FLYING HORSE NORTH

IRRIGATION WELL, PUMP STATION AND RESERVOIR EMBANKMENT

DESIGN REPORT

NOVEMBER 2017

30% SUBMITTAL

Cursory review only with the 30% submittal. Additional comments may be generated with subsequent submittal.

Prepared for:
PRI 2 LLC
6385 CORPORATE DRIVE SUITE 200
COLORADO SPRINGS CO 80919
(719) 592-9333

Prepared by:
CLASSIC CONSULTING ENGINEERS & SURVEYORS
619 N. CASCADE AVE SUITE 200
COLORADO SPRINGS CO 80903
(719) 785-0790

Job no. 1096.11

Add PCD File No. SP-17-012

CLASSIC CONSULTING ENGINEERS & SURVEYORS

FLYING HORSE NORTH
IRRIGATION WELL, PUMP STATION AND RESERVOIR
EMBANKMENT DESIGN REPORT

TABLE OF CONTENTS:

TABLES

Include the Engineer & Developer Certification Page

FIGURES

APPENDICES

CLASSIC SM
CONSULTING
ENGINEERS & SURVEYORS

ACRONYMS AND ABBREVIATIONS

BMP	Best Management Practice
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CCES	Classic Consulting Engineers and Surveyors
EDB	Extended Detention Basin
EURV	Excess Urban Runoff Volume
GIS	Global Information System
HEC-HMS	Hydrologic Engineering Center – Hydrologic Modeling System
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
PUD	Planned Unit Development
SCS	Soil Conservation Service
SWQ	Storm Water Quality
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WQCV	Water Quality Capture Volume

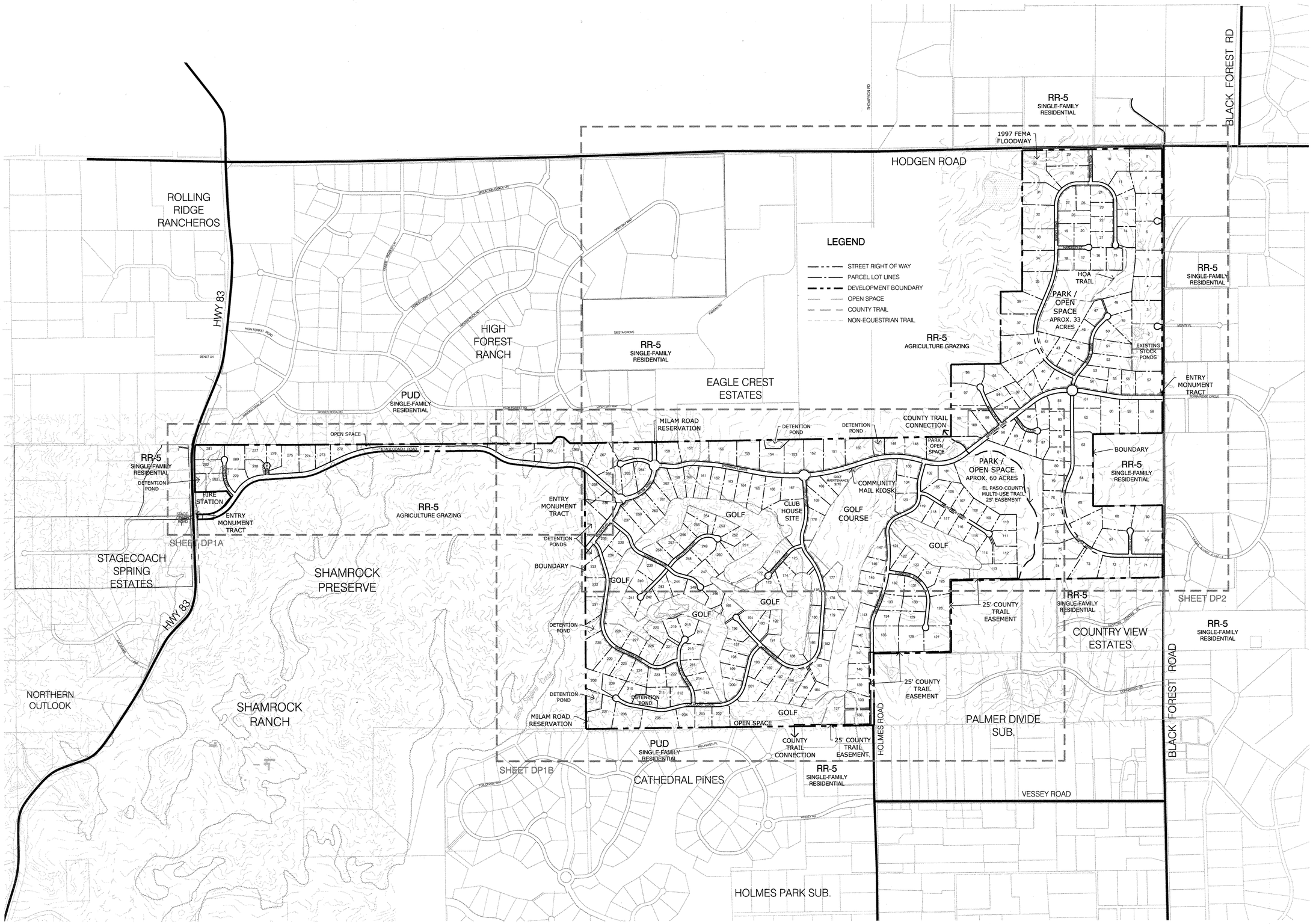
SECTION 1: INTRODUCTION

1.1 PROJECT BACKGROUND

PRI #2 LLC is the property owner and developer of the Flying Horse North (FHN) development in northern El Paso County, Colorado. The overall site contains 1,418 acres located in all of section 36, township 11 south, range 66 west of the sixth principal meridian, and a portion of sections 30 and 31 township 11 south, range 65 west of the sixth principal meridian. The site is bounded on the north by Hodgen Road and the High Forest Ranch Community, to the south by the Cathedral Pines Subdivision and unplatted county land, to the east by Black Forest Road, and to the west by the State Highway 83 and unplatted county land. **(See Figure 1.1)** A Planned Unit Development (PUD) Plan for this property was approved and recorded by El Paso County in February 2017. The development includes large lot single family residential, open space/park land and a private golf course with club house amenities. **(See Figure 1.2)** A phase 1 Final Plat to include the golf course, clubhouse and 81 residential lots will be submitted to El Paso County November 2017. As a part of the private golf course, a lake is planned to serve as a golf course feature, irrigation reservoir for the golf course as well as provide for detention and SWQ. The specific location of this reservoir is within a portion of Section 36, township 11 south, range 66 west of the sixth principal meridian, and a portion of Section 31 township 11 south, range 65 west of the sixth principal meridian. **(See Figure 1.3)** A well, also located in Section 36, is designed to pump directly into the irrigation reservoir with a surface area at normal pool depth of 6.8 acres. A minor jurisdictional dam with low hazard classification will then provide the operational storage for the associated irrigation pump station located adjacent to the reservoir. The pump station is designed to meet the daily peak irrigation demand for the private golf course. The system is planned to be operational in late Spring 2018. Also, per the El Paso County Drainage Criteria Manual and the requirement to provide both stormwater detention and SWQ, this reservoir will also be designed with a separate outlet structure to facilitate the specific release for the various stormwater events.

1.2 TOPOGRAPHIC MAPPING

The topographic base mapping was produced from aerial photography provided by North American Mapping in 2009. The horizontal control is based on a local calibration and the vertical control is based on NGVD 1929 datum.



3/22/2017 217032585

Land Planning
Landscape Architecture
Urban Design

NES

N.E.S. Inc.
619 N. Cascade Avenue, Suite 200
Colorado Springs, CO 80903

Tel. 719.471.0073
Fax 719.471.0267

www.nescolorado.com

PLANNER / LANDSCAPE ARCHITECT

IN ASSOCIATION WITH

FLYING HORSE NORTH

PLANNED UNIT DEVELOPMENT

PROJECT INFO

DATE:	04-18-2016
PROJECT MGR:	J. MAYNARD
PREPARED BY:	K. MARSHALL

SEAL

ISSUE INFO

DATE:	BY:	DESCRIPTION:
07-25-16	KMM	Per review comments
09-07-16	KMM	Per 2nd review comments
11-28-16	KMM	Milam Revisions

ISSUE / REVISION

SHEET TITLE

DEVELOPMENT PLAN OVERALL SITE

SHEET NUMBER

DP
2 OF 6

PLAN FILE #

FIGURE 1.2

P:\Classic2\Shamrock Ranch\Drawings\Planning\Develop\Dp-layout\Flying_Horse_North-DP.dwg [FIGURE.PLAN] 2/8/2017 4:06:11 PM kmarshall

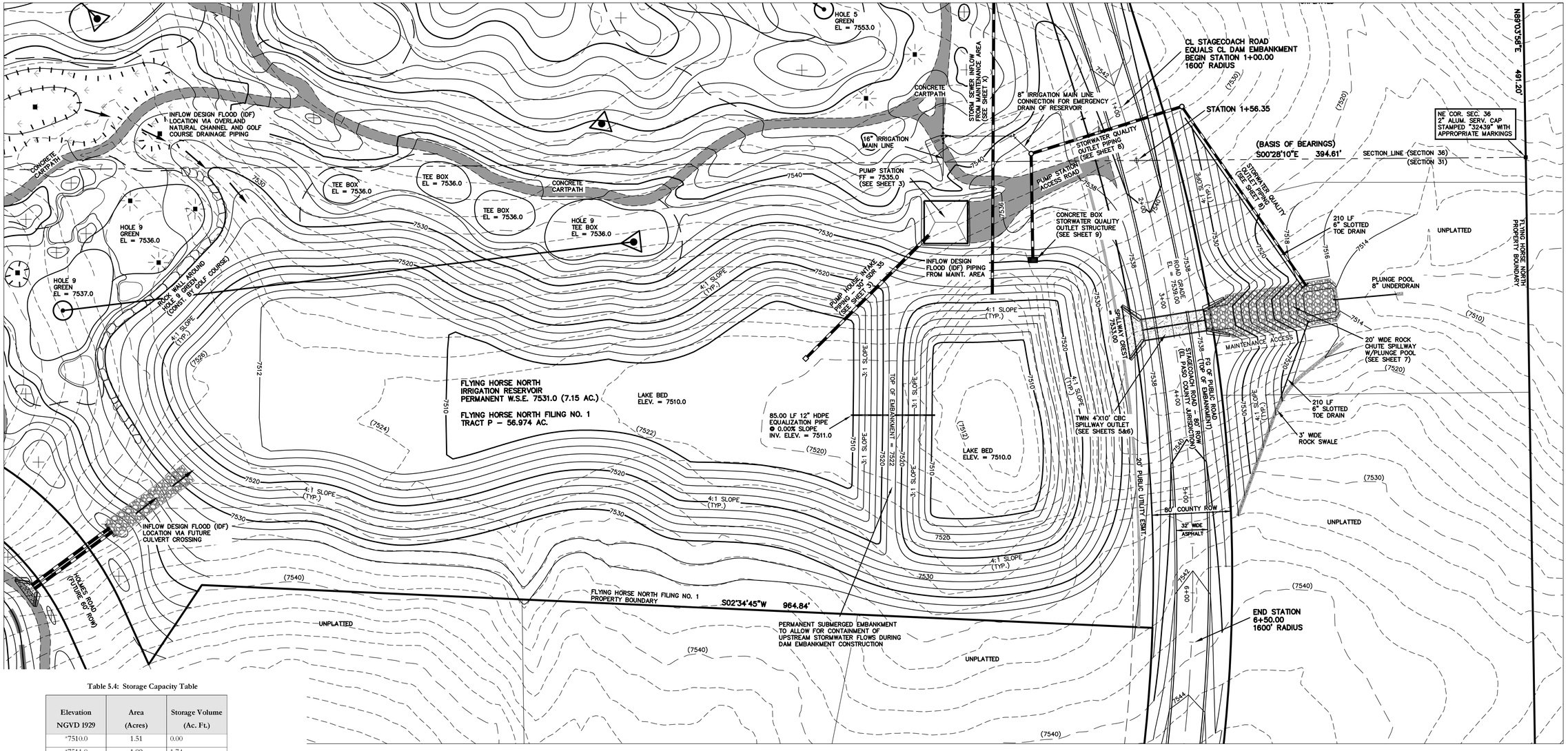


Table 5.4: Storage Capacity Table

Elevation NGVD 1929	Area (Acres)	Storage Volume (Ac. Ft.)
*7510.0	1.51	0.00
*7511.0	1.99	1.74
*7512.0	2.52	3.99
*7513.0	2.85	6.68
*7514.0	3.05	9.63
*7515.0	3.26	12.78
7516.0	3.48	16.15
7517.0	3.70	19.74
7518.0	3.93	23.56
7519.0	4.16	27.60
7520.0	4.40	31.88
7521.0	4.64	36.40
7522.0	4.88	41.16
7523.0	5.14	46.17
7524.0	5.36	51.42
7525.0	5.59	56.89
7526.0	5.84	62.61
7527.0	6.08	68.57
7528.0	6.33	74.77
7529.0	6.57	81.22
7530.0	6.81	87.91
7531.0	7.15	94.89
7532.0	7.52	102.22
7533.0	7.83	109.90
7534.0	8.37	118.00
7535.0	8.77	126.57
7536.0	9.17	135.53

*Indicates dead storage below pumping ability

Table 5.5: Reservoir Discharge Table

Elevation	Discharge (cfs) (SWQ Outlet Box)	Discharge (cfs) (Twin CBC Spillway)	Discharge (cfs) (Total)
7531.0	0.0	0.0	0.0
7532.0	13.89	0.0	13.89
7533.0	27.77	0.0	27.77
7534.0	51.31	49.05	100.36
7535.0	69.52	138.56	208.08
7536.0	74.61	254.72	329.33

Permanent WSE = 7531.0

Top of SWQ Outlet box = 7533.0

Spillway elevation = 7533.0

NOTES:

1. TOPOGRAPHIC BASE MAPPING PRODUCED FROM AERIAL PHOTOGRAPHY PROVIDED BY NORTH AMERICAN MAPPING IN 2009. HORIZONTAL CONTROL IS BASED ON LOCAL CALIBRATION TIED TO SECTION CORNER AND VERTICAL CONTROL IS BASED ON NGVD 1929 DATUM.
2. PERMANENT WSE = 7531.0
3. RESERVOIR LINER INSTALLED UP TO ELEVATION 7534.0

50 25 0 50 100

SCALE: 1" = 50'

48 HOURS BEFORE YOU DIG,
CALL UTILITY LOCATORS
811
UTILITY NOTIFICATION CENTER OF COLORADO
IT'S THE LAW

THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE CAUSED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

NO.	REVISION	DATE

REVIEW:

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF CLASSIC CONSULTING ENGINEERS AND SURVEYORS, LLC

MARC A. WHORTON, COLORADO P.E. #37155 DATE

CLASSIC SM
CONSULTING
ENGINEERS & SURVEYORS
619 N. Cascade Avenue, Suite 200 (719)785-0790
Colorado Springs, Colorado 80903 (719)785-0799(Fax)

FLYING HORSE NORTH
IRRIGATION RESERVOIR EMBANKMENT
SITE LAYOUT WITH GRADING
FIGURE 1.3

CLASSIC CONSULTING ENGINEERS & SURVEYORS

DESIGNED BY	MAW	SCALE		DATE	10-18-17
DRAWN BY	MAW	(H) 1"= 50'		SHEET	4 OF 12
CHECKED BY		(V) 1"= N/A		JOB NO.	1096.11

SECTION 2: IRRIGATION WELL

2.1 LOCATION / WELL DRILLING

Just finished the well drilling and will hopefully have this information to include for 100% submittal.

2.2 HYDRAULIC TESTING

2.3 PUMP DESIGN AND EQUPMENT

2.4 WELL HOUSING

SECTION 3: PUMP STATION

3.1 LOCATION / IRRIGATION DEMAND

The proposed irrigation pump station will be located directly adjacent to the Flying Horse North reservoir as shown on the conceptual plan in **Figure 1.3**. The pump station pumps stored groundwater from the reservoir to the irrigation system that serves the entire golf course that anticipates using an average of 200 AF per year.

3.3 MECHANICAL EQUPMENT

The pump station will include the following components: intake, wet well, pumping equipment, filters and metering equipment and controls.

Lake Intake

The intake for the pump station is located in the Flying Horse North reservoir towards the north end. **(See Figure 1.3)** The 4'x4' intake with 48" stainless steel inlet screens will sit on a 12" thick concrete slab near the base of the lake. A 30" SDR 35 pipe will convey the water from the intake structure to the wet well located beneath the pump station.

Wet Well

The pump station wet well consists of a 96" diameter precast concrete structure with a height of 25'. The base elevation equals 7510. The invert of the 30" SDR 35 intake pipe is 1.0' above the wet well base. This connection is made with a KOR-N-SEAL Boot36. In the wet well there are high and low level water probes that turn on and off the lake fill pump and will shut down the station if the water level gets down to elevation 7514.83. The wet well has access through a 24"x26" hatch located in the floor of the pump station.

Pumping Equipment / Filtering

The pump station is designed as a Variable Frequency Drive (VCD) station with pumping equipment consisting of three 75 hp. pumps and one 5 hp. sustain pump. The VCD system turns on and off the pumps on a pressure / GPM demand allowing each of the 75 hp. pumps to facilitate 150 – 750 GPM rated for a total performance of 2250 GPM @ 110 psi. The construction will also include a blind flange for a

fourth 75 hp. pump which may be installed in the future for a total rating of 3000 GPM @ 110 psi. The pumps are designed to deliver the required flow for the golf course irrigation system via a flanged 16" mainline from the pump station. Internal to the pump station, two 8" VAF 1500 filters with 300 micron screens will provide filtration of the system to eliminate system blockage.

3.4 PUMP HOUSE STRUCTURE

The pump station will be located adjacent to the reservoir along the western edge and have a FF elevation of 7535. (Two feet above spillway) The footprint of the structure is approximately 30'x20'. The access to this facility will be via a paved driveway directly off of Stagecoach Road. The pump station power requirements are 480 V, 60 Hz, 3 PZ, 386 FLA with a 600 AMP disconnect. The power supply will be provided by Mountain View Electric Association (MVEA) via a 3-phase circuit. The underground electric infrastructure serving the entire Flying Horse North development will be designed by MVEA and installed by the property owner/developer. Based on the location of the pump station (directly adjacent to Stagecoach Road and the 3-phase loop) and design provided by the MVEA, this facility will have redundant service built into the system as it will be fed from two directions. Thus, the reliability of power is nearly 100%.

SECTION 4: RESERVOIR AND DAM

4.1 DESIGN CRITERIA

The proposed dam for the Flying Horse North Irrigation Reservoir was designed in accordance with Rule 5 of the State of Colorado Rules and Regulations for Dam Safety and Dam Construction, dated January 2007. The dam meets the criteria for a "**minor jurisdictional low hazard dam"** as defined by Rules 4.2.5.1 and 4.2.5.3.

4.2 RESERVOIR

This watershed will contain development of a private golf course (currently under construction) including an outdoor golf maintenance facility, along with 2.5 ac. rural residential lot development accessed by rural County paved roadways. As such, the irrigation reservoir will also be designed with a separate stormwater detention and SWQ component per El Paso County criteria. This separate structure will be in the form of a concrete outlet box with an orifice plate and 30" RCP outlet allowing the release of the smaller storm events to meet the standards as specified per this criteria and the County's MS4 permit with the State. This SWQ release through the 30" RCP will be constructed outside of the reservoir embankment. The specific location of this reservoir is within a portion of Section 36, township 11 south, range 66 west of the sixth principal meridian, and a portion of Section 31 township 11 south, range 65 west of the sixth principal meridian, El Paso County Colorado. **(See Figure 1.3)**

The reservoir has a surface area at its permanent WSE (Elev. 7530.0) of 6.8 acres with a storage volume of 87.9 acre feet. The maximum depth at this elevation is 20 feet with the lake bed at 7510. The reservoir will have a liner constructed of a flexible membrane. This liner will be laid up to a maximum elevation of 7534. The reservoir is supplied by water from a well located on the Clubhouse site within the development approximately 1/4 mile west of the reservoir. The level in the reservoir is controlled by the two outlet structures. The Detention/SWQ structure will facilitate the State required 72 hr. drain time for the smaller stormwater events and help maintain the permanent water level while the twin box culvert spillway will allow for the County required 100 yr. detention release of the major stormwater events. The total storage capacity table is found in Section 5, Table 5.4.

4.3 DAM EMBANKMENT

The dam embankment for this reservoir will end up being the County owned and maintained Stagecoach Road (80' ROW - Collector). The crest of the embankment, which will be the finished grade of asphalt for the roadway is at elevation 7539.0 at the lowest point. The regulatory height from the twin box culvert emergency spillway invert to the native channel grade equals 18.2'. The length of the embankment measured from the tow of slopes on each side is approximately 450'. Both the upstream and downstream slopes of the embankment will be constructed at no greater than a 4:1 slope. The roadway will have a typical 2% crown with an asphalt width of 32.0' with 2.0' of gravel shoulders and then 6:1 maximum to edge of ROW with a County required clear zone of 14.0'. The twin box culvert emergency spillway structure is outside this clear zone. The dam embankment will be constructed of local material found on-site and tested by the Geotech. According to the State of Colorado Rules and Regulations for Dam Safety and Dam Construction, Rules 4.2.5.1 and 4.2.5.3, this facility is considered a "**Minor Jurisdictional Dam"** given the jurisdictional height greater than 10 feet but less than 20 feet and a capacity less than 100 acre-feet.

4.4 SPILLWAY AND OUTLET WORKS

This facility will be designed with two separate outlet structures. One will facilitate the State/County required detention/SWQ component of the facility while the other will allow for the 100 yr. stormwater event and emergency flow situations. A low level outlet will be built into the pump station design with connection to the SWQ outlet piping.

Detention / SWQ Outlet

Per the County's MS4 permit with the State, this development is required to provide detention and stormwater quality within this reservoir facility. The design for this is being handled by a separate concrete outlet box constructed outside the formal dam embankment. This structure is a 4'x8' concrete box with a steel flow control plate and protective well screen located on the front. The control plate is designed with three rectangular holes to facilitate the State required drain times. The first holes is located at elevation 7531.0 with the top of box at elevation 7533.0. The top of box will be constructed with a grate to allow flows to enter the box as well. A 30" RCP outlet pipe will allow for the release of all the flows entering the box structure. The design of this structure meets all State and County requirements for both EURV and

WQCV. The 30" RCP outlet piping will be routed around the dam embankment and into the rock chute and plunge pool at the base of the emergency spillway.

Spillway Outlet

Given that the embankment for this reservoir will be a County roadway, the conventional emergency spillway channel design at the crest of the embankment was not appropriate. But rather a concrete box culvert spillway design under the roadway to allow for both the major stormwater events and emergency release has been employed. Twin 4'x10' concrete box culverts (CBC) will facilitate the required releases. The crest of the spillway will be constructed at elevation 7533.0 where the release will then travel under the roadway and into a 20' wide rock chute. The rock chute will have a 4:1 slope with 3:1 side slopes and a total drop of 18.0' into a 2.0' deep plunge pool. The rip-rap sizing will be d50=18" with a depth of 3.0' over bedding material as specified in the Geotechnical report. The spillway has been designed to accommodate both the 100 yr. release of 227 cfs with a headwater depth ratio (Hw/D) of 0.62 and the total basin inflow of 505 cfs with a Hw/D of 1.15. This design is well within the required County criteria of Hw/D of 1.40.

Low Level Outlet

This reservoir will not be designed with a formal low level outlet given the nature of the facility and the ability for the pump station to facilitate the draining of the reservoir for embankment inspection or emergency purposes. Thus, directly off of the 16" irrigation main just outside the pump station, a 16"x8" tee with gate valves and an 8" drain line will be installed to allow for the pumped release and draining of the reservoir. This 8" drain line will then connect directly to the 30" RCP storm system via a Type II concrete storm manhole constructed as a part of the release of the Detention/SWQ component as required by El Paso County. This 30" storm system then daylights into the base of the rock chute and plunge pool on the backside of the embankment. The 8" drain line @ 110 psi is expected to release 800-1200 GPM. As mentioned earlier, the pumps will allow for release down to an elevation of 7514.83. Based on the permanent WSE of 7531, this equates to a total of nearly 25 million gallons (MG) to be drained. The total drain time is estimated at approximately 14 days.

4.6 COST ESTIMATE

The construction costs have been estimated for the dam and reservoir construction for budgetary planning purposes. See Table 4.1 below for the major construction activities:

Fill in.

Table 4.1: Estimated Construction Costs

Description	Estimated Cost
Flying Horse North Well No. A-1 (Arapahoe)	
Irrigation Pump Station and Intake	
Reservoir Lining and installation	
Embankment earthwork / Revegetation	
SWQ Outlet box and piping	
Twin 4'x10' CBC Spillway Outlet and wingwalls	
20' wide rock chute and plunge pool	
Two 6" slotted pipe toe drains / 3' rip-rap swale	
8" Irrigation drain piping / 12" HDPE pipe	
Subtotal	
Contingency	
Construction staking / Engineering testing	
Total Project Cost	

4.7 PERMITTING / SCHEDULE

The dam application package will be submitted to The Dam Safety Branch (DSB) for review and comment in the Fall of 2017. No dam related construction will take place on-site until a notice to proceed from DSB is received. A separate submittal package will also be provided to El Paso County for review. Owner/developer to provided DSB approval and notice to proceed to El Paso County prior to their final approval of the facility. Construction is anticipated to begin in the of Spring 2018.

SECTION 5: HYDROLOGY AND HYDRAULICS

5.1 DESIGN CRITERIA

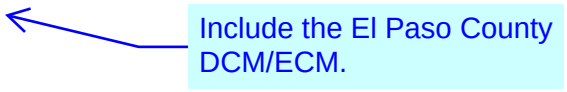
The Flying Horse North irrigation reservoir will function as both a water source for the golf course irrigation and a detention/stormwater quality (SWQ) pond for stormwater flows within the basin. As such, CCES has applied hydrology criteria from the following sources:

"State of Colorado Rules and Regulations for Dam Safety and Dam Construction", dated January 2007 (Inflow Design Flood – IDF requirements)

"City of Colorado Springs/El Paso County Drainage Criteria Manual, Vol. 1 & 2", dated May 2014 (Stormwater detention and SWQ requirements)

"Urban Drainage and Flood Control District Vol. 1, 2 & 3", dated 2017 (Detention and SWQ design requirements)

"NOAA Atlas 14 Point Precipitation Frequency Estimate", dated October 2017 (Precipitation Frequency – 24hr duration)



A Bentley Systems PondPack V8i NRCS unit hydrograph model was utilized to estimate the peak discharge for the 2-, 5-, 50- and 100-year, 24-hour duration storms. NOAA Atlas 14 point precipitation frequency estimates were obtained from the NOAA's National Weather Service Hydro-Meteorological Design Studies Center Precipitation Frequency Data Server (PFDS). This data was taken near the centroid of the basin. (See Appendix B) The NRCS 24-Hour Type II design storm distribution was used within the model.

According to the State of Colorado Rules and Regulations for Dam Safety and Dam Construction, Rules 4.2.5.1 and 4.2.5.3, this facility is considered a "**Minor Jurisdictional Dam"** given the jurisdictional height greater than 10 feet but less than 20 feet and a capacity less than 100 acre-feet. Dead storage of approximately 5.0' (Elev. 7510 – 7515) is assumed based on the low-level outlet design facilitated by the pump station in-take pipe located at elev. 7511 and suction head of 4.0' min. required above pipe. Based on

the "**Low Hazard Classification**" as described in section 5.6 of this report the Inflow Design Flood Requirements (IDF) as found in Rule 5.9.1.3.5 utilize the (NOAA 14 – 24 Hr. duration) 50 Yr. storm event. However, along with the SWQ design component as required by the County, the (NOAA 2 – 24 Hr. duration) 100 Yr. storm event will be utilized. The UD-Detention v3.07 spreadsheet (Per Urban Drainage Vol. 3) will also be utilized in the final design of the Detention and SWQ aspects of this facility. This spreadsheet uses 1 Hr. precipitation depths. See Table 5.1 for precipitation depth comparison.

Table 5.1: Precipitation Depth Comparison

Return Period	1-Hr. Depth (City/County)	1-Hr. Depth (NOAA 14)	24-Hr. Depth (City/County)	24-Hr. Depth (NOAA 14)
2	1.19	0.92	2.10	1.93
5	1.50	1.20	2.70	2.44
50	2.25	2.15	4.20	4.33
100	2.52	2.49	4.60	5.04

5.2 WATER RIGHTS

Based on the water decree filed October 6, 2017 (See Appendix), PRI #2, LLC has the water rights to pump and store in the on-site Flying Horse North reservoir. PRI #2, LLC has a lease from the State Land Board for the following water rights: 515 AF in the Dawson, 577 AF in the Denver, 239 AF in the Arapahoe and 182 AF in the Laramie Fox Hills. The Arapahoe and Laramie Fox Hills are both deemed non-tributary reservoirs. The Flying Horse North Golf Course will take an average of 200 AF per year from their Arapahoe well that will be pumped into the reservoir. Evaporative loss is not an issue when pumping from a non-tributary source. Upon termination of the State Land Board Lease in 2048, all water rights revert automatically back to PRI #2, LLC who will own them in perpetuity.

5.3 WATERSHED CHARACTERISTICS

The watershed of the irrigation reservoir includes a total area of 366.8 acres within the East Cherry Creek drainage basin and just north of the Palmer Divide. A portion of this area is outside the Flying Horse North development as shown in basins OS-12, OS-13 and OS-14. These basins are both currently undeveloped and developed as County zoned RR-5 (5 ac. rural residential). All the on-site basins are zoned PUD for either 2.5 ac. rural residential or golf course/open space. (See Tables 5.2 and 5.3 for sub-basin CN values and associated Tc times) Nearly the entire watershed is outside of the black forest tree line and mainly consists of prairie grasses with grades ranging from 2%-20% with three major natural ravines that drain in a northwesterly direction directly towards the planned irrigation reservoir. The golf course layout aides in the natural conveyance of the majority of the stormwater flows to the reservoir. The storage capacity table for the reservoir is listed in Table 5.4.

Table 5.2: Sub-basin CN Values

ALL LAND ASSUMED 2 ACRE RESIDENTIAL LOTS OR
GOOD CONDITION OPEN SPACE (LAWNS, PARKS GOLF COURSES, CEMETARIES ETC.)

C_N VALUES - DEVELOPED CONDITIONS

BASIN (label)	BASIN AREA (Ac)	GOLF COURSE (B)		2 AC. RESIDENTIAL (B)		COMPOSITE C_N
		CN	AREA (Ac.)	CN	AREA (Ac.)	
CC-1	22.3	61	0.0	65	22.3	**65.0**
CC-2	36.4	61	0.0	65	36.4	**65.0**
CC-3	51.9	61	19.1	65	32.8	**63.5**
CC-4A	108.2	61	63.2	65	45.0	**62.7**
CC-4B	17.0	61	5.5	65	11.5	**63.7**
OS-12	67.7	61	0.0	65	67.7	**65.0**
OS-13	36.9	61	0.0	65	36.9	**65.0**
OS-14	26.4	61	0.0	65	26.4	**65.0**

Table 5.3: Sub-basin Time of Concentration

TIME OF CONCENTRATION DEVELOPED

	COMPOSITE		OVERLAND		STREET / CHANNEL FLOW (DCM Vol. 1 Fig. 6-25)				Tc	Tc
BASIN	Cn	Length	Height	Tc	Length	Slope	Velocity	Tc	TOTAL	LAG (0.6tc)
		(ft)	*(ft)*	*(hr)*	*(ft)*	*(%)*	*(fps)*	*(hr)*	*(hr)*	*(hr)*
CC-1	65.0	300	10	0.40	900	2.0%	1.8	0.14	0.53	0.32
CC-2	65.0	300	10	0.40	1700	2.0%	1.8	0.26	0.66	0.39
CC-3	63.5	300	14	0.35	900	2.5%	2.4	0.10	0.45	0.27
CC-4A	62.7	300	14	0.35	2900	2.0%	2.1	0.38	0.73	0.44
CC-4B	63.7	300	12	0.37	900	3.0%	2.5	0.10	0.47	0.28
OS-12	65.0	300	14	0.35	1500	3.0%	2.5	0.17	0.51	0.31
OS-13	65.0	300	16	0.33	900	3.0%	2.5	0.10	0.43	0.26
OS-14	65.0	300	14	0.35	600	3.5%	2.7	0.06	0.41	0.24

Table 5.4: Storage Capacity Table

Elevation NGVD 1929	Area (Acres)	Storage Volume (Ac. Ft.)
*7510.0	1.51	0.00
*7511.0	1.99	1.74
*7512.0	2.52	3.99
*7513.0	2.85	6.68
*7514.0	3.05	9.63
*7515.0	3.26	12.78
7516.0	3.48	16.15
7517.0	3.70	19.74
7518.0	3.93	23.56
7519.0	4.16	27.60
7520.0	4.40	31.88
7521.0	4.64	36.40
7522.0	4.88	41.16

CLASSIC SM
CONSULTING
ENGINEERS & SURVEYORS

7523.0	5.14	46.17
7524.0	5.36	51.42
7525.0	5.59	56.89
7526.0	5.84	62.61
7527.0	6.08	68.57
7528.0	6.33	74.77
7529.0	6.57	81.22
7530.0	6.81	87.91
7531.0	7.15	94.89
7532.0	7.52	102.22
7533.0	7.83	109.90
7534.0	8.37	118.00
7535.0	8.77	126.57
7536.0	9.17	135.53

*Indicates dead storage below pumping ability

5.4 HYDROLOGIC MODEL

The PondPack model produced peak discharges for the 2-yr, 5-yr, 50-yr and 100-yr storm events assuming a permanent pool elevation of 7531.0. Reference Appendix B for specific hydrologic model results. Table 5.5 below shows the results of these storm events upon the irrigation reservoir.

Table 5.5: Inflow Design Flood (IDF) Summary Table

Storm Event	Peak Inflow (cfs)	Max. WSE (ft.)	Total Discharge (cfs)
2-yr (City/County)	49	7531.45	6
5-yr (City/County)	122	7531.95	13
50-yr (NOAA 14)	446	7533.63	68
100-yr (City/County)	505	7533.89	91

5.5 HYDRAULIC MODEL

Both the SWQ Outlet and the CBC Spillway were modeled using both PondPack (24-hr. precipitation) and the Urban Drainage UD Detention Spreadsheet (1-hr precipitation) as required by County design criteria. Table 5.6 below shows the results of the PondPack model. Reference Appendix B for the UD Detention – Retention Pond Spreadsheet results. As this facility is required to meet both detention and SWQ criteria, the following is applicable to these design components:

Required WQCV =	1.40 ac-ft.	Provided WQCV =	15.01 ac-ft.
Required EURV =	2.82 ac-ft.	Provided EURV =	15.01 ac-ft.
Required 100-yr. =	12.42 ac-ft.	Provided 100-yr =	27.35 ac-ft.

Table 5.6: Reservoir Discharge Table

Elevation	Discharge (cfs) (SWQ Outlet Box)	Discharge (cfs) (Twin CBC Spillway)	Discharge (cfs) (Total)
7531.0	0.0	0.0	0.0
7532.0	13.89	0.0	13.89
7533.0	27.77	0.0	27.77
7534.0	51.31	49.05	100.36
7535.0	69.52	138.56	208.08
7536.0	74.61	254.72	329.33

Permanent WSE = 7531.0

Top of SWQ Outlet box = 7533.0

Spillway elevation = 7533.0

The twin 4'x10' CBC Spillway design has the following results:

100-yr storm release = 227 cfs	Hw/D = 0.62
Emergency release – Max. basin IDF = 505 cfs	Hw/D = 1.15
County Criteria (max.)	Hw/D = 1.40

5.6 HAZARD CLASSIFICATION

As discussed earlier based on the State of Colorado Rules and Regulations for Dam Safety and Dam Construction, dated January 2007, defined by Rule 4.2.5.3, this proposed irrigation reservoir is considered a "Minor Dam". This facility will be lined and has also been designed based on County criteria for detention and SWQ that meets the 100-yr event, which is in excess of the required NOAA 14 50-yr. requirement. The location of the facility is in a rural environment with downstream characteristics being a single property ownership (362 acres) within El Paso County, zoned RR-5 with a single family home and multiple out-buildings. Based on topography, the home seems to be well outside of the possible floodway with no loss of human life expected. Thus, based on the rural nature, location and size of this proposed irrigation reservoir, it is considered a "Low Hazard Dam" as described in the State of Colorado Rules and Regulations for Dam Safety and Dam Construction, dated January 2007, defined by Rule 4.2.14.3.

SECTION 6: GEOLOGICAL INVESTIGATION

6.1 FIELD INVESTIGATIONS

Subsurface conditions within the dam footprint and soil borrow areas were explored by drilling thirteen test borings. The locations of the soil borings were determined based on access points on the property. Six test borings were drilled in the proposed dam footprint, two test borings were drilled in the proposed west borrow area, and five test borings were drilled in the proposed east borrow area to obtain soils information for use within the new dam embankment. The borings were typically advanced to depths of approximately 10 to 40 feet below ground surface (bgs) with one tested area, Test Boring No. 13, that was excavated with a small backhoe by an onsite contractor, prepared to 3 feet (bgs) in the proposed east borrow area. The soils in all but Test Boring No. 13 were obtained using a truck mounted, drilling rig with continuous flight auger supplied and operated by Entech.

Representative soil samples were recovered from each of the borings at approximate 5-foot intervals using 2-inch O.D. split barrel and California samplers and following Standard Penetration Test (ASTM D-1586) procedures. The locations and soil descriptions of the soils field investigation are presented in the appendicies of the Subsurface Soil Investigation which is included in this report, Appendix C.

6.2 TEST BORINGS / LABORATORY TESTING

Boring logs describing the subsurface conditions encountered in each of the borings and excavated area are included in the above-referenced Subsurface Soil Investigation. Laboratory classification testing was completed on selected soil samples recovered from the borings and soil borrow area for purposes of determining water content, evaluating engineering properties, classification and for grouping the materials by soil type. The water content testing results and soil types (by number) are included on the boring logs with respect to the sample depth measured from the existing ground surface. In addition to the classification testing sulfate, pH, resistivity, permeability, and direct shear testing was completed. A summary of the laboratory testing and the Unified Soil Classification System (USCS) designations for each of the soils encountered in the borings and the soil borrow areas are included in the appendicies of the geotechnical report included in Appendix C.

6.3 RECOMMENDATIONS FOR CONSTRUCTION

The test borings were located to provide general geotechnical information and subsurface profiles at the new embankment location and soil borrow areas. Variations in subsurface conditions may be encountered across the site. Pockets of low soil densities determined from the standard penetration testing conducted during drilling indicated isolated zones within the surficial native soil exist in the existing drainageway. The loose zones were encountered in Test Boring Nos. 2 and 3. Surficial clays and silts with low bearing capacities were encountered in Test Boring Nos. 2, 4, and 6 were also encountered in the existing drainageway within the location of the proposed dam embankment. During excavations for the dam foundation, the loose and potentially low bearing soils will be excavated to the underlying medium dense to dense soil strata below. It is likely the granular soils removed from the foundation areas will be reused in the embankment foundation or reused in the new dam embankment. Spoils removed will likely be used elsewhere on the golf course property in softscape areas.

Additional soils drilling and testing is recommended after the dam foundation is exposed to verify the condition of the underlying geology for support and construction of the dam foundation and outlet structures. Based on our Sulfate, pH, and Resistivity Testing conducted on the soils proposed to construct the new dam, the soils exhibit a negligible potential for attack on concrete structures and Type II concrete is recommended. The soils are slightly to moderately acidic and corrosive to highly corrosive; therefore, all steel materials in contact with the new dam embankment soils should be cathodically protected.

The property in the vicinity of the new dam would provide a close staging area for construction equipment and storage of usable soils removed from the dam. The east borrow are was determined to provide an ample and close soil source for the dam embankment. Laboratory testing performed on the soils located at the east borrow area determined the soil suitable for the construction of a new earthen embankment. Initial slope stability analysis' indicates the embankment stability with elevated groundwater seepage through the embankment would meet acceptable factors of safety based on the soils tested for this investigation. Notably, it is likely that the groundwater within the embankment will never reach this elevated state with the proposed manmade pond liner and active toe drains proposed with this project. Additional dam testing is recommended prior to and during construction of the new earthen embankment. It is likely that a toe drain

will be required consisting of manmade and earthen materials during construction of the new dam embankment.

After the dam embankment foundation soils are exposed, potentially mitigated, and approved by the Dam Safety Branch and Geotechnical Engineers, the new embankment shall be constructed and periodically observed and tested. The foundation granular materials (site sands) as approved by the geotechnical engineer shall be compacted to a minimum of 100% of its maximum Standard Proctor Dry Density, ASTM D-698 at 0 to +3 percent of optimum moisture content. The embankment shell materials (site sands and very sandy clays) as approved by the geotechnical engineer shall be compacted to a minimum of 98% of its maximum Standard Proctor Dry Density, ASTM D-698 at 0 to +3 percent of optimum moisture content. The filter materials shall be tamped and observed by a construction materials testing agency prior to covering the filters with embankment materials to verify thicknesses and compaction efforts. The soils testing requirements and frequencies of testing will be noted on the construction drawings and technical specifications.

PREPARED BY:

Classic Consulting Engineers & Surveyors, LLC

Marc A. Whorton, P.E.
Project Manager

maw/1096.11/PHN JD Design Report.doc

REFERENCES

1. State of Colorado Rules and Regulations for Dam Safety and Dam Construction, January 2007

2. State of Colorado Hydrologic Basin Response Parameter Estimation Guidelines, May 2008

3. City of Colorado Springs/County of El Paso Drainage Criteria Manual Volumes I and II, dated May 2014.

4. "Black Squirrel Creek Drainage Basin Planning Study," URS Corporation, dated August 1987.

5. "Flying Horse North Master Development Drainage Plan MDDP" Classic Consulting Engineers and Surveyors, dated October 2016.

6. "Urban Storm Drainage Criteria Manual Volume 1, 2 & 3" Urban Drainage and Flood Control District, dated January 2016.

APPENDIX A

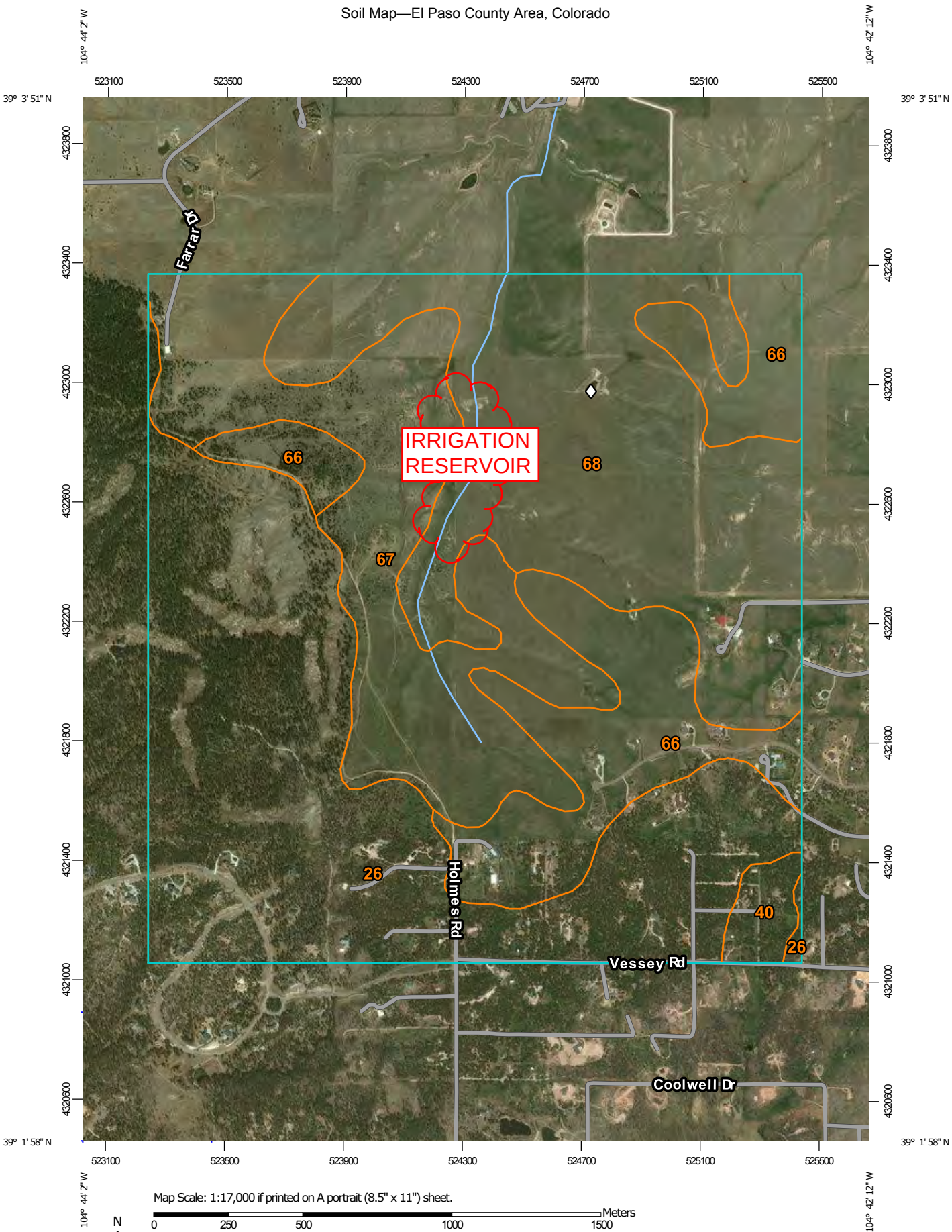
WELL CONSTRUCTION AND TEST REPORT

CLASSIC SM
CONSULTING
ENGINEERS & SURVEYORS

APPENDIX B

HYDROLOGIC / HYDRAULIC MODELS

CLASSIC SM
CONSULTING
ENGINEERS & SURVEYORS



Map Scale: 1:17,000 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 250 500 1000 1500

Feet: 0 500 1000 2000 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 14, Sep 23, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 22, 2016—Mar 9, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
26	Elbeth sandy loam, 8 to 15 percent slopes	433.1	34.4%
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	17.8	1.4%
66	Peyton sandy loam, 1 to 5 percent slopes	200.4	15.9%
67	Peyton sandy loam, 5 to 9 percent slopes	253.2	20.1%
68	Peyton-Pring complex, 3 to 8 percent slopes	353.2	28.1%
Totals for Area of Interest		**1,257.7**	**100.0%**

El Paso County Area, Colorado

66—Peyton sandy loam, 1 to 5 percent slopes

Map Unit Setting

National map unit symbol: 369c
Elevation: 6,800 to 7,600 feet
Farmland classification: Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60

Map Unit Composition

Peyton and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Peyton

Setting

Landform: Flats, hills
Landform position (three-dimensional): Side slope, talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

Typical profile

A - 0 to 12 inches: sandy loam
Bt - 12 to 25 inches: sandy clay loam
BC - 25 to 35 inches: sandy loam
C - 35 to 60 inches: sandy loam

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 14, Sep 23, 2016

El Paso County Area, Colorado

67—Peyton sandy loam, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 369d
Elevation: 6,800 to 7,600 feet
Mean annual air temperature: 43 to 45 degrees F
Frost-free period: 115 to 125 days
Farmland classification: Not prime farmland

Map Unit Composition

Peyton and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Peyton

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

Typical profile

A - 0 to 12 inches: sandy loam
Bt - 12 to 25 inches: sandy clay loam
BC - 25 to 35 inches: sandy loam
C - 35 to 60 inches: sandy loam

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 14, Sep 23, 2016

El Paso County Area, Colorado

68—Peyton-Pring complex, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 369f
Elevation: 6,800 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Peyton and similar soils: 40 percent
Pring and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Peyton

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

Typical profile

A - 0 to 12 inches: sandy loam
Bt - 12 to 25 inches: sandy clay loam
BC - 25 to 35 inches: sandy loam
C - 35 to 60 inches: sandy loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: Sandy Divide (R049BY216CO)
Hydric soil rating: No

Description of Pring

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock

Typical profile

A - 0 to 14 inches: coarse sandy loam
C - 14 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: Loamy Park (R048AY222CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 14, Sep 23, 2016

ALL LAND ASSUMED 2 ACRE RESIDENTIAL LOTS OR
GOOD CONDITION OPEN SPACE (LAWNS, PARKS GOLF COURSES, CEMETARIES ETC.)

C_N VALUES - DEVELOPED CONDITIONS

BASIN (label)	BASIN AREA (Ac)	**GOLF COURSE (B)**		**2 AC. RESIDENTIAL (B)**		**COMPOSITE C_N**
		CN	AREA (Ac.)	CN	AREA (Ac.)	
CC-1	22.3	61	0.0	65	22.3	**65.0**
CC-2	36.4	61	0.0	65	36.4	**65.0**
CC-3	51.9	61	19.1	65	32.8	**63.5**
CC-4A	108.2	61	63.2	65	45.0	**62.7**
CC-4B	17.0	61	5.5	65	11.5	**63.7**
OS-12	67.7	61	0.0	65	67.7	**65.0**
OS-13	36.9	61	0.0	65	36.9	**65.0**
OS-14	26.4	61	0.0	65	26.4	**65.0**

TIME OF CONCENTRATION DEVELOPED

BASIN	COMPOSITE Cn	OVERLAND			STREET / CHANNEL FLOW (DCM Vol. 1 Fig. 6-25)				Tc TOTAL *(hr)*	Tc LAG (0.6tc) *(hr)*
		Length *(ft)*	Height *(ft)*	Tc *(hr)*	Length *(ft)*	Slope *(%)*	Velocity *(fps)*	Tc *(hr)*		
CC-1	65.0	300	10	0.40	900	2.0%	1.8	0.14	0.53	0.32
CC-2	65.0	300	10	0.40	1700	2.0%	1.8	0.26	0.66	0.39
CC-3	63.5	300	14	0.35	900	2.5%	2.4	0.10	0.45	0.27
CC-4A	62.7	300	14	0.35	2900	2.0%	2.1	0.38	0.73	0.44
CC-4B	63.7	300	12	0.37	900	3.0%	2.5	0.10	0.47	0.28
OS-12	65.0	300	14	0.35	1500	3.0%	2.5	0.17	0.51	0.31
OS-13	65.0	300	16	0.33	900	3.0%	2.5	0.10	0.43	0.26
OS-14	65.0	300	14	0.35	600	3.5%	2.7	0.06	0.41	0.24

NOAA Atlas 14, Volume 8, Version 2
Location name: Colorado Springs, Colorado, USA*
Latitude: 39.051°, Longitude: -104.7161°
Elevation: 7569.65 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.237 (0.194-0.290)	0.288 (0.236-0.353)	0.376 (0.308-0.463)	0.455 (0.370-0.562)	0.570 (0.450-0.736)	0.665 (0.510-0.867)	0.765 (0.566-1.02)	0.871 (0.616-1.19)	1.02 (0.692-1.43)	1.14 (0.749-1.61)
10-min	0.346 (0.284-0.425)	0.421 (0.345-0.517)	0.551 (0.450-0.678)	0.666 (0.541-0.823)	0.835 (0.658-1.08)	0.974 (0.747-1.27)	1.12 (0.828-1.50)	1.27 (0.902-1.75)	1.49 (1.01-2.10)	1.67 (1.10-2.36)
15-min	0.422 (0.347-0.518)	0.514 (0.421-0.631)	0.672 (0.549-0.827)	0.812 (0.660-1.00)	1.02 (0.803-1.31)	1.19 (0.911-1.55)	1.37 (1.01-1.82)	1.56 (1.10-2.13)	1.82 (1.24-2.56)	2.03 (1.34-2.88)
30-min	0.603 (0.495-0.739)	0.732 (0.601-0.899)	0.957 (0.782-1.18)	1.16 (0.939-1.43)	1.45 (1.14-1.87)	1.69 (1.30-2.20)	1.94 (1.44-2.59)	2.21 (1.56-3.03)	2.59 (1.76-3.64)	2.89 (1.90-4.10)
60-min	0.768 (0.631-0.942)	0.921 (0.755-1.13)	1.20 (0.977-1.47)	1.45 (1.17-1.79)	1.83 (1.45-2.37)	2.15 (1.65-2.81)	2.49 (1.84-3.33)	2.86 (2.03-3.93)	3.39 (2.30-4.78)	3.82 (2.51-5.42)
2-hr	0.934 (0.771-1.14)	1.11 (0.915-1.35)	1.43 (1.18-1.75)	1.74 (1.42-2.13)	2.20 (1.76-2.85)	2.60 (2.02-3.39)	3.03 (2.27-4.05)	3.51 (2.51-4.80)	4.19 (2.87-5.88)	4.75 (3.15-6.69)
3-hr	1.02 (0.849-1.24)	1.20 (0.996-1.46)	1.54 (1.27-1.88)	1.87 (1.53-2.29)	2.39 (1.92-3.09)	2.84 (2.21-3.70)	3.33 (2.50-4.44)	3.88 (2.79-5.30)	4.68 (3.22-6.55)	5.34 (3.55-7.49)
6-hr	1.20 (0.999-1.44)	1.39 (1.16-1.67)	1.76 (1.46-2.13)	2.13 (1.76-2.59)	2.73 (2.22-3.52)	3.26 (2.56-4.23)	3.85 (2.92-5.11)	4.51 (3.27-6.14)	5.49 (3.81-7.65)	6.29 (4.22-8.78)
12-hr	1.41 (1.18-1.69)	1.63 (1.36-1.95)	2.05 (1.71-2.46)	2.47 (2.05-2.98)	3.15 (2.57-4.03)	3.74 (2.96-4.82)	4.41 (3.36-5.81)	5.15 (3.76-6.96)	6.24 (4.36-8.63)	7.14 (4.82-9.90)
24-hr	1.65 (1.39-1.96)	1.93 (1.62-2.29)	2.44 (2.05-2.91)	2.93 (2.44-3.50)	3.68 (3.01-4.65)	4.33 (3.44-5.51)	5.04 (3.86-6.57)	5.82 (4.26-7.78)	6.95 (4.88-9.52)	7.87 (5.35-10.8)
2-day	1.93 (1.63-2.27)	2.28 (1.93-2.69)	2.91 (2.46-3.45)	3.48 (2.92-4.13)	4.32 (3.53-5.36)	5.01 (3.99-6.30)	5.75 (4.41-7.40)	6.54 (4.81-8.64)	7.66 (5.41-10.4)	8.56 (5.86-11.7)
3-day	2.12 (1.80-2.49)	2.51 (2.13-2.94)	3.18 (2.69-3.74)	3.78 (3.18-4.47)	4.66 (3.82-5.76)	5.39 (4.30-6.73)	6.16 (4.74-7.88)	6.98 (5.15-9.17)	8.13 (5.76-11.0)	9.05 (6.23-12.3)
4-day	2.28 (1.95-2.67)	2.68 (2.28-3.14)	3.37 (2.86-3.96)	3.99 (3.37-4.70)	4.90 (4.02-6.03)	5.65 (4.52-7.04)	6.45 (4.98-8.23)	7.30 (5.40-9.56)	8.49 (6.03-11.4)	9.44 (6.51-12.8)
7-day	2.68 (2.30-3.12)	3.10 (2.65-3.61)	3.84 (3.27-4.48)	4.49 (3.81-5.26)	5.46 (4.50-6.68)	6.26 (5.03-7.74)	7.10 (5.51-9.01)	8.01 (5.96-10.4)	9.28 (6.63-12.4)	10.3 (7.14-13.9)
10-day	3.03 (2.61-3.51)	3.48 (2.99-4.04)	4.27 (3.65-4.96)	4.96 (4.22-5.80)	5.99 (4.95-7.29)	6.83 (5.51-8.41)	7.71 (6.01-9.74)	8.66 (6.46-11.2)	9.98 (7.16-13.3)	11.0 (7.69-14.9)
20-day	4.03 (3.48-4.63)	4.61 (3.98-5.31)	5.60 (4.82-6.47)	6.45 (5.52-7.48)	7.66 (6.36-9.21)	8.63 (6.99-10.5)	9.63 (7.53-12.0)	10.7 (8.01-13.7)	12.1 (8.73-16.0)	13.2 (9.27-17.7)
30-day	4.85 (4.21-5.55)	5.56 (4.82-6.37)	6.73 (5.81-7.74)	7.72 (6.62-8.91)	9.08 (7.54-10.8)	10.1 (8.23-12.3)	11.2 (8.80-13.9)	12.3 (9.27-15.7)	13.8 (9.98-18.1)	14.9 (10.5-19.9)
45-day	5.88 (5.12-6.71)	6.75 (5.87-7.71)	8.15 (7.07-9.33)	9.30 (8.01-10.7)	10.8 (9.01-12.8)	12.0 (9.77-14.4)	13.2 (10.3-16.2)	14.3 (10.8-18.1)	15.8 (11.5-20.6)	16.9 (12.0-22.4)
60-day	6.76 (5.90-7.68)	7.76 (6.76-8.83)	9.35 (8.12-10.7)	10.6 (9.18-12.2)	12.3 (10.2-14.5)	13.6 (11.0-16.2)	14.8 (11.6-18.1)	15.9 (12.0-20.0)	17.4 (12.6-22.5)	18.4 (13.1-24.4)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

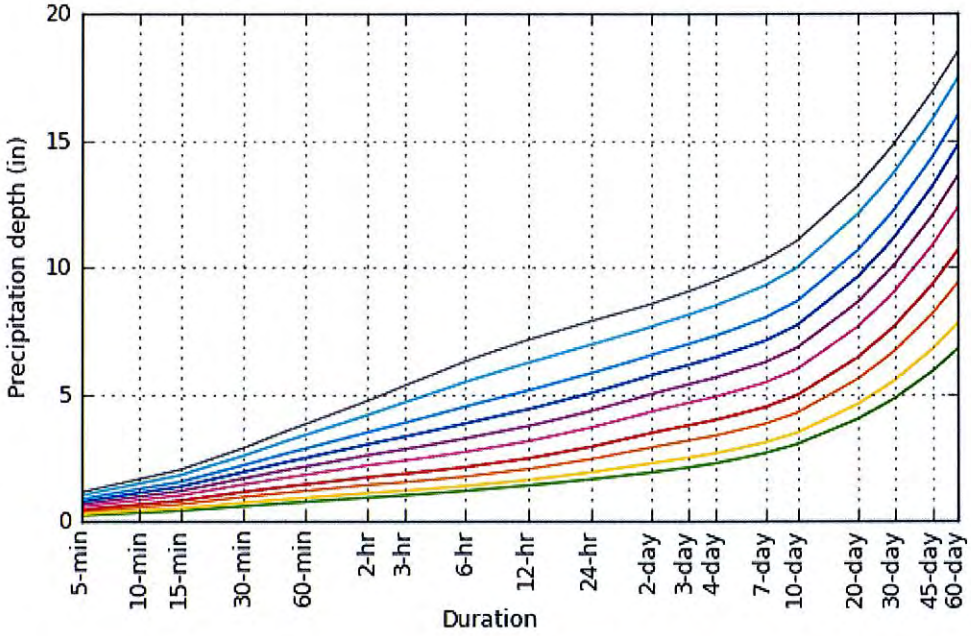
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

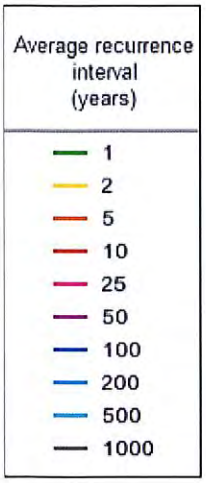
Please refer to NOAA Atlas 14 document for more information.

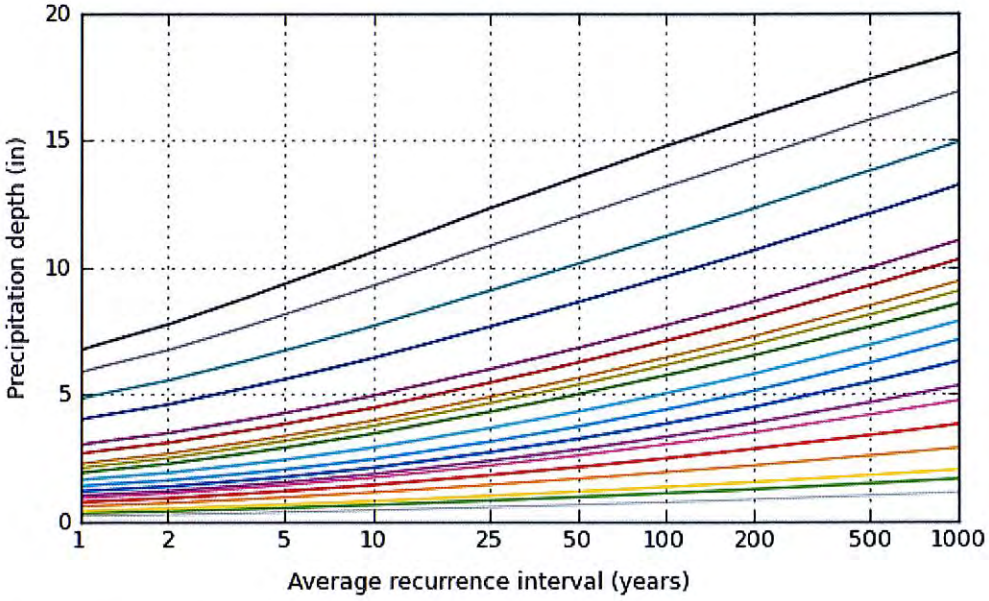
Back to Top

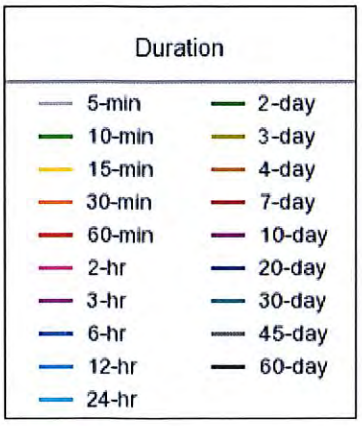
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 39.0510°, Longitude: -104.7161°









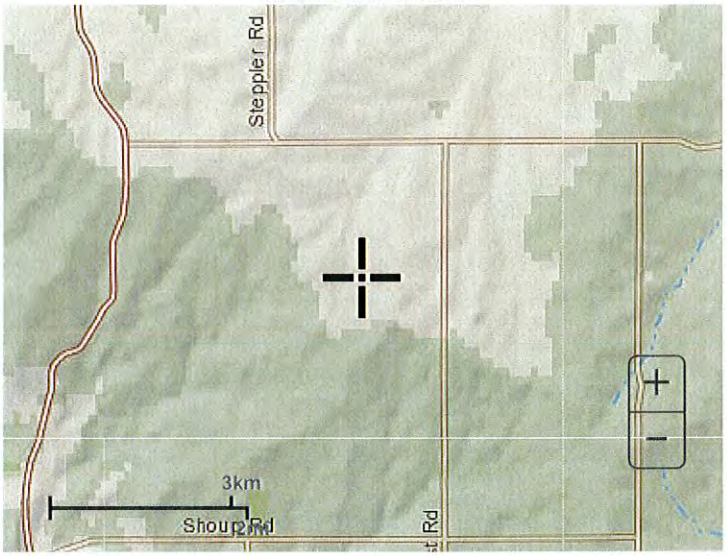
NOAA Atlas 14, Volume 8, Version 2

Created (GMT): Fri Sep 22 14:35:57 2017

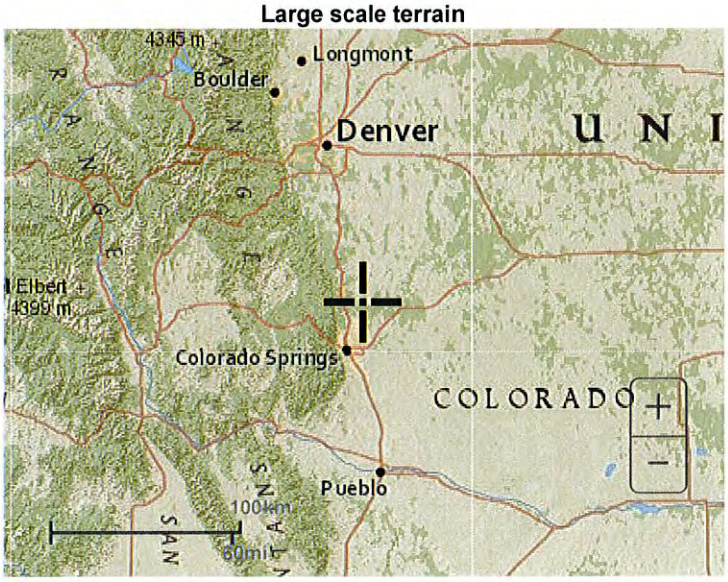
Back to Top

Maps & aerials

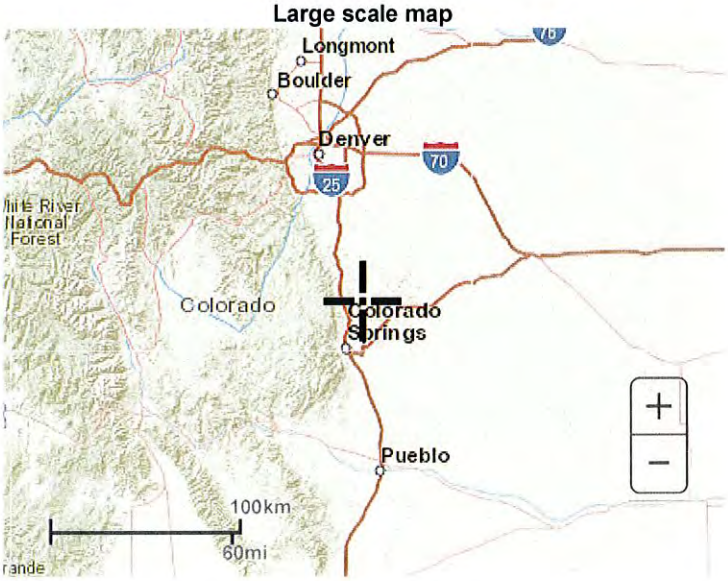
Small scale terrain



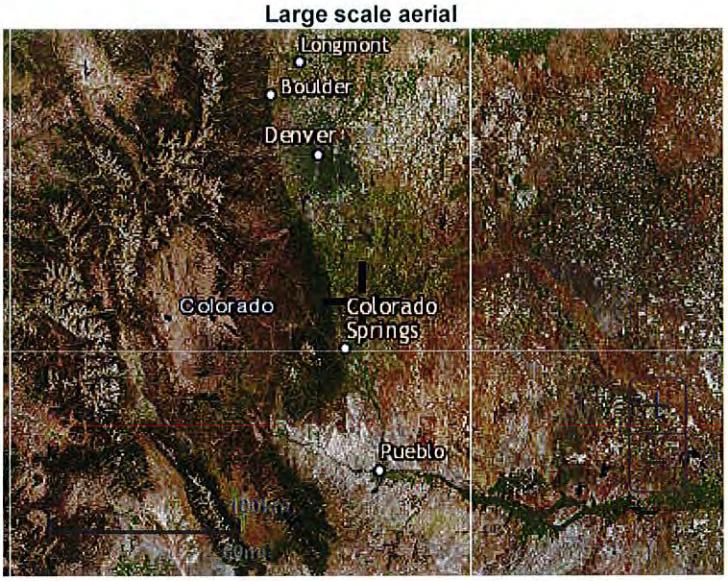
Large scale terrain



Large scale map



Large scale aerial



Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions? HDSC.Questions@noaa.gov

Disclaimer

Table 6-4. NRCS 24-Hour Type II Design Storm Distribution, <10 mi^2
(Fraction of 24-Hour Rainfall Depth)

Hour	Minutes			
	0	15	30	45
0	0.000	0.0020	0.0050	0.0080
1	0.0110	0.0140	0.0170	0.0200
2	0.0230	0.0260	0.0290	0.0320
3	0.0350	0.0380	0.0410	0.0440
4	0.0480	0.0520	0.0560	0.0600
5	0.0604	0.0680	0.0720	0.0760
6	0.0800	0.0850	0.0900	0.0950
7	0.1000	0.1050	0.1100	0.1150
8	0.1200	0.1260	0.1330	0.1400
9	0.1470	0.1550	0.1630	0.1720
10	0.1810	0.1910	0.2030	0.2180
11	0.2360	0.2570	0.2830	0.3870
12	0.6630	0.7070	0.7350	0.7580
13	0.7760	0.7910	0.8040	0.8150
14	0.8250	0.8340	0.8420	0.8490
15	0.8560	0.8630	0.8690	0.8750
16	0.8810	0.8870	0.8930	0.8980
17	0.9030	0.9080	0.9130	0.9180
18	0.9220	0.9260	0.9300	0.9340
19	0.9380	0.9420	0.9460	0.9500
20	0.9530	0.9560	0.9590	0.9620
21	0.9650	0.9680	0.9710	0.9740
22	0.9770	0.9800	0.9830	0.9860
23	0.9890	0.9920	0.9950	0.9980

2.2.1 Depth-Area Reduction Factors (DARFs)

Depth Area Reduction Factors (DARFs) are used to adjust point rainfall depths to average depths as the size of drainage basins increase. As a part of the 2011 rainfall study, Carlton analyzed radar data to develop DARF curves applicable to the Fountain Creek watershed, El Paso County and eastern Colorado. However, these relationships were determined for short-duration thunderstorms and are not applicable to longer-duration frontal storms. Therefore, the DARFs provided in the NOAA Atlas will continue to be applied for the frontal-type storms.

- **Thunderstorm DARFs**: The Carlton study provided DARF curves for various storm return periods for short-duration thunderstorm events; however, the difference between the sets of curves was determined to be insignificant. As described in the technical memorandum *Stormwater Management Assessment and Standards Development Project, Proposed Rainfall and Standard Design Storms* (City of Colorado Springs 2012), the 5-year set of DARF curves was selected for the development of thunderstorm type design storms. These DARF curves for short-duration events are shown in Figure 6-21 at the end of this chapter.

  As described in the memorandum documenting the development of design storms, the HEC-HMS program provides guidance on the application of DARFs to define adjusted design storms as the

Project Summary	
Title	Flying Horse North Irrigation Reservoir (Pond 13)
Engineer	MAW
Company	CCES
Date	11/1/2016

Notes	50 Year (NOAA 14 - 24 hr.)

Table of Contents

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Basin CC-3	Post-Development 50YR	50	5.726	12.050	75.00
Basin CC-4A	Post-Development 50YR	50	13.623	12.150	139.82
Basin CC-4B	Post-Development 50YR	50	3.062	12.050	41.47
Basins OS-12, CC-1	Post-Development 50YR	50	11.135	12.100	137.81
Basins OS-13, CC-2	Post-Development 50YR	50	9.284	12.150	103.18
Basins OS-14	Post-Development 50YR	50	2.805	12.050	39.36

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
DP-18 (MDDP DP 16)	Post-Development 50YR	50	34.622	13.250	68.24

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Golf Course Pond 12 (IN)	Post-Development 50YR	50	8.532	12.050	114.36	(N/A)	(N/A)
Golf Course Pond 12 (OUT)	Post-Development 50YR	50	8.154	12.300	47.35	7,544.99	5.758
JD Reservoir (Pond 13) (IN)	Post-Development 50YR	50	45.258	12.150	446.46	(N/A)	(N/A)
JD Reservoir (Pond 13) (OUT)	Post-Development 50YR	50	34.622	13.250	68.24	7,533.63	114.941

Time-Depth Curve: Type II 24-Hour (NOAA 14)	
Label	Type II 24-Hour (NOAA 14)
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	50 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.00	0.00	0.01	0.01	0.02
0.500	0.02	0.03	0.03	0.04	0.04
1.000	0.05	0.05	0.06	0.06	0.06
1.500	0.07	0.07	0.08	0.08	0.09
2.000	0.10	0.10	0.11	0.11	0.12
2.500	0.12	0.13	0.13	0.14	0.14
3.000	0.15	0.16	0.16	0.17	0.17
3.500	0.18	0.18	0.19	0.20	0.20
4.000	0.21	0.21	0.22	0.23	0.23
4.500	0.24	0.25	0.25	0.26	0.27
5.000	0.27	0.28	0.29	0.29	0.30
5.500	0.31	0.32	0.32	0.33	0.34
6.000	0.35	0.35	0.36	0.37	0.38
6.500	0.39	0.39	0.40	0.41	0.42
7.000	0.43	0.44	0.45	0.46	0.46
7.500	0.47	0.48	0.49	0.50	0.51
8.000	0.52	0.53	0.54	0.55	0.56
8.500	0.57	0.58	0.60	0.61	0.62
9.000	0.64	0.65	0.66	0.68	0.69
9.500	0.71	0.72	0.73	0.75	0.77
10.000	0.78	0.80	0.82	0.84	0.86
10.500	0.88	0.91	0.93	0.96	0.99
11.000	1.02	1.05	1.09	1.13	1.18
11.500	1.23	1.33	1.53	1.87	2.46
12.000	2.87	2.95	3.03	3.09	3.14
12.500	3.18	3.22	3.25	3.29	3.32
13.000	3.34	3.37	3.39	3.42	3.44
13.500	3.46	3.48	3.50	3.52	3.53
14.000	3.55	3.57	3.58	3.60	3.61
14.500	3.63	3.64	3.66	3.67	3.68
15.000	3.70	3.71	3.72	3.73	3.75
15.500	3.76	3.77	3.78	3.79	3.80
16.000	3.81	3.82	3.83	3.84	3.85
16.500	3.86	3.87	3.88	3.89	3.90
17.000	3.90	3.91	3.92	3.93	3.94

Subsection: Time-Depth Curve
Label: NOAA 14

Return Event: 50 years
Storm Event: Type II 24-Hour (NOAA 14)

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
17.500	3.95	3.96	3.96	3.97	3.98
18.000	3.99	4.00	4.00	4.01	4.02
18.500	4.03	4.03	4.04	4.05	4.05
19.000	4.06	4.07	4.07	4.08	4.09
19.500	4.09	4.10	4.10	4.11	4.12
20.000	4.12	4.13	4.13	4.14	4.14
20.500	4.15	4.16	4.16	4.17	4.17
21.000	4.18	4.18	4.19	4.19	4.20
21.500	4.20	4.21	4.21	4.22	4.23
22.000	4.23	4.24	4.24	4.25	4.25
22.500	4.26	4.26	4.27	4.27	4.28
23.000	4.28	4.29	4.29	4.30	4.30
23.500	4.31	4.31	4.32	4.32	4.33
24.000	4.33	(N/A)	(N/A)	(N/A)	(N/A)

Requested Pond Water Surface Elevations	
Minimum (Headwater)	7,510.00 ft
Increment (Headwater)	0.50 ft
Maximum (Headwater)	7,536.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Inlet Box	SWQ Outlet Box	Forward	SWQ Outlet Pipe	7,533.00	7,536.00
Orifice-Area	SWQ Orifice Plate	Forward	SWQ Outlet Pipe	7,531.00	7,536.00
Culvert-Circular	SWQ Outlet Pipe	Forward	TW	7,526.90	7,536.00
Culvert-Box	Twin CBC Spillway	Forward	TW	7,533.00	7,536.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Structure ID: SWQ Outlet Box Structure Type: Inlet Box	
Number of Openings	1
Elevation	7,533.00 ft
Orifice Area	20.8 ft²
Orifice Coefficient	0.600
Weir Length	8.00 ft
Weir Coefficient	3.00 (ft^0.5)/s
K Reverse	1.000
Manning's n	0.000
Kev, Charged Riser	0.000
Weir Submergence	False
Orifice H to crest	False

Structure ID: SWQ Orifice Plate Structure Type: Orifice-Area	
Number of Openings	3
Elevation	7,531.00 ft
Orifice Area	1.4 ft²
Top Elevation	7,533.00 ft
Datum Elevation	7,531.00 ft
Orifice Coefficient	0.600

Structure ID: SWQ Outlet Pipe Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	30.0 in
Length	100.00 ft
Length (Computed Barrel)	100.00 ft
Slope (Computed)	0.010 ft/ft

Outlet Control Data	
Manning's n	0.013
Ke	0.200
Kb	0.009
Kr	0.000
Convergence Tolerance	0.00 ft

Inlet Control Data	
Equation Form	Form 1
K	0.0045
M	2.0000
C	0.0317
Y	0.6900
T1 ratio (HW/D)	1.090
T2 ratio (HW/D)	1.192
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	7,529.63 ft	T1 Flow	27.16 ft^3/s
T2 Elevation	7,529.88 ft	T2 Flow	31.05 ft^3/s

Structure ID: Twin CBC Spillway Structure Type: Culvert-Box	
Number of Barrels	2
Width	10.00 ft
Height	4.00 ft
Length	65.00 ft
Length (Computed Barrel)	65.00 ft
Slope (Computed)	0.010 ft/ft

Outlet Control Data	
Manning's n	0.013
Ke	0.500
Kb	0.003
Kr	0.000
Convergence Tolerance	0.00 ft

Inlet Control Data	
Equation Form	Form 1
K	0.0260
M	1.0000
C	0.0347
Y	0.8100
T1 ratio (HW/D)	1.173
T2 ratio (HW/D)	1.360
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	7,537.69 ft	T1 Flow	280.00 ft³/s
T2 Elevation	7,538.44 ft	T2 Flow	320.00 ft³/s

Structure ID: TW
Structure Type: TW Setup, DS Channel

Tailwater Type	Free Outfall
Convergence Tolerances	
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.01 ft
Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft
Headwater Tolerance (Maximum)	0.50 ft
Flow Tolerance (Minimum)	0.001 ft³/s
Flow Tolerance (Maximum)	10.000 ft³/s

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Box (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
7,510.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,510.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,511.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,511.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,512.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,512.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,513.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,513.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,514.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,514.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,515.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,515.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,516.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,516.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,517.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,517.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,518.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,518.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,519.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,519.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,520.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,520.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,521.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,521.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,522.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,522.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,523.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,523.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,524.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,524.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,525.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,525.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.90	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,527.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,527.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00

Subsection: Individual Outlet Curves
Label: FH North Pond 13

Return Event: 50 years
Storm Event: Type II 24-Hour (NOAA 14)

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Box (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)	Message
7,528.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,528.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.50	0.00	0.00	0.00	7,528.16	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.00	0.00	0.00	0.00	7,528.75	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.50	0.00	0.00	0.00	7,529.24	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,533.00	0.00	0.00	0.00	7,529.71	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,533.50	8.49	7,533.50	Free Outfall	7,530.67	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,534.00	24.00	7,534.00	Free Outfall	7,532.08	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,534.50	44.09	7,534.50	7,533.67	7,533.67	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,535.00	67.88	7,535.00	7,534.99	7,534.99	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,535.50	94.87	7,535.50	7,535.50	7,535.50	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,536.00	124.71	7,536.00	7,536.00	7,536.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Box (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
Weir: H =0.5ft
Weir: H =1ft
FULLY CHARGED RISER: ADJUSTED TO WEIR: H =1.5ft
FULLY CHARGED RISER: ADJUSTED TO WEIR: H =2ft
FULLY CHARGED RISER: ADJUSTED TO WEIR: H =2.5ft
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Orifice Plate (Orifice-Area)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
7,510.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,510.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,511.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,511.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,512.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,512.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,513.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,513.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,514.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,514.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,515.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,515.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,516.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,516.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,517.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,517.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,518.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,518.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,519.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,519.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,520.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,520.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,521.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,521.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,522.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,522.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,523.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,523.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,524.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,524.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,525.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,525.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.90	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,527.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,527.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Orifice Plate (Orifice-Area)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)	Message
7,528.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,528.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.50	6.94	7,531.50	Free Outfall	7,528.16	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.00	13.89	7,532.00	Free Outfall	7,528.75	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.50	20.83	7,532.50	Free Outfall	7,529.24	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,533.00	27.77	7,533.00	Free Outfall	7,529.71	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,533.50	31.05	7,533.50	Free Outfall	7,530.67	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,534.00	27.25	7,534.00	7,532.08	7,532.08	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,534.50	17.92	7,534.50	7,533.67	7,533.67	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,535.00	1.59	7,535.00	7,534.99	7,534.99	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,535.50	0.00	7,535.50	7,535.50	7,535.50	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,536.00	0.00	7,536.00	7,536.00	7,536.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Orifice Plate (Orifice-Area)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
Hi=.50; Ht=2.00; Qt=9.26
Hi=1.00; Ht=2.00; Qt=9.26
Hi=1.50; Ht=2.00; Qt=9.26
H =2.00
H =2.50
H =1.92
H =.83
H =.01
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Pipe (Culvert-Circular)

Mannings open channel maximum capacity: 44.12 ft³/s
Upstream ID = SWQ Outlet Box, SWQ Orifice Plate
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
7,510.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,510.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,511.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,511.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,512.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,512.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,513.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,513.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,514.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,514.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,515.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,515.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,516.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,516.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,517.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,517.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,518.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,518.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,519.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,519.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,520.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,520.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,521.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,521.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,522.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,522.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,523.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,523.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,524.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,524.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,525.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,525.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,526.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,526.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,526.90	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,527.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Pipe (Culvert-Circular)

Mannings open channel maximum capacity: 44.12 ft³/s
Upstream ID = SWQ Outlet Box, SWQ Orifice Plate
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)	Message
7,527.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,528.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,528.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.50	6.94	7,528.16	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.00	13.89	7,528.75	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.50	20.83	7,529.24	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,533.00	27.77	7,529.71	Free Outfall	Free Outfall	0.00	0.01	(N/A)	0.00	WS below an invert; no flow.
7,533.50	39.53	7,530.67	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,534.00	51.31	7,532.08	Free Outfall	Free Outfall	0.00	0.06	(N/A)	0.00	WS below an invert; no flow.
7,534.50	61.99	7,533.67	Free Outfall	Free Outfall	0.00	0.02	(N/A)	0.00	WS below an invert; no flow.
7,535.00	69.52	7,534.99	Free Outfall	Free Outfall	0.00	0.05	(N/A)	0.00	WS below an invert; no flow.
7,535.50	72.13	7,535.50	Free Outfall	Free Outfall	0.00	22.74	(N/A)	0.00	WS below an invert; no flow.
7,536.00	74.61	7,536.00	Free Outfall	Free Outfall	0.00	50.10	(N/A)	0.00	WS below an invert; no flow.

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Pipe (Culvert-Circular)

Mannings open channel maximum capacity: 44.12 ft³/s
Upstream ID = SWQ Outlet Box, SWQ Orifice Plate
Downstream ID = Tailwater (Pond Outfall)

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
CRIT.DEPTH CONTROL Vh= .321ft Dcr= .874ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .493ft Dcr= 1.255ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .659ft Dcr= 1.551ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .840ft Dcr= 1.797ft CRIT.DEPTH Hev= .00ft
INLET CONTROL... Submerged: HW =3.77
INLET CONTROL... Submerged: HW =5.18
INLET CONTROL... Submerged: HW =6.77

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Pipe (Culvert-Circular)

Mannings open channel maximum capacity: 44.12 ft³/s
Upstream ID = SWQ Outlet Box, SWQ Orifice Plate
Downstream ID = Tailwater (Pond Outfall)

Message
FULL FLOW...Lfull=98.92ft Vh=3.117ft HL=6.583ft Hev= .00ft
FULL FLOW...Lfull=99.10ft Vh=3.356ft HL=7.092ft Hev= .00ft
FULL FLOW...Lfull=99.31ft Vh=3.590ft HL=7.594ft Hev= .00ft

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Twin CBC Spillway (Culvert-Box)

Mannings open channel maximum capacity: 778.58 ft³/s
Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
7,510.00	0.00	(N/A)	0.00
7,510.50	0.00	(N/A)	0.00
7,511.00	0.00	(N/A)	0.00
7,511.50	0.00	(N/A)	0.00
7,512.00	0.00	(N/A)	0.00
7,512.50	0.00	(N/A)	0.00
7,513.00	0.00	(N/A)	0.00
7,513.50	0.00	(N/A)	0.00
7,514.00	0.00	(N/A)	0.00
7,514.50	0.00	(N/A)	0.00
7,515.00	0.00	(N/A)	0.00
7,515.50	0.00	(N/A)	0.00
7,516.00	0.00	(N/A)	0.00
7,516.50	0.00	(N/A)	0.00
7,517.00	0.00	(N/A)	0.00
7,517.50	0.00	(N/A)	0.00
7,518.00	0.00	(N/A)	0.00
7,518.50	0.00	(N/A)	0.00
7,519.00	0.00	(N/A)	0.00
7,519.50	0.00	(N/A)	0.00
7,520.00	0.00	(N/A)	0.00
7,520.50	0.00	(N/A)	0.00
7,521.00	0.00	(N/A)	0.00
7,521.50	0.00	(N/A)	0.00
7,522.00	0.00	(N/A)	0.00
7,522.50	0.00	(N/A)	0.00
7,523.00	0.00	(N/A)	0.00
7,523.50	0.00	(N/A)	0.00
7,524.00	0.00	(N/A)	0.00
7,524.50	0.00	(N/A)	0.00
7,525.00	0.00	(N/A)	0.00
7,525.50	0.00	(N/A)	0.00
7,526.00	0.00	(N/A)	0.00
7,526.50	0.00	(N/A)	0.00
7,526.90	0.00	(N/A)	0.00
7,527.00	0.00	(N/A)	0.00
7,527.50	0.00	(N/A)	0.00
7,528.00	0.00	(N/A)	0.00

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Twin CBC Spillway (Culvert-Box)

Mannings open channel maximum capacity: 778.58 ft³/s
Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
7,528.50	0.00	(N/A)	0.00
7,529.00	0.00	(N/A)	0.00
7,529.50	0.00	(N/A)	0.00
7,530.00	0.00	(N/A)	0.00
7,530.50	0.00	(N/A)	0.00
7,531.00	0.00	(N/A)	0.00
7,531.50	0.00	(N/A)	0.00
7,532.00	0.00	(N/A)	0.00
7,532.50	0.00	(N/A)	0.00
7,533.00	0.00	(N/A)	0.00
7,533.50	17.36	(N/A)	0.00
7,534.00	49.05	(N/A)	0.00
7,534.50	90.08	(N/A)	0.00
7,535.00	138.56	(N/A)	0.00
7,535.50	193.63	(N/A)	0.00
7,536.00	254.72	(N/A)	0.00

Computation Messages
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Twin CBC Spillway (Culvert-Box)

Mannings open channel maximum capacity: 778.58 ft³/s
Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Computation Messages
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
CRIT.DEPTH CONTROL Vh= .143ft Dcr= .286ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .286ft Dcr= .572ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .429ft Dcr= .858ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .571ft Dcr= 1.143ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .714ft Dcr= 1.428ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .857ft Dcr= 1.715ft CRIT.DEPTH Hev= .00ft

Subsection: Composite Rating Curve
Label: FH North Pond 13

Return Event: 50 years
Storm Event: Type II 24-Hour (NOAA 14)

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
7,510.00	0.00	(N/A)	0.00
7,510.50	0.00	(N/A)	0.00
7,511.00	0.00	(N/A)	0.00
7,511.50	0.00	(N/A)	0.00
7,512.00	0.00	(N/A)	0.00
7,512.50	0.00	(N/A)	0.00
7,513.00	0.00	(N/A)	0.00
7,513.50	0.00	(N/A)	0.00
7,514.00	0.00	(N/A)	0.00
7,514.50	0.00	(N/A)	0.00
7,515.00	0.00	(N/A)	0.00
7,515.50	0.00	(N/A)	0.00
7,516.00	0.00	(N/A)	0.00
7,516.50	0.00	(N/A)	0.00
7,517.00	0.00	(N/A)	0.00
7,517.50	0.00	(N/A)	0.00
7,518.00	0.00	(N/A)	0.00
7,518.50	0.00	(N/A)	0.00
7,519.00	0.00	(N/A)	0.00
7,519.50	0.00	(N/A)	0.00
7,520.00	0.00	(N/A)	0.00
7,520.50	0.00	(N/A)	0.00
7,521.00	0.00	(N/A)	0.00
7,521.50	0.00	(N/A)	0.00
7,522.00	0.00	(N/A)	0.00
7,522.50	0.00	(N/A)	0.00
7,523.00	0.00	(N/A)	0.00
7,523.50	0.00	(N/A)	0.00
7,524.00	0.00	(N/A)	0.00
7,524.50	0.00	(N/A)	0.00
7,525.00	0.00	(N/A)	0.00
7,525.50	0.00	(N/A)	0.00
7,526.00	0.00	(N/A)	0.00
7,526.50	0.00	(N/A)	0.00
7,526.90	0.00	(N/A)	0.00
7,527.00	0.00	(N/A)	0.00
7,527.50	0.00	(N/A)	0.00
7,528.00	0.00	(N/A)	0.00
7,528.50	0.00	(N/A)	0.00
7,529.00	0.00	(N/A)	0.00
7,529.50	0.00	(N/A)	0.00
7,530.00	0.00	(N/A)	0.00
7,530.50	0.00	(N/A)	0.00
7,531.00	0.00	(N/A)	0.00

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
7,531.50	6.94	(N/A)	0.00
7,532.00	13.89	(N/A)	0.00
7,532.50	20.83	(N/A)	0.00
7,533.00	27.77	(N/A)	0.00
7,533.50	56.89	(N/A)	0.00
7,534.00	100.36	(N/A)	0.00
7,534.50	152.07	(N/A)	0.00
7,535.00	208.08	(N/A)	0.00
7,535.50	265.76	(N/A)	0.00
7,536.00	329.33	(N/A)	0.00

Contributing Structures
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)

Composite Outflow Summary

Contributing Structures
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)

Composite Outflow Summary

Contributing Structures
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)

Subsection: Composite Rating Curve
Label: FH North Pond 13

Return Event: 50 years
Storm Event: Type II 24-Hour (NOAA 14)

Composite Outflow Summary

Contributing Structures
SWQ Orifice Plate,SWQ Outlet Pipe (no Q: SWQ Outlet Box,Twin CBC Spillway)
SWQ Orifice Plate,SWQ Outlet Pipe (no Q: SWQ Outlet Box,Twin CBC Spillway)
SWQ Orifice Plate,SWQ Outlet Pipe (no Q: SWQ Outlet Box,Twin CBC Spillway)
SWQ Orifice Plate,SWQ Outlet Pipe (no Q: SWQ Outlet Box,Twin CBC Spillway)
SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway
SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway
SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway
SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway
SWQ Outlet Box,SWQ Outlet Pipe,Twin CBC Spillway (no Q: SWQ Orifice Plate)
SWQ Outlet Box,SWQ Outlet Pipe,Twin CBC Spillway (no Q: SWQ Orifice Plate)

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	7,531.00 ft
Volume (Initial)	94.889 ac-ft
Flow (Initial Outlet)	0.00 ft³/s
Flow (Initial Infiltration)	0.00 ft³/s
Flow (Initial, Total)	0.00 ft³/s
Time Increment	0.050 hours

Elevation (ft)	Outflow (ft³/s)	Storage (ac-ft)	Area (acres)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
7,510.00	0.00	0.000	1.510	0.00	0.00	0.00
7,510.50	0.00	0.812	1.742	0.00	0.00	393.13
7,511.00	0.00	1.744	1.990	0.00	0.00	844.33
7,511.50	0.00	2.803	2.247	0.00	0.00	1,356.72
7,512.00	0.00	3.994	2.520	0.00	0.00	1,933.23
7,512.50	0.00	5.295	2.682	0.00	0.00	2,562.63
7,513.00	0.00	6.678	2.850	0.00	0.00	3,231.95
7,513.50	0.00	8.127	2.949	0.00	0.00	3,933.62
7,514.00	0.00	9.627	3.050	0.00	0.00	4,659.48
7,514.50	0.00	11.178	3.154	0.00	0.00	5,410.14
7,515.00	0.00	12.781	3.260	0.00	0.00	6,186.22
7,515.50	0.00	14.439	3.369	0.00	0.00	6,988.30
7,516.00	0.00	16.151	3.480	0.00	0.00	7,817.01
7,516.50	0.00	17.918	3.589	0.00	0.00	8,672.34
7,517.00	0.00	19.740	3.700	0.00	0.00	9,554.30
7,517.50	0.00	21.619	3.814	0.00	0.00	10,463.47
7,518.00	0.00	23.555	3.930	0.00	0.00	11,400.48
7,518.50	0.00	25.548	4.044	0.00	0.00	12,365.32
7,519.00	0.00	27.599	4.160	0.00	0.00	13,357.99
7,519.50	0.00	29.709	4.279	0.00	0.00	14,379.10
7,520.00	0.00	31.879	4.400	0.00	0.00	15,429.24
7,520.50	0.00	34.108	4.519	0.00	0.00	16,508.43
7,521.00	0.00	36.398	4.640	0.00	0.00	17,616.66
7,521.50	0.00	38.748	4.759	0.00	0.00	18,753.94
7,522.00	0.00	41.158	4.880	0.00	0.00	19,920.26
7,522.50	0.00	43.630	5.009	0.00	0.00	21,116.81
7,523.00	0.00	46.167	5.140	0.00	0.00	22,344.83
7,523.50	0.00	48.764	5.249	0.00	0.00	23,601.92
7,524.00	0.00	51.417	5.360	0.00	0.00	24,885.64
7,524.50	0.00	54.125	5.474	0.00	0.00	26,196.58
7,525.00	0.00	56.891	5.590	0.00	0.00	27,535.35

Subsection: Elevation-Volume-Flow Table (Pond) Return Event: 50 years
Label: JD Reservoir (Pond 13) Storm Event: Type II 24-Hour (NOAA 14)

Elevation (ft)	Outflow (ft^3/s)	Storage (ac-ft)	Area (acres)	Infiltration (ft^3/s)	Flow (Total) (ft^3/s)	2S/t + O (ft^3/s)
7,525.50	0.00	59.717	5.714	0.00	0.00	28,903.14
7,526.00	0.00	62.606	5.840	0.00	0.00	30,301.19
7,526.50	0.00	65.556	5.959	0.00	0.00	31,728.89
7,526.90	0.00	67.959	6.056	0.00	0.00	32,891.95
7,527.00	0.00	68.565	6.080	0.00	0.00	33,185.63
7,527.50	0.00	71.636	6.204	0.00	0.00	34,672.01
7,528.00	0.00	74.770	6.330	0.00	0.00	36,188.65
7,528.50	0.00	77.965	6.449	0.00	0.00	37,734.94
7,529.00	0.00	81.220	6.570	0.00	0.00	39,310.27
7,529.50	0.00	84.534	6.689	0.00	0.00	40,914.64
7,530.00	0.00	87.909	6.810	0.00	0.00	42,548.05
7,530.50	0.00	91.356	6.979	0.00	0.00	44,216.48
7,531.00	0.00	94.889	7.150	0.00	0.00	45,926.04
7,531.50	6.94	98.509	7.334	0.00	6.94	47,685.48
7,532.00	13.89	102.223	7.520	0.00	13.89	49,489.69
7,532.50	20.83	106.021	7.674	0.00	20.83	51,335.10
7,533.00	27.77	109.897	7.830	0.00	27.77	53,218.02
7,533.50	56.89	113.879	8.098	0.00	56.89	55,174.31
7,534.00	100.36	117.996	8.370	0.00	100.36	57,210.28
7,534.50	152.07	122.230	8.569	0.00	152.07	59,311.55
7,535.00	208.08	126.565	8.770	0.00	208.08	61,465.51
7,535.50	265.76	131.000	8.969	0.00	265.76	63,669.55
7,536.00	329.33	135.534	9.170	0.00	329.33	65,927.87

Peak Discharge	68.24 ft³/s
Time to Peak	13.250 hours
Hydrograph Volume	34.622 ac-ft

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
8.350	0.00	0.00	0.00	0.00	0.01
8.600	0.01	0.01	0.01	0.02	0.02
8.850	0.02	0.03	0.03	0.04	0.05
9.100	0.05	0.06	0.07	0.08	0.09
9.350	0.09	0.10	0.11	0.12	0.13
9.600	0.14	0.15	0.16	0.17	0.18
9.850	0.19	0.20	0.21	0.22	0.23
10.100	0.24	0.25	0.26	0.27	0.28
10.350	0.30	0.31	0.32	0.34	0.35
10.600	0.37	0.39	0.40	0.42	0.44
10.850	0.46	0.48	0.50	0.52	0.55
11.100	0.57	0.60	0.63	0.67	0.71
11.350	0.76	0.81	0.87	0.95	1.03
11.600	1.14	1.27	1.46	1.76	2.20
11.850	2.88	3.92	5.48	7.65	10.36
12.100	13.51	16.75	19.88	22.68	25.10
12.350	27.16	32.39	38.30	43.23	47.34
12.600	50.79	53.65	56.03	58.48	60.78
12.850	62.65	64.15	65.35	66.30	67.03
13.100	67.57	67.94	68.15	68.24	68.22
13.350	68.10	67.89	67.61	67.27	66.87
13.600	66.41	65.91	65.36	64.78	64.17
13.850	63.54	62.88	62.21	61.52	60.81
14.100	60.09	59.37	58.63	57.89	57.15
14.350	56.56	56.04	55.53	55.01	54.49
14.600	53.98	53.47	52.96	52.45	51.95
14.850	51.45	50.95	50.45	49.96	49.48
15.100	48.99	48.51	48.03	47.56	47.09
15.350	46.62	46.16	45.70	45.24	44.79
15.600	44.34	43.89	43.44	43.00	42.56
15.850	42.13	41.69	41.26	40.83	40.40
16.100	39.98	39.56	39.14	38.73	38.32
16.350	37.91	37.52	37.12	36.74	36.36
16.600	35.98	35.62	35.26	34.90	34.56
16.850	34.22	33.88	33.55	33.23	32.91
17.100	32.60	32.29	31.99	31.69	31.40
17.350	31.12	30.83	30.56	30.28	30.02
17.600	29.75	29.49	29.24	28.99	28.74
17.850	28.49	28.25	28.02	27.78	27.71

Subsection: Pond Routed Hydrograph (total out) Return Event: 50 years
Label: JD Reservoir (Pond 13) (OUT) Storm Event: Type II 24-Hour (NOAA 14)

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
18.100	27.65	27.60	27.54	27.48	27.42
18.350	27.36	27.30	27.24	27.18	27.12
18.600	27.05	26.99	26.93	26.87	26.80
18.850	26.74	26.67	26.61	26.54	26.48
19.100	26.41	26.34	26.28	26.21	26.14
19.350	26.07	26.00	25.93	25.86	25.79
19.600	25.72	25.65	25.58	25.51	25.44
19.850	25.36	25.29	25.22	25.14	25.07
20.100	25.00	24.92	24.85	24.77	24.70
20.350	24.63	24.55	24.48	24.40	24.33
20.600	24.26	24.18	24.11	24.04	23.97
20.850	23.89	23.82	23.75	23.68	23.61
21.100	23.54	23.47	23.40	23.33	23.26
21.350	23.19	23.12	23.05	22.99	22.92
21.600	22.85	22.78	22.72	22.65	22.58
21.850	22.52	22.45	22.39	22.32	22.26
22.100	22.19	22.13	22.07	22.00	21.94
22.350	21.88	21.81	21.75	21.69	21.63
22.600	21.56	21.50	21.44	21.38	21.32
22.850	21.26	21.20	21.14	21.08	21.02
23.100	20.96	20.90	20.84	20.79	20.73
23.350	20.67	20.61	20.55	20.49	20.43
23.600	20.38	20.32	20.26	20.20	20.15
23.850	20.09	20.03	19.98	19.92	(N/A)

Index

Project Summary	
Title	Flying Horse North Irrigation Reservoir (Pond 13)
Engineer	MAW
Company	CCES
Date	11/1/2016

Notes	100 Year (Colo. Spgs.)

Table of Contents

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Basin CC-3	Post-Development 100YR	100	6.494	12.100	84.65
Basin CC-4A	Post-Development 100YR	100	15.363	12.150	156.02
Basin CC-4B	Post-Development 100YR	100	3.405	12.100	44.64
Basins OS-12, CC-1	Post-Development 100YR	100	12.557	12.100	153.55
Basins OS-13, CC-2	Post-Development 100YR	100	10.460	12.150	115.36
Basins OS-14	Post-Development 100YR	100	3.186	12.050	44.02

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
DP-18 (MDDP DP 16)	Post-Development 100YR	100	39.865	13.100	91.03

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Golf Course Pond 12 (IN)	Post-Development 100YR	100	9.680	12.100	127.47	(N/A)	(N/A)
Golf Course Pond 12 (OUT)	Post-Development 100YR	100	9.266	12.300	57.42	7,545.21	6.051
JD Reservoir (Pond 13) (IN)	Post-Development 100YR	100	51.051	12.150	504.67	(N/A)	(N/A)
JD Reservoir (Pond 13) (OUT)	Post-Development 100YR	100	39.865	13.100	91.03	7,533.89	117.101

Subsection: Time-Depth Curve
Label: Colo Springs 2015

Return Event: 100 years
Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

Time-Depth Curve: TYPE II 24 HOUR (Colo. Spgs.)	
Label	TYPE II 24 HOUR (Colo. Spgs.)
Start Time	0.000 hours
Increment	0.250 hours
End Time	24.000 hours
Return Event	100 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.250 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.00	0.01	0.02	0.04	0.05
1.250	0.06	0.08	0.09	0.11	0.12
2.500	0.13	0.15	0.16	0.17	0.19
3.750	0.20	0.22	0.24	0.26	0.28
5.000	0.28	0.31	0.33	0.35	0.37
6.250	0.39	0.41	0.44	0.46	0.48
7.500	0.51	0.53	0.55	0.58	0.61
8.750	0.64	0.68	0.71	0.75	0.79
10.000	0.83	0.88	0.93	1.00	1.09
11.250	1.18	1.30	1.78	3.05	3.25
12.500	3.38	3.49	3.57	3.64	3.70
13.750	3.75	3.80	3.84	3.87	3.91
15.000	3.94	3.97	4.00	4.03	4.05
16.250	4.08	4.11	4.13	4.15	4.18
17.500	4.20	4.22	4.24	4.26	4.28
18.750	4.30	4.31	4.33	4.35	4.37
20.000	4.38	4.40	4.41	4.43	4.44
21.250	4.45	4.47	4.48	4.49	4.51
22.500	4.52	4.54	4.55	4.56	4.58
23.750	4.59	4.60	(N/A)	(N/A)	(N/A)

Subsection: Unit Hydrograph Equations

Unit Hydrograph Method (Computational Notes)
Definition of Terms

At	Total area (acres): At = Ai+Ap
Ai	Impervious area (acres)
Ap	Pervious area (acres)
CNi	Runoff curve number for impervious area
CNp	Runoff curve number for pervious area
fLoss	f loss constant infiltration (depth/time)
gKs	Saturated Hydraulic Conductivity (depth/time)
Md	Volumetric Moisture Deficit
Psi	Capillary Suction (length)
hK	Horton Infiltration Decay Rate (time^-1)
fo	Initial Infiltration Rate (depth/time)
fc	Ultimate(capacity)Infiltration Rate (depth/time)
Ia	Initial Abstraction (length)
dt	Computational increment (duration of unit excess rainfall) Default dt is smallest value of 0.1333Tc, rtm, and th (Smallest dt is then adjusted to match up with Tp)
UDdt	User specified override computational main time increment (only used if UDdt is => .1333Tc)
D(t)	Point on distribution curve (fraction of P) for time step t
K	2 / (1 + (Tr/Tp)): default K = 0.75: (for Tr/Tp = 1.67)
Ks	Hydrograph shape factor = Unit Conversions * K: = ((1hr/3600sec) * (1ft/12in) * ((5280ft)**2/sq.mi)) * K Default Ks = 645.333 * 0.75 = 484
Lag	Lag time from center of excess runoff (dt) to Tp: Lag = 0.6Tc
P	Total precipitation depth, inches
Pa(t)	Accumulated rainfall at time step t
Pi(t)	Incremental rainfall at time step t
qp	Peak discharge (cfs) for 1in. runoff, for 1hr, for 1 sq.mi. = (Ks * A * Q) / Tp (where Q = 1in. runoff, A=sq.mi.)
Qu(t)	Unit hydrograph ordinate (cfs) at time step t
Q(t)	Final hydrograph ordinate (cfs) at time step t
Rai(t)	Accumulated runoff (inches) at time step t for impervious area
Rap(t)	Accumulated runoff (inches) at time step t for pervious area
Rii(t)	Incremental runoff (inches) at time step t for impervious area
Rip(t)	Incremental runoff (inches) at time step t for pervious area
R(t)	Incremental weighted total runoff (inches)
Rtm	Time increment for rainfall table
Si	S for impervious area: Si = (1000/CNi) - 10
Sp	S for pervious area: Sp = (1000/CNp) - 10
t	Time step (row) number
Tc	Time of concentration
Tb	Time (hrs) of entire unit hydrograph: Tb = Tp + Tr
Tp	Time (hrs) to peak of a unit hydrograph: Tp = (dt/2) + Lag
Tr	Time (hrs) of receding limb of unit hydrograph: Tr = ratio of Tp

Subsection: Unit Hydrograph Equations

Unit Hydrograph Method
Computational Notes
Precipitation

Column (1)	Time for time step t
Column (2)	D(t) = Point on distribution curve for time step t
Column (3)	Pi(t) = Pa(t) - Pa(t-1): Col.(4) - Preceding Col.(4)
Column (4)	Pa(t) = D(t) x P: Col.(2) x P

Pervious Area Runoff (using SCS Runoff CN Method)

Column (5)	Rap(t) = Accumulated pervious runoff for time step t
	If (Pa(t) is <= 0.2Sp) then use: Rap(t) = 0.0
	If (Pa(t) is > 0.2Sp) then use:
	
	Rap(t) = (Col.(4)-0.2Sp)**2 / (Col.(4)+0.8Sp)

Column (6)	Rip(t) = Incremental pervious runoff for time step t Rip(t) = Rap(t) - Rap(t-1) Rip(t) = Col.(5) for current row - Col.(5) for preceding row.

Impervious Area Runoff (using depression storage method)

Column (7)	Rai(t) = Accumulated impervious runoff for time step t
	If (Pa(t) is <= Ds) then use: Rai(t) = 0.0
	If (Pa(t) is > Ds) then compute runoff using
	the infiltration in next paragraph.

Impervious Area Runoff (using SCS Runoff CN Method)

Column (7)	Rai(t) = Accumulated impervious runoff for time step t
	If (Pa(t) is <= 0.2Si) then use: Rai(t) = 0.0
	If (Pa(t) is > 0.2Si) then use:
	
	Rai(t) = (Col.(4)-0.2Si)**2 / (Col.(4)+0.8Si)

Column (8)	Rii(t) = Incremental impervious runoff for time step t Rii(t) = Rai(t) - Rai(t-1) Rii(t) = Col.(7) for current row - Col.(7) for preceding row.

Incremental Weighted Runoff

Column (9)	R(t) = (Ap/At) x Rip(t) + (Ai/At) x Rii(t) R(t) = (Ap/At) x Col.(6) + (Ai/At) x Col.(8)

SCS Unit Hydrograph Method

Column (10)	Q(t) is computed with the SCS unit hydrograph method using R(t) and Qu(t).

Subsection: Elevation-Area Volume Curve
Label: JD Reservoir (Pond 13)

Return Event: 100 years
Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

Elevation (ft)	Planimeter (ft^2)	Area (acres)	A1+A2+sqr (A1*A2) (acres)	Volume (ac-ft)	Volume (Total) (ac-ft)
7,510.00	0.0	1.510	0.000	0.000	0.000
7,511.00	0.0	1.990	5.233	1.744	1.744
7,512.00	0.0	2.520	6.749	2.250	3.994
7,513.00	0.0	2.850	8.050	2.683	6.678
7,514.00	0.0	3.050	8.848	2.949	9.627
7,515.00	0.0	3.260	9.463	3.154	12.781
7,516.00	0.0	3.480	10.108	3.369	16.151
7,517.00	0.0	3.700	10.768	3.589	19.740
7,518.00	0.0	3.930	11.443	3.814	23.555
7,519.00	0.0	4.160	12.133	4.044	27.599
7,520.00	0.0	4.400	12.838	4.279	31.879
7,521.00	0.0	4.640	13.558	4.519	36.398
7,522.00	0.0	4.880	14.278	4.760	41.158
7,523.00	0.0	5.140	15.028	5.009	46.167
7,524.00	0.0	5.360	15.749	5.250	51.417
7,525.00	0.0	5.590	16.424	5.475	56.891
7,526.00	0.0	5.840	17.144	5.715	62.606
7,527.00	0.0	6.080	17.879	5.960	68.565
7,528.00	0.0	6.330	18.614	6.205	74.770
7,529.00	0.0	6.570	19.349	6.450	81.220
7,530.00	0.0	6.810	20.069	6.690	87.909
7,531.00	0.0	7.150	20.938	6.979	94.889
7,532.00	0.0	7.520	22.003	7.334	102.223
7,533.00	0.0	7.830	23.023	7.674	109.897
7,534.00	0.0	8.370	24.295	8.099	117.996
7,535.00	0.0	8.770	25.708	8.569	126.565
7,536.00	0.0	9.170	26.908	8.969	135.534

Requested Pond Water Surface Elevations	
Minimum (Headwater)	7,510.00 ft
Increment (Headwater)	0.50 ft
Maximum (Headwater)	7,536.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Inlet Box	SWQ Outlet Box	Forward	SWQ Outlet Pipe	7,533.00	7,536.00
Orifice-Area	SWQ Orifice Plate	Forward	SWQ Outlet Pipe	7,531.00	7,536.00
Culvert-Circular	SWQ Outlet Pipe	Forward	TW	7,526.90	7,536.00
Culvert-Box	Twin CBC Spillway	Forward	TW	7,533.00	7,536.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Structure ID: SWQ Outlet Box Structure Type: Inlet Box	
Number of Openings	1
Elevation	7,533.00 ft
Orifice Area	20.8 ft²
Orifice Coefficient	0.600
Weir Length	8.00 ft
Weir Coefficient	3.00 (ft^0.5)/s
K Reverse	1.000
Manning's n	0.000
Kev, Charged Riser	0.000
Weir Submergence	False
Orifice H to crest	False

Structure ID: SWQ Orifice Plate Structure Type: Orifice-Area	
Number of Openings	3
Elevation	7,531.00 ft
Orifice Area	1.4 ft²
Top Elevation	7,533.00 ft
Datum Elevation	7,531.00 ft
Orifice Coefficient	0.600

Structure ID: SWQ Outlet Pipe Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	30.0 in
Length	100.00 ft
Length (Computed Barrel)	100.00 ft
Slope (Computed)	0.010 ft/ft

Outlet Control Data	
Manning's n	0.013
Ke	0.200
Kb	0.009
Kr	0.000
Convergence Tolerance	0.00 ft

Inlet Control Data	
Equation Form	Form 1
K	0.0045
M	2.0000
C	0.0317
Y	0.6900
T1 ratio (HW/D)	1.090
T2 ratio (HW/D)	1.192
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	7,529.63 ft	T1 Flow	27.16 ft³/s
T2 Elevation	7,529.88 ft	T2 Flow	31.05 ft³/s

Structure ID: Twin CBC Spillway Structure Type: Culvert-Box	
Number of Barrels	2
Width	10.00 ft
Height	4.00 ft
Length	65.00 ft
Length (Computed Barrel)	65.00 ft
Slope (Computed)	0.010 ft/ft

Outlet Control Data	
Manning's n	0.013
Ke	0.500
Kb	0.003
Kr	0.000
Convergence Tolerance	0.00 ft

Inlet Control Data	
Equation Form	Form 1
K	0.0260
M	1.0000
C	0.0347
Y	0.8100
T1 ratio (HW/D)	1.173
T2 ratio (HW/D)	1.360
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	7,537.69 ft	T1 Flow	280.00 ft³/s
T2 Elevation	7,538.44 ft	T2 Flow	320.00 ft³/s

Structure ID: TW
Structure Type: TW Setup, DS Channel

Tailwater Type	Free Outfall

Convergence Tolerances	
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.01 ft
Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft
Headwater Tolerance (Maximum)	0.50 ft
Flow Tolerance (Minimum)	0.001 ft^3/s
Flow Tolerance (Maximum)	10.000 ft^3/s

Subsection: Individual Outlet Curves
Label: FH North Pond 13

Return Event: 100 years
Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Box (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft^3/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft^3/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
7,510.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,510.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,511.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,511.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,512.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,512.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,513.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,513.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,514.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,514.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,515.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,515.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,516.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,516.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,517.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,517.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,518.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,518.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,519.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,519.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,520.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,520.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,521.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,521.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,522.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,522.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,523.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,523.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,524.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,524.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,525.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,525.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.90	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,527.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,527.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00

Subsection: Individual Outlet Curves
Label: FH North Pond 13

Return Event: 100 years
Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Box (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)	Message
7,528.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,528.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.50	0.00	0.00	0.00	7,528.16	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.00	0.00	0.00	0.00	7,528.75	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.50	0.00	0.00	0.00	7,529.24	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,533.00	0.00	0.00	0.00	7,529.71	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,533.50	8.49	7,533.50	Free Outfall	7,530.67	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,534.00	24.00	7,534.00	Free Outfall	7,532.08	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,534.50	44.09	7,534.50	7,533.67	7,533.67	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,535.00	67.88	7,535.00	7,534.99	7,534.99	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,535.50	94.87	7,535.50	7,535.50	7,535.50	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,536.00	124.71	7,536.00	7,536.00	7,536.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Box (Inlet Box)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
Weir: H =0.5ft
Weir: H =1ft
FULLY CHARGED RISER: ADJUSTED TO WEIR: H =1.5ft
FULLY CHARGED RISER: ADJUSTED TO WEIR: H =2ft
FULLY CHARGED RISER: ADJUSTED TO WEIR: H =2.5ft
FULLY CHARGED RISER, DOWNSTREAM CONTROL: Kev=0. Hev=0.000

Subsection: Individual Outlet Curves
Label: FH North Pond 13

Return Event: 100 years
Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Orifice Plate (Orifice-Area)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
7,510.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,510.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,511.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,511.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,512.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,512.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,513.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,513.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,514.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,514.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,515.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,515.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,516.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,516.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,517.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,517.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,518.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,518.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,519.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,519.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,520.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,520.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,521.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,521.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,522.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,522.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,523.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,523.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,524.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,524.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,525.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,525.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,526.90	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,527.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00
7,527.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00

Subsection: Individual Outlet Curves
Label: FH North Pond 13

Return Event: 100 years
Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Orifice Plate (Orifice-Area)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)	Message
7,528.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,528.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.50	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.00	0.00	0.00	0.00	0.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.50	6.94	7,531.50	Free Outfall	7,528.16	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.00	13.89	7,532.00	Free Outfall	7,528.75	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.50	20.83	7,532.50	Free Outfall	7,529.24	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,533.00	27.77	7,533.00	Free Outfall	7,529.71	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,533.50	31.05	7,533.50	Free Outfall	7,530.67	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,534.00	27.25	7,534.00	7,532.08	7,532.08	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,534.50	17.92	7,534.50	7,533.67	7,533.67	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,535.00	1.59	7,535.00	7,534.99	7,534.99	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,535.50	0.00	7,535.50	7,535.50	7,535.50	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,536.00	0.00	7,536.00	7,536.00	7,536.00	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Orifice Plate (Orifice-Area)

Upstream ID = (Pond Water Surface)
Downstream ID = SWQ Outlet Pipe (Culvert-Circular)

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
Hi=.50; Ht=2.00; Qt=9.26
Hi=1.00; Ht=2.00; Qt=9.26
Hi=1.50; Ht=2.00; Qt=9.26
H =2.00
H =2.50
H =1.92
H =.83
H =.01
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE
FLOW PRECEDENCE SET TO DOWNSTREAM CONTROLLING STRUCTURE

Subsection: Individual Outlet Curves
Label: FH North Pond 13

Return Event: 100 years
Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Pipe (Culvert-Circular)

Mannings open channel maximum capacity: 44.12 ft³/s
Upstream ID = SWQ Outlet Box, SWQ Orifice Plate
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)
7,510.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,510.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,511.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,511.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,512.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,512.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,513.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,513.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,514.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,514.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,515.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,515.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,516.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,516.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,517.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,517.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,518.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,518.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,519.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,519.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,520.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,520.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,521.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,521.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,522.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,522.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,523.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,523.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,524.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,524.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,525.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,525.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,526.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,526.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,526.90	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00
7,527.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Pipe (Culvert-Circular)

Mannings open channel maximum capacity: 44.12 ft³/s
Upstream ID = SWQ Outlet Box, SWQ Orifice Plate
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Device Flow (ft³/s)	(into) Headwater Hydraulic Grade Line (ft)	Converge Downstream Hydraulic Grade Line (ft)	Next Downstream Hydraulic Grade Line (ft)	Downstream Hydraulic Grade Line Error (ft)	Convergence Error (ft³/s)	Downstream Channel Tailwater (ft)	Tailwater Error (ft)	Message
7,527.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,528.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,528.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,529.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,530.50	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.00	0.00	0.00	0.00	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,531.50	6.94	7,528.16	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.00	13.89	7,528.75	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,532.50	20.83	7,529.24	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,533.00	27.77	7,529.71	Free Outfall	Free Outfall	0.00	0.01	(N/A)	0.00	WS below an invert; no flow.
7,533.50	39.53	7,530.67	Free Outfall	Free Outfall	0.00	0.00	(N/A)	0.00	WS below an invert; no flow.
7,534.00	51.31	7,532.08	Free Outfall	Free Outfall	0.00	0.06	(N/A)	0.00	WS below an invert; no flow.
7,534.50	61.99	7,533.67	Free Outfall	Free Outfall	0.00	0.02	(N/A)	0.00	WS below an invert; no flow.
7,535.00	69.52	7,534.99	Free Outfall	Free Outfall	0.00	0.05	(N/A)	0.00	WS below an invert; no flow.
7,535.50	72.13	7,535.50	Free Outfall	Free Outfall	0.00	22.74	(N/A)	0.00	WS below an invert; no flow.
7,536.00	74.61	7,536.00	Free Outfall	Free Outfall	0.00	50.10	(N/A)	0.00	WS below an invert; no flow.

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Pipe (Culvert-Circular)

Mannings open channel maximum capacity: 44.12 ft³/s
Upstream ID = SWQ Outlet Box, SWQ Orifice Plate
Downstream ID = Tailwater (Pond Outfall)

Message
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
CRIT.DEPTH CONTROL Vh= .321ft Dcr= .874ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .493ft Dcr= 1.255ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .659ft Dcr= 1.551ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .840ft Dcr= 1.797ft CRIT.DEPTH Hev= .00ft
INLET CONTROL... Submerged: HW =3.77
INLET CONTROL... Submerged: HW =5.18
INLET CONTROL... Submerged: HW =6.77

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = SWQ Outlet Pipe (Culvert-Circular)

Mannings open channel maximum capacity: 44.12 ft³/s
Upstream ID = SWQ Outlet Box, SWQ Orifice Plate
Downstream ID = Tailwater (Pond Outfall)

Message
FULL FLOW...Lfull=98.92ft Vh=3.117ft HL=6.583ft Hev= .00ft
FULL FLOW...Lfull=99.10ft Vh=3.356ft HL=7.092ft Hev= .00ft
FULL FLOW...Lfull=99.31ft Vh=3.590ft HL=7.594ft Hev= .00ft

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Twin CBC Spillway (Culvert-Box)

Mannings open channel maximum capacity: 778.58 ft³/s
Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
7,510.00	0.00	(N/A)	0.00
7,510.50	0.00	(N/A)	0.00
7,511.00	0.00	(N/A)	0.00
7,511.50	0.00	(N/A)	0.00
7,512.00	0.00	(N/A)	0.00
7,512.50	0.00	(N/A)	0.00
7,513.00	0.00	(N/A)	0.00
7,513.50	0.00	(N/A)	0.00
7,514.00	0.00	(N/A)	0.00
7,514.50	0.00	(N/A)	0.00
7,515.00	0.00	(N/A)	0.00
7,515.50	0.00	(N/A)	0.00
7,516.00	0.00	(N/A)	0.00
7,516.50	0.00	(N/A)	0.00
7,517.00	0.00	(N/A)	0.00
7,517.50	0.00	(N/A)	0.00
7,518.00	0.00	(N/A)	0.00
7,518.50	0.00	(N/A)	0.00
7,519.00	0.00	(N/A)	0.00
7,519.50	0.00	(N/A)	0.00
7,520.00	0.00	(N/A)	0.00
7,520.50	0.00	(N/A)	0.00
7,521.00	0.00	(N/A)	0.00
7,521.50	0.00	(N/A)	0.00
7,522.00	0.00	(N/A)	0.00
7,522.50	0.00	(N/A)	0.00
7,523.00	0.00	(N/A)	0.00
7,523.50	0.00	(N/A)	0.00
7,524.00	0.00	(N/A)	0.00
7,524.50	0.00	(N/A)	0.00
7,525.00	0.00	(N/A)	0.00
7,525.50	0.00	(N/A)	0.00
7,526.00	0.00	(N/A)	0.00
7,526.50	0.00	(N/A)	0.00
7,526.90	0.00	(N/A)	0.00
7,527.00	0.00	(N/A)	0.00
7,527.50	0.00	(N/A)	0.00
7,528.00	0.00	(N/A)	0.00

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Twin CBC Spillway (Culvert-Box)

Mannings open channel maximum capacity: 778.58 ft³/s
Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
7,528.50	0.00	(N/A)	0.00
7,529.00	0.00	(N/A)	0.00
7,529.50	0.00	(N/A)	0.00
7,530.00	0.00	(N/A)	0.00
7,530.50	0.00	(N/A)	0.00
7,531.00	0.00	(N/A)	0.00
7,531.50	0.00	(N/A)	0.00
7,532.00	0.00	(N/A)	0.00
7,532.50	0.00	(N/A)	0.00
7,533.00	0.00	(N/A)	0.00
7,533.50	17.36	(N/A)	0.00
7,534.00	49.05	(N/A)	0.00
7,534.50	90.08	(N/A)	0.00
7,535.00	138.56	(N/A)	0.00
7,535.50	193.63	(N/A)	0.00
7,536.00	254.72	(N/A)	0.00

Computation Messages
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Twin CBC Spillway (Culvert-Box)

Mannings open channel maximum capacity: 778.58 ft³/s
Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Computation Messages
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
WS below an invert; no flow.
CRIT.DEPTH CONTROL Vh= .143ft Dcr= .286ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .286ft Dcr= .572ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .429ft Dcr= .858ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .571ft Dcr= 1.143ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .714ft Dcr= 1.428ft CRIT.DEPTH Hev= .00ft
CRIT.DEPTH CONTROL Vh= .857ft Dcr= 1.715ft CRIT.DEPTH Hev= .00ft

Subsection: Composite Rating Curve
Label: FH North Pond 13

Return Event: 100 years
Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
7,510.00	0.00	(N/A)	0.00
7,510.50	0.00	(N/A)	0.00
7,511.00	0.00	(N/A)	0.00
7,511.50	0.00	(N/A)	0.00
7,512.00	0.00	(N/A)	0.00
7,512.50	0.00	(N/A)	0.00
7,513.00	0.00	(N/A)	0.00
7,513.50	0.00	(N/A)	0.00
7,514.00	0.00	(N/A)	0.00
7,514.50	0.00	(N/A)	0.00
7,515.00	0.00	(N/A)	0.00
7,515.50	0.00	(N/A)	0.00
7,516.00	0.00	(N/A)	0.00
7,516.50	0.00	(N/A)	0.00
7,517.00	0.00	(N/A)	0.00
7,517.50	0.00	(N/A)	0.00
7,518.00	0.00	(N/A)	0.00
7,518.50	0.00	(N/A)	0.00
7,519.00	0.00	(N/A)	0.00
7,519.50	0.00	(N/A)	0.00
7,520.00	0.00	(N/A)	0.00
7,520.50	0.00	(N/A)	0.00
7,521.00	0.00	(N/A)	0.00
7,521.50	0.00	(N/A)	0.00
7,522.00	0.00	(N/A)	0.00
7,522.50	0.00	(N/A)	0.00
7,523.00	0.00	(N/A)	0.00
7,523.50	0.00	(N/A)	0.00
7,524.00	0.00	(N/A)	0.00
7,524.50	0.00	(N/A)	0.00
7,525.00	0.00	(N/A)	0.00
7,525.50	0.00	(N/A)	0.00
7,526.00	0.00	(N/A)	0.00
7,526.50	0.00	(N/A)	0.00
7,526.90	0.00	(N/A)	0.00
7,527.00	0.00	(N/A)	0.00
7,527.50	0.00	(N/A)	0.00
7,528.00	0.00	(N/A)	0.00
7,528.50	0.00	(N/A)	0.00
7,529.00	0.00	(N/A)	0.00
7,529.50	0.00	(N/A)	0.00
7,530.00	0.00	(N/A)	0.00
7,530.50	0.00	(N/A)	0.00
7,531.00	0.00	(N/A)	0.00

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
7,531.50	6.94	(N/A)	0.00
7,532.00	13.89	(N/A)	0.00
7,532.50	20.83	(N/A)	0.00
7,533.00	27.77	(N/A)	0.00
7,533.50	56.89	(N/A)	0.00
7,534.00	100.36	(N/A)	0.00
7,534.50	152.07	(N/A)	0.00
7,535.00	208.08	(N/A)	0.00
7,535.50	265.76	(N/A)	0.00
7,536.00	329.33	(N/A)	0.00

Contributing Structures
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)

Composite Outflow Summary

Contributing Structures
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)

Composite Outflow Summary

Contributing Structures
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)
(no Q: SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway)

Subsection: Composite Rating Curve
Label: FH North Pond 13

Return Event: 100 years
Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

Composite Outflow Summary

Contributing Structures
SWQ Orifice Plate,SWQ Outlet Pipe (no Q: SWQ Outlet Box,Twin CBC Spillway)
SWQ Orifice Plate,SWQ Outlet Pipe (no Q: SWQ Outlet Box,Twin CBC Spillway)
SWQ Orifice Plate,SWQ Outlet Pipe (no Q: SWQ Outlet Box,Twin CBC Spillway)
SWQ Orifice Plate,SWQ Outlet Pipe (no Q: SWQ Outlet Box,Twin CBC Spillway)
SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway
SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway
SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway
SWQ Outlet Box,SWQ Orifice Plate,SWQ Outlet Pipe,Twin CBC Spillway
SWQ Outlet Box,SWQ Outlet Pipe,Twin CBC Spillway (no Q: SWQ Orifice Plate)
SWQ Outlet Box,SWQ Outlet Pipe,Twin CBC Spillway (no Q: SWQ Orifice Plate)

Subsection: Elevation-Volume-Flow Table (Pond) Return Event: 100 years
Label: JD Reservoir (Pond 13) Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

Infiltration	
Infiltration Method (Computed)	No Infiltration

Initial Conditions	
Elevation (Water Surface, Initial)	7,531.00 ft
Volume (Initial)	94.889 ac-ft
Flow (Initial Outlet)	0.00 ft³/s
Flow (Initial Infiltration)	0.00 ft³/s
Flow (Initial, Total)	0.00 ft³/s
Time Increment	0.050 hours

Elevation (ft)	Outflow (ft³/s)	Storage (ac-ft)	Area (acres)	Infiltration (ft³/s)	Flow (Total) (ft³/s)	2S/t + O (ft³/s)
7,510.00	0.00	0.000	1.510	0.00	0.00	0.00
7,510.50	0.00	0.812	1.742	0.00	0.00	393.13
7,511.00	0.00	1.744	1.990	0.00	0.00	844.33
7,511.50	0.00	2.803	2.247	0.00	0.00	1,356.72
7,512.00	0.00	3.994	2.520	0.00	0.00	1,933.23
7,512.50	0.00	5.295	2.682	0.00	0.00	2,562.63
7,513.00	0.00	6.678	2.850	0.00	0.00	3,231.95
7,513.50	0.00	8.127	2.949	0.00	0.00	3,933.62
7,514.00	0.00	9.627	3.050	0.00	0.00	4,659.48
7,514.50	0.00	11.178	3.154	0.00	0.00	5,410.14
7,515.00	0.00	12.781	3.260	0.00	0.00	6,186.22
7,515.50	0.00	14.439	3.369	0.00	0.00	6,988.30
7,516.00	0.00	16.151	3.480	0.00	0.00	7,817.01
7,516.50	0.00	17.918	3.589	0.00	0.00	8,672.34
7,517.00	0.00	19.740	3.700	0.00	0.00	9,554.30
7,517.50	0.00	21.619	3.814	0.00	0.00	10,463.47
7,518.00	0.00	23.555	3.930	0.00	0.00	11,400.48
7,518.50	0.00	25.548	4.044	0.00	0.00	12,365.32
7,519.00	0.00	27.599	4.160	0.00	0.00	13,357.99
7,519.50	0.00	29.709	4.279	0.00	0.00	14,379.10
7,520.00	0.00	31.879	4.400	0.00	0.00	15,429.24
7,520.50	0.00	34.108	4.519	0.00	0.00	16,508.43
7,521.00	0.00	36.398	4.640	0.00	0.00	17,616.66
7,521.50	0.00	38.748	4.759	0.00	0.00	18,753.94
7,522.00	0.00	41.158	4.880	0.00	0.00	19,920.26
7,522.50	0.00	43.630	5.009	0.00	0.00	21,116.81
7,523.00	0.00	46.167	5.140	0.00	0.00	22,344.83
7,523.50	0.00	48.764	5.249	0.00	0.00	23,601.92
7,524.00	0.00	51.417	5.360	0.00	0.00	24,885.64
7,524.50	0.00	54.125	5.474	0.00	0.00	26,196.58
7,525.00	0.00	56.891	5.590	0.00	0.00	27,535.35

Subsection: Elevation-Volume-Flow Table (Pond) Return Event: 100 years
Label: JD Reservoir (Pond 13) Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

Elevation (ft)	Outflow (ft^3/s)	Storage (ac-ft)	Area (acres)	Infiltration (ft^3/s)	Flow (Total) (ft^3/s)	2S/t + O (ft^3/s)
7,525.50	0.00	59.717	5.714	0.00	0.00	28,903.14
7,526.00	0.00	62.606	5.840	0.00	0.00	30,301.19
7,526.50	0.00	65.556	5.959	0.00	0.00	31,728.89
7,526.90	0.00	67.959	6.056	0.00	0.00	32,891.95
7,527.00	0.00	68.565	6.080	0.00	0.00	33,185.63
7,527.50	0.00	71.636	6.204	0.00	0.00	34,672.01
7,528.00	0.00	74.770	6.330	0.00	0.00	36,188.65
7,528.50	0.00	77.965	6.449	0.00	0.00	37,734.94
7,529.00	0.00	81.220	6.570	0.00	0.00	39,310.27
7,529.50	0.00	84.534	6.689	0.00	0.00	40,914.64
7,530.00	0.00	87.909	6.810	0.00	0.00	42,548.05
7,530.50	0.00	91.356	6.979	0.00	0.00	44,216.48
7,531.00	0.00	94.889	7.150	0.00	0.00	45,926.04
7,531.50	6.94	98.509	7.334	0.00	6.94	47,685.48
7,532.00	13.89	102.223	7.520	0.00	13.89	49,489.69
7,532.50	20.83	106.021	7.674	0.00	20.83	51,335.10
7,533.00	27.77	109.897	7.830	0.00	27.77	53,218.02
7,533.50	56.89	113.879	8.098	0.00	56.89	55,174.31
7,534.00	100.36	117.996	8.370	0.00	100.36	57,210.28
7,534.50	152.07	122.230	8.569	0.00	152.07	59,311.55
7,535.00	208.08	126.565	8.770	0.00	208.08	61,465.51
7,535.50	265.76	131.000	8.969	0.00	265.76	63,669.55
7,536.00	329.33	135.534	9.170	0.00	329.33	65,927.87

Peak Discharge	91.03 ft³/s
Time to Peak	13.100 hours
Hydrograph Volume	39.865 ac-ft

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
8.050	0.00	0.00	0.00	0.00	0.01
8.300	0.01	0.01	0.01	0.02	0.02
8.550	0.03	0.03	0.04	0.04	0.05
8.800	0.06	0.06	0.07	0.08	0.09
9.050	0.09	0.10	0.11	0.12	0.13
9.300	0.14	0.15	0.16	0.17	0.18
9.550	0.18	0.19	0.20	0.22	0.23
9.800	0.24	0.25	0.26	0.27	0.28
10.050	0.29	0.31	0.32	0.33	0.34
10.300	0.36	0.37	0.38	0.40	0.41
10.550	0.43	0.45	0.46	0.48	0.50
10.800	0.53	0.55	0.57	0.60	0.63
11.050	0.67	0.71	0.75	0.80	0.86
11.300	0.92	0.99	1.07	1.16	1.26
11.550	1.38	1.53	1.75	2.07	2.52
11.800	3.13	3.99	5.22	6.98	9.32
12.050	12.30	15.74	19.37	22.88	26.06
12.300	32.14	41.67	49.52	55.94	63.05
12.550	69.14	74.09	78.10	81.34	83.94
12.800	86.02	87.67	88.93	89.86	90.48
13.050	90.86	91.03	91.01	90.83	90.49
13.300	90.03	89.47	88.81	88.08	87.27
13.550	86.41	85.49	84.53	83.53	82.48
13.800	81.40	80.29	79.17	78.03	76.89
14.050	75.75	74.61	73.48	72.35	71.23
14.300	70.12	69.02	67.93	66.84	65.76
14.550	64.68	63.62	62.57	61.51	60.47
14.800	59.43	58.41	57.41	56.57	55.90
15.050	55.24	54.59	53.96	53.34	52.73
15.300	52.14	51.55	50.98	50.40	49.83
15.550	49.25	48.68	48.11	47.54	46.99
15.800	46.44	45.91	45.39	44.88	44.38
16.050	43.89	43.42	42.96	42.51	42.08
16.300	41.66	41.24	40.84	40.45	40.08
16.550	39.71	39.35	38.99	38.62	38.26
16.800	37.88	37.50	37.13	36.75	36.38
17.050	36.01	35.65	35.30	34.96	34.62
17.300	34.30	33.98	33.67	33.36	33.07
17.550	32.78	32.51	32.24	31.97	31.72

Subsection: Pond Routed Hydrograph (total out) Return Event: 100 years
Label: JD Reservoir (Pond 13) (OUT) Storm Event: TYPE II 24 HOUR (Colo. Spgs.)

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
17.800	31.47	31.22	30.98	30.72	30.46
18.050	30.19	29.91	29.63	29.35	29.07
18.300	28.79	28.51	28.24	27.98	27.75
18.550	27.69	27.63	27.57	27.50	27.44
18.800	27.38	27.32	27.26	27.20	27.14
19.050	27.08	27.02	26.96	26.90	26.84
19.300	26.78	26.73	26.67	26.61	26.56
19.550	26.50	26.44	26.39	26.33	26.28
19.800	26.23	26.17	26.11	26.05	25.99
20.050	25.92	25.85	25.78	25.71	25.63
20.300	25.56	25.48	25.40	25.32	25.25
20.550	25.17	25.10	25.02	24.95	24.87
20.800	24.80	24.72	24.65	24.58	24.50
21.050	24.43	24.36	24.29	24.22	24.15
21.300	24.08	24.01	23.94	23.87	23.80
21.550	23.73	23.67	23.60	23.54	23.47
21.800	23.40	23.34	23.28	23.21	23.15
22.050	23.09	23.02	22.96	22.90	22.84
22.300	22.78	22.72	22.66	22.60	22.54
22.550	22.48	22.42	22.36	22.31	22.25
22.800	22.19	22.14	22.08	22.03	21.97
23.050	21.92	21.86	21.81	21.76	21.71
23.300	21.65	21.60	21.55	21.50	21.45
23.550	21.40	21.35	21.30	21.25	21.20
23.800	21.14	21.09	21.04	20.98	20.92

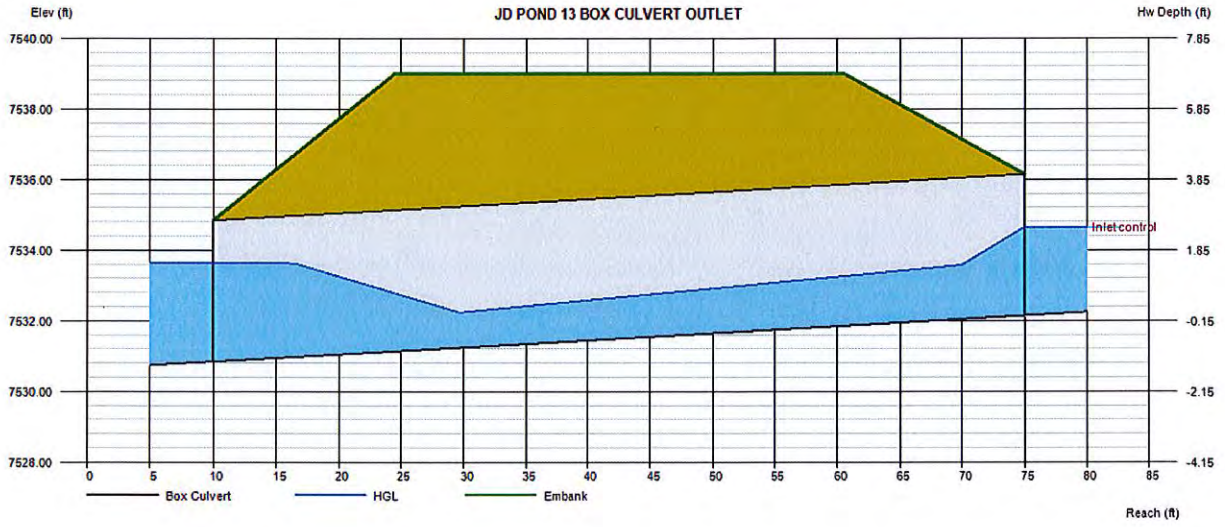
Index

Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Saturday, Nov 4 2017

JD POND 13 BOX CULVERT OUTLET (100 yr. Storm Release)

Invert Elev Dn (ft)	= 7530.85	**Calculations**	
Pipe Length (ft)	= 65.00	Qmin (cfs)	= 0.00
Slope (%)	= 2.00	Qmax (cfs)	= 505.00
Invert Elev Up (ft)	= 7532.15	Tailwater Elev (ft)	= (dc+D)/2
Rise (in)	= 48.0		
Shape	= Box	**Highlighted**	
Span (in)	= 120.0	Qtotal (cfs)	= 227.25
No. Barrels	= 2	Qpipe (cfs)	= 227.25
n-Value	= 0.013	Qovertop (cfs)	= 0.00
Culvert Type	= Flared Wingwalls	Veloc Dn (ft/s)	= 4.07
Culvert Entrance	= 30D to 75D wingwall flares	Veloc Up (ft/s)	= 7.15
Coeff. K,M,c,Y,k	= 0.026, 1, 0.0347, 0.81, 0.4	HGL Dn (ft)	= 7533.65
		HGL Up (ft)	= 7533.74
Embankment		Hw Elev (ft)	= 7534.64
Top Elevation (ft)	= 7539.00	Hw/D (ft)	= 0.62
Top Width (ft)	= 36.00	Flow Regime	= Inlet Control
Crest Width (ft)	= 230.00		

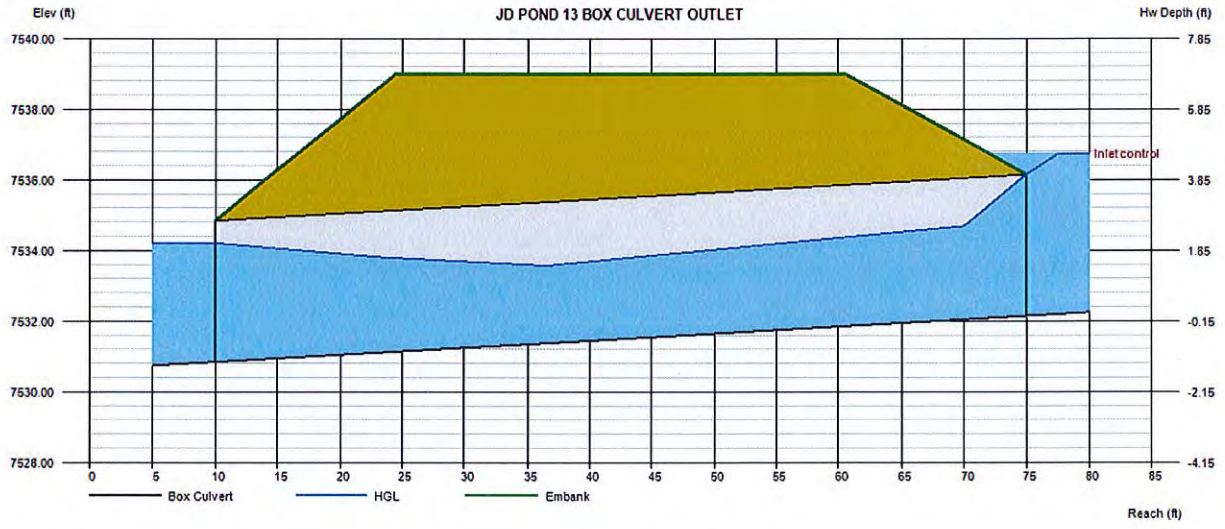


Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Saturday, Nov 4 2017

JD POND 13 BOX CULVERT OUTLET (Emergency Release)

Invert Elev Dn (ft)	= 7530.85	**Calculations**	
Pipe Length (ft)	= 65.00	Qmin (cfs)	= 0.00
Slope (%)	= 2.00	Qmax (cfs)	= 505.00
Invert Elev Up (ft)	= 7532.15	Tailwater Elev (ft)	= (dc+D)/2
Rise (in)	= 48.0		
Shape	= Box	**Highlighted**	
Span (in)	= 120.0	Qtotal (cfs)	= 505.00
No. Barrels	= 2	Qpipe (cfs)	= 505.00
n-Value	= 0.013	Qovertop (cfs)	= 0.00
Culvert Type	= Flared Wingwalls	Veloc Dn (ft/s)	= 7.53
Culvert Entrance	= 30D to 75D wingwall flares	Veloc Up (ft/s)	= 9.34
Coeff. K,M,c,Y,k	= 0.026, 1, 0.0347, 0.81, 0.4	HGL Dn (ft)	= 7534.20
		HGL Up (ft)	= 7534.85
Embankment		Hw Elev (ft)	= 7536.73
Top Elevation (ft)	= 7539.00	Hw/D (ft)	= 1.15
Top Width (ft)	= 36.00	Flow Regime	= Inlet Control
Crest Width (ft)	= 230.00		

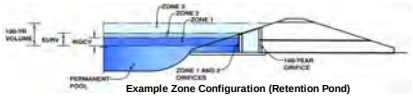


DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Flying Horse North

Basin ID: Golf Course Irrigation Reservoir (Pond - 13)



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	RP	
Watershed Area =	366.80	acres
Watershed Length =	6,975	ft
Watershed Slope =	0.015	ft/ft
Watershed Imperviousness =	8.30%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	12.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	1.395	acre-feet
Excess Urban Runoff Volume (EURV) =	2.819	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	1.903	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	3.006	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	7.525	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	21.442	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	30.109	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	41.427	acre-feet
500-yr Runoff Volume (P1 = 3.39 in.) =	68.375	acre-feet
Approximate 2-yr Detention Volume =	1.765	acre-feet
Approximate 5-yr Detention Volume =	2.813	acre-feet
Approximate 10-yr Detention Volume =	6.361	acre-feet
Approximate 25-yr Detention Volume =	9.142	acre-feet
Approximate 50-yr Detention Volume =	9.507	acre-feet
Approximate 100-yr Detention Volume =	12.417	acre-feet

Optional User Override 1-hr Precipitation	
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.39	inches

Stage-Storage Calculation

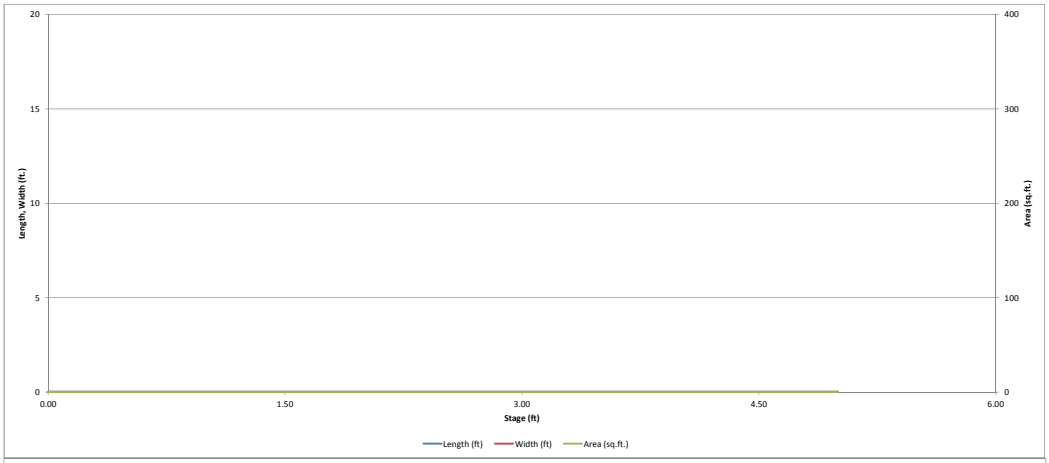
Zone 1 Volume (WQCV) =	1.395	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.424	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	9.598	acre-feet
Total Detention Basin Volume =	12.417	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	N/A	ft
Slope of Trickle Channel (S_{TC}) =	N/A	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

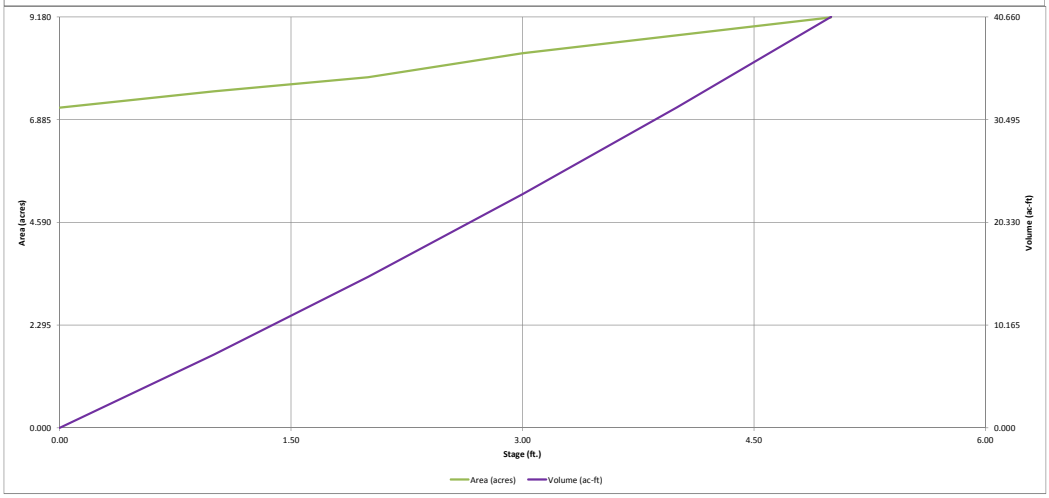
Depth Increment = 0.5 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Permanent Pool	--	0.00	--	--	--	311,545	7.152		
7532	--	1.00	--	--	--	327,571	7.520	316,283	7.261
7533	--	2.00	--	--	--	341,084	7.830	650,475	14.933
7534	--	3.00	--	--	--	364,597	8.370	1,006,726	23.111
7535	--	4.00	--	--	--	382,021	8.770	1,380,035	31.681
7536	--	5.00	--	--	--	399,445	9.170	1,770,768	40.651

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



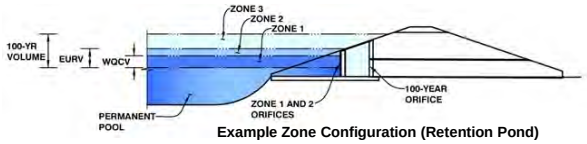


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Flying Horse North

Basin ID: Golf Course Irrigation Reservoir (Pond - 13)



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.20	1.395	Orifice Plate
Zone 2 (EURV)	0.40	1.424	Orifice Plate
Zone 3 (100-year)	1.67	9.598	Weir&Pipe (Restrict)
		12.417	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	2.00	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	8.00	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.70	1.40					
Orifice Area (sq. inches)	196.25	196.25	196.25					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected				
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

Calculated Parameters for Vertical Orifice

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.00	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	3.00	N/A	feet
Overflow Weir Front Edge Length =	8.00	N/A	feet	Over Flow Weir Slope Length =	4.12	N/A	feet
Overflow Weir Slope =	4.00	N/A	H:V (enter zero for flat grate)	Grate Open Area / 100-yr Orifice Area =	5.04	N/A	should be ≥ 4
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Grate Open Area w/o Debris =	24.74	N/A	ft^2
Overflow Grate Open Area % =	75%	N/A	%, grate open area/total area	Overflow Grate Open Area w/ Debris =	12.37	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	4.91	N/A	ft^2
Outlet Pipe Diameter =	30.00	N/A	inches	Outlet Orifice Centroid =	1.25	N/A	feet
Restrictor Plate Height Above Pipe Invert =	30.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	2.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	4.13	feet
Spillway Crest Length =	20.00	feet	Stage at Top of Freeboard =	7.13	feet
Spillway End Slopes =	0.00	H:V	Basin Area at Top of Freeboard =	9.17	acres
Freeboard above Max Water Surface =	1.00	feet			

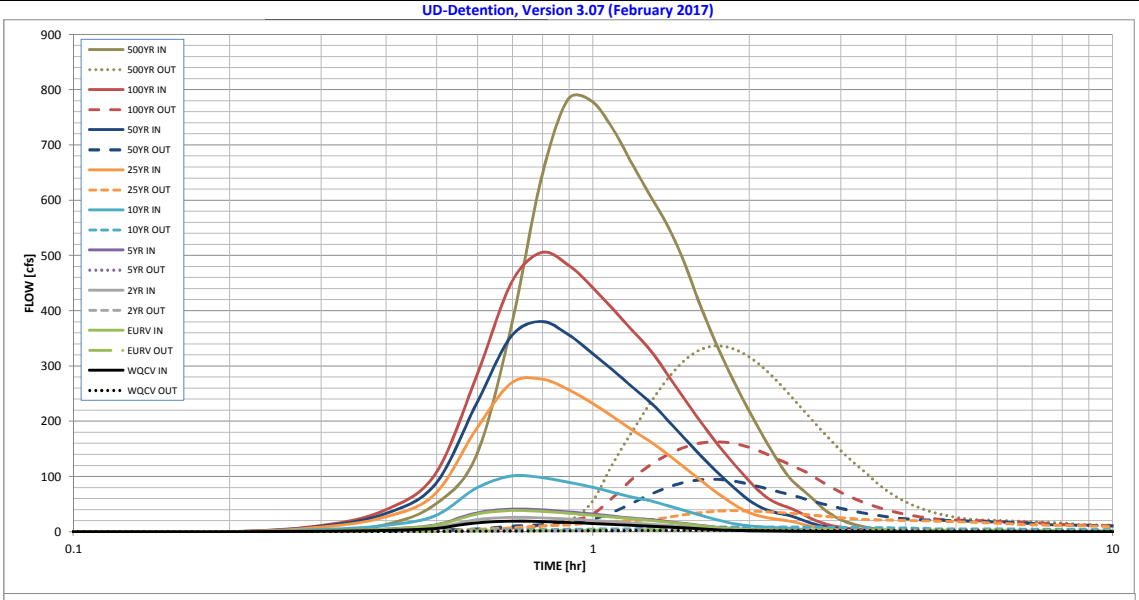
Calculated Parameters for Spillway

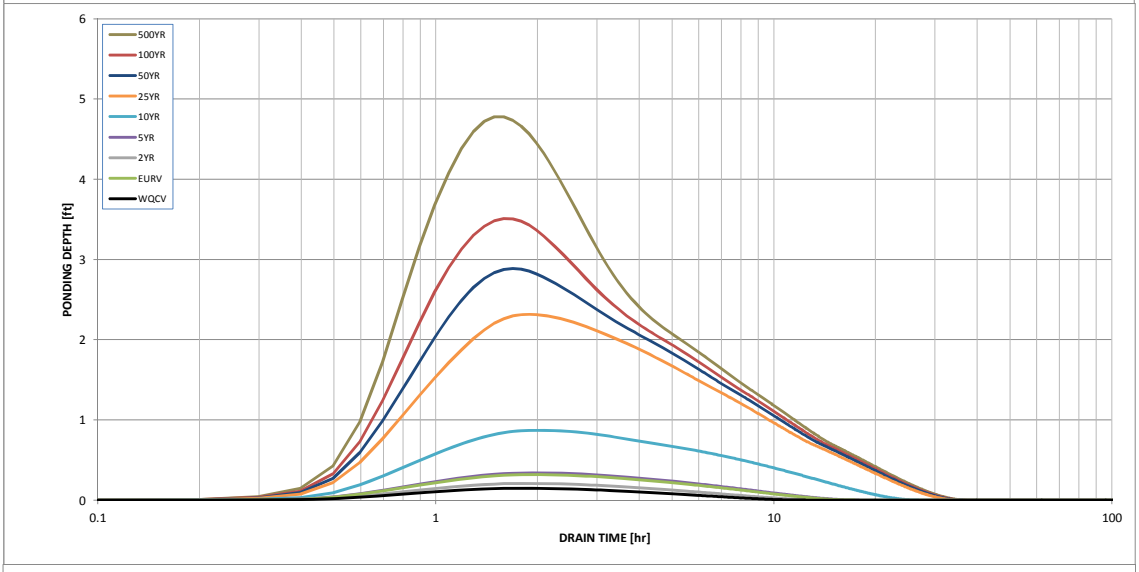
Routed Hydrograph Results

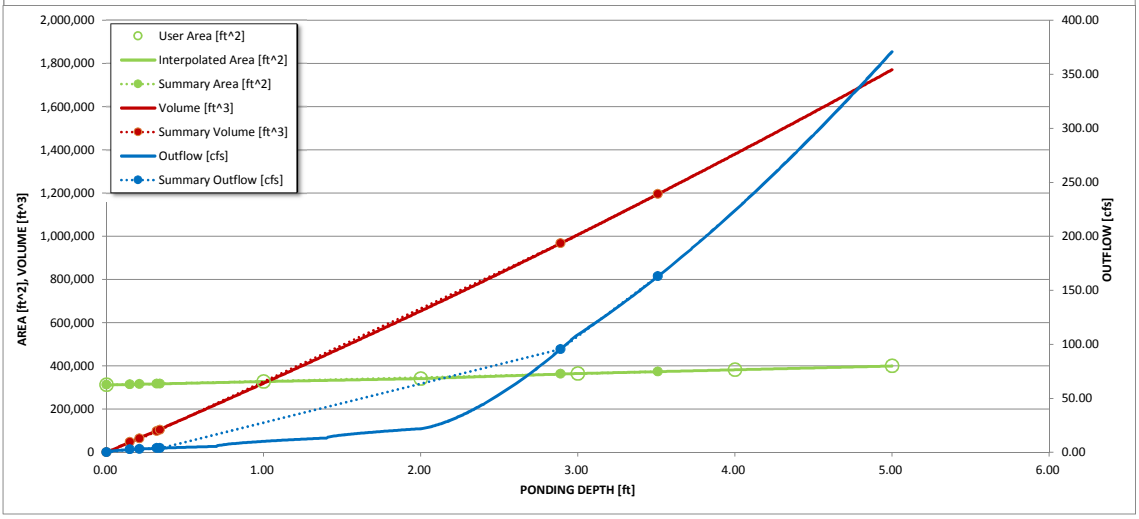
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.39
Calculated Runoff Volume (acre-ft) =	1.395	2.819	1.903	3.006	7.525	21.442	30.109	41.427	68.375
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	1.394	2.816	1.900	3.003	7.514	21.423	30.083	41.387	68.317
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.16	0.54	0.75	1.02	1.63
Predevelopment Peak Q (cfs) =	0.0	0.0	3.6	6.1	57.6	198.0	274.5	372.4	596.7
Peak Inflow Q (cfs) =	19.2	38.5	26.1	41.0	100.7	276.4	380.4	505.1	781.5
Peak Outflow Q (cfs) =	2.5	3.7	3.0	3.8	8.8	38.3	95.3	162.9	335.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.2	0.2	0.3	0.4	0.6
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Spillway	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.1	0.7	0.8	0.7
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	11	15	12	15	22	27	27	26	23
Time to Drain 99% of Inflow Volume (hours) =	**12**	16	14	17	24	31	31	30	29
Maximum Ponding Depth (ft) =	0.15	0.32	0.21	0.34	0.87	2.32	2.89	3.51	4.78
Area at Maximum Ponding Depth (acres) =	7.20	7.27	7.23	7.27	7.47	8.00	8.31	8.57	9.08
Maximum Volume Stored (acre-ft) =	1.005	2.235	1.438	2.380	6.287	17.464	22.111	27.346	38.553

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

Time Interval	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.96 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph	0:11:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant	0:17:53	0.84	1.64	1.13	1.74	3.89	8.10	9.45	10.70	12.53
0.838	0:23:50	2.27	4.50	3.07	4.78	11.19	26.31	32.42	38.79	49.32
	0:29:48	5.84	11.54	7.89	12.28	28.74	68.14	85.23	103.50	136.82
	0:35:46	16.03	31.67	21.66	33.69	78.66	185.19	230.64	279.30	368.39
	0:41:43	19.24	38.52	26.14	41.04	100.72	268.39	352.72	449.09	637.27
	0:47:41	18.41	36.94	25.03	39.36	98.13	276.41	380.45	505.10	781.53
	0:53:38	16.76	33.61	22.78	35.82	89.84	257.86	357.63	483.60	779.55
	0:59:36	15.02	30.23	20.45	32.23	81.03	233.50	324.40	444.47	728.77
	1:05:34	13.03	26.36	17.77	28.12	71.20	208.11	292.31	402.92	664.26
	1:11:31	11.33	22.96	15.44	24.50	62.30	183.66	261.37	363.61	606.64
	1:17:29	10.27	20.78	14.00	22.16	55.97	162.73	233.74	327.83	554.78
	1:23:26	8.54	17.36	11.67	18.53	47.28	140.69	202.49	284.75	493.39
	1:29:24	7.02	14.35	9.62	15.32	39.29	118.61	172.33	244.04	422.82
	1:35:22	5.47	11.31	7.54	12.08	31.42	97.62	144.02	206.83	361.25
	1:41:19	4.14	8.68	5.74	9.28	24.46	78.21	118.31	173.40	308.86
	1:47:17	3.02	6.43	4.22	6.89	18.45	61.46	95.91	143.99	262.60
	1:53:14	2.31	4.85	3.20	5.19	13.70	46.77	75.98	117.98	223.05
	1:59:12	1.89	3.93	2.61	4.20	10.92	35.49	58.65	94.43	186.88
	2:05:10	1.60	3.31	2.20	3.54	9.16	28.97	45.70	73.87	153.72
	2:11:07	1.40	2.89	1.92	3.08	7.94	24.69	38.00	58.86	123.69
	2:17:05	1.26	2.59	1.73	2.76	7.08	21.74	32.93	49.66	98.63
	2:23:02	1.15	2.37	1.59	2.53	6.47	19.61	29.37	43.65	82.75
	2:29:00	0.85	1.76	1.17	1.88	4.91	15.74	24.05	36.21	69.14
	2:34:58	0.62	1.28	0.85	1.36	3.54	11.47	17.96	27.64	54.51
	2:40:55	0.46	0.94	0.63	1.01	2.63	8.39	13.05	20.36	41.02
	2:46:53	0.34	0.70	0.46	0.75	1.95	6.26	9.65	15.04	30.77
	2:52:50	0.24	0.51	0.34	0.54	1.44	4.67	7.32	11.26	22.90
	2:58:48	0.17	0.36	0.24	0.39	1.04	3.45	5.48	8.54	17.17
	3:04:46	0.12	0.26	0.17	0.28	0.75	2.51	4.09	6.43	13.09
	3:10:43	0.08	0.18	0.12	0.20	0.53	1.87	3.05	4.85	9.94
	3:16:41	0.05	0.12	0.07	0.12	0.35	1.31	2.25	3.71	7.63
	3:22:38	0.03	0.06	0.04	0.07	0.21	0.86	1.58	2.74	5.96
	3:28:36	0.01	0.03	0.02	0.03	0.10	0.50	1.02	1.91	4.49
	3:34:34	0.00	0.01	0.00	0.01	0.03	0.24	0.59	1.23	3.23
	3:40:31	0.00	0.00	0.00	0.00	0.00	0.07	0.27	0.70	2.17
	3:46:29	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.32	1.33
	3:52:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.68
	3:58:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25
	4:04:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
	4:10:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:16:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:22:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:28:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:34:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:46:05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:52:02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:58:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:03:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:09:55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:21:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:27:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:33:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:39:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:51:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:57:36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:03:34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:09:31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:15:29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:21:26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:27:24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:33:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:39:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:45:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:51:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:57:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:03:10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:09:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
PERMANENT WSE	0.00	311,545	7.152	0	0.000	0.00
WQCV	0.15	313,949	7.207	46,912	1.077	2.54
2 YR. WSE	0.21	314,750	7.226	62,630	1.438	2.93
EURV	0.32	316,513	7.266	97,349	2.235	3.65
5 YR. WSE	0.34	316,834	7.273	103,682	2.380	3.77
50 YR. WSE	2.89	362,011	8.311	966,763	22.194	95.44
100 YR. WSE	3.51	373,483	8.574	1,194,936	27.432	162.90

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

Rock Chute Design Data

(Version 4.01 - 04/23/03, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Flying Horse North - JD Pond Outlet **County:** EL Paso
Designer: Marc Whorton **Checked by:**
Date: 11/12/2017 **Date:**

Input Channel Geometry

→ Inlet Channel	→ Chute	→ Outlet Channel
Bw = 20.8 ft.	Bw = 20.0 ft.	Bw = 20.0 ft.
Side slopes = 0.0 (m:1)	Factor of safety = 1.20 (F_s)	Side slopes = 4.0 (m:1)
n-value = 0.013	Side slopes = 3.0 (m:1) → 2.0:1 max.	n-value = 0.035
Bed slope = 0.0200 ft./ft.	Bed slope (4:1) = 0.250 ft./ft. → 2.5:1 max.	Bed slope = 0.0100 ft./ft.
Freeboard = 1.0 ft.	Outlet apron depth, d = 2.0 ft.	Base flow = 40.0 cfs

Design Storm Data (Table 2, NHCP, NRCS Grade Stabilization Structure No. 410)

Drainage area = acres Rainfall = ○ 0 - 3 in. ◉ 3 - 5 in. ○ 5+ in.

Apron elev. --- Inlet = 7531.3 ft. --- Outlet = 7511.3 ft. --- (H_{drop} = 18 ft.)

Chute capacity = Q25-year
Total capacity = Q100-year
Minimum capacity (based on a 5-year, 24-hour storm with a 3 - 5 inch rainfall)

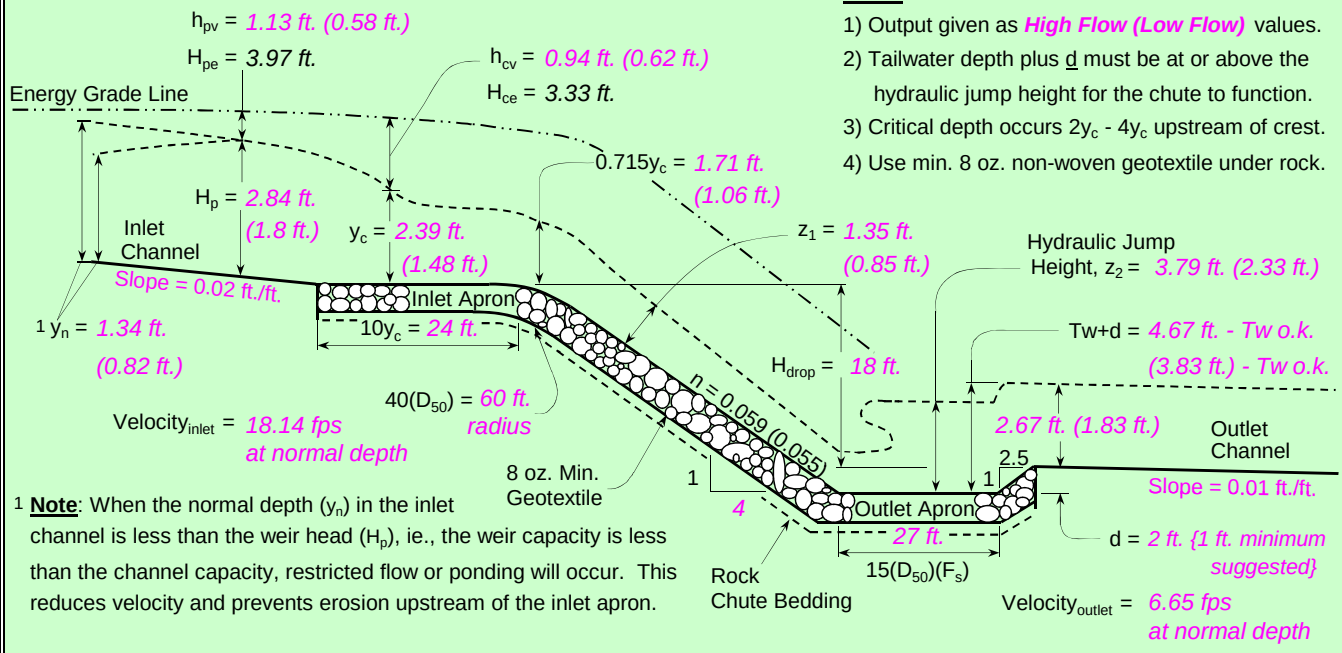
Q_{high} = 505.0 cfs High flow storm through chute → Tw (ft.) = Program

Q_{low} = 229.0 cfs Low flow storm through chute → Tw (ft.) = Program

***Note**: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.*
***Input tailwater (Tw)**:*

0.25

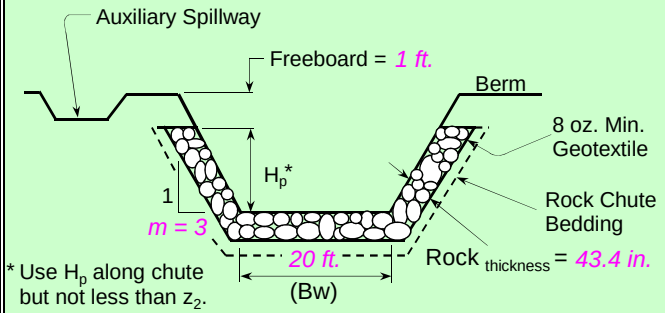
Profile and Cross Section (Output)



Notes:
1) Output given as ***High Flow (Low Flow)*** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs 2y_c - 4y_c upstream of crest.
4) Use min. 8 oz. non-woven geotextile under rock.

[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute



* Use H_p along chute but not less than z_2.

Typical Cross Section

q_t =	20.9 cfs/ft.	Equivalent unit discharge
F_S =	1.20	Factor of safety (multiplier)
z_1 =	1.35 ft.	Normal depth in chute
n-value =	0.059	Manning's roughness coefficient
$D_{50}(F_s)$ =	21.7 in. (747 lbs. - 50% round / 50% angular)	
$2(D_{50})(F_s)$ =	43.4 in.	Rock chute thickness
Tw + d =	4.67 ft.	Tailwater above outlet apron
z_2 =	3.79 ft.	Hydraulic jump height
*** ***The outlet***	***will***	***function adequately***

High Flow Storm Information

Rock Chute Design - Plan Sheet

(Version 4.0 - 07/10/00, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Flying Horse North - JD Pond Outlet
Designer: Marc Whorton
Date: 11/12/2017

County: EL Paso
Checked by:
Date:

Design Values

Angular D_{50} dia. = 21.7 in.
$Rock_{chute}$ thickness = 43.4 in.
Inlet apron length = 24 ft.
Outlet apron length = 27 ft.
Radius = 60 ft.
Will bedding be used? Yes

Rock Gradation Envelope

% Passing	Diameter, in. (weight, lbs.)
D_{100}	33 - 43 (2513 - 5957)
D_{85}	28 - 39 (1636 - 4343)
D_{50}	22 - 33 (745 - 2513)
D_{10}	17 - 28 (381 - 1636)

Depth (in.) = 6.0

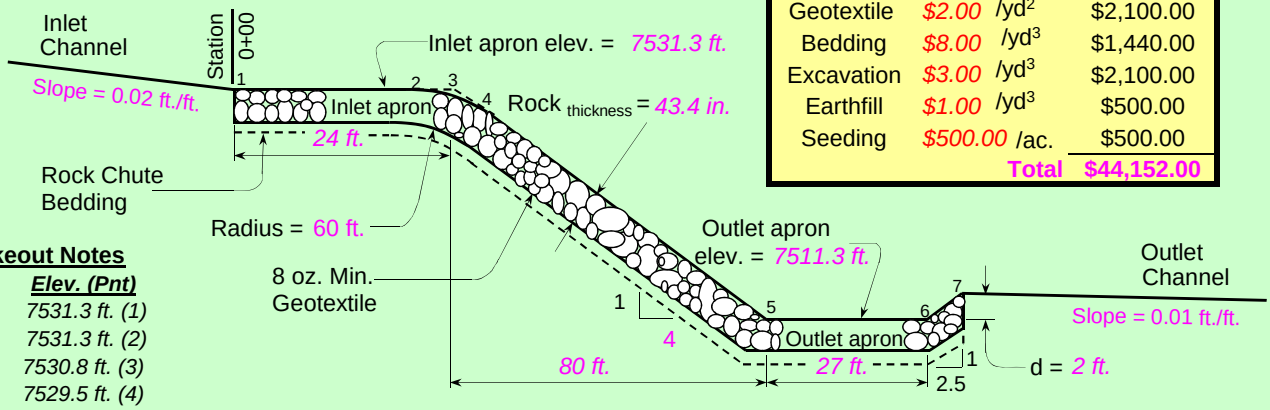
Quantities [a]

Angular Rock = 1042 yd^3
Geotextile (8 oz.)[b] = 1050 yd^2
Bedding (6 in.) = 180 yd^3
Excavation = 700 yd^3
Earthfill = 500 yd^3
Seeding = 1.0 acres

Notes: [a] *Rock, bedding, and geotextile quantities are determined from the x-section below (neglect radius).*
[b] *Geotextile shall be overlapped (18-in. min.) and anchored (18-in. min. along sides and 24-in. min. on the ends).*

Rock Chute Cost Estimate

Unit	Unit Cost	Cost
Rock	$36.00 /$yd^3$	$37,512.00
Geotextile	$2.00 /$yd^2$	$2,100.00
Bedding	$8.00 /$yd^3$	$1,440.00
Excavation	$3.00 /$yd^3$	$2,100.00
Earthfill	$1.00 /$yd^3$	$500.00
Seeding	$500.00 /ac.	$500.00
	Total	**$44,152.00**

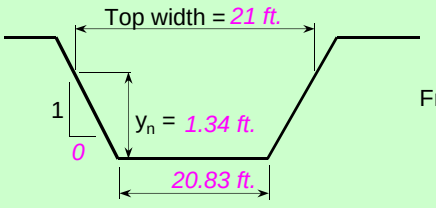


Stakeout Notes

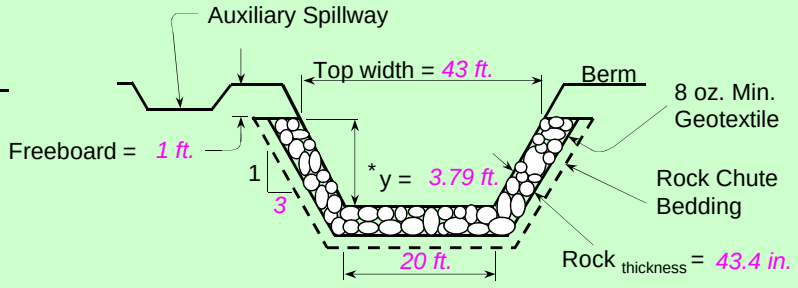
Sta.	Elev. (Pnt)
0+00	7531.3 ft. (1)
0+16.6	7531.3 ft. (2)
0+24	7530.8 ft. (3)
0+31.2	7529.5 ft. (4)
1+4	7511.3 ft. (5)
1+31	7511.3 ft. (6)
1+36	7513.3 ft. (7)

Profile Along Centerline of Rock Chute

****Note**: *The outlet will function adequately*

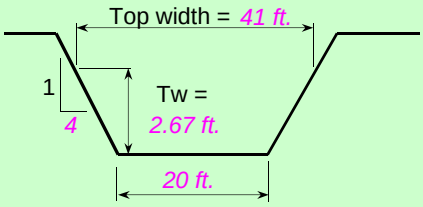


Inlet Channel Cross Section



Rock Chute Cross Section

* Use H_p throughout chute but not less than z_2.



Outlet Channel Cross Section

Profile, Cross Sections, and Quantities

Project: Flying Horse North - JD Pond Outlet
Location: EL Paso County

U.S. Department of Agriculture
Natural Resources Conservation Service

Designed: Marc Whorton	Approved by:
Drawn: NRCS Standard Dwg.	Title:
Traced:	Title:
Checked:	Sheet No. / of
	Drawing No.

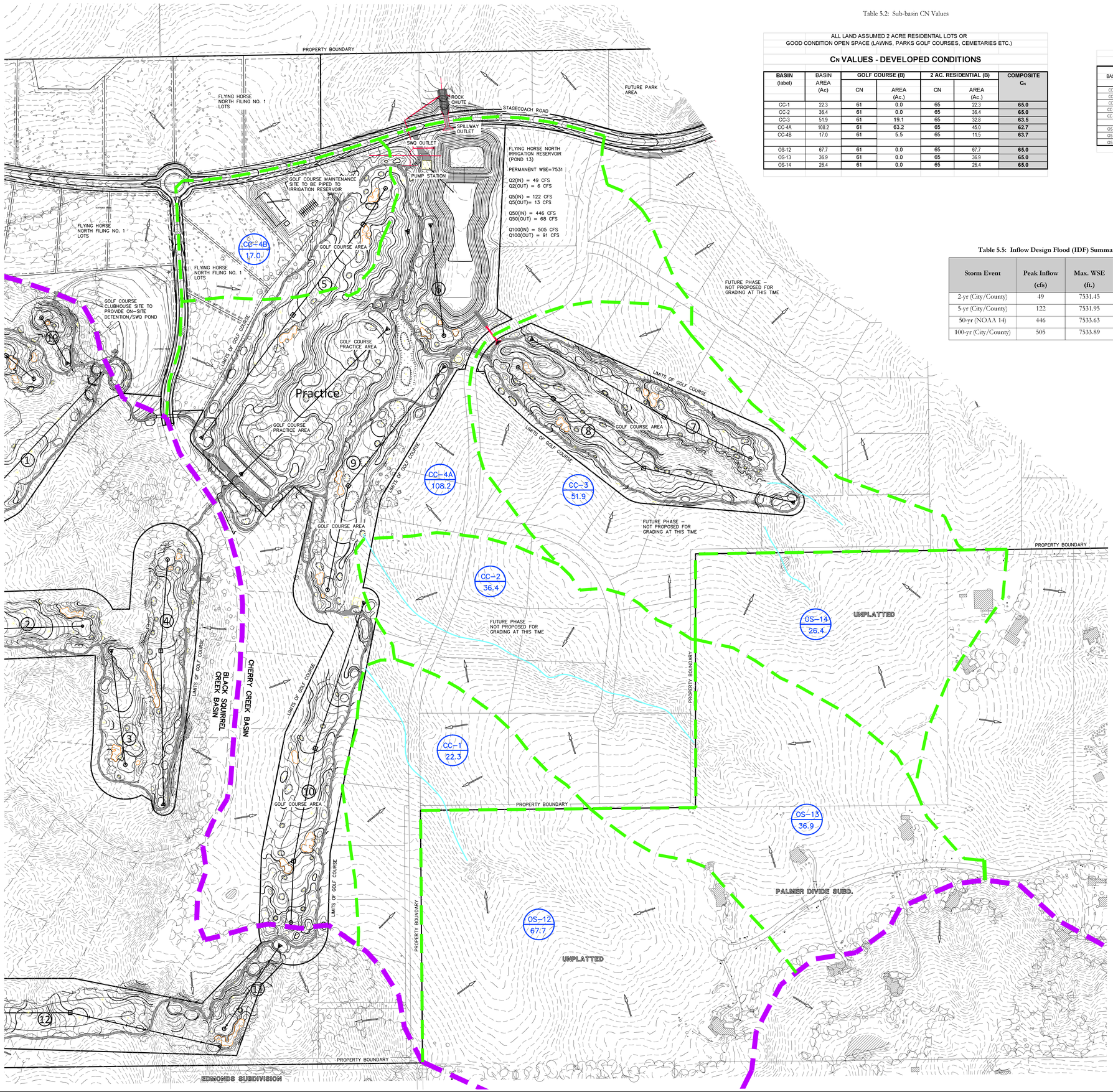


Table 5.2: Sub-basin CN Values

ALL LAND ASSUMED 2 ACRE RESIDENTIAL LOTS OR GOOD CONDITION OPEN SPACE (LAWNS, PARKS GOLF COURSES, CEMETARIES ETC.)

CN VALUES - DEVELOPED CONDITIONS

BASIN (label)	BASIN AREA (Ac)	GOLF COURSE (B)		2 AC. RESIDENTIAL (B)		COMPOSITE CN
		CN	AREA (Ac.)	CN	AREA (Ac.)	
CC-1	22.3	61	0.0	65	22.3	**65.0**
CC-2	36.4	61	0.0	65	36.4	**65.0**
CC-3	51.9	61	19.1	65	32.8	**63.5**
CC-4A	108.2	61	63.2	65	45.0	**62.7**
CC-4B	17.0	61	5.5	65	11.5	**63.7**
OS-12	67.7	61	0.0	65	67.7	**65.0**
OS-13	36.9	61	0.0	65	36.9	**65.0**
OS-14	26.4	61	0.0	65	26.4	**65.0**

Table 5.3 Sub-basin Time of Concentration

TIME OF CONCENTRATION DEVELOPED

BASIN	COMPOSITE Cn	OVERLAND			STREET / CHANNEL FLOW(DCM Vol 1 Fig. 6-25)				Tc TOTAL (hr)	Tc LAG (0.6tc) (hr)
		Length (ft)	Height (ft)	Tc (hr)	Length (ft)	Slope (%)	Velocity (fps)	Tc (hr)		
CC-1	65.0	300	10	0.40	900	2.0%	1.8	0.14	0.53	0.32
CC-2	65.0	300	10	0.40	1700	2.0%	1.8	0.26	0.66	0.39
CC-3	63.5	300	14	0.35	900	2.5%	2.4	0.10	0.45	0.27
CC-4A	62.7	300	14	0.35	2900	2.0%	2.1	0.38	0.73	0.44
CC-4B	63.7	300	12	0.37	900	3.0%	2.5	0.10	0.47	0.28
OS-12	65.0	300	14	0.35	1500	3.0%	2.5	0.17	0.51	0.31
OS-13	65.0	300	16	0.33	900	3.0%	2.5	0.10	0.43	0.26
OS-14	65.0	300	14	0.35	600	3.5%	2.7	0.06	0.41	0.24

Table 5.5: Inflow Design Flood (IDF) Summary Table

Storm Event	Peak Inflow (cfs)	Max. WSE (ft.)	Total Discharge (cfs)
2-yr (City/County)	49	7531.45	6
5-yr (City/County)	122	7531.95	13
50-yr (NOAA 14)	446	7533.63	68
100-yr (City/County)	505	7533.89	91

Table 5.6: Reservoir Discharge Table

Elevation	Discharge (cfs) (SWQ Outlet Box)	Discharge (cfs) (Twin CBC Spillway)	Discharge (cfs) (Total)
7531.0	0.0	0.0	0.0
7532.0	13.89	0.0	13.89
7533.0	27.77	0.0	27.77
7534.0	51.31	49.05	100.36
7535.0	69.52	138.56	208.08
7536.0	74.61	254.72	329.33

Permanent WSE = 7531.0

Top of SWQ Outlet box = 7533.0

Spillway elevation = 7533.0

Table 5.4: Storage Capacity Table

Elevation NGVD 1929	Area (Acres)	Storage Volume (Ac. Ft.)
*7510.0	1.51	0.00
*7511.0	1.99	1.74
*7512.0	2.52	3.99
*7513.0	2.85	6.68
*7514.0	3.05	9.63
*7515.0	3.26	12.78
7516.0	3.48	16.15
7517.0	3.70	19.74
7518.0	3.93	23.56
7519.0	4.16	27.60
7520.0	4.40	31.88
7521.0	4.64	36.40
7522.0	4.88	41.16
7523.0	5.14	46.17
7524.0	5.36	51.42
7525.0	5.59	56.89
7526.0	5.84	62.61
7527.0	6.08	68.57
7528.0	6.33	74.77
7529.0	6.57	81.22
7530.0	6.81	87.91
7531.0	7.15	94.89
7532.0	7.52	102.22
7533.0	7.83	109.90
7534.0	8.37	118.00
7535.0	8.77	126.57
7536.0	9.17	135.53

* Indicates dead storage below pumping ability

LEGEND

DESCRIPTION	SYMBOL
EXISTING GROUND CONTOUR	6910
PROPOSED FINISHED CONTOUR	6910
BASIN BOUNDARY EAST CHERRY CREEK	
MAJOR BASIN BOUNDARY	
BASIN IDENTIFIER / AREA IN ACRES	BB 10.0
EXISTING DIRECTION OF FLOW	
PROPOSED DIRECTION OF FLOW	
STORM SEWER	

N

200 100 0 200 400

SCALE: 1" = 200'

CLASSIC CONSULTING ENGINEERS & SURVEYORS SM
619 N. Cascade Avenue, Suite 200 (719)785-0790
Colorado Springs, Colorado 80903 (719)785-0799 (Fax)

FLYING HORSE NORTH IRRIGATION RESERVOIR
DEVELOPED DRAINAGE MAP

DESIGNED BY	MAW	SCALE		DATE	9-20-17
DRAWN BY	MAW	(H) 1"= 200'		SHEET	1 OF 1
CHECKED BY		(V) 1"= N/A		JOB NO.	1096.11

APPENDIX C

GEOTECHNICAL REPORT

ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
PHONE (719) 531-5599
FAX (719) 531-5238

SUBSURFACE SOIL INVESTIGATION
FLYING HORSE NORTH DAM
COLORADO SPRINGS, COLORADO

Prepared for:

Pulpit Rock, LLC
6385 Corporate Drive, Suite 200
Colorado Springs, Colorado 80919

Attn: Drew Balsick

November 16, 2017

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Reviewed By:

Stan C. Culp, P.E.
Senior Engineer

Joseph C. Goode, Jr., P.E.
President

SCC/rm

Encl.

Entech Job No. 171249
AA projects/2017/171249 ssi

Table of Contents

Tables

Figures

List of Appendices

SUBSURFACE SOIL INVESTIGATION
FLYING HORSE NORTH DAM
COLORADO SPRINGS, COLORADO

1.0 INTRODUCTION

As requested, personnel of Entech Engineering, Inc. have performed a Subsurface Soil Investigation at the proposed dam site and soil borrow site. The investigation was conducted to evaluate the soils to construct a new embankment; and perform laboratory testing within the dam footprint and proposed soil borrow areas. This report presents the results of our soils investigation, site evaluation, laboratory testing, and embankment recommendations. Specific design of the appurtenances within the embankment are beyond the scope of this report, however suggested geotechnical remediation is included based on our field exploration, laboratory testing, and engineering analysis' of the soils recovered from the sites investigated.

2.0 FIELD INVESTIGATION AND LABORATORY TESTING PROGRAM

Subsurface conditions within the dam footprint and soil borrow areas were explored by drilling thirteen test borings. The locations of the soil borings were determined based on the anticipated size of the proposed embankment and access points on the property at the time of drilling. Six test borings were drilled in the proposed dam footprint, two test borings were drilled in the proposed west borrow area, and five test borings were drilled in the proposed east borrow area to obtain soils information for use to construct the new dam embankment. The borings were advanced to depths ranging from 10 to 40 feet below ground surface (bgs) with one tested area, Test Boring No. 13, that was excavated with a small backhoe by an onsite contractor, to 3 feet (bgs) in the proposed east borrow area. The soils in all but Test Boring No. 13 were obtained using a truck mounted, drilling rig with continuous flight auger supplied and operated by Entech.

Notably, the soil borrow area in the vicinity of Test Boring Nos. 7 and 8 were abandoned while developing this report. The soil was used elsewhere on the property. The test boring logs for these two borings are included in the report but have been removed from the Test Boring Location Map, included as Figure 1.

Representative soil samples were recovered from each of the borings at approximate 5-foot intervals using 2-inch O.D. split barrel and California samplers following Standard Penetration Test (ASTM D-1586) procedures. Boring logs describing the subsurface conditions encountered in each of the borings are included in Appendix A. Laboratory classification testing was completed on selected soil samples recovered from the borings and soil borrow area for purposes of determining water content, evaluating engineering properties, classification and for grouping the materials by soil type. The water content testing results and soil types (by number) are included on the boring logs with respect to the sample depth measured from the existing ground surface.

Table 1 presents a summary of the laboratory testing and the Unified Soil Classification System (USCS) designations for each of the soils encountered in the borings and the soils borrow area. The standard laboratory testing results are presented in Appendix B.

In addition to the classification testing sulfate, pH, resistivity, permeability, and direct shear testing was completed. This additional testing was conducted on samples from within the proposed embankment footprint at various depths and from soils recovered from the proposed east soil borrow site. In brief, the sulfate testing results indicate that the soils within the embankment footprint and the soils obtained from the east soil borrow site exhibit a negligible potential for sulfate attack. The sulfate, permeability, and direct shear testing are included in Appendix C.

The tables below present a summary of the permeability and direct shear testing for soils tested in the proposed embankment and soils borrow area. The permeability test results are included in Appendix D, and Filter Calculations are included in Appendix E.

The permeability testing was performed in the laboratory using a falling head permeameter arrangement. The samples were compacted in molds at 95% of their standard proctor dry density and optimum moisture content and saturated for six hours prior to initiating the test. The tests were performed for a duration of seven days.

3.0 SUMMARY OF STANDARD PROCTOR TESTING

(ASTM D-698)

Sample Location	Sample Description	Depth Sampled (Feet)	Maximum Dry Density (pcf)	Optimum Moisture (%)
Test Boring 3	Silty Sand (SM)	0-5	124.1	9.0
Test Boring 6	V. Clayey Sand (SC)	5-10	115.5	13.5
Test Boring 13	V. Clayey Sand (SC)	0-3	116.6	13.3

4.0 SUMMARY OF PERMEABILITY TESTING

Sample Location	Sample Description	Depth Sampled (Feet)	Final Permeability (cm/s)
Test Boring 6	V. Clayey Sand (SC)	5-10	1.48×10^{-7}
Test Boring 13	V. Clayey Sand (SC)	0-3	3.82×10^{-7}

The direct shear testing was performed in the laboratory using a remodeled sample confined in a ring and drained. The samples were compacted in molds at 95% of their Standard Proctor Dry Density and optimum moisture content. The tests were performed for a duration of three days under a constant horizontal load and staged for each point.

5.0 SUMMARY OF DIRECT SHEAR TESTING

Sample Location	Sample Description	Depth Sampled (Feet)	Friction Angle (degrees)	Cohesion (psf)
Test Boring 3	Silty Sand (SM)	0-5	34	52
Test Boring 6	V. Clayey Sand (SC)	5-10	30	134
Test Boring 13	V. Clayey Sand (SC)	0-3	28	179

6.0 SOIL ROCK AND GROUNDWATER

Two primary soil types and two rock types were encountered in the borings:

Type No.	Description	USCS Designation
Type 1	Slightly Silty to Very Silty Sand and Very Clayey Sand	SM, SM-SW, SC
Type 2	Very Sandy Silt-Clay and Sandy to Very Sandy Clay	CL-ML, CL
Type 3	Clayey to Very Clayey Sandstone and Slightly Silty to Silty Sandstone	SC, SM-SW, SM
Type 4	Sandy Claystone	CL

7.0 SULFATE, PH, AND RESISTIVITY TESTING

Sample Description	TB # and Depth	Sulfate	pH	Resistivity
	(ft)	(%solublesulfate)		(ohm-cm)
Silty Sand	1 @ 2-3	0.02	6.0	14706
Very Clayey Sandstone	1 @ 20	<0.01	6.1	>20000
Silty Sandstone	2 @ 20	0.02	5.9	>20000
Sandy Claystone	3 @ 15	<0.01	5.8	>20000
Slightly Silty Sand	5 @ 15	<0.01	6.1	>20000
Sandy Clay	7 @ 2-3	<0.01	5.9	17867
Very Sandy Clay	8 @ 15	<0.01		
Silty Sand	3 @ 5	<0.01		
Very Clayey Sand	13 @ 0-3	<0.01	5.9	19129

Soil Type 1 is described as slightly silty to very silty sand and very clayey sand (SM-SW, SM, SC). The sand was encountered in Test Boring Nos. 1 – 6, 10, 11, and 13 from the existing ground surface and underlying Soil Type 2 to depths of 3 to 39 feet (bgs). SPT Testing conducted on the sand resulted in N-values of 7 to 42 blows-per-foot (bpf), indicating loose to medium dense states. Moisture content and grain size analysis indicated moisture contents of 1.4 to 14.8 percent and 7.7 to 42.7 percent of the soil particles passing the No. 200 Sieve. Atterberg Limits testing resulted in Liquid Limits of no value, 29, and 32 and Plastic Indexes of being non-plastic, 13, and 13. Sulfate testing on the sand resulted in less than 0.01 to 0.02 percent soluble sulfate, indicating a negligible potential for below grade concrete degradation due to sulfate attack. pH Testing on the sands resulted in values between 5.9 and 6.1. These results indicate the soils are slightly to moderately acidic. Resistivity Testing on the sands resulted in soil resistivities between 14706 and greater than 20000 ohm-cm. The test results indicate that the sand soils are mildly corrosive to non-corrosive.

Soil Type 2 is described as sandy to very sandy clay and very sandy silt-clay (CL, CL-ML). The clay was encountered in Test Boring Nos. 2, 4, 6, 7, 8, 9 and 12 from the existing ground surfaces and underlying Soil Type 1 to approximate depths of 5 to 30 feet (bgs). SPT Testing conducted on the sandy clay resulted in N-values of 7 to 25 (bpf). This testing indicates the clays relative density ranges from firm to stiff consistencies. Moisture content indicated moisture contents ranging from 7.7 to 20.5 percent indicating moist conditions. Grain size analysis indicated a range of 51.6 to 88.4 percent of the soil particles passing the No. 200 Sieve. Atterberg Limits testing resulted in Liquid Limits of 24 to 42 and Plastic Indexes of 5 to 19. FHA Swell Testing performed on a sample of very sandy clay-silt resulted in a swell pressure of 150 psf, indicating a low swell potential. Swell/Consolidation Testing on a sample of sandy clay resulted in a volume change of 1.2 percent, also indicating a low swell potential. Sulfate testing on the clays resulted in less than 0.01 percent soluble sulfate, indicating a negligible potential for below grade concrete degradation due to sulfate attack. pH Testing on a clay sample resulted in a value of 5.9. This result indicates the clay soils are moderately acidic. Resistivity Testing on a sample of clay resulted in soil a resistivity of 17867 ohm-cm. This result indicates that the clay soils are mildly corrosive.

Soil Type 3 is described as weathered and formational clayey to very clayey sandstone and slightly silty to silty sandstone (SC, SM, SM-SW). The sandstone was encountered in Test Boring Nos. 1-5 underlying Soil Types 1 and 4 ranging from 14 to 40 feet (bgs). SPT Testing conducted on the sandstone resulted in N-values of 31 and greater than 50 blows per foot, indicating dense to very dense states. Moisture content and grain size analysis indicated moisture contents of 2.8 to 19.5 percent and 11.0 to 38.2 percent of the soil particles passing the No. 200 Sieve. Atterberg Limits testing resulted in the sandstone having a Liquid Limit of 42 and no value and Plastic Indexes of 11 and of being non-plastic. Sulfate testing on the sandstone resulted in less than 0.01 and 0.02 percent soluble sulfate, indicating a negligible potential for below grade concrete degradation due to sulfate attack. pH and Resistivity Testing on the sandstone resulted in values of 6.1 and greater than 20000 ohm-cm. These results indicate the sandstone materials are slightly acidic and non-corrosive.

Soil Type 4 is classified as weathered to formational sandy claystone (CL). The claystone was encountered in Test Boring Nos. 3 and 6 underlying Soil Type 1 between 14 and 40 feet below the ground surface (bgs). Standard Penetration Testing conducted on the claystone resulted in SPT N-values of 45 to greater than 50 blows per foot (bpf), which indicated very stiff to hard consistencies. Moisture content and grain size testing resulted in moisture contents of 11.0 and 17.6 percent with 69.3 to 96.0 percent of the soil size particles passing the No. 200 sieve. Atterberg limits testing was performed on samples of claystone resulted in Liquid Limits of 37 and 49 and Plastic Indexes of 19 and 23, respectively. Swell/Consolidation Testing performed on a sample of claystone resulted in a 1.6 percent volume change, indicating a low swell potential. Sulfate testing on the claystone resulted in less than 0.01 percent soluble sulfate by weight, indicating negligible potential for below grade concrete degradation due to sulfate attack. pH and Resistivity Testing on the claystone resulted in values of 5.8 and greater than 20000 ohm-cm. These results indicate the claystone materials are moderately acidic and non-corrosive.

8.0 SUMMARY OF TEST BORING DRILL AND GROUNDWATER DEPTHS

Test Boring No.	Depth Drilled (feet)	Depth to Groundwater (feet)
1	25	Dry
2	30	Dry
3	25	16
4	40	Dry
5	30	Dry
6	40	Dry
7	10	Dry
8	20	Dry
9	10	Dry
10	10	Dry
11	10	Dry
12	10	Dry
13	3	Dry

It should be noted that groundwater conditions at the site will vary as a result of changes in precipitation, runoff, changes in site use/drainage as well as a result of development on the property or adjacent nearby properties.

9.0 NEW DAM EMBANKMENT

The new dam height will likely not exceed 25 feet, with a jurisdictional height of less than 20 feet, and have a 4:1 upstream slope and 3:1 downstream slope. The dam crest will be 36 feet in width supporting a paved 32-foot wide County Road. The new dam will be constructed on the same alignment of the proposed extension of Stagecoach Road. The new dam embankment will be comprised of a homogenous very sandy clay and clayey sand. During the development of this report the west soil borrow area was used on other areas of the property and additional drilling was performed at an east borrow area also located on the property. The east borrow area is approximately 0.5 miles east-southeast of the new dam embankment. Based on soils obtained from our soil borings and site evaluation of the east soils borrow area for the dam, this ~ 25-acres of land should provide a close and ample soils source to construct the new dam embankment.

The following two report sections present permeability testing, filter design, and a slope stability analysis based on the soils recovered from the field investigations, laboratory test results, and assuming an unlined homogeneous earthen embankment in direct contact with the stored waters. This proposed dam and entire pond will be lined with a man-made 30-mil LDPE liner. Approximately 12 to 18 inches of soil is proposed overlying the liner. The results of the testing and analysis assuming the earthen embankment is in direct contact with the stored waters will be conservative as seepage through the liner should be minimal.

10.0 PERMEABILITY TESTING AND FILTER DESIGN

Based on the results of the permeability testing on two remolded very clayey sand samples obtained from within the footprint of the proposed dam embankment and east soils borrow area proposed to construct the new dam embankment. The soils should provide a structure with minimal seepage. The seepage collection system for the new embankment should include a toe drain system constructed with a blanket drain. The collection systems should include a drain pipe encapsulated in a soil filter for the toe drain with a blanket drain. The toe drain pipe should consist of the minimum sized pipe acceptable by the Dam Safety Branch. The drain pipe shall be made of PVC and mill slotted. The blanket drain should extend from the upper toe drain trench parallel to the dam downstream face with a thickness of one foot. The blanket filter should be constructed with approximately 2 feet of cover and extending to within two feet of the proposed impoundments free surface. The blanket drain cover should consist of site sands proposed to construct the embankment.

The drain filter design was conducted following the National Engineering Handbook developed by the United States Department of Agriculture Natural Resources Conservation Service Division, Part 633, Chapter 26 – Gradation Design of Sand and Gravel Filters. The gradation design was conducted using sieves of the proposed dam shell materials. Coarse and fine filters are suggested to prevent migration of very clayey proposed to construct the new earthen embankment. The filter designs provide an acceptable band range for the coarse and fine filters. The fine filter should consist of a washed concrete sand and the coarse filter comprised

of a No. 57 aggregate. The coarse filter shall encapsulate the drain pipe a minimum of six inches beyond the pipe outside diameter with the fine sand filter encapsulating the coarse filter within the toe drain trench and the downstream blanket filter. Outlet pipes constructed in the new dam embankment shall also be designed with a fine and coarse grained filter constructed near the outlet below the downstream face of the dam, covered with dam shell materials. The contractor should submit sieve analysis' of the proposed filter materials prior to hauling to the site.

The spreadsheets developed for the filter design and a filter detail are included in Appendix D.

11.0 SLOPE STABILITY ANALYSIS

A slope stability analysis was performed on the new dam embankment. Soil values used were determined from our site evaluations and laboratory testing. Two primary soil types and two rock types were tested; site sands, clays, sandstone, and claystone. A slope stability analysis was performed on one section of the proposed dam embankment to quantify its structural integrity based on the geometry and soil properties obtained from this investigation. The slope section analyzed was located at approximately midspan across the length of the new dam. Refer to the Topographic Plan in Appendix E for the location of the slope section on the new dam. The slope stability analysis' were conducted utilizing the STEDwin GSTABL7 computer program. Two models were created in this analysis, both providing profiles of the new dam.

Factors of Safety were calculated by the Modified Bishop Method for Circular Failure Surface. A Factor of Safety of 1.81 was obtained on the initial slope analysis of the new dam embankment, approximately midspan at its deepest section. A Factor of Safety of 1.5 is recommended for earthen dams as specified in the Colorado Department of Natural Resources, Division of Water Resources, Rules and Regulations for Dam Safety and Dam Construction. Refer to Appendix E for the results of these slope stability analysis'.

The potential of accelerated slope failure for the new dam is relatively low due to the proposed liner which will minimize seepage through the embankment. The new dam will have a

downstream face seepage monitoring system. The dam embankment will be a homogenous structure comprised of sands and clays containing clay and silt fines.

Loose native soils were encountered below the proposed dam embankment in a couple of test borings which could be an active or future conduit for swift groundwater movement. Increased groundwater velocities tend to transport soils from below the structure and increased seepage rates are expected over time. The loose zones could be from groundwater movement. These areas will be mitigated during the dam foundation work.

12.0 EMBANKMENT CONSTRUCTION

After the dam foundation is exposed, the excavation shall be observed to determine if addition field exploration or laboratory testing is required. These evaluations will verify the condition of the underlying geology for support and construction of the dam foundation and outlet structures. Based on our Sulfate, pH, and Resistivity Testing conducted on the soils proposed to construct the new dam, the soils exhibit a negligible potential for attack on concrete structures and Type II concrete is recommended. The soils are slightly to moderately acidic and mildly corrosive and should not be corrosive in direct contact with steel; however, due to the nature of this project it is recommended that all steel materials in contact with the new dam embankment soils should be cathodically protected.

The property in the vicinity of the new dam would provide a close staging area for construction equipment and storage of usable soils removed from the dam. The east borrow area was determined to provide an ample and close soil source for the dam embankment. Laboratory testing performed on the soils located at the east borrow area determined the soil suitable for the construction of a new earthen embankment. Initial slope stability analysis' indicates the embankment stability with elevated groundwater seepage through the embankment would meet acceptable factors of safety based on the soils tested for this investigation. Notably, it is likely that the groundwater within the embankment will never reach this elevated state with the proposed manmade pond liner and active toe drains proposed with this project. Additional testing may be required prior to and during construction of the new earthen embankment depending on the contractor's construction materials submittals. It is likely that a toe drain will

be required consisting of manmade and earthen materials during construction of the new dam embankment.

After the dam embankment foundation soils are exposed, mitigated as required, and approved by the Dam Safety Branch and Geotechnical Engineers, the new embankment shall be constructed and periodically observed and tested. The foundation granular materials (site sands) as approved by the geotechnical engineer shall be compacted to a minimum of 100% of its maximum Standard Proctor Dry Density, ASTM D-698 at 0 to +3 percent of optimum moisture content. The embankment shell materials (site sands and very sandy clays) as approved by the geotechnical engineer shall be compacted to a minimum of 98% of its maximum Standard Proctor Dry Density, ASTM D-698 at 0 to +3 percent of optimum moisture content. The filter materials shall be tamped and observed by a construction materials testing agency prior to covering the filters with embankment materials to verify thicknesses and compaction efforts. The soils testing requirements and frequencies of testing will be noted on the construction drawings and technical specifications.

13.0 CLOSURE

The test borings were located to provide general geotechnical information and subsurface profiles at the new embankment location and soil borrow areas. Variations in subsurface conditions may be encountered across the site. Pockets of low soil densities determined from the standard penetration testing conducted during drilling indicated isolated zones within the surficial native soil exist in the existing drainageway. The loose zones were encountered in Test Boring Nos. 2 and 3. Surficial clays and silts with low bearing capacities were encountered in Test Boring Nos. 2, 4, and 6 were also encountered in the existing drainageway within the location of the proposed dam embankment. During excavations for the dam foundation, the loose and potentially low bearing soils will be excavated to the underlying medium dense to dense soil strata below. It is likely the granular soils removed from the foundation areas will be reused in the embankment foundation or reused in the new dam embankment. Spoils removed will likely be used elsewhere on the golf course property in softscape areas.

This report has been prepared for Pulpit Rock, LLC for application to the proposed project in accordance with generally accepted soil engineering practices. No other warranty expressed or implied is made. We trust this has provided you with the information you required. If you have any questions or need additional information, please do not hesitate to contact us.

If there are any questions regarding the information provided herein or if Entech Engineering, Inc. can be of further assistance, please do not hesitate to contact us.

TABLE

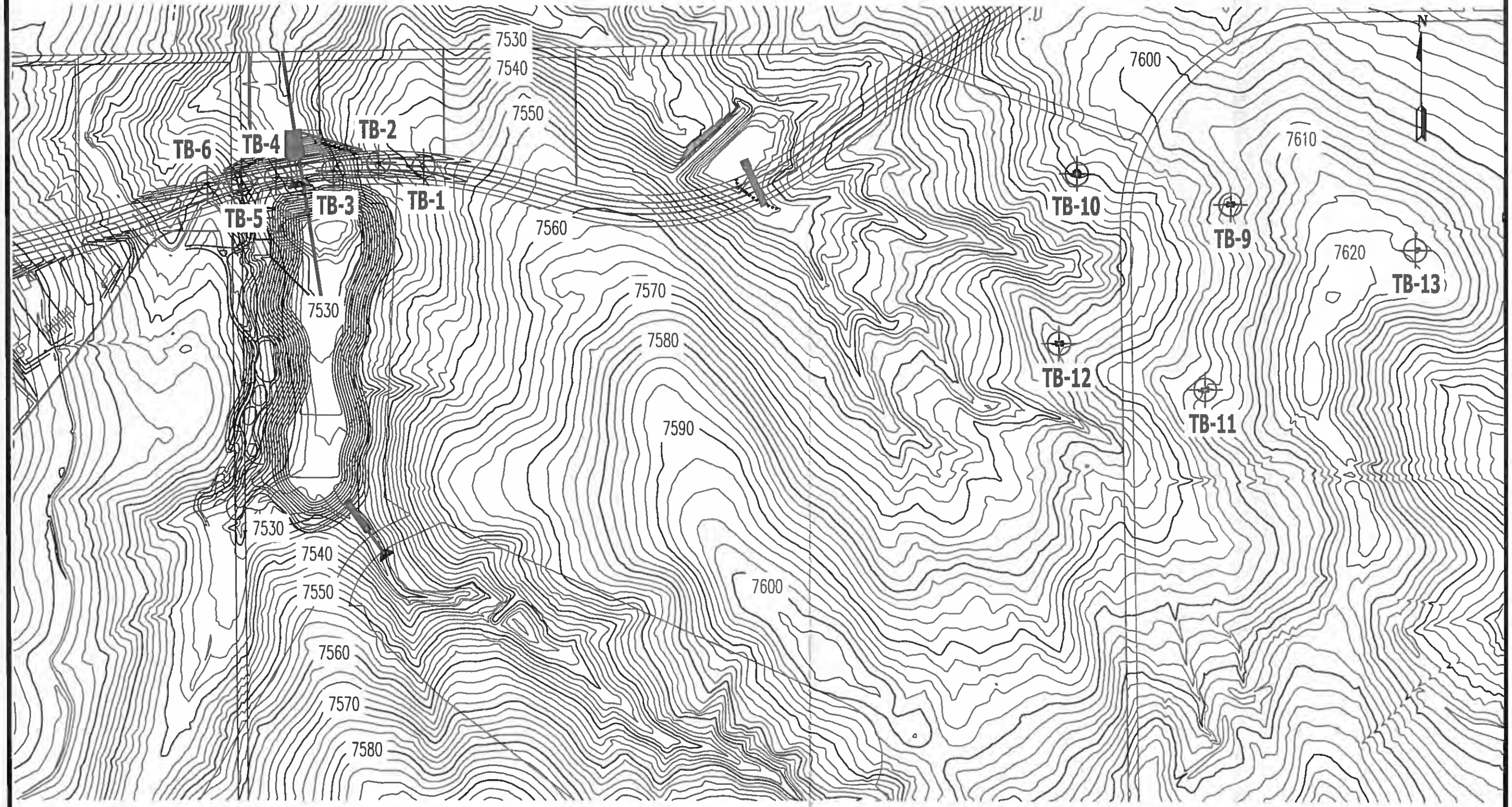
TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT PULPIT ROCK, LLC
PROJECT FLYING HORSE NORTH, DAM
JOB NO. 171249

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	FHA SWELL (PSF)	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1	1	2-3			30.0	NV	NP	0.02			SM	SAND, SILTY
1	4	0-5			42.7						SM	SAND, VERY SILTY
1	5	15			7.7			<0.01			SM-SW	SAND, SLIGHTLY SILTY
1	3	5			22.3	NV	NP	<0.01			SM	SAND, SILTY
1	5	5			17.8						SM	SAND, SILTY
1	10	2-5			47.0						SC	SAND, VERY CLAYEY
1	11	0-10			42.5	32	13				SC	SAND, VERY CLAYEY
1	13	0-3			43.7	29	13	<0.01			SC	SAND, VERY CLAYEY
2	9	1-5			54.7						CL	CLAY, VERY SANDY
2	12	1-8			65.8	29	19				CL	CLAY, SANDY
2	8	15			73.8	28	15	<0.01			CL	CLAY, SANDY
2	2	10			55.5	24	5		150		CL-ML	CLAY, SILT, VERY SANDY
2	4	2-3			81.1	31	16				CL	CLAY, SANDY
2	4	25-30			68.9						CL	CLAY, SANDY
2	6	5-10			58.8						CL	CLAY, VERY SANDY
2	6	10	17.3	107.8	88.4	42	19			1.2	CL	CLAY, SANDY
2	7	2-3			72.7			<0.01			CL	CLAY, SANDY
2	8	0-5			72.0						CL	CLAY, SANDY
2	8	5			51.6	26	11				CL	CLAY, VERY SANDY
3	1	20			38.2			<0.01			SC	SANDSTONE, VERY CLAYEY
3	1	15-20			31.3						SC	SANDSTONE, CLAYEY
3	2	20			13.3	42	11	0.02			SM	SANDSTONE, SILTY
3	4	40			20.6	NV	NP				SM	SANDSTONE, SILTY
3	5	25			11.0						SM-SW	SANDSTONE, SLIGHTLY SILTY
4	3	15	16.8	109.3	96.0	49	23	<0.01		1.6	CL	CLAYSTONE, SANDY
4	6	40			69.3	37	19				CL	CLAYSTONE, SANDY

TEST BORING LOCATION MAP



FLYING HORSE NORTH GOLF COURSE

11" x 17" - SCALE: 1" = 300'

TB-2- APPROXIMATE TEST BORING LOCATION AND NUMBER

STATE OF COLORADO P.E.

REVISIONS	BY:

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907
(719) 531-5599

TEST BORING LOCATION MAP
FLYING HORSE NORTH DAM
COLORADO SPRINGS, CO
FOR: PULPIT ROCK, LLC

DRAWN BY:	S. CULP
DESIGNED BY:	S. CULP
CHECKED BY:	
DATE:	9/30/17
SCALE:	AS SHOWN
JOB NO.:	171249
FIGURE NO.:	1

APPENDIX A: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 8/23/2017
Job # 171249

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 19.5', 9/7/17						
SAND, SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST				15	7.0	1
	5			19	4.0	1
	10			16	7.9	1
SANDSTONE, VERY CLAYEY TO CLAYEY, FINE TO COARSE GRAINED, RED BROWN, VERY DENSE, MOIST	15			50/11"	19.5	3
	20			50/6"	18.6	3
	25			50/7"	11.9	3

TEST BORING NO. 2
DATE DRILLED 8/23/2017
CLIENT PULPIT ROCK, LLC
LOCATION FLYING HORSE NORTH, DAM

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 26.5', 9/7/17						
SAND, SILTY, FINE TO COARSE GRAINED, TAN, LOOSE TO DENSE, MOIST				7	9.2	1
	5			31	4.4	1
CLAY-SILT, VERY SANDY, TAN, FIRM, MOIST	10			7	16.6	2
SAND, SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST	15			17	6.6	1
WEATHERED TO FORMATIONAL SANDSTONE, SILTY, FINE TO COARSE GRAINED, TAN, DENSE TO VERY DENSE, MOIST	20			31	13.1	3
	25			50/4"	11.0	3
	30			50/4"	8.7	3

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249
FIG NO.: A- 1

TEST BORING NO. 3
DATE DRILLED 8/23/2017
Job # 171249

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
WATER @ 16', 9/7/17						
SAND, SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE TO LOOSE, MOIST				12	4.5	1
	5			7	11.6	1
	10			9	12.1	1
WEATHERED CLAYSTONE, SANDY, TAN, VERY STIFF, MOIST	15			45	17.6	4
SANDSTONE, CLAYEY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST	20			50/5"	15.0	3
	25			50/7"	13.3	3

TEST BORING NO. 4
DATE DRILLED 8/23/2017
CLIENT PULPIT ROCK, LLC
LOCATION FLYING HORSE NORTH, DAM

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 27.5', 9/7/17						
CLAY, SANDY, TAN, STIFF, MOIST				20	8.6	2
	5			25	6.4	2
SAND, SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST TO VERY MOIST						
	10			27	1.7	1
	15			25	3.4	1
CLAYEY LENSES	20			12	14.8	1
	25			38	4.9	1
CLAY, SANDY, BROWN, STIFF, MOIST						
	30			15	9.2	2
SAND, SILTY, FINE TO COARSE GRAINED, TAN, LOOSE, MOIST						
	35			8	6.1	1
WEATHERED SANDSTONE, SILTY, FINE TO MEDIUM GRAINED, TAN, DENSE, MOIST	40			40	18.5	3

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO.: 171249
FIG NO.: A- 2

TEST BORING NO. 5
DATE DRILLED 8/23/2017
Job # 171249

REMARKS

DRY TO 27.5', 9/7/17

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			15	7.2	1
			20	7.7	1
			16	12.1	1
			22	1.4	1
			27	4.0	1
			50/11"	2.8	3
			47	11.6	3

SAND, SLIGHTLY SILTY TO SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST

5

10

15

20

SANDSTONE, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE TO DENSE, MOIST

25

30

TEST BORING NO. 6
DATE DRILLED 8/23/2017
CLIENT PULPIT ROCK, LLC
LOCATION FLYING HORSE NORTH, DAM

REMARKS

DRY TO 18.5', 9/7/17

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			42	1.9	1
			13	13.2	1
			15	20.5	2
			16	5.7	1
			20	4.7	1
			26	4.2	1
			*	13.6	1
			25	4.7	1
			24	5.4	1
			50/10"	11.0	4

SAND, SILTY, FINE TO COARSE GRAINED, TAN, DENSE TO MEDIUM DENSE, MOIST

5

CLAY, SANDY, TAN, STIFF, MOIST

10

SAND, SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST

15

20

25

CLAYEY LENSE

30

35

* - BULK SAMPLE TAKEN

40

CLAYSTONE, SANDY, GRAY BROWN, HARD, MOIST

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN	DATE	CHECKED	DATE
		BCC	11/16/17

JOB NO: 171249
FIG NO: A- 3

TEST BORING NO. 7
DATE DRILLED 9/6/2017
Job # 171249

REMARKS

DRY TO 19.5', 9/7/17

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
CLAY, SANDY, TAN, FIRM TO STIFF, MOIST					
			12	9.7	2
5			15	7.8	2
10			22	9.5	2
15					
20					

TEST BORING NO. 8
DATE DRILLED 9/6/2017
CLIENT PULPIT ROCK, LLC
LOCATION FLYING HORSE NORTH, DAM

REMARKS

DRY TO 20', 9/6/17

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
CLAY, VERY SANDY TO SANDY WITH DEPTH, TAN, FIRM TO STIFF, MOIST					
			11	7.7	2
5			10	10.6	2
10			8	10.3	2
15			15	12.3	2
20			13	9.4	2

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO.: 171249
FIG NO.: A- 4

TEST BORING NO. 9
DATE DRILLED 10/20/2017
Job # 171249

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 10', 10/20/17						
CLAY, VERY SANDY, TAN	5					2
	10					
	15					
	20					

TEST BORING NO. 10
DATE DRILLED 10/20/2017
CLIENT PULPIT ROCK, LLC
LOCATION FLYING HORSE NORTH, DAM

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 10', 10/20/17						
SAND, VERY CLAYEY, TAN	5					1
	10					
	15					
	20					

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

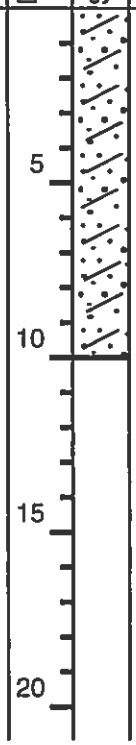
JOB NO: 171249
FIG NO: A- 5

TEST BORING NO. 11
DATE DRILLED 10/20/2017
Job # 171249

REMARKS

DRY TO 10',
10/20/17

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
	SAND, VERY CLAYEY, TAN				1
5					
10					
15					
20					

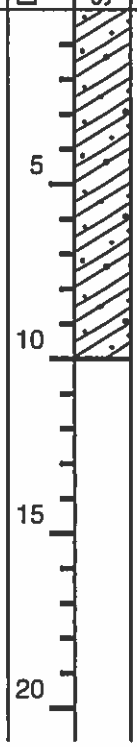


TEST BORING NO. 12
DATE DRILLED 10/20/2017
CLIENT PULPIT ROCK, LLC
LOCATION FLYING HORSE NORTH, DAM

REMARKS

DRY TO 10',
10/20/17

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
	CLAY, SANDY, TAN				2
5					
10					
15					
20					



ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249
FIG NO.: A- 6

TEST BORING NO. 13
DATE DRILLED 10/20/2017
Job # 171249

TEST BORING NO.
DATE DRILLED
CLIENT PULPIT ROCK, LLC
LOCATION FLYING HORSE NORTH, DAM

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
SAND, VERY CLAYEY, FINE TO COARSE GRAINED, TAN	0					1
	5					
	10					
	15					
	20					

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
	0					
	5					
	10					
	15					
	20					

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

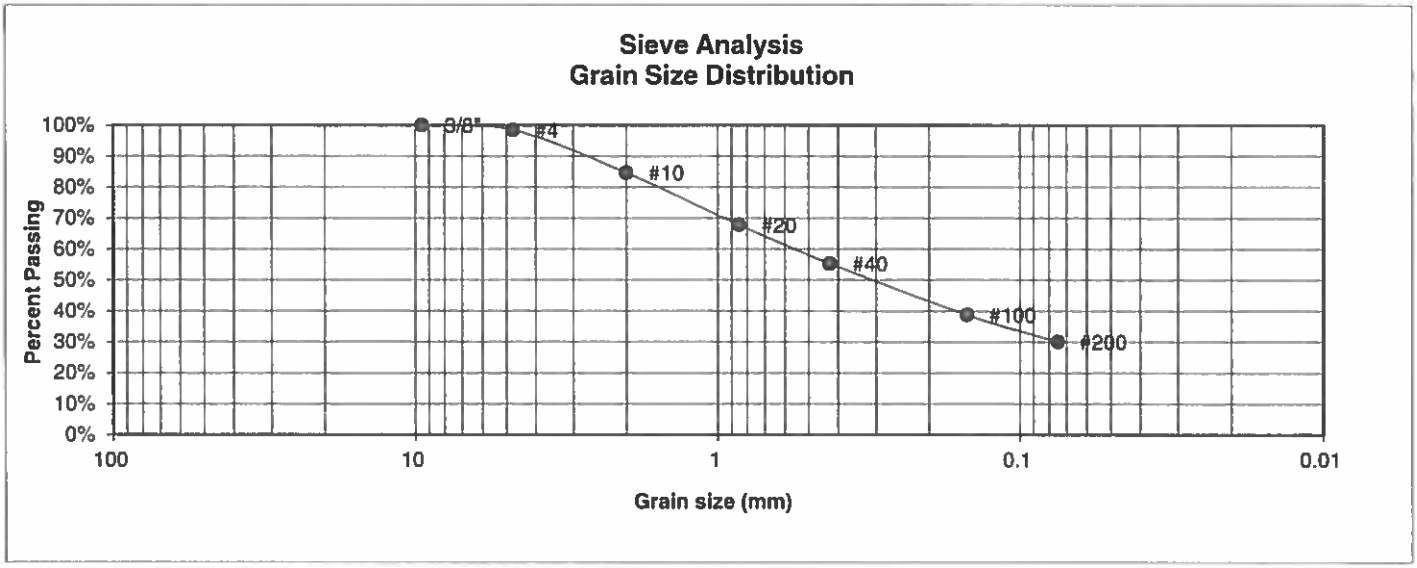
TEST BORING LOG

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO: 171249
FIG NO: A-7

APPENDIX B: Laboratory Test Results

UNIFIED CLASSIFICATION	SM	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	1	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	1	JOB NO.	171249
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.5%
10	84.7%
20	67.8%
40	55.3%
100	38.8%
200	30.0%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

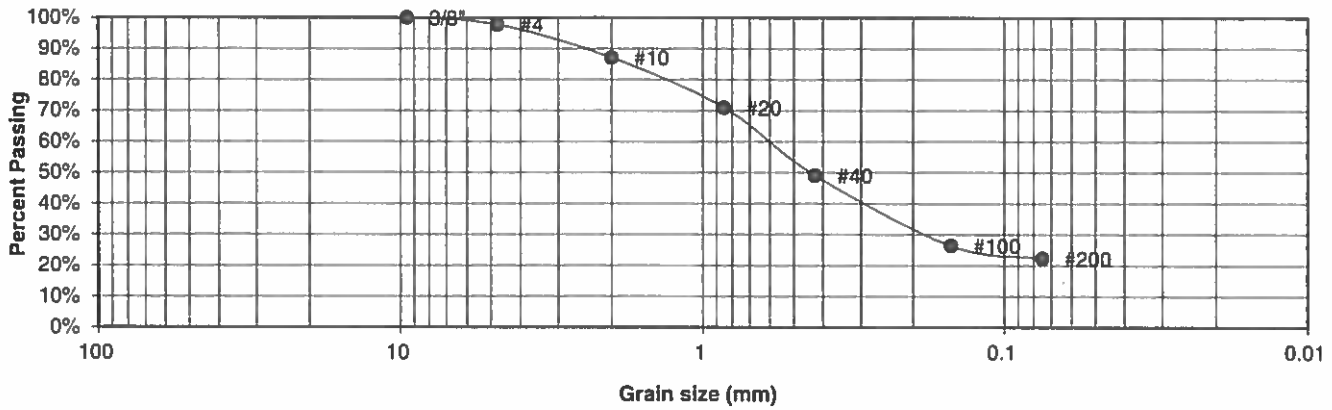
DRAWN	DATE	CHECKED	DATE
		SCC	11/16/17

JOB NO 171249

FIG NO B-1

UNIFIED CLASSIFICATION	SM	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	1	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	3	JOB NO.	171249
DEPTH (FT)	5	TEST BY	BL

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.8%
10	87.1%
20	71.0%
40	49.1%
100	26.4%
200	22.3%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

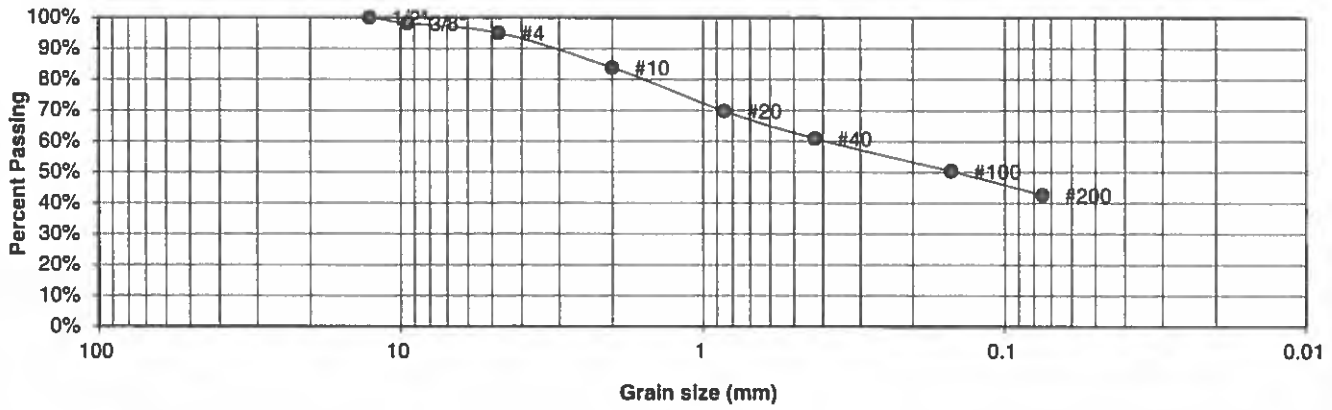
DRAWN	DATE	CHECKED	DATE
		SCC	11/16/17

JOB NO 171249

FIG NO B-2

UNIFIED CLASSIFICATION	SM	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	1	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	4	JOB NO.	171249
DEPTH (FT)	0-5	TEST BY	BL

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	98.3%
4	95.0%
10	83.8%
20	69.8%
40	60.9%
100	50.4%
200	42.7%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

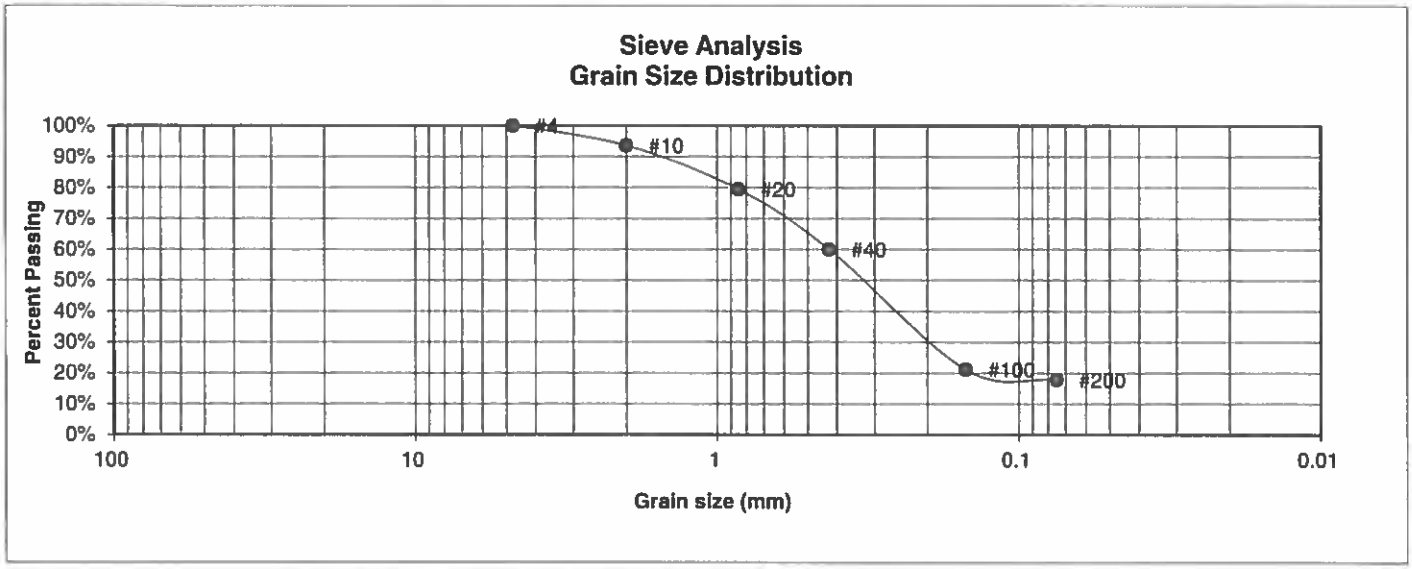
LABORATORY TEST RESULTS

DRAWN	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO. 171249

FIG NO. B-3

UNIFIED CLASSIFICATION	SM	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	1	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	5	JOB NO.	171249
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	93.6%
20	79.5%
40	60.0%
100	21.1%
200	17.8%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

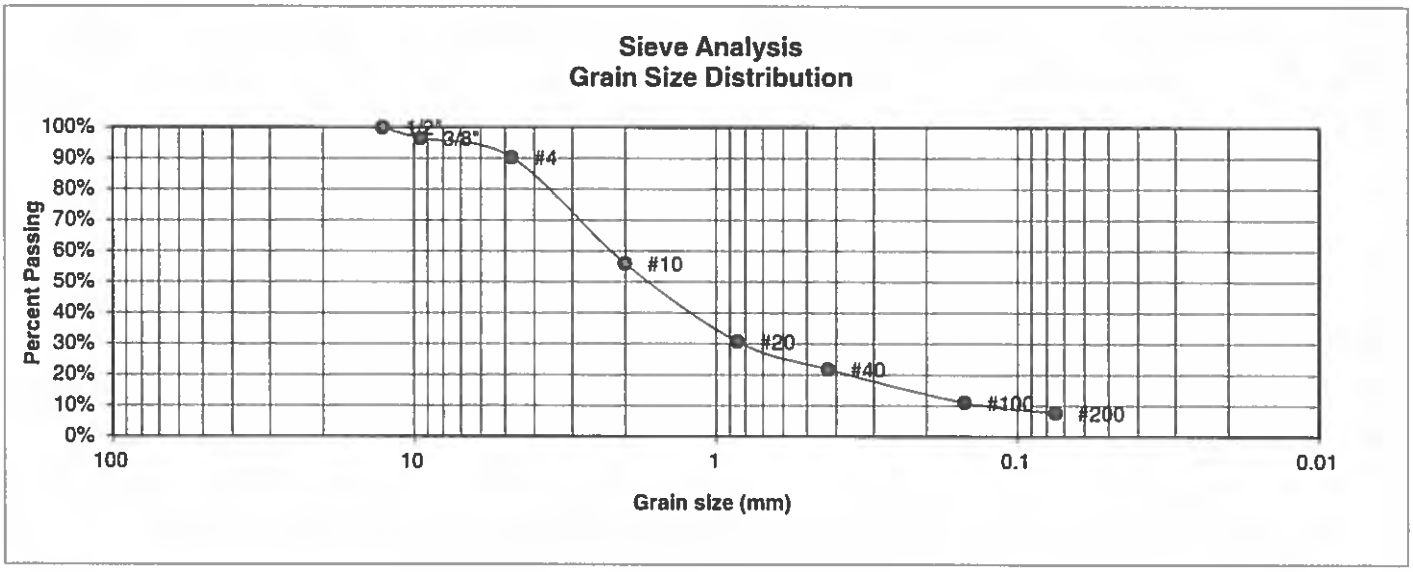
LABORATORY TEST RESULTS

DRAWN	DATE	CHECKED	DATE
		SCC	11/16/17

JOB NO. 171249

FIG NO. B-4

UNIFIED CLASSIFICATION	SM-SW	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	1	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	5	JOB NO.	171249
DEPTH (FT)	15	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	96.5%
4	90.3%
10	56.0%
20	30.8%
40	21.7%
100	11.0%
200	7.7%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

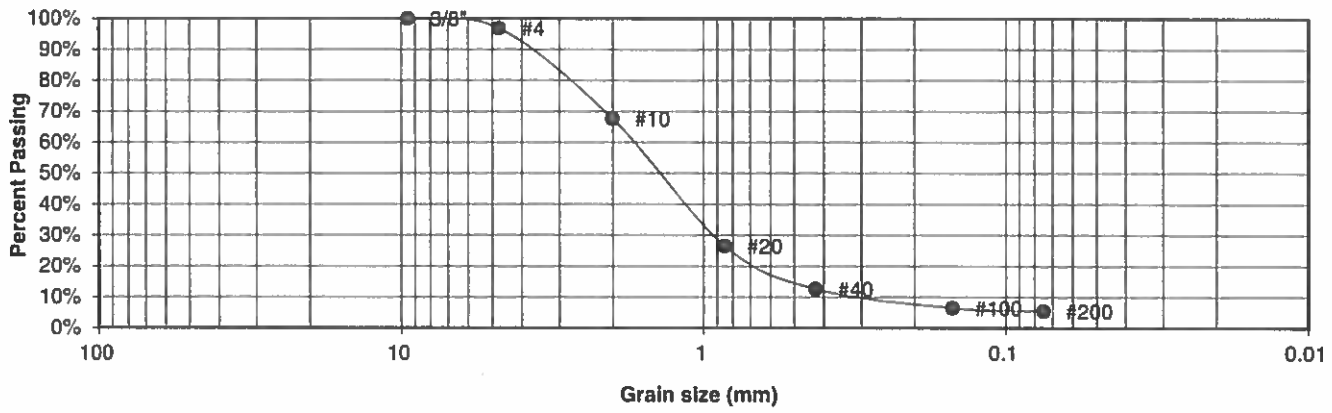
DRAWN	DATE	CHECKED:	DATE
		SCC	11/16/17

JOB NO. 171249

FIG NO. B-5

UNIFIED CLASSIFICATION	SM-SW	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	1	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	9	JOB NO.	171249
DEPTH (FT)	2-3	TEST BY	BL

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	96.9%
10	67.6%
20	26.5%
40	12.6%
100	6.5%
200	5.5%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

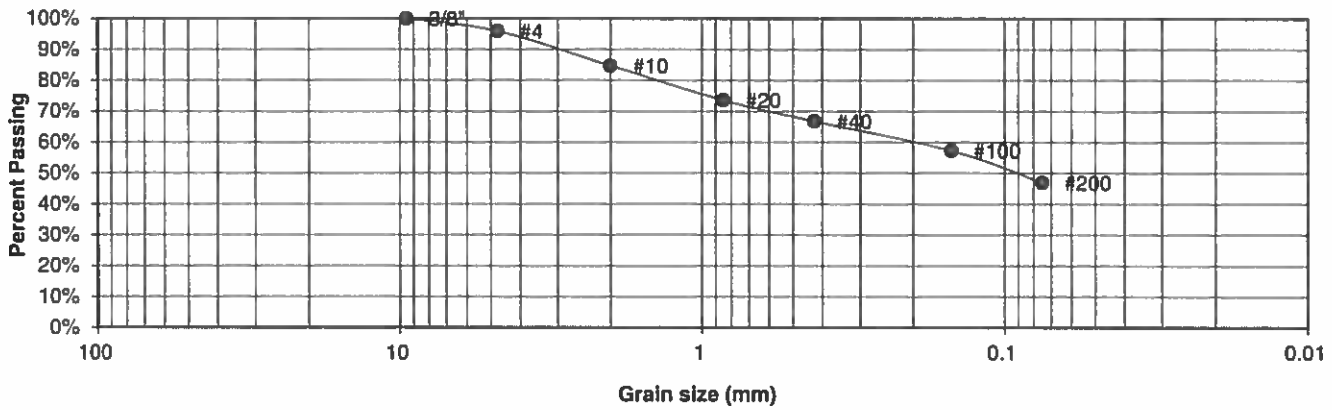
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO. 171249

FIG NO. B-6

UNIFIED CLASSIFICATION	SC	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	1	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	10	JOB NO.	171249
DEPTH (FT)	2-5	TEST BY	BL

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	96.0%
10	84.7%
20	73.6%
40	66.8%
100	57.4%
200	47.0%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

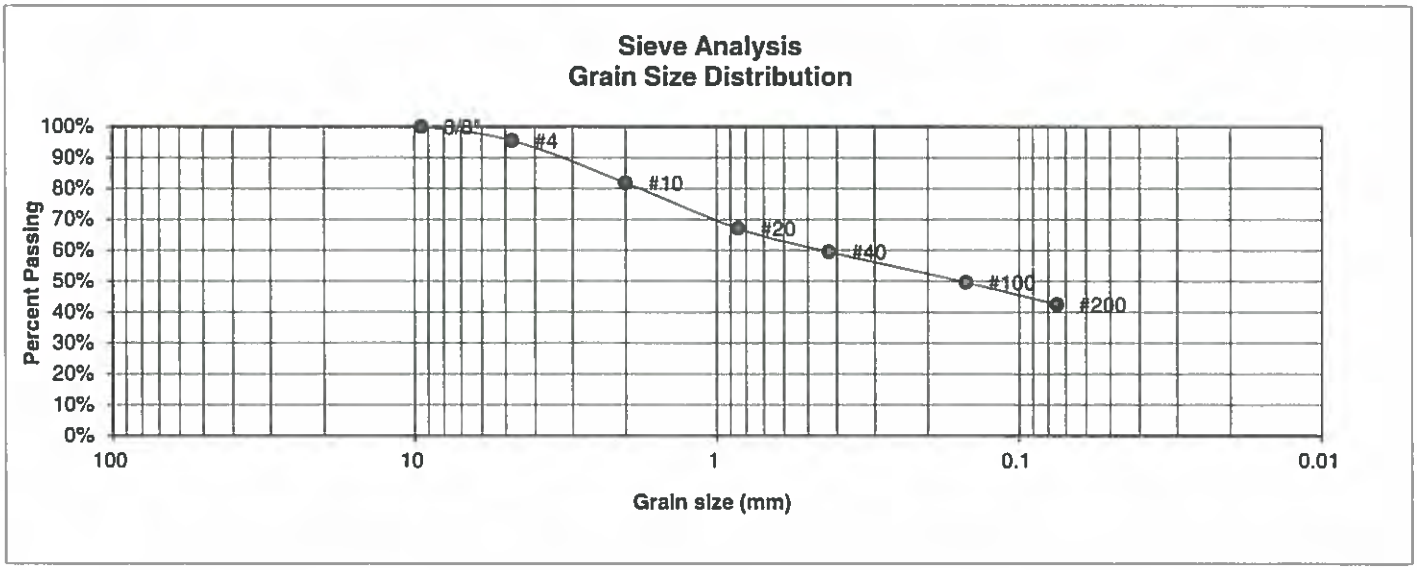
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO. 171249

FIG NO. B-7

UNIFIED CLASSIFICATION	SC	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	1	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	11	JOB NO.	171249
DEPTH (FT)	0-10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	95.5%
10	81.8%
20	67.1%
40	59.5%
100	49.7%
200	42.5%

Atterberg Limits	
Plastic Limit	19
Liquid Limit	32
Plastic Index	13

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

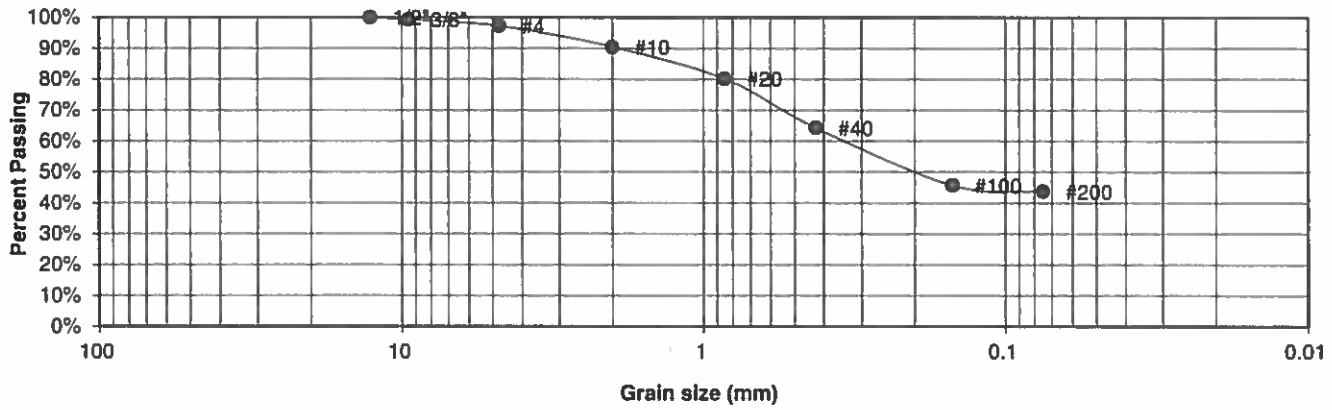
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO. 171249

FIG NO. B-8

UNIFIED CLASSIFICATION	SC	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	1	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	13	JOB NO.	171249
DEPTH (FT)	0-3	TEST BY	BL

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	99.3%
4	97.3%
10	90.5%
20	80.2%
40	64.3%
100	45.7%
200	43.7%

Atterberg Limits

Plastic Limit	16
Liquid Limit	29
Plastic Index	13

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

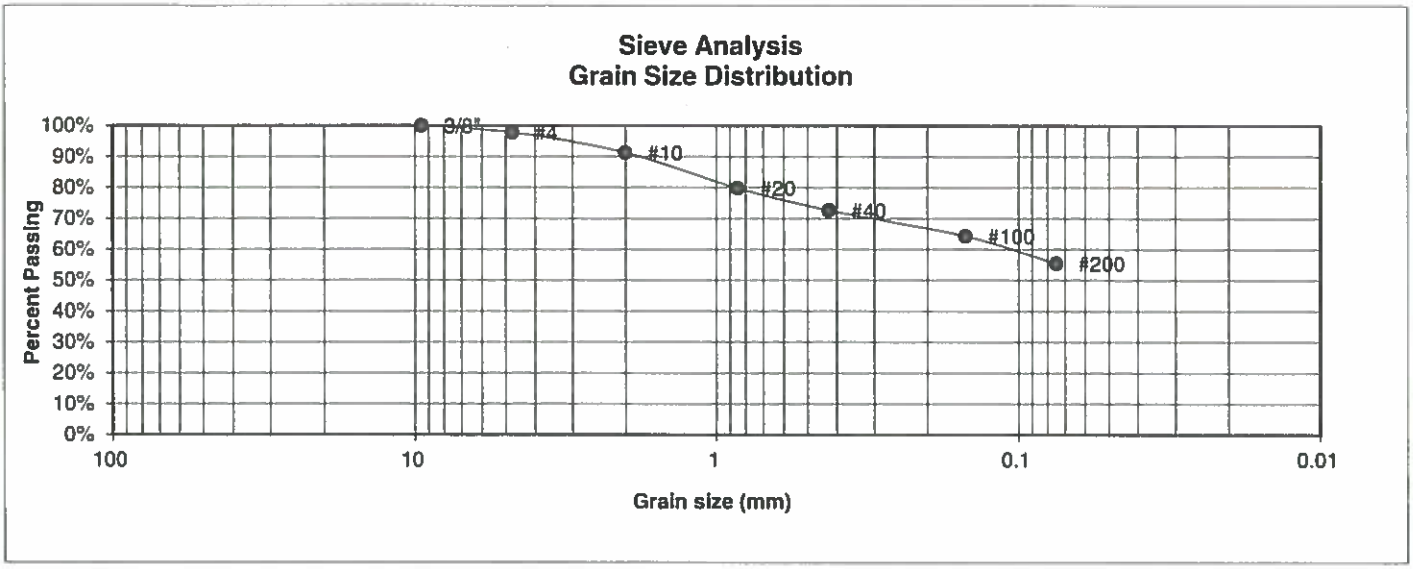
LABORATORY TEST RESULTS

DRAWN	DATE	CHECKED:	DATE:
		JCC	11/16/17

JOB NO: 171249

FIG NO: B-9

UNIFIED CLASSIFICATION	CL-ML	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	2	JOB NO.	171249
DEPTH (FT)	10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.8%
10	91.3%
20	79.9%
40	72.6%
100	64.3%
200	55.5%

Atterberg Limits	
Plastic Limit	19
Liquid Limit	24
Plastic Index	5

Swell	
Moisture at start	10.0%
Moisture at finish	16.4%
Moisture increase	6.4%
Initial dry density (pcf)	111
Swell (psf)	150

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

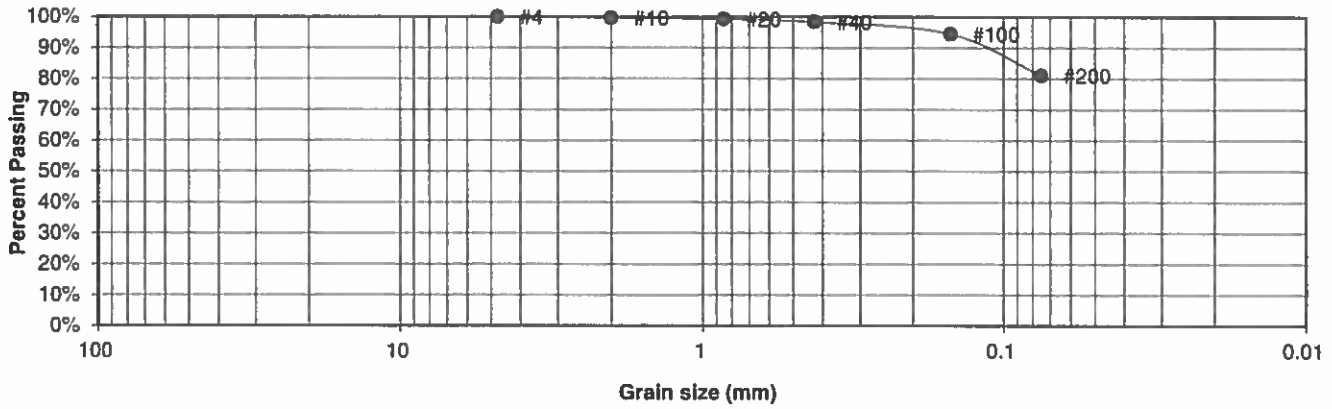
DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO.: 171249

FIG NO.: B-10

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	4	JOB NO.	171249
DEPTH (FT)	2-3	TEST BY	BL

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.7%
20	99.3%
40	98.4%
100	94.5%
200	81.1%

Atterberg Limits	
Plastic Limit	15
Liquid Limit	31
Plastic Index	16

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

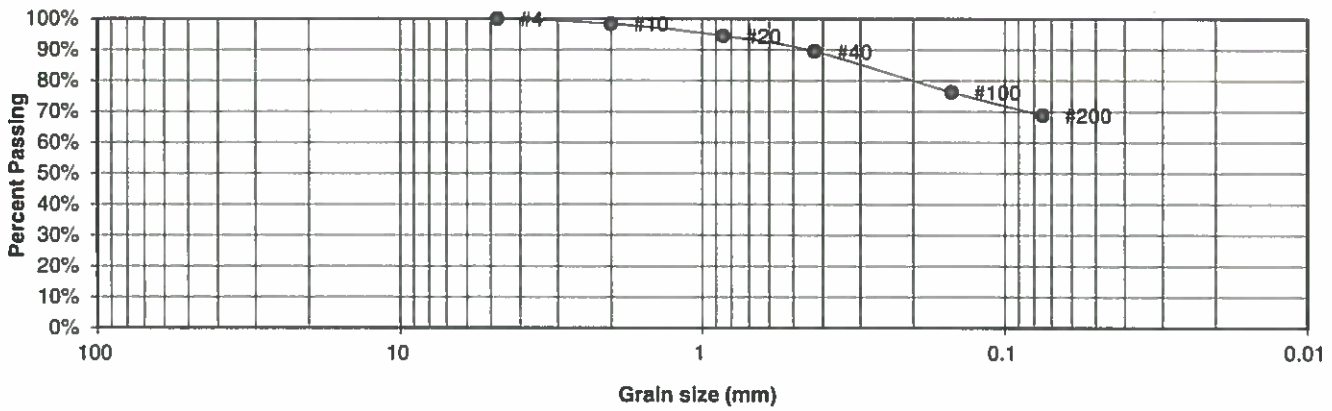
DRAWN	DATE	CHECKED	DATE
		GCC	11/16/17

JOB NO. 171249

FIG NO. B-11

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	4	JOB NO.	171249
DEPTH (FT)	25-30	TEST BY	BL

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	98.4%
20	94.5%
40	89.5%
100	76.4%
200	68.9%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

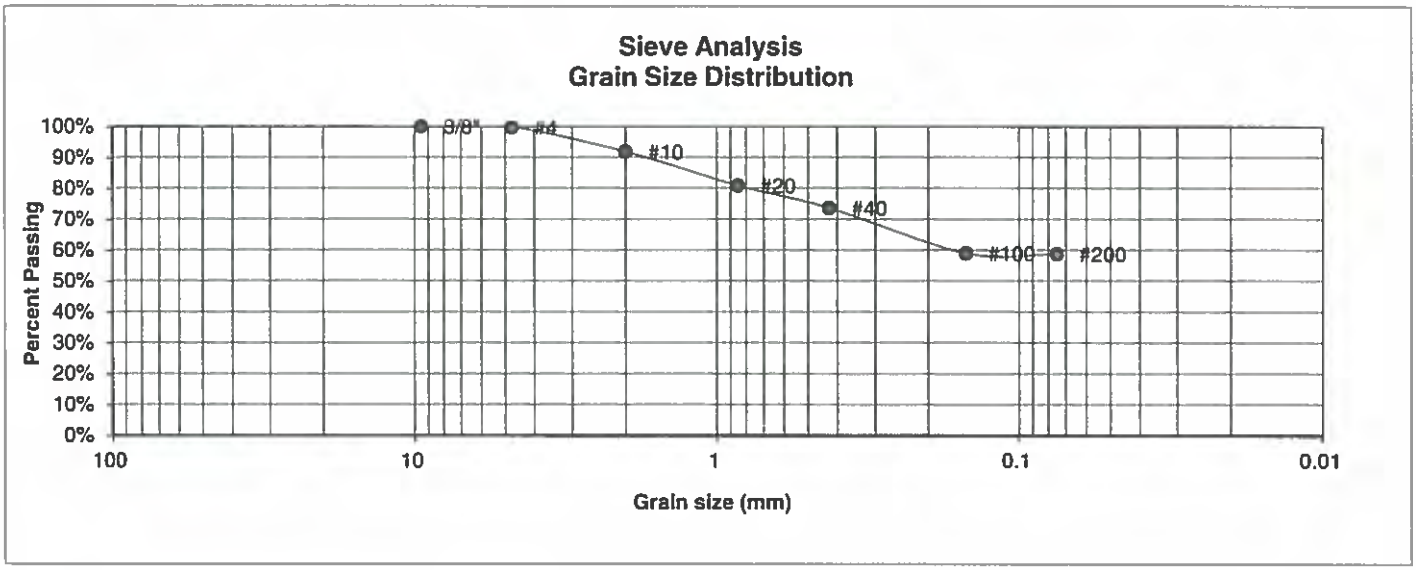
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO.: 171249

FIG NO.: B-12

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	6	JOB NO.	171249
DEPTH (FT)	5-10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.7%
10	91.8%
20	80.8%
40	73.6%
100	58.9%
200	58.8%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

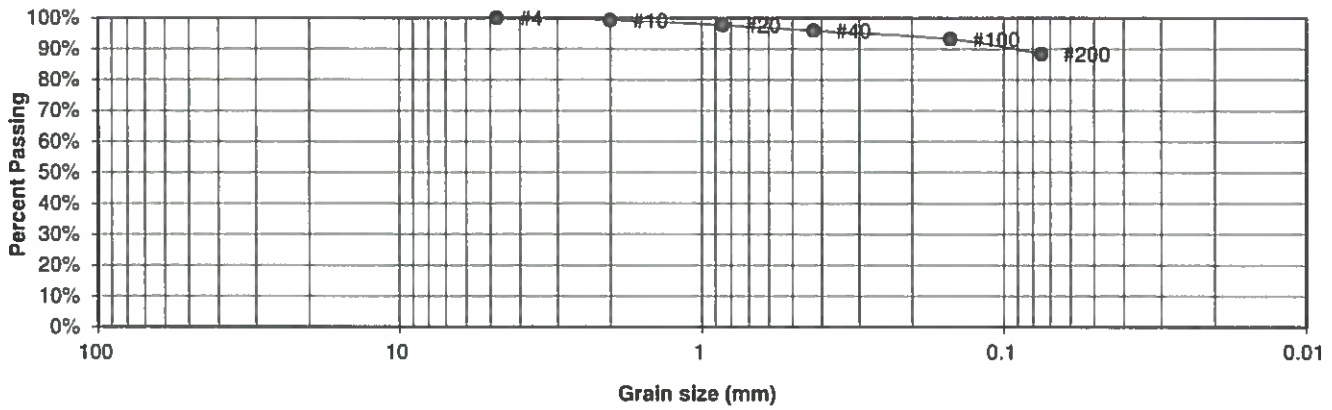
DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO. 171249

FIG NO. B-13

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	6	JOB NO.	171249
DEPTH (FT)	10	TEST BY	BL

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.3%
20	97.7%
40	95.9%
100	93.2%
200	88.4%

Atterberg Limits	
Plastic Limit	23
Liquid Limit	42
Plastic Index	19

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

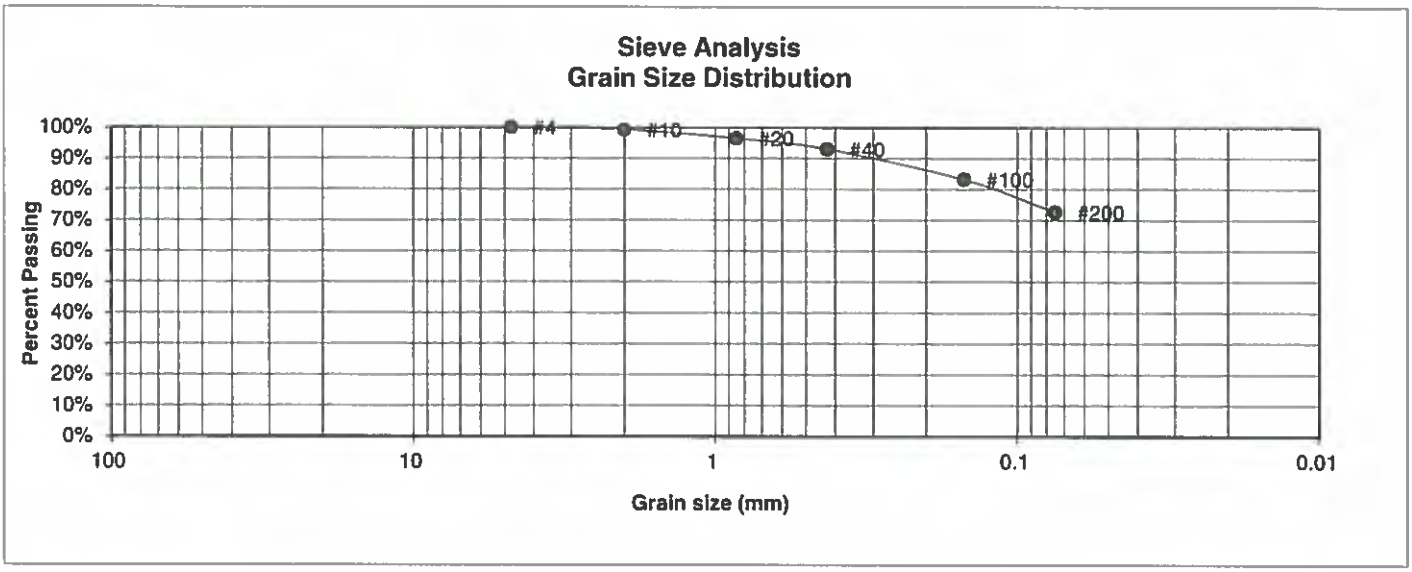
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO.: 171249

FIG NO.: B-14

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	7	JOB NO.	171249
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.3%
20	96.5%
40	93.0%
100	83.2%
200	72.7%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

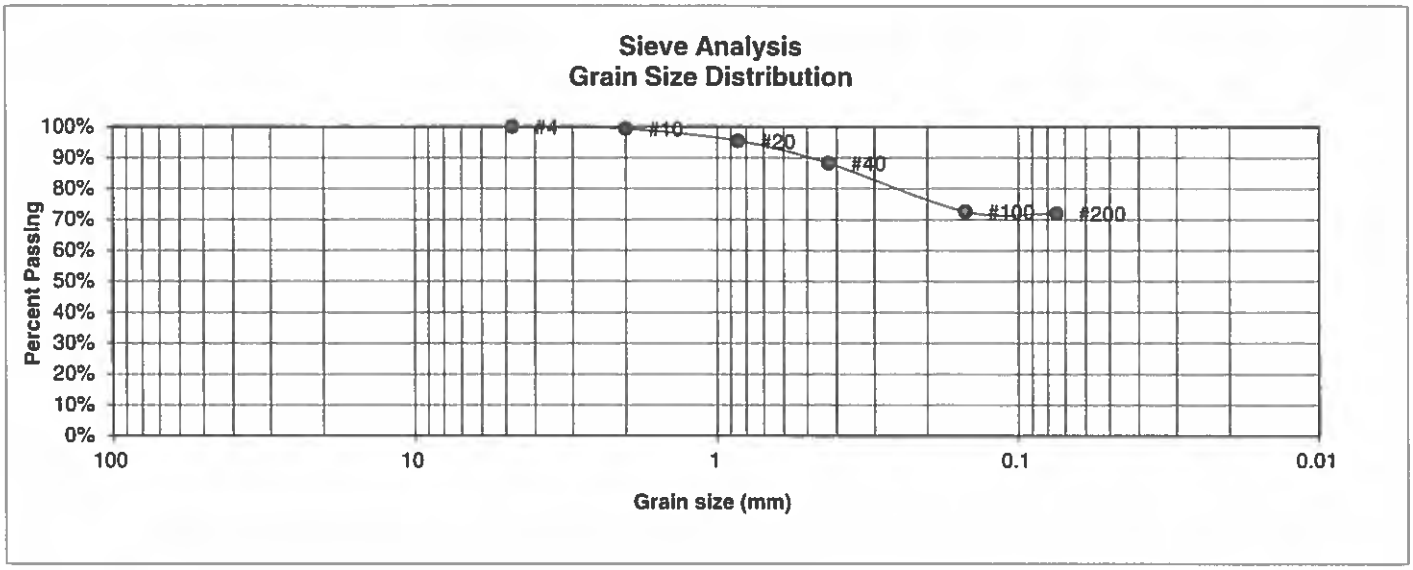
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SCC	DATE: 4/16/17

JOB NO 171249

FIG NO B-15

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	8	JOB NO.	171249
DEPTH (FT)	0-5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.4%
20	95.4%
40	88.3%
100	72.6%
200	72.0%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

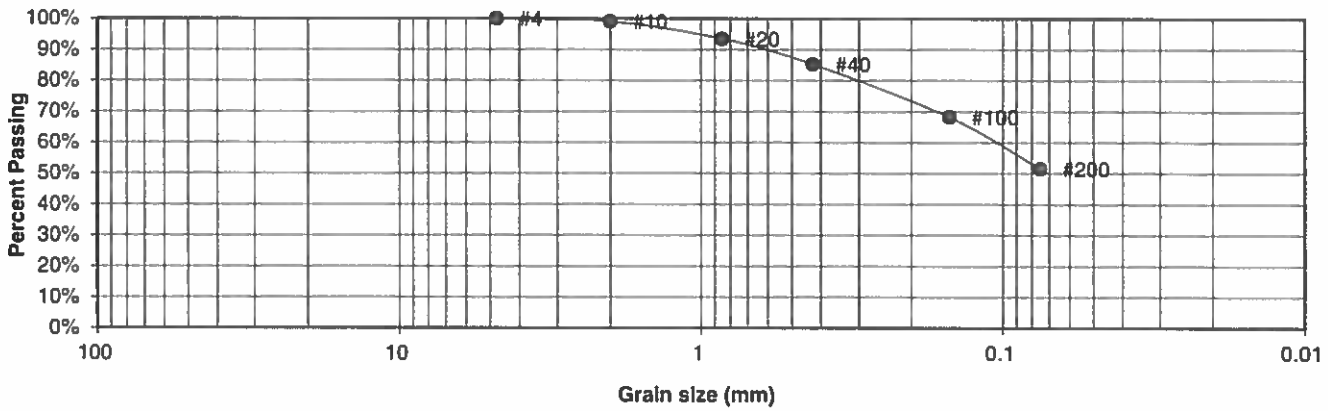
DRAWN	DATE	CHECKED: SCC	DATE: 11/16/17

JOB NO 171249

FIG NO B-16

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	8	JOB NO.	171249
DEPTH (FT)	5	TEST BY	BL

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.1%
20	93.5%
40	85.3%
100	68.2%
200	51.6%

Atterberg Limits	
Plastic Limit	15
Liquid Limit	26
Plastic Index	11

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

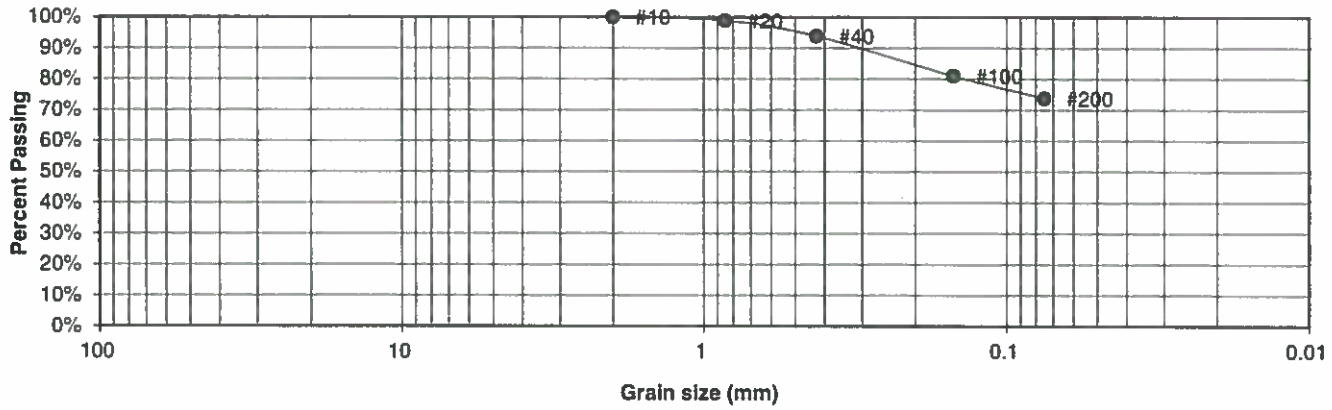
DRAWN	DATE	CHECKED:	DATE
		SCC	11/16/17

JOB NO. 171249

FIG NO. B-17

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	8	JOB NO.	171249
DEPTH (FT)	15	TEST BY	BL

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	100.0%
20	98.9%
40	93.9%
100	81.0%
200	73.8%

Atterberg Limits	
Plastic Limit	13
Liquid Limit	28
Plastic Index	15

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

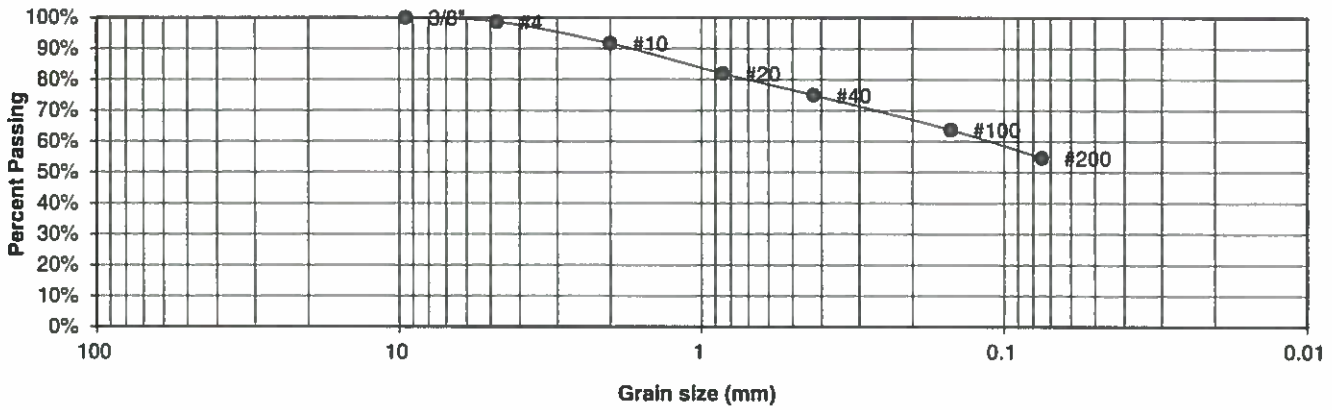
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: B-18

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	9	JOB NO.	171249
DEPTH (FT)	1-5	TEST BY	BL

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.7%
10	91.7%
20	81.9%
40	75.0%
100	63.8%
200	54.7%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

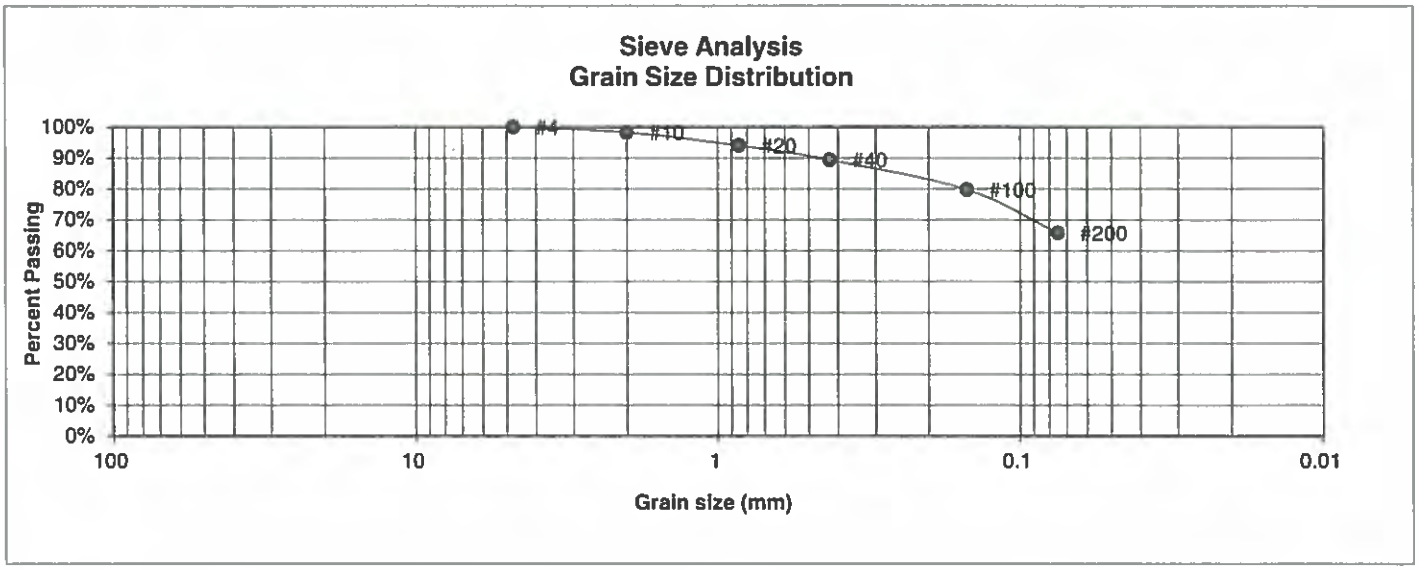
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO.: 171249
FIG NO.: B-19

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	2	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	12	JOB NO.	171249
DEPTH (FT)	1-8	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	98.3%
20	94.1%
40	89.4%
100	79.8%
200	65.8%

Atterberg Limits	
Plastic Limit	10
Liquid Limit	29
Plastic Index	19

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

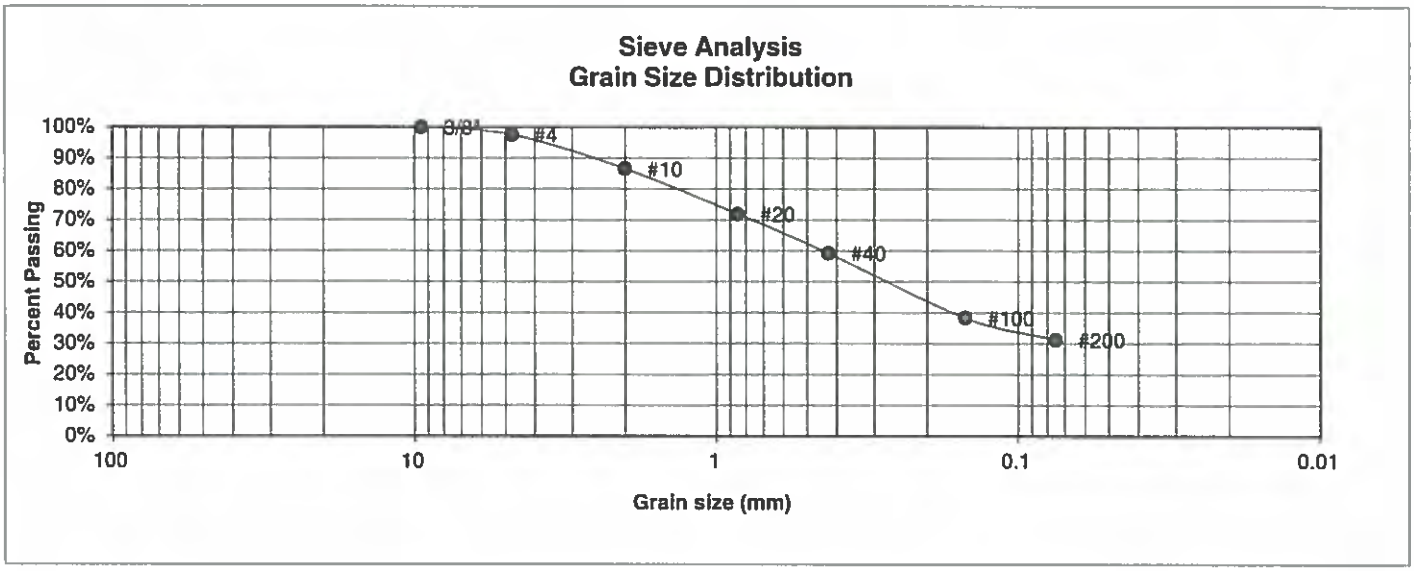
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SCC	DATE: 1/16/17

JOB NO 171249

FIG NO B-20

UNIFIED CLASSIFICATION	SC	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	3	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	1	JOB NO.	171249
DEPTH (FT)	15-20	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.6%
10	86.6%
20	71.9%
40	59.2%
100	38.3%
200	31.3%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

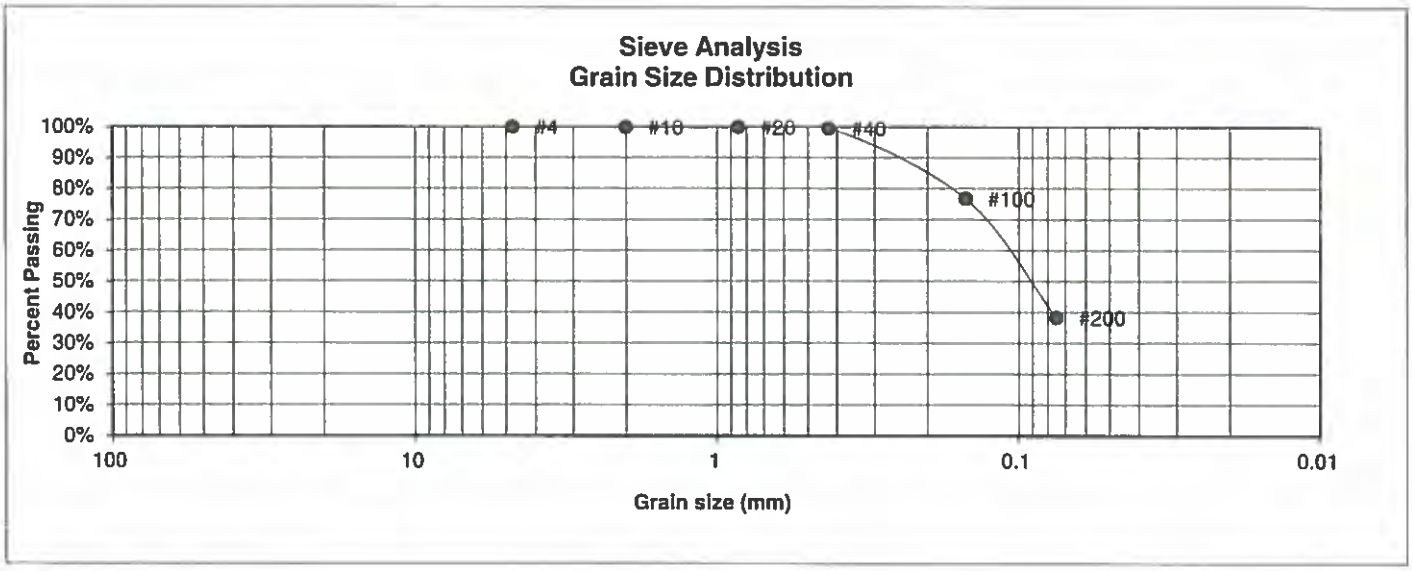
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO. 171249

FIG NO. B-21

UNIFIED CLASSIFICATION	SC	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	3	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	1	JOB NO.	171249
DEPTH (FT)	20	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.9%
20	99.9%
40	99.5%
100	76.7%
200	38.2%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

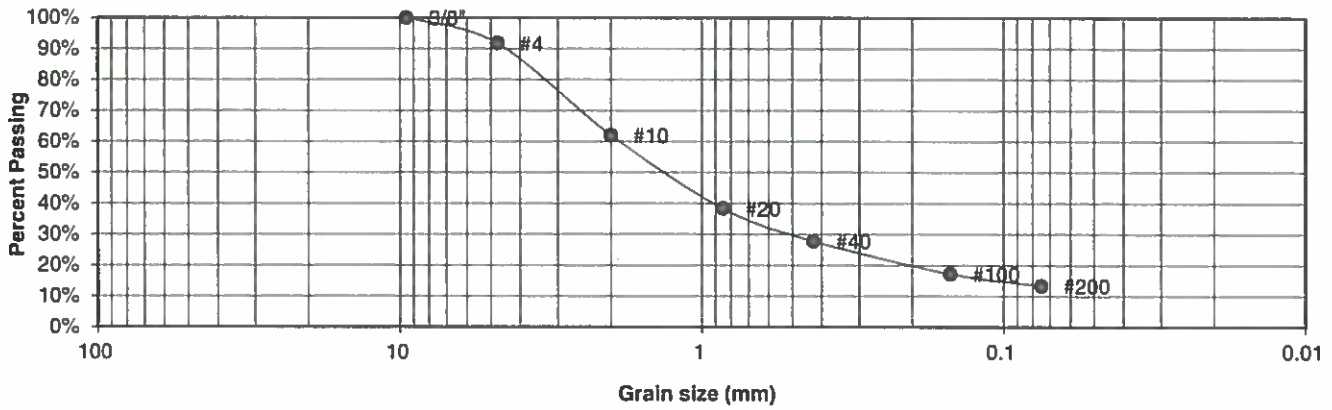
DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

JOB NO. 171249

FIG NO. B-22

UNIFIED CLASSIFICATION	SM	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	3	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	2	JOB NO.	171249
DEPTH (FT)	20	TEST BY	BL

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	91.8%
10	62.0%
20	38.3%
40	27.8%
100	17.2%
200	13.3%

Atterberg Limits	
Plastic Limit	31
Liquid Limit	42
Plastic Index	11

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

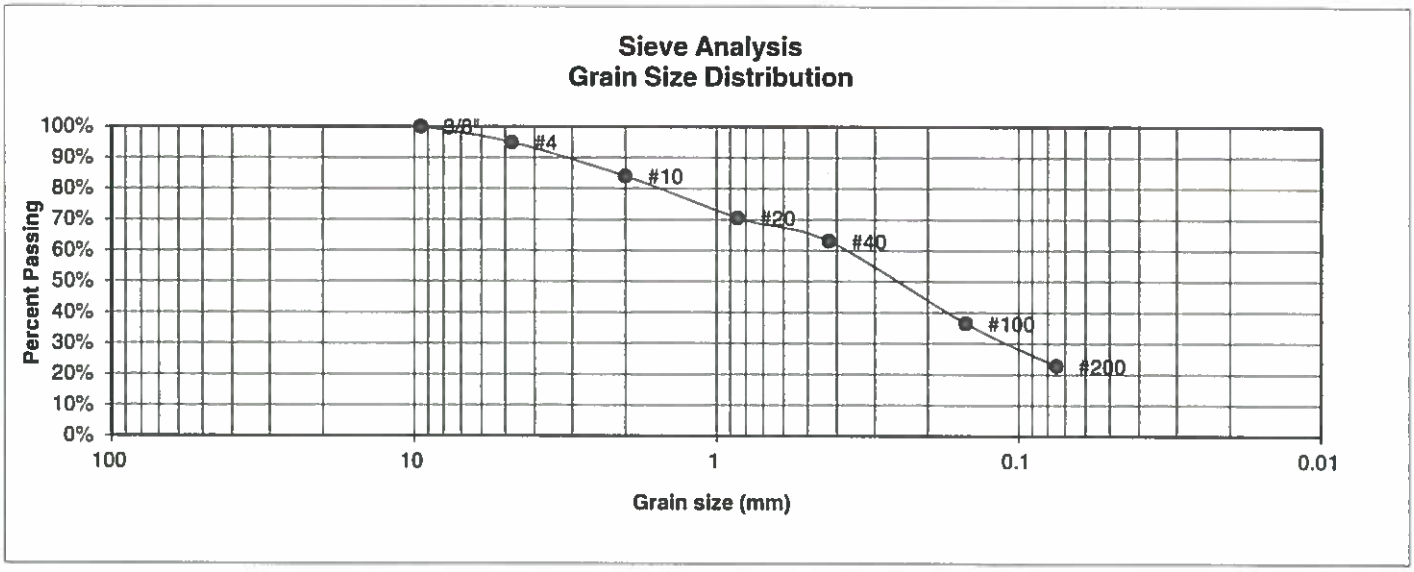
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: B-23

UNIFIED CLASSIFICATION	SC-SM	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	3	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	4	JOB NO.	171249
DEPTH (FT)	10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	94.9%
10	84.1%
20	70.6%
40	63.0%
100	36.6%
200	22.8%

Atterberg Limits	
Plastic Limit	20
Liquid Limit	27
Plastic Index	7

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

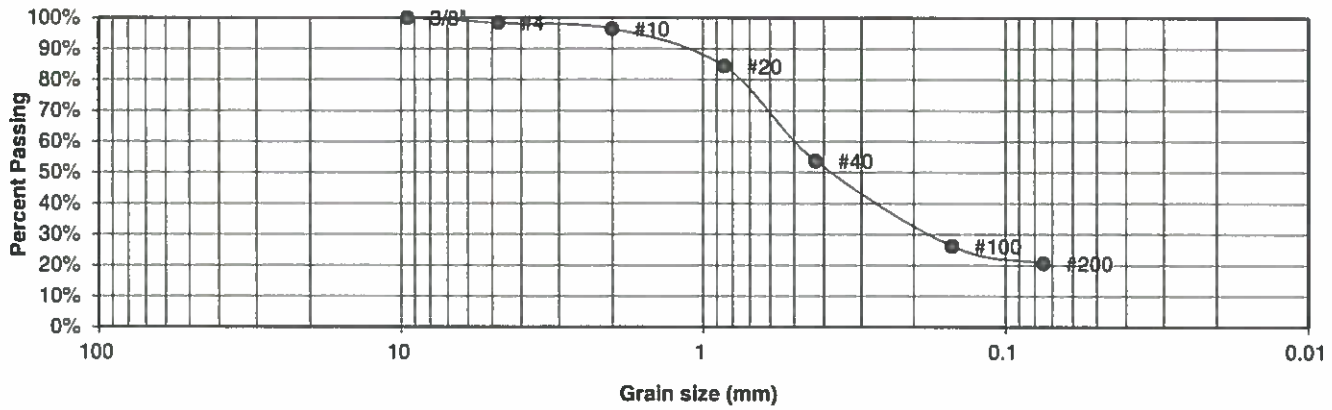
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO. 171249

FIG NO. B-24

UNIFIED CLASSIFICATION	SM	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	3	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	4	JOB NO.	171249
DEPTH (FT)	40	TEST BY	BL

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.4%
10	96.5%
20	84.4%
40	53.7%
100	26.3%
200	20.6%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

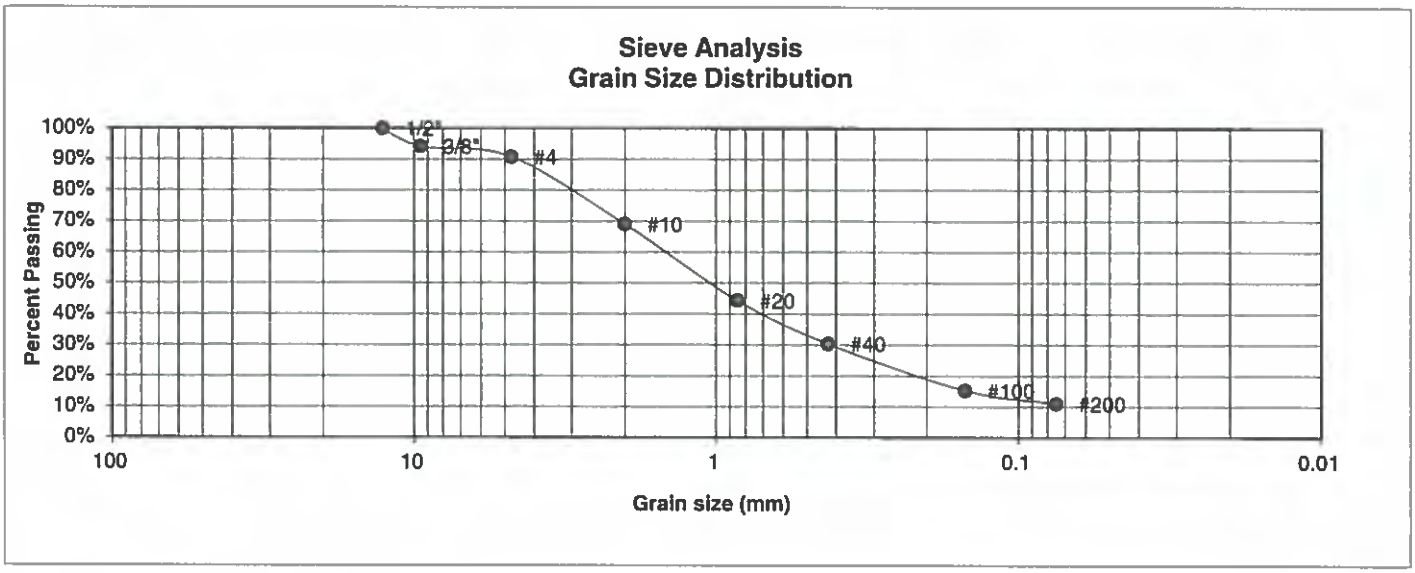
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: B-25

UNIFIED CLASSIFICATION	SM-SW	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	3	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	5	JOB NO.	171249
DEPTH (FT)	25	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	94.2%
4	90.8%
10	69.0%
20	44.3%
40	30.4%
100	15.3%
200	11.0%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

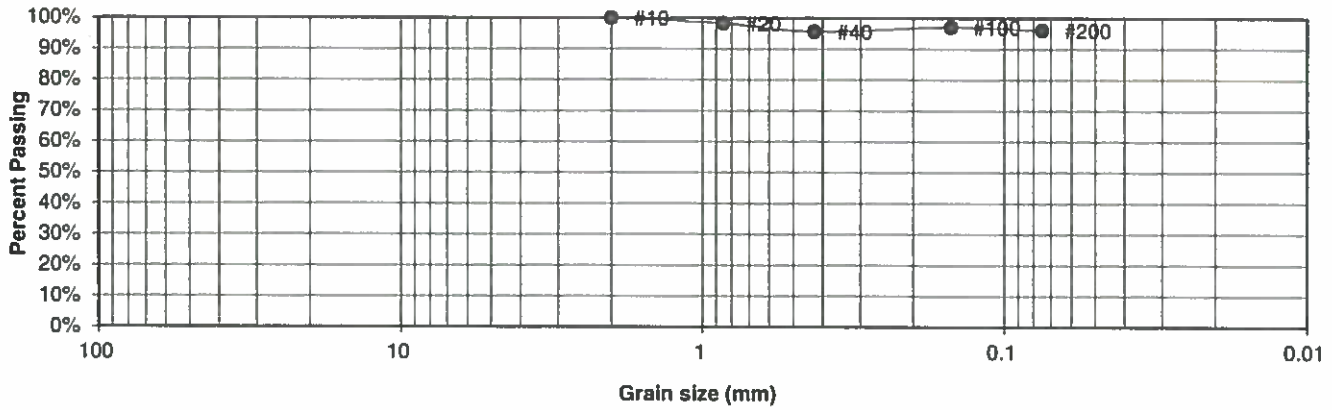
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: B-26

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	4	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	3	JOB NO.	171249
DEPTH (FT)	15	TEST BY	BL

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	100.0%
20	98.3%
40	95.7%
100	97.1%
200	96.0%

Atterberg Limits	
Plastic Limit	26
Liquid Limit	49
Plastic Index	23

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

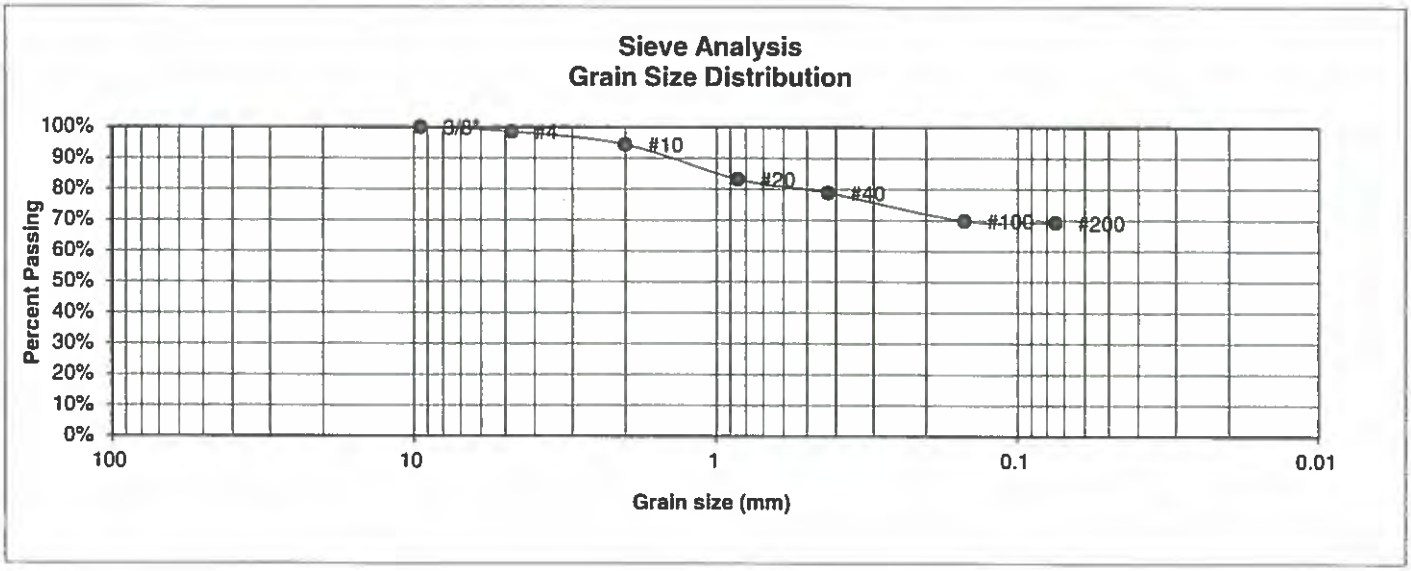
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: B-27

UNIFIED CLASSIFICATION	CL	CLIENT	PULPIT ROCK, LLC
SOIL TYPE #	4	PROJECT	FLYING HORSE NORTH, DAM
TEST BORING #	6	JOB NO.	171249
DEPTH (FT)	40	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.6%
10	94.4%
20	83.2%
40	78.8%
100	69.9%
200	69.3%

Atterberg Limits

Plastic Limit	18
Liquid Limit	37
Plastic Index	19

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SCC	DATE: 11/16/17

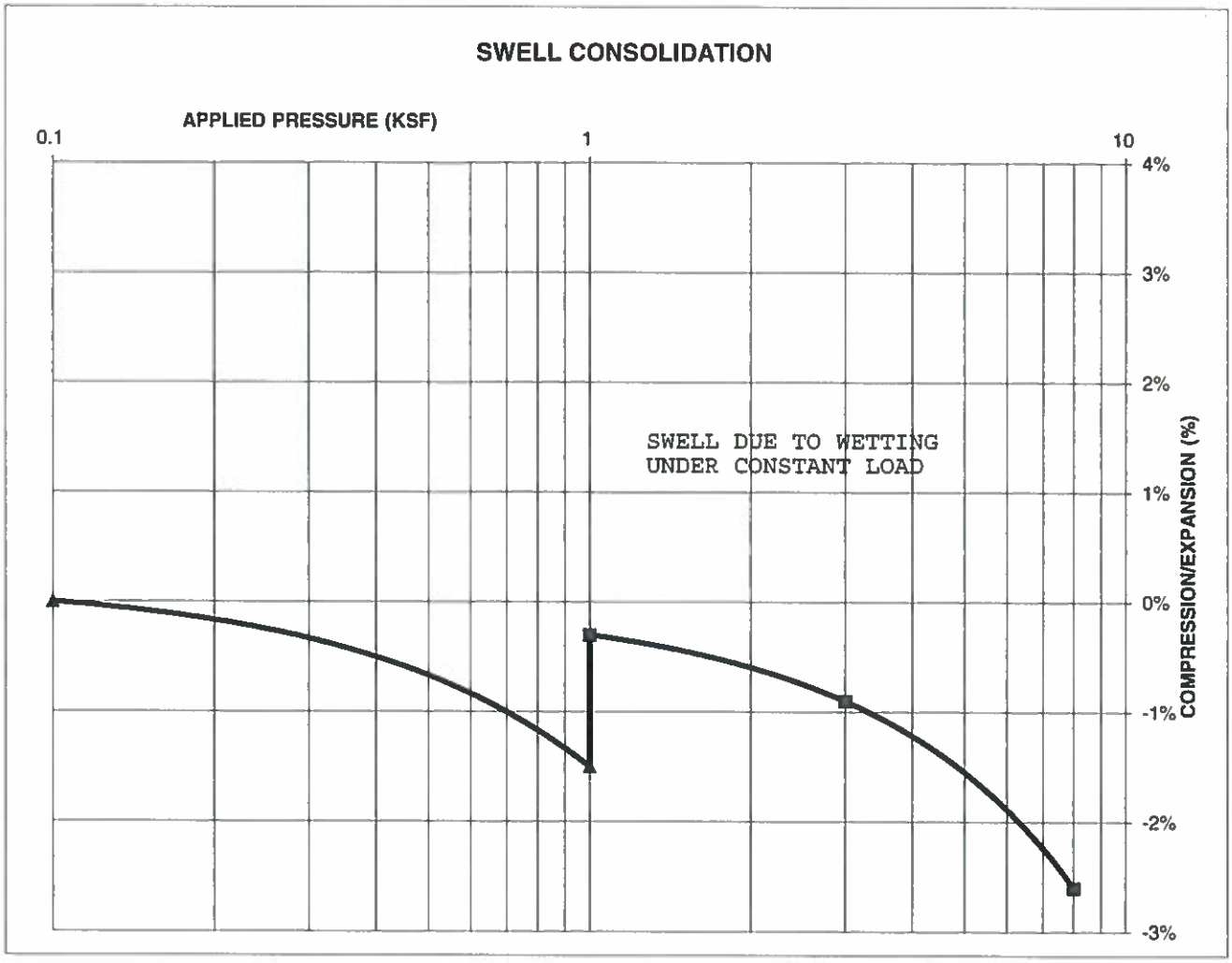
JOB NO. 171249

FIG NO. B-28

CONSOLIDATION TEST RESULTS

TEST BORING #	6	DEPTH(ft)	10
DESCRIPTION	CL	SOIL TYPE	2
NATURAL UNIT DRY WEIGHT (PCF)			108
NATURAL MOISTURE CONTENT			17.3%
SWELL/CONSOLIDATION (%)			1.2%

JOB NO. 171249
CLIENT PULPIT ROCK, LLC
PROJECT FLYING HORSE NORTH, DAM



ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

SWELL CONSOLIDATION
TEST RESULTS

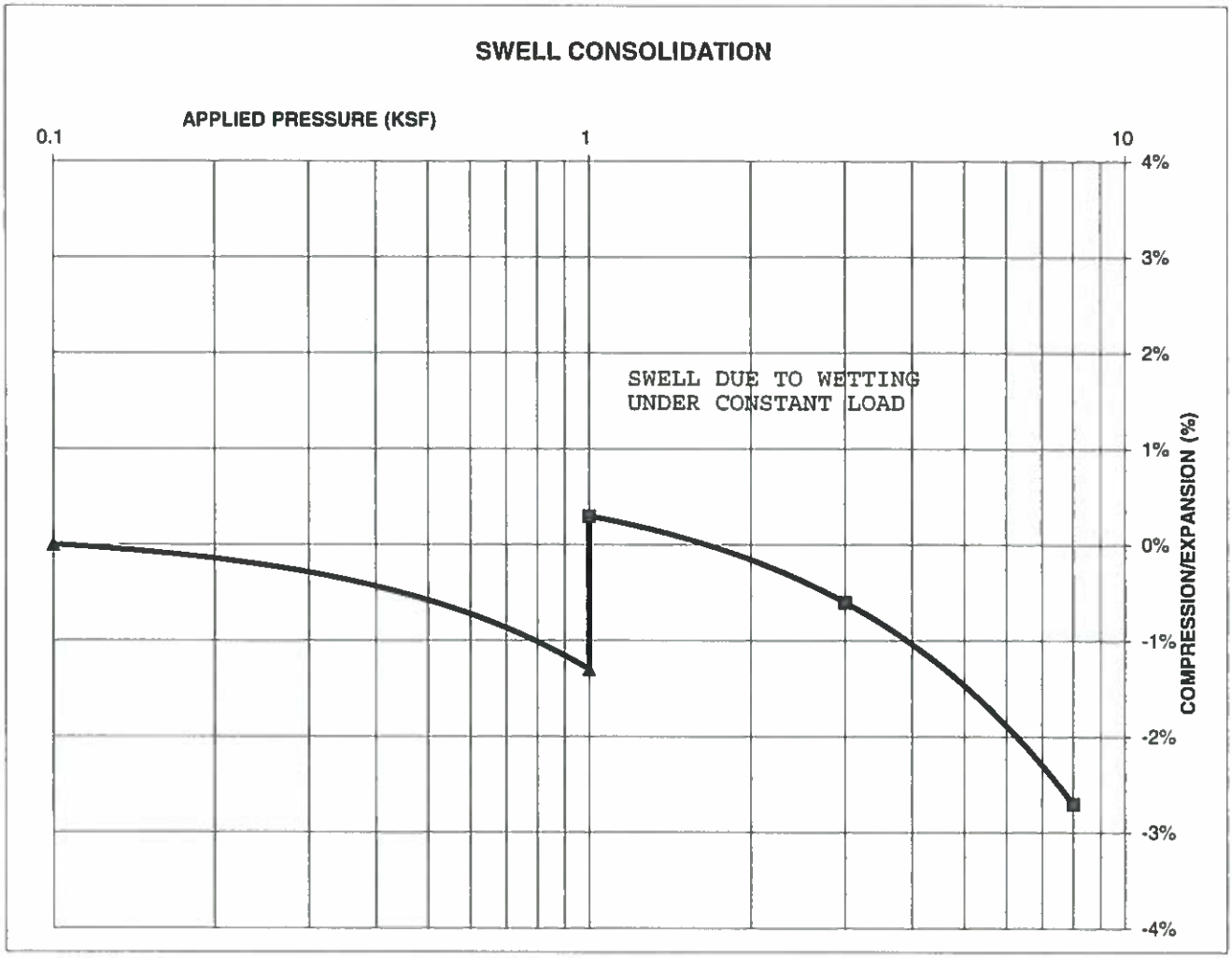
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	9/16/17

JOB NO.: 171249
FIG NO.: B-29

CONSOLIDATION TEST RESULTS

TEST BORING #	3	DEPTH(ft)	15
DESCRIPTION	CL	SOIL TYPE	4
NATURAL UNIT DRY WEIGHT (PCF)			109
NATURAL MOISTURE CONTENT			16.8%
SWELL/CONSOLIDATION (%)			1.6%

JOB NO. 171249
CLIENT PULPIT ROCK, LLC
PROJECT FLYING HORSE NORTH, DAM



ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

SWELL CONSOLIDATION
TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		DCE	11/16/17

JOB NO.: 171249
FIG NO.: B-30

APPENDIX C: Additional Laboratory Test Results

CLIENT	PULPIT ROCK, LLC	JOB NO.	171249
PROJECT	FLYING HORSE NORTH, DAM	DATE	9/8/2017
LOCATION	FLYING HORSE NORTH, DAM	TEST BY	BL

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-1	2-3	1	SM	0.02
TB-1	20	3	SC	<0.01
TB-2	20	3	SM	0.02
TB-3	15	4	CL	<0.01
TB-5	15	1	SM-SW	<0.01
TB-7	2-3	2	CL	<0.01
TB-8	15	2	CL	<0.01
TB-3	5	1	SM	<0.01
TB-13	0-3	1	SC	<0.01

QC BLANK PASS

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST
SULFATE RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: C-1

JOB # 171249 DATE 9/8/2017

CLIENT PULPIT ROCK, LLC

PROJECT FLYING HORSE NORTH, DAM BY BL

LOCATION FLYING HORSE NORTH, DAM

SAMPLE LOCATION	UNIFIED CLASS.	RESISTIVITY, (ohm-cm)	pH
TB-1 @ 2-3'	SM	14706	6.0
TB-5 @ 15'	SM-SW	>20000	6.1
TB-2 @ 20'	CL-ML	>20000	5.9
TB-3 @ 15'	CL	>20000	5.8
TB-1 @ 20'	SC	>20000	6.1
TB-7 @ 2-3'	CL	17857	5.9
TB-13 @ 0-3'	SC	16129	5.9

NOTES: All analysis QC checks passed

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

pH & RESISTIVITY REPORT

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: C-2

PERMEABILITY WORKSHEET

CLIENT	PULPIT ROCK, LLC	PROCTOR % MC	13.50%	JOB #	171249
PROJECT	FLYING HORSE NORTH, DAM	PROCTOR DENSITY	115.5	DATE	10/06/17
LOCATION	TB-6 @ 5-10'	TARGET COMPACTION	95%	TEST BY	BL

INITIAL SAMPLE + MOLD	7104		AREA OF SAMPLE	81.07	cm^2	DISH WT.	266.24	FINAL % MC	19.8%
MOLD WT.	5400		HT. OF SAMPLE	10.45	cm	DISH + WET	384.24	WHOLE SAMPLE	
INITIAL SAMPLE WT.	1704		VOL. OF SAMPLE	847	cm^3	DISH + DRY	364.71		
INITIAL SAMPLE % MC	13.50%		AREA OF TUBING	0.7	cm^2	DISH WT.	261.32	FINAL % MC	23.2%
INIT. SAMPLE DENSITY	110.67	Dry (PCF)	FINAL SAMPLE+MOLD			DISH + WET	299.23	BOTTOM 1"	
INITIAL % COMPACTION	95.8		FINAL SAMPLE % MC	19.8%		DISH + DRY	292.10		

FALLING HEAD DATA

STARTING				ENDING									
DATE	TIME	HEIGHT	CATCH	DATE	TIME	HEIGHT	CATCH	SECONDS	cc OUTFLOW	cc INFLOW	TEMP °C	k_T	k_{20}
10/6	1214	523	0.00	10/6	1314	518	0.00	3600	0.0	3.5	21	2.41E-07	2.42E-07
10/6	1314	518	0.00	10/6	1357	511	0.00	1548	0.0	4.9	21	7.93E-07	7.97E-07
10/6	1357	511	0.00	10/6	1600	496	2.00	8748	2.0	10.5	21	3.07E-07	3.09E-07
10/6	1600	496	2.00	10/7	1100	454	6.00	68400	4.0	29.4	21	1.17E-07	1.17E-07
10/7	1100	454	6.00	10/9	800	342	12.00	162000	6.0	78.4	21	1.58E-07	1.59E-07
10/9	800	342	12.00	10/9	1100	336	13.00	10800	1.0	4.2	21	1.48E-07	1.49E-07

Calculations based on:

Bowles, Joseph E.; "Physical and Geotechnical Properties of Soils," 2nd Edition, 1984

C-7

PERMEABILITY WORKSHEET

CLIENT	PULPIT ROCK, LLC	PROCTOR % MC	13.50%	JOB #	171249
PROJECT	FLYING HORSE NORTH, DAM	PROCTOR DENSITY	116.6	DATE	11/10/17
LOCATION	TB-13 @ 0-3'	TARGET COMPACTION	95%	TEST BY	BL

INITIAL SAMPLE + MOLD	7123		AREA OF SAMPLE	81.07	cm^2	DISH WT.	261.36	FINAL % MC	14.7%
MOLD WT.	5400		HT. OF SAMPLE	10.45	cm	DISH + WET	322.45	WHOLE SAMPLE	
INITIAL SAMPLE WT.	1723		VOL. OF SAMPLE	847	cm^3	DISH + DRY	314.63		
INITIAL SAMPLE % MC	13.50%		AREA OF TUBING	0.7	cm^2	DISH WT.	266.45	FINAL % MC	22.6%
INIT. SAMPLE DENSITY	111.90	Dry (PCF)	FINAL SAMPLE+MOLD			DISH + WET	313.96	BOTTOM 1"	
INITIAL % COMPACTION	96.0		FINAL SAMPLE % MC	14.7%		DISH + DRY	305.21		

FALLING HEAD DATA

STARTING				ENDING					cc	cc	TEMP		
DATE	TIME	HEIGHT	CATCH	DATE	TIME	HEIGHT	CATCH	SECONDS	OUTFLOW	INFLOW	°C	k_T	k_{20}
11/3	1425	527	0.00	11/3	1447	508	0.00	792	0.0	13.3	21	4.18E-06	4.22E-06
11/3	1447	508	0.00	11/3	1555	492	0.00	3888	0.0	11.2	21	7.43E-07	7.49E-07
11/3	1555	492	0.00	11/4	845	431	0.00	60840	0.0	42.7	21	1.96E-07	1.98E-07
11/4	845	431	0.00	11/6	805	223	0.00	171360	0.0	145.6	21	3.47E-07	3.5E-07
11/6	815	519	0.00	11/6	1130	506	2.00	11340	2.0	9.1	21	2.02E-07	2.03E-07
11/6	1130	506	2.00	11/6	1600	498	5.00	16920	3.0	5.6	22	8.5E-08	8.32E-08
11/6	1600	498	5.00	11/7	805	472	11.00	57780	6.0	18.2	23	8.37E-08	7.96E-08
11/7	805	472	11.00	11/7	1100	466	19.00	10620	8.0	4.2	24	1.09E-07	1E-07
11/7	1100	466	19.00	11/7	1300	452	36.00	7200	17.0	9.8	25	3.82E-07	3.41E-07

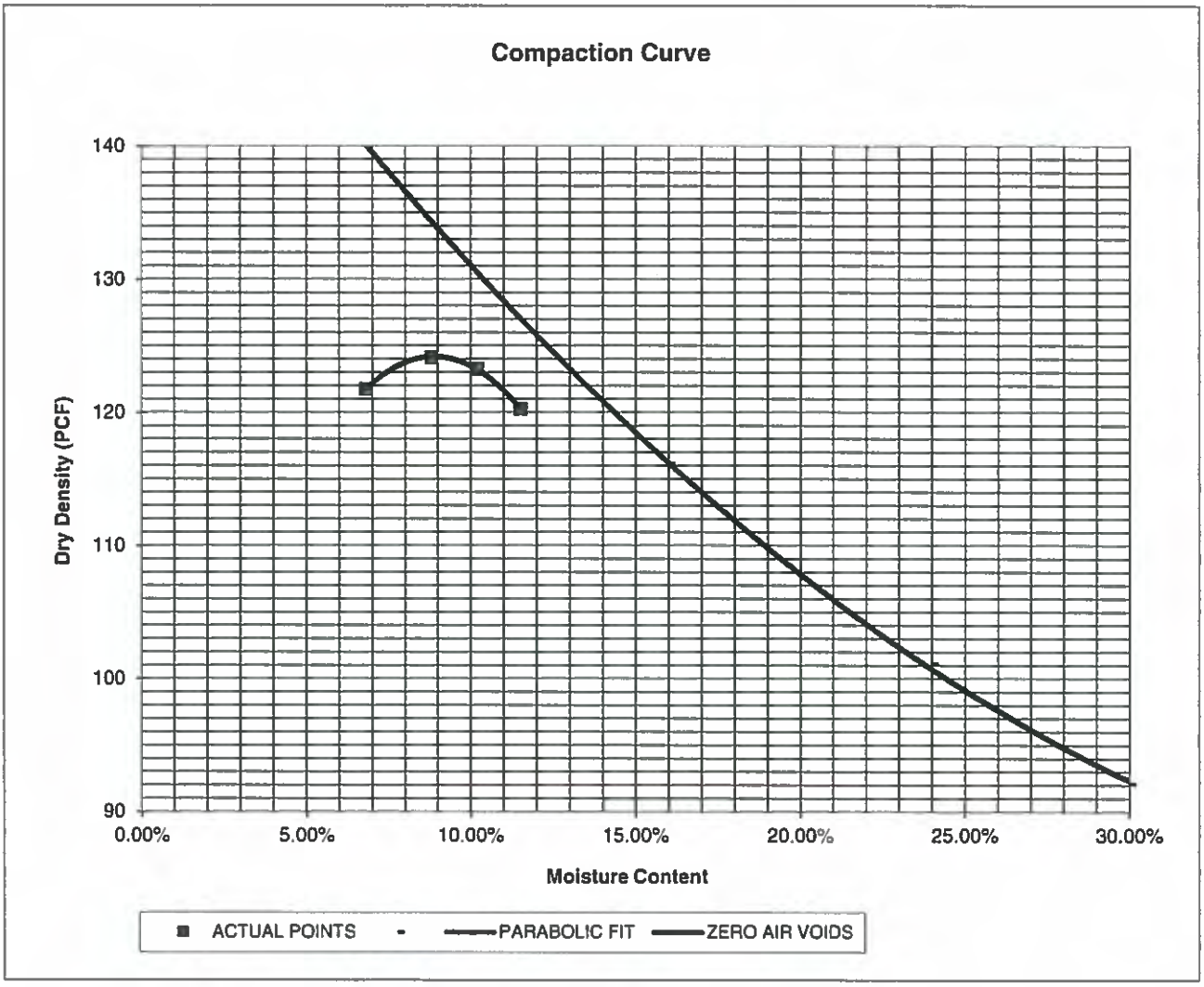
Calculations based on:

Bowles, Joseph E.; "Physical and Geotechnical Properties of Soils," 2nd Edition, 1984

4-17

PROJECT	FLYING HORSE DAM	CLIENT	PULPIT ROCK
SAMPLE LOCATION	TB-3 @ 0-5'	JOB NO.	171249
SOIL DESCRIPTION	SAND, SILTY, BROWN	DATE	09/28/17

IDENTIFICATION	SM	COMPACTION TEST #	3
TEST DESIGNATION / METHOD	ASTM D-1557-A	TEST BY	AS
MAXIMUM DRY DENSITY (PCF)	124.1	OPTIMUM MOISTURE	9.0%



ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

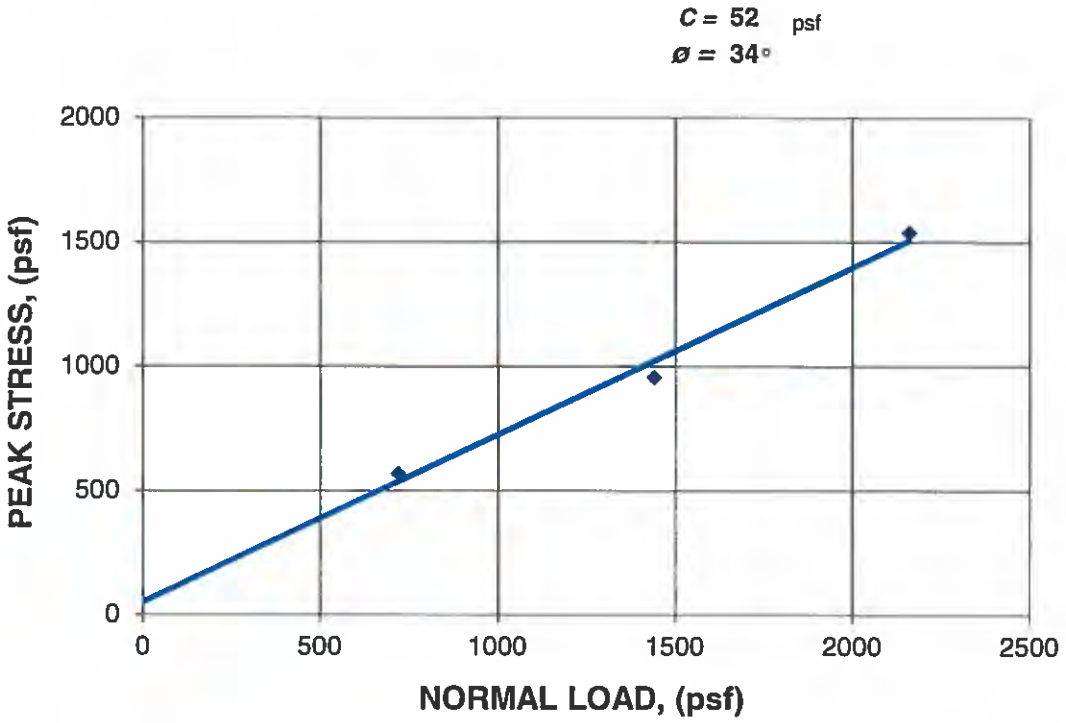
MOISTURE DENSITY RELATION

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: C-5

CLIENT PULPIT ROCK JOB NO 171249
PROJECT FLYING HORSE DAM
LOCATION TB-3 @ 0-5'



ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

FRICTION ANGLES

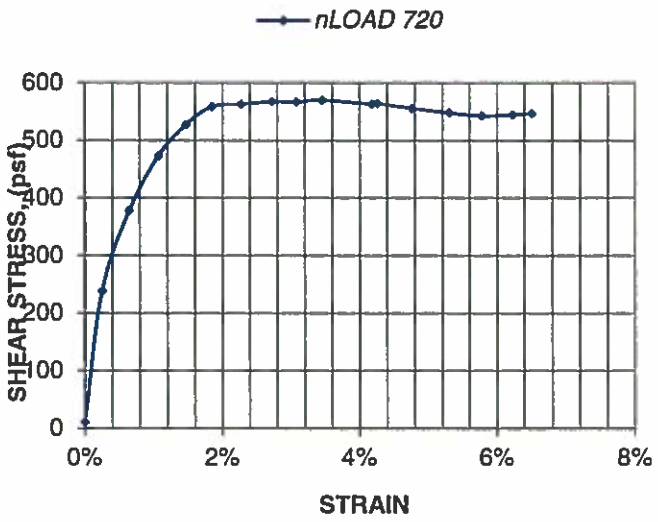
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249
FIG NO.: C-6

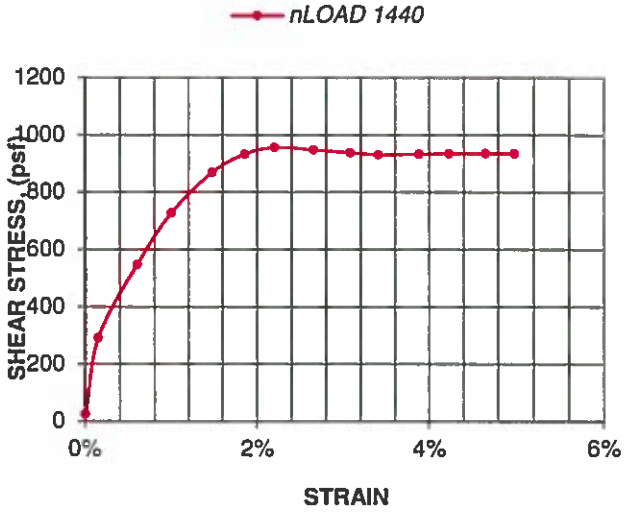
CLIENT PULPIT ROCK
PROJECT FLYING HORSE DAM
LOCATION TB-3 @ 0-5'

JOB NO 171249

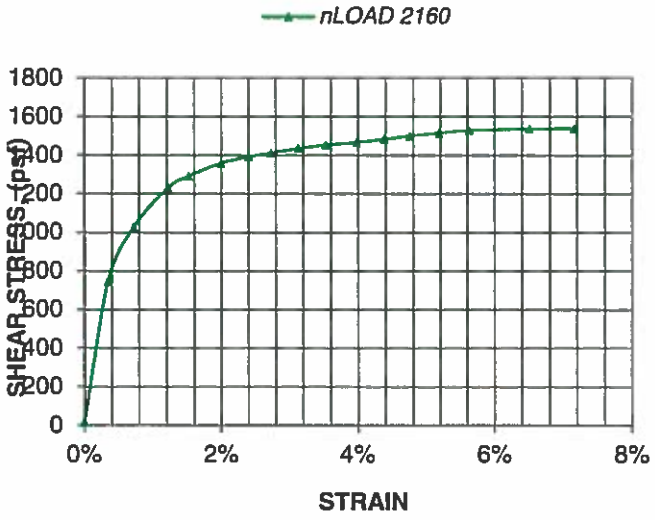
SHEAR STRESS vs SAMPLE STRAIN



SHEAR STRESS vs SAMPLE STRAIN



SHEAR STRESS vs SAMPLE STRAIN



ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

INDIVIDUAL SHEAR POINTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249
FIG NO.: C-7

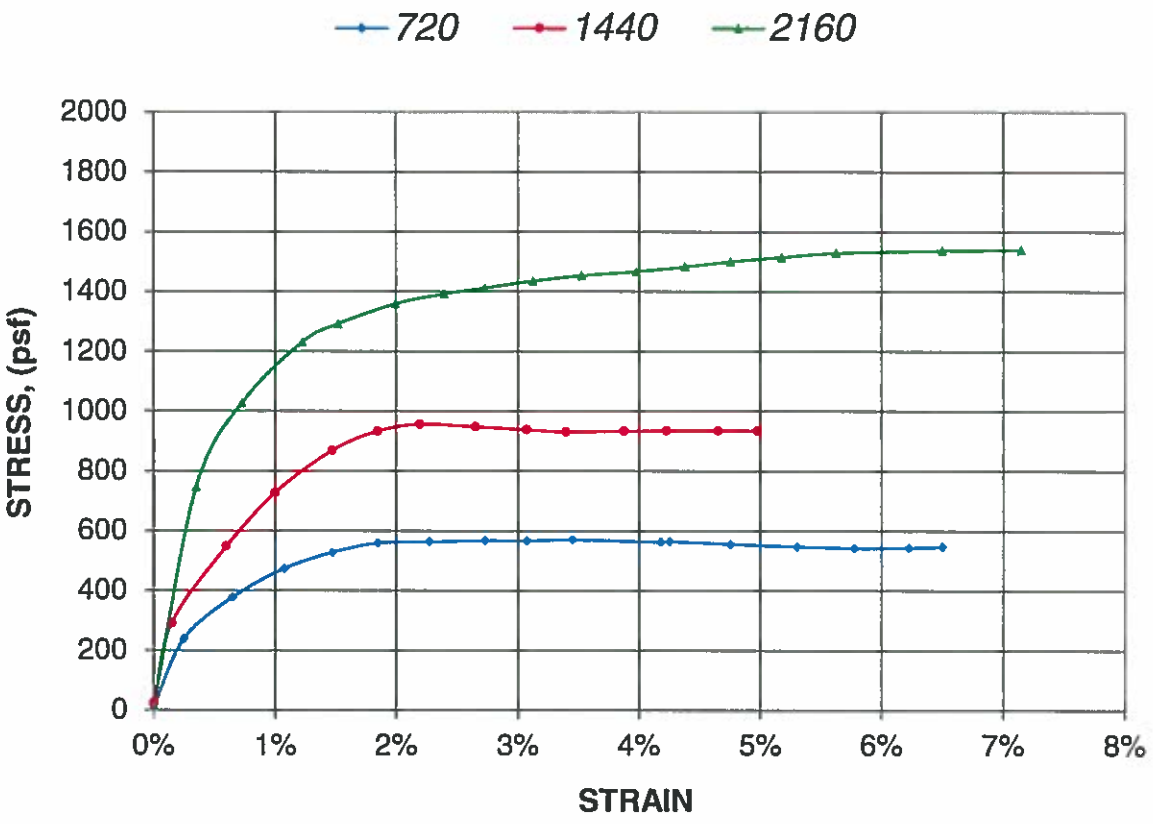
CLIENT PULPIT ROCK

PROJECT FLYING HORSE DAM

LOCATION TB-3 @ 0-5'

JOB NO 171249

SHEAR STRESS vs SAMPLE STRAIN



ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

DIRECT SHEAR COMPOSITE

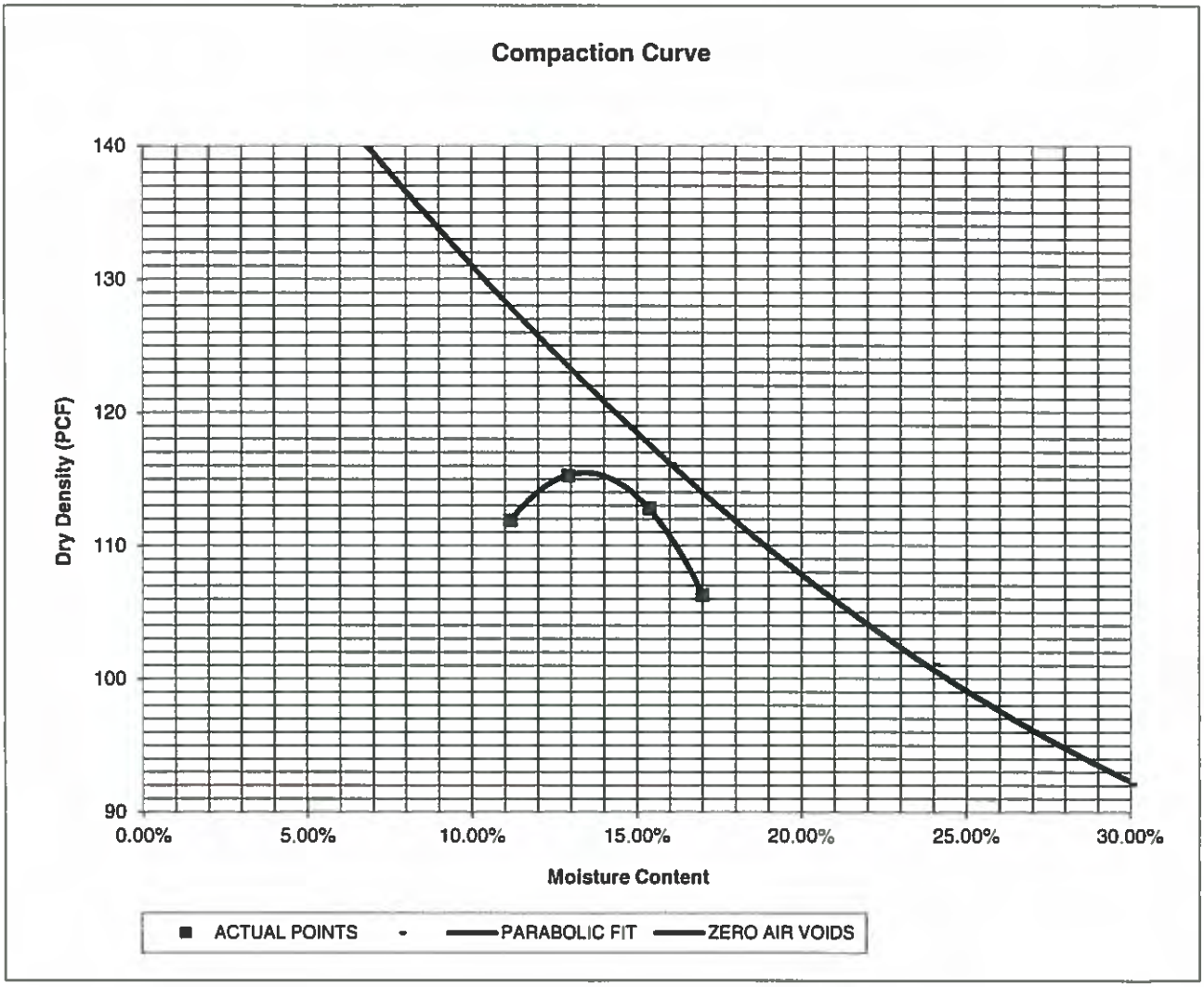
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: C-8

PROJECT	FLYING HORSE DAM	CLIENT	PULPIT ROCK
SAMPLE LOCATION	TB-6 @ 5-10	JOB NO.	171249
SOIL DESCRIPTION	SAND, V. CLAYEY, BROWN	DATE	09/28/17

IDENTIFICATION	SC	COMPACTION TEST #	2
TEST DESIGNATION / METHOD	ASTM D-698-A	TEST BY	AS
MAXIMUM DRY DENSITY (PCF)	115.5	OPTIMUM MOISTURE	13.5%



ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

MOISTURE DENSITY RELATION

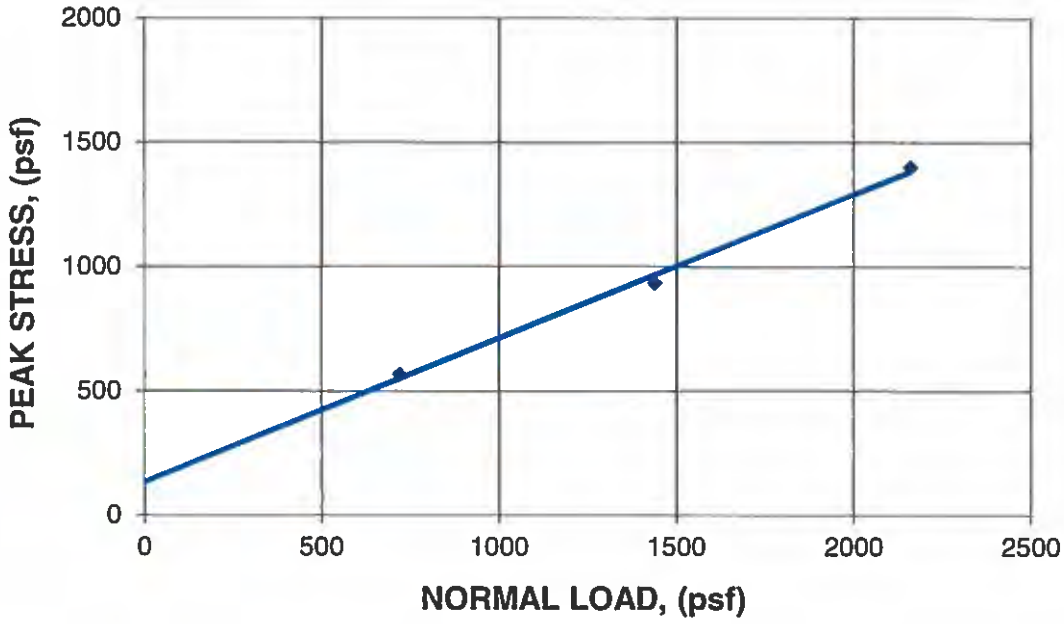
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: C-9

CLIENT PULPIT ROCK JOB NO 171249
PROJECT FLYING HORSE DAM
LOCATION TB-6 @ 5-10'

C = 134 psf
ϕ = 30°



ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

FRICTION ANGLES

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249
FIG NO.: C-10

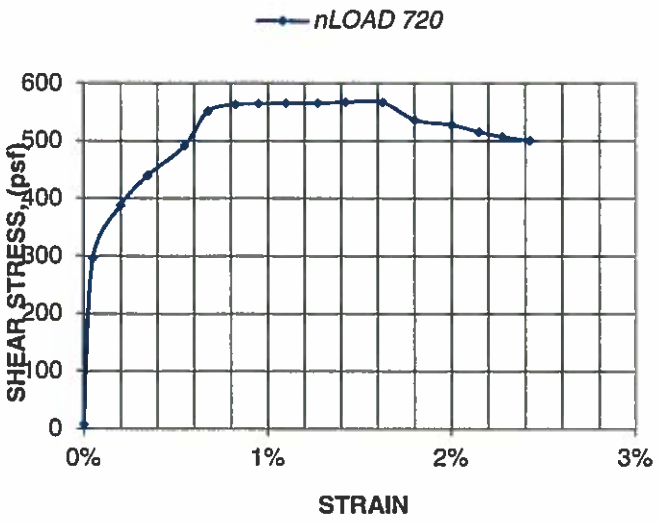
CLIENT PULPIT ROCK

PROJECT FLYING HORSE DAM

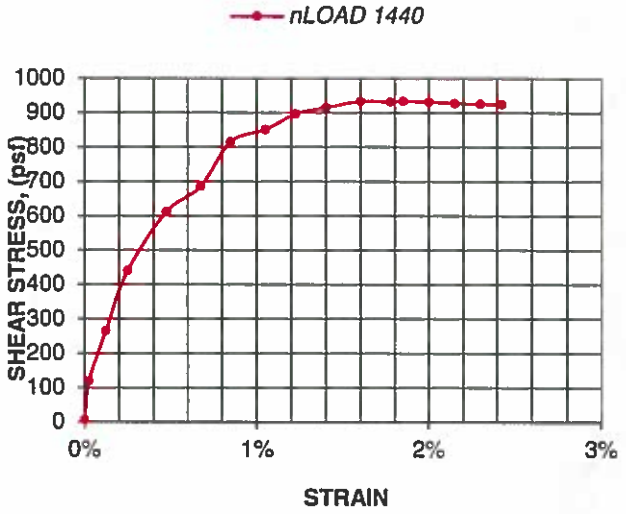
LOCATION TB-6 @ 5-10'

JOB NO 171249

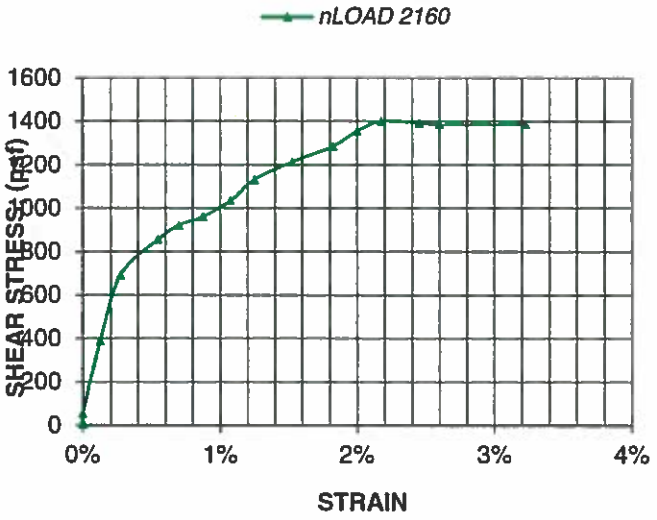
SHEAR STRESS vs SAMPLE STRAIN



SHEAR STRESS vs SAMPLE STRAIN



SHEAR STRESS vs SAMPLE STRAIN



ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

INDIVIDUAL SHEAR POINTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: C-11

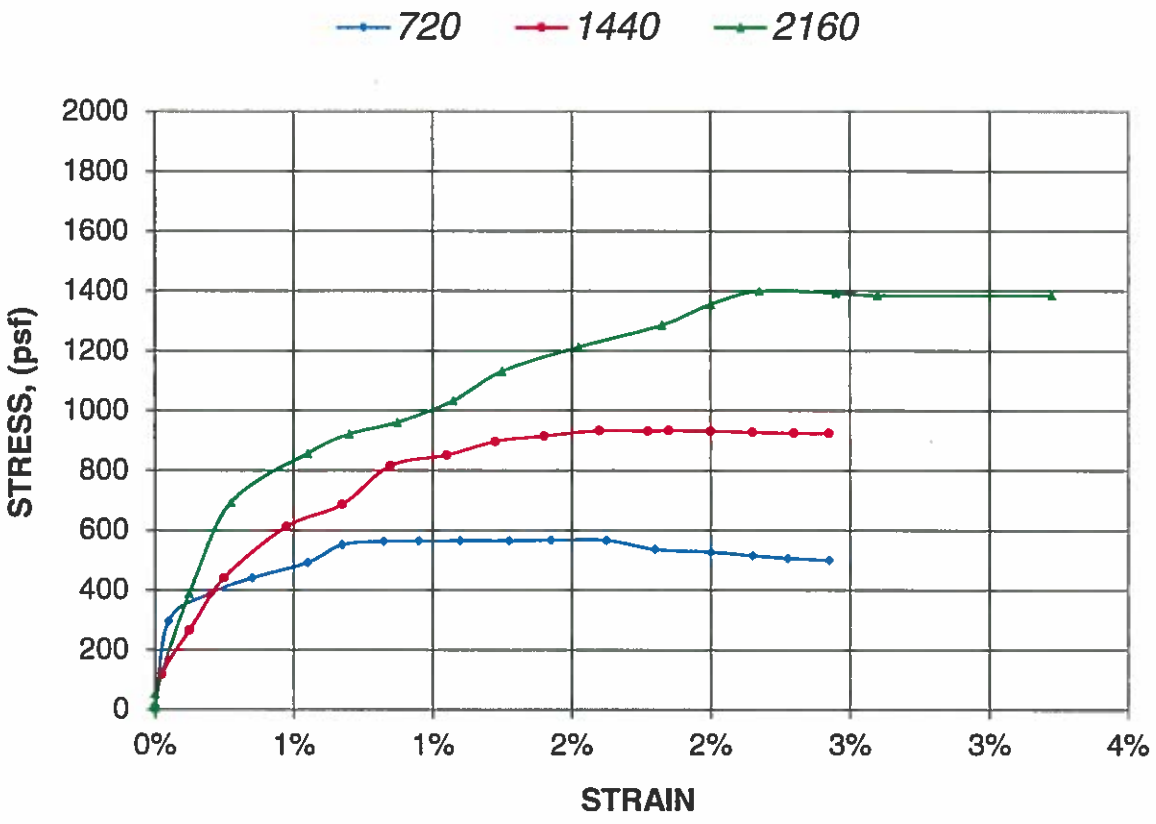
CLIENT PULPIT ROCK

PROJECT FLYING HORSE DAM

LOCATION TB-6 @ 5-10'

JOB NO 171249

SHEAR STRESS vs SAMPLE STRAIN



ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

DIRECT SHEAR COMPOSITE

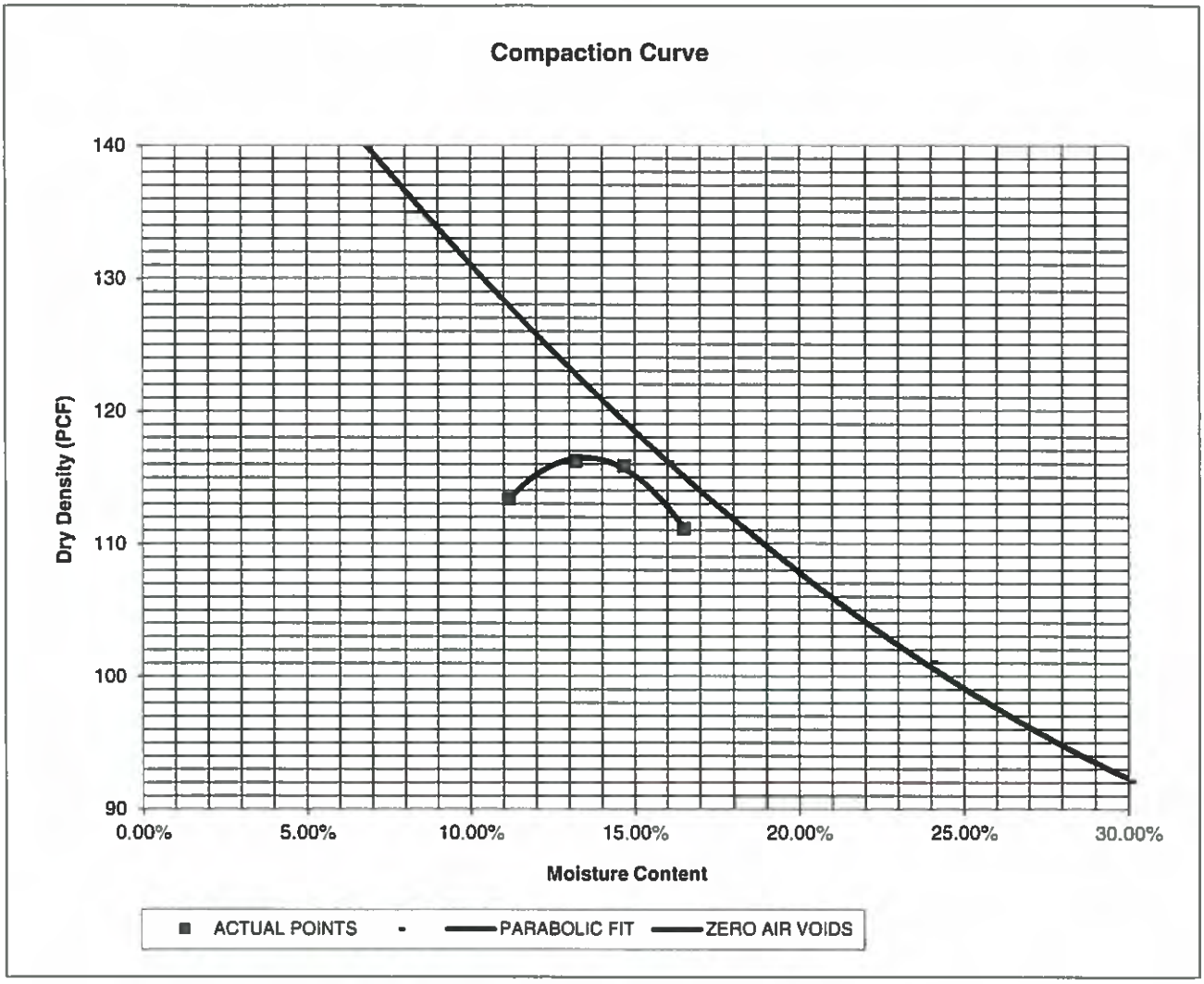
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: C-12

PROJECT	FLYING HORSE DAM	CLIENT	PULPIT ROCK
SAMPLE LOCATION	TB-13 @ 0-3'	JOB NO.	171249
SOIL DESCRIPTION	SAND, VERY CLAYEY, TAN	DATE	10/27/17

IDENTIFICATION	SC	COMPACTION TEST #	4
TEST DESIGNATION / METHOD	ASTM D-698-A	TEST BY	BL
MAXIMUM DRY DENSITY (PCF)	116.6	OPTIMUM MOISTURE	13.3%



ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

MOISTURE DENSITY RELATION

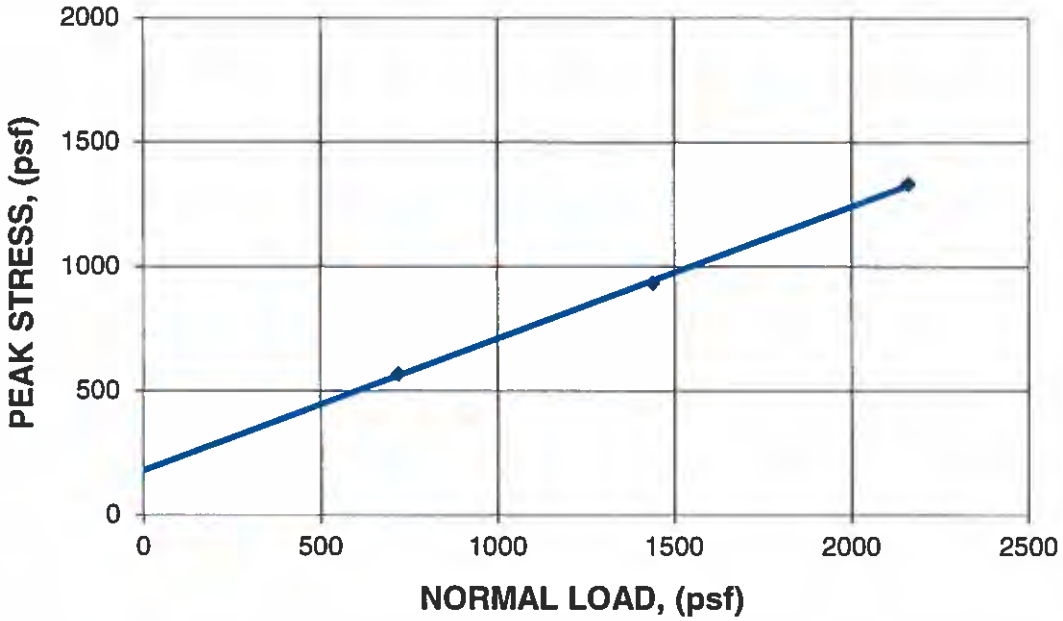
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249

FIG NO.: C-13

CLIENT PULPIT ROCK JOB NO 171249
PROJECT FLYING HORSE DAM
LOCATION TB-13 @ 0-3'

C = 179 psf
ϕ = 28°



ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

FRICTION ANGLES

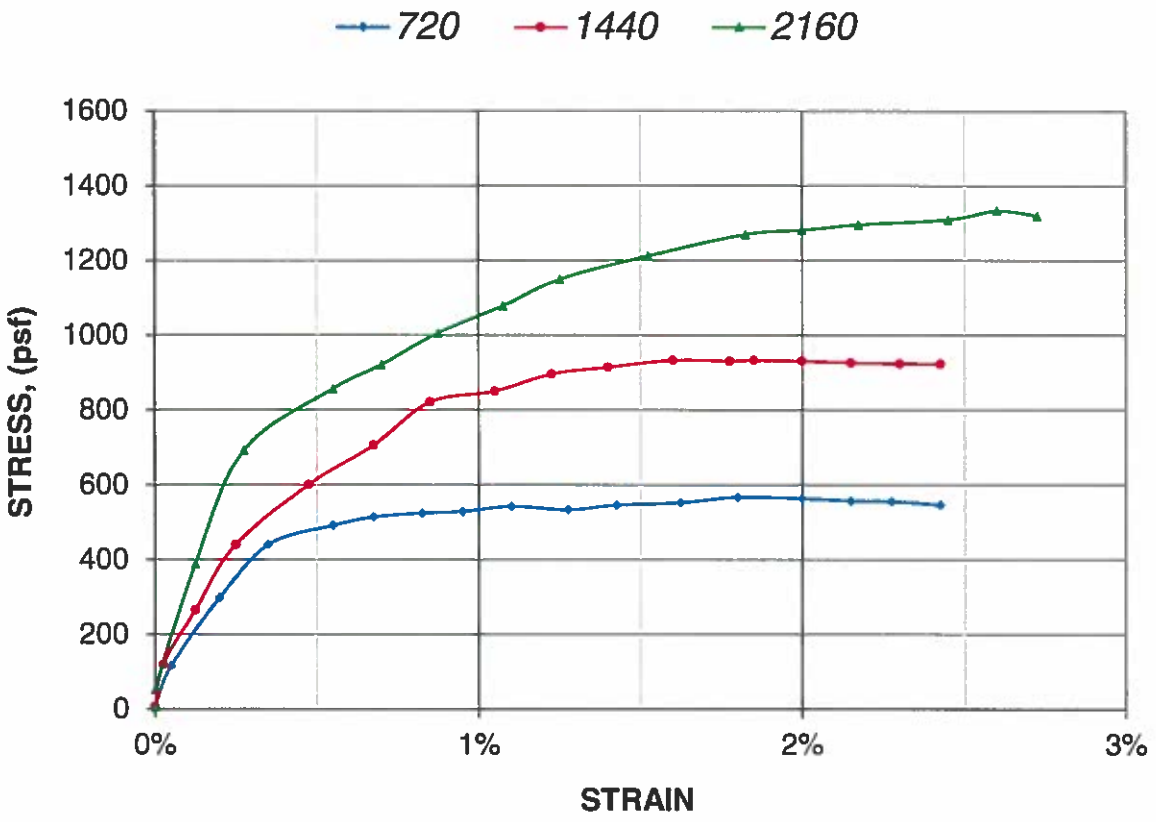
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249
FIG NO.: C-14

CLIENT PULPIT ROCK
PROJECT FLYING HORSE DAM
LOCATION TB-13 @ 0-3'

JOB NO 171249

SHEAR STRESS vs SAMPLE STRAIN



ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

DIRECT SHEAR COMPOSITE

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	11/16/17

JOB NO.: 171249
FIG NO.: C-15

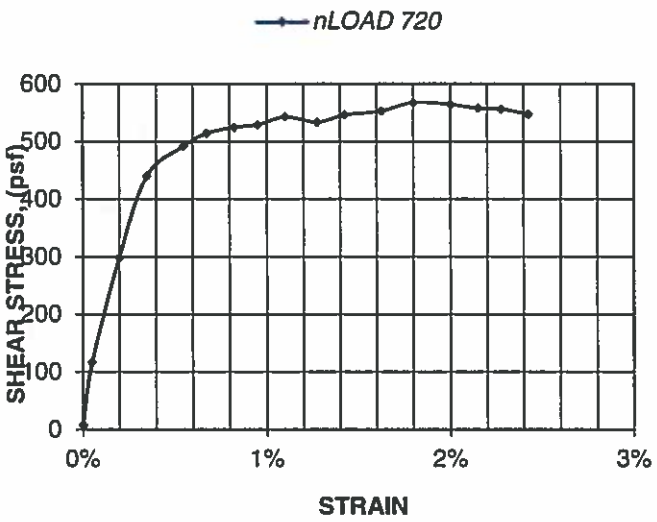
CLIENT PULPIT ROCK

PROJECT FLYING HORSE DAM

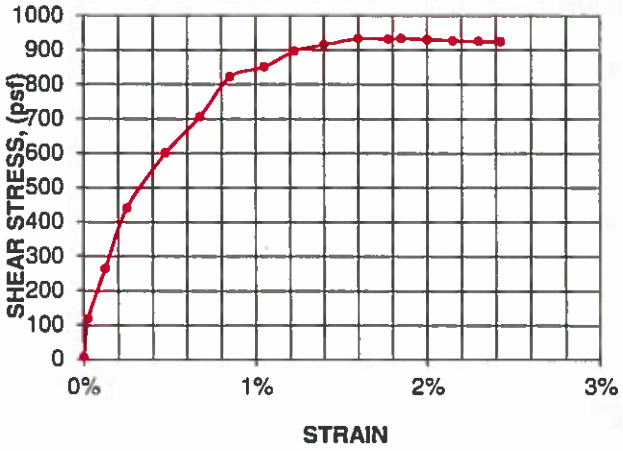
LOCATION TB-13 @ 0-3'

JOB NO 171249

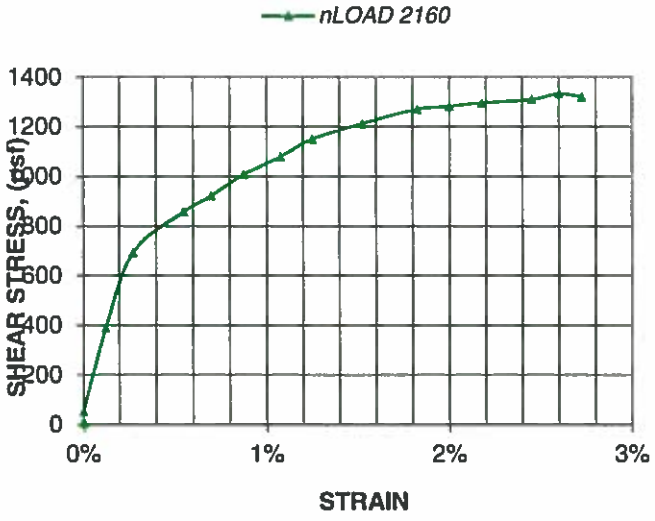
SHEAR STRESS vs SAMPLE STRAIN



SHEAR STRESS vs SAMPLE STRAIN



SHEAR STRESS vs SAMPLE STRAIN



ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

INDIVIDUAL SHEAR POINTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCE	11/16/17

JOB NO.: 171249

FIG NO.: C-16

APPENDIX D: Filter Calculations

Flying Horse North Dam
Filter Compatibility for Dam Embankment

Sieve Analysis

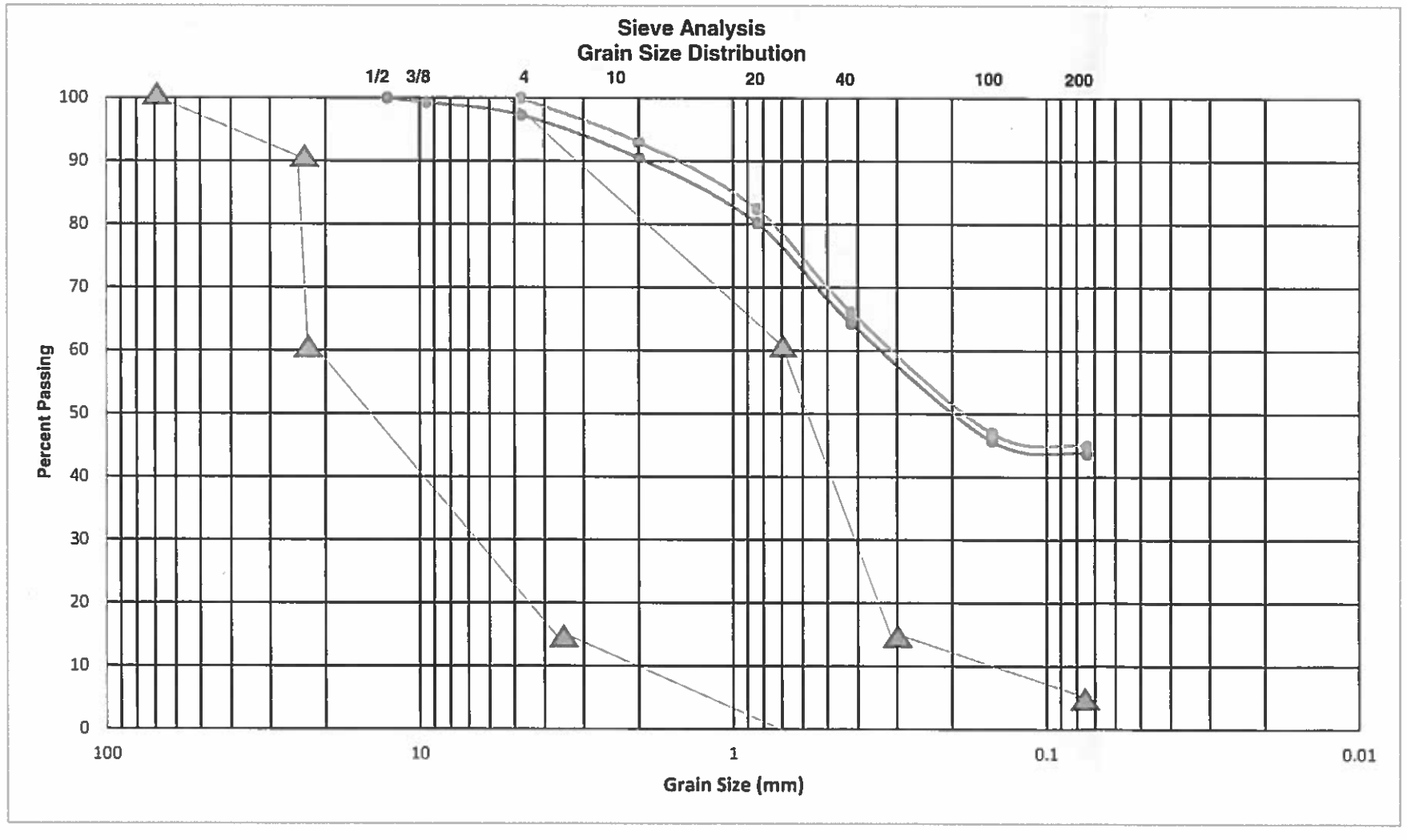
Sieve #	Opening	% Finer	Regraded
	(mm)	(%)	(%)
1.5	37.5		
3/4	19.05		
1/2	12.7	100	
3/8	9.53	99.3	
4	4.76	97.3	100.0
10	2	90.5	93.0
20	0.841	80.2	82.4
40	0.42	64.3	66.1
100	0.149	45.7	47.0
200	0.074	43.7	44.9

NEH - Part 633 - Example 26-2

1)	Regrade Factor	1.027749		
2)	Base Soil Category, Table 26-1	2		
3)	Max D15, Table 26-2	0.7 mm	5.7	D1
4)	Min D15, Table 26-3	0.3 mm	1.14	D2
5)	Band Width	mm		
6)	Max D10	0.58 mm		
7)	Max D60	3.5 mm		D3
8)	Min D60	0.7 mm		D4
9)	Min D5	0.075 mm		D5
10)	Max D100	75 mm		D6
11)	Max D90	25 mm		D7
	Min D10		0.95	

Acceptable Band Range - #8

Sieve #	Minimum	Maximum
	(%)	(%)
3/4"	90	100
1/2"	50	100
3/8"	39	100
4	20	97
10	10	80
20	3	65
40	0	31
100	0	10
200	0	5



Flying Horse North Dam
Coarse Filter Compatibility

Sieve Analysis

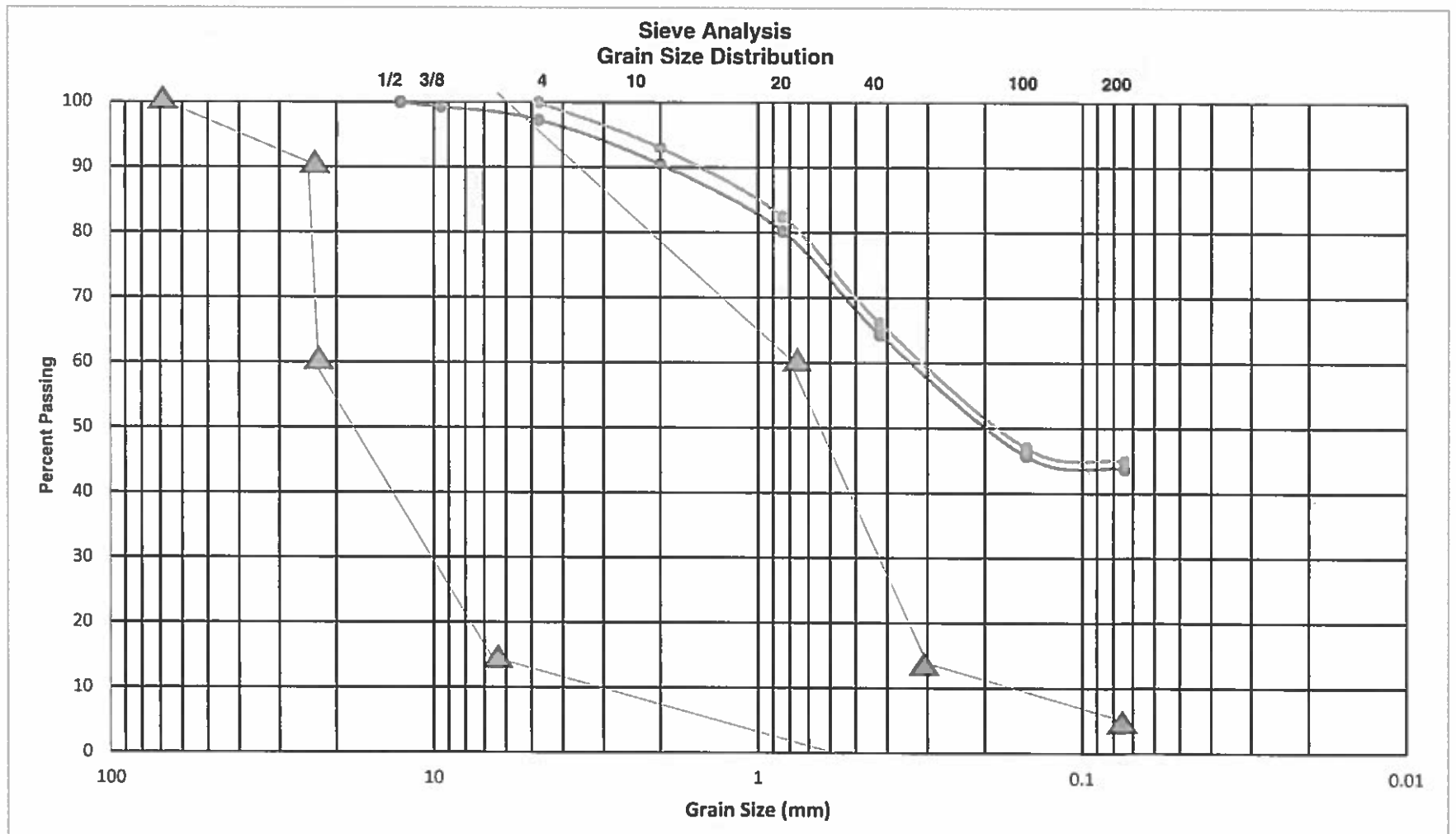
Sieve #	Opening	% Finer	Regraded
	(mm)	(%)	(%)
1.5	37.5		
3/4	19.05		
1/2	12.7	100	
3/8	9.53	99.3	
4	4.76	97.3	100.0
10	2	90.5	93.0
20	0.841	80.2	82.4
40	0.42	64.3	66.1
100	0.149	45.7	47.0
200	0.074	43.7	44.9

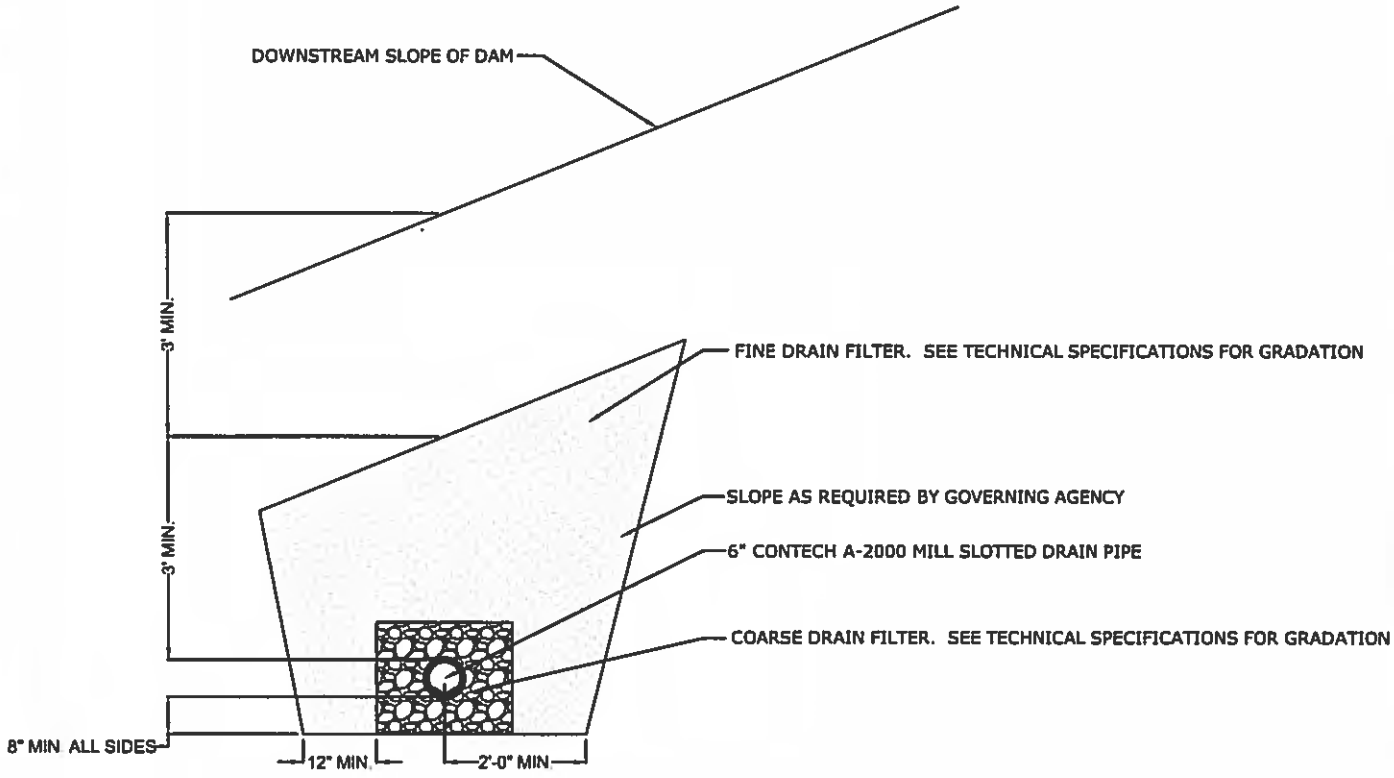
NEH - Part 633 - Example 26-5

1)	Regrade Factor	1.027749		
2)	Base Soil Category, Table 26-1	2		
3)	Max D15	0.7 mm	5.7	D1
4)	Min D15, Table 26-3	0.3 mm	1.14	D2
5)	Band Width	mm		
6)	Max D10	0.58 mm		
7)	Max D60	3.5 mm		D3
8)	Min D60	0.7 mm		D4
9)	Min D5	0.075 mm		D5
10)	Max D100	75 mm		D6
11)	Max D90	25 mm		D7
	Min D10		0.95	

Acceptable Band Range - #57

Sieve #	Minimum	Maximum
	(%)	(%)
3"	100	100
1-1/2"	94	100
3/4"	51	100
1/2"	33	100
3/8"	26	100
4	2	38
10	0	15
20	0	11
40	0	10
100	0	8
200	0	5





ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

TOE DRAIN SECTION
FLYING HORSE NORTH DAM
FOR: PULPIT ROCK, LLC

DRAWN BY:	DATE DRAWN:	DESIGNED BY:	CHECKED:
SCC	11/16/17	SCC	SCC

JOB NO.: 171249
FIG. NO.: 1

APPENDIX E: Slope Stability Calculations

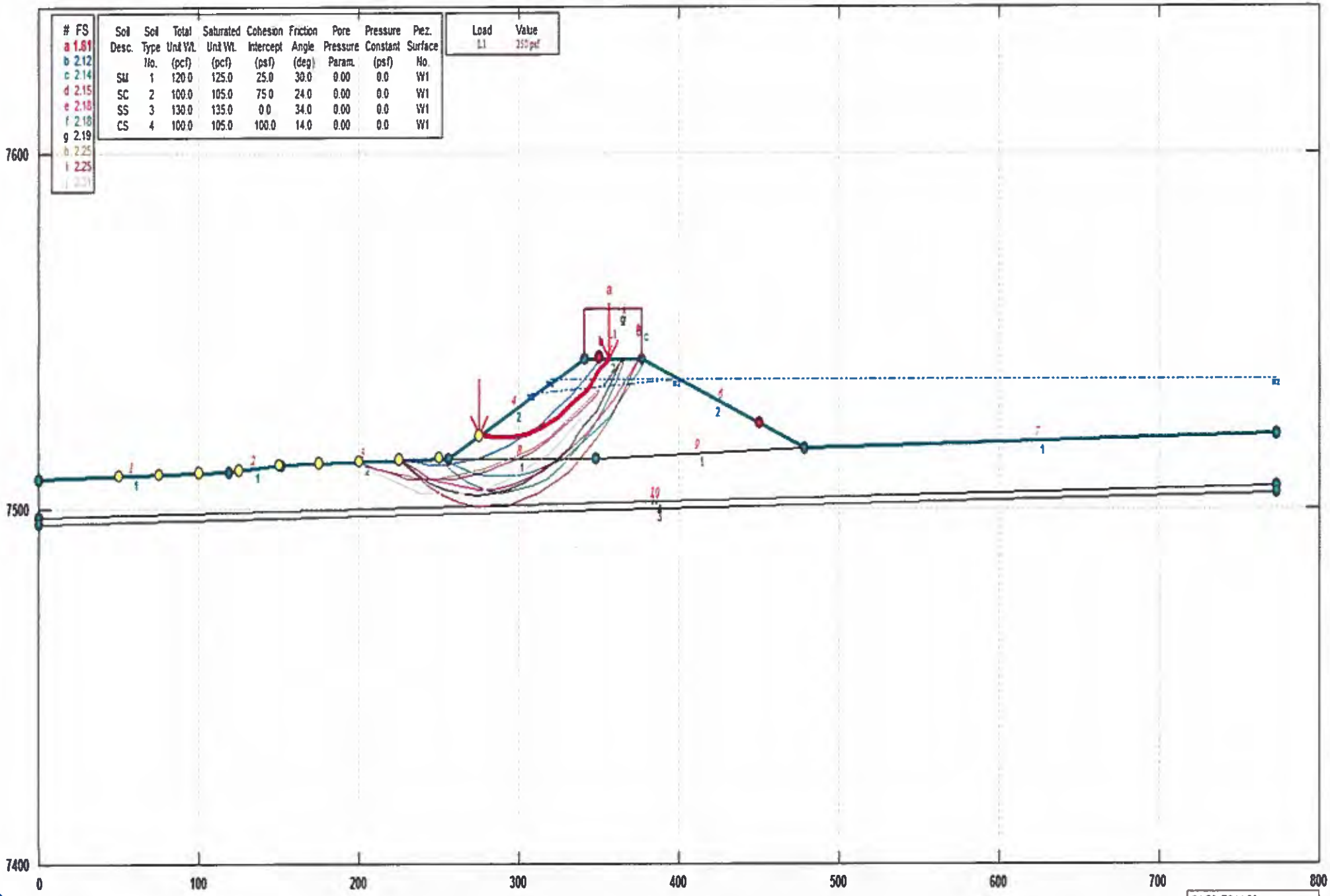
Flying Horse North Golf Course Dam

f:\aa projects\2017\171249-pulpit rock-flying horse north, dam investigation-ssi-200\proposed contour - classic - updated.pl2 Run By: Insert Name/company Here 11/15/2017 04:53PM

#	FS
a	1.81
b	2.12
c	2.14
d	2.15
e	2.18
f	2.18
g	2.19
h	2.25
i	2.25
j	2.31

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Pez. Surface No.
SM	1	120.0	125.0	25.0	30.0	0.00	0.0	W1
SC	2	100.0	105.0	75.0	24.0	0.00	0.0	W1
SS	3	130.0	135.0	0.0	34.0	0.00	0.0	W1
CS	4	100.0	105.0	100.0	14.0	0.00	0.0	W1

Load	Value
L1	350 psf



GSTABL7 v.2 FSmin=1.81

Safety Factors Are Calculated By The Modified Bishop Method

*** GSTABL7 ***
** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **
(All Rights Reserved-Unauthorized Use Prohibited)

****

SLOPE STABILITY ANALYSIS SYSTEM

Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.

****

Analysis Run Date: 11/15/2017
Time of Run: 04:53PM
Run By: Insert Name/company Here
Input Data Filename: F:\AA projects\2017\171249-Pulpit Rock-Flying Horse North, Dam Investigation-SSI-200\proposed contour - classic - updated.in
Output Filename: F:\AA projects\2017\171249-Pulpit Rock-Flying Horse North, Dam Investigation-SSI-200\proposed contour - classic - updated.OUT
Unit System: English
Plotted Output Filename: F:\AA projects\2017\171249-Pulpit Rock-Flying Horse North, Dam Investigation-SSI-200\proposed contour - classic - updated.PLT
PROBLEM DESCRIPTION: Flying Horse North
Golf Course Dam

BOUNDARY COORDINATES
7 Top Boundaries
11 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	7508.50	119.00	7510.50	1
2	119.00	7510.50	152.00	7512.50	1
3	152.00	7512.50	256.50	7514.50	2
4	256.50	7514.50	341.00	7542.50	2
5	341.00	7542.50	376.50	7542.50	2
6	376.50	7542.50	478.00	7517.00	2
7	478.00	7517.00	773.00	7520.50	1
8	256.50	7514.50	348.00	7514.40	1
9	348.00	7514.40	478.00	7517.00	1
10	0.00	7498.00	773.00	7506.00	4
11	0.00	7496.00	773.00	7504.00	3

User Specified Y-Origin = 7400.00(ft)
Default X-Plus Value = 0.00(ft)
User Specified Y-Plus Value = 7458.00(ft)

ISOTROPIC SOIL PARAMETERS
4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	125.0	25.0	30.0	0.00	0.0	1
2	100.0	105.0	75.0	24.0	0.00	0.0	1
3	130.0	135.0	0.0	34.0	0.00	0.0	1
4	100.0	105.0	100.0	14.0	0.00	0.0	1

2 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water = 62.40 (pcf)
Piezometric Surface No. 1 Specified by 2 Coordinate Points
Pore Pressure Inclination Factor = 0.50

Point No.	X-Water (ft)	Y-Water (ft)
1	320.00	7536.00
2	773.00	7536.00

Piezometric Surface No. 2 Specified by 3 Coordinate Points
Pore Pressure Inclination Factor = 0.50

Point No.	X-Water (ft)	Y-Water (ft)
1	308.00	7532.00
2	399.00	7536.00

```
      3        773.00      7536.00
 BOUNDARY LOAD(S)
      1 Load(s) Specified
  Load         X-Left       X-Right      Intensity      Deflection
   No.          (ft)         (ft)          (psf)          (deg)
    1         341.00       376.50         250.0           0.0
  NOTE - Intensity Is Specified As A Uniformly Distributed
         Force Acting On A Horizontally Projected Surface.
  A Critical Failure Surface Searching Method, Using A Random
  Technique For Generating Circular Surfaces, Has Been Specified.
   100 Trial Surfaces Have Been Generated.
    10 Surface(s) Initiate(s) From Each Of    10 Points Equally Spaced
  Along The Ground Surface Between  X =  50.00(ft)
                                and  X = 275.00(ft)
  Each Surface Terminates Between   X = 350.00(ft)
                                and   X = 450.00(ft)
  Unless Further Limitations Were Imposed, The Minimum Elevation
  At Which A Surface Extends Is  Y =      0.00(ft)
  10.00(ft) Line Segments Define Each Trial Failure Surface.
  Following Are Displayed The Ten Most Critical Of The Trial
        Failure Surfaces Evaluated. They Are
        Ordered - Most Critical First.
        * * Safety Factors Are Calculated By The Modified Bishop Method * *
        Total Number of Trial Surfaces Attempted =   100
        Number of Trial Surfaces With Valid FS =  100
        Statistical Data On All Valid FS Values:
           FS Max =  29.761   FS Min =   1.812   FS Ave =   6.530
           Standard Deviation =    3.954   Coefficient of Variation =   60.55 %
        Failure Surface Specified By 10 Coordinate Points
          Point      X-Surf      Y-Surf
           No.         (ft)        (ft)
            1        275.000     7520.630
            2        284.973     7519.895
            3        294.972     7520.040
            4        304.919     7521.064
            5        314.738     7522.961
            6        324.351     7525.715
            7        333.684     7529.305
            8        342.665     7533.703
            9        351.224     7538.875
           10        356.179     7542.500
        Circle Center At X =   288.368 ; Y =  7632.608 ; and Radius =   112.773
              Factor of Safety
             ***    1.812   ***
            Individual data on the    14  slices
                        Water  Water     Tie     Tie      Earthquake
                        Force  Force     Force   Force       Force   Surcharge
Slice  Width   Weight    Top    Bot      Norm     Tan      Hor     Ver     Load
 No.    (ft)    (lbs)   (lbs)  (lbs)    (lbs)   (lbs)    (lbs)   (lbs)   (lbs)
  1     10.0    2115.3  8992.8  9820.1      0.      0.      0.0     0.0     0.0
  2     10.0    5905.1  6841.6 10004.7      0.      0.      0.0     0.0     0.0
  3      9.9    8715.3  4645.3  9639.7      0.      0.      0.0     0.0     0.0
  4      3.1    3135.4  1001.5  2866.1      0.      0.      0.0     0.0     0.0
  5      6.7    7336.6  1469.9  5861.8      0.      0.      0.0     0.0     0.0
  6      5.3    6052.7   460.3  4196.2      0.      0.      0.0     0.0     0.0
  7      4.4    5097.1     0.0  3080.5      0.      0.      0.0     0.0     0.0
  8      9.3   10680.7     0.0  5297.6      0.      0.      0.0     0.0     0.0
  9      7.3    7635.5     0.0  2492.6      0.      0.      0.0     0.0     0.0
 10      1.3    1192.6     0.0   246.0      0.      0.      0.0     0.0   315.7
 11      0.4     362.8     0.0    67.0      0.      0.      0.0     0.0   100.6
 12      3.8    2929.4     0.0   318.3      0.      0.      0.0     0.0   950.4
 13      4.8    2408.7     0.0     0.0      0.      0.      0.0     0.0  1189.4
 14      5.0     898.0     0.0     0.0      0.      0.      0.0     0.0  1238.7
        Failure Surface Specified By 15 Coordinate Points
          Point      X-Surf      Y-Surf
           No.         (ft)        (ft)
            1        225.000     7513.897
```

2	234.952	7512.922
3	244.942	7512.467
4	254.942	7512.535
5	264.924	7513.124
6	274.863	7514.233
7	284.729	7515.860
8	294.498	7518.000
9	304.141	7520.646
10	313.634	7523.792
11	322.949	7527.430
12	332.061	7531.548
13	340.946	7536.136
14	349.580	7541.182
15	351.587	7542.500

Circle Center At X = 248.649 ; Y = 7703.969 ; and Radius = 191.537

Factor of Safety

*** 2.124 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	250.000	7514.375
2	259.694	7511.919
3	269.537	7510.159
4	279.482	7509.104
5	289.476	7508.760
6	299.469	7509.129
7	309.410	7510.208
8	319.250	7511.993
9	328.937	7514.474
10	338.423	7517.639
11	347.660	7521.471
12	356.600	7525.951
13	365.199	7531.056
14	373.412	7536.760
15	379.576	7541.727

Circle Center At X = 289.301 ; Y = 7649.096 ; and Radius = 140.336

Factor of Safety

*** 2.136 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	225.000	7513.897
2	234.085	7509.718
3	243.475	7506.279
4	253.110	7503.601
5	262.927	7501.701
6	272.866	7500.591
7	282.861	7500.279
8	292.849	7500.767
9	302.766	7502.051
10	312.549	7504.124
11	322.135	7506.971
12	331.463	7510.575
13	340.473	7514.913
14	349.108	7519.957
15	357.312	7525.674
16	365.034	7532.028
17	372.223	7538.979
18	375.324	7542.500

Circle Center At X = 281.724 ; Y = 7625.099 ; and Radius = 124.834

Factor of Safety

*** 2.147 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	225.000	7513.897
2	234.553	7510.939

3	244.279	7508.614
4	254.136	7506.930
5	264.082	7505.896
6	274.075	7505.514
7	284.071	7505.788
8	294.028	7506.716
9	303.903	7508.293
10	313.653	7510.514
11	323.237	7513.369
12	332.613	7516.844
13	341.742	7520.927
14	350.584	7525.598
15	359.101	7530.838
16	367.257	7536.625
17	374.484	7542.500

Circle Center At X = 274.896 ; Y = 7658.160 ; and Radius = 152.648

Factor of Safety

*** 2.178 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	250.000	7514.375
2	259.183	7510.416
3	268.738	7507.468
4	278.556	7505.565
5	288.521	7504.729
6	298.518	7504.971
7	308.431	7506.286
8	318.145	7508.661
9	327.547	7512.067
10	336.528	7516.465
11	344.983	7521.804
12	352.816	7528.021
13	359.933	7535.045
14	366.014	7542.500

Circle Center At X = 291.277 ; Y = 7597.451 ; and Radius = 92.765

Factor of Safety

*** 2.182 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	225.000	7513.897
2	234.331	7510.300
3	243.919	7507.461
4	253.704	7505.399
5	263.623	7504.127
6	273.612	7503.653
7	283.606	7503.980
8	293.543	7505.106
9	303.357	7507.023
10	312.987	7509.721
11	322.369	7513.180
12	331.445	7517.379
13	340.155	7522.292
14	348.445	7527.885
15	356.259	7534.125
16	363.550	7540.969
17	364.939	7542.500

Circle Center At X = 274.531 ; Y = 7628.479 ; and Radius = 124.829

Factor of Safety

*** 2.193 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	200.000	7513.418
2	209.831	7511.589
3	219.733	7510.191

4	229.687	7509.228
5	239.673	7508.700
6	249.672	7508.609
7	259.666	7508.955
8	269.636	7509.738
9	279.561	7510.956
10	289.424	7512.606
11	299.205	7514.686
12	308.887	7517.191
13	318.449	7520.117
14	327.874	7523.458
15	337.145	7527.207
16	346.242	7531.358
17	355.150	7535.903
18	363.850	7540.833
19	366.514	7542.500

Circle Center At X = 246.751 ; Y = 7737.354 ; and Radius = 228.764

Factor of Safety

*** 2.252 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	200.000	7513.418
2	209.789	7511.377
3	219.663	7509.792
4	229.600	7508.667
5	239.578	7508.005
6	249.576	7507.806
7	259.572	7508.071
8	269.546	7508.800
9	279.474	7509.991
10	289.337	7511.641
11	299.113	7513.747
12	308.781	7516.304
13	318.319	7519.307
14	327.708	7522.749
15	336.927	7526.624
16	345.956	7530.921
17	354.776	7535.634
18	363.368	7540.750
19	366.019	7542.500

Circle Center At X = 248.862 ; Y = 7723.270 ; and Radius = 215.465

Factor of Safety

*** 2.254 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	200.000	7513.418
2	209.530	7510.390
3	219.223	7507.929
4	229.043	7506.043
5	238.958	7504.740
6	248.932	7504.023
7	258.932	7503.896
8	268.921	7504.359
9	278.866	7505.411
10	288.731	7507.046
11	298.483	7509.261
12	308.087	7512.046
13	317.510	7515.394
14	326.719	7519.291
15	335.683	7523.724
16	344.370	7528.678
17	352.749	7534.135
18	360.792	7540.077
19	363.697	7542.500

Circle Center At X = 256.083 ; Y = 7673.395 ; and Radius = 169.522

```
 Factor of Safety
***     2.310    ***
    **** END OF GSTABL7 OUTPUT ****
```

PUMP STATION SPECIFICATIONS:
NAME: FLYING HORSE RANCH
STATION MODEL:
VTV-1-75x3/(75)/5ST-480-3-2250/(3000)-110

STATION TOTAL PERFORMANCE:
2250GPM @ 110PSI
3000GPM @ 110PSI (FUTURE)

PUMP HORSEPOWER:
SUSTAIN PUMP: 5HP
PUMP NO.1-3: 75HP
PUMP NO.4: 75HP (FUTURE PUMP/MOTOR)

CHECK VALVE SIZE
SUSTAIN: BUILT IN
PUMP NO.1-2: 6"

ISOLATION VALVE SIZES:
SUSTAIN PUMP: 2",
PUMP NO.1-2: 5" (EBV)

DISCHARGE ISOLATION VALVE: 10"
RELIEF VALVE SIZE: 6"

PUMP STATION DISCONNECT: 600 AMP
POWER REQUIREMENTS:
480V, 60 HZ, 3 PZ, 386 FLA
EXHAUST FAN REQ'D FOR BUILDING:
5400 CFM

WET WELL DIMS: ..... Ø96"

WET WELL DEPTH: ....25'-0"

MAIN LINE CONNECTION: .... *16" FLANGED*
NOMINAL PIPE SIZE: ..... *NA*

DROP PIPE COVER: ..... 48"
INTAKE FLUME PIPE SIZE: .....*30"*
INTAKE FLUME MATERIAL:.....SDR35 PVC
OD .....32"

PLEASE VERIFY ALL INFO WITH YOUR INITIALS AND DATE

PLEASE INDICATE POWER SUPPLY CONDITION BELOW FOR FCC COMPLIANCE. REFER TO WATERTRONICS DRAWING # FCC-1 FOR ADDITIONAL INFORMATION

- ☐ A: CONNECTED THROUGH A COMMERCIAL BUILDING
- ☐ B: CONNECTED THROUGH A DEDICATED TRANSFORMER
- ☐ C: CONNECTED THROUGH A PAD TRANSFORMER SHARED WITH OTHER NON-RESIDENTIAL EQUIPMENT.
- ☐ D: CONNECTED TO A POLE TRANSFORMER ON A RESIDENTIAL POWER GRID.
- ☐ E: CONNECTED TO A PAD TRANSFORMER SHARED WITH RESIDENTIAL DWELLINGS.

PLEASE USE THE SPACE BELOW FOR ANY ADDITIONAL COMMENTS:
1. *MIN. WATER LEVEL IN THE WET WELL 56" FROM THE BOTTOM*
2. *NORMAL WATER LEVEL AT THE WET WELL ??*
3. *MAX/HIGH WATER LEVEL IN THE WET WELL ??*
4. *TO DRAIN THE BOND COMPLETELY THE BOTTOM OF THE BOND NEED TO BE LOWER THAN THE BOTTOM OF WET WELL !*

- ☐ APPROVED AS SUBMITTED
- ☐ APPROVED AS NOTED
- ☐ REVISE AND RESUBMIT

REVIEWED BY: _____

NAME: _____

DATE: _____

DIMENSIONS AND SIZES OF EXISTING STRUCTURES, AND/OR COMPONENTS MUST BE VERIFIED TO WATERTRONICS BEFORE STATION CONSTRUCTION BEGINS.

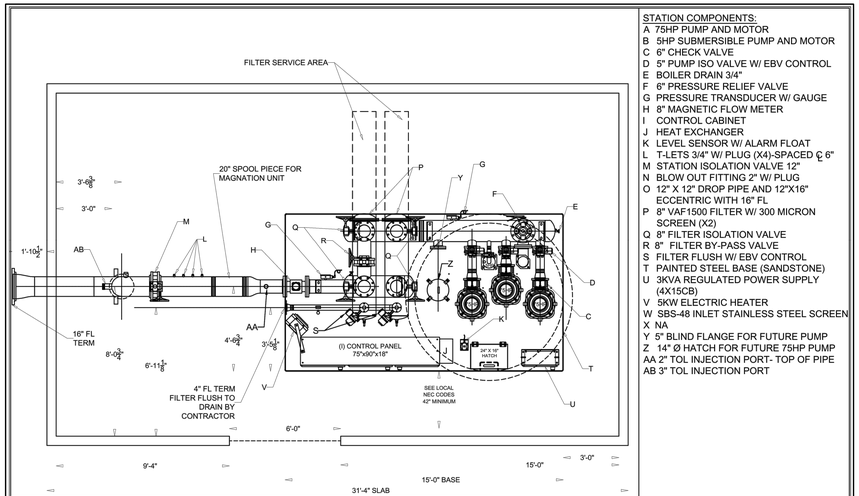
UNLESS SPECIFIED BY THE CUSTOMER, PUMP HOUSE/CONCRETE SLAB DIMENSIONS ARE RECOMMENDED MINIMUMS FOR NEC AND SERVICE CLEARANCE, AND ARE FOR ILLUSTRATION PURPOSES ONLY. PROJECT MANAGER SHALL BE CONSULTED ON FINAL DESIGN.

THE PUMP STATION PROPOSED HEREIN IS DESIGNED TO BE PLACED IN A PUMP HOUSE FOR PROTECTION FROM THE ENVIRONMENT. IF A PUMP HOUSE IS NOT USED, WATERTRONICS MUST BE NOTIFIED AT TIME OF QUOTATION SO SPECIAL PROVISIONS CAN BE MADE.

WATERTRONICS
A LINDSAY COMPANY
PHONE: 1-262-367-5000
FAX: 1-262-367-5551

SHEET 1 OF 4 SHEETS

DRAWING NO. PRVT12023 09/15/2016



PLAN VIEW

STATION COMPONENTS:
A 75HP PUMP AND MOTOR
B 5HP SUBMERSIBLE PUMP AND MOTOR
C 6" CHECK VALVE
D 5" PUMP ISO VALVE W/ EBV CONTROL
E BOILER DRAIN 3/4"
F 6" PRESSURE RELIEF VALVE
G PRESSURE TRANSDUCER W/ GAUGE
H 8" MAGNETIC FLOW METER
I CONTROL CABINET
J HEAT EXCHANGER
K LEVEL SENSOR W/ ALARM FLOAT
L T-LETS 3/4" W/ PLUG (X4)-SPACED ℄ 6"
M STATION ISOLATION VALVE 12"
N BLOW OUT FITTING 2" W/ PLUG
O 12" X 12" DROP PIPE AND 12"X16" ECCENTRIC WITH 16" FL
P 8" VAF-1500 FILTER W/ 300 MICRON SCREEN (X2)
Q 8" FILTER ISOLATION VALVE
R 8" FILTER BY-PASS VALVE
S FILTER FLUSH W/ EBV CONTROL
T PAINTED STEEL BASE (SANDSTONE)
U 3KVA REGULATED POWER SUPPLY (4X15CB)
V 5KW ELECTRIC HEATER
W SBS-48 INLET STAINLESS STEEL SCREEN
X NA
Y 5" BLIND FLANGE FOR FUTURE PUMP
Z 14" Ø HATCH FOR FUTURE 75HP PUMP
AA 2" TOL INJECTION PORT- TOP OF PIPE
AB 3" TOL INJECTION PORT

NO.	DATE	BY	DESCRIPTION
12	11/13/2017	MJH	REVISED ELEVATION
11	10/24/2017	MJH	REVISED SIZE OF THE MAGNATION UNIT PIPE SPOOL FROM 10" TO 12"
10	10/18/2017	MJH	REVISED LOCATION OF AB AND AA FITTING INJECTION PORTS WILL SHULL 10/18/2017
9	10/17/2017	MJH	REVISED LOCATION OF MAGNATION SPOOL PIPE, ISO VALVE, DISCHARGE ELBOW, BLDG. DIM.
8	08/07/2017	MJH	REVISED WET WELL DEPTH FROM 19'-0" TO 25'-0"
7	07/14/2017	MJH	REVISED WET WELL DEPTH FROM 12'-0" TO 19'-0"
6	03/29/2017	MJH	ADDED 20" SPOOL PIECE FOR MAGNATION UNIT
5	03/24/2017	MJH	REVISED DROP PIPE TERMINATION TO 16" FL
4	03/23/2017	MJH	ADD 3KVA REGULATED POWER SUPPLY
3	03/02/2017	MJH	DELETED FERTIGATION, 5KVA REGULATED AND RELOCATED 2" O LET TO TOP
2	02/08/2017	MJH	LOCATED 3/4" TOL, ADDING 2" & 3" TOL TO OTHER SIDE OF THE PIPE
1	10/10/2016	MJH	REVISED WET WELL DEPTH TO 12'-0" & ADDING 2" TOL

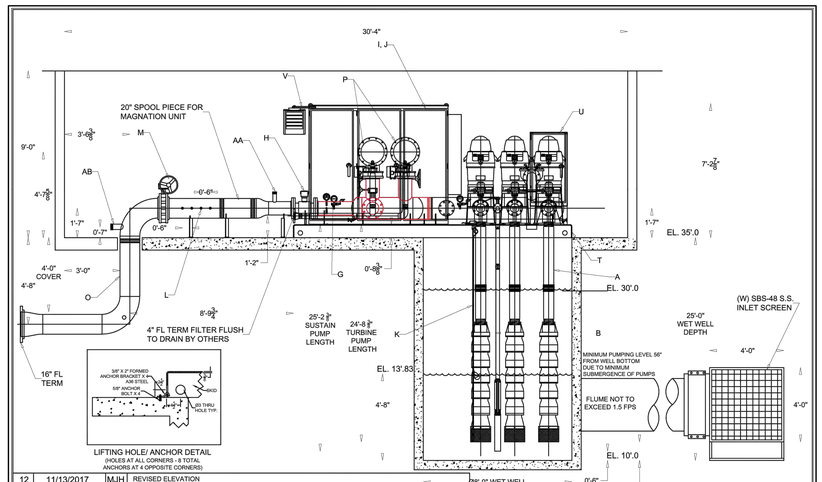
DRAWN BY: MJH DATE: 09/15/2016
CHECKED BY: RJS DATE: 08/07/17

THIS DRAWING AND DESIGN, IS THE PROPERTY OF WATERTRONICS AND IS NOT TO BE REPRODUCED IN WHOLE OR PART, NOR EMPLOYED FOR ANY PURPOSE OTHER THAN SPECIFICALLY PERMITTED IN WRITING BY WATERTRONICS. THIS DRAWING LOANED AND SUBJECT TO RETURN ON DEMAND

TITLE: FLYING HORSE RANCH
VTV-1-75x3/(75)/5ST-480-3-2250/(3000)-110

WATERTRONICS A LINDSAY COMPANY

SCALE: NTS | SHEET 2 OF 4 SHEETS
JOB NO.: --- | DRAWING NO. PRVT12023



ELEVATION VIEW

NO.	DATE	BY	DESCRIPTION
12	11/13/2017	MJH	REVISED ELEVATION
11	10/24/2017	MJH	REVISED SIZE OF THE MAGNATION UNIT PIPE SPOOL FROM 10" TO 12"
10	10/18/2017	MJH	REVISED LOCATION OF AA AND AB FITTINGS INJECTION PORTS WILL SHULL 10/18/2017
9	10/17/2017	MJH	REVISED LOCATION OF MAGNATION SPOOL PIPE, ISO VALVE, DISCHARGE ELBOW, BLDG. DIM.
8	08/07/2017	MJH	REVISED WET WELL DEPTH FROM 19'-0" TO 25'-0"
7	07/14/2017	MJH	REVISED WET WELL DEPTH FROM 12'-0" TO 19'-0"
6	03/29/2017	MJH	ADDED 20" SPOOL PIECE FOR MAGNATION UNIT
5	03/24/2017	MJH	REVISED DROP PIPE TERMINATION TO 16" FL
4	03/23/2017	MJH	ADD 3KVA REGULATED POWER SUPPLY
3	03/02/2017	MJH	DELETED FERTIGATION, 5KVA REGULATED AND RELOCATED 2" O LET TO TOP
2	02/08/2017	MJH	LOCATED 3/4" TOL, ADDING 2" & 3" TOL TO OTHER SIDE OF THE PIPE
1	10/10/2016	MJH	REVISED WET WELL DEPTH TO 12'-0" & ADDING 2" TOL

DRAWN BY: MJH DATE: 09/15/2016
CHECKED BY: RJS DATE: 08/07/17

THIS DRAWING AND DESIGN, IS THE PROPERTY OF WATERTRONICS AND IS NOT TO BE REPRODUCED IN WHOLE OR PART, NOR EMPLOYED FOR ANY PURPOSE OTHER THAN SPECIFICALLY PERMITTED IN WRITING BY WATERTRONICS. THIS DRAWING LOANED AND SUBJECT TO RETURN ON DEMAND

TITLE: FLYING HORSE RANCH
VTV-1-75x3/(75)/5ST-480-3-2250/(3000)-110

WATERTRONICS A LINDSAY COMPANY

SCALE: NTS | SHEET 3 OF 4 SHEETS
JOB NO.: --- | DRAWING NO. PRVT12023

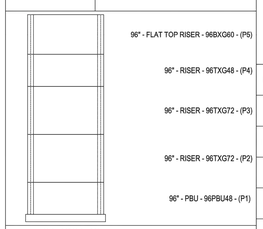
Job Name: Flying Horse Ranch Wet Well
Frontier Environmental

Oldcastle Precast

1) 96" - FLAT TOP RISER - 96BXG60
1) 96" - RISER - 96TXG48
2) 96" - RISER - 96TXG72
1) 96" - PBU - 96PBU48
2) KOR-N-SEAL - BOOT36

Structure ID: **Wet Well**
Size: 96"
Rim to Invert: 24'
Precast Height: 25'
Step Position:

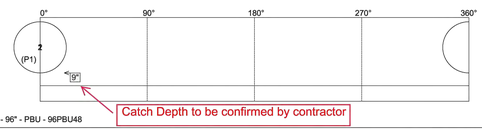
*NOTE: The invert elevation of the 30" PVC is not indicated on the detail drawing. To be confirmed by contractor.



Position	Elev	Angle	Pipe	UP (_)	Hole	Connector
Rim	25'					
Reducer						
Invert 1	1'	0"	30" PVC	9"	36"	KOR-N-SEAL BOOT36
Invert 2	1'	0"	30" PVC	9"	36"	KOR-N-SEAL BOOT36
Invert 3						
Invert 4						
Invert 5						
Invert 6						
Invert 7						
Invert 8						

Hole: 36" Hole: 36"
Flow Direction: OUT
Degree: 0Degree: 0"

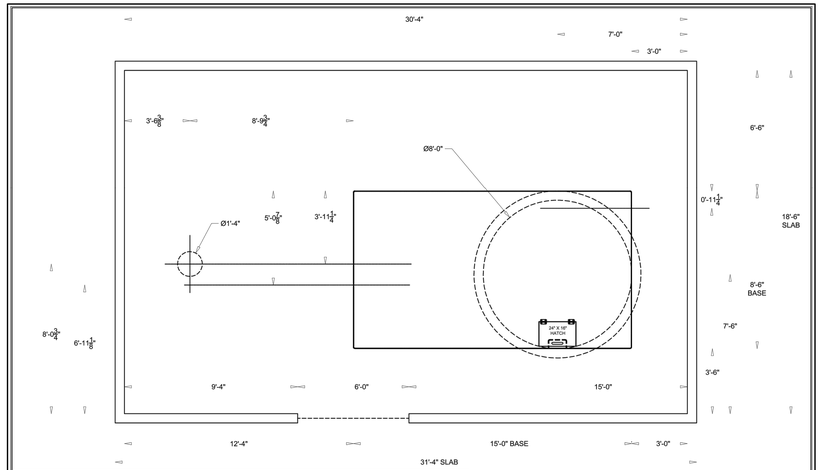
Bottom of Hole - Left - Top of Floor



Catch Depth to be confirmed by contractor

(P1) - 96" - PBU - 96PBU48

Oldcastle Precast / Mark H. 9/22/2017
Approved for production _____
Quote ID: 2017090089
Page: 1 of 1



SLAB VIEW

NO.	DATE	BY	DESCRIPTION
12	11/13/2017	MJH	REVISED ELEVATION
11	10/24/2017	MJH	REVISED SIZE OF THE MAGNATION UNIT PIPE SPOOL FROM 10" TO 12"
10	10/17/2017	MJH	REVISED LOCATION OF AA AND AB FITTINGS INJECTION PORTS WILL SHULL 10/18/2017
9	10/17/2017	MJH	REVISED LOCATION OF MAGNATION SPOOL PIPE, ISO VALVE, DISCHARGE ELBOW, BLDG. DIM.
8	08/07/2017	MJH	REVISED WET WELL DEPTH FROM 19'-0" TO 25'-0"
7	07/14/2017	MJH	REVISED WET WELL DEPTH FROM 12'-0" TO 19'-0"
6	03/29/2017	MJH	ADDED 20" SPOOL PIECE FOR MAGNATION UNIT
5	03/24/2017	MJH	REVISED DROP PIPE TERMINATION TO 16" FL
4	03/23/2017	MJH	ADD 3KVA REGULATED POWER SUPPLY
3	03/02/2017	MJH	DELETED FERTIGATION, 5KVA REGULATED AND RELOCATED 2" O LET TO TOP
2	02/08/2017	MJH	LOCATED 3/4" TOL, ADDING 2" & 3" TOL TO OTHER SIDE OF THE PIPE
1	10/10/2016	MJH	REVISED WET WELL DEPTH TO 12'-0" & ADDING 2" TOL

DRAWN BY: MJH DATE: 09/15/2016
CHECKED BY: RJS DATE: 08/07/17

THIS DRAWING AND DESIGN, IS THE PROPERTY OF WATERTRONICS AND IS NOT TO BE REPRODUCED IN WHOLE OR PART, NOR EMPLOYED FOR ANY PURPOSE OTHER THAN SPECIFICALLY PERMITTED IN WRITING BY WATERTRONICS. THIS DRAWING LOANED AND SUBJECT TO RETURN ON DEMAND

TITLE: FLYING HORSE RANCH
VTV-1-75x3/(75)/5ST-480-3-2250/(3000)-110

WATERTRONICS A LINDSAY COMPANY

SCALE: NTS | SHEET 4 OF 4 SHEETS
JOB NO.: --- | DRAWING NO. PRVT12023

Pump Data Sheet - Hydroflo Pumps USA, Inc.

Company:
Name:
Date: 9/15/2016

Hydroflo Pumps Fluid Solutions

Pump:
Size: 11MH (5 stage)
Type: Vertical
Synch speed: 1800 rpm
Curve: 11MH
Specific Speeds:
Dimensions:
Vertical Turbine:
Speed: 1770 rpm
Dia: 7.445 in
Impeller: 11MH SS ENCL
Ns: 2130
Nss: ---
Suction: 8 in
Discharge: 8 in
Bowl size: 11 in
Max lateral: 0.75 in
Thrust K factor: 7.8 lb/ft

Pump Limits:
Temperature: 120 °F
Pressure: 400 psi g
Sphere size: 0.68 in
Power: ---
Eye area: ---

Search Criteria:
Flow: 750 US gpm
Head: 291 ft

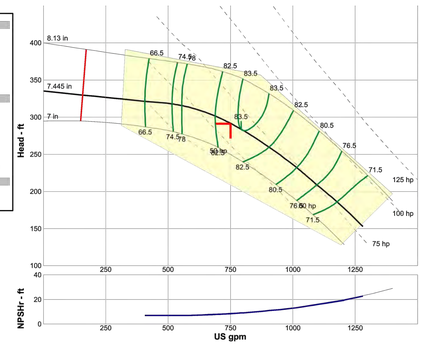
Fluid:
Water
SG: 1
Viscosity: 1.105 cP
NPSHa: ---
Temperature: 60 °F
Vapor pressure: 0.2563 psi a
Atm pressure: 14.7 psi a

Motor:
Standard: NEMA
Enclosure: WP1
Size: 100 hp
Speed: 1800
Frame: 404T
Sizing criteria: Max Power on Design Curve

---- Data Point ----
Flow: 750 US gpm
Head: 291 ft
Eff: 83.1%
Power: 66.2 hp
NPSHr: 8.63 ft

---- Design Curve ----
Shutoff head: 335 ft
Shutoff dP: 145 psi
Min flow: 158 US gpm
BEP: 83.5% @ 792 US gpm
NOL power: 79.7 hp @ 1280 US gpm

--- Max Curve ---
Max power: 102 hp @ 1300 US gpm



Performance Evaluation:

Flow US gpm	Speed rpm	Head ft	Efficiency %	Power hp	NPSHr ft
900	1770	261	82.5	71.7	10.9
750	1770	291	83.1	66.2	8.63
600	1770	311	79.5	59	7.33
450	1770	320	69.7	52	7
300	1770	325	58.7	43.8	7

Selected from catalog: hydroflo vs pumps.60 Vers: 18.3

48 HOURS BEFORE YOU DIG,
CALL UTILITY LOCATORS
811
UTILITY NOTIFICATION CENTER OF COLORADO
IT'S THE LAW

THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE CAUSED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

NO.	REVISION	DATE

REVIEW:

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF CLASSIC CONSULTING ENGINEERS AND SURVEYORS, LLC

30% SUBMITTAL

MARC A. WHORTON, P.E. #37155 DATE

CLASSIC CONSULTING ENGINEERS & SURVEYORS SM
619 N. Cascade Avenue, Suite 200 (719)785-0790
Colorado Springs, Colorado 80903 (719)785-0799(Fax)

FLYING HORSE NORTH
IRRIGATION RESERVOIR EMBANKMENT

PUMP STATION PLAN / DETAILS

CLASSIC CONSULTING ENGINEERS & SURVEYORS

DESIGNED BY	MAW	SCALE		DATE	10-18-17
DRAWN BY	MAW	(H) 1"= N/A		SHEET	3 OF 12
CHECKED BY		(V) 1"= N/A		JOB NO.	1096.11

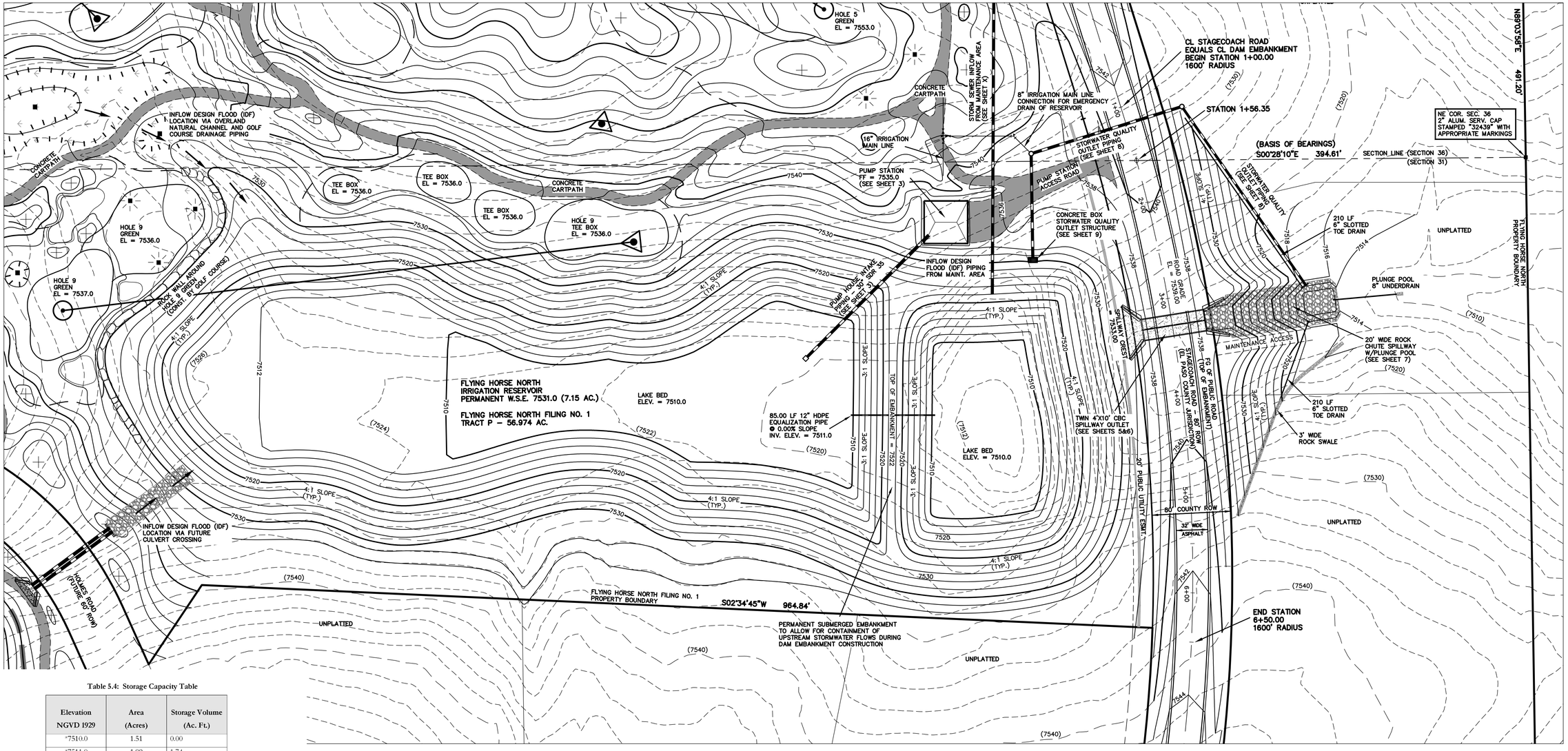


Table 5.4: Storage Capacity Table

Elevation NGVD 1929	Area (Acres)	Storage Volume (Ac. Ft.)
*7510.0	1.51	0.00
*7511.0	1.99	1.74
*7512.0	2.52	3.99
*7513.0	2.85	6.68
*7514.0	3.05	9.63
*7515.0	3.26	12.78
7516.0	3.48	16.15
7517.0	3.70	19.74
7518.0	3.93	23.56
7519.0	4.16	27.60
7520.0	4.40	31.88
7521.0	4.64	36.40
7522.0	4.88	41.16
7523.0	5.14	46.17
7524.0	5.36	51.42
7525.0	5.59	56.89
7526.0	5.84	62.61
7527.0	6.08	68.57
7528.0	6.33	74.77
7529.0	6.57	81.22
7530.0	6.81	87.91
7531.0	7.15	94.89
7532.0	7.52	102.22
7533.0	7.83	109.90
7534.0	8.37	118.00
7535.0	8.77	126.57
7536.0	9.17	135.53

*Indicates dead storage below pumping ability

Table 5.5: Reservoir Discharge Table

Elevation	Discharge (cfs) (SWQ Outlet Box)	Discharge (cfs) (Twin CBC Spillway)	Discharge (cfs) (Total)
7531.0	0.0	0.0	0.0
7532.0	13.89	0.0	13.89
7533.0	27.77	0.0	27.77
7534.0	51.31	49.05	100.36
7535.0	69.52	138.56	208.08
7536.0	74.61	254.72	329.33

Permanent WSE = 7531.0

Top of SWQ Outlet box = 7533.0

Spillway elevation = 7533.0

NOTES:

1. TOPOGRAPHIC BASE MAPPING PRODUCED FROM AERIAL PHOTOGRAPHY PROVIDED BY NORTH AMERICAN MAPPING IN 2009. HORIZONTAL CONTROL IS BASED ON LOCAL CALIBRATION TIED TO SECTION CORNER AND VERTICAL CONTROL IS BASED ON NGVD 1929 DATUM.
2. PERMANENT WSE = 7531.0
3. RESERVOIR LINER INSTALLED UP TO ELEVATION 7534.0

50 25 0 50 100

SCALE: 1" = 50'

48 HOURS BEFORE YOU DIG,
CALL UTILITY LOCATORS
811
UTILITY NOTIFICATION CENTER OF COLORADO
IT'S THE LAW

THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE CAUSED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

NO.	REVISION	DATE

REVIEW:

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF CLASSIC CONSULTING ENGINEERS AND SURVEYORS, LLC

30% SUBMITTAL

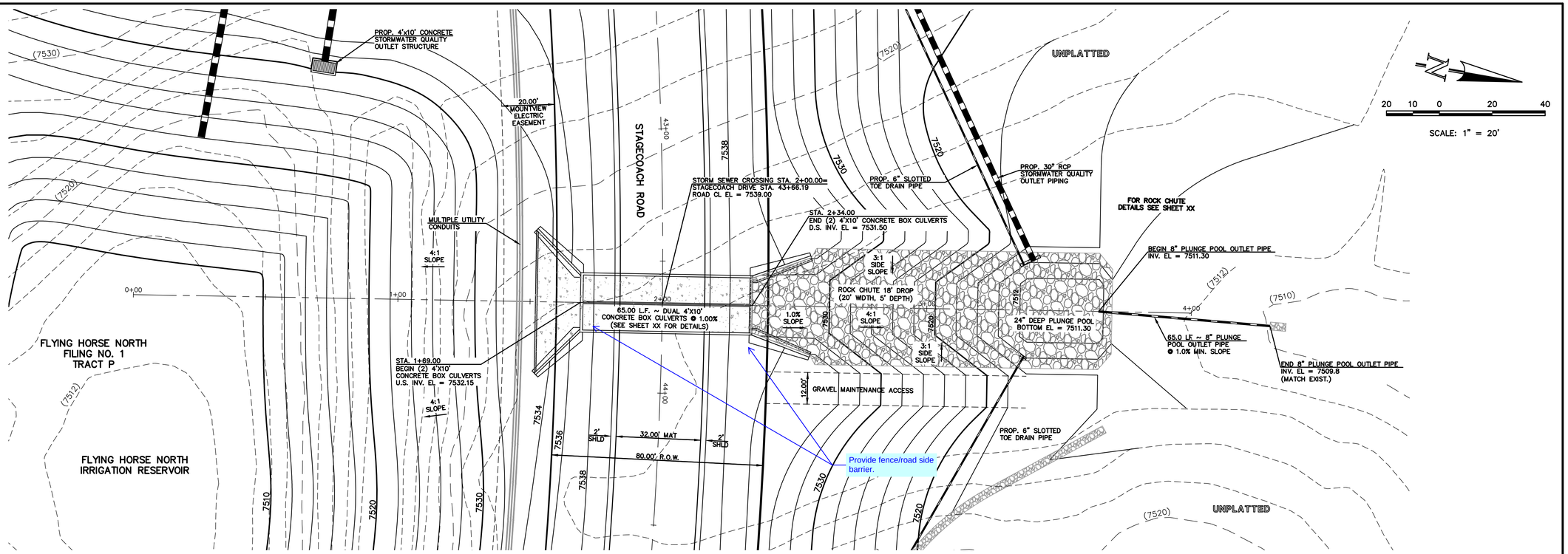
MARC A. WHORTON, COLORADO P.E. #37155 DATE

CLASSIC SM
CONSULTING
ENGINEERS & SURVEYORS
619 N. Cascade Avenue, Suite 200 (719)785-0790
Colorado Springs, Colorado 80903 (719)785-0799(Fax)

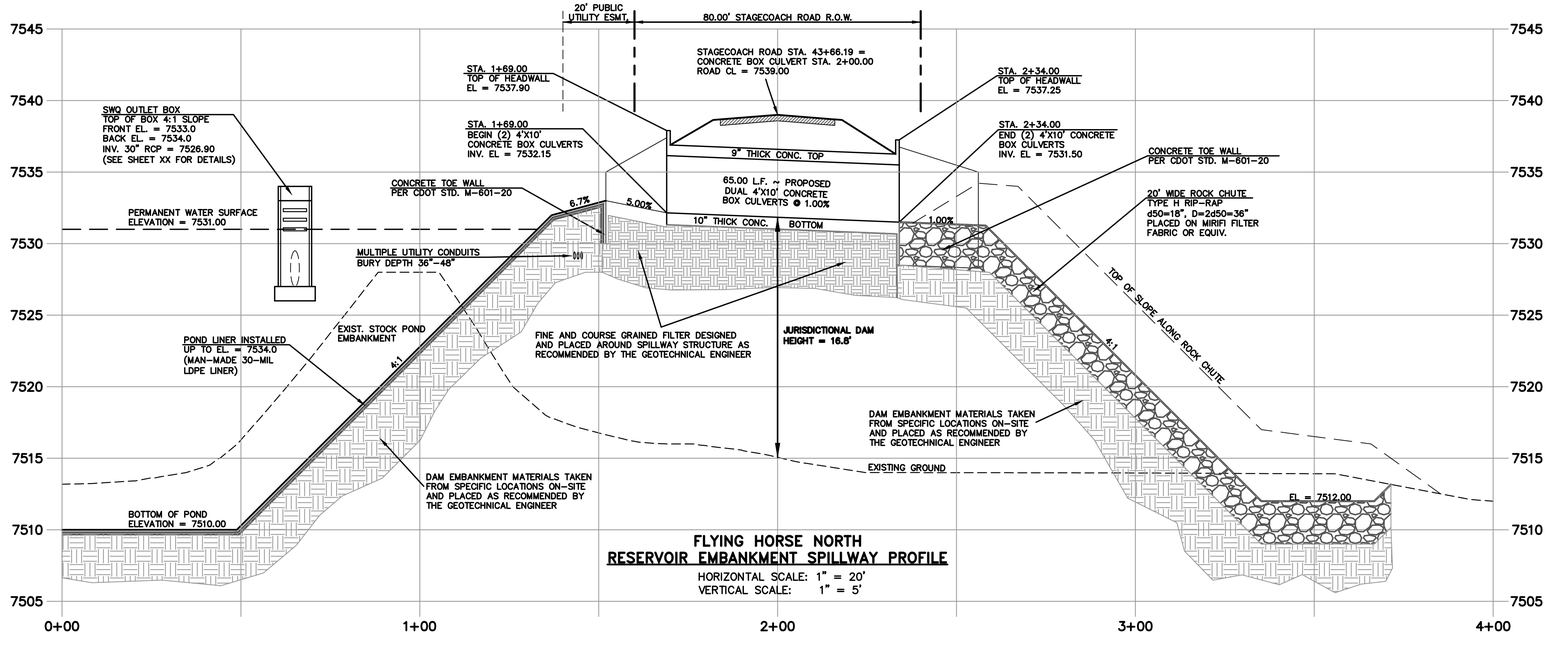
FLYING HORSE NORTH
IRRIGATION RESERVOIR EMBANKMENT
SITE LAYOUT WITH GRADING

CLASSIC CONSULTING ENGINEERS & SURVEYORS

DESIGNED BY	MAW	SCALE		DATE	10-18-17
DRAWN BY	MAW	(H) 1"= 50'		SHEET	4 OF 12
CHECKED BY		(V) 1"= N/A		JOB NO.	1096.11



FLYING HORSE NORTH
RESERVOIR EMBANKMENT SPILLWAY PLAN



FLYING HORSE NORTH
RESERVOIR EMBANKMENT SPILLWAY PROFILE

HORIZONTAL SCALE: 1" = 20'
VERTICAL SCALE: 1" = 5'

48 HOURS BEFORE YOU DIG, CALL UTILITY LOCATORS
811
UTILITY NOTIFICATION CENTER OF COLORADO
IT'S THE LAW

THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE CAUSED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

NO.	REVISION	DATE

REVIEW:

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF CLASSIC CONSULTING ENGINEERS AND SURVEYORS, LLC

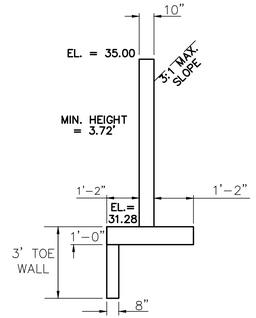
30% SUBMITTAL

MARC A. WHORTON, COLORADO P.E. #37155 DATE

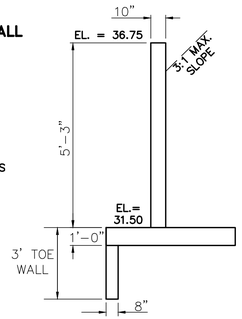
CLASSIC CONSULTING ENGINEERS & SURVEYORS SM
619 N. Cascade Avenue, Suite 200 (719)785-0790
Colorado Springs, Colorado 80903 (719)785-0799(Fax)

FLYING HORSE NORTH
IRRIGATION RESERVOIR EMBANKMENT
RESERVOIR EMBANKMENT SPILLWAY PLAN

DESIGNED BY	MAW	SCALE		DATE	07-18-17
DRAWN BY	MAW	(H) 1"=	20'	SHEET	5 OF 12
CHECKED BY		(V) 1"=	5'	JOB NO.	1096.11

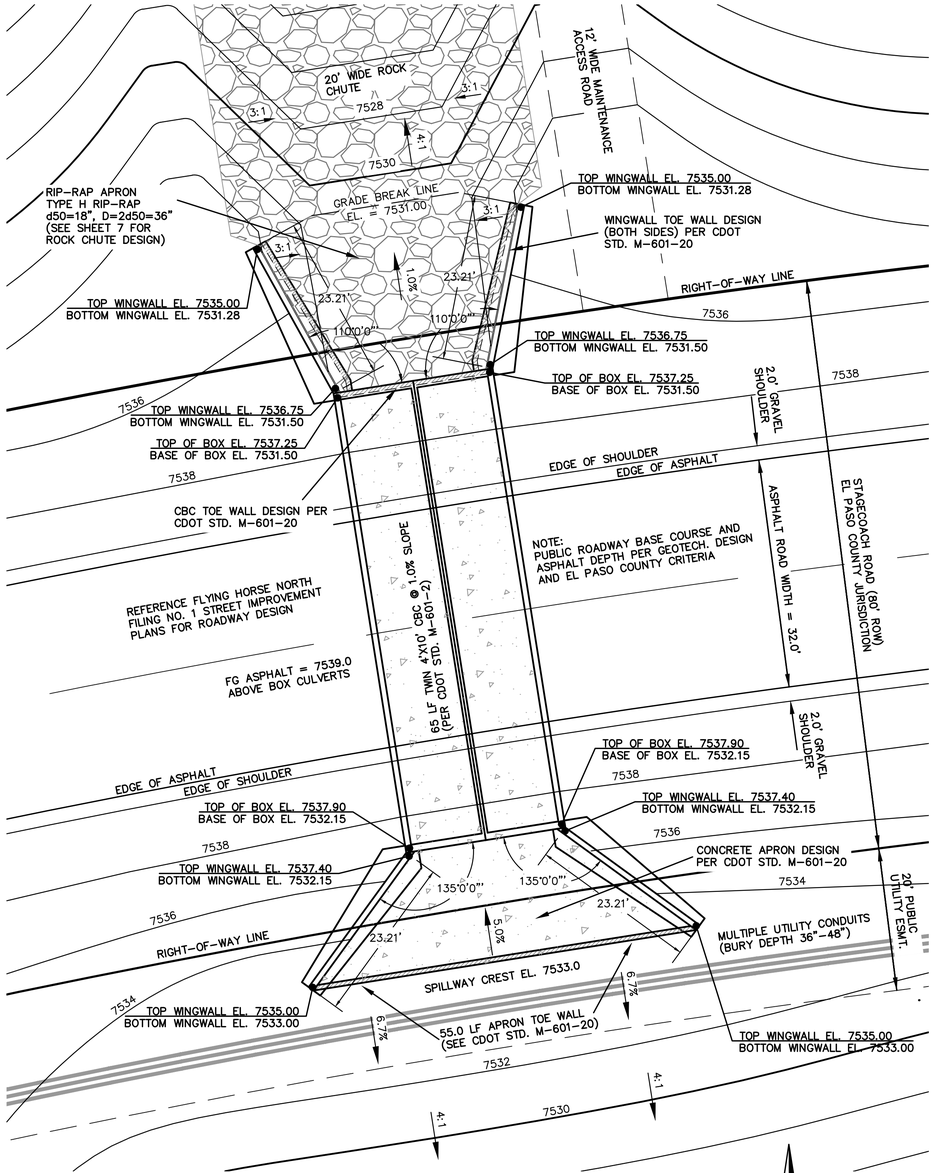


NORTHWEST WINGWALL BOTTOM
N.T.S.
(WALL NW2)

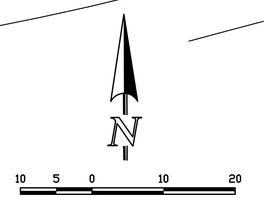


NORTHWEST WINGWALL TOP
N.T.S.
(WALL NW1)

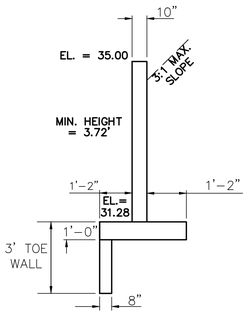
NORTHWEST WINGWALLS
SEE CDOT M-601-20 FOR DESIGN REQUIREMENTS
CBC INV. EL = 7531.50
EL AT TOP OF CBC = 7537.25
EL AT TOP OF WINGWALL NW1 = 7536.75
EL AT TOP OF WINGWALL NW2 = 7535.00



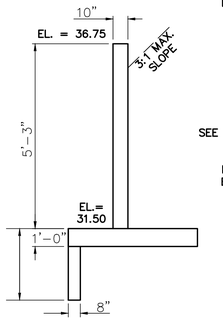
EMBANKMENT SPILLWAY DESIGN



SCALE: 1" = 10'

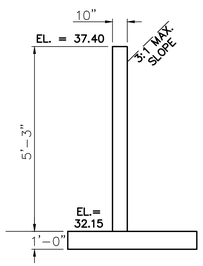


NORTHEAST WINGWALL BOTTOM
N.T.S.
(WALL NE2)



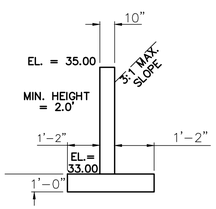
NORTHEAST WINGWALL TOP
N.T.S.
(WALL NE1)

NORTHEAST WINGWALLS
SEE CDOT M-601-20 FOR DESIGN REQUIREMENTS
CBC INV. IN EL = 7531.50
EL AT TOP OF CBC = 7537.25
EL AT TOP OF WINGWALL NE1 = 7536.75
EL AT TOP OF WINGWALL NE2 = 7535.00

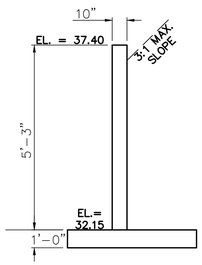


SOUTHWEST WINGWALL TOP
N.T.S.
(WALL SW1)

SOUTHWEST WINGWALLS
SEE CDOT M-601-20 FOR DESIGN REQUIREMENTS
CBC INV. EL = 7532.15
EL AT TOP OF CBC = 7537.90
EL AT TOP OF WINGWALL SW1 = 7537.40
EL AT TOP OF WINGWALL SW2 = 7535.00

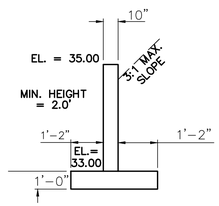


SOUTHWEST WINGWALL BOTTOM
N.T.S.
(WALL SW2)



SOUTHEAST WINGWALL TOP
N.T.S.
(WALL SE1)

SOUTHEAST WINGWALLS
SEE CDOT M-601-20 FOR DESIGN REQUIREMENTS
CBC INV. IN EL = 7532.15
EL AT TOP OF CBC = 7537.90
EL AT TOP OF WINGWALL SE1 = 7537.40
EL AT TOP OF WINGWALL SE2 = 7535.00



SOUTHEAST WINGWALL BOTTOM
N.T.S.
(WALL SE2)

48 HOURS BEFORE YOU DIG,
CALL UTILITY LOCATORS
811
UTILITY NOTIFICATION OF COLORADO
IT'S THE LAW

THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE CAUSED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

NO.	REVISION	DATE

REVIEW:

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF CLASSIC CONSULTING ENGINEERS AND SURVEYORS, LLC

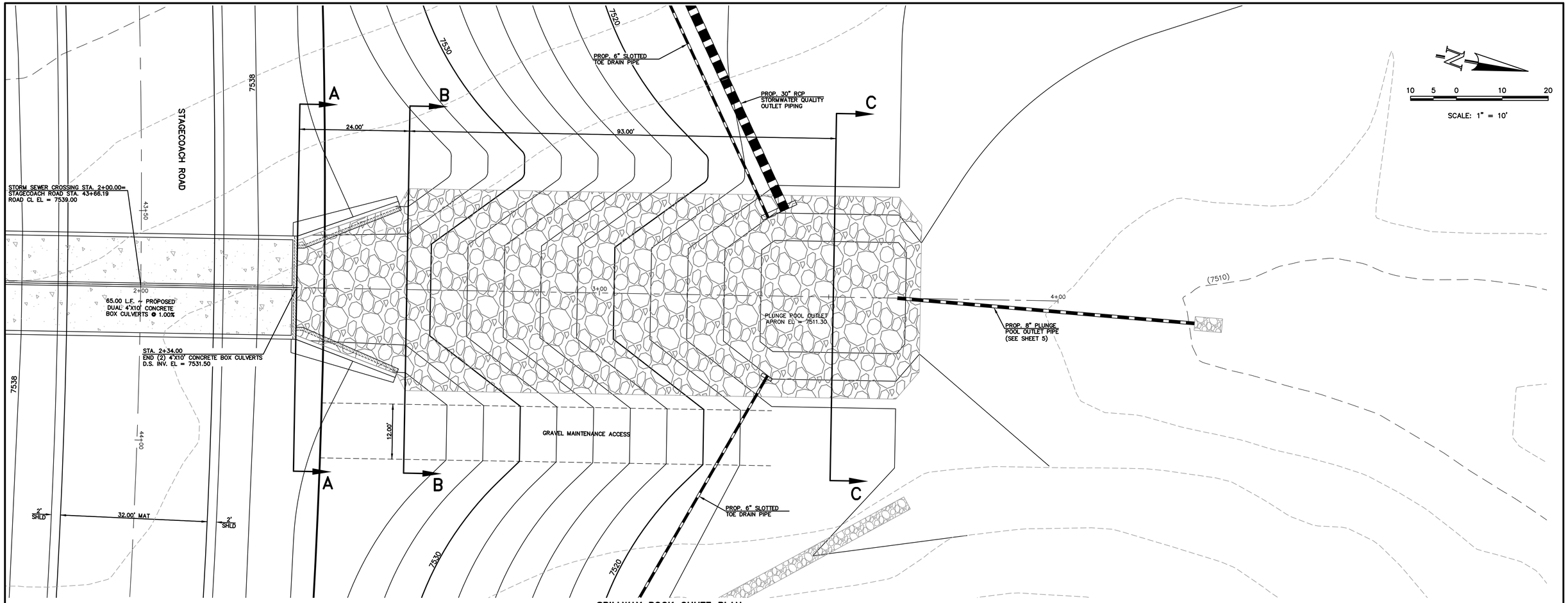
30% SUBMITTAL

MARC A. WHORTON, COLORADO P.E. #37155 DATE

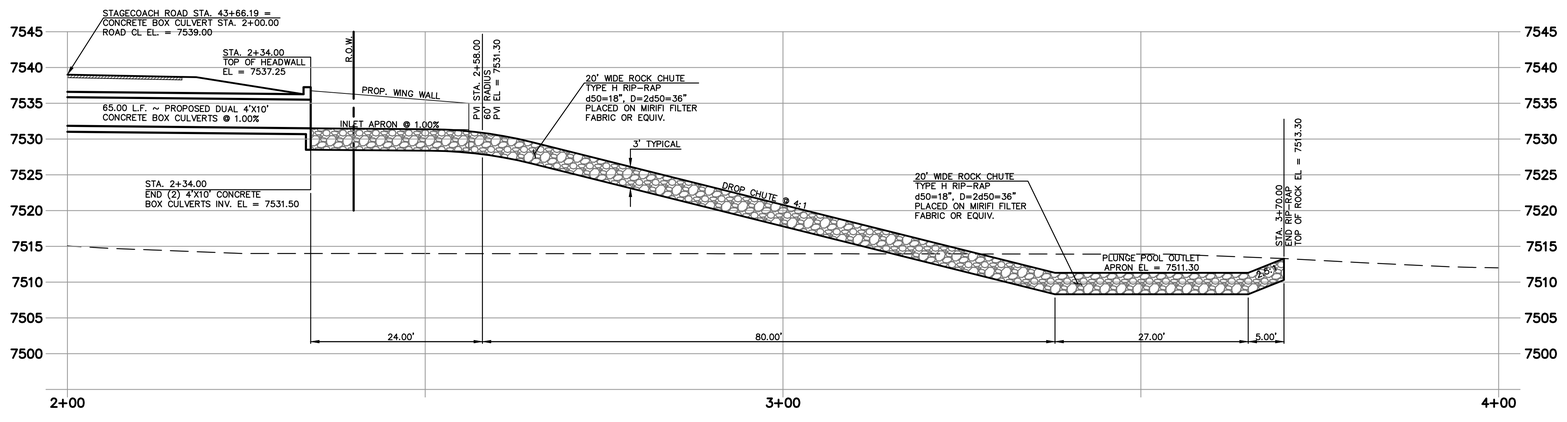
CLASSIC CONSULTING ENGINEERS & SURVEYORS SM
619 N. Cascade Avenue, Suite 200 (719)785-0790
Colorado Springs, Colorado 80903 (719)785-0799(Fax)

FLYING HORSE NORTH
IRRIGATION RESERVOIR EMBANKMENT
EMBANKMENT SPILLWAY DESIGN

DESIGNED BY	MAW	SCALE		DATE	10-18-17
DRAWN BY	MAW	(H) 1"= 20'		SHEET	6 OF 12
CHECKED BY		(V) 1"= N/A		JOB NO.	1096.11

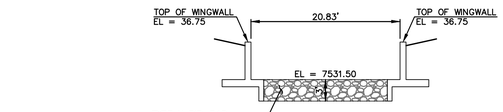


SPILLWAY ROCK CHUTE PLAN

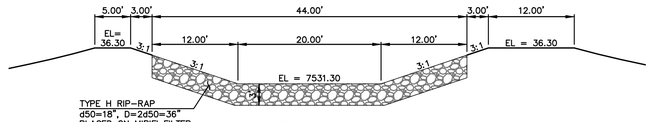


SPILLWAY ROCK CHUTE PROFILE

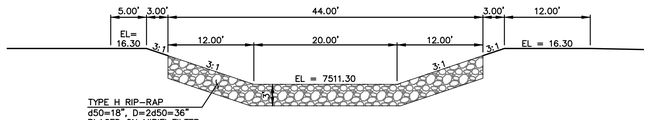
HORIZONTAL SCALE: 1" = 10'
VERTICAL SCALE: 1" = 1'



SECTION A–A



SECTION B–B



SECTION C–C

48 HOURS BEFORE YOU DIG,
CALL UTILITY LOCATORS
811
UTILITY NOTIFICATION CENTER OF COLORADO
IT'S THE LAW

THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE CAUSED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

NO.	REVISION	DATE

REVIEW:

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF CLASSIC CONSULTING ENGINEERS AND SURVEYORS, LLC

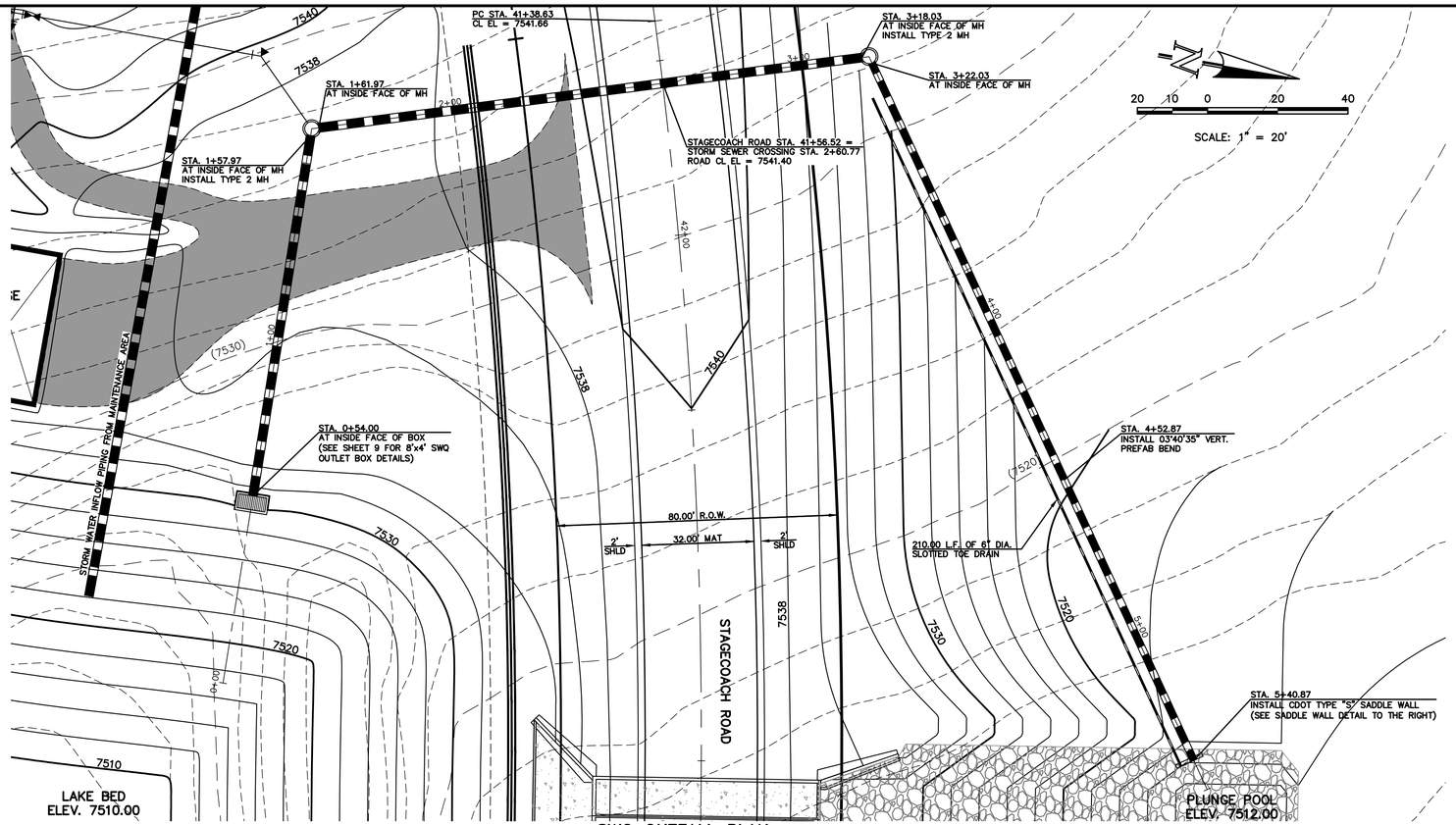
30% SUBMITTAL

MARC A. WHORTON, COLORADO P.E. #37155 DATE

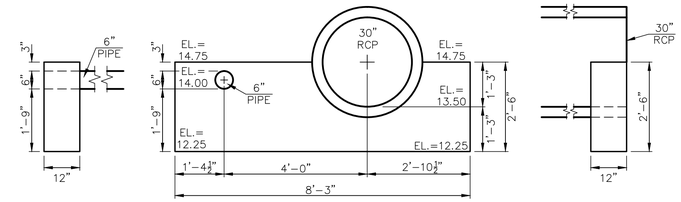
CLASSIC SM
CONSULTING
ENGINEERS & SURVEYORS
619 N. Cascade Avenue, Suite 200 (719)785-0790
Colorado Springs, Colorado 80903 (719)785-0799(Fax)

FLYING HORSE NORTH
IRRIGATION RESERVOIR EMBANKMENT
SPILLWAY ROCK CHUTE DESIGN

DESIGNED BY	MAW	SCALE		DATE	10–18–17
DRAWN BY	MAW	(H) 1"=	10'	SHEET	7 OF 12
CHECKED BY		(V) 1"=	1'	JOB NO.	1096.11

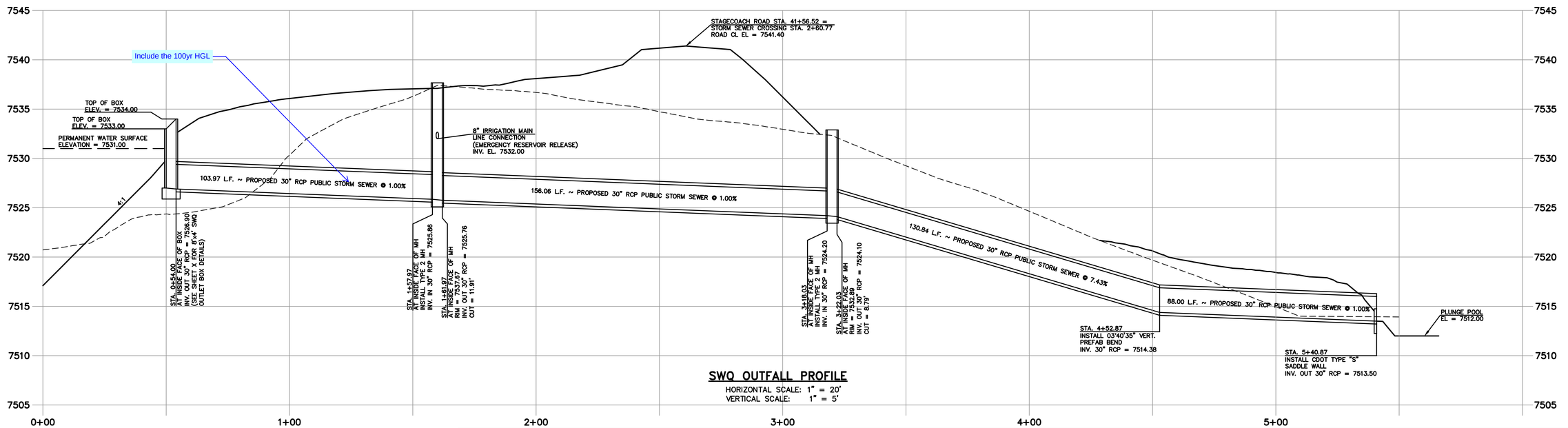


SWQ OUTFALL PLAN



OUTLET SADDLEWALL

PER CDOT M-601-11
SEE CDOT M-601-11 FOR DESIGN REQUIREMENTS
6" PIPE INV. OUT EL = 7514.00
30" RCP INV. OUT EL = 7513.50
EL AT TOP OF SADDLEWALL = 7514.75
FINISHED GRADE EL AT TOP OF SADDLEWALL = 7514.25
EL AT BOTTOM SADDLEWALL = 7512.25



SWQ OUTFALL PROFILE

HORIZONTAL SCALE: 1" = 20'
VERTICAL SCALE: 1" = 5'

48 HOURS BEFORE YOU DIG,
CALL UTILITY LOCATORS
811
UTILITY NOTIFICATION CENTER OF COLORADO
IT'S THE LAW

THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE CAUSED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

NO.	REVISION	DATE

REVIEW:

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF CLASSIC CONSULTING ENGINEERS AND SURVEYORS, LLC

30% SUBMITTAL

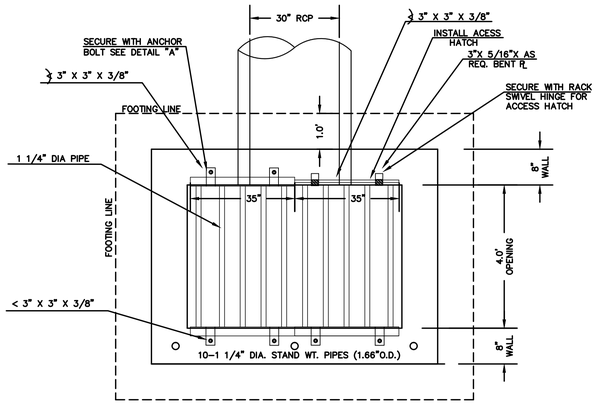
MARC A. WHORTON, COLORADO P.E. #37155 DATE

CLASSIC SM
CONSULTING
ENGINEERS & SURVEYORS
619 N. Cascade Avenue, Suite 200 (719)785-0790
Colorado Springs, Colorado 80903 (719)785-0799(Fax)

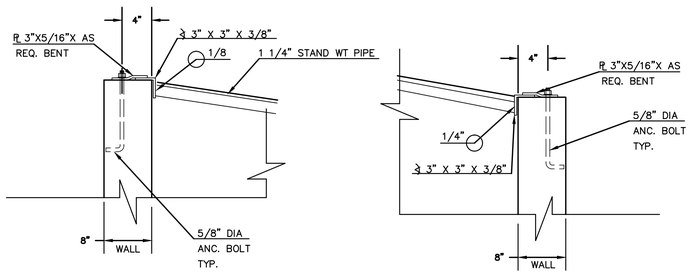
FLYING HORSE NORTH
IRRIGATION RESERVOIR EMBANKMENT
SWQ OUTFALL PLAN & PROFILE

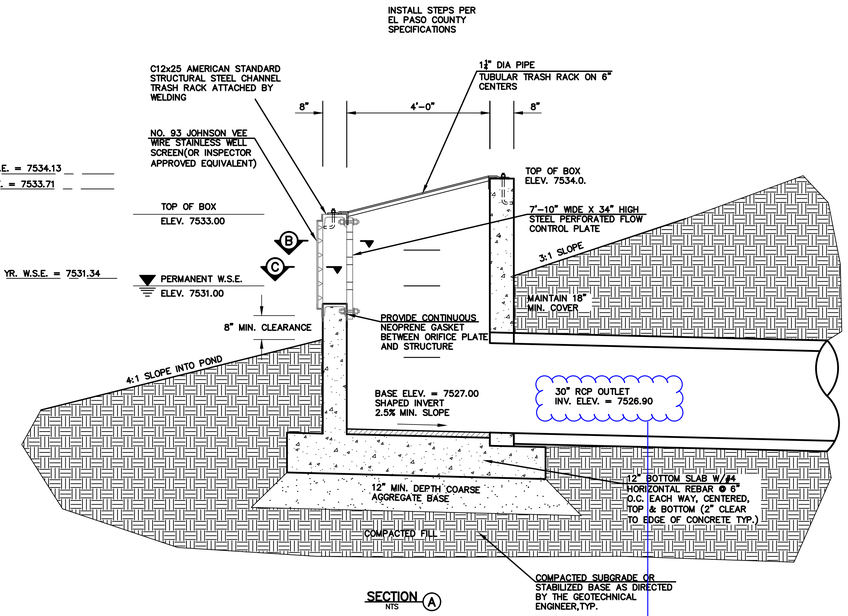
CLASSIC CONSULTING ENGINEERS & SURVEYORS

DESIGNED BY	MAW	SCALE		DATE	10-18-17
DRAWN BY	MAW	(H) 1"=	20'	SHEET	8 OF 12
CHECKED BY		(V) 1"=	5'	JOB NO.	1096.11

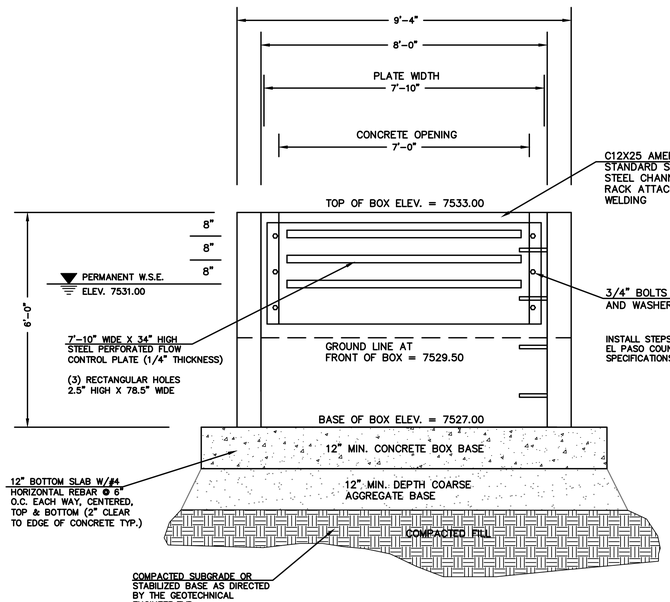


TRASH RACK
ALL WELDED CONSTRUCTION
N.T.S.





SECTION A
NTS



8'X4' SWQ OUTLET BOX WITH FLOW CONTROL PLATE
SCALE: 1"=2'

(ALL MATERIALS PER EL PASO COUNTY SPECIFICATIONS)

ORIFICE PLATE NOTES:

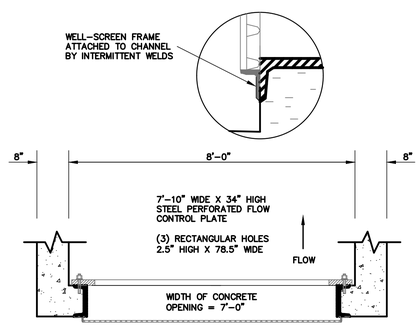
1. INSTALL HOLES AS SHOWN ON DETAIL TO RIGHT.
2. PROVIDE GASKET MATERIAL BETWEEN THE ORIFICE PLATE AND THE CONCRETE

EURV AND WQCV TRASH RACKS:

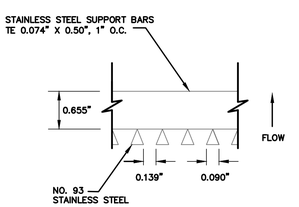
3. WELL-SCREEN TRASH RACKS SHALL BE STAINLESS STEEL AND SHALL BE ATTACHED BY INTERMITTENT WELDS ALONG THE EDGE OF THE MOUNTING FRAME.
4. BAR GRATE TRASH RACKS SHALL BE ALUMINUM AND SHALL BE BOLTED USING STAINLESS STEEL HARDWARE.
5. STRUCTURAL DESIGN OF TRASH RACKS SHALL BE BASED ON FULL HYDROSTATIC HEAD WITH ZERO HEAD DOWNSTREAM OF RACK

OVERFLOW TRASH RACKS:

1. ALL TRASH RACKS SHALL BE MOUNTED USING STAINLESS STEEL HARDWARE AND PROVIDED WITH HINGED AND LOCKABLE OR BOLTABLE ACCESS PANELS
2. TRASH RACKS SHALL BE STAINLESS STEEL, ALUMINUM, OR STEEL. STEEL TRASH RACKS SHALL BE HOT DIP GALVANIZED AND MAY BE HOT POWDER COATED AFTER GALVANIZING.
3. TRASH RACKS SHALL BE DESIGNED SUCH THAT THE DIAGONAL DIMENSION OF EACH OPENING IS SMALLER THAN THE DIAMETER OF THE OUTLET PIPE.
4. STRUCTURAL DESIGN OF THE TRASH RACKS SHALL BE BASED ON FULL HYDROSTATIC HEAD WITH ZERO HEAD DOWNSTREAM OF THE RACK.



SECTION B
NTS



R VALUE = (NET OPEN AREA)/(GROSS RACK AREA) = 0.60

SECTION C
NTS

8'X4' SWQ OUTLET BOX WITH FLOW CONTROL PLATE
SCALE: 1"=2'

Invert of outlet pipe does not match the UD-Detention worksheet.

48 HOURS BEFORE YOU DIG, CALL UTILITY LOCATORS
811
UTILITY NOTIFICATION OF COLORADO
IT'S THE LAW

THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK. THE CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE CAUSED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UNDERGROUND UTILITIES.

NO.	REVISION	DATE

REVIEW:

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF CLASSIC CONSULTING ENGINEERS AND SURVEYORS, LLC

30% SUBMITTAL

MARC A WHORTON, COLORADO P.E. #37155 DATE

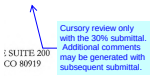
CLASSIC SM CONSULTING ENGINEERS & SURVEYORS
619 N. Cascade Avenue, Suite 200 (719)785-0790
Colorado Springs, Colorado 80903 (719)785-0799(Fax)

FLYING HORSE NORTH
IRRIGATION RESERVOIR EMBANKMENT
DETENTION/SWQ OUTLET BOX DESIGN

DESIGNED BY	MAW	SCALE		DATE	08-05-17
DRAWN BY	MAW	(H) 1"=	2'	SHEET	9 OF 12
CHECKED BY		(V) 1"=	2'	JOB NO.	1096.11

Markup Summary

dsdlaforce (8)



Subject: Callout
Page Label: 1
Lock: Locked
Author: dsdlaforce

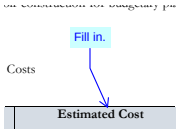
Cursory review only with the 30% submittal. Additional comments may be generated with subsequent submittal.

Subject: Text Box
Page Label: 1
Lock: Locked
Author: dsdlaforce

Add PCD File No. SP-17-012

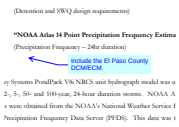
Subject: Text Box
Page Label: 2
Lock: Locked
Author: dsdlaforce

Include the Engineer & Developer Certification Page



Subject: Callout
Page Label: 13
Lock: Locked
Author: dsdlaforce

Fill in.

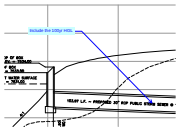


Subject: Callout
Page Label: 14
Lock: Locked
Author: dsdlaforce

Include the El Paso County DCM/ECM.

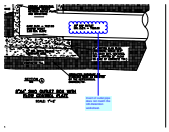
Subject: Callout
Page Label: 211
Lock: Locked
Author: dsdlaforce

Provide fence/road side barrier.



Subject: Callout
Page Label: 214
Lock: Locked
Author: dsdlaforce

Include the 100yr HGL

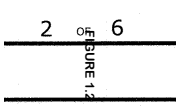


Subject: Cloud+
Page Label: 215
Lock: Locked
Author: dsdlaforce

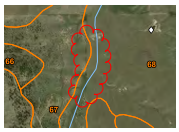
Invert of outlet pipe does not match the UD-Detention worksheet.

MWhorton (11)

Subject: 30% SUBMITAL
Page Label: 1
Lock: Unlocked
Author: MWhorton



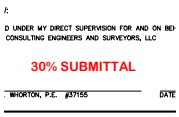
Subject: FIGURE 1.2
Page Label: 5
Lock: Unlocked
Author: MWhorton



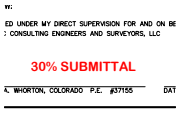
Subject: Polygon
Page Label: 27
Lock: Unlocked
Author: MWhorton

Subject: Text Box
Page Label: 27
Lock: Unlocked
Author: MWhorton

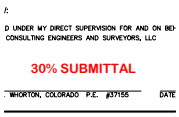
IRRIGATION RESERVOIR



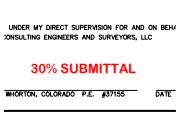
Subject: 30% SUBMITAL
Page Label: 209
Lock: Unlocked
Author: MWhorton



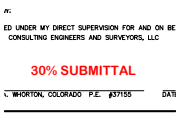
Subject: 30% SUBMITAL
Page Label: 210
Lock: Unlocked
Author: MWhorton



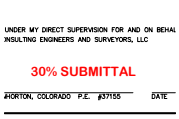
Subject: 30% SUBMITAL
Page Label: 211
Lock: Unlocked
Author: MWhorton



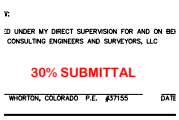
Subject: 30% SUBMITAL
Page Label: 212
Lock: Unlocked
Author: MWhorton



Subject: 30% SUBMITAL
Page Label: 213
Lock: Unlocked
Author: MWhorton



Subject: 30% SUBMITAL
Page Label: 214
Lock: Unlocked
Author: MWhorton



Subject: 30% SUBMITAL
Page Label: 215
Lock: Unlocked
Author: MWhorton