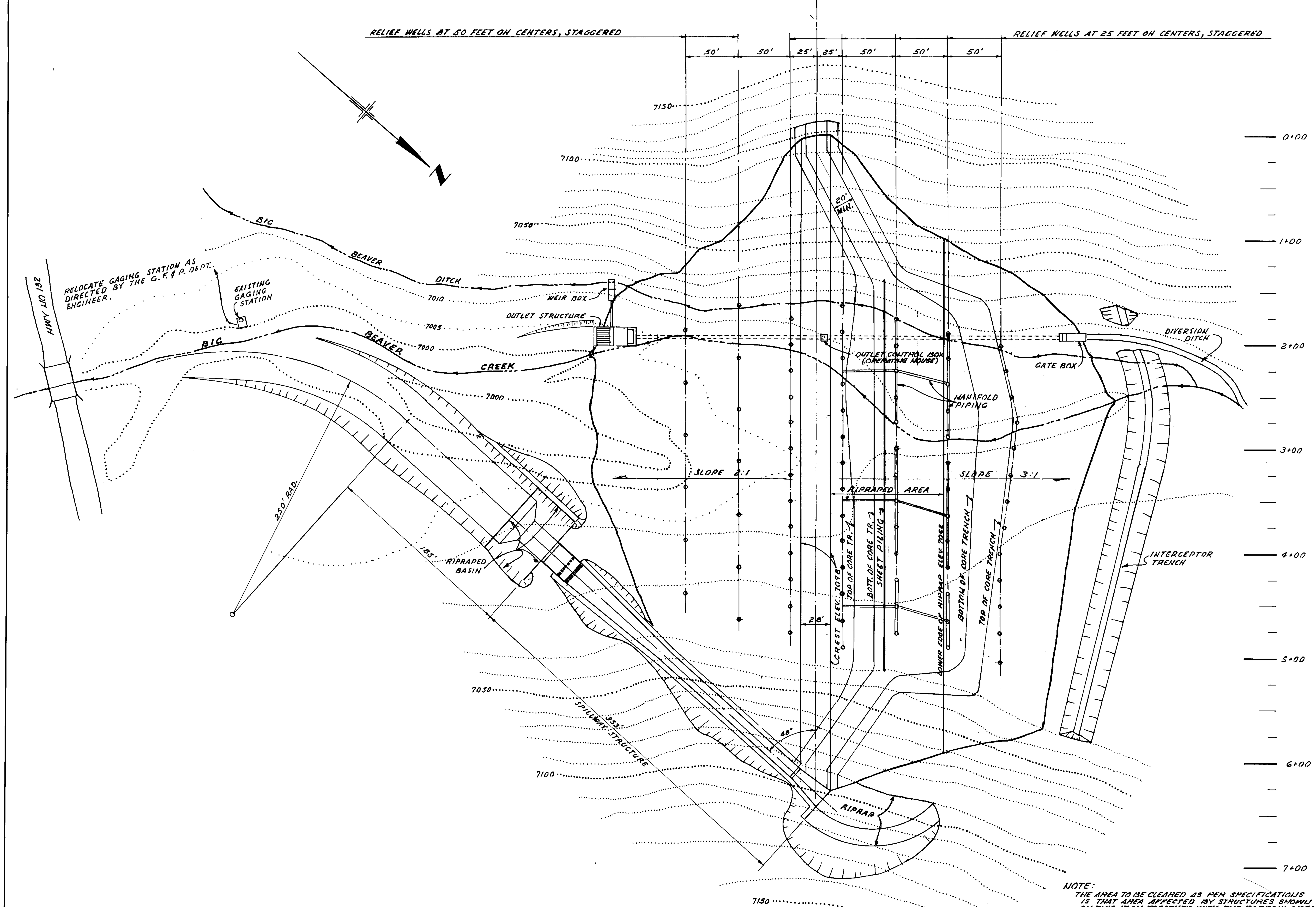
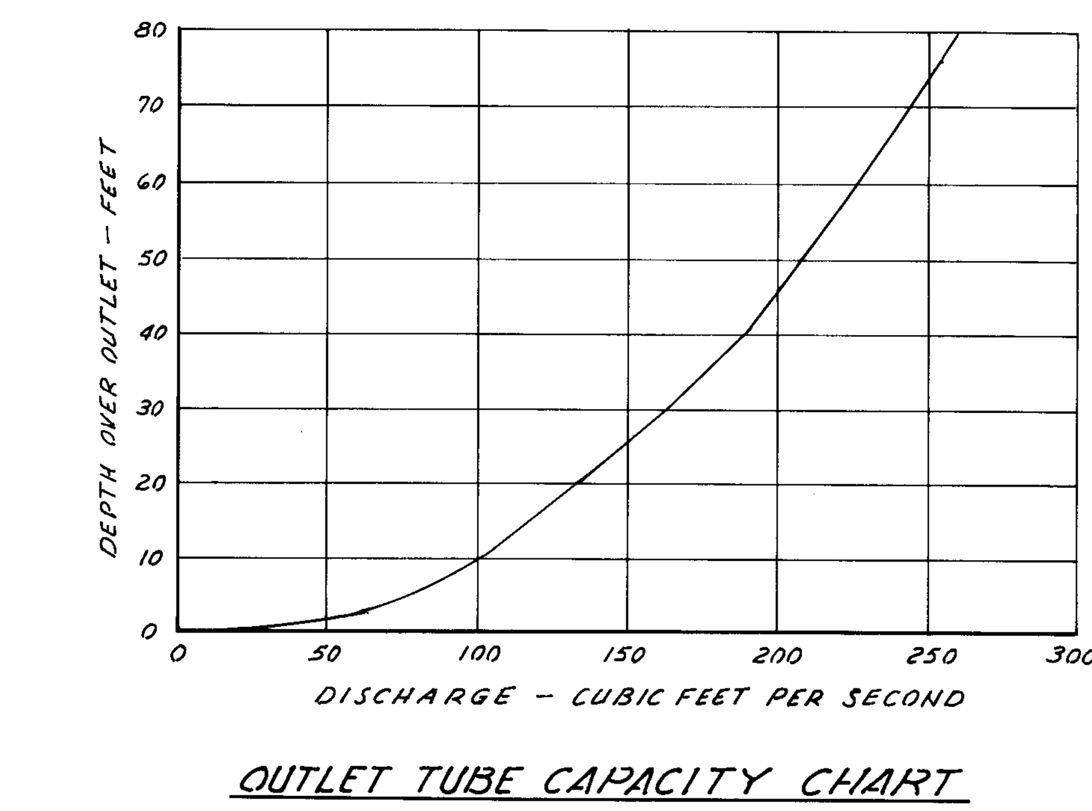
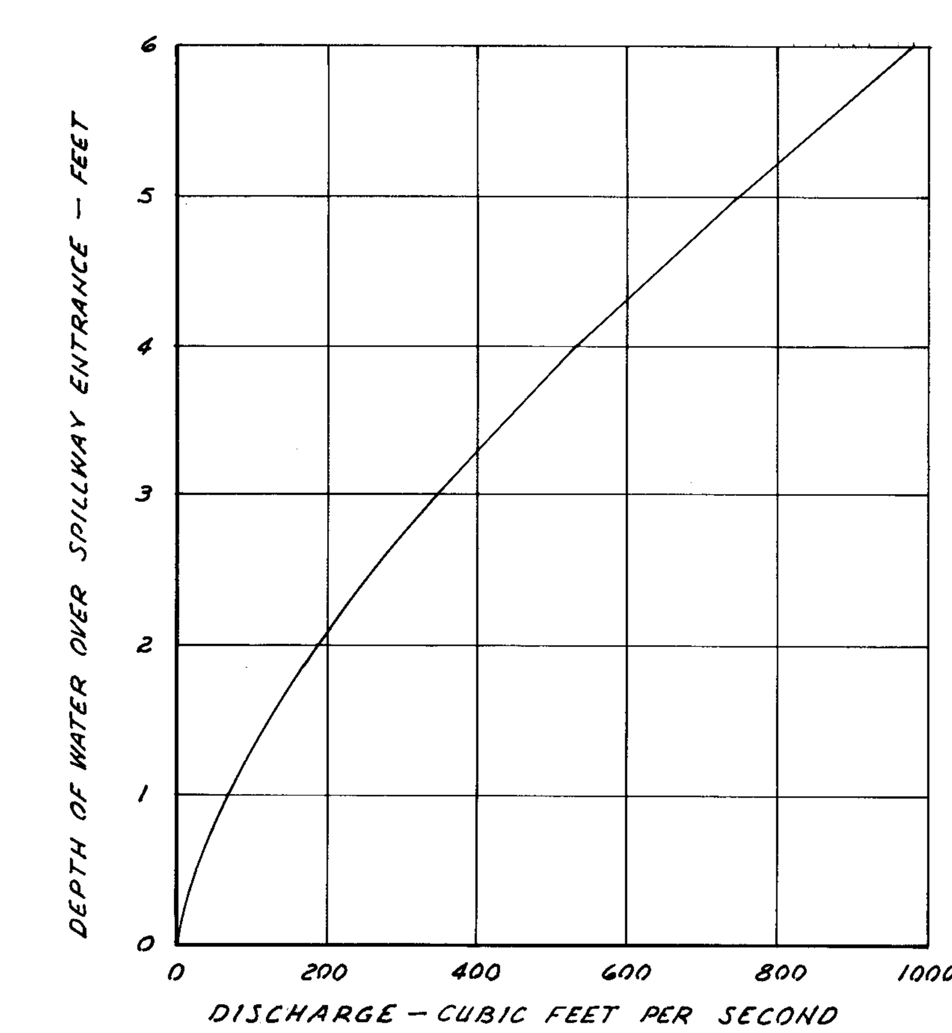


PLAN OF RESERVOIR DAM & SPILLWAY AREA

1" = 50'



OUTLET TUBE CAPACITY CHART



SPILLWAY CAPACITY CHART

PLAN OF RESERVOIR DAM & SPILLWAY AREA OUTLET TUBE CAPACITY CHART SPILLWAY CAPACITY CHART		
IRRIGATION DIVISION NO. 6 WATER DISTRICT NO. 43 RIO BLANCO COUNTY COLORADO	BIG BEAVER CREEK RESERVOIR DAM COLORADO GAME, FISH AND PARKS DEPARTMENT 6060 BROADWAY DENVER, COLORADO	
	EUGENE L. PADON CONSULTING ENGINEER 6415 W 44TH AVE • WHEATRIDGE, COLO. • 424-6431	SHEET NO 2 OF 8
	DRAWN: AZ · DATE: · SCALE: AS SHOWN · FILE NO:	JOB NO 6416

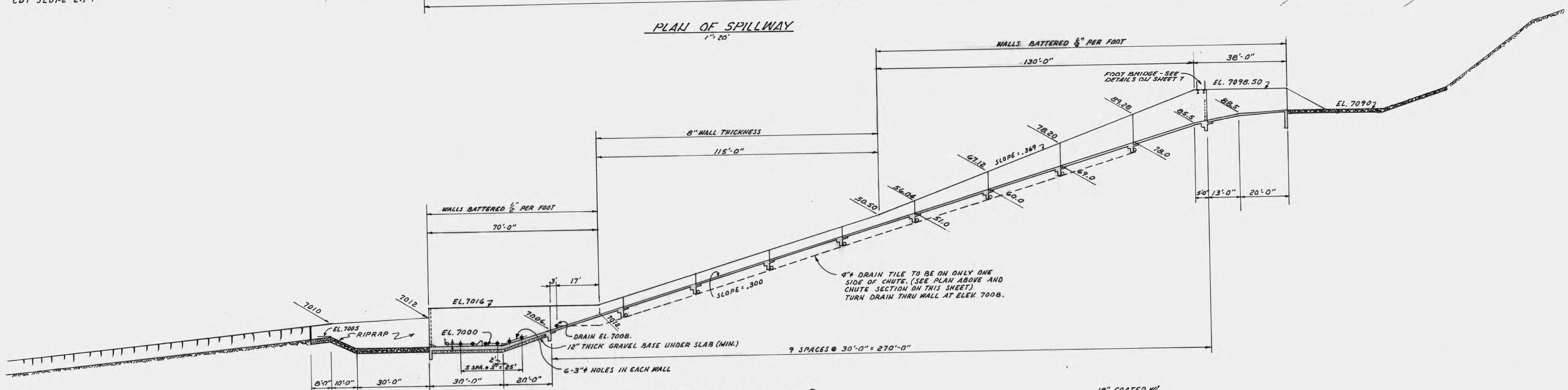
APPROVED ON THE 27TH DAY OF AUGUST 1964.

J. E. WHITTEN
STATE ENGINEER

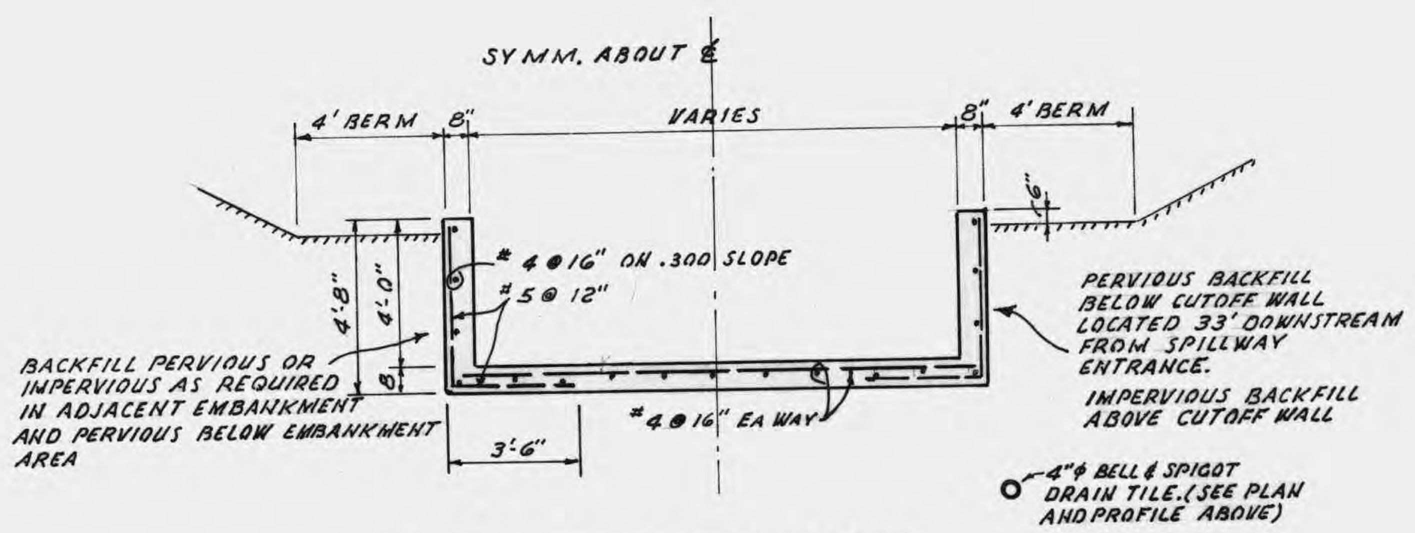
BY: [signature]
DEPUTY

C-1122

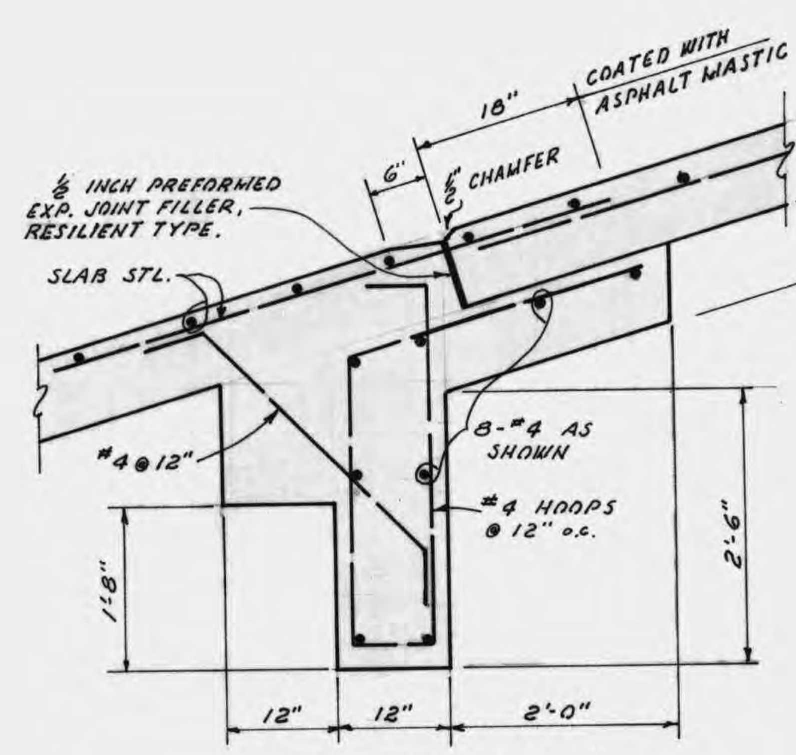
PLAN OF SPILLWAY
1" = 20'



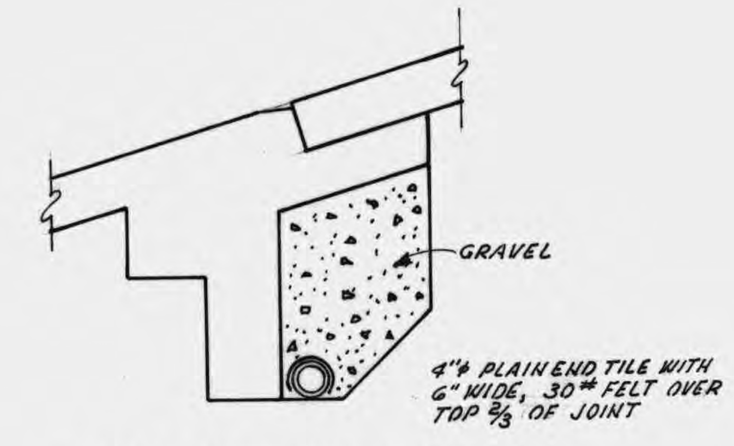
SPILLWAY SECTION ON ℄
1" = 20'



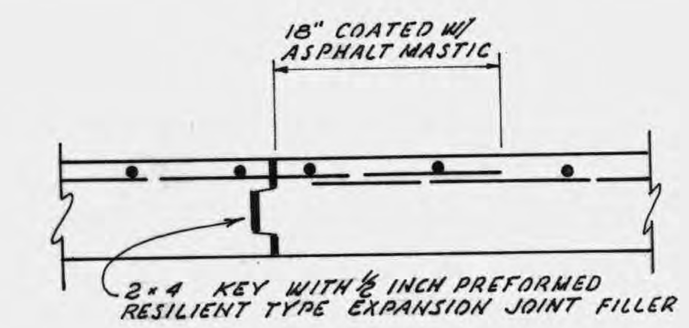
TYPICAL SECTION OF CHUTE
1/4" = 1'-0"



SLIDE KEY DETAIL
3/4" = 1'-0"



SLIDE KEY WITH DRAIN
1/2" = 1'-0"



TYPICAL WALL KEY
NO SCALE

PLAN & SECTION OF SPILLWAY - TYPICAL CHUTE SECTION
SLIDE KEY DETAIL - SLIDE KEY WITH DRAIN - TYPICAL WALL KEY

IRRIGATION DIVISION NO. 6	BIG BEAVER CREEK RESERVOIR DAM
WATER DISTRICT NO. 43	COLORADO GAME, FISH AND PARKS DEPARTMENT 6060 BROADWAY DENVER, COLORADO
RIO BLANCO COUNTY COLORADO	EUGENE L. PADON CONSULTING ENGINEER 6615 W. 44TH AVE. • WHEATRIDGE, COLO. • 424-6231 SHEET NO. 5 OF 8 DRAWN: A.Z. · DATE · SCALE: AS SHOWN · FILE NO. · JOB NO. 6616

APPROVED ON THE 27TH DAY OF August 1964.

J. E. WHITTEN
STATE ENGINEER
BY: [signature]
DEPUTY

C-1122

GATE STRUCTURE DETAILS-OUTLET STRUCTURES DETAILS
OPERATING HOUSE, WEIR BOX & CLEANOUT COVER DETAILS

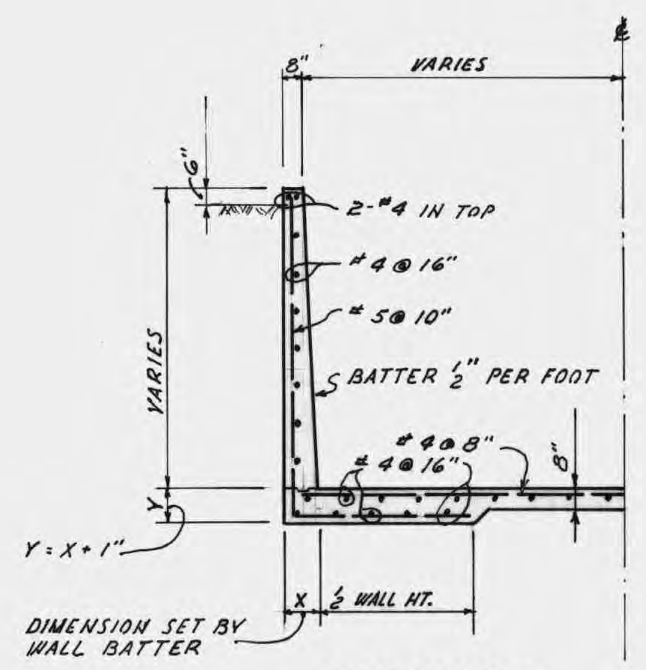
IRRIGATION DIVISION NO. 6 WATER DISTRICT NO. 43 RIO BLANCO COUNTY COLORADO	BIG BEAVER CREEK RESERVOIR DAM			
	COLORADO GAME, FISH AND PARKS DEPARTMENT 6060 BROADWAY DENVER, COLORADO			
	EUGENE L. PADON CONSULTING ENGINEER 6415 W 44TH AVE • WHEATRIDGE, COLO • 424-6431			SHEET NO. 4 OF 8
	DRAWN A.Z.	DATE	SCALE AS SHOWN	FILE NO / JOB NO. 6416

APPROVED ON THE 27TH DAY OF AUGUST 1964.

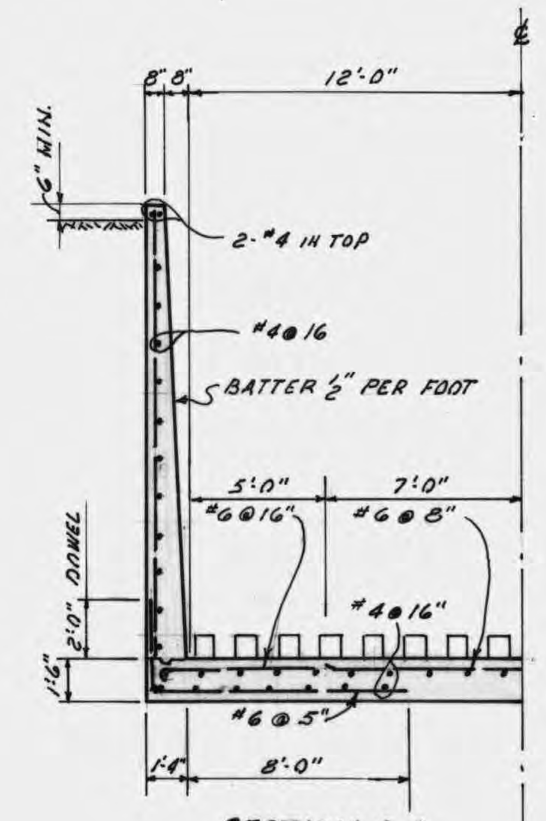
J. E. WHITTEN
STATE ENGINEER

BY: [signature]
DEPUTY

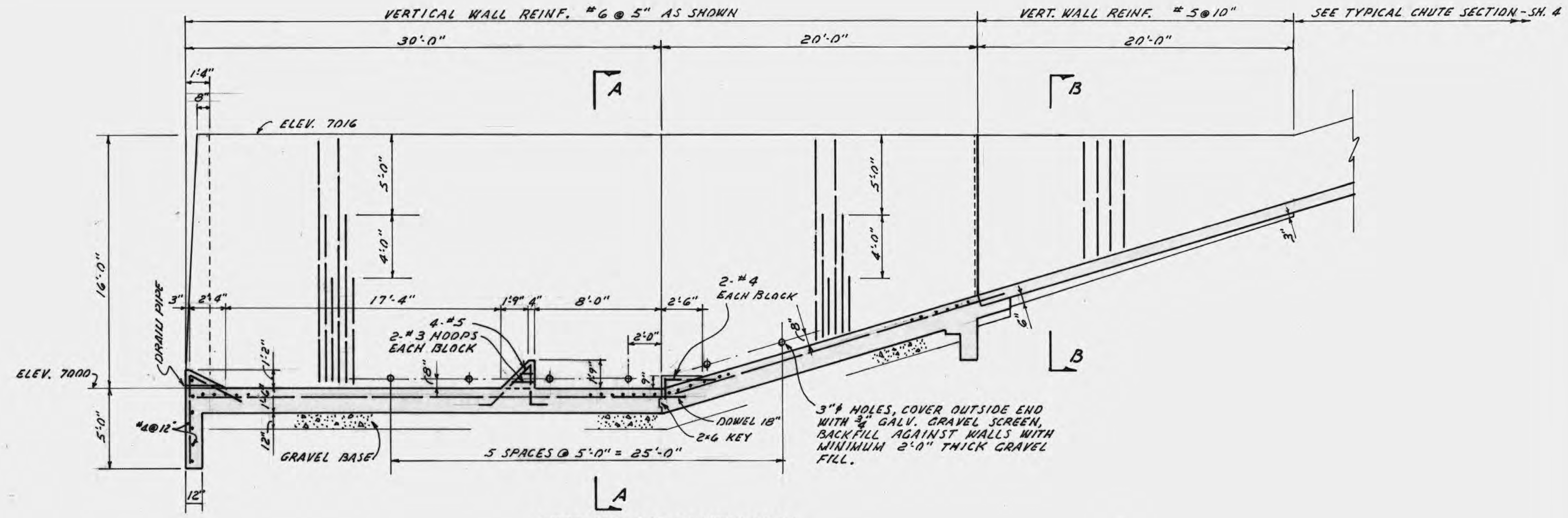
C-1122



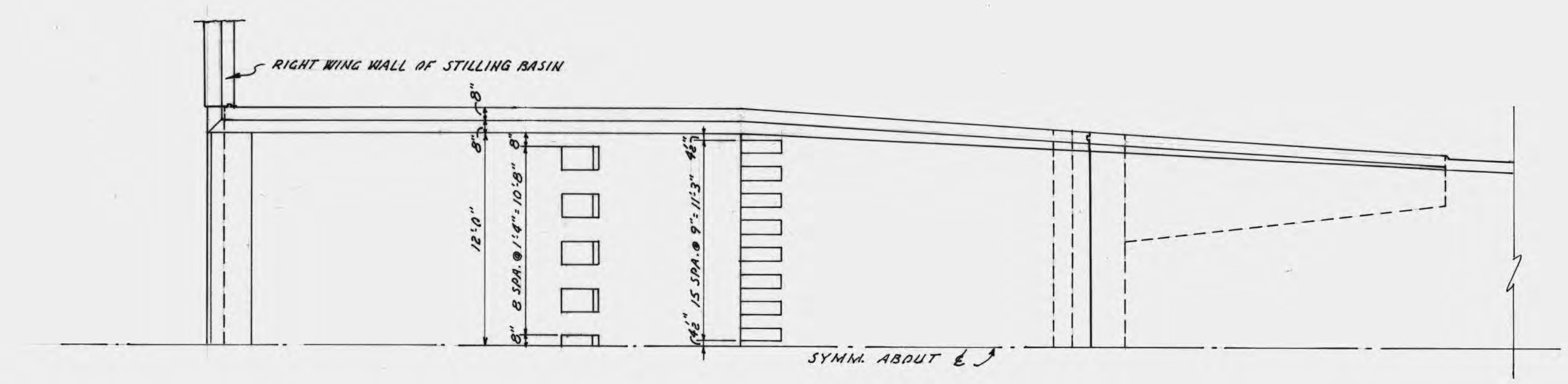
SECTION B-B
3/16" = 1'-0"



SECTION A-A
3/16" = 1'-0"

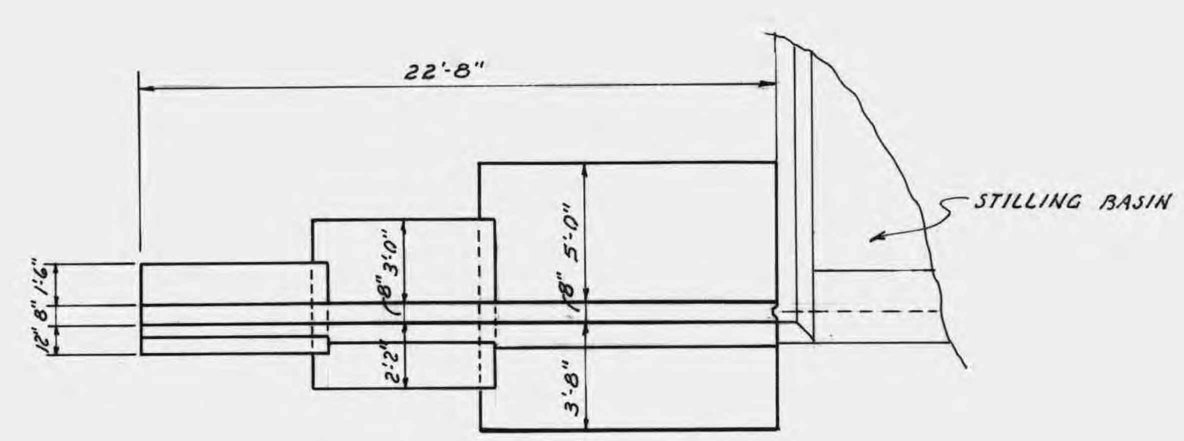


SECTION ON CENTERLINE

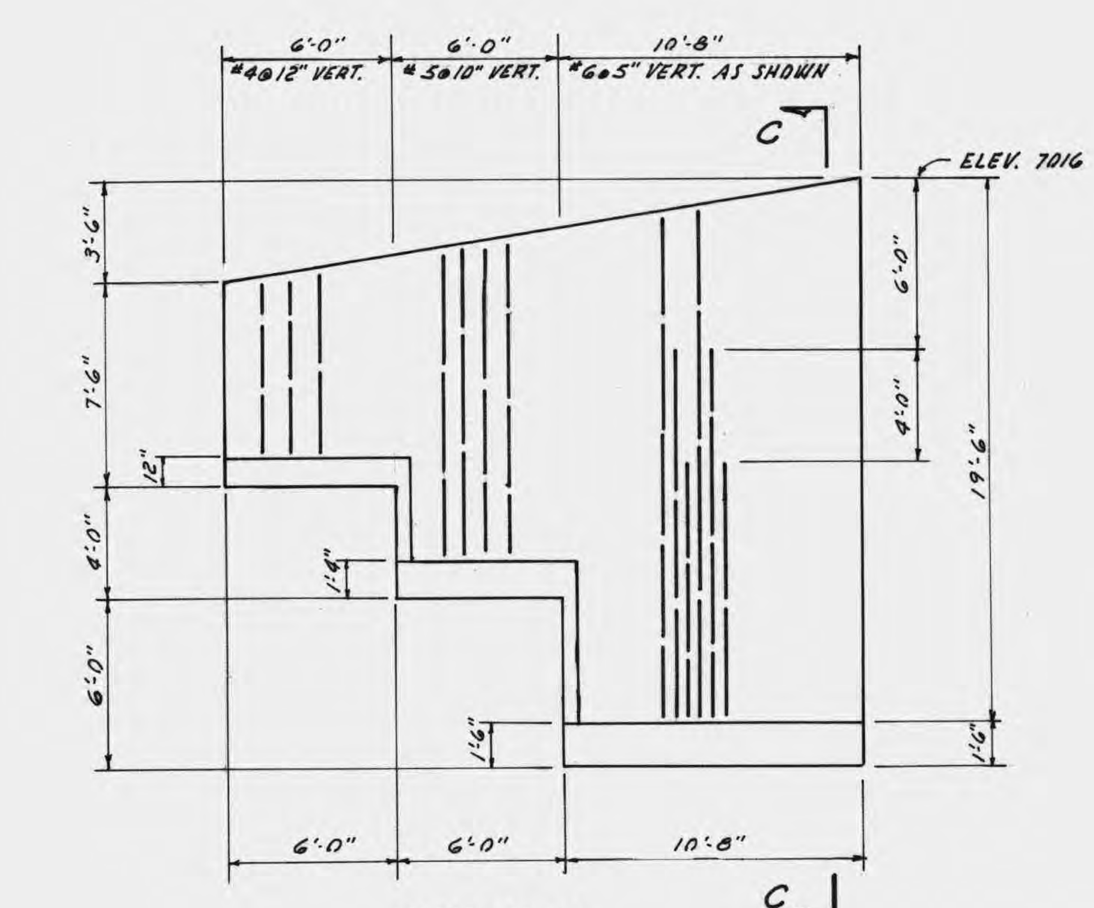


HALF PLAN

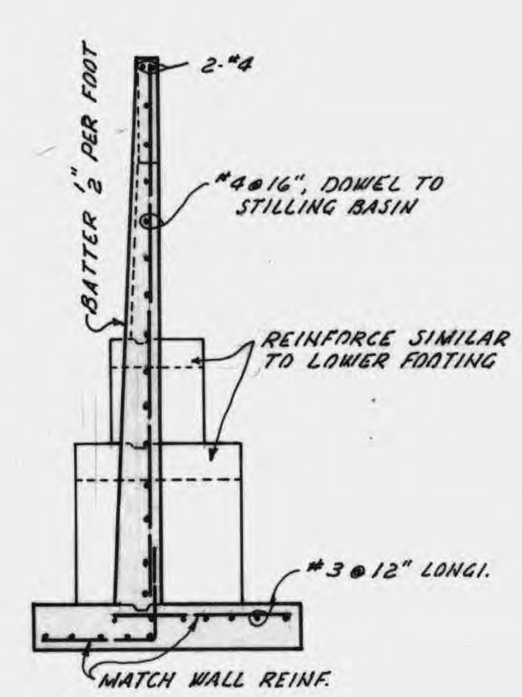
STILLING BASIN DETAILS
3/16" = 1'-0"



PLAN



ELEVATION



SECTION C-C

STILLING BASIN WING WALL DETAIL (RIGHT SIDE)
(MAKE LEFT WING WALL OPPOSITE HAND)
3/16" = 1'-0"

STILLING BASIN DETAILS
STILLING BASIN WING WALL DETAIL

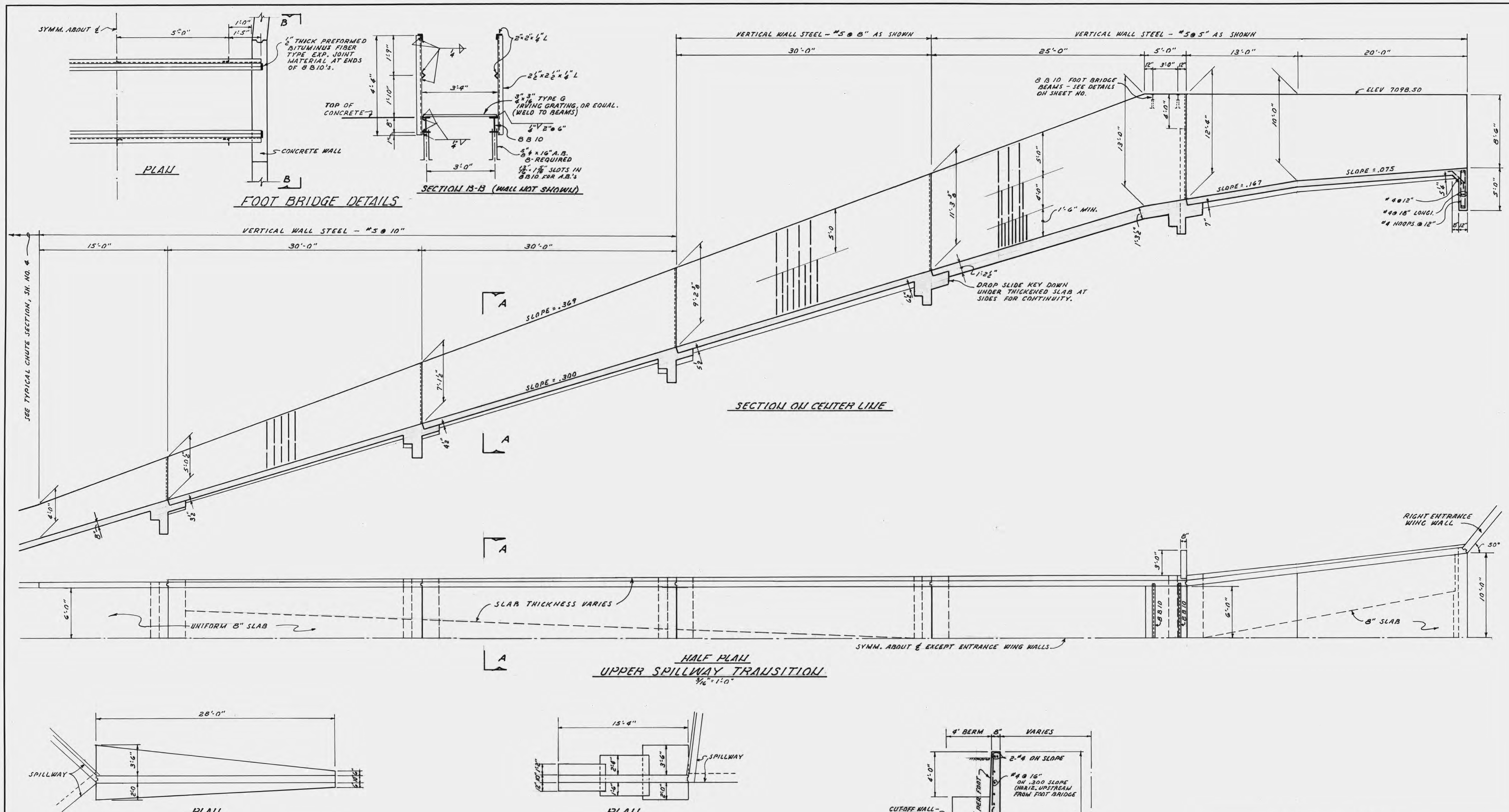
IRRIGATION DIVISION NO. 6
WATER DISTRICT NO. 43
RIO BLANCO COUNTY COLORADO

BIG BEAVER CREEK RESERVOIR DAM
COLORADO GAME, FISH AND PARKS DEPARTMENT
6060 BROADWAY DENVER, COLORADO
EUGENE L. PADON
CONSULTING ENGINEER
6415 W 44TH AVE • WHEATRIDGE, COLO • 424-6631

DRAWN	DATE	SCALE	FILE NO.	SHEET NO.	JOB NO.
AZ		AS SHOWN		6 OF 8	6416

APPROVED ON THE 27TH DAY OF AUGUST 1964.
J. E. WHITTEN
STATE ENGINEER
BY: [signature]
DEPUTY

C-1122



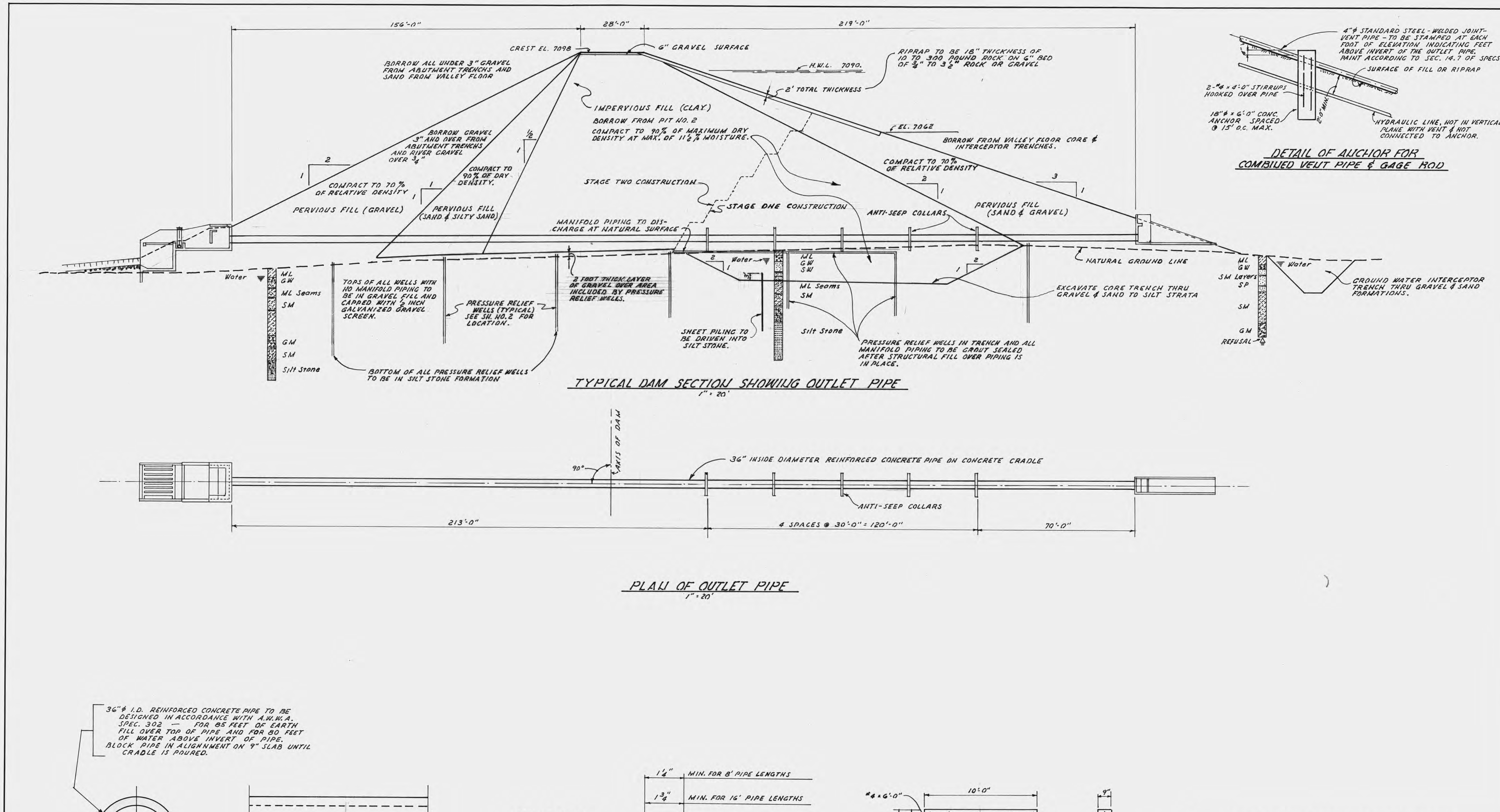
UPPER SPILLWAY TRANSITION
LEFT & RIGHT ENTRANCE DETAILS
FOOT BRIDGE DETAILS

IRRIGATION DIVISION NO. 6 WATER DISTRICT NO. 43 RIO BLANCO COUNTY COLORADO	BIG BEAVER CREEK RESERVOIR DAM COLORADO GAME, FISH AND PARKS DEPARTMENT 6060 BROADWAY DENVER, COLORADO EUGENE L. PADON, CONSULTING ENGINEER, 6415 W 44TH AVE • WHEATRIDGE, COLO • 424-6431 SHEET NO. 7 OF 8 DRAWN A.Z. / DATE / SCALE AS SHOWN / FILE NO. / JOB NO. 6416

APPROVED ON THE 27TH DAY OF AUGUST 1964.

J. E. WHITTEN
STATE ENGINEER
BY: [signature]
DEPUTY

C-1122



TYPICAL DAM SECTION - PLAN OF OUTLET PIPE
PIPE CRADLE & PIPE JOINT DETAILS - ANTI-SEEP COLLAR
VENT PIPE & GAGE ROD ANCHOR DETAIL

IRRIGATION DIVISION NO. 6 WATER DISTRICT NO. 43 RIO BLANCO COUNTY COLORADO	BIG BEAVER CREEK RESERVOIR DAM COLORADO GAME, FISH AND PARKS DEPARTMENT 6060 BROADWAY DENVER, COLORADO

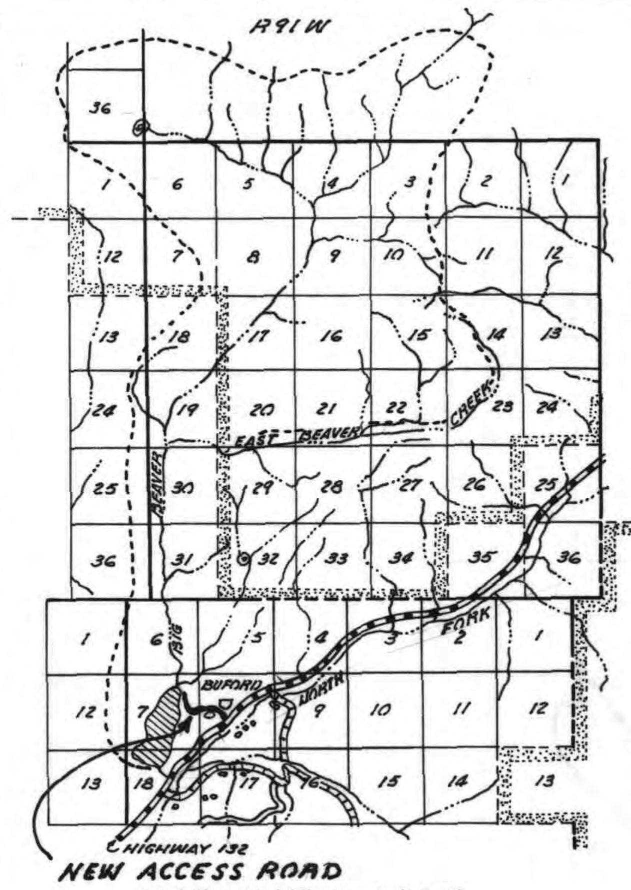
EUGENE L. PADON CONSULTING ENGINEER 6415 W 44TH AVE • WHEATRIDGE, COLO • 424-6431				SHEET NO. 3 OF 8
DRAWN A.Z.	DATE	SCALE AS SHOWN	FILE NO.	JOB NO 6416

APPROVED ON THE 27TH DAY OF August 1964.

J.E. WHITTEN
STATE ENGINEER

BY: [signature]
DEPUTY

C-1122

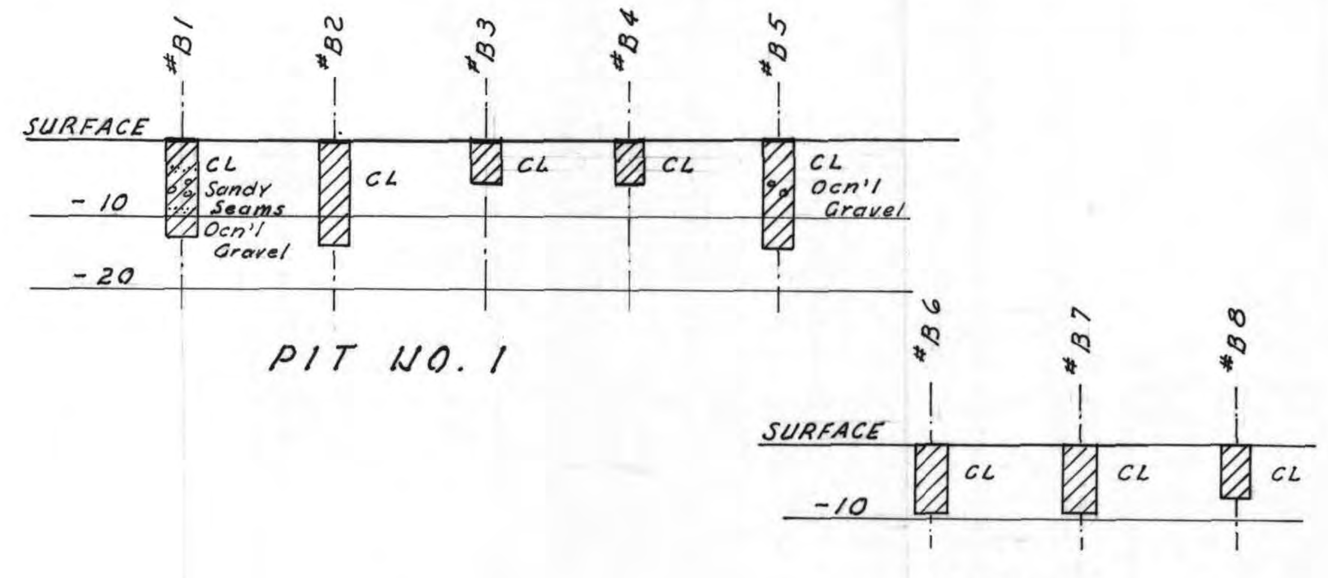


NEW ACCESS ROAD

VICINITY MAP

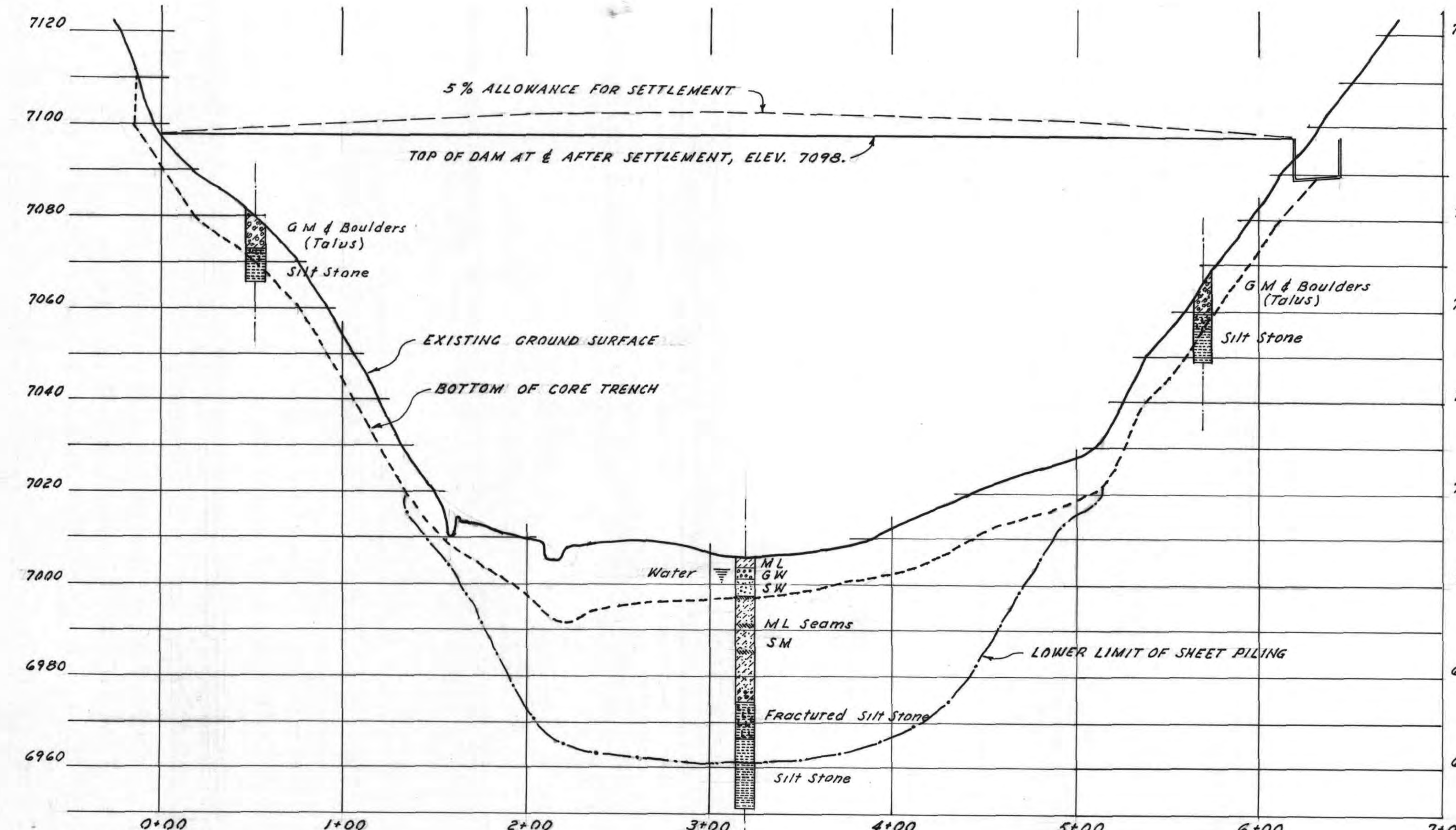
SCALE 1" = 2 MILES

DRAINAGE AREA – 21.67 SQ. MILES
EXPECTED MAXIMUM RUNOFF – 800 C.F.S.
SURFACE AREA OF RESERVOIR AT CREST OF SPILLWAY – 263.28 ACRES
CAPACITY OF RESERVOIR AT CREST OF SPILLWAY – 7658 ACRE FT.



BORROW PIT SOIL BORINGS

1" = 20' VERT.

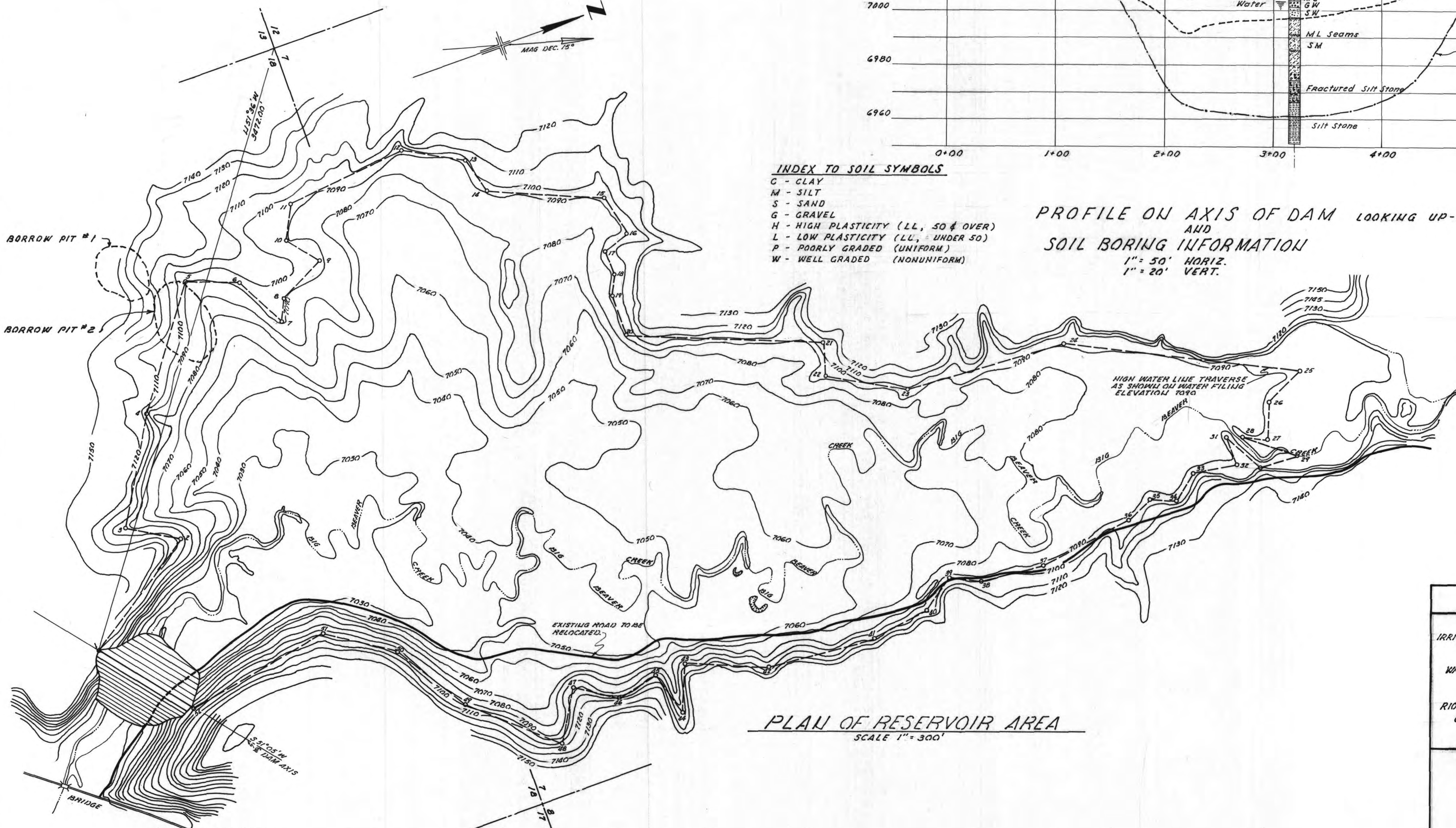


PROFILE ON AXIS OF DAM LOOKING UP-STREAM AND SOIL BORING INFORMATION

1" = 50' HORIZ.
1" = 20' VERT.

INDEX TO SOIL SYMBOLS

C - CLAY
M - SILT
S - SAND
G - GRAVEL
H - HIGH PLASTICITY (LL, 50 & OVER)
L - LOW PLASTICITY (LL, UNDER 50)
P - POORLY GRADED (UNIFORM)
W - WELL GRADED (NONUNIFORM)



PLAN OF RESERVOIR AREA

SCALE 1" = 300'

OWNER'S ACCEPTANCE

THESE PLANS FOR THE CONSTRUCTION OF BIG BEAVER CREEK RESERVOIR DAM ARE HEREBY APPROVED AND ACCEPTED.
THE COLORADO GAME, FISH AND PARKS DEPARTMENT
BY: E. L. Shaw
ENGINEER

ENGINEER'S AFFIDAVIT

I HEREBY CERTIFY THAT THESE PLANS FOR THE CONSTRUCTION OF BIG BEAVER CREEK RESERVOIR DAM WERE PREPARED UNDER MY DIRECT SUPERVISION FOR THE OWNER THEREOF.
Eugene L. Padon
REGISTERED ENGINEER

SUBSCRIBED AND SWORN TO BEFORE ME THIS 22 DAY OF July 1964.
Louis J. Galli
NOTARY PUBLIC

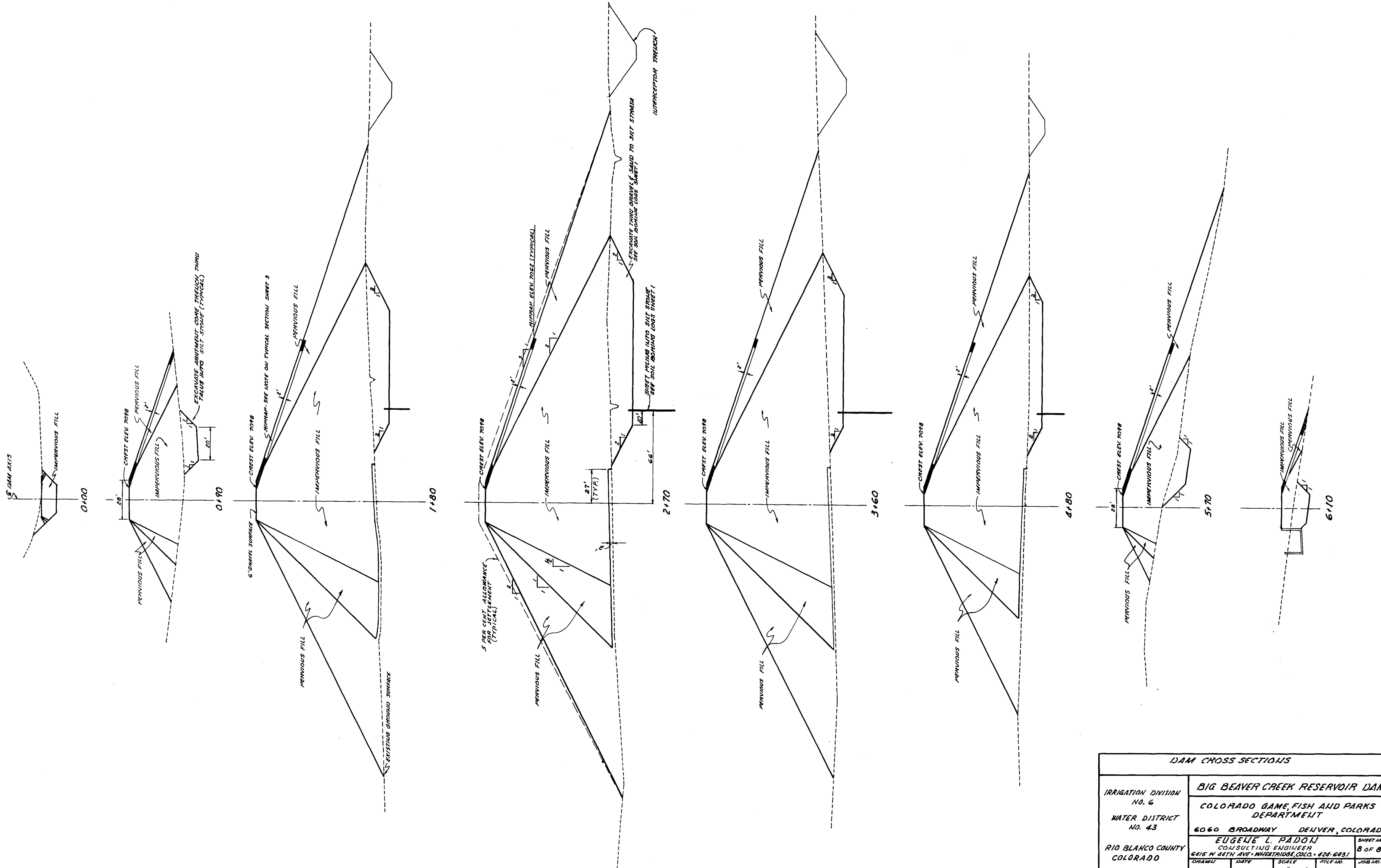
MY COMMISSION EXPIRES ON THE 2 DAY OF Aug 1967

PLAN OF RESERVOIR AREA – PROFILE OF DAM SOIL BORING LOGS			
IRRIGATION DIVISION NO. 6 WATER DISTRICT NO. 43 RIO BLANCO COUNTY COLORADO	BIG BEAVER CREEK RESERVOIR DAM COLORADO GAME, FISH AND PARKS DEPARTMENT 6060 BROADWAY DENVER, COLORADO		
	EUGENE L. PADON CONSULTING ENGINEER 6415 W. 44th Ave. • Wheatridge, Colorado • 424-6131		Sheet No. 1 OF 8
	Drawn B.P. - A.Z.	Date	Scale AS SHOWN
	File No.	Job No. 6416	

APPROVED ON THE 27TH DAY OF AUGUST 1964.
J. E. Whitten
STATE ENGINEER
BY: [signature]
DEPUTY

C-1122

059300



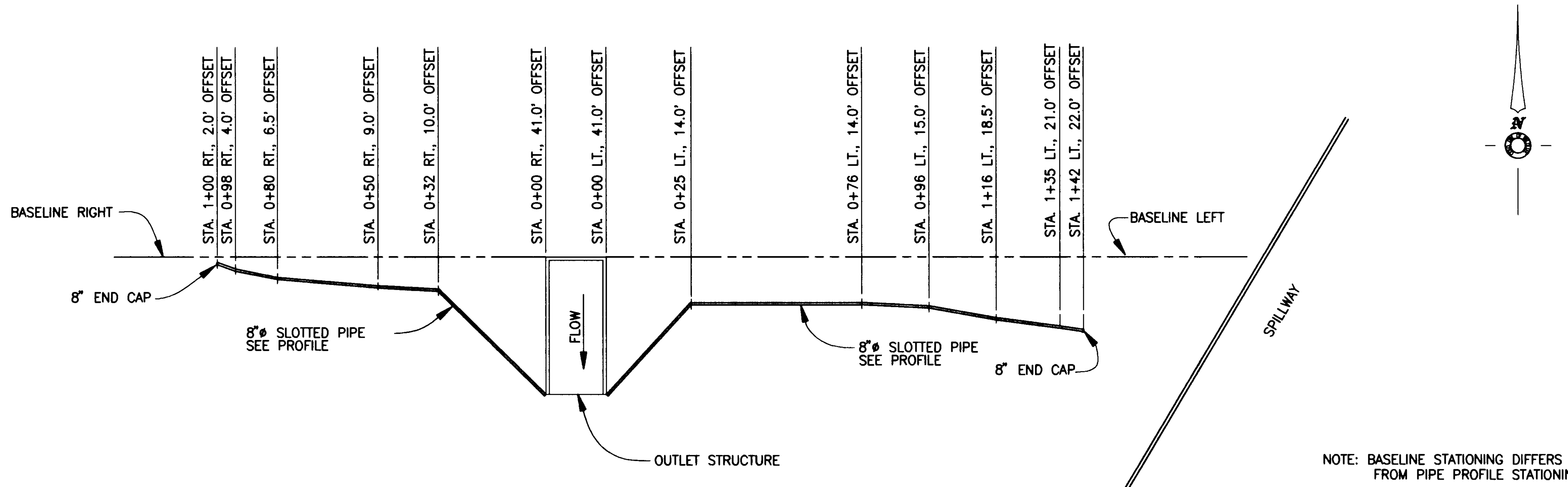
DAM CROSS SECTIONS	
IRRIGATION DIVISION NO. 6 WATER DISTRICT NO. 43 RIO BLANCO COUNTY COLORADO	BIG BEAVER CREEK RESERVOIR DAM COLORADO GAME, FISH AND PARKS DEPARTMENT 6060 BROADWAY DENVER, COLORADO EUGENE L. PADON CONSULTING ENGINEER 6415 W 44TH AVE • WHEATRIDGE, COLO. • 424-6831 — SHEET NO. 8 OF 8 DRAWN B.P. · DATE · SCALE 1" = 30' · FILE NO. · JOB NO. 6416

APPROVED ON THE 27TH DAY OF August 1964.

J. E. Whitten
STATE ENGINEER

BY: [signature]
DEPUTY

C-1122

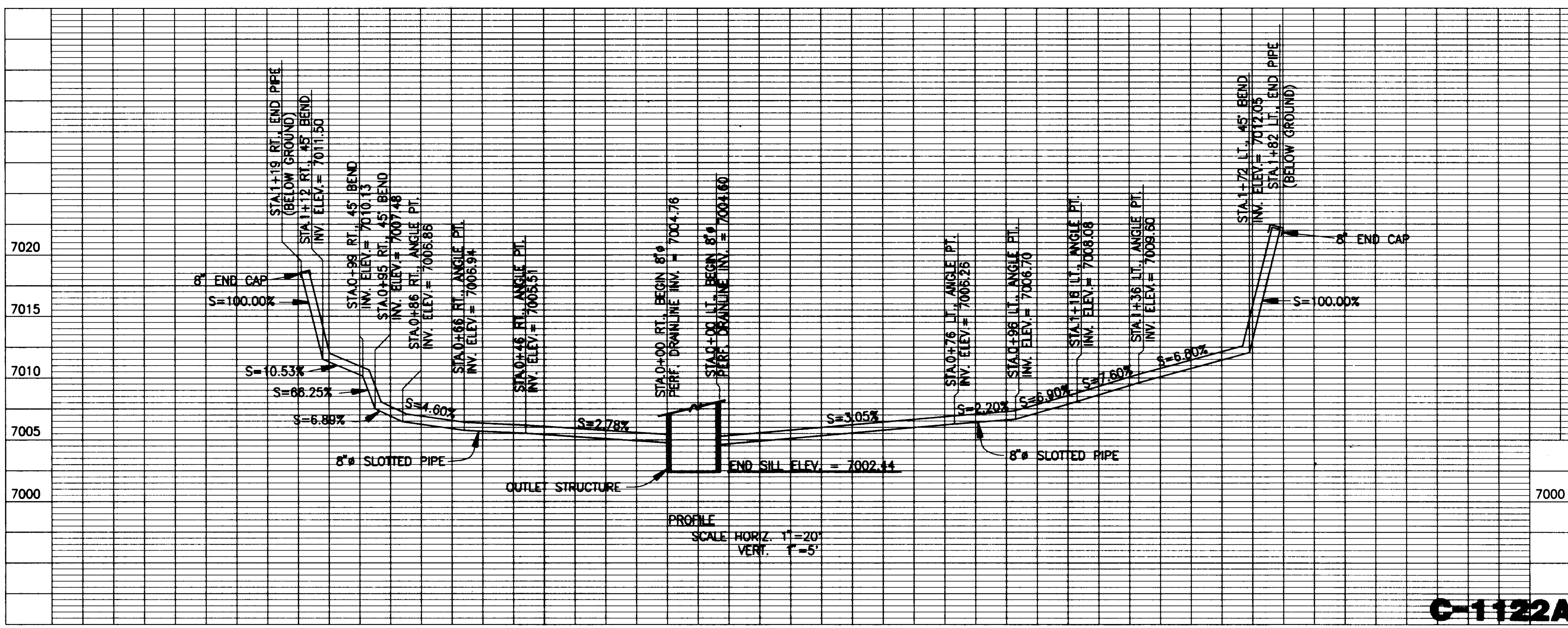


NOTE: BASELINE STATIONING DIFFERS FROM PIPE PROFILE STATIONING

PLAN VIEW - LAKE AVERY DAM TOE DRAINS

20' 0 20' 40'

1"=20'-0"

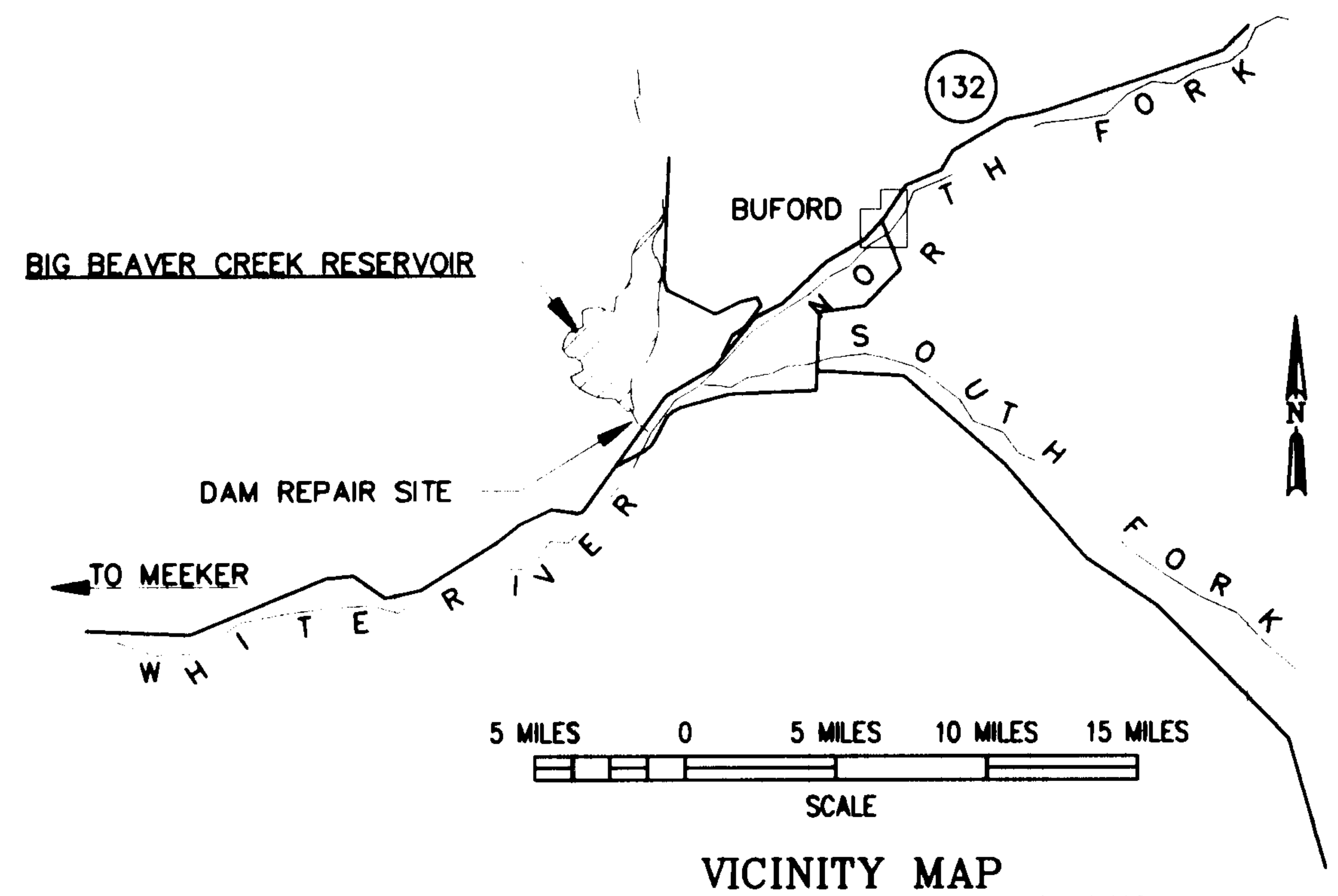


STATE OF COLORADO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE
DENVER, COLORADO

BIG BEAVER CREEK RESERVOIR DAM MODIFICATIONS AS-BUILT

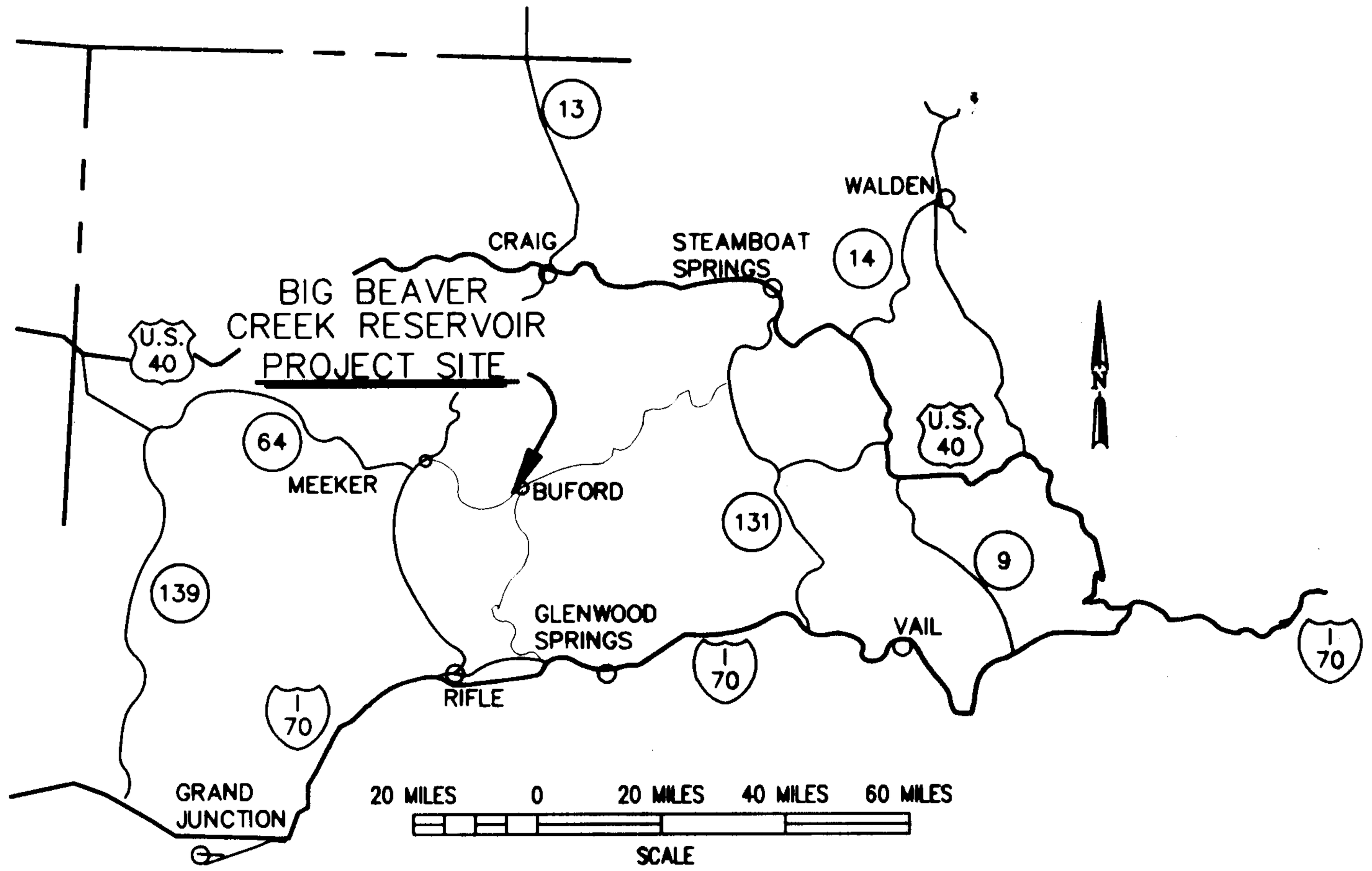
DESIGNED BY ED RABAN	DATE	APPROVED BY	DATE
DRAWN BY J. CONTE	9/93	APPROVED BY	
CHECKED BY		CHIEF ENGINEER	
DRAWING NUMBER		SHEET 5 OF 5	

C-1122A



VICINITY MAP

NOTE:
BIG BEAVER CREEK RESERVOIR IS ALSO KNOWN AS LAKE AVERY RESERVOIR



LOCATION MAP

PLANS FOR THE MODIFICATION OF
BIG BEAVER CREEK RESERVOIR
RIO BLANCO COUNTY COLORADO

WATER DIVISION NO. 6 WATER DISTRICT NO. 43
LOCATED IN
SEC. 18, T. 1 S., R. 91 W., 6th PM
SCALE AS NOTED
SHEET 1 OF 5

THE COLORADO DIVISION OF WILDLIFE, OWNER, WHOSE POST OFFICE ADDRESS IS 6060 BROADWAY, DENVER, COLORADO, DOES HEREBY ACCEPT AND APPROVE THESE PLANS FOR THE MODIFICATION OF BIG BEAVER CREEK RESERVOIR
BY:

L. CLYDE SMITH, CHIEF ENGINEER

SHEETS APPROVED IN THE OFFICE OF THE STATE ENGINEER OF COLORADO ON THE 3RD DAY OF MAY 1993

BY: HAL D. SIMPSON
STATE ENGINEER

for DEPUTY RICHARD STENZEL

I HEREBY CERTIFY THAT THESE PLANS FOR THE MODIFICATION OF BIG BEAVER CREEK RESERVOIR WERE PREPARED UNDER MY, DIRECT SUPERVISION FOR THE COLORADO DIVISION OF WILDLIFE.

JAMES M. NELSON PE # 11663

I, HEREBY CERTIFY THAT THESE PLANS REPRESENT THE AS-CONSTRUCTED CONDITIONS OF BIG BEAVER CREEK RESERVOIR AS OF THE 8TH DAY OF DEC 1993
BY:

EDWARD J. RABAN PE # 25784

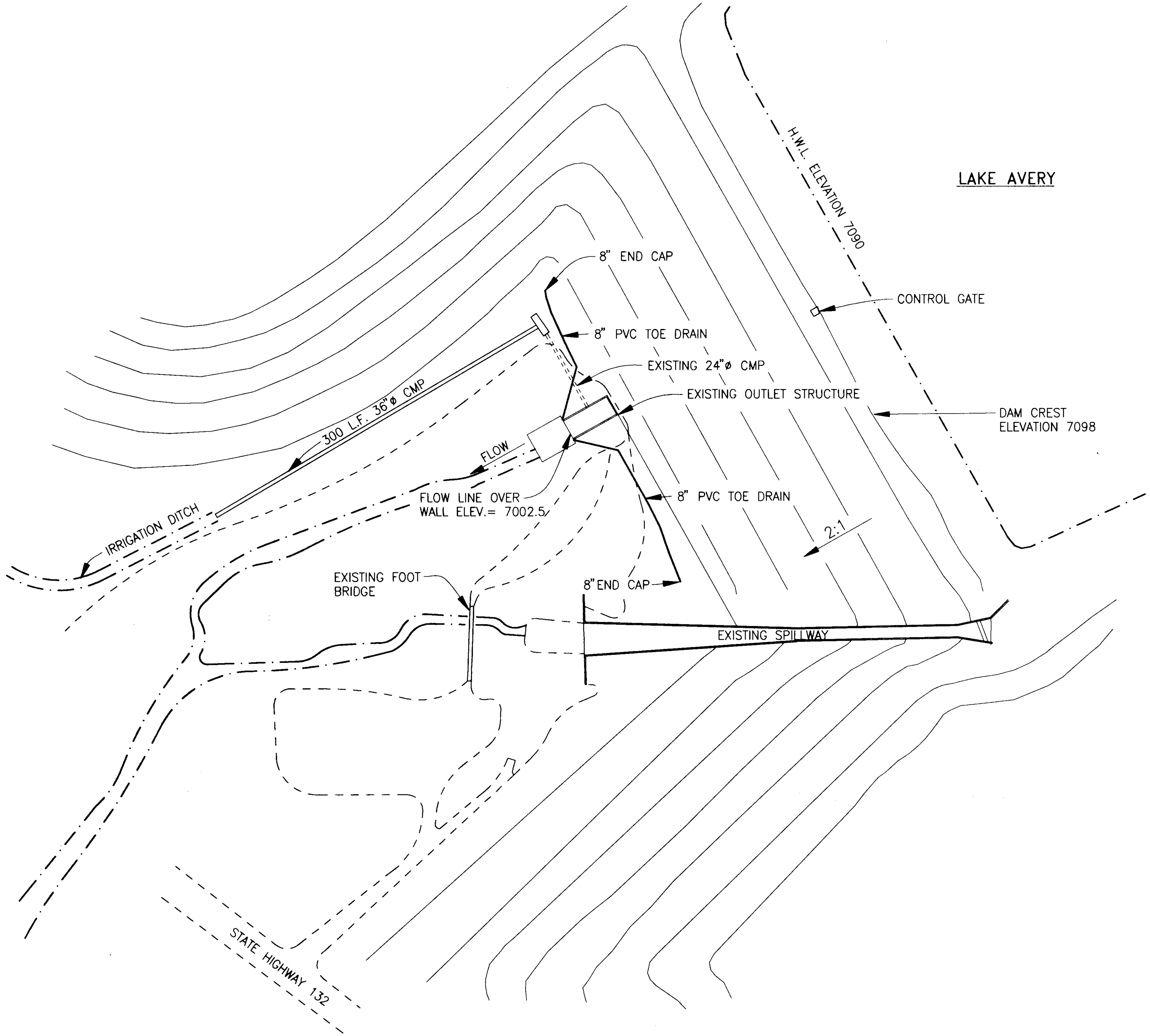
STATE OF COLORADO
DIVISION OF WATER RESOURCES

Plans Review by: ______
CHIEF (New Plans Branch)

Approval Recommended By: ______
SUPERVISOR (Dam and Reservoir Section)

C-1122A SHEET 1 OF 5

103156



SITE PLAN - DAM

50' 0 50' 100'

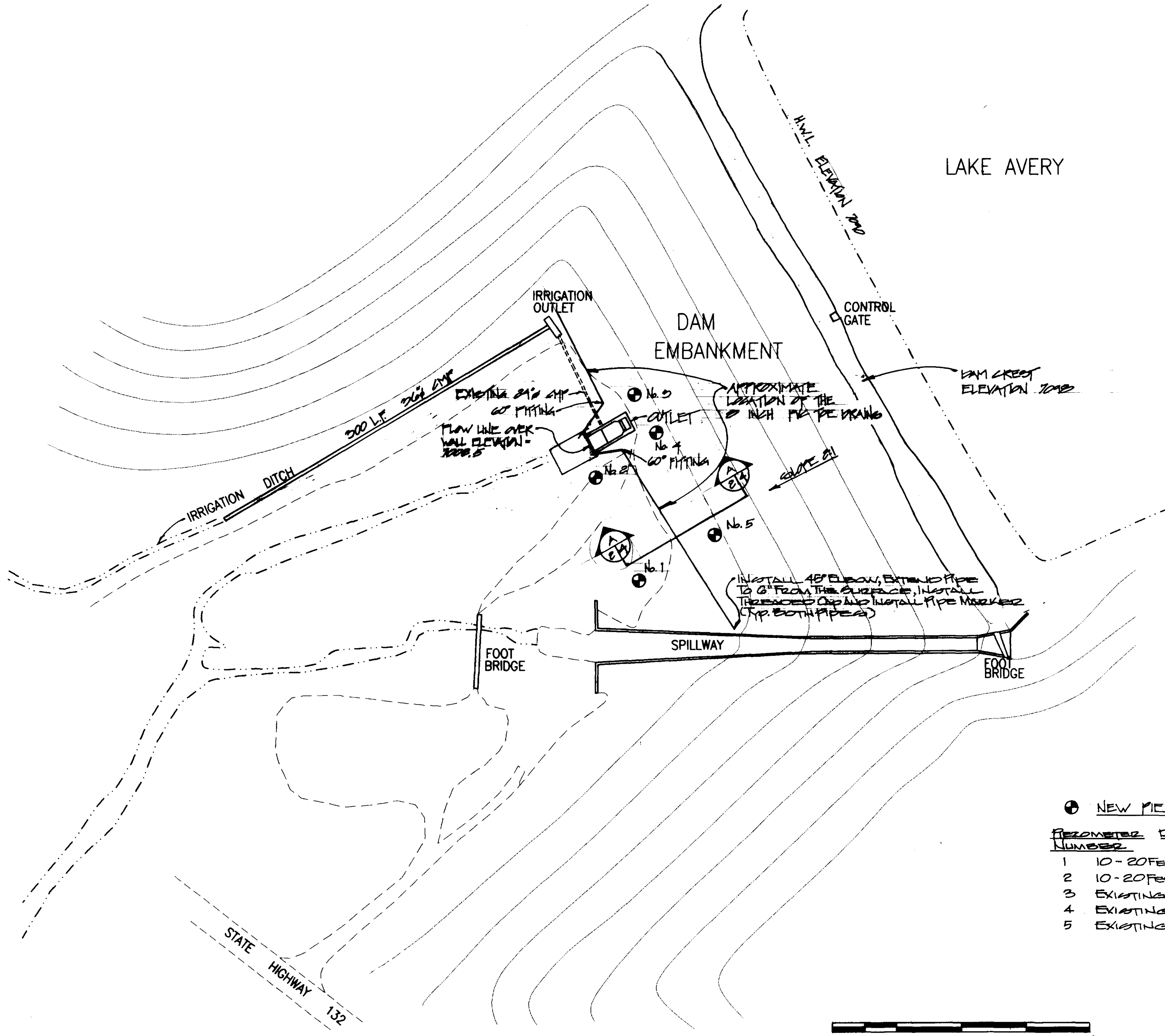
1"=50'

STATE OF COLORADO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE
DENVER, COLORADO

BIG BEAVER CREEK RESERVOIR
DAM MODIFICATIONS
AS-BUILT

DESIGNED BY ED RABAN	DATE	APPROVED BY	DATE
DRAWN BY J. CONTE	9/93	APPROVED BY	
CHECKED BY		CHIEF ENGINEER	
DRAWING NUMBER		SHEET 3 OF 5	

C-1122A



50 0 50 100 150

NEW PIEZOMETERS N.I.C.

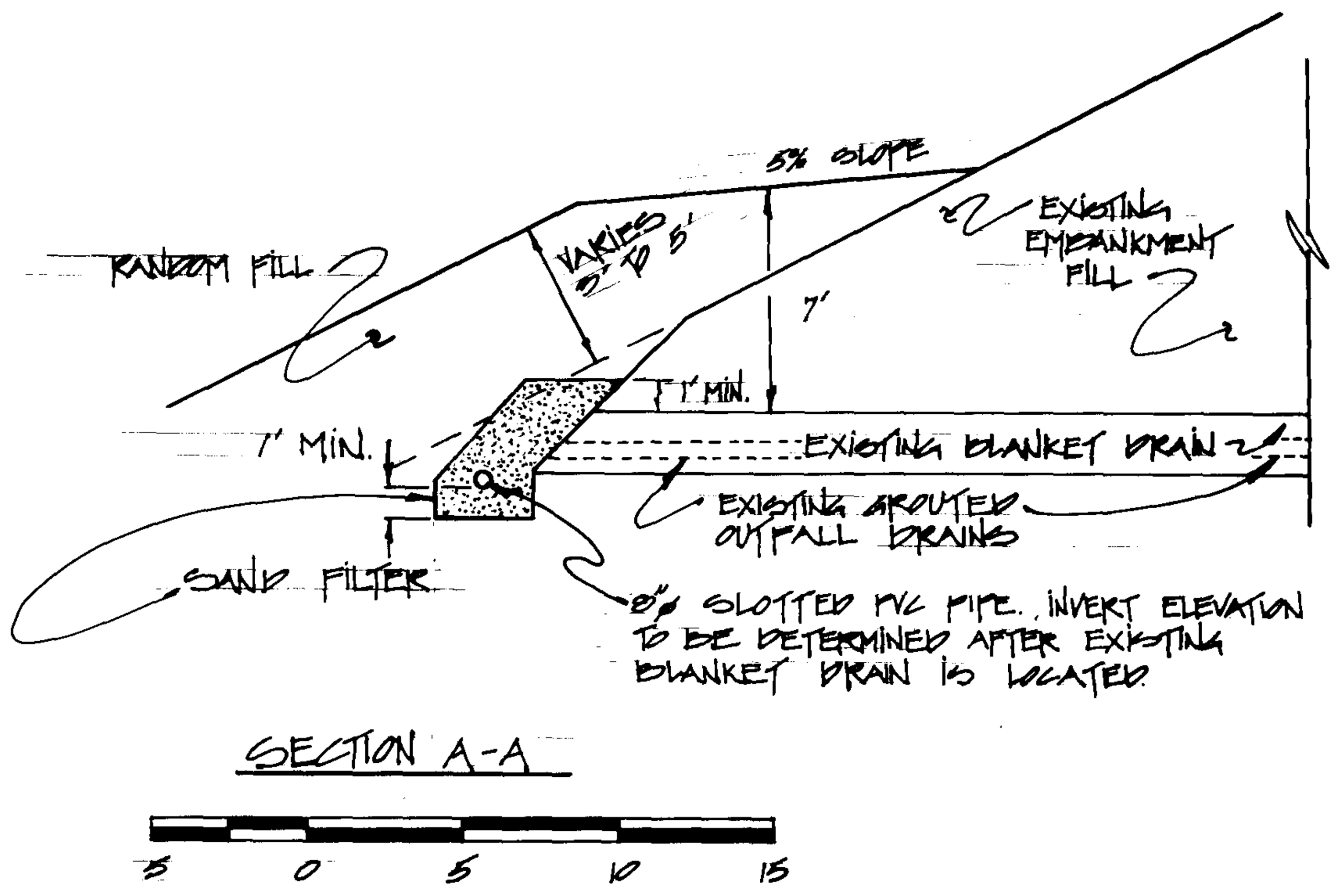
PIEZOMETER NUMBER	DEPTHS OF ZONES
1	10 - 20 FEET, 30 - 40 FEET
2	10 - 20 FEET, BEDROCK TO 10 FOOT ABOVE
3	EXISTING BLANKET DRAIN
4	EXISTING BLANKET DRAIN
5	EXISTING BLANKET DRAIN

C-1122A

STATE OF COLORADO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE
DENVER, COLORADO 80216

BIG BEAVER CREEK RESERVOIR
DAM MODIFICATIONS

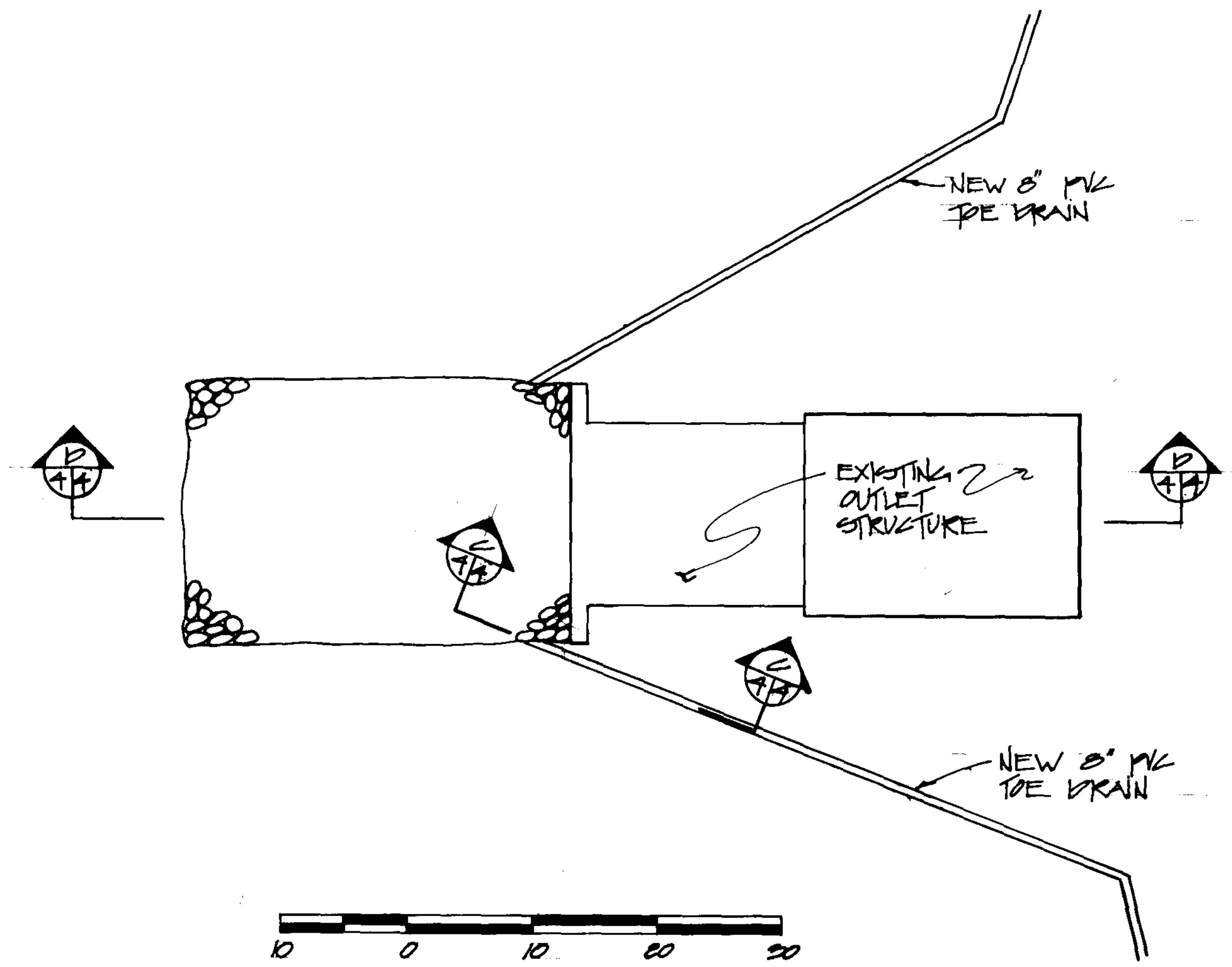
		DATE		DATE
DESIGNED BY	E. KABAN	3/93	APPROVED BY	
DRAWN BY	E. KABAN	3/93	CHIEF ENGINEER	
CHECKED BY				
APPROVED BY			APPROVED BY	
APPROVED BY			DIRECTOR	
DRAWING NUMBER			SHEET 2 OF 5	

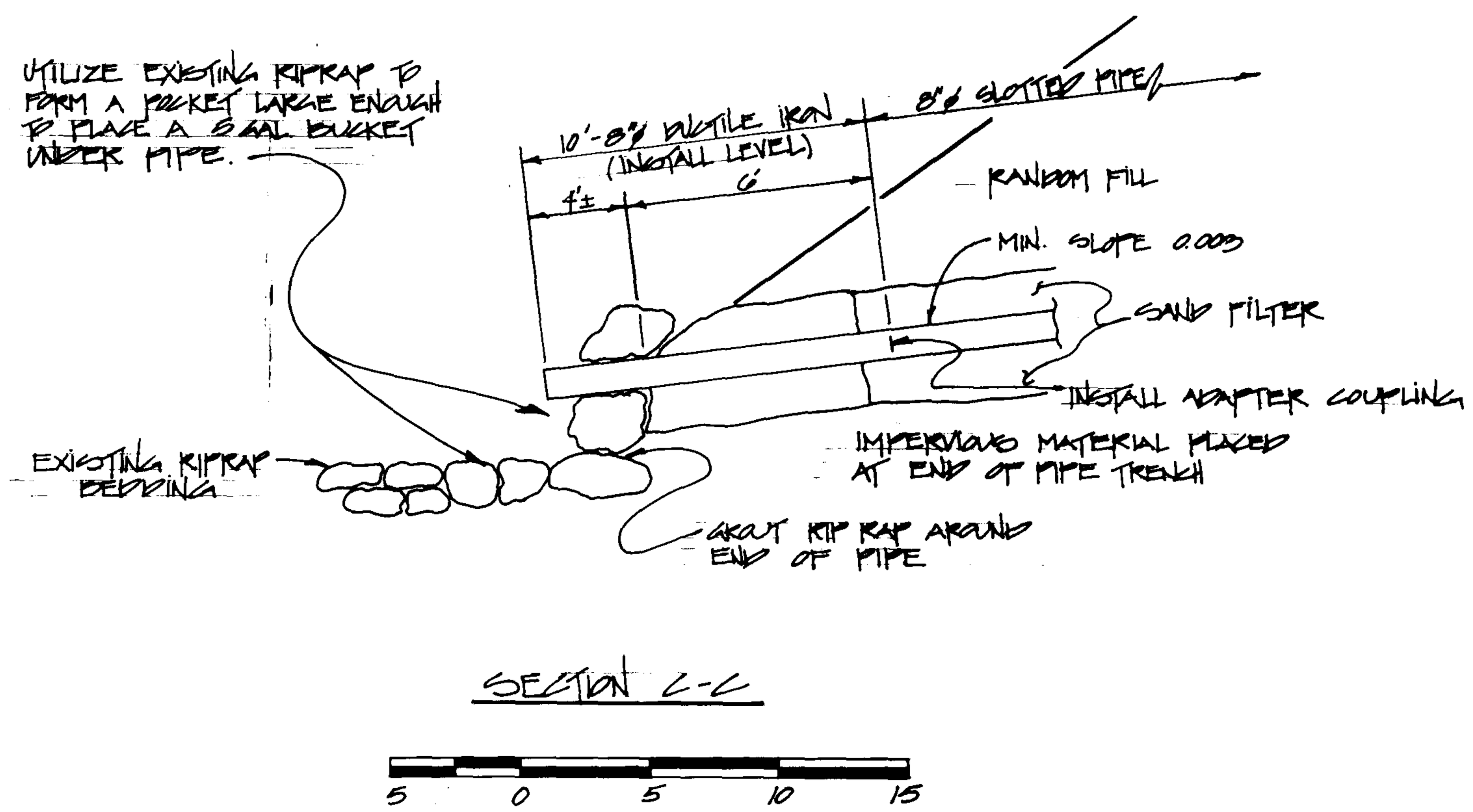


SECTION A-A

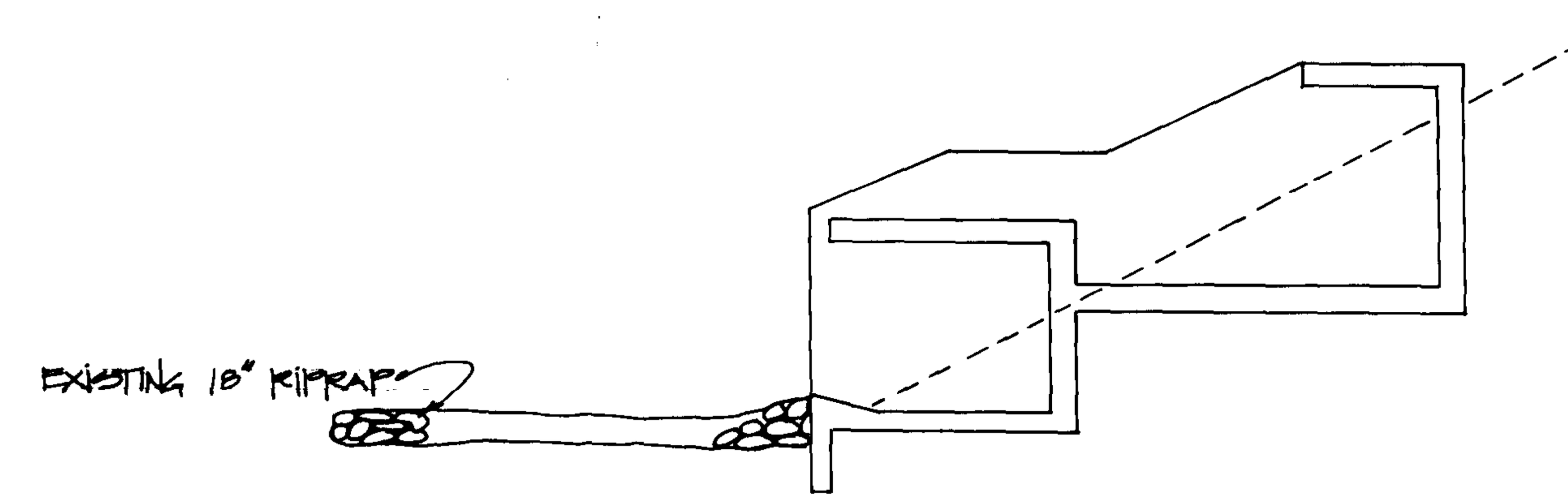
NOTES:

1. RANDOM FILL SHALL BE SEMI COMPACTED.
2. MIN SLOPE OF PIPE SHALL BE 0.003
3. EXACT SLOPE, LENGTH AND LOCATION OF 8 INCH PVC PIPE SHALL BE DETERMINED AFTER EXISTING BLANKET DRAIN IS UNCOVERED.
4. SEEDING SHALL BE PERFORMED BY OWNER.
5. 8 INCH PVC PIPE SHALL BE SCHEDULE 40

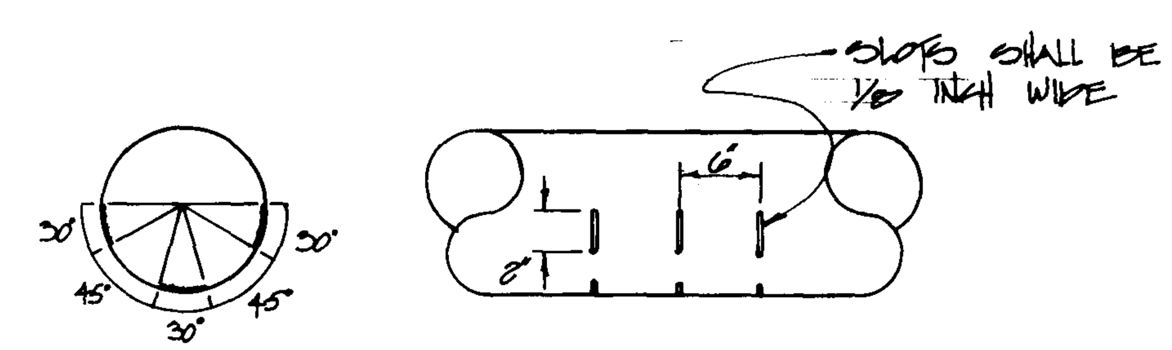




SECTION C-C



SECTION D-D



DETAIL - SLOTTED PVC PIPE
NO SCALE

C-1122A

STATE OF COLORADO DEPARTMENT OF NATURAL RESOURCES DIVISION OF WILDLIFE DENVER, COLORADO 80216			
BIG BEAVER CREEK RESERVOIR DAM MODIFICATIONS			
DESIGNED BY E. KABAN	DATE 5/98	APPROVED BY	DATE
DRAWN BY E. KABAN	5/98		CHIEF ENGINEER
CHECKED BY			
APPROVED BY		APPROVED BY	
APPROVED BY			DIRECTOR
DRAWING NUMBER		SHEET 4 OF 5	

C-1122B

STATE OF COLORADO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE
DENVER, COLORADO

BIG BEAVER DAM
TRAINING WALL PLAN
AND SECTIONS

DESIGNED BY F.O.O.	6/15	APPROVED BY
DRAWN BY M.W.M.	6/15	APPROVED BY
CHECKED BY		APPROVED BY
DRAWING NUMBER S-2		SHEET 6 OF 8

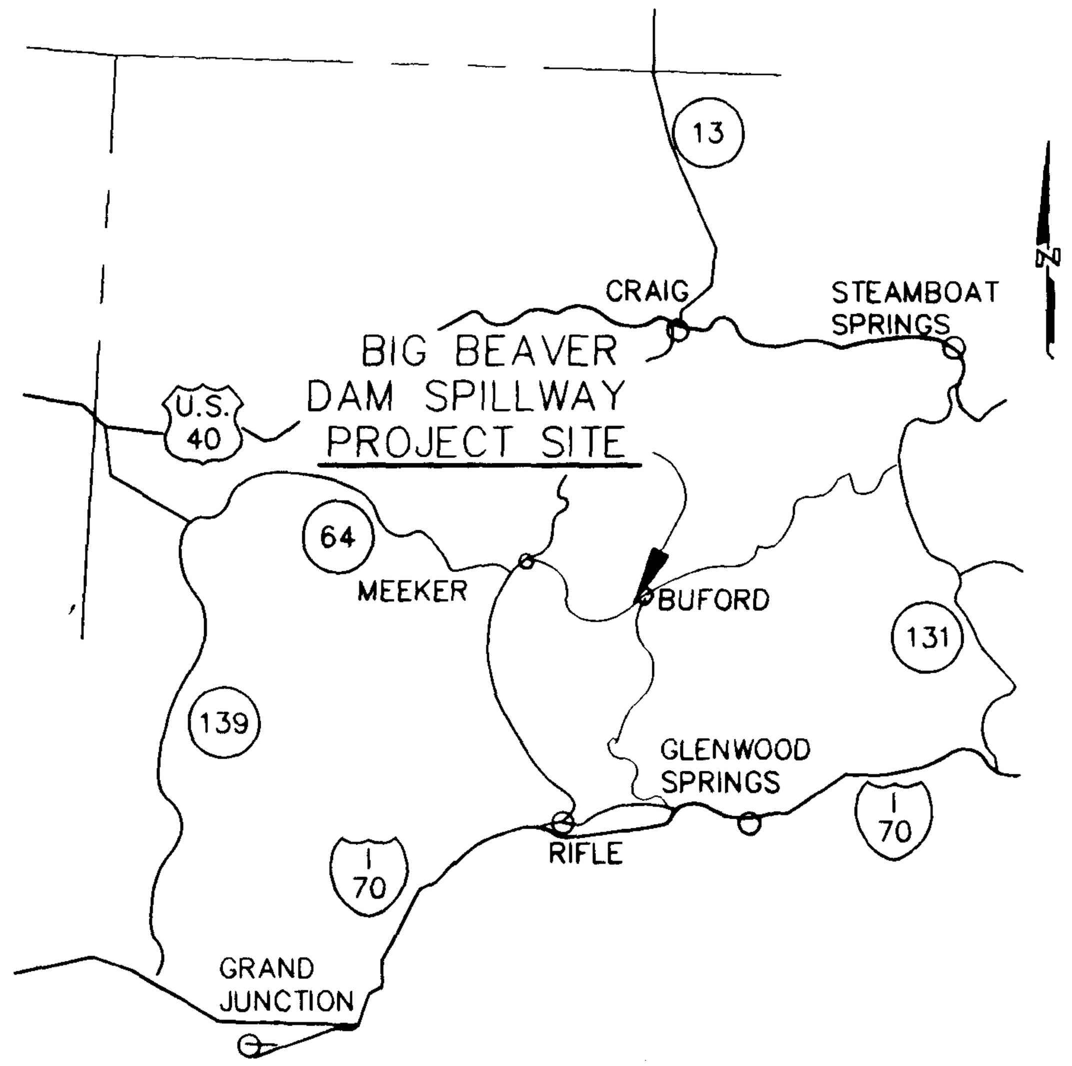
REVISIONS: 4-17-91 AS BUILT; 4/3/95 △2

CONSTRUCTION PLANS
FOR
BIG BEAVER DAM SPILLWAY REPLACEMENT

WATER DIVISION 6 – (FORMER) DISTRICT 43

SEC 18 T1S R91W 6th PM

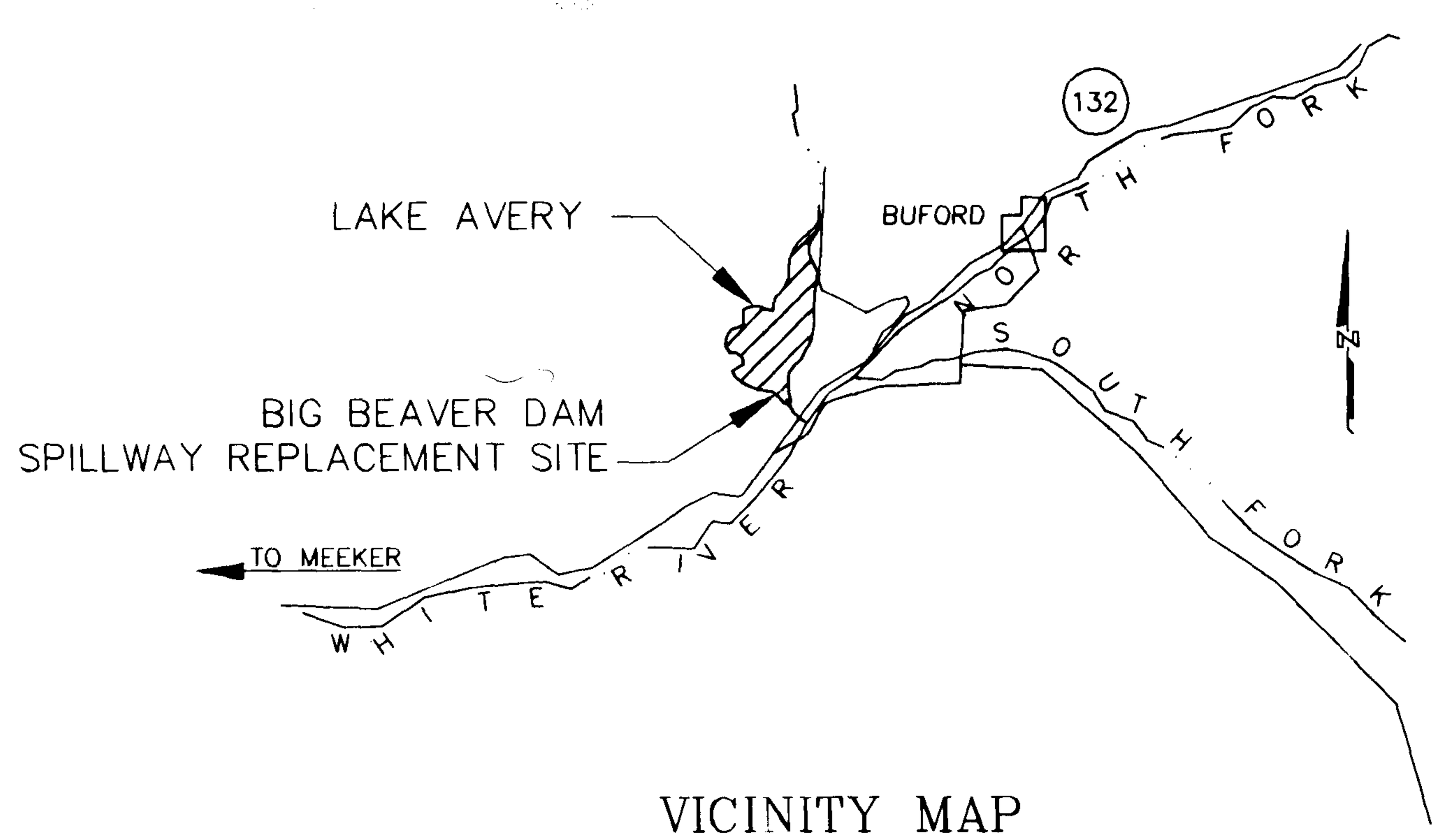
Rio Blanco County, Colorado



LOCATION MAP

0 20 40

APPROXIMATE SCALE IN MILES



VICINITY MAP

0 5 10

APPROXIMATE SCALE IN MILES

NOTE:
LAKE AVERY RESERVOIR IS ALSO KNOWN AS BIG BEAVER CREEK RESERVOIR

INDEX TO DRAWINGS

I HEREBY CERTIFY THAT THESE DRAWINGS FOR THE CONSTRUCTION OF THE LAKE AVERY SPILLWAY REPLACEMENT WERE PREPARED BY ME (OR UNDER MY DIRECT SUPERVISION) FOR THE OWNERS THEREOF

GEOFFREY M. TAYLOR CO PE # 13021
REGISTERED ENGINEER
BOYLE ENGINEERING CORPORATION

AS OWNERS THEREOF WE HEREBY ACCEPT AND APPROVE THESE DRAWINGS FOR THE CONSTRUCTION OF LAKE AVERY SPILLWAY REPLACEMENT

OWNER DATE

APPROVED ON THE 3rd DAY OF April, 1995

Hal D. Simpson
STATE ENGINEER

DEPUTY

THESE DRAWINGS REPRESENT THE AS-CONSTRUCTED CONDITIONS OF LAKE AVERY SPILLWAY REPLACEMENT TO THE BEST OF OUR KNOWLEDGE AND JUDGEMENT BASED IN PART ON INFORMATION FURNISHED BY OTHERS AS OF THE 17 DAY OF APRIL, 1997.

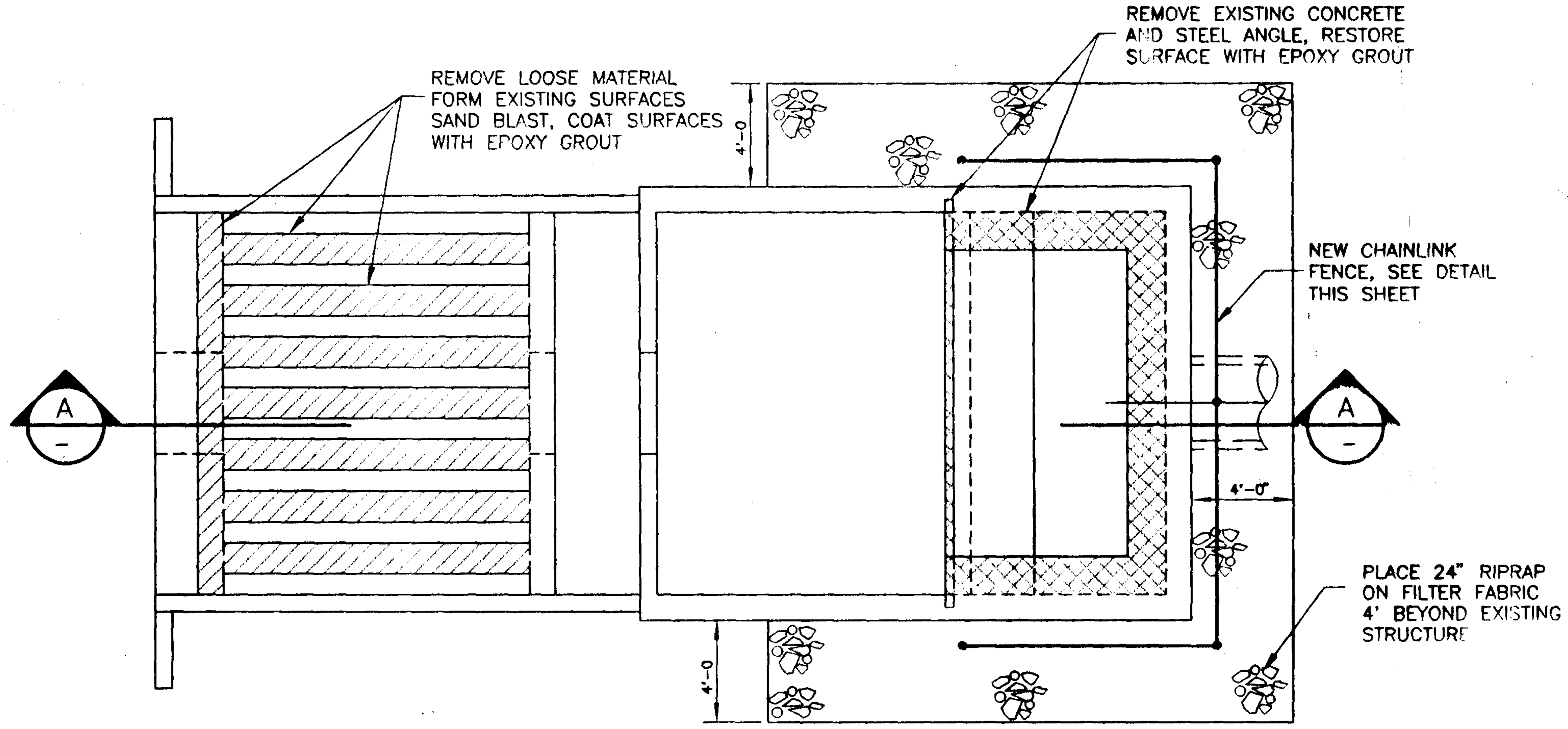
C-1122B

STATE OF COLORADO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE
DENVER, COLORADO

BIG BEAVER DAM
SPILLWAY REPLACEMENT
TITLE SHEET / LOCATION MAP

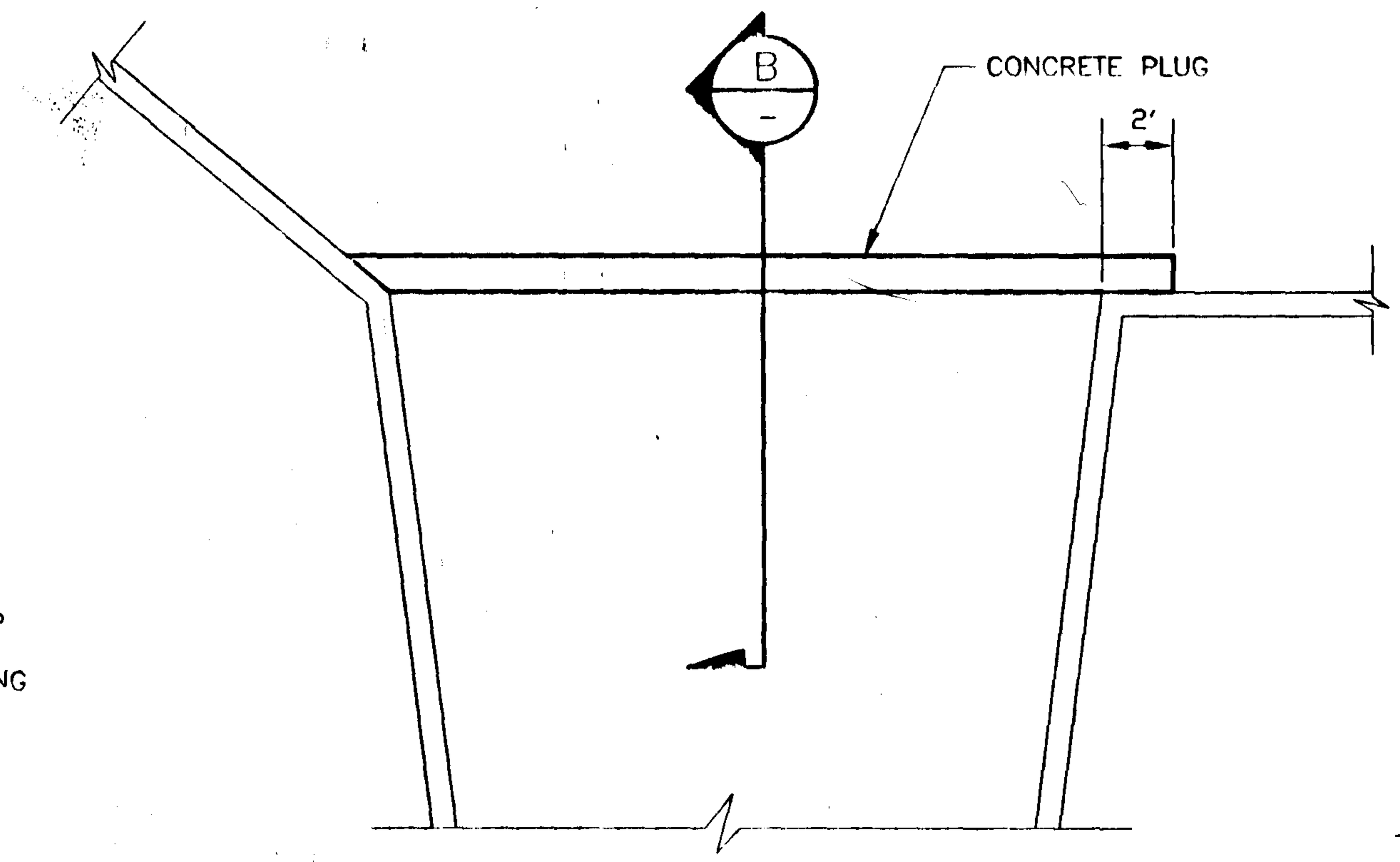
REVISIONS: 2 — AS BUILT 4-17-97 (DATE / DESCRIPTION / BY)

	DATE	
DESIGNED BY GMT	3/95	APPROVED BY
DRAWN BY EW	3/95	APPROVED BY
CHECKED BY TB	3/95	APPROVED BY
		CHIEF ENGINEER
DRAWING NUMBER C-1		SHEET 1 OF 8



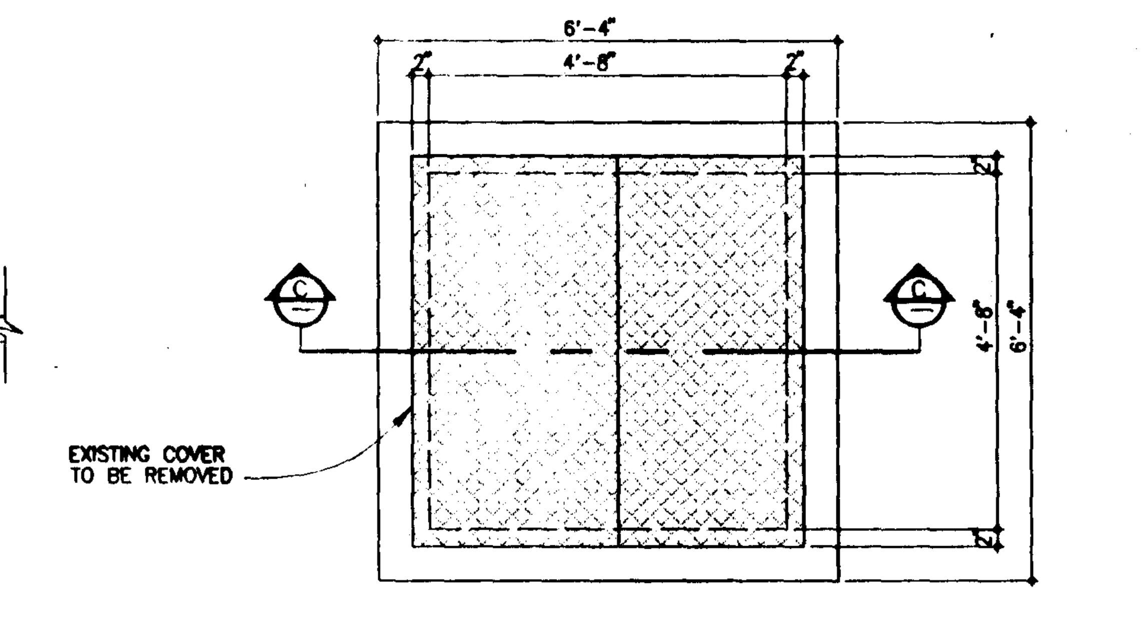
EXISTING OUTLET WORKS

SCALE IN FEET 1/4" = 1'-0"



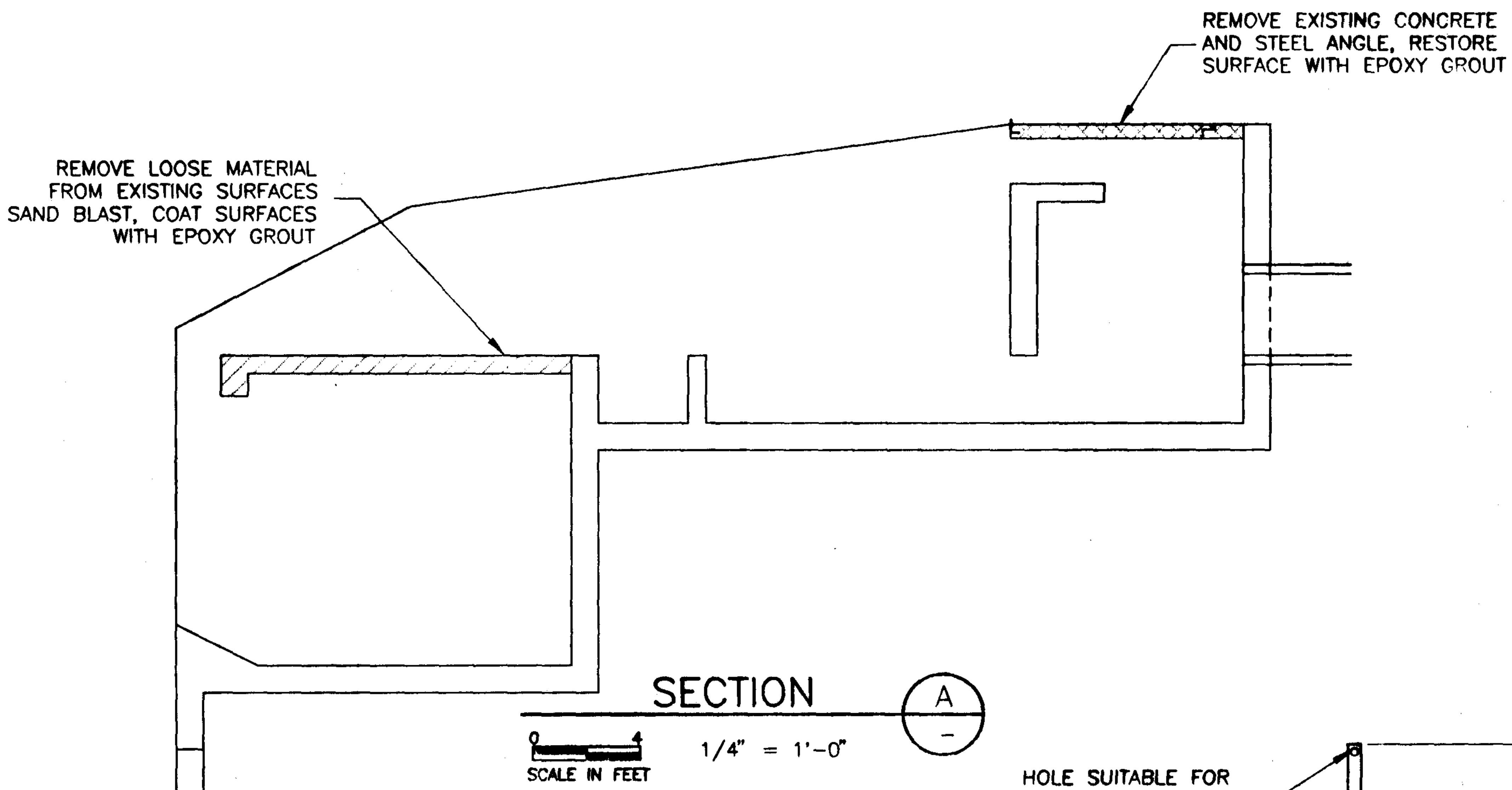
CONCRETE PLUG AT EXISTING OVERFLOW

SCALE IN FEET 1/4" = 1'-0"



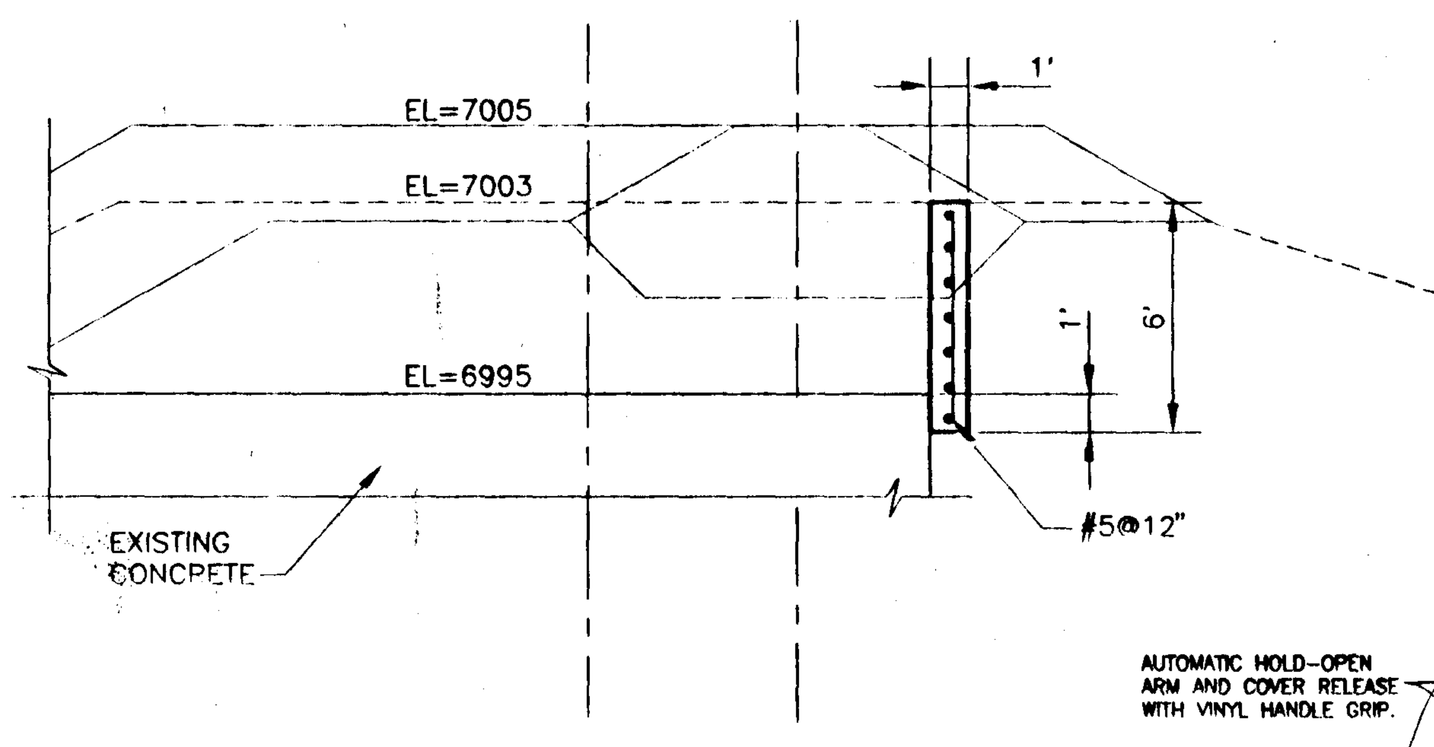
PLAN – CONTROL BOX EXTENSION

N.T.S.



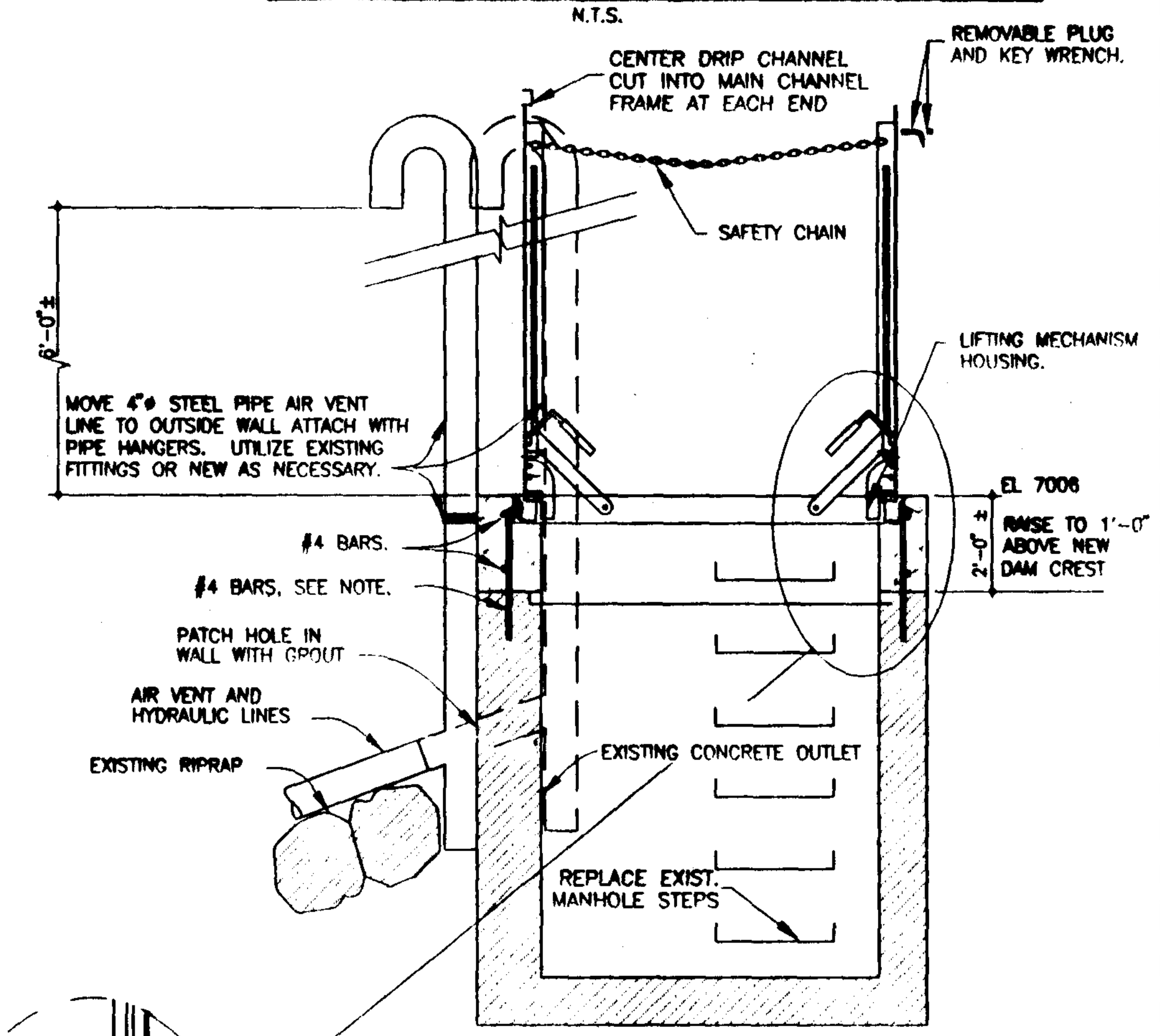
SECTION A

SCALE IN FEET 1/4" = 1'-0"



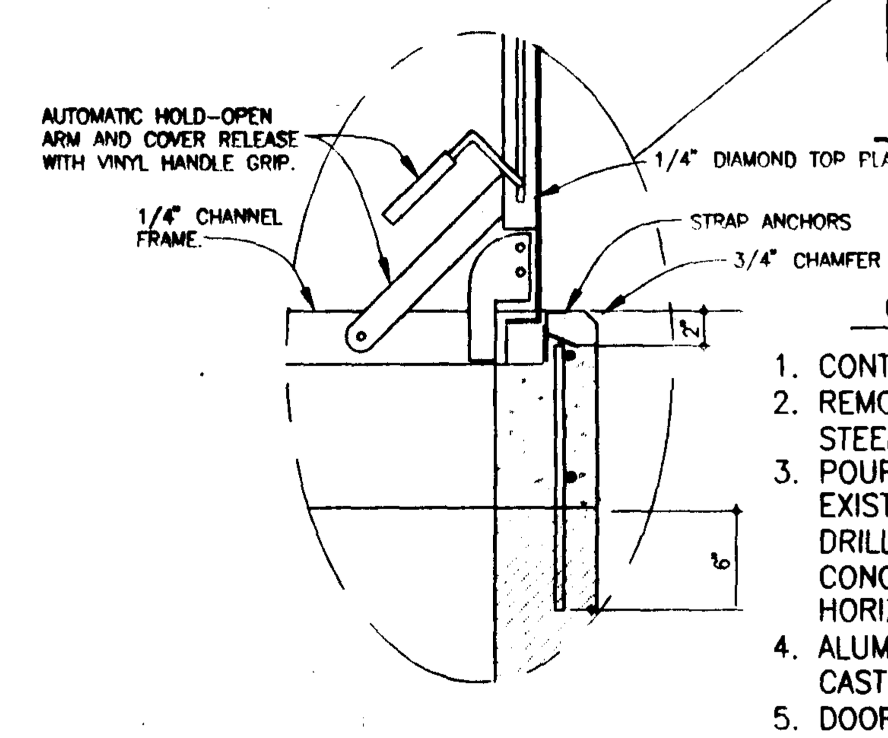
SECTION B

SCALE IN FEET 1/4" = 1'-0"



SECTION C

N.T.S.

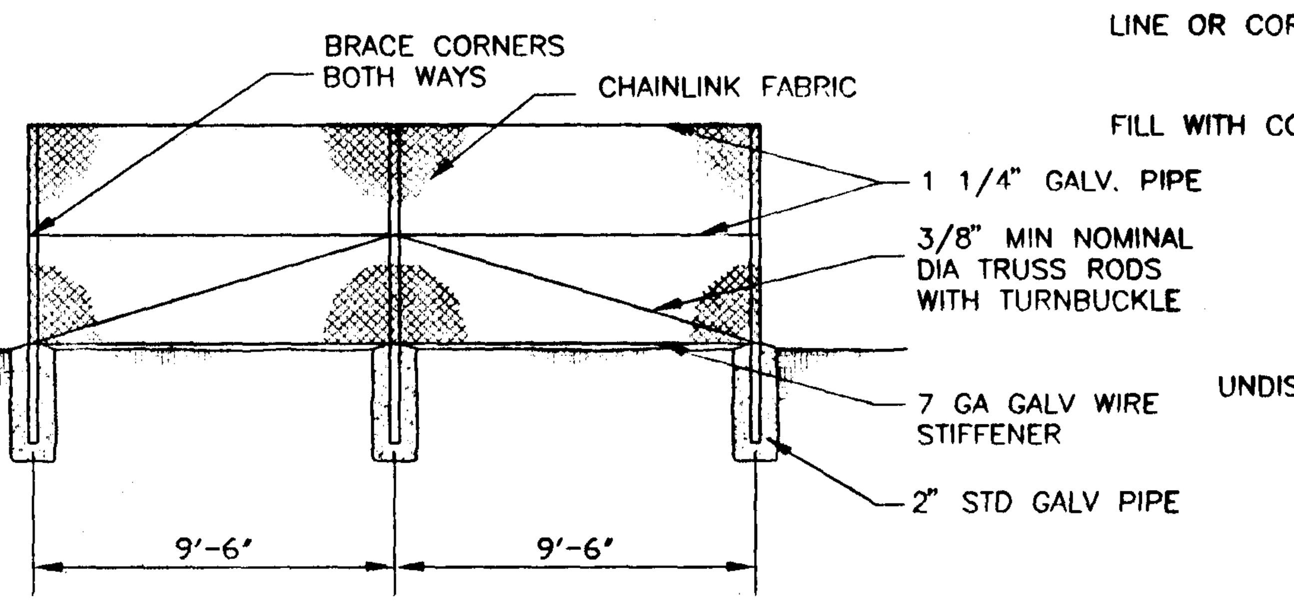


AUTOMATIC HOLD-OPEN ARM.

N.T.S.

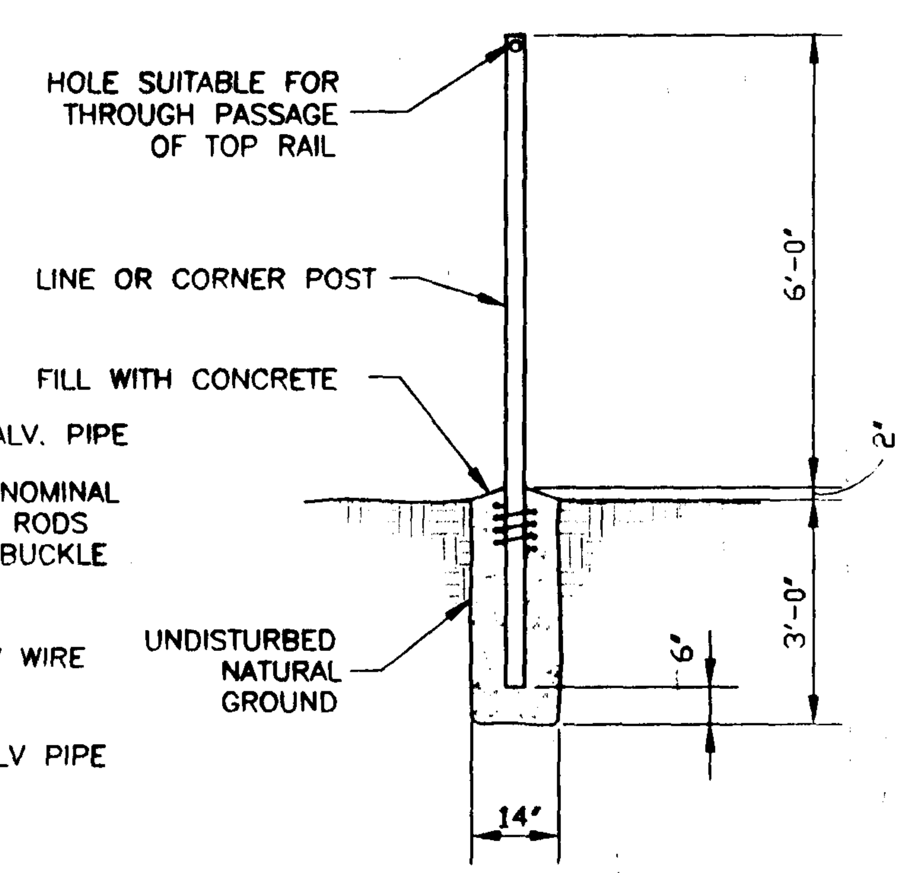
CONTROL BOX NOTES:

1. CONTRACTOR TO VERIFY DIMENSIONS IN THE FIELD.
2. REMOVE AND SALVAGE EXISTING HEAVY GAUGE STEEL PLATE COVER.
3. POUR CONCRETE BOX EXTENSION, BONDED TO EXISTING CONCRETE WITH #4 BARS, 16" LONG DRILLED AND EPOXY GROUTED 6" INTO EXISTING CONCRETE WALLS AT 12" O.C. AND (2)-#4 BARS HORIZONTAL (CONTINUOUS) 2" CLEAR COVER.
4. ALUMINUM DOUBLE LEAF ACCESS DOOR SHALL BE CAST INT NEW CONCRETE BOX EXTENSION.
5. DOOR SHALL HAVE RECESSED HASP WITH A FLUSH HINGED LID FOR USE WITH A PADLOCK.
6. MANHOLE STEPS M.A. INDUSTRIES INC. PS2-PF MANHOLE STEPS OR APPROVED EQUIVALENT. LOCATION OF MANHOLE STEPS TO BE DETERMINED BY THE ENGINEER.



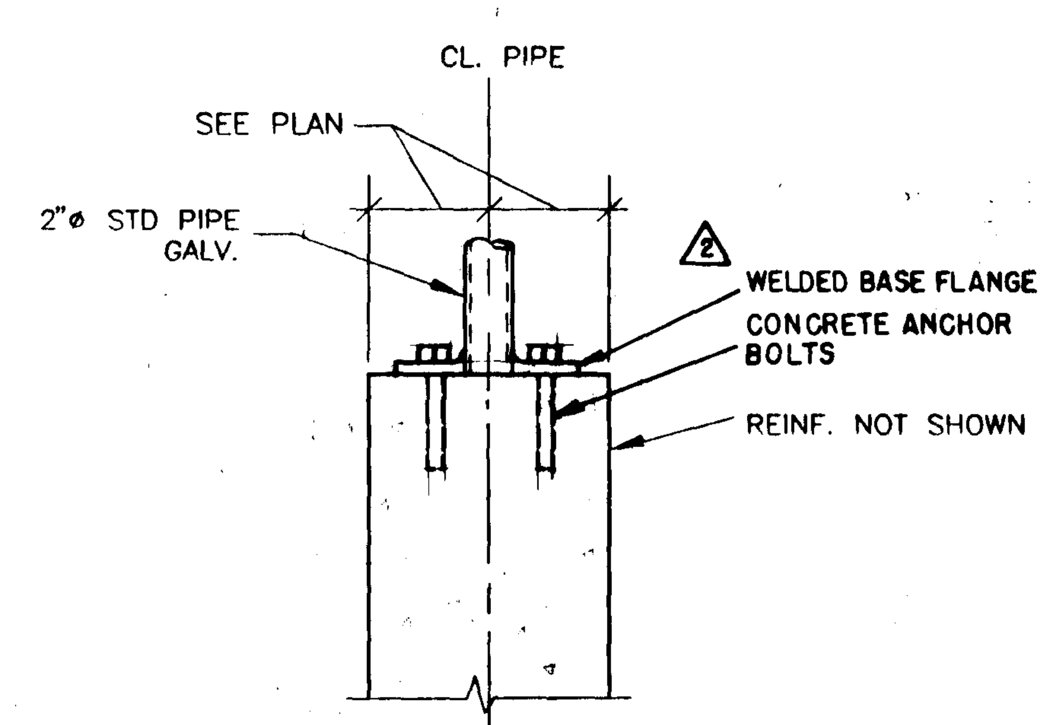
FENCE ELEVATION

SCALE IN FEET 1/4" = 1'-0"



TYPICAL POST SECTION

SCALE IN FEET 1/2" = 1'-0"



DETAIL 5 / F-6

N.T.S.

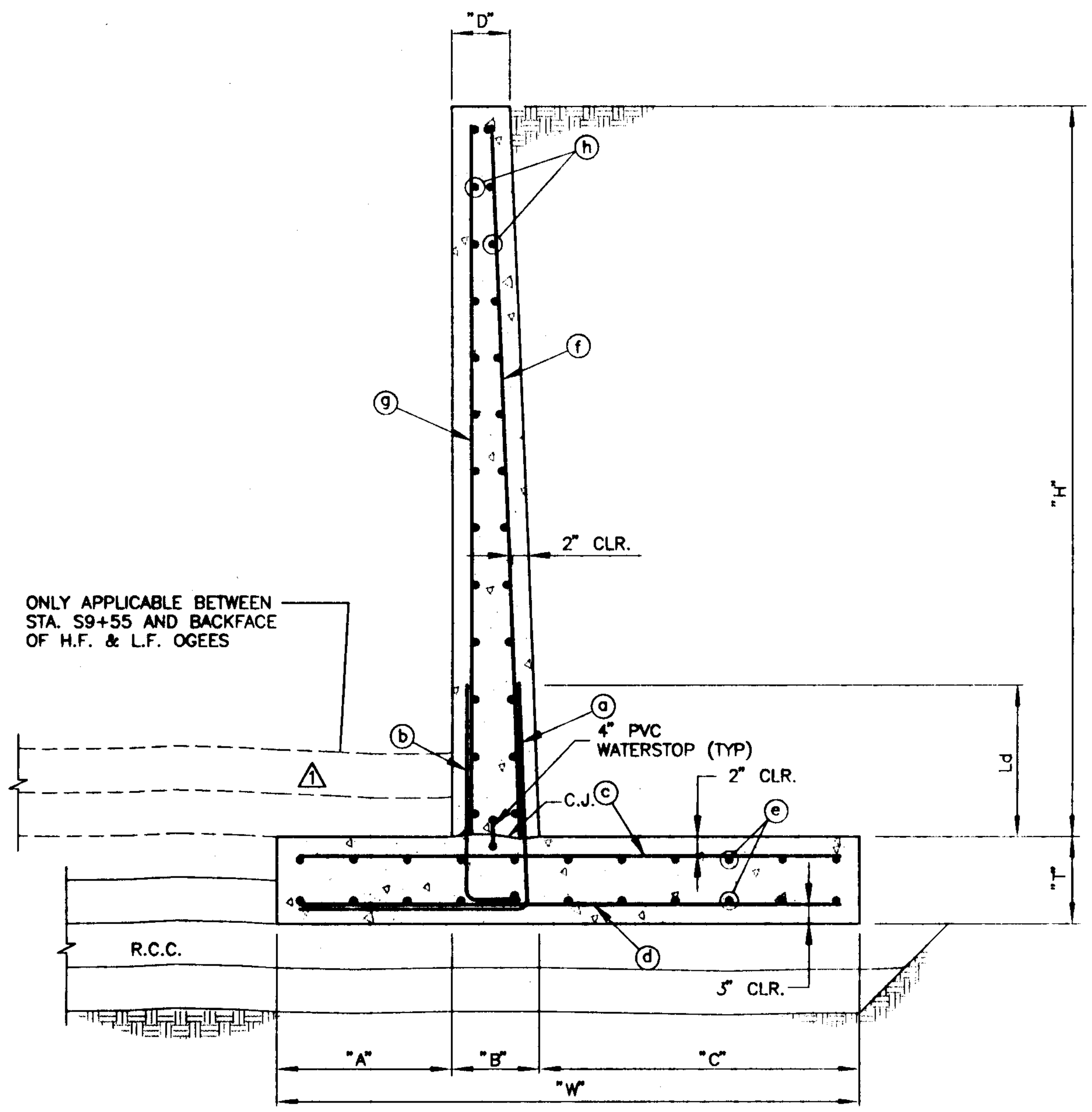
C-1122B

REVISIONS	
DATE	4-17-97
DESCRIPTION	AS BUILT

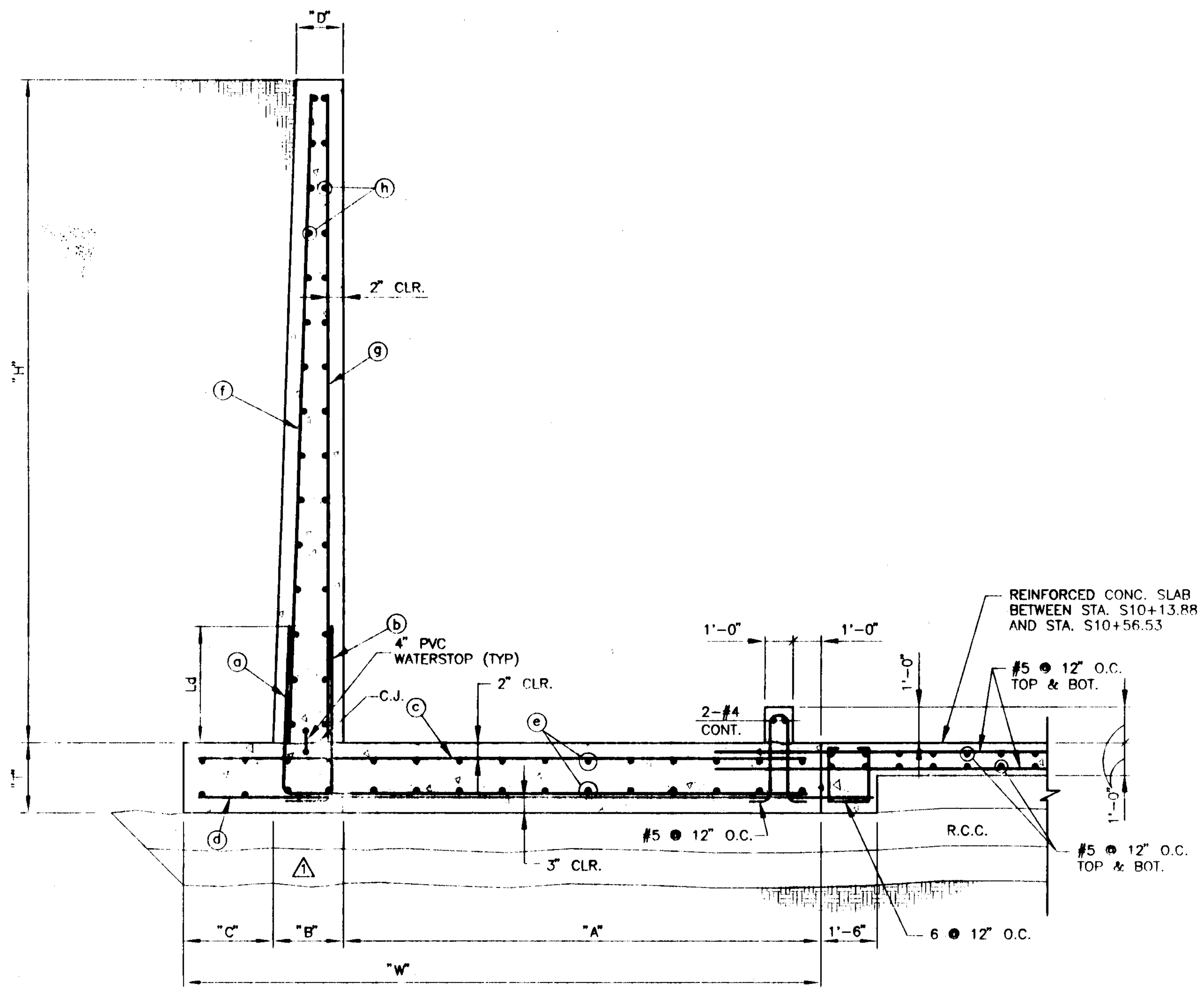
STATE OF COLORADO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE
DENVER, COLORADO

BIG BEAVER DAM
SPILLWAY REPLACEMENT
SECTIONS AND DETAILS

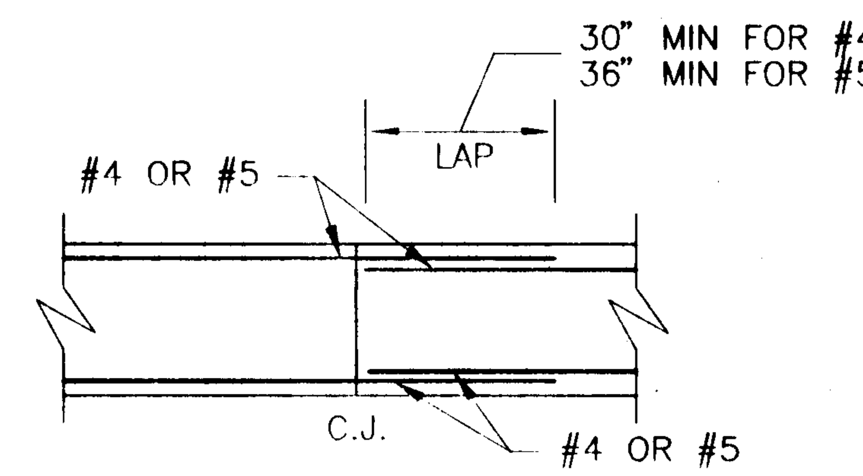
	DATE	
DESIGNED BY GMT		APPROVED BY
DRAWN BY RLM		APPROVED BY
CHECKED BY		APPROVED BY
DRAWING NUMBER C-4		CHIEF ENGINEER
		SHEET 4 OF 8



WALL TYPE (A) THROUGH (G)
N.T.S.



WALL TYPE (H) THROUGH (L)
N.T.S.



TYPICAL CONSTRUCTION JOINT DETAIL
N.T.S.

DIMENSIONS (1)										STEEL REINFORCEMENT								
WALL TYPE	"H" FROM	"H" TO	"T"	"A"	"B" FROM	"B" TO	"C"	"D"	"W"	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	"Ld"
(A) (**)	2'-0"	7'-9"	1'-3"	2'-0"	1'-7/8"	1'-3 1/2"	3'-9"	1'-0"	7'-0"	#6 ● 12"	#5 ● 12"	#5 ● 12"	#5 ● 12"	#4 ● 12"	N/A	N/A	#4 ● 12"	N/A
(A2) (**)	6'-6"	6'-6"	1'-3"	2'-0"	1'-3"	1'-3"	3'-9"	1'-0"	7'-0"	#6 ● 12"	#5 ● 12"	#5 ● 12"	#5 ● 12"	#4 ● 12"	N/A	N/A	#4 ● 12"	N/A
(B)	7'-9"	13'-6"	1'-3"	2'-6"	1'-3 1/2"	1'-6"	4'-9"	1'-0"	8'-6"	#7 ● 12"	#5 ● 12"	#7 ● 12"	#5 ● 12"	#4 ● 12"	#7 ● 12"	#5 ● 12"	#4 ● 12"	3'-0"
(C)	13'-6"	13'-6"	1'-6"	3'-0"	1'-6"	1'-6"	5'-6"	1'-0"	10'-0"	#7 ● 12"	#5 ● 12"	#7 ● 12"	#5 ● 12"	#5 ● 12"	#7 ● 12"	#5 ● 12"	#5 ● 12"	3'-0"
(D)	17'-0"	23'-6"	2'-6"	7'-0"	2'-1"	2'-6"	10'-6"	1'-0"	20'-0"	#9 ● 9"	#6 ● 12"	#9 ● 9"	#5 ● 12"	#6 ● 12"	#9 ● 9"	#6 ● 12"	#6 ● 12"	4'-9"
(E)	10'-10"	17'-0"	2'-0"	5'-0"	1'-8 1/4"	2'-1"	8'-0"	1'-0"	15'-0"	#8 ● 12"	#5 ● 12"	#8 ● 12"	#5 ● 12"	#5 ● 12"	#8 ● 12"	#5 ● 12"	#5 ● 12"	3'-9"
(E1)	14'-6"	14'-6"	2'-0"	5'-0"	2'-0"	2'-0"	8'-0"	1'-0"	15'-0"	#8 ● 12"	#5 ● 12"	#8 ● 12"	#5 ● 12"	#5 ● 12"	#8 ● 12"	#5 ● 12"	#5 ● 12"	3'-9"
(F)	8'-0"	10'-10"	1'-3" (*)	3'-0"	1'-3"	1'-4"	5'-6"	1'-0"	10'-0"	#6 ● 12"	#5 ● 12"	#6 ● 12"	#5 ● 12"	#4 ● 12"	#6 ● 12"	#5 ● 12"	#4 ● 12"	2'-2"
(G)	8'-0"	14'-6"	1'-3" (*)	5'-0"	1'-3"	1'-5 1/2"	8'-0"	1'-0"	15'-0"	#8 ● 12"	#5 ● 12"	#8 ● 12"	#5 ● 12"	#5 ● 12"	#8 ● 12"	#5 ● 12"	#5 ● 12"	3'-9"
(H)	17'-0"	23'-6"	2'-6"	17'-0"	2'-1"	2'-6"	2'-0"	1'-0"	21'-6"	#9 ● 9"	#6 ● 12"	#5 ● 12"	#5 ● 12"	#6 ● 12"	#9 ● 9"	#6 ● 12"	#6 ● 12"	4'-9"
(I)	10'-10"	17'-0"	2'-0"	17'-0"	1'-8 1/4"	2'-1"	2'-0"	1'-0"	21'-0"	#8 ● 12"	#5 ● 12"	#5 ● 12"	#5 ● 12"	#5 ● 12"	#8 ● 12"	#5 ● 12"	#5 ● 12"	3'-9"
(J)	8'-0"	10'-10"	1'-3" (*)	17'-0"	1'-3"	1'-4"	2'-0" to 1'-0"	1'-0"	19'-6"	#6 ● 12"	#5 ● 12"	#5 ● 12"	#5 ● 12"	#5 ● 12"	#6 ● 12"	#5 ● 12"	#5 ● 12"	2'-2"
(K)	8'-0"	8'-0"	1'-3" (*)	17'-0"	1'-3"	1'-3"	1'-0"	1'-0"	19'-3"	#6 ● 12"	#5 ● 12"	#5 ● 12"	#6 ● 12"	#4 ● 12"	N/A	N/A	#4 ● 12"	N/A
(L)	8'-0"	14'-6"	1'-3" (*)	17'-0"	1'-3"	1'-5 1/2"	2'-0"	1'-0"	21'-0"	#9 ● 12"	#5 ● 12"	#6 ● 12"	#5 ● 12"	#5 ● 12"	#9 ● 9"	#5 ● 12"	#5 ● 12"	4'-9"

(*) MINIMUM DIMENSION

(**) FOR REINFORCEMENT OF WALL TYPE (A1) SEE SECTION F-F ON DWG S-3.

C-1122B

STATE OF COLORADO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE
DENVER, COLORADO

BIG BEAVER DAM
TYPICAL WALL
REINFORCEMENT

REVISIONS: 4/13/95 (1) REVISIONS

		DATE
DESIGNED BY	F.O.O.	6/94
DRAWN BY	M.W.M.	6/94
CHECKED BY		
DRAWING NUMBER	S-4	

APPROVED BY
APPROVED BY
APPROVED BY
CHIEF ENGINEER

SHEET 8 OF 8

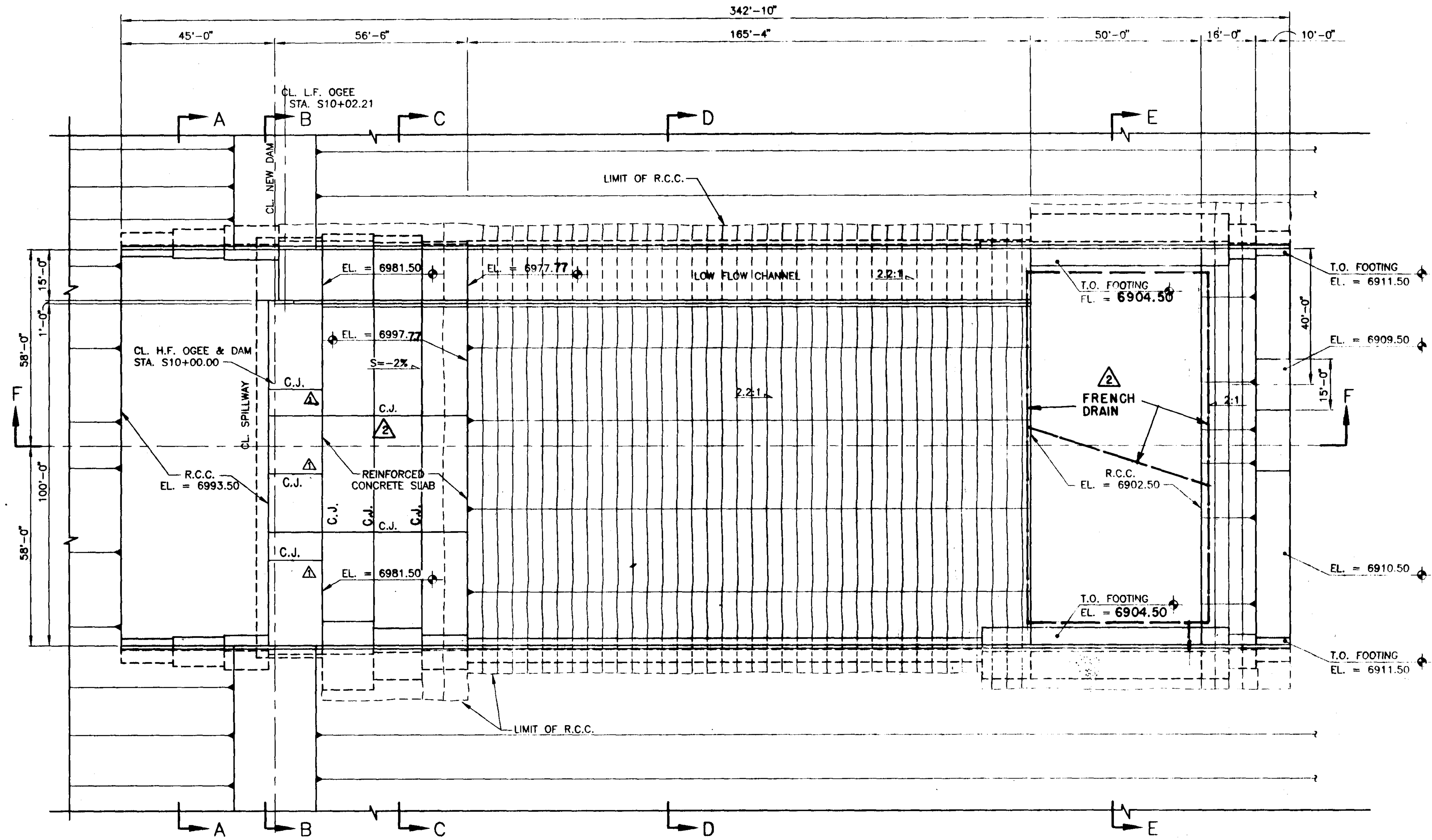
C-1122B

STATE OF COLORADO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE
DENVER, COLORADO

BIG BEAVER DAM STRUCTURAL SECTIONS AND DETAILS

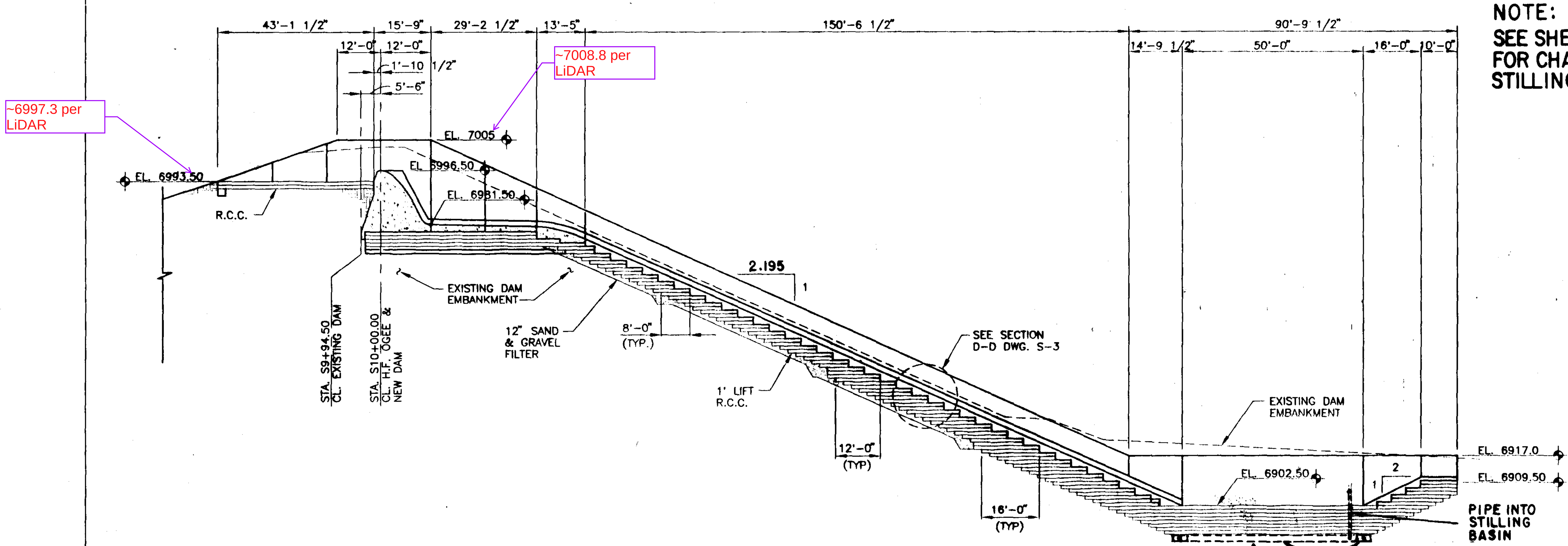
REVISIONS: 2 AS BUILT 4-17-97; 1 7/13/95

DESIGNED BY F.O.O.	6/94	APPROVED BY	
DRAWN BY M.W.M.	6/94	APPROVED BY	
CHECKED BY		APPROVED BY	
DRAWING NUMBER S-3		CHIEF ENGINEER	
		SHEET 7 OF 8	



SPILLWAY PLAN

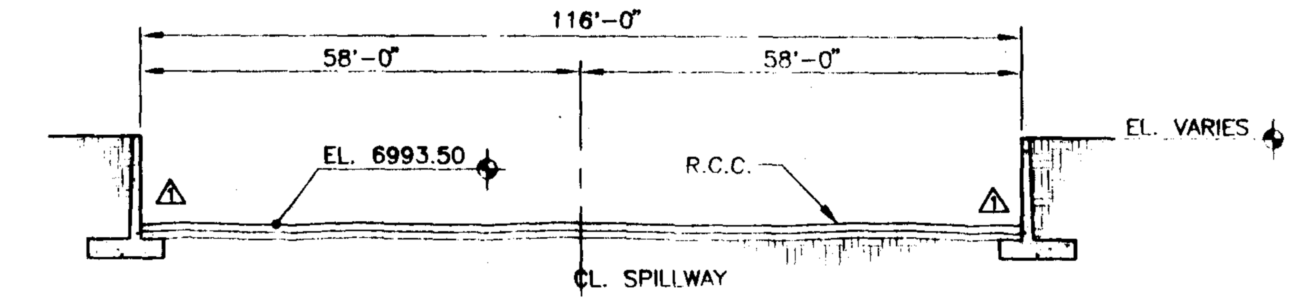
SCALE: 1" = 20'



SECTION F-F

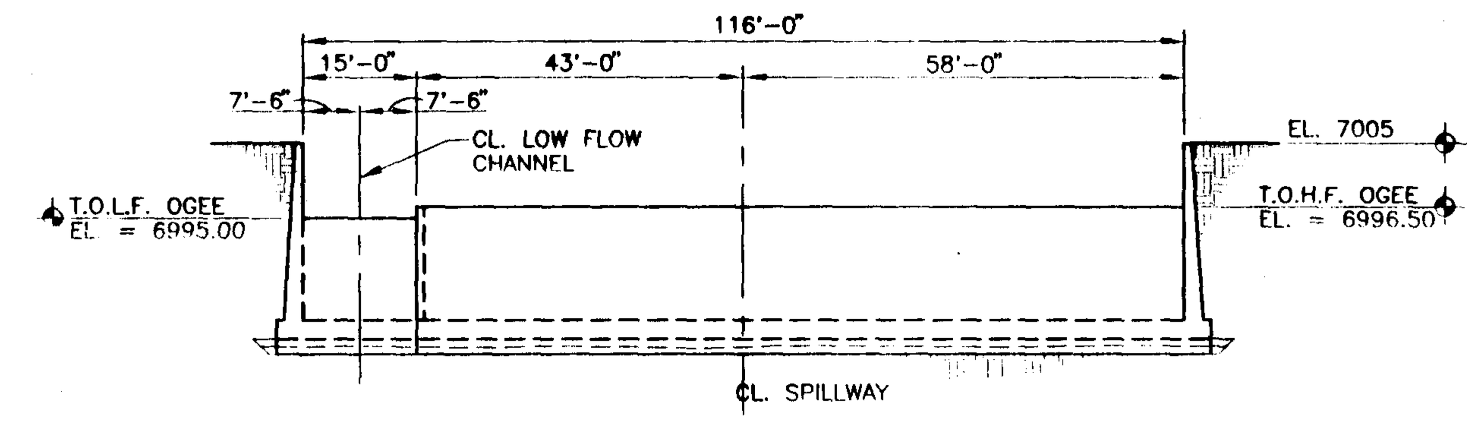
SCALE: 1" = 20'

NOTE:
SEE SHEET 6 of 8 FOR CHANGES TO STILLING BASIN



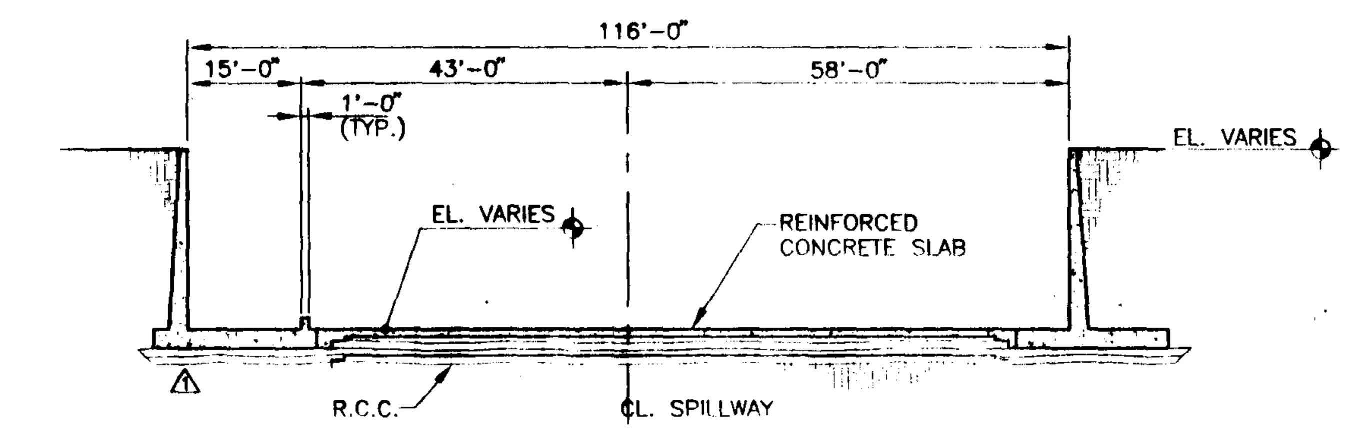
SECTION A-A

SCALE: 1" = 20'



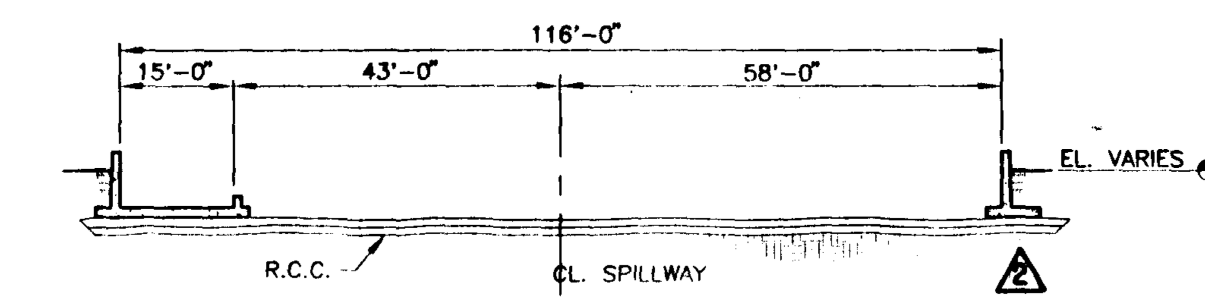
SECTION B-B

SCALE: 1" = 20'



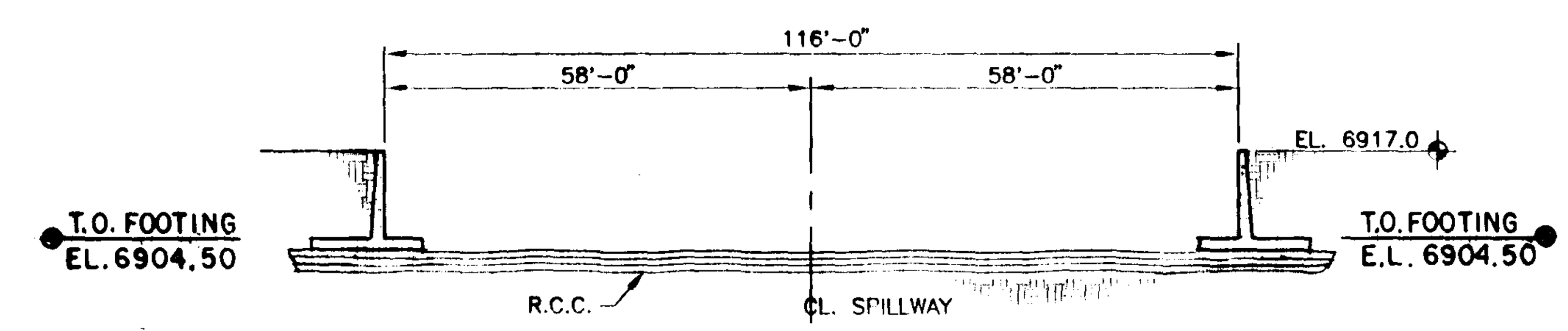
SECTION C-C

SCALE: 1" = 20'



SECTION D-D

SCALE: 1" = 20'



SECTION E-E

SCALE: 1" = 20'

SCALE IN FEET
SCALE: 1" = 20'

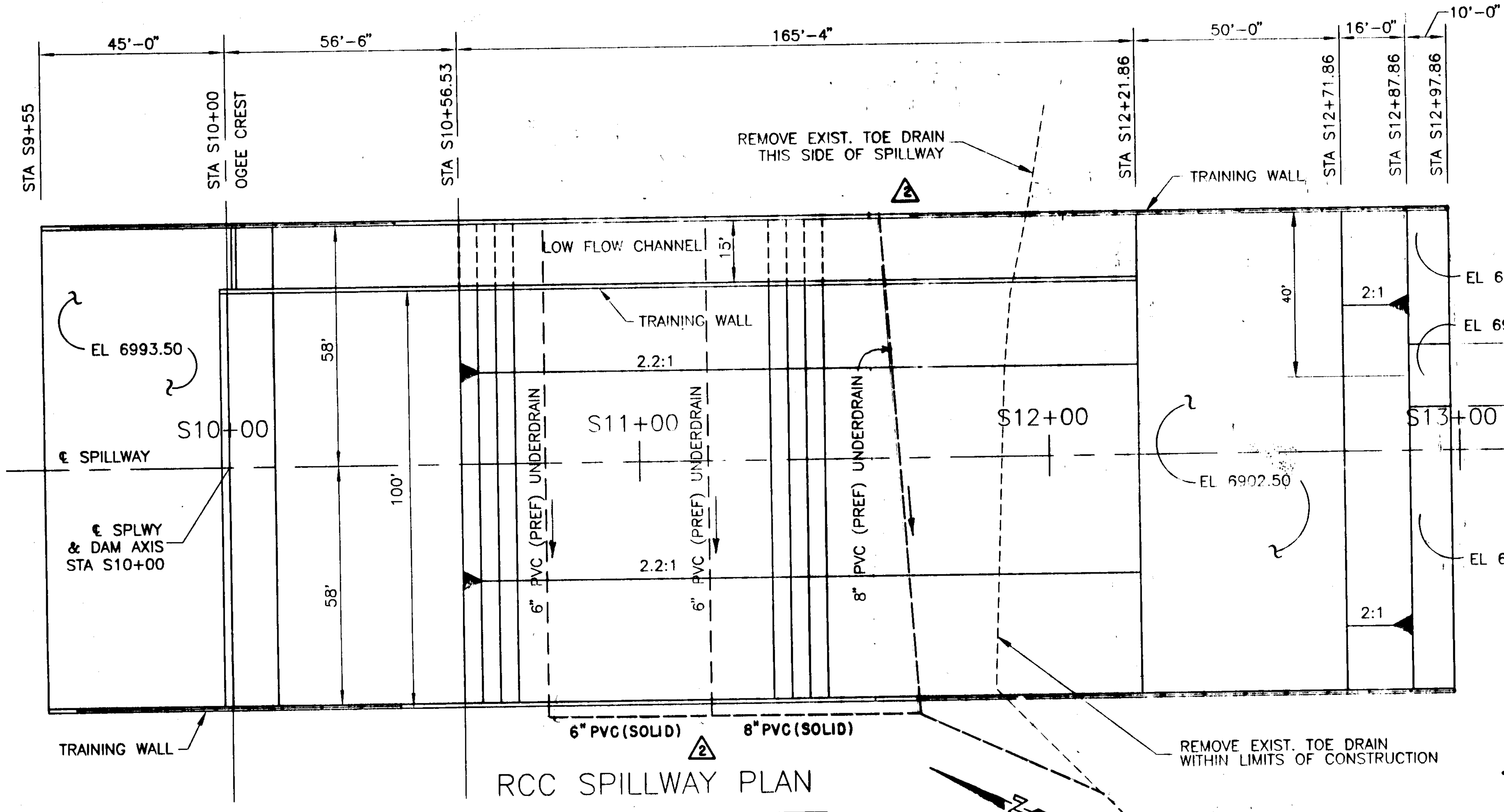
C-1122B

STATE OF COLORADO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE
DENVER, COLORADO

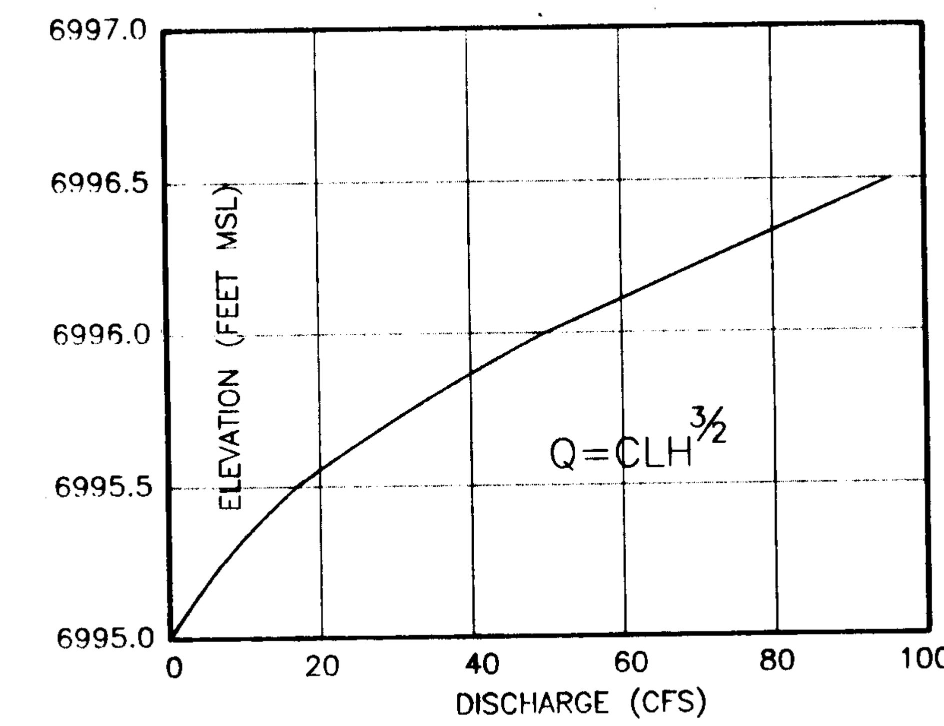
BIG BEAVER DAM
SPILLWAY REPLACEMENT
PLAN AND SECTIONS

DATE	DESCRIPTION	GT	BY
4-17-97	AS BUILT		
4/13/95	REVISIONS		

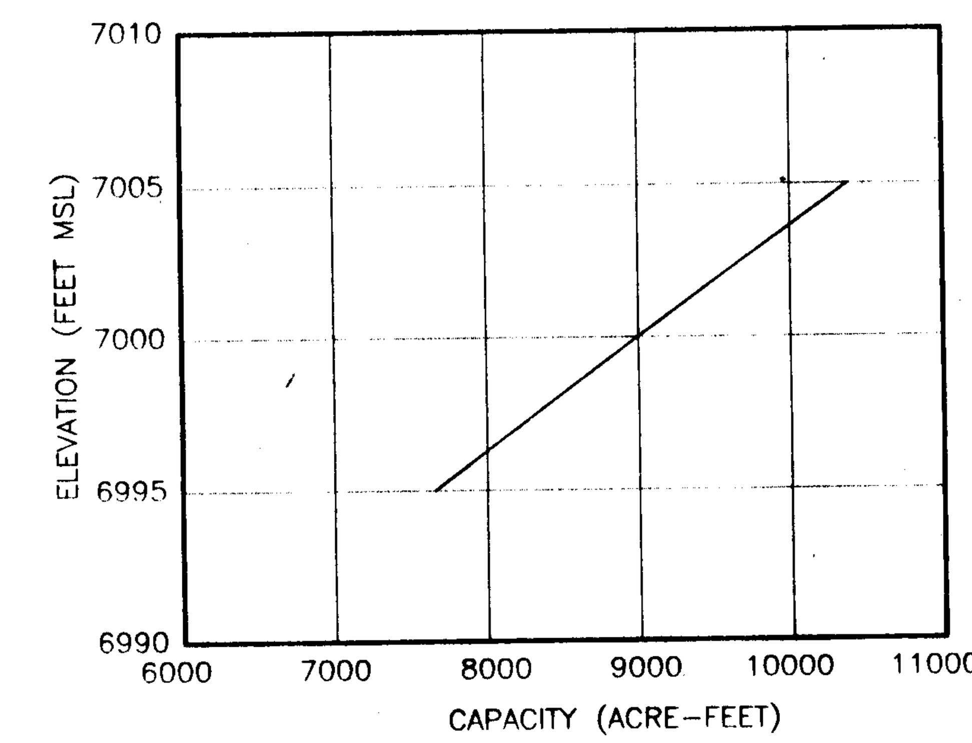
		DATE	
DESIGNED BY	F.O.Q.	6/94	APPROVED BY
DRAWN BY	M.W.M.	6/94	APPROVED BY
CHECKED BY			APPROVED BY
			CHIEF ENGINEER
DRAWING NUMBER	S-1		SHEET 5 OF 8



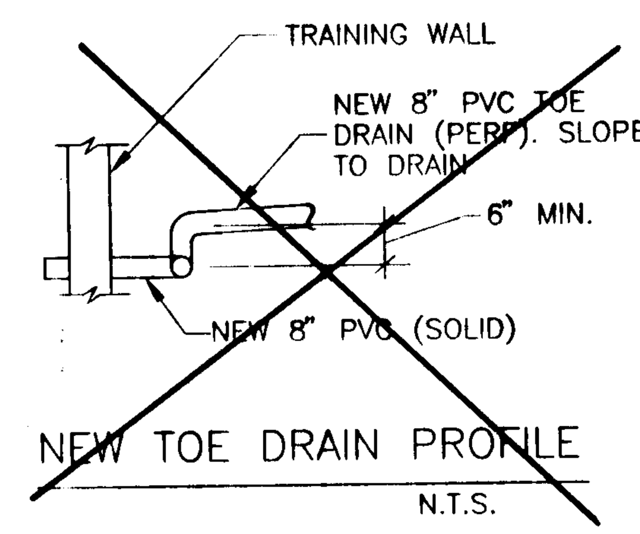
RCC SPILLWAY PLAN



LOW-FLOW SPILLWAY DISCHARGE CURVE

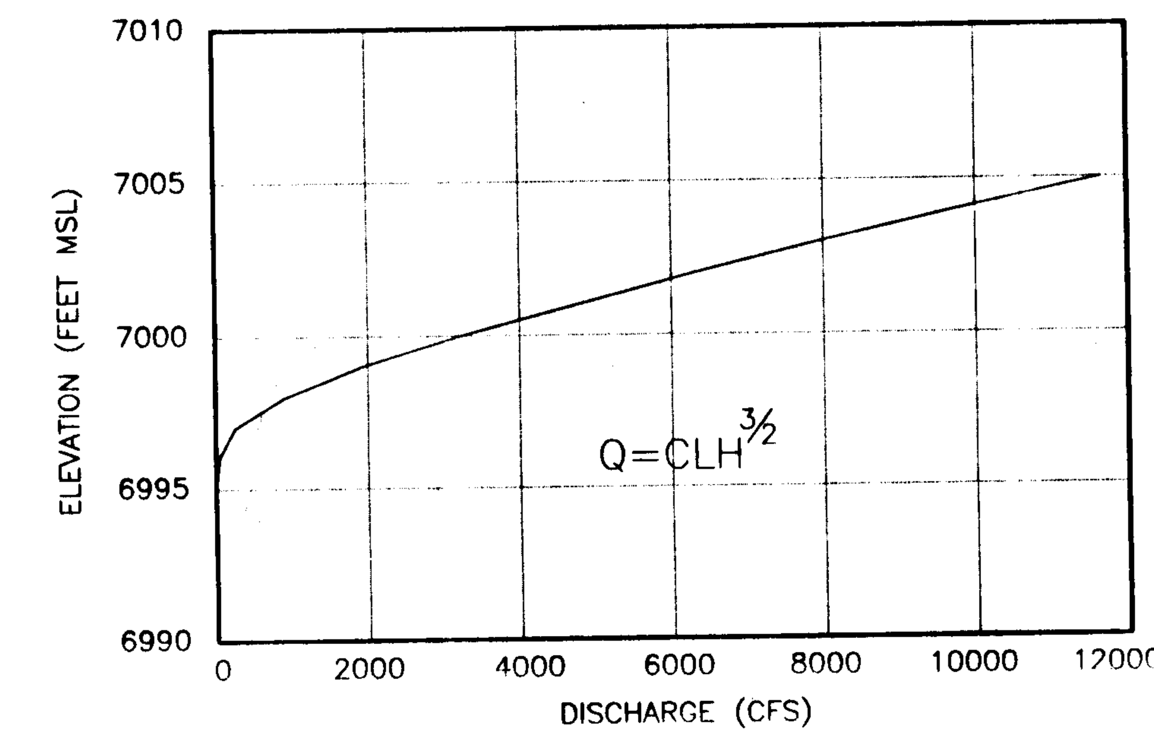


RESERVOIR CAPACITY CURVE



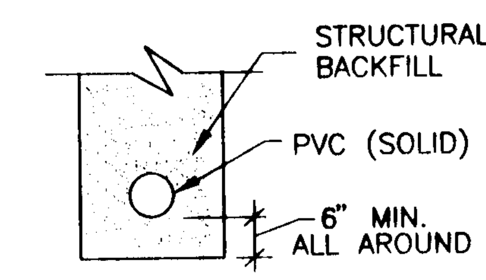
NEW TOE DRAIN PROFILE

N.T.S.



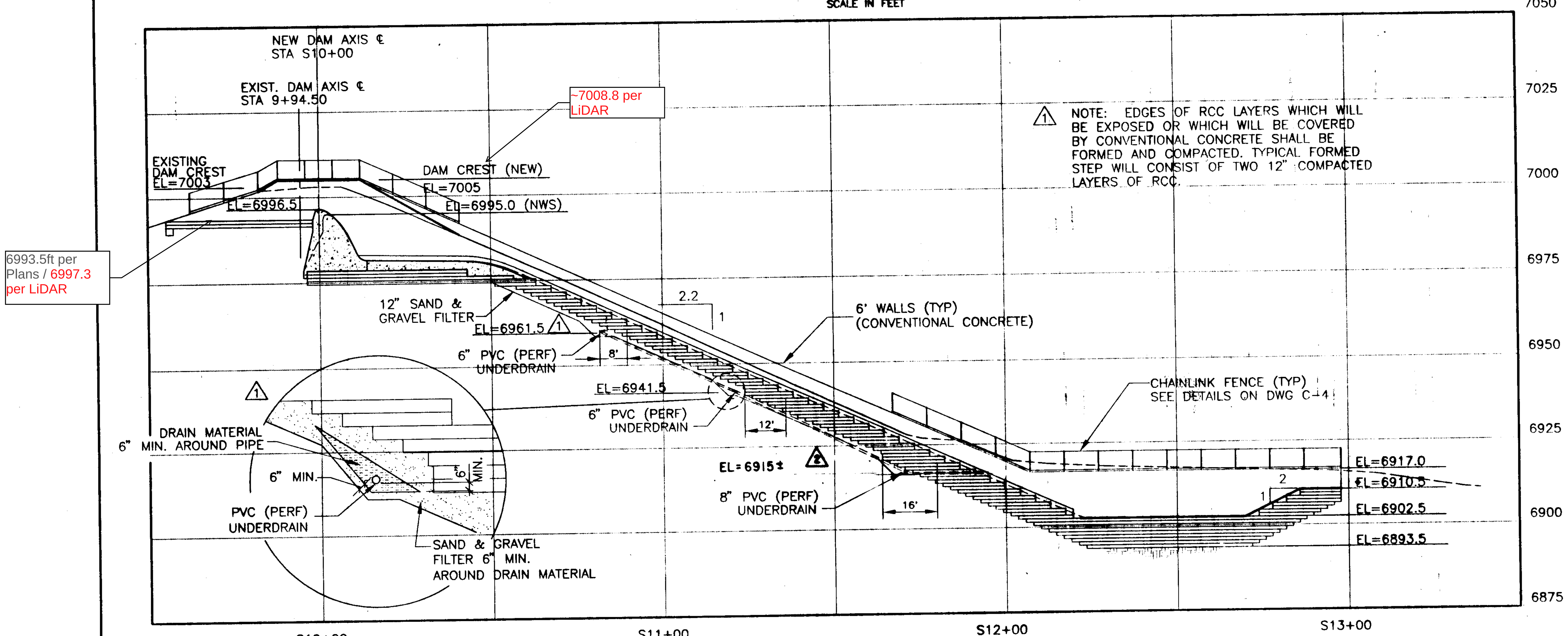
COMBINED SPILLWAY DISCHARGE CURVE

NOTE:
SEE SHEET 6 of 8 FOR CHANGES TO STILLING BASIN



PVC (SOLID) SECTION

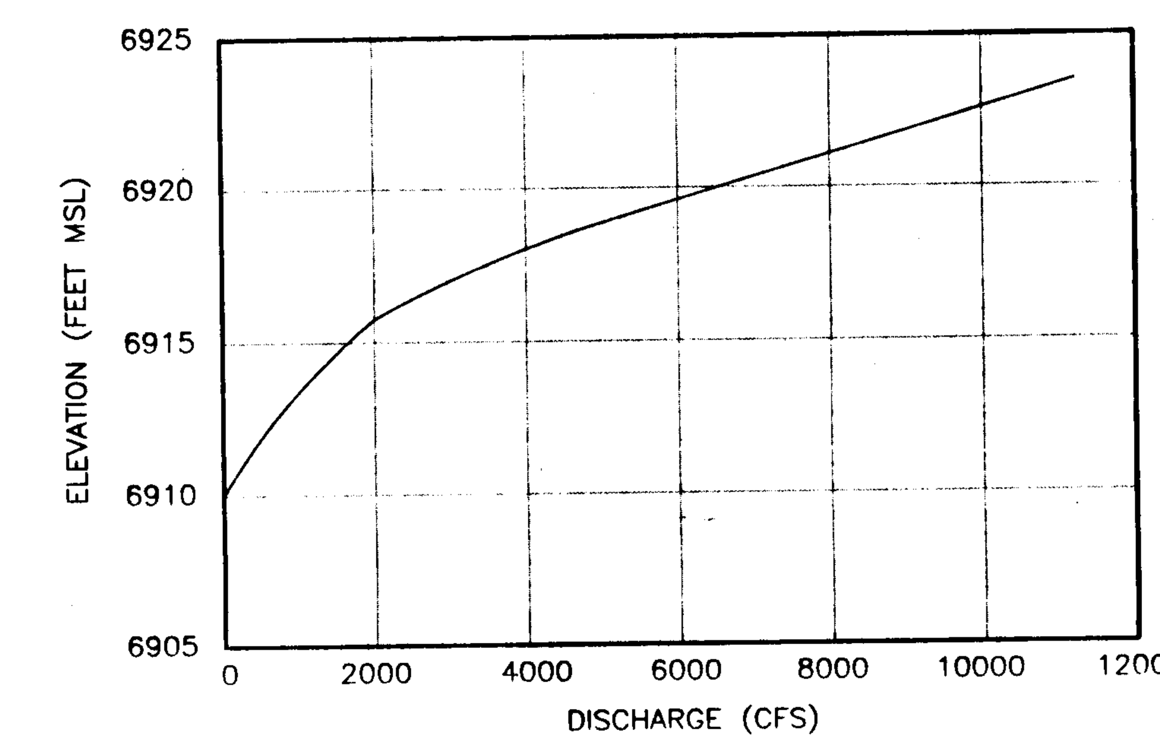
N.T.S.



RCC ℄ SPILLWAY PROFILE

HORIZONTAL 0 10 20 SCALE IN FEET

VERTICAL 0 10 20 SCALE IN FEET



TAILWATER RATING CURVE AT STILLING POOL

C-1122B

STATE OF COLORADO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE
DENVER, COLORADO

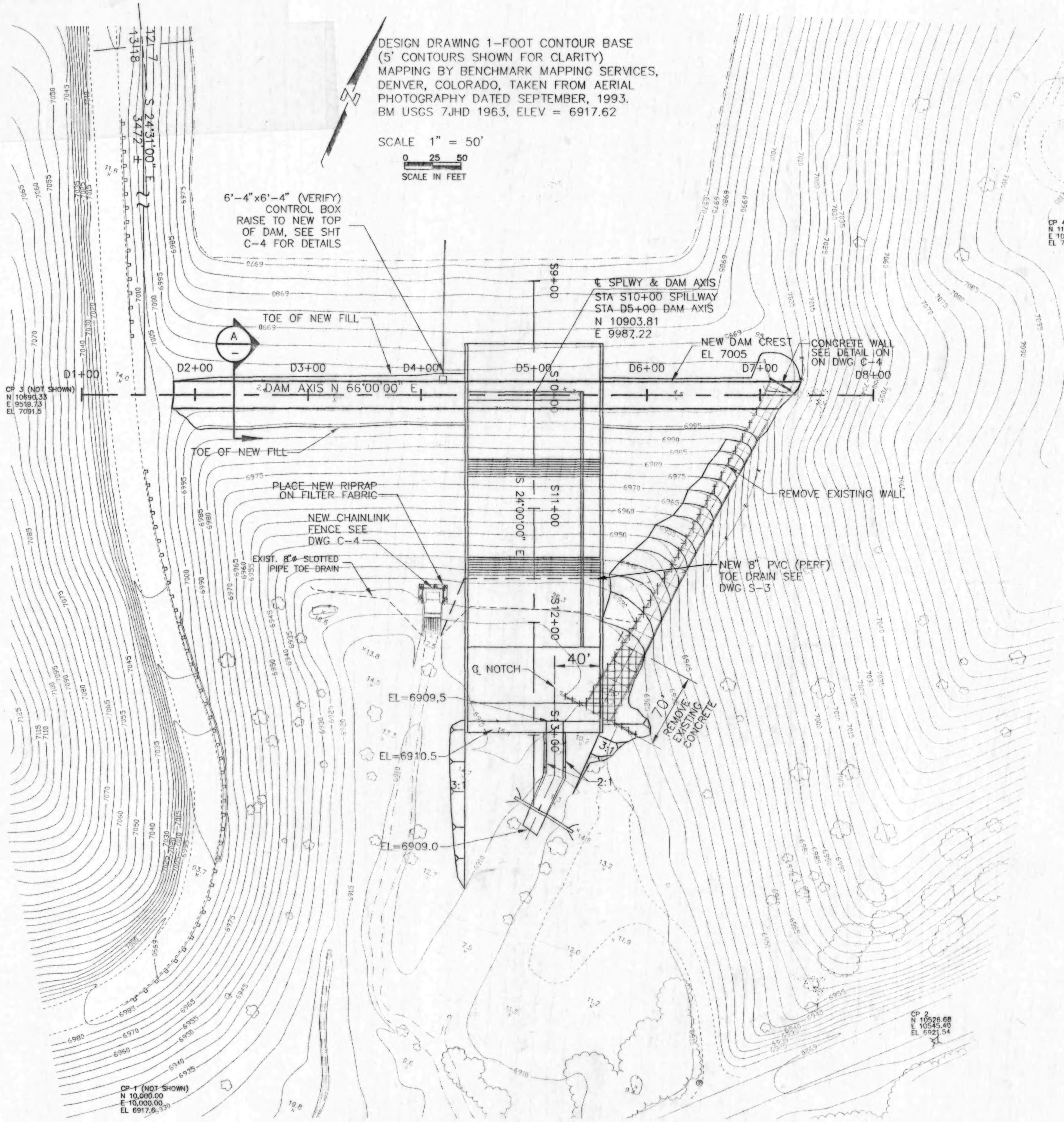
BIG BEAVER DAM
SPILLWAY REPLACEMENT
PLAN AND PROFILE

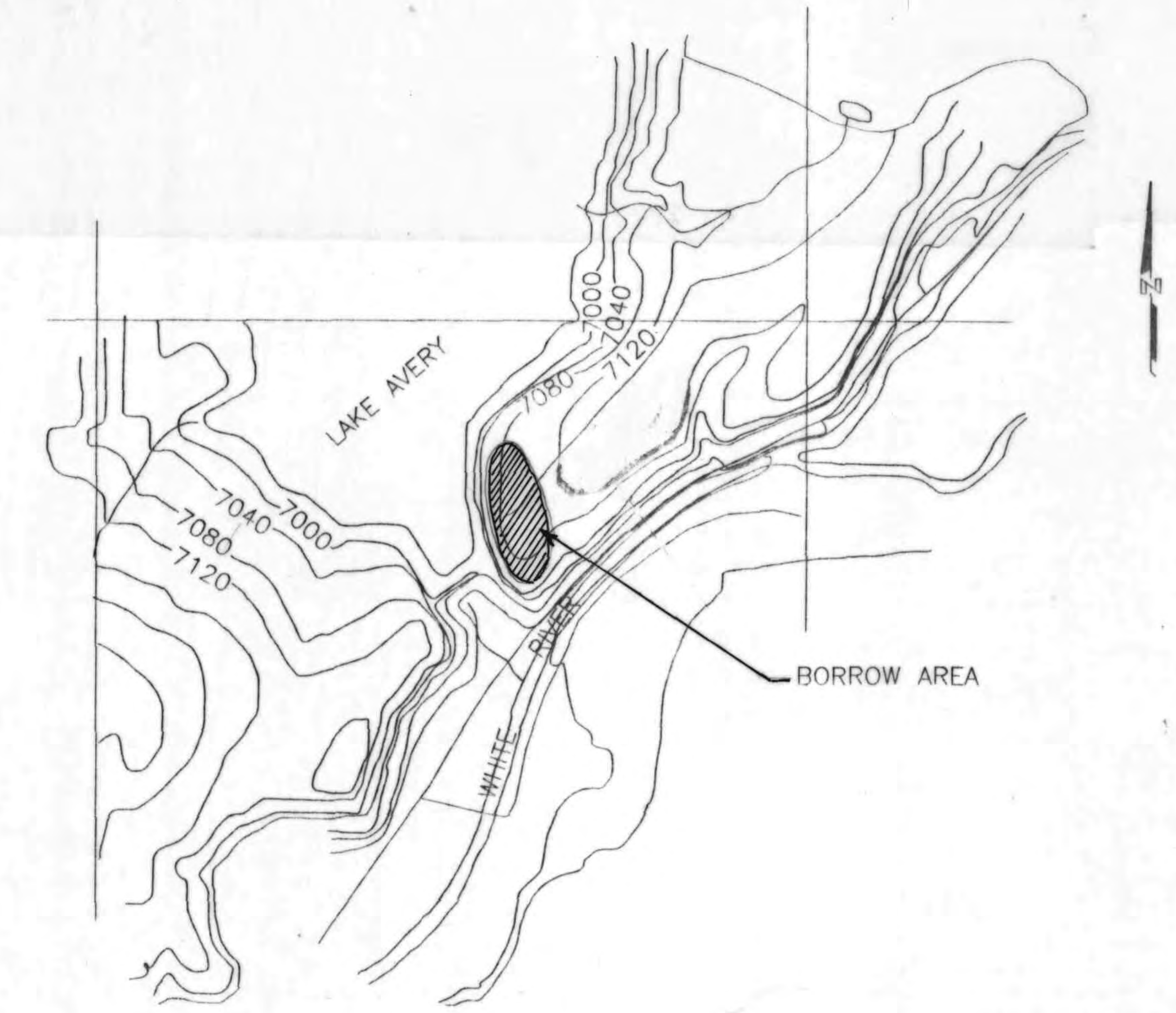
REVISIONS: 4-17-97 AS BUILT; 4/13/95 (1); DATE / REVISION DESCRIPTION / BY / GT

DESIGNED BY GMT
DRAWN BY EW
CHECKED BY
DRAWING NUMBER C-3
APPROVED BY
APPROVED BY
APPROVED BY
CHIEF ENGINEER
SHEET 3 OF 8

DESIGN DRAWING 1-FOOT CONTOUR BASE
(5' CONTOURS SHOWN FOR CLARITY)
MAPPING BY BENCHMARK MAPPING SERVICES,
DENVER, COLORADO, TAKEN FROM AERIAL
PHOTOGRAPHY DATED SEPTEMBER, 1993.
BM USGS 7JHD 1963, ELEV = 6917.62

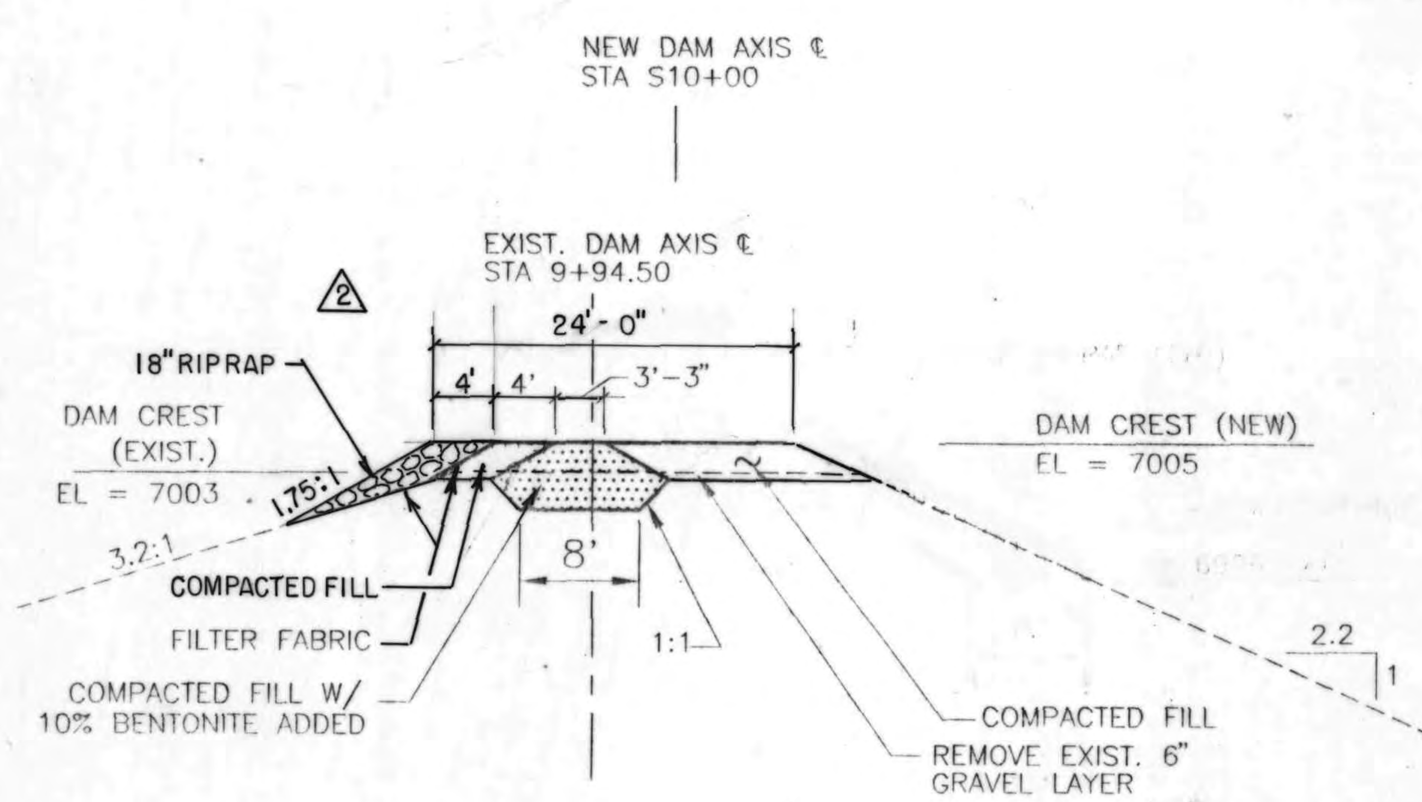
SCALE 1" = 50'





BORROW SITE

0 1000
SCALE IN FEET



SECTION (A)

0 5 10
SCALE IN FEET

C-1122B

REVISIONS			
DATE		DESCRIPTION	BY
4-17-97	2	AS BUILT	GT
4/15/96	1	REVISIONS	

STATE OF COLORADO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE
DENVER, COLORADO

BIG BEAVER DAM
SPILLWAY REPLACEMENT
SITE PLAN/BORROW SITE/SECTION

DESIGNED BY GMT	DATE	APPROVED BY
DRAWN BY EW, RLM		APPROVED BY
CHECKED BY		APPROVED BY
		CHIEF ENGINEER
DRAWING NUMBER C-2		SHEET 2 OF 8

Applegate Group, Inc.
Water Resource Advisors for the West

Memorandum

Date: 12/8/2021	AG Job No.: 10-118
To: Scott Grosscup	From: Craig Ullmann

RE: Lake Avery Enlargement – Next Steps

As you know our past work on a potential Lake Avery Enlargement has focused on the volume of water that could potentially be stored at the site without normal storage levels impacting the Livingston Property to the north. It is our understanding that the Yellow Jacket Water Conservancy District (YJWCD) is interested in further evaluation of this option. The purpose of this memo is to provide a high level outline of the steps necessary to further investigate this site. Since this structure is currently owned by CPW, we assume there will be ongoing coordination and interaction with their staff which is not specifically discussed below.

Task 1: Dam Breach and Flood Hydrology Analysis

The existing Hydrology study for Lake Avery was completed by Boyle Engineering in 1992. In this study the dam was assumed to be a high hazard dam and the regulations at that time required the spillway to pass 75% of the Probable Maximum Precipitation event. In 2020 the Colorado Dam Safety Branch published new guidelines and criteria for the construction and modification of embankment dams in the State of Colorado. These regulations introduced the new concept of Hydrologic Hazard classification which is separate from the existing Hazard Classification. This analysis factors in the population at risk during a dam failure and the hydraulic parameters of a dam breach event below the dam in order to estimate to potential loss of life from a risk-based perspective. Based on this analysis the Hydrologic Hazard for the structure will be classified as Extreme, High, Significant, and Low depending on the potential loss of life from an overtopping dam failure of the dam. This classification will determine the required spillway capacity for the structure. While the embankment dam is classified as a High Hazard dam, Lake Avery could potentially fall under either a High or Extreme Hydrologic Hazard.

Preliminary Dam Breach Analysis

An initial analysis of a dam breach would be performed using estimated dam breach values and an existing online tool offered by FEMA called DSS-WISE. This analysis would calculate the necessary parameters to estimate the population at risk, fatality rate, and thus potential loss of life. Using this information the likely Hydrologic Hazard could be estimated. A cursory analysis of the number of homes downstream of the dam indicates that the structure will likely fall into the Extreme category but since this has dramatic impacts on the spillway design we feel an initial analysis is warranted to verify this assumption prior to performing a Hydrology analysis.

Flood Hydrology Analysis

Following the preliminary dam breach analysis, a Hydrology Study would be performed assuming either a High or Extreme Hydrologic Hazard classification. The purpose of this analysis would be to determine the Inflow Design Flood (IDF) of the reservoir which informs the spillway design going forward. The IDF will be utilized to determine if the current spillway is adequate in the current condition and how raising or altering the spillway would potentially impact the feasibility of the project. This Hydrology analysis would be performed according to the most up to date guidance published by the Colorado Dam Safety Division.

The deliverable for this task would be a memo describing the results of the analysis and recommendations for additional study. This memo will also briefly discuss how the hydrology of the watershed would potentially impact the design of any enlargement.

Task 2: Feasibility Study and Cost Estimates

Our analysis of this structure has been conceptual in nature to date. Following the completion of Task 1 we would suggest performing a more detailed feasibility study of a potential enlargement. This study could evaluation a couple options, one of which would explore improvements to the existing spillway that may allow the storage of additional water by reducing the freeboard on the dam, and the other would include a full raising of the dam embankment and spillway structures.

Geotechnical Data Review

During this study any existing geotechnical reports would be reviewed, monitoring data from the reservoir, including toe drain flowrates, would be compiled, and reviewed to determine how any existing issues with the dam could impact a potential enlargement. This task would not include any additional geotechnical field investigations but would identify what future investigations and testing work would be required should the project be pursued further. The geotechnical analysis will include slope stability modeling of the existing embankment as well as proposed enlargements in order to determine what embankment improvements might be necessary under an enlarged scenario. Soil strength parameters used in this analysis will be based on existing Geotech data and engineering judgement.

Appurtenant Structures

This task will utilize existing LiDAR topography data and dam design documents for information regarding the dam embankment and outlet structure. Improvements and changes to the dam embankment, outlet structure, and spillway would be sketched conceptually to depict the required changes.

Permitting

Enlargement of this structure will undoubtedly require some level of permitting through a variety of agencies. An environmental consultant would provide an outline of the likely Federal, State and Local permitting requirements for either enlargement option.

Opinion of Probable Cost

Concept drawings would be used to estimate the quantities and construction costs associated with any improvements. These cost estimates could be used by YJWCD to strategize potential project funding for the two identified options. Costs would include construction as well as design and permitting costs.

Task 3 – Financial Planning & Funding

Following the feasibility study and generation of the opinion of probable cost, the next step should involve the financial planning of the selected option. Funding for this type of multiple benefit project could include many sources such as Colorado Water Plan Grants, CWCB low interest loan, WSRF Grant, and grants through non-profit groups whose interests and goals would be supported by the construction of the additional storage.

Task 4: Field Data Gathering

If the project continues to be pursued following the completion of the tasks above the project would then move into data gathering phase to collect necessary data needed for final design.

Geotechnical Data

Additional geotechnical information will likely be needed prior to final design, however, the scope will be determined by the work performed in task 2 following a detailed review of existing information. Given that any existing information on the structure was collected over 50 years ago and Dam Safety regulation have evolved since that time, additional geotechnical exploration is highly likely.

Survey

A topographic survey of the existing dam and surrounding area will be needed. This will include any existing infrastructure, property lines, existing utilities, and other pertinent information. A bathymetric survey would also likely be needed to generate an accurate stage-storage curve for the reservoir. This information would also allow CPW to estimate how much storage may have been lost due to sedimentation since the reservoir was constructed.

Wetlands

As mentioned above, enlargement of this reservoir will require permitting through the Army Corps of Engineers due to its on-channel location. A wetlands specialist would survey any existing wetlands that would be impacted at the site and what the likely permitting path and mitigation requirements would be.

Task 5: Final Design & Permitting

Following the collection of all necessary field data the project design could begin. This would involve preparation of detailed construction drawings and specifications for the project as well as a *Design Report*, *Hydrology Report*, and *Hazard Classification Report* detailing the design and analysis of the proposed project. This package would be submitted to the Dam Safety Branch for review. Comments from Dam Safety are typically returned within 6 months and responses are formulated by the design engineer. During this phase the project would also enter the permitting phase of the project where all necessary permits would be pursued and obtained prior to proceeding with construction.

<u>Task 6: Construction</u>

Construction of the project would follow the receipt of all permits including a final approval from Dam Safety. During construction, engineer oversight and a significant amount of QA/QC would be required. Prior to construction Dam Safety requires a construction observation and testing plan to be submitted and approved by their office prior to construction. Weekly updates would be required during construction and a final construction report that summarizes the construction process would be required upon completion of the project.

Timeframe and Estimated Costs

To help the YJWCD plan the potential implementation of this project we have prepared the table below that depicts the estimate timeline and cost of each Task listed above. These estimates are subject to change as the project progresses and additional information is gathered but this at least provides some high-level information for the board to consider. The costs vary widely in the latter tasks due to the fact that the size of the final project is undetermined at this time.

Task	Time for Completion	Cost
Dam Breach and Flood Hydrology	2 months	$15,000
Feasibility Study and Cost Estimates	6 Months	$40,000-$60,000
Financial Planning & Funding	3-6 Months	$5,000-$8,000
Field Data Gathering	3 Months	$100,000-$200,000
Final Design & Permitting	12-18 Months	$200,000 - $1 million
Construction	6-12 Months	$3.5 - $25 million

Memorandum

Date: 1/12/2024 AG Job No.: 10-118

To: Scott Grosscup
sgrosscup@balcombgreen.com

From: Tyler Desiderio, P.E.
tylerd@applegategroup.com

RE: Lake Avery Preliminary Site Studies

Applegate was tasked by the Yellow Jacket Water Conservation District (YJWCD) to perform a preliminary Hydrology Study and Hydrologic Hazard Analysis of Lake Avery in continuation of our efforts evaluating a potential enlargement of the reservoir. These efforts were recommended as next steps in our *Lake Avery Development Memo* sent to YJWCD in 2021. The following memo summarizes our efforts, findings, and future recommendations.

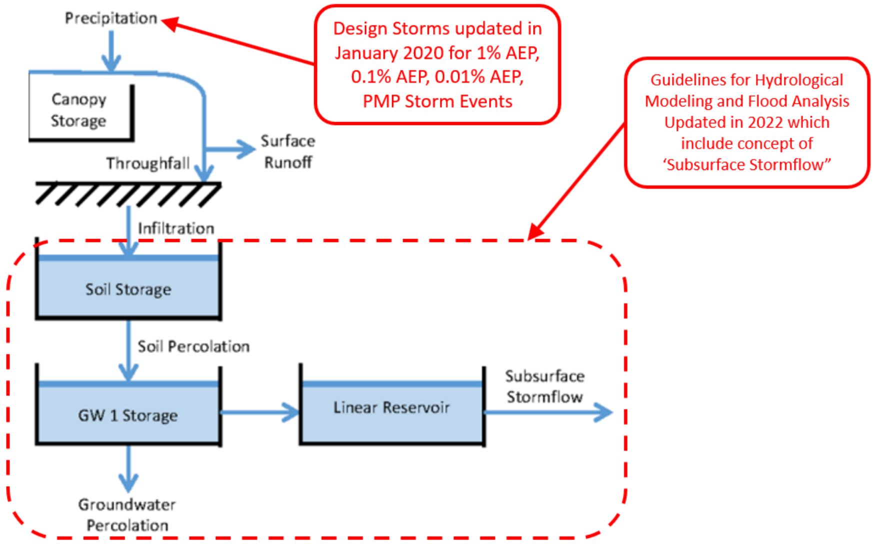
Purpose, Need, and Background Knowledge

Increasing storage at Lake Avery to store YJWCD conditional rights was identified as a viable option in previous studies conducted for YJWCD. An increase in storage can be achieved by either enlarging the entire dam structure or modifying the hydraulic capacity of the spillway to justify a higher normal water level or a combination of those two efforts. Evaluating hydrologic conditions at Lake Avery is fundamental to understanding the feasibility of achieving additional storage at the site.

The existing Hydrology Study for Lake Avery was completed by Boyle Engineering in 1992. In this Study, the dam was assumed to be a high hazard dam and the regulations at the time required the spillway to route 75% of the Probable Maximum Flood event for high hazard structures. Since then, the Colorado Dam Safety Branch has enacted changes to the dam regulation landscape that is relevant to our analysis:

- **Hydrologic Hazard Analysis:** In 2020, The Colorado Dam Safety Branch has updated and re-released their *Rules and Regulations for Dam Safety and Dam Construction (Rules and Regs)*. The new *Rules and Regs* introduced the concept of Hydrologic Hazard classification which determines spillway sizing criteria for dams and reservoirs. Hydrologic Hazard classification is a risk-based analysis that quantifies the expected loss of life resulting from an overtopping dam failure during a flooding event. This concept is separate from Hazard classification which determines all other design criteria and inspection requirements for dams. Hazard classification is a deterministic analysis that estimates the potential for loss of life resulting from a sunny-day failure of a dam.
- **Updated Design Storms:** The standard of practice for hydrology studies of dams in Colorado has also seen recent significant changes. The Colorado Dam Safety Branch conducted extensive climate and precipitation studies, ultimately resulting in updated design storms for use to determine inflow design floods. Previously, design storms, particularly lower frequency events, were based on very general storm data applied to the entirety of the state. Now, the state is divided into distinct regions with storms of similar characteristics defined for each region, resulting in more scientifically based design storm data that considers historical precipitation records. *Guidelines for the use of Regional Extreme Precipitation Study (REPS) Rainfall Estimation Tools* contains more details on these updated design storms and how to gather that data for analysis.
- **Updated Hydrological Modeling and Flood Analysis Guidelines:** In 2022 the Colorado Dam Safety Branch also updated their *Guidelines for Hydrological Modeling and Flood Analysis* which impacts how inflow design floods are determined for dams in the state, and thus how spillways are sized. The new guidelines incorporate many changes to the hydrology modeling but the major difference is soil mositure accounting and subsurface stormflow mechanisms are now explicitly modeled when determining a basin's response to precipitation. The guidelines also require “Reasonableness Checks” and model calibration based on the gage records, paleo flood data, and other available flood records.

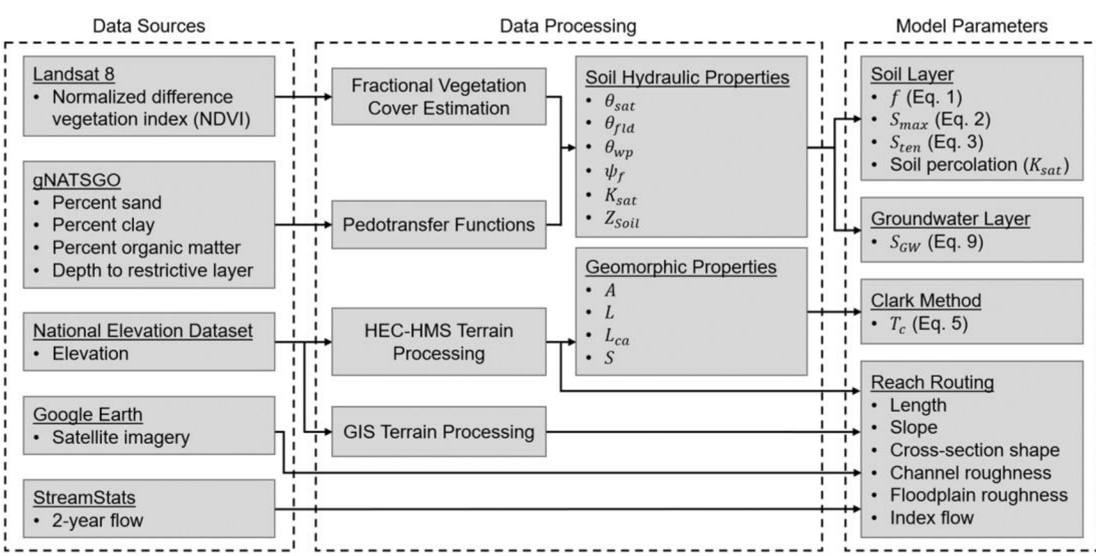
The following figure shows a simplified depiction of how basin runoff is modeled with changes to the standard of practice highlighted in **RED**.



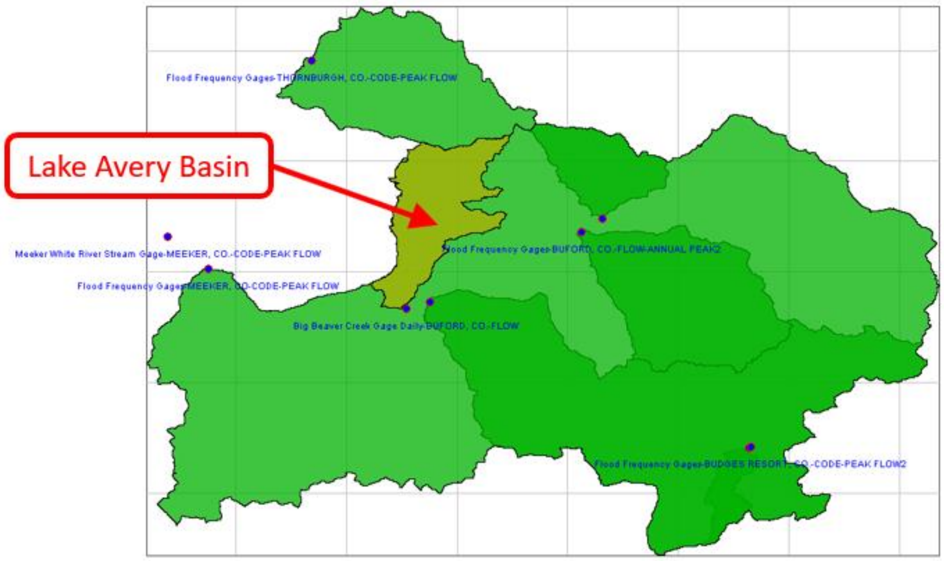
Colorado Dam Safety branch has indicated that the changes discussed above have generally resulted in less intense inflow design storms on the West Slope and more intense inflow design storms on the Front Range and Eastern Plains compared to the previous standard of practice. This creates an opportunity for dams on the West Slope, such as Lake Avery, to increase storage without enlarging the embankment by justifying lower inflow design floods which is the main driver of our efforts.

PRELIMINARY HYDROLOGY STUDY

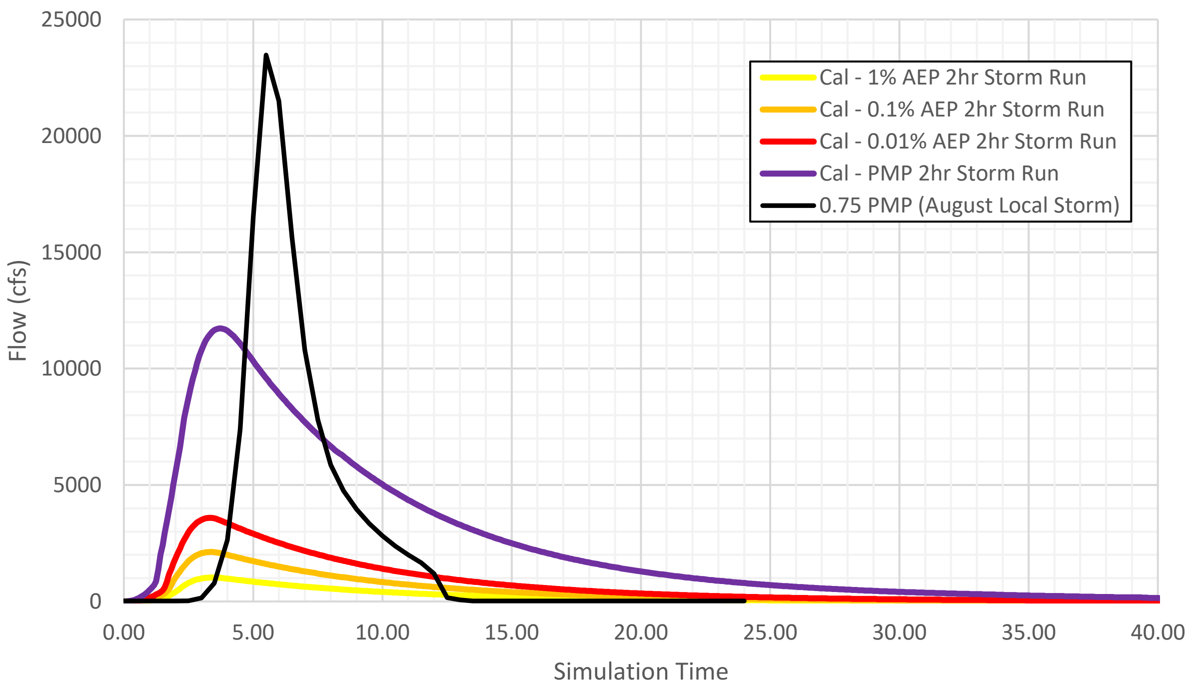
Applegate conducted a preliminary Hydrology Study per the recently updated *Guidelines for Hydrological Modeling and Flood Analysis* and *Guidelines for use of Regional Extreme Precipitation Study (REPS) Rainfall Estimation Tools*. A hydrologic model was developed utilizing HEC-HMS with input parameters determined via the *Guidelines*. The following figure shows a flow chart taken from the *Guidelines for Hydrologic Modeling and Flood Analysis* overviewing model parameters incorporated into the HEC-RAS model.



The hydrology model was refined and calibrated based on flood frequency analysis of nearby gage records performed according to *Guidelines for Determining Flood Flow Frequency Bulletin 17C* published by the United States Geological Survey (USGS). The following map shows USGS stream gages near Lake Avery's basin considered in our analysis (**BLUE** dots show gage station locations while drainage basins for each are shown in **GREEN**).



Ultimately, only USGS Stream Gages 09250000(Milk Creek near Thornburgh), 0903300 (River at Budges Resort), and 09302450 (Lost Creek near Buford) were utilized for calibration as they had an adequate number of records and basin characteristics most similar to Lake Avery's drainage basin. Inflow design flood hydrographs generated from the calibrated HEC-HMS hydrology model are shown in the following chart alongside the inflow design flood hydrograph from the Boyle Engineering 1994 Hydrology Study.



The following table summarizes storm volumes and peak flows generated from each storm.

Storm Characteristic	Design Storm				
	1% AEP 2hr Storm	0.1% AEP 2hr Storm	0.01% AEP 2hr Storm	PMP 2hr Storm	0.75 PMP from 1994 Hydrology Study
Peak Inflow	1,031 cfs	2,129 cfs	3,591 cfs	11,730 cfs	23,472 cfs
Runoff Volume	717 ac-ft	1,473 ac-ft	2,511 ac-ft	8,862 ac-ft	5,857 ac-ft

Our updated preliminary Hydrology Study shows peak flows significantly less than those generated from the inflow design flood from the Boyle Engineering's 1994 Hydrology Study. Storm volume from the 1994 Hydrology Study however is within the range of storm volumes determined from this analyis. This is consistent with Colorado Dam Safety experience that design floods on the West Slope will generally be less intense than design storms determined with older Hydrologic Analysis methods.

PRELIMINARY HYDROLOGIC HAZARD ANALYSIS

As previously mentioned, the recently updated *Rules and Regs* now incorporate the concept of Hydrologic Hazard that determines the inflow design flood and thus spillway sizing for dams and reservoirs in Colorado. This concept classifies dams into Low, Significant, High, or Extreme Hydrolgoic Hazard Groups based on the expected loss of life and significant damage resulting from an overtopping dam failure initiated by a storm event exceeding the spillway capacity. Design rainfall events, and thus inflow design floods, are prescribed for spillway design based on the Hydrologic Hazard designation of the structure per the following table taken from the *Rules and Regs.*

Hydrologic Hazard	Consequence Criteria	Critical Rainfall
Extreme	Life loss potential greater than 1	Probable Maximum Precipitation
High	Life loss potential less than 1	0.01% AEP Storm Event
Significant	No life loss potential but significant damage expected	0.1% AEP Storm Event
Low	No life loss potential or significant damage expected	1% AEP Storm Event

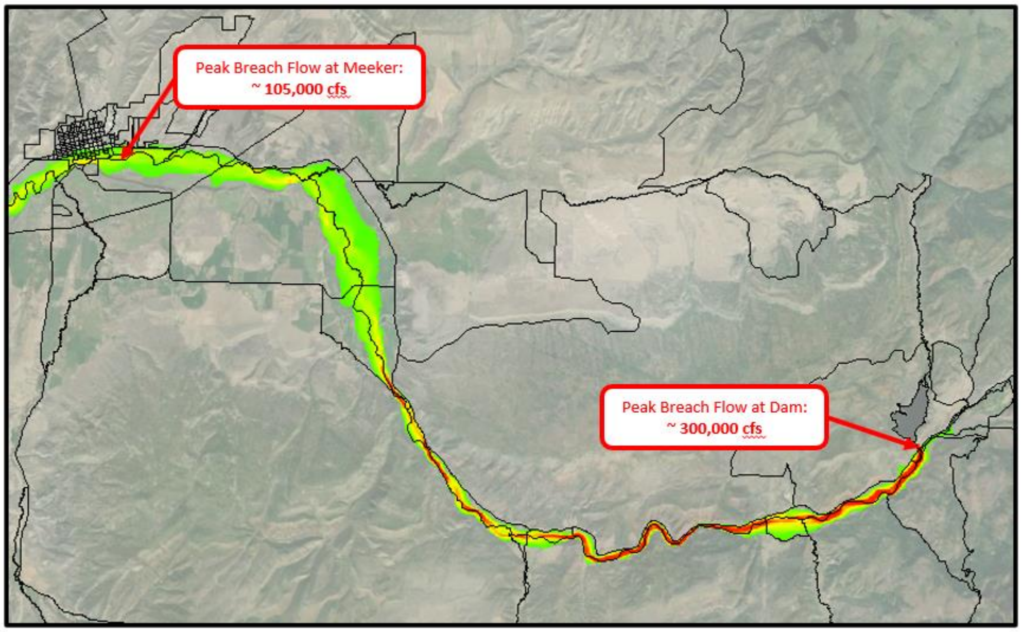
A preliminary Hydrologic Hazard Analysis was completed for Lake Avery following recommendations presented in *Guidelines for Hydrologic Hazard Analysis* and *Guidelines for Dam Breach Analysis*. Hydrologic Hazard analysis can be broken down to the following general steps:

1. Development of overtopping dam failure breach parameters
2. Breach flood modeling and routing
3. Consequence analysis of the resulting inundation area.

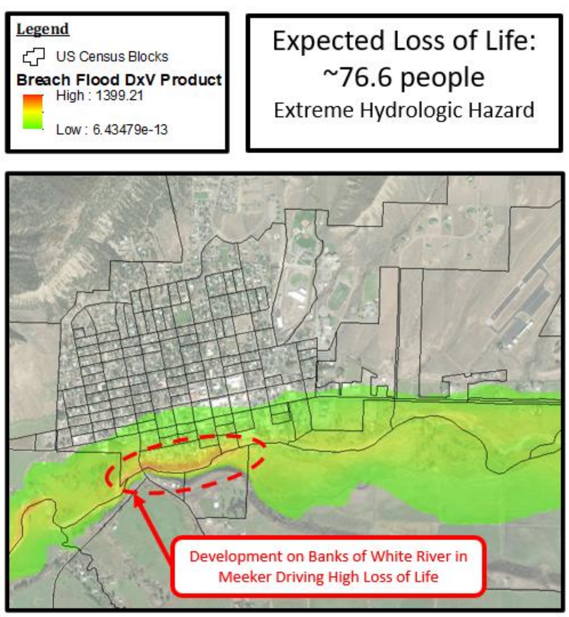
Hydrologic Hazard analysis is an iterative process started by assuming an initial Hydrologic Hazard designation and then repeating the analysis as necessary by increasing the Hydrologic Hazard rating assumption until the consequences match the criteria for that Hydrologic Hazard rating as shown in the table above.

Our analysis assumed an initial High Hydrologic Hazard rating. Breach parameters were determined per *Guidelines for Dam Breach Analysis* and input into the HEC-HMS model to generate a breach flow hydrograph. DSS-WISE Web (2D hydraulic modeling online platform hosted by FEMA) was utilized to route the breach flow hydrograph through the downstream reach. 2D model results were then used to estimate consequences resulting from an overtopping breach failure of Lake Avery.

Consequence analysis entails identifying the Population at Risk (PaR) impacted by the overtopping breach flood and then estimating Loss of Life by applying fatality rates to the PaR based on the hydraulic conditions they experience. The PaR for this analysis was determined based on US Census Block data data within the breach flood inundation area. Fatality rates were assumed from fatality rate curves published by the United States Bureau of Reclamation (USBR). Loss of life was then estimated by applying fatality rate curves to the PaR based on the maximum depth-velocity products they experienced per the 2D modeling results. The following figure shows the overtopping breach flood and the resulting Loss of Life estimate.



Overview Map of Overtopping Breach Flood



Blowup of Results at Meeker

Our analysis estimated a Loss of Life of 76 people resulting from the overtopping failure of Lake Avery, which greatly exceeds the consequence criteria for an Extreme Hydrologic Hazard structure. **We believe Lake Avery would likely receive an Extreme Hydrologic Hazard designation from the Colorado Dam Safety Branch and thus the Probable Maximum Flood is the spillway sizing criteria.** Please note that the Probable Maximum Flood determined as part of our analysis is different from the 0.75 Probable Maximum Flood determined in Boyle Engineering's 1994 Hydrology Study.

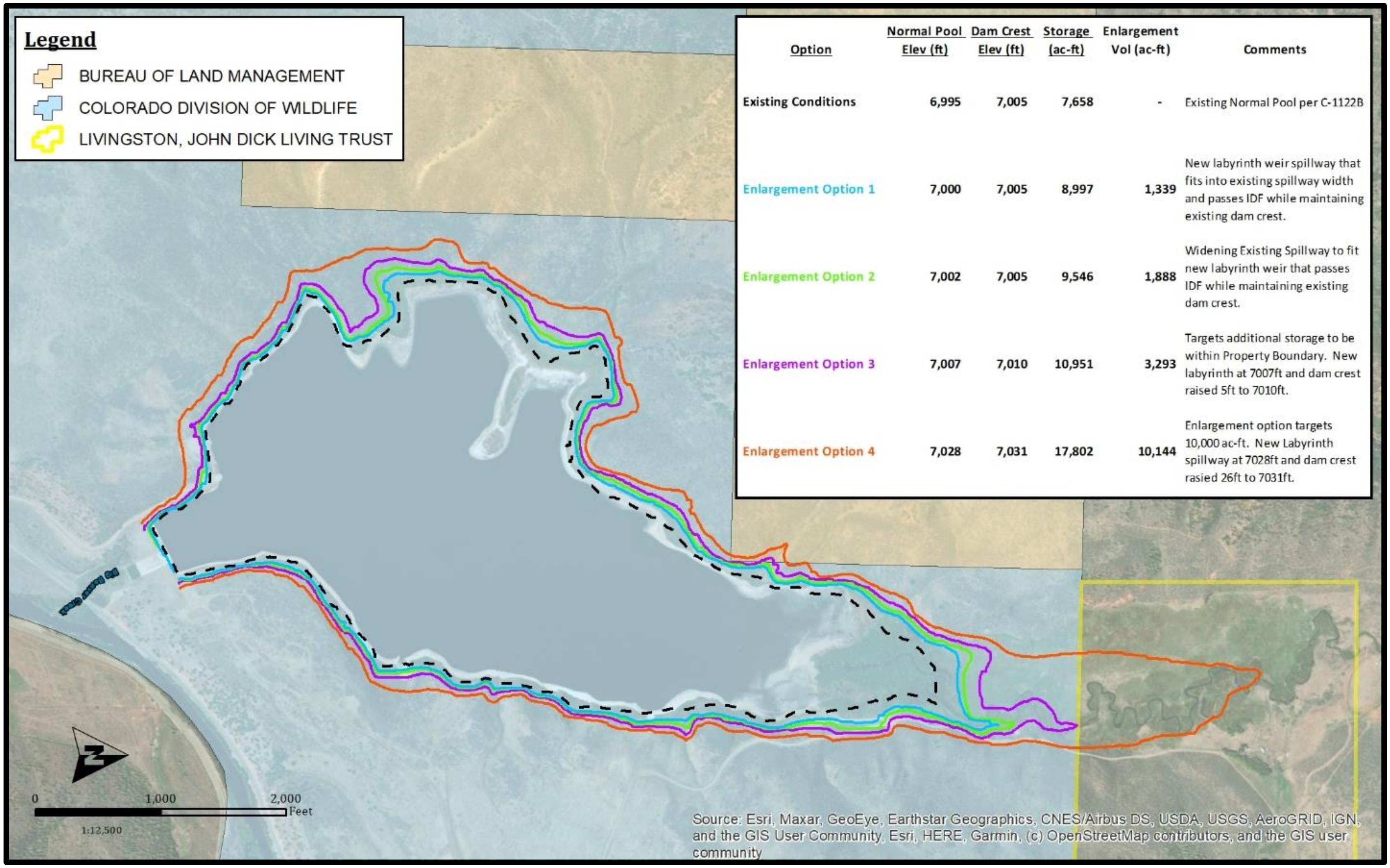
The majority of Loss of life estimated in this analysis originates from developments on the banks of the White River in Meeker impacted by severe hydraulic conditions during the breach flood. It is also worth noting that the estimated breach flows of 300,000cfs at the breach itself which attenuated to 105,000 cfs at the town of Meeker are orders of magnitude larger than peak inflow design flood values determined from the preliminary Hydrology Study. This indicates that further refinement of the inflow design flood or attempting an incremental Hydrologic Hazard analysis approach will not likely justify a lower Hydrologic Hazard rating.

IMPLICATIONS TO LAKE AVERY STORAGE OPTIONS

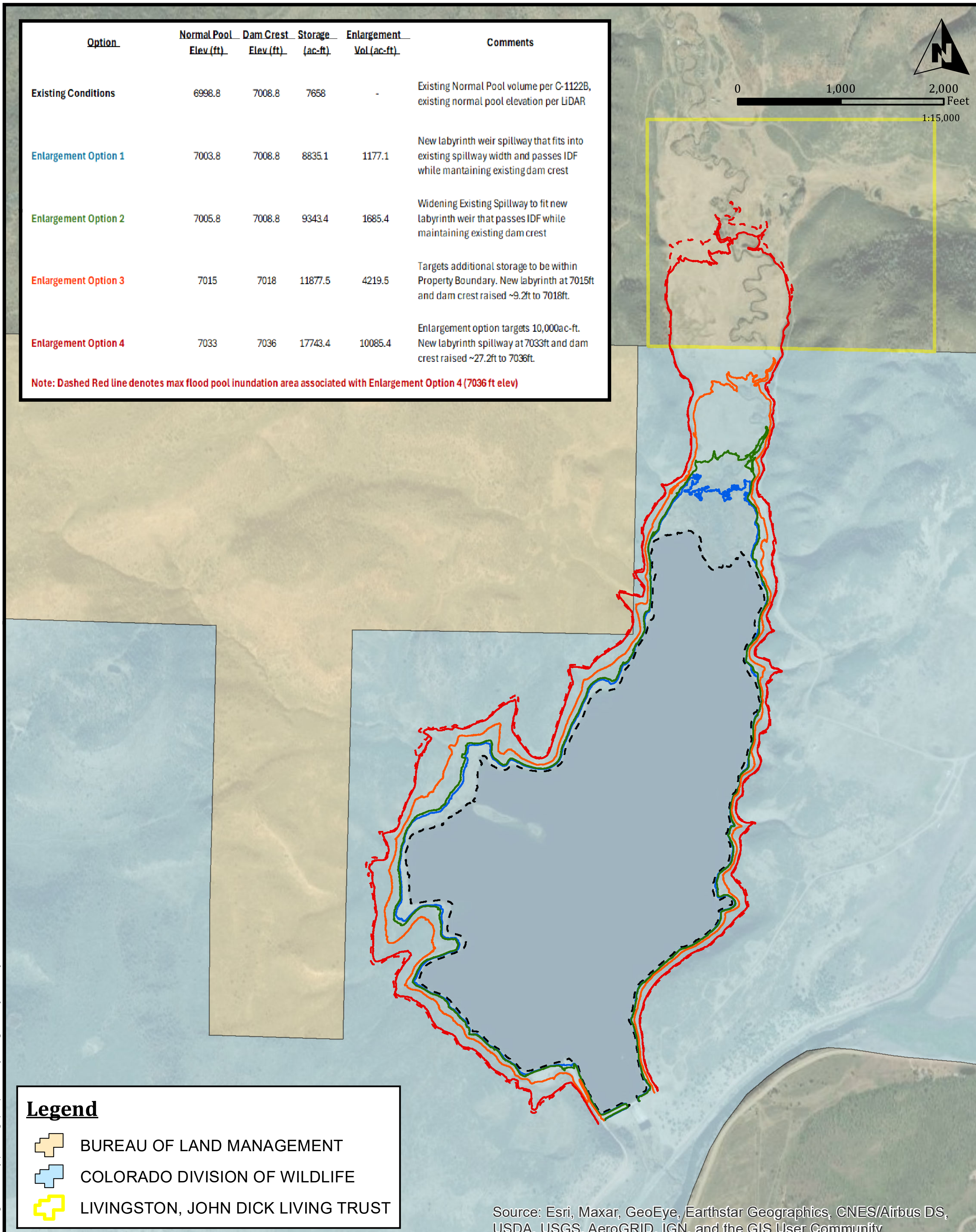
Our preliminary Hydrology Study and Hydrology Hazard analyses were used to refine the potential enlargement option for Lake Avery identified in a previous study. Enlargement options take advantage of the reduced size of the inflow design flood(Probable Maximum Flood, shown as a **PURPLE** line in the hydrograph figure) to achieve additional storage by modifying the spillway configuration in addition to enlarging the dam embankment. The following 4 options were identified which are presented in order of increasing complexity and cost;

- **Enlargement Option 1** proposes raising the spillway invert by 5ft and modifying the spillway with a labyrinth weir in the existing spillway width. The spillway is sized to pass the inflow design flood while maintaining the existing dam crest without enlargement. This option results in 1,339 ac-ft of additional storage.
- **Enlargement Option 2** proposes raising the spillway invert by 7ft and widening the spillway with a new labyrinth weir all while maintaining the existing dam crest without enlargement. This option results in 1,888 ac-ft of additional storage.
- **Enlargement Option 3** proposes raising the spillway invert 12ft with a labyrinth weir and raising the dam crest by 5ft to achieve additional storage contained within Colorado Parks and Wildlife's property boundary. This option results in 3,293 ac-ft of additional storage.
- **Enlargement Option 4** proposes raising the spillway invert 33ft with a labyrinth weir and raising the dam crest by 26ft to target 10,000 ac-ft of additional storage.

These enlargement options are also shown in the Map on the following page.



Option	Normal Pool Elev (ft)	Dam Crest Elev (ft)	Storage (ac-ft)	Enlargement Vol (ac-ft)	Comments
Existing Conditions	6,995	7,005	7,658	-	Existing Normal Pool per C-1122B
Enlargement Option 1	7,000	7,005	8,997	1,339	New labyrinth weir spillway that fits into existing spillway width and passes IDF while maintaining existing dam crest.
Enlargement Option 2	7,002	7,005	9,546	1,888	Widening Existing Spillway to fit new labyrinth weir that passes IDF while maintaining existing dam crest.
Enlargement Option 3	7,007	7,010	10,951	3,293	Targets additional storage to be within Property Boundary. New labyrinth at 7007ft and dam crest raised 5ft to 7010ft.
Enlargement Option 4	7,028	7,031	17,802	10,144	Enlargement option targets 10,000 ac-ft. New Labyrinth spillway at 7028ft and dam crest rasied 26ft to 7031ft.



Option	Normal Pool Elev (ft)	Dam Crest Elev (ft)	Storage (ac-ft)	Enlargement Vol (ac-ft)	Comments
Existing Conditions	6998.8	7008.8	7658	-	Existing Normal Pool volume per C-1122B, existing normal pool elevation per LiDAR
Enlargement Option 1	7003.8	7008.8	8835.1	1177.1	New labyrinth weir spillway that fits into existing spillway width and passes IDF while mantaining existing dam crest
Enlargement Option 2	7005.8	7008.8	9343.4	1685.4	Widening Existing Spillway to fit new labyrinth weir that passes IDF while maintaining existing dam crest
Enlargement Option 3	7015	7018	11877.5	4219.5	Targets additional storage to be within Property Boundary. New labyrinth at 7015ft and dam crest raised ~9.2ft to 7018ft.
Enlargement Option 4	7033	7036	17743.4	10085.4	Enlargement option targets 10,000ac-ft. New labyrinth spillway at 7033ft and dam crest raised ~27.2ft to 7036ft.

Note: Dashed Red line denotes max flood pool inundation area associated with Enlargement Option 4 (7036 ft elev)

Yellow Jacket

Lake Avery Enlargement Options

Date: 21 Oct 2024

Job #: 10-118

Drawn By: TJD

Figure: 1 Of: 1

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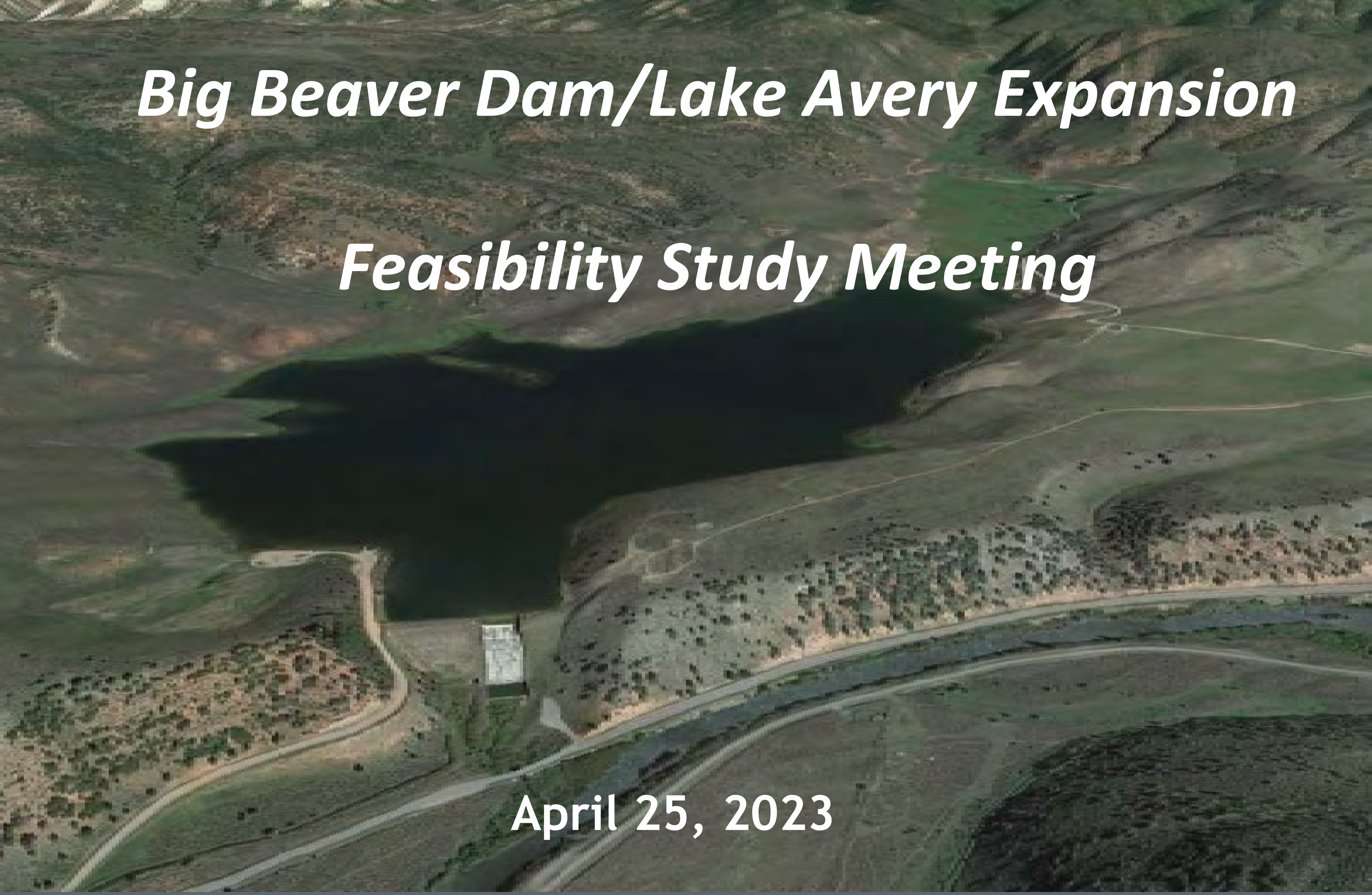
Date Saved: 10/21/2024 4:39:06 PM
Path: N:\10118 Yellow Jacket Water Storage Feasibility\Drawings\GIS\LakeAveryEnlargementOptionsMapv2.mxd

Big Beaver Dam/Lake Avery Expansion

Feasibility Study Meeting



April 25, 2023

LIVE LIFE OUTSIDE

AGENDA

- *Introductions*
- *Big Beaver Dam Outlet Rehab Project Update*
- *Lake Avery Expansion History*
- *CPW Dam Safety Recommendations for Inclusion in the Feasibility Study*
- *Group discussion/Questions*
- *Next steps and path forward*

INTRODUCTIONS

CPW

- *Capital Development Program Manager – Margaret Taylor*
- *Dam Safety Engineer / CPW Project Manager – Eric Eisinger, P.E.*
- *Dam Safety Engineer / CPW Project Manager – Lincoln Harberger, P.E.*
- *Area Wildlife Manager – Bill deVergie*
- *District Wildlife Manager – Bailey Franklin*
- *Assistant Area Wildlife Manager – Mike Swaro*
- *Property Technician – Cory Bullen*

Yellow Jacket Water Conservancy District

- *Scott Grosscup*

Applegate Group

- *Craig Ullmann*

Update on the Big Beaver Dam Outlet Rehab Project

- Large Capital Request funded this year (July 2023)
- Applying for LWCF Grant Funding in April 2024
  (The project will occur regardless of this grant funding)
- Currently soliciting an RFQ for Engineering design services to be awarded and begin design in July.
- Field surveying for Cultural/Environmental Resources and Permitting this summer
- Anticipated design completion Spring 2024*
- Begin reservoir drawdown in August/September 2024*
- Anticipated Construction beginning in November 2024*
- Construction completed in winter 2024/2025 in time to refill during spring runoff 2025*

*Note that CPW Dam Safety's Goal is to make these dates possible, but more clarity on the schedule will become available once design work begins

Update on the Big Beaver Dam Outlet Rehab Project

This project will address the greatest known risks to dam safety – failure of the existing outlet works.

The dam is classified by the State as a High Hazard Dam, meaning that its failure would cause loss of human life downstream.

Project Goals:

- Maintain public safety during and after construction
- Restore dam to safe operating conditions and reinstate the maximum life cycle performance of the dam
- Minimize future long-term maintenance requirements
- Minimize disruption to CPW, recreationalists, and Stakeholders' activities
- Minimize aquatic and terrestrial disruptions

*Note that the repairs are being made based on the existing dam and infrastructure and not an expanded reservoir.

LAKE AVERY EXPANSION HISTORY

Expansion and Safety Evaluation to Date:

1975 – Investigation of dam raise by 93 feet and max capacity of 55,000 AF, Bureau of Reclamation

1984 – Geotechnical Evaluation of expansion suitability, CWCB

1991 – Seismic Refraction Survey, IECO

1992 – Geologic Investigation, Bureau of Reclamation

1992/1994 - Hydrology Study

1993 – Safety Evaluation & Conceptual Designs, Bureau of Reclamation

1997 – Subsurface Categorization during Drilling Operations, Western Engineers

LAKE AVERY EXPANSION HISTORY

General Findings Among Previous Studies:

- Incompetent dam foundation to depths of 40 feet and greater. Likely inadequate seepage cutoff measures. Extremely high pore pressures in the foundation soils
- Deep gravel terrace beginning just above crest elevation in left abutment will make positive seepage cutoff extremely difficult and costly. "Most economically attractive storage alternative… was to remove the present Avery dam and construct a new embankment"
- Indication that environmental exposure (iron bacteria) has destroyed steel pipe drains, and plausible that it has also destroyed the sheet pile seepage cutoff wall
- Lack of construction documentation and the antiquated state of the practice at the time, make dam potential failure modes more plausible

LAKE AVERY EXPANSION HISTORY

Applegate Group

Lake Avery Enlargement – Next Steps Memo, December 8, 2021

This memo proposed a series of 6 tasks to further investigate the feasibility of expanding the storage potential, followed by planning, design and construction

- Task 1: Dam Breach and Flood Hydrology Analysis
- Task 2: Feasibility Study and Cost Estimates
- Task 3: Financial Planning and Funding
- Task 4: Field Data Gathering (Geotechnical, Surveying, Wetlands)
- Task 5: Final Design & Permitting
- Task 6: Construction

**CPW is not aware if Task 1 has begun or was completed already.*

Any updates from Yellow Jacket or Applegate?

LAKE AVERY EXPANSION HISTORY

January 10, 2023 - CPW letter consenting to Yellow Jacket conducting a Feasibility Study in coordination with CPW

The purpose of today's meeting is to discuss the next steps for Yellow Jacket's feasibility study and CPW Dam Safety Program's recommendations for inclusion in the study.

CPW Dam Safety is happy to provide any available documentation that we have, but we would like to note that we are not planning significant staff involvement in the Yellow Jacket Feasibility Study.

CPW cautioned that this letter of approval for a feasibility study is to be conducted at the expense of YJWCD, and does not provide the Conservancy District authority to store its water rights in Lake Avery until any and all potential issues have been resolved to CPW's satisfaction.

CPW Dam Safety Program
Recommendations for Inclusion in the Feasibility Study

- Geologic and Foundation Evaluation
- Geotechnical Evaluation (stability and seepage of the existing and expanded dam)
- Feasibility Level Hydraulic Evaluation (how will the spillway and outlet function?)
- Raise Geometry Evaluation – can the existing infrastructure handle the additional loads of expansion
- Hydrology/IDF – how will these interact with the expanded dam?
  - (Note that CPW expects to receive new Hydrology Evaluation in summer 2023)
- Risk – Downstream Consequence – Evaluate the risk increase and prepare inundation map and model
  - (Note that CPW expects to receive a new CDSE in fall 2023)

CPW Dam Safety Program
Recommendations for Inclusion in the Feasibility Study

- Evaluate Reservoir Rim Stability and Safety
- Identify Operational Impacts and water rights impacts
- Identify Infrastructure impacts – roads, trails, boat ramps, bathrooms, etc.
- Environmental Impacts and Requirements – NEPA, Cultural/SHPO, Wetlands/USACE, Floodplain, etc.
- Regulatory Involvement – SEO Discussion/Coordination
- Identify Public and Private Stakeholders and Public interest and outreach
- Prepare cost estimates and schedule

Group Discussion/Questions?

Path Forward / Next Steps / Action Items

Meeting Minutes – April 25, 2023 – 10:30am-12pm

Attendees: Scott Grosscup (YJ), Craig Ullmann(AG), Tyler Desiderio (AG),

CPW: Bill deVergie, Cory Bullen, Bailey Franklin, Mike Swaro, Margaret Taylor, Eric Eisinger, Lincoln Harberger

- CPW Dam Safety presented these slides and recommendations to Yellow Jacket and Applegate Group for the scope of a future feasibility study to enlarge the dam.
- Following CPW's presentation Applegate Group presented their Hydrology and Hydrologic Hazard Study work (approx. 90% complete). This work presents four preliminary options for reservoir expansion to be presented to Yellow Jacket for discussion at a future board meeting and to determine next steps, prior to moving into the feasibility study Task.
- Applegate concurred with CPW's feasibility study requirements. They noted that their contract with Yellow Jacket only includes the Hydrology/Hydrologic Hazard Study and additional funding/contracting would be needed prior to beginning the next portions of the feasibility study.
- Next step will be Applegate presenting their work to date and the four options to Yellow Jacket for discussion and to decide which option(s) to pursue with a full feasibility study.
- CPW Dam Safety offers any historical info that we have that could be helpful moving forward. Yellow Jacket/Applegate please reach out if you would like to request any of this info.
- CPW Dam Safety requests that Yellow Jacket keep us posted on progress following the Board's future review of the dam raise options with Applegate and regarding plans to move forward with a feasibility study.

WATER AVAILABILITY

The amount of water available at each site will depend primarily upon the water rights used at that location and their relative status to the Taylor Draw hydropower rights. In order to obtain a range of water availability of the sites two scenarios were analyzed representing the highest and lowest potential yields. The high yield scenario assumes that a senior water right would be used at the storage site and agricultural system efficiencies in the basin would increase to a minimum of 30%. The water available under this scenario was calculated by pulling data from the existing StateMod files used for the Ag Needs Study. Data for the lowest yield scenario comes from the existing StateMod files for the revised Energy Needs Study which includes the Taylor Draw hydropower rights and historic irrigation efficiencies. These scenarios are not intended to be exact numbers since they don't actually model a water right priority at a given location. Rather they are intended to provide a rough estimate of the water available at the reservoir sites. The water availability data is summarized in Table 7 below.

TABLE 7 WATER AVAILABILITY

Location	Scenario 1			Scenario 2		
	Min (af/yr)	Average (af/yr)	Max (af/yr)	Min (af/yr)	Average (af/yr)	Max (af/yr)
Ripple Creek Reservoir	7,100	43,400	105,300	0	24,100	84,400
Lost Park Reservoir(native flow)	700	4,300	10,400	0	2,400	8,300
Lost Park Feeder Canal 1(1)	500	2,200	5,100	500	2,200	5,100
Lost Park Feeder Canal 2(1)	500	2,800	6,300	500	2,800	6,300
Lost Park (with Feeder Canals)	1,700	9,300	21,800	1,000	7,400	19,800
Sawmill - Big Beaver Ck Only	4,000	21,600	49,300	0	23,100	49,100
Strawberry Creek	48,900	299,900(2)	636,300(2)	0	81,300	385,800
Tom Little Gulch (White River)	78,100	356,100(2)	847,800(2)	0	81,500	403,400
Mahogany Piceance Ck only	4,900	23,200	83,100	0	5,200	47,500
Thornburgh Reservoir(1)	6,500	21,600	51,800	6,500	21,600	51,800

(1) *Water Right not in White River Basin and not subject to Taylor Draw Hydro priority; Water Right Abandoned during the course of this study*
(2) *Amount exceeds Rio Blanco Reservoir Decree of 131,035 acre feet*

The data shown above does not account for water that will likely be required by the four federally endangered fish species on the lower White River. Currently, Taylor Draw Reservoir is required to bypass 200 cfs for environmental purposes. Future requirements may include an increase in this value as well as some requirements for peaking flows during spring runoff. Numbers presented in Table 7 assume that each project is the sole project constructed and the interference of other senior conditional decrees was not considered. The water availability of Sawmill Reservoir will need further examination during Phase II. A flow gage operated below Big Beaver Reservoir from 1956-1964 shows significantly less flow in the creek than is calculated to be available for diversion by the model. Input data for Big Beaver Creek flows will likely need to be modified in the model to better match historical conditions at this gage. Historical data imply that the amount of water physically available at this point could be half of what is shown in Table 7.