WESTERN TECHNOLOGIES INC.

3737 East Broadway Road
P.O. Box 21387
Phoenix, Arizona 85036
(602) 437-3737

FLOOD CONTROL DISTRICT
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	FINANCE	1 RGB 10/23
REMARKS		

Flood Control District of Maricopa County
3335 West Durango Street
Phoenix, Arizona 85009

October 17, 1985

Attn: Chief, Construction and Contracting Branch

Re: Aqua Fria River Improvement Project
Thomas Road to north of Indian School Road
Construction Contract 85-10
Consultant Contract 85-12 Job No. 2155J020-E

This report contains the results of our geotechnical investigation for a portion of the proposed RID canal embankment located between Stations 20+50 to 24+00 on the above referenced project. The purpose of these services is to provide information relative to foundation conditions and the anticipated performance of the proposed embankment within this portion of the alignment.

Prior to the time of our exploration, this portion of the proposed embankment had been covered by 15 to 20 foot high aggregate stockpiles. We were informed by JSJ personnel that these stockpiles had been in-place approximately 18 months. During removal of the stockpiles, soft subsurface material was encountered which would not support large earthmoving equipment. At this point, removal of the aggregate was discontinued and several test pits were excavated in the area. Observation of the pits indicated that 3 to 8 feet of coarse aggregate remained over the very soft, saturated clay. JSJ personnel later confirmed that this area had been mined as an aggregate source, and then used as a settling pond for wash water from the nearby aggregate and ready-mix plant.

ENGINEERING DIVISION
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Phoenix, Arizona 85036
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FLOOD CONTROL DISTRICT
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OCT 23 '85

	CH ENG		HYDRO
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	MAINTENANCE	1	RGB 10/23
REMARKS			

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ENGINEERING DIVISION
LIBRARY

Three borings were drilled to depths of 25 to 39 feet at the stations shown on the Log of Boring sheets. In addition, continuous penetration resistance was measured at 10 other locations in an attempt to better define the western limits of the old pit. During exploration, subsurface materials were examined visually and sampled at selected intervals. As presented on Logs of Borings, 3.5 to 7.5 feet of coarse aggregate remained at the locations drilled. The underlying clay material exhibited low density and very high plasticity. The clay was soft to very soft and at or near saturation throughout the entire depth. Indications of organic material were encountered in all samples of the clay. Borings 1 and 2, drilled to depths of 25 and 27 feet, did not penetrate the clay. Dense sand, gravel and cobbles were encountered at a depth of 30.5 feet in Boring 3. Auger refusal occurred on cobbles at a depth of 39 feet in Boring 3. A static groundwater table did not develop in any of the borings at the time of this exploration.

Selected samples were tested for water content, density, gradation, plasticity, unconfined compressive strength, and consolidation characteristics. Laboratory test results indicate that the clay material is highly compressible and exhibits relatively low unconfined compressive strength. The water content of the clay was well above the plastic limit and nearing the liquid limit in all of the samples tested. Laboratory test results are included hereinafter.

During the field exploration, a shallow backhoe trench was excavated to locate the south side of the old pit. The edge was located approximately 5 feet south of the proposed canal centerline. This correlated well with the south edge of the existing pit near Sta. 13+00. Based on the continuous penetration measurements, the west end of the old pit was somewhat variable, but appeared to occur around Sta. 23+75. The side slope angles of the old pit are still unknown.

Based on the data developed during the field exploration and laboratory testing, the following conclusions and recommendations are presented:

- The clay sediment material contained within the old settling pond area is highly compressible and exhibits relatively low shear strength. It is anticipated that construction of the embankment, as designed, would be extremely difficult. Calculations indicate that continual progressive bearing capacity failure would occur in the pit foundation area during construction.

- Time rate of settlement analysis indicates that the clay deposit would require 12 to 15 years to reach 90 percent of primary consolidation. In addition, the moderate organic content of the clay would result in significant long-term secondary compression.

- Total settlements at the top of the north side-slope of the proposed embankment are estimated to be within a range of 3 to 4 feet. Native subsoils in the area consist of medium dense sand and gravel which will exhibit only minor settlements under embankment loadings. Since the edge of the old pit occurs within the canal prism, severe differential settlements will occur at this location resulting in cracking and displacement of the canal lining.

- The canal embankment, as designed, will be extremely difficult to construct over this portion of the proposed alignment. In addition, continual long-term maintenance problems should be anticipated as the clay sediment material consolidates with time.

It is recommended that the clay sediment material be removed if the canal embankment, as designed, is constructed over this portion of the alignment. Consideration should be given to redesigning and/or realigning the canal in this area. One such redesign might be a structural flume founded on the native subsoils south of the old pit. A reinforced fill, isolated from the flume, could then be constructed for required access adjacent to the north side. Movements would still be experienced in the fill areas underlain by the clay, but the flume would remain intact and maintenance problems would be greatly reduced. A large diameter pipeline, constructed in the native soil area, may also be a feasible alternative.

The conclusions and recommendations presented in this report are based on the assumption that the subsurface conditions do not deviate appreciably from those disclosed by the borings. If realignment or redesign is performed, additional exploration should be conducted to supplement this information and provide detailed geotechnical recommendations.

If you have any questions concerning this information, or if we may be of any additional service, please call us.

Sincerely,
WESTERN TECHNOLOGIES INC.
Geotechnical Services

Craig P. Wiedeman, P.E.

Reviewed by: Kenneth L. Ricker, P.E.

jh

Copies to: Addressee (3)

DEFINITION OF TERMINOLOGY

ALLOWABLE SOIL BEARING CAPACITY ALLOWABLE FOUNDATION PRESSURE	The recommended maximum contact stress developed at the interface of the foundation element and the supporting material.
BACKFILL	A specified material placed and compacted in a confined area.
BASE COURSE	A layer of specified material placed on a subgrade or subbase.
BASE COURSE GRADE	Top of base course.
BENCH	A horizontal surface in a sloped deposit.
CAISSON	A concrete foundation element cast in a circular excavation which may have an enlarged base. Sometimes referred to as a cast-in-place pier.
CONCRETE SLABS-ON-GRADE	A concrete surface layer cast directly upon a base, subbase or subgrade.
CRUSHED ROCK BASE COURSE	A base course composed of crushed rock of a specified gradation.
DIFFERENTIAL SETTLEMENT	Unequal settlement between or within foundation elements of a structure.
ENGINEERED FILL	Specified material placed and compacted to specified density and/or moisture conditions under observation of a representative of a soil engineer.
EXISTING FILL	Materials deposited through the action of man prior to exploration of the site.
EXISTING GRADE	The ground surface at the time of field exploration.
EXPANSIVE POTENTIAL	The potential of a soil to expand (increase in volume) due to the absorption of moisture.
FILL	Materials deposited by the action of man.
FINISHED GRADE	The final grade created as a part of the project.
GRAVEL BASE COURSE	A base course composed of naturally occurring gravel with a specified gradation.
HEAVE	Upward movement.
NATIVE GRADE	The naturally occurring ground surface.
NATIVE SOIL	Naturally occurring on-site soil.
ROCK	A natural aggregate of mineral grains connected by strong and permanent cohesive forces. Usually requires drilling, wedging, blasting or other methods of extraordinary force for excavation.
SAND AND GRAVEL BASE	A base course of sand and gravel of a specified gradation.
SAND BASE COURSE	A base course composed primarily of sand of a specified gradation.
SCARIFY	To mechanically loosen soil or break down existing soil structure.
SETTLEMENT	Downward movement.
SOIL	Any unconsolidated material composed of discrete solid particles, derived from the physical and/or chemical disintegration of vegetable or mineral matter, which can be separated by gentle mechanical means such as agitation in water.
STRIP	To remove from present location.
SUBBASE	A layer of specified material placed to form a layer between the subgrade and base course.
SUBBASE GRADE	Top of subbase.
SUBGRADE	Prepared native soil surface.

METHOD OF SOIL CLASSIFICATION
(ASTM D 2487)

COARSE-GRAINED SOILS

LESS THAN 50% FINES*

GROUP SYMBOLS	DESCRIPTION	MAJOR DIVISIONS
GW	WELL-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LESS THAN 5% FINES	GRAVELS More than half of coarse fraction is larger than No. 4 sieve size
GP	POORLY-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LESS THAN 5% FINES	
GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES, MORE THAN 12% FINES	
GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES, MORE THAN 12% FINES	
SW	WELL-GRADED SANDS OR GRAVELLY SANDS, LESS THAN 5% FINES	SANDS More than half of coarse fraction is smaller than No. 4 sieve size
SP	POORLY-GRADED SANDS OR GRAVELLY SANDS, LESS THAN 5% FINES	
SM	SILTY SANDS, SAND – SILT MIXTURES, MORE THAN 12% FINES	
SC	CLAYEY SANDS, SAND-CLAY MIXTURES, MORE THAN 12% FINES	

NOTE:
Coarse grained soils receive dual symbols if they contain 5 to 12% fines (e.g. SW-SM, GP-GC, etc.)

FINE-GRAINED SOILS

MORE THAN 50% FINES*

GROUP SYMBOLS	DESCRIPTION	MAJOR DIVISIONS
ML	INORGANIC SILTS, VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS	SILTS AND CLAYS Liquid limit less than 50
CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS	
OL	ORGANIC SILTS OR ORGANIC SILTY-CLAYS OF LOW PLASTICITY	
MH	INORGANIC SILTS, MICACEOUS OR DIA-TOMACEOUS FINE SANDS OR SILTS, ELASTIC SILTS	SILTS AND CLAYS Liquid Limit more than 50
CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY	
PT	PEAT, MUCK, AND OTHER HIGHLY ORGANIC SOILS	HIGHLY ORGANIC SOILS

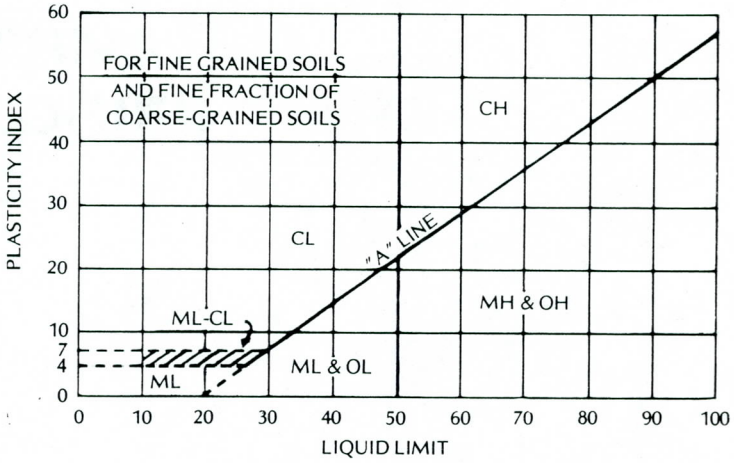
NOTE:
Fine grained soils receive dual symbols if their limits plot in the hatched zone on the Plasticity Chart (ML-CL)

SOIL SIZES

COMPONENT	SIZE RANGE
BOULDERS	ABOVE 12 in.
COBBLES	3 in. to 12 in.
GRAVEL	No. 4 to 3 in.
Coarse	¾ in. to 3 in.
Fine	No. 4 to ¾ in.
SAND	No. 200 to No. 4
Coarse	No. 10 to No. 4
Medium	No. 40 to No. 10
Fine	No. 200 to No. 40
*FINES (Silt or Clay)	BELOW No. 200

NOTE:
Only sizes smaller than three inches are used to classify soils.

PLASTICITY CHART



SOIL PROPERTIES

Job No. 2155J020-E

Boring No.	Depth, ft.	Soil Class.	Expansion/Compression					Water Soluble Matter, %		Shear Strength					Consolidation		
			Initial Dry Density pcf	Initial Moisture Content, %	Surcharge KSF	+ Expan. - Comp. %	Max. Swell Pressure KSF	Salts	Sulfates	Test Method	Initial Moisture Content, %	Dry Density pcf	C KSF	Ø Deg.	Initial Void Ratio	Surcharge KSF	Consol. %
1	5 - 8	CH								UC	85.1	94.5	0.21				
2	14 - 17	CH								UC	61.3 (4)	64.2 (1)	0.18				
3	5 - 8	CH								UC	58.1 (4)	63.6 (1)	0.60				

Boring No.	Depth, ft.	Remarks
1	5 - 8	Possible sample disturbance during test preparation.

LEGEND

Shear Strength Test Method
- DS Direct Shear
- DS Direct Shear (saturated)
- UC Unconfined Compression
- UU Unconsolidated Undrained
- CU Consolidated Undrained w/pore press
- CU Consolidated Undrained
- CD Consolidated Drained
- CR Cyclic Consolidated Undrained w/pore press

REMARKS

1. In-situ density.
2. Compacted density (Approx. 95% of ASTM:D698 max. density at moisture content slightly below optimum).
3. Compacted density (Approx. 95% of ASTM:D1557 max. density at moisture content slightly below optimum).
4. In-situ moisture.
5. Submerged to approximate saturation.
6. Consolidation % upon saturation.
7.

PHYSICAL PROPERTIES

Job No. 2155J020-E

Boring No.	Depth, ft.	Soil Class.	Particle Size Distribution, % Passing by wt.					Atterberg Limits		Moisture - Density Rel.			Specific Gravity	Permeability		'R' Value	Remarks
			3"	#4	#10	#40	#200	LL	PI	Dry Density pcf	Optimum Moisture %	Meth.		Dry Density pcf	K Cm/Sec	Corrected 'R'	
1	5 - 8	CH					100	70	52								2
1	8 - 9	CH					96	85	63								2
1	17 -	CH					100	81	63								2
2	14 - 17	CH					98	77	57								2
2	24 - 27	CH					100	78	57								2
3	5 - 8	CH					100	65	48								2
3	13 - 16	CH					90	72	55								2

Boring No.	Depth, ft.	Comments

REMARKS

Classification/Particle Size
1. Visual
2. Laboratory Tested
3. Minus #200 Only

Moisture Density Relationship
4. Tested ASTM D-689/AASHTO T-99
5. Tested ASTM D-1557/AASHTO T-180
6. Other_____

Specific Gravity
7. Minus #4
8. Plus #4

Permeability
9. Constant Head
10. Falling Head

'R' Value
11. Expansion Pressure_____psf
12. Exudation Pressure_____psi

Note: NP = nonplastic

CONSOLIDATION PROPERTIES OF SOIL

Job No. 2155J020-E

Lab/Invoice No. _____

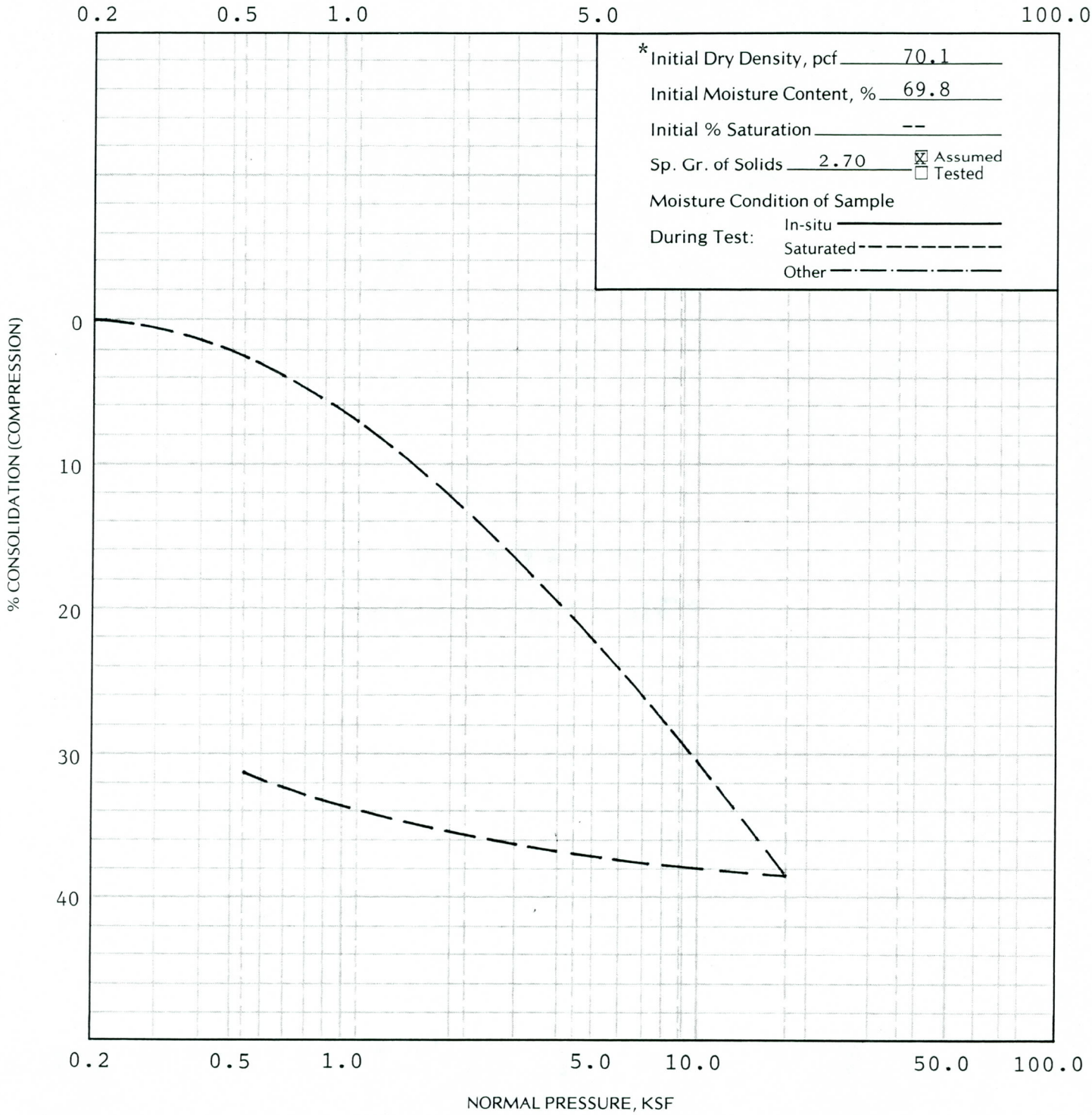
Date of Report _____

Reviewed By CPW

Type of Material Clay (CH)

Source of Material Shelby Tube Sample ☒ Undisturbed ☐ Remolded ☐ Compacted

Boring 1 Depth 5 - 8 Test Procedure ASTM D2435-



*Possible sample disturbance.

CONSOLIDATION PROPERTIES OF SOIL

Job No. 2155J020-E

Lab/Invoice No.

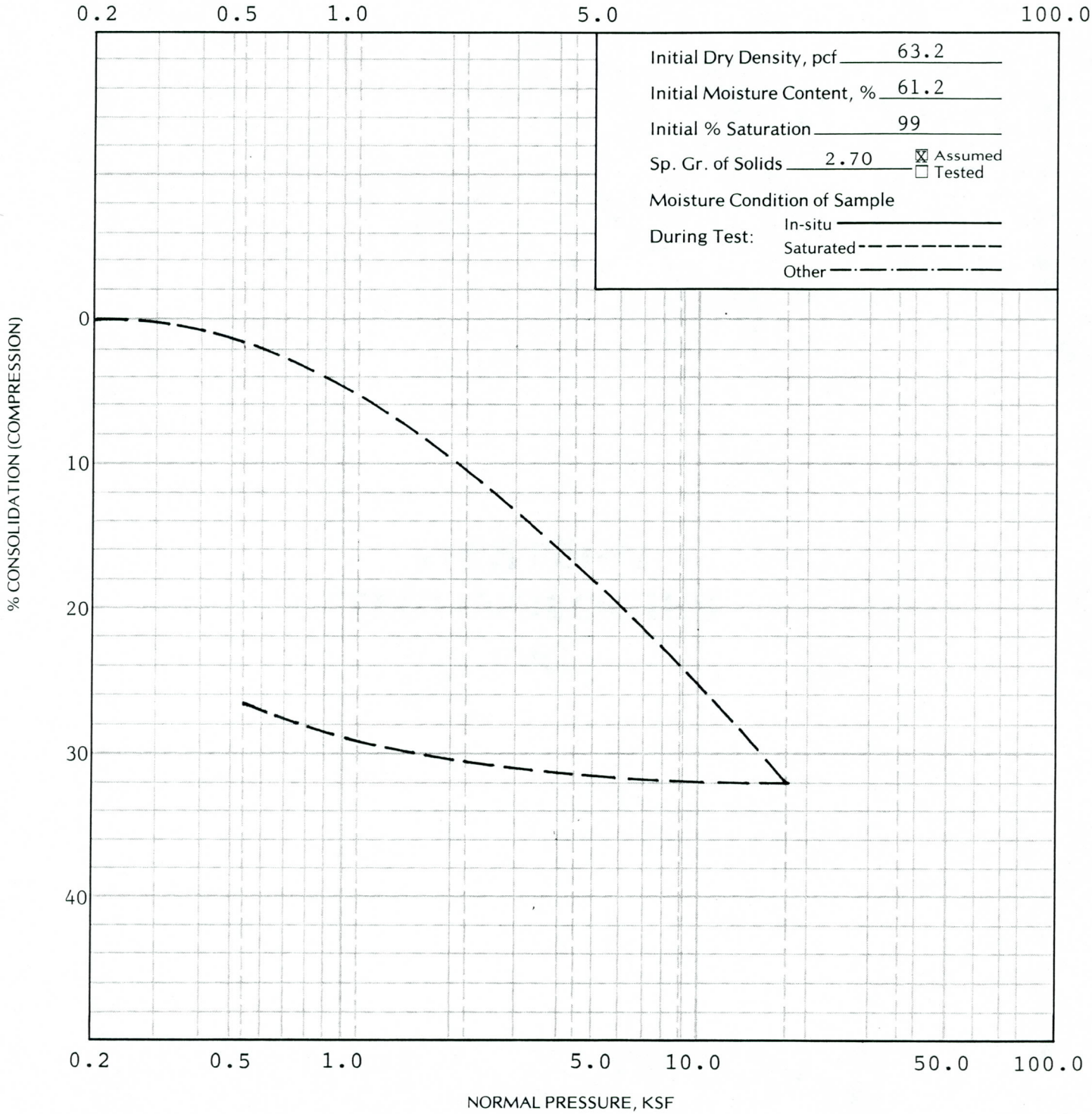
Date of Report

Reviewed By CPW

Type of Material Clay (CH)

Source of Material Shelby Tube Sample ☒ Undisturbed ☐ Remolded ☐ Compacted

Boring 2 Depth 14-17 Test Procedure ASTM D2435-



CONSOLIDATION PROPERTIES OF SOIL

Job No. 2155J020-E

Lab/Invoice No.

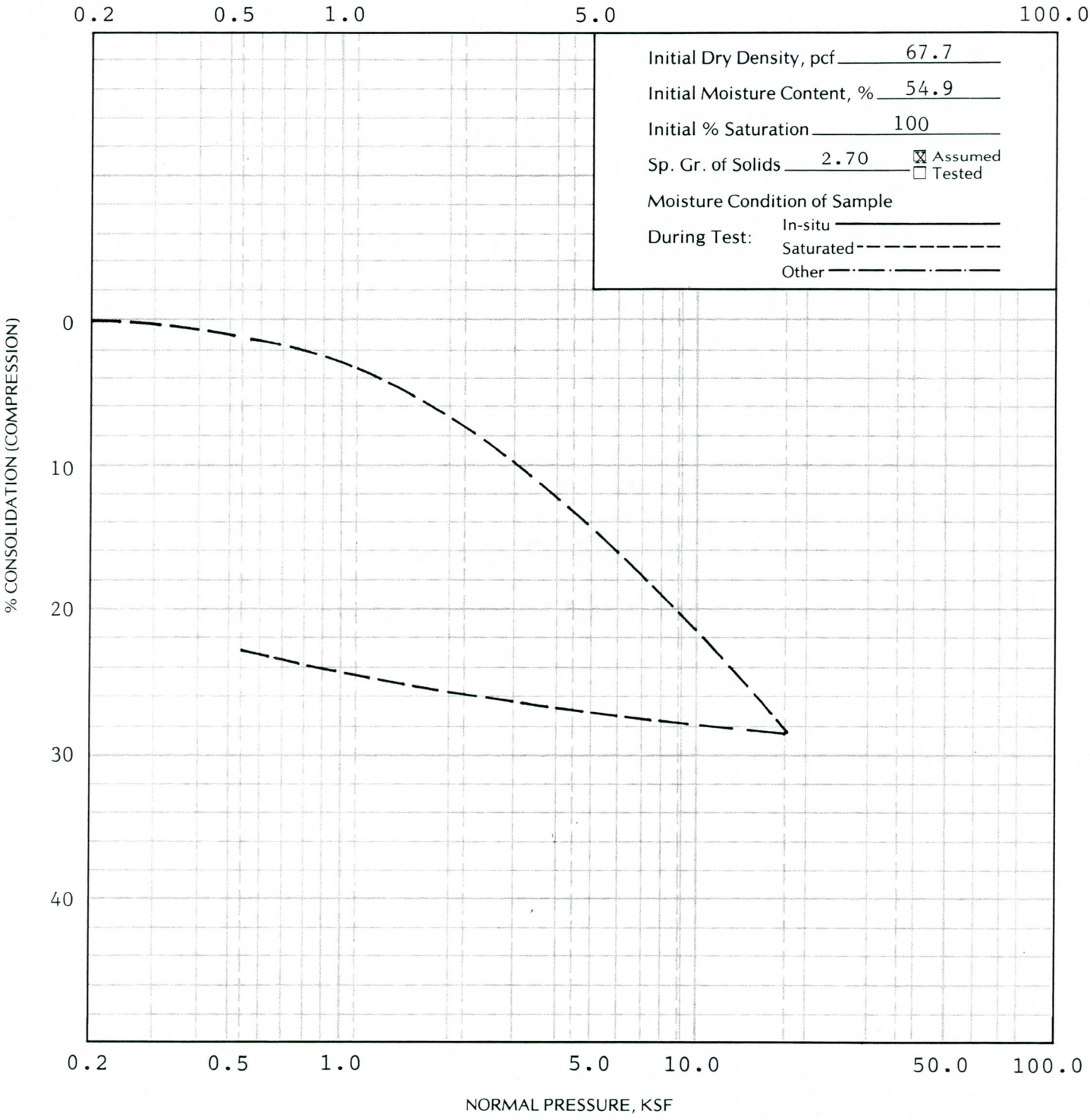
Date of Report

Reviewed By CPW

Type of Material Clay (CH)

Source of Material Shelby Tube Sample ☒ Undisturbed ☐ Remolded ☐ Compacted

Boring 3 Depth 5-8 Test Procedure ASTM D2435-



Flood Control District of Maricopa County
Job No. 2155J020-E

BORING LOG NOTES

"STA" refers to the approximate stationing of the boring along the proposed canal alignment according to centerline control points.

"R" or "L" refers to the approximate lateral offset, right or left respectively, from the centerline of the proposed canal alignment.

"ELEVATION" refers to ground surface elevation at the boring location relative to the indicated "DATUM" established by measurements with a hand level from a project bench mark.

"TYPE/SIZE BORING" refers to the exploratory equipment used in the boring wherein HSA = hollow-stem auger.

"C" in "Blows/Foot" refers to the number of blows of a 140-pound weight, dropped 30 inches, required to advance an AW rod tipped with a two-inch-outside-diameter disk a distance of 1 foot. Refusal to penetration is considered more than 100 blows per foot.

"N" in "Blows/Foot" refers to the number of blows of a 140-pound weight, dropped 30 inches, required to advance a two-inch-outside-diameter split-barrel sampler a distance of 1 foot, Standard Penetration Test (ASTM D1586). Refusal to penetration is defined as more than 100 blows per foot.

"R" in "Blows/Foot" refers to the number of blows of a 140-pound weight, dropped 30 inches, required to advance a 2.42-inch-inside-diameter ring sampler a distance of 1 foot. Refusal to penetration is considered more than 50 blows per foot.

"Sample Type" refers to the form of sample recovery, in which N = Split-barrel sample, R = Ring sample, and T = Thin-walled tube sample.

"Dry Density, pcf" refers to the laboratory-determined dry density in pounds per cubic foot. The symbol "NR" indicates that no sample was recovered. The symbol "*" indicates that determination of dry density was not possible.

"Water Content, %" refers to the laboratory-determined moisture content in percent (ASTM D2216).

"Unified Classification" refers to the soil type as defined by "Method of Soil Classification". The soils were classified visually in the field and, where appropriate, classifications were modified by visual examination of samples in the laboratory and/or by appropriate tests.

BORING LOG NOTES (Cont'd)

These notes and boring logs are intended for use in conjunction with the purposes of our services defined in the text. Boring log data should not be construed as part of the construction plans nor as defining construction conditions.

Boring logs depict our interpretations of subsurface conditions at the locations and on the date(s) noted. Variations in subsurface conditions and soil characteristics may occur between borings. Groundwater levels may fluctuate due to seasonal variations and other factors.

In general, terms and symbols on the boring logs conform with "Standard Definitions of Terms and Symbols Relating to Soil and Rock Mechanics" (ASTM D653).

LOG OF BORING NO. 1 Sta. 23+60 - 34' Rt.

Project RID Canal Embankment Job No. 2155J020-E

Elevation 1009' Datum Centerline Control

Type/Size Boring HSA/7" Rig Type CME 45

Groundwater Conditions None Encountered Date 9/16/85

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Water Content, %	Unified Classification	Description
						GP	SANDY GRAVEL AND COBBLES; some silt, trace clay, remnants of aggregate stockpile, brown to grey, medium dense, moist to wet
5						CH	CLAY; some silt, trace fine sand, reddish brown to grey, soft to very soft, contains plant fibers, near saturation
			T	94.5	85.1		
		3	R	*			
10							
15							
		6	R	64.6	53.5		
			T				
20							
25							
							Stopped @ 25.0 feet
30							

LOG OF BORING NO. 2 Sta. 22+60 - 23' Rt.

Project RID Canal Embankment Job No. 2155J020-E

Elevation 1007.5' Datum Centerline Control

Type/Size Boring HSA/7" Rig Type CME 45

Groundwater Conditions None Encountered Date 9/17/85

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Water Content, %	Unified Classification	Description
5						GP	SANDY GRAVEL AND COBBLES; some silt, trace clay, remnants of aggregate stockpile, brown to grey, medium dense, moist to wet
10			T	62.6	47.5	CH	CLAY; some silt, trace fine sand, reddish brown to grey, soft to very soft, contains plant fibers, near saturation
15			T	64.2	61.3		
20							
25			T	56.4	63.2		
30							Stopped @ 27.0 feet

FLOOD CONTROL DISTRICT of Maricopa County

Interoffice Memorandum

CMT. NO.	SUBJECT: Agua Fria Reach #3, Bid Opening	☐ FILE ☐ DESTROY

TO: FROM: DATE:

CONTRACTOR REVIEW PACKET

AGUA FRIA REA #3, CHANNELIZATION

6900-003
11/78

FLOOD CONTROL DISTRICT of Maricopa County

Interoffice Memorandum

CMT NO.	SUBJECT: Geotechnical Reports related to the Agua Fria River Channel Project	☐ FILE ☐ DESTROY

TO: Earl K. FROM: Dick P. DATE: 6 Mar 85

Attached are six geotech reports from sub-consultants of Simons, Li & Assoc. on the Agua Fria River. Please make them avail. to Western Technologies for their review. We would like to have them returned when they have reviewed them.

Dick.

6900-003
11/78

sla

SIMONS, LI & ASSOCIATES, INC.

120 WEST BROADWAY
SUITE 170
P.O. BOX 2712
TUCSON, ARIZONA 85702
TELEPHONE (602) 884-9594

Michael E. Zeller, P.E.
Vice President
John B. Lynch, P.E.
Associate
Clinton M. Glass, P.E.
Karl E. Kienow, P.E.
James K. Larrington, P.E.
Bayard T. Stevenson III, P.E.

March 4, 1985

Mr. Richard Perreault
Flood Control District of Maricopa County
3335 West Durango Street
Phoenix, Arizona 85009

RE: Agua Fria River Improvements: Buckeye Road to Upstream of Indian School Road

Dear Dick:

Transmitted herewith is one (1) copy each of geotechnical reports related to channelization projects for the Agua Fria River within the referenced reach. Following is a listing of the enclosed reports:

1. Agua Fria River Channelization: Thomas Road to Indian School Road, Report No. 1, dated September 1, 1983. Prepared by Sergent, Hauskins & Beckwith (SLA Project No. PAZ-MC-05).

2. Agua Fria River Channelization: Thomas Road to Indian School Road, Report No. 2 - Final Report, dated September 26, 1983. Prepared by Sergent, Hauskins & Beckwith (SLA Project No. PAZ-MC-05).

3. Roosevelt Irrigation District System Improvements, dated October 23, 1984. Prepared by Desert Earth Engineering (SLA Project No. PAZ-MC-08).

4. Agua Fria River Channelization: Grade-Control Structure at Indian School Road Bridge, dated October 29, 1984. Prepared by Desert Earth Engineering (SLA Project No. PAZ-MC-06).

5. Agua Fria River Channelization: 500 Feet Downstream of Interstate 10 to McDowell Road, dated November 30, 1984. Prepared by Desert Earth Engineering (SLA Project No. PAZ-MC-07).

6. Addendum to Roosevelt Irrigation District System Improvements, dated December 3, 1984. Prepared by Desert Earth Engineering (SLA Project No. PAZ-MC-08).

7. Agua Fria Soil-Cement Design and Permeability Study, dated February 28, 1985. Prepared by Desert Earth Engineering (SLA Project Nos. PAZ-MC-06, PAZ-MC-07, and PAZ-MC-08).

These copies are for your information and files. Should you have any questions related to this matter, please contact me.

Very truly yours,

SIMONS, LI & ASSOCIATES, INC.

John B. Lynch

John B. Lynch, P.E.
Vice President for
Design and Construction Services

JBL:el

cc: Bob Mussetter

Enclosures

R42/R576

WESTERN TECHNOLOGIES INC.
3737 East Broadway Road
P.O. Box 21387
Phoenix, Arizona 85036
(602) 437-3737

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OCT 23 '85

	CH ENG		HYDRO
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2	ENGR		DESTROY
	FINANCE	1	
REMARKS			

October 17, 1985

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3335 West Durango Street
Phoenix, Arizona 85009

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Three borings were drilled to depths of 25 to 39 feet at the stations shown on the Log of Boring sheets. In addition, continuous penetration resistance was measured at 10 other locations in an attempt to better define the western limits of the old pit. During exploration, subsurface materials were examined visually and sampled at selected intervals. As presented on Logs of Borings, 3.5 to 7.5 feet of coarse aggregate remained at the locations drilled. The underlying clay material exhibited low density and very high plasticity. The clay was soft to very soft and at or near saturation throughout the entire depth. Indications of organic material were encountered in all samples of the clay. Borings 1 and 2, drilled to depths of 25 and 27 feet, did not penetrate the clay. Dense sand, gravel and cobbles were encountered at a depth of 30.5 feet in Boring 3. Auger refusal occurred on cobbles at a depth of 39 feet in Boring 3. A static groundwater table did not develop in any of the borings at the time of this exploration.

Selected samples were tested for water content, density, gradation, plasticity, unconfined compressive strength, and consolidation characteristics. Laboratory test results indicate that the clay material is highly compressible and exhibits relatively low unconfined compressive strength. The water content of the clay was well above the plastic limit and nearing the liquid limit in all of the samples tested. Laboratory test results are included hereinafter.

During the field exploration, a shallow backhoe trench was excavated to locate the south side of the old pit. The edge was located approximately 5 feet south of the proposed canal centerline. This correlated well with the south edge of the existing pit near Sta. 13+00. Based on the continuous penetration measurements, the west end of the old pit was somewhat variable, but appeared to occur around Sta. 23+75. The side slope angles of the old pit are still unknown.

Based on the data developed during the field exploration and laboratory testing, the following conclusions and recommendations are presented:

- The clay sediment material contained within the old settling pond area is highly compressible and exhibits relatively low shear strength. It is anticipated that construction of the embankment, as designed, would be extremely difficult. Calculations indicate that continual progressive bearing capacity failure would occur in the pit foundation area during construction.

- Time rate of settlement analysis indicates that the clay deposit would require 12 to 15 years to reach 90 percent of primary consolidation. In addition, the moderate organic content of the clay would result in significant long-term secondary compression.

- Total settlements at the top of the north side-slope of the proposed embankment are estimated to be within a range of 3 to 4 feet. Native subsoils in the area consist of medium dense sand and gravel which will exhibit only minor settlements under embankment loadings. Since the edge of the old pit occurs within the canal prism, severe differential settlements will occur at this location resulting in cracking and displacement of the canal lining.

- The canal embankment, as designed, will be extremely difficult to construct over this portion of the proposed alignment. In addition, continual long-term maintenance problems should be anticipated as the clay sediment material consolidates with time.

It is recommended that the clay sediment material be removed if the canal embankment, as designed, is constructed over this portion of the alignment. Consideration should be given to redesigning and/or realigning the canal in this area. One such redesign might be a structural flume founded on the native subsoils south of the old pit. A reinforced fill, isolated from the flume, could then be constructed for required access adjacent to the north side. Movements would still be experienced in the fill areas underlain by the clay, but the flume would remain intact and maintenance problems would be greatly reduced. A large diameter pipeline, constructed in the native soil area, may also be a feasible alternative.

The conclusions and recommendations presented in this report are based on the assumption that the subsurface conditions do not deviate appreciably from those disclosed by the borings. If realignment or redesign is performed, additional exploration should be conducted to supplement this information and provide detailed geotechnical recommendations.

If you have any questions concerning this information, or if we may be of any additional service, please call us.

Sincerely,
WESTERN TECHNOLOGIES INC.
Geotechnical Services

Craig P. Wiedeman, P.E.

Reviewed by: Kenneth L. Ricker, P.E.

jh

Copies to: Addressee (3)

SOIL PROPERTIES

Job No. 2155J020-E

Boring No.	Depth, ft.	Soil Class.	Expansion/Compression					Water Soluble Matter, %		Shear Strength					Consolidation		
			Initial Dry Density pcf	Initial Moisture Content, %	Surcharge KSF	+ Expan. - Comp. %	Max. Swell Pressure KSF	Salts	Sulfates	Test Method	Initial Moisture Content, %	Dry Density pcf	C KSF	ø Deg.	Initial Void Ratio	Surcharge KSF	Consol. %
1	5 - 8	CH								UC	85.1	94.5	0.21				
2	14 - 17	CH								UC	61.3 (4)	64.2 (1)	0.18				
3	5 - 8	CH								UC	58.1 (4)	63.6 (1)	0.60				

Boring No.	Depth, ft.	Remarks
1	5 - 8	Possible sample disturbance during test preparation.

LEGEND

Shear Strength Test Method
- DS Direct Shear
- DS Direct Shear (saturated)
- UC Unconfined Compression
- UU Unconsolidated Undrained
- CU Consolidated Undrained w/pore press
- CU Consolidated Undrained
- CD Consolidated Drained
- CR Cyclic Consolidated Undrained w/pore press

REMARKS

1. In-situ density.
2. Compacted density (Approx. 95% of ASTM:D698 max. density at moisture content slightly below optimum).
3. Compacted density (Approx. 95% of ASTM:D1557 max. density at moisture content slightly below optimum).
4. In-situ moisture.
5. Submerged to approximate saturation.
6. Consolidation % upon saturation.
7.

PHYSICAL PROPERTIES

Job No. 2155J020-E

Boring No.	Depth, ft.	Soil Class.	Particle Size Distribution, % Passing by wt.					Atterberg Limits		Moisture - Density Rel.			Specific Gravity	Permeability		'R' Value	Remarks
			3"	#4	#10	#40	#200	LL	PI	Dry Density pcf	Optimum Moisture %	Meth.		Dry Density pcf	K Cm/Sec	Corrected 'R'	
1	5 - 8	CH					100	70	52								2
1	8 - 9	CH					96	85	63								2
1	17 -	CH					100	81	63								2
2	14 - 17	CH					98	77	57								2
2	24 - 27	CH					100	78	57								2
3	5 - 8	CH					100	65	48								2
3	13 - 16	CH					90	72	55								2

Boring No.	Depth, ft.	Comments

REMARKS

Classification/Particle Size
1. Visual
2. Laboratory Tested
3. Minus #200 Only

Moisture Density Relationship
4. Tested ASTM D-689/AASHTO T-99
5. Tested ASTM D-1557/AASHTO T-180
6. Other_____

Specific Gravity
7. Minus #4
8. Plus #4

Permeability
9. Constant Head
10. Falling Head

'R' Value
11. Expansion Pressure_____psf
12. Exudation Pressure_____psi

Note: NP = nonplastic

CONSOLIDATION PROPERTIES OF SOIL

Job No. 2155J020-E

Lab/Invoice No.

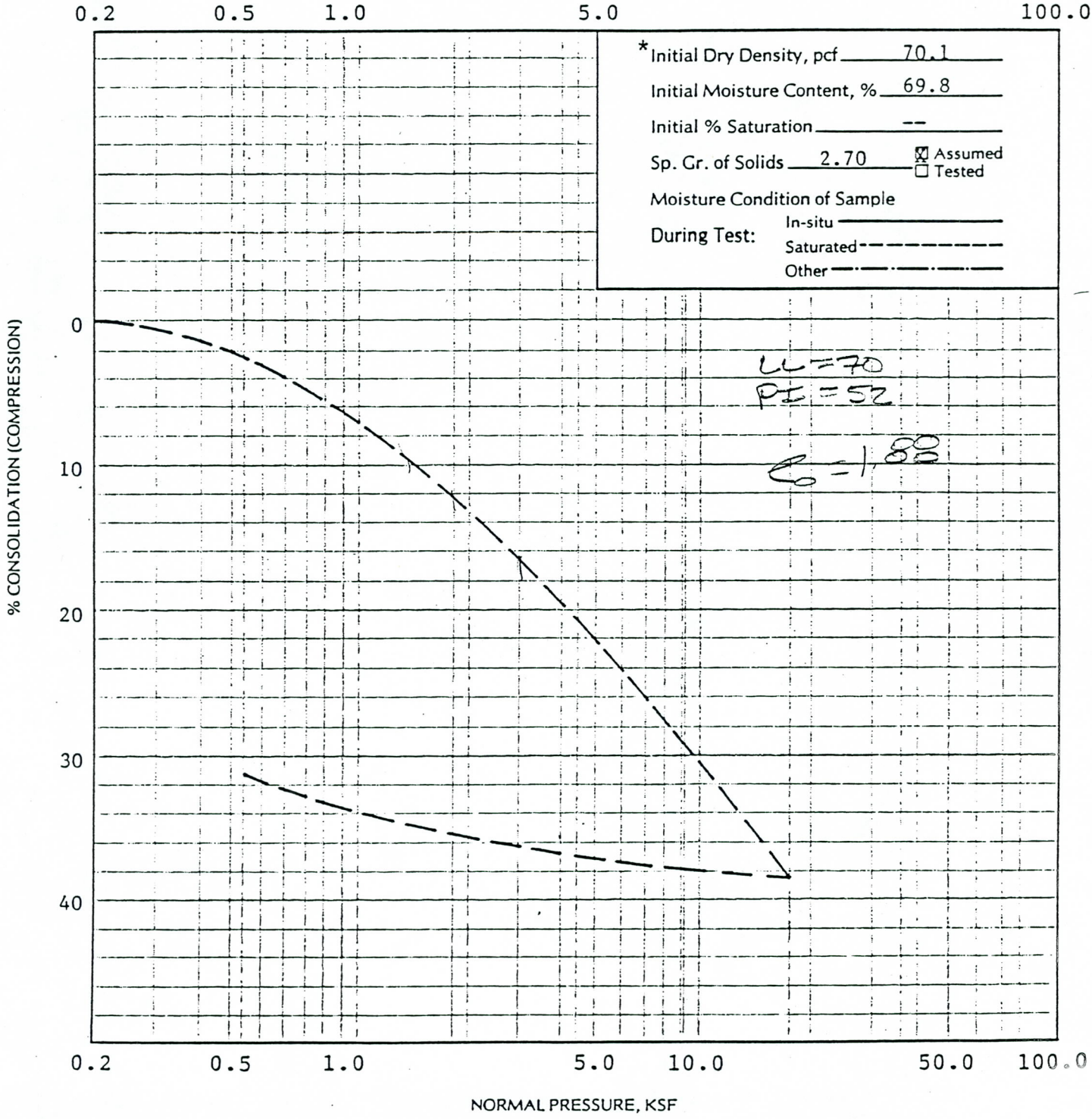
Date of Report

Reviewed By CPW

Type of Material Clay (CH)

Source of Material Shelby Tube Sample ☒ Undisturbed ☐ Remolded ☐ Compacted

Boring 1 Depth 5 - 8 Test Procedure ASTM D2435-



*Possible sample disturbance.

CONSOLIDATION PROPERTIES OF SOIL

Job No. 2155J020-E

Lab/Invoice No.

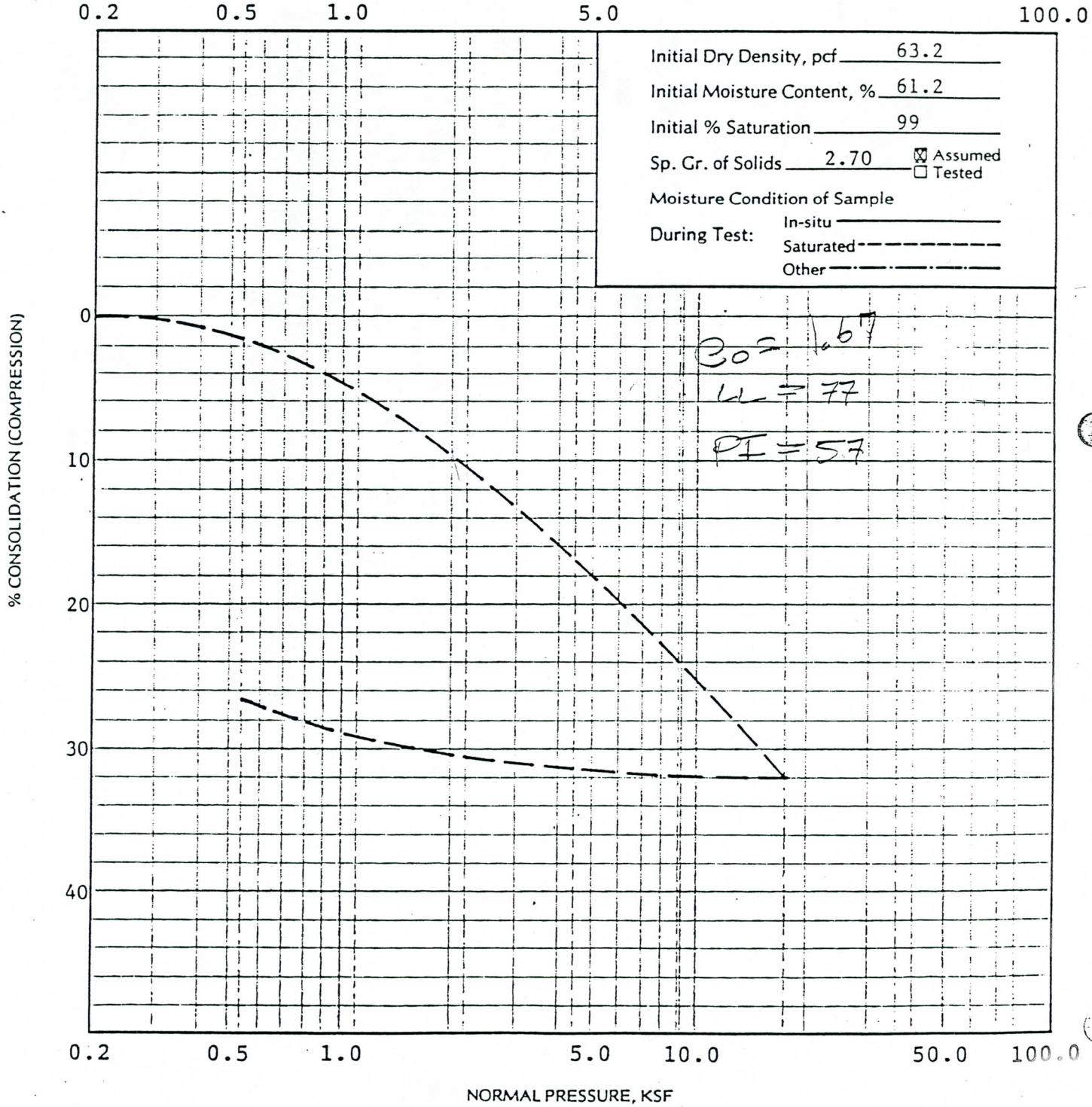
Date of Report

Reviewed By CPW

Type of Material Clay (CH)

Source of Material Shelby Tube Sample ☒ Undisturbed ☐ Remolded ☐ Compacted

Boring 2 Depth 14-17 Test Procedure ASTM D2435-



CONSOLIDATION PROPERTIES OF SOIL

Job No. 2155J020-E

Lab/Invoice No.

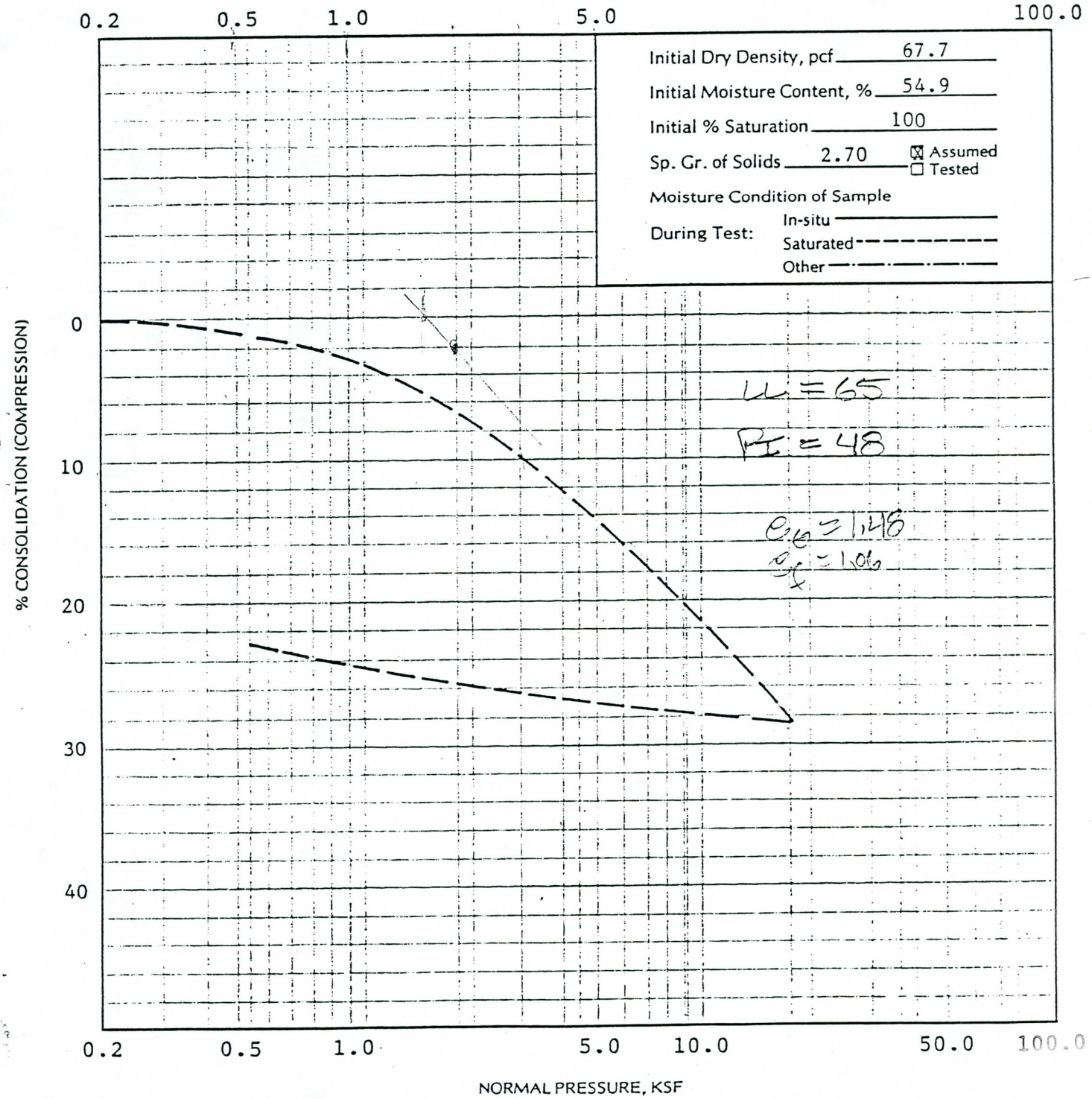
Date of Report

Reviewed By CPW

Type of Material Clay (CH)

Source of Material Shelby Tube Sample ☒ Undisturbed ☐ Remolded ☐ Compacted

Boring 3 Depth 5-8 Test Procedure ASTM D2435-



DEFINITION OF TERMINOLOGY

ALLOWABLE SOIL BEARING CAPACITY ALLOWABLE FOUNDATION PRESSURE	The recommended maximum contact stress developed at the interface of the foundation element and the supporting material.
BACKFILL	A specified material placed and compacted in a confined area.
BASE COURSE	A layer of specified material placed on a subgrade or subbase.
BASE COURSE GRADE	Top of base course.
BENCH	A horizontal surface in a sloped deposit.
CAISSON	A concrete foundation element cast in a circular excavation which may have an enlarged base. Sometimes referred to as a cast-in-place pier.
CONCRETE SLABS-ON-GRADE	A concrete surface layer cast directly upon a base, subbase or subgrade.
CRUSHED ROCK BASE COURSE	A base course composed of crushed rock of a specified gradation.
DIFFERENTIAL SETTLEMENT	Unequal settlement between or within foundation elements of a structure.
ENGINEERED FILL	Specified material placed and compacted to specified density and/or moisture conditions under observation of a representative of a soil engineer.
EXISTING FILL	Materials deposited through the action of man prior to exploration of the site.
EXISTING GRADE	The ground surface at the time of field exploration.
EXPANSIVE POTENTIAL	The potential of a soil to expand (increase in volume) due to the absorption of moisture.
FILL	Materials deposited by the action of man.
FINISHED GRADE	The final grade created as a part of the project.
GRAVEL BASE COURSE	A base course composed of naturally occurring gravel with a specified gradation.
HEAVE	Upward movement.
NATIVE GRADE	The naturally occurring ground surface.
NATIVE SOIL	Naturally occurring on-site soil.
ROCK	A natural aggregate of mineral grains connected by strong and permanent cohesive forces. Usually requires drilling, wedging, blasting or other methods of extraordinary force for excavation.
SAND AND GRAVEL BASE	A base course of sand and gravel of a specified gradation.
SAND BASE COURSE	A base course composed primarily of sand of a specified gradation.
SCARIFY	To mechanically loosen soil or break down existing soil structure.
SETTLEMENT	Downward movement.
SOIL	Any unconsolidated material composed of discrete solid particles, derived from the physical and/or chemical disintegration of vegetable or mineral matter, which can be separated by gentle mechanical means such as agitation in water.
STRIP	To remove from present location.
SUBBASE	A layer of specified material placed to form a layer between the subgrade and base course.
SUBBASE GRADE	Top of subbase.
SUBGRADE	Prepared native soil surface.

METHOD OF SOIL CLASSIFICATION
(ASTM D 2487)

COARSE-GRAINED SOILS

LESS THAN 50% FINES*

GROUP SYMBOLS	DESCRIPTION	MAJOR DIVISIONS
GW	WELL-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LESS THAN 5% FINES	GRAVELS More than half of coarse fraction is larger than No. 4 sieve size
GP	POORLY-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LESS THAN 5% FINES	
GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES, MORE THAN 12% FINES	
GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES, MORE THAN 12% FINES	
SW	WELL-GRADED SANDS OR GRAVELLY SANDS, LESS THAN 5% FINES	SANDS More than half of coarse fraction is smaller than No. 4 sieve size
SP	POORLY-GRADED SANDS OR GRAVELLY SANDS, LESS THAN 5% FINES	
SM	SILTY SANDS, SAND – SILT MIXTURES, MORE THAN 12% FINES	
SC	CLAYEY SANDS, SAND-CLAY MIXTURES, MORE THAN 12% FINES	

NOTE:
Coarse grained soils receive dual symbols if they contain 5 to 12% fines (e.g. SW-SM, GP-GC, etc.)

FINE-GRAINED SOILS

MORE THAN 50% FINES*

GROUP SYMBOLS	DESCRIPTION	MAJOR DIVISIONS
ML	INORGANIC SILTS, VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS	SILTS AND CLAYS Liquid limit less than 50
CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS	
OL	ORGANIC SILTS OR ORGANIC SILTY-CLAYS OF LOW PLASTICITY	
MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDS OR SILTS, ELASTIC SILTS	SILTS AND CLAYS Liquid Limit more than 50
CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY	
PT	PEAT, MUCK, AND OTHER HIGHLY ORGANIC SOILS	HIGHLY ORGANIC SOILS

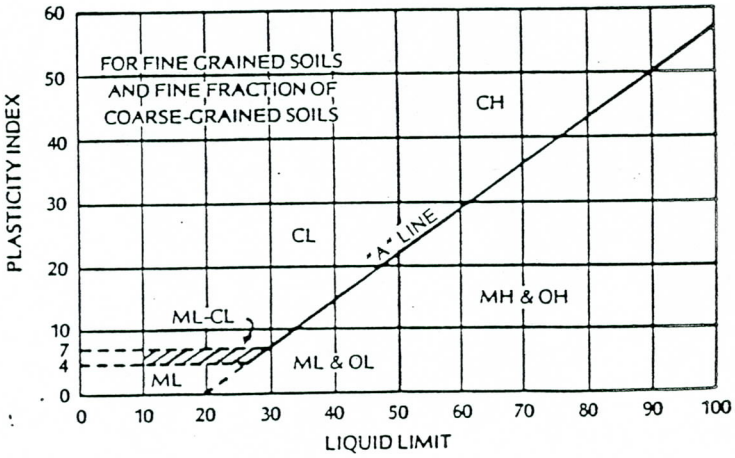
NOTE:
Fine grained soils receive dual symbols if their limits plot in the hatched zone on the Plasticity Chart (ML-CL)

SOIL SIZES

COMPONENT	SIZE RANGE
BOULDERS	ABOVE 12 in.
COBBLES	3 in. to 12 in.
GRAVEL	No. 4 to 3 in.
Coarse	¾ in. to 3 in.
Fine	No. 4 to ¾ in.
SAND	No. 200 to No. 4
Coarse	No. 10 to No. 4
Medium	No. 40 to No. 10
Fine	No. 200 to No. 40
*FINES (Silt or Clay)	BELOW No. 200

NOTE:
Only sizes smaller than three inches are used to classify soils.

PLASTICITY CHART



BORING LOG NOTES (Cont'd)

These notes and boring logs are intended for use in conjunction with the purposes of our services defined in the text. Boring log data should not be construed as part of the construction plans nor as defining construction conditions.

Boring logs depict our interpretations of subsurface conditions at the locations and on the date(s) noted. Variations in subsurface conditions and soil characteristics may occur between borings. Groundwater levels may fluctuate due to seasonal variations and other factors.

In general, terms and symbols on the boring logs conform with "Standard Definitions of Terms and Symbols Relating to Soil and Rock Mechanics" (ASTM D653).

WESTERN TECHNOLOGIES INC.

3737 East Broadway Road
P.O. Box 21387
Phoenix, Arizona 85036
(602) 437-3737

LETTER OF TRANSMITTAL

142

To: Maricopa County Flood Control District
3335 West Durango Street
Phoenix, Arizona 85009

Date: 11-06-85
Job No.: 2155J020
Lab./Invoice No.: **********
Ref. No.: FCD 85-10

Attn.: Chief, Construction & Contracting Branch

Project/Subject: Agua Fria River Improvements

FLOOD CONTROL DISTRICT
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	ADMIN		SUSP
1	C & O	5	FILE 85-10
	ENGR		DESTROY
	FINANCE	2	EOK
		3	WCH
		4	LCE

More fully described as follows: Attached is a copy of cross sections between south edge of existing flume and right of way south of the flume, R.I.D. Canal Stations 11+00, 13+00 and 15+00, showing fill placed within R.I.D. R/W by Continental Homes

For your:

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By Dal N. Wakefield

145

LOG OF BORING NO. 3 Sta. 21+57 - 19' Rt.

Project RID Canal Embankment Job No. 2155J020-E

Elevation 1005.5' Datum Centerline Control

Type/Size Boring HSA/7" Rig Type CME 75

Groundwater Conditions None Encountered Date 9/17/85

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Water Content, %	Unified Classification	Description
						GP	SANDY GRAVEL AND COBBLES; some silt, trace clay, remnants of aggregate stockpile, brown to grey, medium dense, moist to wet
5							
			T	63.6	58.1	CH	CLAY; some silt, trace fine sand, reddish brown to grey, soft to very soft, contains plant fibers, near saturation
10		4	N	NR			
15			T	62.7	62.4		
20			T	63.0	55.9		
25							
30							

LOG OF BORING NO. 3 CONTINUED

Project RID Canal Embankment Job No. 2155J020-E

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Moisture Content, %	Unified Classification	Description
31		39	N	*		CH	CLAY; (Cont'd)
						GW	SAND, GRAVEL AND COBBLES; trace silt and clay, brown, dense, wet
35							
40							Refusal @ 39.0 feet on cobbles
45							
50							
55							
60							

LOG OF BORING NO. 4 Sta. 24+00 - 12' Rt.

Project RID Canal Embankment Job No. 2155J020-E

Elevation 1011.0' Datum Centerline Control

Type/Size Boring -- Rig Type --

Groundwater Conditions None Encountered Date 10/1/85

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Water Content, %	Unified Classification	Description
	41						CONTINUOUS PENETRATION ONLY
	86						
	118						
	78						
5	44						
	33						
	30						
	17						
	6						
10	7						
	7						
	12						
	26						
	38						
15	39						
	30						
	37						
	47						
20							
25							
30							

LOG OF BORING NO. 5 Sta. 24+00 - 37' Rt.

Project RID Canal Embankment Job No. 2155J020-E

Elevation 1010.7' Datum Centerline Control

Type/Size Boring -- Rig Type --

Groundwater Conditions None Encountered Date 10/1/85

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Water Content, %	Unified Classification	Description
	10						CONTINUOUS PENETRATION ONLY
	20						
	26						
	28						
5	84						
	75						
	245						
	137						
	103						
10	90						
	80						
	55						
	55						
	50						
15	30						
	35						
	22						
	22						
	21						
20	22						
	24						
	13						
	9						
	12						
25	11						
30							

LOG OF BORING NO. 6 Sta. 23+70 - 33' Rt.

Project RID Canal Embankment Job No. 2155J020-E

Elevation 1008.6' Datum Centerline Control

Type/Size Boring -- Rig Type --

Groundwater Conditions None Encountered Date 10/1/85

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Water Content, %	Unified Classification	Description
	9						CONTINUOUS PENETRATION ONLY
	17						
	14						
	14						
5	20						
	17						
	16						
	17						
	19						
10	15						
	6						
	6						
	7						
	7						
15	6						
	6						
	5						
	6						
	6						
20	6						
	6						
	7						
	6						
	8						
25	8						
30							

LOG OF BORING NO. 7 Sta. 23+76 - 34' Rt.

Project RID Canal Embankment Job No. 2155J020-E

Elevation 1009.5' Datum Centerline Control

Type/Size Boring -- Rig Type --

Groundwater Conditions None Encountered Date 10/1/85

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Water Content, %	Unified Classification	Description
	2						CONTINUOUS PENETRATION ONLY
	5						
	16						
	20						
5	152						
	240						
	64						
	45						
	51						
10	34						
	24						
	19						
	7						
	6						
15	8						
	8						
	9						
	9						
	9						
20	9						
25							
30							

LOG OF BORING NO. 8 Sta. 23+90 - 34' Rt.

Project RID Canal Embankment Job No. 2155J020-E

Elevation 1010.0' Datum Centerline Control

Type/Size Boring -- Rig Type --

Groundwater Conditions None Encountered Date 10/1/85

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Water Content, %	Unified Classification	Description
	3						CONTINUOUS PENETRATION ONLY
	7						
	17						
	27						
5	252						
10							
15							
20							
25							
30							

LOG OF BORING NO. 8A Sta. 23+88 - 34' Rt.

Project RID Canal Embankment Job No. 2155J020-E

Elevation 1010.0' Datum Centerline Control

Type/Size Boring -- Rig Type --

Groundwater Conditions None Encountered Date 10/1/85

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Water Content, %	Unified Classification	Description
	4						CONTINUOUS PENETRATION ONLY
	10						
	22						
	55						
5	203						
	400						
10							
15							
20							
25							
30							

LOG OF BORING NO. 9 Sta. 23+70 - 5' Rt.

Project RID Canal Embankment Job No. 2155J020-E

Elevation 1008.4' Datum Centerline Control

Type/Size Boring -- Rig Type --

Groundwater Conditions None Encountered Date 10/1/85

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Water Content, %	Unified Classification	Description
	30						CONTINUOUS PENETRATION ONLY
	64						
	100						
	85						
5	39						
	8						
	5						
	6						
	8						
10	9						
	11						
	23						
	27						
	29						
15	31						
20							
25							
30							

LOG OF BORING NO. 10 Sta. 23+76 - 5' Rt.

Project RID Canal Embankment Job No. 2155J020-E

Elevation 1008.9' Datum Centerline Control

Type/Size Boring -- Rig Type --

Groundwater Conditions None Encountered Date 10/1/85

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Water Content, %	Unified Classification	Description
	24						CONTINUOUS PENETRATION ONLY
	75						
	240						
5							
10							
15							
20							
25							
30							

LOG OF BORING NO. 11 Sta. 23+50 - 20' Rt.

Project RID Canal Embankment Job No. 2155J020-E

Elevation 1007.7' Datum Centerline Control

Type/Size Boring -- Rig Type --

Groundwater Conditions None Encountered Date 10/1/85

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Water Content, %	Unified Classification	Description
	8						CONTINUOUS PENETRATION ONLY
	27						
	20						
	20						
5	19						
	27						
	13						
	8						
	3						
10	3						
	4						
	4						
	5						
	4						
15	3						
	5						
	6						
	6						
	8						
20	7						
	9						
	9						
	10						
	9						
25	10						
	11						
	13						
	14						
	19						
30	40						

LOG OF BORING NO. 12 Sta. 23+50 - Centerline

Project RID Canal Embankment Job No. 2155J020-E

Elevation 1007.5' Datum Centerline Control

Type/Size Boring -- Rig Type --

Groundwater Conditions None Encountered Date 10/1/85

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Water Content, %	Unified Classification	Description
	34						CONTINUOUS PENETRATION ONLY
	55						
	105						
	64						
5	28						
	19						
	16						
	13						
	8						
10	9						
	16						
	33						
	21						
	17						
15	34						
	41						
	33						
	25						
	75						
20	48						
25							
30							