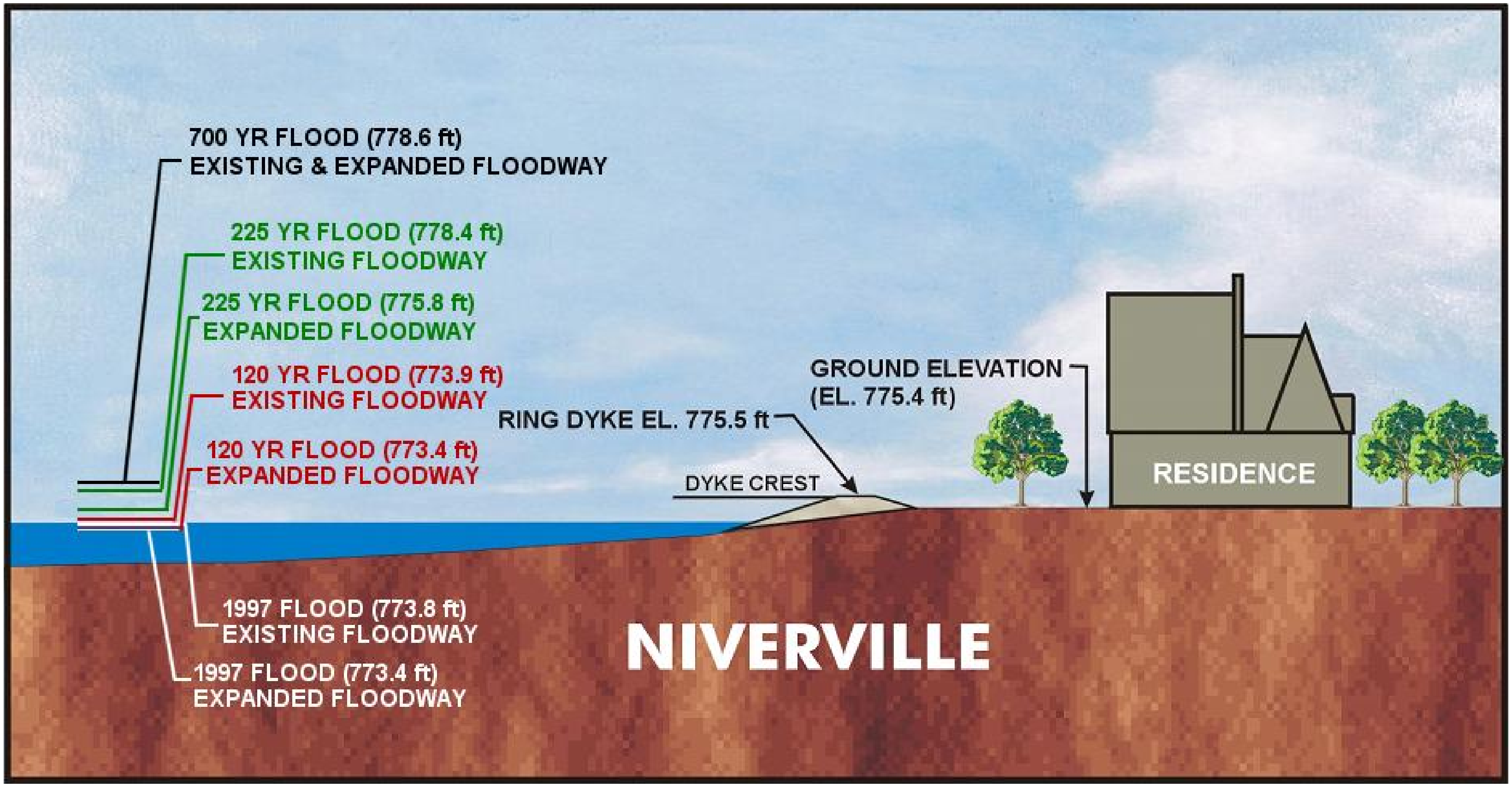
9-avonlea corner.png (938x487x16M png)



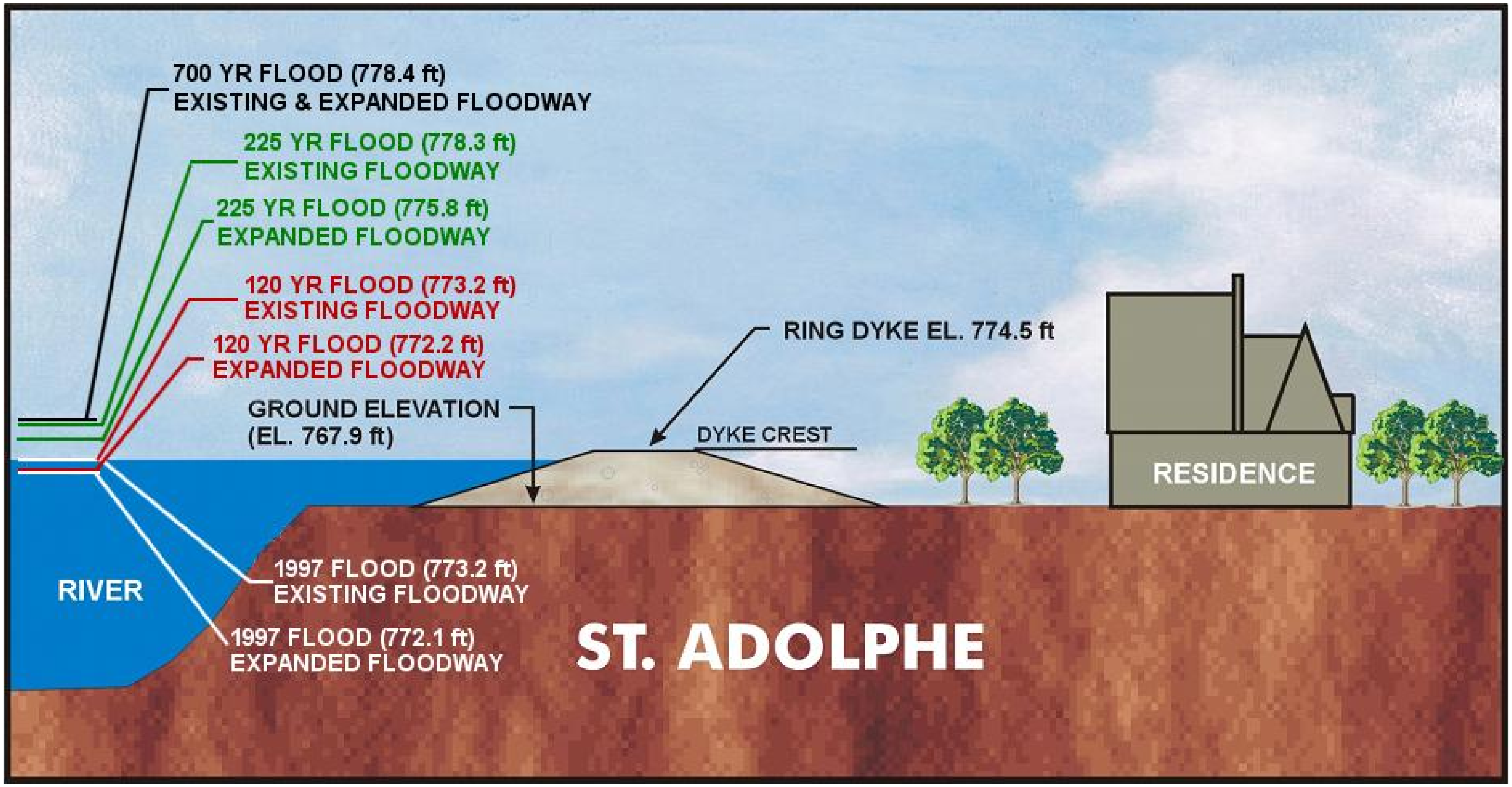
10-st_agathe.png (938x487x16M png)



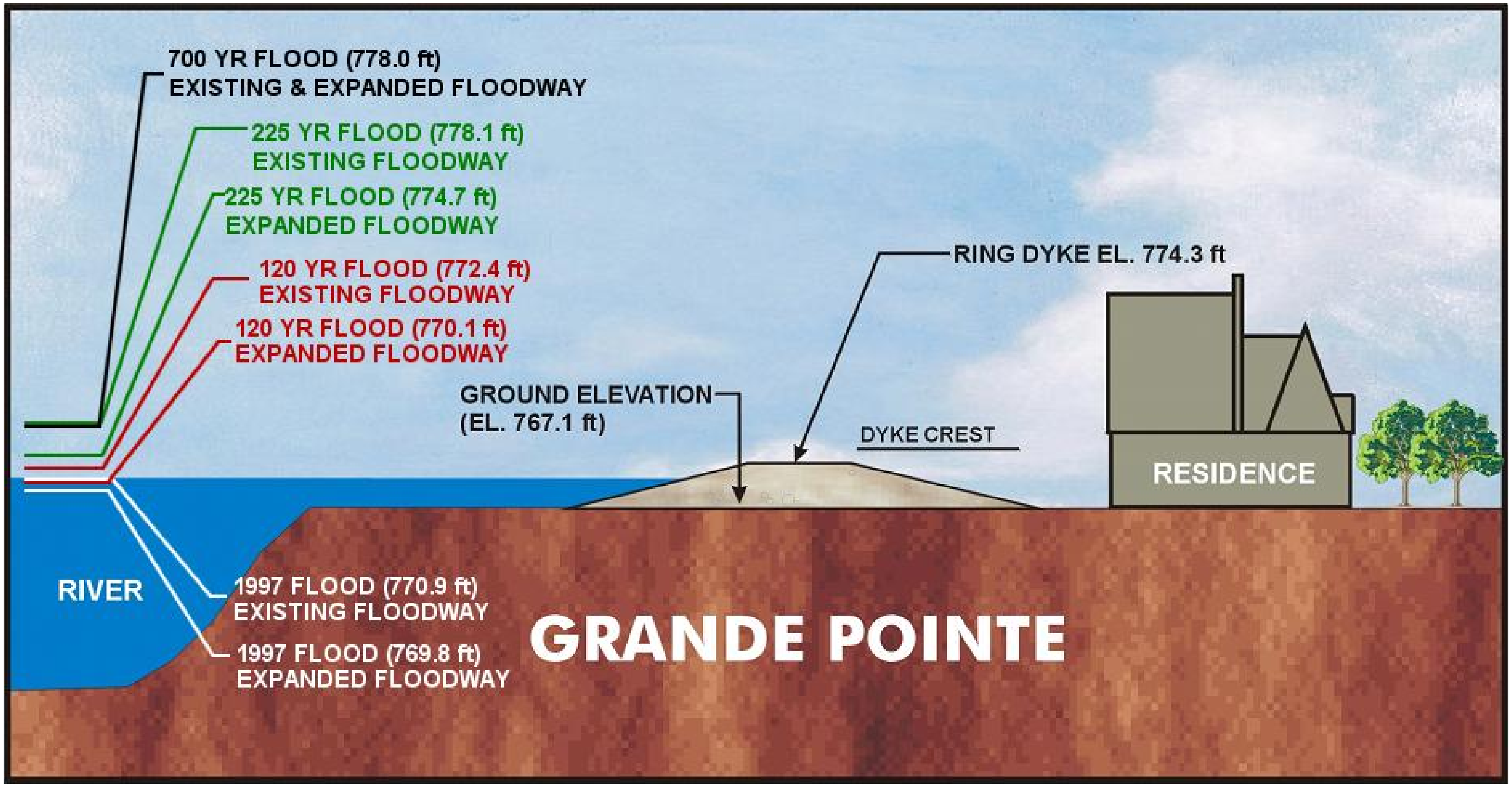
11-niverville.png (938x487x16M png)



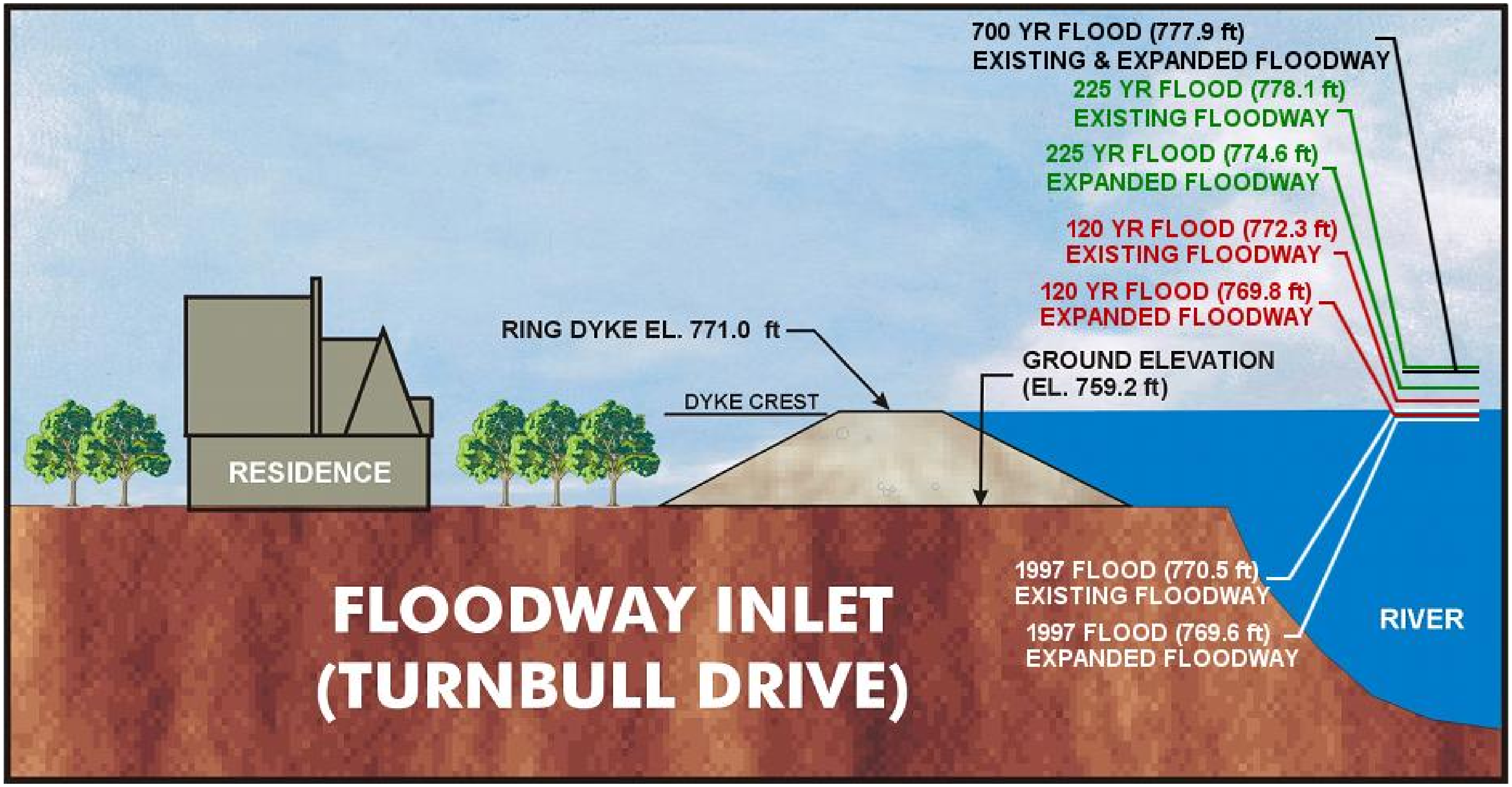
12-st adolphe.png (938x487x16M png)



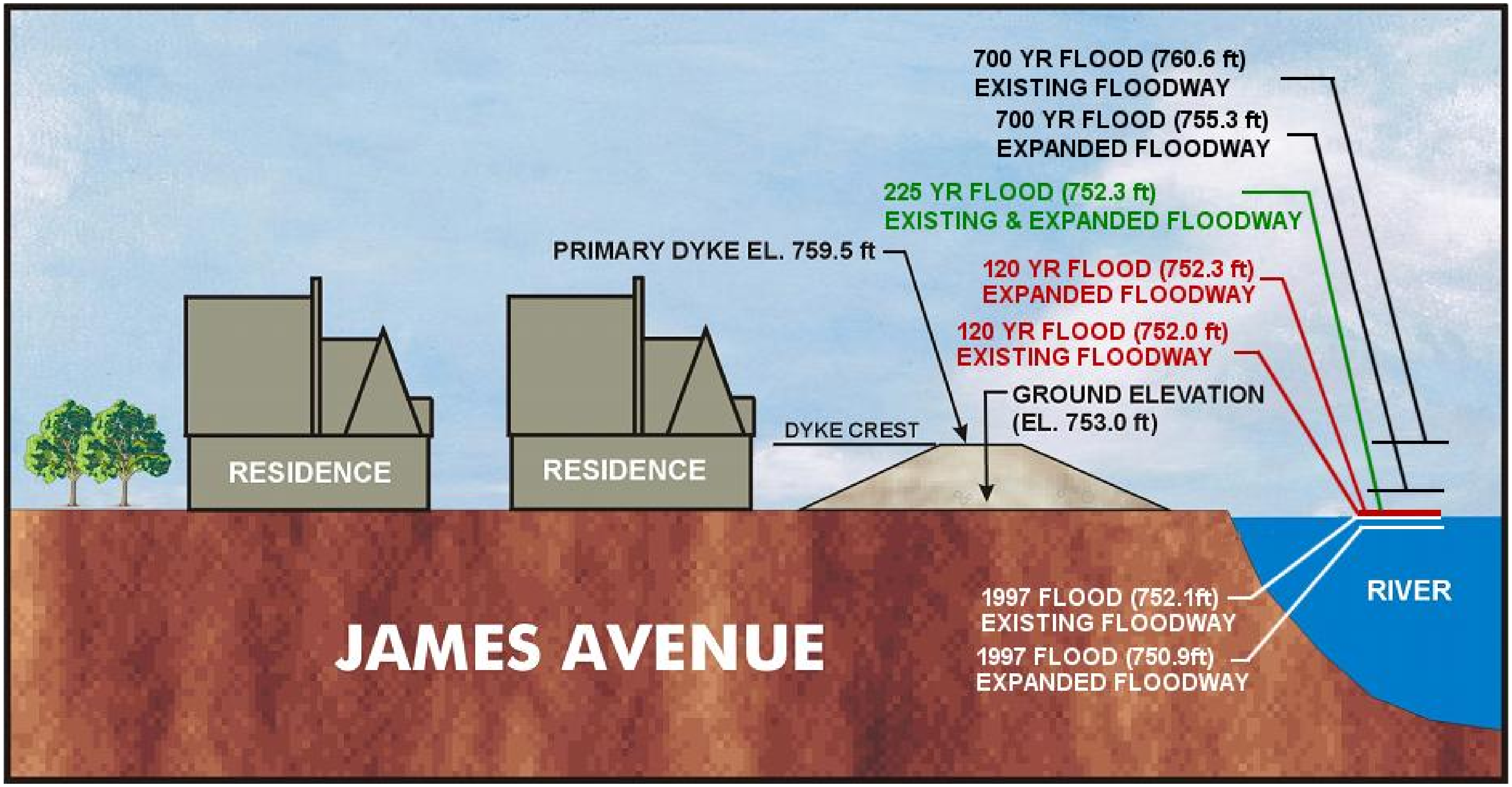
13-grande pointe.png (938x487x16M png)



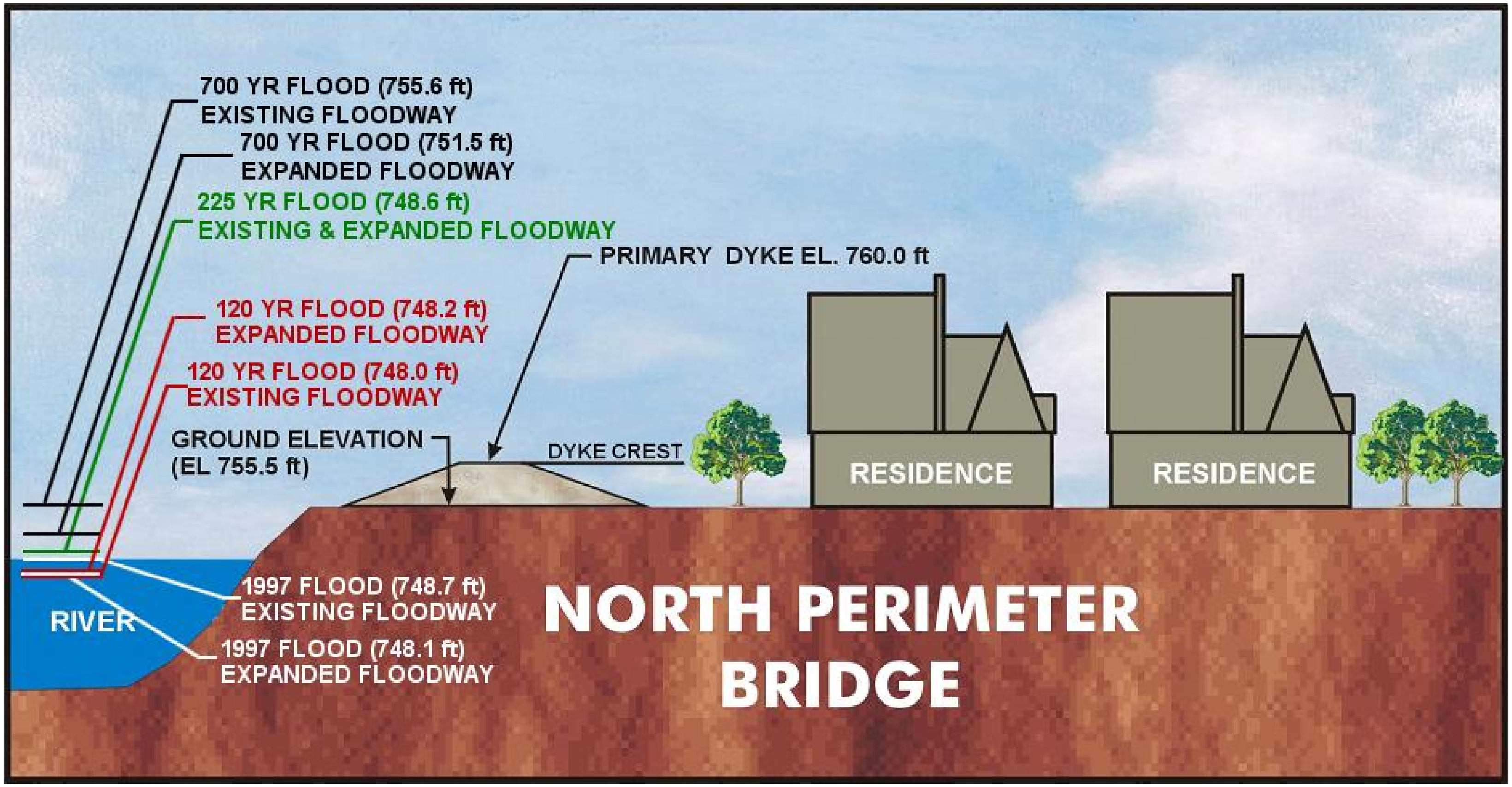
14-floodway inlet.png (938x487x16M png)



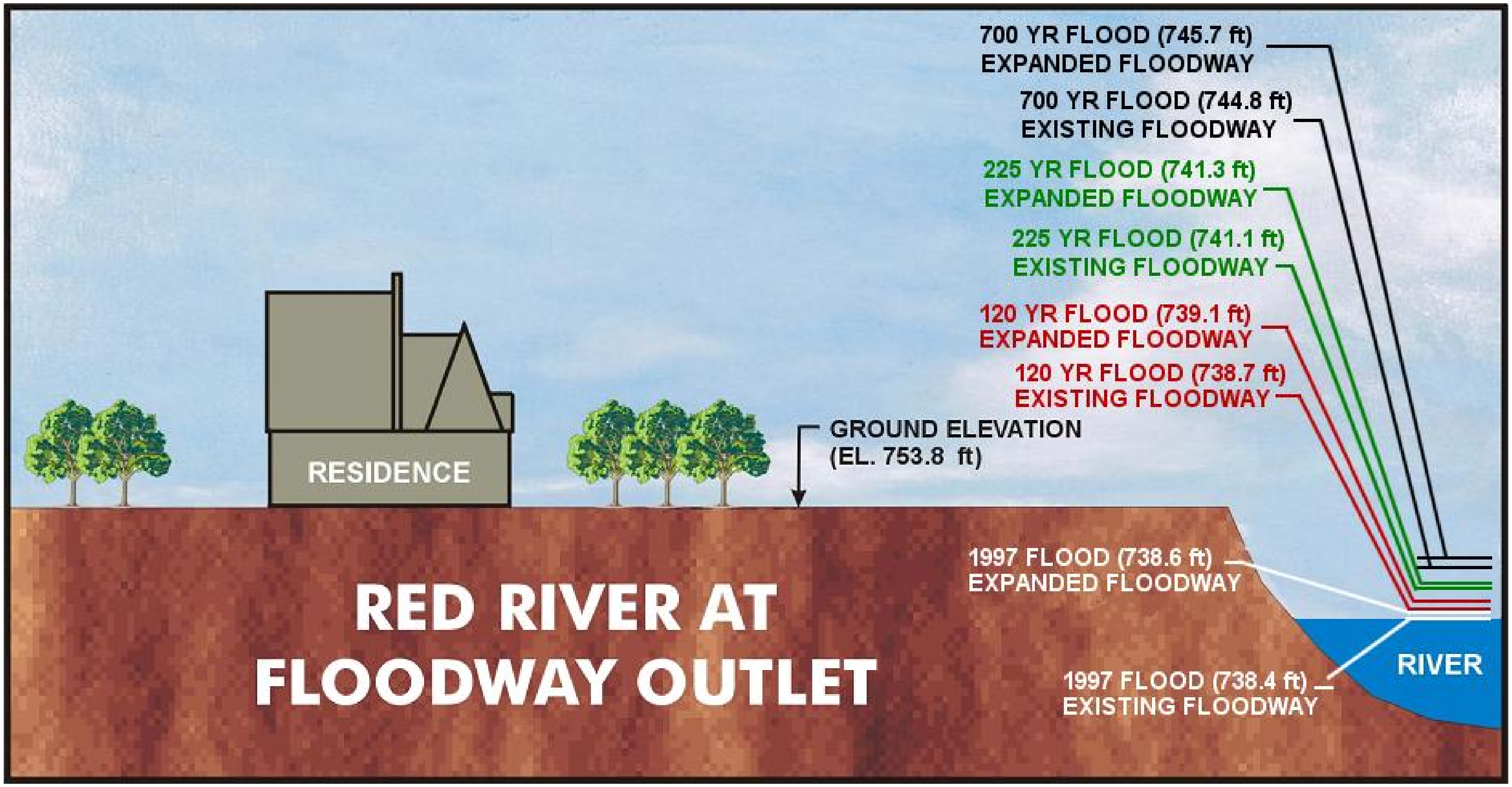
15-james avenue.png (938x487x16M png)



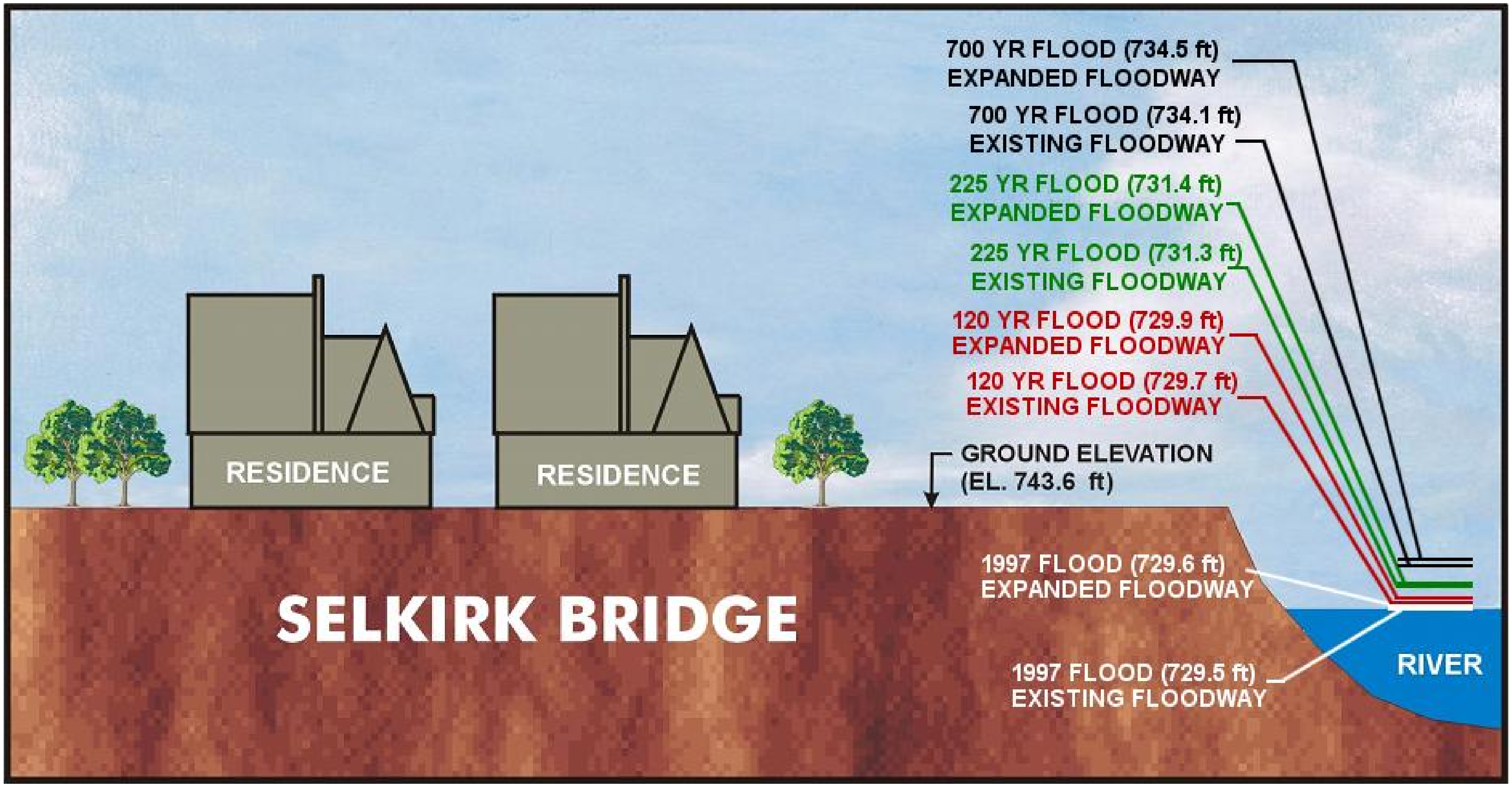
16-north perimeter.png (938x487x16M png)



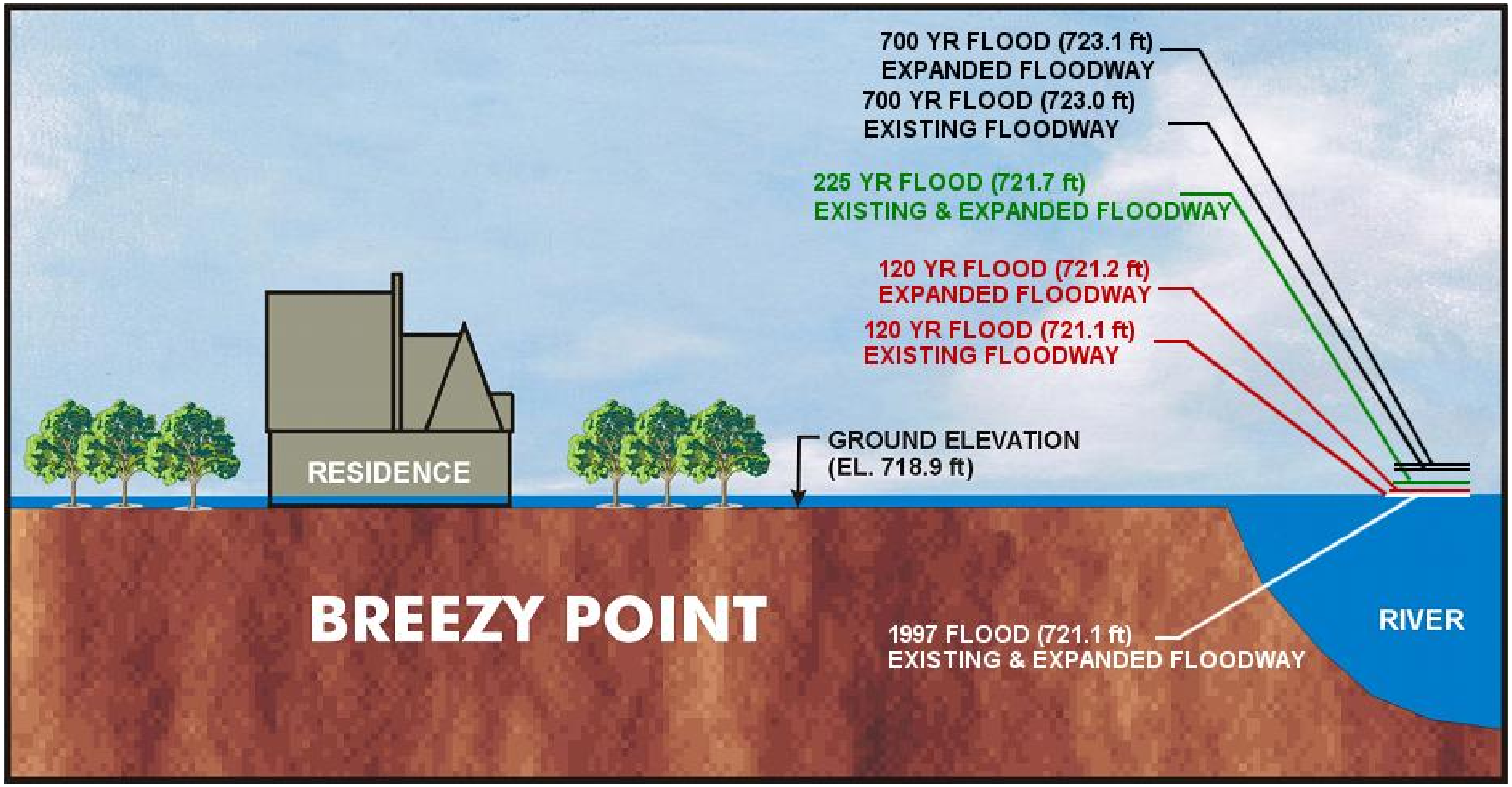
17red river.png (938x487x16M png)



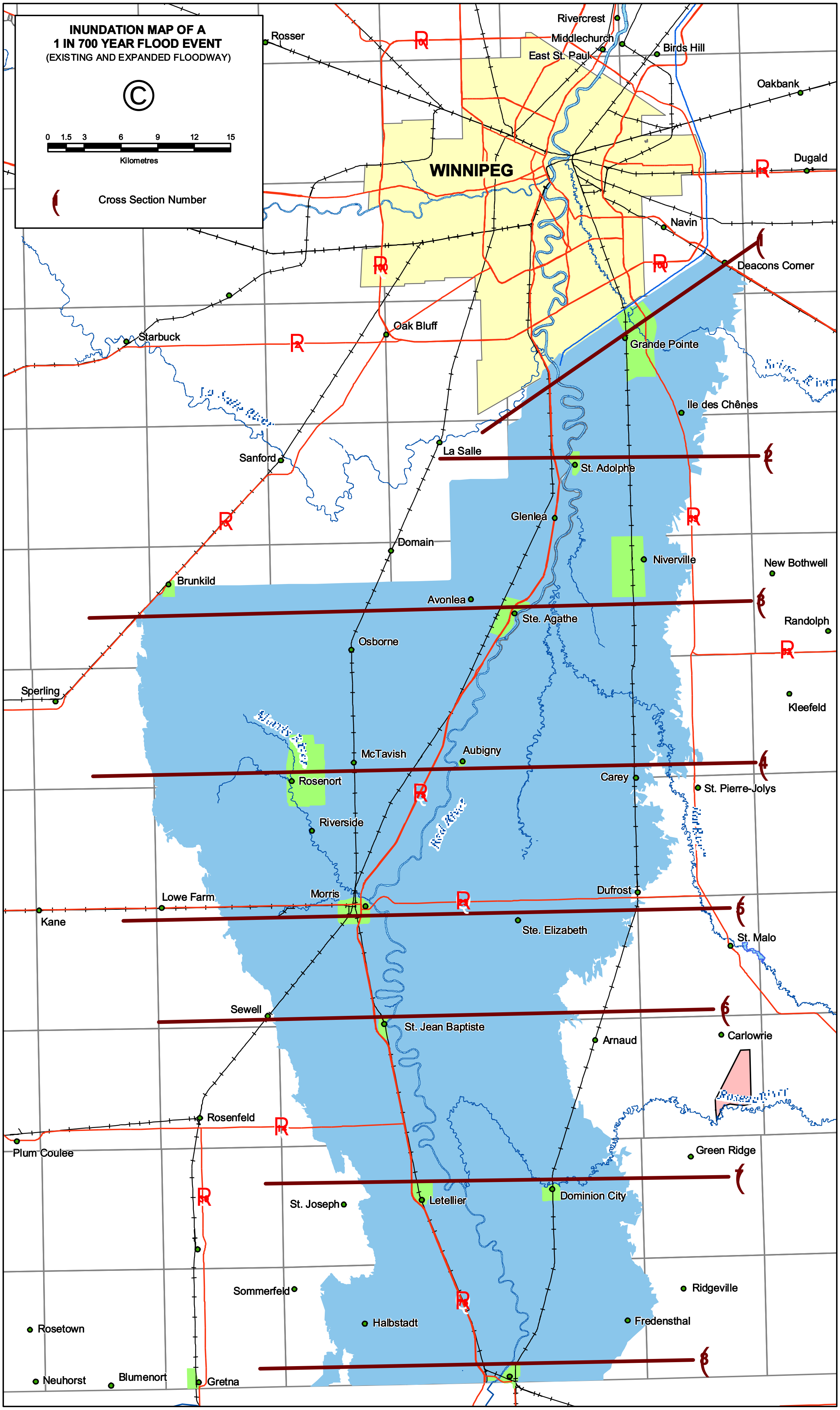
18-selkirk bridge.png (938x487x16M png)

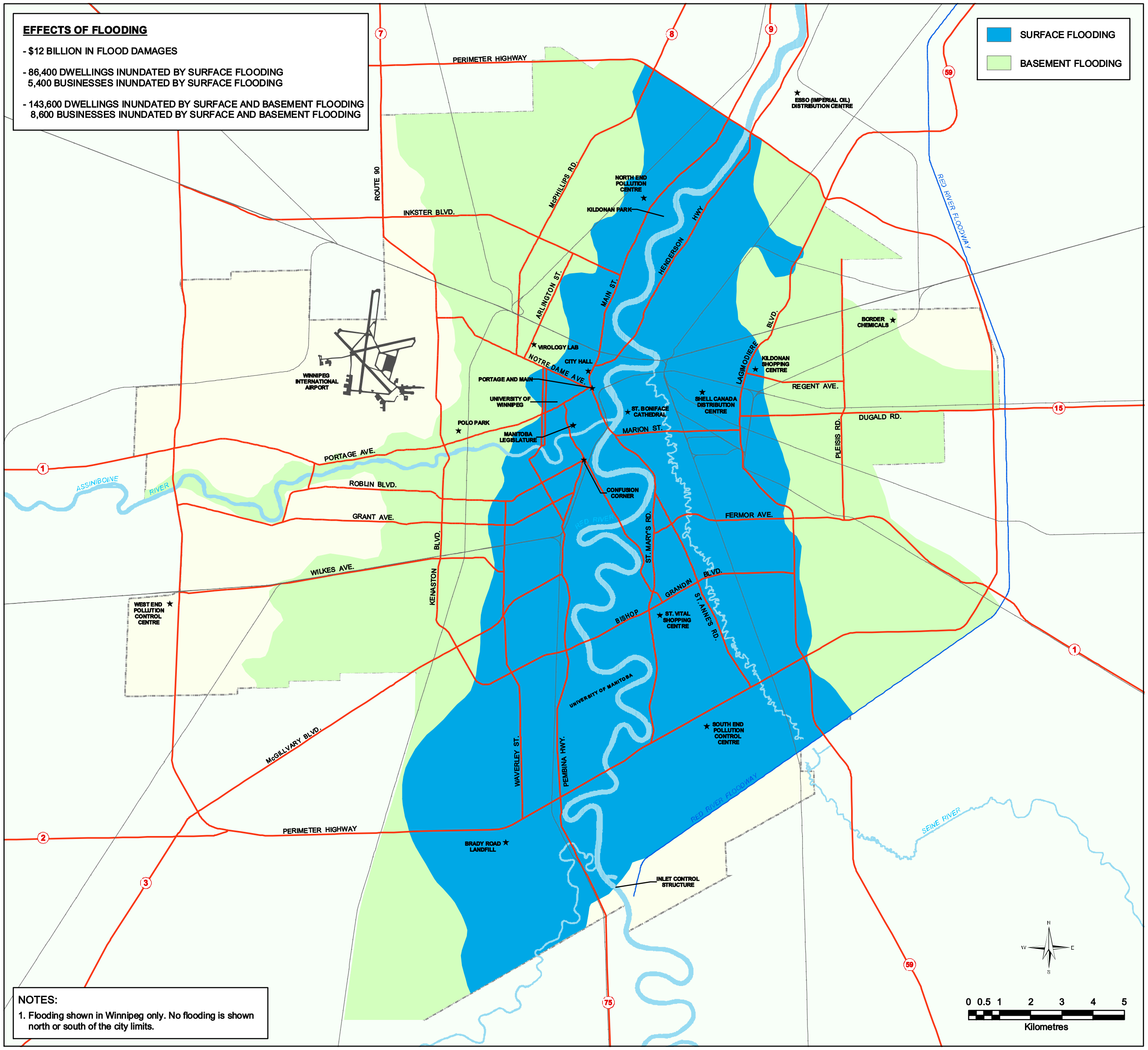


19-breezy point.png (938x487x16M png)



Annex 'F'- Inundation Maps for the 700 Year Design Event (3 pages)

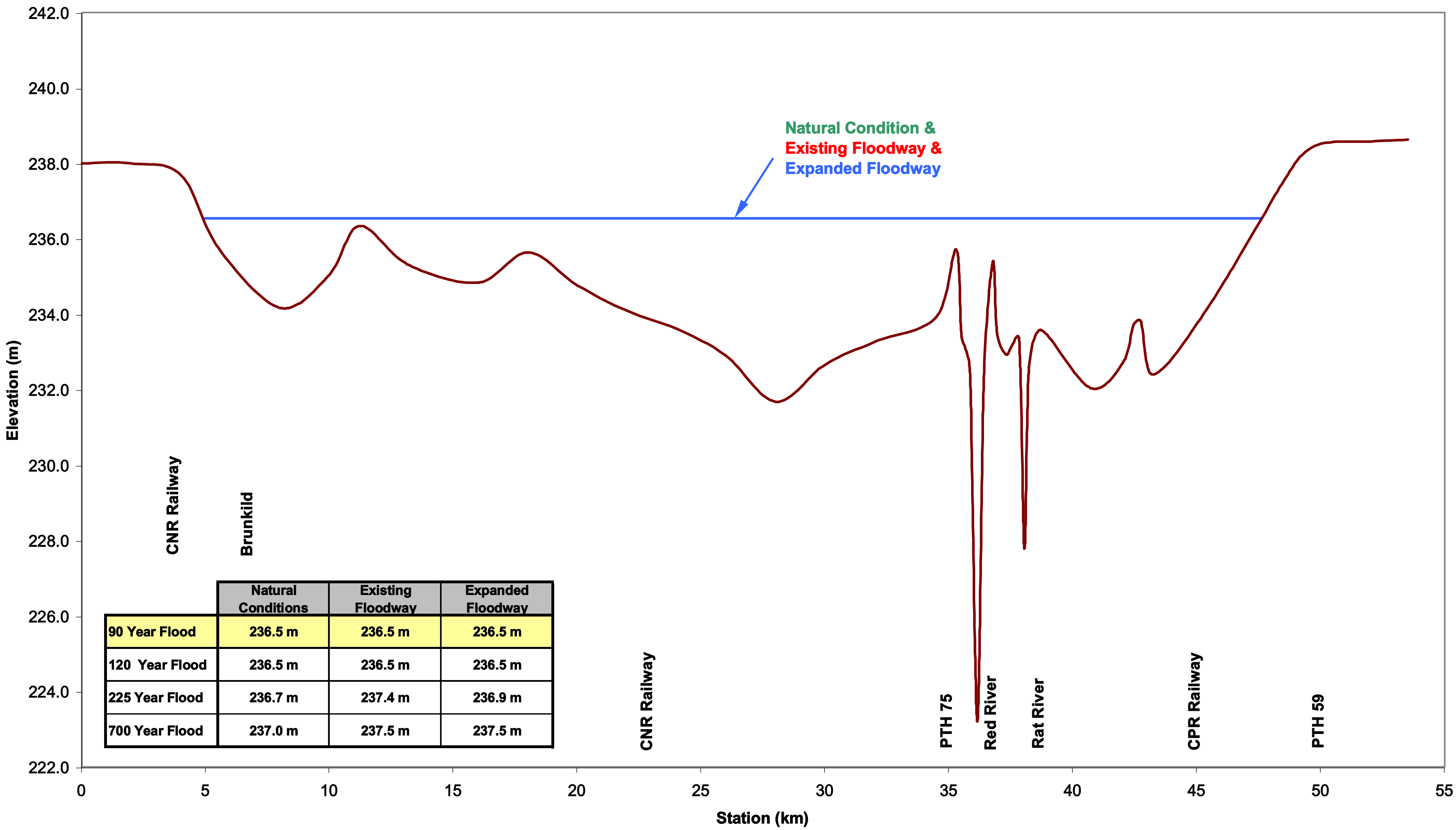

INUNDATION MAP OF A
1 IN 700 YEAR FLOOD EVENT
(EXISTING AND EXPANDED FLOODWAY)
©
0 1.5 3 6 9 12 15
Kilometres
Cross Section Number
WINNIPEG
Rosser
Rivercrest
Middlechurch
East St. Paul
Birds Hill
Oakbank
Dugald
Navin
Deacons Corner
Starbuck
Oak Bluff
Grande Pointe
Ile des Chênes
Sanford
La Salle
St. Adolphe
Glenlea
Domain
Niverville
New Bothwell
Brunkild
Avonlea
Ste. Agathe
Randolph
Osborne
Sperling
Kleefeld
McTavish
Aubigny
Rosenort
Carey
St. Pierre-Jolys
Riverside
Lowe Farm
Morris
Dufrost
Kane
Ste. Elizabeth
St. Malo
Sewell
St. Jean Baptiste
Carlowrie
Arnaud
Rosenfeld
Plum Coulee
Green Ridge
St. Joseph
Letellier
Dominion City
Sommerfeld
Ridgeville
Rosetown
Halbstadt
Fredensthal
Neuhorst
Blumenort
Gretna



EFFECTS OF FLOODING
- $12 BILLION IN FLOOD DAMAGES
- 86,400 DWELLINGS INUNDATED BY SURFACE FLOODING
5,400 BUSINESSES INUNDATED BY SURFACE FLOODING
- 143,600 DWELLINGS INUNDATED BY SURFACE AND BASEMENT FLOODING
8,600 BUSINESSES INUNDATED BY SURFACE AND BASEMENT FLOODING
SURFACE FLOODING
BASEMENT FLOODING
PERIMETER HIGHWAY
ROUTE 90
INKSTER BLVD.
McPHILLIPS RD.
NORTH END POLLUTION CENTRE
KILDONAN PARK
HENDERSON HWY.
MAIN ST.
ARLINGTON ST.
ESSO (IMPERIAL OIL) DISTRIBUTION CENTRE
RED RIVER FLOODWAY
WINNIPEG INTERNATIONAL AIRPORT
VIROLOGY LAB
CITY HALL
NOTRE DAME AVE.
PORTAGE AND MAIN
UNIVERSITY OF WINNIPEG
POLO PARK
MANITOBA LEGISLATURE
ST. BONIFACE CATHEDRAL
MARION ST.
SHELL CANADA DISTRIBUTION CENTRE
LAGIMODIERE BLVD.
KILDONAN SHOPPING CENTRE
BORDER CHEMICALS
REGENT AVE.
DUGALD RD.
PLESSIS RD.
PORTAGE AVE.
ASSINIBOINE RIVER
ROBLIN BLVD.
GRANT AVE.
CONFUSION CORNER
FERMOR AVE.
KENASTON BLVD.
WILKES AVE.
ST. MARY'S RD.
GRANDIN BLVD.
ST. ANNES RD.
BISHOP
ST. VITAL SHOPPING CENTRE
WEST END POLLUTION CONTROL CENTRE
UNIVERSITY OF MANITOBA
McGILLIVARY BLVD.
SOUTH END POLLUTION CONTROL CENTRE
WAVERLEY ST.
PEMBINA HWY.
PERIMETER HIGHWAY
BRADY ROAD LANDFILL
INLET CONTROL STRUCTURE
SEINE RIVER
NOTES:
1. Flooding shown in Winnipeg only. No flooding is shown north or south of the city limits.
0 0.5 1 2 3 4 5
Kilometres

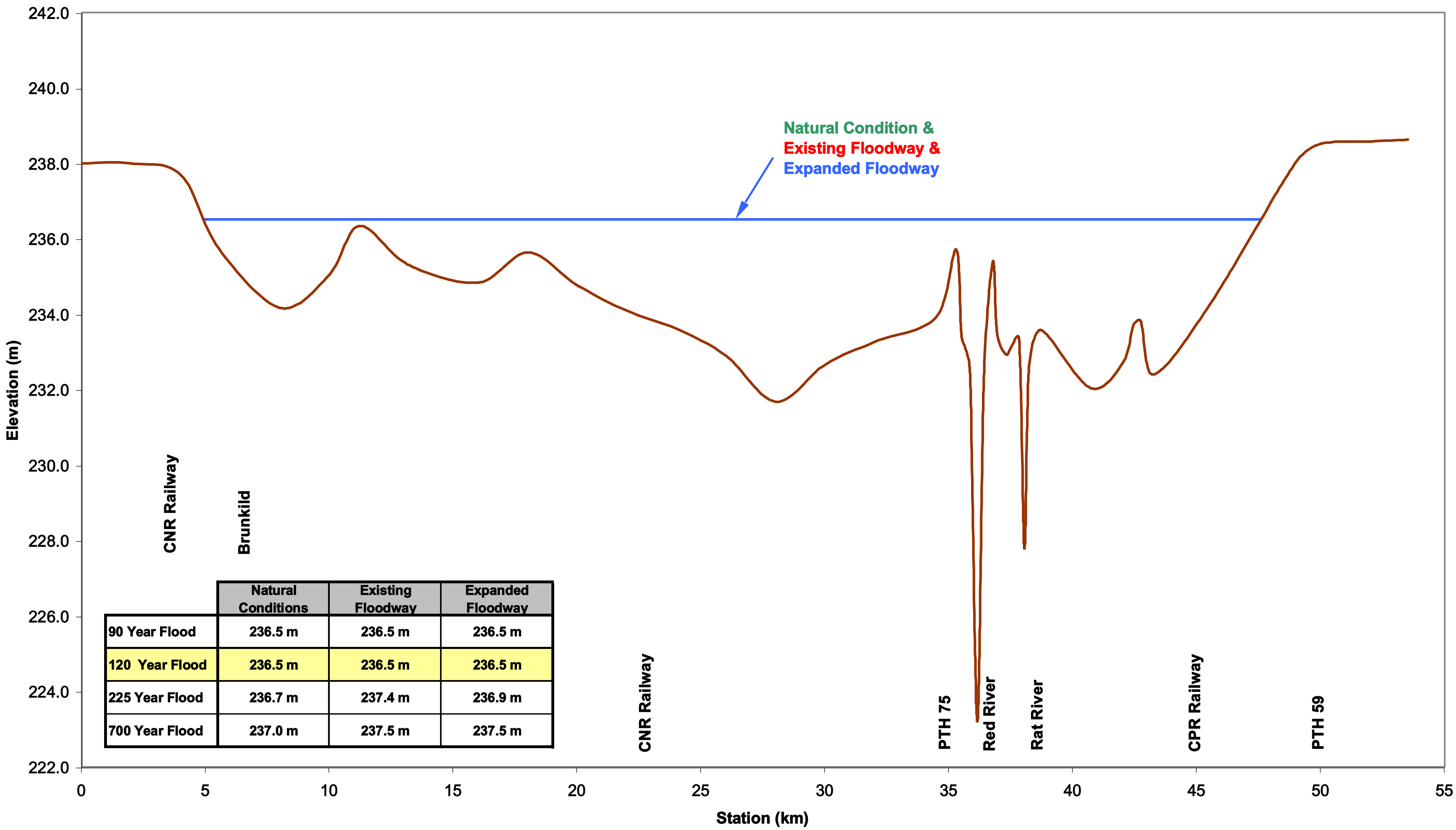
PERIMETER HIGHWAY
INKSTER BLVD.
ROUTE 90
McPHILLIPS RD.
ARLINGTON ST.
MAIN ST.
HENDERSON HWY
NORTH END POLLUTION CENTRE
KILDONAN PARK
ESSO (IMPERIAL OIL) DISTRIBUTION CENTRE
RED RIVER FLOODWAY
WINNIPEG INTERNATIONAL AIRPORT
VIROLOGY LAB
CITY HALL
NOTRE DAME AVE.
PORTAGE AND MAIN
UNIVERSITY OF WINNIPEG
POLO PARK
MANITOBA LEGISLATURE
ST. BONIFACE CATHEDRAL
MARION ST.
SHELL CANADA DISTRIBUTION CENTRE
KILDONAN SHOPPING CENTRE
LAGIMODIERE BLVD.
BORDER CHEMICALS
REGENT AVE.
DUGALD RD.
PLESSIS RD.
PORTAGE AVE.
ASSINIBOINE RIVER
ROBLIN BLVD.
GRANT AVE.
KENASTON BLVD.
CONFUSION CORNER
RED RIVER
FERMOR AVE.
ST. MARY'S RD.
WILKES AVE.
WEST END POLLUTION CONTROL CENTRE
GRANDIN BLVD.
BISHOP
ST. VITAL SHOPPING CENTRE
ST. ANNES RD.
UNIVERSITY OF MANITOBA
McGILLVARY BLVD.
WAVERLEY ST.
PEMBINA HWY.
SOUTH END POLLUTION CONTROL CENTRE
SEINE RIVER
BRADY ROAD LANDFILL
EXISTING FLOODPLAIN
INLET CONTROL STRUCTURE
NOTES:
1. Flooding shown in Winnipeg only. No flooding is shown north or south of the city limits.
0 0.5 1 2 3 4 5
Kilometres

Annex 'G'-Cross-Sectional Representation of Inundation (4 pages)



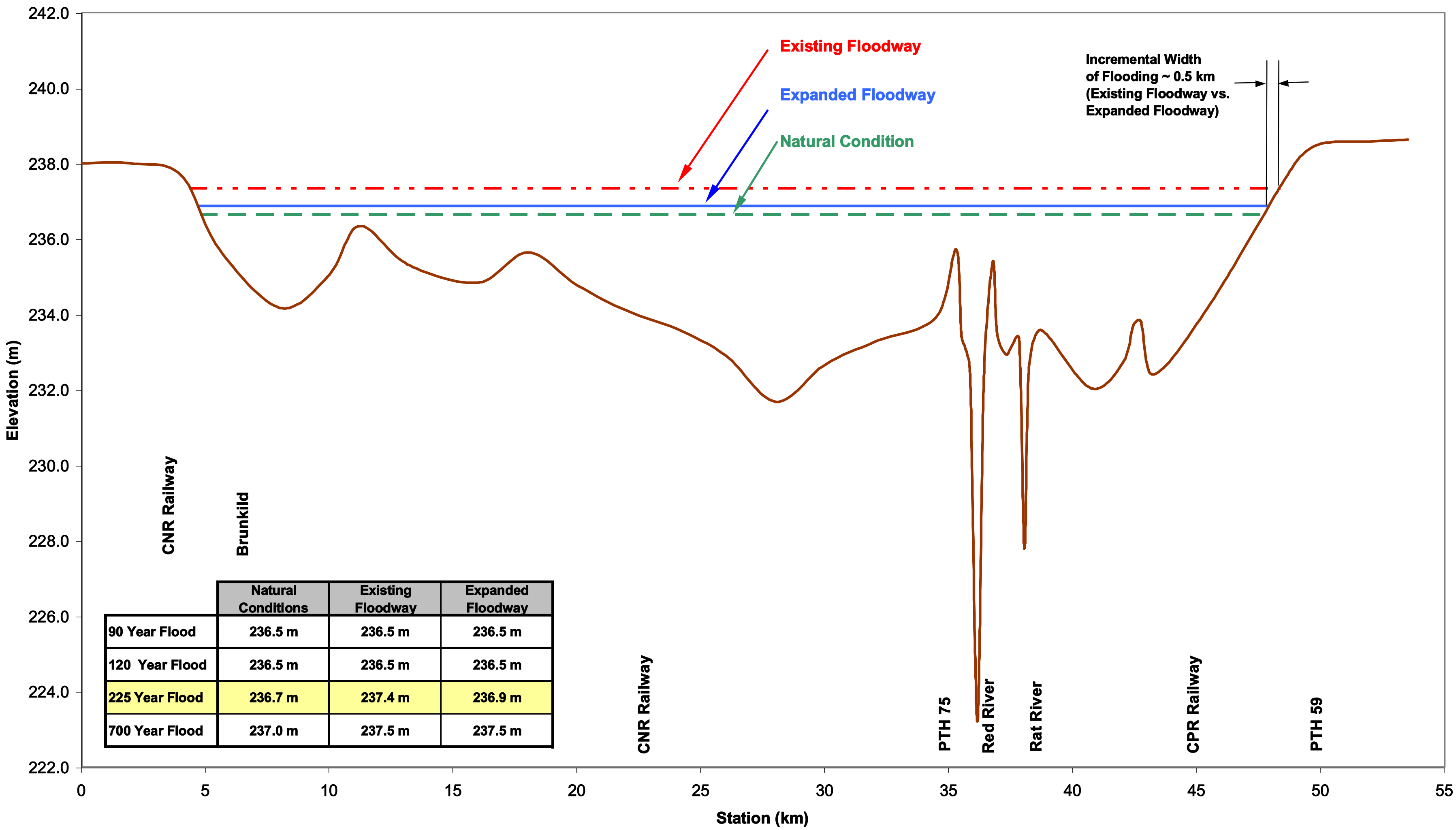
	Natural Conditions	Existing Floodway	Expanded Floodway
90 Year Flood	236.5 m	236.5 m	236.5 m
120 Year Flood	236.5 m	236.5 m	236.5 m
225 Year Flood	236.7 m	237.4 m	236.9 m
700 Year Flood	237.0 m	237.5 m	237.5 m

Cross Section #3
90 Year Flood Event



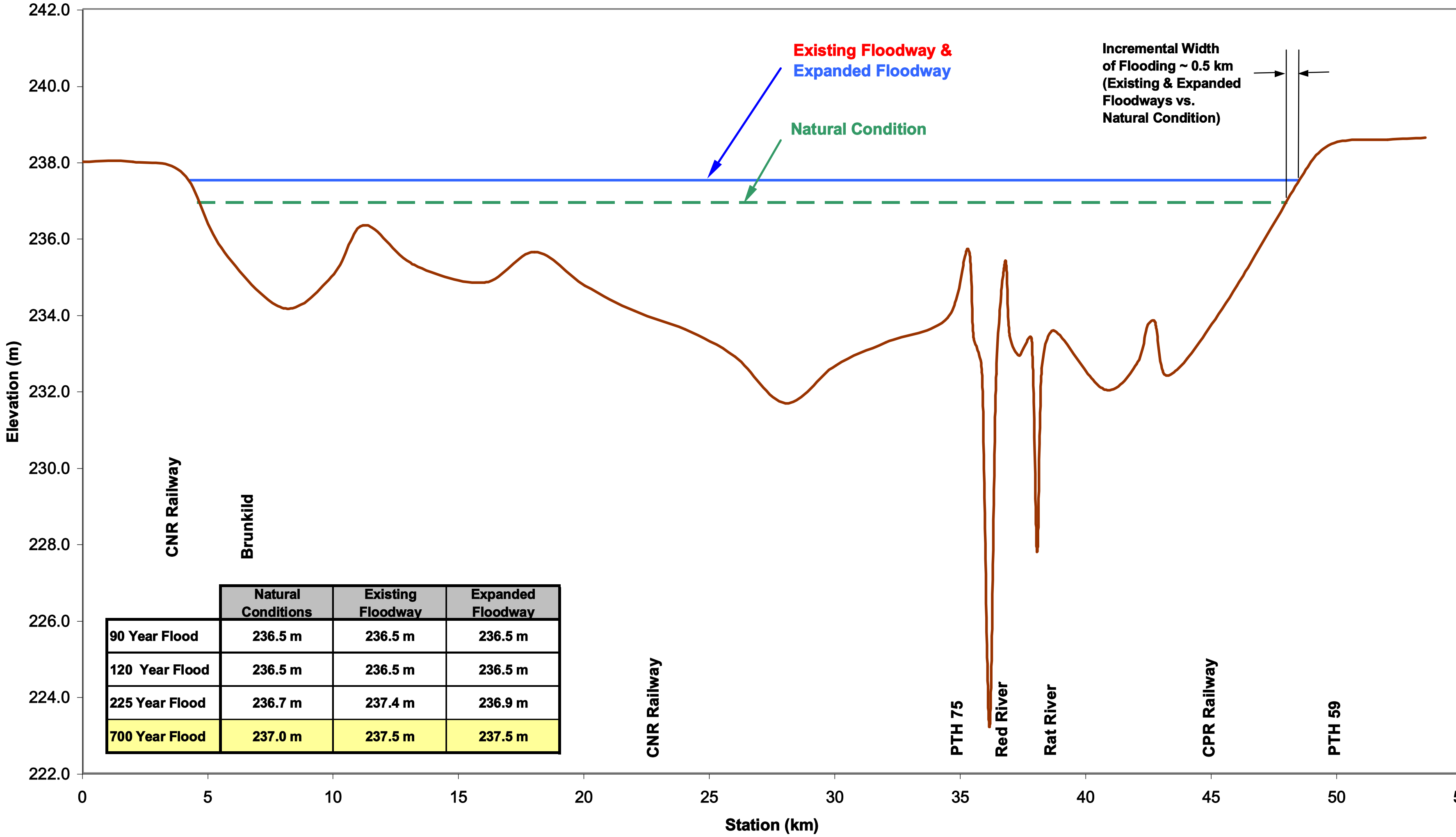
	Natural Conditions	Existing Floodway	Expanded Floodway
90 Year Flood	236.5 m	236.5 m	236.5 m
120 Year Flood	236.5 m	236.5 m	236.5 m
225 Year Flood	236.7 m	237.4 m	236.9 m
700 Year Flood	237.0 m	237.5 m	237.5 m

Cross Section #3
120 Year Flood Event



	Natural Conditions	Existing Floodway	Expanded Floodway
90 Year Flood	236.5 m	236.5 m	236.5 m
120 Year Flood	236.5 m	236.5 m	236.5 m
225 Year Flood	236.7 m	237.4 m	236.9 m
700 Year Flood	237.0 m	237.5 m	237.5 m

Cross Section #3
225 Year Flood Event



	Natural Conditions	Existing Floodway	Expanded Floodway
90 Year Flood	236.5 m	236.5 m	236.5 m
120 Year Flood	236.5 m	236.5 m	236.5 m
225 Year Flood	236.7 m	237.4 m	236.9 m
700 Year Flood	237.0 m	237.5 m	237.5 m

Cross Section #3
700 Year Flood Event

Annex 'H'-Summer Operation Letter and Rule (5 pages)

Manitoba

Deputy Minister of
Water Stewardship

Legislative Building
Winnipeg, Manitoba CANADA
R3C 0V8

November 19, 2004

Mr. Ernie Gilroy
CEO
Manitoba Floodway Authority
200 – 155 Carlton Avenue
Winnipeg MB R3C 3H8

Dear Mr. Gilroy:

As you are aware the department operated the Red River Floodway in the summers of 2002 and 2004 to reduce high river levels in Winnipeg during periods with a significant potential for intense rainfalls. The purpose of these two operations was to reduce the probability of widespread basement flooding and resulting risk to health and damage to property.

Following the 2002 operation, the department commissioned KGS group to study the benefits and impacts of summer operation of the floodway. Their report *"Investigations of the Merits of Management of Red River Summer Water Levels in the City of Winnipeg (November 2003)"* found that benefits exceed the costs associated with a range of emergency summer operation, but recommended that further monitoring be carried out to quantify the impact of summer floodway operation on riverbank stability. The benefit/cost information in the report was used to help make the decision to operate in 2004. A "CD" of the KGS report is enclosed.

The department has also sought approval from Treasury Board to purchase low-lying lands along the Red River south of the Inlet Control Structure that are currently being farmed as market gardens. This has been requested by some of the landowners and is deemed to be a prudent course of action given the unpredictability of extreme precipitation events.

Following the 2004 operation, Water Stewardship also committed to undertake assessments of the impacts of non-spring emergency operations on riverbank stability and on fish and wildlife.

Table 1 summarizes the benefit-cost analysis that supported the decision to operate in July of 2004.

Table 1 Benefits and Costs of Summer Operation in 2004

One Inch Thunderstorm	
Reduced Damages	$14.6M*
Probability	25%
Weighted Benefit	$3.7M
Cost of Compensation	$0.6M
Benefit/Cost Ratio	6:1
Two Inch Thunderstorm	
Reduced Damages	$68M*
Probability	7%
Weighted Benefit	$4.8M
Cost of Compensation	$0.6M
Benefit/Cost Ratio	8:1
*Reduced damages computed from KGS study based on a reduction of the Winnipeg level from a pre-operation level of 15 feet JAPSD.	

This analysis showed that at the time the decision was made there was one chance in four that an intense thunderstorm would develop over the city. It was recognized that operating under these probabilities could result in damage south of the city with no benefits in the city. However, if the thunderstorm did develop the damages prevented by operation would be of such a magnitude that the weighted benefit/cost ratio would be 6:1. A more intense storm would result in an even higher benefit/cost ratio. Therefore, in 2004 the decision was taken to operate the floodway.

Given that there will be circumstances in the future where emergency operation of the floodway may again be necessary to reduce sewer back-up in Winnipeg, the Department has now adopted the attached formal rule governing decisions to carry out such operations.

We have discussed previously your concern respecting the impact of any potential operation of the floodway, outside the rules for the current spring program to prevent overland flooding, on construction of the floodway expansion. Our new rule addresses this concern. Once construction of the expanded floodway is underway, under the parameters of the benefit-cost analysis mandated under the rule, the costs associated with the delayed construction would have to be added to the analysis as shown in Table 2.

Table 2 Benefits and Costs of Summer Operation during Floodway Construction

One Inch Thunderstorm	
Reduced Damages	$14.6M*
Probability	25%
Weighted Benefit	$3.7M
Cost of Compensation	$0.6M
Construction Delay (contractor claims)	$10M
Benefit/Cost Ratio	0.3:1
Two Inch Thunderstorm	
Reduced Damages	$68M*
Probability	7%
Weighted Benefit	$4.8M
Cost of Compensation	$0.6M
Construction Delay (contractor claims)	$10M
Benefit/Cost Ratio	0.5:1
*Reduced damages computed from KGS study.	

Furthermore if the construction delay extends the project into a further year, an additional $30 million in construction costs would result; and an additional $75 million in potential average annual damages associated with an additional year of risk would apply. This analysis shows that there is virtually no possibility of operation to prevent sewer backup during the floodway expansion construction period.

Sincerely,

Norman B. Brandson
Deputy Minister
Manitoba Water Stewardship

Enclosure

Rules for Emergency Operation of the Red River Floodway to Reduce Sewer Backup in Winnipeg

The following shall be added to the Red River Floodway Control Structure Rules of Operation dated December 2000:

Emergency Operation to Reduce Sewer Backup in Winnipeg

4(1) This rule defines the circumstances under which the Minister of Water Stewardship ("the Minister") may determine that emergency operation of the floodway is necessary to prevent widespread basement flooding and resulting risk to health and damage to property within the City of Winnipeg.

4(2) This rule applies after the spring crest from snowmelt runoff at Winnipeg, whenever high river levels substantially impair the capacity of Winnipeg's combined sewer system.

4(3) As long as the Department of Water Stewardship ("the Department") forecasts that river levels for the next 10 days will be below 14 feet JAPSD, the Department will not operate the floodway control structure.

4(4) When the Department forecasts that river levels for the next 10 days are expected to rise to 14 feet JAPSD or higher, the Department will prepare a report that describes:

(a) The basis of the Department's river level forecasts and its risk assessment;

(b) The risk of basement flooding in Winnipeg, including the following factors:

(i) The predicted peak river level in the next 10 days;

(ii) The length of time the Department forecasts the river level will be at 14 feet JAPSD or higher;

(iii) The risk of an intense rainfall event in Winnipeg in the next 10 days;

(c) The benefits and costs of floodway operation, including:

(i) The extent of basement flooding and damage to property expected from various combinations of intense rainfall events and high river levels;

(ii) The risk to the health of Winnipeg residents from sewer back-up;

(iii) Economic loss and damage caused by artificial flooding south of the Inlet Control Structure;

(iv) Impacts of operation on fish and wildlife and their habitat and on water quality;

(v) The risks and potential costs of riverbank instability that may be caused by artificial river level changes, both upstream and downstream of the inlet control structure;

(vi) During construction of the floodway expansion, costs and risks associated with any resulting delays of that construction, including the potential average annual expected damages associated with an additional period of risk of a flood event that would exceed the current capacity of the floodway;

(vii) Such other benefits and costs of operation of which the Department is aware at the time of the preparation of the report, excluding benefits associated with recreational or tourism activities or facilities; and

(d) measures that may be taken to mitigate the costs and impacts of the operation under consideration, including:

(i) minimizing the rate at which river levels are changed both upstream and downstream of the floodway inlet control structure;

(ii) providing means to assure fish passage.

4(5) The Department will consult with the Floodway Operation Review Committee and exchange information on the costs and benefits of operation under this rule before May 15 of each year.

4(6) The Department will not recommend operation of the floodway unless the expected benefits of doing so clearly and substantially outweigh the expected costs.

4(7) The Department will present its report and recommendations to the Minister, who, subject to rule 4(8), will make a decision respecting floodway operation based on his consideration of the report.

4(8) The Department will not operate the floodway control structure under this rule:

(a) to raise river levels immediately upstream of the control structure to an elevation higher than 760 feet above sea level;

(b) to achieve a river level of less than 9 feet JAPSD; or

(c) except in circumstances of extreme urgency, to lower river levels more than one foot per day.

4(9) The Department will issue a news release announcing a decision to operate the floodway at least 24 hours before commencing operation.

4(10) The Department will ensure every reasonable effort is made to personally notify landowners who may be directly affected by flooding due to floodway operation in advance of the operation.

4(11) The Department will sound the horn at the floodway control structure one-half hour before operation commences.

4(12) The Department will maintain a program of compensation for damages suffered by landowners arising from flooding caused by floodway operation under this rule.