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PRELIMINARY ENGINEERING REPORT

FOR

CHANNEL IMPROVEMENTS MIDDLE BRANCH OF THE GOOSE RIVER

NELSON-STEELE DRAIN #7A

NORTH DAKOTA STATE WATER COMMISSION

DECEMBER 1977

PRELIMINARY ENGINEERING REPORT

CHANNEL IMPROVEMENTS MIDDLE BRANCH OF THE GOOSE RIVER

Nelson-Steele
Drain #7A

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I. Introduction

A. Purpose

The purpose of this report is to set forth a water management plan for upgrading the upper reaches of the Middle Branch of the Goose River. The improved channel will provide an adequate outlet to facilitate agricultural drainage. The proposed system will comply with criteria established by the State Water Commission. The proposed alternative will utilize the best practical technology to devise a system that is cost effective, environmentally sound and within the County's implementation capability.

B. Scope

This report contains a brief description of the planning area, a comprehensive statement of the problem, the preliminary hydrologic and hydraulic design of the proposed system, an environmental assessment of the project, and a proposed plan of implementation. Input from the public and concerned organizations is reflected throughout this report. A preliminary plan for the improvement of the channel and structures downstream of the proposed improvements is included in this report. A summary of all conclusions and recommendations is contained at the end of the report.

C. Description of Planning Area

The project study area is located within the Goose River Basin. The watershed area is located within the counties of Nelson and Steele. See Figure 1 for the general location. The drainage area has an elongated shape and extends from ten miles north of Sharon to one mile south of Sharon. A detailed map of the area is contained in the back of this report.

The drainage area lies adjacent to the Pembina Escarpment which separates it from the Red River Valley, an area famous for its rich farmland. The economy of the area is structured around agriculture. The topography is gently rolling to hilly and is known as the Drift Prairie region of North Dakota.

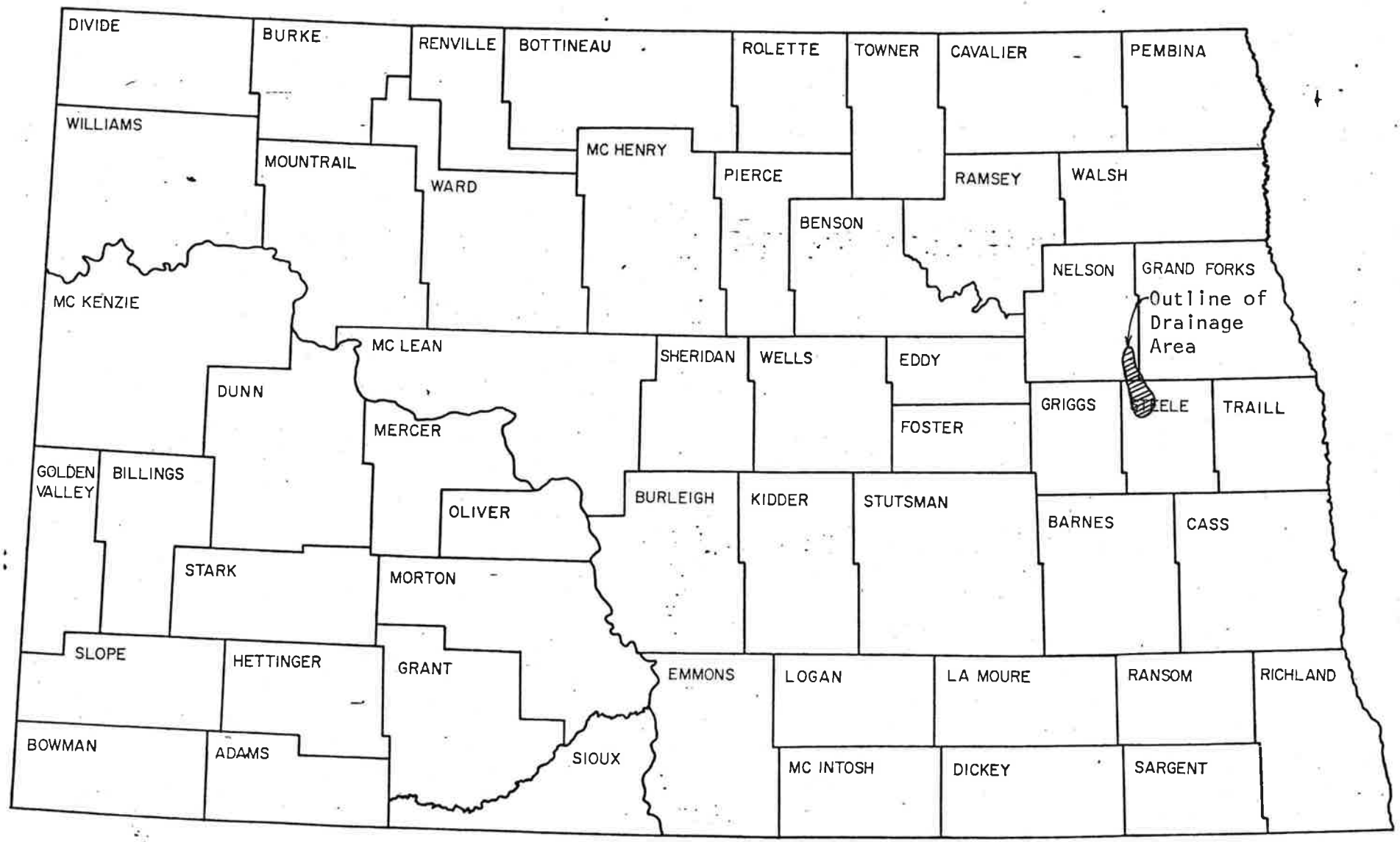

Figure 1

LOCATION MAP

The climate of the area is typical of the Northern Great Plains. The annual average temperature is approximately 40°F. There is an average of 12 to 16 days annually when the temperature is 90°F or above and 55 days annually when the temperature reaches 0°F or below. 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 cover on the ground.

II. Statement of Problem

A. Background

The proposed project was initially conceived in January of 1975. The farmers along the upper reach of the Middle Branch of the Goose River wanted the existing channel improved to alleviate the crop loss and property damage caused by frequent flooding. Many farmers within the watershed area are interested in draining portions of their land but are unable to do so until an adequate outlet is obtained. The counties of Nelson and Steele entered into an investigation agreement with the State Water Commission on February 20, 1975. On September 25, 1975, the Nelson and Steele County Water Management Districts entered into an agreement stating that they would handle this project as a joint effort. The State Water Commission completed the feasibility investigation in January of 1976 and an estimated project cost of $400,000.00 was submitted to the Water Management Districts. It was proposed that the project be constructed in the Spring of 1976. The counties hoped to finance the project as a legal drain and to secure the project as a separate line item that would be added to the Water Commission budget during the next Legislature.

In February of that same year the Steele County Water Management District requested that a downstream survey be conducted to determine the capacity of the channel and road crossings downstream from the proposed project. The downstream survey was completed in May, 1976; the results indicated that approximately 2½ miles of downstream channel would have to be improved, raising the estimated project cost to $480,000.00. The additional cost of easements raised the estimated project cost to $503,000.00. When the area farmers were told what the project was going to cost, there was some opposition to the project. The project was ultimately stopped in court action because Nelson County failed to properly file their petition.

The Water Management Districts have now repetitioned to have the State Water Commission revise the design to determine if the cost of the proposed project can be lowered. On August 10, 1977 the two Counties established a joint commission to monitor the project. Another investigation agreement was signed on September 22, 1977.

Sections of this report contain a complete description of the proposed project as redesigned by the State Water Commission. A cost estimate and a survey of the downstream structures and channel is also included.

B. Anticipated Problems

The need for a water management plan is apparent. The existing channel has silt deposits resulting from uncontrolled surface runoff from cultivated fields. The channel does not have the needed capacity or uniform gradient to allow the expedient removal of excess runoff. If a plan for improvement is not implemented the channel will continue to be filled by silt deposits and area landowners will continue to suffer crop and property damage.

III. Project Design and Cost Estimate

A. Hydrology

A hydrologic analysis was made to estimate the design flows that can be expected from a given drainage area. The total drainage area that would contribute to the design discharge is 20.8 square miles (See Figure 2). A detailed map of the drainage area is contained at the back of this report. Approximately 4.7% of the area consists of potholes. The following is the estimated land use breakdown:

Small Grains	80%
Pasture	13%
Farmsteads	2%
Roads	5%
	100%

Hydrologic predicting is a highly empirical science. Several methods are used and results are compared before the final discharge is obtained. The previous investigation of this project utilized an "M" Curve approximation to obtain the design discharges. This method represents approximately an 8 year frequency storm, but it is no longer used by the State Water Commission to predict flows in streams.

Three hydrologic methods were compared in this analysis. The Soil Conservation Service's TR-20 computer program, the Crosby method, and a method developed by Gerald Spaeth of the North Dakota office of the Soil Conservation Service. The TR-20 program did not represent a realistic model of the drainage area, since the time of concentration could not be estimated accurately due to the marshy conditions. The method developed by Spaeth typically gives low values for flat drainage areas similar to the one in question. Therefore, the Crosby method was used to estimate the runoff from this drainage area.

Established Water Commission criteria requires the channel to be designed

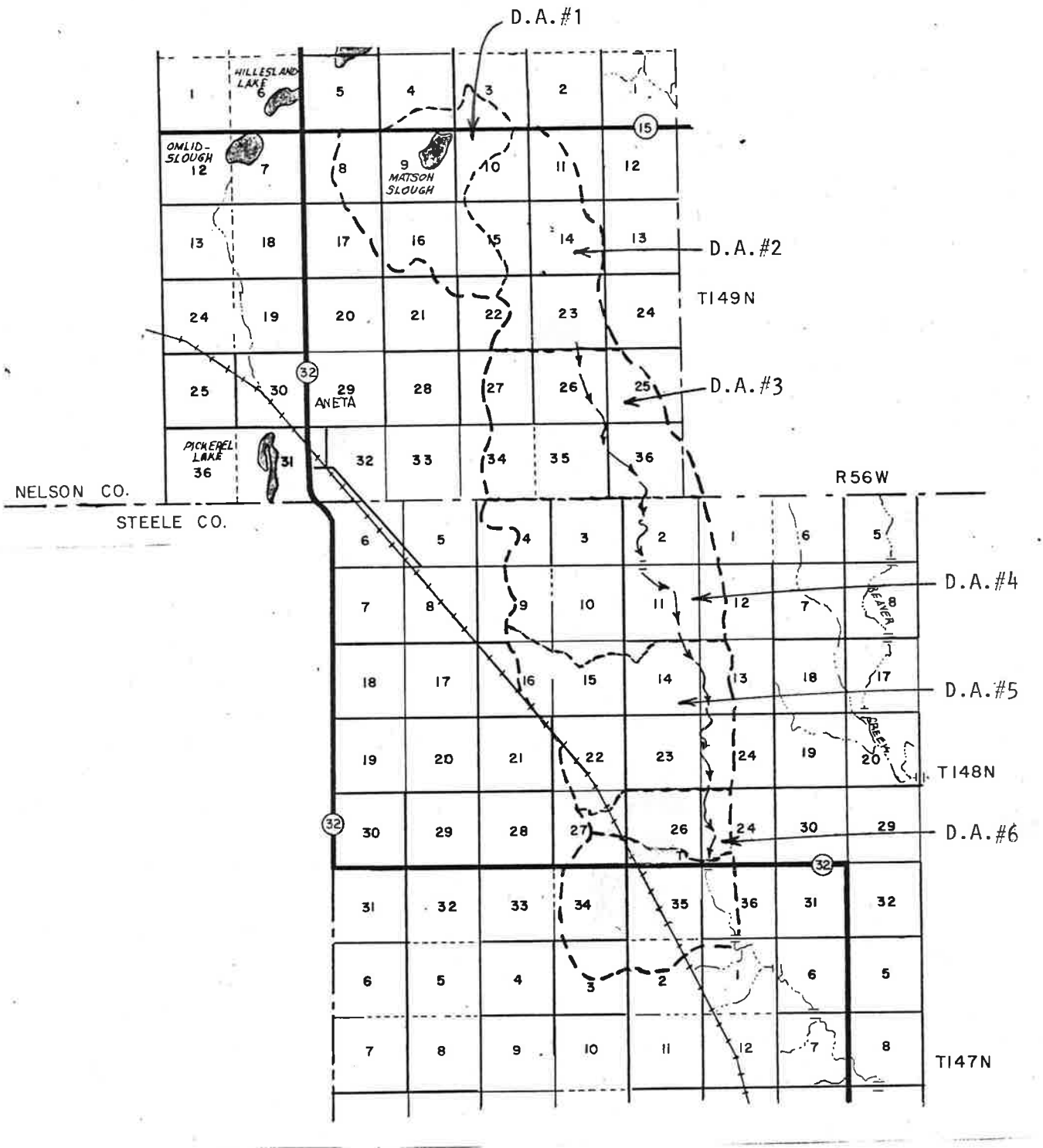

Figure 2

DRAINAGE AREAS

to handle a 10 year frequency storm and the structures to be designed to handle a 25 year frequency storm. The drainage area was analyzed for rain and snow but the discharges from rain were found to be greater. Based on this criteria and using the Crosby method the following discharges are obtained.

D.A.#	D.A. sq.mi.	Discharge for 10 yr. rain cfs	Discharge for 25 year rain cfs
3	8.3	505	690
4	14.7	640	875
5	19.5	720	985
6	20.8	740	1015

B. Engineering Design

Only one alternative design is given in this report, since a extensive amount of previous work has been completed on this project. There is an existing channel so alternate routes were not considered. It was also determined that no areas within the reaches of the channel could be used as storage so regulation structures were not considered.

The proposed routing of the channel is shown on Figure 3 and on the map contained at the back of this report. The accompanying plan and profile drawings contain more detailed information. All of the channel cross sections are designed as trapezoidal sections with bottom widths ranging from 12 feet to 32 feet and side slopes of 4:1. The maximum average flow velocities range from 2.5 fps to 2.7 fps. The average design flow depths range from 4.6 feet to 5.4 feet. Approximately 2.5 feet of channel freeboard is provided along the entire reach of the channel.

All road crossings utilize corrugated metal pipe (CMP) arch culverts. The accompanying plans contain a typical layout of a road crossing and the locations of the crossings. Both the outlet and inlet ends of the culverts will be protected

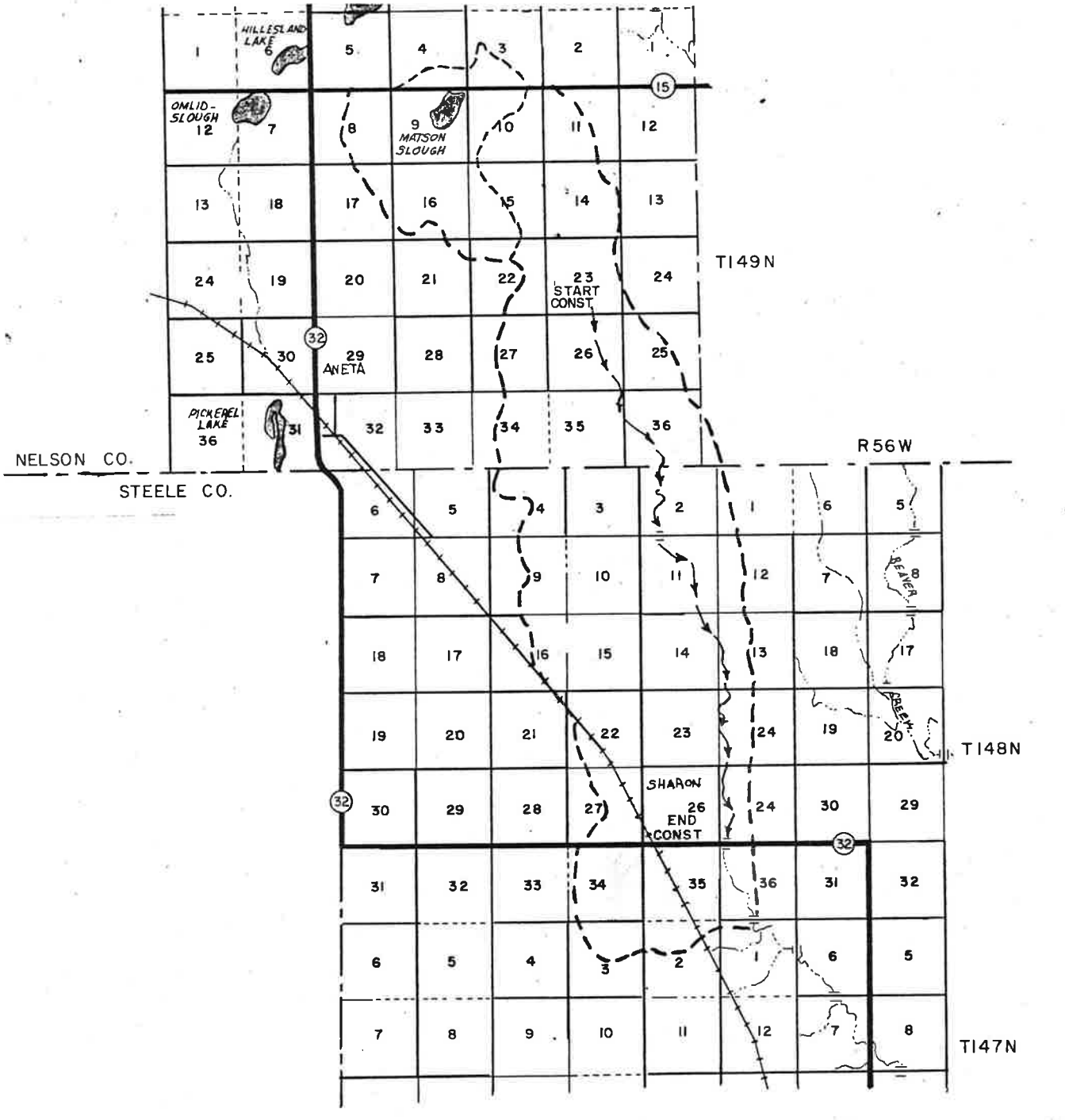

Figure 3

CHANNEL LOCATION

by rock rip rap. The design also includes a provision for field drains which allow runoff to flow through the channel berms. These field drains will consist of 24 inch CMP culvert pipe with flap gates. It is estimated that approximately 20 field drains will be needed. The actual number will be determined by conferring with the local landowners. The Water Bank area within Section 11, Township 148 North, Range 57 West is to remain intact.

C. Cost Estimate

The following table contains an itemized cost estimate for the proposed project. The cost estimate is based on current prices. If construction of the project is delayed over one year from the writing of this report the cost estimate would have to be adjusted accordingly.

Cost Estimate

Item	Quantity	Unit	Unit Price	Extended Price
1. Unclassified Excavation	230,000	Yd^3	$ 0.90	$207,000.00
2. 59" x 81" Arch CMP (14 ga. 3x1 corr.)	600	L.F.	55.00	33,000.00
3. 67" x 95" Arch CMP (12 ga. 3x1 corr.)	360	L.F.	100.00	36,000.00
4. 24" CMP (18 ga.)	480	L.F.	20.00	9,600.00
5. 24" Flap Gates	20	ea.	220.00	4,400.00
6. Seeding	150	Acre	100.00	15,000.00
7. Rock Rip Rap	160	Yd^3	20.00	3,200.00
8. Remove Concrete Bridge	1	ea.	Lump Sum	2,000.00
Total Estimated Construction				$310,200.00
Contingencies (10%)				31,020.00
Engineering, Construction, Inspection, and Contract Administration (15%±)				46,580.00
Estimated Project Cost				$387,800.00

D. Downstream Improvement

Downstream structures and channel sections were analyzed to determine if they had the capacity to handle current flows as well as the predicted flows if the drainage project is completed. The Crosby method was used to determine the design discharges with and without the implementation of the proposed project. The following are tables showing the results of this analysis and a "key" map showing the locations of the channel sections and structures.

The downstream survey indicates that in general the channel and structures do not have the capacity to handle current flows. The cost of upgrading the channel and structure has not been determined. Extensive downstream improvements are necessary so the cost is expected to be very high. It would be unfeasible to make all of these improvements at the same time. It is recommended that a long term downstream improvement plan be incorporated into the design of the project to construct Nelson-Steele Drain #7A.

Downstream Structure Survey

Structure No.	Drainage Area (mi^2) With Drain	Drainage Area (mi^2) Without Drain	Structure Description	Capacity of Structure (cfs)	Design "Q" With Project	Design "Q" Without Project	Adequacy Without Project	Adequacy With Project
1	27.7	13.0	Bridge 7.8'x23'	1541	1463	1065	Yes	Yes
2	32.2	17.5	Bridge 9'x16'	1052	1559	1206	No	No
3	34.7	20.0	2-6'x28' CMP	451	1608	1276	No	No
4	36.6	21.9	Bridge 7.5'x20'	1973	1645	1326	Yes	Yes
5	39.1	24.4	Bridge 11.7'x14'	1068	1691	1381	No	No
6	41.7	27.0	7'x12' Arch CMP	752	1737	1448	No	No
6A	41.7	27.0	8'x12' Arch CMP	725	1737	1448	No	No
7	42.8	28.1	8'x14' Arch CMP	750	1757	1472	No	No
8	45.2	30.5	Bridge 13.6'x35'	3600	1797	1524	Yes	Yes
9	47.4	32.7	Bridge 12.7'x18'	1450	1833	1569	No	No
10	48.2	33.5	Bridge 10.0'x23'	1799	1846	1585	Yes	No
11	51.4	36.7	Bridge 12.5'x36'	3740	1898	1647	Yes	Yes
12	52.3	37.6	Bridge 9.8'x28'	2470	1912	1630	Yes	Yes
13	53.4	38.7	Bridge 13.4'x38'	4817	1929	1650	Yes	Yes
14	55.2	40.5	Bridge 11.5'x23'	2075	1956	1684	Yes	Yes
15	56.6	41.9	RCP 2-6.7'x20'	1697	1977	1709	No	No
16	57.1	42.4	RCP 2-6.4'x18'	1403	1983	1750	No	No
17	58.0	43.3	Bridge 10.7'x23'	1800	1996	1765	Yes	No
18	58.2	43.5	Bridge 10.1'x24'	2053	1999	1769	Yes	Yes
19	81.0	66.3	Bridge 18.8'x70'	13100	2296	2111	Yes	Yes
20	82.2	67.5	Bridge 11.7'x18'	1641	2310	2227	No	No
21	168.1	153.4	Bridge 15.5'x41'	7150	3120	3003	Yes	Yes

Channel Capacity

Upstream From Crossing No.	Bankfull Capacity (cfs)	Design Capacity With Project	Design Capacity Without Project	Adequacy Without Project	Adequacy With Project
2	1383	1164	901	Yes	Yes
3	77	1201	953	No	No
4	944	1228	990	No	No
5	1750	1263	1036	Yes	Yes
6	239	1297	1081	No	No
7	1174	1312	1099	Yes	No
8	598	1342	1138	No	No
9	1612	1369	1171	Yes	Yes
10	1135	1379	1183	No	No
11	323	1418	1230	No	No
12	1101	1427	1242	No	No
13	91	1439	1257	No	No
14	1885	1459	1281	Yes	Yes
15	183	1475	1300	No	No
16	376	1480	1306	No	No
17	418	1490	1318	No	No
18	631	1492	1321	No	No
19	872	1715	1576	No	No
20	485	1725	1588	No	No
21	1026	2330	2242	No	No