GEOTECHNICAL INVESTIGATION

Marsh-Booth 24 Inch Water Main Project
Reno, Nevada

December 6, 2017

Prepared for:

TRUCKEE MEADOWS WATER AUTHORITY
Quality. Delivered.

1355 Capital Boulevard
Reno, Nevada 89502

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12/6/17

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EASTERN SIERRA ENGINEERING

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1.0 INTRODUCTION AND SCOPE

This Report presents the results of Eastern Sierra Engineering's (ESE's) geotechnical investigation for the proposed Marsh-Booth 24-inch Water Main project in Reno, Nevada. The project area includes 1,055 +/- feet on Marsh Avenue, 645 +/- feet on California Avenue, 1,545 +/- feet on Booth Street and 490 +/- feet on a private roadway leading from Booth Street to the Idlewild Pump Station in Reno, Nevada. We understand that the depth to invert may be as deep as 12 feet below finish grade, and possibly 20 feet due to possible conflicts with existing underground utilities. The limits of the project are shown on Figure 1.

The following scope of services was provided:

- Located and marked seven (7) boring locations and contacted Underground Service Alert (USA) to notify them of our intent to excavate and drill at the site;

- Drilled, logged, and sampled six (6) borings ranging in depth from 15 feet to 20 feet;

- Performed laboratory testing that included particle size analysis, Atterberg limits, moisture content, and corrosivity (pH, sulfate, chloride, resistivity, sulfides and redox potential);

- Prepared conclusions and recommendations addressing excavatability of subsurface soils, reuse of excavated material for bedding and backfill material, and mitigation of unstable subgrade;

- Prepared this report that summarizes field activities, subsurface soil conditions and laboratory testing. Also included is a site plan with approximate boring locations, boring logs, particle size distribution charts, plasticity charts, and construction recommendations.

This report was prepared for the sole use of the Truckee Meadows Water Authority (TMWA), the only intended beneficiary of ESE's work. No other party should rely on the information contained herein without prior written consent of TMWA and ESE.

2.0 FIELD INVESTIGATION AND LABORATORY TESTING

2.1 Field Investigation

ESE explored subsurface conditions by drilling six (6) borings (B-1 through B-6) on October 16 and 17, 2017. Borings were drilled to depths ranging from 15 to 20 feet below the existing grade using a track mounted sonic drill rig. A sonic rig drill advances by rotating and vibrating the rod, core barrel, and casing at sonic frequencies. The boring is drilled, cored and cased at the same time while producing a continuous core sample from the entire depth of the hole. The approximate locations of borings are presented on Figure 1. During drilling activities, ESE's geologist logged the borings and obtained continuous representative soil samples from the borings.

During drilling, existing asphalt concrete (AC) pavement and aggregate base (AB)/fill thicknesses (if encountered) were measured. At the completion of logging and sampling, the borings were backfilled and compacted with the excavated material and completed to the original grade with an asphalt concrete cold patch material. Groundwater, if encountered, was measured prior to backfilling test pits. Summary logs of borings B-1 through B-6 are presented on Figures 2 through 13.

Soil samples were classified in accordance with the Unified Soil Classification System (ASTM D2487-00) presented on Figure 14.

2.2 Laboratory Testing

Soil samples were taken to ESE's American Association of State Highway and Transportation Officials (AASHTO) certified materials testing laboratory for further examination and selected laboratory testing. Laboratory testing included particle size analysis, Atterberg limits (plasticity), moisture content; additionally select samples were sent to WETLAB for corrosivity (pH, sulfate, sulfides chloride, resistivity and redox potential) testing. Results of laboratory testing are presented in Figures 15 through 29. Results are also summarized in Table 1 and on the logs of the borings, Figures 2 through 13.

TABLE 1 - Laboratory Test Results

Boring No.	**Sample Depth (ft.)**	**Moisture Content (%)**	**Percent Passing No. 200 Sieve Size (%)**	**Atterberg Limits (%)**	**Soil Type**
B-1	4.0 – 6.0	3.0	14.1	LL = 15 PI = 2	Silty Gravel with Sand (GM)
B-1	8.0 – 9.0	2.0	9.7	LL = 16 PI = 3	Poorly Graded Gravel with Silt and Sand (GP-GM)
B-1	11.0 – 13.0	3.0	22.0	LL = 17 PI = 2	Silty Gravel with Sand (GM))
B-2	9.0 – 11.0	2.0	8.5	LL = 16 PI = 2	Poorly Graded Gravel with Silt and Sand (GP-GM)
B-3	2.0 – 4.0	3.0	9.1	LL = 21 PI = 3	Poorly Graded Gravel with Silt and Sand (GP-GM)
B-3	10.0 – 12.0	3.0	8.1	LL = -- PI = NP	Poorly Graded Gravel with Silt and Sand (GP-GM)
B-3	18.0 – 20.0	3.0	17.3	LL = 25 PI = 9	Clayey Gravel with Sand (GC)

TABLE 1 - Laboratory Test Results (cont.)

Boring No.	Sample Depth (in.)	Moisture Content (%)	Percent Passing No. 200 Sieve Size %	Atterberg Limits (%)	Soil Type
B-4	3.0 – 5.0	8.0	15.8	LL = 29 PI = 4	Silty, Clayey Gravel with Sand (GC-GM)
B-4	9.0 – 11.0	9.0	10.6	LL = 30 PI = 1	Poorly Graded Gravel with Silt and Sand (GP-GM)
B-5	5.0 – 9.0	3.0	8.8	LL = -- PI = NP	Poorly Graded Gravel with Silt and Sand (GP-GM)
B-6	9.0 -11.0	2.0	12.5	LL= 21 PI = 2	Silty Gravel with Sand (GM)
B-6	13.0 – 15.0	4.0	11.9	LL = 21 PI = 3	Poorly Graded Gravel with Silt and Sand (GP-GM)

3.0 SURFACE AND SUBSURFACE CONDITIONS

3.1 Surface Conditions

The Booth Street section of the proposed alignment ranged from 6.5-inches to 11-inches of AC pavement, aggregate base/fill ranged from 4-inches to 6-inches. On California Avenue the AC was found to be 8-inches thick in eastbound right lane, overlying 10-inches of granular fill, in the left lane the AC was 10.5-inches thick, overlying 7-inches of granular fill. The Marsh Avenue section ranged from 9.5-inches to 11.5-inches of AC and the fill ranged from 4-inches to 6-inches.

3.2 Subsurface Conditions

The pipeline alignment is located within an area mapped by the Nevada Bureau of Mines and Geology (NBMG) in the Reno Folio Geologic Map, Reno, Nevada (H.F. Bonham Jr. and E. C. Bingler, 1973,) as: **“Qto” – Tahoe Outwash** – “Boulder to cobble gravel, sandy gravel, and gravely sand. Contains giant boulders. Rock clasts are rounded to subrounded and, in decreasing order of abundance, are granitic, volcanic, and metamorphic." **"Qdo" -** Donner **Lake Outwash –** "Deposits similar to Tahoe outwash except weathered to depths of four feet or more".

Fill material was encountered in all the borings. Fill underlying the AC generally consisted of medium dense to dense, poorly graded gravel with sand, poorly graded sand, and silty sand ranging in thickness from 4.0-inches to 10.0-inches beneath the AC.

Based on ESE's field investigation and laboratory testing, subsurface soils underlying the fill generally consist of medium dense to very dense, poorly graded gravel with sand, cobble and boulders, poorly graded sand with gravel, cobble and boulders, silty gravel with sand, cobble and boulder, and clayey sand.

At the B-4 location on California Ave., a boring was first attempted in right lane in east bound direction, 4.5' from front face of curb, and we encountered concrete (wall footing) at 18-inches below top of finish grade. A second attempt to drill a boring was performed in left lane in east bound direction, 16.5 feet from front face of curb, and we did not encounter concrete.

No groundwater was encountered at the time of drilling activities. Groundwater elevations should be expected to seasonally fluctuate due to precipitation and snowmelt and irrigation.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 General

Based on the field investigation, laboratory testing, and engineering analysis, the site has no geotechnical engineering constraints.

4.2 Excavation

Based on the field exploration, excavation for the majority of the water main alignment will pass through dense to very dense gravels and cobbles. Borings encountered areas of abundant cobbles and some boulders 24 inches in diameter or greater. The contractor should anticipate encountering boulders larger than 24-inches in size along the water main alignment. Some of the borings encountered slow, difficult drilling due to cobble and boulder size rock. Drilling produced some rock cores of a foot or greater in a number of the borings where boulder size material was encountered.

Based on drill rates, rock cores and other material recovered during drilling, a large track hoe equipped with a "rock bucket and rock teeth" would most likely be able to excavate to the proposed water main invert elevations. In some locations the use of a jackhammer or similar pneumatic method may be necessary to break-up very rocky areas and thus allowing excavation.

Additionally, Contractor should pothole existing utilities to verify location and depth to ensure that adequate clearance can be maintained between new water main and existing utilities.

4.3 Water Main Bedding and Backfill

Any material used as pipe bedding or backfill shall meet the minimum requirements of the TMWA Construction and Design Standards (TMWACDS).

4.3.1 Water Main Bedding

All bedding material shall conform to the requirements of the “Standard Specification for the Public Works Construction,” (Orange Book), Revision dated 12-21-2016 and referenced further in this report as the Standard Specifications or other TMWACDS approved alternate.

Class A bedding shall conform to the Standard Specifications, Section 200.03.02. The bedding area (6 inches below pipe, 12 inches laterally beyond pipe, and 12 inches over pipe) should be Class A material moisture conditioned to near optimum moisture content, placed in 8 inch maximum loose lifts, then compacted to at least 95 percent relative compaction. The bedding materials shall be placed as described in Section 305 of the Standard Specifications and as detailed on the drawings.

Based on the field investigation and laboratory testing, the excavated native material will not meet Class A bedding specifications.

4.3.2 Water Main Backfill

The backfill over the bedding material shall be per the requirements of the Drawings and Specifications for the project and shall be Type II, Class B Aggregate Base conforming to Section 200.01.03 of the Standard Specifications. Organic matter and oversized rock will not be permitted.

All backfill shall be moisture conditioned to near optimum moisture content, placed in lifts not exceeding 8 inches (loose thickness), and compacted to the requirements as provided in the Specifications and detailed on the Drawings. Backfill material shall be placed as described in Section 305 of the Standard Specifications.

4.4 Unstable Subgrade

If areas of soft, wet, unstable subgrade are encountered or created, it may require the Contractor to overexcavate and stabilize the subgrade by placing Engineer approved 8-inch to 12-inch diameter, clean, crushed, angular rock, and/or combine the crushed rock with Mirafi HP570 woven geofabric (or acceptable equivalent) to create a working platform. **NOTE:** A test area is recommended to determine the most suitable method of creating a working platform. Relatively light, nonvibratory compaction equipment shall be used during this operation to minimize further softening and pumping of the exposed subgrade.

Any groundwater encountered in excavations shall be removed and excavations kept dry until they are backfilled to at least 2 feet above the static groundwater table. Where static groundwater is within 2 feet of existing grade, excavations shall be kept dry until they are completely backfilled.

4.5 Temporary Excavations

The Contractor is responsible for the selection, design, construction and maintenance of the shoring method and temporary slopes. Safety requirements established by OSHA or other regulatory agencies shall be followed during excavation and construction by the Contractor. Heavy construction equipment, construction materials, or soil stockpiles shall not be located near the top of any excavation. Sloughing of excavation sidewalls should be anticipated during construction excavation due to cohesionless granular soils.

4.6 Corrosion Potential

The results of the corrosion testing on boring soil samples are presented in Table 2.

TABLE - 2
Corrosivity Test Results

Boring No.	Sample Depth (ft.)	Chloride (mg/kg)	Sulfate (mg/kg)	Resistivity (ohm-cm)	pH	Sulfides	Redox potential (mV)
B-2	11.0-13.0	6.1	6.7	1200	9.3	Negative	470
B-3	10.0-12.0	5.5	4.4	9500	9.0	Negative	460
B-3	16.0-18.0	11	15	6700	8.7	Negative	400
B-4	9.0-11.0	54	35	4000	8.0	Negative	470
B-5	5.0-9.0	78	31	2400	8.7	Negative	450

Based on the results of analytical testing there is negligible potential for sulfate exposure/attack to concrete, therefore a Type II cement is acceptable for use. Also, based on the results of laboratory testing the degree of corrosive potential for metals varies from moderately corrosive (10,000-5,000 ohm-cm) to highly corrosive (3,000-1,000 ohm-cm).

Corrosion protection of metal pipelines shall be based upon the recommendations found in AWWA C105, Appendix A and the Design Engineers judgment.

5.0 ADDITIONAL SOILS ENGINEERING SERVICES

Prior to and during construction, the following should be performed under ESE observations to ensure conformance with the intent of ESE's recommendations.

- Excavation;
- Suitability of onsite and imported fill materials;
- Bedding and backfill placement and compaction;

Observation of these operations will allow ESE to check that soil conditions are consistent with this geotechnical investigation and to evaluate variations in soils conditions, which may require special consideration or modification of the recommendations.

6.0 LIMITATIONS

Recommendations contained in this report are based on our field explorations, laboratory tests, and our understanding of the proposed construction. The study was a cost-effective method to evaluate some of the potential geotechnical concerns.

The soils data used in the preparation of this report were obtained from borings located for this investigation. It is possible that variations in soils exist between the points explored. The nature and extent of soil variations may not be evident until construction occurs. If any soil conditions are encountered at this site, which are different from those described in this report, our firm should be immediately notified so that we may make any necessary revisions to our recommendations.

This report may be used only by TMWA and only for the purposes stated within a reasonable time from issuance, but in no event later than three years from the date of the report. Land or facility use, on and off-site conditions, regulations, or other factors may change over time, and additional work may be required with the passage of time.

7.0 REFERENCES

- *Geologic Map of the Reno Folio, Washoe County, Nevada*. H.F. Bonham Jr. and E.C. Bingler, Nevada Bureau of Mines and Geology, U.S. Geological Survey, 1973.

- *Standard Specifications for Public Works Construction*. RTC of Washoe County, Washoe County, City of Sparks, City of Reno, Carson City, and City of Yerington, Revision No. 9, December 21, 2016

- *Construction and Design Standards*, Truckee Meadows Water Authority https://tmwa.com/new-construction/standards/

APPENDIX A - FIGURES

TRUCKEE MEADOWS WATER
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MARSH-BOOTH MAIN

WATERWHERE ONLINE

Figure 1 - Boring Locations

DATE: Sep 08, 2017

MAP BY:

WORK ORDER #:

SCALE: NTS

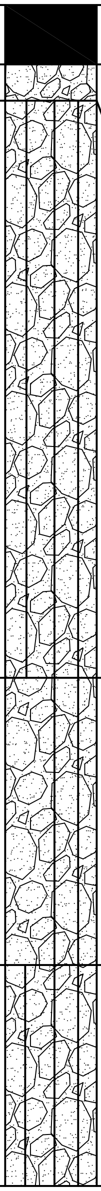
NORTH

NAD 83 NEVADA STATE PLANE WEST FEET

BORING LOG

BORING NO: B-1
EQUIPMENT: SONIC DRILL
LOGGED BY: M. PHELPS

DATE: 10/16/2017
DEPTH TO GROUND WATER (ft): N/A
GROUND ELEVATION (ft): N/A



LIQUID LIMIT (%)	PLASTICITY INDEX	MOISTURE (%)	% PASSING #200 SIEVE	BLOWS/FT.	SAMPLE	DEPTH (FT)	USCS SYMBOL	LITHOLOGY	
							AC		6.5" AC
							GP		BROWN POORLY GRADED GRAVEL WITH SAND (GP); medium dense to dense, dry to moist, (FILL)
15.0	2.0	3.0	14.1			2 4 6	GM		BROWN SILTY GRAVEL WITH SAND AND COBBLE (GM); dense to very dense, dry to moist, cobble dia. ≤10" Difficult drilling due to large volume of cobble size rock.
16.0	3.0	2.0	9.7			8	GP-GM		BROWN POORLY GRADED GRAVEL WITH SILT, SAND AND COBBLE (GP-GM); very dense, dry to moist.
						10 12	GM		BROWN SILTY GRAVEL WITH SAND AND COBBLE (GM); dense to very dense, dry to moist, cobble dia. < 10"

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BORING LOG: B-1
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE
2

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/7/2017		

BORING LOG

BORING NO: B-1 cont.
EQUIPMENT: SONIC DRILL
LOGGED BY: M. PHELPS
DATE: 10/16/2017
DEPTH TO GROUND WATER (ft): N/A
GROUND ELEVATION (ft): N/A

LIQUID LIMIT (%)	PLASTICITY INDEX	MOISTURE (%)	% PASSING #200 SIEVE	BLOWS/FT.	SAMPLE	DEPTH (FT)	USCS SYMBOL	LITHOLOGY	
17.0	2.0	3.0	22.0		☒ ☒ ☒	12 14 16	GM	▨	BROWN SILTY GRAVELS WITH SAND AND COBBLES (GM): very dense, moist Drilling continues to be difficult due to large volume of cobbles, dia. ≤ 10"
						18 20 22 24			Boring terminated at 17.0 feet. No free groundwater encountered at time of drilling.

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BORING LOG: B-1 Cont.
MARSH-BOOTH WATER MAIN
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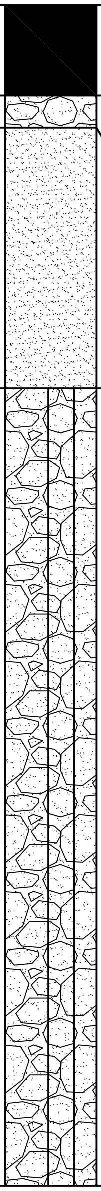
FIGURE
3

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/7/2017		

BORING LOG

BORING NO: B-2
EQUIPMENT: SONIC DRILL
LOGGED BY: M. PHELPS
DATE: 10/17/2017
DEPTH TO GROUND WATER (ft): N/A
GROUND ELEVATION (ft): N/A



LIQUID LIMIT (%)	PLASTICITY INDEX	MOISTURE (%)	% PASSING #200 SIEVE	BLOWS/FT.	SAMPLE	DEPTH (FT)	USCS SYMBOL	LITHOLOGY	
							AC		11.0" AC
							GP		BROWN POORLY GRADED GRAVEL WITH SAND (GP); medium dense to dense, dry to moist, (FILL)
						2	SP		BROWN POORLY GRADED SAND (SP): medium dense to dense, dry to moist, (FILL?)
						4	GP-GM		Encountering cobble, becoming more difficult drilling.
						6			GRAY-BROWN POORLY GRADED GRAVEL WITH SILT, SAND AND COBBLE (GP-GM); very dense, dry to moist, cobble dia. ≤ 10"
						8			Encountering some sand lenses, drill rate speeds up.
16.0	2.0	2.0	8.5			10			
						12			

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BORING LOG: B-2
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE 4

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/7/2017		

BORING LOG

BORING NO: B-2 cont.
EQUIPMENT: SONIC DRILL
LOGGED BY: M. PHELPS
DATE: 10/17/2017
DEPTH TO GROUND WATER (ft): N/A
GROUND ELEVATION (ft): N/A

LIQUID LIMIT (%)	PLASTICITY INDEX	MOISTURE (%)	% PASSING #200 SIEVE	BLOWS/FT.	SAMPLE	DEPTH (FT)	USCS SYMBOL	LITHOLOGY	
					☒ ☒	12 14	GP-GM		GRAY-BROWN POORLY GRADED GRAVEL WITH SILT, SAND AND COBBLE (GP-GM): very dense, moist to wet Encountering free moisture on the soil, and hitting boulder size rock > 1'-2' in diameter.
						16 18 20 22 24			Boring terminated at 15.0 feet. No free groundwater encountered at time of drilling.

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BORING LOG: B-2 Cont.
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

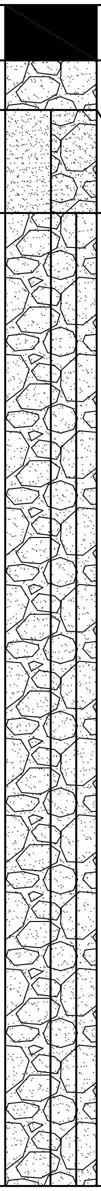
FIGURE
5

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/7/2017		

BORING LOG

BORING NO:	B-3	DATE:	10/16/2017
EQUIPMENT:	SONIC DRILL	DEPTH TO GROUND WATER (ft):	N/A
LOGGED BY:	M. PHELPS	GROUND ELEVATION (ft):	N/A

LIQUID LIMIT (%)	PLASTICITY INDEX	MOISTURE (%)	% PASSING #200 SIEVE	BLOWS/FT.	SAMPLE	DEPTH (FT)	USCS SYMBOL	LITHOLOGY	
							AC		7.0" AC
							GP		BROWN POORLY GRADED GRAVEL WITH SAND (GP); medium dense to dense, dry to moist, (FILL)
						2	SP		BROWN POORLY GRADED SAND WITH GRAVEL AND COBBLE (SP): dense to very dense, dry to moist,
						4	GP-GM		Encountering large cobble, small boulders at 2' to 4'.
21.0	3.0	3.0	9.1			6			BROWN POORLY GRADED GRAVEL WITH SILT, SAND AND COBBLE (GP-GM); dense to very dense, dry to moist, cobble dia. ≤8"
						8 10			Encountering large cobble, small boulders at 9' to 11'.
--	NP	3.0	8.1			12			



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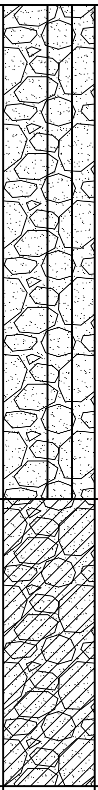
BORING LOG: B-3
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE
6

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/7/2017		

BORING LOG

BORING NO: B-3 cont.
EQUIPMENT: SONIC DRILL
LOGGED BY: M. PHELPS
DATE: 10/16/2017
DEPTH TO GROUND WATER (ft): N/A
GROUND ELEVATION (ft): N/A



LIQUID LIMIT (%)	PLASTICITY INDEX	MOISTURE (%)	% PASSING #200 SIEVE	BLOWS/FT.	SAMPLE	DEPTH (FT)	USCS SYMBOL	LITHOLOGY	
						12			Becoming moist to wet, free moisture on rock.
						14	GP-GM		BROWN POORLY GRADED GRAVEL WITH SILT, SAND AND COBBLE (GP-GM): very dense, moist to wet
						16			
						18	GC		BROWN CLAYEY GRAVEL WITH SAND AND COBBLE (GC); very dense, moist
25.0	9.0	3.0	17.3						Encountering small boulders, 1' to 2' dia.
						20			Boring terminated at 20.0 feet. No free groundwater encountered at time of drilling.
						22			
						24			

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BORING LOG: B-3 Cont.
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

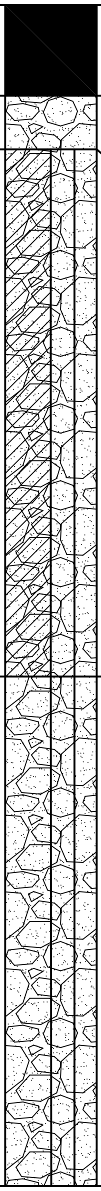
FIGURE
7

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/7/2017		

BORING LOG

BORING NO: B-4
EQUIPMENT: SONIC DRILL
LOGGED BY: M. PHELPS

DATE: 10/17/2017
DEPTH TO GROUND WATER (ft): N/A
GROUND ELEVATION (ft): N/A

LIQUID LIMIT (%)	PLASTICITY INDEX	MOISTURE (%)	% PASSING #200 SIEVE	BLOWS/FT.	SAMPLE	DEPTH (FT)	USCS SYMBOL	LITHOLOGY	
							AC		10.5" AC
							GP		BROWN POORLY GRADED GRAVEL WITH SAND (GP); medium dense to dense, dry to moist, (FILL)
						2			BROWN SILTY, CLAYEY GRAVEL WITH SAND AND COBBLE (GC-GM); medium dense to dense, moist, cobble dia. ≤ 6"
29.0	4.0	8.0	15.8			4	GC-GM		Easy drilling.
						6			
						8			BROWN POORLY GRADED GRAVEL WITH SILT, SAND AND COBBLE (GP-GM); dense, moist.
							GP-GM		
30.0	1.0	9.0	10.6			10			
						12			

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BORING LOG: B-4
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE
8

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/7/2017		

BORING LOG

BORING NO: B-4 cont.
EQUIPMENT: SONIC DRILL
LOGGED BY: M. PHELPS
DATE: 10/17/2017
DEPTH TO GROUND WATER (ft): N/A
GROUND ELEVATION (ft): N/A

LIQUID LIMIT (%)	PLASTICITY INDEX	MOISTURE (%)	% PASSING #200 SIEVE	BLOWS/FT.	SAMPLE	DEPTH (FT)	USCS SYMBOL	LITHOLOGY	
					☒ ☒	12 14	GP-GM	▨	GRAY-BROWN POORLY GRADED GRAVEL WITH SILT, SAND AND COBBLE (GP-GM): very dense, moist
						16 18 20 22 24			Boring terminated at 15.0 feet. No free groundwater encountered at time of drilling.

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BORING LOG: B-4 Cont.
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE
9

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/7/2017		

BORING LOG

BORING NO: B-5

EQUIPMENT: SONIC DRILL

LOGGED BY: M. PHELPS

DATE: 10/17/2017

DEPTH TO GROUND WATER (ft): N/A

GROUND ELEVATION (ft): N/A

LIQUID LIMIT (%)	PLASTICITY INDEX	MOISTURE (%)	% PASSING #200 SIEVE	BLOWS/FT.	SAMPLE	DEPTH (FT)	USCS SYMBOL	LITHOLOGY	
							AC		11.5" AC
							SM		BROWN SILTY SAND (SM), medium dense, moist, (FILL)
						2	SP-SM		RED-BROWN POORLY GRADED SAND WITH SILT, AND GRAVEL (SP-SM); medium dense to dense, dry to moist (FILL?) Encountering large cobble, small boulders at 4'.
--	NP	3.0	8.8			4 6 8 10 12	GP-GM		BROWN POORLY GRADED GRAVEL WITH SILT, SAND AND COBBLE (GP-GM); very dense, dry to moist. Encountering difficult drilling due to boulders at 11'.

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BORING LOG: B-5
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE 10

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/7/2017		

BORING LOG

BORING NO: B-5 cont.
EQUIPMENT: SONIC DRILL
LOGGED BY: M. PHELPS
DATE: 10/17/2017
DEPTH TO GROUND WATER (ft): N/A
GROUND ELEVATION (ft): N/A

LIQUID LIMIT (%)	PLASTICITY INDEX	MOISTURE (%)	% PASSING #200 SIEVE	BLOWS/FT.	SAMPLE	DEPTH (FT)	USCS SYMBOL	LITHOLOGY	
					☒	12	GP-GM	▨	GRAY-BROWN POORLY GRADED GRAVEL WITH SILT, SAND AND COBBLE (GP-GM): very dense, dry to moist Encountering boulders at 13', difficult drilling.
					☒	14		▨	
									Boring terminated at 15.0 feet. No free groundwater encountered at time of drilling.
						16			
						18			
						20			
						22			
						24			

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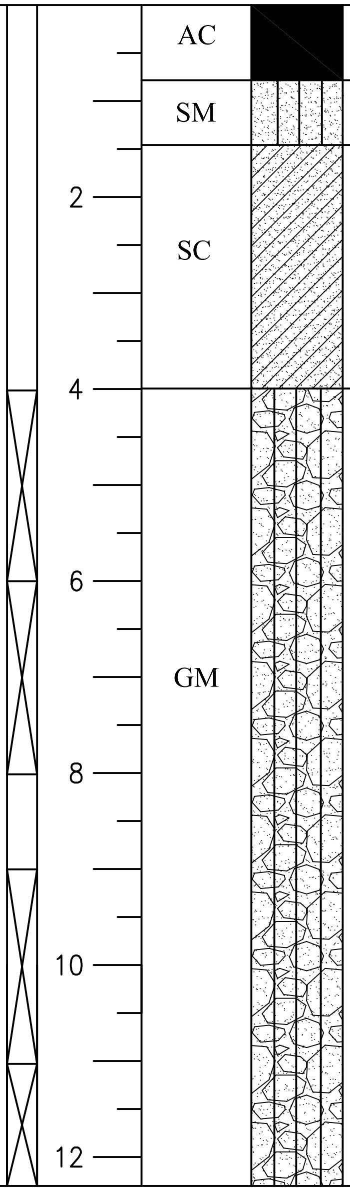
BORING LOG: B-5 Cont.
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE
11

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/7/2017		

BORING LOG

BORING NO: B-6
EQUIPMENT: SONIC DRILL
LOGGED BY: M. PHELPS
DATE: 10/17/2017
DEPTH TO GROUND WATER (ft): N/A
GROUND ELEVATION (ft): N/A



LIQUID LIMIT (%)	PLASTICITY INDEX	MOISTURE (%)	% PASSING #200 SIEVE	BLOWS/FT.	SAMPLE	DEPTH (FT)	USCS SYMBOL	LITHOLOGY	
							AC		9.5" AC
							SM		BROWN SILTY SAND (SM); medium dense to dense, dry to moist (FILL)
							SC		BROWN CLAYEY SAND WITH GRAVEL AND COBBLE (SC); dense, moist
							GM		RED-BROWN SILTY GRAVEL WITH SAND AND COBBLE (GM); dense to very dense, dry, cobble dia. ≥ 6"
									Color change to gray-brown.
									Difficult drilling due to large cobble and boulders.
21.0	2.0	3.0	12.5						

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BORING LOG: B-6
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE 12

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/7/2017		

BORING LOG

BORING NO: B-6 cont.
EQUIPMENT: SONIC DRILL
LOGGED BY: M. PHELPS
DATE: 10/17/2017
DEPTH TO GROUND WATER (ft): N/A
GROUND ELEVATION (ft): N/A

LIQUID LIMIT (%)	PLASTICITY INDEX	MOISTURE (%)	% PASSING #200 SIEVE	BLOWS/FT.	SAMPLE	DEPTH (FT)	USCS SYMBOL	LITHOLOGY	
					☒	12		▨	GRAY-BROWN SILTY GRAVEL WITH SAND, COBBLE AND BOULDER (GM); very dense, dry to moist
21.0	3.0	4.0	11.9		☒	14	GP-GM	▨	BROWN POORLY GRADED GRAVEL WITH SILT, SAND, COBBLE AND BOULDER (GP-GM); very dense, moist
									Boring terminated at 15.0 feet. No free groundwater encountered at time of drilling.
						16			
						18			
						20			
						22			
						24			

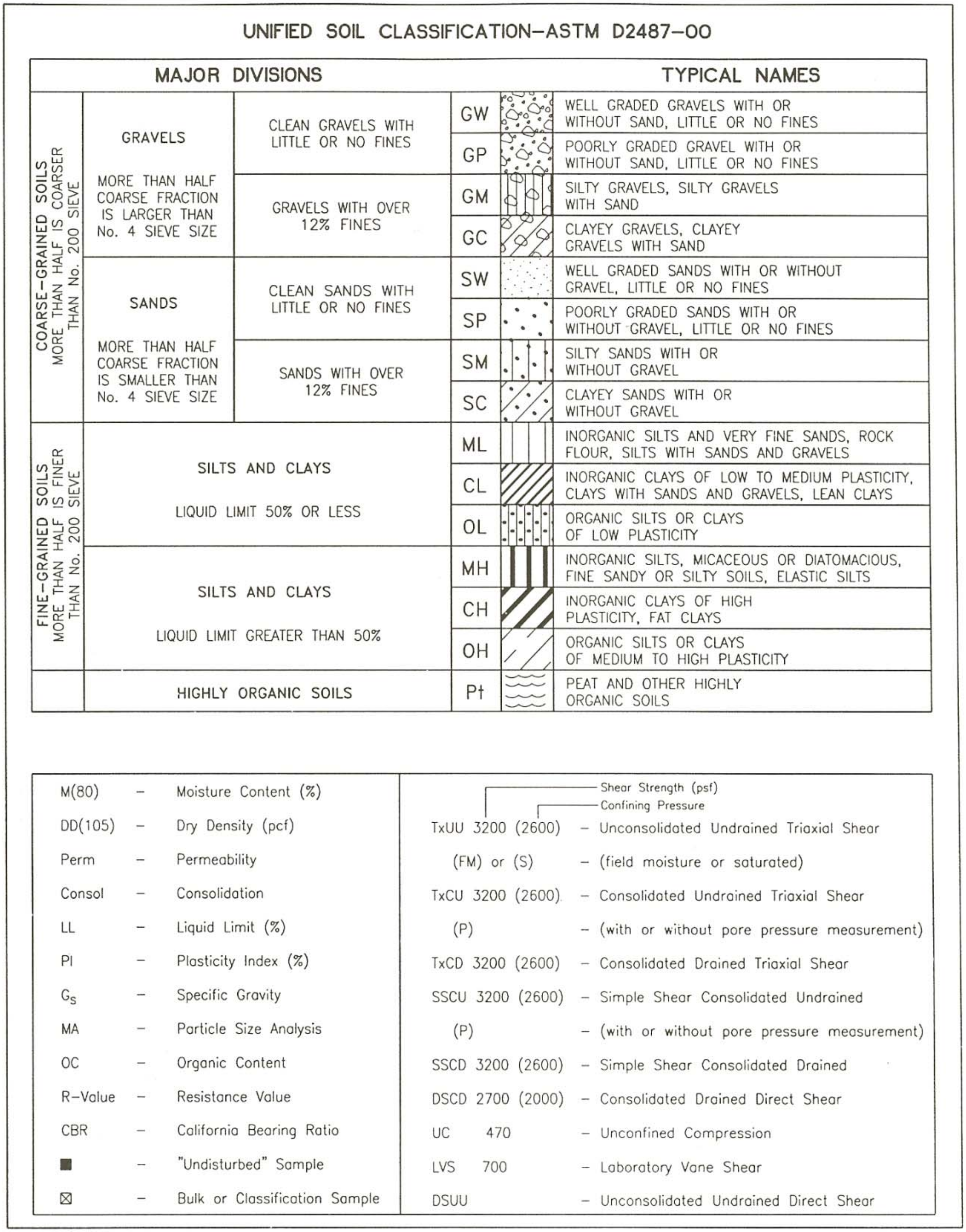
EASTERN
SIERRA
ENGINEERING

BORING LOG: B-6 Cont.
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE
13

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/7/2017		

APPENDIX B - LABORATORY RESULTS



UNIFIED SOIL CLASSIFICATION–ASTM D2487–00

MAJOR DIVISIONS				TYPICAL NAMES
COARSE–GRAINED SOILS MORE THAN HALF IS COARSER THAN No. 200 SIEVE	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN No. 4 SIEVE SIZE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL GRADED GRAVELS WITH OR WITHOUT SAND, LITTLE OR NO FINES
			GP	POORLY GRADED GRAVEL WITH OR WITHOUT SAND, LITTLE OR NO FINES
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVELS, SILTY GRAVELS WITH SAND
			GC	CLAYEY GRAVELS, CLAYEY GRAVELS WITH SAND
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN No. 4 SIEVE SIZE	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL GRADED SANDS WITH OR WITHOUT GRAVEL, LITTLE OR NO FINES
			SP	POORLY GRADED SANDS WITH OR WITHOUT GRAVEL, LITTLE OR NO FINES
		SANDS WITH OVER 12% FINES	SM	SILTY SANDS WITH OR WITHOUT GRAVEL
			SC	CLAYEY SANDS WITH OR WITHOUT GRAVEL
FINE–GRAINED SOILS MORE THAN HALF IS FINER THAN No. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT 50% OR LESS		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTS WITH SANDS AND GRAVELS
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, CLAYS WITH SANDS AND GRAVELS, LEAN CLAYS
			OL	ORGANIC SILTS OR CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50%		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS, FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC SILTS OR CLAYS OF MEDIUM TO HIGH PLASTICITY
	HIGHLY ORGANIC SOILS		Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS

M(80)	–	Moisture Content (%)
DD(105)	–	Dry Density (pcf)
Perm	–	Permeability
Consol	–	Consolidation
LL	–	Liquid Limit (%)
PI	–	Plasticity Index (%)
G_S	–	Specific Gravity
MA	–	Particle Size Analysis
OC	–	Organic Content
R–Value	–	Resistance Value
CBR	–	California Bearing Ratio
■	–	"Undisturbed" Sample
☒	–	Bulk or Classification Sample

TxUU 3200 (2600)	–	Unconsolidated Undrained Triaxial Shear
(FM) or (S)	–	(field moisture or saturated)
TxCU 3200 (2600)	–	Consolidated Undrained Triaxial Shear
(P)	–	(with or without pore pressure measurement)
TxCD 3200 (2600)	–	Consolidated Drained Triaxial Shear
SSCU 3200 (2600)	–	Simple Shear Consolidated Undrained
(P)	–	(with or without pore pressure measurement)
SSCD 3200 (2600)	–	Simple Shear Consolidated Drained
DSCD 2700 (2000)	–	Consolidated Drained Direct Shear
UC 470	–	Unconfined Compression
LVS 700	–	Laboratory Vane Shear
DSUU	–	Unconsolidated Undrained Direct Shear

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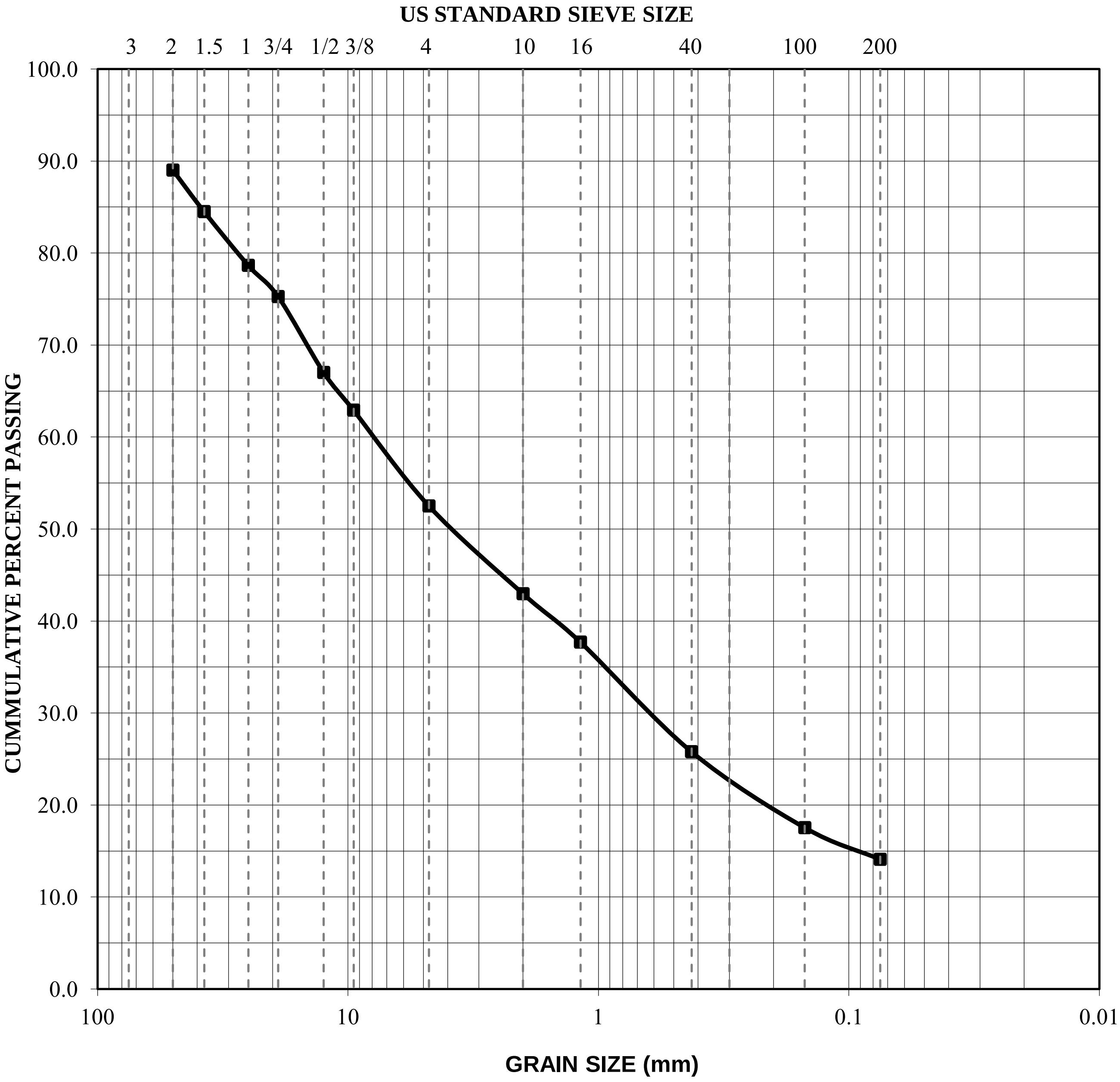
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY
UNIFIED SOIL CLASSIFICATION

FIGURE
14

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/7/2017		



COBBLES	GRAVEL	SAND	SILT OR CLAY

Symbol	Sample Source	Classification
■	B-1 @ 4.0' - 6.0'	SILTY GRAVEL WITH SAND (GM)

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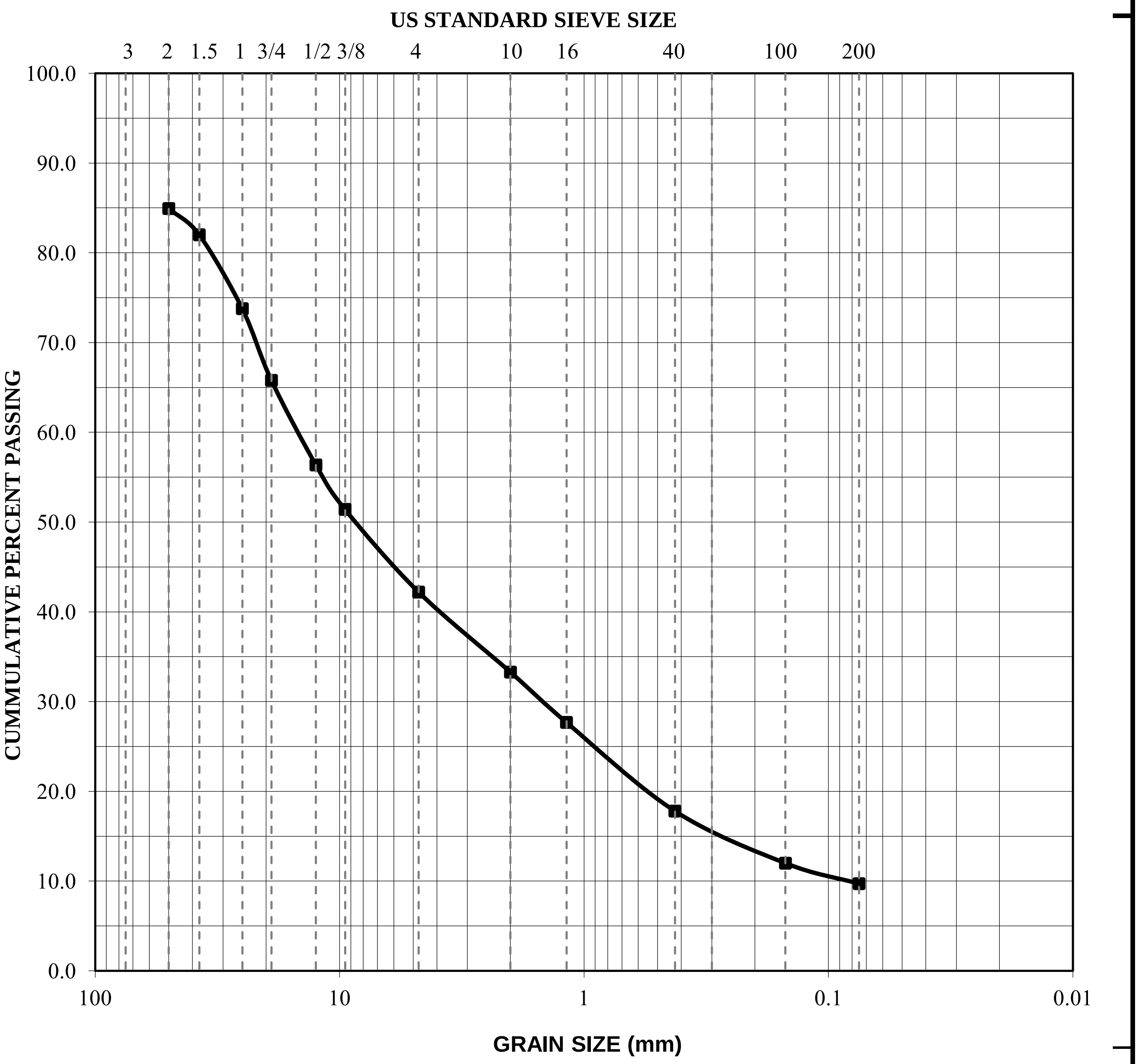
PARTICLE SIZE ANALYSIS
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE
15

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/6/2017		



COBBLES	GRAVEL	SAND	SILT OR CLAY

Symbol	Sample Source	Classification
■	B-1 @ 8.0' - 9.0'	POORLY GRADED GRAVEL W/ SILT & SAND (GP-GM)

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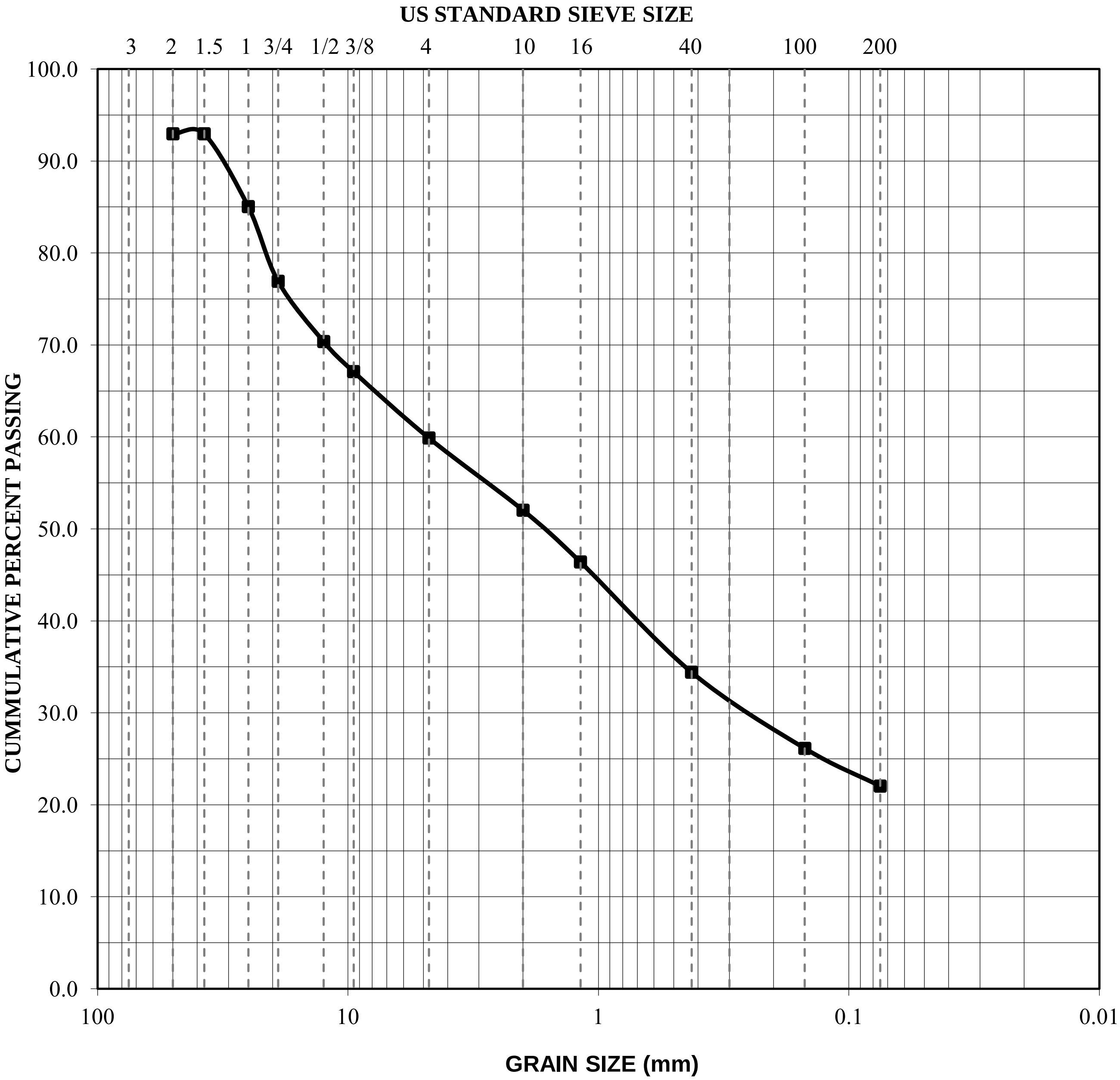
PARTICLE SIZE ANALYSIS

MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE
16

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/6/2017		



COBBLES	GRAVEL	SAND	SILT OR CLAY

Symbol	Sample Source	Classification
■	B-1 @ 11.0' - 13.0'	SILTY GRAVEL WITH SAND (GM)

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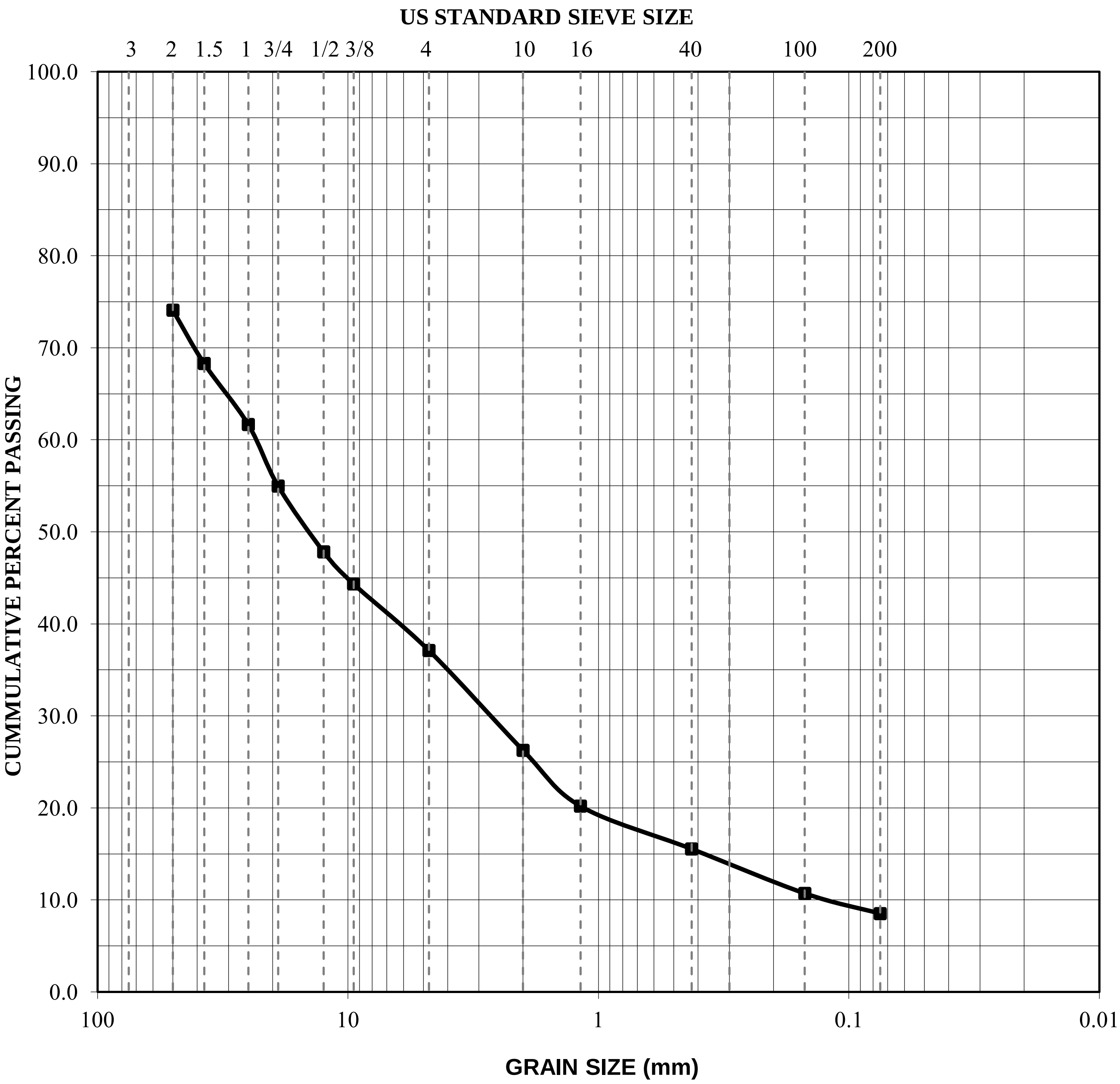
PARTICLE SIZE ANALYSIS
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE
17

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/6/2017		



COBBLES	GRAVEL	SAND	SILT OR CLAY

Symbol	Sample Source	Classification
■	B-2 @ 9.0' - 11.0'	POORLY GRADED GRAVEL W/ SILT & SAND (GP-GM)

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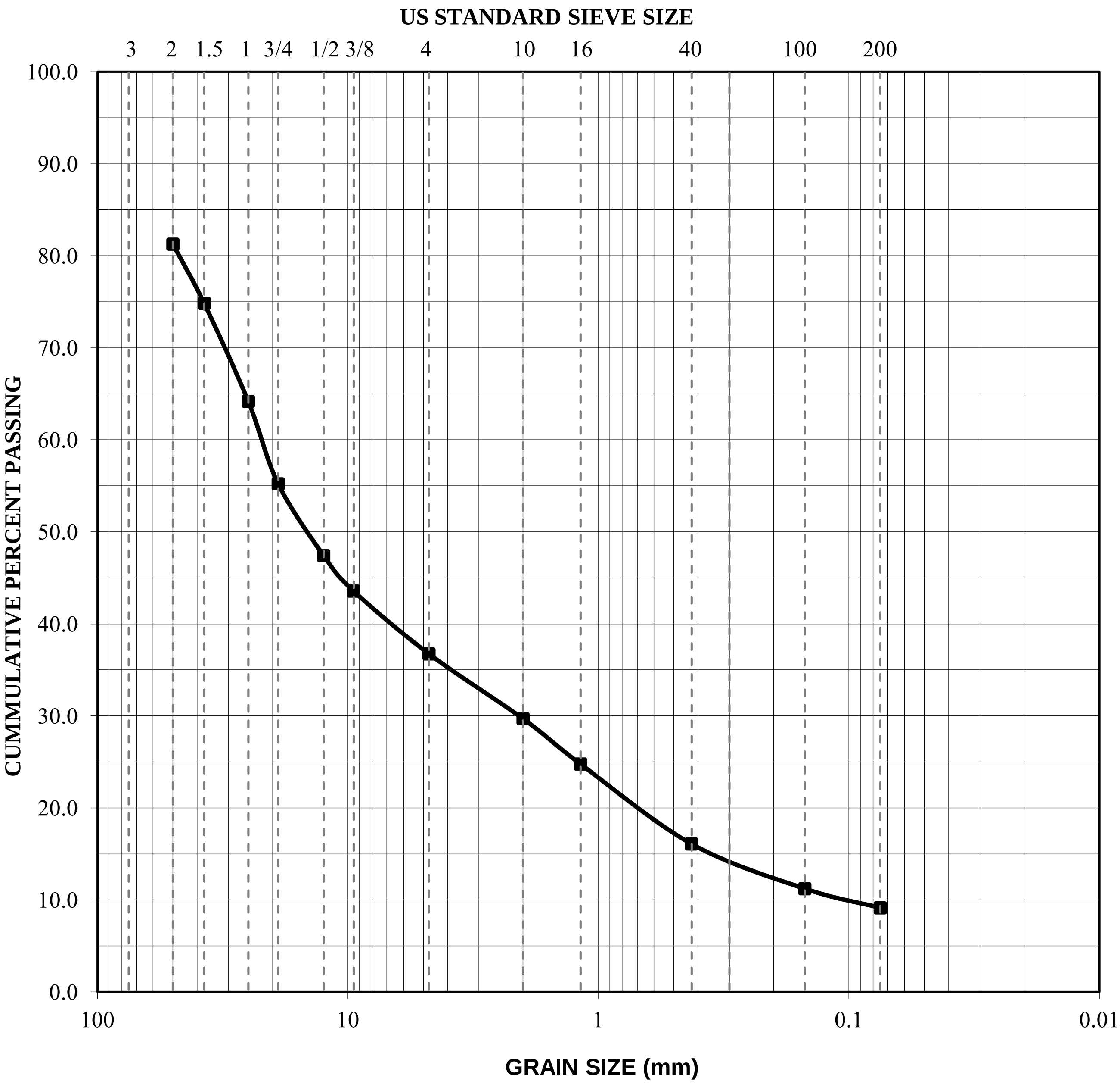
PARTICLE SIZE ANALYSIS

MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE
18

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/6/2017		



COBBLES	GRAVEL	SAND	SILT OR CLAY

Symbol	Sample Source	Classification
■	B-3 @ 2.0' - 4.0'	POORLY GRADED GRAVEL W/ SILT & SAND (GP-GM)

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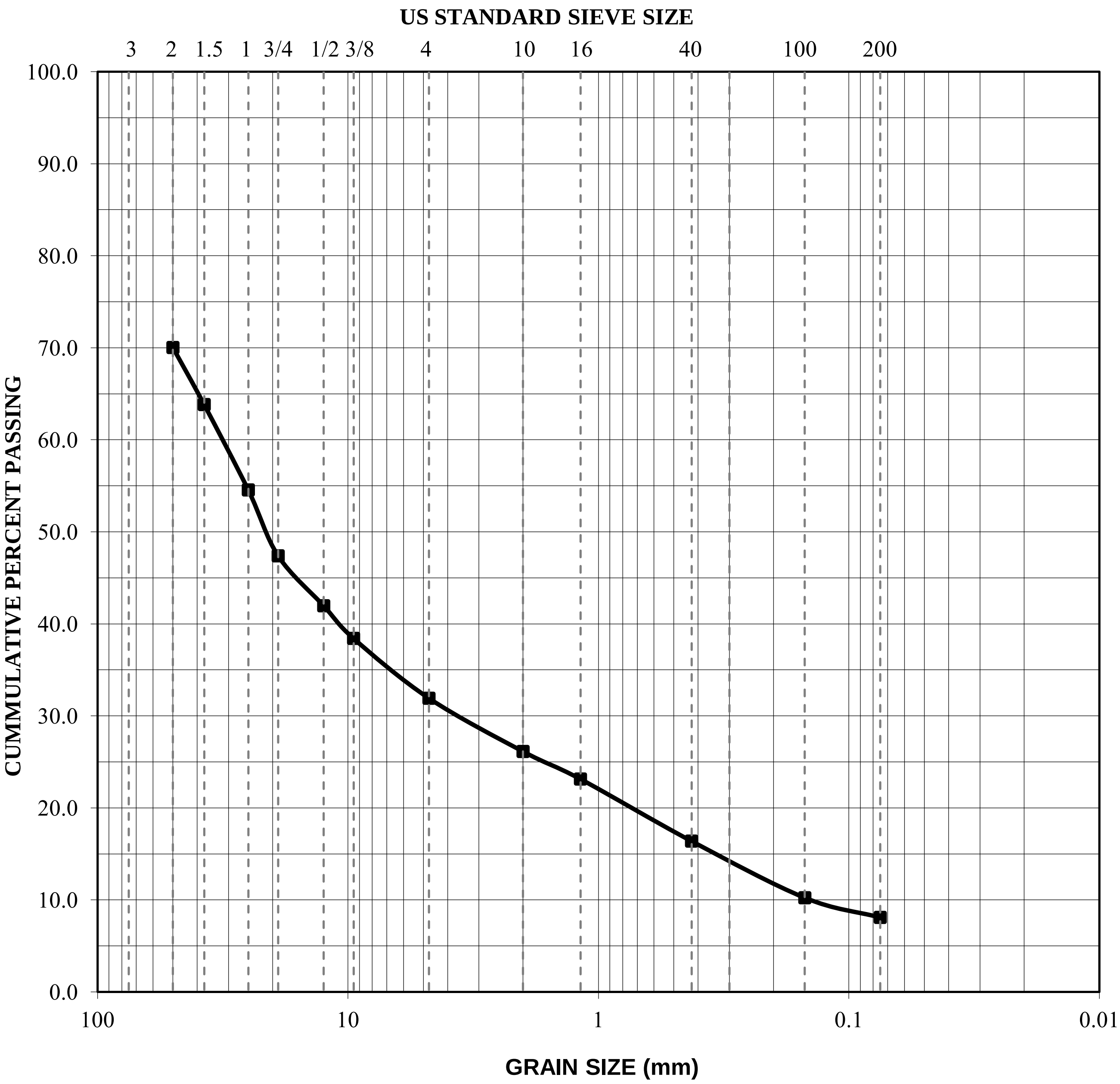
PARTICLE SIZE ANALYSIS
MARSH BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE
19

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/6/2017		



COBBLES	GRAVEL	SAND	SILT OR CLAY

Symbol	Sample Source	Classification
■	B-3 @ 10.0' - 12.0'	POORLY GRADED GRAVEL W/ SILT & SAND (GP - GM)

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PARTICLE SIZE ANALYSIS

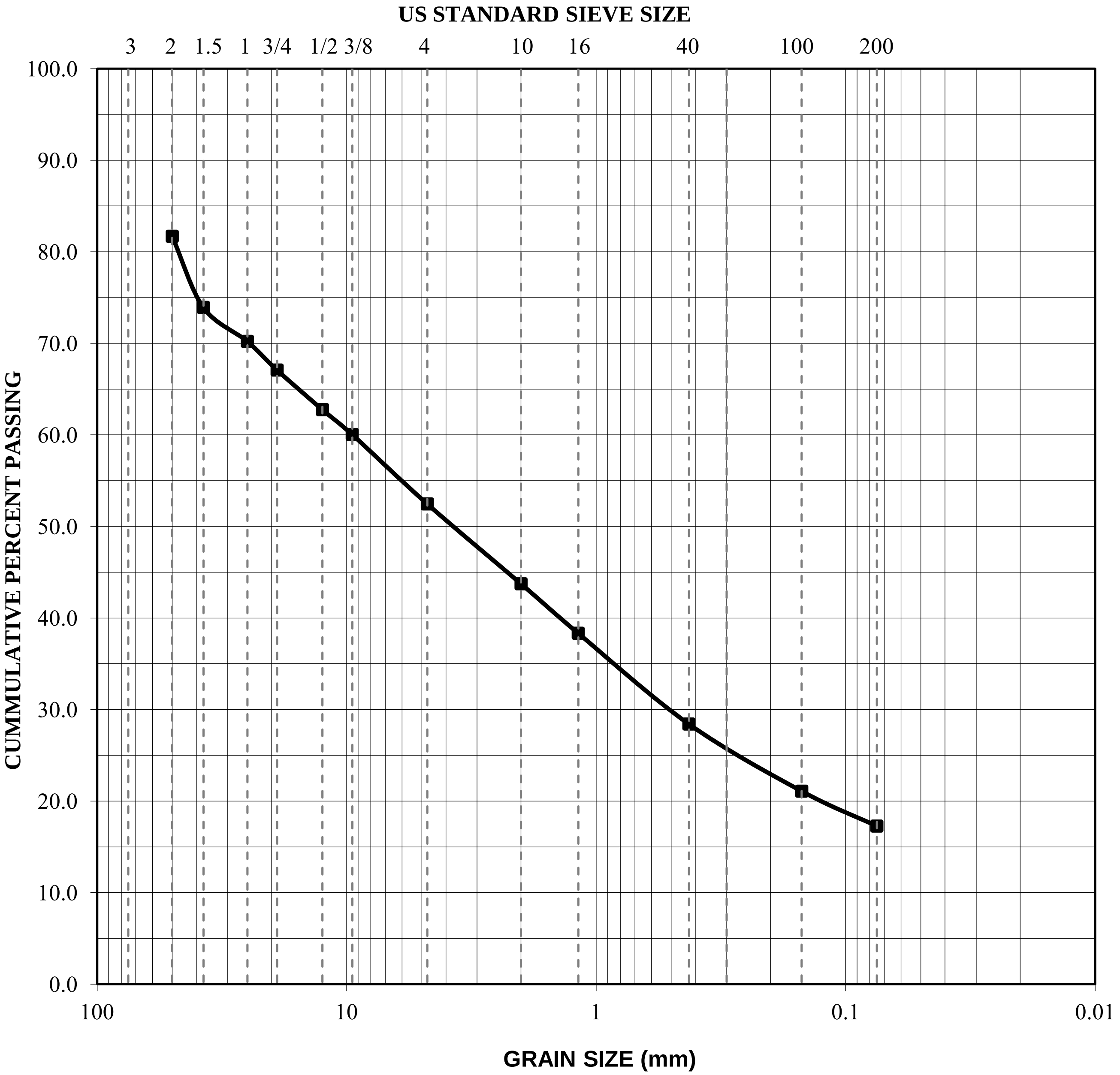
MARSH-BOOTH WATER MAIN

TRUCKEE MEADOWS WATER AUTHORITY

FIGURE

20

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/6/2017		



COBBLES	GRAVEL	SAND	SILT OR CLAY

Symbol	Sample Source	Classification
■	B-3 @ 18.0' - 20.0'	CLAYEY GRAVEL WITH SAND (GC)

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PARTICLE SIZE ANALYSIS

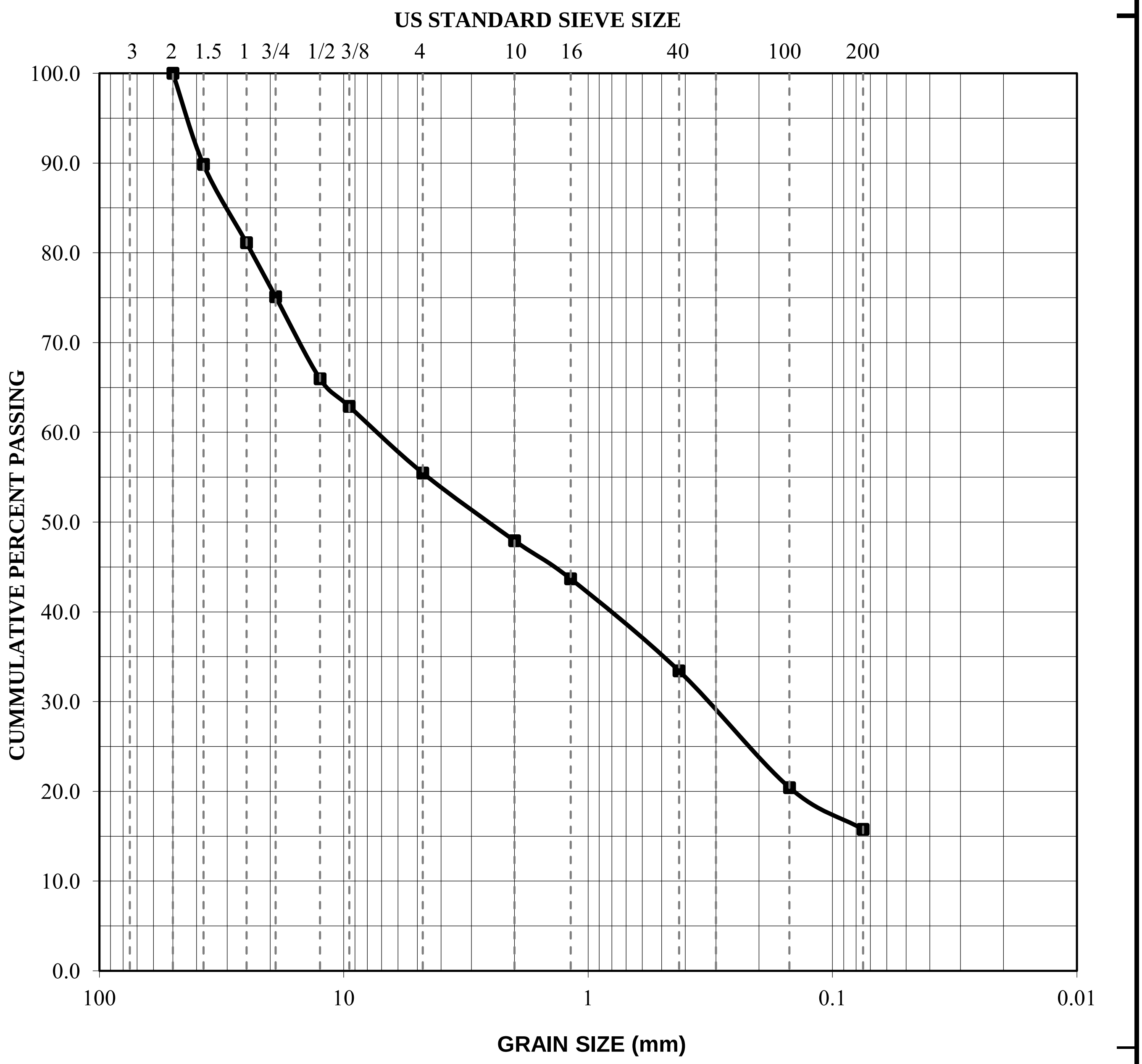
MARSH-BOOTH WATER MAIN

TRUCKEE MEADOWS WATER AUTHORITY

FIGURE

21

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/6/2017		



COBBLES	GRAVEL	SAND	SILT OR CLAY

Symbol	Sample Source	Classification
■	B-4 @ 3.0' - 5.0'	SILTY, CLAYEY GRAVEL WITH SAND (GC-GM)

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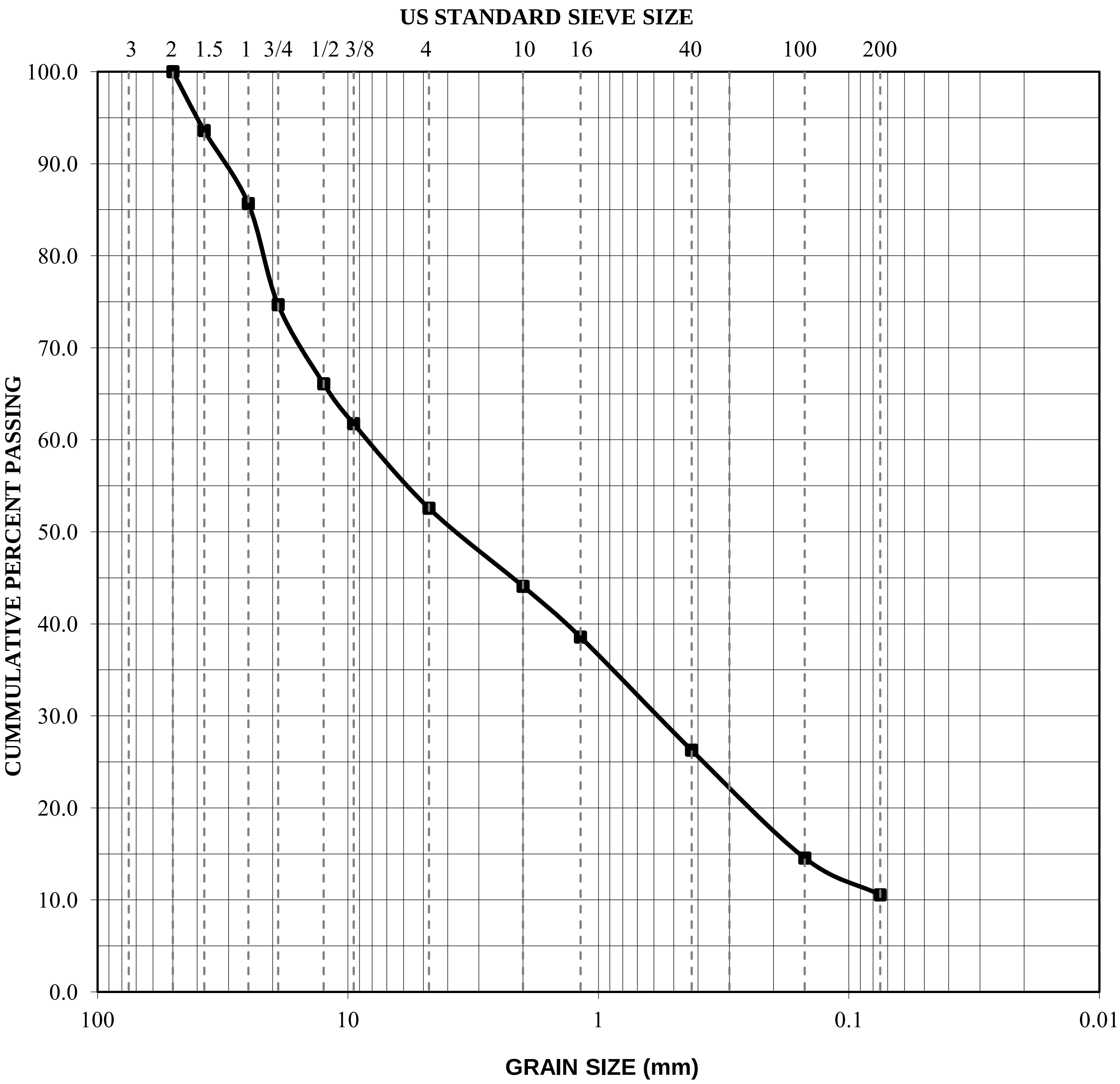
PARTICLE SIZE ANALYSIS
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE
22

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/6/2017		



COBBLES	GRAVEL	SAND	SILT OR CLAY

Symbol	Sample Source	Classification
■	B-4 @ 9.0' - 11.0'	POORLY GRADED GRAVEL W/ SILT & SAND (GP-GM)

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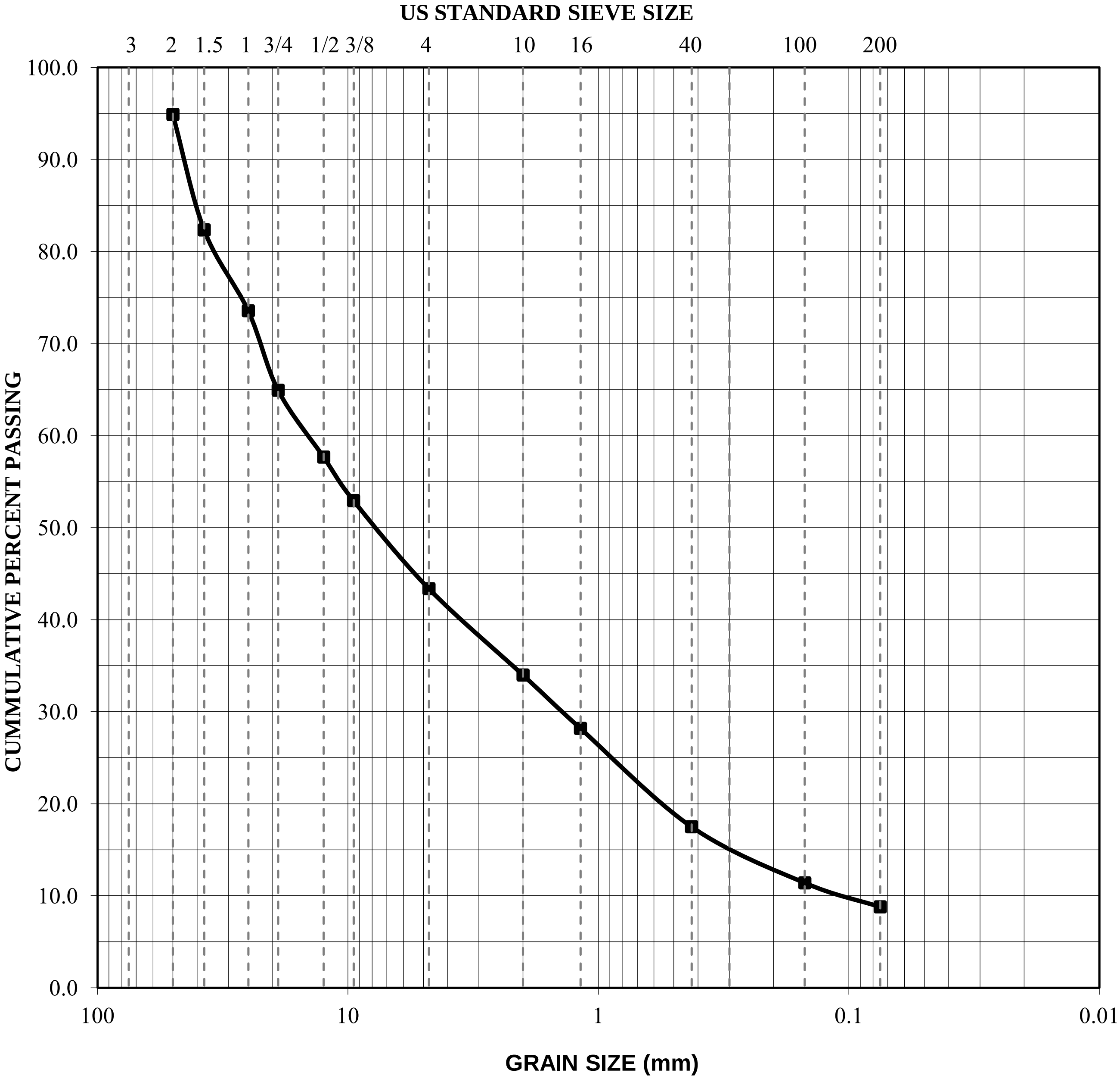
PARTICLE SIZE ANALYSIS
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE

23

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/6/2017		



COBBLES	GRAVEL	SAND	SILT OR CLAY

Symbol	Sample Source	Classification
■	B-5 @ 5.0' - 9.0'	POORLY GRADED GRAVEL W/ SILT & SAND (GP-GM)

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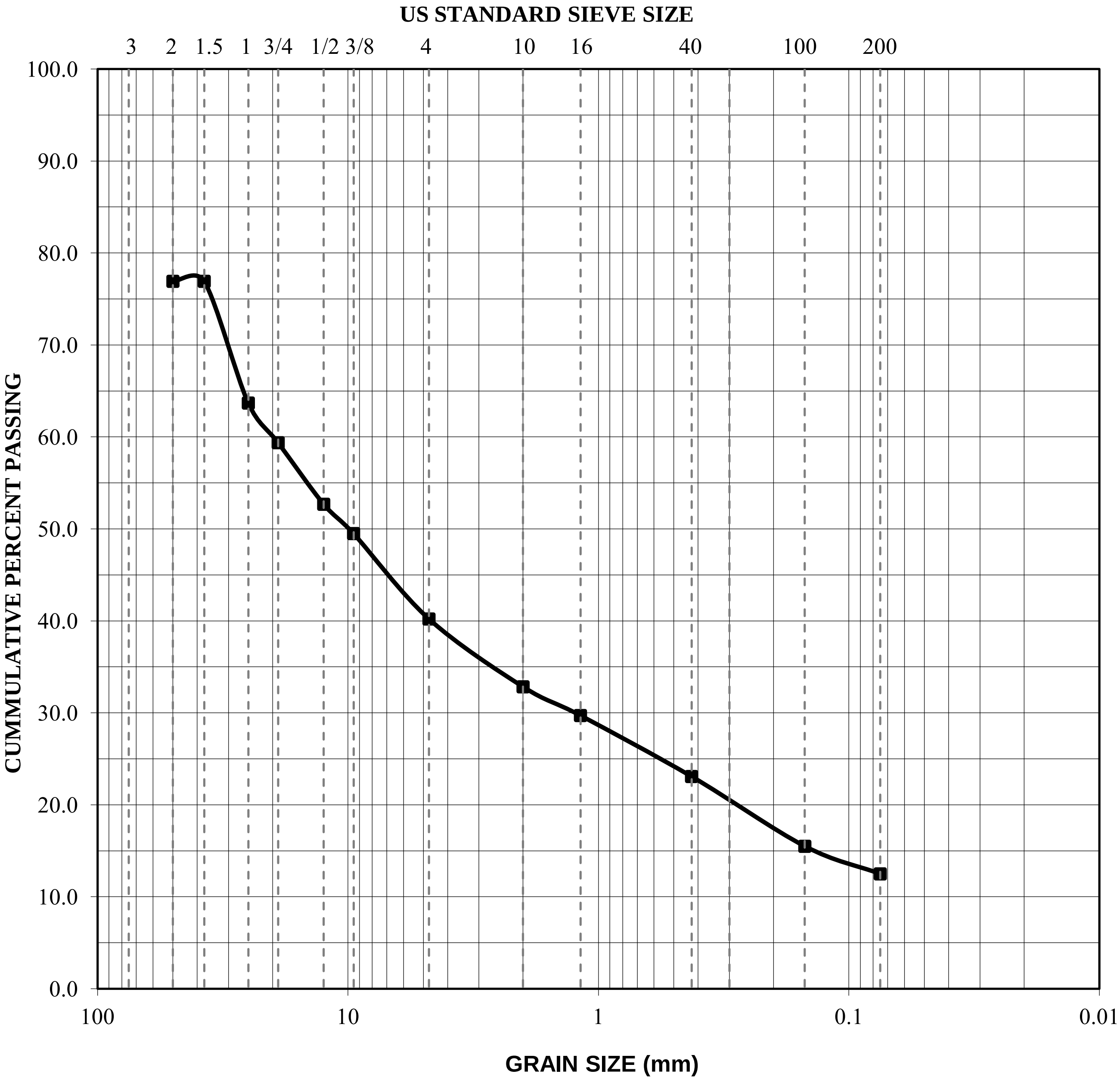
PARTICLE SIZE ANALYSIS
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE

24

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/6/2017		



COBBLES	GRAVEL	SAND	SILT OR CLAY

Symbol	Sample Source	Classification
■	B-6 @ 9.0' - 11.0'	SILTY GRAVEL WITH SAND (GM)

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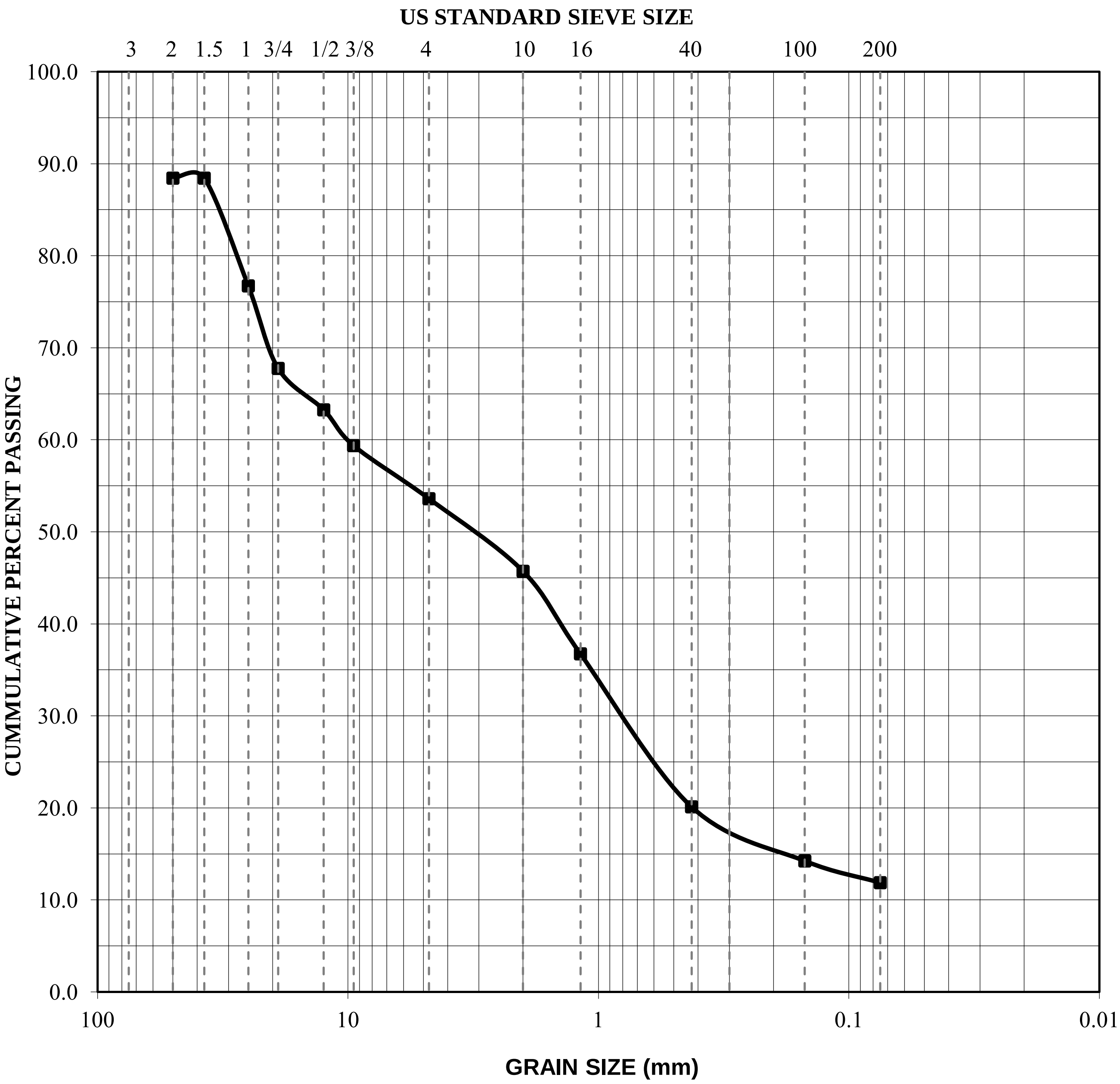
PARTICLE SIZE ANALYSIS
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE
25

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/6/2017		



COBBLES	GRAVEL	SAND	SILT OR CLAY

Symbol	Sample Source	Classification
■	B-6 @ 13.0' - 15.0'	POORLY GRADED GRAVEL W/ SILT & SAND (GP-GM)

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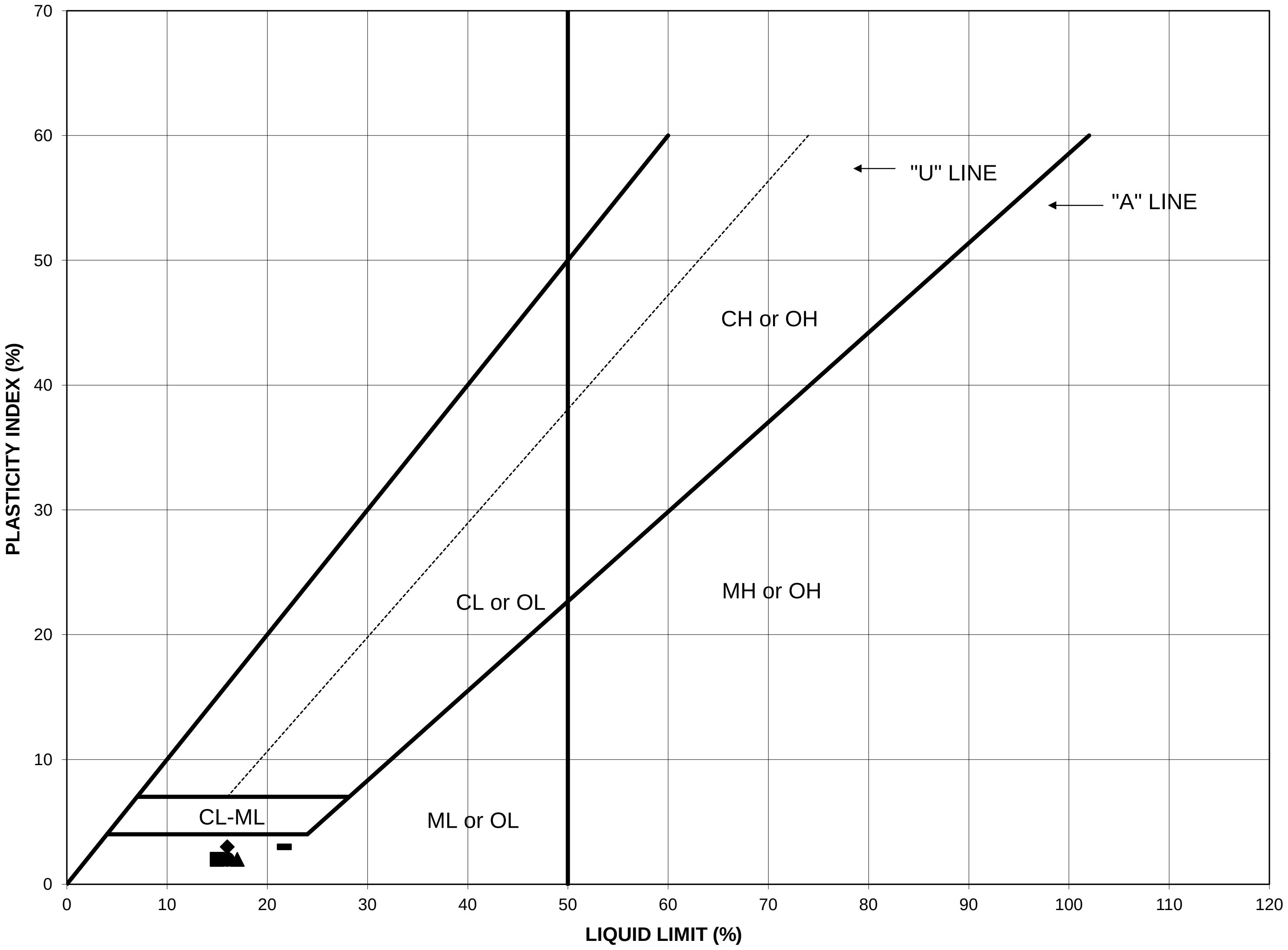
PARTICLE SIZE ANALYSIS

MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE
26

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/6/2017		



Symbol D 4318-10	Sample Source	Classification	Natural M.C. (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	% Passing #200 Sieve
■	B-1 @ 4.0' - 6.0'	SILTY GRAVEL W/ SAND (GM)	3.0	15	13	2	14.1
◆	B-1 @ 8.0' - 9.0'	POORLY GRADED GRAVEL W/ SILT & SAND (GP-GM)	2.0	16	13	3	9.7
▲	B-1 @ 11.0' - 13.0'	SILTY GRAVEL W/ SAND (GM)	3.0	17	15	2	22.0
●	B-2 @ 9.0' - 11.0'	POORLY GRADED GRAVEL W/ SILT & SAND (GP-GM)	2.0	16	14	2	8.5
▬	B-3 @ 2.0' - 4.0'	POORLY GRADED GRAVEL W/ SILT & SAND (GP-GM)	3.0	21	18	3	9.1

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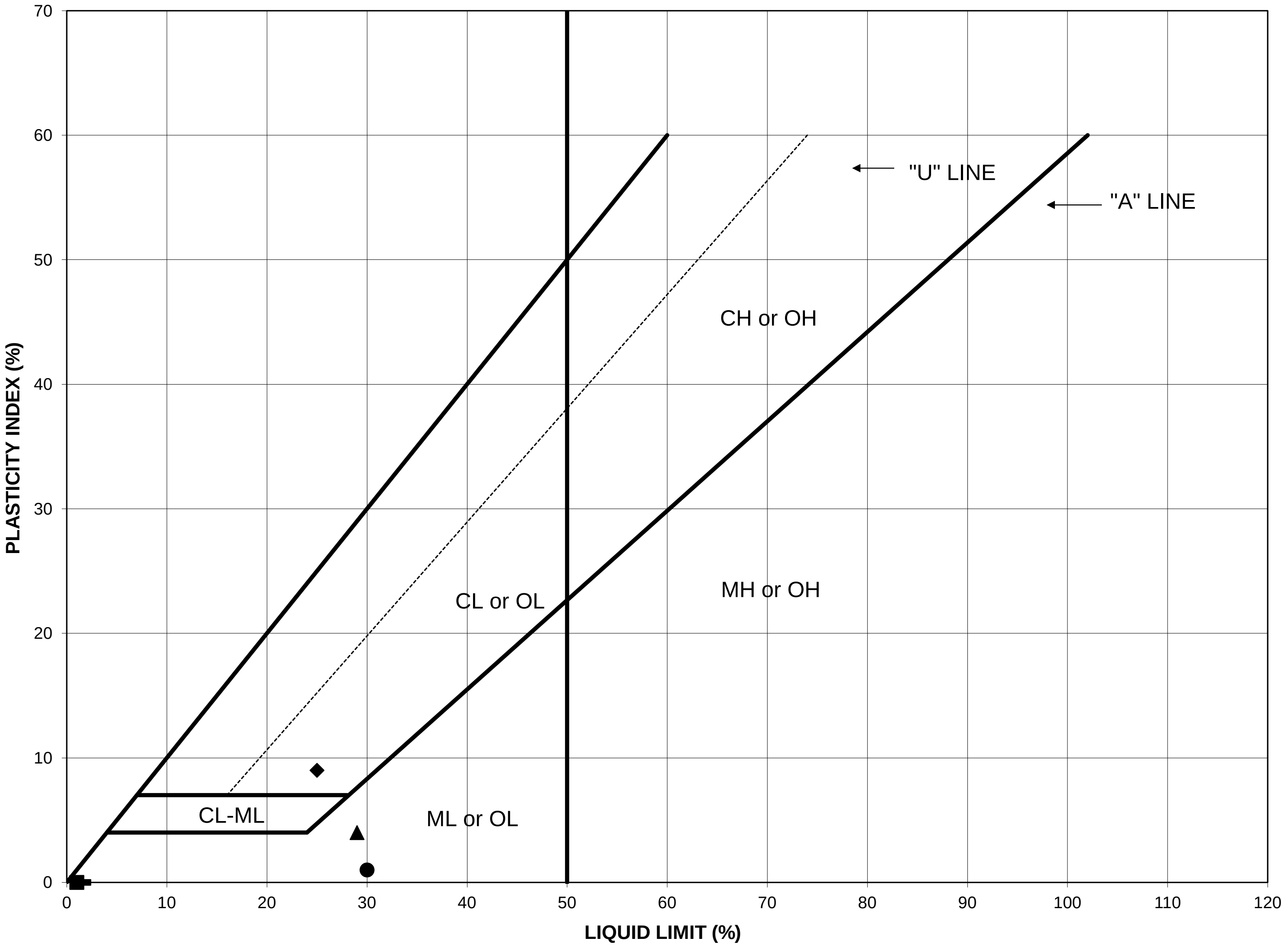
PLASTICITY CHART
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE
27

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/6/2017		



Symbol D 4318-10	Sample Source	Classification	Natural M.C. (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	% Passing #200 Sieve
■	B-3 @ 10.0' - 12.0'	POORLY GRADED GRAVEL W/ SILT & SAND (GP-GM)	3.0	--	--	NP	8.1
◆	B-3 @ 18.0' - 20.0'	CLAYEY GRAVEL WITH SAND (GC)	3.0	25	16	9	17.3
▲	B-4 @ 3.0' - 5.0'	SILTY, CLAYEY GRAVEL WITH SAND (GC-GM)	8.0	29	25	4	15.8
●	B-4 @ 9.0' - 11.0'	POORLY GRADED GRAVEL W/ SILT & SAND (GP-GM)	9.0	30	29	1	10.6
▬	B-5 @ 5.0' - 9.0'	POORLY GRADED GRAVEL W/ SILT & SAND (GP-GM)	3.0	--	--	NP	8.8

EASTERN
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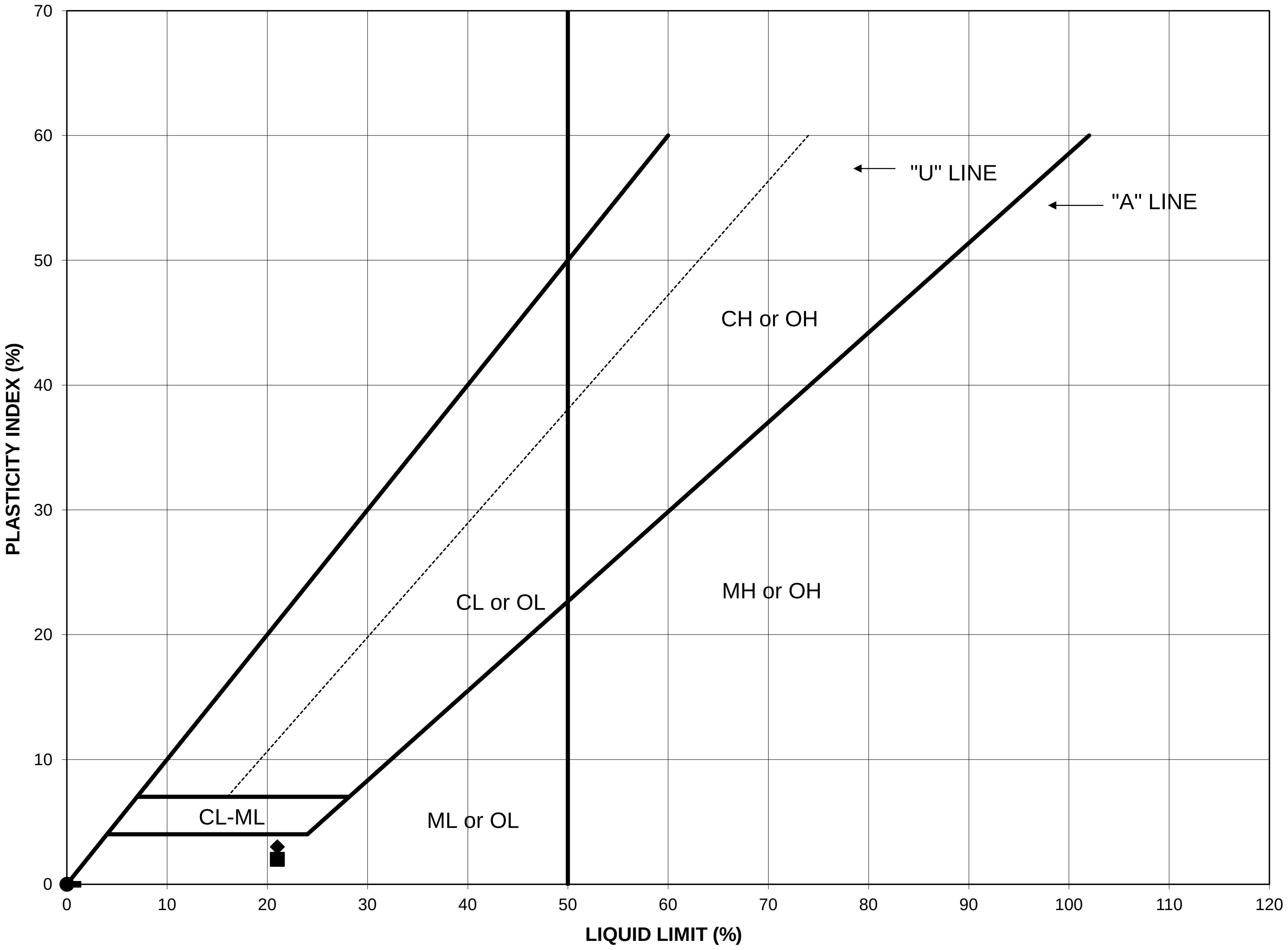
PLASTICITY CHART
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE

28

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/6/2017		



Symbol D 4318-10	Sample Source	Classification	Natural M.C. (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	% Passing #200 Sieve
■	B-6 @ 9.0' - 11.0'	SILTY GRAVEL WITH SAND (GM)	2.0	21	19	2	12.5
◆	B-6 @ 13.0' - 15.0'	POORLY GRADED GRAVEL W/ SILT & SAND (GP-GM)	4.0	21	18	3	11.9
▲							
●							
▬							

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PLASTICITY CHART
MARSH-BOOTH WATER MAIN
TRUCKEE MEADOWS WATER AUTHORITY

FIGURE

29

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MPP	17.1.30	SWJ	11/6/2017		