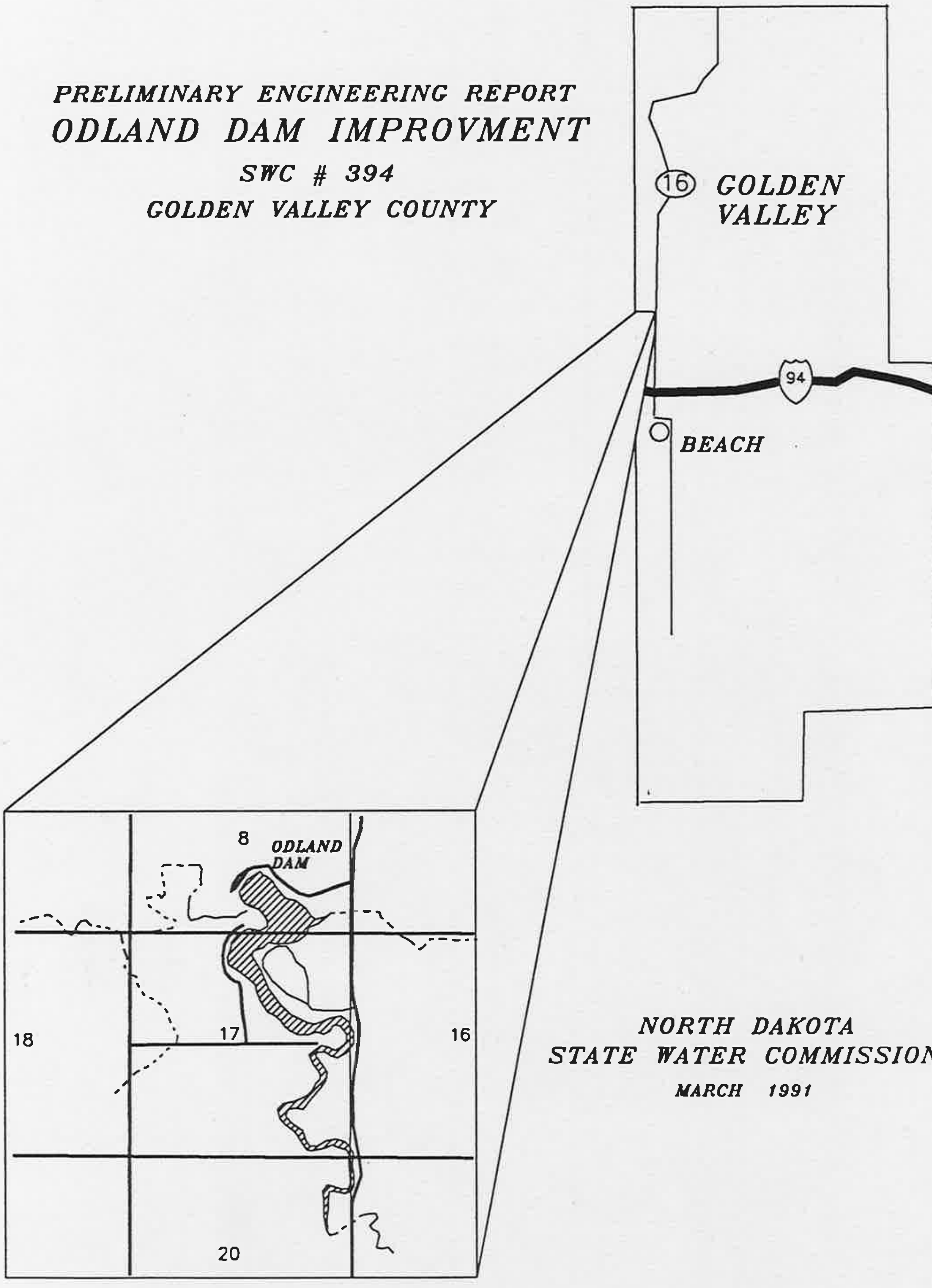
PRELIMINARY ENGINEERING REPORT

ODLAND DAM IMPROVMENT

SWC # 394

GOLDEN VALLEY COUNTY



NORTH DAKOTA

STATE WATER COMMISSION

MARCH 1991

PRELIMINARY ENGINEERING REPORT

ODLAND DAM IMPROVEMENTS

SWC PROJECT #394

North Dakota State Water Commission
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I. PURPOSE AND SCOPE

Since the construction of Odland Dam in 1936, the Odland Reservoir has accumulated sediment and organic material which, in recent years, has essentially eliminated the use of the reservoir as a recreation area. In September 1990, the North Dakota State Water Commission entered into an agreement with the Golden Valley County Water Resource District. The purpose of the agreement is to investigate alternatives to improve conditions at Odland Dam for fishing, boating, and all around water-based recreation activities.

This report contains a history of activity related to Odland Dam, a description of the study area, a description of the methods proposed to increase the depth of the Odland Reservoir, a cost estimate considering several alternatives, and an environmental assessment.

II. BACKGROUND

Odland Dam was constructed in 1936 by the Works Progress Administration and The Federal Emergency Relief Administration to provide fish habitat and recreation. Since its construction, the principal spillway has required periodic repair work consisting mainly of guniting concrete on the spillway. Repairs and modifications to the principal spillway occurred in 1937, 1938, 1949, 1951, 1953, 1956, 1963, and 1983. Currently, the spillway is in fair condition.

The first recorded interest in modifying the Odland Reservoir was a petition, dated April 1956, from local landowners requesting the level of the reservoir be raised. Since then, there has been continued interest in improving the recreational value of the reservoir. In 1970, the State Water Commission investigated the feasibility of raising the dam for the Golden Valley Park Board. The feasibility of raising the control elevation of the dam was again studied by the State Water Commission in 1982 for the Golden Valley County Water Resource District. In 1987, a proposal, as requested by the Board, examined the excavation of the reservoir area being Odland Dam such that any area presently more the 4 feet deep would be at least 8 feet deep. The project would consist of breaching the embankment, draining the reservoir, allowing the reservoir area to dry out, excavating areas between 4 and 8 feet deep, repairing the breached embankment, and allowing the reservoir to re-fill. The project proposed in 1987 was rejected because it was designed more for a boating and water-skiing lake. Golden Valley County Water Resource District want to expand upon 1987 State Water Commission work and look at overall possibility of producing a fishing, boating, and all around water-based recreation area.

III. DESCRIPTION OF AREA

Location and Basin Description:

Odland Dam is located in the SE 1/4 of Section 8, Township 141 North, Range 105 West. The site is about eight miles north and one-half-mile west of Beach, in Golden Valley County (see Figure 1). The embankment lies across Little Beaver Creek approximately nine miles above its confluence with the main stem of Beaver Creek in Montana. Beaver Creek flows into the Little Missouri River and then into Lake Sakakawea.

The drainage area above Odland Dam is 79 square miles. The Little Beaver Creek valley flattens and widens upstream of the reservoir. The bluffs rise to elevation 2800 mean sea level (msl). Most of the upstream drainage area is under cultivation with the exception of the steep slopes of the buttes and their tops.

Climate:

Precipitation for crop production is adequate during normal years, although occasionally the area suffers from periods of drought. The average annual precipitation is 13.8 inches, most of which occurs during the period of April through September. The annual mean temperature is approximately 42°F.

Geology:

Odland Dam and its drainage area lie within the unglaciated Missouri Plateau Section of the Great Plains Province. The

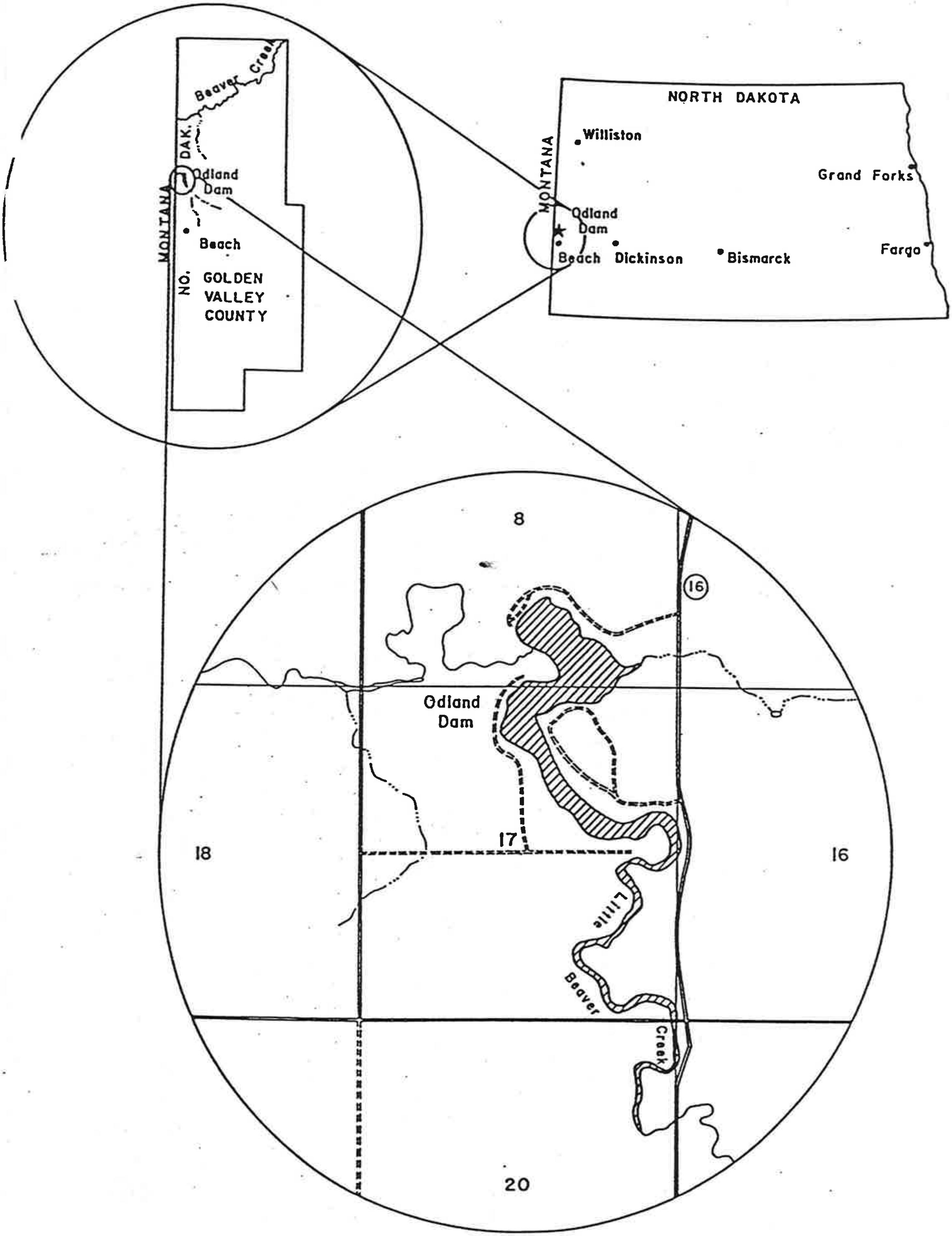


Figure 1. LOCATION MAP

surficial materials are basically bedrock and consist primarily of the Bullion Creek Formation with erosional remnants of the Sentinel Butte Formation. Both the Bullion Creek and Sentinel Butte Formations are of the Paleocene age.

Hydrology:

A hydrologic analysis of the watershed was performed using the HEC-1 computer model, developed by the U.S. Army Corps of Engineers. It was used to determine the peak discharges and flow volumes of various frequency storms. It formulates a mathematical hydrologic model of the watershed based on the following data: the amount of rainfall, the rainfall distribution, soil type, land use, and the hydraulic characteristics of channels and drainage areas. The HEC-1 model is designed to calculate the surface runoff of the watershed, in relation to precipitation, by representing the basin as an interconnected system of hydrologic and hydraulic components. Each component of the model represents an aspect of the precipitation-runoff process within a portion of the subbasin. These components were put into the model to determine the magnitude and duration of runoff from hydrologic events with a range of frequencies.

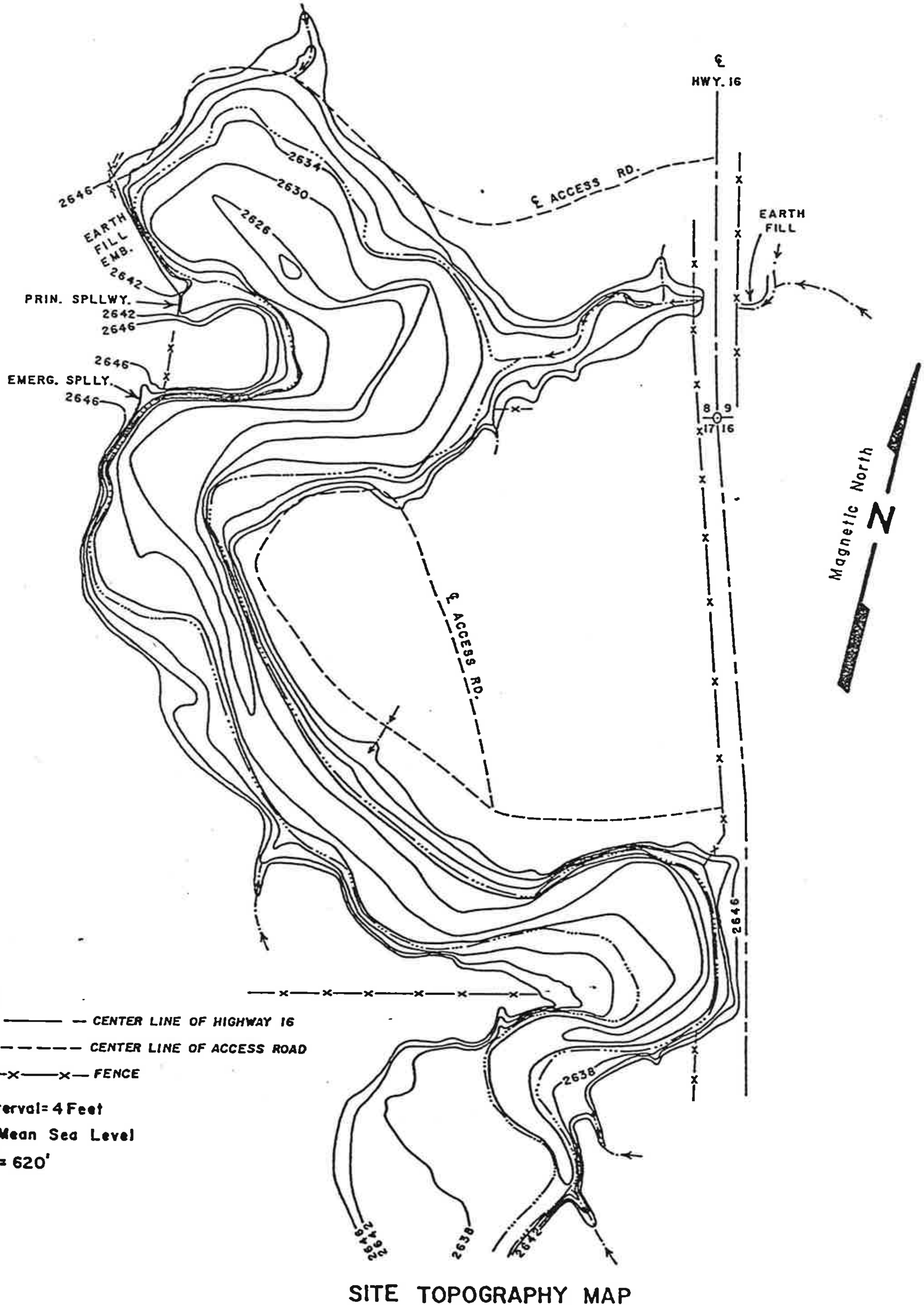
The model was developed to determine the hydrologic response of Odland Dam watershed. The results gained from the model included: (1) inflow hydrographs, (2) reservoir stage hydrographs, and (3) outflow hydrographs.

Dam Description:

The Odland Dam embankment is a rolled earth-fill type whose top elevation is 2645 msl. The 28-foot high embankment has a 3H:1V (3 horizontal to 1 vertical) upstream slope with no berms. The downstream face has a slope of 2.5H:1V with a 10-foot wide berm at elevation 2632 msl. The top of the embankment is 690 feet long and 10 feet wide. A clay core is shown on the original plans. A low-level drawdown pipe is not included as part of the structure.

The principal spillway consists of an approach channel, rubble masonry weir with a chute structure, and a plunge pool. The approach channel consists of a flat curved channel approximately 150 feet long at the same elevation as the principal spillway (2638 msl). The principal spillway is 100 feet wide with a 1H:1V side slope and vertical sidewalls. The sidewalls were originally at a slope of 1H:1V in 1936, and reconstructed in approximately 1938. The stilling basin consists of the original 11-foot long flat rubble masonry apron, 12 feet of riprap, and a scour hole. The crest elevation of the principal spillway is 2638 msl. The reservoir's water surface is at 2638 msl, covers 130 acres, and the capacity is 740 acre-feet. The average depth is 5.7 feet and maximum depth is 13 feet (see Figure 2).

The grassed emergency spillway lies in a natural low area between two hills about 400 feet south of the principal spillway.



LEGEND

CENTER LINE OF HIGHWAY 16

CENTER LINE OF ACCESS ROAD

FENCE

Contour Interval = 4 Feet

Datum is Mean Sea Level

Scale : 1" = 620'

SITE TOPOGRAPHY MAP
Figure 2

The 148-foot wide emergency spillway has 2H:1V sides. At the emergency spillway crest elevation of 2641.6 msl, the reservoir covers 178 acres and the capacity is 1280 acre-feet.

Dam Design Classification:

Dams are classified according to their potential hazard to property and potential for loss of life, if the dam should suddenly fail. Odland Dam is located in a rural area where there is little probability of future residential development downstream of the dam site. Failure of this dam could result in damage to agricultural land and township roads, however, no loss of life would be expected. Therefore, Odland Dam is considered a low hazard dam. The embankment height is 28 feet, classifying Odland Dam as classification III, according to the North Dakota Dam Design Handbook.

Sedimentation:

The rate of sedimentation in reservoirs is dependent upon the amount of soil eroded from the watershed and transported into the reservoir. There are several factors which determine the amount of sediment that is carried by surface runoff. Among them are soil type, amount of runoff, slope of land, land use and conservation practices used. Also contributing to the sediment accumulation is the organic material that is generated within the reservoir itself.

Sedimentation in the Odland Reservoir could be reduced by examining the watershed to determine land treatment measures which could reduce the erosion rate. Treatment practices include conservation cropping systems, crop residue use, stubble mulching, strip cropping, contour plowing, grassed waterways, windbreaks and buffers, and sediment catching ponds.

There is limited data available on the total sediment accumulation in the Odland Reservoir. An original topographic map of the reservoir area is not available and no sedimentation surveys of the reservoir have been completed. Locals have indicated that over the years sediment accumulations have been substantial.

Water Quality:

Water quality data for Odland Reservoir is limited. State Health Department water samples taken in February of 1985, and March of 1986, show high nutrient and phosphorus concentrations. These high concentrations are attributed to three sources: releases from the existing sediment due to wave action, agricultural non-point source runoff, and the city of Beach's wastewater treatment facility.

Odland Reservoir is currently hypereutrophic. Draining the lake and excavating sediment, as proposed in this report, would tend to decrease phosphorus concentrations and improve the current oxygen depletion in the lake. Implementation of agricultural Best Management Practices throughout the Odland Dam watershed would further improve overall water quality. A substantial upgrading of Beach's wastewater treatment plant to include nutrient removal or total containment would be desirable. Any methods used to improve the water quality would improve the recreational value of the reservoir.

Fish Life:

The existing condition of Odland Reservoir prohibits the sustainment of fish life. Winterkill resulting from shallow water depths and low dissolved oxygen levels due to the oxygen demand of the lake sediment make sustainment of fish life impossible. The enhancement of the reservoir, as proposed in this report, would produce habitat capable of sustaining fish life.

Groundwater:

When the reservoir is drained, the water table in the reservoir area would be lowered to a level where it would reach an equilibrium with the lower natural water table of adjacent areas. The natural groundwater conditions in the area adjacent to the reservoir will determine the complexity of the excavation work required. Groundwater inflow to the reservoir, either directly or from springs discharging into the upstream channel, could significantly increase the amount of dewatering required to allow for excavation of the reservoir bottom.

There are no wells in the immediate reservoir area that would give information on groundwater levels. The absence of standing water in low areas above and below the dam site would seem to indicate a low groundwater table. A low water table would reduce the time required to dry out the reservoir bottom and could reduce costs associated with excavating wet material. Using available information, it is difficult to predict the amount of time which will be required to adequately dry out the reservoir bottom to allow for excavation. The time required to adequately dry out the reservoir before excavation begins is estimated at several months to several years.

IV. DESCRIPTION OF PROJECT

Discussion of Alternatives:

The existing water quality conditions of the lake prohibits the sustainment of fish life. The oxygen demand for the nutrient rich sediment depletes the dissolved oxygen in the lower depths of the reservoir. According to the North Dakota State Game and Fish Department, the lake would sustain fish life if the organic deposits were removed. The objective of the alternatives would be to deepen the lake to maximum depth of 20 feet with an average depth of 8 feet.

There are four alternatives being considered to increase the reservoir's depth. The first alternative consists of breaching the existing embankment and draining the reservoir. Once the material has dried out it would be excavated using conventional methods. The second alternative consists of constructing a new dam at a location downstream of the existing dam. Using hydraulic dredging would be the third alternative, and the fourth alternative consists of no modifications.

Alternative One

Breaching the Embankment:

The first step for Alternative One is breaching the embankment and draining the reservoir. This could be done immediately following the spring runoff. Depending on the level of the reservoir, it may be necessary to siphon or pump the level of the reservoir down a few feet prior to breaching the embankment.

Lowering the reservoir level prior to breaching the embankment would reduce the risk of damaging downstream areas.

Another option to drain the reservoir would be to excavate a notch in the downstream half of the embankment, install a gated culvert, backfill around the culvert, and excavate the upstream side of the embankment allowing the reservoir to drain through the culvert at an orderly rate. The controlled releases through the culvert would help prevent downstream erosion and decrease the sediment load of the released flows. Breaching the embankment would provide less control over the releases and could result in downstream flooding, erosion, and sedimentation problems. After the reservoir is drained, the culvert would be removed and the embankment would remain breached while the reservoir bed is drying out. Riprap would be required to provide erosion protection to the breached section of the embankment.

Regardless of the method of breaching the embankment, a slow initial drawdown rate is necessary to prevent slope failure of the embankment. Removing water from the reservoir faster than the pore water pressures in the embankment can dissipate, could cause slope failure. Drawdown should be less than 0.3 feet per day while the water surface is between the maximum water level (2638 msl) and mid-height of the dam (2631 msl).

A channel, with a maximum depth of approximately 4 feet, would be required upstream and downstream of the embankment to provide adequate drainage of the reservoir through the breach. The channel would need to extend approximately 100 feet both on the upstream and downstream side of the embankment.

After the reservoir is drained and dried, the bottom sediment can be expected to consolidate 20 to 30 percent. Depending on the depth of sediment, areas within the reservoir could be lowered as much a 2 feet due to consolidation alone. Before excavation begins the reservoir bottom should be re-surveyed and excavation quantities determined. The present excavated quantity does not consider the consolidation of the material.

<u>Excavation of Sediment</u>:

Earth-moving equipment would be used to excavate material from the dewatered reservoir bottom. If the reservoir is drained in the spring of the year, it would be allowed to dry out two years and then the sediment would be excavated in the fall, if it has dried out. If the reservoir bottom is still in a saturated condition, the sediment from the reservoir bed could be excavated after it freezes or the reservoir bed could be allowed to dry out another year. Some water may be retained within lower areas of the reservoir during the period that excavation is taking place.

In order to improve conditions for a suitable fishery, the depth of the lake needs to be 20 feet and an average depth of 7 feet. The depth of which sediment excavation will be determined by soil borings taken after the site has dried out. Layers of coal are verified at elevation 2610 msl on the original dam design plans from 1936. The elevation of coal seams may vary throughout the site. Soil borings will be needed to determine location of coal seams. Abundant water losses could occur if coal seams come in direct contact with water surface. Therefore, it will be necessary that at least 2 feet of original clay material be sustained between water surface and coal seams. Table 1 lists the existing conditions and the proposed modifications for Alternative One.

Table 1

	Existing Condition	Alternative One
Maximum Depth (Feet)	12	20
Volume (Acre-Feet)	740	1026
Normal Pool Area (Acres)	130	130
Average Depth (Feet)	5.7	7.9
Excavation (CY)		535,900
Excavated Area (Acres)		128

The quantity of excavated sediment for Alternative One is approximately 535,900 cubic yards. The sediment being excavated is located between elevation 2626 msl and 2638 msl, with a maximum cut of 8 feet. An average of 2.55 feet of sediment will be excavated throughout the lake. The area depth of the lake at the 12-foot contour will be increased from 8.35 to 29.70 acres. The area of the lake at the 8-foot contour will be increased from 37.5 to 57.7 acres.

Sites for sediment disposal have not been determined. There will probably be at least four proposed sites with haul distances less than 3000 feet for each one. Abandoned coal mines in the area may be used for disposal sites, but haul distances and the size of the mines cannot be determined with the information available. The disposal site locations will be determined in the final design phase.

It is anticipated that the draining of the reservoir would be completed prior to the bidding of the excavation contract. This would allow the contractors to look at the drained reservoir before submitting their bids. Soil borings will provide information in determining the amount of sediment and the type of material that would be excavated. This information will help contractors in determining a cost unit price for the excavation of sediment. A unit cost of $0.70 per cubic yard is estimated for removal of sediment by scrapers. Material removed by a large backhoe or dragline, is estimated at $1.75 per cubic yard. All of this information is difficult to estimate until the site has dried and soil borings taken.

Cost Estimate - Alternative One

Item	Quantity	Unit	Unit Cost	Total
Breach and Drain	1	LS	$15000.00	$ 15,000.00
Mobilization	1	LS		10,000.00
Stripping	10,000	SY	0.25	2,500.00
Excavation	535,900	CY	1.30	696,700.00
Embankment	5,000	CY	1.20	6,000.00
Low-Level Drawdown	1	LS		12,000.00
Rock Riprap	300	CY	25.00	7,500.00
Riprap Filter Bedding	200	CY	15.00	3,000.00
Seeding	2	Ac	300.00	600.00
Fencing	18,500	LF	0.70	13,000.00
Subtotal				$766,300.00
Engineering 10%				76,600.00
Administration 10%				76,600.00
Contingencies				76,500.00
Total				$996,000.00

Alternative Two

Construction of New Dam:

The second alternative would be to construct a new dam downstream from the existing dam and use the existing embankment for a settling basin. The dam would be located 1/2-mile downstream from the existing dam site. The new dam location is in a rural area where there is little probability of future residential development downstream of the dam site. Failure of this dam could result in damage to agricultural land and township roads, however, no loss of life would be expected. Therefore, the new dam is considered a low hazard dam. The embankment height is 36 feet, classifying the dam as classification III, according to the North Dakota Dam Design Handbook.

Hydrology:

Precipitation design amounts were determined once the dam was classified. Outlet works of a dam are required to have flow capacities such that they pass the runoff from precipitation events as suggested by its classification.

Based on the North Dakota Dam Design Handbook, the requirements for a class III dam are: 1) the principal spillway is to pass the flows of a 25-year event without the use of a non-structural emergency spillway, 2) the emergency spillway is to pass the flows of a 100-year event within acceptable velocity limits, 3) the dam is to withstand the 0.3 PMP event without overtopping. A 10-day rainfall, 24-hour rainfall, and 10-day snowmelt precipitation tables were used for the 25-year and 100-year events, and a 6-hour extreme rainfall table developed from Hydrometeorological Report Number 51, was used for the 0.3 PMP event. The 24-hour rainfall event was found to be the critical event for the watershed and was used for dam design criteria. Table 2 shows the resulting peak inflows and total volumes for 24-hour rainfall events.

Table 2 - Peak Inflows and Volumes for Design Frequency 24-Hour Rainfall Event

Event	Peak Inflows (cfs)	Total Inflow Volume (acre-feet)
25-year	1791	3155
100-year	2792	4920
0.3 PMP	4990	9124

An area-capacity curve for the new dam site was developed using a USGS topographic map of the reservoir area. The elevation capacity curve and the inflow hydrographs were then used to determine reservoir stages and outflow hydrographs by routing the inflows through the reservoir using the HEC-1 model. Table 3 shows the area capacity for the existing Odland Dam, and Table 4 shows the values for a new dam constructed downstream.

Table 3
Existing Site

Elevation (feet)	Area (acres)	Volume (ac-ft)
2626	8.4	0
2630	37.5	91.7
2634	77.0	320.7
2638	130.0	740.0
2640	158.0	1022.0
2643	204.0	1565.0

Table 4
New Dam Site

Elevation (feet)	Area (acres)	Volume (ac-ft)
2609	0	0
2620	5.8	21.3
2630	59.4	300.5
2638	155.0	1178.0
2640	185.0	1472.2
2643	236.0	2102.1

Twenty-five acres in surface area will be added at 2638 msl, the normal pool elevation with the construction of a new dam and the volume increased by 390 acre-feet. The surface area at the flood pool elevation (2643 msl) will be increased by 32 acres and 537.0 acre-feet added to the volume.

Principal Spillway:

The principal spillway will consist of a approach channel, chute structure, and a plunge pool. The approach channel consists of a flat curved channel approximately 150 feet long at the same elevation as the principal spillway (2638 msl). The new reservoir will have a surface area of 155 acres and a volume of 1178 acre-feet. The maximum depth of the reservoir will be 31 feet and have an average depth of 7.6 feet.

The elevation of the principal spillway will be the same as the existing dam's principal spillway (2638 msl). The principal spillway was designed at this elevation to avoid additional loss to agricultural lands upstream. Since the normal pool elevation will be the same for the existing and proposed reservoirs, the existing embankment will have to be lowered. A large diameter pipe will be laid at low elevation in the embankment to allow fish crossing into each reservoir during low water conditions. Excavating a notch in the existing embankment will provide boat travel between reservoirs. The notch would have a 10-foot bottom and side slopes of 2H:1V.

Emergency Spillway:

A grassed emergency spillway will be located 200 feet south of the principal spillway. The emergency spillway will have a bottom width of 200 feet and a crest elevation of 2642 msl. The reservoir covers 219 acres and the capacity is 1892 acre-feet at the emergency spillway crest. The suggested design criteria for setting the crest of the emergency spillway was based on the 25-year event. Table 5 shows the peak stages for 24-hour rainfall events.

Table 5

Events	Peak Stage
25-year	2641.09
100-year	2642.09
0.3 PMP	2642.80

Embankment Design:

The new dam embankment would be a rolled earth-fill type whose top elevation is 2645 msl. The 36-foot high embankment will have a 3H:1V upstream slope and the downstream face will have a slope of 3H:1V. The top of the embankment is 800 feet long and 15 feet wide. The embankment will have a clay core and a low-level drawdown pipe will be added to the reservoir. The criteria for the dam is preliminary and a soil investigation will be needed to verify site and construction data.

Cost Estimate - Alternative Two

Item	Quantity	Unit	Unit Cost	Total
Mobilization	1	LS	$	$ 10,000.00
Water Control	1	LS		20,000.00
Stripping Topsoil	25,000	SY	0.25	6,250.00
Core Trench Excavation	8,000	CY	2.25	18,000.00
Embankment	80,000	CY	1.20	96,000.00
Water For Compaction	2,000	M Gal	5.00	10,000.00
Slab Concrete	330	CY	250.00	82,500.00
Wall Concrete	195	CY	300.00	58,500.00
Reinforcing Steel	122,500	Lbs	0.50	61,250.00
Rock Riprap Filter	800	CY	12.50	10,000.00
Rock Riprap	2,000	CY	25.00	50,000.00
Drain Fill	125	CY	20.00	2,500.00
Manhole	1	LS		6,000.00
Ductile Iron Pipe	1	LS		1,250.00
PVC Pipe	1	LS		10,000.00
Miscellaneous Metals	1	LS		4,000.00
Boat Pass Excavation	1	LS		5,000.00
Boat Pass Piping	1	LS		5,000.00
Boat Pass Fill	1	LS		1,750.00
Seeding	10	AC	300.00	3,000.00
Fencing	21,500	LF	0.70	15,000.00
Subtotal				$476,000.00
Engineering 10%				47,000.00
Administration 10%				47,000.00
Contingencies 10%				47,000.00
Total				$617,000.00

Alternative Three

Hydraulic Dredging:

The third alternative would use hydraulic dredging for a method of excavation. Hydraulic dredging is developed for the removal of material that is underwater. The dredge consists of a steel hull, cutter arm, pump, diesel engine, and a discharge pipeline. The dredge pumps the material, which is approximately 50-70 percent water, from the lake bottom through the discharge pipe to a disposal area. The disposal site is usually a diked area that acts as a settling pond. A control section in the dike allows the sediment-free water to flow back into the lake. This maintains the water level in the lake and allows for continuous dredging. Upon completion of the dredging project, disposal sites have been used for recreation areas, crop production or excavated, and sold for field, lawn, and garden fertilizer.

Hydraulic dredging is generally the most costly component of a restoration; it is also the most effective when combined with implementing watershed Best Management Practices. The quantity used for excavating in hydraulic dredging is the same as Alternative One. Alternative One would excavate 535,900 CY from the lake at a unit cost of $1.30 a cubic yard, while dredging would be $4.00 a cubic yard. Mobilization for the site is eight times more for dredging than common excavation.

Cost Estimate - Alternative Three

Item	Quantity	Unit	Unit Cost	Total
Mobilization	1	LS	$	$ 75,000.00
Settling Pond Const.	1	LS		12,500.00
Settling Pond Rest.	1	LS		12,500.00
Miscellaneous Pipeline	1	LS		4,000.00
Hydraulic Excavation	535,900	CY	4.00	2,143,000.00
Fencing	18,500	LF	0.70	13,000.00
Subtotal				$2,260,000.00
Engineering 10%				226,000.00
Administration 10%				226,000.00
Contingencies 10%				226,000.00
Total				$2,938,000.00

Alternative Four

No Modification:

The fourth alternative consists of no modifications to the existing embankment and reservoir. The embankment would continue to capture sediment, continuing the ongoing process of filling the reservoir storage with sediment. A yearly inspection of he dam would continue for safety precautions. The dam was last repaired in May 1983, at a cost $22,500. Repairs included excavating and cleaning the upstream side of the spillway. The face of the spillway was also cleared of loose concrete and repaired with gunite. The embankment is in good condition and minimal repairs is foreseen for the dam in the next 10 to 20 years due to deterioration. Estimated cost for future repairs is $30,000 with no other major unforeseeable additional cost.

V. ENVIRONMENTAL ASSESSMENT

The project would have minimal environmental impacts. The areas impacted would include the reservoir area and the disposal sites. The placement of sediment in the disposal areas may convert non-productive farmland into productive agricultural areas. There should be an increase in recreational activity and there may be an increase in residential development near the reservoir.

There would be less downstream flood protection provided while the dam is breached. The proposed project would have minimal effect on downstream flood flows when it is completed. The exposure of the reservoir to overland runoff should not create a problem with erosion and subsequent sediment deposition downstream. Local changes in air quality and noise levels would be noticeable during the construction phase of the project. The project would not increase the wildlife value of the reservoir.

If the project is pursued, the State Historical Society should be contacted concerning any historical, archaeological or cultural resources that may be affected.

VI. LAND RIGHTS

The Golden Valley Water Resource District and the State of North Dakota obtained the easements for the land to be flooded or inundated by the construction of Odland Dam in 1936. No additional land will be needed to be obtained in Alternative One, Three, and Four. There will be the need to obtain an easement for Alternative Two, the construction of a new dam downstream of Odland Dam. The site will consist of approximately 35 acres in Section 8, Township 141 North, Range 105 West. The cost for this land acquisition is not figured into the cost estimate proposal for the alternative. An additional land may need to be required for recreation development near the reservoir, if the Water Resource District pursues the development of a park and recreational site near the reservoir.

VII. RECREATION DEVELOPMENT

Recreation areas are proposed on the north and south shores of the reservoir. The recreation development along the reservoir will include boat ramps, fishing docks, picnic areas, a softball field, horseshoe pits, trails and a beach area. The recreational area will not provide overnight camping or activities. Access will be provided to the recreation developments from Highway 16. The recreation development will have a separate contract from the restoration contract for Odland Reservoir. Land acquisition is not included in the development cost.

The North Dakota State Park and Recreation Department designed and provided the cost estimate for the recreational development. The proposed cost for recreational development is shown in Table 4. The cost for each area is separate and the Board may wish to revise the development to fit their own needs.

Odland Dam Recreation Concept
Cost Estimates

<u>North Shore</u>

Group Picnic - Entrance Area		
- Shelter 40'x50'	$24,500	
- Ball Field - Backstop, Fence	1,500	
- Bleacher	1,200	
- Picnic Tables (5)	600	
- Horseshoes (2)	250	
- Double Vault Toilet (1)	4,500	
- Picnic Tables (20)	2,400	
- Trash Cans (2)	120	
- Group Grill	375	
Total		$ 35,445

Beach		
- Swim Buoys	$ 2,500	
- Sand Beach Development	3,800	
- Sand Volley Ball Court	125	
Total		$ 6,425
Single Picnic		
- Playground	$13,750	
- Benches (2)	250	
- Picnic Tables (18)	2,160	
- Trash Cans (3)	180	
- Double Vault Toilet	4,500	
Total		$ 20,840
Boat Ramp		
- Single Vault Toilet	$ 3,000	
- Trash Can (1)	60	
- Fishing Docks (2)	5,200	
Total		$ 8,260
Group Picnic - Ramp Area		
- Shelter 20'x30'	$ 9,500	
- Picnic Tables (10)	1,200	
- Horseshoes (1)	125	
- Trash Can (1)	60	
- Group Grill (1)	200	
Total		$ 11,085
Miscellaneous		
- Roads and Parking - Gravel	$44,625	
- Well, Hand Pump	7,500	
- Entrance Sign	200	
- Trees - Variable Cost*	2,500	
Total		$ 54,825
Development Cost		$136,880**
Contingency at 10 Percent		13,700
North Shore Development Estimate Total		$150,580

* Depends on Size Purchase - Cost Estimate is $10/tree

** Estimates are Contracted Costs - Turn Key

Odland Dam Recreation Concept
Cost Estimates

South Shore

Group Picnic			
- Shelter 20'x30'		$ 9,500	
- Single Vault Toilet (1)		3,000	
- Play Ground		6,300	
- Horseshoe (1)		125	
- Picnic Tables (10)		1,200	
- Group Grill		200	
- Trash Cans (2)		120	
	Total		$ 20,445
Single Picnic			
- Single Vault Toilet (1)		$ 3,000	
- Fishing Docks (2)		5,200	
- Picnic Tables (12)		1,440	
- Trash Cans (4)		240	
	Total		$ 9,880
Miscellaneous			
- Roads and Parking		$18,450	
- Entrance Sign		200	
- Trees - Variable Cost*		1,000	
	Total		$ 19,650
Development Cost			$ 49,975**
Contingency at 10 Percent			4,900
West Shore Development Estimate Cost			$ 54,875

* Depends on Size Purchase - Cost Estimate is $10/tree
** Estimates are Contracted Costs - Turn Key

VIII. SUMMARY

In recent years there has been a continued interest in increasing the recreational value of the Odland Reservoir. In its present condition, the Odland Reservoir offers limited recreational value due to shallow water depths and poor water quality. To improve the conditions of the reservoir, the Golden Valley County Water Resource District requested the State Water Commission to investigate the feasibility of increasing the depth of Odland Dam.

The Odland Reservoir has a surface area of 130 acres and a capacity of 740 acre-feet. The maximum depth is 13 feet and the average depth is 5.7 feet. The embankment is 28 feet high and 690 feet long. The 100-foot wide principal spillway consists of an approach channel, rubble masonry weir with a chute structure, and a plunge pool. The grassed emergency spillway lies about 400 feet to the south of the principal spillway at an elevation of 2641.6 msl. At this flood pool elevation, the reservoir covers 178 acres and the capacity is 1280 acre-feet.

Little data exists on sediment accumulations in the Odland Reservoir. Sediment depths probably range from 0 to 6 feet and can be expected to consolidate 20 to 30 percent when dried. The poor water quality of the reservoir would improve as a result of the proposed project, however, additional steps would need to be taken to further improve overall water quality. Groundwater levels surrounding the reservoir appear to be low and when the reservoir is drained, the bottom should dry sufficiently in two to three years to allow for excavation.

Draining the reservoir, letting the sediment dry and then excavating 535,900 cubic yards of sediment by conventional methods would be Alternative One. The reservoir's depth will be increased from 12 to 20 feet and the volume increased to 1026 acre-feet. The average depth of the reservoir would be 7.9 feet. The sediment being excavated is located below elevation 2638 msl and has a surface area of 128 acres.

The cost for Alternative One would be $996,000. The biggest expense for the project would come from the excavation of reservoir sediment. An estimated cost of $1.30 per cubic yard to remove sediment was used in the engineer's cost estimate. This value may be higher or lower depending upon the condition of the sediment to be removed. Sediments with higher moisture content will increase the cost of excavation. Consolidation of the sediment was not figured into the total amount of excavated material. The sediment may consolidate 20 to 30 percent after it has sufficiently dried out.

Construction of a new dam downstream is Alternative Two. The dam would be considered low hazard and with a classification III, according to the North Dakota Dam Design Handbook. The new reservoir would have a normal pool elevation of 2638 msl, that would add an additional 25 acres of surface area to the existing reservoir. The total volume of the reservoir would be increased to 1177 acre-feet with an average depth of 7.6 feet. A grassed emergency spillway will be located 200 feet south of the principal spillway at elevation 2643 msl. The new dam embankment would be a rolled earth-fill type with a top elevation of 2645 msl. The criteria for the dam is preliminary and a soil investigation will be needed to verify site and construction data.

The existing dam and spillway would remain in place and would be used as a sediment trap for the new reservoir. A v-notch would be cut into the existing embankment to allow boat access between reservoirs. A large diameter pipe may also be laid at a low elevation in the embankment to allow fish crossing into each reservoir during low water conditions.

The cost estimate for a new dam would be $617,000. Land acquisition for the alternative is not figured into the engineer's cost estimate.

The third alternative consists of hydraulic dredging for the method of sediment excavation. Hydraulic dredging would remove 535,900 cubic yards of sediment. The dredge would remove the sediment without draining the reservoir by pumping the water-sediment mixture to disposal ponds. The disposal site is usually a diked area that acts as a settling pond. A control section in the dike allows the sediment-free water to flow back into the reservoir. This maintains the water level in the reservoir and allows for continuous dredging.

Hydraulic dredging would increase the depth and volume the same as Alternative One. The depth increased to 20 feet and the volume to 1026 acre-feet. The average depth of the reservoir increased to 7.9 feet. Restoration through hydraulic dredging would have a total cost of $2,938,000.

The fourth alternative consists of no modifications to the existing embankment and reservoir. There would be no restoration project forth taken and the reservoir and dam would continue to deteriorate. The State Water Commission would continue annual inspection of the dam for safety precautions.

IX. RECOMMENDATIONS

Odland Reservoir is in need of restoration to improve the value of the reservoir. Three alternatives considered will improve Odland Reservoir for fishing, boating, and all around water-based recreation activities. Alternative Two, the construction of a new dam downstream, will add 25 acres to the original 130 acres of surface area. This is the least expensive of the three alternatives for restoration, but apparently land acquisition may be a problem. The cost of this alternative is $617,000. Alternative One consists of draining the dam and excavating the sediments after the reservoir area has dried. This alternative has the advantages of an increased total depth and it does not require additional land acquisition. The cost of excavating the sediment is $996,000. There are factors such as consolidation and the unit price for excavation that may reduce the cost of Alternative One. It is recommended that the entire reservoir area be fenced. Fencing will greatly enhance the recreational aspects of the project, including improved water quality conditions. The decision to proceed with the project must be made by the Golden Valley Water Resource District.

SWC Project #394
September 18, 1990

A G R E E M E N T

Investigation of Odland Dam to Excavate the Reservoir Sediment

I. PARTIES

THIS AGREEMENT is between the North Dakota State Water Commission, hereinafter Commission, acting by and through its Secretary, David Sprynczynatyk, hereinafter Secretary; and the Golden Valley County Water Resource District, hereinafter District, acting by and through its Chairman, Orville Moe.

II. PROJECT, LOCATION, AND PURPOSE

The District wishes to increase the depth of Odland Dam located in Section 8, Township 141 North, Range 105 West, Golden Valley County, North Dakota. In order to improve conditions for fishing, boating, and all around water-based recreation area, the Board wishes to drain the existing reservoir and excavate the reservoir sediment and underlying deposits to depths which will sustain a fishery and promote future recreational development. This agreement does not include any design or construction work.

III. PRELIMINARY INVESTIGATION

The parties agree that further information is necessary concerning the quantity of material to be excavated, the cost of excavation, and alternative ways of increasing the depth. Therefore, the Commission shall conduct the following:

1. The field surveys for the 1986 investigation agreement will be used for this study. If additional survey data is needed to determine the quantity of material to be excavated, it can be obtained under this agreement;

2. Develop a preliminary cost estimate for the project;

3. Consider alternative methods of increasing the reservoir depth; and

4. Prepare a preliminary engineering report containing the results of this study.

IV. DEPOSIT - REFUND

The District shall deposit a total of $500.00 with the Commission to partially defray the costs associated with this investigation.

V. RIGHTS-OF-ENTRY

The District agrees to obtain written permission from any affected landowners for field investigations by the Commission which are required for the preliminary investigation.

VI. INDEMNIFICATION

The District hereby accepts responsibility for, and holds the state of North Dakota, the Commission, the State Engineer, and their employees and agents, free from all claims and damages to public or private property, rights, or persons arising out of this agreement. In the event a suit is initiated or judgment entered against the state of North Dakota, the Commission, the State Engineer, or their employees or agents, the District agrees to indemnify it for any settlement arrived at or judgment satisfied.

VII. CHANGES TO THE AGREEMENT

Changes to any contractual provisions herein will not be effective or binding unless such changes are made in writing, signed by both parties, band attached hereto.

NORTH DAKOTA STATE WATER COMMISSION	GOLDEN VALLEY COUNTY WATER RESOURCE DISTRICT
By: David A Sprynczynatyk	By: Orville K. Moe
DAVID A. SPRYNCZYNATYK Secretary	ORVILLE MOE Chairman
DATE:	DATE:
Sept. 21, 1990	10-1-90
WITNESS:	WITNESS:
Dale L Frink	Ted Nyberg