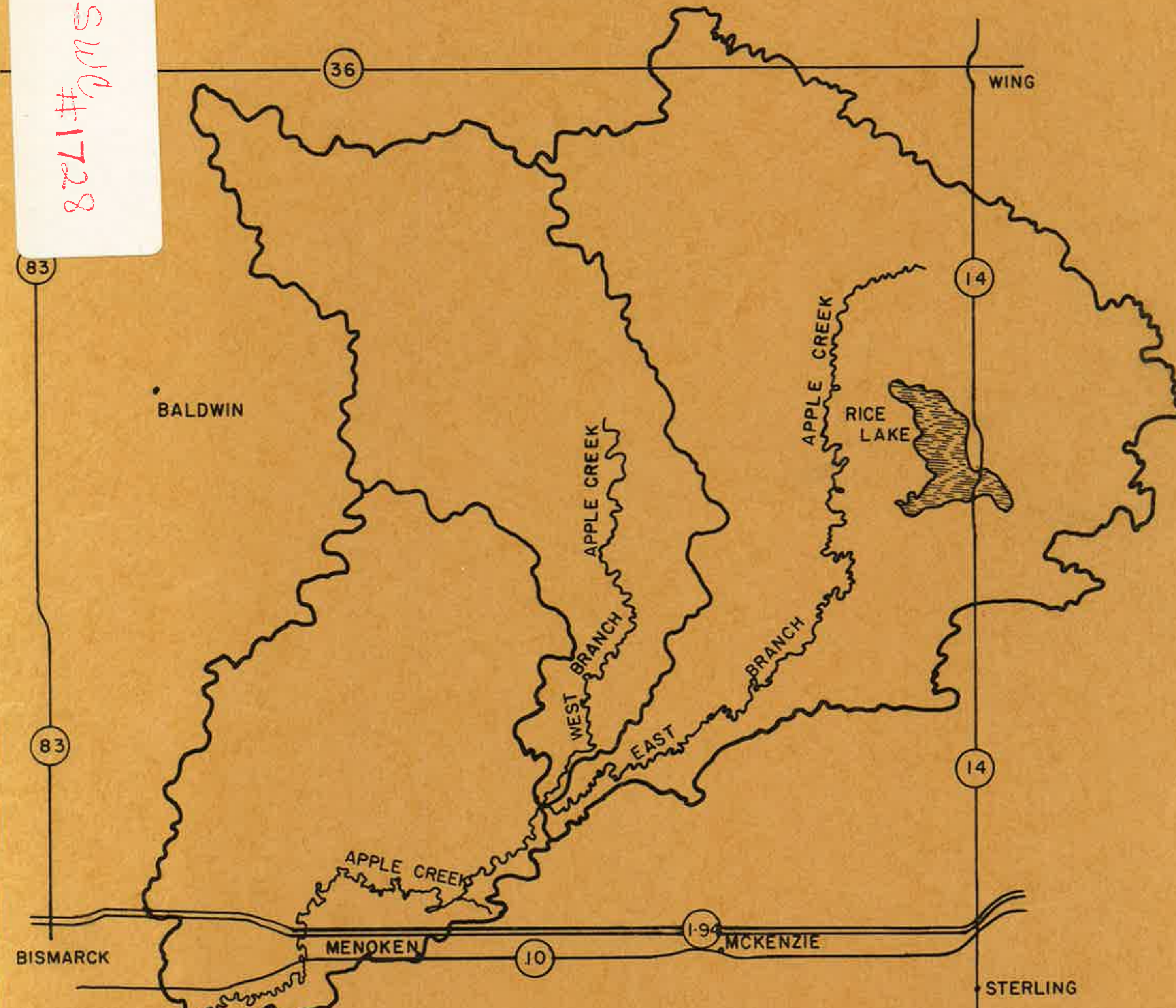
PRELIMINARY ENGINEERING REPORT

APPLE CREEK FLOOD CONTROL STUDY

NEIDEFFER DAM

S.W.C. PROJECT NO. 1728



NORTH DAKOTA

STATE WATER COMMISSION

MARCH 1981

PRELIMINARY ENGINEERING REPORT

APPLE CREEK FLOOD CONTROL STUDY
NEIDEFFER DAM
SWC PROJECT #1728

March, 1981

North Dakota State Water Commission
State Office Building
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Prepared for the
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TABLE OF CONTENTS

APPLE CREEK

I. INTRODUCTION

In July of 1980, the North Dakota State Water Commission entered into an agreement with the Burleigh County Water Management Board to investigate the feasibility of constructing a water control structure on the upper reaches of the East Branch of Apple Creek. The purpose of this structure is to reduce downstream flood peaks. This is to be accomplished by impounding water behind an embankment and slowly releasing it through a small diameter pipe. Located on a tributary of the East Branch of Apple Creek, the structure is in Section 4, Township 141 North, Range 76 West (see Figure 1). It is referred to as Neideffer Dam. Being a dry dam, it would only temporarily retain flood waters from a drainage area of 11.4 square miles.

The Burleigh County Water Management Board plans to consider constructing a number of these water control structures throughout the watershed. These would be constructed over a period of years, possible one per year. In order to evaluate the effects of these structures, a hydrologic study of the entire watershed was conducted. This study could be used to plan the most beneficial location of these proposed structures.

This report describes the geology, subsurface conditions, and the soil characteristics of the proposed Neideffer Dam. As mentioned above, it also discusses the basin's hydrology. It contains a summary of the project's preliminary design, a cost estimate, a short environmental assessment, and a discussion of the feasibility of the project. The preparation of final plans and specifications would be done after the project has been authorized and construction is imminent.

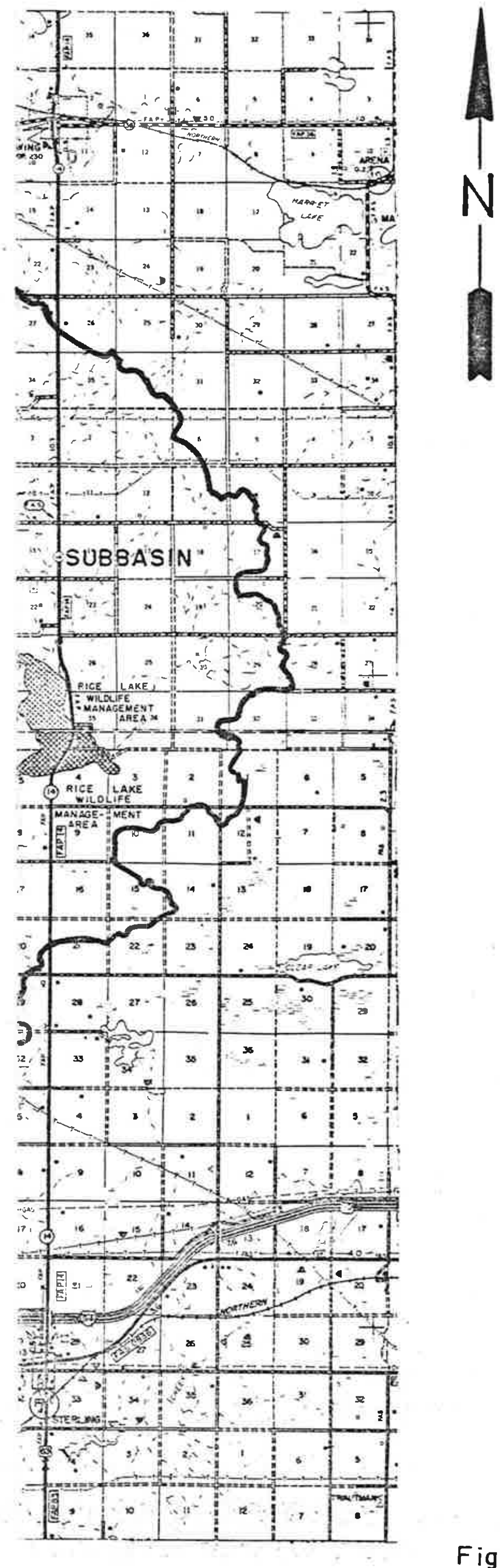

SUBBASIN
RICE LAKE WILDLIFE MANAGEMENT AREA
RICE LAKE WILDLIFE MANAGE-MENT AREA
ARENA
NORTHERN
STERLING
N

Figure 1

II. HISTORICAL BACKGROUND

Apple Creek has experienced some flooding during the period of record, starting in 1947. These flood peaks have been caused mostly by spring snowmelt. On an annual basis, this flooding has not been severe, although two floods in 1950 and 1974 (6,750 cfs and 5,900 cfs, respectively), have caused considerable damage. The 1950 flood has been estimated to have been a 50 year event while the 1979 flood was estimated to be about a 30 year event. Two smaller floods during the period of record included 2,300 cfs in 1951 and 4,040 cfs in 1969.

In 1979, $348,200 worth of damages occurred as a result of flooding along Apple Creek. Most of it was to roads and old bridges. The flood-waters did come close to the Lincoln Elementary School south of Bismarck. Damages would have been much greater if these facilities would have been inundated. This flood rekindled concern over flooding possibilities along the lower reach of Apple Creek.

Milo Hoisveen, consulting engineer for the Burleigh County Water Management Board, proposed a plan involving the construction of a number of water control structures throughout the watershed. These were planned to be built over a period of up to twenty years. The structures would reduce flood peaks by storing water from subbasins tributary to Apple Creek. Water stored in these reservoirs was proposed to be used for irrigation. According to Mr. Hoisveen, the water released from these reservoirs could help to keep Apple Creek a live stream.

An investigation agreement was signed in July of 1980. A copy is included in Appendix A. It called for a hydrologic study of the Apple Creek watershed, along with a preliminary design of a water control structure. This included studying the flood peak reduction potential

III. GEOLOGY AND PHYSIOGRAPHY

The Neideffer Dam site, as described in this section of the report, is located in the S½ Section 4, Township 141 North, Range 76 West, in the northeastern portion of Burleigh County, in east-central North Dakota.

Burleigh County, according to Fenneman's physiographic classification of the United States (1931, 1946 map), lies in the Interior Plains major division, the Great Plains province, and the Glaciated Missouri Plateau section. Clayton (1962, p. 14) divided the Glaciated Missouri Plateau section into three districts: the Glaciated Missouri Slope, Coteau Slope, and Missouri Coteau. Kume and Hansen (1965, p. 8) added a fourth district, the Missouri River Trench district.

The dam site and reservoir is situated in the Coteau Slope, the glaciated slope west of the Missouri Coteau (Figure 2). The Coteau Slope is subject to active erosion with mostly integrated drainage.

The Coteau Slope district in Burleigh County is divided into seven subdistricts. This section of the report deals only with the Apple Creek Uplands subdistrict.

> According to, Kume and Hanson (1965, p. 25): "the Apple Creek Uplands subdistrict is characterized by glacially modified, stream-eroded bedrock topography. Bedrock crops out throughout the subdistrict, and many small areas were mapped as bedrock, because the till cover was thin or non-existent except for scattered erratic boulders. The highest uplands are at an elevation of over 2200 feet, about 700 feet above the adjoining McKenzie lake plain to the south. The local relief is commonly over 100 feet per square mile, but may reach several hundred feet in the butte areas. The Tongue River Formation caps most of the highest uplands in the northern part of the subdistrict with the Cannonball Formation forming the lower slopes. The streams of this subdistrict are ephemeral except for the intermittent Apple Creek. The streams flow westward to the Missouri River. All of the major drainage valleys contain some outwash, and during glaciation most of these channels carried meltwater."

Apple Creek is an intermittent stream in a narrow meltwater valley. The valley floor ranges from about 200 to 300 feet wide in the area of the dam site. The topography is gently rolling with approximately 84 feet of relief at elevations ranging between 1884 and 1968 msl.

The outwash valley floor is underlain by valley fill sediments, chiefly glaciofluvial, ranging in thickness from 7 to 10 feet. The material is generally stratified and consists predominantly of sand and gravel. The valley fill sediments were undoubtedly formed by waters flowing from melting glacial ice and later reworked and redeposited as recent alluvium (undifferentiated).

The glacial-drift/unweathered-bedrock contact beneath the valley floor occurs between elevations 1876.0 and 1879.0 in test borings 2 and 3, respectively. Contact with the underlying gray silty sands is distinct. The sands are friable, non-calcareous, non-plastic and predominantly fine-grained.

The left, or north, abutment is underlain by outwash sediments, probably an outwash terrace. The sediments deposited by meltwater streams are composed chiefly of washed and stratified sands and gravels. A wide range of particle sizes exist, varying from boulders to sand. The silt and clay fraction is small or little, having been carried downstream as suspended load beyond the recognizable outwash body.

The right, or south, abutment and emergency spillway consists of weathered silty clays of the Cannonball Formation. The weathered portion of the Cannonball extends to approximate elevation 1879.0. The weathered bedrock clays are blocky or massive, with only a trace of faint laminations. Iron oxide staining is intense to subdued, becoming less intense with depth.

IV. SOILS ANALYSIS

SUBSURFACE EXPLORATION

A preliminary subsurface exploration program was initiated by the State Water Commission to determine the feasibility of an earthfill flood detention dam on the East Branch of Apple Creek.

This section of the report describes the exploration and testing program, geology, subsurface deposits, soil properties, foundation, and embankment design.

The soil and geologic exploration program was developed by the State Water Commission. Drilling and testing were performed by Soil Exploration Company of St. Paul, Minnesota; Metzger's Prospecting Service, Mandan, North Dakota and the State Water Commission. The topography of the dam site, showing locations and elevations of all centerline test borings and borrow area test holes, was surveyed by the Water Commission. A Water Commission engineer supervised and inspected the drilling, sampling, and field testing operations.

With the exception of test holes drilled in the borrow and proposed emergency spillway areas on November 6, 1980, the subsurface exploration began November 17, 1980 and was completed on November 19, 1980. The entire program consisted of 26 borings: 7 test borings on proposed centerline of dam; 5 auger power holes along the proposed centerline of emergency spillway; and 9 and 10 auger power holes in the north and south borrow areas, respectively.

Six-4 inch rotary wash borings and one-6 inch hollowstem auger boring were located on proposed centerline of dam. The borings ranged in depth from 21 to 51 feet. Split spoon samples were obtained from all of the borings. The split spoon samples were recovered with a standard sampler, 2 inches O.D. by 1 3/8 inches I.D., driven 18 inches into the

Soil testing at the State Water Commission's laboratory included the following:

a. Visual Classification
b. Natural Moisture Content
c. Mechanical Analysis
d. Atterberg Limits
e. Specific Gravity
f. Moisture-Density Relationship of Soil (proctor test)
g. Classification of Soils for Engineering Purposes

The undistrubed samples from boring six were sealed and shipped to Soil Exploration Company's laboratory. Testing included:

a. Visual Classification
b. Natural Moisture Content
c. In-place Unit Weight
d. Confined and Unconfined Compressive Strengths

FOUNDATION SOILS

The term "foundation" as used herein includes both the valley floor and the abutments.

Bedrock

Regional stratigraphy is presented in Kume and Hanson (1965). The Cannonball Formation is the major formation underlying the valley fill sediments and exposed along the valley walls. The Cannonball belongs to the Tertiary Fort Union Group of Paleocene Age. This group is divided into a comformable sequence, including from oldest to youngest, the Ludlow, Cannonball, and Tongue River.

The Ludlow, a continental formation is exposed in southwestern and south-central Burleigh County. Because it is so thin, the Ludlow Formation is not easily shown as a separate formation on a geologic map. Therefore, during surficial mapping, the Ludlow Formation is generally included with its marine facies equivalent, the Cannonball Formation.

Two unconfined compression tests and one unconsolidated-undrained triaxial compression test were made on the weathered bedrock material from Borings 4 and 5. The test results are shown on Figure 3. The unconfined compressive strength of the sample from Boring 5, at a depth of 8.0 to 10.2 feet was only 1.16 tsf. The testing manager attributes the obviously low compressive strength to the somewhat blocky and small vertical fissures. The test results were voided. The U-U triaxial compression test was conducted with a confinement of 0.5 tsf, which is roughly equal to the existing overburden load. The maximum compressive stress was 2.36 tsf. This appears to be indicative of the in-situ conditions.

Unconsolidated Material

As previously mentioned, the deposits underlying the valley floor are described as valley fill sediments, chiefly glaciofluvial, ranging in thickness from 7 to 10 feet. The deposits were formed by meltwater flowing from glacial ice and later reworked and redeposited as recent alluvium (undifferentiated). The material is generally stratified and consists predominantly of sand and gravel.

The deposits within this portion of the foundation consist essentially of sand-silt mixtures (SM) and poorly graded gravelly sands (SP). The samples contain from 13 to 41 percent retained on the #4 sieve, 39 to 82 percent retained on the #200 sieve and from 5 to 41 percent fines.

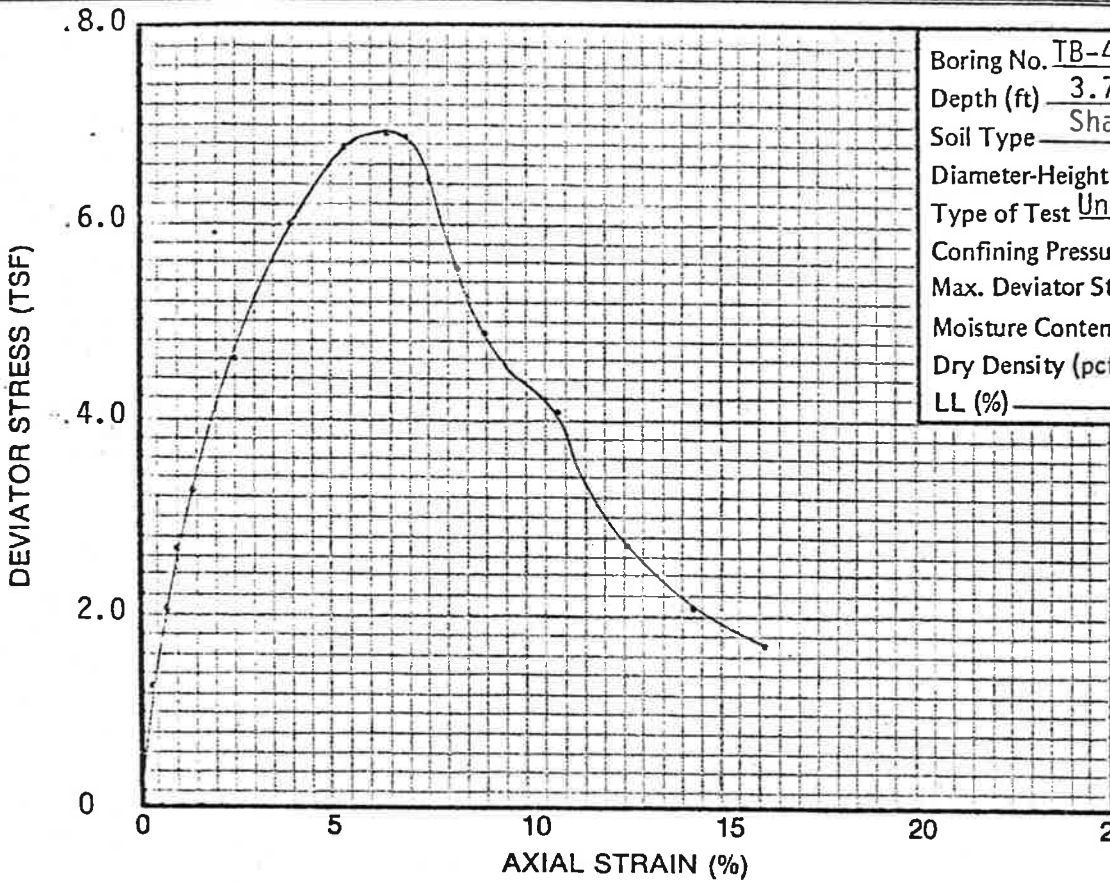
Split spoon samples were taken both above and below the water table in the glaciofluvial sediments. Standard penetration test blow counts below the water table ranged from 11 to 30 in borings 1 and 2.

CONFINED — **STRESS - STRAIN CURVES** — UNCONFINED

Project: PROPOSED NEIDEFFER DAM-BURLEIGH COUNTY, NORTH DAKOTA SWC#1728

Date: March 9, 1981

Project No. 520-1238



Boring No. TB-4 Sample No.

Depth (ft) 3.7-5.7 (Bottom)

Soil Type Shale (CH-CL)

Diameter-Height (inches) 2.82 x 5.58

Type of Test Unconfined compression

Confining Pressure None

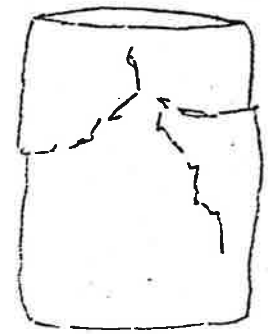
Max. Deviator Stress 6.92 tsf

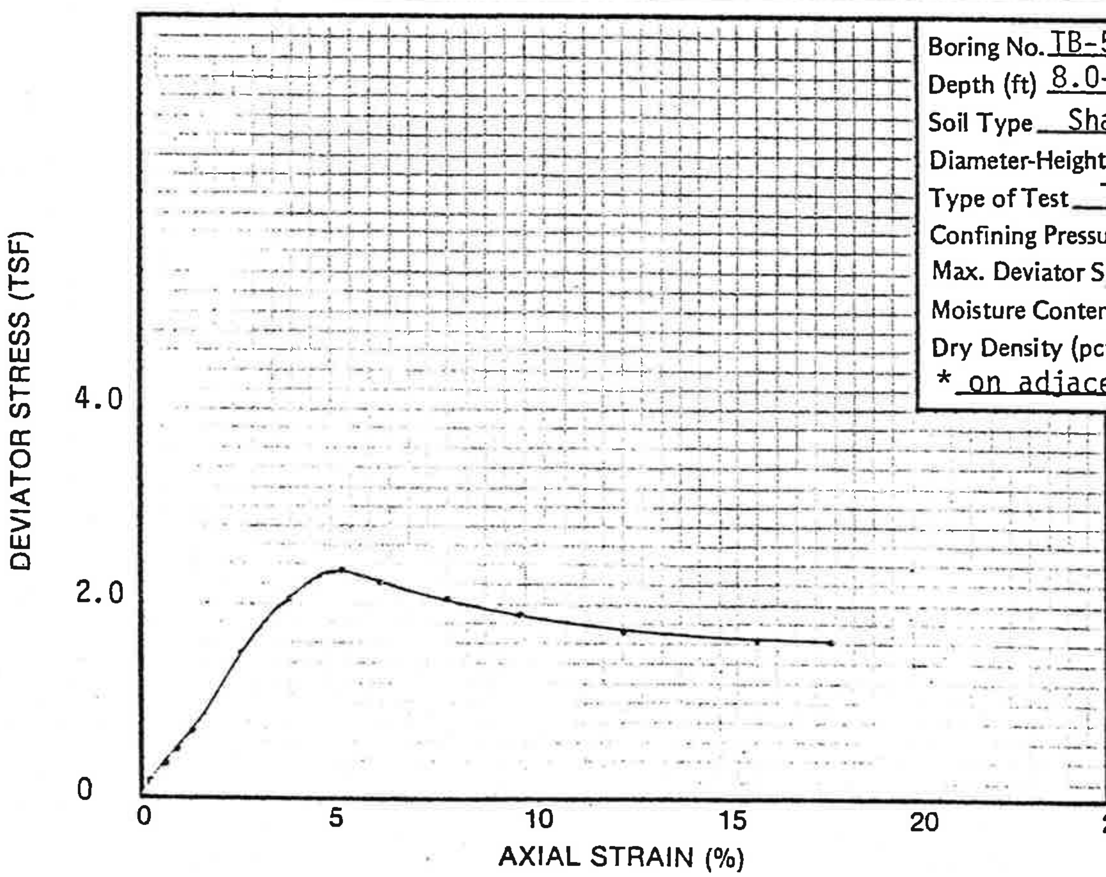
Moisture Content (%) 20.1

Dry Density (pcf) 105.9

LL (%) PL (%)

Sketch of sample after failure.





Boring No. TB-5 Sample No.

Depth (ft) 8.0-10.2 (Top)

Soil Type Shale (CL)

Diameter-Height (inches) 2.84 x 5.60

Type of Test Triaxial U-U

Confining Pressure 6.9 psi

Max. Deviator Stress 2.36 tsf

Moisture Content (%) 24.0, 25.4*

Dry Density (pcf) 89.5, 85.3*

* on adjacent sample

Sketch of sample after failure.

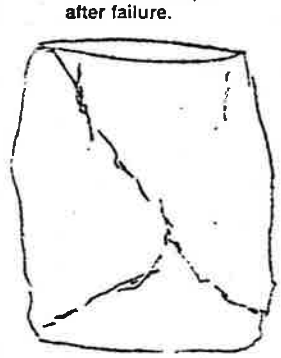


Figure 3

EMBANKMENT SOILS

The upland surface on the north and south sides of the dam as well as the emergency spillway were explored for borrow materials. The borrow areas explored are shown on Plate 1. Due to extensive sand and gravel deposits adjacent to the left abutment, this area should not be considered for borrow.

Nine samples were submitted from five test holes in the emergency spillway. All of the samples are classified as plastic CH's. The samples contain from 2 to 24 percent retained on the #200 sieve and from 76 to 98 percent fines. Liquid limits range from 51 to 63 and PI's from 31 to 39. The natural moisture content ranged between 21 to 27 percent with an average of 24.5 percent.

Ten auger holes were drilled in the south borrow area. Four samples were submitted to represent the weathered bedrock in this area. The samples submitted represent fine-grained soils that are classed as CH. The hydrometer analyses show that 90 percent of the material is finer than 0.074 mm. Liquid limits range from 51 to 58 and PI's from 31 to 34. The water content had a very narrow range from 23 to 25 percent.

Standard Proctor compaction (ASTM D 698 - Method A) tests were made on the emergency spillway and south borrow area soils. The data are summarized in Tables 1 and 2.

V. HYDROLOGY

DISCUSSION OF THE STUDY

The hydrology of the entire Apple Creek watershed, excluding McKenzie Slough, was analyized using the TR-20 computer program which was developed by the U.S. Soil Conservation Service. It was used to determine the peak discharges and flow volumes of the various frequency storms. The program formulates a mathematical, hydrologic model of the watershed. This is based on the following data: the amount of rainfall, rainfall distribution, soil type, land use, and the hydraulic characteristics of the stream channels and drainage area.

This study included an overall investigation of the Apple Creek watershed above the U.S.G.S. stream gage located on old Highway 10 in Section 9, Township 138 North, Range 79 West (see Figure 1). Investigating the entire watershed allows a more accurate assessment of any downstream flood benefits provided by any potential water control structures. The investigation can be a basis by which one can compare flood flows before a structure is built to the flows after its construction. This would be done using the hydrologic model mentioned above. Both the Schwartz and Neideffer sites were studied for their effects on downstream flooding. Each reduced the flows at the stream gage by about the same amount. The Neideffer site was selected for further study because of high water table problems at the Schwartz site.

McKenzie Slough and its drainage basin were not included in this hydrologic study. The slough has a very large drainage area, most of which is noncontributing. During most years the peak flow into McKenzie Slough occurs later than the Apple Creek peak. In addition to this, rather than rainfall. This is as expected, since all recorded floods on Apple Creek occurred during the snowmelt period. Neideffer Dam reduced the inflow peak of the 100 year event at its location from 800 cfs to 42 cfs. This results in a 95 percent reduction in flows at the dam site (see Figure 4). This percentage of reduction will lessen further downstream, due to the addition of other flows into the East Branch of Apple Creek.

Figures 5 and 6 show the 100 year hydrographs, with and without Neideffer Dam, at the East Branch of Apple Creek just above the confluence with the West Branch of Apple Creek and at the stream gage respectively. These graphs show that with the dam, the 100 year peak discharge would be reduced by 500 cfs at the confluence. This amounts to a 9.1 percent reduction. At the stream gage east of Bismarck, the dam reduces the peak discharge by 350 cfs, a 3.3 percent reduction.

Table 3 shows the peak inflow of various floods at the Neideffer site. It also shows peak discharge from the dam along with peak reservoir elevation and the resulting amount of flooded land. Peak discharges with and without Neideffer Dam are listed in Table 4. These figures are for the confluence and the stream gage locations.

In order to evaluate the accuracy of the TR-20 model study, the peak discharges estimated were compared to the recorded discharges at the stream gage. Table 5 is a comparison of the estimated flows for various frequency flows and the recorded flows for these frequencies. The historical flow rate for various frequencies was determined from recorded flows by the Log Pearson Type III method. Although the TR-20 estimated discharges are somewhat higher, the discharges are comparable in most cases. The ten year event peak flows differ the most. This is probably due to flows from Apple Creek backing into McKenzie Slough

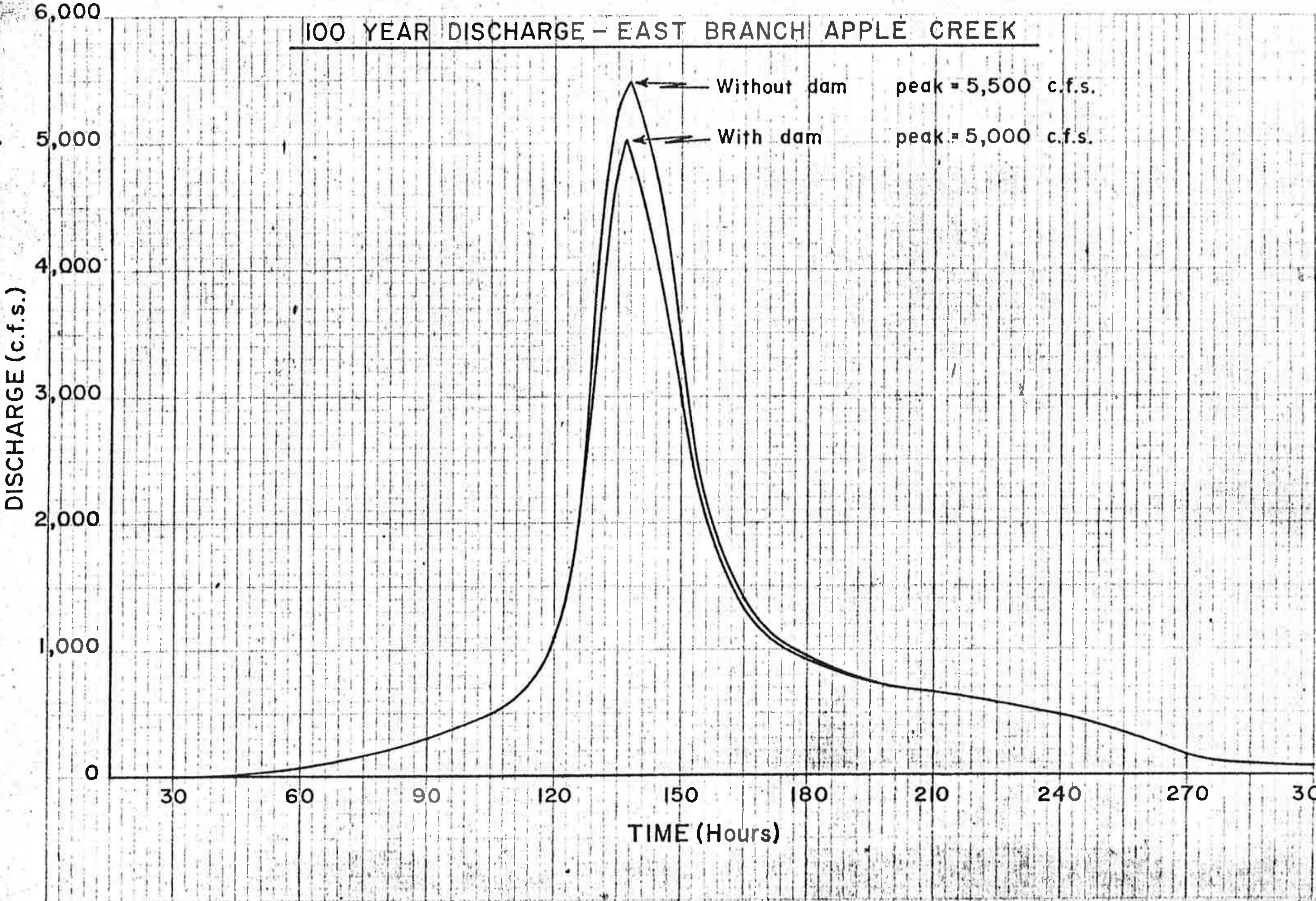

100 YEAR DISCHARGE - EAST BRANCH APPLE CREEK
Without dam peak = 5,500 c.f.s.
With dam peak = 5,000 c.f.s.
DISCHARGE (c.f.s.)
6,000
5,000
4,000
3,000
2,000
1,000
0
30
60
90
120
150
180
210
240
270
300
TIME (Hours)

Figure 5

TABLE 3

NEIDEFFER DAM HYDROLOGY DATA[1/]

Storm Frequency (years)	Natural Inflow (cfs)	Reduced Outflow (cfs)	Peak Reservoir Elevation (msl)	Flooded Area (acres)	Duration of Flooding (Days)
2	50	10	1898.0	30	9
5	195	31	1900.2	40	16
10	350	35	1904.5	65	21
100	800	42	1912.5	130	31

[1/]Snowmelt hydrology

TABLE 4

DOWNSTREAM HYDROLOGY DATA[1/]

Storm Frequency (years)	East Branch Apple Creek[2/] Peak Flow w/o Dam (cfs)	East Branch Apple Creek[2/] Peak Flow With Dam (cfs)	U.S.G.S. Streamgage[3/] Peak Flow w/o Dam (cfs)	U.S.G.S. Streamgage[3/] Peak Flow With Dam (cfs)
2	300	280	700	670
5	1200	1100	2250	2250
10	2180	2020	4350	4300
100	5500	5000	10700	10350

[1/]Snowmelt hydrology.

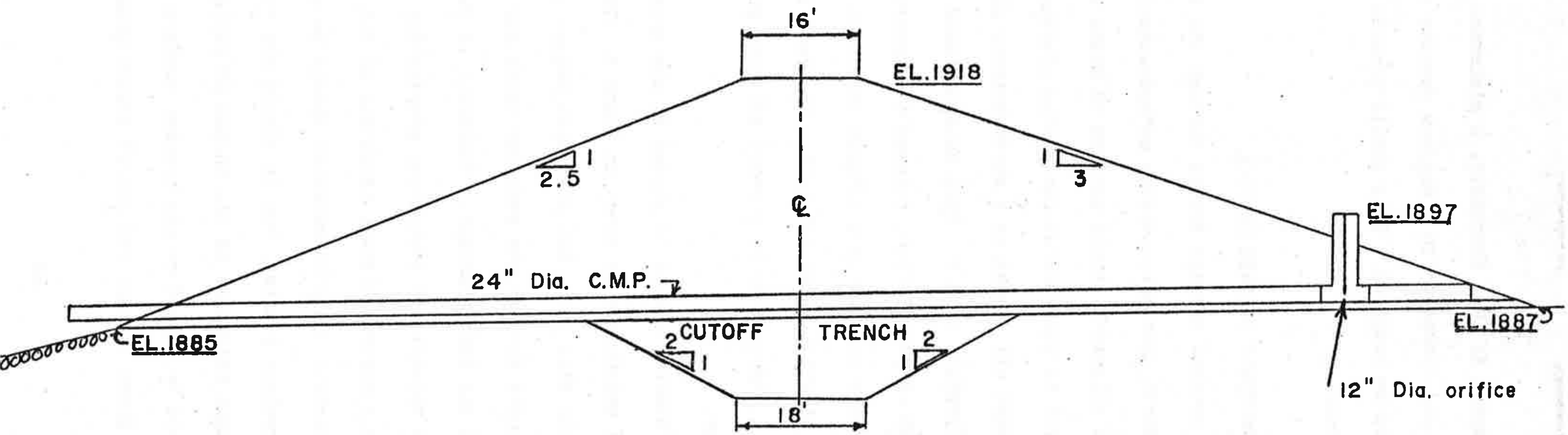
[2/]At the confluence of the West and East Branches of Apple Creek.

[3/]At the U.S.G.S. Streamgage on Old Highway 10.

which would reduce the estimated peak. During the 100 year event, McKenzie Slough would probably be too full to receive backwater from Apple Creek. Therefore, the peak reduction, compared to estimated peaks, would be smaller.

TR-20 did not account for McKenzie Slough flows since they were assumed to be noncontributing. The computer program estimated flows resulting from runoff coming from the study area only. As explained previously, McKenzie Slough should decrease the flood peaks expected from the Apple Creek watershed in most years. It may reduce mainstem peaks from 0 to 2000 cfs depending on the flood magnitude and the level of McKenzie Slough at the time of the flood. This is why recorded flows are less than those estimated.

Comparing the runoff from the watershed to the storage available at the Neideffer site shows why downstream flood levels are only slightly reduced. During the 100 year flood, 44.640 acre-feet of water flows past the U.S.G.S. streamgage east of Bismarck. Neideffer Dam reaches a pool elevation of 1912.5 msl for the same event. At this elevation the reservoir is storing 1,320 acre-feet, approximately 3 percent of the runoff. This compares well with the estimated 3.3 percent reduction in the peak flood discharge for the 100 year flood.



NEIDEFFER DAM
S.W.C. 1728
SECTION THRU SPILLWAY
SCALE: 1"=20'

Figure 7

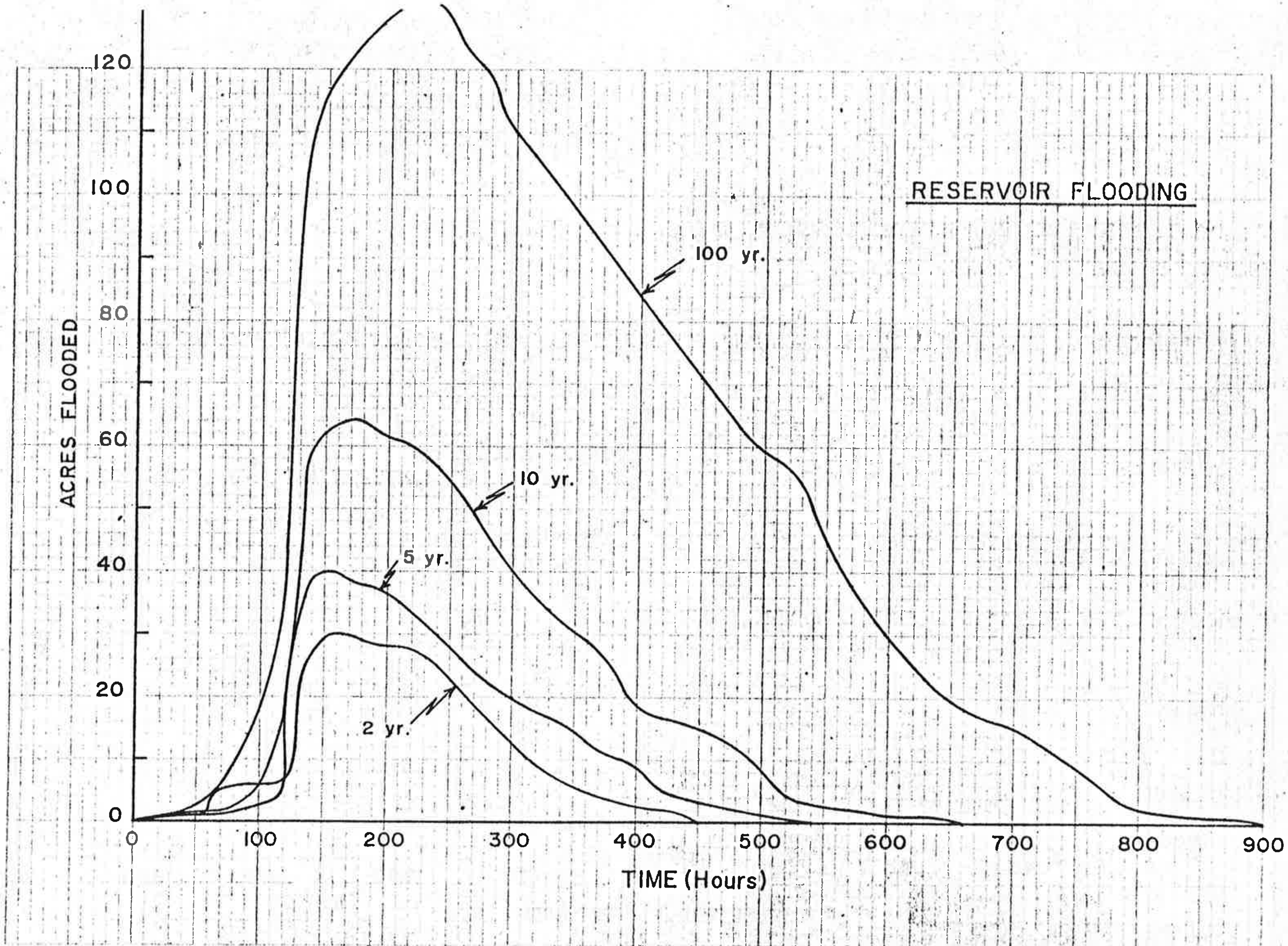
ideal material for the blanket surface because it is not very susceptible to cracking when it drys.

Because of seepage conditions that may develop on the downstream face of the abutment, monitoring of this area during flood periods should be performed. In the event that excessive, uncontrolled seepage does develop, horizontal drains and collectors may be required in addition to the upstream abutment blanketing.

HYDRAULIC DESIGN

Neideffer Dam is proposed to have both a principal and an emergency spillway. The principal spillway is to be a 24 inch diameter corrugated metal pipe approximately 190 feet long. It will have a standard flared end section with an invert elevation of 1887.0 msl. at the upstream end. At the outlet, the pipe will have an invert elevation of 1885.0 msl. A plunge pool protected with rock riprap will be constructed at the outlet to dissipate the hydraulic energy of the discharging flows (see Figure 7).

Normal design of a water control structure of this type would include only a pipe through the embankment. This would back up very little water on more frequent runoff events such as the one to five year event. Since one of the purposes of the project is to increase hay yields in the reservoir area by means of flood irrigation, a 36 inch diameter corrugated metal riser ten feet in height will be installed near the upstream end of the principal spillway pipe. The riser, shown in Figure 7, will contain a divider having a 12 inch diameter orifice near the bottom to act as a flow retention device. This feature will serve to retain the more frequent floods within the reservoir for a longer period of time, allowing the reservoir elevation to increase and more acres to be flood irrigated behind the embankment. less frequent floods having larger



RESERVOIR FLOODING
ACRES FLOODED
TIME (Hours)
100 yr.
10 yr.
5 yr.
2 yr.
0
20
40
60
80
100
120
0
100
200
300
400
500
600
700
800
900

Figure 8

TABLE 6

NEIDEFFER DAM COST ESTIMATE

Item	Quantity	Unit Price	Cost
1. Strip. Stockpile & Spread Topsoil	54,000 S.Y.	$ 0.25	$ 13,500.00
2. Cutoff Trench	12,500 C.Y.	2.00	25,000.00
3. Embankment[1/]	75,000 C.Y.	1.20	90,000.00
4. 24" Ø CMP	200 L.F.	40.00	8,000.00
5. Rock Riprap	50 C.Y.	25.00	1,250.00
6. RRR Filter Material	20 C.Y.	7.50	150.00
7. Seeding	12 Acres	300.00	3,600.00
		SUBTOTAL	$141,500.00
		+20% Engineer, Contract Administration and Contingencies	28,500.00
		TOTAL	$170,000.00

[1/] Includes cost of impervious blanket.

of damages for these flows could be calculated. These benefits would then be plotted against the probability of their occurrence. Measuring the area under this curve would yield the annual benefits that could be expected due to reduced flooding.

It was difficult to find records of flood damage along Apple Creek. Most of the information found came from a flood damage survey done by the U.S. Soil Conservation Service. This survey is included in Appendix B. It gives a breakdown of damages that occurred during the 1979 flood. This flood was estimated to have been a thirty year event. Table 7 shows the breakdown of these flood damages and the adjusted costs in 1981 dollars.

TABLE 7
1979 FLOOD DAMAGES

	Item	1979 Damages	1981 Adjusted Costs
1.	Roads and Bridges	$258,600	$324,400
2.	Residential	31,100	39,000
3.	Lincoln School	1,500	1,900
4.	Agricultural	27,000	33,800
5.	Golf Course	20,000	25,100
6.	Nursery	10,000	12,500

In order to estimate the damages that will occur for various frequency events, one should have at least two data points. More would give a better picture of how much damage can be expected for each frequency event. The data in Table 7 would be the data points for the thirty year event, broken down into the listed categories. There was no other information available for residential, Lincoln School, agricultural, golf course, or nursery damages. To get second points for each of these types of damages, a point where they would become zero was assumed. Residential damage was assumed to become zero at the ten

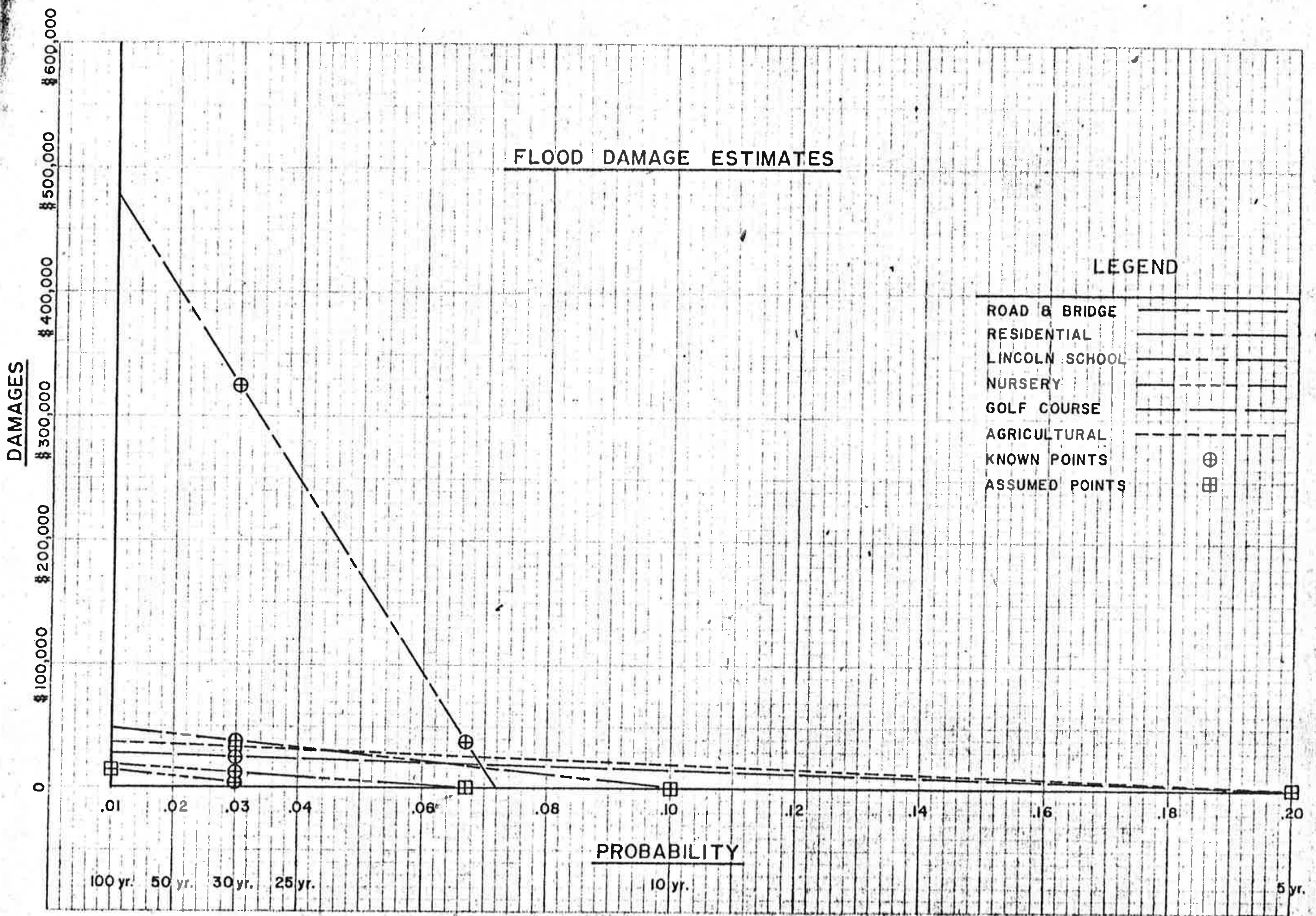

FLOOD DAMAGE ESTIMATES
DAMAGES
$600,000
$500,000
$400,000
$300,000
$200,000
$100,000
0
LEGEND
ROAD & BRIDGE
RESIDENTIAL
LINCOLN SCHOOL
NURSERY
GOLF COURSE
AGRICULTURAL
KNOWN POINTS
ASSUMED POINTS
.01
.02
.03
.04
.06
.08
.10
.12
.14
.16
.18
.20
PROBABILITY
100 yr.
50 yr.
30 yr.
25 yr.
10 yr.
5 yr.

Figure 10

Therefore, it was assumed that flood damages in the East Branch subbasin would be reduced by 12 percent to take this into account. The hydrology study also showed that the flood peaks at the stream gage would be reduced 4.3 percent for a two year event, 2.2 percent for a five year event, 1.2 percent for a ten year event, and 3.3 percent for a 100 year event. Weighing these reductions by their probability of occurrence yields an average reduction factor of 3.1 percent for all frequency floods. Being as the stream gage is between the confluence of the East and West Branches and the mouth of Apple Creek, it was assumed that this 3.1 percent reduction factor was good for the lower reaches.

Since agricultural and road and bridge damage was assumed to occur over the entire watershed, it was assumed that each subbasin would sustain a proportionate amount of the total damage according to the area. Each subbasin would receive a different amount of benefit according to expected flood reductions. The West Branch subbasin has no reduction, the East Branch subbasin average 12 percent reduction, and the lower reaches have a 3.1 percent reduction factor. Weighing these by the size of the subbasin gives a reduction factor of 5.6 percent for all agricultural and road and bridge damages in the watershed. Table 8 lists the subbasins and their drainage areas.

TABLE 8
SUBBASIN AREAS

Subbasin	Area	% of Total Area
West Branch Apple Creek	122 sq. mi.	34
East Branch Apple Creek	145 sq. mi.	40
Lower Reach Apple Creek	95 sq. mi.	26
TOTALS	362 sq. mi.	100

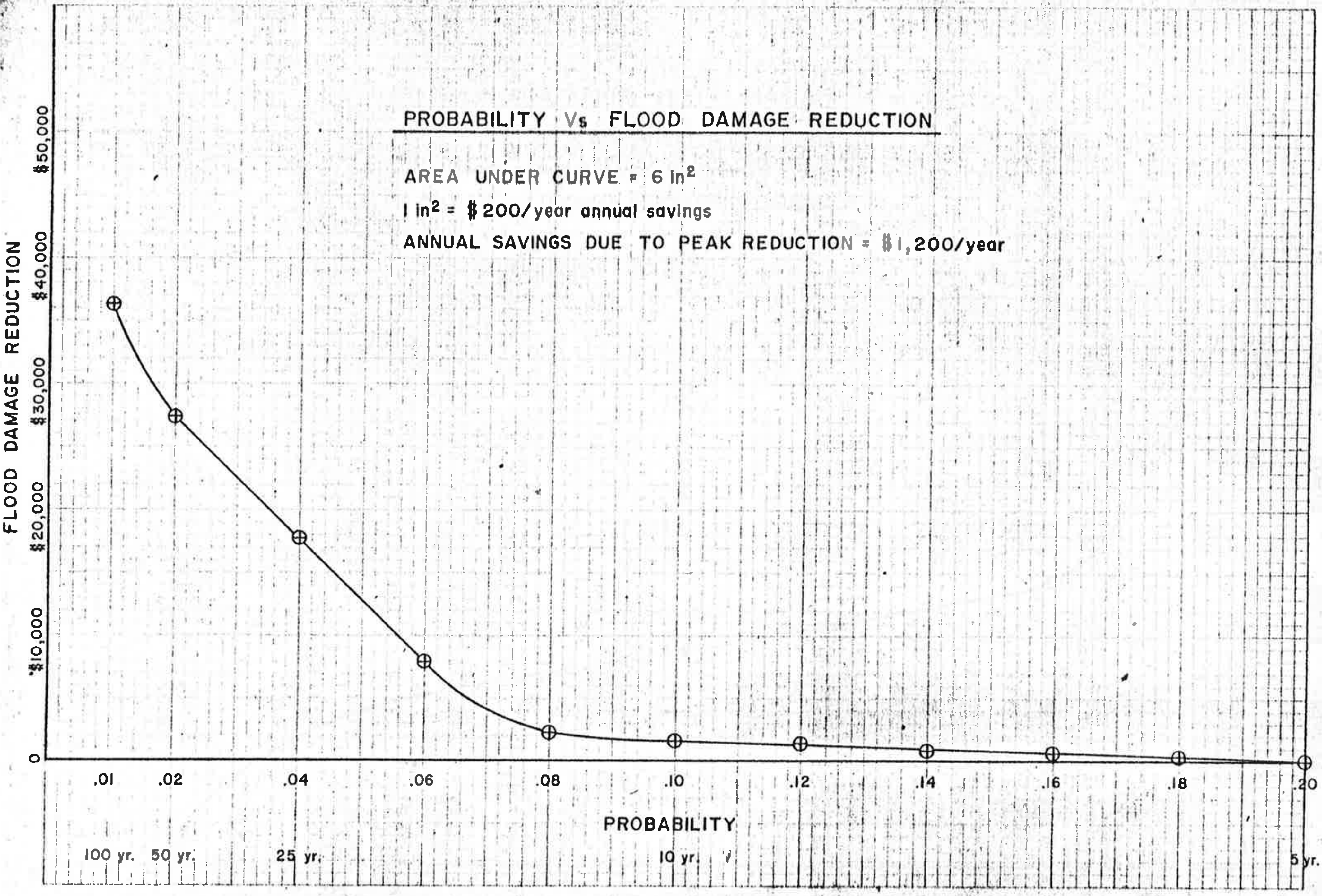

PROBABILITY Vs FLOOD DAMAGE REDUCTION
AREA UNDER CURVE = 6 in^2
1 in^2 = $200/year annual savings
ANNUAL SAVINGS DUE TO PEAK REDUCTION = $1,200/year
FLOOD DAMAGE REDUCTION
$50,000
$40,000
$30,000
$20,000
$10,000
0
.01
.02
.04
.06
.08
.10
.12
.14
.16
.18
.20
PROBABILITY
100 yr.
50 yr.
25 yr.
10 yr.
5 yr.

Figure 11

VIII. ENVIRONMENTAL ASSESSMENT

The following is an overview of the environmental impacts that could result from the construction of this project. This is not intended to be a comprehensive environmental assessment. It will identify potential problems that may exist which would be analyzed in detail in a more comprehensive assessment. Positive effects of the project will also be briefly mentioned.

CLIMATE, TOPOGRAPHY AND SOILS

Apple Creek watershed has a dry-subhumid, continental climate that is characterized by warm summers and long cold winters. There are frequent fronts that pass through the area. These can cause large and rapid temperature fluctuations that may last a few days to a week or two. A normal midwinter day can see a temperature range of 18^{o}F. This difference between the high and low temperatures can be as great as 29^{o}F on a normal fall day. The maximum temperature recorded in the area was 114^{o}F at Bismarck. A minimum temperature of -45^{o}F was also recorded there. The average annual temperature is 42^{o}F. There are about 130 frost free days during the year. Average rainfall for the watershed is 16 inches. Three quarters of this, 12 inches, falls during the growing season.

The watershed lies within the mid-grass prairie. It's physiography consists of glacial landforms, steep residual plains of several geologic formations, loess deposits, windblown sands, and glaciofluvial deposits. Most of the land is level to gently rolling. Typical slopes are less than six percent except for occasional knobs. Main drainages are also well defined, having steeper valley walls with slopes greater than six percent.

Every year, depending on the amount of runoff, an area behind the dam will be flooded. Because the structure is designed to be a dry dam, all of the water will be allowed to slowly drain away through a small diameter pipe. During the 100 year flood the pool will reach an elevation of 1912.5 msl. This will inundate about 130 acres. Most of the land to be flooded is pastureland. A few acres of cropland are in the 100 year flood pool.

Because the flood pool area will be flooded to some extent in most years, the land would not be suitable for growing crops. Any grasses not able to survive periods of inundation would be destroyed. That means most of the native grasses would have to be replaced with varieties able to withstand flooding. It is proposed to reseed the flood pool with reed canary grass which is such a variety. This grass could be used as a hay crop. The irrigation effect of the annual flooding would increase yield by between two and two and one half times. Using the flood pool area to grow hay crops would mean little change in the land use of the site. The few acres of affected cropland would be replaced with reed canary grass.

WILDLIFE AND HABITAT

No actual survey of the watershed was made to identify the plants and animals that exist. According to literature on the area, some of the more common game birds found in the watershed are ring-necked pheasant, sharptail grouse, gray (Hungarian) partridge and duck. White tail deer, long tail weasel, mink, striped skunk, badger, raccoon, red fox, muskrat, beaver, white tailed jackrabbit and cottontail rabbit are some common mammals found throughout the area. The flooding of the

Wetlands exist within the watershed, but none are near the dam site. No wetlands would be affected by the project. No permanent wetland will be created by the project. Being a dry dam, there will be no permanent reservoir to sustain fish life. The temporary pool may be used by migrating ducks depending on when the runoff occurs.

PROJECT IMPACTS

The impacts to plants and animals by the project have already been discussed. Except for the probable loss of the native grasses in the flood pool, most effects will be temporary. After the pool drains, the cover of reed canary grass should come back and abound. Any displaced animals will be able to return and take advantage of the improved cover.

Construction of the dry dam will affect the aesthetics of the site. During construction, areas will be stripped bare of vegetation. The operation of heavy earthmoving equipment will cause an increase in air borne dust and noise. This situation, however, will be temporary and will cease after construction. Presently the site is a small valley. After construction an embankment will span the valley. When the seeded grasses take hold, the dam should blend into the existing topography to some extent. There will be no permanent pool, so the embankment will appear as a large roadway fill. This may be objectionable to some people, since the absence of a reservoir may seem strange.

The downstream channel will be affected mostly by the reduction in flow peaks. These will be greatest immediately below the dam and become less pronounced the farther downstream one goes. This should lessen the amount of channel erosion and lessen the amount of flooding on adjacent

IX. SUMMARY AND CONCLUSIONS

SUMMARY

Since the flood of 1979, there has been a renewed concern about flooding along Apple Creek. Development along the lower reaches of Apple Creek has resulted in areas which are especially vulnerable to flooding. Realizing this, the Burleigh County Water Management Board is planning a series of water control structures to help reduce downstream flooding. These would be located in the upper reaches of Apple Creek. One of these structures is the proposed Neideffer Dam. It would be a dry dam located in Section 4, Township 141 North, Range 76 West.

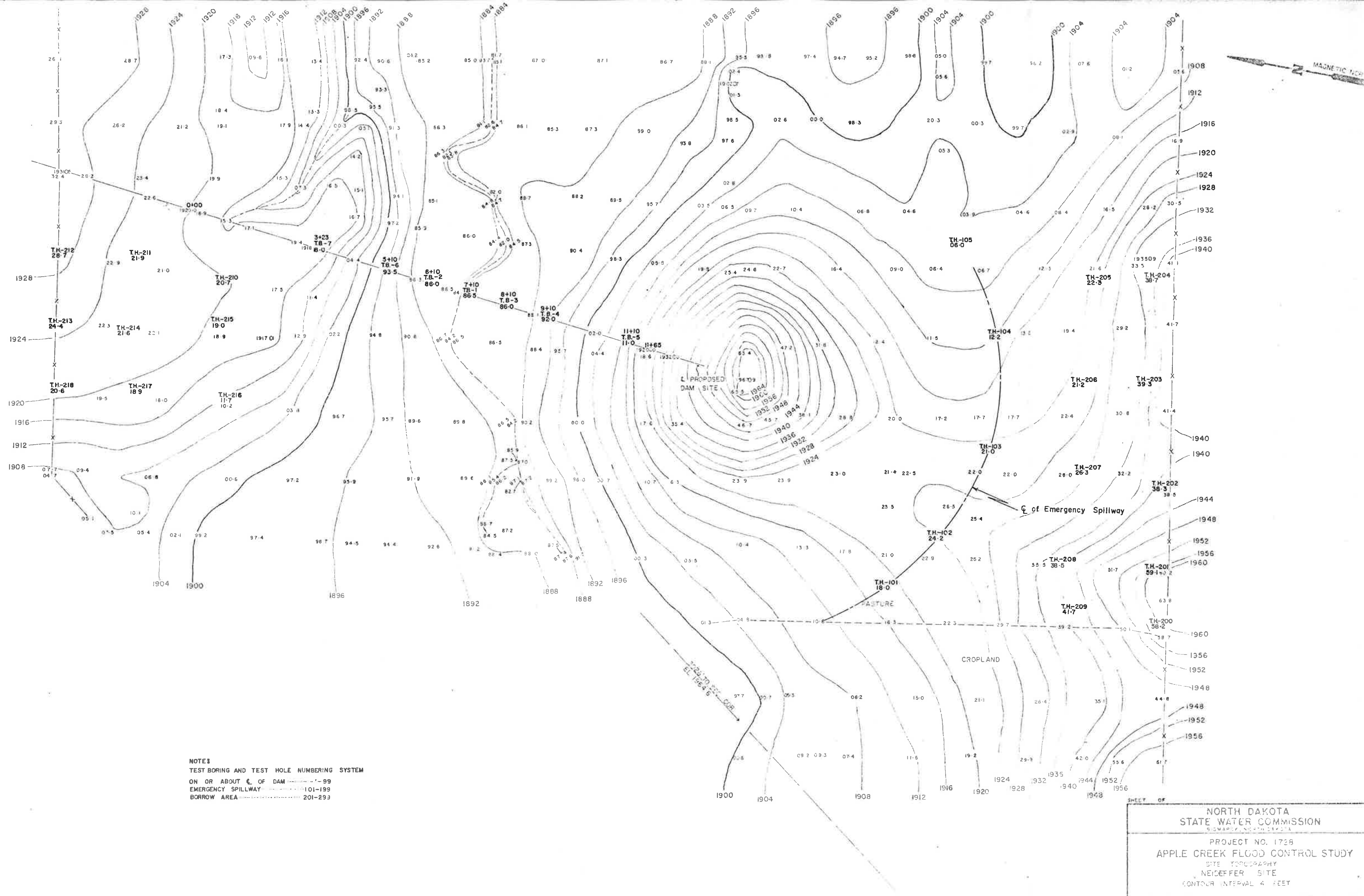
Neideffer Dam would be an earthfilled embankment having a height of 33 feet above the stream bottom. The upstream face will have a slope of 3H:1V while the downstream face will have a slope of 2.5H:1V. Approximately 75,000 cubic yards of material would be incorporated into the structure. Hydraulic features include both a principal and an emergency spillway. The principal spillway will be a 24 inch diameter corrugated metal pipe through the bottom of the embankment. On the upstream end, a ten foot high riser is proposed. The riser will have a divider with a 12 inch diameter oriface near the bottom to retain lower flows. The emergency spillway will be a 200 foot wide channel with 3H:1V side slopes. It will be located in a natural saddle just south of the dam as shown on Plate 1. The upstream face of the embankment will be seeded with a flood resistant grass like reed canary grass to control erosion.

The soils survey showed suitable material in the emergency spillway and surrounding areas to construct the dam. A core trench will extend down to suitable foundation material. Sandy and gravely soil was found on the left, or north, abutment. This presents a potential seepage problem. To increase the seepage path length, the alignment of the

CONCLUSIONS

Generally it is desirable for a project's benefits to be equal to or greater than its costs. This is not the case with Neideffer Dam. The benefits appear to be equal to only about one third of the project's costs. This project is planned to be a part of a series of like water control structures to be located throughout the Apple Creek Watershed. Completion of this entire planned project would further reduce flood levels downstream, however, costs would also increase. Each additional dam would have a somewhat reduced affect on downstream flood levels. This is due to the fact that upstream dams affect downstream flows by only a small percentage. Additional dams upstream will reduce flows but they will mix with other flows downstream, controlled and uncontrolled, which will tend to reduce the effect of the reduced upstream flows. Even controlled flows, when added together as they flow downstream, will cause flooding during high runoff. These flows would be less than if they were totally uncontrolled, however, it is doubtful that benefits would exceed costs. Therefore, the benefit-cost ratio will probably not increase much if at all by adding more structures. Based on the traditional method determining a project's feasibility, the Neideffer Dam project is not feasible.

Some people feel that a benefit-cost ratio study is not a fair way to analyze a project's feasibility, especially in rural areas. There are always benefits that may not be foreseen for one reason or another. This may be true here if development continues along Apple Creek. Flood flow reduction upstream may enable downstream flows to be controlled easier by dikes or some other method. However, it would be better to prevent flood damages by controlling the development along Apple Creek.



NOTE:
TEST BORING AND TEST HOLE NUMBERING SYSTEM
ON OR ABOUT ℄ OF DAM .... '-99
EMERGENCY SPILLWAY 101-199
BORROW AREA 201-293

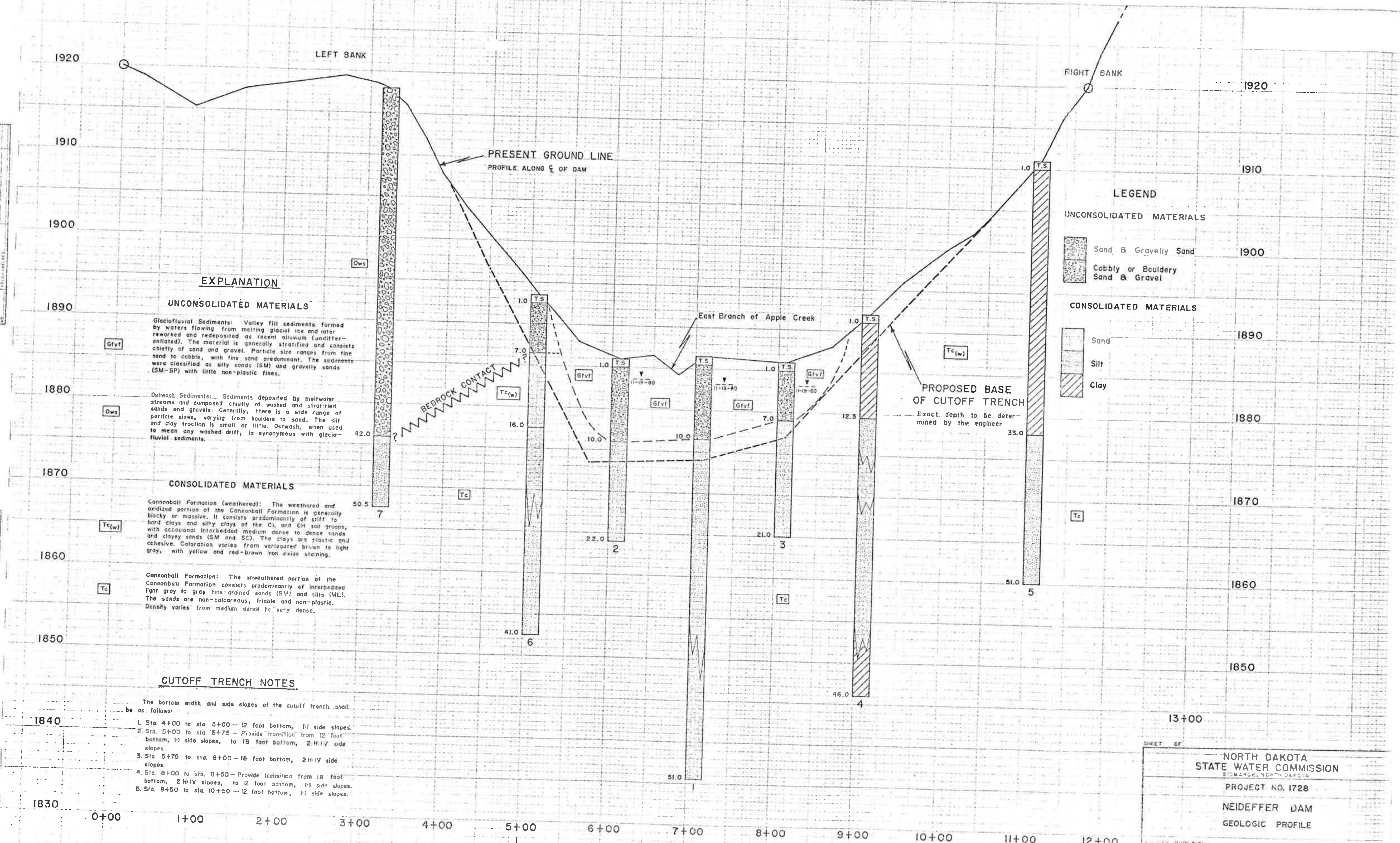
SHEET OF

NORTH DAKOTA
STATE WATER COMMISSION
BISMARCK, NORTH DAKOTA

PROJECT NO. 1728
APPLE CREEK FLOOD CONTROL STUDY
SITE TOPOGRAPHY
NEIDEFFER SITE
CONTOUR INTERVAL 4 FEET

COUNTY BURLEIGH DATE 6 NOV. 50

Plate 1



LEGEND

UNCONSOLIDATED MATERIALS

- Sand & Gravelly Sand
- Cobbly or Bouldery Sand & Gravel

CONSOLIDATED MATERIALS

- Sand
- Silt
- Clay

EXPLANATION

UNCONSOLIDATED MATERIALS

Gfvf — Glaciofluvial Sediments: Valley fill sediments formed by waters flowing from melting glacial ice and later reworked and redeposited as recent alluvium (undifferentiated). The material is generally stratified and consists chiefly of sand and gravel. Particle size ranges from fine sand to cobble, with fine sand predominant. The sediments were classified as silty sands (SM) and gravelly sands (SM-SP) with little non-plastic fines.

Ows — Outwash Sediments: Sediments deposited by meltwater streams and composed chiefly of washed and stratified sands and gravels. Generally, there is a wide range of particle sizes, varying from boulders to sand. The silt and clay fraction is small or little. Outwash, when used to mean any washed drift, is synonymous with glaciofluvial sediments.

CONSOLIDATED MATERIALS

Tc(w) — Cannonball Formation (weathered): The weathered and oxidized portion of the Cannonball Formation is generally blocky or massive. It consists predominantly of stiff to hard clays and silty clays of the CL and CH soil groups, with occasional interbedded medium dense to dense sands and clayey sands (SM and SC). The clays are plastic and cohesive. Coloration varies from variegated brown to light gray, with yellow and red-brown iron oxide staining.

Tc — Cannonball Formation: The unweathered portion of the Cannonball Formation consists predominantly of interbedded light gray to gray fine-grained sands (SM) and silts (ML). The sands are non-calcareous, friable and non-plastic. Density varies from medium dense to very dense.

CUTOFF TRENCH NOTES

The bottom width and side slopes of the cutoff trench shall be as follows:

1. Sta. 4+00 to sta. 5+00 – 12 foot bottom, 1:1 side slopes.
2. Sta. 5+00 to sta. 5+75 – Provide transition from 12 foot bottom, 1:1 side slopes, to 18 foot bottom, 2H:1V side slopes.
3. Sta 5+75 to sta. 8+00 – 18 foot bottom, 2H:1V side slopes.
4. Sta. 8+00 to sta. 8+50 – Provide transition from 18 foot bottom, 2H:1V slopes, to 12 foot bottom, 1:1 side slopes.
5. Sta. 8+50 to sta. 10+50 – 12 foot bottom, 1:1 side slopes.

SHEET OF

NORTH DAKOTA
STATE WATER COMMISSION
BISMARCK, NORTH DAKOTA

PROJECT NO. 1728

NEIDEFFER DAM

GEOLOGIC PROFILE

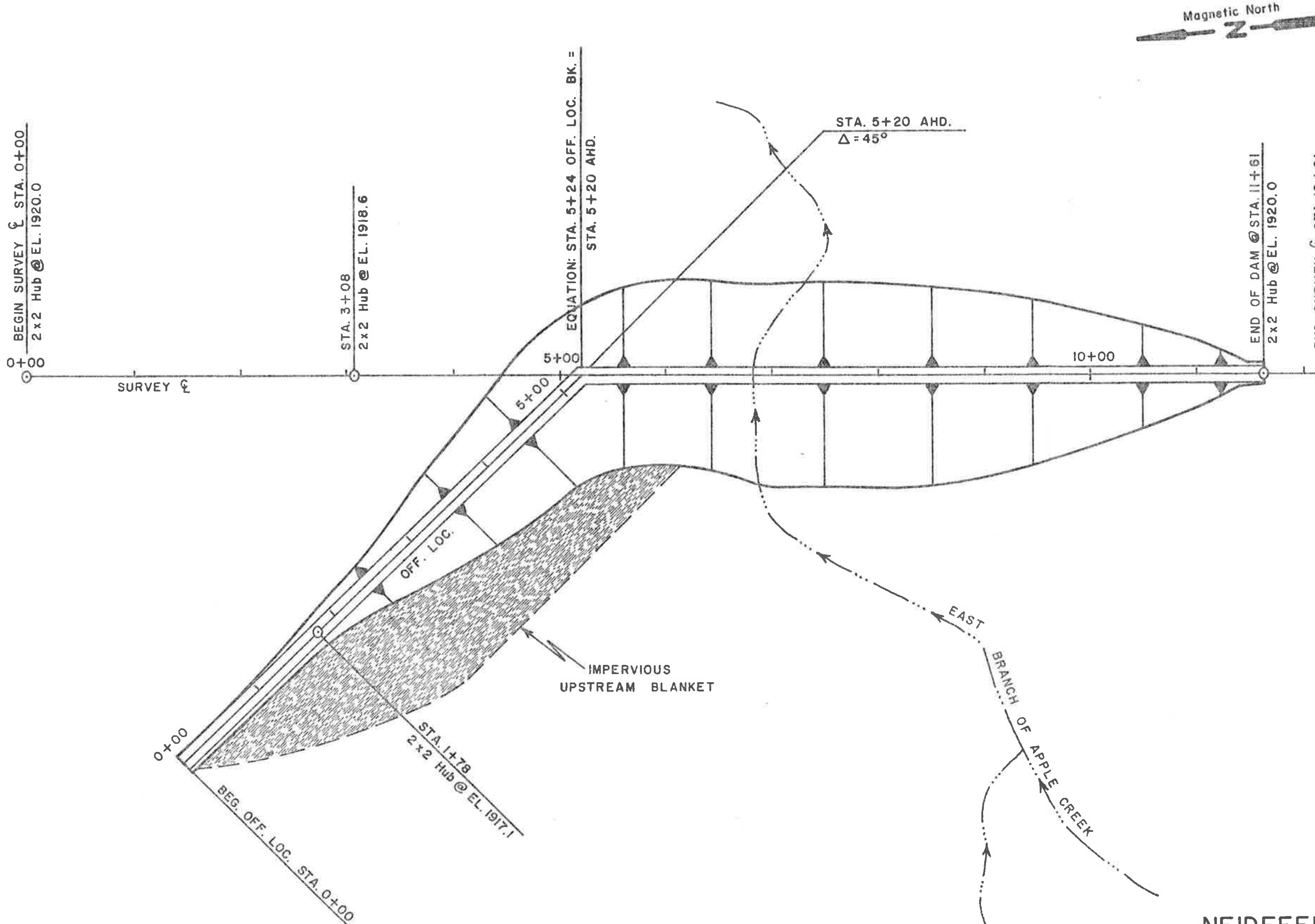
COUNTY BURLEIGH — DATE 1-30-81

DRILLED BY: SOIL EXPLORATION CO.
INVESTIGATED & DESIGNED BY: A.C.G.
DRAWN: A.C.G. & D.S.S.
CHECKED BY: A.C.G.
SUBMITTED:
APPROVED:

DRAWING NO.

SCALE 1"=5' Vert. 1"=50' Horiz.

Plate 2



NEIDEFFER DAM

EMBANKMENT ALIGNMENT

Sec. 4, T. 141 N., R. 76 W.

PLATE 3

APPENDIX A

Preliminary Investigation Agreement

~~NSAT~~, KAY & File

SWC Project #~~331~~ #1728
June 24, 1980

A G R E E M E N T

I. PARTIES

THIS AGREEMENT is between the North Dakota State Water Commission, hereinafter referred to as the Commission, acting through the State Engineer, Vernon Fahy, and the Board of Commissioners of the Burleigh County Water Management District, acting through its Chairman, G. A. Neideffer, hereinafter referred to as the Board.

II. PROJECT, LOCATION AND PURPOSE

The Board has requested the Commission to investigate and determine the feasibility of constructing a water control structure, or structures, on the upper reaches of the east branch of Apple Creek for the purpose of storing flood waters for release at a later time. Two sites have been proposed by the Board. One site is located in Section 4, Township 141 North, Range 76 West, and the second site in Section 22, Township 142 North, Range 77 West.

The initial water control structure is proposed to be part of a series that are being planned for the Apple Creek Basin by the Board. This investigation will involve the initial water control structure only.

The proposed investigation will study the hydrology of the basin and the potential flood reduction that could be realized by installation of water control structures in several locations. From this study, the site along the east branch of Apple Creek having the best potential for flood control will be chosen. The remainder of the investigation will concern this particular site only.

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. Acquiring the field data necessary for the investigation.

2. A hydrologic analysis of the watershed.

3. A study of the flood reduction potential for various water control sites including the two proposed.

4. A preliminary design of the hydraulic and structural features of the site having the best flood control potential.

5. Preliminary foundation and materials investigations on the selected site.

6. A detailed cost estimate of the selected site.

7. A detailed preliminary engineering report.

IV. DEPOSIT - REFUND

The Board shall deposit a total of $3,000 with the Commission to partially pay the costs of the investigation. Upon completion of the preliminary investigation, upon receipt of a request from the Board to terminate proceeding further with the preliminary 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 for field investigations by the Commission which are required for the preliminary investigation.

VI. 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.

VII. EXECUTION OF AGREEMENT

This agreement becomes effective upon execution by the parties thereto and the deposit of $3,000 by the Board with the Commission.

If the Board does not execute this agreement within sixty (60) days of execution by the State Engineer, this agreement will become invalid.

G. A. NEIDEFFER Chairman	VERNON FAHY State Engineer
DATE:	DATE:
7-1-80	6-27-80
WITNESS:	WITNESS:

Dist.
Board
SWC Accountant
SWC Project #331
Investigations Engineer

SWC Project #1728
November 13, 1980

ADDENDUM TO AGREEMENT

Investigation for Determining the
Feasibility of Constructing Water Control Structures
on Apple Creek

I. PURPOSE

The purpose of the Addendum to the previously executed agreement is to expand the preliminary investigation to include a second site, and to increase the investigation deposit required from the Board due to the expanded investigation.

II. EXPANSION OF PRELIMINARY INVESTIGATION

The Commission shall conduct a preliminary investigation for one site as required by the previously executed agreement. In addition, the Commission shall conduct additional investigation on a second site consisting of the following:

1. A dam site topographical survey for a second site.
2. Preliminary foundation and materials investigations at the second site.

III. DEPOSIT INCREASE

The investigation deposit required from the Board shall increase to $7,000. The Board shall deposit an additional $4,000 with the Commission to pay the costs of the additional field activities to be done on the second site.

IV. EXECUTION OF ADDENDUM

This addendum becomes effective upon execution by the parties thereto and the deposit of $4,000 by the Board with the Commission. If the Board does not execute this addendum within thirty (30) days of execution by the State Engineer, this addendum will become invalid.

V. CHANGE TO AGREEMENT

The initial agreement was signed by Vernon Fahy for the North Dakota State Water Commission and G. A. Neideffer, Chairman for the Burleigh County Water Management Board. The undersigned authorities hereby agree to this aforementioned addendum to the previously assigned agreement.

G.A. Neideffer
Chairman

Vernon Fahy
State Engineer

November 15, 1980
Date

November 13, 1980
Date

Witness

Witness

Distribution
Board
SWC Accountant
SWC Project #1728
SWC Director of Engineering
ck #1289 - $4,000.00 - 11/15/80

APPENDIX B

Soil Conservation Service 1979 Flood Damage Survey
Economic Benefits Calculations

ECONOMIC ANALYSIS OF APPLE CREEK FLOOD PLAIN
1979 EVENT

Floodwaters affected 15 homes to varying degrees. Two homes had water on the first floor, another six had basement and/or foundation problems. All residents had some silting, debris cleanup, and flood fighting expenses. Residental damages were estimated at $31,100.

Lincoln School, a new structure located near Apple Creek, did not actually incur floodwater damage; however, the building was surrounded by floodwater for several days. Flood fighting and inconvenience was estimated at $1,500.

Apple Creek Golf Course has some damage most every year, especially on the back nine located adjacent to the creek; the same situation prevailed this year. Damage to the golf course from this event appeared to be silt deposit on fairways, removal of sand from bunkers and delay in opening of the course. The damages are conservatively placed at $20,000.

A tree nursery located next to Apple Creek suffered loss of tree stock estimated at $10,000.

Approximately 1,800 acres of cropland were inundated which results in delayed seeding and increased weed problems which in turn affects yield and quality. These damages were estimated at $27,000.

Grassland acreage affected by floodwater was extensive; however, it was felt that the irrigated effect more than offset the cost of fence repair and debris cleanup.

Information on road and bridge damages incurred as a result of the 1979 flood event were furnished by FHWA and were as follows:

Apple Creek Area	$258,598
McKenzie Area	96,424
Total	$355,022

Recap of total damages:

Road & Bridge	$355,000	or ($258,600, does not include McKenzie area)
Residental	31,100	
School	1,500	
Golf Course	20,000	
Agricultural	27,000	
Nursery	10,000	
	$444,600	or ($348,200)

The 1979 event was estimated to be a 30-year frequency event. The total damages ($444,600) divided by the 30-year frequency event equals $14,820 ($11,606) average annual damages.

My thanks to Gary Gross, District Conservationist, who assisted me in gathering the data presented.

Respectfully Submitted

Bruce O. Clark
Agricultural Economist

PAUL D. URBAN	APPLE CREEK FLOODING	#1728
MARCH 10, 1981	NIEDEFFER DAM	ECONOMIC STUDY

INFLATION INDEX

Yr.	Inflation	Yr.	Inflation
69	5%	75	10%
70	5%	76	8%
71	5%	77	7%
72	5%	78	9%
73	5%	79	12%
74	7%	80	12%

Assume damages paid at mid year so use half the inflation rate for the year you want to bring up to 1981 $.

1969 = 2.32
1970 = 2.21
1975 = 1.66
1979 = 1.25

1979 DAMAGES ADJUSTED TO 1981 DOLLARS:

ITEM	1979		1981
Road & Bridge	$258,600	x 1.25 =	$324,400
Residential	31,100	x 1.25 =	39,000
School	1,500	x 1.25 =	1,900
Golf Course	20,000	x 1.25 =	25,100
Agricultural	27,000	x 1.25 =	33,800
Nursery	10,000	x 1.25 =	12,500
	$348,200		$436,700

DRAINAGE AREAS:

West Branch Apple Creek	=	122 sq. miles	34%
East Branch Apple Creek	=	145 sq. miles	40%
Lower Reach Apple Creek	=	95 sq. miles	26%
		362 sq. miles	100%

ASSUMPTIONS ON DAMAGE DISTRIBUTION:

1. Assume road & bridge damage split by percent of drainage area. D.E.S. lists $21,659 damages in Burleigh Co. in 1969 with 15 year event. This seems to be about right. Assume these damages, 75% of them, happended along Apple Creek.
   1969 was 15 year event 1969 damages = $16,300
   Converted to 1981 dollars, damages = $38,000
2. Residential damage assumed to be only on lower reach. Assume no damage on less than 10 year event.
3. Assume school damage only on lower reach. Assume $15,000 damage during a 100 year flood. None on less than 30 year event.
4. Golf course damage on lower reach. No damage on less than 5 year event.
5. Split agricultural damage according to drainage area. No damage on less than 5 year event.
6. Assume nursery damage on lower reach and no damage on less than 15 year event.

PAUL D. URBAN
MARCH 10, 1981

APPLE CREEK STUDY
NEIDEFFER DAM

ECONOMIC STUDY

TABULATION OF DAMAGES DUE TO FLOODING AND THEIR REDUCTION

ROADWAY AND BRIDGE DAMAGE:

Probability	Damage		Reduction Factor	Savings
0.01	$480,000	x	0.056	$26,880
0.02	400,000	x	0.056	22,400
0.04	250,000	x	0.056	14,000
0.06	90,000	x	0.056	5,040
0.08	0	x	0.056	0

RESIDENTIAL DAMAGE:

Probability	Damage		Reduction Factor	Savings
0.01	$50,000	x	0.031	$1,550
0.02	42,000	x	0.031	1,302
0.04	32,000	x	0.031	992
0.06	21,000	x	0.031	651
0.08	11,000	x	0.031	341
0.10	0	x	0.031	0

NURSERY DAMAGE:

Probability	Damage		Reduction Factor	Savings
0.01	$20,000	x	0.031	$ 620
0.02	15,000	x	0.031	465
0.04	9,000	x	0.031	279
0.06	2,000	x	0.031	62
0.07	0	x	0.031	0

LINCOLN SCHOOL DAMAGES:

Probability	Damage		Reduction Factor	Savings
0.01	$15,000	x	0.031	$ 465
0.02	8,000	x	0.031	248
0.03	1,900	x	0.031	59

PAUL D. URBAN
MARCH 11, 1981

APPLE CREEK STUDY
NEIDEFFER DAM

ECONOMIC STUDY

PROBABILITY OF LAND BEHIND THE DAM BEING FLOODED:

During the 100 year flood, the pool reaches elev. 1912.5
Acres flooded = 130 Acres
During the 35 year flood, the pool reaches elev. 1908.6
Acres flooded = 95 Acres
During the 10 year flood, the pool reaches elev. 1904.5
Acres flooded = 63 Acres
During the 5 year flood, the pool reaches elev. 1900.2
Acres Flooding = 40 acres
During the 2 year flood, the pool reaches elev. 1898
Acres flooded = 30 acres

IRRIGATION BENEFITS ASSUMPTIONS:

1. Assume the pool area will be seeded to reed - canary grass and used for hay.
2. Assume the flood irrigation will only benefit the first hay cutting. Any second cutting will depend on rainfall.
3. Assume dryland yield at 1 1/2 ton/acre
4. Assume flood-irrigated land yield at 4 tons/acre.
5. Assume the value of the hay at $45/ton.
6. Assume no benefits for the 1.1 year event (p=0.90)

IRRIGATION BENEFITS:

Probability	Acres Flooded	Dryland Hay Value	Irrigated Hay Value	Benefit
0.01	130 Acres	$8,775	$23,400	$14,625
0.03	95 Acres	6,413	17,100	10,687
0.10	64 Acres	4,320	11,520	7,200
0.20	40 Acres	2,700	7,200	4,500
0.50	30 Acres	2,025	5,400	3,375

BENEFIT COST RATIO:

The $170,000 construction cost at 8% for 50 years yields an annual cost of $13,900.

Annual Benefits -- Flood Reduction = 1,200/year
Flood Irrigation = 3,640/year
TOTAL 4,840/year