PRELIMINARY ENGINEERING REPORT

RYGG SLOUGH OUTLET IMPROVEMENTS

NORTH DAKOTA

STATE WATER COMMISSION

JANUARY 1978

PRELIMINARY ENGINEERING REPORT

RYGG SLOUGH OUTLET IMPROVEMENTS

January 20, 1978

Prepared By:

DuWayne A. Marthaller
Project Engineer

Submitted By:

David A. Sprynczynatyk
Director of Engineering

Approved By:

Vernon Fahy
State Engineer

Prepared By:

North Dakota State Water Commission
State Office Building
900 East Boulevard
Bismarck, North Dakota 58505

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. INTRODUCTION

A. Purpose and Scope

The purpose of this report is to set forth a plan for upgrading the existing outlet to Rygg Slough. Current conditions warrant the need for an improved outlet that will not erode or flood downstream lands while allowing the land within the slough to remain in agricultural production. A water management plan should have been established before the natural hydrologic conditions were altered.

Contained in this report is a brief description of the planning area, a comprehensive statement of the problem, a hydrologic analysis, a preliminary design of the proposed system, an environmental survey of the project and a proposed plan of implementation. The proposed system will comply with criteria established for legal drains by the State Water Commission. The recommended alternatives will utilize the best practical technology to devise a system that is cost effective, environmentally sound and within the Water Management District's implementation capability. Input from the Water Management Board and local residents was utilized throughout the investigation.

Accompanying the report are preliminary construction plans that show the details of the proposed improvements. A detailed topographic map showing the drainage area and the location of the drain is contained at the back of this report. This map is referred to throughout the report. A summary, including recommendations and conclusions, is contained at the end of the report.

B. Description of Planning Area

The project study area is located in central Steele County, 10 miles east and 2 miles south of Finley (see Figure 1). The watershed is located within the Goose River Basin. The existing drain discharges into a tributary of

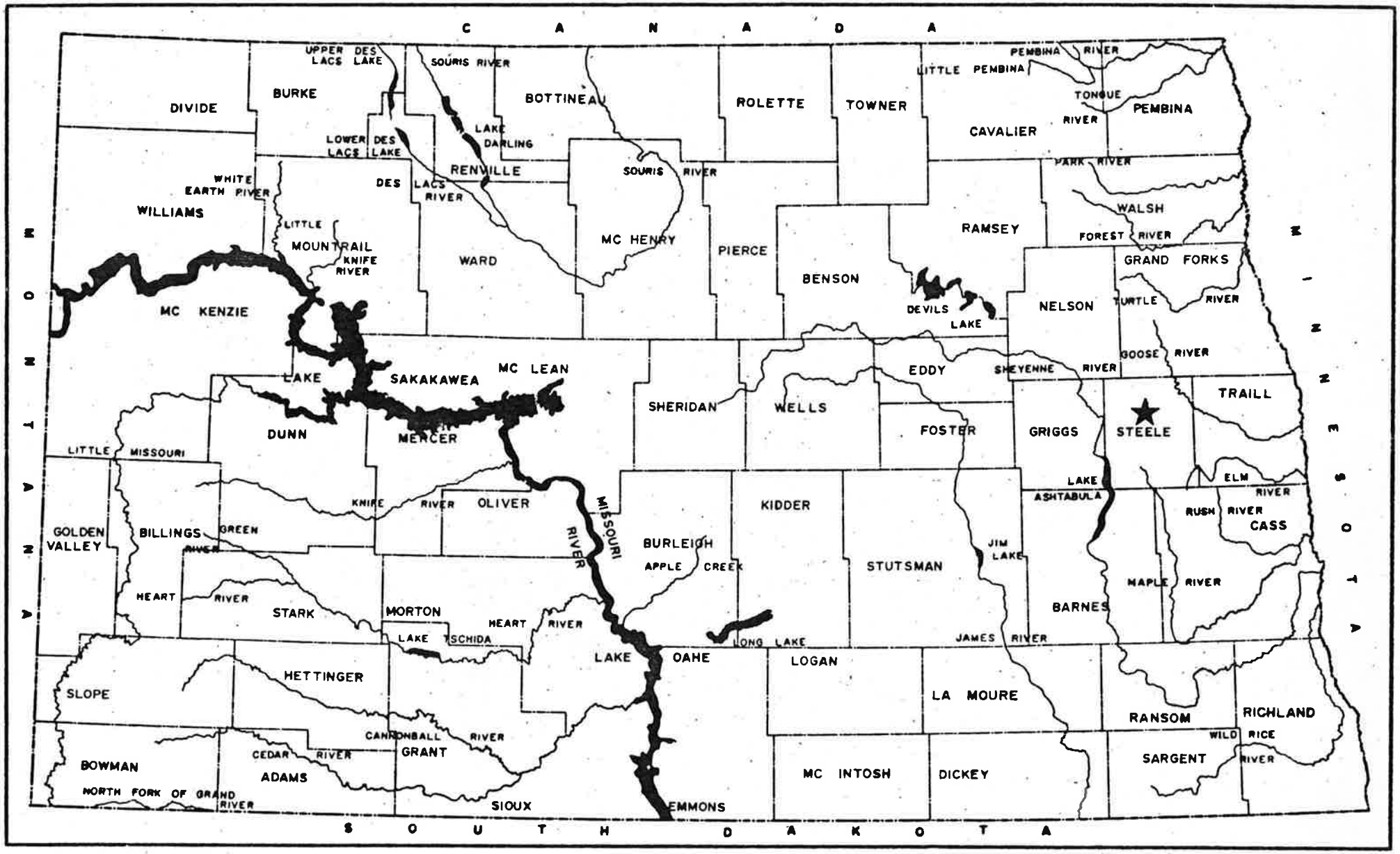

FIGURE I

PROJECT LOCATION

★ LOCATION OF RYGG SLOUGH

the Middle Branch of the Goose River. The drainage area consists of land that naturally drains into Rygg Slough as well as land that has been artificially drained.

The area is located in the Central Lowlands area of North Dakota. In relatively recent geologic time the region was covered by a continental glacier and as a result the land surface is flat and poorly drained. Broad divides, numerous potholes, sloughs, and lakes are characteristic of the area. There are many small closed basins that do not contribute to stream outflow. The soils consist primarily of glacial till, a heterogeneous mixture of clay, silt, sand and gravel. Also evident are intermittent strips of glacial outwash, mostly sand and gravel.

The economy of the area is structured around agriculture. Most of the land within this area is productive farmland. The settlement of the area was closely related to the construction of the railroads which provided a means of marketing agricultural produce. The closest major commercial center is Grand Forks, located 47 miles to the northeast.

Precipitation for crop production is adequate during normal years although occasionally the region suffers from periods of drought. The average annual precipitation is 18 inches of which most occurs during the growing season with 14 to 15½ inches falling in the period of April through September. The average annual snowfall is 30 to 40 inches with 110 days of one inch or more snow on the ground.

II. STATEMENT OF PROBLEM

A. Background

Rygg Slough is not designated as a meandered body of water which means that the adjacent landowners own the land inundated by water (see Figure II). Information solicited from area residents concerning the land use of Rygg Slough indicates that the periods of crop production within the slough have been inconsistent. Testimony indicates that the slough was flooded from 1950 to 1954. Thereafter it was planted and harvested until 1964 when it flooded again. At that time area landowners were interested in finding a way to drain the slough so it could be farmed consistently.

Three adjacent landowners undertook a cooperative effort to drain Rygg Slough in the fall of 1964. Unaware that a drainage permit would be required, they began to construct a ditch that would drain the slough. The landowners paid for the construction themselves and also did some of the work. They had no professional engineering consultation for the project and there was no organized monitoring of the construction.

The three landowners sought federal financial assistance to complete the drain but were not successful. The Fish and Wildlife Service made an unsuccessful attempt to establish a permanent easement on the land in 1965 to prevent the slough from being drained. They also informed the landowners that they would need a drainage permit from the State Water Commission before they could drain the slough. In September of 1965, the landowners wrote a letter to the State Water Commission requesting permission to continue with their project which by then was nearly complete. The letter stated a control culvert would be placed at the outlet of the slough. The size of the culvert was not specified. One month later the North Dakota Wildlife Federation sent a letter to the State Water Commission stating their disapproval of the project because Rygg Slough represented a valuable wildlife habitat.

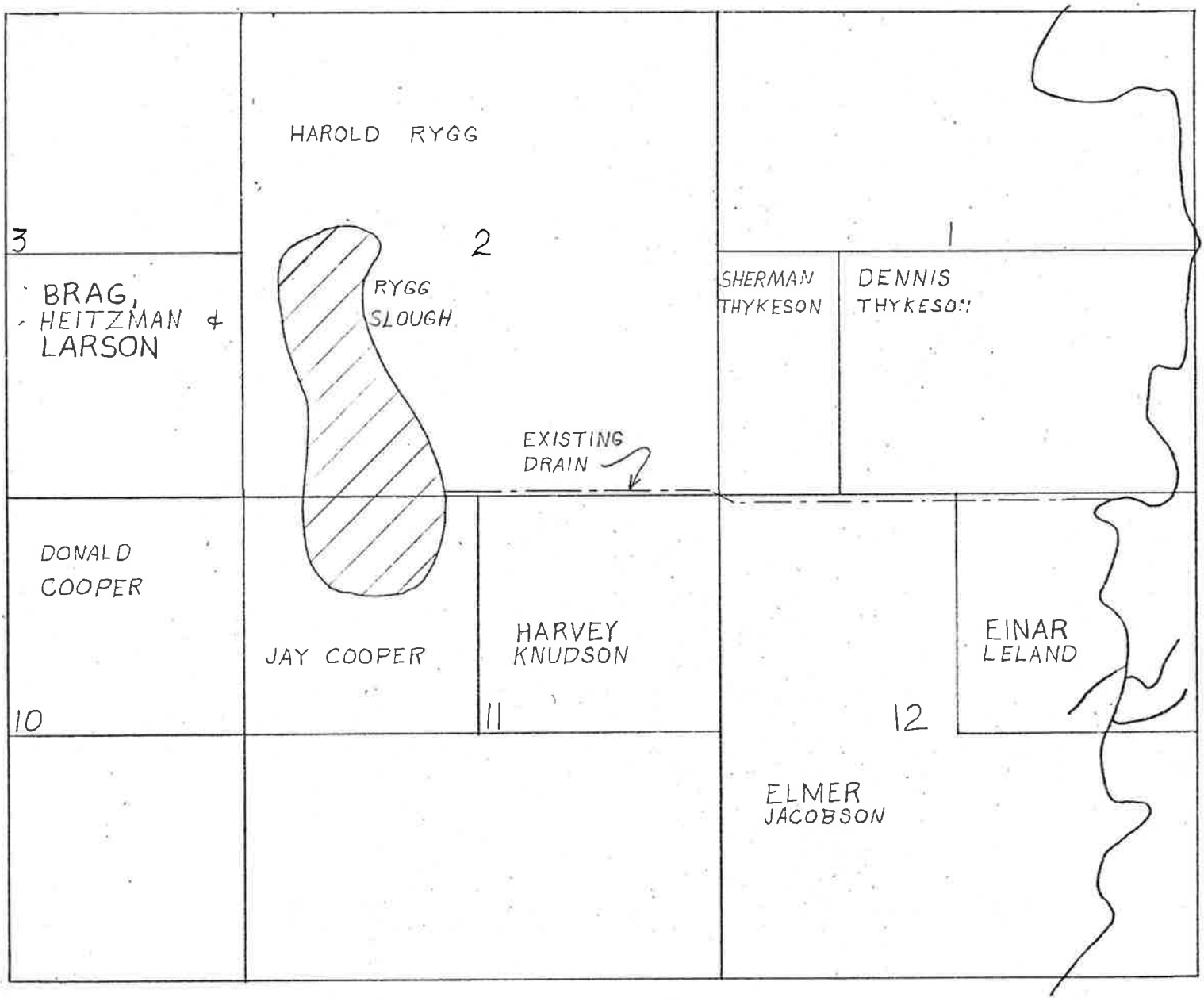

FIGURE II
LANDOWNERS

In November of 1965, the State Water Commission Drainage Engineer, C. P. Nelson, and a representative of the State Game and Fish Department made a reconnaissance of the area. Mr. Nelson, in a report on the investigation, stated that modernized farming practices and artifical drainage has caused the slough to flood more often and remain flooded for longer periods of time. No additional work was done on the project until 1970 when Mr. Nelson suggested that the Steele County Water Management Board establish the outlet as a legal drain. In November of 1976, the Water Management District requested that a survey be conducted on the project. An investigation agreement was signed on March 1, 1977, to conduct "an evaluation of alternatives for the management of runoff waters from Rygg Slough". This report is the result of that investigation agreement.

B. Current Conditions

A very serious situation exists on the channel that was constructed to drain Rygg Slough. The outlet control culvert has washed out and the east end of the channel has serious erosion problems. The channel has not been maintained so there are areas where brush and small trees are growing. The huge spoil piles at the outlet of the slough give an unsightly appearance to the area.

The last 1/8 mile of the channel does not have the location that the designers intended. The water has chosen its own course down a steep grade and the result has been excessive erosion. The channel should be reconstructed throughout its entire length to improve the hydraulic characteristics of the flow. If a plan for improvement is not implemented the erosion will continue and excessive runoff will overflow the channel and flood adjacent farmland. If the slough is not drained approximately 100 acres of farmland will be inundated from a 10 year flood. The water would remain in the slough until it is disipated by evaporation and seepage. The following sections of this report will outline the suggested improvements.

III. ENGINEERING DESIGN AND COST ESTIMATE

A. Hydrologic Analysis

The TR-20 computer program developed by the U. S. Soil Conservation Service was used to determine the peak discharge and corresponding flow volumes for various frequency storms. The program formulates a mathematical model of the watershed based in the following input data: the rainfall distribution, type of soil, soil moisture condition, time of concentration, hydraulic characteristics of the channels and the size of the drainage area. The hydrologist must make accurate estimates of this data to formulate an accurate model of the watershed. The program was used to generate an inflow hydrograph for Rygg Slough to determine the adequacy of the existing outlet and delimit the necessary improvements.

The total contributing drainage area is 6.7 square miles (see topographic map contained at the back of the report). The system was analyzed for runoff from rainfall as well as snowmelt. The rainfall is given as the number of inches that would occur over a 24 hour period and snowmelt is specified as inches of runoff that would occur over a 10 day period. Table I contains the peak flows and corresponding volumes for the inflow to Rygg Slough resulting from various frequency floods, as obtained from tht TR-20 computer program.

TABLE I - Runoff into Rygg Slough

Storm Frequency (years)	Rainfall			Snowmelt		
	24 Hr. Rainfall (In.)	Peak Discharge (cfs)	Flow Volume (Ac-Ft)	10-Day Runoff (In.)	Peak Discharge (cfs)	Flow Volume (Ac-Ft)
2	2.2	108	109	0.3	12	68
10	3.4	401	348	2.3	98	545
25	4.0	559	474	3.3	176	976
50	4.4	880	675	4.0	218	1211
100	5.0	1126	848	4.7	263	1462

Table 1 shows that the peak discharges obtained from rainfall exceed those from snowmelt, but the volume from snowmelt exceed those from rainfall. Therefore, the system must be analysed for rainfall as well as snowmelt.

B. Hydraulic & Structural Design

Criteria established by the State Water Commission designates that all channels and assoicated structures shall be designed for 10 and 25 year floods, respectively. Table 1 shows that the peak discharge from rainfall into Rygg Slough for a 10 year flood is 401 cfs. Rygg Slough has very little natural storage capability and the existing outlet channel has an estimated capacity of 100 cfs. To avoid major modifications to the existing channel a flow regulation structure must be installed at the outlet of the slough. The structure will consist of an earthfill embankment with two 36" corregated metal pipe (CMP) culverts and a plunge-pool outlet. See the accompanying construction plans for a schematic drawing of the structure. The culvert inlets will be placed at mean sea level elevation 1124.5, thus completely draining the slough. The structure is designed to handle a 25 year flood with sufficient freeboard to prevent overtopping of the embankment. The top of the structure will be at elevation 1133.0 msl. In addition to the controlled outlet there are two natural outlets, one north and one south of the regulation structure. These outlets, at approximate elevation 1130.0 msl, will prevent the overtopping of the embankment on the higher frequency storms.

The regulation structure will control the outflow from Rygg Slough such that the peak discharge is governed by rainfall and is equal to 160 cfs with a corresponding Rygg Slough water surface elevation of 1132.1 msl for a 25 year flood. This discharge does not consider flows through the natural outlets which will provide a safety factor to the system. All downstream structures will be designed for this flow. The downstream channel will be designed for 140 cfs, the 10 year flood peak discharge through the control structure.

The location of the proposed channel is shown on the plan and profile drawings. The alignment of the channel follows the existing channel with the exception of the last 1000 feet. This later portion of the channel will divert the flow across the road and follow a natural drainage swail into a tributary of the Middle Branch of the Goose River. The final reach of the existing channel will no longer be utilized because it is very steep and heavily eroded.

The proposed channel will have a bottom width of 8 feet, 4:1 side slopes and a minimum channel depth of 5 feet. The plan and profile drawings show the hydraulic data for the channel. The road crossings will utilize 72" x 44" CMP arch culverts and are designed to handle the 25 year flood discharge of 160 cfs. Refer to the accompaning plans for schematic drawings of the crossings.

Four drop structures will be needed along the length of the channel. Two of the drop structures will be rock drops with total drops of 1.5 feet and 1.6 feet. The other two drop structures will consist of a semi-circular section of CMP culvert placed vertically along with steel sheeting and rock riprap. Typical drawings for these drop structures are contained in the construction plans.

The amount of earthwork was estimated using surveyed cross sectional data. It will be necessary to waste some of the excavated material so the unit price for earthwork was raised to take this into account. Some of the materials will be used to fill in the downstream portion of the existing channel which is heavily eroded and will not be utilized in the project.

C. Preliminary Cost Estimate

Table II contains an itemized cost estimate for the proposed project. The cost estimate is based on current prices; if construction of the project is delayed past the 1978 construction season, the cost estimate should be adjusted accordingly.

TABLE 1.1 - Project Cost Estimate

	Item	Quantity	Unit	Unit Cost	Extended Cost
1.	Excavation	27,800	Cubic Yards	$ 1.00	$ 27,800.00
2.	36" CMP (14 ga.)	130	Lineal Feet	22.50	2,925.00
3.	72"x44" Arch CMP (12 ga.)	144	Lineal Feet	55.10	7,935.00
4.	72"x44" Flared End Section	4	Each	620.00	2,480.00
5.	2.6' Drop Structure	1	Lump Sum	2,500.00	2,500.00
6.	2.2' Drop Structure	1	Lump Sum	2,500.00	2,500.00
7.	Rock Riprap	300	Cubic Yards	20.00	6,000.00
8.	Gravel Filter	130	Cubic Yards	8.00	1,040.00
9.	Seeding	11	Acres	100.00	1,100.00
			Total Estimated Construction Cost		$ 54,280.00
			Contingencies (10%+)		5,430.00
			Engineering, Construction Inspection & Contract Administration (15%+)		8,140.00
			Total Estimated Project Cost		$ 67,850.00

IV. Environmental Survey

The following environmental survey will give 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, however, 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 Rygg Slough watershed.

Land Use

The Rygg Slough watershed currently has the following land use breakdown:

Cropland (small grains)	75%
Fallow	19%
Pasture and Hay	4%
Farmstead	1%
Roads	1%
	100%

The project will result in 2.5-3.0 acres of cropland being removed from agricultural production and used to construct the channel. Portions of the channel near road crossings and drop structures will be covered with rock riprap for erosion protection. The areas of the existing channel that are heavily eroded will be filled in and reseeded with native grasses.

Aesthetics

The poor construction practices used in constructing the existing channel created unsightly spoil piles and caused a portion of the channel to be heavily eroded. These current conditions will be altered when the project is constructed. The spoil piles will be removed and the eroded channel will be filled in and reseeded. The channel will blend into the surroundings because it will exist as a road ditch for all but 1000 feet of the entire length. The last 1000 feet of the channel will cross an existing field. The drop structures and the slough outlet structure will not conform to the natural environment.

Effects on Downstream Flood Flows

Currently the discharge from Rygg Slough flows from the man-made drain into a tributary of the Middle Branch of the Goose River in an uncontrolled fashion. The proposed control structure at the outlet of the slough will decrease the peak discharge from approximately 400 cfs to 160 cfs. The project will decrease downstream flood flows, but the flow volume will remain the same. The decrease in peak discharge will not be significant enough to be noticed downstream on the Middle Branch of the Goose River.

Effects on Downstream Water Quality

The sediment load of water currently discharging from the drain is quite high. The sediment load builds up as velocities increase and causes erosion throughout the last 1000 feet of the channel. When the water enters the tributary, the velocities decrease and most of the sediment is deposited in the channel. The implementation of this project will reduce the sediment load by reducing the flow velocities and eliminating erosion.

The biological and chemical characteristics of the water flowing into the tributary of the Middle Branch of the Goose River will not change as a result of this project. The Steele County Water Management Board does not intend to allow any additional artificial drainage so the amount of cropland that contributes to the drainage area will not be increased.

Effects on Fish and Wildlife

There is no existing water within the watershed that is suitable for maintaining a fish habitat, and the proposed project will not produce a body of water that would support fish life. No field data has been obtained for wildlife population within the watershed. The project will not destroy an existing wildlife habitat because the area has been completely drained. The artificial drainage that has occured has degraded the wildlife habitat by reducing the wetland area. This degradation will not increase with the implementation of this project.

Irreversible and Irretrievable Committment of Resources

Approximately 2.5-3.0 acres of farmland used to construct the improved channel can be assumed to be permanently altered. Fossil fuel and labor used in the construction of the project will be irretrievably committed.

V. Plan of Implementation

It has been proposed that the outlet to Rygg Slough be established as a legal drain. The cost of a legal drain is directly assessed to the benefitting landowners. The cost of each landowner is proportional to the benefits received. After the engineering investigation and cost estimate is complete the Water Management Board must identify the benefitting landowners and determine the percentage of the total benefits that each will receive. Upon approval of the assessed landowners, the Water Management Board and the State Water Commission, the legal drain can then be established.

Once a legal drain is established, the State Water Commission will consider its cost participation in the project if requested. Once the project is approved the Water Management District will enter into an agreement with the State Water Commission for the preparation of the final plans and specifications. All procedures assoicated with the contract administration and construction monitoring would be conducted by the State Water Commission.

VI. Summary, Conclusions and Recommendations

1. The current conditions of the Rygg Slough outlet warrant the need for an improved outlet.

2. The high discharge into Rygg Slough requires that a flow regulating structure be placed in the slough outlet.

3. Four (4) drop structures, one control structure and one road crossing will be installed.

4. The proposed improvements will eliminate erosion and flooding resulting from a 10 year flood throughout the entire length of the channel.

5. The estimated construction cost of the project is $67,850.00.

6. 2.5-3.0 acres of cropland will be removed from agricultural production.

7. The project will slightly reduce downstream flood flows.

8. The sediment currently being carried into the tributary of the Middle Branch of the Goose River will be decreased.

9. The unsightly spoil piles will be removed and the eroded channel sections will be filled in.

10. The Steele County Water Management Board should establish the outlet as a legal drain.

11. Upon the establishment of a legal drain, the appropriation of necessary funds and upon the approval and request of the Water Management Board; the State Water Commission will complete the final plans and specifications, handle the contract administration and conduct the construction inspection for the project.

12. The Steele County Water Management Board must establish a water management plan for the Rygg Slough watershed. This plan must not allow additional drainage into Rygg Slough so the capacity of the legal drain will not be exceeded.