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GLACIAL SPILLWAYS IN THE PRAIRIES

A NATURAL HISTORY THEME STUDY OF GLACIAL SPILLWAYS IN NATURAL REGIONS 12, 13, AND 14

bу

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SUMMARY

The three best and most outstanding glacial spillways in the Prairies are the Qu'Appelle, Milk River, and Battle. The Qu'Appelle Spillway is the longest, widest, and deepest of these three and has the highest natural value score. Even though 11 points were deducted from the Qu'Appelle Spillway score for human impact, the final rating for this spillway is six more than for the Milk River and Battle Spillways.

In the opinion of the author, the Qu'Appelle Spillway is the best and most outstanding spillway in the Prairie Provinces.

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INTRODUCTION

Objective

The objective of this study of "Glacial Spillways in the Prairies" is fourfold:

- 1. To prepare a professional discussion on the origin and character of spillways.
- 2. To inventory glacial spillways of the Prairie Provinces incorporating the following:
 - a. name of spillway;
 - b. location of spillway;
 - c. a brief descritpion of spillway including length, width of valley floor, vertical relief, and other factors;
 - d. a brief description of natural values associated with spillway;
 - e. a brief description of the significant human impact on spillways; and
 - f. a list of references.
- 3. To comparatively rank all spillways in terms of quality of representing the glacial landform theme.
- 4. To select from the above inventory the best and most outstanding example of a glacial spillway in the Prairie Provinces.

<u>Previous Work</u>

Publications used in the compilation of this report are listed in the references cited, and the material used in the inventory is also cited on the inventory sheets in the Appendix.

Much of the material presented in the report is taken from a paper being prepared for submission to the Canadian Journal of Earth Sciences which is entitled, "History of deglaciation of southern Saskatchewan and adjacentareas". This compilation covers an area between 112°W. Long. in Alberta and Lake Agassiz in Manitoba and between 48°N. Lat. in the U.S.A. and 58°N. Lat. in Canada.

<u>Present Study</u>

The discussion on the origin and character of glacial spillways is based on the published information cited in the bibliography and on original unpublished material gathered by the author during studies of the Quaternary geology of Saskatchewan.

The inventory of glacial spillways is based primarily on office work in Saskatoon but includes a two-day office study of maps and photographs at the Alberta Department of Energy and Resources, Edmonton; a two-day field study of Alberta spillways; and after the first phase of the inventory was completed, a four-day field study of the best spillways in the Prairies. Because the history of the last deglaciation was not compiled for much of Alberta, it was necessary to determine the various glacial lake levels and associated ice frontal positions in order to locate the spillways of that Province.

GLACIAL DRAINAGE

As the continental glacier retreated upslope from the Mississippi River Basin (Fig. 1), meltwater was carried directly away from the retreating ice in meltwater channels which emptied into the Missouri River. Most meltwater channels occur in interlobate areas which were formed by the protrusion of pre-existing topographically high areas within the drainage basins (Fig. 2). As the lobes of ice retreated downslope from these uplands, the meltwater traced out ice-marginal meltwater channels (Manybone Creek, Fig. 3; and Arm River, Fig. 4) which were compelled to follow the surface contour rather than trending down the regional slope.

As the glacier retreated downslope in the Nelson, Churchill, and Mackenzie River Basins (Fig. 1), however, extra-glacial channels such as the South and North Saskatchewan Rivers (Fig. 5) carried runoff from the region that sloped toward the continental glacier and meltwater from the Rocky Mountain glaciers into ice-dammed glacial lakes. This extra-glacial water and the meltwater from the continental glacier drained southeastward from lake to lake through glacial spillways (Assiniboine Spillway, Fig. 5) which cut major valleys in drift and bedrock, particularly in drainage basin divides.

GLACIAL SPILLWAYS

Glacial spillways were formed by overflow of water from glacially dammed lakes. As the glacier retreated down the regional slope to the northeast in the Prairie Provinces, successively lower and younger glacial lakes were dammed by the retreating ice and, consequently, successively lower and younger spillways were formed. The level of a glacial lake at a particular time was governed not only by the position of the glacier but also by the level of the lake into which the spillway drained. The level of glacial Lake Melfort (Fig. 5), for example, was governed by the level of glacial Lake Agassiz into which the

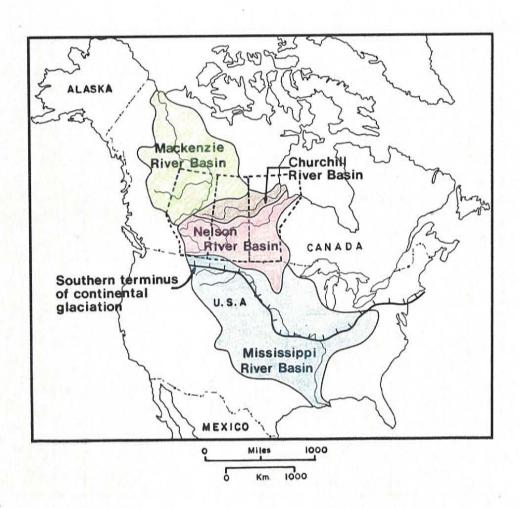


Figure 1. Map showing major drainage basins in the Prairie Provinces.

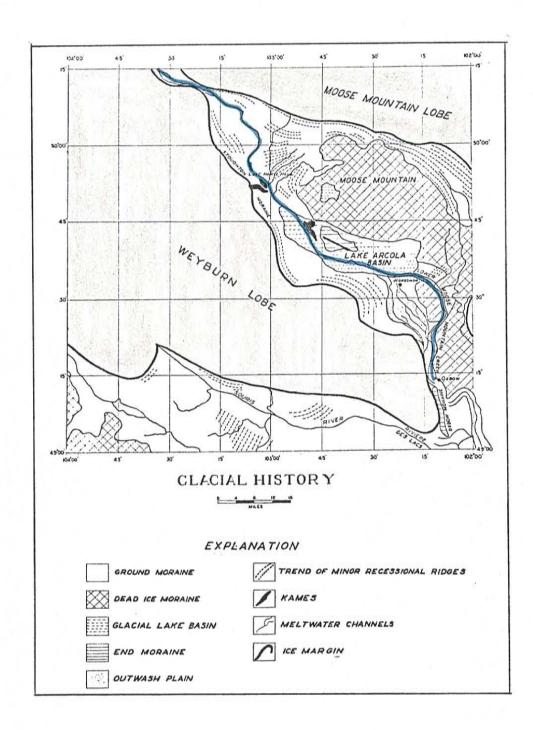


Figure 2. Origin of the Moose Mountain Creek meltwater channel. This interlobate area was initiated by the protrusion of the Moose Mountain Upland. (From Christiansen, 1956, p. 29).

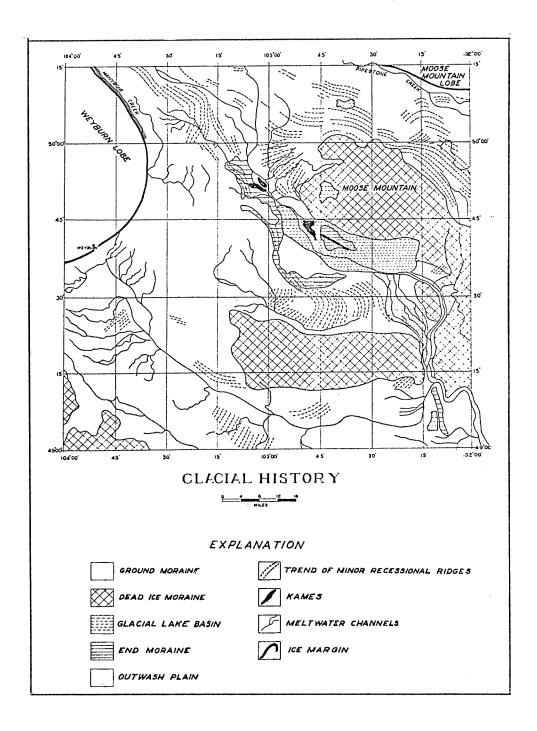


Figure 3. Origin of the ice-marginal meltwater channel, Manybone Creek. (From Christiansen, 1956, p. 31).

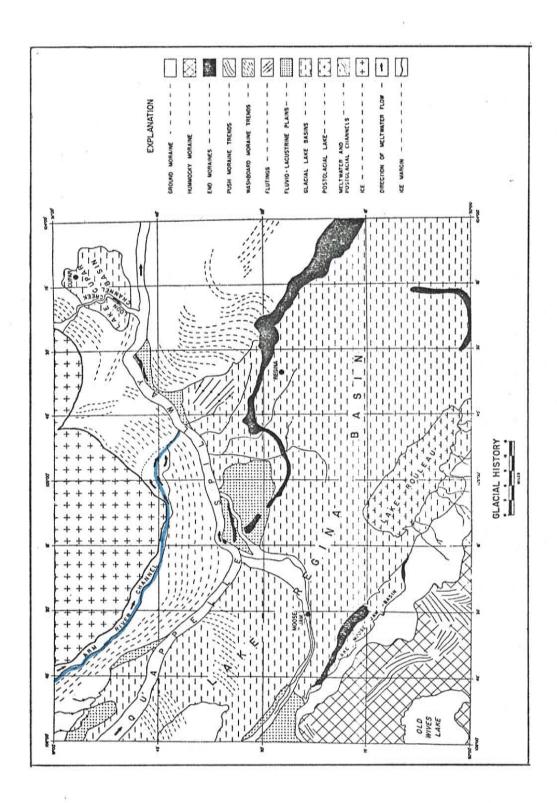


Figure 4. Origin of Arm River Channel. (From Christiansen, 1961, p. 51).

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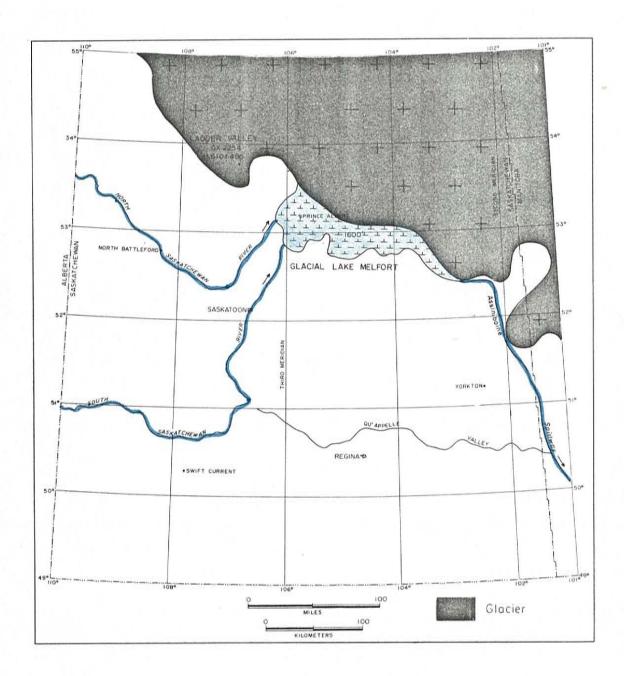


Figure 5. Extra-glacial South and North Saskatchewan Rivers. (From Christiansen, 1972 p. 43).

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Assiniboine Spillway drained.

Glacial spillways carried water from glacial lakes which in turn were replenished by flow through extra-glacial channels (South and North Saskatchewan, Fig. 5) and by meltwater flow through meltwater channels. The Assiniboine Spillway (Fig. 5) carried both extra-glacial water and meltwater from the continental glacier, whereas the Cutarm Spillway (Fig. 6), for example, carried only meltwater from glacial Lake Saltcoats.

As in the case of meltwater channels, many spillways were formed along the ice margin (Pipestone Spillway, Fig. 7). Other spillways, however, were quite remote from the glacier (Souris Spillway, Fig. 7). The separation of these two spillways was caused by the Moose Mountain Uplands which formed the drainage divide between them. It was the protrusion of such pre-existing topographically high areas that dominated the shape of the ice margin and, consequently, the pattern of the meltwater channels and spillways.

Presently both meltwater channels and glacial spillways are being filled with sediments derived mainly from erosion in the valley walls and adjacent uplands as shown by well-developed, piedmont alluvial fans and plains that flank the valley walls. Between the alluvial fans and the slump blocks, the latter of which are abundant where the valley is cut in shale, particularly glacially disturbed shale, alluvial flood plains meander on top of alluvial fills. In the Qu'Appelle Valley, testholes indicate the alluvium is up to 90 metres thick. The flood plains are occupied by underfit streams, marshes, and temporary or permanent lakes.

Both meltwater channels and spillways are out-of-equilibrium with the postglacial environment. Since glaciation, more sediment has been brought into the valleys than the underfit streams can remove resulting in deposition of alluvium. Although recent, unpublished radiocarbon dates from the Qu'Appelle Valley indicate the rate of sedimentation is decreasing, ultimately these valleys will be filled with sediment.

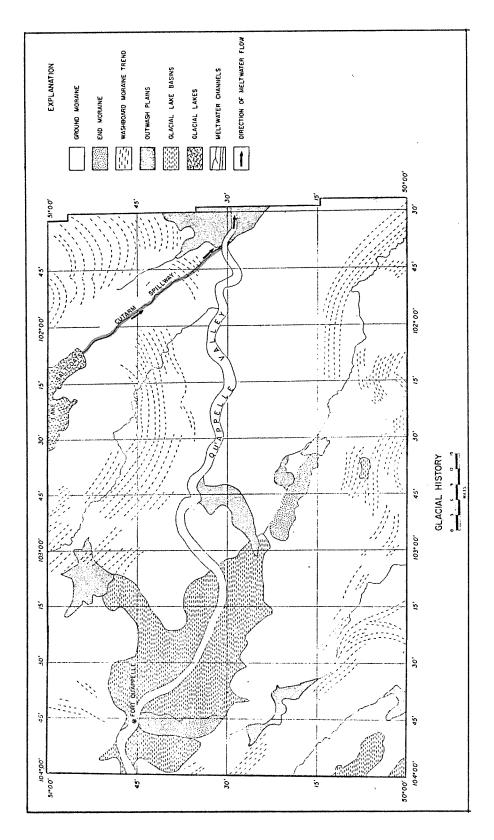


Figure 6. Origin of the Cutarm Spillway. (From Christiansen, 1960, p. 41).

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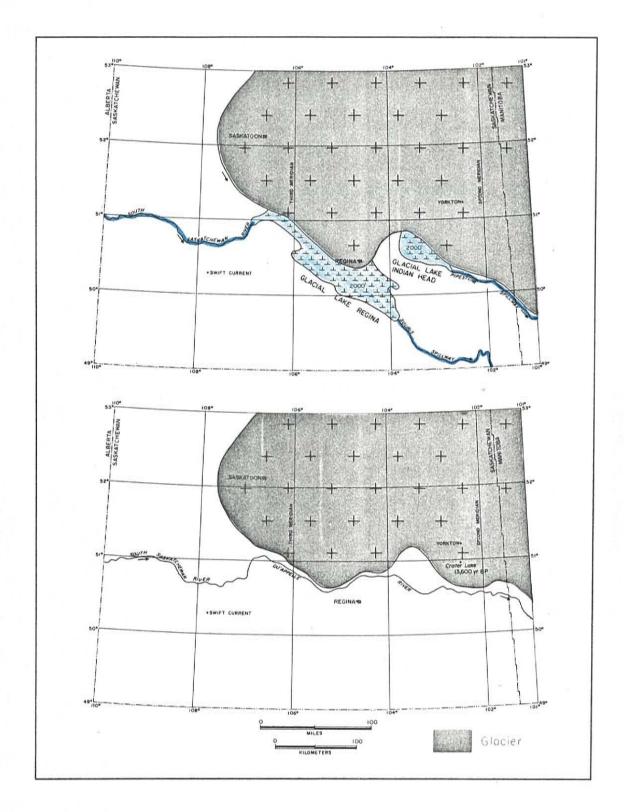


Figure 7. Origin of glacial Lakes Regina and Indian Head and the Souris and Pipestone Spillways. (From Christiansen, 1972, p. 42).

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INVENTORY OF GLACIAL SPILLWAYS

Introduction

The spillways were inventoried under the following headings: (1) name of spillway; (2) location of spillway; (3) description of spillway; (4) natural values associated with spillway; and (5) significant human impact on spillway; (Appendix, pages 1 and 2 of 3). A list of references for each spillway appears on pages 2 of 3 (Appendix).

Name of Spillway

The name of the spillway was taken from the literature or from a stream or lake occupying it. The words "creek" or "river" may or may not appear in the name depending of the sound of the spillway name.

Location of Spillway

The location of the spillway is shown on a map (Appendix, page 1 of 3). A scale was chosen which would permit the location of the spillway to be shown on a map with demensions less than 13x18 centimetres.

The seven best developed spillways have a part of their courses also located on topographic maps at a scale of 1:250,000 with 100-foot contour intervals. In addition to these location maps, the three best spillways have the best part of their courses located on topographic maps at a scale of 1:125,000 with 25-foot contour intervals (Appendix, between pages land 2 of 3).

Description of Spillway

The description of the spillway includes length, width of valley floor, relief, depth of fill, whether in drift only or in drift and bedrock, and whether it drained meltwater only or meltwater and extra-glacial runoff. The length of a spillway is taken as the length occupied by the present stream from which the spillway was named. Although the Qu'Appelle Spillway at one time, for example, extended to the Assiniboine Delta east of Brandon (Klassen, 1975, p. 50), the spillway between the confluence of the present Qu'Appelle and the Assiniboine Delta was assigned to the Assiniboine Spillway.

The width of the spillway was measured at the widest point along its coarse but not where it is locally anomalously wide because of some peculiarity. The relief measured represents the maximum relief along the entire course of the spillway. Because the depth of the fill is only known for the Qu'Appelle

and Assiniboine Valleys, this item was not included in the description although it appears in the inventory sheets.

NATURAL VALUES ASSOCIATED WITH SPILLWAYS

Introduction

Natural values in the uplands within 20 kilometres of the spillway include ridged moraine, ice-thrust moraine, end moraine, flutings, eskers, tunnel valleys, glacial lake basins, outwash plains, and meltwater channels. Natural values within the spillways include landslides, bedrock exposures, springs, alluvial fans, flood plains, streams, marshes, lakes, deltas, beaches, and terraces (Appendix, pages 2 of 3).

Ridged Moraine

Ridged moraine is used herein to describe minor, subparallel, generally arcuate ridges (1-5 m high) and intervening swales in till. Gwynne (1942) demonstrated the ridged moraine trend is parallel to the position formerly occupied by the ice margin.

Ice-thrust Moraine

Ice-thrust moraine is used herein to describe major, subparallel generally arcuate ice-thrust ridges (up to 60 m high) and intervening swales. The landform is similar to ridged moraine except the ice-thrust ridges are larger. Byers (1959) demonstrated the ice-thrust moraine is the surface expression of glacial thrusting and that the ridges are parallel to the position formerly occupied by the ice margin. The ice-thrust moraine associated with the Qu'Appelle Spillway south of Esterhazy (Appendix, p. 3) was overridden by ice as shown by the occurrence of till that blankets the moraine. The similar appearance of the ice-thrust moraine associated with the Milk River Spillway (Appendix, p. 8) suggests that this thrust moraine was also overridden by ice.

End Moraine

The broad, long ridges (up to 50 m high) that are conspicuous on 1:50,000 topographic sheets are interpreted as end moraines. In some localities, end moraines are composed of belts of hummocky moraine.

Flutings

Flutings are narrow, straight to gently curved, parallel ridges and grooves in till. The ridges are 1 to 10 metres high and the inter-ridge distance is up to 130 metres. Chapman and Putnam (1951, p. 15, 99, 212) concluded that the grooves are erosional features formed at the base of a moving glacier and that the ridges and grooves trend in the direction of ice movement.

Eskers

Eskers are sinuous ridges of sand and gravel formed in tunnels at the base of melting glaciers. For the most part, eskers are poorly developed in the Prairies.

Tunnel Valleys

Meltwater flowing beneath the ice can either form depositional features (eskers) or erode valleys in the material under the glacier to form tunnel valleys (Embleton and King, 1968).

Glacial Lake Basins

As the glacier retreated down the regional slope to the northeast in the Prairies, successively lower glacial lakes were dammed by the retreating ice. These lakes are recorded in the present landscape by deltaic sands and gravels and lacustrine silts and clays and are called glacial lake basins.

Outwash Plains

Outwash plains are used herein to describe blankets of sand and gravel which are either derived from the melting glacier or from the erosion of drift, mainly till. Outwash plains form either where there was a decrease in gradient or an increase in the width of the stream.

Meltwater Channels

Meltwater channels are channels which carried meltwater directly from the retreating glacier (Fig. 2). Meltwater channels appear in the present landscape as valleys which are identical in appearance to spillways and which can only be distinguished on the basis of origin.

Landslides

Landslides are perceptible downward movement of relatively dry drift and bedrock. These features are best developed where the spillway was eroded in bedrock, particularly disturbed bedrock shales.

Bedrock Exposures

Bedrock exposures are best developed in sandy bedrock which is less susceptible to sliding than shale. Where the spillway is cut into the weaker shales, most of the bedrock is covered with landslide debris which is composed of a mixture of bedrock and drift.

<u>Springs</u>

Springs discharge into the valley slopes of the spillways from bedrock sand, from sand and gravel between bedrock and till, from intertill sand and gravel, and from surficial sand and gravel. The rate of discharge from these springs depends on the areal extent and permeability of the water bearing material.

Alluvial Fans

Alluvial fans are low, outspreading, gently sloping masses of loose gravel, sand, silt, and clay shaped like an open fan. This landform develops where tributary valleys enter the spillway floor. Alluvial fans are the most important sedimentary environment in the alluvial fills in the spillways.

Flood Plains

Flood plains are strips of relatively smooth land adjacent to stream channels and are constructed when the streams overflow their banks in times of high water. The positions of the flood plains and streams on the spillway bottoms are controlled primarily by the growth of the alluvial fans. Where the fans are extensive on one side of the valley, the flood plains are restricted to the opposite side of the spillway floor.

Streams

All streams on the spillway floors are underfit and in many cases ephemeral. With a normal snowmelt, these streams generally reach flood stage. During the remainder of the year, however, they flow at a very reduced rate or dry-up entirely.

Marshes

Marshes develop in water-saturated areas that are covered by shallow water at least during the growing season. Marshes occur in oxbow lakes, in low-lying parts of the flood plain, in deltas, in the periphery of alluvial fans extending into lakes, or wherever there is a relatively permanent body of shallow, quiet water.

Lakes

Lakes cover parts of the valley floor of many spillways. Most lakes are shallow and are believed to be dammed by alluvial and colluvial material from fans and landslides. Other lakes are anomalously deep such as The Fishing Lakes in the Qu'Appelle Spillway which are believed to be related to an enormous groundwater discharge that took place from the buried Hatfield Valley during deglaciation.

Deltas

A delta is a low, nearly flat alluvial tract of land deposited at or near the mouth of a stream. Because the spillways are commonly occupied by small ephemeral streams, the deltas are poorly developed. Where the streams are well developed, however, and the distances between lakes are considerable, well-developed deltas occur.

Beaches

The best beaches are developed where the shore is in alluvial fans. In such areas offshore bars, raised beaches, and lagoons occur.

Terraces

Terraces are bench-like features which break the continuity of the valley slope. In a few places, paired terraces occur. In most places, however, terraces are restricted to the inside of meander bends where the ancient stream bottoms were preserved as the stream slipped-off toward the other side of the valley.

SIGNIFICANT HUMAN IMPACT ON SPILLWAYS

The major human impact on spillways are dams and conveyance channels, highways and grid roads, railroads, towns, villages, and resorts. The impact of agriculture on the physical features of the spillway is believed to be negligible. Although sand and gravel operations are common on many of the terraces, a field inventory would be required to assess this impact because most aerial photographs are out-of-date.

Although dams are listed on pages 2 of 3 in the Appendix, they were not evaluated because it could not be determined from the maps and photographs whether they are merely control structures maintaining the level of natural lakes or impounding artifical lakes. Furthermore, most maps and photographs are out-of-date and do not show all the structures.

Because secondary roads are believed to have much less impact than high-ways on the spillways, only highways are evaluated for their impact. It is known, however, that some grid roads have a major impact because of substantial cuts and fills. An impact assessment of secondary roads would require a field inventory.

EVALUATION OF SPILLWAYS

<u>Introduction</u>

Spillways were evaluated on description, natural values, and human impact. Out of 100 points, 40 were assigned to the description, 40 to the natural values, and 20 to the human impact. The breakdown is shown on pages 3 of 3 of the Appendix.

Evaluation

Twenty one of the best developed spillways were evaluated (Table 1). Although other spillways occur in the Prairie Provinces, they are not well enough developed to be evaluated.

Table 1. Evaluation of Spillways

Qu'Appelle	85	Thunder Creek	66
Milk River	79	Whitebear	66
Battle	79	Chin	65
Pembina	75	Pipestone	65
Assiniboine	74	Cutarm	62
Clearwater	73	Lewis	62
Big Muddy	73	Neidpath	59
Souris	71	Spruce Creek	58
Tramping Lake	71	Crawling Valley	58
Sounding Creek	71	Pass Creek	52
Etzikom	66		

The comparison of the top three spillways is shown in Table 2.

Table 2. Comparison of the Evaluations of the Top Three Spillways

<u>Spillwa</u> y	<u>Description</u>	<u>Natural Values</u>	<u>Human Impac</u> t	<u>Point</u> s
Qu'Appelle	38	38	9	85
Milk River	32	27	20	79
Battle	28	33	18	79

The Qu'Appelle Spillway is the longest, widest, and deepest spillway and has the highest natural values associated with it. Compared to the Milk River and Battle Spillways, however, the Qu'Appelle Spillway has a considerably larger human impact.

The Milk River Spillway, although the most spectacular because of its steep walls of exposed, colored bedrock giving it a canyon-like form, has no marshes, lakes, deltas, and beaches within the valley. It could be argued such features are not spillway values but are postglacial landforms. The author, however, has chosen to evaluate the spillways as they appear today rather than as they might have appeared when they functioned as overflow channels.

The Battle Spillway, although shallower than the Milk River Spillway, has more natural values associated with it. As in the case of the Qu'Appelle Spillway, many of the natural values associated with the Battle Spillway are postglacial and, consequently, were not present when it functioned as a spillway.

CONCLUSION

The Qu'Appelle Spillway is selected by the author as the best and most outstanding spillway in the Prairies. The Qu'Appelle Spillway has the longest, widest, and deepest valley and has the most natural values associated with it. Although this spillway lost 11 points in the evaluation because of human impact, it still received 6 points more than the second and third ranking spillways.

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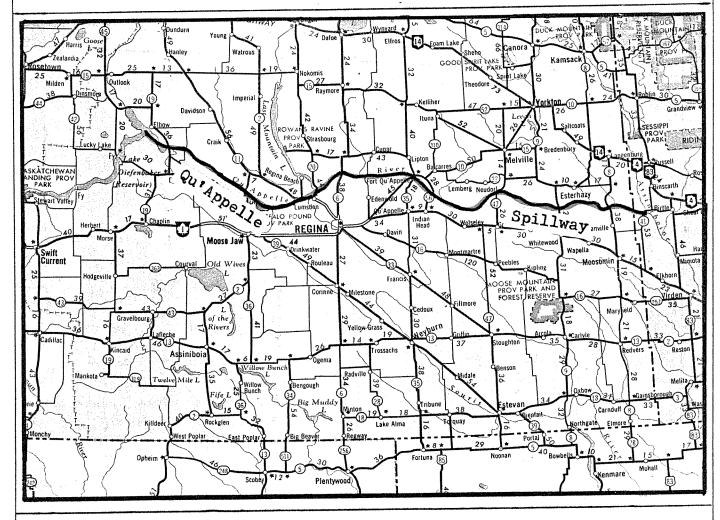
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INVENTORY OF GLACIAL SPILLWAYS

NAME OF SPILLWAY Qu'Appelle Spillway

LOCATION OF SPILLWAY

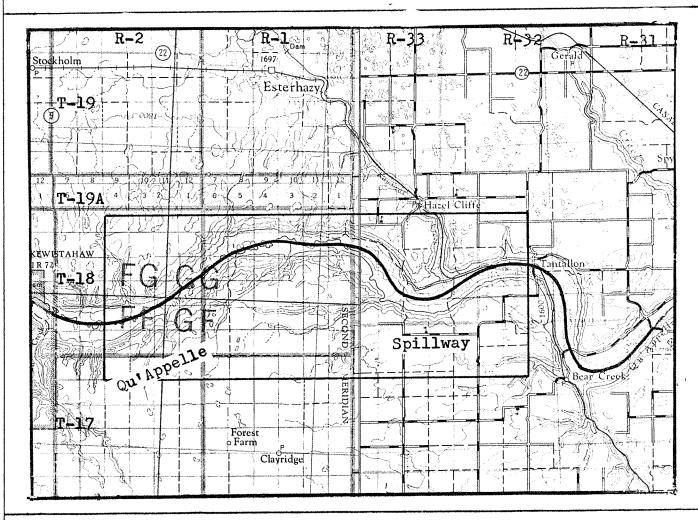


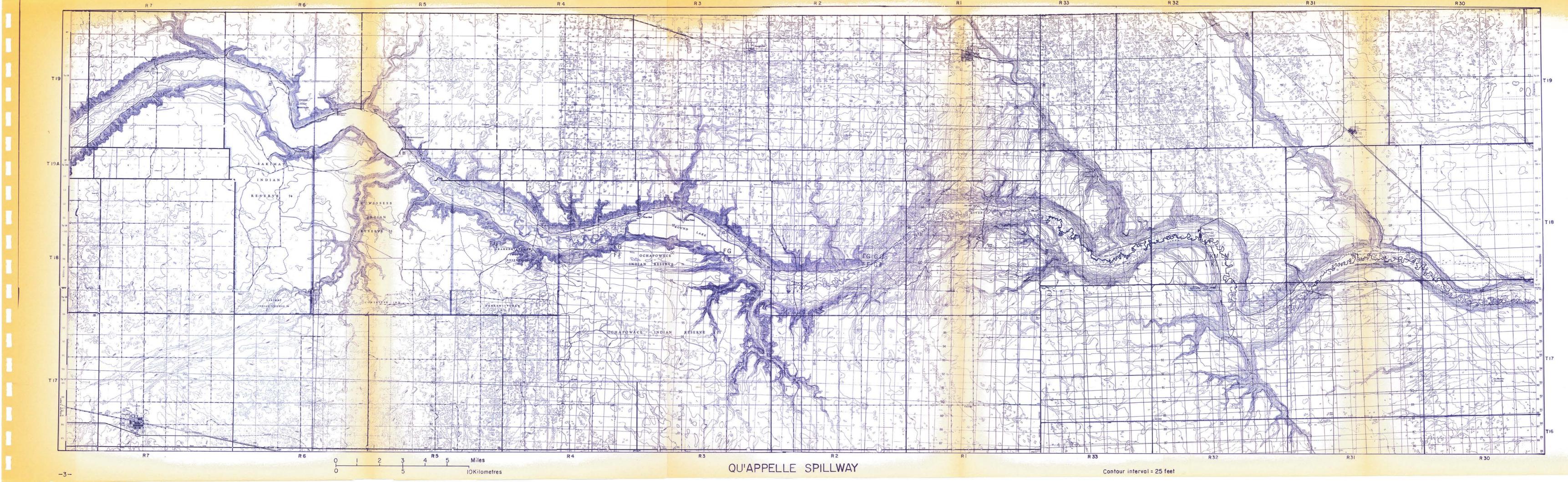
DESCRIPTION OF SPILLWAY Length _____ km | Depth of fill _____ m Width ______ m In drift _____ Relief ______ m In drift & bedrock _____ x Drained meltwater only _____ Drained meltwater & runoff __x Other remarks . 100 Kilometres 0004-002 ____E. A. Christiansen Consulting Ltd. -

INVENTORY OF GLACIAL SPILLWAYS

NAME OF SPILLWAY Qu'Appelle Spillway

LOCATION OF SPILLWAY





NATURAL VALUES	ASSOC:	IATED WITH SPILLWAY *	
Ridged Moraine	Pg	Bedrock Exposures	Рр
Ice-thrust Moraine		Springs	Pg
End Moraine		Alluvial Fans	Pg
Flutings		Flood Plains	Pg
Eskers		Stream	Pg
Tunnel Valleys		Marshes	Pg
Glacial Lake Basins		Lakes	Pg
Outwash Plains		Deltas	Pg
Meltwater Channels		Beaches	Pg
Landslides		Other Terraces	Pg
Landslides			
SIGNIFICANT	NAMUH	IMPACT ON SPILLWAY	
	7	No. of tours	2
No. of dams		No. of villages	5
Km of highways		1	
Km of railroads		No. of resorts	
		S ON SPILLWAY	- h o
Christiansen, E.A. 1960. Geol	ogy ar	nd ground-water resources of t	ne
Qu'Appelle area, Saska	atchewa	an. Sask. Res. Counc., Geol. I)iv.,
Rept. 1, 53 p.			
Klassen, R.W. 1975, Quaternar	y geo	logy and geomorphology of	<u></u>
Assiniboine and Qu'App	oelle V	Valleys of Manitoba and	
Saskatchewan, Geol. Si	ury. Ca	an., Bull. 228, 61 p.	
* Within 20 km of spillway.	Pg=goo	od; Pp = poor; and NP= not pres	sent.
	2 .7		04-002
Qu'Appelle Spillway			
		Q A (Q) . (Q)	(0.)
		E. A. Christiansen Consulting	Ild

EVALUATION OF SPILLWAY

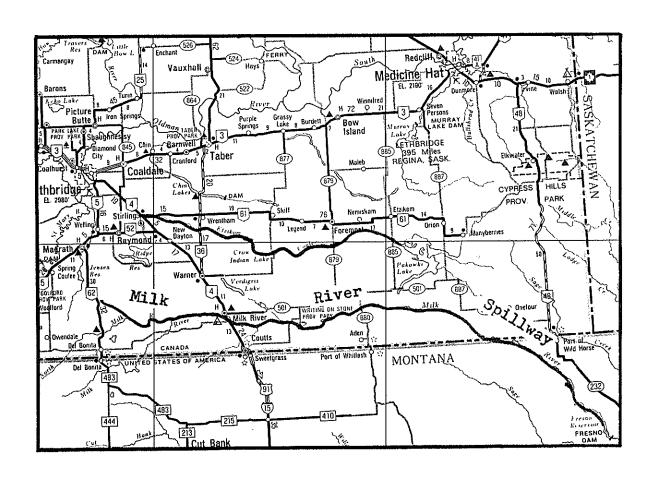
DESCRIPTION OF SPILLWAY

Length (>300 km = 10; 200-300 km = 7; $<$ 200 km = 4	10
Width (>2000 m = 10; 1000-2000 m = 7; < 1000 m = 4)	10
Relief	8
Drained glacial meltwater only = 5	
Drained glacial meltwater and proglacial runoff= 10	10
NATURAL VALUES ASSOCIATED WITH SPILLWAY **	
Ridged Moraine 2 Bedrock Exposures	1
Ice-thrust Moraine 2 Springs	2
End Moraine 2 Alluvial Fans	2
Flutings 2 Flood Plains	2
Eskers 1 Stream	2
Tunnel Valleys 2 Marshes	2
Glacial Lake Basins 2 Lakes	2
Outwash Plains 2 Deltas	2
Meltwater Channels 2 Beaches	2
Landslides 2 Other Terraces	2
SIGNIFICANT HUMAN IMPACT ON SPILLWAY	
Km of highways=4-(km of highways/length of spillway x 4)	. 3
Km of railroads=4-(km of railroads/length of spillway x 4) $\underline{}$	3
No. of towns (0 or $l=4$, $2=3$, $3=2$, 4 or more = 0)	
No. of villages (0 or $l = 4$, $2 = 3$, $3 = 2$, 4 or more $= 0$)	0
No. of resorts (0 or $l=4$, $2=3$, $3=2$, 4 or more $=0$)	0
Total out of 100	85
*** Pg = 2, Pp = 1, and NP = 0. ** < 100 m = 2 100-125 m = 4 125-150 m = 6 150-175 m = 8 175-200 m = 10	
0004·	i
E. A. Christiansen Consulting S	Ltd

INVENTORY OF GLACIAL SPILLWAYS

NAME OF SPILLWAY Milk River Spillway

LOCATION OF SPILLWAY

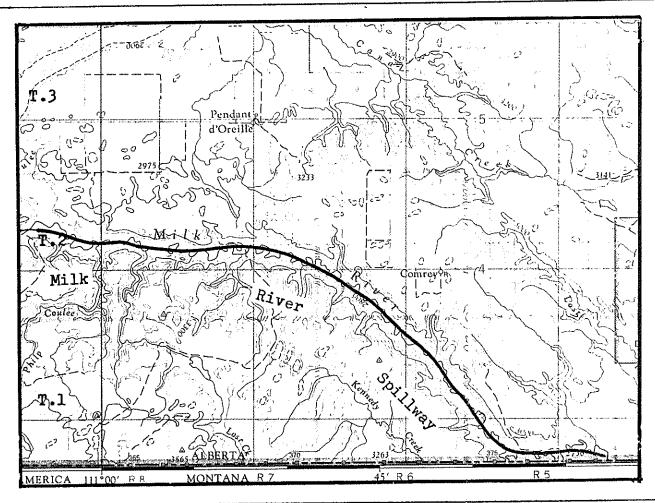


			DES	CRI	PTION	OF SPILLWAY	
Length _	240			· · · · · · · · · · · · · · · · · · ·	_ km	Depth of fill	m
Width	1	200			m	In drift	
Relief .	150				m	In drift & bedrock x	
Drained	meltwater	only .				Drained meltwater & runoff x	
Other re	emarks					The second secon	
		Miles Kilometres	10 	0 ^, ; 0 1	, ' , -	20 30 40 50 Mrles 0 40 50 60 70 Kilometres	
				Scale: Or	ne Inch Equa	s Approximately 25 Miles	
						0004-00	2
						E. A. Christiansen Consulting Ltd.	

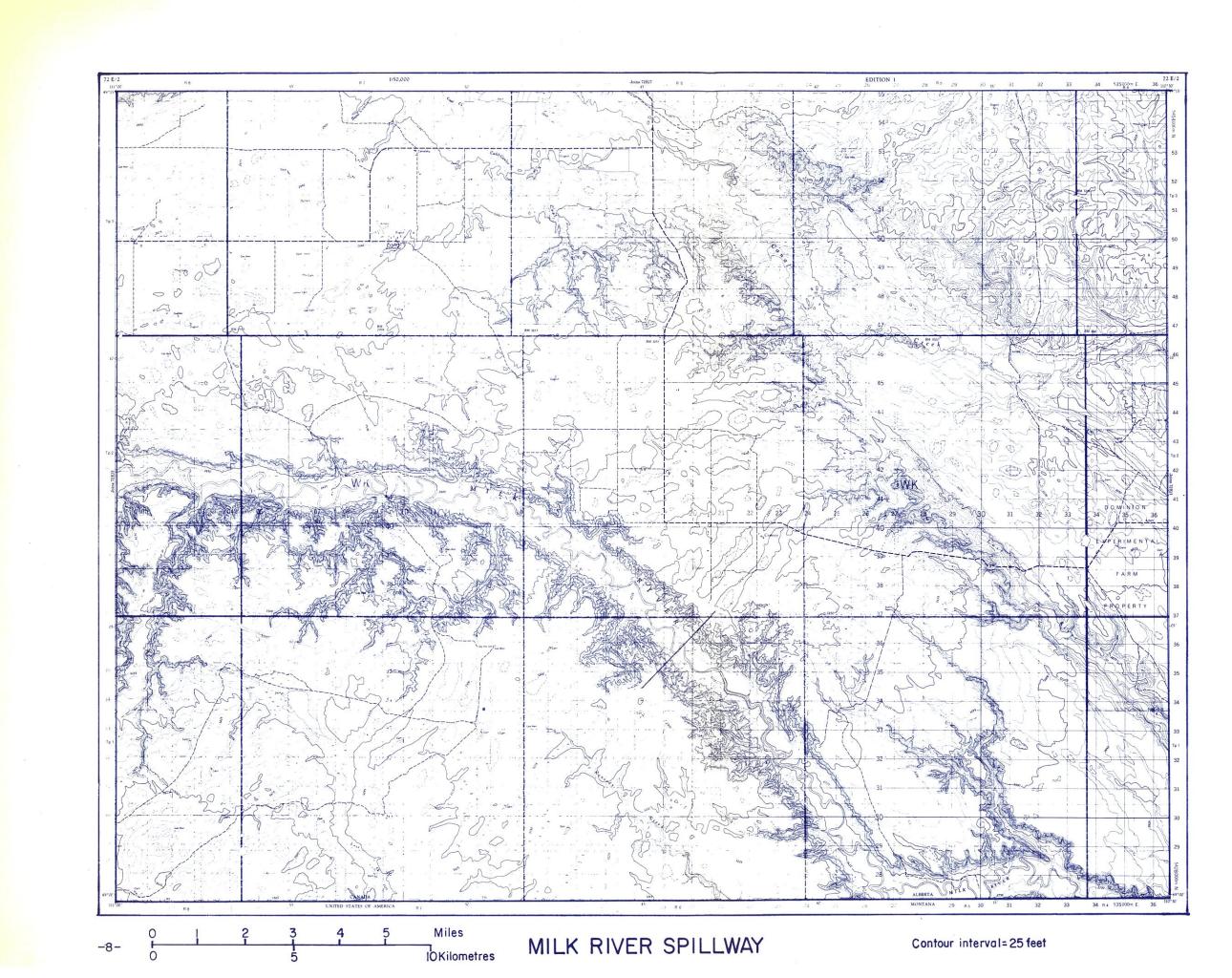
INVENTORY OF GLACIAL SPILLWAYS

NAME OF SPILLWAY Milk River Spillway

LOCATION OF SPILLWAY



DESCRIPTION OF SPILLWAY Length _____ km | Depth of fill _____ m Width _____ m In drift ____ Relief _____ m | In drift & bedrock _____ Drained meltwater only _____ Drained meltwater & runoff _____ Other remarks 0004-002 _____E. A. Christiansen Consulting Ltd. -



NATURAL VALUES ASSO	CIATED WITH SPILLWAY *
Ridged Moraine Pg	Bedrock Exposures Pg
Ice-thrust Moraine Pp	Springs Pp
End MorainePg	Alluvial Fans Pg
Flutings Pg	Flood Plains Pg
Eskers Pg	Stream Pg
Tunnel Valleys Pp	Marshes NP
Glacial Lake Basins Pg	Lakes NP
Outwash Plains Pg	Deltas NP
Meltwater Channels Pg	Beaches NP
	Other Terraces Pp
Landslides Pp	
SIGNIFICANT HUMA	N IMPACT ON SPILLWAY
No. of dams 0	No. of towns 1
Km of highways 2	No. of villages 0
Km of railroads 2	No. of resorts 0
LIST OF REFERENCE	
Bretz, J.H. 1943. Keewatin end mo	
Geol. Soc. Am. Bull., v. 5	
Westgate, J.A. 1968. Surficial ge	eology of the Foremost - Cypress
westgate, o.a. 1700, but a. Res.	Counc. Alta., Bull. 22, 121 p.
TILLS GLOST THE	
→ Within 20 km of spillway. Pg=g	ood; Pp = poor; and NP= not present. 0004-002
Milk River Spillway	
	6 A Christianson Consulting Std

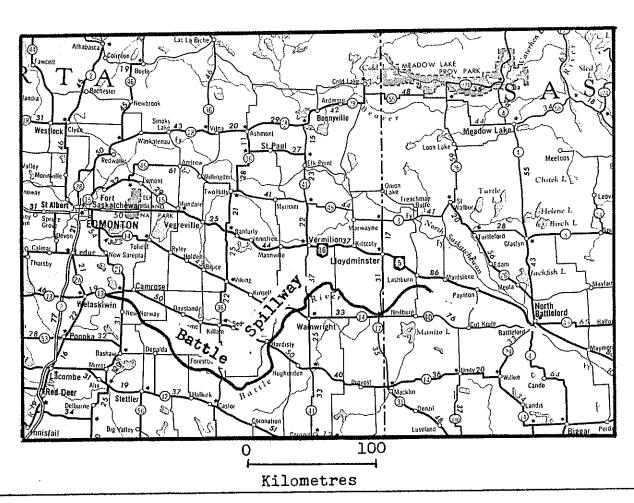
EVALUATION OF SPILLWAY

DESCRIPTION OF SPILLWAY

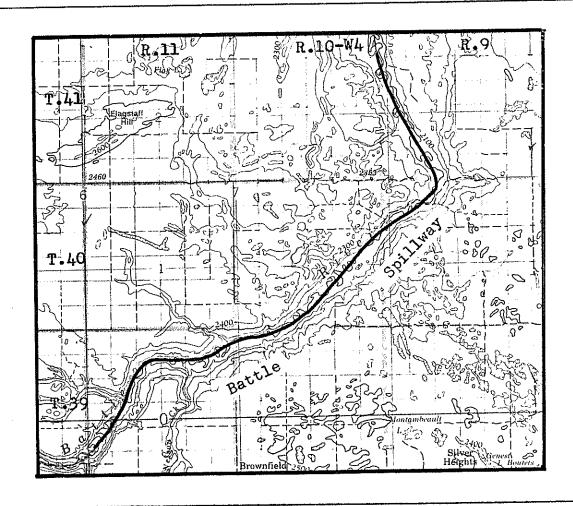
Length (>300 km = 10; $200-300$ km = 7	;<200 km = 4	7
Width (>2000 m = 10; $1000-2000 m = 7$	•	
Relief	•	
Drained glacial meltwater only = 5 -	•	
Drained glacial meltwater and progl	-	10
	IATED WITH SPILLWAY **	
Ridged Moraine 2	Bedrock Exposures	2
Ice-thrust Moraine l	Springs	1
End Moraine 2	Alluvial Fans	_2
Flutings 2	Flood Plains	2
Eskers 2	Stream	2
Tunnel Valleys 1	Marshes	0
Glacial Lake Basins 2	Lakes	0
Outwash Plains 2	Deltas	0
Meltwater Channels 2	Beaches	0
Landslides 1	OtherTerraces	1
SIGNIFICANT HUHAN	IMPACT ON SPILLWAY	
Km of highways = 4 -(km of highways/1	ength of spillway x 4)	4
Km of railroads = $\frac{1}{4}$ -(km of railroads	/length of spillway x 4) $_{-}$	
No. of towns (0 or $1=4$, $2=3$,	3=2, 4 or more=0)	4
No. of villages (0 or $l=4$, $2=3$	3=2, 4 or more $=0$)	4
No. of resorts (0 or $l=4$, $2=3$	3=2, 4 or more =0)	4
Total out of 100	and the tree and the tree the tree to the control of the control of the tree tree tree to the tree tree tree tree tree tree tree	79
** $Pg = 2$, $Pp = 1$, and $NP = 0$.	100 m = 2 00-125 m = 4 25-150 m = 6 50-175 m = 8	
	75-200 m = 10	₊ - 002
	E. A. Christiansen Consulting	
-10-	- Olorio Charletta Constituing	oc/116

NAME OF SPILLWAY Battle Spillway

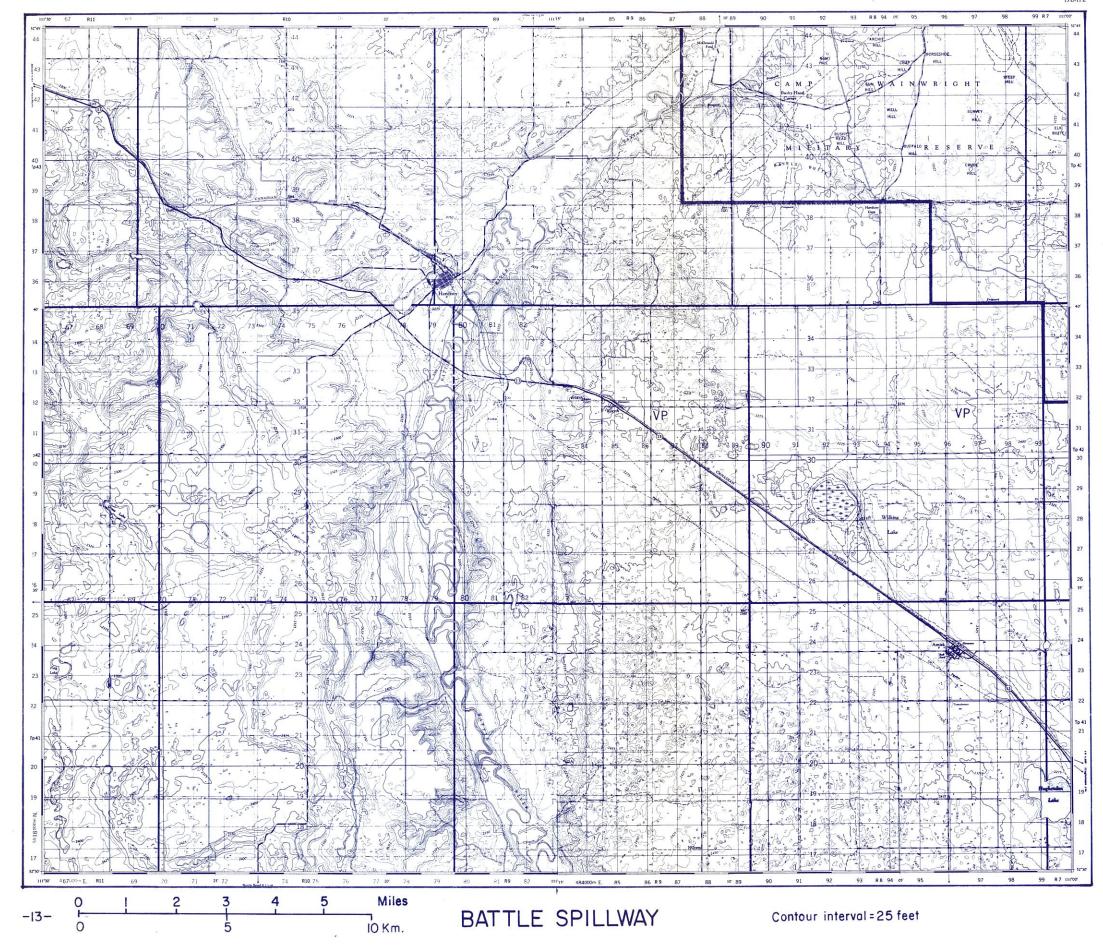
LOCATION OF SPILLWAY



NAME OF SPILLWAY	Battle Spillway
	LOCATION OF SPILLWAY



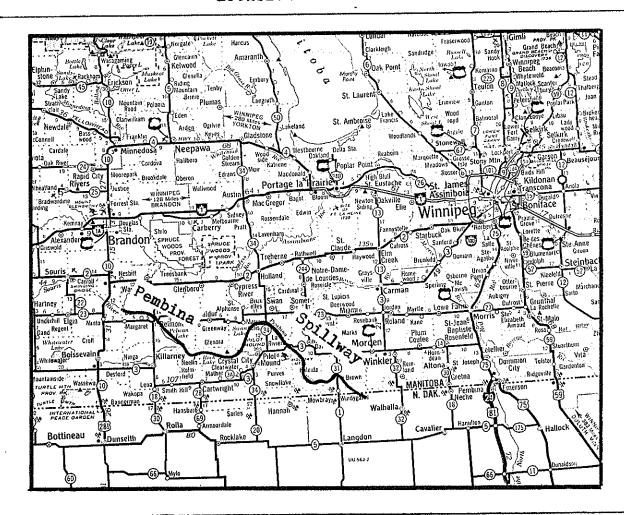
DESCRIPTION OF SPILLWAY						
Length	km	Depth of fill m				
Width	.m	In drift	_			
Relief	m	In drift & bedrock				
Drained meltwater only		Drained meltwater & runoff				
Other remarks	 					
Miles 5	0	5				
Kilometres 5	0	5 10				
		0004-002				
		E. A. Christiansen Consulting Ltd				



NATURAL VALUES	ASSOCI	TATED WITH SPILLWAY *				
Ridged Moraine	Pg	Bedrock Exposures	Pg			
Ice-thrust Moraine	t	Springs	<u>Pg</u>			
End Moraine		Alluvial Fans	Pg			
Flutings		Flood Plains	Pg			
	NP	Stream	<u>Pg</u>			
Tunnel Valleys	NP	Marshes	<u> Pp</u>			
Glacial Lake Basins	1	Lakes	=			
Outwash Plains		Deltas	Pp ———			
Meltwater Channels		Beaches	<u> Pp</u>			
Landslides		Other <u>Terraces</u>	Pg			
		IMPACT ON SPILLWAY	_			
No. of dams		No. of towns				
Km of highways		No. of villages	_2			
Km of railroads	40	No. of resorts	_0			
	LIST OF REFERENCES ON SPILLWAY					
Bayrock, L.A. 1967. Surficial			<u> </u>			
		ounc. Alta., Rept. 67-4.				
Bayrock, L.A. 1972. Surficial	geolo	gy, Edmonton (NTS-83H).				
Res. Counc. Alta., Map.	<u> </u>					
Stalker, A.M. 1960. Surficial	geolo	gv of the Red Deer-Stettler				
map-area, Alberta, Geol	l. Sur	v. Can., Mem. 306, 140 p.				
* Within 20 km of spillway. I	Pg=goo	d; Pp = poor; and NP= not pres	sent. 04-002			
		E. A. Christiansen Consulting	Ltd			

Length (>300 km = 10; $200-300$ km = 7	':<200 km = 1 7
Width (>2000 m = 10; $1000-2000 m = 7$	
*	7
Drained glacial meltwater only = 5 -	
Drained glacial meltwater and progl	
	SIATED WITH SPILLWAY **
	Bedrock Exposures 2
Ice-thrust Moraine 2	Springs 2
End Moraine2	Alluvial Fans 2
	Flood Plains 2
	Stream 2
Tunnel Valleys 0	Marshes 1
Glacial Lake Basins 2	Lakes 2
Outwash Plains 2	Deltas 1
Meltwater Channels 2	Beaches 1
Landslides 2	Other2
SIGNIFICANT HUMAN	IMPACT ON SPILLWAY
Km of highways = $4-(km \text{ of highways/l})$	ength of spillway x 4) 4
$Km ext{ of } railroads = I_4 - (km ext{ of } railroads)$	/length of spillway x 4) 3
No. of towns (0 or $l = 4$, $2 = 3$,	3=2, 4 or more=0) <u>4</u>
No. of villages (0 or $l=4$, $2=3$	3=2, 4 or more $=0$) 3
No. of resorts (0 or $l=4$, $2=3$	3 = 2, 4 or more $= 0$) $$ 4
Total out of 100	79
** Pg = 2, Pp = 1, and NP = 0.	<pre>%100 m = 2 00-125 m = 4 25-150 m = 6 50-175 m = 8 75-200 m = 10</pre>
	0004–002 ———E. A. Christiansen Consalting Ltd.
-15-	• Onvisiunsen Consuling Ltd.

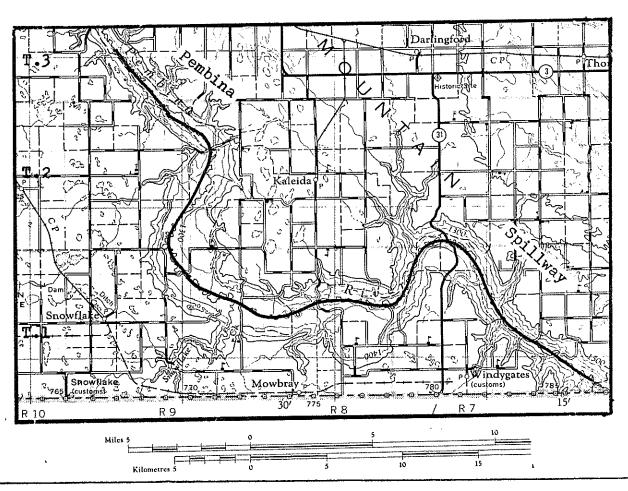
NAME OF SPILLWAY	Pembina Spillway	_
	LOCATION OF SPILLWAY	



DESCRIPTION OF SPILLWAY					
Length 160		km	Depth of fill	m	
Width <u>1400</u>		_ :m	In drift		
Relief 120		_ m	In drift & bedrock x		
Drained meltwater only			Drained meltwater & runoffx	·	
Other remarks	<u> </u>				
·	0		50 100		
		Kilo	metres		
			0004-00)2	
			E. A. Christiansen Consulting Ltd	<u>. </u>	

NAME OF SPILLWAY

LOCATION OF SPILLWAY

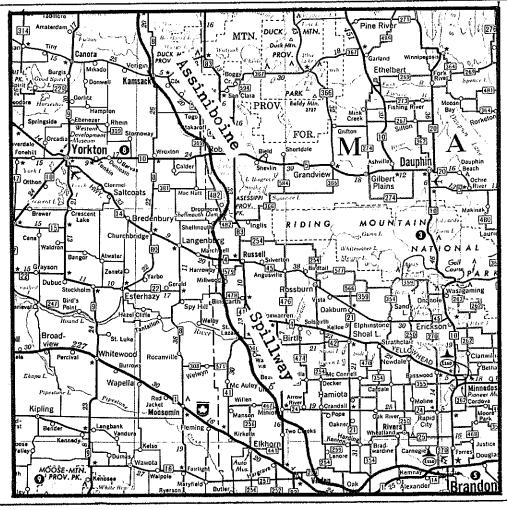


Length km Depth of fill m Width In drift Relief m In drift & bedrock Drained meltwater only Drained meltwater & runoff Other remarks Best developed part of spillway. O004-002 E. A. Christiansen Consulting Ltd.

NATURAL VALUES	S ASSOC	IATED WITH SPILLWAY *	
Ridged Moraine	Pg	Bedrock Exposures	Pp
Ice-thrust Moraine	<u>Pp</u>	Springs	Pp
End Moraine	Pg	Alluvial Fans	Pg
Flutings		Flood Plains	Pg
Eskers		Stream	Pg
Tunnel Valleys	Pр	Marshes	Pg
	Pg	Lakes	Pg
Outwash Plains	Pg	Deltas	Pg
Meltwater Channels		Beaches	<u>Pp</u>
Landslides		Other Terraces	Pg
SIGNIFICANT	HUMAN	IMPACT ON SPILLWAY	
No. of dams	0	No. of towns	0
Km of highways		No. of villages	3
Km of railroads		No. of resorts	0
		S ON SPILLWAY	
Elson, J.A. 1956. Surficial	geolog	y of the Tiger Hills region.	
Unpub. Ph.D. Thesis,	Yale U	niv., New Haven, Conn.,	
316 p.			
Klassen, R.W., Wyder, J.E.,	and Bar	nnatyne, B.B. 1970. Bedrock	
topography and geolog	y of so	outhern Manitoba. Geol. Surv.	
Can., Paper 70-51.			
	· <u>· · · · · · · · · · · · · · · · · · </u>		
★ Within 20 km of spillway.	Pg=goo	d; Pp = poor; and NP= not pres	ent. 04-002
Pembina Spillway			
		6. A. Chaistiannen Consulting	Gul

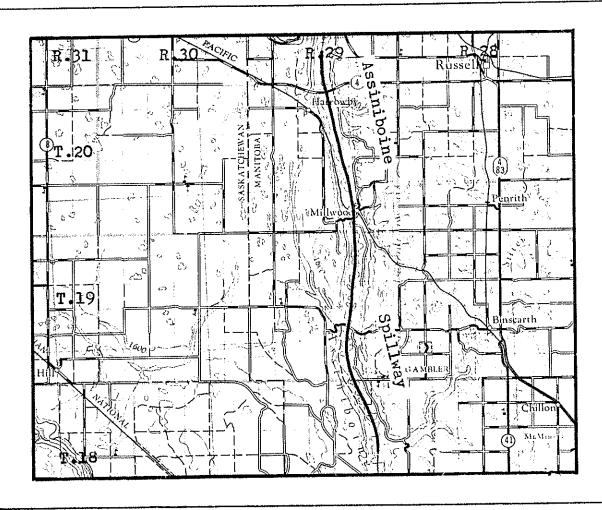
Length (>300 km = 10 ; 200-300 km = 7	;<200 km = 4 4
Width (>2000 m = 10; $1000-2000 m = 7$;<1000 m=4) <u>7</u>
Relief*	
Drained glacial meltwater only = 5 -	والم الله الله الله الله الله الله الله ا
Drained glacial meltwater and progl	acial runoff= 10 10
NATURAL VALUES ASSOC	IATED WITH SPILLWAY **
Ridged Moraine2	Bedrock Exposures 1
Ice-thrust Moraine 1	Springs 1
End Moraine 2	Alluvial Fans 2
Flutings 1	Flood Plains 2
Eskers 1	Stream 2
Tunnel Valleys 1	Marshes 2
Glacial Lake Basins 2	Lakes2
Outwash Plains 2	Deltas 2
Meltwater Channels 2	Beaches 1
Landslides 2	Other2
SIGNIFICANT HUMAN	IMPACT ON SPILLWAY
Km of highways = 4-(km of highways/l	ength of spillway x 4) 4
Km of railroads = l_4 -(km of railroads,	/length of spillway x 4) $\frac{3}{}$
No. of towns (0 or $l = 4$, $2 = 3$,	3 = 2, · 4 or more = 0) 4
No. of villages (0 or $l=4$, $2=3$	3=2, 4 or more $=0$) 2
No. of resorts (0 or $1=4$, $2=3$	3 = 2, 4 or more $= 0$) 4
Total out of 100	75
** $Pg = 2$, $Pp = 1$, and $NP = 0$.	<pre>< 100 m = 2 00-125 m = 4 25-150 m = 6 50-175 m = 8 75-200 m = 10</pre>
	0004-002
_1	E. A. Christiansen Consulting Ltd

NAME OF SPILLWAY Assimiboine Spillway



	,	DESCRIP	TION	OF SPILLWAY	
Length	300		km	Depth of fill	m
Width _	1800		ın	In drift	
Relief	105		m	In drift & bedrock _	x
Draine	d meltwater only			Drained meltwater &	runoff x
Other 1	remarks		·		
				700	and the second s
		U 	50	100	
		Kil	omet	res	0004-002
				E & Christians	Constitute Pet

NAME OF SPILLWAY Assiniboine Spillway



,	DESCR	IPTION	OF SPILL	YAW	
Length		km	Depth of	fill	m
Width		m:	In drift	,	
Relief		m	In drift	& bedrock _	
Drained meltwater	only		Drained	meltwater &	runoff
Other remarks					
	10			20 Milles	
	15	20	25	30 Kilometres	
					0004-002
			6	. A. Christiansen	Consulting Ltd. —

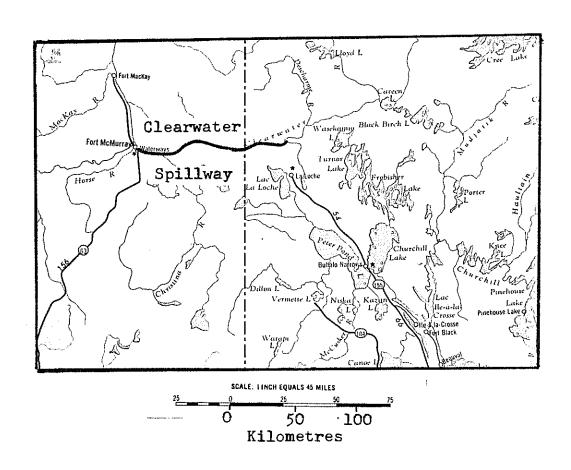
NATURAL	VALUES	ASSO	CIATED	WITH	SPILLWAY	<u> </u>	*
		Pø	1 Bodro	ock E	vnosures		

NATURAL VALUES	ADDOO.		
Ridged Moraine	Pg	Bedrock Exposures	Pp
Ice-thrust Moraine		Springs	Pg
End Moraine	1	Alluvial Fans	Pg
Flutings		Flood Plains	Pg_
Eskers		Stream	Pg
Tunnel Valleys		Marshes	Pg
Glacial Lake Basins		Lakes	NP
Outwash Plains		Deltas	NP
Meltwater Channels		Beaches	NP
Landslides		Other Terraces	Pg
		IMPACT ON SPILLWAY	2
No. of dams		No. of towns	
Km of highways		No. of villages	
Km of railroads	46	No. of resorts	0
		S ON SPILLWAY	
Klassen, R.W., Wyder, J.E.,	and Ba	nnatyne, B.B. 1970. Bedrock	
topography and geolog	y of s	outhern Manitoba. Geol. Surv.	
Can., Paper 70-51.			
Klassen, R.W. 1975. Quaterna	ry geo	logy and geomorphology of	
Assiniboine and Qu'Ap	pelle	Valleys of Manitoba and	
Saskatchewan. Geol. S	Surv. C	an., Bull. 228, 61 p.	
* Within 20 km of spillway.	Pg=go	od; $Pp = poor$; and $NP = not pres 000$	sent. 04-002
Assiniboine Spillway			
		E. A. Christiansen Consulting	Ltd

Length (>300 km = 10; $200-300$ km = 7	;<200 km = 4 7		
Width (>2000 m = 10; 1000-2000 m = 7; < 1000 m = 4) 7			
Relief			
Drained glacial meltwater only = 5 -			
Drained glacial meltwater and progl	acial runoff= 10 10		
NATURAL VALUES ASSOC	IATED WITH SPILLWAY **		
Ridged Moraine 2	Bedrock Exposures 1		
Ice-thrust Moraine 0	Springs 2		
End Moraine 2	Alluvial Fans 2		
Flutings 1	Flood Plains 2		
Eskers2	Stream 2		
Tunnel Valleys 2	Marshes 2		
Glacial Lake Basins 2	Lakes 0		
Outwash Plains 2	Deltas 0		
Meltwater Channels 2	Beaches 0		
Landslides 2	Other2		
SIGNIFICANT HUMAN	IMPACT ON SPILLWAY		
Km of highways = 4-(km of highways/length of spillway x 4) 4			
Km of railroads = 4 -(km of railroads/length of spillway x 4) 3			
No. of towns (0 or $l = 4$, $2 = 3$,	3=2, 4 or more=0) 3		
No. of villages (0 or $l=4$, $2=3$	3=2, 4 or more $=0$) 2		
No. of resorts (0 or $1 = 4$, $2 = 3$	3=2, 4 or more $=0$) 4		
Total out of 100	74		
** Pg = 2, Pp = 1, and NP = 0.	<pre>< 100 m = 2 00-125 m = 4 25-150 m = 6 50-175 m = 8 75-200 m = 10</pre>		
	0004-002 E. A. Christiansen Consulting Ltd.		
0.0			

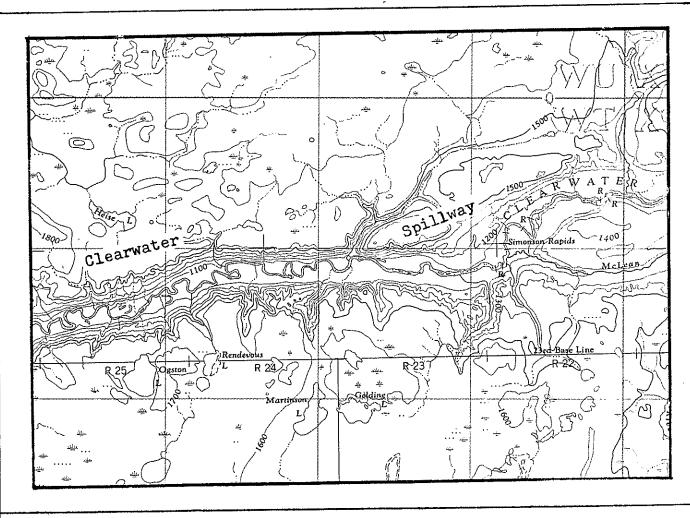
NAME OF SPILLWAY

Clearwater Spillway



		DESCRIPTION	OF SPILLWAY	
Length _	120	km	Depth of fill	m
Width	1500	m	In drift	<u>.</u>
Relief _	180	m	In drift & bedrock x	
Drained	meltwater only		Drained meltwater & runoff	x
Other re	emarks			
			0:004-0	02
			E. A. Christiansen Consulting L	U

NAME OF SPILLWAY Clearwater Spillway



, DESCRIPT	rion-	OF SPILLWAY
Length	km	Depth of fillm
Width	. m	In drift
Relief	m	In drift & bedrock
Drained meltwater only		Drained meltwater & runoff
Other remarks Best develope	ed p	part of spillway.
Miles 5		5 10
Kilometres 5		5 10 15 0004-002
		6 A Christiansen Consulting Ild -

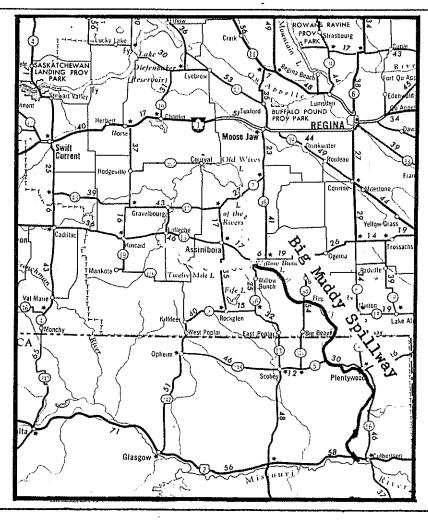
		Page 2 01 3		
NATURAL VALUES	ASSOC:	IATED WITH SPILLWAY *		
Ridged Moraine	NP	Bedrock Exposures Pg		
Ice-thrust Moraine	NP	Springs Pg		
End Moraine	NP	Alluvial Fans Pg		
Flutings	Pg	Flood Plains Pg		
Eskers	NP	Stream Pg		
Tunnel Valleys	NP	Marshes Pp		
Glacial Lake Basins	Pg	Lakes NP		
Outwash Plains	Pg	Deltas NP		
Meltwater Channels	Pg	Beaches NP		
Landslides	¹ Pg	Other Terraces Pg		
SIGNIFICANT HUMAN IMPACT ON SPILLWAY				
No. of dams		No. of towns 1		
Km of highways		No. of villages 0		
Km of railroads		No. of resorts 0		
LIST OF REFERENCES ON SPILLWAY				
Bayrock, L.A. and Reimchen T.H.F. 1973. Surficial geology,				
Waterways (NTS-74D). I	Res. Co	ounc. Alta., Map.		
	······································			
* Within 20 km of spillway.	Pg=goo	ed; $Pp = poor$; and $NP = not present$. 0004-002		
Clearwater Spillway		0004=007		

_E. A. Christiansen Consulting Ltd. -

Length (>300 km = 10; 200-300 km = 7; < 200 km = 4 4			
Width (>2000 m = 10; 1000-2000 m = 7	; < 1000 m = 4) 7		
Relief*			
Drained glacial meltwater only = 5 -			
Drained glacial meltwater and progl	acial runoff= 10 10		
NATURAL VALUES ASSOC	IATED WITH SPILLWAY **		
Ridged Moraine 0	Bedrock Exposures 2		
Ice-thrust Moraine 0	Springs 2		
End Moraine 0	Alluvial Fans 2		
Flutings 2	Flood Plains -, 2		
Eskers 0	Stream 2		
Tunnel Valleys 0	Marshes 1		
Glacial Lake Basins 2	Lakes 0		
Outwash Plains 2	Deltas 0		
Meltwater Channels 2	Beaches 0		
Landslides 2	Other2		
SIGNIFICANT HUMAN	IMPACT ON SPILLWAY		
Km of highways = 4-(km of highways/length of spillway x l_1) l_2			
$Km ext{ of railroads} = \mathcal{L} - (km ext{ of railroads})$	/length of spillway x 4) 3		
No. of towns (0 or $l = 4$, $2 = 3$,	3 = 2, 4 or more = 0) 4		
No. of villages (0 or $l=4$, $2=3$, 3=2, 4 or more=0) 4		
No. of resorts (0 or $l=4$, $2=3$, 3=2, 4 or more =0) 4		
Total out of 100	73		
** $Pg = 2$, $Pp = 1$, and $NP = 0$.	<pre></pre>		
	75-200 m = 10 0004-002		
	E. A. Christiansen Consulting Ltd.		

NAME OF SPILLWAY _____ Big Muddy Spillway

LOCATION OF SPILLWAY

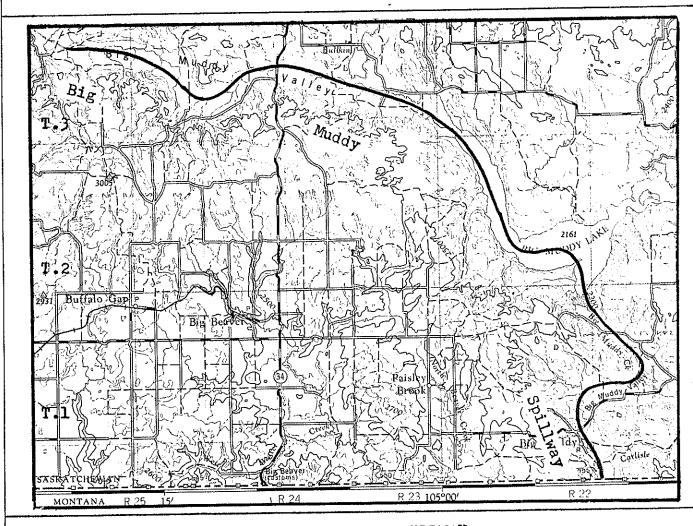


DESCRIPTION OF SPILLWAY Length 200. km | Depth of fill m Width 2000 m In drift Relief 170 m In drift & bedrock x Drained meltwater only _____ Drained meltwater & runoff __x Other remarks 0 Kilometres · 100 0004-002

_____E. A. Christiansen Consulting Ltd. _

NAME OF SPILLWAY Big Muddy Spillway

LOCATION OF SPILLWAY



		Page 2	2 of 3	
NATURAL VALUES	ASSOC	IATED WITH SPILLWAY *		
Ridged Moraine	P <u>p</u>	Bedrock Exposures	Pg	
Ice-thrust Moraine	NP	Springs	Pp	
End Moraine		Alluvial Fans	Pg	
Flutings		Flood Plains	Pp_	
Eskers		Stream	Pp	
Tunnel Valleys		Marshes	Pp	
Glacial Lake Basins		Lakes	Pg	
Outwash Plains		Deltas	Pp	
Meltwater Channels		Beaches	Pp	
Landslides		Other Terraces	Pg	
SIGNIFICANT	MAMUH	IMPACT ON SPILLWAY		
No. of dams	0	No. of towns	1	
Km of highways	20.	No. of villages	1	
Km of railroads	50	No. of resorts	0	
LIST OF REFERENCES ON SPILLWAY				
Parizek, R.R.1964. Geology	of the	Willow Bunch Lake area (72-F	1),	
Saskatchewan. Sask. R	es. Co	unc.,Geol. Div.,Rept. 4, 47 p).	
Whitaker, S.H. 1965. Geolog	y of t	he Wood Mountain area (72-G),	<u> </u>	
Saskatchewan. Unpub.	Ph.D.	Thesis, Univ. Ill., Urbana, l	.51 p.	
* Within 20 km of spillway, Pg=good; Pp = poor; and NP= not present.				
			04-002	

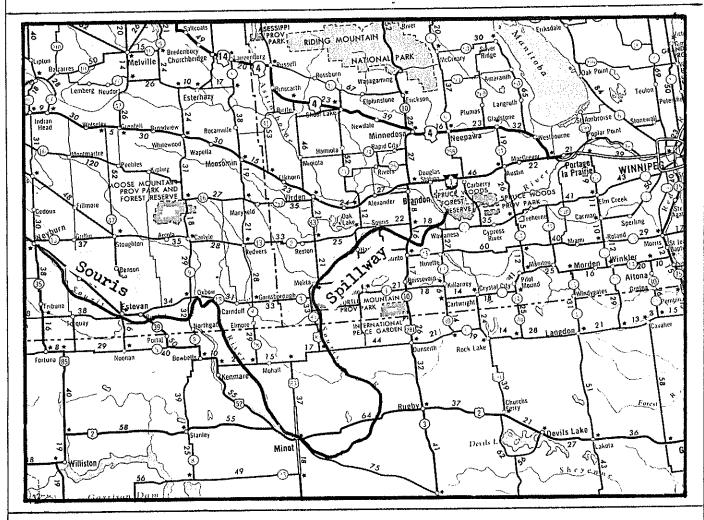
_E. A. Christiansen Consulting Ltd. -

Big Muddy Spillway

Length (>300 km = 10; 200-300 km = 7; < 200 km = 4 4		
Width (>2000 m = 10; $1000-2000 m = 7$; < 1000 m = 4) 7	
Relief*		
Drained glacial meltwater only = 5 -	حس بين اسل شير عيم شده بين شدن بين شين الله على شين شين فيل الله على الله على الله على الله على الله على الله 	
Drained glacial meltwater and progl	acial runoff= 10 10	
NATURAL VALUES ASSOC	IATED WITH SPILLWAY **	
Ridged Moraine 1	Bedrock Exposures 2	
Ice-thrust Moraine 0	Springs 1	
End Moraine 2	Alluvial Fans 2	
Flutings 1	Flood Plains 1	
Eskers0	Stream 1	
Tunnel Valleys 0	Marshes 1	
Glacial Lake Basins 2	Lakes 2	
Outwash Plains 2	Deltas 1	
Meltwater Channels 2	Beaches 1	
Landslides 1	Other2	
SIGNIFICANT HUMAN	IMPACT ON SPILLWAY	
Km of highways = 4-(km of highways/1	ength of spillway x 4) 4	
Km of railroads = L -(km of railroads	/length of spillway x 4) 3	
No. of towns (0 or $l = 4$, $2 = 3$,	3=2, 4 or more=0) 4	
No. of villages (0 or $l=4$, $2=3$, 3=2, 4 or more=0) <u>4</u>	
No. of resorts (0 or $l=4$, $2=3$, 3=2, 4 or more =0) <u>4</u>	
Total out of 100		
** $Pg = 2$, $Pp = 1$, and $NP = 0$.	<pre></pre>	
Big Muddy Spillway 1	75-200 m=10 0004-002	
	E. A. Christiansen Consulting Ltd.	

INVENTORY OF GLACIAL SPILLWAYS Souris Spillway

NAME OF SPILLWAY



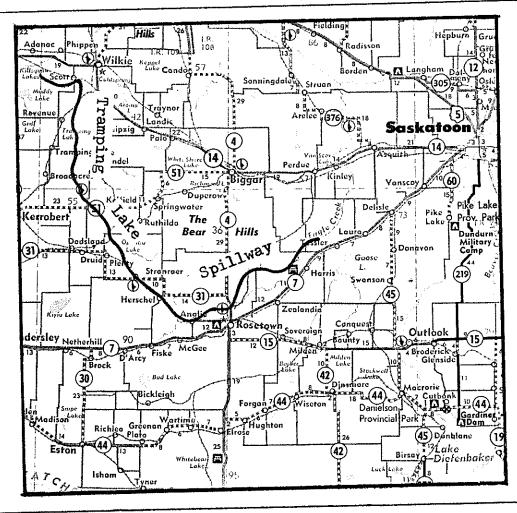
	,	DESCRIPTI	ON	OF SPILLWAY	
Length	590	l-	cm.	Depth of fill	_ m
Width _	1000		m	In drift	
Relief	60		m	In drift & bedrock x	
Drained	meltwater only _			Drained meltwater & runoff x	
Other r	emarks				
	-	0		100	
		Ki	lon	netres	
				0004-00)2
				E. A. Christiansen Consulting Lla	l

	Page 2 01 3
NATURAL VALUES ASSO	CIATED WITH SPILLWAY *
Ridged Moraine Pg	Bedrock Exposures Pg
Ice-thrust Moraine NP	Springs Pp
End Moraine Pg	Alluvial Fans Pg
Flutings Pg	Flood Plains Pg
Eskers NP	Stream Pg
Tunnel Valleys NP	Marshes Pg
Glacial Lake Basins Pg	Lakes NP
Outwash Plains Pg	
Meltwater Channels Pg	Beaches NP
Landslides Pp	Other Terraces Pg
No. of dams	No. of towns 4 No. of villages 1 No. of resorts 5 CES ON SPILLWAY
Christiansen, E.A. 1956. Glacial	geology of the Moose Mountain
	Dept. Min. Res., Rept. 21, 35 p.
Elson, J.A. 1956. Surficial geold	gy of the Tiger Hills region.
Unpub. Ph.D. Thesis, Yale I	Jniv., Connecticut, 316 p.
	ood; Pp = poor; and NP= not present. 0004-002
Souris Spillway	

_E. A. Christiansen Consulting Ltd. -

Length (>300 km = 10; 200-300 km = 7; < 200 km = 4				
Width (>2000 m = 10; 1000-2000 m = 7; < 1000 m = 4)				
Relief	22			
Drained glacial meltwater only = 5				
Drained glacial meltwater and proglacial runoff = 10	10			
NATURAL VALUES ASSOCIATED WITH SPILLWAY **				
Ridged Moraine 2 Bedrock Exposures	2			
Ice-thrust Moraine O Springs	1			
End Moraine 2 Alluvial Fans	_2			
Flutings 2 Flood Plains	2			
Eskers 0 Stream	2			
Tunnel Valleys 0 Marshes	2			
Glacial Lake Basins 2 Lakes	0			
Outwash Plains 2 Deltas	0			
Meltwater Channels 2 Beaches	0			
Landslides 1 Other Terraces	2			
SIGNIFICANT HUMAN IMPACT ON SPILLWAY				
Km of highways=4-(km of highways/length of spillway x 4) 4				
Km of railroads = \mathcal{L} -(km of railroads/length of spillway x 4)	_4			
No. of towns (0 or $l=4$, $2=3$, $3=2$, 4 or more $=0$)				
No. of villages (0 or $l=4$, $2=3$, $3=2$, 4 or more $=0$)	_4			
No. of resorts (0 or $l=4$, $2=3$, $3=2$, 4 or more $=0$)	_4			
Total out of 100	71			
* $-100 \text{ m} = 2$ ** $Pg = 2$, $Pp = 1$, and $NP = 0$. 100-125 m = 4 125-150 m = 6 150-175 m = 8				
Souris Spillway 175-200 m=10	-002			
E. A. Christiansen Consulting	1			

NAME OF SPILLWAY Tramping Lake Spillway

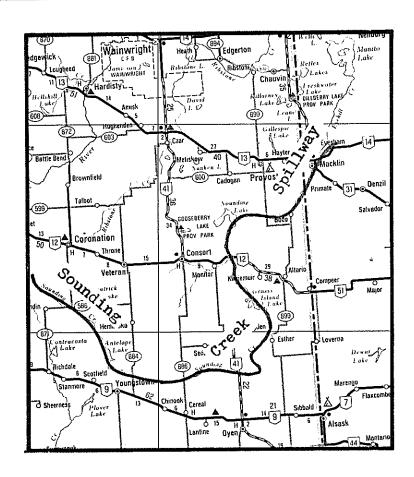


		DESCRIP	MOIT	OF SPILL	VAY		
Length	160		km	Depth of	fill		_ m
Width	1200		-				,,
Relief	7 5				& bedrock _		
Drained melt	water only			Drained 1	meltwater &	runoff	<u>x</u>
Other remark	(S		Scale in	Miles			<u></u>
		10 0 10 0 Sc	10 10 ale in Ki	20 30 40 lometres			
						0004-0)02
				6.	A. Christiansen	Consulting L	ld

Ridged Moraine Pg Bedrock Exposures Pp Ice-thrust Moraine Pg Springs Pp End Moraine Pg Alluvial Fans Pg Flutings Pg Flood Plains Pp Eskers NP Stream Pp Tunnel Valleys NP Marshes Pg Glacial Lake Basins Pg Lakes Pg Outwash Plains Pg Deltas Pg Meltwater Channels NP Beaches Pp Meltwater Channels NP Beaches Pp Landslides Pg Other Terraces Pg SIGNIFICANT HUMAN IMPACT ON SPILLWAY No. of dams On No. of towns On No. of resorts Interpretations of the Kindersley area (72-N). Saskatchewan. Sask. Res. Counc., Geol. Div. Rept. 7, 26 D. Graig, B.G. 1959, Surficial geology, Battleford, West of Third Meridian, Saskatchewan. Geol. Surv. Gan., Map 15-1959. Scott. J.S. 1971. Surficial geology of Rosetown Map-area. Geol. Surv. Can., Bull. 190, A0 p. * Within 20 km of spillway. Pg-good; Pp = poor; and NP = not present. COO4-002	NATURAL VALUES ASS	OCIATED WITH SPILLWAY *			
End Moraine — Pg	Ridged Moraine Pg	Bedrock Exposures Pp			
Flutings ————————————————————————————————————	Ice-thrust Moraine Pg	Springs			
Eskers	End Moraine Pg	Alluvial Fans Pg			
Tunnel Valleys	Flutings Pg	Flood Plains Pg			
Glacial Lake Basins	Eskers NP	Stream Pp			
Outwash Plains	Tunnel Valleys NP	Marshes Pg			
Meltwater Channels	Glacial Lake Basins Pg	Lakes Pg			
SIGNIFICANT HUMAN IMPACT ON SPILLWAY No. of dams	Outwash Plains Pg	Deltas Pg			
SIGNIFICANT HUMAN IMPACT ON SPILLWAY No. of dams	Meltwater Channels NP				
No. of dams	Landslides Pg	Other Terraces Pg			
<pre>Km of highways</pre>	SIGNIFICANT HUMA	AN IMPACT ON SPILLWAY			
Km of railroads	No. of dams 1	No. of towns 0			
LIST OF REFERENCES ON SPILLWAY Christiansen, E.A. 1965 . Geology and groundwater resources of the Kindersley area (72-N), Saskatchewan. Sask. Res. Counc., Geol. Div., Rept. 7, 26 p. Craig. B.G. 1959. Surficial geology, Battleford, West of Third Meridian, Saskatchewan. Geol. Surv. Can., Map 15-1959. Scott, J.S. 1971. Surficial geology of Rosetown map-area. Geol. Surv. Can., Bull. 190, 40 p. * Within 20 km of spillway. Pg=good; Pp = poor; and NP= not present. 0004-002 Tramping Lake Spillway	Km of highways 10	No. of villages 2			
Christiansen, E.A. 1965 . Geology and groundwater resources of the Kindersley area (72-N), Saskatchewan. Sask. Res. Counc., Geol. Div., Rept. 7, 26 p. Craig. B.G. 1959. Surficial geology, Battleford, West of Third Meridian, Saskatchewan. Geol. Surv. Can., Map 15-1959. Scott, J.S. 1971. Surficial geology of Rosetown map-area. Geol. Surv. Can., Bull. 190, 40 p. * Within 20 km of spillway. Pg=good; Pp = poor; and NP= not present. 0004-002 Tramping Lake Spillway	Km of railroads 50	No. of resorts 1			
the Kindersley area (72-N), Saskatchewan, Sask, Res. Counc., Geol. Div., Rept. 7, 26 p. Craig. B.G. 1959. Surficial geology, Battleford, West of Third Meridian, Saskatchewan, Geol. Surv. Can., Map 15-1959. Scott, J.S. 1971. Surficial geology of Rosetown map-area. Geol. Surv. Can., Bull. 190, 40 p. * Within 20 km of spillway. Pg=good; Pp = poor; and NP= not present. 0004-002 Tramping Lake Spillway					
Geol. Div., Rept. 7, 26 p. Craig. B.G. 1959. Surficial geology, Battleford, West of Third Meridian. Saskatchewan. Geol. Surv. Can., Map 15-1959. Scott. J.S. 1971. Surficial geology of Rosetown map-area. Geol. Surv. Can., Bull. 190, 40 p. * Within 20 km of spillway. Pg=good; Pp = poor; and NP= not present. 0004-002 Tramping Lake Spillway	Christiansen, E.A. 1965 . Geology and groundwater resources of				
Craig. B.G. 1959. Surficial geology, Battleford, West of Third Meridian. Saskatchewan. Geol. Surv. Can., Map 15-1959. Scott. J.S. 1971. Surficial geology of Rosetown map-area. Geol. Surv. Can., Bull. 190, 40 p. * Within 20 km of spillway. Pg=good; Pp = poor; and NP= not present. 0004-002 Tramping Lake Spillway					
Meridian, Saskatchewan, Geol. Surv. Can., Map 15-1959. Scott, J.S. 1971. Surficial geology of Rosetown map-area. Geol. Surv. Can., Bull. 190, 40 p. * Within 20 km of spillway. Pg=good; Pp=poor; and NP= not present. 0004-002 Tramping Lake Spillway	Geol. Div., Rept. 7, 26 p.				
Scott, J.S. 1971. Surficial geology of Rosetown map-area. Geol. Surv. Can., Bull. 190, AO p. * Within 20 km of spillway. Pg=good; Pp = poor; and NP= not present. 0004-002 Tramping Lake Spillway	Craig. B.G. 1959. Surficial geolo	gy, Battleford, West of Third			
Surv. Can., Bull. 190, 40 p. * Within 20 km of spillway. Pg=good; Pp = poor; and NP= not present. 0004-002 Tramping Lake Spillway	Meridian, Saskatchewan, Ge	eol. Surv. Can., Map 15-1959.			
* Within 20 km of spillway. Pg=good; Pp = poor; and NP= not present. 0004-002 Tramping Lake Spillway	Scott, J.S. 1971. Surficial geold	ngy of Rosetown map-area. Geol.			
Tramping Lake Spillway	Surv. Can., Bull. 190, 40	р.			
Tramping Lake Spillway					
Tramping Lake Spillway	* Within 20 km of spillway. Pg=8	good; Pp = poor; and NP= not present.			
	Tramping Lake Spillway	0004-002			
& A (O) O 1 (O. 1		E. A. Christiansen Consultina Ltd. —			

Length (>300 km = 10; $200-300$ km = 7; < 200 km = 4 4			
Width (>2000 m = 10; $1000-2000 m = 7; < 1000 m = 4)$ 7			
Relief			
Drained glacial meltwater only = 5 -			
Drained glacial meltwater and progla	acial runoff= 10 10		
NATURAL VALUES ASSOC	IATED WITH SPILLWAY **		
Ridged Moraine2	Bedrock Exposures 1		
Ice-thrust Moraine 2	Springs 1		
End Moraine 2	Alluvial Fans 2		
Flutings 2	Flood Plains 2		
Eskers 0	Stream 1		
Tunnel Valleys 0	Marshes 2		
Glacial Lake Basins 2	Lakes2		
Outwash Plains 2	Deltas 2		
Meltwater Channels 0	Beaches 1		
Landslides 2	Other2		
SIGNIFICANT HUMAN IMPACT ON SPILLWAY			
Km of highways=4-(km of highways/length of spillway x 4) 4			
Km of railroads = $\frac{1}{4}$ - (km of railroads/length of spillway x 4) 3			
No. of towns (0 or l= 4, 2=3, 3=2, 4 or more=0) 4			
No. of villages (0 or $l=4$, $2=3$, $3=2$, 4 or more $=0$) 3			
No. of resorts (0 or $1=4$, $2=3$,	3=2, 4 or more =0) 4		
Total out of 100 71			
* <100 m = 2 100-125 m = 4 125-150 m = 6 150-175 m = 8 175-200 m = 10			
	E. A. Christiansen Consulting Ltd.		

NAME OF SPILLWAY Sounding Creek Spillway



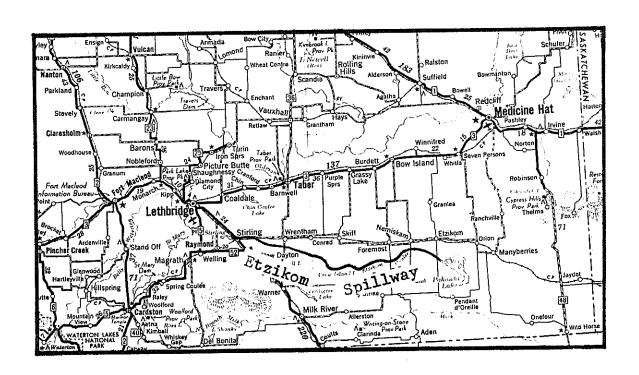
DESCRIPTION OF SPILLWAY				
Length	220 *	km	Depth of fill	m
į	1800		In drift	
Relief	120	m	In drift & bedrock x	
Drained mel	Ltwater only		Drained meltwater & runoff x	· · • • · · ·
Other remai	rks			
	0	50	, 100	
Kilometres				
* Only 50 kilometres have distinct valley walls. 0004-002				
			E. A. Christiansen Consultina Ltd	<i>,</i>

		rake A	. 01)
NATURAL VA	LUES ASSOC	IATED WITH SPILLWAY *	
Ridged Moraine	NP	Bedrock Exposures	_Pp
Ice-thrust Moraine		Springs	<u>Pp</u>
End Moraine	Pg	Alluvial Fans	Pg_
Flutings	<u>NP</u>	Flood Plains	Pp
Eskers		Stream	Pp
Tunnel Valleys	<u>NP</u>	Marshes	_Pg
Glacial Lake Basins		Lakes	Pg
Outwash Plains	<u>Pg</u>	Deltas	_Pg
Meltwater Channels	<u>NP</u>	Beaches	Pp
Landslides	Pg	Other	<u>NP</u>
	<u>l</u>	No. of towns	
Km of highways		No. of villages	
Km of railroads	20	No. of resorts	0
LIST OF REFERENCES ON SPILLWAY			
Stalker, A.M. Surficial g	eology of	the Red Deer-Stettler map are	a,
		m. 306, 140 p.	
National Control of the Control of t			
* Within 20 km of spill	way. Pg=goo	od; Pp = poor; and NP= not pre	
Sounding Creek Spillwa	v	00	04-002
Sounding Greek Spillwa	<u>. I.</u>		
		E. A. Christiansen Consulting	Ltd

Length (>300 km = 10; 200-300 km = 7; < 200 km = 4 7			
Width (>2000 m = 10; 1000-2000 m = 7; < 1000 m = 4)			
Relief			
Drained glacial meltwater only = 5 -	ر ۱۳۵۲ کال ۱۹۵۲ کال کال ۱۹۵۲ کال ۱۹۵۲ کال بازی کار کال ۱۹۵۲ کال ۱۹۵۲ کال ۱۹۵۲ کال ۱۹۵۲ کال ۱۹۵۲ کال ۱۹۵۲ کال ۱۹۵۲ ۱۴۵۲ کال ۱۹۵۲ کال ۱		
Drained glacial meltwater and progl	acial runoff= 10 10		
NATURAL VALUES ASSOC	IATED WITH SPILLWAY **		
Ridged Moraine 0	Bedrock Exposures 1		
Ice-thrust Moraine 2	Springs		
End Moraine 2	Alluvial Fans 2		
Flutings 0	Flood Plains 1		
Eskers0	Stream1		
Tunnel Valleys 0	Marshes 2		
Glacial Lake Basins 2	Lakes2		
Outwash Plains 2	Deltas 2		
Meltwater Channels 0	Beaches l		
Landslides 2	Other0		
SIGNIFICANT HUMAN IMPACT ON SPILLWAY			
Km of highways = $4-(km \text{ of highways/le})$	ength of spillway x 4) 4		
Km of railroads = μ -(km of railroads,	/length of spillway x 4) 4		
No. of towns (0 or $l = 4$, $2 = 3$,	3=2, 4 or more=0) 4		
No. of villages (0 or $l=4$, $2=3$, 3=2, 4 or more=0) 4		
No. of resorts (0 or $l = 4$, $2 = 3$)	, 3 = 2, 4 or more =0) 4		
Total out of 100	71		
** $Pg = 2$, $Pp = 1$, and $NP = 0$.	<pre></pre>		
	50-175 m = 8 75-200 m = 10		
	0004-002		
	E. A. Christianson Consulting Ltd		

NAME OF SPILLWAY Etzikom Spillway

LOCATION OF SPILLWAY

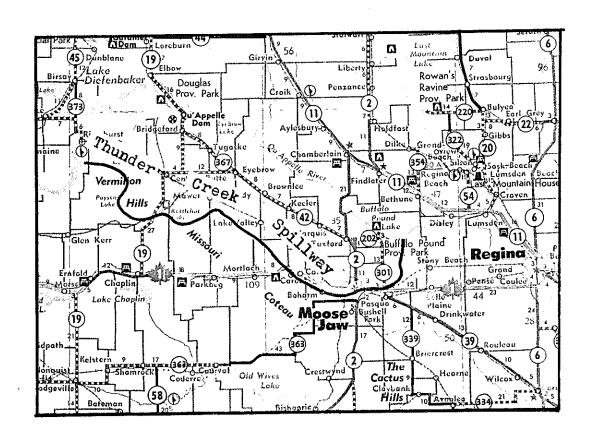


		DESCRIPT	ION	N OF SPILLWAY	
Length	110		km	Depth of fill	n
Width			;m	In drift	
Relief	55			In drift & bedrock x	
Drained mel	twater only	-]	Drained meltwater & runoff x	
Other remar	ks O	Scale of 19 20 20 50 Kilome	40	100	
				0004-002 E. A. Christiansen Consulting Ltd.	

NAMINAT TEATHER ACC	OCIATED WITH SPILLWAY *		
	Bedrock Exposures Pp		
Ridged MorainePg			
Ice-thrust Moraine NP	Springs Pp		
End Moraine Pg	Alluvial Fans Pg		
Flutings NP	Flood Plains Pg		
Eskers NP	Stream		
Tunnel Valleys NP	Marshes <u>Pg</u>		
Glacial Lake Basins Pg	Lakes Pg		
Outwash Plains Pg	Deltas Pp		
Meltwater Channels Pg	Beaches Pp		
Landslides Pp	Other Terraces Pg		
SIGNIFICANT HUM	AN IMPACT ON SPILLWAY		
No. of dams 0	No. of towns 0		
Km of highways 0	No. of villages 0		
Km of railroads 0'	No. of resorts 0		
 			
LIST OF REFERENCES ON SPILLWAY Bretz, J.H. 1943. Keewatin end moraines in Alberta, Canada.			
Geol. Soc. Am. Bull., v. 54, p. 31-52. Westgate, J.A. 1968. Surficial geology of the Foremost - Cypress			
Hills area, Alberta, Res. Counc. Alta., Bull. 22, 121p.			
	1 NDt		
* Within 20 km of spillway. Pg=	good; Pp = poor; and NP= not present.		
	0004-002		
Etzikom Spillway	•		
	6 A. Conistingson Consulting Ltd		

Length (>300 km = 10; 200-300 km = 7; $<$ 200 km = 4 4			
Width (>2000 m = 10; 1000-2000 m = 7; < 1000 m = 4)			
Relief			
Drained glacial meltwater only = 5 -			
Drained glacial meltwater and progl	acial runoff= 10 10		
NATURAL VALUES ASSOC	IATED WITH SPILLWAY **		
Ridged Moraine2	Bedrock Exposures 1		
Ice-thrust Moraine 0	Springs		
End Moraine 2	Alluvial Fans 2		
Flutings 0	Flood Plains 2		
Eskers 0	Stream 1		
Tunnel Valleys 0	Marshes 2		
Glacial Lake Basins 2	Lakes 2		
Outwash Plains 2	Deltas 1		
Meltwater Channels 2	Beaches 1		
Landslides 1	Other2		
SIGNIFICANT HUMAN IMPACT ON SPILLWAY			
Km of highways=4-(km of highways/length of spillway x 4) 4			
Km of railroads = 4 -(km of railroads/length of spillway x 4) 4			
No. of towns (0 or $l = 4$, $2 = 3$,	3=2, 4 or more=0) 4		
No. of villages (0 or $l=4$, $2=3$	3=2, 4 or more $=0$) 4		
No. of resorts (0 or $1=4$, $2=3$	3=2, 4 or more $=0$) 4		
Total out of 100	66		
** $Pg = 2$, $Pp = 1$, and $NP = 0$.	<pre>< 100 m = 2 00-125 m = 4 25-150 m = 6 50-175 m = 8 75-200 m = 10</pre>		
	E. A. Christiansen Consulting Ltd.		
	7		

NAME OF SPILLWAY Thunder Creek Spillway

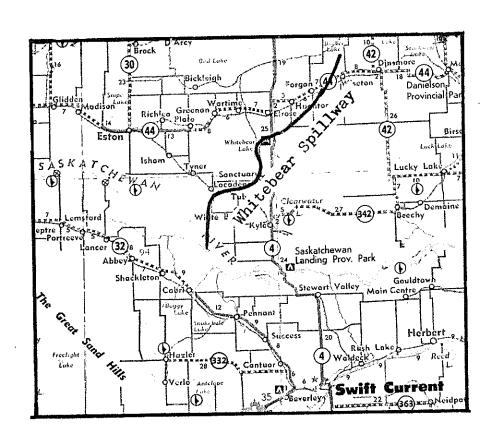


		DESCRIPTION	OF SPILLWAY	
Length	150	km	Depth of fill	m
Width _	1000	m	In drift	
Relief	60	m	In drift & bedrock x	
Drained	meltwater only	<u> </u>	Drained meltwater & runoff x	
Other r	emarks			
Scale in Miles 10 0 10 20 30 10 0 10 20 30 40 Scale in Kilometres				
0004-002				
			E. A. Christiansen Consulting Lld	<u> </u>

•		Tupo 2	01)
NATURAL VALUES	3 ASSOC	IATED WITH SPILLWAY *	
Ridged Moraine	Рр	Bedrock Exposures	Рр
Ice-thrust Moraine		Springs	
End Moraine		Alluvial Fans	Pg
Flutings		Flood Plains	_Pg
Eskers		Stream	<u>Pp</u>
Tunnel Valleys		Marshes	Pg
Glacial Lake Basins		Lakes	Pg
Outwash Plains		Deltas	
Meltwater Channels		Beaches	_Pp
Landslides		Other Terraces	_Pg
SIGNIFICANT HUMAN IMPACT ON SPILLWAY			
No. of dams	0	No. of towns	1
Km of highways	20	No. of villages	3
Km of railroads	45'	No. of resorts	0
LIST OF REFERENCES ON SPILLWAY			
Christiansen, E.A. 1961. Geology and ground-water resources of			
the Regina area, Saskatchewan. Sask. Res. Counc., Geol.			
Div., Rept. 2, 72 p.			<u> </u>
Edmunds, F.H. 1962. Recession			<u></u>
central Saskatchewan. Sask. Dept. Min. Res., Rept. 67, 23 p.			
* Within 20 km of spillway. Pg=good; Pp = poor; and NP= not present.			
Thunder Creek Spillway			
		E. A. Christiansen Consulting	Ltd
		ı f	

Length (>300 km = 10; 200-300 km = 7; $<$ 200 km =	4
Width (>2000 m = 10; 1000-2000 m = 7; < 1000 m = 4)	
Relief*	2
Drained glacial meltwater only = 5	th may him from the back again soon and area was may may soon and
Drained glacial meltwater and proglacial runos	f= 10 10
NATURAL VALUES ASSOCIATED WITH	SPILLWAY **
Ridged Moraine 1 Bedrock Ex	xposures 1
Ice-thrust Moraine 2 Springs	1
End Moraine 2 Alluvial F	ans 2
Flutings 1 Flood Plai	ns 2
Eskers O Stream	
Tunnel Valleys 0 Marshes	2
Glacial Lake Basins 2 Lakes	2
Outwash Plains 2 Deltas	
Meltwater Channels O Beaches	1
Landslides 2 Other	Terraces 2
SIGNIFICANT HUMAN IMPACT ON S	PILLWAY
Km of highways = 4-(km of highways/length of sp	illway x 4) 3
Km of railroads = $\frac{1}{4}$ -(km of railroads/length of	spillway x 4) 3
No. of towns (0 or $l=4$, $2=3$, $3=2$, 4 or	more = 0) 4
No. of villages (0 or $1=4$, $2=3$, $3=2$, 4	or more =0) 2
No. of resorts (0 or $l=4$, $2=3$, $3=2$, 4	or more =0) 4
Total out of 100	66
* < 100 m = 2 100-125 m = 4 125-150 m = 6 150-175 m = 8 Thunder Creek Spillway 175-200 m = 1	
$oldsymbol{\mathcal{E}}$. A.	Christiansen Consulting Ltd

NAME OF SF	PILLWAY	Whitebear Spillway	
	LOC	TION OF SPILLWAY	

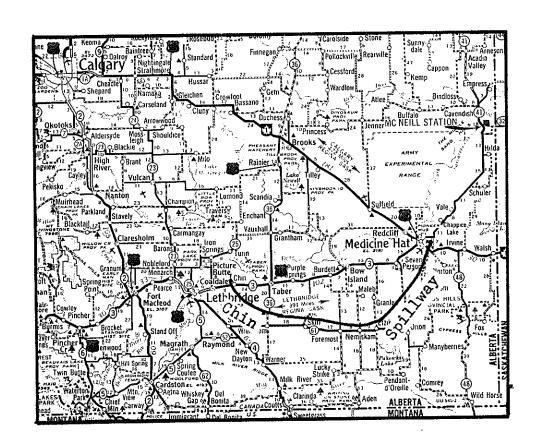


		DESCRIP	TION	OF SPILLWAY	
Length _	80		km	Depth of fill	m
Width _			מבי	In drift x	
	90		m	In drift & bedrock	
Drained	meltwater only			Drained meltwater & runoff	<u> </u>
Other r					,
		50 ° Sc	ale in A	files	
		10 Scal	10 20 e in Kilo		
				0004-0	02
				E. A. Christiansen Consulting Li	id

NATURAL VALUES	ASSOCI	IATED WITH SPILLWAY *	
Ridged Moraine	NP	Bedrock Exposures	NP
Ice-thrust Moraine	Pg	Springs	<u> Pp</u>
End Moraine		Alluvial Fans	<u>Pg</u>
Flutings	ı	Flood Plains	<u>Pg</u>
	NP	Stream	<u>Pp</u>
	NP	Marshes	_Pg
Glacial Lake Basins	Pg	Lakes	_Pg
Outwash Plains		Deltas	_Pp
	NP	Beaches	<u>Pp</u>
Landslides	Pp	Other <u>Terraces</u>	Pg
		IMPACT ON SPILLWAY	0
No. of dams		No. of towns	
Km of highways		No. of villages	
Km of railroads		No. of resorts	
1		S ON SPILLWAY	
Christiansen, E.A. 1965, Geol	ogy an	d groundwater resources of the	· <u>S</u>
		atchewan. Sask. Res. Counc.,	
Geol. Div., Rept. 7, 2	26 p.	and resources of	
David, P.P. 1964, Surficial a			
		katchewan, Unpub. Ph.D. Thesi	-
McGill Univ., Montreal			
Scott, J.S. 1971. Surficial a	georog)	10 m	
		, 40 p.	sent.
* Within 20 km of spillway.	Pg=goo	od; Pp = poor; and NP= not pre	04-002
Whitebear Spillway			
		E. A. Christiansen Consultina	Ltd

DESCRIPTION OF SPILLWAY			
Length (>300 km = 10 ; 200-300 km = 7	';< 200 km = 4 4		
Width (>2000 m = 10; $1000-2000 \text{ m} = 7$	7; < 1000 m = 4) 7		
Relief*	2		
Drained glacial meltwater only = 5 -	، حجم وجو جي شيع مين مين مين مين مين المار ا 		
Drained glacial meltwater and progl	acial runoff= 10 10		
NATURAL VALUES ASSOC	SIATED WITH SPILLWAY **		
Ridged Moraine 0	Bedrock Exposures 0		
Ice-thrust Moraine 2	Springs 1		
End Moraine2	Alluvial Fans 2		
Flutings2	Flood Plains 2		
Eskers 0	Stream1		
Tunnel Valleys 0	Marshes 2		
Glacial Lake Basins 2	Lakes2		
Outwash Plains 2	Deltas1		
Meltwater Channels 0	Beaches1		
Landslides 1	Other2		
SIGNIFICANT HUMAN	IMPACT ON SPILLWAY		
Km of highways = 4-(km of highways/l	ength of spillway x 4) 4		
Km of railroads = L -(km of railroads	/length of spillway x 4) 2		
No. of towns (0 or $l = 4$, $2 = 3$,	3=2, 4 or more=0) 4		
No. of villages (0 or $l=4$, $2=3$, 3=2, 4 or more=0) <u>4</u>		
No. of resorts (0 or $1 = 4$, $2 = 3$, $3=2$, 4 or more $=0$) 4		
Total out of 100	66		
** $Pg = 2$, $Pp = 1$, and $NP = 0$.	<pre>< 100 m = 2 00-125 m = 4 25-150 m = 6 50-175 m = 8 75-200 m = 10</pre>		
	0004-002		
	E. A. Christiansen Consulting Ltd		

NAME OF SPILLWAY	Chin Spillway	
	LOCATION OF SPILLWAY	

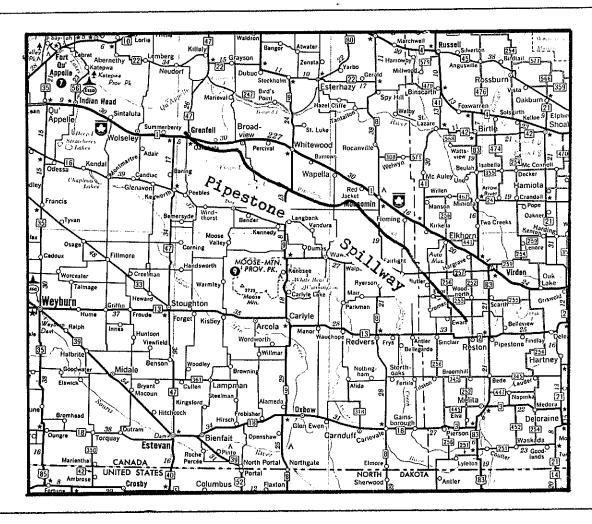


		·			
	· P	DESCRIPT	ION-	OF SPILLWAY	
Length _	130		km	Depth of fill	m .
Width	1000		im.	In drift	
	75		m	In drift & bedrock x	
Drained	meltwater only			Drained meltwater & runoff x	
Other re	emarks	0	50	0 100	
		_ Ki	lom	etres	2
				E A Christianson Consulting Ital	,

NATURAL VALUES AS	SSOCI	ATED WITH SPILLWAY *	
Ridged Moraine	5	Bedrock Exposures	Pp
Ice-thrust Moraine NI		Springs	
End Moraine Pg	l	Alluvial Fans	
FlutingsNI	1	Flood Plains	Pg
	ł	Stream	
Eskers N		Marshes	
Tunnel Valleys N			
Glacial Lake Basins P	g	Lak(s	
Outwash Plains P	g	Deltas	
Meltwater Channels P	g	Beaches	Pp
LandslidesPI		Other	<u>NP</u>
No. of dams	2	No. of villages	
Km of railroads	O	No. of resorts	0
LIST OF REFER	ENCE	S ON SPILLWAY	
Bretz, J.H. 1943. Keewatin end	mora	ines in Alberta, Canada.	
Geol. Soc. Am. Bull., v.			
Westgate, J.A. 1968. Surficial	geol	ogy of the Foremost - Cypress	<u> </u>
Hills area, Alberta, Res	co	unc. Alta., Bull. 22, 121 p.	
* Within 20 km of spillway. P	g=g00	od; Pp = poor; and NP = not pres	sent. 04-002
Chin Spillway			
		6 A Whitiman Consulting	G1

Length (>300 km = 10; $200-300$ km = 7	; < 200 km = 4 4
Width (>2000 $m = 10$; 1000-2000 $m = 7$; < 1000 m = 4) 7
Relief*	
Drained glacial meltwater only = 5 -	
Drained glacial meltwater and progl	acial runoff= 10 10
NATURAL VALUES ASSOC	IATED WITH SPILLWAY **
Ridged Moraine2	Bedrock Exposures 1
Ice-thrust Moraine 0	Springs 1
End Moraine 2	Alluvial Fans 2
Flutings 0	Flood Plains 2
Eskers0	Stream 1
Tunnel Valleys 0	Marshes l
Glacial Lake Basins 2	Lakes 1
Outwash Plains 2	Deltas 1
Meltwater Channels 2	Beaches1
Landslides 1	Other0
SIGNIFICANT HUMAN	IMPACT ON SPILLWAY
Km of highways = $4-(km \text{ of highways/le})$	ength of spillway x 4) 4
Km of railroads = $\frac{1}{4}$ (km of railroads)	/length of spillway x 4) 4
No. of towns (0 or $l = 4$, $2 = 3$,	3=2, 4 or more = 0) 4
No. of villages (0 or $l=4$, $2=3$	3=2, 4 or more $=0$) 4
No. of resorts (0 or $1 = 4$, $2 = 3$, 3=2, 4 or more =0) 4
Total out of 100	65
** $Pg = 2$, $Pp = 1$, and $NP = 0$.	<pre> < 100 m = 2 00-125 m = 4 25-150 m = 6 50-175 m = 8 75-200 m = 10 </pre>
•	0004-002
	E. A. Christiansen Consulting Ltd

NAME OF SPILLWAY Pipestone Spillway

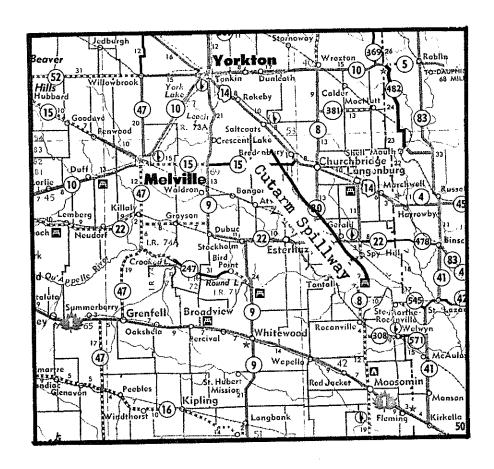


	,	DESCRIPTION	OF SPILLWAY	
Length	170	km	Depth of fill	_ m
Width _	500	m	In drift	
Relief .	50	m	In drift & bedrock x	-
Drained	meltwater only _		Drained meltwater & runoff	<u>x</u>
Other r	emarks			
		SCALE OF MILES	Lambert Conformal Projection 20 30 49	
		_ Q	50 metres	
		VTTO	metres	
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			E. A. Christiansen Consulting Lle	d

NATURAL VALUES A	ASSOC:	IATED WITH SPILLWAY *	
Ridged Moraine	Pg	Bedrock Exposures	Pp
Ice-thrust Moraine	NP	Springs	Pp
End Moraine	Pg	Alluvial Fans	Pр
Flutings	Рр	Flood Plains	Pg
Eskers	NP	Stream	Pр
Tunnel Valleys	NP	Marshes	Pр
Glacial Lake Basins	Pg	Lakes	Pg
Outwash Plains	Pg	Deltas	Рр
Meltwater Channels	Pg	Beaches	Pp
Landslides	Pg_	Other Terraces	Pg
SIGNIFICANT H	UMAN	IMPACT ON SPILLWAY	
No. of dams	2	No. of towns	0
Km of highways	8	No. of villages	<u> </u>
Km of railroads 1	ΓQ	No. of resorts	<u> </u>
LIST OF REFER	RENCE	S ON SPILLWAY	
Christiansen, E.A. 1960. Geold	ogy ar	nd ground-water resources of t	the
Qu'Appelle area, Saskat	chewa	an. Sask. Res. Counc., Geol. I)iv.,
Rept. 1, 53 p.			·
★ Within 20 km of spillway. Page 1.	g=g00	d; $Pp = poor$; and $NP = not pres$	ent.
Pipestone Spillway		000	4-002
		Ed Glistian Garage	41

Length (>300 km = 10 ; 200-300 km = 7	;<200 km = 4 4		
Width (>2000 m = 10; 1000-2000 m = 7; < 1000 m = 4)			
Relief			
Drained glacial meltwater only = $5 -$			
Drained glacial meltwater and progl			
	IATED WITH SPILLWAY **		
Ridged Moraine 2	Bedrock Exposures 1		
Ice-thrust Moraine 0	Springs 1		
End Moraine 2	Alluvial Fans 1		
Flutings 1	Flood Plains 1		
Eskers0	Stream 1		
Tunnel Valleys 0	Marshes 1		
Glacial Lake Basins 2	Lakes 2		
Outwash Plains 2	Deltas 1		
Meltwater Channels 2	Beaches 1		
Landslides2	Other2		
SIGNIFICANT HUMAN	IMPACT ON SPILLWAY		
Km of highways = $4-(km \text{ of highways/l})$	ength of spillway x 4) 0		
Km of railroads = $4-(km \text{ of railroads})$	/length of spillway x 4) 0		
No. of towns (0 or $l=4$, $2=3$,	3=2, 4 or more=0) 0		
No. of villages (0 or $l=4$, $2=3$, 3=2, 4 or more=0) 0		
No. of resorts (0 or $1=4$, $2=3$, 3=2, 4 or more =0) <u>0</u>		
Total out of 100			
Pinestone Spillway 1	<pre>< 100 m = 2 00-125 m = 4 25-150 m = 6 50-175 m = 8 75-200 m = 10 0004-002</pre>		
	E. A. Christiansen Consulting Ltd.		

NAME OF SPILLWAY Cutarm Spillway



	,	DESCRIP	TION	4 OF SPILLWAY	
Length	60		km	Depth of fill	m
Width	500		:m	In drift	, , , , , , , , , , , , , , , , , , ,
Relief			m	In drift & bedrockx	
Drained melt		x		Drained meltwater & runoff _	
Other remark	S				
	· · · · · · · · · · · · · · · · · · ·		calo in A	20 30 	
				0004	- 002
				E. A. Christiansen Consulting	Lld

NATURAL VALUES ASSOC	IATED WITH SPILLWAY *			
Ridged Moraine Pg	Bedrock Exposures Pp			
Ice-thrust Moraine Pg	Springs Pp			
End Moraine NP	Alluvial Fans Pp			
_	Flood Plains Pp			
Flutings Pg	Stream Pp			
Eskers	Marshes NP			
Tunnel valleys	Lakes NP			
Glacial Lake Basins	Deltas NP			
Outwash Plains	Beaches NP			
Meltwater Channels -	Other Terraces Pg			
Landslides Pg	Other leffaces 18			
ςτοντετολην ΗΙΙΜΑΝ	IMPACT ON SPILLWAY			
_				
No. of dams1	No. of towns			
Km of highways 4	No. of villages 0			
Km of railroads 2'	No. of resorts 0			
LIST OF REFERENCES ON SPILLWAY				
Christiansen, E.A. 1960. Geology a				
Qu'Appelle area, Saskatchew	an. Sask. Res. Counc., Geol. Div.,			
Rept. 1, 53 p.				
* Within 20 km of spillway. Pg=go	od; Pp = poor; and NP = not present.			
	0004-002			
Cutarm Spillway				
	& A Christiansen Consulting Std -			

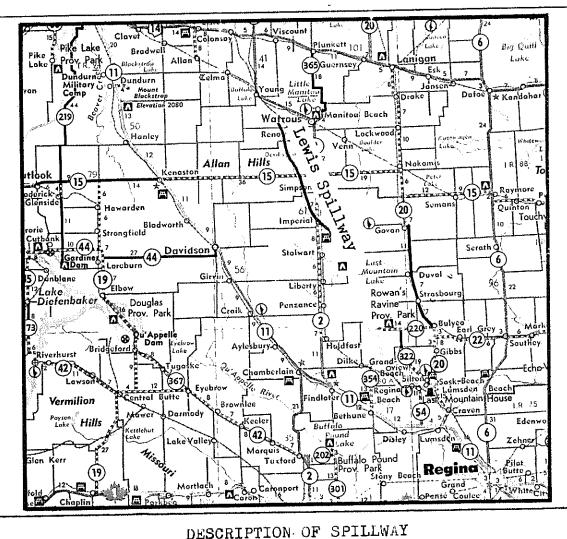
Tangel: (>300 lm - 10: 200-300 lm - 7	•== 200 km = 1				
Length (>300 km = 10; 200-300 km = 7; < 200 km = 4 $\frac{4}{}$					
Width (>2000 m = 10; 1000-2000 m = 7; < 1000 m = 4) 4 Relief*					
Relief	وميد المدار المراجعة ومن مدين المدار الم المدار المدار				
Drained glacial meltwater only = 5 -	The said this that the time and the said this said that the time to the time the said the sai				
Drained glacial meltwater and progl	acial runoff= 10				
NATURAL VALUES ASSOC	IATED WITH SPILLWAY **				
Ridged Moraine 2	Bedrock Exposures 1				
Ice-thrust Moraine 2	Springs 1				
End Moraine 0	Alluvial Fans 1				
Flutings 2	Flood Plains 1				
Eskers2	Stream 1				
Tunnel Valleys 2	Marshes 0				
Glacial Lake Basins 2	Lakes 0				
Outwash Plains 2	Deltas 0				
Meltwater Channels 2	Beaches 0				
Landslides 2	Other2				
SIGNIFICANT HUMAN IMPACT ON SPILLWAY					
Km of highways=4-(km of highways/length of spillway x 4) $\frac{4}{}$					
Km of railroads = $\frac{1}{4}$ (km of railroads/length of spillway x 4) $\frac{4}{4}$					
No. of towns (0 or $1=4$, $2=3$, $3=2$, 4 or more $=0$)					
No. of villages (0 or $l=4$, $2=3$	$3=2$, 4 or more $=0$) $\frac{4}{}$				
No. of resorts (0 or $1 = 4$, $2 = 3$	j				
Total out of 100	62				
** Pg = 2, Pp = 1, and NP = 0, 10	<pre>1 < 100 m = 2 00-125 m = 4 25-150 m = 6 50-175 m = 8 75-200 m = 10 0004-002</pre>				
	E. A. Christiansen Consulting Ltd				

0004-002

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INVENTORY OF GLACIAL SPILLWAYS

NAME OF SPILLWAY Lewis Spillway

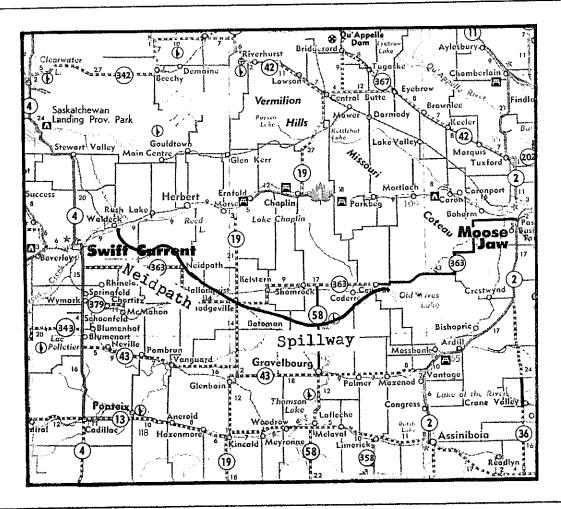


Length	40		km	Depth of fill	m
Width	500	· · · · · · · · · · · · · · · · · · ·	m	In driftx	
Relief	40		m	In drift & bedrock	
Drained meltw	ater only			Drained meltwater & runoff	X
Other remarks					
001101		10 0	Scale in	Miles	
		- - - - - - - - - -	to ale in K	20 30 40 ilometres	

NATURAL VALUES ASSOCIATED WITH SPILLWAY *					
Ridged MoraineP	g_	Bedrock Exposures	NP		
Ice-thrust Moraine N	Р	Springs	Pp_		
End Moraine P	g	Alluvial Fans	Рр		
Flutings N	P	Flood Plains	<u>Pp</u>		
Eskers P	g	Stream	Рр		
Tunnel Valleys N	Р	Marshes	<u>Pp</u>		
Glacial Lake Basins P	g	Lakes	Pg		
Outwash Plains P	<u>g</u>	Deltas	_Pp		
Meltwater Channels N	P	Beaches	<u> Pp</u>		
Landslides	'n,	Other Terraces	Pg		
SIGNIFICANT HU		IMPACT ON SPILLWAY			
No. of dams 0		No. of towns			
Km of highways 0	.,	No. of villages			
Km of railroads 0	!	No. of resorts	0		
LIST OF REFERENCES ON SPILLWAY					
Edmunds, F.H. 1962. Recession of Wisconsinan glacier from central					
Saskatchewan, Sask, Dep. Min. Res., Rept. 67, 23 p.					
Greer, J.E. and Christiansen, E.	Α.	1963. Geology and groundwater	· •••••		
		a (72-P), Saskatchewan. Sask.			
Res. Counc., Geol. Div., Rept. 3, 56 p.					
* Within 20 km of spillway. Pg=good; Pp = poor; and NP= not present. 0004-002					
Lewis Spillway					
		E. A. Christiansen Consulting .	Ltd		

Length (>300 km = 10; 200-300 km = 7; < 200 km = 4		
Width (>2000 m = 10; 1000-2000 m = 7; < 1000 m = 4)		
Relief		
Drained glacial meltwater only = 5 -		
Drained glacial meltwater and progl	acial runoff= 10 10	
NATURAL VALUES ASSOC	IATED WITH SPILLWAY **	
Ridged Moraine2	Bedrock Exposures 0	
Ice-thrust Moraine 0	Springs	
End Moraine 2	Alluvial Fans 1	
Flutings 0	Flood Plains 1	
Eskers2	Stream 1	
Tunnel Valleys 0	Marshes 1	
Glacial Lake Basins 2	Lakes 2	
Outwash Plains 2	Deltas 1	
Meltwater Channels 0	Beaches 1	
Landslides 1	Other2	
SIGNIFICANT HUHAN	IMPACT ON SPILLWAY	
Km of highways = 4-(km of highways/1	ength of spillway x 4) 4	
Km of railroads = \mathcal{L} -(km of railroads)	/length of spillway x 4) 4	
No. of towns (0 or $l = 4$, $2 = 3$,	3=2, 4 or more = 0) 4	
No. of villages (0 or $l=4$, $2=3$	3=2, 4 or more $=0$) 4	
No. of resorts (0 or $1 = 4$, $2 = 3$	3=2, 4 or more $=0$) 4	
Total out of 100	62	
** $Pg = 2$, $Pp = 1$, and $NP = 0$.	<pre>< 100 m = 2 00-125 m = 4 25-150 m = 6 50-175 m = 8 75-200 m = 10 0004-002</pre>	
	E. A. Christianson Consultina Ltd	

NAME OF SPILLWAY Neidpath Spillway

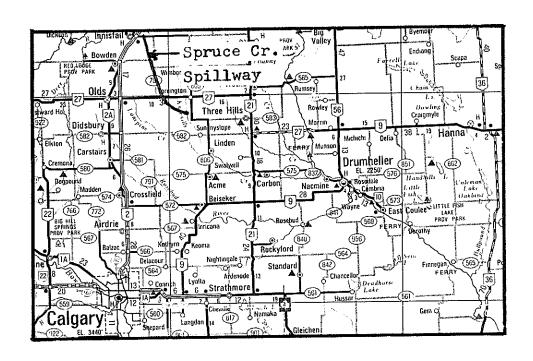


	,	DESCRIP	TION	OF SPILLWAY	
Length _	100	2	km	Depth of fill	m
Width	600		:m	In drift	
Relief	115		m	In drift & bedrock x	
Drained	meltwater only		, <u>, , , , , , , , , , , , , , , , , , </u>	Drained meltwater & runoff	<u>x</u>
Other re	emarks		le in Mi 10 0 20 in Kilom	20 30 	
*****				0004-0	02
				E. A. Christiansen Consulting L	ld

NATURAL VALUES	S ASSOCI	IATED WITH SPILLWAY *		
Ridged Moraine		Bedrock Exposures	Pp	
Ice-thrust Moraine	ŀ	Springs	Pp	
End Moraine			Pg	
Flutings			Ро	
Eskers		Stream	_Pp	
Tunnel Valleys			_Pg	
Glacial Lake Basins		Lak(s	_Pp	
Outwash Plains		Deltas		
		Beaches		
Meltwater Channels Landslides		Other Terraces		
Landslides			•	
SIGNIFICANT	r HUMAN	IMPACT ON SPILLWAY		
No. of dams	. 1	No. of towns	<u> </u>	
Km of highways		No. of villages		
Km of railroads		No. of resorts	_0	
LIST OF REFERENCES ON SPILLWAY				
Bretz, J.H. 1943. Keewatin end moraines in Alberta, Canada. Geol.				
Soc. Am. Bull., v. 54,p. 31-52.				
Christiansen, E.A. 1959. Gl	acial g	eology of the Swift Current	 	
		ot. Min. Res., Rept. 32, 62 p		
* Within 20 km of spillway	• Pg=go	od; $Pp = poor$; and $NP = not pre}$	esent.	
Neidpath Spillway			, J. q. J.	
		6 & Chairtingen Consulting	. Gul	

Length (>300 km = 10; 200-300 km = 7; $<$ 200 km = 4 4			
Width (>2000 m = 10; 1000-2000 m = 7; < 1000 m = 4)			
Relief	4		
Drained glacial meltwater only = 5			
Drained glacial meltwater and proglacial runoff = 10	10		
NATURAL VALUES ASSOCIATED WITH SPILLWAY **			
Ridged Moraine 2 Bedrock Exposures	_ 1		
Ice-thrust Moraine O Springs	- 1		
End Moraine 2 Alluvial Fans	_ 2		
Flutings 2 Flood Plains	_ 2		
Eskers 0 Stream	_ 1		
Tunnel Valleys 0 Marshes	. 2		
Glacial Lake Basins 2 Lakes	1		
Outwash Plains O Deltas	. 1		
Meltwater Channels O Beaches	0		
Landslides 1 Other Terraces			
SIGNIFICANT HUMAN IMPACT ON SPILLWAY			
Km of highways=4-(km of highways/length of spillway x 4)	3		
Km of railroads = 4 -(km of railroads/length of spillway x 4)	2		
No. of towns (0 or $l=4$, $2=3$, $3=2$, 4 or more $=0$)	4		
No. of villages (0 or $l=4$, $2=3$, $3=2$, 4 or more $=0$)	2		
No. of resorts (0 or $l=1$, $2=3$, $3=2$, 4 or more =0)	4		
Total out of 100	59		
** Pg = 2, Pp = 1, and NP = 0.	4-002		
E. A. Christiansen Consulting	Lld.		

NAME OF SPILLWAY Spruce Creek Spillway



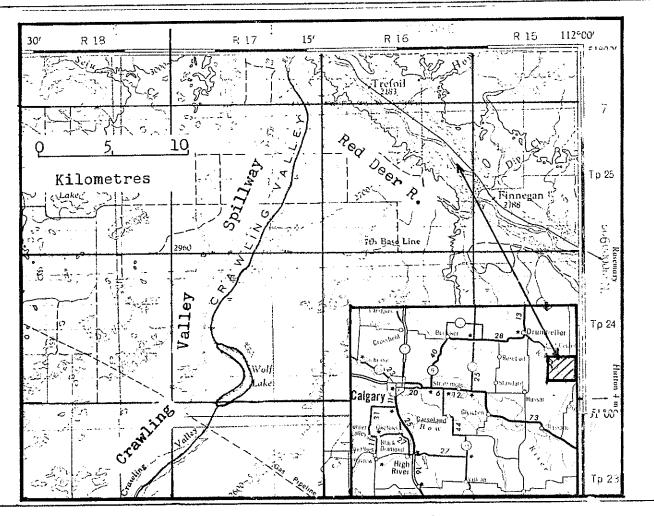
	DESC	RIPTION	OF SPILLWAY
Length	30	km	Depth of fill m
Width	500	n	In drift
Relief	60	m	In drift & bedrockx
Drained melt	water only		Drained meltwater & runoff x
Other remark	S		
	0	5	100
Kilometres			
			0004-002
			E. A. Christianson Consulting Std

NATURAL VALUES ASSOC	CIATED WITH SPILLWAY *
Ridged Moraine NP	Bedrock Exposures Pp
Ice-thrust Moraine NP	Springs Pp
End Moraine NP	Alluvial Fans Pg
Flutings NP	Flood Plains Pp
Eskers Pg	Stream Pp
Tunnel Valleys NP	Marshes NP
Glacial Lake Basins Pg	Lakes NP
Outwash Plains Pg	Deltas NP_
Meltwater Channels Pg	Beaches NP
Landslides pg	Other Terraces Pg
	IMPACT ON SPILLWAY
No. of dams 0	No. of towns 0
Km of highways 2	
Km of railroads	No. of resorts
LIST OF REFERENC	
Stalker, A.M. 1973. Surficial geol	
Alberta. Geol. Surv. Can.,	Mem. 370, 122 p.
* Within 20 km of spillway. Pg=go	od; Pp = poor; and NP= not present.
Spruce Creek Spillway	0004-002
Spinos of our opining	
	E. A. Christiansen Consulting Ltd

Length (>300 km = 10; 200-300 km = 7; < 200 km = 4 4				
Width (>2000 m = 10; 1000-2000 m = 7; < 1000 m = 4)				
Relief				
Drained glacial meltwater only = 5 -				
Drained glacial meltwater and progl	acial runoff= 10 10			
NATURAL VALUES ASSOC	IATED WITH SPILLWAY **			
Ridged Moraine 0	Bedrock Exposures 1			
Ice-thrust Moraine 0	Springs 1			
End Moraine 0	Alluvial Fans 2			
Flutings 0	Flood Plains1			
Eskers 2	Stream 1			
Tunnel Valleys 0	Marshes 0			
Glacial Lake Basins 2	LakesO			
Outwash Plains 2	Deltas0			
Meltwater Channels 2	Beaches 0			
Landslides 2	Other2			
SIGNIFICANT HUMAN IMPACT ON SPILLWAY				
Km of highways = 4-(km of highways/length of spillway x 4)				
Km of railroads = 4 -(km of railroads/length of spillway x 4)				
No. of towns (0 or $l = 4$, $2 = 3$,	3=2, 4 or more=0) 4			
No. of villages (0 or $l=4$, $2=3$, 3=2, 4 or more=0) 4			
No. of resorts (0 or $1 = 4$, $2 = 3$)	, 3 = 2, 4 or more =0) 4			
Total out of 100				
** $Pg = 2$, $Pp = 1$, and $NP = 0$.	<pre>5 100 m = 2 00-125 m = 4 25-150 m = 6 50-175 m = 8 75-200 m = 10</pre>			
opiaco oroca opia	0004-002			
	E. A. Christiansen Consulting Ltd			

NAME OF SPILLWAY Crawling Valley Spillway

LOCATION OF SPILLWAY



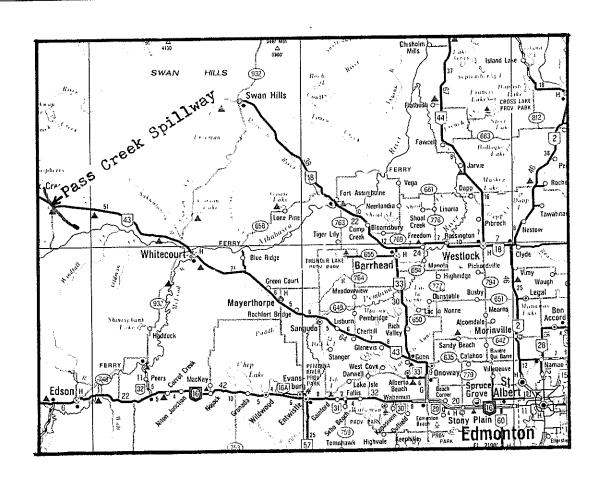
Length 55	km	Depth of fill m
Width 600	:m	In drift
Relief 45	m	In drift & bedrock x
Drained meltwater only		Drained meltwater & runoff x
Other remarks		
		0004-002
		E. A. Christianson Consulting Ltd

	Page 2	of 3
NATURAL VALUES ASSOC	IATED WITH SPILLWAY *	
Ridged Moraine NP	Bedrock Exposures	Pp
Ice-thrust Moraine NP	Springs	Рр
End Moraine NP	Alluvial Fans	Pg
Flutings NP	Flood Plains	Pg
Eskers NP	Stream	Рр
Tunnel Valleys NP	Marshes	Pp
Glacial Lake Basins Pg	Lakes	Рр
Outwash Plains Pg	Deltas	Рр
Meltwater Channels NP	Beaches	Рр
Landslides Pp	Other Terraces	Pg
	IMPACT ON SPILLWAY	0
No. of dams 2	No. of towns	0
Km of highways O	No. of villages	
Km of railroads 0	No. of resorts	0
LIST OF REFERENCE	CS ON SPILLWAY	
	. C. the Downhollon area	
Stalker, A.M. 1973. Surficial geolo		
Geol. Surv. Can. Mem. 370,	122 p.	
) ND	
≠ Within 20 km of spillway. Pg=goo		4-002
	000	4-00 <i>c</i>
Crawling Valley Spillway	•	

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Length (>300 km = 10; 200-300 km = 7; $<$ 200 km = 4		4	
Width (>2000 m = 10; 1000-2000 m = 7; $<$ 1000 m = 4)		4	
Relief		2	
Drained glacial meltwater only = 5			
Drained glacial meltwater and progl	acial runoff= 10	10	
NATURAL VALUES ASSOC	IATED WITH SPILLWAY **		
Ridged Moraine 0	Bedrock Exposures	1	
Ice-thrust Moraine 0	Springs	1	
End Moraine 0	Alluvial Fans	2	
Flutings 0	Flood Plains	2	
Eskers0	Stream	1	
Tunnel Valleys 0	Marshes	1	
Glacial Lake Basins 2	Lakes	1	
Outwash Plains 2	Deltas	1	
Meltwater Channels 0	Beaches	1	
Landslides 1	Other Terraces	2	
SIGNIFICANT HUMAN IMPACT ON SPILLWAY			
Km of highways = 4-(km of highways/length of spillway x 4)			
Km of railroads = 4 -(km of railroads/length of spillway x 4)		4	
No. of towns (0 or $1=4$, $2=3$, $3=2$, 4 or more $=0$)		4	
No. of villages (0 or $l=4$, $2=3$)	, 3=2, 4 or more=0)	4	
No. of resorts (0 or $1 = 4$, $2 = 3$)	, 3 = 2, 4 or more =0)	4	
Total out of 100	معرب من من من الله الله الله الله الله الله الله الل	58	
** $Pg = 2$, $Pp = 1$, and $NP = 0$.	<pre><100 m = 2 00-125 m = 4 25-150 m = 6 50-175 m = 8</pre>		
Crawling Valley Spillway	75-200 m=10 0004-	-002	
	E. A. Christiansen Consulting	Etd	

NAME OF	SPILLWAY	Pass Creek Spillway
		LOCATION OF SPILLWAY



	, DESCRI	PTION	OF SPILLWAY	
Length .	35	_ km	Depth of fill	m
Width _	600	_ m	In drift X	
Relief .	60	_ m	In drift & bedrock	
Drained	meltwater only		Drained meltwater & runoff	<u>x</u>
Other r	emarks			
	0	5	0 100	
		Kilor	etres	
			0004-	.002
			E. A. Christiansen Consulting .	Lld

NATURAL VALUES	ASSOCI	IATED WITH SPILLWAY *		
Ridged Moraine	NP	Bedrock Exposures	ИЪ	
Ice-thrust Moraine	1	Springs	<u> Pp</u>	
End Moraine		Alluvial Fans	Pg	
Flutings		Flood Plains	<u>Pp</u>	
Eskers		Stream	<u> Pp</u>	
Tunnel Valleys		Marshes	NP	
Glacial Lake Basins		Lakes	NP	
Outwash Plains		Deltas	NP_	
Meltwater Channels		Beaches	NP	
Landslides		Other Terraces	Pg	
SIGNIFICANT HUMAN IMPACT ON SPILLWAY No. of dams O No. of towns O				
Km of highways		No. of villages		
Km of railroads		No. of resorts		
LIST OF REFERENCES ON SPILLWAY				
The surficial geology of this				
The interprretation is based			s	
	u			
* Within 20 km of spillway. Pg=good; Pp = poor; and NP= not present.				
Pass Creek Spillway		E. A. Christiansen Consulting	Ltd	

Length (>300 km = 10; 200-300 km = 7; < 200 km = 4			
Width (>2000 m = 10; 1000-2000 m = 7; <1000 m = 4)			
Relief			
Drained glacial meltwater only = 5	dang atah lain man ann ann ann ann ann ann ann ann an		
Drained glacial meltwater and proglaci	al runoff= 10 10		
NATURAL VALUES ASSOCIAT	ED WITH SPILLWAY **		
Ridged Moraine 0 Bee	drock Exposures 0		
Ice-thrust Moraine 0 Sp	rings		
End Moraine 0 Al	luvial Fans 2		
Flutings 0 Florings	ood Plains 1		
Eskers O St:	ream l		
Tunnel Valleys 0 Max	rshes 0		
Glacial Lake Basins 2 Lake	kes		
Outwash Plains 2 De:	ltas 0		
Meltwater Channels 0 Bea	aches 0		
Landslides 1 Oth	her2		
SIGNIFICANT HUMAN IMPACT ON SPILLWAY			
Km of highways=4-(km of highways/length of spillway x 4)			
Km of railroads = μ -(km of railroads/length of spillway x μ)			
No. of towns (0 or $l=4$, $2=3$, $3=3$	2, 4 or more = 0) 4		
No. of villages (0 or $l=4$, $2=3$,	3=2, 4 or more $=0$) 4		
No. of resorts (0 or $l=4$, $2=3$,			
Total out of 100			
** $Pg = 2$, $Pp = 1$, and $NP = 0$. 100-1125-1150-1175-2	100 m = 2 125 m = 4 150 m = 6 175 m = 8 200 m = 10		
Pass Creek Spillway	0001,-002		
	E. A. Christiansen Consulting Ltd		