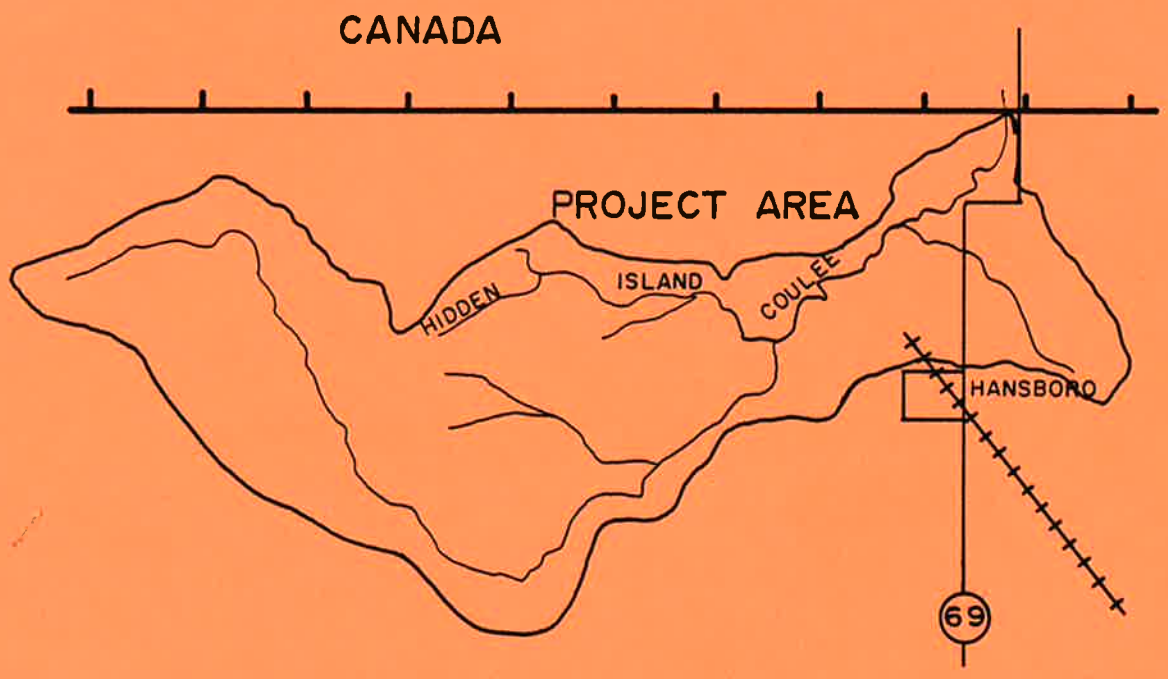
1702

PRELIMINARY ENGINEERING REPORT

FEASIBILITY STUDY

FOR THE

FLOOD CONTROL OF HIDDEN ISLAND COULEE



NORTH DAKOTA
STATE WATER COMMISSION
MARCH 1980

SWC PROJECT #1702

PRELIMINARY ENGINEERING REPORT
HIDDEN ISLAND COULEE

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Prepared For:

Towner County Water Management Board

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I. INTRODUCTION

A. Purpose And Scope

The following report contains the results of a study conducted by the State Water Commission to develop plans to alleviate the flooding problem on the lower reaches of Hidden Island Coulee. It is the intention of the Towner County Water Management Board to provide flood protection for agricultural land which in the previous years has been experiencing erosion problems. Therefore, the Water Management Board requested the State Water Commission to investigate the feasibility of several alternatives for the reduction of flood damage on Hidden Island Coulee.

This report includes a brief discussion of the problem, a physical description of the watershed, an engineering analysis of the flooding problems, and a short environmental assessment of the project's impact on the area. Included in the engineering analysis, is an analysis of the drainage basin, a construction cost estimate, a description of the project benefits, and a summary of the report. The engineering analysis utilizes the best practical technology to devise alternatives that will sufficiently meet the needs of the watershed. The design of the alternatives comply with criteria established by the State Water Commission.

II. BRIEF HISTORY

Flood problems along the lower reaches of Hidden Island Coulee have been evident for many years. The problems originate in the NE¼ of Section 6, Township 164 North, Range 67 West where the channel's natural

capacity changes from 1800 cfs to 350 cfs. Futile flood protection measures have been attemped by individual landowners to protect their land in recent years.

The magnitude of the problems have been too great for one or two individuals to handle. In 1977, the Towner County Water Management Board requested the State Water Commission to look at the problem in total. Stephen Hoetzer, the Drainage Engineer for the State Water Commission, inspected the flood problem of Hidden Island Coulee in 1978. He suggested that an investigation agreement be entered into with the Towner County Water Management Board. In October of 1978 an investigation agreement was signed "To determine the condition and adequacy of the river channel and appurtenant structure, and determine the necessary improvements and prepare a cost estimate for these improvements." A copy of this agreement is contained in the Appendix.

During July, 1979, a field survey was conducted on the lower portion of Hidden Island Coulee. The purpose of this field survey was to gather profile and cross section data along proposed channel improvements and routes. This report will discuss the alternatives evaluated.

III. PHYSICAL DESCRIPTION

A. Geology and Physiography

The project area under study is located in northern Towner County, approximately 1½ miles north of the town of Hansboro, North Dakota (see Figure 1). Hidden Island Coulee is a tributary to the Pembina River which is part of the Red River Basin. Approximately 95% of the watershed contributes directly to surface water runoff. The remainder of the

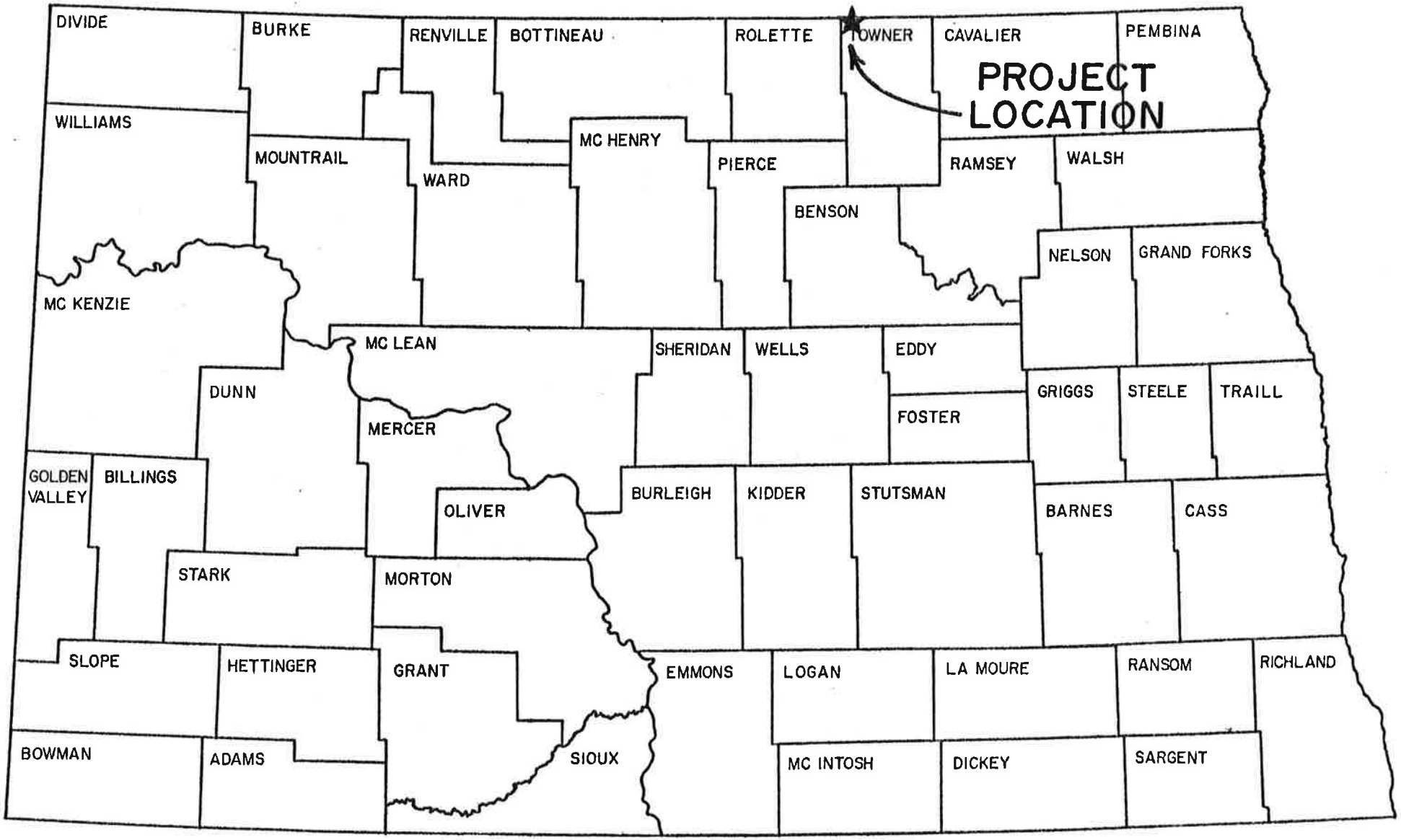

DIVIDE
BURKE
RENVILLE
BOTTINEAU
ROLETTE
TOWNER
CAVALIER
PEMBINA
PROJECT LOCATION
WILLIAMS
MOUNTRAIL
WARD
MC HENRY
PIERCE
RAMSEY
WALSH
BENSON
NELSON
GRAND FORKS
MC KENZIE
MC LEAN
SHERIDAN
WELLS
EDDY
DUNN
MERCER
FOSTER
GRIGGS
STEELE
TRAILL
GOLDEN VALLEY
BILLINGS
OLIVER
BURLEIGH
KIDDER
STUTSMAN
BARNES
CASS
STARK
MORTON
SLOPE
HETTINGER
GRANT
EMMONS
LOGAN
LA MOURE
RANSOM
RICHLAND
BOWMAN
ADAMS
SIOUX
MC INTOSH
DICKEY
SARGENT

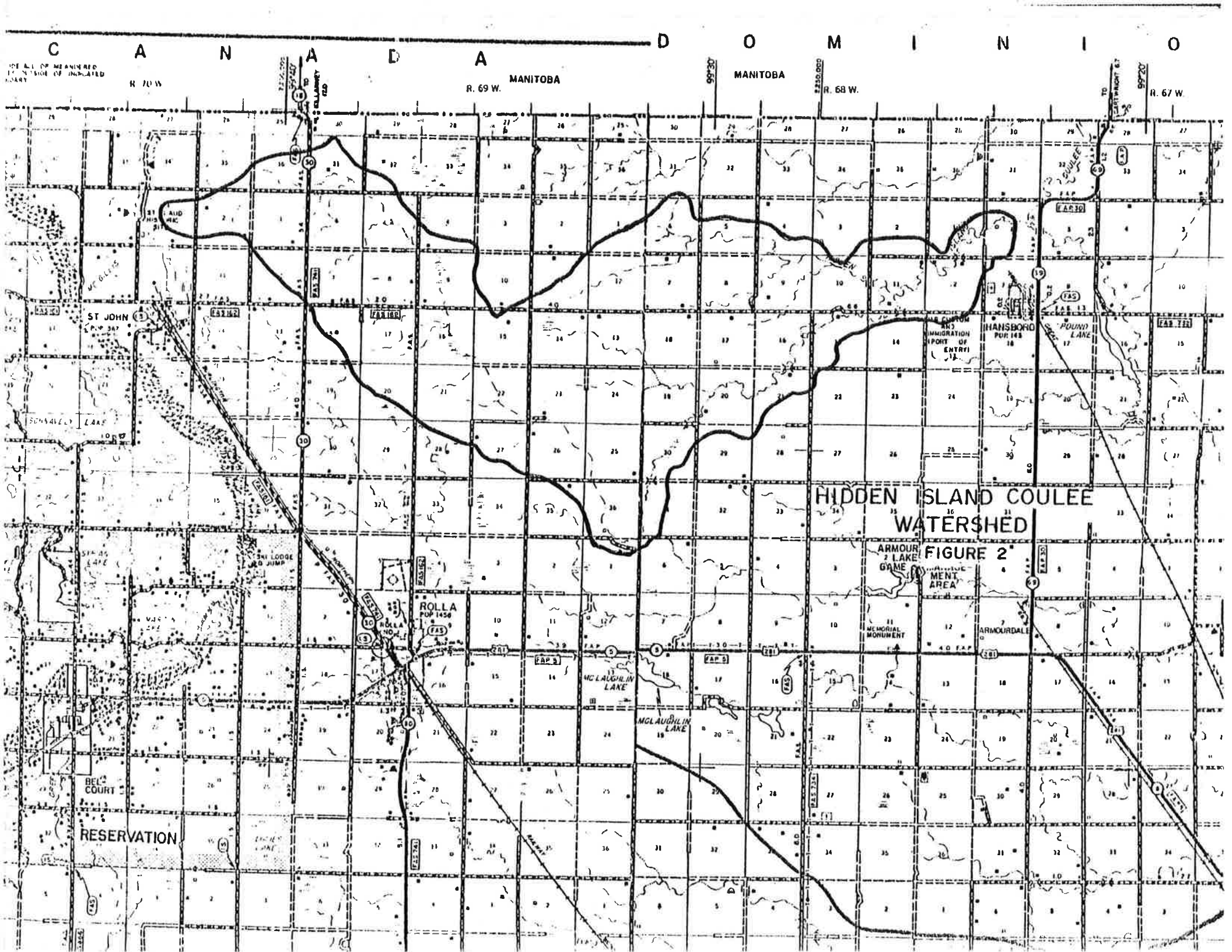
FIGURE 1

drainage area consists of small closed basins, not contributing to stream flow. No known artificial agricultural drainage takes place within the watershed.

Hidden Island Coulee is located in the Red River Basin which is classified as a sub-humid to humid continental climate with moderately warm summers and cold winters. Rapid changes in daily weather patterns are characteristic of this area. Frequent passage of weather fronts and high and low pressure systems result in a wide variety of weather. The annual mean temperature is 39° F. with the warmest month being July and the coldest month being January. The annual mean precipitation is 16 inches.

The contributing drainage area to Hidden Island Coulee is approximately 42 square miles (Figure 2). It takes about 16.6 hours for the runoff to travel from the hydraulically most distant part of the watershed to the location of flooding. Throughout most of the watershed the channel of Hidden Island Coulee is well defined. About one-half mile west of Highway 69 and 1½ miles north of Hansboro, the channel converts from a well defined channel to a condition of mostly overland flow. The water at this point flows in a northeastern direction. At a discharge of 350 cfs, it breaks out of the channel approximately ¼ mile east of Highway 69, Section 6, Township 163 North, Range 68 West, and starts to flow in an easterly direction. The water continues north and east in an overland flow condition causing considerable erosion as well as crop damage during summer floods.

The flooding affects approximately 2500 acres of cropland and grassland in the United States and an unknown number of acres of cropland and grassland in Canada (see Figure 3).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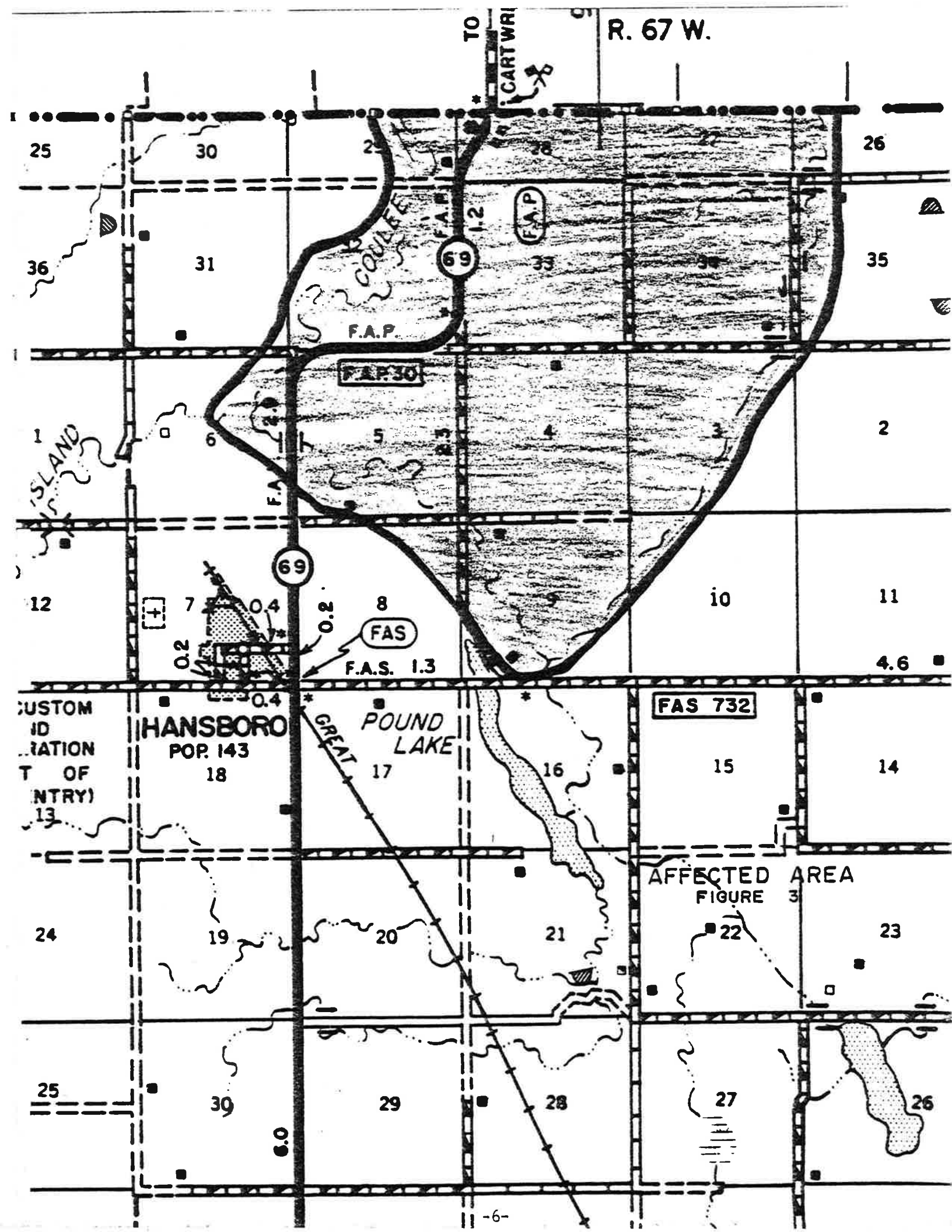
ROLLA
POP 1456
HANSBORO
POP 148
HIDDEN ISLAND COULEE
WATERSHED
FIGURE 2
ARMOURDALE
MC LAUGHLIN LAKE
MC LAUGHLIN LAKE
RESERVATION
BELCOURT
POUND LAKE
ARMOUR 2 LAKE GAME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IV. ENGINEERING ANALYSIS

A. Hydrologic Investigation

The TR-20 computer program developed by the U.S. Soil Conservation Service was used to determine the peak discharge and corresponding flow volume for various frequency storms. The program formulates a mathematical model of the watershed based on the following input data: rainfall distribution, type of soil, soil moisture condition, land use, time of concentration, hydraulic characteristics of the channels and the size of the drainage area. The hydrologist must make accurate estimates of the data to formulate an accurate model of the watershed. The program was used to generate peak discharges at the point where overland flow begins.

Peak discharges were analyzed for both rainfall and snowmelt runoff. The 10, 25, 50 and 100 year rainfall and snowmelt frequencies were evaluated. Because of its larger peak and higher volume, the 10 year snowmelt frequency was used as the design flow.

The 10 year frequency snowmelt on the watershed is approximately 2.53 inches. Discharges for the various frequency storms are shown in Table 1. These are the peaks that can be expected in the natural channel one-half mile east of Highway 69 in Section 1, Township 163 North, Range 69 West.

TABLE 1

Frequency (years)	Snowmelt (cfs)	Rainfall (cfs)
10	1194	1006
25	1445	1494
50	1912	1997
100	2406	2569

To check accuracy of the TR-20 program, the discharges for the different frequencies were evaluated at a point where a United States Geological Survey Stream gage is located in the watershed. The results of the comparison are shown in Table 2.

TABLE 2

	U.S.G.S.	TR-20 Program	
Frequency (years)	Stream Gage (cfs)	Rainfall (cfs)	Snowmelt (cfs)
10	751	754	816
25	1272	1118	932
50	1754	1475	1239
100	2300	1885	1503

The drainage area to the stream gage is 27.5 miles. Discharge frequencies for the stream Gage were calculated by the Log-Pearson Type III Method. Comparing the 10 year frequencies of the stream gage records and the TR-20 results it can be seen that the correlation between the two are very close. This is an indication of the accuracy of the 10 year design flows utilized in this evaluation.

B. Alternatives

During the Engineering Investigation many alternatives were studied and evaluated to determine the most feasible method of reducing the flood damage caused by Hidden Island Coulee. The analysis found that three of the alternatives gave the maximum flood protection for the cost. Two of the proposed alternatives involve channel improvement and construction. The third alternative proposes the construction of a dry dam. A description and a discussion of each alternative follows.

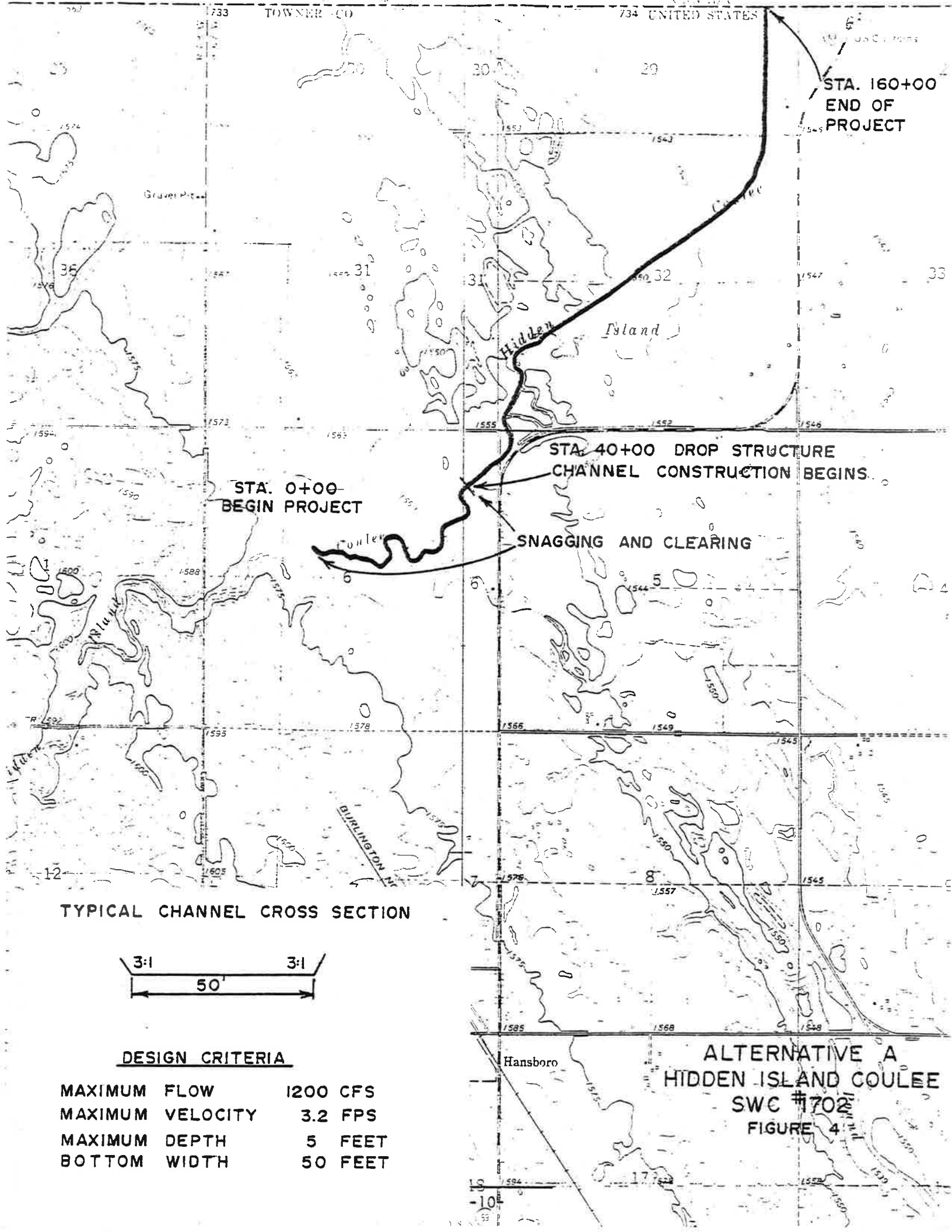
ALTERNATIVE A

The intention of this alternative is to improve the existing northeast channel so it can handle the 10 year flow. To accomplish this would require the snagging and clearing of 4000 feet of the channel in the NE¼ of Section 6 (see Figure 4). A drop structure will be placed in the NW¼ of Section 6 at Station 40+00. From Station 40+00 to Station 160+00, at the Canadian Border, construction of a new channel will be necessary. The capacity of this channel will be 1200 cfs; for flows greater than the 10 year event, the new channel will not be effective in reducing flood damage. An overland flow condition will exist for these flows. This alternative is expected to cost $206,505. A breakdown of the quantities and construction costs are shown in Table 3. This cost estimate does not include land acquisition.

There are several drawbacks to this proposed alternative. The main one is that the entire flow is routed to the Canadian Border where the channel capacities are unknown. Alleviating the problem for American farmers might create flooding problems for Canadian farmers. Another possible drawback is that the reconstructed channel must run through land on which the Bureau of Fish and Wildlife has obtained easements (see Figure 5).

ALTERNATIVE B

Alternative B involves the construction of a dam in Section 11, Township 163 North, Range 68 West (see Figure 6) with a capacity of approximately 1100 acre-feet. This dam will be operated as a dry dam so

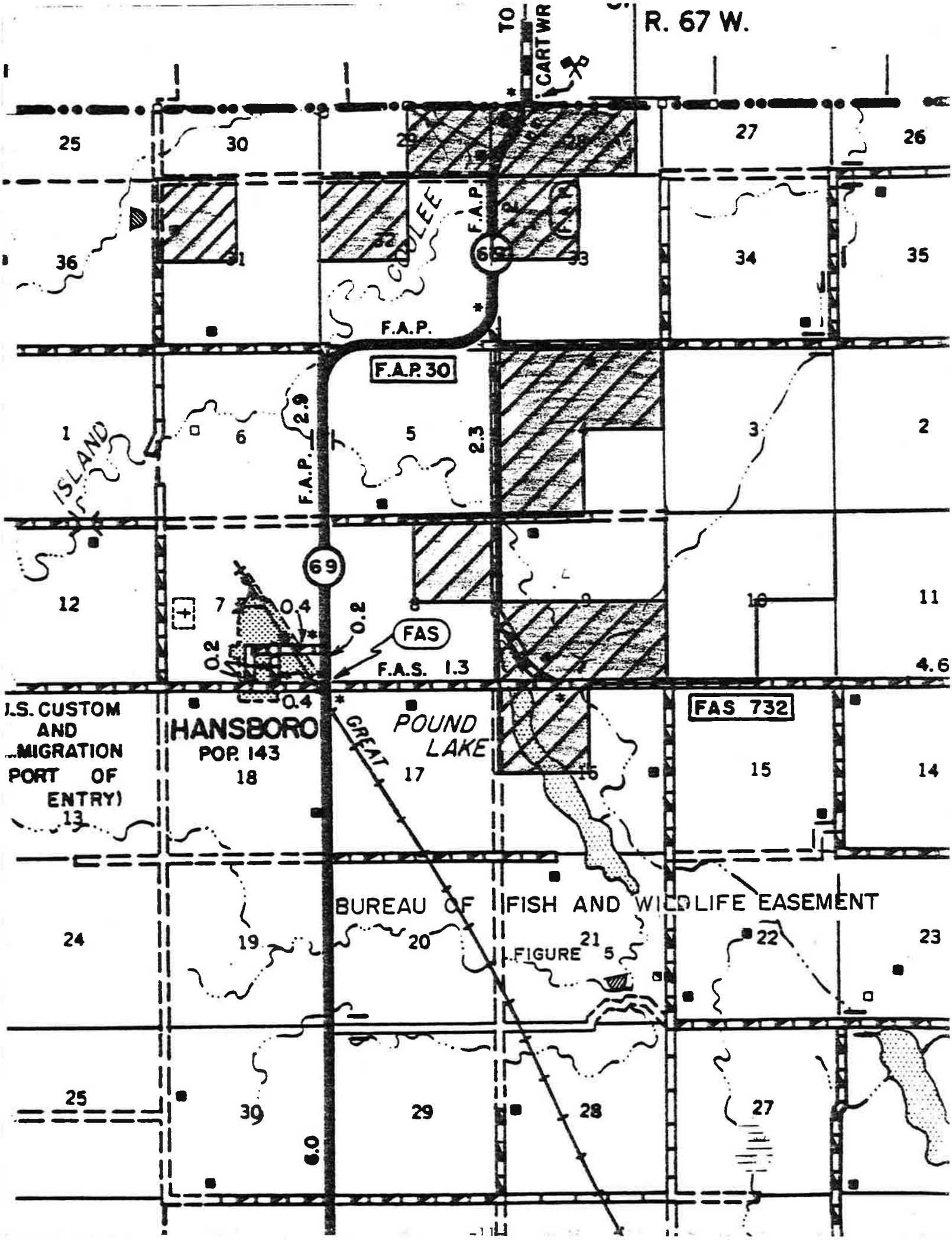


TYPICAL CHANNEL CROSS SECTION

DESIGN CRITERIA

MAXIMUM	FLOW	1200 CFS
MAXIMUM	VELOCITY	3.2 FPS
MAXIMUM	DEPTH	5 FEET
BOTTOM	WIDTH	50 FEET

ALTERNATIVE A
HIDDEN ISLAND COULEE
SWC #1702
FIGURE 4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ISLAND
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F.A.S. 1.3
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11
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0.4
U.S. CUSTOM AND IMMIGRATION PORT OF ENTRY)
13
HANSBORO
POP. 143
18
GREAT
POUND LAKE
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FAS 732
15
14
BUREAU OF FISH AND WILDLIFE EASEMENT
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FIGURE 5
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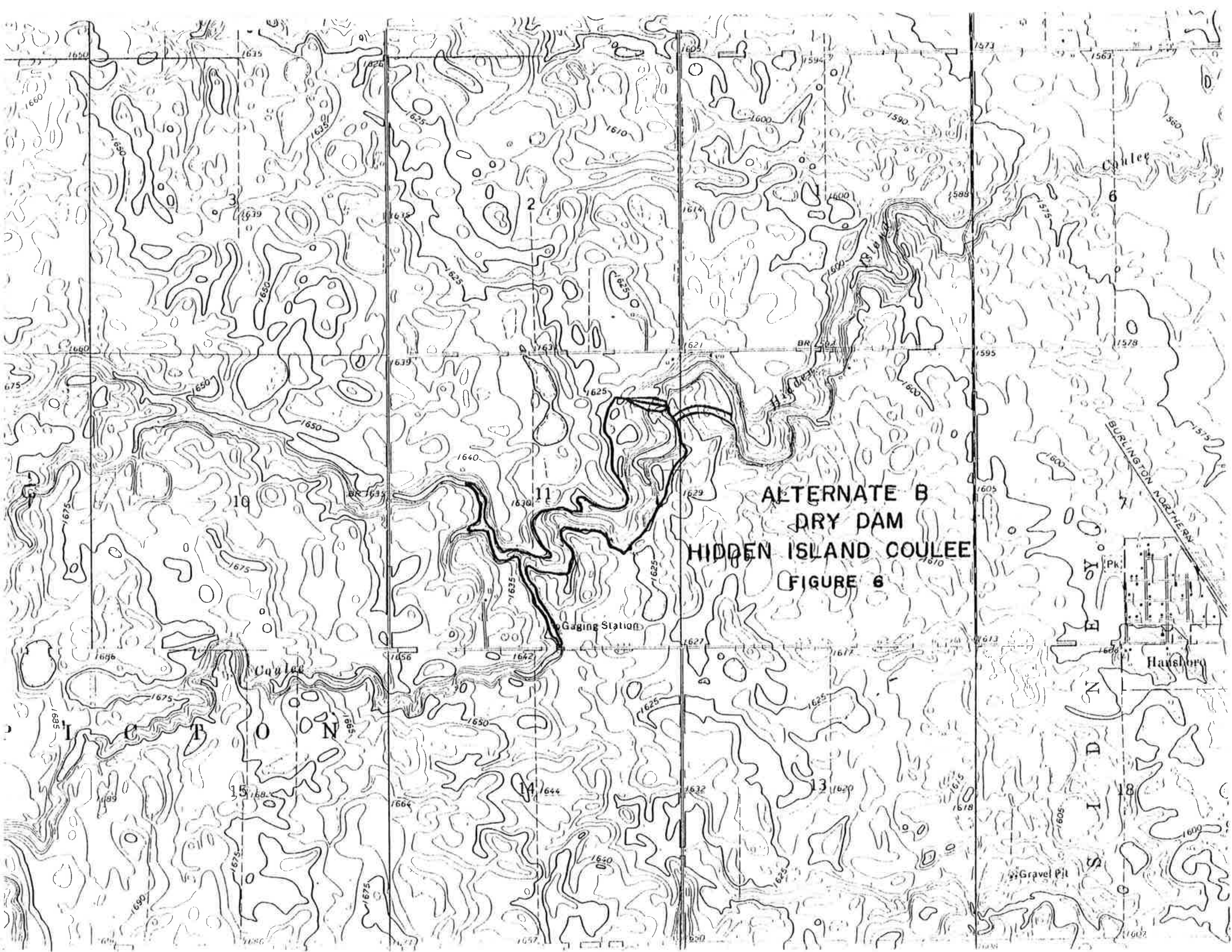
COST ESTIMATE HIDDEN ISLAND COULEE ALTERNATE A

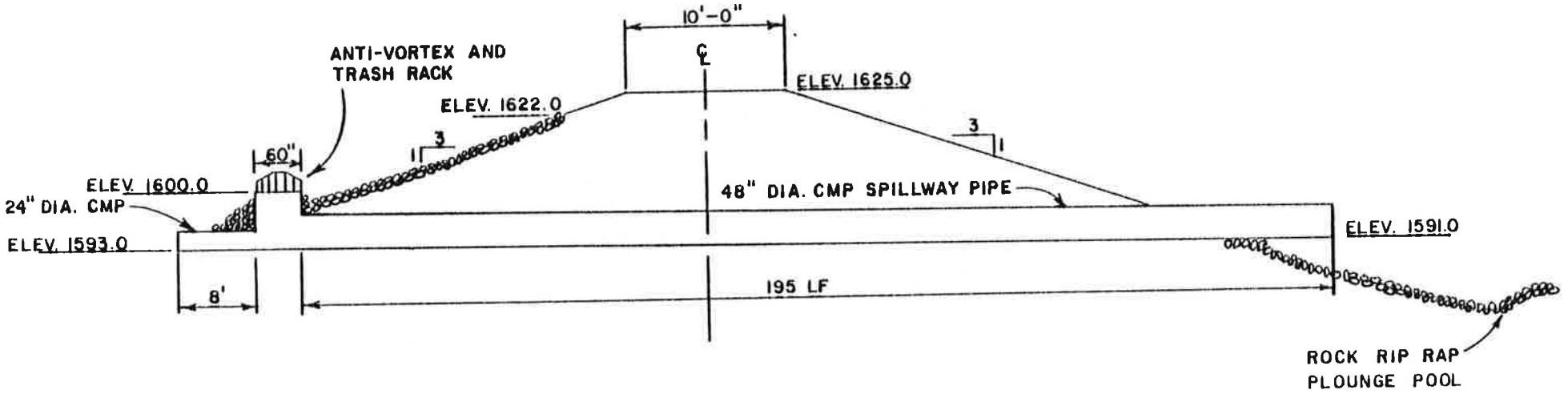
TABLE 3

	Quantity	Unit Cost	Total
Salvaging and Spreading Topsoil	50,000 ft.^{3}	$ .25	$ 12,500
Excavation	58,000 yd.^{3}	$ 2.00	$116,000
Riprap	30 yd.^{3}	$ 25.00	$ 750
Riprap Filter Material	10 yd.^{3}	$ 10.00	$ 100
Seeding	14 acres	$200.00	$ 2,800
Application of Water	1000 M.	$ 4.00	$ 4,000
Concrete	50 yd.^{3}	$400.00	$ 20,500
Reinforcing Steel	4500 lbs.	$ .60	$ 2,700
		TOTAL	$158,850
		+ 30% Contingencies, Engineering & Inspection	47,655
			$206,505

NOTE: Not including land acquisition



ALTERNATE B
DRY DAM
HIDDEN ISLAND COULEE
FIGURE 6



TYPICAL CROSS SECTION OF DAM AT MAIN SPILLWAY

NO SCALE

FIGURE 7

maximum flood storage may be utilized during storm runoff. Because of the limited storage, this dam will only be effective for the 10 year flow. The maximum discharge allowed for the 10 year flow will be about 390 cfs, a reduction of 67% from the 1194 cfs estimate at this point. There will be no reduction in flow for any storms greater than the 10 year frequency. Downstream channels will be able to handle a flow of approximately 400 cfs.

The design characteristics of the dam required to achieve this amount of reduction consist of a 4 foot (48") diameter corrugated steel pipe with its inlet invert at the elevation 1593.0 msl. This pipe will handle most of the low flows and act as a control for the high flows. Higher flows will go through a 100' wide emergency spillway. This spillway will be riprapped and have a crest elevation of 1620.0 msl. Once the 10 year runoff has begun, the hydraulics of the dam will allow the dam to drain down to an elevation of 1610.0 msl in one week, the elevation where farming can be resumed.

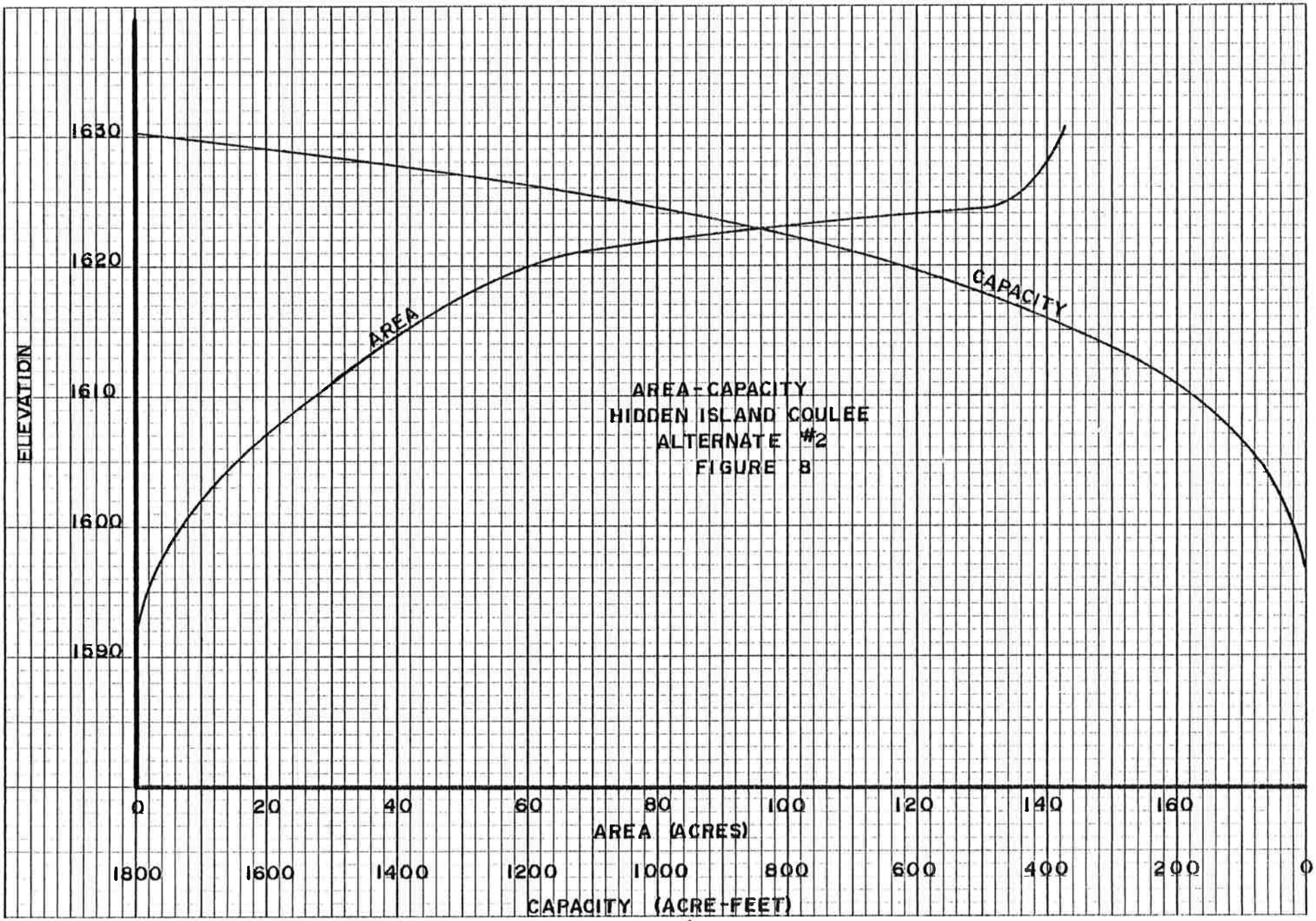
The estimated cost construction is $233,570, not including land acquisition. See Table 4 for a list of the costs and quantities.

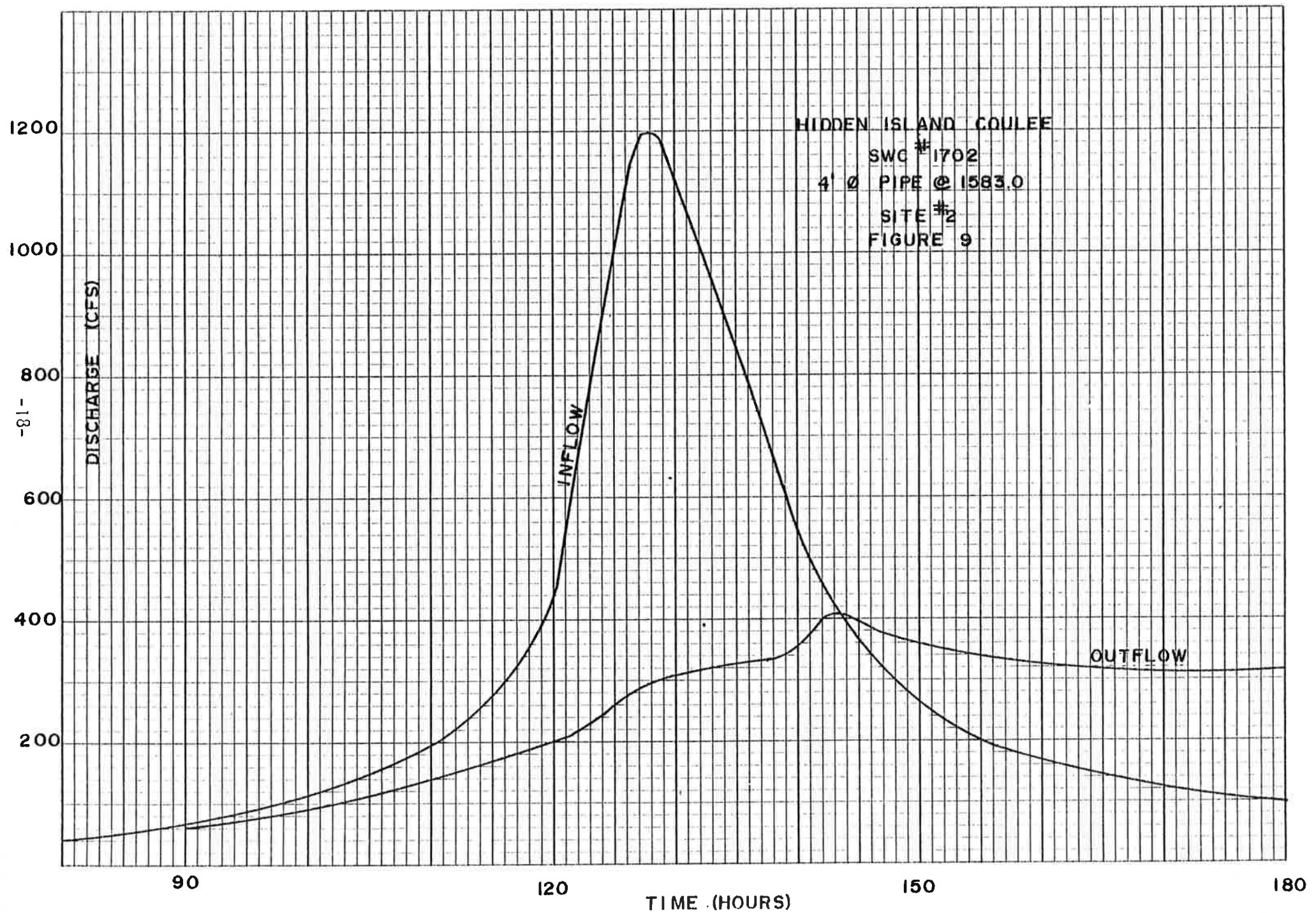
The benefits of constructing a dam are much greater than those realized from channel improvements. The dam benefits all the downstream landowners by containing most of the damaging flows. The construction of a channel just routes the water through the area to be protected leaving landowners further downstream with the same or greater possibilities

COST ESTIMATE HIDDEN ISLAND COULEE ALTERNATIVE B

TABLE 4

	Quantity	Unit Cost	Total
Salvaging and Spreading Topsoil	35,000 yd^2	$ .25	$ 8,750
Stripping Excavation	12,000 yd^2	$ .20	$ 2,400
Cutoff Trench Excavation	560 yd^3	$ 2.00	$ 1,120
Borrow Excavation	34,200 yd^3	$ 2.00	$ 68,400
Riprap	3,000 yd^3	$ 20.00	$ 60,000
Riprap Filter Material	760 yd^3	$ 10.00	$ 7,600
Seeding	7 acres	$200.00	$ 1,400
Application of Water	1500 M.Gal.	$ 4.00	$ 6,000
Cost and Installation of Riser and Pipe			
Riser	60" 10 ga.	LS	$ 24,000
Pipe	48" 12 ga.		
Trash Rack	60" 12 ga.		
		TOTAL	$179,670
		+ 30% Contingencies	59,900
		Engineering & Inspection	$233,570

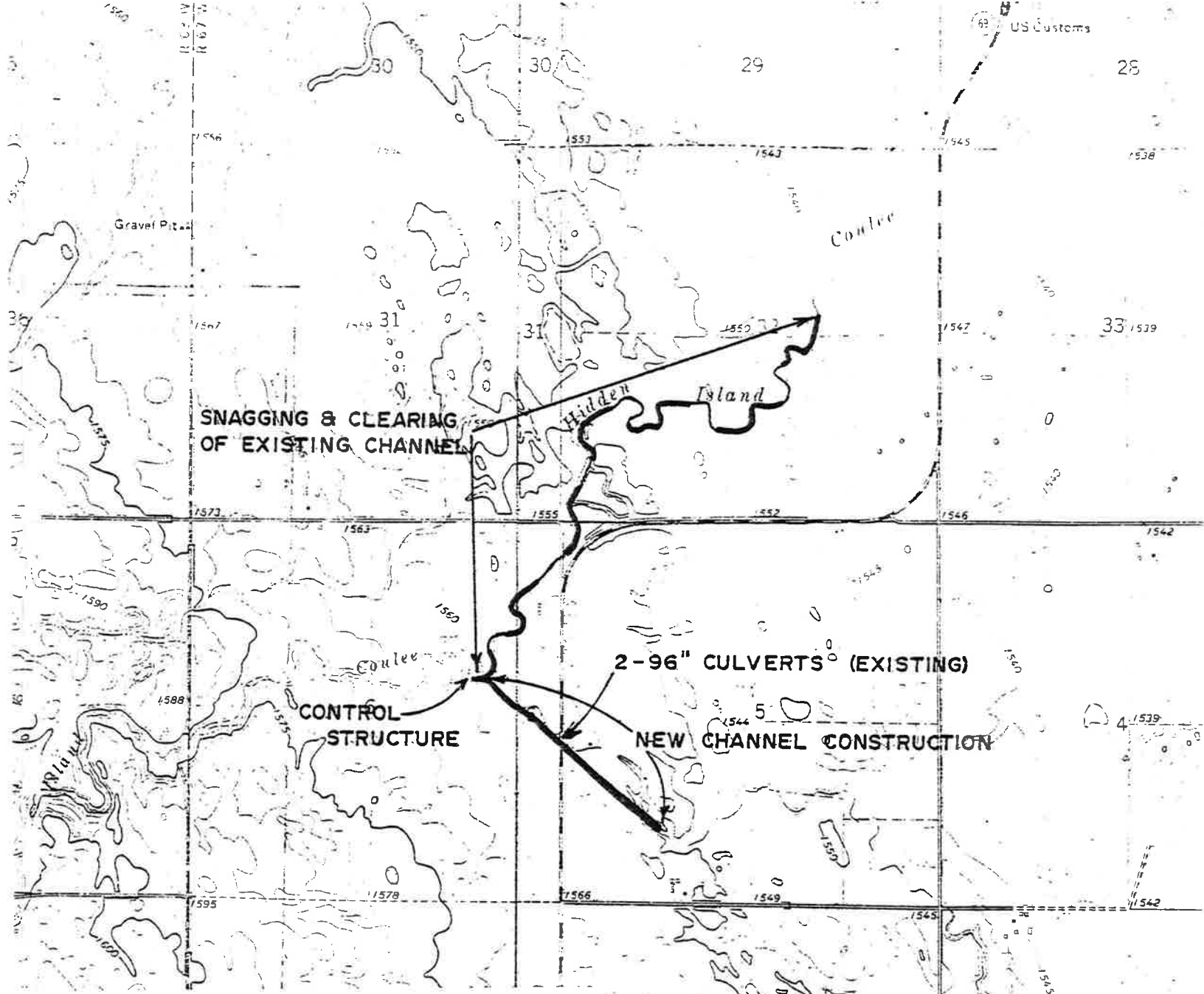




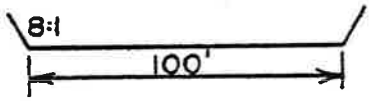
of experiencing flood damage. Another benefit of the dam is the amount of land lost to productivity due to construction. The land required in the construction of a dry dam (Alternative B) is approximately 80% less than the land required in the construction of a channel (Alternative A).

ALTERNATIVE C

The objective of this proposal is to divide the flow into two separate directions once the flow reaches a designated discharge. At a point, (see Figure 10) approximately $\frac{1}{4}$ mile west of Highway 69, Section 6, Township 163 North, Range 68 West, a control structure will divide the flow. The water will be allowed to flow north until it reaches a magnitude of 400 cfs, at which time the overflow will start flowing east. This alternative is designed to separate the 10 year flow of 1200 cfs by allowing 400 cfs to flow north and up to 800 cfs to flow east. As in Alternative A, this proposal will also require snagging and clearing of 4,000 feet of the northeastern channel of Hidden Island Coulee in Section 32, Township 164 North, Range 68 West. A channel will have to be constructed from the control structure located on Hidden Island Coulee to Highway 69, where 2-96 inch culverts already exist. From the culverts on the east side of the highway, the channel will continue southeast approximately 1000 feet to an existing channel. The cost of this alternative is approximately $77,415, not including land acquisition and flood easements. The construction costs and quantities are listed in Table 5.



TYPICAL CHANNEL CROSS SECTION



DESIGN CRITERIA

MAXIMUM FLOW	800	CFS
MAXIMUM VELOCITY	3.2	FPS
MAXIMUM DEPTH	2	FEET
BOTTOM WIDTH	100	FEET

ALTERNATIVE C

HIDDEN ISLAND COULEE

SWC #1702

FIGURE 10

COST ESTIMATE HIDDEN ISLAND COULEE ALTERNATE C

TABLE 5

	Quantity	Unit Cost	Total
Salvaging and Spreading Topsoil	20,000 yd^2	$ .25	$ 5,000
Excavation	15,700 yd^3	$ 2.00	$31,400
Riprap	150 yd^3	$ 25.00	$ 3,750
Riprap Filter Material	40 yd^3	$ 10.00	$ 400
Seeding	5 acres	$ 200.00	$ 1,000
Snagging and Clearing	1.8 miles	$10,000.00	$18,000
		TOTAL	$59,550
		+ 30% Contingencies	17,865
		Engineering & Inspection	$77,415

As stated the objective of this alternative is to divide the flow into two different directions. The diversion of the flow to the north and east is approximately the same as what would be experienced during natural flow of the 10 year runoff without channel improvements. This proposal offers protection by improving the natural channels around the affected project area.

V. ENVIRONMENTAL SURVEY

The following environmental survey gives an overview of the positive and negative environmental impacts that would result from the implementation of this project. This is not intended to be a comprehensive environmental assessment, it will identify subjects that would be analyzed in detail in an environmental assessment. In the following paragraphs, several environmental categories are identified and discussed specifically for the watershed of Hidden Island Coulee.

A. Land Use

The watershed of Hidden Island Coulee currently has the following land use breakdown:

Small Grain Crops	60%
Pasture	20%
Ponds and Sloughs	5%
Farmsteads	1%
Roads	2%
Fallow	13%
	100%

It should be noted that all easements for lands which will be inundated during flood periods will have to be obtained before construction of any of the alternatives can begin. The land use of the watershed will not be changed or affected from the projects.

B. Aesthetics

The aesthetics of the watershed will not be affected very much from the construction of any of the proposed alternatives. Each alternative conforms to the natural environment and material. Once the construction has been completed, the areas of borrow and fill will be seeded with native grasses. If the dry dam is built, some silting is expected to occur in the retention area of the dam.

C. Fish and Wildlife

Because of the short period of time water exists in the project area, there is no fish life. The construction of the dry dam cannot be expected to support fish life either. The alternatives that require snagging and clearing of the existing channels will have an adverse effect on the wildlife which relies on the area for cover. There were no actual observations made pertaining to the wildlife population of the project area. Therefore, no conclusion can be made to determine the exact effects each alternative will have on the wildlife population.

D. Irreversible and Irretrievable Commitment of Resources

Excavated land removed and used to construct the channels and the dry dam can be assumed to be partially altered. Fossil fuel and labor used during the construction of the project will be irretrievably committed.

VI. SUMMARY AND RECOMMENDATIONS

The purpose of this study was to find solutions to minimize the flood damage caused by the runoff of Hidden Island Coulee and then determine the feasibility of each solution.

The amount of land protected by the proposed alternatives is approximately 2500 acres of crop and grassland in the United States. The amount of land in Canada which will benefit from the project is unknown.

From the study it was found that the three alternatives discussed in this report were the most economical solutions for alleviating the flooding problems. There were other solutions evaluated that were equally successful in reducing flood damage, but their cost made them infeasible. All three alternatives discussed will assure protection from the 10 year runoff with the proper maintenance and operation. Therefore, from a technical aspect, the project can be considered feasible.

As stated before, Alternative A has drawbacks that could discourage construction. Besides routing the entire flow to the Canadian Border where the channel capacities are unknown, the channel must pass through land for which the Fish and Wildlife Service has obtained easements. Also, Alternative A requires some snagging and clearing which will destroy natural habitat for local wildlife. Because snagging and clearing of the existing channel is also required for Alternative C, the same drawback of affecting wildlife habitat exists for Alternative C. Construction of Alternative C would relieve the affected area from flood damages, but areas downstream would still experience the same flood damage. Thus, Alternative C would only alleviate part of the flood problem.

Therefore, it is recommended that Alternative B, the dry dam, be considered further, for providing the needed flood protection. This

alternative insures flood protection for all landowners with the least amount of impact on wildlife and farming. Snagging and clearing is not required in this alternative, thus no wildlife habitat is affected. Also, because of the operation of the dry dam, there is little farmland affected compared to the operation of a channel.

The local sponsors must determine whether this project is feasible on a financial basis.

APPENDIX

AGREEMENT

AGREEMENT

PRELIMINARY INVESTIGATION
BY THE
NORTH DAKOTA STATE WATER COMMISSION

I. PARTIES

THIS AGREEMENT is between the North Dakota State Water Commission, hereinafter referred to as the Commission, acting through the State Engineer, Vern Fahy and the Board of Commissioners, Towner County Water Management District, hereinafter referred to as the Board, acting through its Chairman, James Gibbens.

II. PROJECT, LOCATION AND PURPOSE

The Board has requested the Commission to investigate and determine the feasibility of a channel improvement project on Hidden Island Coulee and the overflow channel described herein. This investigation shall be conducted on Hidden Island Coulee from the North-South quarter line of Section 6, Township 163 North, Range 67 West, downstream to the Canadian border. The overflow channel which extends from its confluence with Hidden Island Coulee in Section 6, Township 163 North, Range 67 West, through Section 5, Township 163 North, Range 67 West, is also included in this investigation.

The purpose of this investigation is to determine the condition and adequacy of the river channel and appurtenant structure, determine the necessary improvements and prepare a cost estimate for these improvements.

III. PRELIMINARY INVESTIGATION

The parties agree that further information is necessary concerning the proposed project. Therefore, the Commission shall conduct a preliminary investigation consisting of the following:

1. Detailed Field Survey - to gather cross sectional and profile data.
2. Hydrologic Analysis - to determine design discharges.

3. Preliminary Design

4. Preliminary Cost Estimate

5. Conclusions and Recommendations

Subsurface exploration and design work for the final design and specification stage shall not be made under this agreement.

IV. DEPOSIT - REFUND

The Board shall deposit $750.00 with the Commission to partially pay the costs of the investigation. Upon completion of the investigation outlined herein, upon receipt of a request from the Board to terminate the investigation, or upon a breach of this agreement by any of the parties, the Commission shall provide the Board with a statement of all expenses incurred in the investigation and shall refund to the Board any unexpended funds.

V. RIGHTS OF ENTRY

The Board agrees to obtain written permission from any affected landowner to allow the Commission to enter upon his property to conduct field surveys which are required for the investigation.

VI. INDEMNIFICATION

The Board hereby accepts responsibility for and holds the Commission free from all claims and damages to public and private properties, rights or persons arising out of this investigation. In the event a suit in initiated or judgement rendered against the Commission, the Board shall indemnify it for any judgement arrived at or judgement satisfied.

VII. CHANGES TO AGREEMENT

Changes to any contractual provisions herein will not be effective or binding unless such changes are made in writing, signed by the parties and attached hereto.

BOARD OF COMMISSIONERS
TOWNER COUNTY WATER MANAGEMENT DISTRICT

James Gibbens
Chairman

Nov. 6, 1978
Date

NORTH DAKOTA STATE WATER
COMMISSION

David A. Sprynczynatyk
for Vernon Fahy
State Engineer

10-12-78
Date

Distribution
Board
SWC Project #1702
SWC Accountant
SWC Investigation Engineer