

“Design of Dale Creek Dam”

Dillon Cotterman

Harrison Carter

Prapti Giri

Dept. of Civil and Architectural Engineering

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A. Summary of Design

1. Amount of storage – 11167.64 acre-ft.
2. Water storage height – 100 ft.
3. Maximum/Design water surface elevation – 7997 ft.
4. Crest of Dam elevation – 8007 ft.
5. Base of Dam elevation – 7897 ft
6. Crest of dam above streambed – 110 ft.
7. Freeboard above max. – 10 ft.
8. Estimated cost per acre-ft. - \$2000.
9. Estimated cost of dam - \$22,340,000.

A. Summary of Design

- Watershed area
- 14.54 square miles

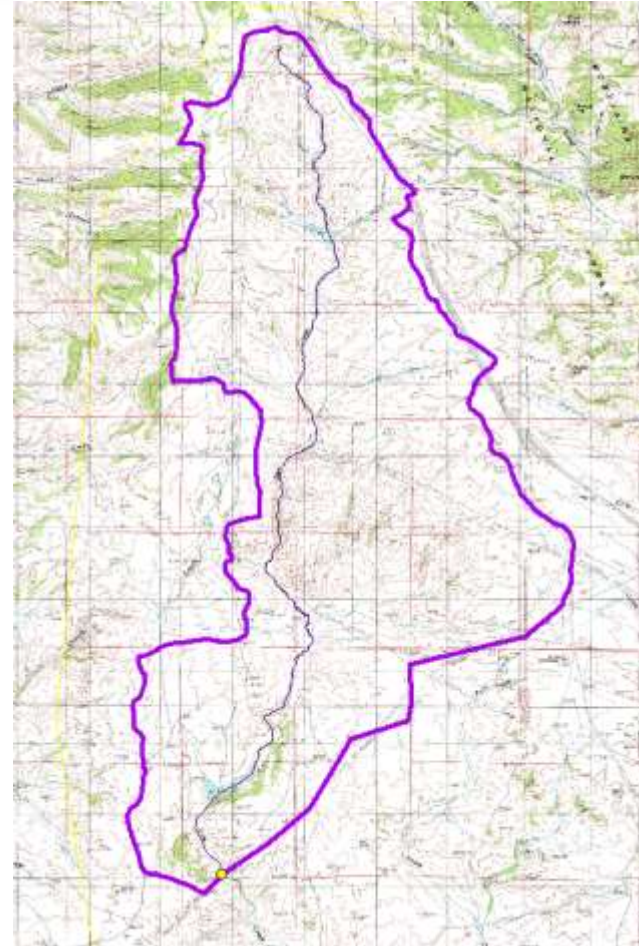


Fig 1. Catchment Basin

A. Summary of Design

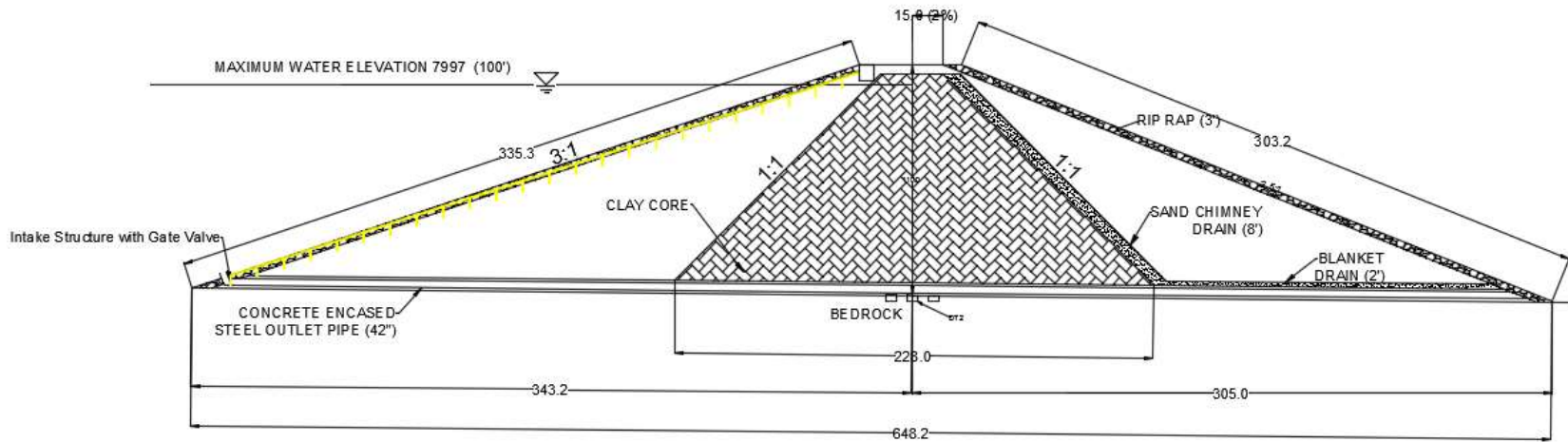


Fig 2. Detailed Maximum Cross-Section of Dam

A. Summary of Design

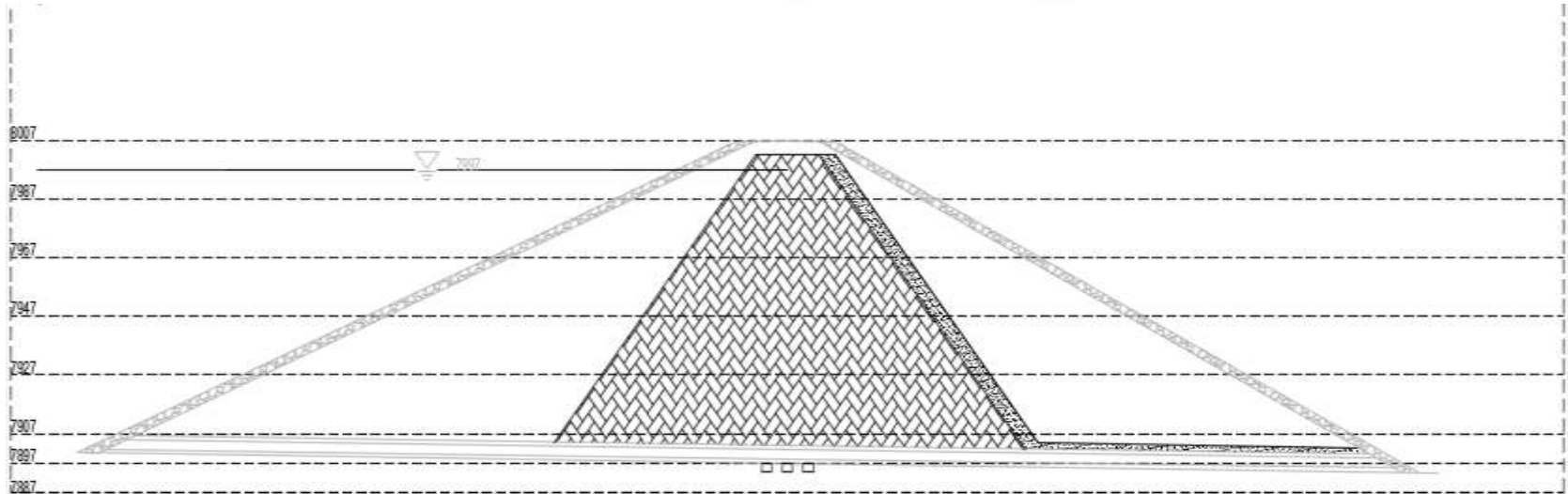


Fig 3. Maximum Cross-Section of Dam with Elevations

A. Summary of Design

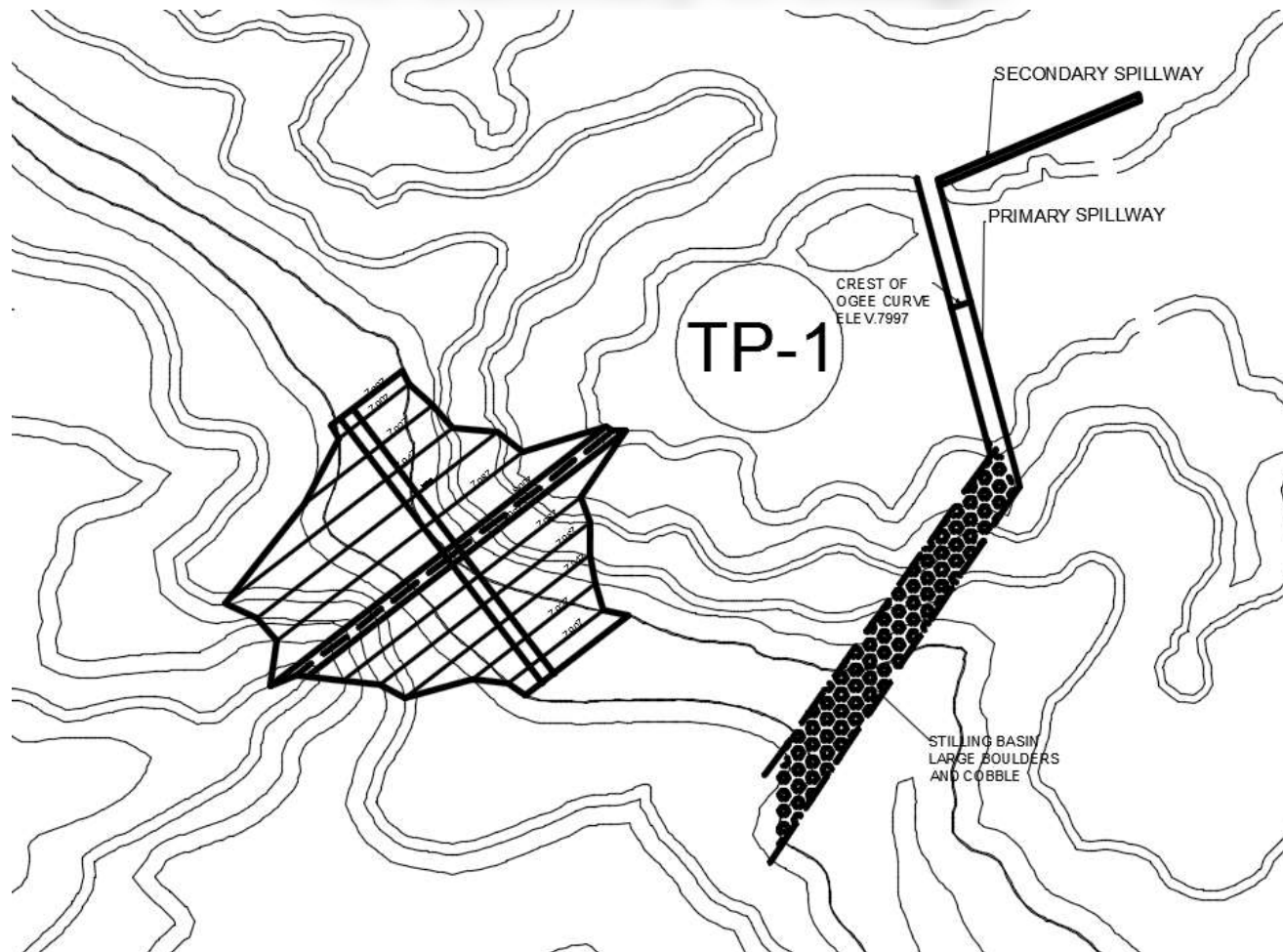


Fig 4. Plan View

A. Summary of Design

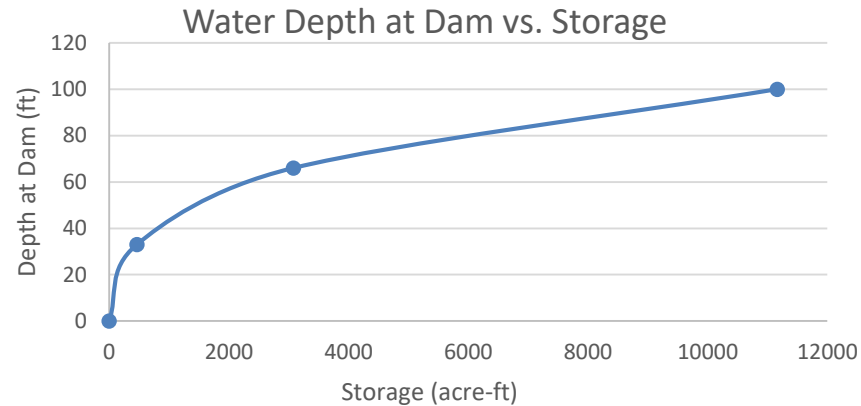


Fig 5. Depth Vs. Storage Graph

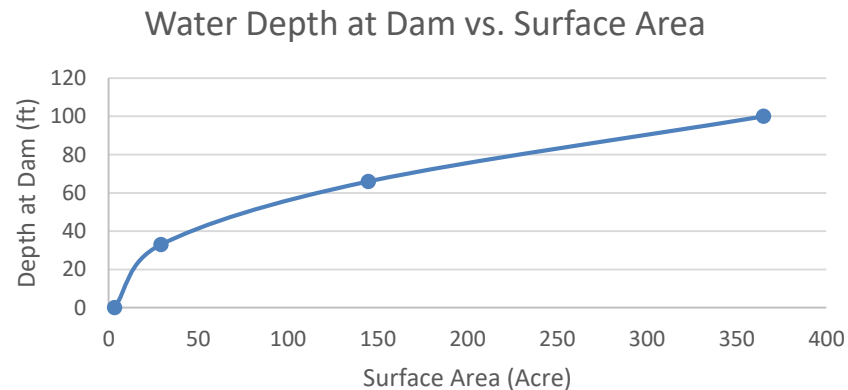


Fig 6. Depth Vs. Area Graph

B. Site Description

Purpose

- To meet water demand during dry season for domestic purpose (esp. municipal use).

Location

- 3 mi South of Vedauwoo and 2 mi West of Sherman, Albany county, Wyoming.
- Nearest City - Laramie.
- Co-ordinates - $41^{\circ}6'15''\text{N}$, $105^{\circ}27'17''\text{W}$
- Proposed dam site is located in the exact location of Dale Creek crossing on the Union Pacific Railroad (UP).



Fig 6. Dale Creek Dam Location

(Source: <http://www.whatwasthere.com/browse.aspx#!/ll/41.0827777387707,-105.421531858469/id/40671/info/zoom/14/>)

C. Soils

Geotechnical Investigation

Purpose:

- Determine soil profiles around proposed dam site.
- Find possible borrow material for dam construction.

Results:

- Bedrock at shallow depth in majority of boreholes.
 - All bedrock RQDs were 75 and below.
- Wide range soil profiles throughout the site.
- Provides many options for possible borrow material.

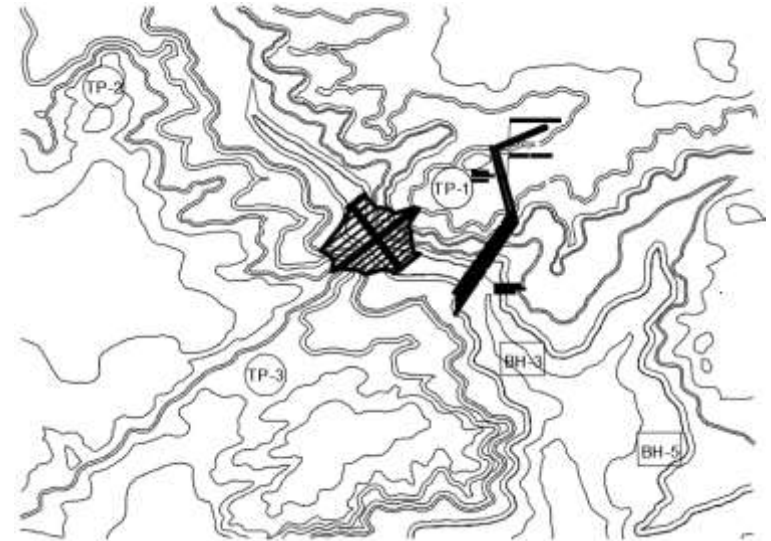


Fig 7. Dam Site Topography

C. Soils

Dam Structure

- Zoned dam
 - Zone 1- Clay Core
 - Zone 2- Shell

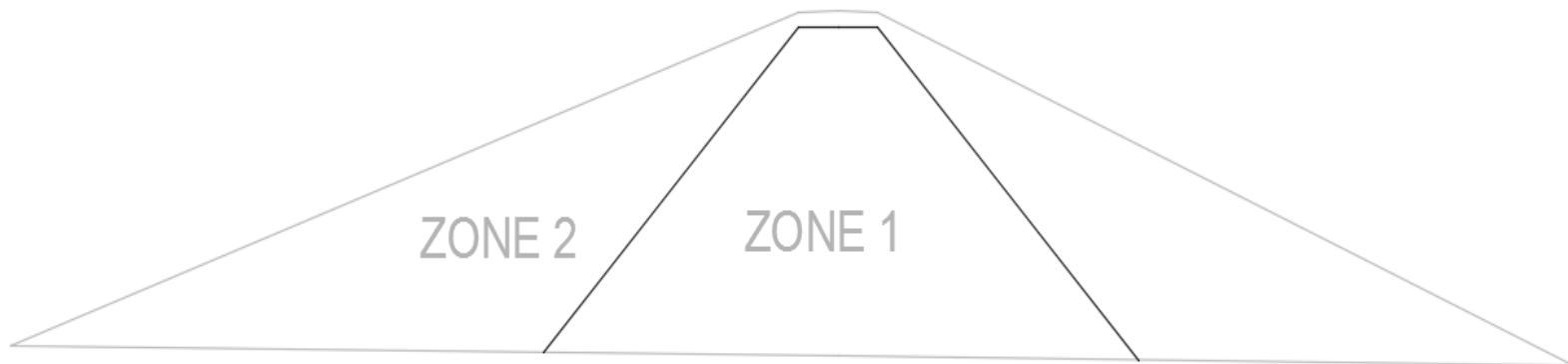


Fig 8. Zoned Dam Structure

C. Soils

Geotechnical Investigation contd...

Filter material analysis from Borehole 5 and Borehole 3

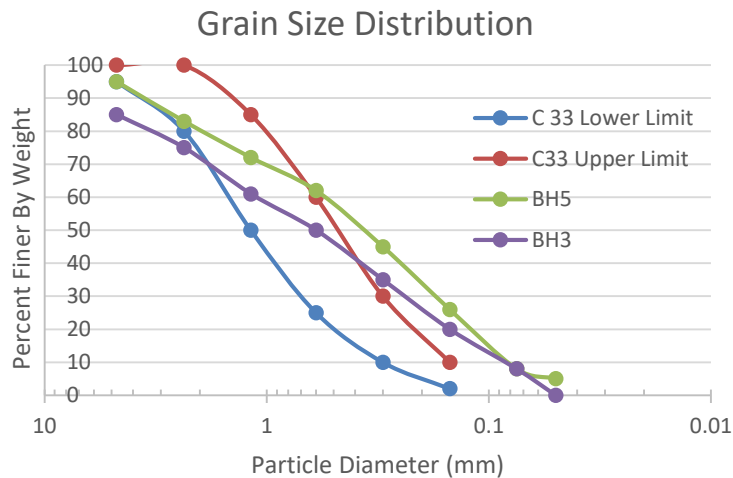


Fig 9. Grain Size Analysis

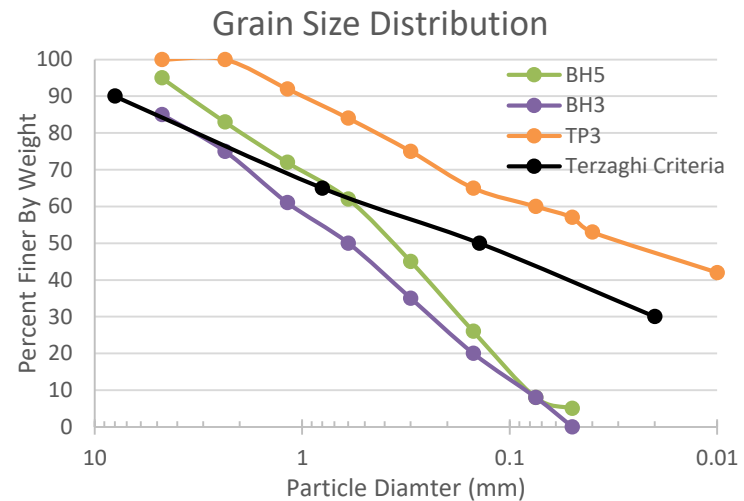


Fig 10. Grain Size Analysis (Terzaghi criteria)

- Gradation analysis showed BH3 contained too Silty material to be used for filter material
- BH5 may need to have small amount of fines washed out
- Crusher and washer on site
- QA personnel will be onsite to ensure quality of filter material

C. Soils

Geotechnical Investigation contd...

Conclusion:

- Substantial and suitable borrow material for dam construction
- Test Pit 1 and 2 showed a cobble, gravel, sandy, silty soils that are sufficient for shell material
- Test Pit 3 revealed a clay seam 5 feet thick that is suitable for the core
- Borehole 5 and 3 were analyzed for possible filter material
- Borehole 5 contained a sandy, silty material that can be used for the chimney and blanket drain

C. Soils

Material Handling and Borrow

- Quarry locations close to dam construction site.
- Hauling distances:
 - Core material – TP3, about 0.3 miles.
 - Shell material – TP1 and TP2, about 0.3 and 0.5 miles respectively.
 - Filter material – BH5, about 0.6 miles.

Compaction

- Core material:
 - Compaction – 98% of Standard Proctor Density test.
 - Moisture content – 2% below and 4% above the optimum moisture content.
- Shell material:
 - Compaction – 95% of Standard Proctor Density test.
 - Moisture content - +/- 2% of optimum moisture content.

C. Soils

Key trench, Cutoff Trench, Grouting

- **Key Trench**- Not required

Justification:

- Embankment over the bedrock foundation

- **Cutoff Trench** – Not required

Justification:

- Embankment over the bedrock foundation

- **Grouting** – Required

Justification:

- Low rock quality designation (RQD) value of the bedrock material.

C. Soils

Key trench, Cutoff Trench, Grouting contd...

- **Grouting**

Description of Grouting:

- Bentonite slurry used for grouting.
- 3 rows of grouting along the length of the dam with center to center distance of 10 ft.
- Grout cap of (5- 8) ft. deep, 3 ft. wide along the length of the dam.
- Grouting along the centerline of the crest

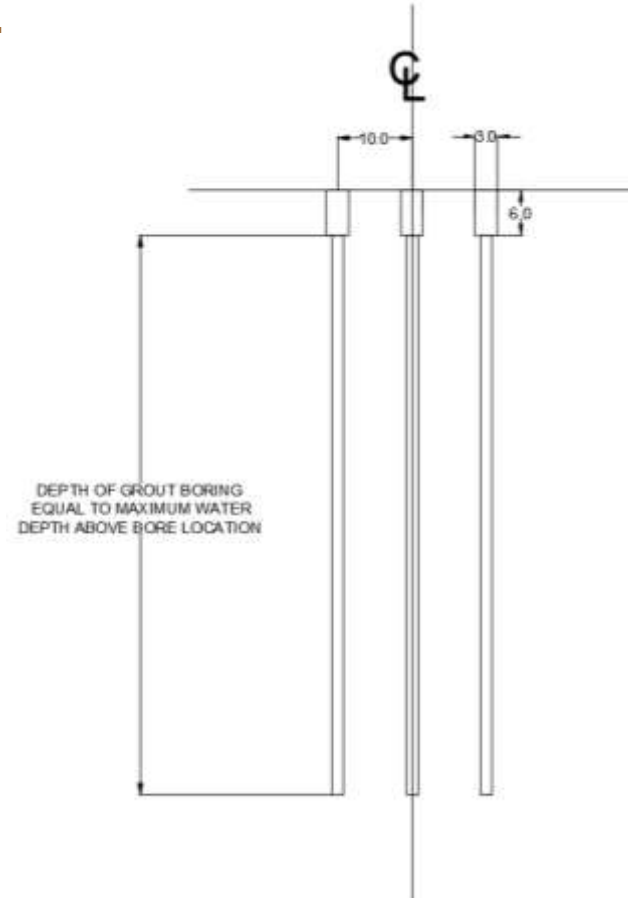


Fig 11. Grout Detail

C. Soils

Seepage Analysis contd...

Results:

- Assuming Test Pit 3 clay is used as core with $K_x=1.1E-5$ ft/min and $K_z=1.2E-6$ ft/min, largest flow through the core of the dam is $1.12 \cdot 10^{-6}$ cfs.
- Flow through dam will be monitored using a V-Notch Weir.

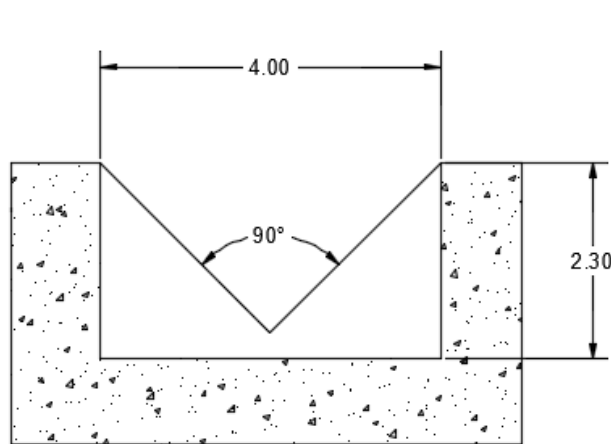


Fig 13. V-Notch Weir

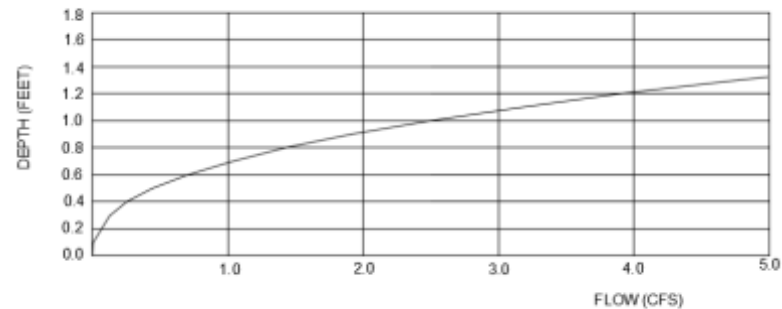


Fig 14. V-Notch Weir Flow Graph

C. Soils

Slope Stability Analysis

- Slide 6.0 was used for the stability analysis of dam.
- Janbu and Bishop methods were selected for the analysis.
- The lowest factor of safety obtained was 1.623 using Janbu method.

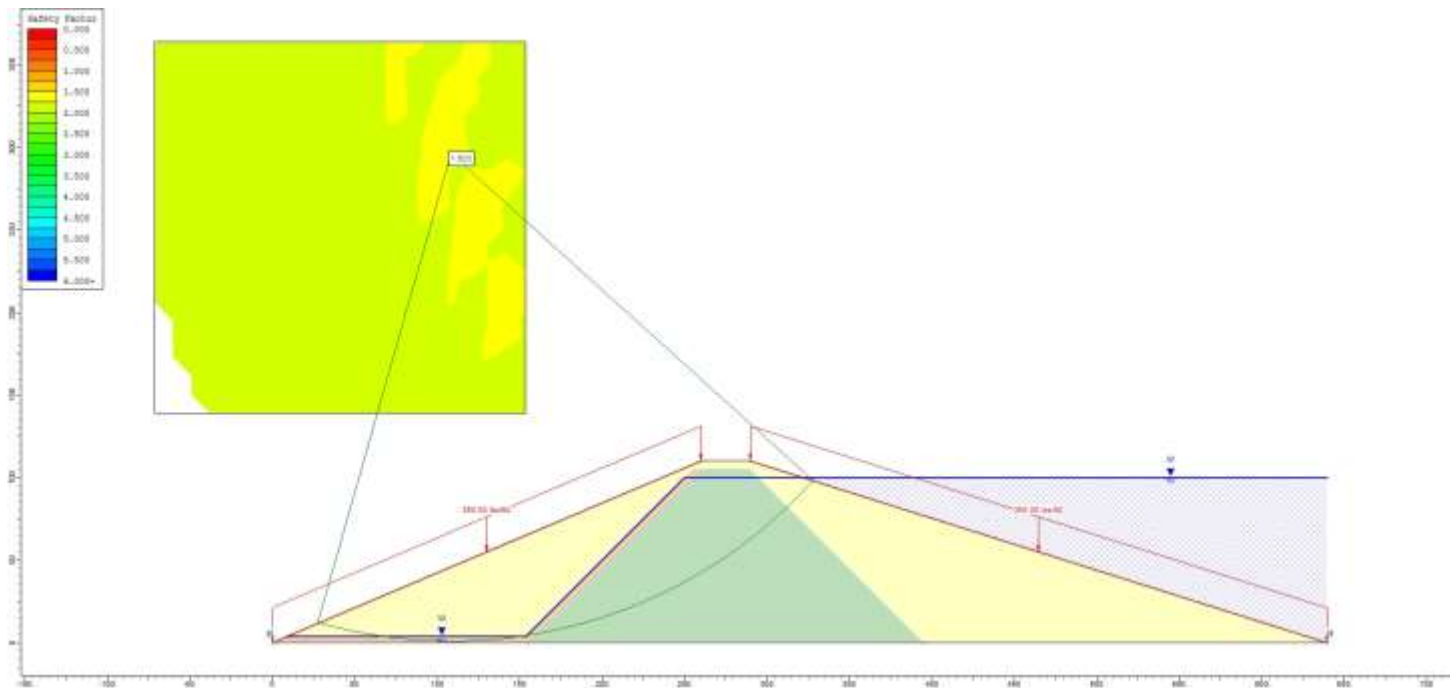


Fig 15. Dam Slope Stability Analysis at Max. Water Level (Janbu method)

C. Soils

Slope Stability Analysis contd...

- Rapid Drawdown Condition:
 - The lowest factor of safety obtained was 1.635 using Janbu method.

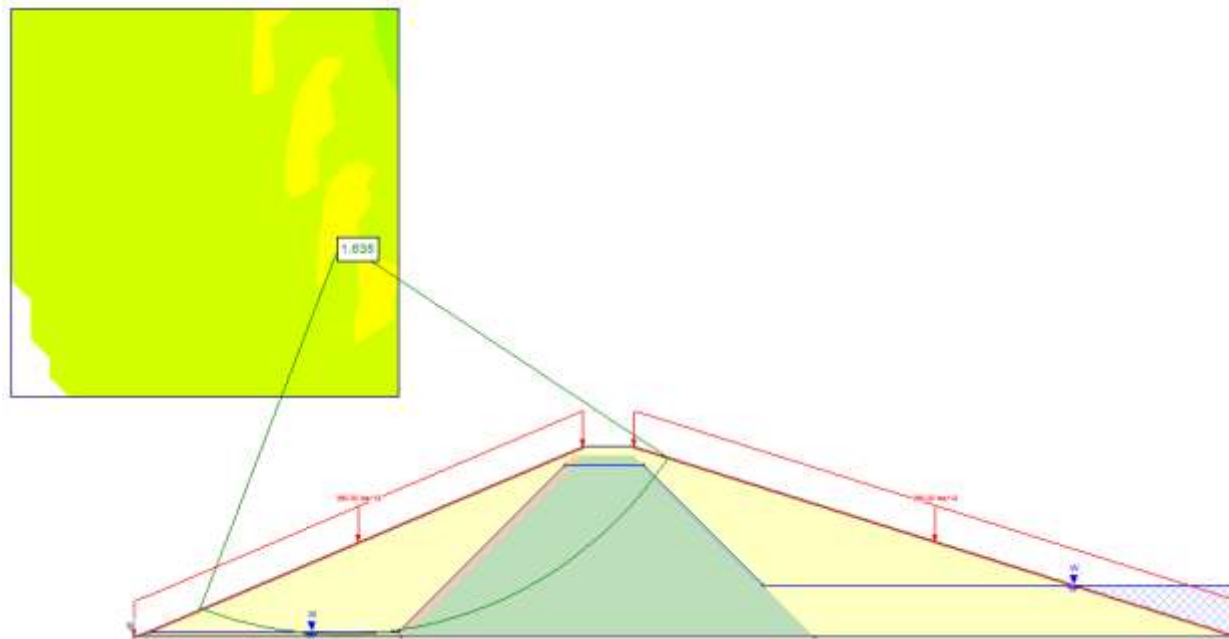


Fig 16. Dam Slope Stability Analysis for Rapid Drawdown (Janbu method)

D. Hydrology

Flood Analysis

- Synthetic Rainfall Events – SCS 24hr rainfall distributions are used to calculate design flood.
- SCS type storms divides country into 4 regions.
- Our study area lies in region with storm Type II.
- Among the 6,12,18 & 24 hr. rainfall distributions developed by SCS, 24 hr. is commonly used for:
 - All rainfalls/storms
 - All time durations

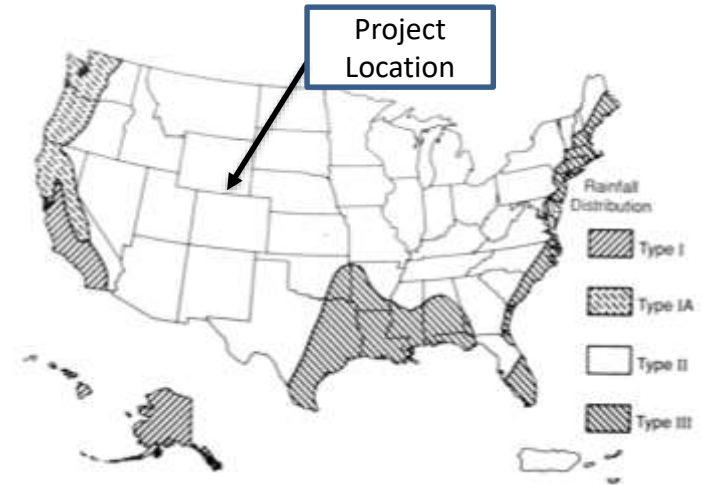


Fig 17. Approximate geographic areas for SCS rainfall distributions

D. Hydrology

Probable Maximum Precipitation(PMP)/Probable Maximum Flood(PMF)

- **PMP**- The theoretical possible maximum depth of precipitation over a catchment area during a certain time of year.
- **PMF**- The flood that is expected to result from the most severe combination of meteorological and hydrological conditions.
- PMP is used in the calculation of PMF which is used as a basis for the design of dams.
- Inflow Design Flood (IDF) based on hazard classification of dam:
 - Low hazard – 24hr, 100yr Flood
 - Significant hazard – $\frac{1}{2}$ 24hr PMF
 - High hazard – Full 24hr PMF
- Considering high risk to downstream users, we have selected Full 24hr PMF as IDF.

D. Hydrology

100 Year Hydrograph Input Parameters

Table 1. Input Parameters for Design WWDC-100yr 24hr Hydrograph

Length (miles) =	9.115	miles
Length Centroid (mi) =	3.59	miles
Area (mi ²) =	14.54	mi ²
Slope (ft./mile) =	86.06	ft./mile
K_N =	0.24	
Rainfall Duration =	24	hrs.
Max Rain =	4	inches
Abstractions =	0.05	in/hr.
Basin Factor =	3.53	
Lag =	9.46	hrs.
D =	1	hrs.
Lagged/2 =	9.96	hrs.
Pe =	391.0	

D. Hydrology

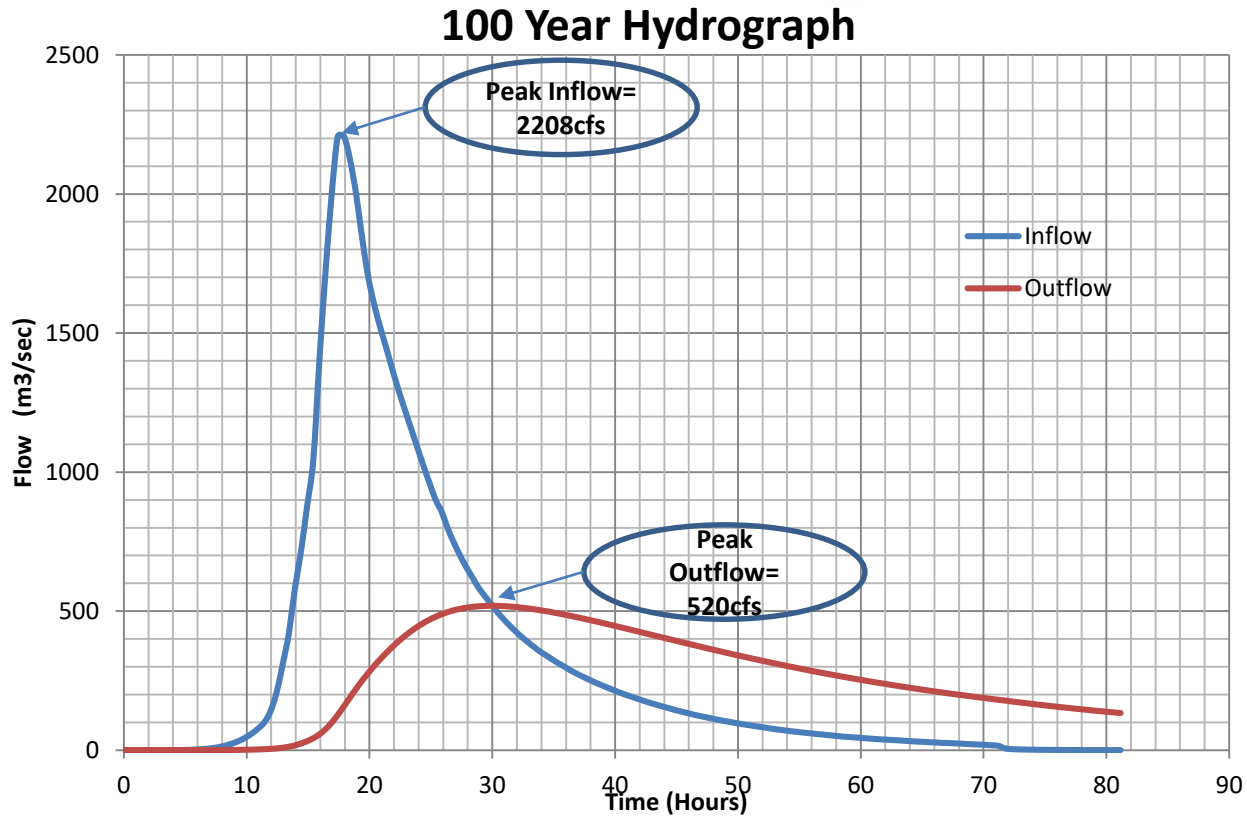


Fig 18. 100 Year Hydrograph

Total Flood Volume = 2190 acre-ft.

Peak outflow = 520 cfs

Time to peak = 29.87 hrs.

D. Hydrology

Primary Spillway

- Used the 100 year flood of 520 cfs to design primary spillway.
- Width of spill way: 35 ft.
- Located just east of dam crest.
- Designed an Ogee curve.
- Crest of Ogee curve at elevation of 7997 feet.
- Maximum 4 feet of water flowing over at elevation 8001 feet.

Stilling Basin

- Provided at the end of spillway and outlet works to protect bed erosion.
- Materials – boulders and cobbles.

D. Hydrology

Primary Spillway contd...

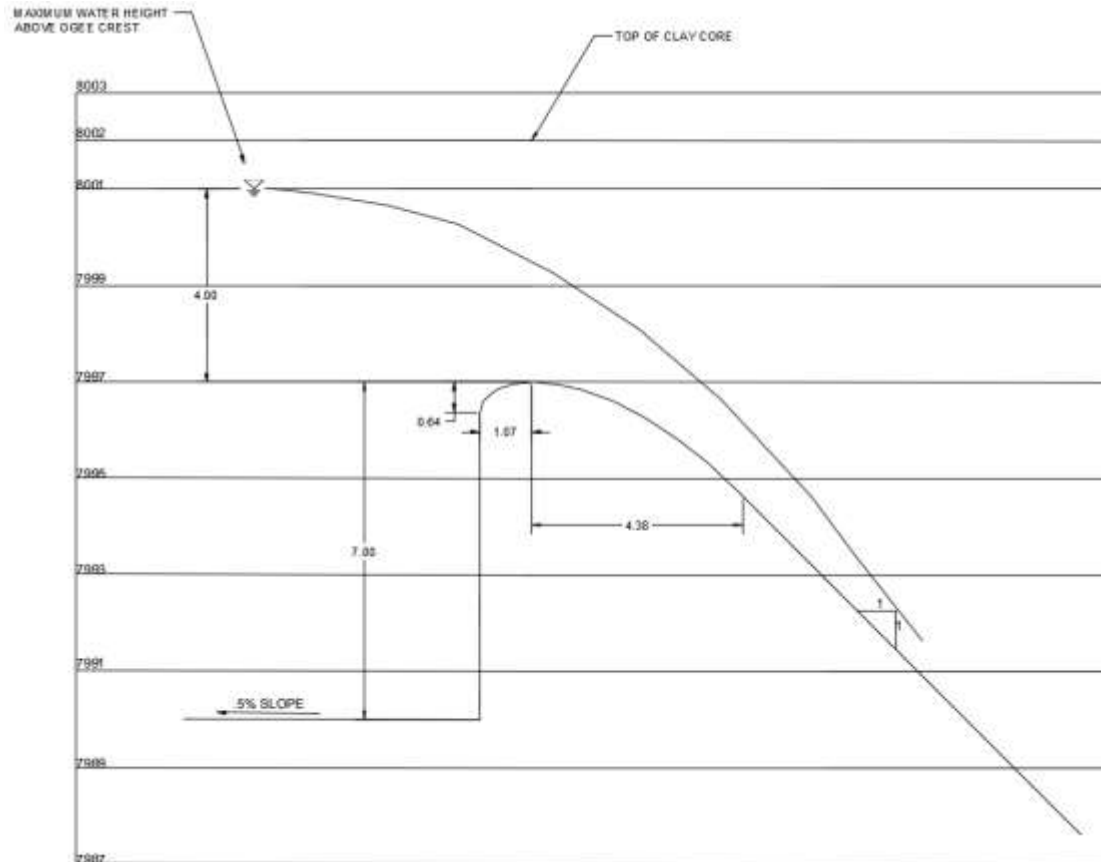


Fig 19. Ogee Curve

D. Hydrology

PMF Hydrograph Input Parameters

Table 1. Input Parameters for Design HMR55A-24hr PMF Hydrograph

Length (miles) =	9.115	miles
Length Centroid (mi) =	3.59	miles
Area (mi ²) =	14.54	mi ²
Slope (ft./mile) =	86.06	ft./mile
K_N =	0.12	
Rainfall Duration =	24	hrs.
Max Rain =	28	inches
Abstractions =	0.05	in/hr.
Basin Factor =	3.53	
Lag =	4.73	hrs.
D =	1	hrs.
Lagged/2 =	5.23	hrs.
Pe =	391.0	

D. Hydrology

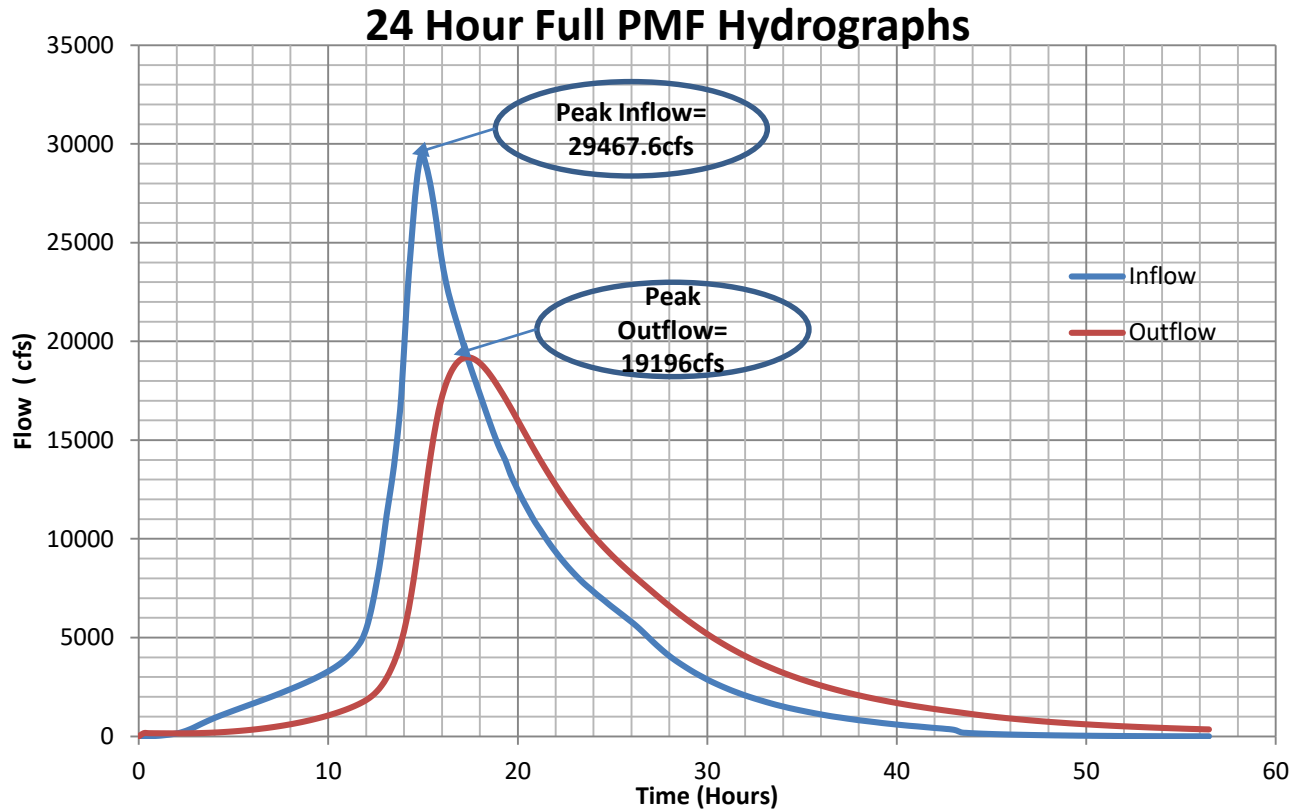


Fig 20. HMR55A-24hr Full PMF Hydrograph

Total Flood Volume = 20757.4 acre-ft.

Peak outflow at Full PMF = 19196 cfs

Time to peak = 17.25 hrs.

D. Hydrology

Auxiliary

- Used the PMF flood of 19196 cfs to design emergency spillway
- Emergency spillway is 425 feet long
- Crest of emergency spillway 8001 feet
- Located just east of the primary spillway

E. Hydraulics

Outlet Work

- Designed to release the 50% of the maximum storage volume of water in 30 days.
- Hazen-William equation was used to determine the diameter of concrete pipe required to meet the drainage.
- Design Discharge = 93.839 cfs
- Outlet pipe diameter = 3.5 ft. = 42 in.
- Length of pipe = 650 ft.
- Gradation of pipe = 1 in 100
- Gate Valve at the intake of pipe.

Outlet Work Design		
To release 50% of the max. storage volume of water in 30 days,		
t=	30 days	2592000 secs
V=	486462331 cf	
50%V=	243231166 cf	
design Q=	93.8391842 cfs	
Concrete Circular Section		
Design Equation: Hazen-William Equation		
Design Q=	93.8391842 cfs	
dia. Of pipe (d)=	3.5 ft	
A=	9.6211275 sqft.	
R=	0.875	
S=	0.01	
C=	100 for concrete	
	$1.318 * C * A * R^{(0.63)}$	
Q=	$63 * S^{(.54)}$	
Q=	96.9630915 cfs	

E. Hydraulics

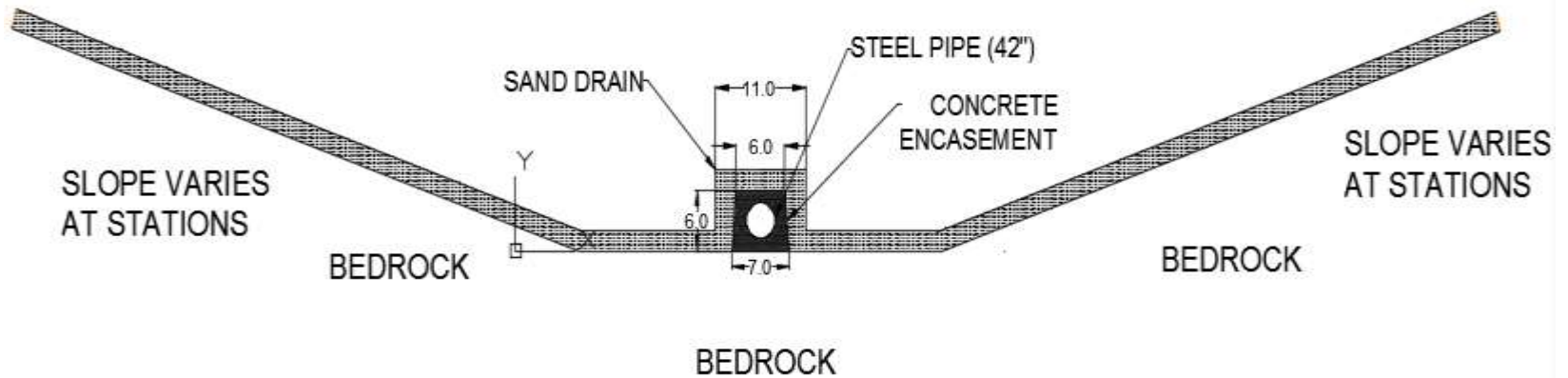


Fig 21. Cross-Sectional Detail of Outlet Work

F. Feasibility/Practicality of Design

- Direct Cost- about \$ 22.34 million.
- Construction Materials – Available from nearby quarry locations.
- Dam completion in one construction season
- Dam Type – Simple zoned earth dam, easy to construct.
- Water storage for domestic supply during dry season.
- Additional recreational facilities:

- Fishing



- Boating



Thank You!

Questions?