

**GEOTECHNICAL DESIGN REPORT
(90 PERCENT LEVEL)
WHITE TANKS
FLOOD RETARDING STRUCTURE NO. 4
REHABILITATION PROJECT - PHASE II
BUCKEYE, ARIZONA
CONTRACT FCD 2008C002
PROJECT CONTROL NO. 201.02.31
LOW ORG NO. 6975**

PREPARED FOR:
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009-6399

PREPARED BY:
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December 17, 2014
N&M Project No. 602257001

December 17, 2014
N&M Project No. 602257001

Mr. David Degerness, P.E.
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009

Subject: Geotechnical Design Report (90 percent Level)
White Tanks Flood Retarding Structure No. 4
Rehabilitation Project - Phase II
Buckeye, Arizona
Contract FCD 2008C002
Project Control No. 201.02.31
Low Org No. 6975

Dear Mr. Degerness:

In accordance with your authorization, Ninyo & Moore has prepared this Geotechnical Design Report for White Tanks FRS No. 4. The work was performed in accordance with Work Assignment No. 3 of Contract FCD 2008C002, outlined in the Statement of Work dated November 12, 2013. Transmitted herewith is the Geotechnical Design Report associated with Phase II of Work Assignment No. 3. Included are a description of our methodologies, conclusions, and geotechnical design for the planned rehabilitation of the subject FRS.

We appreciate the opportunity to be of service to you during this phase of the project.

Sincerely,
NINYO & MOORE



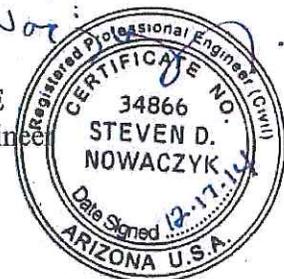
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Steven D. Nowaczyk, PE
Managing Principal Engineer



EXPIRES 06/30/2015

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Geotechnical Design Report (90%)
White Tanks FRS No. 4 Rehabilitation Project, Phase II
Buckeye, Arizona

December 17, 2014
Project No. 602257001
Contract FCD 2008C002
Project Control No. 201.02.31

APPENDIX B

NORTHEAST DAM EXTENSION

FOUNDATION EXCAVATION FOR NORTHEAST DAM EXTENSION

PURPOSE

The northeast extension will extend from the existing FRS northeastern limits, near Station 210+00, to about 1,000 feet to the north. The purpose of this assessment was to evaluate the suitability of foundation soils directly below the new Northwest Dam Extension in order to evaluate the depth of excavation needed below the new embankment fill for the planned improvements at White Tanks FRS No. 4, Phase II. This excavation of existing soils is meant to provide a stability base for construction of the new embankment fill and reduce possible post-construction settlement of the new embankment fill.

REFERENCES

The assessment of the excavation limits was generally performed using the following references:

- American Society for Testing and Materials (ASTM), 2009, Annual Book of ASTM Standards.
- AMEC, 2011, Seismic Refraction Evaluation of White Tanks FRS No. 4: dated November.
- Beckwith, G.H., and Hansen, L.A., "Calcareous Soils of the Southwestern United States." Geotechnical Properties, Behavior, and Performance of Calcareous Soils, ASTM STP 77, K. R. Demars and R. C. Chaney, Eds., American Society of Testing and Materials, 1982, pp. 16-35.
- Burmister, D. M., 1948, The Importance and Practical Use of Relative Density in Soil Mechanics: Proceedings ASTM, Vol. 48, p. 1249.
- LaCroix, Y. and Horn, H., 1973, Direct Determination and Indirect Evaluation of Relative Density and Its Use on Earthwork Construction Projects. An Evaluation of Relative Density and Its Role in Geotechnical Projects Involving Cohesionless Soils: ASTM Special Technical Publication 523, pp. 251-280.
- URS, 2009, 100 Percent Design Report: White Tanks Flood Retarding Structure No. 3 - Phase 2: dated October.

- Excavations that extend below the original ground surface tend to intercept shallow transverse cracks that may exist or develop within these surface soils.

Blow Count Resistance - We also evaluated the field blow counts as part of this project. In order to standardize the field blow counts obtained during our explorations, the field blow counts from the California Modified sampler were converted to the equivalent standard penetration test (SPT) blow counts by reducing the values by a factor of 0.5. This conversion factor was established after we researched previous studies along these lines that revealed conversion factors ranging from 0.65 (Burmister, 1948) and 0.44 (LaCroix and Horn, 1973) and represents an approximate average. Blow count resistance and collapse potential data collected during the Phase I of the project was analyzed and this analysis is presented in detail in Ninyo & Moore Geotechnical Design Report (100 percent) prepared for Phase I of the project and dated November 30, 2010. As a result of the analysis, we concluded that foundations soils with blow count resistance equal to or greater than about 40 blows per foot will be suitable foundation material for this project.

Seismic Velocity – We also reviewed the results and interpretations of the seismic refraction surveys that were performed by AMEC for this project at part of Phase I. As a result of the analysis, we concluded that a seismic p-wave velocity value greater than about 1,800 ft/s is indicative of suitable foundation material for this project.

RESULTS AND RECOMMENDATIONS

In evaluating the foundation profile at this end of the dam we considered many factors, including field explorations and laboratory test results. The proposed dam extension alignment and approximate field exploration locations are presented on Figure B-1. Several auger borings and test pits were excavated in this area during the previous and supplementary geotechnical explorations (B-29, B-35 through B-38 and TP-101 through TP-105). The logs of these explorations are presented on Figures B-2 through B-11. These logs show a suitable foundation interface between 1.5 and 5 feet below the ground surface (bgs). We also analyzed the laboratory test results from soil collected from this area that show response-to-wetting (collapse) on the order of 2 percent or less for soil samples collected from the borings and on the order of 3 to 5

this location. Furthermore, because of the very short duration of the maximum water level and the proximity of the water associated with the maximum water level with respect to the end of the dam extension (+/- 240 lateral feet), it is our opinion that the foundation for this dam extension can safely terminate about 350 feet north of the Roosevelt Road alignment without adverse risk to foundation soil erosion or scour as a result of the maximum water level planned.

Because the White Tanks FRS No. 4 Inlet Channel will be re-aligned immediately to the north and west of this extension, we recommend that the tip of this extension be protected against erosion should the inlet channel overtop during a large storm event. We further recommend that this erosion protection consist of rip-rap that is placed around the perimeter of the extension. This rip rap should extend bgs. A sketched plan and cross-section of this rip-rap erosion protection is presented on Figures B-28 and B-29, respectively.

DEPTH (feet)	BULK SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED	BORING NO.				
							4/21/09	B-29				
							GROUND ELEVATION	1,052' ± MSL	SHEET	1	OF	1
							METHOD OF DRILLING					Diedrich D-50, 6.5" Diameter Hollow-Stem Auger (D&S Drilling)
							DRIVE WEIGHT	140 lbs. (Automatic)	DROP	30"		
							SAMPLED BY	TLC	LOGGED BY	TLC	REVIEWED BY	JSR
DESCRIPTION/INTERPRETATION												
0						SC	<u>ALLUVIUM:</u> Reddish yellow (7.5 YR, 6/6), damp, medium dense, clayey fine to medium SAND; scattered caliche nodules, filaments, and rootlets.					
12							Light brown (7.5 YR, 6/4), caliche nodules up to 1/2" in diameter; nodules are well integrated into soil matrix; moderately cemented; increase in caliche filaments; strong reaction to HCl.					
29						ML	Reddish yellow (7.5 YR, 6/6), damp, dense, sandy SILT; trace gravel with caliche coating; scattered caliche nodules up to 1/2" in diameter; nodules well integrated into soil matrix; scattered caliche layers.					
28							Light brown (7.5 YR, 6/4).					
51			7.2	98.3								
10						SM	Reddish yellow (7.5 YR, 6/6), damp, dense, silty fine to coarse SAND; scattered caliche nodules.					
30							Total Depth = 15 feet. Groundwater not encountered during drilling. Grouted in two lifts on 4/21/09 promptly after completion of drilling. Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.					
20												
30												
40												



BORING LOG		
WHITE TANKS FRS NO. 4 REHABILITATION PROJECT, PHASE II BUCKEYE, ARIZONA		
PROJECT NO.	DATE	FIGURE
602257001	12/14	B-2

DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED <u>9/6/11</u> BORING NO. <u>B-36</u>	
	Bulk	Driven						GROUND ELEVATION <u>1,058' ± MSL</u>	SHEET <u>1</u> OF <u>1</u>
								METHOD OF DRILLING <u>CME-75, 6.5" Diameter Hollow-Stem Auger (Enviro-Drill, Inc.)</u>	
								DRIVE WEIGHT <u>140 lbs. (Automatic)</u> DROP <u>30"</u>	
								SAMPLED BY <u>TLC</u> LOGGED BY <u>TLC</u> REVIEWED BY <u>JSR</u>	
DESCRIPTION/INTERPRETATION									
0			18	4.6	114.3		SC	<u>ALLUVIUM:</u> Light brown (7.5YR, 6/4), damp, medium dense, clayey SAND; scattered caliche filaments.	
		31	Scattered caliche nodules up to approximately 1/4" in diameter.						
		71	Very dense.						
		39	Trace gravel.						
10			70					Pink (7.5YR, 7/4); dense to very dense; increase in gravel content.	
			20				SM	Light brown (7.5YR, 6/4), damp, medium dense to dense, silty SAND; few gravel.	
			82/11"				SC	Light brown (7.5YR, 6/4), damp, medium dense to dense, clayey SAND; trace gravel; scattered caliche filaments.	
			50				CL	Light brown (7.5YR, 6/4), damp, hard, sandy CLAY; scattered caliche layers and nodules up to 1/2" in diameter; moderately cemented.	
20			57						
								Total Depth = 20.5 feet. Groundwater not encountered during drilling. Backfilled on 9/6/11 promptly after completion of drilling.	
								<u>Note:</u> Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.	
30									
40									

Ninyo & Moore

BORING LOG

WHITE TANKS FRS NO. 4 REHABILITATION PROJECT, PHASE II
BUCKEYE, ARIZONA

PROJECT NO.
602257001

DATE
12/14

FIGURE
B-4

DEPTH (feet)	SAMPLES		BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED <u>9/7/11</u> BORING NO. <u>B-38</u>	
	Bulk	Driven						GROUND ELEVATION <u>1,063' ± MSL</u>	SHEET <u>1</u> OF <u>1</u>
								METHOD OF DRILLING <u>CME-75, 6.5" Diameter Hollow-Stem Auger (Enviro-Drill, Inc.)</u>	
								DRIVE WEIGHT <u>140 lbs. (Automatic)</u> DROP <u>30"</u>	
								SAMPLED BY <u>TLC</u> LOGGED BY <u>TLC</u> REVIEWED BY <u>JSR</u>	
DESCRIPTION/INTERPRETATION									
0							SM	<u>ALLUVIUM:</u> Light brown (7.5YR, 6/4), damp, loose to medium dense, silty SAND; trace gravel; scattered rootlets; moderate reaction to HCl.	
			60				SC	Dense. Pink (7.5YR, 7/4), damp, dense to very dense, clayey SAND; trace gravel; scattered caliche nodules up to 1" in diameter; scattered caliche filaments and roots; strong reaction to HCl.	
			50/5"						
			67						
			65					Decrease in fines content; increase in gravel content.	
10			50/5"						
			81						
			48				CL	Light brown (7.5YR, 6/4), damp, hard, sandy CLAY; scattered caliche nodules and filaments; strong reaction to HCl.	
			50/5"				SC	Light brown (7.5YR, 6/4), damp, very dense, clayey SAND; few gravel; scattered caliche nodules and filaments; scattered pinhole-size pore spaces.	
20								Total Depth = 19.4 feet. Groundwater not encountered during drilling. Backfilled on 9/7/11 promptly after completion of drilling.	
								<u>Note:</u> Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.	
30									
40									

Ninyo & Moore

BORING LOG

WHITE TANKS FRS NO. 4 REHABILITATION PROJECT, PHASE II
BUCKEYE, ARIZONA

PROJECT NO.
602257001

DATE
12/14

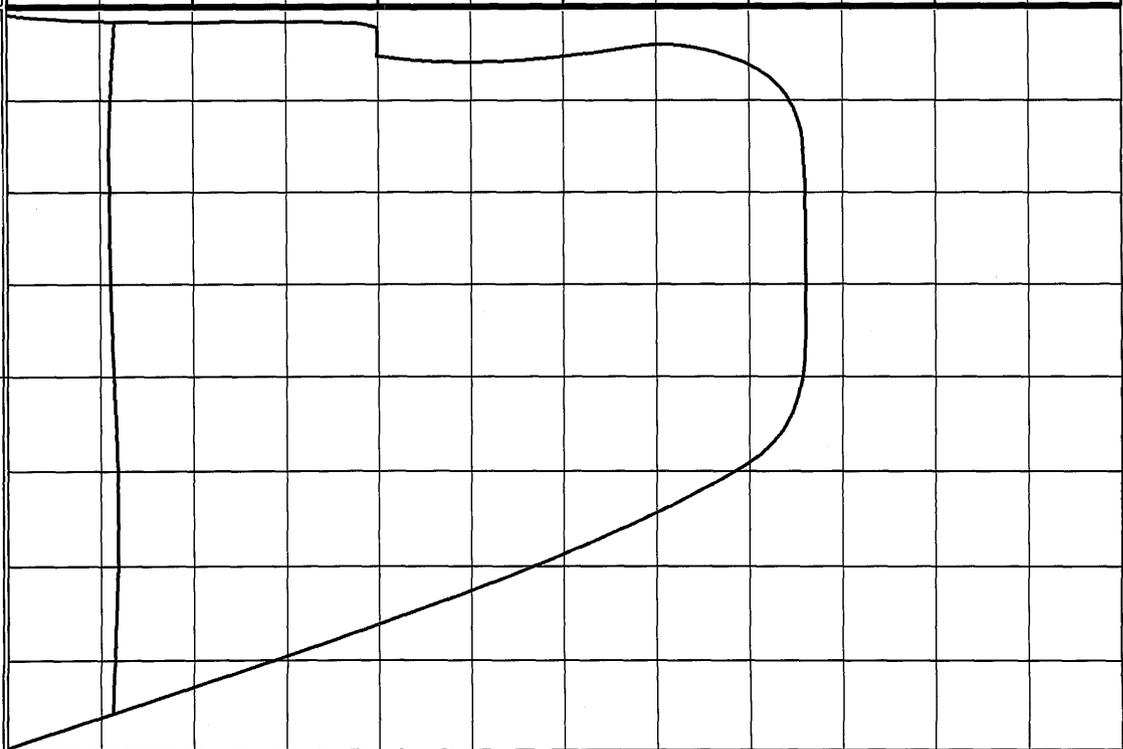
FIGURE
B-6

Ninyo & Moore

TEST PIT LOG

WHITE TANKS FRS NO. 4 REHABILITATION PROJECT
BUCKEYE, ARIZONA

PROJECT NO. 602257001
DATE 12/14



DEPTH (FEET)	SAMPLES		MOISTURE (%)	DRY DENSITY (PCF)	CLASSIFICATION U.S.C.S.	DESCRIPTION
	Bulk	Driven Sand Cone				
0 - 4	█				SM	REWOKED ALLUVIUM: Brown, damp, loose to medium dense, silty SAND; trace gravel.
4 - 6	█				SM	ALLUVIUM: Brown, damp, medium dense to dense, silty SAND; trace gravel; weakly cemented by caliche.
6 - 8	█				SM	Light brown, damp, dense to very dense, silty SAND; trace to few gravel; moderately cemented by caliche; scattered caliche nodules up to 1/2" in diameter.
8 - 10	█				SC	Light brown, damp, very dense, clayey SAND; trace gravel; weakly to moderately cemented by caliche; caliche nodules up to 1/2" in diameter.
10 - 12						Increase in amount of disseminated caliche in soil matrix; moderately to strongly cemented.
Total Depth = 8.5 feet. Groundwater not encountered during excavation. Backfilled on 8/20/13 shortly after completion of excavating.						
Note: Groundwater, though not encountered at the time of excavating, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.						

DATE EXCAVATED 8/20/13 TEST PIT NO. TP-102
 GROUND ELEVATION 1,055'± (MSL) LOGGED BY MDE
 METHOD OF EXCAVATION Case 580 Super M Backhoe
 LOCATION Near Middle of East Dam Extension

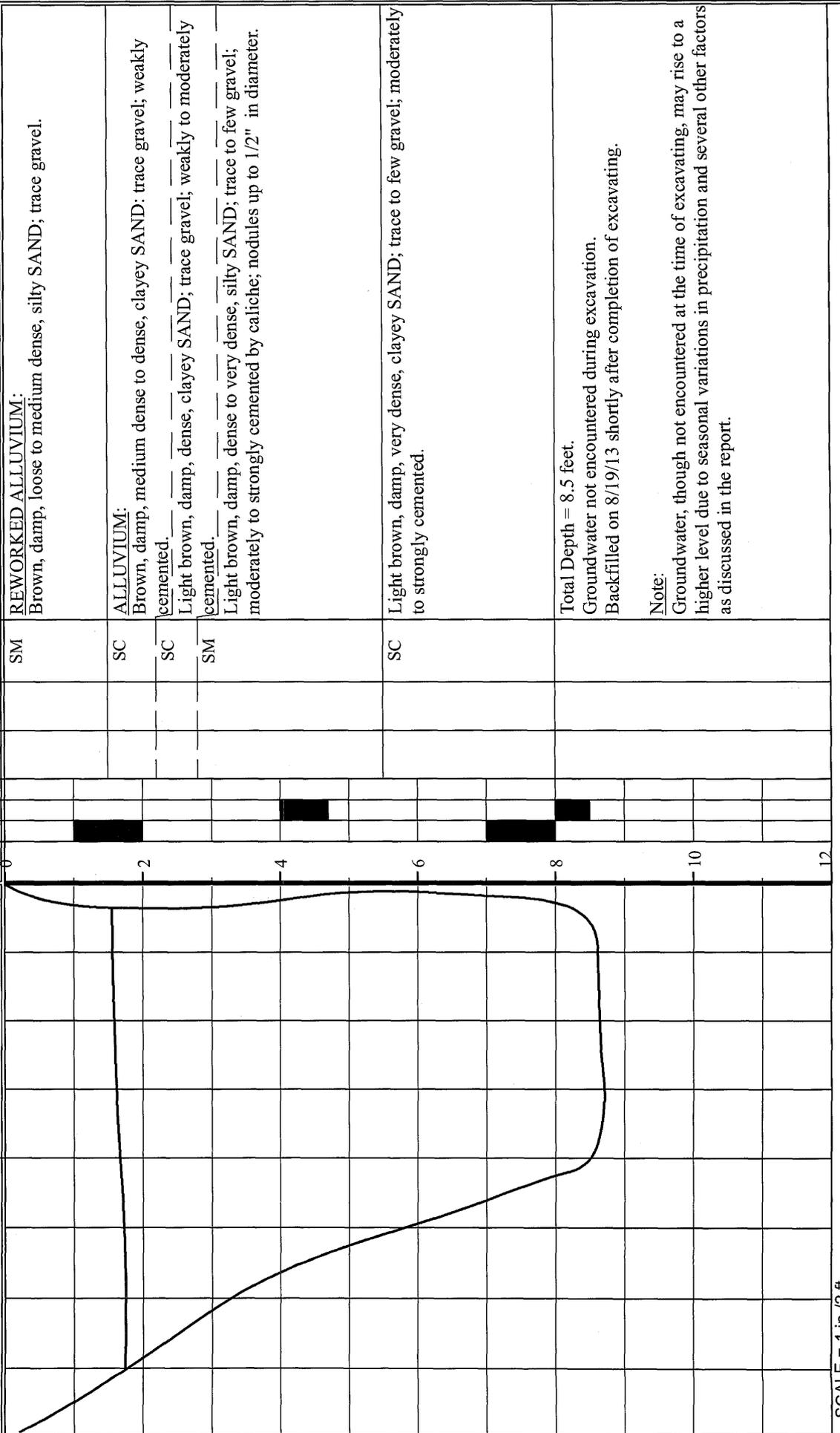
SCALE = 1 in./2 ft.

FIGURE B-8

TEST PIT LOG

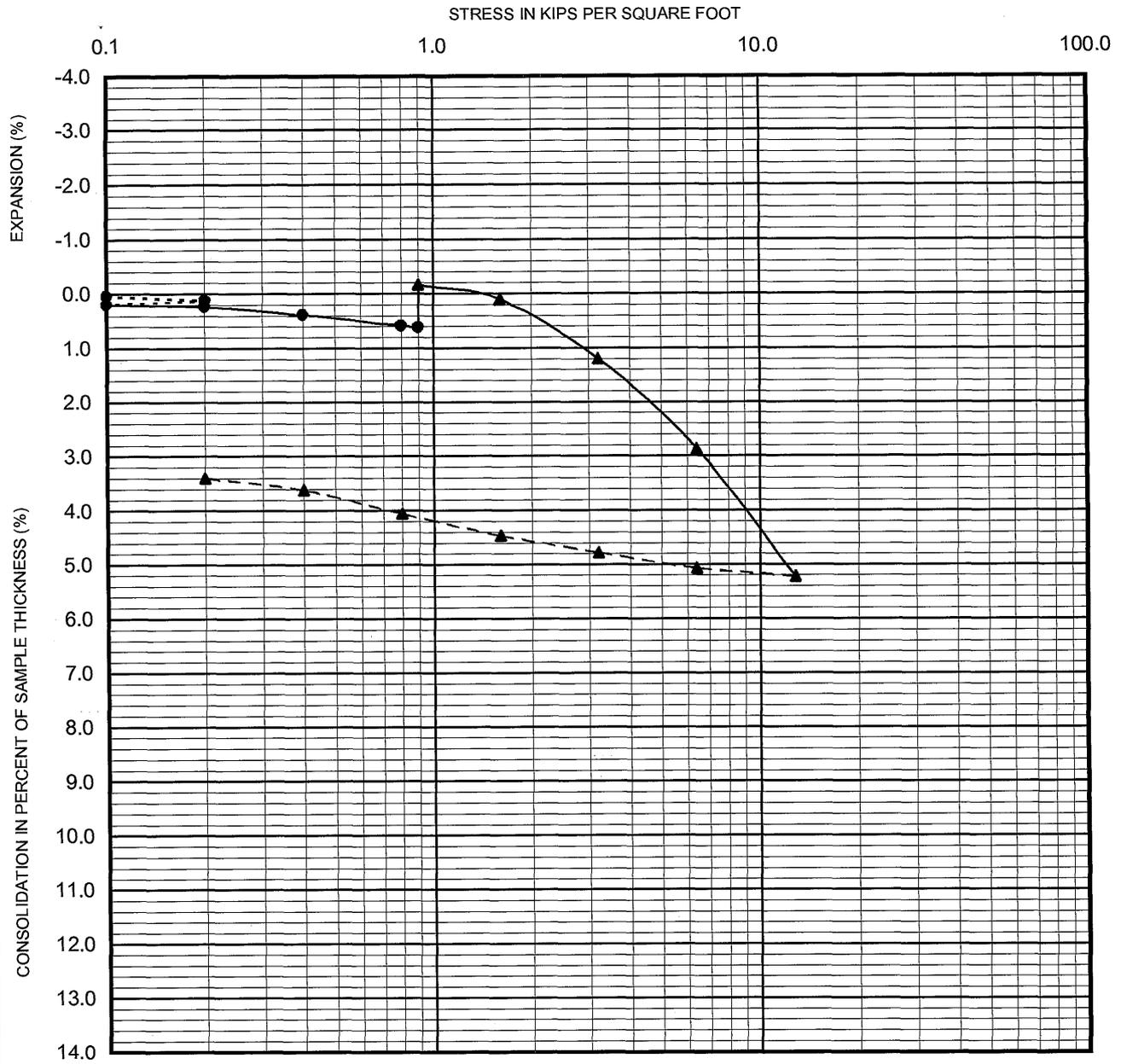
WHITE TANKS FRIS NO. 4 REHABILITATION PROJECT
BUCKEYE, ARIZONA

PROJECT NO. 602257001
DATE 12/14



SCALE = 1 in./2 ft.

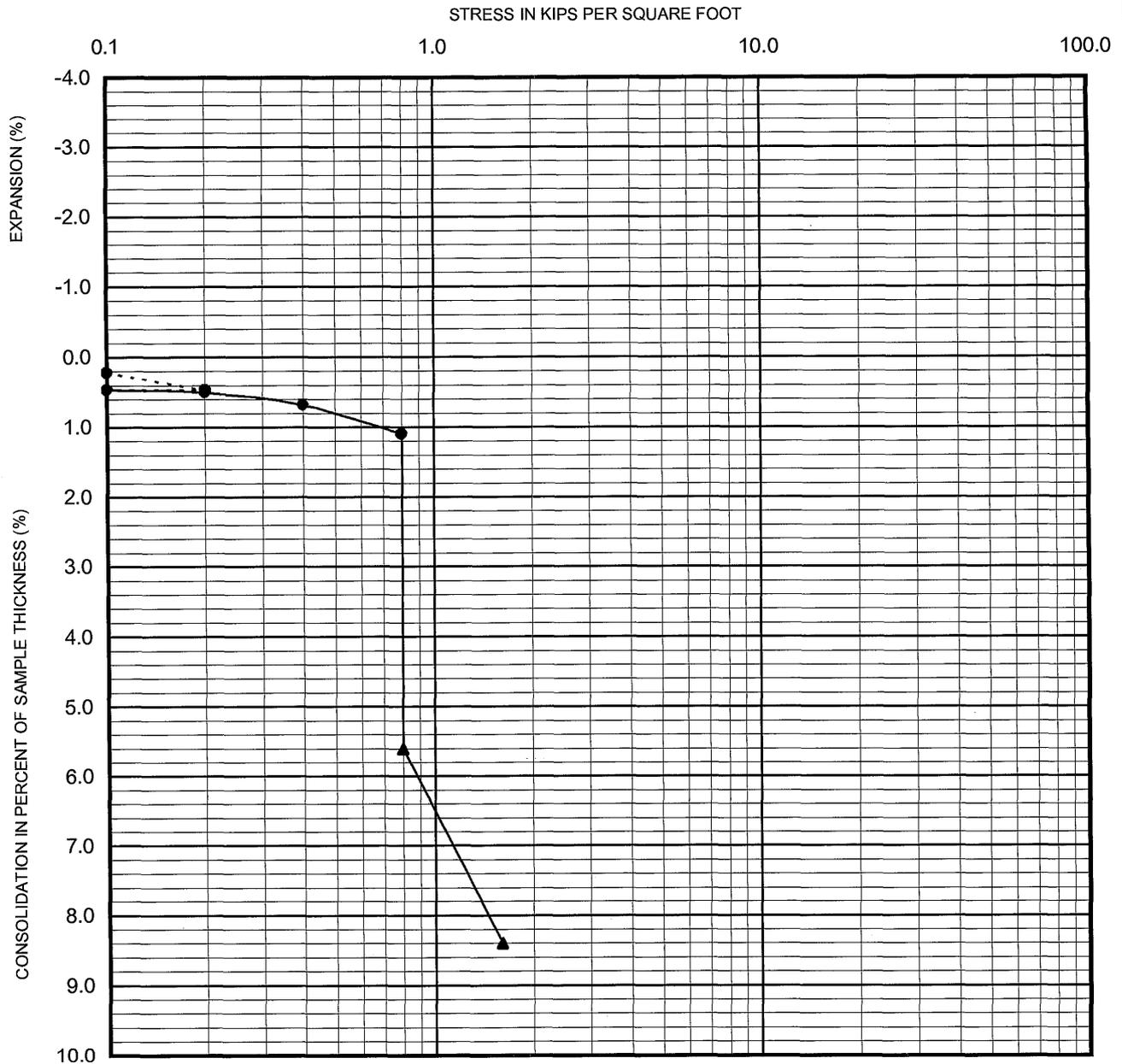
FIGURE B-10



---●---	Seating Cycle	Sample Location	B-37
—●—	Loading Prior to Inundation	Depth (ft.)	2.5-3.8
—▲—	Loading After Inundation	Soil Type	SC
---▲---	Rebound Cycle		

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

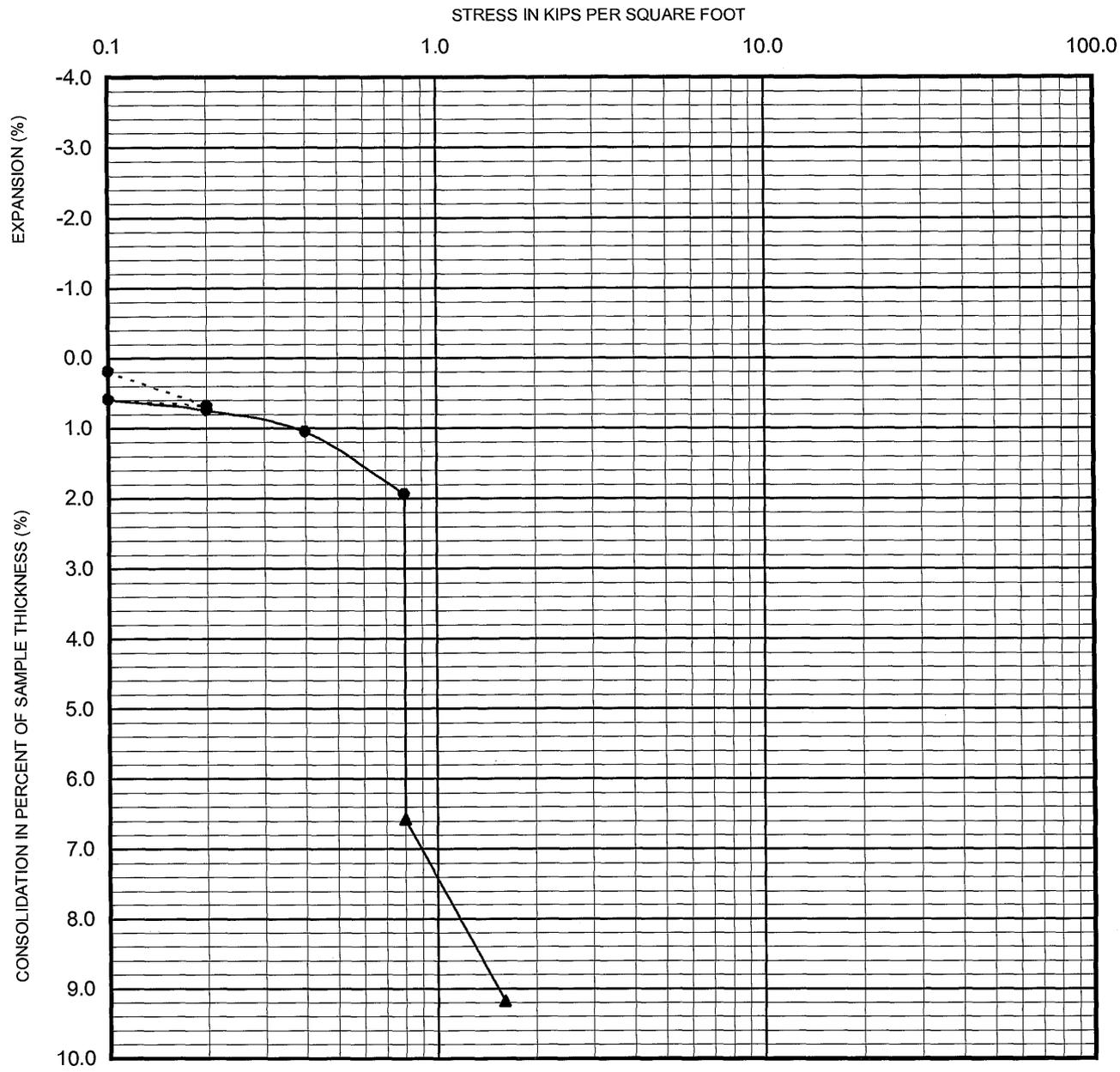
Ninyo & Moore		CONSOLIDATION TEST RESULTS	FIGURE
PROJECT NO.	DATE	WHITE TANKS FRS NO. 4 REHABILITATION PROJECT, PHASE II BUCKEYE, ARIZONA	B-14
602257001	12/14		



---●---	Seating Cycle	Sample Location	TP-102
—●—	Loading Prior to Inundation	Depth (ft.)	4-4.8
—▲—	Loading After Inundation	Soil Type	SC
---▲---	Rebound Cycle		

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

Ninyo & Moore		CONSOLIDATION TEST RESULTS	FIGURE
PROJECT NO.	DATE		
602257001	12/14	WHITE TANKS FRS NO. 4 REHABILITATION PROJECT, PHASE II BUCKEYE, ARIZONA	B-18



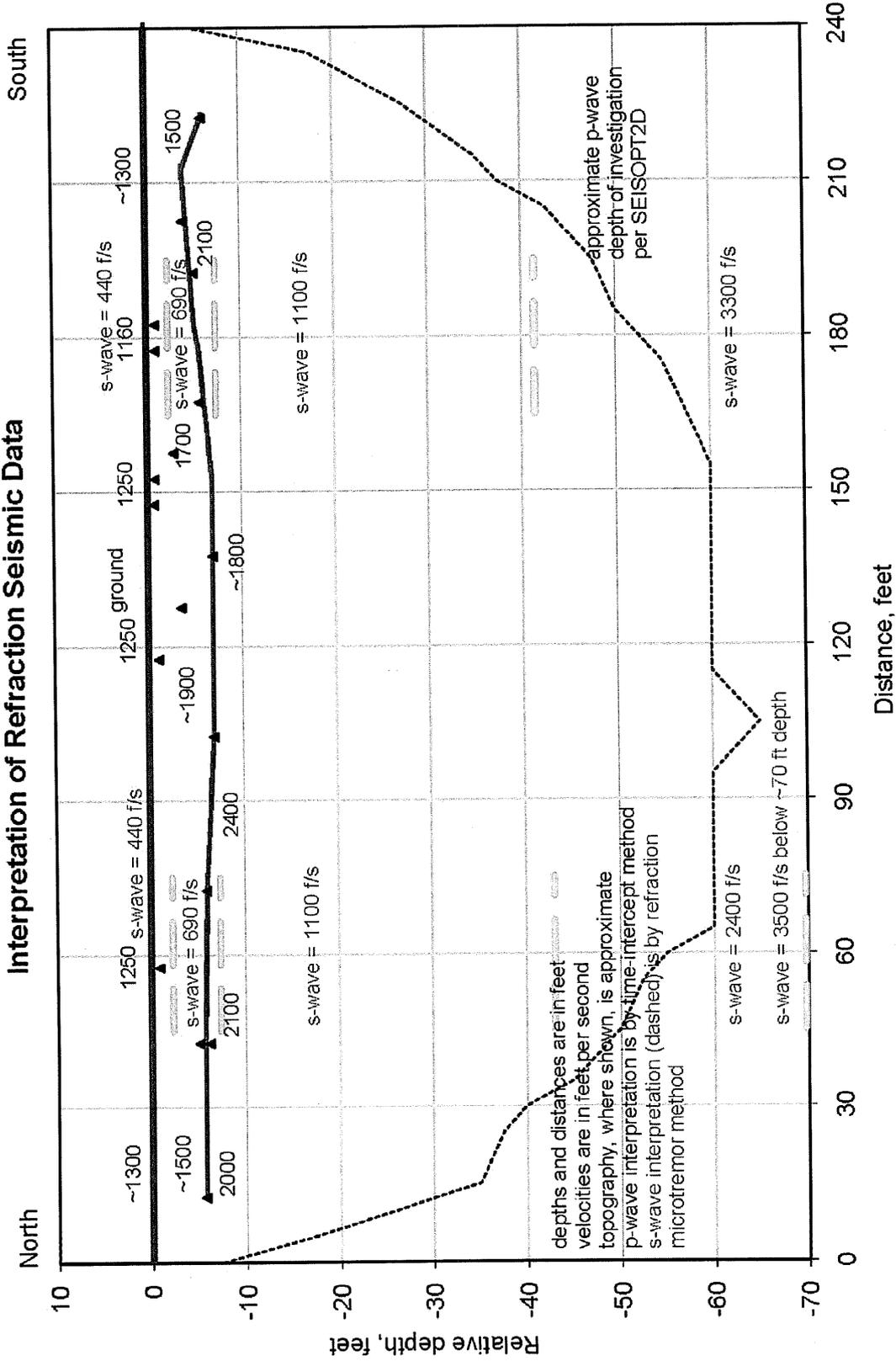
---●---	Seating Cycle	Sample Location	TP-104
—●—	Loading Prior to Inundation	Depth (ft.)	8-8.5
—▲—	Loading After Inundation	Soil Type	SC
---▲---	Rebound Cycle		

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

Ninyo & Moore		CONSOLIDATION TEST RESULTS	FIGURE
PROJECT NO.	DATE	WHITE TANKS FRS NO. 4 REHABILITATION PROJECT, PHASE II BUCKEYE, ARIZONA	B-20
602257001	12/14		

Line 37

Interpretation of Refraction Seismic Data

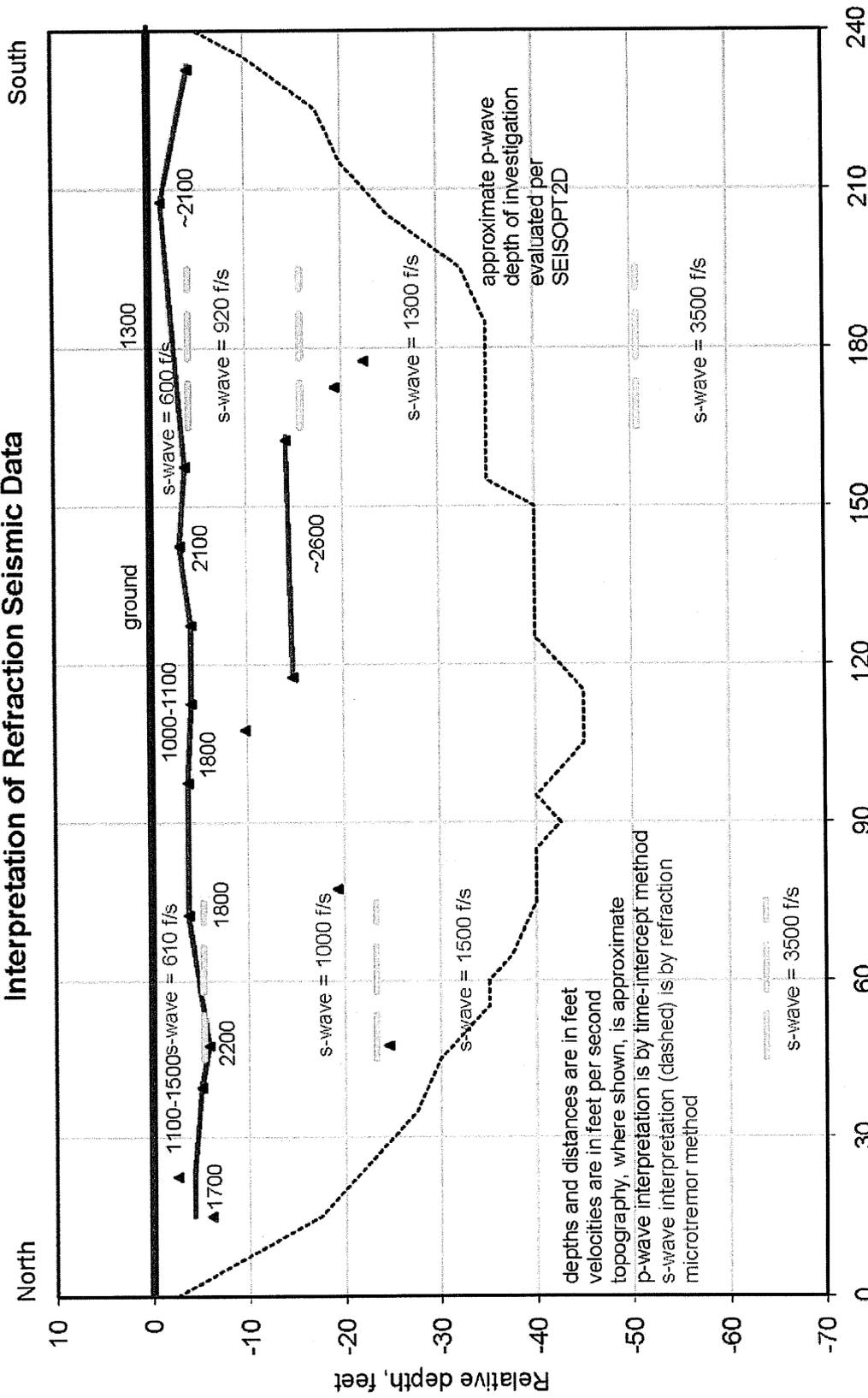


Ninyo & Moore		FIGURE B-22	
PROJECT NO: 602257001		NORTHEAST DAM EXTENSION, SEISMIC REFRACTION SURVEY LINE 37	
DATE: 12/14		WHITE TANKS FRS No. 4 REHABILITATION PROJECT, PHASE II BUCKEYE, ARIZONA	

Source: AMEC, 2011.

Line 39

Interpretation of Refraction Seismic Data



FIGURE

NORTHEAST DAM EXTENSION,
SEISMIC REFRACTION SURVEY LINE 39

B-24

Ninyo & Moore

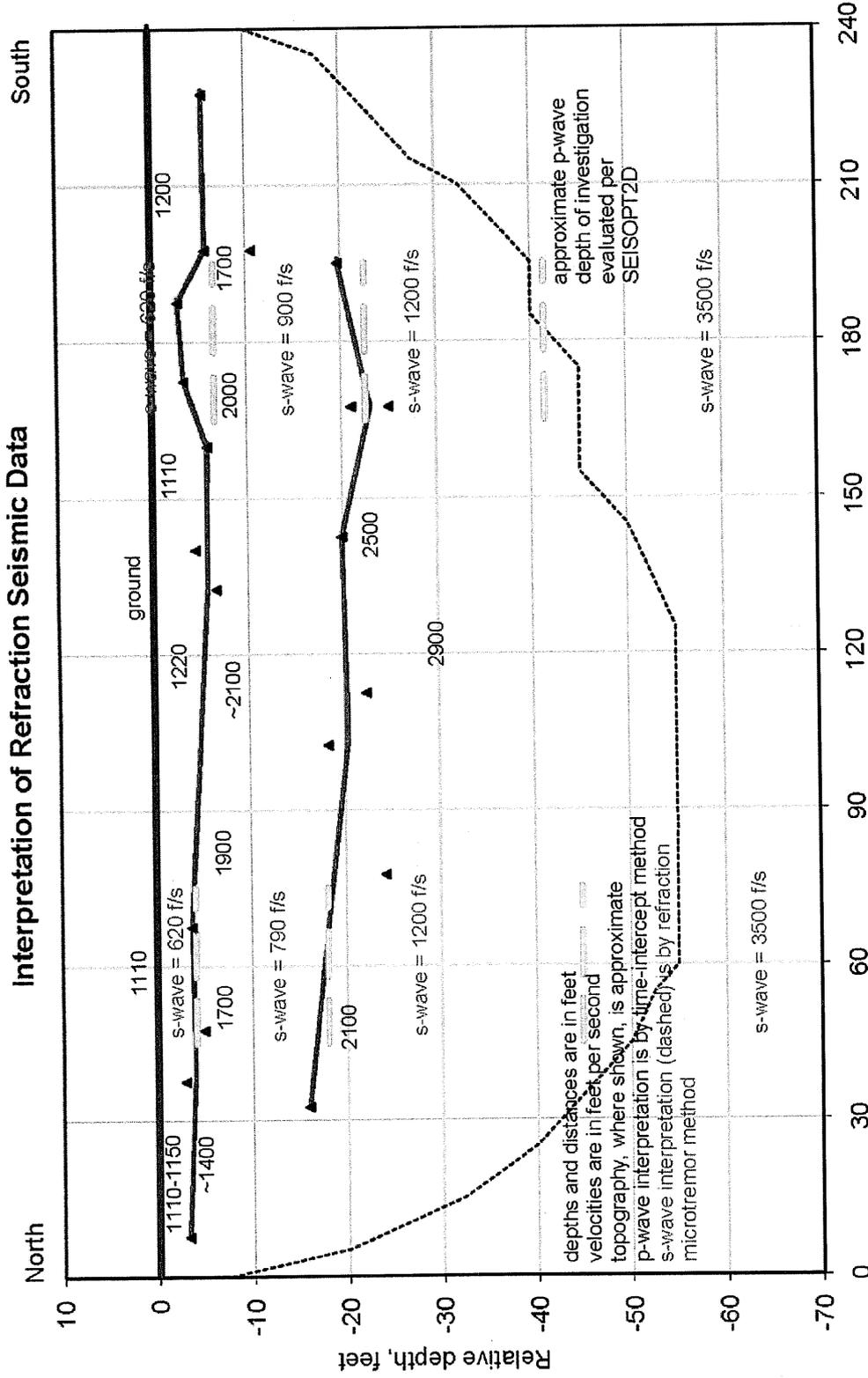
PROJECT NO:
602257001

DATE:
12/14

WHITE TANKS FRS No. 4 REHABILITATION PROJECT, PHASE II
BUCKEYE, ARIZONA

Line 41

Interpretation of Refraction Seismic Data



FIGURE

NORTHEAST DAM EXTENSION,
SEISMIC REFRACTION SURVEY LINE 41

B-26

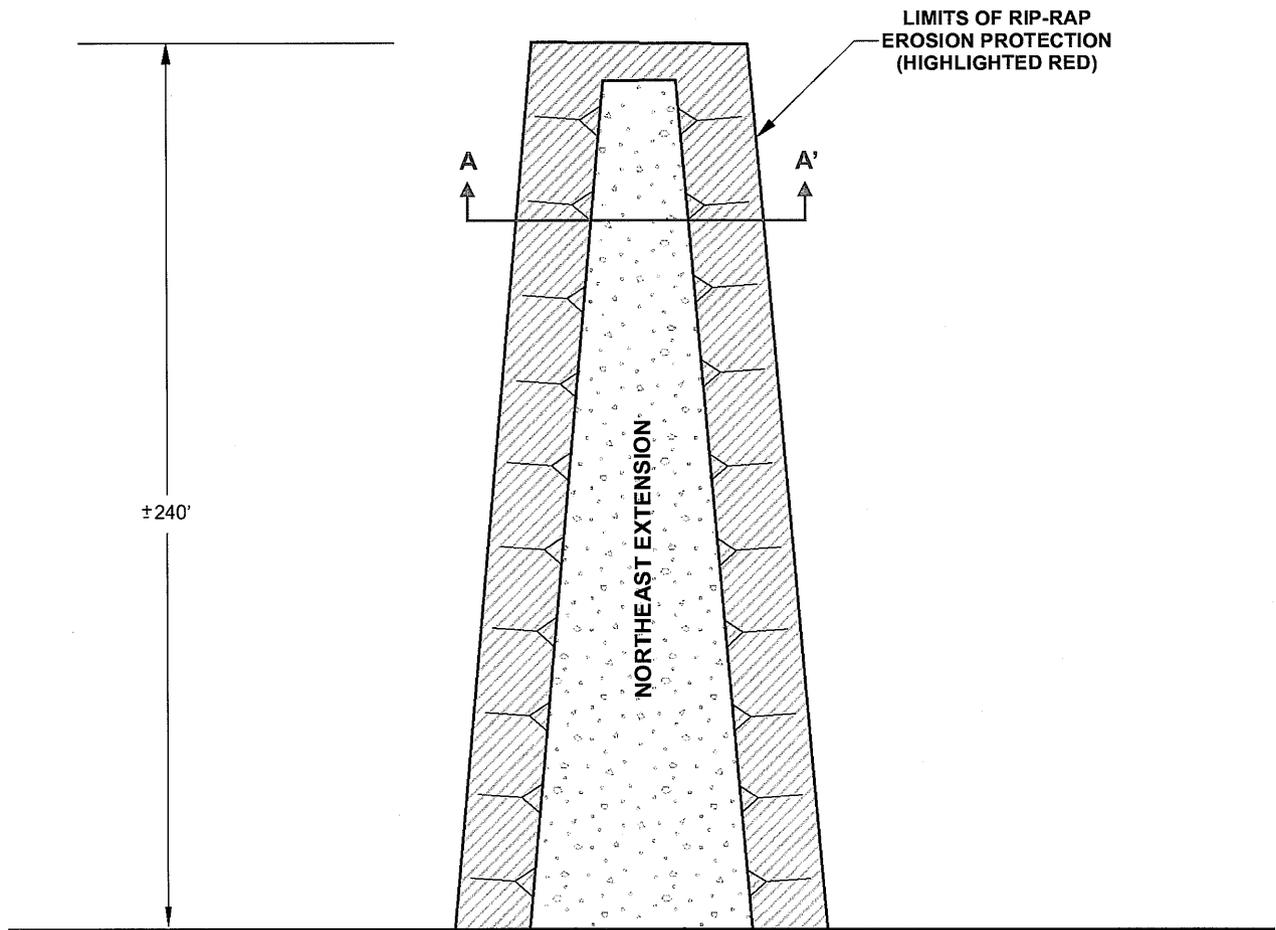
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BUCKEYE, ARIZONA

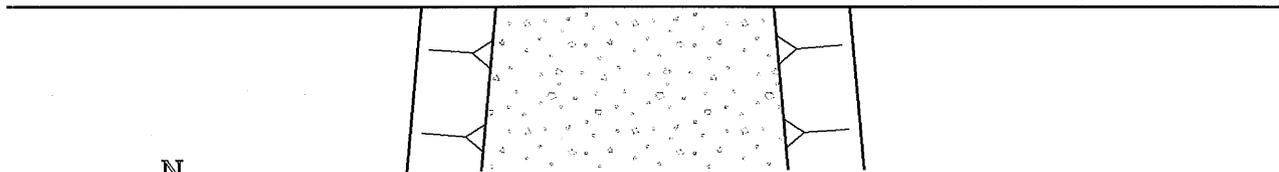
DATE:
12/14

PROJECT NO:
602257001

Source: AMEC, 2011.



← ROOSEVELT ALIGNMENT →



NOT TO SCALE

Note: Dimensions, directions and locations are approximate.

		NORTHEAST DAM EXTENSION, EMBANKMENT EROSION PROTECTION - PLAN VIEW		FIGURE
		WHITE TANKS FRS No. 4 REHABILITATION PROJECT, PHASE II BUCKEYE, ARIZONA		B-28
PROJECT NO: 602257001	DATE: 12/14			