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SINNARD RESERVOIR REHABILITATION PROJECT

LEVEL II FEASIBILITY STUDY

EXECUTIVE SUMMARY

MARCH, 1993

BANNER

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1.0 INTRODUCTION

1.1 PROJECT AUTHORIZATION

The 1991 session of the Wyoming Legislature authorized the Wyoming Water Development Commission (WWDC) to conduct a Level II Feasibility Study of the rehabilitation of the Sinnard Reservoir Dam. On June 18, 1991, the WWDC contracted with Banner Associates, Inc. to provide the Level II services. Kennedy Engineering and Inberg-Miller Engineers provided specialty subconsultant services during the investigation.

1.2 PROJECT DESCRIPTION

Sinnard Reservoir is located on Dry Creek, a tributary to Lone Tree Creek, approximately 7.6 miles upstream from the confluence with Horse Creek. The Sinnard Dam and Reservoir (Permit No. 3605 Res) are owned and operated by the Horse Creek Conservation District (HCCD). The reservoir facility is located in Goshen County in Section 7, Township 21 North, Range 62 West, approximately 1 mile north and 4 miles west of Hawk Springs, Wyoming. Refer to Figure 1 for the Vicinity Map. Although the reservoir is located in a natural drainage tributary to Lone Tree Creek, it is considered an off-channel reservoir since its principal water supply is the Hawk Springs Canal (Canal). The drainage area which contributes runoff to Sinnard Reservoir contributes inflow to the reservoir only during flood events. Sinnard Reservoir was constructed in the 1920s with a reservoir capacity of approximately 1,600 acre-feet. The dam is approximately 24 feet high, and has a crest width of nearly 14 feet and a crest length of approximately 700 feet.

Hawk Springs Reservoir, located southeast of the town of Hawk Springs, is the primary storage reservoir for the Horse Creek Conservation District. Irrigation storage water is released from this reservoir to the Canal, which traverses along topographic contour northwest approximately 13 miles to Sinnard Reservoir. Improvements were completed to the Hawk Springs Reservoir and Canal in 1985. As part of these improvements the portion of the Canal which historically encircled Sinnard Reservoir was abandoned along with the headgate structure which supplied water to the reservoir from the Canal. The improvements also resulted in a relocation of the Canal with a new reservoir supply structure located on a new segment of the Canal near the right abutment of Sinnard Dam. The supply structure permits all or a portion of the water conveyed in the Canal to be diverted to the reservoir. Refer to Figure 2 for the Location Map. Irrigation water not delivered to Sinnard Reservoir enters an inverted siphon which crosses the Lone Tree Creek drainage below the dam embankment and continues north to a continuation of the Canal called the North Main.

Sinnard Reservoir is used primarily as a re-regulation facility. During periods of peak irrigation demand, the Canal has insufficient conveyance capacity to serve demand, and water stored in Sinnard Reservoir is released to satisfy the shortfall in supply from the Canal. Irrigation water released from Sinnard Reservoir enters Sinnard Ditch which serves lands within the HCCD along the north side of Lone Tree Creek. The outlet of Sinnard Reservoir provides the only means of conveying irrigation storage water from the Canal to Sinnard Ditch. During periods of normal irrigation demand, Sinnard Reservoir receives water conveyed in the Canal which exceeds water demand from HCCD lands served by the North Main. Thus, during the majority of the irrigation season, Sinnard Reservoir provides a buffer in the HCCD canal system which allows relatively constant releases to be maintained from Hawk Springs Reservoir.

This feasibility engineering study was initiated by the WWDC in response to an inspection by the Wyoming State Engineer's Office (SEO), Dam Safety Division. This inspection of May 16, 1989 and a subsequent letter to the HCCD notes various dam safety concerns regarding Sinnard Reservoir. The letter to the HCCD, dated May 26, 1989, also noted water rights questions regarding Sinnard Reservoir created by the discrepancies between the existing and permitted facility. The scope of work under this study relates only to the dam safety concerns and the physical condition of the dam. The major safety issues cited in the May 26th letter were the

presence of an animal burrow adjacent to the outlet works, and questions regarding spillway adequacy. Maintenance related issues were also noted including brush on the embankment, spalled concrete both on the upstream face and in the outlet conduit, and the need for riprap below the outlet works.

1.3 PURPOSE AND SCOPE

The purpose of this Level II Feasibility Study is to provide a conceptual level design and opinion of probable cost for the construction of rehabilitation elements identified for safe and efficient operation of the Sinnard facility.

The investigation was conducted in two phases. A feasibility analysis of alternative rehabilitation measures for the embankment and structures appurtenant to the reservoir was completed under Phase I of the investigation. The scope of the Phase I Alternative Analysis included the following tasks.

- Providing a flood analysis and incremental damage analysis of Sinnard Reservoir.
- Performing a geotechnical investigation to evaluate the stability of the dam embankment.
- Providing an analysis of the hydraulic capacity of the natural spillway located on the northwest side of the reservoir.
- Providing survey maps of the existing dam and control structures.
- Providing a preliminary opinion of probable cost for the design and construction of the rehabilitation alternatives identified.

Several rehabilitation alternatives were identified during Phase I of this investigation and a preliminary opinion of probable cost was presented for each alternative in a Rehabilitation Plan Design Memorandum dated January, 1992. The second phase of investigation comprised a conceptual design of the rehabilitation measures selected for further consideration by the WWDC and the HCCD. The scope of the Phase II Conceptual Design for Improvements included the succeeding tasks.

- Performing additional geotechnical exploration to substantiate the feasibility of selected rehabilitation alternatives.
- Performing engineering analyses to provide a conceptual design and layout of a new dam embankment and appurtenant structures.
- Preparing a conceptual level opinion of probable cost for the design and construction of project components.
- Providing a preliminary opinion of the technical feasibility and cost of repairing the existing dam embankment.
- Preparing an economic analysis of the project to assist the state in determining a fair and equitable financing plan for selected project improvements.

This document presents recommendations based upon the conclusion of both phases of the Level II study to assist in the selection of project improvements to be considered for further evaluation in Level III.

This Rehabilitation Plan was developed from information gathered and analyses performed from May, 1991 to October, 1992. Informational sources included a review of the filing records and dam safety files at the

SEO, surveys and geotechnical investigations performed for this study, and numerous field trips to Sinnard Reservoir beginning with the pre-proposal tour on March 25, 1991. Recommendations within this Rehabilitation Plan are based on observed conditions and results of the flood and incremental damage analyses, and the geotechnical investigation.

2.0 CONCLUSIONS AND RECOMMENDATIONS

A wide variety of alternatives to rehabilitate Sinnard Reservoir have been investigated in this Level II study. Since this study was initiated in 1991, the condition of the existing dam embankment has been observed to worsen. We recommend prompt action be taken to rehabilitate this facility. The most favorable of the rehabilitation alternatives evaluated during the project investigation may generally be summarized as follows.

2.1 ALTERNATIVE I - CONSTRUCTION OF A NEW DAM

Alternative I is the complete removal of the existing dam embankment and outlet works and construction of a new earthen embankment and ancillary facilities. Refer to Figure 3 for the plan location of the new dam embankment. Suitable material for construction of the new dam embankment is believed available at the site. Riprap and granular materials needed for construction of upstream slope protection, the blanket drain, toe drain and roadway are planned to be imported. The plan includes construction of a new embankment with a 3(H):1(V) upstream slope, a 15-foot crest width and a 2.5(H):1(V) downstream slope. The conceptual design incorporates features to mitigate the potential for a piping failure such as has been observed in the existing dam. A 3-foot thick blanket drain and toe drain, encapsulated in a geotextile filter fabric, is proposed to provide drainage for seepage flows anticipated through the foundation and embankment (see Figure 4).

The new outlet works incorporates two inclined slide gates located at an intake structure on the upstream face of the dam. The gate operators are located at the dam crest with a gate stem installed on the upstream face. The outlet is to be constructed of 36-inch diameter welded steel pipe. Water released from the reservoir would enter an impact type stilling basin similar to the existing stilling basin located an the inlet from Hawk Springs Canal.

Table I presents an opinion of probable cost for the plan for construction of a new dam and appurtenances.

2.2 ALTERNATIVE II - REMEDIAL REPAIR TO EXISTING DAM

Alternative II is the remedial repair of the existing dam embankment and outlet works. This plan is provided on the premise that the cause of the observed failure will be effectively mitigated by restriction of the reservoir level to an elevation of 4374, 10 feet below the top of the dam.

The maximum reservoir level, at 4374 feet, will be maintained by excavating a trapezoidal channel, approximately 1300 feet in length, along the existing natural spillway (see Figure 5). A concrete spillway crest structure will be located at the entrance to the channel. The design of the crest structure provides a V-notch weir which allows the restriction to be effected with minimal spill due to wave action.

The plan for remedial repair considers excavation and fill of the area of sloughing on the downstream face of the dam (see Figure 5). Suitable natural fill material is believed to be available on site from the area of the natural emergency spillway. A drainage blanket covering the area of the base of the excavation is also

TABLE I
Opinion of Probable Cost for Conceptual Design

	Amount
Preparation of Final Designs and Specifications	$75,000
Geotechnical Engineering	$10,000
Permitting and Mitigation	$10,000
Legal Fees	$5,000
Acquisition of Access and Rights-of-Way	$5,000
Cost of Project Components:	

Item Description	Quantity	Unit	Unit Price	Amount
Mobilization and Demobilization	Lump Sum	LS	$35,000.00	$35,000
Demolition of Outlet Works & Concrete Facing	Lump Sum	LS	$15,000.00	$15,000
Earthwork				
Excavate Existing Embankment, Keyway and Accumulated Sediment Upstream	47,600	CY	$2.25	$107,100
Borrow Embankment Fill	50,700	CY	$1.25	$63,375
Place and Compact New Embankment	44,100	CY	$4.00	$176,400
Riprap	3,600	CY	$35.00	$126,000
Riprap Bedding	1,000	CY	$15.00	$15,000
Blanket and Toe Drain	4,250	CY	$15.00	$63,750
Geotextile Filter	4,775	SY	$1.30	$6,208
Gate, Stem, Operator and Vent Pipe	Lump Sum	LS	$35,000.00	$35,000
Outlet Pipe	150	LF	$250.00	$37,500
Seepage Collars	8	EA	$360.00	$2,880
Impact Stilling Basin	27	CY	$300.00	$8,100
Armored Spillway Crest Structure	Lump Sum	LS	$5,000.00	$5,000
Monitoring Instrumentation	Lump Sum	LS	$15,000.00	$15,000
Clear, Grub, & Revegetate	8.3	Ac	$1,000.00	$8,300
			SUBTOTAL	$719,613
Repair Inlet Basin	Lump Sum	LS	$4,575.00	$4,575
Parshall Flume, Stilling Well	Lump Sum	LS	$5,500.00	$5,500
Downstream Channel Lining				
Excavate Hillside	7,130	CY	$1.25	$8,913
Excavate Channel	615	CY	$4.50	$2,768
Channel Lining	210	CY	$275.00	$57,750
			SUBTOTAL	$ 799,119
			10% Construction Engineering	$ 79,912
			SUBTOTAL	$ 879,031
			15% Contingencies	$ 131,855
			CONSTRUCTION COST TOTAL	$1,010,886

CONSTRUCTION COST TOTAL	$1,010,000
TOTAL COST	$1,115,000
USE	$1,100,000

considered in the plan. Granular material, suitable for use in a drainage blanket, is believed available from Torrington. Access to the area of repair is very restricted which contributes to higher unit prices relative to those shown for Alternative I. Attention will need to be made to restricting construction activity away from the area of the inverted siphon of the pipeline to the North Main Canal.

During the inspection conducted on October 23, 1992, the existing outlet conduit was observed to be cracked in a number of locations. The cracks provide a pathway for piping into the embankment. The proposed remedial rehabilitation plan includes inserting a welded steel pipe, with a maximum diameter of 30 inches, into the existing outlet conduit. The new outlet pipe will be extended approximately 30 feet downstream of the existing outfall to provide discharge of released water away from the toe of the embankment. The plan also includes a new inclined slide gate intake structure and a new stilling basin located at the out-fall of the steel outlet pipe.

The plan does not include any remedial repair of the existing concrete facing on the upstream slope of the dam. The worst deterioration of the facing was observed to be limited to a horizontal "band" between historic high and low reservoir levels. The reservoir restriction should keep the pool level below this "band" and the existing facing may provide adequate protection to the embankment from wave action.

Table II presents an opinion of probable cost for the remedial repair of the existing dam and appurtenances.

2.3 ADDITIONAL IMPROVEMENTS

Both alternative plans include three items ancillary to repair of the dam. First, repair of the existing inlet stilling basin from Hawk Springs Canal is included because of differential settlement noted during field investigations. The pipe which leads to the stilling basin from the bifurcation structure on Hawk Springs Canal has become offset, thereby impairing its function.

Second, during one of our discussions with the HCCD, they had requested inclusion of a flow measuring device below the dam. Accordingly, installation of a Parshall flume measuring device is provided.

Finally, each plan considers lining the outlet channel from the dam downstream to Sinnard Ditch. The channel alignment is proposed to be straightened. Excavation of the hillside which forms the south and east bank to the existing channel will be completed to allow the proposed alignment.

3.0 ECONOMIC ANALYSIS

The HCCD reports they currently assess a total of 10,178.83 acres on an acre-share basis. Their assessment rate has risen from $9.00 per acre-share in 1986 to $12.00 per acre-share in 1992. Assessments could increase by $10.29 beginning in 1993 in order to generate the revenue to repay two loans made from the State of Wyoming to construct improvements to district facilities in the mid-1980s. The first payment on these two loans is due May 1, 1994.

The 1993 Session of the Wyoming Legislature appropriated $1,100,000 to HCCD to construct the selected rehabilitation plan for Sinnard Dam. Of this total amount, 75 percent or $825,000, was a grant, and 25 percent, $275,000, was in the form of a loan with an interest rate of 4 percent and a 50-year amortization period. The annual repayment obligation for this loan is $12,801.31, or $1.26 per acre-share. The repayment period for this loan begins after the rehabilitation project has been completed.

The combined effect of the two existing loans and the new loan for Sinnard Dam could be to increase the annual assessment by $11.55. HCCD may need to increase the annual assessment from $12.00 to $23.55 per acre-share.

TABLE II

Opinion of Probable Cost for Remedial Rehabilitation Plan

	Amount
Preparation of Final Designs and Specifications	$40,000
Geotechnical Engineering	$10,000
Permitting and Mitigation	$10,000
Legal Fees	$5,000
Acquisition of Access and Rights-of-Way	$5,000
Cost of Project Components:	

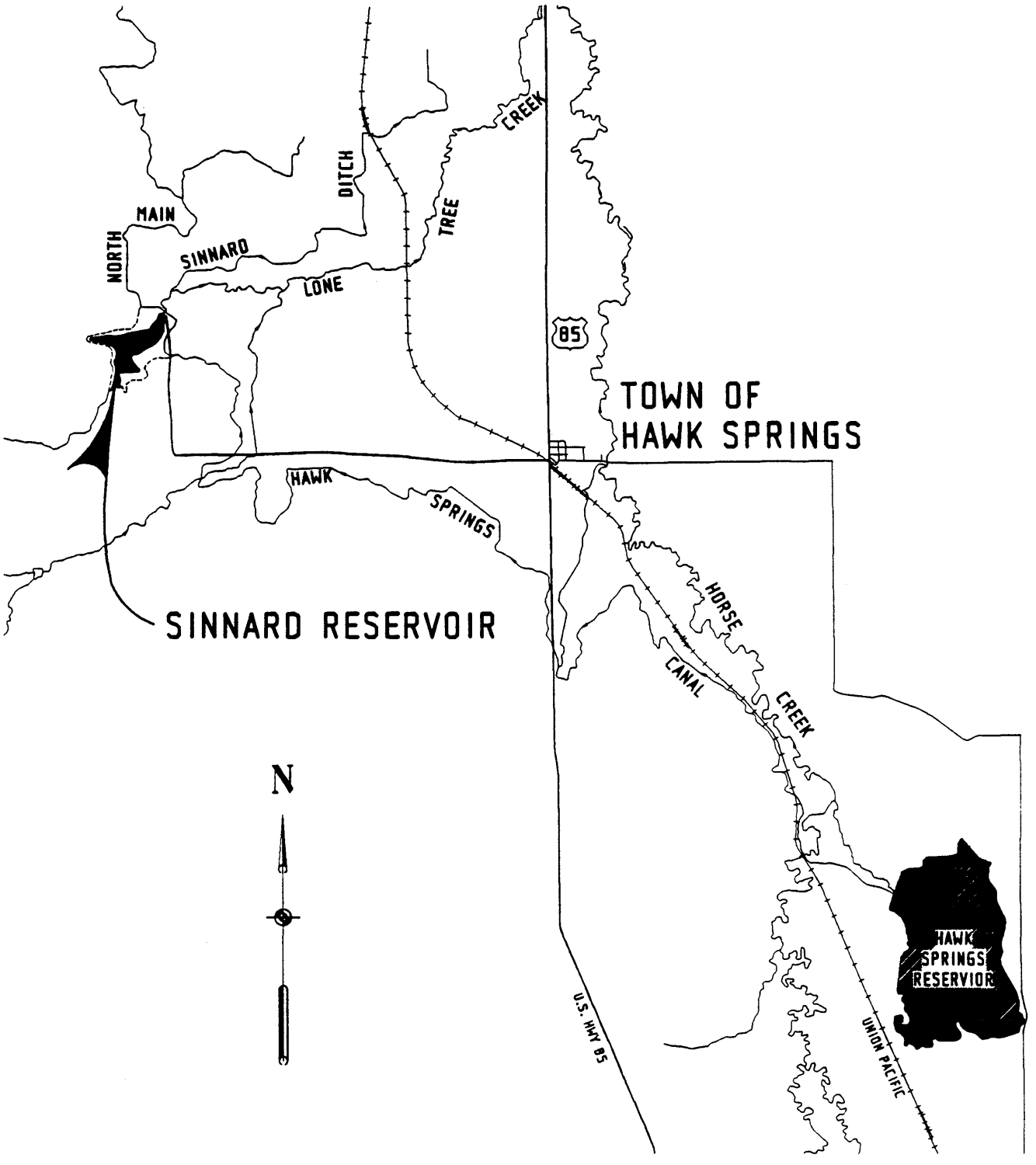
Item Description	Quantity	Unit	Unit Price	Amount
Mobilization and Demobilization	Lump Sum	LS	$10,000.00	$10,000
Demolition				
Outlet Headwalls	Lump Sum	LS	$1,000.00	$1,100
Operator, Gate, & Stem	Lump Sum	LS	$2,750.00	$2,750
Rehabilitate Outlet Works				
30" Welded Steel Pipe	140	LF	$100.00	$14,000
Grout Outlet Conduit	16	CY	$550.00	$8,800
Stilling Basin	13	CY	$300.00	$3,900
Pipe Encasement	30	CY	$250.00	$7,500
New Gate, Operator & Stem	Lump Sum	LS	$17,500.00	$17,500
Repair Dam Embankment				
Excavation of Sloughed Area	2,400	CY	$4.50	$10,800
Dewatering	Lump Sum	LS	$3,500.00	$3,500
Fill & Compact Sloughed Area	3,150	CY	$6.75	$21,263
Drainage Blanket	250	CY	$15.00	$3,750
Filter Fabric	605	SY	$1.30	$787
Spillway Excavation				
Earthwork	10,650	CY	$1.25	$13,313
Crest Structure	15	CY	$275.00	$4,125
Riprap	15	CY	$35.00	$525
Clear, Grub, & Revegetate	5.4	CY	$1,000.00	$5,400
			SUBTOTAL	$129,013
Repair Inlet Basin	Lump Sum	LS	$4,575.00	$4,575
Parshall Flume, Stilling Well	Lump Sum	LS	$5,500.00	$5,500
Downstream Channel Lining				
Excavate Hillside	7,130	CY	$1.25	$8,913
Excavate Channel	615	CY	$4.50	$2,768
Channel Lining	210	CY	$275.00	$57,750
			SUBTOTAL	$208,519
			10% Construction Engineering	$20,852
			SUBTOTAL	$229,371
			15% Contingencies	$34,406
			CONSTRUCTION COST TOTAL	$263,777

	$264,000
TOTAL COST	$334,000
USE	$350.000

4.0 RECOMMENDATIONS

The lower cost associated with Alternative I is offset by associated risks. The most immediate risk is that the combined effect of lost storage due to significant accumulation of sediment in the reservoir and the restriction to the reservoir elevation, to 4374 feet, may likely render the facility inadequate to meet the needs of the HCCD. Additionally, there exists the possibility that the assumption that restricting the reservoir elevation to 4374-feet elevation will eliminate the cause of the observed sloughing is not valid.

Based on the cost of the reconstruction alternatives identified at the conclusion of Phase I studies, the WWDC and HCCD evaluated the operational and economic worth of Sinnard Reservoir. It was concluded the HCCD believes Sinnard Reservoir is invaluable to the efficient operation of their irrigation system. In consideration of the value of this facility to the HCCD, the project team recommended construction of a new dam and appurtenances (Alternative I) at Sinnard Reservoir. If the plan for construction of a new dam and appurtenances is not economically feasible, remedial repair of the facility should be considered. In connection with the final design and construction of the chosen rehabilitation plan, an accurate survey of the reservoir area should be completed to allow historical permit discrepancies with the SEO to be resolved.



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SINNARD RESERVIOR
VICINITY MAP

FIGURE
1

N

TO NORTH MAIN

4380

4374

4368

4374

4380

4386

4380

4386

4398

4392

4386

4380

4392

4386

4380

TEST HOLE #5

TEST HOLE #9

TEST HOLE #8

TEST HOLE #6

TEST HOLE #2

TEST HOLE #1

TEST HOLE #3

TEST HOLE #4

TEST HOLE #7

TEST HOLE #11

APPROXIMATE LOCATION OF OUTLET CHANNEL TO SINNARD DITCH

HEADGATE

APPROXIMATE LOCATION OF INVERTED SIPHON PIPELINE TO NORTH MAIN

X-SECTION BASELINE AT TOP EDGE OF EXISTING CONCRETE SLOPE PAVING

TOE OF EXISTING DAM DOWNSTREAM SIDE

TOP OF EXISTING DAM DOWNSTREAM SIDE

TOP OF EXISTING DAM UPSTREAM SIDE

TEST HOLE #10

HAWK SPRINGS CANAL DIVERSION (BEGIN INVERTED SIPHON TO NORTH MAIN)

HAWK SPRINGS CANAL

EXISTING IMPACT STILLING BASIN

DIVERSION FROM CANAL TO RESERVOIR

RESERVOIR

EXISTING NATURAL EMERGENCY SPILLWAY

0+00

1+00

2+00 (END CONCRETE)

3+00

4+00

5+00

6+00

7+00 (END CONCRETE)

8+00

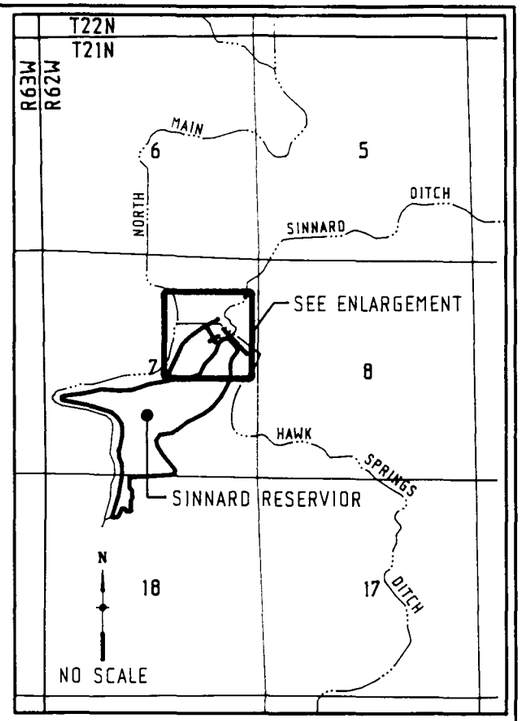
8+50

SECTION 7
T21N, R62W

SECTION 8
T21N, R62W

200 0 200 400 600

APPROXIMATE SCALE OF FEET



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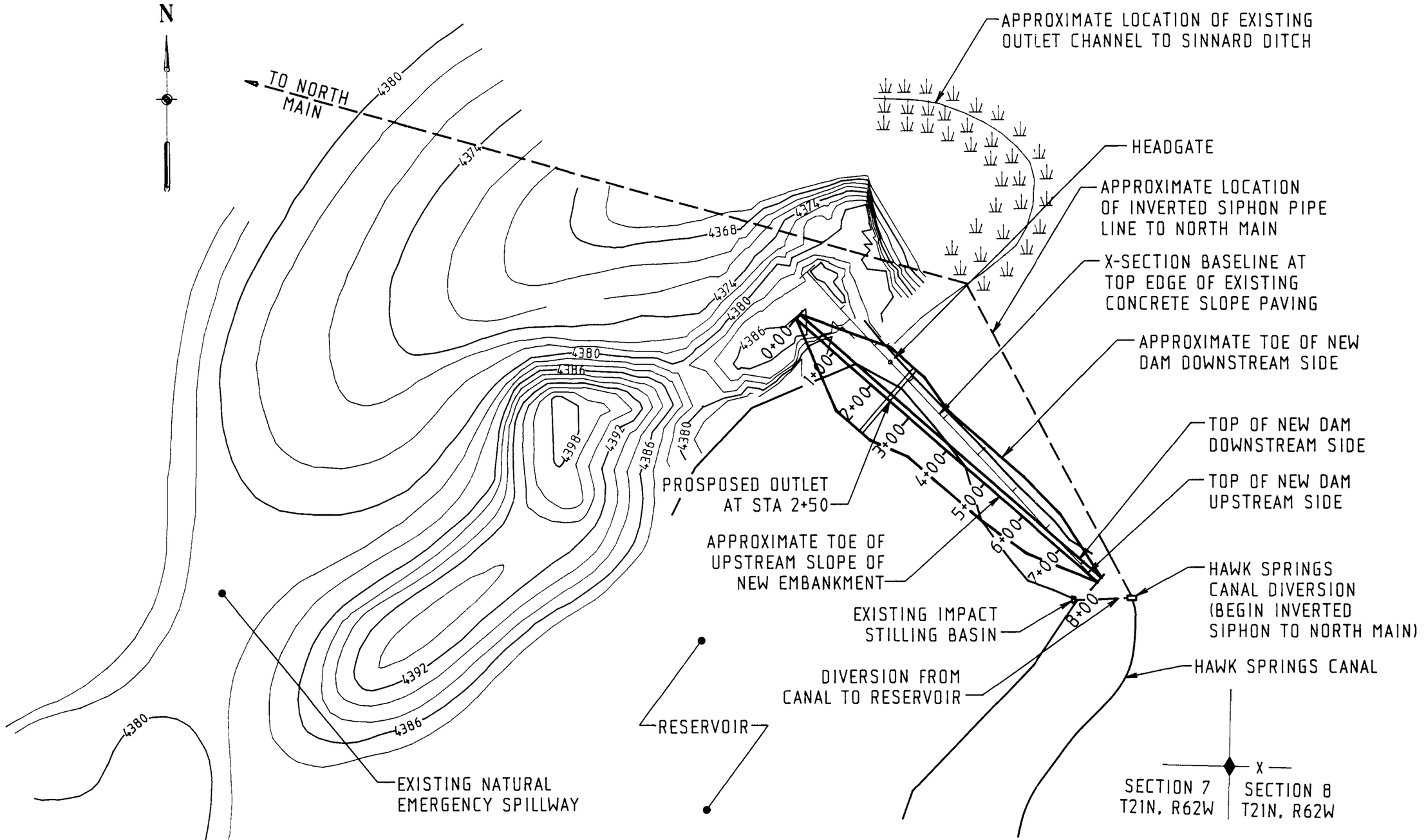
SINNARD RESERVOIR

LOCATION MAP

FIGURE:
2



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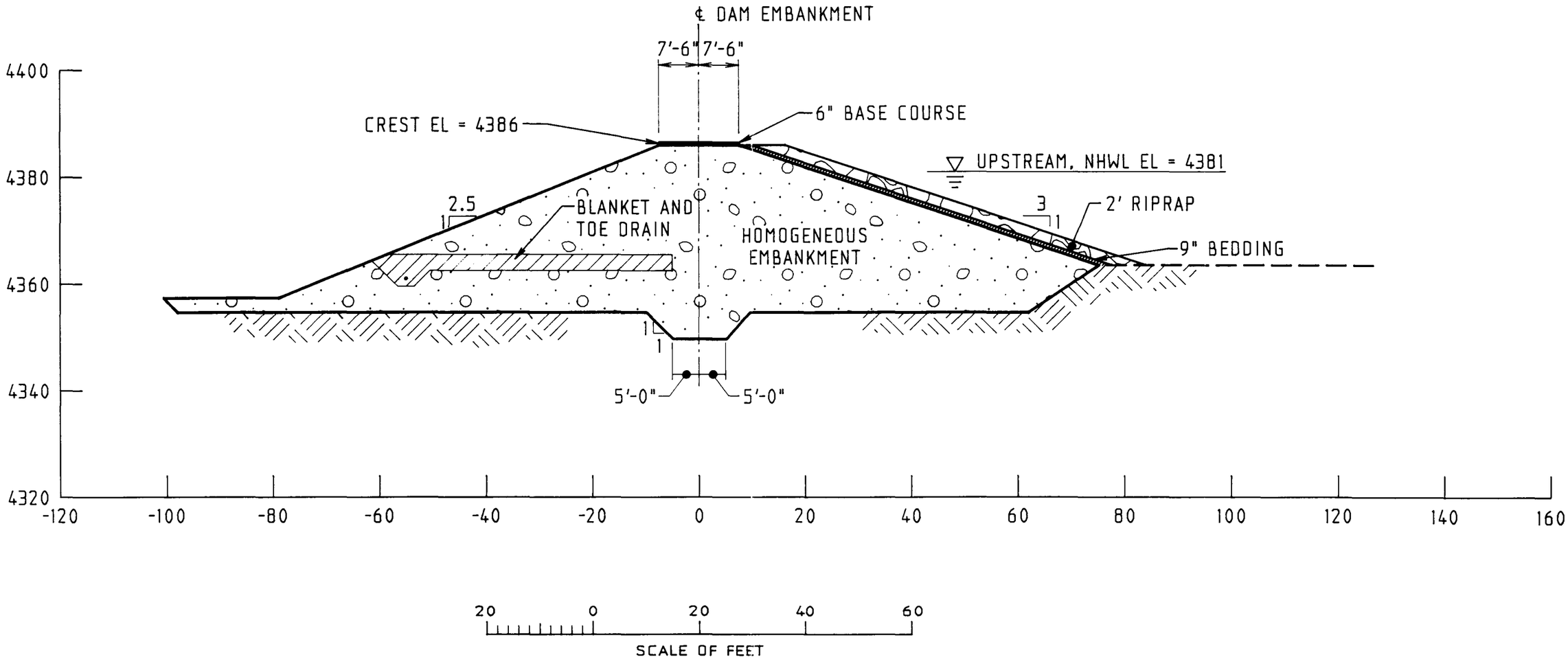
SINNARD RESERVOIR

PROPOSED NEW EMBANKMENT ALIGNMENT

FIGURE 3



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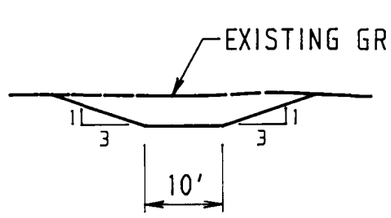
SINNARD RESERVOIR

GENERAL EMBANKMENT
CROSS SECTION

FIGURE
4



TYPICAL SECTION A-A
SCALE: 1"=20'

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SINNARD RESERVOIR

REMEDIAL REHABILITATION PLAN

FIGURE: 5