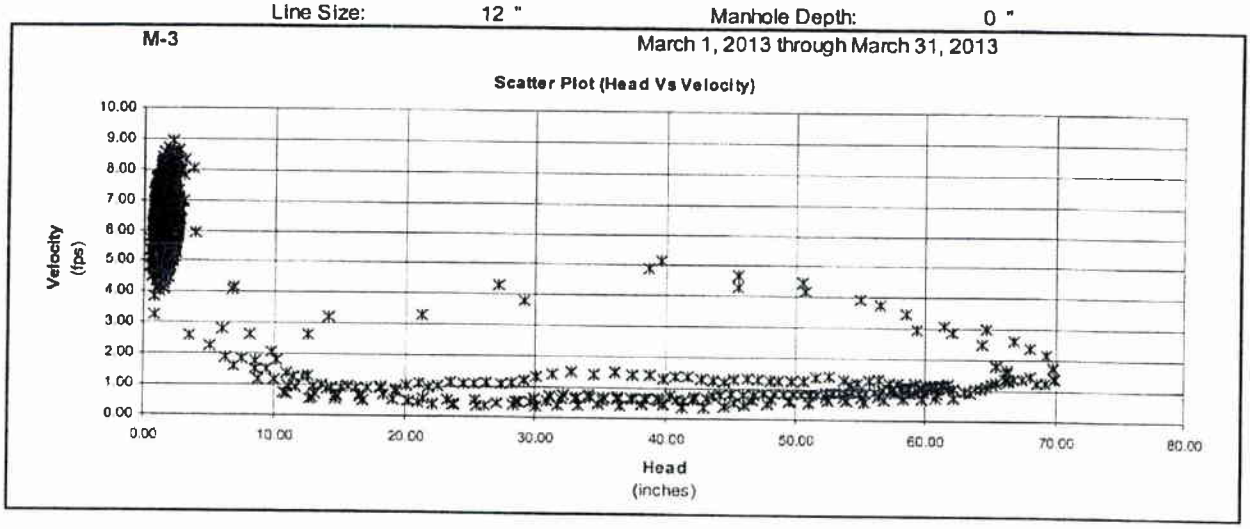
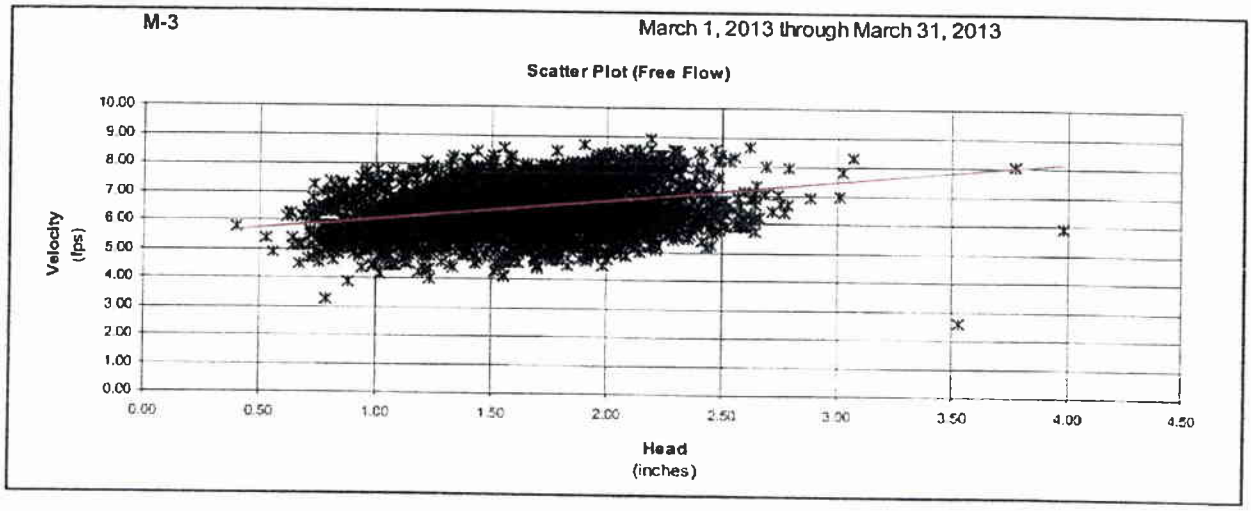
Line Size: 12 " Manhole Depth: 0 "

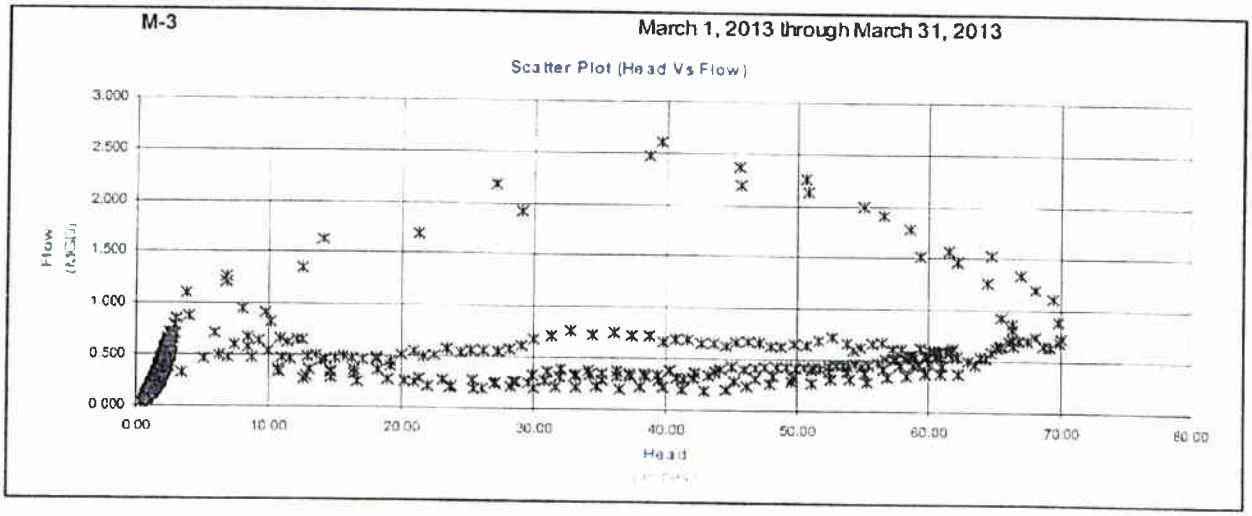
M-3 March 1, 2013 through March 31, 2013



M-3 March 1, 2013 through March 31, 2013



M-3 March 1, 2013 through March 31, 2013



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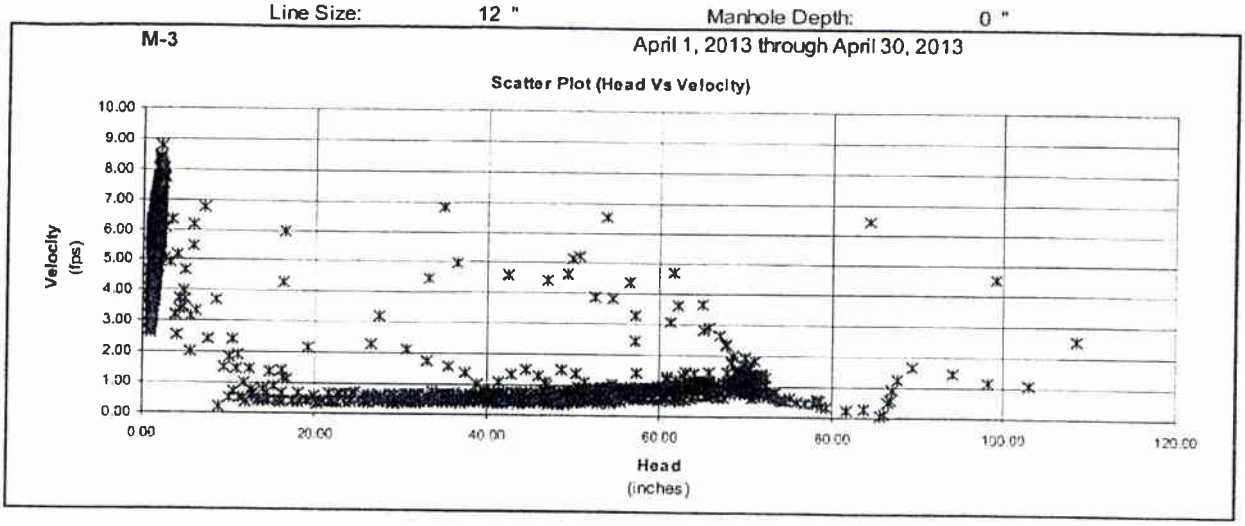

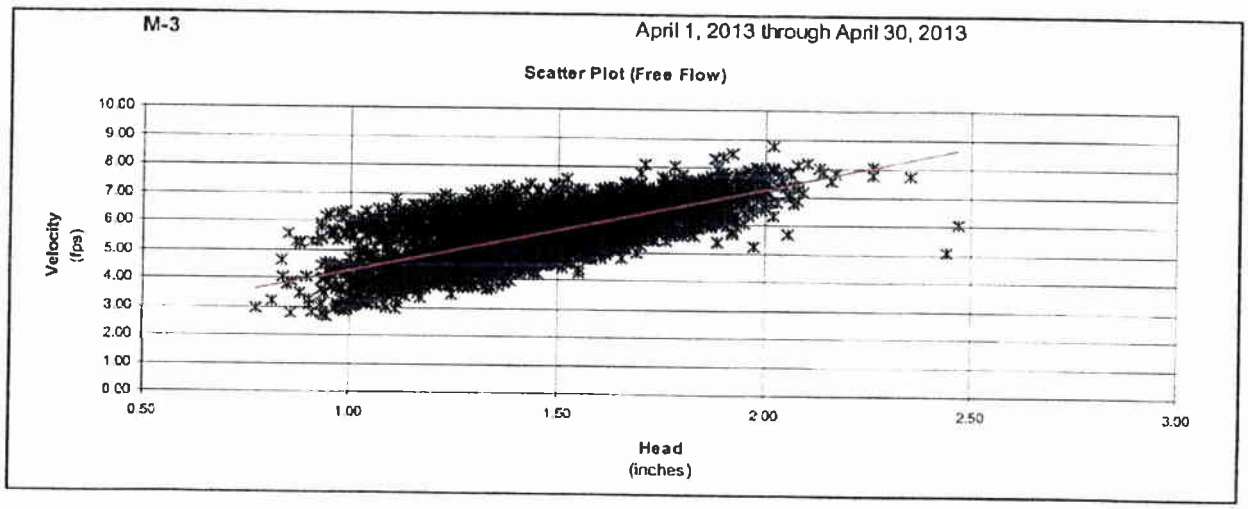

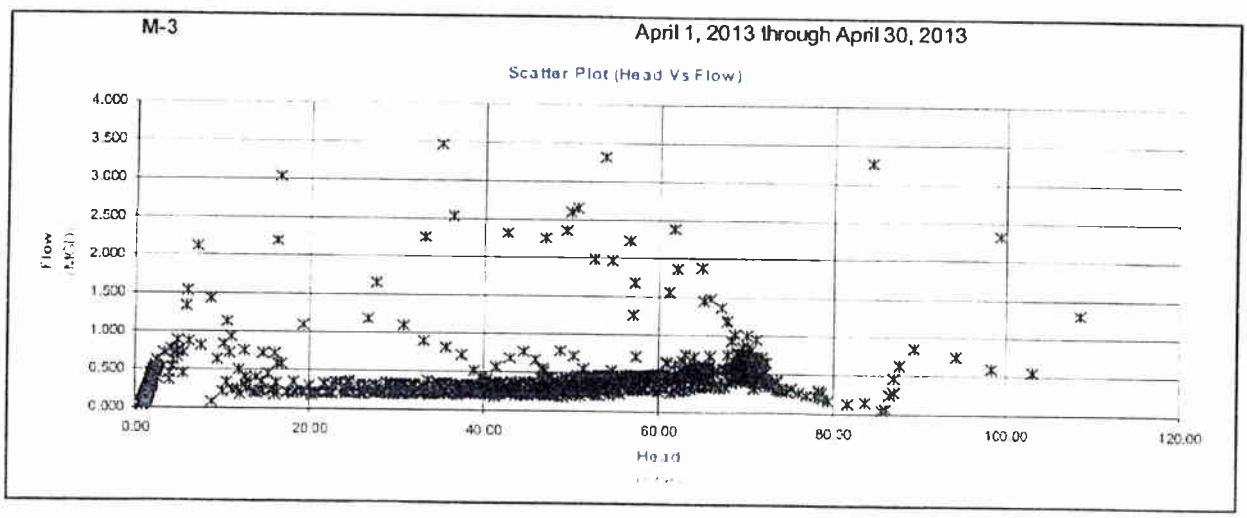

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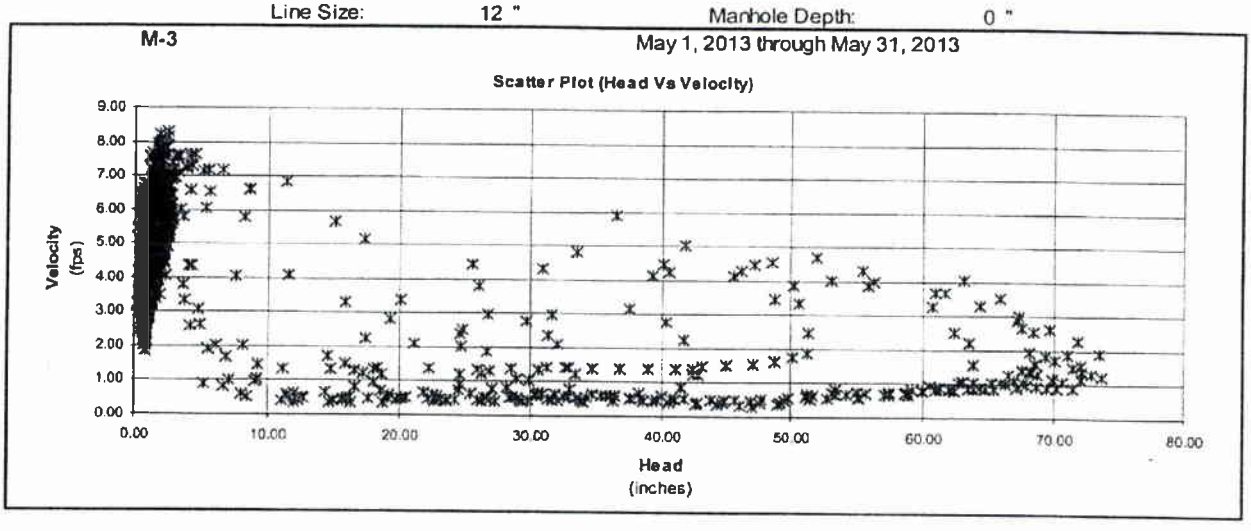
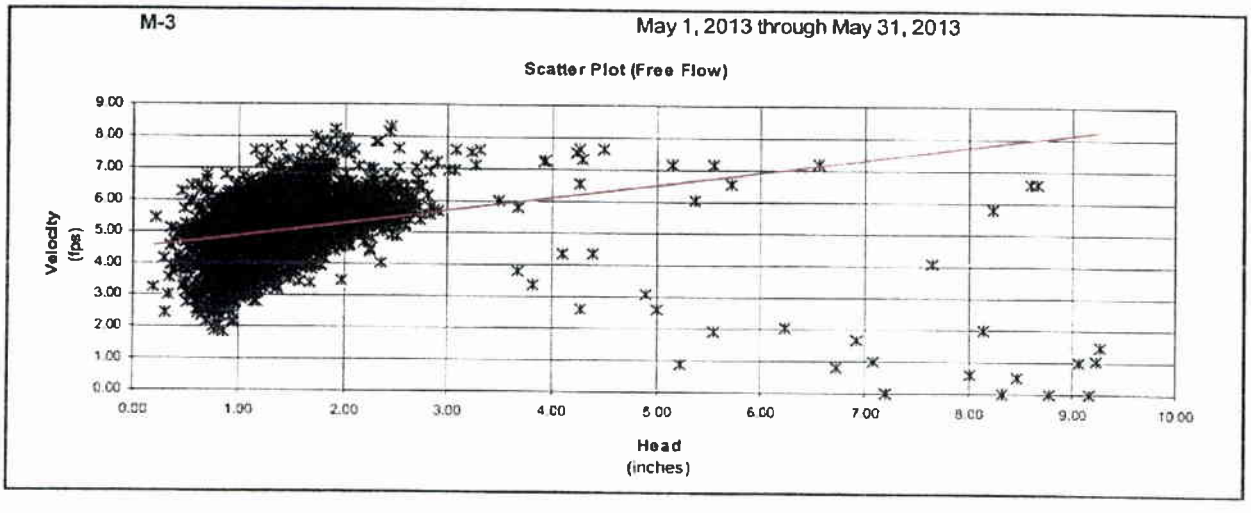
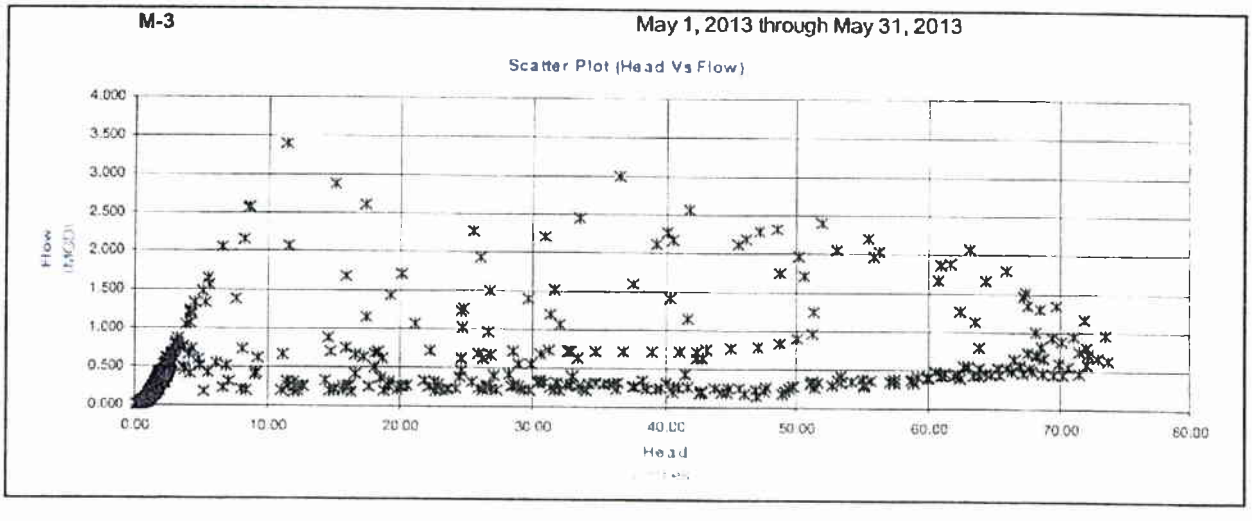
M-3 May 1, 2013 through May 31, 2013



M-3 May 1, 2013 through May 31, 2013

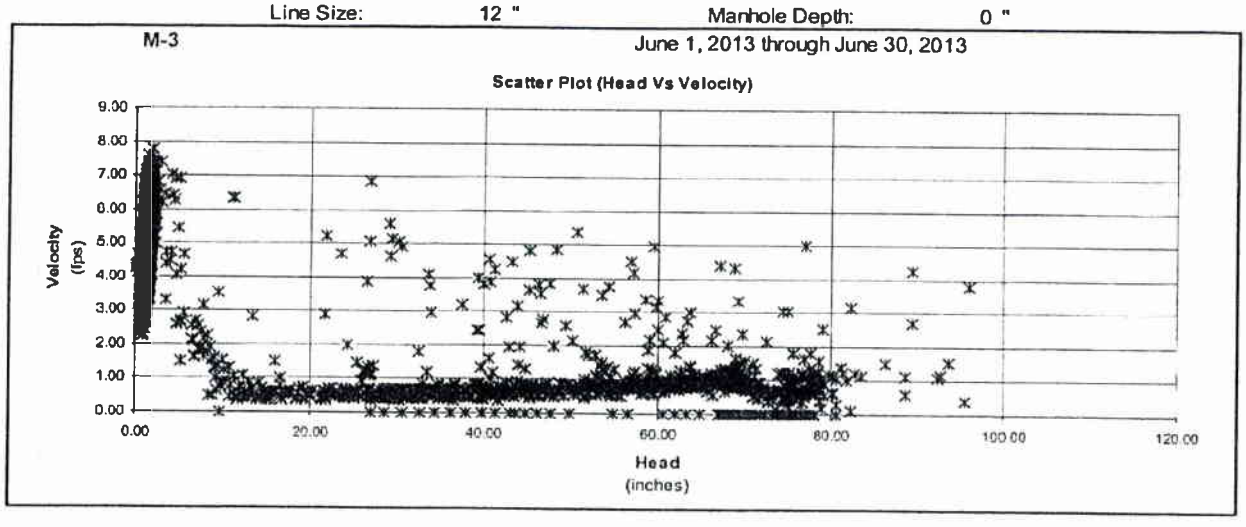


M-3 May 1, 2013 through May 31, 2013

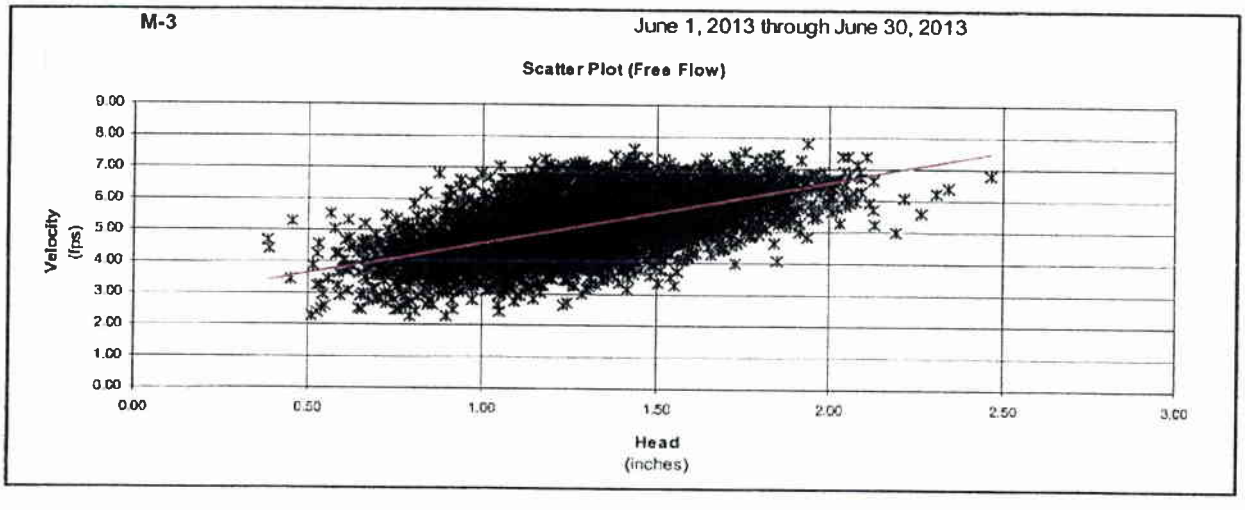


Line Size: 12 " Manhole Depth: 0 "

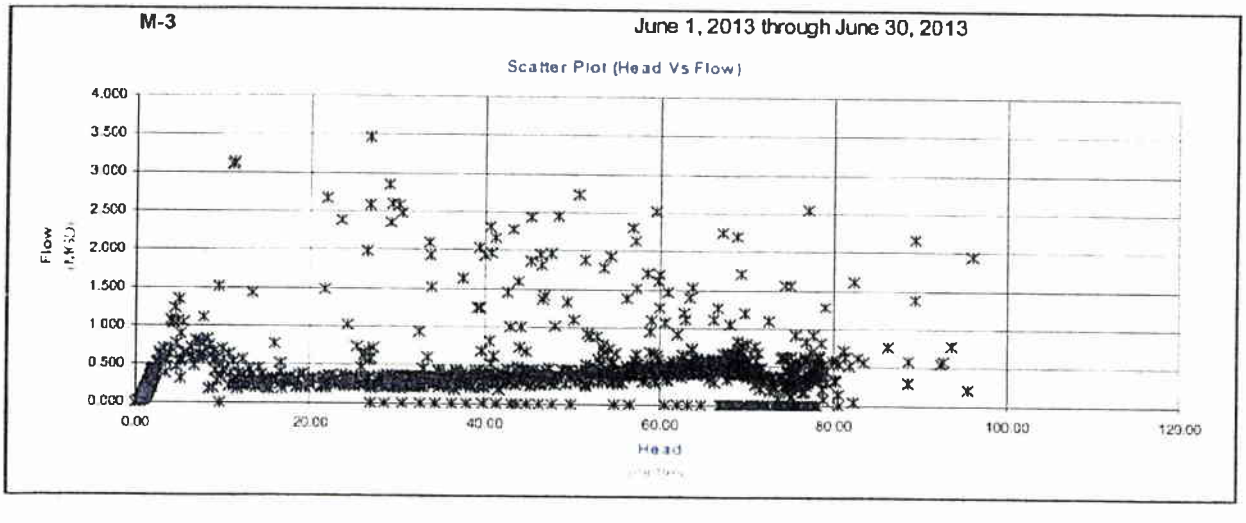
M-3 June 1, 2013 through June 30, 2013



M-3 June 1, 2013 through June 30, 2013



M-3 June 1, 2013 through June 30, 2013



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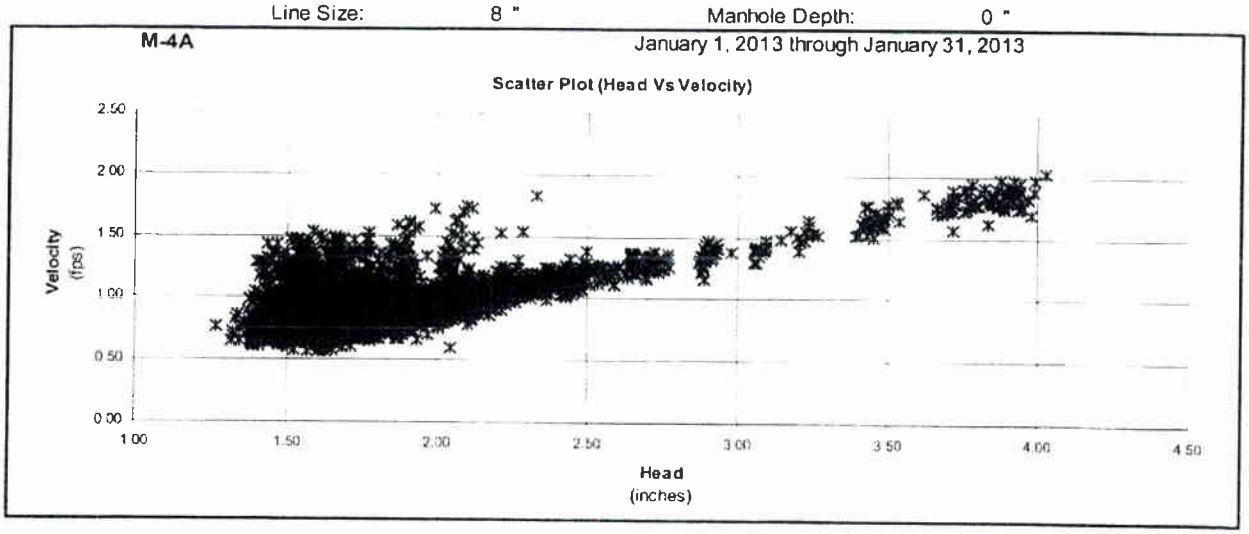

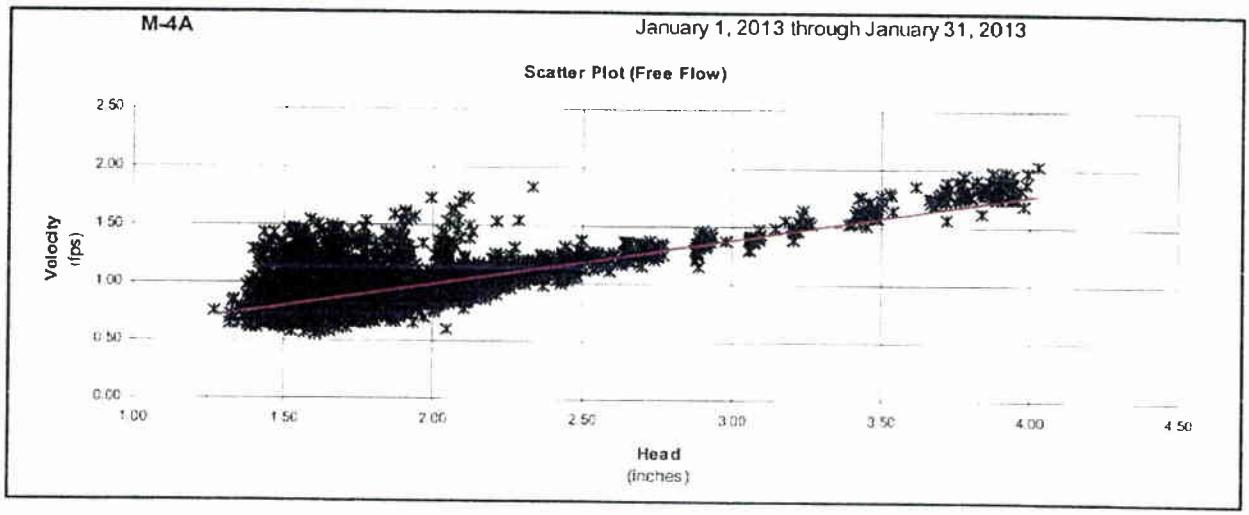

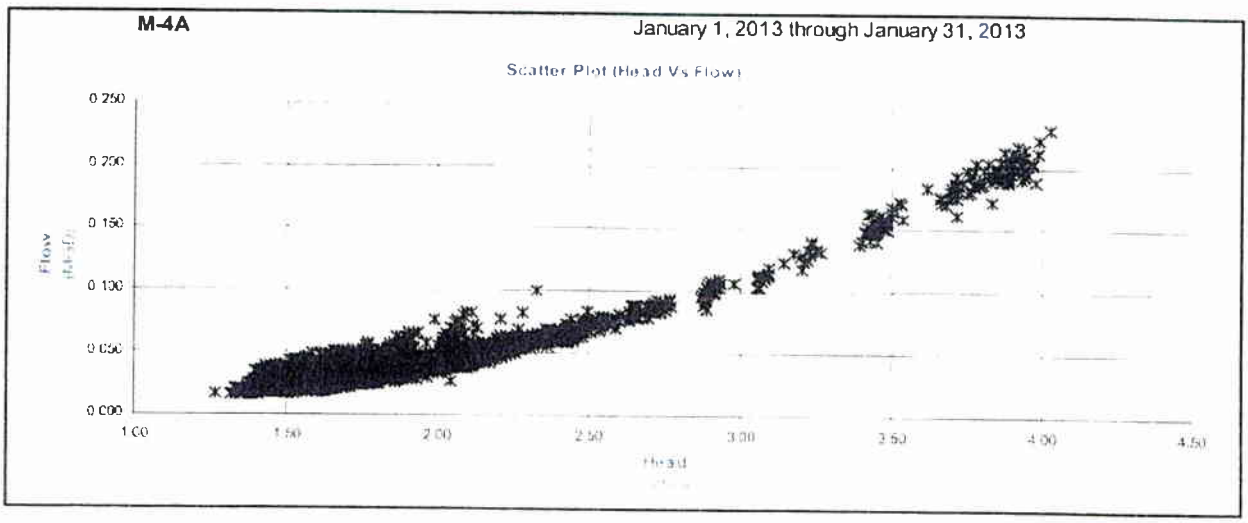

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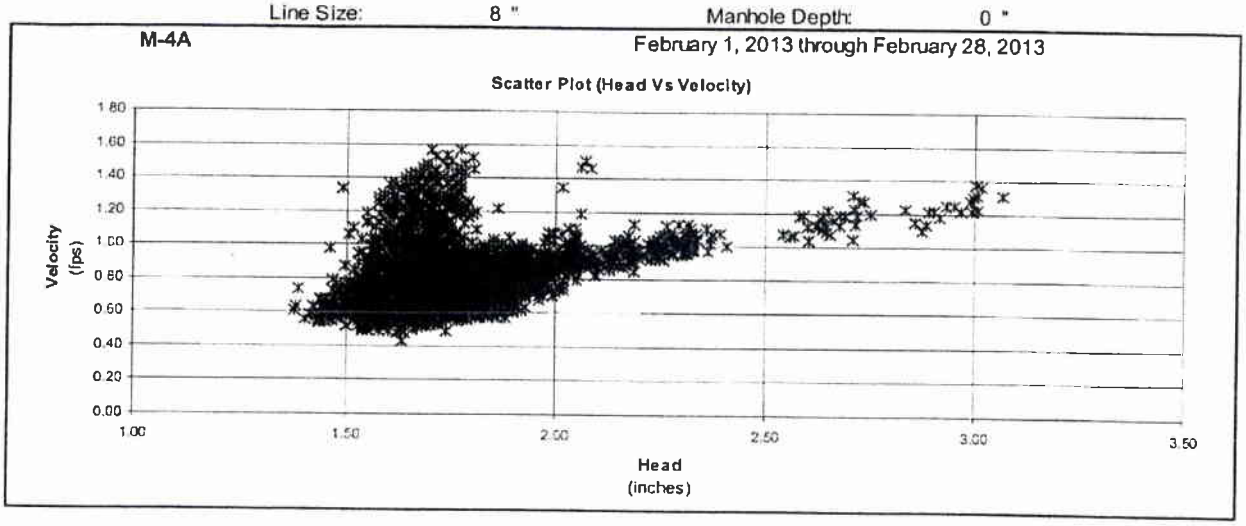
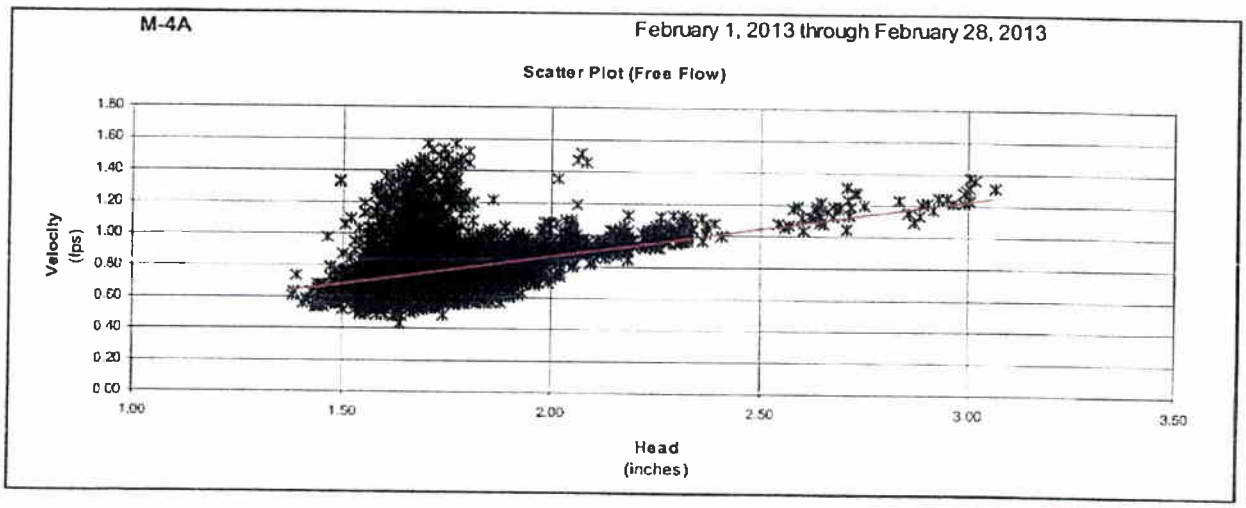
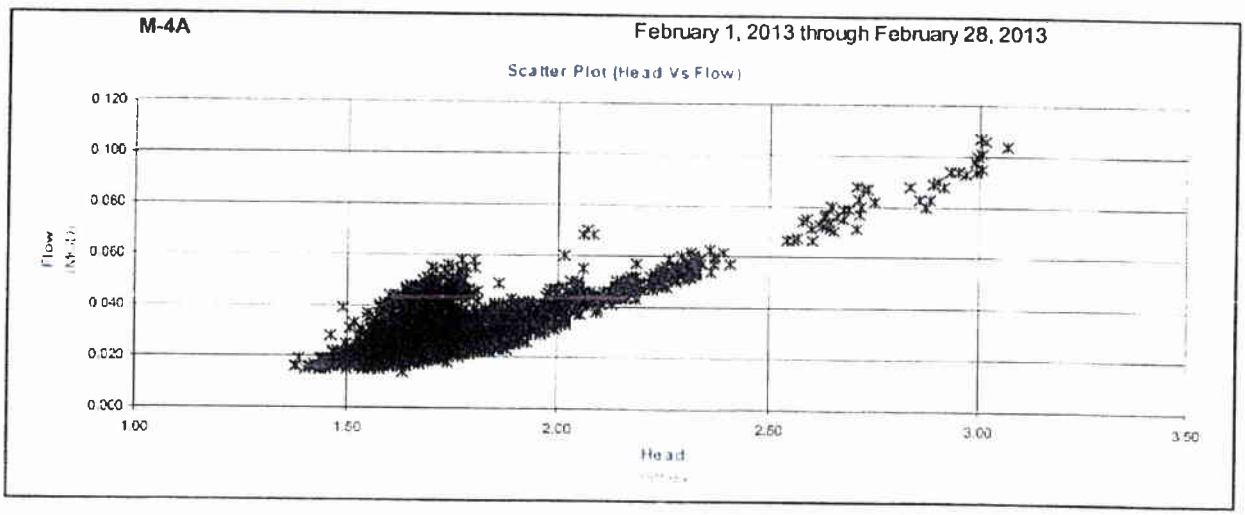
M-4A February 1, 2013 through February 28, 2013



M-4A February 1, 2013 through February 28, 2013



M-4A February 1, 2013 through February 28, 2013



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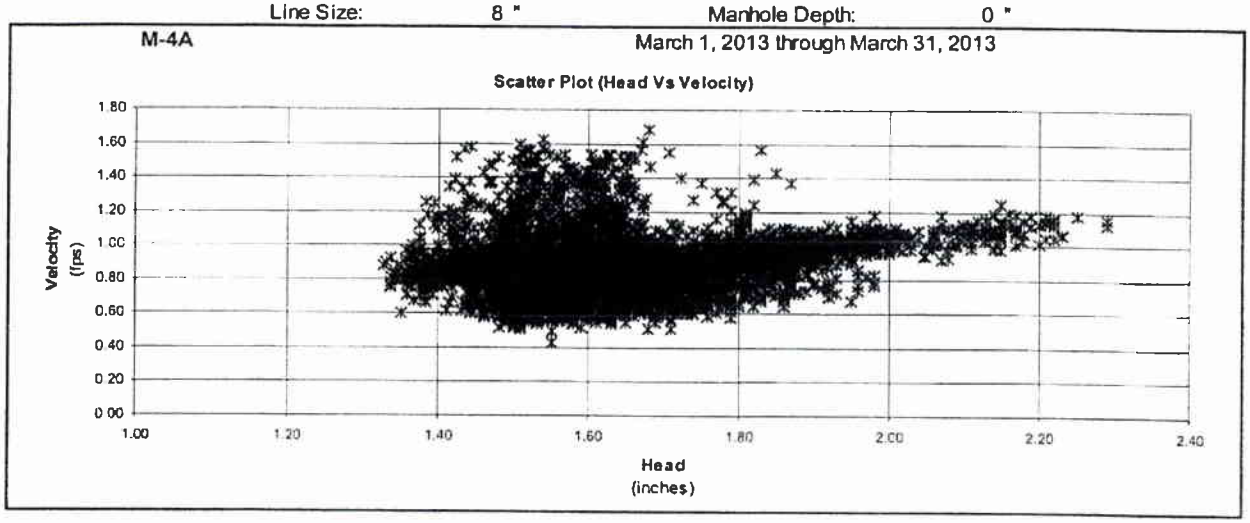
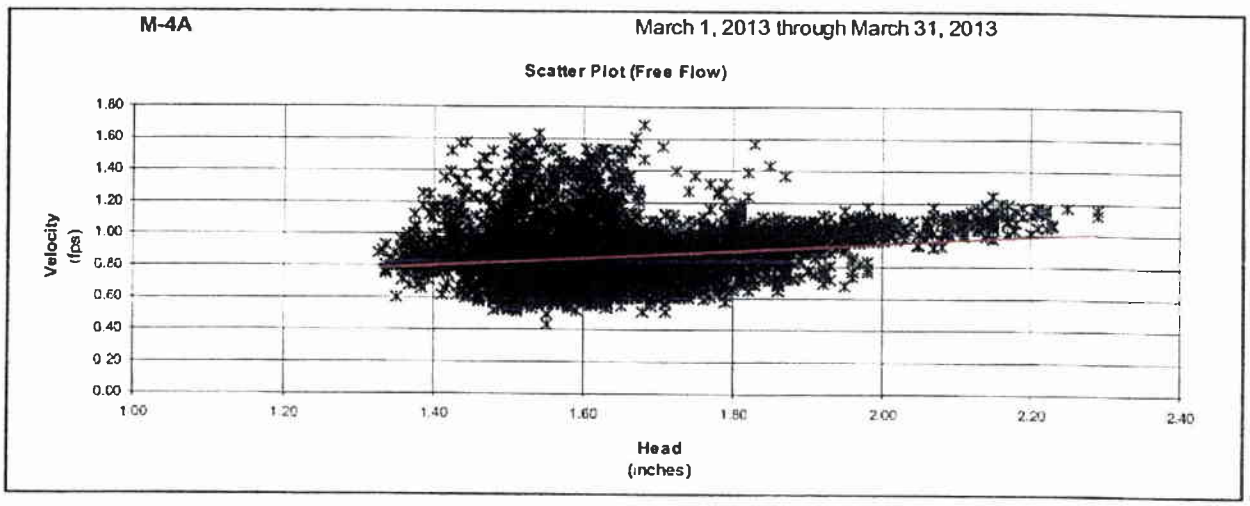
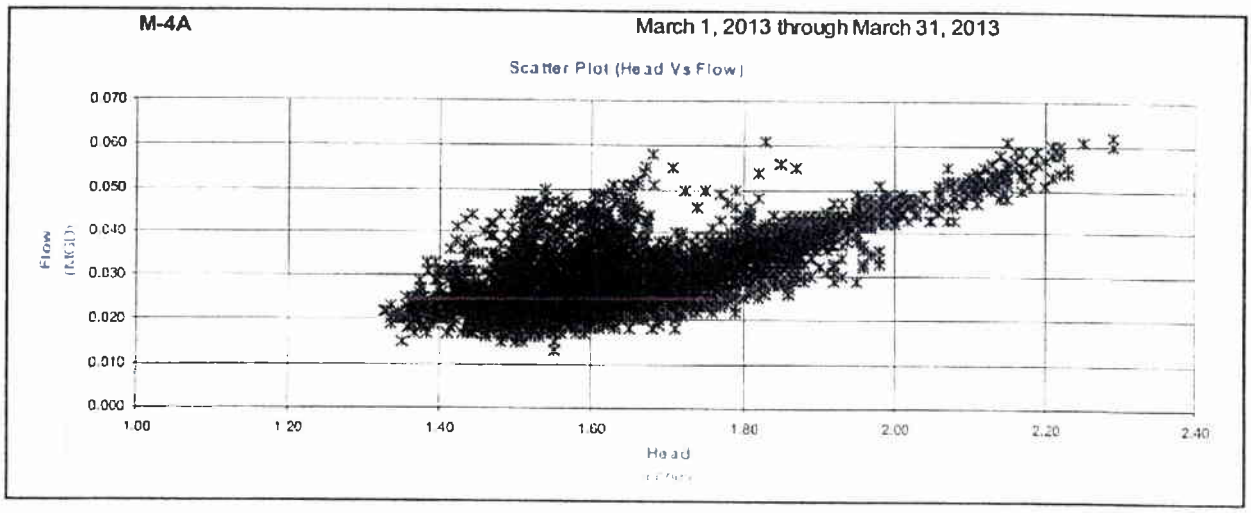
M-4A March 1, 2013 through March 31, 2013



M-4A March 1, 2013 through March 31, 2013



M-4A March 1, 2013 through March 31, 2013



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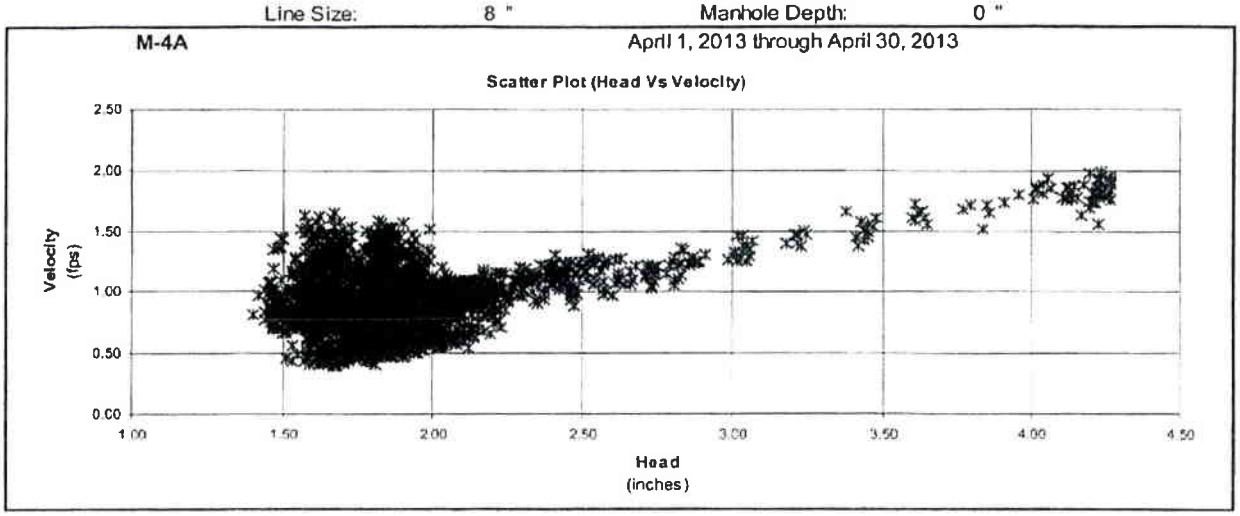
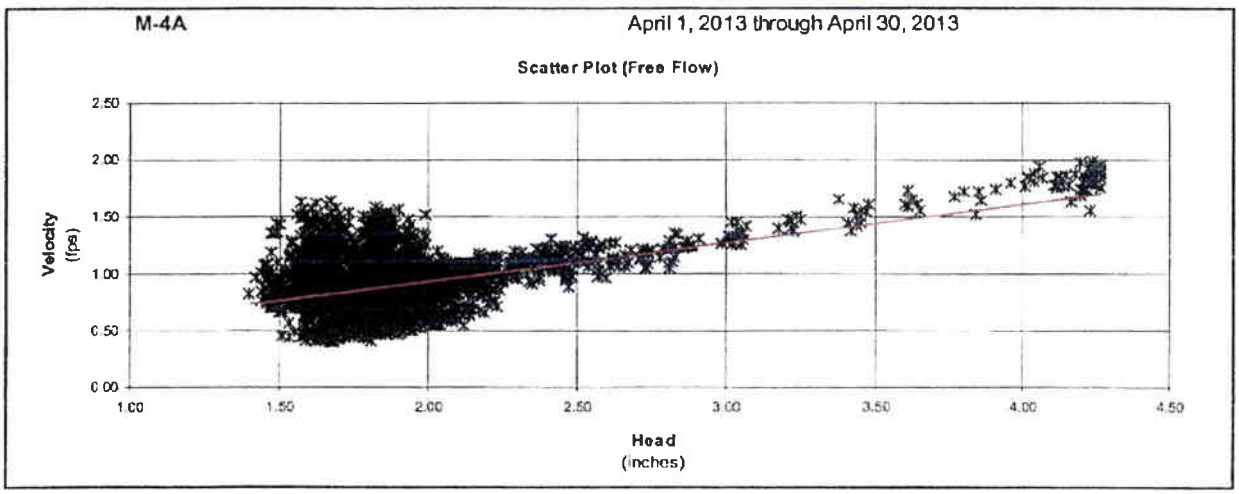
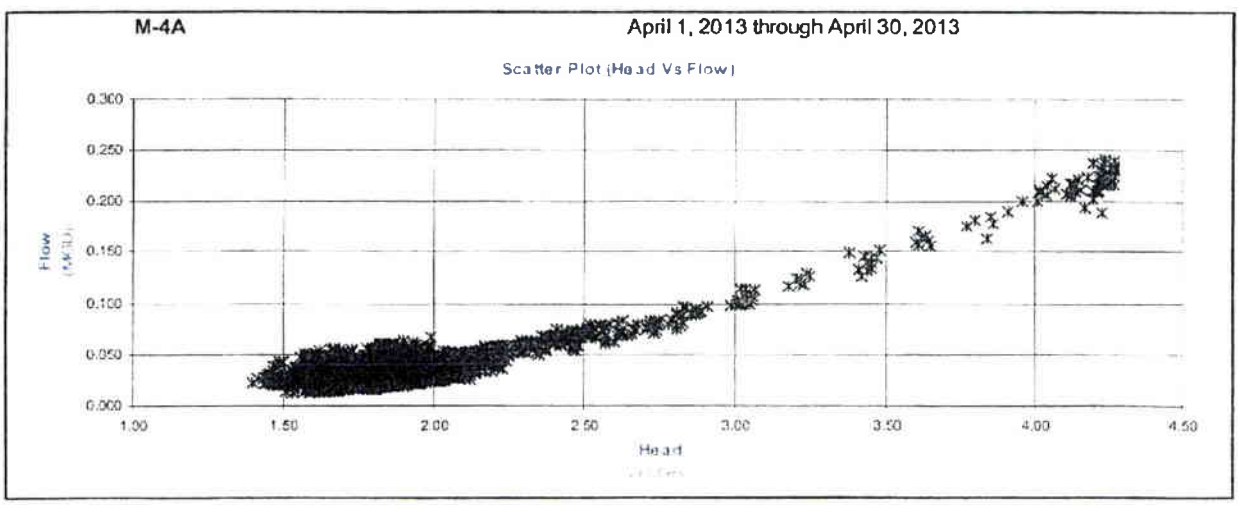
M-4A April 1, 2013 through April 30, 2013



M-4A April 1, 2013 through April 30, 2013



M-4A April 1, 2013 through April 30, 2013



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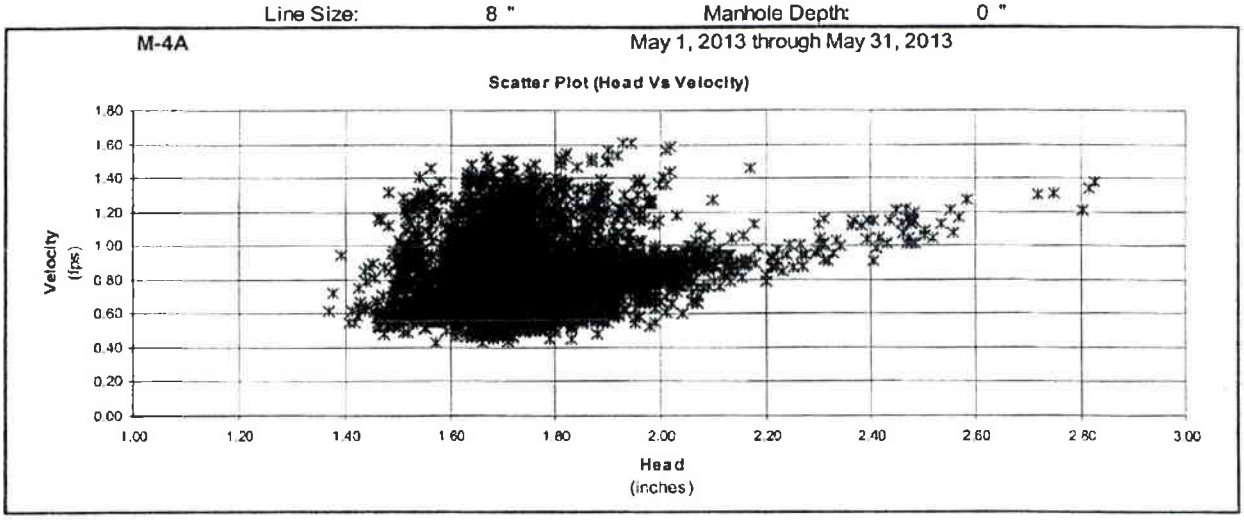
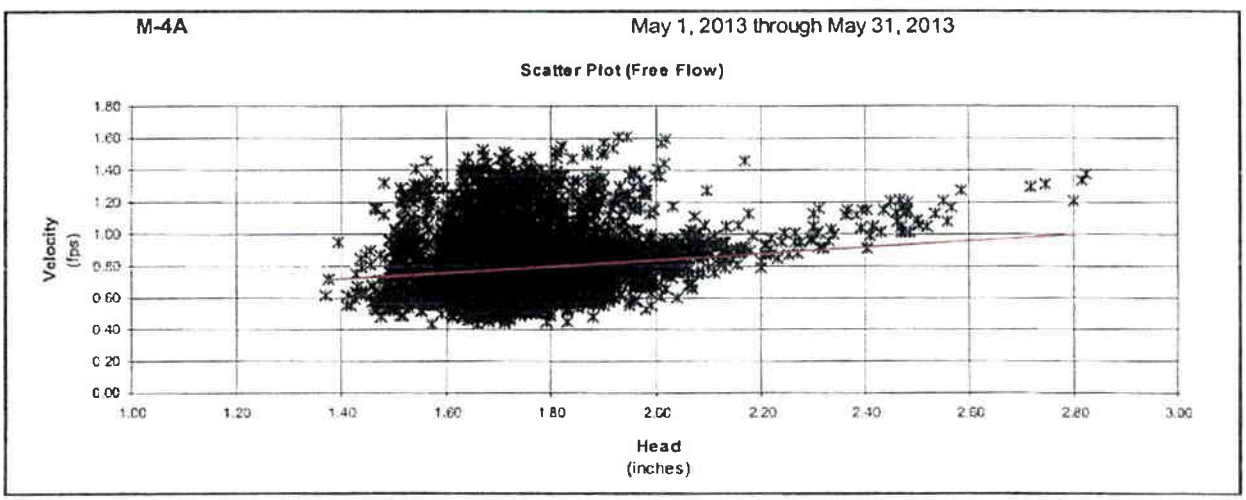
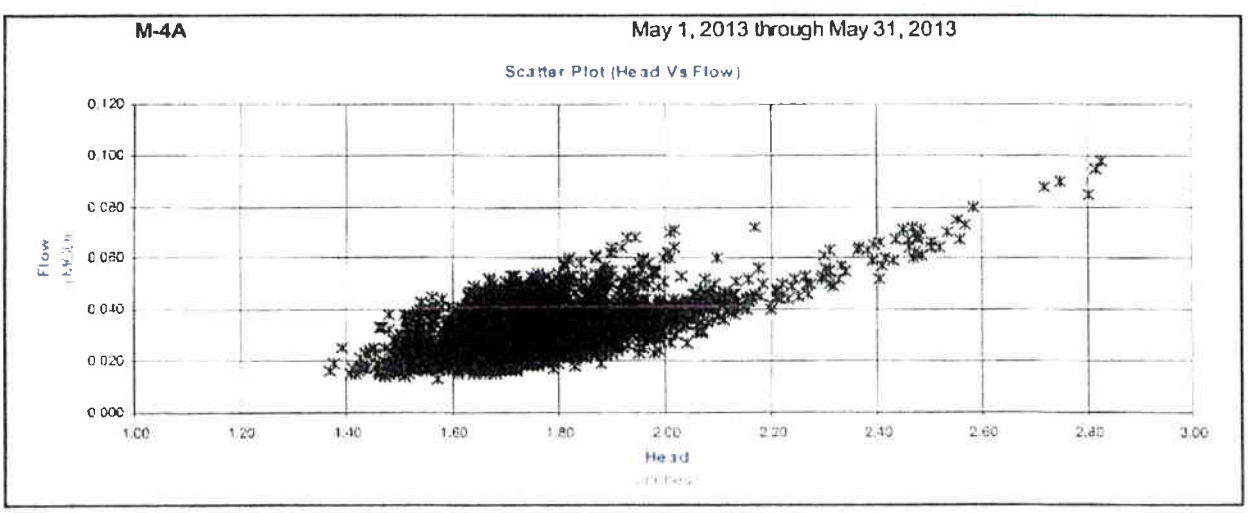
M-4A May 1, 2013 through May 31, 2013



M-4A May 1, 2013 through May 31, 2013



M-4A May 1, 2013 through May 31, 2013



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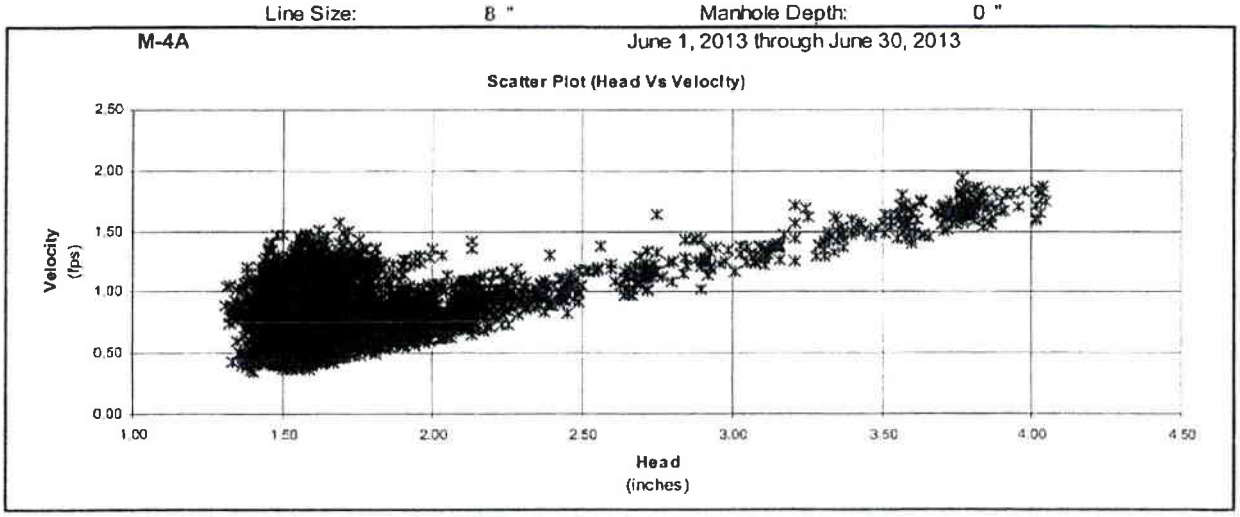
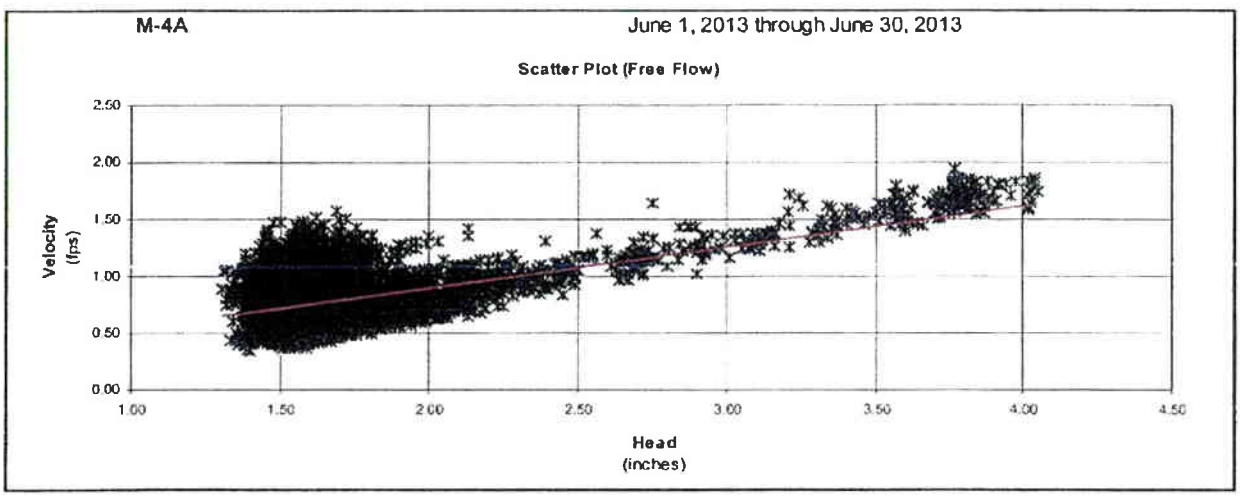
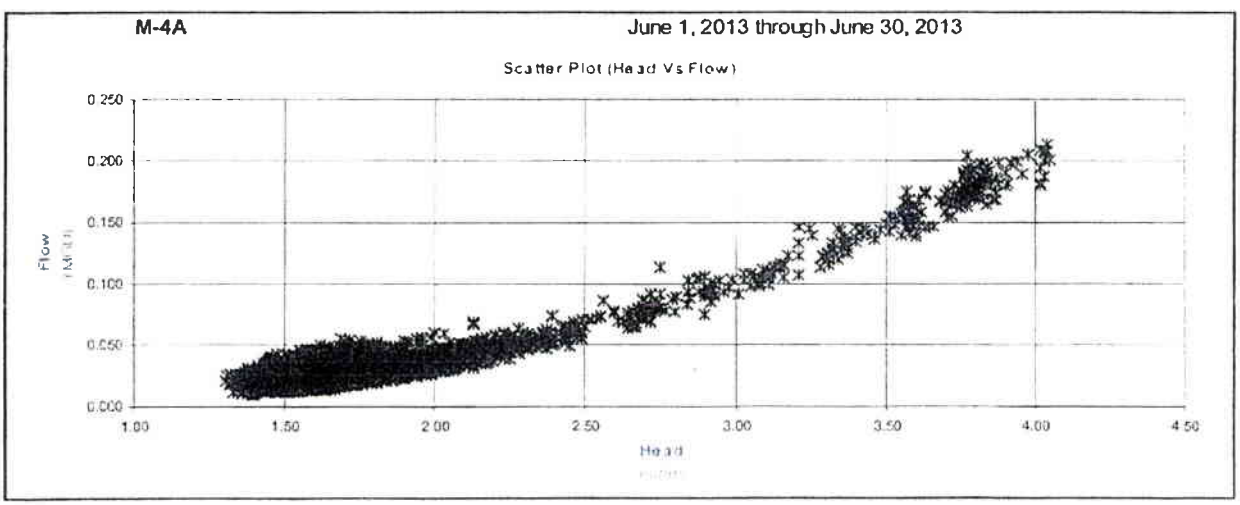
M-4A June 1, 2013 through June 30, 2013



M-4A June 1, 2013 through June 30, 2013

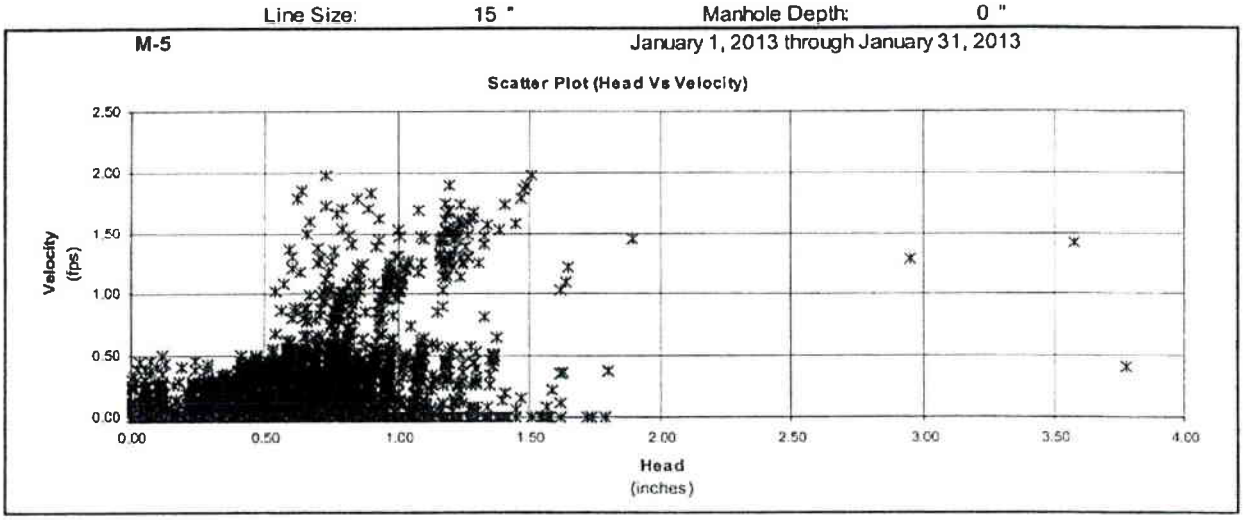


M-4A June 1, 2013 through June 30, 2013

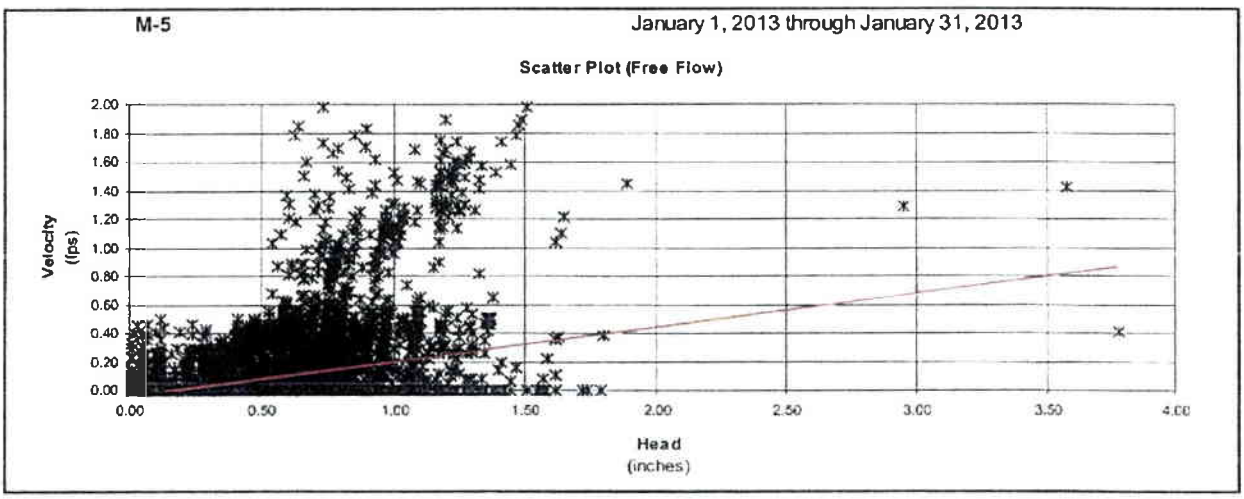


Line Size: 15 " Manhole Depth: 0 "

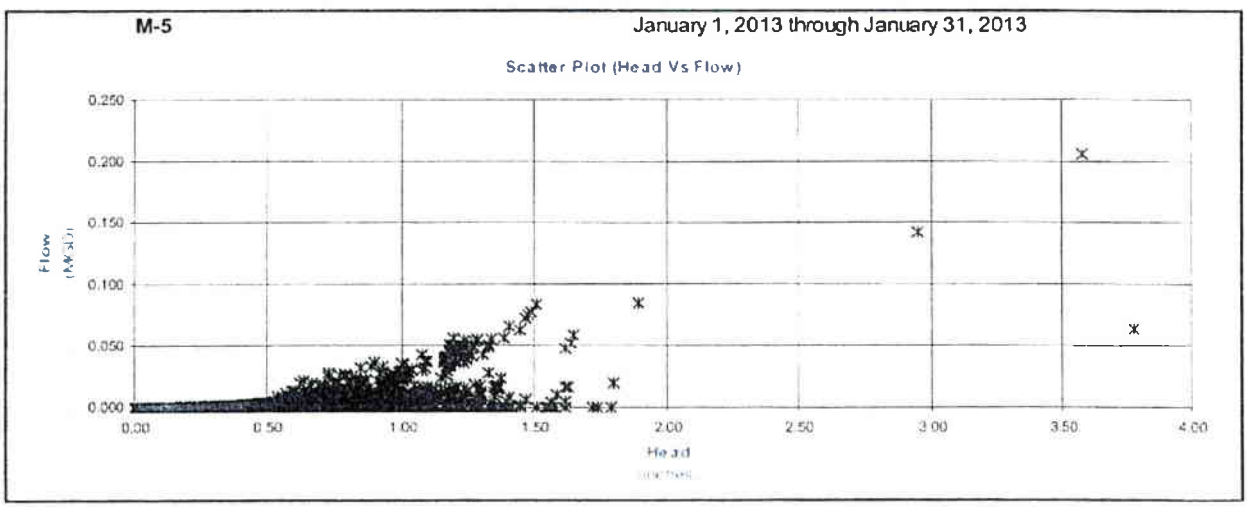
M-5 January 1, 2013 through January 31, 2013



M-5 January 1, 2013 through January 31, 2013

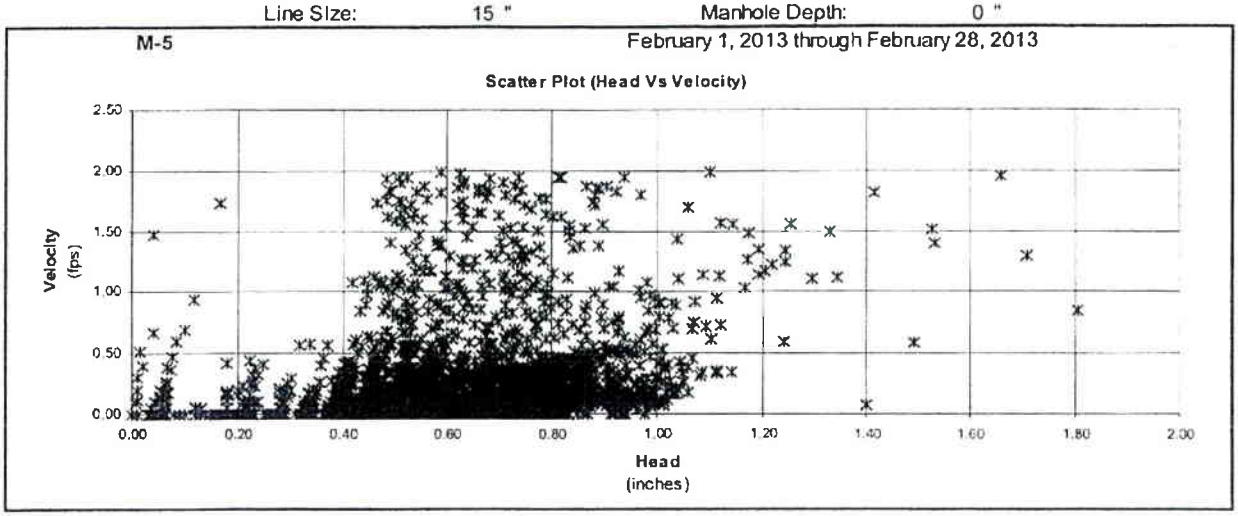


M-5 January 1, 2013 through January 31, 2013

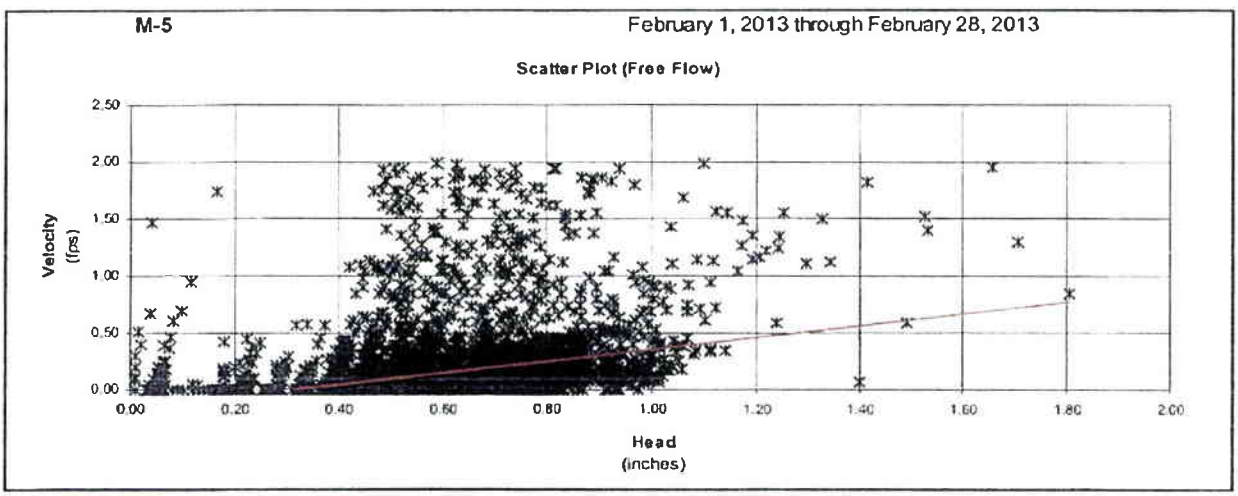


Line Size: 15 " Manhole Depth: 0 "

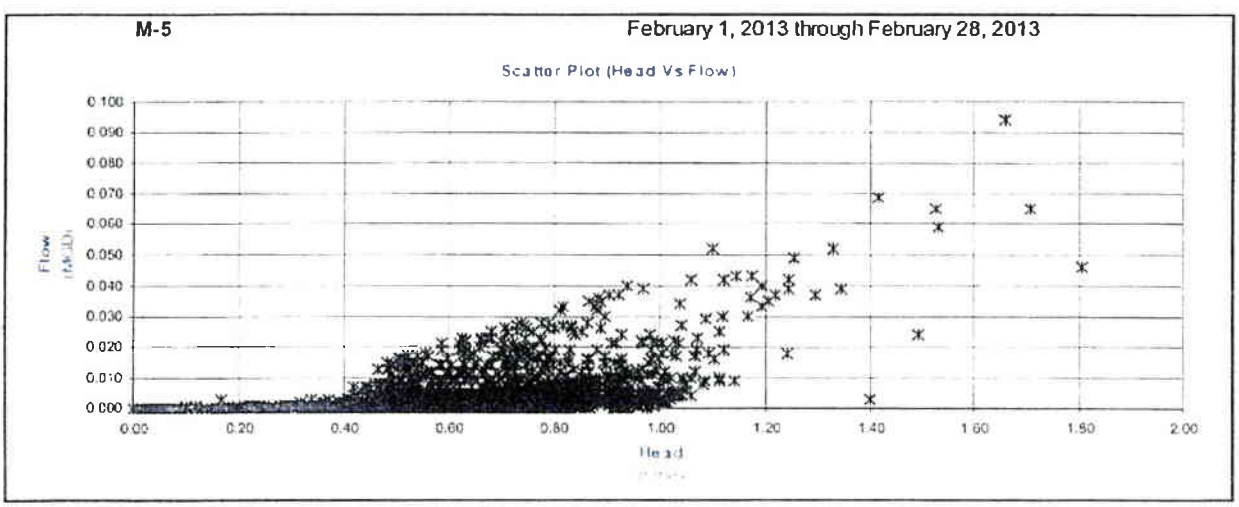
M-5 February 1, 2013 through February 28, 2013



M-5 February 1, 2013 through February 28, 2013



M-5 February 1, 2013 through February 28, 2013



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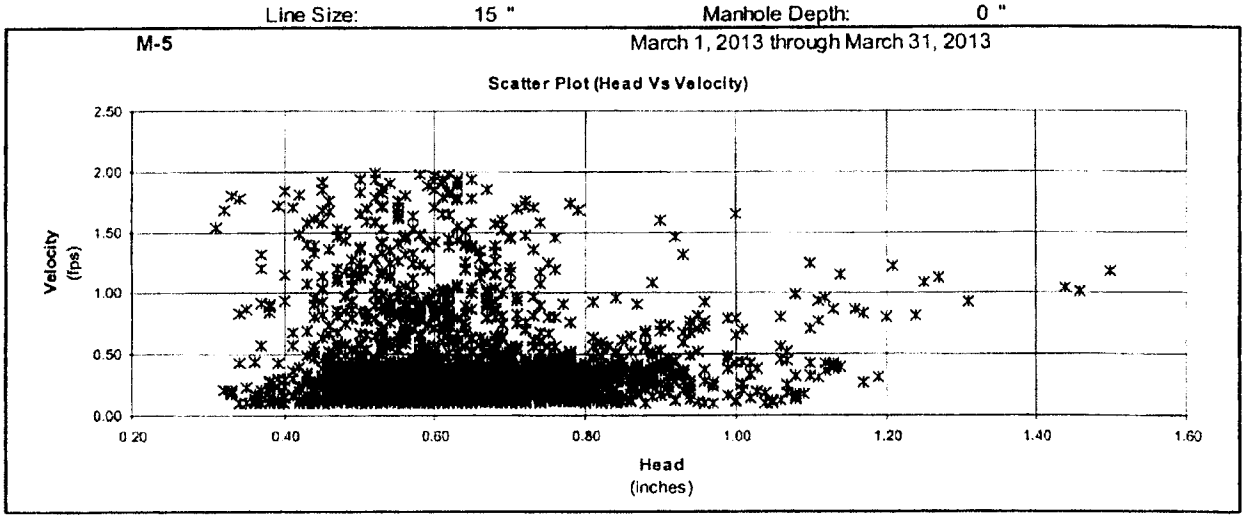
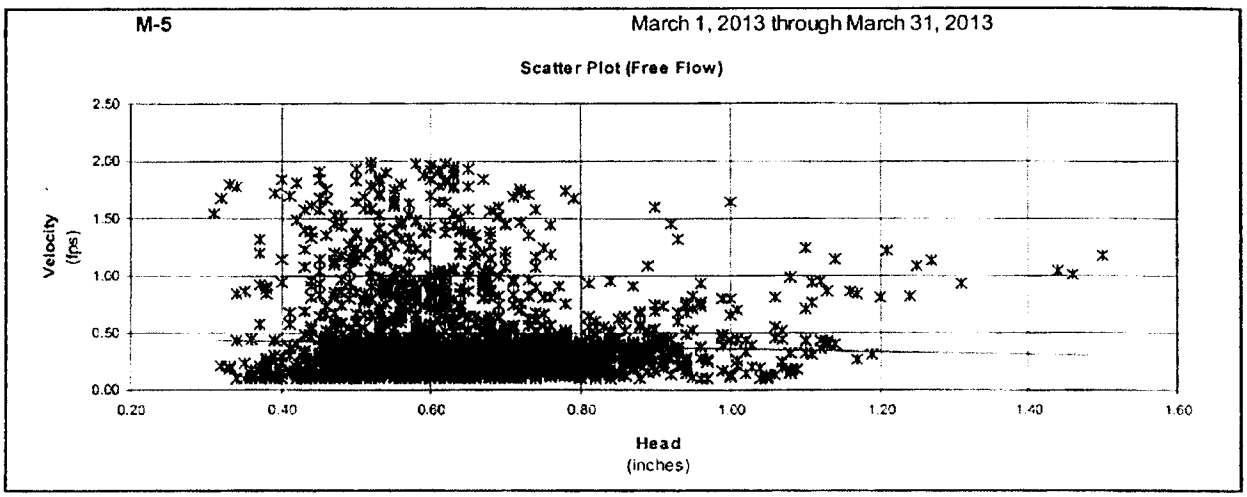
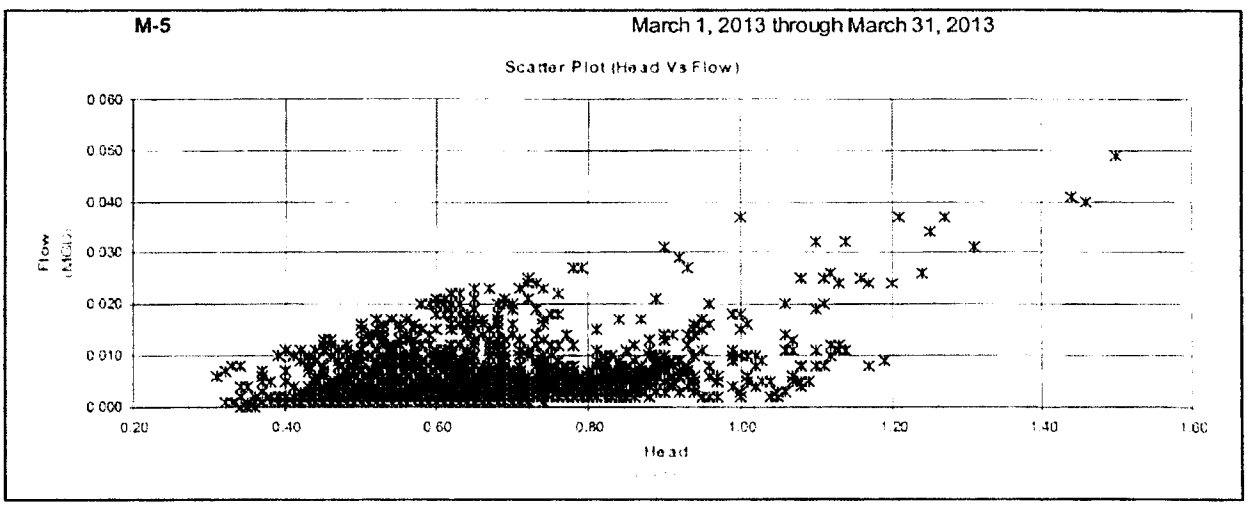
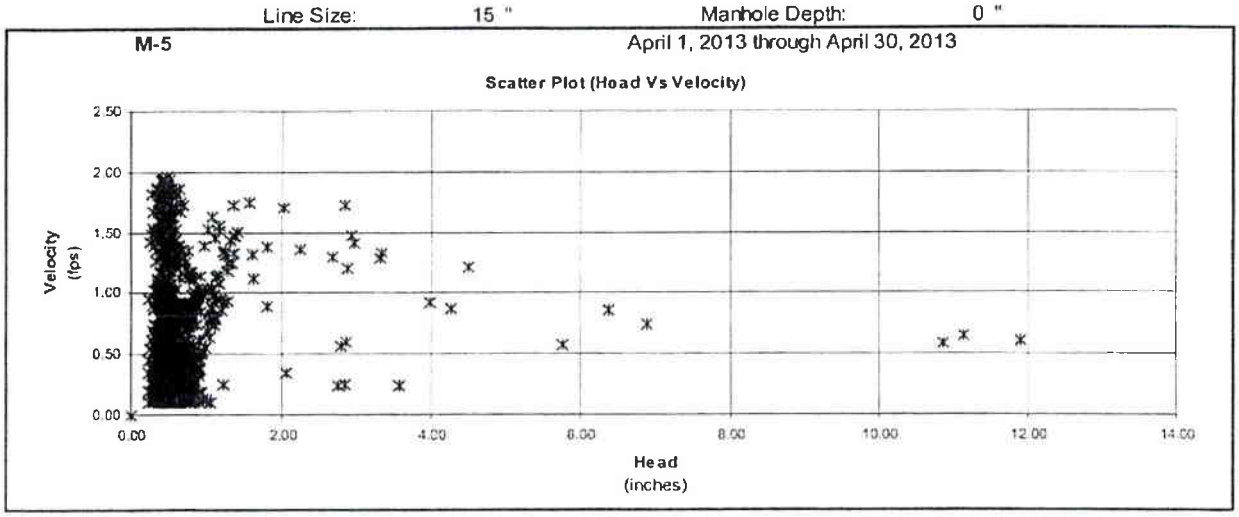




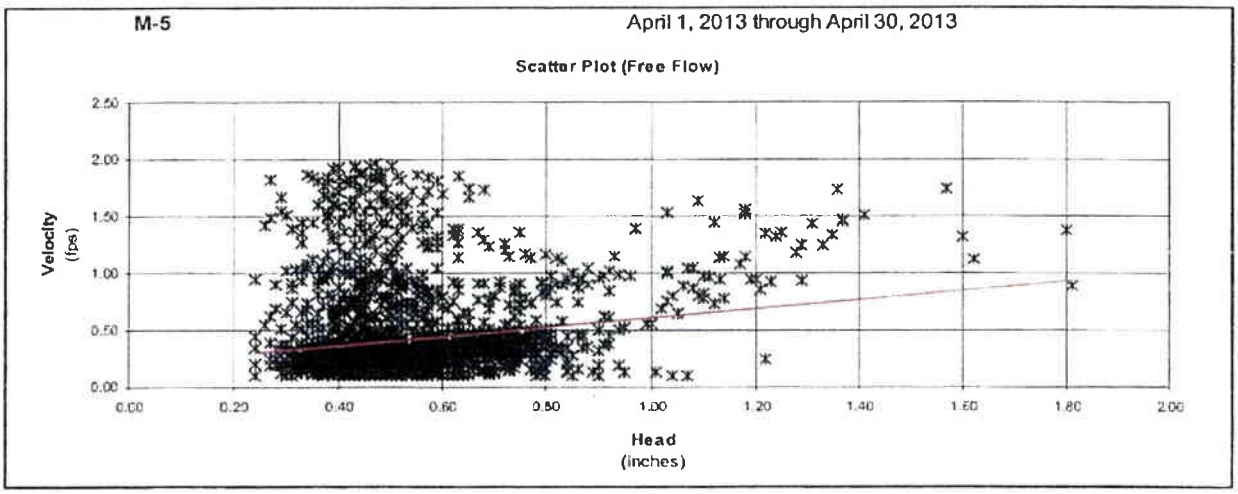


Line Size: 15 " Manhole Depth: 0 "

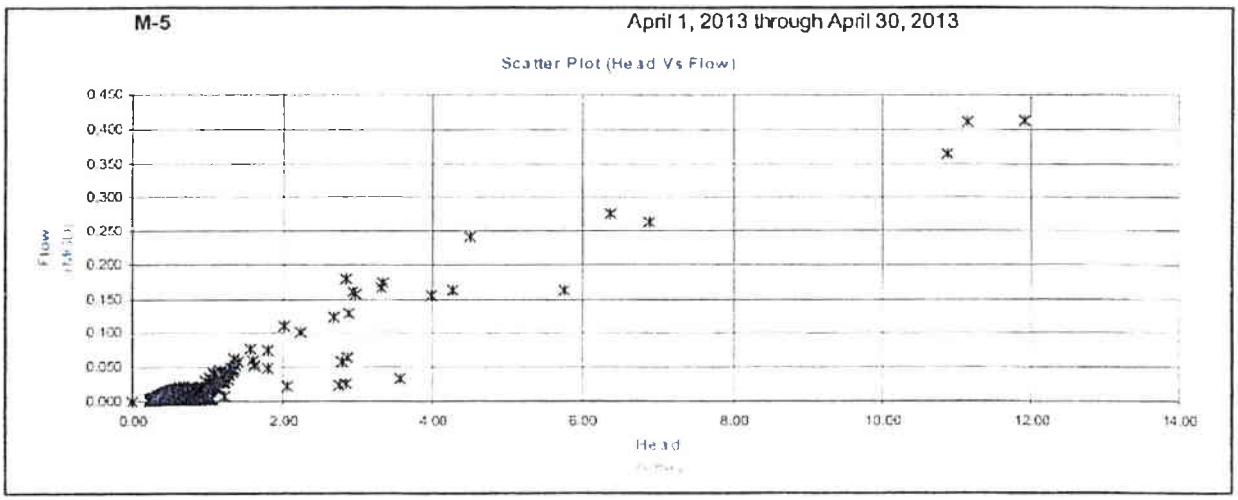
M-5 April 1, 2013 through April 30, 2013



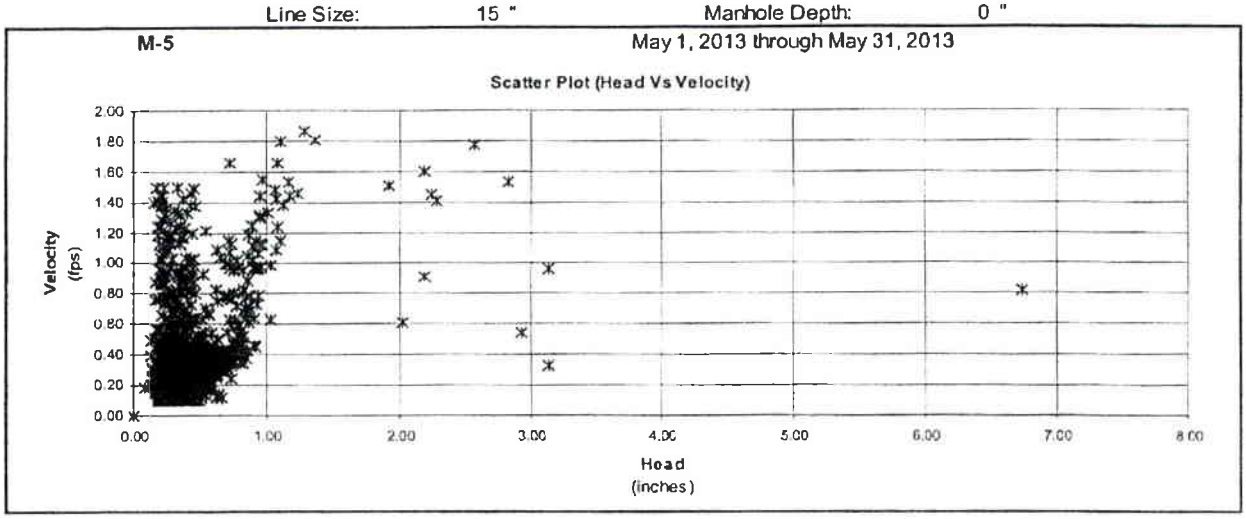
M-5 April 1, 2013 through April 30, 2013

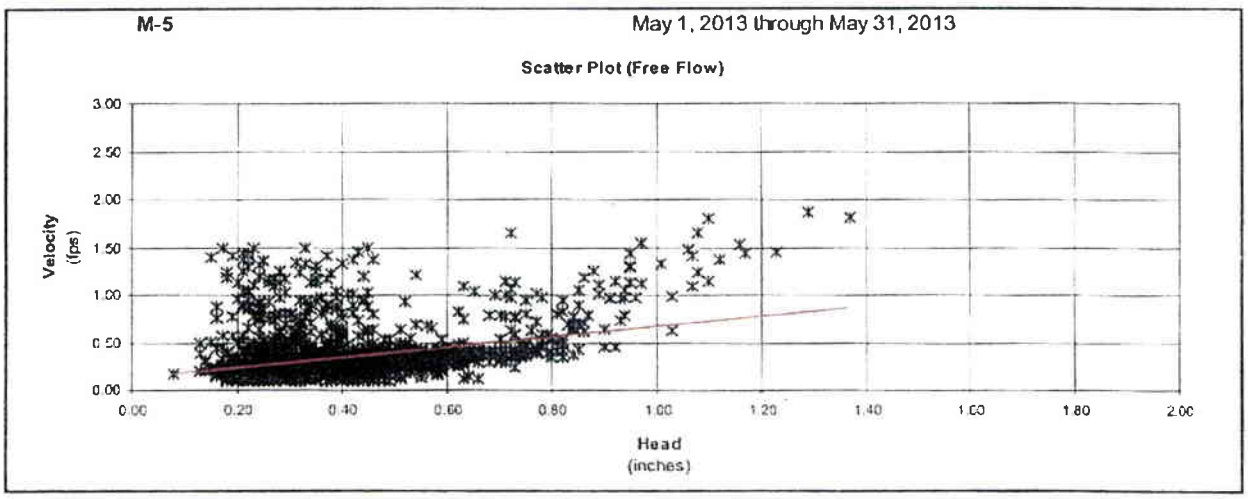


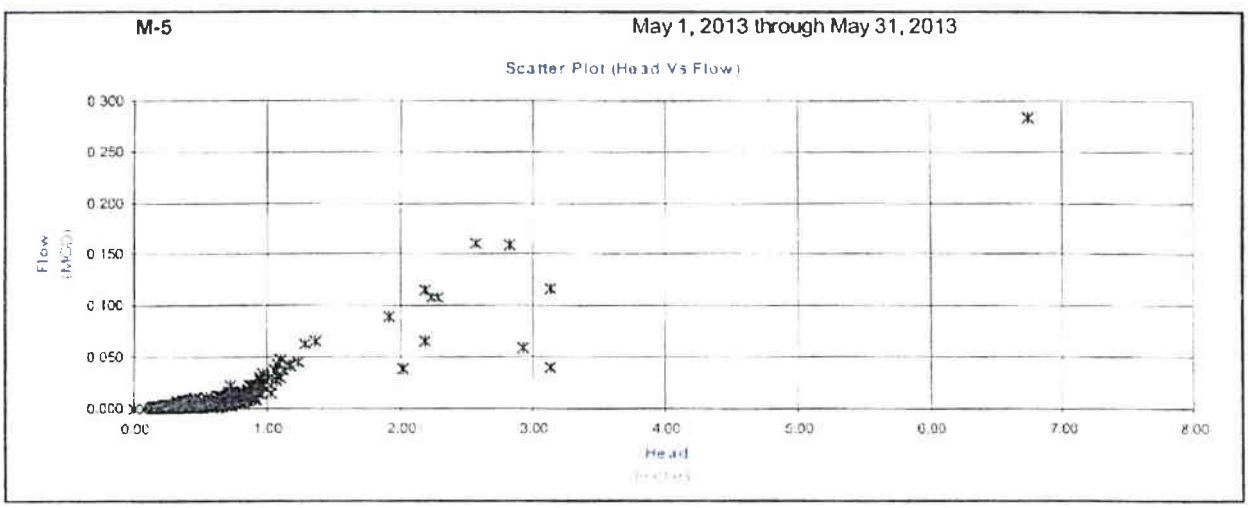
M-5 April 1, 2013 through April 30, 2013



Line Size: 15 " Manhole Depth: 0 "







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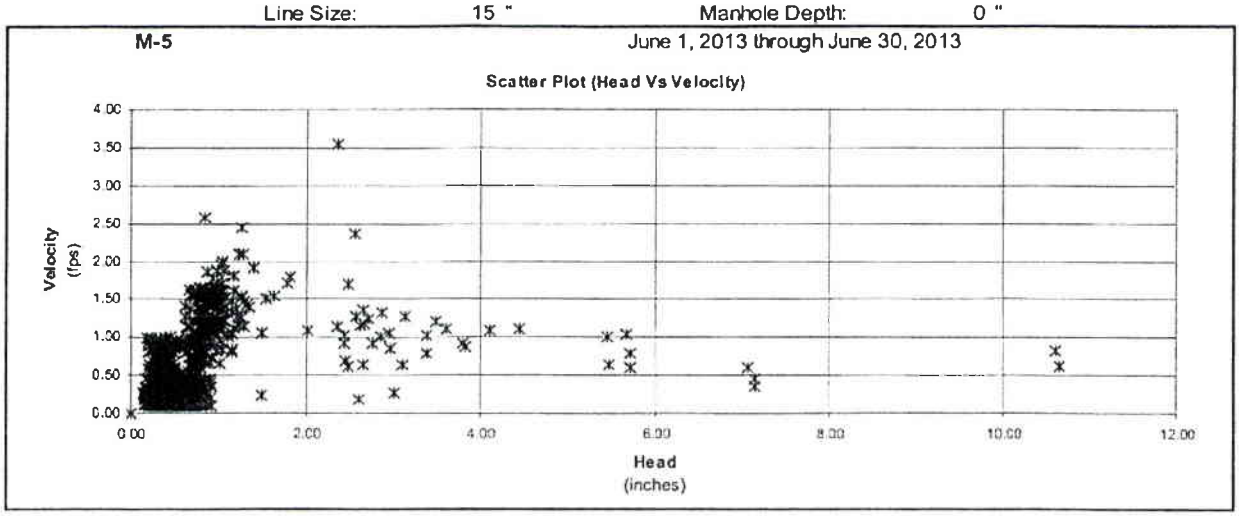

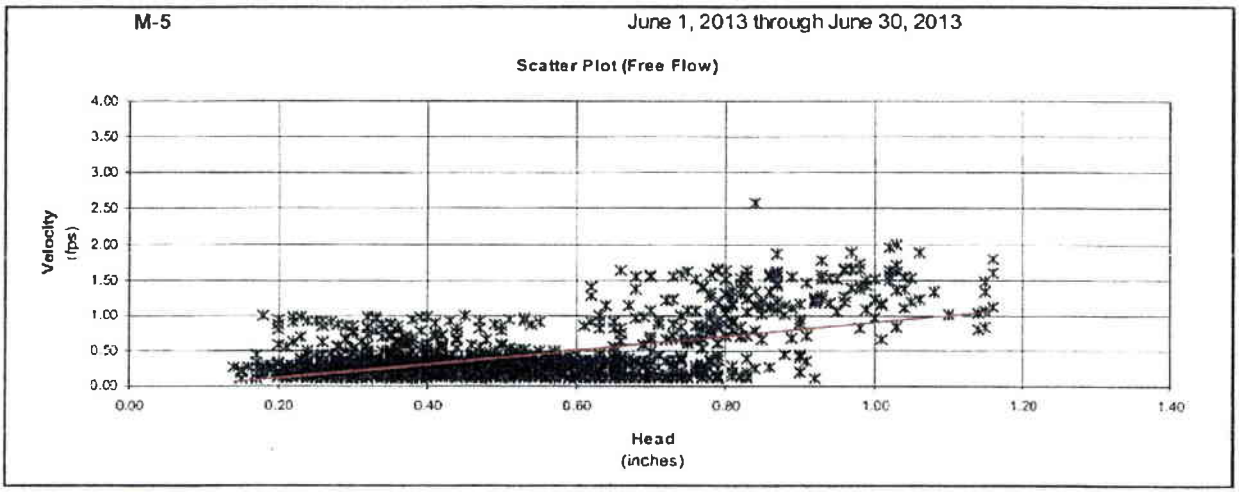

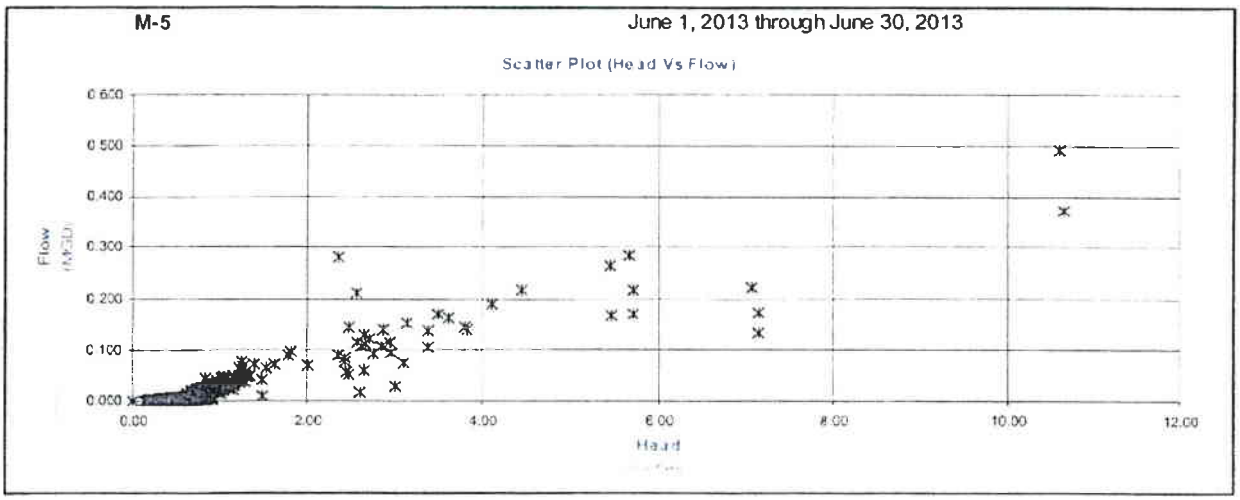

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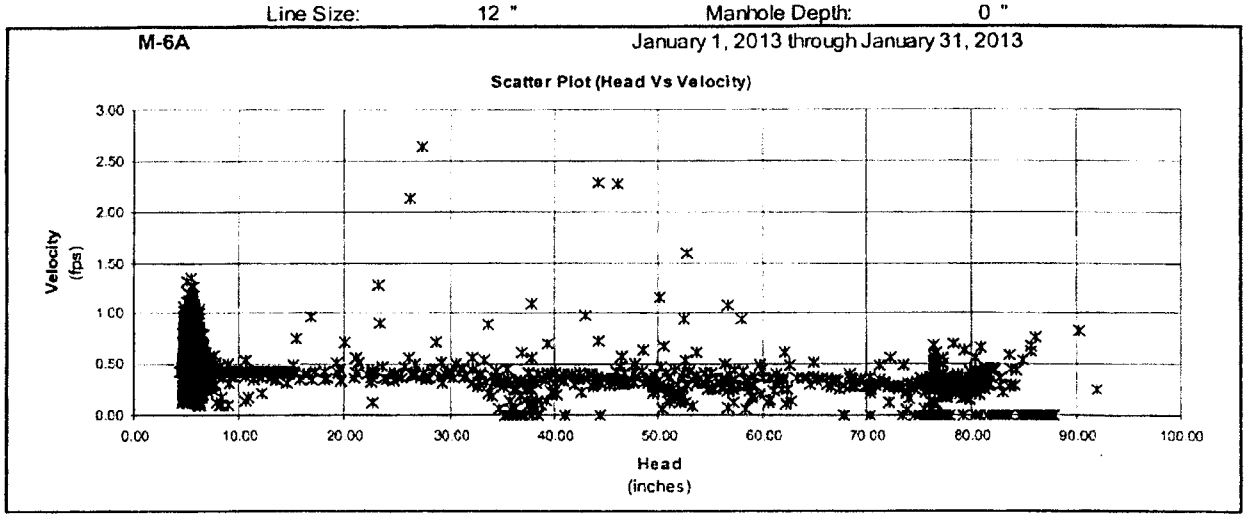
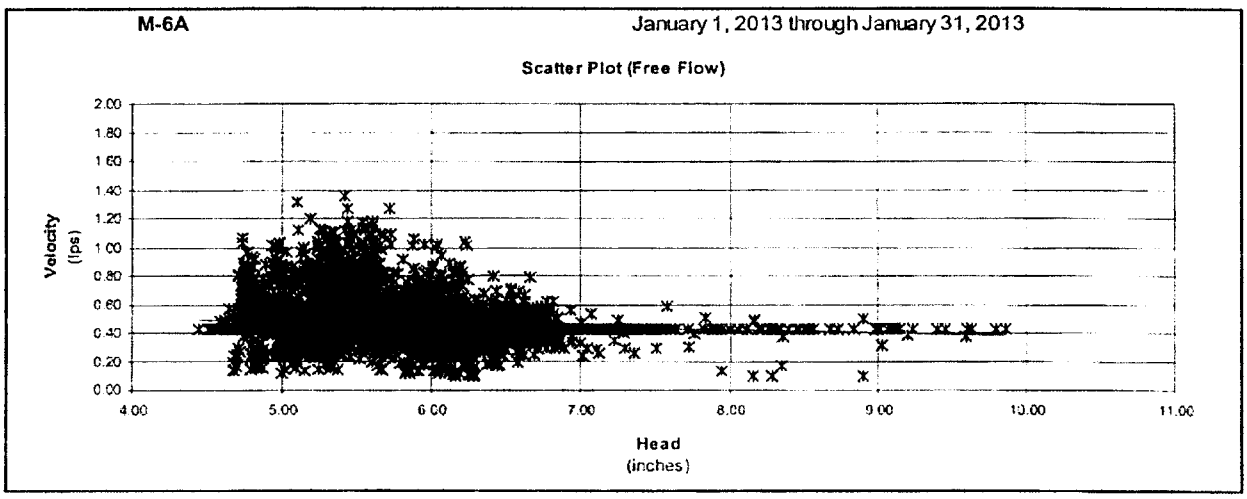
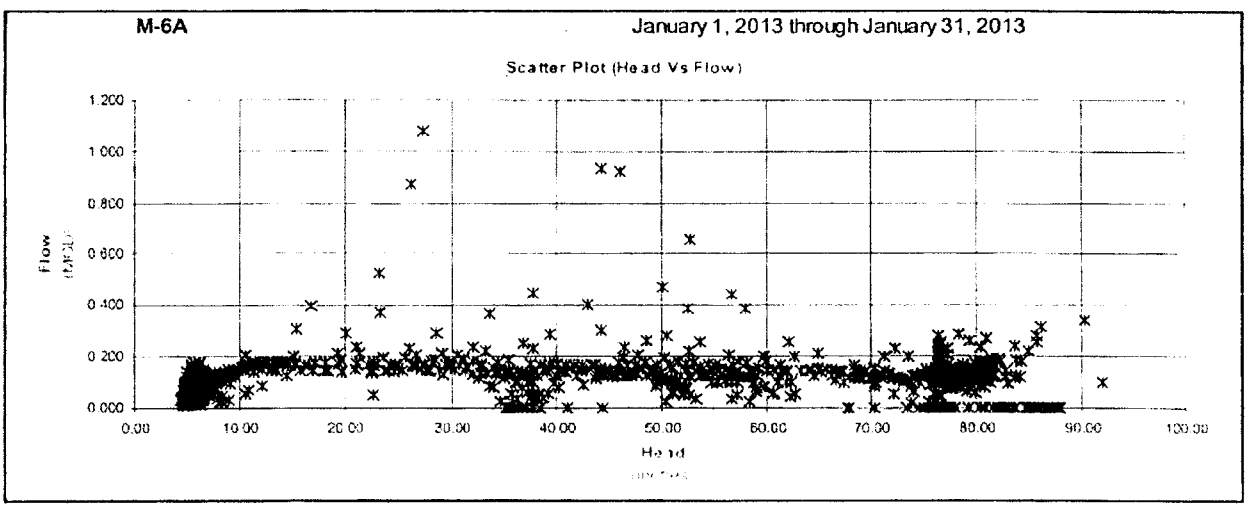
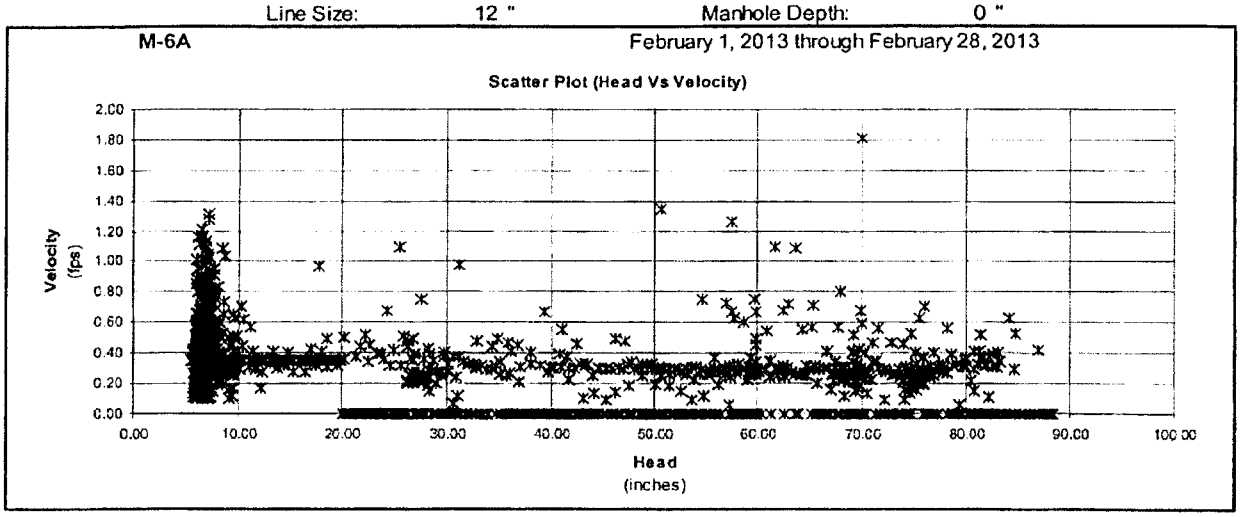
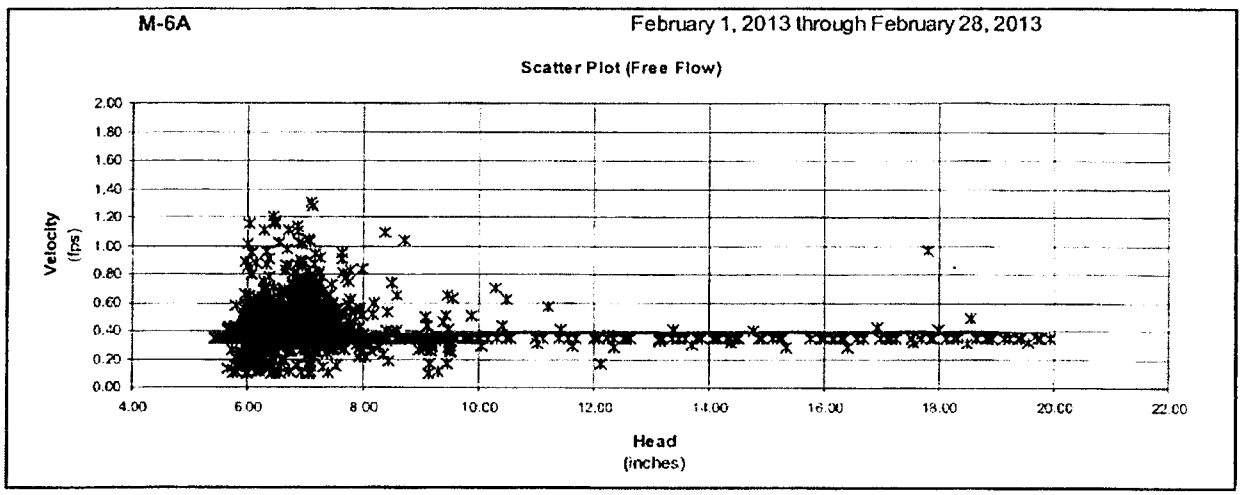


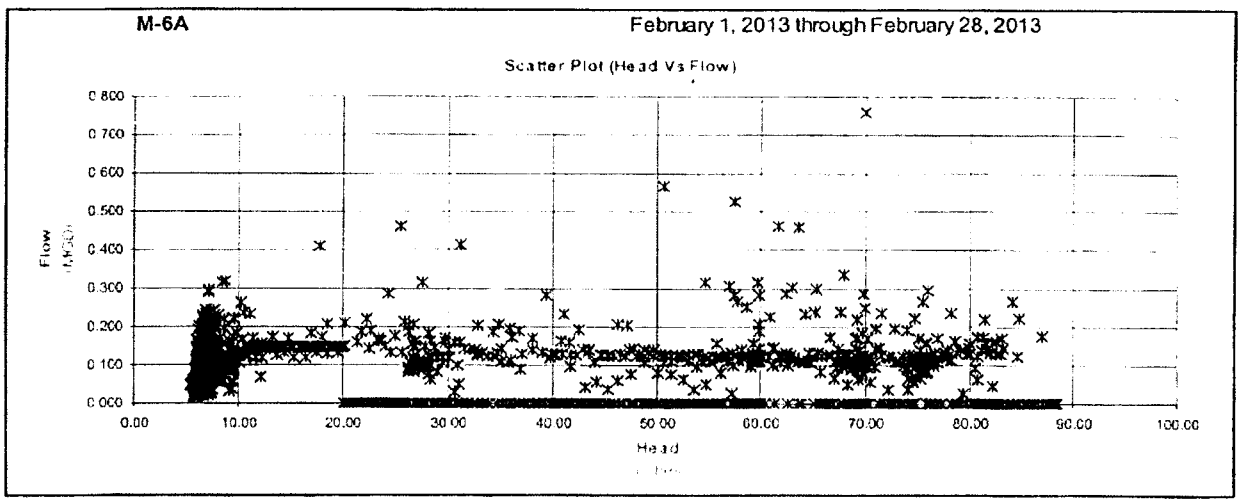




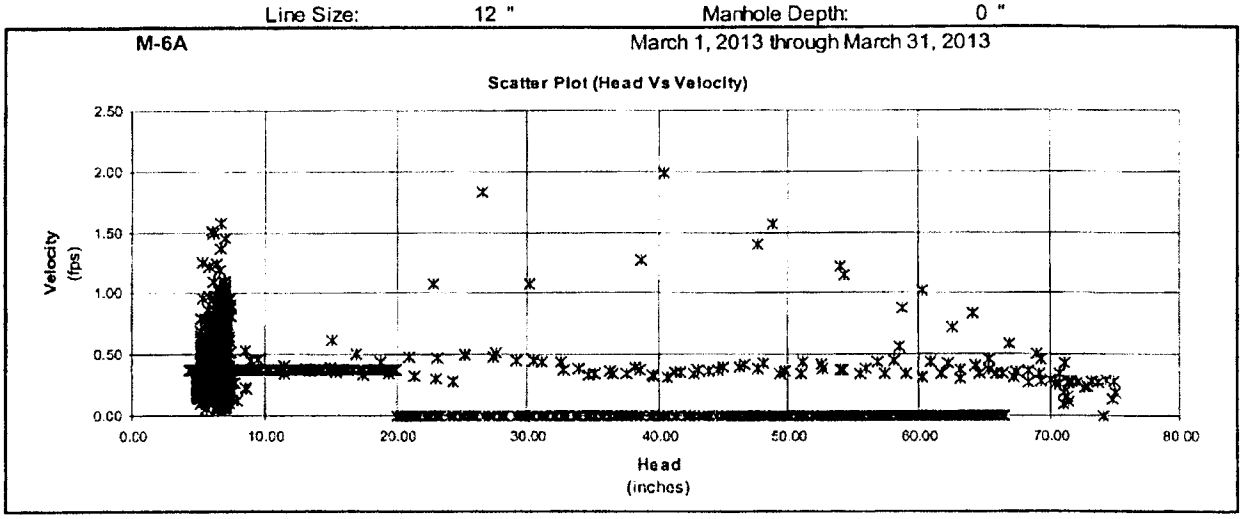
Line Size: 12 " Manhole Depth: 0 "

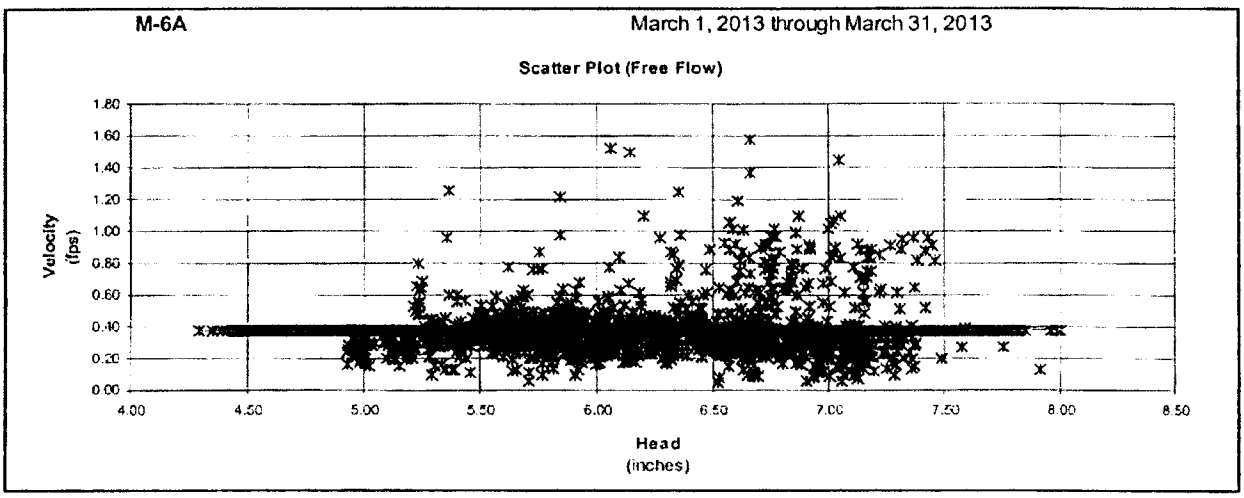


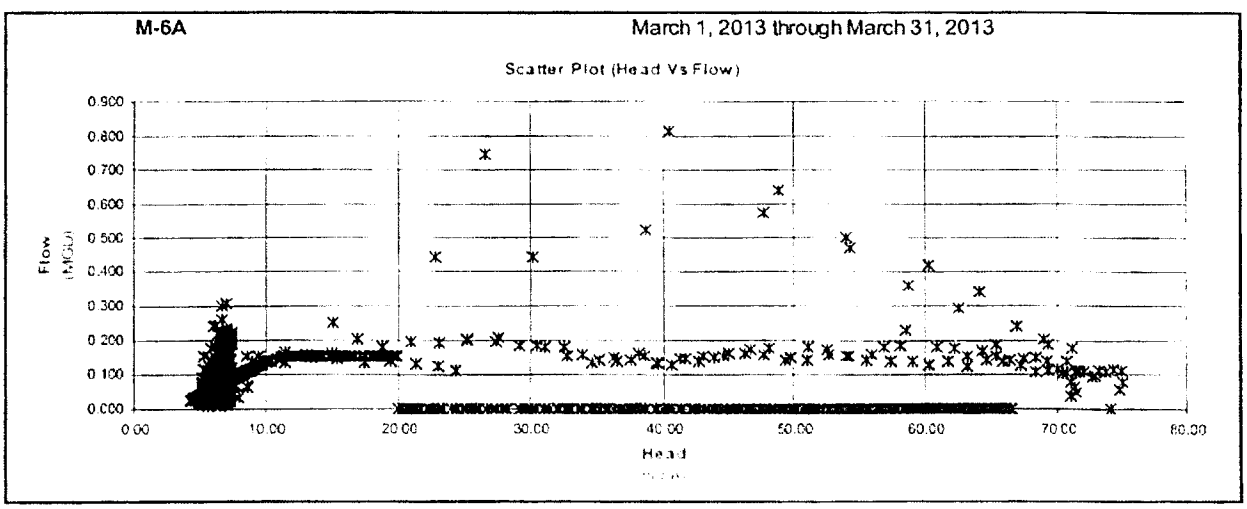




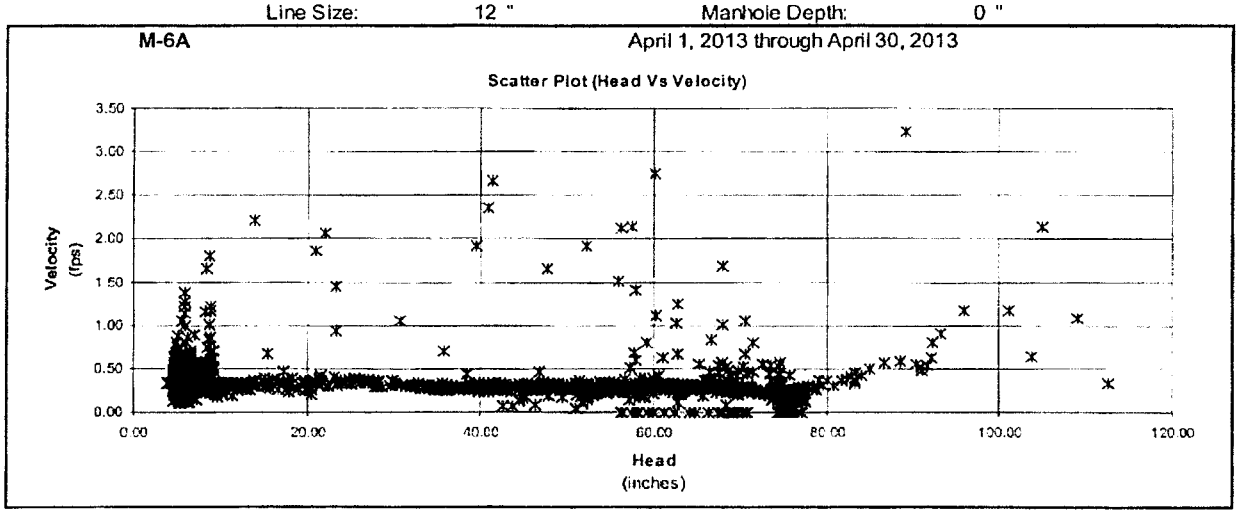
Line Size: 12 " Manhole Depth: 0 "

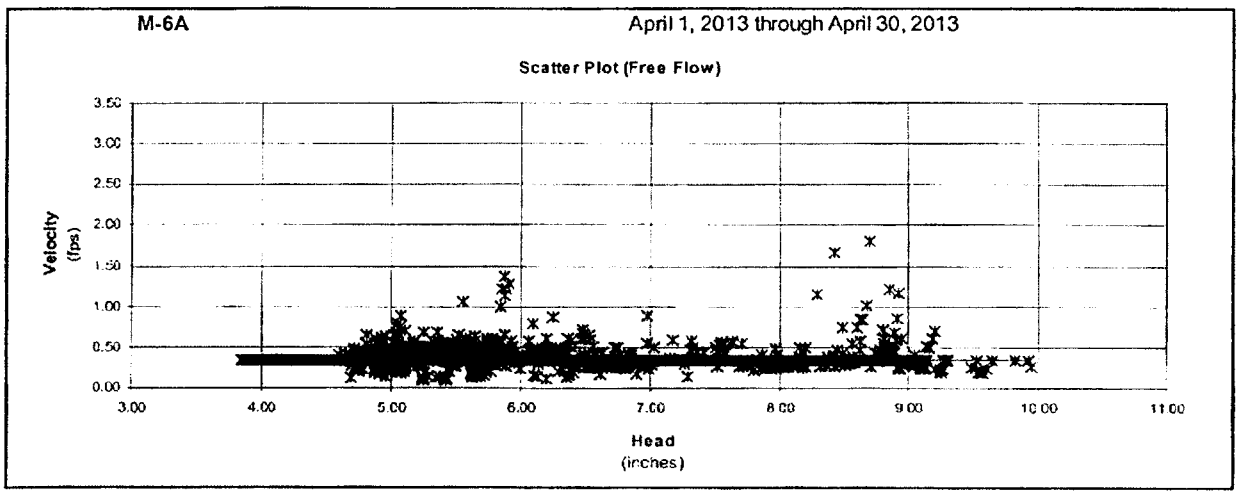


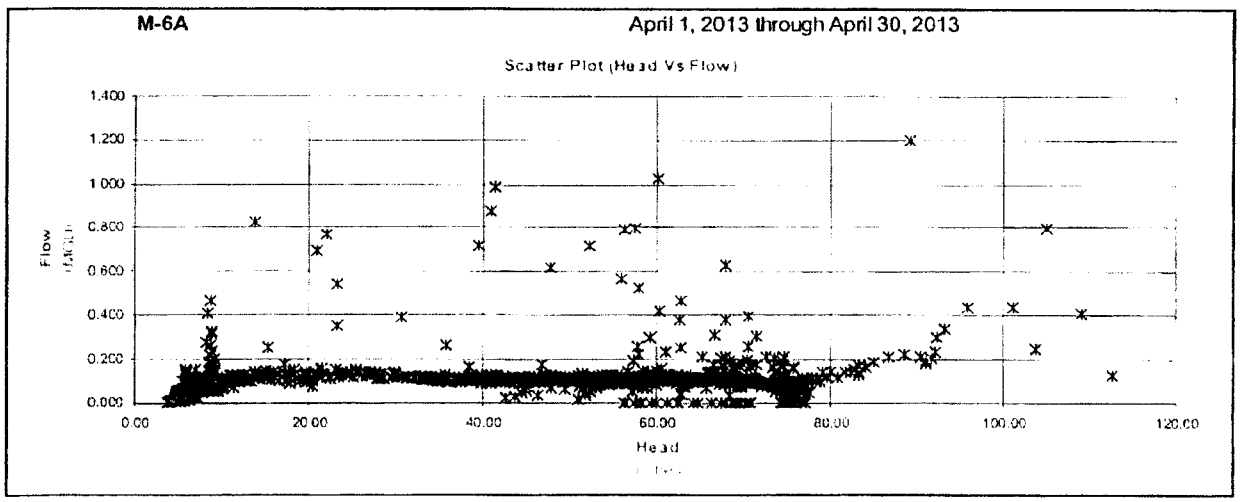




Line Size: 12 " Manhole Depth: 0 "







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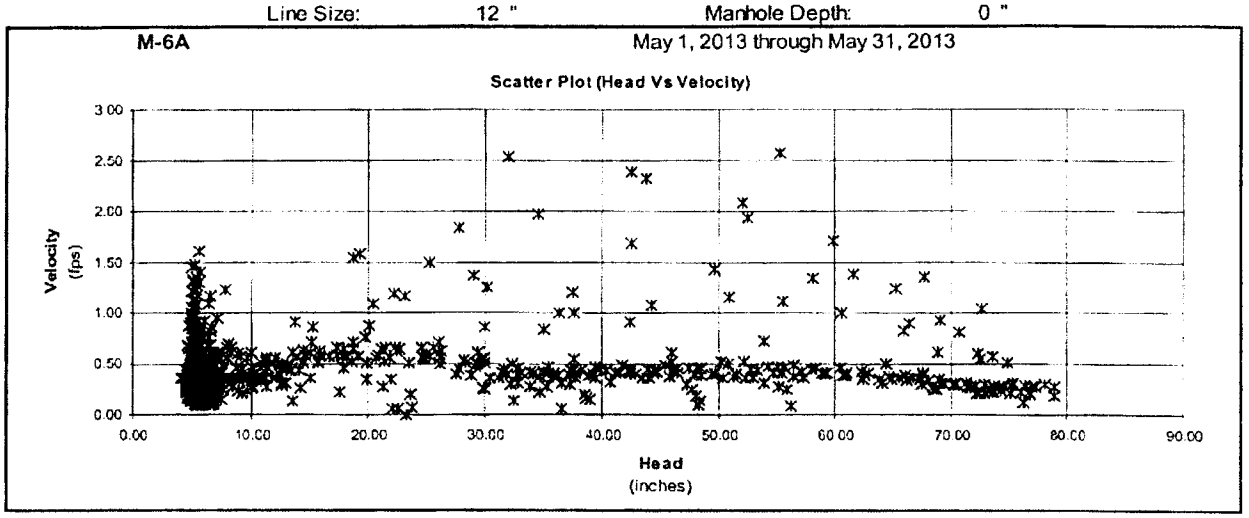

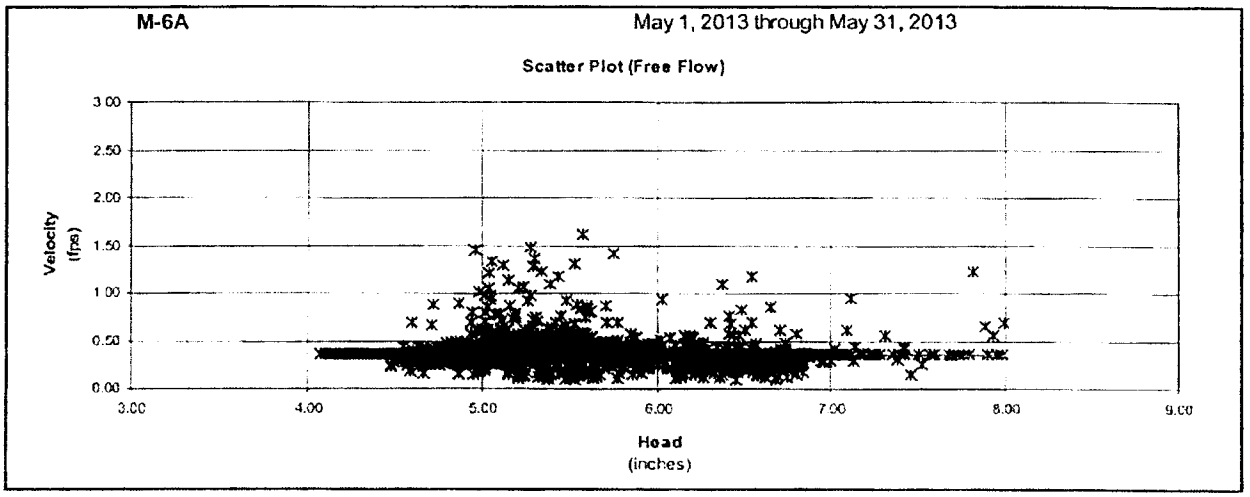

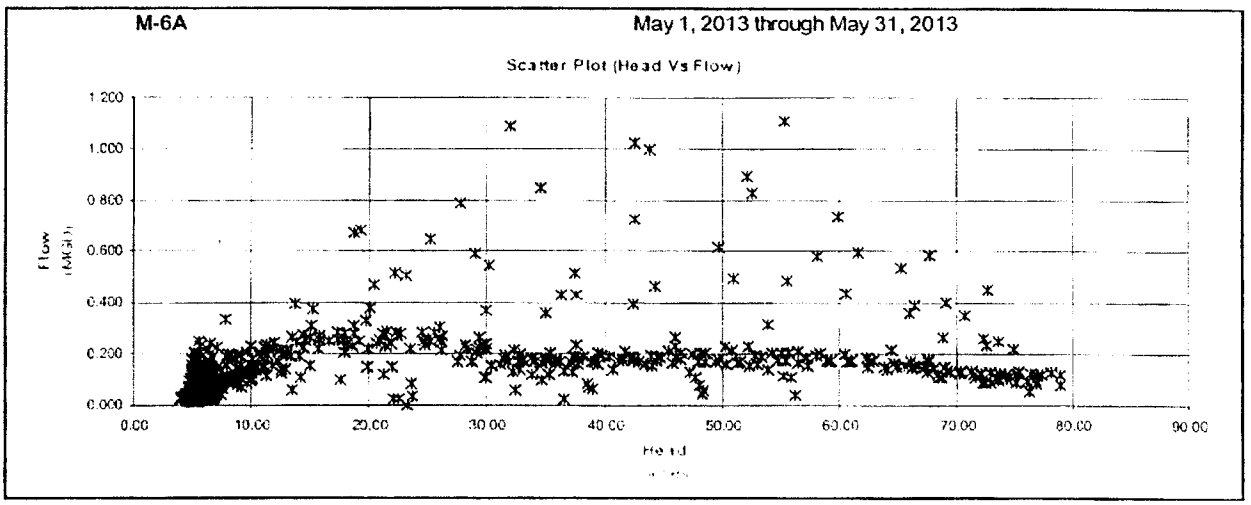

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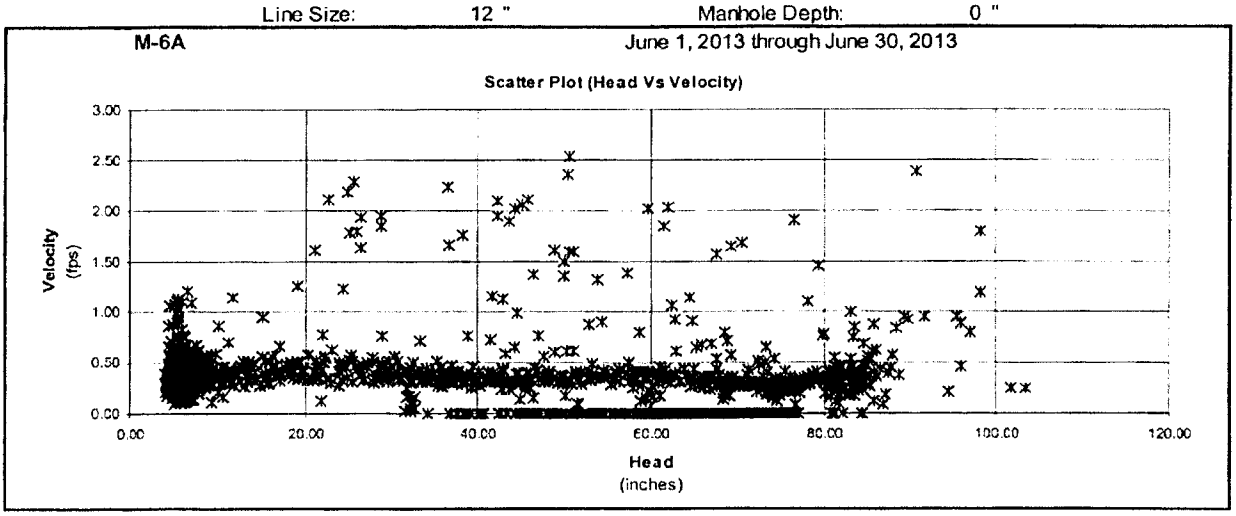
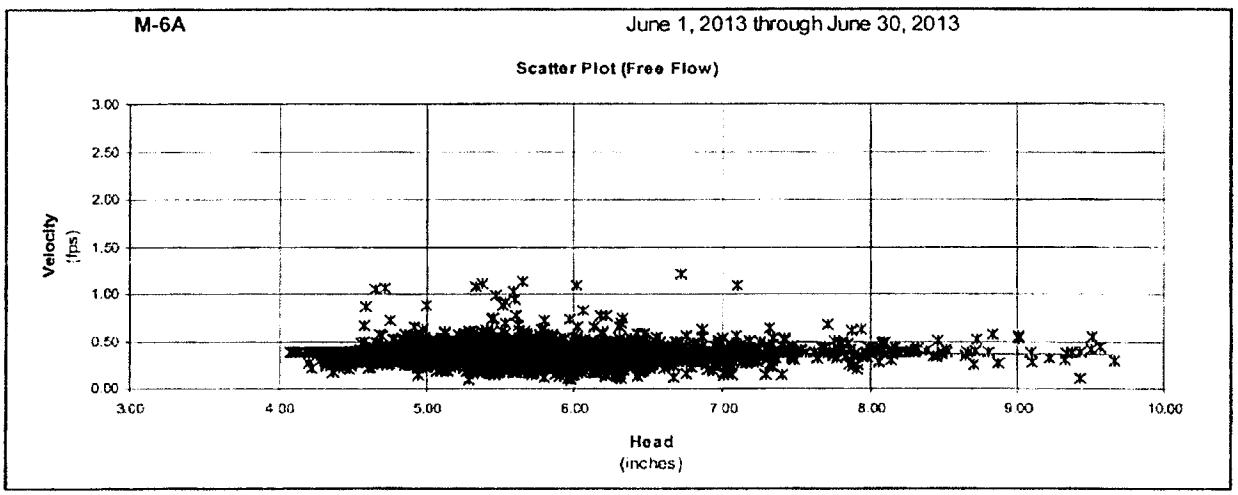
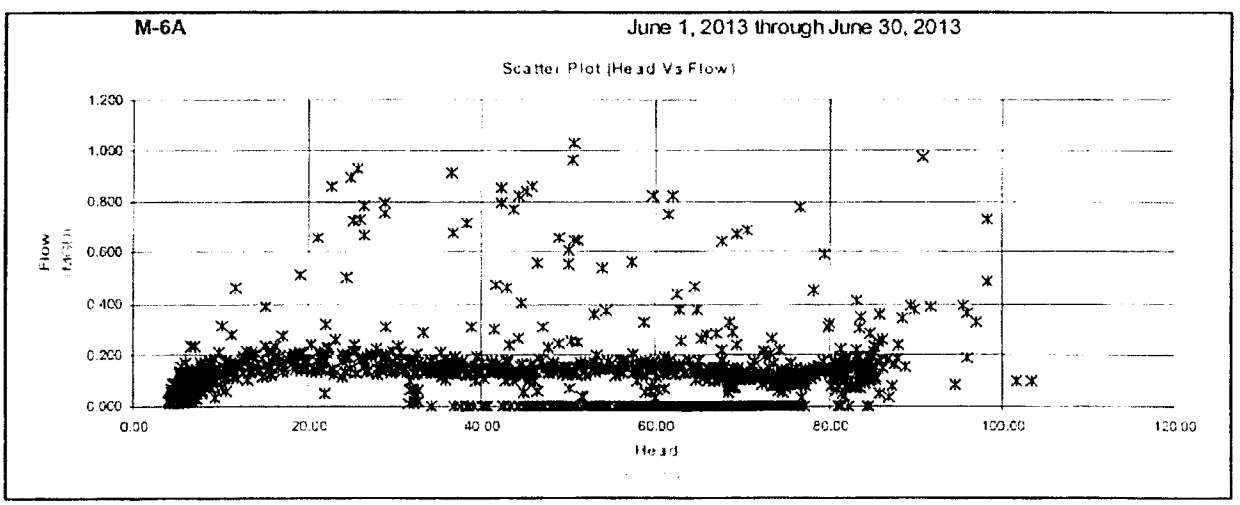
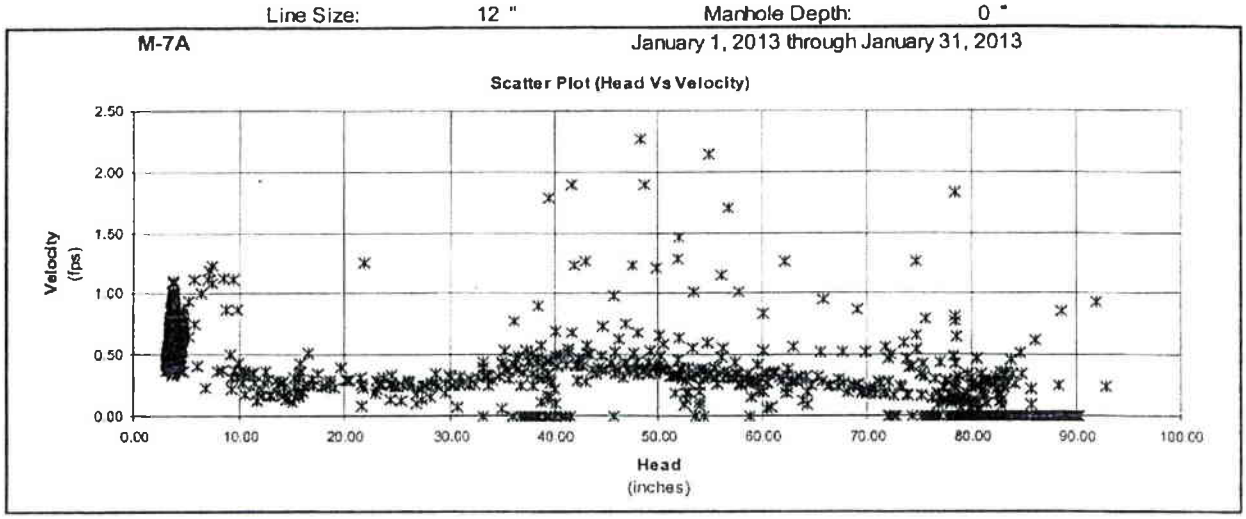




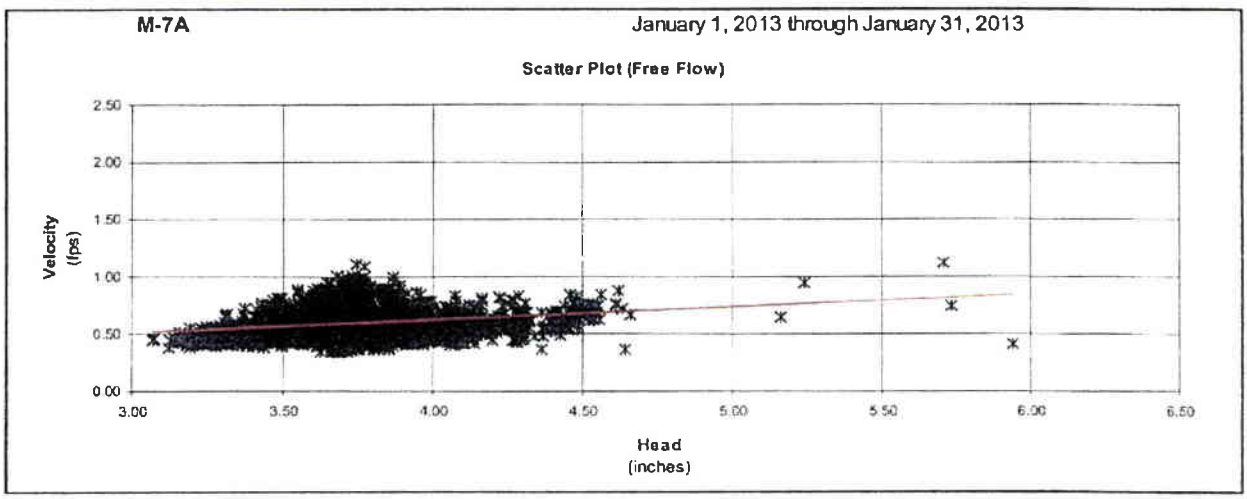


Line Size: 12 " Manhole Depth: 0 "

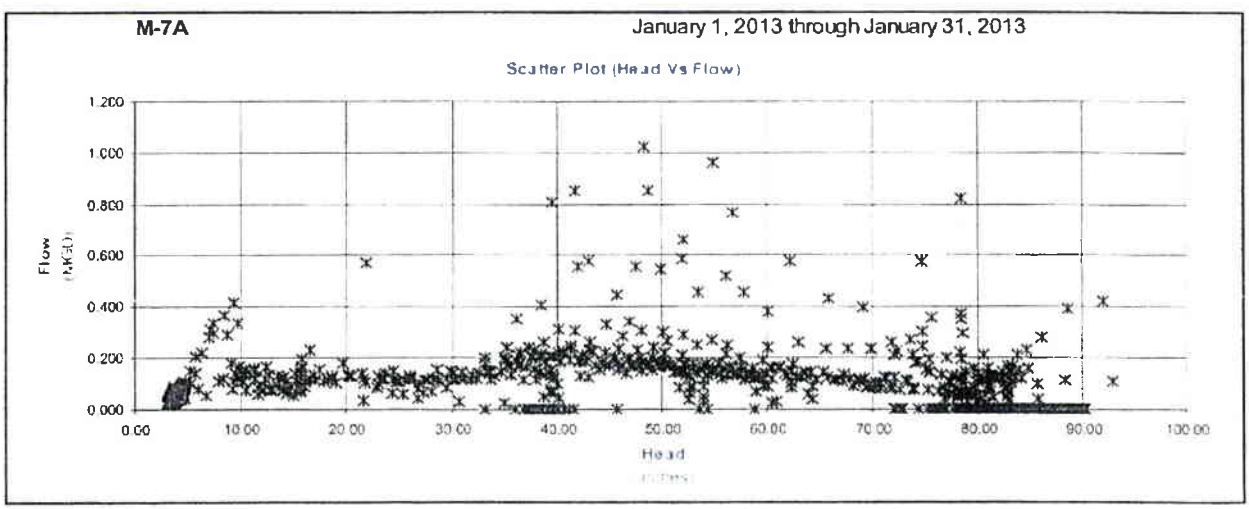
M-7A January 1, 2013 through January 31, 2013



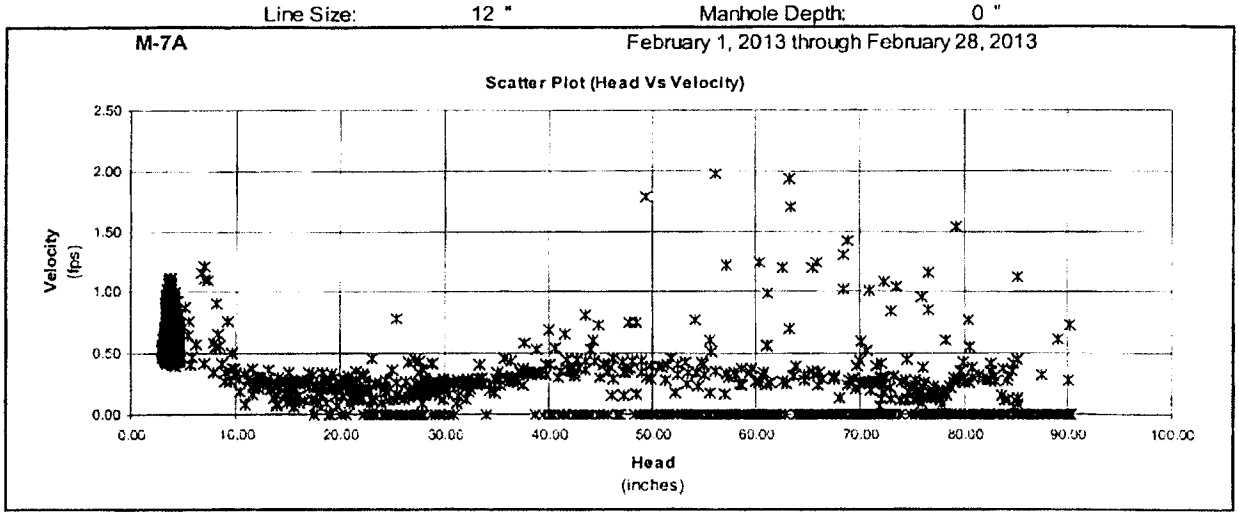
M-7A January 1, 2013 through January 31, 2013

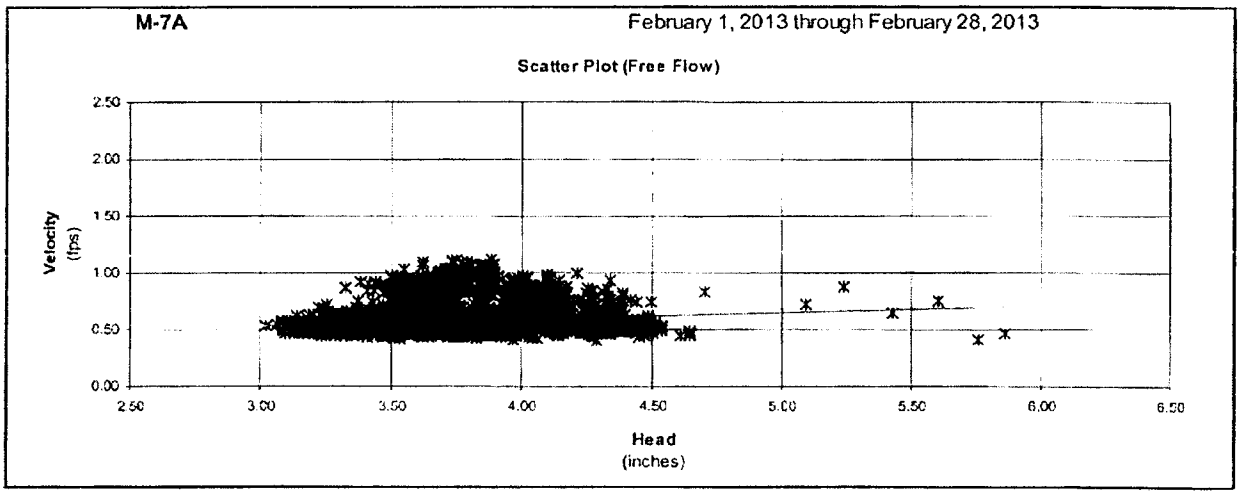


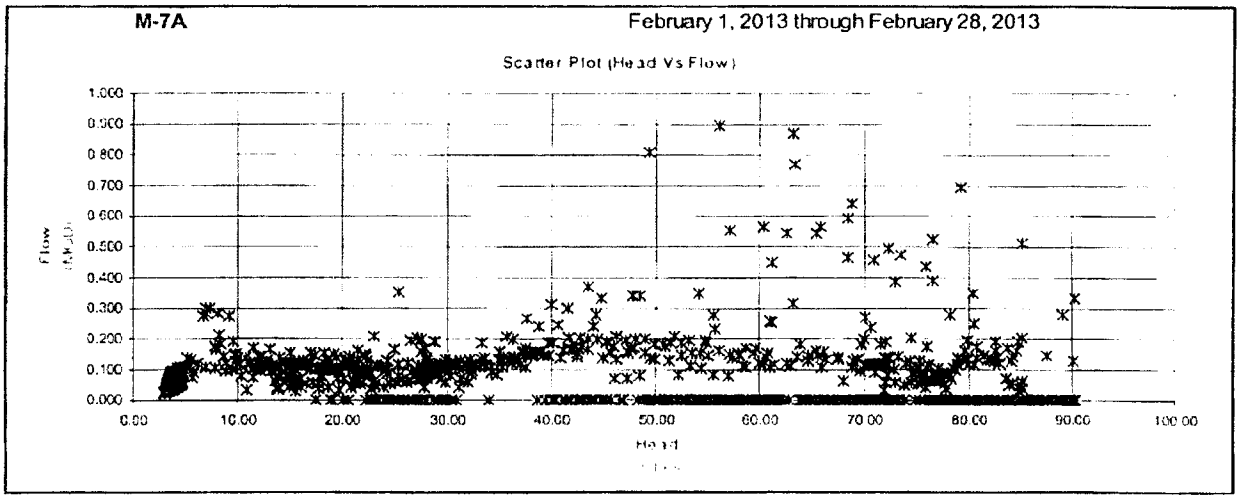
M-7A January 1, 2013 through January 31, 2013



Line Size: 12 " Manhole Depth: 0 "

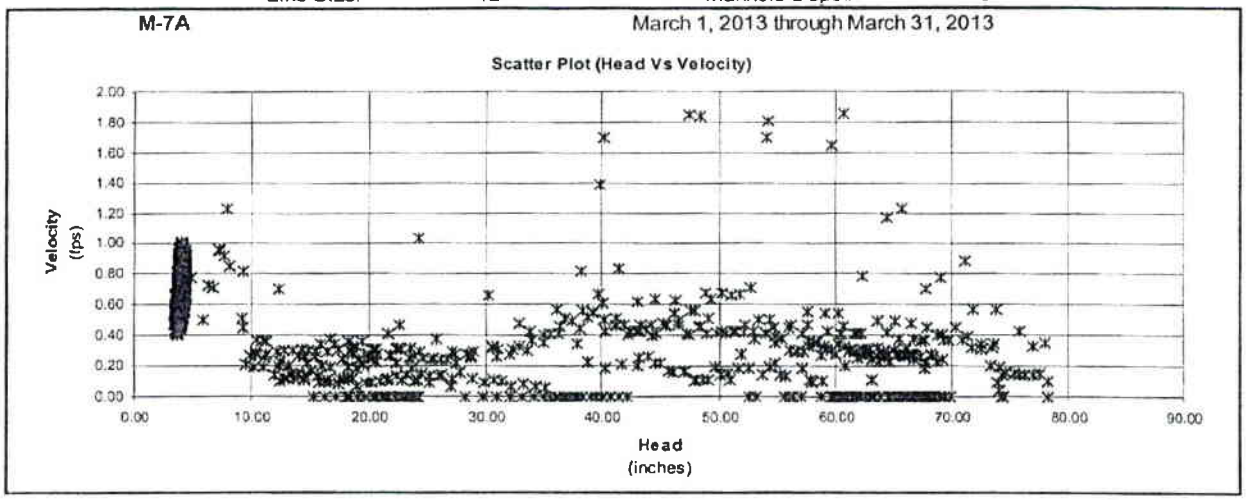




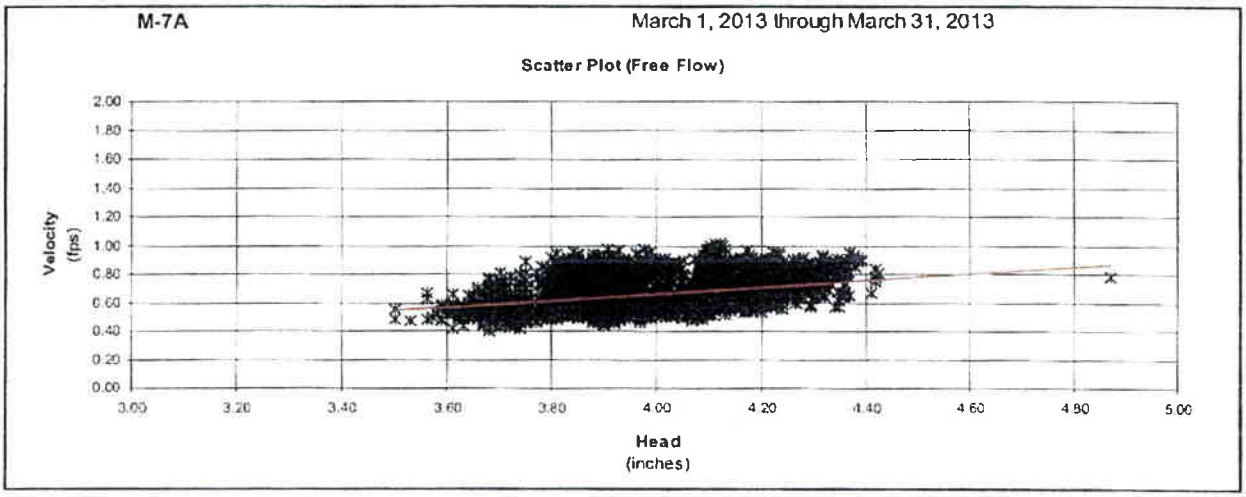


Line Size: 12 " Manhole Depth: 0 "

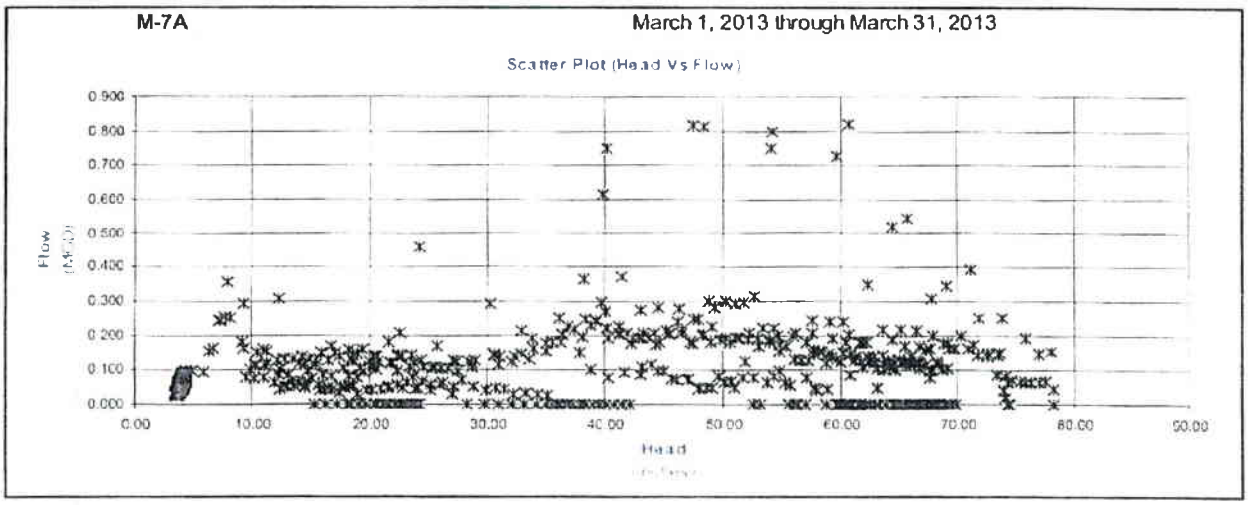
M-7A March 1, 2013 through March 31, 2013



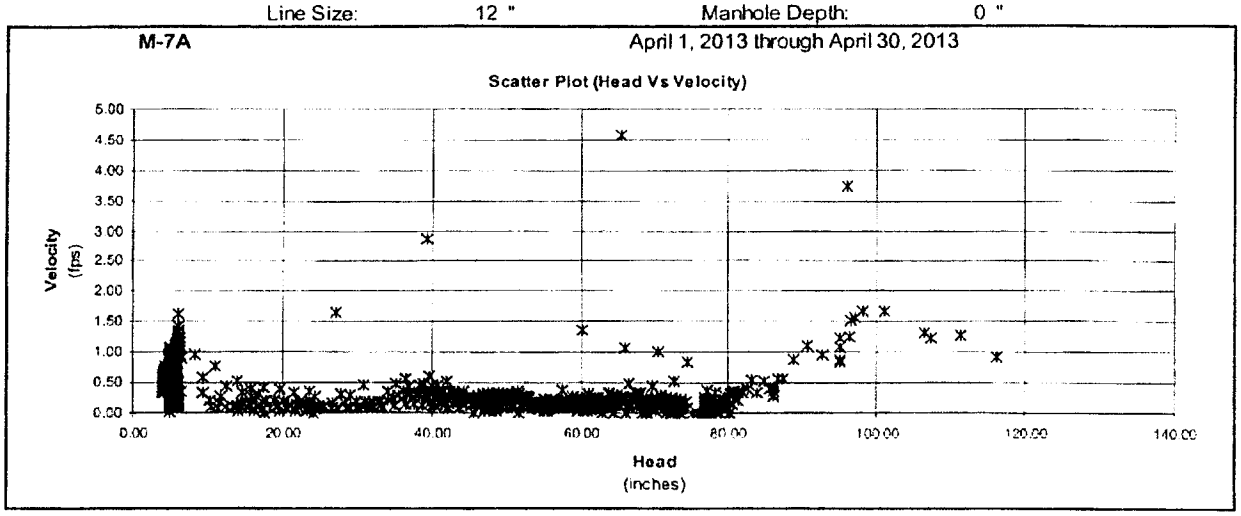
M-7A March 1, 2013 through March 31, 2013

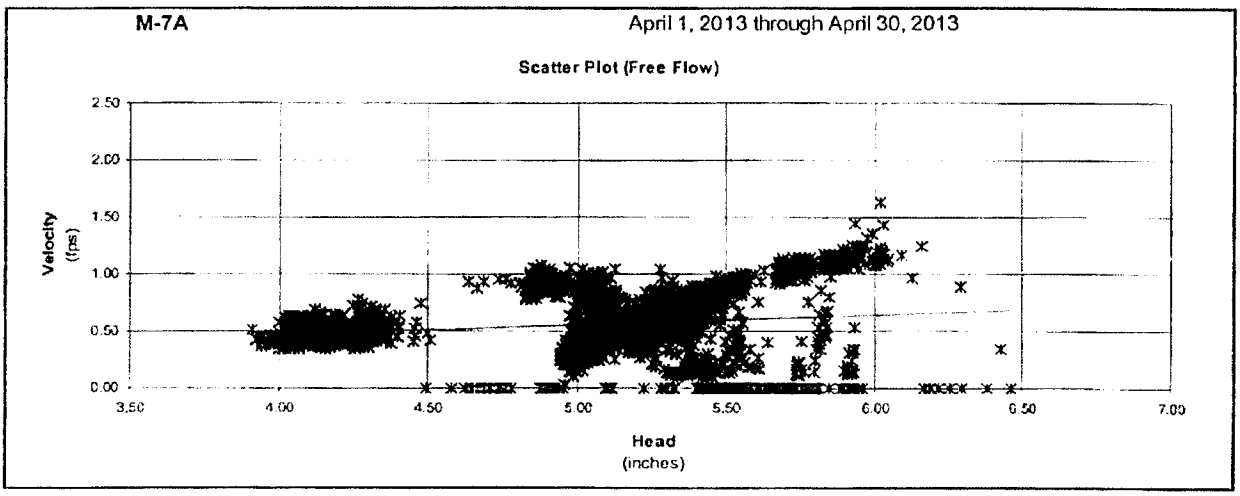


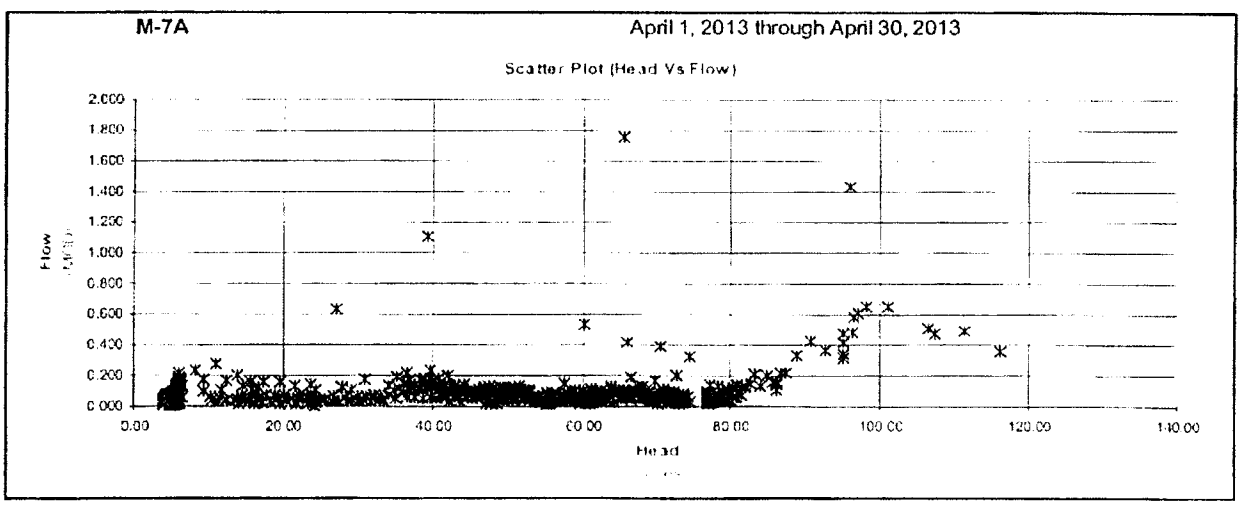
M-7A March 1, 2013 through March 31, 2013



Line Size: 12 " Manhole Depth: 0 "

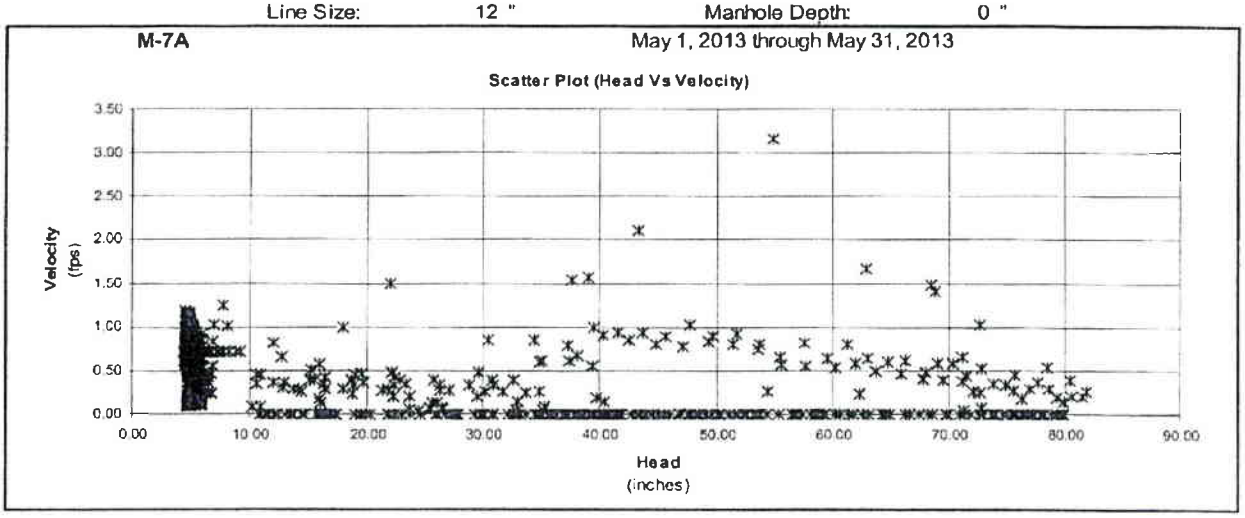




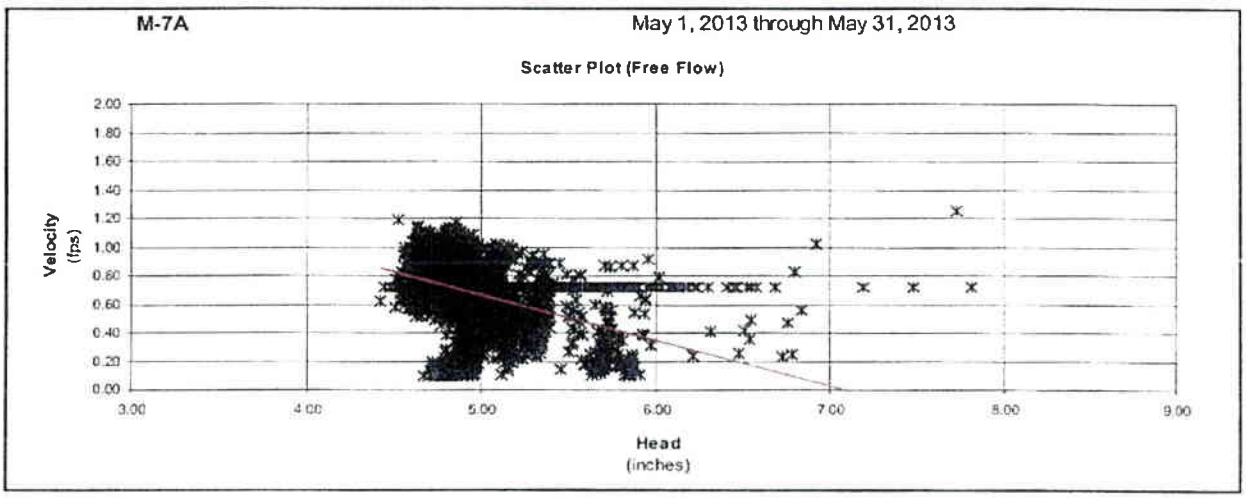


Line Size: 12 " Manhole Depth: 0 "

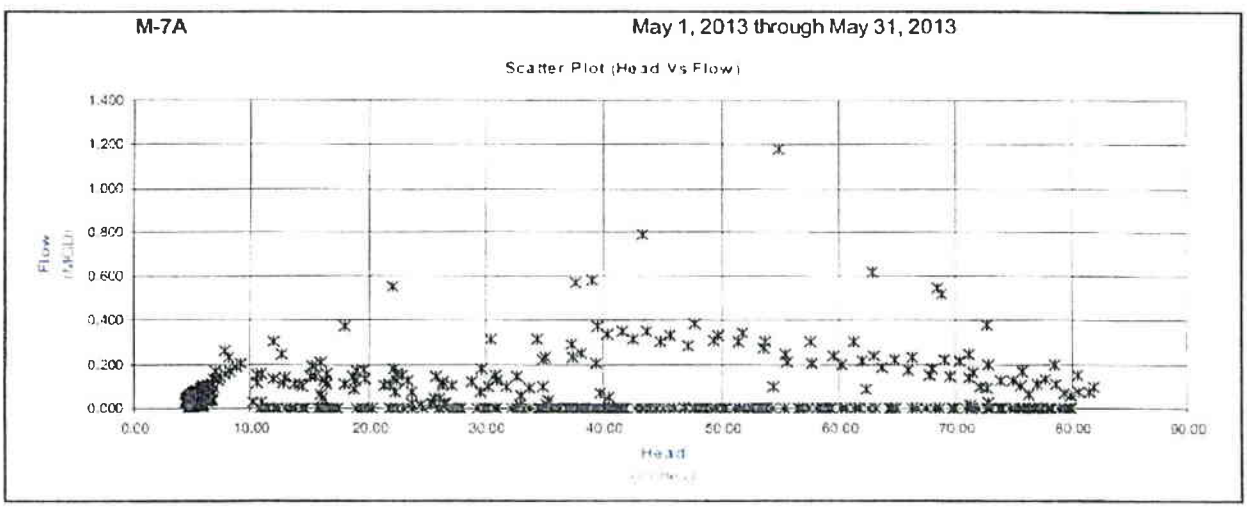
M-7A May 1, 2013 through May 31, 2013



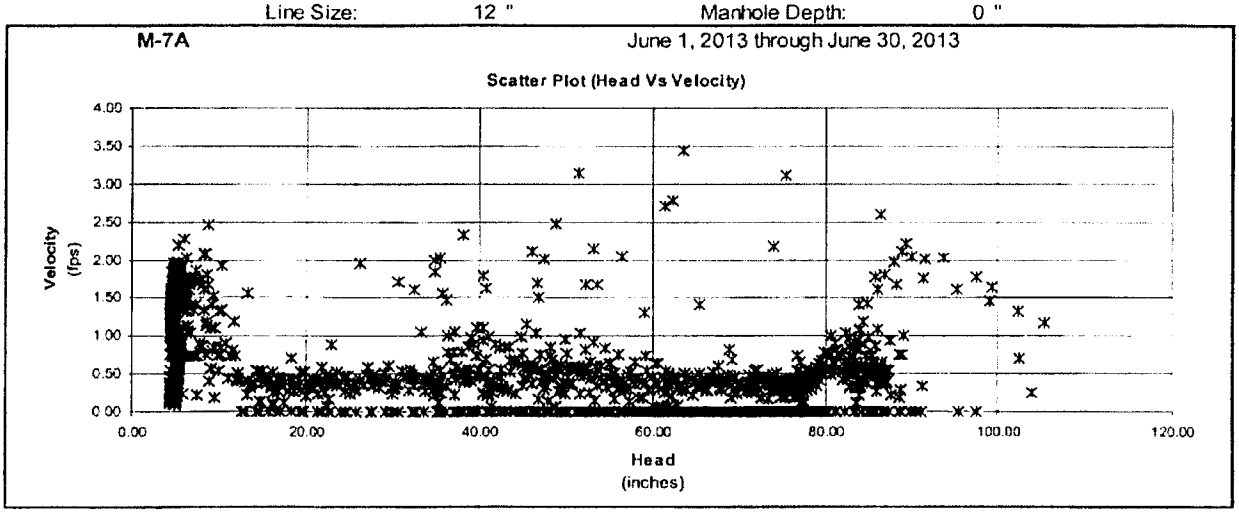
M-7A May 1, 2013 through May 31, 2013

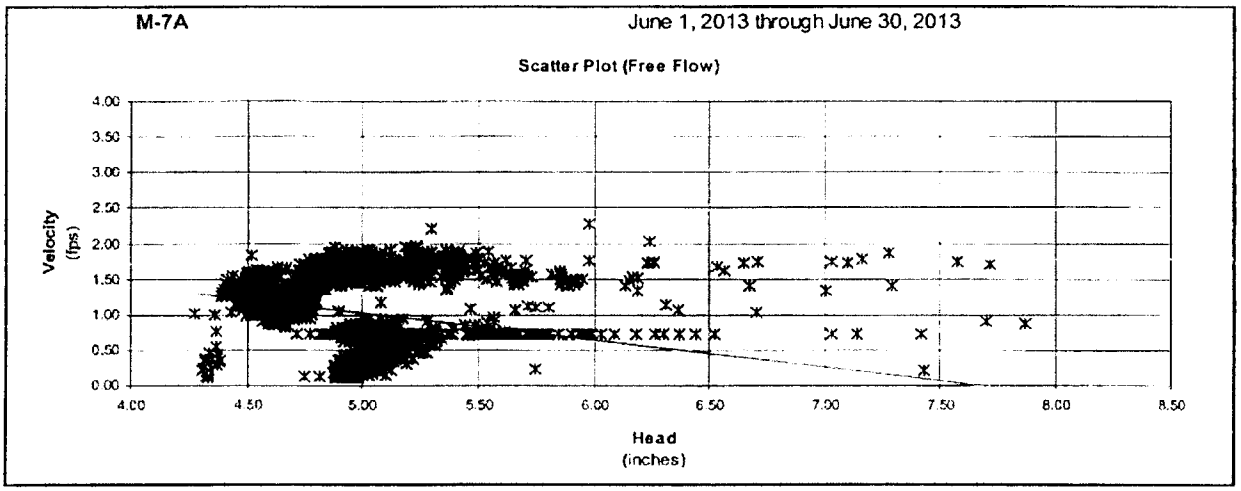


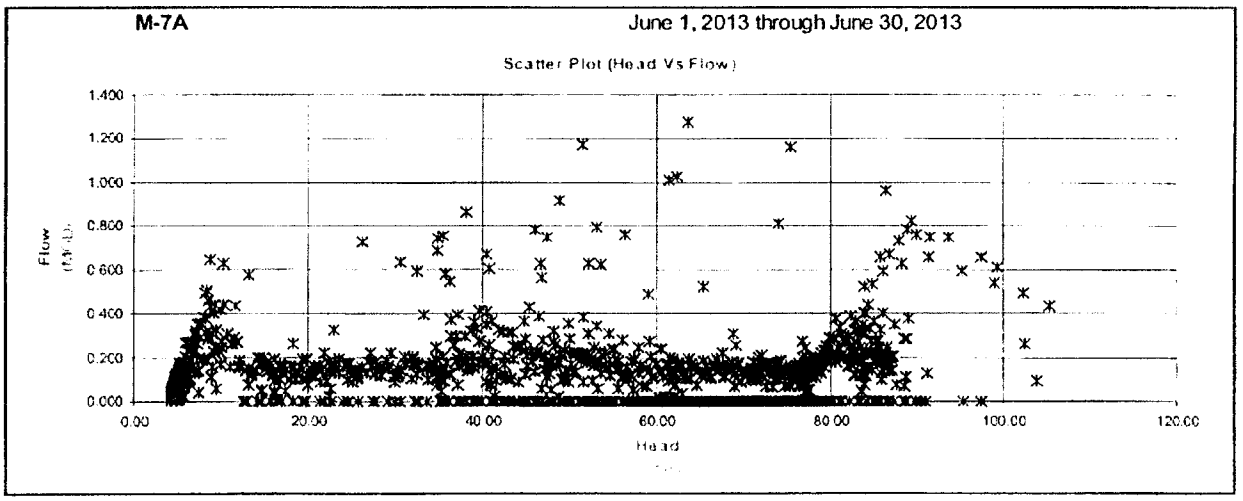
M-7A May 1, 2013 through May 31, 2013



Line Size: 12 " Manhole Depth: 0 "

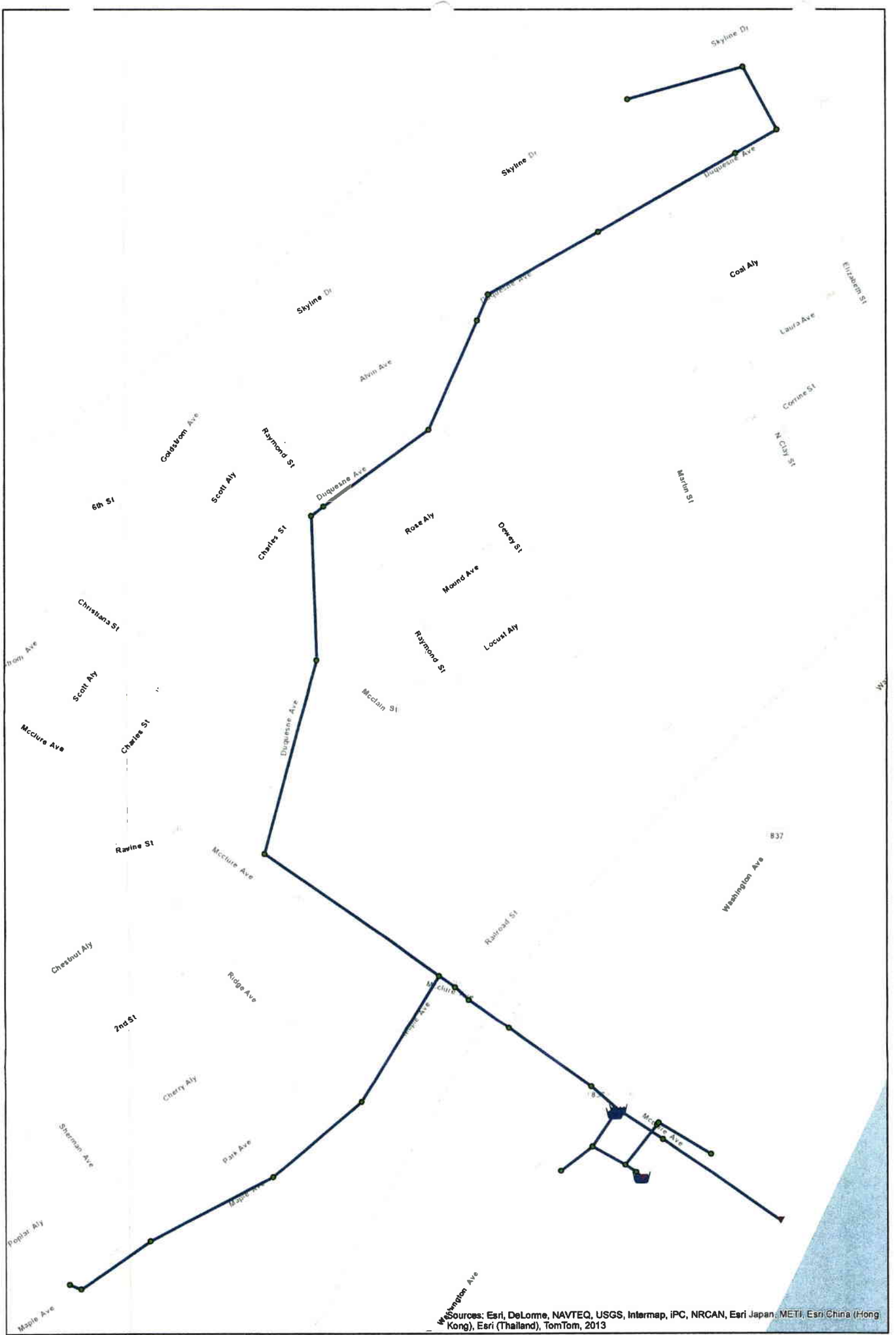






APPENDIX E

DRAVOSBURG MODEL SYSTEM MAP



220-53	0 140 280 Feet	**CITY OF DRAVOSBURG**	KLH ENGINEERS, INC
Exhibit	Author: Ross Volkwein Date: 7/29/2014 NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet Projection: Lambert Conformal Conic	**ALLEGHENY COUNTY, PENNSYLVANIA** **MODEL SYSTEM MAP**	5173 Campbells Run Road Pittsburgh, PA 15205 Phone: 412-494-0010 Fax: 412-494-0408 www.klhengineers.com

APPENDIX F

DRAVOSBURG MODEL PHYSICAL CHARACTERISTICS (LIST)

MODEL HYDRAULIC CHARACTERISTICS

Storage Nodes

Storage ID	Invert Elevation (ft)	Maximum Depth (ft)
DV_VAULT	726.68	14.25
REGULATOR_PIT	725.643	14.82
WETWELL	720.735	20.42

Outfall Nodes

Outfall ID	TYPE	Invert Elevation (ft)
DV200	0: Free	723.652
DUMMY_OUTFALL	0: Free	715

Conduits

Conduit ID	LENGTH (ft)	Manning's N	Upstream Offset (ft)	Downstream Offset (ft)	Average Loss Coeff.	Flap Gate Installed	Shape Type	Diameter (ft)	Width
DV_72-DV_73	300.844	0.013	0	0	0.05	No	0: Circular	6	
DV102-DV101	28.827	0.013	0	0.14	0.05	No	0: Circular	1	
DV_DUMMY_OUTFALL	28.556	0.013	0	0	0.05	No	0: Circular	1	
DV103-DV102	77.943	0.013	0.04	0.17	0.05	No	0: Circular	1.5	
DV_105-DV_106	127.445	0.013	0	0.26	0.05	No	0: Circular	1	
DV_CHAM-DV103	64.148	0.013	0	0.64	0.05	No	0: Circular	1	
DV_DUMMY-DV103	64.284	0.013	0	0	0.05	No	0: Circular	0.667	
DV105-DV_CHAM	75.444	0.013	0	0.47	0.05	No	0: Circular	8	
DV_174-DV_175	240.576	0.013	0	0.06	0.05	No	0: Circular	6	
DV173-DV174	103.178	0.013	0	0.57	0.05	No	0: Circular	6	
DV_175-DV_176	88.478	0.013	0	0.22	0.05	No	0: Circular	6	
DV434-DV171	444.357	0.013	0	0.32	0.05	No	2: Rect-Closed	4	3
DV_434-DV_435	407.185	0.013	0	0	0.05	No	0: Circular	2	
DV416-DV414	300.414	0.013	0.41	0.62	0.05	No	0: Circular	2	
DV_409-DV_410	81.787	0.013	0	0	0.05	No	0: Circular	2	
DV408-DV409	271.638	0.013	0.2	0.66	0.05	No	0: Circular	2	
DV_407-DV_408	248.824	0.013	0	0	0.05	No	0: Circular	1.5	
DV406-DV407	57.691	0.013	0	0.19	0.05	No	0: Circular	1.5	
DV_405-DV_406	265.178	0.013	0	1.02	0.05	No	0: Circular	1.5	
DV403-DV405	330.934	0.013	0	0.14	0.05	No	0: Circular	1.5	
DV_402-DV_403	107.115	0.013	0	0.23	0.05	No	0: Circular	1.5	
DV351-DV402	148.37	0.013	0	0.7	0.05	No	0: Circular	0.667	
DV_350-DV_351	240.748	0.013	0	1.24	0.05	No	0: Circular	0.667	
DV144-DV107	244.914	0.013	0	0.24	0.05	No	0: Circular	2	
DV_108-DV_144	290.159	0.013	0	0.5	0.05	No	0: Circular	2	
DV156-DV108	175.84	0.013	0	0.16	0.05	No	0: Circular	1.5	
DV_157-DV_156	29.887	0.013	0	0	0.05	No	0: Circular	1.5	0
DV_CHAM-DV176	311.652	0.013	1.74	0.09	0.05	No	0: Circular	6	
DV_176-DV_177	40.108	0.013	0	1.33	0.05	No	2: Rect-Closed	4	3
DV107-DV_DUMMY	319.255	0.013	0	0	0.05	No	0: Circular	2	
DV_DUMMY-DV_DUMMY	117.533	0.013			0.05	No	0: Circular	1	
DV230-DV300	5.482	0.013			0.05	No	0: Circular	1	
WETWELL_OUTFALL-DUMMY_OUTFALL	5.148	0.013			0	No	0: Circular	1	

Manholes

Junction ID	Invert Elevation (ft)	Max Depth (ft)
DV352	980.275	6.55
DV351	**977.567**	**10.35**
DV201	721.89	18.98
DV103	**721.677**	**18.52**
DV157	830.341	11.77
DV156	**829.875**	**11.31**
DV108	823.894	10.22
DV144	**797.003**	**8.84**
DV107	774.089	6.68
DV402	**952.878**	**6.12**
DV403	947.717	7.92
DV405	**924.804**	**14.84**
DV406	915.654	9.22
DV407	**914.833**	**8.54**
DV408	910.669	9.37
DV409	**899.298**	**8.72**
DV416	894.838	11.32
DV414	**854.103**	**11.03**
DV434	788.08	30.96
DV171	**742.859**	**12.03**
DV173	733.376	17.72
DV174	**732.656**	**13.3**
DV105	728.304	11.14
DV102	**721.402**	**21.12**
DV101	720.905	21.53
DV176	**726.774**	**15.06**
DV_DUMMY	746.176	4
DV300	**722.133**	**20.01**
DV230	722.17	19.97
DV229	**722.402**	**17.05**

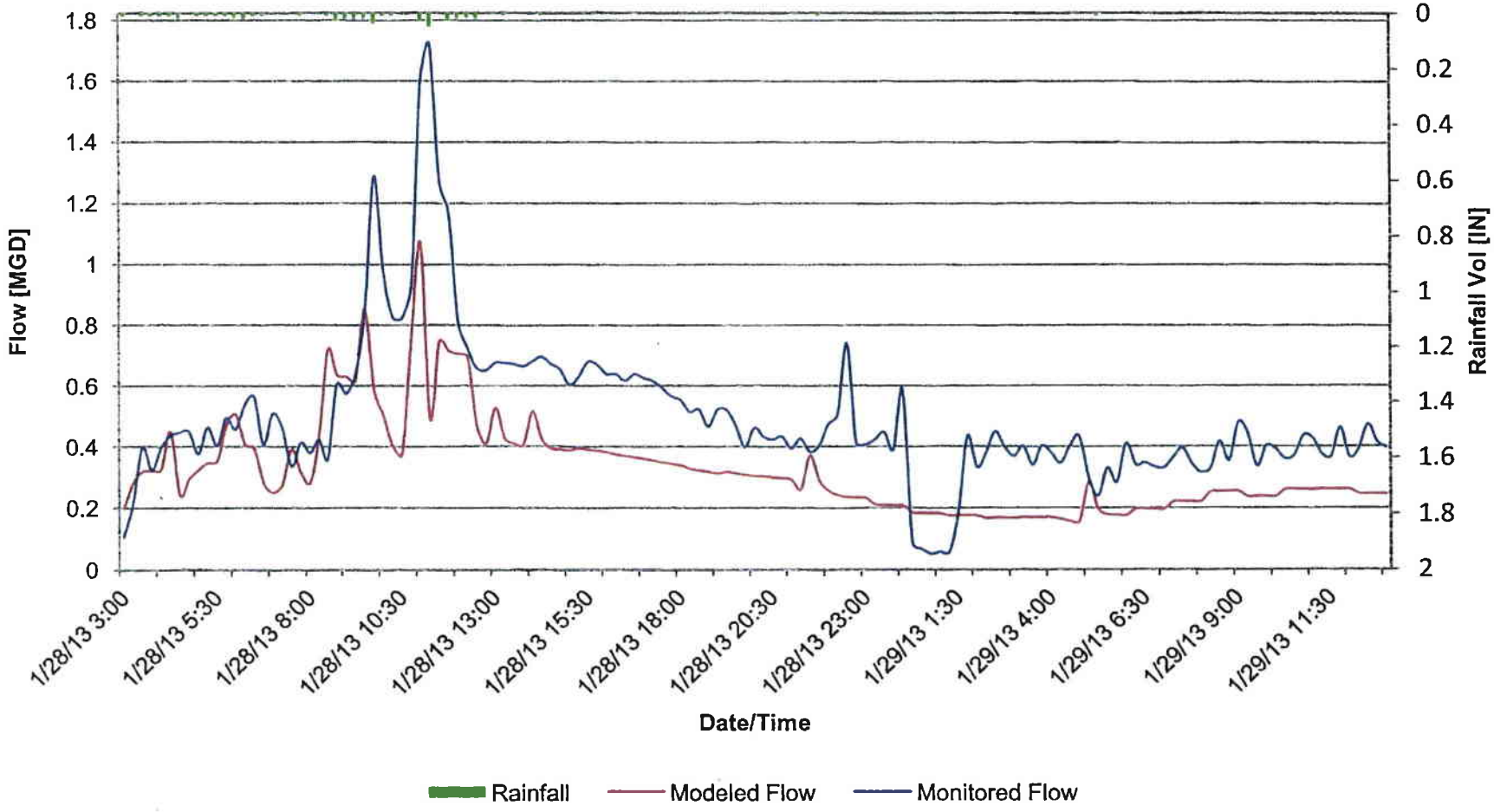
APPENDIX G

MONITORED VS. MODELED HYDROGRAPHS

Meter M-3
SUMMER MODEL
RAIN EVENTS

No.	Start Date	End Date	Total Rain	Max Int	Peak MOD Flow	Peak MON Flow	% Difference		Modeled Volume	Monitored Volume	% Difference	
1	1/28/13 3:00	1/29/13 13:00	0.55	0.20	1.07	1.72	37.88%	Mod LOW	0.236	0.334	29.25%	Mod LOW
2	1/30/13 10:15	1/31/13 10:30	1.08	0.32	1.60	1.87	14.69%	Mod LOW	0.408	0.451	9.55%	Mod LOW
3	2/26/13 12:30	2/27/13 15:15	1.01	0.44	1.87	1.92	2.16%	Mod LOW	0.362	0.453	20.15%	Mod LOW
4	3/25/13 8:30	3/26/13 8:30	0.78	0.44	1.81	0.00	100.00%	Mod HIGH	0.275	0.000	100.00%	Mod HIGH
5	4/10/13 15:45	4/11/13 7:30	0.58	0.88	3.03	2.23	26.34%	Mod HIGH	0.099	0.106	6.61%	Mod LOW
6	4/16/13 20:00	4/17/13 6:45	1.13	2.40	3.43	2.97	13.50%	Mod HIGH	0.204	0.090	55.65%	Mod HIGH
7	5/10/13 9:15	5/11/13 16:45	0.79	0.52	1.765	2.164	18.45%	Mod LOW	0.254	0.255	0.35%	Mod LOW
8	5/22/13 16:00	5/24/13 11:30	1.13	1.08	2.466	2.477	0.44%	Mod LOW	0.272	0.360	24.48%	Mod LOW
		No Monitored Flow										

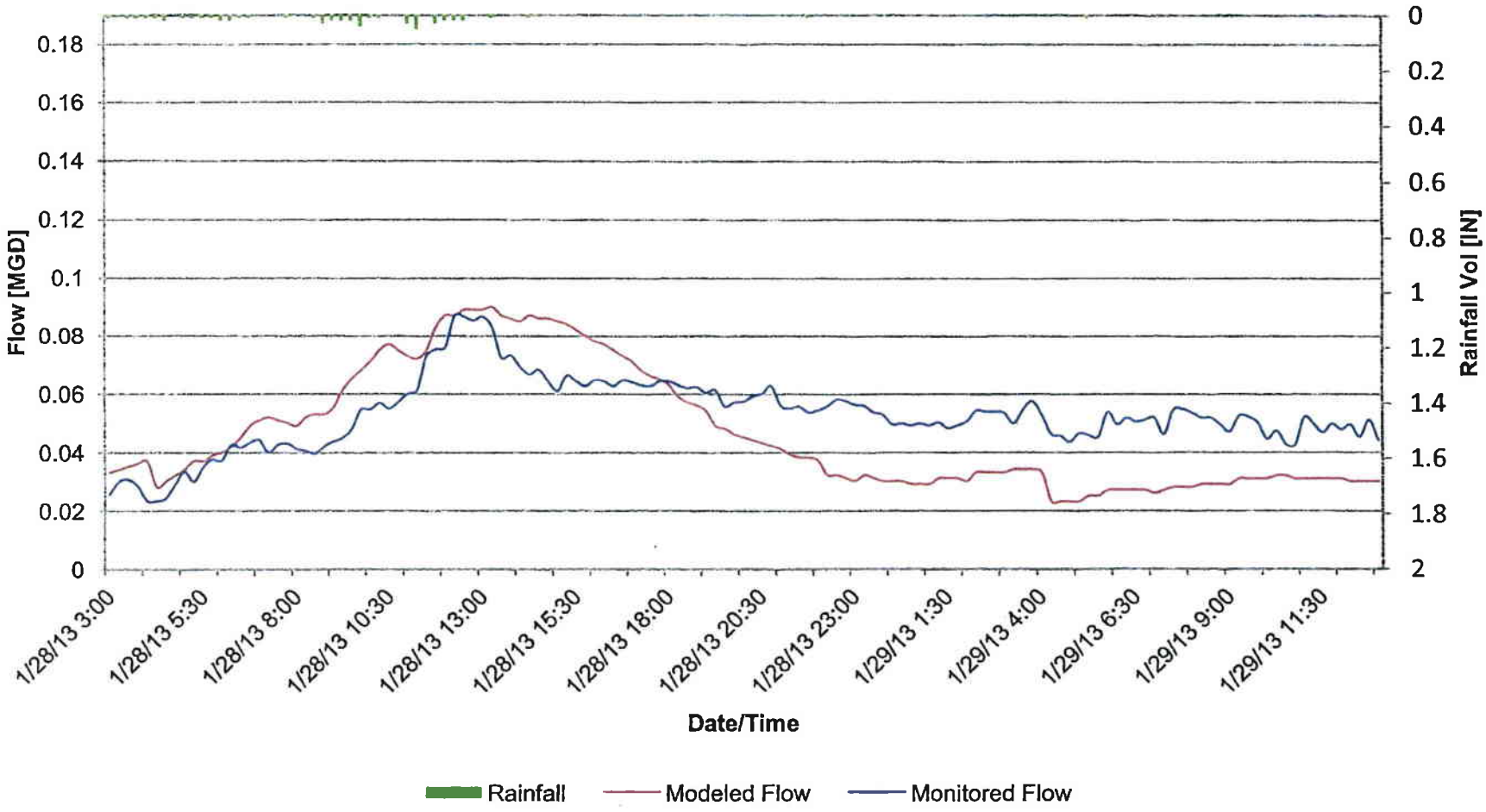
Meter M-3
Rain Event 1

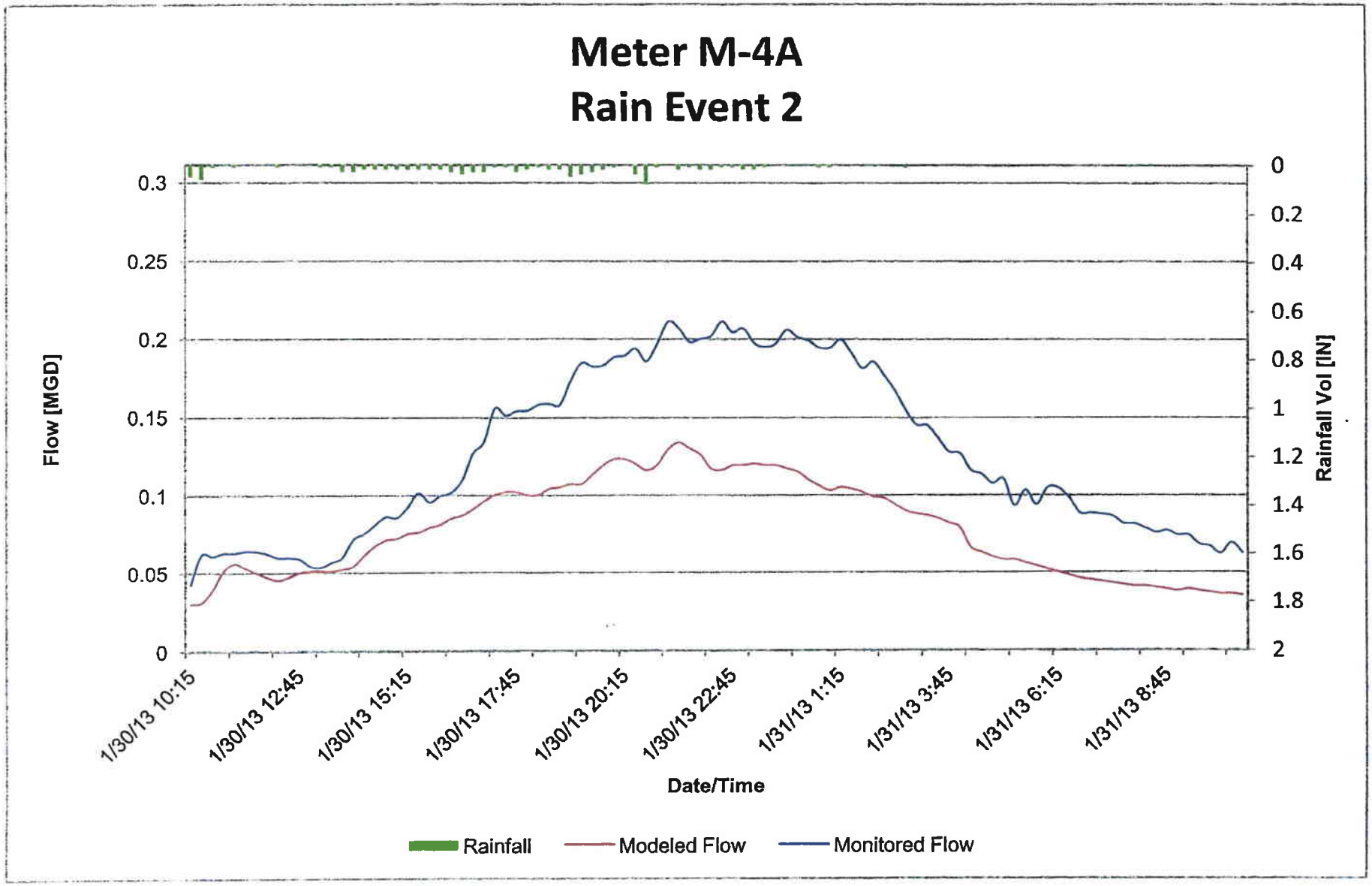


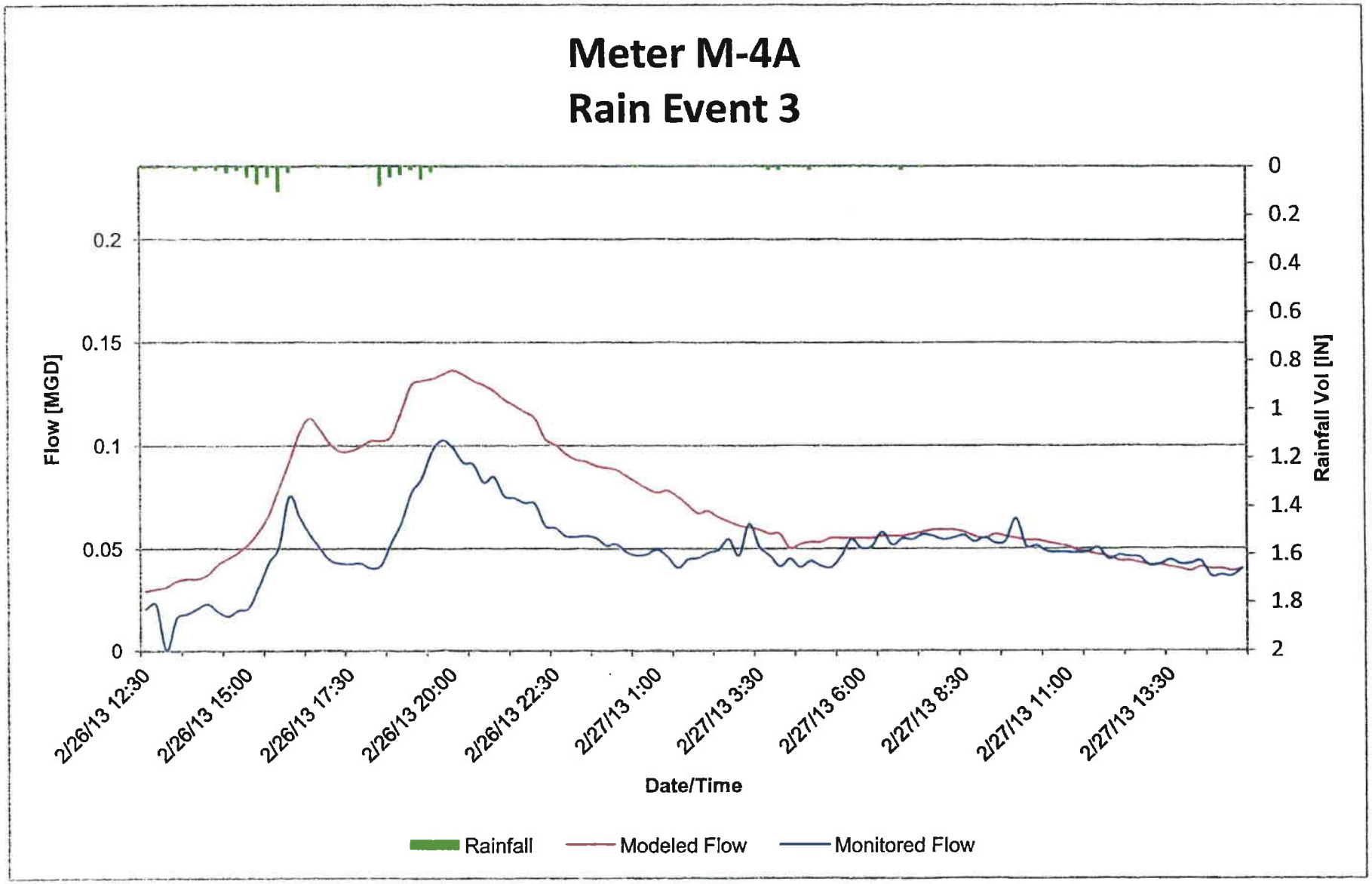
Meter M-4A
SUMMER MODEL
RAIN EVENTS

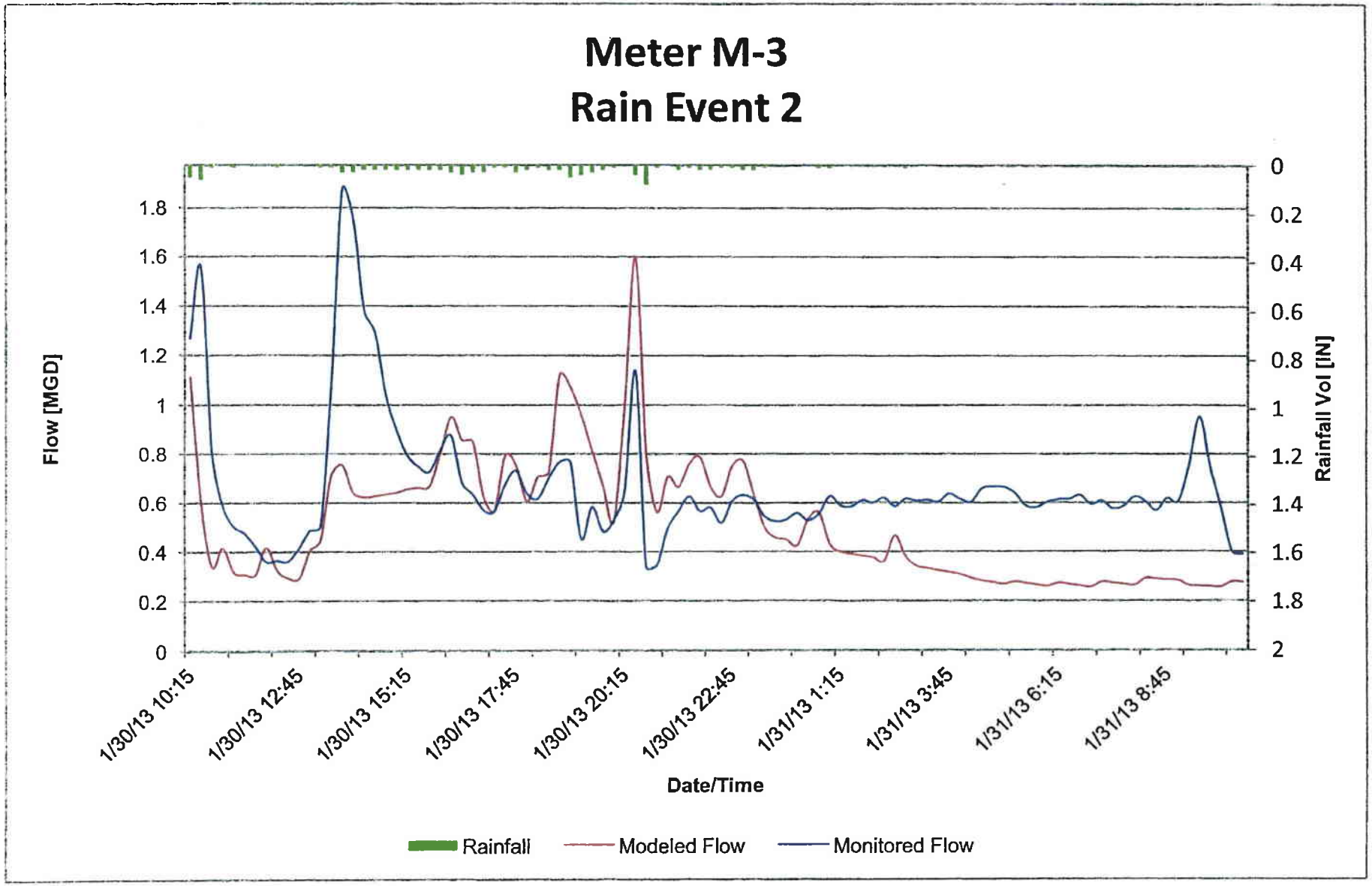
No.	Start Date	End Date	Total Rain	Max Int	Peak MOD Flow	Peak MON Flow	% Difference		Modeled Volume	Monitored Volume	% Difference	
1	1/28/13 3:00	1/28/13 20:00	0.53	0.20	0.09	0.09	3.33%	Mod HIGH	0.029	0.024	15.20%	Mod HIGH
2	1/30/13 10:15	1/31/13 8:30	1.08	0.32	0.13	0.21	36.59%	Mod LOW	0.057	0.088	34.88%	Mod LOW
3	2/26/13 12:30	2/27/13 13:15	1.01	0.44	0.14	0.10	24.75%	Mod HIGH	0.047	0.030	35.23%	Mod HIGH
4	3/25/13 15:15	3/26/13 6:30	0.77	0.44	0.13	0.06	58.33%	Mod HIGH	0.038	0.016	58.94%	Mod HIGH
5	4/10/13 15:45	4/11/13 5:30	0.58	0.88	0.11	0.07	30.86%	Mod HIGH	0.014	0.011	23.23%	Mod HIGH
6	4/16/13 20:00	4/17/13 4:45	1.13	2.40	0.21	0.23	9.70%	Mod LOW	0.024	0.032	25.32%	Mod LOW
7	5/22/13 23:15	5/23/13 14:30	0.52	0.72	0.125	0.069	44.53%	Mod HIGH	0.019	0.009	52.55%	Mod HIGH
8	5/10/13 9:15	5/11/13 20:45	0.79	0.52	0.191	0.071	63.00%	Mod HIGH	0.045	0.020	56.00%	Mod HIGH
9	5/22/13 16:00	5/24/13 15:30	1.13	1.08	0.281	0.094	66.43%	Mod HIGH	0.049	0.017	65.14%	Mod HIGH

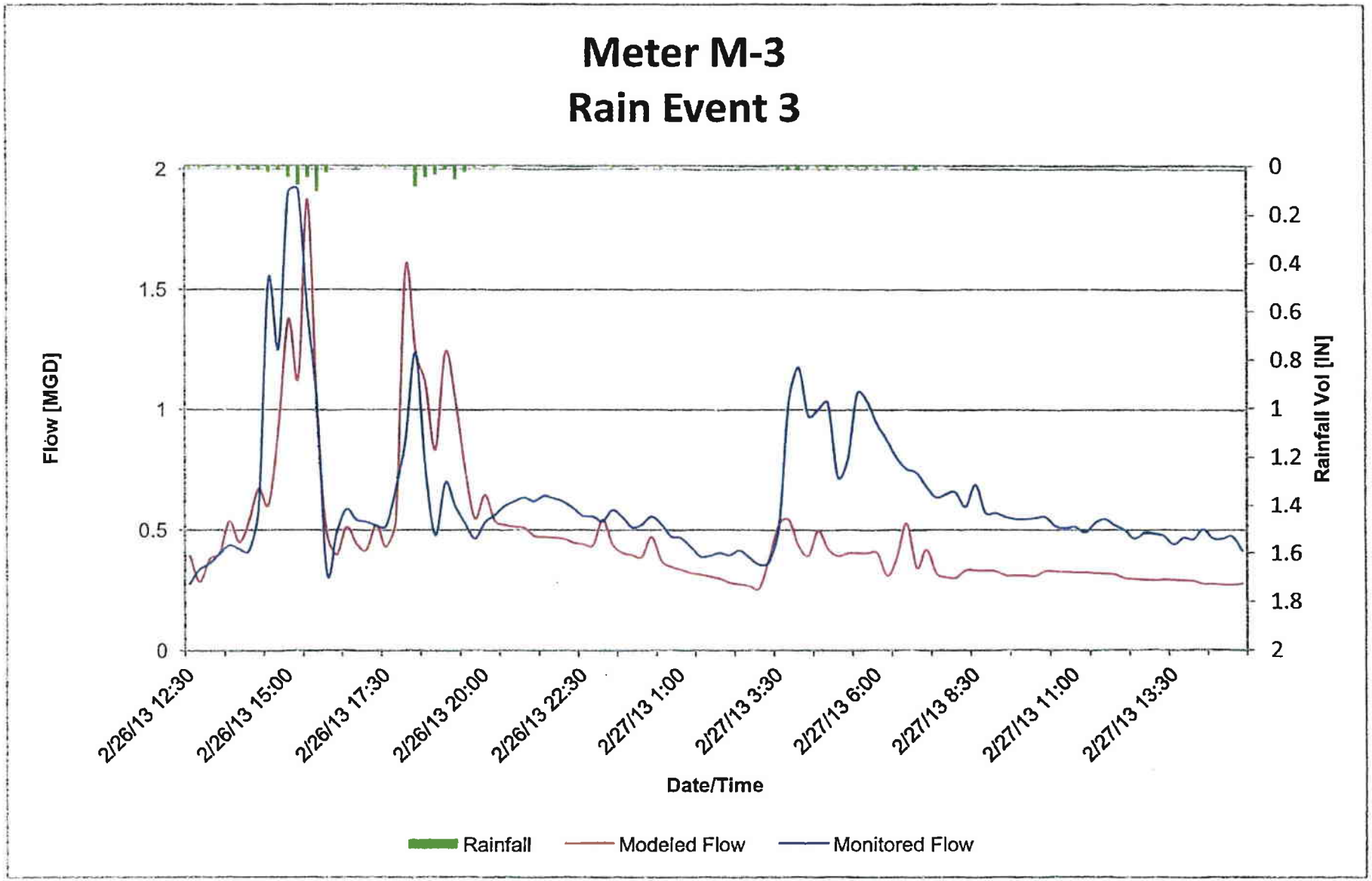
Meter M-4A
Rain Event 1

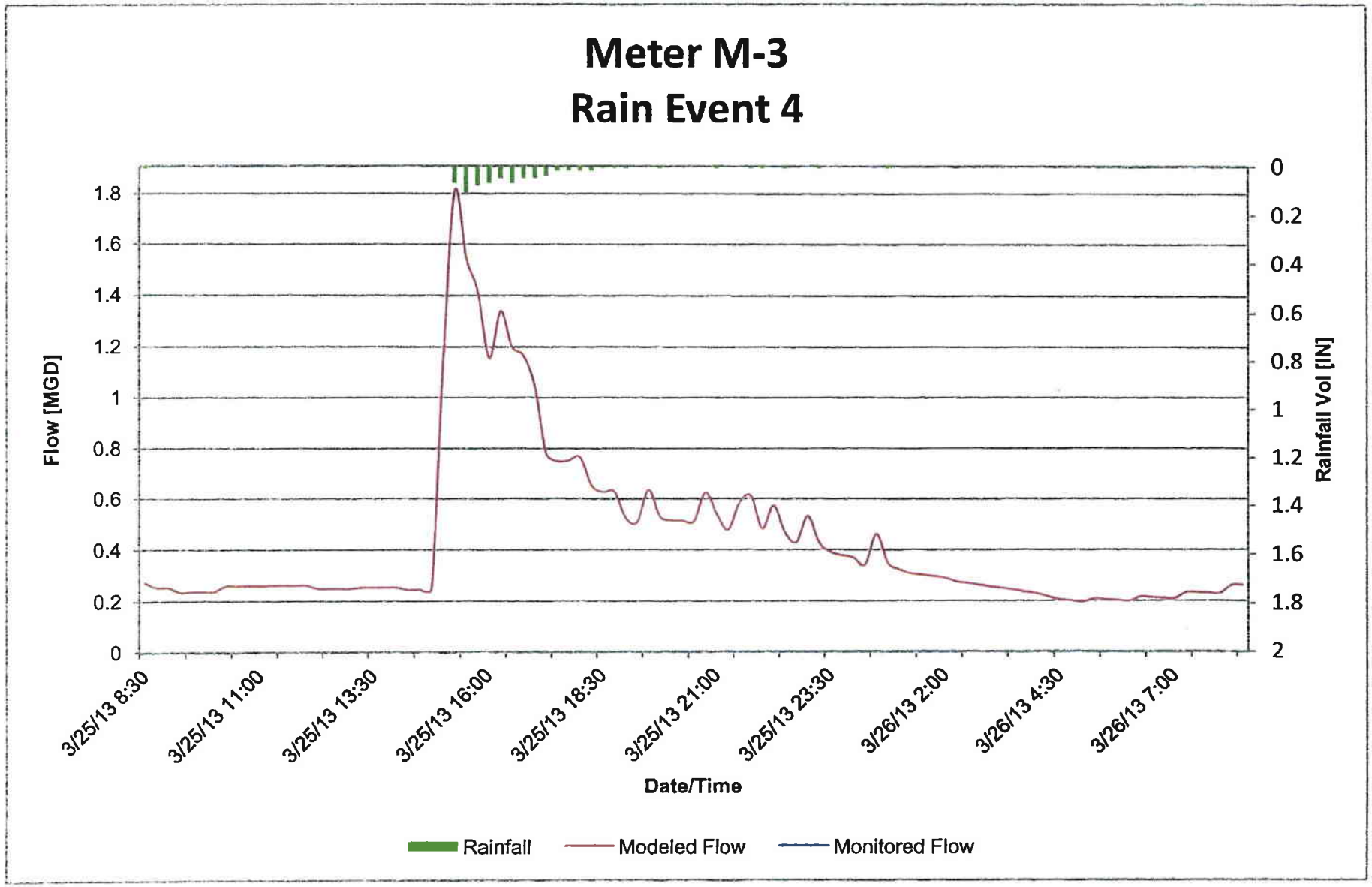


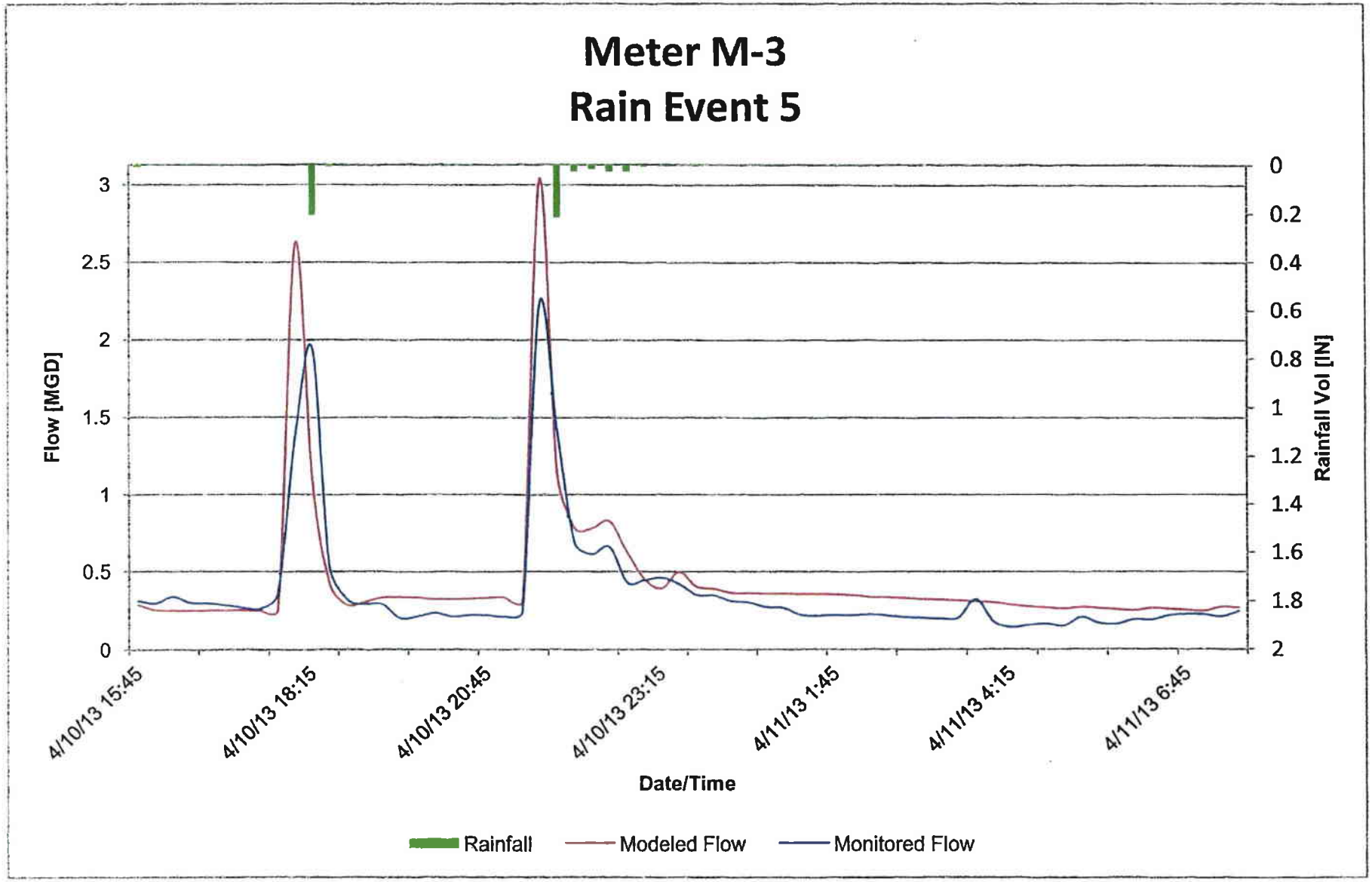

Meter M-4A
Rain Event 2
Flow [MGD]
0.3
0.25
0.2
0.15
0.1
0.05
0
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
1/30/13 10:15
1/30/13 12:45
1/30/13 15:15
1/30/13 17:45
1/30/13 20:15
1/30/13 22:45
1/31/13 1:15
1/31/13 3:45
1/31/13 6:15
1/31/13 8:45
Date/Time
Rainfall
Modeled Flow
Monitored Flow


Meter M-4A
Rain Event 3
Flow [MGD]
0.2
0.15
0.1
0.05
0
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2/26/13 12:30
2/26/13 15:00
2/26/13 17:30
2/26/13 20:00
2/26/13 22:30
2/27/13 1:00
2/27/13 3:30
2/27/13 6:00
2/27/13 8:30
2/27/13 11:00
2/27/13 13:30
Date/Time
Rainfall
Modeled Flow
Monitored Flow

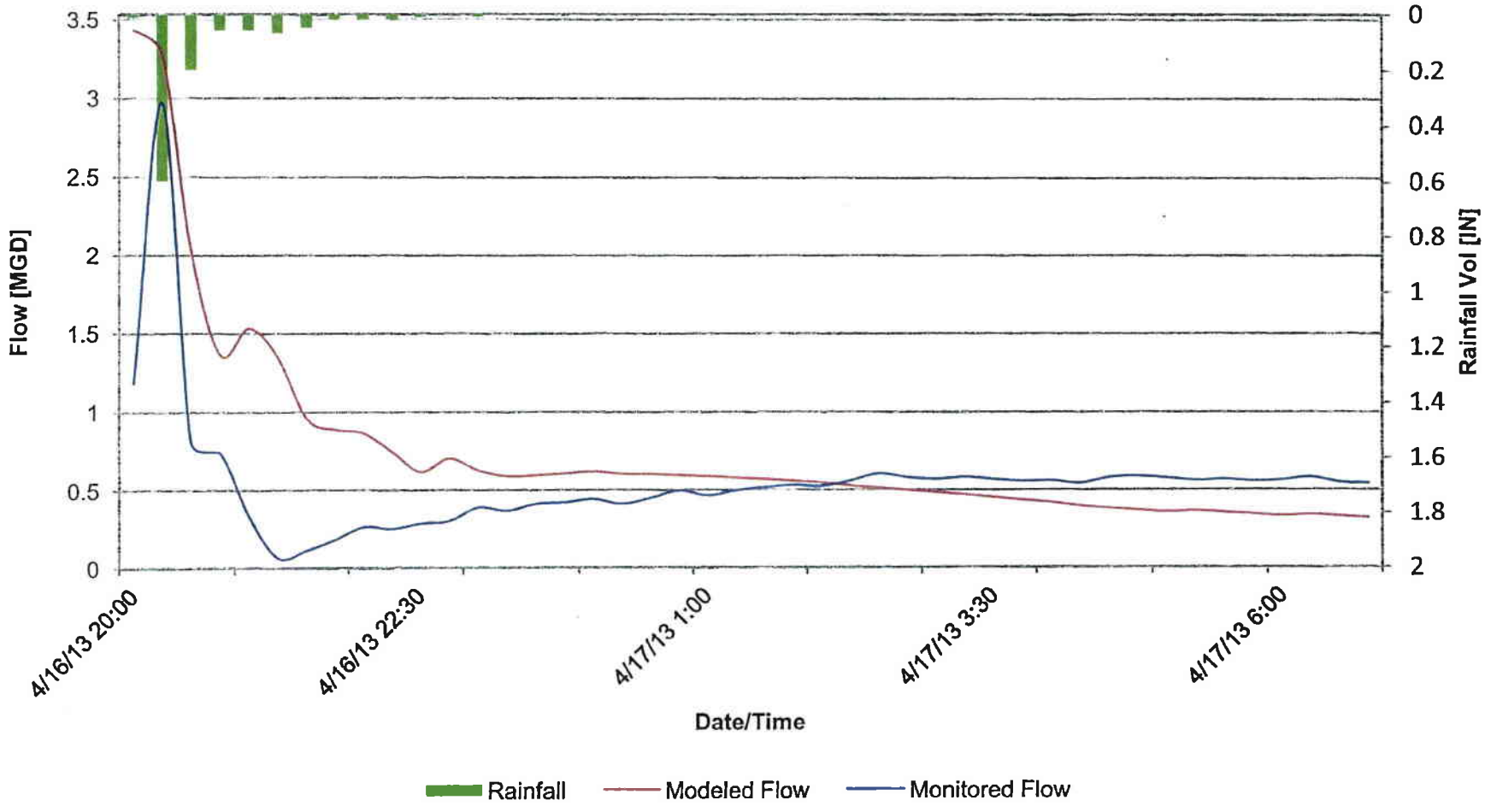

Meter M-3
Rain Event 2
Flow [MGD]
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
1/30/13 10:15
1/30/13 12:45
1/30/13 15:15
1/30/13 17:45
1/30/13 20:15
1/30/13 22:45
1/31/13 1:15
1/31/13 3:45
1/31/13 6:15
1/31/13 8:45
Date/Time
Rainfall
Modeled Flow
Monitored Flow

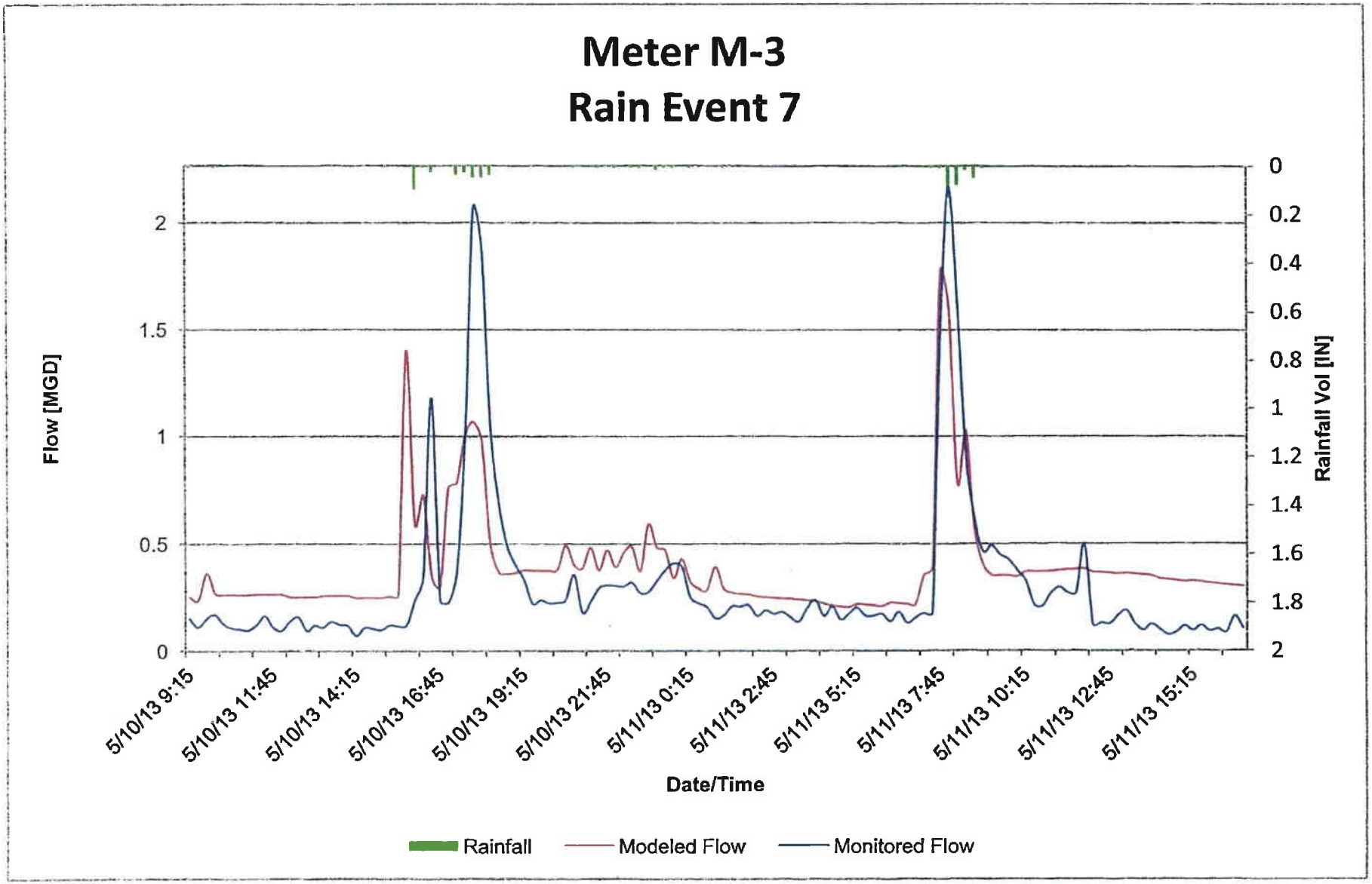

Meter M-3
Rain Event 3
Flow [MGD]
Rainfall Vol [IN]
2
1.5
1
0.5
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2/26/13 12:30
2/26/13 15:00
2/26/13 17:30
2/26/13 20:00
2/26/13 22:30
2/27/13 1:00
2/27/13 3:30
2/27/13 6:00
2/27/13 8:30
2/27/13 11:00
2/27/13 13:30
Date/Time
Rainfall
Modeled Flow
Monitored Flow


Meter M-3
Rain Event 4
Flow [MGD]
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
3/25/13 8:30
3/25/13 11:00
3/25/13 13:30
3/25/13 16:00
3/25/13 18:30
3/25/13 21:00
3/25/13 23:30
3/26/13 2:00
3/26/13 4:30
3/26/13 7:00
Date/Time
Rainfall
Modeled Flow
Monitored Flow

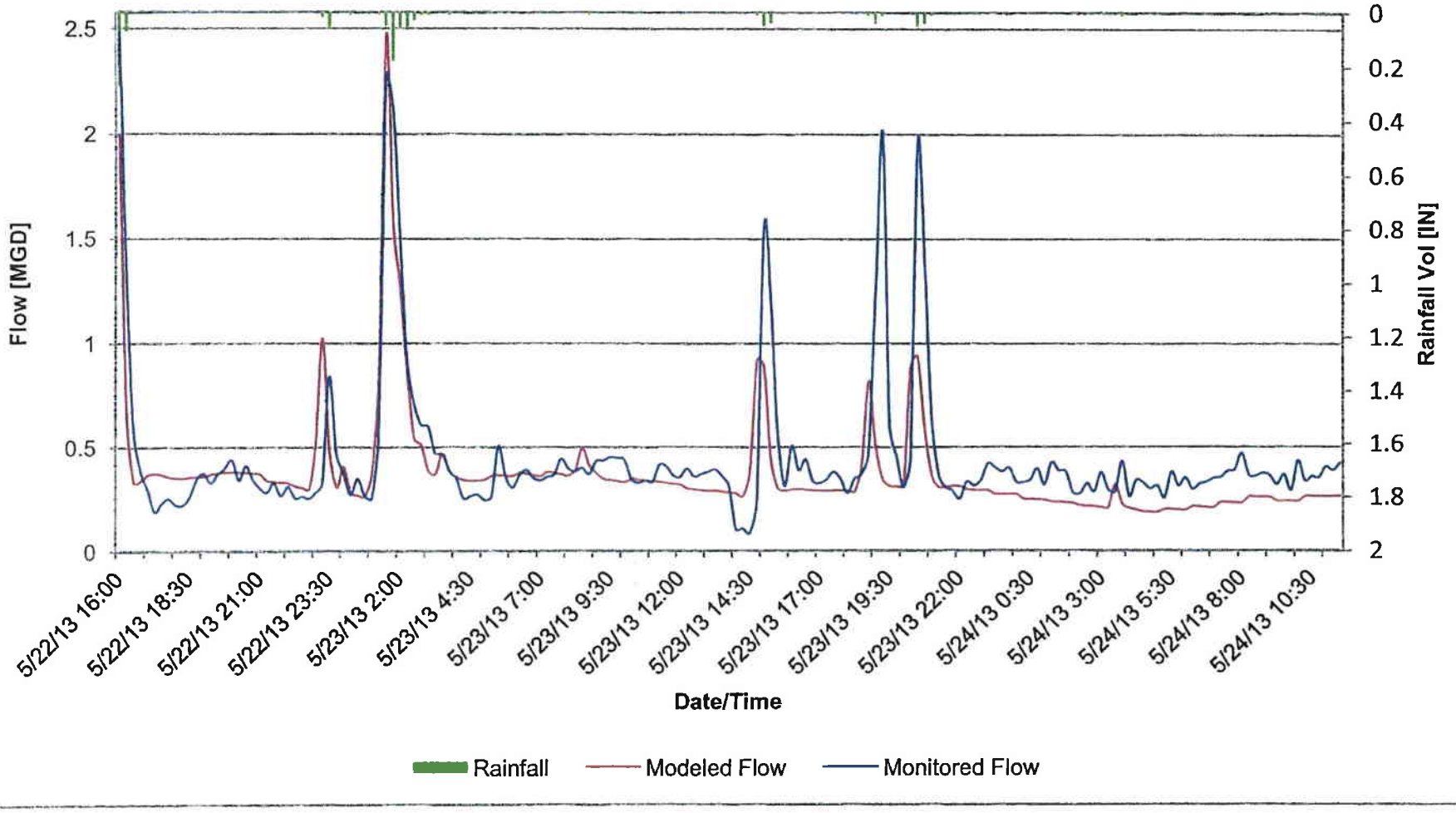

Meter M-3
Rain Event 5
Flow [MGD]
Rainfall Vol [IN]
3
2.5
2
1.5
1
0.5
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
4/10/13 15:45
4/10/13 18:15
4/10/13 20:45
4/10/13 23:15
4/11/13 1:45
4/11/13 4:15
4/11/13 6:45
Date/Time
Rainfall
Modeled Flow
Monitored Flow

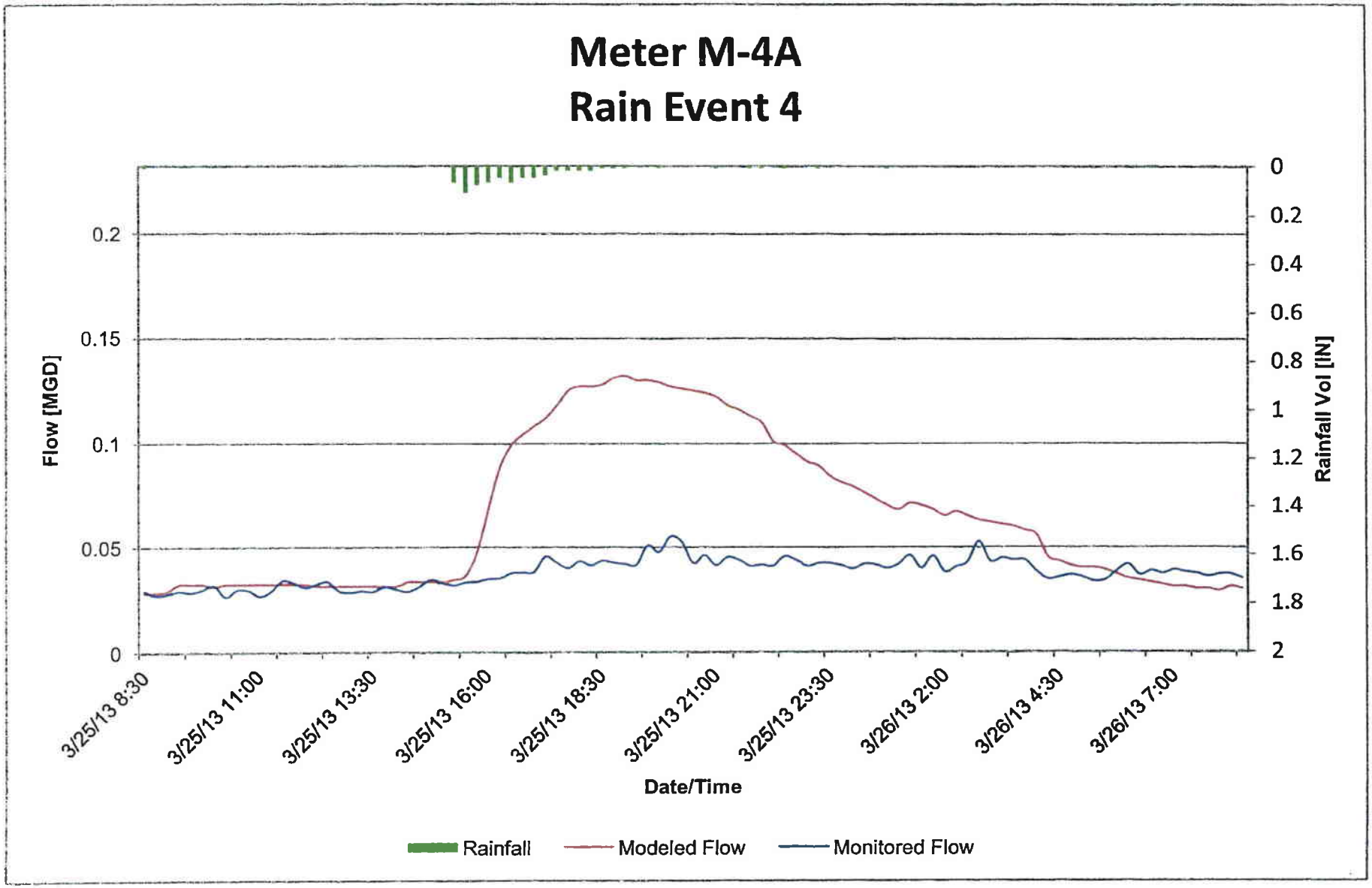
Meter M-3
Rain Event 6

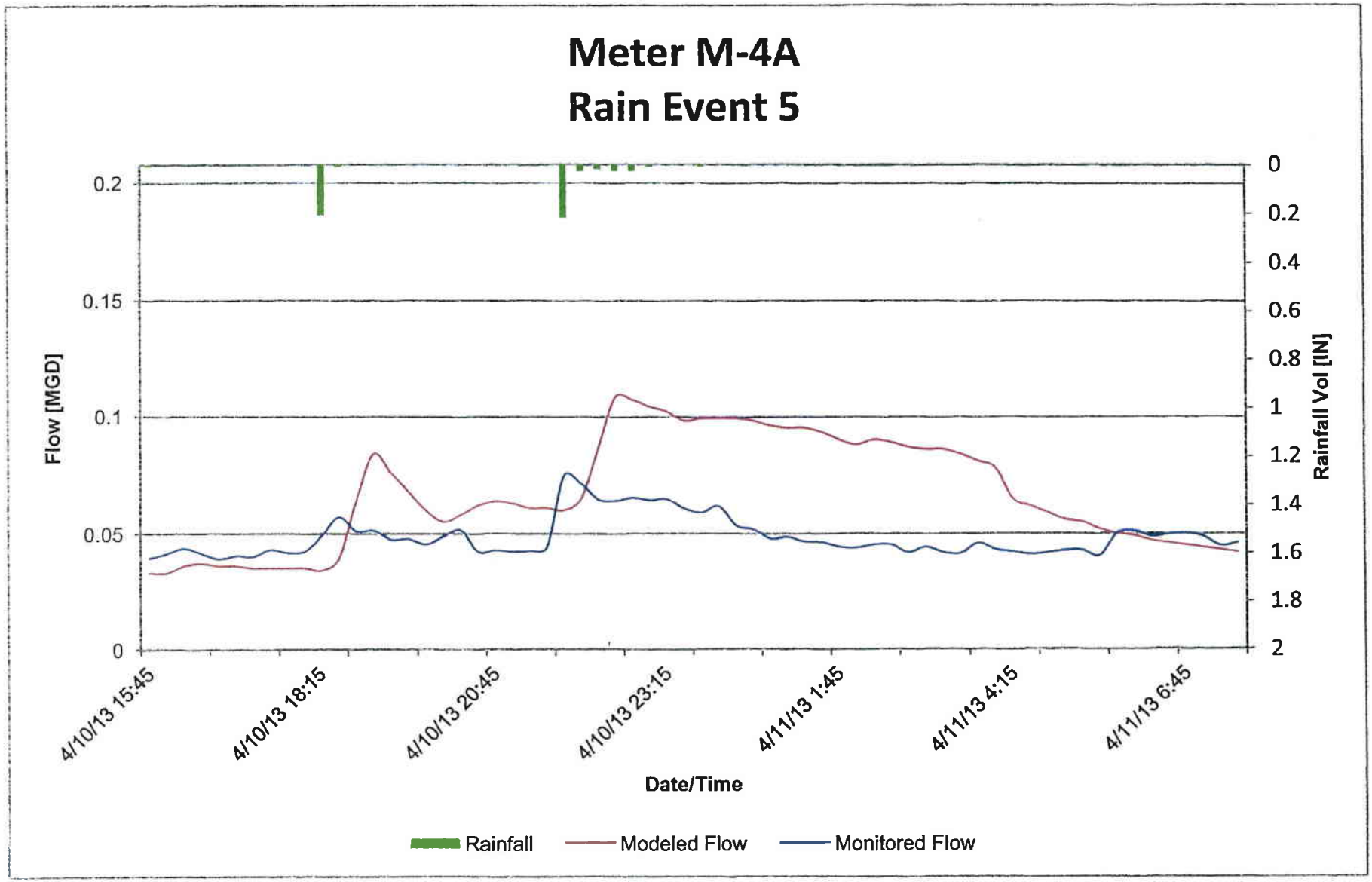


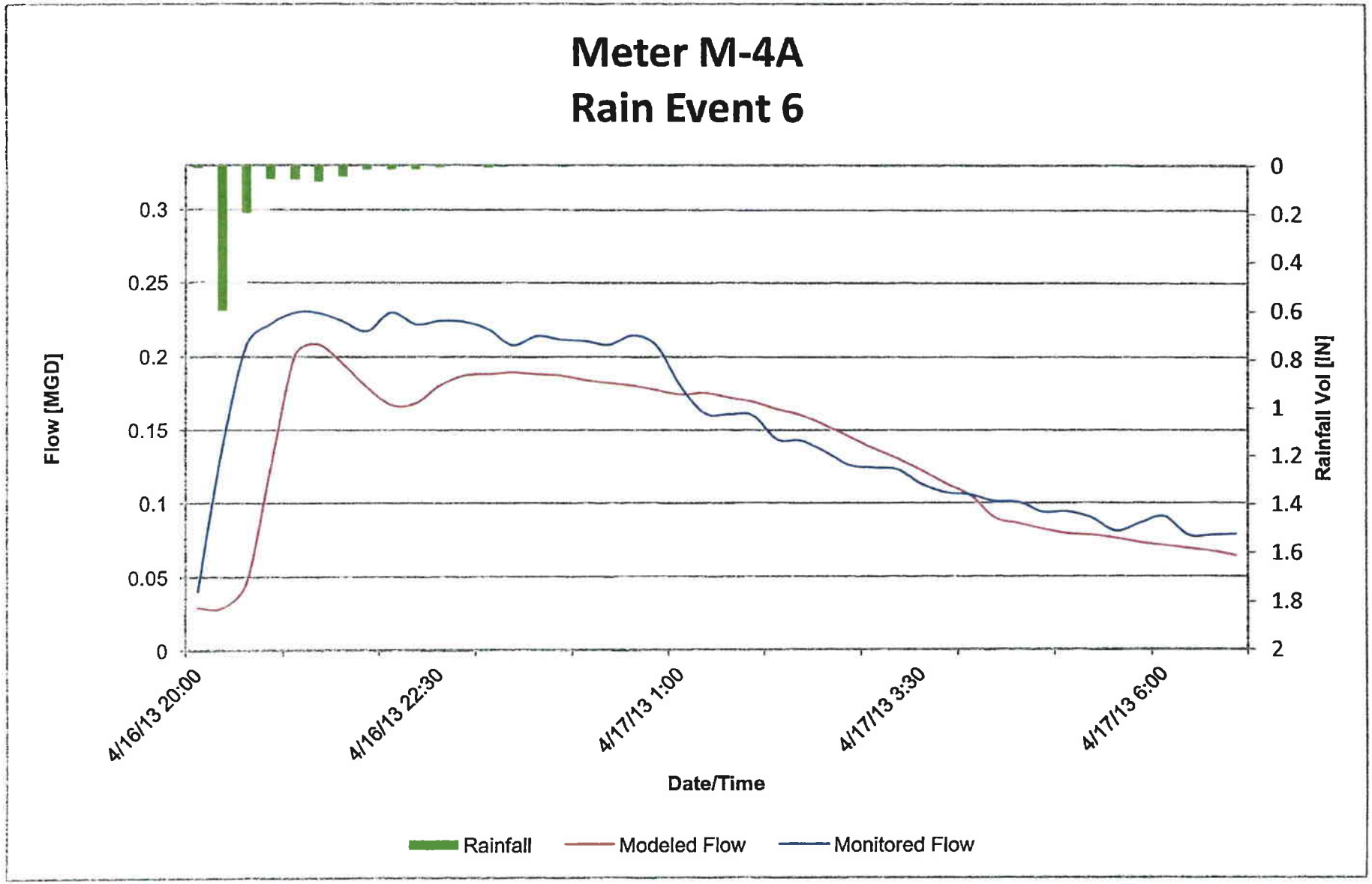

Meter M-3
Rain Event 7
Flow [MGD]
Rainfall Vol [IN]
0
0.5
1
1.5
2
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
5/10/13 9:15
5/10/13 11:45
5/10/13 14:15
5/10/13 16:45
5/10/13 19:15
5/10/13 21:45
5/11/13 0:15
5/11/13 2:45
5/11/13 5:15
5/11/13 7:45
5/11/13 10:15
5/11/13 12:45
5/11/13 15:15
Date/Time
Rainfall
Modeled Flow
Monitored Flow

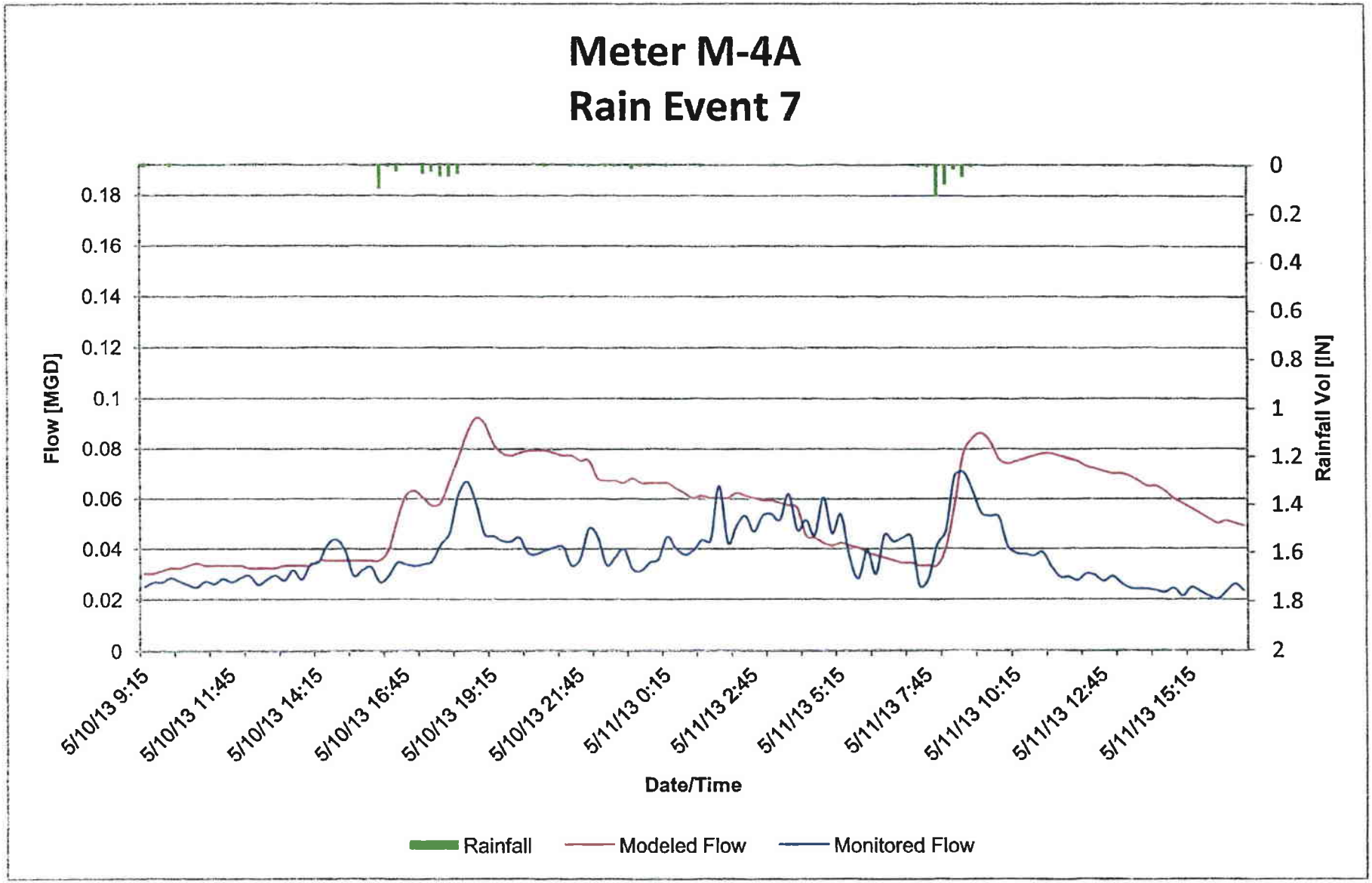
Meter M-3
Rain Event 8



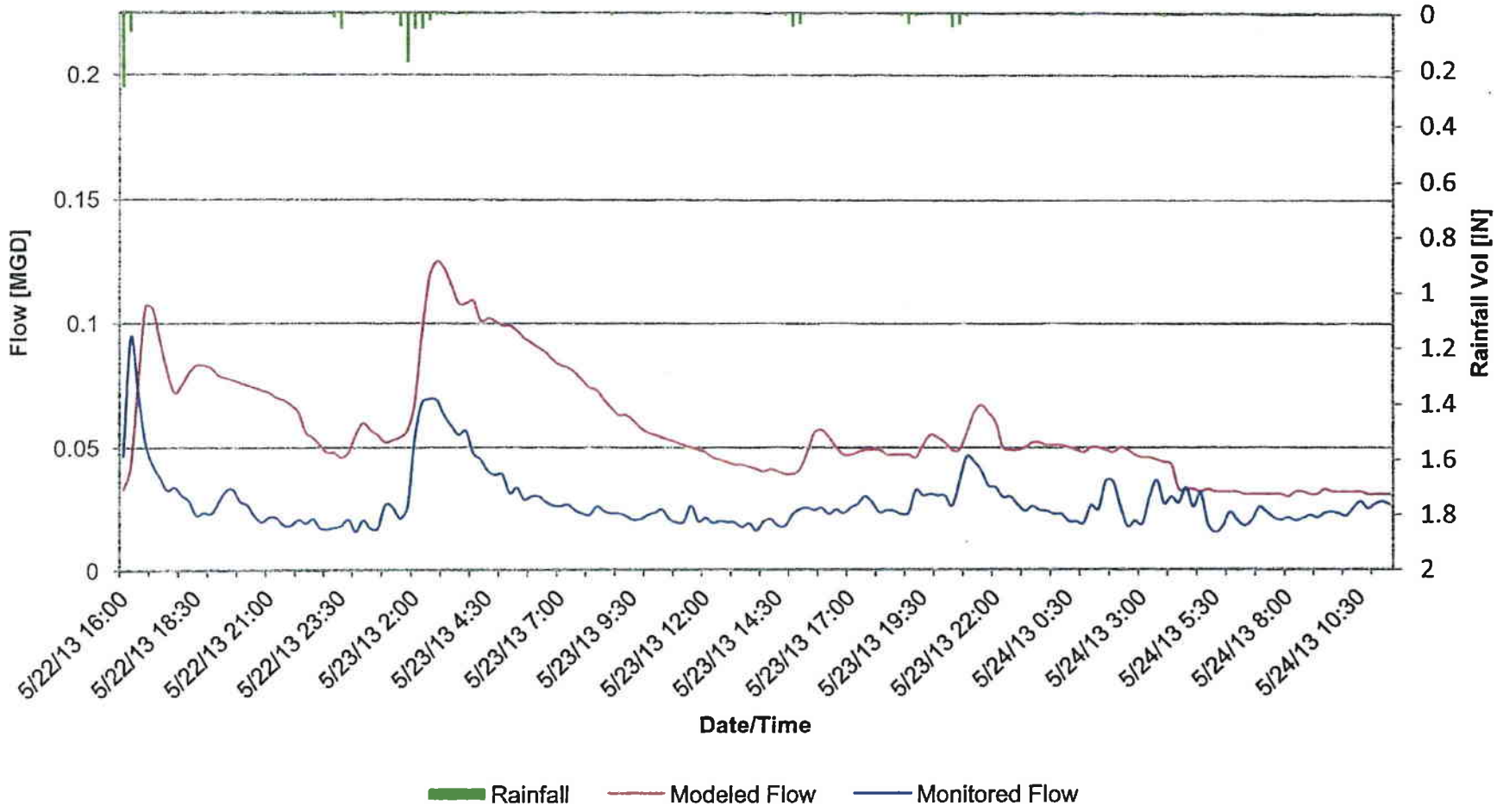

Meter M-4A
Rain Event 4
Flow [MGD]
0.2
0.15
0.1
0.05
0
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
3/25/13 8:30
3/25/13 11:00
3/25/13 13:30
3/25/13 16:00
3/25/13 18:30
3/25/13 21:00
3/25/13 23:30
3/26/13 2:00
3/26/13 4:30
3/26/13 7:00
Date/Time
Rainfall
Modeled Flow
Monitored Flow


Meter M-4A
Rain Event 5
Flow [MGD]
0.2
0.15
0.1
0.05
0
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
4/10/13 15:45
4/10/13 18:15
4/10/13 20:45
4/10/13 23:15
4/11/13 1:45
4/11/13 4:15
4/11/13 6:45
Date/Time
Rainfall
Modeled Flow
Monitored Flow


Meter M-4A
Rain Event 6
Flow [MGD]
0.3
0.25
0.2
0.15
0.1
0.05
0
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
4/16/13 20:00
4/16/13 22:30
4/17/13 1:00
4/17/13 3:30
4/17/13 6:00
Date/Time
Rainfall
Modeled Flow
Monitored Flow


Meter M-4A
Rain Event 7
Flow [MGD]
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
5/10/13 9:15
5/10/13 11:45
5/10/13 14:15
5/10/13 16:45
5/10/13 19:15
5/10/13 21:45
5/11/13 0:15
5/11/13 2:45
5/11/13 5:15
5/11/13 7:45
5/11/13 10:15
5/11/13 12:45
5/11/13 15:15
Date/Time
Rainfall
Modeled Flow
Monitored Flow

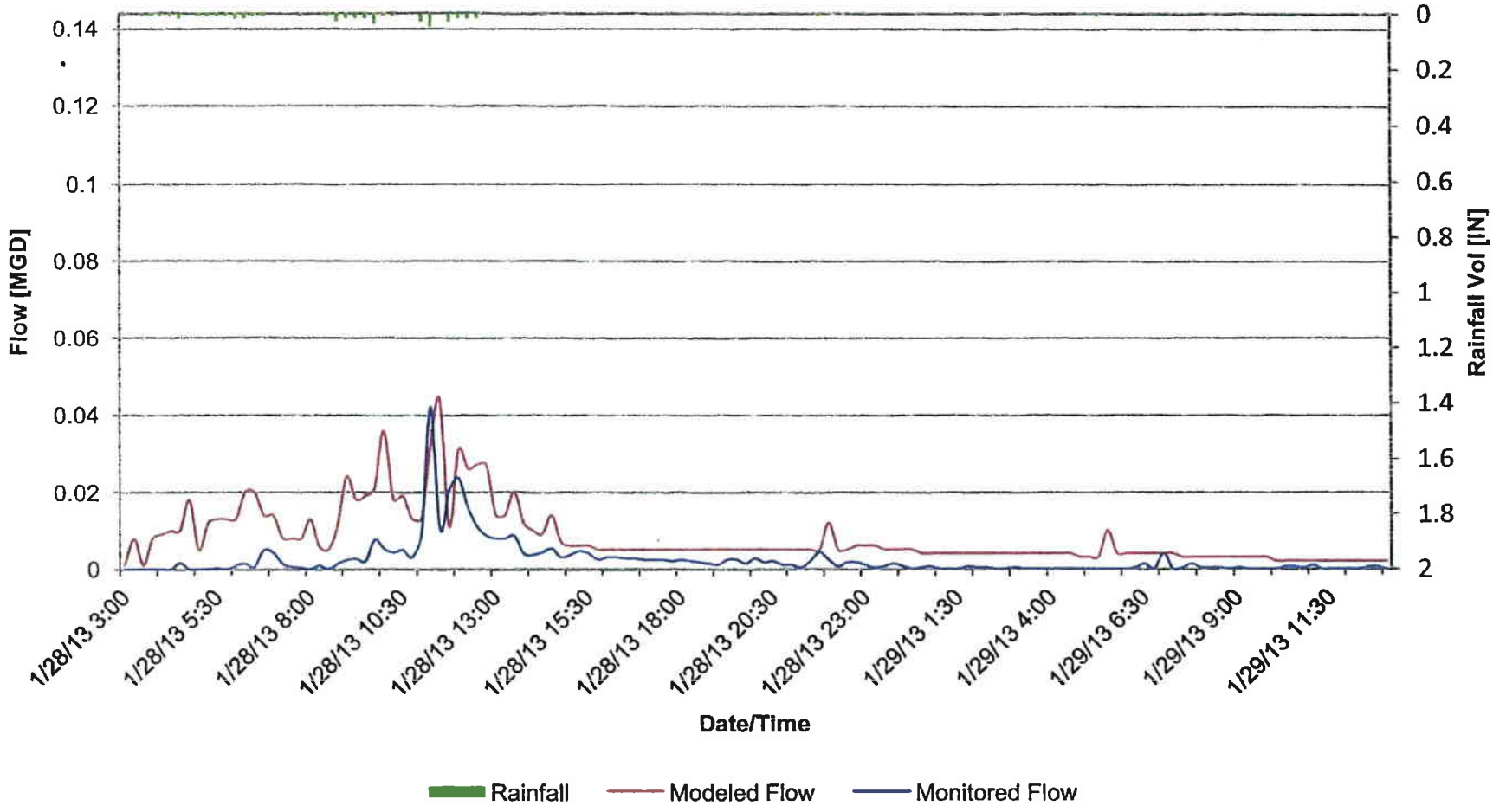
Meter M-4A
Rain Event 8

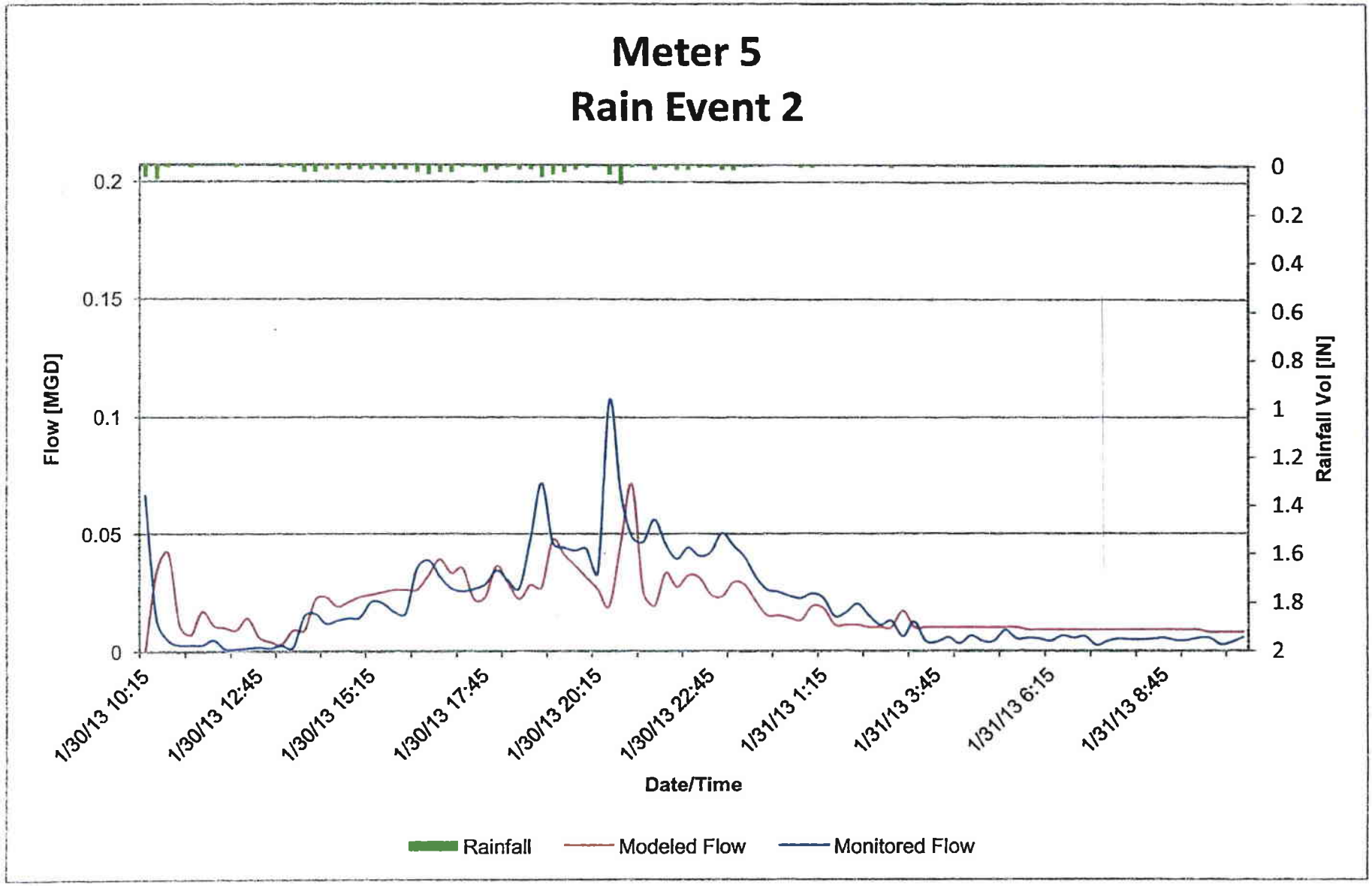


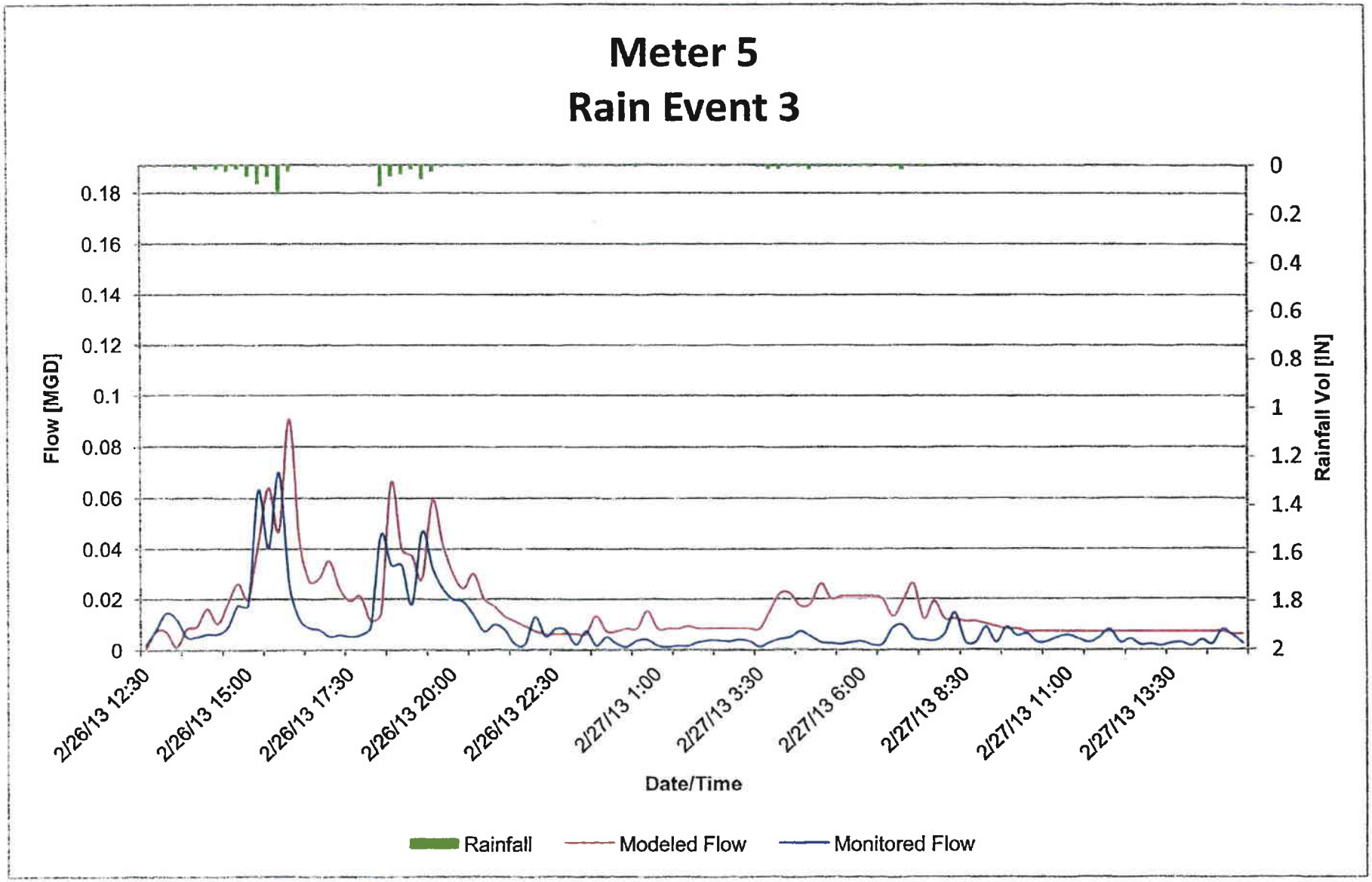
Meter 5
SUMMER MODEL
RAIN EVENTS

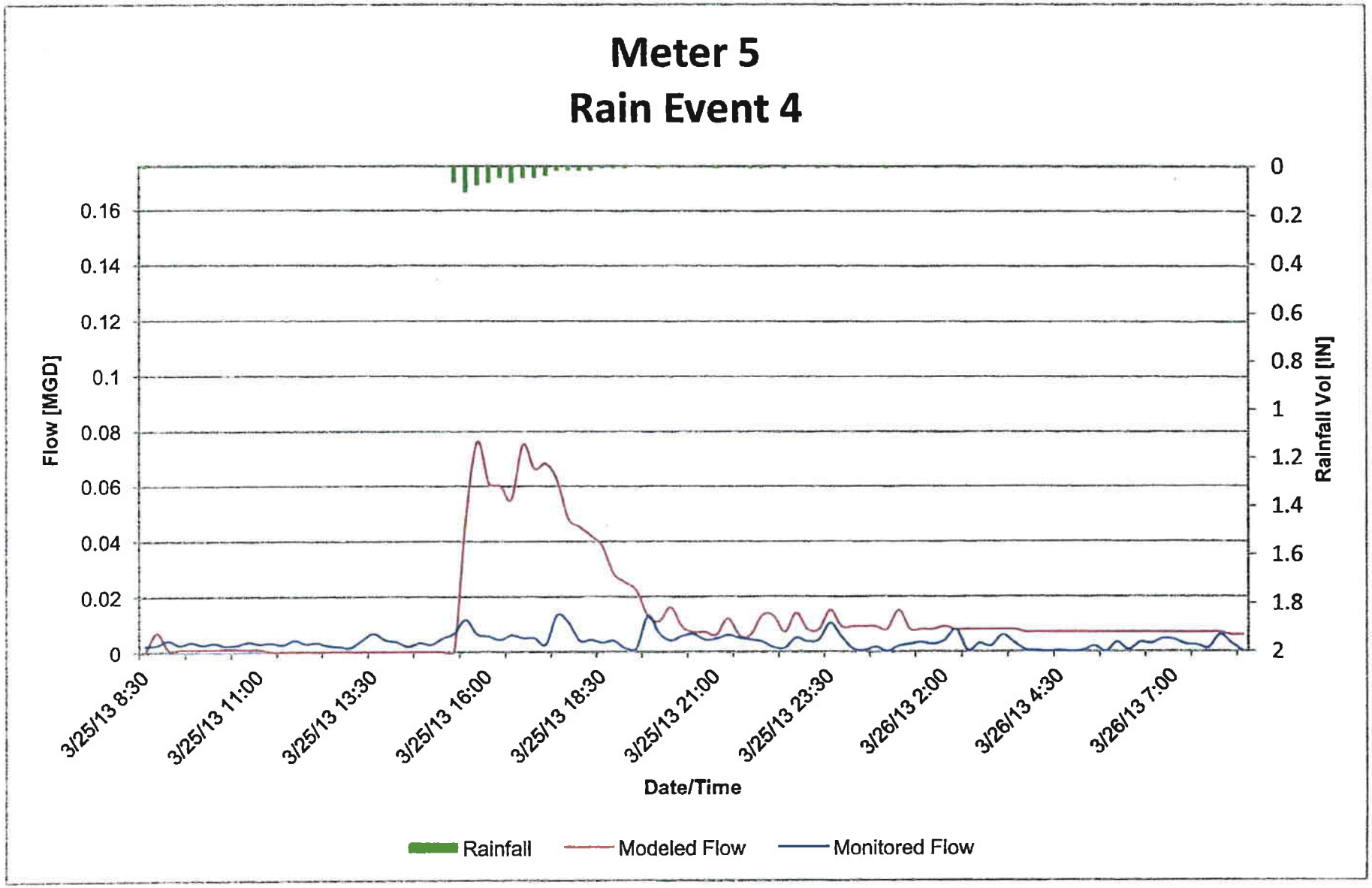
No.	Start Date	End Date	Total Rain	Max Int	Peak MOD Flow	Peak MON Flow	% Difference		Modeled Volume	Monitored Volume	% Difference	
1	1/28/13 3:00	1/28/13 20:00	0.53	0.20	0.04	0.04	4.55%	Mod HIGH	0.007	0.002	67.11%	Mod HIGH
2	1/30/13 10:15	1/31/13 8:30	1.08	0.32	0.07	0.11	33.64%	Mod LOW	0.015	0.018	16.34%	Mod LOW
3	2/26/13 12:30	2/27/13 13:15	1.01	0.44	0.09	0.07	23.08%	Mod HIGH	0.014	0.008	45.71%	Mod HIGH
4	3/25/13 15:15	3/26/13 6:30	0.77	0.44	0.08	0.01	82.46%	Mod HIGH	0.011	0.002	81.77%	Mod HIGH
5	4/10/13 15:45	4/11/13 5:30	0.58	0.88	0.15	0.14	7.16%	Mod HIGH	0.006	0.002	62.53%	Mod HIGH
6	4/16/13 20:00	4/17/13 4:45	1.13	2.40	0.40	0.36	10.17%	Mod HIGH	0.014	0.014	3.03%	Mod LOW
7	5/22/13 23:15	5/23/13 14:30	0.52	0.72	0.129	0.093	27.91%	Mod HIGH	0.007	0.003	60.39%	Mod HIGH
8	5/10/13 9:15	5/11/13 20:45	0.79	0.52	0.064	0.095	32.87%	Mod LOW	0.007	0.004	46.53%	Mod HIGH
9	5/22/13 16:00	5/24/13 15:30	1.13	1.08	0.122	0.187	34.64%	Mod LOW	0.011	0.006	44.62%	Mod HIGH

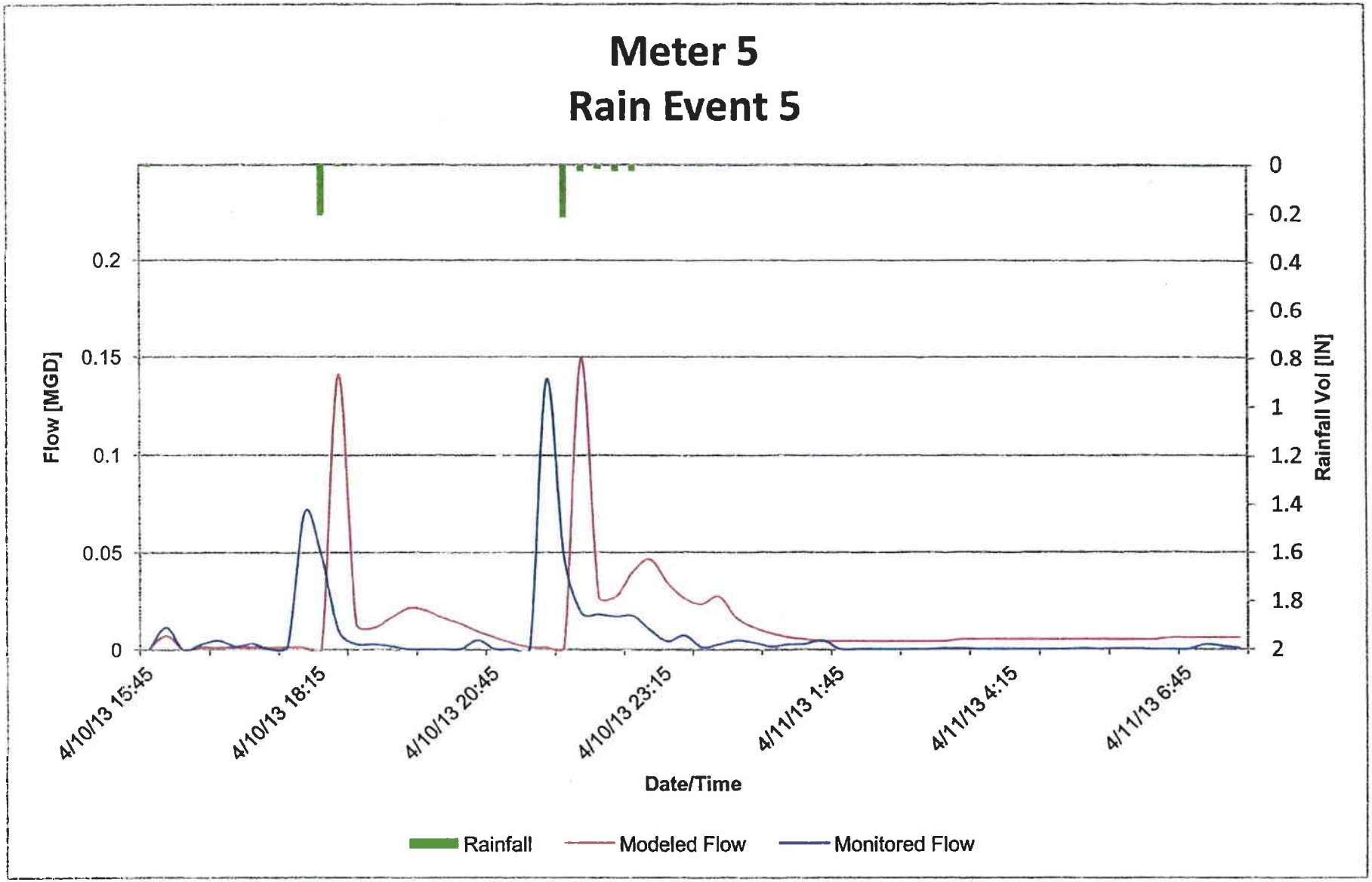
Meter 5
Rain Event 1



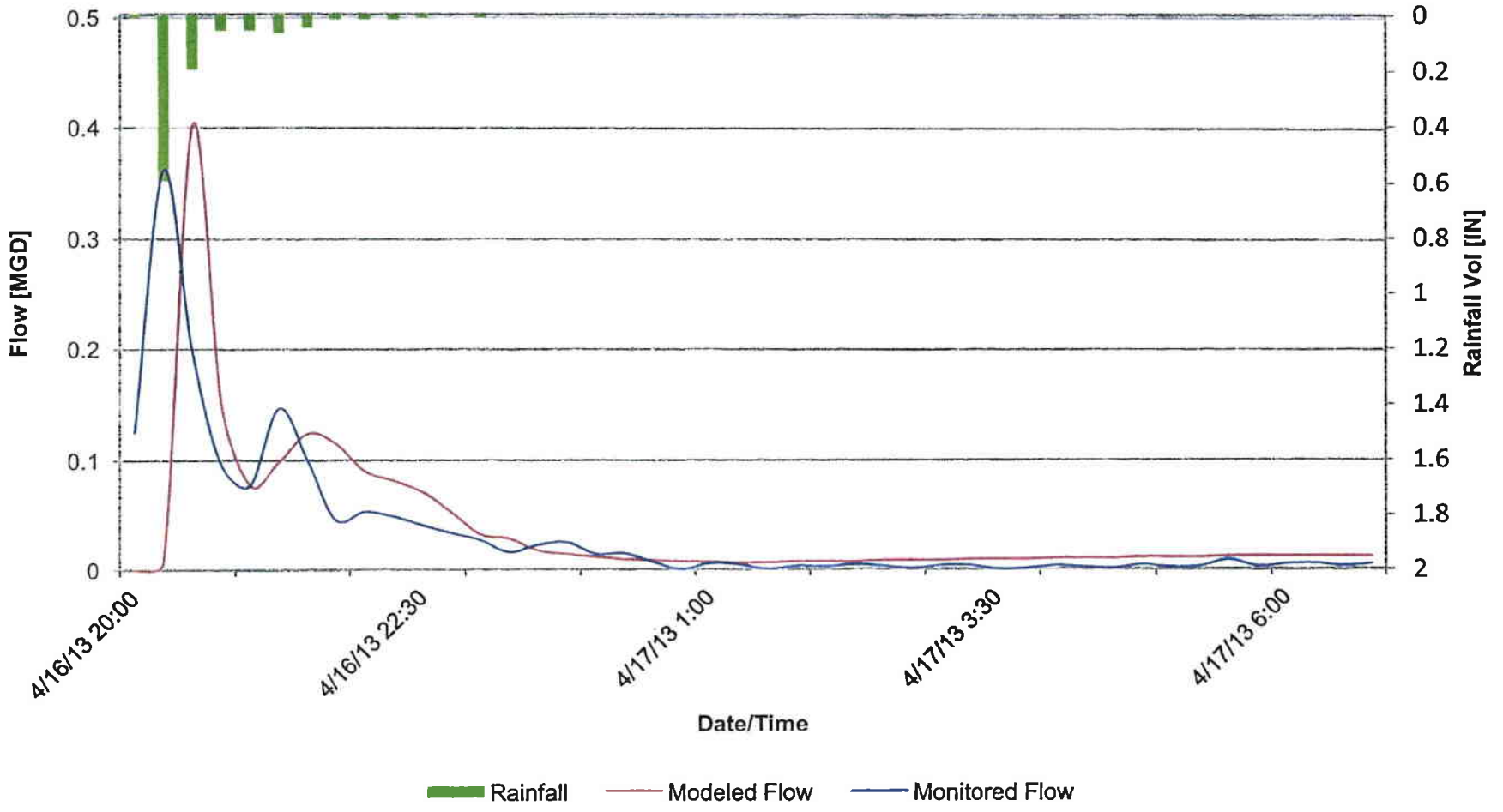

Meter 5
Rain Event 2
Flow [MGD]
0.2
0.15
0.1
0.05
0
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
1/30/13 10:15
1/30/13 12:45
1/30/13 15:15
1/30/13 17:45
1/30/13 20:15
1/30/13 22:45
1/31/13 1:15
1/31/13 3:45
1/31/13 6:15
1/31/13 8:45
Date/Time
Rainfall
Modeled Flow
Monitored Flow

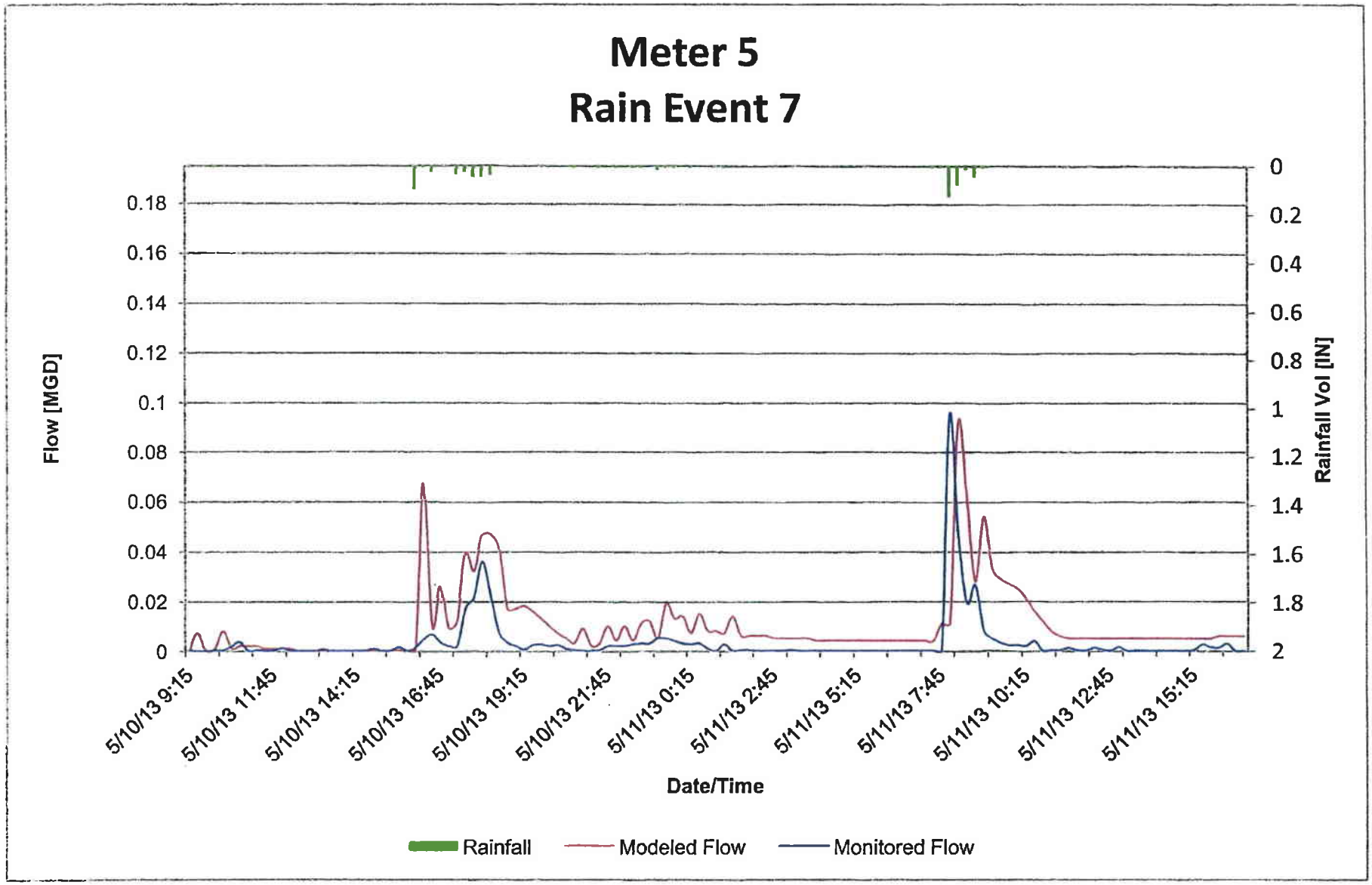

Meter 5
Rain Event 3
Flow [MGD]
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2/26/13 12:30
2/26/13 15:00
2/26/13 17:30
2/26/13 20:00
2/26/13 22:30
2/27/13 1:00
2/27/13 3:30
2/27/13 6:00
2/27/13 8:30
2/27/13 11:00
2/27/13 13:30
Date/Time
Rainfall
Modeled Flow
Monitored Flow


Meter 5
Rain Event 4
Flow [MGD]
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
3/25/13 8:30
3/25/13 11:00
3/25/13 13:30
3/25/13 16:00
3/25/13 18:30
3/25/13 21:00
3/25/13 23:30
3/26/13 2:00
3/26/13 4:30
3/26/13 7:00
Date/Time
Rainfall
Modeled Flow
Monitored Flow

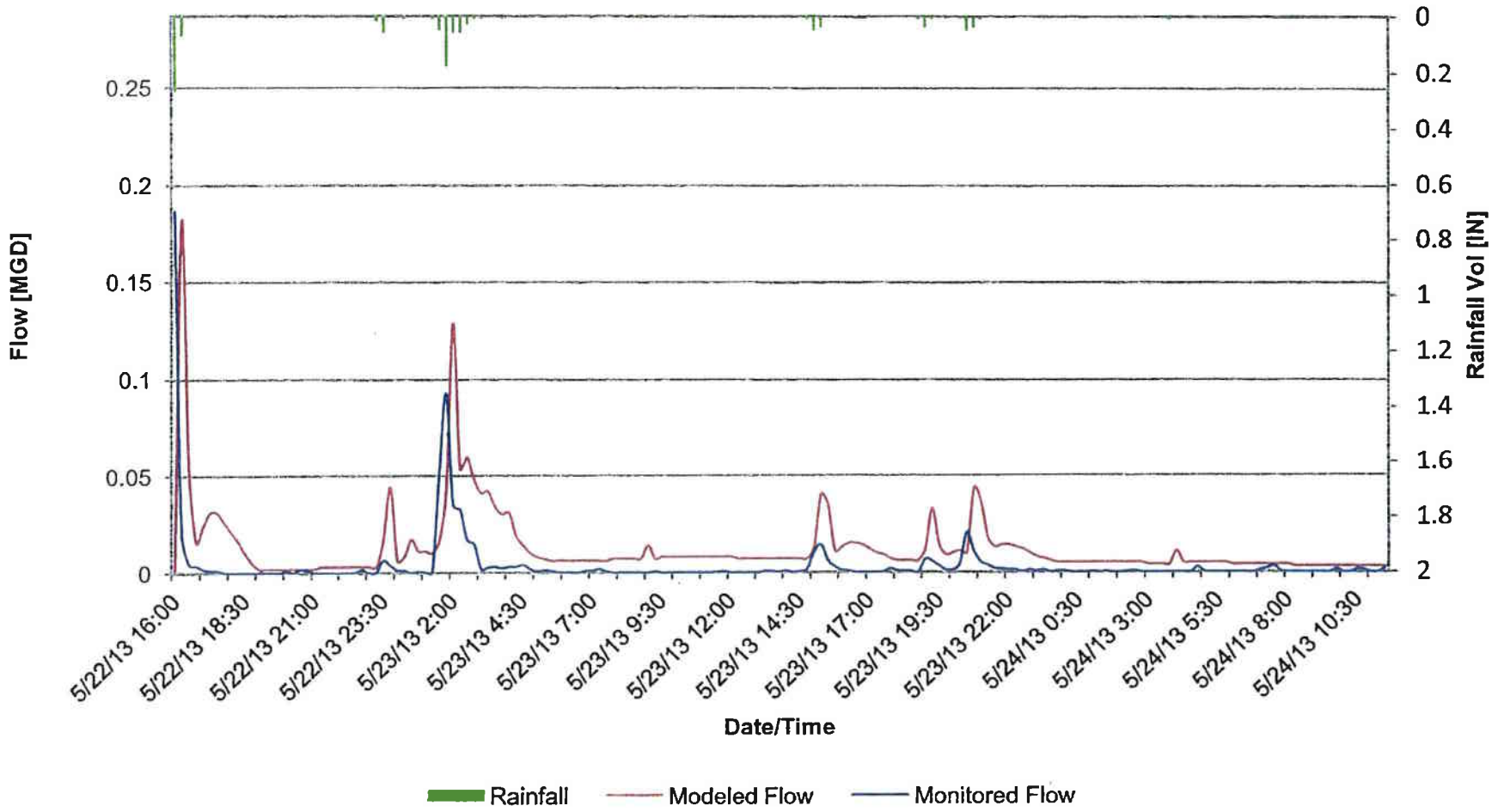

Meter 5
Rain Event 5
Flow [MGD]
0.2
0.15
0.1
0.05
0
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
4/10/13 15:45
4/10/13 18:15
4/10/13 20:45
4/10/13 23:15
4/11/13 1:45
4/11/13 4:15
4/11/13 6:45
Date/Time
Rainfall
Modeled Flow
Monitored Flow

Meter 5
Rain Event 6




Meter 5
Rain Event 7
Flow [MGD]
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
5/10/13 9:15
5/10/13 11:45
5/10/13 14:15
5/10/13 16:45
5/10/13 19:15
5/10/13 21:45
5/11/13 0:15
5/11/13 2:45
5/11/13 5:15
5/11/13 7:45
5/11/13 10:15
5/11/13 12:45
5/11/13 15:15
Date/Time
Rainfall
Modeled Flow
Monitored Flow

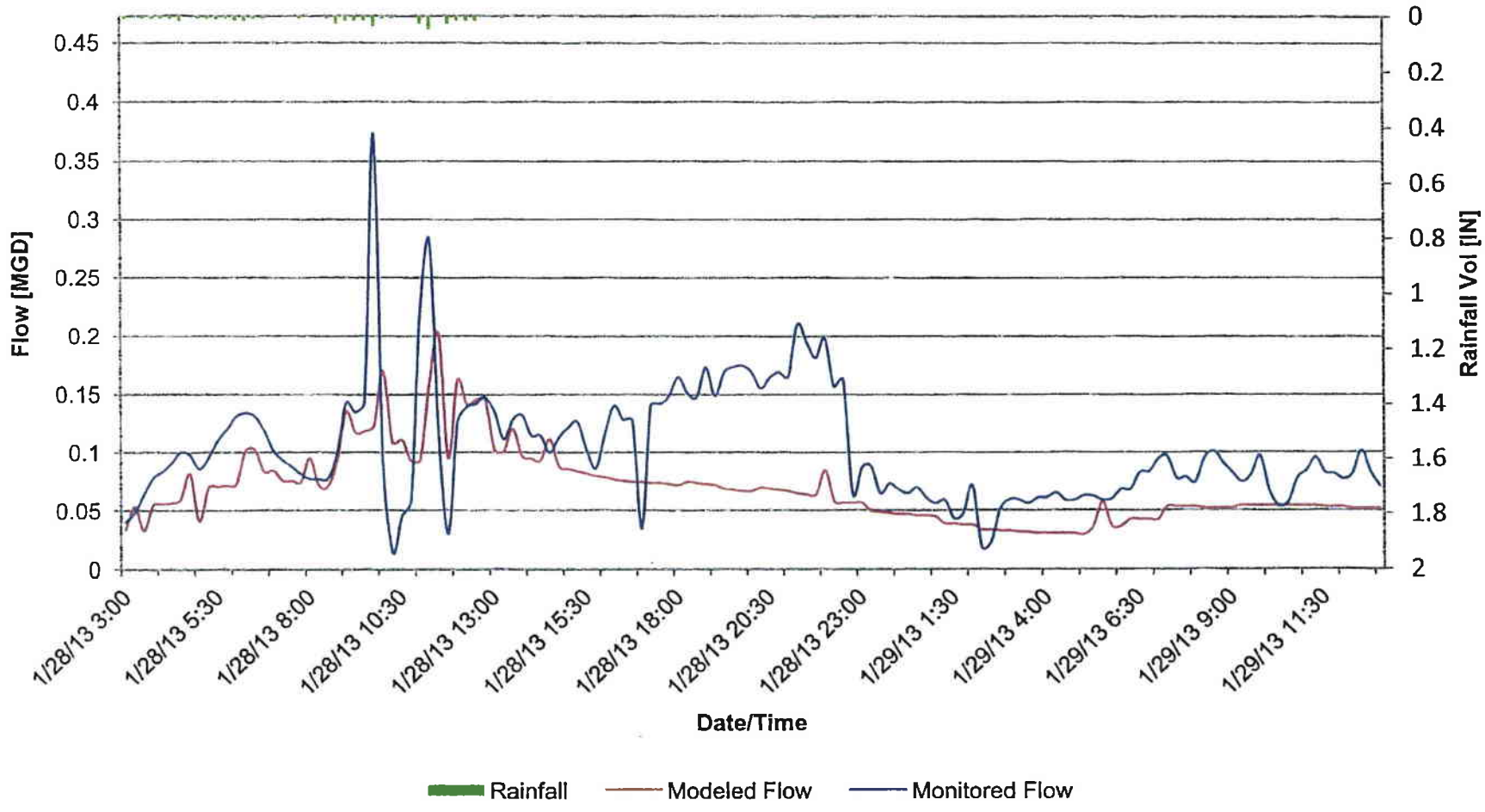
Meter 5
Rain Event 8

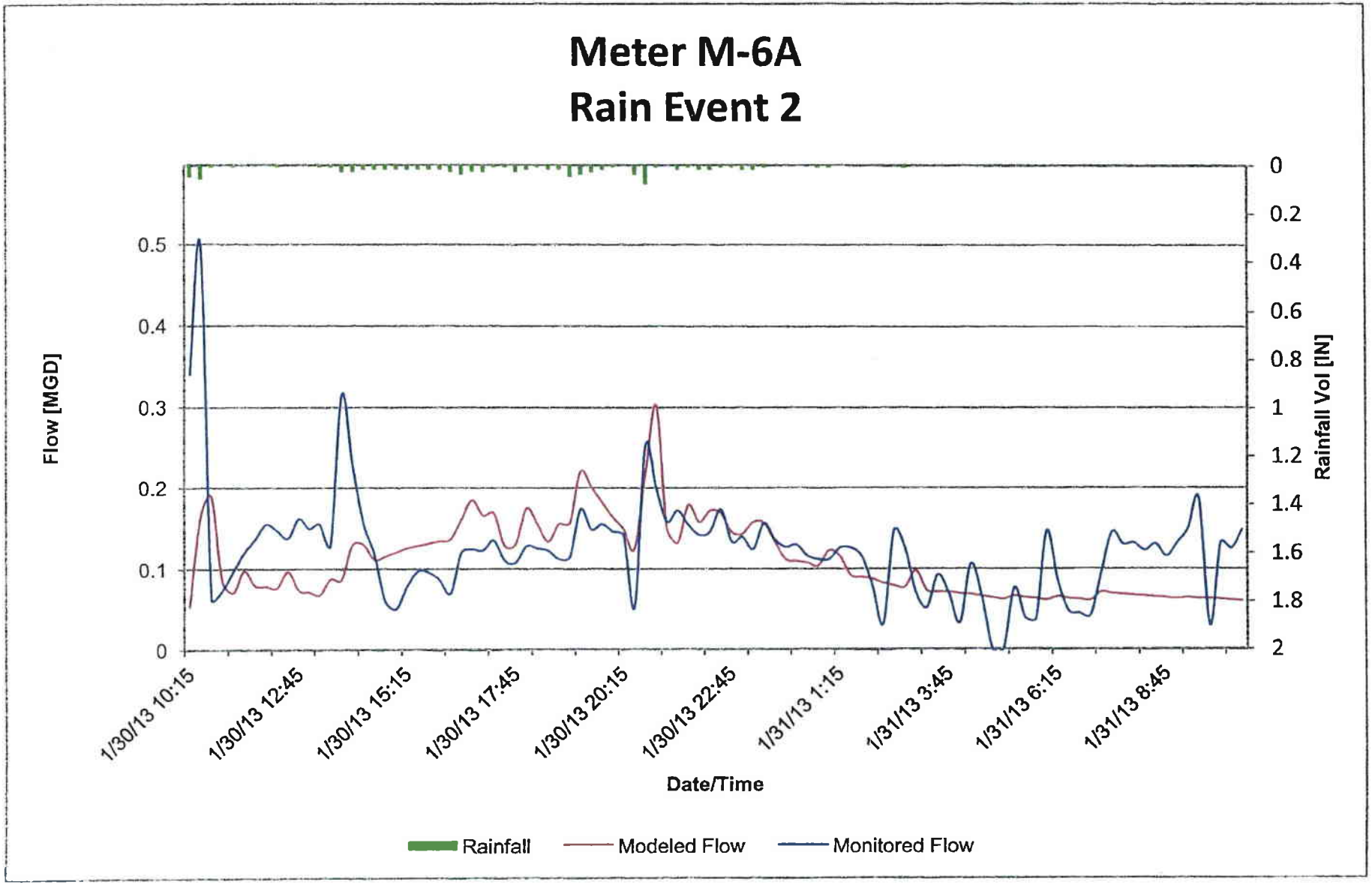


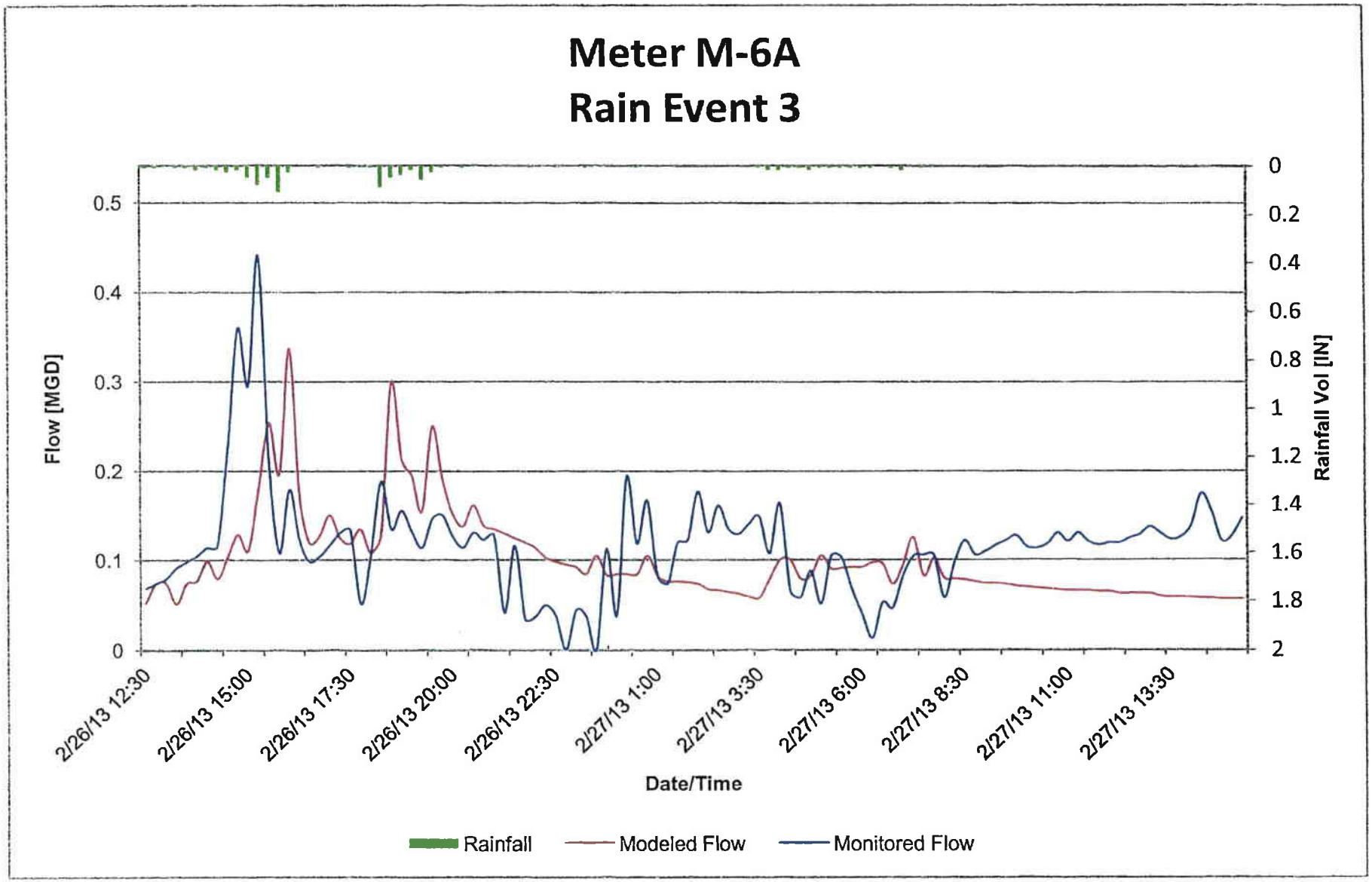
Meter M-6A
SUMMER MODEL
RAIN EVENTS

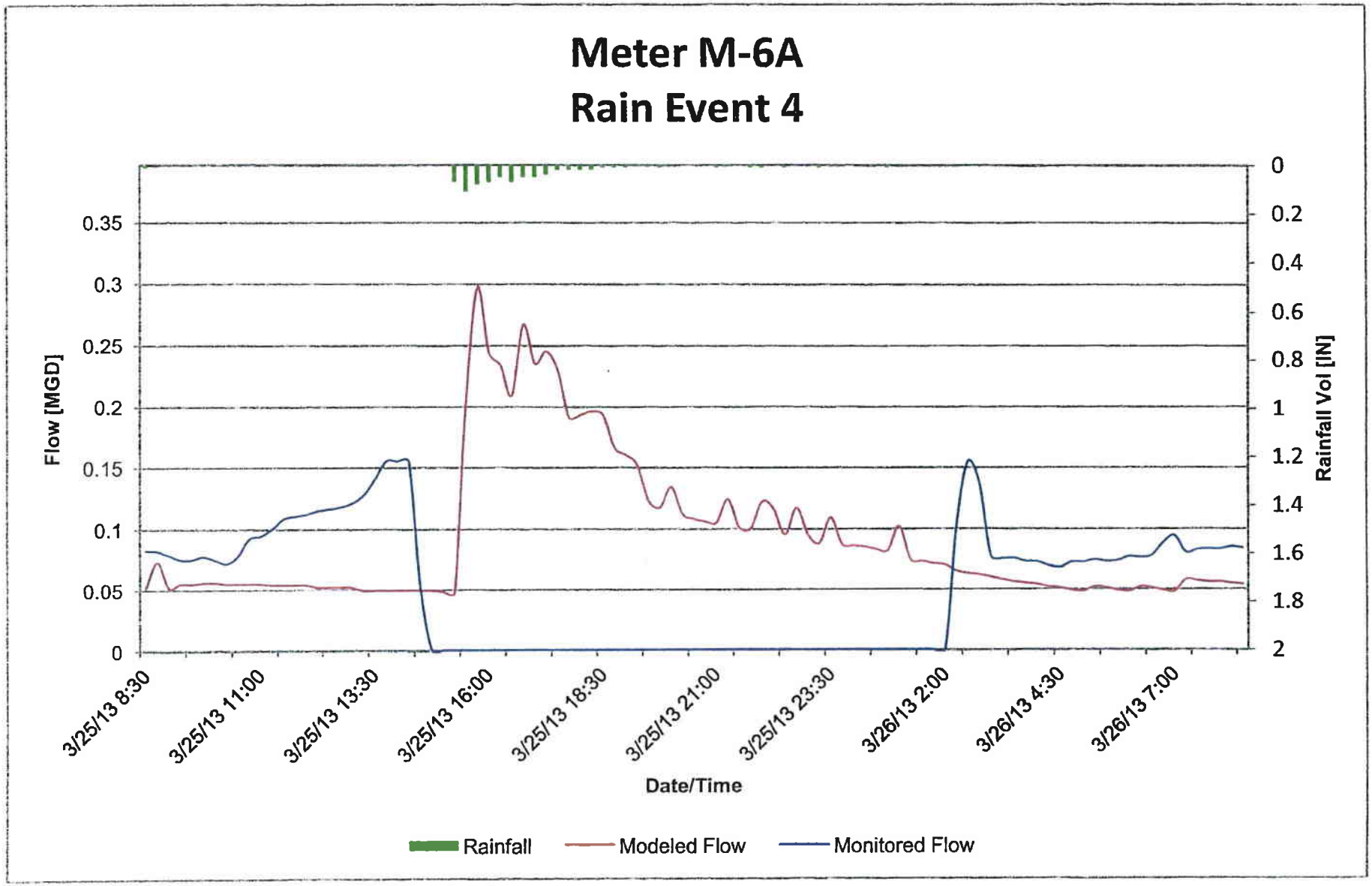
No.	Start Date	End Date	Total Rain	Max Int	Peak MOD Flow	Peak MON Flow	% Difference		Modeled Volume	Monitored Volume	% Difference	
1	1/28/13 3:00	1/28/13 20:00	0.53	0.20	0.20	0.37	45.84%	Mod LOW	0.046	0.054	14.41%	Mod LOW
2	1/30/13 10:15	1/31/13 8:30	1.08	0.32	0.30	0.50	39.40%	Mod LOW	0.086	0.088	3.11%	Mod LOW
3	2/26/13 12:30	2/27/13 13:15	1.01	0.44	0.34	0.44	23.58%	Mod LOW	0.075	0.073	2.61%	Mod HIGH
4	3/25/13 15:15	3/26/13 6:30	0.77	0.44	0.30	0.16	47.81%	Mod HIGH	0.057	0.000	100.00%	Mod HIGH
5	4/10/13 15:45	4/11/13 5:30	0.58	0.88	0.55	0.61	10.33%	Mod LOW	0.029	0.018	38.09%	Mod HIGH
6	4/16/13 20:00	4/17/13 4:45	1.13	2.40	1.39	1.01	27.20%	Mod HIGH	0.053	0.037	29.14%	Mod HIGH
7	5/22/13 23:15	5/23/13 14:30	0.52	0.72	0.463	0.722	35.90%	Mod LOW	0.032	0.038	14.50%	Mod LOW
8	5/22/13 16:00	5/24/13 15:30	1.13	1.08	0.779	0.931	16.33%	Mod LOW	0.071	0.081	12.44%	Mod LOW

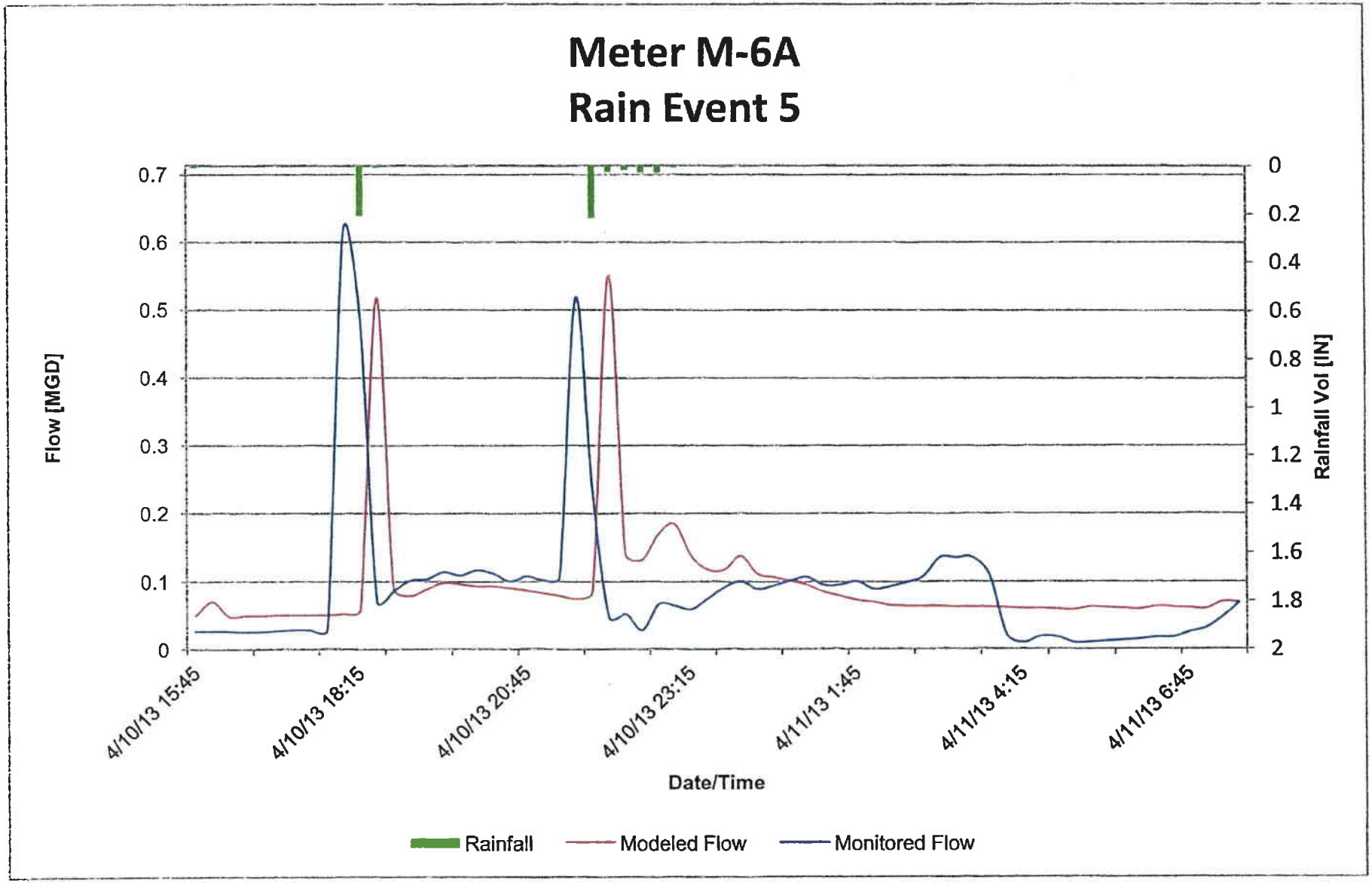
Meter M-6A
Rain Event 1

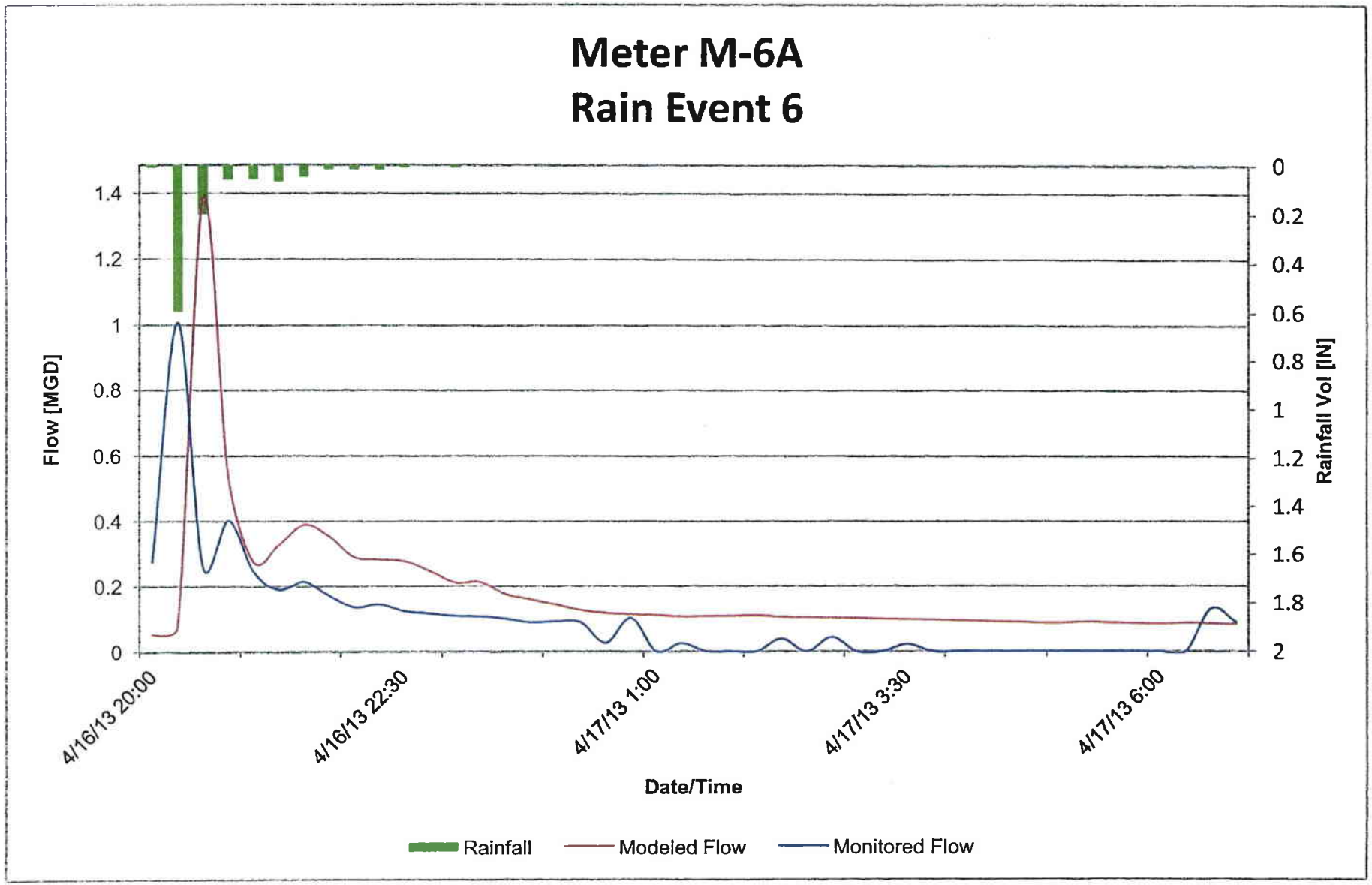



Meter M-6A
Rain Event 2
Flow [MGD]
0.5
0.4
0.3
0.2
0.1
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Rainfall Vol [IN]
1/30/13 10:15
1/30/13 12:45
1/30/13 15:15
1/30/13 17:45
1/30/13 20:15
1/30/13 22:45
1/31/13 1:15
1/31/13 3:45
1/31/13 6:15
1/31/13 8:45
Date/Time
Rainfall
Modeled Flow
Monitored Flow

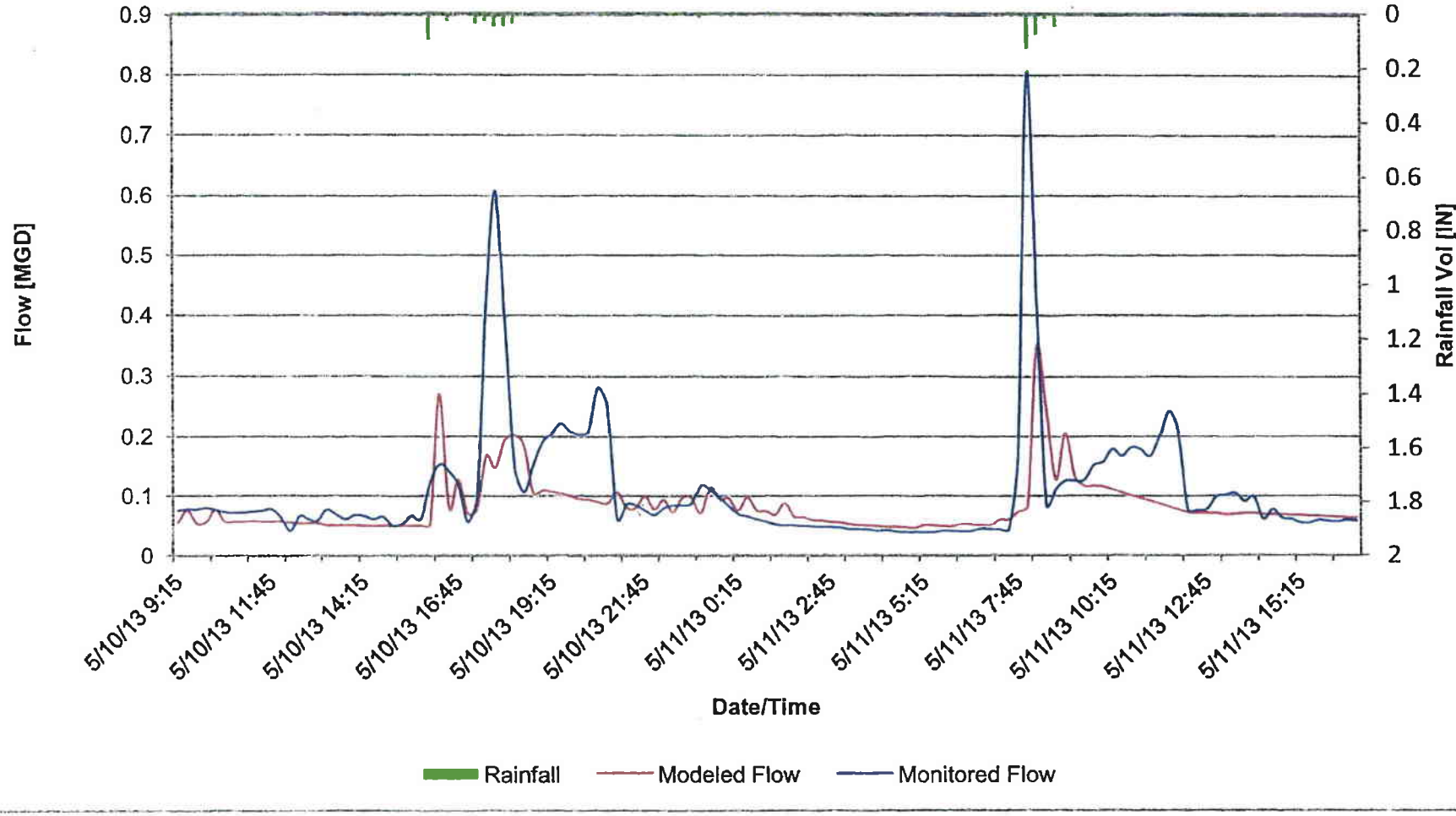

Meter M-6A
Rain Event 3
Flow [MGD]
0.5
0.4
0.3
0.2
0.1
0
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2/26/13 12:30
2/26/13 15:00
2/26/13 17:30
2/26/13 20:00
2/26/13 22:30
2/27/13 1:00
2/27/13 3:30
2/27/13 6:00
2/27/13 8:30
2/27/13 11:00
2/27/13 13:30
Date/Time
Rainfall
Modeled Flow
Monitored Flow


Meter M-6A
Rain Event 4
Flow [MGD]
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
3/25/13 8:30
3/25/13 11:00
3/25/13 13:30
3/25/13 16:00
3/25/13 18:30
3/25/13 21:00
3/25/13 23:30
3/26/13 2:00
3/26/13 4:30
3/26/13 7:00
Date/Time
Rainfall
Modeled Flow
Monitored Flow

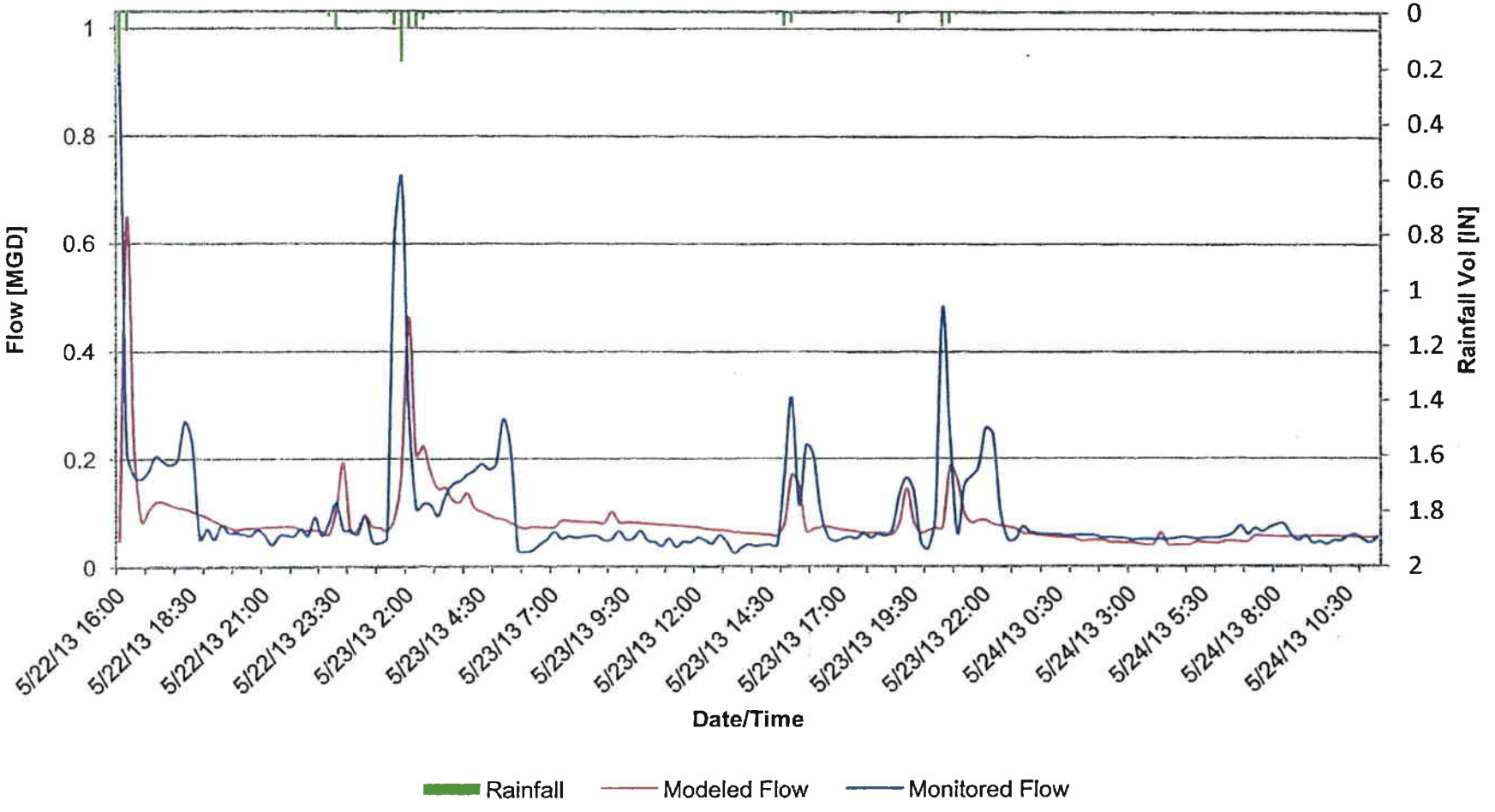

Meter M-6A
Rain Event 5
Flow [MGD]
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
4/10/13 15:45
4/10/13 18:15
4/10/13 20:45
4/10/13 23:15
4/11/13 1:45
4/11/13 4:15
4/11/13 6:45
Date/Time
Rainfall
Modeled Flow
Monitored Flow


Meter M-6A
Rain Event 6
Flow [MGD]
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
4/16/13 20:00
4/16/13 22:30
4/17/13 1:00
4/17/13 3:30
4/17/13 6:00
Date/Time
Rainfall
Modeled Flow
Monitored Flow

Meter M-6A
Rain Event 7

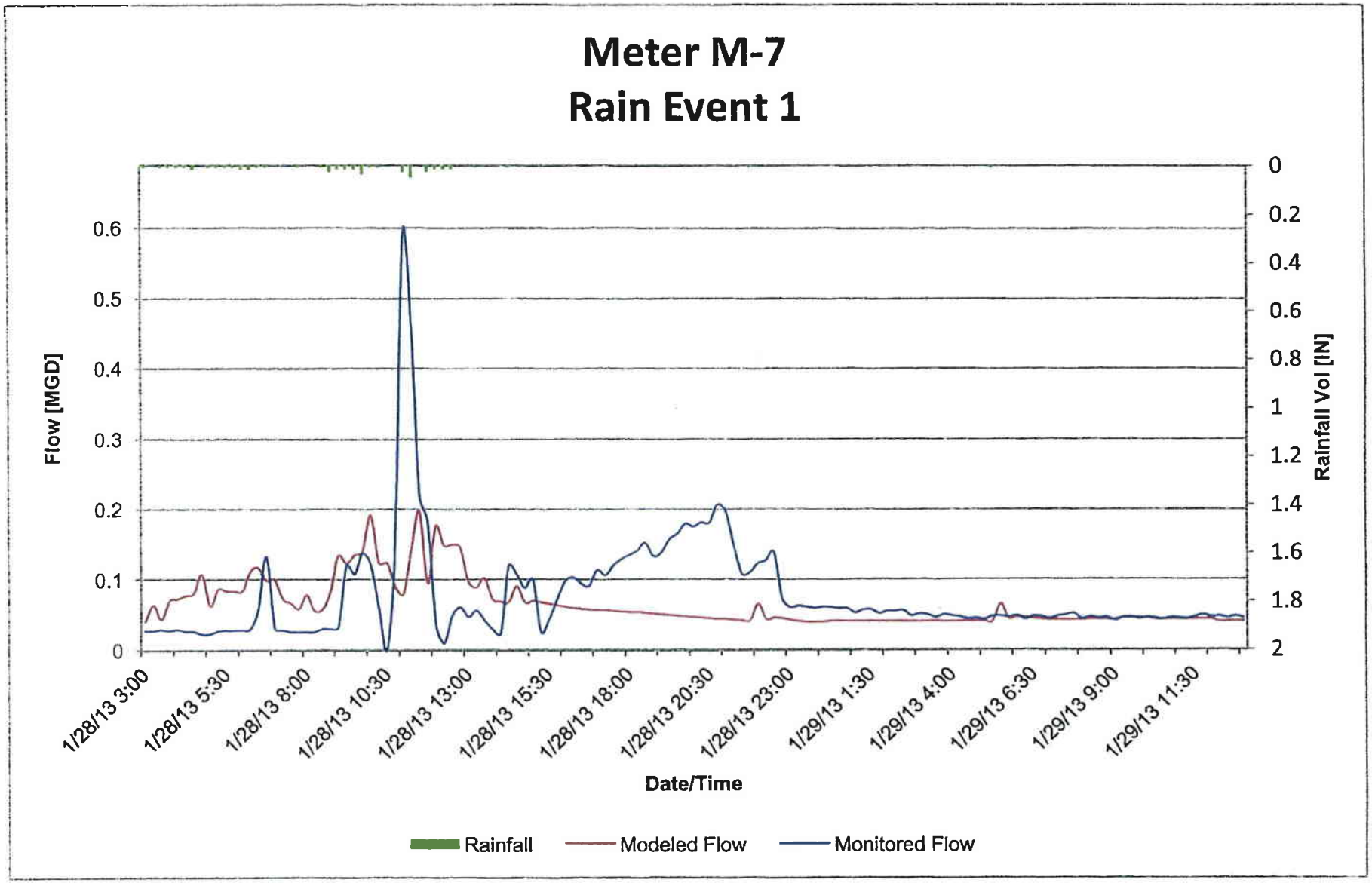


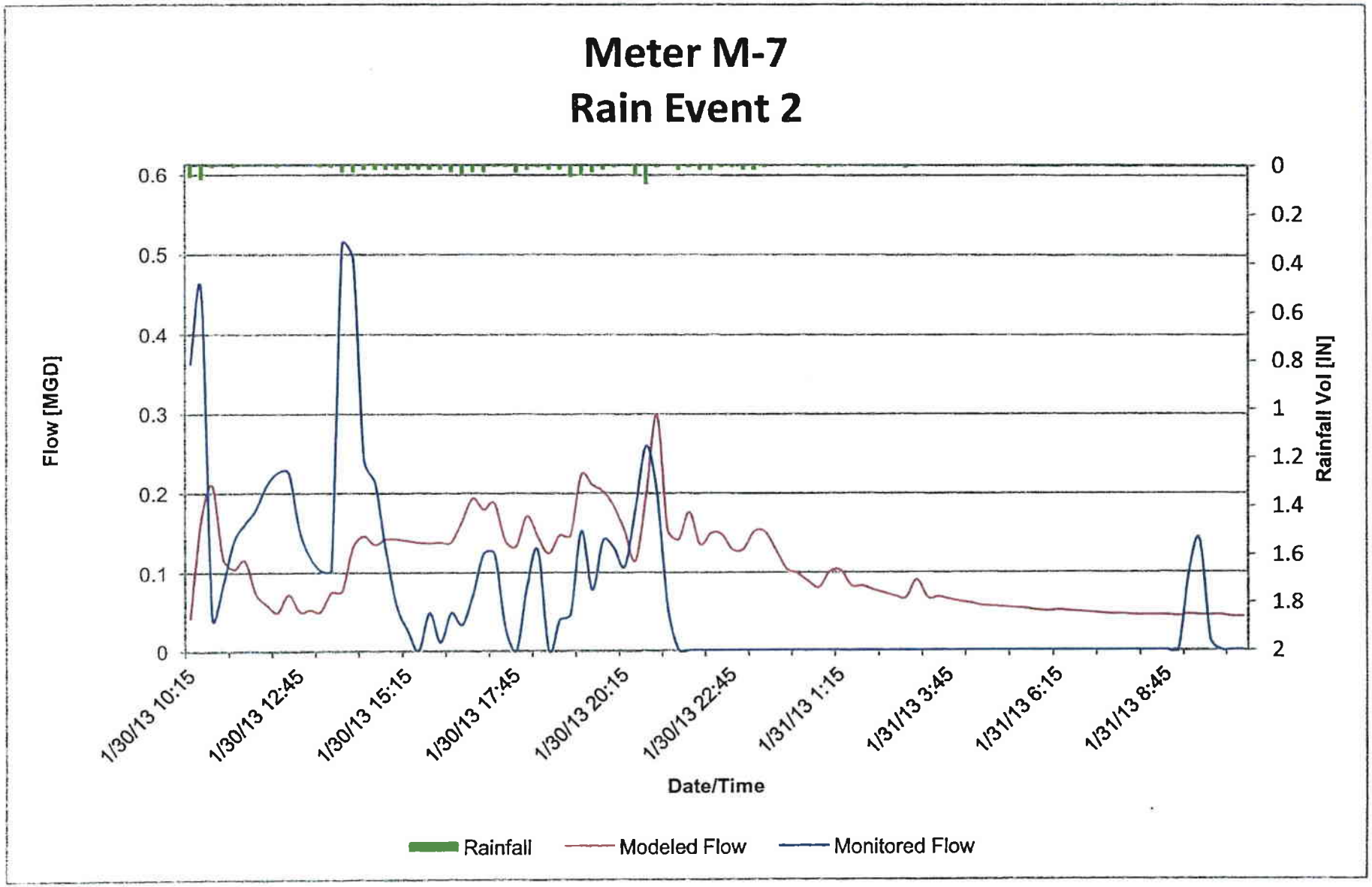
Meter M-6A
Rain Event 8

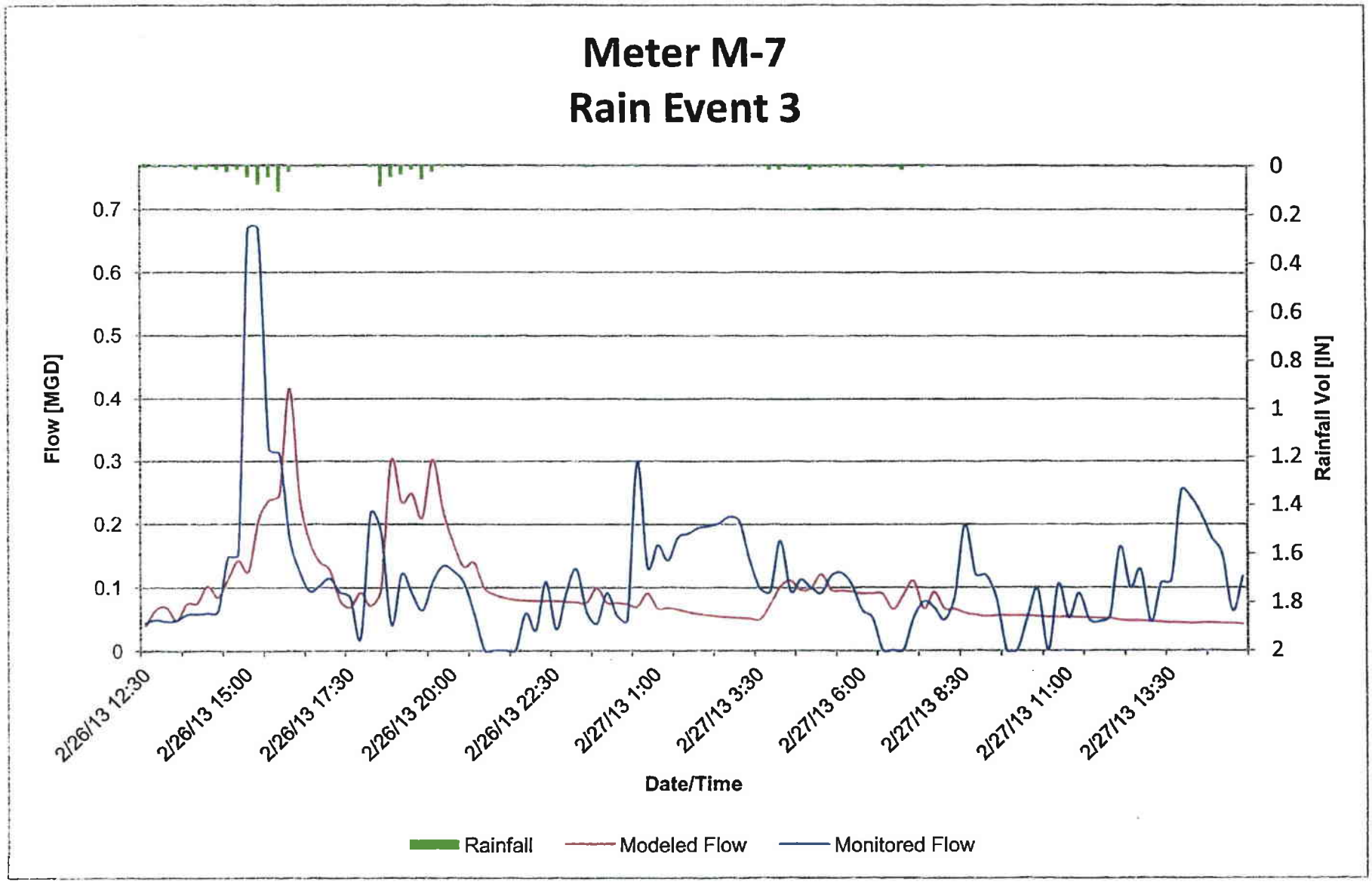


Meter M-7
SUMMER MODEL
RAIN EVENTS

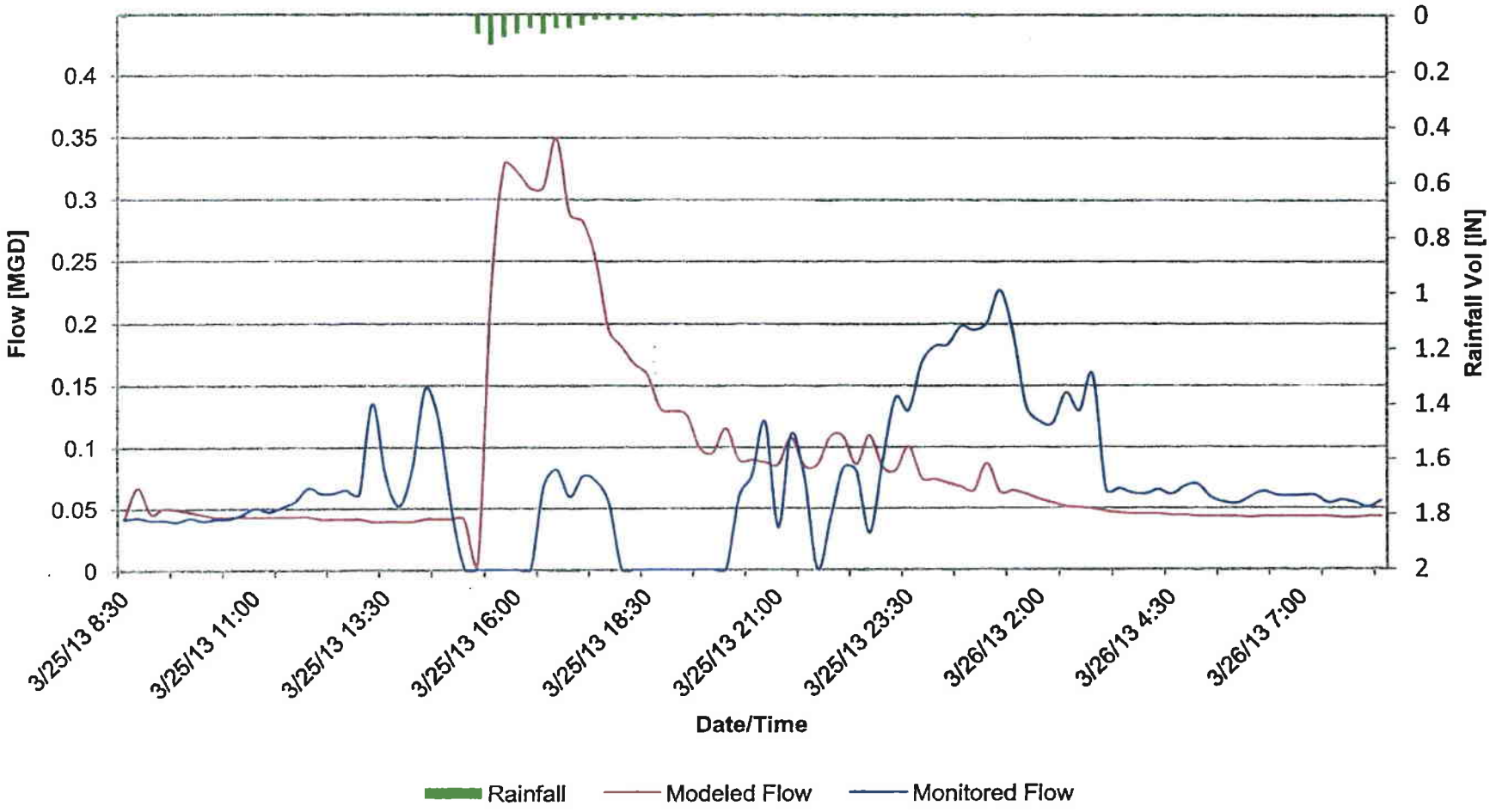
No.	Start Date	End Date	Total Rain	Max Int	Peak MOD Flow	Peak MON Flow	% Difference		Modeled Volume	Monitored Volume	% Difference	
1	1/28/13 3:00	1/29/13 13:00	0.55	0.20	0.20	0.59	66.55%	Mod LOW	0.050	0.043	15.74%	Mod HIGH
2	1/30/13 10:15	1/31/13 10:30	1.08	0.32	0.30	0.51	41.83%	Mod LOW	0.085	0.062	26.76%	Mod HIGH
3	2/26/13 12:30	2/27/13 15:15	1.01	0.44	0.42	0.67	37.82%	Mod LOW	0.076	0.073	4.69%	Mod HIGH
4	3/25/13 8:30	3/26/13 8:30	0.78	0.44	0.35	0.23	35.05%	Mod HIGH	0.059	0.023	61.10%	Mod HIGH
5	4/10/13 15:45	4/11/13 7:30	0.58	0.88	0.59	0.00	100.00%	Mod HIGH	0.034	0.000	100.00%	Mod HIGH
6	4/16/13 20:00	4/17/13 6:45	1.13	2.40	1.54	1.43	6.83%	Mod HIGH	0.060	0.051	14.91%	Mod HIGH
7	5/10/13 9:15	5/11/13 16:45	0.79	0.52	0.378	0.191	49.47%	Mod HIGH	0.057	0.019	66.89%	Mod HIGH
8	5/22/13 16:00	5/24/13 11:30	1.13	1.08	0.724	0.665	8.20%	Mod HIGH	0.070	0.051	26.82%	Mod HIGH
		No Monitored Flow										

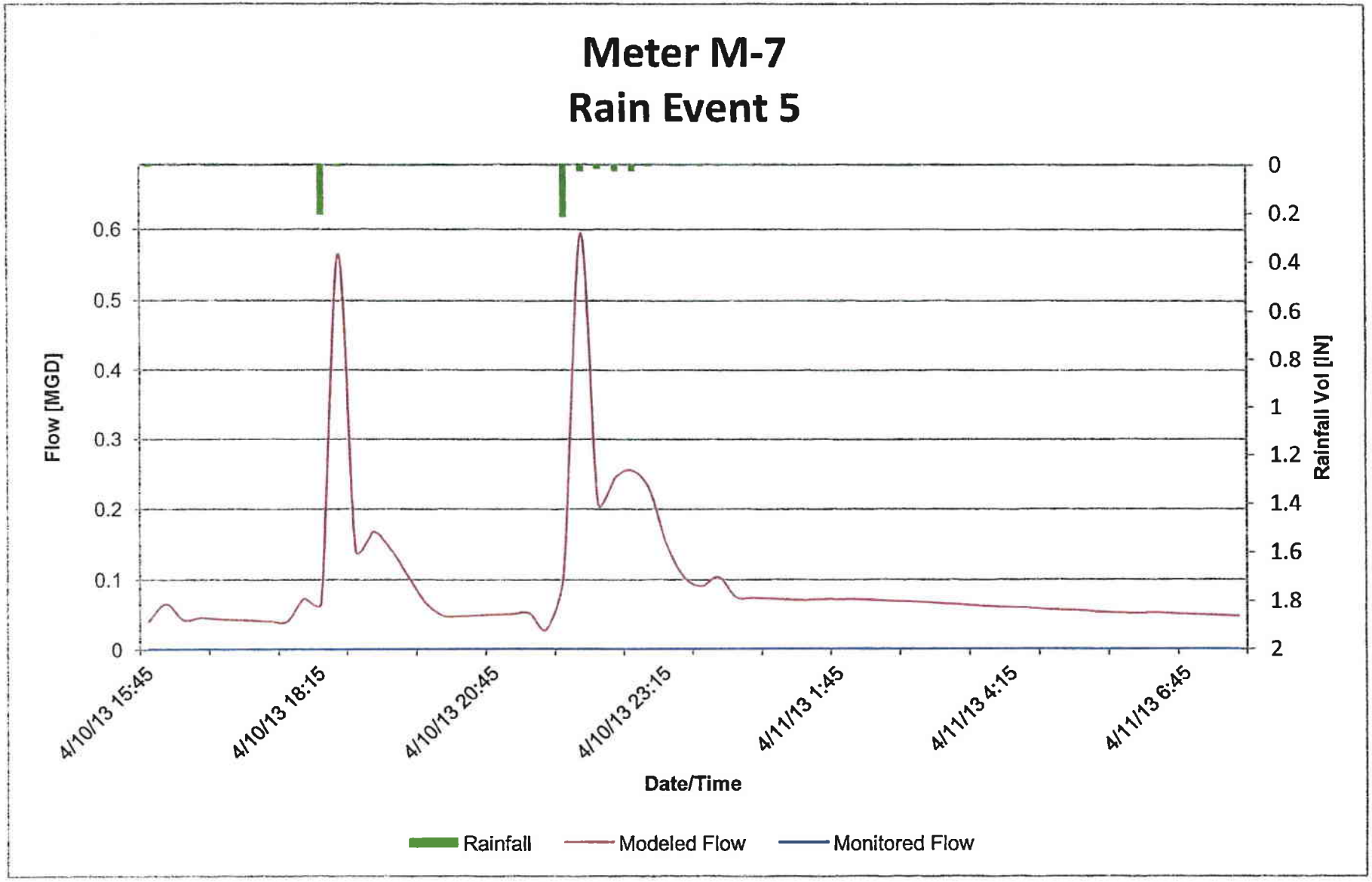

Meter M-7
Rain Event 1
Flow [MGD]
0
0.1
0.2
0.3
0.4
0.5
0.6
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
1/28/13 3:00
1/28/13 5:30
1/28/13 8:00
1/28/13 10:30
1/28/13 13:00
1/28/13 15:30
1/28/13 18:00
1/28/13 20:30
1/28/13 23:00
1/29/13 1:30
1/29/13 4:00
1/29/13 6:30
1/29/13 9:00
1/29/13 11:30
Date/Time
Rainfall
Modeled Flow
Monitored Flow


Meter M-7
Rain Event 2
Flow [MGD]
0.6
0.5
0.4
0.3
0.2
0.1
0
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
1/30/13 10:15
1/30/13 12:45
1/30/13 15:15
1/30/13 17:45
1/30/13 20:15
1/30/13 22:45
1/31/13 1:15
1/31/13 3:45
1/31/13 6:15
1/31/13 8:45
Date/Time
Rainfall
Modeled Flow
Monitored Flow

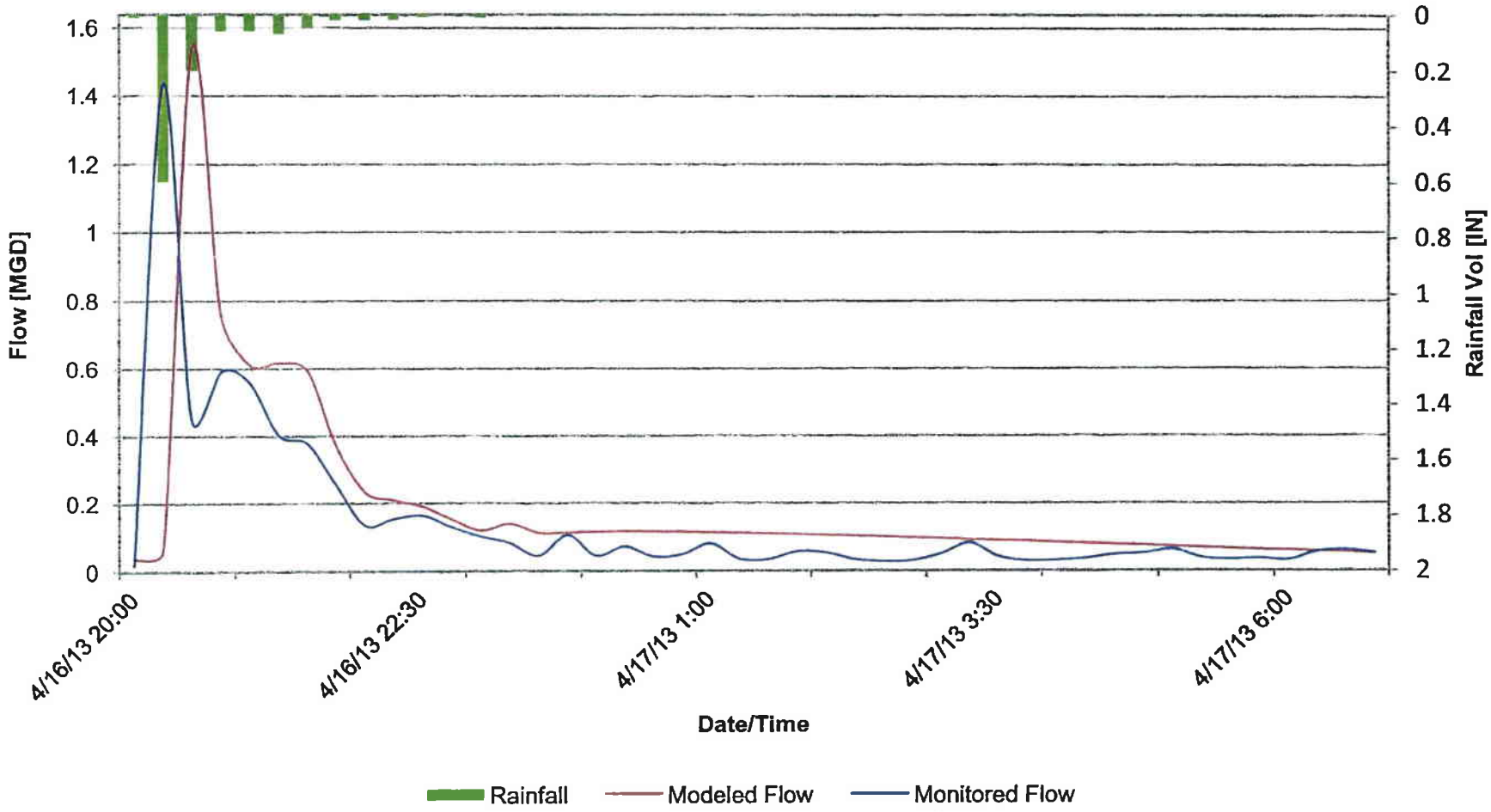

Meter M-7
Rain Event 3
Flow [MGD]
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2/26/13 12:30
2/26/13 15:00
2/26/13 17:30
2/26/13 20:00
2/26/13 22:30
2/27/13 1:00
2/27/13 3:30
2/27/13 6:00
2/27/13 8:30
2/27/13 11:00
2/27/13 13:30
Date/Time
Rainfall
Modeled Flow
Monitored Flow

Meter M-7
Rain Event 4

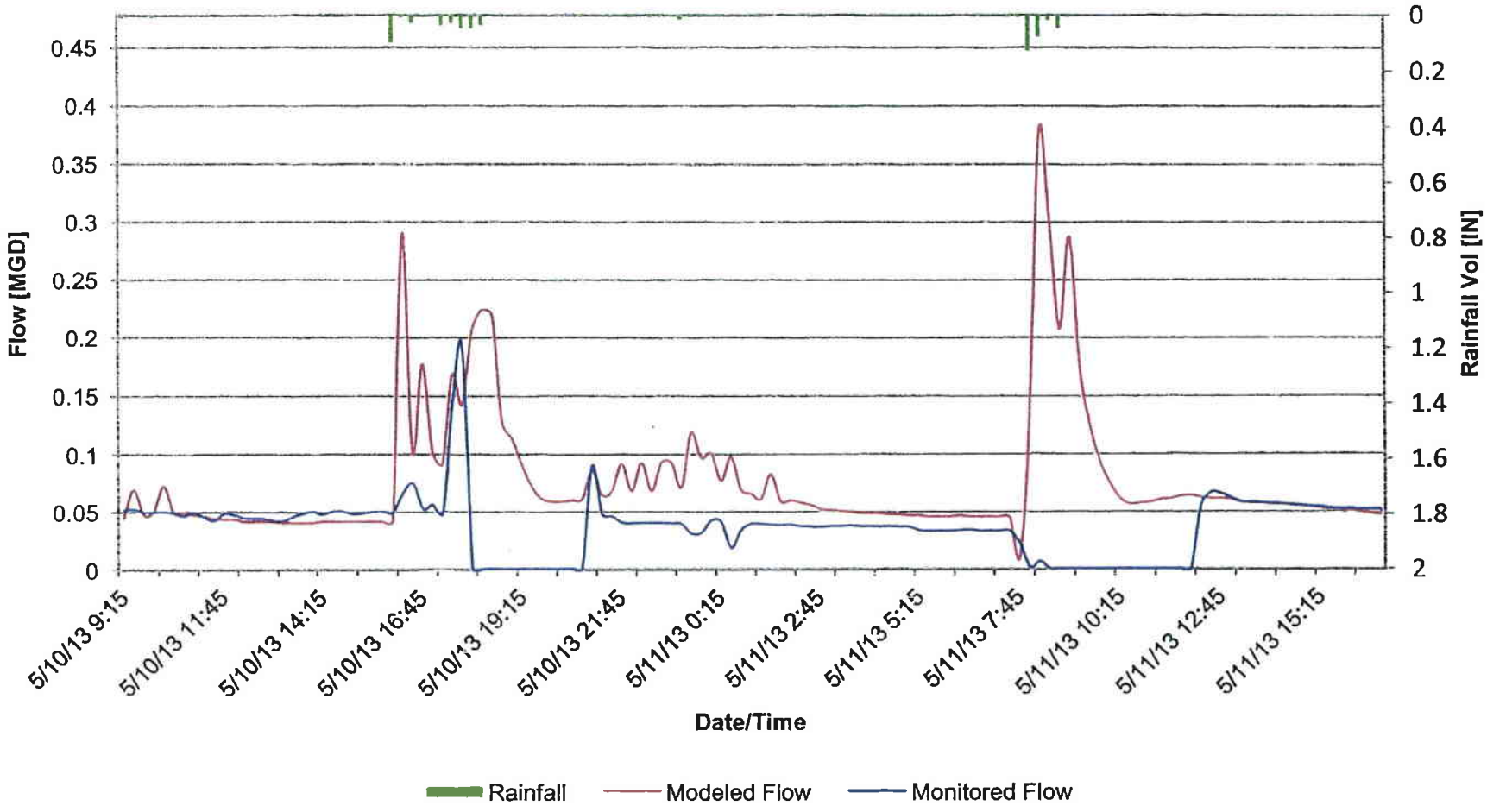



Meter M-7
Rain Event 5
Flow [MGD]
0
0.1
0.2
0.3
0.4
0.5
0.6
Rainfall Vol [IN]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
4/10/13 15:45
4/10/13 18:15
4/10/13 20:45
4/10/13 23:15
4/11/13 1:45
4/11/13 4:15
4/11/13 6:45
Date/Time
Rainfall
Modeled Flow
Monitored Flow

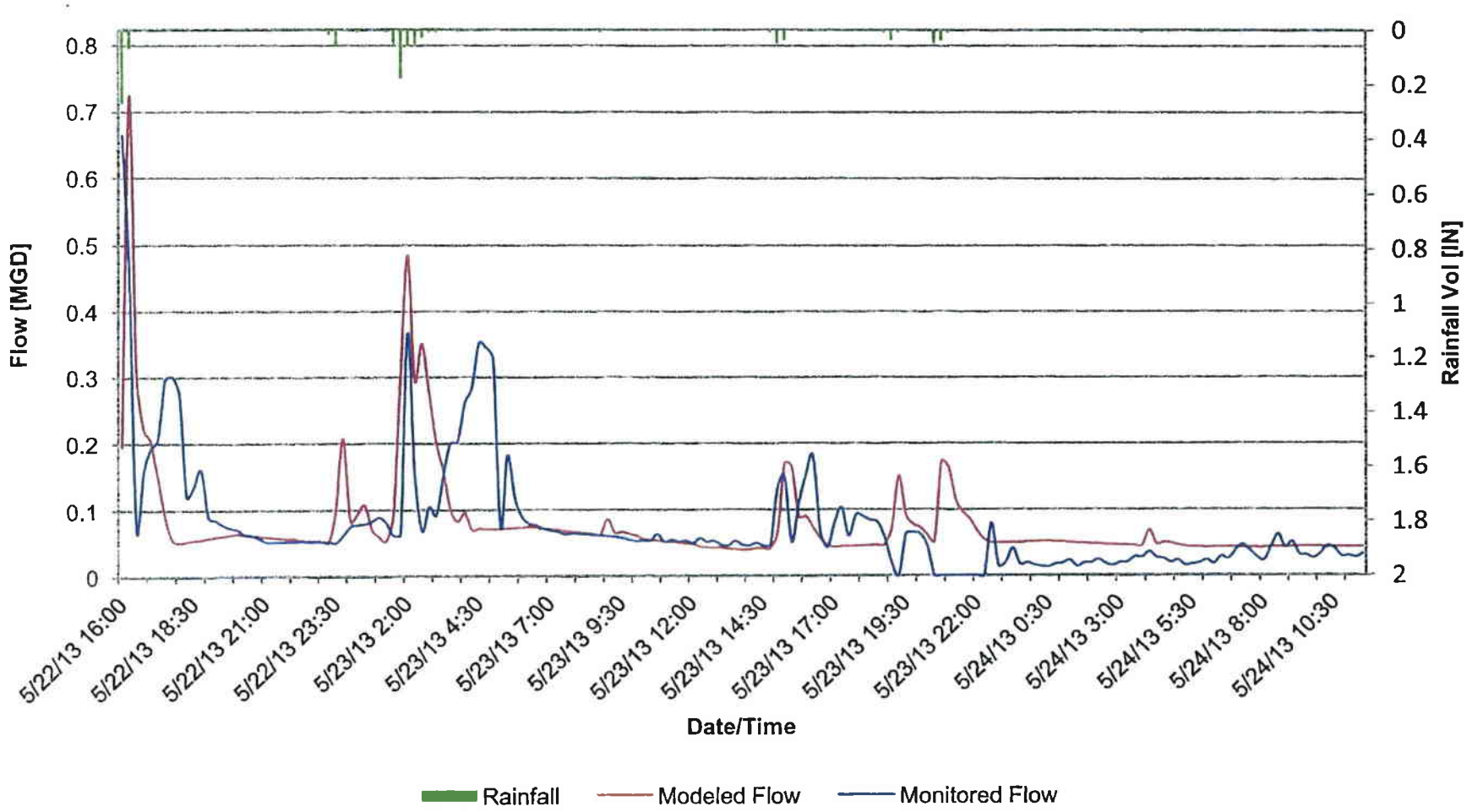
Meter M-7
Rain Event 6



Meter M-7
Rain Event 7

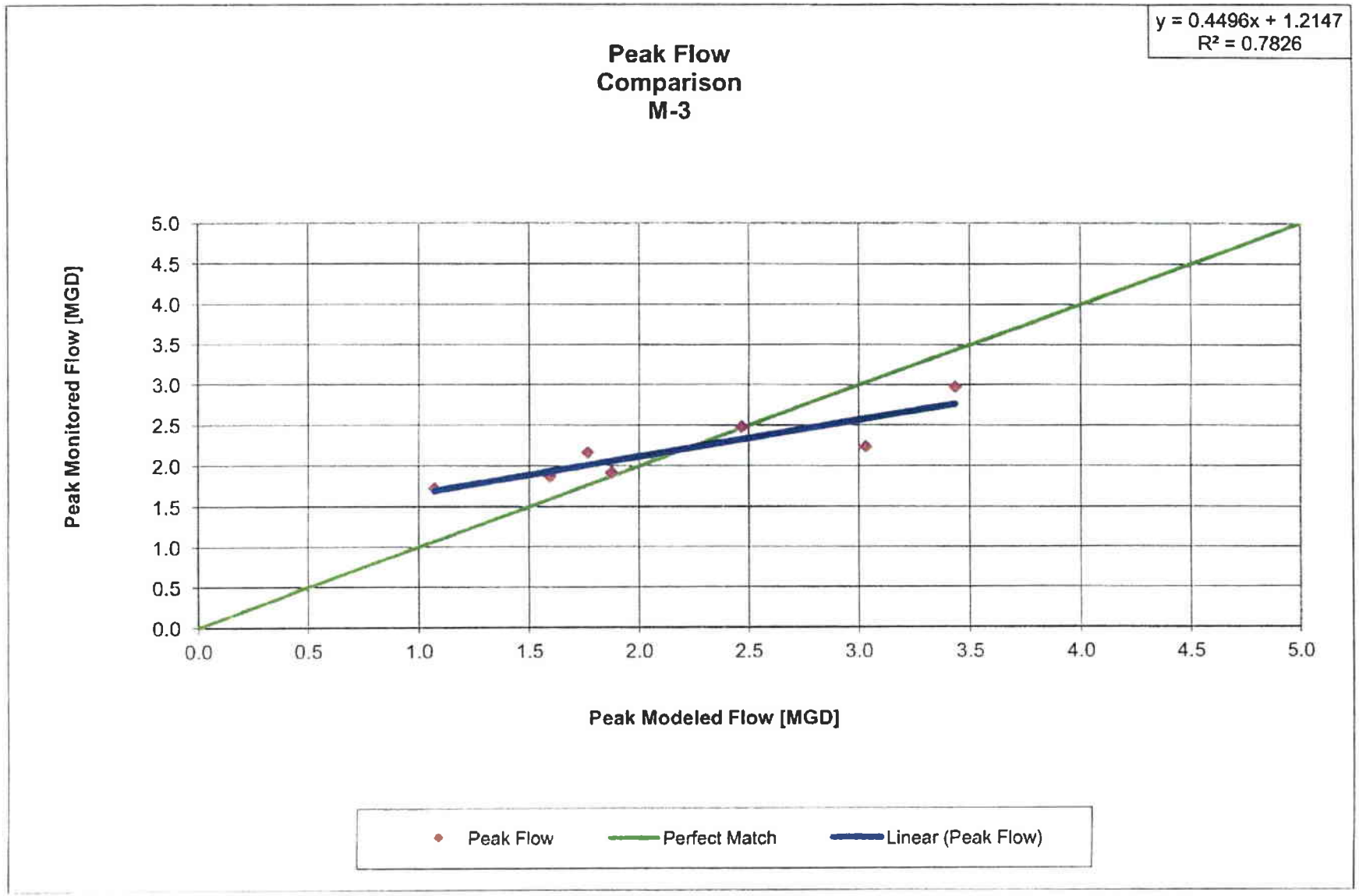


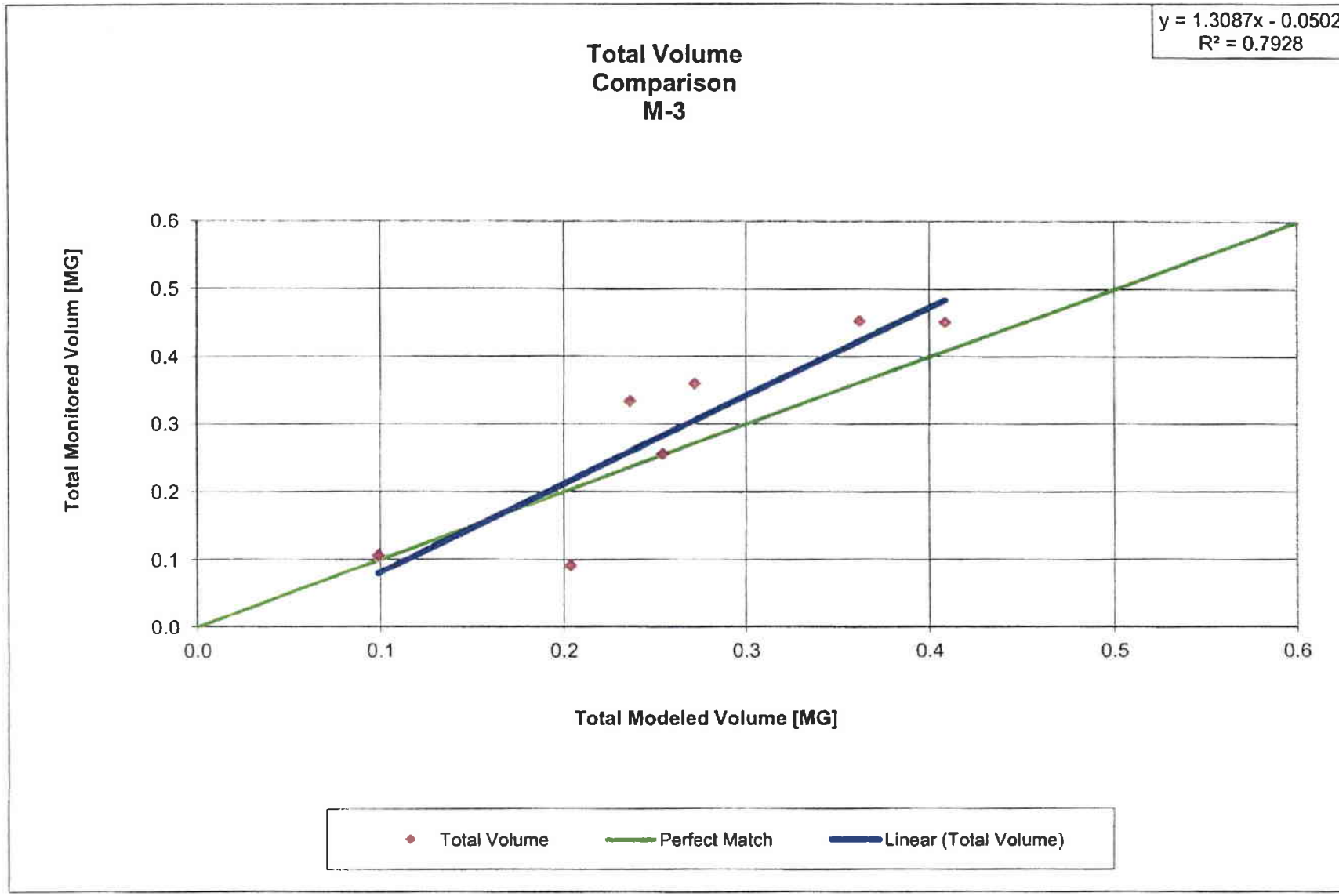
Meter M-7
Rain Event 8

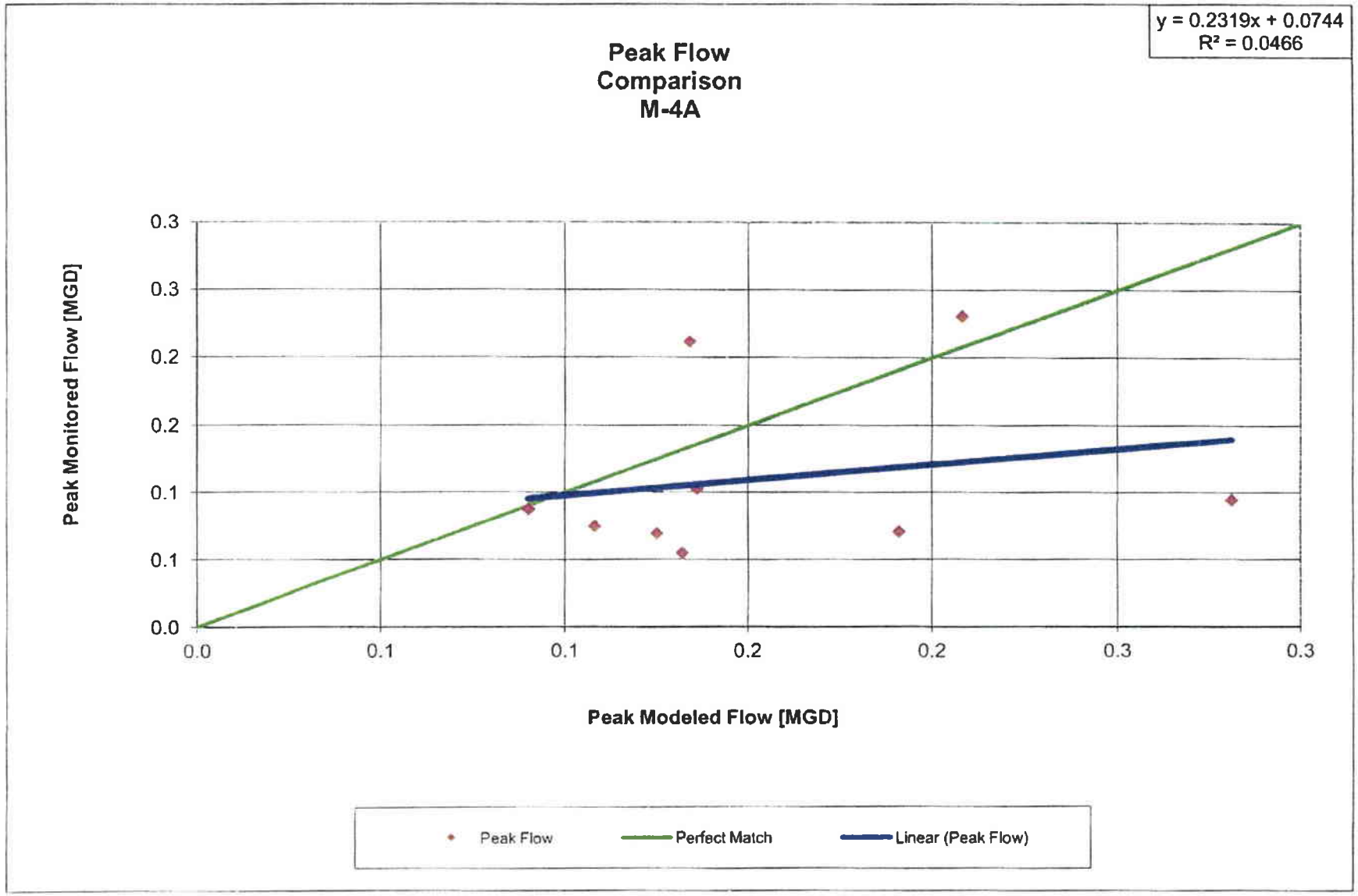


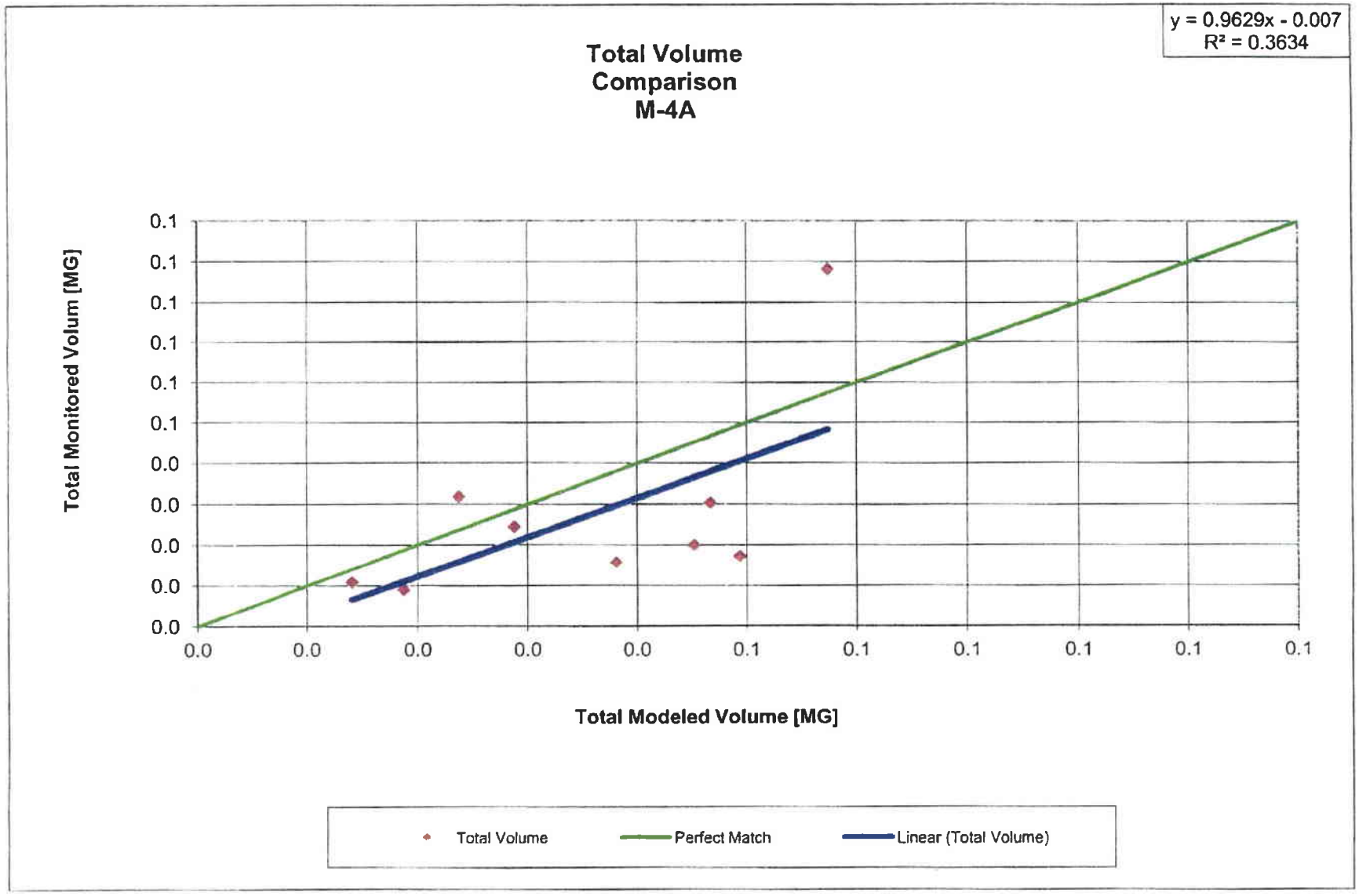
APPENDIX H

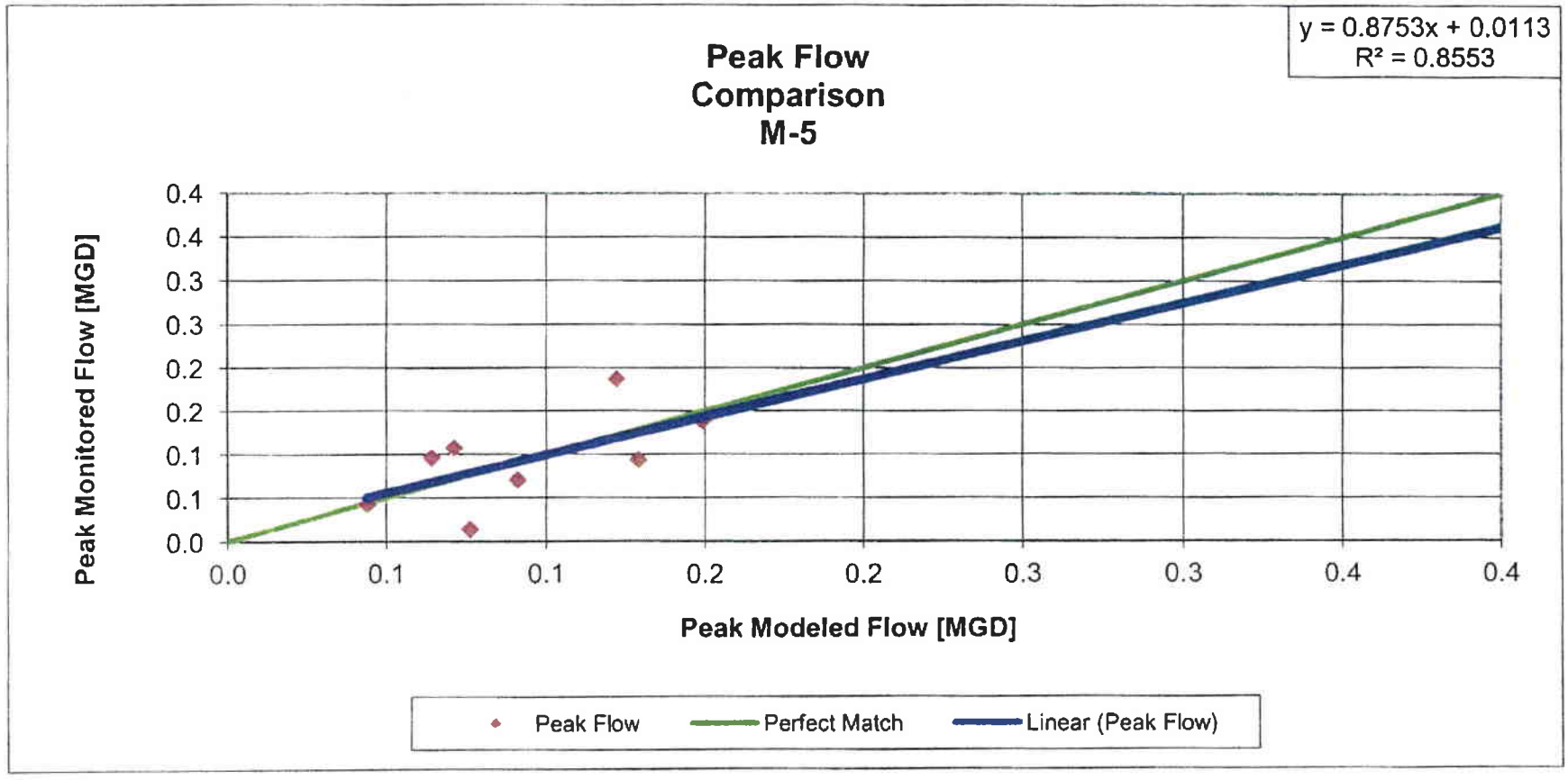
MONITORED VS. MODELED REGRESSION PLOTS

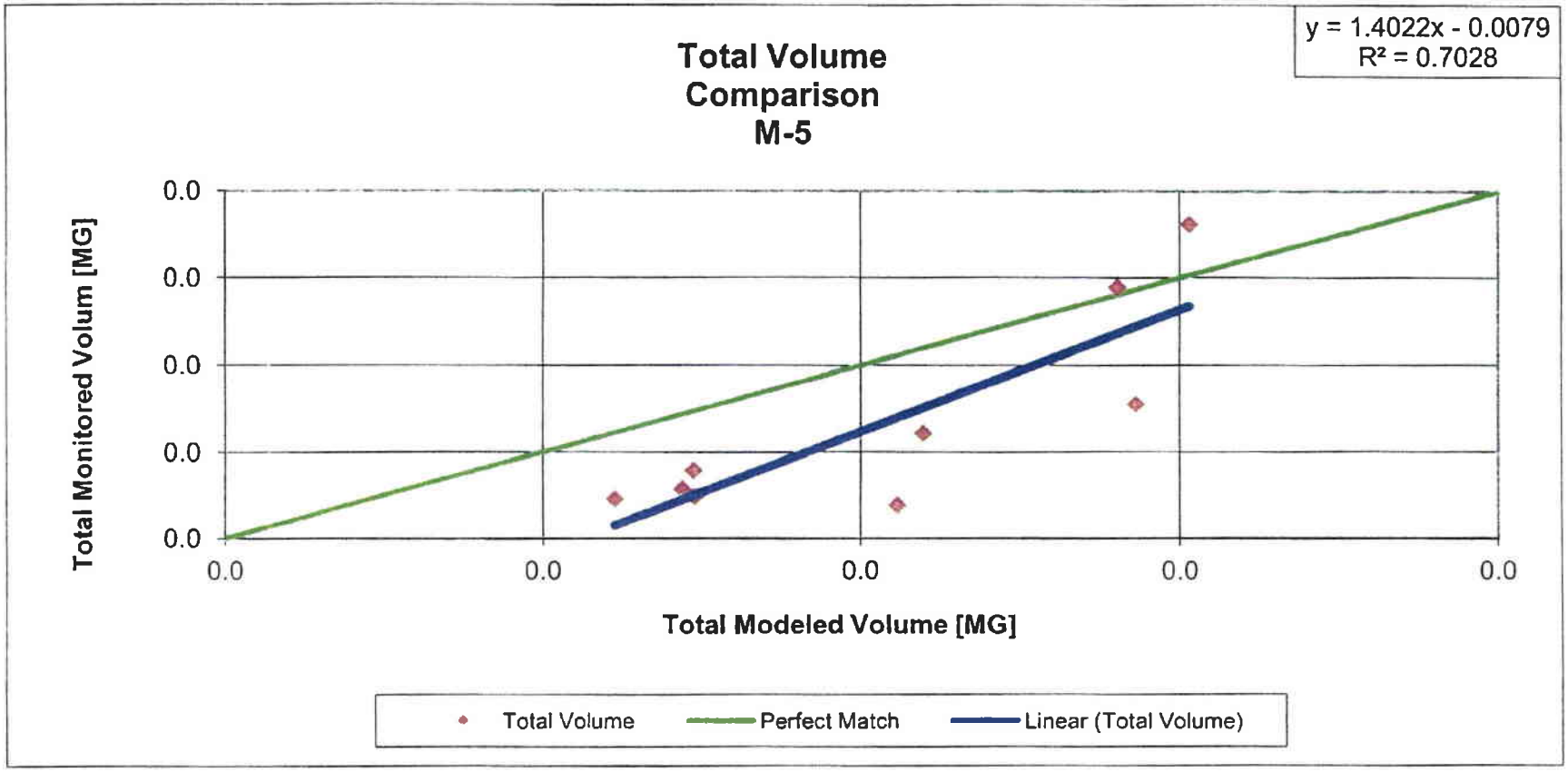

y = 0.4496x + 1.2147
R² = 0.7826
Peak Flow Comparison M-3
Peak Monitored Flow [MGD]
Peak Modeled Flow [MGD]
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Peak Flow
Perfect Match
Linear (Peak Flow)

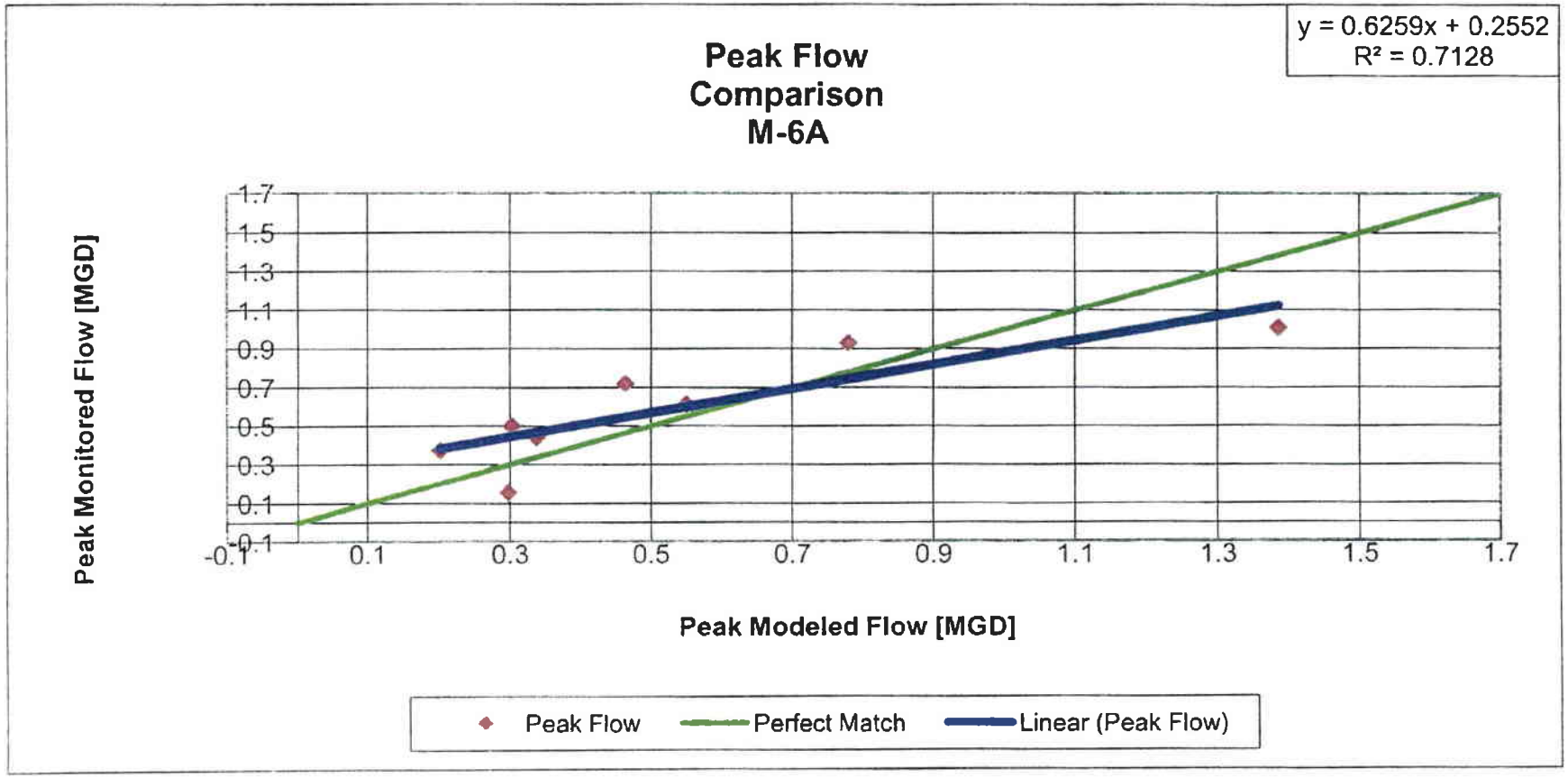

y = 1.3087x - 0.0502
R² = 0.7928
Total Volume Comparison M-3
Total Monitored Volum [MG]
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
Total Modeled Volume [MG]
Total Volume
Perfect Match
Linear (Total Volume)

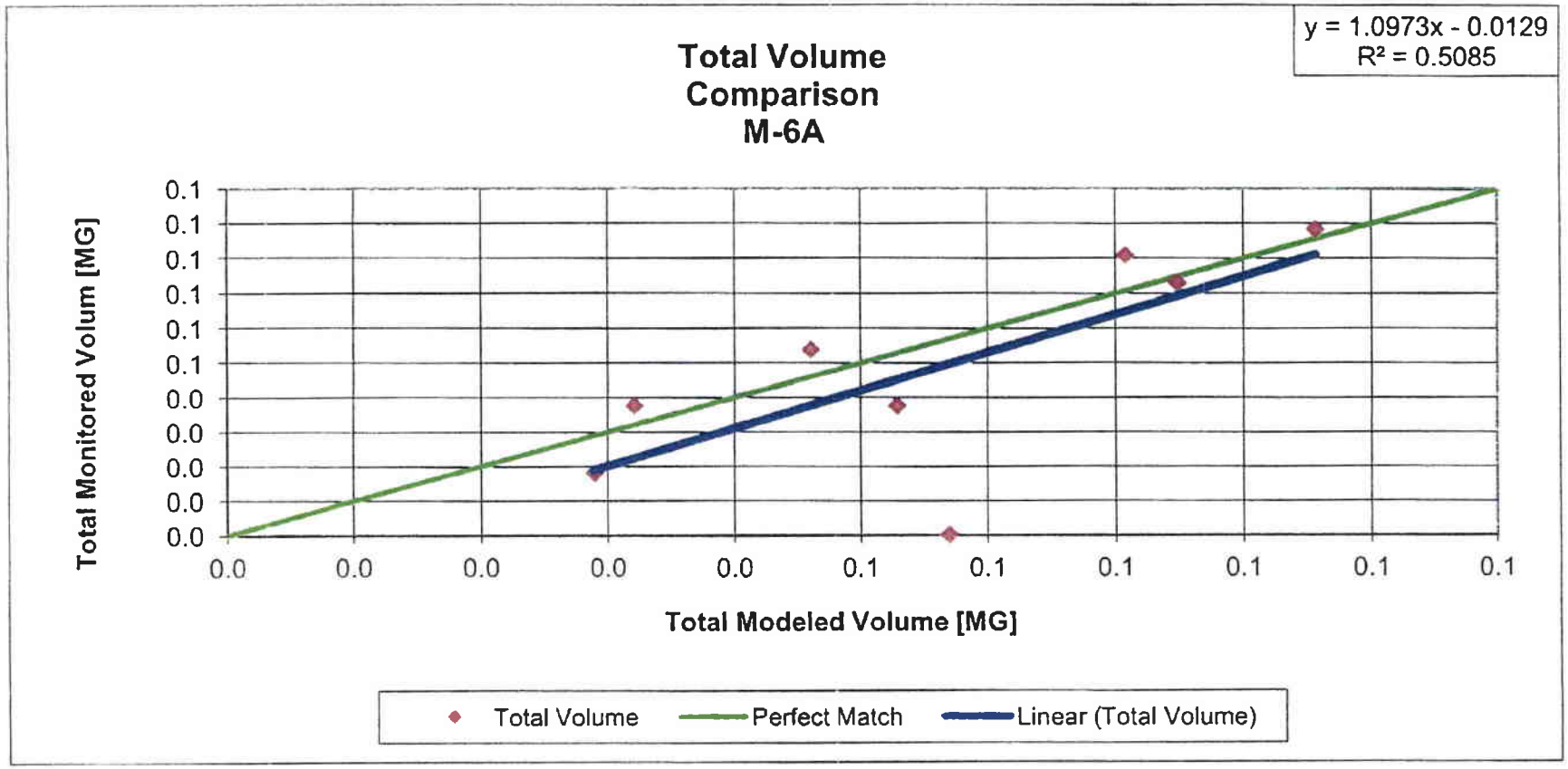

y = 0.2319x + 0.0744
R² = 0.0466
Peak Flow Comparison M-4A
Peak Monitored Flow [MGD]
0.0
0.1
0.1
0.2
0.2
0.3
0.3
Peak Modeled Flow [MGD]
Peak Flow
Perfect Match
Linear (Peak Flow)

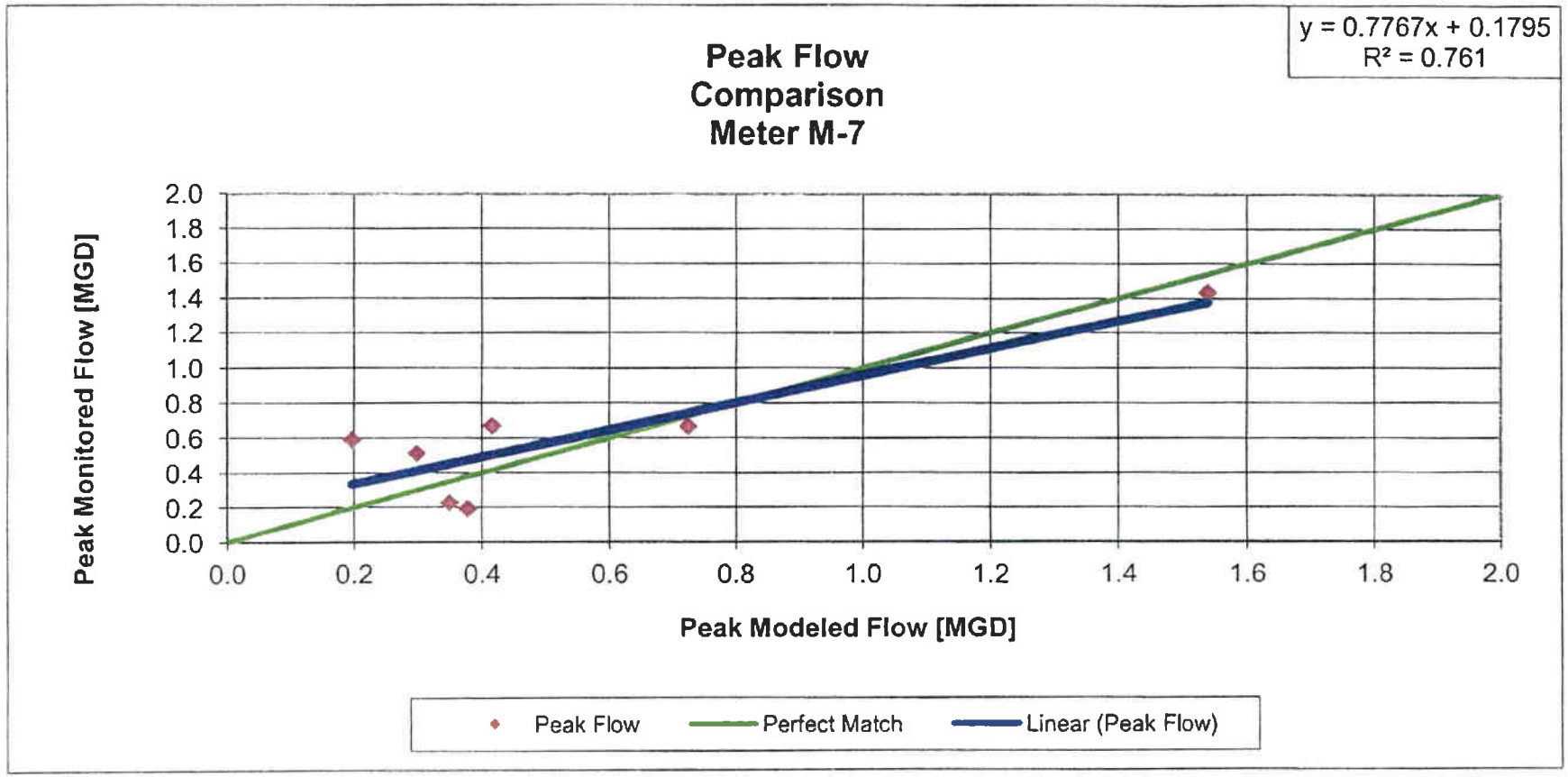

y = 0.9629x - 0.007
R² = 0.3634
Total Volume Comparison M-4A
Total Monitored Volum [MG]
0.1
0.1
0.1
0.1
0.1
0.1
0.0
0.0
0.0
0.0
0.0
0.0
0.0
0.0
0.0
0.1
0.1
0.1
0.1
0.1
Total Modeled Volume [MG]
Total Volume
Perfect Match
Linear (Total Volume)

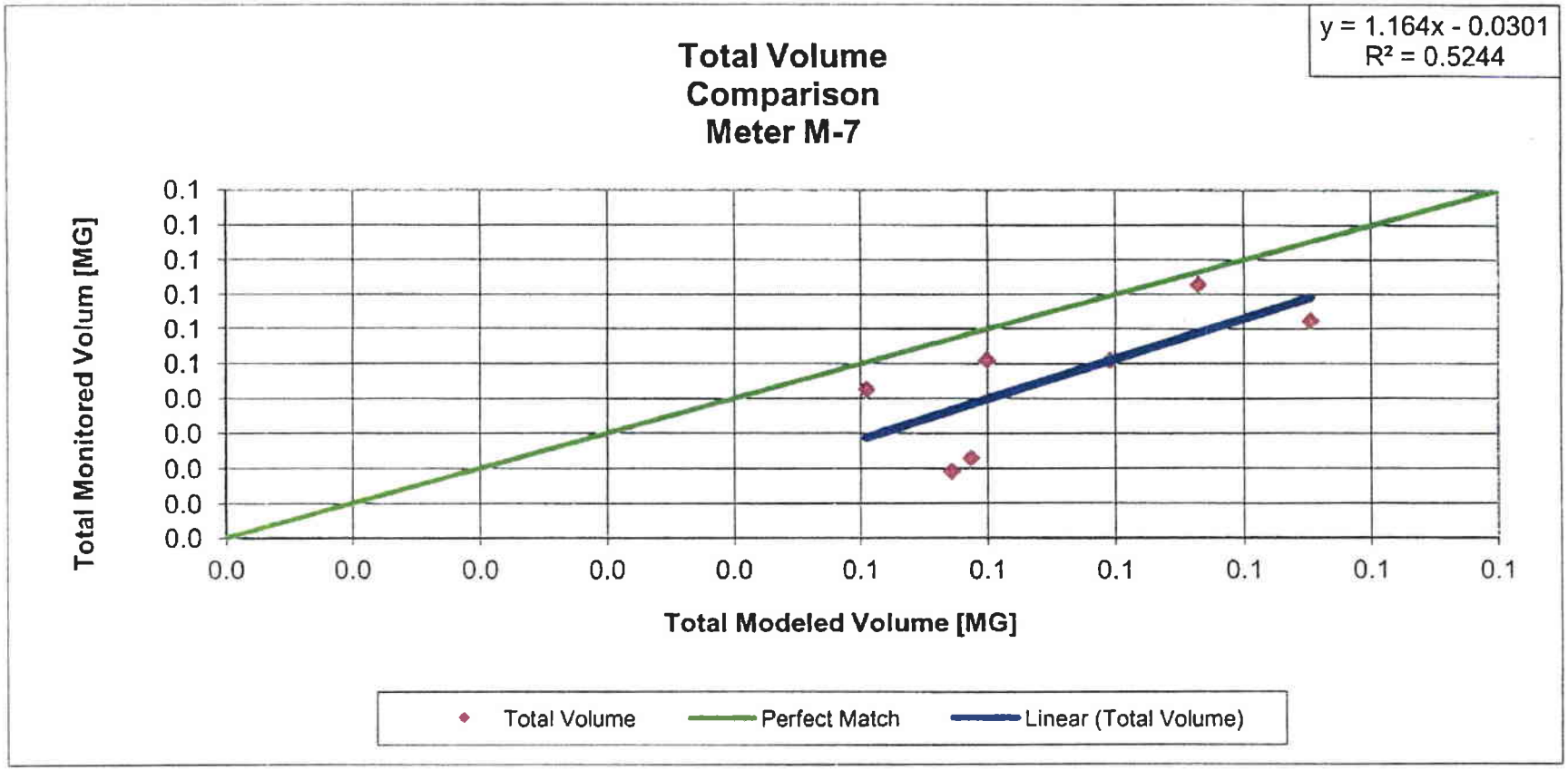

y = 0.8753x + 0.0113
R² = 0.8553
Peak Flow Comparison M-5
Peak Monitored Flow [MGD]
0.4
0.4
0.3
0.3
0.2
0.2
0.1
0.1
0.0
0.0
0.1
0.1
0.2
0.2
0.3
0.3
0.4
0.4
Peak Modeled Flow [MGD]
Peak Flow
Perfect Match
Linear (Peak Flow)


y = 1.4022x - 0.0079
R² = 0.7028
Total Volume Comparison M-5
Total Monitored Volum [MG]
0.0
0.0
0.0
0.0
0.0
0.0
0.0
0.0
Total Modeled Volume [MG]
Total Volume
Perfect Match
Linear (Total Volume)


y = 0.6259x + 0.2552
R² = 0.7128
Peak Flow Comparison M-6A
Peak Monitored Flow [MGD]
1.7
1.5
1.3
1.1
0.9
0.7
0.5
0.3
0.1
-0.1
-0.1
0.1
0.3
0.5
0.7
0.9
1.1
1.3
1.5
1.7
Peak Modeled Flow [MGD]
Peak Flow
Perfect Match
Linear (Peak Flow)


y = 1.0973x - 0.0129
R² = 0.5085
Total Volume Comparison M-6A
Total Monitored Volum [MG]
0.1
0.1
0.1
0.1
0.1
0.1
0.0
0.0
0.0
0.0
0.0
0.0
0.0
0.0
0.1
0.1
0.1
0.1
0.1
Total Modeled Volume [MG]
Total Volume
Perfect Match
Linear (Total Volume)

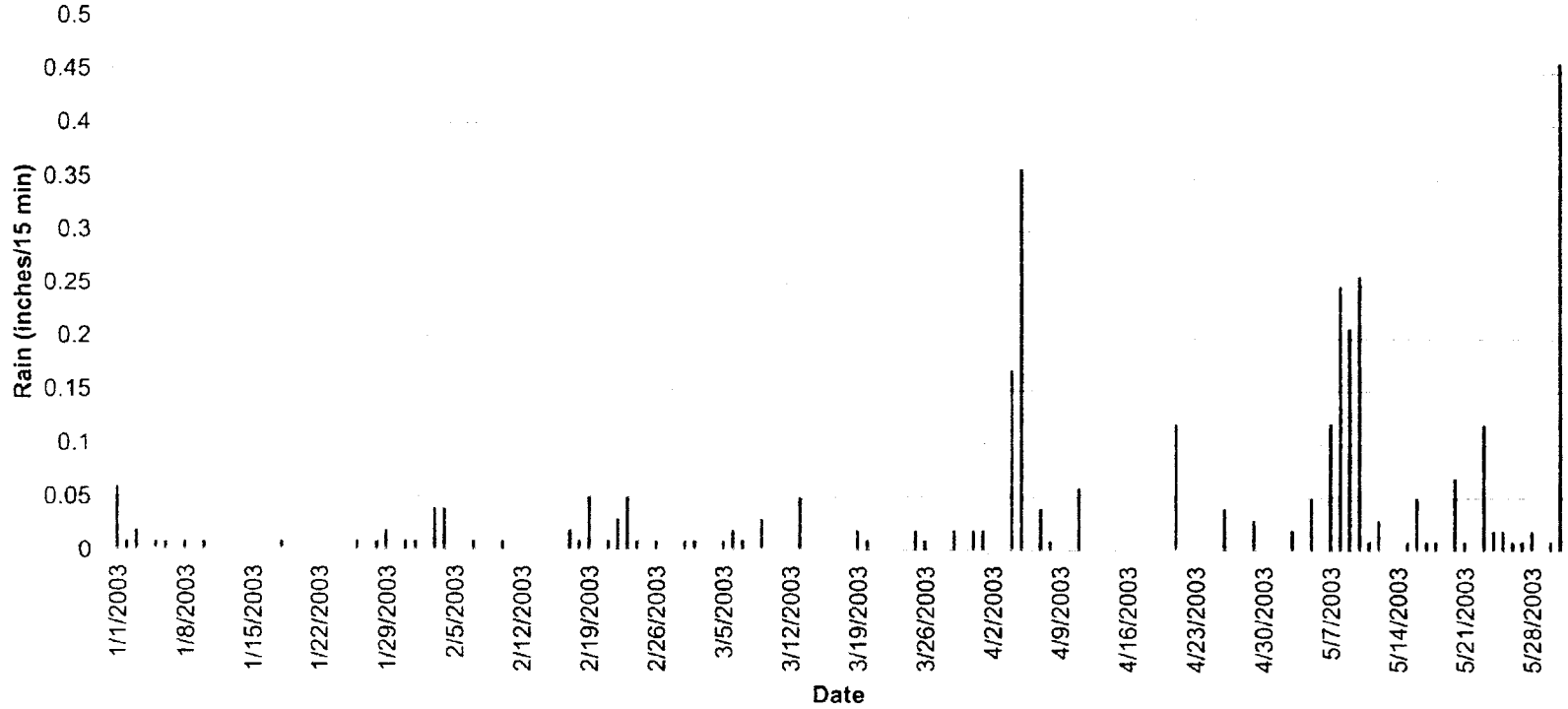

y = 0.7767x + 0.1795
R² = 0.761
Peak Flow Comparison Meter M-7
Peak Monitored Flow [MGD]
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
Peak Modeled Flow [MGD]
Peak Flow
Perfect Match
Linear (Peak Flow)


y = 1.164x - 0.0301
R² = 0.5244
Total Volume Comparison Meter M-7
Total Monitored Volum [MG]
0.1
0.1
0.1
0.1
0.1
0.1
0.0
0.0
0.0
0.0
0.0
0.0
0.0
0.0
0.0
0.1
0.1
0.1
0.1
0.1
0.1
Total Modeled Volume [MG]
Total Volume
Perfect Match
Linear (Total Volume)

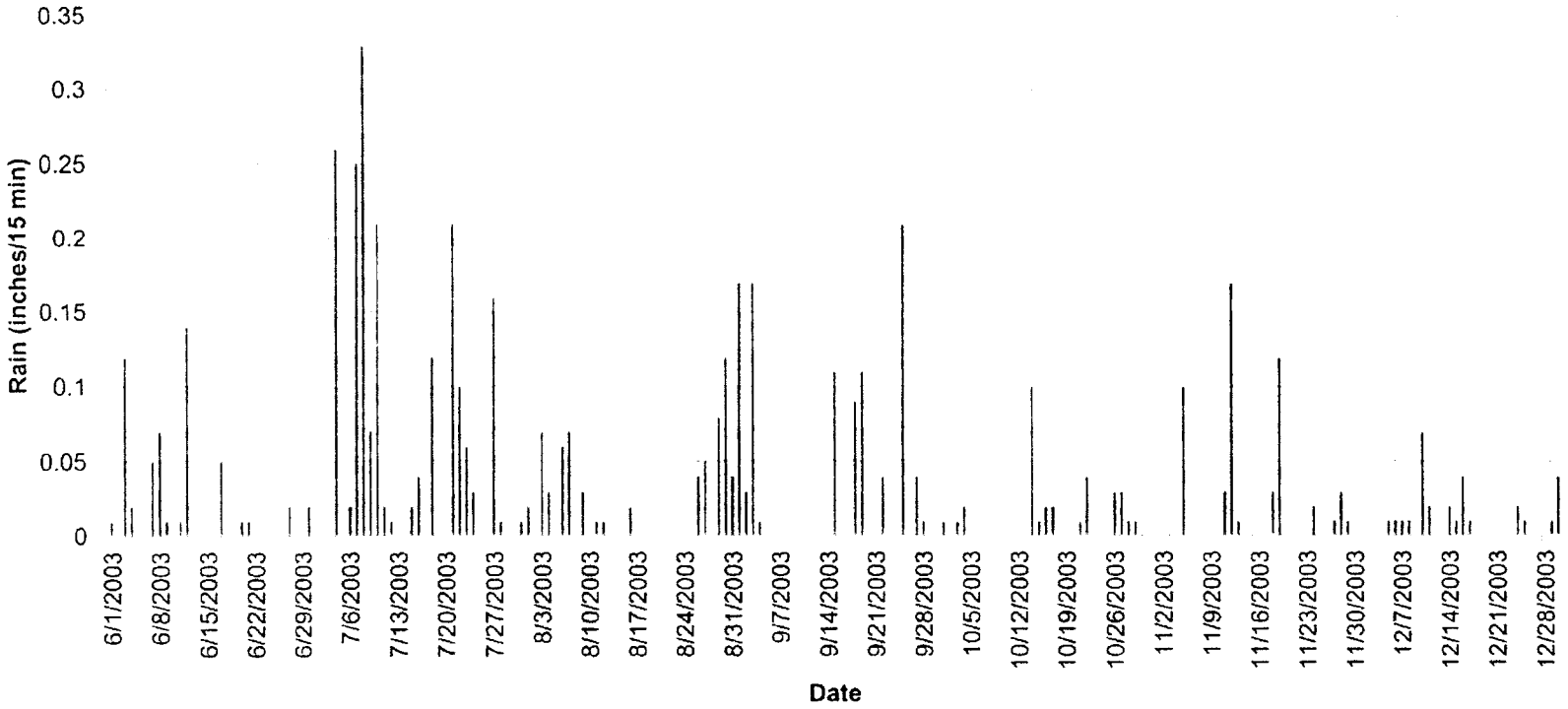
APPENDIX I

TYPICAL YEAR RAIN HYETOGRAPH

Typical Year Rainfall (Jan - June)



Typical Year Rainfall (June - Dec)



APPENDIX J

INFOSWMM TYPICAL YEAR MODEL REPORT

```
  ------------------------------------------------------------
    Comprehensive Storm Water Management Model: based on EPA-SWMM 5.0.022
  ------------------------------------------------------------

Warning 08: elevation drop 5.735 exceeds length 5.186 for Conduit WETWELL-
DUMMY_OUTFALL
 Needed length: 5.735000 ft
Warning 02: maximum depth 4.320 increased for Node DV_DUMMY

  *************************
    Rainfall File Summary
  *************************
  Station     First         Last          Recording   Periods     Periods
Periods
  ID          Date          Date          Frequency   w/Precip    Missing
Malfunc.
  ------------------------------------------------------------------------
----
  RG-274385S001 DEC-21-2002  DEC-30-2003      15 min       1497           0
0


  ***********************          Volume        Volume
  Rainfall Dependent I/I        acre-feet      10^6 gal
  ***********************       ---------      ---------
  Sewershed Rainfall ......       666.662        217.242
  RDII Produced ...........        47.369         15.436
  RDII Ratio ..............         0.071


  ************************************************************
    NOTE: The summary statistics displayed in this report are
    based on results found at every computational time step,
    not just on results from each reporting time step.
  ************************************************************

  *********************
    Analysis Options
  *********************
  Flow Units ............... MGD
  Process Models:
    Rainfall/Runoff ........ YES
    Snowmelt ............... NO
    Groundwater ............ NO
    Flow Routing ........... YES
    Ponding Allowed ........ YES
    Water Quality .......... NO
  Flow Routing Method ...... DYNWAVE
  Starting Date ............ DEC-25-2002 00:00:00
  Ending Date .............. JAN-05-2004 11:45:00
  Antecedent Dry Days ...... 5.0
  Report Time Step ......... 00:15:00
  Routing Time Step ........ 15.00 sec
```

Flow Routing Continuity	Volume acre-feet	Volume 10^6 gal
Dry Weather Inflow	346.968	113.065
Wet Weather Inflow	0.000	0.000
Groundwater Inflow	0.000	0.000
RDII Inflow	47.369	15.436
External Inflow	0.000	0.000
External Outflow	388.744	126.678
Internal Outflow	0.000	0.000
Storage Losses	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.005	0.002
Continuity Error (%)	1.417	

Highest Continuity Errors

Node WETWELL	5.26%	7.0270
Node DV101	-4.05%	-5.1935
Node DV176	-0.32%	-0.0005
Node DV102	-0.01%	-0.0157
Node DV156	0.01%	0.0001
Node DV108	-0.01%	-0.0001
Node DV107	-0.00%	-0.0000
Node DV300	0.00%	0.0004
Node DV103	0.00%	0.0022
Node DV408	0.00%	0.0002
Node DV405	0.00%	0.0002
Node DV144	-0.00%	-0.0000
Node REGULATOR_PIT	0.00%	0.0010
Node DV416	0.00%	0.0001
Node DV434	0.00%	0.0001
Node DV_DUMMY	0.00%	0.0001
Node DV406	-0.00%	-0.0001
Node DV171	0.00%	0.0001
Node DV351	0.00%	0.0001
Node DV105	0.00%	0.0003
		1.8220 Mgal

Time-Step Critical Elements

Link DV101-DV_WETWELL (94.73%)
Link DV230-DV300 (5.26%)
Link DV102-DV101 (0.01%)
Link DV103-DV102 (0.00%)
Link DV201-DV103 (0.00%)
Link DV_CHAM-DV103 (0.00%)
Link DV156-DV108 (0.00%)
Node DV105 (0.00%)
Link CDT-13 (0.00%)
Link DV414-DV434 (0.00%)
Link DV351-DV402 (0.00%)
Link DV105-DV_CHAM (0.00%)

```
  Link DV144-DV107 (0.00%)
  Node DV103 (0.00%)
  Node DV402 (0.00%)
  Link DV171-DV173 (0.00%)
  Link DV300-DV102 (0.00%)
  Link DV352-DV351 (0.00%)
  Link DV176-DV100 (0.00%)
  Link DV157-DV156 (0.00%)

  ************************************
    Highest Flow Instability Indexes
  ************************************
  Link WETWELL-DUMMY_OUTFALL (0)
  Link DV101-DV_WETWELL (0)
  Link DV102-DV101 (0)
  Link DV_CHAM-DV103 (0)
  Link DV230-DV300 (0)
  Link DV351-DV402 (0)
  Link DV406-DV407 (0)
  Link DV300-DV102 (0)
  Link DV103-DV102 (0)
  Link DV201-DV103 (0)
  Link DV173-DV174 (0)
  Link DV229-DV230 (0)
  Link DV171-DV173 (0)
  Link DV176-DV100 (0)
  Link DV105-DV_CHAM (0)
  Link DV157-DV156 (0)
  Link IN_VAULT (0)
  Link DV_CHAM-DV176 (0)
  Link DV409-DV416 (0)
  Link DV416-DV414 (0)

  ******************************
    Routing Time Step Summary
  ******************************
  Minimum Time Step           :     0.10 sec
  Average Time Step           :     1.93 sec
  Maximum Time Step           :     2.36 sec
  Percent in Steady State     :     0.00
  Average Iterations per Step :     1.97
  Total Steps                 :  16520888
  Total Iterations            :  32536306
  Minimum Possible Steps      :  13800891


  ***********************
    Node Depth Summary
  ***********************

  ------------------------------------------------------------------------------
  ------------------
                                    Average  Maximum  Maximum  Time of Max
  Maximum  Time of Max
                                      Depth    Depth  Run HGL   Occurrence
  Output HGL   Occurrence
```

Node	Type	Feet	Feet	Feet	days	hr:min
DV101	JUNCTION	0.41	7.32	728.23	329	08:32
725.69	157	11:45				
DV102	JUNCTION	0.26	6.13	727.54	157	11:37
726.92	157	11:45				
DV103	JUNCTION	0.38	5.94	727.62	157	11:36
727.17	157	11:45				
DV105	JUNCTION	0.13	0.61	728.92	157	11:50
728.86	157	11:45				
DV107	JUNCTION	0.01	0.14	774.23	157	11:48
774.23	157	11:45				
DV108	JUNCTION	0.01	0.12	824.01	157	11:50
824.01	157	11:45				
DV144	JUNCTION	0.01	0.12	797.12	157	11:50
797.12	157	11:45				
DV156	JUNCTION	0.01	0.16	830.04	157	11:50
830.04	157	11:45				
DV157	JUNCTION	0.01	0.26	830.60	157	11:35
830.55	157	11:45				
DV171	JUNCTION	0.02	0.08	742.94	329	13:20
742.94	329	13:15				
DV173	JUNCTION	0.23	1.05	734.43	157	11:50
734.33	157	11:45				
DV174	JUNCTION	0.12	0.57	733.23	157	11:50
733.18	157	11:45				
DV176	JUNCTION	0.00	0.57	727.34	157	11:50
727.26	157	11:45				
DV201	JUNCTION	0.19	13.42	735.31	136	08:05
728.90	157	11:45				
DV229	JUNCTION	0.17	41.60	764.00	157	11:37
727.98	157	11:45				
DV230	JUNCTION	0.12	10.78	732.95	157	11:36
727.28	157	11:45				
DV300	JUNCTION	0.12	12.16	734.29	157	11:36
727.25	157	11:45				
DV351	JUNCTION	0.05	0.15	977.71	157	12:15
977.71	157	12:15				
DV352	JUNCTION	0.09	0.30	980.58	157	12:14
980.58	157	12:15				
DV402	JUNCTION	0.05	0.15	953.03	157	12:15
953.03	157	12:15				
DV403	JUNCTION	0.05	0.14	947.86	157	12:15
947.86	157	12:15				
DV405	JUNCTION	0.06	0.17	924.97	157	12:15
924.97	157	12:15				
DV406	JUNCTION	0.07	0.22	915.88	157	12:16
915.88	157	12:15				
DV407	JUNCTION	0.07	0.20	915.03	157	12:16
915.03	157	12:15				
DV408	JUNCTION	0.25	0.35	911.02	157	12:17
911.02	157	12:15				
DV409	JUNCTION	0.04	0.11	899.41	157	12:17
899.41	157	12:15				

DV414	JUNCTION	0.04	0.12	854.23	157	12:18	854.22
157 12:15							
DV416	JUNCTION	0.44	0.52	895.36	157	12:18	895.36
157 12:15							
DV434	JUNCTION	0.01	0.04	783.12	157	12:20	783.12
157 12:15							
DV_DUMMY	JUNCTION	0.01	0.05	746.23	329	13:20	746.23
329 13:15							
DUMMY_OUTFALL	OUTFALL	0.05	0.19	715.19	195	03:52	715.16
157 11:45							
DV100	OUTFALL	0.00	0.58	724.43	157	11:50	724.34
157 11:45							
DV_VAULT	STORAGE	0.26	2.26	728.94	157	11:50	728.87
157 11:45							
REGULATOR_PIT	STORAGE	0.16	2.50	728.14	157	11:50	728.06
157 11:45							
WETWELL	STORAGE	0.04	0.40	721.14	195	03:52	721.07
157 11:45							

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow MGD	Maximum Total Inflow MGD	Time of Max Occurrence days hr:min		Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal
DV101	JUNCTION	0.000	4.743	157	11:37	0.000	128.363
DV102	JUNCTION	0.000	4.717	157	11:50	0.000	128.348
DV103	JUNCTION	0.000	4.146	157	11:36	0.000	111.037
DV105	JUNCTION	0.000	7.387	157	11:50	0.000	91.985
DV107	JUNCTION	0.000	0.315	157	11:50	0.000	0.778
DV108	JUNCTION	0.000	0.315	157	11:50	0.000	0.778
DV144	JUNCTION	0.000	0.315	157	11:50	0.000	0.778
DV156	JUNCTION	0.000	0.327	157	11:35	0.000	0.778
DV157	JUNCTION	0.315	0.315	157	11:45	0.758	0.778
DV171	JUNCTION	0.000	0.409	329	13:20	0.000	13.491

DV173	JUNCTION	6.997	7.391	157	11:50	76.966
91.985						
DV174	JUNCTION	0.000	7.389	157	11:50	0.000
91.985						
DV176	JUNCTION	0.000	5.015	157	11:50	0.000
0.139						
DV201	JUNCTION	1.093	1.093	157	11:45	18.817
19.192						
DV229	JUNCTION	1.256	2.678	157	11:37	16.971
17.312						
DV230	JUNCTION	0.000	3.386	157	11:37	0.000
17.313						
DV300	JUNCTION	0.000	13.311	157	11:36	0.000
17.314						
DV351	JUNCTION	0.000	0.330	157	12:14	0.000
12.714						
DV352	JUNCTION	0.331	0.331	157	12:10	12.462
12.714						
DV402	JUNCTION	0.000	0.330	157	12:15	0.000
12.714						
DV403	JUNCTION	0.000	0.330	157	12:15	0.000
12.714						
DV405	JUNCTION	0.000	0.330	157	12:15	0.000
12.714						
DV406	JUNCTION	0.000	0.330	157	12:15	0.000
12.713						
DV407	JUNCTION	0.000	0.330	157	12:16	0.000
12.714						
DV408	JUNCTION	0.000	0.330	157	12:16	0.000
12.714						
DV409	JUNCTION	0.000	0.329	157	12:17	0.000
12.713						
DV414	JUNCTION	0.000	0.329	157	12:18	0.000
12.713						
DV416	JUNCTION	0.000	0.329	157	12:17	0.000
12.713						
DV434	JUNCTION	0.000	0.329	157	12:18	0.000
12.713						
DV_DUMMY	JUNCTION	0.000	0.409	329	13:20	0.000
13.491						
DUMMY_OUTFALL	OUTFALL	0.000	6.487	195	03:52	0.000
126.529						
DV100	OUTFALL	0.000	5.014	157	11:50	0.000
0.139						
DV_VAULT	STORAGE	0.000	7.387	157	11:50	0.000
91.985						
REGULATOR_PIT	STORAGE	0.000	3.284	101	02:50	0.000
91.846						
WETWELL	STORAGE	0.000	4.763	157	11:37	0.000
133.556						

****
Node Surcharge Summary
****

Surcharging occurs when water rises above the top of the highest conduit.

Node	Type	Hours Surcharged	Max. Height Above Crown Feet	Min. Depth Below Rim Feet
DV101	JUNCTION	30.69	6.184	14.206
DV102	JUNCTION	12.51	4.463	14.987
DV103	JUNCTION	10.60	4.302	12.578
DV201	JUNCTION	27.74	12.750	0.513
DV229	JUNCTION	9.82	40.596	0.000
DV230	JUNCTION	11.67	9.775	9.195
DV300	JUNCTION	12.12	11.162	7.848
REGULATOR_PIT	STORAGE	3.83	1.499	12.321

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	E&I Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days hr:min	Maximum Outflow MGD
DV_VAULT	0.000	0.00	0.00	0.000	0	0 00:00	7.699
REGULATOR_PIT	0.000	0.00	0.00	0.000	0	0 00:00	3.709
WETWELL	0.000	0.00	0.00	0.000	0	0 00:00	6.487

****
Outfall Loading Summary
****

Outfall Node	Flow Freq. Pcnt.	Avg. Flow MGD	Max. Flow MGD	Total Volume 10^6 gal
DUMMY_OUTFALL	98.12	0.367	6.487	126.529
DV100	0.14	0.780	5.014	0.139
System	49.13	1.146	9.960	126.669

****
Link Flow Summary
****

Time of Max Occurrence Link days hr:min	Max/ Full Flow	Maximum |Veloc| Type ft/sec	Maximum Time of Max |Run Flow| Occurrence days hr:min	Maximum MGD	Time of Max Max/ Occurrence Full Depth	Time of Max Occurrence days hr:min	Maximum |Output Flow| Top Width MGD ft
CDT-13		CONDUIT		0.409	329	13:20	0.399
329 13:15	0.00	4.14	329 13:20	0.01	329	13:20	3.00
DV101-DV_WETWELL		CONDUIT		4.763	157	11:37	4.686
157 11:45	1.98	13.19	157 11:37	0.69	195	03:52	1.00
DV102-DV101		CONDUIT		4.743	157	11:37	4.683
157 11:45	1.85	9.34	157 11:37	1.00	7	12:13	1.00
DV103-DV102		CONDUIT		4.115	157	11:36	3.461
157 11:45	1.40	3.60	157 11:36	1.00	100	21:10	1.50
DV105-DV_CHAM		CONDUIT		7.387	157	11:50	6.023
157 11:45	0.02	4.83	195 03:51	0.20	157	11:50	5.04
DV107-DV_DUMMY		CONDUIT		0.315	157	11:50	0.311
157 11:45	0.01	8.89	157 11:42	0.05	157	11:50	0.84
DV108-DV144		CONDUIT		0.315	157	11:50	0.311
157 11:45	0.01	6.30	157 11:50	0.06	157	11:50	0.95
DV144-DV107		CONDUIT		0.315	157	11:50	0.311
157 11:45	0.01	6.34	157 11:50	0.06	157	11:50	0.98
DV156-DV108		CONDUIT		0.315	157	11:50	0.311
157 11:45	0.03	4.46	157 11:50	0.11	157	11:50	0.87
DV157-DV156		CONDUIT		0.327	157	11:35	0.311
157 11:45	0.04	4.10	157 11:35	0.12	157	11:45	0.99
DV171-DV173		CONDUIT		0.409	329	13:20	0.399
329 13:15	0.00	6.20	209 00:34	0.08	157	11:50	3.36
DV173-DV174		CONDUIT		7.389	157	11:50	6.027
157 11:45	0.07	3.89	157 11:50	0.16	157	11:50	3.94
DV174-DV105		CONDUIT		7.387	157	11:50	6.023
157 11:45	0.02	8.20	157 11:50	0.10	157	11:50	3.42
DV176-DV100		CONDUIT		5.014	157	11:50	3.645
157 11:45	0.02	5.64	157 11:50	0.10	157	11:50	3.28
DV201-DV103		CONDUIT		1.180	157	11:36	1.089
157 11:45	3.01	5.23	157 11:36	1.00	7	11:02	0.67
DV229-DV230		CONDUIT		1.490	157	11:37	1.234
157 11:45	1.52	3.09	157 11:35	1.00	100	21:11	1.00
DV230-DV300		CONDUIT		13.101	157	11:36	1.223
157 11:45	6.93	25.81	157 11:36	1.00	100	21:10	1.00
DV300-DV102		CONDUIT		1.728	157	11:37	1.214
157 11:45	0.97	3.40	157 11:37	1.00	100	21:10	1.00
DV351-DV402		CONDUIT		0.330	157	12:15	0.330
157 12:15	0.10	9.04	157 12:15	0.22	157	12:15	0.56
DV352-DV351		CONDUIT		0.330	157	12:14	0.330
157 12:15	0.42	3.33	157 12:14	0.45	157	12:14	0.63

DV402-DV403		CONDUIT		0.330	157	12:15		0.330			
157 12:15	0.02	5.26	157	12:15	0.10	157 12:15		0.89			
DV403-DV405		CONDUIT		0.330	157	12:15		0.330			
157 12:15	0.02	5.97	157	12:15	0.10	157 12:15		0.91			
DV405-DV406		CONDUIT		0.330	157	12:15		0.330			
157 12:15	0.03	4.11	157	12:13	0.12	157 12:15		1.01			
DV406-DV407		CONDUIT		0.330	157	12:16		0.330			
157 12:15	0.05	3.16	157	12:16	0.15	157 12:16		1.04			
DV407-DV408		CONDUIT		0.330	157	12:16		0.329			
157 12:15	0.04	2.31	157	12:16	0.18	157 12:17		1.16			
DV408-DV409		CONDUIT		0.329	157	12:17		0.326			
157 12:15	0.01	4.79	157	12:17	0.07	157 12:17		1.27			
DV409-DV416		CONDUIT		0.329	157	12:17		0.326			
157 12:15	0.01	1.60	157	12:17	0.16	157 12:18		1.46			
DV414-DV434		CONDUIT		0.329	157	12:18		0.323			
157 12:15	0.01	11.39	157	12:17	0.04	157 12:19		0.79			
DV416-DV414		CONDUIT		0.329	157	12:18		0.324			
157 12:15	0.01	7.30	157	12:18	0.06	157 12:18		1.47			
DV434-DV171		CONDUIT		0.329	157	12:20		0.317			
157 12:15	0.00	3.95	157	12:20	0.01	157 12:20		3.00			
DV_CHAM-DV103		CONDUIT		3.709	101	02:50		2.943			
157 12:00	0.81	8.88	195	03:51	1.00	100 21:18		1.00			
DV_CHAM-DV176		CONDUIT		5.015	157	11:50		3.646			
157 11:45	0.02	6.43	157	11:50	0.09	157 11:50		5.00			
WETWELL-DUMMY_OUTFALL		CONDUIT		6.487	195	03:52		4.901			
157 11:45	0.00	27.33	329	10:46	0.05	195 03:52		2.39			
IN_VAULT		ORIFICE		3.284	101	02:50		2.943			
157 12:00					1.00	100 21:07					

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class: Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
CDT-13	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	2.52	0.0000
DV101-DV_WETWELL	1.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00	1.56	0.0000
DV102-DV101	1.00	0.00	0.00	0.00	0.02	0.69	0.00	0.27	1.34	0.0000
DV103-DV102	1.00	0.00	0.00	0.00	0.01	0.00	0.00	0.97	0.72	0.0000
DV105-DV_CHAM	1.00	0.00	0.00	0.00	0.00	0.01	0.00	0.97	1.80	0.0000
DV107-DV_DUMMY	1.00	0.00	0.13	0.00	0.54	0.32	0.00	0.00	0.96	0.0000

DV108-DV144	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	
2.00 0.0000									
DV144-DV107	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	
2.01 0.0000									
DV156-DV108	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	
1.45 0.0000									
DV157-DV156	1.00	0.00	0.00	0.00	0.63	0.35	0.00	0.00	
0.89 0.0000									
DV171-DV173	1.00	0.00	0.00	0.00	0.02	0.30	0.00	0.66	
3.78 0.0000									
DV173-DV174	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	
0.88 0.0000									
DV174-DV105	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	
1.98 0.0000									
DV176-DV100	1.00	0.25	0.00	0.00	0.73	0.00	0.00	0.00	
0.00 0.0000									
DV201-DV103	1.00	0.00	0.00	0.00	0.98	0.00	0.00	0.00	
0.22 0.0000									
DV229-DV230	1.00	0.00	0.00	0.00	0.98	0.00	0.00	0.00	
0.61 0.0000									
DV230-DV300	1.00	0.00	0.00	0.00	0.91	0.07	0.00	0.00	
0.95 0.0000									
DV300-DV102	1.00	0.00	0.00	0.00	0.98	0.00	0.00	0.00	
0.66 0.0000									
DV351-DV402	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	
4.33 0.0000									
DV352-DV351	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	
1.18 0.0000									
DV402-DV403	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	
2.46 0.0000									
DV403-DV405	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	
2.87 0.0000									
DV405-DV406	1.00	0.00	0.00	0.00	0.00	0.11	0.00	0.87	
2.07 0.0000									
DV406-DV407	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	
1.21 0.0000									
DV407-DV408	1.00	0.00	0.00	0.00	0.98	0.00	0.00	0.00	
0.27 0.0000									
DV408-DV409	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	
2.23 0.0000									
DV409-DV416	1.00	0.00	0.00	0.00	0.98	0.00	0.00	0.00	
0.10 0.0000									
DV414-DV434	1.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00	
7.18 0.0000									
DV416-DV414	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	
3.90 0.0000									
DV434-DV171	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.98	
2.65 0.0000									
DV_CHAM-DV103	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97	
2.50 0.0000									
DV_CHAM-DV176	1.00	0.98	0.00	0.00	0.00	0.00	0.00	0.00	
0.00 0.0000									
WETWELL-DUMMY_OUTFALL	1.00	0.00	0.00	0.00	0.00	0.98	0.00	0.00	
12.28 0.0000									

****

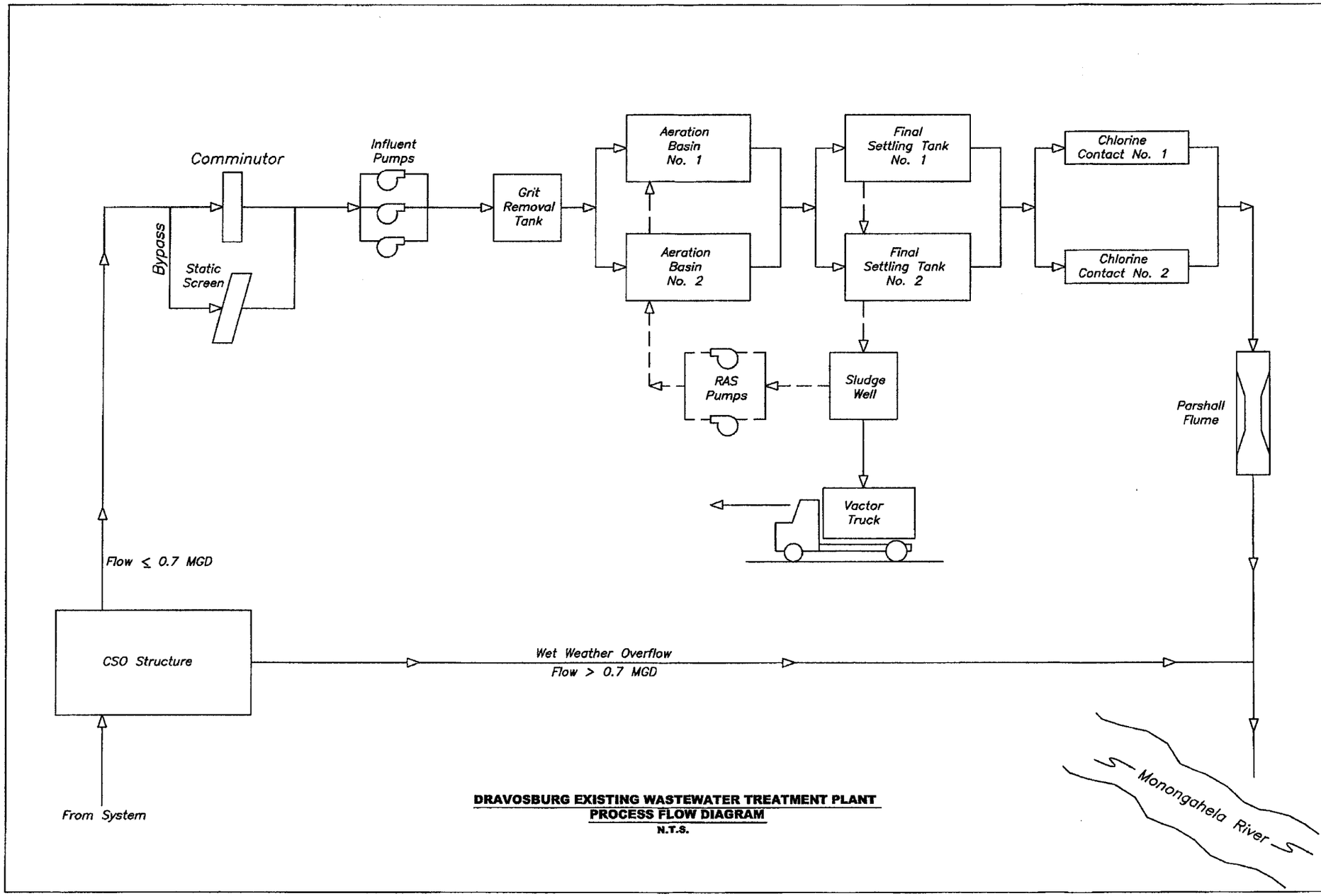
Conduit Surcharge Summary

Conduit	Hours Full: Both Ends	Hours Full: Upstream	Hours Full: Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
DV101-DV_WETWELL	0.01	0.01	0.01	13.40	0.01
DV102-DV101	25.22	25.22	25.23	10.41	11.57
DV103-DV102	11.70	11.70	11.70	5.70	6.23
DV201-DV103	27.70	27.70	27.72	6.57	6.57
DV229-DV230	9.81	9.81	9.83	0.47	0.46
DV230-DV300	11.67	11.67	11.68	0.01	0.15
DV300-DV102	12.11	12.11	12.12	0.01	0.03
DV_CHAM-DV103	3.83	3.83	3.83	0.01	0.01

Analysis begun on: Thu May 22 08:45:38 2014
Analysis ended on: Thu May 22 09:11:52 2014
Total elapsed time: 00:26:14

APPENDIX K

EXISTING PROCESS FLOW DIAGRAM



DRAVOSBURG EXISTING WASTEWATER TREATMENT PLANT
PROCESS FLOW DIAGRAM
N.T.S.

Revisions	Date

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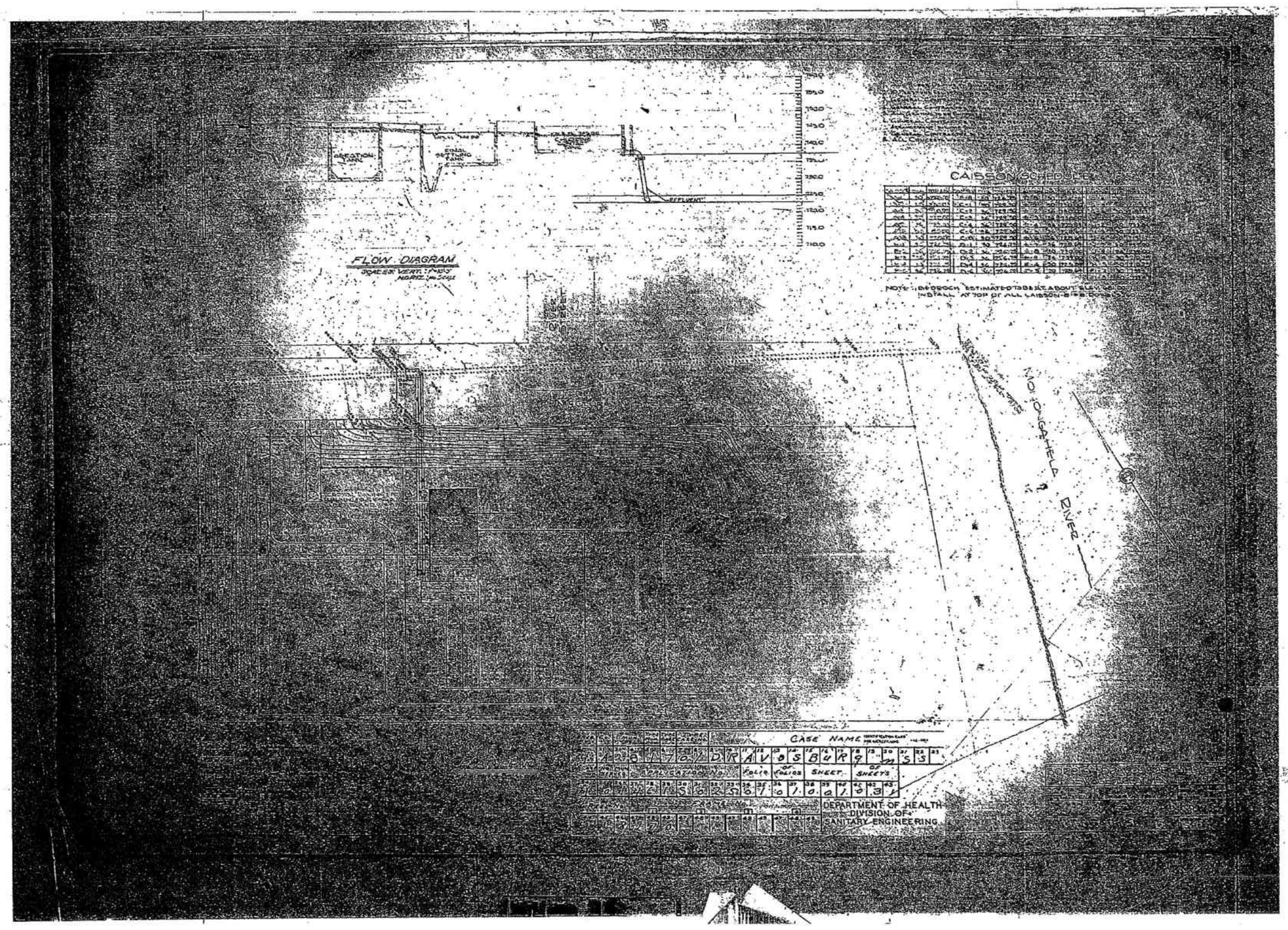
KLH ENGINEERS, INC

BOROUGH OF DRAVOSBURG
ALLEGHENY COUNTY, PENNSYLVANIA
EXISTING WASTEWATER TREATMENT PLANT
PROCESS FLOW DIAGRAM

Scale:	As Shown
Date:	August 2014
Drawn By:	EHD
Checked By:	BMC
Approved By:	SMG
Order No.	220-53
Drawing No.	EX3
Sheet No.	1 of 1

APPENDIX L

EXISTING SITE PLAN


FLOW DIAGRAM
SCALES VERT. 1"=5'
HORIZ. 1"=20'
AERATION TANK
FINAL SETTLING TANK
EFFLUENT
CAISSON SCHEDULE
NOTE: INFLOW, ESTIMATED TO BE ABOUT
INSTALL AT TOP OF ALL CAISSON STEEL CORES
MONONGAHELA RIVER
CASE NAME
DEPARTMENT OF HEALTH
DIVISION OF
SANITARY ENGINEERING

APPENDIX M

EXISTING PROCESS CALCULATIONS

Dravosburg WWTP Capacity Analysis

Tank Description	Surface Area	Depth Max	Depth @ Q_{av}	Vol Max		Vol Avg	
	[FT^2]	[FT]	[FT]	[FT^3]	[KGAL]	[FT^3]	[KGAL]
Aeration Tank No. 1	2,700.00	15.00	15.00	40,500.00	302.94	40,500.00	302.94
Aeration Tank No. 2	2,700.00	15.00	15.00	40,500.00	302.94	40,500.00	302.94
Final Clarifier No. 1	408.00	10.67	9.50	4,353.36	32.56	3,876.00	28.99
Final Clarifier No. 2	408.00	10.67	9.50	4,353.36	32.56	3,876.00	28.99
CL Contact Tank No. 1	116.33	6.75	4.25	785.19	5.87	494.38	3.70
CL Contact Tank No. 2	116.32	6.75	4.25	785.16	5.87	494.36	3.70
Grit Chamber	---			700.00	5.24	700.00	5.24

**For capacity analysis, assume depth @ Q_{av} in all volume calculations*

Chlorine Contact Tank Capacity

Design Criteria			
	$T_D \geq$	30.00 min	[MMAF]
	$T_D \geq$	15.00 min	[PHF]
Method			
	Q =	V / T_D	
Assumptions			
	$T_D \geq$	26.888 min	[MMAF]
Analysis			
	V_{Qav} =	7,395.78 gallons	
	Q_{av} =	275.06 gpm	
		396,090.30 gpd	
	V_{Qav} =	7,395.78 gallons	
	Q_{max} =	493.05 gpm	
		709,995.32 gpd	

Final Clarifier Capacity

Design Criteria			
	Surface Overflow Rate =	800.00 gpd/ft^2	[MMAF]
	Surface Overflow Rate =	1,200.00 gpd/ft^2	[PHF]
	Weir Loading =	10,000.00 gpd/ft	[MMAF]
Method			
	Q =	(SOR) x (A)	
	Q =	(WL) x (L)	
Analysis			
	A =	816.00 ft^2	
	Q_{av} =	652,800.00 gpd	
	Q_{max} =	979,200.00 gpd	
	Total Weir Length =	68.00 ft	
	Q_{av} =	680,000.00 gpd	

Aeration Capacity

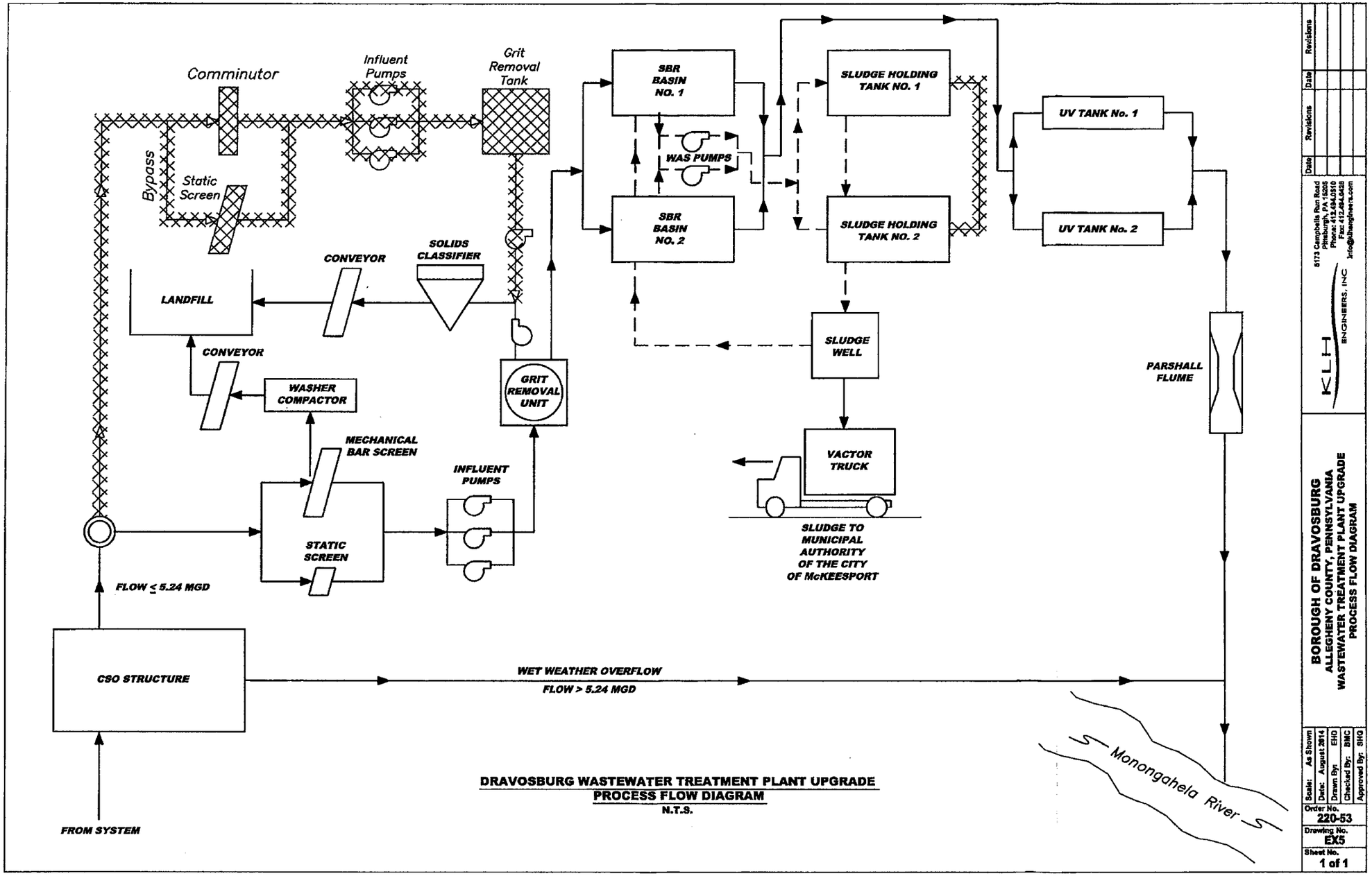
Design Criteria			
	$T_D \geq$	6.00 hr	[MMAF]
Method			
	Q =	V / T_D	
Analysis			
	V_{Qav} =	605,880.00 gallons	
	Q_{av} =	100,980.00 gph	
		2.42 mgd	

Grit Chamber Capacity

Design Criteria			
	$T_D \geq$	3.00 min	[MMAF]
Method			
	Q =	V / T_D	
Analysis			
	V_{Qav} =	5,236.00 gallons	
	Q_{av} =	1,745.33 gpm	
		2.51 mgd	

APPENDIX N

ALTERNATIVE 1
PROCESS FLOW DIAGRAM



DRAVOSBURG WASTEWATER TREATMENT PLANT UPGRADE
PROCESS FLOW DIAGRAM
N.T.S.

Revisions	Date

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KLH ENGINEERS, INC

BOROUGH OF DRAVOSBURG
ALLEGHENY COUNTY, PENNSYLVANIA
WASTEWATER TREATMENT PLANT UPGRADE
PROCESS FLOW DIAGRAM

Scale:	As Shown
Date:	August 2014
Drawn By:	EHD
Checked By:	BMC
Approved By:	SHG
Order No.	220-53
Drawing No.	EX5
Sheet No.	1 of 1

APPENDIX O

ALTERNATIVE 1
SITE PLAN

Sheet No. 1 of 1	Drawing No. EX2	Order No. 220-53	Scale: As Shown
			Date: July 2014
			Drawn By: EHD
			Checked By: BMC
			Approved By: SHG

BOROUGH OF DRAVOSBURG
ALLEGHENY COUNTY, PENNSYLVANIA
LONG TERM CONTROL PLAN
ALTERNATIVE 1 SITE PLAN

KLH ENGINEERS, INC
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Date	Revisions	Date	Revisions

APPENDIX P

ALTERNATIVE 1
PROCESS CALCULATIONS

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SANITAIRE ICEAS Detailed Design Calculations
BOD Removal, Nitrification, and De-Nitrification Process

SANITAIRE Project #24970-14a
Dravosburg, PA

Design Parameters

A. Flow

Average Daily Flow	600,000 GPD
Peak Dry Weather Flow	1,100,000 GPD
Peak Wet Weather Flow	2,200,000 GPD

B. Treatment

	Influent Quality	Effluent Requirement
BOD_5 (20°C), mg/l	190	10
Suspended Solids, mg/l	210	10
TKN, mg/l	40	
NH_3-N, mg/l		1
TN, mg/l		
Phosphorus	7	1

C. Environment

Alkalinity (Minimum Requirement)	180 mg/l
Max Wastewater Temperature	20 °C
Min Wastewater Temperature	10 °C
Ambient Air Temperature	20 - 90 °F
Site Elevation	740 ft

D. ICEAS Process Design Criteria

F / M	0.042 BOD_5 / MLSS / day
SVI (after 30 minutes settling)	150 ml/g
Number of ICEAS Basins	2
Top Water Level	16.25 ft

E. Cycle Timing

		Normal	Storm
Air-On	min	96	48
Air-Off	min	72	24
Settle	min	48	36
Decant	min	72	36
Total	hrs	4.8	2.4

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F. Detailed Calculations

Mass of Biomass

$$BODL = \frac{Q \times BODin \times 8.34}{1{,}000{,}000} = \frac{300{,}000 \times 190 \times 8.34}{1{,}000{,}000} = \mathbf{475\ lb/day/basin}$$

where: BODL = BOD Load (lb/day/basin)
Q = Average Dry Weather Flow per basin (gal/day)
BODin = Influent BOD concentration (mg/l)
1,000,000 = Conversion (l/mg)
8.34 = Conversion (lb/gal)

Mass of Biomass

$$MBOD = \frac{BOD_L}{F/M} = \frac{475}{0.042} = \mathbf{11{,}346\ lb/basin}$$

where: MBOD = Mass of Biomass for BOD Removal (lb/day/basin)
F / M = Food to Microorganism ratio (day^{-1})

Volume of Biomass

$$Vbio = MBOD \times SVI = 11{,}346 \times 2.4 = \mathbf{27{,}231\ ft^3/basin}$$

where: Vbio = Volume of Biomass (ft^3/basin)
SVI = Sludge Volume Index (ft^3/lb)

Maximum Volume Above Bottom Water Level

Peak Dry Weather Flow:

$$Vbwld = \frac{PDWF \times (NCT - NDT)}{24 \times 7.48} = \frac{550{,}000 \times (4.8 - 1.20)}{24 \times 7.48} = \mathbf{11{,}029\ ft^3/basin}$$

where: Vbwld = Maximum Volume Above BWL at Peak Dry Weather Flow (ft^3/basin)
PDWF = Peak Dry Weather Flow (gal/day)
NCT = Normal Cycle Time (hr/cycle)
NDT = Decant Time (hr/cycle)
7.48 = Conversion (gal/ft^3)
24 = Conversion (hours/day)

Peak Wet Weather Flow:

$$Vbwls = \frac{PWWF \times (SCT - SDT)}{24 \times 7.48} = \frac{1{,}100{,}000 \times (2.4 - 0.60)}{24 \times 7.48} = \mathbf{11{,}029\ ft^3/basin}$$

where: Vbwls = Maximum Volume Above BWL at Peak Wet Weather (Storm) Flow (ft^3/basin)
PWWF = Peak Wet Weather Flow (gal/day)
SCT = Storm Cycle Time (hr/cycle)
SDT = Storm Decant Time (hr/cycle)

MVAB (Maximum Volume Above Bottom Water Level) is larger of Peak Dry Weather and Peak Wet Weather Calculation

$$MVAB = \mathbf{11{,}029\ ft^3/basin}$$

Decant Rates

Peak Dry Weather Flow:

$$PDR = \frac{MVAB \times 7.48}{NDT} + \frac{PDWF}{1{,}440} = \frac{11{,}029 \times 7.48}{72.0} + \frac{550{,}000}{1{,}440} = \mathbf{1{,}528\ gal/min}$$

where: PDR = Normal Decant Rate (gal/min)
NDT = Normal Decant Time (min/cycle)
1440 = Conversion (min/day)

Peak Wet Weather Flow:

$$PWR = \frac{MVAB \times 7.48}{SDT} + \frac{PWWF}{1{,}440} = \frac{11{,}029 \times 7.48}{36.0} + \frac{1{,}100{,}000}{1{,}440} = \mathbf{3{,}056\ gal/min}$$

where: PWR = Peak Decant Rate (gal/min)
SDT = Storm Decant Time (min/cycle)

Decanter Sizing

Peak Dry Weather Flow:

$$DLa = \frac{PDR}{\text{Weir Loading Rate} \times 7.48} = \frac{1,528}{20 \times 7.48} = \mathbf{10.21\ ft}$$

where: DLa = Decanter Length for Average Dry Weather Flow (ft)
20 = Weir Loading Rate (ft^3/min/ft of decanter weir)

Peak Wet Weather Flow:

$$DLp = \frac{PWR}{\text{Weir Loading Rate} \times 7.48} = \frac{3,056}{25 \times 7.48} = \mathbf{16.34\ ft}$$

where: DLp = Decanter Length for Peak Wet Weather (Storm) Flow (ft)
25 = Weir Loading Rate (ft^3/min/ft of decanter weir)

Design Decanter Length = **17.5 ft**

Basin Working Volume

$$BWV = MVAB + Vbio + Vc = 11,029 + 27,231 + 66 = \mathbf{38,326\ ft^3/basin}$$

where: BWV = Basin Working Volume (ft^3/basin)
Vc = Volume of chemical sludge due to Phosphorus removal (ft^3/basin)
(Please refer to phosphorus removal calculation.)

Basin Area

$$BA = \frac{BWV}{TWL - BZ} = \frac{38,326}{16.3 - 3.0} = \mathbf{2,893\ ft^2/basin}$$

where: BA = Basin Area (ft^2)
TWL = Top Water Level (ft)
BZ = Buffer Zone (ft) (Safety Factor)

Sludge Depth

$$SD = \frac{Vbio}{BA} = \frac{27,231}{2,893} = \mathbf{9.41\ ft}$$

where: SD = Sludge Depth (ft)

Decanter Draw Down

$$DD = \frac{MVAB}{BA} = \frac{11,029}{2,893} = \mathbf{3.81\ ft}$$

where: DD = Draw Down (ft)

Bottom Water Level

$$BWL = SD + BZ + Vd = 9.41 + 3.00 + 0.02 = \mathbf{12.44\ ft}$$

where: BWL = Bottom Water Level (ft)
Vd = Depth of Chemical Sludge for Phosporus precipitation (ft)

Top Water Level

$$TWL = BWL + DD = 12.44 + 3.81 = \mathbf{16.25\ ft}$$

where: TWL = Top Water Level (ft)

Hydraulic Retention Time

$$HRT = \frac{BA \times MAFD \times 7.48}{QT}$$

where: HRT = Hydraulic Retention Time (days)
MAFD = Maximum Average Flow Depth (ft)
QT = Fill Rate at Average Dry Weather Flow (gal/day)

$$MAFD = \frac{Q \times [(NCT \times 60) - NDT]}{BA \times 1,440 \times 7.48} + BWL = \frac{300,000 \times [(4.8 \times 60) - 72.0]}{2,893 \times 1,440 \times 7.48} + 12.44 = \mathbf{14.52\ ft}$$

$$HRT = \frac{2,893 \times 14.52 \times 7.48}{300,000} = \mathbf{1.05\ days}$$

MLSS Concentration at Bottom Water Level

$$MLSS = \frac{Mbio \times 1{,}000{,}000}{BWL \times (BA - CA) \times 62.42} = \frac{11{,}346 \times 1{,}000{,}000}{12.44 \times (2{,}893 - 4.04) \times 62.42} = \mathbf{5{,}062\ mg/l}$$

where: MLSS = Mixed Liquor Suspended Solids concentration at Bottom Water Level (mg/l)
62.42/1E+06 = Conversion (lb/mg x l/ft^3)
CA = Area Increment due to chemical sludge (ft^2/basin)

Mass of Sludge Produced

$$\Delta M = \left(\frac{Y \times (BODin - BODout)}{1 + (B \times \theta^{(T-20)} \times SRT)} + Zio + Zno \right) \times \frac{Q \times 8.34}{1{,}000{,}000}$$

$$\Delta M = \left(\frac{0.6 \times (190 - 10.0)}{1 + (0.07 \times 1.04^{(10-20)} \times 28.1)} + 84.0 + 21.0 \right) \times \frac{3.0E{+}05 \times 8.34}{1{,}000{,}000} = \mathbf{379\ lb/day/basin}$$

(Lawrence-McCarty Equation as presented in WEF MOP/8 4th Edition, pg 11-11, Eqn. 11.7)

where: ΔM = Mass of Sludge Produced (lb/day/basin)
Y = Volatile cell yield (VSS/BOD removed)
q = Arrhenius Temperature Correction Factor
B = Decay Rate (day^{-1})
BODout = Anticipated Effluent BOD (mg/l)
SRT = Solids Retention Time (days)
Zio = Influent nonvolatile suspended solids (mg/l)
Zno = Influent volatile nonbiodegradable solids (mg/l)
T = Minimum Wastewater Temperature (°C)

Volume of Sludge Produced

$$Vws = \frac{\Delta M + Csludge}{SFws \times 8.34} = \frac{379 + 27}{0.0085 \times 8.34} = \mathbf{5{,}727\ gal/day/basin}$$

where:
- Vws = Volume of Waste Sludge (gal/day/basin)
- SFws = Solids Fraction in Waste Sludge
- 8.34 = Density (lb/gal)
- Csludge = Mass of chemical sludge produced (lb/day/basin) (Please refer to phosphorus removal calculation)

Observed Yield Factor

$$Yobs = \frac{\Delta M}{BOD_L} = \frac{379}{475} = \mathbf{0.80}\ \frac{MLSS}{BOD}$$

Observed Yield Factor (lb/day MLSS/lb/day BODremoved)

Mean Cell Residence Time

$$MCRT = \frac{Mbio}{\Delta M + ((Q - Vws) \times SSout \times 8.34 / 1E{+}06)}$$

$$MCRT = \frac{11{,}346}{379 + ((300{,}000 - 5{,}727) \times 10.0 \times 8.34 / 1{,}000{,}000)} = \mathbf{28.1\ days}$$

where:
- MCRT = Mean Cell Residence Time (days)
- SSout = Anticipated Effluent Total Suspended Solids (mg/l)
- 8.34E-06 = Conversion (lb/mg x l/gal)

Sludge Age for Nitrification

Refer to Metcalf and Eddy, Edition IV pages 614 and 705

Constants and Temperature Corrections:

Coefficient	Base Value	Theta	Temperature Corrected	Symbol
Maximum Specific Growth Rate of Nitrifying bacteria, g VSS/g VSS.day	0.75	1.07	0.381	$\mu_{nm}(T)$
Half-Velocity constant for nitrifiers	0.74	1.053	0.442	Kn(T)
Nitrifier decay rate	0.08	1.04	0.054	Kdn(T)
Dissolved Oxygen, mg/l	2		2	DO
Half-Velocity Constant for Dissolved Oxygen, mg/l	0.5		0.5	Ko
Minimum Water Temperature, °C	10		10	T
Safety Factor	1.5		1.5	SF

Calculations:

$$\mu_n = \left(\mu_{nm}(T) \times \frac{TENH_3}{TENH_3 + Kn(T)} \times \frac{DO}{DO + Ko} \right) - Kdn(T)$$

$$\mu_n = \left(0.381 \times \frac{1.0}{1.0 + 0.442} \times \frac{2.0}{2.0 + 0.5} \right) - 0.054 = \mathbf{0.158\ days^{-1}}$$

$$SRTmin = \frac{1}{\mu_n} = \frac{1}{0.158} = \mathbf{6.3\ days}$$

$$SRTaerobic = SRTmin \times SF = 6.3 \times 1.5 = \mathbf{9.5\ days}$$

$$SRToverall = \frac{SRTaerobic \times 24}{TA} = \frac{9.5 \times 24}{8.0} = \mathbf{28.6\ days}$$

Design sludge age not adequate for nitrification.

where: $\mu nm(T)$ = Maximum Temperature Corrected Nitrifier Growth Rate ($days^{-1}$)

μ_n = Specific Nitrifier Growth Rate at Temperature, DO, and Effluent NH_3 (g/g-days)

SRTmin = Minimum Sludge age required for Nitrification (days)

SRTaerobic = Design Aerobic Sludge Age (days)

SF = Safety Factor

SRToverall = Sludge Age accounting for entire ICEAS cycle (days)

TA = Aeration Time (hrs/day)

$TENH_3$ = Anticipated Effluent Ammonia (mg/l)

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Waste Sludge Pump Capacity

$$WSP = \frac{Vws \times NCT}{24 \times SPT} = \frac{5{,}727 \times 4.8}{24 \times 10.41} = \mathbf{110\ gal/min}$$

where: WSP = Waste Sludge Pump Capacity(gal/min)
SPT = Sludge Pumping Time (min/cycle)

Biological Phosphorus Removal

$$TPb = TPi - [Yobs \times (BODin - BODout)] \times TPps = 7.0 - [0.80 \times (190 - 10.0) \times 0.03] = \mathbf{2.70\ mg/l}$$

where: TPb = Concentration of the Total Phosphorus in the Effluent after biological removal (mg/l)
TPi = Concentration of the Total Phosphorus in the Influent (mg/l)
TPps = Percent of Total Phosphorus in Biomass

Chemical Dosing

$$CD = CDt \times (TPb - TPe) \times (1 + SF)$$

where: CDt= Theoretical Weight Ratio Chemical Dosage
SF= Safety Factor for Chemical Dosing (%)
TPe = Required Phosphorus concentration in effluent (mg/l)

Alum Dosage Based on percentage removal (PR) of Phosphorus:
Refer to ASCE Design of Municipal Wastewater Treatment Plants (4th Edition) pg 16-67

PR	CDt
PR < 85	13
85 ≤ PR ≤ 95	16
PR > 95	22

$$PR = \frac{TPb - TPe}{TPb} \times 100 = \frac{2.70 - 1.0}{2.70} \times 100 = \mathbf{63\%}$$

CDt= 13

$$CD = 13 \times (2.70 - 1.0) \times (1 + 25\%) = \mathbf{27.6\ mg/l}$$

...Rounded to the next 5 mg/l

CD= 30 mg/l

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Mass of Chemical Sludge

$$Csludge = \frac{Q \times CD \times 0.091 \times 4 \times 8.34}{1{,}000{,}000} = \frac{300{,}000 \times 30 \times 0.091 \times 4 \times 8.34}{1{,}000{,}000} = \mathbf{27\ lb/day/basin}$$

where: 0.091 = Fraction of Alum reacting with Phosphorus
4 = Mass of Precipitate formed per Mass of Alum

Volume of Chemical Sludge

$$Vcs = Csludge \times SVI = 27 \times 2.4 = \mathbf{66\ ft^3/basin}$$

where: Vcs = Volume of Chemical Sludge (ft^3/basin)

Carbonaceous Oxygen Demand

$$AOR1 = A \times \frac{Q \times BODin}{1{,}000{,}000} \times 8.34 = 1.20 \times \frac{300{,}000 \times 190}{1{,}000{,}000} \times 8.34 = \mathbf{570\ lb/day/basin}$$

where AOR1 = Actual Oxygen Required for BOD oxidation (lb/day/basin)
A = O2 / BOD
Q = Average flow (gal/day/basin)
BODin = Influent BOD received (mg/l)
1,000,000 = Conversion (g x mg)
8.34 = Conversion (lb x gal)

$$A = \mathbf{1.20\ O2/BOD}$$

Nitrification Oxygen Demand

$$AOR2 = \Delta N \times 4.60 = 72.5 \times 4.60 = \mathbf{333\ lb/day/basin}$$

where AOR2 = Actual Oxygen required for Ammonia Oxidation (lb/day/basin)

$$\Delta N = \frac{[\,(NH3in - NH3out) - (BODin - BODout) \times Yobs \times Ns\,] \times Q \times 8.34}{1{,}000{,}000}$$

$$\Delta N = \frac{[\,(40.0 - 1.0) - (190.0 - 10.0) \times 0.80 \times 0.07\,] \times 300{,}000 \times 8.34}{1{,}000{,}000} = \mathbf{72.5\ lb/day/basin}$$

where AOR2 = Actual Oxygen required for Ammonia Oxidation (lb/day/basin)
TKNin = Influent TKN concentration (mg/l)
4.6 = Mass of O_2 per Mass of Ammonia Oxidized
NLOAD = Mass of TKN applied lb/day/basin
NH3out = Effluent ammonia required (mg/l)
Ns = Sludge Nitrogen content (N / sludge)
BODout = Effluent BOD (mg/l)

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Total Actual Oxygen Transfer

$$AOR = AOR1 + AOR2 = 570 + 333 = \mathbf{904\ lb/day/basin}$$

where AOR = Total Actual Oxygen Required (lb/day/day/basin)

Total Standard Oxygen Transfer

$$SOR = \frac{AOR}{AOR/SOR} = \frac{904}{0.4766} = \mathbf{1{,}897\ lb/day/basin}$$

$$\frac{AOR}{SOR} = \frac{\alpha \times \theta^{(TSite - 20)} \times (\beta \times C^{*}sat_{20} \times Psite / Pstd \times Csurf_T / Csurf_{20} - D.O.)}{C^{*}sat_{20}}$$

$$\frac{AOR}{SOR} = \frac{0.65 \times 1.024^{(20-20)} \times (0.95 \times 10.31 \times 14.34 / 14.70 \times 9.07 / 9.07 - 2.0)}{10.31} = 0.4766$$

where SOR = Standard Condition Oxygen Requirement (lb/day/day/basin
α = Alpha factor
θ = Temperature coefficient
Tsite = Water temperature (°C)
β = Beta factor
Psite = Site Atmospheric Pressure
Pstd = Standard atmospheric pressure (psig)
$C^{*}sat_{20}$ = Dissolved oxygen solubility at standard conditions (mg/l)
$Csurf_T$ = Dissolved oxygen solubility at site water temperature (mg/l)
$Csurf_{20}$ = Dissolved oxygen solubility at 20°C (mg/l)
D.O. = Residual dissolved oxygen concentration (mg/l)

Aeration System Standard Oxygen Transfer Rate

$$SOTR = \frac{SOR}{TA} = \frac{1{,}897}{8} = \mathbf{237\ lb/hr}$$

where SOTR = Standard oxygen transfer rate (lb/day/hr)
TA = Aeration Time, hrs/day

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Aeration Depth

Average Aeration Depth

$$MADad = \frac{Q \times [(NCT \times 60) - (NDT + NST)]}{2 \times 1{,}440 \times 7.48 \times BA} + BWL$$

$$MADad = \frac{300{,}000 \times [(4.8 \times 60) - (72 + 48)]}{2 \times 1{,}440 \times 7.48 \times 2{,}890} + 12.44 = \mathbf{13.25\ ft}$$

where AADad = Average Aeration Depth at Average Dry Weather Flow (gpd)
Q = Average Dry Weather Flow (gpd/basin)
NCT = Normal Cycle Time (hr)
NDT = Normal Decant Time (min)
NST = Normal Settling Time (min)
BA = Basin Area (ft^2)
1440 = Conversion (min/day)
7.48 = Conversion (gal/ft^3)
2 = Calculate Aeration Depth at Middle of Normal Reaction Phase (NCT - NST - NDT)

Maximum Aeration Depth

$$MADpw = \frac{PWWF \times [(SCT \times 60) - (SDT + SST)]}{1{,}440 \times 7.48 \times BA} + BWL$$

$$MADpw = \frac{1{,}100{,}000 \times [(2.4 \times 60) - (36 + 36)]}{1{,}440 \times 7.48 \times 2{,}890} + 12.44 = \mathbf{14.98\ ft}$$

where MADpw = Maximum Aerartion Depth at Peak Wet Weather Flow (gpd)
PWWF = Peak Wet Weather Flow (gpd/basin)
SCT = Storm Cycle Time (hr)
SDT = Storm Decant Time (min)
SST = Storm Settle time (min)
MAD = Maximum Aeration Depth (ft)

MAD is larger of MADad and MADpw

$$\boxed{MAD = \mathbf{15.40\ ft}}$$

Air Flow Requirement

$$Process\ Air = \frac{SOTR \times 10{,}000}{\rho \times SOTE \times Opw \times 60} = \frac{237 \times 10{,}000}{0.075 \times 26.05 \times 23.2 \times 60} = \mathbf{872\ scfm}$$

where Process Air = Process air flow requirement (scfm)

ρ = Air density (0.075 lb/day/ft³)
SOTE = Standard Oxygen Transfer Efficiency @ Submergence of 12.25 ft
Opw = Fraction of Oxygen in air by Weight
10,000 = Conversion (100% * 100%)
60 = Conversion (min/hr)

Mixing Air = MI x BA = 0.13 x 2,890 = 362 scfm

where Mixing Air = Mixing air flow requirement (scfm)
MI = recommended air flow per unit area of basin (scfm/ft²)

Blower Unit Capacity

Blower unit capacity (BUC) is the larger of the process air requirement and the mixing air requirement.

Process Air 872 scfm

Mixing Air 362 scfm

Use 1 blower per tank

BUC = 880 scfm

Blower Pressure

psig = MAD x 0.432 + H_L = 14.98 x 0.432 + 1.00 = 7.7 psig

where psig = blower pressure (rounded to next psig)
0.432 = water density (psi/ft)
H_L = Cumulative piping and diffuser headloss (psig)

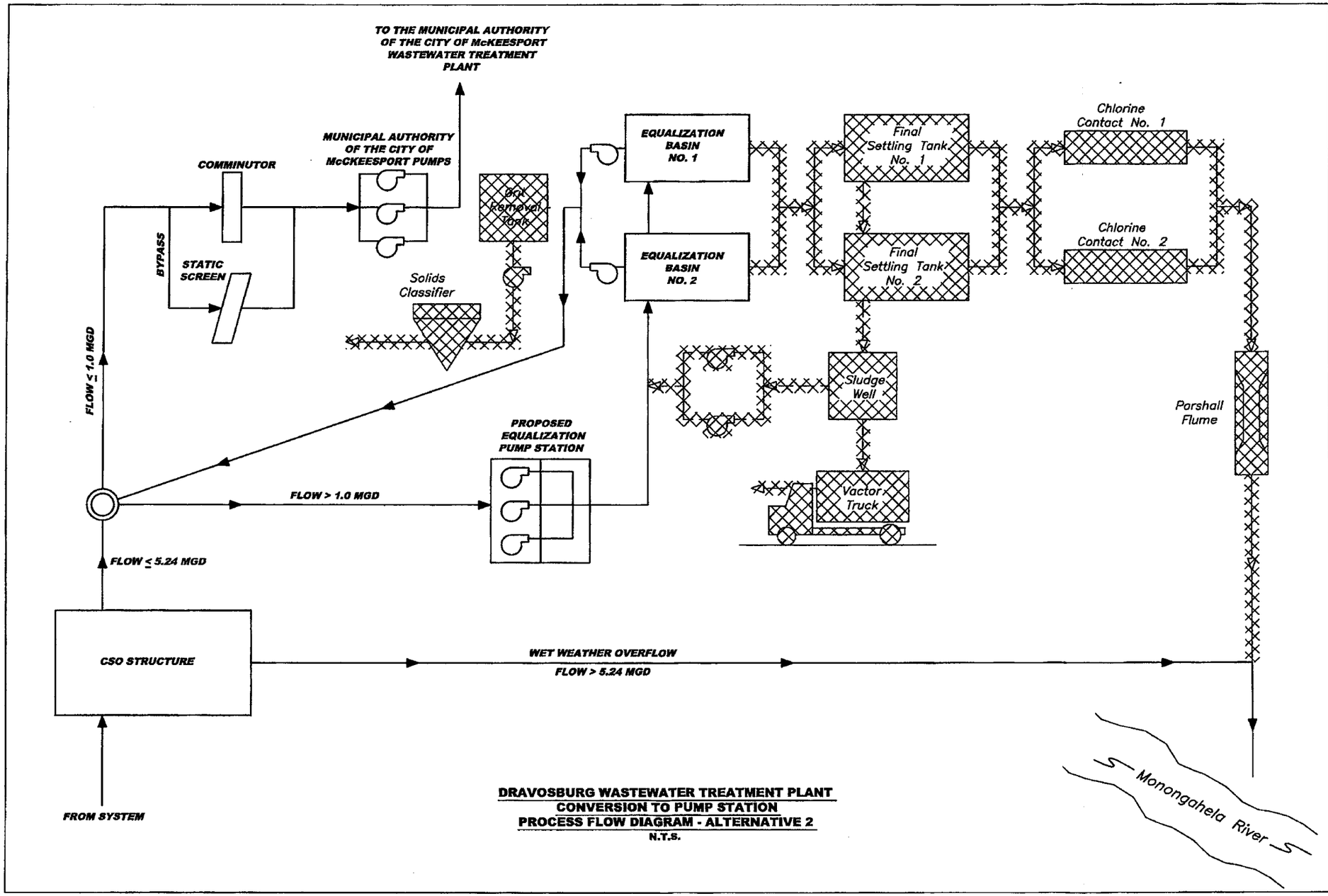
Average Blower Power

Blower power based on vendor curves, BUC, and Average Aeration Depth (12.25 ft)

$Power_{avg}$ = 40.0 bhp

APPENDIX Q

ALTERNATIVE 2
PROCESS FLOW DIAGRAM



DRAVOSBURG WASTEWATER TREATMENT PLANT
CONVERSION TO PUMP STATION
PROCESS FLOW DIAGRAM - ALTERNATIVE 2
N.T.S.

Revisions	Date
Revisions	Date

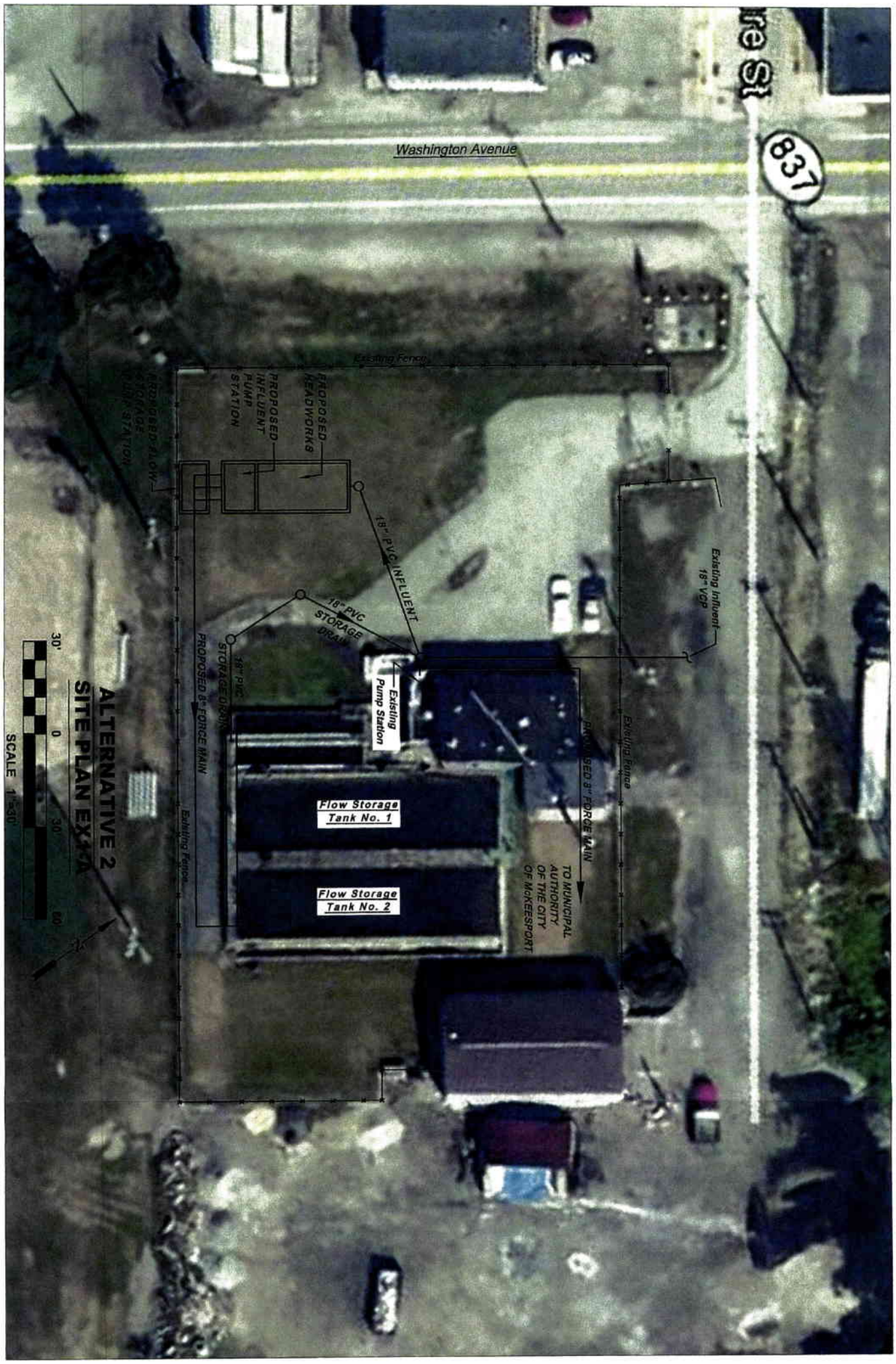
6172 Campbells Run Road
Pittsburgh, PA 15205
Phone: 412.494.0810
Fax: 412.494.0838
Info@klhengr.com
KLH ENGINEERS, INC

BOROUGH OF DRAVOSBURG
ALLEGHENY COUNTY, PENNSYLVANIA
WASTEWATER TREATMENT PLANT CONVERSION
TO PUMP STATION
PROCESS FLOW DIAGRAM

Scale:	As Shown
Date:	August 2014
Drawn By:	EHD
Checked By:	BMC
Approved By:	SHG
Order No.	220-53
Drawing No.	EX4
Sheet No.	1 of 1

APPENDIX R

ALTERNATIVE 2
SITE PLAN



Sheet No. 1 of 1	Drawing No. EX1	Order No. 220-53	Scale: As Shown Date: July 2014 Drawn By: EHD Checked By: BMC Approved By: SHG

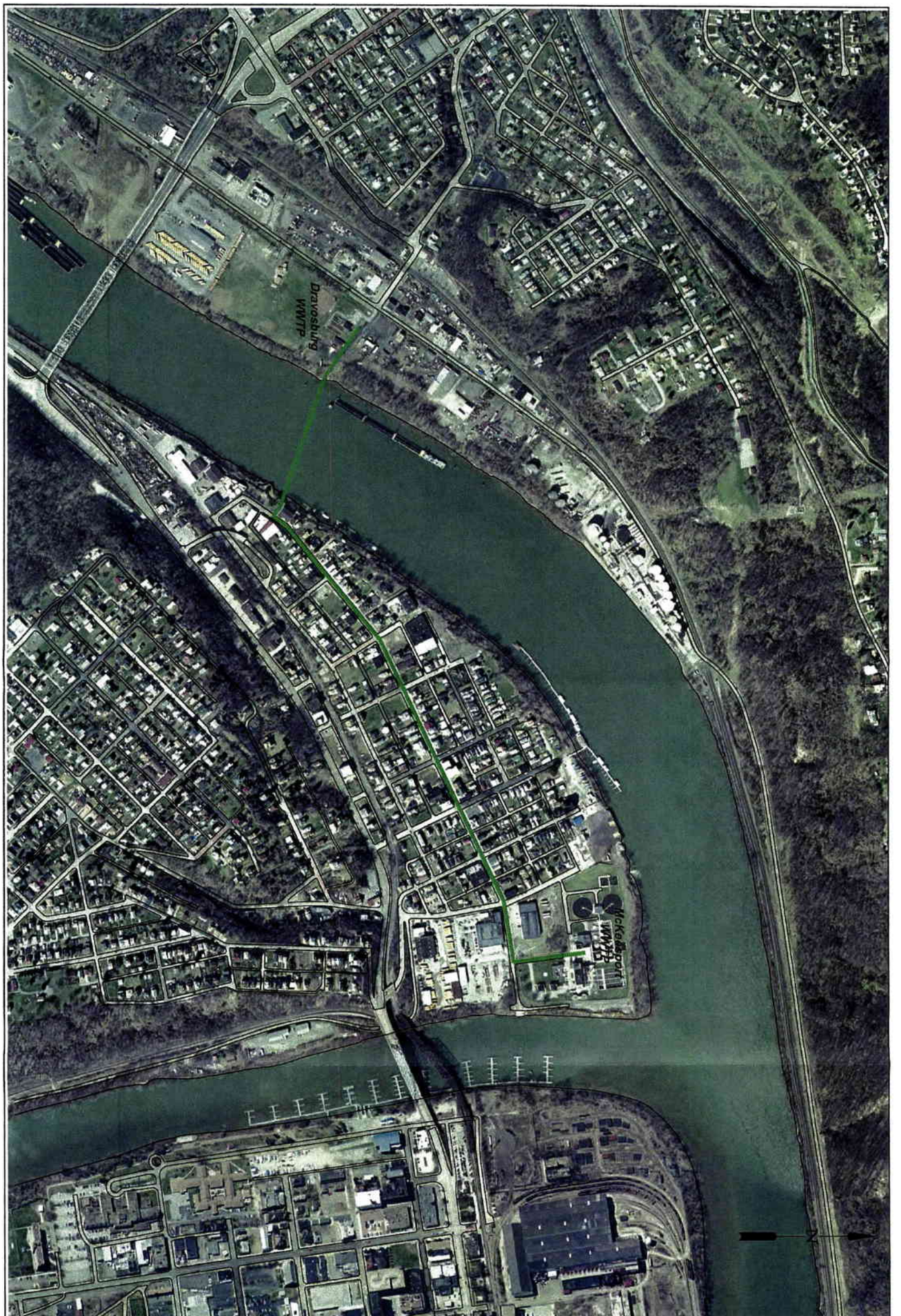
BOROUGH OF DRAVOSBURG
ALLEGHENY COUNTY, PENNSYLVANIA
LONG TERM CONTROL PLAN
ALTERNATIVE 2 SITE PLAN

KLH ENGINEERS, INC
5173 Campbells Run Road
Pittsburgh, PA 15205
Phone: 412.494.9610
Fax: 412.494.0426
info@klhengineers.com

Date	Revisions	Date	Revisions

APPENDIX S

ALTERNATIVE 2
FORCE MAIN ALIGNMENT



Sheet No. 1 of 1	Drawing No. FM-EX2	Order No. 220-53	Scale: NTS Date: May 2014 Drawn By: VLB Checked By: BMC Approved By: SHG	**MUNICIPAL AUTHORITY OF THE CITY OF MCKEESPORT** **ALLEGHENY COUNTY, PENNSYLVANIA** **DRAVOSBURG-DUQUESNE AREA ACT 537 & LONG TERM CONTROL PLAN** **FORCE MAIN EXHIBIT**	KLH ENGINEERS, INC 5173 Campbells Run Road Pittsburgh, PA 15205 Phone: 412.494.0510 Fax: 412.494.0426 info@klhengineers.com

Date	Revisions	Date	Revisions

APPENDIX T

PROJECT COST ESTIMATES

Dravosburg WWTP Long Term Control Plan

Alternative 1 - Upgrade WWTP

Planning Cost Estimate

ITEM	COST
General Site Work	$ 138,000
Headworks Building	$ 863,000
SBR Tank Conversion	$ 864,000
Influent Pump Station	$ 1,199,000
Grit Removal	$ 504,000
Sludge Holding Facilities	$ 130,000
Ultraviolet Disinfection	$ 477,000
SUBTOTAL CONSTRUCTION COST	**$ 4,175,000**
Electrical Costs (25%)	$ 1,044,000
Mobilization/Demobilization/Bonds/Insurance (15%)	$ 627,000
Contingency (30%)	$ 1,253,000
TOTAL CONSTRUCTION COST	**$ 7,099,000**
Engineering, Permitting, Legal (15%)	$ 1,065,000
Construction Administration (10%)	$ 710,000
TOTAL PROJECT COST	**$ 8,874,000**

Site Work

			Qty	Unit	Price per Unit	Materials	Total
Division 2	Site Work						
		E&S Controls	1	lot	$ 10,000.00	$ 10,000.00	$ 10,000.00
		By-Pass Pumping	1	lot	$ 50,000.00	$ 50,000.00	$ 50,000.00
		Site Paving	385	s.y.	$ 50.00	$ 19,259.26	$ 19,259.26
		Lawn Restoration	1	lot	$ 5,000.00	$ 5,000.00	$ 5,000.00
Division 3	Concrete						
		Repairs/Rehabilitation	1	lot	$ 10,000.00	$ 10,000.00	$ 10,000.00
		Manholes (0'-8' Deep)	3	ea	$2,500.00	$ 7,500.00	$ 7,500.00
		Manhole VF over 8' Deep	25	v.f.	$110.00	$ 2,750.00	$ 2,750.00
						$ -	
Division 15	Mechanical						
		8" D.I. Pipe (Buried) - F.M.	250	L.F.	$ 50.00	$ 12,500.00	$ 12,500.00
		18" D.I. Pipe (Buried) - F.M.	100	L.F.	$ 200.00	$ 20,000.00	$ 20,000.00

Subtotal Construction = $ 137,009.26

Headworks

			Qty	Unit	Price per Unit	Materials	Total
Division 2	Site Work						
		Excavation	972.2	c.y.	$ 50.00	$ 48,611.11	$ 48,611.11
		Backfill	243.1	c.y.	$ 50.00	$ 12,152.78	$ 12,152.78
		Stone Backfill	28.11	c.y.	$ 172.00	$ 4,834.92	$ 4,834.92
		Excavation/Shoring/Dewatering/Backfill	1	LOT	$ 50,000.00	$ 50,000.00	$ 50,000.00
Division 3	Concrete						
		Foundation Slab	84.33	c.y.	$ 532.10	$ 44,871.99	$ 44,871.99
		First Floor Slab	56.22	c.y.	$ 1,123.40	$ 63,157.55	$ 63,157.55
		Walls	85.92	c.y.	$ 1,123.40	$ 96,522.53	$ 96,522.53
Division 4	Masonry						
		Block	1200	s.f.	$ 8.35	$ 10,020.00	$ 14,923.83
Division 5	Metals						
		Aluminum Grating	150	s.f.	$ 65.00	$ 9,750.00	$ 9,750.00
		Aluminum Handrail	200	L.F.	$ 70.00	$ 14,000.00	$ 14,000.00
		4'x4' Aluminum Hatchway	1	each	$ 3,500.00	$ 3,500.00	$ 5,212.91
		Stairs	82	riser	$ 185.00	$ 15,170.00	$ 22,594.26
Division 7	Thermal and Moisture						
		Masonry Insulation	1200	s.f.	$ 1.31	$ 1,572.00	$ 2,341.34
		Roofing	1	Lot	$ 25,000.00	$ 25,000.00	$ 37,235.10
		Alum Fascia	100	s.f.	$ 5.35	$ 535.00	$ 796.83
		Alum Soffit	404	s.f.	$ 7.65	$ 3,090.60	$ 4,603.15
		Alum Gutters	100	L.F.	$ 5.00	$ 500.00	$ 744.70
		Downspouts	48	L.F.	$ 4.84	$ 232.32	$ 346.02
Division 8	Doors and Windows						
		7'x3' Mandoor w/window	1	each	$ 1,000.00	$ 1,000.00	$ 1,489.40
		7'x6' Door	1	each	$ 2,500.00	$ 2,500.00	$ 3,723.51
		10'x14' Rolling Garage	1	each	$ 7,000.00	$ 7,000.00	$ 10,425.83
		3'x3' window	2	each	$ 500.00	$ 1,000.00	$ 1,489.40
		4'x4' skylight	2	each	$ 200.00	$ 400.00	$ 595.76
Division 9	Coatings						
		Paints	10000	s.f.	$ 2.00	$ 20,000.00	$ 29,788.08
Division 11	Equipment						
		Coarse Screen (Mechanical)	1	each	$ 234,000.00	$ 234,000.00	$ 304,200.00
		Coarse Screen (Manual)	1	each	$ 7,500.00	$ 7,500.00	$ 7,500.00
Division 15	Mechanical						
		Sluice Gates	4	each	$ 3,500.00	$ 14,000.00	$ 20,851.66
		HVAC	1	Lot	$ 50,000.00	$ 50,000.00	$ 50,000.00
						Subtotal Construction = $	**862,762.69**

SBR Tanks							
			Qty	Unit	Price per Unit	Materials	Total
Division 3	Concrete						
		Walls	68.15	c.y.	$1,123.40	$ 76,557.63	$ 76,557.63
Division 11	Equipment						
		SBR Equipment	1	each	$ 510,000.00	$ 510,000.00	$ 663,000.00
		SCADA and SIMS	1	each	$ 80,000.00	$ 80,000.00	$ 104,000.00
Division 15	Mechanical						
		WAS Sludge Piping	200	LF	$ 100.00	$ 20,000.00	$ 20,000.00
						Subtotal Construction =	$ 863,557.63

Influent Pump Station and Valve Vault

			Qty	Unit	Price per Unit	Materials	Total
Division 2	Site Work						
		Excavation	513	c.y.	$ 50.00	$ 25,648.15	$ 25,648.15
		Backfill	128	c.y.	$ 50.00	$ 6,412.04	$ 6,412.04
		Stone Backfill	21	c.y.	$ 172.00	$ 3,612.00	$ 3,612.00
		Excavation/Shoring/Dewatering/Backfill	1	LOT	$ 100,000.00	$ 100,000.00	$ 100,000.00
		Anchoring					
Division 3	Concrete						
		Foundation Slab	62	c.y.	$ 532.10	$ 32,990.20	$ 32,990.20
		Elevated Slabs and Walls	191	c.y.	$1,123.40	$ 214,569.40	$ 214,569.40
Division 5	Metals						
		6'x6' Aluminum Hatchway	2	each	$ 5,000.00	$ 10,000.00	$ 10,000.00
Division 11	Equipment						
		Influent Pumps	3	each	$ 100,000.00	$ 300,000.00	$ 300,000.00
		MCC	1	each	$ 300,000.00	$ 300,000.00	$ 300,000.00
		PLC and Controls	1	each	$ 100,000.00	$ 100,000.00	$ 100,000.00
		Bridge Crane	1	each	$ 25,000.00	$ 25,000.00	$ 25,000.00
Division 15	Mechanical						
		Wet Well and Valve Vault Piping	1	LOT	$ 80,000.00	$ 80,000.00	$ 80,000.00

Subtotal Construction = $ **1,198,231.79**

Grit Removal

			Qty	Unit	Price per Unit	Materials	Total
Division 2	Site Work						
		Excavation	188.15	c.y.	$ 49.00	$ 9,219.26	$ 9,219.26
		Backfill	47.037	c.y.	$ 49.00	$ 2,304.81	$ 2,304.81
		Stone Backfill	80.22	c.y.	$ 172.00	$ 13,797.84	$ 13,797.84
		Fill Existing Grit Basin	25.87	c.y.	$ 30.00	$ 776.10	$ 776.10
		Remove Existing Grit Equipment	1	LOT	$ 5,000.00	$ 5,000.00	$ 5,000.00
Division 3	Concrete						
		Foundation Slab	37.62	c.y.	$ 532.10	$ 20,017.60	$ 20,017.60
		Elevated Slabs and Walls	53.51	c.y.	$1,123.40	$ 60,113.13	$ 60,113.13
Division 5	Metals						
		Aluminum Grating	508	s.f.	$ 23.00	$ 11,684.00	$ 11,684.00
		Aluminum Handrail	100	L.F.	$ 75.21	$ 7,521.00	$ 7,521.00
Division 11	Equipment						
		Grit Unit Equipment	1	each	$ 259,000.00	$ 259,000.00	$ 336,700.00
		Davit Crane	1	each	$ 5,000.00	$ 5,000.00	$ 7,447.02
Division 15	Mechanical						
		Stop Plate	2	each	$ 10,000.00	$ 20,000.00	$ 20,000.00
		Weir Plate	2	each	$ 2,000.00	$ 4,000.00	$ 4,000.00
		16" D.I. Pipe (Flanged)	20	L.F.	$ 160.00	$ 3,200.00	$ 4,766.09

Subtotal Construction = $ **503,346.86**

UV Disinfection

			Qty	Unit	Price per Unit	Materials	Total
Division 2	Site Work						
		Convert CCT to UV	1	LOT	$ 250,000.00	$ 250,000.00	$ 250,000.00
Division 11	Equipment						
		UV Equipment	1	each	$ 174,500.00	$ 174,500.00	$ 226,850.00

Subtotal Construction = **$ 476,850.00**

Sludge Holding

			Qty	Unit	Price per Unit	Materials	Total
Division 2	Site Work						
		Equipment Removal	1	LOT	$ 30,000.00	$ 30,000.00	$ 30,000.00
Division 11	Equipment						
		Diffusers	1	each	$ 100,000.00	$ 100,000.00	$ 100,000.00

Subtotal Construction = **$ 130,000.00**

Dravosburg WWTP Long Term Control Plan

Alternative 2 - Pump Dravosburg to MACM

Planning Cost Estimate

ITEM		COST
General Site Work	$	181,000
Pump Station and Valve Vault	$	1,449,000
Force Main to MACM	$	748,000
Aeration/Storage Tank Rennovations	$	210,000
SUBTOTAL CONSTRUCTION COST	$	**2,588,000**
Electrical Costs (25%)	$	647,000
Mobilization/Demobilization/Bonds/Insurance (15%)	$	389,000
Contingency (30%)	$	777,000
TOTAL CONSTRUCTION COST	$	**4,401,000**
Engineering, Permitting, Legal (15%)	$	661,000
Construction Administration (10%)	$	441,000
TOTAL PROJECT COST	$	**5,503,000**

Site Work

			Qty	Unit	Price per Unit	Materials	Total
Division 2	Site Work						
		E&S Controls	1	lot	$ 10,000.00	$ 10,000.00	$ 10,000.00
		By-Pass Pumping	1	lot	$ 50,000.00	$ 50,000.00	$ 50,000.00
		Fill Final Clarifiers (Stone)	323	c.y.	$ 30.00	$ 9,690.00	$ 9,690.00
		Site Paving	385	s.y.	$ 50.00	$ 19,259.26	$ 19,259.26
		Lawn Restoration	1	lot	$ 5,000.00	$ 5,000.00	$ 5,000.00
Division 3	Concrete						
		Repairs/Rehabilitation	1	lot	$ 10,000.00	$ 10,000.00	$ 10,000.00
		Manholes (0'-8' Deep)	3	ea	$2,500.00	$ 7,500.00	$ 7,500.00
		Manhole VF over 8' Deep	25	v.f.	$110.00	$ 2,750.00	$ 2,750.00
		Fill Final Clarifiers (Cap)	31	c.y.	$ 532.10	$ 16,495.10	$ 16,495.10
						$ -	
Division 15	Mechanical						
		8" D.I. Pipe (Buried) - F.M.	150	L.F.	$ 50.00	$ 7,500.00	$ 7,500.00
		18" D.I. Pipe (Buried) - F.M.	210	L.F.	$ 200.00	$ 42,000.00	$ 42,000.00

Subtotal Construction = $ **180,194.36**

Influent Pump Station and Valve Vault

			Qty	Unit	Price per Unit	Materials	Total
Division 2	Site Work						
		Excavation	513	c.y.	$ 50.00	$ 25,648.15	$ 25,648.15
		Backfill	128	c.y.	$ 50.00	$ 6,412.04	$ 6,412.04
		Stone Backfill	21	c.y.	$ 172.00	$ 3,612.00	$ 3,612.00
		Excavation/Shoring/Dewatering/Backfill	1	LOT	$ 100,000.00	$ 100,000.00	$ 100,000.00
Division 3	Concrete						
		Foundation Slab	62	c.y.	$ 532.10	$ 32,990.20	$ 32,990.20
		Elevated Slabs and Walls	191	c.y.	$1,123.40	$ 214,569.40	$ 214,569.40
Division 5	Metals						
		6'x6' Aluminum Hatchway	2	each	$ 5,000.00	$ 10,000.00	$ 10,000.00
Division 11	Equipment						
		Normal Flow Pumps	3	each	$ 50,000.00	$ 150,000.00	$ 150,000.00
		Storm Pumps	3	each	$ 100,000.00	$ 300,000.00	$ 300,000.00
		MCC	1	each	$ 300,000.00	$ 300,000.00	$ 300,000.00
		PLC and Controls	1	each	$ 100,000.00	$ 100,000.00	$ 100,000.00
		Bridge Crane	1	each	$ 25,000.00	$ 25,000.00	$ 25,000.00
		Grinder Unit	1	each	$ 100,000.00	$ 100,000.00	$ 100,000.00
Division 15	Mechanical						
		Wet Well and Valve Vault Piping	1	LOT	$ 80,000.00	$ 80,000.00	$ 80,000.00

Subtotal Construction = **$ 1,448,231.79**

Force Main to MACM

			Qty	Unit	Price per Unit	Materials	Total
Division 2	Site Work						
		Select Backfill	3025	c.y.	$ 30.00	$ 90,750.00	$ 90,750.00
		Fliter Fence	4600	L.F.	$ 2.50	$ 11,500.00	$ 11,500.00
		Municipal Road Repavement	4533	s.y.	$ 50.00	$ 226,666.67	$ 226,666.67
		Exploratory Excavation	10	ea	$ 270.00	$ 2,700.00	$ 2,700.00
Division 3	Concrete						
		Manhole 0-8' Deep - 4'-0" Diameter	10	ea	$ 2,150.00	$ 21,500.00	$ 21,500.00
		Watertight Manhole Frame and Cover	5	ea	$ 500.00	$ 2,500.00	$ 2,500.00
Division 15	Mechanical						
		8" D.I. Pipe (Buried)	4600	L.F.	$ 50.00	$ 230,000.00	$ 230,000.00
		Bore 20" Stl. Casing Pipe	800	L.F.	$ 190.00	$ 152,000.00	$ 152,000.00
		CCTV Inspection	4600	L.F.	$ 1.50	$ 6,900.00	$ 6,900.00
		Force Main Testing	4600	L.F.	$ 0.60	$ 2,760.00	$ 2,760.00

Subtotal Construction = $ 747,276.67

Storage Tanks

			Qty	Unit	Price per Unit	Materials	Total
Division 11	Equipment						
		Storage Basin Dewatering Pumps	2	each	$ 30,000.00	$ 60,000.00	$ 60,000.00
		Replace Aeration Diffusers	1	LOT	$ 150,000.00	$ 150,000.00	$ 150,000.00
							$ 210,000.00

APPENDIX E

MUNICIPAL ADOPTION THROUGH RESOLUTION

Municipal Adoption through Resolution

to be included with Final Plan submission

APPENDIX F

ACHD AND MUNICIPAL PLANNING DEPARTMENT GENERAL CORRESPONDENCE

ACHD and Municipal Planning Department General Correspondence

to be included with Final Plan submission

APPENDIX G

PROOF OF PUBLICATION FOR COMMENT PERIOD

Proof of Publication for Comment Period

to be included with Final Plan submission

APPENDIX H

PUBLIC COMMENT AND RESPONSES

Public Comment and Responses

to be included with Final Plan submission

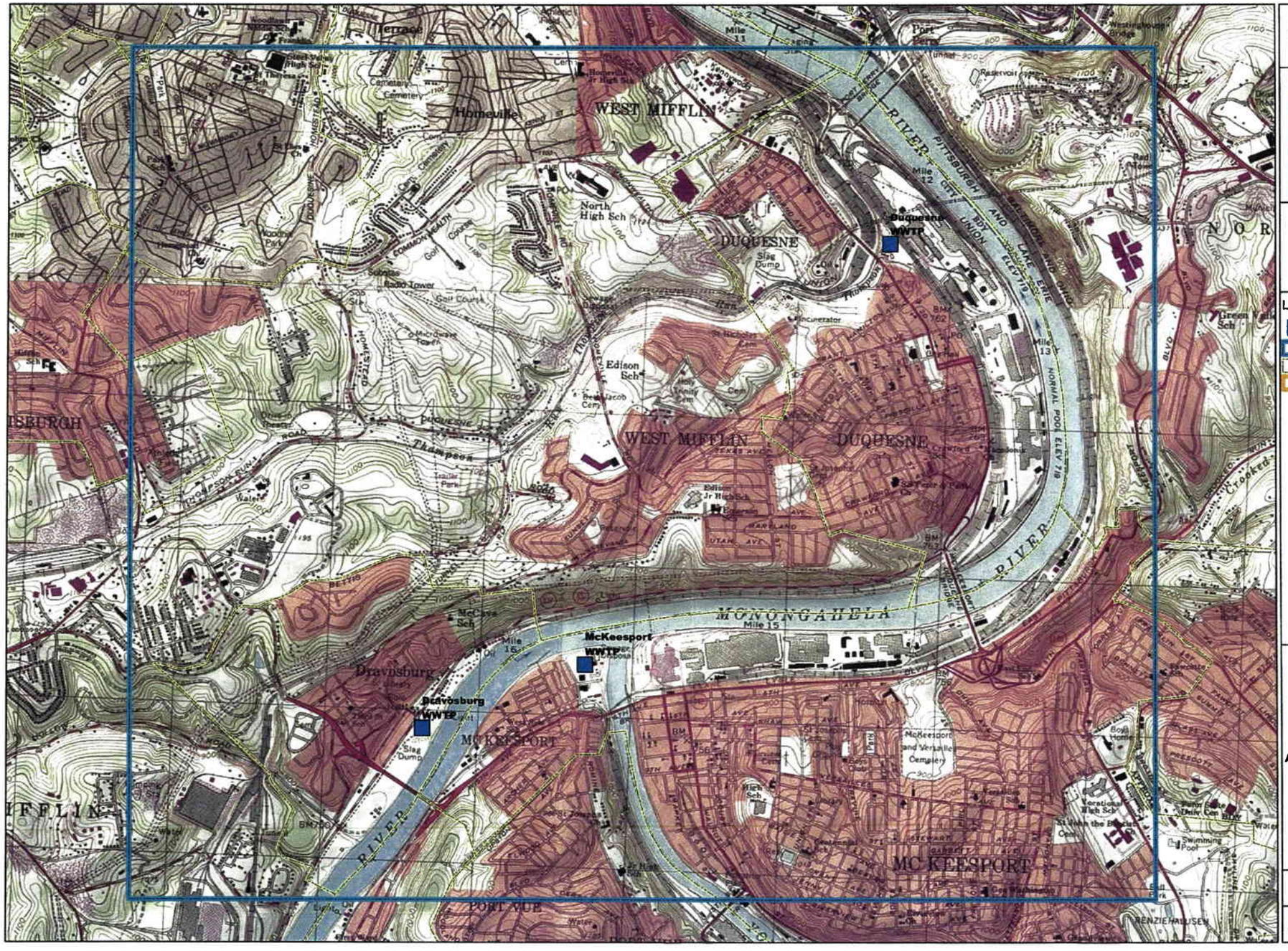
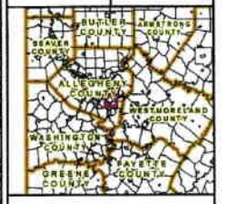


EXHIBIT 1

220-53



KLH

5173 Campbells Run Road
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Phone: 412-494-0510
Fax: 412-494-0426
www.klhengineers.com

Legend

- WWTP Locations
- Boundary
- Municipal Boundaries
- County Boundaries

CITY OF MCKEESPORT ALLEGHENY COUNTY PENNSYLVANIA LOCATION

0 1,200 2,400
Feet

Author: Ross Vollhrein
Date: 6/21/2014
NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet
Projection: Lambert Conformal Conic

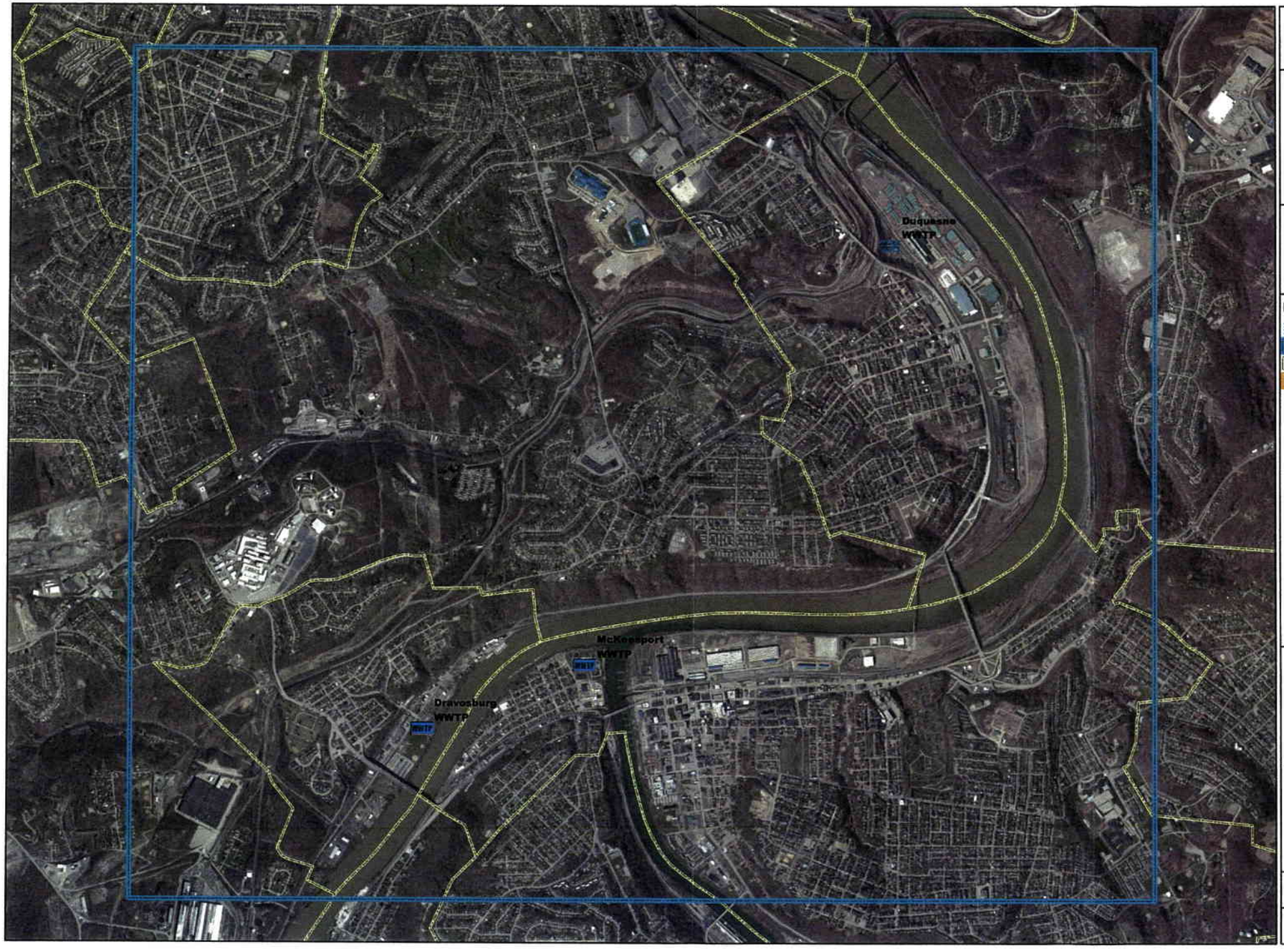
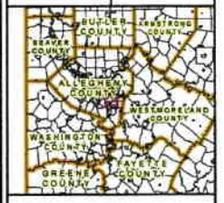


EXHIBIT 2

220-53



KLH

5173 Campbells Run Road
Pittsburgh, PA 15205
Phone: 412-494-0510
Fax: 412-494-0426
www.klhengineers.com

Legend

- WWTP Locations
- Boundary
- Municipal Boundaries
- County Boundaries

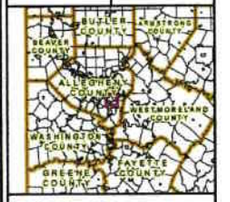
CITY OF MCKEESPORT ALLEGHENY COUNTY PENNSYLVANIA LOCATION

0 1,200 2,400
Feet

Author: Ross Vollmann
Date: 8/21/2014
NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet
Projection: Lambert Conformal Conic

EXHIBIT 3

220-53



KLH

5173 Campbells Run Road
Pittsburgh, PA 15205
Phone: 412-494-0510
Fax: 412-494-0426
www.klhengineers.com

Legend

- WWTP Locations
- All areas are prime farmland
- Farmland of statewide importance
- Not prime farmland
- Boundary
- Municipal Boundaries
- County Boundaries

AgC	EvC	SmD
CaB	GID	SmF
CmD	GkF	Ub
CoB	GwF	UcB
CoC	GuB	UcD
CuD	GvC	UcE
CwB	GuD	UgB
CwC	GvB	UgD
CwD	GvC	UrB
DeB	Gx	UrC
DeC	Ha	UrB
DeD	HaB	W
Dw	HaC	WbB
ErC	SmB	

CITY OF MCKEESPORT ALLEGHENY COUNTY PENNSYLVANIA SOIL AND FARMLAND CLASSIFICATION

0 1,200 2,400

Feet

Author: Ross Vollmann
Date: 6/21/2014
NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet
Projection: Lambert Conformal Conic

EXHIBIT 4

220-53

KLH
5173 Campbells Run Road
Pittsburgh, PA 15205
Phone: 412-494-0510
Fax: 412-494-0426
www.klhengineers.com

Legend

- WWTP Locations

Rock Formations

- Casselman Formation
- Glenshaw Formation
- Monongahela Group
- Boundary
- Municipal Boundaries
- County Boundaries

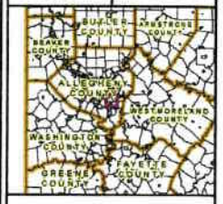
CITY OF MCKEESPORT ALLEGHENY COUNTY PENNSYLVANIA GEOLOGIC FEATURES

0 1,200 2,400
Feet

Author: Ross Volkmann
Date: 5/21/2014
NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet
Projection: Lambert Conformal Conic

EXHIBIT 5

220-53



KLH

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Legend

- WWTP Locations
- Freshwater Pond
- Riverine
- All hydric
- Not hydric
- Partially hydric
- Unknown
- Boundary
- Municipal Boundaries
- County Boundaries

CITY OF MCKEESPORT ALLEGHENY COUNTY PENNSYLVANIA WETLANDS AND HYDRIC CONDITIONS

0 1,200 2,400
Feet

Author: Ross Vollmann
Date: 8/21/2014
NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet
Projection: Lambert Conformal Conic

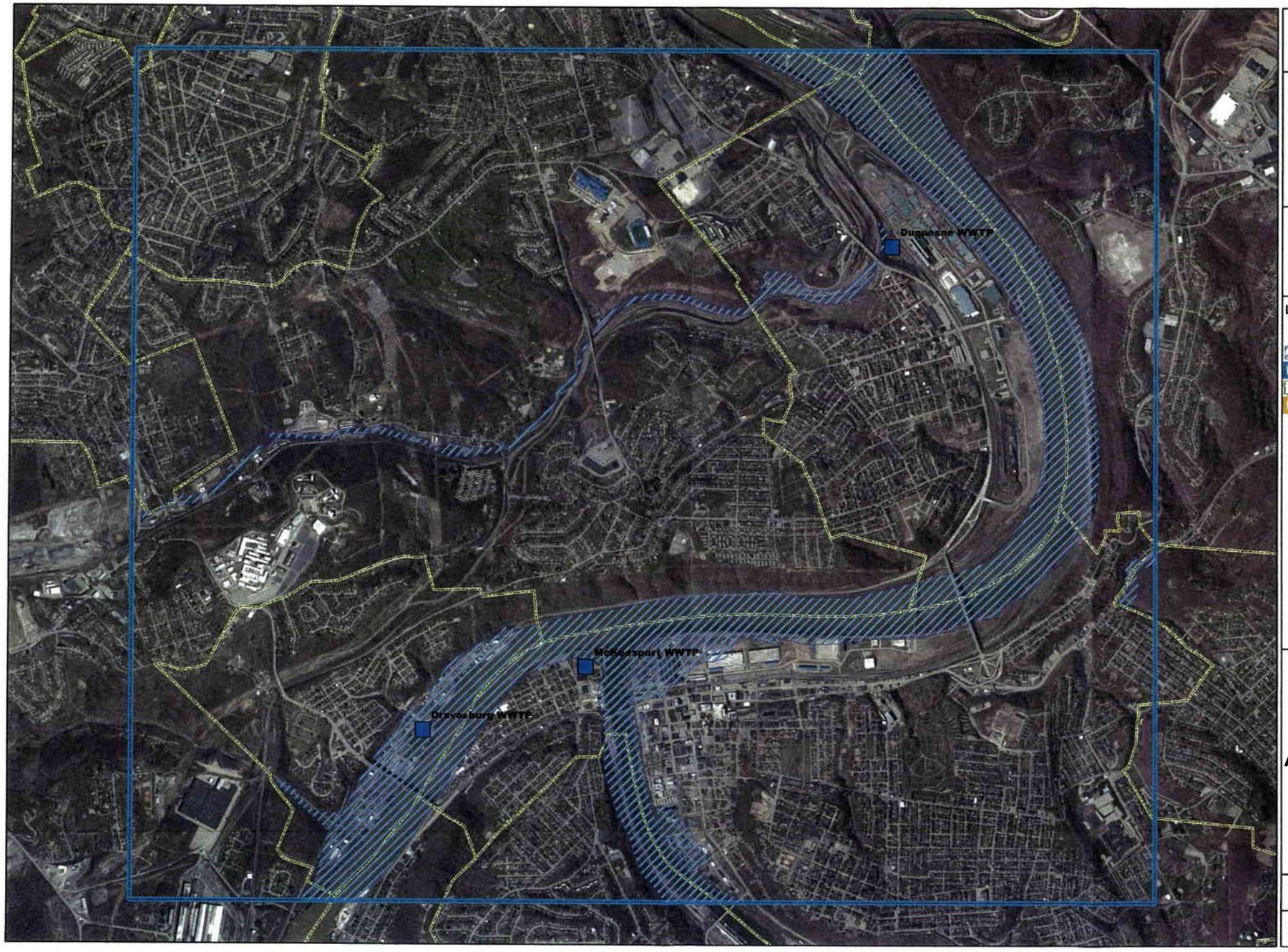
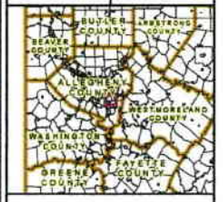


EXHIBIT 6

220-53



KLH

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Pittsburgh, PA 15205
Phone: 412-494-0610
Fax: 412-494-0426
www.klhengineers.com

Legend

- WWTP Locations
- Floodplains
- Boundary
- Municipal Boundaries
- County Boundaries

CITY OF MCKEESPORT ALLEGHENY COUNTY PENNSYLVANIA FLOODPLAINS

0 1,200 2,400
Feet

Author: Ross Vollbrecht
Date: 9/21/2014
NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet
Projection: Lambert Conformal Conic

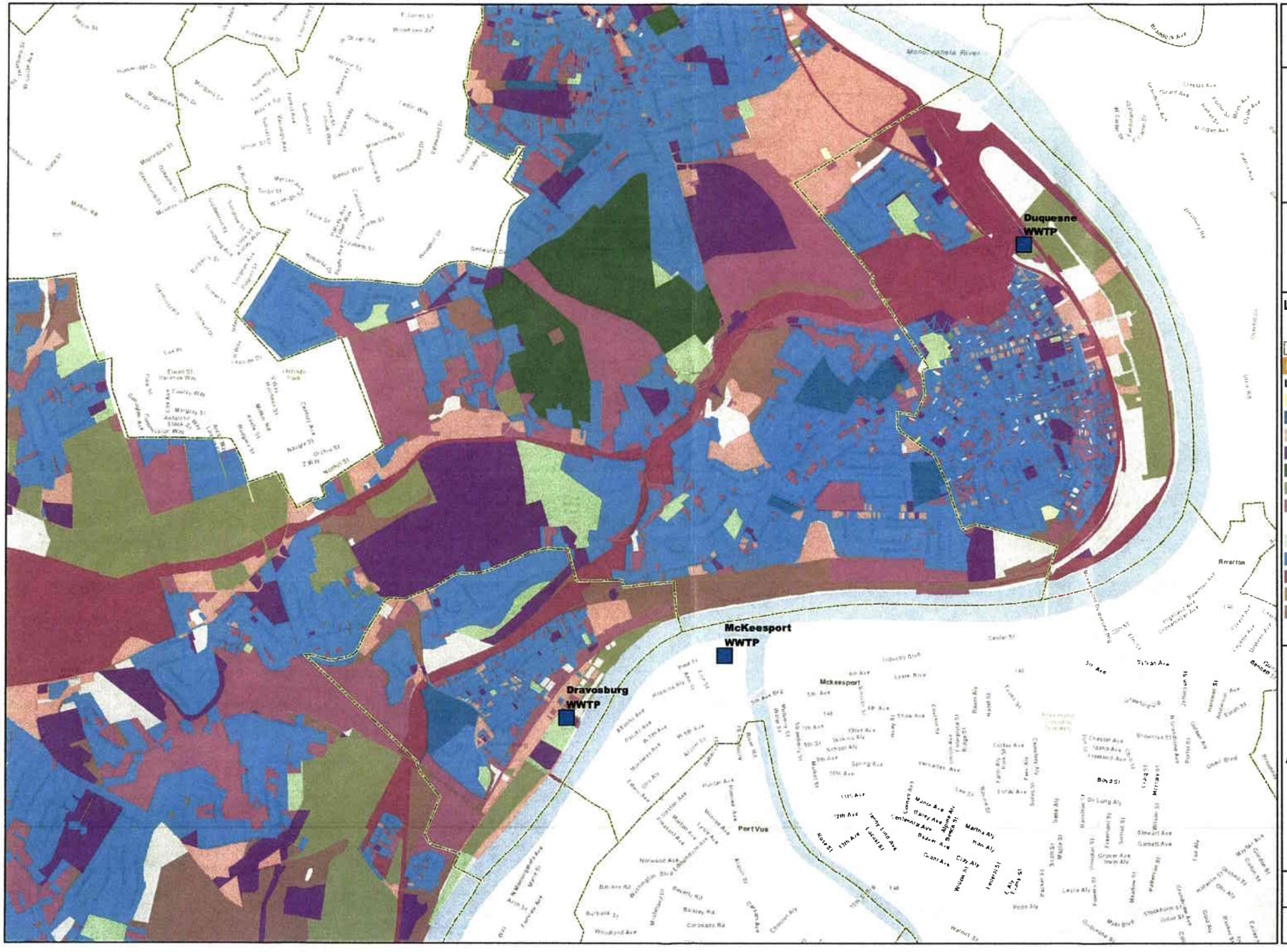
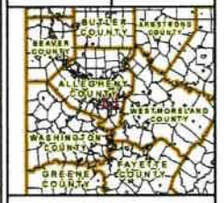


EXHIBIT 7

220-53



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Legend

- WWTP Locations
- Municipal Boundaries
- County Boundaries

Landuse

- Agriculture
- Cemetery
- Commercial
- Community Facilities
- Golf Courses
- Industrial
- Open Space
- Recreation / Conservation
- Recreation/Conservation
- Residential
- Transportation
- Unclassified
- Undeveloped
- Vacant

CITY OF MCKEESPORT ALLEGHENY COUNTY PENNSYLVANIA LANDUSE

0 1,000 2,000
Feet

Author: Ross Wilkinson
Date: 9/2/2014
NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet
Projection: Lambert Conformal Conic

APPENDIX J

PNDI SEARCH RESULTS

No response has been received from the PA Fish and Boat Commission to date. The response will be included in the final submission of the Act 537 Plan.

KLH
ENGINEERS, INC

September 2, 2014
Ref. No.: 220-53

CERTIFIED RETURN RECEIPT
7010-0290-0000-3358-9159

PA Fish and Boat Commission
Division of Environmental Services
450 Robinson Lane
Bellefonte, PA 16823-7437

To Whom It May Concern:

Municipal Authority of the City of McKeesport
Allegheny County, Pennsylvania
Act 537 Sewage Facilities Plan Update – City of Duquesne and Borough of Dravosburg

On behalf of the Municipal Authority of the City of McKeesport (MACM), KLH Engineers, Inc. is providing this correspondence to fulfill the requirements of the Pennsylvania Natural Diversity Inventory (PNDI) review process. This is being done in an effort to complete the planning required as part of the Act 537 Sewage Facilities Plan Update to evaluate proposed wastewater treatment plant (WWTP) and combined sewer system (CSS) upgrades in the City of Duquesne and the Borough of Dravosburg. The Plan Update was developed to serve as the governing Act 537 Sewage Facilities Plan for the City of Duquesne and the Borough of Dravosburg, whose conveyance and treatment facilities are now owned and operated by the MACM.

The PNDI search was conducted for the alternatives proposed within the Plan Update resulting in a potential impact identified by the PA Fish and Boat Commission at the site of the Duquesne WWTP. The location of the Duquesne WWTP is shown on the enclosed USGS 7.5-minute Quadrangle Map.

Detailed evaluation led to the recommendation of continued operation of existing processes at the Duquesne WWTP and construction of new combined sewer overflow (CSO) bypass treatment facilities. The existing WWTP is in good operating condition with adequate capacity for dry weather flows. This alternative utilizes the existing WWTP up to peak flows of 2.5 MGD. Peak flows above 2.5 MGD will receive CSO bypass treatment. The project, which will be constructed at the existing WWTP site that is roughly one third of an acre in size, includes construction of new headworks facilities, influent pump station, and CSO bypass treatment facilities, as well as the installation of new clarifier equipment to maximize efficiency. The proposed site plan is shown on an enclosed exhibit.

The following items are included in the project proposed for the Duquesne WWTP:

- New automatic bar screen and by-pass channel with static screen.
- New headworks building.
- New raw sewage pump station and controls.
- New raw sewage pump station piping and valve vault.
- New pump flow meter.

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- Site gravity and force main piping.
- New CSO bypass treatment.
- Upgrade final clarifier equipment to maximize efficiency.

As part of the Act 537 planning process, a preliminary evaluation of the presence of wetlands and hydric soil conditions was conducted. The results of these studies are shown on the enclosed hydric soil and wetlands mapping. The only wetland areas in the planning area are located along the Monongahela River and are classified as riverine. Furthermore, there are soils in the planning areas classified as partially hydric.

The MACM will make all attempts to minimize the impact on ecologically sensitive areas during any construction activities. All construction work associated with the chosen alternative will be consistent with all applicable state and federal regulations regarding wetlands. A detailed wetlands delineation analysis to determine the extent of jurisdictional wetlands will be completed should any proposed construction encroach on areas conducive to the presence of wetlands. Implementation of this Plan Update is not expected to affect wetlands in any way and the selected alternative will be consistent with wetland protection practices and legislation.

Enclosed with this correspondence are the following documents:

- Signed copy of the Project Environmental Review Receipt.
- USGS 7.5-minute Quadrangle Map showing the location of the Duquesne WWTP.
- Hydric Soils and Wetlands Mapping.
- Proposed WWTP site plan.

All appropriate permits will be obtained before any construction activities, and the project will meet all local, county, state and federal regulations regarding wetlands, prime agricultural areas, erosion and sedimentation pollution control, stormwater management, and all other applicable requirements. No environmental impacts are expected as a result of these projects.

Please feel free to contact our office if you have any questions or concerns.

Sincerely,

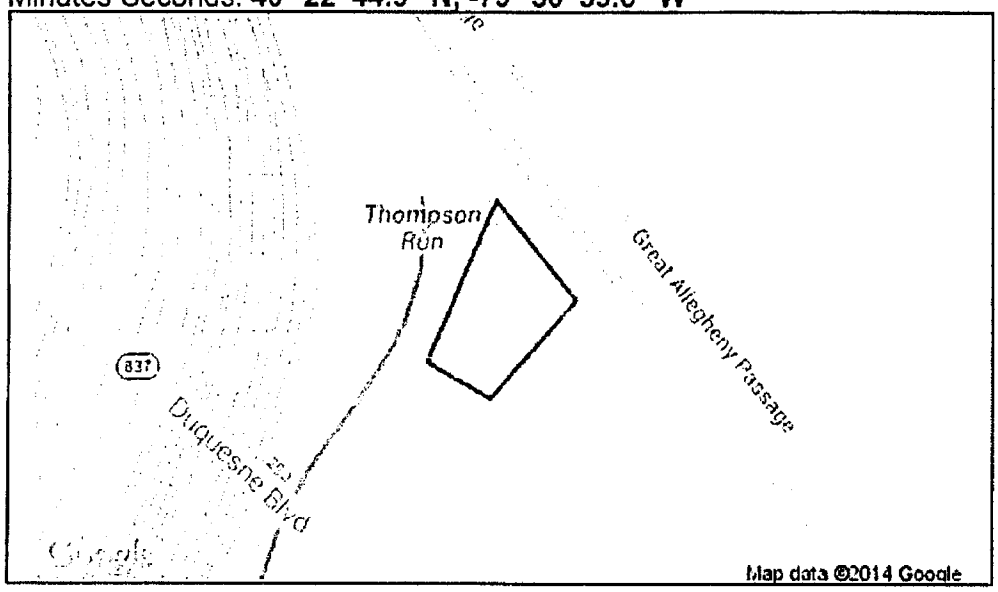
KLH ENGINEERS, INC.

Samuel R. Gibson, E.I.T.

Enclosures

1. PROJECT INFORMATION

Project Name: **Duquesne WWTP**
Date of review: **8/5/2014 1:53:04 PM**
Project Category: **Waste Transfer, Treatment, and Disposal,Liquid waste/Effluent,Wastewater treatment plant (construction, expansion or modification)**
Project Area: **0.8** acres
County: **Allegheny** Township/Municipality: **Duquesne**
Quadrangle Name: **BRADDOCK** ~ ZIP Code: **15110**
Decimal Degrees: **40.379129 N, -79.849883 W**
Degrees Minutes Seconds: **40° 22' 44.9" N, -79° 50' 59.6" W**



2. SEARCH RESULTS

Agency	Results	Response
PA Game Commission	No Known Impact	No Further Review Required
PA Department of Conservation and Natural Resources	No Known Impact	No Further Review Required
PA Fish and Boat Commission	**Potential Impact**	**FURTHER REVIEW IS REQUIRED, See Agency Response**
U.S. Fish and Wildlife Service	No Known Impact	No Further Review Required

As summarized above, Pennsylvania Natural Diversity Inventory (PNDI) records indicate there may be potential impacts to threatened and endangered and/or special concern species and resources within the project area. If the response above indicates "No Further Review Required" no additional communication with the respective agency is required. If the response is "Further Review Required" or "See Agency Response," refer to the appropriate agency comments below. Please see the DEP Information Section of this receipt if a PA Department of Environmental Protection Permit is required.

3. AGENCY COMMENTS

Regardless of whether a DEP permit is necessary for this proposed project, any potential impacts to threatened and endangered species and/or special concern species and resources must be resolved with the appropriate jurisdictional agency. In some cases, a permit or authorization from the jurisdictional agency may be needed if adverse impacts to these species and habitats cannot be avoided.

These agency determinations and responses are **valid for two years** (from the date of the review), and are based on the project information that was provided, including the exact project location; the project type, description, and features; and any responses to questions that were generated during this search. If any of the following change: 1) project location, 2) project size or configuration, 3) project type, or 4) responses to the questions that were asked during the online review, the results of this review are not valid, and the review must be searched again via the PNDI Environmental Review Tool and resubmitted to the jurisdictional agencies. The PNDI tool is a primary screening tool, and a desktop review may reveal more or fewer impacts than what is listed on this PNDI receipt. The jurisdictional agencies **strongly advise against** conducting surveys for the species listed on the receipt prior to consultation with the agencies.

PA Game Commission

RESPONSE: No Impact is anticipated to threatened and endangered species and/or special concern species and resources.

PA Department of Conservation and Natural Resources

RESPONSE: No Impact is anticipated to threatened and endangered species and/or special concern species and resources.

PA Fish and Boat Commission

RESPONSE: Further review of this project is necessary to resolve the potential impacts(s). Please send project information to this agency for review (see WHAT TO SEND).

PFBC Species: (Note: The PNDI tool is a primary screening tool, and a desktop review may reveal more or fewer species than what is listed below.)
Scientific Name: Chaenobryttus gulosus
Common Name: Warmouth
Current Status: Endangered

Scientific Name: Toxolasma parvus
Common Name: Lilliput
Current Status: Special Concern Species*

U.S. Fish and Wildlife Service

RESPONSE: No impacts to federally listed or proposed species are anticipated. Therefore, no further consultation/coordination under the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.* is required. Because no take of federally listed species is anticipated, none is authorized. This response does not reflect potential Fish and Wildlife Service concerns under the Fish and Wildlife Coordination Act or other