INITIAL SAFETY FACTOR ASSESSMENT
PLANT GORGAS ASH POND
ALABAMA POWER COMPANY

EPA's "Disposal of Coal Combustion Residuals from Electric Utilities Final Rule" (40 C.F.R. Part 257 and Part 261), §257.73(e), requires the owner or operator of an existing CCR surface impoundment to conduct periodic safety factor assessments. The owner or operator must document that the minimum safety factors outlined in §257.73(e)(1)(i) through (iv) for the critical embankment section are achieved.

The CCR surface impoundment located at Alabama Power Company's Plant Gorgas also referred to as the Plant Gorgas Ash Pond is located on Plant Gorgas property, southeast of Parrish, Alabama. The CCR surface impoundment is formed by an engineered cross-valley embankment. The critical section of this CCR unit has been determined to be located at the centerline of the embankment, which is the highest section of the embankment.

The analyses used to determine the minimum safety factor for the critical section resulted in the following minimum safety factors:

Loading Condition	Minimum Calculated Safety Factor	Minimum Required Safety Factor
Long-term Maximum Storage Pool (Static)	1.5	1.5
Maximum Surcharge Pool (Static)	1.5	1.4
Seismic	1.5	1.0

The embankments are not constructed of clays and silts that are not susceptible to liquefaction. Therefore, a minimum liquefaction safety factor determination was not required.

I hereby certify that the safety factor assessment was conducted in accordance with 40 C.F.R. Part 257.73 (e)(1).

10/17/16

James C. Pegues, P.E.
Licensed State of Alabama, PE No. 16516

SOUTHERN COMPANY

Engineering and Construction Services Calculation

Calculation Number:
TV-GO-APC389153-001

Project/Plant:	**Unit(s):**	**Discipline/Area:**
Plant Gorgas Ash Pond	Units 8-10	ESFS
Title/Subject: Slope Stability Analysis of Plant Gorgas Ash Pond Dam		
Purpose/Objective: Analyze slope stability of the Plant Gorgas Ash Pond Dam		
System or Equipment Tag Numbers: NA	**Originator:** Stacey H. Simpson, P.E.	

Contents

Revision Record

Rev. No.	Description	Originator Initial / Date	Reviewer Initial / Date	Approver Initial / Date
0	Issued for Information	SHS 10/06/16	JAJ 10/10/16	JCP 10/10/10

Notes:

Purpose of Calculation

The William C. Gorgas Electric Generating Plant is a 3-unit electric generating facility, all of which are coal-fired units. The Plant Gorgas Ash Pond is designed to receive and store coal combustion residuals produced during the electric generating process at Plant Gorgas, as well as serve as a low-volume waste treatment pond. CCR products are sluiced from the plant to the Ash Pond.

The purpose of this calculation is to provide a slope stability assessment of the Plant Gorgas Ash Pond dam under conditions prescribed by the EPA CCR rule.

Methodology

The calculation was performed using the following methods and software:

GeoStudio 2012 (Version 8.15.5.11777), August 2015 Release, Copyright 1991-2016, GEO-SLOPE International, Ltd.

Strata (Version alpha, Revision 0.2.0), Geotechnical Engineering Center, Department of Civil, Architectural, and Environmental Engineering, University of Texas.

The Morgenstern-Price analytical method with an entry-exit slip surface was used for slope stability calculation.

Criteria and Assumptions

The slope stability models were run using the following assumptions and design criteria:

- Seismic site response was determined using a one-dimensional equivalent linear site response analysis. The analysis was performed using Strata and utilizing random vibration theory. The input motion consisted of the USGS published 2008 Uniform Hazard Response Spectrum (UHRS) for Site Class B/C at a 2% Probability of Exceedance in 50 years. The UHRS was converted to a Fourier Amplitude Spectrum, and propagated through a representative one dimensional soil column using linear wave propagation with strain-dependent dynamic soil properties. The input soil properties and layer thickness were randomized based on defined statistical distributions to perform Monte Carlo simulations for 100 realizations, which were used to generate a median estimate of the surface ground motions.

- The median surface ground motions were then used to calculate a pseudostatic seismic coefficient for utilization in the stability analysis using the approach suggested by Bray and Tavasarou (2009). The procedure calculates the seismic coefficient for an allowable seismic displacement and a probability exceedance of the displacement. For this analysis, an allowable displacement of 0.5 ft, and a probability of exceedance of 16% were conservatively selected, providing a seismic coefficient of 0.028g for use as a horizontal acceleration in the stability analysis.

- The Corps of Engineers (COE) EM 1110-2-1902 standard, October 2003, allows the use of the phreatic surface established for the maximum storage condition (normal pool) in the analysis for the maximum surcharge loading condition. This is based on the short term duration of the surcharge loading relative to the permeability of the embankment and the foundation materials. This method is used in the analysis for the impoundments at this facility with surcharge loading.

- The current required minimum criteria (factors of safety) were taken from the Structural Integrity Criteria for Existing CCR Surface Impoundments, 40 CFR 257.73, published April 17, 2015.

- The critical section was selected at location having the apparent maximum dam height. The cross-section of the Plant Gorgas Ash Pond dam was modeled using the following sources:
    1) Historical Alabama Power Company (APC) Drawings F-97854, C-189068, and D-586217 depicting typical dam cross sections for original construction, the 1977 dam raise and the 2007 dam raise.
    2) Plant Gorgas CCR Topo and Plan View Mapping Rattlesnake Ash Pond, 2016

Input Data

- Soil Properties: Because the physical properties of the dam construction (materials and configuration) make sampling and testing unfeasible, the selection of soil properties used for the analysis (unit weight, phi angle, and cohesion) relied on historical construction records and historical records of laboratory analyses of borrow material used to construct portions of the dam. The ash properties used for the analysis (unit weight, phi angle, and cohesion) were based on laboratory testing performed on undisturbed and remolded samples of ash from various plants and on engineering judgment.

Soil Description	Unit Weight, pcf	Effective Stress Parameters	
		Cohesion, psf	Phi Angle, degrees
Old Rockfill	140	0	38
New Rockfill	145	0	43
Class H Mine Spoil	129	500	22
Clay Foundation	134	500	31
Ash	98	0	28
Shale	Impenetrable bedrock		

- Phreatic Surface: The phreatic surface used in the analysis was developed from historic geophysical testing and seepage analyses, supplemented by visual observation of dam seepage and engineering judgment.

Summary of Conclusions

The following table summarizes the factors of safety resulting from the slope stability analyses. The results indicate the safety factors of the Plant Gorgas Ash Pond dam meet or exceed the minimum criteria set forth in the structural integrity criteria for existing CCR surface impoundments, 40 CFR 257.73.

Factor of Safety Summary Table

Loading Condition	Minimum Calculated Safety Factor	Minimum Required Safety Factor
Long-term Maximum Storage Pool (Static)	1.5	1.5
Maximum Surcharge Pool (Static)	1.5	1.4
Seismic	1.5	1.0

Design Inputs/References

- Bray, J. D. and Travasarou, T., *Pseudostatic Coefficient for Use in Simplified Seismic Slope Stability Evaluation*, Journal of Geotechnical and Environmental Engineering, American Society of Civil Engineers, September 2009
- APC Drawing F-97854, Gorgas Ash Disposal Pond, Rattlesnake Hollow Site, Rock Fill Dam, 1953
- APC Drawing C-189068, Gorgas Ash Handling, Sloping Core Design (Typical Cross Section), 1973
- APC Drawing D-586217, Crest Raise of Rattlesnake Hollow Ash Pond Sections and Details, 2006
- Crest Raise Feasibility Study, Rattlesnake Hollow Ash Pond Dam, Gorgas Steam Plant, Southern Company Technical Services, 2005

Body of Calculation

Slope/W files attached

Plant Gorgas
Ash Pond

Long Term Maximum Storage Pool

Name: Ash
Unit Weight: 98 pcf
Cohesion': 0 psf
Phi': 28 °

Name: Roller Compacted Concrete
Unit Weight: 140 pcf
Cohesion': 144,000 psf
Phi': 40 °

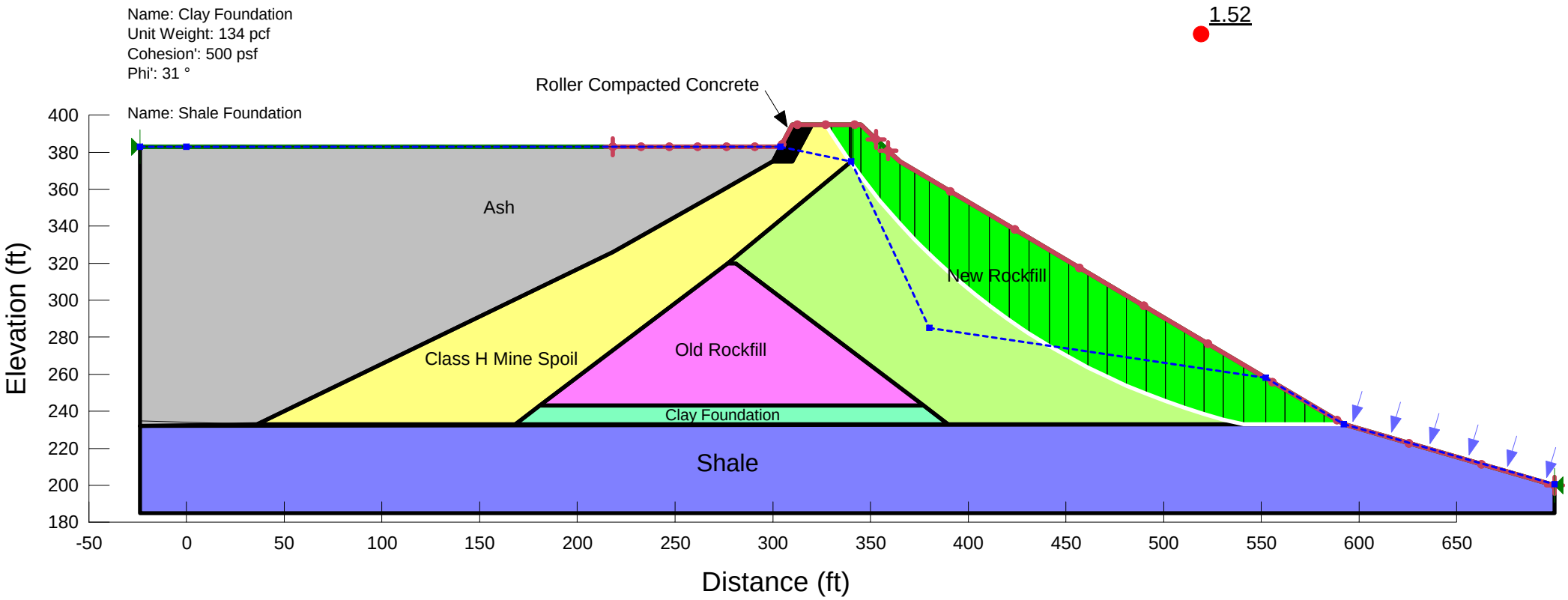
Name: Class H Mine Spoil
Unit Weight: 129 pcf
Cohesion': 500 psf
Phi': 22 °

Name: New Rockfill
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 43 °

Name: Old Rockfill
Unit Weight: 140 pcf
Cohesion': 0 psf
Phi': 38 °

Name: Clay Foundation
Unit Weight: 134 pcf
Cohesion': 500 psf
Phi': 31 °

Name: Shale Foundation



Plant Gorgas
Ash Pond

Maximum Surcharge Pool

Name: Ash
Unit Weight: 98 pcf
Cohesion': 0 psf
Phi': 28 °

Name: Roller Compacted Concrete
Unit Weight: 140 pcf
Cohesion': 144,000 psf
Phi': 40 °

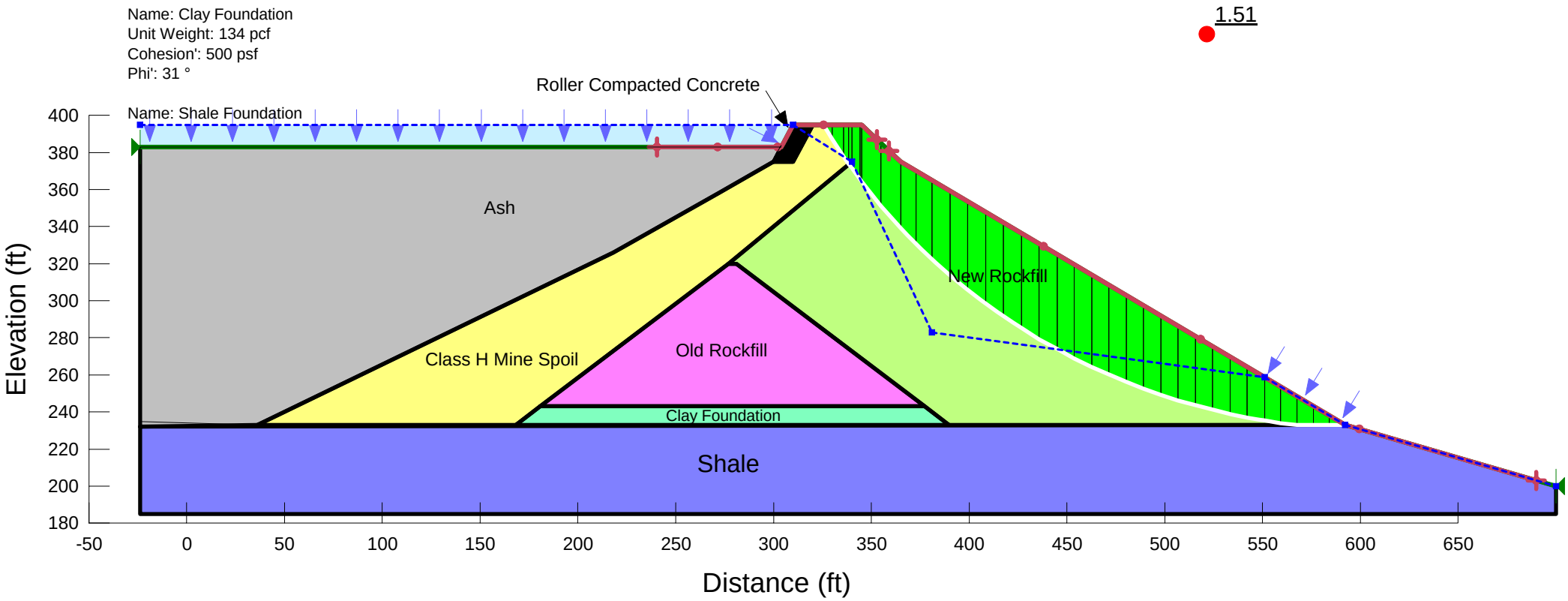
Name: Class H Mine Spoil
Unit Weight: 129 pcf
Cohesion': 500 psf
Phi': 22 °

Name: New Rockfill
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 43 °

Name: Old Rockfill
Unit Weight: 140 pcf
Cohesion': 0 psf
Phi': 38 °

Name: Clay Foundation
Unit Weight: 134 pcf
Cohesion': 500 psf
Phi': 31 °

Name: Shale Foundation



Plant Gorgas

Ash Pond

Seismic

Name: Ash
Unit Weight: 98 pcf
Cohesion': 0 psf
Phi': 28 °

Name: Roller Compacted Concrete
Unit Weight: 140 pcf
Cohesion': 144,000 psf
Phi': 40 °

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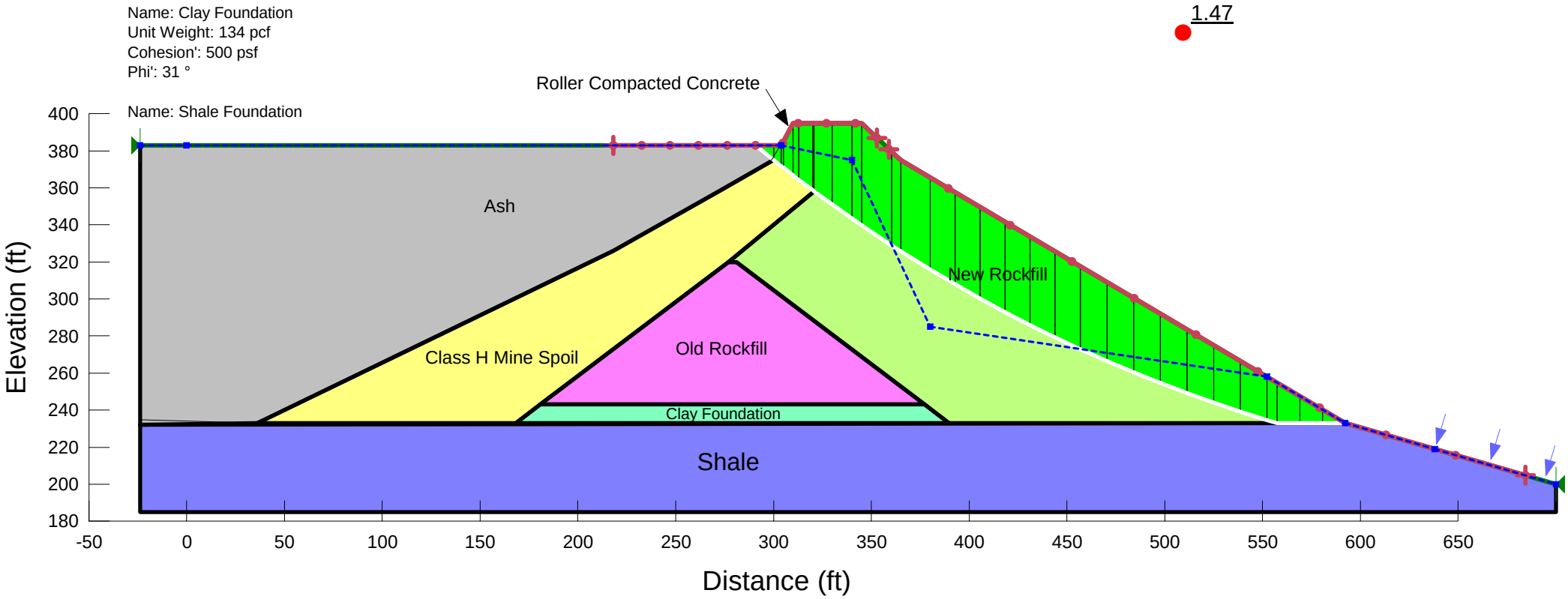
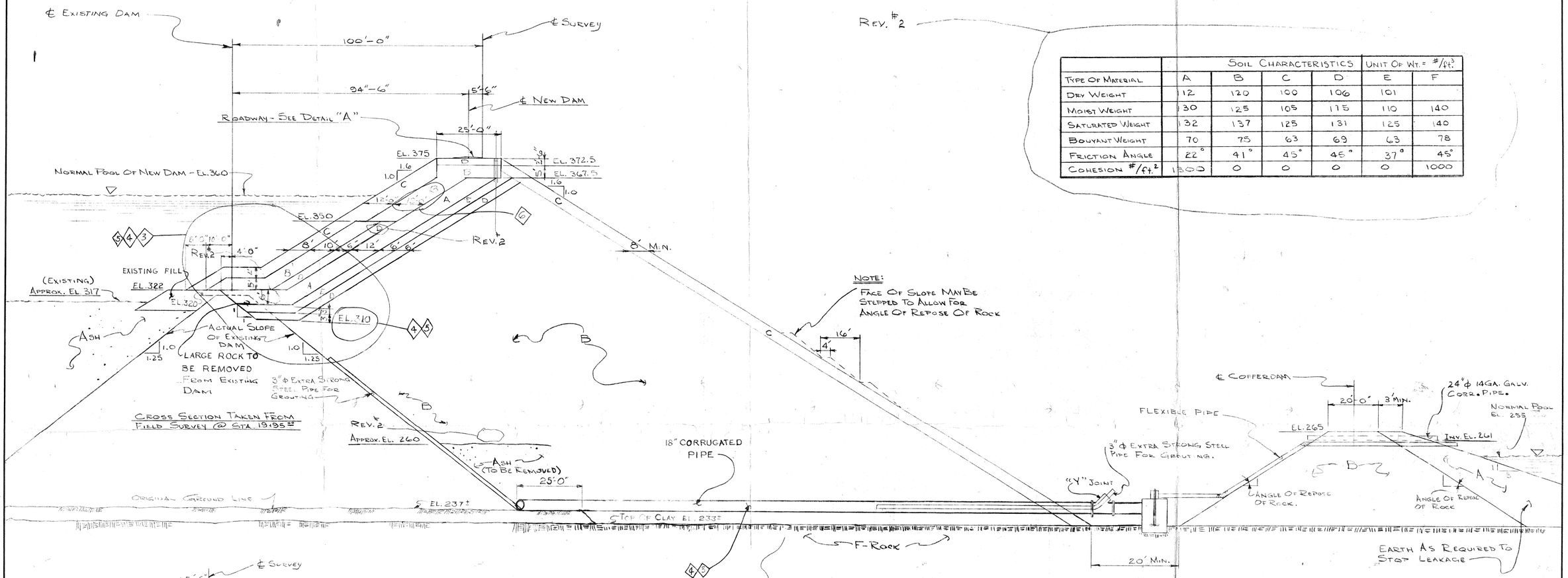


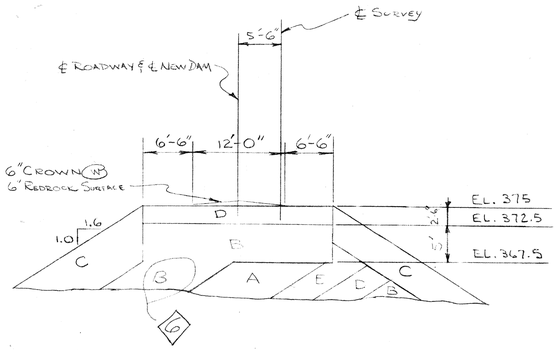
ATTACHMENTS

Attachment A – Laboratory Analyses



REV. #2

	Soil Characteristics				Unit Of Wt. = #/ft.³	
Type Of Material	A	B	C	D	E	F
Dry Weight	112	120	100	106	101	
Moist Weight	130	125	105	175	110	140
Saturated Weight	132	137	125	131	125	140
Bouyant Weight	70	75	63	69	63	78
Friction Angle	22°	41°	45°	45°	37°	45°
Cohesion #/ft.²	1300	0	0	0	0	1000



DETAIL - "A"

NOTE:
LOCATION OF SUMPS, PUMPS AND UNWATERING PIPE LINES TO BE DETERMINED AFTER OVERBURDEN IS REMOVED AND AMOUNT OF LEAKAGE IS DETERMINED. PIPE LINES TO BE CEMENT GROUTED AFTER THEY ARE NO LONGER NEEDED.

NOTES:
1. MATERIAL DESIGNATION (ALL MATERIAL TO BE COMPACTED).
   "A" IMPERVIOUS FILL.
   "B" ROCK, 12" MAX. SIZE.
   "C" ROCK, 12" AND LARGER.
   "D" COARSE FILTER.
   "E" FINE FILTER.
   "F" ROCK.
2. TOP OF DAM TO BE FURNISHED WITH A 12 FOOT WIDE REDROCK SURFACED ROADWAY - SEE DETAIL "A".

REFERENCE:
D-189178 - GENERAL LAYOUT OF DAM.

Rev.	By	Date	Description
Rev. #6	G.L.H	3-5-75	CHGD 6' LAYER OF "E" & "D" FILTER MTL. TO 12' LAYER OF "B" MAT'L ABOVE ELEV. 350' ON U.S. SIDE OF CORE.
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Rev. #2 (cont'd)		4-27-73	CHANGED ASSUMED SOIL CHARACTERISTICS TO ACTUAL RESULTS FROM LAB TESTS. R.D.C.
Rev. #1		3-13-73	GENERAL REVISION. R.D.C.

3-13-73 DRAWN R. CROWSON CHECKED GDB 3-26-73 TRACED
APPROVED [signature] DATE 3-26-73
APPROVED [signature] DATE 3/24/73

ALABAMA POWER COMPANY
JOB GORGAS ASH HANDLING
DETAIL SLOPING CORE DESIGN - (TYPICAL CROSS SECTION).
SCALE 1"=20' VERTICAL & HORIZONTAL B/M
SHEET 1 OF 1 SHEETS
SUPERSEDES
C-189068

K&E 17 0253 2-72 2300▪

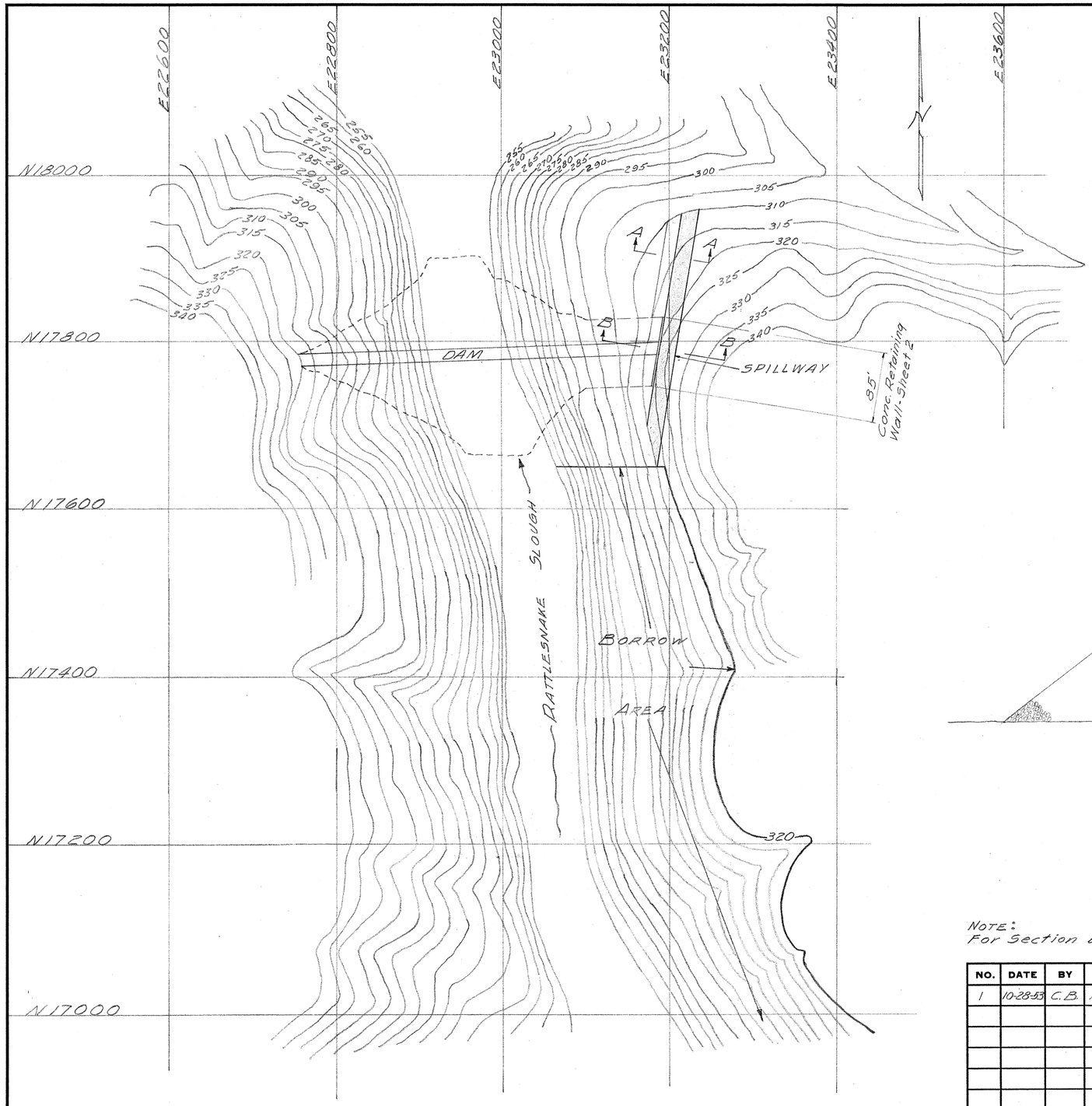
3.1.3 Dike Material Engineering Properties

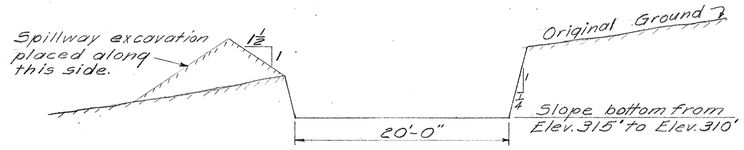
In considering the possible increase in seepage from a proposed raise in hydrostatic head, it was necessary to research previous files for information regarding soil types and properties used in design/construction of the core and filter materials of the last dike raise. During March and April of 1979, samples from potential borrow sources and mine spoil stockpiles in the immediate area were transported to APCo's Central Soils Testing Laboratory in Vamons, Alabama. Most of this material was mine waste with sufficient fines to be considered for use as the upstream "impervious" blanket, or Class H material. These were samples #332 and #333. Two other samples from local sources selected by plant personnel were also tested, taken from areas near the abutments and thought to have greater fines contents. These were designated samples #334 and #335. All samples were tested for shear strength and permeability at both 85% and 92% of their Standard Proctor (SP) maximum dry density for compaction. Table 1 below presents a summary of those test results.

Table 1: Properties of Class H Material

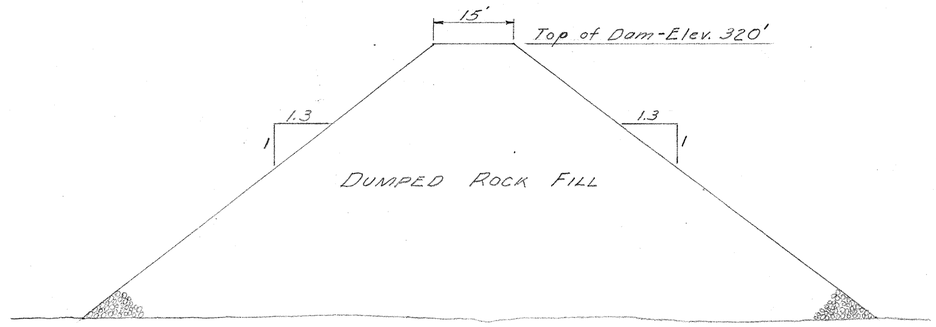
	Lab #332	Lab #333	Lab #334	Lab #335
Description:	Mine Spoil (E)	Mine Spoil (S)	Clayey Silt Borrow 57% passing LL=31, PI=4	NW Abutment 60% passing (25% cl) LL=31, PI=7
Density:	γ_m=122.7 OMC=13.6%	γ_m=118.9 OMC=13.2%	γ_m=107.5 OMC=18.2%	γ_m=111.0 OMC=16.5%
Permeability, κ (cm/sec):				
85% SP	7.4×10^{-4}	5.1×10^{-4}	1.9×10^{-4}	2.0×10^{-4}
92% SP	8.1×10^{-6}	1.0×10^{-5}	2.2×10^{-5}	7.3×10^{-6}
Strength (C=cohesion, ϕ=angle of internal friction. Prime values are effective stress):				
85% SP	C=2.2 ksf ϕ=5° C'=0 ksf ϕ'=32.9°	C=1.4 ksf ϕ=23° C'=0 ksf ϕ'=35°	C=0.4 ksf ϕ=21.5° C'=0 ksf ϕ'=33.7°	
92% SP	C=2.1 ksf ϕ=6.5° C'=0 ksf ϕ'=36.1°	C=1.5 ksf ϕ=28° C'=0 ksf ϕ'=36.1°	C=1.0 ksf ϕ=23° C'=0 ksf ϕ'=36°	C=2.2 ksf ϕ=9°

Attachment B - Drawings Used to Develop Critical Section Profile





SECTION A-A
SPILLWAY DETAILS
Scale: 1"=10'



TYPICAL FILL SECTION
Scale: 1"=20'

Note:
For Section B-B see sheet 2.

NO.	DATE	BY	REVISION
1	10-28-53	C.B.	Relocate spillway.

ALABAMA POWER COMPANY

SUBJECT Gorgas Ash Disposal Pond

DETAIL Rattlesnake Hollow Site
Rock Fill Dam

DRAWN C.B. TRACED

CHECKED DATE August 19, 1953

APPROVED DATE

APPROVED DATE

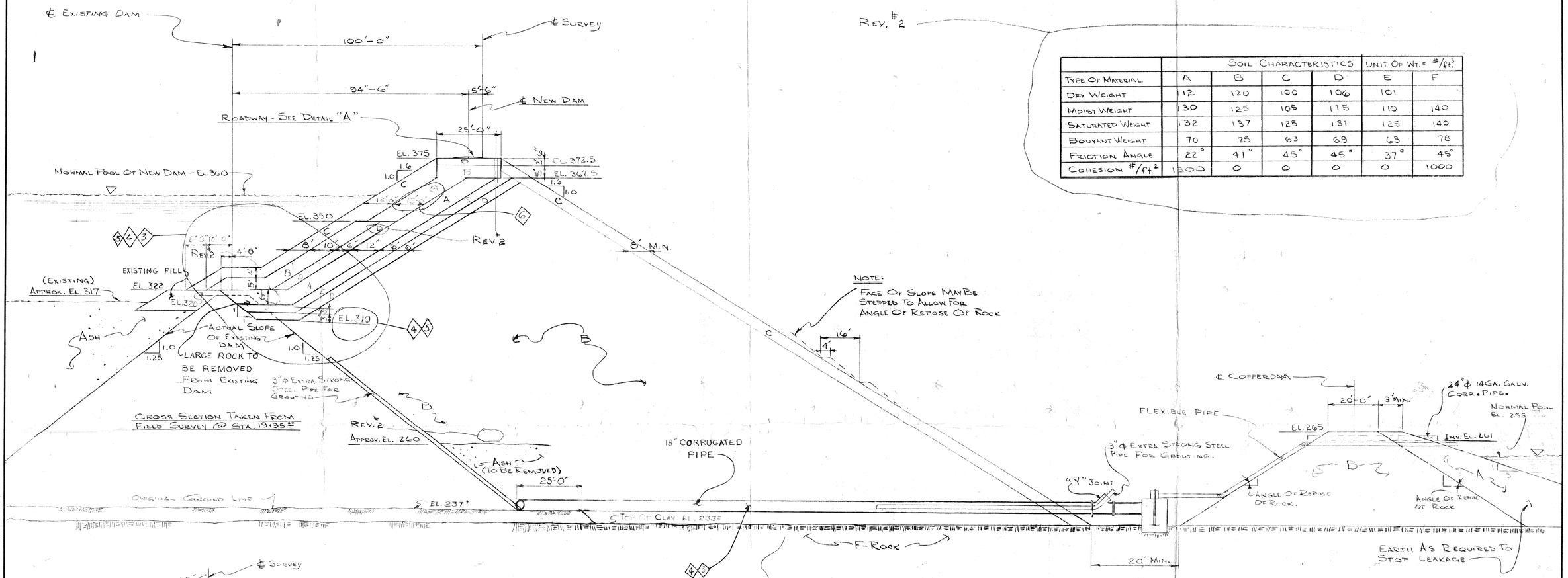
SCALE As Shown

SHEET 1 OF 2 SHEETS

SUPERSEDES

B/M

F-97854



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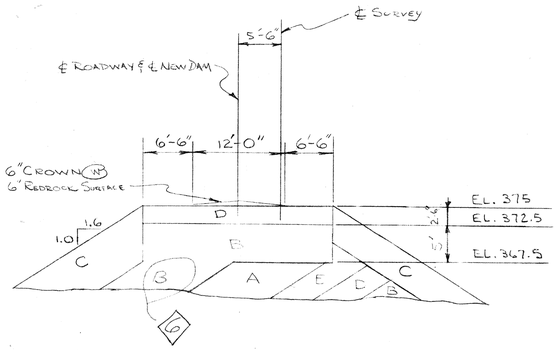
Cohesion #/ft.²	1300	0	0	0	0	1000



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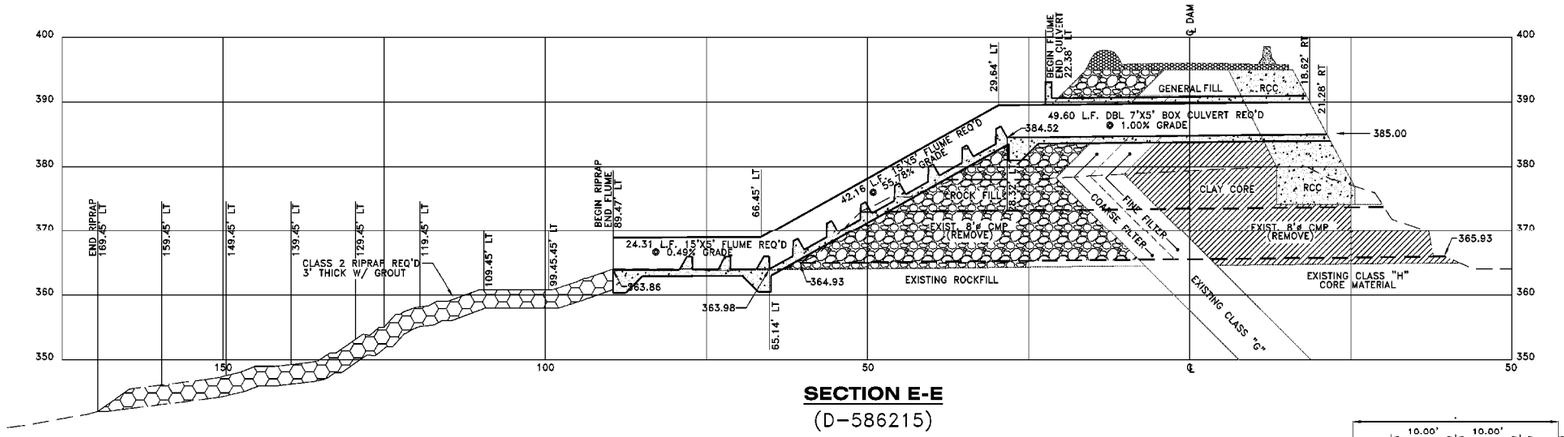
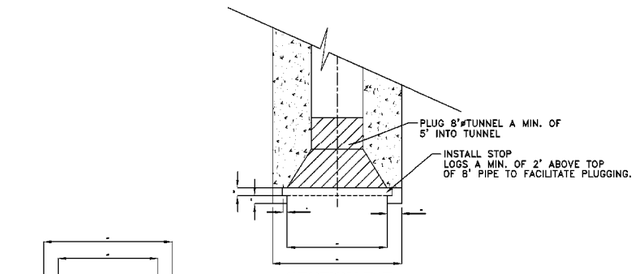
ALABAMA POWER COMPANY
JOB GORGAS ASH HANDLING
DETAIL SLOPING CORE DESIGN - (TYPICAL CROSS SECTION).
SCALE 1"=20' VERTICAL & HORIZONTAL B/M
SHEET 1 OF 1 SHEETS
SUPERSEDES
C-189068

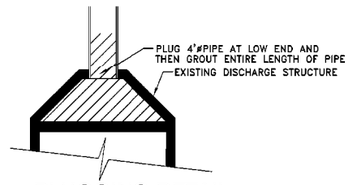
K&E 17 0253 2-72 2300▪



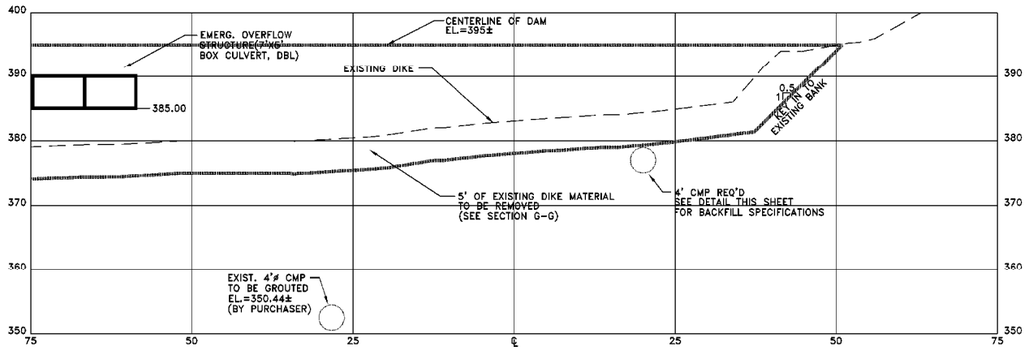
SECTION E-E
(D-586215)



PLUGGING DETAIL
FOR 8'Ø PIPE AT PRESCOTT CREEK
(BY CONTRACTOR)



PLUGGING DETAIL
FOR 4' Ø CMP AT EXISTING WEIR
(BY PURCHASER)



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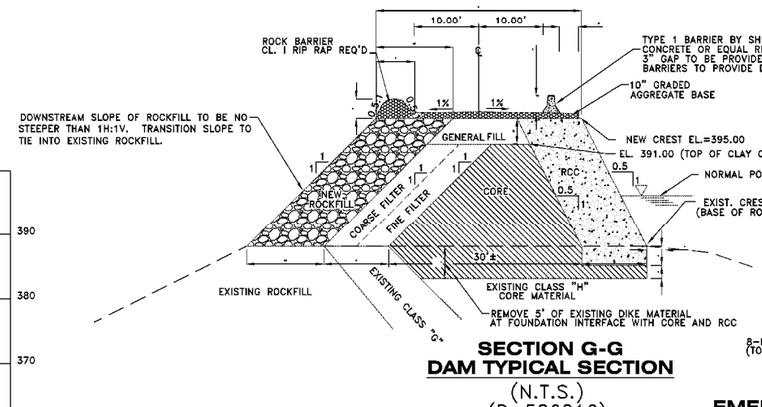
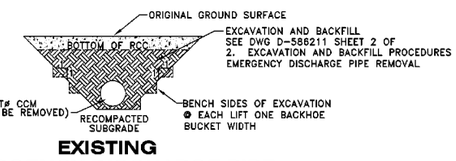
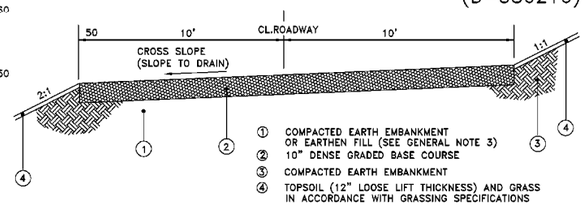
(D-586215)



SECTION G-G
DAM TYPICAL SECTION
(N.T.S.)
(D-586216)



EXISTING
EMERGENCY DISCHARGE PIPE
EXCAVATION & BACKFILL
(N.T.S.)
(D-586215)



SECTION H-H
WEST DOWNSTREAM ACCESS ROAD
(N.T.S.)
(D-586216)

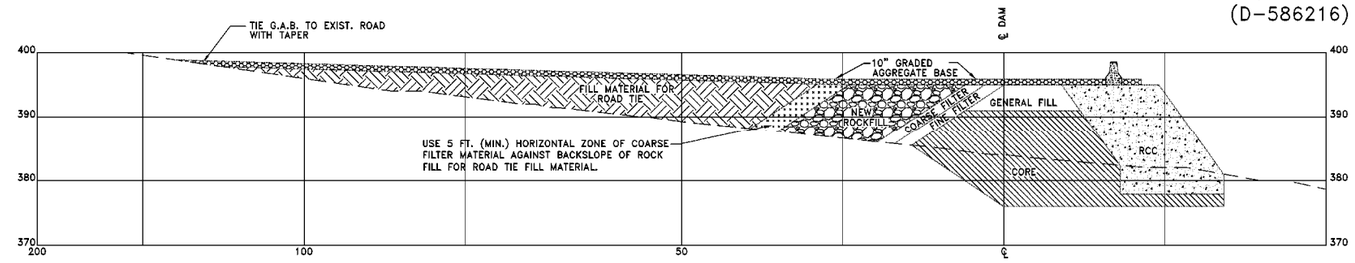
NOTES:

1. FOR DRAWING INDEX, NOTES, AND SPECIFICATIONS SEE DWG. NO. D-586211, SHEETS 1 & 2.
2. CURVE DATA SHOWN ON D-586214.
2. WORK THIS DRAWING WITH DRAWINGS:
   D-586214
   D-586215
   D-586216
   D-586220

REFERENCES:

SEE DRAWING D-586211

SEE TECHNICAL SPECIFICATIONS FOR EARTHWORK AND ROLLER COMPACTED CONCRETE CREST RAISE CONSTRUCTION



SECTION D-D
(D-586215)

REVISION	DATE

REVISION A	DATE 7-21-06
ISSUED FOR INQUIRY	
JOB NO. 2101FS	

BY	CHK'D	CIVIL APPR	ELECT APPR	I/C APPR	MECH APPR	MGR APPR

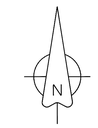
BY	CHK'D	CIVIL APPR	ELECT APPR	I/C APPR	MECH APPR	MGR APPR
JWM	PMG / JCP	JBS				CKT

Southern Company Services, Inc.
FOR
Alabama Power Company

PLANT GORGAS
CREST RAISE OF RATTLESNAKE
HOLLOW ASH POND
SECTIONS AND DETAILS

SCALE	PROJ I.D.	DRAWING NUMBER	SH	CONT'D	REV
1"=10'		D-586217	1	FINAL	A

ANSI F: 28x40 Acad2000



GRID COORDINATES
ALABAMA STATE PLANE
NAD 83 WEST ZONE

0 400' 800'

NOTES:
1) SURVEY FIELD DATA COLLECTED 5/5/16.
2) SOUNDING DATA DATA COLLECTED 5/5/16.
3) LIDAR TOPO DATA FROM 4/12/16 FLIGHT.
4) CONTOUR INTERVAL 1 FOOT.
5) CONTOURS WERE PRODUCED BY DIGITAL TERRAIN MODEL.
5) DRAWING IS ACCURATE ONLY AT ORIGINAL SCALE.

TOPOGRAPHIC/HYDROGRAPHIC SURVEY

Southern Company Generation
Engineering and Construction Services
FOR

Alabama Power Company

Plant Gorgas
CCR Topo and Plan View Mapping
Rattlesnake Ash Pond

REVISION	DATE
0	06/7/2016

BY	CHK'D	CIVIL APPR	ELECT APPR	I/C APPR	MECH APPR	DISC MGR
ENP						

SCALE	DRAWING NUMBER	SHEET	CONT'D	REV
As Noted		1	FINAL	0

ANSI E: 44x34