ATL, INC.

CONSTRUCTION QUALITY CONTROL
GEOTECHNICAL CONSULTANTS

BULLARD WASH
LEVEES AND EMBANKMENTS
FCD PROJECT NO. 95-39
ATL JOB NO. 198013

BULLARD WASH
LEVEES AND EMBANKMENTS
FCD PROJECT NO. 95-39
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ATL Job No. 198013 *June 8, 1998*

GEOTECHNICAL INVESTIGATION

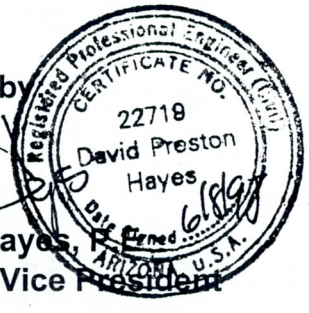
REPORT FOR

SVERDRUP CIVIL, INC.

PROJECT

BULLARD WASH
LEVEES AND EMBANKMENTS
FCD PROJECT NO. 95-39
ATL JOB NO. 198013

Reviewed by:



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June 8, 1998

Mr. Brad Olbert, P.E.
Sverdrup Civil, Inc.
637 South 48th Street, Suite 101
Tempe, AZ 85281

Re: Geotechnical Investigation Report
Bullard Wash
Levees and Embankments
FCD Project No. 95-39
ATL Job No. 198013

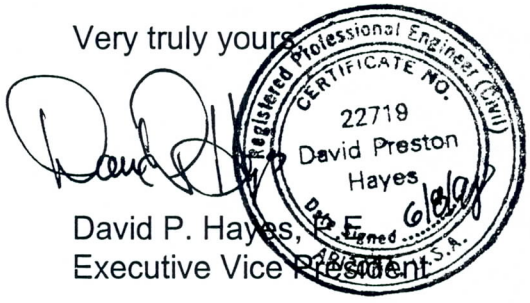
Dear Mr. Olbert:

This report presents the results of a geotechnical investigation for the proposed construction of a roadway embankment along Lower Buckeye Road, and a levee embankment on both sides of the proposed canal, between Broadway Road and the BID Canal, in Goodyear, Arizona. Field exploration, laboratory tests, and engineering analysis are included along with boring logs and laboratory results. ATL's work was performed in accordance with ATL Revised Proposal No. P97348 dated December 17, 1997.

ATL drilled and sampled nine (9) boreholes to depths of approximately 11½ feet below grade. The roadway embankment slopes should not be steeper than 2H:1V and the levee slopes should match the channel slopes on the front side and 1H:1V on the backside. A non-woven geotextile will be placed between the stepped gabion baskets and the soil embankment in the channel section.

ATL has appreciated the opportunity to be of service to Sverdrup Civil, Inc. on this project and looks forward to a continued association on future projects. Should any questions arise, please do not hesitate to contact us at your earliest convenience.

Very truly yours,



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GEOTECHNICAL INVESTIGATION

REPORT FOR

SVERDRUP CIVIL, INC.

PROJECT

BULLARD WASH
LEVEES AND EMBANKMENTS
FCD PROJECT NO. 95-39
ATL JOB NO. 198013

1.0 PROJECT DESCRIPTION

The Flood Control District of Maricopa County is intending to construct embankments in two areas along the Bullard Wash Channel. One area involves both sides of the Bullard Wash Channel from Broadway Road, south of the BID Canal and result in the construction of levees as an extension of the channel side slopes. The other area is located at the northern end of the channel at Lower Buckeye Road. The embankment that will be constructed near the northern end of the Channel will function as a roadway embankment for the extension of Lower Buckeye Road and will be oriented perpendicular to the new channel. This will require a northerly extension of the proposed Bullard Wash channel and the raising of Lower Buckeye Road. Farm roads will be constructed on either side of Lower Buckeye Road.

2.0 LOCATION AND SITE DESCRIPTION

The project site is located south of Interstate 10 Freeway (I-10), west of Litchfield Road, and east of Sarival Avenue. It is situated in a predominantly farm area in Goodyear, Arizona.

The project area is located in the western Salt River Valley, a broad basin filled with alluvium of varying grain-sizes. The fill deposits are composed of a Lower Conglomerate Unit consisting of cemented sand, gravel, silt, and clay but design considerations interested in materials found in the Upper Alluvial Unit, which consist primarily of sands and gravels with clay and silt lenses. Groundwater flows to the northwest, north of Yuma road and to the southwest, south of Yuma Road at depths between 40 and 120 feet below land surface.

3.0 SCOPE OF WORK

ATL's responsibility was to drill and sample sub-surface material in order to develop design data for the construction of the levee embankments.

Field and Laboratory testing were performed to appraise the ability of the in-situ soils to support the proposed embankments. The following issues were addressed as a result of the investigation:

1) Recommendations for the levee and embankment construction.
2) Settlements and Rapid Draw-down effects and Lateral Pressures on the proposed Levees and Embankment.
3) Earth Fill Stability.

4.0 DRILLING AND SAMPLING PROCEDURES

A total of nine (9) borings were drilled for this project, each to a depth of 11½ feet below grade. Six (6) of these borings were drilled, along the Bullard Wash Channel alignment, from Broadway Road south, to the BID Canal. The remaining borings were drilled along the alignment of the proposed roadway embankment at Lower Buckeye Road.

A Mobile B-50 drill rig, with 6-inch outside diameter auger, was utilized in the drilling and sampling of the boreholes. SPT values were obtained at 10 feet below grade using a split-spoon sampler driven by a 140-pound hammer dropping 30-inches until the sampler penetrated 18-inches into the soil in accordance with ASTM D1586 standards. Ring samples were also obtained near the surface. Bulk samples of the existing native material were selectively sampled from the auger flights as drilling proceeded.

Upon completion, each borehole was backfilled with excess cuttings. All samples were transported to ATL's Phoenix Laboratory for analysis. Upon delivery to the laboratory, soil samples were checked by the Project Engineer and the following ASTM tests assigned:

- Sieve Analysis
- Plasticity Index
- Moisture Content
- Direct Shear Test
- Standard Proctor Analysis
- Consolidation Test
- Percent Swell Test

5.0 LABORATORY TESTING

Bulk samples of the subgrade were collected off the auger flights throughout the depth of each boring. Visual field classifications noted on the field boring logs were modified by the results of index tests such as Sieve Analysis and Atterberg Limits. The resulting Unified Soils Classification presented on the edited logs in Appendix A. Moisture Content tests were performed to determine the amount of water present in the soil at the time of sampling. Standard Proctor Analysis were completed on the subgrade material to determine the relationship between the maximum dry density and optimum moisture content. A Consolidation Test was conducted to determine the amount of vertical movement a sample would experience under specific loading and moisture conditions. A Percent Swell Test was performed to determine the expansion tendencies of the material under given surcharge load when water is added. A Direct Shear Test was also performed to provide parameters that were used in determining equivalent fluid pressures that potentially will be acting against the proposed levee embankment.

All laboratory tests were conducted in accordance with ASTM published standards and are summarized in Appendix B, "Laboratory Test Results". The soils described on the edited boring logs were classified using the Unified Soils Classification System (USCS). The following table summarizes the type and quantities of laboratory tests completed for this project.

TEST	QUANTITY
Sieve Analysis	9
Atterberg Limit	9
Moisture Content	9
Standard Proctor	2
Consolidation	1
Direct Shear	1
Percent Swell	1

6.0 SUMMARY OF EXISTING CONDITIONS

Classification data for the soils sampled from the borings suggests the following soil profile variation. Refer to Appendix A for detailed boring information.

a) At Lower Buckeye Road, the subgrade, to a depth of 11½ feet, consisted primarily of a **lean CLAY (CL)** with sand. In some areas a **clayey SAND (SC)** or a **sandy fat CLAY (CH)** with gravel were observed.

b) The channel alignment, south of Broadway Road, revealed **lean CLAY (CL)** to a depth of 11½ feet.

c) The *N* values obtained at 10 feet below grade revealed the CL materials as "Stiff" to "Hard". The SC material was observed to be "very firm" as revealed by the *N* values obtained; moderate cementation was observed from Boring No. 3 starting at 8 feet below grade and extended to approximately 10 feet below grade.

The minus No. 200 results ranged from 63% to 95%. The Plasticity Indices ranged from 9 to 30. The SC material tested contained a minus #200 content of 39% with a Plasticity Index of 8. The CH material tested contained a minus #200 of 55% with a Plasticity Index of 32.

Standard Proctor Analyses were performed from Boring No. 2 and from Boring No. 7, which were both classified as CL material. The CL material from Boring No. 2, at the depth of 0 to 5 feet below grade, yielded a maximum dry density of 120.4 pcf at an optimum moisture content of 12.3%. The CL material from Boring No. 7, at the depth of 2½ to 5 feet below grade, yielded a maximum dry density of 103.5 pcf at an optimum moisture content of 21.0%.

A Consolidation Test was performed on a CL material from Boring No. 7, at a depth of 2½ to 3 feet below grade. A total consolidation of 2% was observed when the sample was 100% saturated with water under a stress of 2,280 psf.

A Percent Swell Test was also performed on a CL material from Boring No. 7, at a depth of 2½ to 3 feet below grade. The material swelled 1.1% under a surcharge of 100 psf.

A friction angle of 38° was obtained when a Direct Shear Test was performed on CL material from Boring No. 7.

7.0 DISCUSSIONS AND RECOMMENDATIONS

The sampling of the subsurface materials was performed on May 14 & 15, 1998. Groundwater was not encountered during drilling. Variances in groundwater levels should not effect the construction of the levees. Surface water, however, could effect the project construction sequence, particularly if a flood occurs prior to the beginning of construction.

7.1 Lower Buckeye Roadway Embankment

The roadway embankment will be constructed on Lower Buckeye Road extended, from Estrella Parkway, east to the proposed location of the Bullard Wash Channel. The embankment height will range from 3 to 5 feet above existing grade to an elevation of 948.0, will be 16 feet wide, and will serve as a roadway subgrade for the eastern

extension of Lower Buckeye Road. Farm roads are planned on either side of the embankment to allow for local access.

In ATL's geotechnical report for the new channel "**Bullard Wash - Channel**", dated November 22, 1997, it was recommended that some of the material excavated from the channel be mixed specifically with the granular material excavated between ATL Boring Nos. 12 and 17. The northern end of the channel was represented by Boring Nos 9 through 11 and the material was a cohesive lean clay with some silt. While the plasticity was less than 10 for this material, the minus No. 200 amounts exceeded 70%. Thus, this cohesive material should be mixed with excavated granular material before being used as roadway embankment.

Placement and compaction should be performed in accordance with the recommendations contained in Section 8. The roadway embankment construction will require that the existing ground be scarified and compacted to a depth of 12 inches below grade. The embankment should be placed in 10 inch compacted layers to the requirements presented in Section 8.0 of this report. Al layers will be placed horizontally and the slopes trimmed to the specified angle. This will insure uniform compaction throughout the fill.

The slope of the levee, which should not exceed 2H:1V, will be protected from possible erosion by providing stabilizing treatments such as spraying with clear lignosufinites, applying seed mixes, or gravel mulch. It is also important to provide drainage along the intersection of the slope and the farm road surface to carry water away from the embankment toe. We suggest that this ditch be paved or otherwise sealed and the farm road sloped transversely away from the embankment.

In preparing the subgrade for the levee fill, we anticipate that due to scarification and compaction, that the resulting elevation will be less than that of the original ground. The difference is the "Ground Compaction Factor". For this project, that estimated value is:

Ground Compaction Factor = 0.2 feet

A shrinkage factor has been computed for the difference between the in-situ density and the compacted density of the channel material in the aforementioned ATL report. That estimated value is:

Shrinkage Factor = 15%

During a flood, the roadway embankment will function as a levee, providing a barrier for the water and directing it to the new Bullard Wash Channel. It should be noted that this levee embankment is not a dam designed to constrain a given volume of water for the life of the structure. In addition, our embankment is not sealed from the infiltration of water on the face that will be exposed to the flood waters. While the effects of rapid draw down are consideration with this fine-grained soils, because of the short height of the embankment we don not anticipate that they will influence the structures performance as much as the potential harm that saturation could cause.

7.2 Bullard Wash Channel Levee

A levee is proposed to be constructed on either side of the Bullard Wash Channel from Broadway Road south to the BID Canal. The front face of the channel slope and levee will be protected with stepped gabions and a geotextile fabric bank lining. The height from the channel invert to the top of the levee is 10 feet. Between Stations 33+30 to 63+01, the back face of the levee embankment will also be protected by the gabions.

Since the gabions for the levee will be an extension of the channel slope protection, the material and installation requirements for the rock will be identical. The geotextile fabric will function as a barrier and an impermeable layer between the embankment material and the gabion baskets. Backfill behind each course of gabion baskets should be compacted to 95%.

The top of each levee will be utilized as an unpaved operations and maintenance road, 15 feet wide. A handrail will be constructed between the road edge and the back of the gabion baskets. A four inch compacted layer of aggregate base course will be placed as a wearing surface for these roads. Specifications of compaction are presented in Section 8.

7.3 Material Source

The material excavated from the Bullard Wash Channel will be used to build up the Levee on all areas. As indicated in ATL's Channel Report, some blending of the excavated materials might be required. Placement and compaction requirements will conform to appropriate item in Section 8.0 of this report.

8.0 CONSTRUCTION RECOMMENDATIONS

ATL recommends that MAG Standards be used as a guideline for the development of construction specifications. The following sub-sections provide specific references to MAG, as well as containing additional recommendations specific to this project.

8.1 Site Preparation

Stripping of organic soil, small bushes and grass will be required prior to excavating the native subsoil for subsequent use in the roadway and levee embankments. The stripped materials should be disposed of off-site.

The native ground should be scarified a depth of 12 inches and compacted as required in 8.4. Moisture might have to be added in order to reach the acceptable range of water content during compaction.

8.2 Excavation and Backfill

Excavation is not required for this part of the project. Material excavated from the channel construction will be used as backfill for the roadway and levee embankment construction. Backfilling operations should be conducted in accordance with Section 206 of MAG. The contractor may need to prepare an area to mix the excavated materials to create an acceptable embankment material.

The following specifications are suggested for the material used as embankment in the levee whether it is mixed or sole sourced:

Sieve Size	Percent Passing by Weight
2"	100
No. 40	30 - 75
No. 200	10 - 60

$5 \leq$ Plasticity Index ≥ 12

8.3 Borrow

The only anticipated use for borrow or imported material is to either mix with the existing granular material or use solely as embankment for the construction of the Levee. No specification is presented in this section, since Section 8.2 provides the grading allowance for the **final** product, mixed or not. The Contractor will submit a borrow source, along with recent gradations and Atterberg Limit data. If mixed, the Contractor will also be required to provide a mixing procedure.

8.4 Placement and Compaction

Structural backfill for the levee and roadway embankments should be placed in 12-inch compacted layers. The lifts will be compacted to within 95% of the maximum laboratory dry density and within ±2% of the optimum moisture content as determined by ASTM D698, Standard Proctor. All layers will be placed horizontally and slopes trimmed after placement to conform to the plan requirements. Recompaction of the native subsoil material is also required and it shall be compacted to 95% of ASTM D698 and within 2% of the optimum moisture content.

8.5 Geotextile

The geotextile fabric is utilized under the gabions baskets and relieves the hydrostatic pressure and prevents the embankment soils from sloughing, and reduces water penetration to the subgrade during a flood. ATL suggests the following specifications as a minimum for this non-woven product, utilizing ISO 9002 certified production facilities:

Mullen Burst Strength	475 psi - Min
Permeability	0.48 cm/sec - MAX
Apparent Opening Size	150 μm - MAX
UV Resistence	70% Retained in 100 hrs. - MIN

9.0 LIMIT OF SERVICES

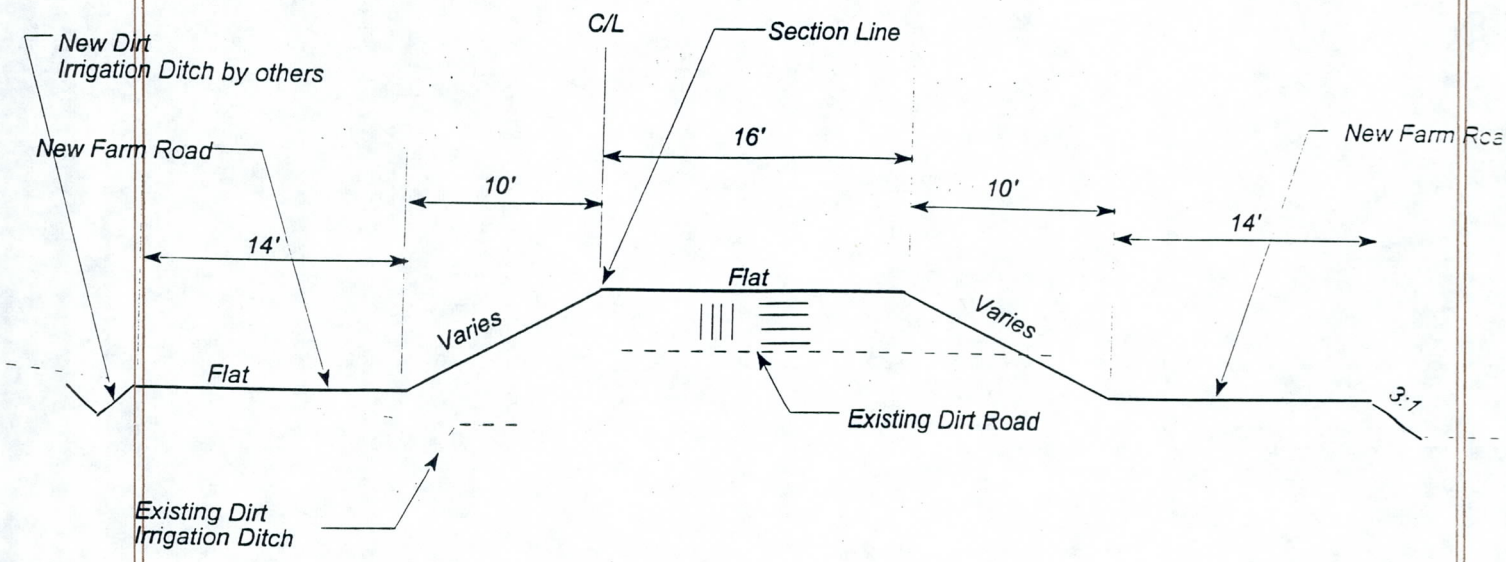
The Geotechnical Engineer may also be retained to provide testing services during excavation, backfill, and grading, and levee construction phases of the work. Construction testing, including field and laboratory evaluation of backfill should be performed by a competent, certified laboratory to determine whether applicable project requirements have been met. ATL, Inc. is highly qualified to provide these additional services.

The analyses and recommendations in this report are based in part upon data obtained from field exploration. The nature and extent of variations beyond the location of test borings may not become evident until construction. If variations then appear evident, it may be necessary to reevaluate the recommendations of this report.

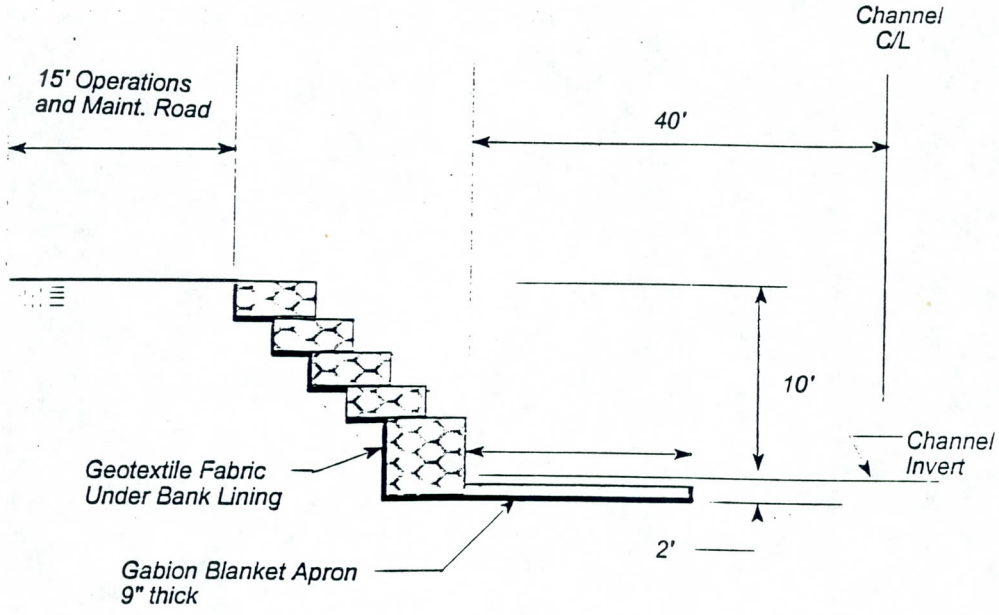
Our professional services were performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers practicing in this or similar localities. No warranty, express or implied, is made. We prepared the report as an aid in design of the proposed project. This report is for the exclusive purpose of providing geotechnical engineering and/or testing information and recommendations. The scope of services for this project does not include, either specifically or by implication, and environmental assessment of the site or identification of contaminated or hazardous materials or conditions.

10.0 REFERENCES

- ***Uniform Standard Specifications for Public Works Construction,*** Maricopa Association of Governments, 1992
- ***Roadside Geology of Arizona***, Holka Chronic, 1995
- Arizona Department of Water Resources, ***Hydrologic Map Series, Report No. 12***, Sheet 1, 1983.
- Lambe and Whitman, ***Soil Mechanics***, 1969.
- ***GeoCal for Windows***, Geotechnical Software by DataSurge.
- ***Geosynthetics Specifications***, GSI Construction Products.



LOWER BUCKEYE ROAD
Typical Section



STEPPED GABION BANK LINING
Typical Section

PLATES

GUIDELINES IN THE USE AND INTERPRETATION

OF THIS GEOTECHNICAL REPORT

ATL Job No. 198013

Our professional services were performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

The geotechnical report was prepared for the use of the Owner in the design of the subject facility and should be made available to potential contractors and/or the Contractor for information on factual data only. This report should not be used for contractual purposes as a warranty of interpreted subsurface conditions such as those indicated by the interpretive boring and test pit logs, cross sections, or discussion of subsurface conditions contained herein.

The analyses, conclusions and recommendations contained in the report are based on site conditions as they presently exist and assume that the exploratory borings, test pits, and/or probes are representative of the subsurface conditions of the site. If, during construction, subsurface conditions are found which are significantly different from those observed in the exploratory borings and test pits, or assumed to exist in the excavations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. If there is a substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, this report should be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions and time lapse.

The Summary Boring Logs are our opinion of the subsurface conditions revealed by periodic sampling of the ground as the borings progressed. The soil descriptions and interfaces between strata are interpretive and actual changes may be gradual.

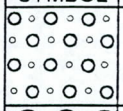
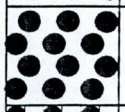
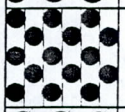
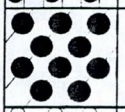
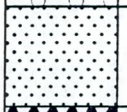
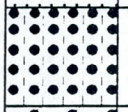
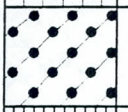
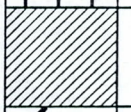
The boring logs and related information depict subsurface conditions only at these specific locations and at the particular time designated on the logs. Soil conditions at other locations may differ from conditions occurring at these boring locations. Also, the passage of time may result in a change in the soil conditions at these boring locations.

Groundwater levels often vary seasonally. Groundwater levels reported on the boring logs or in the body of the report are factual data only for the dates shown.

Unanticipated soil conditions are commonly encountered on construction sites and cannot be fully anticipated by merely taking soil samples, borings or test pits. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. It is recommended that the Owner consider providing a contingency fund to accommodate such potential extra costs.

This firm cannot be responsible for any deviation from the intent of this report including, but not restricted to, any changes to the scheduled time of construction, the nature of the project or the specific construction methods or means indicated in this report; nor can our firm be responsible for any construction activity on sites other than the specific site referred to in this report.

SOIL CLASSIFICATION & TERMINOLOGY

GRAPHIC SYMBOL	GROUP SYMBOL	TYPICAL NAMES
	GW	Well graded gravels, gravel - sand mixtures, or sand - gravel - cobble mixtures.
	GP	Poorly graded gravels, gravel - sand mixtures, or sand - gravel - cobble mixtures.
	GM	Silty gravels, gravel - sand - silt mixtures.
	GC	Clayey gravels, gravel - sand - clay mixtures.
	SW	Well graded sands, gravelly sands.
	SP	Poorly graded sands, gravelly sands.
	SM	Silty sands, sand - silt mixtures
	SC	Clayey sands, sand - clay mixtures
	ML	Inorganic silts, clayey silts with slight plasticity
	MH	Inorganic silts, micaceous or diatomaceous silty soils, elastic silts.
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
	CH	Inorganic clays of high plasticity, fat clays, sandy clays of high plasticity.

1. Relative Density. Terms for description of relative density of cohesionless, uncemented sands and sand - gravel mixtures,

N	Relative Density
0 - 4	Very loose
5 - 10	Loose
11 - 30	Medium dense
31 - 50	Dense
50	Very dense

2. Relative Consistency. Terms for description of clays which are saturated or near saturation.

N	Relative Consistency	Remarks
0 - 4	Very soft	Easily penetrated several inches with fist.
3 - 4	Soft	Easily penetrated several inches with thumb.
5 - 8	Medium stiff	Can be penetrated several inches with thumb with moderate effort.
9 - 15	Stiff	Readily indented with thumb but penetrated only with great effort.
16 - 30	Very stiff	Readily indented with thumbnail.
30 +	Hard	Indented only with difficulty by thumbnail.

3. Relative Firmness. Terms for description of partially saturated and / or cemented soils which commonly occur in the Southwest including clays, cemented granular materials, silts and silty and clayey granular soils.

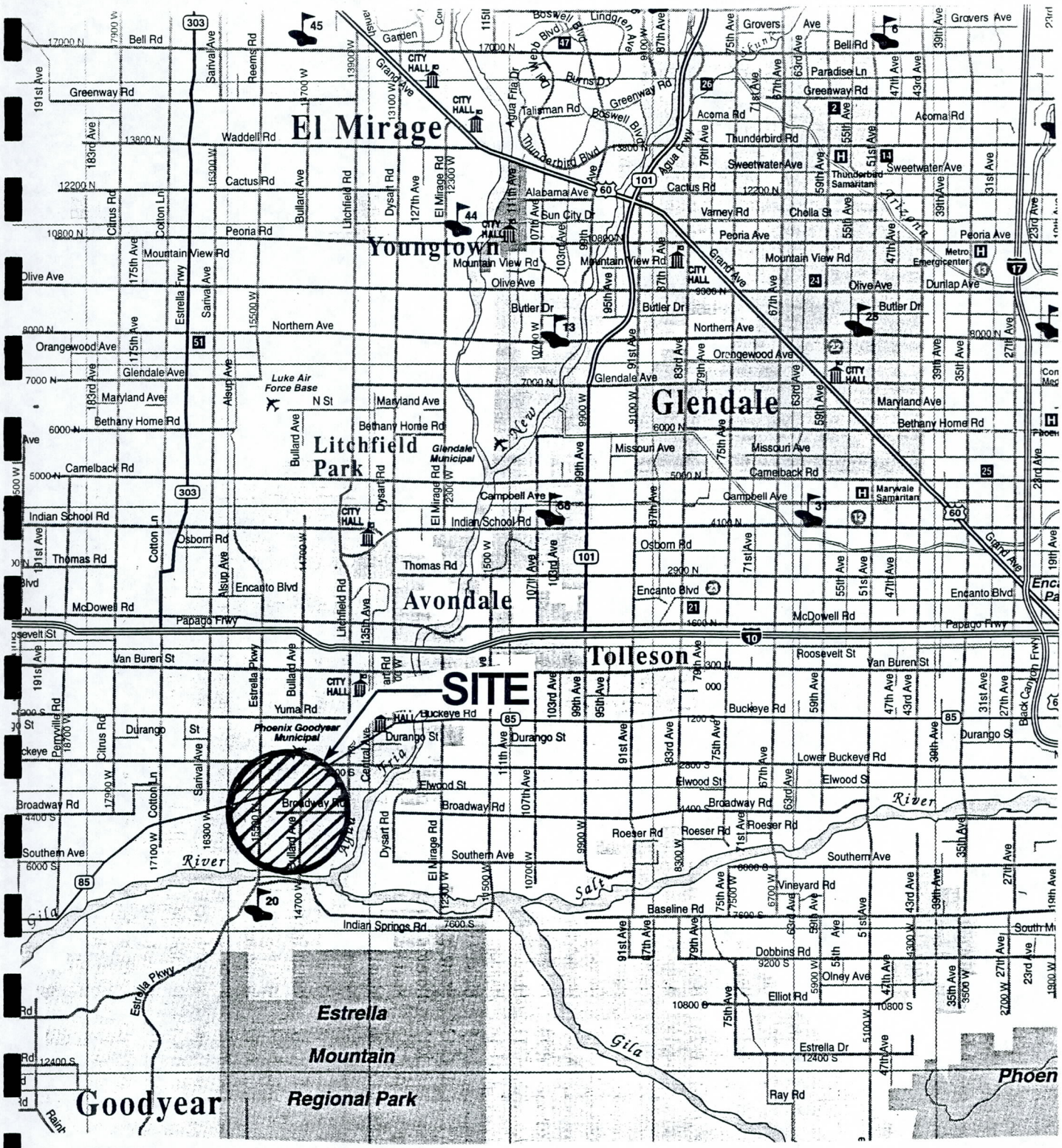
N	Relative Firmness
0 - 4	Very soft
5 - 8	Soft
9 - 15	Moderately firm
16 - 30	Firm
31 - 50	Very firm
50 +	Hard

4. Standard Penetration Tests (SPT) =

DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Cobbles	Above 3 inches
Gravel	3 inches to No. 4 sieve
Coarse gravel	3 inches to 3/4 inch
Fine gravel	3/4 inch to No. 4 sieve
Sand	No. 4 sieve to No. 200
Coarse	No. 4 sieve to No. 10
Medium	No. 10 sieve to No. 40
Fine	No. 40 sieve to No. 200
Fines (silt or clay)	Below No. 200 sieve

PLATE 2



VICINITY MAP

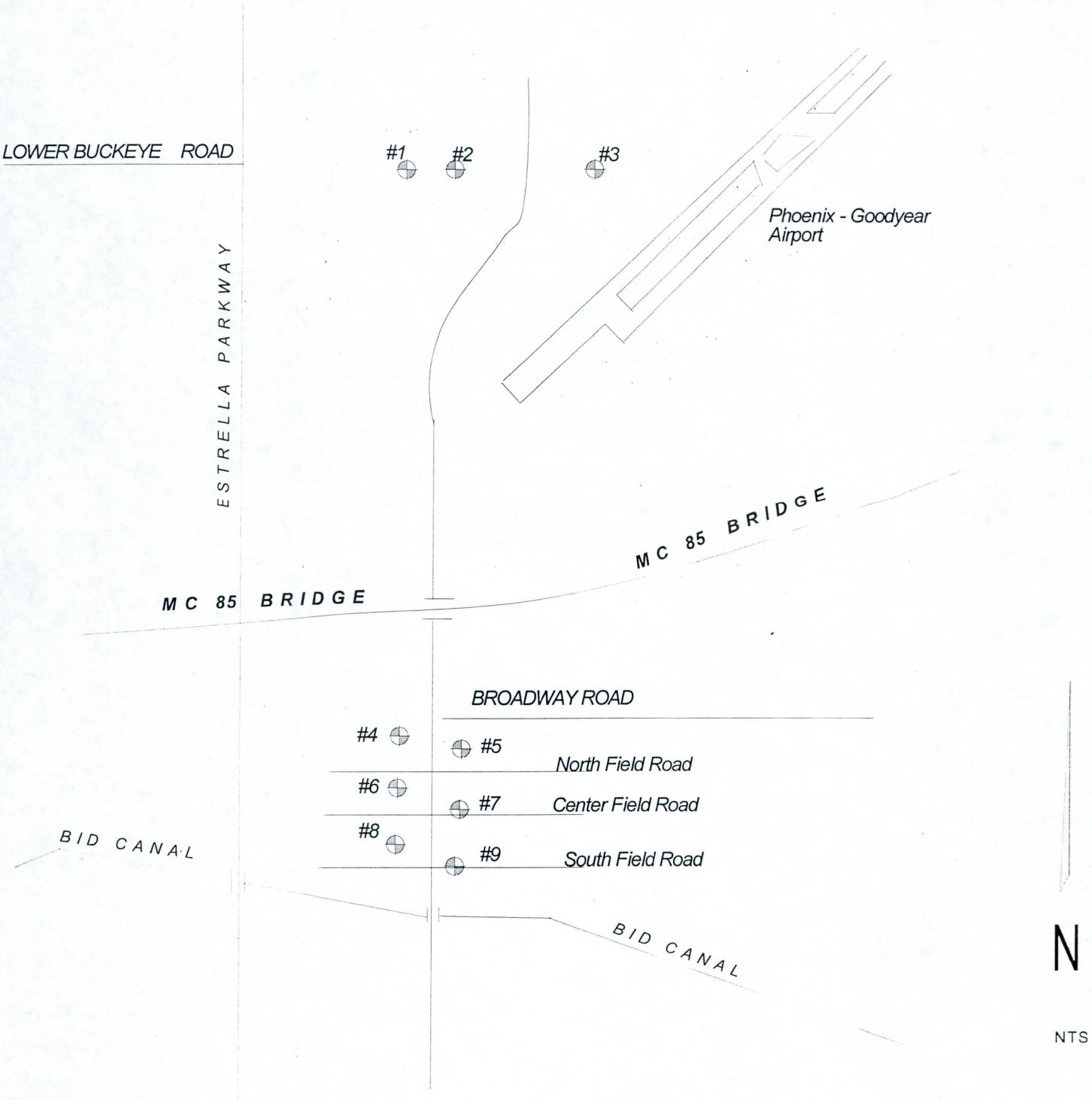
BULLARD WASH - LEVEES

Lower Buckeye Road, Broadway Road and BID Canal

Goodyear, Arizona

ATL JOB NO. 198013

PLATE 3



BORING LOCATIONS

BULLARD WASH - LEVEES

Lower Buckeye Road, Broadway Road and BID Canal

Goodyear, Arizona

ATL JOB NO. 198013

PLATE 4

APPENDIX A

BORING LOGS

BULLARD WASH - LEVEES
Lower Buckeye Road, Broadway Road and BID Canal

ATL Job No. 198013
Boring No.: 1

Boring Location: *300 west of Channel centerline*
Southern edge of Lower Buckeye Road

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *5/15/98* **Elevation of Boring:** *Existing*

Driller: *K. Phillips* **Logger:** *K. Phillips* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Dark brown, clayey SAND(SC), slightly moist				
	5	*Gravel was observed at 5 feet below grade, in a moist condition*				
	10		32			
		(Bottom of Boring at 11 ½ feet)				
	15					
	20					
	25					

Boring Stopped at 11 ½ Feet below Existing Grade

Groundwater — Initial Depth — Hour — 24 Hour Depth

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

A1

BULLARD WASH - LEVEES
Lower Buckeye Road, Broadway Road and BID Canal

ATL Job No. 198013
Boring No.: 2

Boring Location: *200 west of Channel centerline*
Southern edge of Lower Buckeye Road

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *5/15/98* **Elevation of Boring:** *Existing*

Driller: *K. Phillips* **Logger:** *K. Phillips* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Dark brown, sandy lean CLAY(CL), moist				
	5			32		
		Small lenses of clay was observed starting at 7 feet below grade				
	10		11			
		(Bottom of Boring at 11 ½ feet)				
	15					
	20					
	25					

Boring Stopped at 11 ½ Feet below Existing Grade

Groundwater — Initial Depth — Hour — 24 Hour Depth

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

A2

BULLARD WASH - LEVEES
Lower Buckeye Road, Broadway Road and BID Canal

ATL Job No. 198013

Boring No.: 3

Boring Location: *225 east of Channel centerline*
Southern edge of Lower Buckeye Road

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *5/15/98* **Elevation of Boring:** *Existing*

Driller: *K. Phillips* **Logger:** *K. Phillips* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Dark brown, sandy lean CLAY(CL), slightly moist				
		White, sandy fat CLAY(CH), with gravel, slightly moist				
	5	*Light brown, sandy lean CLAY(CL) with gravel, moist*				
		Observed Moderate cementation at 8 to 10 feet below grade				
	10		*88 / 7"*			
		(Bottom of Boring at 11 feet and 1 inch)				
	15					
	20					
	25					

Boring Stopped at 11'-1" below Existing Grade

Groundwater — Initial Depth — Hour — 24 Hour Depth

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

A3

BULLARD WASH - LEVEES
Lower Buckeye Road, Broadway Road and BID Canal

ATL Job No. 198013

Boring No.: 4

Boring Location: *75 feet west of centerline*
25 feet south of Broadway Road

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *5/14/98* **Elevation of Boring:** *Existing*

Driller: *K. Phillips* **Logger:** *K. Phillips* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Dark brown, lean CLAY(CL) with sand, moist				
	5					
	10		41			
		(Bottom of Boring at 11 ½ feet)				
	15					
	20					
	25					

Boring Stopped at 11 ½ Feet below Existing Grade

Groundwater — Initial Depth — Hour — 24 Hour Depth

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - LEVEES
Lower Buckeye Road, Broadway Road and BID Canal

ATL Job No. *198013*
Boring No.: 5

Boring Location: *75 feet east of centerline*
59 feet north of north field road

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *5/14/98* **Elevation of Boring:** *Existing*

Driller: *K. Phillips* **Logger:** *K. Phillips* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Dark brown, lean CLAY(CL), moist				
		Percentage of sand was observed at 1 to 10 feet below grade				
	5					
	10		38			
		(Bottom of Boring at 11 ½ feet)				
	15					
	20					
	25					

Boring Stopped at 11 ½ Feet below Existing Grade

Groundwater — Initial Depth — Hour — 24 Hour Depth

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - LEVEES
Lower Buckeye Road, Broadway Road and BID Canal

ATL Job No. 198013
Boring No.: 6

Boring Location: *75 feet west of centerline*
25 feet south of north field road

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *5/14/98* **Elevation of Boring:** *Existing*

Driller: *K. Phillips* **Logger:** *K. Phillips* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Dark brown, lean CLAY(CL), moist				
	5					
	10		24			
		(Bottom of Boring at 11 ½ feet)				
	15					
	20					
	25					

Boring Stopped at 11 ½ Feet below Existing Grade

Groundwater — Initial Depth — Hour — 24 Hour Depth

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - LEVEES
Lower Buckeye Road, Broadway Road and BID Canal

ATL Job No. 198013
Boring No.: 7

Boring Location: *75 feet east of centerline*
Center of field road north shoulder

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *5/14/98* **Elevation of Boring:** *Existing*

Driller: *K. Phillips* **Logger:** *K. Phillips* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Black, lean CLAY(CL), slightly moist				
		Changed color to Dark brown, in a moist condition starting at 2 ½ feet below grade		27		
	5	*Changed color to Light brown at 5 feet below grade*				
	10		14			
		(Bottom of Boring at 11 ½ feet)				
	15					
	20					
	25					

Boring Stopped at 11 ½ Feet below Existing Grade

Groundwater — Initial Depth — Hour — 24 Hour Depth

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - LEVEES
Lower Buckeye Road, Broadway Road and BID Canal

ATL Job No. 198013
Boring No.: 8

Boring Location: *60 feet south of center field road*
75 feet west of centerline

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *5/15/98* **Elevation of Boring:** *Existing*

Driller: *K. Phillips* **Logger:** *K. Phillips* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Black, lean CLAY(CL), moist				
		Changed color to Dark brown at 3 feet below grade				
	5					
	10		24			
		(Bottom of Boring at 11 ½ feet)				
	15					
	20					
	25					

Boring Stopped at 11 ½ Feet below Existing Grade

Groundwater — Initial Depth — Hour — 24 Hour Depth

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

BULLARD WASH - LEVEES
Lower Buckeye Road, Broadway Road and BID Canal

ATL Job No. 198013
Boring No.: 9

Boring Location: *75 feet east of centerline South field road*

Boring Equipment: *Mobile B-50 with 6 - Inch diameter hollow stem auger*

Date of Boring: *5/15/98* **Elevation of Boring:** *Existing*

Driller: *K. Phillips* **Logger:** *K. Phillips* **Reviewed By:** *A. Osorio*

Graphical Log	Depth (Feet)	SOIL DESCRIPTION	SPT Blows/ft	Ring Blows/ft	% Passing No. 200	Plasticity Index
		Black, lean CLAY(CL), moist				
		Changed color to Dark brown at 3 feet below grade				
	5					
	10		*36*			
		(Bottom of Boring at 11 ½ feet)				
	15					
	20					
	25					

Boring Stopped at 11 ½ Feet below Existing Grade

Groundwater — Initial Depth — Hour — 24 Hour Depth

NOTE: THE ABOVE DATA FOR DESIGN PURPOSES ONLY.

APPENDIX B

LABORATORY TEST RESULTS

SUMMARY OF LABORATORY ANALYSIS

CLIENT: SVERDRUP CIVIL, INC. DATE: 05/29/98

PROJECT: BULLARD WASH LEVEES

LOCATION: LOWER BUCKEYE ROAD, BROADWAY ROAD AND BID CANAL , GOODYEAR, ARIZONA

MATERIAL: See Below SAMPLING DATE: 05/15/98

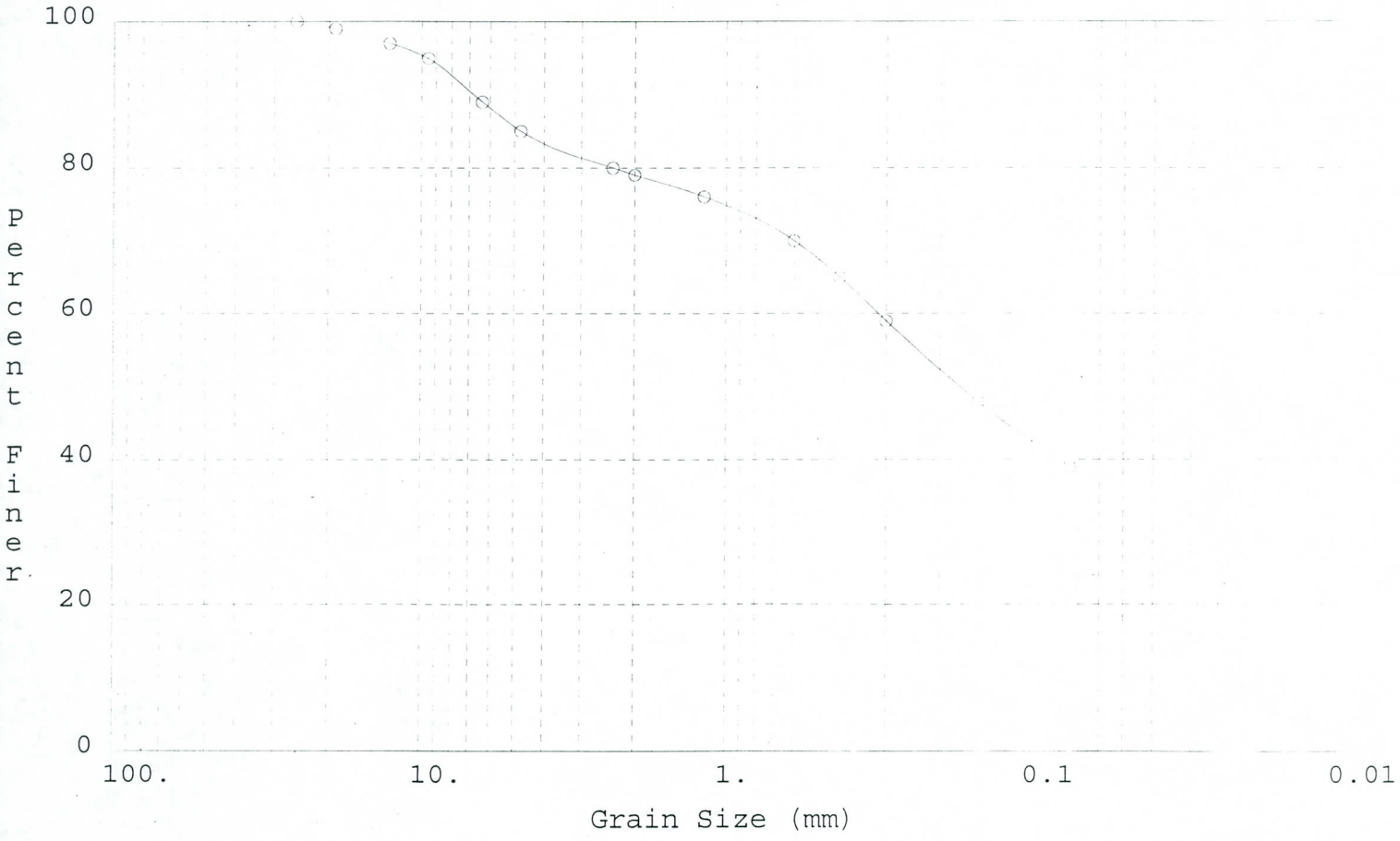
REQUESTED BY: David Hayes ATL JOB NO: 198013

BORING	DEPTH	MOIST	USCS	LL	PI	SIEVE ANALYSIS - PERCENT PASSING											
No.	(Feet)	%				200	100	50	40	30	16	10	4	3/8	3/4	1.0	3
1	5 - 10	8.8	SC	27	8	39.3	48	59	65	70	76	79	85	95	99	100	-
2	0 - 10	9.0	CL	47	30	63.0	79	95	98	99	100	-	-	-	-	-	-
3	3 - 5	15.2	CH	54	32	55.2	60	65	68	71	77	82	88	95	99	100	-
4	0- 7	14.8	CL	48	30	74.8	91	99	100	-	-	-	-	-	-	-	-
5	1 - 5	20.6	CL	32	13	82.7	96	99	100	-	-	-	-	-	-	-	-
6	0 - 10	17.9	CL	30	9	88.0	98	100	-	-	-	-	-	-	-	-	-
7	2 1/2 - 5	20.9	CL	38	18	95.0	99	100	-	-	-	-	-	-	-	-	-
8	3 - 10	22.9	CL	36	17	92.3	98	98	98	99	99	100	-	-	-	-	-
9	5 - 10	21.7	CL	34	10	93.3	97	98	98	98	99	99	100	-	-	-	-

Project Number = 198013 Client: Sverdrup, Inc.
Location = Bullard Wash Levees, Lower Buckeye Road
Date = 5/20/98
Tested By = M. Castillo
Boring Number = 1
Depth = 5' - 10'
Sample Number = 98-0519
Description = Dark brown, clayey SAND(SC) with gravel
Dry Sample Weight (g) = 1000

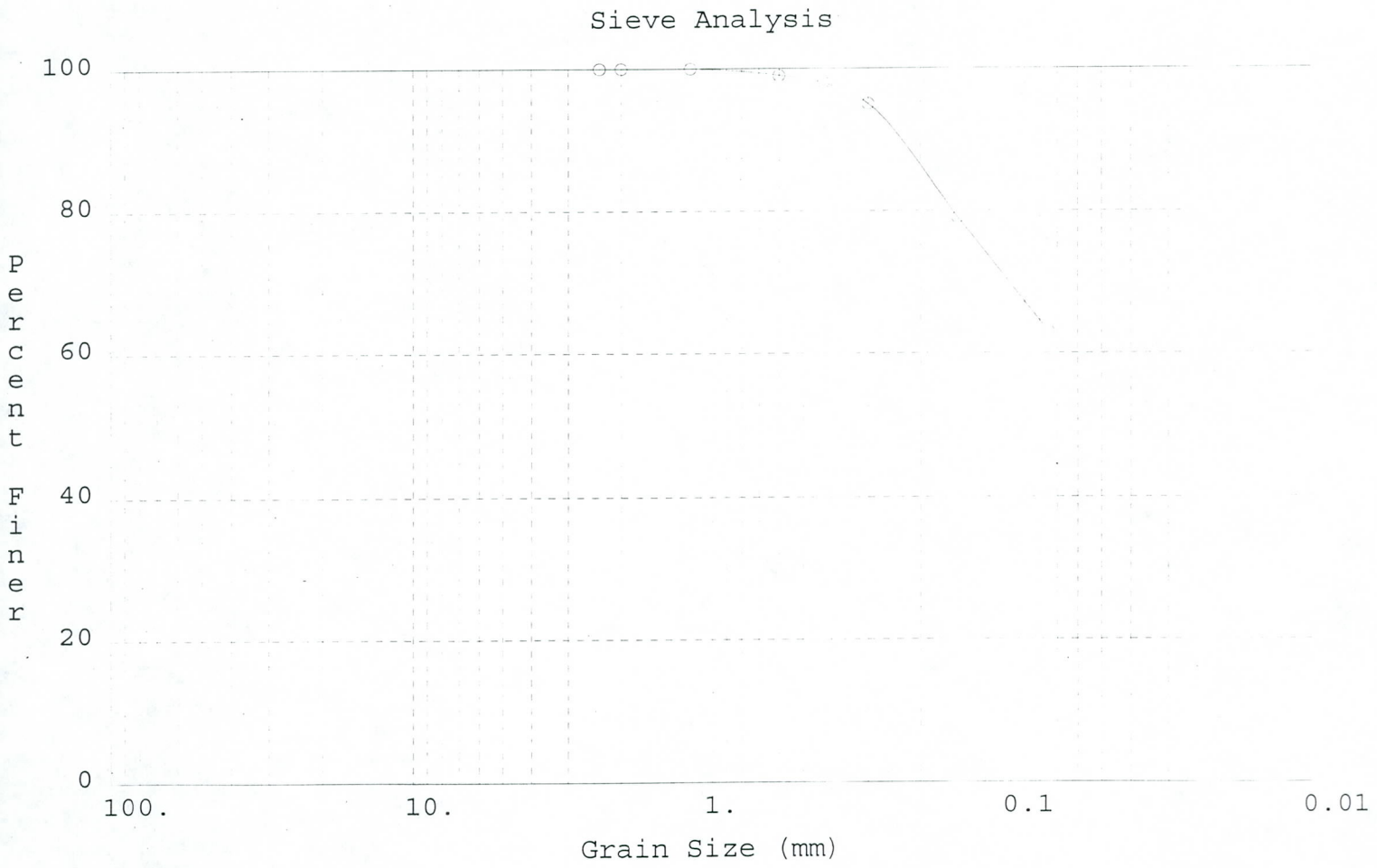
SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
1"	25.400	0.00	0.00	0.00	100.00
3/4"	19.050	10.00	1.00	1.00	99.00
1/2"	12.700	20.00	2.00	3.00	97.00
3/8"	9.500	20.00	2.00	5.00	95.00
1/4"	6.350	60.00	6.00	11.00	89.00
#4	4.750	40.00	4.00	15.00	85.00
#8	2.360	50.00	5.00	20.00	80.00
#10	2.000	10.00	1.00	21.00	79.00
#16	1.180	30.00	3.00	24.00	76.00
#30	0.600	60.00	6.00	30.00	70.00
#40	0.425	50.00	5.00	35.00	65.00
#50	0.300	60.00	6.00	41.00	59.00
#100	0.150	110.00	11.00	52.00	48.00
#200	0.075	90.00	9.00	61.00	39.00
Pan	0.000	0.00	0.00	61.00	39.00

Sieve Analysis



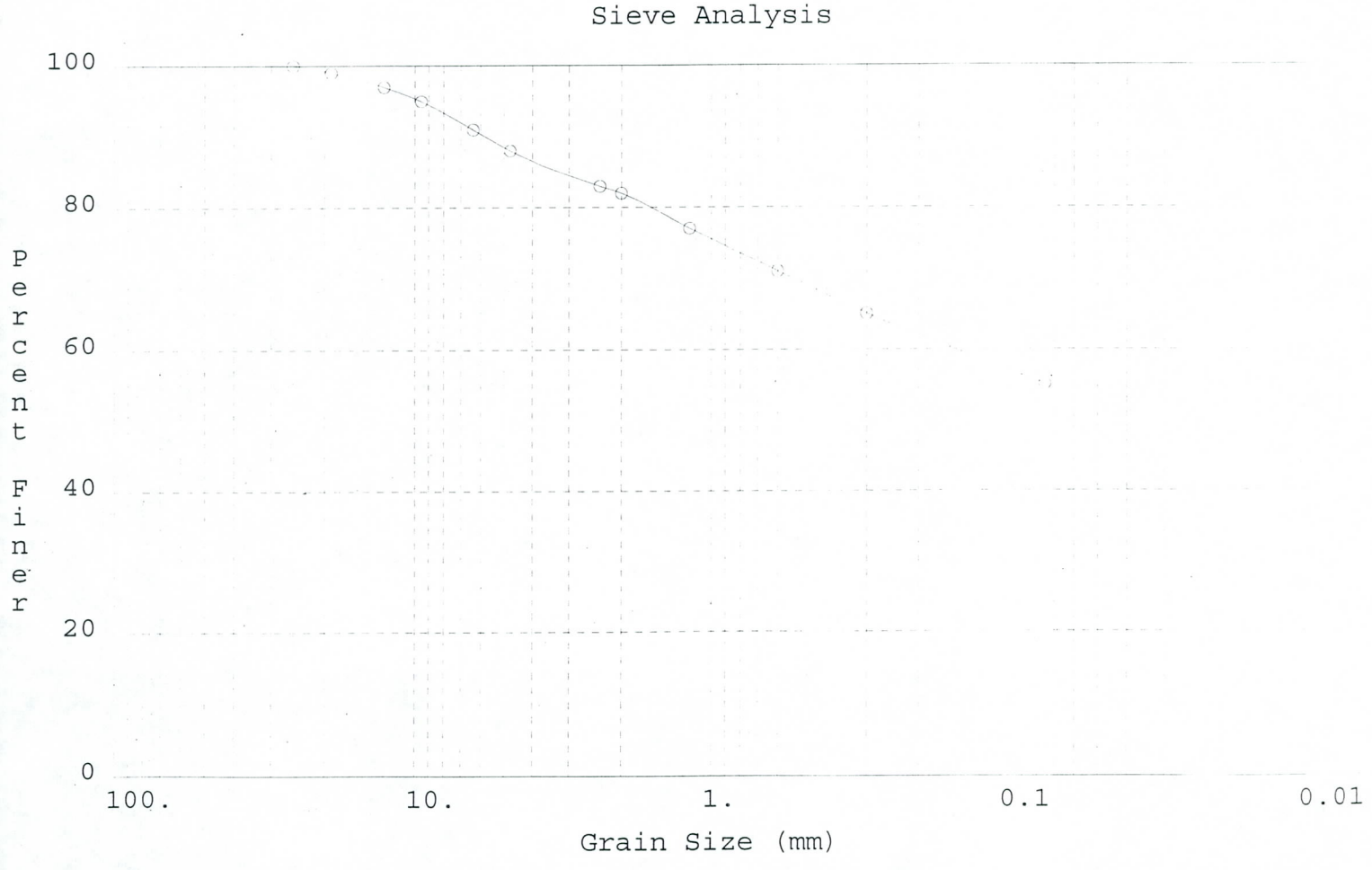
Project Number = 198013 Client: Sverdrup, Inc.
Location = Bullard Wash Levees, Lower Buckeye Road
Date = 5/20/98
Tested By = M. Castillo
Boring Number = 2
Depth = 0 - 10'
Sample Number = 98-0520
Description = Dark brown, sandy lean CLAY(CL)
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
#8	2.360	0.00	0.00	0.00	100.00
#10	2.000	0.00	0.00	0.00	100.00
#16	1.180	0.00	0.00	0.00	100.00
#30	0.600	10.00	1.00	1.00	99.00
#40	0.425	10.00	1.00	2.00	98.00
#50	0.300	30.00	3.00	5.00	95.00
#100	0.150	160.00	16.00	21.00	79.00
#200	0.075	160.00	16.00	37.00	63.00
Pan	0.000	0.00	0.00	37.00	63.00



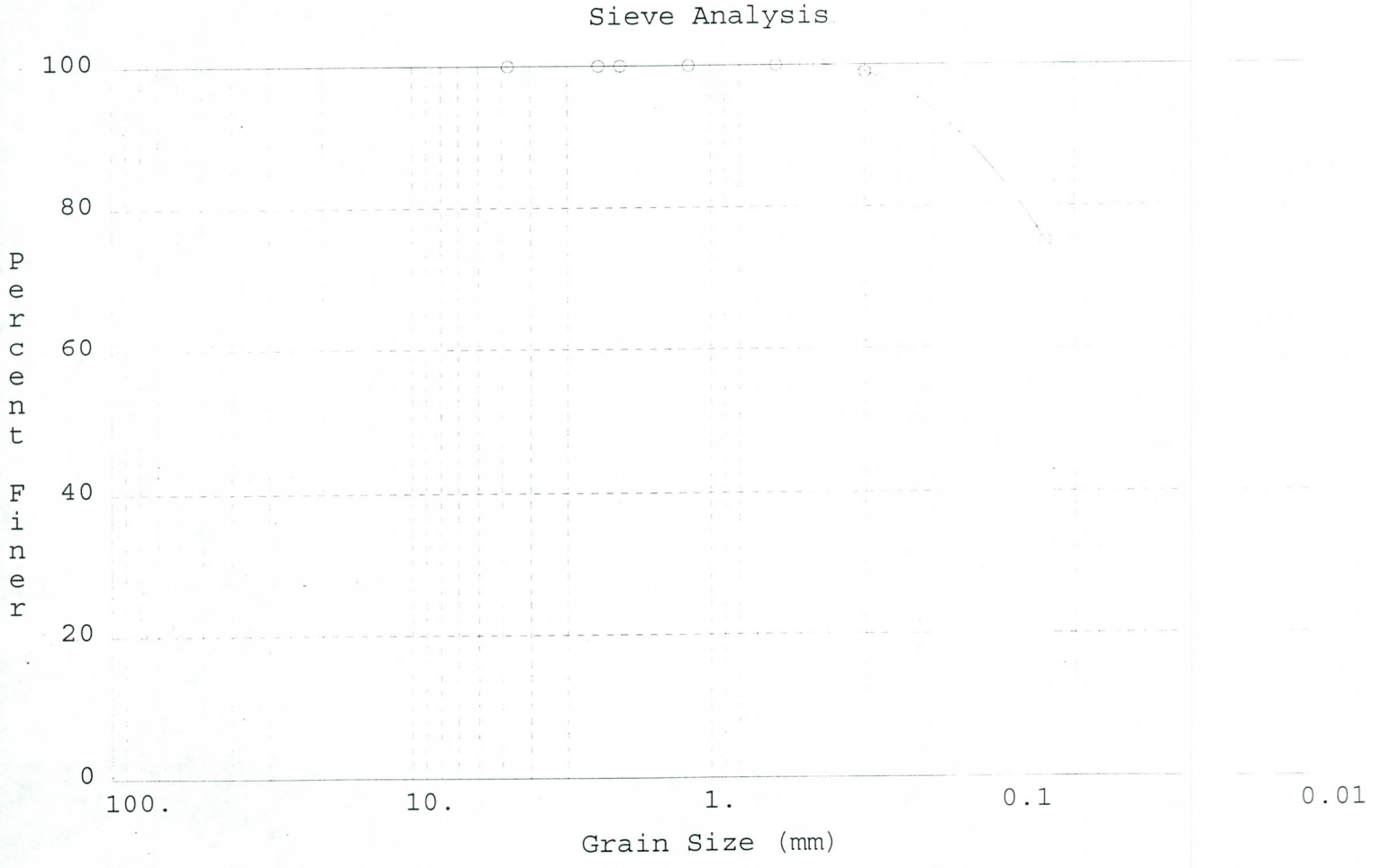
Project Number = 198013 Client: Sverdrup, Inc.
Location = Bullard Wash Levees, Lower Buckeye Road
Date = 5/20/98
Tested By = M. Castillo
Boring Number = 3
Depth = 3' - 5'
Sample Number = 98-0522
Description = Tan, sandy fat CLAY(CH)
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
1"	25.400	0.00	0.00	0.00	100.00
3/4"	19.050	10.00	1.00	1.00	99.00
1/2"	12.700	20.00	2.00	3.00	97.00
3/8"	9.500	20.00	2.00	5.00	95.00
1/4"	6.350	40.00	4.00	9.00	91.00
#4	4.750	30.00	3.00	12.00	88.00
#8	2.360	50.00	5.00	17.00	83.00
#10	2.000	10.00	1.00	18.00	82.00
#16	1.180	50.00	5.00	23.00	77.00
#30	0.600	60.00	6.00	29.00	71.00
#40	0.425	30.00	3.00	32.00	68.00
#50	0.300	30.00	3.00	35.00	65.00
#100	0.150	50.00	5.00	40.00	60.00
#200	0.075	50.00	5.00	45.00	55.00
Pan	0.000	0.00	0.00	45.00	55.00



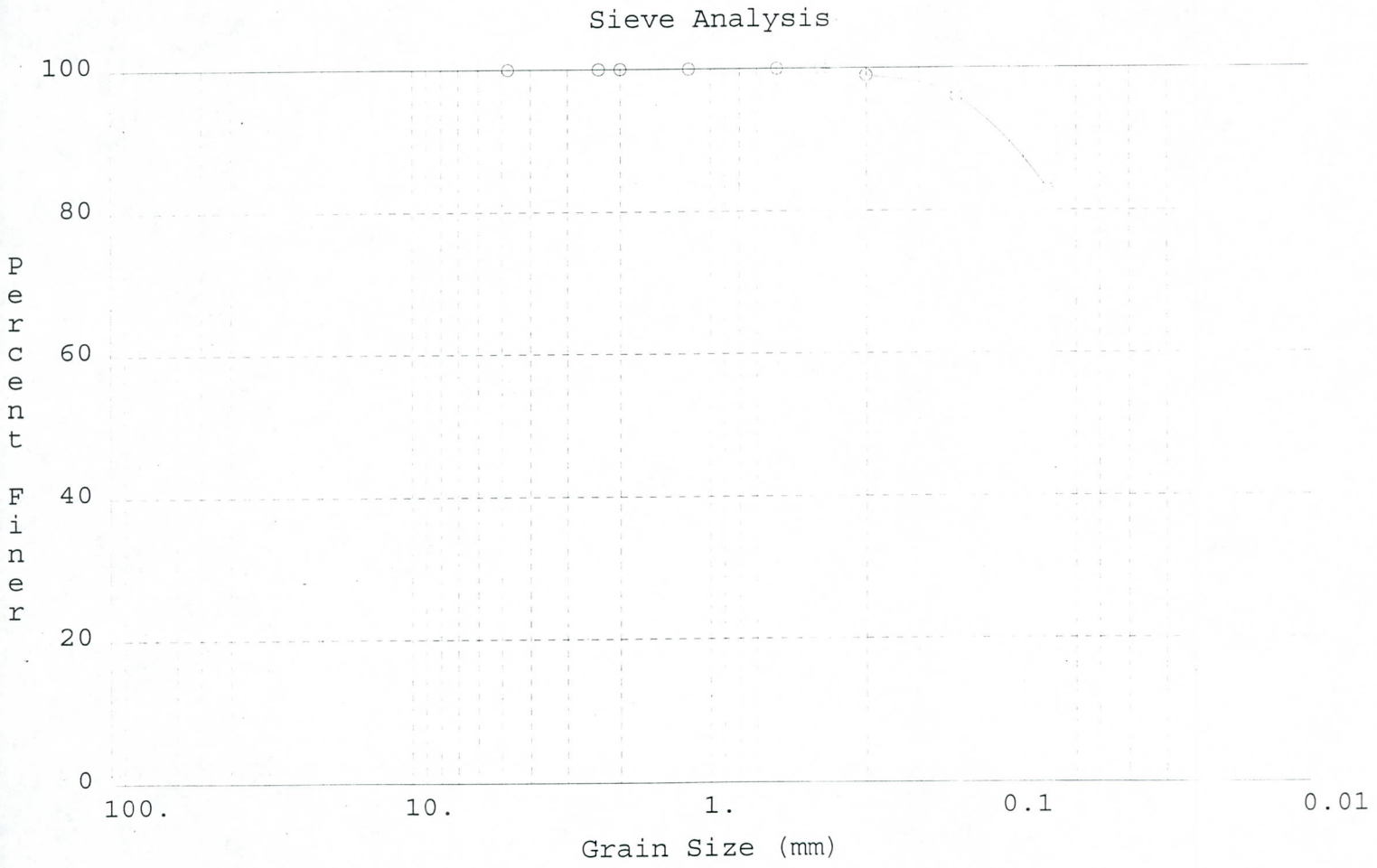
Project Number = 198013 Client: Sverdrup, Inc.
Location = Bullard Wash Levees, Lower Buckeye Road
Date = 5/20/98
Tested By = M. Castillo
Boring Number = 4
Depth = 0 - 7'
Sample Number = 98-0523
Description = Dark brown, lean CLAY(CL) with sand
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
#4	4.750	0.00	0.00	0.00	100.00
#8	2.360	0.00	0.00	0.00	100.00
#10	2.000	0.00	0.00	0.00	100.00
#16	1.180	0.00	0.00	0.00	100.00
#30	0.600	0.00	0.00	0.00	100.00
#40	0.425	0.00	0.00	0.00	100.00
#50	0.300	10.00	1.00	1.00	99.00
#100	0.150	80.00	8.00	9.00	91.00
#200	0.075	160.00	16.00	25.00	75.00
Pan	0.000	0.00	0.00	25.00	75.00



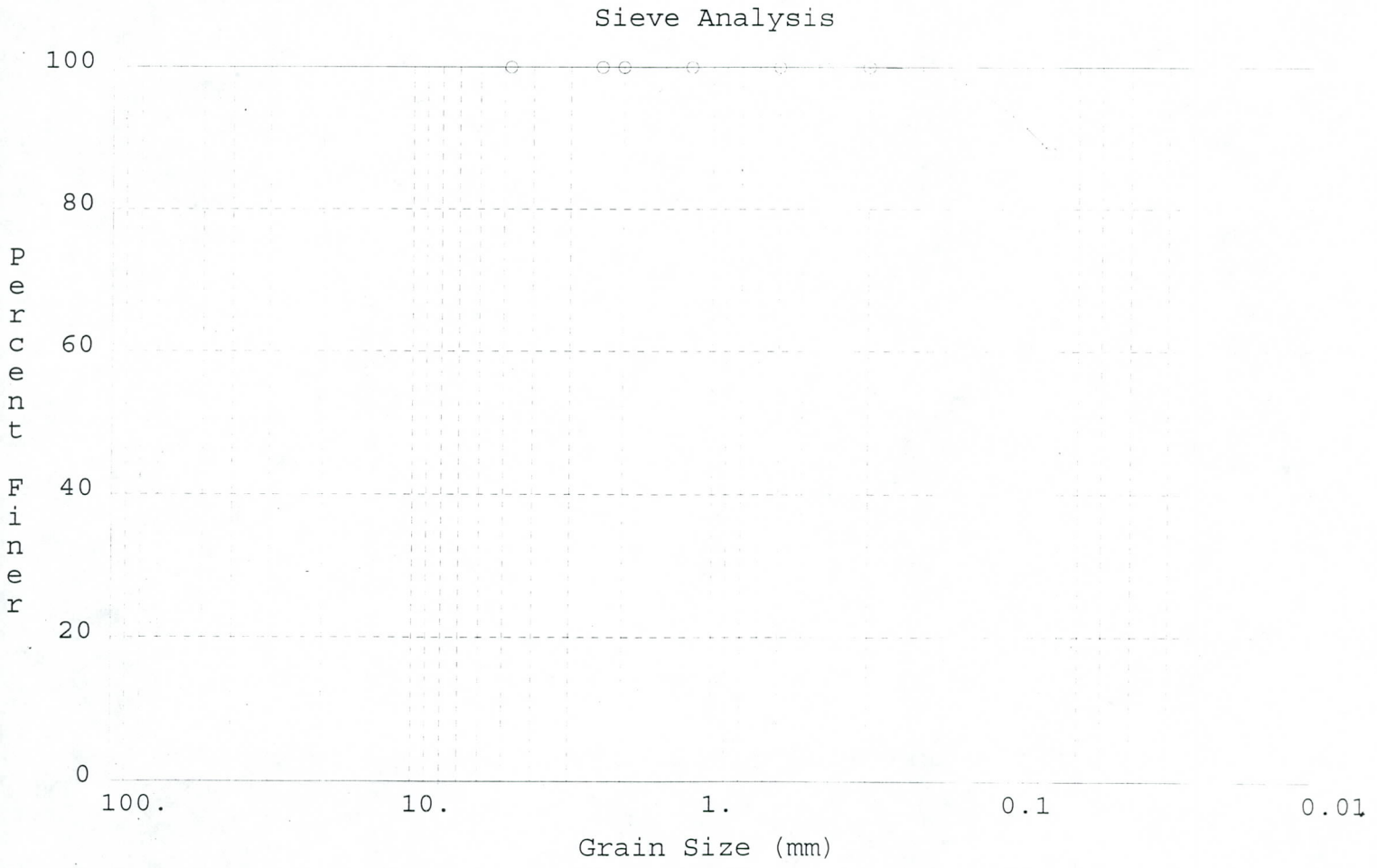
Project Number = 198013 Client: Sverdrup, Inc.
Location = Bullard Wash Levees, Lower Buckeye Road
Date = 5/26/98
Tested By = M.Blalock
Boring Number = 5
Depth = 1 - 5'
Sample Number = 98-0524
Description = Dark brown, lean CLAY(CL) with sand
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
#4	4.750	0.00	0.00	0.00	100.00
#8	2.360	0.00	0.00	0.00	100.00
#10	2.000	0.00	0.00	0.00	100.00
#16	1.180	0.00	0.00	0.00	100.00
#30	0.600	0.00	0.00	0.00	100.00
#40	0.425	0.00	0.00	0.00	100.00
#50	0.300	10.00	1.00	1.00	99.00
#100	0.150	30.00	3.00	4.00	96.00
#200	0.075	130.00	13.00	17.00	83.00
Pan	0.000	0.00	0.00	17.00	83.00



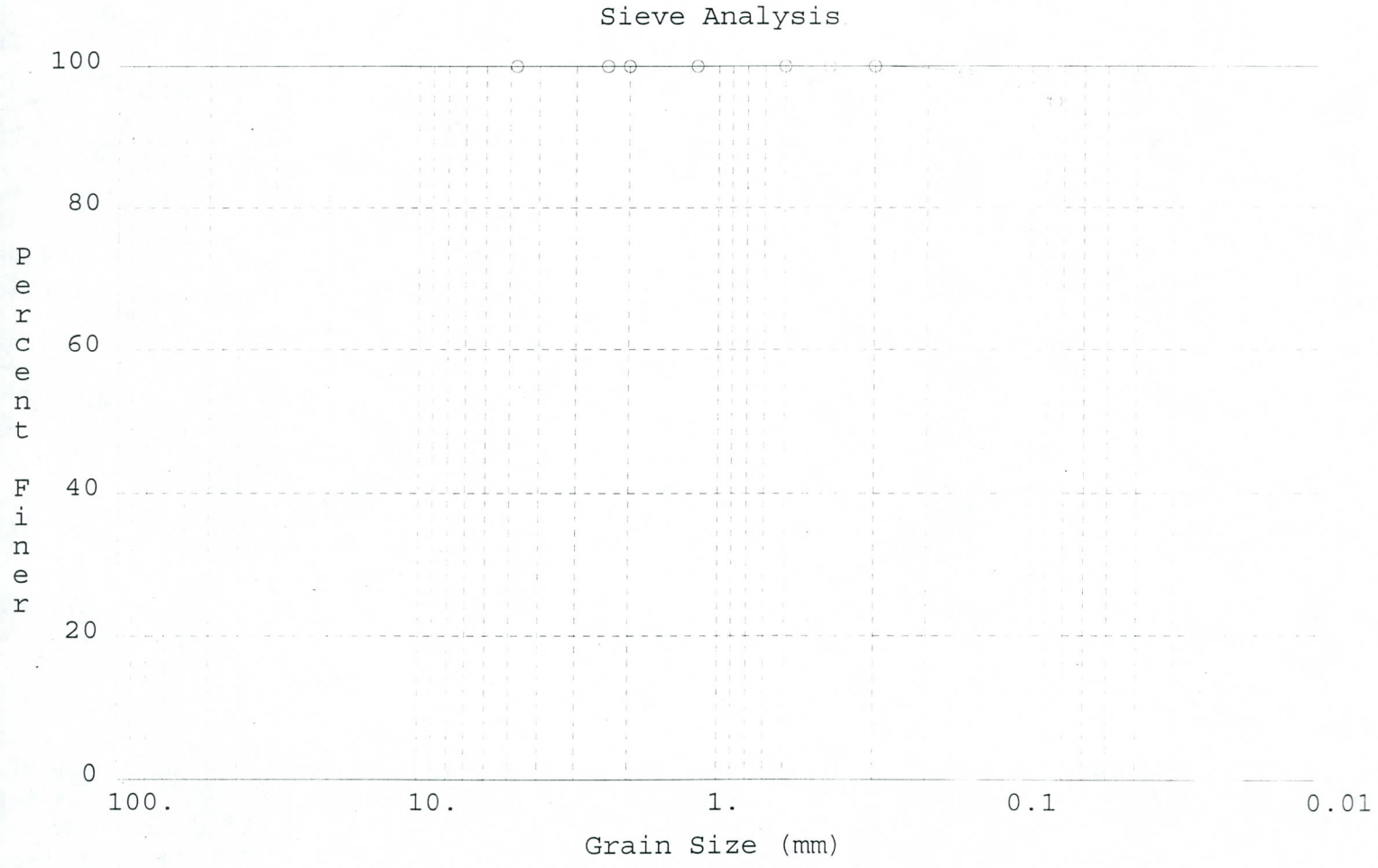
Project Number = 198013 Client: Sverdrup, Inc.
Location = Bullard Wash Levees, Lower Buckeye Road
Date = 5/20/98
Tested By = M. Castillo
Boring Number = 6
Depth = 0 - 10'
Sample Number = 98-0525
Description = Dark brown, lean CLAY(CL)
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
#4	4.750	0.00	0.00	0.00	100.00
#8	2.360	0.00	0.00	0.00	100.00
#10	2.000	0.00	0.00	0.00	100.00
#16	1.180	0.00	0.00	0.00	100.00
#30	0.600	0.00	0.00	0.00	100.00
#40	0.425	0.00	0.00	0.00	100.00
#50	0.300	0.00	0.00	0.00	100.00
#100	0.150	20.00	2.00	2.00	98.00
#200	0.075	100.00	10.00	12.00	88.00
Pan	0.000	0.00	0.00	12.00	88.00



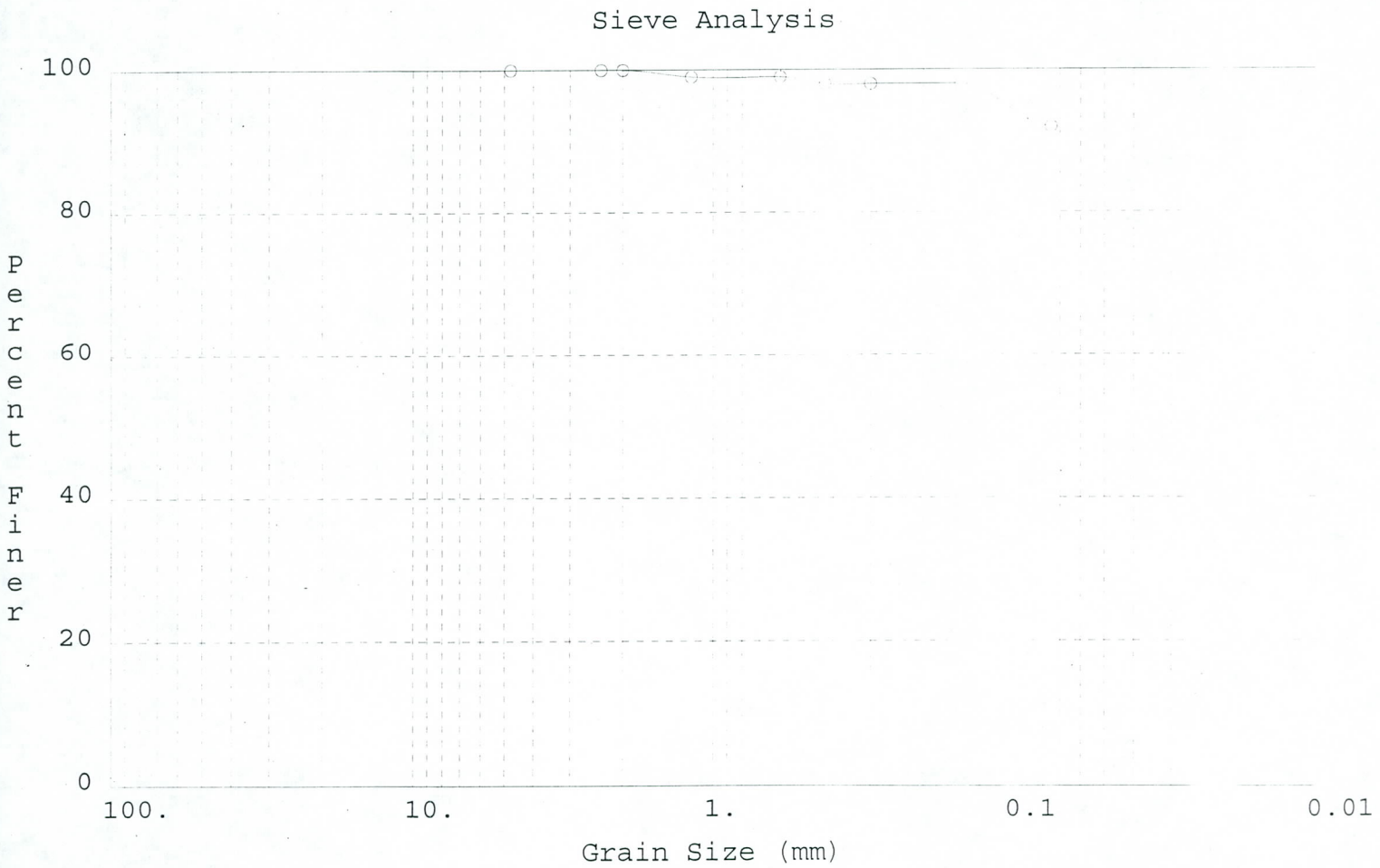
Project Number = 198013 Client: Sverdrup, Inc.
Location = Bullard Wash Levees, Lower Buckeye Road
Date = 5/20/98
Tested By = M. Castillo
Boring Number = 7
Depth = 2 1/2' - 5'
Sample Number = 98-0526
Description = Dark brown, lean CLAY(CL)
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
#4	4.750	0.00	0.00	0.00	100.00
#8	2.360	0.00	0.00	0.00	100.00
#10	2.000	0.00	0.00	0.00	100.00
#16	1.180	0.00	0.00	0.00	100.00
#30	0.600	0.00	0.00	0.00	100.00
#40	0.425	0.00	0.00	0.00	100.00
#50	0.300	0.00	0.00	0.00	100.00
#100	0.150	10.00	1.00	1.00	99.00
#200	0.075	40.00	4.00	5.00	95.00
Pan	0.000	0.00	0.00	5.00	95.00



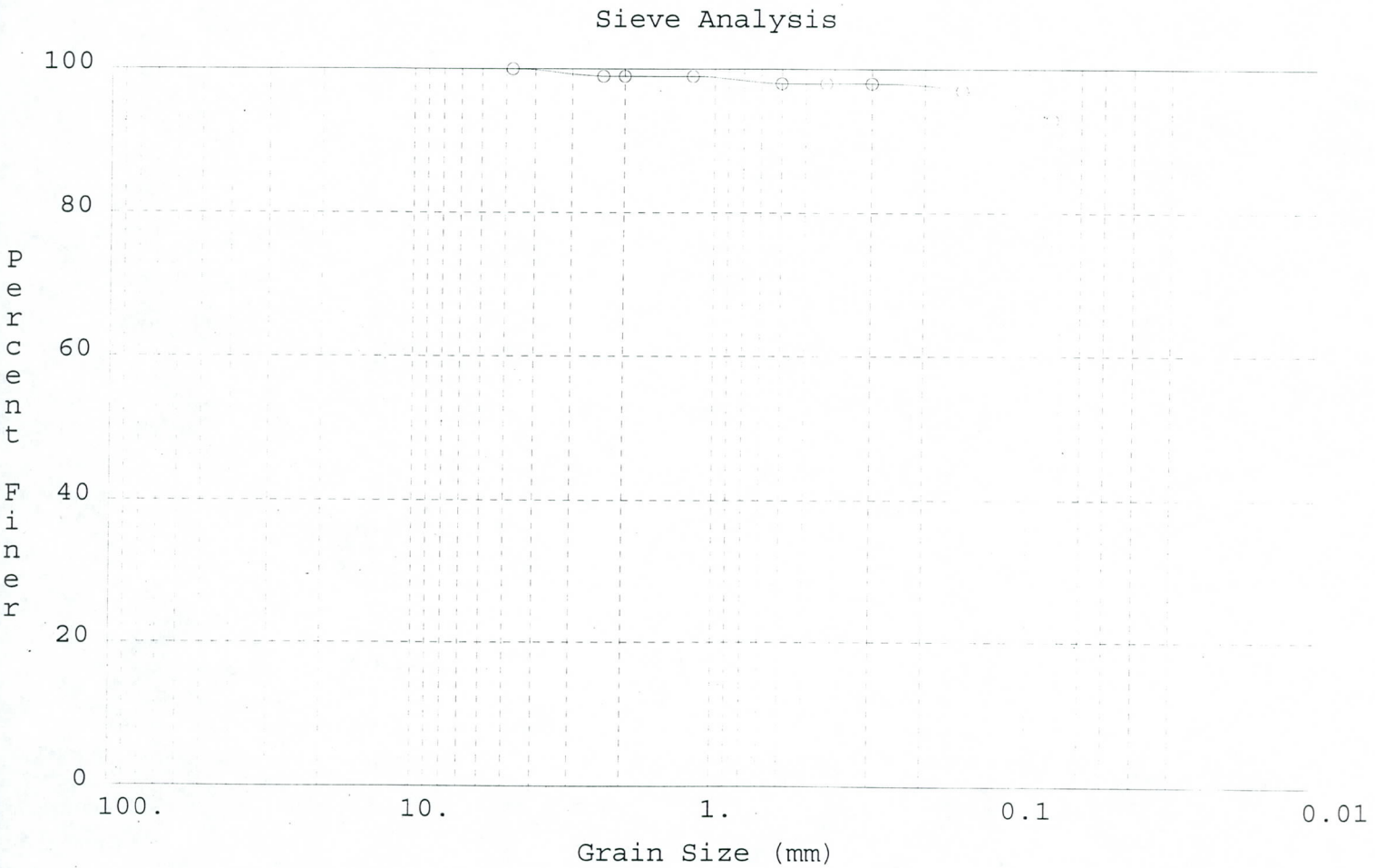
Project Number = 198013 Client: Sverdrup, Inc.
Location = Bullard Wash Levees, Lower Buckeye Road
Date = 5/26/98
Tested By = M. Blalock
Boring Number = 8
Depth = 3' - 10'
Sample Number = 98-0529
Description = Dark brown, lean CLAY(CL)
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
#4	4.750	0.00	0.00	0.00	100.00
#8	2.360	0.00	0.00	0.00	100.00
#10	2.000	0.00	0.00	0.00	100.00
#16	1.180	10.00	1.00	1.00	99.00
#30	0.600	0.00	0.00	1.00	99.00
#40	0.425	10.00	1.00	2.00	98.00
#50	0.300	0.00	0.00	2.00	98.00
#100	0.150	0.00	0.00	2.00	98.00
#200	0.075	60.00	6.00	8.00	92.00
Pan	0.000	0.00	0.00	8.00	92.00



Project Number = 198013 Client: Sverdrup, Inc.
Location = Bullard Wash Levees, Lower Buckeye Road
Date = 5/26/98
Tested By = M. Blalock
Boring Number = 9
Depth = 5' - 10'
Sample Number = 98-0530
Description = Dark brown, lean CLAY(CL)
Dry Sample Weight (g) = 1000

SIEVE NUMBER	SIEVE OPENING (mm)	RETAINED WEIGHT (g)	PERCENT OF WEIGHT RETAINED	CUMULATIVE PERCENT RETAINED	PERCENT FINER (%)
#4	4.750	0.00	0.00	0.00	100.00
#8	2.360	10.00	1.00	1.00	99.00
#10	2.000	0.00	0.00	1.00	99.00
#16	1.180	0.00	0.00	1.00	99.00
#30	0.600	10.00	1.00	2.00	98.00
#40	0.425	0.00	0.00	2.00	98.00
#50	0.300	0.00	0.00	2.00	98.00
#100	0.150	10.00	1.00	3.00	97.00
#200	0.075	40.00	4.00	7.00	93.00
Pan	0.000	0.00	0.00	7.00	93.00



ATL, INC.
CONSTRUCTION QUALITY CONTROL
GEOTECHNICAL CONSULTANTS

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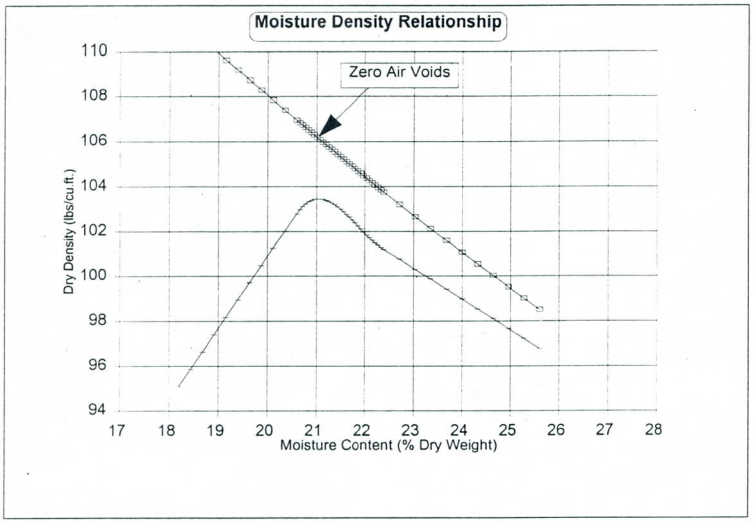
Summary of Moisture Density Relationship Tests

Client:	Sverdrup, Inc. 637 South 48th St. Ste 101 Tempe, AZ 85281	**Job No.**	198013
		Lab No.	98-0528
		Type of Rammer:	Manual
Project:	Bullard Wash Levees, Lower Buckeye Rd. Goodyear, AZ	**Test Date:**	05/22/98
		Material Description:	Dark brown, sandy lean CLAY(CL)
Test Designation:	ASTM D-698		
Test Method:	A	**Sample Source:**	Boring No.: 7 ; Depth: 2 1/2' - 5'



Specific Gravity Used For Zero Air Voids Curve: 2.65

Test No.	1	2	3	4
Dry Density (lbs/cu.ft.)	95.1	102.8	101.2	96.8
Moisture Content (%)	18.2	20.6	22.4	25.6

Maximum Dry Density (lbs/cu.ft.): **103.5**
Optimum Moisture Content (% of Dry Weight): **21.0**

Remarks:

Respectfully Submitted:

Reviewed By:
Input By: AO

Joseph B. Lopez, SET
Laboratory Supervisor

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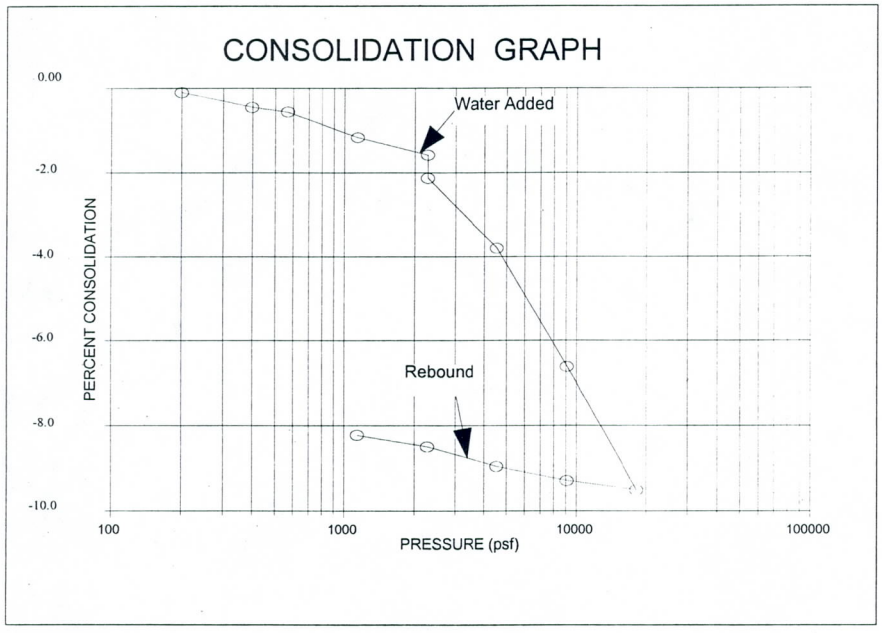
CONSOLIDATION TEST
(ASTM D-2435)

Client:	Sverdrup Civil, Inc.	**Lab No.:**	98-0527
Project Name :	Bullard Wash-Levees, Goodyear, AZ	**Test Date:**	05/19/98
Project No. :	198013	**Sample Location:**	Boring No.: 7
Initial Reading:	0.2000		Depth:2 1/2' - 3'
Dry Density:	96.5 pcf	**Soil Description:**	Dark brown, lean CLAY(CL)
Moisture Content:	Before: 21.8% After: 24.4%		

LOAD (tsf)	LOAD (psf)	DIAL READING	PERCENT CONSOLIDATION
0.05	100	0.2001	-0.01
0.10	200	0.2009	-0.09
0.20	400	0.2044	-0.44
0.29	570	0.2055	-0.55
0.57	1140	0.2116	-1.16
1.14	2280	0.2158	-1.58
1.14	2280	0.2212	-2.12
2.28	4560	0.2379	-3.79
4.56	9120	0.2661	-6.61
9.12	18240	0.2950	-9.50
4.56	9120	0.2928	-9.28
2.28	4560	0.2895	-8.95
1.14	2280	0.2849	-8.49
0.57	1140	0.2822	-8.22



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BULLARD WASH LEVEES
LOWER BUCKEYE ROAD
BROADWAY ROAD & BID CANAL
GOODYEAR, ARIZONA
ATL JOB NO. 198013

PERCENT SWELL TEST
(Surcharge = 100psf)

Boring No. No.	Sample Depth (ft)	USCS	Percent Swell	Dry Density (pcf)	Saturation Moisture (%)
7	2 ½ - 3	CL	1.1	89.2	33.1

RESULTS OF DIRECT SHEAR TESTS

Client: Sverdrup Civil, Inc. **Date:** 27-May-98

Project Name: Bullard Wash-Levees, Goodyear, AZ

Sample Source: Boring No.: 7 Depth: 2 1/2' - 3'

Type: Driven Ring; Dry Density: 97.7 pcf; Moisture Content: 25.8%

Material: Dark brown, lean CLAY(CL)

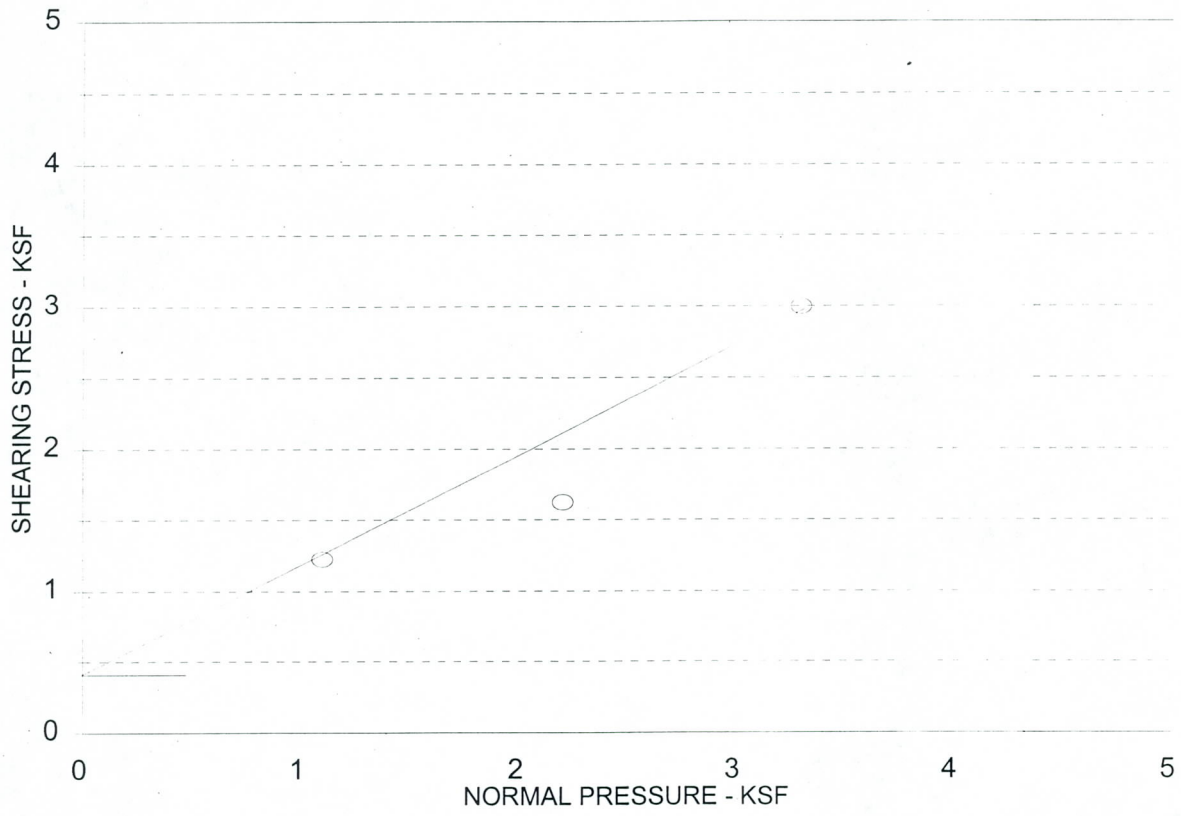
Sampled By: K. Phillips

Lab. No.: 98-0527

TESTED: ASTM D3080; Samples soaked.

RESULTS:

Friction Angle (phi)= 38 Deg. Cohesion (c) = 0.4 ksf



Project No. 198013