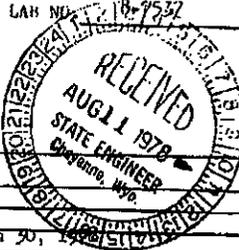


APPENDIX C
CEMETERY AND PENITENTIARY WELL PERMITS

WDA-267

3846

WATER ANALYSIS
 Wyoming Department of Agriculture
 Division of Laboratories
 P. O. Box 3200
 Laramie, WY 82001



OWNER or USER City of Rawlins
 ADDRESS P.O. Box 953, Rawlins, WY 82301
 SOURCE 1 gallon milk bottle LOCATION _____
 DESCRIPTION _____
 DATE COLLECTED _____ DATE RECEIVED March 30, 1978

CATIONS	mg/l	mg/l	ANIONS	mg/l	mg/l
Calcium	5.95	120	Carbonate	0.00	0.0
Magnesium	2.25	27	Bicarbonate	3.52	110
Sodium	6.05	140	Sulfate	6.25	300
Potassium	0.41	16	Chloride	4.40	160
			Nitrate	0.00	0.1
			Fluoride	0.04	0.0
Total Cations	14.66		Total Anions	14.21	

	E.P.A. STANDARD	U.S.P.H. STANDARD	Found mg/l	E.P.A. STANDARD	
Arsenic	0.05				
Chloride		250	160		
Copper					
Carbon (T.D.C.)					
Cyanide					
Fluoride	1.5		0.8		
Iron		0.3			
Manganese		0.05			
Nitrate			0.1		
Phosphate					
Sulfate			300		
Total Hardness			1090		
Zinc					
H.F.A.S.					
Mercury					
Barium					
Cadmium					
Chromium					
Cobalt					
Copper					
Lead					110
Nickel					
Selenium					
Silver					
Sulfur			7.5		

Date May 11, 1978

[Signature]

Amount for Fee I no charge (Pay for name of analysis)

Please make checks payable to Wyoming Department of Agriculture

1000 Camp Avenue

Laramie, WY 82001

E.P.A. Standards are maximum contaminant levels

U.S.P.H. Standards are maximum contaminant levels

E.P.A. U.S.P.H.

E.P.A.

STANDARD STANDARD

STANDARD

37510

Found mg/l

	E.P.A. STANDARD	U.S.P.H. STANDARD	Found mg/l		
Arsenic	0.05			M.O.D.	
Chloride		250	160	C.O.D.	
Copper		1		Color	
Carbon (T.O.C.)	0.7			Bromide	
Cyanide				Aluminum (Al)	
Fluoride	1.4-2.4		0.8	Mercury (Hg) 0.002	
Iron		0.3		Nickel (Ni)	
Manganese		0.05		Nitrite	
Nitrate	44.3		0.1	Nitrogen (NH ₃)	
Phenols				Total Kjeldahl Nitrogen	
Sulfate		250	300	Oil & Grease	
Total Dis. Solids		500	1090	Sulfide (S)	
Zinc		5		Solids, Total	
M.B.A.S.		0.5		Solids, Dissolved	
Barium	1.0			Solids, Volatile	
Cadmium	0.01			Solids, Suspended	
Chromium	0.05			Total CO ₂	110
Lead	0.05			Total Alkalinity	
Selenium	0.01			Total Acidity	
Silver	0.05			Phosphate (PO ₄) Urino-Total	
pH			7.7	Solids, Dissolved (Sus.)	
Conductance			1560	Turbidity (N.T.U.)	
Hardness (CaCO ₃)			410		
Sodium, %					
Boron			0.0	Colony count (1/100 ml) MPN	
Silica (SiO ₂)			7.5	Fecal Coliforms/100 ml MPN	

Date May 12, 1978

Michael Hill
State Chemist or Director

Laboratory Fee \$ no charge (Paid) (Charged-to be billed monthly)

Please make checks payable to: Wyoming Department of Agriculture
2219 Carey Avenue
Cheyenne, WY 82002

E.P.A. Standards are maximum contaminant levels.
U.S.P.H. Standards are recommended levels for Public Supplies.

37510



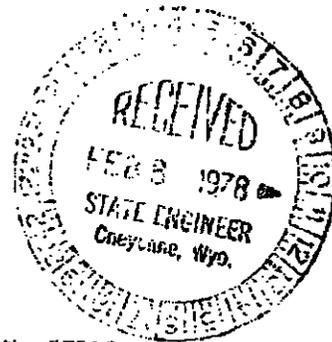
MAYOR
EVERETT E. MANN

City of Rawlins Wyoming

CITY COUNCIL
BOB L. HARBISON
CAROL A. MOORE
JUNE R. AYLSWORTH
JESUS P. JUAREZ
ARTURO ARCHULETA
STEVEN L. OLSON

February 7, 1978

George L. Christopoulos,
State Engineer
State Engineers Office
Barrett Building
Cheyenne, Wyoming 82002



Re: Water Right Permits Nos. U.W. 37508, U.W. 37509, U.W. 37510,
U.W. 37511, U.W. 37512.

Dear Sir:

The City of Rawlins is in receipt of a certified letter stating that several Water Right Permits are subject to cancellation if construction is not underway by May 5, 1978.

The City of Rawlins strongly objects to the cancellation of Water Right Permits Nos. U.W. 37508, U.W. 37509, U.W. 37510, U.W. 37511, U.W. 37512. We still intend to develop these permits. The drawings and specifications were put to bid, but we failed to obtain a bidder. We are now in the process of negotiating a cost-plus contract for the well construction.

The City of Rawlins hereby respectfully requests an extension of time for the above stated permits.

Thank you in advance for your efforts.

Sincerely,

Tom A Gardner
Asst. City Engineer

TAG:ct

February 8, 1978 - Request for extension of time for commencement received and granted until May 5, 1979. Completion and completion of beneficial use extended until December 31, 1979.

3-27-78
Date of approval

RICHARD G. STOCKDALE, Ground Water Geologist

37510

Oct. 27, 1978

City of Rawlins
City Engineer's Office
Attn: Kim Keaton
Box 953
Rawlins, WY 82301

Re: Cemetery No. 1
Permit No. U. W. 37510
Old City Well No. 1
Permit No. U. W. 26776
New City Well No. 1 A
Permit No. U. W. 26777

Dear Mr. Keaton:

Your letter of October 23, 1978 to Richard Stockdale have been directed to my attention. A review of our records indicates the following:

Cemetery No. 1 Well - all forms are in. The only remaining requirement is the Map to accompany Proof of Appropriation and Beneficial Use which will be required for the adjudication (finalization) of the water right.

Old City Well No. 1 - these permits are expired since the commencement forms and forms U. W. 6 and U. W. 8 indicating completion (including pump installation) and beneficial use of the well were not filed and requests for extension of time were not received. If pumps were installed in these wells and the water was beneficially used in the municipal supply system before the expiration date (December 31, 1976) the permits can be returned to a valid status by filing the enclosed forms. Please note that all forms must be notarized since the expiration dates have passed. The date of completion is considered to be the date the pump was installed and the date of beneficial use (form U. W. - 8) is the date the water from these wells was pumped into the municipal system. If the pumps were not installed before December 31, 1976 the permits should be cancelled and refiled.

I am enclosing copies of information which was sent to us on these wells in 1974. You may transfer any of this information which is still applicable to the forms U. W. - 6 and add the pump data and any changes which may have been made.

STATE



OF WYOMING

37510

MIKE SULLIVAN
GOVERNORGORDON W. FASSETT
STATE ENGINEER*State Engineer's Office*

HERSCHLER BUILDING

CHEYENNE, WYOMING 82002

August 21, 1987

City of Rawlins
P.O. Box 953
Rawlins, WY 82301

Attention: Jerry Miller, City

Re: Cemetery No. 1 Well
Permit No. U.W. 37510

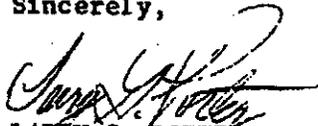
Dear Mr. Miller:

On August 12, 1987, an onsite inspection was conducted on the above referenced well for the Process of Adjudication (finalization). This well is used for the watering of lawn and shrubbery within the Rawlins Cemetery. One of the requirements of the adjudication inspection is to measure or determine a production rate from the well.

On the date of the inspection, it was noted that there was a short run of three and four inch line trending west from the well head into the wall of the well pit. There is no apparent access on this line for the insertion of the test equipment to establish a flow rate from the well. A production rate, however, could be established if you have the pump information available. This would include pump manufacturer, horsepower, model, number of stages, etc. Please advise.

Your earliest attention to these matters would be appreciated. If you have any questions, please feel free to contact this office.

Sincerely,


LARRY G. PORTER
Ground Water Section

?:db

Form U.W. 8

---Office Copy---

Proof Number U.W. 3326

37510

PROOF OF APPROPRIATION AND BENEFICIAL USE OF GROUND WATER
(Revised Form - Instructions to be furnished with form)
PART III

WATER DIVISION 1 DIST. 6
STATEMENT OF CLAIM NO. U.W. _____
PERMIT NO. U.W. 37510
WELL REGISTRATION NO. U.W. _____
NAME OF WELL Cemetery No. 1

COUNTY Carbon
U.W. DISTRICT None
DATE OF PRIORITY February 7, 1977
LOCATION NE 1/4 NE 1/4
SECTION 17 T. 21 N., R. 87 W.

Name of Claimant City of Rawlins

Post Office Box 953 Rawlins State Wyoming Zip Code 82301

What documentary evidence is attached showing your ownership or control of the following lands?
Municipality

AMOUNT TO BE APPROPRIATED: 250 G.P.M.

Use (s): Describe fully in Comments. Miscellaneous

ACREAGE TABULATION AND/OR POINTS OF USE

wp.	Range	Sec.	NE 1/4				NW 1/4				SW 1/4				SE 1/4				TOTAL
			NE 1/4	NW 1/4	SW 1/4	SE 1/4	NE 1/4	NW 1/4	SW 1/4	SE 1/4	NE 1/4	NW 1/4	SW 1/4	SE 1/4	NE 1/4	NW 1/4	SW 1/4	SE 1/4	
---SEE ATTACHMENT Sheet for Related Rights and Area of Use---																			

Does above tabulation agree with Map submitted? Yes No. If not, Why? _____

Are all ditches, pipelines, etc. shown and properly labeled? Yes No. If Not, Describe difference _____

Do other wells commingle in this system? Yes No. If yes, describe Water from Old City Well No. 1, Permit No. U.W. 26776; New City Well No. 1A, Permit No. U.W. 26777; Rawlins Nugget Well No. 1, Permit No. U.W. 70332; Rawlins Nugget Well No. 2, Permit No. U.W. 70333; Rawlins Nugget Well No. 3, Permit No. J.W. 70334, as part of the City of Rawlins Municipal water supply may be commingled with that (1) Description of Conveyance of Water From well site via 3" line, approximately two feet west to a 4" line and the City of Rawlins Cemetery water distribution system.

MAR-24-2009 11:35

GROUND WATER

13077775451

P.08

5/15/10

I.D. No. None

Rated H.P. 25 Type of Power Electric Make Gould I.D. No. None

Discharge Pressure N/A psi Static Water Level 70.10' Pumping Level 100.00' After Ten Minutes

Size of Discharge Line 3" Amount of Water Produced 250 (Closed System) GPM

How was production determined? Statement of Completion and Pump Data

Is well described accurately on Statement of Completion? [X] Yes [] No If not, describe difference

Does construction comply with State Engineer's Standards? [X] Yes [] No If not, Why?

SPRINKLER SYSTEMS: Type N/A Length Make

I.D. No. Nozzle size & spacing @ No. of Towers

Mainline Size Lateral Lines End Gun

System Pressure psi Where measured?

COMMENTS: If there is anything unusual about this right such as a domestic or stock use in addition to irrigation or other use, please detail here.

(1) Total Estimated Annual Production is approximately 25 acre-feet per year if and when needed.

Do you recommend approval? [X] Yes [] No

THE STATE OF WYOMING

County of Carbon } SS.

I, Carlos M. Miranda do depose and say that I have read the Proof of Appropriation and Beneficial Use of Ground Water and am aware that a field inspection was conducted the 12th day of August, 1987. I agree with the findings of said inspection and exceptions as noted above. I further agree to the amendment of existing records to reflect the findings of this inspection.

Inspected and witnessed by me this 12th day of August, 1987.

Carlos M. Miranda, City Manager Claimant (If business, give position)

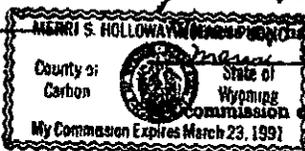
13/15/88 Date

[Signature] Representative of State Engineer

The foregoing instrument was acknowledged before me this 15th day of March, 1988.

Fees Paid \$ N/A

[Signature] Representative of State Engineer



Henri S. Holloway Notary Public Commission expires: March 23, 1991

Filed in the office of the State Engineer on this 15th day of March, 1988. By [Signature]

Proof No. U.W. PROOF OF APPROPRIATION WATER Permit No. U.W. Division No. 1 D. C.R. U.W. 61 Order Record 3



Wyoming State Land and Farm Loan Office

122 WEST 25TH STREET, HERSCHLER BUILDING
CHEYENNE, WYOMING 82002-0600
PHONE 307-777-7334

HOWARD M. SCHRINAR, COMMISSIONER, 777-4629
PAUL R. CLEARY, DEPUTY COMMISSIONER, 777-4629
CARL E. JOHNSON, STATE FORESTER, 777-7884
SHARON S. GARLAND, ASSISTANT COMMISSIONER, 777-4629
ACCOUNTING & ADMINISTRATION
DAVE W. FORCE, ASSISTANT COMMISSIONER, 777-4638
FARM LOANS & SURFACE LEASING
DON L. COLBANDRE, ASSISTANT COMMISSIONER, 777-7309
GOVERNMENT GRANTS & LOANS
HAROLD D. KEMP, ASSISTANT COMMISSIONER, 777-4643
MINERAL LEASING & ROYALTY COMPLIANCE

W. R. No. U. W. 726

April 8, 1988

Carol Lacy
Office of the State Engineer
Herschler Building, 4 East
Cheyenne, WY 82002

RE: Transfer of Water Rights at the Old State Penitentiary in Rawlins, Wyoming

Dear Ms. Lacy:

As per our previous conversations, attached is a copy of the Quitclaim Deed transferring 45.19 acres which is the old penitentiary to the "Old Penitentiary Joint Powers Board." As a condition of this transaction, the State agreed to transfer any existing well permits and/or water rights to the said Board.

Your research has yielded only one well permit. Wyoming Pen Well No. 2, permit LW 726 with a priority date of December 10, 1957. Please transfer this permit from the State of Wyoming to the "Old Penitentiary Joint Powers Board", P.O. Box Box 952, Rawlins, WY 82301.

I have advised the Old Penitentiary Joint Powers Board, there is only one well registered in your office. Also, I have explained to them you would send them the necessary materials to register the other well, if they so desire.

If I can provide any information or assistance in this matter, please contact me at 777-6634.

Sincerely,

HOWARD M. SCHRINAR
COMMISSIONER OF PUBLIC LANDS

Curtis D. Dewey

Curtis D. Dewey
Lands Specialist/Appraiser

CDD/kc

cc: Wade Waldrip, William, Kelley and Waldrip, P.O. Box 1740, Rawlins, WY 82301-1740





THE STATE

OF WYOMING

MIKE SULLIVAN
GOVERNORGORDON W. FASSETT
STATE ENGINEER*State Engineer's Office*MICRO
FILMED MAY 2 '88

HERSCHLER BUILDING

CHEYENNE, WYOMING 82002

April 21, 1988

Curtis D. Dewey
Lands Specialist/Appraiser
Wyoming State Land and Farm
Loan Board
Herschler Building, Third East
Cheyenne, WY 82002

Re: Well Registration No. U.W. 726
Wyoming Penitentiary Well No. 2

Dear Mr. Dewey:

Please be advised that all right, title and interest in and to the above referenced water well permit has been assigned from State of Wyoming, Board of Charities and Reform to Old Penitentiary Joint Powers Board per Quitclaim Deed received April 12 1988. Said assignment has been made a matter of record in State Engineer's Office.

I am sending a copy of the assigned Well Registration to the Joint Powers Board along with the forms and instructions for registering the other well.

Sincerely,

A handwritten signature in cursive script that reads "Carol Lacy".

Carol Lacy
Ground Water Rights Analyst

CL:ls



THE STATE

OF WYOMING

MIKE SULLIVAN
GOVERNORGORDON W. FASSETT
STATE ENGINEER*State Engineer's Office*MICRO
FILMED MAY 2 '88

HERSCHLER BUILDING

CHEYENNE, WYOMING 82002

April 25, 1988

Old Penitentiary Joint
Powers Board
P.O. Box 953
Rawlins, Wy 82301

Re: Well Registration No. U.W. 726
Wyoming Penitentiary Well No. 2

Dear Sir:

Pursuant to correspondence from Curtis D. Dewey, Wyoming State Land and Farm Loan Office, and a copy of the Quitclaim Deed conveying the land served by the water well referenced above from the State of Wyoming to the Old Penitentiary Joint Powers Board, the Well Registration has been assigned to the Joint Powers Board. A copy of the assigned document is enclosed.

Please be assured that this is a valid permit but it has not been adjudicated (finalized) by the State Board of Control. At the time this filing was made, no procedure for the adjudication of ground water permits had been established.

A search of the records of our office indicates that this is the only well serving the penitentiary registered with the State Engineer's Office and therefore, it is the only water source for which a valid water right exists. It is our understanding that two wells have served the institution for some time. If you plan to continue to use the second well, you should register it with this office to establish the water right.

To register the existing well, you need to file an Application (form U.W. 5); a Statement of Completion and Description of Well (form U.W. 6); and a Proof of Appropriation and Beneficial Use of Ground Water (form U.W. 8) with the filing fee of \$25.00. These forms are enclosed. Please note the map requirements as specifically described in Part II of the Proof form. The map should show both wells, and you may wait until the application for the second well has been approved and a permit number given to it before you have it prepared.

If I can be of assistance, feel free to call me at 777-7354.

Sincerely,

Carol Lacy
Ground Water Rights Analyst

CL:ls
Enclosures

726

**REGISTRATION OF WELL
FOR
APPROPRIATION AND USE OF UNDERGROUND WATER**

(Under Chapter 107, Session Laws of Wyoming, 1947)

WATER DIVISION NO. 1

I, Robert Jack Smith
of Rawlins, County of Carbon, State of Wyoming, being duly sworn according to law, upon my oath say:

1. The name of the registrant Old Penitentiary Joint Powers Board
State of Wyoming, Board of Charities and Reform
P.O. Box 953, Rawlins, Wyoming 82301
2. The postoffice address of the registrant Charleston, Wyoming
3. The use to which the water has been applied is Domestic for Wyoming State Penitentiary.
(State whether for irrigation, municipal, railway, industrial, domestic, stock)
4. The name of the well is Wyoming Penitentiary Well No. 2.
(Designate by name and number)
5. The well is located S. 29° 18' W. 1627.7 feet from the E 1/16 on line between corner of Section 8 - 17 T. 21 N., R. 87 W., and is in the SW 1/4 of Section 17, T. 21 N., R. 87 W. (Designate subdivision)
6. The type of well is Drilled.
(Drilled, dug, driven or jettied)
7. The depth of the well is 384 feet. As reported Oct. 18, 1957 As measured 65
8. The depth to water in the well below land surface is 65 feet. As measured on Oct. 18, 1957
9. The diameter of well at top is 10 inches, and at bottom 10 inches.
10. The kind of casing used, if any, is Steel casing to 61'
11. Type of pump, if any Turbine Capacity of pump 300 Gal. per min.
(Centrifugal, turbine, rotary, plunger)
12. Method of operation Electric Horsepower of engine or motor 15 HP
(Electrical motor, steam or gasoline engine)
13. Amount of water claimed 250 cubic feet per second or 250 gallons per minute.
14. Estimated yield of water per minute 250 gallons.
15. Cost of well and pumping equipment \$9000.00 Dollars.
16. (a) Date of completion of well Oct. 18, 1957
(b) Date water was first used for beneficial purposes Well to be in use in Spring of 1958

17. The land irrigated is described in the following tabulation: (Give irrigable acreage in each legal subdivision and designate ownership of land. If not used for irrigation, state location of place of use.)

Township	Range	Sec.	NE 1/4				NW 1/4				SW 1/4				SE 1/4				TOTALS
			NE 1/4	NW 1/4	SW 1/4	SE 1/4	NE 1/4	NW 1/4	SW 1/4	SE 1/4	NE 1/4	NW 1/4	SW 1/4	SE 1/4	NE 1/4	NW 1/4	SW 1/4	SE 1/4	
21 N.	87 W.	17	Water will be used for domestic purposes at the Wyoming State Penitentiary in SW 1/4 NE 1/4 Section 17, T. 21 N., R. 87 W.																

TOTAL NUMBER OF ACRES TO BE IRRIGATED

18. Depth at which main source of water was encountered is 105 feet, and the water bearing formation is Sand and Sandstone
(Sand, gravel, shale, clay, limestone, sandstone, etc.)

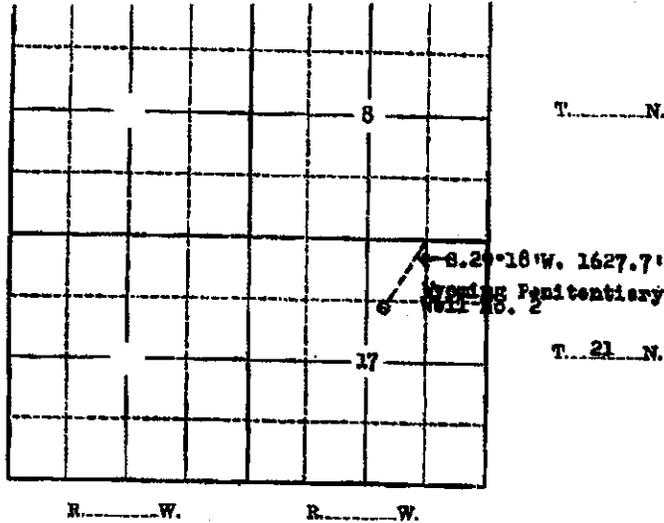
19. If other water sources were found give depth to each. GROUND WATER 70' feet. (Signed) Robert Jack Smith

THE STATE OF WYOMING
County of CARBON) ss.

I hereby certify that the foregoing registration was signed in my presence and sworn to before me by Robert Jack Smith this 5th day of December, 19 57.

(SEAL) My Comm. expires 7/18/61. Lavina M. Peters
Notary Public

726



Locate well and acreage of irrigated land on plat.
Scale: 2 inches = 1 mile

REMARKS:

Well tested 250 gallons per minute with no appreciable drawdown.
Test was limited by pumping equipment available.

LOG OF WELL

Boulders	0	20	
Yellow Clay and Boulders	20	55	
Granite Rock - Hard	55	80	Some Water at 70'
Extra Hard Sand	80	85	
Red & Gray Rock	85	100	Med. Hard
Fine Gray Lims	100	103	Hard

LOG OF WELL

KIND OF ROCK OR OTHER MATERIAL (Give color and tell whether hard or soft)	DEPTH, IN FEET		VERTICIES IN FEET	REMARKS (Especially information as to water found)
	From	To		
White Sandy Lims - Hard	103	115		
Gray Sand - Hard	115	130		Water increased 105' to 110' - Water level 65' - 15 P.M.
Hard Sharp Quartz	130	145		
Hard Quartz	145	150		
Brown Lims	150	170		
Gray Lims - Hard	170	195		
Hard Chert	195	204		
Chert quartzite sand	204	213		
Crevices	213	215		
Quartz Chert - Hard	215	225		
Lims, Mineralized, sharp	225	242		
Extra Hard white quartz	242	270		
Gray, sandy lims	270	290		
Brown quartz and white chert	290	308		Extra Hard
Sandy Gray Lims	308	325		
Red Shale	325	330		
Brown Lims	330	332		
Brown Quartz, extra hard	332	349		
Brown quartz, white chert	349	358		extra hard
Brown quartz, extra hard	358	384		
Granite -	384			TOTAL DEPTH Water level 90'

THE STATE OF WYOMING,
State Engineer's Office,) ss.

This instrument was received and filed for record on the 10th day of December, A. D. 19 57, at

2:30 o'clock P. M.

E. L. Lloyd
E. L. Lloyd, State Engineer.

Recorded in Book 3 of Underground Water, Well Registrations, on Page 97

April 12, 1988 -- All right, title and interest in and to this Well Registration assigned from STATE OF WYOMING, BOARD OF CHARITIES AND REFORM to OLD PENITENTIARY JOINT POWERS BOARD per Quit Claim Deed received April 12, 1988. Filed in Certificate File under "Old Penitentiary Joint Powers Board"; COPY filed in Miscellaneous Notices under W.R. No. U.W. 726.

LOG OF WELL

Boulders
 Yellow Clay and Boulders
 Granite Rock - Hard
 Extra Hard Sand
 Red & Gray Rock
 Fine Gray Lime

Some Water at 70'
 Med. Hard
 Hard

0
 20
 55
 80
 85
 100
 103

LOG OF WELL

KIND OF ROCK OR OTHER MATERIAL (Give color and tell whether hard or soft)	DEPTH, IN FEET		THICKNESS IN FEET	REMARKS (Especially information as to water found)
	From	To		
White Sandy Lime - Hard	103	115		Water increased 105' to 110' - Water level 65' - 15 G.P.M.
Gray Sand - Hard	115	130		
Hard Sharp Quartz	130	145		
Hard Quartz	145	150		
Brown Lime	150	170		
Gray Lime - Hard	170	196		
Hard Chert	196	204		
Chert quartzite sand	204	213		
Crevice	213	215		
Quartz Chert - Hard	215	225		
Lime, Mineralized, sharp	225	242		
Extra Hard white quartz	242	270		
Gray, sandy lime	270	290		
Brown quartz and white chert	290	308		
Sandy Gray Lime	308	326		
Red Shale	326	330		
Brown Lime	330	332		
Brown Quartz, extra hard	332	349		
Brown quartz, white chert	349	358		
Brown quartz, extra hard	358	384		
Granite -	384			
TOTAL DEPTH				
Water level 90'				

THE STATE OF WYOMING, } ss.
 State Engineer's Office,

This instrument was received and filed for record on the 10th day of December, A. D. 19 57, at

2:30 o'clock P. M.

Karl Lloyd,
 State Engineer.

Recorded in Book 3 of Underground Water, Well Registrations, on Page 97.

April 12, 1988 -- All right, title and interest in and to this Well Registration assigned from STATE OF WYOMING, BOARD OF CHARITIES AND REFORM to OLD PENITENTIARY JOINT POWERS BOARD per Quit Claim Deed received April 12, 1988. Filed in Certificate File under "Old Penitentiary Joint Powers Board"; COPY filed in Miscellaneous Notices under W.R. No. U.W. 726.

WILLIAMS, KELLY & WALDRIP
ATTORNEYS & COUNSELORS
618 WEST BUFFALO
POST OFFICE BOX 1740
RAWLINS, WYOMING 82301

K. CRAIG WILLIAMS
KURT KELLY
WADE E. WALDRIP

TELEPHONE
AREA CODE 307
328-0619

June 28, 1988

Carol Lacy
Ground Water Rights Analyst
State Engineer's Office
Herschler Building
Cheyenne, WY 82002

Re: Wyoming Penitentiary Well No. 2, W.R. 726

Dear Ms. Lacy:

Your letter of April 25, 1988 to the Old Penitentiary Joint Powers Board regarding Wyoming Penitentiary Well No. 2 has been turned over to me for a reply. Enclosed please find a State of Wyoming memorandum from A. A. Britton, Facility Services Manager to Gene Tromburg, Central Services Manager, regarding water wells at the Old Penitentiary. As you can see, the Old Penitentiary Joint Powers Board has insufficient information with which to complete the Proof of Appropriation and Beneficial Use of Ground Water form and the Application for Permit to appropriate Ground Water form. In the memo of June 7, 1988, Mr. Britton states that Mr. Jim Kladianos of the Rawlins Office of the Wyoming Highway Department is investigating the possibility of producing registered maps and documentation. I wonder if you have been contacted by Mr. Britton or Mr. Kladianos? Do you have any suggestions on how we can obtain the appropriate permits for Well No. 2?

I appreciate your cooperation, and by copy of this letter would ask for any help Mr. Britton or Mr. Kladianos may be able to provide.

Sincerely,

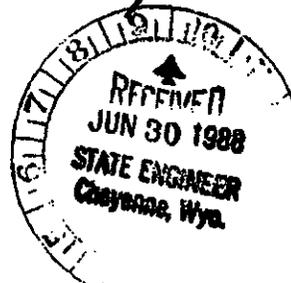


Wade E. Waldrip

WW:cm

Enc.

cc: A. A. Britton
Jim Kladianos
Warden Shillinger
Bill Harshman



MAR-24-2009 11:36
JUN 20 1988

GROUND WATER
STATE OF WYOMING
MEMORANDUM

1307775451 P.16

MICRO FILMED JUL 7 '88

film w/ reply



Gene Tromburg
Central Services Manager

DATE: June 7, 1988

JM: A.A. Britton
Facility Services Manager

SUBJECT: Water wells at old site

Information on the old site wells is very limited. The South well is 340' deep. The North well is 140' deep. Both have 15 H.P. 3 phase turbine pumps which pump 250 G.P.M. this information is all approximated on these wells. (#2 Well - WRR 726)

The actions necessary to validate the water rights claims are out lined on the accompanying forms. These wells are considered miscellaneous wells. They require a licensed surveyor or certified engineer to complete exact maps. Since most information is unknown the well #1 would be considered as pre-1948, which do not require all information but still would require registration to establish water rights.

Jim Kladianos, Rawlins Office of the Wyoming Highway Department, is investigating the possibility of them producing the registered maps, and documentation for us at this time.

A.A. Britton

AAB/rjj





State Engineer's Office

HERSCHLER BUILDING

CHEYENNE, WYOMING 82002

July 7, 1988

Wade E. Waldrip
Williams, Kelly and Waldrip
P.O. Box 1740
Rawlins, WY 82301

Re: Wyoming Penitentiary Well No. 2
W.R. No. U.W. 726

Wyoming Penitentiary Well No. 1,
Unfiled

Dear Mr. Waldrip:

In response to your letter of June 28, 1988, enclosed are the following partially completed forms:

1. Wyoming Penitentiary Well No. 2.
W.R. No. U.W. 726
 - A. Proof of Appropriation and Beneficial Use of Ground Water
(Form U.W. 8)
2. Wyoming Penitentiary Well No. 1, unfiled
 - A. Application for Permit to Appropriate Ground Water, (Form U.W. 5)
 - B. Statement of Completion and Description of Well (Form U.W. 6)
 - C. Proof of Appropriation and Beneficial Use of Ground Water
(Form U.W. 8)

All items on these forms indicated with an X should be completed; all forms should be signed where indicated (the U.W. 8 forms need notarization) and returned to this office. A \$25.00 filing fee should accompany the application for the No. 1 well.

After the application for the No. 1 well has been approved and a permit number assigned to it, both wells will have valid permits. To proceed with the adjudication process, a map should be prepared by a land surveyor licensed to practice in Wyoming showing the locations of both wells and the area(s) and/or point(s) of use. We will send specific map instructions to the land surveyor upon your direction.

I have not received any inquiries or information from Mr. Britton or Mr. Kladianos; therefore, I assume you will coordinate this endeavor. The application for the No. 1 well will be processed by Michael Penz in this office.

Mr. Wade E. Waldrip
Page 2
July 7, 1988

If you have additional questions, please feel free to call me or Mr. Penz at 777-7354.

Sincerely,



Carol Lacy
Ground Water Rights Analyst

CL:ls

Enclosures

xc: Mike Penz

APPENDIX D
DISTRIBUTION LINE WATER BREAKS SUMMARY
(2004 – 2008)

Appendix D - Line Break Summary

Rawlins Water Leak Log (sorted by Section)

No.	Date	Section	Number Street	Street	Pipe Size / Material	Break Type
38	1/21/2005	0	Block 1	Lot 4	6-inch / CIP	Pin Hole
67	6/13/2005	0	Manley Ranch ?		12-inch / CIP	Wall Penetration & Longitudinal Crack
102	3/28/2006	0	East of RR Golfcourse County		12-inch / PVC	Leak @ Bell
189	9/8/2007	0	3rd St.	@Armory tap ?	12-inch / CIP	Wall Penetration
206	12/31/2007	0	East of Manley's Ranch ?		12-inch / CIP	Wall penetration
220	8/9/2008	0	East of WWTP		12-inch / CIP	
221	8/9/2008	0	East of WWTP		12-inch / CIP	
222	8/10/2008	0	East of ? Asphalt		12-inch / CIP	
195	11/9/2007	4	Lerwick	Shetland Dr.	8-inch / PVC	Contractor Damage, Broken pipe
175	6/12/2007	6	2319 Inverness		12-inch / DIP	Wall Penetration
118	9/27/2006	8	Kendrick	Pacific (By PP&I)	8-inch / CIP	Longitudinal Crack
1	1/7/2004	8	1405 Montana		6-inch / CIP	Wall Penetration (Hole)
21	5/17/2004	8	1526 California		6-inch / CIP	Longitudinal Crack
70	7/24/2005	8	3rd St.	Heath	20-inch / DIP	Wall Penetration
161	3/17/2007	8	209 W. Heath (alley)		6-inch / CIP	Froze Up
163	3/20/2007	8	202 W. Kendrick		6-inch / CIP	Longitudinal Crack
193	9/25/2007	8	1206 Montana		6-inch / CIP	
203	12/7/2007	8	Montana	Murray	6-inch / CIP	Circumferential Crack & wall penetration
241	12/2/2008	8	3rd St.	Heath	20-inch / DIP	Loose bolts on 2 clamps
48	2/20/2005	9	2226 Kilmary		6-inch / CIP	Wall Penetration @ Bell Spigot (repl. 5-ft)
104	4/5/2006	9	2304 Kilmary		6-inch / CIP	Wall Penetration @ 6-inch Dell Hub (cutout)
105	4/7/2006	9	2312 Kilmary		6-inch / CIP	Wall Penetration
173	6/12/2007	9	Kilmary	Kirkcolm E.	8-inch / DIP	Wall Penetration
176	6/12/2007	9	2523 Kilmary Drive		6-inch / DIP	Wall Penetration
178	6/13/2007	9	Kilmary	KirkColm	6-inch / DIP	Wall Penetration
180	6/14/2007	9	Kilmary	Kirkcolm E.	6-inch / DIP	Wall Penetration
197	11/9/2007	9	2401 Kilmary St.		6-inch / DIP (wrapped)	Wall Penetration & Tap blown out
199	11/10/2007	9	2402 Kilmary St.		6-inch / DIP	
229	9/10/2008	9	2226 Kilmary St.		6-inch / DIP	Longitudinal Crack
230	9/10/2008	9	2226 Kilmary St.		6-inch / DIP	
37	1/14/2005	9	1507 Edinburgh		6-inch / DIP	
179	6/14/2007	9	1703 Edinburgh		6-inch / CIP	Circumferential Crack
186	8/16/2007	9	Edinburgh St.	by Sp. 22	6-inch / CIP	Wall Penetration
196	11/9/2007	9	Edinburgh St.	Inverness & ?	6-inch / DIP	Circumferential Crack
201	11/20/2007	9	Edinburgh St.	Inverness	6-inch / DIP	Wall Penetration
202	11/30/2007	9	1720 Edinburgh St.		6-inch / DIP	Circumferential Crack
91	12/12/2005	9	Murray St.	Ritter & Rodeo	8-inch / CIP	Wall Penetration
94	12/27/2005	9	1025 Murray St.		8-inch / CIP	Flange Bolts
166	4/2/2007	9	Murray	Withrow Ln.	6-inch G.V.	Loose Bolts
167	4/3/2007	9	Murray	Stanford	6-inch / CIP	Master meter install
169	4/9/2007	9	Murray	Koontz	6-inch G.V.	Bolts corroded
223	8/15/2008	9	Murray	Sigma		
22	6/30/2004	9	1210 Ritter		6-inch / CIP	Wall Penetration/Hydrant Line
76	8/23/2005	9	1718 Kirkcolm		8-inch / CIP	Wall Penetration
100	2/21/2006	9	1610 Inveanness Blvd.		6-inch / CIP	Circumferential Crack
132	12/27/2006	9	Inverness	Loch Lomand	6-inch / CIP	Circumferential Crack
174	6/12/2007	9	2317 Cutty Sark		6-inch / DIP	3/4 Tap
177	6/12/2007	9	2517 Dunblane		6-inch / DIP	Wall Penetration
181	6/14/2007	9	2620 Inverness		12-inch / DIP	Wall Penetration
187	8/30/2007	9	Loch Tay	Inverness	12-inch / DIP	Install 12-inch G.V.
191	9/13/2007	9	1210 Ritter			Wall Penetration, split
194	10/29/2007	9	1808 Inverness		6-inch / DIP	Longitudinal Crack
198	11/9/2007	9	2324 Cutty Sark		6-inch / DIP	Wall Penetration
208	1/6/2008	9	1717 Loch Lomund		6-inch / DIP	Circumferential Crack
228	9/3/2008	9	2312 Cutty Sark		6-inch / DIP	Wall Penetration
216	1/31/2008	10	1925 E. Murray St.		6-inch / DIP	
130	12/14/2006	15	Seiloff St	Murray & Daley	8-inch / CIP	Longitudinal Crack
131	12/15/2006	15	Seiloff St	Murray & Daley	6" G.V.	Flange bolts
146	2/12/2007	15	Seiloff St	Daley	6-inch / CIP	Longitudinal Crack
217	2/5/2008	15	1021 Seiloff St		8-inch / DIP	
218	2/6/2008	15	1021 Seiloff St		8-inch / DIP	
236	11/17/2008	15	Seiloff St	Murray St.	6-inch / CIP	
240	12/1/2008	15	Seiloff St	Murray	6-inch / CIP	6-inch G.V.
10	2/20/2004	15	Glenn Addition		6-inch / CIP	Longitudinal Crack
54	5/2/2005	15	Dinsmore St.		6-inch / PVC	2-inch Tap
92	12/15/2005	15	Airport	Mahoney	Fire Hydr.	Split Barrel Section
112	5/8/2006	15	201 Airport Rd.		6-inch / CIP	Wall Penetration
122	11/6/2006	15	Plaza	Airport Rd.	12-inch AC/PVC	Replaced a couple bolts
135	1/9/2007	15	Glenn Addition	Block 1, Lot 3	3/4 PVC	Pin hole
219	8/7/2008	15	Glenn Addition		6-inch / CIP	
6	1/29/2004	16	1412 E. Murray		6-inch / CIP	Longitudinal Crack (2 ft.)
12	2/22/2004	16	1410 E. Murray		6-inch / CIP	Longitudinal Crack & G.V.
33	12/12/2004	16	1410 E. Murray		6-inch / CIP	Circumferential Crack
234	11/14/2008	16	1410 E. Murray St.		6-inch / CIP	
8	2/16/2004	16	1006 Stanford		6-inch / CIP	Longitudinal Crack
51	4/19/2005	16	Rodeo	Mahoney	6-inch / CIP	6-inch G.V.
83	10/5/2005	16	811 Rodeo		6-inch / CIP	Wall Penetration & Longitudinal Crack
96	12/28/2005	16	508 Rodeo		6-inch / CIP	Broken Stem
124	12/5/2006	16	405 Harshman		6-inch / CIP	Circumferential Crack
125	12/5/2006	16	405 Harshman		6-inch / CIP	Wall Penetration
126	12/5/2006	16	405 Harshman		6-inch / CIP	Replaced old clamp
127	12/6/2006	16	Harshman	Daley & Spruce	6-inch / CIP	Wall Penetration
165	3/26/2007	16	Stanford	Murray	6-inch / CIP	Wall Penetration
170	4/19/2007	16	Stanford	Murray and McMilken	6-inch / CIP	Wall Penetration x 3
183	7/28/2007	16	Stanford St.	Murray & Ryan	6-inch / CIP	Wall Penetration
224	8/15/2008	16	606 Rodeo St.		4-inch / CIP (lead joint)	Wall Penetration
225	8/17/2008	16	606 Rodeo St.		6-inch	Wall Penetration
237	11/20/2008	16	Stanford	Murray St. & Daley St.	6-inch / CIP	
45	2/2/2005	16	Daley	Koontz	6-inch / PVC	6-inch G.V.
50	2/26/2005	16	Daley	Scloff	6-inch / CIP	Wall Penetration & Crack
53	4/20/2005	16	Daley	Koontz	6-inch / CIP	6-inch G.V.
65	6/6/2005	16	309 Mahoney (Alley)		6-inch / CIP	Wall Penetration & Split (10-ft)
66	6/9/2005	16	309 Mahoney (Alley)		6-inch / CIP	Wall Penetration
79	9/14/2005	16	Daley	Scloff	6-inch / CIP	Wall Penetration
85	10/18/2005	16	Daley	Koontz	6-inch / PVC & CIP	Replace 6-inch G.V.
98	2/20/2006	16	Daley	Spruce	6-inch / CIP	Circumferential Crack
136	1/19/2007	16	316 Daley St.		6-inch / CIP	Circumferential Crack
138	1/22/2007	16	515 Daley St.		6-inch / PVC	Bad tapping saddle
205	12/28/2007	16	814 Illinois(alley)			Split & accidental wal penetration
233	11/13/2008	16	515 Mahoney St.		6-inch / PVC	

Appendix D - Line Break Summary

No.	Date	Section	Number Street	Street	Pipe Size / Material	Break Type
28	9/19/2004	16	1920 Alton Lane		6-inch / CIP	Split-Bell (2 ft)
39	1/29/2005	16	1920 Alton Ln.		6-inch / CIP	Wall Penetration (2)
41	1/29/2005	16	2510 E. Cedar (East of Wendy's)		6-inch / CIP	Wall Penetration
40	1/29/2005	16	2222 E. Cedar (rear)		6-inch / CIP	Wall Penetration / split
42	1/31/2005	16	1920 Alton Ln.		6-inch / CIP	Wall Penetration
111	4/28/2006	16	1920 Alton Ln.		6-inch / CIP	Gate Valve 2"
142	1/29/2007	16	1712 E. Cedar		2-inch service	Customer frozeup
182	7/13/2007	16	Alton Ln.		6-inch / CIP	Wall Penetration
200	11/13/2007	16	1920 Alton Ln.		6-inch	Longitudinal Crack
245	12/8/2008	16	504 E. Cedar St.		4-inch / CIP	Longitudinal Crack
113	7/9/2006	16	502 Higley Blvd.		6-inch / CIP	Wall Penetration
9	2/20/2004	16	706 Cedar		6-inch / CIP	Longitudinal Crack
16	3/29/2004	16	2105 E. Daley		6-inch / CIP	Longitudinal Crack (4.5 ft.)
18	5/6/2004	16	J.B. Court (Alley)		4-inch / CIP	Wall Penetration (Hole)
24	7/5/2004	16	302 Pershing		6-inch / CIP	Wall Penetration (Hole)
26	8/25/2004	16	106 W. State		6-inch / CIP	Service line break
43	2/1/2005	16	1411 McMicken		6-inch / CIP	Wall Penetration / Circumferential
44	2/2/2005	16	1411 McMicken		6-inch / CIP	Circumferential Crack
46	2/8/2005	16	Rodeo	Murray (30 ft east)	6-inch / CIP	Longitudinal Crack
47	2/9/2005	16	514 E. Daley (Alley)		4-inch / CIP	Longitudinal Crack
49	2/22/2005	16	602 N. Higley Blvd.		6-inch / CIP	Wall Penetration
52	4/20/2005	16	Rodeo	Ryan	6-inch / VCP	Collapsed Sanitary Sewer
55	5/4/2005	16	308 Pershing (Alley)		6-inch / CIP	Wall Penetration
58	5/13/2005	16	308 Pershing (Alley)		6-inch / CIP	Wall Penetration
72	8/7/2005	16	1411 McMicken		6-inch / CIP	Replace 165 ft.
81	9/21/2005	16	Pershing	State & Center (Alley)	6-inch / CIP	Wall Penetration
123	11/8/2006	16	205 Utah St.		4-inch / CIP	Circumferential Crack
129	12/14/2006	16	Ryan St.	Koontz	6-inch / CIP	Longitudinal Split
133	12/30/2006	16	410 E. Spruce (alley)		4-inch / CIP	Circumferential Crack / Wall Penetration
137	1/22/2007	16	Utah St.	Walnut & Maple	12-inch / CIP	Replace 4-ft and 4" valve
153	2/21/2007	16	505 Utah (alley)		6-inch / CIP	Break Type
158	3/4/2007	16	Rodeo	Murray (NE Corner)	8-inch / CIP	Wall Penetration
172	4/20/2007	16	1423 McMicken		6-inch / CIP	Wall Penetration
209	1/8/2008	16	215 E. Daley St.		6-inch / CIP	Wall Penetration
214	1/27/2008	16	CC Higher Education Center		4-inch / CIP	Wall Penetration
215	1/28/2008	16	Higley Blvd	Murray St.		
238	11/20/2008	16	705 Rodeo St.		6-inch / CIP	
75	8/16/2009	16	Circle Cross @ Master meter			
101	3/22/2006	17	410 Daley (alley)		6-inch / CIP	Circumferential Crack
107	4/19/2006	17	7th	Date (alley)		
149	2/16/2007	17	7th	Walnut	8-inch / CIP	Froze up main, longitudinal crack
154	2/22/2007	17	7th	Walnut (SE Corner)	8-inch / CIP	new 3/4 Tap
184	8/7/2007	17	Date St.	7th & 8th	6-inch / PVC	Abandoned to 7th St.
235	11/17/2008	17	901 Date St. (alley)		6-inch / CIP	
13	2/24/2004	17	627 W. State		4-inch / CIP	Tapping Saddle
17	4/14/2004	17	1110 13th St.		4-inch / CIP	Contractor Damage
20	5/14/2004	17	13th	Cherry	12-inch / CIP	Longitudinal Crack (12 ft.)
30	12/7/2004	17	313 4th St.		4-inch / CIP	Circumferential Crack
31	12/8/2004	17	313 4th St.		4-inch / CIP	Split Bell / Brack (10 ft)
32	12/9/2004	17	313 4th St.		4-inch / CIP	Wall Penetration (Hole)
35	1/5/2005	17	612 11th St.		6-inch / CIP	Circumferential Crack
36	1/14/2005	17	W. Spruce (13th and 14th Alley)		3/4 Copper	Air valve d/c
57	5/12/2005	17	710 14th St.		6-inch / PVC	Offset @ tap connection
63	6/3/2005	17	1115 High St.		6-inch / CIP	Wall Penetration (2)
68	6/29/2005	17	803 High St.		6-inch / CIP	Longitudinal Crack (2 ft)
69	7/7/2005	17	High St.	7th & 8th	6-inch / CIP	6-inch G.V.
74	8/12/2005	17	Birch	8th & 9th	12-inch / CIP	Wall Penetration
78	9/7/2005	17	Cemetery		6-inch / CIP	Replace 2-inch G.V.
82	9/21/2005	17	Wyoming	Walnut & Maple (Alley)	8-inch / CIP	Wall Penetration - split
90	11/28/2005	17	502 W. Spruce St. (alley)		1-inch Service Meter ftg.	Service Line Break
93	12/20/2005	17	1333 Mt. View Blvd.		6-inch / CIP	Circumferential Crack
99	2/21/2006	17	Between 9th	11th	6-inch / CIP	Circumferential Crack
109	4/20/2006	17	Maple St.	11th and 12th	4-inch / CIP	Longitudinal Crack
108	4/20/2006	17	Spruce	11th and 12th	6-inch / CIP	Isolated at crossing under Spruce St.
114	7/30/2006	17	Veterans	Mt. View	6-inch / CIP	Wall Penetration
117	9/27/2006	17	900 14th St.		4-inch / CIP	
84	10/6/2006	17	8th	Buffalo (Alley)	4-inch / CIP	
128	11/25/2006	17	Wyoming	Walnut & Maple	8-inch / CIP	Wall Penetration @ Bell Spigot
141	1/29/2007	17	616 W. Buffalo (alley)		3/4 copper service	Wall Penetration
144	2/7/2007	17	4th	Walnut	6-inch compound meter	Froze up
145	2/8/2007	17	401 W. State		6-inch / PVC	Longitudinal Crack
148	2/13/2007	17	104 W. Spruce			Wall Penetration
150	2/16/2007	17	1004 8th		4-inch / CIP	
159	3/5/2007	17	3rd	Pine & Spruce	6-inch / CIP	Bad bolts, main valve
160	3/6/2007	17	? 822 E Kendrick		8-inch irrigation pipe, glued joints (undersized)	Leak at hub
164	3/21/2007	17	8th	Birch (SE Corner)	12-inch / CIP	Wall Penetration
171	4/18/2007	17	12th	C St. (cemetery)	6-inch / PVC	4-inch Butterfly valve
185	8/10/2007	17	927 14th St. (alley)		4-inch / CIP	Longitudinal crack
192	9/13/2007	17	123 E. Murray St. - Cemetery		8-inch / CIP	Replaced bolts, repaired 6-inch G.V. nut
204	12/20/2007	17	121 E. Buffalo (alley)		6-inch / CIP	Lead Service Line
211	1/16/2008	17	1317 Mt. View Blvd.		6-inch / CIP	Circumferential Break
212	1/21/2008	17	1142 Mt. View Blvd.		6-inch / CIP	Circumferential Break
213	1/25/2008	17	F. Station #1 (alley)		4-inch	Circumferential Break
226	8/22/2008	17	Alder	@ Ft. Lincoln School tap		Wall Penetration
227	9/2/2008	17	702 Mt. View Blvd.		4-inch / CIP	Wall Penetration caused by 16-inch PRV
232	11/4/2008	17	915 3rd St.			
244	12/5/2008	17	513 12th St.		4-inch / CIP	Sm. Longitudinal crack
246	12/9/2008	17	Alder St.	8th & 9th St.	4-inch / CIP	Broken Fire Hydrant
15	3/15/2004	18	1644 Park Dr.		6-inch / CIP	MJ Bolts Replaced
62	6/2/2005	18	1644 Park Dr.		6-inch / CIP	Longitudinal Crack
106	4/10/2006	18	1644 Park Dr.		6-inch / CIP	Longitudinal Crack
151	2/16/2007	18	1660 Park Dr.		6-inch / CIP	Wall Penetration
168	4/5/2007	18	1686 Park Dr.		1-inch Curb stop	Broken Bonnet
247	12/26/2008	18	Park Dr.	Mt. View Blvd	6-inch / CIP	Circumferential Break
2	1/7/2004	18	23rd	Elm	6-inch / CIP	Longitudinal Crack
3	1/10/2004	18	183 El Rancho		4-inch / CIP	Longitudinal Crack
14	2/26/2004	18	16th	Spruce	6-inch / CIP	Circumferential Crack
34	1/1/2005	18	206 LaPaloma		4-inch / CIP	Circumferential Crack
61	5/31/2005	18	23rd	Elm	6-inch / CIP	G.V. Test Plug
64	6/3/2005	18	El Rancho	Sonora	6-inch / CIP	Wall Penetration
77	8/25/2005	18	23rd	Elm	6-inch / CIP	Longitudinal Crack
80	9/15/2005	18	21st	Spruce	20-inch / DIP 6-inch / CIP	6x6 Tee and G.V.

Appendix D - Line Break Summary

No.	Date	Section	Number Street	Street	Pipe Size / Material	Break Type
97	2/18/2006	18	18th	Elm	6-inch / CIP	Wall Penetration
139	1/27/2007	18	154 El Rancho		3/4 copper service	Froze up
140	1/29/2007	18	174 Los Altos		3/4 copper service	Froze Up
147	2/13/2007	18	521 1st St.		6-inch / CIP	Longitudinal Crack
207	1/1/2008	18	El Rancho	Savors Ct.?	6-inch / CIP	Wall Penetration
210	1/10/2008	18	187 Los Altos		4-inch / CIP	Wall Penetration
239	11/27/2008	18	2403 Wagon Circle Road		6-inch / CIP	Wall Penetration
25	8/23/2004	20	I-80	MP 212	20-inch / DIP	Longitudinal Crack
60	5/19/2005	20	Grant / State	Hugus	12-inch / RCP	Replace 26'
134	1/5/2007	20	Bennett	Davis	6-inch / CIP	Circumferential Crack
188	9/5/2007	20	600 Donnell St.		12-inch / CIP	Longitudinal Crack
4	1/14/2004	21	417 Sage Hills		6-inch / CIP	Longitudinal Crack (3 ft.)
5	1/14/2004	21	417 Sage Hills		6-inch / CIP	Wall Penetration (Hole)
7	2/12/2004	21	37 Ash Ave.		6-inch / PVC	Service Connection / Saddle
23	6/30/2004	21	Olive Circle		6-inch / PVC	Service Connection / Saddle
56	5/10/2005	21	67 & 68 Ash Ave.		6-inch / PVC	F. Hydrant Bolts (Barrel)
59	5/16/2005	21	67 Ash Ave.		6-inch / PVC	Longitudinal Crack (5 ft)
71	8/1/2005	21	Olive Circle		6-inch / PVC	D/C @ Corp stop, Service abandoned
73	8/12/2005	21	41 Ash Ave.		6-inch / PVC	Service Connection Abandoned
86	10/20/2005	21	47 Ash Ave.		1-inch / PVC to north	Pin Hole-Service line
87	10/26/2005	21	Olive Circle		1 inch / PVC 1 North, 1 South	Pin Hole-Abandoned
89	11/22/2005	21	Sage Hills Alley		6-inch / CIP	Wall Penetration (pin hole)
95	12/28/2005	21	Higley Blvd.	Locust St. (?)	Fire Hydr.	FL x MI 6-inch G.V.
103	4/4/2006	21	415 Sage Hills		6-inch / CIP	Wall Penetration
115	8/16/2006	21	64 Ash		6-inch / PVC	Service Line installed
116	8/23/2006	21	Olive Circle		6-inch / PVC	Service line installed and repaired
143	1/31/2007	21	Sage Hills (alley)		6-inch / CIP	Wall Penetration
152	2/17/2007	21	33 Ash Ave.		6-inch / PVC	Tapping saddle deteriorated
156	2/27/2007	21	71 Ash Ave.		6-inch / CIP	Tee to Hydrant, bolts deteriorated
162	3/20/2007	21	23 Ash Ave.		6-inch / PVC	Service Saddle
190	9/12/2007	21	417 Sage Hills (alley)		6-inch / DIP	
231	11/5/2008	21	700 Olive Circle		6-inch / PVC	3/4-inch service split
120	10/16/2006	21	228 E. State St. (alley)		6-inch / CIP	Longitudinal Crack
11	2/21/2004	21	206 Washington		6-inch / CIP	Replaced
19	5/7/2004	21	Washington	RR	4-inch / PVC	Longitudinal Crack
27	8/25/2004	21	215 W. Hugus		6-inch / CIP	Wall Penetration
29	9/20/2004	21	302 W. Hugus		12-inch / CIP	Longitudinal Crack
88	10/26/2005	21	Wash	Hughes	Storm Sewer Inlet	Longitudinal Crack
110	4/21/2006	21	McKinley	Davis & Hugus	12-inch / CIP	Longitudinal Crack
119	9/29/2006	21	410 Washington (alley)		6-inch / CIP	Wall Penetration
121	10/27/2006	21	220 W. Hugus (alley)		12-inch / CIP	Longitudinal Crack
155	2/23/2007	21	401 Washington (alley)		6-inch / CIP	G.V. Broken Stem
157	2/28/2007	21	214 W. Hugus (alley)		12-inch / CIP	longitudinal crack (4-ft)
242	12/3/2008	21	1000 Ash Ave.		6-inch / PVC	3/4-inch taps
243	12/4/2008	21	998 Ash Ave.		6-inch / PVC	3/4-inch taps

APPENDIX E
GEOTECHNICAL DATA EVALUATION REPORT
ATLANTIC RIM RESERVOIR



GEOTECHNICAL AND
WATER RESOURCES ENGINEERING

GEOTECHNICAL DATA EVALUATION REPORT

ATLANTIC RIM RESERVOIR CARBON COUNTY, WYOMING

Submitted to
Wester-Wetstein & Associates, Inc.
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Laramie, Wyoming 82073

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April 2010
Project 09121



Robert J. Huzjak, P.E.
Project Manager

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SECTION 1 - INTRODUCTION

1.1 Purpose

Wester-Wetstein & Associates, Inc. (Wester-Wetstein) retained RJH Consultants, Inc. (RJH) to provide a preliminary engineering evaluation of existing geotechnical data related to ongoing seepage concerns at Atlantic Rim Reservoir (Site). The purposes of this preliminary evaluation were to review and evaluate available data from previous geotechnical reports; identify the reliability of the data and analyses; identify geotechnical concerns related to rehabilitation of the reservoir; and identify areas where additional geotechnical information is needed to evaluate seepage issues, develop a rehabilitation concept, and prepare rehabilitation design documents.

1.2 Background

Atlantic Rim Reservoir is an off-channel reservoir located about 2 miles south of the Rawlins Water Treatment Plant as shown on Figure 1.1. The dam is owned and operated by the City of Rawlins and provides raw water storage for municipal use. The reservoir stores about 614 acre-feet (ac-ft) of water and is operated in tandem with Peaking Reservoir to supply raw water to the water treatment plant.

Atlantic Rim Reservoir was constructed in 1979 and was first filled during the winter of 1979-1980. The reservoir has a history of seepage problems that started during first filling and are presently ongoing. Various geotechnical firms investigated the seepage problems from about 1980 to 1983. A chronology of significant events for the Atlantic Rim Reservoir was compiled by Gannett Fleming (2005) and is in Appendix A.

1.3 Data Reviewed

RJH obtained information related to geotechnical and seepage conditions at the Site and general information regarding the design, performance, and operation of the reservoir from the following sources:

- Previous reports and design documents.
- Meeting at the water treatment plant and Site visit on September 11, 2009.
- Published geologic maps.



RJH reviewed the following reports that document the construction, seepage concerns, and proposed rehabilitation of Atlantic Rim Reservoir:

- *Construction Drawings, File No. 48351, Sheets 3, 6, and 7 of 8.* Prepared by Meurer, Serafini and Meurer, Inc. (MSM, Inc.), Denver, CO, January 1979. (MSM, 1979).
- *Fill Observations, Atlantic Rim Reservoir, Rawlins, Wyoming.* Prepared by CTL/Thompson, Inc., Denver, CO, September 25, 1979. (CTL/Thompson, 1979).
- *Evaluation of Underseepage, Atlantic Rim Reservoir, Rawlins, Wyoming.* Draft Report Prepared by CTL/Thompson, Inc., Denver, CO, June 18, 1981. (CTL/Thompson, 1981).
- *Atlantic Rim Reservoir Remedial Measures, Hazard Evaluation, Temporary Maintenance and Monitoring Procedures.* Letter to the City of Rawlins from Law Engineering Testing Company, Englewood, CO, August 3, 1982. (Law Engineering, 1982).
- *Contract Documents and Construction Specifications for Lining Atlantic Rim Reservoir for the City of Rawlins in Carbon County, Wyoming.* Prepared by MSM/SP Group, Denver, CO, June 1983. (MSM/SP, 1983).
- *Technical Memorandum Geotechnical Reconnaissance and Preliminary Design Recommendations – Rawlins Raw Water Supply, Level II.* Prepared by Gannett Fleming, Inc., December 2005. (Gannett Fleming, 2005).

RJH obtained and reviewed the following published geologic maps:

- *Geologic Map of Wyoming.* U.S. Geological Survey Map by J.D. Love and A.C. Christiansen, Denver, CO, 1985.
- *Landslide Map of the Rawlins 1° x 2° Quadrangle.* Geological Survey of Wyoming Open File Report 91-20 by James C. Case and Laura L. Larsen, Laramie, WY, 1991.
- *Preliminary Digital Surficial Geologic Map of the Rawlins 30 x 60 Minute Quadrangle, Carbon and Sweetwater Counties, Wyoming.* Wyoming State Geological Survey Map HSDM 98-6 by Laura L. Hallberg and James C. Chase, Laramie, WY, 1998.
- *Preliminary Map of Known Surficial Structural Features for the Rawlins 1° x 2° Quadrangle.* Geological Survey of Wyoming Open File Report 87-10 by Jon K. King, Phillip L. Greer, and Alan J. Ver Ploeg, Laramie, WY, 1987.

- *Tectonic Relationships of the Southeastern Wind River Range, Southwestern Sweetwater Uplift, and Rawlins Uplift, Wyoming.* Geological Survey of Wyoming Report of Investigations No. 47 by D.L. Blackstone, Jr., Laramie, WY, 1991.
- *Unofficial Soil Survey of the Rawlins Reservoir Area, Wyoming.* Natural Resources Conservation Service, Casper, Wyoming. This information has not been verified to meet National Cooperative Soil Survey (NCSS) standards of quality.

Gannett Fleming (2005) presented information from several documents that appear to be related to seepage problems at the Site. RJH could not obtain copies of these reports, but the secondhand information presented by Gannett Fleming (2005) has been summarized in this report. Gannett Fleming (2005) presented information from the following documents:

- *Review of Geotechnical Conditions, Atlantic Rim Site.* Prepared by Law Engineering Testing Company, Denver, CO, June 10, 1982.
- *Analysis of Seepage Control Measures, Atlantic Rim Reservoir, Rawlins, Wyoming.* Prepared by Law Engineering Testing Company, Denver, CO, July 8, 1982.
- *Subsurface Soils Investigation, Peaking Reservoir II, Rawlins, Wyoming.* Prepared by Lincoln Devore, Colorado Springs, CO, November 22, 1978.

1.4 Scope of Work

RJH performed the following services for this preliminary phase of the project:

- Participated in a combined kick-off meeting and Site visit and obtained piezometer data and other information from Wyoming Water Development Commission (WWDC) and the City of Rawlins.
- Reviewed existing geotechnical reports that were provided to RJH by Wester-Wetstein and WWC Engineering.
- Reviewed existing piezometer data.
- Identified concerns with the reliability of the existing geotechnical and piezometer data.
- Identified opinions of potential seepage pathways.

- Identified geotechnical issues that are expected to impact reservoir rehabilitation.
- Identified areas where additional geotechnical information is required to support evaluation of reservoir rehabilitation and develop a recommended geotechnical field program.
- Prepared this report.

1.5 Authorization and Project Personnel

This work was authorized by Mr. Larry Wester of Wester-Wetstein & Associates, Inc. The following personnel from RJH are responsible for the work contained in this report:

Project Manager	Robert J. Huzjak, P.E.
Project Engineer	Adam B. Prochaska, Ph.D., E.I.
Technical Review	A. Tom MacDougall, P.E. ⁽¹⁾
	Edwin R. Friend, P.E. ⁽¹⁾ , P.G.

(1) Registered in states other than Wyoming.

1.6 Site Description

Atlantic Rim Reservoir is impounded by an earthen dam approximately 33 feet high and about 2,300 feet long. A general plan of the dam and reservoir are shown on Figure 1.2. The crest is at about Elevation (El.) 7227 and is about 15 feet wide. The dam extends from about Station 20+00 to Station 54+47.2 and Station 0+00 to Station 7+25, with the maximum embankment section generally being located from about Station 27+00 to Station 50+00. From about Station 7+25 to Station 20+00 the reservoir is impounded by a natural hillside and cut slopes. The upstream slope of the dam is about 3H:1V and the downstream slope is about 2.5H:1V. The dam generally consists of homogenous clayey fill with a blanket drain, toe drain, and upstream riprap slope protection. Based on construction records, sandstone and other granular materials were incorporated in the embankment downstream of the crest and above the blanket drain; however, the extent and properties of this granular fill are unknown. The blanket drain extends from about Station 27+00 to Station 50+00 and is located under the downstream third of the embankment footprint. The blanket drain is 2 feet thick and consists of filter sand that connects to the toe drain. The toe drain extends from about Station 26+00 to Station 52+00 along the downstream toe of the dam. The toe drain consists of a 6-inch perforated PVC pipe on a minimum 0.5 percent slope that is encased in a gravel collector



that is surrounded by filter sand. The toe drain pipe discharges at three locations near the downstream toe of the embankment slope: at about Stations 29+25, 35+90, and 43+00.

Foundation treatment appears to consist of a cutoff trench that was constructed by excavating about 10 feet below the original ground surface and backfilling the excavation with compacted clayey fill similar to that used to construct the embankment. The cutoff trench extends from about Station 26+50 to Station 51+30. From Station 46+80 to Station 50+90 the cutoff trench extends up to about 8 feet below the bedrock surface. From about Station 26+50 to Station 46+80 and Station 50+90 to Station 51+30 the cutoff trench does not extend to bedrock and terminates in overburden soils. Between these stations bedrock is generally 6 to 19 feet below the bottom of the cutoff trench. The cutoff trench has a bottom width of about 20 feet and side slopes of about 1H:1V. The downstream edge of the cutoff trench bottom appears to be aligned with the centerline of the dam crest.

The inlet and outlet each consist of 24-inch pipe and are located at Stations 39+35 and 39+55, respectively. Inlet and outlet pipes are Interpace lock joint pipe with rubber and steel gaskets. The intake and outlet pipes each have eight concrete seepage collars spaced every 20 feet within the embankment. One report states that the inlet and outlet pipes are supported on piers, although this is not shown on the drawings. The inlet and outlet pipes both connect to an existing 16-inch wood pipe about 230 feet downstream of the embankment centerline. The inlet pipe discharges into the reservoir at about Station 5+35 at El. 7203.3. Flow into the outlet pipe is controlled by two sluice gates on the upstream slope of the embankment with invert elevations at about El. 7201.7 and El. 7197.7. The 24-inch outlet pipe at Station 39+55 connects into a 6-inch drain line that discharges to a riprap-lined outlet channel downstream of the southwest corner of the embankment.

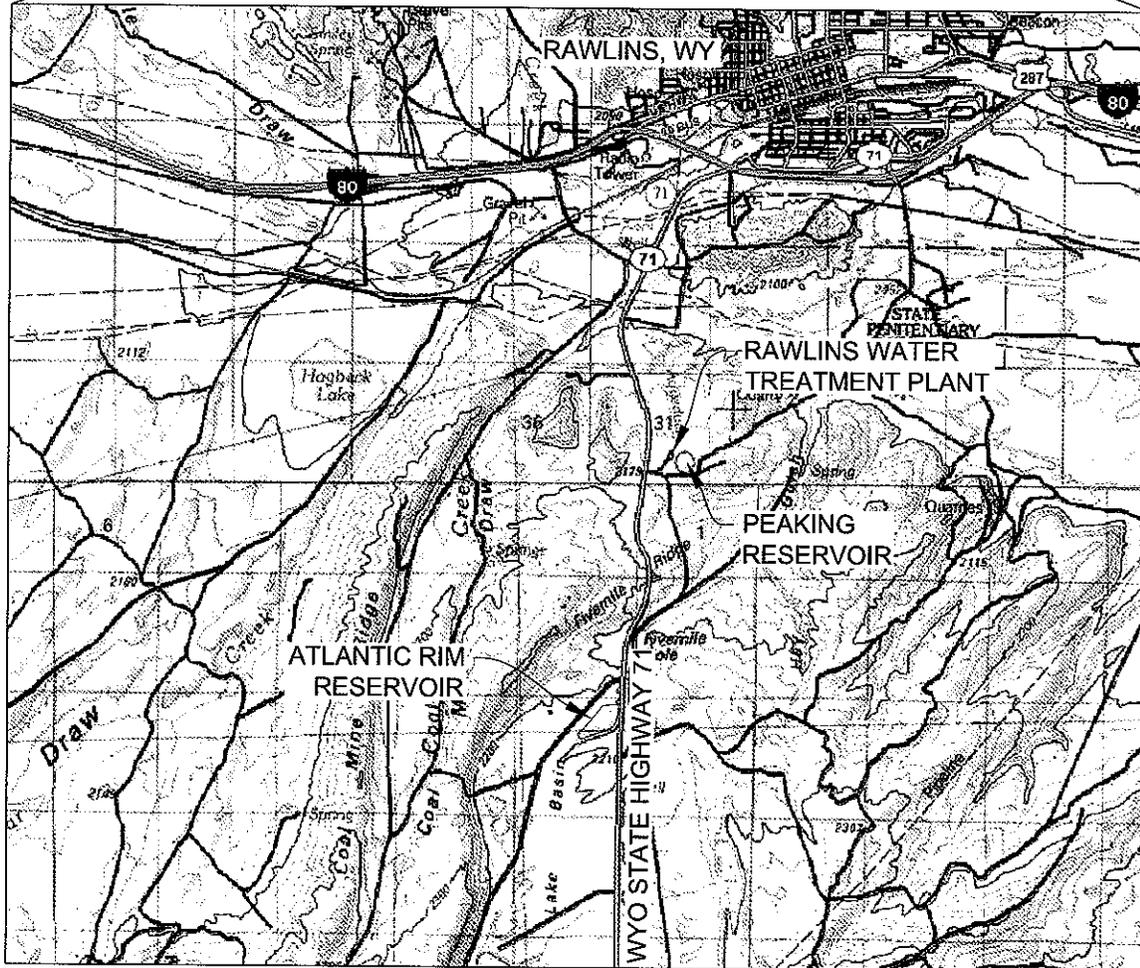
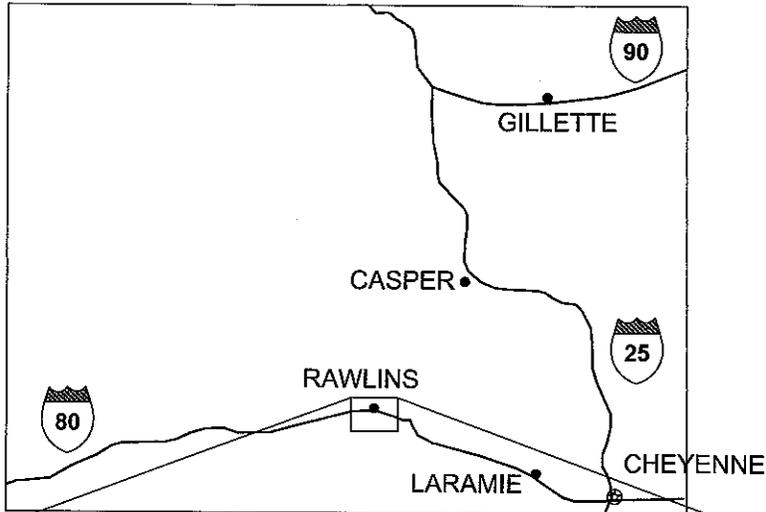
Upstream slope protection consists of 2 feet of riprap overlying 1 foot of riprap bedding. Slope protection extends around the entire perimeter of the reservoir from the dam crest to about El. 7208, which is about 9 to 12 vertical feet from the bottom of the slope at the maximum embankment section. A 15-foot radius of upstream slope protection is provided around the inlet pipe discharge tee. Slope protection also extends 15 feet on all sides from each of the two inlet sluice gates for the outlet pipe.

The spillway for the reservoir consists of a 24-inch pipe (overflow pipe) with an invert at about El. 7222.33 at about Station 29+15. Five feet of soil cover is present over the overflow pipe within the embankment and 2 feet of soil cover is present downstream of

the dam. The overflow pipe has five concrete seepage collars spaced every 20 feet within the embankment. The overflow discharges to the same riprap-lined structure as the 6-inch outlet drain.

1.7 Survey Datum

The reviewed documents listed in Section 1.3 do not specify what datum was used for horizontal and vertical control. Elevations and locations discussed in this report by RJH are referenced from information presented in the documents reviewed.



ATLANTIC RIM
RESERVOIR

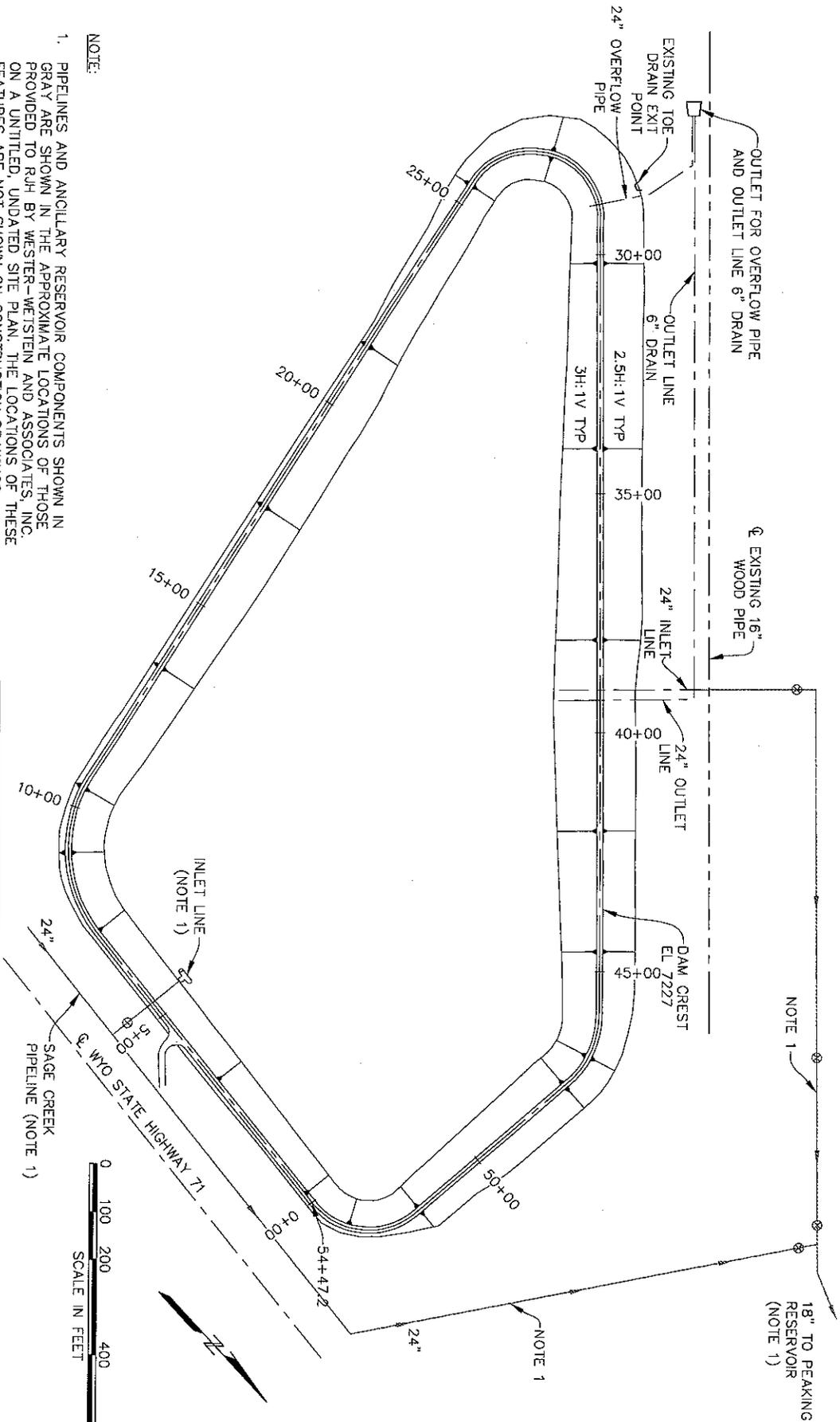
SITE VICINITY MAP

PROJECT NO. 09121

April 2010

Figure 1.1

- NOTE:
1. PIPELINES AND ANCILLARY RESERVOIR COMPONENTS SHOWN IN GRAY ARE SHOWN IN THE APPROXIMATE LOCATIONS OF THOSE PROVIDED TO RJH BY WESTER-WETSTEIN AND ASSOCIATES, INC. ON A UNTITLED, UNDATED SITE PLAN. THE LOCATIONS OF THESE FEATURES ARE NOT SHOWN ON CONSTRUCTION DRAWINGS.
 2. DRAWING ILLUSTRATES STATIONING, GENERAL LOCATIONS OF FACILITIES, AND THE LIMIT OF CUT AND FILL SLOPES. ALL LOCATIONS ARE APPROXIMATE.



WESTER-WETSTEIN & ASSOCIATES, INC.	 RJH CONSULTANTS, INC.	ATLANTIC RIM RESERVOIR PROJECT NO. 09121	GENERAL PLAN OF RESERVOIR AND APPURTENANCES April 2010 Figure 1.2
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SECTION 2 - GEOLOGY

2.1 General Geologic Setting

Based on geologic mapping performed by the U.S. Geological Survey and Wyoming State Geological Survey, the Site is located near the axis of an anticline that trends approximately north/south and plunges to the north. The closest mapped faults to the reservoir are the Bell Springs Thrust Fault, located about 3.5 miles north of the Site, and an unnamed normal fault, located about 4 miles southwest of the Site. The Bell Springs Thrust Fault is mapped as being possibly active.

2.2 Dam and Reservoir Geology

Bedrock at the Site is mapped as Steele Shale. The Steele Shale is a Cretaceous-aged (78 to 82 million years old) soft marine shale that contains numerous bentonite beds and thin lenticular sandstone (Love and Christiansen, 1985). Overburden soils around the Site are mapped as slopewash mixed with residuum and alluvium (Hallberg and Chase, 1998). Based on Natural Resources Conservation Service (NRCS) maps, soils near the Site are identified as sandy loam to sandy clay loam with moderate to moderately slow permeability.

SECTION 3 - CONSTRUCTION DOCUMENTATION

3.1 Dam Construction Documentation

CTL/Thompson (1979) provided daily reports during construction between May 16 and September 7, 1979 that document construction of the Atlantic Rim Dam. Embankment fill was generally described as sandy clay, silty clay, claystone, and siltstone. Sandstone or other granular material encountered in borrow areas was reported to have been placed as embankment fill in the downstream portion of the embankment above the blanket drain. Borrow material was occasionally described as being calcareous or having very high sulfate content. Concerns about sulfate-bearing soils were also raised during construction of the inlet and outlet piers and pipes.

The blanket drain and filter drain were zones comprised of filter sand material which generally consisted of gravelly sand and sandy gravel. Riprap bedding and the gravel collector around the toe drain generally consisted of sandy gravel. The specified gradation ranges for the gravel collector, filter sand, and riprap bedding are presented in Table 3.1. The gradation of the riprap was not documented in the available records.

The gradation for the riprap bedding specified by CTL/Thompson (1979) differed from that specified by MSM (1979) and the riprap bedding gradation accepted by the field engineer differed from the material specified by CTL/Thompson and MSM. It is not documented why the specified gradation for riprap bedding was changed. These final accepted gradations were generally finer than the range specified by CTL/Thompson and coarser than the range specified by MSM. The gravel collector and filter sand gradations specified by CTL/Thompson were consistent with those specified by MSM (1979). Based on the available construction records, many gradation tests performed on filter sand did not meet the specified range. It is not clear from the construction records if the material that did not meet the specifications was used in the completed work, or what gradations are representative of the in-place material.

**TABLE 3.1
 GRADATIONS FOR GRAVEL COLLECTOR, FILTER SAND, AND RIPRAP
 BEDDING**

Sieve Size	Percent Finer			
	Specified by MSM (1979)		Specified by CTL/Thompson (1979)	Accepted by Field Engineer
	Gravel Collector	Filter Sand and Riprap Bedding	Riprap Bedding	Riprap Bedding
4-inch			100	100
3-inch	100		80 – 100	92 – 100
1.5-inch	50 – 100		52 – 76	76 – 81
0.75-inch	30 – 70	100	25 – 55	62
0.5 inch	20 – 60	95 – 100		
No. 4	5 – 40	80 – 100	15 – 30	40 – 44
No. 10	0 – 30	60 – 85	12 – 26	34 – 37
No. 20	0 – 15	40 – 65		
No. 40	0 – 10	20 – 50	4 – 18	20 – 24
No. 200	0 – 5	0 – 10	0 – 10	10 – 11

About 2 feet of surface water had accumulated in the cutoff trench excavation from about Station 30+00 to Station 32+00 and Station 37+00 to Station 39+00 due to precipitation in June 1979. Groundwater was also encountered in the cutoff trench excavation between Stations 47+00 and 49+00. These portions of the cutoff trench were dewatered prior to fill placement.

CTL/Thompson also provided material testing during construction. The types and number of field and laboratory tests conducted during dam construction are summarized in Table 3.2. Test results are presented in Appendix B.1 and are discussed in Section 7.

**TABLE 3.2
 SUMMARY OF LABORATORY TESTS FROM DAM CONSTRUCTION**

Type of Test ⁽¹⁾	Number of Tests				
	Embankment Fill	Blanket Drain	Gravel Collector	Filter Drain	Riprap Bedding
Standard Proctor (ASTM D 698)	8	0	0	0	0
In-Situ Moisture-Density (nuclear)	187	0	0	0	0
In-Situ Moisture-Density (sand cone)	97	0	0	0	0
Liquid Limit and Plasticity Index	6	0	0	0	0
Gradation	3	11	1	1	2
Percent Passing No. 200 Sieve	3	0	0	0	0

Note:

1. ASTM Standards for most tests were not referenced in the documents reviewed.

3.2 Clay Liner Construction Documentation

According to CTL/Thompson (1981), between September and November 1980, a clay liner ranging from 2.5 to 3 feet thick was constructed in the bottom of the reservoir, but the liner did not extend up the reservoir slopes. The following activities were performed for liner construction:

- Excavated 17 test pits prior to construction in the reservoir bottom.
- Excavated four test pits prior to construction in a borrow area located between Highway 71 and the southeast reservoir corner.
- Performed six field density tests on native soils in the reservoir bottom.
- Performed nine field percolation tests on native soils in the reservoir bottom.
- Performed 71 field density tests performed on the constructed liner.
- Performed 39 field permeability tests on the constructed liner.

Test pit logs, percolation test results, permeability test results, and density results of the native soils were not included in the available documentation. Based on the distribution of field density tests performed during liner construction, it appears that the liner may have been installed across the entire reservoir bottom. However, the highest concentration of tests were located in about the western three-quarters of the reservoir

bottom. The locations of these test pits and field tests are shown on plans in Appendix B.2.

CTL/Thompson (1981) provided the following test results from liner construction:

- Seven Standard Proctor tests (ASTM D 698)
- Seven Liquid Limit and Plasticity Index tests
- Seven Gradation tests
- Seventy-one moisture-density tests (sand cone)

Liner fill was placed using up to four lifts. Nearly all moisture-density tests were performed on the top lift or within 1 foot below the top of the liner. Test results from the liner construction are summarized in Section 7 and are presented in Appendix B.2.

City of Rawlins personnel who were employed in the fall of 1980 did not recall construction of a 3-foot-thick clay liner in the reservoir bottom. They remember four to six truckloads of bentonite being imported to the site, and graders being used to mix the bentonite with the native soil along the west and north sides of the reservoir bottom. They also remember a fabric liner being installed at a similar time as the bentonite lining.

3.3 Hypalon Liner Documentation

In June 1983 the MSM/SP Group developed contract documents and construction specifications for construction of a hypalon liner at the Site. This liner was never constructed.

3.4 Slurry Trench Documentation

RJH reviewed a plan to construct a slurry trench (seepage cutoff) at Atlantic Rim Reservoir. The plans were prepared by CTL/Thompson and were dated September 1981. The plans also provide notes on an alternative hypalon liner. It appears that neither the slurry trench or the hypalon alternatives were constructed. A copy of the plan is in Appendix B.3.

3.5 Remedial Measures, Hazard Evaluation, and Temporary Maintenance and Monitoring Procedures

Law Engineering provided the City of Rawlins with a letter dated August 3, 1982 that discussed remedial measures, hazard evaluation, and temporary maintenance and monitoring procedures for Atlantic Rim Reservoir. Law Engineering concluded that the following remedial measures were necessary to operate the reservoir temporarily until a liner could be installed:

- The ditch that collects seepage from downstream of the embankment (collector ditch) should be extended.
- Lateral ditches should be constructed every 100 feet to connect the embankment toe drain with the collector ditch.
- Areas adjacent to the embankment should be graded to drain to the collector ditch.
- A weir should be installed to monitor flows in the collector ditch.
- Reservoir stage markings on the valve aprons should be improved and referenced to a benchmark.
- An evaporation pan and rain gauge should be installed at the Site.
- Rawlins personnel should perform weekly inspections of the embankment, instruments, and seepage conditions.

Based on RJH's Site visit on September 11, 2009, installation of the weir appears to be the only remedial measure from the above list that was implemented at the Site.

Law Engineering concluded that floodwaters from a sudden failure of Atlantic Rim Dam would be contained entirely within the Eight Mile Lake basin. Law Engineering concluded the consequences from a sudden flood release would be:

- Loss of the water storage facility (reservoir).
- Scour damage to pipelines.
- Scour, channelization, and deposition of material in the Eight Mile Lake basin.
- Flood hazards to livestock that occasionally cross the Eight Mile Lake basin.

Besides the abovementioned items, Law Engineering did not foresee any other damage to public or private property.

SECTION 4 - GEOTECHNICAL EXPLORATION

4.1 Borings and Test Pits

Numerous borings and test pits were drilled and excavated by various firms from 1978 to 1982. RJH was not provided reports from most of these investigations, but Gannett Fleming (2005) summarized the explorations and findings.

According to Gannett Fleming (2005), CTL/Thompson excavated seven test pits in the northern part of the reservoir in July 1978. Test pits ranged from 14 to 25 feet deep and encountered 2.5 to 15 feet of silty, sandy clay. RJH could not obtain test pit locations, logs, or other information from this exploration program.

According to Gannett Fleming (2005), MSM excavated four test pits in the northern part of the reservoir in September 1978. Test pits ranged from 8 to 13 feet deep and encountered 3 to 13 feet of sandy clay that was identified as being suitable for construction of a dam and liner. A lens with high sulfate content was encountered 4.5 to 7 feet deep in one of the test pits. RJH could not obtain test pit locations, logs, or other information from this exploration program.

According to Gannett Fleming (2005), Lincoln Devore excavated eight borings within the reservoir footprint in November 1978. Borings ranged from 15 to 45 feet deep and encountered 12 to 20 feet of lean clay. CTL/Thompson (1981) reported that six borings were drilled along the proposed dam axis by Lincoln Devore as part of the original dam investigation, but they did not provide data or logs. RJH could not obtain boring locations, logs, or other information from this exploration program.

According to Gannett Fleming (2005), Law Engineering drilled eight borings and excavated two test pits in July 1982. The borings were located along the outside perimeter of the reservoir, were 20 to 55 feet deep, and encountered 5.5 to 8 feet of sandy silty clay and silty sand. The test pits were located along the southern edge of the reservoir, were 10 to 11 feet deep, and encountered 1 to 3 feet of sandy clay. RJH could not obtain locations, logs, or other information from these borings and test pits.

CTL/Thompson (1981) drilled 27 borings in 1980 and 1981. These borings were performed to identify the subsurface stratigraphy, collect samples for classification and laboratory testing, identify the top of bedrock, and install observation wells. Borings were generally drilled along the embankment crest or near the downstream embankment



toe. The majority of borings were drilled along the western side of the embankment between about Stations 25+00 and 54+47.2. Borings were generally aligned to assist with the generation of embankment cross sections. Boring locations and boring logs are presented in Appendix C.1.

CTL/Thompson excavated 21 test pits in 1980 to support design and construction of a reservoir clay liner. Seventeen test pits were generally distributed throughout the reservoir bottom prior to liner construction. Four test pits were excavated in a liner borrow area between the reservoir and Highway 71. Logs or other information from these test pits could not be located by RJH. Test pit locations are provided in Appendix B.2.

Gannett Fleming performed at least two test pits west of the Site on May 24, 2006. Four test pit locations had been proposed as shown on the plan in Appendix C.2. RJH could only locate two test pit logs (Test Pit Nos. 3 and 4). Test pit logs are presented in Appendix C.2. RJH could not locate information to clarify the total number of test pits performed during this investigation.

4.2 Observation Wells

Twenty-seven observation wells were installed by CTL/Thompson in borings (O.W. 1 to O.W. 27). Nine observation wells were installed in the summer of 1980 and 18 were installed in the summer of 1981. Observation wells were installed in the embankment along the crest and near the downstream toe of the dam to monitor the phreatic surface within the embankment and foundation.

Observation wells were generally installed in borings drilled using 4-inch-diameter continuous flight auger, but O.W. 21, 23, 24, and 25 were installed in borings drilled using a hand auger. Observation wells consisted of 2-inch-diameter PVC pipe and the bottom 5 to 15 feet of pipe was perforated. Observation wells installed to monitor the water pressure in the foundation were screened throughout the entire foundation interval, which often included multiple soil or rock units. CTL/Thompson (1981) did not provide information about filter compatibility between the well screens and surrounding soil, or details of how the wells were constructed. Observation wells were often installed in rows perpendicular to the dam crest stationing to enable measurement of the phreatic surface at various cross sections through the dam. These observation wells were measured about every 3 days to 3 weeks from November 14, 1980 until June 17, 1981.



According to Gannett Fleming (2005), an unknown number of observation wells were also installed by Law Engineering in July 1982. RJH did not obtain any information about the locations, screened intervals, or water level measurements from these observation wells.

During the site visit on September 11, 2009, RJH attempted to measure water levels in observation wells at the Site. Of the 27 documented observation wells, water levels could be measured in eight observation wells, seven observation wells could not be located, and 12 observation wells were blocked by sediment. RJH also located and measured water levels in five additional observation wells presumably installed by Law Engineering.

Piezometer locations are shown in Appendix C.1. Piezometer measurements are discussed in Sections 5.2 and 6.4 and the data is included in Appendix E.

4.3 Sample Collection

Sampling intervals in the 27 borings performed by CTL/Thompson (1981) were typically every 5 to 10 feet, although many borings were advanced with limited to no sampling. Sampling locations are shown on the boring logs presented in Appendix C.1. Samples were primarily obtained using California samplers and standard split-spoon samplers. Samples were also obtained using two other different methods that were not specified by CTL/Thompson in their legend. Based on experience and general standard practice, it is possible that these other sample types were likely Shelby tube and core samples.

4.4 Field Testing

Field testing in the 27 borings performed by CTL/Thompson (1981) included sampler blowcounts. Blowcounts were recorded while driving California and standard split-spoon samplers. Blowcounts obtained from California samplers are the number of blows of a 140-pound hammer falling 30 inches that were required to drive a 2.5-inch outside-diameter (O.D.) sampler 12 inches. Blowcounts obtained from standard split-spoon samplers are the number of blows of a 140-pound hammer falling 30 inches that were required to drive a 2.0-inch O.D. sampler the last 12 inches of an 18-inch interval. Blowcounts obtained during subsurface investigations are discussed in Section 7.

CTL/Thompson (1981) performed an in-situ permeability test in observation well O.W. 4 by evacuating water from the well and measuring the time it took for the well to refill with water. The permeability of the soil around the screened interval of this observation

well was calculated by CTL/Thompson to be about 1.45×10^{-3} cm/s. O.W. 4 is screened through about 5 feet of clay foundation soil, 2.5 feet of weathered bedrock, and 3 feet of claystone bedrock.

CTL/Thompson (1981) performed in-situ permeability tests on the compacted clay liner by hand-augering a small hole, filling it with water, and measuring the rate at which the water level dropped. Test data were not provided. The results of the clay liner permeability tests computed by CTL/Thompson were about 1.35×10^{-5} cm/s, but CTL/Thompson believed that the clay liner has a permeability of about 1×10^{-5} to 1×10^{-7} cm/s. Test holes were backfilled and compacted following the tests.

Gannett Fleming (2005) reported that Law Engineering also performed field permeability tests as part of their subsurface investigation in 1982, and summarized permeability ranges that were developed by Law Engineering. Permeability values developed from the laboratory and field tests are summarized in Table 4.2.

4.5 Laboratory Data

Laboratory tests were performed on soil and rock samples obtained from the 27 borings conducted by CTL/Thompson (1981). The types and number of tests performed are summarized in Table 4.1. The locations of tested samples are shown on the boring logs presented in Appendix C.1. Test results are presented in Appendix D.1 and are summarized in Section 7.

**TABLE 4.1
SUMMARY OF LABORATORY TESTS ON BOREHOLE SAMPLES**

Type of Test	Number of Tests			
	Fill	Foundation Soil	Weathered Bedrock	Bedrock
In-Situ Moisture Content	11	16	5	11
In-Situ Dry Unit Weight	11	9	4	10
Particle Size Analysis	0	10	2	0
Unconfined Compressive Strength	0	2	0	3
Liquid Limit and Plasticity Index	0	3	1	0

CTL/Thompson (1981) performed laboratory permeability tests on compacted embankment material, but were unable to develop flow through the samples in a 2- to 3-month test period. CTL/Thompson estimated the permeability of embankment fill to be about 1×10^{-6} to 1×10^{-7} cm/s.

Gannett Fleming performed the following laboratory testing on soil samples collected from their test pits performed on May 24, 2006:

- Three Natural Moisture Contents
- Two Particle Size Analyses (ASTM D 422)
- One Double Hydrometer and Percent Dispersion (ASTM D 4221)
- Two Atterberg Limits (ASTM D 4318)
- One Standard Proctor (ASTM D 698)

These laboratory test results are presented in Appendix D.2 and are discussed in Section 7.7.

According to Gannett Fleming (2005), Law Engineering performed the following laboratory tests on samples collected from their 1982 subsurface investigation:

- Permeability
- Soluble mineral contents of soils
- Total dissolved solids in groundwater
- Dispersion potential of foundation soils

Foundation soils at the Site were found to be slightly susceptible to dispersion.

Results of soluble mineral content and total dissolved solids in groundwater are discussed in Section 5.1. Permeability values developed from the laboratory and field tests are summarized in Table 4.2.

**TABLE 4.2
 PERMEABILITY VALUES DEVELOPED BY LAW ENGINEERING FROM
 FIELD AND LABORATORY TESTS**

Geologic Unit	Permeability (cm/s) ⁽¹⁾	
	Range	Typical ⁽²⁾
Embankment and Clay Liner	5.1×10^{-6} to 5.1×10^{-7}	5.1×10^{-7}
Colluvium	1.4×10^{-8}	
Residual Clay Soil	1.9×10^{-5} to 2.2×10^{-6}	5.1×10^{-4}
Weathered Bedrock	1.3×10^{-2} to $< 3.0 \times 10^{-5}$	

Notes:

1. Gannett Fleming (2005) reported the permeability values in ft/min. The reported values were converted to cm/s by RJH.
2. Nomenclature is identical to that used by Gannett Fleming (2005). No information is provided as to what is meant by "Typical" values.

SECTION 5 - SEEPAGE STUDIES

5.1 Chemical Analyses

CTL/Thompson (1981) performed chemical analysis of a soil sample that was collected “downstream of the embankment in an area where considerable seepage had occurred.” Results are summarized in Table 5.1.

TABLE 5.1
CTL/THOMPSON SOIL CHEMICAL ANALYSIS RESULTS

Chemical	Concentration (ppm)
Calcium	2,710
Magnesium	5,290
Sodium	10,700
Potassium	315
Carbonate	<1.5
Bicarbonate	530
Chloride	1,710
Sulfate	47,400

Based on the data presented in Table 5.1, CTL/Thompson (1981) reported that the chemical combinations and concentrations presented in Table 5.2 probably existed in the overburden soils.

TABLE 5.2
CTL/THOMPSON PROBABLE CHEMICAL CONCENTRATIONS IN SOIL

Chemical	Concentration (ppm)
Potassium Chloride	600
Sodium Chloride	2,350
Sodium Sulfate	30,200
Magnesium Sulfate	26,200
Calcium Sulfate	8,600
Calcium Bicarbonate	705

CTL/Thompson (1981) also performed chemical analysis of reservoir water and seepage discharge. Reservoir water was collected from near the inlet and East Road. Seepage discharge was collected from the west end of the “structure.” Test results are summarized in Table 5.3.

TABLE 5.3
CTL/THOMPSON WATER CHEMICAL ANALYSIS RESULTS

Sample Location	Concentration (mg/L)		
	Reservoir at Inlet	Reservoir at East Road	Seepage discharge at West End of "Structure"
Calcium	59	60	450
Magnesium	10	10	2,070
Sodium	23	24	3,400
Potassium	7.7	7.6	75
Carbonate	< 0.1	< 0.1	72
Bicarbonate	160	165	270
Chloride	8.3	8.9	410
Sulfate	100	100	15,600
Total Dissolved Solids	315	305	22,900

Based on the data presented in Tables 5.1, 5.2, and 5.3, CTL/Thompson concluded about 6 percent of soil at the Site consists of water soluble material, and that each cubic foot of seepage water has the potential to remove 1.4 pounds of water soluble material. Over time this would result in voids that could allow significant flow volumes and differential embankment settlement.

According to Gannett Fleming (2005), Law Engineering also tested soils and weathered bedrock for soluble minerals. Soluble mineral content ranged from 0.23 to 0.95 percent with an average of 0.54 percent by weight. Over 60 percent of the soluble minerals present were sulfates, and sodium comprised about 7 to 13 percent of the soluble fraction.

Gannett Fleming (2005) also reported dissolved solids concentrations present in water sampled from piezometers. Data is presented in Table 5.4.

TABLE 5.4
DISSOLVED SOLIDS CONCENTRATIONS IN WATER SAMPLED FROM
PIEZOMETERS

Area	Total Dissolved Solids (mg/L)
Southwest reservoir corner	40,000 to 95,000
West and northwest boundaries where the reservoir is contained by embankments	10,000 to 20,000
Northeast and southeast abutment contacts between the embankment and the cut slope	< 10,000

5.2 Observation Well Readings

Observation well readings and reservoir water surface elevations obtained by CTL/Thompson (1981) from November 14, 1980 to June 17, 1981 are included in Appendix E. Observation well locations are shown in Appendix C.1. This time period represents the second filling of the reservoir. The initial filling occurred in the winter of 1979-1980, but the reservoir could not be completely filled due to excessive seepage. The reservoir was drained during construction of the clay liner from September to November 1980, and refilling began in November 1980. During the measurement period, CTL/Thompson concluded that no seepage had been observed in piezometers screened within embankment fill, and relatively high piezometric surfaces existed within wells screened both below the cutoff trench and at the downstream toe.

Piezometer levels measured by RJH on September 11, 2009 were generally within about 1 foot of those measured by CTL/Thompson in June 1981. In June 1981 the reservoir water surface elevation was about 7,217 feet. On September 11, 2009, RJH measured the reservoir water surface elevation to be about 7,214.4 feet, assuming a high watermark at 7,217 feet. Piezometer data collected by RJH on September 11, 2009 is included in Appendix E.

5.3 Seepage Losses

CTL/Thompson (1981) estimated the seepage losses to be about 100 gallons per minute (gpm) for the time period from April 1 to June 15, 1981. CTL/Thompson assumed evaporation rates to be 4 inches in April, 5 inches in May, and 6 inches in June.



Using the reservoir area and permeability of the clay liner, CTL/Thompson estimated that seepage through the reservoir liner should be about 1,400 gpm. Since the measured seepage was much less than the liner seepage capacity, CTL/Thompson concluded that seepage was occurring somewhere other than through the liner or embankment. They hypothesized seepage was occurring through high-permeability soil and weathered bedrock, similar to that tested during the field permeability test at O.W. 4. These materials are exposed to the reservoir in cutslopes from Station 20+00 to Station 26+00 and near Station 51+00.

CTL/Thompson (1981) calculated that seepage through soil and weathered bedrock should be about 97 gpm in the dam foundation and about 20 gpm in reservoir cutslopes. Although their calculations assumed uniform seepage over a broad area, CTL/Thompson postulated that flow was likely concentrated in areas of sands or soluble materials. They believed the liner was performing acceptably, and that water was seeping into the dam foundation from imperfections at the joining of the liner with the embankment.

According to Gannett Fleming (2005), Law Engineering attributed seepage problems to highly fractured and pervious bedrock that underlies the reservoir and is exposed in cutslopes along the east side of the reservoir. The permeable zone was estimated to be about 30 feet thick and to extend to about El. 7150 (45 to 50 feet below the bottom of the reservoir). Law Engineering estimated that seepage losses of 80 gpm were occurring when the reservoir was at El. 7210, and 200 gpm would be lost at the maximum pool of El. 7222. Law Engineering expected about half of the reservoir seepage to daylight on the ground surface downstream of the reservoir.

City of Rawlins employees believe that seepage losses have recently been decreasing. Seepage drains to the Rim Lakes, which are southwest of the site, and the lakes have not been filling as much recently.

SECTION 6 - DATA RELIABILITY

6.1 General

RJH reviewed the information presented in the previous sections and assessed the reliability and applicability of the data. The reliability of the collected data is discussed as follows: construction documentation, boring and test pit locations, observation well construction and measurements, sample collection, field testing, identification of geologic units, identification of stratigraphy, laboratory data and material classification, chemical analyses, and seepage loss estimations.

RJH ranked the reliability of the reviewed data as being generally reliable, moderately reliable, or low reliability. General definitions for these three categories are provided below:

- **Generally Reliable:** The data was considered reasonably complete and would be suitable to use for future evaluations.
- **Moderately Reliable:** The reviewed data could not be considered generally reliable because important information was not included; however, the data may be useful in future stages of this project if the data can be confirmed with additional investigations.
- **Low Reliability:** Not enough information was provided to consider the data reliable, and the reliability of the data cannot be improved by additional investigations.

6.2 Construction Documentation

It is RJH's opinion that the documentation from embankment construction is generally reliable and provides a reasonable indication of index properties of the clayey embankment fill, gravel collector, and riprap bedding. Documentation of the filter sand gradation is moderately reliable because the accepted gradations used in the dam are not clear from the construction documentation. Documentation of the granular fill placed above the blanket drain near the downstream toe of the embankment is also moderately reliable because information about the extent and properties of this fill is not provided.

In our opinion, documentation from construction of the clay liner is moderately reliable because the documentation provided by CTL/Thompson (1981) and recollection of Rawlins employees regarding construction of the liner differ. The construction



documentation also does not provide any information regarding how or if the liner is connected to the embankment.

6.3 Boring and Test Pit Locations

In our opinion, locations of the 27 CTL/Thompson (1981) borings are generally reliable. Although surveyed coordinates were not provided for each borehole, during the Site visit on September 11, 2009 RJH was able to locate 18 observation wells at the locations near where borings were shown on figures.

The locations of the test pits performed by Gannett Fleming on May 24, 2006 are of low reliability. A plan is provided that shows proposed test pit locations, but each proposed location is about 200 feet in diameter, and it is not specified which proposed location corresponds to which test pit log.

The locations of the 21 test pits performed by CTL/Thompson (1981) are of low reliability because coordinates were not provided. Even after the reservoir is drained it is unlikely that the locations could be identified. These test pits are also considered unreliable because no test pit logs are currently available.

Locations of the other borings and test pits mentioned in Section 4.1 are also of low reliability because only their general locations are currently available.

6.4 Observation Well Construction and Measurements

It is RJH's opinion that the observation well measurements are of low reliability. Details of observation well construction are lacking. It is unknown if the screen is filter compatible with the surrounding soil, if filter material was installed around the screens, or how the piezometers were backfilled. Also, many piezometers are screened in more than one geologic unit. Therefore, it is unknown which geologic unit is the primary influence to the piezometric surface. In addition, measurements were not taken for a long enough period to develop a relationship between reservoir level and piezometric surfaces. The piezometers have also not been well maintained since their installation, and many of them are uncovered or blocked by sediment.

6.5 Sample Collection

It is the opinion of RJH that the California samples and standard split-spoon samples collected in the 27 CTL/Thompson (1981) borings are generally reliable because the sample type is documented. These sample types appear to have been collected following standard procedures, and the sample types are appropriate for the laboratory tests performed. Once collected, California and split-spoon samples would not have required any special packaging and transport to be used for the tests that were conducted. Other sample types are of low reliability because the sampling method cannot be determined.

6.6 Field Testing

In the 27 CTL/Thompson (1981) borings, each location where blowcounts were obtained specify whether a California sampler or split-spoon sampler was used. California samples and standard split-spoon samples appear to be collected in general conformance with ASTM Standards, although the respective standards are not explicitly referenced. Blowcounts from California samplers and split-spoon samplers are considered to be generally reliable. Blowcounts from these samples would provide a general indication of the density or stiffness of the sampled materials.

Field permeability tests performed by the methods described by CTL/Thompson (1981) are technically possible, but not enough information is provided to evaluate if the tests or calculations were performed correctly. The field permeability test performed in O.W. 4 was performed throughout the entire screened interval, which is within foundation soil, weathered bedrock, and bedrock. Therefore, it is difficult to use this data to evaluate the permeability of a particular unit. No information is provided about the field permeability tests performed by Law Engineering, but the range for weathered bedrock presented in Table 4.3 encompasses the value obtained by CTL/Thompson from their test of O.W. 4. For these reasons, it is our opinion that the field permeability test results are moderately reliable and would need to be confirmed through additional permeability testing.

6.7 Identification of Geologic Units

The general subsurface profile developed by CTL/Thompson (1981) based on their 27 borings, consists of embankment fill overlying foundation soil overlying weathered bedrock and bedrock. Law Engineering describes the foundation as consisting of colluvium overlying residual bedrock overlying weathered bedrock. It appears the material described as residual soil by Law Engineering may correspond to the unit that

CTL/Thompson described as weathered bedrock, and the material that Law Engineering described as weathered bedrock may have been described as bedrock by CTL/Thompson. Due to these inconsistencies of material identification, it is our opinion that the identification and description of materials is of low to moderate reliability and would need to be confirmed through additional subsurface investigations.

6.8 Identification of Stratigraphy

Twelve of the 27 boreholes performed by CTL/Thompson (1981) were advanced without sampling. In these boreholes up to four material types were identified. In boreholes that were sampled regularly, the sampling interval was generally every 5 to 10 feet. Many material contacts are identified at unsampled locations. We presume that CTL/Thompson identified material types based on cuttings and drilling conditions. Logging boreholes using these methods may result in inaccurate identification of material depths or the omission of thin soil layers. For these reasons it is our opinion that the stratigraphy identified in the boreholes conducted by CTL/Thompson is of moderate reliability and would need to be confirmed through additional subsurface investigations.

6.9 Laboratory Testing and Material Classification

It is RJH's opinion that most of the laboratory test results presented by CTL/Thompson (1981) are generally reliable, even though ASTM Standards are not explicitly referenced. The majority of the tests conducted could be performed on disturbed samples. Except for five samples, tests that require undisturbed samples (unit weight and unconfined compression tests) were generally performed on California samples. Five unit weight tests were performed on samples obtained by an undefined sampling method. We consider these results to be of low reliability.

- Material classifications performed by CTL/Thompson (1981) are of low reliability and should be confirmed or corrected by additional sampling and laboratory testing. Sufficient laboratory testing to allow for material classification (Atterberg limits and gradation tests) was only performed on three samples obtained from their 27 borings: two samples of clayey foundation soil and one sample of weathered claystone.
- During embankment construction, Atterberg limits and gradation tests were only performed on six of the eight standard Proctor samples. Atterberg limits and gradation tests were performed on all seven of the standard Proctor samples during construction of the clay liner.

- In most instances, CTL/Thompson did not provide specific USCS Group Names for soil units, but rather only provided a general description. Some of the materials identified are not classified on the boring logs according to the results of laboratory testing (e.g., OW-18 at 49.5 feet, OW-19 and 49 feet OW-20 at 39 feet).

6.10 Chemical Analyses

Chemical analyses of soil are of low reliability. CTL/Thompson (1981) also acknowledges the shortcomings of their sample collection. No information is provided about the location or depth of the sampled soil used for the chemical analysis. If the sample was collected from the ground surface downstream of the dam it could have had an elevated mineral content due to precipitation of chemicals caused by evaporation of seepage water. During the site visit on September 11, 2009 a white mineral crust was observed on the ground surface downstream of the dam. It would have been more representative to collect soil samples for chemical analysis from test pit or boring samples.

Chemical analysis results from water collected from the reservoir is generally reliable. However, in our opinion chemical analysis performed on seepage water is of low reliability because it was sampled by CTL/Thompson (1981) from the west end of the "structure." This water could have accumulated additional dissolved minerals by flowing over overburden soils downstream of the dam. It would have been more representative to collect water directly from the seep location or from piezometers near the downstream toe. Gannett Fleming reports that chemical analyses were performed on water collected from piezometers, but does not specify the locations of the sampled piezometers.

CTL/Thompson's (1981) dissolution estimations are based on an assumption that seepage water will continue to dissolve soluble material from the dam foundation indefinitely. It is our opinion that dissolution will probably only continue until seepage pathways have been developed, and from then on seepage will primarily be concentrated in these pathways and only minimal additional dissolution of foundation materials would result. For this reason, it is our opinion that CTL/Thompson's dissolution estimates are of low reliability.

6.11 Seepage Loss Estimations

The reservoir evaporation losses assumed by CTL/Thompson (1981) were estimated based on previously published data for similar climates. This estimation method is considered to be moderately reliable. If a more reliable estimate of evaporation loss is required, a site-specific study should be performed.

RJH is of the opinion that seepage loss estimations performed by CTL/Thompson (1981) are of low reliability. CTL/Thompson believed seepage was occurring elsewhere in the reservoir besides the clay liner because the measured seepage losses were less than the estimated liner seepage capacity. If seepage was occurring somewhere other than through the liner, the total seepage losses would have been greater than the liner seepage capacity. Information to support the seepage loss estimates are lacking, and therefore the accuracy of these estimates cannot be confirmed without re-performing the calculations.

RJH is of the opinion that specific seepage pathways identified by others are of moderate reliability because Law Engineering and CTL/Thompson (1981) have different opinions regarding seepage. Law Engineering believed that seepage is occurring through fractured and weathered bedrock exposed in the reservoir bottom and cut slopes. CTL/Thompson believed that seepage is also occurring through foundation soils exposed in reservoir cut slopes. The general consensus is that seepage is occurring through the foundation and not through the embankment, which in our opinion appears to be generally reliable.

6.12 Data Reliability Summary

This section summarizes the reliability of the existing available information, and its usefulness during future design of embankment and reservoir rehabilitation. Justification these opinions is provided throughout Section 6.

It is the opinion of RJH that the following existing information is reliable and could be useful during future stages of investigation and design:

- Index properties of the clayey fill, gravel collector, and riprap bedding obtained from embankment construction documentation.
- Locations of the 27 boreholes conducted by CTL/Thompson (1981).
- California and split-spoon samples collected from the 27 CTL/Thompson (1981) borings.

- Blowcounts from California samplers and split-spoon samplers from the 27 CTL/Thompson (1981) borings.
- Laboratory test results from samples obtained from the 27 CTL/Thompson (1981) boreholes.
- Chemical analyses of reservoir water results.
- Seepage losses are generally occurring through foundation materials.

In our opinion, the following existing information is moderately reliable, and could be useful if it is confirmed through additional investigations:

- Presence of granular fill placed above the blanket drain near the downstream toe of the embankment.
- Filter sand gradation.
- Index properties and extent of clay placed for the reservoir liner.
- Field permeability test results.
- Identification and description of subsurface materials.
- Stratigraphy identified in the 27 CTL/Thompson (1981) borings.
- Evaporation loss estimations.
- Specific units through which seepage is occurring.

In our opinion, the following information is not reliable, and should not be used during future stages of investigation and design. The reliability of this information may improve if additional details can be obtained.

- Locations of the test pits performed by Gannett Fleming.
- Locations of the 21 test pits conducted by CTL/Thompson (1981).
- Material classifications.
- Locations of the borings and test pits and summarized by Gannett Fleming (2005) and discussed in Section 4.1.
- Piezometer readings.
- Samples other than California and split-spoon samples collected from the 27 CTL/Thompson (1981) borings.

- Laboratory test results from samples other than California and split-spoon samples.
- Chemical analyses of soil results.
- Chemical analyses of seepage water results.
- CTL/Thompson (1981) dissolution estimations.
- Seepage loss estimations.

SECTION 7 - SUBSURFACE CONDITIONS

7.1 General

Although CTL/Thompson (1981) and Law Engineering described foundation materials differently, this section will use the nomenclature of CTL/Thompson (1981) because of the unavailability of the Law Engineering report.

Foundation soil generally consists of clay with occasional clayey sand and silty sand. Bedrock generally consists of claystone with occasional sandstone. CTL/Thompson (1981) also documented construction of a clay liner on the reservoir bottom. The following sections discuss the properties of these units. Subsurface sections and profiles developed by CTL/Thompson (1981) are presented in Appendix F.

7.2 Embankment Fill

Embankment fill is located within the constructed embankment and cutoff trench. Embankment fill was encountered in O.W. 1, 2, 4, 5, 7, 8, 10, 11, 17, 18, 19, 20, 26, and 27 extending 14 to 48 feet below the dam crest. In O.W. 12 and 13, 4 to 5 feet of embankment fill was encountered below the access road. Based on the subsurface profile developed by CTL/Thompson, embankment fill generally extends from Station 20+00 to Station 54+47.2 and Station 0+00 to Station 7+25.

Based on construction documentation, embankment fill generally consisted of lean clay, lean clay with sand, and sandy lean clay. Fines contents ranged from 61 to 95 percent and averaged about 81 percent. Liquid limits ranged from 22 to 48 percent and averaged about 32 percent, and plasticity indices ranged from 13 to 26 percent and averaged about 18 percent. At the time of fill placement, dry unit weights ranged from 105 to 127 pounds per cubic foot (pcf) and averaged 115 pcf, and moisture contents ranged from 9.9 to 22.5 percent and averaged 16.4 percent. Fill was compacted to about 93 to 106 percent of the standard Proctor (ASTM D 698) maximum dry density at moisture contents between about 3 percent below and 5 percent above optimum. These data are based on eight standard Proctor tests, six particle size analyses, six Atterberg limits tests, and 284 field moisture-density tests performed during embankment construction.

Based on samples collected in their 1981 subsurface investigation, CTL/Thompson described embankment fill as generally being very stiff, moist sandy clay. Moisture

contents ranged from 11.2 to 19.1 percent and averaged 15.1 percent. Dry unit weights ranged from 109 to 126 pcf and averaged about 117 pcf.

California sampler blowcounts in embankment fill ranged from 16 to 43 blows per foot and averaged about 26 blows per foot. In O.W. 19, one California sampler location achieved refusal (50 blows) after 11 inches of penetration.

7.3 Embankment Foundation Soil

7.3.1 Clay

Embankment foundation soil was described by CTL/Thompson (1981) as primarily consisting of clay and sandy clay with occasional lenses of clayey sand that was soft to very stiff and moist to very wet. Beneath the embankment crest, clayey foundation soil ranged from 1 to 18 feet thick and was generally identified as the uppermost material within the foundation soils. Beneath the downstream toe of the embankment, clayey foundation soil ranged from 4 to 18 feet thick and was present at the ground surface. Clayey foundation soil deposits were generally continuous with depth, except in O.W. 21 where a silty sand layer was identified within a clayey soil deposit.

Clayey foundation soils contained 57 to 89 percent fines and averaged 82 percent fines and up to 1 percent gravel. Liquid limits ranged from 26 to 29 percent and plasticity indices ranged from 10 to 13 percent. Moisture contents ranged from 13.5 to 23.7 percent and averaged 18.5 percent. Dry unit weights ranged from 107 to 123 pcf and averaged about 114 pcf. Two tested samples had unconfined compressive strengths of 2,400 and 9,900 psf.

California sampler blowcounts in clay foundation soil ranged from 8 to 50 blows per foot and averaged about 26 blows per foot.

7.3.2 Clayey Sand

Clayey sand within the embankment foundation was described by CTL/Thompson (1981) as being fine to coarse grained, soft to stiff, very moist to wet, with lenses of sandy clay. This material extended to about 1 foot below the ground surface and was encountered in borings O.W. 13, 14, 15, and 16 beneath the access road from about Station 5+00 to Station 20+00.



From about Station 27+50 to Station 35+00 at a depth of about 47 feet below the embankment crest, a clayey sand layer about 2 to 5 feet thick was encountered in O.W. 18 and 19. In O.W. 19 the clayey sand was located between embankment fill and bedrock. In O.W. 18 the clayey sand was located beneath clayey foundation soil, and the borehole terminated in the clayey sand. Laboratory test results do not support that this material should be classified as a clayey sand but should be classified as a low plasticity clay.

Downstream of the embankment between about Stations 40+00 and 47+00 at a depth of about 13 feet below the natural ground surface, a clayey sand layer about 2 feet thick was encountered in O.W. 22 and 23. In both of these boreholes the clayey sand was located beneath clayey foundation soil, and both boreholes terminated in the clayey sand.

Although clayey sand was not identified by CTL/Thompson (1981) in other adjacent borings, its lateral continuity cannot be evaluated because many of the boreholes were advanced with little or no sampling.

Materials identified by CTL/Thompson (1981) as clayey sand contained 2 to 3 percent gravel, 49 to 60 percent sand, and 33 to 49 percent fines. One tested sample had a liquid limit of 22 percent and a plasticity index of 10 percent. Moisture contents ranged from 14.0 to 15.2 percent and averaged 14.8 percent. One tested sample had a dry unit weight of 122 pcf.

In O.W. 18 at about 51 feet deep, a California sampler required 12 blows for 6 inches of penetration.

7.3.3 Silty Sand

Silty sand within the embankment foundation was described by CTL/Thompson (1981) as being fine to coarse grained, medium dense, very moist to wet, with lenses of sandy clay. Between about Stations 40+00 and 45+00, 4 feet of silty sand was encountered about 41 feet below the embankment crest in O.W. 20 and 1 foot of silty sand was encountered 11 feet below the natural ground surface in O.W. 21. In O.W. 20 the silty sand was present between clayey foundation soil and bedrock. In O.W. 21 the silty sand was present as a layer within clayey foundation soil. These two locations of silty sand are at similar elevations, and also correspond well with the clayey sand that was encountered in O.W. 22 and 23. The silty sand and clayey sand may be part of a continuous granular deposit between about Stations 40+00 and 47+00. Other adjacent

boreholes did not encounter silty sand, but again were advanced with little or no sampling.

In O.W. 20 at about 40.5 feet, and based on one laboratory test result, the "silty sand" had 10 percent fines and a moisture content of 13 percent. Based on this laboratory test result, the material should be classified as sand with silt.

One standard split-spoon test location required 16 blows for 1 foot of penetration 44 feet deep in O.W. 20.

7.4 Weathered Bedrock

Weathered bedrock was described by CTL/Thompson (1981) as being silty claystone and sandy claystone that was medium hard, moist to very moist, with occasional roots. Weathered bedrock was primarily encountered beneath the access road from about Station 0+00 to Station 27+00. Weathered bedrock in this area was 1 to 9 feet thick and was first encountered 1 to 7 feet below the access road in O.W. 12, 13, 14, 15, 16, and 17. Between about Stations 35+00 and 37+50, 3 to 6 feet of weathered bedrock was encountered about 9 feet below the natural ground surface in O.W. 6 and 24. In O.W. 4, 11, and 17, 2 to 3 feet of weathered bedrock was encountered beginning 14 to 44 feet below the embankment crest.

Weathered bedrock contained 79 to 94 percent fines, had a liquid limit of 29 percent, and a plasticity index of 15 percent. Moisture contents ranged from 11.2 to 15.2 percent and averaged 13.2 percent. Dry unit weights ranged from 117 to 121 pcf and averaged 119 pcf.

California sampler blowcounts in weathered bedrock ranged from 14 to 37 blows per foot and averaged about 24 blows per foot.

7.5 Bedrock

7.5.1 Claystone

CTL/Thompson (1981) described claystone bedrock as being silty claystone with occasional sandstone lenses that was medium hard to very hard, moist to very moist, blocky, and contained sulfates and soluble salts. Claystone bedrock was encountered in every borehole that extended to bedrock. Every borehole that extended to bedrock also

terminated in claystone. Claystone was generally continuous with depth, except in O.W. 15 a sandstone bed was identified within the claystone. From about Station 0+00 to Station 20+00, claystone was encountered in O.W. 12, 13, 14, 15, and 16, at depths that ranged from 4 to 12 feet below the access road. From about Station 25+00 to Station 52+00, claystone was encountered 16 to 61 feet below the embankment crest. Near the downstream embankment toe from about Station 30+00 to Station 43+00, claystone was encountered 14 to 18 feet below the natural ground surface in O.W. 3, 6, and 9.

Claystone moisture contents ranged from 5.0 to 16.6 percent and averaged about 9.9 percent. Dry unit weights ranged from 114 to 137 pcf and averaged about 128 pcf. Unconfined compressive strengths ranged from 10,900 to 24,900 psf and averaged 18,300 psf.

Most California sampler locations in claystone bedrock encountered refusal prior to 1 foot of penetration. Refusal (50 blows) resulted after 1 to 9 inches of penetration and averaged about 4 inches. Two California sampler locations in O.W. 14 and 15 achieved 1 foot of penetration after 50 and 37 blows, respectively.

7.5.2 Sandstone

CTL/Thompson (1981) described sandstone bedrock as being clayey sandstone and silty sandstone that was hard to very hard and dry to slightly moist. On the east side of the reservoir near Station 15+00, 4 feet of sandstone was encountered in O.W. 15 about 16 feet below the access road.

No laboratory tests were performed on sandstone bedrock.

One California sampler location in sandstone bedrock encountered refusal after 6 inches of penetration.

7.6 Reservoir Bottom

7.6.1 Native Soil

CTL/Thompson (1981) described the native soils in the reservoir bottom as consisting of about 2 to 3 feet of stiff, brown, silty clay underlain by sandy clay with a porous structure and white salts. These materials were covered by the clay liner.



7.6.2 Clay Liner

Based on field and laboratory tests performed by CTL/Thompson (1981) during construction of the clay liner, fill placed for the clay liner generally consisted of lean clay, lean clay with sand, sandy lean clay, and sandy silty clay. Fines contents ranged from 59 to 89 percent and averaged about 73 percent. Liquid limits ranged from about 25 to 43 percent and averaged about 32 percent, and plasticity indices ranged from about 6 to 25 percent and averaged about 15 percent. At the time of fill placement, dry unit weights ranged from 105 to 126 pcf and averaged about 114 pcf, and moisture contents ranged from 12.5 to 21.1 percent and averaged about 16.6 percent. Fill was compacted to 96 to 105 percent of the standard Proctor (ASTM D 698) maximum dry density at moisture contents between 2.2 percent below and 6.5 percent above of optimum.

7.7 Downstream Native Soils

Gannett Fleming encountered surficial native soils in their test pits excavated on May 24, 2006. These test pits were located about 1,400 to 3,800 feet west of the Site. Each test pit extended 10 feet below the ground surface. One test pit encountered lean clay with sand through its entire depth and the other test pit encountered sandy silty clay through the entire depth. Both materials were described as being moist, residual soil with medium plasticity and medium dry strength. In both test pits, a considerable concentration of evaporites was encountered within 2 to 3 feet of the ground surface and thin lenses of clay containing evaporites were present throughout both test pits.

The lean clay with sand consisted of about 20 percent sand, 57 percent silt, and 23 percent clay with a liquid limit of 34 percent and a plasticity index of 18. The natural moisture content was 10.2 percent and the material had 25 percent dispersion.

The sandy silty clay consisted of about 1 percent gravel, 42 percent sand, 24 percent silt, and 33 percent clay with a liquid limit of 24 percent and a plasticity index of 6. The natural moisture content was 10.9 percent. The standard Proctor (ASTM D 698) maximum dry density was 117.5 pcf and the optimum moisture content was 12.0 percent.

SECTION 8 - CONCLUSIONS

Based on our review of available data, RJH concludes the following:

1. We did not identify geotechnical conditions or geotechnical fatal flaws that would preclude rehabilitating the Atlantic Rim Reservoir.
2. The existing geotechnical data is suitable to develop a generalized understanding of the subsurface profile at the dam. However, much of the existing data is low to moderately reliable and is not suitable for use in future analyses or design. Additional geotechnical data is needed to evaluate rehabilitation concepts, to select a preferred rehabilitation concept, and to develop design documents.
3. The current integrity and settlement potential of the existing foundation is not well understood. As a result of the long history of seepage, dissolution or piping of materials may have occurred and as a result, voids may be present in the foundation. If there are voids present, they could result in future deformation of the embankment or an internal erosion failure through the foundation.
4. The current internal seepage stability of the embankment is not well understood. RJH did not identify references to a design seepage analysis, nor to a filter-compatibility analysis between the embankment soils and the other granular zones within the existing dam. Additionally, the depth of the cutoff trench appears to not have been based on keying into a specific geologic material, but rather selected to consistently be 10 feet below the original ground surface. This may or may not provide sufficient head loss to maintain acceptable seepage stability.
5. The slope stability of the existing embankment is not well understood. RJH neither reviewed nor identified references to a slope stability evaluation of the existing dam. The published geologic maps refer to the presence of bentonite seams within the foundation bedrock. If present, these could significantly impact the foundation strength and embankment stability.
6. The extents, locations, and volume of potential seepage cannot be accurately evaluated or defined based on the existing data and previous seepage studies.
7. The extent and materials used to construct the clay liner in the reservoir bottom are not well defined. There is an apparent discrepancy between the CTL/Thompson (1981) construction records and City of Rawlins personnel recollection.
8. The hazard classification of the dam was not specifically identified during our review and may not be defined. However, based on Law Engineering's

considerations of potential impacts from dam failure, it is likely that the hazard classification is III. The hazard classification can impact geotechnical exploration and design decisions and needs to be understood.

9. Relatively high concentrations of sulfates are present in the soils at the Site. This could lead to rapid deterioration of the existing concrete structures.

SECTION 9 - RECOMMENDATIONS

Based on our understanding that fatal flaws have not been identified for rehabilitation, RJH recommends:

1. Additional effort to collect existing data should be made. RJH recommends that if not already done for this project, City of Rawlins, State dam safety, and WWDC files be searched for the following documents:
 - a. *Review of Geotechnical Conditions, Atlantic Rim Site*. Prepared by Law Engineering Testing Company, Denver, CO , June 10, 1982.
 - b. *Analysis of Seepage Control Measures, Atlantic Rim Reservoir, Rawlins, Wyoming*. Prepared by Law Engineering Testing Company, Denver, CO, July 8, 1982.
 - c. *Subsurface Soils Investigation, Peaking Reservoir II, Rawlins, Wyoming*. Prepared by Lincoln Devore, Colorado Springs, CO, November 22, 1978.
 - d. The following information from the investigation for and construction of the reservoir liner. Location of these test pits and field tests are presented on figures included in Appendix B.2.
 - i. Test pit logs.
 - ii. Field density and percolation tests performed on native soils in the reservoir bottom.
 - iii. Field permeability tests performed on the constructed clay liner.
 - e. Additional information about test pits performed by Gannett Fleming in 2006.
 - f. MSM Design Report and Construction Drawings, Sheets 1, 2, 4, 5, and 8 of 8.
 - g. Photographs of the reservoir liner construction or additional information to clarify the apparent discrepancy between the descriptions provided by City personnel and CTL/Thompson's construction documents.
 - h. Hazard Classification Report (if exists).
2. Additional geotechnical data should be collected at Atlantic Rim Reservoir to characterize the existing geotechnical conditions, to obtain the data needed to evaluate rehabilitation alternatives, and to develop a final design and contract documents. The exploration should collect data to support evaluation of:
 - a. The extent and engineering properties of the embankment and foundation materials. Some of the existing data is likely suitable but should be confirmed

- and supplemented by additional data collection. This should be performed by using a series of borings and test pits. The reservoir should be evacuated and the bottom of the reservoir should be stable enough to support exploration equipment.
- b. The integrity of the existing foundation. Geotechnical exploration should include test pits and borings with continuous soil sampling or bedrock coring to enable identification of voids or bentonite seams in the foundation. Test pits should be performed to directly observe foundation conditions, evaluate potential clay borrow sources, and measure bedrock bedding orientations.
 - c. The internal seepage integrity of the existing embankment and foundation (e.g., filter compatibility, exit gradients, etc.). Grain-size data should be collected within the filter sands in the drain blanket zone. Test pits should be used to confirm if coarse-grained material was placed above the drain blanket and to collect samples to evaluate filter compatibility between these soils and the embankment fill. Relatively undisturbed samples of the embankment fill should be collected to evaluate grain-size and permeability characteristics.
 - d. The sliding stability of the existing embankment and foundation. Relatively undisturbed samples of the embankment soils, foundation soils, and foundation bedrock are needed and should be collected. Triaxial strength tests should be performed on embankment and foundation soils to develop strength envelopes. Unconfined compression tests and residual strength tests should be performed on foundation bedrock.
3. Following the geotechnical data collection, RJH recommends that geotechnical analysis be performed to evaluate the existing dam's current internal seepage and slope stability. Engineering evaluation of internal seepage and slope stabilities is needed for the existing embankment to assess current dam safety and impacts of potential rehabilitation concepts. Stability analyses should be performed for the following loading conditions:
- a. Steady state seepage with peak bedrock strength
 - b. Steady state seepage with residual bedrock strength
 - c. Rapid drawdown with peak bedrock strength
 - d. Rapid drawdown with residual bedrock strength
 - e. Seismic loading (this may or may not be needed for the dam depending on its hazard classification).

4. If needed, perform a hazard classification analysis and identify the hazard potential of the dam in accordance with Wyoming State Dam Safety requirements.
5. Perform an alternatives analysis to assess the advantages and disadvantages of various rehabilitation concepts. Preliminary considerations of possible rehabilitation alternatives are presented in Section 10.

SECTION 10 - PRELIMINARY CONSIDERATIONS OF REHABILITATION ALTERNATIVES

Prior to selecting the preferred rehabilitation alternative, additional geotechnical exploration and evaluation are needed. Based on the long history of seepage issues at the dam and the multiple attempts to evaluate seepage issues and implement plans to reduce the seepage, it is our opinion that any rehabilitation concept needs to be highly reliable and incorporate reasonable redundancies. Other potential issues such as slope stability or embankment deformation due to the presence of voids in the foundation need to be evaluated prior to selecting a preferred rehabilitation concept.

Based on our current understanding of the reservoir, excessive seepage is the primary issue to be addressed in rehabilitation. Possible alternatives to rehabilitate the reservoir from excessive seepage losses include constructing:

- A synthetic reservoir liner
- A clay reservoir liner
- A perimeter foundation cutoff wall

RJH has considered the conceptual advantages and disadvantages for each of these alternatives below.

10.1 Synthetic Reservoir Liner

A synthetic liner would likely need to extend across the entire reservoir bottom and up the embankment slopes to the dam crest. Possible advantages of this rehabilitation method include:

1. A synthetic liner is basically impervious and if liner seams are effectively sealed, it can have very low seepage losses.
2. It can be used in most soil types and its effectiveness is relatively independent of site geology.
3. The material is readily available from various suppliers.
4. The construction would not require significant earthwork and may be cost effective.

5. Synthetic liners do not desiccate during prolonged periods of reservoir drawdown.

Possible disadvantages of this method include:

1. A single-layer synthetic liner such as a high-density polyethylene (HDPE) is not redundant and if a leak develops, there is a high potential for internal erosion to develop within the underlying embankment. Therefore, a synthetic liner with a redundant seepage barrier (e.g., geosynthetic clay liner) may be required.
2. A synthetic liner degrades when exposed to ultraviolet radiation (i.e., sunlight). The liner can also be punctured by animals, vandals, or during construction or maintenance of overlying materials.
3. Uplift pressures on the liner when the reservoir is empty could be a concern. Groundwater levels in the reservoir bottom need to be investigated when the reservoir is empty.
4. Relative to earthwork construction and depending on the quality, volume, and proximity to a clay source, a synthetic liner system is generally more expensive and requires specialized construction experience and knowledge.

It may be beneficial to install a clay liner in conjunction with a synthetic liner to lengthen the seepage path and provide protection to the synthetic liner. Additional details about a clay liner are presented in the following section.

10.2 Clay Liner

A clay liner would generally consist of compacted low-permeability soil placed on the reservoir bottom and up embankment slopes to the crest. Clay liners have the following potential advantages:

1. Clay liners are generally more reliable than synthetic liners because of their thickness and construction methods.
2. Can be cost effective if a nearby clay source is available.
3. Depending on the findings of the geotechnical exploration, it is possible that very little additional clay may be needed to finish lining of the reservoir.

Possible disadvantages of clay liners are:



1. They must be protected against desiccation and generally cannot accommodate prolonged periods of reservoir drawdown.
2. A suitable clay borrow source may not be readily available and costs could be very high to import clayey material to the Site.
3. Clay materials can pipe (or be eroded) into the underlying materials and foundation materials may not be filter compatible with the clay liner. Gradation tests and filter compatibility analyses need to be performed to investigate if a sand filter would be required below the clay liner.
4. A clay liner appears to have already been constructed across much of the reservoir bottom, but seepage problems continue. Investigations need to be performed in the reservoir bottom to examine the extent and condition of the current clay liner, and if this liner was connected to the embankment.

10.3 Cutoff Wall

A cutoff wall would generally consist of a very low permeability wall extending into low-permeability bedrock that is installed around the perimeter of the reservoir. A possible advantage to this method is that a cutoff wall could be installed without removing riprap from the reservoir slopes. The possible disadvantages of this method include:

1. Bedrock at the Site appears to be dipping to the west and the wall may need to extend very deep below the embankment to cut off permeable units that are exposed in the reservoir bottom.
2. It requires that a consistent low-permeable bedrock layer be identified at the Site below the reservoir. Additional borings need to be advanced to identify the bedrock profile at the Site. Field or laboratory permeability tests need to be performed to identify probable seepage pathways and to identify a suitable unit to which to extend the wall. Geologic mapping needs to be performed at the Site to identify bedrock attitudes. Additional difficulties with construction of a cutoff wall would include excavation around the existing outlet, inlet, and spillway pipes, and identification of a staging and work area.

SECTION 11 - REFERENCES

- Blackstone, D.L. Jr. (1991). *Tectonic Relationships of the Southeastern Wind River Range, Southwestern Sweetwater Uplift, and Rawlins Uplift*, Wyoming. Geological Survey of Wyoming Report of Investigations No. 47, Laramie, WY.
- Case, J.C. and Larsen, L.L. (1991). *Landslide Map of the Rawlins 1° x 2° Quadrangle*. Geological Survey of Wyoming Open File Report 91-20, Laramie, WY.
- CTL/Thompson (1979). *Fill Observations, Atlantic Rim Reservoir, Rawlins, Wyoming*. Prepared by CTL/Thompson, Inc., Denver, CO, September 25.
- CTL/Thompson (1981). *Evaluation of Underseepage, Atlantic Rim Reservoir, Rawlins, Wyoming*. Draft Report Prepared by CTL/Thompson, Inc., Denver, CO, June 18.
- Gannett Fleming, Inc. (2005). *Technical Memorandum Geotechnical Reconnaissance and Preliminary Design Recommendations – Rawlins Raw Water Supply, Level II*, December 16.
- Hallberg, L.L. and Chase, J.C. (1998). *Preliminary Digital Surficial Geologic Map of the Rawlins 30 x 60 Minute Quadrangle, Carbon and Sweetwater Counties, Wyoming*. Wyoming State Geological Survey Map HSDM 98-6, Laramie, WY.
- King, J.K., Greer, P.L., and Ver Ploeg, A.J. (1987). *Preliminary Map of Known Surficial Structural Features for the Rawlins 1o x 2o Quadrangle*. Geological Survey of Wyoming Open File Report 87-10, Laramie, WY.
- Law Engineering (1982). *Atlantic Rim Reservoir Remedial Measures, Hazard Evaluation, Temporary Maintenance and Monitoring Procedures*. Letter to the City of Rawlins from Law Engineering Testing Company, Englewood, CO, August 3.
- Love, J.D. and Christiansen, A.C. (1985). *Geologic Map of Wyoming*. U.S. Geological Survey, Denver, CO.
- MSM (1979). *Construction Drawings, File No. 48351, Sheets 3, 6, and 7 of 8*. Prepared by Meurer, Serafini and Meurer, Inc. (MSM, Inc.), Denver, CO, January.

MSM/SP (1983). *Contract Documents and Construction Specifications for Lining Atlantic Rim Reservoir for the City of Rawlins in Carbon County, Wyoming.* Prepared by MSM/SP Group, Denver, CO, June.

Natural Resources Conservation Service (n.d.). *Unofficial Soil Survey of the Rawlins Reservoir Area, Wyoming.* Casper, Wyoming. This information does not meet National Cooperative Soil Survey (NCSS) standards of quality.

APPENDIX A

ATLANTIC RIM RESERVOIR CHRONOLOGY

Table 1. History of Atlantic Rim Reservoir

Date	Event
1978	Reservoir designed by Meurer, Serafini, and Meurer (MSM) Consultants
1979	Reservoir constructed: embankment complete except for riprap by Sept.
1980	Initial filling begun in winter 1979-1980
June 1980	Excessive seepage noted at toe of dam; seepage so excessive that reservoir could not be filled; CTL Thompson Consultants of Denver, CO, was contacted to initiate investigations and make recommendations
Summer 1980	CTL seepage evaluation included 9 observation wells on high portion of dam (6 in embankment and 3 at downstream toe); 3 alternatives presented to reduce seepage rates; clay liner in bottom of reservoir selected as preferred alternative
Sept-Nov 1980	A 3-foot thick clay liner was constructed in the bottom of reservoir; liner was not carried to normal water surface elevation; re-filling of reservoir begun in November
Nov 1980 – Feb 1981	Reservoir filled to maximum elevation of 7218 feet; when water surface reached elevation 7214, seepage was observed at the downstream toe of the maximum embankment section; at elevation 7215 seepage was also observed where the embankment abuts the natural hillside
Feb-Apr 1981	CTL monitored existing observation wells; high pore pressures were noted in the foundation; CTL recommended reservoir filling be stopped on April 1, 1981
May-June 1981	CTL installed 18 additional observation wells and conducted geotechnical investigation of seepage; investigation reported zone of "porous" clay with substantial amounts of soluble minerals (salts) in soils below the cutoff trench above bedrock; interpretation was that the bottom liner was effective, but that transition zones at cut slopes exposed the "porous" clay zone; an estimated 100-125 gpm of seepage was estimated.
July-Sept 1981	CTL evaluated cutoff alternatives including slurry trench, grouting, cutoff trench to bedrock and geomembrane lining; recommended installation of slurry trench cutoff along upstream toe of the embankment section; and seepage monitoring systems
Jun 1982	Law Engineering evaluated seepage control measures proposed by CTL; Law Engineering was concerned that the slurry trench cutoff may not be effective due to possibility of high permeability bedrock exposed on the west side cut slope; recommended additional testing of bedrock permeability to evaluate this concern.
July 1982	Law Engineering conducted additional subsurface investigations of the dam and reservoir foundation. Eight borings and two test pits were excavated, geotechnical samples of soil and rock were collected and tested, and monitoring wells were installed. Tests included field and laboratory permeability tests, soluble minerals contents of soils, total dissolved solids in groundwater, and dispersion potential of soils. Primary interpretation from the study was that seepage was attributed to a 30 feet thick fractured, weathered bedrock zone that underlies soil materials beneath the bottom of the reservoir and is exposed in the cut

Table 1. History of Atlantic Rim Reservoir

Date	Event
	slope on the eastern margin of the reservoir. Developed 3 options for remediation: (1) slurry trench perimeter cutoff, (2) extension of clay soil liner with enhanced monitoring ("leaky reservoir" option), and (3) installation of synthetic membrane liner.
August 1982	Law Engineering in a letter report dated August 3, 1982, recommended temporary remedial actions for dam safety, including: 1. Collector Drain - recommended extension and improvements to ditch collector located about 100 feet downstream from toe of the west and southwest portions of the embankment; 2. Embankment Toe Drain - installation of lateral drains on about 100-foot centers to connect the embankment toe drain to the collector drain; 3. Area Grading - areas adjacent to the embankment graded to direct seepage and runoff to the collection system and prevent ponding at the toe of the dam; 4. Effluent Monitoring - Installation of a weir box to measure seepage flow rate and monitoring for any fines transport; 5. Reservoir Stage Monitoring - to allow comparison of weir measurements with reservoir levels; and 6. Site Monitoring Program - measurement of piezometric levels in installed monitoring wells, reservoir stage, seepage water flowrate, general embankment conditions, seepage water inspection for fines, and general maintenance of all instruments on site. Also recommended installation of weather station and monitoring of evaporation and precipitation data.
March 1983	Law Engineering engineer (Mr. David Thompson) conducted a site visit to discuss monitoring program and results of initial analyses of groundwater levels and weir discharge measurements. In a letter dated March 22, 1983, Law Engineering recommended the City "...complete the construction of the seepage collection and monitoring system and to continue regular observation and reporting of measurement of site instruments." Mr. Thompson noted a "boil" near the south edge of the northern lateral ditch, approximately 20 feet from the embankment toe. The letter report stated that "...concentrated seepage may indicate the commencement of piping, which is a type of internal erosion of the dam on its foundation which can lead to dam failure." Significance of the boil was expressed in a meeting between Mr. Thompson and City engineers on March 11, 1983. Recommended that city pursue existing plans to install an impermeable liner in the reservoir as a positive means of reducing or eliminating the under seepage.
April 1983	In a letter report from Law Engineering to the City of Rawlins dated April 5, 1983, the engineers noted that monitoring of the boil area indicated increasing movement of fines (on the order of 35 cubic inches per day). Law recommended that the city provide means for drainage of zones of concentrated seepage. Means for draining the reservoir were discussed with the city engineers.

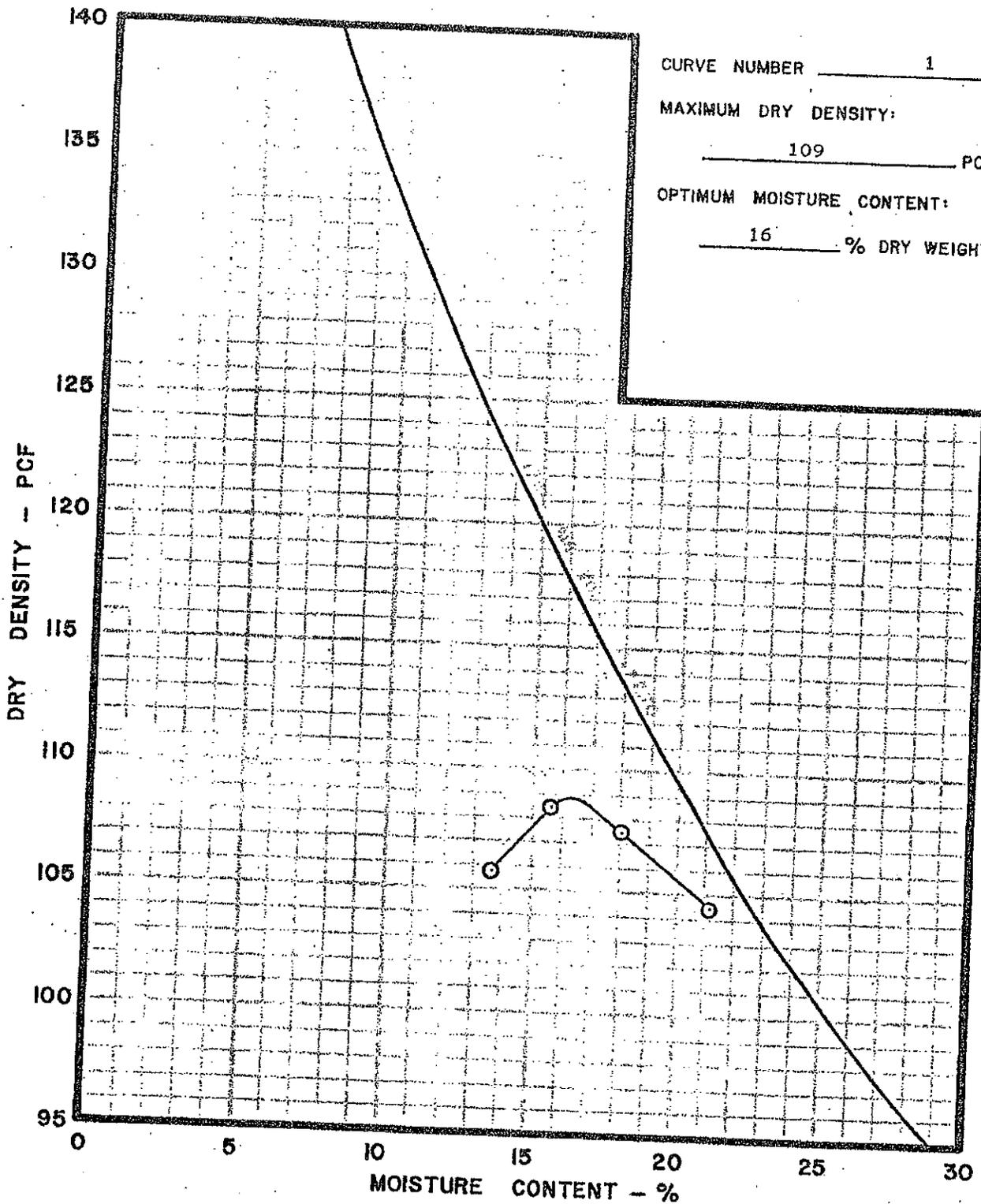
APPENDIX B

CONSTRUCTION DOCUMENTATION

- B.1 DAM CONSTRUCTION TEST RESULTS**
- B.2 LINER CONSTRUCTION TEST RESULTS**
- B.3 SLURRY TRENCH PLAN**

APPENDIX B.1

DAM CONSTRUCTION TEST RESULTS



SAMPLE DESCRIPTION CLAY, SLIGHTLY SANDY, HIGHLY CALCAREOUS, BROWN

LOCATION ATLANTIC RIM RESERVOIR

COMPACTION TEST PROCEDURE ASTM D 698-70, METHOD 'A'

LIQUID LIMIT 35 %

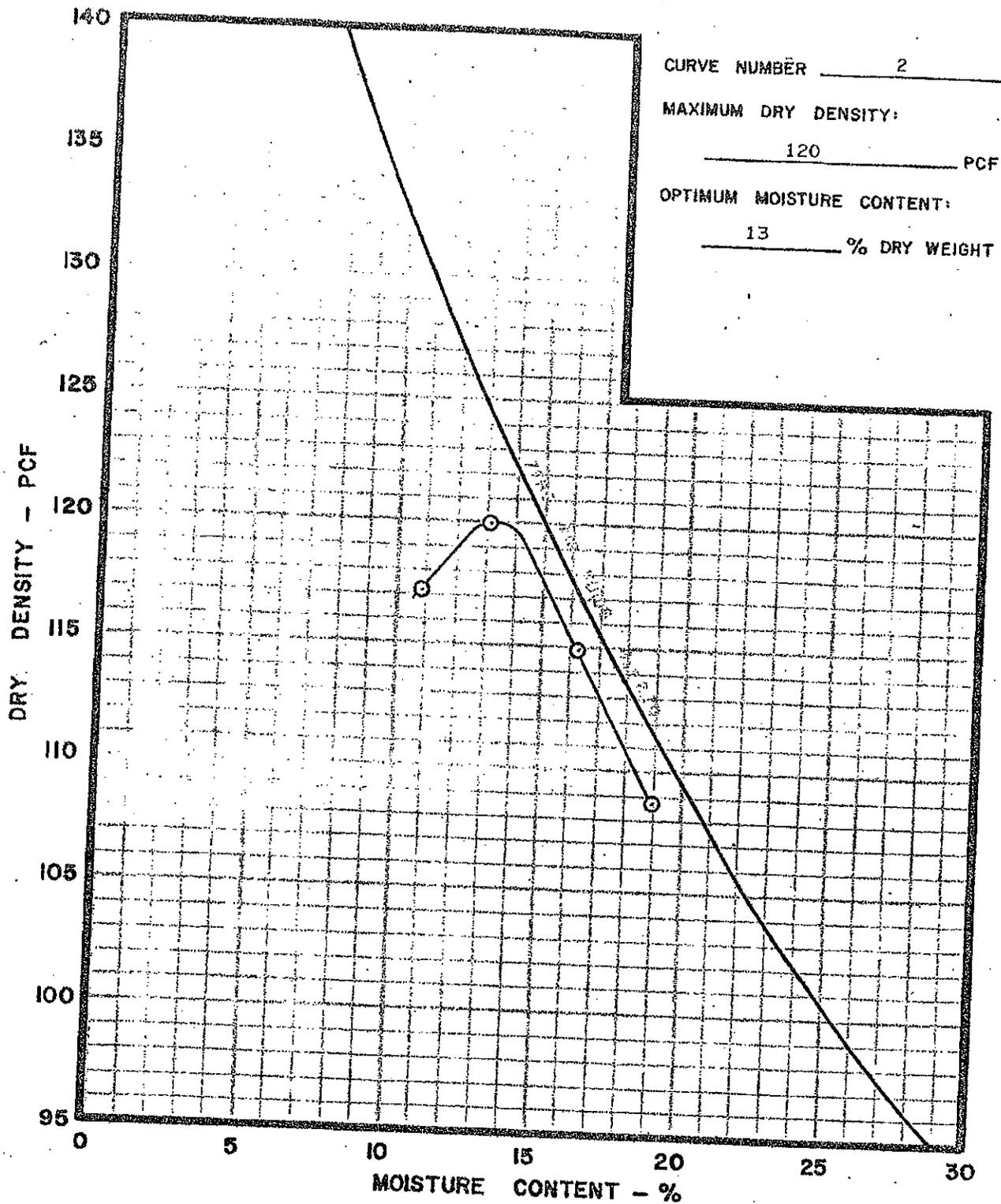
PLASTICITY INDEX 20 %

GRAVEL — %

SAND 11 %

SILT & CLAY 89 %

COMPACTION TEST RESULTS



SAMPLE DESCRIPTION CLAYSTONE, VERY SILTY, SLIGHTLY SANDY, GRAY, GREEN

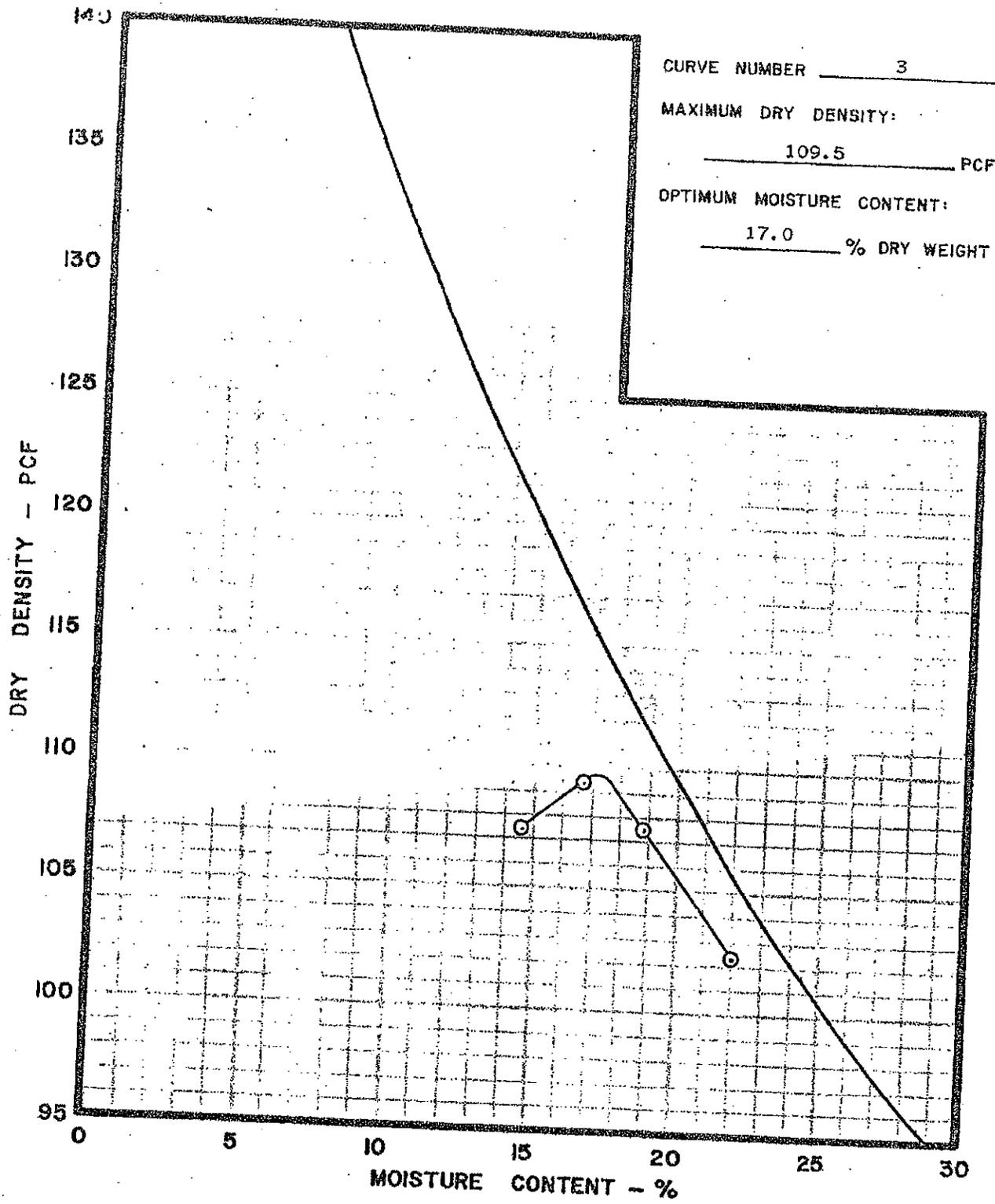
LOCATION ATLANTIC RIM RESERVOIR

COMPACTION TEST PROCEDURE ASTM D 698-70, METHOD 'A'

LIQUID LIMIT 30 % PLASTICITY INDEX 13 %

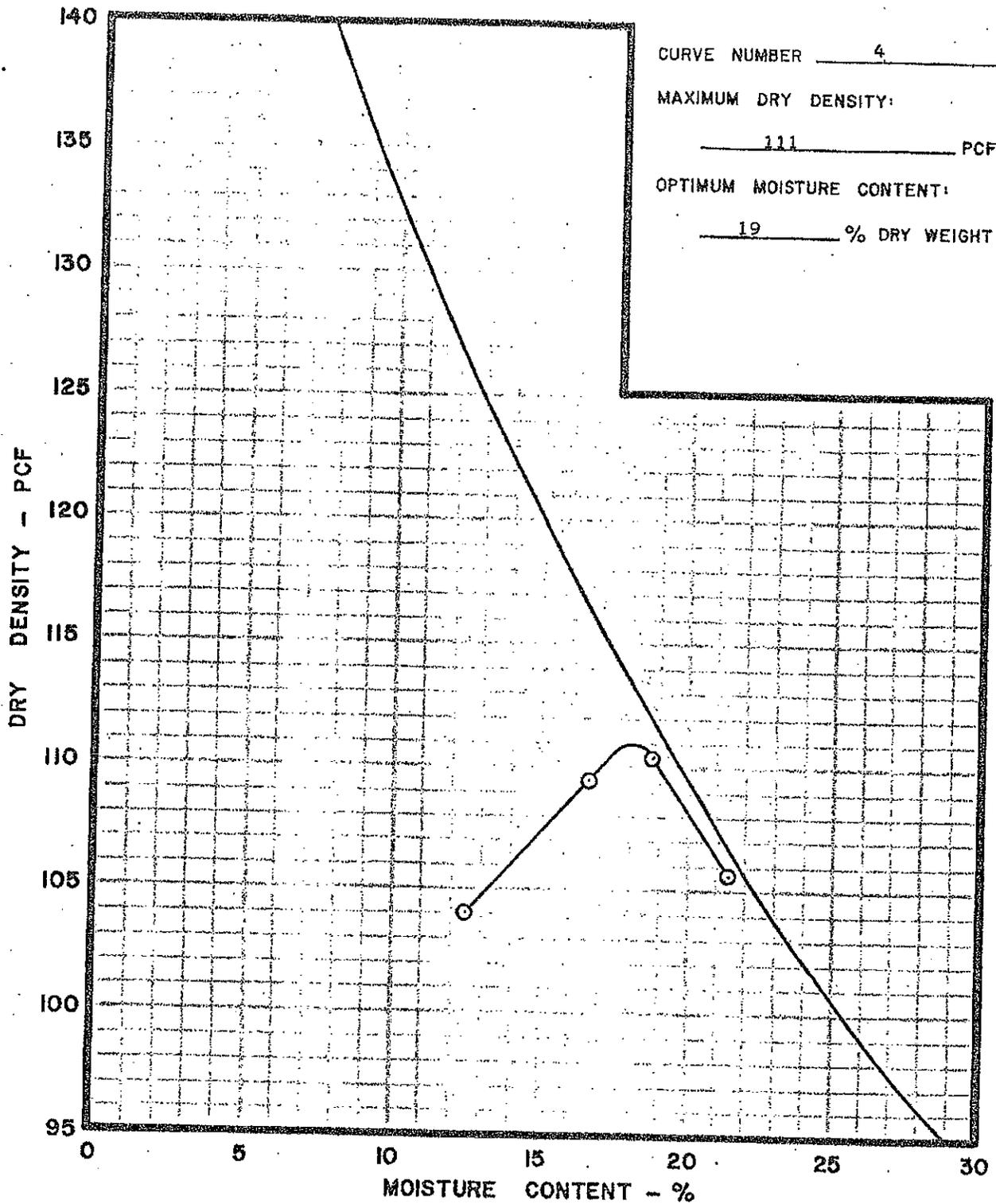
GRAVEL 0 % SAND 10 % SILT & CLAY 90 %

COMPACTION TEST RESULTS



SAMPLE DESCRIPTION CLAY, SANDY, RED-BROWN
 LOCATION ATLANTIC RIM RESERVOIR
 COMPACTION TEST PROCEDURE ASTM D 698-70, METHOD 'A'
 LIQUID LIMIT 25 % PLASTICITY INDEX 20 %
 GRAVEL 0 % SAND 22 % SILT & CLAY 78 %

COMPACTION TEST RESULTS



SAMPLE DESCRIPTION CLAY, SANDY, VERY HIGH SULFATE CONTENT, BROWN

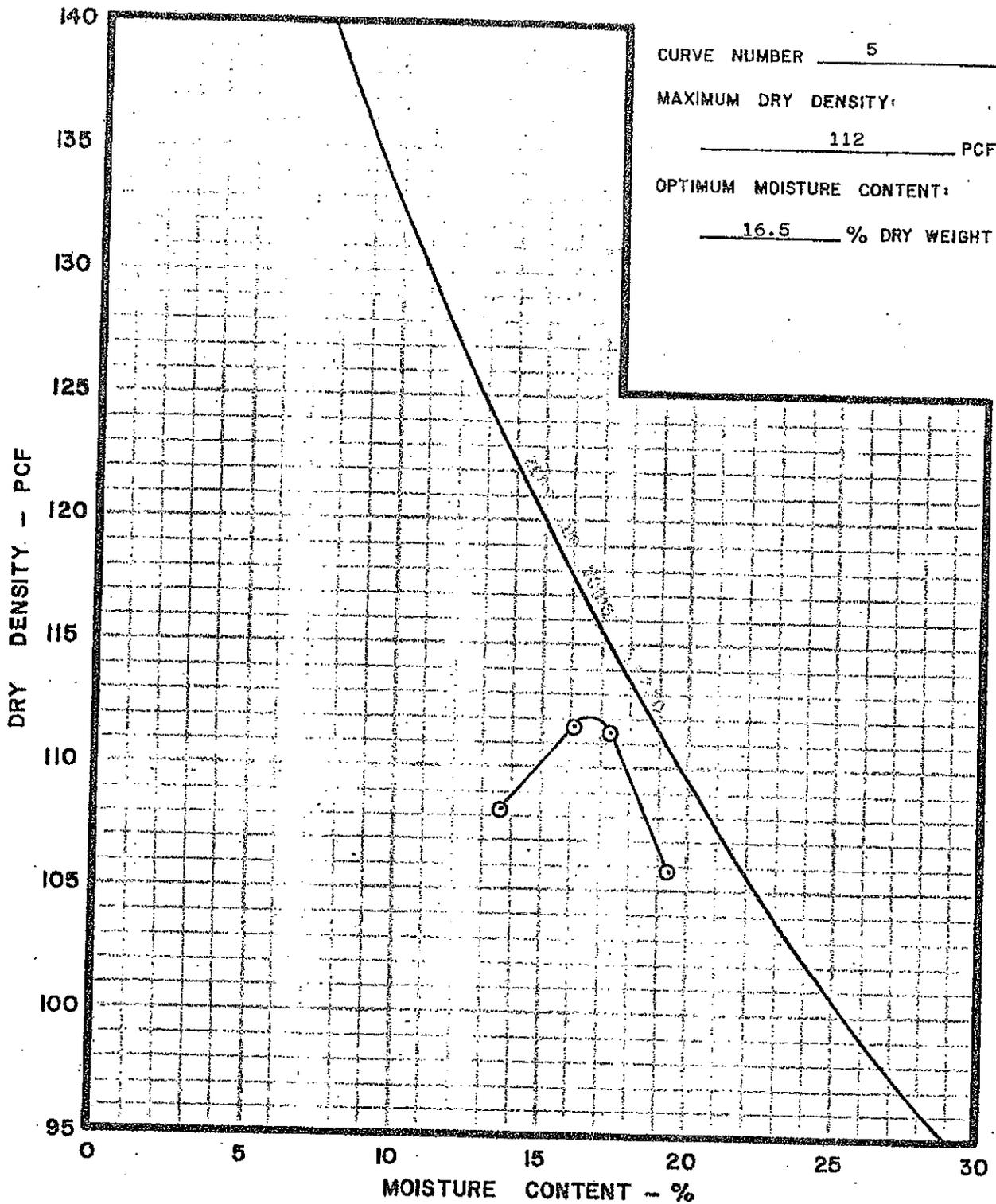
LOCATION ATLANTIC RIM RESERVOIR - CORE TRENCH, 4-7 FEET

COMPACTION TEST PROCEDURE _____

LIQUID LIMIT _____% PLASTICITY INDEX _____%

GRAVEL _____% SAND _____% SILT & CLAY _____%

COMPACTION TEST RESULTS



SAMPLE DESCRIPTION CLAY, SANDY, SLIGHTLY GRAVELLY, RED, BROWN

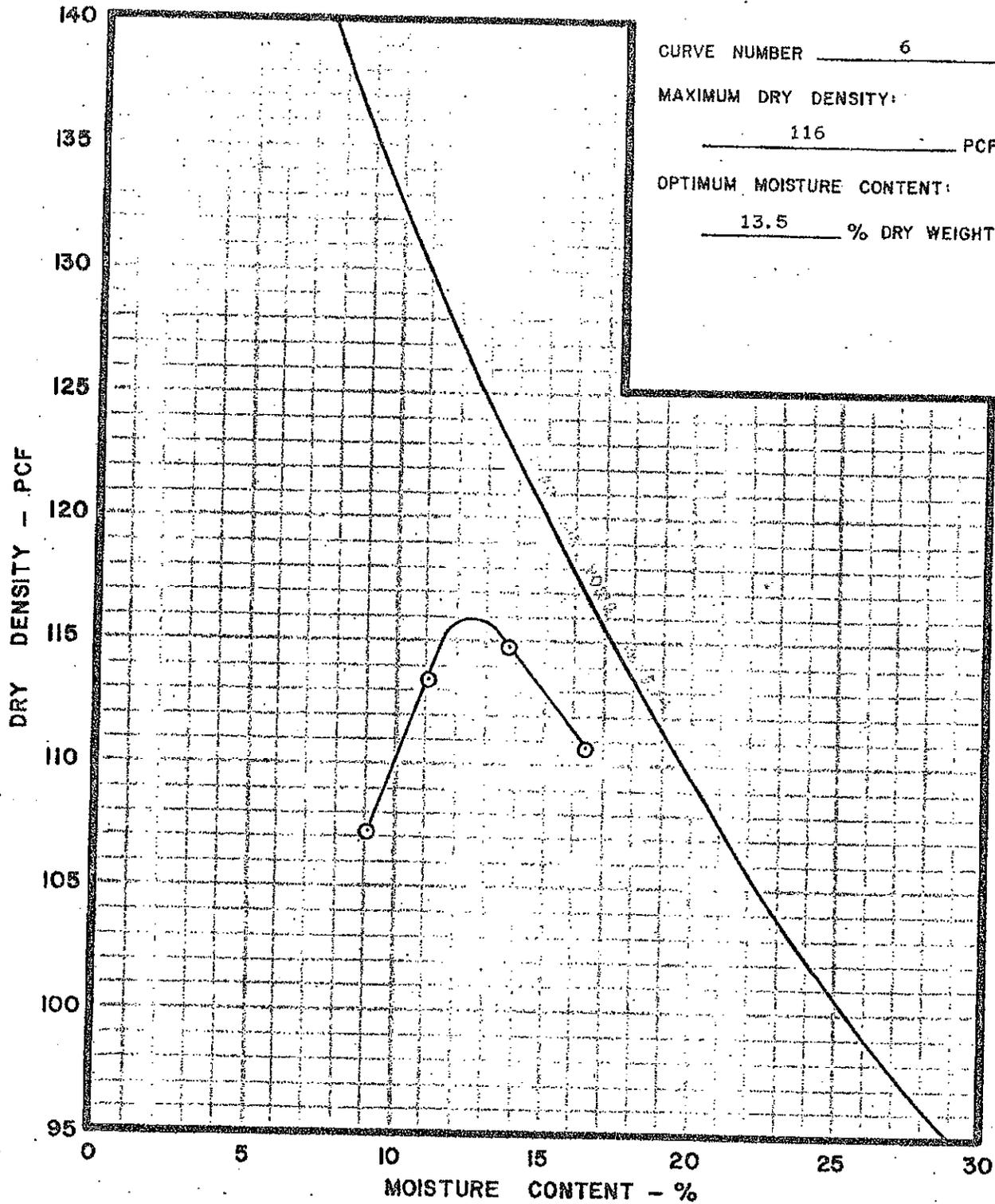
LOCATION _____

COMPACTION TEST PROCEDURE ASTM D 698-70, METHOD 'A'

LIQUID LIMIT 22 % PLASTICITY INDEX 13.5 %

GRAVEL _____ % SAND _____ % SILT & CLAY 61 %

COMPACTION TEST RESULTS



SAMPLE DESCRIPTION CLAY, VERY SILTY, LIGHT BROWN, SLIGHTLY CALCAREOUS

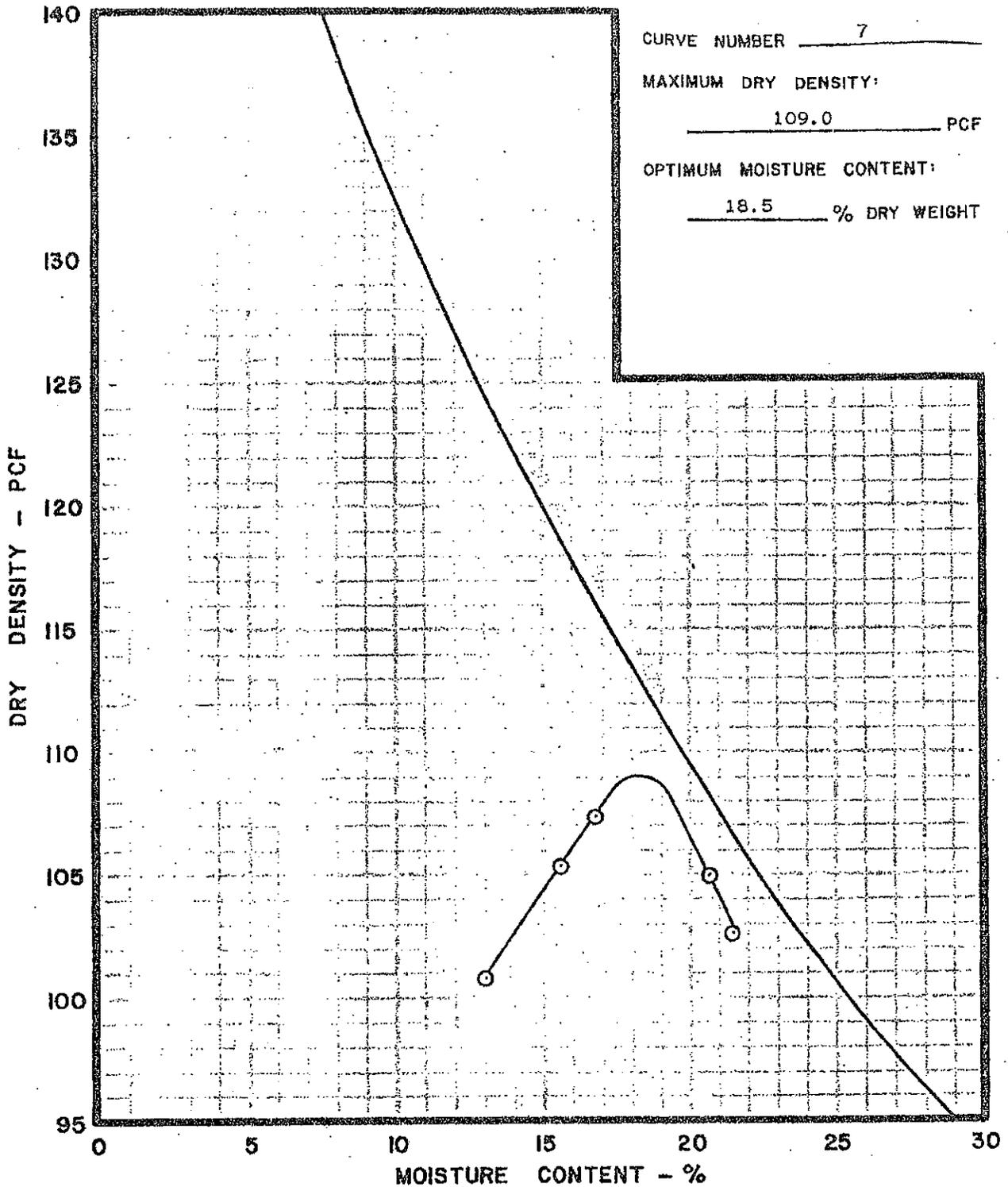
LOCATION ATLANTIC RIM RESERVOIR, RAWLINS, WYOMING

COMPACTION TEST PROCEDURE ASTM D 698-70, METHOD 'A'

LIQUID LIMIT _____ % PLASTICITY INDEX _____ %

GRAVEL _____ % SAND _____ % SILT & CLAY _____ %

COMPACTION TEST RESULTS



SAMPLE DESCRIPTION CLAYSTONE, SILTSTONE, HIGH SULFATE, DARK, GRAY-GREEN

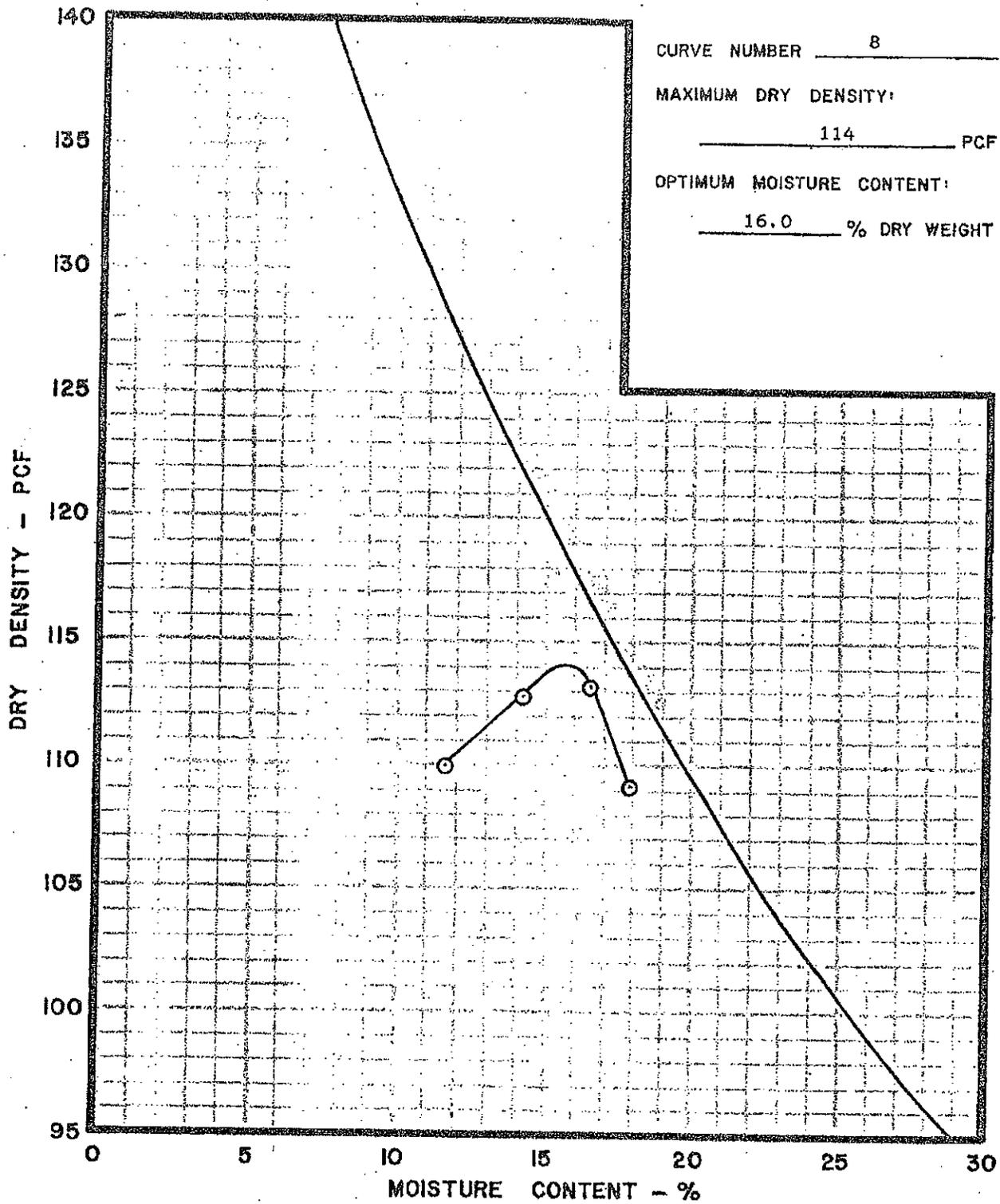
LOCATION ATLANTIC RIM RESERVOIR

COMPACTION TEST PROCEDURE ASTM D 698-70, METHOD 'A'

LIQUID LIMIT 48 % PLASTICITY INDEX 26 %

GRAVEL _____ % SAND _____ % SILT & CLAY 95 %

COMPACTION TEST RESULTS



SAMPLE DESCRIPTION CLAY, SANDY, SILTY, SLIGHTLY CALCAREOUS, BROWN

LOCATION ATLANTIC RIM RESERVOIR

COMPACTION TEST PROCEDURE ASTM D 698-70, METHOD 'A'

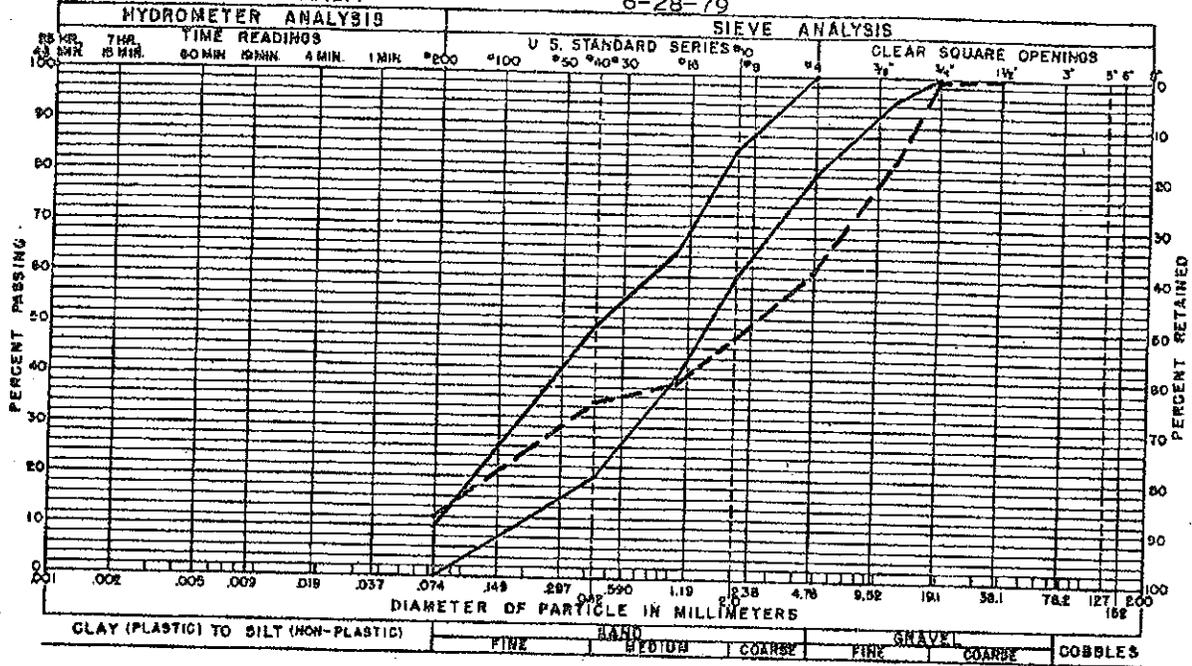
LIQUID LIMIT 31 % PLASTICITY INDEX 16.0 %

GRAVEL _____ % SAND _____ % SILT & CLAY 75 %

COMPACTION TEST RESULTS

BLANKET DRAIN

6-28-79

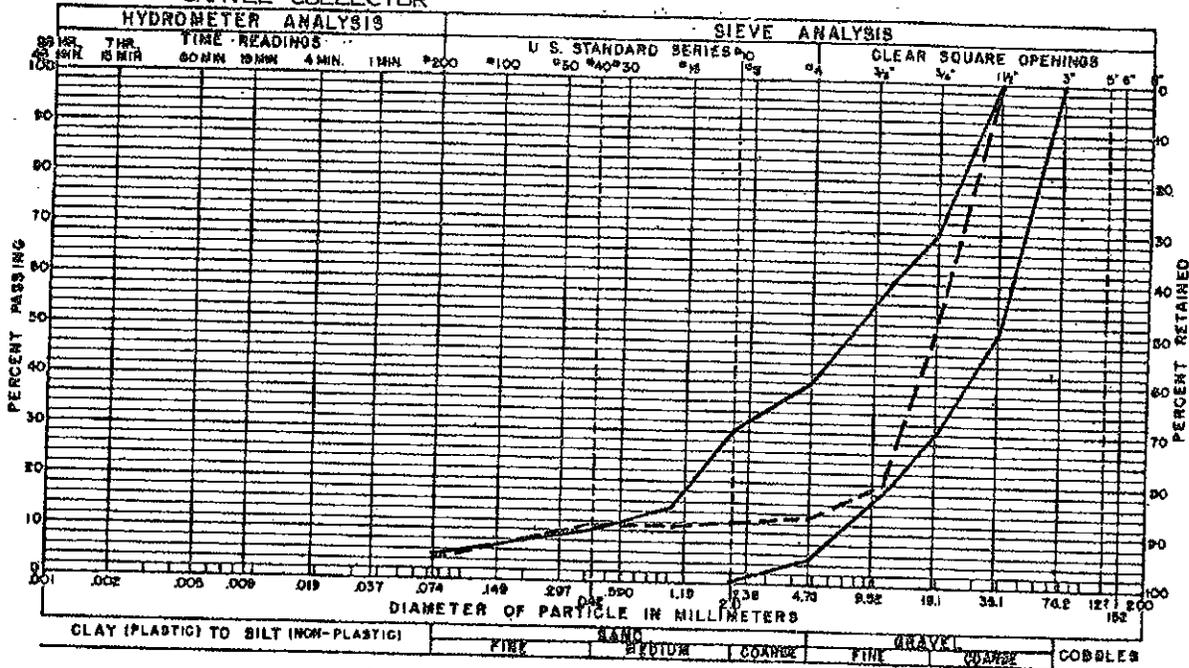


GRAVEL 39 % SAND 49 % SILT AND CLAY 12 %
 LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF SAND, GRAVELLY

FROM STATE GRAVEL PIT, NORTHWEST OF RAWLINS (REJECT MATERIAL)

GRAVEL COLLECTOR



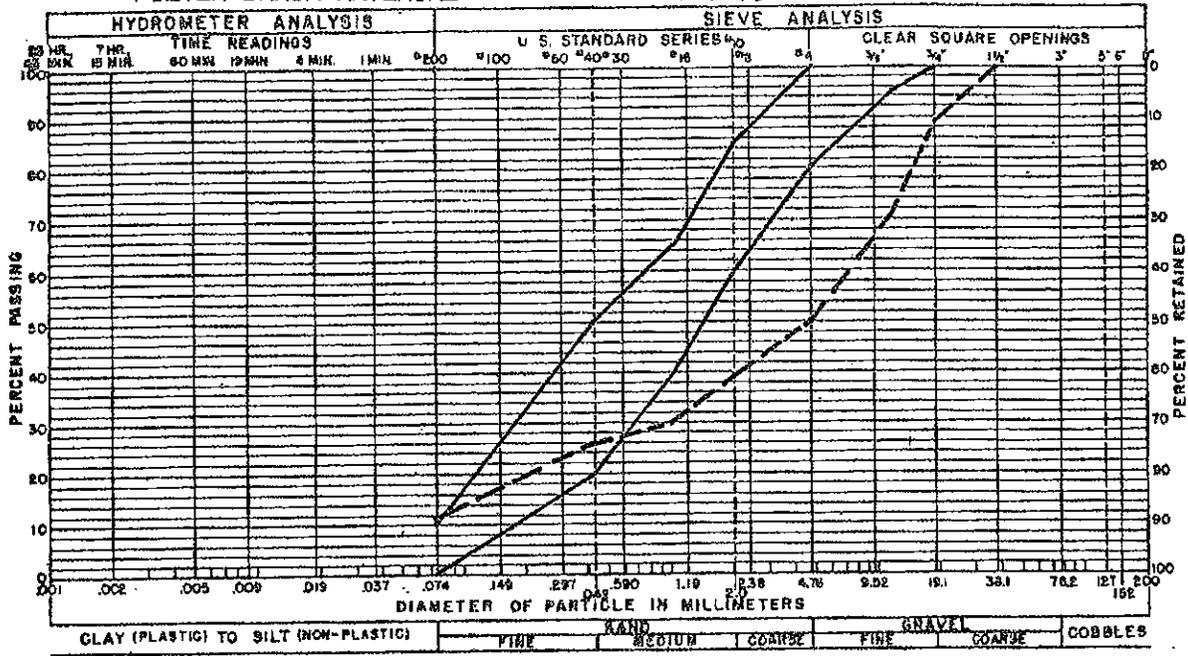
GRAVEL 87 % SAND 9 % SILT AND CLAY 4 %
 LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF GRAVEL, SLIGHTLY SANDY FROM RAWLINS SAND AND GRAVEL

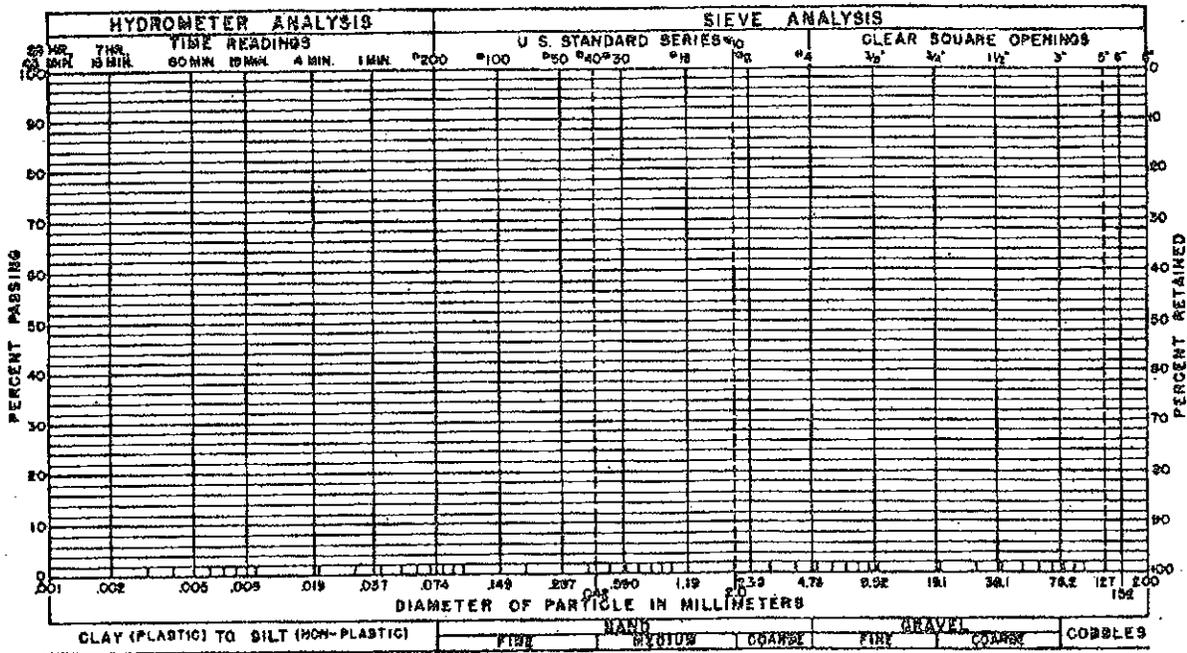
GRADATION TEST RESULTS

FILTER DRAIN MATERIAL

7-3-79



GRAVEL 50 % SAND 39 % SILT AND CLAY 11 %
 LIQUID LIMIT % PLASTICITY INDEX %
 SAMPLE OF GRAVEL, SANDY FROM RAWLINS AND AND GRAVEL

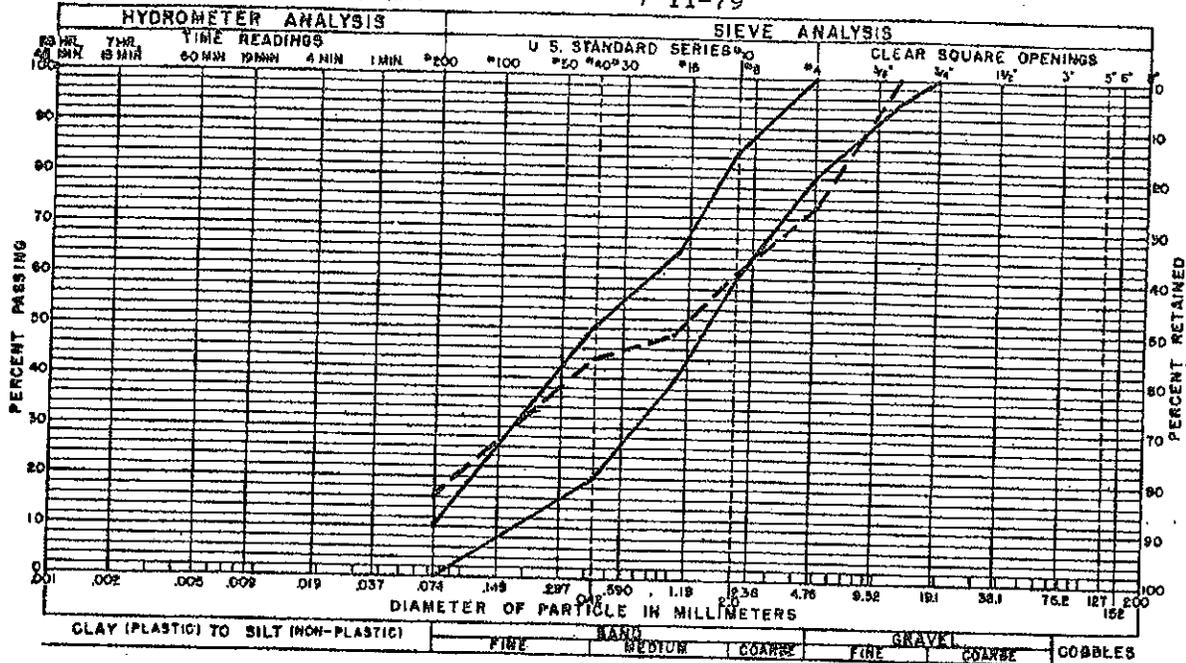


GRAVEL % SAND % SILT AND CLAY %
 LIQUID LIMIT % PLASTICITY INDEX %
 SAMPLE OF FROM

GRADATION TEST RESULTS

BLANKET DRAIN

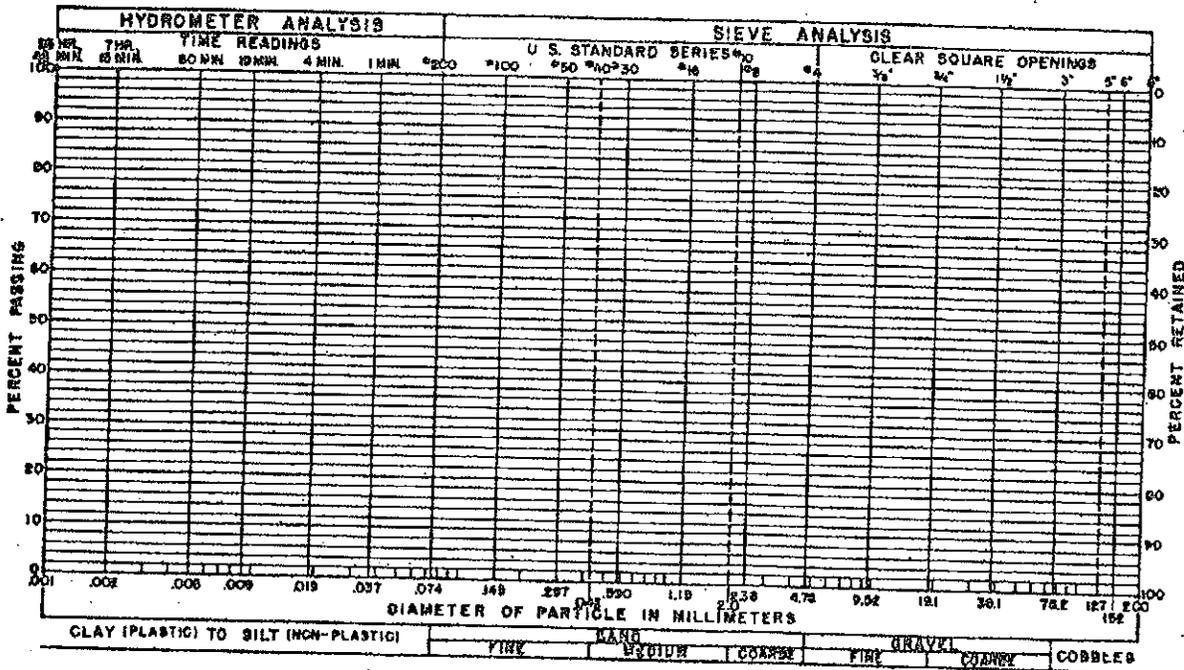
7-11-79



GRAVEL 25 % SAND 59 % SILT AND CLAY 16 %
 LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF SAND, GRAVELLY

FROM RAWLINS GRAVEL PIT, SOUTH WEST OF RAWLINS



GRAVEL % SAND % SILT AND CLAY %
 LIQUID LIMIT % PLASTICITY INDEX %

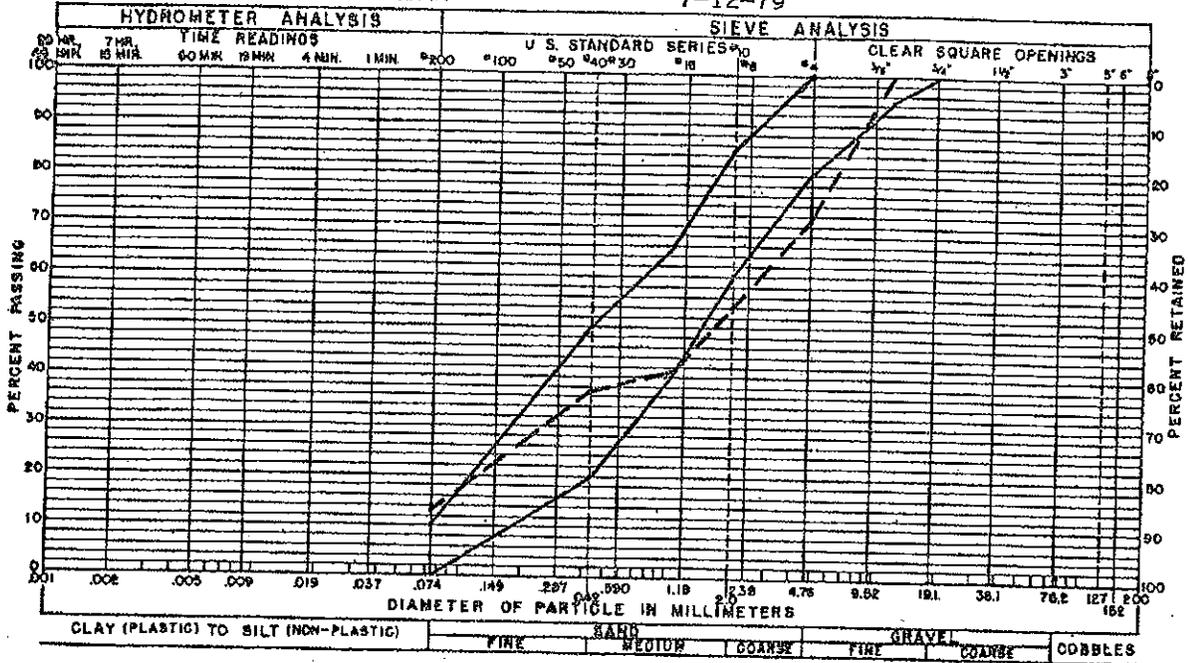
SAMPLE OF

FROM

GRADATION TEST RESULTS

BLANKET DRAIN MATERIAL

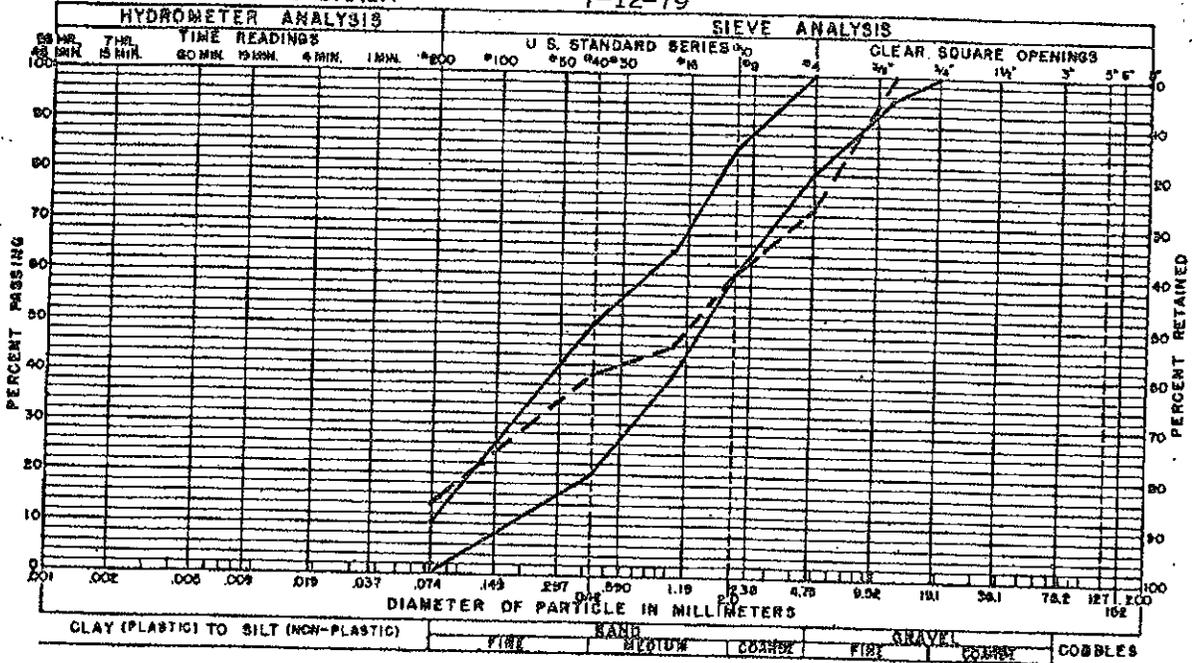
7-12-79



GRAVEL 29 % SAND 58 % SILT AND CLAY 13 %
 LIQUID LIMIT % PLASTICITY INDEX %
 SAMPLE OF SAND, GRAVELLY FROM RAWLINS GRAVEL PIT, SOUTH-WEST OF RAWLINS

BLANKET DRAIN

7-12-79

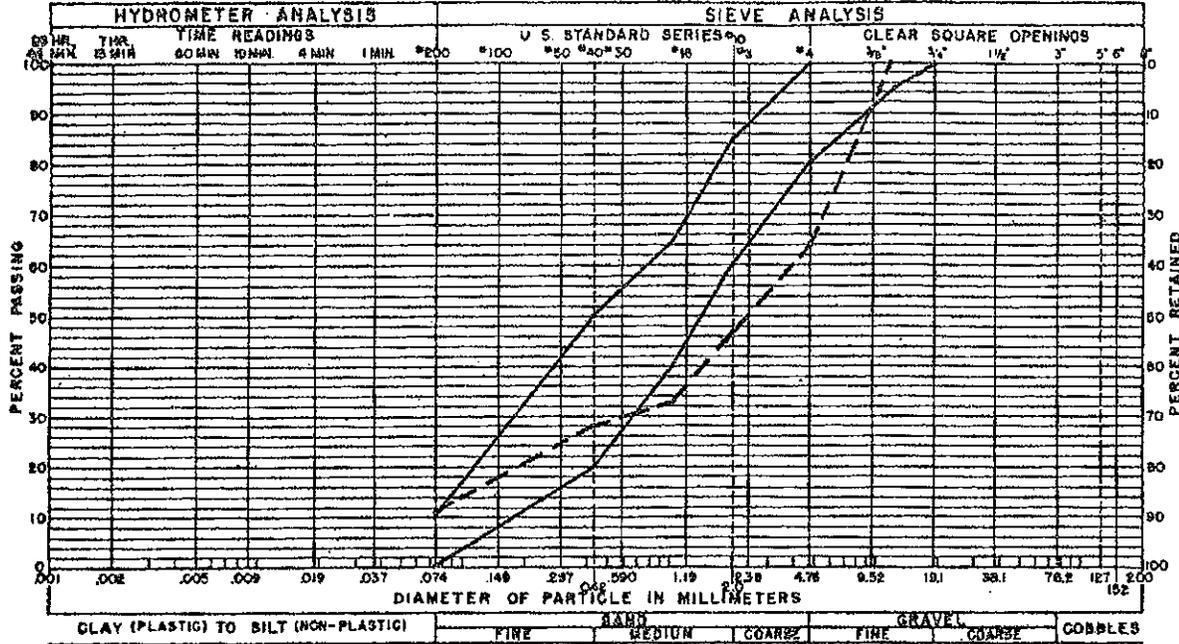


GRAVEL 27 % SAND 59 % SILT AND CLAY 14 %
 LIQUID LIMIT % PLASTICITY INDEX %
 SAMPLE OF SAND, GRAVELLY FROM RAWLINS GRAVEL PIT, SOUTH-WEST OF RAWLINS

GRADATION TEST RESULTS

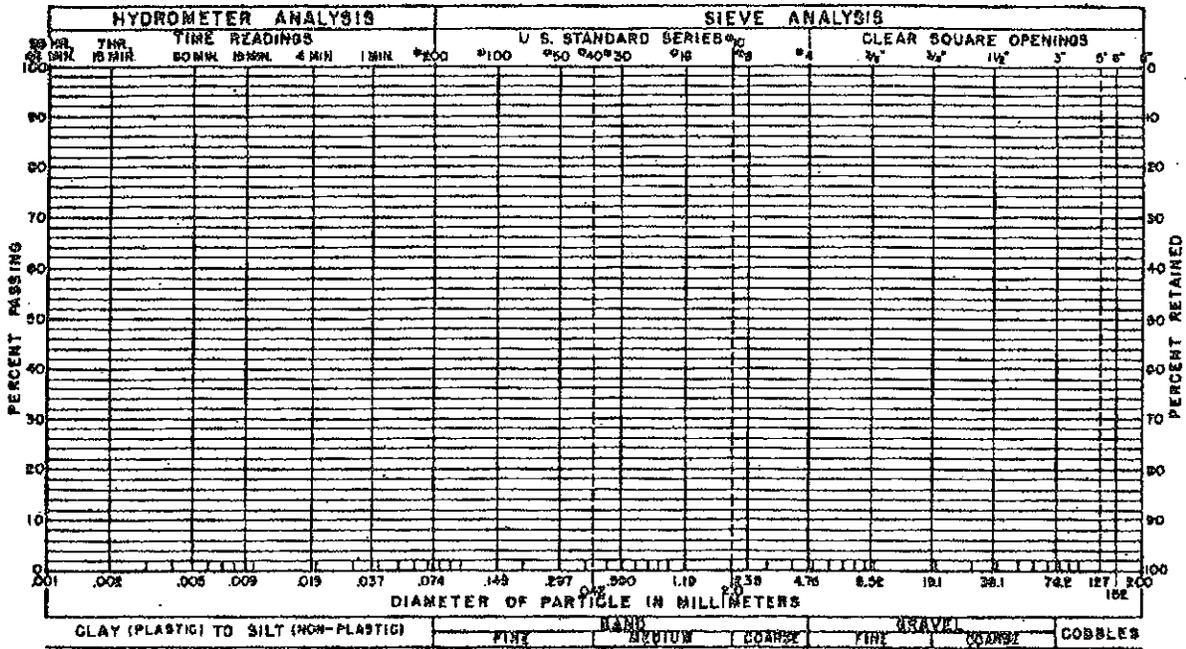
BLANKET DRAIN

7-23-79



GRAVEL 35 % SAND 54 % SILT AND CLAY 11 %
 LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF SAND, GRAVELLY FROM RAWLINS GRAVEL PIT, SOUTH-WEST OF RAWLINS

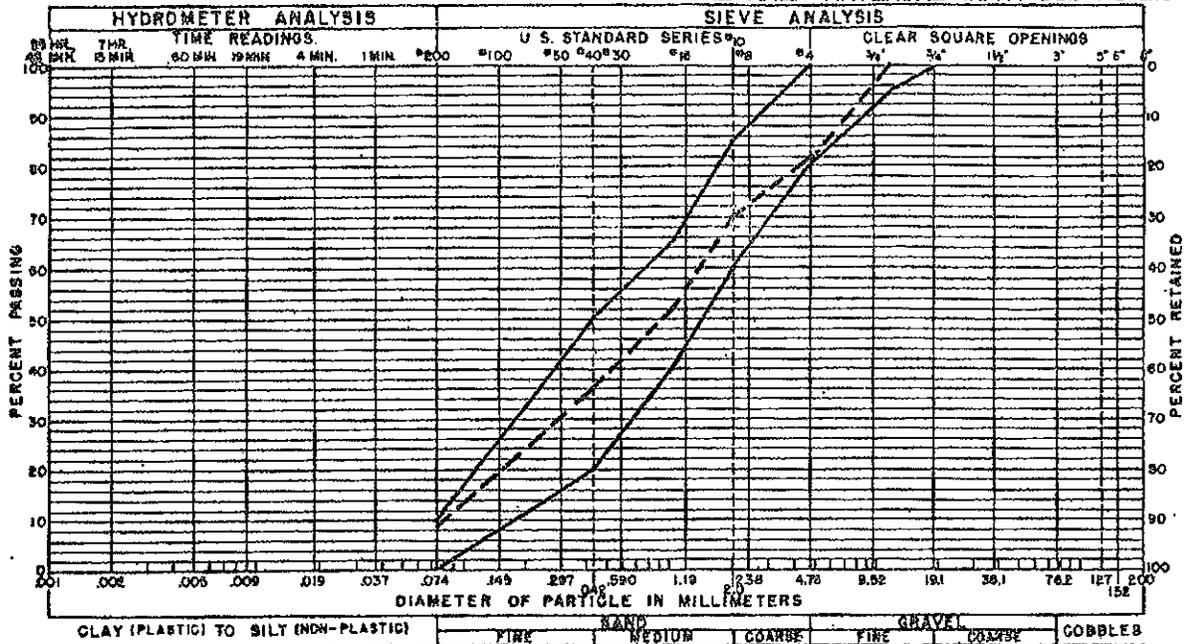


GRAVEL % SAND % SILT AND CLAY %
 LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF FROM

GRADATION TEST RESULTS

BLANKET DRAIN 7-25-79 (CLEAN SAND) ONE-HALF MATERIAL WITH 11% FINES
 ONE-HALF RAWLINS SAND AND GRAVEL

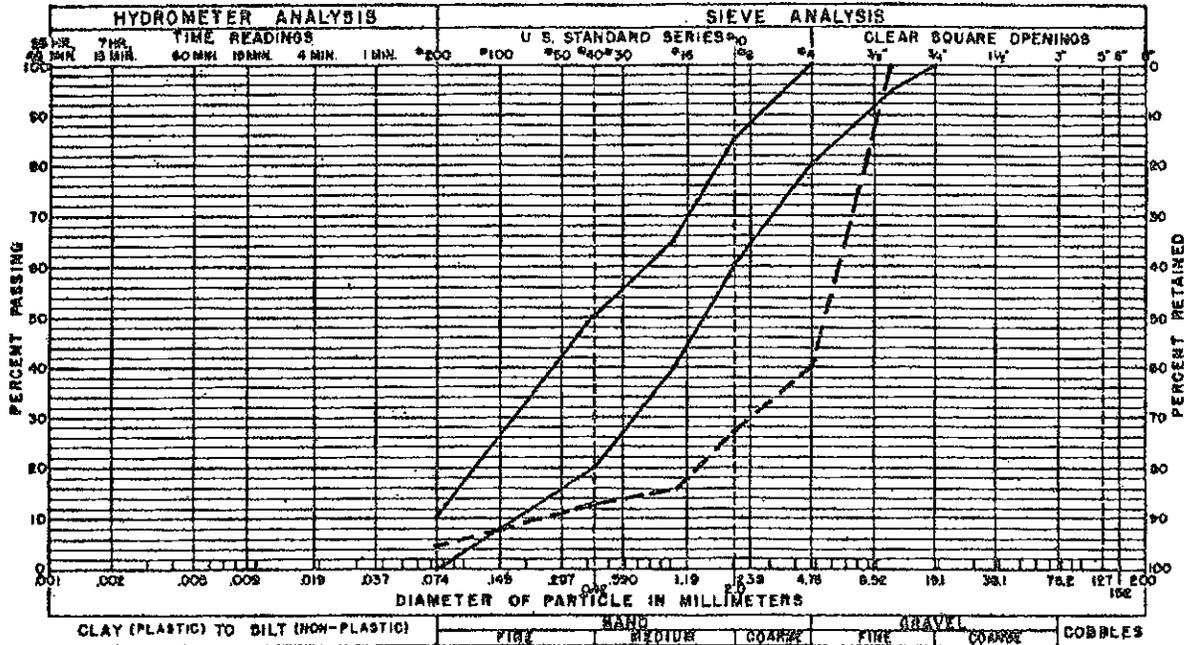


GRAVEL 19.4 % SAND 72 % SILT AND CLAY 8.6 %

LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF SAND, SLIGHTLY GRAVELLY FROM 1/2 RAWLINS GRAVEL PIT; 1/2 CLEAN SAND FROM RAWLINS SAND AND GRAVEL

BLANKET DRAIN 7-25-79 CHIPS ADDED



GRAVEL 59.6 % SAND 35.9 % SILT AND CLAY 4.5 %

LIQUID LIMIT % PLASTICITY INDEX %

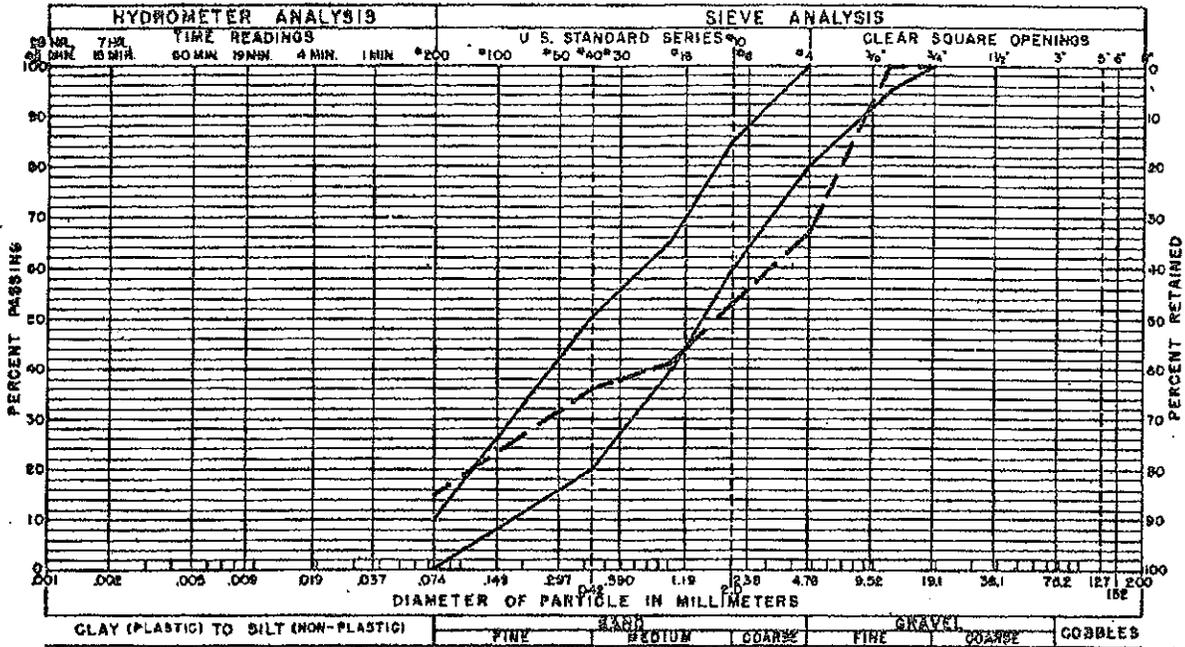
SAMPLE OF GRAVEL, SANDY FROM RAWLINS GRAVEL PIT, SOUTH-WEST OF RAWLINS

GRADATION TEST RESULTS

BLANKET DRAIN

7-30-79

CHIPS AND MORE FINES (REJECTED)



GRAVEL 32.9 % SAND 52.3 % SILT AND CLAY 14.8 %

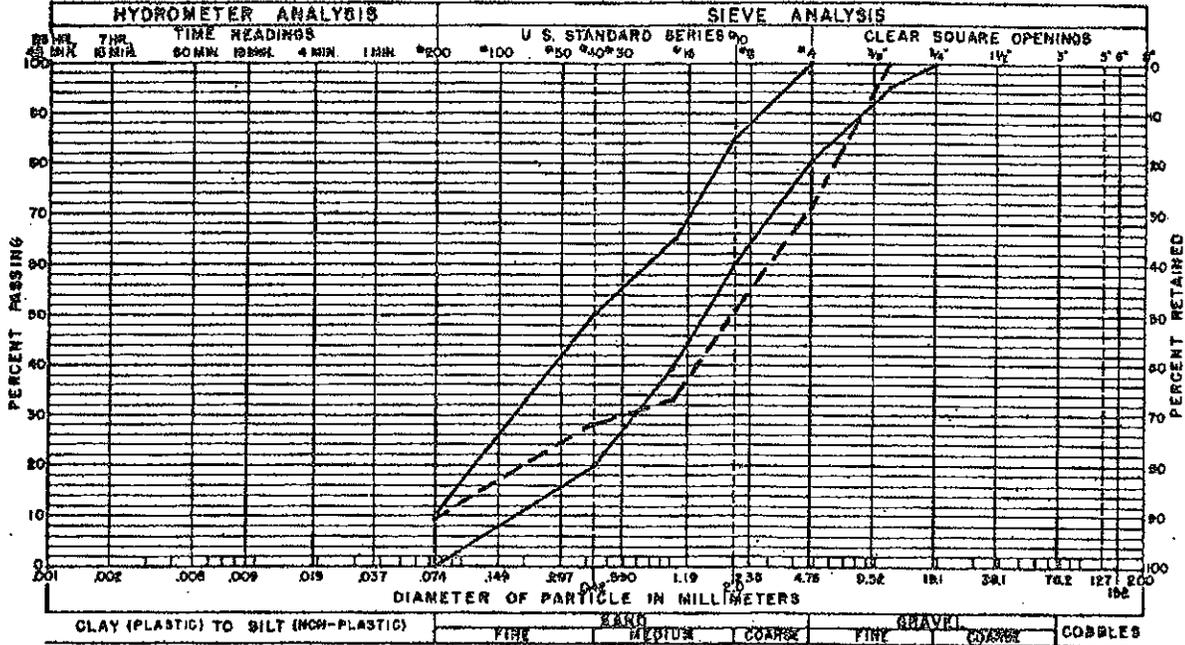
LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF SAND, GRAVELLY FROM RAWLINS GRAVEL PIT, SOUTH-WEST OF RAWLINS

BLANKET DRAIN

7-30-79

ACCEPTED FOR TOP FOOT OF BLANKET DRAIN



GRAVEL 28.9 % SAND 61.6 % SILT AND CLAY 9.5 %

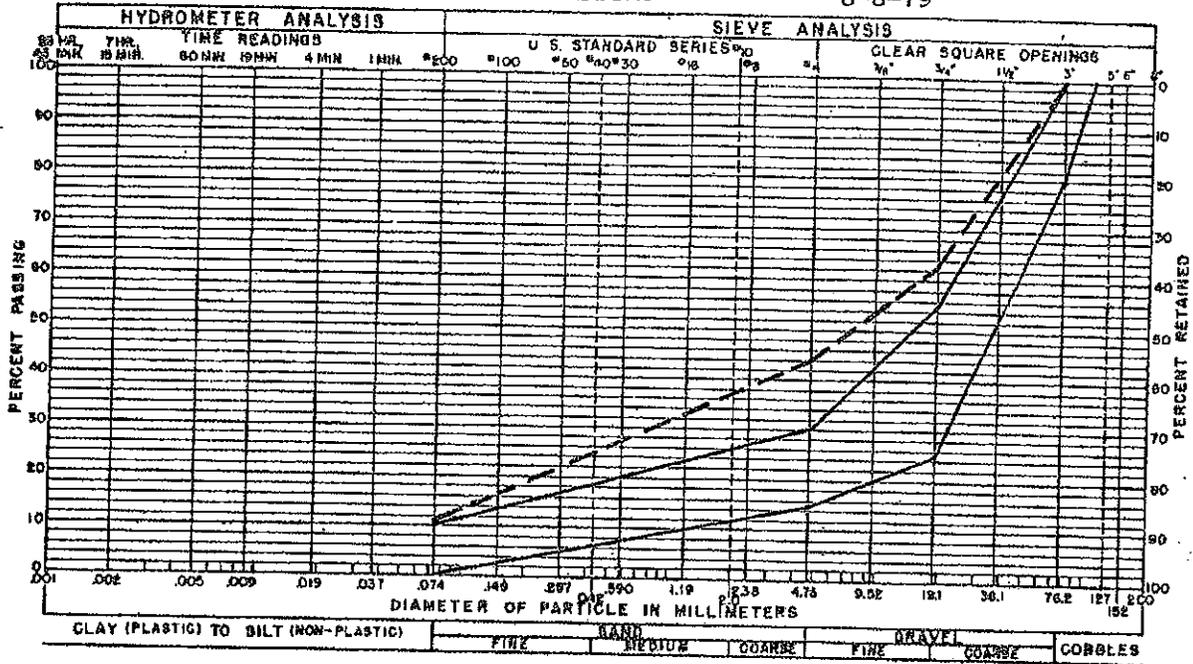
LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF SAND, GRAVELLY FROM RAWLINS GRAVEL PIT, SOUTH-WEST OF RAWLINS

GRADATION TEST RESULTS

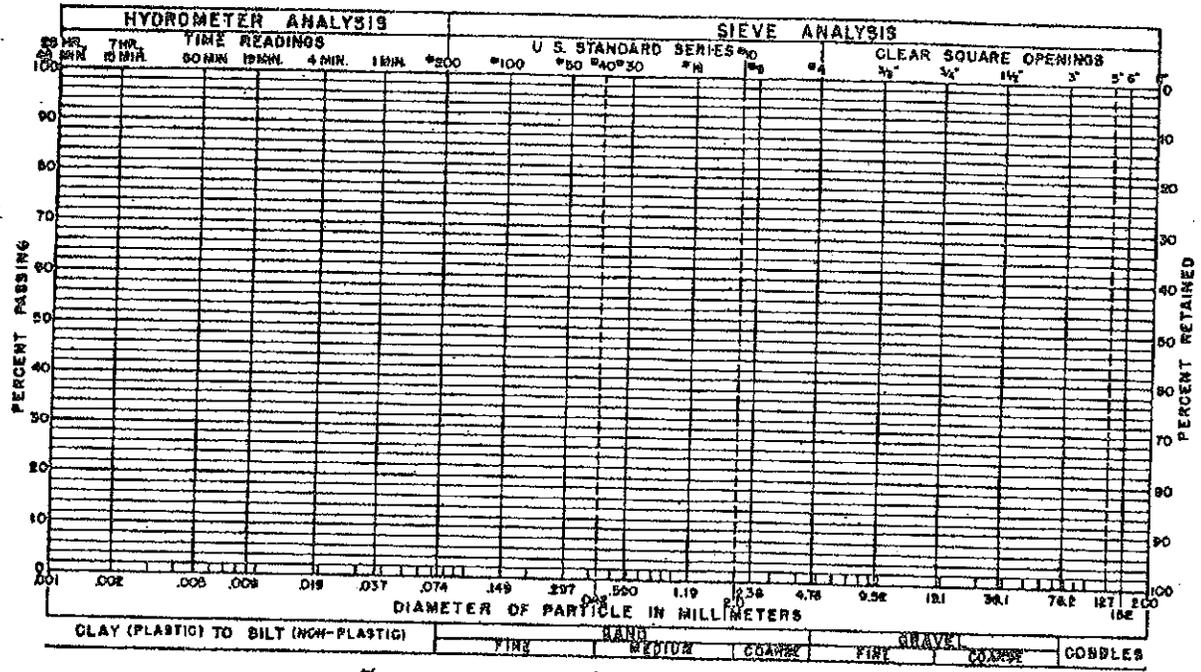
RIPRAP BEDDING

8-8-79



GRAVEL 56 % SAND 32.9% SILT AND CLAY 11.1 %
 LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF GRAVEL, SANDY FROM RAWLINS GRAVEL PIT
 SOUTHWEST OF RAWLINS



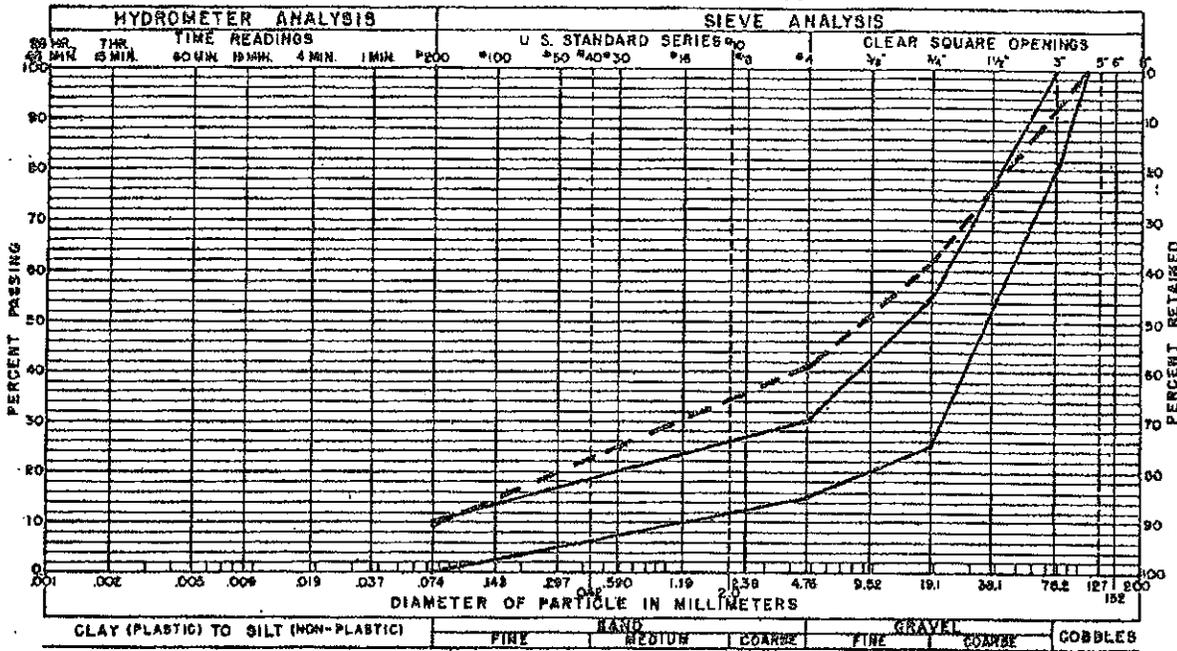
GRAVEL % SAND % SILT AND CLAY %
 LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF FROM

GRADATION TEST RESULTS

RIPRAP BEDDING

8-9-79

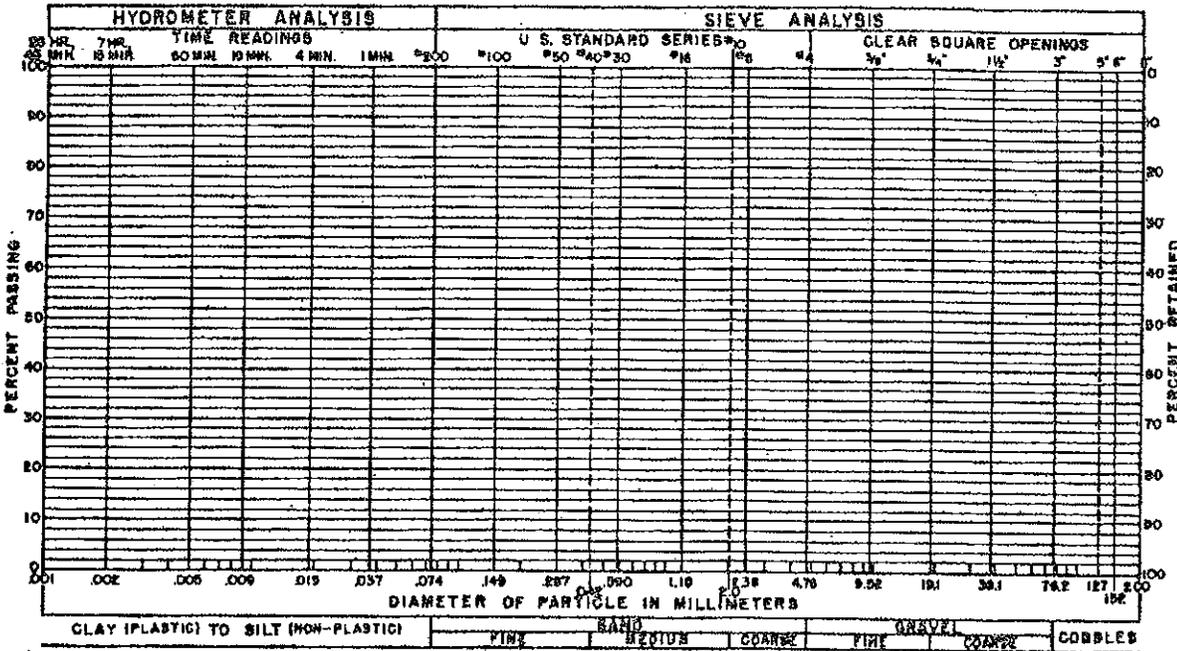


GRAVEL 59 % SAND 31.4 % SILT AND CLAY 9.6 %

LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF GRAVEL, SANDY

FROM RAWLINS GRAVEL PIT SOUTHWEST OF RAWLINS



GRAVEL % SAND % SILT AND CLAY %

LIQUID LIMIT % PLASTICITY INDEX %

SAMPLE OF

FROM

GRADATION TEST RESULTS

Summary of Field Moisture-Density Tests Performed on Atlantic Rim Reservoir Embankment Fill
See CTL/Thompson (1979) for the specific location of each test.

Test Number	Maximum Density (PCF)	Optimum Moisture Content (%)	Field Density (PCF)	Field Moisture Content (%)	Relative Compaction (%)	Water Content Deviation (%)	Proctor Number	Notes
1	109.5	17.0	109.0	17.8	99.5	0.6	3	
2	109.5	17.0	107.5	20.1	98.2	3.1	3	
3	109.5	17.0	112.0	18.2	102.3	1.2	2	
4	109.5	17.0	106.6	19.8	97.3	2.8	3	
5	109.5	17.0	105.0	22.5	95.9	5.5	3	Moisture content high
6	109.5	17.0	112.0	18.2	102.3	1.2	3	
7	109.5	17.0	109.0	19.8	99.5	2.8	3	
8	111.0	19.0	113.0	18.6	101.8	-0.4	4	Retest of #5
9	111.0	19.0	108.0	22.5	97.3	3.5	4	
10	111.0	19.0	113.0	18.7	101.8	-0.3	4	
11	111.0	19.0	111.0	18.1	100.0	0.1	1	
12	111.0	19.0	115.0	18.6	103.6	-0.5	4	
13	111.0	19.0	111.0	20.3	100.0	1.3	4	
14	111.0	19.0	115.0	17.1	103.6	-1.9	4	
15	111.0	19.0	113.0	19.5	101.8	0.5	4	
16	111.0	19.0	107.0	20.6	96.4	1.6	4	
17	112.0	16.5	109.0	17.1	97.3	0.6	4	
18	112.0	16.5	113.0	17.4	100.9	0.9	5	
19	112.0	16.5	110.0	18.6	98.2	2.1	5	
20	112.0	16.5	112.0	14.1	100.0	-2.4	5	Moisture content low
21	112.0	16.5	111.0	19.0	99.1	2.5	5	
22	112.0	16.5	111.0	17.1	99.1	0.6	5	Retest of #20
23	112.0	16.5	112.0	18.3	100.0	1.8	5	
24	109.5	17.0	112.0	18.2	102.3	1.2	3	
25	112.0	16.5	112.0	18.9	100.0	2.4	6	
26	109.5	17.0	108.0	18.9	96.8	1.9	3	
27	109.5	17.0	107.0	21.8	97.7	4.8	3	
28	120.0	13.0	117.0	16.4	97.5	3.4	2	
29	120.0	13.0	108.0	21.5	90.0	8.6	2	Density low
30	120.0	13.0	112.0	15.4	93.3	2.4	2	
31	120.0	13.0	116.0	15.3	99.7	2.3	2	Retest of #29
32	120.0	13.0	115.0	16.2	95.8	3.2	2	Sand cone retest of #29
33	111.0	19.0	112.0	18.5	100.9	-0.5	4	
34	111.0	19.0	112.0	19.2	100.9	0.2	4	
35	112.0	16.5	116.0	15.1	103.6	-1.4	5	
36	112.0	16.5	116.0	15.3	103.6	-1.2	5	
37	112.0	16.5	114.0	15.6	101.8	-0.9	5	
38	111.0	19.0	114.0	17.1	102.7	-1.9	4	
39	120.0	13.0	117.0	16.1	97.5	3.1	2	
40	120.0	13.0	124.0	13.0	103.3	0.0	2	
41	120.0	13.0	114.0	14.3	95.0	1.3	2	
42	120.0	13.0	120.0	12.5	100.0	-0.6	2	
43	120.0	13.0	119.0	13.7	99.2	0.7	2	
44	109.5	17.0	113.0	17.0	103.2	0.0	3	
45	112.0	16.5	114.0	16.4	101.8	1.9	5	
46	120.0	13.0	119.0	15.2	99.2	2.2	2	
47	118.0	13.5	112.0	18.0	96.6	4.5	6	
48	118.0	13.5	120.0	11.7	103.4	-1.8	6	
49	112.0	16.5	113.0	17.7	100.9	1.2	5	
50	112.0	16.5	113.0	17.3	100.9	0.8	5	
51	112.0	16.5	110.0	20.0	98.2	3.5	5	
52	112.0	16.5	115.0	18.5	102.7	2.0	5	
53	112.0	16.5	118.0	16.8	103.6	0.3	5	
54	112.0	16.5	114.0	17.9	101.8	1.4	5	
55	112.0	16.5	118.0	16.7	103.6	0.2	5	
56	112.0	16.5	112.0	16.2	100.0	-0.3	5	
57	111.0	19.0	112.0	19.1	100.9	0.1	4	
58	112.0	16.5	110.0	19.3	98.2	2.8	5	
59	112.0	16.5	103.0	19.8	92.0	3.3	5	Density low
60	112.0	16.5	117.0	15.2	104.5	-1.3	5	
61	112.0	16.5	115.0	17.3	102.7	0.8	5	
62	112.0	16.5	114.0	19.2	101.8	2.7	5	
63	112.0	16.5	114.0	17.1	101.8	0.6	5	
64	112.0	16.5	109.0	18.0	97.3	-0.5	5	
65	112.0	16.5	119.0	13.5	106.3	-3.0	5	Moisture content Low
66	114.0	18.0	111.0	14.5	97.4	-1.5	8	
67	112.0	16.5	109.0	19.3	97.3	2.8	5	Retest of #59
68	114.0	16.0	115.0	17.2	100.9	1.2	8	
69	114.0	16.0	113.0	17.5	99.1	1.5	8	
70	112.0	16.5	112.0	15.9	100.0	-0.6	5	Retest of #65
71	114.0	16.0	112.0	18.5	98.2	2.5	8	
72	114.0	16.0	118.0	18.1	103.6	0.1	8	
73	114.0	16.0	115.0	18.2	100.9	2.2	8	
74	114.0	16.0	114.0	17.0	100.0	1.0	8	
75	114.0	16.0	112.0	18.4	98.2	2.4	8	
76	109.0	18.5	108.0	21.3	99.1	2.8	7	

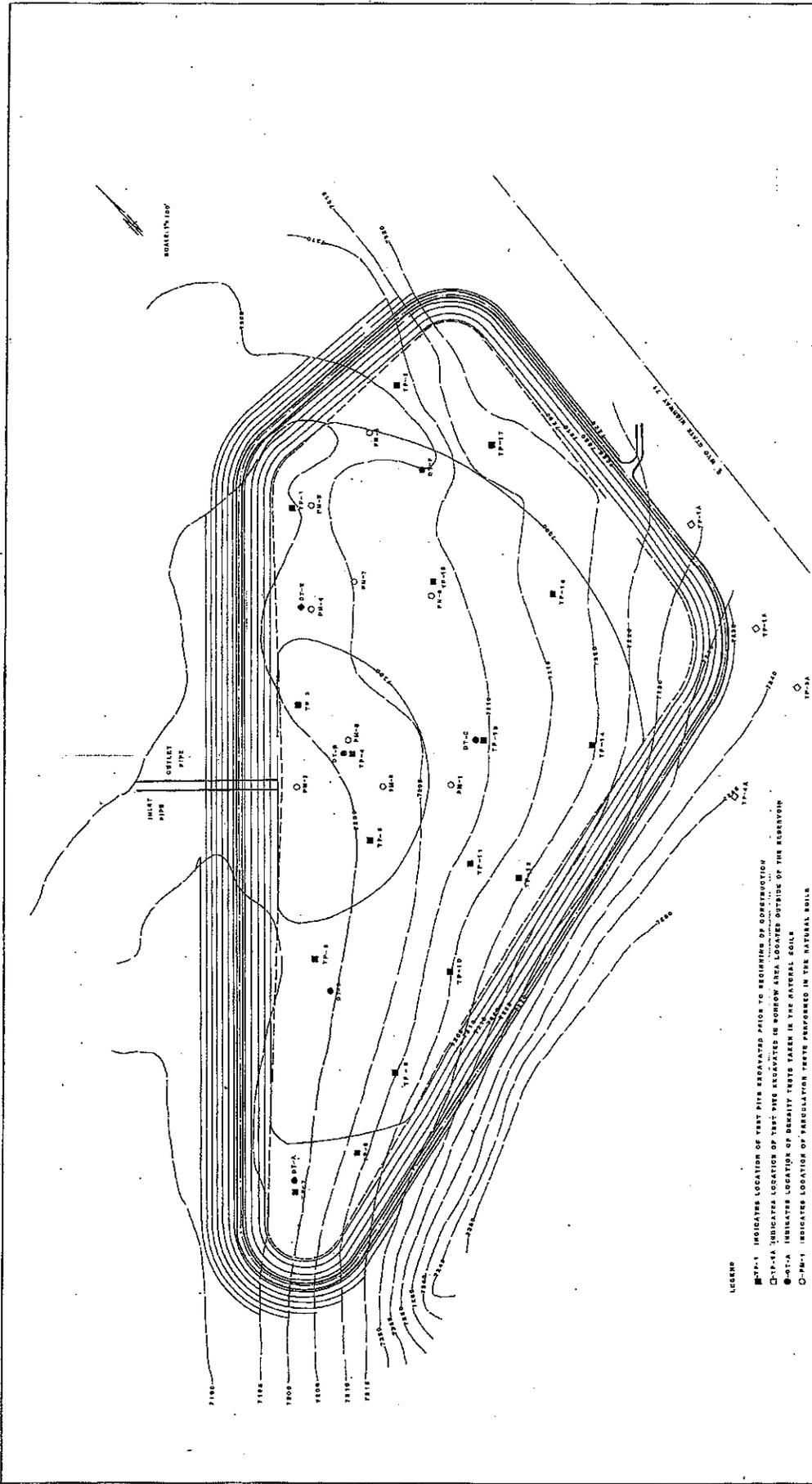
Test Number	Maximum Density (PCF)	Optimum Moisture Content (%)	Field Density (PCF)	Field Moisture Content (%)	Relative Compaction (%)	Water Content Deviation (%)	Proctor Number	Notes
77	114.0	16.0	113.0	16.2	99.1	0.2	8	
78	114.0	16.0	116.0	15.4	101.8	-0.6	8	
79	114.0	16.0	114.0	17.9	100.0	1.9	8	
80	114.0	16.0	114.0	17.2	100.0	1.2	8	
81	114.0	16.0	110.0	19.7	98.5	3.7	8	
82	114.0	16.0	111.0	18.0	97.4	2.0	8	
83	114.0	16.0	119.0	15.2	104.4	-0.6	8	
84	109.0	18.5	108.0	18.3	99.1	-0.2	8	
85	114.0	16.0	118.0	15.7	103.5	-0.3	8	
86	114.0	16.0	112.0	17.7	98.2	1.7	8	
87	114.0	16.0	117.0	15.8	102.6	-0.2	8	
88	114.0	16.0	113.0	17.3	99.1	1.3	8	
89	109.0	18.5	108.0	20.8	99.1	2.3	7	
90	114.0	16.0	112.0	15.9	98.2	-0.1	8	
91	114.0	16.0	111.0	18.8	97.4	0.8	8	
92	114.0	16.0	114.0	17.8	100.0	1.8	8	
93	114.0	16.0	115.0	16.0	100.9	2.0	8	
94	109.0	18.5	108.0	20.5	99.1	2.0	7	
95	114.0	16.0	111.0	17.2	97.4	1.2	8	
96	109.0	18.5	105.0	19.4	98.3	0.9	7	
97	109.0	18.5	109.0	19.3	100.0	0.8	7	
98	114.0	16.0	115.0	16.4	100.9	0.4	8	
99	114.0	16.0	113.0	17.9	99.1	1.9	8	
100	114.0	16.0	111.0	18.2	97.4	2.2	8	
101	114.0	16.0	111.0	18.3	97.4	2.3	8	
102	114.0	16.0	113.0	14.8	99.1	-1.2	8	Moisture content inadequate
103	120.0	13.0	123.0	10.5	102.5	-2.5	2	Moisture content inadequate
104	120.0	13.0	119.0	10.8	99.2	-2.2	2	
105	120.0	13.0	121.0	8.9	100.8	-4.1	2	Moisture content inadequate
106	120.0	13.0	118.0	16.2	98.3	3.2	2	
107	120.0	13.0	120.0	14.4	100.0	1.4	2	
108	120.0	13.0	123.0	12.4	102.5	-0.6	2	
109	114.0	16.0	112.0	18.4	98.2	2.4	8	
110	120.0	13.0	115.0	13.6	95.8	0.6	2	Retest of #105
111	120.0	13.0	119.0	16.0	99.2	3.0	2	
112	120.0	13.0	122.0	12.2	101.7	-0.8	2	
113	120.0	13.0	121.0	12.1	100.8	-0.9	2	
114	120.0	13.0	124.0	9.9	103.3	-3.1	2	Inadequate
115	120.0	13.0	121.0	11.3	100.8	-1.7	2	
116	114.0	16.0	119.0	9.2	104.4	-6.8	8	Moisture content low
117	120.0	13.0	123.0	13.5	102.5	0.6	2	
118	120.0	13.0	121.0	13.8	100.8	0.6	2	
119	109.0	18.5	110.0	20.2	100.9	1.7	7	
120	120.0	13.0	121.0	11.6	100.8	-1.4	2	
121	120.0	13.0	113.4	14.2	94.5	1.2	2	
122	120.0	13.0	122.0	13.7	101.7	0.7	2	
123	114.0	16.0	112.0	16.4	98.2	0.4	8	Retest of #116
124	120.0	13.0	119.0	14.3	99.2	1.3	2	
125	114.0	16.0	115.0	17.0	100.9	1.0	8	
126	114.0	16.0	109.0	21.1	95.6	5.1	8	
127	114.0	16.0	117.0	16.7	102.6	0.7	8	
128	114.0	16.0	114.0	16.6	100.0	0.6	8	
129	120.0	13.0	117.0	11.5	97.5	-1.5	2	
130	114.0	16.0	112.0	17.8	98.2	1.8	8	
131	114.0	16.0	112.0	15.7	98.2	-0.3	8	
132	114.0	16.0	113.0	17.4	99.1	1.4	8	
133	120.0	13.0	118.0	13.5	98.3	0.5	2	
134	120.0	13.0	120.0	11.6	100.0	-1.4	2	
135	120.0	13.0	119.0	13.7	99.2	0.7	2	
136	120.0	13.0	117.0	15.0	97.5	2.0	2	
137	120.0	13.0	115.0	16.3	95.8	3.3	2	
138	114.0	16.0	113.0	18.1	99.1	2.1	8	
139	120.0	13.0	120.0	15.0	100.0	2.0	2	
140	114.0	16.0	112.0	20.2	98.2	4.2	8	
141	120.0	13.0	127.0	13.8	105.8	0.8	2	
143	120.0	13.0	118.0	15.2	98.3	2.2	2	
144	116.0	13.5	108.0	14.3	91.4	0.8	6	Falling test, not mentioned in report
145	114.0	16.0	113.0	17.8	99.1	1.8	8	
146	116.0	13.5	115.0	14.3	99.1	0.6	8	Retest of #144
147	114.0	16.0	112.0	16.1	98.2	0.1	8	
148	120.0	13.0	116.0	14.4	98.3	1.4	2	
149	120.0	13.0	118.0	14.8	98.3	1.8	2	
150	114.0	16.0	111.0	19.2	97.4	3.2	8	
151	120.0	13.0	119.0	15.1	99.2	2.1	2	
152	112.0	16.5	110.0	19.3	98.2	2.8	5	
153	114.0	16.0	112.0	18.1	98.2	2.1	8	
154	114.0	16.0	115.0	16.5	100.9	0.5	8	
155	114.0	16.0	115.0	16.8	100.9	0.8	8	Retest of #102
156	114.0	16.0	111.0	18.6	97.4	2.6	8	

Test Number	Maximum Density (PCF)	Optimum Moisture Content (%)	Field Density (PCF)	Field Moisture Content (%)	Relative Compaction (%)	Water Content Deviation (%)	Proctor Number	Notes
157	112.0	18.5	113.0	17.5	100.9	1.0	5	
158	112.0	16.5	110.0	20.3	98.2	3.8	5	
159	112.0	16.5	112.0	19.1	100.0	2.6	5	
160	112.0	16.5	110.0	18.2	98.2	1.7	5	
161	114.0	16.0	115.0	15.7	100.9	-0.3	8	
162	114.0	16.0	113.0	15.2	99.1	-0.8	8	
163	114.0	16.0	118.0	14.3	103.5	-1.7	8	
164	114.0	16.0	115.0	16.6	100.0	-0.5	8	
165	114.0	16.0	112.0	16.7	98.2	0.7	8	
166	114.0	16.0	116.0	13.9	101.8	-2.1	8	
167	114.0	16.0	114.0	18.3	100.0	2.3	8	
168	114.0	16.0	113.0	17.9	99.1	1.9	8	
169	114.0	16.0	111.0	19.5	97.4	3.5	8	
170	114.0	16.0	115.0	16.8	100.9	0.8	8	
171	114.0	16.0	117.0	17.9	102.6	1.9	8	
172	114.0	16.0	113.0	19.1	99.1	0.1	8	
173	114.0	16.0	113.0	18.7	99.1	2.7	8	
174	114.0	16.0	111.0	17.0	97.4	1.0	8	
175	114.0	16.0	116.0	14.1	101.8	-1.9	8	
176	114.0	16.0	110.0	16.9	98.5	0.9	8	
177	114.0	16.0	115.0	14.9	100.9	-1.1	8	
178	114.0	16.0	114.0	16.4	100.0	0.4	8	
179	114.0	16.0	118.0	15.2	103.5	-0.8	8	
180	114.0	16.0	118.0	15.1	103.5	-0.9	8	
181	114.0	16.0	117.0	14.0	102.6	-2.0	8	
182	114.0	16.0	121.0	13.9	106.1	-2.1	8	
183	114.0	16.0	115.0	16.9	100.9	0.9	8	
184	114.0	16.0	118.0	15.9	103.5	-0.1	8	
185	114.0	16.0	121.0	13.9	106.1	-2.1	8	
186	114.0	16.0	114.0	14.0	100.0	-2.0	8	
187	114.0	16.0	111.0	17.7	97.4	1.7	8	
188	114.0	16.0	121.0	15.4	106.1	-0.6	8	
189	114.0	16.0	114.0	18.5	100.0	2.5	8	
190	120.0	13.0	120.0	15.6	100.0	2.6	2	
191	120.0	13.0	119.0	15.4	99.2	2.4	2	
192	114.0	16.0	116.0	15.1	101.8	-0.9	8	
193	114.0	16.0	118.0	14.3	103.5	-1.7	8	
194	114.0	16.0	114.0	16.5	100.0	0.5	8	
195	120.0	13.0	120.0	13.6	100.0	0.6	2	
196	114.0	16.0	117.0	16.7	102.6	-0.3	8	
197	120.0	13.0	123.0	10.8	102.5	-2.2	2	
198	120.0	13.0	122.0	14.3	101.7	1.3	2	
199	114.0	16.0	113.0	16.3	99.1	0.3	8	
200	114.0	16.0	116.0	15.9	101.8	-0.1	8	
201	114.0	16.0	121.0	16.4	106.1	0.4	8	
202	114.0	16.0	118.0	16.3	103.5	0.3	8	
203	114.0	16.0	115.0	17.3	100.9	1.3	8	
204	114.0	16.0	116.0	16.0	101.8	0.0	8	
205	120.0	13.0	125.0	14.5	104.2	1.5	2	
206	120.0	13.0	122.0	12.3	101.7	-0.7	2	
207	120.0	13.0	123.0	10.7	102.5	-2.3	2	
208	116.0	13.5	121.0	15.7	104.3	2.2	8	
209	114.0	16.0	116.0	14.9	101.8	-1.1	8	
210	120.0	13.0	122.0	11.9	101.7	-1.1	2	
211	120.0	13.0	121.0	16.3	100.8	3.3	2	
212	114.0	16.0	118.0	15.4	103.5	-0.6	8	
213	120.0	13.0	122.0	12.3	101.7	-0.7	2	
214	114.0	16.0	116.0	14.7	101.8	-1.3	8	
215	114.0	16.0	118.0	16.9	103.5	0.9	8	
216	114.0	16.0	114.0	17.4	100.0	1.4	8	
217	114.0	16.0	114.0	17.4	100.0	1.4	8	
218	120.0	13.0	127.0	11.8	105.8	-1.4	2	
219	114.0	16.0	111.0	16.2	97.4	0.2	8	
220	114.0	16.0	114.0	14.2	100.0	-1.8	8	
221	114.0	16.0	116.0	16.5	101.8	0.5	8	
222	114.0	16.0	116.0	14.1	101.8	-1.9	8	
223	120.0	13.0	117.0	13.0	97.5	0.0	2	Moisture content low
224	120.0	13.0	122.0	10.4	101.7	-2.6	2	Moisture content high
225	120.0	13.0	116.0	17.9	96.7	4.9	2	
226	109.0	18.5	109.0	19.2	100.0	0.7	7	
227	109.0	18.5	94.0	22.6	85.2	4.1	7	Falling test, not mentioned in report
228	114.0	16.0	115.0	17.9	100.9	1.9	8	
229	114.0	16.0	111.0	14.6	97.4	-1.4	8	
230	120.0	13.0	121.0	15.2	100.8	2.2	2	
231	109.0	18.5	107.0	22.1	98.2	3.6	7	
232	109.0	18.5	111.0	19.3	101.8	0.8	7	
233	120.0	13.0	121.0	12.5	100.8	-0.5	2	Retest of #227
234	120.0	13.0	119.0	13.0	99.2	0.0	2	Moisture content low
235	114.0	16.0	114.0	17.5	100.0	1.5	8	

Test Number	Maximum Density (PCF)	Optimum Moisture Content (%)	Field Density (PCF)	Field Moisture Content (%)	Relative Compaction (%)	Water Content Deviation (%)	Proctor Number	Notes
236	120.0	13.0	125.0	9.6	104.2	-3.4	2	Falling test, not mentioned in report
237	120.0	13.0	121.0	11.4	100.8	-1.6	2	
238	120.0	13.0	123.0	13.8	102.5	0.8	2	
239	120.0	13.0	121.0	15.0	100.8	2.0	2	
240	114.0	16.0	111.0	14.6	97.4	-1.4	8	
241	114.0	16.0	117.0	17.5	102.6	1.5	8	
242	114.0	16.0	112.0	18.4	98.2	2.4	8	
243	114.0	16.0	117.0	14.4	102.6	-1.6	8	
244	120.0	13.0	123.0	12.9	102.5	-0.1	2	Retest of #236
245	114.0	16.0	113.0	16.1	99.1	0.1	8	
246	120.0	13.0	121.0	13.5	100.8	0.5	2	
247	114.0	16.0	114.0	16.2	100.0	0.2	8	
248	114.0	16.0	108.0	11.1	93.0	-4.9	8	Falling test, not mentioned in report
249	114.0	16.0	114.0	14.8	100.0	-1.2	8	
250	114.0	16.0	114.0	18.1	100.0	0.1	8	Retest of #248
251	114.0	16.0	114.0	16.9	100.0	0.9	8	
252	114.0	16.0	121.0	17.2	106.1	1.2	8	
253	114.0	16.0	107.0	19.3	93.9	3.3	8	Density low
254	114.0	16.0	110.0	16.1	96.5	2.1	8	
255	114.0	16.0	111.0	17.0	97.4	1.9	8	
256	114.0	16.0	116.0	13.7	100.0	-2.3	8	Moisture content low
257	114.0	16.0	109.0	19.6	95.6	3.6	8	
258	114.0	16.0	113.0	17.2	98.1	1.2	8	
259	114.0	16.0	112.0	18.7	98.2	2.7	8	
260	114.0	16.0	111.0	19.0	97.4	3.0	8	Retest of #256
261	114.0	16.0	115.0	17.6	100.9	1.6	8	Retest of #253
262	114.0	16.0	104.0	14.1	91.2	-1.9	8	Fill does not meet specifications, removed
263	114.0	16.0	116.0	18.3	101.8	2.3	8	
264	114.0	16.0	115.0	17.7	100.9	1.7	8	
265	114.0	16.0	120.0	16.1	105.3	0.1	8	
266	114.0	16.0	111.0	18.1	97.4	2.1	8	
267	114.0	16.0	109.0	21.0	95.6	5.0	8	
268	114.0	16.0	114.0	18.4	100.0	2.4	8	
269	114.0	16.0	118.0	14.6	103.5	-1.4	8	
270	114.0	16.0	119.0	15.9	104.4	-0.1	8	
271	114.0	16.0	118.0	16.5	101.8	0.5	8	
272	114.0	16.0	113.0	15.5	99.1	-0.5	8	
273	114.0	16.0	112.0	15.7	96.2	-0.3	8	
274	114.0	16.0	116.0	16.4	101.8	0.4	8	
275	114.0	16.0	114.0	17.5	100.0	1.5	8	
176	114.0	16.0	117.0	16.5	102.6	0.5	8	
277	114.0	16.0	113.0	19.2	99.1	3.2	8	
278	114.0	16.0	112.0	18.2	98.2	2.2	8	
279	114.0	16.0	112.0	15.9	96.2	-0.1	8	
280	114.0	16.0	119.0	14.9	104.4	-1.1	8	
281	114.0	16.0	117.0	15.4	102.6	-0.6	8	
282	116.0	13.5	123.0	11.9	106.0	-1.6	6	
283	116.0	13.5	121.0	13.5	104.3	0.0	6	

APPENDIX B.2

LINER CONSTRUCTION TEST RESULTS



LEGEND

- TP-1 INDICATES LOCATION OF TEST PIT EXAMINED PRIOR TO BEGINNING OF CONSTRUCTION
- TP-101 INDICATES LOCATION OF TEST PIT EXAMINED IN BOMBED AREA LOCATED OUTSIDE OF THE RESERVOIR
- TP-102 INDICATES LOCATION OF DENSITY TESTS TAKEN IN THE NATURAL SOIL
- TP-103 INDICATES LOCATION OF PERCUSSION TESTS PERFORMED IN THE NATURAL SOIL

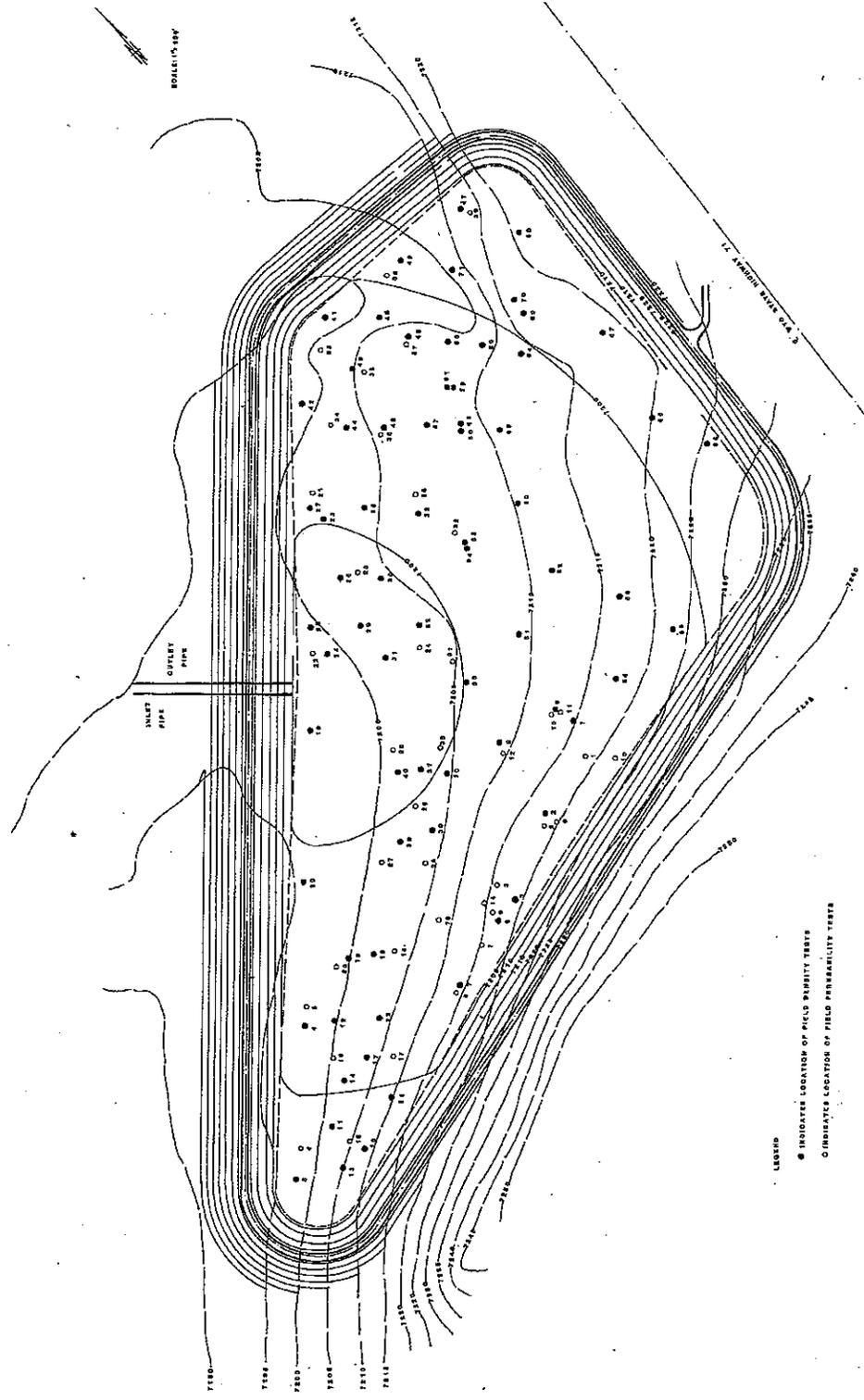
ATLANTIC RIM RESERVOIR
 RAWLINS, WYOMING

LOCATION OF TEST PIT LINES
 CONSTRUCTION PERIOD

DRAWN

CITY THOMPSON, INC.
 CONSULTING ENGINEERS
 AND MATERIALS ENGINEERS
 1011 WEST 18TH AVENUE, CENTRAL COLORADO BLDG.
 DENVER, COLORADO

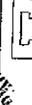
DATE: 10/22/51 DRAWN BY: J.M. CHECKED BY: J.M.
 JOB NO. SHEET OF



LEGEND
 ● INDICATES LOCATION OF FIELD DENSITY TESTS
 ○ INDICATES LOCATION OF FIELD PERMEABILITY TESTS

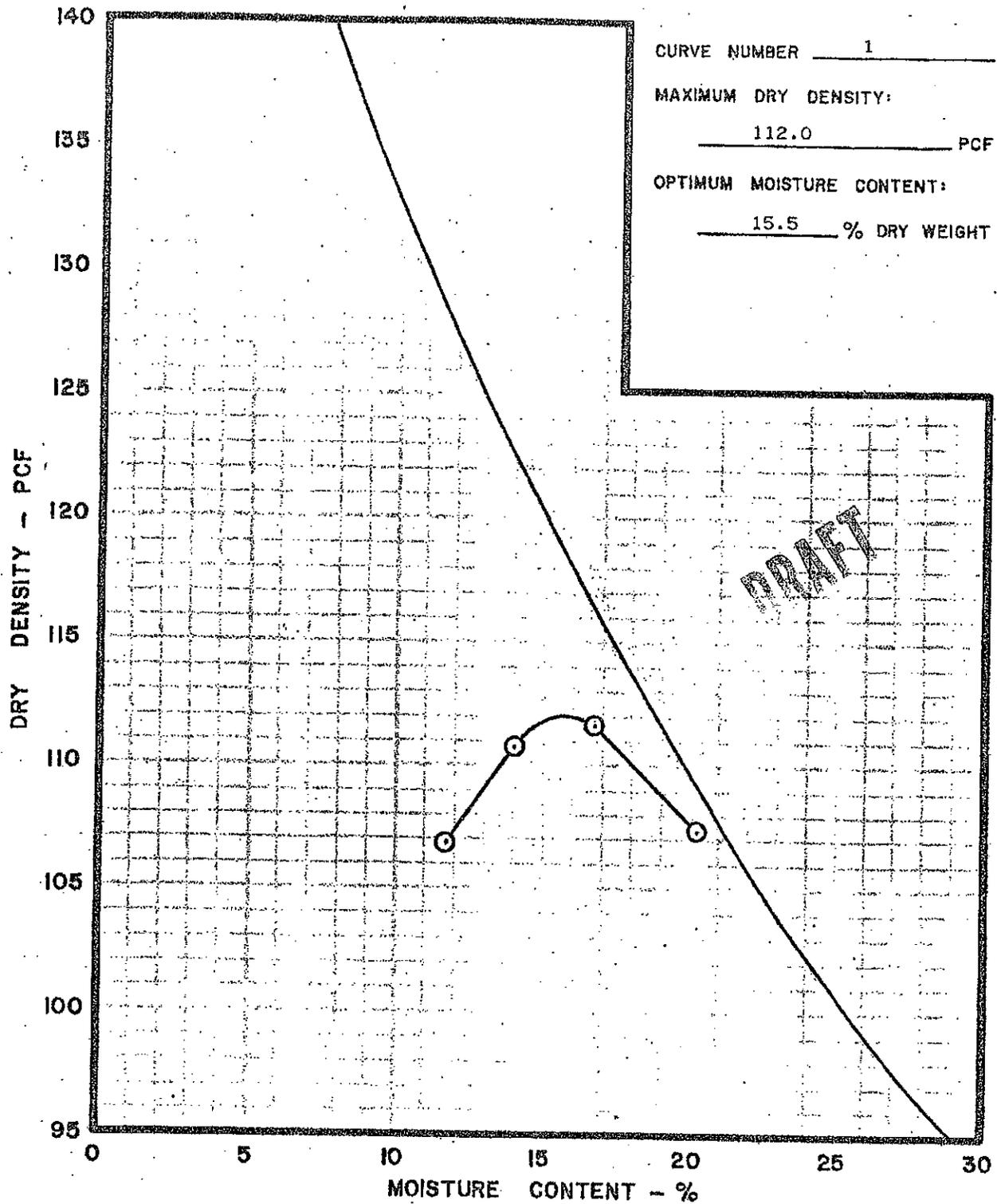
ATLANTIC RIM RESERVOIR
 RAWLINS, WYOMING

LOCATIONS OF FIELD DENSITY AND
 PERMEABILITY TESTS FOR
 CONSTRUCTION PERIOD



CTL/THOMPSON, INC.
 CONSULTING GEOTECHNICAL
 AND CIVIL ENGINEERS
 1821 WEST 10TH AVENUE, COLORADO SPRINGS
 COLORADO 80902

DATE: 10/15/84
 SHEET NO. 07



SAMPLE DESCRIPTION CLAY, SANDY, SILTY, BROWN

LOCATION TEST PIT NO. 8

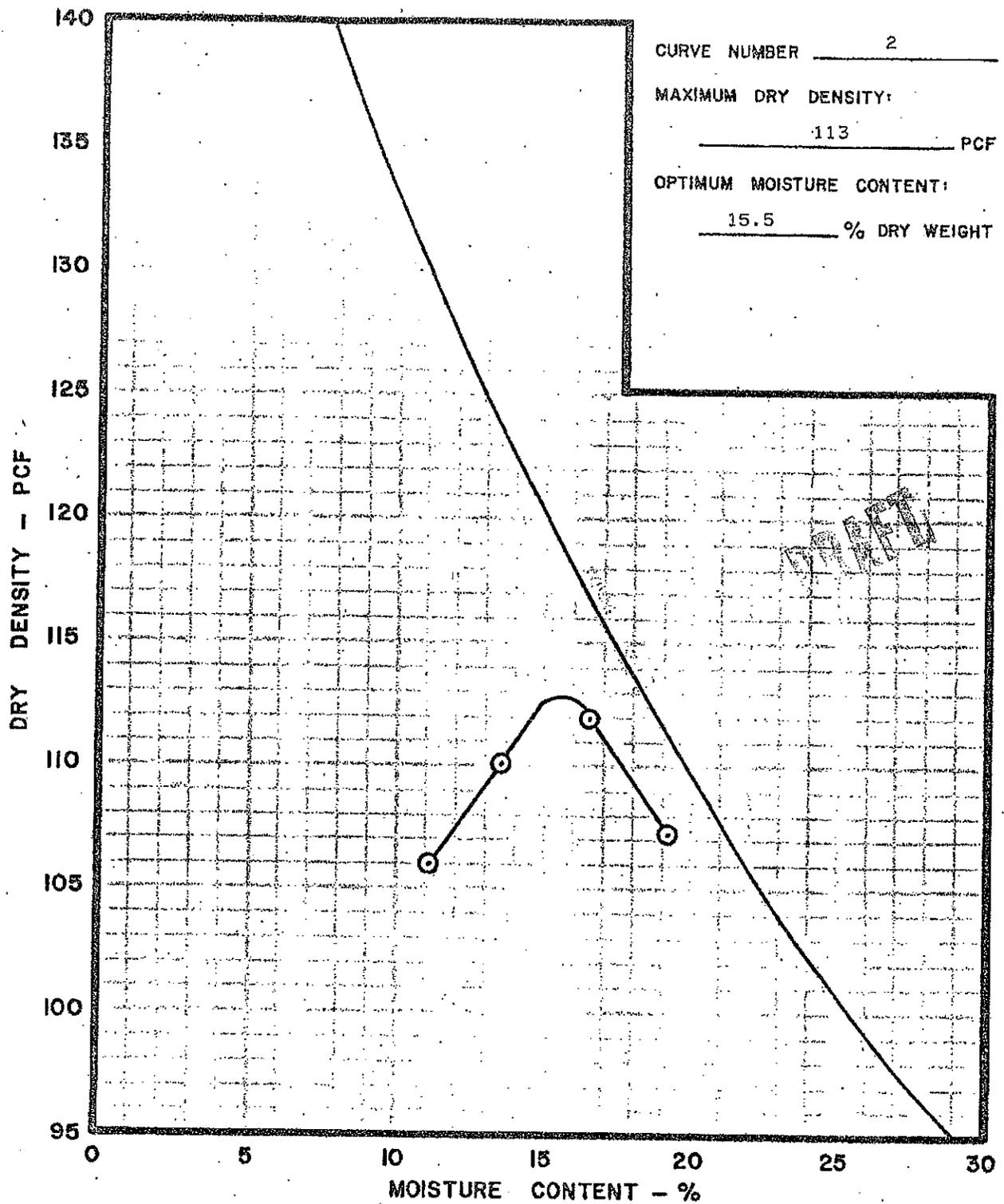
COMPACTION TEST PROCEDURE ASTM D 698-70, METHOD 'A'

LIQUID LIMIT 35.5 % PLASTICITY INDEX 14.1 %

GRAVEL _____ % SAND 12 % SILT & CLAY 88 %

JOB NO. 7170

COMPACTION TEST RESULTS



SAMPLE DESCRIPTION CLAY, VERY SILTY, VERY SANDY, BROWN, LIGHT BROWN

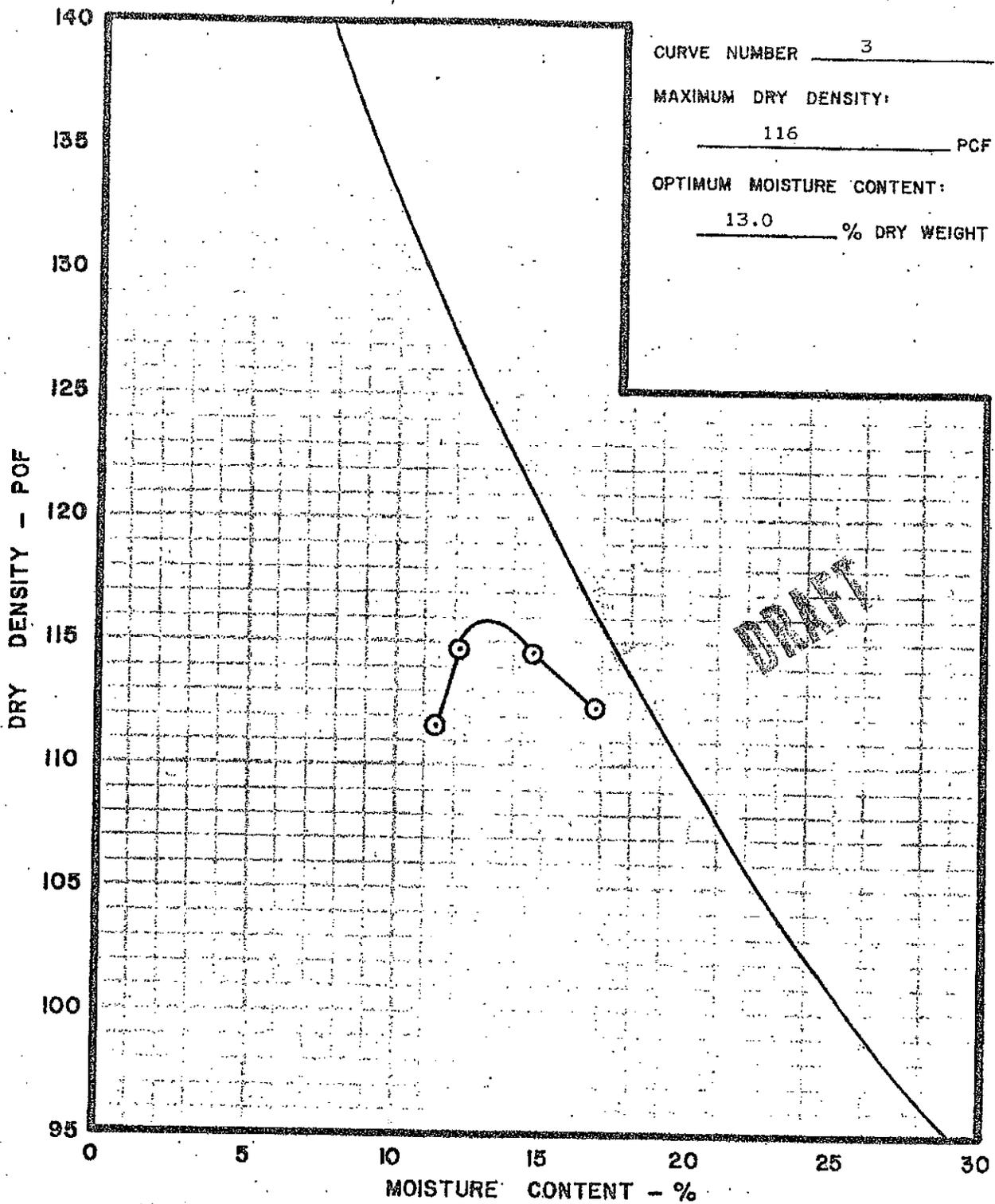
LOCATION STOCKPILE FROM FIRST CUT TO BEGIN PLACEMENT OF RESERVOIR LINING

COMPACTION TEST PROCEDURE ASTM D 698-70, METHOD 'A'

LIQUID LIMIT 25.0 % PLASTICITY INDEX 6.0 %

GRAVEL % SAND 41 % SILT & CLAY 59 %

COMPACTION TEST RESULTS



SAMPLE DESCRIPTION CLAY, SILTY, SANDY, BROWN

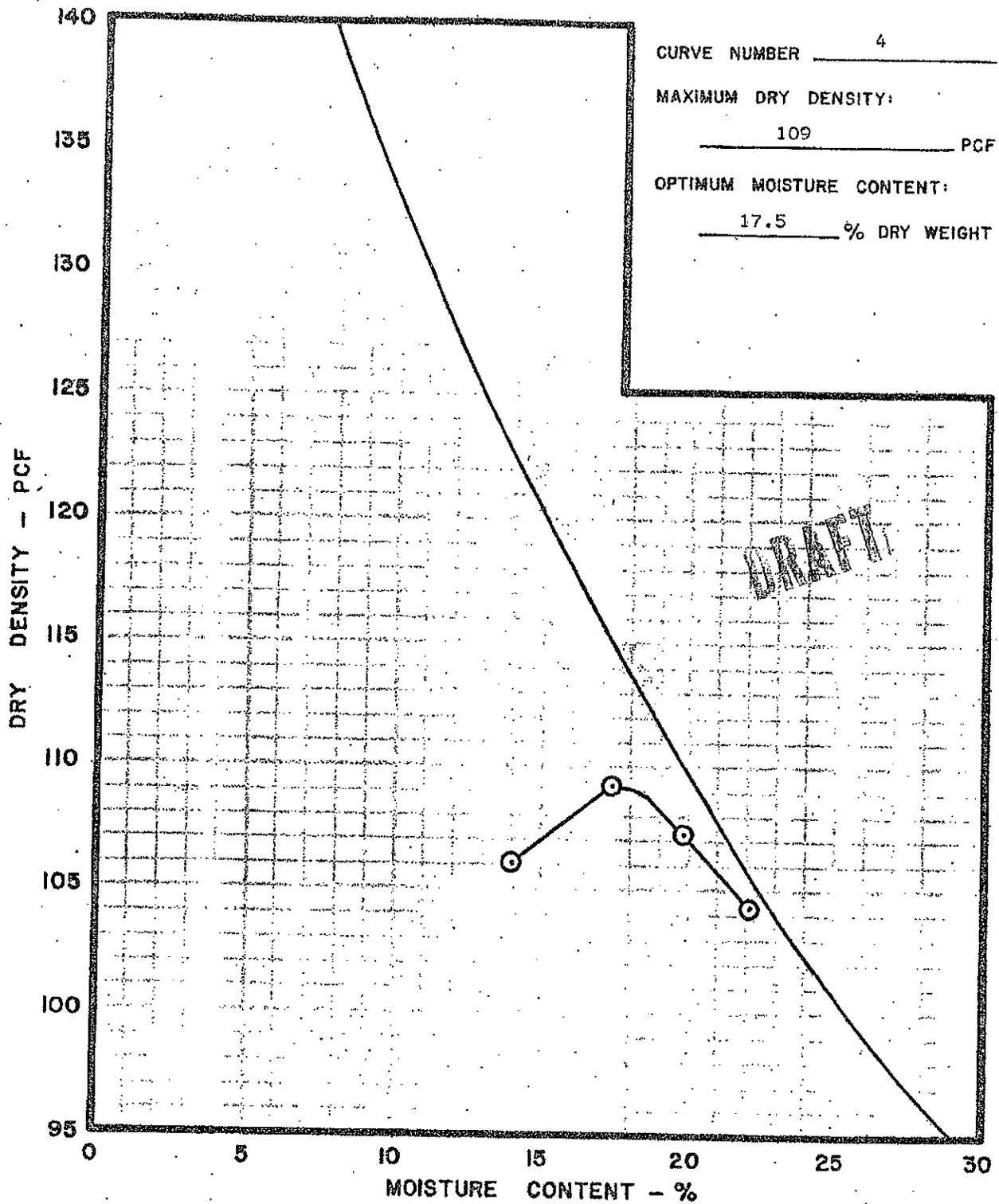
LOCATION STOCKPILE FROM FIRST CUT

COMPACTION TEST PROCEDURE ASTM D 698-70, METHOD 'A'

LIQUID LIMIT 27.2 % PLASTICITY INDEX 13.1 %

GRAVEL 0 % SAND 36 % SILT & CLAY 64 %

COMPACTION TEST RESULTS



SAMPLE DESCRIPTION CLAY, SLIGHTLY SILTY, SLIGHTLY SANDY, SULFATES, BROWN

LOCATION WEST HALF OF PONDING AREA FOR ATLANTIC RIM RESERVOIR

COMPACTION TEST PROCEDURE ASTM D 698-70, METHOD 'A'

LIQUID LIMIT 43.1 %

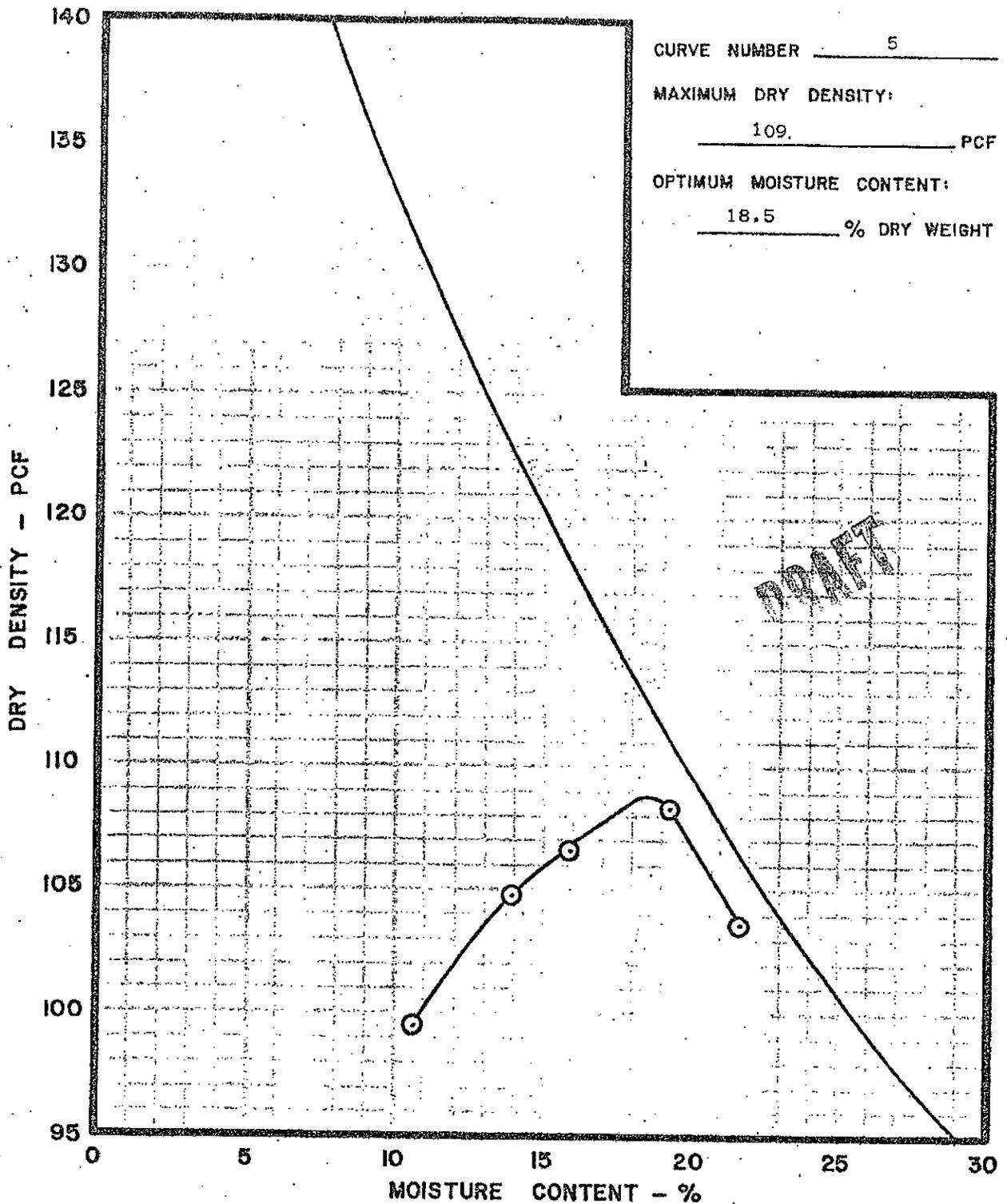
PLASTICITY INDEX 24.8 %

GRAVEL _____ %

SAND 11 %

SILT & CLAY 89 %

COMPACTION TEST RESULTS



SAMPLE DESCRIPTION CLAY, SANDY, SLIGHTLY SILTY, RED BROWN, BROWN

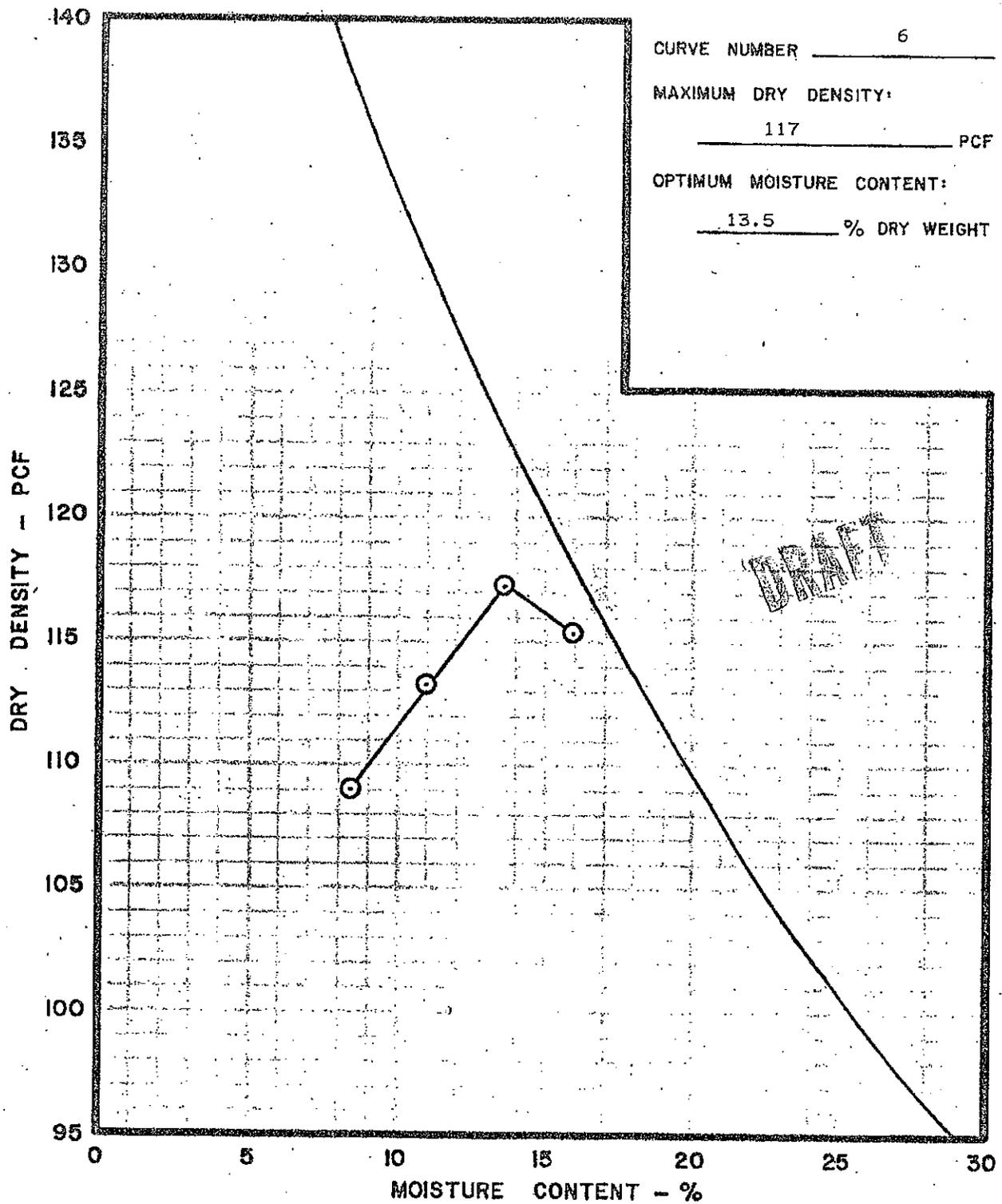
LOCATION INSIDE TOE BETWEEN STA 38+00 AND 40+00

COMPACTION TEST PROCEDURE ASTM D 698-70, METHOD 'A'

LIQUID LIMIT 37.0 % PLASTICITY INDEX 21.9 %

GRAVEL _____ % SAND 18 % SILT & CLAY 82 %

COMPACTION TEST RESULTS



SAMPLE DESCRIPTION CLAY, VERY SANDY, SILTY, BROWN (CL)

LOCATION TP-3

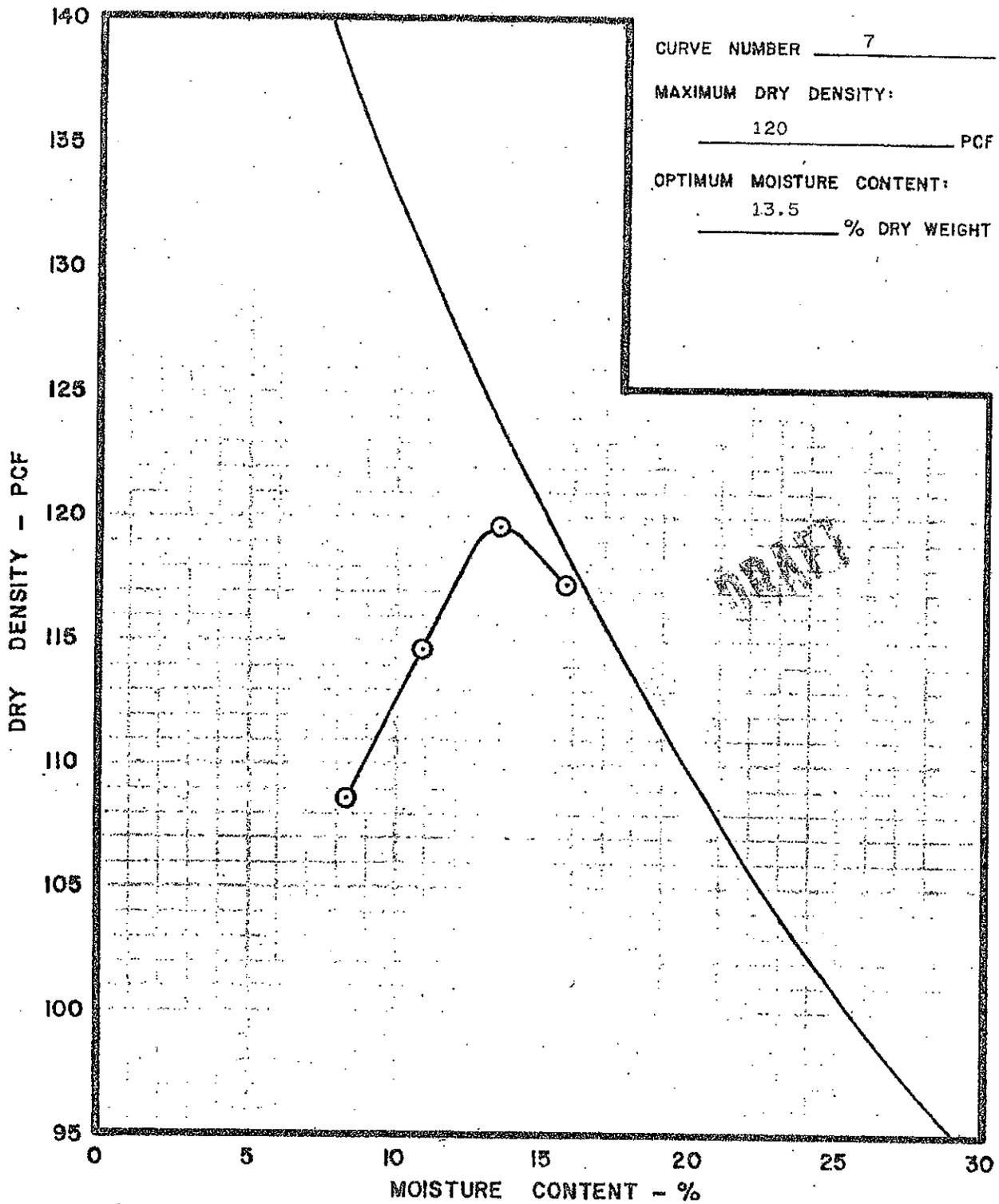
COMPACTION TEST PROCEDURE ASTM D 698-70, METHOD 'A'

LIQUID LIMIT 26.6 % PLASTICITY INDEX 12.0 %

GRAVEL _____ % SAND 35 % SILT & CLAY 65 %

COMPACTION TEST RESULTS

JOB NO. 7170



SAMPLE DESCRIPTION CLAY, VERY SANDY, SILTY, SULFATES, BROWN (CL)

LOCATION TP-1

COMPACTION TEST PROCEDURE ASTM D 698-70, METHOD 'A'

LIQUID LIMIT 26.3 % PLASTICITY INDEX 12.2 %

GRAVEL _____ % SAND 35 % SILT & CLAY 65 %

COMPACTION TEST RESULTS

SUMMARY OF FIELD DENSITY TESTS

TEST NO.	TEST DATE	TEST LOCATION	DEPTH OR ELEV. (FEET)	TEST TYPE	CURVE NO.	MAXIMUM DRY DENSITY (PCF)	OPTIMUM MOISTURE CONTENT (%)	FIELD DRY DENSITY (PCF)	FIELD MOISTURE CONTENT (%)	COMPAC. (%)	ACCURACY	SOIL DESCRIPTION
1	9/23	STA. 14+50 100' from inside toe of embankment	*1st lift	sand	3	116	13.0	118	14.9	100+	X	Clay, silty, sandy, CL
2	9/23	STA. 16+00 125' from inside toe of embankment	*1st lift	sand	3	116	13.0	113	15.8	97	X	Clay, silty, sandy, CL
3	9/23	STA. 17+50 150' from inside toe of embankment	*1st lift	sand	3	116	13.0	118	17.1	100H	X	Clay, silty, sandy, CL
4	9/25	STA. 15+00 100' from inside toe of embankment	*4th lift	sand	5	109	18.5	109	18.6	100	X	Clay, silty, sandy, CL
5	9/25	STA. 17+00 25' from inside toe of embankment	*4th lift	sand	5	109	18.5	112	17.9	100+	X	Clay, sandy, CL
6	9/30	STA. 32+00 40' from inside toe of embankment	*1st lift	sand	7	120	13.5	120	15.2	100	X	Clay, sandy, CL
7	9/30	STA. 30+00 40' from inside toe of embankment	*1st lift	sand	4	109	17.5	113	18.6	100+	X	Clay, silty, sandy, CL
8	9/30	STA. 19+00 40' from inside toe of embankment	*top lift	sand	6	117	13.5	114	16.8	97	X	Clay, slightly sandy, CL
9	9/30	STA. 20+00 40' from inside toe of embankment	*top lift	sand	7	120	13.5	124	13.9	100+	X	Clay, slightly sandy, CL
10	10/2	STA. 34+00 40' from inside toe of embankment	*top lift	sand	6	117	13.5	116	17.8	99	X	Clay, slightly sandy, CL
11	10/2	STA. 32+00 25' from inside toe of embankment	*top lift	sand	4	109	17.5	113	19.8	100+	X	Clay, slightly sandy, CL
12	10/2	STA. 30+00 30' from inside toe of embankment	*top lift	sand	7	120	13.5	119	16.8	99	X	Clay, slightly sandy, CL
13	10/6	STA. 30+00 140' from inside toe of embankment	*top lift	sand	4	109	17.5	108	19.2	95	X	Clay, slightly sandy, CL
14	10/6	STA. 32+50 140' from inside toe of embankment	*top lift	sand	4	109	17.5	108	18.2	99	X	Clay, slightly silty, slightly sandy, CL
15	10/6	STA. 34+50 140' from inside toe of embankment	*top lift	sand	4	109	17.5	111	19.7	100+	X	Clay, slightly silty, slightly sandy, CL
16	10/8	STA. 29+50 185' from inside toe of embankment	*top lift	sand	6	117	13.5	114	16.3	97	X	Clay, slightly silty, slightly sandy, CL
17	10/8	STA. 33+00 185' from inside toe of embankment	*top lift	sand	4	109	17.5	110	19.1	100+	X	Clay, slightly silty, slightly sandy, CL
18	10/8	STA. 34+00 185' from inside toe of embankment	*top lift	sand	6	117	13.5	114	20.0	97	X	Clay, slightly silty, slightly sandy, CL
19	10/10	STA. 39+00 25' from inside toe of embankment	*top lift	sand	4	109	17.5	113	15.7	100+	X	Clay, slightly silty, slightly sandy, CL
20	10/10	STA. 37+00 40' from inside toe of embankment	*top lift	sand	4	109	17.5	109	17.3	100	X	Clay, slightly silty, slightly sandy, CL
21	10/10	STA. 23+00 75' from inside toe of embankment	*top lift	sand	4	109	17.5	112	17.2	100+	X	Clay, slightly silty, slightly sandy, CL
22	10/10	STA. 21+00 150' from inside toe of embankment	*top lift	sand	4	109	17.5	113	16.3	100+	X	Clay, slightly silty, slightly sandy, CL
23	10/25	STA. 40+00 60' southeast of inside toe of embankment	*#1 foot	sand	6	117	13.5	112	17.7	95	X	Clay, silty, sandy, CL
24	10/25	STA. 43+00 60' southeast of inside toe of embankment	*#1 foot	sand	6	117	13.5	115	13.3	99	X	Clay, silty, sandy, CL
25	10/26	STA. 46+50 30' southeast of inside toe of embankment	*top lift	sand	4	109	17.5	111	16.8	100+	X	Clay, slightly silty, sandy, CL

NOTE:
 *Fill
 **Below final grade

JOB NO. 7170

N - INDICATES NUCLEAR GAGE TEST (ASTM D2922)
 S - INDICATES SAND CONE TEST (ASTM D1550)

DRAFT

SUMMARY OF FIELD DENSITY TESTS

TEST NO.	TEST DATE	TEST LOCATION	DEPTH OR ELEV. (FEET)	TEST TYPE	CURVE NO.	MAXIMUM DRY DENSITY (PCF)	OPTIMUM MOISTURE CONTENT (%)	FIELD DRY DENSITY (PCF)	FIELD MOISTURE CONTENT (%)	COMPAC. (%)	ACCEPT	SOIL DESCRIPTION
26	10/26	STA. 41+50 80' southeast of inside toe of embankment	*top lift	sand	4	109	17.5	111	17.9	100+	X	Clay, slightly silty, sandy, CL
27	10/26	STA. 43+00 30' southeast of inside toe of embankment	*top lift	sand	1	112	15.5	115	15.0	100+	X	Clay, very silty, CL
28	10/28	STA. 40+70 130' southeast of inside toe of embankment	*top lift	sand	6	117	13.5	113	16.7	97	X	Clay, sandy, CL
29	10/28	STA. 41+50 140' southeast of inside toe of embankment	*top lift	sand	6	117	13.5	117	13.2	100	X	Clay, sandy, CL
30	10/28	STA. 43+00 165' southeast of inside toe of embankment	*top lift	sand	6	117	13.5	119	14.1	100+	X	Clay, sandy, CL
31	10/29	STA. 40+00 175' southeast of inside toe of embankment	*top lift	sand	6	117	13.5	116	13.1	99	X	Clay, sandy, CL
32	10/29	STA. 40+7. 240' southeast of inside toe of embankment	*top lift	sand	6	117	13.5	114	15.7	97	X	Clay, sandy, CL
33	10/29	STA. 43+00 250' southeast of inside toe of embankment	*top lift	sand	6	117	13.5	113	16.1	97	X	Clay, sandy, CL
34	10/31	STA. 42+50 350' southeast of inside toe of embankment	*top lift	sand	5	109	18.5	103	18.4	94	X	Clay, silty, sandy, CL
35	10/31	STA. 39+50 350' southeast of inside toe of embankment	*top lift	sand	5	109	18.5	112	17.9	100+	X	Clay, silty, sandy, CL
36	11/1	Rebet of 34	*top lift	sand	5	109	18.5	110	18.3	100+	X	Clay, silty, sandy, CL
37	11/6	STA. 38+00 250' southeast of inside toe of embankment	**1 foot	sand	6	117	13.5	117	15.3	100	X	Clay, very silty, sandy, CL
38	11/6	STA. 36+50 220' southeast of inside toe of embankment	**1 foot	sand	7	120	13.5	123	13.5	100+	X	Clay, sandy, silty, CL
39	11/7	STA. 36+80 280' southeast of inside toe of embankment	*top lift	sand	6	117	13.5	116	15.2	99	X	Clay, very silty, sandy, CL
40	11/7	STA. 38+00 210' southeast of inside toe of embankment	*top lift	sand	4	109	17.5	111	16.2	100+	X	Clay, slightly sandy, silty, CL
41	11/8	STA. 48+00 25' south of inside toe of embankment	**1 foot	sand	4	109	17.5	109	16.2	100	X	Clay, slightly sandy, silty, CL
42	11/8	STA. 45+30 35' southeast of inside toe of embankment	**1 foot	sand	4	109	17.5	109	15.8	100	X	Clay, slightly sandy, silty, CL
43	11/8	STA. 46+00 140' southeast of inside toe of embankment	**1 foot	sand	4	109	17.5	112	17.7	100+	X	Clay, slightly sandy, silty, CL
44	11/9	STA. 44+75 110' southeast of inside toe of embankment	**1 foot	sand	5	109	18.5	111	20.8	100+	X	Clay, slightly sandy, silty, CL
45	11/9	STA. 49+00 100' south of inside toe of embankment	**1 foot	sand	5	109	18.5	113	20.6	100+	X	Clay, slightly sandy, silty, CL
46	11/10	STA. 50+00 40' south of inside toe of embankment	*top lift	sand	5	109	18.5	105	18.7	96	X	Clay, slightly sandy, silty, CL
47	11/10	STA. 51+75 40' south of inside toe of embankment	*top lift	sand	5	109	18.5	113	16.3	100+	X	Clay, slightly sandy, silty, CL
48	11/10	STA. 49+00 150' south of inside toe of embankment	*top lift	sand	5	109	18.5	110	18.7	100+	X	Clay, slightly sandy, silty, CL
49	11/10	STA. 45+00 180' southeast of inside toe of embankment	*top lift	sand	5	109	18.5	112	18.6	100+	X	Clay, slightly sandy, silty, CL
50	11/11	STA. 43+00 450' southeast of inside toe of embankment	*top lift	sand	7	120	13.5	119	15.0	99	X	Clay, silty, sandy, CL

* Fill

**Below final grade

NOTE:

N - INDICATES NUCLEAR GAGE TEST (ASTM D2922)

S - INDICATES SAND CONE TEST (ASTM D1558)

DRAFT

SUMMARY OF FIELD DENSITY TESTS

TEST NO.	TEST DATE	TEST LOCATION	DEPTH OR ELEV. (FEET)	TEST TYPE	CURVE NO.	MAXIMUM DRY DENSITY (PCF)	OPTIMUM MOISTURE CONTENT (%)	FIELD DRY DENSITY (PCF)	FIELD MOISTURE CONTENT (%)	COMPAC. (%)	ACCEPTANCE	SOIL DESCRIPTION
51	11/11	STA. 40+50 southeast of inside toe of embankment	*top lift	sand	7	120	13.5	126	13.2	100+	X	Clay, silty, sandy, CL
52	11/11	STA. 42+00 southeast of inside toe of embankment	**1 foot	sand	7	120	13.5	115	15.1	97	X	Clay, silty, sandy, CL
53	11/12	STA. 12+30 northwest of inside toe of embankment	*top lift	sand	7	120	13.5	116	16.7	97	X	Clay, silty, sandy, CL
54	11/12	STA. 14+00 northwest of inside toe of embankment	*top lift	sand	7	120	13.5	123	14.8	100+	X	Clay, silty, sandy, CL
55	11/12	STA. 12+30 northwest of inside toe of embankment	*top lift	sand	7	120	13.5	122	14.7	100+	X	Clay, silty, sandy, CL
56	11/13	STA. 49+50 230' south of inside toe of embankment	*top lift	sand	7	120	13.5	116	13.7	97	X	Clay, silty, sandy, CL
57	11/13	STA. 48+00 320' south of inside toe of embankment	*top lift	sand	7	120	13.5	116	15.5	97	X	Clay, silty, sandy, CL
58	11/14	STA. 49+00 300' south of inside toe of embankment	**1 foot	sand	7	120	13.5	109	13.0	91	X	Clay, silty, sandy, CL
59	11/14	STA. 50+00 280' south of inside toe of embankment	**1 foot	sand	7	120	13.5	121	12.5	100+	X	Clay, silty, sandy, CL
60	11/14	STA. 48+50 380' south of inside toe of embankment	**1 foot	sand	7	120	13.5	112	13.8	94	X	Clay, silty, sandy, CL
61	11/17	Resteet of 58	**1 foot	sand	1	112	15.5	109	17.7	97	X	Clay, very silty, sandy, CL
62	11/17	Resteet of 60	**1 foot	sand	1	112	15.5	115	16.1	100+	X	Clay, very silty, sandy, CL
63	11/17	STA. 49+00 430' south of inside toe of embankment	*top lift	sand	1	112	15.5	112	17.9	100	X	Clay, very silty, sandy, CL
64	11/17	STA. 50+50 340' south of inside toe of embankment	*top lift	sand	1	112	15.5	112	15.6	100	X	Clay, very silty, sandy, CL
65	11/18	STA. 6+60 40' northwest of inside toe of embankment	*top lift	sand	1	112	15.5	107	21.1	96	X	Clay, very silty, sandy, CL
66	11/18	STA. 5+20 100' northwest of inside toe of embankment	*top lift	sand	1	112	15.5	113	16.7	100+	X	Clay, very silty, sandy, CL
67	11/19	STA. 3+50 80' northwest of inside toe of embankment	*top lift	sand	1	112	15.5	112	17.6	100	X	Clay, very silty, sandy, CL
68	11/19	STA. 0+80 80' northwest of inside toe of embankment	*top lift	sand	7	120	13.5	120	13.4	100	X	Clay, sandy, silty, CL
69	11/20	STA. 2+30 170' west of inside toe of embankment	**1 foot	sand	1	112	15.5	107	18.7	96	X	Clay, very silty, sandy, CL
70	11/20	STA. 1+90 170' west of inside toe of embankment	*top lift	sand	1	112	15.5	115	16.4	100+	X	Clay, very silty, sandy, CL
71	11/20	STA. 0+40 220' west of inside toe of embankment	*top lift	sand	7	120	13.5	119	15.7	95	X	Clay, sandy, silty, CL

JOB NO. 7170
 NOTE:
 N - INDICATES NUCLEAR GAGE TEST (ASTM D2922)
 S - INDICATES SAND CONE TEST (ASTM D1556)
 * FILL
 **Below final grade
 SHEET NO. 3

APPENDIX B.3

SLURRY TRENCH PLAN

ATLANTIC RIM RESERVOIR

FOR THE

CITY OF RAWLINS

IN

CARBON COUNTY, WYOMING

SEPTEMBER, 1981

PREPARED UNDER THE SUPERVISION OF

Robert W. Thompson
ROBERT W. THOMPSON, P.E.

10/1/81
DATE



CTL/THOMPSON, INC.

1011 WEST 15TH AVENUE - DENVER, COLORADO

JOB NO. 7454

APPROVED FOR THE CITY OF RAWLINS

JAMES GARNER, CITY ENGINEER
DATE

APPENDIX C

GEOTECHNICAL INVESTIGATIONS

- C.1 CTL/THOMPSON BORING LOGS - 1980 AND 1981
- C.2 GANNETT FLEMING TEST PIT LOGS - 2006

APPENDIX C.1

CTL/THOMPSON BORING LOGS - 1980 AND 1981

LEGEND



FILL, CLAY, SANDY, VERY STIFF, MOIST, BROWN, DARK-BROWN



CLAY, SLIGHTLY SANDY TO VERY SANDY, WITH LENSES OF CLAYEY SAND, SOFT TO VERY STIFF, MOIST TO VERY MOIST, BROWN, DARK BROWN (CL, CH)



SAND, CLAYEY WITH LENSES OF SANDY CLAY, SOFT TO STIFF, VERY MOIST TO WET, FINE TO COARSE GRAIN SIZES, TAN, BROWN (SC, SP-SG)



SAND, SILTY, WITH LENSES OF SANDY CLAY, MEDIUM DENSE, VERY MOIST TO WET, FINE TO COARSE GRAIN SIZES, BROWN (SM, SP-SM)



WEATHERED BEDROCK, CLAYSTONE, SILTY, SANDY, MEDIUM HARD, MOIST TO VERY MOIST, OCCASIONAL ROOTS, BROWN, GRAY-BROWN



BEDROCK CLAYSTONE, OCCASIONAL SANDSTONE LENSES, SLIGHTLY SILTY TO SILTY, MEDIUM HARD TO VERY HARD, MOIST TO VERY MOIST, BLOCKY, SULFATES AND SOLUBLE SALTS, BROWN, GRAY-BROWN, DARK GRAY-BROWN



BEDROCK SANDSTONE, CLAYEY, SILTY, HARD TO VERY HARD, DRY TO SLIGHTLY MOIST, TAN

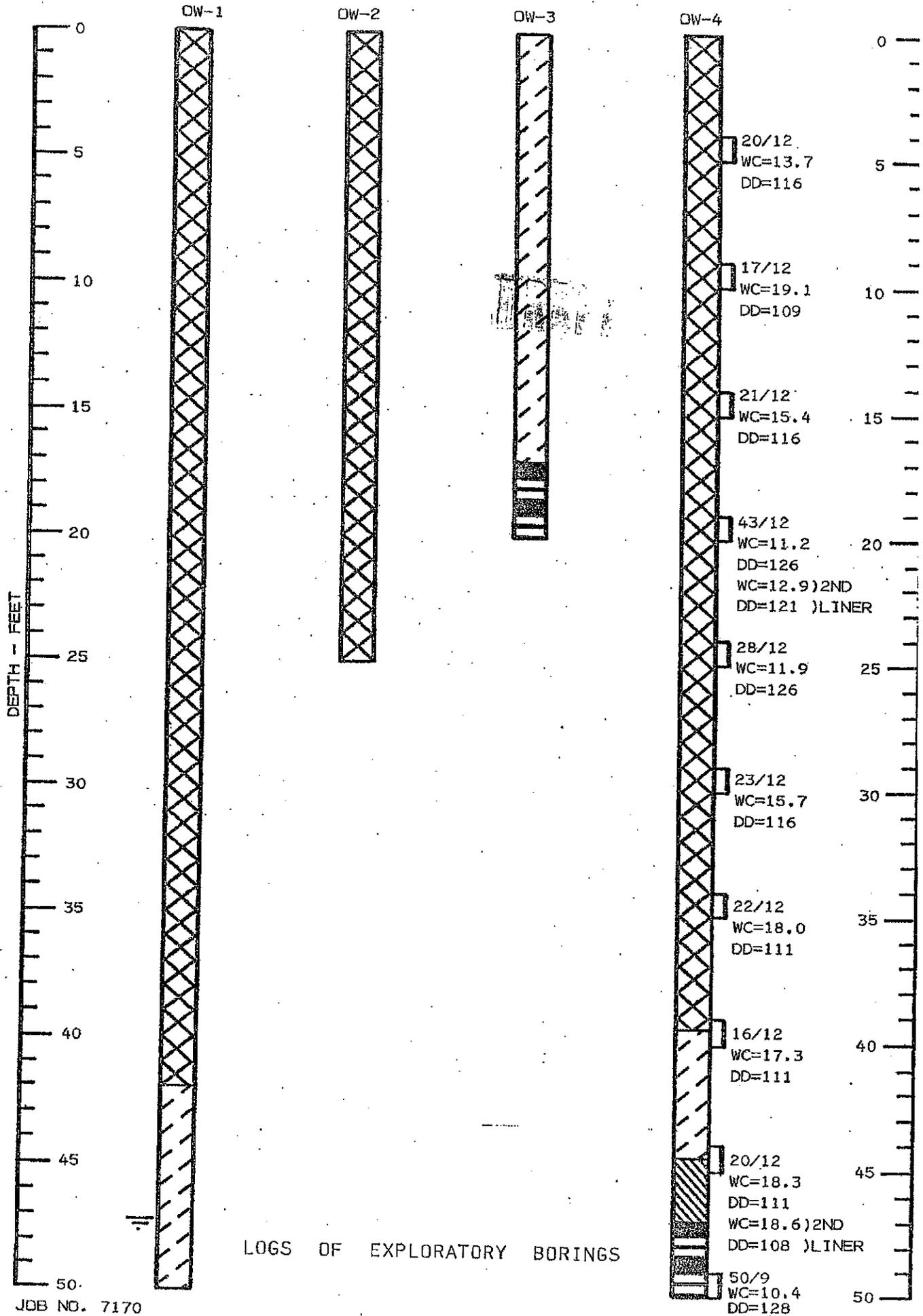


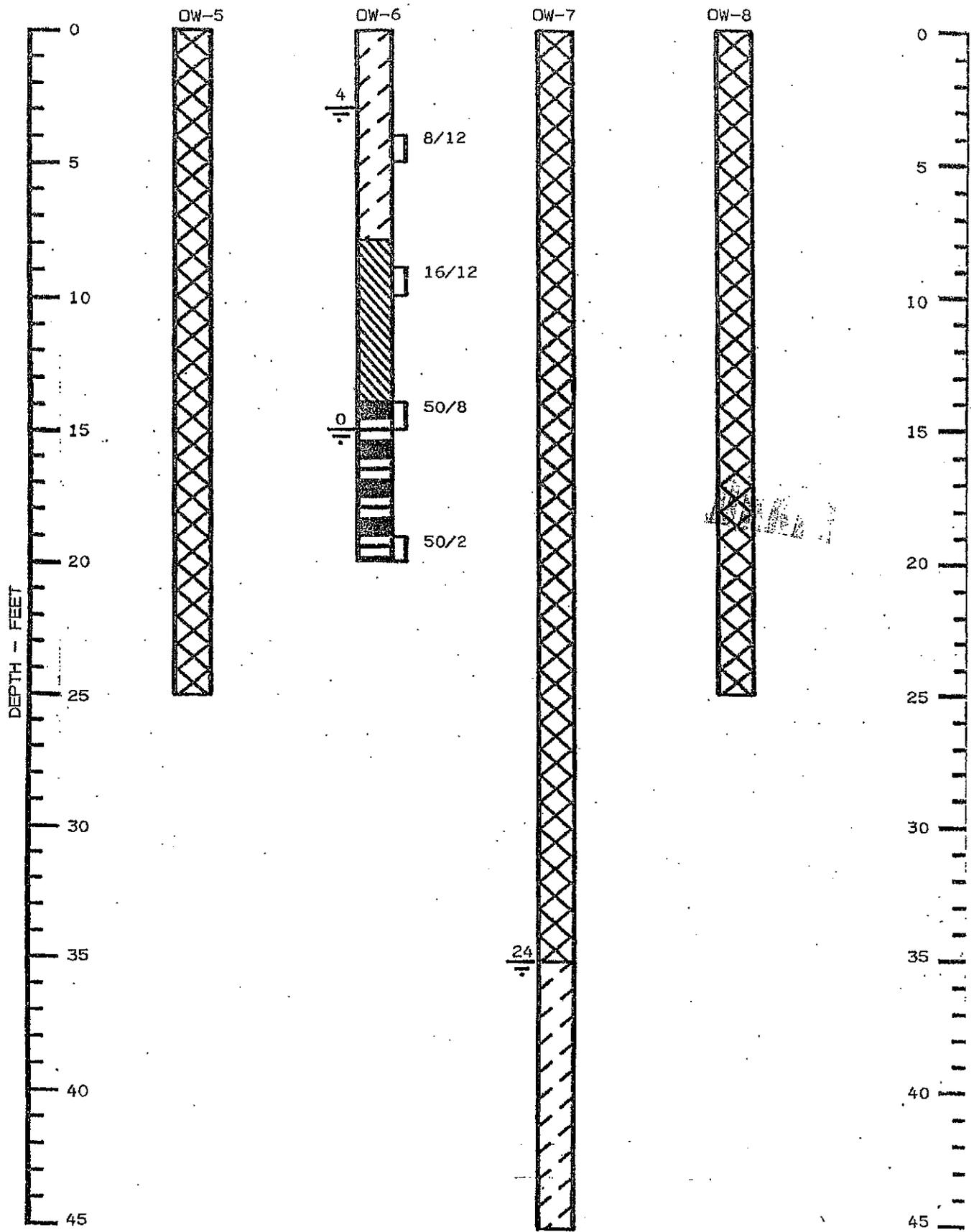
 DRIVE SAMPLE. THE SYMBOL 20/12 INDICATES THAT 20 BLOWS OF A 140-LB. HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5 INCH O.D. SAMPLER 12 INCHES.

 DRIVE SAMPLE. THE SYMBOL 16/12 INDICATES THAT 16 BLOWS OF A 140-LB. HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.0 INCH O.D. SAMPLER 12 INCHES.

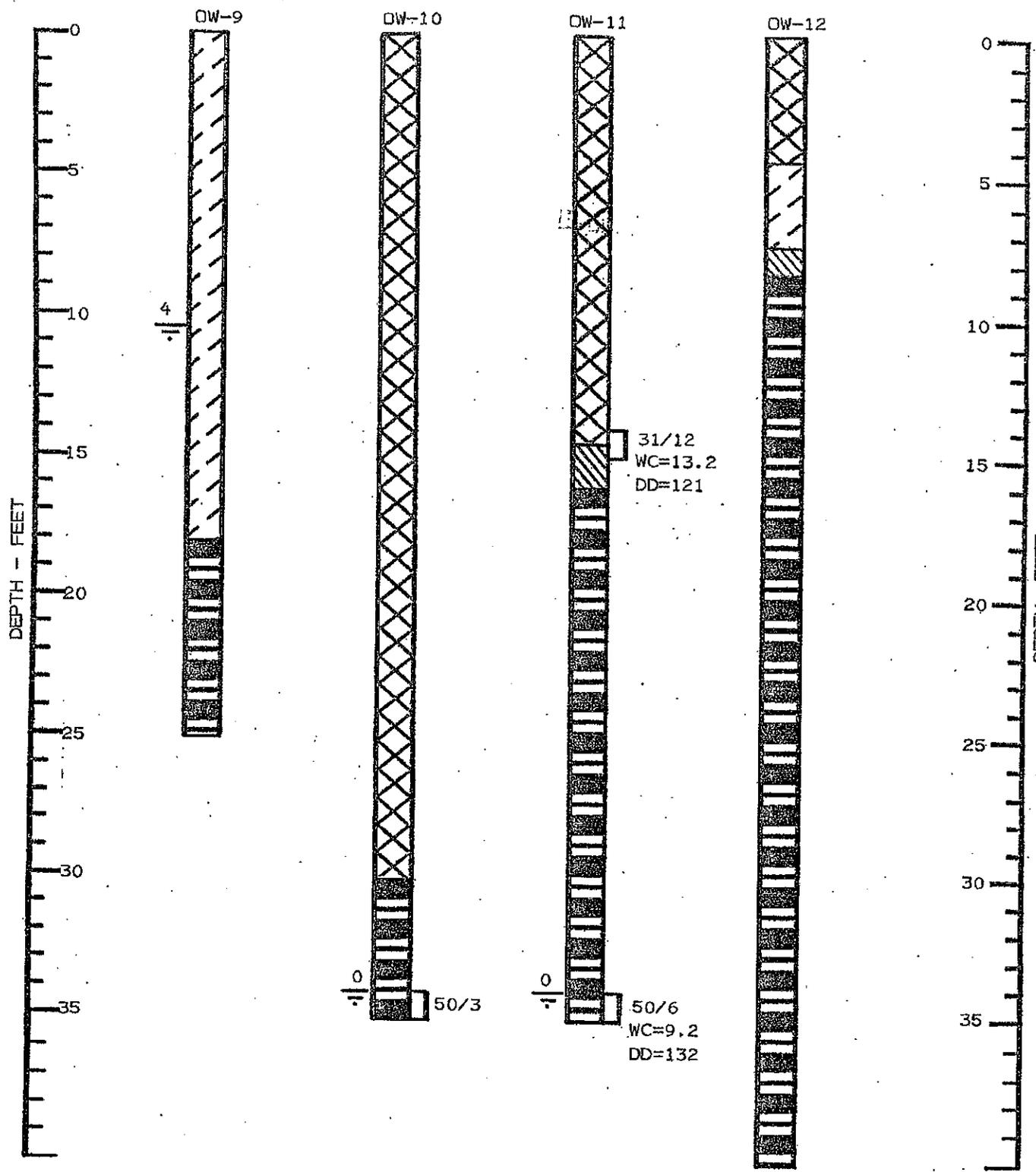
NOTES:

1. EXPLORATORY BORINGS WERE DRILLED AUG. 5&6, 1980; 5/5,7,8,9 & 6/17, 1981 USING A 4-INCH DIAMETER CONTINUOUS FLIGHT POWER AUGER. EXPLORATORY BORINGS WERE DRILLED MAY 19, 20, AND 21, 1981 USING A POST-HOLE AUGER.
2. THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS AND CONCLUSIONS AS CONTAINED IN THIS REPORT.
3. ELEVATIONS OF BORINGS OBTAINED BY SURVEYING FROM KNOWN PHYSICAL FEATURES ON DAM
4. WC INDICATES NATURAL MOISTURE CONTENT (%)
DD INDICATES DRY DENSITY (PCF)
-200 INDICATES PERCENT PASSING THE NO. 200 SIEVE
PI INDICATES PLASTICITY INDEX (%)
LL INDICATES LIQUID LIMIT (%)
UC INDICATES UNCONFINED COMPRESSIVE STRENGTH (PSF)
SS INDICATES SOLUBLE SULFATES (PPM)

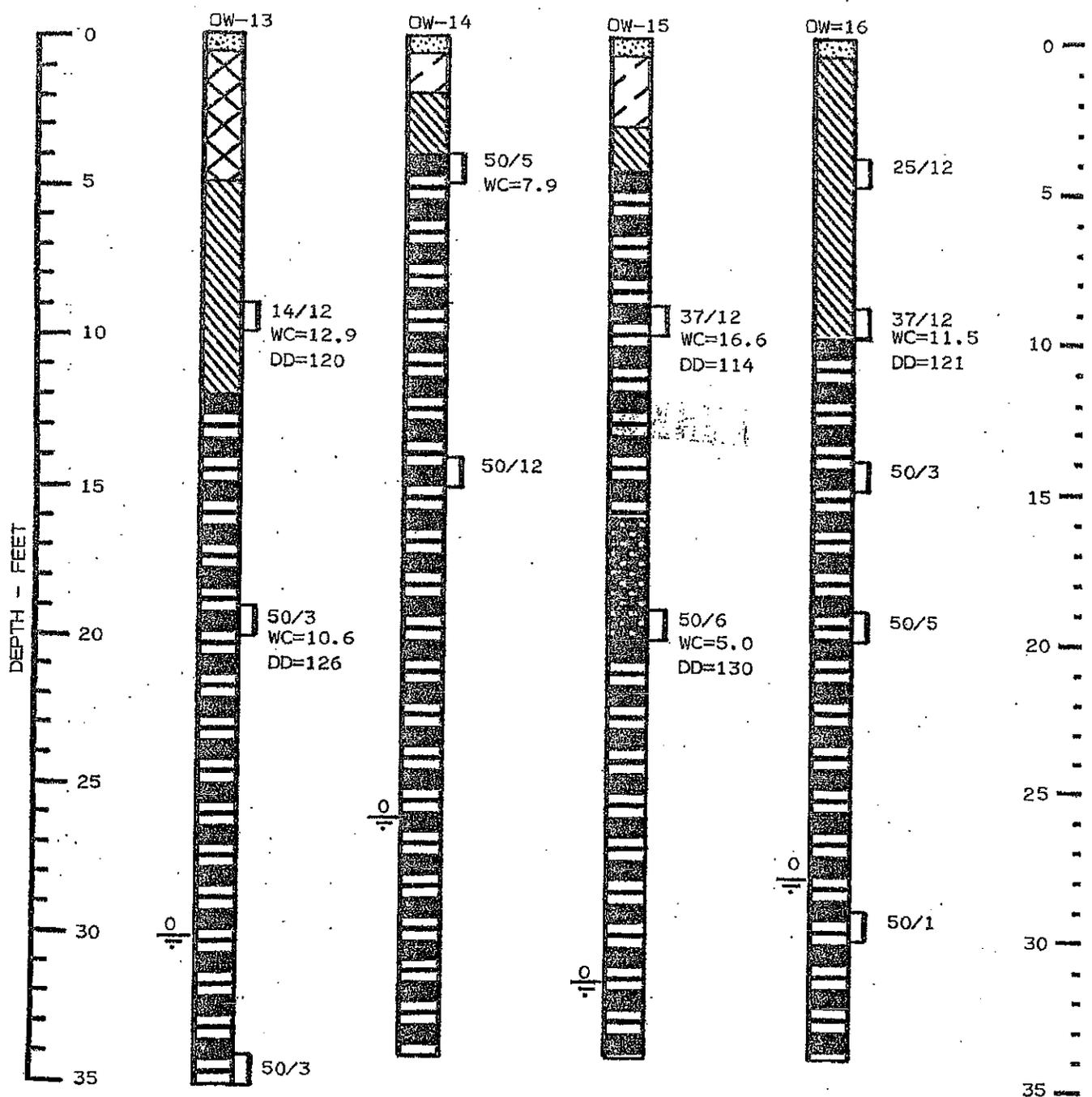




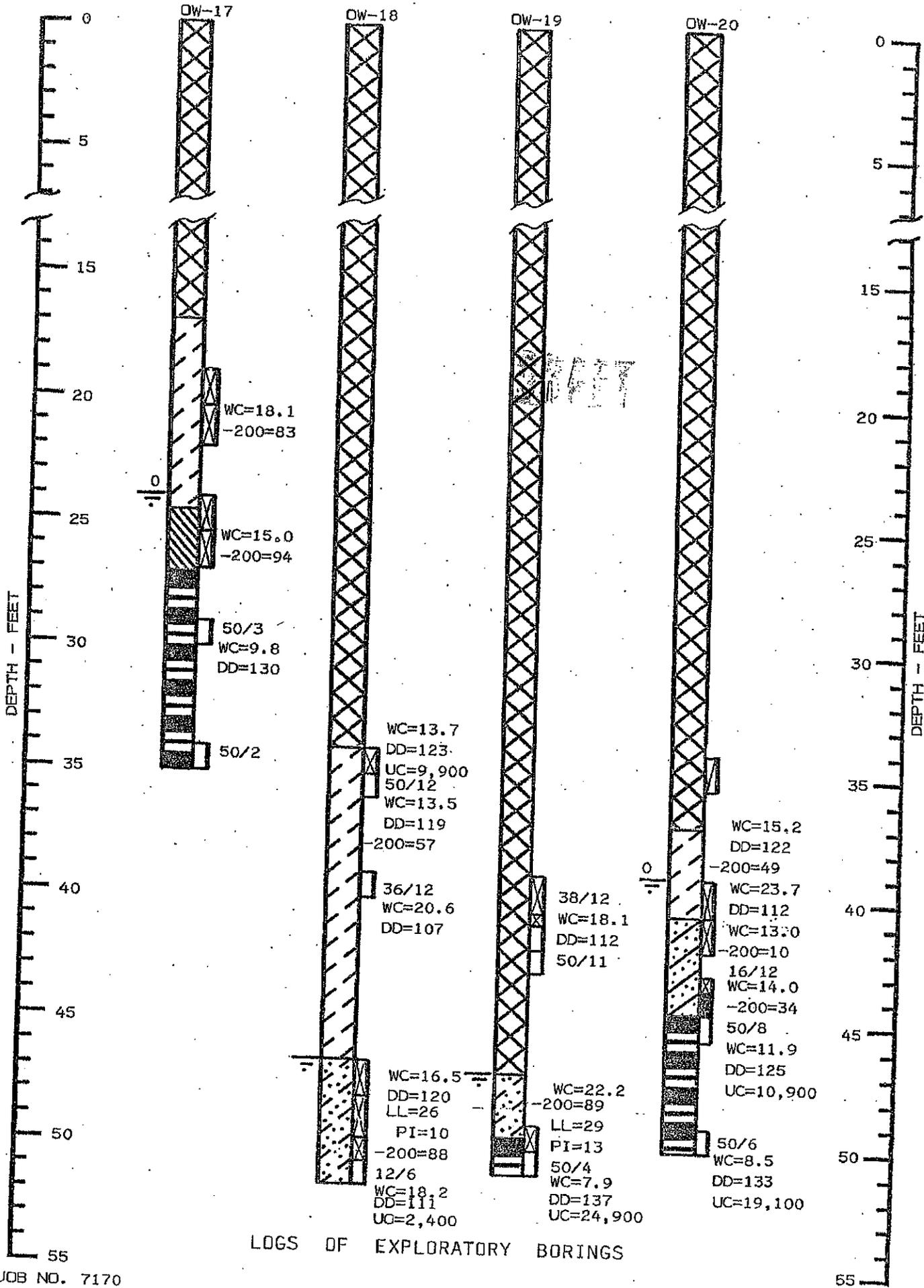
LOGS OF EXPLORATORY BORINGS

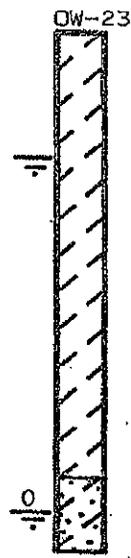
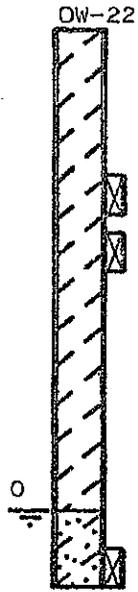


LOGS OF EXPLORATORY BORINGS

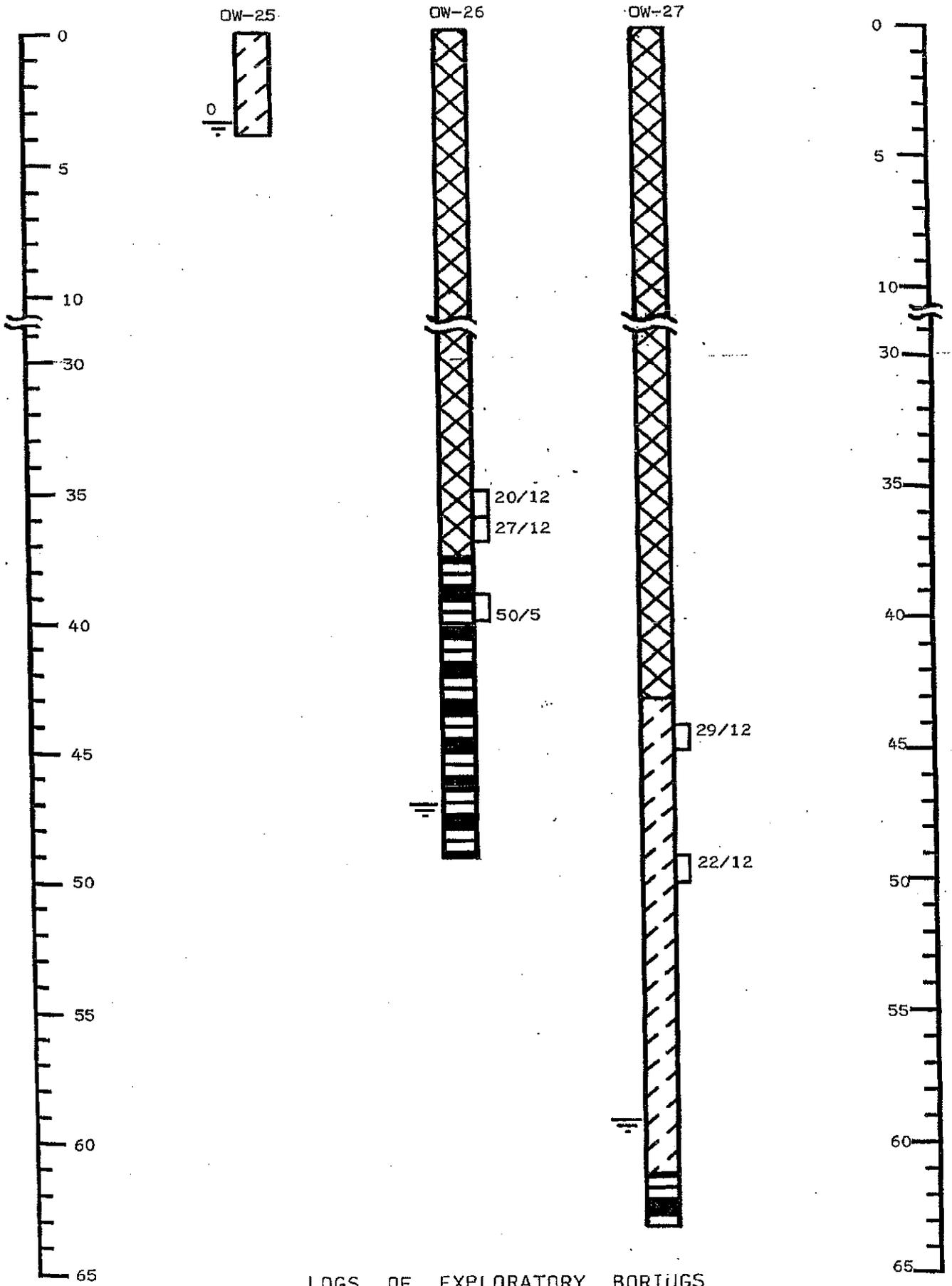


LOGS OF EXPLORATORY BORINGS





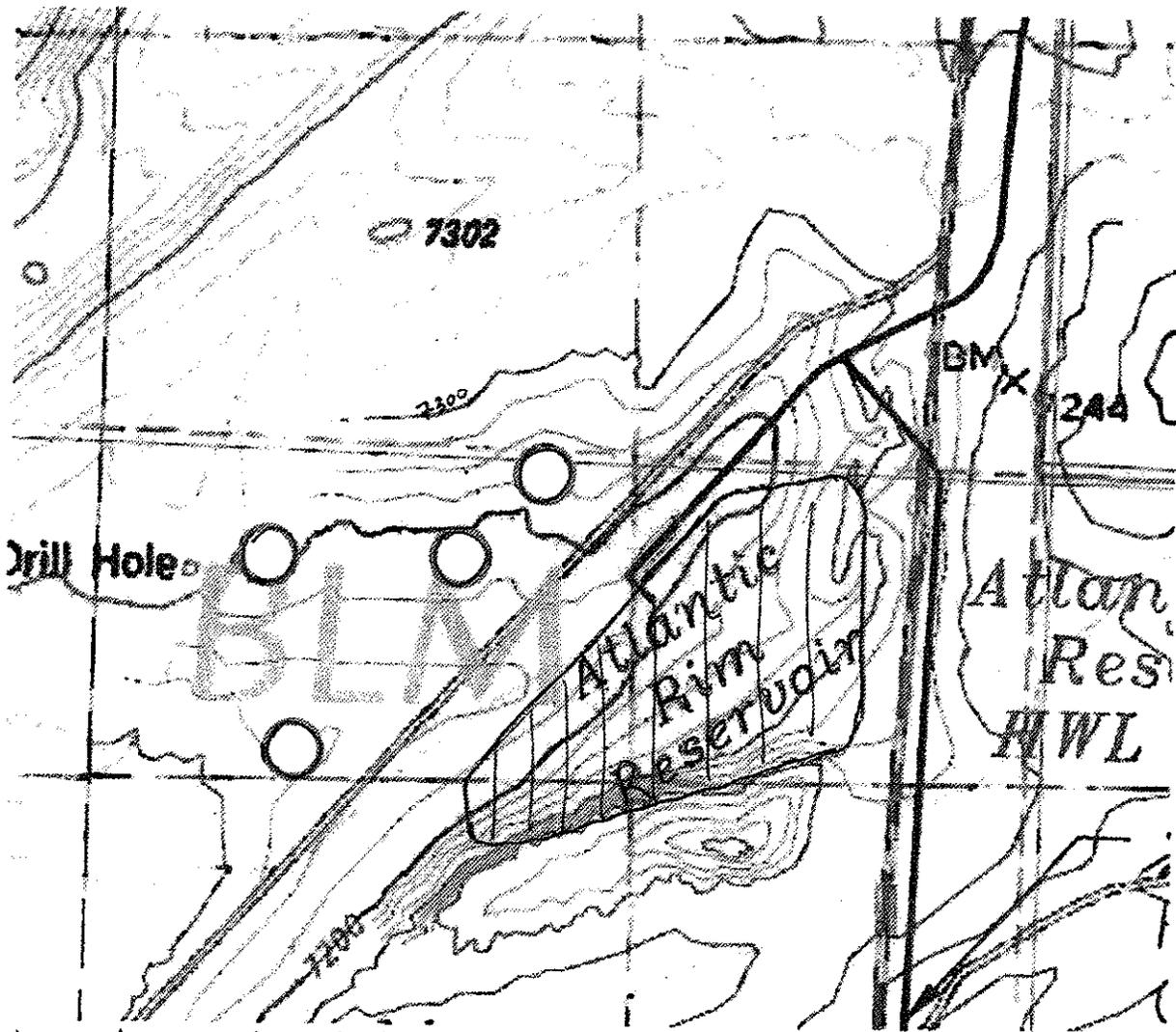
LOGS OF EXPLORATORY BORINGS



LOGS OF EXPLORATORY BORINGS

APPENDIX C.2

GANNETT FLEMING TEST PIT LOGS - 2006



Approximate scale: 1 inch = 1600 feet

○ Proposed Test Pit Locations

T20 R88 S 14

Date Started: 05-24-06
 Date Finished: 05-24-06
 Total Depth of Pit: 10.0 Ft.



Test Pit No.: 3
 Sheet 1 of 1
 Line & Station: --

Inspector: Jessica Humble, EIT, GIT

Project: City of Rawlins - Atlantic Rim Clay Liner Borrow

Offset: --

Photographic Log: Yes No

Excavation Contractor: A & D OilField Dozers, Inc.

N Coordinate:

Groundwater Observations
 Not Encountered

Operator: Wade Burichka

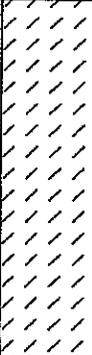
E Coordinate:

Excavation Equipment: CAT E200B

Surface Elevation: 7198.0 Ft.

Depth (Ft.)	Sample No.	Legend	Description of Materials	Remarks
0				
1.0 - 2.0	B-3		Lean clay with sand, residual, brown, moist, medium plasticity, medium dry strength, % dispersion = 25	6" - 2' Considerable concentration of evaporites
2.5			Thin lenses of clay containing evaporites throughout Moisture content = 10.2%	
5				
7.5				
10			Bottom of Test Pit = 10.0 Feet	El. 7188.0'
12.5				
15				
17.5				
20				
22.5				
25				
27.5				
30				
32.5				
35				

Remarks:

Date Started: 05-24-06		 Gannett Fleming ENGINEERS AND PLANNERS		Test Pit No.: 4	
Date Finished: 05-24-06				Sheet 1 of 1	
Total Depth of Pit: 10.0 Ft.				Line & Station: --	
Inspector: Jessica Humble, EIT, GIT		Project: City of Rawlins - Atlantic Rim Clay Liner Borrow		Offset: --	
Photographic Log: Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>		Excavation Contractor: A & D OilField Dozers, Inc.		N Coordinate:	
Groundwater Observations Not Encountered		Operator: Wade Burichka		E Coordinate:	
		Excavation Equipment: CAT E200B		Surface Elevation: 7208.0 Ft.	
Depth (Ft.)	Sample No.	Legend	Description of Materials	Remarks	
0			Sandy silty clay, residual, brown, moist, medium plasticity, medium dry strength	1' - 3' Considerable concentration of evaporites	0
2.5			Thin lenses of clay containing evaporites throughout		2.5
4.0 - 5.0	B-4A		Water content = 10.9%		5
6.0 - 8.0	B-4B		Maximum Dry Density = 117.5 pcf, OMC = 12%		7.5
10			Bottom of Test Pit = 10.0 Feet		El. 7198.0'
12.5					12.5
15					15
17.5					17.5
20					20
22.5					22.5
25					25
27.5					27.5
30					30
32.5					32.5
35					35
Remarks:					

APPENDIX D

LABORATORY TEST RESULTS

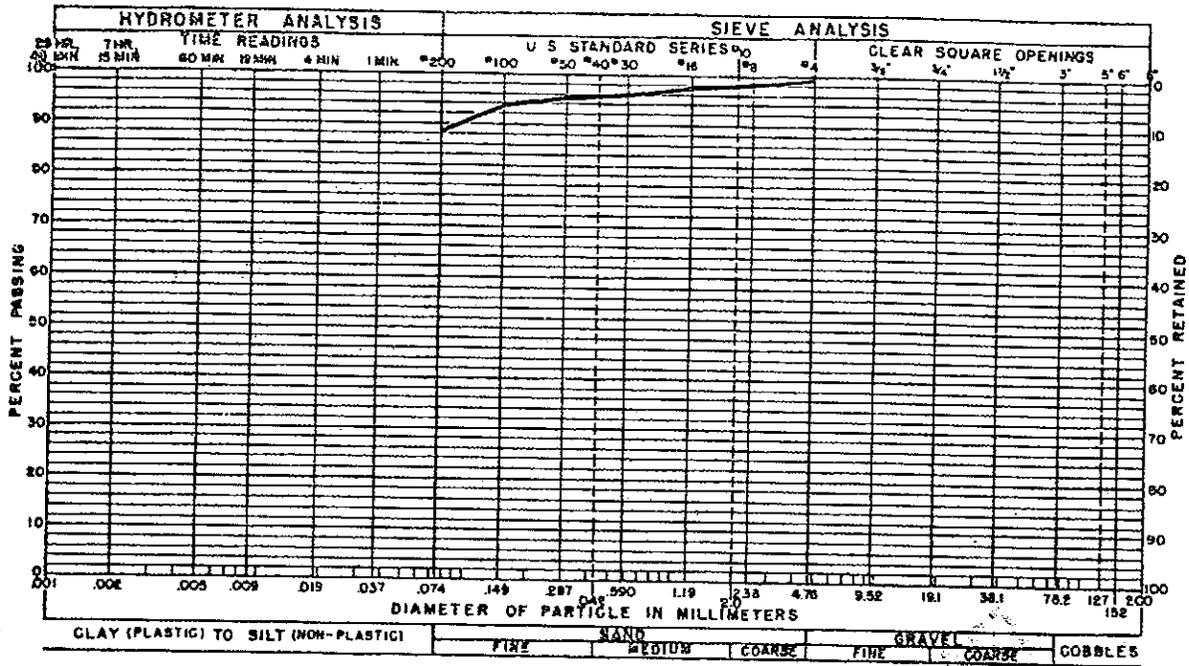
- D.1 CTL/THOMPSON - 1980 AND 1981
- D.2 GANNETT FLEMING - 2006

APPENDIX D.1

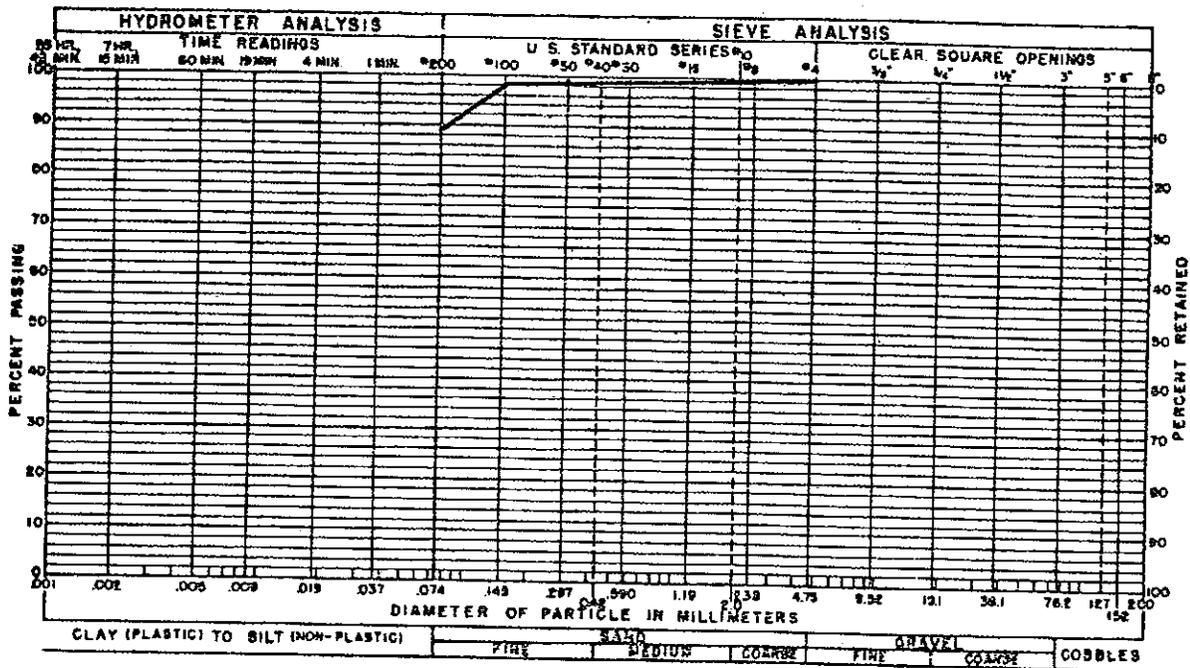
CTL/THOMPSON - 1980 AND 1981

TABLE I
SUMMARY OF LABORATORY TEST RESULTS

HOLE	DEPTH (FEET)	NATURAL MOISTURE (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	TRIAxIAL SHEAR TESTS		PASSING NO. 200 SIEVE (%)	SOIL TYPE
				LIQUID LIMIT (%)	PLASTICITY INDEX (%)		DEVIATOR STRESS (PSF)	CONFINING PRESSURE (PSF)		
4	4	13.7	116							FILL, CLAY, SANDY (CL)
	9	19.1	109							FILL, CLAY, SANDY (CL)
	14	15.4	116							FILL, CLAY, SANDY (CL)
	19	11.2	126							FILL, CLAY, SANDY (CL)
	19	12.9	121							FILL, CLAY, SANDY (CL)
	24	11.9	126							FILL, CLAY, SANDY (CL)
	29	15.7	116							FILL, CLAY, SANDY (CL)
	34	18.0	111							FILL, CLAY, SANDY (CL)
	39	17.3	111							FILL, CLAY, SANDY (CL)
	44	18.3	111							FILL, CLAY, SANDY (CL)
	44	18.6	108							CLAY, SANDY (CL)
	49	10.4	128							CLAY, SANDY (CL)
10	34	11.0	126							CLAYSTONE
11	14	13.2	121							CLAYSTONE
11	14	15.2	117							FILL, CLAY, SANDY (CL)
11	34	9.2	132							WEATHERED CLAYSTONE
13	9	12.9	120							CLAYSTONE
13	19	10.6	126							WEATHERED CLAYSTONE
14	4	7.9								CLAYSTONE
15	9	16.6	114							CLAYSTONE
15	19	5.0	130							CLAYSTONE
16	4	11.2	118	29	15				79	CLAYSTONE
16	9	11.5	121							WEATHERED CLAYSTONE



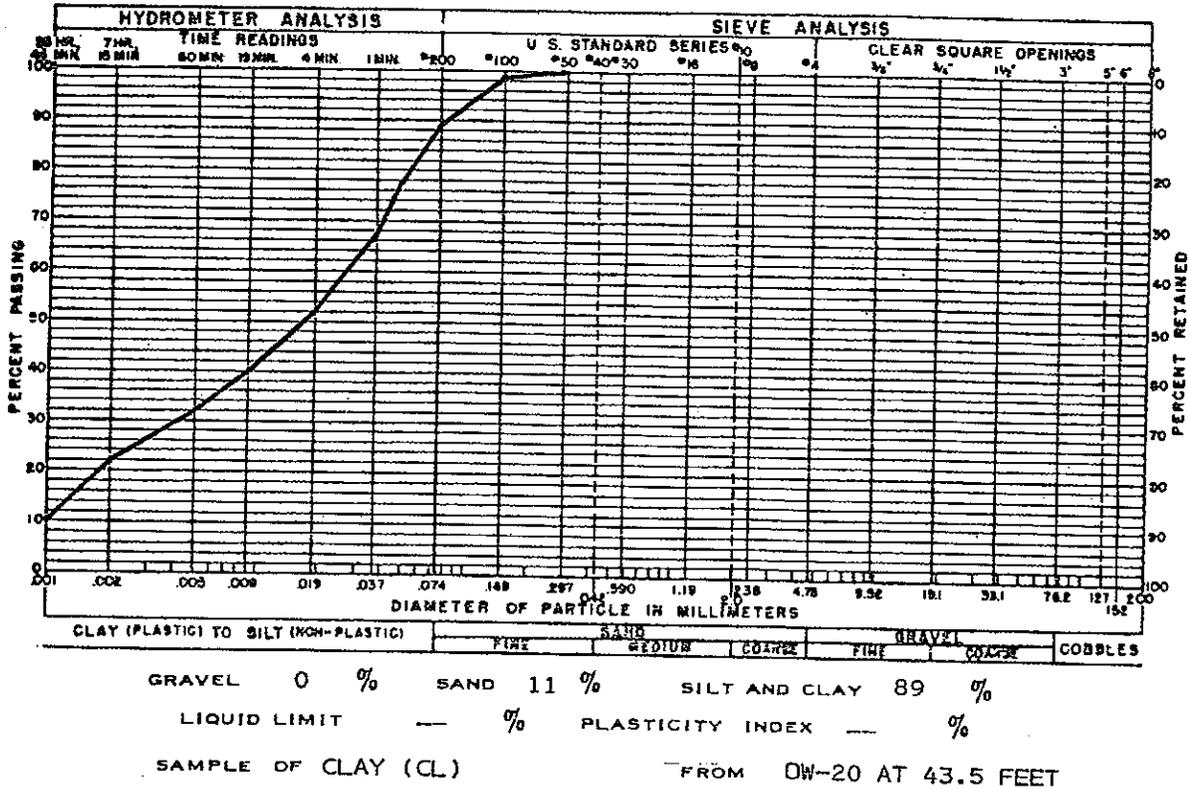
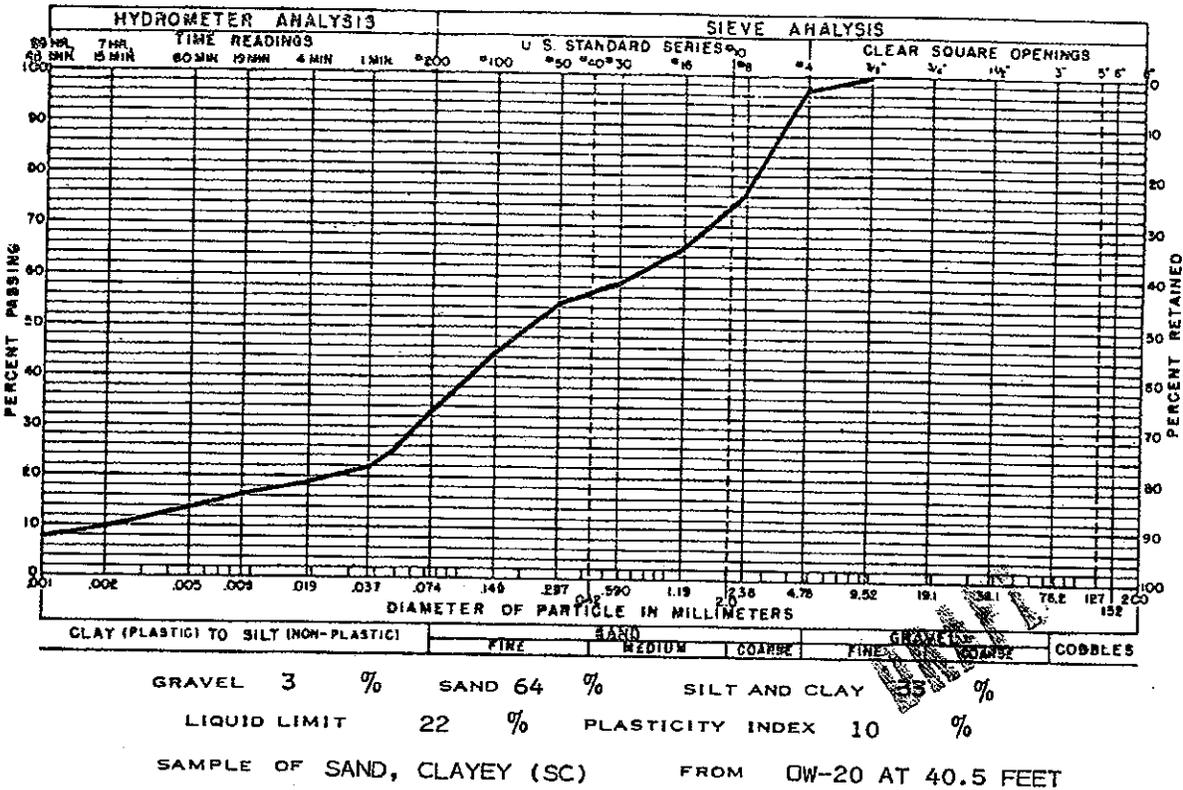
GRAVEL 1 % SAND 11 % SILT AND CLAY 88 %
 LIQUID LIMIT 26 % PLASTICITY INDEX 10 %
 SAMPLE OF CLAY (CL) FROM DW-18 AT 49.5 FEET



GRAVEL 0 % SAND 11 % SILT AND CLAY 89 %
 LIQUID LIMIT 27 % PLASTICITY INDEX 13 %
 SAMPLE OF CLAY (CL) FROM DW-19 AT 49 FEET

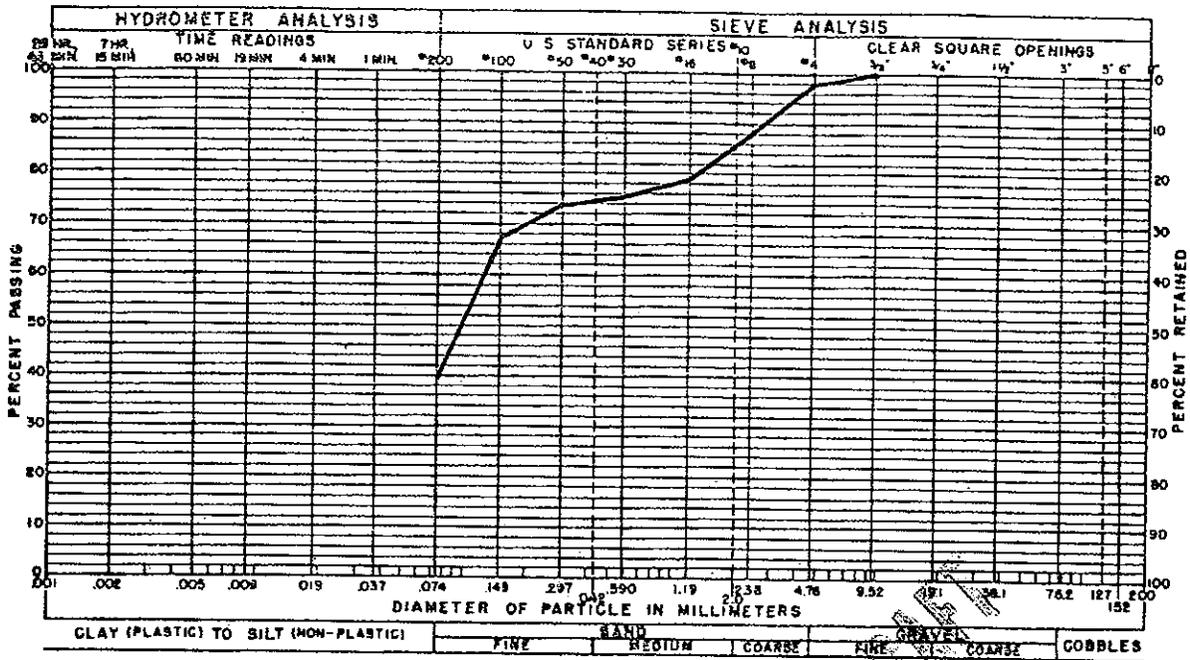
GRADATION TEST RESULTS

JOB NO. 7170



GRADATION TEST RESULTS

JOB NO. 7170

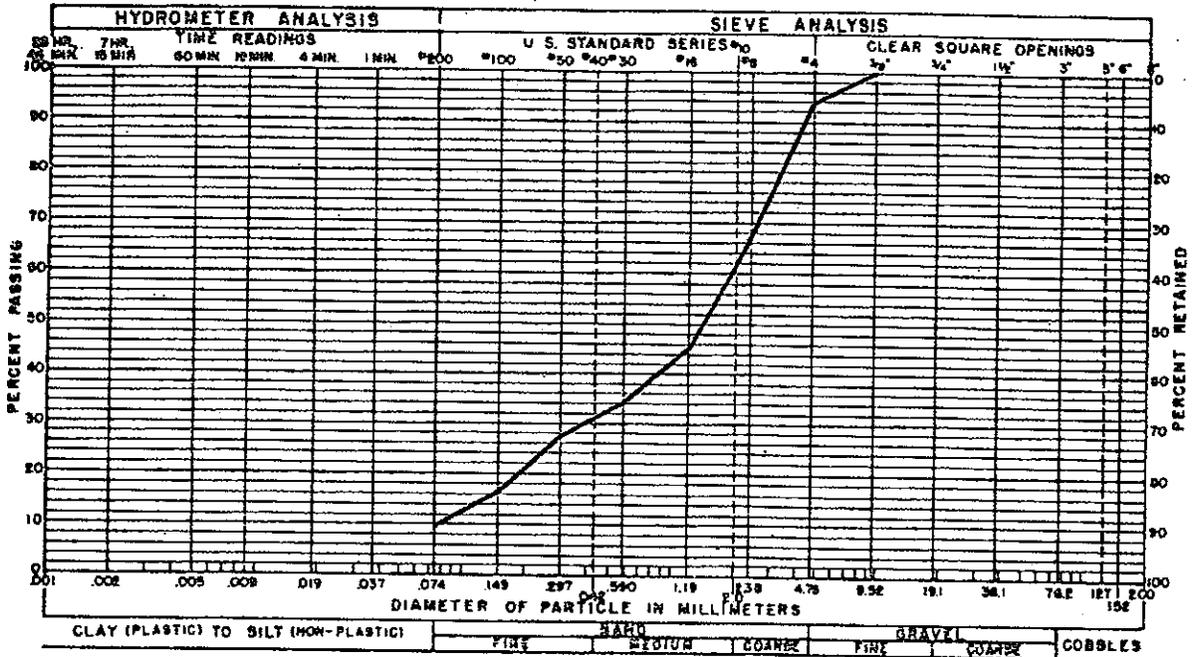


CLAY (PLASTIC) TO SILT (NON-PLASTIC) SAND GRAVEL COBBLES

GRAVEL 2 % SAND 49 % SILT AND CLAY 49 %

LIQUID LIMIT — % PLASTICITY INDEX — %

SAMPLE OF SAND, CLAYEY (SC) FROM OW-20 AT 39 FEET



CLAY (PLASTIC) TO SILT (NON-PLASTIC) SAND GRAVEL COBBLES

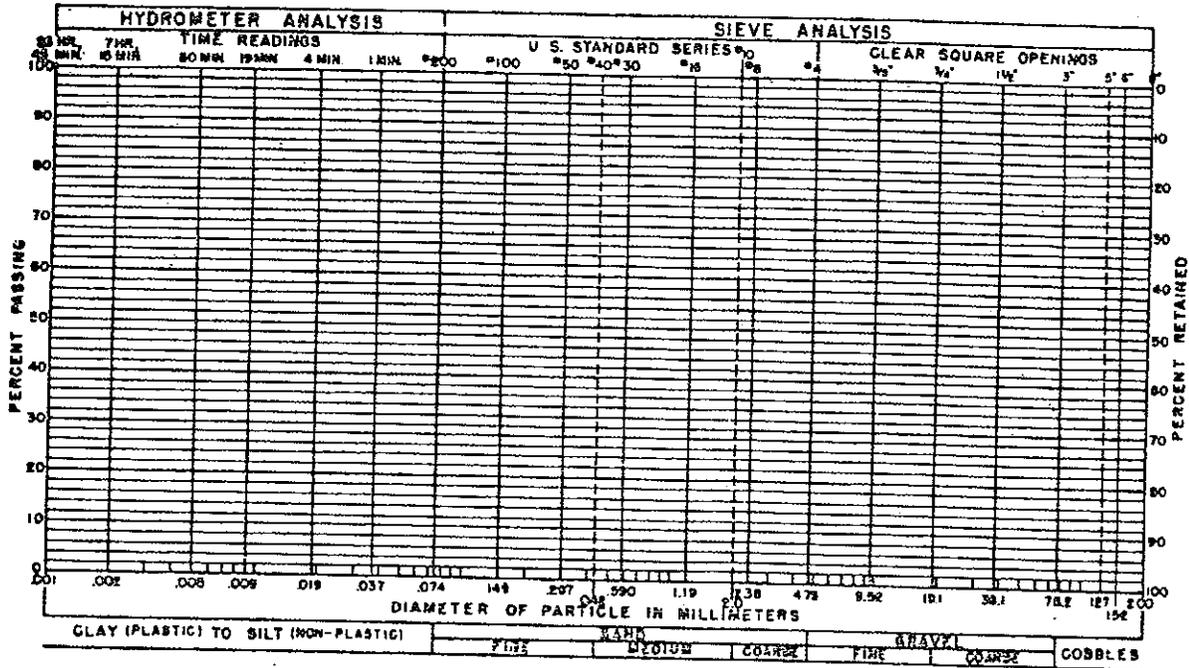
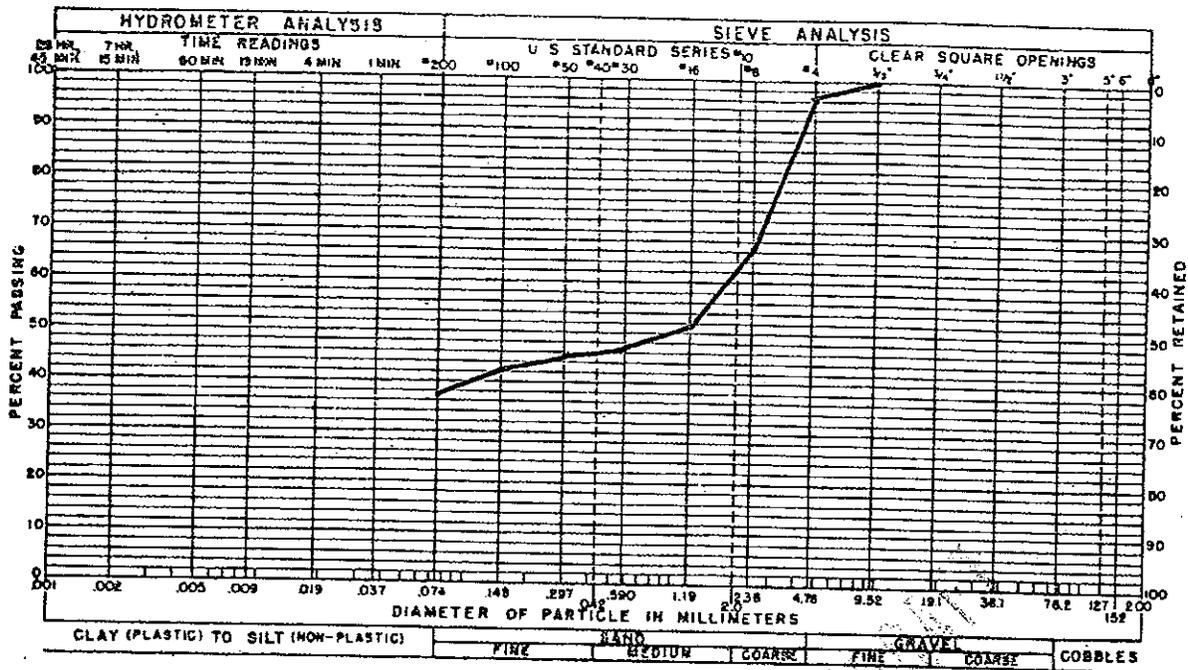
GRAVEL 6 % SAND 84 % SILT AND CLAY 10 %

LIQUID LIMIT — % PLASTICITY INDEX — %

SAMPLE OF SAND, SILTY (SM) FROM OW-20 AT 40.5 FEET

GRADATION TEST RESULTS

JOB NO. 7170



GRADATION TEST RESULTS

JOB NO. 7170

APPENDIX D.2

GANNETT FLEMING - 2006

Atlantic Rim, TP-3 @ 1-2'

ASTM D422 Sieve Analysis plus Hydrometer

<u>Description</u>	<u>Date Delivered</u>	<u>Sieve Size</u>	<u>Percent Passing</u>
TP-3 @ 1-2'	06/02/06	no. 10	100
		no. 20	98
		no. 40	94
		no. 100	87
		no. 200	80.2
		0.041 mm	33.6
		0.030 mm	30.9
		0.019 mm	30.0
		0.011 mm	28.2
		0.008 mm	26.3
		0.006 mm	25.4
		0.003 mm	17.3
		0.002 mm	8.2

ASTM D4221 Double Hydrometer

<u>Description</u>	<u>Date Delivered</u>	<u>Sieve Size</u>	<u>Percent Passing</u>
TP-3 @ 1-2'	06/02/06	0.051 mm	19.4
		0.036 mm	19.4
		0.023 mm	11.6
		0.013 mm	7.7
		0.010 mm	7.7
		0.007 mm	7.7
		0.003 mm	3.9
		0.002 mm	1.9

ASTM D4221 Percent Dispersion

$$\% \text{Dispersion} = \frac{\% \text{ passing } 5 - \mu\text{m in ASTM D4221}}{\% \text{ passing } 5 - \mu\text{m in ASTM D422}} \times 100$$

$$\% \text{Dispersion} = \frac{5.84}{23.30} \times 100 = 25.06\% \quad \text{As delivered moisture content: } 10.2\%$$

ASTM D4318 Plasticity Index

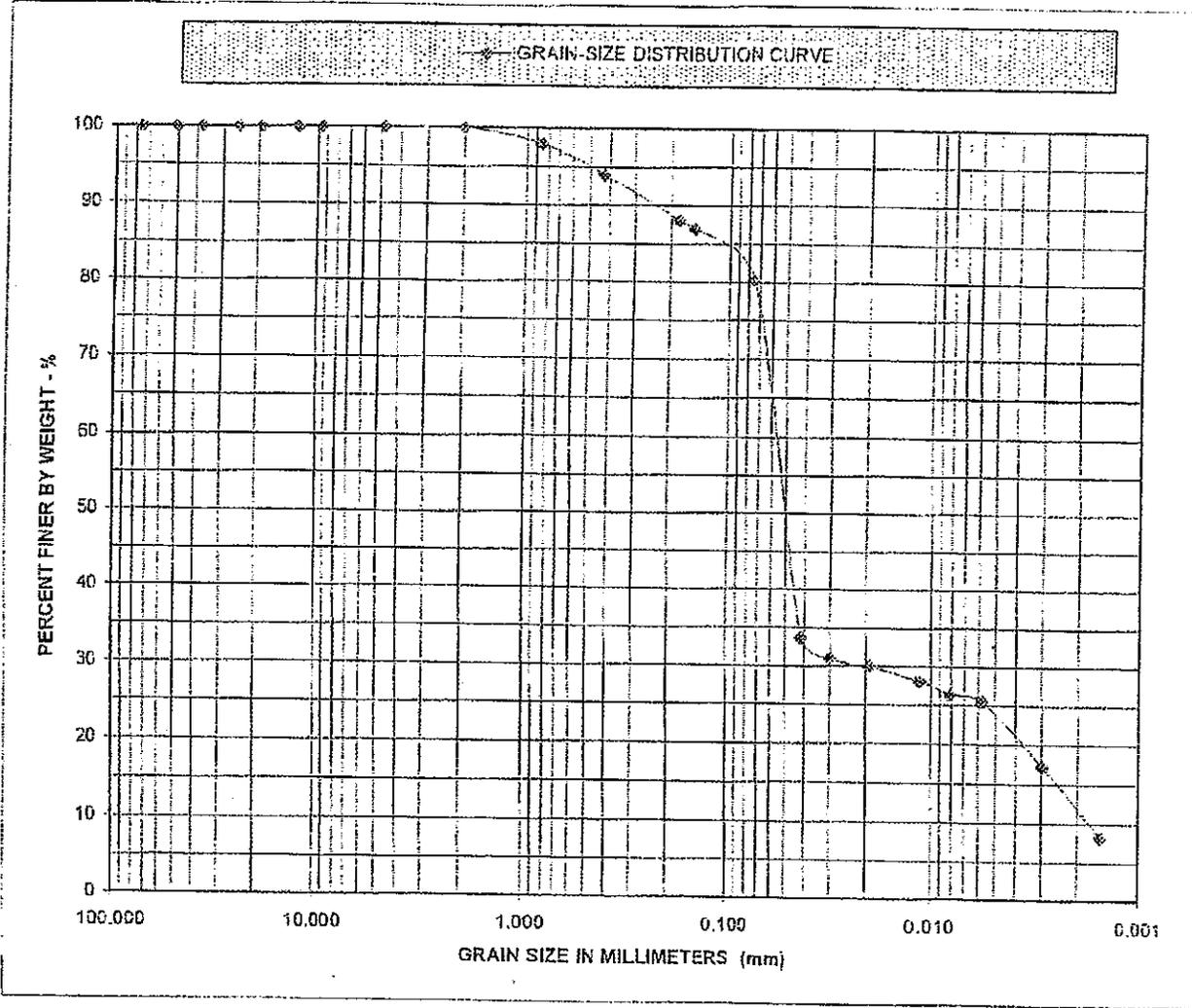
Liquid Limit: 34

Plastic Limit: 16

Plasticity Index: 18

CLIENT: WWC Engineering
PROJECT: Atlantic Rim & Peaking 2 Test Fill Samples
PROJECT LOCATION: Rawlins, Wyoming
SAMPLE LOCATION: TF-3 @ 1-2'

DATE: June 21, 2006
PROJ. NO: 24061061



SAMPLE LOCATION	SOIL CLASSIFICATION	MC%	LL	PI	Cc	Cu
TP-3 @ 1-2'	Sandy Lean Clay (CL)	10.2	34	18	3.41	33.27

SAMPLE LOCATION	D100	D60	D30	D10	% GRAVEL	% SAND	% SILT	% CLAY
TP-3 @ 1-2'	2.000	0.060	0.019	0.002	0.0	19.8	56.9	23.3

REMARKS: NR: DENOTES NOT REPORTED DATA NV: DENOTES NO VALUE

WWC Engineering
Atlantic Rim & Peaking #2 Test Pit Samples
Terracon Project No. 24061061

Terracon

Atlantic Rim. TP-4 @ 6-8'

ASTM D422 Sieve Analysis plus Hydrometer

<u>Description</u>	<u>Date Delivered</u>	<u>Sieve Size</u>	<u>Percent Passing</u>
TP-4 @ 6-8'	06/02/06	3/8"	100
		no. 4	99
		no. 10	93
		no. 20	86
		no. 40	80
		no. 100	69
		no. 200	57.4
		0.044 mm	52.7
		0.032 mm	49.6
		0.020 mm	46.5
		0.012 mm	41.8
		0.009 mm	38.7
		0.006 mm	35.6
		0.003 mm	29.4
		0.002 mm	13.9

ASTM D4318 Plasticity Index

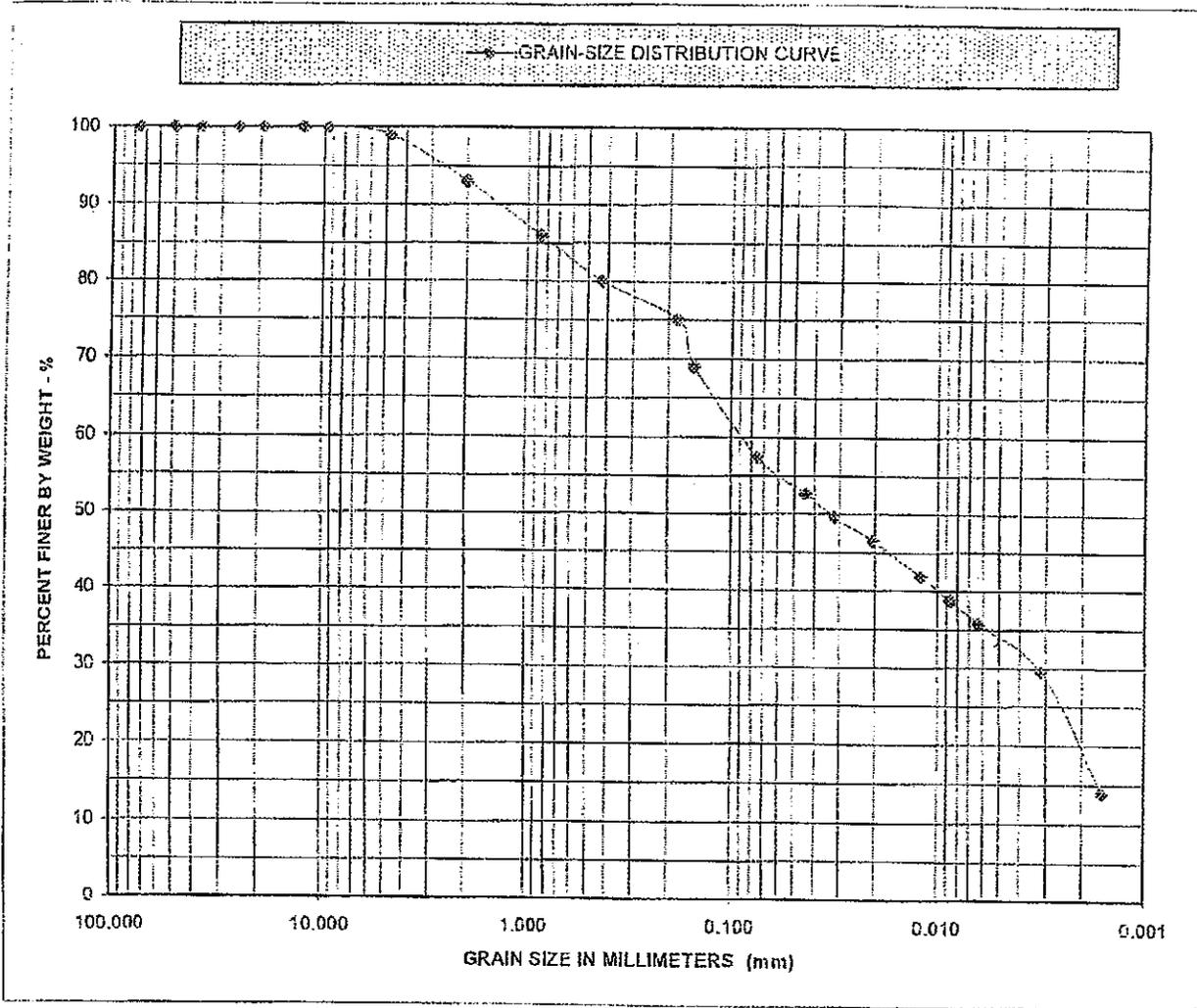
Liquid Limit: 24

Plastic Limit: 18

Plasticity Index: 6

CLIENT: WWC Engineering
 PROJECT: Atlantic Rim & Peaking 2 Test Pit Samples
 PROJECT LOCATION: Rawlins, Wyoming
 SAMPLE LOCATION: TP-4 @ 6-8'

DATE: June 21, 2006
 PROJ. NO: 24061061



SAMPLE LOCATION	SOIL CLASSIFICATION	MC%	LL	PI	Cc	Cu
TP-4 @ 6-8'	Sandy Silty Clay (CL-ML)	10.9	24	6		

SAMPLE LOCATION	D100	D60	D30	D10	% GRAVEL	% SAND	% SILT	% CLAY
TP-4 @ 6-8'	9.500	0.092	0.003		1.0	41.6	24.2	33.2

REMARKS: NR: DENOTES NOT REPORTED DATA NV: DENOTES NO VALUE

LABORATORY COMPACTION CHARACTERISTICS OF SOIL



Report Number: 24061061.0001
 Service Date: June 2, 2006

1505 Old Happy Jack Road
 Cheyenne, Wyoming 82001
 (307) 632-9274

Client: WWC Engineering
 511 Skyline Rd
 Laramie WY 82071

Report Date: June 21, 2006
 Project: Atlantic Rim Test Pit Samples
 South of Rawlins
 Rawlins, WY

Project Number: 24061061

Material Information

Contractor: WWC Engineering
 Source of Material: Atlantic Rim
 Proposed Use:
 USCS: CL-ML

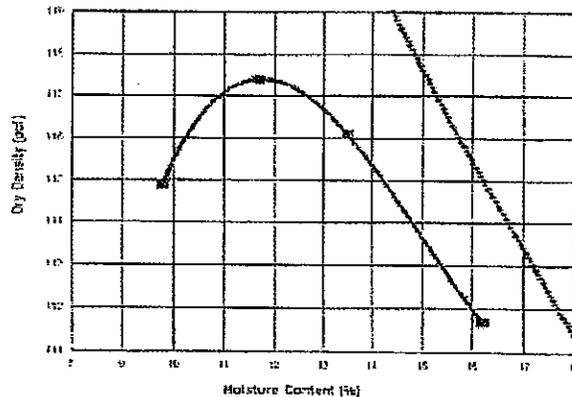
Sample Information

Sampled By: Leather L. Rogers
 Sample Location: TP - 4 @ 6- 8'
 Sample Description: Sandy Silty Clay

Laboratory Test Data

		Result	Specifications
Test Procedure:	ASTM D698-91	Liquid Limit:	24
Test Method:	Method A	Plastic Limit:	18
Sample Preparation:	Wet Preparation	Plasticity Index:	6
Rammer Type:	Mech. Rammer	% Passing #200:	57.4
Maximum Dry Unit Weight, pcf:	117.5	% Passing #40:	80.0
Optimum Water Content, %:	12.0		

Moisture Density Relations
 Zero Air Voids Curve for assumed specific gravity 2.63



Services--Obtain a sample of treated subgrade at the project site and return it to the laboratory. Laboratory test data is performed by Terracon in substantial accordance with ASTM D 4318, Liquid Limit, Plastic Limit, and Plasticity Index of Soils; ASTM D 1140, Amount of Soils Finer than the No. 200 Sieve; and ASTM D 422, Partical Size Analysis of Soils.

Report Distribution: Terracon Rep: Leather L. Rogers
 (1) WWC Engineering

Reviewed by: *Brent F. Wilkins*

Brent F. Wilkins
 Department Manager I

The tests were performed in general accordance with applicable ASTM, AASHTO, or DOT test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other, apparently similar or identical materials.

Atlantic Rim. TP-4 @ 4-5'

As delivered moisture content: 10.9%

Peaking #2. TP-5 @ 8-10'

As delivered moisture content: 3.7%

Peaking #2. TP-6 @ 2-3'

ASTM D422 Sieve Analysis

<u>Description</u>	<u>Date Delivered</u>	<u>Sieve Size</u>	<u>Percent Passing</u>
TP-6 @ 2-3'	06/02/06	2"	100
		1 1/2"	95
		1"	87
		3/4"	82
		1/2"	75
		3/8"	71
		no. 4	63
		no. 10	57
		no. 20	53
		no. 40	49
		no. 100	27
no. 200	13.2		

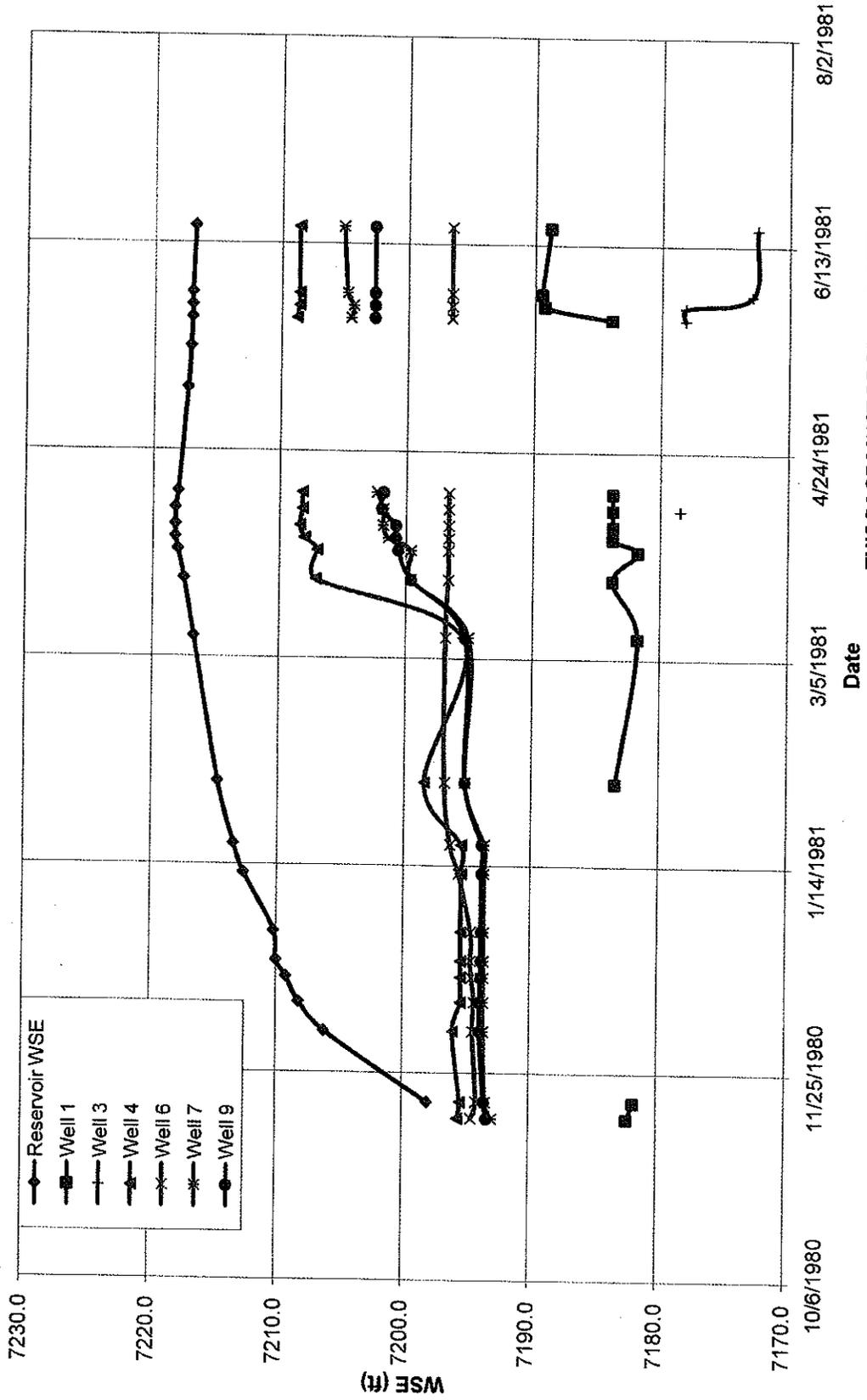
APPENDIX E

OBSERVATION WELL MEASUREMENTS

1980

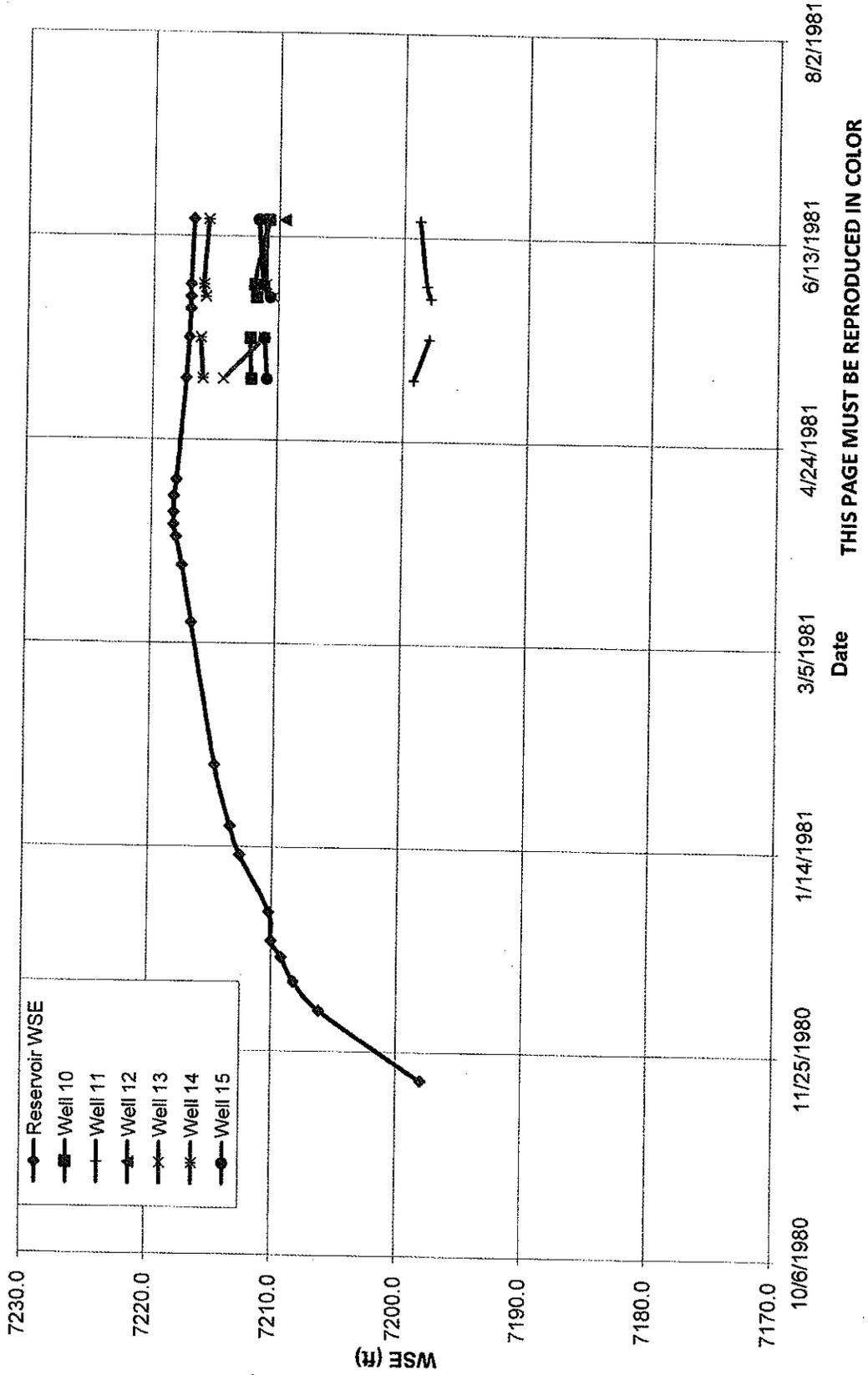
DATE	11/14	11/17	11/18	12/5	12/12	12/18	12/22	12/29
WATER SURFACE ELEVATION	RES-ERVOIR EMPTY	FILLING BEGAN	7198.0	7206.2	7208.2	7209.2	7210.0	7210.2
OBSERVATION WELL NUMBER AND ELEVATION OF WATER IN WELL	1	7182.3		7181.8	DRY	DRY	DRY	DRY
	2	DRY		DRY	DRY	DRY	DRY	DRY
	3	DRY		DRY	DRY	DRY	DRY	DRY
	4	7195.6		7195.4	7196.0	7195.4	7195.4	7195.4
	5	DRY		DRY	DRY	DRY	DRY	DRY
	6	7194.5		7194.1	7194.4	7194.3	7194.5	7194.6
	7	7192.9		7193.4	7193.6	7193.6	7193.6	7193.6
	8	DRY		DRY	DRY	DRY	DRY	DRY
	9	7193.3		7193.5	7193.9	7193.9	7193.8	7193.8
	10							
	11							
	12							
	13							
	14							
	15							
	16							
	17							
	18							
	19							
	20							
	21							
	22							
	23							
	24							
	25							
	26							

Atlantic Rim Reservoir WSE and Observation Well Levels



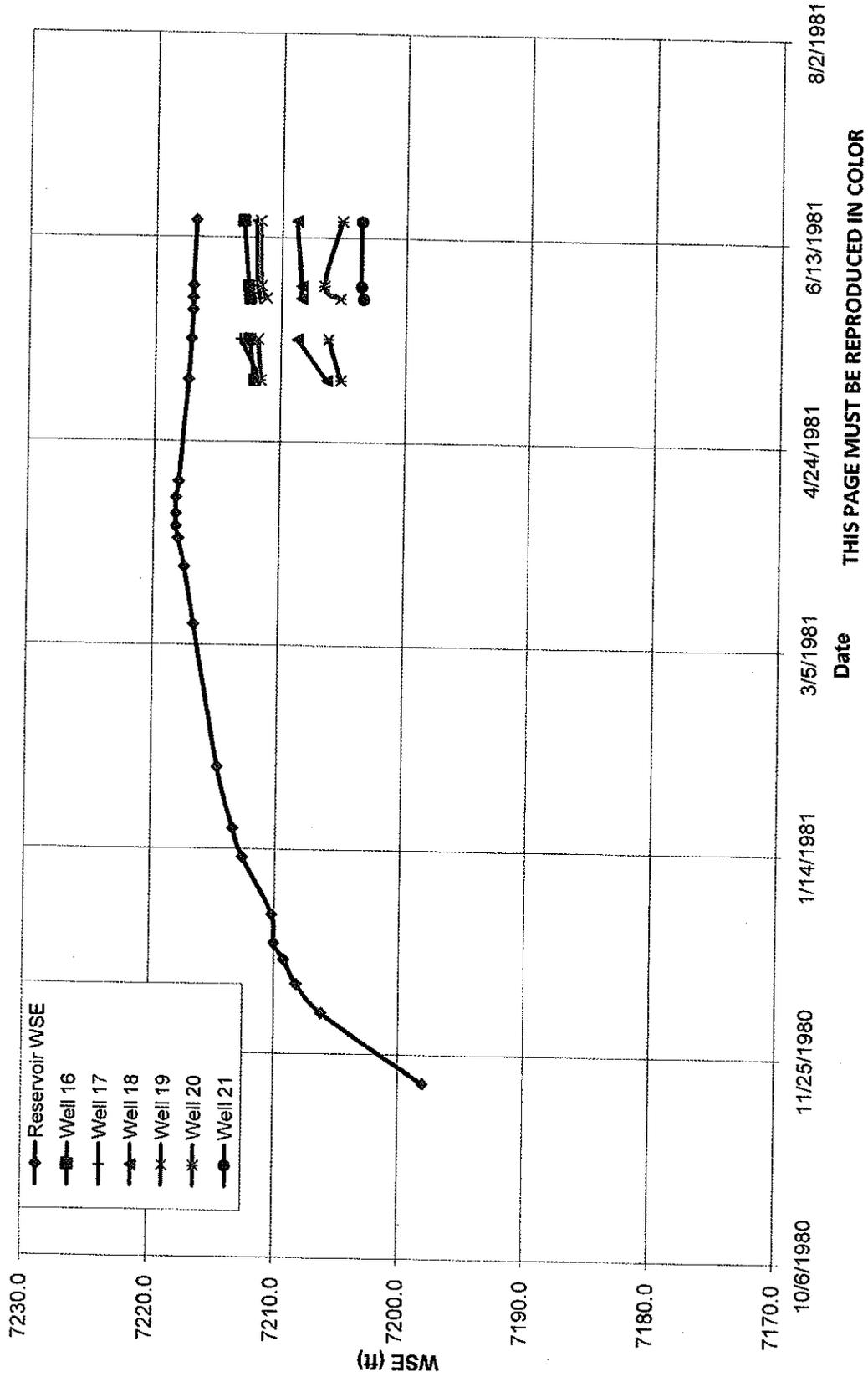
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Atlantic Rim Reservoir WSE and Observation Well Levels



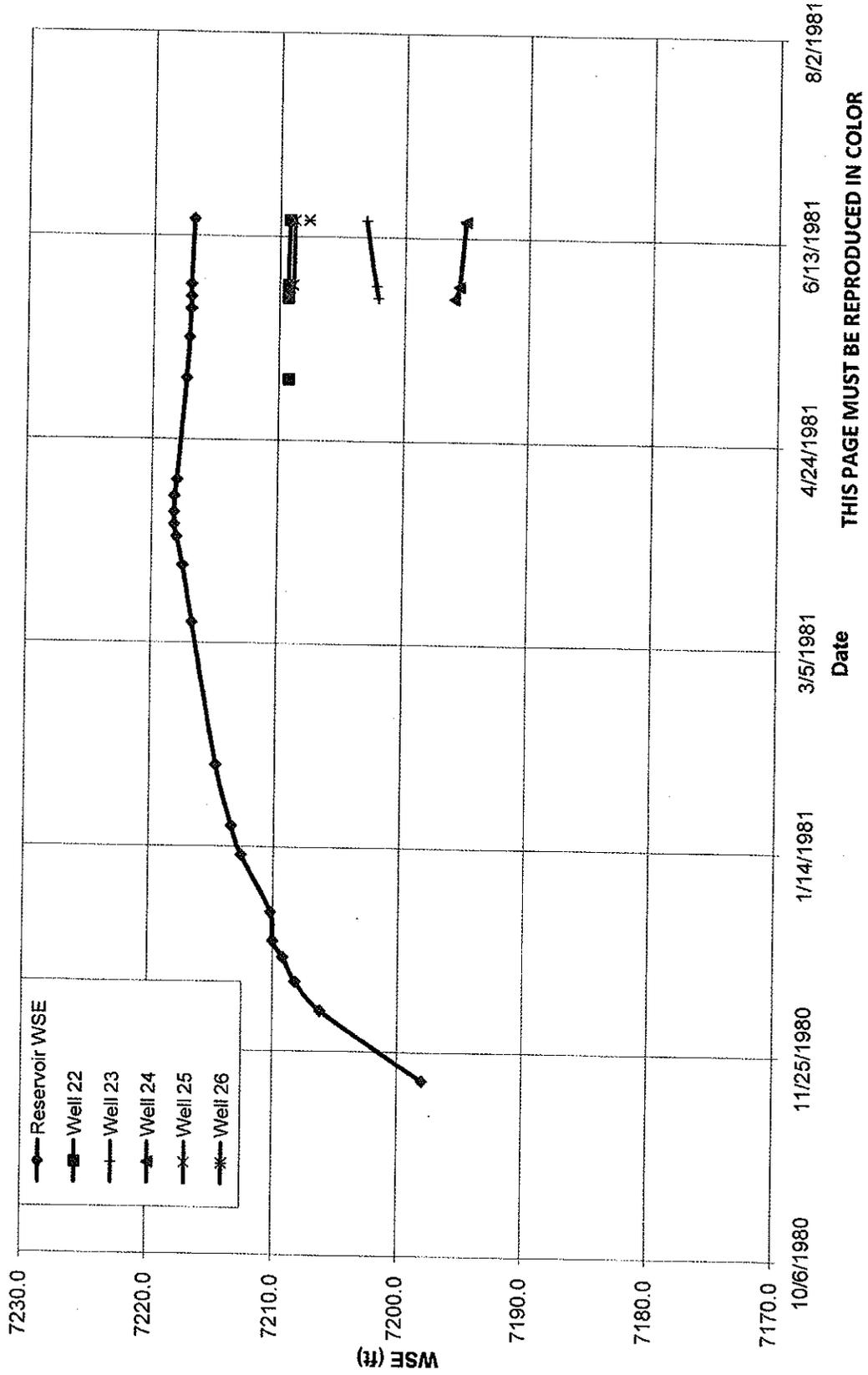
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Atlantic Rim Reservoir WSE and Observation Well Levels

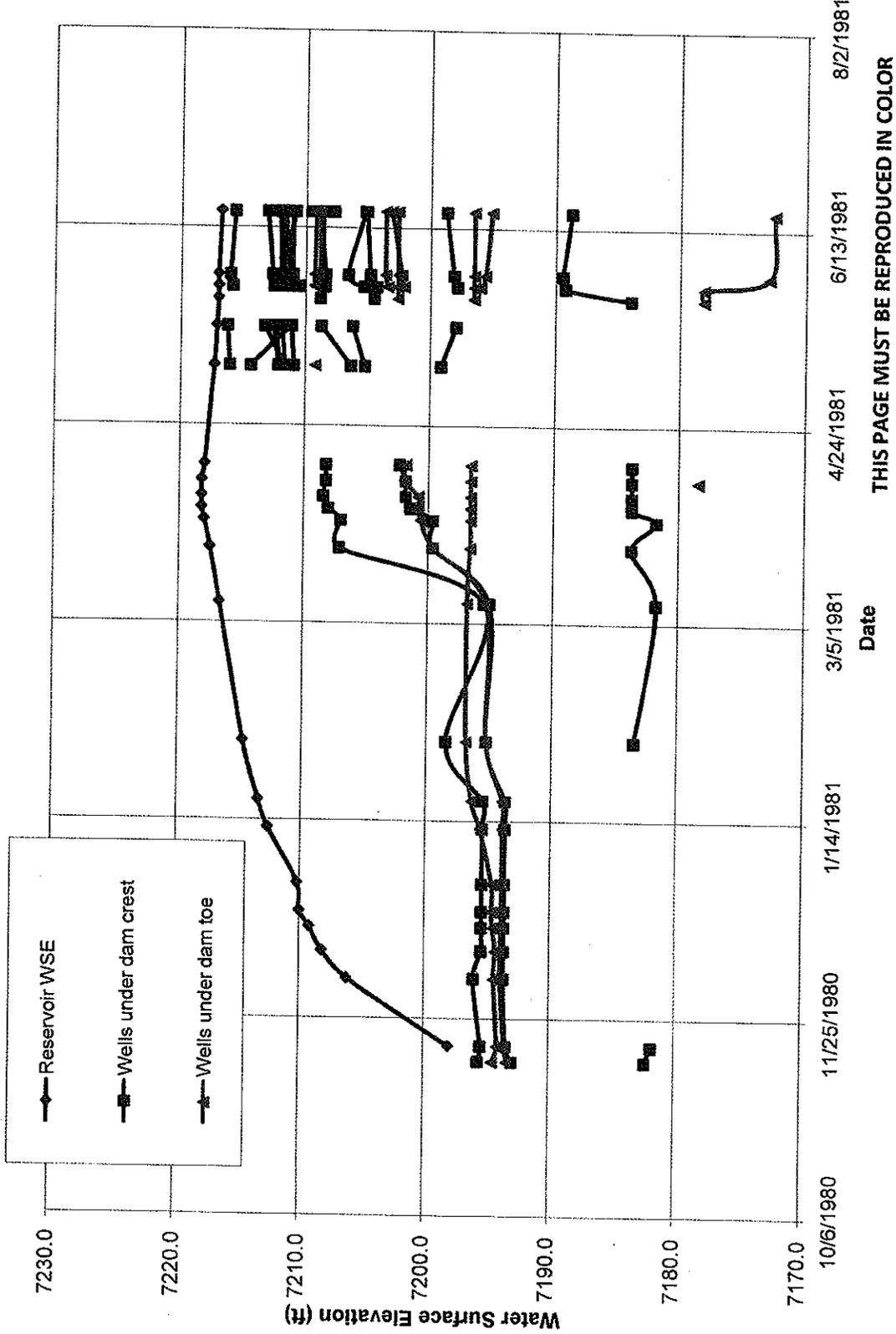


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Atlantic Rim Reservoir WSE and Observation Well Levels



Atlantic Rim Reservoir WSE and Observation Well Levels by Location



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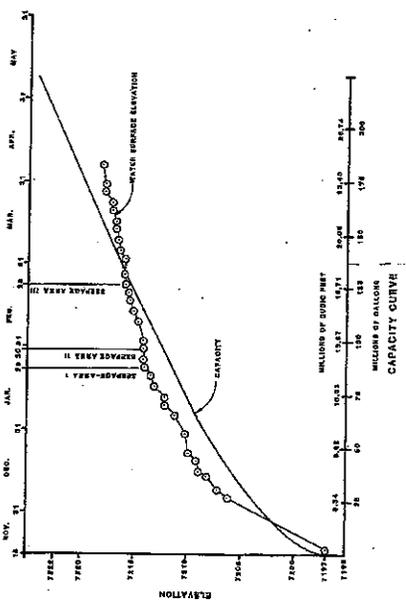
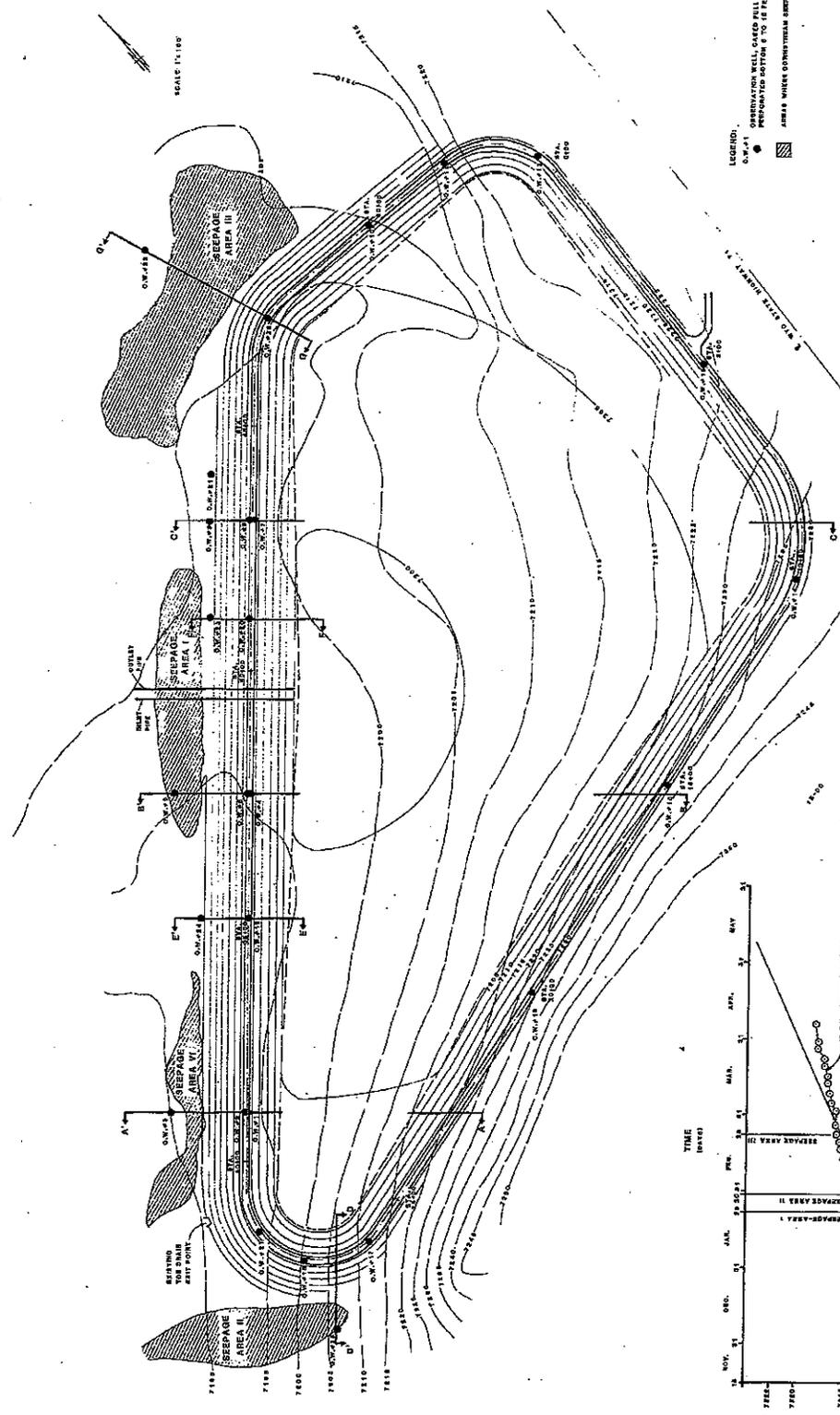
09121 Atlantic Rim Reservoir
 ABP
 Monitoring Well water levels on 9-11-09

Well	Water level	Notes
O.W. # 1	--	
O.W. # 2	--	Blocked by sediment 13.5 to 14.5 ft bgs, one casing bent in the top foot
O.W. # 3	--	Could not locate well
O.W. # 4	--	Blocked by sediment 9 ft bgs
O.W. # 5	--	Dry 24.8 ft bgs
O.W. # 6	0.5 ft above ground	
O.W. # 7	--	Blocked by sediment
O.W. # 8	--	Blocked by sediment
O.W. # 9	1.5 ft above ground	
O.W. # 10	--	Blocked by sediment 1 ft bgs
O.W. # 11	--	Blocked by sediment 4 ft bgs
O.W. # 12	--	Blocked by sediment 11 ft bgs
O.W. # 13	--	Could not locate well
O.W. # 14	--	Could not locate well
O.W. # 15	--	Could not locate well
O.W. # 16	--	Could not locate well
O.W. # 17	--	Blocked by sediment 16.7 ft bgs
O.W. # 18	--	Blocked by sediment 15.5 ft bgs
O.W. # 19	--	Blocked by sediment 14.5 ft bgs
O.W. # 20	23.3 ft below crest	
O.W. # 21	1.5 ft above toe	
O.W. # 22	--	Could not locate well
O.W. # 23	1.5 ft above ground	
O.W. # 24	at ground surface	Erosion around well grout
O.W. # 25	--	Blocked by sediment at ground surface
O.W. # 26	15.95 ft below crest	
O.W. # 27	--	Could not locate well
Unmarked	3.7 ft below ground	Located across ditch, 50 ft downstream of O.W. # 6
Unmarked	11.9 ft below ground	Located 75 feet downstream of toe at same section as O.W. # 17
Unmarked	37.3 ft below ground	Located 175 feet downstream of STA 2+50
Unmarked	2.5 ft below ground	Located about 200 ft downstream of dam between STA 48+00 and 49+00
Unmarked	at ground surface	Located about 60 ft downstream of dam between STA 48+00 and 49+00
Reservoir	2.6 ft below high water mark	WSE = 7214.4, assuming max WSE = 7217.0

Note: bgs = below ground surface

APPENDIX F

SUBSURFACE SECTIONS AND PROFILES



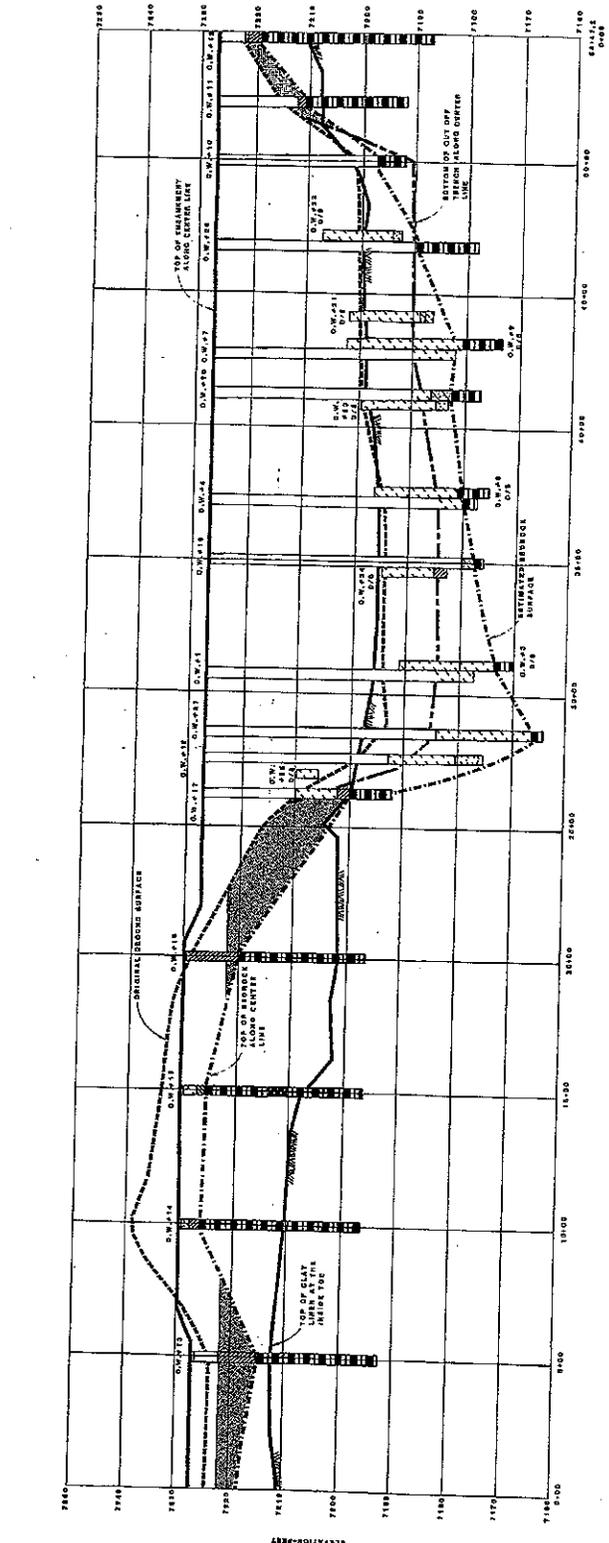
- NOTES:
1. OBSERVATION WELLS ARE INSTALLED AT VARIOUS DEPTHS OF 10 FEET, 20 FEET, 30 FEET, 40 FEET, 50 FEET, 60 FEET, 70 FEET, 80 FEET, 90 FEET, 100 FEET, 110 FEET, 120 FEET, 130 FEET, 140 FEET, 150 FEET, 160 FEET, 170 FEET, 180 FEET, 190 FEET, 200 FEET, 210 FEET, 220 FEET, 230 FEET, 240 FEET, 250 FEET, 260 FEET, 270 FEET, 280 FEET, 290 FEET, 300 FEET, 310 FEET, 320 FEET, 330 FEET, 340 FEET, 350 FEET, 360 FEET, 370 FEET, 380 FEET, 390 FEET, 400 FEET, 410 FEET, 420 FEET, 430 FEET, 440 FEET, 450 FEET, 460 FEET, 470 FEET, 480 FEET, 490 FEET, 500 FEET, 510 FEET, 520 FEET, 530 FEET, 540 FEET, 550 FEET, 560 FEET, 570 FEET, 580 FEET, 590 FEET, 600 FEET, 610 FEET, 620 FEET, 630 FEET, 640 FEET, 650 FEET, 660 FEET, 670 FEET, 680 FEET, 690 FEET, 700 FEET, 710 FEET, 720 FEET, 730 FEET, 740 FEET, 750 FEET, 760 FEET, 770 FEET, 780 FEET, 790 FEET, 800 FEET, 810 FEET, 820 FEET, 830 FEET, 840 FEET, 850 FEET, 860 FEET, 870 FEET, 880 FEET, 890 FEET, 900 FEET, 910 FEET, 920 FEET, 930 FEET, 940 FEET, 950 FEET, 960 FEET, 970 FEET, 980 FEET, 990 FEET, 1000 FEET.
 2. OBSERVATION WELLS WERE LOCATED BY TURNING FROM PHYSICAL FEATURES ON THE DAM.
 3. OBSERVATION WELLS WERE INSTALLED AT VARIOUS DEPTHS OF 10 FEET, 20 FEET, 30 FEET, 40 FEET, 50 FEET, 60 FEET, 70 FEET, 80 FEET, 90 FEET, 100 FEET, 110 FEET, 120 FEET, 130 FEET, 140 FEET, 150 FEET, 160 FEET, 170 FEET, 180 FEET, 190 FEET, 200 FEET, 210 FEET, 220 FEET, 230 FEET, 240 FEET, 250 FEET, 260 FEET, 270 FEET, 280 FEET, 290 FEET, 300 FEET, 310 FEET, 320 FEET, 330 FEET, 340 FEET, 350 FEET, 360 FEET, 370 FEET, 380 FEET, 390 FEET, 400 FEET, 410 FEET, 420 FEET, 430 FEET, 440 FEET, 450 FEET, 460 FEET, 470 FEET, 480 FEET, 490 FEET, 500 FEET, 510 FEET, 520 FEET, 530 FEET, 540 FEET, 550 FEET, 560 FEET, 570 FEET, 580 FEET, 590 FEET, 600 FEET, 610 FEET, 620 FEET, 630 FEET, 640 FEET, 650 FEET, 660 FEET, 670 FEET, 680 FEET, 690 FEET, 700 FEET, 710 FEET, 720 FEET, 730 FEET, 740 FEET, 750 FEET, 760 FEET, 770 FEET, 780 FEET, 790 FEET, 800 FEET, 810 FEET, 820 FEET, 830 FEET, 840 FEET, 850 FEET, 860 FEET, 870 FEET, 880 FEET, 890 FEET, 900 FEET, 910 FEET, 920 FEET, 930 FEET, 940 FEET, 950 FEET, 960 FEET, 970 FEET, 980 FEET, 990 FEET, 1000 FEET.
 4. OBSERVATION WELLS WERE INSTALLED WITH 2-INCH QUARTER SIZE PIPES WITH 1/2 INCH DIA. HOLES. APPROX. 100 FT. OF PIPING WAS ALONG WITH EACH QUARTER SIZE PIPE. APPROX. 100 FT. OF PIPING WAS ALONG WITH EACH QUARTER SIZE PIPE.
 5. CAPACITY CURVE TAKEN FROM THE U.S. GEOLOGICAL SURVEY, DIVISION OF WATER RESOURCES, ATLANTIC RIM RESERVOIR.
 6. CROSS SECTIONS 1-1' AND 2-2' ON SHEET 1, CROSS SECTIONS 3-3' AND 4-4' ON SHEET 2, CROSS SECTIONS 5-5' AND 6-6' ON SHEET 3.

ATLANTIC RIM RESERVOIR
RAWLINS, WYOMING

LOCATION OF OBSERVATION WELLS
 AND SEEPAGE AREAS

CTL/THOMPSON, INC.
 CONSULTING GEOTECHNICAL
 AND MATERIALS ENGINEERS
 1411 WEST 14TH AVENUE, DENVER, COLORADO 80202
 PHONE 303-733-1111 FAX 303-733-1112

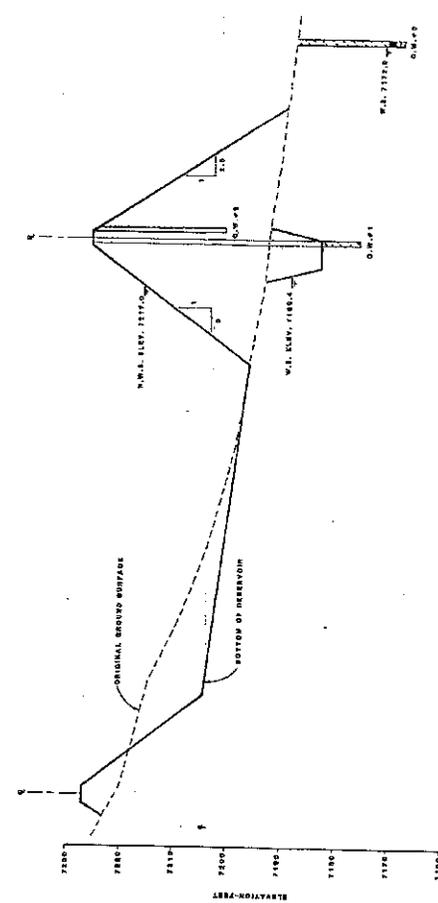
DATE: _____ SHEET NO. _____ OF _____



LEGEND:
 POTENTIAL SEEPAGE AREAS

PROFILE AT C. OF EMBANKMENT SCALE: HORIZ. 1"=50' VERT. 1"=10'

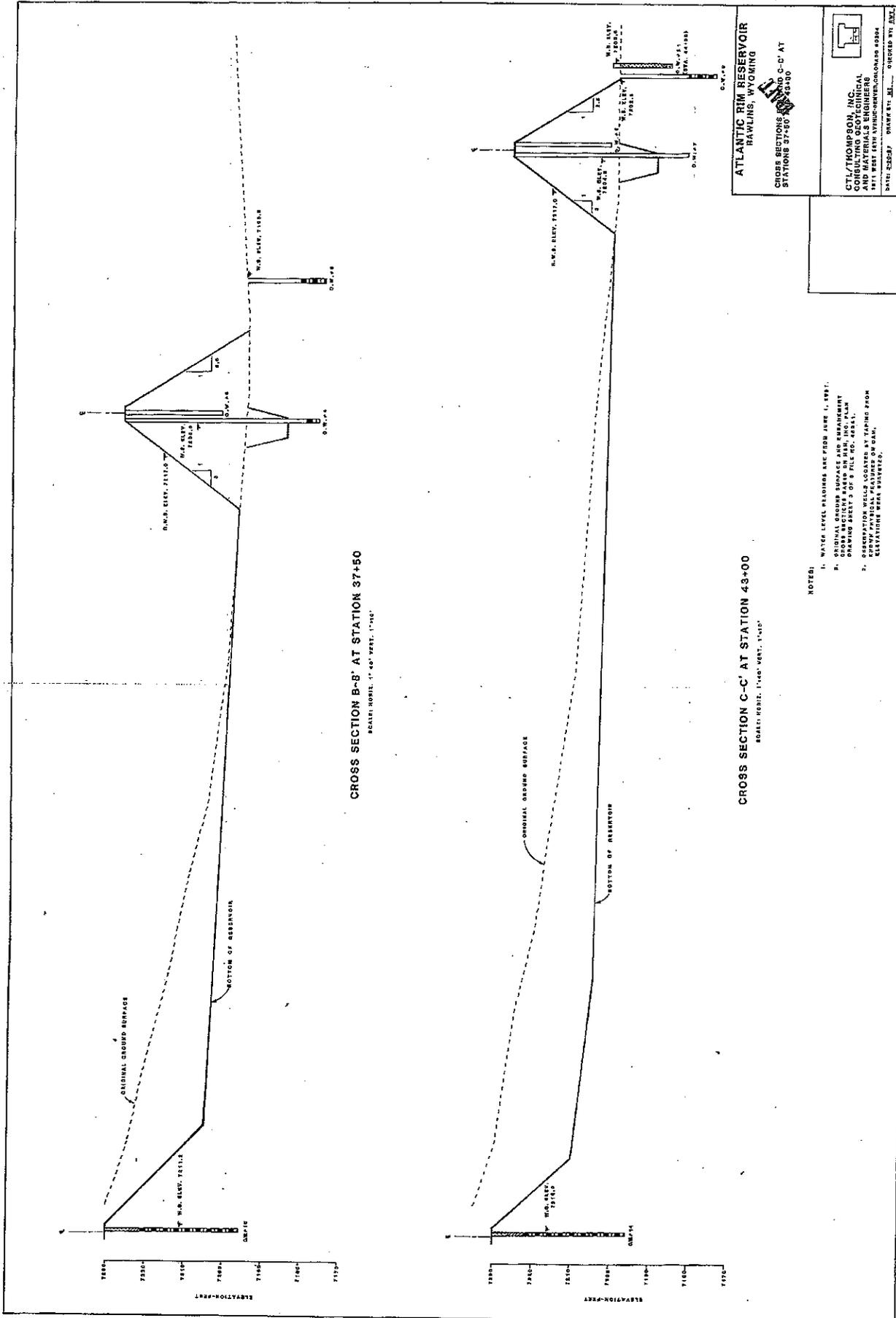
- NOTES:
1. ORIGINAL GROUND SURFACE, TOP OF EMBANKMENT OF RESERVOIR AND CUT OFF BRANCH PROFILE HIGHLIGHTED IN BLACK.
 2. LOCATION OF OBSERVATION WELLS ESTABLISHED BY TAPING FROM BROWN PIERCE'S SURVEY ON THE D.M.
 3. ELEVATION OF OBSERVED OBSERVATION WELLS DETERMINED BY A LEVEL
 4. LOGS BY BRIDGESIDE RECORDS AND PRESERVED IN COMPLETE ORIGIN ON FILE, TRANS. OF DEPT. NO. 1709



CROSS SECTION A-A' AT STATION 31400 SCALE: HORIZ. 1"=50' VERT. 1"=10'

ATLANTIC RIM RESERVOIR
 RAWLINS, WYOMING
 PROFILE ALONG & OF DAM AND CROSS
 SECTION A-A' AT STATION 31400

CTL/THOMPSON, INC.
 CONSULTING GEOTECHNICAL
 & ENGINEERS
 1075 WEST CENTRAL AVENUE, COVINGTON, LA 70038
 (504) 891-1111 FAX (504) 891-1112
 JOB NO. 1237 SHEET NO. 107



CROSS SECTION B-B' AT STATION 37+50
SCALE: HORIZ. 1" = 40' VERT. 1" = 10'

CROSS SECTION C-C' AT STATION 43+00
SCALE: HORIZ. 1" = 40' VERT. 1" = 10'

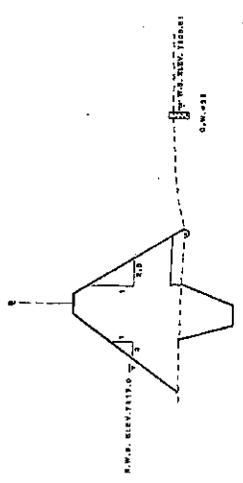
- NOTES:
1. WATER LEVEL ELEVATIONS ARE FROM JUNE 1, 1957.
 2. ORIGINAL GROUND SURFACE AND EMBANKMENT CONSTRUCTION ARE SHOWN IN PLAN DRAWING SHEET 3 OF PROJECT NO. 44-153-100.
 3. OBSERVATION WELLS LOCATED AT STATION 37+50 AND STATION 43+00. ELEVATIONS WERE SUBMITTED BY THE UNIVERSITY OF WYOMING.

ATLANTIC RIM RESERVOIR
HAWLINS, WYOMING

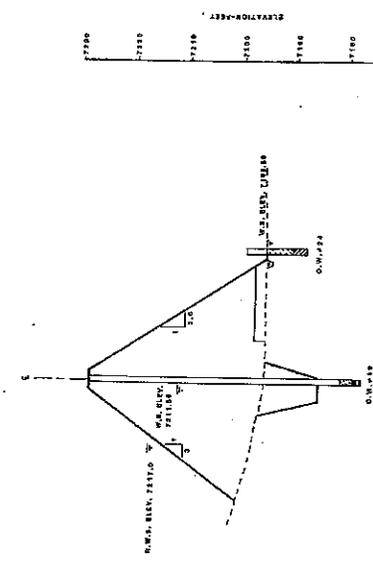
CROSS SECTIONS B-B' AND C-C' AT STATIONS 37+50 AND 43+00

CTL/THOMPSON, INC.
CONSULTING GEOTECHNICAL ENGINEERS
1415 WEST 14TH AVENUE
DENVER, COLORADO 80202

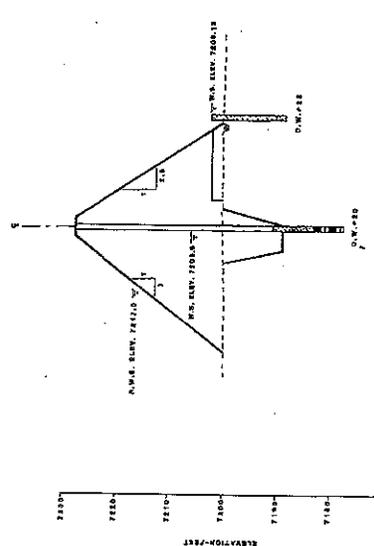
DATE: 10/23/57 CHECKED BY: ENL
JOB NO. 44-153-100 SHEET 29



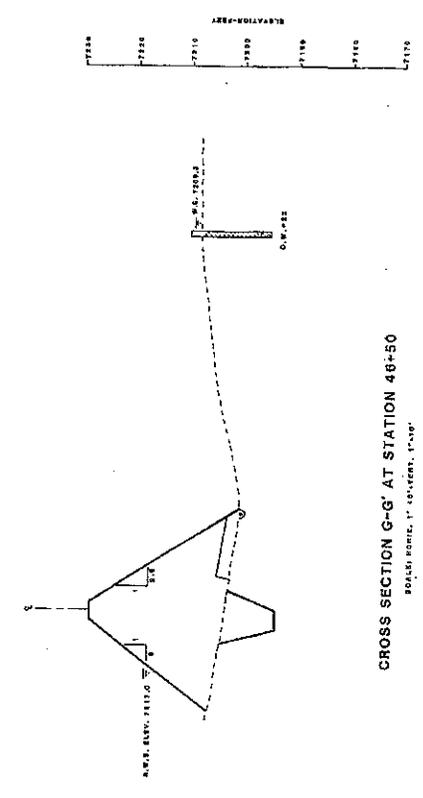
CROSS SECTION D-D' AT STATION 26+70
SCALE: HORIZ. 1"=40' VERT. 1"=4'



CROSS SECTION E-E' AT STATION 35+00
SCALE: HORIZ. 1"=40' VERT. 1"=4'



CROSS SECTION F-F' AT STATION 41+00
SCALE: HORIZ. 1"=40' VERT. 1"=4'



CROSS SECTION G-G' AT STATION 48+50
SCALE: HORIZ. 1"=40' VERT. 1"=4'

- NOTES:
1. WATER LEVEL MEASUREMENTS FROM JUNE 1, 1951.
 2. ORIGINAL CHANNEL SURFACE AND EMBANKMENT CONTOURS SHOWN BY DASHED LINES.
 3. CHANNEL BOTTOMS BASED ON READING FILE NO. 1000.
 4. CHANNEL WIDTHS BASED ON READING FROM CROSS SECTION DATA SHEETS DERIVED FROM SURVEYING DATA.

ATLANTIC RIM RESERVOIR
RAWLINS, WYOMING

CROSS SECTIONS D-E-E', F-F', AND G-G-G' AT STATIONS 26+70, 35+00, 41+00, 48+50

CTL/THOMPSON, INC.
CONSULTING GEOTECHNICAL
AND MATERIALS ENGINEERS
1421 WEST 19TH AVENUE, DENVER, COLORADO 80202
DATE: _____ DRAWN BY: J.M. CHECKED BY: J.M.
JOB NO. 5168 SHEET _____ OF _____

APPENDIX F
GIS DATA CD

WORKS CITED

WORKS CITED

- Bureau of Land Management (Rawlins Field Office-Rawlins, Wyoming). *Final Environmental Impact Statement, Atlantic Rim Natural Gas Field Development Project*, November, 2006.
- CH2MHILL. *Medicine Bow Fuel & Power, LLC, Coal-to-Liquids Project, Carbon County, Wyoming, Industrial Siting Permit Application*, September, 2007.
- Ductile Iron Pipe Research Association. *Soil Corrosivity Testing Results – Rawlins, WY* by Harry O. Niles III, P.E.. June 30, 2008.
- James M. Montgomery, Consulting Engineers, Inc. *City of Rawlins, Wyoming, Water Development Master Plan Volume I*, May, 1983.
- James M. Montgomery, Consulting Engineers, Inc. *Wyoming Water Development Commission. Rawlins Groundwater Project-Level III Interim Report*, February, 1986.
- James M. Montgomery, Consulting Engineers, Inc. *City of Rawlins, Construction of Sage Creek Transmission Pipeline Phase II Drawings*, 1987.
- Natural Resources Conservation Service. *NWCC – SNOTEL Water Year Graph*. Retrieved March 18, 2009, from the World Wide Web: <http://www.wcc.nrcs.usda.gov/cgi-bin/wygraph-swe-only.pl?stationidname=07H06S-SAGE+CREEK+BASIN&state=WY>
- PMPC Civil Engineers Inc., *High/Low Pressure Zone Investigation*, August 14, 2000.
- Western Water Consultants, Inc. *City of Rawlins Water Supply Project, Level II Phase I Report*, November 14, 1997.
- Western Water Consultants, Inc. *City of Rawlins North Platte Pipeline Carbon County (As-Built Drawings)*, March, 2004.
- Western Water Consultants, Inc. *Rawlins Raw Water Storage Level II, Phase I and II Report*, October 18, 2006.
- Western Water Consultants, Inc. *Rawlins Raw Water Storage Level II, Phase II Report*, September, 2008.