

WATER PERMIT NO. 6130-3

Name of Applicant: US Fish & Wildlife Service

Address: PO Box 25486, DFC, Denver CO 80225

Phone: 605 236-5321

Amount of Water Claimed: 100 AF storage plus 29 AF seasonal (total 129 AF) Total Acres: NA

Source of Water Supply: Cain Creek

Water to be used for: fish & wildlife propagation

County: Beadle

Type of Waste Disposal System: NA

Location: 6 miles southwest of Huron

PRIORITY Date Received: 3-15-1999

Fee: \$15

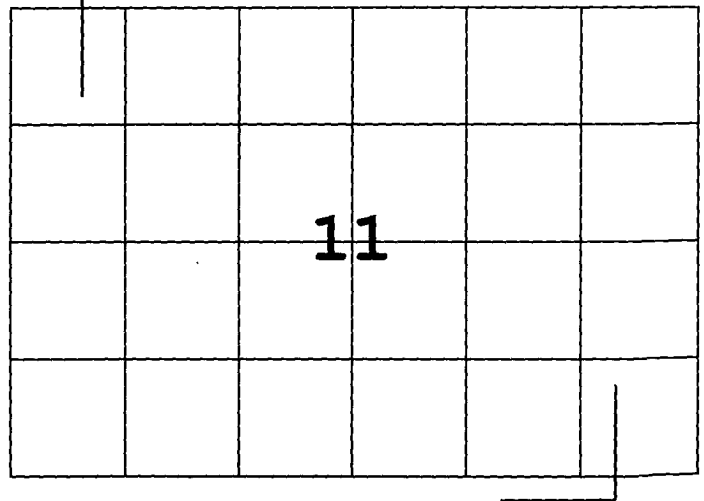
Corrected Application Received:

Period of Annual Use: January 1 – December 31

Remarks: Vested Right with claimed priority date of December 31, 1939

Water Impounded: E ½ SE ¼ Sec 11-T109N-R62W

Land to be Irrigated: NA



Depth of Well:

Well Driller:

Remarks:

Type of Map: topographic

Prepared by: A E Bevilacqua, USFWS

Reviewed and the Number Assigned on: 3-15-1999

By: Karen Schlaak

Notice of Hearing - date to intervene: _____

SOUTH DAKOTA
VESTED WATER RIGHT NO. 6130-3

Date of Receipt of Claim March 15, 1999.

Date of Validation September 17, 1999.

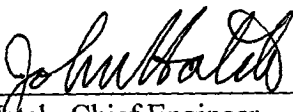
The Chief Engineer, on behalf of the Water Management Board validated Vested Water Right Claim No. 6130-3 for U. S. Fish & Wildlife Service, PO Box 25486, Denver Federal Center, Denver CO 80225 with the following limitations, conditions and qualifications:

1. Vested Water Right No. 6130-3 validates a vested water right claim to reconstruct a 11.0 acre-feet impoundment known as Cain Creek Dam. The dam stores 11.0 acre feet of water at normal service outlet elevation. The dam is located in the SE ¼ SE ¼ Section 11 with water impounded in the E ½ SE ¼ Section 11; all in T109N-R62W. The dam is undergoing repair work due to flooding in 1997 and normal maintenance.
2. The water appropriated is from Cain Creek and runoff used to provide habitat for fish and wildlife propagation at the Cain Creek Dam and may not exceed the amount of water needed for beneficial use.
3. The water is to be used during the following annual period: January 1 – December 31.
4. The priority date of the Vested Water Right is December 31, 1939.
5. The water use system has been constructed and water has been applied to beneficial use.
6. Water Rights obtained in compliance with the laws of the State of South Dakota must not be unlawfully impaired by this appropriation.

QUALIFICATION

Vested Water Right No. 6130-3 is validated for a dam with storage capacity of 11.0 acre feet of water and sufficient water annually to maintain the water level to the outlet elevation of 1288 feet mean sea level.

WATER MANAGEMENT BOARD

By: 
John Hatch, Chief Engineer
Water Rights Program
Department of Environment and Natural Resources

SEP 27 1999

date



STATE OF SOUTH DAKOTA

VESTED RIGHT WATER LICENSE NO. 6130-3

(1) The U.S. Fish & Wildlife Service, PO Box 25486, Denver Federal Center, Denver CO 80225 made Application No. 6130-3, for validation of a vested right claim to impound 11.0 acre-feet of water from Cain Creek and runoff, Beadle County, South Dakota, for fish and wildlife propagation purposes at the Cain Creek Dam. Vested Water Right No. 6130-3 was validated September 17, 1999 with a priority date of December 31, 1939. Construction of the described water supply system and application of water to beneficial use complies with applicable provisions of South Dakota State Law.

(2) It is certified that the vested right owner is entitled to impound 11.0 acre-feet of water for beneficial use with sufficient water annually to maintain the water level to the outlet elevation of 1288 feet mean sea level. The location of Cain Creek dam is in the SE ¼ SE ¼ Section 11 and impounds water in the E ½ SE ¼ Section 11-T109N-R62W.

(3) Pursuant to Section 46-5-30.1 the U.S. Fish & Wildlife Service, PO Box 25486, Denver Federal Center, Denver CO 80225 the holder and/or owner of Vested Water Right No. 6130-3 with a priority date of December 31, 1939 is issued a license to impound 11.0 acre-feet of water from Cain Creek and runoff in Cain Creek Dam with sufficient water annually to maintain the water level to the outlet elevation of 1288 feet mean sea level. The water is to be used for the purpose of fish and wildlife propagation. This license is subject to any limitations, conditions or qualifications listed in Vested Water Right No. 6130-3 and subject to South Dakota State Law.



JOHN HATCH, Chief Engineer
Water Rights Program
Department of Environment and Natural Resources

SEP 27 1999

date



FORM 2: Application for uses other than irrigation.
(type or print)



Mail to: Water Rights Program Joe Foss Building 523 E. Capitol Pierre, SD 57501-3181 (605) 773-3352	(office use only)
	No. <u>6/30-3</u> Hydrologic Unit <u>10/60006</u>
	Basin <u>James River</u>
	Newspaper <u>The Plainsman, Huron, SD</u>

Application For Permit To Appropriate Water Within The State Of South Dakota

Check use(s) of water:

☐ Municipal	☐ Suburban Housing	☐ Recreational	☐ Institutional
☐ Rural Water System	☐ Commercial	☒ Fish & Wildlife	☐ Geothermal Heat
☐ Domestic (over 18 gpm)	☐ Industrial	☐ Other	

Type of Application: ☐ New ☒ Vested Right (Use predates Mar 2, 1955) ☐ Future Use Reservation
(check one) ☐ Place to Beneficial Use Water Reserved by Future Use Permit No. _____
☐ Amendment/Correction to Permit No. _____

Description of amendment/correction: (i.e. change diversion point(s), add diversion point(s), change use, etc.) _____

1. Name of Applicant UNITED STATES OF AMERICA
Fish and Wildlife Service Phone (303) 236-5321
(check one) ☒ Owner ☐ Tenant/lessee

Mailing Address P.O. Box 25486, DFC Denver State CO 80225
(Street, RR. or Box) (Zip Code)

2. Amount of water claimed _____ *CFS or _____ **GPM 11 ***AF
(*Cubic Feet per Second) (**Gallons per Minute) (**Acre Feet - storage capacity of dam/dugout or annual use if applicable)

3. Source of water supply Cain Creek

4. Location of point of diversion (example - 3 wells in SW1/4 NE1/4 section 12-T104N-R53W) Water Impounded:
E 1/2 SE 1/4 Section 11, T109N, R62W Diversion Pt.: SE 1/4 SE 1/4 Sec 11-T109N-R62W
County Beadle

5. County or counties where water will be used Beadle

6. Annual period during which water is to be used January 1 thru December 31

7. Give a description of the project. When available include any preliminary engineering report or other reports or information that will help explain the project. (Attach sheet if more space is needed)

As described in letter, enclosures, and attachments.

11 AF at service elevation & 268 AF at embankment crest.

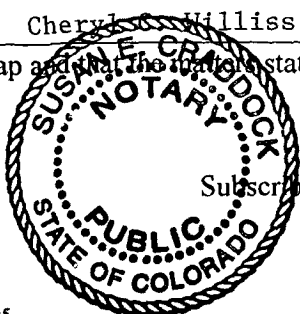
Attachments: Attach Form 2A if diversion is from a well or dugout, or if storage of water is proposed. Attach map and any other technical information. (see instructions)

STATE OF ~~SOUTH DAKOTA~~ COLORADO

SS

County of Jefferson

I, Cheryl C. Willis, the applicant, certify that I have read this application, have examined the attached map and that the information stated are true and that I intend, and am able to complete the necessary construction.



Subscribed and sworn to before me this 9th day of March 1999

Signed Cheryl C. Willis
Cheryl C. Willis, Agent

Susan E. Craddock
Notary Public

Supplemental Information

(type or print in ink)

1. Well Information - Proposed Construction

- a) Drill Hole Diameter _____ Depth _____
- b) Casing Type _____ Diameter _____ Thickness _____
- c) Screen Type _____ Diameter _____ Thickness _____
- d) Gravel Pack Thickness _____ Length of Gravel Pack _____
- e) Depth to Top of Water Bearing Material _____
- f) Depth to Water (ground surface to water level) _____
- g) Distance to nearest existing domestic well:
On applicants property _____ On property owned by others _____

2. Wastewater Disposal System Information

- a) Type of System (i.e. septic tank, drain field) _____
- b) System Capacity (gallons) _____ c) Year Constructed _____
- d) Connected to the City of _____ Sanitary System.

3. Dugout Information

- a) Surface Dimensions _____ Depth _____
- b) Depth to water (ground surface to water level) _____

4. Water Storage Dams

If the proposed water use system contains one or more storage dams, please furnish the information requested below for each dam. The locations of the dams need to be shown on the map submitted with the application.

- a) If a private engineering firm or government agency was involved in the design of this dam, please give their name and address:

UNITED STATES OF AMERICA
Fish and Wildlife Service

P.O. Box 25486, DFC, Denver, CO 80225

b) Freeboard 7'

c) Crest Width 10'

Crest Length 646'

d) Height 14'

e) Primary Outlet Capacity 60 cfs

If pipe, diameter stoplog bay

f) Secondary Spillway Capacity 2400 cfs 6870 cfs

Spillway Width 115'

g) X & Y Slope

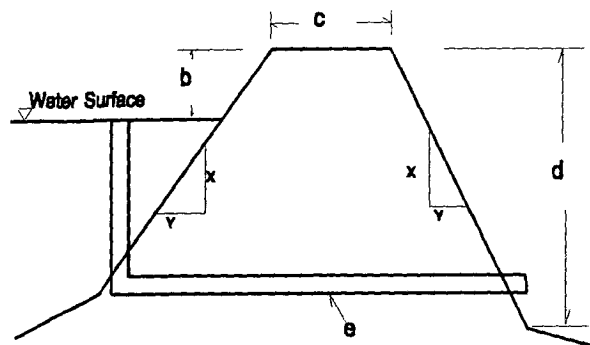
Upstream 3:1

Downstream 3:1

h) Surface Area of Impoundment 26 acres

i) Storage 11 Acre Feet

j) Drainage Area Above Dam 137,866 Acres



AFFIDAVIT OF WATER USE

**AFFIDAVIT OF CONSTRUCTION OF WATER USE SYSTEM
AND APPLICATION OF WATER TO BENEFICIAL USE**

For the
CAIN CREEK WPA
BEADLE COUNTY, SOUTH DAKOTA

Name of Applicant: U.S. Fish and Wildlife Service
P.O. Box 25486, DFC
Denver, CO 80225

A. **Notice of Appropriation** None **Date of Posting** None

Date of Recording None

B. **Date of start of construction of water supply system**

Estimated 1939 (*December 31, 1939*)

C. **Date that water was first applied to beneficial use**

Estimated 1939 (*December 31, 1939*)

D. **Name of owner of original water supply system**

State of South Dakota under Easement Contract with Travelers Insurance
Company of Hartford, Connecticut (*Assumed*)

E. **Amount of water originally applied to beneficial use**

Between 15 - 100 Acre-feet

F. **Present Use of Water - Amount of water now being used**

Between 15 - 100 Acre-feet

G. **Chronological History of Water Use**

In 1994 the Service acquired the Cain Creek Waterfowl Production Area which contains the subject dam.

Since the Service acquired the dam, use has been under the authorities of the Migratory Bird Hunting and Conservation Stamp Act 16 U.S.C. 718(c); the Fish and the Wildlife Act of 1956 (16 U.S.C. 742a-j); and the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd-ee) as amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57) for the purpose(s) of wildlife and recreation as a Waterfowl Production Area subject to all of the provisions of the Migratory Bird Conservation Act 16 U.S.C. 715d, for any other management purposes, for migratory birds, except the inviolate sanctuary provisions.

G. Chronological History of Water Use continued

The WPA is managed to provide suitable nesting and brood-rearing habitat for migratory waterfowl and other migratory bird species. The lake provides brood water for duckling survival and historically, a recreational fishery for local residents.

It is estimated that the original dam was constructed in the late 1930's or early 1940's. On record is an Easement Contract to the State of South Dakota dated November 4, 1936 containing the "right to build a dam."

Because the dam never had a low-level outlet works structure, water would have been impounded continuously until the breach occurred in the spring of 1997. Although there is evidence of a previous breach, repair is also evident and the dam remained functional until this 1997 breach.

The dam was in place when the Service acquired the lands in 1994. We, therefore, are relying upon information in our files and provided by the consultant Woodward-Clyde Federal Services that reference the dam, and the estimated date of construction.

State of Colorado)
) ss
County of Jefferson)

I, Cheryl C. Williss, as agent for the applicant, certify that I have read the foregoing and that the matters therein stated are true.



Signed Cheryl C. Williss

Subscribed and sworn to before me March 9, 1999

Susan E. Craddock
Notary Public

My Commission Expires Aug. 05, 2001

I, the undersigned do hereby certify that I know about the water use system described above, that I have read the foregoing, and that the matters therein stated are true.

Cheryl C. Williss 3/9/1999
Cheryl C. Williss, Agent



BA WTR
WR SD
Mail Stop 60189

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Mountain-Prairie Region

MAILING ADDRESS:
Post Office Box 25486
Denver Federal Center
Denver, Colorado 80225

STREET LOCATION:
134 Union Blvd.
Lakewood, Colorado 80228



MAR 10 1999

Mr. John Hatch
Department of Environment
and Natural Resources
Joe Foss Building
523 East Capitol
Pierre, South Dakota 57501-3181



Dear Mr. Hatch:

The Cain Creek Dam is located on Cain Creek, in Beadle County, South Dakota, near the City of Huron. The dam is located within the Cain Creek Waterfowl Production Area which is owned and managed by the U.S. Fish and Wildlife Service. The 240 acre WPA was acquired by the Service in December 1994, through a title transfer from the U.S. Department of Agriculture, Farmers Home Administration. Prior to the title transfer, the dam had been in private ownership.

The State of South Dakota apparently acquired "...the easement and right to build and construct an artificial lake which will flood with water..." under Easement Contract dated November 4, 1936, for lands on which the dam is located. It is believed that the dam was originally constructed in the late 1930's or early 1940's, as a Works Progress Administration project.

In late March and early April 1997, the dam embankment was overtopped by inflow until a breach approximately 10 feet deep and 25 feet wide developed. Because extensive repair work to this structure is currently proposed, I am submitting the following documents for your review and consideration for the issuance of a Vested Water Right:

- (1) Application for Permit to Appropriate Water Within the State of South Dakota, Forms 2 and 2A, (Vested Right) with attachment;
- (2) Form 2B, Affidavit of Water Use;
- (3) Copy of 1936 Easement Contract;
- (4) Filing Map No. 6R-SD-638-WR-P-36.0;
- (5) Proposed Repair, Plans, and Specifications;
- (6) 1994 Quit Claim Deed; and
- (7) FedSelect Check in the amount of \$15 to cover filing fees.

Mr. John Hatch

2

Please notify this office of the newspaper selected, prior to publication of Notice of Hearing, so that the Authorizations of Advertisement can be forwarded to them.

Because the varied information we have contains conflicting amounts with regard to surface acres and acre feet capacity, we have provided maximum amounts for this application. Prior to construction, a survey will be completed and the corrected information will be provided to your office.

Personnel from the Huron Wetland Management District will contact your office upon completion of the required repairs, so that an inspection can be accomplished.

I apologize that this documentation of use has never been provided, but unfortunately it did not come to my attention until a construction and water rights review was required.

If you have any questions or require further information, please contact Don Fazzan of our Engineering Division regarding design at (303) 236-5320, extension 286 or Ginger Price regarding the water permit process at (303) 236-5321, extension 238.

Sincerely,



Cheryl C. Williss
Chief, Division of Water Resources

Enclosures (7)

RECEIPT

Water Rights Program

South Dakota Department of Environment and Natural Resources

№ 416071

Pierre, _____ March 15, 1999

RECEIVED OF US Fish & Wildlife Services, P.O. Box 25486, Denver, CO 80225-0486
the following amount in fees for services rendered as provided for by law:

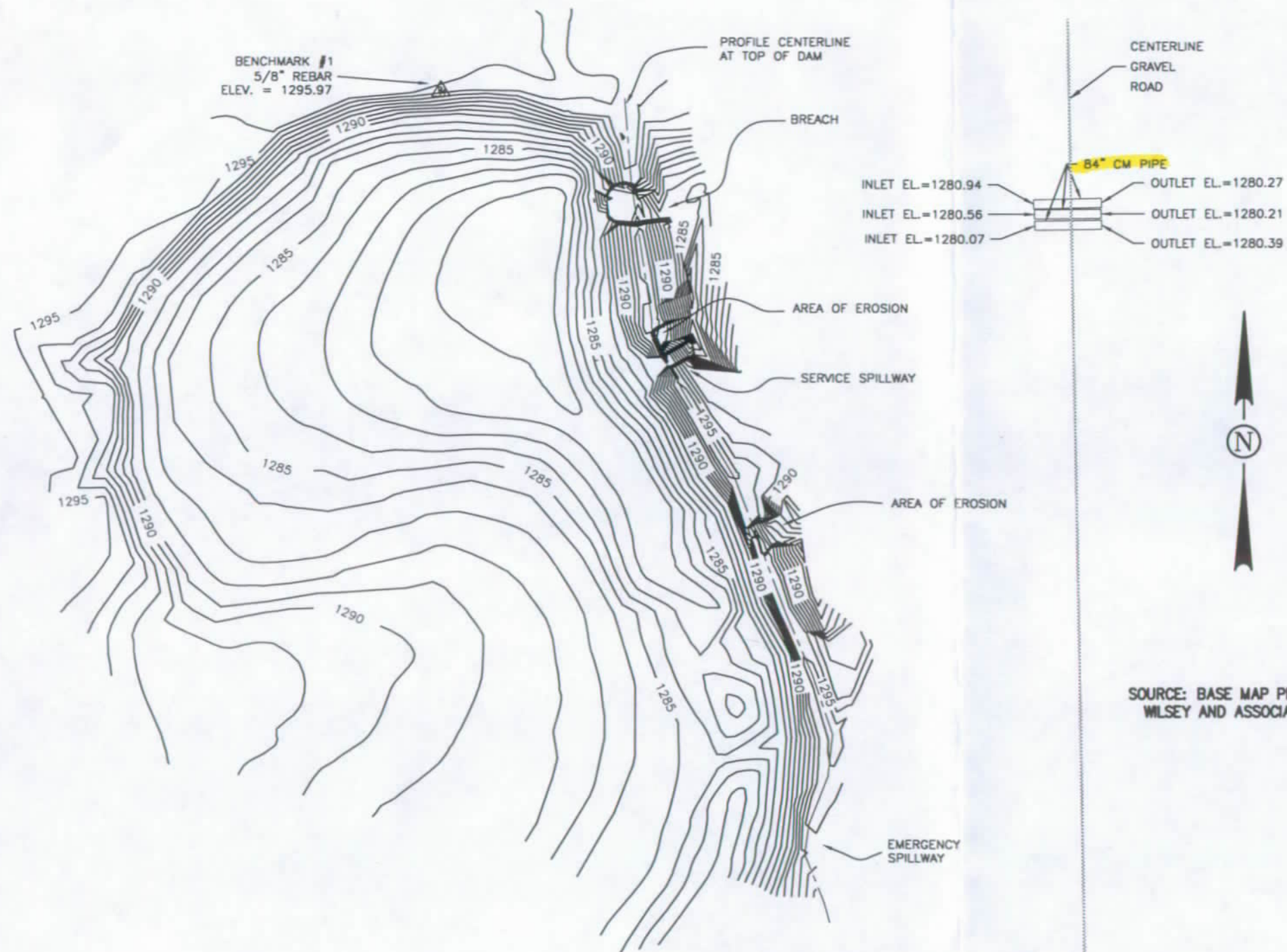
Fee for Application for Permit No. <u>6130-3</u> to Appropriate Water, to construct and to put water to beneficial use _____	15	00
Fee for Application for Permit No. _____ to Appropriate Water, for Future Use _____		
Fee to retain Future Use Permit No. _____ after period of seven years.		
Fee for Inspecting Constructed Works, confirming beneficial use and issuing Water License No. _____		
Fee for Filing Transfer Form _____		
Fee for Filing Extension Request _____		
Fee for _____		

(Any Other Work Provided by Law)	Total	15 00

By

Chief Engineer

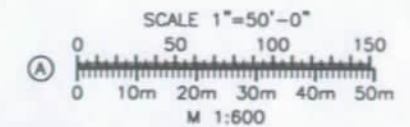
John Hatch 



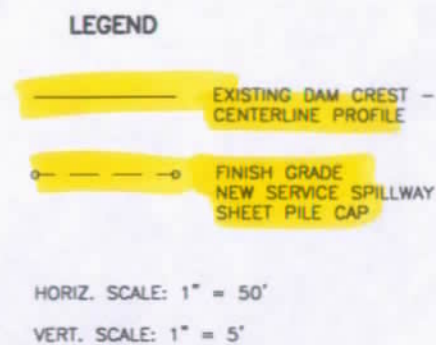
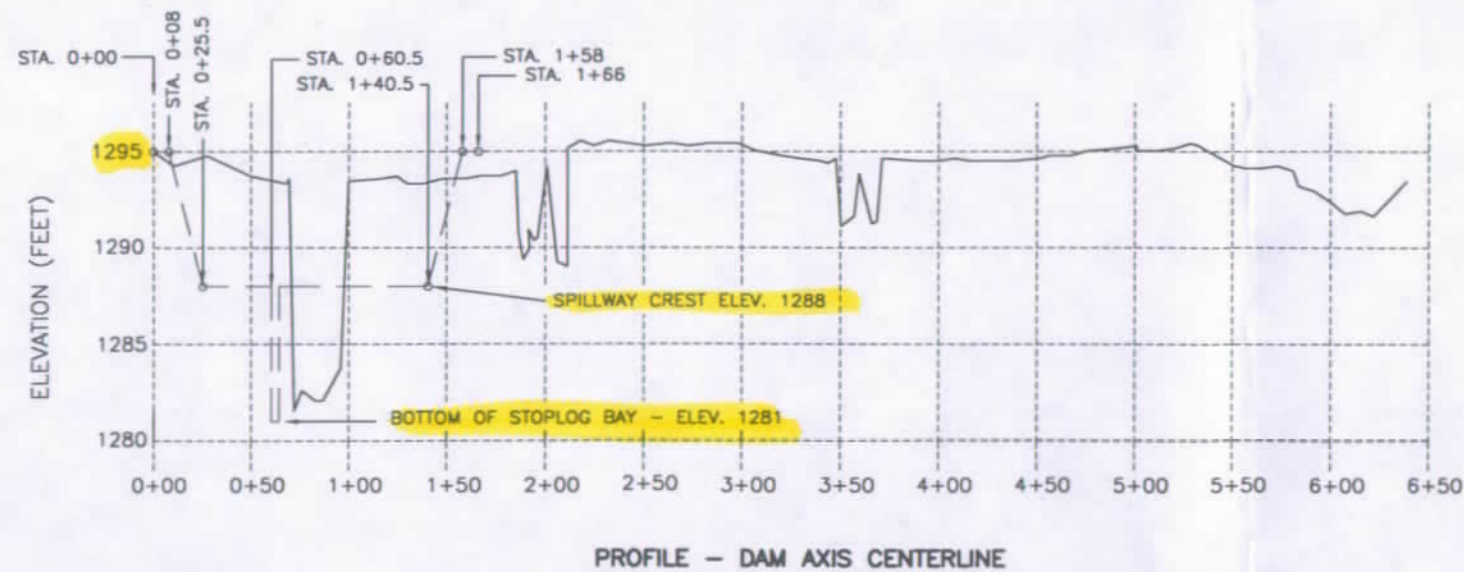
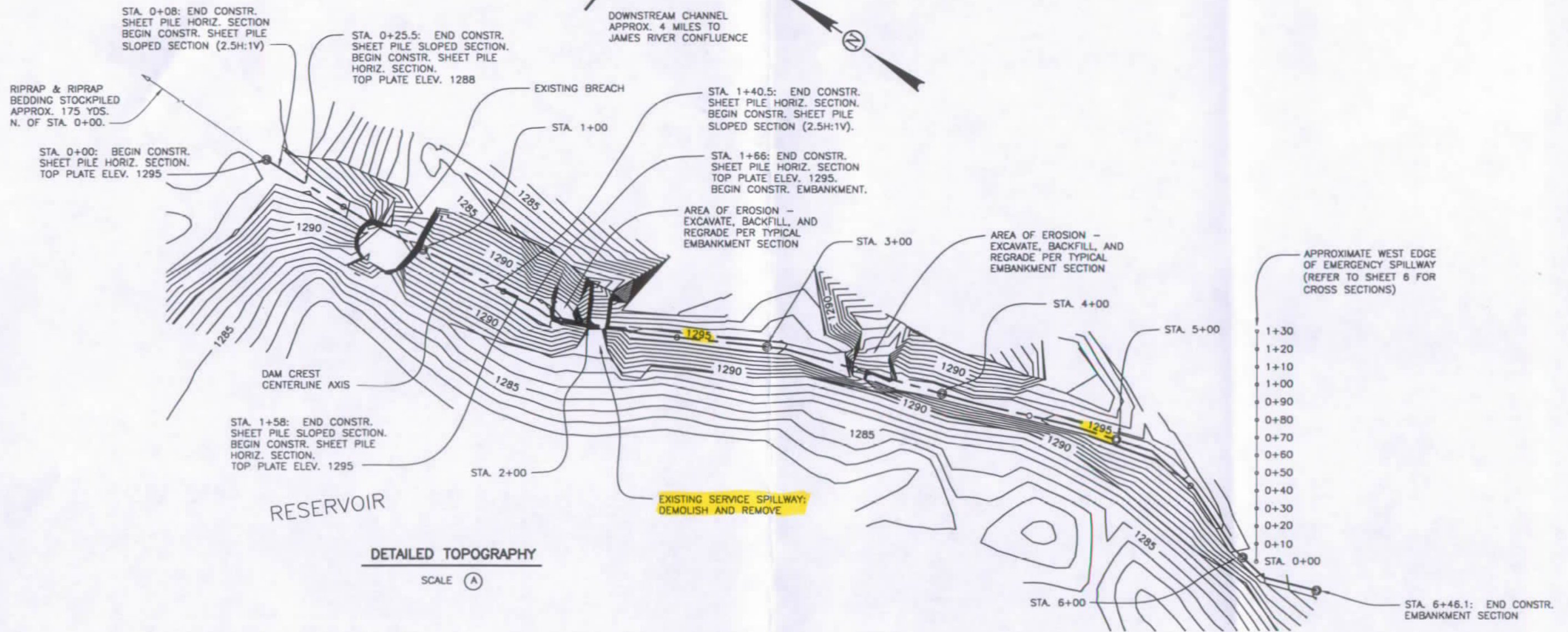
CAIN CREEK DAM
EXISTING SITE TOPOGRAPHY

SCALE (A)

BENCHMARK #2
FIRST POWER POLE NORTH
OF INTERSECTION (APPROX.
400' NORTH OF SECTION CORNER)
NAIL IN EAST POLE
ELEV. = 1304.00

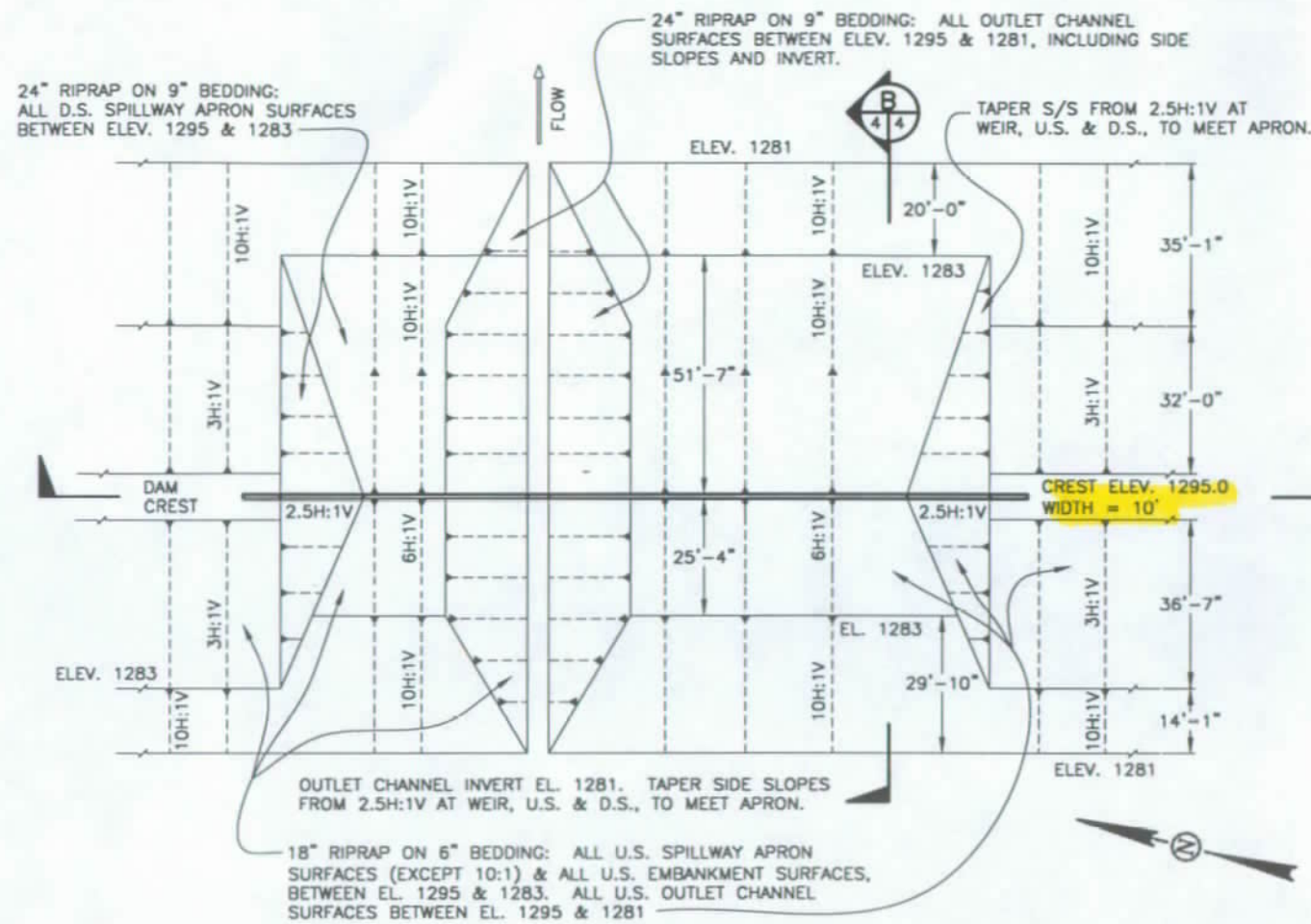


HURON WMD					SUB-SHEET
GENERAL PLAN VIEW AND TOPOGRAPHY					
CAIN CREEK DAM REHABILITATION					
DESIGNED D. FAZZAN	DRAWN D. FAZZAN	CHECKED J. MIYAKE	DATE 02/99	DRAWING NO. 6R-SQ-638-2.0	SHEET 2 OF 9



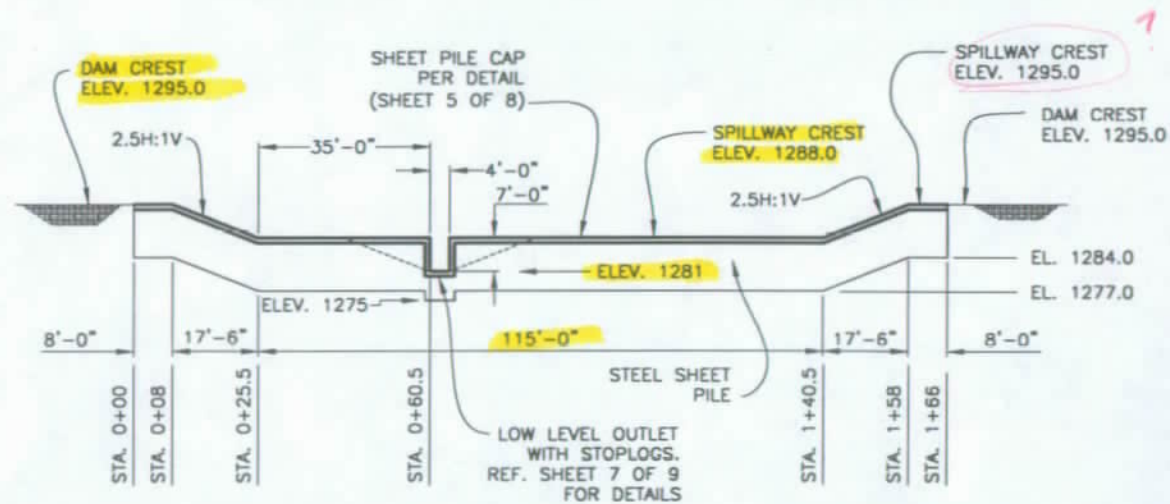
- NOTES:
- STA. 0+00 TO 1+66: CONSTRUCT NEW SPILLWAY SECTION
 - STA. 1+66 TO 2+00: REPAIR EMBANKMENT EROSION
 - STA. 2+00 TO 2+10: REMOVE EXISTING SERVICE SPILLWAY REPAIR EXISTING EMBANKMENT
 - STA. 3+50 TO 3+70: REPAIR EMBANKMENT EROSION
 - STA. 6+16 TO 6+46.1: EXCAVATE, REFILL, AND REGRADE EXISTING EMERGENCY SPILLWAY SECTION
 - STA. 1+66 TO 6+46.1: REHABILITATE EXISTING EMBANKMENT

HURON WMD		DETAILED TOPOGRAPHY & PROFILE ON CREST			SUB-SHEET
CAIN CREEK DAM REHABILITATION					
DESIGNED D. FAZZAN	DRAWN D. FAZZAN	CHECKED J. MIYAKE	DATE 02/99	DRAWING NO. SR-50-638-2.0	SHEET 3 OF 9



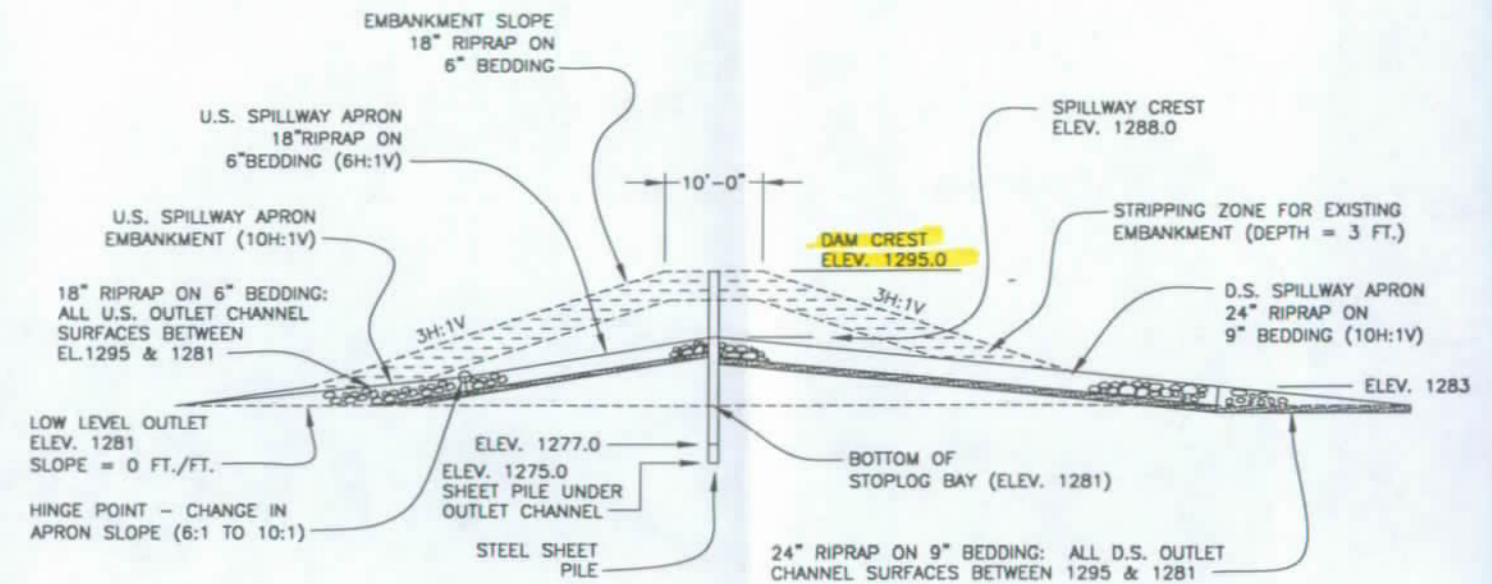
PLAN - NEW SHEET PILE SPILLWAY STRUCTURE

SCALE (A)



SECTION A-A

SCALE (A)

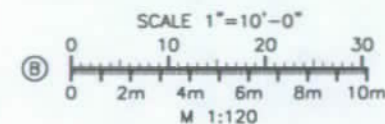


SECTION B-B

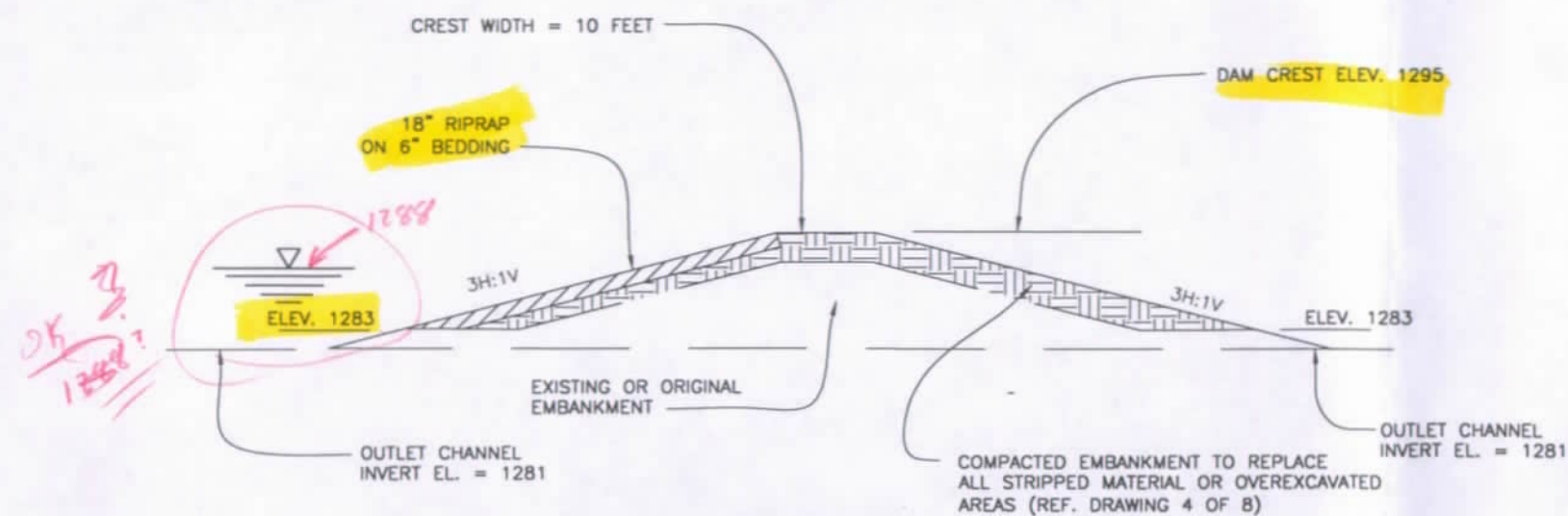
SCALE (B)

NOTES:

1. AT CENTER SECTION OF SPILLWAY, SHEET PILES SHALL BE DRIVEN TO A BOTTOM EDGE ELEV. OF 1277.0
2. SHEET PILE SHALL HAVE CONTINUOUS CAP AS SHOWN ON SHEET PILE CAP DETAIL, SHEET 5 OF 8.
3. REFERENCE SHEET 3 FOR STATIONING OF SPILLWAY STRUCTURE. STA. 0+00 SHALL BE AS LOCATED AND STAKED IN THE FIELD BY GOVERNMENT PERSONNEL.
4. RIPRAP & RIPRAP BEDDING WILL BE GOVERNMENT FURNISHED, CONTRACTOR INSTALLED. MATERIALS ARE STOCKPILED APPROX. 175 YARDS NORTH OF EXISTING LEFT ABUTMENT (REF. SHEET 3 OF 9).
5. ALL ELEVATIONS GIVEN ARE FINISH GRADE. SHEET PILE FINISH GRADE INCLUDES INSTALLED PILE CAP.

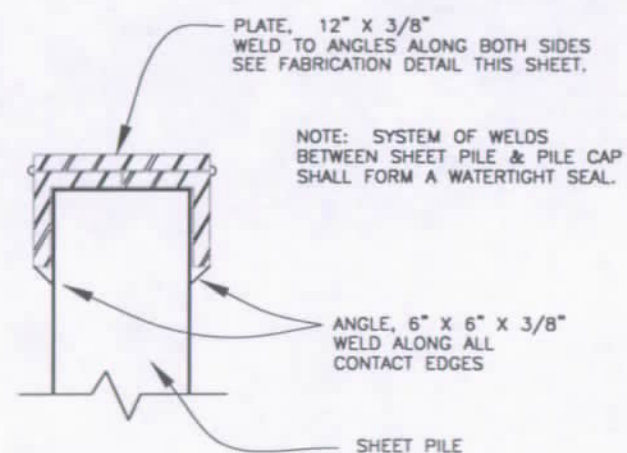


HURON WMD					SUB-SHEET
CAIN CREEK DAM REHABILITATION					
DESIGNED D. FAZZAN	DRAWN D. FAZZAN	CHECKED J. MIYAKE	DATE 02/99	DRAWING NO. 58-SQ-638-2.0	SHEET 4 OF 9



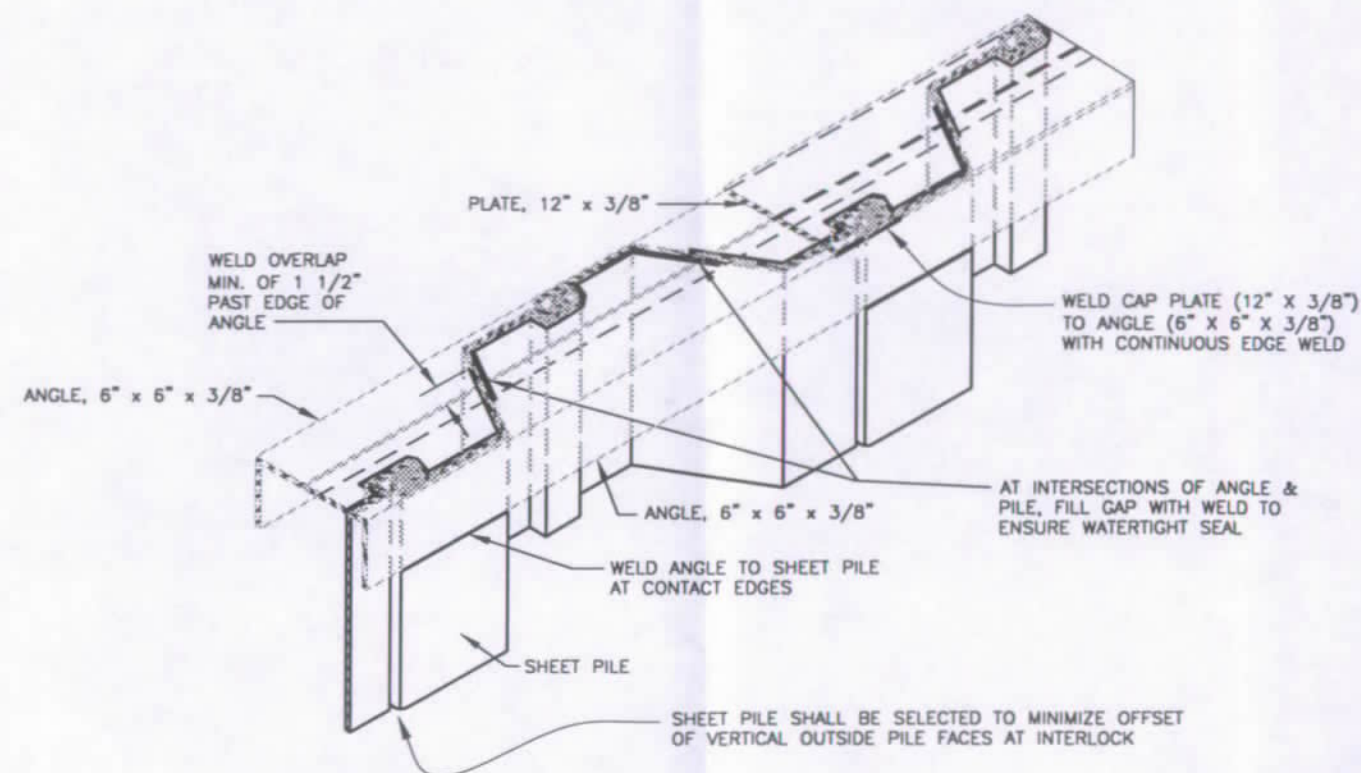
TYPICAL SECTION — REHABILITATED DAM EMBANKMENT

NO SCALE



DETAIL - SHEET PILE CAP

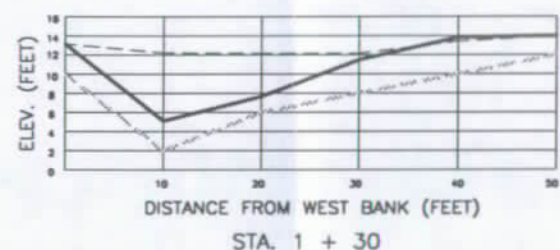
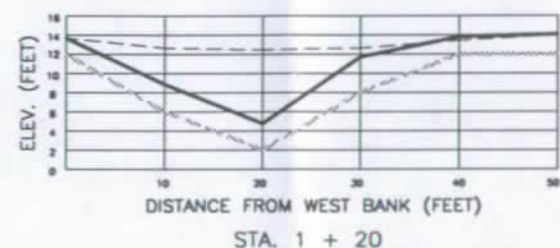
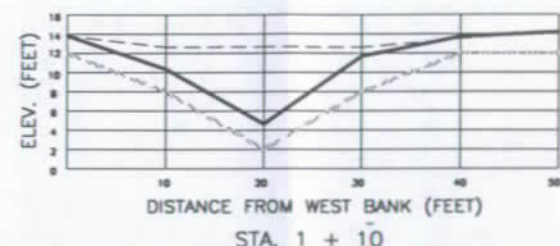
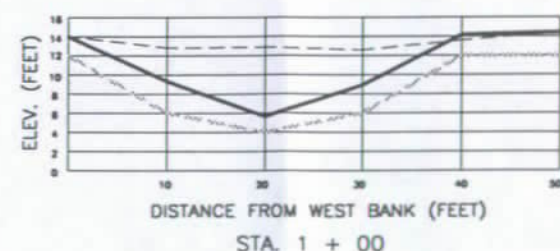
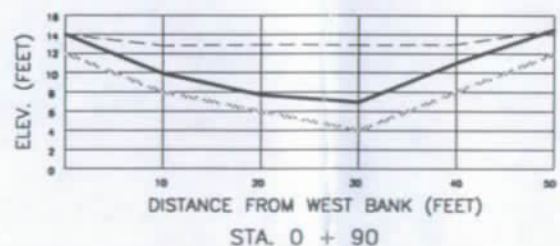
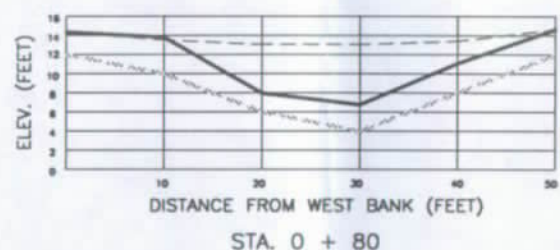
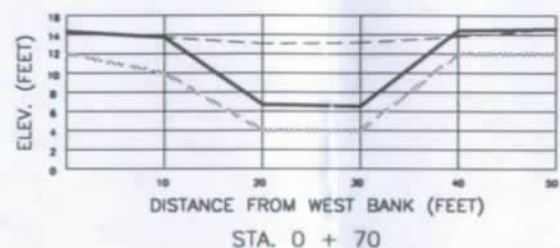
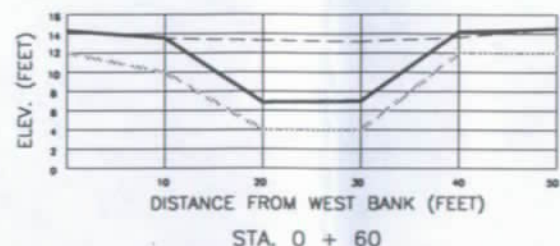
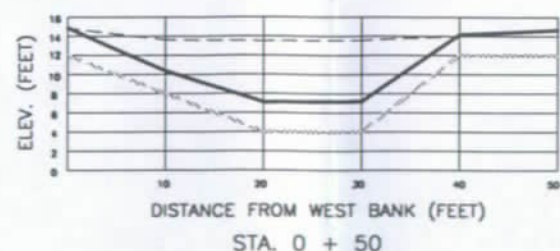
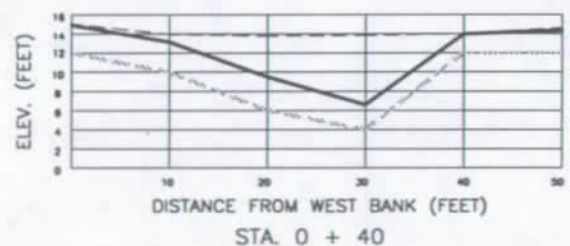
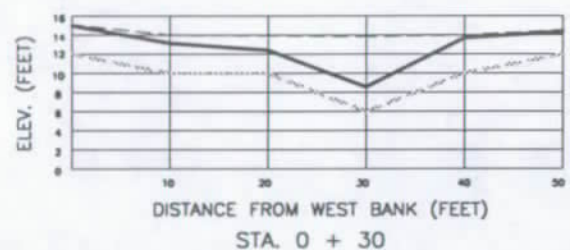
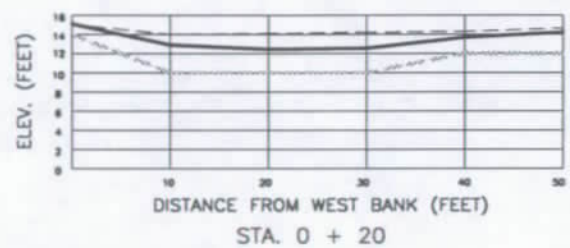
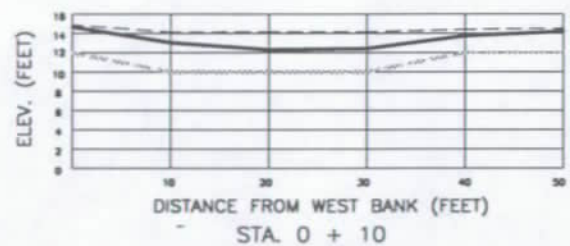
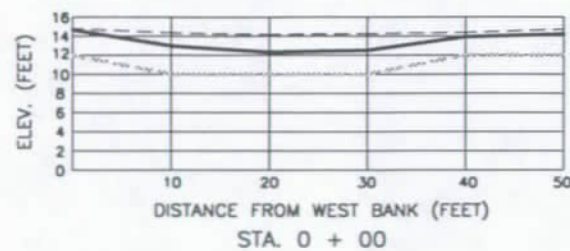
NO SCALE



DETAIL - SHEET PILE PROFILE AND CAP

NO SCALE

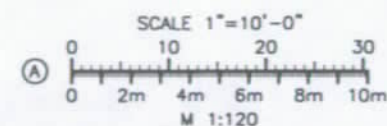
HURON WMD		TYPICAL SECTIONS AND DETAILS			SUB-SHEET
CAIN CREEK DAM REHABILITATION					
DESIGNED D. FAZZAN	DRAWN D. FAZZAN	CHECKED J. MIYAKE	DATE 02/99	DRAWING NO. 6R-SD-638-2.0	SHEET 5 OF 9



Elevations?
Top of Dam Elev 1295'
to STA 6+50

LEGEND

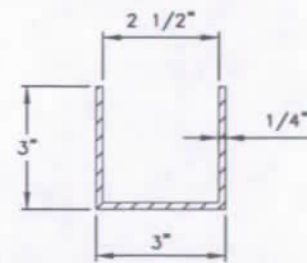
- EXISTING GROUND SURFACE
- RECONSTRUCTED FINAL GRADE (SEE NOTES, THIS SHEET)
- APPROXIMATE STRIPPING DEPTH (SEE NOTES, THIS SHEET)



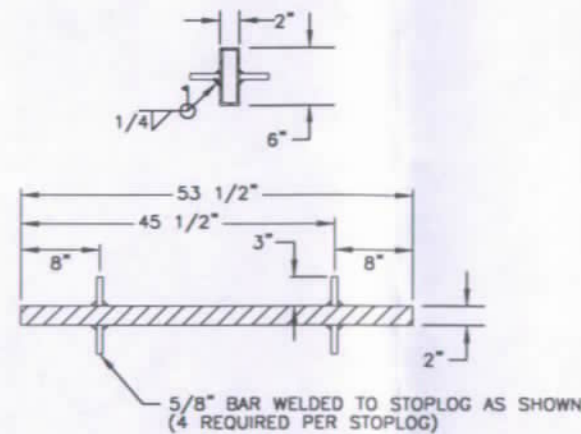
NOTES:

- FOR ALL VIEWS, VERT. SCALE = HORIZ. SCALE = SCALE A.
- STATIONING FROM UPSTREAM TOWARD DOWNSTREAM. HORIZ. DISTANCE MEASURED FROM WEST (LEFT) BANK. REFER TO STATIONING SHOWN ON SHEET 3 OF 9.
- SPILLWAY MAY BE USED AS DISPOSAL AREA, SUBJECT TO APPROVAL BY REFUGE PERSONNEL. IF USED, DISPOSAL OPERATIONS WILL BE CONDUCTED PER SPECIFICATIONS (REF. SECT. 02100, PART 3.02B).

HURON WMD		EMERGENCY SPILLWAY			SUB-SHEET
CAIN CREEK DAM		CROSS SECTIONS			
DESIGNED	D. FAZZAN	DRAWN	D. FAZZAN	CHECKED	J. MIYAKE
DATE	02/99	DRAWING NO.	6R-50-638-2.0	SHEET	6 OF 9

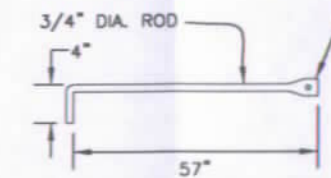


STOPLOG GUIDE DETAIL
NO SCALE

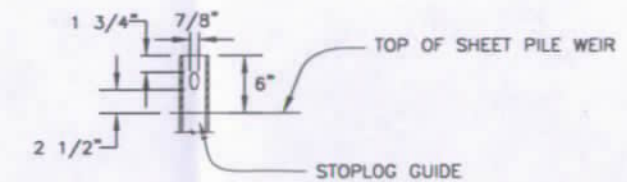


STEEL STOPLOG DETAIL
NO SCALE

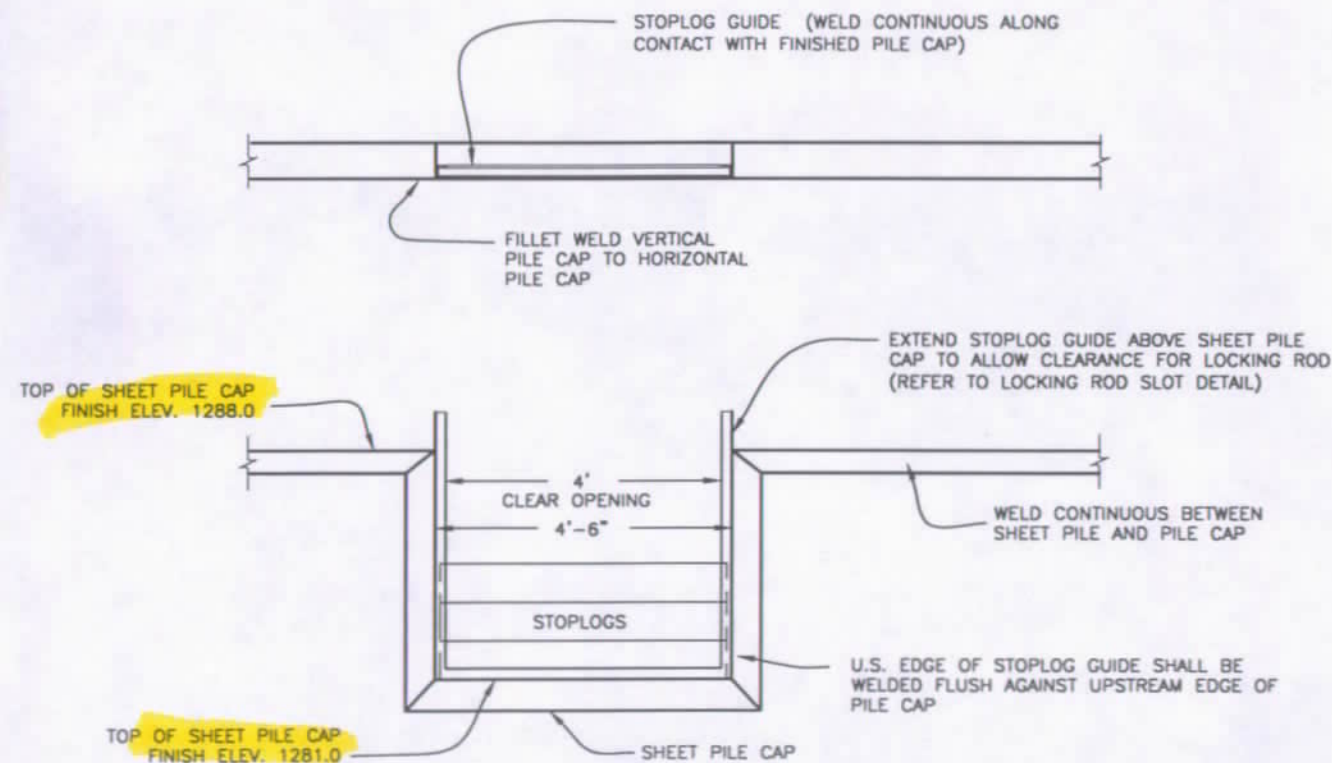
FLATTEN END OF ROD TO APPROX.
3/8" X 1 1/2" AND DRILL 1/2" DIA. HOLE
CENTERED 3/4" FROM END OF ROD



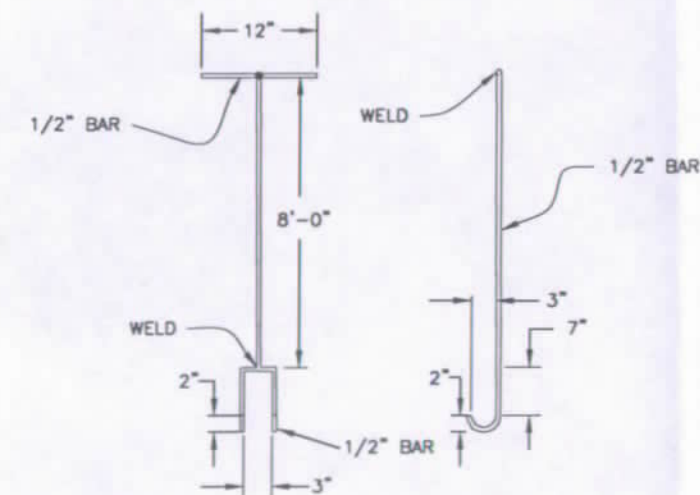
LOCKING ROD DETAIL
NO SCALE



LOCKING ROD SLOT DETAIL
NO SCALE



STOPLOG BAY - PLAN AND ELEVATION
NO SCALE



STOPLOG LIFTING HOOK DETAIL
2 REQUIRED
NO SCALE

NOTES:

1. DRAWING NOT TO SCALE.
2. TOP OF SHEET PILE SHALL BE TRIMMED TO GRADES INDICATED ON PLANS. REMOVE ANY DAMAGE CAUSED BY DRIVING.
3. INSTALL STOPLOG CHANNEL IN STOPLOG BAY WITH U.S. EDGE FLUSH AGAINST U.S. EDGE OF PILE CAP. WELD CHANNEL CONTINUOUS TO PILE CAP.
4. ALL WELDS TO BE 1/4" FILLET OR EDGE.
5. NUMBER OF STOPLOGS REQUIRED = 16, 14 FOR STOPLOG BAY + 2 SPARES.

HURON WMD			STOPLOGS AND DETAILS			SUB-SHEET	
CAIN CREEK DAM REHABILITATION							
DESIGNED D. FAZZAN	DRAWN D. FAZZAN	CHECKED J. MIYAKE	DATE 02/99	DRAWING NO. 6R-SD-638-2.0	SHEET 7 OF 9		



PHOTO NO. 1

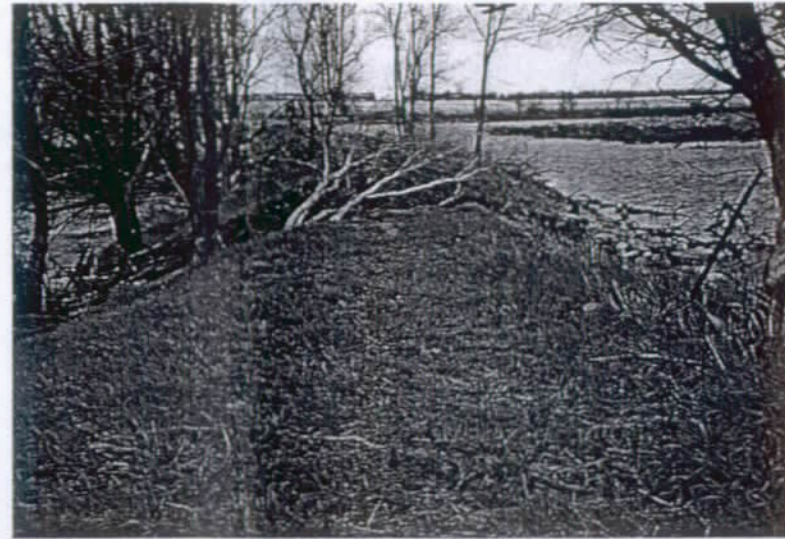


PHOTO NO. 3



PHOTO NO. 2



PHOTO NO. 4

NOTES:

PHOTO NO. 1:
CREST OF DAM FROM RIGHT SIDE OF BREACH,
LOOKING RIGHT.

PHOTO NO. 2:
CREST OF DAM FROM RIGHT SIDE OF BREACH,
LOOKING LEFT.

PHOTO NO. 3:
CREST OF DAM FROM LEFT ABUTMENT,
LOOKING RIGHT, ACROSS THE BREACH.

PHOTO NO. 4:
BREACH VIEWED FROM DOWNSTREAM.



PHOTO NO. 5



PHOTO NO. 7



PHOTO NO. 6



PHOTO NO. 8

NOTES:

PHOTO NO. 5:
DOWNSTREAM SIDE OF EXISTING MASONRY
SERVICE SPILLWAY.

PHOTO NO. 6:
ERODED SECTION OF EXISTING DAM CREST
LOCATED BETWEEN STA. 3+00 & 4+00 (REF.
DWG. SHEET 3)

PHOTO NO. 7:
ERODED SECTION OF EXISTING DAM CREST
LOCATED BETWEEN STA. 1+70 & 2+00 (REF.
DWG. SHEET 3)

PHOTO NO. 8:
DOWNSTREAM SIDE OF EXISTING DAM.
EXISTING MASONRY SERVICE SPILLWAY AT FAR
LEFT AND EXISTING BREACH AT FAR RIGHT.
(REF DWG. SHEET 3)

File No. 6130-3

Water Rights Division -DENR
Conversation or File Documentation

NAME OF PERSON OR FILE: US Fish & Wildlife Service

ADDRESS: PO Box 25486 Denver, CO 80225 COUNTY: Beadle

DATE: March 22, 1999

TELEPHONE: (303) 236-5320 ext. 286

RE: Cain Creek Dam

I talked to Dan Fazzen today about the USF&WS Vested Right Claim No. 6130-3 for repair of Cain Creek Dam. WE discussed the Easement to S&PL and the fact that we treated these easements as indicating ownership. I suggested they discuss this with S&PL. We also talked about the amount of storage in the dam was unclear and we needed an exact number before the VR Claim or the P&S for the dam repair could be approved. We would also need the spillway routing information for the P&S review and would need the storage capacity for this also. He said he would talk to Ginger Price about this and get her the information we needed for P&S review.

March 30, 1999

I talked to Ginger Price today about Cain Creek Dam. She said they did not really want to repair the dam if it was State Owned and did not know if they would go through with the project. We talked about the storage capacity needing to be determined for the VR Claim and P&S approval. She said they would talk to S&PL about the easement and try to get the storage and spillway routing information to us.



Timothy G. Schaal, P.E.
Natural Resources Engineer III
Water Rights Program

Water Rights Division -DENR
Conversation or File Documentation

NAME OF PERSON OR FILE: US Fish & Wildlife Service

ADDRESS: Huron, SD COUNTY: Beadle

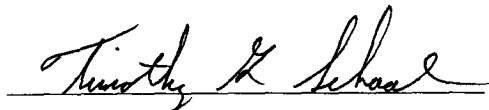
DATE: May 6, 1999 TELEPHONE: (605) 352-5894

RE: Cain Creek Dam

I talked to Mark Heisinger from the USF&WS Office in Huron today about the USF&WS Vested Right Claim No. 6130-3 for repair of Cain Creek Dam. He also had Morris Wright & Bob Dennert from the Denver Office on the line with him. We discussed the easement to S&PL and the fact that we treated these easements as indicating ownership. I suggested they discuss this with S&PL and could maybe work out an agreement to transfer the easement **after** the repairs were completed, because they could not transfer the easement if the structure was unsafe. They had already opened bids for this project and were about ready to let the contract. I explained to them that we still did not have what we need to approve the VR Claim or P&S for the repair and could not start the repair until these were approved. They asked about doing the repair before the VR Claim was approved and I got Eric Gronlund on the line to explain this. We talked about implied water rights, etc. and basically told them they needed to get the VR Claim approved before they repaired the dam.

May 7, 1999

I talked to Mark Heisinger again today about Cain Creek Dam and explained to him that after talking to Diane Best the USF&WS may have some type of "unperfected riparian claim", since the dam has been there since before 1955. Our interpretation of this was the Water Rights Program would not stop them from completing the repairs before the VR Claim was approved, but they would be doing the repair at their own risk. He said that this sounded good to them and would talk to Ginger Price about it and she may call us with questions.



Timothy C. Schaal, P.E.
Natural Resources Engineer III
Water Rights Program

SECTION C

DESCRIPTION/SPECIFICATION

CAIN CREEK DAM REHABILITATION
AT
HURON WETLAND MANAGEMENT DISTRICT

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NOT USED

DIVISION 4- MASONRY

NOT USED

X

P. Lane - Huron WMD District

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DIVISION 6 THROUGH 18

NOT USED



PART 1 GENERAL

1.01 WORK UNDER THIS CONTRACT

- A. Provide all labor, material, and equipment necessary to rehabilitate Cain Creek Dam in accordance with the plans and specifications. Work includes:
1. Remove and dispose of all trees, shrubs, grass, and other vegetative growth on the entire existing embankment.
 2. Remove existing riprap from the upstream face of the dam and stockpile the removed riprap.
 3. Demolish and remove the existing masonry service spillway. Stockpile any of the removed rock from the masonry service spillway which may be reusable for riprap.
 4. Excavate and remove the entire upper dam embankment, indicated as "stripping depth" in the drawings. Overexcavate (below the "stripping depth" boundary) as needed to remove animal burrows, organic material, tree roots, and other materials unsuitable for dam embankment. Excavate, refill with compacted embankment, and regrade two areas of erosion on the existing embankment.
 5. Rehabilitate the dam embankment to the lines and grades indicated in the drawings. Rehabilitation will include stripping and refilling of two existing eroded areas, and removal and refill of the former masonry service spillway area. Compacted backfill will be used in all refilled areas to construct the rehabilitated dam embankment.
 6. Construct a new sheet pile and riprap spillway, with low-level outlet channel and stoplog control structure, near the left abutment. Install riprap over bedding upon the surfaces indicated in the specifications. Install riprap upon the upstream side of the dam embankment as indicated in the specifications.

1.02 LOCATION OF SITE

- A. The work site is located in Beadle County, near the City of Huron, South Dakota. Cain Creek Dam is managed by the U.S. Fish and Wildlife Service, Huron Wetland Management District (WMD), 200 4th St., S.W., Federal Building, Room 309, Huron, South Dakota 57350-2470, telephone number 605-352-5894.
- B. Prospective bidders are encouraged to visit the site and become familiar with existing conditions.

1.03 SURVEY DATA

- A. The Contractor shall be responsible for all construction surveys and staking required for performance of all work to the lines, grades, and slopes shown on the drawings, except as provided in 1.03C.
- B. The sheet pile spillway structure, compacted fill, and riprap shall be installed at the location and elevations shown on the drawings.
- C. Local control (Sta. 0+00) shall be established by the Government. All Contractor surveying shall be tied to the Government-established local control as applicable.
- D. The U.S. Fish and Wildlife Service requires as-built topography of the impoundment and a determination of the reservoir area-capacity. The Contractor shall survey the dam and reservoir impounded by Cain Creek Dam in accordance with the requirements given in Section 01050: Field Engineering.
- E. The Contractor shall establish mean sea level elevations for the water control structures and the embankment. Survey control will be used to establish the proper elevations for construction of the inverts, crests, stoplog slots, and spillways.

1.04 APPLICABLE CODES, STANDARDS AND SPECIFICATIONS

- A. All work shall comply with codes and standards applicable to each type of work as listed in individual sections of these specifications.
 - 1. Where a conflict occurs between referenced documents and the Project Specifications, the Project Specifications govern.
 - 2. Where a conflict occurs between referenced documents, the document containing the most stringent requirements governs.

3. Where referenced documents are not specified by date, the document current at the bid opening applies.
4. Materials, applications, and tests specified by reference to published standards of a society, association, code, or other published standards are included in the specifications as if written in their entirety.
5. Conform to all regulations and statutes of the State of South Dakota and to all Federal regulations which apply.

1.05 REFERENCE STANDARDS

- A. Following is a list of abbreviations for reference standards that may be used throughout the specifications, and the organization or document represented:

AASHTO	American Association of State Highways & Transportation Officials 444 North Capitol Street, N.W. Washington, D.C. 20001
ACI	American Concrete Institute P.O. Box 9094 Farmington Hills, MI 48333-9094
AISC	American Institute of Steel Construction 400 N. Michigan Avenue Chicago, IL 60611
AISI	American Iron and Steel Institute 1000 16th Street, N.W. Washington, D.C. 20036
ANSI	American National Standards Institute 1430 Broadway New York, NY 10018
ASTM	American Society for Testing and Materials 1916 Race Street Philadelphia, PA 19103

AWS	American Welding Society, Inc. 550 N.W. LeJeune Road P.O. Box 351040 Miami, FL 33135
CRSI	Concrete Reinforcing Steel Institute 933 N. Plum Grove Road Schaumburg, IL 60195
CSI	Construction Specifications Institute 1150 17th Street, N.W., Suite 300 Washington, D.C. 20036
EPA	Environmental Protection Agency Washington, D.C. 20460
OSHA	Occupational Safety and Health Administration (U.S. Department of Labor) Government Printing Office Washington, D.C. 20402

- B. Additional abbreviations will be defined as they appear in the specifications.

1.06 MANUFACTURERS' SPECIFICATIONS

- A. Where manufacturers' products and processes are included in the specifications by reference, they shall be included in these specifications as if written in their entirety.
- B. Products and processes included in the specifications shall conform to the manufacturer's latest published specifications.
- C. Upon request of the Contracting Officer, the Contractor shall provide a sworn affidavit from the manufacturer certifying that material, products, and processes delivered and used on the project meet the specified requirements. This affidavit shall not relieve the Contractor from his responsibility for full compliance with the requirements of the specifications.

1.07 SUBSTITUTIONS

- A. The contractor shall provide all equipment, materials, and services as specified or noted on the drawings, unless an approved substitution is obtained.

**DIVISION 1
GENERAL REQUIREMENTS**

**SECTION 01010
SUMMARY OF WORK**

- B. Where multiple manufacturers' names are noted, the first named shall indicate the basis for equipment design and drawing layout for the project.
- C. Requests for substitutions must be submitted, in writing, to the Contracting Officer for approval. Submittals shall include all data necessary for thorough comparison with specified item and reason for the proposed substitution.
- D. For proposed substitutions, the Contractor shall:
 - 1. Provide all additional drawings and data for approval as considered necessary by the Contracting Officer.
 - 2. Pay for all labor and materials required as a result of the substitutions.

1.08 MEANS AND METHODS

- A. Means and methods of construction shall be such as the Contractor or subcontractors may choose; subject, however, to the Contracting Officer's right to reject means and methods proposed which:
 - 1. Constitute a hazard to the work, persons, or property.
 - 2. Will not produce finished work in accordance with terms of the contract.
 - 3. Are contrary to specified means or methods included in the contract.
- B. The right to reject means and methods of the Contractor or subcontractor shall not be construed or interpreted as acceptance of control of means and methods by the Contracting Officer.
- C. The Contracting Officer's approval of means and methods or failure to exercise right to reject means and methods shall not relieve the Contractor of the obligation to complete the work required by the contract.
- D. Total responsibility for control of all means and methods lies with the Contractor for all work.

1.09 ENVIRONMENTAL PROTECTION

- A. Pollution Control

1. The Contractor shall abate and control all environmental pollution arising from construction activities by complying with all applicable Federal, State, and local laws and regulations concerning environmental pollution control and abatement, as well as the specified requirements in this contract.
 - a. Compliance with this requirement by subcontractors will be the responsibility of the Contractor.

B. Fossils and Artifacts

1. Should the Contractor discover any fossils or artifacts during construction operations, such objects shall become the property of the Government. The Contractor shall cease construction operations in the area of the "find," and immediately notify the station manager of such discovery. Construction operations may proceed in other areas not affected by this clause. Care shall be exercised by the Contractor not to damage fossils or artifacts uncovered during excavation operations.

C. Prevention of Water Pollution

1. During construction the Contractor shall comply with all applicable Federal, State, and local laws and regulations concerning the control and abatement of water pollution.
2. The Contractor's construction activities shall be performed by methods that will prevent entrance or accidental spillage of solid matter, contaminants, debris, and other objectionable pollutants and wastes into streams, flowing or dry water-courses, lakes, ponds, and underground water sources. The Contractor shall dispose of all pollutants such as petroleum products, rubbish, cement, concrete, etc., and objectionable material shall be hauled away in tanks or barrels or buried in an approved landfill.
3. Sanitary facilities, such as chemical toilets shall be located far enough from wells, live streams, or ponds to prevent pollution of the water.
4. Dewatering work for structure foundations or earthwork operations adjacent to, or encroaching on, streams or watercourses shall be conducted in a manner which prevents muddy water and eroded materials from entering the streams or water courses. This shall be accomplished by construction of intercepting ditches, bypass channels, barriers, settling ponds, or other approved means. Excavated material shall not be placed in, or adjacent to, watercourses where it can be washed away by high water or storm runoff.

D. Abatement of Air Pollution

1. The Contractor shall comply with applicable Federal, State, and local laws and regulations concerning the prevention and control of air pollution.
2. Construction activities shall be performed in such a manner that air pollution is held to a minimum.
3. Burning of materials, trees and brush, combustible construction materials, and rubbish will not be permitted. Construction debris shall be disposed of at a location designated by the Contracting Officer or hauled off the Station to an approved disposal site.

E. Environmental Litigation

1. Time lost due to work stoppage because of failure of the Contractor to comply with these requirements may not be the subject of a claim for extension of time or for costs or damages.

1.10 COORDINATION

- A. Coordinate work so that Station operations will not be restricted.
- B. The Contractor shall schedule travel on access roadways so as to minimize disruption for local traffic and normal Station operations.
- C. Coordinate all work of the project to facilitate orderly progress and proper sequence of work at all times.
- D. Coordinate work with private landowners so as not to disrupt farm or ranch operations.
- E. In the event that other contracts are in progress concurrently with this contract, the Contractor shall coordinate his work so as not to disrupt progress of other work, and shall cooperate to facilitate orderly progress of all work.

END OF SECTION 01010

PART 1 GENERAL

1.01 WORK INCLUDES

- A. The topography is based on surveys performed by Woodward-Clyde, Inc. in 1997. Two survey control points were located near the site and are shown on the General Plan View and Topography drawing.

It shall be the responsibility of the Contractor to install, maintain, and preserve other necessary survey control points at all times during construction. The existing survey control is site specific and is not tied to state plane coordinates.

- B. The Contractor shall furnish the services of experienced construction surveyors. All Contractor survey work shall be under the direction of a Land Surveyor registered in the State of South Dakota and approved by the Contracting Officer. The surveyor responsible for the surveys shall submit resumes of appropriate construction survey and engineering experience, prior to any construction, to the Contracting Officer in accordance with Section 01300: Submittals. The key survey personnel's experience shall include a minimum of 2 years in responsible charge of construction surveys relating to earthwork and/or roads and dams.

All survey work performed by the Contractor shall be subject to field and office review by the Contracting Officer.

- C. Layout of work: from the survey control points, shown on the drawings, the Contractor shall lay out the work by establishing all lines and grades at the site necessary to control the work and shall be responsible for all measurements that may be required for the execution of the work, to the location and limits marked, and tolerances prescribed, in the Specification or on the drawings.

The Contractor shall place and establish, or replace such additional stakes, markers, or make complete surveys as may be required by the Contracting Officer for control, intermediate checks, and guidance for the contractor's construction operations.

At least 10 calendar days prior to beginning any phase of the survey work, the Contractor shall submit to the Contracting Officer the Contractor's proposed plan for establishing lines and grades for control of the work, including the Contractor's plans and timetable for submitting data to the Contracting Officer. Prior to the start of construction, the Contractor shall submit the qualifications and resume of the construction surveyor.

- D. A survey of the as-built topography of the dam, and a survey of the water control structure (new service spillway) will be required to determine area-capacity and structure operation. The Contractor shall survey the reservoir impounded by the rehabilitated Cain Creek Dam. The survey will be based on adequate control and number of survey points to produce 2-foot contours with an accuracy of (+/-) 0.5 feet. Data will be collected in Latitude-Longitude coordinates and mean sea level in feet. The Contractor shall produce AutoCad drawings of the topography with elevation and Latitude-Longitude coordinates. All contour lines will be generated as closed polylines in order to ascertain the area within each contour. The Contractor shall produce an area-capacity table for the reservoir using the data obtained from the survey.
- E. Records: all survey data shall be recorded in accordance with standard methods approved by the Contracting Officer. All original field notes, computations, and other records for the purpose of layout shall be recorded in field books. Upon completing a field survey book, the original shall be submitted to the Contracting Officer. Notes not in accordance with acceptable formats will be rejected. Illegible notes or erasures on any page(s) of notes in any field book will be considered sufficient cause for rejection of a field book containing such illegible notes or erasures. Copied notes will not be accepted; therefore, rejection of a field notebook may necessitate resurveys of the rejected portions. Corrections made by ruling or lining out errors will be acceptable.
- F. Degree of accuracy: the Contractor shall establish mean sea level elevations for the water control structures and the embankment. Survey control will be used to establish the proper elevations for construction of the inverts, crests, stoplog slots, and spillways. Points for cross sections shall be located to the nearest 0.1 foot horizontally and vertically. Points for structures shall be set to the nearest 0.01 foot.

1.02 SURVEY CONTROLS

- A. Horizontal and vertical survey control shall be based on the survey control points, as shown on the drawings.
- B. The Contractor may change the locations of the survey controls with the approval of the Contracting Officer.

1.03 SUBMITTALS

- A. Qualifications and resume of construction surveyor.
- B. Survey layout plan and time table for data submittal.

- C. Field survey notes.
- D. Topographic drawings.
- E. Area-capacity table.

PART 2 PRODUCTS

2.01 EQUIPMENT AND MATERIALS

- A. The Contractor shall furnish all equipment and materials including instruments, stakes, spikes, steel pins, templates, platforms, tools, and other accessories as may be required in laying out any part of the work, including the primary control points and in performing quantity surveys. Instruments shall be accurate and shall be subject to inspection, and any defective instruments, as determined by the Contracting Officer, shall be promptly replaced, repaired, or adjusted as directed.

END OF SECTION 01050

PART 1 GENERAL

1.01 PROGRESS MEETING

- A. The Contractor or his project superintendent shall be available to meet with the Contracting Officer's Technical Representative (COTR) and/or Site Inspector at the jobsite periodically during construction to discuss work progress.
- B. At these meetings, the Contractor or his superintendent shall give verbal reports of progress on the project, discuss the work schedule, and present all conflicts, discrepancies, or other difficulties for resolution. The verbal report shall be supplemented by a written detailed work schedule for next period and an update of the overall schedule to complete the construction.

END OF SECTION 01200

PART 1 GENERAL

1.01 SUBMITTALS

- A. Refer to technical specifications for all submittals required.
- B. All submittals shall be accompanied by Government-furnished submittal form GPO 1998-674-266 which shall be used as the document for approving or disapproving the material. Four copies of data shall be submitted to allow the Government to retain three copies.
- C. Make all submittals of data, items, materials, and samples after receipt of the Notice to Proceed and allow sufficient time for review. Submittals shall be provided in sufficient detail to ensure conformity with contract requirements and specifications. Submittals on component parts forming a system, or that are inter-related, shall be submitted at one time as a single submittal.
- D. Make all submittals of test data within three calendar days after test was performed.
- E. Any work performed before the approval of required shop drawings, samples, or submittals shall be at the Contractor's risk.

1.02 CONSTRUCTION PROGRESS SCHEDULES

- A. Submit construction schedule for approval after Notice to Proceed, including the following:
 - 1. Breakdown of work activities in categories, as necessary, to allow monitoring of progress of work during construction.
 - 2. Sequence of construction by activity with start dates, duration, and finish dates.

1.03 SHOP DRAWINGS AND MANUFACTURERS' LITERATURE

- A. Prior to the use or installation of any item specified as requiring submittal, the Contractor shall submit manufacturers' literature containing detailed specifications and performance data, or shop drawings, fully describing the items.
- B. The Contractor shall not perform work related to shop drawings or samples prior to obtaining the required shop drawings or samples approved by the Fish and Wildlife

Service. Shop drawings shall be in sufficient detail compatible with the complexity of the project to adequately illustrate the relationship of major components.

- C. Shop drawings used at the site must bear approval stamp of the Contracting Officer. The Contractor shall submit four (4) copies of all shop drawings. Contractor shall check shop drawings for conformity to the contract documents and mark them to this effect before submitting to the Contracting Officer.

1.04 SAMPLES

- A. Submit in duplicate.
- B. Submit samples at the same time as shop drawings when both are required.

1.05 SURVEYS

- A. Submit qualifications and resume of construction surveyor prior to commencement of any construction activity.
- B. Submit survey layout plan and time table for data submittal a minimum of 10 (ten) days prior to any survey work.

1.06 RECORD (AS-BUILT) DRAWINGS

- A. Provide and maintain at the project site, one complete set of prints of the project drawings. The drawings shall be kept in good, clean, and readable condition.
- B. The project site drawings shall have neatly inscribed all changes in work, including location of lines, fixtures, and changes in type of material; including depth, size, and location of existing underground utilities encountered during construction. Changes shall be noted with red pencil or red ink.
- C. Submit these corrected prints at time of final acceptance. Note all data and changes on these record drawings in sufficient detail and clarity and provide information necessary for preparation of "as-built" drawings.

1.07 TESTS AND COMPLIANCE STANDARDS

- A. The Contractor shall submit copies of tests or compliance standards as required in each Division. Written results of all testing shall be submitted to the Contracting Officer.

1.08 GUARANTEES, WARRANTIES, AND CERTIFICATES

- A. Submit all guarantees, warranties, and certificates. Refer to Section 01700, Project Closeout.

1.09 DELIVERY TICKETS

- A. The Contractor shall submit to the Contracting Officer's authorized representative one legible copy of each delivery ticket for all material delivered to the construction site.
- B. The delivery ticket shall show brand name, catalog number, and number of items received.

1.10 SUBMITTAL LIST

- A. The following list of submittals shall be provided. The Contractor shall submit a list of required submittals to the Contracting Officer containing proposed submittal dates for all items, for approval, within 15 days of receipt of a "Notice to Proceed".

SECTION 01050 - FIELD ENGINEERING

- Surveyor Qualifications
- Survey Layout Plan and Time Table
- Field Survey Notes
- Topographic Drawings
- Area-Capacity Table

SECTION 01300 - SUBMITTALS

- Construction Progress Schedule
- Shop Drawings and Manufacturer's Literature
- Surveyor Qualifications, Survey Layout Plan and Time Table
- As-Built Drawings
- Guarantees, Warranties, and Certificates
- Material Delivery Tickets
- Submittal List

SECTION 01400 - QUALITY CONTROL

- Name of Testing Laboratory
- Certified Test Results
- Welder's Certification
- Sheet Piling Product Data and Mill Certificate

SECTION 01700 - PROJECT CLOSEOUT

Date of Completion
Guarantees, Warranties, and Certificates
As-Built Drawings

SECTION 02140 - DEWATERING

Dewatering Plan
Request for Approval to Discontinue

SECTION 02190 - DIVERSION

River Diversion Plan
Request for Approval to Discontinue and Remove

SECTION 02200 - EARTHWORK

Certified Test Results

SECTION 02365 - SHEET PILING

Product Data and Mill Certificate
Certificate of Compliance
Installation Plan

SECTION 05500 - METAL FABRICATION

Shop Drawings
Certificate of Compliance for Materials
AWS Welding Certifications

END OF SECTION 01300

PART 1 GENERAL

1.01 QUALITY CONTROL

- A. The test procedures defined in this section also apply to all tests required in other Sections of the specifications.
- B. The cost for all required testing shall be paid for by the Contractor and included in the bid price.

1.02 SUBMITTALS

- A. Refer to Section 01300.

1.03 TESTS BY INDEPENDENT TESTING LABORATORY

- A. Testing Laboratory
 - 1. Independent testing laboratory shall be selected by the Contractor and the name and qualifications of the proposed laboratory submitted for approval.
 - 2. The testing lab shall conduct all tests included in these specifications, unless specifically noted or provided by the Government.
- B. Contractor's Responsibilities:
 - 1. It shall be the Contractor's responsibility to provide for all tests included in these specifications. Failure to provide a specified test shall be considered the same as a test with a failed result.
 - 2. To make available to the testing laboratory, at no cost, all materials to be tested.
 - 3. Provide labor necessary to supply samples and assist in making tests.
 - 4. Advise laboratory of the identity of material sources and instruct suppliers to allow inspections by the laboratory.
 - 5. Submit written reports from the testing laboratory in accordance with the specified time requirements cited in Section 01300.

6. After initial tests have been performed, and if sampling, method, or workmanship does not comply with these specifications, the Contractor shall pay for any additional testing necessary to ensure compliance.

C. Test Standards

1. Tests shall be conducted in accordance with the requirements of the specifications designated or, where not specified, the latest standards of American Society for Testing and Materials.

D. Earthwork Quality Control Testing

1. Compacted Soils

- a. Secure samples of material proposed for use and test in accordance with the applicable Sections of these specifications. For borrow sites, identify the site by location.
- b. Establish optimum moisture-density relationship in accordance with AASHTO T99 or ASTM D698.
- c. Conduct required moisture-density tests during compaction operations in accordance with the appropriate tests listed:

ASTM D1556 - Standard Test Methods for Density of Soil in Place by the Sand Cone Method

ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

ASTM D2922 - Standard Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods.

1.04 QUALIFICATION FOR WELDING WORK

- A. Welders shall possess qualification papers given by an independent testing laboratory under AWS code, Standard Qualification Procedure.
- B. Qualification papers shall be dated not earlier than six months prior to the start of the job. Welders not engaged in welding for a period of three or more months must be requalified.

1.05 REQUIREMENTS FOR SHEET PILING

- A. The Contractor shall be responsible for providing product data and mill certificate for the sheet pile and pile cap for approval prior to construction.

END OF SECTION 01400

PART 1 GENERAL

1.01 WEATHER PROTECTION

A. General

1. Provide necessary protection against weather to keep all materials, equipment, and completed work free from damage during shipment, in storage, or in place.
2. Do not perform wet work when temperature is below 40 degrees Fahrenheit or it is forecast to be below 40 degrees Fahrenheit within the ensuing 48 hours, except when work is properly protected and sufficient heat is provided.

B. Heat Provision

1. When heat is required for proper weather protection, provide temporary enclosures of work and acceptable means to provide sufficient heat to maintain a temperature of not less than 50 degrees Fahrenheit. Provide higher temperatures when required by these specifications.
2. Use only heat equipment and fuels of approved, safe types. Keep equipment and surroundings in a clean, safe condition. Use flame resistant tarpaulins and other materials for temporary enclosure of space. Use vented heaters only.

1.02 TEMPORARY UTILITIES

A. Electricity and Lighting

1. The Contractor will be responsible for providing temporary electrical service for equipment required to perform the work.
2. Provide and maintain temporary lighting as may be required for safety.

B. Telephone

1. No Government telephone is available in the vicinity of the work. The Contractor shall have communication equipment available and ready at the work site, to alert others in emergency situations.

C. Toilets

1. Provide and maintain suitable, weathertight, painted, sanitary toilet facilities for all workmen during the construction period. Each toilet shall be disinfected and cleaned as necessary, but not less than once per week. When toilet facilities are no longer required they shall be promptly removed from the site and the site shall be cleaned and disinfected as necessary.
2. Provide and maintain facilities in accordance with the requirements of applicable local and State health authorities and OSHA.
3. Keep all toilet facilities supplied with toilet paper at all times.

D. Water

1. Provide, protect, and maintain an adequate water supply for use on the project for construction purposes.
2. The Contractor shall be responsible for providing potable water at the worksite for all construction personnel.

1.03 OPERATION AND STORAGE AREAS

- A. All operations of the Contractor (including storage of materials) upon Government premises shall be confined to areas authorized or approved by the Contracting Officer.
- B. Government premises adjacent to the construction will be made available for use by the Contractor without cost whenever such use will not interfere with other Government uses or purposes.
- C. The Contractor shall not enter or occupy with men, tools, equipment, or material, any ground outside the Government's property without the written consent of the owner of such ground.
- D. Other contractors and employees or agents of the Government may for all necessary purposes enter upon the work and premises used by the Contractor, and the Contractor shall conduct his work so as not to impede unnecessarily any work being done by others on or adjacent to the site.
- E. Materials which are stored at the site that may be damaged by exposure to the environment shall be protected by the Contractor through use of weathertight coverings or

storage sheds.

1.04 ACCESS ROADS

- A. Permissible access routes upon Government property shall be designated by the Contracting Officer prior to commencement of any work related to these specifications. The designated routes shall be strictly adhered to by the Contractor.
- B. The Contractor shall be responsible for any damage to roads, crops, fences or other property during construction operations. The Contractor shall repair any damage to roads or property resulting from construction operations and shall restore all roads and access routes to the same condition as existing when project was started.
- C. Laws and Regulations
 - 1. Observe all laws and regulations of the local, county, and State authorities in the use of all public roads and highways for the transportation of materials and equipment in connection with work on the project. Observe all overhead construction, bridges, cables, and the like. Repair damage to roads, highways overhead construction and similar off-site items, resulting from operations in connection with this project.

1.05 WATER CONTROL

- A. Perform construction work in a manner that will direct surface water away from existing structures. Coordinate any water diversion onto adjacent property in advance with the Contracting Officers's Representative.
- B. Provide own means of pumping or otherwise maintaining excavations free from ground water encountered. Coordinate any water diversion onto adjacent property in advance with the Contracting Officer.

1.06 PARKING

- A. The Contractor shall provide employee parking on the project within the areas designated by the Contracting Officer's Representative. Maintain all roads and parking areas during the construction period.
- B. Park vehicles to avoid interference with normal construction activities and to avoid interference with Government or private operations.

1.07 SAFETY

- A. Provide personal safety equipment and training commensurate with the hazards which may exist at the worksite. The personal safety equipment and training shall be determined by a thorough hazard analysis of all worksite areas. The safety program available at all worksites shall include a minimum of:
1. One nonfreezing-type fire extinguisher in each workshop and shed used for storage of materials at the worksite. Place in location readily accessible to workmen.
 2. A first aid kit for use of workmen commensurate with size of project with items necessary for first aid treatment of all injuries.
 3. The Contractor shall conduct regular onsite safety inspections and all workmen shall receive a safety orientation.
 4. Post telephone numbers of nearest hospital or ambulance service and fire station in conspicuous location. Advise all workers of location of telephone numbers.

1.08 TRAFFIC REGULATION

- A. The Contractor shall provide, erect and maintain all necessary barricades, suitable and sufficient flasher lights, flagmen, danger signals and signs, and shall take all necessary precautions for the protection of the work and the safety of the public. All ponds, water control structures, and valve structures shall remain accessible by vehicle. Roads closed to traffic shall be protected by effective barricades and shall be placed with acceptable warning signs. All barricades and obstructions shall be illuminated at night and all lights shall be kept burning from sunset until sunrise. Install appropriate traffic signs at crossroads and approaches to site as needed to direct affected public traffic. Specific signs and barricade requirements are detailed in the American National Standards Institute, Inc., "Manual on Uniform Traffic Control Devices", (ANSI D61).

1.09 PROTECTION AND RESTORATION

- A. The Contractor shall protect all structures during the progress of the work; shall remove from the worksite(s) all debris and unused material; and shall, upon completion of the work, restore the site as nearly as possible to its original condition, including the replacement, at the Contractor's expense, of any facility which has been damaged.

END OF SECTION 01500

PART 1 GENERAL

1.01 MATERIALS

- A. Removed materials may be used by others for historic restoration work. Stockpile removed materials as selected by the Contracting Officer.

1.02 ITEMS NOT IN CONTRACT

- A. All items indicated "N.I.C." on drawings or in specifications are items not included in this contract.

1.03 GOVERNMENT-FURNISHED, CONTRACTOR-INSTALLED EQUIPMENT (GF-CI)

- A. The Contractor shall obtain the approval of the Contracting Officer's Technical Representative ten (10) days in advance of installation of GF-CI material.

1.04 STORAGE AND PROTECTION

- A. Protect all materials, work, and equipment against damage at all times.
- B. Refer to Section 01500 for requirements for storage of materials. Store all materials that might be damaged in storage sheds, or under weathertight coverings.
- C. Prefabricated components, and other manufactured items, shall be delivered and stored in such a manner that they will not be damaged or deformed. Material shall be stacked on platforms or pallets and covered with tarpaulins or other suitable weathertight, ventilated covering.

END OF SECTION 01600

PART 1 GENERAL

1.01 FINAL INSPECTION

- A. The Contractor shall request a final inspection, in writing, at least ten (10) days prior to the anticipated date of completion.
- B. Work will not be considered ready for final inspection until all the work has been completed and the Contractor has certified that all items are properly installed and in strict compliance with all contract terms and conditions.
- C. The Contractor or his project supervisor shall be at the jobsite during the final inspection.

1.02 SUBMITTALS

- A. Submit all written guarantees, warranties, and certificates required under Section 01300 to the Contracting Officer prior to final payment.
 - 1. Guarantees shall extend the full period of the required guarantee period after:
 - a. Replacement of work found defective during guarantee period.
 - b. Repair of inoperative items or adjustments to proper working condition of items not operating properly at time of inspection at final completion.
- B. Refer to technical specifications (Divisions 2 through 18) for special requirements affecting the submission of all instructions and other information required.
- C. Prior to final payment, submit required record (as-built) drawings to the Contracting Officer. Refer to Section 01300.

1.03 CLEANUP

- A. All work and storage areas shall be kept clean and free from paper, garbage, and trash. Such materials shall be removed by the Contractor and disposed of in properly designated areas.
- B. Fuels, lubricants, petroleum products, chemicals or other waste materials shall be disposed of in properly designated areas off Government premises.

DIVISION 1
GENERAL REQUIREMENTS

SECTION 01700
PROJECT CLOSEOUT

- C. No burning of rubbish on Government premises will be allowed.
- D. Tools, equipment, and temporary facilities shall be removed when no longer required for execution of the work.
- E. After all work is completed according to the specifications of this contract, the contractor shall clean the worksite areas, and perform all other work incidental to site restoration.

END OF SECTION 01700

END OF DIVISION 1

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Remove and dispose of the existing service spillway structure.

1.02 EXPLOSIVES

- A. The use of explosives will not be permitted.

1.03 RELATED WORK

- A. Earthwork - Section 02200.

PART 2 PRODUCTS

2.01 MATERIALS

None

PART 3 EXECUTION

3.01 PREPARATION

- A. Protect existing landscaping materials which are not to be removed.

3.02 DEMOLITION

- A. Remove the existing concrete masonry structure utilizing mechanical equipment, jack hammers, or drills as necessary.
- B. All materials, not approved by the Contracting Officer for reuse, shall become the property of the Contractor.

3.03 DISPOSAL

- A. Reduce the structure to broken pieces weighing a maximum of 500 pounds. Any reinforcement shall be cut off flush with the concrete surface. All pieces shall be stockpiled or disposed of in a location designated by Station personnel.

- B. Debris and unsalvageable materials created by the demolition and construction will be collected, loaded, and hauled off the site weekly by the Contractor to a non-Government disposal site.

END OF SECTION 02050

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Clearing and grubbing of all trees, shrubs, grass, and other vegetative growth, on the entire existing embankment, to prepare the site for the contract work.

1.02 JOB CONDITIONS

- A. Work limits - refer to the specification drawings and as follows:
 - 1. The entire existing dam embankment, including the existing dam breach area, and two areas of erosion on the embankment. Areas immediately adjacent to the existing dam embankment which may be required to provide construction access, and as further defined in Part 3.01 of this Section.
 - 2. Borrow areas.
 - 3. Construction material staging and stockpile areas.
- B. Bidders are expected to examine the site to determine the character of the materials to be encountered and the amount and size of vegetation to be removed.

1.03 LANDSCAPE PRESERVATION

- A. All vegetation, terrain and improvements outside the construction areas shall be protected from injury and defacement.

PART 2 PRODUCTS

None

PART 3 EXECUTION

3.01 CLEARING AND GRUBBING

- A. The Contractor shall clear only those portions of rights-of-way to be occupied by permanent construction under these specifications, and those portions required for access to the work, and surfaces of borrow areas, stockpile sites, wastepile sites, and

construction staging areas, of: all vegetation, such as trees, shrubs, brush, stumps, roots, downed timber, branches, grass, weeds; of all rubbish; and of all other objectionable material as determined by the Contracting Officer.

- B. Clearing adjacent to cut or fill sections shall be to a minimum distance of 3 (three) feet outside of slope lines. Any excavation or clearing outside this boundary shall be subject to approval by Station personnel.
- C. Proper restoration of the main dam embankment will require removal of vegetation. The entire existing dam embankment surface, to a depth of approximately three (3) feet shall be cleared of all stumps, roots, and vegetable matter of every kind. This shall include the entire area identified as the "stripping zone for existing embankment" on the drawings. All trees scheduled for removal shall be properly identified and marked for removal by the Contractor prior to construction. Such trees shall not be removed until verified and approved by Station personnel.

Once the primary clearing is completed within the "stripping zone", as described above, further excavation of roots and stumps, beneath the "stripping zone", may be required. Further excavation shall continue to the depth necessary to remove and grub all roots and stumps which are greater than one (1) inch in diameter.

The cost of grubbing and of all work incident thereto, including disposal of the grubbed materials, shall be included in the prices bid in the schedule for excavation.

3.02 DISPOSAL

- A. All wasted material shall be hauled from the site and legally disposed of at the Contractor's expense. Subject to approval, wasted material may be disposed of at sites designated by Station personnel.
- B. Disposal sites may include, if approved, the existing emergency spillway channel. Reference the drawings for the recommended "stripping depth" and "final grade". If the existing emergency spillway channel is approved as a disposal site, proper refill methods will be used to avoid the potential for future erosion of the channel. Disposal within the emergency spillway channel shall be limited only to earth materials and rock. The channel shall first be graded to the recommended "stripping depth" shown on the drawings. Excess vegetation, shrubs, and trees should be removed and disposed of with other vegetation from the embankment. The channel shall be refilled uniformly, in layers along its length, with earth materials and rock compacted in the manner designated in

these specifications for embankment backfill. The maximum recommended refill level within the channel is shown on the drawings as "final grade".

- C. Subject to approval by Station personnel, vegetative material from clearing operations may be disposed of by chipping and spreading, stockpiling, or removing from the worksite. In accordance with the Government's policy for maximum utilization of timber, the Contractor shall make every reasonable effort to channel timber removed from the worksite into beneficial use.
- D. Where approved, material to be disposed of by chipping and spreading shall be reduced to chips of ½-inch maximum thickness. Chips shall be distributed uniformly to a three-inch maximum thickness on the ground surface between slope lines and right-of-way lines, designated areas shown on the drawings, or as directed by the Contracting Officer, and shall be mixed with underlying earth so as to not float or support combustion.
- E. Cut timber, down timber, dead timber, and branches approved for disposal by stockpiling, shall be stacked at locations directed by Station personnel.
- F. All costs of clearing, including disposal of cleared material, shall be included in the prices bid in the schedule for excavation.

END OF SECTION 02100

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide all materials and labor to install and maintain facilities to control, collect, and dispose of ground water and surface water for the proper construction of all contract work.
- B. Maintain the foundations and other parts of the work free from water as required for constructing each part of the work.
- C. Comply with all applicable local, state, and federal environmental protection laws and requirements in operation of the dewatering system.
- D. Remove all components of the dewatering system after it is no longer required.

1.02 RELATED WORK

- A. Section 01300: Submittals
- B. Section 01500: Temporary Facilities and Control
- C. Section 02190: Diversion
- D. Section 02200: Earthwork

1.03 SUBMITTALS

- A. Prior to beginning any work on the project and removal of water from foundations, the Contractor shall submit for approval a Dewatering Plan indicating the proposed method(s) for diversion and protective works during construction. The Dewatering Plan shall include details regarding the anticipated types and locations of various dewatering facilities and design calculations required to substantiate the dewatering plan. The Plan shall be designed using accepted professional methods and engineering consistent with current practice. If the Contractor purchases, rents, installs, or mobilizes to the site any elements of the dewatering system prior to the Contracting Officer's approval of the dewatering submittal, he does so at his own risk, and will not be due any additional compensation from the Government if such elements are not subsequently used for the work.

- B. Approval by the Contracting Officer of the dewatering methods proposed by the Contractor will only be with respect to the basic principles of the methods the Contractor intends to employ. Approval by the Contracting Officer does not relieve the Contractor of the full responsibility for the adequacy of the dewatering system.

1.04 REQUIREMENT

- A. The Contractor shall design, furnish, install, maintain, and operate dewatering systems which shall prevent loss of fines, boiling, quick conditions, or softening of foundation strata and maintain stability of bottom of excavation so that every phase of the work can be performed in the dry. The dewatering operations shall be such that the bottoms of all excavations shall be kept firm at all times and in all respects acceptable to the Contracting Officer.
- B. The Contractor shall, at all times during construction, provide ample means and devices to remove promptly and dispose of properly all water entering excavations and keep the bottoms of the excavations firm and free of standing water until the structures to be built therein are completed and/or the backfill to be placed therein has been placed. Discharged water shall be piped to an area approved by the Contracting Officer. The dewatering discharge shall not cause siltation or other negative environmental impact on natural waterways or other property; such discharge shall be in accordance with applicable federal, state, and local regulations. At dewatering discharge locations, hay-bale silt barriers or other control measures, as approved by the Contracting Officer, shall be installed to control and prevent siltation.
- C. At certain locations, the Contracting Officer may require dewatering to a depth below the working surface. The pumping and dewatering operations shall be carried out in such a manner that no disturbance to the bearing soil or rock, or to soil or rock supporting any other work, will result from the dewatering operations. Pumping shall not disturb other work. Locations shall be subject to approval by the Contracting Officer.
- D. Dewatering systems shall be operated continuously or as necessary to prevent flotation of partially completed structures or other work.
- E. Prior to any excavation below the hydrostatic groundwater level, the dewatering system shall be placed into operation to lower the water levels as required and then shall be operated continuously 24 hours per day, 7 days per week, or as necessary, until all facilities and structures affected by the dewatering have been satisfactorily constructed, including placement of fill materials to an elevation above the hydrostatic groundwater level. The Contractor shall maintain the water levels low enough to fulfill the

requirements of this section and shall not allow the water level to rise until the constructed facilities are so complete that the water can be allowed to rise without damaging the facilities, their foundations, or surrounding areas and structures.

- F. When the dewatering system does not meet the specified requirements, and as a consequence loosening or disturbance of the foundations strata, instability of the slopes or damage to the foundations or structures occur, the Contractor shall supply all materials, labor, and perform all work for restoration of foundations soil, slopes, foundation, or structures, to the satisfaction of the Contracting Officer, at no additional expense to the Government. Restoration may include removal of damaged foundation soils and backfilling in accordance with Section 02223: Earthwork.
- G. The Contractor shall obtain written approval from the Contracting Officer before discontinuing the operation of any portion of the dewatering systems.
- H. After having served their purpose, all temporary protective works shall be removed. The Contractor shall be responsible for and shall repair at his expense any damage of the work caused by water, or failure of any part of the protective works.

END OF SECTION 02140

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Construct and maintain all temporary diversion channels and cofferdams, or other means to control inflow from Cain Creek, around all work areas. Provide all materials and labor to install, operate and maintain all pumps, piping, and other facilities for the diversion of the river flows during construction. Maintain river control until all facilities shown on the drawings are complete and ready to safely pass river flows.
- B. Upon written approval of the Contracting Officer, remove temporary cofferdam(s), pumps, piping, and all other river control facilities. Fill in as necessary any temporary diversion channels.

1.02 RELATED WORK

- A. Section 01300: Submittals
- B. Section 01500: Temporary Facilities and Control
- C. Section 02140: Dewatering
- D. Section 02200: Earthwork

1.03 SUBMITTALS

- A. Submit a River Diversion Plan, for approval by the Contracting Officer, which includes the design of cofferdams, sequence of construction, protection of such facilities, dewatering, protection of river embankment, pollution control provisions, and sequence for removal.

PART 2 PRODUCTS:

Not Used

PART 3 EXECUTION:

3.01 RIVER CONTROL

- A. Install the temporary river control provisions, as specified by the Contractor's approved River Diversion Plan, to protect the construction areas from river flows.

- B. Furnish and install temporary pumps, pipes, and other facilities, as required by the Contractor's approved River Diversion Plan, to provide river control during construction.
- C. Maintain the features of the Contractor's approved River Diversion Plan throughout the construction period until written approval to remove river control features is received from the Contracting Officer.

3.02 PROTECTION

- A. The Contractor's approved River Diversion Plan will be required to contain and divert a flood event with a recurrence interval of 2 years, having a discharge of 335 cubic feet per second (cfs). The Contractor's approved River Diversion Plan shall include provisions and/or methods for measurement of discharges from the diversion works.
- B. The existing Cain Creek Dam Emergency Spillway and/or the existing masonry Service Spillway may be used, upon approval from the Contracting Officer, for inclusion as part of the Contractor's River Diversion Plan. Restoration of project works shall be specifically included and stated in the River Diversion Plan.
- C. For flood events less than 335 cfs, as measured by the methods described in the Contractor's approved River Diversion Plan, the Contractor shall be liable for damages to private property or Government property and shall repair flood damages to work at the Contractor's sole cost.

3.03 REMOVAL

- A. Upon written approval of the Contracting Officer, remove the temporary river control features.
- B. The Contractor shall be responsible for restoration of all facilities as specifically described in the approved River Diversion Plan.

PART 4 PAYMENT

4.01 PAYMENT

- A. Payment for all work required in this section shall be included in the lump sum bid. Such price shall include excavation and earthwork; and all labor, equipment and materials to furnish, install, and remove cofferdams; cofferdam protection, necessary dewatering associated with the control of the river and all costs to satisfy diversion requirements.

END OF SECTION 02190

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Includes excavation, backfill, compaction, grading and testing required for the dam embankment and related work not specified elsewhere, as shown on the drawings and required by these specifications.

1.02 JOB CONDITIONS

- A. Bidders are expected to examine the site to determine the character of material to be encountered.
- B. All stockpiles shall be located according to the directions of the Contracting Officer.

1.03 SAFETY AND PROTECTION

- A. Trenches and excavations shall be sloped, benched, sheeted, shored, and/or braced where required in a manner consistent with established safe practices and in accordance with the U.S. Bureau of Reclamation "Reclamation Safety and Health Standards" (CSS), published in 1993.
- B. Barricade open excavations occurring as part of this work.
- C. Protect excavations from freezing. If frost action occurs, compact ground after thawing as specified herein.

1.04 RELATED WORK

- A. Submittals - Section 01300.
- B. Quality Control - Section 01400.
- C. Clearing and Grubbing - Section 02100.
- D. Dewatering - Section 02140.

1.05 SUBMITTALS

- A. Submit the following information in accordance with Section 01300 - Submittals:

1. Submit all earthwork test data as required in Section 01300: Submittals and Section 01400: Quality Control.

1.06 FIELD QUALITY CONTROL

A. Where tests are required, the following quality control shall be adhered to:

1. Density Testing and Control - Refer to Section 01400, Quality Control, for responsibilities.
2. Moisture-Density Curves - Tests shall be conducted in accordance with requirements of ASTM D698 or AASHTO T99 Standard Method of Test for Moisture-Density Relations of Soils using a 5.5-lb. Rammer and a 12-inch Drop. Obtain moisture-density curves for each type of material encountered or utilized. Results shall be submitted to the Contracting Officer by the testing agency.

Use the moisture-density curves as a basis for compaction control.

3. Density Control - Conduct tests for density control during compaction operations in accordance with the requirements of:

ASTM D2922 - Test for Density of Soil and Soil-Aggregate in Place by Nuclear methods.

ASTM D1556 - Test for Density of Soil-in-Place by the Sand-cone method, or

ASTM D2167 - Test for Density of Soil-in-Place by the Rubber-Balloon method.

B. Tests Required:

1. The Contractor will perform field tests of density and moisture content of in-place backfill, embankment fill, and associated one-point compaction tests. Compaction tests shall be made by an independent laboratory at no expense to the Government. The Contractor shall submit the results of these tests to the Government as verification of properly compacted material. Tests shall be performed in sufficient numbers to ensure that the specified density is being obtained. Compaction tests shall be made at a minimum of three tests for each two feet of embankment lift in the dam.
2. The method and equipment used to place backfill are to be selected by the Contractor, unless otherwise specified, provided that the specified density is obtained.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Backfill and Embankment fill shall be obtained from material removed in excavation from the existing dam embankment or from approved borrow areas. All backfill material shall be free from muck, frozen material, roots, trash, and other deleterious material, and shall meet the following requirements:
 - 1. Embankment fill shall be a select mixture of clay, silt, sand, and gravel with a maximum particle size of 3 inches.
 - 2. Minimum of 12 percent passing the No. 200 sieve.
 - 3. Minimum plasticity index of 6 and a maximum liquid limit of 50.
 - 4. Embankment fill shall be tested and approved before it can be used.
 - 5. Materials removed in clearing and grubbing shall not be used for backfill.
- B. Preliminary earth materials investigations have been conducted by the Government to locate prospective borrow areas near Cain Creek Dam. The investigations consisted of test pits followed by soil classification tests of samples taken from the test pits. This information is available upon request by the contractor. This information may be used by the contractor during the selection process for the actual borrow sites proposed for use during construction.
- C. Riprap and Riprap Bedding: these materials shall be furnished by the Government and will be stockpiled at locations as shown on the drawings.

PART 3 EXECUTION

3.01 EXCAVATION

- A. Excavation to the lines and grades as shown on the drawings. Repair any damage to the work caused by the Contractor's operations, including disturbance of the material beyond the required excavation, at no additional cost to the Government. All repairs will be as directed by the Contracting Officer.
- B. The Contractor shall assume all responsibility for deductions and conclusions as to the

nature of the materials to be excavated and the difficulties of making and maintaining the required excavations.

- C. Additional excavation (over excavation), beyond the designated lines and grades, may be required to remove animal burrows, organic materials, tree roots, and other materials unsuitable for the dam embankment.
- D. Unless authorized in writing by the Contracting Officer's Technical Representative, all excavations shall be in the dry, in accordance with Section 02140, Dewatering.
- E. Excavation in frozen materials, without prior written approval of the Contracting Officer, is prohibited.
- F. All excavated material which is unsuitable for backfill shall be wasted.
- G. All excavated material suitable for backfill shall be stockpiled and reused for reconstruction purposes.
- H. The subgrade shall be accurately graded to provide uniform bearing and accurate line and grade. The entire subgrade shall be compacted to at least 95 percent of maximum density in accordance with ASTM D698 or AASHTO T99.

3.02 BACKFILL

- A. All backfill shall be placed across the full width of the excavation in 8-inch lifts. Flooding or puddling will not be allowed. The addition of water shall be limited to that needed for obtaining optimum moisture content plus or minus 2 percent. Foundation surfaces shall be sloped no steeper than a ratio of one horizontal to one vertical. The foundation shall be thoroughly scarified before placement of backfill to improve the bond between the backfill and the foundation.
- B. Backfill shall be placed to form homogenous layers free from lenses, pockets, streaks or layers of material differing substantially in texture or gradation from the surrounding material. If it is necessary to use materials of varying texture and gradation, the more impervious material shall be placed in the center and upstream part of the dam. No backfill shall be placed upon a frozen surface nor shall snow, ice or frozen material be incorporated in the backfill. Backfill shall be placed and spread beginning at the lowest point of the foundation.

3.03 COMPACTION

- A. The backfill shall be uniformly compacted to a minimum 95 percent of the maximum dry density determined by ASTM D698 or AASHTO T99. Flooding or puddling will not be allowed. The addition of water shall be limited to that needed for obtaining optimum moisture content plus or minus 2 percent.
- B. Compaction equipment shall be operated over each layer of the backfill to ensure that the required compaction is obtained. Special equipment such as tamping rollers shall be used if needed to obtain the required compaction.
- C. Excessive settlement or other evidence of improper backfill shall be corrected by reopening the area to the depth required for proper compaction and then shall be refilled and compacted as required.
- D. Materials not meeting the specified moisture content and dry density requirements, as determined by the tests, shall be reworked until approved results are obtained. Reworking may include removal, rehandling, reconditioning, rerolling or combinations of these procedures. No additional allowances or payment shall be made for any additional work required to achieve the placement moisture content and density specified in these specifications.

3.04 DISPOSAL OF UNSUITABLE MATERIAL

- A. Earth materials and rock, not suited for backfill, shall be hauled from the site and legally disposed of at the Contractor's expense. Subject to approval by Station personnel, such materials may be disposed of within the existing emergency spillway channel (refer to Section 02100, "Clearing and Grubbing").

3.05 FINISH GRADING

- A. All work shall be finished to a smooth, uniform surface conforming to the lines and grades on the drawings or established in the field.

END OF SECTION 02220

PART 1 GENERAL

1.01 WORK INCLUDED

- A. The work shall consist of placing bedding for riprap, constructed in accordance with these specifications, at the locations and in conformity with the lines, grades and dimensions shown on the drawings.

1.02 RELATED WORK

- A. Clearing and Grubbing - Section 02100
- B. Earthwork - Section 02200
- C. Riprap - Section 02291

PART 2 PRODUCTS

2.01 MATERIALS

- A. All riprap bedding shall be Government Furnished - Contractor Installed. Bedding material will be stockpiled at the location noted in the drawings for use by the Contractor to complete the work in these specifications.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

- A. The subgrade surface or slopes on which the bedding for riprap is to be placed shall be cut or filled and graded to the dimensions and grades shown on the drawings. Bedding for riprap shall not be placed until the subgrade is completed.

3.02 PLACEMENT OF BEDDING FOR RIPRAP

- A. The bedding need not be compacted in place, but shall be placed in such a manner as will result in uniform layers of bedding for riprap of the specified thickness.

END OF SECTION 02290

PART 1 GENERAL

1.01 WORK INCLUDED

- A. The work shall consist of placing stone riprap for erosion protection, constructed in accordance with these specifications, at the locations and in conformity with the lines, grades and dimensions shown on the drawings.

1.02 RELATED WORK

- A. Bedding for Riprap - Section 02290.

PART 2 PRODUCTS

2.01 MATERIALS

- A. All riprap stone shall be Government Furnished - Contractor Installed. Stone will be stockpiled for use by the Contractor at the location shown in the drawings.
- B. Stone salvaged from the existing service spillway (Section 02050) may be used if approved by the Contracting Officer. Riprap salvaged from the upstream face of the existing embankment may be used if approved by the Contracting Officer.

PART 3 EXECUTION

3.01 PLACEMENT OF RIPRAP

- A. The riprap shall be placed upon riprap bedding (ref: Section 02290, Bedding for Riprap). All riprap shall be placed in a homogenous layer upon the dam embankment and spillway channel; the larger stone shall be uniformly distributed and firmly in contact, one to another, with the smaller rocks and spalls filling the voids between the larger rocks. The thickness of the riprap, as shown on the drawings, shall be measured perpendicular to the slope on which it is placed.
- B. Special care shall be taken in handling and placing riprap around structures. Structures which are damaged shall be repaired or replaced by the Contractor at no expense to the Government.

END OF SECTION 02291

PART I GENERAL

1.01 WORK INCLUDED

- A. Work includes furnishing and installing steel sheet piling and piling cap to the lines and grade shown on the drawings.

1.02 RELATED SECTIONS

- A. Section 01300: Submittals
- B. Section 01400: Quality Control
- C. Section 02140: Dewatering
- D. Section 02190: Diversion
- E. Section 02200: Earthwork
- F. Section 05500: Metal Fabrication

1.03 SUBMITTALS

- A. Refer to Section 01300, Submittals.
- B. Submit a sheet pile installation plan for approval, which shall include:
 - 1. Product data and mill certificate for the proposed sheet piling and cap.
 - 2. Details of the pile hammers and related equipment for driving the sheet piling.
 - 3. A pile driving plan that illustrates the sequence of proposed piling operations. Submit layout drawings showing installation of steel piling components. Include details of angled pile.

1.04 REFERENCES

- A. ASTM A328 - Specifications for Steel Sheet Piling.

- B. AISC - Specifications for Structural Steel
- C. ASTM A490 - Specifications for Structural Steel Bolts

1.05 DESIGN REQUIREMENTS

- A. Minimum section modulus for sheet pile shall be 23.0 cubic inches per linear foot of sheet pile wall. Piling may be Z-shape or Deep-Arch profile. Medium-arch, shallow-arch, or straight-web shapes will not be permitted.
- B. Sheet piles shall be driven as required to provide a finish grade as shown on the drawings, including the installed pile cap.

1.06 DELIVERY, STORAGE, AND HANDLING

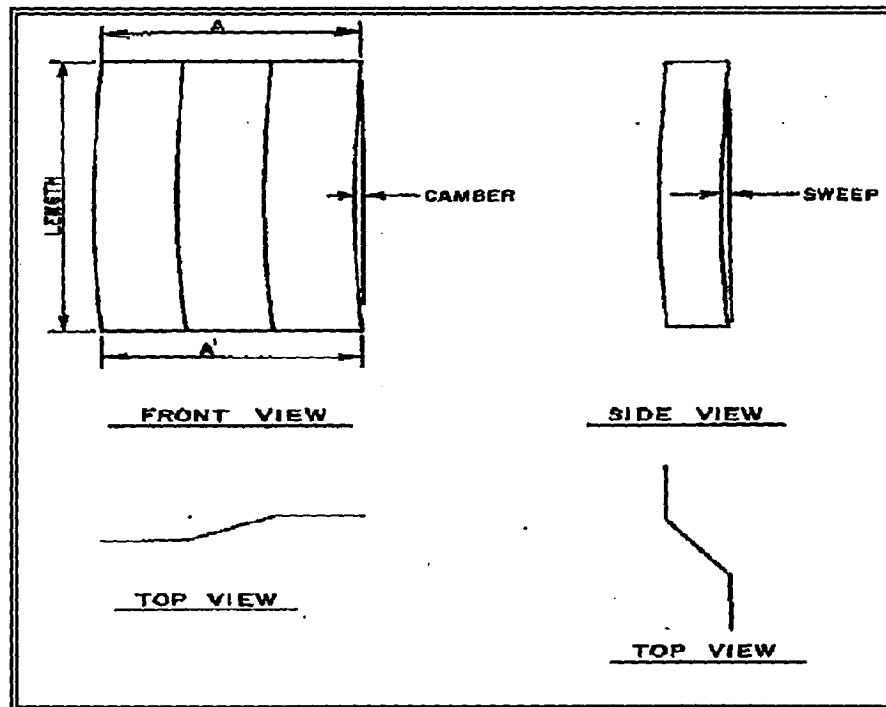
- A. Obtain and ship sheet pile material to the site in a timely manner.
- B. Deliver to site, store, and protect products under provisions of Section 01600.
- C. Piling shall be handled in such a manner as to ensure no damage to the pile.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Sheet piling shall be made of new standard ASTM A-328 grade steel and be of the section and length specified in 1.04. Alternate sheet piling may be used if approved by the Contracting Officer and if it has a thickness and section modulus equal to or greater than that specified. The sides of each piling shall be furnished with an interlock that is continuous for the full length of the pile. The interlock shall have an opening of sufficient width to allow free slippage of the adjoining sheet pile. The sheet pile shall have an interlock configuration which minimizes the offset of the vertical outside pile faces. Minimizing the offset will allow continuous contact between the vertical outside pile face and the sheet pile cap angles (ref. Sheet No. 5 of 9, "Typical Sections and Details" in the drawing set).
- B. Sheet pile dimensions and weight variations shall be within the tolerances as shown in Figure 1 on the following page. Unacceptable sheet pile shall not be driven.

FIGURE 1



TOLERANCES:

A and A': $\frac{1}{2}$ " per 10' length
Camber: $[1/4" \times (\text{total length, ft.})]/10'$
Sweep: $[1/4" \times (\text{total length, ft.})]/10'$
Weight: $\pm 2.5\%$ theoretical or specified amount

- C. A sufficient amount of sheet piling shall be provided to construct a structure of the dimensions shown on the drawings.
- D. Sheet pile cap shall be constructed as shown on the drawings, using ASTM A-36 structural steel.

PART 3 EXECUTION

3.01 EQUIPMENT

- A. The Contractor shall provide the necessary driving equipment that is capable of driving the specified sheet pile to the depth and alignment shown based on soils information provided and knowledge of equipment capability.
- B. Driving hammers may be drop, single acting, double acting, diesel, vibratory, or as approved by the Contracting Officer. Drop hammers shall weigh between 1000-3000 lbs. with drops of 12 to 48 inches. Single acting, double acting and diesel hammers shall develop at least 7000 ft.-lbs. with ram weights of at least 1400 lbs. Vibratory hammers shall be at least 40 horsepower and capable of driving at a minimum of 1000 vibrations per minute. Regardless of what type of hammer is utilized, the energy developed by the hammer shall be of sufficient energy to adequately drive the sheet pile without damaging it.
- C. Pile driver leads shall be of a type that will hold the pile and pile hammer in proper alignment during the driving operations and shall be long enough to preclude the necessity for the use of punches and chasers. Leads for drop hammers shall be steel or steel shod. Generally, the recommendations of the pile hammer manufacturer shall be followed with respect to pile leads.
- D. Piles shall be protected at all times from damage during driving. This shall include but is not limited to the use of suitable caps, rings, heads, blocks, mandrels, and other devices. A driving cap shall be used at all times and the heads of the steel piles shall be cut square to accept this cap. It will be the Contractor's responsibility to provide all items (driving heads, mandrels, etc.) necessary to drive special types of piles per pile manufacturer's recommendations.

3.02 DRIVING

- A. The piling shall be driven in such a manner as to insure proper interlocking throughout the entire length of each pile. The piles shall be held in proper alignment during driving by means of assembling frames or other suitable temporary guide structures. Temporary guide structures shall be removed after they have served their purpose.
- B. All piles shall be driven to the depth shown on the drawings and specified herein. If a pile hits refusal prior to reaching the required depth and can no longer be driven without damage to the pile or driving it out of alignment, then driving of the pile shall cease and the Contracting Officer notified. Refusal shall be determined by inability of driving equipment to drive the pile more than one inch with four blows of the driving hammer operating at normal capacity. If a pile is starting to deform or move out of alignment prior to determining if it has hit refusal, then driving shall also cease. If it appears that a pile has encountered a boulder or some other obstruction within the first five feet of driving, then the pile shall be pulled and the area excavated. The obstruction shall be removed, if possible, with the excavation backfilled and compacted prior to redriving the pile. If the obstruction can not be removed, then the excavation shall be backfilled and recompacted, with the pile redriven to the obstruction unless directed otherwise by the Contracting Officer. In all cases of refusal, the undriven portion of sheetpile shall be cut at the specified elevation, and saved on site for inspection and measurement by a representative of the Contracting Officer prior to removal of this material from the site.
- C. Under no circumstances shall the top of the pile vary from the design alignment, by more than 1 inch (horizontal or vertical).

3.03 PILE CUTOFF

- A. The contractor shall cut the piles off at the elevations shown on the drawings and specified herein. The head of each pile, after cutoff, shall be sound, undamaged material. The length of the cutoff shall be sufficient to permit the removal of all damaged material.

3.04 DEFECTIVE PILES

- A. Any pile damaged, driven out of its proper location, driven below the specified cutoff elevation or inaccurately cut off shall be corrected by one of the following methods, whichever is approved by the Contracting Officer:
 - 1. The defective pile shall be pulled, replaced, and redriven.

2. A new pile shall be driven adjacent to the defective pile.
3. The defective pile shall be spliced or built up.

- B. All piles pushed up due to the driving of adjacent piles or by any other cause, shall be driven down again to their specified elevation. Any sheet pile, ruptured in the interlock, or otherwise damaged during driving, shall be pulled and replaced.

3.05 SHEET PILE CAP

- A. The sheet pile cap shall rest upon the sheet pile top face. The contact surface between the sheet pile top face and the pile cap web shall be welded as shown in the drawings to provide a watertight barrier.

3.06 CORRECTIVE SURFACE HEAVE

- A. Any excess material resulting from displacement of earth by pile driving shall be removed. Materials disturbed by pile driving shall be reconditioned and compacted to a density equal to that of the adjacent undisturbed material.

3.07 DISPOSAL

- A. Dispose of all refuse materials at a legal disposal site.

END OF SECTION 02365

END OF DIVISION 2

PART 1 GENERAL

1.01 WORK INCLUDES

- A. Work under this Section shall consist of supplying all labor, materials, and equipment required to fabricate and install stoplog guides, stoplogs, rods, angles, and plates.

1.02 RELATED WORK

- A. Section 01300 - Submittals.
- B. Section 01400 - Quality Control.

1.03 SUBMITTALS

- A. Submit shop drawings for approval prior to manufacture and installation in accordance with Section 01300: Submittals.
- B. Submit Certificate of Compliance certifying materials meet requirements set forth in the specifications.

1.04 QUALIFICATIONS FOR WELDING WORK

- A. Refer to Section 01400

PART 2 PRODUCTS

2.01 MATERIAL

- A. All stoplog guides, stoplogs, rods, angles, and plates specified shall be ASTM A36 steel.
- B. Arc-welding electrodes shall conform to the American Welding Society (AWS) Specifications for Iron and Steel Arc Welding Electrodes, latest edition, and shall be suitable for the position and other conditions of intended use.

PART 3 EXECUTION

3.01 FABRICATION

- A. Fabrication shall conform to the sizes, length, width, and type as shown on the drawings.
- B. Fabrication shall be in accordance with the applicable provisions of the latest "Specification for the Design, Fabrication, and Erection of Steel for Buildings" (AISC), and with the details shown on the drawings.
- C. Welding of steel shall conform to American Welding Society Standards. Surfaces to be welded shall be clean and free from scale and foreign matter, and all welding shall be done by the shielded-arc method.
- D. Before being laid out or worked, material shall be straight and free from sharp kinks and bends. Shearing and cutting by torch or electric arc shall be performed carefully, and all portions of the work which will be exposed to view after completion shall be finished neatly. After fabrication, all material shall be straight and true and free from kinks, twists, and warps. If straightening is necessary, it shall be done by methods that will not injure the metal.

3.02 WORKMANSHIP

- A. Fit all joints tightly; execute welds neatly.
- B. Any member not constructed according to the specifications may be subject to rejection. Any rejected material or fabrication work shall be replaced at the Contractor's expense.
- C. Sharp edges or corners shall be ground flat or rounded to reduce the potential for injury.

END OF SECTION 05500

END OF DIVISION 5

SECTION J

LIST OF ATTACHMENTS

The Contractor will be furnished with such additional copies of the specification and drawings as may be required for carrying out the work. Full-size prints of the original drawings from which the attached reproductions were made will be furnished without cost to the Contractor for construction purposes upon request.

The following drawings are made a part of this solicitation:

DRAWING NO.	DESCRIPTION	SHEET NO.
6R-SD-638-2.0	VICINITY MAP, LOCATION MAP, AND DRAWING INDEX	SHEET 1 OF 9
6R-SD-638-2.0	GENERAL PLAN VIEW AND TOPOGRAPHY	SHEET 2 OF 9
6R-SD-638-2.0	DETAILED TOPOGRAPHY AND PROFILE ON CREST	SHEET 3 OF 9
6R-SD-638-2.0	SPILLWAY PLAN AND SECTIONS	SHEET 4 OF 9
6R-SD-638-2.0	TYPICAL SECTIONS AND DETAILS	SHEET 5 OF 9
6R-SD-638-2.0	EMERGENCY SPILLWAY CROSS SECTIONS	SHEET 6 OF 9
6R-SD-638-2.0	STOPLOGS AND DETAILS	SHEET 7 OF 9
6R-SD-638-2.0	EXISTING EMBANKMENT PHOTOGRAPHS	SHEET 8 OF 9
6R-SD-638-2.0	EXISTING EMBANKMENT PHOTOGRAPHS	SHEET 9 OF 9

FINAL

INCLUDED ARE PORTIONS
OF THIS DOCUMENT (SEE T OF C)

CAIN CREEK DAM SURVEY DATA COLLECTION AND HYDROLOGY AND HYDRAULIC ANALYSIS

Prepared for
U.S. Fish and Wildlife Service
Denver, Colorado

October 8, 1997

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Appendix B	Pertinent Data
Appendix C	PMF and 100 Year Flood Analysis
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Appendix E	Reservoir Routing Analysis

Survey data collection and hydrology-hydraulics analyses were completed for Cain Creek Dam, South Dakota. The purposes of the work were to 1) develop a recommendation for the hazard classification for the dam and 2) to evaluate the capacities of existing spillways with respect to dam safety requirements.

? Appl. has 18'

The facility is a 650 feet long, 14 feet high embankment dam located in the Cain Creek Waterfowl Production Area, in Beadle County, near the City of Huron, South Dakota. Appurtenant structures include a stone masonry service spillway and an earth cut emergency spillway. The facility is operated by the U.S. Fish and Wildlife Service (the Service), as a part of the Huron Wetlands Management District.

The collected survey data consisted of 1) topographic survey data at the dam, 2) topographic cross sections in the reservoir area, 3) stream channel cross sections at four downstream road crossings and at other selected downstream channel locations, and 4) dimensions and elevations for three, three-barrel culverts and one bridge at the downstream road crossings. Two survey benchmarks were installed at the site for future reference. The results of the survey data collection effort are presented in Appendix A, and the survey data were used in the hydrology-hydraulics analyses. The survey data and the results of the hydrology-hydraulics analyses were used to update the pertinent data table for the dam, and the updated table is presented in Appendix B.

Hydrology-hydraulic analyses included: 1) an estimate of the elevation-storage relationship for the dam, 2) estimates of discharge curves for the spillways at the dam, 3) a downstream hazard classification analysis, 4) an evaluation of Federal and State spillway design flood requirements, and 5) reservoir routing analyses to evaluate the capacities of the spillways relative to the required spillway design flood.

The elevation-storage curve and the discharge curves were estimated from the survey data, and they are presented on Figures 3 and 4 of this report. It was estimated that the surface area and storage for the reservoir are about 3 acres and 11-acre-feet, respectively, with the water at the crest of the service spillway. If the reservoir rose to the embankment crest elevation, it was estimated that the surface area and storage would increase to about 76 acres and 260 acre-feet, respectively. For a reservoir surface at the embankment crest elevation, the discharge from the service spillway is estimate to be about 580 cfs, while the discharge from the emergency spillway is estimated to be about 670 cfs.

The hazard classification analysis was completed according to the guidelines in the U.S. Bureau of Reclamation publication ACER TM No. 11, which is the current Department of Interior standard for downstream hazard classification of dams. The analysis considered hazards in the reach of Cain Creek from Cain Creek Dam to the confluence of the creek with the James River, a reach length of about 4 miles. The valley of the James River is much larger than that of Cain Creek, and it is judged that there would be negligible downstream impact of the failure of Cain Creek Dam in the James River valley. The only potential flooding hazards currently within that reach of the Cain Creek are three township road crossings and one state highway crossing. The township road crossings are gravel roads with corrugated metal pipe culverts, while the state highway crossing is a bridge about 27 feet above the bottom of the creek channel. The hazard classification analyses indicated that dam failure would not contribute significantly to the

flooding hazards at the four potential hazard locations, for the full range of loading from a "sunny day" failure to failure during the probable maximum flood (PMF). Consequently, it is recommended that the facility be classified as a LOW HAZARD dam. This recommendation is based on existing conditions in the downstream valley. Although there are no known plans for development in the valley, future development could result in a change in the hazard classification.

A review of dam safety policies and regulations indicated that the governing Federal policies and standards are those of the U.S. Fish and Wildlife Service. Under Service policies, the facility is classified as a SMALL size dam, for which the spillway design flood (SDF) would be the 100-year flood, for the recommended LOW hazard classification. The facility would also be classified as a SMALL size dam under South Dakota dam safety regulations, however, for a small size, LOW hazard dam with the storage and reservoir depth at Cain Creek Dam, South Dakota regulations require only a 25-year flood as the SDF.

Both a 100-year flood and a PMF were estimated for Cain Creek Dam; and reservoir routing analyses were completed for the 100-year flood and selected percentages of the PMF. The 100-year flood was estimated to have a peak inflow to the reservoir of about 9,650 cfs, while the peak inflow for the PMF was estimated to be about 142,000 cfs. It was found that the existing spillways could not pass the 100-year flood, the Service SDF, without overtopping the embankment; it was estimated that this flood would result in overtopping of the embankment for 66.8 hours by up to about 2.7 feet of water. A 25-year flood, the SDF according to South Dakota regulations, was not estimated for this report, and it is not known if the embankment would be overtopped during that event. It was estimated that the embankment would be overtopped for 98.5 hours by up to about 18.5 feet of water during the full PMF, and that all floods in excess of 1% of the PMF would result in overtopping of the embankment.

5.1 PROBABLE MAXIMUM FLOOD

The Probable Maximum Precipitation (PMP) for the catchment was derived using Hydrometeorological Report No. 55 (HMR55) and the U.S. Army Corps of Engineers HEC Probable Maximum Storm (HMR52) computer model. Key inputs to this analysis are discussed in Appendix C. The PMP was calculated at 22.32 inches over 72 hours for a total catchment of 340 mi².

Determination of the Probable Maximum Flood (PMF) was performed using the U.S. Army Corps of Engineers HEC-1 computer program (USACE, 1990). The analysis involved dividing the catchment into four sub-basins and incorporating estimates of channel routing upstream of the dam. The PMF inflow to the reservoir was estimated as 141,724 cfs. The PMF inflow hydrograph and the 1%, 4% and 30% PMF hydrographs are presented in Appendix C and key inputs to the analysis are discussed in Appendix C.

5.2 100-YEAR FLOOD

The 100 year flood was derived using the HEC-1 computer model program and precipitation estimates from the rainfall-frequency atlas of the United States (Technical Report 40, U.S. Department of Commerce). The 100-year, 24-hr precipitation for Beagle county is estimated as 5.4 inches, which results in a peak inflow to the reservoir of 9,653 cfs. The 100-year flood inflow hydrograph is presented in Appendix C, and key inputs to the analysis are discussed in Appendix C.

6.1 HAZARD CLASSIFICATION PROCEDURE

The hazard classification for Cain Creek Dam was completed according to the procedure given in ACER TM No. 11, published by the U.S. Bureau of Reclamation, which is the current Department of Interior Standard for hazard classification. The classification was completed for the case of the existing breach being repaired to restore the dam to the configuration that existed before the breach.

The procedure given in TM No. 11 consists of up to four steps, as shown in the flow chart for the procedure which is reproduced in Appendix D of this report and is summarized below:

- Step 1 - Evaluate the hazard classification based on analysis of the sunny day failure case. If the resulting hazard classification is high, stop and assign a high hazard classification to the dam.
- Step 2 - If the hazard classification from Step 1 is not high, evaluate the hazard classification based on analysis of the PMF plus dam-break case. If the hazard classification does not increase from Step 1 to Step 2, stop and assign the resulting hazard classification to the dam (e.g., if significant hazard from both Step 1 and Step 2, then assign significant hazard classification).
- Step 3 - If the hazard classification increases from Step 1 to Step 2 (e.g., significant hazard from Step 1 and high hazard from Step 2), then evaluate the hazard classification based on analysis of the PMF case with no dam in place. If the hazard classification decreases from Step 2 to Step 3, stop and assign the hazard classification from Step 2 to the dam (e.g., if high hazard from Step 2 and significant hazard from Step 3, then assign high hazard classification).
- Step 4 - If the hazard classification does not decrease from Step 2 to Step 3 (e.g., high hazard from both Step 2 and Step 3), then evaluate the hazard classification based on analysis of incipient danger flood cases for pertinent possible hazards. Assign the hazard classification based on the incremental effects of dam failure under incipient danger flood conditions.

The flow chart reproduced in Appendix D appears to indicate that, once the analysis has proceeded to Step 4, the only two possible outcomes are a significant hazard rating or a high hazard rating. Based on a review of the text of TM No. 11 and on discussions with Reclamation personnel, it appears that the flow chart is not correct for Step 4. The philosophy embodied in TM No. 11 can be summarized as follows: If it can be shown that, for dam failure scenarios over the entire range of loading conditions from sunny day conditions to the PMF, the incremental effects of dam failure do not increase the downstream flooding hazard; then it is appropriate to classify the dam as a low hazard structure. This philosophy is illustrated in the following quote from the text of TM No. 11:

Increasing the loading conditions does not always raise the downstream hazard classification. For example, consider a small dam and reservoir located in a channel that drains a basin capable of producing very large floods. The dam is rated low hazard under "sunny day" failure conditions. However, downstream flooding

from a runoff flood (not including a dam failure discharge) would result in large loss of life and severe economic loss. The effects of the dam failure combined with such a flood would be negligible and probably imperceptible. Thus, the dam would still be rated low hazard.

The philosophy described above is used in the hazard classification analysis presented in this report, rather than the flow chart paths given for Step 4.

The hazard classification categories used by the Department of Interior are high, significant, and low. The selection of the appropriate hazard classifications is based on an assessment of lives-in-jeopardy and economic loss for dam failure according to the guidelines summarized in Table 1. Hazard classification is not associated with the existing condition of the structure; the anticipated performance and operation of the structure; or judgment regarding the likelihood of dam failure. Rather, hazard classification is a statement of the likely adverse impact on human life and downstream development if a dam failed for whatever reason.

As can be seen, in Table 1, the hazard classification criteria for lives-in-jeopardy are quantitative and specific, while those for economic loss are more judgmental. This is normally not a problem, because hazard classification is usually decided based on lives-in-jeopardy, and economic losses do not often become a deciding factor.

For purposes of hazard classification, TM No. 11 defines lives-in-jeopardy as "all individuals within the inundation boundaries who, *if they took no action to evacuate* [emphasis added], would be subject to danger" from flood water of depth and velocity sufficient to threaten their lives. TM No. 11 includes charts that define flood dangers for persons at several different types of locations (e.g., houses on foundations, passenger vehicles, adult pedestrians, etc.). The charts, which are plots of depth versus velocity, are divided into three zones: the high danger zone, the judgment zone, and the low danger zone. The high and low danger zones are self explanatory. For flooding in the judgment zone, the assessment of the danger is left to the judgment of the analyst completing the assessment.

For the Cain Creek dam hazard classification, the chart relating to passenger vehicles is applicable. The watershed downstream of the dam has no residences or other buildings which would be affected by floods. A copy of the depth-velocity flood danger relationship for passenger vehicles is provided in Appendix D.

6.2 HAZARD CLASSIFICATION ANALYSIS FOR CAIN CREEK DAM

6.2.1 Methodology

The BOSS DAMBRK model was used for the downstream inundation analyses completed to support the hazard classification for the Cain Creek dam. In addition, hand-calculations were completed for the incipient danger flood analyses for the township road crossings.

The National Weather Service Dam Break Flood Forecasting Model (DAMBRK), by D.L. Fread, is currently the standard model accepted for dam failure routings. A PC version of DAMBRK was developed by the National Weather Service, based on direct conversion of the mainframe

Table 1
Downstream Hazard Classification System From ACER TM No. 11

Downstream Hazard Classification	Lives-in-Jeopardy	Economic Loss
Low	0	Minimal (undeveloped agriculture, occasional uninhabited structures, or minimal outstanding natural resources)
Significant	1-6	Appreciable (rural area with notable agriculture, industry, or worksites, or outstanding natural resources)
High	More than 6	Excessive (urban area including extensive community, industry, agriculture, or outstanding natural resources)

DAMBRK model. A commercial version of the program, BOSS DAMBRK (Boss, 1994), was used to model all runs for this study. The BOSS Corporation has added additional graphics and output options. The inner workings of the two programs are identical, and the input data files are interchangeable.

The DAMBRK model is composed of two basic elements. The first simulates the outflow hydrograph resulting from time-dependent, erosion-type breach of a dam, using a hydraulic weir representation of the outflow through the breach. The model simultaneously considers the effects of the reservoir storage depletion and the inflow hydrograph. The second element simulates the routing of the generated outflow hydrograph through the downstream valley, via an implicit finite difference solution of the complete, one-dimensional equation of unsteady flow.

The dambreak model does not allow easy modeling of the downstream road culverts. Consequently, hand-calculations were completed to evaluate the impacts of dam failure under incipient danger flood conditions at the three township road crossings, as discussed further below.

6.2.1.1 Analysis Assumptions

The following assumptions are made in the dam-break modeling process:

1. Existing conditions in the downstream valley.
2. Changes in cross section geometry caused by scour or deposition are neglected.
3. The backwater and failure associated with small embankments and bridges is neglected.
4. Discharge through culverts is ignored.

6.2.1.2 Breach Parameters

Breach parameters include breach width, breach side slopes, breach bottom elevation, time for full breach development, and reservoir level at the initiation of the breach. For a piping failure, the starting position of the breach is usually determined based on experience and the physical features of the dam. For this analysis breach dimensions similar to those which developed in the dam earlier this year were applied (30 ft breach width with base at El. 1282). The time of failure was varied in the analysis. For the sunny day failure and the PMF failure conditions, the time of failure was conservatively assumed to be 1 hour for full breach develop. However, for incipient danger flood analyses, it was found that the conservative 1 hour failure time produced breach outflows that were not consistent with the breach outflow that reportedly occurred in March and April 1997. Specifically, analysis with the short failure time indicated a significant overtopping of the first downstream township road, while reportedly no overtopping of the road occurred during the 1997 breach. For the incipient danger flood conditions, which are similar to those that occurred in March and April 1997, the time of failure was increased to 10 hours. The breach outflow for this larger failure time still appears to be greater than the outflow that occurred in the 1997 breach, however, it would not be prudent to rely on a time of failure larger than 10 hours.

For the sunny day failure case, the reservoir water level at breach initiation was taken as the service spillway crest elevation. For failures during flood events, the reservoir water level at breach initiation was assumed to be 1 foot above the embankment crest elevation, or the maximum reservoir elevation, if the reservoir rose to less than 1 foot above the embankment crest elevation.

6.2.1.3 Initial Flow Conditions (Base Flow)

Base flows are required by the DAMBRK software to prevent numerical problems. For Cain Creek, the baseflow to the reservoir was assumed as 10 cfs at the beginning of the simulation period. The minimum flow through the reservoir and the downstream channel was also set as 10 cfs during the flood routing period for a sunny day dam failure and 10 cfs for a dam-break during a PMF overtopping scenario.

6.2.1.4 Study Reach and Cross-Sections

The DAMBRK analyses considered the downstream reach from the dam to the confluence of Cain Creek with the James River, a distance of about 4 miles. The James River valley is much wider and larger than the Cain Creek valley, and it is judged that failure of Cain Creek Dam would not have any significant impact downstream of the study reach.

Cross-section locations used in the analysis are described in Appendix D. In order to prevent non-convergence of the model, it was necessary to “smooth out” differences in cross-sections. In addition a constant Mannings roughness coefficient of 0.04 was applied to each cross-section.

6.2.2 Hazard Classification Analysis Results

The hazard classification analysis for Cain Creek Dam required all four steps of the ACER TM No. 11 procedure. The downstream hazards considered in the analysis were the three township road crossings and the State Highway 37 crossing; and flood hazards for passenger vehicles were considered at all four locations. No other potential hazard locations were identified in the study reach.

The results for Step 1, sunny day failure are summarized in Table 2. As shown in the table, the flooding from the sunny day failure is estimated to be in the low danger zone for passenger vehicles, at all four potential hazard locations. In fact, the first downstream township road crossing acts as a detention dam for the breach outflow; that is the first road crossing is not overtopped, and the culverts at that location effectively meter the breach flow out into the channel further downstream. Consequently, based on the sunny day failure a low hazard classification would be justified.

The results for Steps 2 and 3, PMF plus dambreak and PMF alone, are summarized in Table 3. At all four potential hazard locations, the flooding resulting from the PMF combined with dam failure is estimated to be in the high danger zone for passenger vehicles. However, flooding in the high danger zone for passenger vehicles is also indicated for the case of the PMF alone. Consequently, the flooding hazard attributable to dam failure under PMF flood levels is negligible; that is the failure of the dam does not significantly increase the flood hazard posed by

Table 2
Summary of Results for Sunny Day Failure Scenario
Cain Creek Dam, South Dakota

Potential Hazard	Stream Bottom Elevation feet	Elevation of Low Point in the Road feet	Assumed Initial Water Level Elevation feet	Elevation of Maximum Stage from Breach feet	Maximum Depth of Road Overtopping feet	Peak Discharge From Breach cfs	Culvert Capacity cfs	Flood Hazard Potential Zone ⁽¹⁾
1. First Downstream Township Road	1280.1	1291.5	1284	1289.1	0	1 ⁽²⁾	2400	LOW
2. State Highway 37	1270.0	1296.0	1270	1270	0	1 ⁽²⁾	N/A ⁽³⁾	LOW
3. Second Downstream Township Road	1256.7	1268.5	1258	1258	0	3 ⁽²⁾	1700	LOW
4. Third Downstream Township Road	1243.5	1253.5	1245	1246	0	4 ⁽²⁾	3200	LOW

Notes:

⁽¹⁾ For passenger vehicles, based on Figure 4 from ACER TM No. 11.

⁽²⁾ Flows are assumed base flows applied to dam structures for analysis.

⁽³⁾ "N/A" indicates not applicable.

Table 3
Summary of Results for PMF Plus Dam Breach and PMF Alone
Cain Creek Dam, South Dakota

Potential Hazard	Stream Bottom Elevation feet	Elevation of Low Point in the Road feet	PMF Plus Dam Breach				PMF Alone			
			Elevation of Maximum Stage Drain Breach feet	Maximum Depth of Road Overtopping feet	Flow Velocity fps	Flood Hazard Potential Zone ⁽¹⁾	Elevation of Maximum Stage feet	Maximum Depth of Road Overtopping feet	Flow Velocity fps	Flood Hazard Potential Zone ⁽¹⁾
1. First Downstream Township Road	1280.1	1291.5	1307.4	15.4	4.5	High	1307.4	15.4	4.6	High
2. State Highway 37	1272.0	1296.0	1303.0	7.0	28.2	High	1303.1	7.0	24.5	High
3. Second Downstream Township Road	1256.7	1268.5	1290.8	23.8	11.2	High	1290.8	23.8	11.0	High
4. Third Downstream Township Road	1243.5	1253.5	1267.6	14.1	12.9	High	1267.7	14.2	15.9	High

Note: ⁽¹⁾ For passenger vehicles, based on Figure 4 from ACER TM No. 11.

the PMF alone. Consequently, it was necessary to continue to Step 4 in the procedure: incipient danger flood analysis.

Incipient danger flood analyses were completed for all four potential hazard locations, and the results are summarized in Table 4. The incipient danger flood for the State Highway 37 crossing was found to be about 30% PMF. For that flood without dam failure, the water level would rise to the top of the highway bridge deck, but water would not flow over the bridge. The addition of the dam breach outflow to the 30% PMF would result in flooding over the bridge that is in the low danger zone for passenger vehicles.

The incipient danger flood levels for the three township road crossings were all less than 5% PMF and were controlled by the culvert capacities at each of the three crossings. It was estimated that the culvert capacities are about 2400 cfs, 1700 cfs, and 3200 cfs for the first, second, and third downstream crossings, respectively, with the upstream water level to the elevation of the low point in the road crossing in each instance. Incipient danger floods were estimated using the dam break model without failure of the dam, and then the impacts of dam failure during the incipient danger floods were estimated by repeating the same routings with a dam break. The incipient danger flood analysis was completed separately for each of the three township road crossings, and the incipient danger floods for the three crossings were estimated to be flows of 2460 cfs, 2176 cfs, and 3700 cfs for the first, second, and third downstream township crossings, respectively. The incremental flooding depths at the three crossings from dam failure during the respective incipient danger flood were between 1.0 and 1.2 feet with flow velocities less than 1 fps, which plot in the low danger zone for passenger vehicles, as summarized in Table 4.

The results summarized in Table 4 indicate that the flooding attributable to dam failure under incipient flooding conditions is estimated to be in the low danger zone for passenger vehicles for all four potential hazard locations.

Details of the hazard classification analysis are discussed in Appendix D.

6.3 RECOMMENDED HAZARD CLASSIFICATION FOR CAIN CREEK DAM

Based on the results of the hazard classification analysis, it is recommended that Cain Creek Dam be classified as a LOW HAZARD structure. For dam failure scenarios over the entire range of loading conditions from sunny day conditions to the PMF, the incremental flooding attributable to dam failure is either in the low danger zone for passenger vehicles or does not significantly affect the danger level. This is true at the State Highway 37 bridge and at the three downstream township road crossings, which are the only potential hazard locations that currently exist downstream of the dam. Although we are not aware of any current plans for downstream development, future changes in downstream conditions could change the hazard classification for the dam.

Table 4
Summary of Results for Incipient Danger Flood Conditions
Cain Creek Dam, South Dakota

Potential Hazard	Incipient Danger Flood	Impacts of Dam Failure During Incipient Danger Flood		
		Maximum Depth of Road Overtopping feet	Flow Velocity Over the Road fps	Flood Hazard Potential Zone ⁽¹⁾
1. First Downstream Township Road	2,460 cfs	1.2	0.25	Low
2. State Highway 37	33,000 cfs ⁽²⁾	0.3	5.9	Low
3. Second Downstream Township Road	2,176 cfs	1.0	0.8	Low
4. Third Downstream Township Road	3,700 cfs	1.0	6.9	Low

Note: ⁽¹⁾ "PMF" indicates probable maximum flood.

⁽²⁾ 30% PMF

7.1 FEDERAL REQUIREMENTS

The applicable federal dam safety requirements are the Service dam safety policies and standards. The Service policies and standards are generally the same as those of the Bureau of Reclamation, with minor modifications to better suit Service facilities. Reclamation policies and standards are similar to those of other federal agencies, such as the Corps of Engineers and the Natural Resources Conservation Service.

According to Service guidelines, Cain Creek Dam is classified as a SMALL dam. The size classification is determined by either the structural height or water storage capacity at maximum water storage elevation, whichever yields the larger size classification. The Service criteria for a small dam are either a height between 25 and 40 feet or a storage capacity between 50 and 1000 acre-feet. Cain Creek dam has a height of 14 feet and a maximum storage capacity of 260 acre-feet; and hence is classified as a SMALL dam, based on the storage capacity.

Based on the SMALL size classification and the recommended LOW hazard classification, Service policies and standards indicate that the spillway design flood (SDF) for Cain Creek Dam is the 100-year flood.

7.2 SOUTH DAKOTA REQUIREMENTS

According to South Dakota dam safety requirements, Cain Creek Dam would be classified as a SMALL size, CATEGORY 3 dam. The criteria for a SMALL size dam in the South Dakota dam safety regulations are exactly the same as those in the Service policies and standards.

CATEGORY 3 is the lowest hazard classification in the South Dakota dam safety regulations, and it corresponds to "a low hazard dam whose failure may cause limited damage to agricultural lands or county and township roads or minimum economic loss." There is no loss of life potential associated with the failure of a CATEGORY 3 dam.

For a SMALL size, CATEGORY 3 dam, the South Dakota regulations indicate a nominal SDF equal to a 50-year flood. However, the South Dakota regulations also include the following exception for SMALL size, CATEGORY 3 dams: "For small size category 3 dams with an emergency spillway, the minimum spillway design flood is the 25-year frequency if the product of the intermediate storage capacity times the effective height is less than 3000." The intermediate storage capacity is "the volume in acre-feet in the reservoir at the crest of the emergency spillway;" and the effective height is "the difference in elevation in feet between the lowest point in the cross section taken along the centerline of the dam and the crest of the emergency." For Cain Creek Dam the intermediate storage is estimated to be 130 acre-feet (see Appendix B), and the effective height is estimated to be 11 feet (emergency spillway crest, Elevation 1292 feet, minus stream channel, Elevation 1281 feet); resulting in a product of 1430, which meets the requirements for the exception. Consequently, according to the South Dakota dam safety regulations, the SDF for Cain Creek Dam is the 25-year flood.

8.1 100-YEAR FLOOD

A reservoir routing analysis was completed for the 100-year flood using the computer program HEC-1. The results indicated that the embankment would be overtopped for 66.8 hours by up to about 2.7 feet of water. The 100-year reservoir routing analysis is included in Appendix E, and the results are summarized in Table 5.

8.2 PERCENTAGES OF THE PROBABLE MAXIMUM FLOOD

Reservoir routing analyses were also completed for the PMF and selected percentages of the PMF, using the computer program HEC-1. The results indicated that the dam would be overtopped for 98.5 hours by up to about 18.5 feet of water during the full PMF, and that the dam would be overtopped by all floods in excess of about 1% PMF. The routing analyses for the various percentages of the PMF are presented in Appendix E, and the results are summarized in Table 5.

Dam overtopping depths and durations were also calculated in some of the DAMBRK runs, and the DAMBRK results do not always agree with those from the HEC-1 analyses. The differences are attributable to the fact that DAMBRK is a hydrodynamic model while HEC-1 is not, and the fact that DAMBRK requires an assumed initial base flow for the model to be mathematically stable. The HEC-1 analyses are considered to be the most appropriate results for the evaluation of the ability of the spillways to pass inflow floods.

From a review of the numbers reported in Table 5, it is noted that the peak to the reservoir for the various percentages of the PMF do not correspond to a mathematical proration of the full PMF hydrograph. For example the inflow of about 61,500 cfs for 50% PMF is less than 50% of the inflow of about 141,700 cfs for the full PMF. The hydrographs for the percentages of the PMF were calculated using "flow percentage" option in the HEC-1 program, however, using that option, the hydrograph to the reservoir is calculated as the combination of the inflows from the various sub-basins included in the model. Because of storage that is available in some of the sub-basins, the inflow hydrographs do not combine together to produce percent PMF inflows to the reservoir that are exact percentages of the full PMF inflow hydrograph, as indicated in Table 5.

8.3 SPILLWAY DESIGN FLOOD

As discussed in Section 6, according to Service policies and standards the spillway design flood (SDF) for Cain Creek Dam is the 100-year flood. The reservoir routings indicate that the current spillways are not capable of passing this SDF without significant embankment overtopping. Both the peak inflow and the peak outflow for the 100-year flood are estimated to be about 9,650 cfs, while the estimated combined spillway capacity (service spillway capacity plus emergency spillway capacity) is 1,250 cfs before overtopping of the embankment begins.

According to South Dakota dam safety regulations, the SDF for the dam is the 25-year flood. A 25-year flood was not estimated for this analysis, and it is not known if the spillways could safely pass that flood without embankment overtopping.

Table 5
Summary of Results of Reservoir Routing Analysis
Cain Creek Dam, South Dakota

Inflow Flood	Peak Inflow to the Reservoir cfs	Peak Outflow from the Reservoir cfs	Embankment Overtopping	
			Duration Hours	Maximum Depth Feet
100-Year Flood	9,654	9,653	66.8	2.65
100% PMF ⁽¹⁾	141,732	141,732	98.5	18.5
50% PMF	61,537	61,537	90.0	10.43
30% PMF	32,861	32,861	82.0	0.71
20% PMF	19,743	19,743	75.0	4.63
10% PMF	8,449	8,449	58.5	2.33
5% PMF	3,833	3,833	36.0	0.99
4% PMF	3,045	3,045	28.0	0.71
1% PMF	758	758	0	0.0

Note: ⁽¹⁾ "PMF" indicates probable maximum flood.

Based on the data collection and analyses completed for this report, the following conclusions were developed:

1. According to Service policies and standards, South Dakota dam safety regulations, and the survey data collected for this report, Cain Creek Dam is classified as a SMALL size dam.
2. Based on hazard classification analyses completed according to the U.S. Bureau of Reclamation's ACER TM No. 11, it is recommended that Cain Creek Dam be classified as a LOW HAZARD dam.
3. Based on South Dakota dam safety regulations, Cain Creek Dam would be classified as a CATEGORY 3, or LOW HAZARD, dam.
4. According to Service policies and standards, and based on the recommended classification as a SMALL, LOW HAZARD dam, the spillway design flood (SDF) for Cain Creek Dam is the 100-year flood.
5. According to South Dakota dam safety regulations, the SDF for Cain Creek Dam would be the 25-year flood. This SDF is based on an exception in the South Dakota regulations that allows the SDF to be reduced to the 25-year flood, for SMALL, CATEGORY 3 dams that meet certain height and storage criteria. Cain Creek Dam meets these criteria. Without the exception, the SDF required by the South Dakota regulations for a SMALL, CATEGORY 3 dam is the 50-year flood.
6. Reservoir routing analyses indicate that the spillways at Cain Creek Dam cannot safely pass the 100-year flood, the SDF required by the Service policies and standards. The analyses indicate that the embankment would be overtopped for 66.8 hours by up to about 2.7 feet of water during the 100-year flood. The available spillway capacity before overtopping commences is only 1,250 cfs, compared to the routed inflow and outflow for the 100-year flood, which both are equal to about 9,650 cfs.
7. A 25-year flood inflow hydrograph, as required by the South Dakota regulations, was not estimated for this report, and it is not known if the dam could safely pass that flood.
8. Reservoir routing analyses completed for various percentages of the probable maximum flood (PMF) indicate that the embankment would be overtopped for 98.5 hours by up to 18.5 feet of water during the full PMF, and that the embankment would be overtopped by all floods exceeding approximately 1% PMF.

C-1 METHODOLOGY

Both the probable maximum flood (PMF) and the 100-year flood were derived using the U.S. Army Corps of Engineers HEC-1 computer program. The PMP was derived using the HEC probable maximum storm (HMR52) package and the 100 year storm precipitation data was extracted from the rainfall frequency atlas of the United States (Technical Report 40, U.S. Department of Commerce). Hydrologic parameters for the watershed used in the analysis are summarized in Section C-2. Results of the PMP analysis are discussed in Section C-3 and results of the flood analysis are provided in Section C-4.

C-2 WATERSHED CHARACTERISTICS

The Cain Creek watershed extends almost 40 miles west of the dam, originating in Hand County. The East and West branches of Pearl Creek merge with Cain Creek approximately 0.5 mile north of Wessington and contribute almost 140 mi² to a total watershed of 340 mi². For analysis, the watershed was divided into four sub-basins. Key hydrologic parameters for these sub-basins are provided in Table C-1.

TABLE C-1
SUMMARY OF SUB-BASIN CHARACTERISTICS

Sub-basin	Location	Drainage Area (mi²)	Basin Slope (ft/mi)	Basin Length (mi)	Basin Lag Time (hr)
1	Pearl Creek	138.8	6	26	6.7
2	Cain Creek west of Wessington	15.6	78	5	0.8
3	Cain Creek Wessington to Wolsey	100.7	11	20	8.1
4	Cain Creek Wolsey to dam	84.9	7.4	19	13.3
TOTAL		340			

For runoff calculations, an SCS curve number of 61 was applied to the entire watershed, and it was assumed that there is zero impervious area. Examination of USGS topographic maps for the watershed indicates that significant routing of flood flows would be provided within the creek flood plain and in naturally occurring pond areas such as the State Game Production Area in the Pearl Creek catchment. Detailed survey information for such reservoirs and for the flood plain upstream of the dam was not available, hence estimates of the storage available in these features was input to the HEC-1 analysis.

C-3 PMP ANALYSIS

The computer program HMR52 computes basin-average Probable Maximum Storms (PMS) in accordance with the criteria specified in Hydrometeorological Report (HMR) No. 52. HMR52

Appendix C

PMF And 100 Year Flood Analysis

describes a procedure for developing a temporal and spatial storm pattern to be associated with the PMP estimates provided in HMR51. South Dakota is within the region of the US for which HMR51 is applicable for PMP derivations.

Data required for the HMR52 analysis includes:

- X,Y coordinates describing the watershed;
- PMP derived from HMR51; and
- Storm orientation.

The analysis assumes the storm is centered at the centroid of the basin area. Table C-2 summarizes the PMS calculated for Cain Creek. The HMR52 analysis output is provided in this Appendix.

TABLE C-2
CAIN CREEK DAM PMS

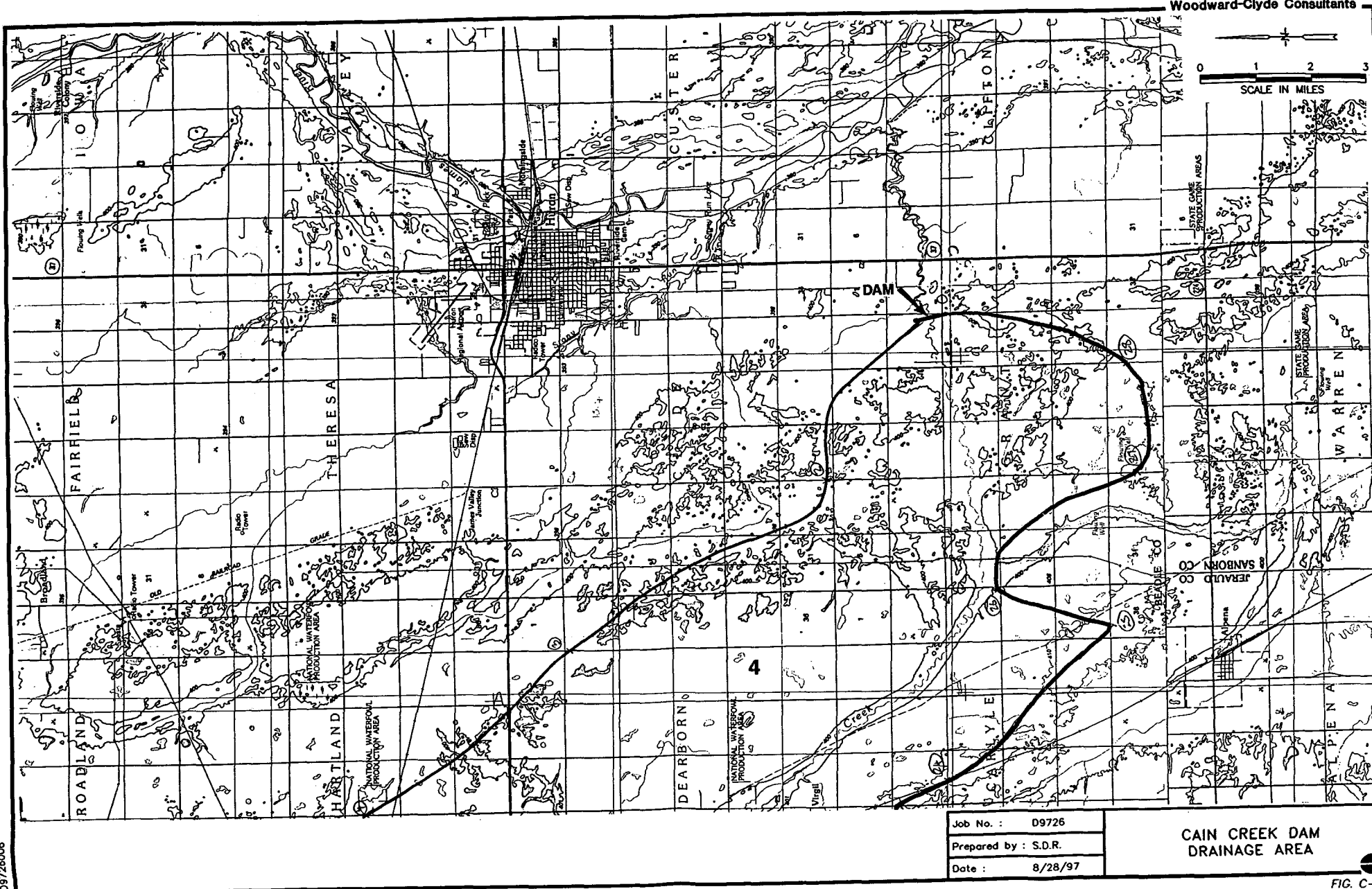
Day	6 Hour Total (inches)				Total
	6	12	18	24	
1	0.28	0.34	0.43	0.60	1.65
2	0.96	2.49	13.92	1.39	18.76
3	0.73	0.50	0.38	0.31	1.92
Cumulative Total					22.33

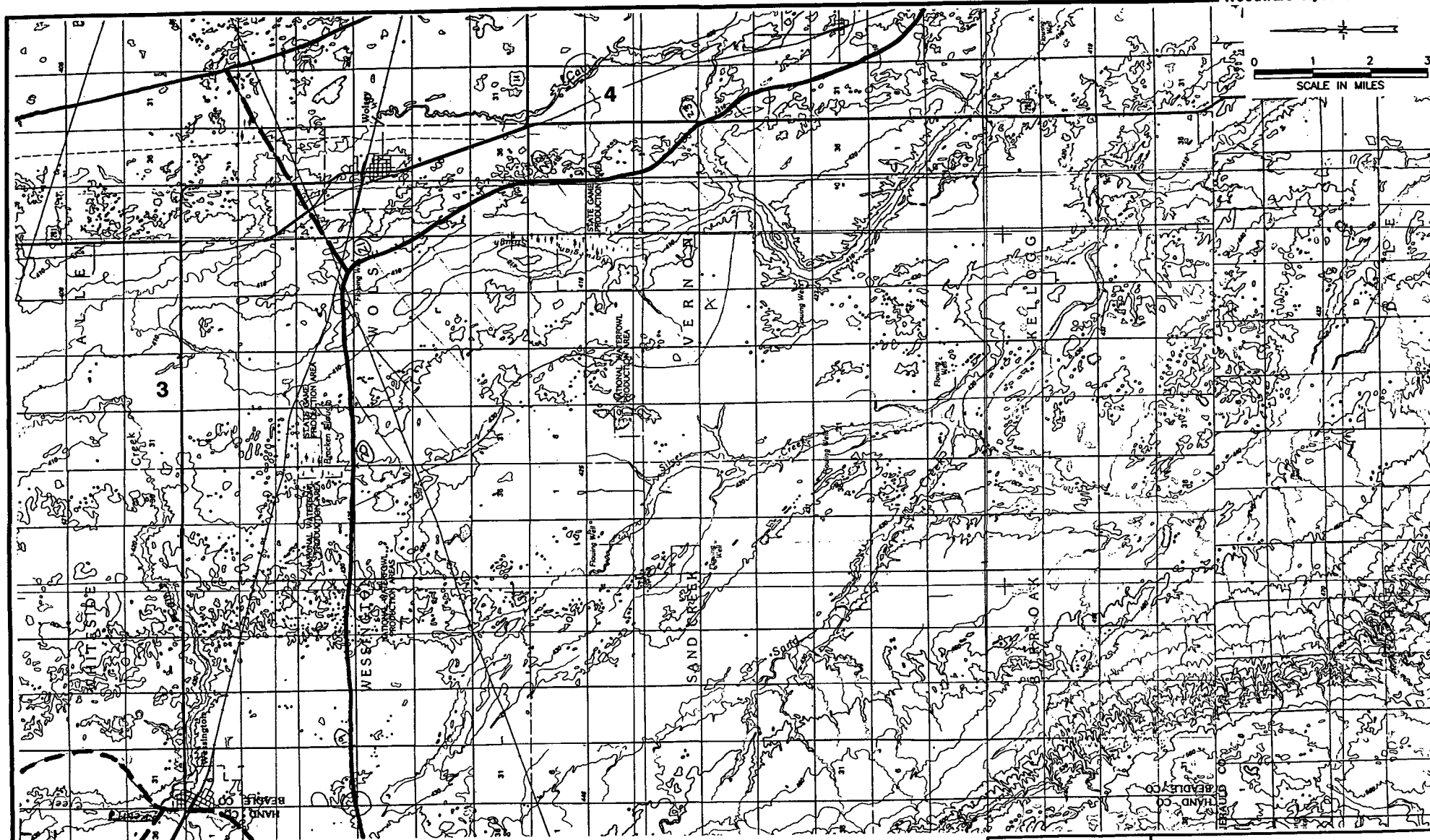
The above precipitation distribution was input to the HEC-1 analysis of the PMF.

C-4 FLOOD ANALYSIS

The layout of the Cain Creek dam watershed and sub-basins used in HEC-1 analysis of the PMF and 100-year flood is provided as Figure C-1. HEC-1 analysis inputs and outputs are provided in this Appendix.

Figure C-2 illustrates graphically the PMF hydrograph derived from the analysis, and Figure C-3 illustrates the hydrograph derived for the 100-year flood.



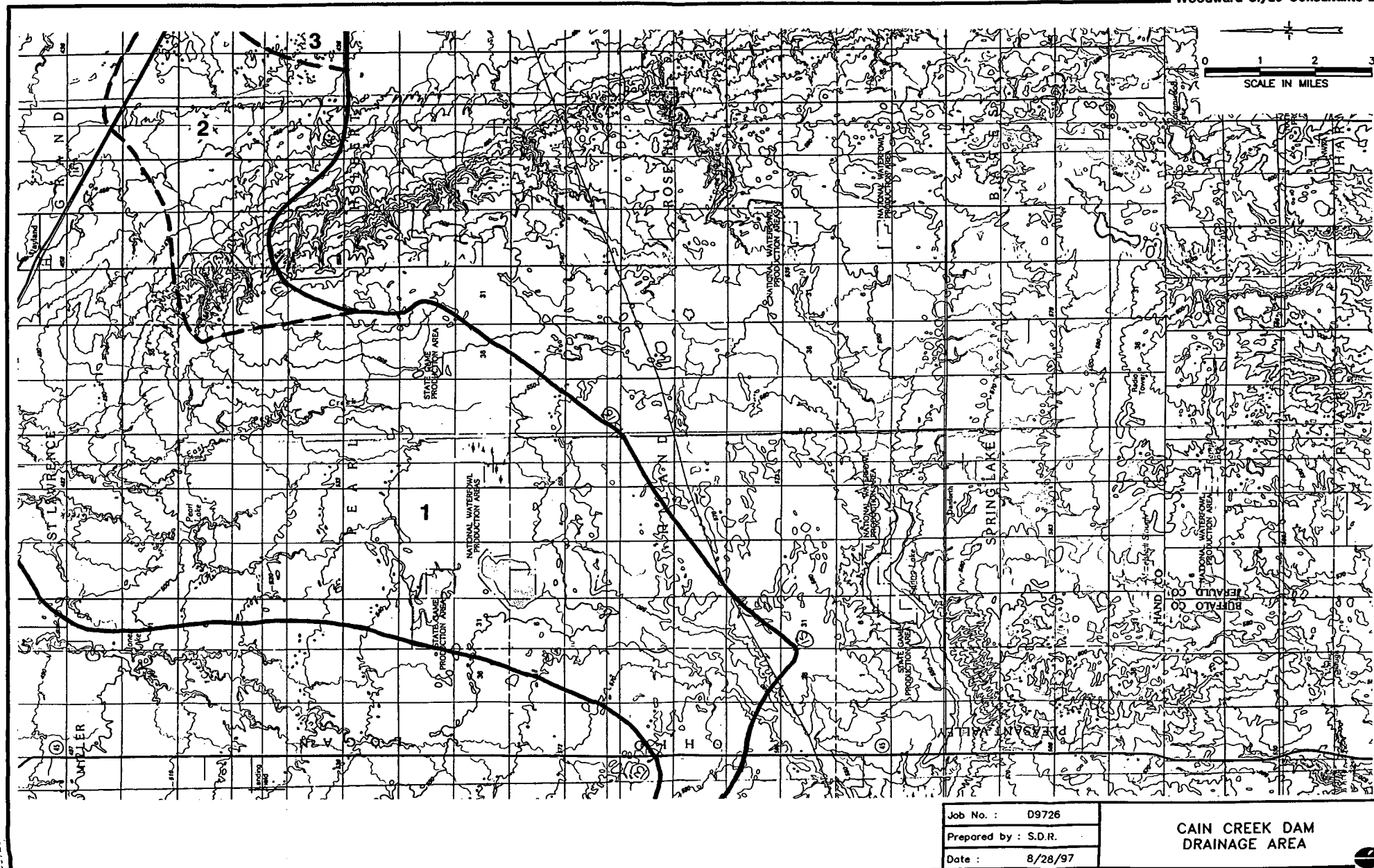


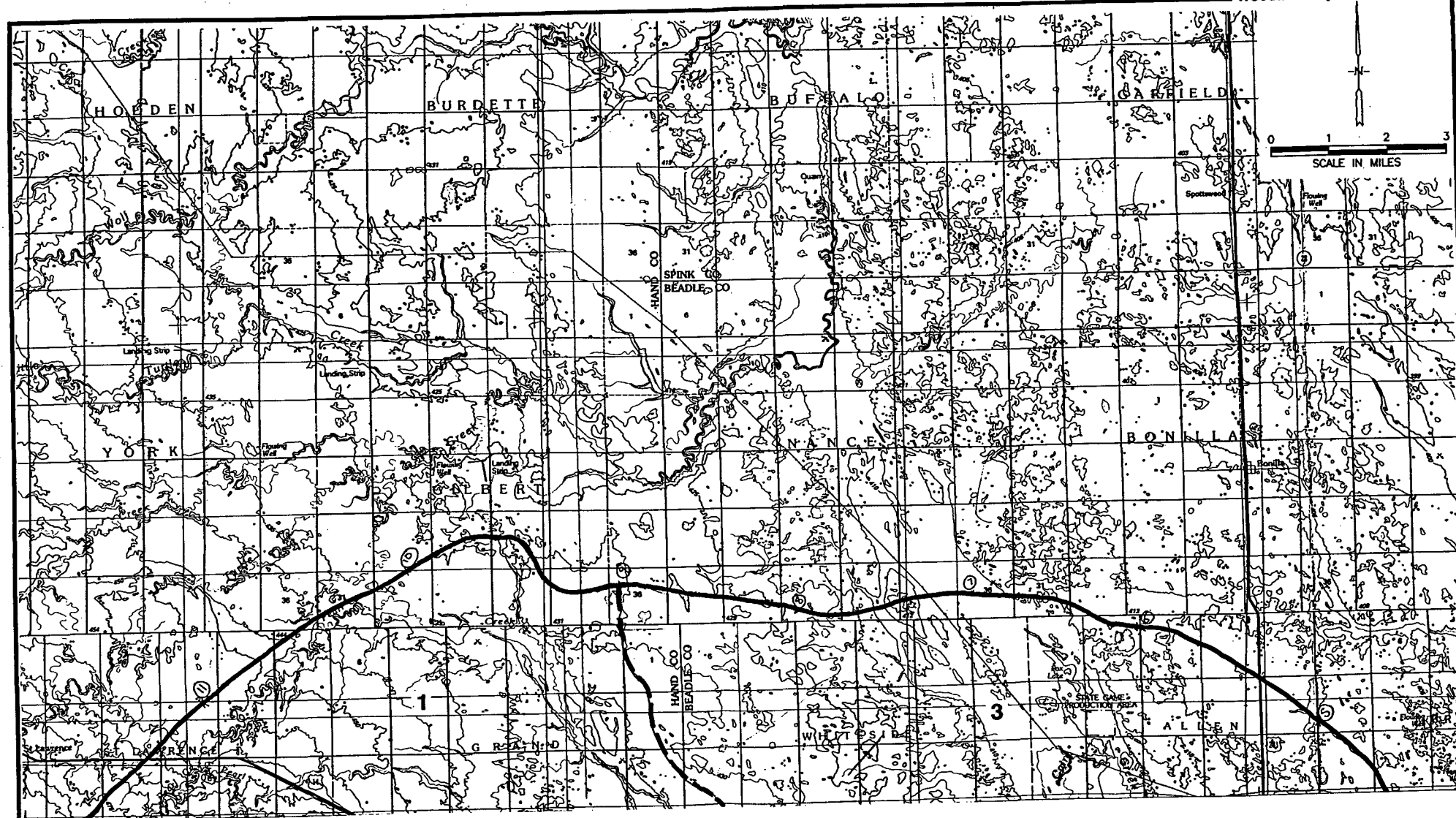
Job No. : D9726

Prepared by : S.D.R.

Date : 8/28/97

CAIN CREEK DAM
DRAINAGE AREA





Job No. :	D9726
Prepared by :	S.D.R.
Date :	8/28/97

CAIN CREEK DAM
DRAINAGE AREA

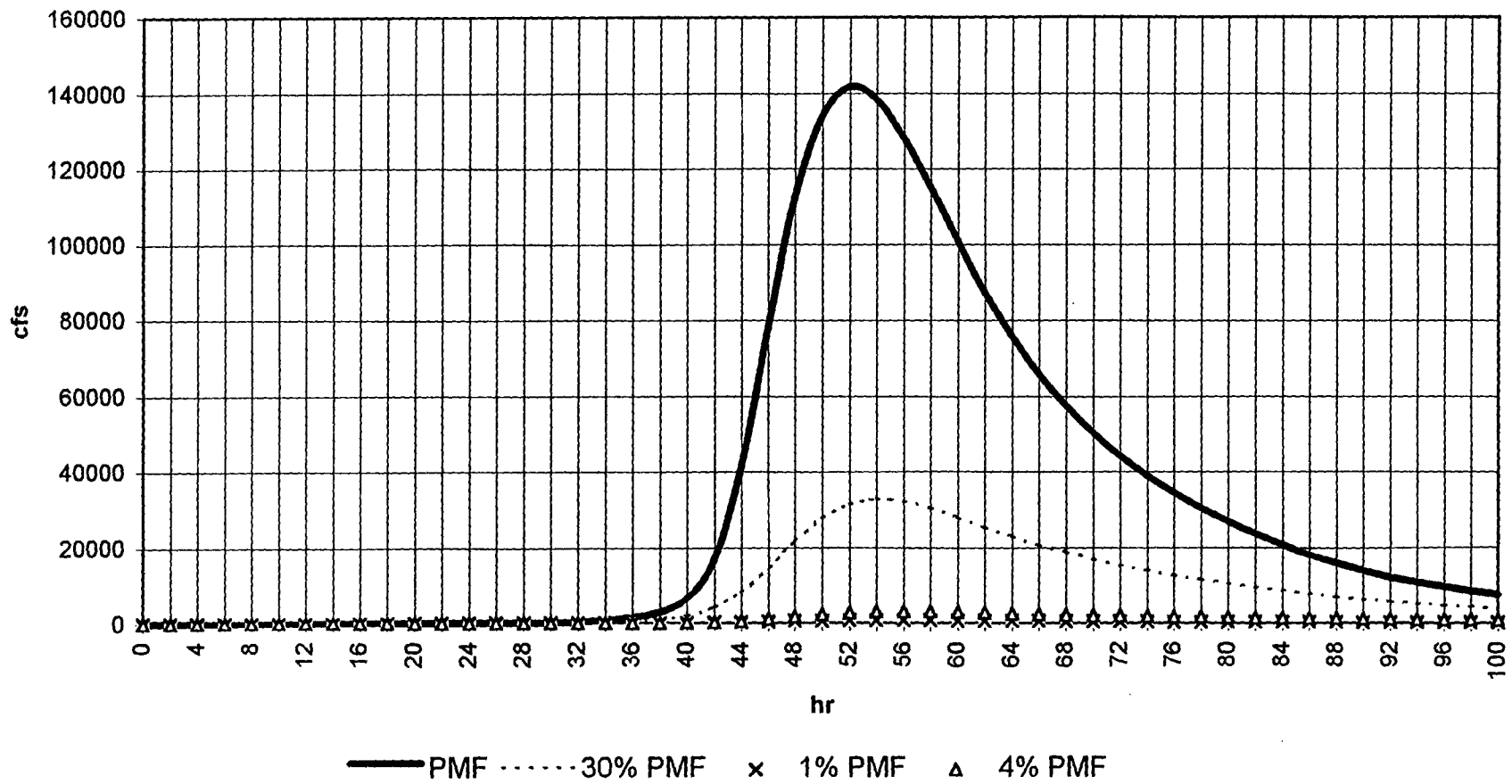


Figure C-2. PMF Hydrograph for Cain Creek Dam

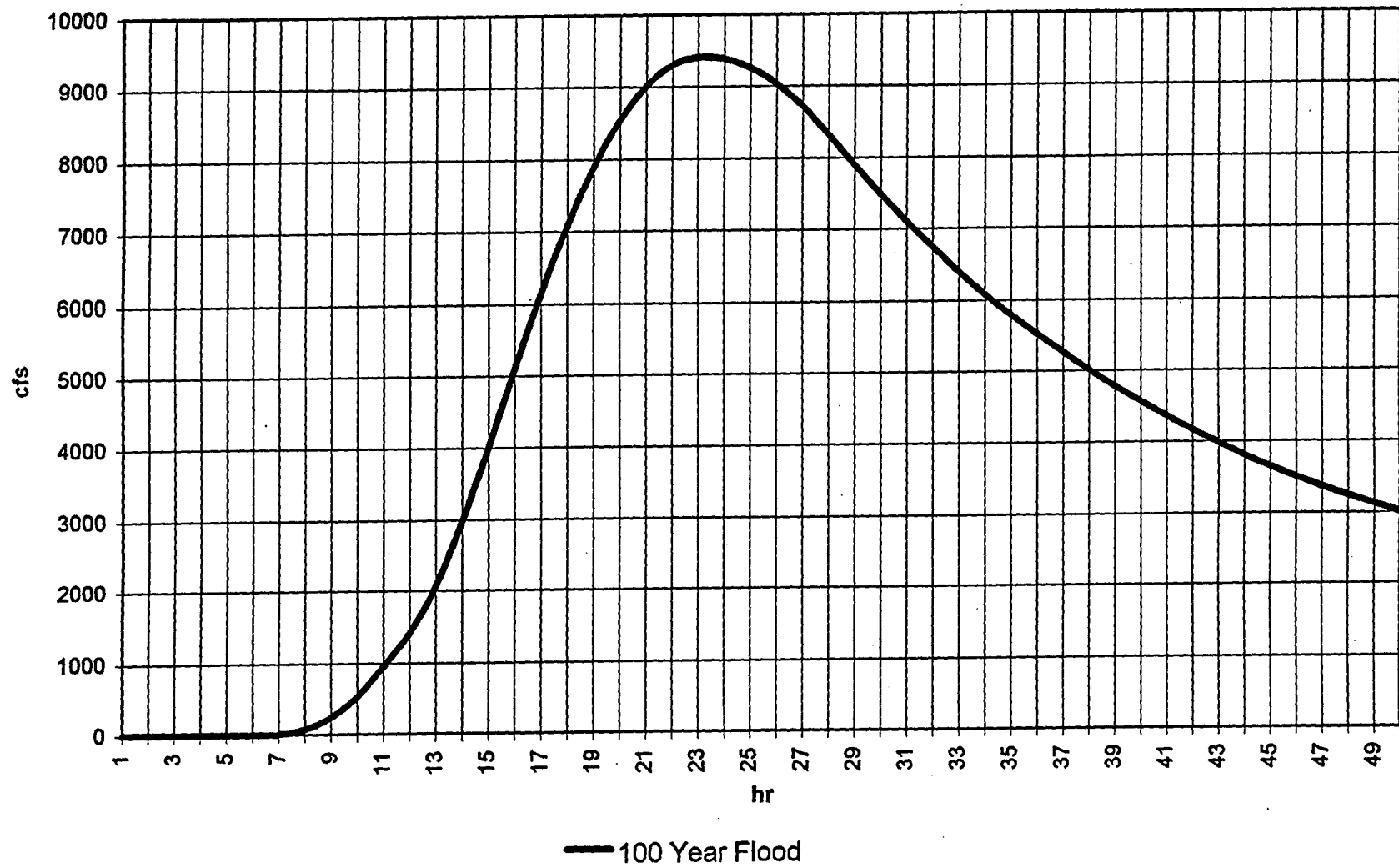


Figure C-3.100 Year Flood at Cain Creek Dam

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*
*   PROBABLE MAXIMUM STORM (HMR52)
*   NOVEMBER 1982
*   REVISED 26 JUL 86
*
*   RUN DATE 22/ 7/1997 TIME 15:11:55
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*
*   U.S. ARMY CORPS OF ENGINEERS
*   THE HYDROLOGIC ENGINEERING CENTER
*   609 SECOND STREET
*   DAVIS, CALIFORNIA 95616
*   (916) 551-1748 OR (FTS) 460-1748
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H   H   M   M   RRRRRR   555555   22222
H   H   MM  MM   R   R   5       2   2
H   H   M   M   M   R   R   5       2
HHHHHHH M   M   M   RRRRRR   555555   2
H   H   M   M   R   R   5       5   2
H   H   M   M   R   R   5       5   2
H   H   M   M   R   R   55555   2222222

```

HEC PROBABLE MAXIMUM STORM (HMR52) INPUT DATA

PAGE 1

LINE	ID	1	2	3	4	5	6	7	8	9	10
1	ID	CAIN									
2	ID	PMS									
3	BN	CAIN CREEK									
4	BS	1.0									
5	BX	0.0	-2.0	-6.33	-9.58	-12.15	-15.16	-18.22	-21.23	-24.24	-27.78
6	BX	-31.64	-33.8	-37.28	-39.24	-35.22	-31.26	-28.2	-25.82	-22.18	-17.16
7	BX	-13.47	-12.15	-11.09	-8.61	-5.81	-4.96	-3.01	-1.0		
8	BY	0.0	1.16	7.25	11.25	18.22	19.8	20.6	20.33	20.96	21.12
9	BY	19.01	16.90	5.39	5.28	2.22	5.44	12.25	10.98	11.09	11.04
10	BY	11.04	8.03	5.02	0.1	-3.01	-0.9	-3.54	-3.33		
11	HO	244									
12	HP	10	24.0	28.2	30.0	32.8	34.4				
13	HP	200	17.7	20.9	23.5	25.5	26.8				
14	HP	1000	13.0	15.5	17.1	20.3	21.7				
15	HP	5000	7.8	10.0	11.7	14.5	16.0				
16	HP	10000	6.0	7.9	9.5	12.3	13.8				
17	HP	20000	4.3	6.0	7.5	10.2	11.6				
18	SA	0	0								
19	ST	15	0.32								
20	PL	2									
21	ZZ										

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*****
*
*   PROBABLE MAXIMUM STORM (HMR52)
*   NOVEMBER 1982
*   REVISED 26 JUL 86
*
*   RUN DATE 22/ 7/1997 TIME 15:11:55
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*
*   U.S. ARMY CORPS OF ENGINEERS
*   THE HYDROLOGIC ENGINEERING CENTER
*   609 SECOND STREET
*   DAVIS, CALIFORNIA 95616
*   (916) 551-1748 OR (FTS) 460-1748
*
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CAIN
PMS

PMP DEPTHS FROM HMR 51

AREA (SQ. MI.)	6-HR	12-HR	24-HR	48-HR	72-HR
10.	24.00	28.20	30.00	32.80	34.40
200.	17.70	20.90	23.50	25.50	26.80
1000.	13.00	15.50	17.10	20.30	21.70
5000.	7.80	10.00	11.70	14.50	16.00
10000.	6.00	7.90	9.50	12.30	13.80
20000.	4.30	6.00	7.50	10.20	11.60

TORM AREA

PMP DEPTHS FOR 6-HOUR INCREMENTS

10.	23.99	3.78	1.64	1.06	0.79	0.63	0.52	0.44	0.39	0.34	0.31	0.28
25.	22.51	3.67	1.61	1.04	0.77	0.61	0.51	0.44	0.38	0.34	0.30	0.28
50.	21.27	3.57	1.57	1.02	0.76	0.60	0.50	0.43	0.38	0.33	0.30	0.27
100.	19.46	3.41	1.53	1.00	0.74	0.59	0.49	0.42	0.37	0.33	0.29	0.27
175.	17.99	3.31	1.49	0.98	0.73	0.58	0.48	0.41	0.36	0.32	0.29	0.26
300.	16.48	2.98	1.48	0.99	0.75	0.60	0.50	0.43	0.38	0.33	0.30	0.27
450.	15.33	2.66	1.46	1.01	0.77	0.63	0.53	0.45	0.40	0.36	0.32	0.29
700.	14.09	2.30	1.41	1.02	0.80	0.66	0.56	0.49	0.43	0.39	0.35	0.32
1000.	13.09	2.02	1.36	1.03	0.82	0.69	0.59	0.52	0.46	0.42	0.38	0.35
1500.	11.78	1.98	1.34	1.01	0.81	0.68	0.58	0.51	0.46	0.41	0.37	0.34
2150.	10.61	1.94	1.31	1.00	0.80	0.67	0.58	0.51	0.45	0.41	0.37	0.34
3000.	9.53	1.90	1.30	0.98	0.79	0.67	0.57	0.50	0.45	0.40	0.37	0.34
4500.	8.21	1.86	1.27	0.97	0.78	0.66	0.57	0.50	0.44	0.40	0.36	0.33
6500.	7.19	1.74	1.23	0.95	0.77	0.65	0.57	0.50	0.45	0.40	0.37	0.34
10000.	6.07	1.57	1.16	0.92	0.76	0.65	0.57	0.51	0.45	0.41	0.38	0.35
15000.	5.09	1.47	1.11	0.89	0.74	0.63	0.55	0.49	0.44	0.40	0.37	0.34
20000.	4.36	1.44	1.08	0.86	0.72	0.62	0.54	0.48	0.43	0.39	0.36	0.33

BOUNDARY COORDINATES FOR CAIN C

0.0	-2.0	-6.3	-9.6	-12.1	-15.2	-18.2	-21.2	-24.2	-27.8
Y 0.0	1.2	7.2	11.2	18.2	19.8	20.6	20.3	21.0	21.1
-31.6	-33.8	-37.3	-39.2	-35.2	-31.3	-28.2	-25.8	-22.2	-17.2
19.0	16.9	5.4	5.3	2.2	5.4	12.2	11.0	11.1	11.0
X -13.5	-12.1	-11.1	-8.6	-5.8	-5.0	-3.0	-1.0		
Y 11.0	8.0	5.0	0.1	-3.0	-0.9	-3.5	-3.3		

SCALE = 1.0000 MILES PER COORDINATE UNIT

BASIN AREA = 341.4 SQ. MI.

BASIN CENTROID COORDINATES, X = -20.3, Y = 11.3"

1

VARYING STORM AREA SIZE AND FIXED ORIENTATION

STORM AREA	ORIENTATION	BASIN-AVERAGED INCREMENTAL DEPTHS FOR 6-HR PERIODS											SUM OF DEPTHS FOR 3 PEAK 6-HR PERIODS	
10.	289.	6.78	1.08	0.47	0.30	0.23	0.18	0.15	0.13	0.11	0.10	0.09	0.08	8.33
25.	289.	8.90	1.62	0.73	0.47	0.35	0.28	0.23	0.20	0.17	0.15	0.14	0.13	11.25
50.	289.	10.48	2.02	0.92	0.60	0.44	0.35	0.29	0.25	0.22	0.19	0.18	0.16	13.43
100.	289.	11.76	2.36	1.10	0.72	0.53	0.42	0.35	0.30	0.26	0.23	0.21	0.19	15.23
175.	289.	12.76	2.63	1.23	0.80	0.60	0.48	0.40	0.34	0.30	0.26	0.24	0.22	16.62
300.	289.	13.54	2.63	1.34	0.90	0.68	0.54	0.45	0.39	0.34	0.30	0.27	0.25	17.51
450.	289.	13.92	2.49	1.39	0.96	0.73	0.60	0.50	0.43	0.38	0.34	0.31	0.28	17.80
700.	289.	13.95	2.25	1.39	1.00	0.78	0.65	0.55	0.48	0.42	0.38	0.34	0.31	17.59
1000.	289.	13.82	2.03	1.35	1.01	0.81	0.68	0.58	0.51	0.46	0.41	0.37	0.34	17.20
1500.	289.	13.39	2.02	1.33	1.00	0.80	0.67	0.58	0.51	0.45	0.41	0.37	0.34	16.74
2150.	289.	12.93	1.99	1.30	0.98	0.79	0.66	0.57	0.50	0.44	0.40	0.36	0.33	16.22
3000.	289.	12.44	1.96	1.28	0.95	0.77	0.65	0.56	0.49	0.43	0.39	0.36	0.33	15.68
4500.	289.	11.86	1.95	1.26	0.94	0.76	0.64	0.55	0.48	0.43	0.39	0.35	0.32	15.07
6500.	289.	11.44	1.85	1.22	0.92	0.75	0.63	0.55	0.48	0.43	0.39	0.36	0.33	14.50
10000.	289.	10.79	1.70	1.16	0.89	0.74	0.63	0.55	0.49	0.44	0.40	0.37	0.34	13.64
15000.	289.	9.99	1.62	1.11	0.86	0.72	0.61	0.54	0.48	0.43	0.39	0.36	0.33	12.72
20000.	289.	9.19	1.59	1.08	0.84	0.70	0.60	0.52	0.47	0.42	0.38	0.35	0.32	11.86

FIXED STORM AREA SIZE AND VARYING ORIENTATION

STORM AREA	ORIENTATION	BASIN-AVERAGED INCREMENTAL DEPTHS FOR 6-HR PERIODS											SUM OF DEPTHS FOR 3 PEAK 6-HR PERIODS	
450.	140.	12.78	2.35	1.32	0.91	0.70	0.57	0.48	0.41	0.36	0.32	0.29	0.26	16.44
450.	150.	12.08	2.26	1.27	0.88	0.67	0.55	0.46	0.40	0.35	0.31	0.28	0.26	15.61
450.	160.	11.47	2.17	1.23	0.85	0.65	0.53	0.44	0.38	0.34	0.30	0.27	0.25	14.87
450.	170.	11.03	2.10	1.19	0.82	0.63	0.51	0.43	0.37	0.33	0.29	0.26	0.24	14.32
450.	180.	10.74	2.06	1.17	0.81	0.62	0.50	0.42	0.36	0.32	0.28	0.26	0.23	13.97
450.	190.	10.65	2.04	1.16	0.80	0.61	0.50	0.42	0.36	0.32	0.28	0.26	0.23	13.85
450.	200.	10.72	2.06	1.16	0.80	0.62	0.50	0.42	0.36	0.32	0.28	0.26	0.23	13.94
450.	210.	10.92	2.09	1.18	0.82	0.62	0.51	0.43	0.37	0.32	0.29	0.26	0.24	14.18
450.	220.	11.28	2.14	1.21	0.83	0.64	0.52	0.44	0.38	0.33	0.29	0.27	0.24	14.62
450.	230.	11.75	2.20	1.24	0.86	0.66	0.53	0.45	0.39	0.34	0.30	0.27	0.25	15.19
450.	240.	12.26	2.27	1.27	0.88	0.67	0.55	0.46	0.40	0.35	0.31	0.28	0.26	15.80

PROBABLE MAXIMUM STORM FOR CAIN C
STORM AREA = 450. SQ. MI., ORIENTATION = 290., PREFERRED ORIENTATION = 244."
STORM CENTER COORDINATES, X = -20.3, Y = 11.3"

1[illegible]

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*   E   DD   C   BBB**
F   EE   *D*****CCC**
*FF   EEE   *
* FFF   EEE*
*   FFFF   E
*   FFFF   *
+++   FFFFF
*   ++++++
*   ++++++
*   +
HHHHHH
*   HHHHHHHH
*   HH
IIII
*   IIIIIIIII
*
*****
***JJJ
JJJJJJJJ
***

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*   E   FF   ***
*EE   FF   ***
E *   FF   ***
*   FFF   ***
*FF   ++   ***
**   +++   ****
*   +++   ****
*   HHH**
*   HHH
*   HHHH
*   HHH
*** HHHH ***
HH*   *   ** IIII**
*** *   * II**
**

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TIME INTERVAL = 15. MINUTES
1-HR TO 6-HR RATIO FOR ISOHYET A AT 20000 SQ. MI. =0.320

DEPTH VS. DURATION

ISOHYET	5MIN	10MIN	15MIN	30MIN	1-HR	2-HR	3-HR	6-HR	12-HR	18-HR	24-HR	30-HR	36-HR	42-HR	48-HR	54-HR	60-HR	66-HR	72-HR
A	0.88	1.75	2.62	5.03	8.35	11.82	14.78	20.20	23.20	24.71	25.71	26.48	27.11	27.63	28.09	28.48	28.84	29.16	29.45
B	0.82	1.64	2.44	4.70	7.81	11.07	13.86	18.98	21.87	23.36	24.36	25.13	25.76	26.28	26.73	27.13	27.49	27.81	28.10
C	0.77	1.53	2.28	4.38	7.28	10.33	12.94	17.75	20.54	22.01	23.02	23.79	24.41	24.93	25.39	25.78	26.14	26.46	26.75
D	0.71	1.41	2.11	4.06	6.74	9.58	12.02	16.53	19.24	20.69	21.70	22.47	23.09	23.62	24.07	24.47	24.82	25.14	25.44
E	0.66	1.32	1.96	3.77	6.28	8.93	11.21	15.46	18.10	19.55	20.55	21.32	21.95	22.47	22.92	23.32	23.68	24.00	24.29
F	0.60	1.20	1.79	3.45	5.75	8.20	10.29	14.23	16.81	18.25	19.26	20.03	20.65	21.18	21.63	22.03	22.38	22.70	23.00
G	0.56	1.11	1.65	3.18	5.30	7.56	9.49	13.16	15.68	17.12	18.13	18.90	19.52	20.05	20.50	20.90	21.25	21.57	21.87
H	0.17	0.34	0.52	1.03	2.07	4.08	5.94	9.64	11.70	12.92	13.76	14.41	14.93	15.38	15.76	16.09	16.39	16.66	16.90
I	0.14	0.27	0.41	0.82	1.63	3.22	4.69	7.65	9.40	10.44	11.15	11.70	12.14	12.51	12.83	13.12	13.37	13.60	13.80
J	0.10	0.21	0.31	0.62	1.23	2.43	3.54	5.82	7.26	8.13	8.74	9.20	9.57	9.89	10.16	10.40	10.61	10.80	10.98
K	0.08	0.16	0.24	0.49	0.97	1.92	2.79	4.59	5.77	6.50	7.00	7.39	7.70	7.96	8.19	8.39	8.56	8.72	8.87
L	0.06	0.12	0.19	0.37	0.74	1.46	2.13	3.52	4.49	5.06	5.46	5.76	6.01	6.22	6.40	6.55	6.69	6.82	6.94
M	0.04	0.08	0.12	0.24	0.48	0.95	1.38	2.30	2.97	3.41	3.71	3.94	4.13	4.29	4.42	4.54	4.65	4.74	4.83
N	0.02	0.04	0.06	0.13	0.26	0.50	0.73	1.22	1.60	1.87	2.06	2.21	2.33	2.43	2.51	2.59	2.66	2.72	2.77
O	0.01	0.02	0.02	0.05	0.10	0.19	0.28	0.46	0.58	0.68	0.75	0.80	0.85	0.88	0.92	0.94	0.97	0.99	1.01
P	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AVERAGE	0.55	1.10	1.64	3.16	5.32	7.78	9.90	13.92	16.41	17.80	18.76	19.49	20.09	20.59	21.02	21.40	21.74	22.04	22.32

PROBABLE MAXIMUM STORM FOR CAIN C

Y 1

TIME	PRECIPITATION INCR	TOTAL	TIME	PRECIPITATION INCR	TOTAL	TIME	PRECIPITATION INCR	TOTAL	TIME	PRECIPITATION INCR	TOTAL
0015	0.01	0.01	0615	0.01	0.29	1215	0.02	0.64	1815	0.02	1.07
0030	0.01	0.02	0630	0.01	0.31	1230	0.02	0.65	1830	0.02	1.10
0045	0.01	0.03	0645	0.01	0.32	1245	0.02	0.67	1845	0.02	1.12
0100	0.01	0.05	0700	0.01	0.34	1300	0.02	0.69	1900	0.02	1.15
0115	0.01	0.06	0715	0.01	0.35	1315	0.02	0.71	1915	0.02	1.17
0130	0.01	0.07	0730	0.01	0.36	1330	0.02	0.73	1930	0.02	1.20
0145	0.01	0.08	0745	0.01	0.38	1345	0.02	0.74	1945	0.02	1.22
0200	0.01	0.09	0800	0.01	0.39	1400	0.02	0.76	2000	0.02	1.25
0215	0.01	0.10	0815	0.01	0.41	1415	0.02	0.78	2015	0.02	1.27
0230	0.01	0.12	0830	0.01	0.42	1430	0.02	0.80	2030	0.02	1.30
0245	0.01	0.13	0845	0.01	0.43	1445	0.02	0.82	2045	0.02	1.32
0300	0.01	0.14	0900	0.01	0.45	1500	0.02	0.83	2100	0.02	1.35
0315	0.01	0.15	0915	0.01	0.46	1515	0.02	0.85	2115	0.02	1.37
0330	0.01	0.16	0930	0.01	0.48	1530	0.02	0.87	2130	0.02	1.40
0345	0.01	0.17	0945	0.01	0.49	1545	0.02	0.89	2145	0.02	1.42
0400	0.01	0.19	1000	0.01	0.50	1600	0.02	0.91	2200	0.02	1.45
0415	0.01	0.20	1015	0.01	0.52	1615	0.02	0.92	2215	0.02	1.47
0430	0.01	0.21	1030	0.01	0.53	1630	0.02	0.94	2230	0.02	1.50

0445	0.01	0.22	1045	0.01	0.55	1645	0.02	0.96	2245	0.02	1.52
0500	0.01	0.23	1100	0.01	0.56	1700	0.02	0.98	2300	0.02	1.54
0515	0.01	0.24	1115	0.01	0.58	1715	0.02	1.00	2315	0.02	1.57
0530	0.01	0.26	1130	0.01	0.59	1730	0.02	1.01	2330	0.02	1.59
0545	0.01	0.27	1145	0.01	0.60	1745	0.02	1.03	2345	0.02	1.62
0600	0.01	0.28	1200	0.01	0.62	1800	0.02	1.05	2400	0.02	1.64

6-HR TOTAL	0.28		0.34		0.43		0.60
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DAY 2

TIME	PRECIPITATION INCR	TOTAL	TIME	PRECIPITATION INCR	TOTAL	TIME	PRECIPITATION INCR	TOTAL	TIME	PRECIPITATION INCR	TOTAL
0015	0.03	1.68	0615	0.07	2.68	1215	0.18	5.27	1815	0.07	19.09
0030	0.04	1.71	0630	0.08	2.75	1230	0.26	5.54	1830	0.07	19.16
0045	0.04	1.75	0645	0.08	2.83	1245	0.32	5.86	1845	0.07	19.23
0100	0.04	1.79	0700	0.08	2.91	1300	0.37	6.23	1900	0.07	19.30
0115	0.04	1.82	0715	0.08	2.98	1315	0.40	6.63	1915	0.07	19.37
0130	0.04	1.86	0730	0.08	3.06	1330	0.41	7.04	1930	0.06	19.43
0145	0.04	1.89	0745	0.08	3.15	1345	0.46	7.50	1945	0.06	19.49
0200	0.04	1.93	0800	0.08	3.23	1400	0.57	8.07	2000	0.06	19.56
0215	0.04	1.97	0815	0.09	3.32	1415	0.56	8.62	2015	0.06	19.62
0230	0.04	2.01	0830	0.09	3.41	1430	0.62	9.24	2030	0.06	19.68
0245	0.04	2.05	0845	0.09	3.50	1445	0.96	10.20	2045	0.06	19.73
0300	0.04	2.09	0900	0.10	3.60	1500	1.52	11.72	2100	0.06	19.79
0315	0.04	2.13	0915	0.10	3.70	1515	1.64	13.36	2115	0.06	19.85
0330	0.04	2.17	0930	0.10	3.80	1530	1.20	14.56	2130	0.05	19.90
0345	0.04	2.21	0945	0.11	3.91	1545	0.72	15.28	2145	0.05	19.96
0400	0.04	2.25	1000	0.11	4.02	1600	0.56	15.84	2200	0.05	20.01
0415	0.04	2.29	1015	0.12	4.13	1615	0.58	16.42	2215	0.05	20.06
0430	0.04	2.33	1030	0.12	4.25	1630	0.53	16.94	2230	0.05	20.11
0445	0.04	2.38	1045	0.13	4.38	1645	0.41	17.36	2245	0.05	20.16
0500	0.04	2.42	1100	0.13	4.51	1700	0.41	17.77	2300	0.05	20.21
0515	0.04	2.46	1115	0.14	4.65	1715	0.39	18.15	2315	0.05	20.26
0530	0.05	2.51	1130	0.14	4.79	1730	0.35	18.50	2330	0.05	20.31
0545	0.05	2.56	1145	0.15	4.94	1745	0.29	18.79	2345	0.05	20.36
0600	0.05	2.60	1200	0.16	5.09	1800	0.22	19.02	2400	0.05	20.40

6-HR TOTAL	0.96		2.49		13.92		1.39
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DAY 3

TIME	PRECIPITATION INCR	TOTAL	TIME	PRECIPITATION INCR	TOTAL	TIME	PRECIPITATION INCR	TOTAL	TIME	PRECIPITATION INCR	TOTAL
0015	0.03	20.43	0615	0.02	21.16	1215	0.02	21.65	1815	0.01	22.03
0030	0.03	20.46	0630	0.02	21.18	1230	0.02	21.67	1830	0.01	22.04
0045	0.03	20.50	0645	0.02	21.20	1245	0.02	21.69	1845	0.01	22.06
0100	0.03	20.53	0700	0.02	21.22	1300	0.02	21.70	1900	0.01	22.07
0115	0.03	20.56	0715	0.02	21.24	1315	0.02	21.72	1915	0.01	22.08
0130	0.03	20.59	0730	0.02	21.26	1330	0.02	21.73	1930	0.01	22.09
0145	0.03	20.62	0745	0.02	21.28	1345	0.02	21.75	1945	0.01	22.11
0200	0.03	20.65	0800	0.02	21.30	1400	0.02	21.76	2000	0.01	22.12
0215	0.03	20.68	0815	0.02	21.33	1415	0.02	21.78	2015	0.01	22.13
0230	0.03	20.71	0830	0.02	21.35	1430	0.02	21.80	2030	0.01	22.14
0245	0.03	20.74	0845	0.02	21.37	1445	0.02	21.81	2045	0.01	22.16
0300	0.03	20.77	0900	0.02	21.39	1500	0.02	21.83	2100	0.01	22.17
0315	0.03	20.80	0915	0.02	21.41	1515	0.02	21.84	2115	0.01	22.18
0330	0.03	20.83	0930	0.02	21.43	1530	0.02	21.86	2130	0.01	22.20
0345	0.03	20.86	0945	0.02	21.45	1545	0.02	21.88	2145	0.01	22.21
0400	0.03	20.89	1000	0.02	21.47	1600	0.02	21.89	2200	0.01	22.22
0415	0.03	20.92	1015	0.02	21.49	1615	0.02	21.91	2215	0.01	22.23
0430	0.03	20.95	1030	0.02	21.51	1630	0.02	21.92	2230	0.01	22.25
0445	0.03	20.98	1045	0.02	21.53	1645	0.02	21.94	2245	0.01	22.26
0500	0.03	21.02	1100	0.02	21.55	1700	0.02	21.95	2300	0.01	22.27
0515	0.03	21.05	1115	0.02	21.58	1715	0.02	21.97	2315	0.01	22.29
0530	0.03	21.08	1130	0.02	21.60	1730	0.02	21.99	2330	0.01	22.30
0545	0.03	21.11	1145	0.02	21.62	1745	0.02	22.00	2345	0.01	22.31
0600	0.03	21.14	1200	0.02	21.64	1800	0.02	22.02	2400	0.01	22.32

6-HR TOTAL	0.73		0.50		0.38		0.31
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*
* FLOOD HYDROGRAPH PACKAGE (HEC-1) *
*   SEPTEMBER 1990                *
*   VERSION 4.0                    *
*
* RUN DATE 09/11/1997 TIME 16:14:35 *
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* U.S. ARMY CORPS OF ENGINEERS    *
*   HYDROLOGIC ENGINEERING CENTER *
*   609 SECOND STREET              *
*   DAVIS, CALIFORNIA 95616        *
*   (916) 756-1104                *
*
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X   X XXXXXXX XXXXX      X
X   X X      X      X    XX
X   X X      X      X    X
XXXXXXX XXXX  X      XXXXX X
X   X X      X      X    X
X   X X      X      X    X
X   X XXXXXXX XXXXX      XXX

```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE. THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION. NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE, SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY, DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL, LOSS RATE:GREEN AND AMPT INFILTRATION, KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

HEC-1 INPUT

PAGE 1

LINE	ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
1	ID Cain Creek Dam
2	ID PMF
3	IO 4
4	JR FLOW 1.0 0.5 0.4 0.3 0.2 0.1 0.05 0.04 0.01
5	IT 30
6	IN 15
7	KK Area 1A
8	KM Runoff
9	PB 22.32
10	BA 36.95
11	PC 0.01 0.02 0.03 0.05 0.06 0.07 0.08 0.09 0.1 0.12
12	PC 0.13 0.14 0.15 0.16 0.17 0.19 0.2 0.21 0.22 0.23
13	PC 0.24 0.26 0.27 0.28 0.29 0.31 0.32 0.34 0.35 0.36
14	PC 0.38 0.39 0.41 0.42 0.43 0.45 0.46 0.48 0.49 0.5
15	PC 0.52 0.53 0.55 0.56 0.58 0.59 0.6 0.62 0.64 0.65
16	PC 0.67 0.69 0.71 0.73 0.74 0.76 0.78 0.8 0.82 0.83
17	PC 0.85 0.87 0.89 0.91 0.92 0.94 0.96 0.98 1.0 1.01
18	PC 1.03 1.05 1.07 1.1 1.12 1.15 1.17 1.2 1.22 1.25
19	PC 1.27 1.3 1.32 1.35 1.37 1.4 1.42 1.45 1.47 1.5
20	PC 1.52 1.54 1.57 1.59 1.62 1.64 1.68 1.71 1.75 1.79
21	PC 1.82 1.86 1.89 1.93 1.97 2.01 2.05 2.09 2.13 2.17
22	PC 2.21 2.25 2.29 2.33 2.38 2.42 2.46 2.51 2.56 2.6
23	PC 2.68 2.75 2.83 2.91 2.98 3.06 3.15 3.23 3.32 3.41
24	PC 3.5 3.6 3.7 3.8 3.91 4.02 4.13 4.25 4.38 4.51
25	PC 4.65 4.79 4.94 5.09 5.27 5.54 5.86 6.23 6.63 7.04
26	PC 7.5 8.07 8.62 9.24 10.20 11.72 13.36 14.56 15.28 15.84
27	PC 16.42 16.94 17.36 17.77 18.15 18.5 18.79 19.02 19.09 19.16
28	PC 19.23 19.3 19.37 19.43 19.49 19.56 19.62 19.68 19.73 19.79
29	PC 19.85 19.9 19.96 20.01 20.06 20.11 20.16 20.21 20.26 20.31
30	PC 20.36 20.4 20.43 20.46 20.5 20.53 20.56 20.59 20.62 20.65
31	PC 20.68 20.71 20.74 20.77 20.8 20.83 20.86 20.89 20.92 20.95
32	PC 20.98 21.02 21.05 21.08 21.11 21.14 21.16 21.18 21.2 21.22
33	PC 21.24 21.26 21.28 21.3 21.33 21.35 21.37 21.39 21.41 21.43
34	PC 21.45 21.47 21.49 21.51 21.53 21.55 21.58 21.6 21.62 21.64
35	PC 21.65 21.67 21.69 21.7 21.72 21.73 21.75 21.76 21.78 21.8
36	PC 21.81 21.83 21.84 21.86 21.88 21.89 21.91 21.92 21.94 21.95
37	PC 21.97 21.99 22 22.02 22.03 22.04 22.06 22.07 22.08 22.09
38	PC 22.11 22.12 22.13 22.14 22.16 22.17 22.18 22.2 22.21 22.22
39	PC 22.23 22.25 22.26 22.27 22.29 22.3 22.31 22.32
40	LS 1.3 61 0

41 UD 3.6

42 KK NWPA Ponds

43 KM Pond Rout

44 RS 1 elev 1620

45 SV 505.1 1010 1515 3352

46 SE 1617 1618 1619 1620

47 SS 1619.5 30 2.8 1.5

48 ST 1620 5000 2.6 1.5

HEC-1 INPUT

PAGE 2

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

49 KK Area 18

50 KM Runoff

51 BA 101.85

52 LS 1.3 61 0

53 UD 3.1

54 KK Combine 1A and 1B

55 HC 2

56 KK Area 2

57 KM Runoff

58 BA 15.6

59 LS 1.3 61 0

60 UD 0.8

61 KK Wessington

62 KM Combine 1 and 2

63 HC 2

64 KK To Wolsey

65 KM Channel Rout

66 RC 0.04 0.04 0.04 105600 0.0003

67 RS 1 STOR

68 RX 5150 5400 5600 6120 6170 6580 6690 6970

69 RY 1410 1400 1390 1369 1369 1390 1400 1410

70 KK Area 3

71 KM Runoff

72 BA 100.4

73 LS 1.3 61 0

74 UD 8.1

75 KK Combine 1,2 and 3

76 KM

77 HC 2

78 KK To Dam

79 KM Channel Rout

80 RC 0.04 0.04 0.04 100320 0.0003

81 RS 1 STOR

82 RX 0 500 1000 1005 1020 1100 2700 3800

83 RY 1325 1315 1310 1305 1305 1310 1315 1325

84 KK Area 4

85 KM U/S DAM

86 BA 84.9

87 LS 1.3 61 0

88 UD 13.3

89 IO 0

90 KO 5

HEC-1 INPUT

PAGE 3

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

91 KK Combine 1-4

92 KM

93 HC 2

94 KK Cain Creek Dam

95 KM Dam Rout

96 KO 3

97 RS 1 ELEV 1288.

98 SV 0.4 1.1 2.2 3.8 5.8 8.1 10.6 13.7 24.3 48

99 SV 83.3 130 188.6 258.8 336.8 500 1320

100 SE 1282 1283 1284 1285 1286 1287 1288 1289 1290 1291

101	SE	1292	1293	1294	1295	1296	1300	1320
102	SQ	0	0	0	0	0	0	0
103	SQ	261	461	881	1681	2160	2753	7124
104	ST	1295	570	3.0	1.5			
105	ZZ							

31 89 163

```

*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* SEPTEMBER 1990
* VERSION 4.0
*
* RUN DATE 09/11/1997 TIME 16:14:35
*
*****

```

```

*****
*
* U.S. ARMY CORPS OF ENGINEERS
* HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET
* DAVIS, CALIFORNIA 95616
* (916) 756-1104
*
*****

```

Cain Creek Dam PMF

```

3 IO OUTPUT CONTROL VARIABLES
      IPRNT      4 PRINT CONTROL
      IPLOT      0 PLOT CONTROL
      QSCAL      0. HYDROGRAPH PLOT SCALE

```

* ERROR *** SPECIFIED START AND END DATES RESULT IN TOO MANY TIME PERIODS

```

IT HYDROGRAPH TIME DATA
   NMIN      30 MINUTES IN COMPUTATION INTERVAL
   IDATE      1 0 STARTING DATE
   ITIME     0000 STARTING TIME
   NQ        300 NUMBER OF HYDROGRAPH ORDINATES
   NDDATE      7 0 ENDING DATE
   NDTIME     0530 ENDING TIME
   ICENT      19 CENTURY MARK

```

COMPUTATION INTERVAL .50 HOURS
TOTAL TIME BASE 149.50 HOURS

```

ENGLISH UNITS
DRAINAGE AREA SQUARE MILES
PRECIPITATION DEPTH INCHES
LENGTH, ELEVATION FEET
FLOW CUBIC FEET PER SECOND
STORAGE VOLUME ACRE-Feet
SURFACE AREA ACRES
TEMPERATURE DEGREES FAHRENHEIT

```

```

JP MULTI-PLAN OPTION
   NPLAN      1 NUMBER OF PLANS

```

```

JR MULTI-RATIO OPTION
   RATIOS OF RUNOFF
   1.00 .50 .40 .30 .20 .10 .05 .04 .01

```

*** **

```

*****
*
* 7 KK Area 1 * A
*
*****

```

Runoff

```

6 IN TIME DATA FOR INPUT TIME SERIES
      JXMIN      15 TIME INTERVAL IN MINUTES
      JXDATE      1 0 STARTING DATE
      JXTIME      0 STARTING TIME

```

SUBBASIN RUNOFF DATA

```

10 BA SUBBASIN CHARACTERISTICS
      TAREA      36.95 SUBBASIN AREA

```

PRECIPITATION DATA

16 PB STORM 22.32 BASIN TOTAL PRECIPITATION

10 PI INCREMENTAL PRECIPITATION PATTERN

.02	.03	.02	.02	.03	.02	.02	.03	.02	.02
.03	.02	.03	.03	.03	.03	.02	.03	.03	.03
.03	.03	.02	.04	.03	.04	.03	.04	.04	.03
.04	.03	.04	.04	.03	.04	.05	.05	.05	.05
.05	.05	.05	.05	.05	.05	.05	.06	.07	.07
.07	.08	.08	.08	.08	.08	.09	.08	.10	.12
.15	.15	.17	.17	.18	.20	.21	.22	.25	.27
.29	.33	.59	.77	.87	1.12	1.58	3.16	1.92	1.14
.94	.79	.64	.30	.14	.14	.12	.13	.11	.12
.11	.10	.10	.10	.10	.07	.07	.06	.06	.06
.06	.06	.06	.06	.06	.07	.06	.05	.04	.04
.04	.05	.04	.04	.04	.04	.04	.05	.04	.03
.04	.03	.03	.03	.03	.03	.04	.03	.03	.03
.03	.03	.03	.02	.03	.02	.03	.02	.03	.02
.03	.03	.02	.01						

40 LS SCS LOSS RATE
STRTL 1.30 INITIAL ABSTRACTION
CRVNBR 61.00 CURVE NUMBER
RTIMP .00 PERCENT IMPERVIOUS AREA

41 UD SCS DIMENSIONLESS UNITGRAPH
TLAG 3.60 LAG

UNIT HYDROGRAPH
38 END-OF-PERIOD ORDINATES

236.	713.	1380.	2352.	3428.	4209.	4597.	4621.	4401.	3994.
3486.	2829.	2188.	1759.	1420.	1167.	950.	769.	619.	499.
408.	328.	262.	214.	174.	141.	115.	92.	74.	61.
50.	42.	35.	28.	21.	15.	9.	3.		

* *** **

*
42 KK * NWPA * Ponds
*

Pond Rout

HYDROGRAPH ROUTING DATA

44 RS STORAGE ROUTING
NSTPS 1 NUMBER OF SUBREACHES
ITYP elev TYPE OF INITIAL CONDITION
RSVRIC 1620.00 INITIAL CONDITION
X .00 WORKING R AND D COEFFICIENT

45 SV STORAGE 505.1 1010.0 1515.0 3352.0

46 SE ELEVATION 1617.00 1618.00 1619.00 1620.00

47 SS SPILLWAY
CREL 1619.50 SPILLWAY CREST ELEVATION
SPWID 30.00 SPILLWAY WIDTH
COQW 2.80 WEIR COEFFICIENT
EXPW 1.50 EXPONENT OF HEAD

48 ST TOP OF DAM
TOPEL 1620.00 ELEVATION AT TOP OF DAM
DAMWID 5000.00 DAM WIDTH
COQD 2.60 WEIR COEFFICIENT
EXPD 1.50 EXPONENT OF HEAD

COMPUTED OUTFLOW-ELEVATION DATA

(EXCLUDING FLOW OVER DAM)

OUTFLOW	.00	.00	.01	.04	.14	.33	.64	1.10	1.74	2.61
---------	-----	-----	-----	-----	-----	-----	-----	------	------	------

ELEVATION	1617.00	1619.50	1619.50	1619.51	1619.51	1619.52	1619.54	1619.56	1619.58	1619.60
OUTFLOW	3.71	5.09	6.78	8.80	11.18	13.97	17.18	20.85	25.02	29.70
ELEVATION	1619.63	1619.65	1619.69	1619.72	1619.76	1619.80	1619.85	1619.90	1619.95	1620.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

(INCLUDING FLOW OVER DAM)

STORAGE	505.10	1010.00	1515.00	2433.50	2459.06	2478.80	2504.36	2535.53	2572.31	2614.91
OUTFLOW	.00	.00	.00	.00	.14	.33	.64	1.10	1.74	2.61
ELEVATION	1617.00	1618.00	1619.00	1619.50	1619.51	1619.52	1619.54	1619.56	1619.58	1619.60

STORAGE	2663.13	2716.94	2776.59	2841.62	2912.48	2989.17	3071.25	3159.15	3252.88	3352.00
OUTFLOW	3.71	5.09	6.78	8.80	11.18	13.97	17.18	20.85	25.02	29.70
ELEVATION	1619.63	1619.65	1619.69	1619.72	1619.76	1619.80	1619.85	1619.90	1619.95	1620.00

49 KK *****
 * *
 * Area 1 * B
 * *

 Runoff

SUBBASIN RUNOFF DATA

51 BA SUBBASIN CHARACTERISTICS
 TAREA 101.85 SUBBASIN AREA

PRECIPITATION DATA

10 PB STORM 22.32 BASIN TOTAL PRECIPITATION

10 PI INCREMENTAL PRECIPITATION PATTERN

.02	.03	.02	.02	.03	.02	.02	.03	.02	.02
.03	.02	.03	.03	.03	.03	.02	.03	.03	.03
.03	.03	.02	.04	.03	.04	.03	.04	.04	.03
.04	.03	.04	.04	.03	.04	.05	.05	.05	.05
.05	.05	.05	.05	.05	.05	.05	.06	.07	.07
.07	.08	.08	.08	.08	.08	.09	.08	.10	.12
.15	.15	.17	.17	.18	.20	.21	.22	.25	.27
.29	.33	.59	.77	.87	1.12	1.58	3.16	1.92	1.14
.94	.79	.64	.30	.14	.14	.12	.13	.11	.12
.11	.10	.10	.10	.10	.07	.07	.06	.06	.06
.06	.06	.06	.06	.06	.07	.06	.05	.04	.04
.04	.05	.04	.04	.04	.04	.04	.05	.04	.03
.04	.03	.03	.03	.03	.03	.04	.03	.03	.03
.03	.03	.03	.02	.03	.02	.03	.02	.03	.02
.03	.03	.02	.01						

52 LS SCS LOSS RATE
 STRTL 1.30 INITIAL ABSTRACTION
 CRVNBR 61.00 CURVE NUMBER
 RTIMP .00 PERCENT IMPERVIOUS AREA

53 UD SCS DIMENSIONLESS UNITGRAPH
 TLAG 3.10 LAG

UNIT HYDROGRAPH
 33 END-OF-PERIOD ORDINATES

947.	2770.	5673.	9607.	12786.	14496.	14616.	13707.	12118.	10093.
7608.	5818.	4549.	3631.	2868.	2211.	1755.	1380.	1073.	832.
660.	520.	406.	319.	250.	197.	156.	130.	104.	77.
55.	33.	11.							

54 KK * *
* Combin * e 1A and 1B
* *

55 HC HYDROGRAPH COMBINATION
ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

* **

56 KK * *
* Area 2 *
* *

Runoff

SUBBASIN RUNOFF DATA

58 BA SUBBASIN CHARACTERISTICS
TAREA 15.60 SUBBASIN AREA

PRECIPITATION DATA

10 PB STORM 22.32 BASIN TOTAL PRECIPITATION

10 PI INCREMENTAL PRECIPITATION PATTERN
.02 .03 .02 .02 .03 .02 .02 .03 .02 .02
.03 .02 .03 .03 .03 .03 .02 .03 .03 .03
.03 .03 .02 .04 .03 .04 .03 .04 .04 .03
.04 .03 .04 .04 .03 .04 .05 .05 .05 .05
.05 .05 .05 .05 .05 .05 .05 .06 .07 .07
.07 .08 .08 .08 .08 .08 .09 .08 .10 .12
.15 .15 .17 .17 .18 .20 .21 .22 .25 .27
.29 .33 .59 .77 .87 1.12 1.58 3.16 1.92 1.14
.94 .79 .64 .30 .14 .14 .12 .13 .11 .12
.11 .10 .10 .10 .10 .07 .07 .06 .06 .06
.06 .06 .06 .06 .06 .07 .06 .05 .04 .04
.04 .05 .04 .04 .04 .04 .04 .05 .04 .03
.04 .03 .03 .03 .03 .03 .04 .03 .03 .03
.03 .03 .03 .02 .03 .02 .03 .02 .03 .02
.03 .03 .02 .01

59 LS SCS LOSS RATE
STRTL 1.30 INITIAL ABSTRACTION
CRVNBR 61.00 CURVE NUMBER
RTIMP .00 PERCENT IMPERVIOUS AREA

50 UD SCS DIMENSIONLESS UNITGRAPH
TLAG .80 LAG

UNIT HYDROGRAPH
10 END-OF-PERIOD ORDINATES
3120. 7190. 5429. 2367. 1103. 511. 236. 107. 55. 17.

61 KK * *
* Wessin * gton
* *

Combine 1 and 2

63 HC HYDROGRAPH COMBINATION
ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

*** **

* *
64 KK * To Wol * sey
* *

Channel Rout

HYDROGRAPH ROUTING DATA

67 RS STORAGE ROUTING
NSTPS 1 NUMBER OF SUBREACHES
ITYP STOR TYPE OF INITIAL CONDITION
RSVRIC .00 INITIAL CONDITION
X .00 WORKING R AND D COEFFICIENT

66 RC NORMAL DEPTH CHANNEL
ANL .040 LEFT OVERBANK N-VALUE
ANCH .040 MAIN CHANNEL N-VALUE
ANR .040 RIGHT OVERBANK N-VALUE
RLNTH 105600. REACH LENGTH
SEL .0003 ENERGY SLOPE
ELMAX .0 MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

CROSS-SECTION DATA

--- LEFT OVERBANK --- + ----- MAIN CHANNEL ----- + --- RIGHT OVERBANK ---
69 RY ELEVATION 1410.00 1400.00 1390.00 1369.00 1369.00 1390.00 1400.00 1410.00
68 RX DISTANCE 5150.00 5400.00 5600.00 6120.00 6170.00 6580.00 6690.00 6970.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	.00	511.50	1522.90	3034.19	5045.37	7556.44	10567.41	14078.27	18089.02	22599.67
OUTFLOW	.00	174.28	766.98	1936.69	3826.46	6566.51	10277.86	15074.39	21064.30	28351.11
ELEVATION	1369.00	1371.16	1373.32	1375.47	1377.63	1379.79	1381.95	1384.10	1386.26	1388.42
STORAGE	27604.81	33000.07	38745.24	44840.34	51285.38	58130.20	65556.63	73581.30	82204.25	91425.45
OUTFLOW	37637.51	50090.21	64159.48	79902.73	97369.88	116465.40	137475.40	160604.60	185958.60	213644.90
ELEVATION	1390.58	1392.74	1394.89	1397.05	1399.21	1401.37	1403.53	1405.68	1407.84	1410.00

*** **

* *
70 KK * Area 3 *
* *

Runoff

SUBBASIN RUNOFF DATA

72 BA SUBBASIN CHARACTERISTICS
TAREA 100.40 SUBBASIN AREA

PRECIPITATION DATA

10 PB STORM 22.32 BASIN TOTAL PRECIPITATION

10 PI INCREMENTAL PRECIPITATION PATTERN

.02	.03	.02	.02	.03	.02	.02	.03	.02	.02
.03	.02	.03	.03	.03	.03	.02	.03	.03	.03
.03	.03	.02	.04	.03	.04	.03	.04	.04	.03
.04	.03	.04	.04	.03	.04	.05	.05	.05	.05
.05	.05	.05	.05	.05	.05	.05	.06	.07	.07
.07	.08	.08	.08	.08	.08	.09	.08	.10	.12
.15	.15	.17	.17	.18	.20	.21	.22	.25	.27
.29	.33	.59	.77	.87	1.12	1.58	3.16	1.92	1.14
.94	.79	.64	.30	.14	.14	.12	.13	.11	.12
.11	.10	.10	.10	.10	.07	.07	.06	.06	.06
.06	.06	.06	.06	.06	.07	.06	.05	.04	.04
.04	.05	.04	.04	.04	.04	.04	.05	.04	.03
.04	.03	.03	.03	.03	.03	.04	.03	.03	.03

.03 .03 .03 .02 .03 .02 .03 .02 .03 .02
.03 .03 .02 .01

73 LS SCS LOSS RATE
STRTL 1.30 INITIAL ABSTRACTION
CRVNBR 61.00 CURVE NUMBER
RTIMP .00 PERCENT IMPERVIOUS AREA

74 UD SCS DIMENSIONLESS UNITGRAPH
TLAG 8.10 LAG

UNIT HYDROGRAPH
83 END-OF-PERIOD ORDINATES

104.	255.	498.	787.	1100.	1517.	1979.	2535.	3159.	3820.
4379.	4881.	5264.	5535.	5744.	5784.	5797.	5763.	5618.	5410.
5168.	4914.	4636.	4315.	3967.	3553.	3155.	2807.	2523.	2280.
2069.	1870.	1696.	1550.	1423.	1296.	1175.	1071.	966.	862.
790.	720.	651.	591.	539.	487.	438.	400.	362.	323.
296.	270.	244.	222.	202.	183.	165.	151.	138.	124.
113.	102.	92.	83.	76.	69.	63.	59.	55.	51.
46.	42.	38.	34.	30.	26.	23.	19.	16.	12.
9.	5.	2.							

* *** **

* *
75 KK * Combin * e 1,2 and 3
* *

77 HC HYDROGRAPH COMBINATION
ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

* *** **

* *
78 KK * To Dam *
* *

Channel Rout

HYDROGRAPH ROUTING DATA

81 RS STORAGE ROUTING
NSTPS 1 NUMBER OF SUBREACHES
ITYP STOR TYPE OF INITIAL CONDITION
RSVRIC .00 INITIAL CONDITION
X .00 WORKING R AND D COEFFICIENT

90 RC NORMAL DEPTH CHANNEL
ANL .040 LEFT OVERBANK N-VALUE
ANCH .040 MAIN CHANNEL N-VALUE
ANR .040 RIGHT OVERBANK N-VALUE
RLNTH 100320. REACH LENGTH
SEL .0003 ENERGY SLOPE
ELMAX .0 MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

CROSS-SECTION DATA

	--- LEFT OVERBANK ---	+	----- MAIN CHANNEL -----	+	--- RIGHT OVERBANK ---			
83 RY ELEVATION	1325.00	1315.00	1310.00	1305.00	1310.00	1315.00	1325.00	
82 RX DISTANCE	.00	500.00	1000.00	1005.00	1020.00	1100.00	2700.00	3800.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	.00	58.05	159.49	304.30	492.49	756.17	1802.30	3920.15	7109.74	11371.06
---------	-----	-------	--------	--------	--------	--------	---------	---------	---------	----------

OUTFLOW	.00	13.49	54.27	130.09	248.53	430.07	869.94	1856.68	3632.53	6403.37
ELEVATION	1305.00	1306.05	1307.11	1308.16	1309.21	1310.26	1311.32	1312.37	1313.42	1314.47

STORAGE	16621.23	22362.68	28512.40	35070.40	42036.68	49411.23	57194.07	65385.18	73984.58	82992.25
OUTFLOW	10612.13	16278.72	23115.38	31129.11	40337.50	50764.35	62437.32	75386.61	89643.97	105242.30
ELEVATION	1315.53	1316.58	1317.63	1318.68	1319.74	1320.79	1321.84	1322.89	1323.95	1325.00

*** **

84 KK

 * *
 * Area 4 *
 * *

U/S DAM

89 IO OUTPUT CONTROL VARIABLES
 IPRNT 0 PRINT CONTROL
 IPLOT 0 PLOT CONTROL
 QSCAL 0. HYDROGRAPH PLOT SCALE

90 KO OUTPUT CONTROL VARIABLES
 IPRNT 5 PRINT CONTROL
 IPLOT 0 PLOT CONTROL
 QSCAL 0. HYDROGRAPH PLOT SCALE

*** **

91 KK

 * *
 * Combin * e 1-4
 * *

93 HC HYDROGRAPH COMBINATION
 ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

HYDROGRAPH AT STATION Combin
 SUM OF 2 HYDROGRAPHS
 PLAN 1, RATIO = 1.00

DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*
1	0000	1	0.	*	2	1330	76	2466.	*	4	0300	151	36702.	*	5	1630	226	4014.					
1	0030	2	0.	*	2	1400	77	2935.	*	4	0330	152	35607.	*	5	1700	227	3922.					
1	0100	3	0.	*	2	1430	78	3524.	*	4	0400	153	34538.	*	5	1730	228	3832.					
1	0130	4	0.	*	2	1500	79	4309.	*	4	0430	154	33493.	*	5	1800	229	3744.					
1	0200	5	0.	*	2	1530	80	5329.	*	4	0500	155	32475.	*	5	1830	230	3663.					
1	0230	6	0.	*	2	1600	81	6680.	*	4	0530	156	31478.	*	5	1900	231	3590.					
1	0300	7	0.	*	2	1630	82	8393.	*	4	0600	157	30498.	*	5	1930	232	3519.					
1	0330	8	0.	*	2	1700	83	10614.	*	4	0630	158	29534.	*	5	2000	233	3450.					
1	0400	9	0.	*	2	1730	84	13347.	*	4	0700	159	28599.	*	5	2030	234	3382.					
1	0430	10	0.	*	2	1800	85	16993.	*	4	0730	160	27734.	*	5	2100	235	3315.					
1	0500	11	0.	*	2	1830	86	21486.	*	4	0800	161	26886.	*	5	2130	236	3250.					
1	0530	12	0.	*	2	1900	87	27189.	*	4	0830	162	26050.	*	5	2200	237	3186.					
1	0600	13	0.	*	2	1930	88	33991.	*	4	0900	163	25227.	*	5	2230	238	3123.					
1	0630	14	0.	*	2	2000	89	41703.	*	4	0930	164	24418.	*	5	2300	239	3061.					
1	0700	15	0.	*	2	2030	90	50206.	*	4	1000	165	23626.	*	5	2330	240	3001.					
1	0730	16	0.	*	2	2100	91	59260.	*	4	1030	166	22850.	*	6	0000	241	2942.					
1	0800	17	0.	*	2	2130	92	68762.	*	4	1100	167	22091.	*	6	0030	242	2884.					
1	0830	18	0.	*	2	2200	93	78294.	*	4	1130	168	21346.	*	6	0100	243	2828.					
1	0900	19	0.	*	2	2230	94	87594.	*	4	1200	169	20617.	*	6	0130	244	2772.					
1	0930	20	0.	*	2	2300	95	96589.	*	4	1230	170	19904.	*	6	0200	245	2718.					
1	1000	21	0.	*	2	2330	96	104867.	*	4	1300	171	19244.	*	6	0230	246	2665.					
1	1030	22	0.	*	3	0000	97	112570.	*	4	1330	172	18624.	*	6	0300	247	2612.					
1	1100	23	0.	*	3	0030	98	119331.	*	4	1400	173	18019.	*	6	0330	248	2561.					

1	1130	24	0.	*	3	0100	99	125156.	*	4	1430	174	17428.	*	6	0400	249	2511.
1	1200	25	0.	*	3	0130	100	130186.	*	4	1500	175	16852.	*	6	0430	250	2462.
1	1230	26	0.	*	3	0200	101	134238.	*	4	1530	176	16293.	*	6	0500	251	2413.
1	1300	27	0.	*	3	0230	102	137383.	*	4	1600	177	15751.	*	6	0530	252	2366.
1	1330	28	0.	*	3	0300	103	139634.	*	4	1630	178	15223.	*	6	0600	253	2320.
1	1400	29	0.	*	3	0330	104	141050.	*	4	1700	179	14711.	*	6	0630	254	2274.
1	1430	30	0.	*	3	0400	105	141724.	*	4	1730	180	14213.	*	6	0700	255	2230.
1	1500	31	0.	*	3	0430	106	141705.	*	4	1800	181	13730.	*	6	0730	256	2186.
1	1530	32	0.	*	3	0500	107	141080.	*	4	1830	182	13264.	*	6	0800	257	2143.
1	1600	33	0.	*	3	0530	108	139909.	*	4	1900	183	12813.	*	6	0830	258	2101.
1	1630	34	0.	*	3	0600	109	138214.	*	4	1930	184	12377.	*	6	0900	259	2060.
1	1700	35	0.	*	3	0630	110	136106.	*	4	2000	185	11974.	*	6	0930	260	2019.
1	1730	36	0.	*	3	0700	111	133660.	*	4	2030	186	11625.	*	6	1000	261	1980.
1	1800	37	0.	*	3	0730	112	130939.	*	4	2100	187	11288.	*	6	1030	262	1941.
1	1830	38	0.	*	3	0800	113	128007.	*	4	2130	188	10963.	*	6	1100	263	1903.
1	1900	39	0.	*	3	0830	114	124920.	*	4	2200	189	10647.	*	6	1130	264	1866.
1	1930	40	0.	*	3	0900	115	121746.	*	4	2230	190	10341.	*	6	1200	265	1834.
1	2000	41	0.	*	3	0930	116	118445.	*	4	2300	191	10044.	*	6	1230	266	1804.
1	2030	42	0.	*	3	1000	117	115011.	*	4	2330	192	9755.	*	6	1300	267	1774.
1	2100	43	0.	*	3	1030	118	111489.	*	5	0000	193	9474.	*	6	1330	268	1745.
1	2130	44	0.	*	3	1100	119	107902.	*	5	0030	194	9202.	*	6	1400	269	1716.
1	2200	45	0.	*	3	1130	120	104267.	*	5	0100	195	8936.	*	6	1430	270	1688.
1	2230	46	1.	*	3	1200	121	100729.	*	5	0130	196	8678.	*	6	1500	271	1660.
1	2300	47	1.	*	3	1230	122	97233.	*	5	0200	197	8427.	*	6	1530	272	1633.
1	2330	48	2.	*	3	1300	123	93803.	*	5	0230	198	8183.	*	6	1600	273	1606.
2	0000	49	3.	*	3	1330	124	90451.	*	5	0300	199	7945.	*	6	1630	274	1579.
2	0030	50	5.	*	3	1400	125	87228.	*	5	0330	200	7714.	*	6	1700	275	1553.
2	0100	51	7.	*	3	1430	126	84121.	*	5	0400	201	7490.	*	6	1730	276	1528.
2	0130	52	10.	*	3	1500	127	81216.	*	5	0430	202	7271.	*	6	1800	277	1502.
2	0200	53	15.	*	3	1530	128	78417.	*	5	0500	203	7059.	*	6	1830	278	1478.
2	0230	54	21.	*	3	1600	129	75709.	*	5	0530	204	6853.	*	6	1900	279	1453.
2	0300	55	29.	*	3	1630	130	73096.	*	5	0600	205	6683.	*	6	1930	280	1429.
2	0330	56	39.	*	3	1700	131	70574.	*	5	0630	206	6517.	*	6	2000	281	1406.
2	0400	57	51.	*	3	1730	132	68133.	*	5	0700	207	6356.	*	6	2030	282	1383.
2	0430	58	66.	*	3	1800	133	65834.	*	5	0730	208	6198.	*	6	2100	283	1360.
2	0500	59	84.	*	3	1830	134	63662.	*	5	0800	209	6043.	*	6	2130	284	1337.
2	0530	60	109.	*	3	1900	135	61558.	*	5	0830	210	5893.	*	6	2200	285	1315.
2	0600	61	140.	*	3	1930	136	59517.	*	5	0900	211	5746.	*	6	2230	286	1294.
2	0630	62	176.	*	3	2000	137	57536.	*	5	0930	212	5604.	*	6	2300	287	1272.
2	0700	63	220.	*	3	2030	138	55619.	*	5	1000	213	5465.	*	6	2330	288	1251.
2	0730	64	277.	*	3	2100	139	53768.	*	5	1030	214	5332.	*	7	0000	289	1231.
2	0800	65	344.	*	3	2130	140	51992.	*	5	1100	215	5204.	*	7	0030	290	1210.
2	0830	66	424.	*	3	2200	141	50333.	*	5	1130	216	5080.	*	7	0100	291	1190.
2	0900	67	525.	*	3	2230	142	48723.	*	5	1200	217	4960.	*	7	0130	292	1171.
2	0930	68	643.	*	3	2300	143	47164.	*	5	1230	218	4843.	*	7	0200	293	1151.
2	1000	69	784.	*	3	2330	144	45672.	*	5	1300	219	4730.	*	7	0230	294	1132.
2	1030	70	951.	*	4	0000	145	44234.	*	5	1330	220	4620.	*	7	0300	295	1114.
2	1100	71	1135.	*	4	0030	146	42843.	*	5	1400	221	4512.	*	7	0330	296	1096.
2	1130	72	1320.	*	4	0100	147	41496.	*	5	1430	222	4408.	*	7	0400	297	1078.
2	1200	73	1534.	*	4	0130	148	40193.	*	5	1500	223	4306.	*	7	0430	298	1060.
2	1230	74	1789.	*	4	0200	149	38972.	*	5	1530	224	4206.	*	7	0500	299	1043.
2	1300	75	2093.	*	4	0230	150	37822.	*	5	1600	225	4109.	*	7	0530	300	1026.

PEAK FLOW	TIME		6-HR	24-HR	72-HR	149.50-HR
+	(CFS)	(CFS)				
+	141724.	52.00	137939.	102745.	47029.	23294.
		(INCHES)	3.775	11.248	15.446	15.886
		(AC-FT)	68399.	203792.	279843.	287808.

CUMULATIVE AREA = 339.70 SQ MI

HYDROGRAPH AT STATION Combin
SUM OF 2 HYDROGRAPHS
PLAN 1, RATIO = .50

				*					*					*								
DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW
1	0000	1	0.	*	2	1330	76	1258.	*	4	0300	151	20843.	*	5	1630	226	3031.				
1	0030	2	0.	*	2	1400	77	1476.	*	4	0330	152	20261.	*	5	1700	227	2972.				
1	0100	3	0.	*	2	1430	78	1751.	*	4	0400	153	19707.	*	5	1730	228	2914.				
1	0130	4	0.	*	2	1500	79	2117.	*	4	0430	154	19195.	*	5	1800	229	2857.				

1	0200	5	0.	*	2	1530	80	2583.	*	4	0500	155	18694.	*	5	1830	230	2802.
1	0230	6	0.	*	2	1600	81	3180.	*	4	0530	156	18202.	*	5	1900	231	2747.
1	0300	7	0.	*	2	1630	82	3929.	*	4	0600	157	17715.	*	5	1930	232	2694.
1	0330	8	0.	*	2	1700	83	4830.	*	4	0630	158	17235.	*	5	2000	233	2641.
1	0400	9	0.	*	2	1730	84	5978.	*	4	0700	159	16761.	*	5	2030	234	2590.
1	0430	10	0.	*	2	1800	85	7330.	*	4	0730	160	16295.	*	5	2100	235	2539.
1	0500	11	0.	*	2	1830	86	8925.	*	4	0800	161	15838.	*	5	2130	236	2490.
1	0530	12	0.	*	2	1900	87	10854.	*	4	0830	162	15387.	*	5	2200	237	2442.
1	0600	13	0.	*	2	1930	88	13002.	*	4	0900	163	14943.	*	5	2230	238	2394.
1	0630	14	0.	*	2	2000	89	15670.	*	4	0930	164	14507.	*	5	2300	239	2348.
1	0700	15	0.	*	2	2030	90	18550.	*	4	1000	165	14079.	*	5	2330	240	2302.
1	0730	16	0.	*	2	2100	91	21890.	*	4	1030	166	13660.	*	6	0000	241	2257.
1	0800	17	0.	*	2	2130	92	25459.	*	4	1100	167	13249.	*	6	0030	242	2214.
1	0830	18	0.	*	2	2200	93	29176.	*	4	1130	168	12845.	*	6	0100	243	2171.
1	0900	19	0.	*	2	2230	94	33011.	*	4	1200	169	12450.	*	6	0130	244	2128.
1	0930	20	0.	*	2	2300	95	36692.	*	4	1230	170	12109.	*	6	0200	245	2087.
1	1000	21	0.	*	2	2330	96	40370.	*	4	1300	171	11784.	*	6	0230	246	2047.
1	1030	22	0.	*	3	0000	97	43828.	*	4	1330	172	11466.	*	6	0300	247	2007.
1	1100	23	0.	*	3	0030	98	46961.	*	4	1400	173	11153.	*	6	0330	248	1968.
1	1130	24	0.	*	3	0100	99	49852.	*	4	1430	174	10847.	*	6	0400	249	1930.
1	1200	25	0.	*	3	0130	100	52478.	*	4	1500	175	10547.	*	6	0430	250	1892.
1	1230	26	0.	*	3	0200	101	54740.	*	4	1530	176	10254.	*	6	0500	251	1857.
1	1300	27	0.	*	3	0230	102	56657.	*	4	1600	177	9968.	*	6	0530	252	1826.
1	1330	28	0.	*	3	0300	103	58222.	*	4	1630	178	9689.	*	6	0600	253	1797.
1	1400	29	0.	*	3	0330	104	59447.	*	4	1700	179	9416.	*	6	0630	254	1767.
1	1430	30	0.	*	3	0400	105	60364.	*	4	1730	180	9151.	*	6	0700	255	1738.
1	1500	31	0.	*	3	0430	106	61024.	*	4	1800	181	8892.	*	6	0730	256	1710.
1	1530	32	0.	*	3	0500	107	61412.	*	4	1830	182	8641.	*	6	0800	257	1682.
1	1600	33	0.	*	3	0530	108	61543.	*	4	1900	183	8397.	*	6	0830	258	1654.
1	1630	34	0.	*	3	0600	109	61417.	*	4	1930	184	8160.	*	6	0900	259	1627.
1	1700	35	0.	*	3	0630	110	61083.	*	4	2000	185	7929.	*	6	0930	260	1601.
1	1730	36	0.	*	3	0700	111	60571.	*	4	2030	186	7706.	*	6	1000	261	1574.
1	1800	37	0.	*	3	0730	112	59902.	*	4	2100	187	7490.	*	6	1030	262	1548.
1	1830	38	0.	*	3	0800	113	59098.	*	4	2130	188	7281.	*	6	1100	263	1523.
1	1900	39	0.	*	3	0830	114	58184.	*	4	2200	189	7078.	*	6	1130	264	1498.
1	1930	40	0.	*	3	0900	115	57188.	*	4	2230	190	6892.	*	6	1200	265	1473.
1	2000	41	0.	*	3	0930	116	56103.	*	4	2300	191	6731.	*	6	1230	266	1449.
1	2030	42	0.	*	3	1000	117	54924.	*	4	2330	192	6573.	*	6	1300	267	1425.
1	2100	43	0.	*	3	1030	118	53671.	*	5	0000	193	6419.	*	6	1330	268	1402.
1	2130	44	0.	*	3	1100	119	52352.	*	5	0030	194	6268.	*	6	1400	269	1379.
1	2200	45	0.	*	3	1130	120	50977.	*	5	0100	195	6120.	*	6	1430	270	1356.
1	2230	46	0.	*	3	1200	121	49573.	*	5	0130	196	5976.	*	6	1500	271	1334.
1	2300	47	1.	*	3	1230	122	48165.	*	5	0200	197	5835.	*	6	1530	272	1312.
1	2330	48	1.	*	3	1300	123	46769.	*	5	0230	198	5697.	*	6	1600	273	1290.
2	0000	49	1.	*	3	1330	124	45389.	*	5	0300	199	5562.	*	6	1630	274	1269.
2	0030	50	2.	*	3	1400	125	44051.	*	5	0330	200	5430.	*	6	1700	275	1248.
2	0100	51	4.	*	3	1430	126	42749.	*	5	0400	201	5301.	*	6	1730	276	1228.
2	0130	52	5.	*	3	1500	127	41479.	*	5	0430	202	5176.	*	6	1800	277	1207.
2	0200	53	8.	*	3	1530	128	40299.	*	5	0500	203	5052.	*	6	1830	278	1188.
2	0230	54	11.	*	3	1600	129	39148.	*	5	0530	204	4932.	*	6	1900	279	1168.
2	0300	55	14.	*	3	1630	130	38029.	*	5	0600	205	4814.	*	6	1930	280	1149.
2	0330	56	19.	*	3	1700	131	36939.	*	5	0630	206	4699.	*	6	2000	281	1130.
2	0400	57	25.	*	3	1730	132	35876.	*	5	0700	207	4587.	*	6	2030	282	1112.
2	0430	58	33.	*	3	1800	133	34847.	*	5	0730	208	4477.	*	6	2100	283	1093.
2	0500	59	42.	*	3	1830	134	33848.	*	5	0800	209	4369.	*	6	2130	284	1076.
2	0530	60	53.	*	3	1900	135	32872.	*	5	0830	210	4264.	*	6	2200	285	1058.
2	0600	61	66.	*	3	1930	136	31919.	*	5	0900	211	4162.	*	6	2230	286	1041.
2	0630	62	83.	*	3	2000	137	30988.	*	5	0930	212	4063.	*	6	2300	287	1024.
2	0700	63	105.	*	3	2030	138	30080.	*	5	1000	213	3966.	*	6	2330	288	1007.
2	0730	64	130.	*	3	2100	139	29208.	*	5	1030	214	3872.	*	7	0000	289	991.
2	0800	65	160.	*	3	2130	140	28402.	*	5	1100	215	3782.	*	7	0030	290	975.
2	0830	66	196.	*	3	2200	141	27612.	*	5	1130	216	3697.	*	7	0100	291	959.
2	0900	67	241.	*	3	2230	142	26841.	*	5	1200	217	3623.	*	7	0130	292	943.
2	0930	68	294.	*	3	2300	143	26090.	*	5	1230	218	3552.	*	7	0200	293	928.
2	1000	69	357.	*	3	2330	144	25366.	*	5	1300	219	3481.	*	7	0230	294	913.
2	1030	70	431.	*	4	0000	145	24666.	*	5	1330	220	3413.	*	7	0300	295	898.
2	1100	71	523.	*	4	0030	146	23984.	*	5	1400	221	3346.	*	7	0330	296	884.
2	1130	72	628.	*	4	0100	147	23320.	*	5	1430	222	3281.	*	7	0400	297	870.
2	1200	73	753.	*	4	0130	148	22674.	*	5	1500	223	3216.	*	7	0430	298	857.
2	1230	74	903.	*	4	0200	149	22047.	*	5	1530	224	3153.	*	7	0500	299	844.
2	1300	75	1081.	*	4	0230	150	21438.	*	5	1600	225	3092.	*	7	0530	300	832.

PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW			
(CFS)	(HR)	6-HR	24-HR	72-HR	149.50-HR
61543.	53.50	60146.	46898.	22924.	11516.
(INCHES)		1.646	5.134	7.529	7.854

(AC-FT) 29824. 93020. 136408. 142286.

CUMULATIVE AREA = 339.70 SQ MI

HYDROGRAPH AT STATION Combin
SUM OF 2 HYDROGRAPHS
PLAN 1, RATIO = .40

DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW
1	0000	1	0.	*	2	1330	76	1012.	*	4	0300	151	17241.	*	5	1630	226	2740.				
1	0030	2	0.	*	2	1400	77	1197.	*	4	0330	152	16800.	*	5	1700	227	2687.				
1	0100	3	0.	*	2	1430	78	1414.	*	4	0400	153	16367.	*	5	1730	228	2635.				
1	0130	4	0.	*	2	1500	79	1704.	*	4	0430	154	15941.	*	5	1800	229	2584.				
1	0200	5	0.	*	2	1530	80	2068.	*	4	0500	155	15525.	*	5	1830	230	2534.				
1	0230	6	0.	*	2	1600	81	2526.	*	4	0530	156	15116.	*	5	1900	231	2485.				
1	0300	7	0.	*	2	1630	82	3118.	*	4	0600	157	14713.	*	5	1930	232	2437.				
1	0330	8	0.	*	2	1700	83	3826.	*	4	0630	158	14316.	*	5	2000	233	2390.				
1	0400	9	0.	*	2	1730	84	4661.	*	4	0700	159	13924.	*	5	2030	234	2343.				
1	0430	10	0.	*	2	1800	85	5703.	*	4	0730	160	13541.	*	5	2100	235	2298.				
1	0500	11	0.	*	2	1830	86	6913.	*	4	0800	161	13164.	*	5	2130	236	2253.				
1	0530	12	0.	*	2	1900	87	8300.	*	4	0830	162	12792.	*	5	2200	237	2210.				
1	0600	13	0.	*	2	1930	88	9974.	*	4	0900	163	12442.	*	5	2230	238	2167.				
1	0630	14	0.	*	2	2000	89	11801.	*	4	0930	164	12133.	*	5	2300	239	2125.				
1	0700	15	0.	*	2	2030	90	13897.	*	4	1000	165	11828.	*	5	2330	240	2084.				
1	0730	16	0.	*	2	2100	91	16256.	*	4	1030	166	11528.	*	6	0000	241	2044.				
1	0800	17	0.	*	2	2130	92	18691.	*	4	1100	167	11232.	*	6	0030	242	2004.				
1	0830	18	0.	*	2	2200	93	21420.	*	4	1130	168	10941.	*	6	0100	243	1965.				
1	0900	19	0.	*	2	2230	94	24222.	*	4	1200	169	10653.	*	6	0130	244	1927.				
1	0930	20	0.	*	2	2300	95	26934.	*	4	1230	170	10371.	*	6	0200	245	1890.				
1	1000	21	0.	*	2	2330	96	29671.	*	4	1300	171	10094.	*	6	0230	246	1855.				
1	1030	22	0.	*	3	0000	97	32306.	*	4	1330	172	9822.	*	6	0300	247	1825.				
1	1100	23	0.	*	3	0030	98	34717.	*	4	1400	173	9556.	*	6	0330	248	1795.				
1	1130	24	0.	*	3	0100	99	36905.	*	4	1430	174	9295.	*	6	0400	249	1766.				
1	1200	25	0.	*	3	0130	100	38965.	*	4	1500	175	9039.	*	6	0430	250	1737.				
1	1230	26	0.	*	3	0200	101	40790.	*	4	1530	176	8790.	*	6	0500	251	1709.				
1	1300	27	0.	*	3	0230	102	42363.	*	4	1600	177	8547.	*	6	0530	252	1681.				
1	1330	28	0.	*	3	0300	103	43676.	*	4	1630	178	8311.	*	6	0600	253	1654.				
1	1400	29	0.	*	3	0330	104	44735.	*	4	1700	179	8080.	*	6	0630	254	1627.				
1	1430	30	0.	*	3	0400	105	45565.	*	4	1730	180	7854.	*	6	0700	255	1600.				
1	1500	31	0.	*	3	0430	106	46172.	*	4	1800	181	7635.	*	6	0730	256	1574.				
1	1530	32	0.	*	3	0500	107	46577.	*	4	1830	182	7422.	*	6	0800	257	1548.				
1	1600	33	0.	*	3	0530	108	46792.	*	4	1900	183	7215.	*	6	0830	258	1523.				
1	1630	34	0.	*	3	0600	109	46816.	*	4	1930	184	7014.	*	6	0900	259	1498.				
1	1700	35	0.	*	3	0630	110	46684.	*	4	2000	185	6848.	*	6	0930	260	1474.				
1	1730	36	0.	*	3	0700	111	46419.	*	4	2030	186	6687.	*	6	1000	261	1449.				
1	1800	37	0.	*	3	0730	112	46034.	*	4	2100	187	6530.	*	6	1030	262	1426.				
1	1830	38	0.	*	3	0800	113	45544.	*	4	2130	188	6377.	*	6	1100	263	1402.				
1	1900	39	0.	*	3	0830	114	44956.	*	4	2200	189	6229.	*	6	1130	264	1379.				
1	1930	40	0.	*	3	0900	115	44284.	*	4	2230	190	6084.	*	6	1200	265	1357.				
1	2000	41	0.	*	3	0930	116	43538.	*	4	2300	191	5942.	*	6	1230	266	1334.				
1	2030	42	0.	*	3	1000	117	42716.	*	4	2330	192	5804.	*	6	1300	267	1312.				
1	2100	43	0.	*	3	1030	118	41831.	*	5	0000	193	5669.	*	6	1330	268	1291.				
1	2130	44	0.	*	3	1100	119	40892.	*	5	0030	194	5537.	*	6	1400	269	1270.				
1	2200	45	0.	*	3	1130	120	39905.	*	5	0100	195	5408.	*	6	1430	270	1249.				
1	2230	46	0.	*	3	1200	121	38889.	*	5	0130	196	5282.	*	6	1500	271	1228.				
1	2300	47	0.	*	3	1230	122	37866.	*	5	0200	197	5158.	*	6	1530	272	1208.				
1	2330	48	1.	*	3	1300	123	36845.	*	5	0230	198	5037.	*	6	1600	273	1188.				
2	0000	49	1.	*	3	1330	124	35833.	*	5	0300	199	4919.	*	6	1630	274	1169.				
2	0030	50	2.	*	3	1400	125	34850.	*	5	0330	200	4803.	*	6	1700	275	1150.				
2	0100	51	3.	*	3	1430	126	33891.	*	5	0400	201	4690.	*	6	1730	276	1131.				
2	0130	52	4.	*	3	1500	127	32955.	*	5	0430	202	4580.	*	6	1800	277	1112.				
2	0200	53	6.	*	3	1530	128	32044.	*	5	0500	203	4472.	*	6	1830	278	1094.				
2	0230	54	8.	*	3	1600	129	31153.	*	5	0530	204	4366.	*	6	1900	279	1076.				
2	0300	55	11.	*	3	1630	130	30290.	*	5	0600	205	4263.	*	6	1930	280	1059.				
2	0330	56	15.	*	3	1700	131	29492.	*	5	0630	206	4162.	*	6	2000	281	1042.				
2	0400	57	20.	*	3	1730	132	28711.	*	5	0700	207	4063.	*	6	2030	282	1025.				
2	0430	58	26.	*	3	1800	133	27952.	*	5	0730	208	3967.	*	6	2100	283	1008.				
2	0500	59	34.	*	3	1830	134	27213.	*	5	0800	209	3873.	*	6	2130	284	992.				
2	0530	60	42.	*	3	1900	135	26489.	*	5	0830	210	3781.	*	6	2200	285	976.				
2	0600	61	53.	*	3	1930	136	25779.	*	5	0900	211	3698.	*	6	2230	286	960.				
2	0630	62	66.	*	3	2000	137	25082.	*	5	0930	212	3621.	*	6	2300	287	944.				
2	0700	63	82.	*	3	2030	138	24401.	*	5	1000	213	3547.	*	6	2330	288	929.				
2	0730	64	102.	*	3	2100	139	23737.	*	5	1030	214	3475.	*	7	0000	289	914.				
2	0800	65	126.	*	3	2130	140	23088.	*	5	1100	215	3406.	*	7	0030	290	899.				

2	0830	66	155.	*	3	2200	141	22454.	*	5	1130	216	3338.	*	7	0100	291	885.
2	0900	67	188.	*	3	2230	142	21835.	*	5	1200	217	3272.	*	7	0130	292	870.
2	0930	68	229.	*	3	2300	143	21232.	*	5	1230	218	3208.	*	7	0200	293	858.
2	1000	69	279.	*	3	2330	144	20651.	*	5	1300	219	3145.	*	7	0230	294	845.
2	1030	70	337.	*	4	0000	145	20096.	*	5	1330	220	3083.	*	7	0300	295	833.
2	1100	71	404.	*	4	0030	146	19592.	*	5	1400	221	3023.	*	7	0330	296	821.
2	1130	72	488.	*	4	0100	147	19099.	*	5	1430	222	2964.	*	7	0400	297	809.
2	1200	73	585.	*	4	0130	148	18617.	*	5	1500	223	2907.	*	7	0430	298	797.
2	1230	74	700.	*	4	0200	149	18147.	*	5	1530	224	2850.	*	7	0500	299	786.
2	1300	75	842.	*	4	0230	150	17689.	*	5	1600	225	2795.	*	7	0530	300	774.

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
(CFS)	(HR)		6-HR	24-HR	72-HR	149.50-HR
46816.	54.00	(CFS)	45856.	36219.	18142.	9166.
		(INCHES)	1.255	3.965	5.959	6.251
		(AC-FT)	22739.	71839.	107955.	113244.
CUMULATIVE AREA = 339.70 SQ MI						

HYDROGRAPH AT STATION Combin
SUM OF 2 HYDROGRAPHS
PLAN 1, RATIO = .30

DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*
1		0000	1	0.	*	2		1330	76	730.	*	4		0300	151	13221.	*	5		1630	226	2371.	*
1		0030	2	0.	*	2		1400	77	884.	*	4		0330	152	12887.	*	5		1700	227	2325.	*
1		0100	3	0.	*	2		1430	78	1078.	*	4		0400	153	12595.	*	5		1730	228	2280.	*
1		0130	4	0.	*	2		1500	79	1296.	*	4		0430	154	12317.	*	5		1800	229	2236.	*
1		0200	5	0.	*	2		1530	80	1566.	*	4		0500	155	12044.	*	5		1830	230	2193.	*
1		0230	6	0.	*	2		1600	81	1902.	*	4		0530	156	11774.	*	5		1900	231	2151.	*
1		0300	7	0.	*	2		1630	82	2322.	*	4		0600	157	11508.	*	5		1930	232	2110.	*
1		0330	8	0.	*	2		1700	83	2838.	*	4		0630	158	11243.	*	5		2000	233	2069.	*
1		0400	9	0.	*	2		1730	84	3451.	*	4		0700	159	10981.	*	5		2030	234	2029.	*
1		0430	10	0.	*	2		1800	85	4161.	*	4		0730	160	10723.	*	5		2100	235	1990.	*
1		0500	11	0.	*	2		1830	86	4992.	*	4		0800	161	10469.	*	5		2130	236	1952.	*
1		0530	12	0.	*	2		1900	87	5996.	*	4		0830	162	10217.	*	5		2200	237	1915.	*
1		0600	13	0.	*	2		1930	88	7110.	*	4		0900	163	9967.	*	5		2230	238	1878.	*
1		0630	14	0.	*	2		2000	89	8358.	*	4		0930	164	9720.	*	5		2300	239	1846.	*
1		0700	15	0.	*	2		2030	90	9797.	*	4		1000	165	9477.	*	5		2330	240	1816.	*
1		0730	16	0.	*	2		2100	91	11314.	*	4		1030	166	9238.	*	6		0000	241	1786.	*
1		0800	17	0.	*	2		2130	92	12908.	*	4		1100	167	9002.	*	6		0030	242	1757.	*
1		0830	18	0.	*	2		2200	93	14731.	*	4		1130	168	8770.	*	6		0100	243	1729.	*
1		0900	19	0.	*	2		2230	94	16548.	*	4		1200	169	8541.	*	6		0130	244	1701.	*
1		0930	20	0.	*	2		2300	95	18319.	*	4		1230	170	8316.	*	6		0200	245	1673.	*
1		1000	21	0.	*	2		2330	96	20111.	*	4		1300	171	8096.	*	6		0230	246	1646.	*
1		1030	22	0.	*	3		0000	97	21959.	*	4		1330	172	7881.	*	6		0300	247	1620.	*
1		1100	23	0.	*	3		0030	98	23664.	*	4		1400	173	7670.	*	6		0330	248	1593.	*
1		1130	24	0.	*	3		0100	99	25225.	*	4		1430	174	7463.	*	6		0400	249	1567.	*
1		1200	25	0.	*	3		0130	100	26635.	*	4		1500	175	7262.	*	6		0430	250	1542.	*
1		1230	26	0.	*	3		0200	101	27914.	*	4		1530	176	7079.	*	6		0500	251	1517.	*
1		1300	27	0.	*	3		0230	102	29103.	*	4		1600	177	6915.	*	6		0530	252	1492.	*
1		1330	28	0.	*	3		0300	103	30112.	*	4		1630	178	6754.	*	6		0600	253	1468.	*
1		1400	29	0.	*	3		0330	104	30946.	*	4		1700	179	6597.	*	6		0630	254	1444.	*
1		1430	30	0.	*	3		0400	105	31620.	*	4		1730	180	6442.	*	6		0700	255	1420.	*
1		1500	31	0.	*	3		0430	106	32138.	*	4		1800	181	6291.	*	6		0730	256	1397.	*
1		1530	32	0.	*	3		0500	107	32516.	*	4		1830	182	6144.	*	6		0800	257	1374.	*
1		1600	33	0.	*	3		0530	108	32758.	*	4		1900	183	6001.	*	6		0830	258	1352.	*
1		1630	34	0.	*	3		0600	109	32862.	*	4		1930	184	5860.	*	6		0900	259	1330.	*
1		1700	35	0.	*	3		0630	110	32856.	*	4		2000	185	5724.	*	6		0930	260	1308.	*
1		1730	36	0.	*	3		0700	111	32753.	*	4		2030	186	5590.	*	6		1000	261	1287.	*
1		1800	37	0.	*	3		0730	112	32564.	*	4		2100	187	5461.	*	6		1030	262	1266.	*
1		1830	38	0.	*	3		0800	113	32298.	*	4		2130	188	5334.	*	6		1100	263	1245.	*
1		1900	39	0.	*	3		0830	114	31961.	*	4		2200	189	5212.	*	6		1130	264	1225.	*
1		1930	40	0.	*	3		0900	115	31561.	*	4		2230	190	5092.	*	6		1200	265	1205.	*
1		2000	41	0.	*	3		0930	116	31104.	*	4		2300	191	4974.	*	6		1230	266	1185.	*
1		2030	42	0.	*	3		1000	117	30587.	*	4		2330	192	4860.	*	6		1300	267	1165.	*
1		2100	43	0.	*	3		1030	118	30023.	*	5		0000	193	4748.	*	6		1330	268	1146.	*
1		2130	44	0.	*	3		1100	119	29415.	*	5		0030	194	4638.	*	6		1400	269	1128.	*
1		2200	45	0.	*	3		1130	120	28770.	*	5		0100	195	4531.	*	6		1430	270	1109.	*
1		2230	46	0.	*	3		1200	121	28102.	*	5		0130	196	4426.	*	6		1500	271	1091.	*

1	2300	47	0.	*	3	1230	122	27427.	*	5	0200	197	4324.	*	6	1530	272	1073.
1	2330	48	1.	*	3	1300	123	26751.	*	5	0230	198	4223.	*	6	1600	273	1056.
2	0000	49	1.	*	3	1330	124	26079.	*	5	0300	199	4125.	*	6	1630	274	1039.
2	0030	50	1.	*	3	1400	125	25426.	*	5	0330	200	4029.	*	6	1700	275	1022.
2	0100	51	2.	*	3	1430	126	24788.	*	5	0400	201	3936.	*	6	1730	276	1005.
2	0130	52	3.	*	3	1500	127	24163.	*	5	0430	202	3844.	*	6	1800	277	989.
2	0200	53	5.	*	3	1530	128	23552.	*	5	0500	203	3758.	*	6	1830	278	973.
2	0230	54	6.	*	3	1600	129	22953.	*	5	0530	204	3681.	*	6	1900	279	957.
2	0300	55	9.	*	3	1630	130	22369.	*	5	0600	205	3607.	*	6	1930	280	942.
2	0330	56	12.	*	3	1700	131	21797.	*	5	0630	206	3533.	*	6	2000	281	927.
2	0400	57	15.	*	3	1730	132	21237.	*	5	0700	207	3461.	*	6	2030	282	912.
2	0430	58	20.	*	3	1800	133	20731.	*	5	0730	208	3391.	*	6	2100	283	897.
2	0500	59	25.	*	3	1830	134	20237.	*	5	0800	209	3322.	*	6	2130	284	883.
2	0530	60	32.	*	3	1900	135	19752.	*	5	0830	210	3255.	*	6	2200	285	869.
2	0600	61	40.	*	3	1930	136	19274.	*	5	0900	211	3188.	*	6	2230	286	856.
2	0630	62	49.	*	3	2000	137	18805.	*	5	0930	212	3124.	*	6	2300	287	844.
2	0700	63	60.	*	3	2030	138	18345.	*	5	1000	213	3061.	*	6	2330	288	832.
2	0730	64	74.	*	3	2100	139	17895.	*	5	1030	214	3000.	*	7	0000	289	820.
2	0800	65	92.	*	3	2130	140	17453.	*	5	1100	215	2940.	*	7	0030	290	808.
2	0830	66	114.	*	3	2200	141	17019.	*	5	1130	216	2883.	*	7	0100	291	796.
2	0900	67	139.	*	3	2230	142	16594.	*	5	1200	217	2826.	*	7	0130	292	784.
2	0930	68	168.	*	3	2300	143	16178.	*	5	1230	218	2771.	*	7	0200	293	773.
2	1000	69	201.	*	3	2330	144	15776.	*	5	1300	219	2717.	*	7	0230	294	762.
2	1030	70	244.	*	4	0000	145	15386.	*	5	1330	220	2665.	*	7	0300	295	751.
2	1100	71	294.	*	4	0030	146	15004.	*	5	1400	221	2613.	*	7	0330	296	740.
2	1130	72	352.	*	4	0100	147	14630.	*	5	1430	222	2563.	*	7	0400	297	730.
2	1200	73	420.	*	4	0130	148	14264.	*	5	1500	223	2513.	*	7	0430	298	719.
2	1230	74	506.	*	4	0200	149	13908.	*	5	1530	224	2465.	*	7	0500	299	709.
2	1300	75	607.	*	4	0230	150	13560.	*	5	1600	225	2417.	*	7	0530	300	699.

PEAK FLOW	TIME		6-HR	24-HR	72-HR	149.50-HR
(CFS)	(HR)	(CFS)				
32862.	54.00		32243.	25844.	13389.	6819.
		(INCHES)	.882	2.829	4.398	4.650
		(AC-FT)	15988.	51260.	79672.	84245.

CUMULATIVE AREA = 339.70 SQ MI

HYDROGRAPH AT STATION Combin
SUM OF 2 HYDROGRAPHS
PLAN 1, RATIO = .20

DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*
1	0000	1	0.	*	2	1330	76	461.	*	4	0300	151	9139.	*	5	1630	226	1869.					
1	0030	2	0.	*	2	1400	77	559.	*	4	0330	152	8943.	*	5	1700	227	1839.					
1	0100	3	0.	*	2	1430	78	681.	*	4	0400	153	8749.	*	5	1730	228	1810.					
1	0130	4	0.	*	2	1500	79	847.	*	4	0430	154	8559.	*	5	1800	229	1781.					
1	0200	5	0.	*	2	1530	80	1058.	*	4	0500	155	8372.	*	5	1830	230	1752.					
1	0230	6	0.	*	2	1600	81	1291.	*	4	0530	156	8187.	*	5	1900	231	1724.					
1	0300	7	0.	*	2	1630	82	1565.	*	4	0600	157	8004.	*	5	1930	232	1696.					
1	0330	8	0.	*	2	1700	83	1891.	*	4	0630	158	7822.	*	5	2000	233	1669.					
1	0400	9	0.	*	2	1730	84	2274.	*	4	0700	159	7642.	*	5	2030	234	1642.					
1	0430	10	0.	*	2	1800	85	2729.	*	4	0730	160	7468.	*	5	2100	235	1616.					
1	0500	11	0.	*	2	1830	86	3249.	*	4	0800	161	7317.	*	5	2130	236	1590.					
1	0530	12	0.	*	2	1900	87	3839.	*	4	0830	162	7168.	*	5	2200	237	1565.					
1	0600	13	0.	*	2	1930	88	4492.	*	4	0900	163	7019.	*	5	2230	238	1539.					
1	0630	14	0.	*	2	2000	89	5267.	*	4	0930	164	6872.	*	5	2300	239	1515.					
1	0700	15	0.	*	2	2030	90	6112.	*	4	1000	165	6727.	*	5	2330	240	1490.					
1	0730	16	0.	*	2	2100	91	7005.	*	4	1030	166	6584.	*	6	0000	241	1466.					
1	0800	17	0.	*	2	2130	92	7944.	*	4	1100	167	6443.	*	6	0030	242	1443.					
1	0830	18	0.	*	2	2200	93	8984.	*	4	1130	168	6303.	*	6	0100	243	1419.					
1	0900	19	0.	*	2	2230	94	10028.	*	4	1200	169	6165.	*	6	0130	244	1396.					
1	0930	20	0.	*	2	2300	95	11051.	*	4	1230	170	6029.	*	6	0200	245	1374.					
1	1000	21	0.	*	2	2330	96	12040.	*	4	1300	171	5896.	*	6	0230	246	1352.					
1	1030	22	0.	*	3	0000	97	13026.	*	4	1330	172	5764.	*	6	0300	247	1330.					
1	1100	23	0.	*	3	0030	98	14024.	*	4	1400	173	5635.	*	6	0330	248	1308.					
1	1130	24	0.	*	3	0100	99	14946.	*	4	1430	174	5508.	*	6	0400	249	1287.					
1	1200	25	0.	*	3	0130	100	15785.	*	4	1500	175	5383.	*	6	0430	250	1266.					
1	1230	26	0.	*	3	0200	101	16533.	*	4	1530	176	5261.	*	6	0500	251	1246.					
1	1300	27	0.	*	3	0230	102	17194.	*	4	1600	177	5141.	*	6	0530	252	1226.					

1	1330	28	0.	*	3	0300	103	17764.	*	4	1630	178	5024.	*	6	0600	253	1206.
1	1400	29	0.	*	3	0330	104	18243.	*	4	1700	179	4909.	*	6	0630	254	1186.
1	1430	30	0.	*	3	0400	105	18644.	*	4	1730	180	4796.	*	6	0700	255	1167.
1	1500	31	0.	*	3	0430	106	19028.	*	4	1800	181	4686.	*	6	0730	256	1148.
1	1530	32	0.	*	3	0500	107	19326.	*	4	1830	182	4578.	*	6	0800	257	1130.
1	1600	33	0.	*	3	0530	108	19543.	*	4	1900	183	4473.	*	6	0830	258	1111.
1	1630	34	0.	*	3	0600	109	19675.	*	4	1930	184	4370.	*	6	0900	259	1093.
1	1700	35	0.	*	3	0630	110	19738.	*	4	2000	185	4270.	*	6	0930	260	1075.
1	1730	36	0.	*	3	0700	111	19740.	*	4	2030	186	4172.	*	6	1000	261	1058.
1	1800	37	0.	*	3	0730	112	19688.	*	4	2100	187	4077.	*	6	1030	262	1041.
1	1830	38	0.	*	3	0800	113	19587.	*	4	2130	188	3984.	*	6	1100	263	1024.
1	1900	39	0.	*	3	0830	114	19441.	*	4	2200	189	3894.	*	6	1130	264	1008.
1	1930	40	0.	*	3	0900	115	19254.	*	4	2230	190	3811.	*	6	1200	265	991.
1	2000	41	0.	*	3	0930	116	19029.	*	4	2300	191	3736.	*	6	1230	266	975.
1	2030	42	0.	*	3	1000	117	18766.	*	4	2330	192	3661.	*	6	1300	267	960.
1	2100	43	0.	*	3	1030	118	18470.	*	5	0000	193	3589.	*	6	1330	268	944.
1	2130	44	0.	*	3	1100	119	18145.	*	5	0030	194	3517.	*	6	1400	269	929.
1	2200	45	0.	*	3	1130	120	17794.	*	5	0100	195	3447.	*	6	1430	270	914.
1	2230	46	0.	*	3	1200	121	17426.	*	5	0130	196	3379.	*	6	1500	271	900.
1	2300	47	0.	*	3	1230	122	17052.	*	5	0200	197	3312.	*	6	1530	272	885.
1	2330	48	0.	*	3	1300	123	16677.	*	5	0230	198	3246.	*	6	1600	273	871.
2	0000	49	1.	*	3	1330	124	16303.	*	5	0300	199	3182.	*	6	1630	274	858.
2	0030	50	1.	*	3	1400	125	15941.	*	5	0330	200	3118.	*	6	1700	275	846.
2	0100	51	1.	*	3	1430	126	15586.	*	5	0400	201	3057.	*	6	1730	276	834.
2	0130	52	2.	*	3	1500	127	15238.	*	5	0430	202	2996.	*	6	1800	277	822.
2	0200	53	3.	*	3	1530	128	14898.	*	5	0500	203	2936.	*	6	1830	278	810.
2	0230	54	4.	*	3	1600	129	14564.	*	5	0530	204	2878.	*	6	1900	279	798.
2	0300	55	6.	*	3	1630	130	14237.	*	5	0600	205	2821.	*	6	1930	280	787.
2	0330	56	8.	*	3	1700	131	13944.	*	5	0630	206	2765.	*	6	2000	281	776.
2	0400	57	10.	*	3	1730	132	13659.	*	5	0700	207	2710.	*	6	2030	282	765.
2	0430	58	13.	*	3	1800	133	13382.	*	5	0730	208	2656.	*	6	2100	283	754.
2	0500	59	17.	*	3	1830	134	13110.	*	5	0800	209	2603.	*	6	2130	284	743.
2	0530	60	21.	*	3	1900	135	12843.	*	5	0830	210	2552.	*	6	2200	285	732.
2	0600	61	26.	*	3	1930	136	12578.	*	5	0900	211	2501.	*	6	2230	286	722.
2	0630	62	33.	*	3	2000	137	12317.	*	5	0930	212	2451.	*	6	2300	287	712.
2	0700	63	40.	*	3	2030	138	12060.	*	5	1000	213	2403.	*	6	2330	288	701.
2	0730	64	49.	*	3	2100	139	11808.	*	5	1030	214	2356.	*	7	0000	289	691.
2	0800	65	60.	*	3	2130	140	11560.	*	5	1100	215	2310.	*	7	0030	290	682.
2	0830	66	73.	*	3	2200	141	11315.	*	5	1130	216	2265.	*	7	0100	291	672.
2	0900	67	89.	*	3	2230	142	11074.	*	5	1200	217	2222.	*	7	0130	292	662.
2	0930	68	109.	*	3	2300	143	10839.	*	5	1230	218	2179.	*	7	0200	293	653.
2	1000	69	131.	*	3	2330	144	10610.	*	5	1300	219	2138.	*	7	0230	294	644.
2	1030	70	157.	*	4	0000	145	10388.	*	5	1330	220	2097.	*	7	0300	295	634.
2	1100	71	187.	*	4	0030	146	10170.	*	5	1400	221	2057.	*	7	0330	296	625.
2	1130	72	223.	*	4	0100	147	9955.	*	5	1430	222	2018.	*	7	0400	297	617.
2	1200	73	268.	*	4	0130	148	9745.	*	5	1500	223	1979.	*	7	0430	298	608.
2	1230	74	320.	*	4	0200	149	9539.	*	5	1530	224	1942.	*	7	0500	299	599.
2	1300	75	382.	*	4	0230	150	9337.	*	5	1600	225	1905.	*	7	0530	300	591.

PEAK FLOW	TIME		6-HR	MAXIMUM AVERAGE FLOW		149.50-HR
(CFS)	(HR)			24-HR	72-HR	
+	19740.	55.00	19396.	15915.	8683.	4479.
		(INCHES)	.531	1.742	2.852	3.054
		(AC-FT)	9618.	31568.	51670.	55336.

CUMULATIVE AREA = 339.70 SQ MI

HYDROGRAPH AT STATION Combin
SUM OF 2 HYDROGRAPHS
PLAN 1, RATIO = .10

DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*
1	0000	1	0.	*	2	1330	76	212.	*	4	0300	151	4419.	*	5	1630	226	1176.					
1	0030	2	0.	*	2	1400	77	256.	*	4	0330	152	4346.	*	5	1700	227	1158.					
1	0100	3	0.	*	2	1430	78	312.	*	4	0400	153	4276.	*	5	1730	228	1140.					
1	0130	4	0.	*	2	1500	79	387.	*	4	0430	154	4206.	*	5	1800	229	1122.					
1	0200	5	0.	*	2	1530	80	484.	*	4	0500	155	4137.	*	5	1830	230	1104.					
1	0230	6	0.	*	2	1600	81	607.	*	4	0530	156	4069.	*	5	1900	231	1087.					
1	0300	7	0.	*	2	1630	82	762.	*	4	0600	157	4002.	*	5	1930	232	1070.					
1	0330	8	0.	*	2	1700	83	954.	*	4	0630	158	3934.	*	5	2000	233	1053.					

1	0400	9	0.	*	2	1730	84	1168.	*	4	0700	159	3867.	*	5	2030	234	1036.
1	0430	10	0.	*	2	1800	85	1379.	*	4	0730	160	3800.	*	5	2100	235	1020.
1	0500	11	0.	*	2	1830	86	1617.	*	4	0800	161	3734.	*	5	2130	236	1004.
1	0530	12	0.	*	2	1900	87	1887.	*	4	0830	162	3668.	*	5	2200	237	988.
1	0600	13	0.	*	2	1930	88	2183.	*	4	0900	163	3603.	*	5	2230	238	973.
1	0630	14	0.	*	2	2000	89	2520.	*	4	0930	164	3538.	*	5	2300	239	957.
1	0700	15	0.	*	2	2030	90	2885.	*	4	1000	165	3473.	*	5	2330	240	942.
1	0730	16	0.	*	2	2100	91	3271.	*	4	1030	166	3409.	*	6	0000	241	927.
1	0800	17	0.	*	2	2130	92	3673.	*	4	1100	167	3346.	*	6	0030	242	913.
1	0830	18	0.	*	2	2200	93	4087.	*	4	1130	168	3283.	*	6	0100	243	898.
1	0900	19	0.	*	2	2230	94	4516.	*	4	1200	169	3221.	*	6	0130	244	884.
1	0930	20	0.	*	2	2300	95	4961.	*	4	1230	170	3159.	*	6	0200	245	871.
1	1000	21	0.	*	2	2330	96	5392.	*	4	1300	171	3099.	*	6	0230	246	858.
1	1030	22	0.	*	3	0000	97	5805.	*	4	1330	172	3039.	*	6	0300	247	846.
1	1100	23	0.	*	3	0030	98	6188.	*	4	1400	173	2980.	*	6	0330	248	834.
1	1130	24	0.	*	3	0100	99	6544.	*	4	1430	174	2922.	*	6	0400	249	822.
1	1200	25	0.	*	3	0130	100	6868.	*	4	1500	175	2865.	*	6	0430	250	811.
1	1230	26	0.	*	3	0200	101	7157.	*	4	1530	176	2809.	*	6	0500	251	799.
1	1300	27	0.	*	3	0230	102	7414.	*	4	1600	177	2754.	*	6	0530	252	788.
1	1330	28	0.	*	3	0300	103	7648.	*	4	1630	178	2700.	*	6	0600	253	777.
1	1400	29	0.	*	3	0330	104	7858.	*	4	1700	179	2647.	*	6	0630	254	766.
1	1430	30	0.	*	3	0400	105	8034.	*	4	1730	180	2596.	*	6	0700	255	755.
1	1500	31	0.	*	3	0430	106	8177.	*	4	1800	181	2545.	*	6	0730	256	745.
1	1530	32	0.	*	3	0500	107	8290.	*	4	1830	182	2495.	*	6	0800	257	734.
1	1600	33	0.	*	3	0530	108	8372.	*	4	1900	183	2447.	*	6	0830	258	724.
1	1630	34	0.	*	3	0600	109	8422.	*	4	1930	184	2399.	*	6	0900	259	714.
1	1700	35	0.	*	3	0630	110	8446.	*	4	2000	185	2353.	*	6	0930	260	704.
1	1730	36	0.	*	3	0700	111	8448.	*	4	2030	186	2308.	*	6	1000	261	694.
1	1800	37	0.	*	3	0730	112	8429.	*	4	2100	187	2263.	*	6	1030	262	685.
1	1830	38	0.	*	3	0800	113	8393.	*	4	2130	188	2220.	*	6	1100	263	675.
1	1900	39	0.	*	3	0830	114	8339.	*	4	2200	189	2178.	*	6	1130	264	666.
1	1930	40	0.	*	3	0900	115	8270.	*	4	2230	190	2137.	*	6	1200	265	656.
1	2000	41	0.	*	3	0930	116	8188.	*	4	2300	191	2096.	*	6	1230	266	647.
1	2030	42	0.	*	3	1000	117	8089.	*	4	2330	192	2057.	*	6	1300	267	638.
1	2100	43	0.	*	3	1030	118	7978.	*	5	0000	193	2018.	*	6	1330	268	629.
1	2130	44	0.	*	3	1100	119	7856.	*	5	0030	194	1980.	*	6	1400	269	621.
1	2200	45	0.	*	3	1130	120	7722.	*	5	0100	195	1943.	*	6	1430	270	612.
1	2230	46	0.	*	3	1200	121	7582.	*	5	0130	196	1910.	*	6	1500	271	604.
1	2300	47	0.	*	3	1230	122	7440.	*	5	0200	197	1879.	*	6	1530	272	595.
1	2330	48	0.	*	3	1300	123	7299.	*	5	0230	198	1849.	*	6	1600	273	587.
2	0000	49	0.	*	3	1330	124	7158.	*	5	0300	199	1819.	*	6	1630	274	579.
2	0030	50	0.	*	3	1400	125	7024.	*	5	0330	200	1789.	*	6	1700	275	571.
2	0100	51	1.	*	3	1430	126	6895.	*	5	0400	201	1760.	*	6	1730	276	563.
2	0130	52	1.	*	3	1500	127	6769.	*	5	0430	202	1732.	*	6	1800	277	555.
2	0200	53	2.	*	3	1530	128	6647.	*	5	0500	203	1703.	*	6	1830	278	548.
2	0230	54	2.	*	3	1600	129	6527.	*	5	0530	204	1676.	*	6	1900	279	540.
2	0300	55	3.	*	3	1630	130	6411.	*	5	0600	205	1649.	*	6	1930	280	533.
2	0330	56	4.	*	3	1700	131	6298.	*	5	0630	206	1622.	*	6	2000	281	525.
2	0400	57	5.	*	3	1730	132	6187.	*	5	0700	207	1595.	*	6	2030	282	518.
2	0430	58	7.	*	3	1800	133	6079.	*	5	0730	208	1569.	*	6	2100	283	511.
2	0500	59	8.	*	3	1830	134	5974.	*	5	0800	209	1544.	*	6	2130	284	504.
2	0530	60	11.	*	3	1900	135	5870.	*	5	0830	210	1519.	*	6	2200	285	497.
2	0600	61	13.	*	3	1930	136	5767.	*	5	0900	211	1494.	*	6	2230	286	490.
2	0630	62	16.	*	3	2000	137	5665.	*	5	0930	212	1470.	*	6	2300	287	484.
2	0700	63	20.	*	3	2030	138	5565.	*	5	1000	213	1446.	*	6	2330	288	477.
2	0730	64	25.	*	3	2100	139	5467.	*	5	1030	214	1423.	*	7	0000	289	471.
2	0800	65	30.	*	3	2130	140	5370.	*	5	1100	215	1400.	*	7	0030	290	464.
2	0830	66	36.	*	3	2200	141	5275.	*	5	1130	216	1378.	*	7	0100	291	458.
2	0900	67	43.	*	3	2230	142	5181.	*	5	1200	217	1356.	*	7	0130	292	452.
2	0930	68	52.	*	3	2300	143	5088.	*	5	1230	218	1335.	*	7	0200	293	446.
2	1000	69	62.	*	3	2330	144	4999.	*	5	1300	219	1314.	*	7	0230	294	440.
2	1030	70	74.	*	4	0000	145	4912.	*	5	1330	220	1293.	*	7	0300	295	434.
2	1100	71	89.	*	4	0030	146	4826.	*	5	1400	221	1273.	*	7	0330	296	426.
2	1130	72	106.	*	4	0100	147	4742.	*	5	1430	222	1253.	*	7	0400	297	417.
2	1200	73	126.	*	4	0130	148	4659.	*	5	1500	223	1233.	*	7	0430	298	408.
2	1230	74	149.	*	4	0200	149	4578.	*	5	1530	224	1214.	*	7	0500	299	399.
2	1300	75	177.	*	4	0230	150	4498.	*	5	1600	225	1195.	*	7	0530	300	390.

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	149.50-HR
+	(CFS)	(HR)				
+	8448.	55.00				
		(CFS)	8320.	6996.	4087.	2156.
		(INCHES)	.228	.766	1.342	1.470
		(AC-FT)	4125.	13876.	24321.	26633.

CUMULATIVE AREA = 339.70 SQ MI

HYDROGRAPH AT STATION Combin
SUM OF 2 HYDROGRAPHS
PLAN 1, RATIO = .05

DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW
1		0000	1	0.	*	2		1330	76	101.	*	4		0300	151	2049.	*	5		1630	226	632.
1		0030	2	0.	*	2		1400	77	121.	*	4		0330	152	2019.	*	5		1700	227	623.
1		0100	3	0.	*	2		1430	78	147.	*	4		0400	153	1989.	*	5		1730	228	615.
1		0130	4	0.	*	2		1500	79	180.	*	4		0430	154	1960.	*	5		1800	229	606.
1		0200	5	0.	*	2		1530	80	223.	*	4		0500	155	1931.	*	5		1830	230	598.
1		0230	6	0.	*	2		1600	81	280.	*	4		0530	156	1902.	*	5		1900	231	590.
1		0300	7	0.	*	2		1630	82	350.	*	4		0600	157	1873.	*	5		1930	232	582.
1		0330	8	0.	*	2		1700	83	434.	*	4		0630	158	1845.	*	5		2000	233	574.
1		0400	9	0.	*	2		1730	84	538.	*	4		0700	159	1816.	*	5		2030	234	566.
1		0430	10	0.	*	2		1800	85	659.	*	4		0730	160	1788.	*	5		2100	235	559.
1		0500	11	0.	*	2		1830	86	800.	*	4		0800	161	1761.	*	5		2130	236	551.
1		0530	12	0.	*	2		1900	87	962.	*	4		0830	162	1733.	*	5		2200	237	544.
1		0600	13	0.	*	2		1930	88	1122.	*	4		0900	163	1706.	*	5		2230	238	536.
1		0630	14	0.	*	2		2000	89	1277.	*	4		0930	164	1678.	*	5		2300	239	529.
1		0700	15	0.	*	2		2030	90	1446.	*	4		1000	165	1651.	*	5		2330	240	522.
1		0730	16	0.	*	2		2100	91	1623.	*	4		1030	166	1624.	*	6		0000	241	515.
1		0800	17	0.	*	2		2130	92	1809.	*	4		1100	167	1598.	*	6		0030	242	508.
1		0830	18	0.	*	2		2200	93	2000.	*	4		1130	168	1571.	*	6		0100	243	501.
1		0900	19	0.	*	2		2230	94	2195.	*	4		1200	169	1545.	*	6		0130	244	494.
1		0930	20	0.	*	2		2300	95	2392.	*	4		1230	170	1519.	*	6		0200	245	488.
1		1000	21	0.	*	2		2330	96	2582.	*	4		1300	171	1494.	*	6		0230	246	481.
1		1030	22	0.	*	3		0000	97	2764.	*	4		1330	172	1469.	*	6		0300	247	475.
1		1100	23	0.	*	3		0030	98	2932.	*	4		1400	173	1444.	*	6		0330	248	469.
1		1130	24	0.	*	3		0100	99	3088.	*	4		1430	174	1420.	*	6		0400	249	462.
1		1200	25	0.	*	3		0130	100	3229.	*	4		1500	175	1396.	*	6		0430	250	456.
1		1230	26	0.	*	3		0200	101	3353.	*	4		1530	176	1372.	*	6		0500	251	450.
1		1300	27	0.	*	3		0230	102	3464.	*	4		1600	177	1349.	*	6		0530	252	444.
1		1330	28	0.	*	3		0300	103	3558.	*	4		1630	178	1326.	*	6		0600	253	438.
1		1400	29	0.	*	3		0330	104	3636.	*	4		1700	179	1304.	*	6		0630	254	432.
1		1430	30	0.	*	3		0400	105	3701.	*	4		1730	180	1282.	*	6		0700	255	424.
1		1500	31	0.	*	3		0430	106	3752.	*	4		1800	181	1260.	*	6		0730	256	415.
1		1530	32	0.	*	3		0500	107	3791.	*	4		1830	182	1239.	*	6		0800	257	406.
1		1600	33	0.	*	3		0530	108	3817.	*	4		1900	183	1218.	*	6		0830	258	397.
1		1630	34	0.	*	3		0600	109	3829.	*	4		1930	184	1198.	*	6		0900	259	389.
1		1700	35	0.	*	3		0630	110	3834.	*	4		2000	185	1178.	*	6		0930	260	381.
1		1730	36	0.	*	3		0700	111	3831.	*	4		2030	186	1158.	*	6		1000	261	373.
1		1800	37	0.	*	3		0730	112	3819.	*	4		2100	187	1139.	*	6		1030	262	365.
1		1830	38	0.	*	3		0800	113	3799.	*	4		2130	188	1121.	*	6		1100	263	357.
1		1900	39	0.	*	3		0830	114	3772.	*	4		2200	189	1103.	*	6		1130	264	350.
1		1930	40	0.	*	3		0900	115	3737.	*	4		2230	190	1085.	*	6		1200	265	342.
1		2000	41	0.	*	3		0930	116	3697.	*	4		2300	191	1067.	*	6		1230	266	335.
1		2030	42	0.	*	3		1000	117	3649.	*	4		2330	192	1050.	*	6		1300	267	328.
1		2100	43	0.	*	3		1030	118	3595.	*	5		0000	193	1033.	*	6		1330	268	321.
1		2130	44	0.	*	3		1100	119	3536.	*	5		0030	194	1016.	*	6		1400	269	315.
1		2200	45	0.	*	3		1130	120	3473.	*	5		0100	195	1000.	*	6		1430	270	308.
1		2230	46	0.	*	3		1200	121	3406.	*	5		0130	196	984.	*	6		1500	271	302.
1		2300	47	0.	*	3		1230	122	3339.	*	5		0200	197	968.	*	6		1530	272	296.
1		2330	48	0.	*	3		1300	123	3273.	*	5		0230	198	952.	*	6		1600	273	290.
2		0000	49	0.	*	3		1330	124	3208.	*	5		0300	199	937.	*	6		1630	274	284.
2		0030	50	0.	*	3		1400	125	3146.	*	5		0330	200	922.	*	6		1700	275	278.
2		0100	51	0.	*	3		1430	126	3087.	*	5		0400	201	907.	*	6		1730	276	273.
2		0130	52	1.	*	3		1500	127	3030.	*	5		0430	202	893.	*	6		1800	277	267.
2		0200	53	1.	*	3		1530	128	2975.	*	5		0500	203	880.	*	6		1830	278	262.
2		0230	54	1.	*	3		1600	129	2921.	*	5		0530	204	867.	*	6		1900	279	257.
2		0300	55	1.	*	3		1630	130	2870.	*	5		0600	205	854.	*	6		1930	280	252.
2		0330	56	2.	*	3		1700	131	2820.	*	5		0630	206	841.	*	6		2000	281	247.
2		0400	57	3.	*	3		1730	132	2771.	*	5		0700	207	829.	*	6		2030	282	242.
2		0430	58	3.	*	3		1800	133	2724.	*	5		0730	208	817.	*	6		2100	283	238.
2		0500	59	4.	*	3		1830	134	2678.	*	5		0800	209	805.	*	6		2130	284	234.
2		0530	60	5.	*	3		1900	135	2633.	*	5		0830	210	793.	*	6		2200	285	230.
2		0600	61	7.	*	3		1930	136	2589.	*	5		0900	211	781.	*	6		2230	286	226.
2		0630	62	8.	*	3		2000	137	2545.	*	5		0930	212	770.	*	6		2300	287	222.
2		0700	63	10.	*	3		2030	138	2502.	*	5		1000	213	758.	*	6		2330	288	218.
2		0730	64	12.	*	3		2100	139	2463.	*	5		1030	214	747.	*	7		0000	289	214.
2		0800	65	15.	*	3		2130	140	2424.	*	5		1100	215	737.	*	7		0030	290	210.
2		0830	66	18.	*	3		2200	141	2386.	*	5		1130	216	726.	*	7		0100	291	207.
2		0900	67	22.	*	3		2230	142	2348.	*	5		1200	217	716.	*	7		0130	292	203.
2		0930	68	26.	*	3		2300	143	2311.	*	5		1230	218	706.	*	7		0200	293	199.
2		1000	69	31.	*	3		2330	144	2276.	*	5		1300	219	696.	*	7		0230	294	196.

2	1030	70	36.	*	4	0000	145	2241.	*	5	1330	220	687.	*	7	0300	295	193.
2	1100	71	43.	*	4	0030	146	2208.	*	5	1400	221	677.	*	7	0330	296	189.
2	1130	72	51.	*	4	0100	147	2175.	*	5	1430	222	668.	*	7	0400	297	186.
2	1200	73	59.	*	4	0130	148	2142.	*	5	1500	223	659.	*	7	0430	298	183.
2	1230	74	70.	*	4	0200	149	2111.	*	5	1530	224	650.	*	7	0500	299	180.
2	1300	75	84.	*	4	0230	150	2080.	*	5	1600	225	641.	*	7	0530	300	177.

PEAK FLOW	TIME	MAXIMUM AVERAGE FLOW			
(CFS)	(HR)	6-HR	24-HR	72-HR	149.50-HR
3834.	54.50	3779.	3182.	1918.	1021.
		(INCHES)	.103	.348	.630
		(AC-FT)	1874.	6311.	11413.
					12609.

CUMULATIVE AREA = 339.70 SQ MI

HYDROGRAPH AT STATION Combin
SUM OF 2 HYDROGRAPHS
PLAN 1, RATIO = .04

DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*
1	0000	1	0.	*	2	1330	76	79.	*	4	0300	151	1632.	*	5	1630	226	518.					
1	0030	2	0.	*	2	1400	77	95.	*	4	0330	152	1609.	*	5	1700	227	511.					
1	0100	3	0.	*	2	1430	78	115.	*	4	0400	153	1585.	*	5	1730	228	505.					
1	0130	4	0.	*	2	1500	79	142.	*	4	0430	154	1562.	*	5	1800	229	498.					
1	0200	5	0.	*	2	1530	80	176.	*	4	0500	155	1539.	*	5	1830	230	491.					
1	0230	6	0.	*	2	1600	81	217.	*	4	0530	156	1516.	*	5	1900	231	484.					
1	0300	7	0.	*	2	1630	82	273.	*	4	0600	157	1494.	*	5	1930	232	478.					
1	0330	8	0.	*	2	1700	83	340.	*	4	0630	158	1471.	*	5	2000	233	472.					
1	0400	9	0.	*	2	1730	84	417.	*	4	0700	159	1449.	*	5	2030	234	465.					
1	0430	10	0.	*	2	1800	85	512.	*	4	0730	160	1427.	*	5	2100	235	459.					
1	0500	11	0.	*	2	1830	86	620.	*	4	0800	161	1405.	*	5	2130	236	453.					
1	0530	12	0.	*	2	1900	87	745.	*	4	0830	162	1383.	*	5	2200	237	447.					
1	0600	13	0.	*	2	1930	88	887.	*	4	0900	163	1361.	*	5	2230	238	441.					
1	0630	14	0.	*	2	2000	89	1038.	*	4	0930	164	1339.	*	5	2300	239	435.					
1	0700	15	0.	*	2	2030	90	1171.	*	4	1000	165	1318.	*	5	2330	240	428.					
1	0730	16	0.	*	2	2100	91	1312.	*	4	1030	166	1297.	*	6	0000	241	419.					
1	0800	17	0.	*	2	2130	92	1459.	*	4	1100	167	1276.	*	6	0030	242	410.					
1	0830	18	0.	*	2	2200	93	1611.	*	4	1130	168	1255.	*	6	0100	243	401.					
1	0900	19	0.	*	2	2230	94	1763.	*	4	1200	169	1234.	*	6	0130	244	392.					
1	0930	20	0.	*	2	2300	95	1912.	*	4	1230	170	1213.	*	6	0200	245	384.					
1	1000	21	0.	*	2	2330	96	2057.	*	4	1300	171	1193.	*	6	0230	246	376.					
1	1030	22	0.	*	3	0000	97	2200.	*	4	1330	172	1173.	*	6	0300	247	368.					
1	1100	23	0.	*	3	0030	98	2333.	*	4	1400	173	1154.	*	6	0330	248	360.					
1	1130	24	0.	*	3	0100	99	2457.	*	4	1430	174	1134.	*	6	0400	249	353.					
1	1200	25	0.	*	3	0130	100	2569.	*	4	1500	175	1115.	*	6	0430	250	345.					
1	1230	26	0.	*	3	0200	101	2668.	*	4	1530	176	1096.	*	6	0500	251	338.					
1	1300	27	0.	*	3	0230	102	2756.	*	4	1600	177	1078.	*	6	0530	252	331.					
1	1330	28	0.	*	3	0300	103	2830.	*	4	1630	178	1060.	*	6	0600	253	324.					
1	1400	29	0.	*	3	0330	104	2893.	*	4	1700	179	1042.	*	6	0630	254	317.					
1	1430	30	0.	*	3	0400	105	2944.	*	4	1730	180	1024.	*	6	0700	255	311.					
1	1500	31	0.	*	3	0430	106	2984.	*	4	1800	181	1007.	*	6	0730	256	304.					
1	1530	32	0.	*	3	0500	107	3015.	*	4	1830	182	990.	*	6	0800	257	298.					
1	1600	33	0.	*	3	0530	108	3035.	*	4	1900	183	974.	*	6	0830	258	292.					
1	1630	34	0.	*	3	0600	109	3045.	*	4	1930	184	957.	*	6	0900	259	286.					
1	1700	35	0.	*	3	0630	110	3046.	*	4	2000	185	942.	*	6	0930	260	280.					
1	1730	36	0.	*	3	0700	111	3039.	*	4	2030	186	926.	*	6	1000	261	275.					
1	1800	37	0.	*	3	0730	112	3026.	*	4	2100	187	912.	*	6	1030	262	269.					
1	1830	38	0.	*	3	0800	113	3008.	*	4	2130	188	898.	*	6	1100	263	264.					
1	1900	39	0.	*	3	0830	114	2983.	*	4	2200	189	885.	*	6	1130	264	258.					
1	1930	40	0.	*	3	0900	115	2954.	*	4	2230	190	872.	*	6	1200	265	253.					
1	2000	41	0.	*	3	0930	116	2920.	*	4	2300	191	859.	*	6	1230	266	248.					
1	2030	42	0.	*	3	1000	117	2880.	*	4	2330	192	846.	*	6	1300	267	244.					
1	2100	43	0.	*	3	1030	118	2837.	*	5	0000	193	833.	*	6	1330	268	239.					
1	2130	44	0.	*	3	1100	119	2789.	*	5	0030	194	821.	*	6	1400	269	235.					
1	2200	45	0.	*	3	1130	120	2738.	*	5	0100	195	809.	*	6	1430	270	231.					
1	2230	46	0.	*	3	1200	121	2685.	*	5	0130	196	797.	*	6	1500	271	227.					
1	2300	47	0.	*	3	1230	122	2632.	*	5	0200	197	785.	*	6	1530	272	222.					
1	2330	48	0.	*	3	1300	123	2580.	*	5	0230	198	774.	*	6	1600	273	218.					
2	0000	49	0.	*	3	1330	124	2528.	*	5	0300	199	762.	*	6	1630	274	215.					
2	0030	50	0.	*	3	1400	125	2480.	*	5	0330	200	751.	*	6	1700	275	211.					

2	0100	51	0.	*	3	1430	126	2433.	*	5	0400	201	740.	*	6	1730	276	207.
2	0130	52	0.	*	3	1500	127	2389.	*	5	0430	202	729.	*	6	1800	277	203.
2	0200	53	1.	*	3	1530	128	2346.	*	5	0500	203	718.	*	6	1830	278	200.
2	0230	54	1.	*	3	1600	129	2305.	*	5	0530	204	708.	*	6	1900	279	196.
2	0300	55	1.	*	3	1630	130	2265.	*	5	0600	205	697.	*	6	1930	280	193.
2	0330	56	2.	*	3	1700	131	2227.	*	5	0630	206	687.	*	6	2000	281	189.
2	0400	57	2.	*	3	1730	132	2190.	*	5	0700	207	677.	*	6	2030	282	186.
2	0430	58	3.	*	3	1800	133	2154.	*	5	0730	208	667.	*	6	2100	283	183.
2	0500	59	3.	*	3	1830	134	2120.	*	5	0800	209	657.	*	6	2130	284	180.
2	0530	60	4.	*	3	1900	135	2086.	*	5	0830	210	648.	*	6	2200	285	177.
2	0600	61	5.	*	3	1930	136	2053.	*	5	0900	211	639.	*	6	2230	286	173.
2	0630	62	7.	*	3	2000	137	2020.	*	5	0930	212	629.	*	6	2300	287	171.
2	0700	63	8.	*	3	2030	138	1988.	*	5	1000	213	620.	*	6	2330	288	168.
2	0730	64	10.	*	3	2100	139	1957.	*	5	1030	214	612.	*	7	0000	289	165.
2	0800	65	12.	*	3	2130	140	1927.	*	5	1100	215	603.	*	7	0030	290	162.
2	0830	66	14.	*	3	2200	141	1897.	*	5	1130	216	595.	*	7	0100	291	159.
2	0900	67	17.	*	3	2230	142	1867.	*	5	1200	217	586.	*	7	0130	292	156.
2	0930	68	21.	*	3	2300	143	1838.	*	5	1230	218	578.	*	7	0200	293	154.
2	1000	69	25.	*	3	2330	144	1810.	*	5	1300	219	570.	*	7	0230	294	151.
2	1030	70	29.	*	4	0000	145	1783.	*	5	1330	220	563.	*	7	0300	295	149.
2	1100	71	34.	*	4	0030	146	1757.	*	5	1400	221	555.	*	7	0330	296	146.
2	1130	72	40.	*	4	0100	147	1731.	*	5	1430	222	547.	*	7	0400	297	144.
2	1200	73	47.	*	4	0130	148	1706.	*	5	1500	223	540.	*	7	0430	298	141.
2	1230	74	56.	*	4	0200	149	1681.	*	5	1530	224	533.	*	7	0500	299	139.
2	1300	75	65.	*	4	0230	150	1656.	*	5	1600	225	526.	*	7	0530	300	137.

PEAK FLOW	TIME		6-HR	24-HR	72-HR	149.50-HR
(CFS)	(HR)	(CFS)				
3046.	54.50		2999.	2521.	1529.	811.
		(INCHES)	.082	.276	.502	.553
		(AC-FT)	1487.	5000.	9095.	10024.
CUMULATIVE AREA = 339.70 SQ MI						

HYDROGRAPH AT STATION Combin
SUM OF 2 HYDROGRAPHS
PLAN 1, RATIO = .01

DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*	DA	MON	HRMN	ORD	FLOW	*
1	0000	1	0.	*	2	1330	76	19.	*	4	0300	151	385.	*	5	1630	226	113.					
1	0030	2	0.	*	2	1400	77	23.	*	4	0330	152	379.	*	5	1700	227	112.					
1	0100	3	0.	*	2	1430	78	27.	*	4	0400	153	372.	*	5	1730	228	110.					
1	0130	4	0.	*	2	1500	79	33.	*	4	0430	154	366.	*	5	1800	229	109.					
1	0200	5	0.	*	2	1530	80	41.	*	4	0500	155	360.	*	5	1830	230	108.					
1	0230	6	0.	*	2	1600	81	50.	*	4	0530	156	354.	*	5	1900	231	106.					
1	0300	7	0.	*	2	1630	82	61.	*	4	0600	157	348.	*	5	1930	232	105.					
1	0330	8	0.	*	2	1700	83	74.	*	4	0630	158	342.	*	5	2000	233	104.					
1	0400	9	0.	*	2	1730	84	92.	*	4	0700	159	336.	*	5	2030	234	102.					
1	0430	10	0.	*	2	1800	85	111.	*	4	0730	160	330.	*	5	2100	235	101.					
1	0500	11	0.	*	2	1830	86	133.	*	4	0800	161	324.	*	5	2130	236	100.					
1	0530	12	0.	*	2	1900	87	157.	*	4	0830	162	318.	*	5	2200	237	99.					
1	0600	13	0.	*	2	1930	88	183.	*	4	0900	163	313.	*	5	2230	238	97.					
1	0630	14	0.	*	2	2000	89	215.	*	4	0930	164	307.	*	5	2300	239	96.					
1	0700	15	0.	*	2	2030	90	250.	*	4	1000	165	301.	*	5	2330	240	95.					
1	0730	16	0.	*	2	2100	91	287.	*	4	1030	166	296.	*	6	0000	241	94.					
1	0800	17	0.	*	2	2130	92	326.	*	4	1100	167	290.	*	6	0030	242	93.					
1	0830	18	0.	*	2	2200	93	365.	*	4	1130	168	285.	*	6	0100	243	91.					
1	0900	19	0.	*	2	2230	94	409.	*	4	1200	169	280.	*	6	0130	244	90.					
1	0930	20	0.	*	2	2300	95	452.	*	4	1230	170	275.	*	6	0200	245	89.					
1	1000	21	0.	*	2	2330	96	493.	*	4	1300	171	270.	*	6	0230	246	88.					
1	1030	22	0.	*	3	0000	97	533.	*	4	1330	172	265.	*	6	0300	247	87.					
1	1100	23	0.	*	3	0030	98	570.	*	4	1400	173	260.	*	6	0330	248	86.					
1	1130	24	0.	*	3	0100	99	604.	*	4	1430	174	256.	*	6	0400	249	85.					
1	1200	25	0.	*	3	0130	100	637.	*	4	1500	175	251.	*	6	0430	250	84.					
1	1230	26	0.	*	3	0200	101	665.	*	4	1530	176	247.	*	6	0500	251	83.					
1	1300	27	0.	*	3	0230	102	691.	*	4	1600	177	242.	*	6	0530	252	82.					
1	1330	28	0.	*	3	0300	103	713.	*	4	1630	178	238.	*	6	0600	253	81.					
1	1400	29	0.	*	3	0330	104	731.	*	4	1700	179	234.	*	6	0630	254	80.					
1	1430	30	0.	*	3	0400	105	746.	*	4	1730	180	230.	*	6	0700	255	79.					
1	1500	31	0.	*	3	0430	106	758.	*	4	1800	181	226.	*	6	0730	256	78.					

1	1530	32	0.	*	3	0500	107	767.	*	4	1830	182	222.	*	6	0800	257	77.
1	1600	33	0.	*	3	0530	108	773.	*	4	1900	183	218.	*	6	0830	258	76.
1	1630	34	0.	*	3	0600	109	776.	*	4	1930	184	214.	*	6	0900	259	75.
1	1700	35	0.	*	3	0630	110	776.	*	4	2000	185	210.	*	6	0930	260	74.
1	1730	36	0.	*	3	0700	111	775.	*	4	2030	186	207.	*	6	1000	261	73.
1	1800	37	0.	*	3	0730	112	772.	*	4	2100	187	203.	*	6	1030	262	72.
1	1830	38	0.	*	3	0800	113	767.	*	4	2130	188	200.	*	6	1100	263	71.
1	1900	39	0.	*	3	0830	114	760.	*	4	2200	189	197.	*	6	1130	264	70.
1	1930	40	0.	*	3	0900	115	752.	*	4	2230	190	193.	*	6	1200	265	69.
1	2000	41	0.	*	3	0930	116	743.	*	4	2300	191	190.	*	6	1230	266	68.
1	2030	42	0.	*	3	1000	117	732.	*	4	2330	192	187.	*	6	1300	267	67.
1	2100	43	0.	*	3	1030	118	720.	*	5	0000	193	184.	*	6	1330	268	67.
1	2130	44	0.	*	3	1100	119	708.	*	5	0030	194	181.	*	6	1400	269	66.
1	2200	45	0.	*	3	1130	120	694.	*	5	0100	195	178.	*	6	1430	270	65.
1	2230	46	0.	*	3	1200	121	679.	*	5	0130	196	175.	*	6	1500	271	64.
1	2300	47	0.	*	3	1230	122	665.	*	5	0200	197	172.	*	6	1530	272	63.
1	2330	48	0.	*	3	1300	123	651.	*	5	0230	198	170.	*	6	1600	273	62.
2	0000	49	0.	*	3	1330	124	637.	*	5	0300	199	167.	*	6	1630	274	62.
2	0030	50	0.	*	3	1400	125	623.	*	5	0330	200	164.	*	6	1700	275	61.
2	0100	51	0.	*	3	1430	126	610.	*	5	0400	201	162.	*	6	1730	276	60.
2	0130	52	0.	*	3	1500	127	598.	*	5	0430	202	159.	*	6	1800	277	59.
2	0200	53	0.	*	3	1530	128	586.	*	5	0500	203	157.	*	6	1830	278	59.
2	0230	54	0.	*	3	1600	129	574.	*	5	0530	204	154.	*	6	1900	279	58.
2	0300	55	0.	*	3	1630	130	563.	*	5	0600	205	152.	*	6	1930	280	57.
2	0330	56	0.	*	3	1700	131	552.	*	5	0630	206	149.	*	6	2000	281	56.
2	0400	57	1.	*	3	1730	132	542.	*	5	0700	207	147.	*	6	2030	282	56.
2	0430	58	1.	*	3	1800	133	532.	*	5	0730	208	145.	*	6	2100	283	55.
2	0500	59	1.	*	3	1830	134	522.	*	5	0800	209	142.	*	6	2130	284	54.
2	0530	60	1.	*	3	1900	135	512.	*	5	0830	210	140.	*	6	2200	285	54.
2	0600	61	1.	*	3	1930	136	503.	*	5	0900	211	138.	*	6	2230	286	53.
2	0630	62	2.	*	3	2000	137	494.	*	5	0930	212	136.	*	6	2300	287	53.
2	0700	63	2.	*	3	2030	138	484.	*	5	1000	213	134.	*	6	2330	288	52.
2	0730	64	2.	*	3	2100	139	476.	*	5	1030	214	132.	*	7	0000	289	52.
2	0800	65	3.	*	3	2130	140	467.	*	5	1100	215	130.	*	7	0030	290	51.
2	0830	66	4.	*	3	2200	141	459.	*	5	1130	216	128.	*	7	0100	291	50.
2	0900	67	4.	*	3	2230	142	450.	*	5	1200	217	127.	*	7	0130	292	50.
2	0930	68	5.	*	3	2300	143	442.	*	5	1230	218	125.	*	7	0200	293	49.
2	1000	69	6.	*	3	2330	144	434.	*	5	1300	219	123.	*	7	0230	294	49.
2	1030	70	7.	*	4	0000	145	427.	*	5	1330	220	122.	*	7	0300	295	48.
2	1100	71	9.	*	4	0030	146	420.	*	5	1400	221	120.	*	7	0330	296	48.
2	1130	72	10.	*	4	0100	147	412.	*	5	1430	222	119.	*	7	0400	297	48.
2	1200	73	12.	*	4	0130	148	405.	*	5	1500	223	117.	*	7	0430	298	47.
2	1230	74	14.	*	4	0200	149	398.	*	5	1530	224	116.	*	7	0500	299	47.
2	1300	75	16.	*	4	0230	150	392.	*	5	1600	225	115.	*	7	0530	300	46.

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
(CFS)	(HR)		6-HR	24-HR	72-HR	149.50-HR
776.	54.50	(CFS)	763.	631.	366.	195.
		(INCHES)	.021	.069	.120	.133
		(AC-FT)	378.	1251.	2177.	2412.

CUMULATIVE AREA = 339.70 SQ MI

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94 KK *****
 * *
 * Cain C * reek Dam
 * *

 Dam Rout

96 KO OUTPUT CONTROL VARIABLES
 IPRNT 3 PRINT CONTROL
 IPLOT 0 PLOT CONTROL
 QSCAL 0. HYDROGRAPH PLOT SCALE

HYDROGRAPH ROUTING DATA

97 RS STORAGE ROUTING
 NSTPS 1 NUMBER OF SUBREACHES
 ITYP ELEV TYPE OF INITIAL CONDITION

	RSVRIC	1288.00	INITIAL CONDITION								
	X	.00	WORKING R AND D COEFFICIENT								
98 SV	STORAGE	.4	1.1	2.2	3.8	5.8	8.1	10.6	13.7	24.3	48.0
		83.3	130.0	188.6	258.8	336.8	500.0	1320.0			
100 SE	ELEVATION	1282.00	1283.00	1284.00	1285.00	1286.00	1287.00	1288.00	1289.00	1290.00	1291.00
		1292.00	1293.00	1294.00	1295.00	1296.00	1300.00	1320.00			
102 SQ	DISCHARGE	0.	0.	0.	0.	0.	0.	0.	31.	89.	163.
		261.	461.	881.	1681.	2160.	2753.	7124.			
104 ST	TOP OF DAM										
	TOPEL	1295.00	ELEVATION AT TOP OF DAM								
	DAMWID	570.00	DAM WIDTH								
	COQD	3.00	WEIR COEFFICIENT								
	EXPD	1.50	EXPONENT OF HEAD								

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HYDROGRAPH AT STATION Cain C
FOR PLAN 1, RATIO = 1.00

EAK OUTFLOW IS 141732. AT TIME 52.50 HOURS

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
(CFS)	(HR)		6-HR	24-HR	72-HR	149.50-HR
+ 141732.	52.50	(CFS)	137930.	102772.	47042.	23286.
		(INCHES)	3.775	11.251	15.450	15.880
		(AC-FT)	68395.	203846.	279918.	287701.
EAK STORAGE	TIME		MAXIMUM AVERAGE STORAGE			
(AC-FT)	(HR)		6-HR	24-HR	72-HR	149.50-HR
+ 1053.	52.50		1039.	898.	611.	376.
PEAK STAGE	TIME		MAXIMUM AVERAGE STAGE			
(FEET)	(HR)		6-HR	24-HR	72-HR	149.50-HR
1313.50	52.50		1313.16	1309.71	1302.70	1297.25

CUMULATIVE AREA = 339.70 SQ MI

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HYDROGRAPH AT STATION Cain C
FOR PLAN 1, RATIO = .50

EAK OUTFLOW IS 61537. AT TIME 53.50 HOURS

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
(CFS)	(HR)		6-HR	24-HR	72-HR	149.50-HR
+ 61537.	53.50	(CFS)	60154.	46906.	22927.	11505.
		(INCHES)	1.646	5.135	7.530	7.846
		(AC-FT)	29828.	93037.	136426.	142145.
PEAK STORAGE	TIME		MAXIMUM AVERAGE STORAGE			
(AC-FT)	(HR)		6-HR	24-HR	72-HR	149.50-HR
723.	53.50		716.	646.	486.	306.
PEAK STAGE	TIME		MAXIMUM AVERAGE STAGE			
(FEET)	(HR)		6-HR	24-HR	72-HR	149.50-HR
1305.43	53.50		1305.27	1303.57	1299.67	1295.61

CUMULATIVE AREA = 339.70 SQ MI

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HYDROGRAPH AT STATION Cain C
FOR PLAN 1, RATIO = .40

AK OUTFLOW IS 46822. AT TIME 54.00 HOURS

PEAK FLOW	TIME		6-HR	24-HR	72-HR	149.50-HR
+ (CFS)	(HR)					
+ 46822.	54.00	(CFS)	45847.	36217.	18143.	9154.
		(INCHES)	1.255	3.965	5.959	6.243
		(AC-FT)	22734.	71836.	107961.	113102.

PEAK STORAGE	TIME		6-HR	24-HR	72-HR	149.50-HR
+ (AC-FT)	(HR)					
+ 648.	54.00		643.	588.	456.	288.

PEAK STAGE	TIME		6-HR	24-HR	72-HR	149.50-HR
+ (FEET)	(HR)					
+ 1303.62	54.00		1303.49	1302.15	1298.93	1295.20

CUMULATIVE AREA = 339.70 SQ MI

HYDROGRAPH AT STATION Cain C
FOR PLAN 1, RATIO = .30

PEAK OUTFLOW IS 32861. AT TIME 54.50 HOURS

PEAK FLOW	TIME		6-HR	24-HR	72-HR	149.50-HR
+ (CFS)	(HR)					
+ 32861.	54.50	(CFS)	32238.	25844.	13388.	6807.
		(INCHES)	.882	2.829	4.397	4.642
		(AC-FT)	15986.	51262.	79664.	84107.

PEAK STORAGE	TIME		6-HR	24-HR	72-HR	149.50-HR
+ (AC-FT)	(HR)					
+ 570.	54.50		566.	525.	421.	266.

PEAK STAGE	TIME		6-HR	24-HR	72-HR	149.50-HR
+ (FEET)	(HR)					
+ 1301.71	54.50		1301.62	1300.61	1298.12	1294.73

CUMULATIVE AREA = 339.70 SQ MI

HYDROGRAPH AT STATION Cain C
FOR PLAN 1, RATIO = .20

PEAK OUTFLOW IS 19743. AT TIME 55.00 HOURS

PEAK FLOW	TIME		6-HR	24-HR	72-HR	149.50-HR
+ (CFS)	(HR)					
+ 19743.	55.00	(CFS)	19392.	15916.	8679.	4468.
		(INCHES)	.531	1.743	2.851	3.047
		(AC-FT)	9616.	31569.	51645.	55206.

PEAK STORAGE	TIME		6-HR	24-HR	72-HR	149.50-HR
+ (AC-FT)	(HR)					
+ 485.	55.00		482.	456.	380.	240.

PEAK STAGE	TIME		6-HR	24-HR	72-HR	149.50-HR
+ (FEET)	(HR)					

1299.63 55.00 1299.57 1298.91 1297.18 1294.15

CUMULATIVE AREA = 339.70 SQ MI

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HYDROGRAPH AT STATION Cain C
FOR PLAN 1, RATIO = .10

PEAK OUTFLOW IS 8449. AT TIME 55.00 HOURS

PEAK FLOW	TIME		6-HR	24-HR	72-HR	149.50-HR
(CFS)	(HR)	(CFS)				
8449.	55.00		8317.	6995.	4082.	2147.
		(INCHES)	.228	.766	1.341	1.464
		(AC-FT)	4124.	13875.	24288.	26526.

PEAK STORAGE	TIME		6-HR	24-HR	72-HR	149.50-HR
(AC-FT)	(HR)					
391.	55.00		390.	376.	318.	197.

PEAK STAGE	TIME		6-HR	24-HR	72-HR	149.50-HR
(FEET)	(HR)					
1297.33	55.00		1297.30	1296.95	1295.91	1293.31

CUMULATIVE AREA = 339.70 SQ MI

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HYDROGRAPH AT STATION Cain C
FOR PLAN 1, RATIO = .05

PEAK OUTFLOW IS 3833. AT TIME 54.50 HOURS

PEAK FLOW	TIME		6-HR	24-HR	72-HR	149.50-HR
(CFS)	(HR)	(CFS)				
3833.	54.50		3778.	3176.	1911.	1016.
		(INCHES)	.103	.348	.628	.693
		(AC-FT)	1873.	6300.	11369.	12557.

PEAK STORAGE	TIME		6-HR	24-HR	72-HR	149.50-HR
(AC-FT)	(HR)					
336.	54.50		334.	317.	252.	151.

PEAK STAGE	TIME		6-HR	24-HR	72-HR	149.50-HR
(FEET)	(HR)					
1295.99	54.50		1295.97	1295.75	1294.85	1292.49

CUMULATIVE AREA = 339.70 SQ MI

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HYDROGRAPH AT STATION Cain C
FOR PLAN 1, RATIO = .04

PEAK OUTFLOW IS 3045. AT TIME 54.50 HOURS

PEAK FLOW	TIME		6-HR	24-HR	72-HR	149.50-HR
(CFS)	(HR)	(CFS)				
3045.	54.50		2997.	2515.	1522.	809.
		(INCHES)	.082	.275	.500	.552
		(AC-FT)	1486.	4988.	9056.	9993.

PEAK STORAGE	TIME		6-HR	24-HR	72-HR	149.50-HR

+	(AC-FT)	(HR)	6-HR	24-HR	72-HR	149.50-HR
	314.	54.50	313.	296.	230.	136.
	PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
+	(FEET)	(HR)	6-HR	24-HR	72-HR	149.50-HR
	1295.71	54.50	1295.69	1295.48	1294.54	1292.22

CUMULATIVE AREA = 339.70 SQ MI

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HYDROGRAPH AT STATION Cain C
FOR PLAN 1, RATIO = .01

AK OUTFLOW IS 758. AT TIME 56.50 HOURS

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW				
+	(CFS)	(HR)	6-HR	24-HR	72-HR	149.50-HR	
+	758.	56.50	(CFS)	746.	615.	364.	195.
			(INCHES)	.020	.067	.120	.133
			(AC-FT)	370.	1220.	2167.	2406.

PEAK STORAGE	TIME		MAXIMUM AVERAGE STORAGE			
+	(AC-FT)	(HR)	6-HR	24-HR	72-HR	149.50-HR
	171.	56.50	170.	151.	98.	56.

PEAK STAGE	TIME		MAXIMUM AVERAGE STAGE			
+	(FEET)	(HR)	6-HR	24-HR	72-HR	149.50-HR
	1293.71	56.50	1293.68	1293.36	1292.18	1290.47

CUMULATIVE AREA = 339.70 SQ MI

1

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

ERATION	STATION	AREA	PLAN		RATIOS APPLIED TO FLOWS									
					RATIO 1 1.00	RATIO 2 .50	RATIO 3 .40	RATIO 4 .30	RATIO 5 .20	RATIO 6 .10	RATIO 7 .05	RATIO 8 .04	RATIO 9 .01	
HYDROGRAPH AT														
+	Area 1	36.95	1	FLOW TIME	45213. 43.00	22606. 43.00	18085. 43.00	13564. 43.00	9043. 43.00	4521. 43.00	2261. 43.00	1809. 43.00	452. 43.00	
ROUTED TO														
+	NWPA	36.95	1	FLOW TIME	43062. 43.50	20594. 44.00	16010. 44.00	11312. 44.50	6472. 45.00	1502. 47.50	21. 76.50	10. 77.50	0. 50	
				** PEAK STAGES IN FEET **										
			1	STAGE TIME	1622.21 43.50	1621.35 44.00	1621.14 44.00	1620.90 44.50	1620.62 45.00	1620.23 47.50	1619.90 76.50	1619.74 77.50	1619.23 78.00	
DROGRAPH AT														
+	Area 1	101.85	1	FLOW TIME	135215. 42.50	67607. 42.50	54086. 42.50	40564. 42.50	27043. 42.50	13521. 42.50	6761. 42.50	5409. 42.50	1352. 42.50	
COMBINED AT														
+	Combin	138.80	1	FLOW TIME	173866. 42.50	84379. 42.50	66110. 42.50	47852. 43.00	29162. 43.00	13527. 42.50	6761. 42.50	5409. 42.50	1352. 42.50	
DROGRAPH AT														
+	Area 2	15.60	1	FLOW TIME	34793. 39.50	17396. 39.50	13917. 39.50	10438. 39.50	6959. 39.50	3479. 39.50	1740. 39.50	1392. 39.50	348. 39.50	
COMBINED AT														
+	Wessin	154.40	1	FLOW TIME	183477. 42.50	89185. 42.50	69955. 42.50	50384. 42.50	30596. 42.50	14908. 42.00	7453. 42.00	5963. 42.00	1491. 42.00	

UTED TO

+		To Wol	154.40	1	FLOW TIME	105664. 45.50	43371. 46.00	32026. 46.50	22097. 46.50	13022. 47.00	4953. 47.50	2014. 47.00	1545. 47.00	278. 48.50
					** PEAK STAGES IN FEET **									
				1	STAGE TIME	1400.15 45.50	1391.57 46.00	1389.27 46.50	1386.57 46.50	1383.18 47.00	1378.52 47.50	1375.56 47.00	1374.75 47.00	1371.54 48.50
	DROGRAPH AT													
+		Area 3	100.40	1	FLOW TIME	70699. 47.50	35349. 47.50	28279. 47.50	21210. 47.50	14140. 47.50	7070. 47.50	3535. 47.50	2828. 47.50	707. 47.50
	COMBINED AT													
+		Combin	254.80	1	FLOW TIME	172557. 46.00	78043. 46.50	60001. 47.00	43235. 47.00	27151. 47.00	12023. 47.50	5546. 47.00	4372. 47.50	984. 47.50
	ROUTED TO													
+		To Dam	254.80	1	FLOW TIME	101635. 52.00	41609. 54.00	31047. 54.50	21247. 55.50	12256. 57.00	4826. 59.00	2025. 60.00	1580. 60.00	405. 58.50
					** PEAK STAGES IN FEET **									
				1	STAGE TIME	1324.76 52.00	1319.86 54.00	1318.67 54.50	1317.34 55.50	1315.83 57.00	1313.87 59.00	1312.47 60.00	1312.07 60.00	1310.12 58.50
	HYDROGRAPH AT													
+		Area 4	84.90	1	FLOW TIME	40215. 52.50	20107. 52.50	16086. 52.50	12064. 52.50	8043. 52.50	4021. 52.50	2011. 52.50	1609. 52.50	402. 52.50
	COMBINED AT													
+		Combin	339.70	1	FLOW TIME	141724. 52.00	61543. 53.50	46816. 54.00	32862. 54.00	19740. 55.00	8448. 55.00	3834. 54.50	3046. 54.50	776. 54.50
	UTED TO													
+		Cain C	339.70	1	FLOW TIME	141732. 52.50	61537. 53.50	46822. 54.00	32861. 54.50	19743. 55.00	8449. 55.00	3833. 54.50	3045. 54.50	758. 56.50
					** PEAK STAGES IN FEET **									
				1	STAGE TIME	1313.50 52.50	1305.43 53.50	1303.62 54.00	1301.71 54.50	1299.63 55.00	1297.33 55.00	1295.99 54.50	1295.71 54.50	1293.71 56.50

PLAN 1

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1619.06	1619.50	1620.00
STORAGE	1620.	2434.	3352.
OUTFLOW	0.	0.	30.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1622.21	2.21	7410.	43062.	63.50	43.50	.00
.50	1621.35	1.35	5831.	20594.	59.00	44.00	.00
.40	1621.14	1.14	5447.	16010.	57.50	44.00	.00
.30	1620.90	.90	5013.	11312.	56.00	44.50	.00
.20	1620.62	.62	4494.	6472.	53.50	45.00	.00
.10	1620.23	.23	3778.	1502.	47.50	47.50	.00
.05	1619.90	.00	3159.	21.	.00	76.50	.00
.04	1619.74	.00	2869.	10.	.00	77.50	.00
.01	1619.23	.00	1937.	0.	.00	.00	.00

SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION Cain C
(PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED DURING BREACH FORMATION)

PLAN 1

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1288.00	1295.00	1295.00
STORAGE	11.	259.	259.
OUTFLOW	0.	1681.	1681.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1313.50	18.50	1053.	141732.	98.50	52.50	.00
.50	1305.43	10.43	723.	61537.	90.00	53.50	.00
.40	1303.62	8.62	648.	46822.	87.00	54.00	.00
.30	1301.71	6.71	570.	32861.	82.00	54.50	.00
.20	1299.63	4.63	485.	19743.	75.00	55.00	.00

.10	1297.33	2.33	391.	8449.	58.50	55.00	.00
.05	1295.99	.99	336.	3833.	36.00	54.50	.00
.04	1295.71	.71	314.	3045.	28.00	54.50	.00
.01	1293.71	.00	171.	758.	.00	56.50	.00

*** NORMAL END OF HEC-1 ***

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*****
*
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* SEPTEMBER 1990
* VERSION 4.0
*
* RUN DATE 09/11/1997 TIME 16:16:56
*
*****

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*****
*
* U.S. ARMY CORPS OF ENGINEERS
* HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET
* DAVIS, CALIFORNIA 95616
* (916) 756-1104
*
*****

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X   X   XXXXXXX   XXXXX   X
X   X   X         X   X   XX
X   X   X         X       X
XXXXXXX   XXXX   X       XXXXX   X
X   X   X         X       X
X   X   X         X   X   X
X   X   XXXXXXX   XXXXX   XXX

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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE. THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
 NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
 DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

HEC-1 INPUT

PAGE 1

LINE	ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
1	ID Cain Creek Dam
2	IO 4
3	ID 100 YEAR
4	IT 15
5	IN 15
6	KK Area 1A
7	KM Runoff
8	PB 5.40
9	BA 36.95
10	PC 0.0 .005 .01 .015 .02 .028 .035 .043 .05 .058
11	PC .065 .073 .08 .09 .1 .11 .12 .13 .14 .16
12	PC .18 .205 .235 .285 .665 .735 .775 .8 .82 .835
13	PC .85 .865 .88 .89 .9 .91 .92 .928 .935 .943
14	PC .95 .956 .963 .969 .975 .981 .988 .994 1.00
15	LS 1.3 61 0
16	UD 3.6
17	KK NWPA Ponds
18	KM Pond Rout
19	RS 1 elev 1620
20	SV 505.1 1010 1515 3352
21	SE 1617 1618 1619 1620
22	SS 1619.5 30 2.8 1.5
23	ST 1620 5000 2.6 1.5
24	KK Area 1B
25	KM Runoff
26	BA 101.85
27	LS 1.3 61 0
28	UD 3.1
29	KK Combine 1A and 1B
30	HC 2
31	KK Area 2
32	KM Runoff
33	BA 15.6
34	LS 1.3 61 0
35	UD 0.8

36 KK Wessington
 37 KM Combine 1 and 2
 38 HC 2

39 KK To Wolsey
 40 KM Channel Rout
 41 RC 0.04 0.04 0.04 105600 0.0003
 42 RS 1 STOR
 43 RX 0 150 400 800 850 1000 1100 1200
 44 RY 1400 1395 1390 1385 1385 1390 1395 1400

HEC-1 INPUT

PAGE 2

LINE ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

45 KK Area 3
 46 KM Runoff
 47 BA 100.4
 48 LS 1.3 61 0
 49 UD 8.1

50 KK Combine 1,2 and 3
 51 KM
 52 HC 2

53 KK To Dam
 54 KM Channel Rout
 55 RC 0.04 0.04 0.04 100320 0.0003
 56 RS 1 STOR
 57 RX 200 500 1000 1005 1020 1100 2700 3400
 58 RY 1320 1315 1310 1305 1305 1310 1315 1320

59 KK Area 4
 60 KM U/S DAM
 61 BA 84.9
 62 LS 1.3 61 0
 63 UD 13.3

64 KK Combine 1-4
 65 KM
 66 HC 2

67 X KK Cain Creek Dam
 68 KM Dam Rout
 69 KO 3
 70 RS 1 ELEV 1288.
 71 SV 0.4 1.1 2.2 3.8 5.8 8.1 10.6 13.7 24.3 48
 72 SV 83.3 130 188.6 1285 1286 1287 1288 1289 1290 1291
 73 SE 1282 1283 1284 1295 1296 1300
 74 SE 1292 1293 1294 0 0 0 0 31 89 163
 75 SQ 0 0 0 0 0 0
 76 SQ 261 461 881 1681 2160 2753
 77 ST 1295 570 3.0 1.5
 78 ZZ

Elev. storage
 1288 19.6
 1295 258.8

Spillway Q @ Elev. 1295'

$$Q = CLH^{3/2}$$

$$1681 = C(3)(7)^{1.5}$$

$$C = 3.025$$

 * FLOOD HYDROGRAPH PACKAGE (HEC-1) *
 * SEPTEMBER 1990 *
 * VERSION 4.0 *
 * RUN DATE 09/11/1997 TIME 16:16:56 *

 * U.S. ARMY CORPS OF ENGINEERS *
 * HYDROLOGIC ENGINEERING CENTER *
 * 609 SECOND STREET *
 * DAVIS, CALIFORNIA 95616 *
 * (916) 756-1104 *

Cain Creek Dam

2 10 OUTPUT CONTROL VARIABLES
 IPRNT 4 PRINT CONTROL
 IPLOT 0 PLOT CONTROL
 QSCAL 0. HYDROGRAPH PLOT SCALE
 100 YEAR

* ERROR *** SPECIFIED START AND END DATES RESULT IN TOO MANY TIME PERIODS

IT HYDROGRAPH TIME DATA
 NMIN 15 MINUTES IN COMPUTATION INTERVAL

IDATE 1 0 STARTING DATE
ITIME 0000 STARTING TIME
NQ 300 NUMBER OF HYDROGRAPH ORDINATES
NDDATE 4 0 ENDING DATE
NOTIME 0245 ENDING TIME
ICENT 19 CENTURY MARK

COMPUTATION INTERVAL .25 HOURS
TOTAL TIME BASE 74.75 HOURS

ENGLISH UNITS

DRAINAGE AREA SQUARE MILES
PRECIPITATION DEPTH INCHES
LENGTH, ELEVATION FEET
FLOW CUBIC FEET PER SECOND
STORAGE VOLUME ACRE-FEET
SURFACE AREA ACRES
TEMPERATURE DEGREES FAHRENHEIT

* *** **

6 KK * Area 1 * A

Runoff

5 IN TIME DATA FOR INPUT TIME SERIES
JXMIN 15 TIME INTERVAL IN MINUTES
JXDATE 1 0 STARTING DATE
JXTIME 0 STARTING TIME

SUBBASIN RUNOFF DATA

9 BA SUBBASIN CHARACTERISTICS
TAREA 36.95 SUBBASIN AREA

PRECIPITATION DATA

9 PB STORM 5.40 BASIN TOTAL PRECIPITATION

9 PI INCREMENTAL PRECIPITATION PATTERN
.00 .00 .00 .00 .01 .01 .01 .01 .01 .01
.01 .01 .01 .01 .01 .01 .01 .01 .02 .02
.02 .03 .05 .38 .07 .04 .03 .02 .01 .02
.01 .01 .01 .01 .01 .01 .01 .01 .01 .01
.01 .01 .01 .01 .01 .01 .01 .01

15 LS SCS LOSS RATE
STRTL 1.30 INITIAL ABSTRACTION
CRVNBR 61.00 CURVE NUMBER
RTIMP .00 PERCENT IMPERVIOUS AREA

16 UD SCS DIMENSIONLESS UNITGRAPH
TLAG 3.60 LAG

UNIT HYDROGRAPH
74 END-OF-PERIOD ORDINATES

96.	259.	485.	774.	1115.	1506.	2021.	2588.	3194.	3708.
4131.	4472.	4665.	4763.	4789.	4757.	4626.	4430.	4204.	3959.
3693.	3371.	3008.	2632.	2310.	2053.	1834.	1641.	1470.	1318.
1201.	1084.	971.	874.	778.	689.	625.	560.	500.	452.
404.	359.	324.	288.	256.	232.	208.	186.	168.	151.
135.	122.	109.	97.	88.	78.	69.	63.	57.	51.
47.	43.	40.	36.	32.	28.	24.	21.	18.	14.
11.	8.	5.	2.						

* *** **

* *

17 KK * NWPA * Ponds
* *

Pond Rout

HYDROGRAPH ROUTING DATA

19 RS STORAGE ROUTING
NSTPS 1 NUMBER OF SUBREACHES
ITYP elev TYPE OF INITIAL CONDITION
RSVRIC 1620.00 INITIAL CONDITION
X .00 WORKING R AND D COEFFICIENT

20 SV STORAGE 505.1 1010.0 1515.0 3352.0

21 SE ELEVATION 1617.00 1618.00 1619.00 1620.00

22 SS SPILLWAY
CREL 1619.50 SPILLWAY CREST ELEVATION
SPWID 30.00 SPILLWAY WIDTH
COQW 2.80 WEIR COEFFICIENT
EXPW 1.50 EXPONENT OF HEAD

23 ST TOP OF DAM
TOPEL 1620.00 ELEVATION AT TOP OF DAM
DAMWID 5000.00 DAM WIDTH
COQD 2.60 WEIR COEFFICIENT
EXPD 1.50 EXPONENT OF HEAD

COMPUTED OUTFLOW-ELEVATION DATA

(EXCLUDING FLOW OVER DAM)

OUTFLOW	.00	.00	.01	.04	.14	.33	.64	1.10	1.74	2.61
ELEVATION	1617.00	1619.50	1619.50	1619.51	1619.51	1619.52	1619.54	1619.56	1619.58	1619.60
OUTFLOW	3.71	5.09	6.78	8.80	11.18	13.97	17.18	20.85	25.02	29.70
ELEVATION	1619.63	1619.65	1619.69	1619.72	1619.76	1619.80	1619.85	1619.90	1619.95	1620.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

(INCLUDING FLOW OVER DAM)

STORAGE	505.10	1010.00	1515.00	2433.50	2459.06	2478.80	2504.36	2535.53	2572.31	2614.91
OUTFLOW	.00	.00	.00	.00	.14	.33	.64	1.10	1.74	2.61
ELEVATION	1617.00	1618.00	1619.00	1619.50	1619.51	1619.52	1619.54	1619.56	1619.58	1619.60
STORAGE	2663.13	2716.94	2776.59	2841.62	2912.48	2989.17	3071.25	3159.15	3252.88	3352.00
OUTFLOW	3.71	5.09	6.78	8.80	11.18	13.97	17.18	20.85	25.02	29.70
ELEVATION	1619.63	1619.65	1619.69	1619.72	1619.76	1619.80	1619.85	1619.90	1619.95	1620.00

* *** **

* *
24 KK * Area 1 * B
* *

Runoff

SUBBASIN RUNOFF DATA

26 BA SUBBASIN CHARACTERISTICS
TAREA 101.85 SUBBASIN AREA

PRECIPITATION DATA

9 PB STORM 5.40 BASIN TOTAL PRECIPITATION

9 PI INCREMENTAL PRECIPITATION PATTERN

.00	.00	.00	.00	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.02	.02
.02	.03	.05	.38	.07	.04	.03	.02	.01	.02

.01 .01 .01 .01 .01 .01 .01 .01 .01 .01
.01 .01 .01 .01 .01 .01 .01 .01 .01 .01

27 LS SCS LOSS RATE
STRTL 1.30 INITIAL ABSTRACTION
CRVNBR 61.00 CURVE NUMBER
RTIMP .00 PERCENT IMPERVIOUS AREA

28 UD SCS DIMENSIONLESS UNITGRAPH
TLAG 3.10 LAG

UNIT HYDROGRAPH
64 END-OF-PERIOD ORDINATES
355. 1045. 1973. 3083. 4502. 6319. 8406. 10561. 12453. 13772.
14671. 15150. 15244. 15126. 14529. 13758. 12903. 11956. 10788. 9452.
8118. 6960. 6132. 5396. 4745. 4185. 3754. 3322. 2938. 2583.
2233. 1997. 1760. 1551. 1373. 1196. 1060. 930. 812. 724.
635. 563. 498. 436. 388. 341. 301. 265. 230. 206.
182. 162. 148. 134. 120. 105. 91. 77. 65. 53.
41. 30. 18. 6.

29 KK *****
* *
* Combin * e 1A and 1B
* *

30 HC HYDROGRAPH COMBINATION
ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

31 KK *****
* *
* Area 2 *
* *

Runoff

SUBBASIN RUNOFF DATA

33 BA SUBBASIN CHARACTERISTICS
TAREA 15.60 SUBBASIN AREA

PRECIPITATION DATA

9 PB STORM 5.40 BASIN TOTAL PRECIPITATION

9 PI INCREMENTAL PRECIPITATION PATTERN
.00 .00 .00 .00 .01 .01 .01 .01 .01 .01
.01 .01 .01 .01 .01 .01 .01 .01 .01 .01
.02 .03 .05 .38 .07 .04 .03 .02 .01 .02
.01 .01 .01 .01 .01 .01 .01 .01 .01 .01
.01 .01 .01 .01 .01 .01 .01 .01 .01 .01

34 LS SCS LOSS RATE
STRTL 1.30 INITIAL ABSTRACTION
CRVNBR 61.00 CURVE NUMBER
RTIMP .00 PERCENT IMPERVIOUS AREA

35 UD SCS DIMENSIONLESS UNITGRAPH
TLAG .80 LAG

UNIT HYDROGRAPH
18 END-OF-PERIOD ORDINATES
1330. 4457. 7631. 8082. 6673. 4387. 2728. 1799. 1145. 746.

472. 307. 199. 126. 84. 58. 33. 11.

* *** **

* *
36 KK * Wessin * gton
* *

Combine 1 and 2

38 HC HYDROGRAPH COMBINATION
ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

* *** **

* *
39 KK * To Wol * sey
* *

Channel Rout

HYDROGRAPH ROUTING DATA

42 RS STORAGE ROUTING
NSTPS 1 NUMBER OF SUBREACHES
ITYP STOR TYPE OF INITIAL CONDITION
RSVRIC .00 INITIAL CONDITION
X .00 WORKING R AND D COEFFICIENT

41 RC NORMAL DEPTH CHANNEL
ANL .040 LEFT OVERBANK N-VALUE
ANCH .040 MAIN CHANNEL N-VALUE
ANR .040 RIGHT OVERBANK N-VALUE
RLNTH 105600. REACH LENGTH
SEL .0003 ENERGY SLOPE
ELMAX .0 MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

CROSS-SECTION DATA

--- LEFT OVERBANK --- + ----- MAIN CHANNEL ----- + --- RIGHT OVERBANK ---
44 RY ELEVATION 1400.00 1395.00 1390.00 1385.00 1385.00 1390.00 1395.00 1400.00
43 RX DISTANCE .00 150.00 400.00 800.00 850.00 1000.00 1100.00 1200.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	.00	178.78	523.75	1034.90	1712.24	2555.77	3565.48	4727.96	5999.56	7376.92
OUTFLOW	.00	31.51	136.19	340.50	668.60	1142.53	1782.79	2740.51	3969.61	5414.42
ELEVATION	1385.00	1385.79	1386.58	1387.37	1388.16	1388.95	1389.74	1390.53	1391.32	1392.10
STORAGE	8860.03	10448.90	12143.52	13942.23	15823.20	17779.71	19811.76	21919.35	24102.48	26361.15
OUTFLOW	7082.65	8981.78	11119.29	13512.72	16174.11	19083.55	22243.54	25657.09	29327.52	33258.42
ELEVATION	1392.89	1393.68	1394.47	1395.26	1396.05	1396.84	1397.63	1398.42	1399.21	1400.00

* *** **

* *
45 KK * Area 3 *
* *

Runoff

SUBBASIN RUNOFF DATA

47 BA SUBBASIN CHARACTERISTICS

TAREA 100.40 SUBBASIN AREA

PRECIPITATION DATA

9 PB STORM 5.40 BASIN TOTAL PRECIPITATION

9 PI INCREMENTAL PRECIPITATION PATTERN

.00	.00	.00	.00	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.02	.02
.02	.03	.05	.38	.07	.04	.03	.02	.01	.02
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01		

48 LS SCS LOSS RATE

STRTL	1.30	INITIAL ABSTRACTION
CRVNBR	61.00	CURVE NUMBER
RTIMP	.00	PERCENT IMPERVIOUS AREA

49 UD SCS DIMENSIONLESS UNITGRAPH
TLAG 8.10 LAG

UNIT HYDROGRAPH
164 END-OF-PERIOD ORDINATES

54.	108.	161.	266.	391.	517.	657.	819.	980.	1148.
1363.	1578.	1794.	2069.	2356.	2642.	2959.	3299.	3640.	3966.
4253.	4540.	4827.	5026.	5224.	5421.	5557.	5664.	5772.	5845.
5862.	5880.	5895.	5877.	5859.	5841.	5750.	5643.	5535.	5419.
5293.	5168.	5038.	4895.	4751.	4608.	4431.	4252.	4072.	3870.
3655.	3440.	3238.	3058.	2879.	2704.	2578.	2453.	2327.	2216.
2108.	2001.	1902.	1812.	1723.	1638.	1573.	1507.	1442.	1376.
1311.	1245.	1187.	1133.	1080.	1026.	972.	918.	865.	830.
794.	758.	722.	686.	650.	619.	592.	565.	538.	511.
484.	457.	437.	417.	397.	378.	358.	338.	320.	307.
293.	280.	267.	253.	240.	229.	219.	209.	199.	189.
179.	170.	163.	156.	148.	141.	134.	127.	121.	115.
110.	105.	99.	94.	89.	85.	81.	78.	74.	71.
67.	64.	62.	60.	58.	55.	53.	51.	49.	47.
45.	42.	40.	38.	36.	34.	32.	30.	28.	26.
24.	22.	21.	19.	17.	15.	13.	12.	10.	8.
6.	4.	3.	1.						

* *** **

50 KK * Combin * e 1,2 and 3

52 HC HYDROGRAPH COMBINATION
ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

* *** **

53 KK * To Dam *

Channel Rout

HYDROGRAPH ROUTING DATA

56 RS STORAGE ROUTING
NSTPS 1 NUMBER OF SUBREACHES
ITYP STOR TYPE OF INITIAL CONDITION
RSVRIC .00 INITIAL CONDITION
X .00 WORKING R AND D COEFFICIENT

55 RC
 NORMAL DEPTH CHANNEL
 ANL .040 LEFT OVBANK N-VALUE
 ANCH .040 MAIN CHANNEL N-VALUE
 ANR .040 RIGHT OVBANK N-VALUE
 RLNTH 100320. REACH LENGTH
 SEL .0003 ENERGY SLOPE
 ELMAX .0 MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

CROSS-SECTION DATA

58 RY
 57 RX
 ELEVATION 1320.00 1315.00 1310.00 1305.00 1305.00 1310.00 1315.00 1320.00
 DISTANCE 200.00 500.00 1000.00 1005.00 1020.00 1100.00 2700.00 3400.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	.00	39.47	103.34	191.61	304.28	441.35	602.81	917.07	1801.93	3289.59
OUTFLOW	.00	7.83	30.00	69.63	130.08	214.51	325.91	504.40	869.79	1544.36
ELEVATION	1305.00	1305.79	1306.58	1307.37	1308.16	1308.95	1309.74	1310.53	1311.32	1312.10
STORAGE	5380.06	8073.32	11369.39	15250.79	19489.57	24015.39	28828.26	33928.18	39315.14	44989.16
OUTFLOW	2631.99	4223.64	6402.21	9356.48	13216.99	17752.32	22972.55	28891.57	35525.57	42892.21
ELEVATION	1312.89	1313.68	1314.47	1315.26	1316.05	1316.84	1317.63	1318.42	1319.21	1320.00

*** **

59 KK

*
 * Area 4 *
 *

U/S DAM

SUBBASIN RUNOFF DATA

61 BA
 SUBBASIN CHARACTERISTICS
 TAREA 84.90 SUBBASIN AREA

PRECIPITATION DATA

9 PB STORM 5.40 BASIN TOTAL PRECIPITATION

9 PI INCREMENTAL PRECIPITATION PATTERN

.00	.00	.00	.00	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.02
.02	.03	.05	.38	.07	.04	.03	.02	.01	.02
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
.01	.01	.01	.01	.01	.01	.01	.01	.01	.01

52 LS
 SCS LOSS RATE
 STRTL 1.30 INITIAL ABSTRACTION
 CRVNBR 61.00 CURVE NUMBER
 RTIMP .00 PERCENT IMPERVIOUS AREA

63 UD
 SCS DIMENSIONLESS UNITGRAPH
 TLAG 13.30 LAG

UNIT HYDROGRAPH

268 END-OF-PERIOD ORDINATES

17.	34.	51.	68.	85.	117.	157.	196.	236.	276.
319.	370.	421.	472.	524.	575.	641.	709.	778.	846.
914.	994.	1085.	1176.	1267.	1358.	1452.	1560.	1668.	1776.
1884.	1992.	2087.	2178.	2269.	2360.	2451.	2531.	2593.	2656.
2718.	2781.	2842.	2876.	2911.	2945.	2979.	3013.	3028.	3034.
3039.	3045.	3051.	3053.	3047.	3042.	3036.	3030.	3025.	2993.
2958.	2924.	2890.	2856.	2819.	2779.	2739.	2699.	2659.	2619.
2573.	2527.	2482.	2436.	2391.	2336.	2279.	2222.	2165.	2109.
2047.	1978.	1910.	1842.	1774.	1706.	1649.	1592.	1535.	1479.
1422.	1377.	1337.	1297.	1257.	1218.	1180.	1146.	1112.	1077.
1043.	1009.	981.	952.	924.	895.	867.	843.	822.	801.
781.	760.	739.	718.	698.	677.	656.	635.	618.	601.
584.	566.	549.	532.	515.	498.	481.	464.	448.	436.
425.	414.	402.	391.	379.	368.	357.	345.	334.	324.

315.	307.	298.	289.	281.	272.	264.	255.	247.	238.
231.	225.	219.	212.	206.	200.	194.	187.	181.	175.
169.	164.	160.	156.	151.	147.	143.	139.	134.	130.
126.	122.	119.	115.	112.	109.	106.	103.	100.	97.
94.	90.	88.	85.	83.	81.	79.	76.	74.	72.
69.	67.	65.	63.	61.	60.	58.	56.	54.	53.
51.	49.	48.	46.	45.	44.	42.	41.	40.	39.
38.	37.	36.	35.	33.	33.	32.	31.	31.	30.
29.	29.	28.	27.	27.	26.	25.	25.	24.	23.
23.	22.	21.	20.	20.	19.	18.	18.	17.	16.
16.	15.	15.	14.	13.	13.	12.	12.	11.	11.
10.	9.	9.	8.	8.	7.	7.	6.	5.	5.
4.	4.	3.	3.	2.	1.	1.	0.		

*** **

64 KK *****
* *
* Combin * e 1-4
* *

66 HC HYDROGRAPH COMBINATION
ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

*** **

67 KK *****
* *
* Cain C * reek Dam
* *

Dam Rout

69 KO OUTPUT CONTROL VARIABLES
IPRNT 3 PRINT CONTROL
IPLOT 0 PLOT CONTROL
QSCAL 0. HYDROGRAPH PLOT SCALE

HYDROGRAPH ROUTING DATA

70 RS STORAGE ROUTING
NSTPS 1 NUMBER OF SUBREACHES
ITYP ELEV TYPE OF INITIAL CONDITION
RSVRIC 1288.00 INITIAL CONDITION
X .00 WORKING R AND D COEFFICIENT

71 SV	STORAGE	.4	1.1	2.2	3.8	5.8	8.1	10.6	13.7	24.3	48.0
		83.3	130.0	188.6	258.8	336.8	500.0				

73 SE	ELEVATION	1282.00	1283.00	1284.00	1285.00	1286.00	1287.00	1288.00	1289.00	1290.00	1291.00
		1292.00	1293.00	1294.00	1295.00	1296.00	1300.00				

75 SQ	DISCHARGE	0.	0.	0.	0	0.	0.	0.	31.	89.	163.
		261.	461.	881.	1681.	2160.	2753.				

77 ST TOP OF DAM
TOPEL 1295.00 ELEVATION AT TOP OF DAM
DAMWID 570.00 DAM WIDTH
COQD 3.00 WEIR COEFFICIENT
EXPD 1.50 EXPONENT OF HEAD

*** **

HYDROGRAPH AT STATION Cain C

PEAK OUTFLOW IS 9653. AT TIME 22.25 HOURS

Storage
Elev
1288
1295
12.6
258.8

Elev Discharge
1288
1295
1681
1681

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
(CFS)	(HR)		6-HR	24-HR	72-HR	74.75-HR
9653.	22.25	(CFS)	9466.	7506.	3936.	3791.
		(INCHES)	.259	.822	1.293	1.293
		(AC-FT)	4694.	14888.	23423.	23423.

PEAK STORAGE	TIME		MAXIMUM AVERAGE STORAGE			
(AC-FT)	(HR)		6-HR	24-HR	72-HR	74.75-HR
403.	22.25		401.	381.	291.	281.

PEAK STAGE	TIME		MAXIMUM AVERAGE STAGE			
(FEET)	(HR)		6-HR	24-HR	72-HR	74.75-HR
1297.62	22.25		1297.58	1297.07	1295.29	1295.02

CUMULATIVE AREA = 339.70 SQ MI

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
					6-HOUR	24-HOUR	72-HOUR			
+	HYDROGRAPH AT									
+		Area 1	5803.	10.25	4637.	1592.	531.	36.95		
+	ROUTED TO									
+		NWPA	2272.	15.00	1851.	705.	251.	36.95	1620.31	15.00
+	HYDROGRAPH AT									
+		Area 1	17760.	9.50	13480.	4387.	1462.	101.85		
+	2 COMBINED AT									
+		Combin	17760.	9.50	13822.	5074.	1714.	138.80		
+	HYDROGRAPH AT									
+		Area 2	6849.	6.75	2519.	672.	224.	15.60		
+	2 COMBINED AT									
+		Wessin	19197.	9.50	15184.	5746.	1938.	154.40		
+	ROUTED TO									
+		To Wol	5639.	15.75	5409.	3812.	1772.	154.40	1392.21	15.75
+	HYDROGRAPH AT									
+		Area 3	8657.	15.25	8089.	4190.	1442.	100.40		
+	2 COMBINED AT									
+		Combin	14278.	15.50	13474.	7961.	3213.	254.80		
+	ROUTED TO									
+		To Dam	5256.	25.25	5205.	4608.	2754.	254.80	1314.06	25.25
+	HYDROGRAPH AT									
+		Area 4	4760.	20.50	4602.	3155.	1219.	84.90		
+	2 COMBINED AT									
+		Combin	9654.	22.25	9467.	7507.	3973.	339.70		
+	ROUTED TO									
+		Cain C	9653.	22.25	9466.	7506.	3936.	339.70	1297.62	22.25

SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION NWPA
(PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED DURING BREACH FORMATION)

PLAN 1		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	1619.06	1619.50	1620.00
	STORAGE	1620.	2434.	3352.
	OUTFLOW	0.	0.	30.

1

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1620.31	.31	3916.	2272.	32.00	15.00	.00

SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION Cain Creek Dam
(PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED DURING BREACH FORMATION)

PLAN 1

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1288.00	1295.00	1295.00
STORAGE	11.	259.	259.
OUTFLOW	0.	1681.	1681.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1297.62	2.62	403.	9653.	55.00	22.25	.00

*** NORMAL END OF HEC-1 ***

Appendix:
Researcher Routine Analyses

Appendix E Reservoir Routing Analysis

The 100-year flood was routed through the dam using HEC-1 as part of the 100-year flood derivation described in Appendix C. Similarly the HEC-1 analysis used to derive the PMF was used to route reduced PMF flows through the dam. A summary of the results of routing analysis is provided below. Graphical presentation of routing analysis for the 100-year storm is provided as Figure E-1.

**Table E-1
Summary of Results of Reservoir Routing Analysis**

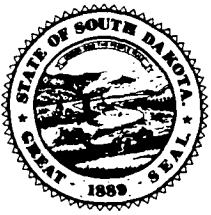
Inflow Flood	Peak Inflow to the Reservoir cfs	Peak Outflow from the Reservoir cfs	Embankment Overtopping	
			Duration Hours	Maximum Depth Feet
100-Year Flood	9,654	9,653	66.8	2.65
100% PMF ⁽¹⁾	141,732	14,732	98.5	18.5
50% PMF	61,537	61,537	90.0	10.43
30% PMF	32,861	32,861	82.0	0.71
20% PMF	19,743	19,743	75.0	4.63
10% PMF	8,449	8,449	58.5	2.33
5% PMF	3,833	3,833	36.0	0.99
4% PMF	3,045	3,045	28.0	0.71
1% PMF	758	758	0	0.0

*30ft
Spillway*

Note: ⁽¹⁾ "PMF" indicates probable maximum flood.

The BOSS DAMBRK model analysis described in Appendix D also provides estimates of maximum reservoir water levels and maximum discharge rates. These values are provided in Table D-3. As discussed in Appendix D in order to ensure convergence of the BOSS DAMBRK model the flood hydrograph generally required some truncation and/or smoothing. As a result there is some variation between values presented in Table D-3 and Table E-1.

It should also be noted that % PMF values are not derived directly from the flow as it enters the dam, rather HEC-1 factors down flows calculated for each sub-catchment. The provision of storage within the upper catchment determines that for the lower flows, significant flow volumes are retained in storage and the resulting flow at the dam is less than that which would be calculated by factoring the PMF hydrograph at the dam.



Office of the Commissioner of School and Public Lands

500 East Capitol Avenue
Pierre, South Dakota 57501-5070
(605) 773-3303
FAX: (605) 773-5520

Curt Johnson
Commissioner

Bryce Healy
Deputy Commissioner

May 6th, 1999

Attn: Maury Wright
U.S. Fish and Wildlife Service
P.O. 25486
Denver Federal Center
Denver, Colorado 80225



RE: Cain Creek WPA (Huron WMD) SE $\frac{1}{4}$ Sec 11 Twp 109N Rge 62W 5th PM Beadle Co. S.D..

Dear Maury;

In response to our telephone conversation earlier today I am giving your office permission to proceed with repairs to the above referenced Dam.

It is our intent to transfer our easement for the above referenced Dam once you have satisfied the State of South Dakota Dam Safety Standards.

Please our office if you have questions.

Sincerely;

Curt Johnson
Commissioner

cc: Tim Schaal SD DENR
cc: Mark Heisinger Huron Office USFWS
cc: Dianne Best SD Attorney General's Office
cc: Don Fazzan Denver USFWS

Water Permit Application #6130-3
US Fish & Wildlife Service
Cain Creek Dam

Top of Dam Elev. - 1295
P. Spillway Elev. - 1288
D/S Emb Toe Elev. - 1281 } HL = 14 ft Cat 3 - Low Hazard Dam

Normal Storage Capacity = 11 Ac-Ft
Max. Storage Capacity = 260 Ac-Ft

The proposed repair project will install a 115 ft wide sheet pile weir and abandon the existing primary and secondary spillways.

Minimum Spillway Design (No 2nd Spillway)

Max. Capacity x Eff Ht = $260 \times 14 = 3640 > 3000 \therefore$ 50 year
Minimum Spillway Design

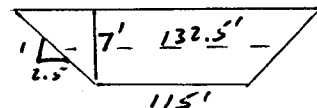
The proposed repair project is design by Woodward-Clyde. They used the COK HEC-1 model to route upstream runoff thru 4 subbasins and have the following peak estimates.

50 year flood = 6370 cfs
100 year flood = 9650 cfs
PMF flood = 142,000 cfs

Spillway Capacity

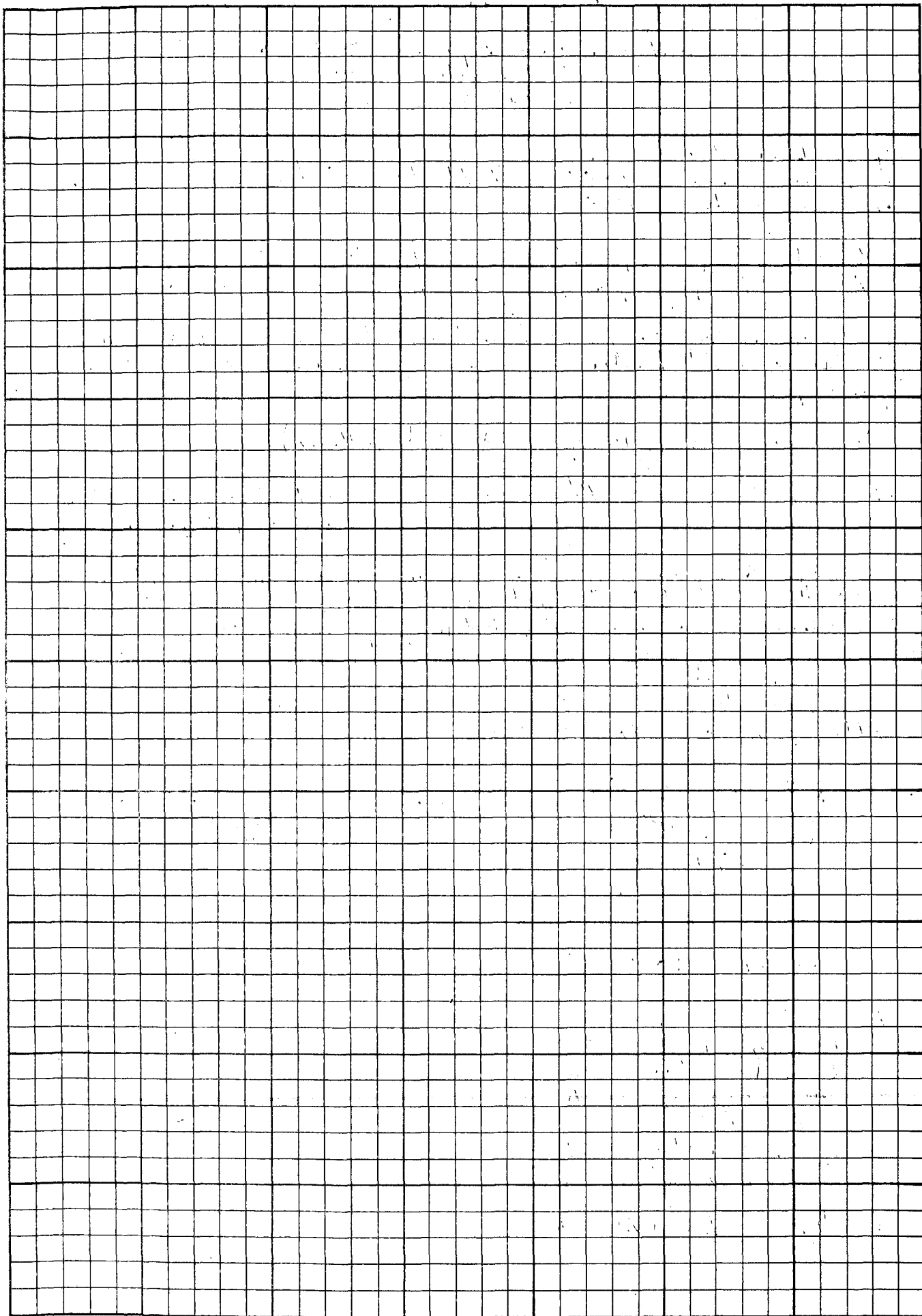
$$Q = C L H^{3/2} \\ = (2.8)(132.5)(7)^{1.5} \\ = \underline{\underline{6870 \text{ cfs}}}$$

$$C = 2.8 \\ h = 132.5 \\ H = 7$$



Section 74:02:08:09

1. Topo Map - OK
2. Dam Axis Profile - OK
3. Dam X-Section - OK
4. Area - Capacity - OK
5. Outlet Details - OK
6. Spillway Rating - OK
7. Spillway Details - OK
8. Specs - OK
9. EPP - Cat. 3 N/A - OK



Attachment to Application
for Permit to Appropriate
Water Within the State of
South Dakota - Form 2

CAIN CREEK DAM WPA
BEADLE COUNTY, SOUTH DAKOTA

Evaporation = 33.5 " NWS 33
Precipitation = 19.96" Earth Info NCDC, Huron SD 1948-96
Net Evaporation = 13.54 inches or 1.13 feet.

MAXIMUM

100 AF Storage

+29 AF Seasonal *

129 AF TOTAL

* Over the 26 surface acre wetland, this results in a
net seasonal use of 29 acre-feet, annually.

NOTE: Because there is some question as to actual surface acres and acre-feet capacity, a
ground survey will be completed once construction activities commence. These
calculations are based on maximum amounts and will be corrected once the survey data
is available.



U.S. Department of the Interior

Fish and Wildlife Service Region 6 Division of Engineering



Mailing Address:
P.O. Box 25486
Denver Federal Center
Denver, Colorado 80225-0486

TO: Tim Schaal	FAX No.: 605-773-1068
State of South Dakota	Telephone No.: 605-773-5559
Div. of Environmental Services - Water Rights	Number of Pages (incl. cover sheet): 6
FROM: Don Fazzan, Civil Engineer Branch of Structures and Dams	Telephone No.: 303-236-5319, ext. 286 Fax No.: 303-236-4759 E-mail Address: don_fazzan@fws.gov

MESSAGE:

I have attached sheets which are excerpts from the consultant's report for Cain Creek Dam. As you can see, there are some discrepancies in the text. I would recommend that you use the graph titled: "Figure 3. Elevation Storage Curve for Cain Creek Dam" to compute the reservoir storage volume.

I visited briefly with Mr. John France, Vice-President of Woodward-Clyde, Denver. He said that he would try to determine if they completed a routing for the dam, assuming the rehabilitated dam structure was in place.

John explained that the reservoir volume is so small, compared with the drainage area, that there is minimal attenuation with any of the floods studied. Their report provided three alternative spillway designs, sized to pass the 25, 50, and 100-year flood volumes. The alternative included in our specifications incorporates the design for the 50-year flood, which was deemed adequate to meet the State of South Dakota dam safety requirements.

Please let me know if this information is satisfactory.



FINAL

CAIN CREEK DAM SURVEY DATA COLLECTION AND HYDROLOGY AND HYDRAULIC ANALYSIS

Prepared for
U.S. Fish and Wildlife Service
Denver, Colorado

October 8, 1997

Woodward-Clyde



Woodward-Clyde
4582 S. Ulster St. Parkway, Suite 1000
Denver, CO 80237
D9726

SECTION THREE

Survey Data Collection

3.1 DAM AND RESERVOIR AREA

Surveys of the dam and reservoir area were made to define the dam profile and layout and the topography of the reservoir. Specifically, survey work carried out in the dam and reservoir area included:

- Survey of a profile along the centerline of the dam, including both the service spillway and the emergency spillway.
- Surveys of the toe and crest of the dam at 20 feet maximum spacing and at critical sections; and plotting of a topographic plan of the dam.
- Survey of five cross-sections perpendicular to the natural flow path through the reservoir area, including shots below the water surface where possible.
- Establishment of two permanent survey benchmarks on the left and right abutments, the benchmarks are referenced to National Geodetic Vertical Datum (NGVD).

Detailed results of the survey data in the dam and reservoir area are presented in Appendix A.

The surveyed dam centerline profile indicates that the embankment crest elevation varies from about Elevation 1294 feet to Elevation 1295+ feet. The lowest section of the embankment crest extends from just to the left of the breached section to the service spillway, a length of about 150 feet. The structural height of the dam is calculated as 14 feet, based on a typical crest elevation of 1295 feet and an apparent stream elevation of about 1281 feet in the bottom of the breach. The hydraulic height was estimated as 12 feet, based on the same stream channel elevation and an estimated "maximum design water level" of elevation 1293 feet, which corresponds to a minimum freeboard of 1 foot and a flow depth through the emergency spillway of 1 foot. The dam crest length is measured at 650 feet, including both spillways.

With the reservoir pool at the service spillway crest (Elevation 1288 feet), the area of the reservoir is estimated to be about 3 acres and the storage is estimated to be about 14 acre-feet. With the reservoir pool at the embankment crest (Elevation 1295 feet) the area and storage increase to about 76 acres and 260 acre-feet, respectively. Based on a surveyed minimum reservoir bottom elevation of 1281 feet, the maximum pool depth is about 7 feet with the pool at the service spillway crest and about 14 feet with the pool at the embankment crest. The impoundment topography is shown in Figures 1 and 2.

3.2 DOWNSTREAM CHANNEL AND STRUCTURES

The following locations downstream of the dam were surveyed:

- A channel cross section between the dam and the first downstream township road crossing.
- A road profile at each of the three downstream township road crossings
- A stream cross section immediately upstream of each of the three downstream township road crossings.
- Sizes and invert elevations (upstream and downstream) of the culverts at all three of the downstream township road crossings.

SECTION THREE**Survey Data Collection**

- The dimensions of the State Highway 37 bridge crossing; including elevations of the roadway and the bottom of the bridge deck, span lengths, channel bottom width and elevation.
- A stream cross section immediately upstream of the State Highway 37 crossing.
- Stream cross sections at six other selected locations along the stream between the dam and the confluence with the James River.

A summary of cross section references and locations is provided in Appendix A. Survey cross-section plots are also provided in Appendix A.

3.3 PERTINENT DATA

The pertinent data table for the dam has been updated based on the survey data and the results of the analyses completed for this report, and the updated table is presented in Appendix B.

SECTION FOUR

Reservoir and Spillway Characteristics

4.1 RESERVOIR AREA AND STORAGE RELATIONSHIPS

An elevation-storage relationship for the dam was developed using the topographical information provided by the recent survey in combination with the USGS topographical map for Huron (7.5 minute series). The later source was used primarily to provide estimates of the storage upstream of the dam for water levels above the spillway crests levels. Based on the USGS map, storage would be provided within the boundaries of Cain Creek (to EL 1995) for up to 2 miles upstream of the dam. Calculations indicate that at the normal operating level, i.e. with water at the service spillway crest elevation, the dam impounds 11 acre feet of water, and at dam crest level the water impounded would be about 260 acre feet.

An elevation-storage curve for the reservoir is presented on Figure 3.

4.2 SPILLWAY DISCHARGE RELATIONSHIPS

The discharge capacities of the service and emergency spillways are calculated as 580 cfs and 670 cfs, respectively, for the reservoir level at the embankment crest elevation (1295 feet). The service spillway capacity was calculated assuming a weir length of 9.5 ft and a discharge coefficient of 3.3. The emergency spillway capacity was calculated from Mannings equation assuming a roughness coefficient of 0.035. Rating curves for the individual and combined spillways are presented on Figure 4.

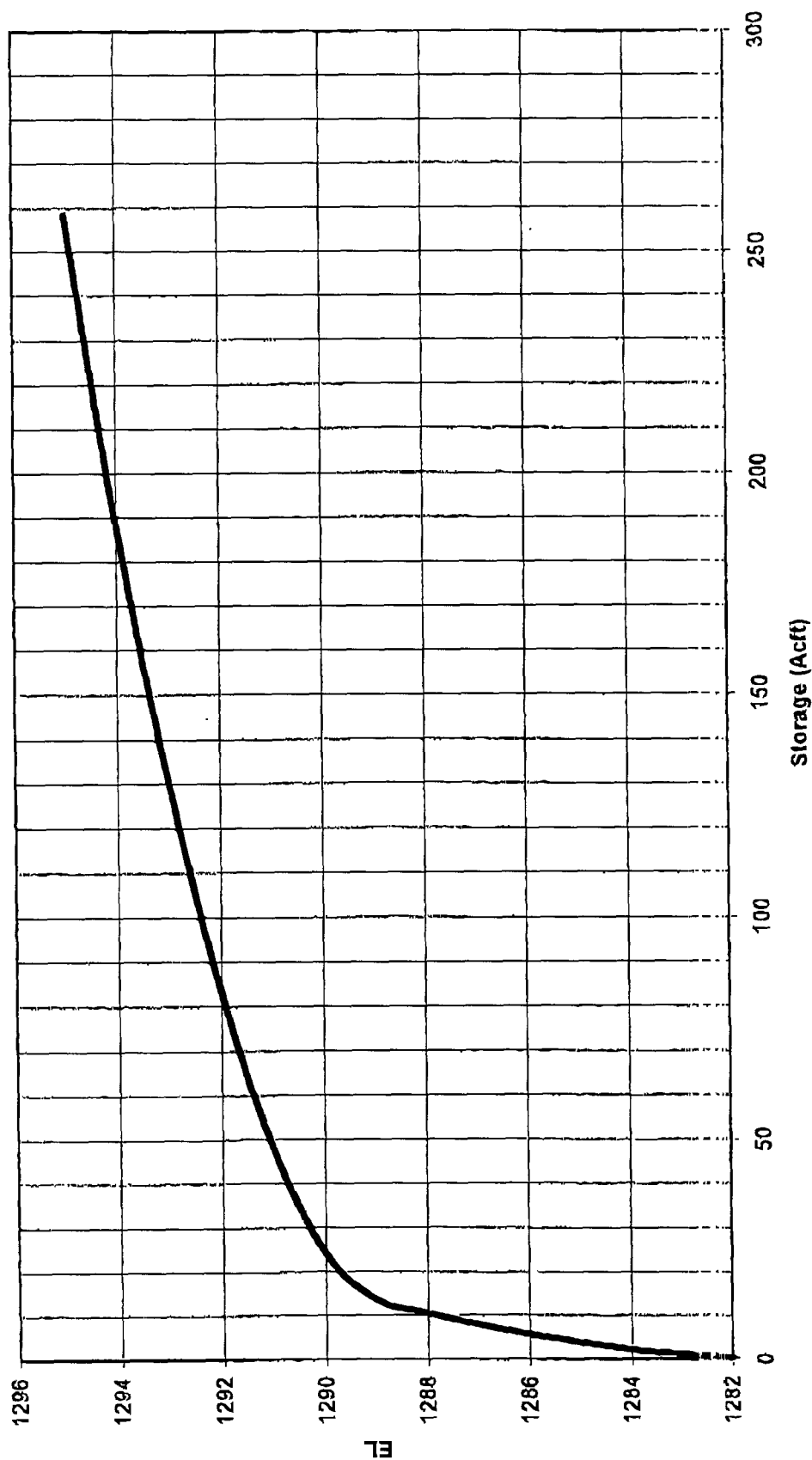


Figure 3. Elevation Storage Curve for Cain Creek Dam

Gronlund, Eric

From: Gronlund, Eric
Sent: Wednesday, May 26, 1999 2:07 PM
To: Schaal, Tim
Cc: Best, Diane; Schlaak, Karen
Subject: USFWS Cain Creek application (No. 6130-3)

I talked again to Ginger Price with USFWS in Denver in regard to the vested water right application for reconstruction of Cain Creek dam. She requested that the application be put on hold until they resolve some issues. The primary issue is School & Public Land owning the dam. Transfer of dam ownership is hampered by the fact that S&PL can't transfer ownership of a dam in disrepair and USFWS can't put money into this dam until they own it (for some reason).

Mrs. Price stated she didn't believe they could even hold a water right on a dam they don't own. I said I believe USFWS can hold the water right in their name but some type of an agreement/easement would need to be secured with S&PL.

I indicated that they will need to contact me when they want to proceed with the application.



U.S. Department of the Interior

**Fish and Wildlife Service
Region 6
Division of Engineering**

Mailing Address:
P.O. Box 25486
Denver Federal Center
Denver, Colorado 80225-0486



TO: Tim Schaal	Fax No.: 605-773-4068
State of South Dakota	Telephone No.: 605-773-5559
Div. of Environmental Services - Water Rights	Number of Pages (incl. cover sheet): 4
FROM: Don Fazzan, Civil Engineer Branch of Structures and Dams	Telephone No.: 303-235-5319, ext. 286 Fax No.: 303-235-4759 E-mail Address: don_fazzan@fws.gov

MESSAGE:

Tim,

Per our last discussion on this issue (June 10, 1999), I am transmitting the calculations we received from our consultant (Woodward-Clyde) for sizing of the spillway at Cain Creek Dam.

As you may recall, the proposed spillway design, given in our specifications, is sized to pass the 50-year flood, which was deemed adequate to meet the State of South Dakota dam safety requirements.

I believe this is the only other data you required to complete your dam safety review for this project.

Please let me know if this information is satisfactory.

It would also be helpful to know when we might expect to receive formal approval of this project.

FAX TRANSMITTAL

URS Greiner Woodward Clyde

4582 S. Ulster Street
Suite 1000

DATE: 7/7/99

PAGE 1 OF: 3

Denver, CO 80237
TEL: (303) 694-2660 FAX: (303) 694-3946

TO: Don Fazzan

FROM: John France

FIRM: U.S. Fish and Wildlife
Service

SUBJECT: Cain Creek Spillway

FAX NO: 303 236 4759

CC:

MEMO:

Here is the calculation that you requested for the sheetpile/riprap spillway alternative for Cain Creek Dam.

As we have discussed previously, no reservoir routings were completed to size the spillway. Rather, reservoir routings completed for the original conditions at the dam indicated that the reservoir provides very little flood attenuation. Therefore, the spillway was sized to pass the peak inflow for the 50-year flood, with no attenuation. The peak inflow for the 50-year flood was estimated to be 6,370 cfs.

Please do not hesitate to contact me if you need any additional information.

Regards,

John France

URS Greiner Woodward Clyde

Job Cain Creek Dam

Description Spillway capacity

Project No. D9735

Computed by MUB

Checked by JHS

Page of

Sheet of

Date 7/6/99

Date 7/7/99

Reference

Objective:

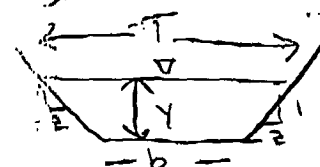
- Check the capacity of the proposed spillway.

Given:

- $Q_{50} = 6,370$ cfs
- Spillway length = 115 ft.
- maximum head = 7 ft.
- Preliminary design (see attached).

Solution:

For a trapezoidal weir



$$Q = CAH^{1/2}$$

$$A = (b + Zy)y$$

where $C \approx 2.8$ (conservative)

$$Z = 2.5$$

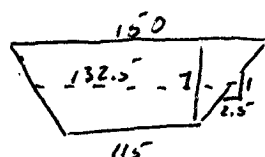
$$y_{max} = 7 \text{ ft}$$

$$b = 115$$

and

$$A = [115 + (2.5)(7)]7 = 927.5 \text{ ft}^2$$

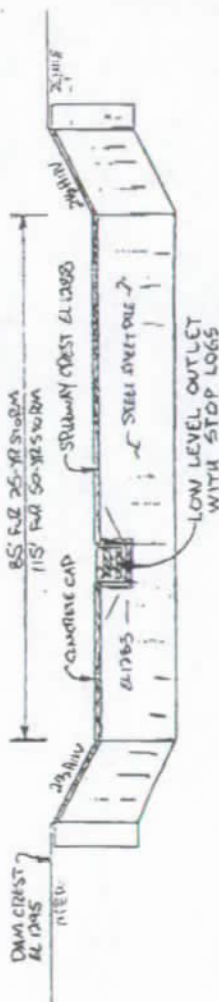
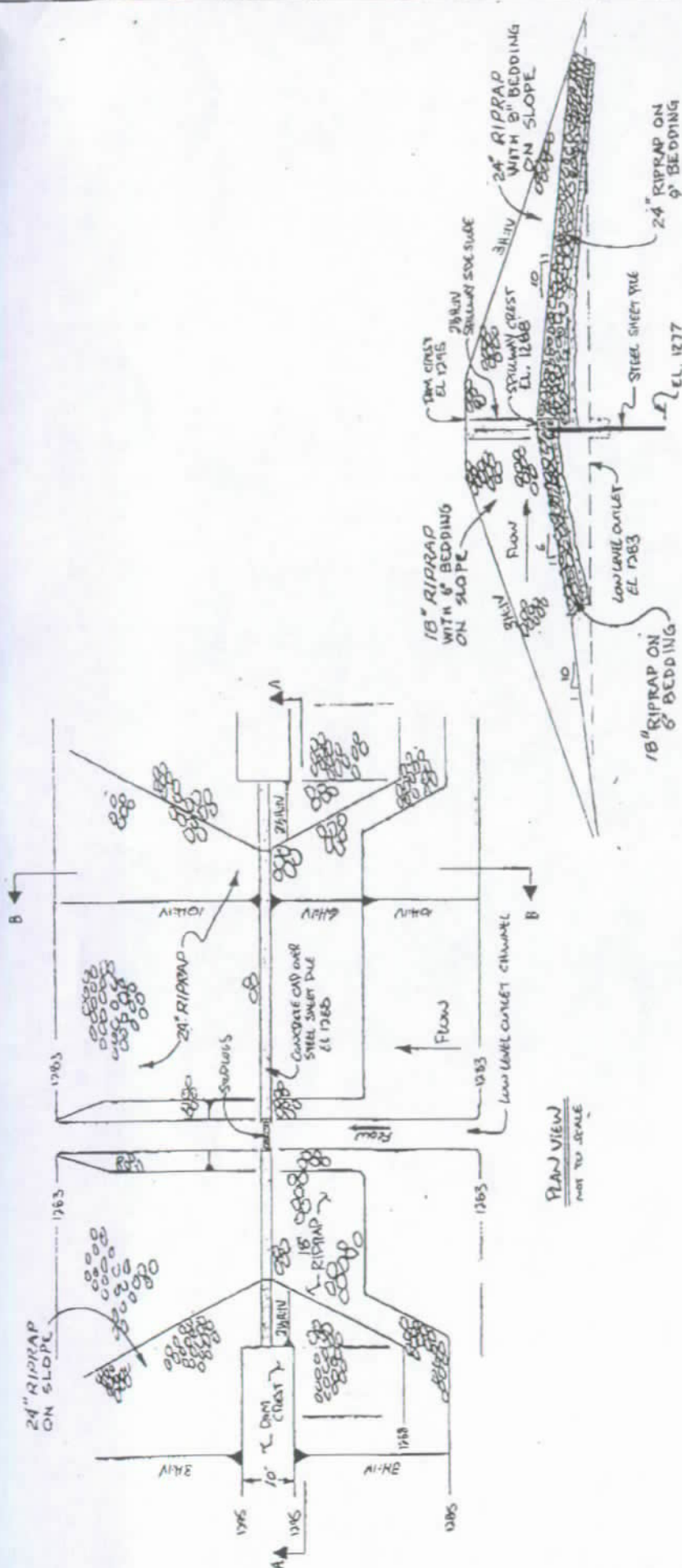
$$Q = 2.8(927.5 \text{ ft}^2)^{1/2} = 6871.0 > 6,370 \text{ ok}$$



$$Q = CLH^{3/2}$$

$$= 2.8(132.5)(7)^{1.5}$$

$$= 6871 \text{ cfs}$$



SECTION B
NOT TO SCALE

Job No. :	09730
Prepared by :	J.D.R.
Date :	2/5/98

CAIN CREEK DAM SPILLWAY ALTERNATIVES
SHEET PILE SPILLWAY WITH
RIPRAP PROTECTION

FIG. 4



**DEPARTMENT of ENVIRONMENT
and NATURAL RESOURCES**

JOE FOSS BUILDING
523 EAST CAPITOL
PIERRE, SOUTH DAKOTA 57501-3181
www.state.sd.us/denr

August 3, 1999

Don Fazzan Jr. P.E.
U.S. Fish & Wildlife Service
Region 6, Engineering
PO Box 25486, DFC
Denver, CO 80225-0486

Dear Mr. Fazzan:

We have reviewed the plans and specifications for the U. S. Fish & Wildlife Service (USFWS) Cain Creek Dam Rehabilitation Project located in the SE ¼ of Section 11-T109N-R62W, in Beadle County. The plans and specifications as submitted are approved. Approval of the plans and specifications does not authorize reconstruction of the dam.

The USFWS currently has a vested water right application pending for the Cain Creek Dam Rehabilitation Project. Approval of these plans and specification is not intended to represent an approval of the vested water right application. In fact, the Water Rights Program believes the best course of action is for the vested water right application to be validated prior to reconstruction of the dam. Additionally, it is our understanding that construction may not begin until the easement transfer agreement between the South Dakota Office of School and Public Land and USFWS is approved.

Our review was to determine compliance with the requirements of the Water Management Board Safety of Dams Rules, Chapter 74:02:08. Approval of these plans and specifications does not release the USFWS, as owner of the dam, from the responsibility for operating and maintaining the dam in good repair to ensure its safety.

The Cain Creek Dam will be classified as a small size Category 3, Low Hazard dam with a dam height of 14 feet, a normal storage capacity of 11 acre-feet and a maximum storage capacity of 260 acre-feet.

If you have any questions, please feel free to contact us.

Sincerely,

Gale N. Selken, P.E.
Natural Resources Engineer IV
for John Hatch, Chief Engineer
Water Rights Program
(605) 773-3352

c: Curt Johnson, Office of School & Public Lands
Cheryl Williss, USFWS, Denver
Mark Heisinger, USFWS, Huron
Diane Best, SD Attorney General Office

D D TO U.S. FISH AND WILDLIF SERVICE

THIS DEED made this 16th day of December, 1994, by and between the UNITED STATES OF AMERICA acting by and through the SECRETARY OF AGRICULTURE represented by the Farmers Home Administration, its successor or assigns, (hereafter "Grantor"), and the UNITED STATES OF AMERICA by and through the SECRETARY OF THE INTERIOR on behalf of the United States Fish and Wildlife Service (hereafter "Grantee"), 18th and "C" Streets, Washington, D.C. 20240.

BY AUTHORITY conferred on the Grantor by Section 354 of the Consolidated Farm and Rural Development Act (7 U.S.C. 2002) providing for the transfer, without reimbursement, of fee title or other interest therein of inventory lands to any Federal or State agency for conservation purposes; and,

THE GRANTOR ACKNOWLEDGES, by this instrument, the determination that the rights of all prior owners and operators of the lands described below have expired, that the land is determined to be suitable or surplus, and that it has marginal value for agricultural production, is environmentally sensitive, or has special management importance, and that this transfer and conveyance comports with and is in furtherance of said authority.

NOW THEREFORE, for and in consideration of the Congressionally mandated purposes as authorized by the above referenced authority and other conservation benefits conferred by the transfer of these lands pursuant to Federal law, the Grantor does hereby transfer and quitclaim to the Grantee the following described lands:

Southeast one-quarter (SE1/4) and the South One-half of the Southwest One-quarter (S1/2SW1/4) of Section Eleven (11) Township One-hundred Nine (109) North, Range Sixty-two (62) West of the 5th Principal Meridian Beadle County, South Dakota.

And being [part of] the same land conveyed from Marshall's Deed to U.S. of America acting through Farmers Home Administration, U.S.D.A. deed dated June 2, 1986, and recorded in Book 432, Page 241 of the land records of Beadle County in the State of South Dakota.

The above described land shall hereafter be administered by the Secretary of the Interior, acting by and through the United States Fish and Wildlife Service, as part of the National Wildlife Refuge system pursuant to the National Wildlife Refuge System Administration Act (16 U.S.C. 668dd, et seq.).

TO HAVE AND TO HOLD, the herein described land unto the Grantee forever.

WITNESS, the signature of the authorized officer of the Grantor.

UNITED STATES OF AMERICA
THE SECRETARY OF AGRICULTURE

By:


DALLAS TONSAGER

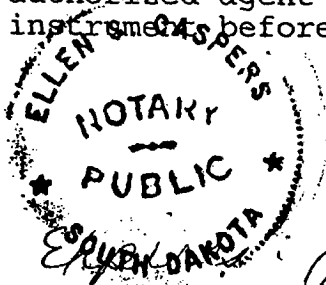
Acting State Director
Rural Economic and Community Development
on behalf of the Farmers Home
Administration, its successor or assigns

☐ TRANSFER FEE PAID \$ _____
☒ EXEMPT FROM TRANSFER FEE

Prepared by: State Loan Technician, FmHA
200 4th Street SW, Room 308
Huron, SD 57350
605-352-1123

State of SOUTH DAKOTA
County of BEADLE, S.S.

I, Ellen S. Caspers, Notary Public in and for the above
State and County do certify that Dallas Tonsager, being duly
authorized agent of the Secretary of Agriculture, did acknowledge this
instrument before me this 16th day of December, 1994.



Ellen S. Caspers
Notary Public

June 27, 1997

INDEXED ☒
RECORDED ☒
COMPARED ☒
GRANTOR ☒
GRANTEE ☒

17458

STATE OF SOUTH DAKOTA)
COUNTY OF BEADLE) SS.
File Dec. 21 1994
at 9 o'clock and 20 minutes
and recorded in Disk 18 # 3026
of the records in my office
Barb Whaley
Register of Deeds
By _____ Deputy
Fees \$7.00 and 2 Pages
U.S. Fish & Wildlife
Fed. Building
Huron

EASEMENT CONTRACT.

THIS AGREEMENT, made and entered into this 4th day of November, 1936, by and between The Travelers Insurance Company of Hartford, Conn., Party of the First Part, and the State of South Dakota, Pierre, South Dakota, Party of the Second Part,

WITNESSETH: That for an in consideration of the sum of One Dollar and other valuable considerations, the receipt whereof is hereby acknowledged, the party of the first part hereby grants, bargains and sells unto the party of the second part the easement and right to build and construct an artificial lake which will flood with water the following described land, in Beadle County, South Dakota, to-wit:

A tract of land Eighteen and Four-tenths (18.4) acres located in creek channel in the SE¹ of Section Eleven (11), Township One Hundred and Nine (109), Range Sixty-two (62), West of the 5th Principal Meridian. Tract of land as shown on attached Plat. A 33 foot strip of land from a point on public highway to the nearest point on the lake.

In addition thereto, the party of the first part hereby grants, bargains and sells to the party of the second part an easement and right to dedicate to the public a strip of land Twelve (12) feet in width lying above the highwater contour of the lake.

It is mutually understood and agreed that if said lake project shall be abandoned, the land herein described and all rights hereunder shall revert to the grantor, his successors and assigns.

In witness whereof, it has hereunto set its hand and seal this 4th day of November, 1936.

{The Travelers Insurance Company}
{Seal}

THE TRAVELERS INSURANCE COMPANY,
By J. L. Howard, Vice President

STATE OF CONNECTICUT, }

ss

COUNTY OF HARTFORD.

On this 7th day of November in the year 1936, before me, the undersigned, a Notary Public in and for said County and State, personally appeared J. L. Howard known to me to be the Vice President of the corporation that is described in and that executed the within instrument, and acknowledged to me that such corporation executed the same.

{F. C. Smith, Notary Public}
{Hartford, Conn. Seal}

F. C. Smith, Notary Public,
Hartford County, Connecticut
My commission expires January 31, 1939.

Filed for record in the office of the Register of Deeds of Beadle County, S. Dak. on the 23rd day of November, 1936, at 2:00 P.M. and recorded in Book 279, Page 178.

By Nora Hopkins, Deputy

Minnie R. McCord, Register of Deeds.

Water Rights Program - DENR
Conversation File Documentation

NAME OF PERSON OR FILE: Vested Water Right Application No. 6130-3, USFWS

ADDRESS: COUNTY:

DATE: 8/17/99 TELEPHONE: 303 236-5321 ext. 223

RE: Vested Water Right application for Cain Creek

COMMENTS:

Cheryl Williss called regarding their vested water right application on Cain Creek. She asked that we proceed with the application. Ms. Williss stated that if we there is any additional information necessary to proceed with the application to give her a call.

She had some question on whether we could validate the vested water right prior to the easement transfer agreement between the SD Office of School and Public Lands and USFWS is approved. I said I did not know the answer to her question.

File in Permit or other file as necessary. Use to document conversations and what the other party was told; why action or decision was made.

NAME: Eric Lundberg

Water Rights Program - DENR
Conversation File Documentation

NAME OF PERSON OR FILE: Vested Water Right Application No. 6130-3, U.S. Fish & Wildlife
Service

ADDRESS: COUNTY: Beadle

DATE: May 24, 1999 TELEPHONE: 303 236-5321 Ext. 238

RE: Call to Ginger Price, USFWS in Denver

COMMENTS:

I contacted Ginger Price to discuss the reconstruction of the Cain Creek Dam WPA. It is there intent to survey the actual capacity once the dam reconstruction is complete. I explained that since this was a vested water right application which is to represent historic conditions, we are concerned over some of the inconsistencies in the amount of water being claimed. For example:

What acre-foot amount qualifies for vested status

- ◆ Application states 129 acre feet (100 ac-ft storage – 29 ac-ft seasonal)
- ◆ Affidavit states between 15 – 100 ac-ft
- ◆ Woodward Clyde on Cain Creek dam survey states two different storage quantities – 14 ac-ft and 11 ac-ft in another place

I also stated the proposed surface area of the impoundment is inconsistent in the application.

- Woodward Clyde report - estimates surface area of 3 acres
- Surface area on application states 26 acres (that's how the seasonal quantity was calculated)
- Dot count on quad submitted with application – 4 acres
- Dot count of ASCS aerial 5 – 10 acres

Ginger Price stated that they used the 100 ac-ft on the application thinking that like standard new water permit the amount would just be reduced to actual storage capacity during licensing. However, she realized now that this being a vested water right that the amount to be validated is the amount historically impounded. She was going to do some more checking and get back to me.

I also discussed the problems that could occur with constructing the impoundment prior to having the vested water right in place. I explained someone could petition and question the quantity or the continuous use of the structure (ie. whether it was breached for greater than 3 years in the past).

Finally, she stated they have hit a snag since the dam is owned by SD School & Public Lands although USFWS owns the land around the dam. Supposedly SP&L is not allowed to transfer a dam in disrepair and USFWS can not provide the funds to repair someone else's dam. They are working to iron out those problems.

File in Permit or other file as necessary. Use to document conversations and what the other party was told; why action or decision was made.

NAME: 

REPORT ON
VESTED WATER RIGHT APPLICATION NO. 6130-3
US Fish & Wildlife Service
August 18, 1999

Vested Water Right Application No. 6130-3 has been filed by the US Fish & Wildlife Service (USFWS) to reconstruct Cain Creek Dam located in the SE ¼ of Section 11-T109N-R62W, in Beadle County. Vested Water Right Application No. 6130-3 authorizes a dam with a storage capacity of 11 acre-feet of water and sufficient water annually to maintain the water level at the primary spillway elevation of 1288 feet mean sea level (fmsl). The water will be used for fish and wildlife propagation.

Discussion:

Cain Creek Dam was originally constructed in 1939, by the Works Progress Administration (WPA). Spring runoff in 1997, overtopped the embankment crest and caused a partial failure of the dam. The USWFS acquired a deed to the SE ¼ and the S ½ SW ¼ of Section 11-T109N-R62W in 1994, and manage the property as a Waterfowl Production Area. Their proposed repair to Cain Creek Dam will establish the normal reservoir level at the same elevation (1288 fmsl) as the original dam.

The reconstructed Cain Creek Dam will be classified as a Category 3, Low Hazard dam. The proposed repair has been designed by URS Greiner Woodward-Clyde and the plans and specifications have been reviewed and approved; however, it is recommended that reconstruction of the dam not begin until Vested Water Right Application No. 6130-3 is approved.

The Cain Creek Dam will be 14 feet high with a normal storage capacity of 11 acre-feet with a reservoir level at the primary spillway elevation, and a maximum storage capacity of 260 acre-feet with a reservoir level at the top of dam elevation. A dam of this size and hazard classification is required to have a minimum spillway design capable of passing a 50-year frequency event.

Cain Creek Dam has a drainage area of 215 square miles. Woodward-Clyde used the Corps of Engineers HEC-1 model to route a 50-year frequency event for this drainage area, which produced a peak of 6370 cfs. The reconstructed Cain Creek Dam is designed to have a 115 foot wide steel sheet pile weir with 7 feet of available head as the primary spillway structure. This structure has a capacity to pass approximately 6870 cfs before overtopping the dam embankment.

Cain Creek Dam is located on Cain Creek about four miles upstream of its confluence with the James River. There are no existing Water Permits/Rights located on Cain Creek between the dam and the James River.

Conclusions:

1. Vested Water Right Application No. 6130-3 should be approved since water has been appropriated since 1939, and approval should not have any adverse effect on existing Water Permits/Rights.


Timothy G. Schaal, P.E.
Natural Resources Engineer III

Approved by:

Gale N. Selken, P.E.
Natural Resources Engineer IV

RECOMMENDATION OF CHIEF ENGINEER FOR VALIDATION OF VESTED WATER
RIGHT APPLICATION NO. 6130-3, U. S. Fish and Wildlife Service

Pursuant to SDCL 46-2A-2, the following is the recommendation of the Chief Engineer, Water Rights Division, Department of Environment and Natural Resources concerning Validation of Vested Water Right Application No. 6130-3, U. S. Fish and Wildlife Service, c/o Cheryl Williss, P.O. Box 25486, Denver Federal Center, Denver CO 80225.

The Chief Engineer is recommending VALIDATION of Application No. 6130-3 for 11.0 acre feet of water because 1) water has been appropriated as described for fish and wildlife use with a priority date of December 31, 1939, 2) the use has been developed without unlawful impairment of existing rights, 3) the use is a beneficial use and 4) it is in the public interest with the following qualification:

Vested Water Right No. 6130-3 is validated for a dam with storage capacity of 11.0 acre feet of water and sufficient water annually to maintain the water level to the outlet elevation of 1288 feet mean sea level.

See report on application for additional information.

A handwritten signature in cursive script, appearing to read "John Hatch".

JOHN HATCH, Chief Engineer
August 24, 1999



**DEPARTMENT of ENVIRONMENT
and NATURAL RESOURCES**

JOE FOSS BUILDING
523 EAST CAPITOL
PIERRE, SOUTH DAKOTA 57501-3181
www.state.sd.us/denr

NOTE: TO BE SURE OF PUBLICATION ON
THE CORRECT DATES, CONTACT
THE NEWSPAPER RIGHT AWAY.

August 25, 1999

US Fish & Wildlife Service
%Cheryl Williss
P.O. Box 25486, DFC
Denver, CO 80225

Dear Ms. Williss:

Water Permit Application No. 6130-3 for fish and wildlife propagation has been examined and found to comply with the South Dakota Water Laws and applicable rules. A notice of hearing has been sent to the Publisher of the Plainsman printed at Huron, SD (Ph # (605) 352-6401). For your information, a copy of the notice, the recommendation of the Chief Engineer and a report on the application are enclosed. Please review the notice prior to publication and notify this office, if you have any corrections or questions.

Be sure to contact the above newspaper to authorize publication of your Notice of Hearing and to arrange for payment. Early contact with the paper can eliminate delays. The publisher has been instructed to publish your notice once each week for two consecutive weeks with the last publication to occur twenty days before the board meeting. The newspaper has been instructed to send us the Proof of Publication. We must receive Proof of Publication before action can be taken on the application.

Sincerely,


Eric Gronlund
Natural Resources Engineer
(605) 773-3352

enclosures

NOTE: If you plan to contest any part of the Chief Engineer's recommendation, you must file a petition pursuant to the procedures outlined in the attached notice of hearing. The Water Management Board will then consider your concerns during a hearing on the application.



DEPARTMENT of ENVIRONMENT
and NATURAL RESOURCES

JOE FOSS BUILDING
523 EAST CAPITOL
PIERRE, SOUTH DAKOTA 57501-3181
www.state.sd.us/denr

August 25, 1999

The Plainsman
P.O. Box 1278
Huron, SD 57350-1278

ATTENTION: Legal Public Notice

Enclosed is a Notice of Hearing on Application No. 6130-3 to Appropriate Water to be published twice. Please publish the first notice on August 31, 1999, with the second publication 7 days later.

The applicant must verify to you that the notice is to be published, before you make the first publication. **Please BILL the APPLICANT for the cost of publication.** The APPLICANT is US Fish & Wildlife Service, %Cheryl Williss, P.O. Box 25486, DFC, Denver, CO 80225 (Ph # (605) 236-5321).

Please send the Water Rights Program the first publication immediately. The publication is checked for accuracy so any corrections can be made in the second publication. You may use the form below or fax a copy of the first publication. Any fax should be sent to the attention of Karen Schlaak at (605) 773-4068. Publication errors can invalidate the public notice.

After the second publication, **please send us an affidavit or use the enclosed Proof of Publication form.** The applicant pays the cost of publication, but the Water Rights Program records require an affidavit or Proof of Publication. Delays in receiving the affidavit can be costly to the applicant.

Sincerely,


Eric Gronlund
Natural Resources Engineer
605 773-3352

enclosures

-----CU T HERE-----

No. 6130-3

TO: Eric Gronlund
Water Rights Program
Joe Foss Building
Pierre SD 57501-3181

Date _____

We are in receipt of your letter of August 24, 1999, enclosing Notice of Hearing to Appropriate Water by Application No. 6130-3 which was first published in our issue of _____. ENCLOSED IS A COPY OF THIS FIRST PUBLICATION.

Name

Newspaper

Instruction to Newspaper - Publish first Notice on August 31, 1999, with the second publication 7 days later. The applicant is responsible for payment.

NOTICE To Validate
Vested Water Right Application No. 6130-3 to Appropriate Water

Notice is given that the US Fish & Wildlife Service, PO Box 25486, Denver Federal Center, Denver CO 80225 has filed an application to validate a vested water right claim to appropriate 11.0 acre-feet of water by reconstructing a dam. The structure stores 11.0 acre feet of water at normal service outlet elevation. The dam is located in the SE ¼ SE ¼ Section 11 with water impounded in the E ½ SE ¼ Section 11; all in T109N-R62W. Water is used to provide habitat for fish and wildlife propagation. The water use has a claimed priority date of December 31, 1939. The dam is undergoing repair work due to flooding in 1997 and normal maintenance.

Pursuant to SDCL 46-2A-2, the Chief Engineer recommends VALIDATION of Vested Water Right Application No. 6130-3 because 1) water has been appropriated as described to provide habitat for fish and wildlife propagation with a claimed priority date of December 31, 1939, 2) the use has been developed without unlawful impairment of existing rights, 3) it is a beneficial use of water, and 4) it is in the public interest. In accordance with SDCL 46-2A-23, the Chief Engineer will act on the application, as recommended, unless a petition is filed opposing the application or the applicant files a petition contesting the Chief Engineer's recommendation. If a petition opposing the application or contesting the recommendation is filed, then a hearing will be scheduled and the Water Management Board will consider the application. Notice of the hearing will be given to the applicant and any person filing a petition.

Any person interested in opposing or supporting this application or recommendation must file a written petition with BOTH the applicant and Chief Engineer. The applicant must file a petition if contesting the Chief Engineer's recommendation. The Chief Engineer's address is "Water Rights Program, Foss Building, 523 E Capitol, Pierre SD 57501 (605 773-3352)" and the applicant's mailing address is given above. A petition filed by either an interested person or the applicant must be filed by September 17, 1999.

The petition may be informal, but must include a statement describing the petitioner's interest in the application, the petitioner's reasons for opposing or supporting the application, and the signature and mailing address of the petitioner or the petitioner's legal counsel, if legal counsel is obtained. Contact Eric Gronlund at the above Water Rights Program address to request copies of information pertaining to this application. Nettie H. Myers, Secretary, Department of Environment and Natural Resources.

PRINTER'S AFFIDAVIT

STATE OF SOUTH DAKOTA,
COUNTY OF BEADLE: ss.

I, Connie Nelson, being duly sworn on oath, say that THE PLAINSMAN is a daily paper published at Huron, Beadle County, South Dakota, and that said newspaper has a bona fide circulation of at least 250 copies daily; that said newspaper has been published within said county for fifty-two consecutive weeks immediately prior to this date, that said newspaper is printed in whole or in part, in an office maintained at said place of publication; that I am Legal Advertising Coordinator of said newspaper and know the facts herein state. The annexed notice headed:

SD Dept. of Environment & Natural Resources, Notice to Validate Vested Water Right

was published for two weeks, once each week, the same day each week, in said newspaper, and not in any supplement of the said newspaper, the publication was on 31st day of August, 1999, and the last publication on the 7th day of September 1999. That the full amount of the fee charged for publishing the same, to wit: Ninety and 00/100 Dollars inures to the benefit of the publisher of said newspaper; that no agreement or understanding for the division thereof has been made with any other person, and that no part thereof has been agreed to be paid to any person whomsoever.

Connie Nelson

Subscribed and sworn to before me this 7th day of

September, 1999.

Gloria Fraser
Notary Public, South Dakota

My term expires 7/15/2004

Legal #344



F.P. 8-31-99 L.P. 9-7-99
NOTICE TO VALIDATE VESTED WATER RIGHT
APPLICATION NO. 6130-3 TO APPROPRIATE WATER
Notice is given that the US Fish & Wildlife Service, PO Box 25486, Denver Federal Center, Denver CO 80225 has filed an application to validate a vested water right claim to appropriate 11.0 acre-feet of water by reconstructing a dam. The structure stores 11.0 acre-feet of water at normal service outlet elevation. The dam is located in the SE 1/4 SE 1/4 Section 11 with water impounded in the E 1/2 SE 1/4 Section 11; all in T109N-R62W. Water is used to provide habitat for fish and wildlife propagation. The water use has a claimed priority date of December 31, 1939. The dam is undergoing repair work due to flooding in 1997 and normal maintenance.
Pursuant to SDCL 46-2A-2, the Chief Engineer recommends VALIDATION of Vested Water Right Application No. 6130-3 because 1) water has been appropriated as described to provide habitat for fish and wildlife propagation with a claimed priority date of December 31, 1939, 2) the use has been developed without unlawful impairment of existing rights, 3) it is a beneficial use of water, and 4) it is in the public interest. In accordance with SDCL 46-2A-23, the Chief Engineer will act on the application, as recommended, unless a petition is filed opposing the application or the applicant files a petition contesting the Chief Engineer's recommendation. If a petition opposing the application or contesting the recommendation is filed, then a hearing will be scheduled and the Water Management

Board will consider the application. Notice of the hearing will be given to the applicant and any person filing a petition.

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The petition may be informal, but must include a statement describing the petitioner's interest in the application, the petitioner's reasons for opposing or supporting the application, and the signature and mailing address of the petitioner or the petitioner's legal counsel, if legal counsel is obtained. Contact Eric Gronlund at the above Water Rights Program address to request copies of information pertaining to this application. Nettie H. Myer, Secretary, Department of Environment and Natural Resources.

No. 344 (adv.)







**DEPARTMENT of ENVIRONMENT
and NATURAL RESOURCES**

JOE FOSS BUILDING
523 EAST CAPITOL
PIERRE, SOUTH DAKOTA 57501-3181
www.state.sd.us/denr

SEP 27 1999

VR 6130-3

U.S. Fish & Wildlife Service
%Cheryl Williss
P.O. Box 25486
Denver Federal Center
Denver, CO 80225

Dear Ms. Williss:

Enclosed are your Validated Vested Water Right and Water License No. 6130-3. As long as you use the water beneficially, as stated in the Water License, the State Water Laws provide that you have a continuing right to use the water.

Very truly yours,

JOHN HATCH, Chief Engineer
Water Rights Program
(605) 773-3352

enclosures



U.S. FISH & WILDLIFE SERVICE

HURON WETLAND MANAGEMENT DISTRICT

CAIN CREEK DAM REHABILITATION

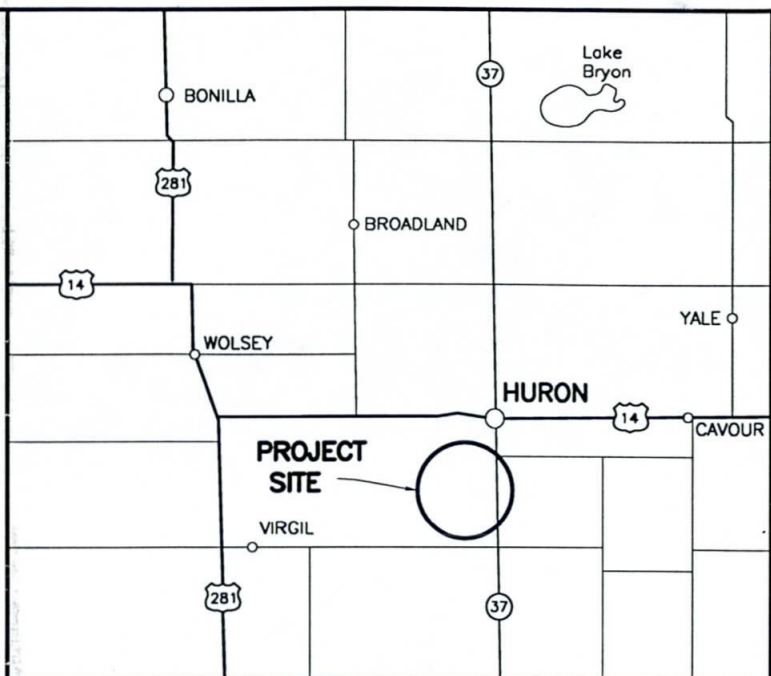


PROJECT SITE

STATE HIGHWAY 37

LOCATION MAP

NO SCALE



VICINITY MAP

NO SCALE

DRAWING INDEX

SHEET NO.	TITLE
1 OF 9	VICINITY MAP, LOCATION MAP, AND DRAWING INDEX
2 OF 9	GENERAL PLAN VIEW AND TOPOGRAPHY
3 OF 9	DETAILED TOPOGRAPHY & PROFILE ON CREST
4 OF 9	SPILLWAY PLAN AND SECTIONS
5 OF 9	TYPICAL SECTIONS AND DETAILS
6 OF 9	EMERGENCY SPILLWAY CROSS SECTIONS
7 OF 9	STOPLOGS AND DETAILS
8 OF 9	EXISTING EMBANKMENT PHOTOGRAPHS
9 OF 9	EXISTING EMBANKMENT PHOTOGRAPHS

NOTE TO BIDDERS:

ANY PRINT ACCOMPANYING THIS INVITATION TO BID MAY BE A REDUCED REPRODUCTION OF THE WORKING DRAWINGS. IF LINE BELOW DOES NOT MEASURE SIX INCHES IN LENGTH, THE INDICATED SCALES ARE TO BE ADJUSTED ACCORDINGLY.



UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
REGION 6 ENGINEERING - DENVER, COLORADO

SUBMITTED DATE 3/18/99 REGIONAL ENGINEER RECOMMENDED DATE 3/18/99 APPROVED DATE 3/18/99 ASS'T. REGIONAL DIR.	REGIONAL ENGINEER WETLAND MANAGEMENT DISTRICT BEADLE COUNTY SOUTH DAKOTA CAIN CREEK DAM REHABILITATION VICINITY MAP, LOCATION MAP, AND DRAWING INDEX DESIGNED: D. FAZZAN DRAWN: D. FAZZAN CHECKED: J. MIYAKE DATE: 02/99 DRAWING No. 6R-SO-638-2.0 SHEET 1 OF 9
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6/30-3