1985 REVALUATION

OF

CAMEL HUMP BUTTE DAM

SWC PROJECT NO. 1382

GOLDEN VALLEY COUNTY

Geotechnical Review & Report Preparation By

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INTRODUCTION

SECTION I

Camel Hump Butte Dam is located in the SW¼ of the NW¼ of Section 16, Township 140 North, Range 104 West, in Golden Valley County, North Dakota. It is approximately 1½ miles northeast of the city of Sentinel Butte. It lies on an unnamed, intermittent tributary of Andrews Creek, which flows into the Little Missouri River Basin.

The dam was designed and engineered by the North Dakota State Highway Department. Completed in December of 1968, its purpose was to impound water for fish and wildlife habitat and to provide recreational facilities. The dam is an integral part of Interstate Highway No. 94 which crosses the valley at this point.

INTER-AGENCY ACTIVITIES

SECTION II

On May 3, 1971, the State Water Commission received its first letter from the Rojic Brothers complaining about seepage below the dam. They reported the area was becoming very boggy.

Upon receipt of the above letter, the State Water Commission informed the State Highway Department by phone about its intention of making an inspection of the downstream area of the dam. They agreed to provide a representative for the inspection.

On May 6, 1971, Arland Grunseth, State Water Commission and Erling Pederson, State Highway Department inspected referenced dam. They walked the entire downstream area including the dam and its abutments. The reconnaissance revealed several small water ponds west and southwest of the outlet structure. The area was relatively boggy, and reedy marsh plants were growing. A small channel dam was also observed further downstream. It was constructed by Joe Mayo and Sons Construction Company to impound water for use in construction of the highway. The dam was holding back water and had further created a stagnant pool below the outlet structure. This was causing backup water to partially cover the structure. A method of draining the pond to eliminate inundation of the spillway dissipator was rejected by the Rojic Brothers in 1969 (Reference Highway Department Memo dated May 28, 1969 by Erling Pederson). No actual seeps or flowing water was observed at the embankment toe or along the embankment slopes and groins. If the dam was seeping, the flow paths were not detected.

As a result of the aforementioned inspection and the insufficient information acquired, the State Water Commission and State Highway

Department agreed to cost-share in the installation of monitoring (observation) wells (See Investigations Section). The wells were installed in the summer of 1971 and monitored until the spring of 1973.

With the continued use of the downstream area by the Rojics for livestock feeding, four of the seven well pipes were broken off. The wells became plugged and ground-water levels were either inaccurate or unobtainable. Their continued use of the area, the destruction of the observation wells and a seeming lack of cooperation by the Rojics, led to the abandonment of the ground-water study.

Due to the abandonment of the monitoring program, the Commission on June 25, 1973 sent a letter to the State Highway Department. The letter briefly described the monitoring program and indicated no identifiable change in well levels except for seasonal fluctuations. The letter also mentioned the problem of evaluating seepage patterns or groundwater movement in an attempt to differentiate between the probable causes or to trace the problem to one cause alone. Due to the complexity of the problem and additional exploration programs being too costly, the Commission requested the State Highway Department's assistance in obtaining flowage easements from the Rojics.

Upon notice of the above, the State Highway Department contacted the Rojics on July 12, 1973, relative to obtaining flowage easements, relocation of their livestock feeding areas and the construction of a drainage system within and beyond the sheltered livestock feeding area immediately below the dam. The meeting of the two parties failed to achieve an agreement on any of the above solutions. On October 17, 1973, the Game and Fish Department was informed by the State Highway Department of this stalemate between the Rojics, their agency and the

Commission. Two solutions to the problem were suggested as follows:

1) Replacement costs of relocating a 1.3 acre sheltered feeding area together with 500 feet of access roadway estimated to cost $5,965.00.

2) Installing a drainage system at approximately $3,125.00.

It was also suggested that the Game and Fish Department coordinate with the Commission in any resolution of the problem that might be proper.

Relative to the seepage problem at the dam, the State Highway Department went on record in their letter of October 17, 1973; that upon reviewing the agreement for construction of the dam, they felt they did not have any responsibility in this problem.

Upon receiving another letter from the Rojics dated June 3, 1974, the Commission by letter of June 20, 1974, went on record in again suggesting two solutions to the problem. They were:

1) Install a drain trench consisting of 6-inch perforated PVC pipe and backfilled with drain material.

2) Replace a 1.3 acre sheltered feeding area and access roadway, plus a 36"x12' culvert.

Copies of the above letter were also sent to the Golden Valley Water Resource District, State Highway Department and Game and Fish Department.

As a result of a letter from the Rojics dated November 13, 1974, the Commission's response of November 18, 1974 was as follows:

> "The flowage easement or the two remedial solutions suggested in our letter of June 20, 1974, are final. To continue our on-site investigations and inspections would be an exercise of past efforts."

In ending, the Commission suggested that the Rojics contact their local county water board in an effort to coordinate any resolution of the problem that they find satisfactory.

The next letter of any significance was a letter to the Commission dated September 3, 1985, from C.B. Dahl, District Engineer, State Highway Department, Dickinson, North Dakota. Their office was again receiving complaints from Jack Rojic. Although the letter was discussed by Commission engineers, no formal action or reply was forwarded to the Rojics or the State Highway Department.

On August 7, 1985, a letter was received from the law firm of Freed, Dynes, Reichert and Buresh, representing Walt and Jack Rojic. In addition to the Commission, the letter was also addressed to the State Highway Department and the Game and Fish Department. The letter addressed the complaints of their clients and also mentioned corrective measures of the past. It was further mentioned that all three agencies should cooperate in their efforts to determine the cause for the dam's seepage problem and to seek an effective solution.

INVESTIGATIONS

SECTION III

Cooperative investigations by the State Water Commission and the State Highway Department of the project's downstream area occurred as early as the spring of 1969. A small channel dam located downstream from the roadway embankment revealed a potential problem to the dam. During periods of high runoff volumes into the reservoir, discharge flows beneath the main dam were restricted by this lowhead channel dam. Restriction caused backup waters in excess of three feet into the spillway dissipator and unto the embankment drainage system located at the downstream toe of the dam. In April of 1969, a topographic survey was made of the downstream area by the State Water Commission. After several months of correspondence between the Rojics and the State Highway Department relative to the drainage problem, differences of opinion and remedial measures could not be reconciled or agreed to. As a result of this, the State Highway Department recommended by office memo dated May 28, 1969, that nothing be done to change the downstream drainage area. A copy of the memorandum was sent to the State Water Commission and the Game and Fish Department.

As previously mentioned on May 3, 1971, the State Water Commission received its first letter from the Rojic Brothers complaining about downstream seepage. After conferring with the State Highway Department, the Commission agreed to investigate the potential problem downstream of the dam.

The soil and geologic exploration program was developed by the State Water Commission. Drilling of the test holes and installation of the observation wells were performed by Soil Exploration Company of St.

Paul, Minnesota and the State Water Commission. The topography of the downstream area and locations of the wells were surveyed by the State Water Commission. A ground-water geologist and engineering geologist supervised and inspected the field operations. Both were employed by the State Water Commission.

The preliminary subsurface exploration began on June 2, 1971, and was completed on June 4, 1971. The exploratory program was made to determine characteristics of the subsurface materials, ground-water conditions and their geologic relationship to the dam.

A total of seven test holes were drilled, ranging in depth from ten (10) to seventy (70) feet. They were later cased with 1¼-inch plastic pipe with "v" slot screens.

The observation wells were monitored until the spring of 1973. Ground-water levels fluctuated from season to season and from one year to the next. Except for seasonal fluctuations in surface elevations, the data obtained was not thorough enough to provide accurate correlation of geologic conditions underlying the dam and to supply the desired information on ground-water conditions downstream of the dam. Although a high water table probably existed prior to construction of the dam and still exists, the rate and direction of ground-water movement was not definitely ascertained. However, the presence of fine, non-plastic sands and silts with interbedded lignite beds underlying the dam's foundation, leads to the assumption that seepage was possible through one or more of these lithologies. (See Attachment "A", "Evaluation of Camel's Hump Dam Area", by Alan Wanek, Hydrologist.)

Although the groundwater data was somewhat insufficient in detail, we intended to continue to monitor the area. Each ground-water situation

will have some identifiable characteristics which will help to determine the best procedures to use. In this case, we believed our observation wells, in time, might provide us with these characteristics. We then hoped to select more applicable procedures for detailed investigations. However, as previously mentioned, the Rojics continued to pasture the area and by mid-summer of 1973, four of seven observation standpipes had been broken off. The wells became plugged and ground-water levels were either inaccurate or unobtainable. Their continued use of the area and the destruction of the observation wells, led to the abandonment of the monitoring program and any immediate or future geological or ground-water studies.

On July 9, 1985, representatives from the State Water Commission and State Highway Department inspected the project. The inspection revealed no major changes from previous inspections. Photos of the upstream and downstream areas were taken, along with water levels.

In view of the aforementioned, we and others offer the following comments and suggestions regarding the hydrogeologic data needed to help solve the problem at Camel Hump Butte Dam:

Due to the construction of the original monitoring wells some of the data is of questionable value. In order to attempt to determine whether seepage exists through the dam, it is important that piezometers be constructed for the collection of additional data. Piezometers should be placed in air drilled holes that are only slightly deeper than the zone to be monitored and pressure grouted from just above the screened interval to the surface. This type of construction will eliminate any hydrologic interference from aquifers with different hydrostatic head than the one being monitored. We think that existing wells #3 and 6 are

probably valid in that they are screened in the shallowest zone and were not drilled much deeper than the screened interval.

This array of piezometers would produce vertical and horizontal water level data of the area in question. Staff gauges to determine the water level elevation of the reservoir and water standing downstream of the dam would complete the picture. If the reservoir level doesn't tie in fairly well, another pair of piezometers may be required on the upstream side of I-94.

A monitoring program should then be established with monthly measurements through the winter and weekly, or every other day measurements when and if there is any increase in the stage of the reservoir.

The construction of a dozen piezometers in about 500 feet of hole could run upwards of $7,000.

In addition to the monitoring program, a drainage system should be considered for the area downstream of the dam embankment. The plan for this system is shown as Attachment "B". The proposed drainage system would intercept and collect the excess ground-water and conduct it to a low point downstream of the existing stock watering dam. This would help to alleviate the wet problem downstream of the dam. The cost estimate to do this is $10,000.

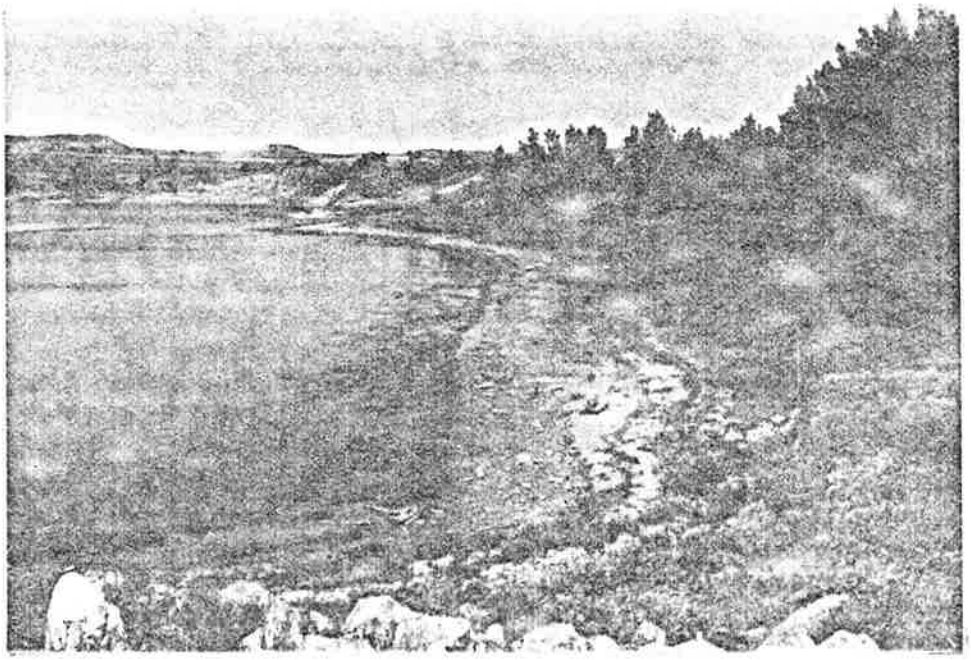


Photo #1
Looking Upstream
Along Eastside
of Reservoir
July 9, 1985

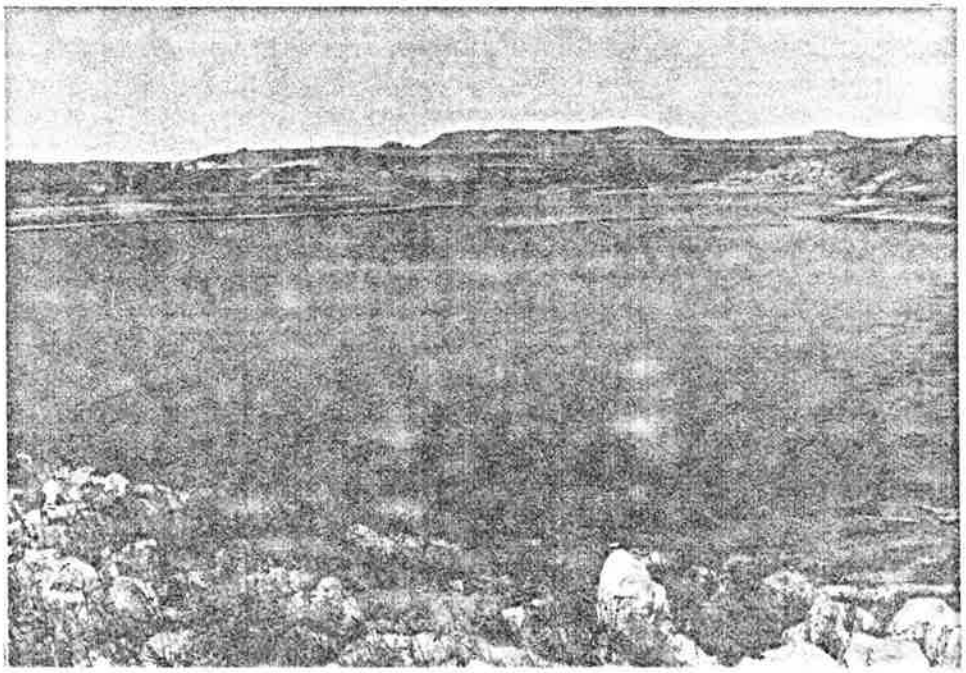


Photo #2
Looking Upstream
of Embankment
July 9, 1985

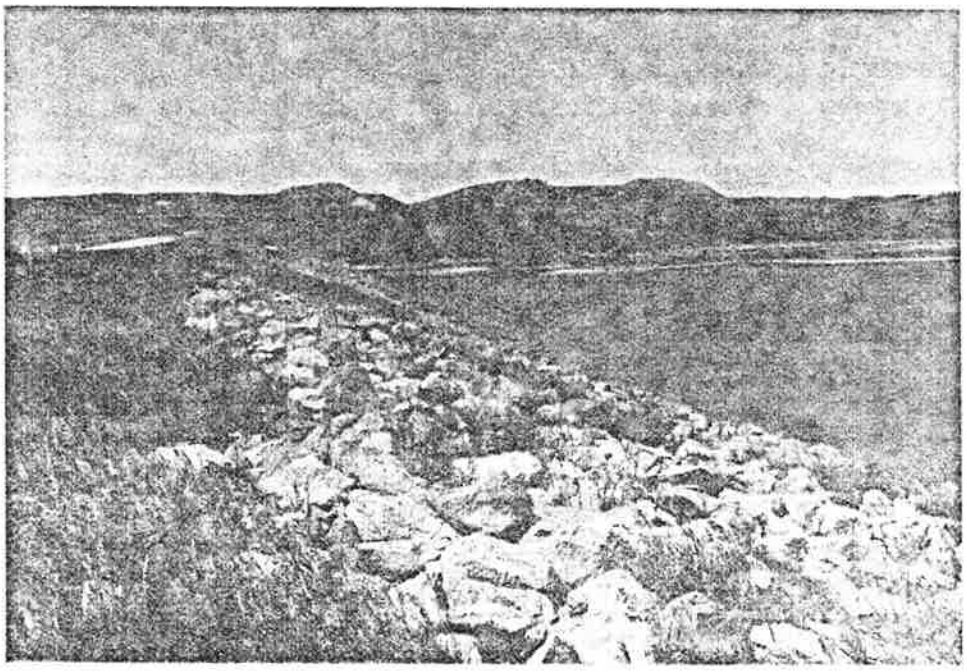


Photo #3
Looking West
Along Upstream
Slope of Dam
July 9, 1985

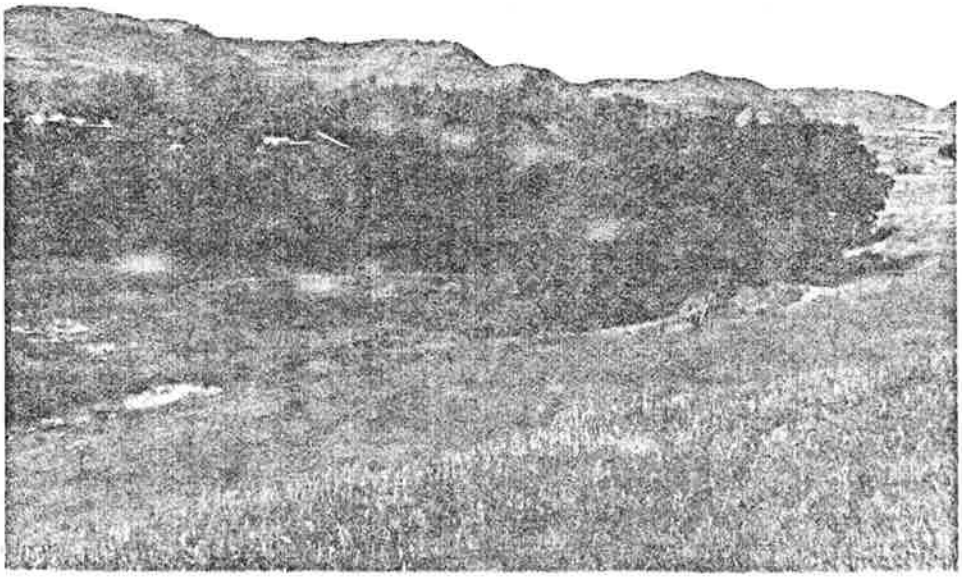


Photo #4
View of Downstream
Area Looking
Southwest
July 9, 1985

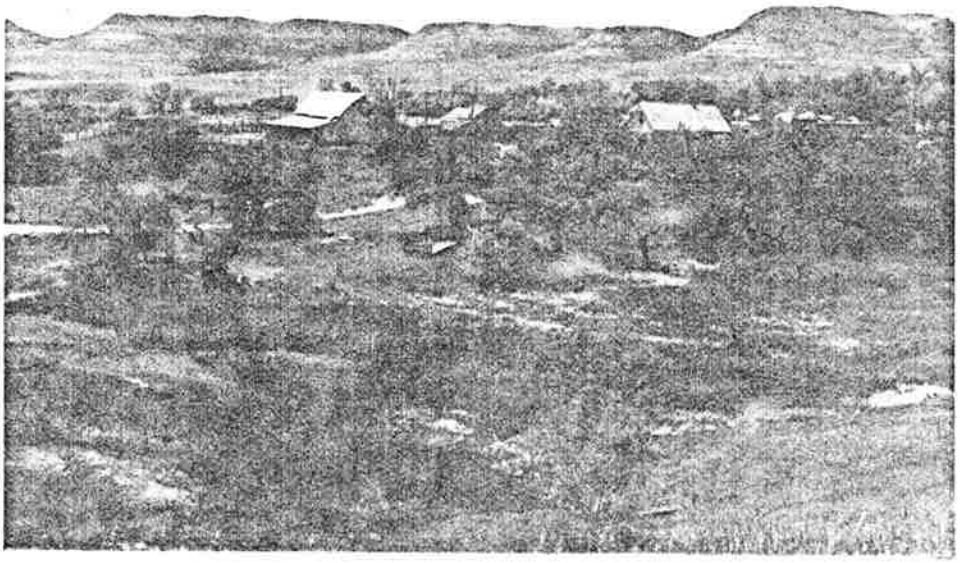


Photo #5
View of Downstream
Area Looking
South
July 9, 1985

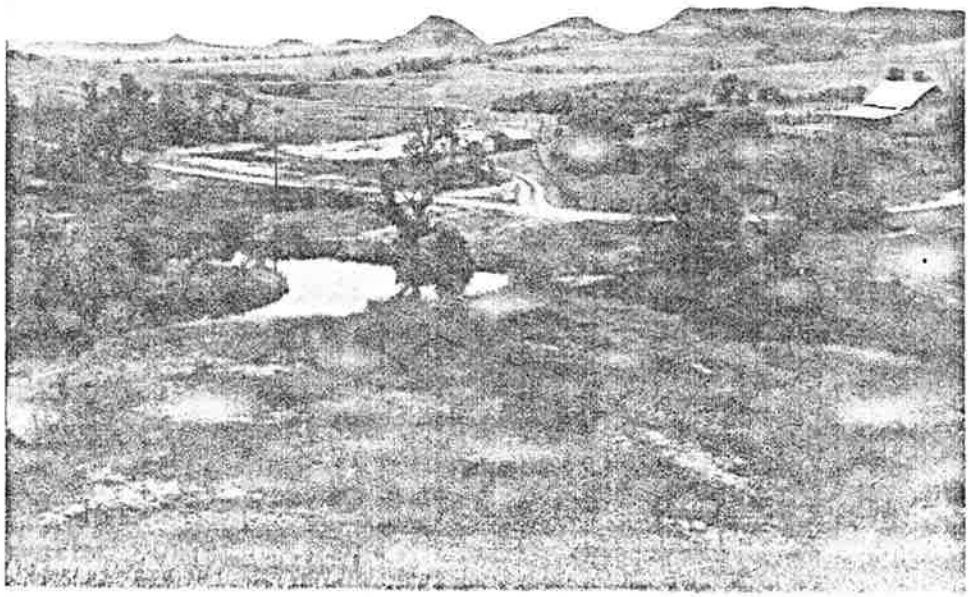


Photo #6
View of Downstream
Area Looking
South-Southeast
July 9, 1985

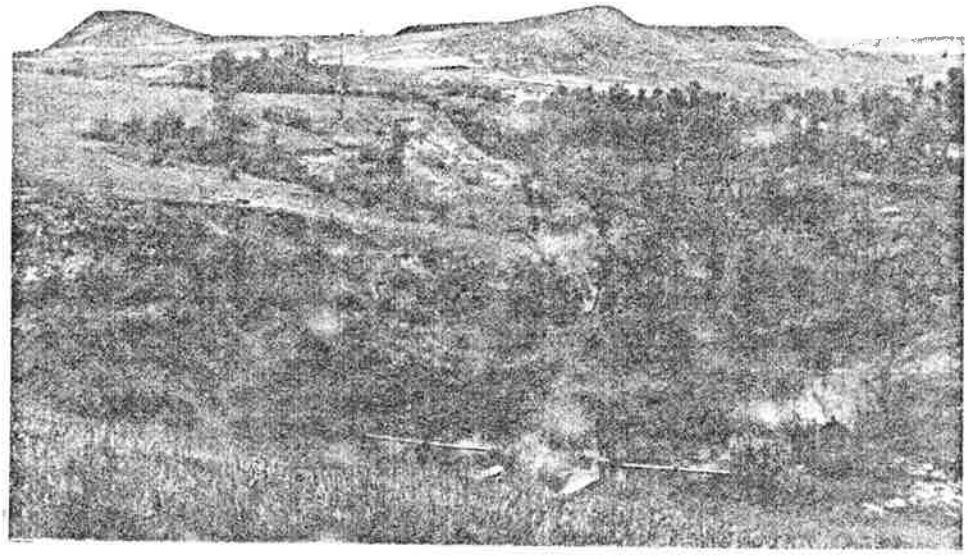


Photo #7
View of Downstream
Area Below
Outlet Structure
July 9, 1985

Photo #8
View of Channel
Below Outlet
Structure
July 9, 1985

NORTH DAKOTA STATE WATER COMMISSION
OFFICE MEMO

TO: File #1382
FROM: Alan Wanek, Hydrologist
SUBJECT: Evaluation of Camels Hump Dam Area
DATE: September 25, 1985

I have evaluated the data available at the Water Commission for the possible influence of the dam and reservoir on high water levels immediately downgradient of the Camels Hump Dam.

The downgradient valley area consists of the creek channel and an adjacent meander scar to the west. The meander scar represents a former channel of the creek. Water stands in a bend in the channel 200 feet downgradient from the dam dissipator structure. At the time of a photograph taken in July of 1985 water was backed up in the channel to the dissipator structure. The meander scar and the low lying ground within the arc of the meander scar has a land surface level six to seven feet higher than the water level in the channel. The meander scar is topographically lower than the surrounding area except for an outlet to the water filled bend in the creek channel. The meander scar is in a low area presumably once occupied by an oxbow lake. The trees lining the meander scar indicate a historic high water table.

A possible dam seepage influence on the meander scar area is indicated by the lithologies encountered during test hole drilling associated with the dam construction and later observation well installation. Sediments encountered across the valley were generally silt-clay mixtures, with

a ten foot thick lignite bed located between 20 and 30 feet below the base of valley. Test holes drilled as part of the dam axis soils investigation penetrated primarily fine sand in the interval above the lignite bed in a 100 foot wide interval (+ or - 50 feet). The test holes penetrating sand were located in the western half of the valley, upvalley from the meander scar. A group of four observation wells, located between the meander scar and the dam spillway also penetrated fine sand through the interval above the lignite bed. Together the drilled holes indicate a northwest-southeast trending zone of sandy sediment going from the western side of the dam towards the channel between the dissipator structure and the water filled channel. The fine sand may represent alluvial fill along a former channel of the river which downcut to or through the lignite bed; however, almost no granular material coarser than fine sand was reported in the sieve tests run on the sandy sediments.

Whatever the origin of the sandy section, its presence could provide a conduit for water seepage from the reservoir or from the lignite bed underlying the area. The head of the reservoir is about 30 feet above the meander scar base. A near surface water level occurs in wells located downgradient of the dam and completed in the sand at a depth of 9 to 12 feet.

The pressure head in the lignite bed underlying the meander scar was near land surface when observation wells were completed in the lignite bed in 1971. The lignite seam probably acts as a drain for the surrounding area, discharging in springs where valleys cut through

the bed. The water level in the one remaining observation well, located on the highway right-of-way just west of the valley and screened in the lignite bed, was 1.3 feet higher on September 25, 1985 than on the previous measurement, March 20, 1973. If the pressure head in the lignite bed can be used as a general indicator for the area, water levels are up slightly over the period 12 to 14 years ago.

The meander scar, located along an earlier path of the creek, probably has historically had a high water table as evidenced by the arc of trees. The high water table could be naturally fed by water discharging from the lignite seam through overlying sandy sediments. Alternatively, or additionally, the high water table could be caused by water seeping from the reservoir through the sandy sediment underlying a portion of the dam.

It is difficult to say how much of the high water table in the meander scar area is attributable to the installation of the dam. Natural conditions are such that a high water table may be expected in the area. Conditions are also such that seeping through the dam could add to the high water table.

The meander scar area naturally drains to the creek channel and is therefore influenced by the amount of water in the creek channel. Possible remedial measures could include improving the interconnection between the meander scar and the creek channel or draining the low area filling the bend in the creek channel.

Alan Wanek

Alan Wanek, Hydrologist

NORTH DAKOTA STATE WATER COMMISSION

OFFICE MEMO

MEMO TO: David A. Sprynczynatyk, Director, Engineering Division
FROM: Ronald A. Swanson, Design Engineer R.A.S.
SUBJECT: Camel Hump Butte Dam
SWC Project #1382
DATE: September 25, 1985

A drainage system may be needed to carry off the excess ground water that is saturating the soil downstream of Camel Hump Butte Dam. The plan for the proposed drainage system is shown in the attached Sketch No. 1 and the profiles of the proposed drains are shown in Sketch No. 2.

The drains would be constructed of a corrugated plastic pipe installed in a narrow trench with a granular filter material enclosing the pipe. The two drains (A and B) would be located as shown in Sketch No. 1.

Drain A would consist of 360 LF of non-perforated 6-inch Ø CPP, 400 LF of perforated 6-inch CPP and would have seven laterals of perforated 4-inch Ø CPP, each 50 feet long.

Drain B would consist of 300 LF of perforated 6-inch Ø CPP.

The drainage piping would be layed out to conform as much as possible with the topographical contours of the existing ground condition in order to keep the amount of ditch excavation to a minimum, while at the same time, placing the pipe at the proper gradient to ensure proper drainage.

After installation of the pipe in its surrounding envelope of granular filter material in the bottom of the trench, which would be wrapped with filter fabric, the balance of the trench would be backfilled with excavated fill material. Any excess spoil would be disposed of in a designated area.

The cost estimate for the work required is as follows:

1.	Mobilization	LS	$ 2,000.00
2.	Site Preparation & Restoration	LS	1,000.00
3.	6-inch Ø non-perforated CPP	360 LF @$3.00	1,080.00
4.	6-inch Ø perforated CPP	700 LF @ $3.00	2,100.00
5.	4-inch Ø perforated CPP	350 LF @ $2.00	700.00
6.	Granular Filter Material	25 CY @ $12.00	300.00
7.	Filter Fabric	LS	500.00
		Subtotal	$ 7,680.00
		Plus 30% Engineering, Administration and Contingencies	2,320.00
		TOTAL	$10,000.00

TOE OF CAMEL HUMP BUTTE DAM

R/W

STA 3+00

DRAIN B - 300 LF 6"Ø P.C.P.P.

STA 0+00

R/W

STA 7+60

7 LATERALS

DRAIN A

400 LF - 6"Ø P.C.P.P.

STA 3+60

360 LF - 6"Ø N.P.C.P.P.

STA 0+00

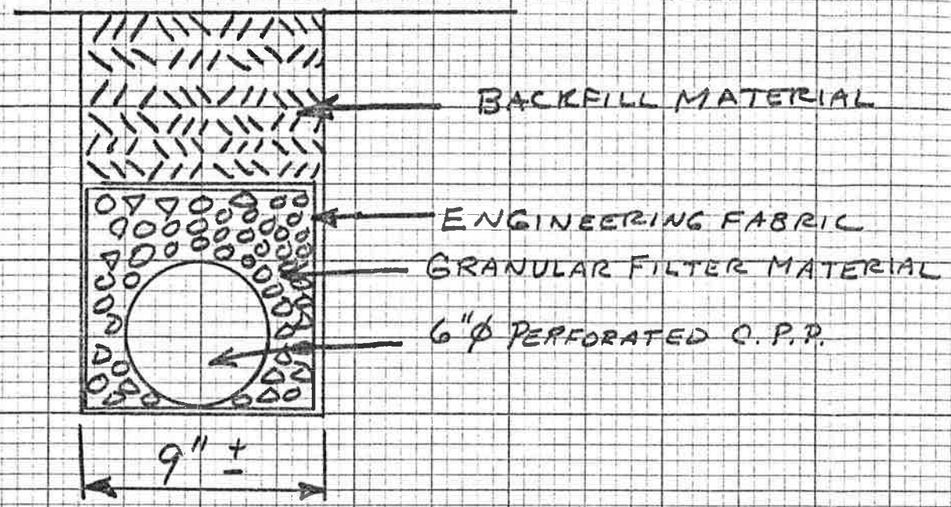
Scoria Road to Farm 7.8

Magnetic

W.S. = Water Surface

N

N.D.S.W.C.
SWC # 1382
CAMEL HUMP BUTTE DAM
SKETCH No. 1
PROPOSED DRAIN LAYOUT
RAS 9-25-85
SCALE 1" = 50 FT



TYPICAL TRENCH DETAIL
NOT TO SCALE

DRAIN B

EXISTING GROUND

300 LF - 6"ϕ PERFORATED C.P.P.

DRAIN A

EXISTING GROUND

400 LF - 6"ϕ PERFORATED C.P.P.

360 LF - 6"ϕ NON-PERFORATED C.P.P.

STATIONS

N.D. S.W.C.
SWC # 1382
CAMEL HUMP BUTTE DAM
SKETCH No. 2
PROPOSED DRAIN PROFILES
R.A.S. 9-25-85