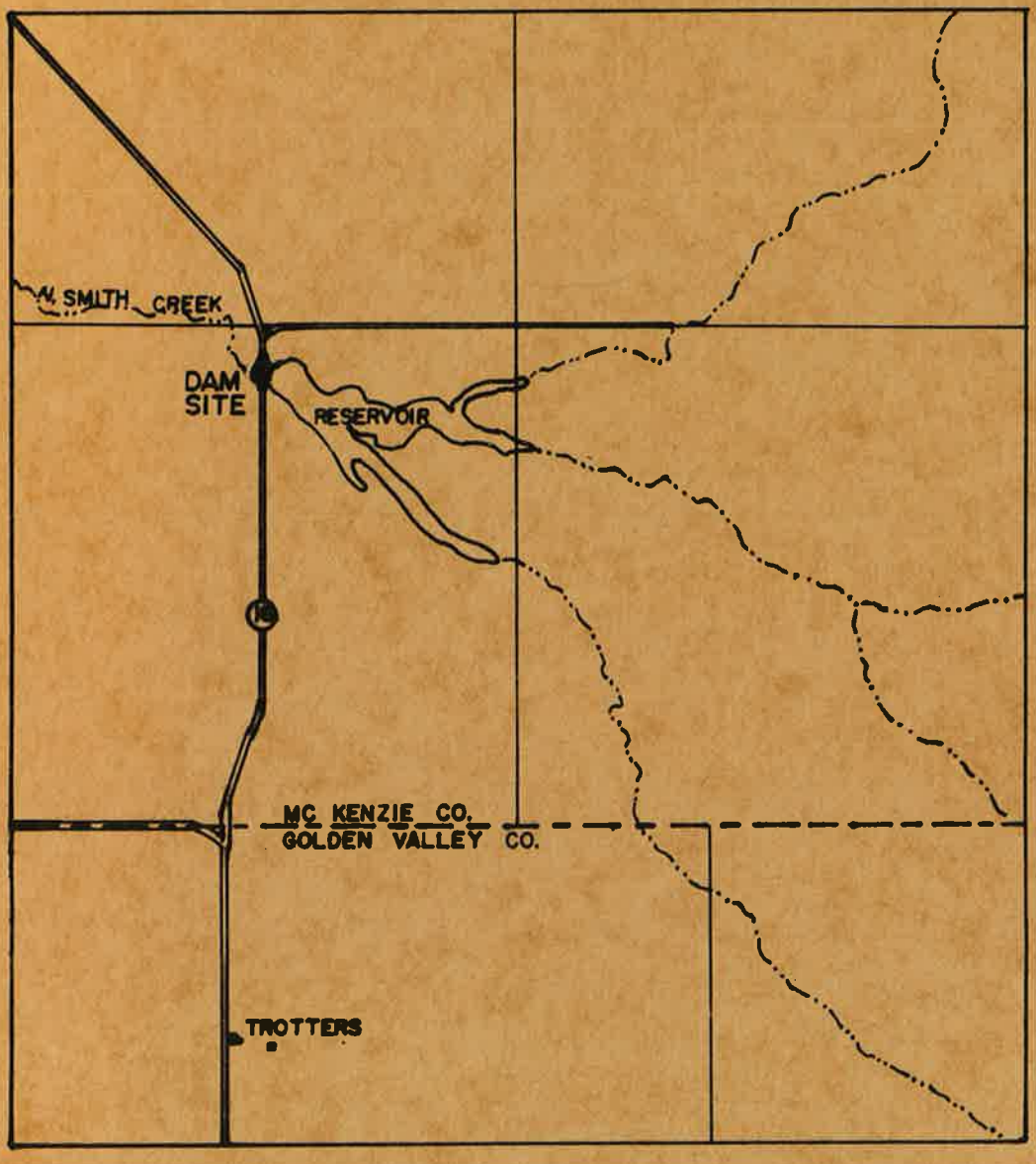
PRELIMINARY ENGINEERING REPORT

TROTTERS DAM

S.W.C. PROJECT NO. 1776

MC KENZIE COUNTY



NORTH DAKOTA
STATE WATER COMMISSION
DEC. 1983

PRELIMINARY ENGINEERING REPORT

TROTTERS DAM
SWC PROJECT #1776

DECEMBER, 1983

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

PREPARED BY:

Ronald A. Swanson

RONALD A. SWANSON
Design Engineer

SUBMITTED BY:

David A Sprynczynatyk

DAVID A SPRYNCZYNATYK, P.E.
Director of Engineering

APPROVED BY:

Vernon Fahy

VERNON FAHY, P.E.
State Engineer

Prepared for the
North Dakota Game & Fish Department

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INTRODUCTION

There are very few water based recreational facilities available in extreme western North Dakota. On June 28, 1983 an investigations agreement was entered into with the North Dakota State Game & Fish Department to develop the preliminary engineering for the Trotters Dam.

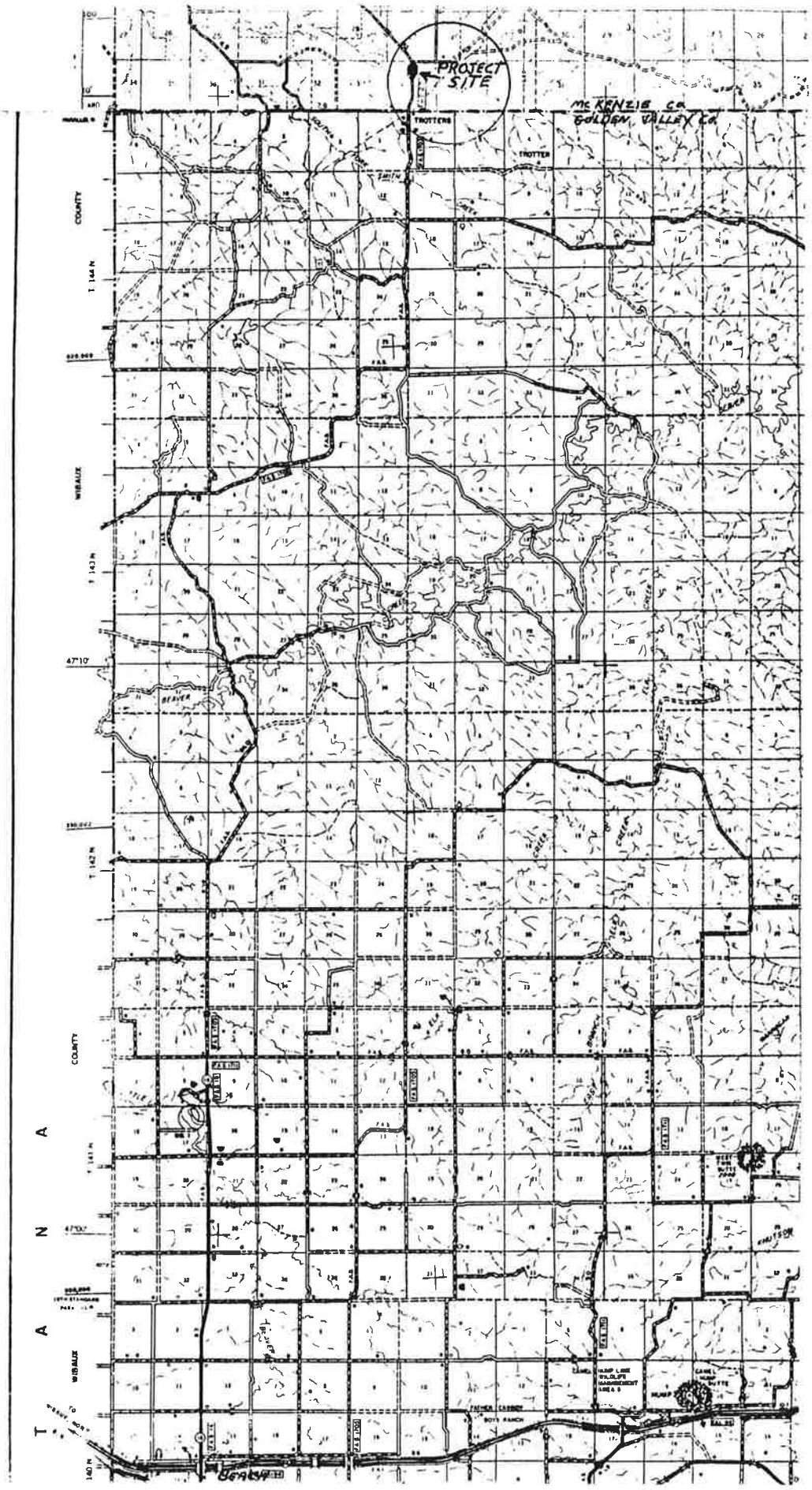
Trotters Dam would present an opportunity to develop such a facility in an area where there is no nearby body of water. The area is sparsely populated and the traffic along the existing roadway is very low. However, it is anticipated that when Highway 16 is reconstructed, the traffic patterns in that part of the State will change and the route will become more heavily traveled. Therefore, the potential local and regional residential use of Trotters Dam should increase as traffic patterns change. Additional demand for recreational facilities may also be created by the possible inflow of people caused by the potential energy development in the area.

PURPOSE

The purpose of this study is to determine the feasibility of constructing a recreation dam in conjunction with the scheduled improvement of North Dakota Highway No. 16 on Smith Creek in McKenzie County about one mile north of Trotters. Figure 1 shows the project site.

The new Highway 16 will be built in 1985 upon the existing gravel roadway. The roadway would serve as the embankment for the dam. The existing corrugated metal culvert and embankment would first be excavated and removed. Then a new spillway system consisting of reinforced concrete inlet structure, box culvert and outlet basin would be constructed through the excavated area. The excavation would be backfilled with compacted fill to the new roadway profile. The upstream face of the dam and the outlet of spillway would be riprapped. A recreation area would be developed next to the reservoir which would include such features as comfort stations, picnic shelters, picnic tables, outdoor grills, trash racks, and playground equipment. The reservoir would be stocked with various species of fish.

The alternative to this proposal would be the construction of a normal highway section at this location which would utilize the existing embankment and culvert with only minor modifications.



Site Location Map
Figure 1

DESCRIPTION OF SITE

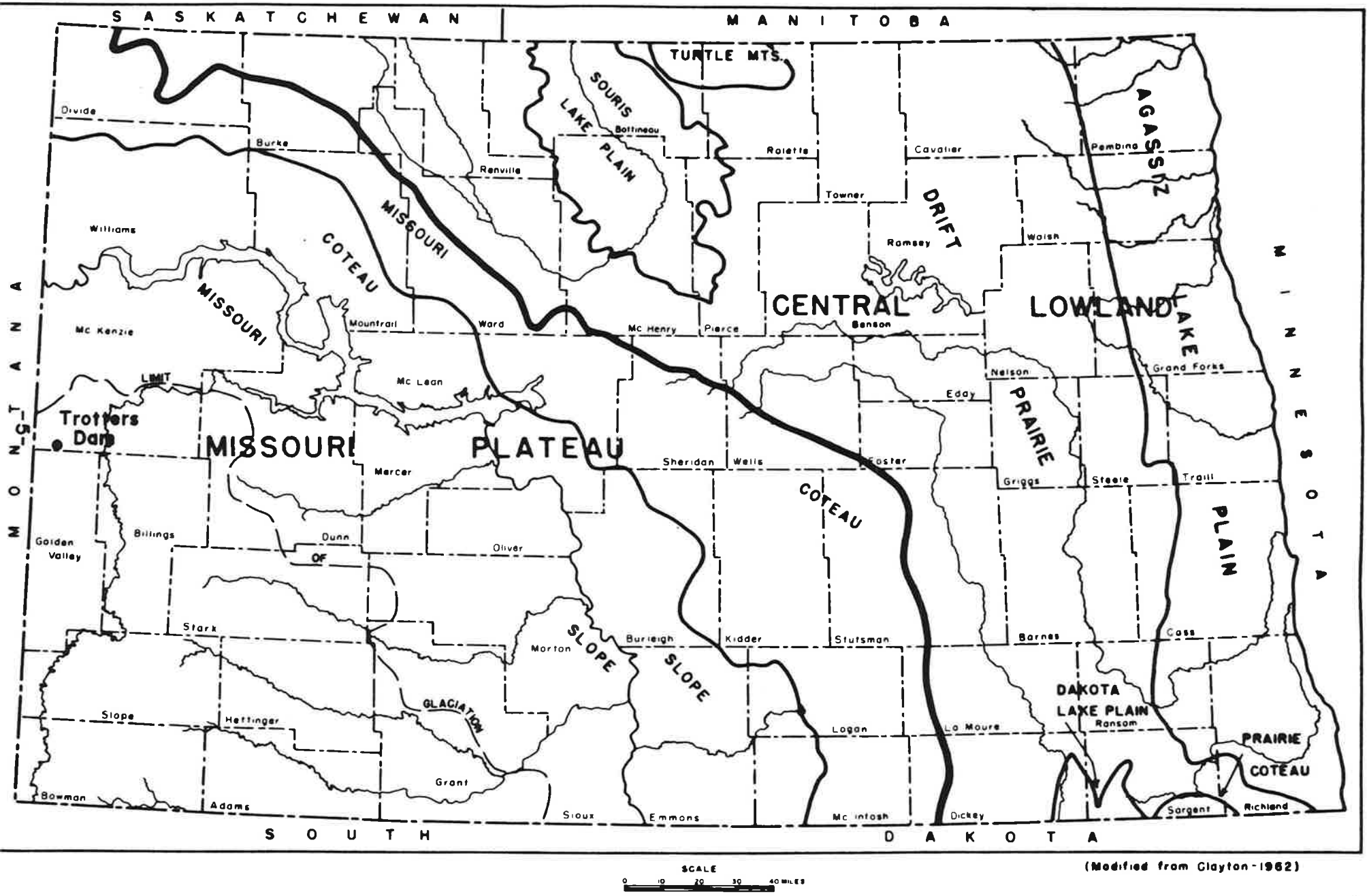
The proposed site is located in Section 34, Township 145 North, Range 104 West, in McKenzie County. The village of Trotters is approximately one mile south of the site. The stream is the north fork of Smith Creek which is a tributary of the Yellowstone River. Figure 2 is a map showing the general location of the dam and the surficial geology of the area.

The existing roadway consists of an earthen road embankment with a nine-foot diameter sectional plate culvert.

The existing roadway has a crest elevation of approximately 2351.0 msl and the culvert has an invert elevation of about 2315 feet.

The topography of the area is hilly and the average slope of the stream channel is about 100 feet per mile. The drainage area is about 7½ square miles. The drainage area and site location are shown in Figure 3.

The site is located in the Missouri Plateau Section of the Great Plains Physiographic Province. The area is underlain by bedrock sediments of the Tertiary Tongue River Formation. The Tongue River Formation is made up of light colored beds of sand, silt, and clay, with varying amounts of all three lithologies present in the most beds. Interbedded with the sand, silt, and clay are beds of lignite. The sediments were derived from erosion off the Rocky Mountains. The surficial topography and drainage history of the valley have been influenced by nearby glaciation and the cooler, wetter climate during recent ice ages.



(Modified from Clayton-1962)

Figure 2-LOCATION OF TROTTERS DAM AND PHYSIOGRAPHIC PROVINCES OF THE AREA

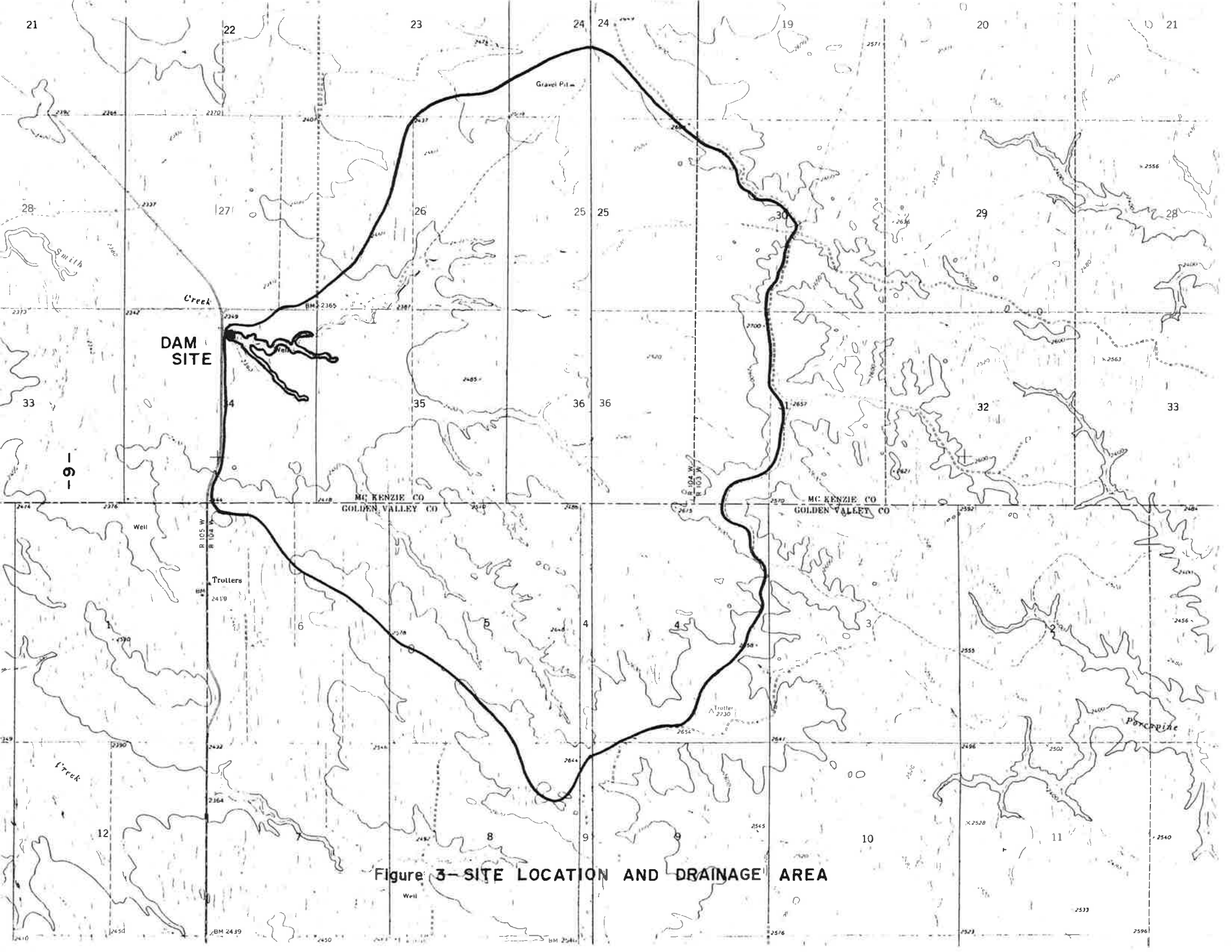


Figure 3– SITE LOCATION AND DRAINAGE AREA

PRELIMINARY ENGINERING

Project Alternatives

There are two alternatives available for this project, Alternative A and Alternative B.

Alternative A is to reconstruct the roadway to current highway standards re-using the existing embankment as a subbase for the new fill and leaving the old sectional plate culvert in place and adding new extensions on either end. This option will present an efficient re-use of existing material, but will provide no recreational benefits.

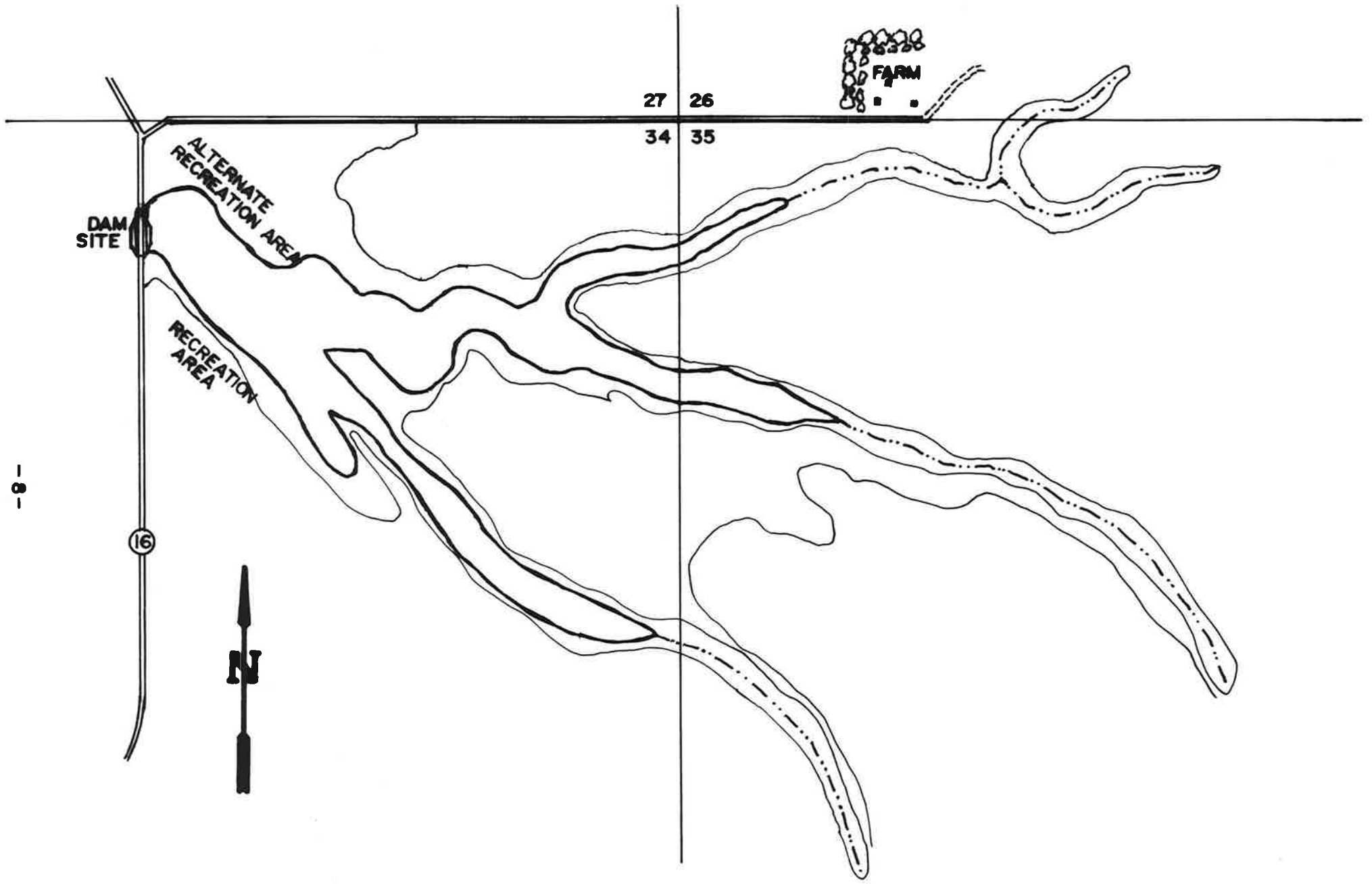
Alternative B is to construct the roadway dam in conjunction with the reconstruction of the highway. This option will produce a recreational area in a region that has little currently available. Figure 4 shows the layout for the potential reservoir. Figure 5 and 6 show Alternative A and Alternative B.

This report will attempt to compare the costs and benefits of the alternative options and present the resultant conclusions and recommendations.

Hydrological Analysis

The total drainage area above Trotters Dam is 7.5 square miles. Nearly all of the watershed is range land with a very steep gradient. The main channel drops over 400 feet in approximately four miles of total length. Figure 7 is an area capacity curve for the potential site.

The HEC-1 computer program developed by the U.S. Corps of Engineers was used to estimate the surface runoff in the Trotters Dam watershed. The computer program estimated inflow hydrographs and flood-routed the

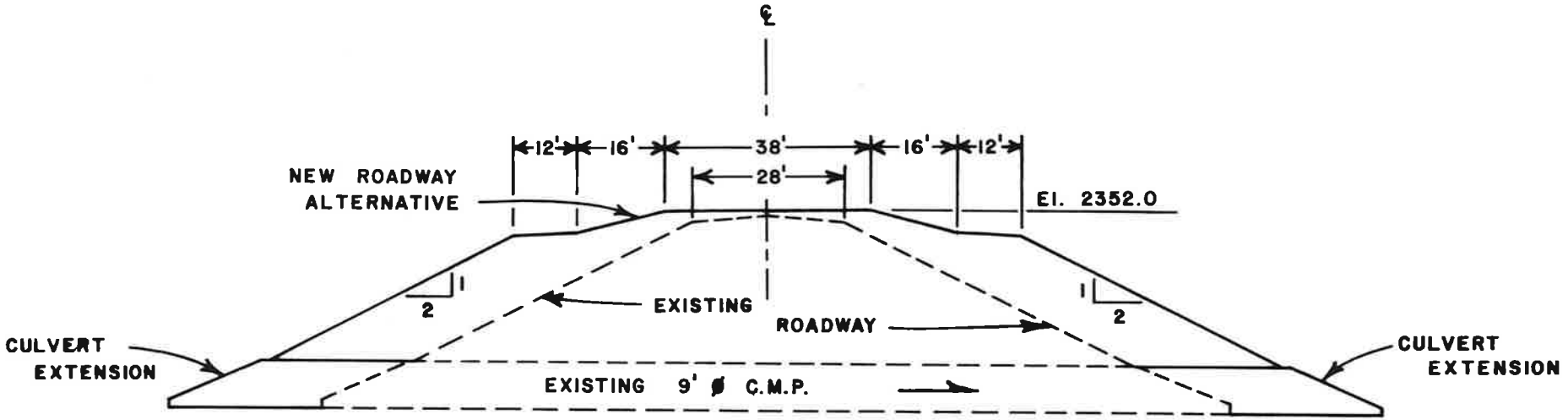


TROTTERS DAM

RECREATION AREA LAYOUT

Scale: 1" = 660'

FIGURE 4



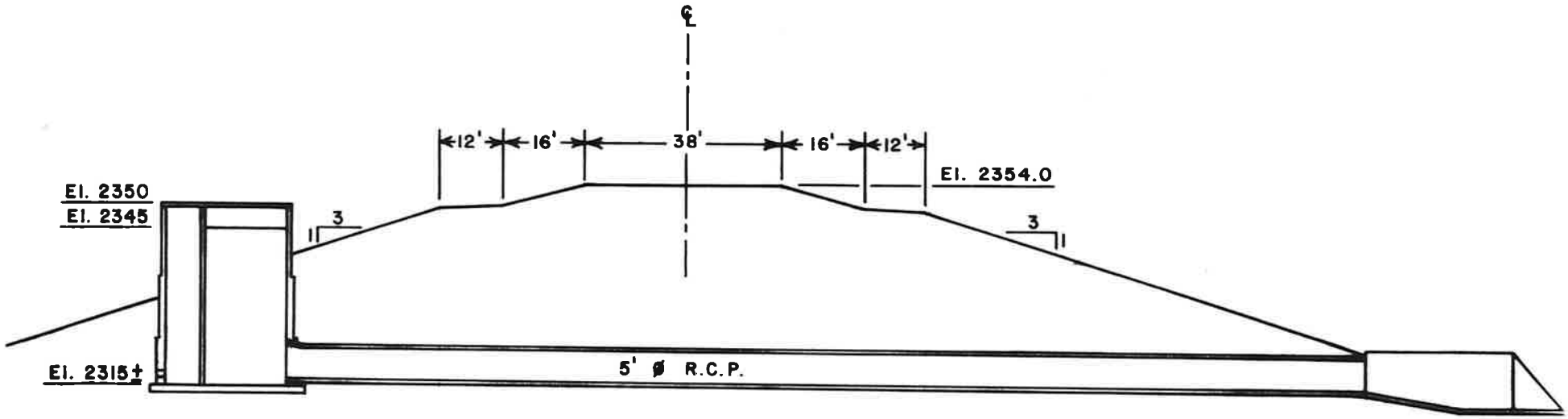
SECTION THROUGH EXISTING CULVERT

SCALE: 1" = 30'

ALTERNATIVE A

ROADWAY ONLY

FIGURE 5



MAXIMUM SECTION OF DAM
SCALE: 1" = 30'

ALTERNATIVE B

ROADWAY DAM COMBINATION

FIGURE 6

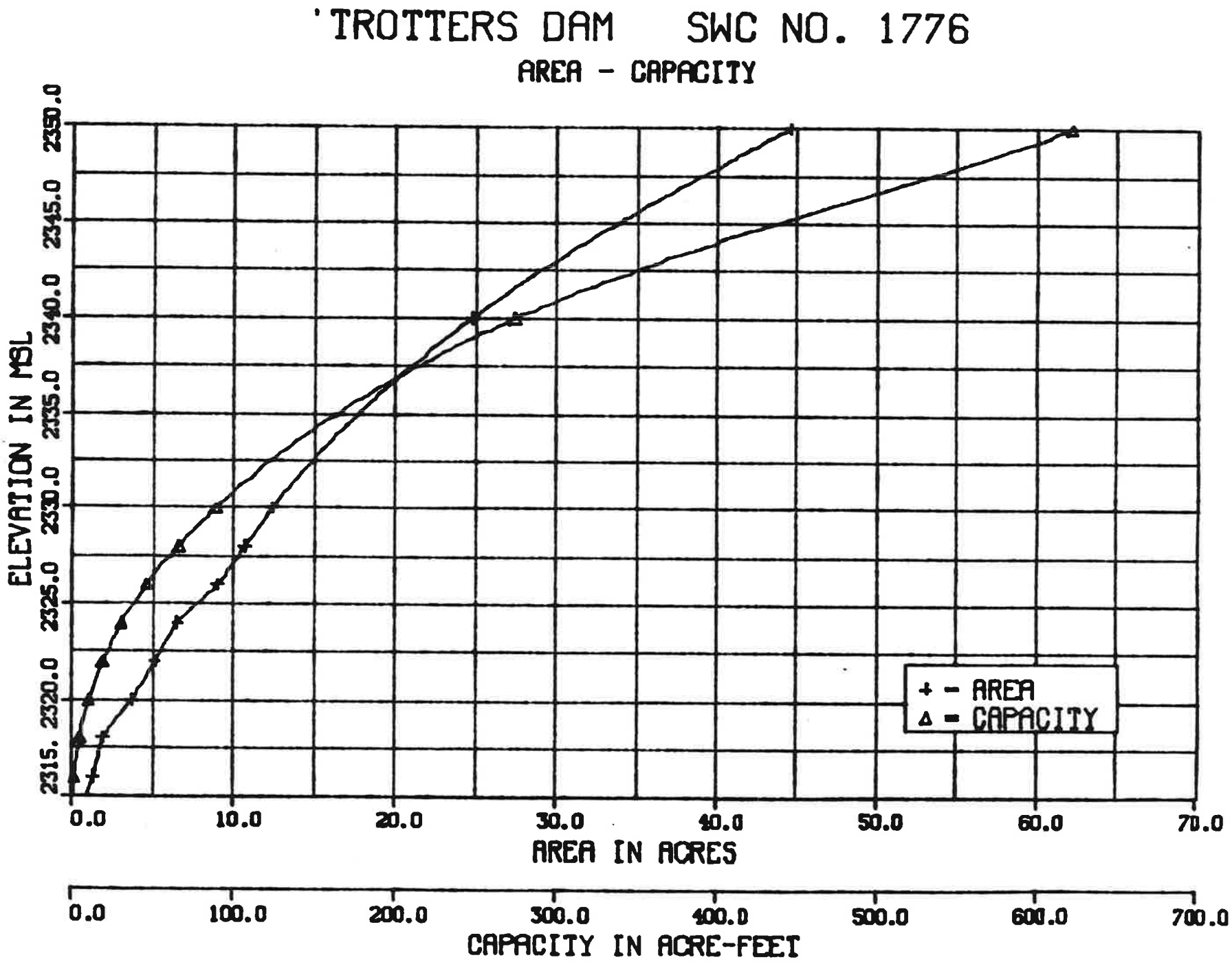

'TROTTERS DAM SWC NO. 1776
AREA - CAPACITY
ELEVATION IN MSL
2315.
2320.0
2325.0
2330.0
2335.0
2340.0
2345.0
2350.0
+ = AREA
Δ = CAPACITY
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
AREA IN ACRES
0.0
100.0
200.0
300.0
400.0
500.0
600.0
700.0
CAPACITY IN ACRE-FEET

FIGURE 7

flows through the dam.

The relative smallness of the impoundment results in a need to establish a control elevation as high as possible in order to produce an acceptable sized body of water. This in turn causes the crest of the roadway to be raised sufficiently to produce a satisfactory freeboard and results in proportionally more expensive dam. A balance must be found between these two factors. Various sizes of spillways and permanent pool elevations were considered. A 5-foot by 5-foot box culvert was selected as the optimal section.

Dam design standards have traditionally been based upon the 100-year flood. However, current dam safety standards have increased the requirement to include the capability to contain a less frequent runoff events. Both standards were considered in this study.

The 100-year 24-hour rainfall storm produced a peak inflow of 1,400 cubic feet per second with a volume of 850 acre-feet. The outflow was 900 cubic feet per second. The peak pool elevation from 100-year inflow was 2350.0 feet above mean sea level. The 100-year inflow and outflow hydrographs are shown in Figure 8.

A Class A rainfall storm 1/ was used to size the emergency spillway. The Class A emergency spillway freeboard storm used was a 5.5 inch rainfall with a six-hour duration. The emergency spillway consisted of a 150-foot wide grassed spillway at 2351 feet above mean sea level. The peak inflow from this storm was 3,100 cubic feet per second. The peak discharge from the dam was 2,600 cfs at a maximum pool elevation of 2353.4 feet above mean sea level. The inflow and outflow hydrographs from a Class A emergency spillway freeboard storm are shown in Figure 9.

1/ U.S. Soil Conservation Service. Hydrology Manual for North Dakota.

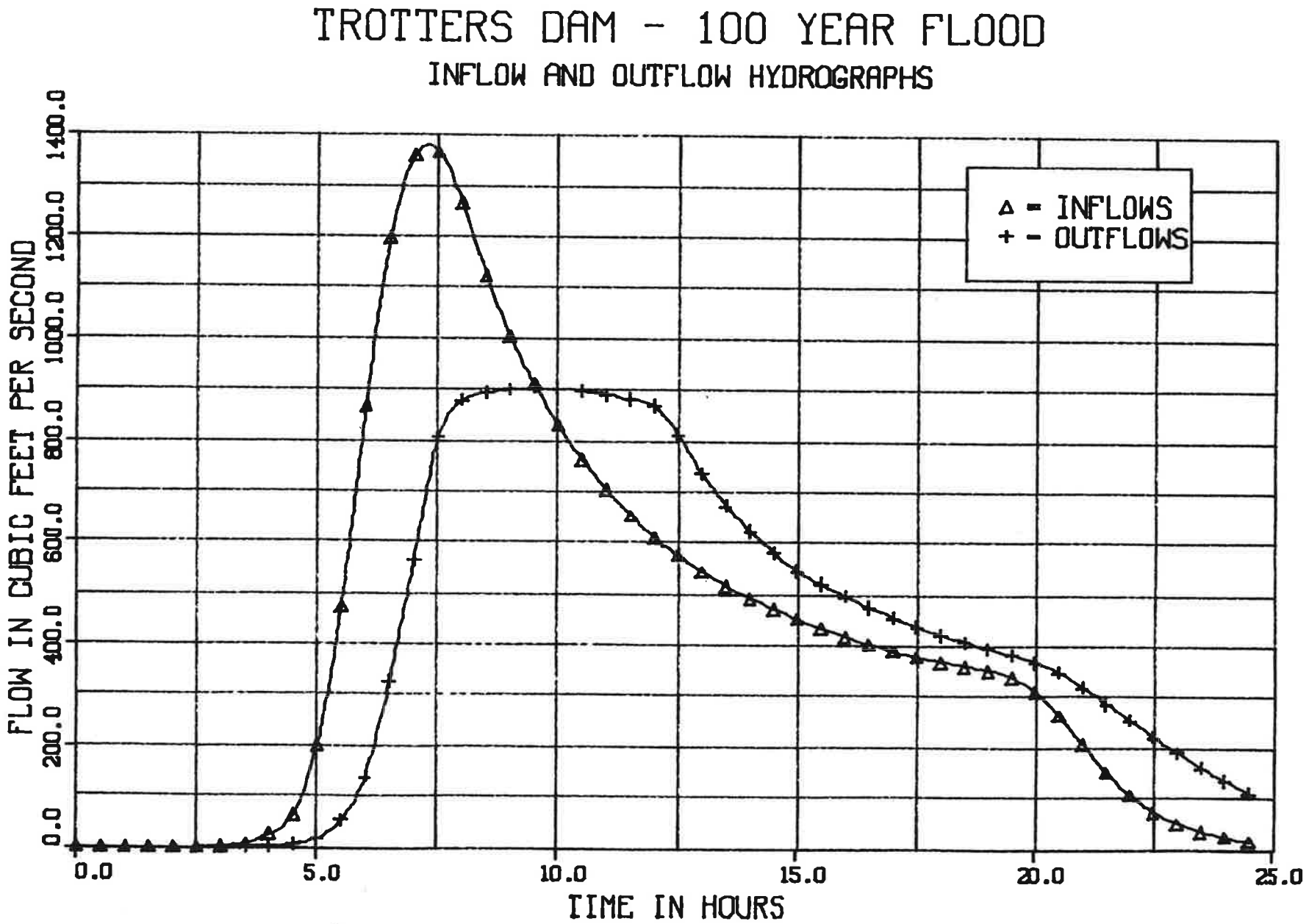

TROTTERS DAM - 100 YEAR FLOOD
INFLOW AND OUTFLOW HYDROGRAPHS
Δ = INFLOWS
+ = OUTFLOWS
FLOW IN CUBIC FEET PER SECOND
0.0
200.0
400.0
600.0
800.0
1000.0
1200.0
1400.0
0.0
5.0
10.0
15.0
20.0
25.0
TIME IN HOURS

FIGURE 8

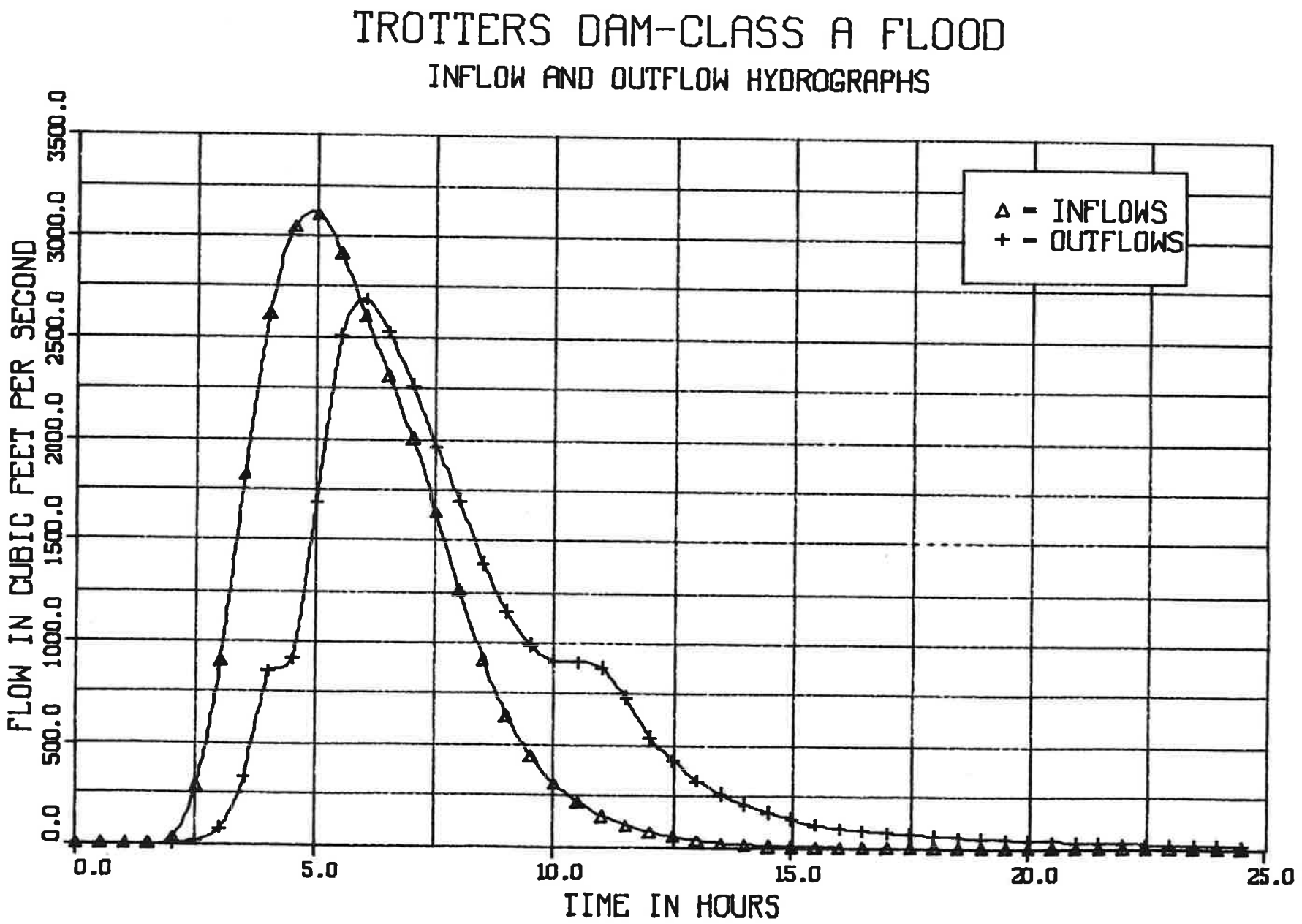

TROTTERS DAM-CLASS A FLOOD
INFLOW AND OUTFLOW HYDROGRAPHS
Δ = INFLOWS
+ = OUTFLOWS
FLOW IN CUBIC FEET PER SECOND
0.0
500.0
1000.0
1500.0
2000.0
2500.0
3000.0
3500.0
0.0
5.0
10.0
15.0
20.0
25.0
TIME IN HOURS

FIGURE 9

Construction Features

Alternative A would require a minimum of construction effort. The culvert would be extended at either end and a concrete headwall constructed. The roadway would be constructed to the required lines and grades and rock riprap installed.

Alternative B would require the complete excavation and reconstruction of the embankment section. A core trench would be excavated into the base material and backfilled with select non-pervious material. A 5-foot by 5-foot reinforced concrete box culvert 180 feet long would be constructed through the cut and four concrete cutoff collars would be built along the culvert to prevent seepage. Concrete inlet and outlet structures would be constructed at each end.

The invert of the box culvert would be built at an elevation of 2315.0 msl and its outlet end would be at 2312.0 msl. This would result in a 440 acre-foot permanent pool, covering 34 acres. The average depth would be 12.9 feet.

The inlet structure would be a double celled box with an inlet weir 15 feet long constructed at each side. The elevation of the control weir would be 2345.0 msl. The inlet structure will also incorporate a wet well with a control valve for a low level drawdown. It will have flared wing walls, a concrete roof and a trash rack.

The outlet structure will be a S.A.F. (St. Anthony Falls) stilling basin designed to reduce the velocity of the discharged water to a level that will not erode the downstream natural creek channel. Rock riprap will be placed as required at critical areas.

An emergency spillway could be constructed to the north of the dam embankment. The width would be 150 feet.

A low level drawdown system will be installed to remove the highly nutrient laden water off the bottom of the reservoir. This will consist of a wet well portion of the inlet structure, a 12-inch square control valve, a notch at 2344.0 msl to permit automatic drawdown operation, 12-inch diameter ductile iron pipe from the structure to the toe of the dam and a 12-inch diameter perforated plastic pipe on the bottom of the reservoir.

This system will service to improve the quality of the water by drawing the stratum of bad water that builds up on the bottom of the reservoir.

When the pool elevation is at or slightly below the weir, the poor quality water will automatically be syphoned out. When the water elevation is lower than the notch, water can be drained by opening the slide gate.

Soils Investigation

Northern Engineering and Testing, Inc., of Billings, Montana, was retained to conduct the geologic technical investigations in order to determine the stability of the proposed Trotters Dam embankment.

Twenty-four test borings were drilled with a truck mounted drill using hollow stem augers to depths of about 10 to 50 feet.

Laboratory tests were performed on the field samples and soil classifications were made. Slope stability analysis were made on the proposed embankment for three separate conditions: A. full reservoir, steady state seepage, without earthquake; B. full reservoir, steady state seepage, with earthquake; C. sudden drawdown from full reservoir.

The elevation of the stability analysis studies revealed that both

the upstream and downstream slopes would require a slope of at least three horizontal to one vertical or the equivalent. Figure 10 shows the maximum section of the dams.

Other results of the studies show that the Portland Cement used in the reinforced concrete spillway structures should be resistant to sulfate soil conditions.

Also the spillway conduit should be cambered up to 10 inches in the maximum fill areas to take of the expected embankment settlement and consolidation. Additional recommendations were made regarding the utilization and placement methods for the borrow material used in the embankment construction.

Dam Safety

Currently, dam safety standards require that the downstream channel be evaluated to determine the potential hazard to life and property if the dam for some reason fails. Engineers from the North Dakota State Water Commission inspected the site. They looked at the proposed site in regards to hazard classification (mostly downstream). Within 10 miles downstream of the dam, six farmsteads exist along Smith Creek. Most of these were in excess of 30 feet above the stream bottom.

The first farmstead was approximately 1¼ miles downstream. There is a well, livestock feeding yards, and a couple of old sheds, but no house or home. The floodplain was about a 1/2 mile wide and the buildings were about a 1,000 feet from the creek. The second farmstead was about 80 feet above the floodplain and in no danger of being flooded. The buildings were vacant and located about two miles downstream. The third place was located about three miles downstream and also set about

80 feet above the floodplain.

The fourth farmstead was located near the old town of Skaar and below the confluence of the north and south forks of Smith Creek. The farmyard was about 20 feet above the creek. This location is on a side stream, called Poison Spring Creek, and is about 3/4 of a mile upstream from its confluence with north fork of Smith Creek.

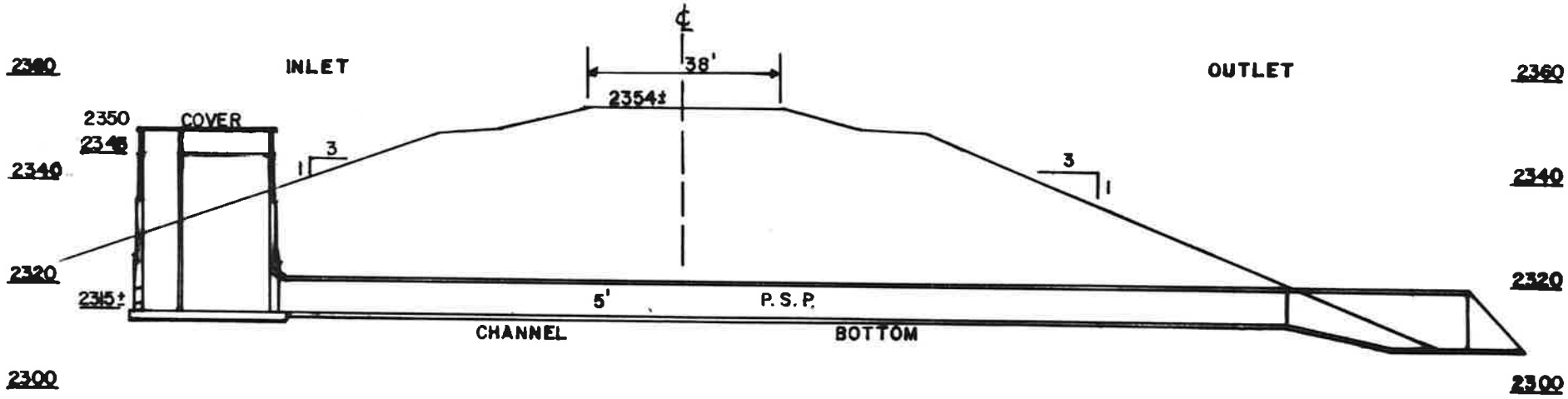
The fifth farmstead, is located about eight miles downstream. One or two farm buildings (barns) could possibly have from 0 to 3 feet of water in them. It was estimated that the barn was 20 feet above the channel bottom. The house was setting 5-6 feet higher than the barn and was not anticipated to be in the flood zone.

The sixth farmstead was located about ten miles downstream and it was estimated to be 25 feet above the channel bottom. There were six county bridges which could suffer damages.

Based on this information, the dam site would be classified as a Class III or Low Hazard Category.

Project Cost

The cost estimates for the two alternatives are $50,000 for Alternative A and $380,000 for Alternative B. The cost estimates do not include land acquisition. Considering the difference in cost between Alternative A and Alternative B, the additional cost for the dam would be $330,000. The cost for the recreational facilities would be about $70,000. Thus, the total cost for the dam and facilities, excluding land rights would be $400,000. The cost estimates for the two alternatives are as follows:



MAXIMUM SECTION OF DAM
SCALE 1" = 30'

ALTERNATIVE B

ROADWAY DAM COMBINATION

FIGURE 10

TROTTERS DAM
PRO. 1776 OCT 27.83

Alternative A - Roadway Only
Cost Estimate

Clearing & Grubbing	Approx. 690	CY	@	$ 0.90	= $ 621.00
Common Excavation	11,500	CY	@	0.90	= 10,350.00
Water	14	M Gal.	@	5.00	= 70.00
Extend 9'0" Ellip, Structure Plate Pipe	70	LF	@	225.00	= 15,750.00
Class I Excavation	135	CY	@	5.00	= 675.00
Foundation Fill	169	CY	@	8.00	= 1,352.00
Class AE-Concrete (Headwalls)	12	CY	@	300.00	= 3,600.00
Loose Rock Riprap (Pipe Outlet)	555	CY	@	20.00	= 11,000.00
Seeding (Permanent)	4	Acres	@	100.00	= 400.00
Seeding (Temporary Cover Crop)	2	Acres	@	100.00	= 200.00
Subtotal					$44,018.00
Plus 13.6% Engineering, Administration & Contingencies					$ 5,982.00
Total					$50,000.00

Alternative B - Dam/Roadway
Cost Estimate

Excavation	25,000	CY	@	$ 1.00	= $25,000.00
Core Trench	2,000	CY	@	2.00	= 4,000.00
Salvage Old Pipe		LS	@		= 1,000.00
Earthfill	65,000	CY	@	1.00	= 65,000.00
Concrete	410	CY	@	250.00	= 102,500.00
Rebar	50,000	Lb.	@	50	= 25,000.00
Rock Riprap	1,000	CY	@	25.00	= 25,000.00
Rock Riprap Filter Material	500	CY	@	12.00	= 6,000.00
Low Level Drawdown		LS			= 10,000.00
Drains		LS			= 10,000.00
Miscellaneous Metals		LS			= 3,000.00
Seeding		LS			= 1,000.00
Emergency Spillway		LS			= 30,000.00
Subtotal					$297,500.00
Plus 27.7% Engineering, Administration & Contingencies					$ 82,500.00
Total					$380,000.00

SPORT FISHERY

The sport fishery in Trotters Dam will consist of rainbow trout with bass and bluegill added as they become available. This type of fishery yields high recreational use by anglers. It is not uncommon to receive as high as 200 man-days per surface acre use on trout lakes such as Sather Dam as compared to 25 man-days on lakes managed for pike and walleye.

It is expected that Trotters Dam will support a reasonably high amount of sport fishing. The fact that it is situated in a remote area of the State is not especially significant. With the completion of the new highway from Beach to Highway 68, access will be excellent. In addition to providing a much needed sport fishery to local residents and those of Beach, considerable use from residents of eastern Montana can be expected. Upland game hunters often combine hunting with trout fishing such as is observed at Davis Dam, Camel Hump Dam and Sather Dam.

PROJECT FEASIBILITY

The total cost for the dam and facilities, excluding land would be $400,000. Approximately 125 acres should be acquired for the project. All of the land presently is Federal land. This being the case, land costs should be minimal.

The annual cost of the dam amortized over 40 years at an 8% rate, would be $33,544. Annual cost of maintenance would be $1,000. Total annual costs would be approximately $35,000.

From surveys of other dams in Western North Dakota, it would appear that Trotters Dam will receive approximately 200 man-days per surface acre of fishing uses. Annual visitation would be approxiately 6,800 man-days. An exact determination of the value of a man-day of fishing is not readily available, although recent studies at North Dakota State University have shown that at a minimum, the average fisherman will spend $25.00 per day to fish in North Dakota. Although not all of this expenditure can be considered a benefit, a good portion can be shown as a return to the local area and to the State.

With a total annual cost of $35,000, and with annual visitations of 6,800 man-days, the project can be considered feasible if the benefit per man-day exceeds $5.15. This would seem conservative in view of the NDSU findings, thus the project appears feasible.

CONCLUSIONS AND RECOMMENDATIONS

It is technically feasible to construct a roadway dam structure that will create a 34-acre reservoir impounding 440 acre-feet of water with an average depth of 12.9 feet. The total cost of the dam alternative was estimated at $450,000, including about $70,000 for land and the associated recreational area development. Since the cost of the proposed highway only alternative was estimated at $50,000, the net cost of the recreation dam project will be $400,000.

Although this seems to be a large expenditure for a small recreation facility, the project does appear economically feasible when the potential for use is considered. Further development of the project should include both the McKenzie County Water Resource District and the Golden Valley County Water Resource District. Potential agencies to share in the project cost would be the two Water Resource Districts, the West River Joint Water Resource District, the State Water Commission, the North Dakota State Game & Fish Department, the State Parks and Recreation Department, the North Dakota State Highway Department and the U.S. Forest Service, owner of the land. If the decision is made to proceed with the project, it must be done very quickly in order to complete the project in conjunction with the Highway 16 reconstruction.