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Report to:

Province of Manitoba
Department of Natural Resources
Water Resources Branch

Feasibility Study: Dyking Alternatives for South of the Red River Floodway

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Report to:

Province of Manitoba
Department of Natural Resources
Water Resources Branch

Feasibility Study: Dyking Alternatives for South of the Red River Floodway

APRIL 1998

WARDROP ENGINEERING INC.

971692-05-02

WARDROP Engineering Inc.

Mr. Jim McLean, P.Eng.
Contract Engineer
Manitoba Natural Resources
200 Saulteaux
Winnipeg, MB R3J 3T3

971692-05-02
April 27, 1998

Dear Mr. McLean:

Re: Feasibility Study: Dyking Alternatives for South of the Red River Floodway

Wardrop is pleased to submit our final report for dyking alternatives south of the Red River Floodway.

This feasibility study report documents our investigation to determine the most cost-effective dyking alternative, to protect the existing homes and businesses from a flood event similar to the 1997 Flood.

This study documents feasibility findings including geotechnical and hydraulic concerns, construction cost estimates, flood damage estimates and benefit-costs analysis and the study conclusions and recommendation.

We thank the Steering Committee and Manitoba Water Resources staff for their cooperation and assistance throughout the study.

Sincerely,

WARDROP ENGINEERING INC.

L. Chambers, C.E.T., P.Eng.
Principal and Manager
Civil and Transportation Engineering

LGC/bb

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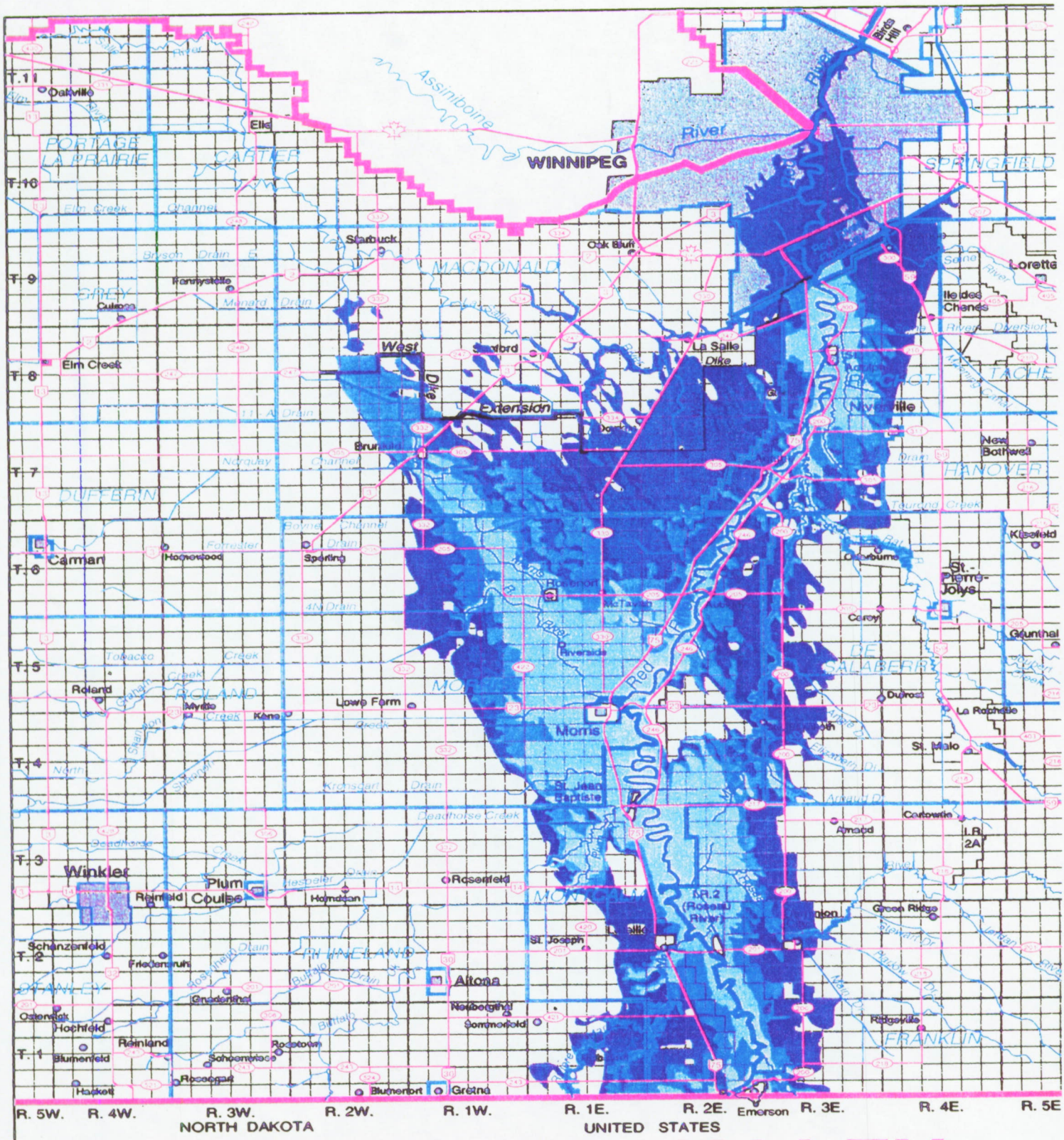

RED RIVER VALLEY

AREAS FLOODED BY THE RED RIVER IN 1950, 1979, 1996 AND 1997

1996
1979
1950
1997

July 15, 1997

Manitoba Natural Resources Water Resources

EXECUTIVE SUMMARY

As a result of the 1997 Flood, the Department of Natural Resources, Water Resources Branch initiated several feasibility studies, as part of the Flood Proofing Program, to find permanent solutions to protect a number of properties immediately south of the Floodway, east of the Red River. Initially, eight alignments were investigated, and reported on. At an Open House presentation, on November 28, 1997, feedback suggested that there were other options that the local and surrounding area residents would like to have investigated.

Three alternatives were investigated for this subsequent Feasibility Study to protect the subject area, which includes Grande Pointe to the east and Richardson Road to the South (see Figure 1). The study area contains approximately 231 homes and 10 businesses.

The three alternative dyke alignments investigated were presented at a second Public Open House, held on March 19, 1998. Feedback from the Open House led the Steering Committee to recommend **Alignment C**: the ***St. Mary's Road & Hallama Drive Community Ring Dykes Alternative*** (See Figure 4) as the preferred dyke alternative. The overriding criteria cited was the perception that Alignment C offers significantly less hydraulic impact.

Under the guidance of the Steering Committee the feasibility study team carried out the following tasks:

- estimated the cost of the various dyke alignment projects;
- determined the Benefit : Cost ratio for the various dyking alignments;
- determined the extent of protection provided to the study area;
- assessed the hydraulic and geotechnical impacts of the assorted dyking alignments; and
- reviewed the impacts of diverting the Seine River at the proposed PTH No. 59.

The study conclusions are summarized below:

Conceptual Alignment	Estimated Project Cost	Benefit : Cost	Property Protected (Homes & Businesses)	Estimated Net Headloss @ St. Adolphe
A	$9,070,000	1.18	224	0.4 ft. or 4 to 5 in.
B	$7,650,000	1.34	222	0.3 ft. or 3 to 4 in.
C	$7,925,000	1.29	221	0.3 ft. or 3 to 4 in.
Constriction alone				0.25 ft. or ≈ 3 in.

A special note regarding the Benefit : Cost calculation: The Benefit calculation (damage) does not include intangible costs such as cost for volunteers, the Canadian Army, Manitoba Highways and Transportation, City of Winnipeg, Manitoba Water Resources, Red Cross, loss of income, and so on.

The Steering Committee, after public consultation, recommends proceeding to environmental review, detailed surveys, Right-of-way plans, land acquisition, final design and construction of Alignment C.

The Steering Committee based their decision on the following major criteria:

- Public response
- Best fit solution for stakeholders
- Perceived negative impacts of the project (hydraulic, social, economic)
- Cost.

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The Wardrop Engineering Study Team acknowledges with appreciation, the contributions of the individuals consulted during the course of this Report, particularly:

- Councillor John Angus, City of Winnipeg
- Mr. Steve Topping, Water Resources
- Mr. Jim McLean, Water Resources
- Mr. Alf Warkentin, Water Resources
- Mr. John Atkins, Steering Committee Chairman
- Mr. Doug McNeil, City of Winnipeg, Steering Committee Member
- Mr. Eugene Whitney, R.M. of Ritchot, Steering Committee Member
- Mr. Ed Zylema, Community Resident
- Mr. Doug McMahon, P.Eng., Manitoba Highways and Transportation
- Mr. Tim Lock, P.Eng., Manitoba Highways and Transportation
- Mr. Ron Richardson, P.Eng., Manitoba Highways and Transportation
- The Council for the R.M. of Ritchot

1.0 INTRODUCTION

1.1 STUDY BACKGROUND AND OBJECTIVES

As a result of the 1997 Flood, the Department of Natural Resources, Water Resources Branch initiated several feasibility studies, as part of the Flood Proofing Program, to find permanent solutions to protect a number of homes in southern Manitoba.

This Feasibility Study expands the investigation that initially investigated eight different dyke alignments and culminated in the Wardrop Engineering Inc. October report "Feasibility Study: Dyking Alternatives for South of the Red River Floodway. This subsequent part of the Feasibility Study has narrowed its focus and considers three alignments, including one alignment from the first report and two new dyke alignments, to protect the Study Area (see Figure 1). Figures 2 to 4 show the three conceptual dyke alignments. The study area contains approximately 231 homes and small businesses and 10 large businesses.

This Feasibility Study investigated the various dyke alignments with respect to the estimated project costs, their Benefit : Cost ratio, the potential hydraulic and geotechnical impacts, the extent of protection provided to the study area and some of the potential impacts of diverting the Seine River at Proposed PTH No. 59.

The study focuses on the 1997 flood event and specifically the 1997 flood level and flow, as recorded by Manitoba Water Resources Branch (elevation 771.5 ft. and flow of 138,000 cfs upstream of the floodway inlet). The level of protection designated by Manitoba Water Resources Branch, is the 1997 flood elevation plus two (2) ft.

This report documents the data collected, feasibility study findings including geotechnical and hydraulic concerns, comments on dyke construction practices, project cost estimates, flood damage estimates, benefit/cost analysis, the study conclusions, and the steering committee's recommendations.

1.2 PROPOSED DYKE ALIGNMENTS

Three distinct community dyke alignments were investigated in this feasibility study. For comparison purposes, we have included a construction cost estimate for individual flood proofing for the entire study area.

1.3 STUDY METHODOLOGY AND ORGANIZATION

1.3.1 Project Meetings

A project initiation meeting for the initial study was held with the Steering Committee on September 3, 1997.

An Open House to present the findings from the first feasibility investigation was conducted in November, 1997. At this event, it was suggested that other alignments be investigated.

A follow-up meeting was held with Manitoba Water Resources personnel on January 30, 1998. The informal meeting provided a forum to report on work to-date, and reaffirm previously set project priorities, and to reiterate the concerns of the Government of Manitoba, the City of Winnipeg, and the R.M. of Ritchot.

1.3.2 Data Collection

Data collection involved gathering maps, hydrometric data, previous reports, on-site inspections and interviews with local residents, and consultation with Manitoba Highways and Transportation and Manitoba Water Resources Branch. In addition, aerial photographs both before and at the peak of the 1997 flood were reviewed. A list of references is in this report.

1.3.3 Site Inspection

A project site inspection was held on Sunday, September 7, 1997, for the previous report, with the following parties represented:

- The City of Winnipeg
- Manitoba Water Resources Branch
- Steering Committee for Dykes South of the Red River Floodway
- Wardrop Engineering Inc.

During the on-site visit, conceptual dyke alignments were examined. Following this, a subsequent site visit was arranged for September 11, 1997.

For this second tour, the following parties were represented:

- Steering Committee for Dyking South of the Red River Floodway
- Wardrop Engineering Inc.

Following this second visit, several additional trips were made to the site to verify the number of existing homes and businesses, including those that have either been raised or have constructed some measure of flood proofing.

On-site inspections allowed the Study Team the opportunity to investigate potential realignments, consult with local residents, assess hydraulic and geotechnical considerations first-hand, and in general, confirm the practicality of the various alignments.

The site visits and review of the maps led to some alignment modification to reduce the cost and to provide a more efficient dyking system.

1.3.4 Identification of Geotechnical and Hydraulic Considerations

Through data review, site visits, and preliminary calculations the Study Team looked at geotechnical and hydraulic considerations affecting the various alignments. Geotechnical considerations that were identified in the previous report and that are still applicable include:

- identification of potential borrow areas;
- highway and road construction;
- riverbank stability;
- properties protected and left unprotected by the various alignments; and
- Right-of-way purchase (surveys will be required to determine extent).

Hydraulic considerations identified include:

- backwater effects on the Red River due to dyke alignments;
- downstream effects on the floodway control structure;
- control and conveyance structures required;
- internal drainage;
- impacts related to the Seine River;
- the impacts of spring ice jams during breakup; and
- the impact of reduced flood plain storage.

1.3.5 Cost Evaluation Criteria

The Study Team developed estimates of project costs for each of the proposed dyking alignments. Costs were developed under the guidance of Manitoba Water Resources Branch.

The Study Team gathered data on specific costs related to the 1997 flood as much as practical and projected estimates for damages and floodproofing based on information provided by Manitoba Emergency Management Organization (MEMO) and Manitoba Water Resources Branch.

It should be noted that the policies for MEMO-related damage claims are constantly evolving. For example, on Friday, October 24, 1997, the government expanded the allowable claims to pay for replacement value of chattels, as opposed to an arbitrary depreciated value.

A benefit/cost analysis provides a basis for economic comparison and an estimation of the viability of the various dyking alignments. The dyking alignment with the highest Benefits to Cost Ratio indicates the project with the most economic return for the investment made. Other factors which influence the decision are the number of homes actually protected, hydraulic impacts and practically of building the dyke. A major consideration in any dyke alignment is to maximize the number of homes and businesses protected by a community dyke.

2.0 DESCRIPTION OF COMMUNITY DYKE ALIGNMENTS

Table A summarizes the level of protection for each alignment expressed as the number of homes, small and large businesses protected. Properties nearby but not protected by the dyking alignments must consider other means of flood proofing such as individual ring dykes, relocation, raising the main floor or taking the risk of not being protected in the future. There are approximately 231 homes and small businesses and 10 large businesses in the area.

Most of the homes that are not inside the proposed dyke alignments protected, are too close to the river bank to permit construction of the dyke or are outside the conceptual dyke alignment. The homes, not protected by the dyke scheme, could be individually protected or relocated.

All three dyking alignments include diverting the Seine River, on the upstream side of the proposed PTH No. 59 with a diversion channel designed to carry the Seine flows north to the floodway. In consultation with the Manitoba Highways Department, the study team reviewed the concept of raising the new northbound lane of PTH No. 59 to the 1997 flood elevation to form the west (left) bank of the diversion channel. The diversion channel conceptual alignment is shown on Figures 2 to 4. A preliminary sizing of typical cross-sections for the Seine River Diversion at proposed PTH No. 59 and through the open field, is shown on Figure 5.

All the dyking schemes protect most of the properties bounded by the Red River, Richardson Road and the proposed PTH No. 59 south of the City.

In the eastern portion of the study area, the homes and businesses not protected by the various dyking alignments include the homes on the east side of the proposed PTH No. 59 alignment and the diversion channel. It is not known at this time if any of these properties are being relocated due to the new highway alignment.

TABLE A: SUMMARY of Properties Protected

Dyke Alignment	Description	No. of Homes & Small Business Protected	No. of Large Business Protected	No. of Homes & Small Business NOT Protected	No. of Large Business NOT Protected
A	Richardson Road with Seine Diversion	215	9	16	1
B	City Boundary with Seine Diversion	214	8	17	2
C	St. Mary's Road & Hallama Drive with Seine Diversion	213	8	18	2

2.1 ALIGNMENT A: RICHARDSON ROAD (SEE FIGURE 2)

Dyking Alignment A, called the Richardson Road alignment, can be seen in Figure 2 in the FIGURES appendix. Alignment A requires St. Mary's Road and Richardson Road to be built up to the 1997 Flood Elevation plus two (2) feet. This alignment also requires a closure for the railroad tracks near Grande Pointe for a flood of similar magnitude to the 1997 flood event.

This dyking scheme protects a total of 215 homes and small businesses and 9 large businesses, for a total of 224 properties, but excludes 16 homes and small businesses and three larger businesses. A consideration of this alignment is that in raising St. Mary's Road and Richardson Road, transportation links are maintained in a flood emergency situation, and during a flood event, access is maintained to the proposed pumping station at St. Mary's Road and Richardson Coulee.

In the western portion of the project area, three homes not protected are situated on the Richardson property and another three homes are next to the river south of the City / R.M. boundary.

Alignment A builds more of the dyke in existing Right-of-way's (Richardson & St. Mary's Roads). This could expedite construction by minimizing the time spent in land acquisition.

2.2 ALIGNMENT B: CITY OF WINNIPEG BOUNDARY (FIGURE 3)

Dyking Alignment B, called the City Boundary alignment, can be seen in Figure 3 in the FIGURES appendix. Alignment B has one road closure at St. Mary's Road and one railroad track closure for a 1997 flood event. Alignment B encircles all of the property within the current City of Winnipeg Boundary which is less than half the area of Alignment A. This area allows for some internal storage during flood events and provides a measure of protection to any future development within the City boundary.

This dyking scheme protects a total of 214 homes and small businesses and eight large businesses, for a total of 222 properties, but excludes 17 homes and small businesses and two large businesses.

2.3 ALIGNMENT C: ST. MARY'S ROAD, HALLAMA DRIVE (FIGURE 4)

Dyking Alignment C, called the St. Mary's Road & Hallama Drive Alignment, can be seen in Figure 4. Alignment C requires a road closure at St. Mary's Road for a flood of similar magnitude to the 1997 flood event. Alignment C consists of two separate protective ring dykes, one around the St. Mary's Road Properties and another for the Grande Pointe Settlement.

Alignment C requires one high level crossing for the property excluded from the ring dyke (property located at the eastern extreme of Greenview Road).

This dyking alignment protects the same properties as Alignment B, except the one at the east end of Greenview Road.

3.0 GEOTECHNICAL CONSIDERATIONS

3.1 DYKE CONSTRUCTION ASPECTS

3.1.1 Potential Borrow Areas

The dyke fill material shall consist of suitable native clays from borrow areas located throughout the study area. The final borrow area locations will depend on fill quantity requirements and requires negotiations with local landowners. Additional fill material will be available from the construction of ditching along the dykes. In some cases there may be sufficient excavated material available to construct sections of the dyke (e.g., a dyke along Richardson Road will obtain most of its' borrow from the adjacent ditches). Another fill material source is the existing spoil berm south of the Floodway inlet which was constructed with material excavated during construction of the Floodway. Here, fill material may be obtained by narrowing the dyke. Borrow material can also be obtained from the Richardson Coulee. Additional fill material could be obtained by the removal of existing ring dykes around the individual residential homes, if the residents agree. Typical dyke construction will conform to the guidelines developed by Water Resources Branch. A typical dyke cross-section is included in the FIGURES appendix as Figure 6.

3.1.2 Highways and Road Construction

Alignment A considers using the highways and public roads as the primary dyke. For the feasibility study we have assumed a surface similar to existing for any raised roads. For gravel roads this comprises about 4" (100 mm) thick base material, and for asphalt roads a 4" (100 mm) thick lift of asphalt over 20" (500 mm) of base material. The final construction design and specifications will be reviewed with Manitoba Highways Department.

3.1.3 Riverbank Stability Considerations

The proposed dyke alignments have been selected to provide sufficient top of bank set back to preclude slope stability concerns. This will require relocation of one existing home.

3.1.4 Earthwork Quantities

Earthwork quantities were estimated from the 1:20,000 maps received from Manitoba Natural Resources Mapping. In local areas, some more detailed contour maps exist, however they do not add much to the level of certainty for the quantities. A detailed topographic survey of the area would increase confidence in earthwork quantities and Right-of-way limits and would be a necessary precursor to final design.

4.0 HYDRAULIC AND HYDROLOGICAL CONSIDERATIONS

4.1 DYKING ALIGNMENTS IMPACT ON DOWNSTREAM FLOODWAY OPERATION

The downstream impact of dyking alignments on the operation of the Floodway Inlet Control Structure was considered for all the Alignments due to the potential for these dykes, in conjunction with the existing Turnbull Drive dyke, to more effectively convey the floodwaters than the pre-dyke condition.

This consideration was reviewed with Senior Water Resources Branch personnel. Although it was agreed that this could affect the timing of the operation of the Floodway control, it would not have an impact on the gate operation, assuming similar inflows as experienced in the 1997 Flood.

4.2 DYKING ALIGNMENTS IMPACT ON UPSTREAM WATER LEVELS

The impact of dyking alignments on upstream water levels was considered for all the Alignments. The Study Team considered the potential for these alignments to produce additional head loss from the constriction created in the reach one to two km upstream of the Floodway Inlet.

After consulting with Senior Water Resources Branch personnel it was agreed that some additional head loss is likely to occur, due to the new St. Mary's Road Dyke and existing Turnbull Dyke, and could cause a rise in water levels upstream.

The Study Team analysed this condition using the US Army Corps of Engineers Hydraulic Engineering Centre - River Analysis System (HEC-RAS) computer modelling program to estimate the amount of the backwater effect. The model HEC-RAS software performs steady-state backwater surface profile calculations.

The base data file was originally developed by Manitoba Water Resources Branch in the HEC-2 computer modelling program. More recently the file has been converted, expanded and calibrated into HEC-RAS 2.0, by Manitoba Highways and Transportation, Bridges and Structures Branch for a study of the hydraulic impacts of raising PR 210 based on the

1996, 1979 and the 100 year flood. Manitoba Highways updated the original files and used the information to produce a report authored by Mr. Tim Lock, P.Eng. of the Bridges and Structures Branch.

The Study Team reviewed the model and calibrated it using the 1997 Flood data. To assess the impact of the proposed dyking alignments the Study Team modelled the dyke with the most significant hydraulic impact, Alignment A.

Two of the major contributing factors to an increase in water levels upstream are:

- the physical constriction just upstream of the floodway inlet, created by the Turnbull Drive Dyke on the west and the various eastern dyke alignments; and
- the loss of flood plain storage.

4.2.1 Relative Impact of Dyke Constriction on Upstream Water Levels

A sensitivity analysis over a range of flows was performed to evaluate the upstream impacts of the dyke alignments under similar inflows to the 1997 Flood event, the water level upstream of PR 210 would increase about 0.25 ft (~3 in.) due to the constriction alone.

4.2.2 Relative Impact of Reduced Floodplain Storage on Upstream Water Levels

Alignment A would cause the greatest reduction in the flood plain storage for this region which will cause some local staging in the river reach upstream of the Floodway Inlet.

To estimate how much additional staging would be attributable to the loss in flood plain storage, the model was run using an estimated 1997 equivalent flood flow for dyke Alignment A. Based on these calculations, it is estimated the Richardson Road dyke alignment would cause less than 0.1 of a foot (or about 1 inch) in staging.

Table B: Relative Water Level Impact at PR 210

Conceptual Alignment	Estimated Headloss @ St. Adolphe due to Constriction alone	Estimated Headloss @ St. Adolphe due to Reduced Floodplain Storage	Estimated Total Headloss @ PR 210 near St. Adolphe
A	0.25 ft. or about 3 in.	0.1 ft or about 1 in.	0.4 ft. or 4 to 5 in.
B	0.25 ft. or about 3 in.	< 0.1 ft. < 1 in.	0.3 ft. or 3 to 4 in.
C	0.25 ft. or about 3 in.	< 0.1 ft. < 1 in.	0.3 ft. or 3 to 4 in.

Based on proportional storage area, Alignment B, the City Boundary Alignment, was calculated to have less than 0.1 ft (less than 1 in.) relative increase in water levels, due to storage effects alone.

Alignment C, St. Mary's Road & Hallama Drive, has a relative increase in water levels of less than 0.1 ft (less than 1 in.) due to storage effects alone.

4.2.3 Total Impact of Dyke Constriction and Reduced Floodplain Storage on Upstream Water Levels

The total estimated staging of local water levels, due to Alignment A, is 0.4 ft.

Table B summarizes the relative headlosses estimated at PR 210 (just north of St. Adolphe) in the HEC-RAS model due to the various dyke alignments and supersedes the Table of Hydraulic impacts published in the October 1997 Wardrop report on the Feasibility of Dykes South of the Red River Floodway.

This analysis is limited to providing a relative comparison of steady-state river profile for the 1997 flood discharges assuming both pre-dyke and post-dyke conditions and is not intended to provide accurate real-time water surface profile elevations.

4.3 Impacts on Spring Ice Passage during Breakup

For all the dyke Alignments the proposed alignment immediately upstream of the Floodway, coupled with the Turnbull Drive dyke create a potential flow constriction in the reach from 1 to 2 km upstream of the Floodway Inlet Control Structure. This was identified as a potential zone for ice jams to occur during spring breakup, leading to local staging upstream and problems with ice control at the lip of the inlet.

In consulting with Senior Water Resources Branch personnel, it was pointed out that historically:

- The spring breakup process generally precedes the flood crest by a week to ten days and local staging from ice jams take place at water levels within the normal river banks and below the elevation of the proposed dyke sections.

- The ice passage typically occurs at water levels less than 752', the elevation of the floodway inlet sill (lip).

- Ice floes have only entered the Floodway channel once (1975) in the past 27 years of operation.

On this basis, it was assumed that the potential for additional problems with ice during spring breakup, were insignificant due to the current proposed dyking alignments.

In the detailed design phase, ice control measures to restrict ice from entering the Floodway should be reviewed and a contingency plan developed (in consultation with Manitoba Water Resources Branch) to handle the unlikely event of ice entering the Floodway Inlet.

4.4 HYDRAULIC IMPACTS ASSOCIATED WITH THE SEINE RIVER

4.4.1 1997 Seine River Flood Existing Conditions

Each dyking alignment protecting Grande Pointe from Red River flooding must consider the impact of the coinciding Seine River flooding.

Water levels and discharge measurements for the Seine River, during the 1997 Flood were provided by the Water Resources Branch (Figure 7: Seine River Hydrograph) and analysed for three conditions:

1. Seine River flood independent of flow in the Floodway Channel; assuming free outlet conditions at the Seine River drop structure.

2. Seine River flood with flow in the Floodway Channel; assuming partially submerged outlet conditions at the Seine River drop structure.

Table C: Seine River Diversion at Grande Pointe

Date of flow	S.R. Flow	S.R. W.S.E. Outlet	Fldwy W.S.E. S.R.Outlet	S.R. Total Outlet Flow	S.R. Syphon Flow	Allow Flow in S.R. to Protect Low Home	Flow to be Diverted @ Proposed PTH #59
	cfs	ft	ft	cfs	cfs	cfs	cfs
*Apr-22	1000	763.0	738.0	1000	130	1000	0
Apr-23	1500	765.4	738.0	1500	145	135	1365
Apr-24	2000	767.1	762.5	2000	150	135	1865
Apr-25	2500	768.2	763.8	2250	160	135	2365
Apr-26	3000	769.3	765.2	2250	170	135	2865
Apr-28	2500	769.8	767.0	1800	175	135	2365
Apr-30	2000	770.0	767.3	1700	175	135	1865
*May-03	1500	771.5	768.6	1500	185	135	1365
*May-06	1000	770.6	768.5	1000	180	135	865

This entire analysis is based on 1997 conditions only.

W.S.E. = Water Surface Elevation; S.R. = Seine River; Fldwy = Floodway

Elevation of Lowest Home in Grande Pointe = 764' (233 m)

Assume allowable W.S.E. = 764' at Seine River/Floodway Structure.

Overflow weir elevation = 755'
Syphon elevation = 752.5'

* These are estimates taken by extrapolating the Hydrograph curve.
** Influence from the Red River Overland flow begins.

From April 22, 1997 to April 28, 1997 the Hydrograph is in the rising limb for the Seine River Flows. From the April 28, 1997 on the Hydrograph is on the falling limb.

3. Seine River flood with flow in the Floodway Channel; assuming fully submerged outlet conditions at the Seine River drop structure.

All three conditions assume inflow from the Seine River only, with no additional flow due to overland flooding from the Red River, since the adjacent area will be protected by the proposed dyking.

The existing Seine River outlet structure, consisting of 4 - 2.4 m (8') diameter culverts and the syphon structure, has an outlet capacity, prior to flooding occurring in Grande Pointe (Lowest Home Elevation 764 ft) of about 4200 cfs for condition 1 and reduces to about 2250 cfs for a head differential of 4 ft. and 1600 cfs for a 2 ft. head differential (condition 3).

The Seine River outlet capacity is derived from the rating curves from the structure design drawings.

4.4.2 Seine River Flood Mitigation

The Study Team investigated the 1997 Flood conditions, specifically as they pertain to the impact the Seine River had on flooding in the Study Area.

The Seine River peaked about a week in advance of the Red River. However, due to the restricted (submerged) outlet condition in the Floodway the structure was limited to approximately 1500 cfs capacity, while the flow in the Seine was already 1800 cfs and rising to a peak of 3000 cfs. See Table C for a summary of the preliminary diversion sizing.

Data for the Seine River water surface elevation starts at 766.8 ft at the outlet structure for the 1997 flood, which is 2.8 ft higher than the lowest known house in the Grande Pointe area (764 ft).

Based on a similar event to the 1997 flood, the Grande Pointe area could be protected from the Seine River flooding, if 3000 cfs was diverted and water from the floodway was prevented from backing up through the existing syphon. The preliminary configuration, to convey 3000 cfs, for the diversion channel would be five metres depth, sixteen metres bottom width and 5:1 side slopes (See Figure 5).

Studying the Seine River Flooding is a significant undertaking, independent of the Red River Floodway being in operation. This subject warrants further investigation in the detailed design phase.

4.4.3 Reduced Seine River Diversion

Manitoba Water Resources has commissioned a concurrent investigation into diverting approximately one-third of the Seine River tributaries downstream of the Ste. Anne Seine River Diversion and upstream of the proposed PTH No. 59. The effects, as reported in a letter from Stefanson Watershed Services to the Water Resources Branch dated December 1, 1997, are to reduce the flow from 3104 cfs to 1812 cfs, a reduction of 1292 cfs (See appendix).

The reduction in flow at the proposed PTH No. 59 Seine River Diversion reduces the channel cross-section to approximately four metres depth, sixteen metres bottom width and 5:1 side slopes. The reduction in flow would translate into a project cost savings, on this project, of as much as $1,200,000, in earthworks and structure costs.

4.4.4 Seine River Diversion Environmental Considerations

The terms of reference for this report did not include an environmental assessment, however, a few comments regarding some of the impacts are stated below for consideration. Reid Crowther and Partners, on behalf of Manitoba Highways and Transportation, produced an *Environmental Act Proposal*[1] in February 1994, for the PTH No. 59:

- The operation of the Seine River Diversion is intended to maintain a minimum flow of 135 cfs through Grande Pointe during a spring flood event. This ensures that the syphon structure has the capacity to pass all the flow that it normally would, and not force water into storage that would flood and damage property inside the protective dykes.

- Essentially, all the water that would currently go through Grande Pointe Settlement and eventually into the floodway would be diverted a few miles upstream of the community and would still be carried to the floodway.
- This concept attempts to address the need to maintain riparian flow to the Seine River and to prevent the occurrence of dried up creek beds.

4.5 INTERNAL DRAINAGE

To provide protection from spring rainstorm events, it is recommended that temporary pumps be installed to provide protection against flooding within the dyke during a major flood event. The pumps will be sized to provide protection for a 1 in 50 year event, and to use the storage provided in the existing drainage works. Preliminary estimates of runoff were used in the development of the internal drainage works. For the Richardson Coulee crossing, in Alignment A, a permanent pumping station is considered.

Of these alternatives, alignment A provides the greatest internal drainage capacity in the Richardson Coulee. The additional capacity provides an internal storage safety margin in case of pump failure during a significant spring rainstorm or snow melt event coinciding with a major Red River flood.

4.6 HYDRAULIC STRUCTURES

There are several types of structures considered for the various alignments, including:

- gated culvert crossings;
- temporary and permanent pumping facilities;
- major water conveyance and control structures; and
- road/track closures.

Table D summarizes the structures for each of the dyke alignments and their estimated construction costs.

4.6.1 Gated Culvert Crossings

Culvert crossings will be installed where natural drainage is cut off. Culvert crossings will typically consist of one or more culverts from 3 ft. to 4 ft. in diameter, complete with a concrete head wall, wing walls, apron and screw gate (as required) for control. Culvert crossing cost will vary with the flow to be passed and the height of fill above the crown. For the feasibility study, we have used an installed cost of about $175 per metre of culvert, based on a 3 ft. diameter culvert complete with a concrete head-wall at a cost of about $2,250 per metre of width. Typical estimated cost is $35,000 supplied and installed.

TABLE D : Summary of Alignment Structures

Dyke Alignment	Description	Permanent Pumping Station	Culverts Temporary Pumping Station	Seine River Diversion Control Structure	Seine River Crossing Structure	Seine River Outlet Structure
A	Richardson Road with Seine Diversion	1	1	1	1	1
B	City Boundary with Seine Diversion	0	3	1	1	1
C	St. Mary's Road & Hallama Drive with Seine Diversion	0	3	1	1	1
	Individual Dykes for Protecting the Area	0	0	0	0	0

4.6.2 Major Water Conveyance and Control

Table D summarizes the various alignments structure requirements and the estimated cost of structures.

All three alignments include the same structures for the Seine River Diversion:

- The diversion structure sluice gate $ 50,000
- Concrete box culvert crossing $ 450,000
- Seine River Outlet Structure $1,500,000

The total for the Seine River Diversion Structures (Design Flow of 3000 cfs) equals $2,000,000.

Manitoba Department of Highways and Transportation have indicated that reducing the flow of the Seine River through PTH No. 59 to less than 150 cfs will constitute a reduction in structure costs to the Highways project of approximately $1,000,000.

The Seine River Diversion requires one municipal road crossing for farm access, at an estimated cost of $450 000, based on a concrete box culvert structure.

The other major structure, is the Richardson Coulee crossing at St. Mary's Road. The estimated cost of this structure, including a permanent pumping station, is $300,000.

4.6.3 Road/Track Closures

Road or track closures, temporary dykes over a transportation link, are constructed on an as-required basis prior to the peak of a serious flooding situation.

4.6.4 Utility Relocation

There is a natural gas pipeline that crosses Richardson Road and the floodway. The study allocates $20,000 for relocating this service.

5.0 COST EVALUATION OF THE ALIGNMENTS

5.1 COST ESTIMATING FOR DYKE ALIGNMENTS

Cost estimating and Benefit Cost analysis for the various dyking alignments includes capital investment for structures and earthworks directly related to the protective dyking works. In addition, an estimation of the annual operation and maintenance costs for both the structures, pumping facilities and the earthwork dykes has been made.

Capital costs also include land purchase costs at $500 per acre. Manitoba Water Resources Branch indicated that this is the fair market value of agricultural land south of the Red River Floodway. The cost of land acquisition including appraiser fees, negotiations and legal work is an additional 30% of land cost.

The legal survey costs, including cutting and clearing of survey lines, drafting and preparation of legal plans is estimated at 50% of land costs. Therefore, the cost per acre is estimated at $900 per acre.

Severed land packages (properties severed into two or more parcels by the dyke alignment) were used in the computation of compensation and are a cost to the project.

For the costs in this report, the Study Team used $900 per acre.

The study uses $4 per cubic metre for construction of dykes in open areas away from riverbank and treed areas. Near riverbanks and treed areas, $6 per cubic metre has been used. These costs include excavation, hauling, placing, compaction, topsoil and seeding and restoration of borrow areas. These costs are based on discussions with Manitoba Water Resources personnel and other consultants.

In areas where there is more development, the study uses $5000 per acre. There are two levels of assumed expropriation costs of $250,000 and $100,000.

We have also included costs for utility relocations where required.

For individual flood proofing, it is assumed that the maximum cost is $40,000 per house or business. This equates to the maximum contribution of government of $30,000 per house or business and $10,000 (25%) investment by the property owner. Under the individual flood proofing program, the government pays the 75% up to a maximum of

$30,000. If a house and a business is on the same lot, the government will contribute a maximum of $60,000 for an $80,000 investment in flood protection by the owner.

Since this is a feasibility study, contingencies are assumed at 25% (increased from 20% in the October 1997 Wardrop report at the direction of Water Resources) and an engineering allowance of 15% in addition to dyke and structures construction, utility relocation and land acquisition costs. Administration, finance and GST have not been included.

5.2 BENEFIT/COST ANALYSIS

Table E summarizes the Benefit Cost calculation as well as the dyke alignment Capital Costs. For a more detailed breakdown of each alignment, see the appendices for cost estimates and benefit cost calculations.

The Benefit/Cost ratio is assumed to be a straight line increase in damages with the increase in return period, starting with assumed damages equal to zero until the first house is flooded and maximum of all homes damaged at a flood equivalent to 1997 Flood event.

For this feasibility study, it is estimated that the future damages protected against are $100,000 per house or small business and $1,000,000 for a large business.

It is important to note that the benefit/cost analysis does not quantify the contribution made by volunteers and the Canadian Armed Forces are not included in the benefits/damages protected. It must be acknowledged that both these groups provided substantial resources to the flood fighting effort in 1997. For this reason, the $100,000 assumption of damages is not a final number, but rather the limit of the Provinces liability through the MEMO Flood Disaster Relief funding. The complete equation would include such costs as the investment by volunteers and the Canadian Army, the loss of income due to the flood, the impact on future economic growth in the area and many other intangible costs.

At this time, there is no reliable information available to make a reasonable assumption to assign a quantity for the items just listed. However, we can assume that the true level of protection and benefits is significantly higher than what is reflected in the Benefit Cost ratio.

Table E: SUMMARY of Costs and Benefit:Cost

Dyke Alternative	Description	Total Estimated Construction Cost	Average Annual Benefit	Average Annual Cost	Benefit:Cost Ratio
A	Richardson Road with Seine Diversion	$9,070,000	$610,000	$517,500	**1.18**
B	City Boundary with Seine Diversion	$7,650,000	$588,000	$440,000	**1.34**
C	St. Mary's Road, Hallama Drive with Seine Diversion	$7,925,000	$586,000	$455,000	**1.29**
	Individual Dykes for Protecting the Area	$11,664,000	$485,134	$542,962	**0.89**

Social Discount Rate (Interest) = 4%

Amortization Period = 50 years

Annual amortization costs in the study assume a 4% social discount rate (interest rate), and a 50 year economic life for the capital works.

On the Benefit side of the equation no allowance is made for future developments that would be protected by some of the alignments, and no allowance is made for inflation on damages.

5.3 BENEFIT COST COMPARISON OF THE ALIGNMENTS

See Table E for a summary of the Project Costs and their Benefit: Cost ratios.

5.4 COST REDUCTION DUE TO DIVERSION OF SEINE RIVER TRIBUTARIES UPSTREAM OF PROPOSED PTH NO. 59

The Water Resource Branch commissioned a parallel study to investigate the impacts of diverting the Seine River watershed north of highway No. 1 directly to the floodway. An interim memo from the author (Stefanson memo 12/97, see References Appendix) indicates a flow reduction in the Seine River at proposed PTH No. 59.

The reduction in flow at the proposed PTH No. 59 Seine River diversion, due to the upstream diversion translates into project cost savings. Savings are derived from a reduced channel cross-section, crossing structure, Seine River Diversion outlet structure and Right-of-way land acquisition width.

Total savings, for each alignment project cost, based on preliminary sizing of reduced channel, is estimated to be approximately $1,200,000.

Table Summary of Feasibility Study

Conceptual Alignment	Estimated Project Cost	Benefit : Cost	Property Protected (Homes & Business)	Estimated Total Headloss @ St. Adolphe
A	$9,070,000	1.18	224	0.4 ft. or 4 to 5 in.
B	$7,650,000	1.34	222	0.3 ft. or 3 to 4 in.
C	$7,925,000	1.29	221	0.3 ft. or 3 to 4 in.
Constriction alone				0.25 ft. or about 3 in.

6.0 CONCLUSIONS

To provide adequate flood protection to the Grande Pointe Settlement, it is necessary to divert approximately 2900 cfs of the Seine River flow upstream of the proposed PTH No. 59.

All alignments increase upstream water levels in the Red River as follows, Alignment A less than 0.4 ft., Alignment B about 0.3 ft. and Alignment C about 0.3 ft.

Alignment A protects large tracts of agricultural land in the study area. This provides protection for potential future development in the area. In addition, this area provides internal drainage for a significant spring rainstorm or snow melt event. Alignments B & C have internal drainage capacity to a lesser degree.

During a 1997 magnitude flood, access during emergency flood conditions from St. Mary's Road to PTH No. 59 is maintained along Richardson Road in Alignment A. For Alignment B, emergency access from St. Mary's Road to PTH No. 59 is maintained along the top of the dyke. Alignment C would isolate St. Mary's Road from PTH No. 59 immediately south of the floodway, and it will also require a high level crossing to provide access for the property at the extreme eastern end of Greenview Drive.

Alignment A minimizes right-of-way problems and reduces severance of lands as most construction takes place in existing right-of-way's.

To proceed to final design, a more detailed topographic survey of the study area for quantities and right-of-way requirements.

Further study of the Seine River flooding is warranted, in particular it's interaction with the Red River and the Red River Floodway.

Properties not protected by a community ring dyke alignment must consider individual floodproofing or relocation.

This study is limited to reviewing the impacts of the three (3) dyke alignments under consideration and in isolation. That is, there has been no consideration of the combined effects this dyke may have with other dyking in the Red River valley. A hydrodynamic model of the Red River Basin could be used to quantify the cumulative effects.

7.0 RECOMMENDATIONS

The recommended alignment, as selected by the Steering Committee and the Public Consultation Process is Alignment C: the St. Mary's Road & Hallama Drive Community Ring Dykes. The overriding criteria cited was the perception that Alignment C offers significantly less hydraulic impact. Other important criteria for the decision by The Steering Committee were:

- Public response
- Best fit solution for stakeholders
- Cost.

The Seine River should be diverted north at the Proposed PTH. No. 59, and routed to the floodway with a new outlet structure into the floodway approximately one mile downstream of the current Seine River Outlet Structure. This is to mitigate the effects of Seine River flooding concurrent with Red River flooding.

The residents of properties not protected by the recommended alignment should be advised of options for individual flood proofing.

Detailed topographical surveys should be undertaken to determine exact quantities and legal surveys should commence to define land requirements for the selected alignment.

A detailed environmental assessment of the approved project should be undertaken prior to final design.

DYKE ALIGNMENT
COST ESTIMATES

Community Dyke South of the FLOODWAY
Alignment A

Project Cost Estimate Sheet

Description of Item	Cost
DYKE WORKS (including)	$3,050,000
Dyke Earthworks (m3) Road Dyke Earthworks (m3) Channel Earthworks Seine River Channel Improvements Approach Rehabilitation Stripping Road Resurfacing	
D Dyke Sub-Total	$3,050,000
STRUCTURE WORKS (including)	$2,350,000
Gas Line Crossing Richardson Coulee Crossing & Permanent Pumping Station Temporary Pumping Station Seine River Diversion Seine River Diversion Crossing Seine River Diversion Outlet Structure Culverts	
S Structures Sub-Total	$2,350,000
C Construction Total (D + S)	$5,400,000
E Engineering (15%)	$810,000
Project Sub-Total (C + E)	$6,210,000
L Land Acquistion/Property Damage/Other Costs	$1,045,000
P Project Total (L + C + E)	$7,255,000
Contingency (25%)	$1,813,750
Total Project Estimate for Community Dyke	$9,068,750
Say: **South of the FLOODWAY Community Dyke** **Project Estimate**	**$9,070,000**

23/04/98

Job No. 971692-05-02

South of the FLOODWAY Community Dyke Alignment A

Benefit Cost Ratio Calculation Sheet

Total Project Estimate for South of the FLOODWAY Community Dyke	$9,070,000
O & M Pumps	$6,000
O & M Dykes (1%/yr)	$30,500
O & M Structures (2.5%/yr)	$58,750

Annual Cost (1997$)		Benefit (1997 Flood Damage Cost)	
Discount Rate	4%	Number of Properties	215
Economic Life	50 years	Number of Large Businesses	9
Cost Estimate			
Amortization	$422,210	Average Damage	$100,000
O&M Dykes	$30,500	Average Damage for Large Busines	$1,000,000
O&M Pumps	$6,000	Total Benefits (1997 Est. Damages)	$30,500,000
O&M Structures	$58,750		
Total	**$517,460** /yr		

Flood Return	Probability	Annual Benefit	Annual Cost	B/C	Net Benefits (B-C)
20.4 111.1	0.049 0.009	**$610,000**	**$517,460**	**1.18**	**$92,540**

1. Assumption: For Dykes South of the FLOODWAY
   - damages start with the lowest home flooded increasing to full area damages when the flood reaches 1997 levels.
2. Assumption: Estimate lowest property in Grande Point is at elevation = 233.00'.
   Probability of a Flood exceeding this elevation is 4.9%.
3. The 1997 Flood elevation is about a 0.009% probability flood.

Community Dyke South of the FLOODWAY
Alignment B

Project Cost Estimate Sheet

Description of Item	Cost
DYKE WORKS (including) Dyke Earthworks Road Dyke Earthworks Channel Earthworks Seine River Channel Improvements Approach Rehabilitation Stripping Road Resurfacing	$2,400,000
D Dyke Sub-Total	$2,400,000
STRUCTURE WORKS (including) Gas Line Crossing Richardson Coulee Crossings Temporary Pumping Station Seine River Diversion Seine River Diversion Crossing Seine River Diversion Outlet Structure Culverts	$2,125,000
S Structures Sub-Total	$2,125,000
C Construction Total (D + S)	$4,525,000
E Engineering (15%)	$678,750
Project Sub-Total (C + E)	$5,203,750
L Land Acquistion/Property Damage/Other Costs	$910,000
P Project Total (L + C + E)	$6,113,750
Contingency (25%)	$1,528,438
Total Project Estimate for Community Dyke	$7,642,188
Say: **South of the FLOODWAY Community Dyke** **Project Estimate**	**$7,650,000**

23/04/98

Job No. 971692-05-02

South of the FLOODWAY Community Dyke Alignment B

Benefit Cost Ratio Calculation Sheet

Total Project Estimate for South of the FLOODWAY Community Dyke	$7,650,000
O & M Pumps	$6,000
O & M Dykes (1%/yr)	$24,000
O & M Structures (2.5%/yr)	$53,125

Annual Cost (1997$)		Benefit (1997 Flood Damage Cost)	
Discount Rate	4%	Number of Properties	214
Economic Life	50 years	Number of Large Businesses	8
Cost Estimate			
Amortization	$356,109	Average Damage	$100,000
O&M Dykes	$24,000	Average Large Business Damage	$1,000,000
O&M Pumps	$6,000	Total Benefits (1997 Est. Damages)	$29,400,000
O&M Structures	$53,125		
Total	**$439,234** /yr		

Flood Return	Probability	Annual Benefit	Annual Cost	B/C	Net Benefits (B-C)
20.4 111.1	0.049 0.009	**$588,000**	**$439,234**	**1.34**	**$148,766**

1. Assumption: For Dykes South of the FLOODWAY
   - damages start with the lowest home flooded increasing to full area damages when the flood reaches 1997 levels.
2. Assumption: Estimate lowest property in Grande Point is at elevation = 233.00'.
   Probability of a Flood exceeding this elevation is 4.9%.
3. The 1997 Flood elevation is about a 0.009% probability flood.

Community Dyke South of the FLOODWAY
Alignment C

Project Cost Estimate Sheet

Description of Item	Cost
DYKE WORKS (including) Dyke Earthworks Road Dyke Earthworks Channel Earthworks Seine River Channel Improvements Approach Rehabilitation Stripping Road Resurfacing	$2,500,000
D Dyke Sub-Total	$2,500,000
STRUCTURE WORKS (including) Temporary Pumping Stations Seine River Diversion Seine River Diversion Crossing Seine River Diversion Outlet Structure Culverts	$2,125,000
S Structures Sub-Total	$2,125,000
C Construction Total (D + S)	$4,625,000
E Engineering (15%)	$693,750
Project Sub-Total (C + E)	$5,318,750
L Land Acquistion/Property Damage/Other Costs	$1,020,000
P Project Total (L + C + E)	$6,338,750
Contingency (25%)	$1,584,688
Total Project Estimate for Community Dyke	$7,923,438
Say: **South of the FLOODWAY Community Dyke** **Project Estimate**	**$7,925,000**

23/04/98

Job No. 971692-05-02

South of the FLOODWAY Community Dyke Alignment C

Benefit Cost Ratio Calculation Sheet

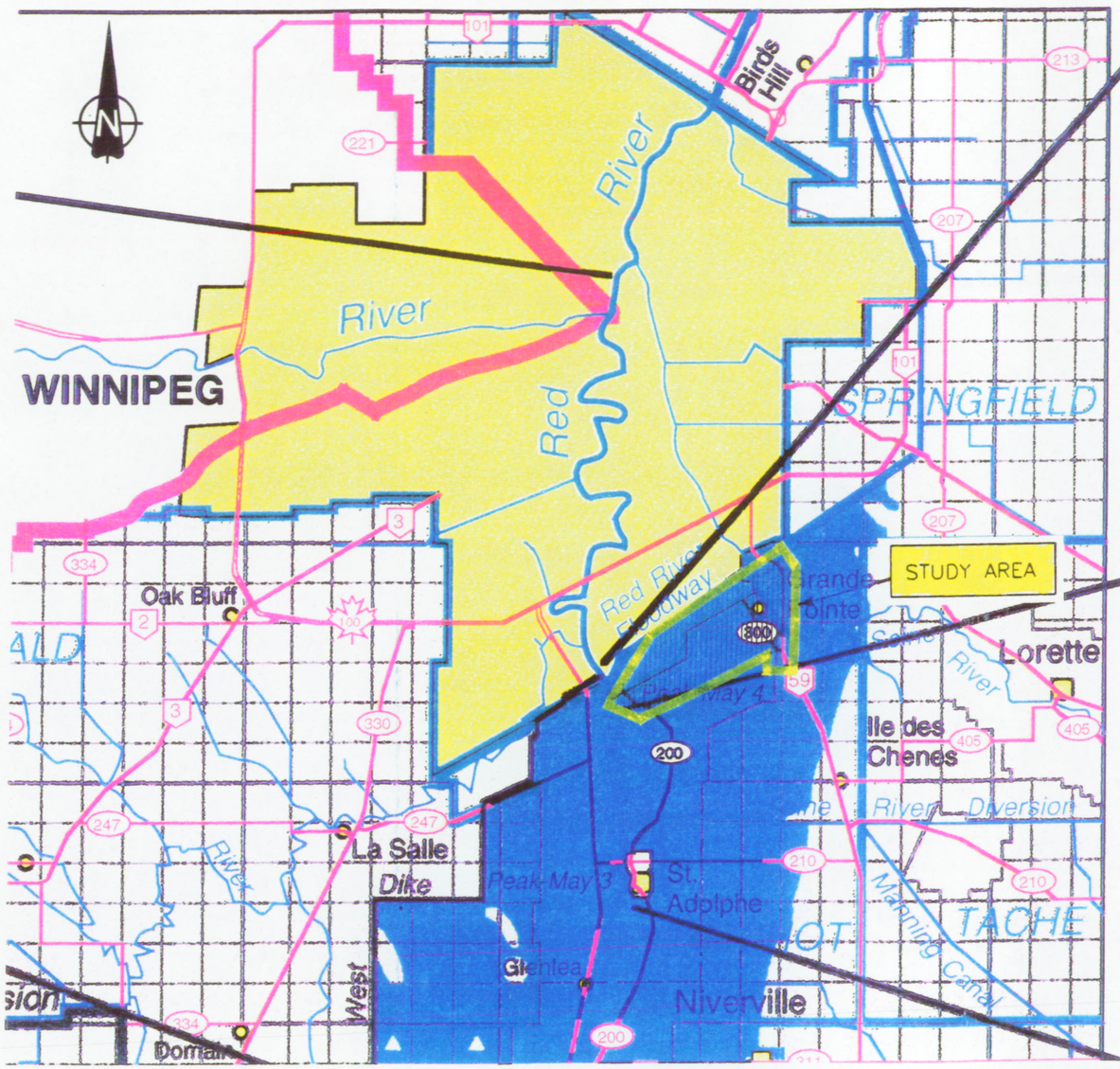
Total Project Estimate for South of the FLOODWAY Community Dyke	$7,925,000
O & M Pumps	$8,000
O & M Dykes (1%/yr)	$25,000
O & M Structures (2.5%/yr)	$53,125

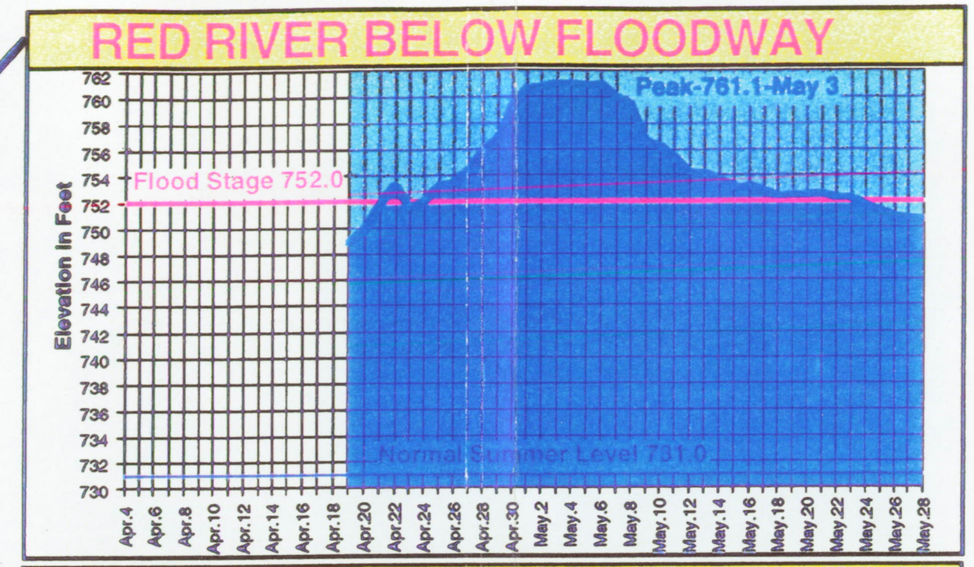
Annual Cost (1997$)		Benefit (1997 Flood Damage Cost)	
Discount Rate	4%	Number of Properties	213
Economic Life	50 years	Number of Large Businesses	8
			221
Cost Estimate			
Amortization	$368,910	Average Damage	$100,000
O&M Dykes	$25,000	Average Large Business Damage	$1,000,000
O&M Pumps	$8,000	Total Benefits (1997 Est. Damages)	$29,300,000
O&M Structures	$53,125		
Total	**$455,035** /yr		

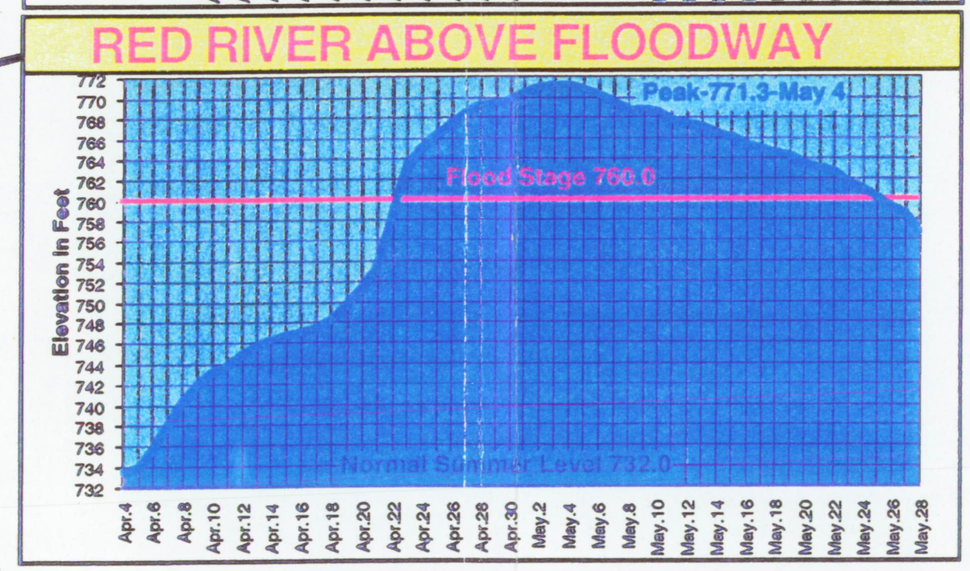
Flood Return	Probability	Annual Benefit	Annual Cost	B/C	Net Benefits (B-C)
20.4 111.1	0.049 0.009	**$586,000**	**$455,035**	**1.29**	**$130,965**

1. Assumption: For Dykes South of the FLOODWAY
   - damages start with the lowest home flooded increasing to full area damages when the flood reaches 1997 levels.
2. Assumption: Estimate lowest property in Grande Point is at elevation = 233.00'.
   Probability of a Flood exceeding this elevation is 4.9%.
3. The 1997 Flood elevation is about a 0.009% probability flood.

DYKE FEASIBILITY STUDY
FIGURES





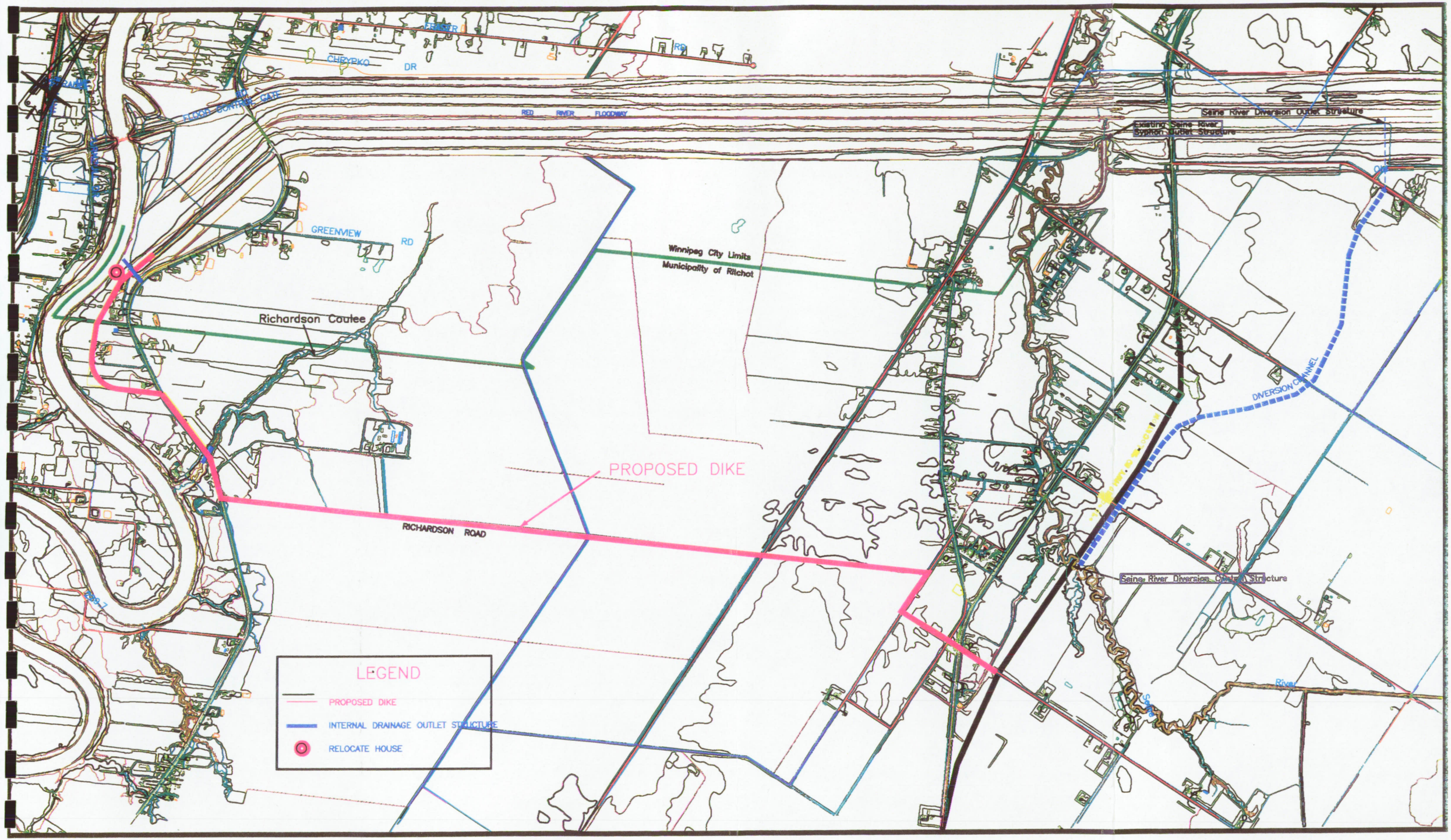


Manitoba Natural Resources

WARDROP ENGINEERING INC.
WINNIPEG TORONTO THUNDER BAY

DWG DESCRIPTION
DYKES SOUTH OF FLOODWAY FEASIBILITY STUDY
STUDY AREA

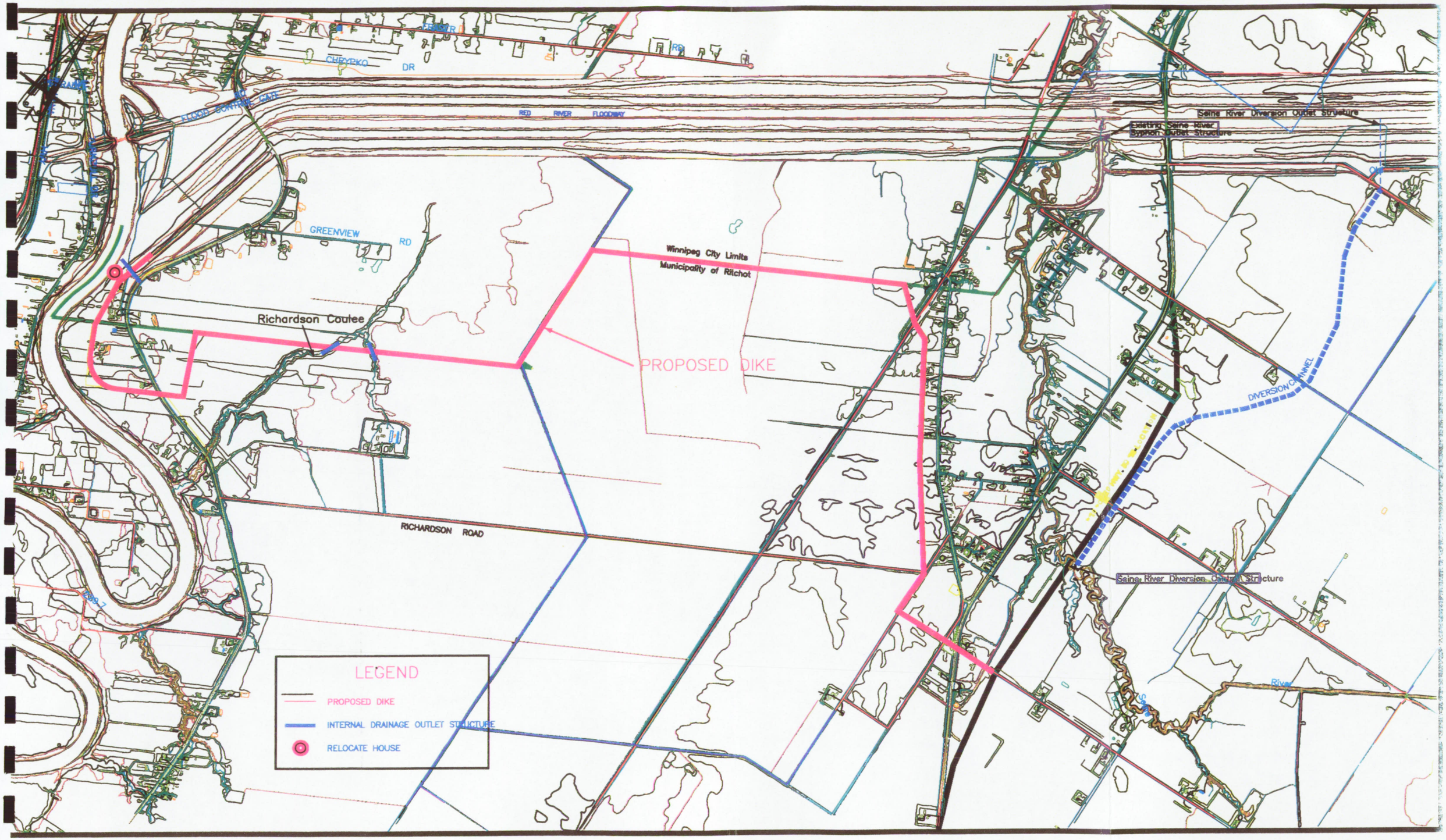
DESIGNED BY: K.M.	DRAWN BY: G.M.D.	DWG NO.
CHECKED BY: L.G.C.	DATE: 97.09.26	971692-05-00-1



DIKE ALIGNMENT ALTERNATIVE A

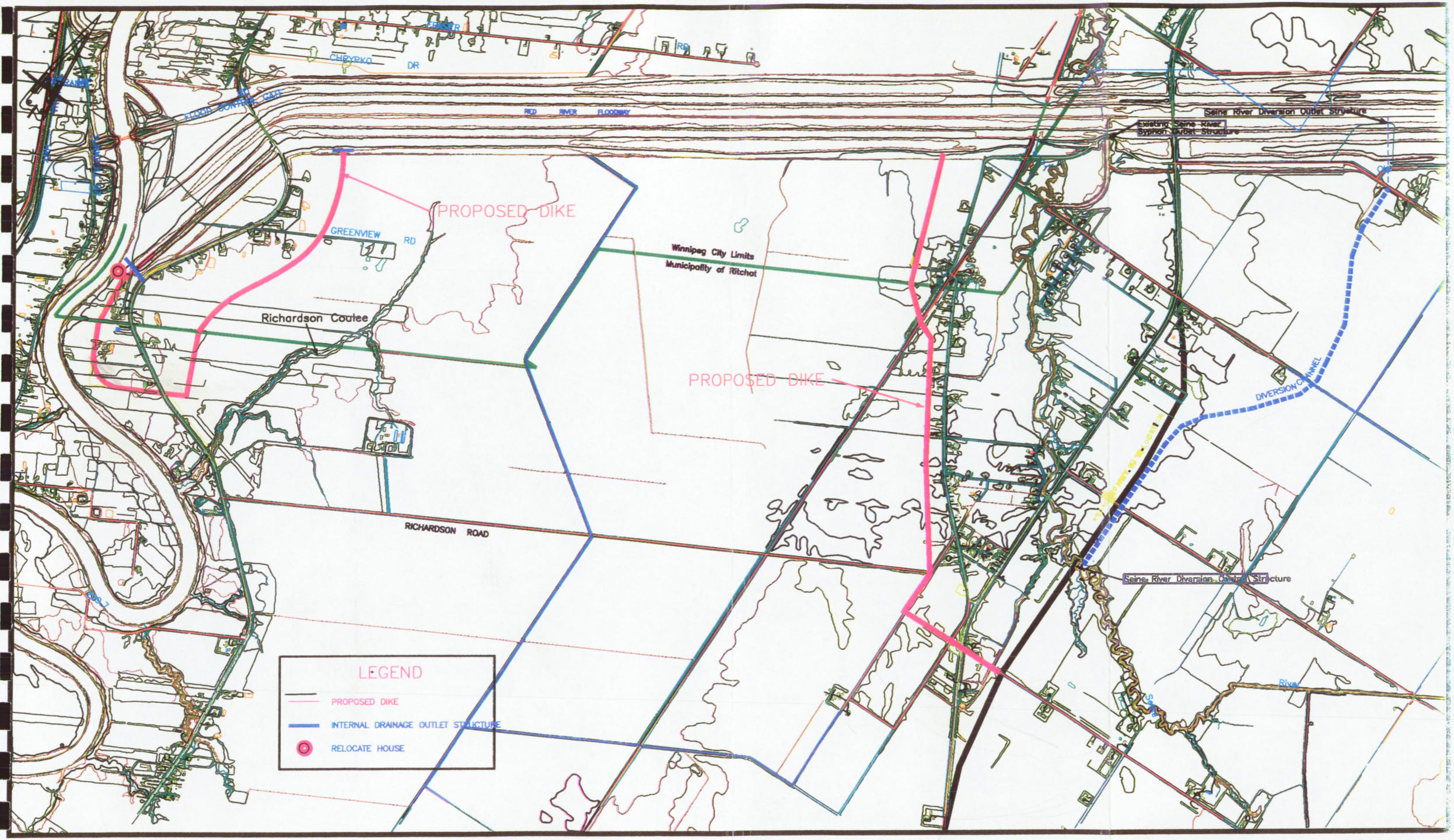
Figure 2

97 12 17



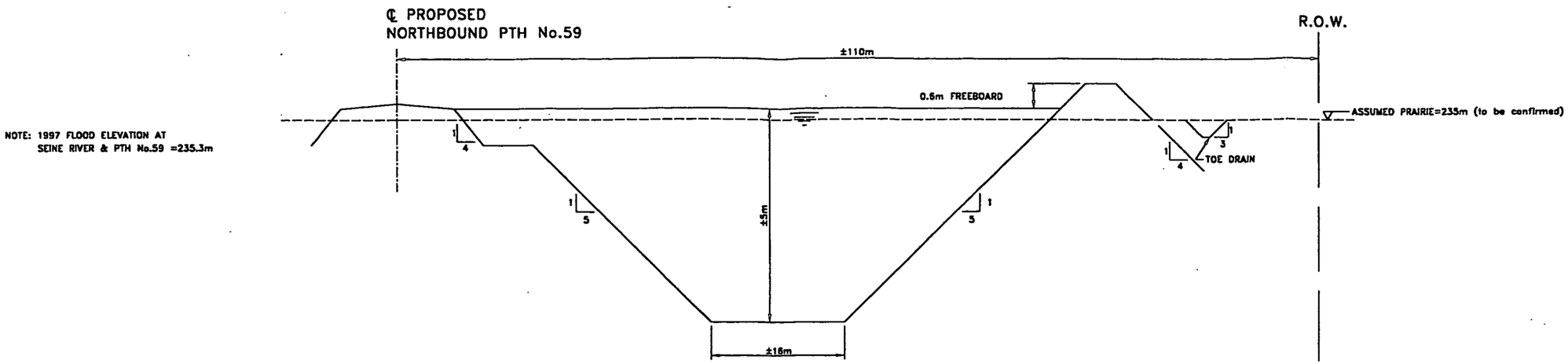
DIKE ALIGNMENT ALTERNATIVE B

Figure 3

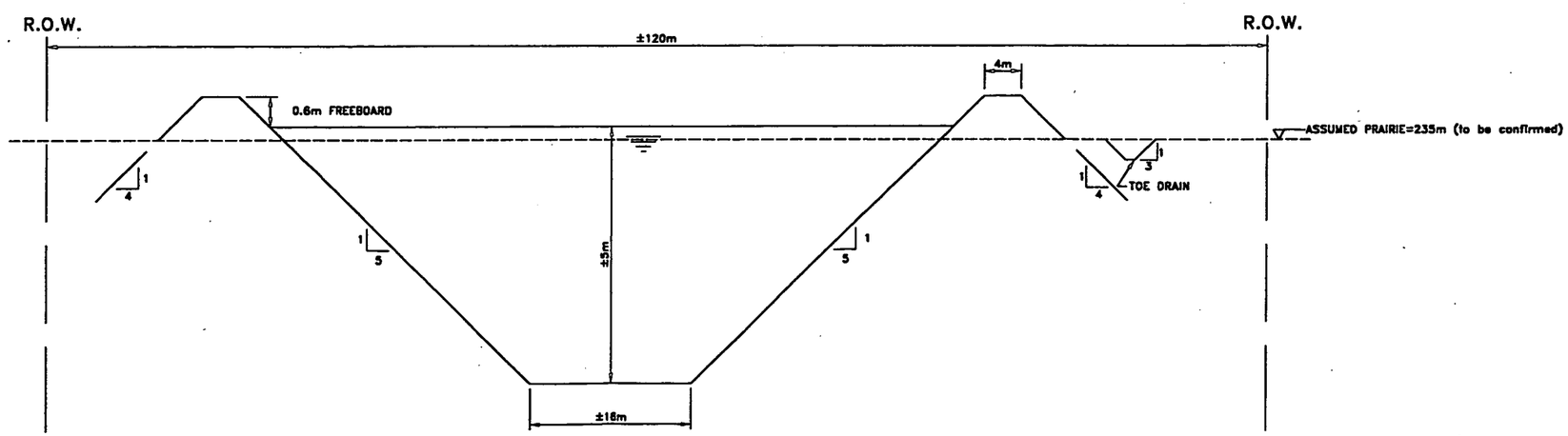


DIKE ALIGNMENT ALTERNATIVE C

Figure 4



TYPICAL CROSS SECTION OF SEINE RIVER DIVERSION CHANNEL
ADJACENT TO PROPOSED PTH. No.59
Q=3000cfs (85cms)



TYPICAL CROSS SECTION OF SEINE RIVER DIVERSION CHANNEL
Q=3000cfs (85cms)

NO.	REVISIONS	DATE	BY
–	FEASIBILITY STUDY	98/04/22	K.M.

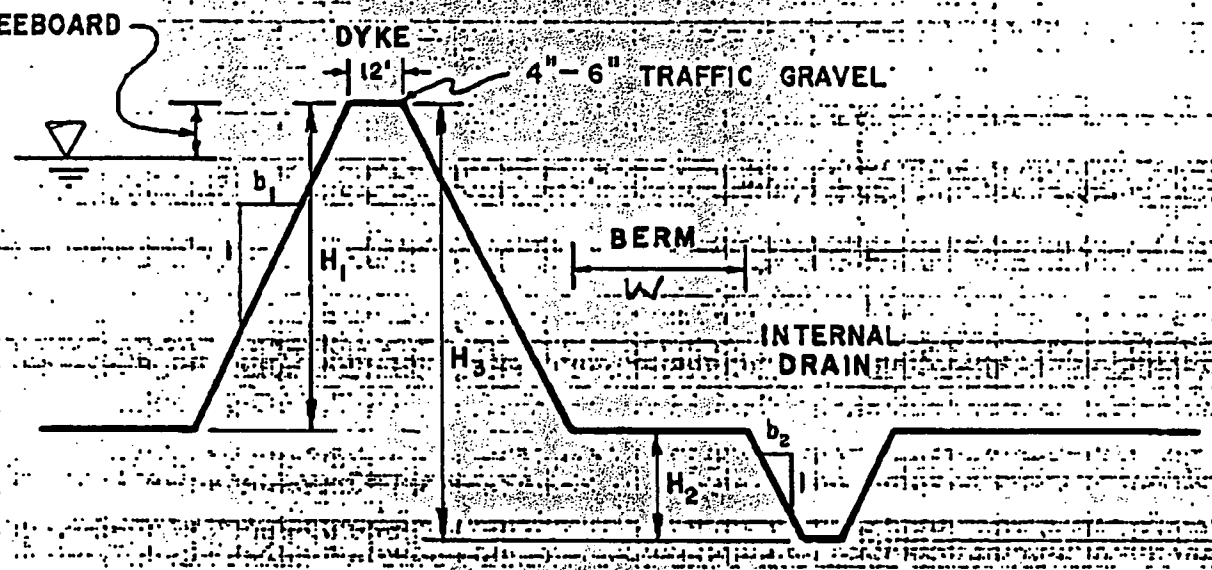
REVISIONS/ISSUE

Manitoba
Natural Resources
Water Resources Branch

WARDROP Engineering Inc.
Winnipeg • Toronto • Thunder Bay • Saskatoon

FEASIBILITY STUDY FOR COMMUNITY RING DYKES SOUTH OF THE RED RIVER FLOODWAY: SEINE RIVER DIVERSION TYPICAL CROSS-SECTIONS

DESIGNED BY: K.M.	DRAWN BY: S.L.M.	DWG NO.
CHECKED BY:	DATE: 98.04.22	971692-05-02 FIG. 5



DYKE SLOPES

H_1 Ft	b
0 - 6	~~3~~ 4
6 - 9	4
9 - 18	5

BERM WIDTH

H_3 Ft	W Ft
0 - 10	0
10 - 15	10
15 -	12

DRAIN SLOPES

H_2 Ft	b_2
0 - 4	3
4 -	4

GEOMETRIC DESIGN STANDARDS FOR DYKES

TOWN OF MORRIS, MANITOBA

FIG. 6

STEFANSON WATERSHED SERVICES

8631 Roblin Blvd., Headingley, MB R4J 1B4

Tel.: (204) 888-8040
Fax: (204) 897-3236

1 December 1997

Mr. Steven Topping, P.Eng.
Director
Water Resources Branch
1577 Dublin Ave.
Winnipeg, MB R3E 3J5

Dear Mr. Topping:

SEINE RIVER TRIBUTARY DIVERSION STUDY

In my original proposal leading to the above-noted preliminary study, I indicated that there would be an early submission of information specifically regarding reduction in flood flows on the Seine River at PTH #59 to facilitate the consideration of a diversion of the Seine River in that vicinity. In that regard, I have determined the nature of the drainage areas for the Seine River at PTH #59 as currently exists, and as would occur with a full diversion of Seine River tributaries at PTH #1, and have obtained the corresponding flood flows at various frequencies of exceedance from your Surface Water Management Section. The drainage areas are indicated on the attached location map.

The flow of information is listed as follows:

Frequency of Exceedance		Flood Flow at PTH #59			
		Current Drainage Area		Full Diversion at PTH #1	
%	Return Period	cms	cfs	cms	cfs
2.00	50 year	64.4	2,274	37.5	1,324
1.00	100 year	73.1	2,581	42.7	1,508
0.67	150 year	78.7	2,779	45.9	1,621
0.50	200 year	81.7	2,885	47.7	1,685
0.33	300 year	87.9	3,104	51.3	1,812

A diversion at PTH #59 would also involve flows from the Old Prairie Grove Drain System which is not affected by the proposed diversion along PTH #1.

Questions remain, with significance to the consideration of diversion of the Seine River at PTH #59, with respect to the feasibility and likelihood of a tributary diversion project at PTH #1 proceeding, and whether or not a feasible project would involve 100% diversion of the tributary flood flows. These questions will be addressed in the overall report on the conceptual feasibility of diversion of the Seine River tributaries at PTH #1. One must also keep in mind that, if it is ultimately decided to pursue such a project, a major channel along PTH #1, and by some route to outlet into the Red River Floodway, would arouse strong concern among those who perceive themselves to be directly affected. These concerns would require attention and how well they are addressed might determine the fate of the project.

The above information and comments are submitted for your information pending completion of the overall report.

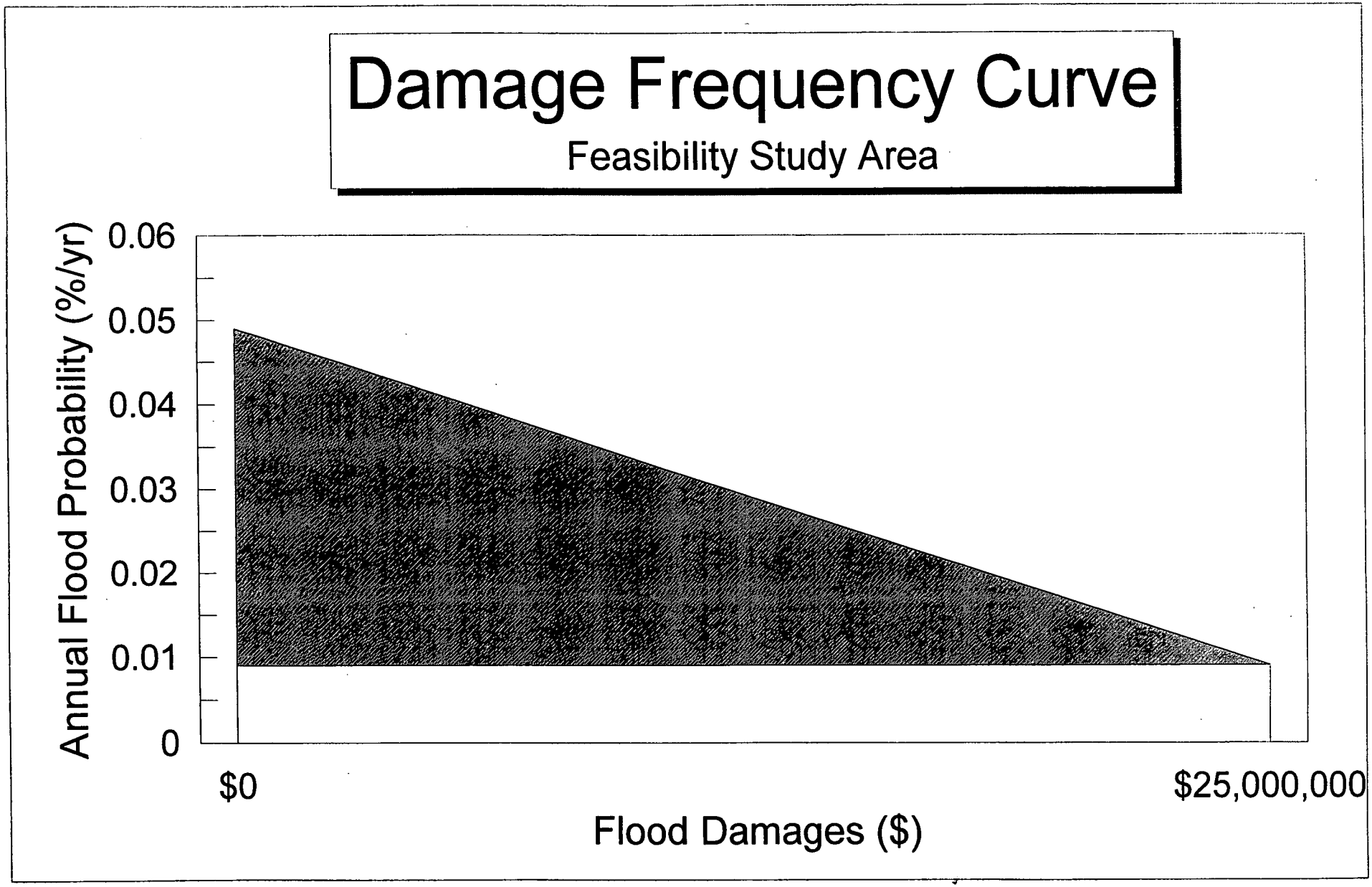
Yours truly,

Jon P. Stefanson, P.Eng.

Att.

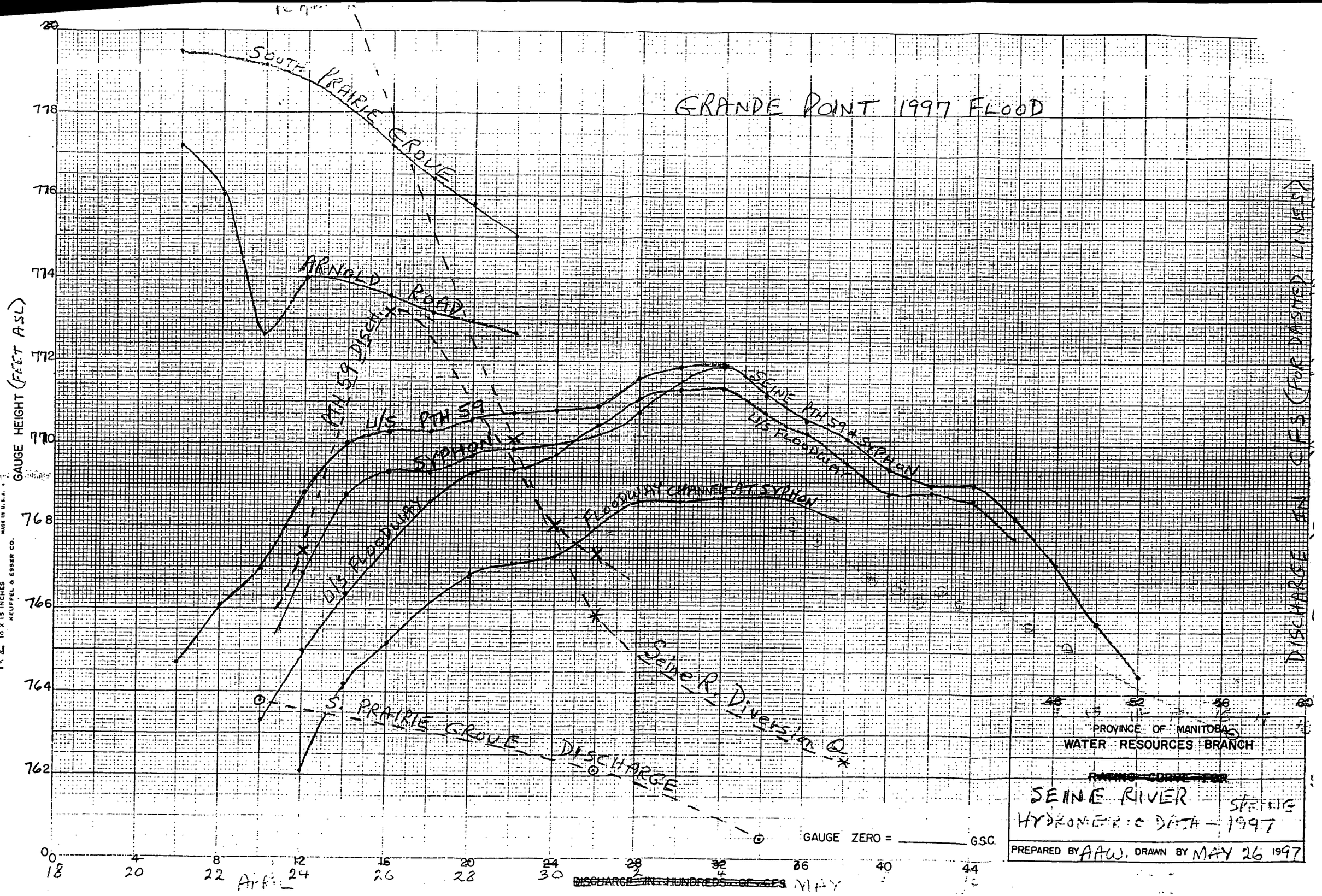
c.c. J. McLean

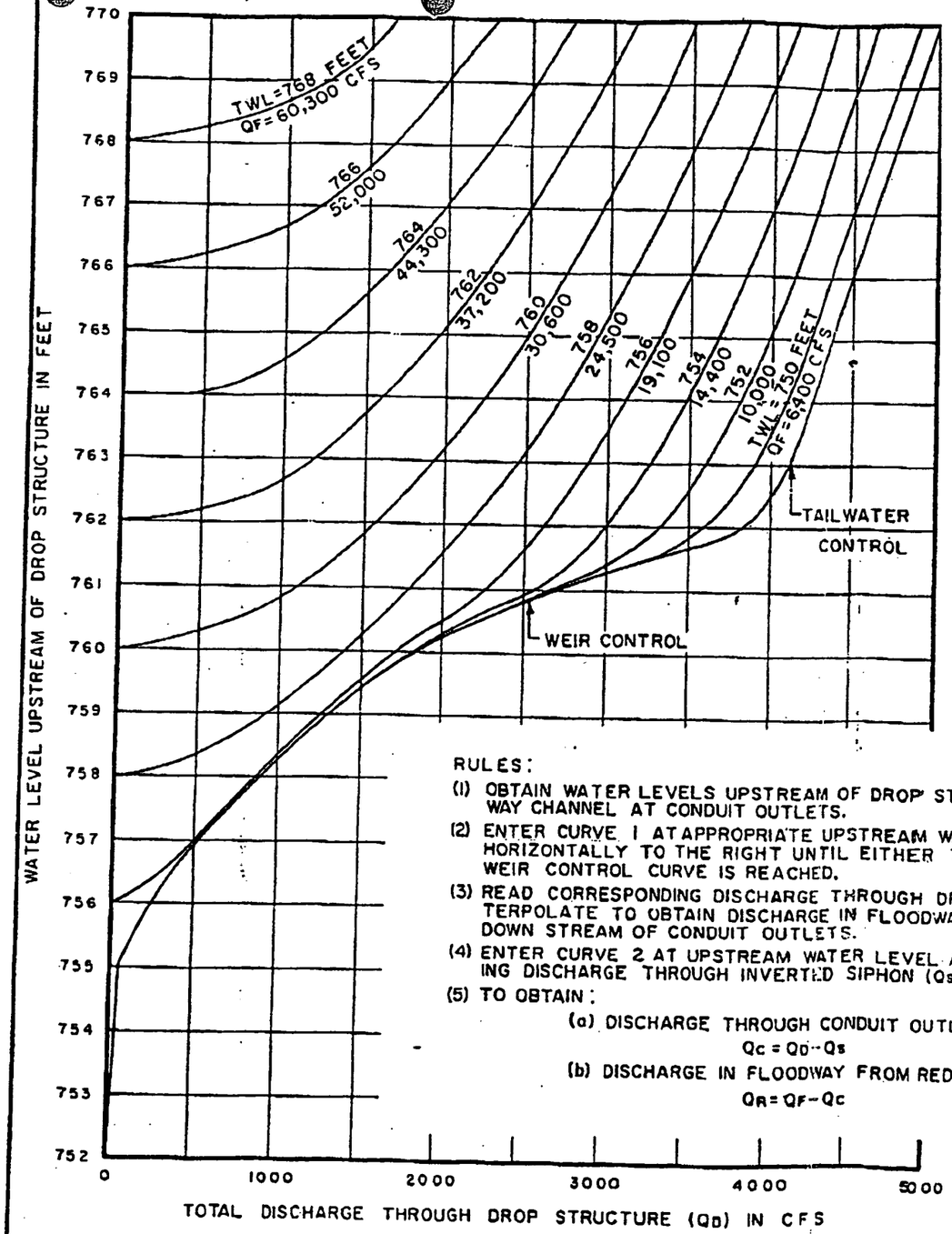
DYKE FEASIBILITY STUDY
REFERENCES



Date: 23/04/98

Job No.: 971692-05-02


GRANDE POINT 1997 FLOOD
SOUTH PRAIRIE GROVE
ARNOLD ROAD
PTH 59 DISCH X
U/S PTH 59 SYPHON X
U/S FLOODWAY
FLOODWAY CHANNEL AT SYPHON
SEINE PTH 59 & SYPHON
U/S FLOODWAY
Seine R. Diversion Q
S. PRAIRIE GROVE DISCHARGE
GAUGE HEIGHT (FEET ASL)
DISCHARGE (CFS) (FOR DASHED LINES)
GAUGE ZERO = _____ G.S.C.
~~DISCHARGE IN HUNDREDS OF CFS~~
APRIL
MAY
PROVINCE OF MANITOBA
WATER RESOURCES BRANCH
~~RATING CURVE FOR~~
SEINE RIVER
HYDROMETRIC DATA - 1997
PREPARED BY AAW. DRAWN BY MAY 26 1997



CURVE 1

RULES:

(1) OBTAIN WATER LEVELS UPSTREAM OF DROP STRUCTURE AND IN FLOODWAY CHANNEL AT CONDUIT OUTLETS.

(2) ENTER CURVE 1 AT APPROPRIATE UPSTREAM WATER LEVEL. PROCEED HORIZONTALLY TO THE RIGHT UNTIL EITHER THE DESIRED TWL OR WEIR CONTROL CURVE IS REACHED.

(3) READ CORRESPONDING DISCHARGE THROUGH DROP STRUCTURE (Q_D). INTERPOLATE TO OBTAIN DISCHARGE IN FLOODWAY (Q_F) IMMEDIATELY DOWN STREAM OF CONDUIT OUTLETS.

(4) ENTER CURVE 2 AT UPSTREAM WATER LEVEL AND OBTAIN CORRESPONDING DISCHARGE THROUGH INVERTED SIPHON (Q_S).

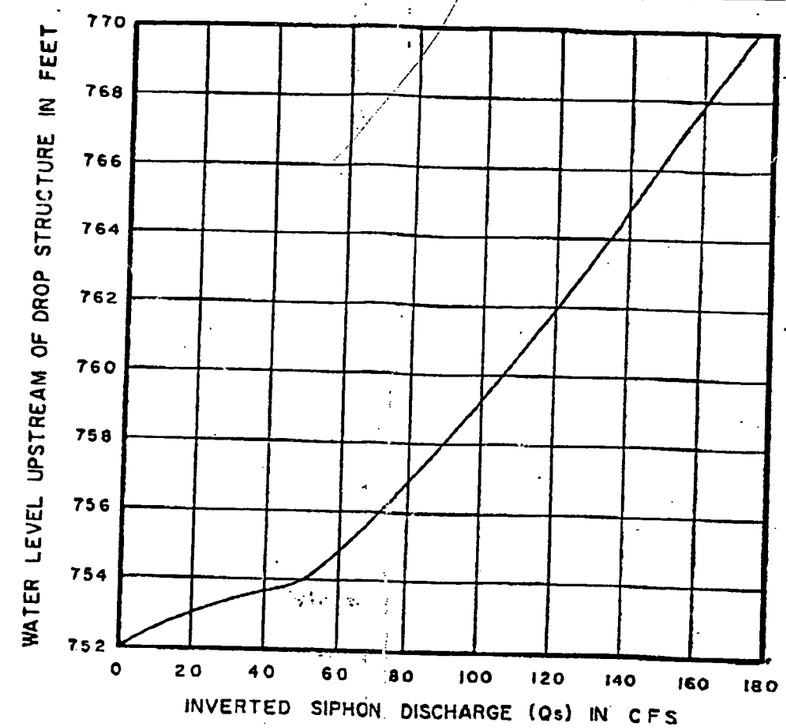
(5) TO OBTAIN:

(a) DISCHARGE THROUGH CONDUIT OUTLETS (Q_C)

$$Q_C = Q_D - Q_S$$

(b) DISCHARGE IN FLOODWAY FROM RED RIVER ONLY (Q_R)

$$Q_R = Q_F - Q_C$$



CURVE 2

NOTE:

THE RATING CURVES FOR THE SEINE RIVER AND THE FLOODWAY, AT THE DROP STRUCTURE SITE, WERE SUPPLIED BY THE PROVINCE OF MANITOBA, DEPARTMENT OF AGRICULTURE AND CONSERVATION, WATER CONTROL AND CONSERVATION BRANCH.

ACRES WESTERN LIMITED

PROVINCE OF MANITOBA
DEPARTMENT OF AGRICULTURE AND CONSERVATION

RED RIVER FLOODWAY – SEINE RIVER DROP STRUCTURE

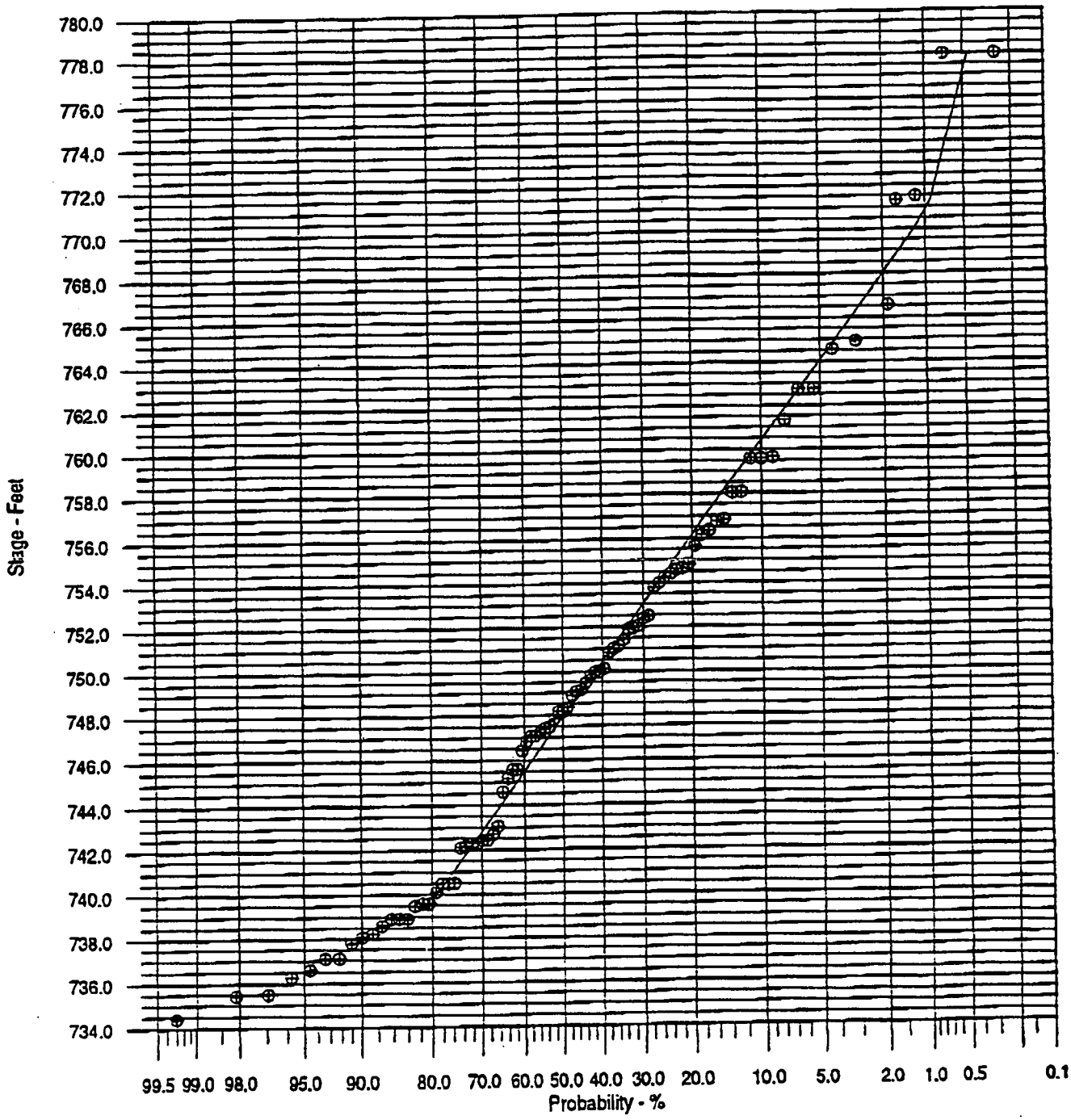
DROP STRUCTURE RATING CURVES

ACRES WESTERN LIMITED	SCALE			MATERIAL LIST No.
	DATE APRIL 26, 1966			INDEX No.
	DRAWN G.E.W.	CHECKED D.G.R.	PROJECT ENGINEER	DRAWING No. SK-1386-A-505 SHEET OF
				REV.

DRAWING No. SK-1386-A-505 SHEET OF REV.

PROVINCE OF MANITOBA
WATER RESOURCES BRANCH
RED RIVER ABOVE FLOODWAY CONTROL STRUCTURE
STAGE - FREQUENCY CURVE

Period of Record 1913 - 1997
Including Historic Floods of 1776, 1826 & 1852



17 Land Purchase

17.1 Land Values

Region [d]	Good [a] Agric. Land	Average [b] œ[Bœ[B Agric. Land	Poor [c] Agric. Land
Steinbach	$1500/ha	$1000/ha	$250/ha
Morden	$2900/ha	$1300/ha	$500/ha
Souris	$ 800/ha	$ 600/ha	$300/ha
Portage la Prairie	$1300/ha	$1000/ha	$250/ha
Selkirk	$1200/ha	$ 600/ha	$300/ha
Minnedosa	$1100/ha	$ 700/ha	$250/ha
Dauphin	$1200/ha	$ 800/ha	$300/ha
Brandon	$1300/ha	$ 800/ha	$300/ha

[a] Good agricultural land — Class 1 and 2
[b] Average agricultural land — Class 3
[c] Poor agricultural land — Classes 4, 5 and 6
[d] Regions outlined as per Appendix A.

17.2 Land Acquistion Costs

Cost of land acquisition including appraiser fees, negotiations and legal work = 30% of land cost, but not less than $1500/title.

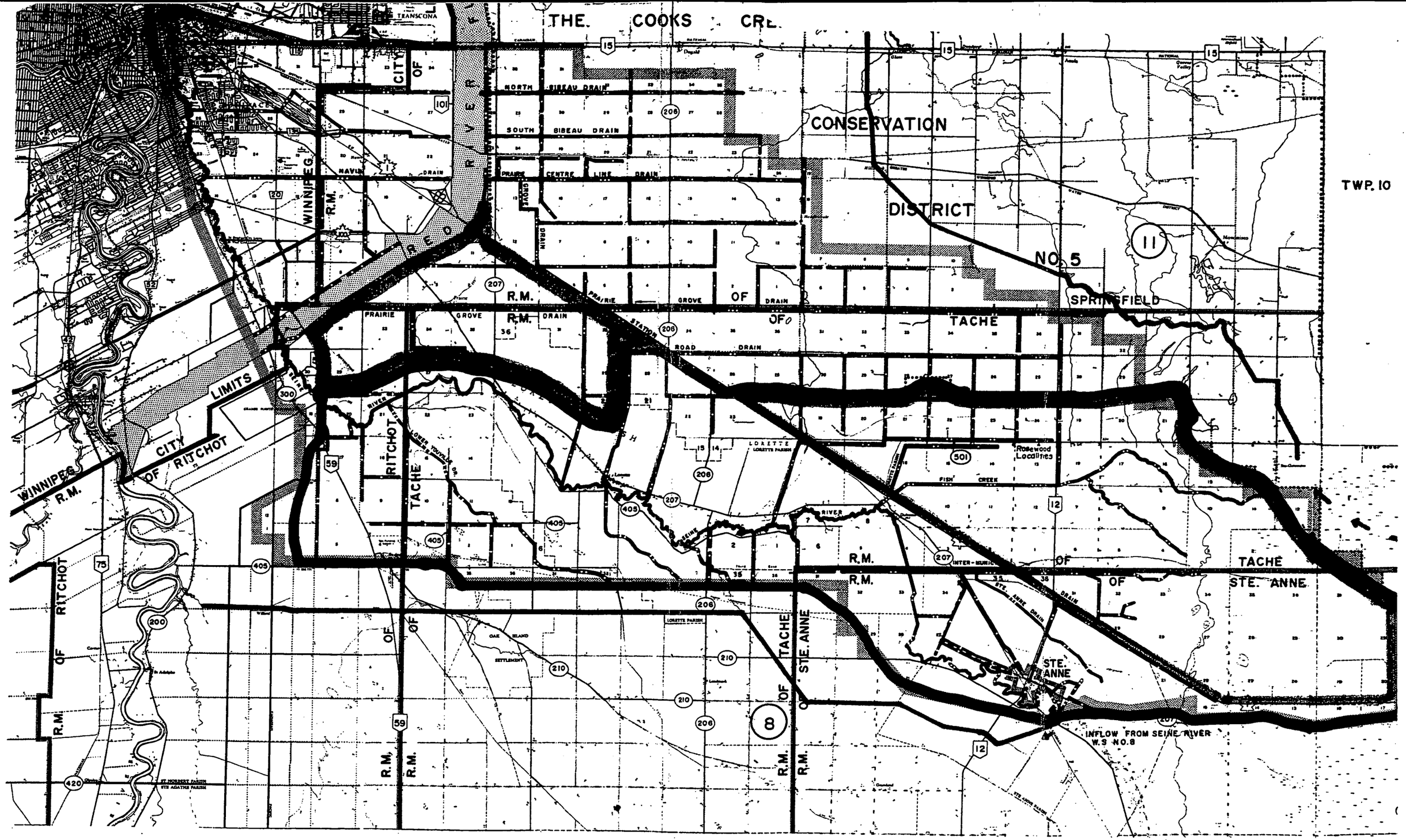
17.3 Legal Survey Costs

Cost of legal survey including cutting and clearing of survey line, drafting and preparation of legal plan = 50% of land cost, but not less than $800/parcel.

18 Equipment Rentals

Table of Typical Equipment Rentals Rates per Hour

Machine	Type	Hourly Rate
Backhoe	Drott, 1 yd^3	$75.90
Loader	$1\frac{1}{2} yd^3$ bucket, front-end wheeled	$34.86
Scraper	self-propelled single engine	$4.73/$yd^3$ + $16.25
	self-propelled twin engine	$5.62/$yd^3$ + $16.25
	pull type with D–8H	$1.42/$yd^3$ + $81.00
Dozer	D-8H	$81.00
Dragline	cable operated, $1\frac{1}{2} yd^3$ bucket	$90.62


THE COOKS CREEK
TRANSCONA
CITY OF WINNIPEG
NORTH BIBEAU DRAIN
SOUTH BIBEAU DRAIN
PRAIRIE GROVE CENTRE LINE DRAIN
CONSERVATION DISTRICT NO. 5
SPRINGFIELD
TWP. 10
R.M. OF TACHE
PRAIRIE GROVE DRAIN
STATION ROAD DRAIN
WINNIPEG R.M. OF RITCHOT
CITY OF RITCHOT LIMITS
RITCHOT
TACHE
LORETTE
Rosewood Localities
FISH CREEK
R.M. OF TACHE
R.M. OF STE. ANNE
STE. ANNE
INFLOW FROM SEINE RIVER W.S. NO. 8
RGE. 3E.
RGE. 4E.
RGE. 5E.
RGE. 6E.
RGE. 7E.

Manitoba

Memorandum

Date · March 10, 1998

To · R. J. Bowering, P. Eng.
· Manager
· Surface Water Management Section
· Water Resources Branch

From · R. W. Harrison, P. Eng.
Senior Hydrologist
· Surface Water Management Section
Water Resources Branch

Telephone · 945-7411
File: 5.5

Subject · **Dyking South of the Red River Floodway - Impact Lost Floodplain Storage**

First | Fold

The impact that dyking south of the Red River Floodway would have on the 1997 flood levels has been assessed. The area proposed to be dyked extends from P.T.H. No. 59 to the Red River west and south to Richardson Road. The dyked area will result in the loss of the natural floodplain storage.

The reduction in natural floodplain storage would result in increased water levels and flows on the rising limb of the flood hydrograph and conversely decreased water levels and flows on the falling limb of the flood hydrograph. The change in daily flows was estimated to be equivalent to the daily lost floodplain storage. The daily change in flows was computed using daily water levels recorded on the Red River above the Floodway Control Structure (from our flood sheets) and a flooded area relationship for the dyked area. The flooded area relationship was based on topography obtained from the 1951 Red River Basin Investigation (plan 11-5-1002A). The change in floodplain storage was added to the recorded flow on the Red River above the Floodway Control Structure. Water levels for the dyked condition were estimated from the discharge rating curve for the Red River above the Floodway Control Structure using the adjusted flows for the dyked condition.

The analysis indicates the greatest increase in stage at the dyked area occurs on the raising limb of the flood hydrograph at about elevation 768.0 feet. This corresponds to the most rapidly rising point on the 1997 flood hydrograph. At this point the maximum increase in water level of about 0.7 feet occurs as a result of lost floodplain storage. At the 1997 flood peak, an increase in water level of only 0.02 feet is expected as a result of the lost floodplain storage. The increases at the peak flood level is relatively minor as almost all the lost floodplain storage has occurred and water levels are increasing very slowly in 1997 at the peak.

The Wardrop Report on the "Feasibility Study: Dyking Alternatives for South of the Red River Floodway" assesses the impact of lost floodplain storage on the 1997 flood. A worst case scenario would be more rapidly rising flood levels at the peak, as occurred in 1974. If a flood peak similar to 1974 had occurred, the reduction in floodplain storage would produce an increase in the peak flow of 1000 to 1500 cfs. This would translate into a relative increase in water levels of 0.10 to 0.15 feet at the peak. However, this analysis does not account for the impact of increased floodplain storage upstream of the dyked area due to increased water levels caused by the construction of the dykes on upstream water levels. This incease in floodplain storage upstream of the dyked area may offset the lost in floodplain storage from the dyked area. However, a dynamic routing model would be required to assess this impact.

For large floods, it is generally expected that flood peaks would be relatively flat as experienced in 1997 as opposed to 1974 (a smaller flood) due to greater impacts of floodplain storage in the Red River Valley.

R. W. Harrison

RWH:jm

MS 1 25 894 01-00830

REFERENCES

Reference No.	Description
Reference 1	Environment Act Proposal (for PTH 59, February, 1994 Report by Reid Crowther & Partners Ltd. (For Manitoba Highways & Transportation)
Reference 2	Stefanson Memo - December, 1997

REFERENCE - DRAWINGS

Drawing No.	Project	Description/Title
1386-C-1001	Seine River Drop Structure	Site Plan
1386-C-1002	Seine River Drop Structure	General Arrangement of Project
1386-C-1003	Seine River Drop Structure	Excavation
1386-C-1004	Seine River Drop Structure	Outlet Conduits and Inverted Siphon
1386-C-1005	Seine River Drop Structure	Inlet Concrete Details
1386-C-1006	Seine River Drop Structure	Inlet Reinforcing Details
1386-C-1007	Seine River Drop Structure	Inverted Siphon Outlet Concrete & Reinforcing Details
1386-C-1008	Seine River Drop Structure	Backfill & Slope Protection
1386-A-1006-RS (3)	Seine River Drop Structure	Inlet Reinforcing Details
1386-A-1007-RS (2)	Seine River Drop Structure	Inverted Siphon Outlet Concrete & Reinforcing Details
1386-5A-1009	Seine River Drop Structure	Reinforcing Steel Data Sheet
11-5-3014A	Seine River Drop Structure	Tunnel Line Installation
AI37	Map	Ile Des Chênes
AH36	Map	Ste. Agathe
AJ38	Map	Lorette
AI36	Map	St. Adolphe
No. 72	Map	General Highway Map-R.M. of of Ritchot
62H/11 (edition 4)	Map	St. Adolphe
62H/14 (edition 4)	Map	Winnipeg
12,965	Land Titles	Special No. 1 Red River Floodway - Special Plot

REFERENCE - DRAWINGS

	Map	Hallama Drive
	Map	Hallama Drive
	Map	Red River Floodway (3)
	Map	Legal Map: Study Area for Dykes South of the Red River Floodway Area Property Count Information
	Proposed Dyke Allowance	Dominion City
	Proposed Dyke Allowance	Landmark
	Proposed Dyke Allowance	Red River Drive
	Proposed Dyke Allowance	Riverside
	Proposed Dyke Allowance	Gretna
	Proposed Dyke Allowance	Grande Pointe
	Proposed Dyke Allowance	Niverville
	Proposed Dyke Allowance	Aubigny
	Proposed Dyke Allowance	Ste. Agathe
	Proposed Dyke Allowance	St. Lazarre
	Proposed Dyke Allowance	Rosenort
	Proposed Dyke Allowance	Emerson
	Proposed Dyke Allowance	St. Pierre-Jolys
	Proposed Dyke Allowance	St. Adolphe
11-1-1220	Township Map	Ste. Agathe
16-1-1305 (total of 6 sheets)	Map	Grande Pointe
11-1-1629A (4)	Flood Damage Reduction Program	City of Winnipeg
	Interim Flood Risk Map	City of Winnipeg

REFERENCE - DRAWINGS

No. 1746A	R.M. of Ritchot	Profile of P.R. No. 200 (St. Mary's Rd.) From South Boundary of Red River Floodway to St. Adolphe
	Property Ownership Map for R.M. #165	Ritchot - St. Adolphe
Plate 5.4A	P.T.H. 59 Functional Planning Study	East of Floodway Interchange
Plate 5.4A	P.T.H. 59 Functional Planning Study	South Side of Floodway to Lavallée Rd.
Plate 5.4B	P.T.H. 59 Functional Planning Study	South Side of Floodway to Lavallée Rd.
Plate 5.6A	P.T.H. 59 Functional Planning Study	North of Lavellée Rd. To North of Mondor Rd.
Plate 5.6B	P.T.H. 59 Functional Planning Study	North of Lavallée Rd. To North of Mondor Rd.
AJ36	Map	St. Norbert
AJ37	Map	Prairie Grove
	Map of Flooded Area (Charts)	Northern Red River
	Map of Flooded Area (Charts)	Northern Red River
	Map of Flooded Area (Charts)	Red River Valley
17-5-1045	Plan of Marsh River Watershed & Adjacent Areas	Designation of Drains
10-1-1275	Proposed Profile of P.R. 246	From P.T.H. 23 to Augigny

REFERENCES AERIAL PHOTOGRAPHS

Photo No.	Description
MH96677402-256 L-1001	Red River Floodway South
MH96677402-255 L-1001	Red River Floodway South
MH96677402-257 L-1001	Red River Floodway South
MH96677402-259 L-1001	Red River Floodway South
MH96677402-258 l-1001	Red River Floodway South
MH96677402-260 L-1001	Red River Floodway South
MB87003 16	Red River Floodway South
MB87003 15	Red River Floodway South
MB87003 14	Red River Floodway South
MB87003 13	Red River Floodway South
MB87003 209	Red River Floodway South
MB87003 208	Red River Floodway South
MB87003 207	Red River Floodway South
MB87003 206	Red River Floodway South
MB87002 18	Red River Floodway South
MB87002 17	Red River Floodway South
MB87002 16	Red River Floodway South
MB87002 15	Red River Floodway South
MB97002-230	Red River Floodway South
MB97002-231	Red River Floodway South
MB97002-232	Red River Floodway South
MB97002-233	Red River Floodway South
MB97002-234	Red River Floodway South
MB97002-235	Red River Floodway South
MB97002-223	Red River Floodway South

REFERENCES AERIAL PHOTOGRAPHS

MB97002-222	Red River Floodway South
MB97002-221	Red River Floodway South
MB97002-220	Red River Floodway South
MB97002-219	Red River Floodway South
MB97002-218	Red River Floodway South
MB97002-217	Red River Floodway South
MB97002-187	Red River Floodway South
MB97002-188	Red River Floodway South
MB97002-189	Red River Floodway South
MB97002-190	Red River Floodway South
MB97002-191	Red River Floodway South
	Red River Floodway South