Yeh and Associates, Inc.
Consulting Engineers & Scientists

August 29, 2014

Mr. Scott T. Asher, P.E.
Wilson & Company, Inc., Engineers & Architects
5755 Mark Dabling Blvd. #220
Colorado Springs, CO 80919

Re: Addendum to Final Initial Geotechnical Investigation Report dated July 23, 2014
I-25 and Cimarron Street Design-Build
Colorado Department of Transportation, Region 2
Colorado Springs, Colorado

Dear Mr. Asher:

At the request of Wilson & Company, Inc., Engineers & Architects, Yeh and Associates, Inc. (Yeh) prepared this addendum to provide results of additional subsurface investigation and estimate for settlement of existing I25/Cimarron Street embankments under the proposed new embankment fill.

The purpose of the additional subsurface investigation was to obtain samples for one-dimensional consolidation test so that the settlement characteristics of the existing I25/Cimarron Street bridge embankments under the proposed new embankment fill can be estimated. Two additional borings YA-B02a and YA-B04a that extended to 21 feet below existing grade were drilled approximately 5 feet north of the borings YA-B02 and YA-B04, respectively to supplement the subsurface information provided in Final Initial Geotechnical Investigation Report dated July 23, 2014. The borings were completed by Dakota Drilling, Inc. utilizing a Diedrich 50 drill rig, equipped with 4-inch outside diameter, solid-stem augers. The subsurface conditions encountered in the borings were logged by a representative of Yeh and Associates, Inc. Modified California samples and Shelby Tube Samples were taken during field investigation.

Fill materials were encountered in both of the borings and extended to the full depth of exploration. The fill materials generally consisted of stiff to hard sandy clay and medium dense to dense clayey/silty sand with gravel, silt and claystone fragments in various mixtures. Groundwater was not encountered during drilling. Based on visual classification and laboratory tests, the fill materials are fairly non-homogenous and no individual sample is considered representative for the general fill materials. Therefore one-dimensional consolidation test was not performed on these samples. The boring logs and laboratory test results are attached.

Settlements of existing I25 embankments and foundation soils are anticipated during and after construction of the proposed new embankment. We understand that settlement plates will be required on the existing embankment along I-25 to monitor the magnitude and time rate of settlement. The settlement will greatly depend on the nature of the fill imported to the site and the rate of fill construction. The amount and rate of settlement will be increased if water is introduced into the fill.

We estimated the settlement and time for 90% consolidation settlement based on the soil properties, laboratory test results, thickness of soil layers, the embankment geometry and our engineering judgments. Table 1 summarizes the settlements calculated for the existing

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embankment under the proposed new embankment up to 30 feet in thickness. Due to the non-homogeneous nature of the materials in the existing embankments, estimates presented in Table 1 should be considered as an indicator of general trend of the settlement behavior. Settlement plates will be a more effective tool for the management of embankment settlement for this site.

Table 1: Estimated Settlements and Time for 90% Consolidation Settlement.

New Embankment Thickness (feet)	Settlement (inches)		Time (months)
	Immediate	Consolidation	
10	0.5	3	19
15	0.5	4	106
25	1	4.5	42
30	1	4	22

*Estimates based on I-25 draft cross-section at station 132+00 provided on July 22, 2014

If you have any questions or require any additional information, please contact us.

Respectfully Submitted,
Yeh and Associates, Inc.

I-Ping Chen, P.E
Project Geotechnical Engineer

Hsing-Cheng Liu, P.E.
Senior Project Manager

COLORADO REGISTERED
HSING-CHENG LIU
50955
8-29-14
PROFESSIONAL ENGINEER

YEH AND ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING CONSULTANTS

Project: I-25 and Cimarron Street
Project Number: 213-207 Date:

Boring: **YA-B02a**
Sheet 1 of 2

Boring Began: 8/5/2014
Drilling Method: Solid-Stem Auger
Drill: Diedrich D-50, Manual Hammer
Driller: Dakota Drilling
Logged By: R. Beach
Final By: R. Beach
Inclination: Vertical

Completed: 8/5/2014
Drill Bit:
Casing:
Weather: Calm, P. Cloudy

Total Depth: 21.0 ft
Ground Elevation:
Location: NB I-25, N of Cimarron, 5' N of YA-B02
Coordinates: N: E:

Ground Water Notes: Not encountered at time of drilling

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.6 ft. ASPHALT PAVEMENT 8 inches.	
								0.6 - 3.0 ft. silty SAND FILL with gravel, reddish brown, moist.	
								3.0 - 21.0 ft. sandy CLAY and clayey SAND FILL with silt and occasional gravel, gray to brown, moist, medium dense to dense, stiff to very stiff.	
	5				5/4	9			**CA sample @ 5 ft** MC= 20.3 % DD= 102.2 pcf #200= 60 % LL= 45 PL= 17 PI= 28 AASHTO: A-7-6 (14) USCS: CL
	10				13/11	24			**Shelby Tube @ 7 ft** MC= 21.5 % DD= 82.5 pcf #200= 25 % LL= 38 PL= 13 PI= 25 AASHTO: A-2-6 (0) USCS: SC
	15				30/20	50		Gravel lense encountered at 15 ft..	**CA sample @ 10 ft** MC= 19.2 % DD= 106.6 pcf #200= 68 % LL= 51 PL= 22 PI= 29 AASHTO: A-7-6 (18) USCS: CH
								Claystone fragments encountered within fill material at 20 feet.	
	20				12/15	27			
								Bottom of Hole at 21.0 ft.	**CA sample @ 15 ft** MC= 7.4 % DD= 117.0 pcf #200= 21 % LL= 46 PL= 19 PI= 27 AASHTO: A-2-7 (0) USCS: SC
	25								**CA sample @ 17.5 ft** MC= 3.5 % #200= 10 % LL= NV PL= NV PI= NP AASHTO: A-1-b (0) USCS: SW-SM
	30								**CA sample @ 20 ft** MC= 11 % DD= 122.9 pcf #200= 31 % LL= 39 PL= 15

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Project: I-25 and Cimarron Street
Project Number: 213-207 Date:

Boring: **YA-B02a**

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
									PI= 24 AASHTO: A-2-6 (1) USCS: SC
	40								
	45								
	50								
	55								
	60								
	65								
	70								
	75								

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Project: I-25 and Cimarron Street
Project Number: 213-207 Date:

Boring: **YA-B04a**
Sheet 1 of 2

Boring Began: 8/4/2014
Drilling Method: Solid-Stem Auger
Drill: Diedrich D-50, Manual Hammer
Driller: Dakota Drilling
Logged By: R. Beach
Final By: R. Beach
Inclination: Vertical

Completed: 8/4/2014
Drill Bit:
Casing:
Weather: Calm, P. Cloudy

Total Depth: 21.0 ft
Ground Elevation:
Location: NB I-25, S of Cimarron, 5' N of YA-B04
Coordinates: N: E:

Ground Water Notes: Not encountered at time of drilling

Depth	-	-	-	-
Date	-	-	-	-
Time	-	-	-	-

Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
								0.0 - 0.6 ft. ASPHALT PAVEMENT 8 inches.	
								0.6 - 4.0 ft. silty SAND FILL with gravel, brown to reddish brown, moist.	
	5				12/23	35		**4.0 - 21.0 ft. sandy CLAY and clayey SAND FILL** with silt and occasional gravel, brown to gray, moist, medium dense to dense, very stiff to hard.	**CA sample @ 5 ft** MC= 8.1 % #200= 16 % LL= 35 PL= 12 PI= 23 AASHTO: A-2-6 (0) USCS: SC
	10				9/10	19			**Shelby Tube @ 7 ft** MC= 9.9 % #200= 22 % LL= 34 PL= 13 PI= 21 AASHTO: A-2-6 (0) USCS: SC
	15				15/25	40			**CA sample @ 10 ft** MC= 15.6 % DD= 116.1 pcf #200= 59 % LL= 47 PL= 19 PI= 28 AASHTO: A-7-6 (14) USCS: CL
	20				15/23	38			**Shelby Tube @ 12 ft** MC= 7.1 % DD= 103.5 pcf #200= 43 % LL= 47 PL= 17 PI= 30 AASHTO: A-7-6 (7) USCS: SC
								Bottom of Hole at 21.0 ft.	
	25								**CA sample @ 15 ft** MC= 8.3 % DD= 127.9 pcf #200= 20 % LL= NV PL= NP PI= NP AASHTO: A-1-b (0) USCS: SM
	30								**Shelby Tube @ 17 ft** MC= 8.9 % DD= 101.0 pcf #200= 33 % LL= 44 PL= 18 PI= 26

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Project: I-25 and Cimarron Street
Project Number: 213-207 Date:

Boring: **YA-B04a**
Sheet 2 of 2

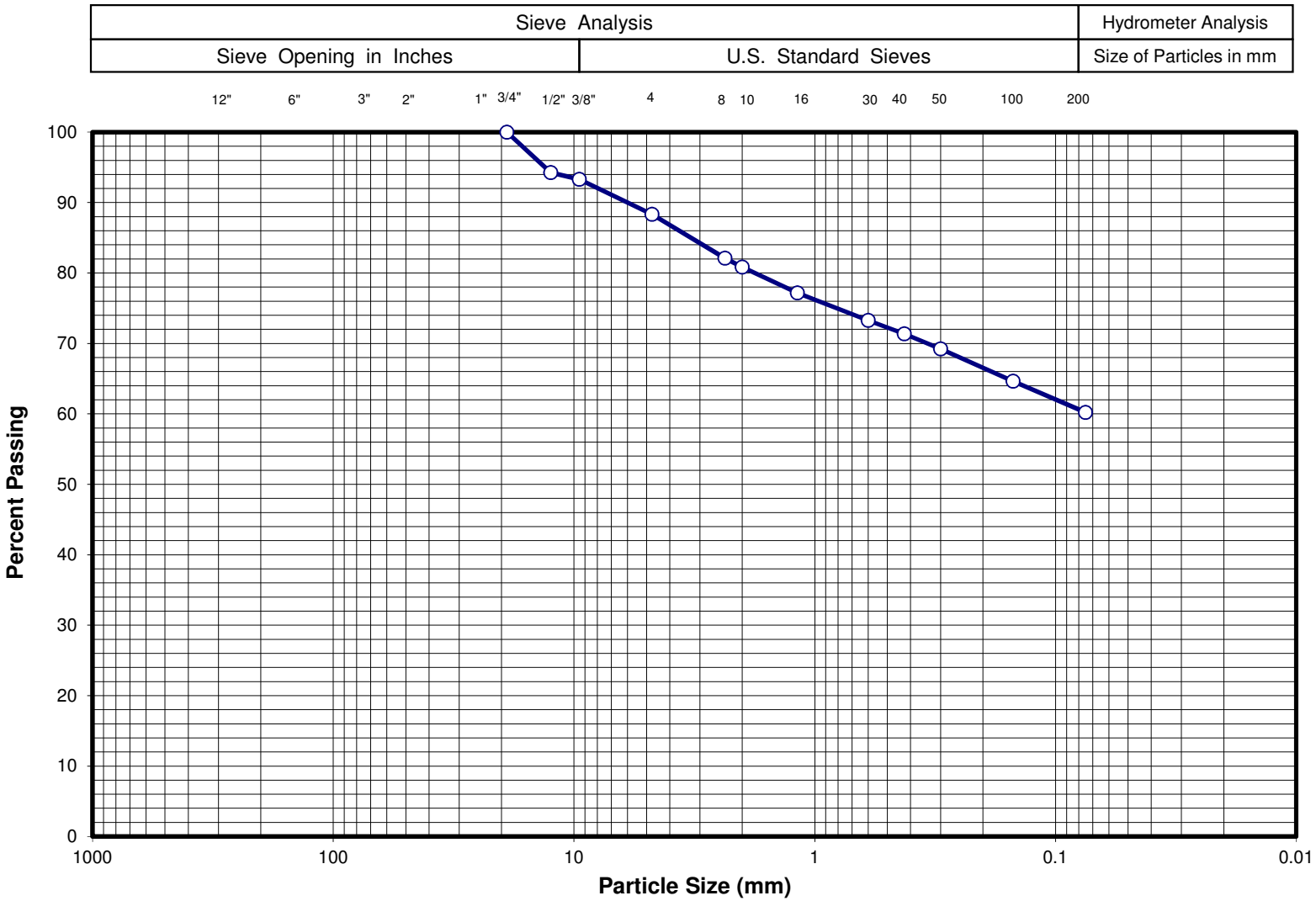
Elevation (feet)	Depth (feet)	Run / Sample Type	Recovery (%)	Rock RQD	Soil Samples Blows per 6 in	Soil Samples N	Lithology	Material Description	Field Notes and Lab Tests
									AASHTO: A-2-7 (2) USCS: SC **CA sample @ 20 ft** MC= 13.2 % DD= 110.6 pcf #200= 57 % LL= 42 PL= 14 PI= 28 AASHTO: A-7-6 (12) USCS: CL
	40								
	45								
	50								
	55								
	60								
	65								
	70								
	75								

YEH & ASSOCIATES, INC

Summary of Laboratory Test Results

Project No: 213-207 Project Name: I-25 / Cimarron Street Date: 8/21/2014

Sample Location			Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg			pH	Water Soluble Sulfate %	Resistivity ohm.cm	Chloride %	% Swell (+) / Consoli-dation (-)	R-VALUE	CLASSIFICATION	
Boring NO.	Depth (ft)	Sample Type			Gravel > #4 (%)	Sand (%)	Fines < #200 (%)	LL	PL	PI							AASHTO	USCS
YA-B02a	5	CA	20.3	102.2	12	28	60	45	17	28	–	–	–	–	–	–	A-7-6 (14)	CL
YA-B02a	7-9	ST	21.5	82.5	13	62	25	38	13	25	–	–	–	–	–	–	A-2-6 (0)	SC
YA-B02a	10	CA	19.2	106.6	10	22	68	51	22	29	–	–	–	–	–	–	A-7-6 (18)	CH
YA-B02a	15	CA	7.4	117.0	35	44	21	46	19	27	–	–	–	–	–	–	A-2-7 (0)	SC
YA-B02a	17.5	CA	3.5	–	24	66	10	NV	NP	NP	–	–	–	–	–	–	A-1-b (0)	SW-SM
YA-B02a	20	CA	11.0	122.9	26	43	31	39	15	24	–	–	–	–	–	–	A-2-6 (1)	SC
YA-B04a	5	CA	8.1	–	19	65	16	35	12	23	–	–	–	–	–	–	A-2-6 (0)	SC
YA-B04a	7-9	ST	9.9	–	18	60	22	34	13	21	–	–	–	–	–	–	A-2-6 (0)	SC
YA-B04a	10	CA	15.6	116.1	9	32	59	47	19	28	–	–	–	–	–	–	A-7-6 (14)	CL
YA-B04a	12-14	ST	7.1	103.5	12	45	43	47	17	30	–	–	–	–	–	–	A-7-6 (7)	SC
YA-B04a	15	CA	8.3	127.9	15	65	20	NV	NP	NP	–	–	–	–	–	–	A-1-b (0)	SM
YA-B04a	17-19	ST	8.9	101.0	9	58	33	44	18	26	–	–	–	–	–	–	A-2-7 (2)	SC
YA-B04a	20	CA	13.2	110.6	13	30	57	42	14	28	–	–	–	–	–	–	A-7-6 (12)	CL



Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	-
1"	-
¾ "	100
½"	94
⅜"	93
#4	88
#10	81
#40	71
#200	60

Gravel (%)	12	LL	45	Project Name:	I-25/Cimarron Street
Sand (%)	28	PL	17	Sample ID:	YA-B02a
Fines (%)	60	PI	28	Sample Depth (ft.):	5
Sample Description:	**A-7-6 (14) / CL**				

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SIEVE ANALYSIS

Drawn By:	MA	Project No.:	213-207
Checked By:	Dr.Liu		
Date:	08/21/14	Figure No.:	-

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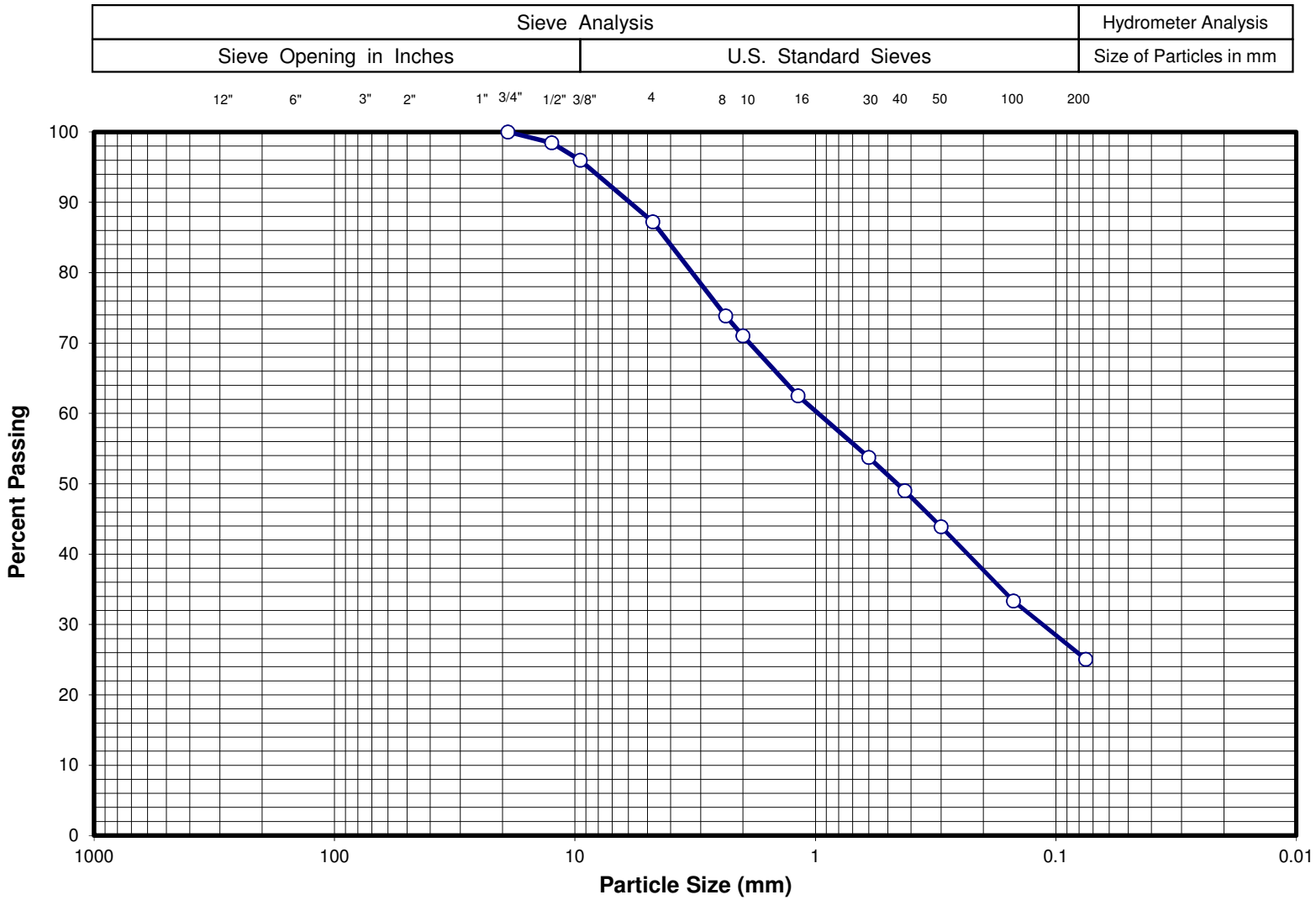

Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	-
1"	-
¾ "	100
½"	98
⅜"	96
#4	87
#10	71
#40	49
#200	25

Gravel (%)	13	LL	38	Project Name:	I-25/Cimarron Street
Sand (%)	62	PL	13	Sample ID:	YA-B02a
Fines (%)	25	PI	25	Sample Depth (ft.):	7-9
Sample Description:	**A-2-6 (0) / SC**				

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SIEVE ANALYSIS

Drawn By:	MA	Project No.:	213-207
Checked By:	Dr. Liu		
Date:	08/23/14	Figure No.:	-

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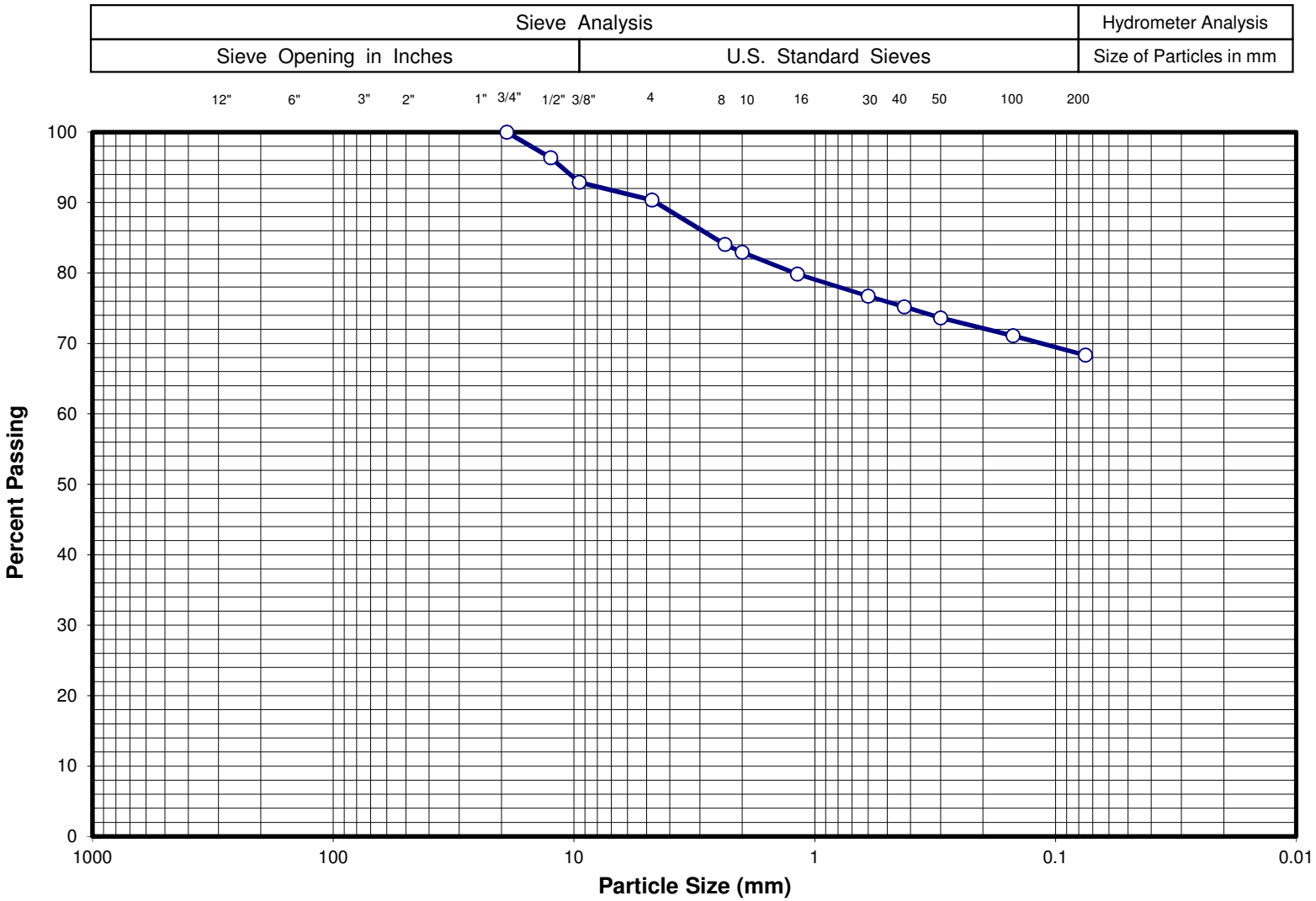

Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	-
1"	-
¾ "	100
½"	96
⅜"	93
#4	90
#10	83
#40	75
#200	68

Gravel (%)	10	LL	51	Project Name:	I-25/Cimarron Street
Sand (%)	22	PL	22	Sample ID:	YA-B02a
Fines (%)	68	PI	29	Sample Depth (ft.):	10
Sample Description:	**A-7-6 (18) / CH**				

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Drawn By:	MA	Project No.:	213-207
Checked By:	Dr. Liu		
Date:	08/21/14	Figure No.:	-

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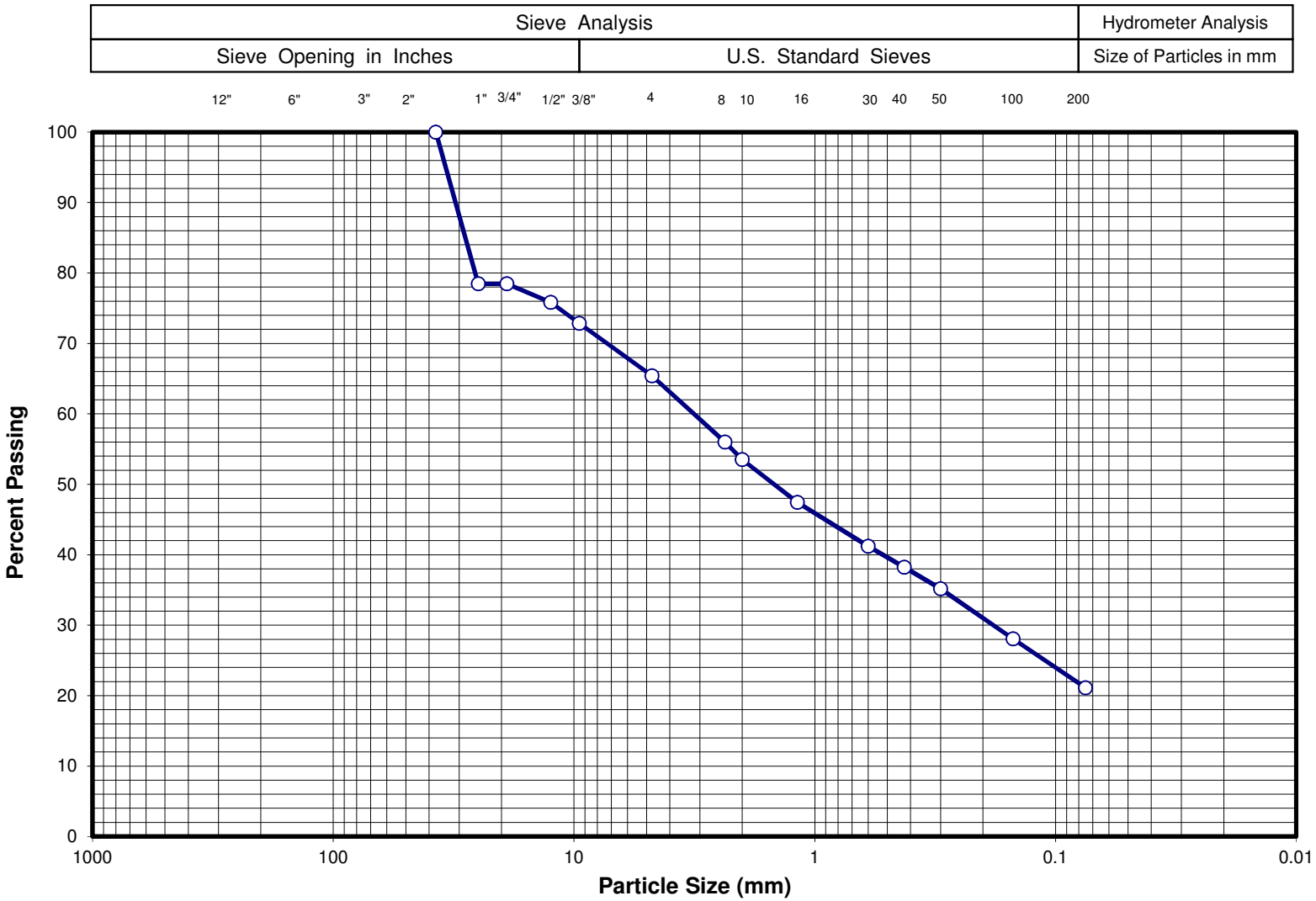

Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	100
1"	78
¾ "	78
½"	76
⅜"	73
#4	65
#10	54
#40	38
#200	21

Gravel (%)	35	LL	46	Project Name:	I-25/Cimarron Street
Sand (%)	44	PL	19	Sample ID:	YA-B02a
Fines (%)	21	PI	27	Sample Depth (ft.):	15
Sample Description:	**A-2-7 (0) / SC**				

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SIEVE ANALYSIS

Drawn By:	MA	Project No.:	213-207
Checked By:	Dr. Liu		
Date:	08/21/14	Figure No.:	-

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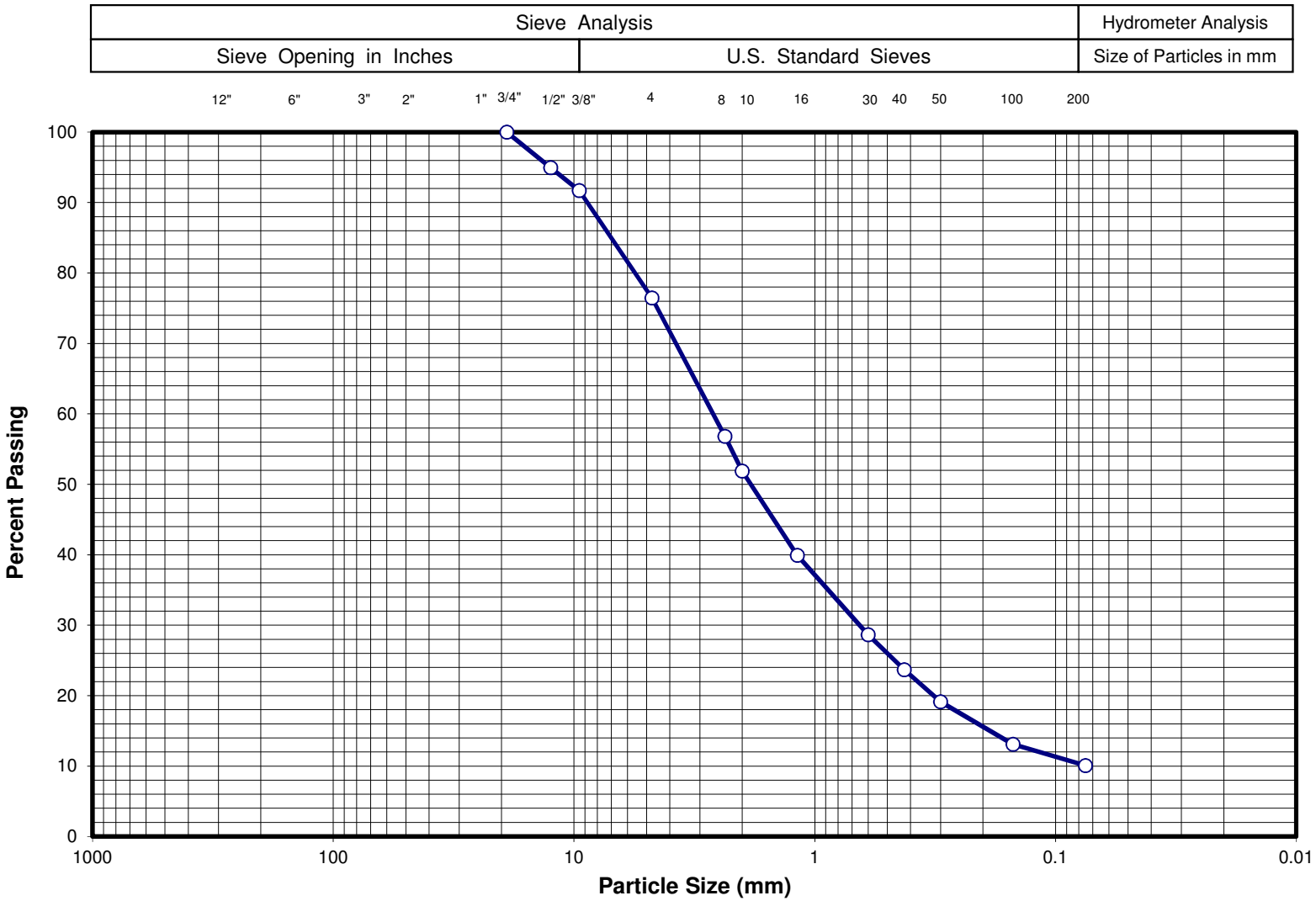

Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	-
1"	-
¾ "	100
½"	95
⅜"	92
#4	76
#10	52
#40	24
#200	10

Gravel (%)	24	LL	NV	Project Name:	I-25/Cimarron Street
Sand (%)	66	PL	NP	Sample ID:	YA-B02a
Fines (%)	10	PI	NP	Sample Depth (ft.):	17.5
Sample Description:	**A-1-b (0) / SW-SM**				

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SIEVE ANALYSIS

Drawn By:	MA	Project No.:	213-207
Checked By:	Dr. Liu		
Date:	08/21/14	Figure No.:	-

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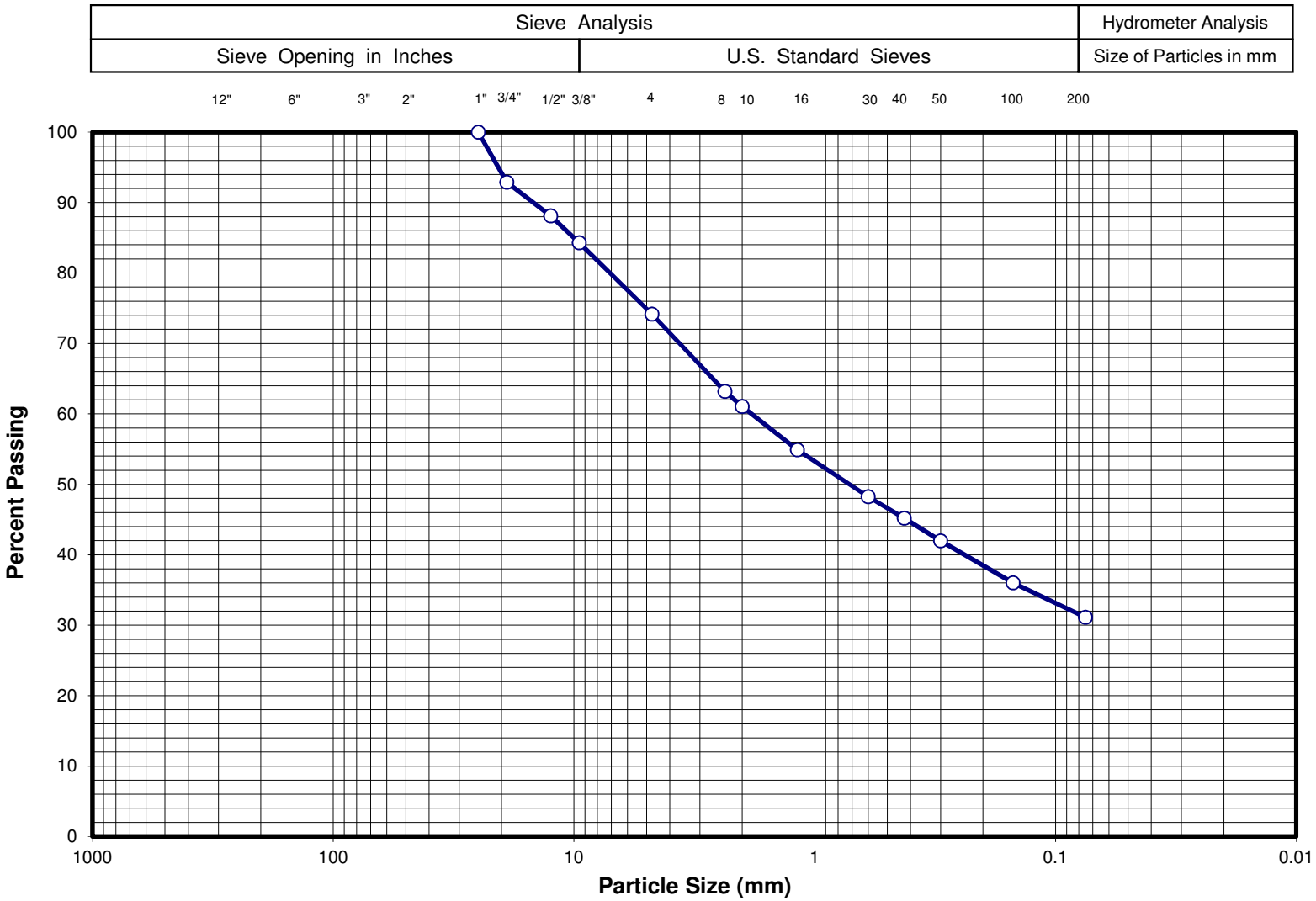

Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	-
1"	100
¾ "	93
½"	88
⅜"	84
#4	74
#10	61
#40	45
#200	31

Gravel (%)	26	LL	39	Project Name:	I-25/Cimarron Street
Sand (%)	43	PL	15	Sample ID:	YA-B02a
Fines (%)	31	PI	24	Sample Depth (ft.):	20
Sample Description:	**A-2-6 (1) / SC**				

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SIEVE ANALYSIS

Drawn By:	MA	Project No.:	213-207
Checked By:	Dr. Liu		
Date:	08/21/14	Figure No.:	-

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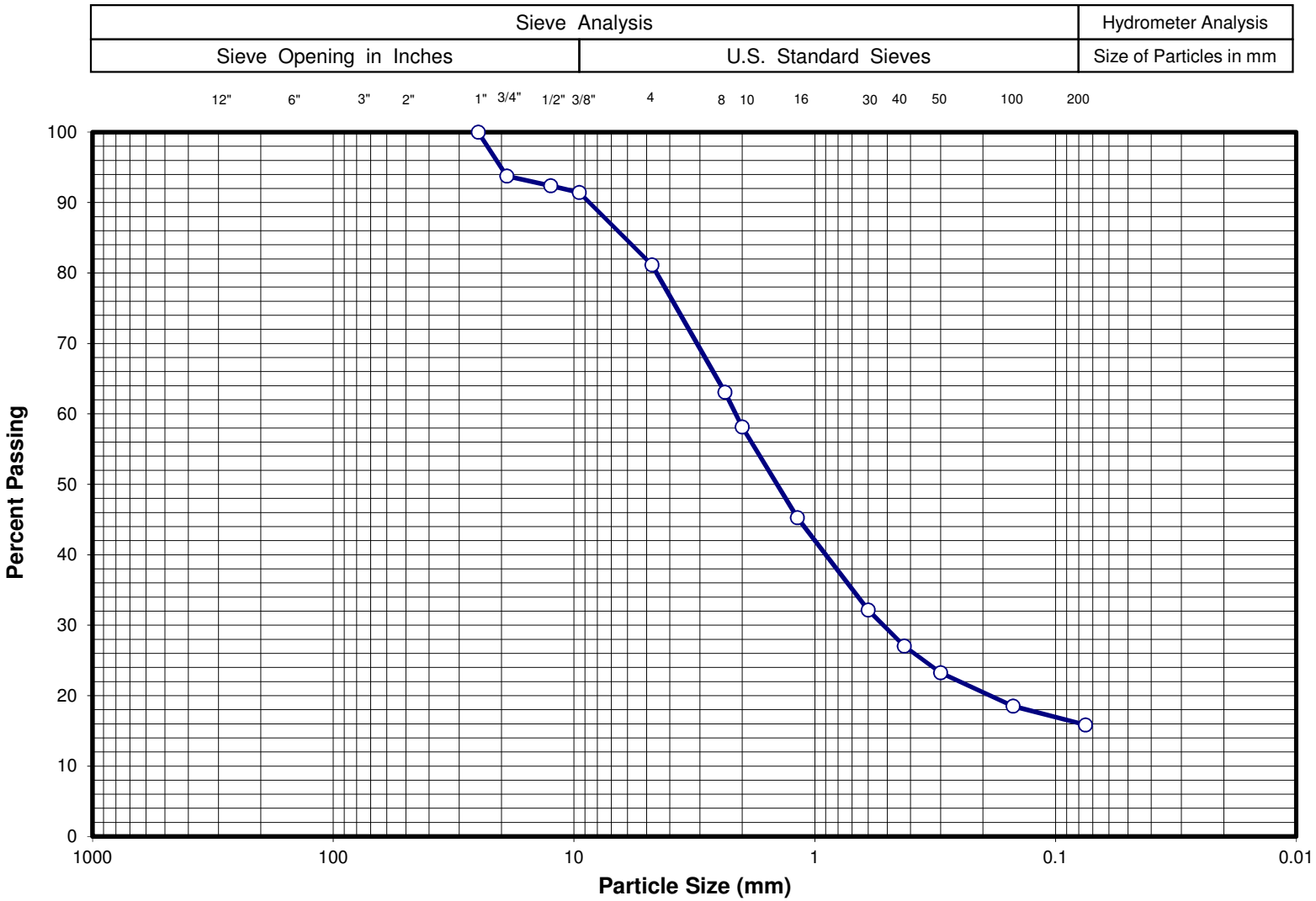

Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	-
1"	100
¾ "	94
½"	92
⅜"	91
#4	81
#10	58
#40	27
#200	16

Gravel (%)	19	LL	35	Project Name:	I-25/Cimarron Street
Sand (%)	65	PL	12	Sample ID:	YA-B04a
Fines (%)	16	PI	23	Sample Depth (ft.):	5
Sample Description:	**A-2-6 (0) / SC**				

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SIEVE ANALYSIS

Drawn By:	MA	Project No.:	213-207
Checked By:	Dr.Liu		
Date:	08/21/14	Figure No.:	-

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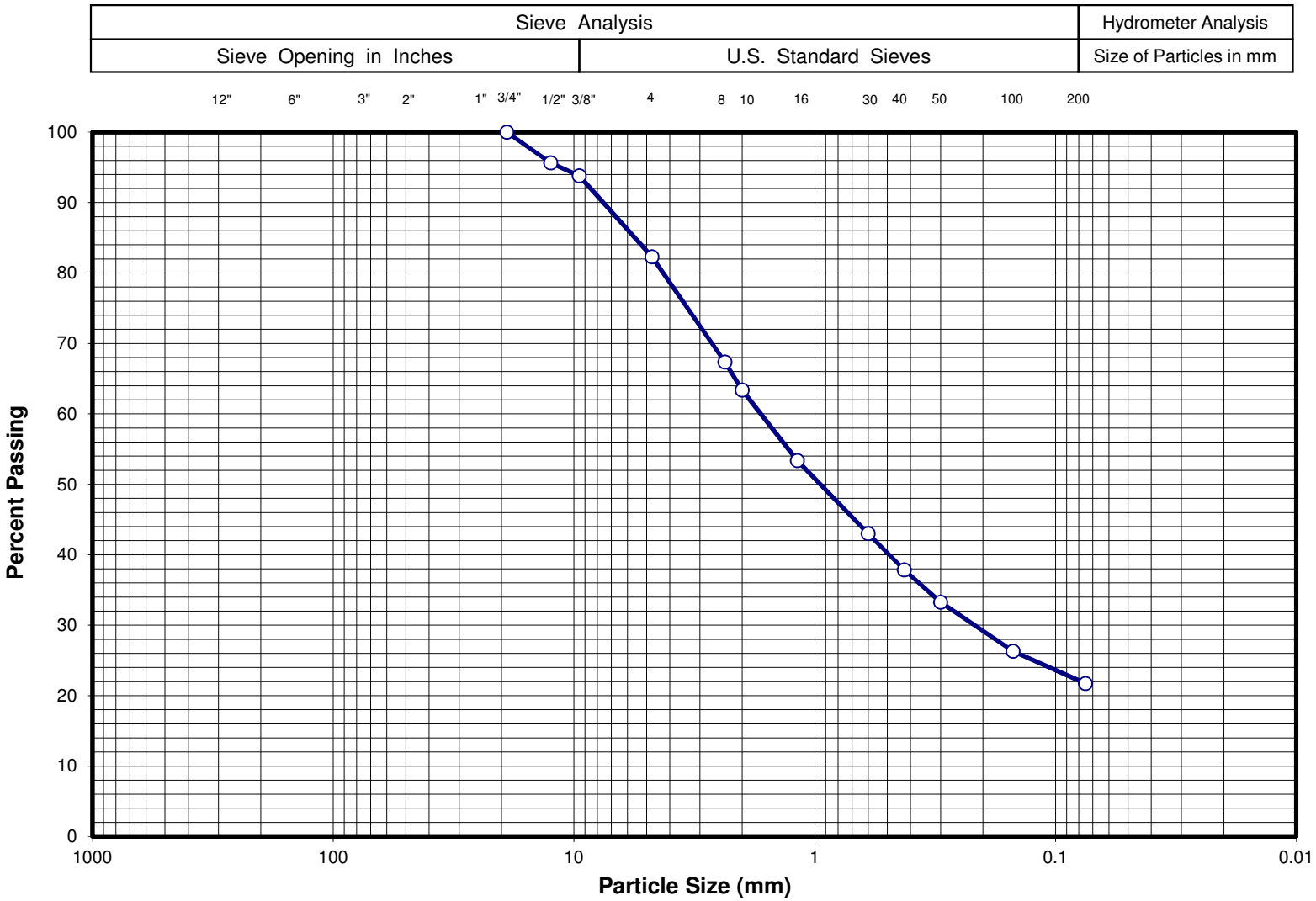

Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	-
1"	-
¾ "	100
½"	96
⅜"	94
#4	82
#10	63
#40	38
#200	22

Gravel (%)	18	LL	34	Project Name:	I-25/Cimarron Street
Sand (%)	60	PL	13	Sample ID:	YA-B04a
Fines (%)	22	PI	21	Sample Depth (ft.):	7-9
Sample Description:	**A-2-6 (0) / SC**				

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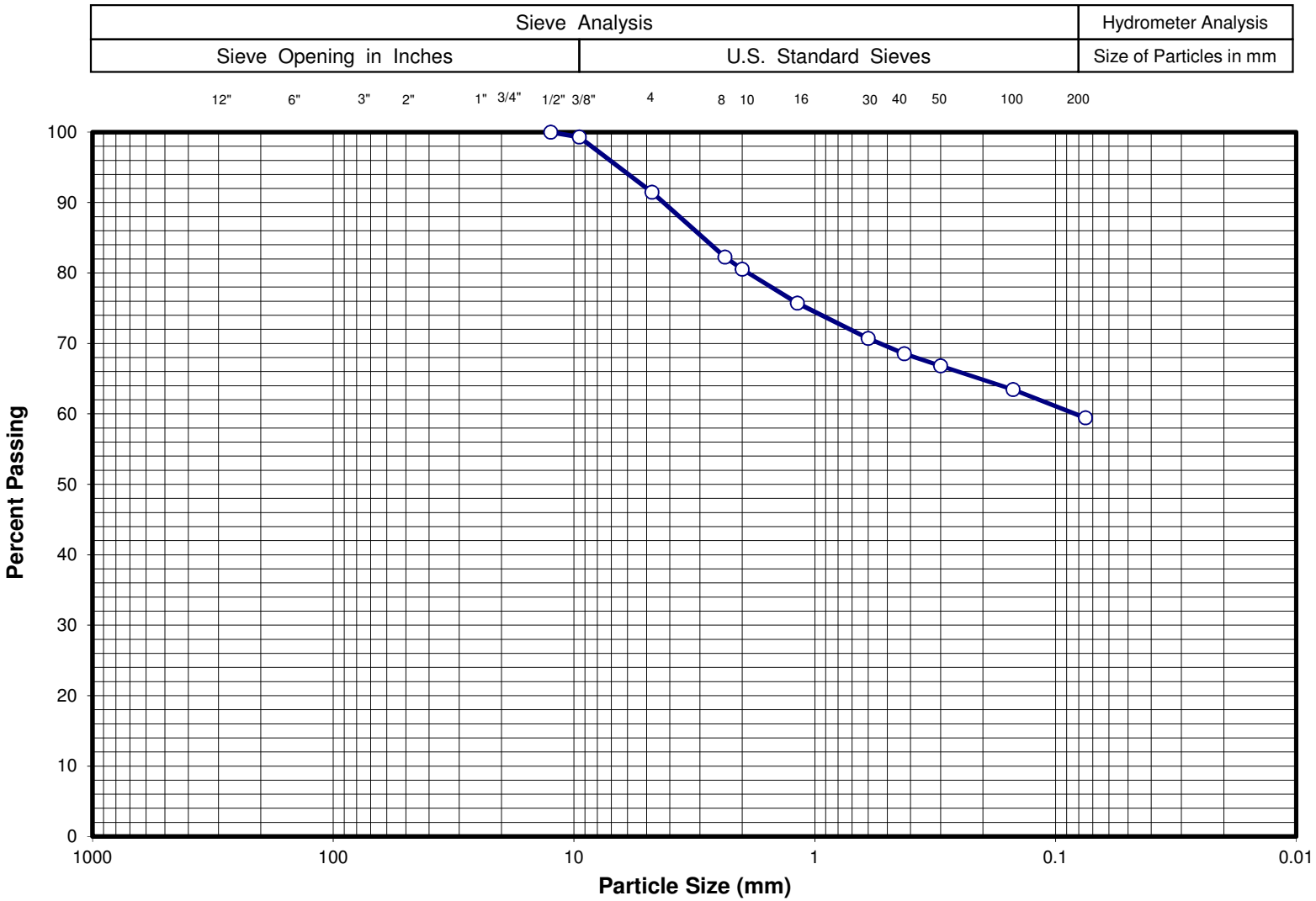
SIEVE ANALYSIS

Drawn By:	MA	Project No.:	213-207
Checked By:	Dr. Liu		
Date:	08/23/14	Figure No.:	-

Revised 04/27/2004



Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	-
1"	-
¾ "	-
½"	100
⅜"	99
#4	91
#10	81
#40	69
#200	59

Gravel (%)	9	LL	47	Project Name:	I-25/Cimarron Street
Sand (%)	32	PL	19	Sample ID:	YA-B04a
Fines (%)	59	PI	28	Sample Depth (ft.):	10
Sample Description:	**A-7-6 (14) / CL**				

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Geotechnical Engineering Consultants

SIEVE ANALYSIS

Drawn By:	MA	Project No.:	213-207
Checked By:	Calvin		
Date:	05/02/14	Figure No.:	-

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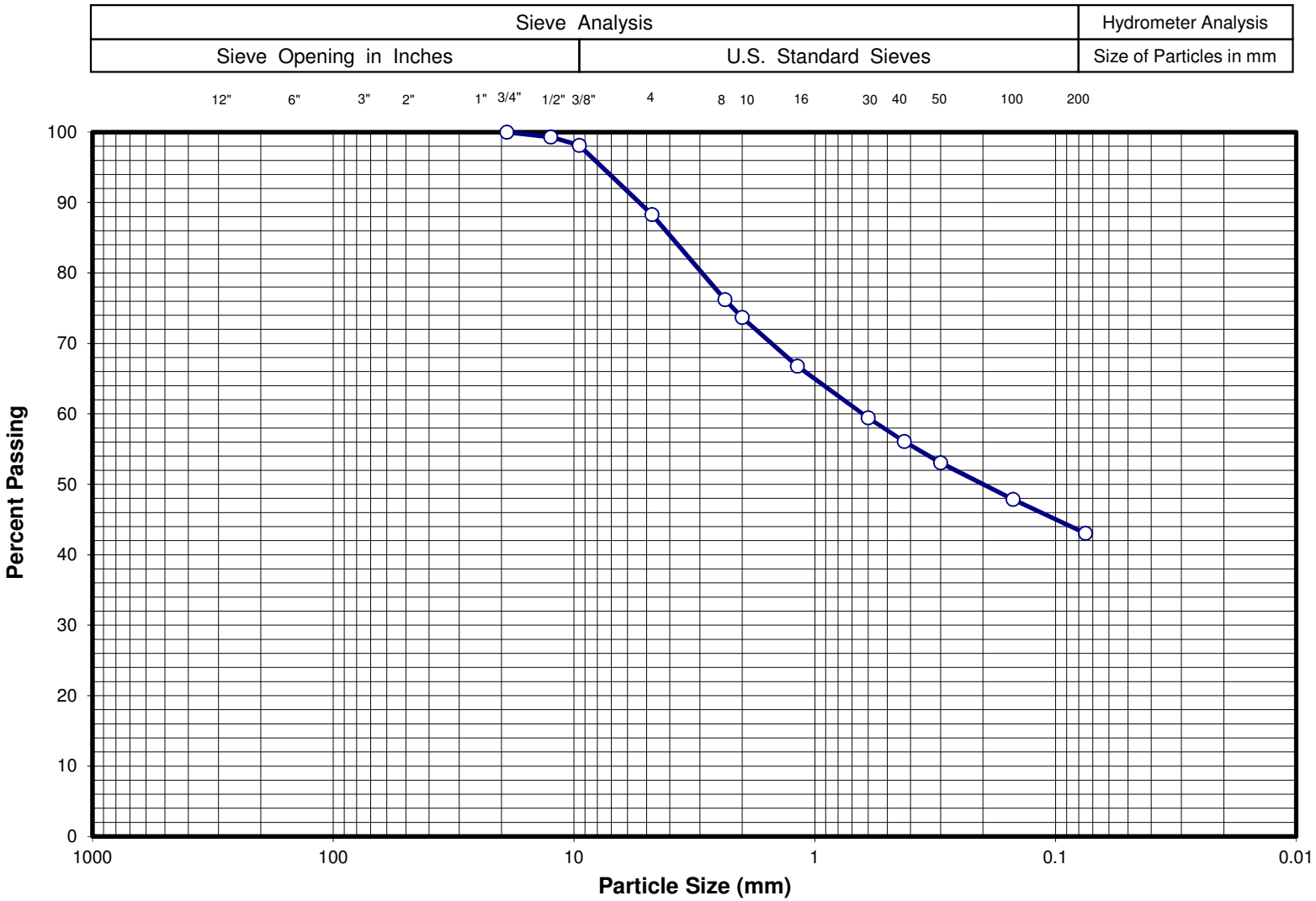

Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	-
1"	-
¾ "	100
½"	99
⅜"	98
#4	88
#10	74
#40	56
#200	43

Gravel (%)	12	LL	47	Project Name:	I-25/Cimarron Street
Sand (%)	45	PL	17	Sample ID:	YA-B04a
Fines (%)	43	PI	30	Sample Depth (ft.):	12-14
Sample Description:	**A-7-6 (7) / SC**				

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SIEVE ANALYSIS

Drawn By:	MA	Project No.:	213-207
Checked By:	Dr. Liu		
Date:	08/23/14	Figure No.:	-

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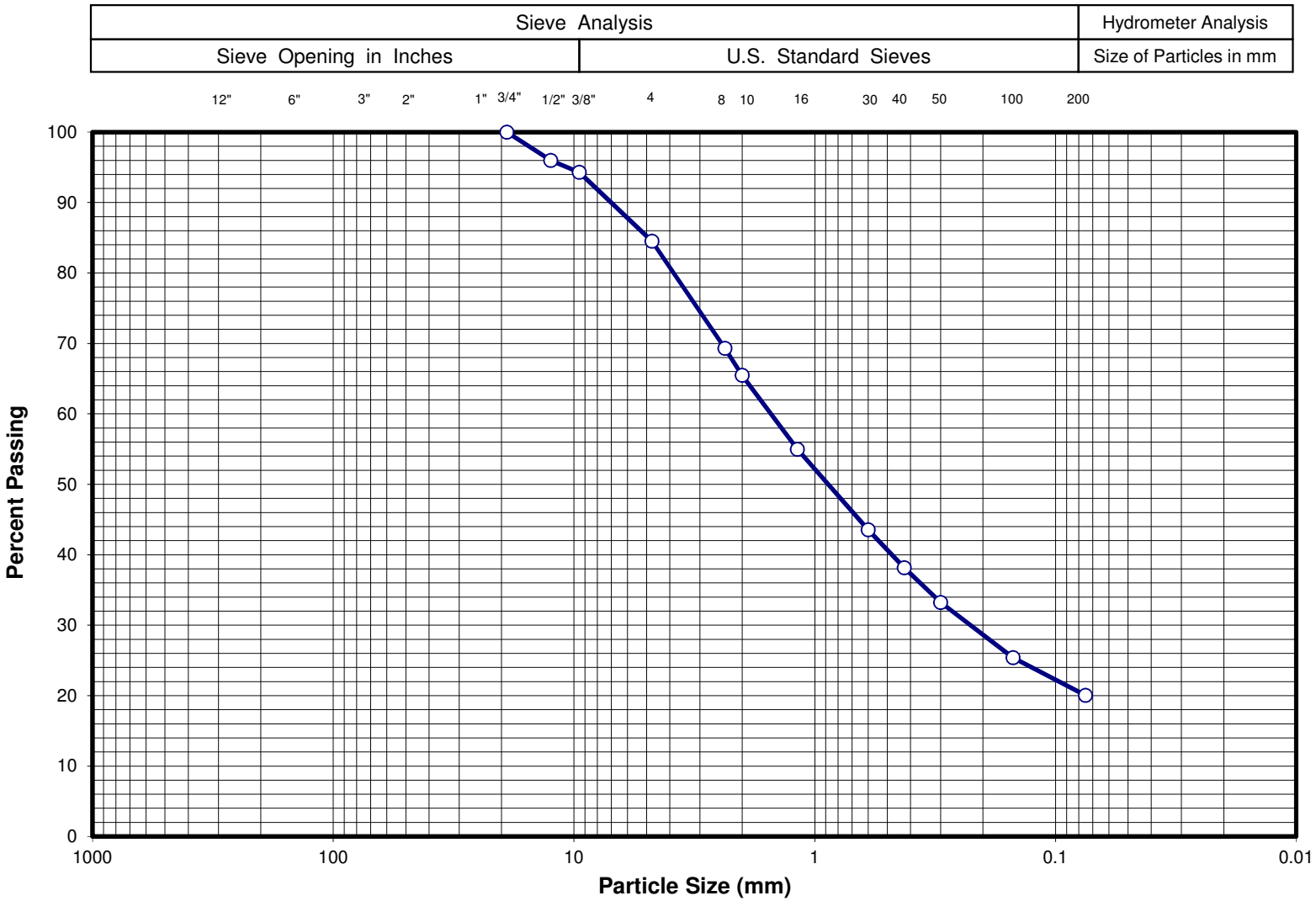

Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	-
1"	-
¾ "	100
½"	96
⅜"	94
#4	85
#10	65
#40	38
#200	20

Gravel (%)	15	LL	NV	Project Name:	I-25/Cimarron Street
Sand (%)	65	PL	NP	Sample ID:	YA-B04a
Fines (%)	20	PI	NP	Sample Depth (ft.):	15
Sample Description:	**A-1-b (0) / SM**				

Yeh & Associates, Inc.
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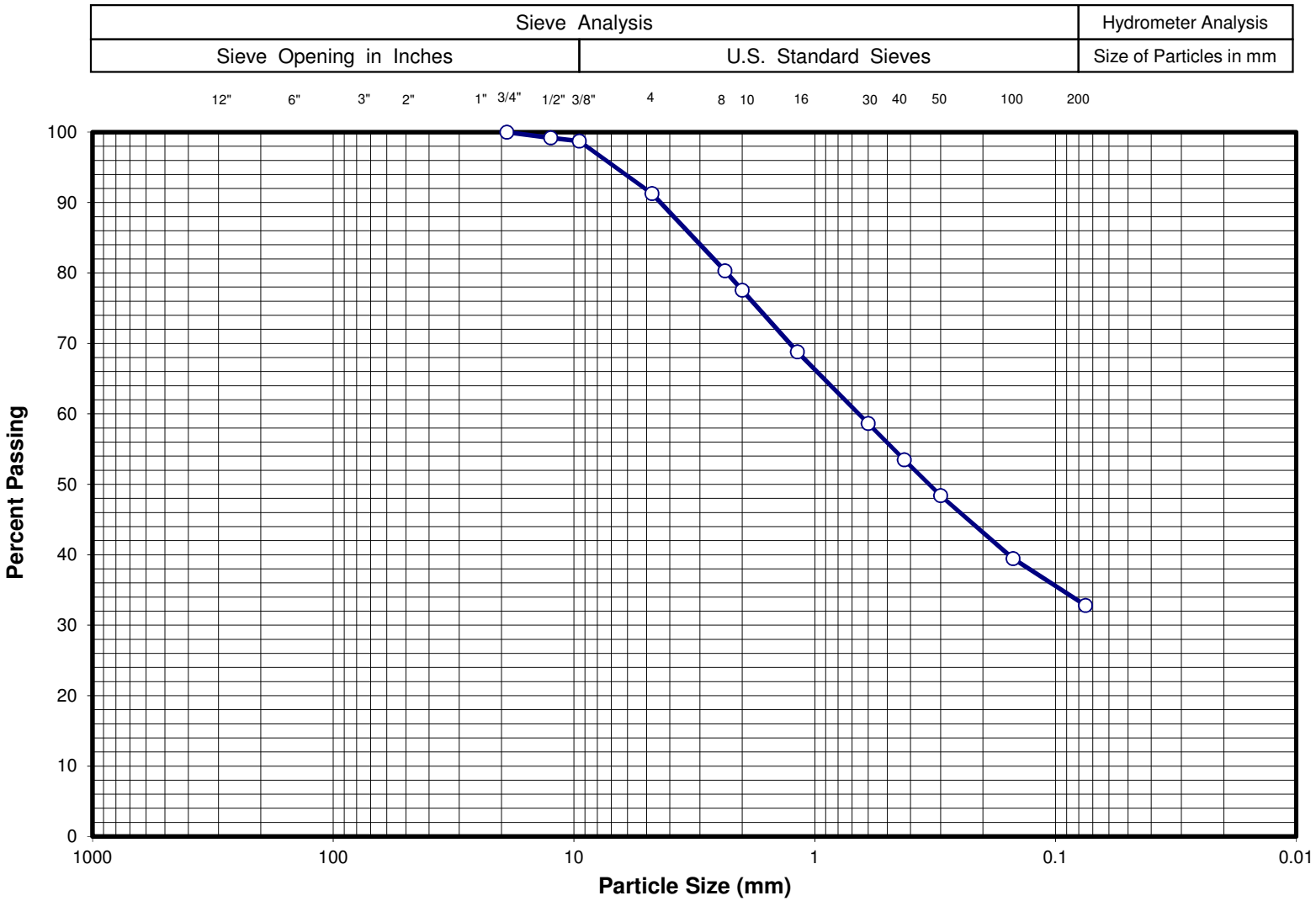
SIEVE ANALYSIS

Drawn By:	MA	Project No.:	213-207
Checked By:	Dr.Liu		
Date:	08/21/14	Figure No.:	-

Revised 04/27/2004



Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	-
1"	-
¾ "	100
½"	99
⅜"	99
#4	91
#10	78
#40	53
#200	33

Gravel (%)	9	LL	44	Project Name:	I-25/Cimarron Street
Sand (%)	58	PL	18	Sample ID:	YA-B04a
Fines (%)	33	PI	26	Sample Depth (ft.):	17-19
Sample Description:	**A-2-7 (2) / SC**				

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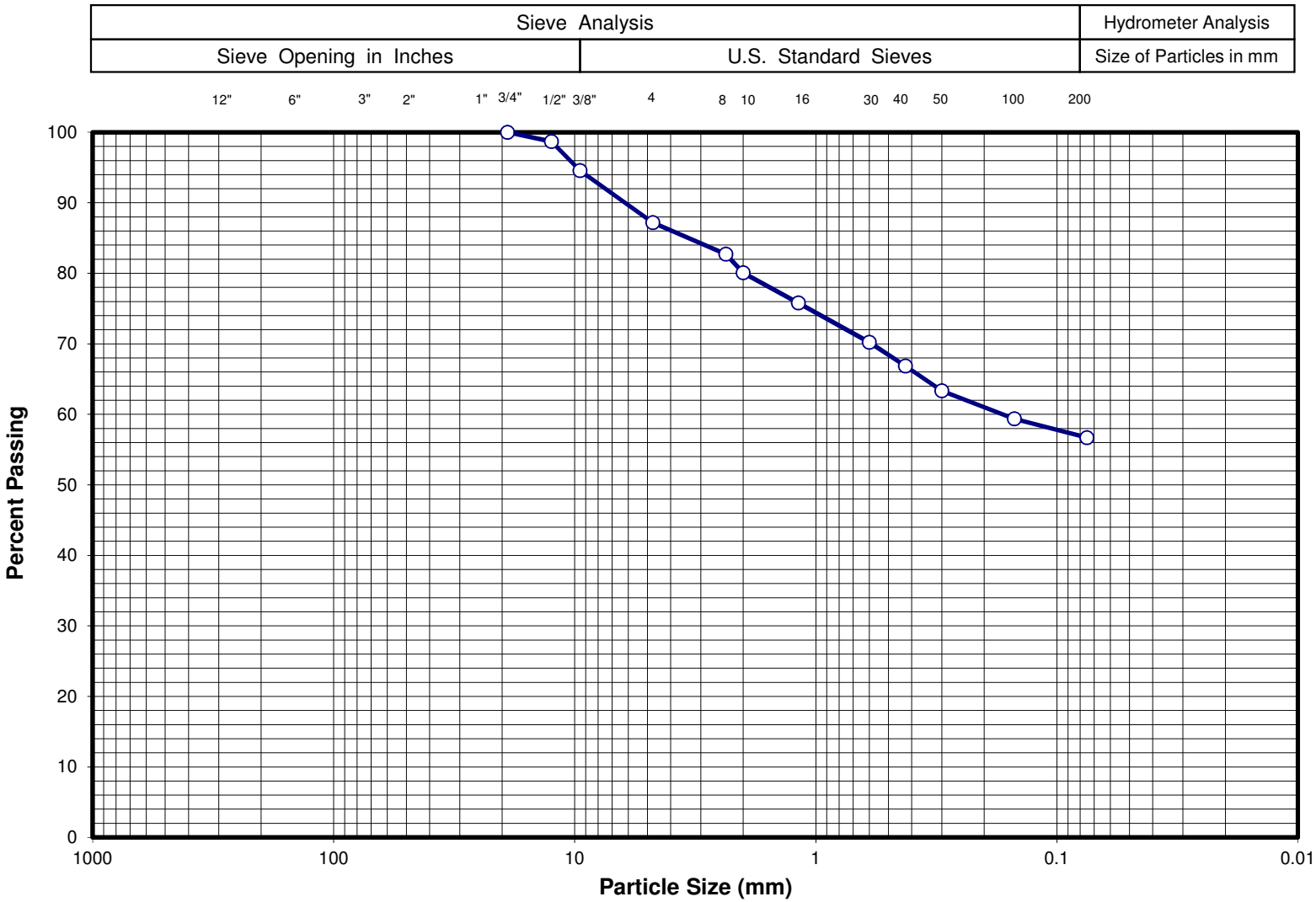
SIEVE ANALYSIS

Drawn By:	MA	Project No.:	213-207
Checked By:	Dr. Liu		
Date:	08/23/14	Figure No.:	-

Revised 04/27/2004



Sieve Size	% Passing
3"	-
2 ½"	-
2"	-
1 ½"	-
1"	-
¾ "	100
½"	99
⅜"	95
#4	87
#10	80
#40	67
#200	57

Gravel (%)	13	LL	42	Project Name:	I-25/Cimarron Street
Sand (%)	30	PL	14	Sample ID:	YA-B04a
Fines (%)	57	PI	28	Sample Depth (ft.):	20
Sample Description:	**A-7-6 (12) / CL**				

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SIEVE ANALYSIS

Drawn By:	MA	Project No.:	213-207
Checked By:	Dr. Liu		
Date:	08/21/14	Figure No.:	-

Revised 04/27/2004