



NOVA Consultants, Inc.

Professional Engineering, Environmental, and Energy Services

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Novi, Michigan 48375
(248) 347-3512 • FAX (248) 347-4152

March 7, 2018

Ms. Kendra Gwin, P.E.
Deputy Director
Transportation & Utilities Department
City of Portage
7719 S. Westnedge Avenue
Portage, MI 49002

Dear Ms. Gwin:

NOVA Consultants, Inc. (NOVA) conducted two groundwater elevation events, one IDEP observation event and one storm water outfall sampling event as part of the ongoing City of Portage Retention Basins and Surface Water Monitoring Program in 2017. This report presents our findings, data collected, and remarks regarding the project.

GROUNDWATER ELEVATION EVENTS

Two groundwater elevation events were conducted on May 16, 2017 and November 14, 2017. A total of twenty-three (23) semi-annual testing locations (34 monitoring wells) were visited during each groundwater elevation event pursuant to the City of Portage Project Concept Statement. Groundwater elevations were obtained utilizing a water level indicator designed specifically for monitoring wells. Monitoring wells were allowed to stabilize prior to elevation readings by opening the monitoring wells for a period of time prior to collecting the elevation readings.

The following table identifies the monitoring well locations which were visited during the May 16, 2017 and November 14, 2017 groundwater elevation monitoring events.

Basin	Location	Well
53	4731 Andover Wood Ct	MW-1, MW-2
37	8160 Black Forest	MW-1, MW-2, Staff Gauge
29	2917 Bynmawr	MW-1
9	3210 Coachlite	MW-1
13	2217 Hickory Point	MW-1, MW-2
20	6140 Marlow-Milam Woods	MW-1
5	6101 Oakland Dr. – Fire Station	MW-1, MW-2, MW-3, MW-4
16	7550 Oakland Dr. – Park	MW-1
18	1105 E. Centre – Greenhouse	MW-1
21	10137 S. Westnedge Access	MW-1
26	1326 Schuring Rd	MW-1, MW-2, MW-3
40	10270 Shuman	MW-1, MW-2
2	Sturgeon Bay @I-94	MW-1
10	6700 Sunburst	MW-1
42	8420-8440 Valleywood Dr.	MW-1
6	NE Corner VanHoesen & Ohio	MW-1
7	SW Corner VanHoesen & Ohio	MW-1
22	3655 Westcove	MW-1
3	2220 Winters Drive	MW-1
31	Lori Court – Access 8905 Lori	MW-1
86	North Montego Bay	MW-1, MW-2
86	7235 Jamaica Lane (N. Montego Bay)	MW-1
49	7919 Wapiti	MW-4

Data summary tables which show depth to groundwater and groundwater elevations are contained in **Appendix A** as **Tables 1 & 2**. Groundwater depth and elevation was unable to be collected at monitoring wells MW-2 at Black Forest, MW-1 at Lori Court and MW-1 at Sturgeon Bay due to the monitoring well locations not being located on the day of the event. Monitoring well MW-4 at 6101 Oakland Drive stickup cover was heavily rusted and has compromised the well casing and, therefore, the original top of casing elevation at that location may no longer be 100% accurate.

Groundwater Contour Maps

Three monitoring points are needed to generate a localized groundwater contour map.

Groundwater contour maps were generated for the Oakland Drive Fire Station location and the Schuring Drive location. Groundwater contour maps for the groundwater elevation collection events are contained in **Appendix B** of this report as **Figures 1-4**.

Groundwater contours show groundwater to flow to the east by northeast (ENE) at the Oakland Drive Fire Station location and to the northeast (NE) at the Schuring Road location.

Graphs Plotting Water Level vs. Time

Graphs plotting water level versus time for all the monitoring wells visited during the 2017 semi-annual monitoring events are contained in **Appendix C** of this report.

Generally, the graphs show groundwater elevations at 17 of the locations being above the statistical limits in 2017. However, monitoring well MW-1 at the Hickory Point location was dry at the time of gauging, and MW-1 at the Schuring Road location was below the statistical limits. The remaining locations fell within the statistical average range.

STORMWATER OUTFALL SAMPLING OVERVIEW

Two out of the five sampling locations were able to be sampled on October 18, 2017. National Pollutant Discharge Elimination System (NPDES) locations 16NWS2 Behind 1223 Woodland Drive, 15NWS1 near 7320 Garden Lane, and 16SES1 at 7901 Shaver Road were unable to be sampled due to the outfalls being dry at the time of the visit. There had recently been considerable rainfall around that time, but three of the locations were dry, nonetheless. The following locations were visited for sampling during the October 18, 2017 sampling event:

NPDES Outfall	Location	Pipe Diameter
01SES1	East of Berwick Street	36"
16NWS2	Behind 1223 Woodland Ave	36"
16SES1	7901 Shaver Road	36"
21NWS3	865 Lenox Drive	36"
15NWS1	7320 Garden Lane	72"

The outfall samples that were collected during the sampling event were discrete, grab samples

and are not necessarily representative of “first-flush” conditions at each outfall location. The samples were sent to an independent analytical laboratory, under Chain of Custody, within 24-hours of the collection time for the analysis of total dissolved nitrogen, total phosphorus, total suspended solids, and E.coli. Field measurements of dissolved oxygen (DO), temperature, pH, and specific conductivity were recorded at each sample location utilizing a low-flow groundwater sampling instrument.

Analytical Results

Reported total phosphorus concentrations ranged from 0.036 mg/L to 0.042 mg/L. The U.S. Environmental Protection Agency’s (EPA) Nationwide Urban Runoff Program (NURP) reported an event mean concentration (EMC) for total phosphorus at 0.47 mg/L, 0.24 mg/L, and 0.33 mg/L for residential, commercial and mixed urban settings, respectively. The storm water total phosphorus analytical results for outfalls 01SES1 and 21NWS3 were below the NURP EMC values.

Reported total nitrate and total nitrite concentrations ranged from less than 0.1 mg/L to 2 mg/L. Total nitrogen storm water EMCs reported in the NURP study were 3.31 mg/L, 2.11 mg/L, and 1.91 mg/L for residential, commercial and mixed urban settings, respectively. The storm water total nitrogen analytical results for outfall 21NWS3 were all below the NURP EMC values. The storm water total nitrogen analytical results for outfall 01SES1 were above NURP EMC values for mixed urban settings, and below the NURP EMC value for residential and commercial settings.

Concentrations of total suspended solids in the collected storm water outfall samples ranged from 2.3 mg/L to 8.5 mg/L. The NURP reported storm water runoff EMCs for total suspended solids at 140 mg/L, 91 mg/L, and 102 mg/L for residential, commercial and mixed urban settings, respectively. The storm water total suspended solids analytical results for outfalls 01SES1 and 21NWS3 were below all NURP EMC values.

The results of the E-Coli testing in the outfalls ranged from 500 in outfall 01SES1 to 2600 in outfall 21NWS3. Current E-Coli levels in outfalls 15NWS1, 16NWS2, and 16SES1 are unknown at this time due to the outfalls being dry at the time of the sampling event.

Contaminant Concentration versus Time

The concentration of contaminants over time is summarized in **Appendix D** of this report.

RECOMMENDATIONS

The current sampling approach may not provide analytical concentrations fully representative of an entire storm water event. Storm water outfall conditions are highly variable and dependent on rainfall volume, local variability in rainfall patterns, previous rainfall amounts, and peak rainfall timing in relation to sample collection. NOVA would recommend conducting more frequent seasonal sampling of the outfalls instead of annual sampling. Seasonal sampling of the outfalls, such as a sampling event in spring, summer, and early winter, would provide more representative samples throughout the year, and would increase likelihood of capturing the outfalls while water is actively flowing, and increase the amount of seasonal pollution data. Results could then be more closely connected to rainfall and land cover, with relationships established that better predict outflows, pollutant concentrations and loads.

Many of the addresses contain multiple wells. To ensure more reliable gauging of each monitoring well, NOVA recommends to the City of Portage to collect and provide latitude and longitude data for each groundwater monitoring well location, and re-label the covers, in order to more quickly locate and identify wells for future gauging events. NOVA also recommends abandoning MW-2 and possible reinstalling at 8160 Black Forest due to flush mount cover and well damage during grass cutting activities at the site.

Three monitoring wells (MW-2 at Black Forest Dr., Sturgeon Bay @I-94 and Lori Court – Access 8905 Lori) were unable to be located during the two gauging events. NOVA suggests removing them from the list of monitoring wells which are required to be sampled during the semi-annual gauging events.

NOVA recommends that the City of Portage implement best management practices (BMPs) to treat pollutants from transportation infrastructure, maintenance areas, storage yards, sand and salt storage areas, and waste transfer stations.

We hope this report meets with your current needs. If the City of Portage wishes to discuss the recommendations presented in this report NOVA would be happy to present a further detailed work plan and estimated cost. If you have any questions regarding the sampling summary, groundwater elevation collection, or any other work which was performed during the annual monitoring, please contact our office at (248) 347-3512.

Thank you.

Sincerely,
NOVA Consultants, Inc.

Gregory D. Wagner

Gregory D. Wagner
Assistant Project Manager - Environmental

APPENDIX A

GW ELEVATION TABLES &

CHEM ANALYSIS

Groundwater Elevation Data Summary May 16, 2017 - City of Portage Stormwater
Retention Basin Monitoring

<u>Basin Location</u>	<u>Basin Number</u>	<u>Monitoring Well</u>	<u>Total Well Depth (ft)</u>	<u>Top of Casing Elevation (ft)</u>	<u>Depth to Water (ft)</u>	<u>Water Level Elevation (ft)</u>	<u>Observations & Notes</u>
4731 Andover Wood Ct.	53	MW-1	35.8	901.09	28.18	872.91	
4731 Andover Wood Ct.	53	MW-2	27.5	901.11	20.8	880.31	
8149 Black Forest	37	MW-1	16.22	861.32	6.08	855.24	
8149 Black Forest*	37	MW-2	16.34	859.71		859.71	cnf
8149 Black Forest	37	Staff Gauge	N/A	N/A	3.8	N/A	
2917 Bynmawr	29	MW-1	65.91	923.06	58.58	864.48	
3210 Coachlite	9	MW-1	35.05	897.25	29.06	868.19	
2217 Hickory Point	13	MW-1	30.73	874.54	30.15	844.39	
2217 Hickory Point	13	MW-2	19.06	892.89	11.7	881.19	Located outside on the the west side of fence
6140 Marlow-Milham Woods	20	MW-1	54.2	902.92	46.36	856.56	
6101 Oakland Drive-Fire Station	5	MW-1	59.75	908.92	49.15	859.77	
6101 Oakland Drive-Fire Station	5	MW-2	60.74	910.79	51.1	859.69	
6101 Oakland Drive-Fire Station	5	MW-3	60.9	907.85	47.82	860.03	
6101 Oakland Drive-Fire Station	5	MW-4	51.33	902.59	41.85	860.74	
7550 Oakland Drive - Park	16	MW-1	14.62	869.43	8.8	860.63	
1105 E. Centre-Greenhouse	18	MW-1	34.13	874.16	26.37	847.79	
10137 S. Westnedge	21	MW-1	22.1	872.74	15.65	857.09	
1326 Schuring Rd.	26	MW-1	12.82	861.57	5.49	856.08	
1326 Schuring Rd.	26	MW-2	12.96	862.31	5.13	857.18	
1326 Schuring Rd.	26	MW-3	9.16	862.09	7.82	854.27	
10270 Shuman	40	MW-1	13.02	864.33	5	859.33	
10270 Shuman	40	MW-2	13.85	863.31	4.3	859.01	
Sturgeon Bay	2	MW-1	60.57	920.69		920.69	CNF
6700 Sunburst	10	MW-1	36.03	905.66	33.74	871.92	
8420 Valleywood Dr.	42	MW-1	7.75	855.66	3.63	852.03	
VanHoesen-Ohio (NE)	6	MW-1	21.91	863.17	12.7	850.47	
VanHoesen-Ohio (SW)	7	MW-1	17.86	860.54	9.92	850.62	
3655 Westcove	22	MW-1	37.05	900.61	31.25	869.36	
2220 Winters Dr.	3	MW-1	33.16	866.55	22.42	844.13	
8905 Lori Ct.	31	MW-1	28.33	889.01		889.01	CNF
N. Montego Bay	86	MW-1	15.12	864.38	10.48	853.9	
7235 Jamaica Lane (N. Montego Bay)	86	MW-4	11.07	859.4	7.4	852	7235 Jamaica Lane
7919 Wapiti	49	MW-1	15	863.01	7.9	855.11	
7919 Wapiti	49	MW-2	15.25	863.41	7.41	856	

Groundwater Elevation Data Summary November 14, 2017 - City of Portage

<u>Basin Location</u>	<u>Basin Number</u>	<u>Monitoring Well</u>	<u>Total Well Depth (ft)</u>	<u>Top of Casing Elevation (ft)</u>	<u>Depth to Water (ft)</u>	<u>Water Level Elevation (ft)</u>	<u>Observations & Notes</u>
4731 Andover Wood Ct.	53	MW-1	35.8	901.09	28.19	872.9	
4731 Andover Wood Ct.	53	MW-2	27.5	901.11	20.81	880.3	
8149 Black Forest	37	MW-1	16.23	861.32	6.51	854.81	
8149 Black Forest*	37	MW-2	16.34	859.71		859.71	cnf
8149 Black Forest	37	Staff Gauge	N/A	N/A	3.2	N/A	
2917 Bynmawr	29	MW-1	60.55	923.06	59.84	863.22	
3210 Coachlite	9	MW-1	35.05	897.25	30.14	867.11	
2217 Hickory Point	13	MW-1	30.54	874.54	dry	#VALUE!	
2217 Hickory Point	13	MW-2	19.06	892.89	12.98	879.91	Located outside on the west side of fence
6140 Marlow-Milham Woods	20	MW-1	54.2	902.92	46.72	856.2	
6101 Oakland Drive-Fire Station	5	MW-1	59.7	908.92	49.42	859.5	
6101 Oakland Drive-Fire Station	5	MW-2	60.79	910.79	51.34	859.45	
6101 Oakland Drive-Fire Station	5	MW-3	60.94	907.85	48.1	859.75	
6101 Oakland Drive-Fire Station	5	MW-4	51.35	902.59	42.23	860.36	
7550 Oakland Drive - Park	16	MW-1	14.6	869.43	9.18	860.25	
1105 E. Centre-Greenhouse	18	MW-1	34.13	874.16		874.16	could not access
10137 S. Westnedge	21	MW-1	21.91	872.74	16.82	855.92	
1326 Schuring Rd.	26	MW-1	14.02	861.57	6.89	854.68	
1326 Schuring Rd.	26	MW-2	12.96	862.31	5.59	856.72	
1326 Schuring Rd.	26	MW-3	9.16	862.09	8.63	853.46	
10270 Shuman	40	MW-1	13.03	864.33	5.38	858.95	
10270 Shuman	40	MW-2	13.85	863.31	4.6	858.71	
Sturgeon Bay	2	MW-1	60.57	920.69		920.69	CNF
6700 Sunburst	10	MW-1	35.95	905.66	33.95	871.71	
8420 Valleywood Dr.	42	MW-1	7.75	855.66	3.63	852.03	
VanHoesen-Ohio (NE)	6	MW-1	21.9	863.17	12.8	850.37	
VanHoesen-Ohio (SW)	7	MW-1	17.88	860.54	10.04	850.5	
3655 Westcove	22	MW-1	37.05	900.61	31.55	869.06	
2220 Winters Dr.	3	MW-1	33.17	866.55	22.05	844.5	
8905 Lori Ct.	31	MW-1	28.33	889.01		889.01	CNF
N. Montego Bay	86	MW-1	15.02	864.38	11.29	853.09	
7235 Jamaica Lane (N. Montego Bay)	86	MW-4	11.07	859.4	7.4	852	7235 Jamaica Lane
7919 Wapiti	49	MW-1	15.01	863.01	8.63	854.38	
7919 Wapiti	49	MW-2	15.25	863.41	8.12	855.29	



1049 - 28th Street SE
Grand Rapids, MI 49508
Ph: 616/248-4900
Toll Free: 800/362-LABS
Fax: 616/248-4904

October 27, 2017

Greg Wagner
NOVA Consultants
21580 Novi Rd.
Ste 300
Novi, MI 48375

TEL: (248) 347-3512

FAX (248) 347-4152

RE: Portage

Dear Greg Wagner:

Order No.: 1710086

BIO-CHEM Laboratories, Inc. received 2 samples on 10/18/2017 for the analyses presented in the following report.

There were no problems with the analyses and all data for associated QC met EPA or laboratory specifications except where noted in the Case Narrative.

If you have any questions regarding these tests results, please feel free to call.

Please note that unless otherwise instructed, residual samples will be held for sixty (60) days from the original report date. At that time, all non-hazardous samples will be disposed of in accordance with federal, state and local regulations and ordinances, and hazardous samples shall be returned to you. Please contact the laboratory within thirty (30) days if other arrangements for sample retention need to be made.

Sincerely,

A handwritten signature in blue ink that reads "Cindy Euwema".

Cindy Euwema
Office Manager



Chain of Custody

1049 28th Street SE • Grand Rapids, MI 49508
Ph: (616) 248-4900 • Toll Free: 800-362-LABS
Fax: (616) 248-4904

1710086

Firm Name NOVA Consultants, Inc.						Turn around time Standard						Project Number					
Firm Address 2580 Novi Rd. Suite 300						Project Name Portage						Date 10/18/2017					
City, State, Zip Novi MI 48375						State Samples Taken From						Date Due					
Phone 248-347-3512			Fax 248-341-4152			Contact Person Greg Wagner											
Item No	Lab I.D.	Client Sample Number	Date Taken	Time Taken	Sample Description (sample type: water, soil, other)	Number of Containers	Analysis Desired (One per line) TSS TKN * Conductivity Phos E-coli										Remarks
1		21NWS3	10/18/17	1100	water	5	X	X	X	X	X						
2		01SE51	10/18/17	1230	water	5	X	X	X	X	X						
3																	
4																* Nitrate Nitrite	
5																	
6																	
7																	
8																	
9																	
10																	
Released by [Signature]			Received by Cindy Ecuena			Date 10-18-17		Time 2:35		Laboratory use only ☐ Blue Ice ____° ☒ Regular Ice ☐ No Coolant							

CLIENT: NOVA Consultants
Project: Portage
Lab Order: 1710086**Work Order Sample Summary**

Lab Sample ID	Client Sample ID	Matrix	Collection Date	Date Received
1710086-01A	21NWS3	Aqueous	10/18/2017	10/18/2017
1710086-02A	01SES1	Aqueous	10/18/2017	10/18/2017

CLIENT: NOVA Consultants
Project: Portage
Lab Order: 1710086

CASE NARRATIVE

Samples are routinely analyzed using methods outlined in the following references:

- (SW) Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW846, 3rd Ed.
- (E) Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020.
- (A) Standard Methods for the Examination of Water and Wastewater, APHA, 18th Ed.
- (D) Annual Book of ASTM Standards.

Specific methods utilized for this project are provided in the analytical report and are identified by the reference document abbreviation () followed by the method number.

All QA/QC and sample analyses met method, laboratory and/or regulatory data quality objectives unless otherwise specified below.

No data qualifications required.

CLIENT: NOVA Consultants

Project Number: N/A

Lab Order: 1710086

Client Sample ID: 21NWS3

Project: Portage

Collection Date: 10/18/2017

Lab Sample ID: 1710086-01A

Matrix: AQUEOUS

Analyses	Method Ref.	Result	Q	PQL	Units	DF	Analyst	Date
Anions by Ion Chromatography								
1. Nitrogen, Nitrate (As N)	E300.0	0.8		0.10	mg/L	1	RHS	10/18/2017
2. Nitrogen, Nitrite (As N)	E300.0	< 0.10		0.10	mg/L	1	RHS	10/18/2017
Coliform by Membrane Filtration								
1. Escherichia Coli	H10029	2,600		1.0	CFU/100 mL	1	SCL	10/19/2017
Total Kjeldahl Nitrogen								
1. Nitrogen, Total Kjeldahl (TKN)	E351.4	1.4		0.10	mg/L	1	SCL	10/26/2017
Conductance								
1. Specific Conductance	E120.1	650		1.0	µmhos/cm	1	BDW	10/18/2017
Phosphorus by UV/VIS Spec.								
1. Phosphorus, Total (As P)	E365.3	0.036		0.010	mg/L	1	RHS	10/27/2017
Suspended Solids (Gravimetric)								
1. Suspended Solids (Residue, Non-Filterable)	E160.2	2.3		1.0	mg/L	1	BDW	10/24/2017

Definitions: PQL - Practical Quantitation Limit
DF - Dilution Factor

Qualifiers (Q): J - Detected below PQL but above MDL: Estimated
S - Spike Recovery Outside Acceptance Limits
B - Analyte detected in associated Method Blank
N - See case narrative for explanation

CLIENT: NOVA Consultants

Project Number: N/A

Lab Order: 1710086

Client Sample ID: 01SES1

Project: Portage

Collection Date: 10/18/2017

Lab Sample ID: 1710086-02A

Matrix: AQUEOUS

Analyses	Method Ref.	Result	Q	PQL	Units	DF	Analyst	Date
Anions by Ion Chromatography								
1. Nitrogen, Nitrate (As N)	E300.0	2.0		0.10	mg/L	1	RHS	10/18/2017
2. Nitrogen, Nitrite (As N)	E300.0	< 0.10		0.10	mg/L	1	RHS	10/18/2017
Coliform by Membrane Filtration								
1. Escherichia Coli	H10029	500		1.0	CFU/100 mL	1	SCL	10/19/2017
Total Kjeldahl Nitrogen								
1. Nitrogen, Total Kjeldahl (TKN)	E351.4	0.43		0.10	mg/L	1	SCL	10/26/2017
Conductance								
1. Specific Conductance	E120.1	1,100		1.0	µmhos/cm	1	BDW	10/18/2017
Phosphorus by UV/VIS Spec.								
1. Phosphorus, Total (As P)	E365.3	0.042		0.010	mg/L	1	RHS	10/27/2017
Suspended Solids (Gravimetric)								
1. Suspended Solids (Residue, Non-Filterable)	E160.2	8.5		1.0	mg/L	1	BDW	10/24/2017

Definitions: PQL - Practical Quantitation Limit
DF - Dilution Factor

Qualifiers (Q): J - Detected below PQL but above MDL: Estimated
S - Spike Recovery Outside Acceptance Limits
B - Analyte detected in associated Method Blank
N - See case narrative for explanation

Lab Order: 1710086
 Client: NOVA Consultants
 Project: Portage

ANALYTICAL DETAIL REPORT

Sample ID	Client Sample ID	Matrix	Test Name	Date Sampled	TCLP/SPLP Date	Prep Date	QC Batch	Analysis Date	Analytical Batch
1710086-01A	21NWS3	Aqueous	Anions by Ion Chromatography	10/18/2017			R88596	10/18/2017	IC_A_171018B
	21NWS3	Aqueous	Coliform by Membrane Filtration	10/18/2017			R88654	10/19/2017	SCW_171019A
	21NWS3	Aqueous	Conductance	10/18/2017			R88584	10/18/2017	POTENTIAL_171018B
	21NWS3	Aqueous	Conductance	10/18/2017			R88584	10/18/2017	POTENTIAL_171018B
	21NWS3	Aqueous	Phosphorus by UV/VIS Spec.	10/18/2017			R88658	10/27/2017	SPEC_A_171027A
	21NWS3	Aqueous	Suspended Solids (Gravimetric)	10/18/2017			R88649	10/24/2017	GRAVIMETRIC_171024A
	21NWS3	Aqueous	Total Kjeldahl Nitrogen	10/18/2017			R88655	10/26/2017	SCW_171026A
1710086-02A	01SES1	Aqueous	Anions by Ion Chromatography	10/18/2017			R88596	10/18/2017	IC_A_171018B
	01SES1	Aqueous	Coliform by Membrane Filtration	10/18/2017			R88654	10/19/2017	SCW_171019A
	01SES1	Aqueous	Conductance	10/18/2017			R88584	10/18/2017	POTENTIAL_171018B
	01SES1	Aqueous	Conductance	10/18/2017			R88584	10/18/2017	POTENTIAL_171018B
	01SES1	Aqueous	Phosphorus by UV/VIS Spec.	10/18/2017			R88658	10/27/2017	SPEC_A_171027A
	01SES1	Aqueous	Suspended Solids (Gravimetric)	10/18/2017			R88649	10/24/2017	GRAVIMETRIC_171024A
	01SES1	Aqueous	Total Kjeldahl Nitrogen	10/18/2017			R88655	10/26/2017	SCW_171026A

APPENDIX B

GROUNDWATER CONTOUR MAPS

FIGURE 1
GROUNDWATER FLOW MAP
SCHURING ROAD-BASIN #26
PORTAGE, MI
5/16/2017

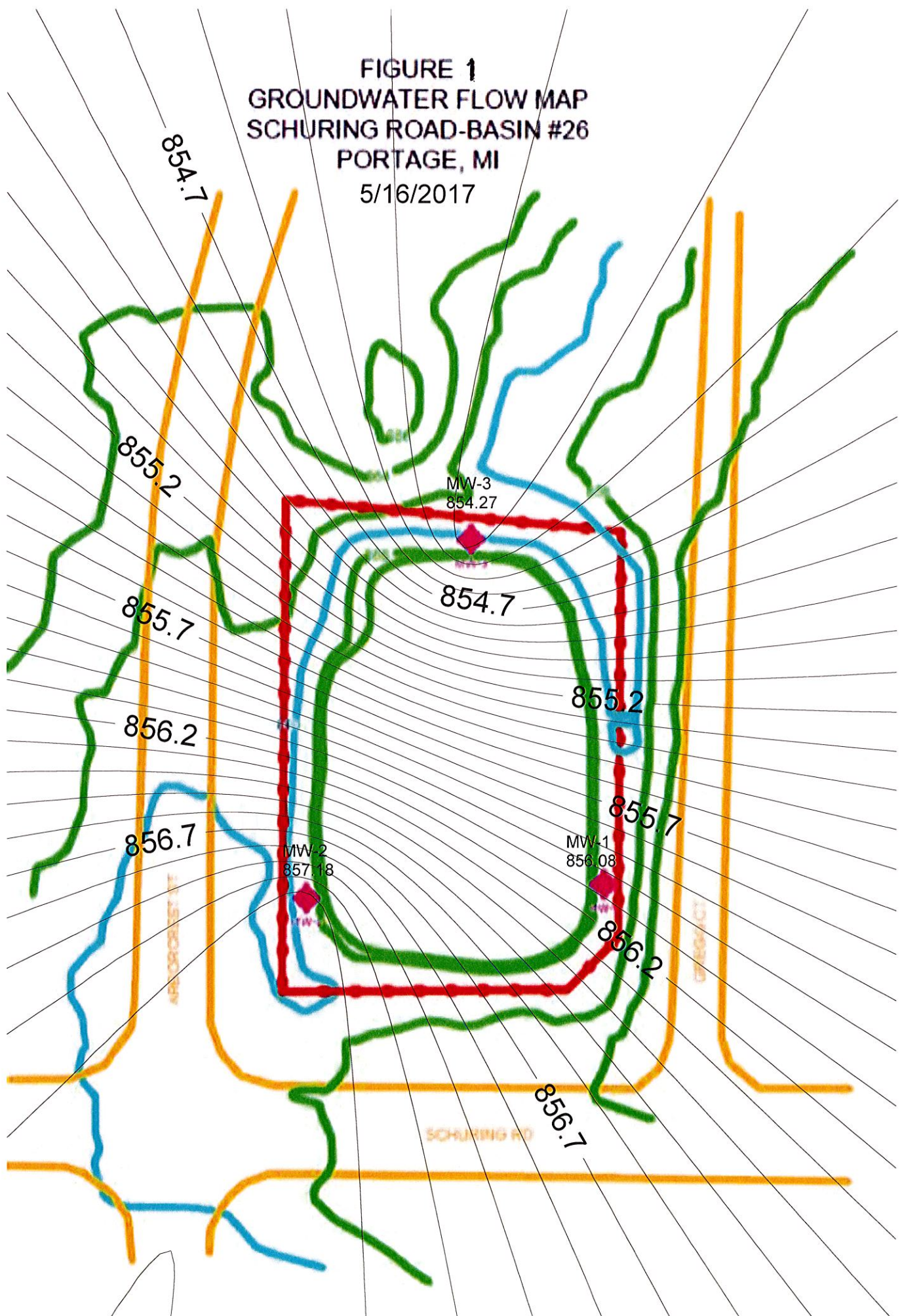


FIGURE 2
GROUNDWATER FLOW MAP
SCHURING ROAD-BASIN #26
PORTAGE, MI
11/14/17

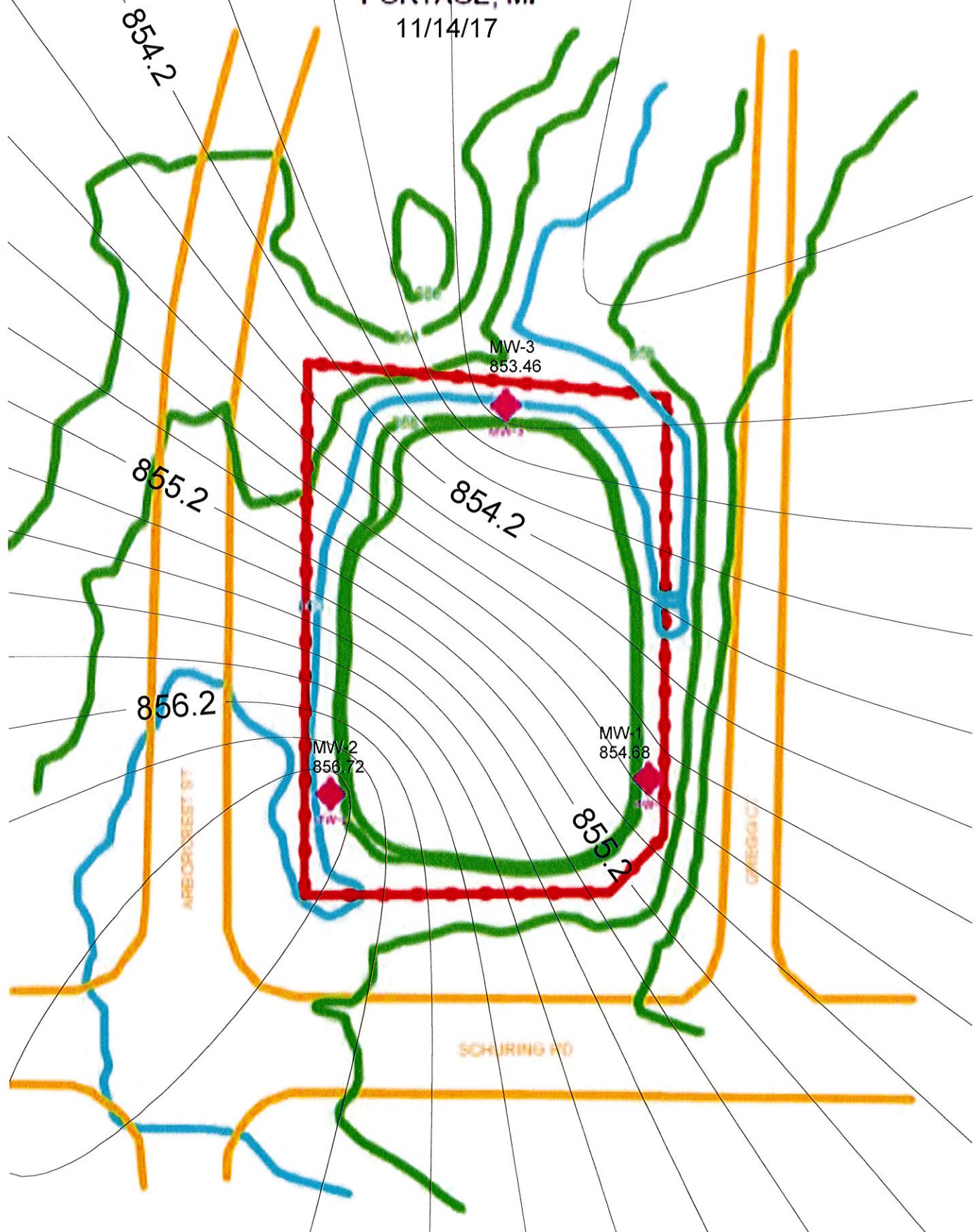


FIGURE 3
GROUNDWATER FLOW MAP
OAKLAND DRIVE FIRE STATION-BASIN #5
PORTAGE, MI
5/16/2017

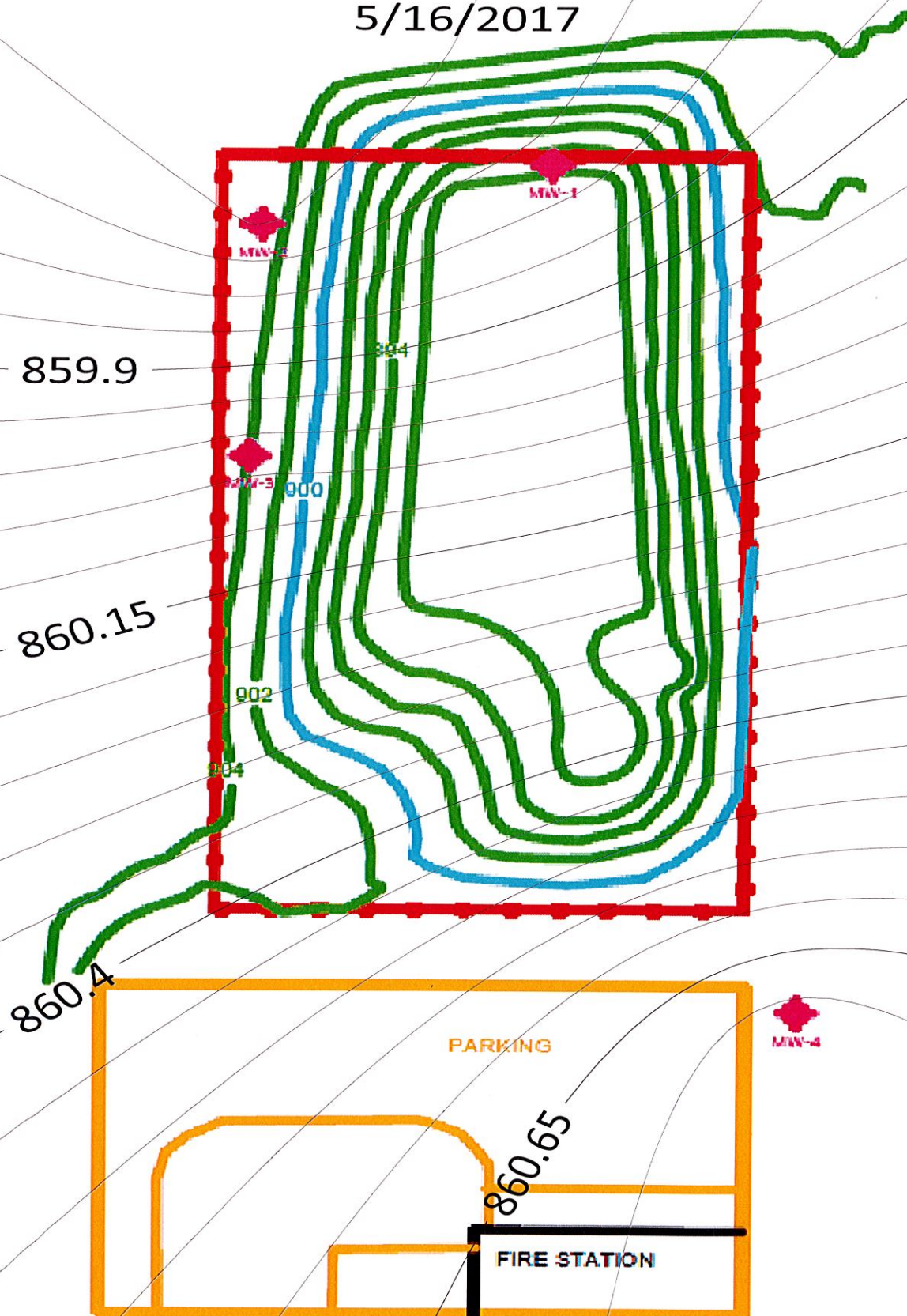
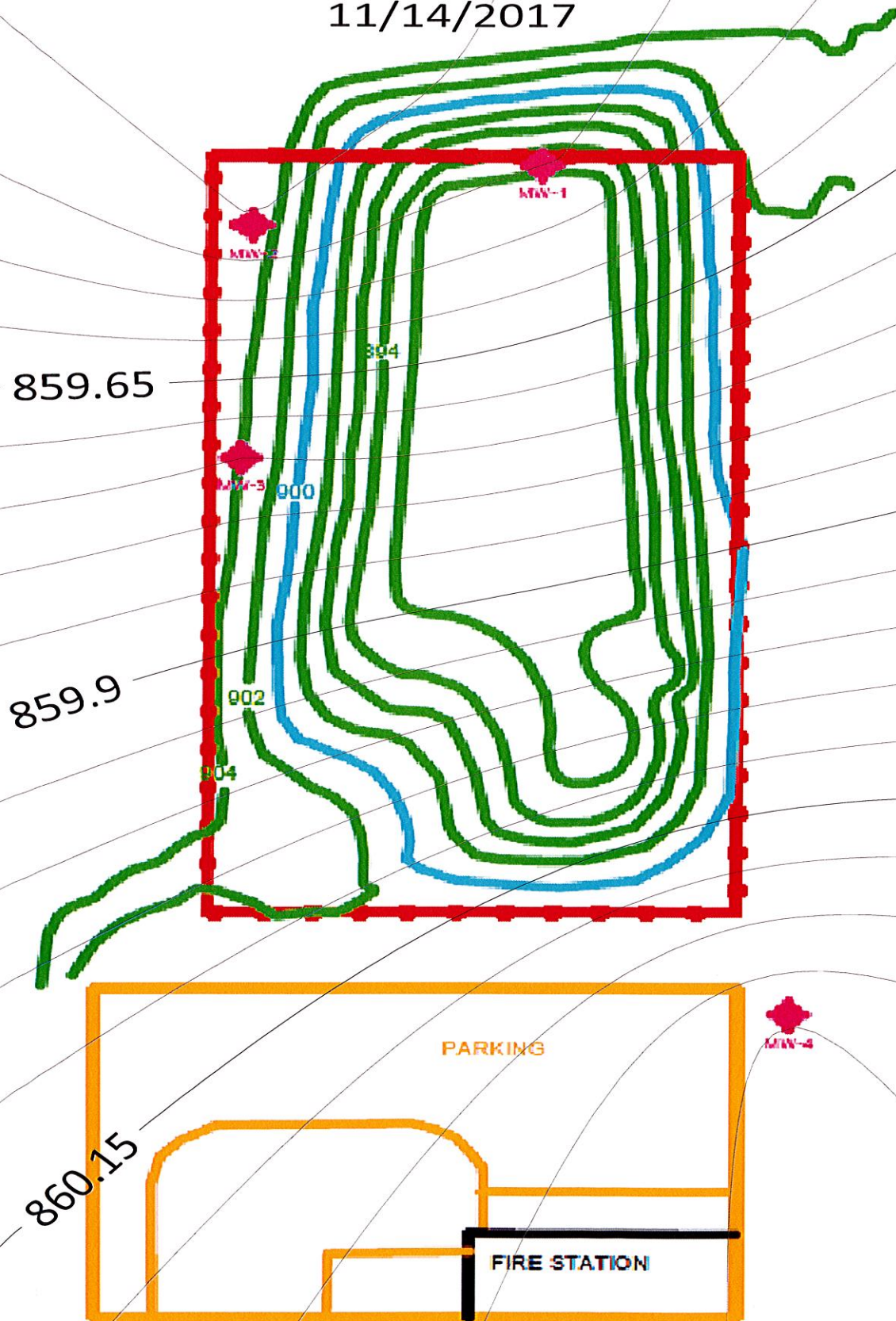


FIGURE 4
GROUNDWATER FLOW MAP
OAKLAND DRIVE FIRE STATION-BASIN #5
PORTAGE, MI
11/14/2017



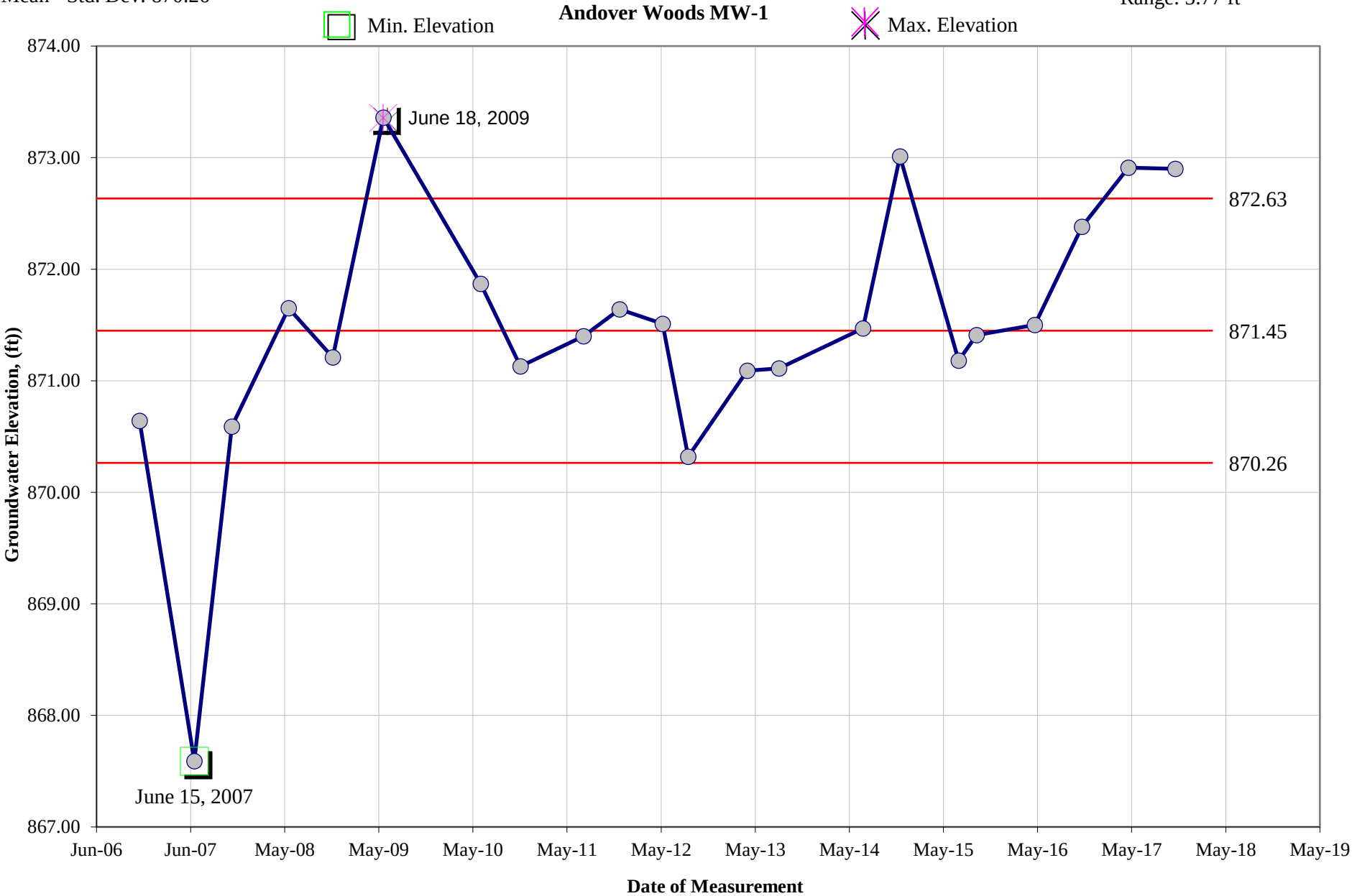
APPENDIX C

WATER LEVEL VS. TIME GRAPHS

Mean + Std. Dev: 872.63
Mean: 871.45
Mean - Std. Dev: 870.26

City of Portage Retention Basins
Historic Summary of Elevation Data

Observed Max: 873.36
Observed Min: 867.59
Range: 5.77 ft



Mean + Std. Dev: 877.76

Mean: 873.93

Mean - Std. Dev: 870.09

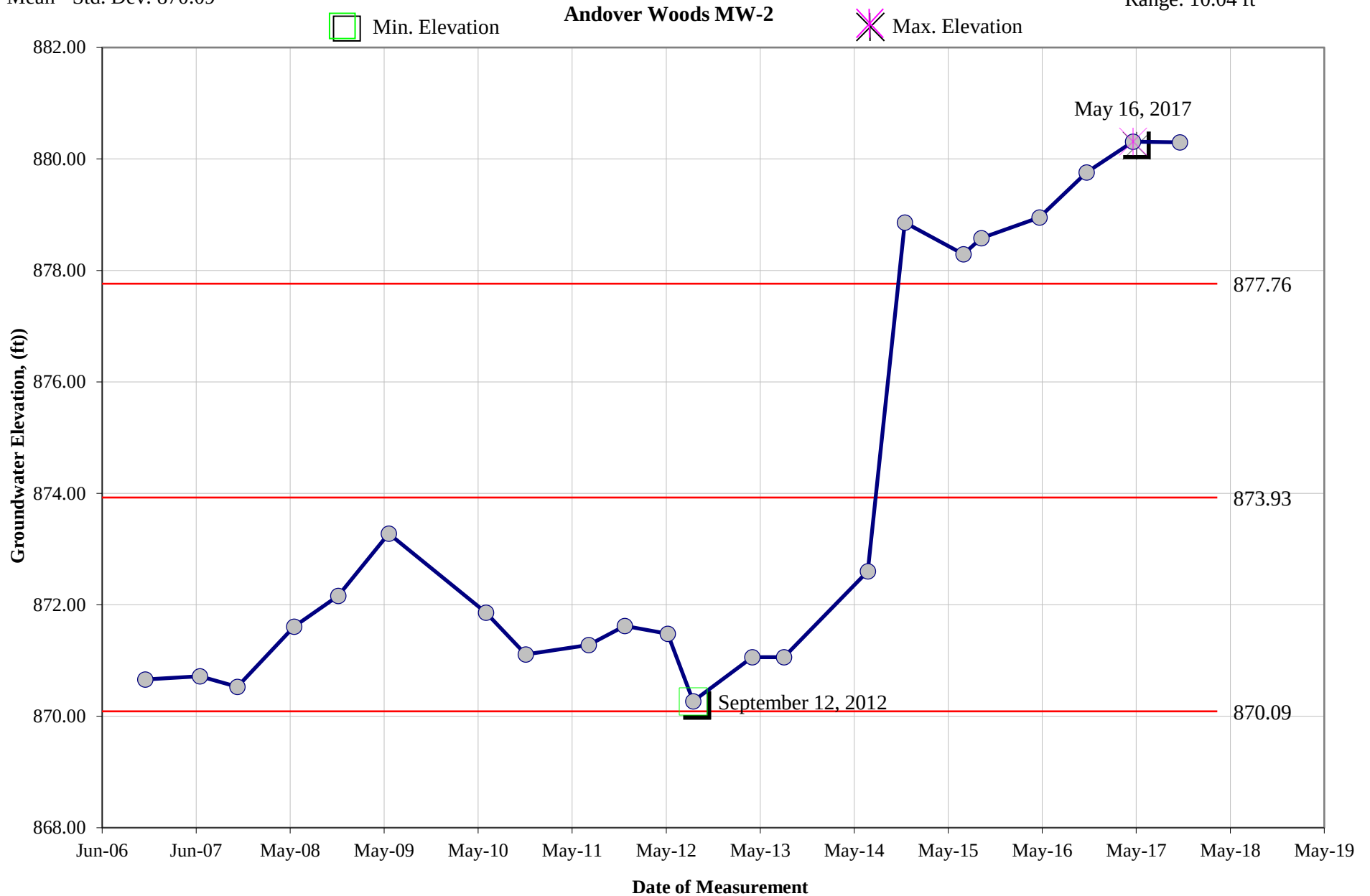
City of Portage Retention Basins

Historic Summary of Elevation Data

Observed Max: 880.31

Observed Min: 870.27

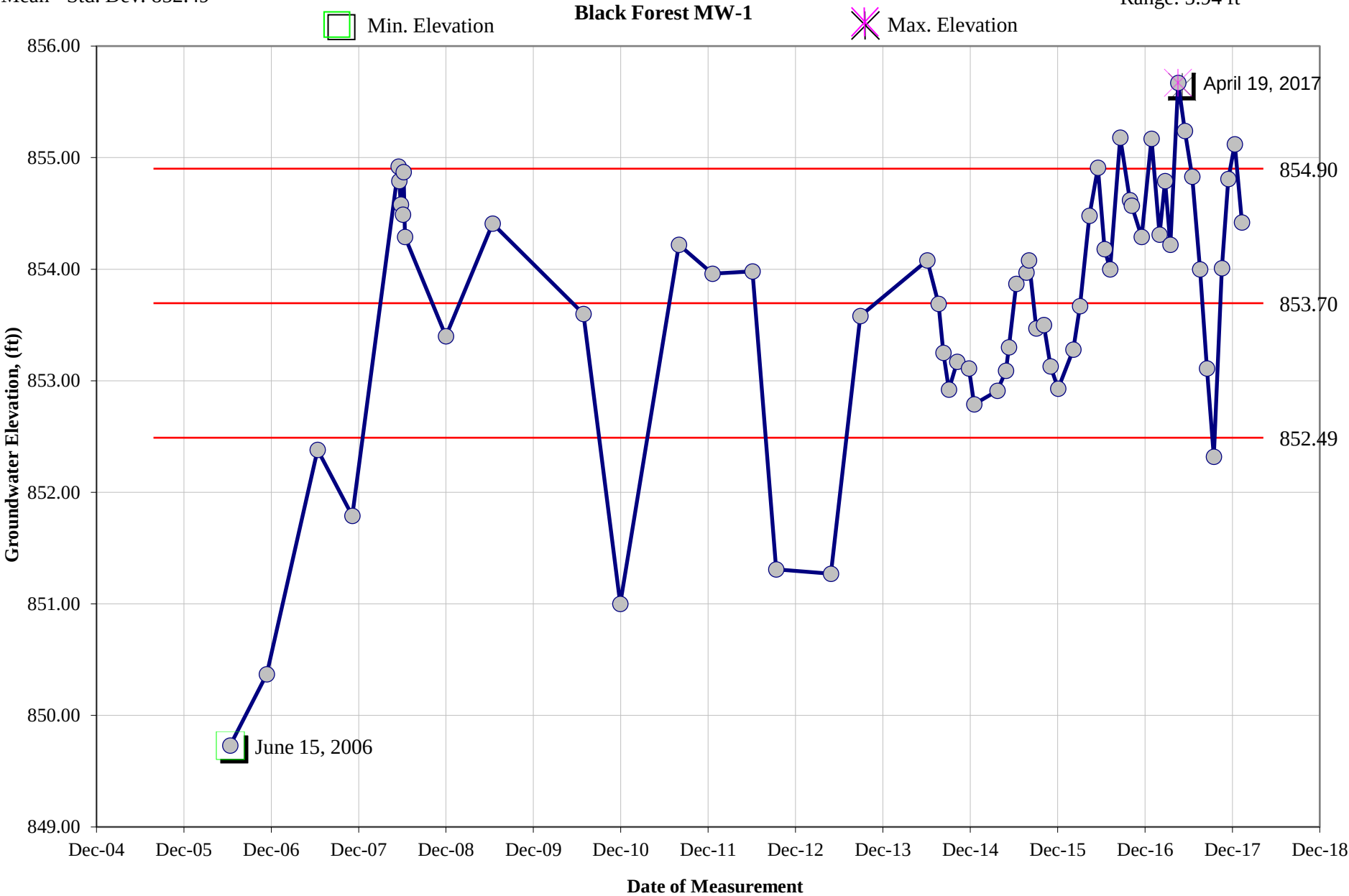
Range: 10.04 ft



Mean + Std. Dev: 854.90
Mean: 853.70
Mean - Std. Dev: 852.49

City of Portage Retention Basins
Historic Summary of Elevation Data

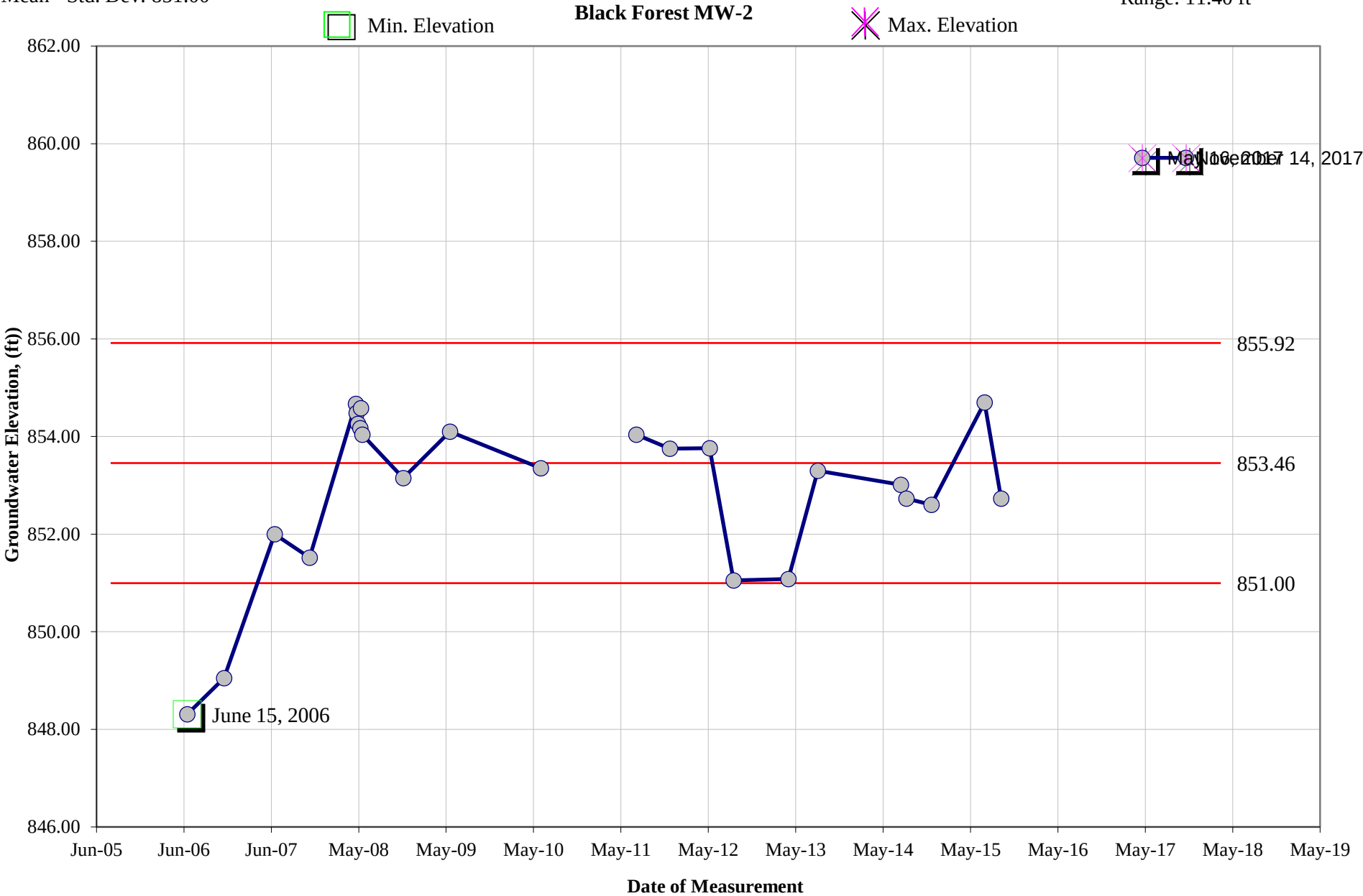
Observed Max: 855.67
Observed Min: 849.73
Range: 5.94 ft



Mean + Std. Dev: 855.92
Mean: 853.46
Mean - Std. Dev: 851.00

City of Portage Retention Basins
Historic Summary of Elevation Data

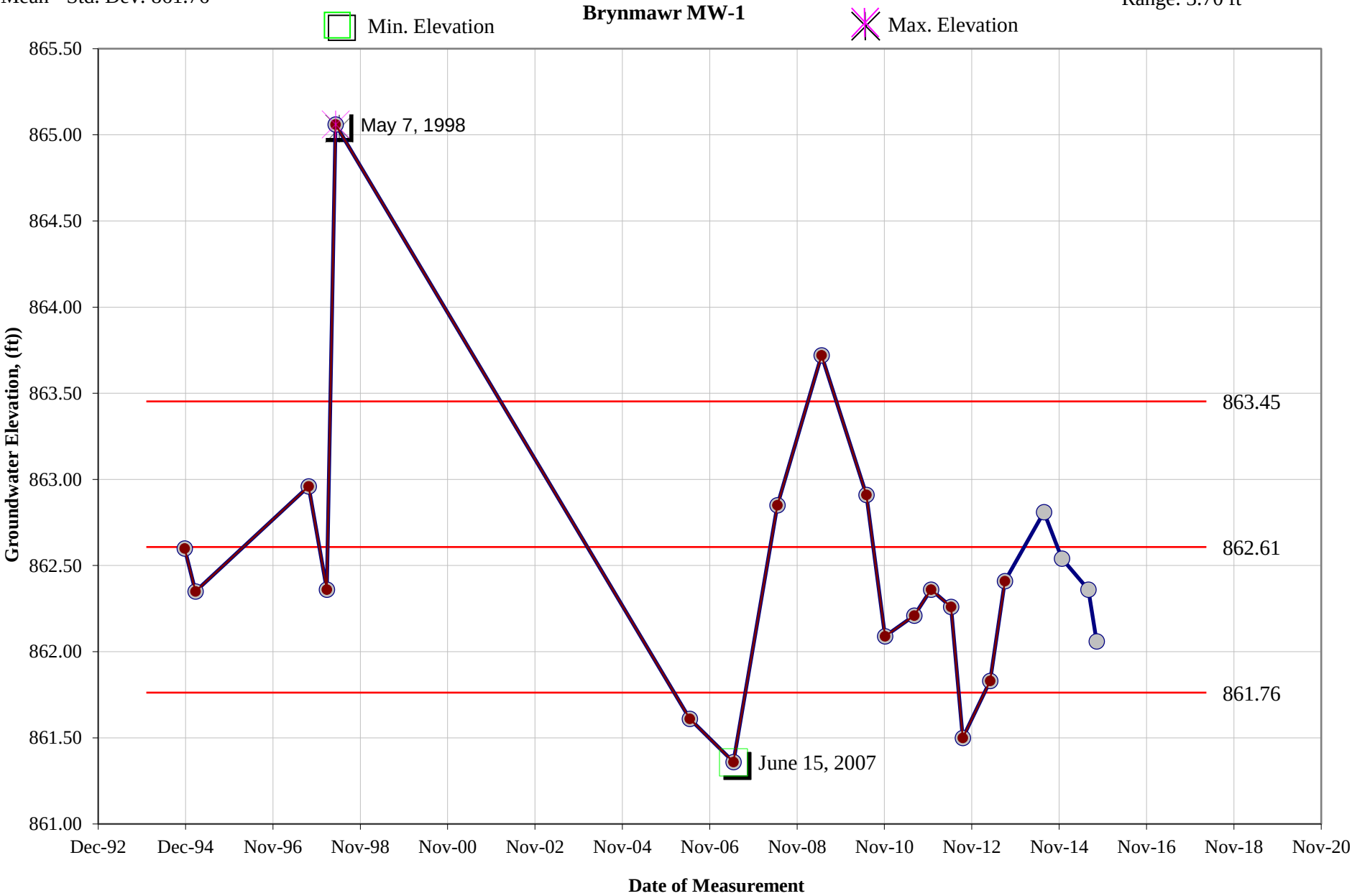
Observed Max: 859.71
Observed Min: 848.31
Range: 11.40 ft



Mean + Std. Dev: 863.45
Mean: 862.61
Mean - Std. Dev: 861.76

City of Portage Retention Basins
Historic Summary of Elevation Data

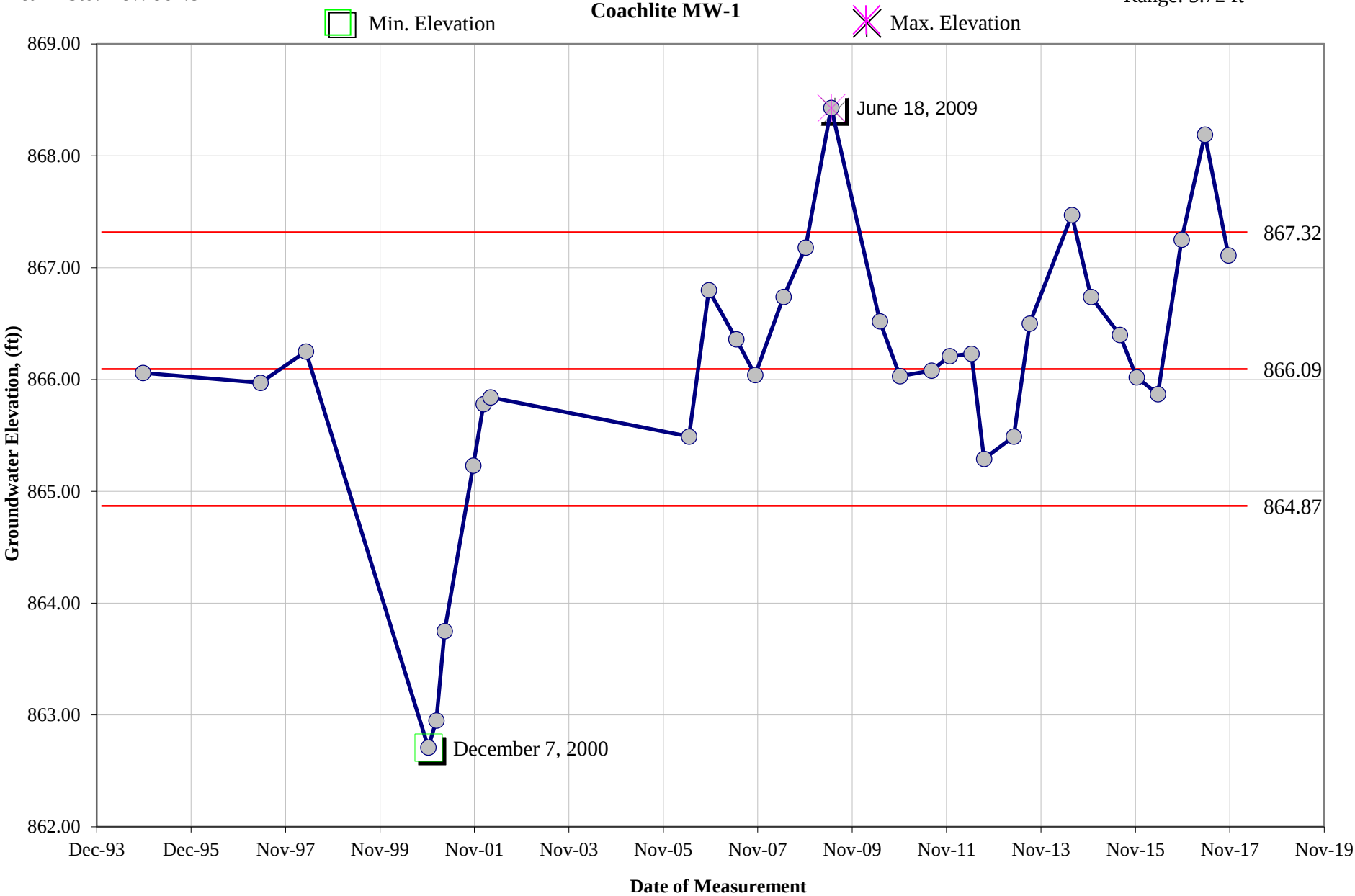
Observed Max: 865.06
Observed Min: 861.36
Range: 3.70 ft



Mean + Std. Dev: 867.32
Mean: 866.09
Mean - Std. Dev: 864.87

City of Portage Retention Basins
Historic Summary of Elevation Data

Observed Max: 868.43
Observed Min: 862.71
Range: 5.72 ft



Mean + Std. Dev: 864.65

Mean: 860.43

Mean - Std. Dev: 856.22

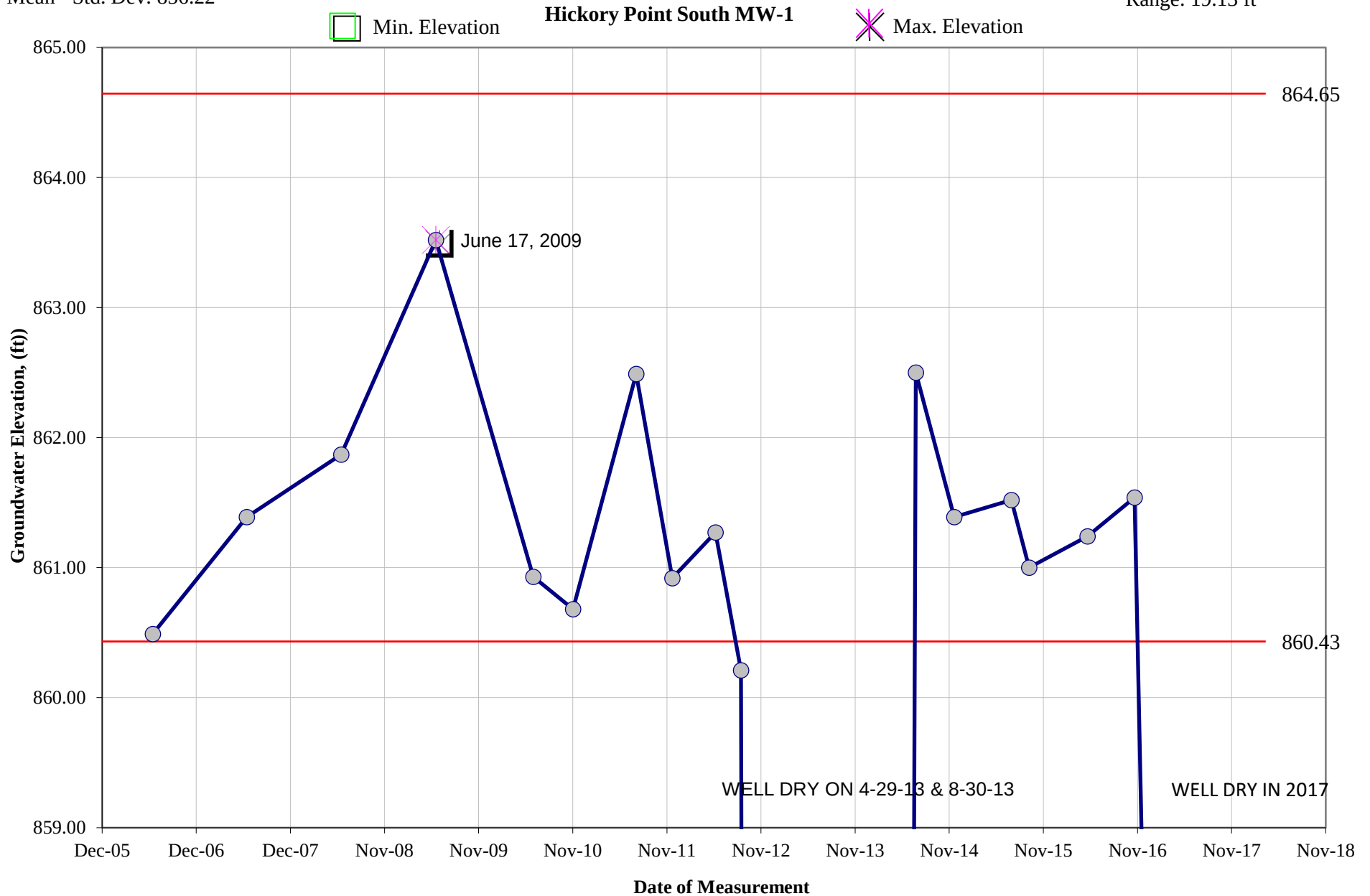
City of Portage Retention Basins

Historic Summary of Elevation Data

Observed Max: 863.52

Observed Min: 844.39

Range: 19.13 ft



Mean + Std. Dev: 873.23

Mean: 864.83

Mean - Std. Dev: 856.42

City of Portage Retention Basins

Historic Summary of Elevation Data

Observed Max: 881.19

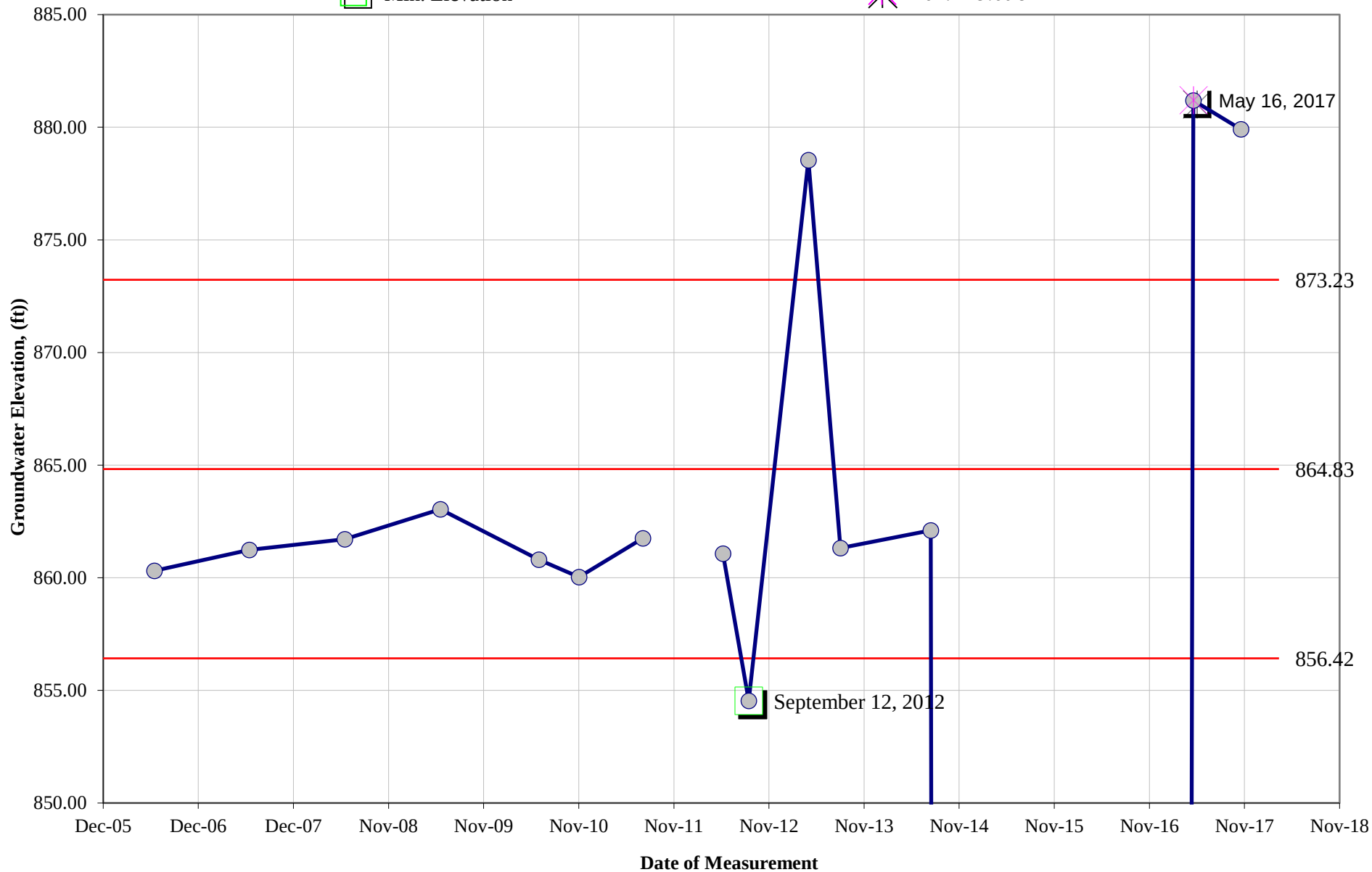
Observed Min: 854.54

Range: 26.65 ft

Hickory Point South MW-2

Min. Elevation

Max. Elevation



Mean + Std. Dev: 856.06

Mean: 855.07

Mean - Std. Dev: 854.09

City of Portage Retention Basins

Historic Summary of Elevation Data

Observed Max: 857.33

Observed Min: 852.92

Range: 4.41 ft

Marlow MW-1

Min. Elevation

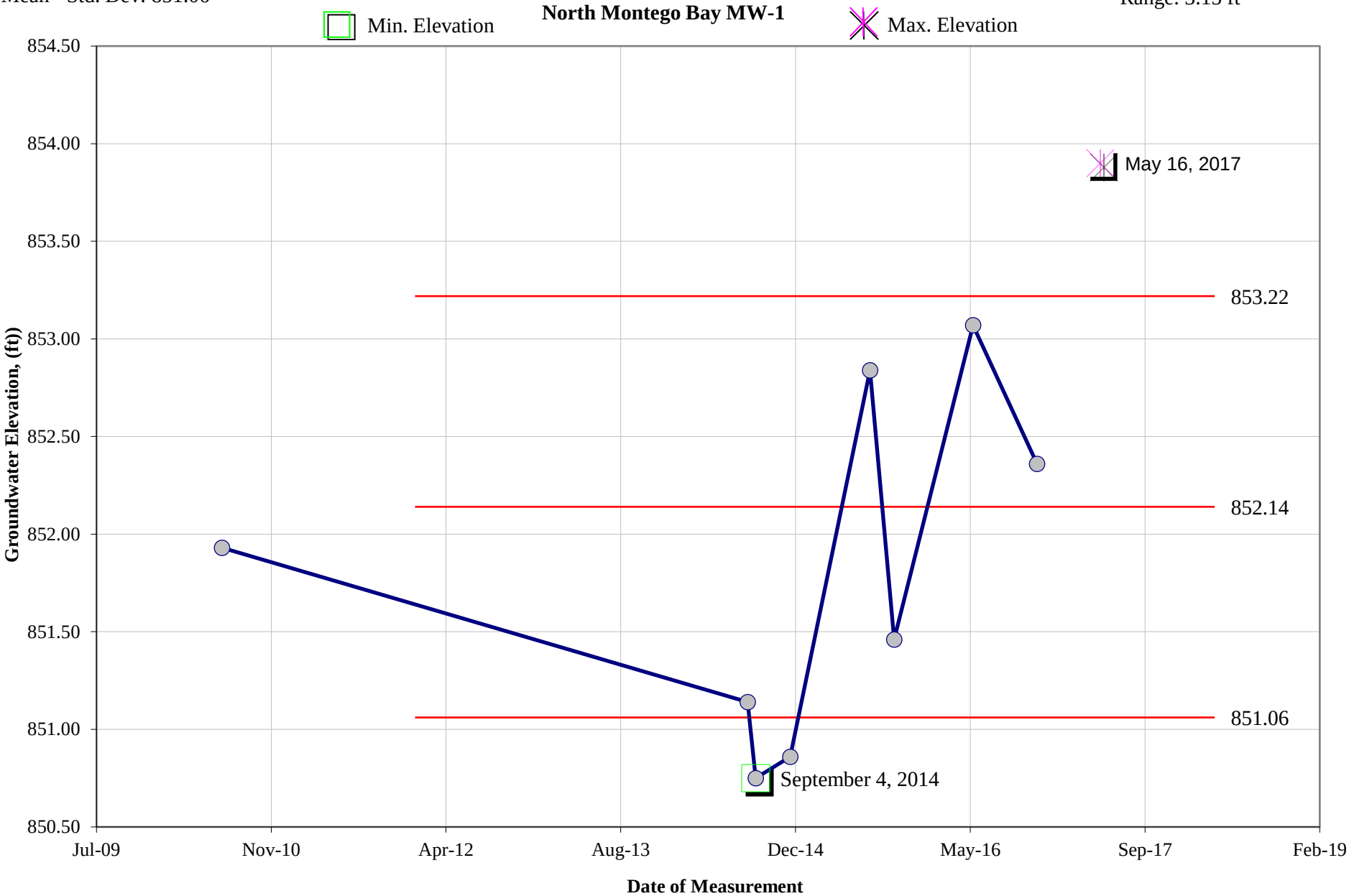
Max. Elevation



Mean + Std. Dev: 853.22
Mean: 852.14
Mean - Std. Dev: 851.06

City of Portage Retention Basins
Historic Summary of Elevation Data

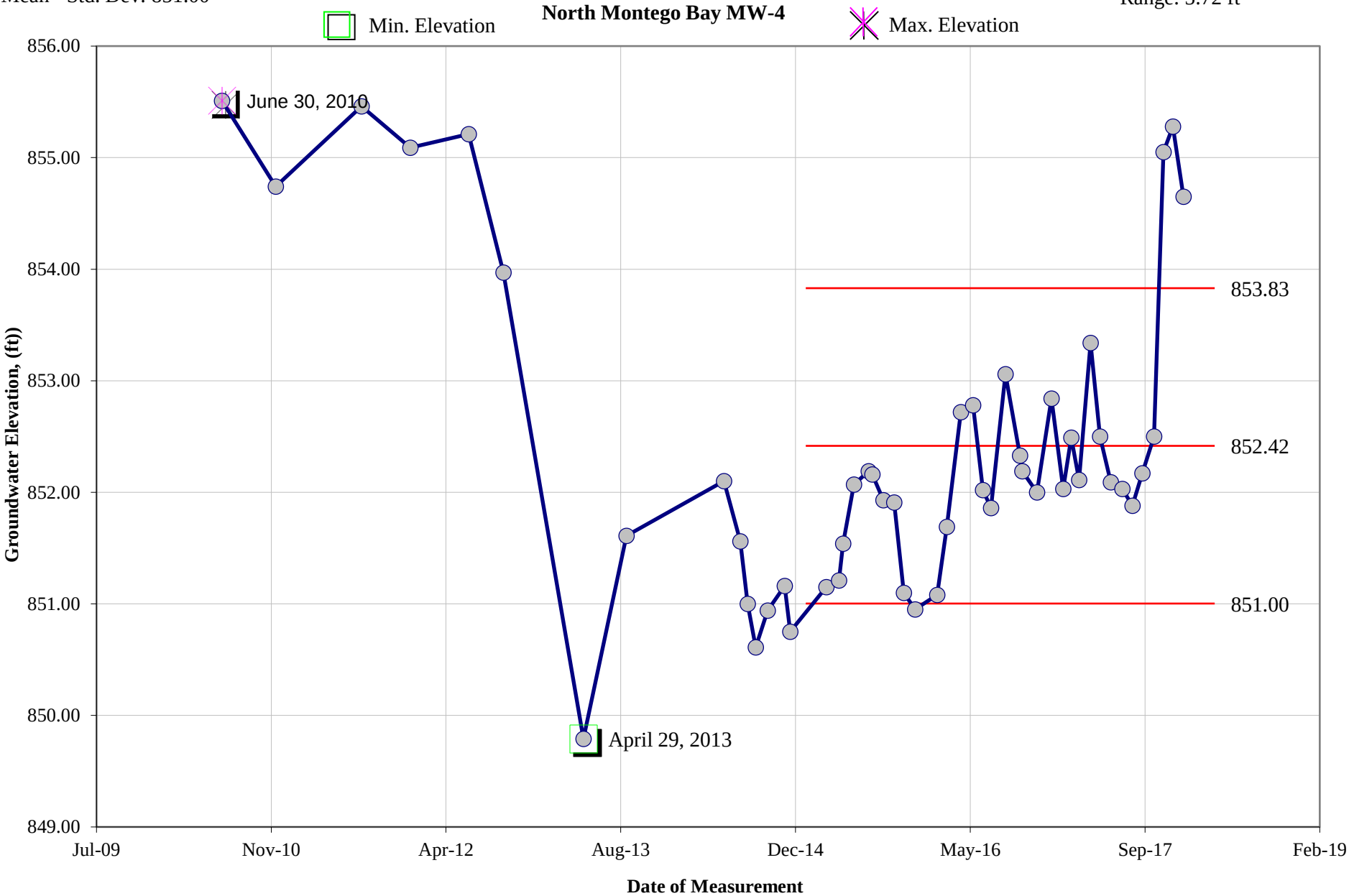
Observed Max: 853.90
Observed Min: 850.75
Range: 3.15 ft



Mean + Std. Dev: 853.83
Mean: 852.42
Mean - Std. Dev: 851.00

City of Portage Retention Basins
Historic Summary of Elevation Data

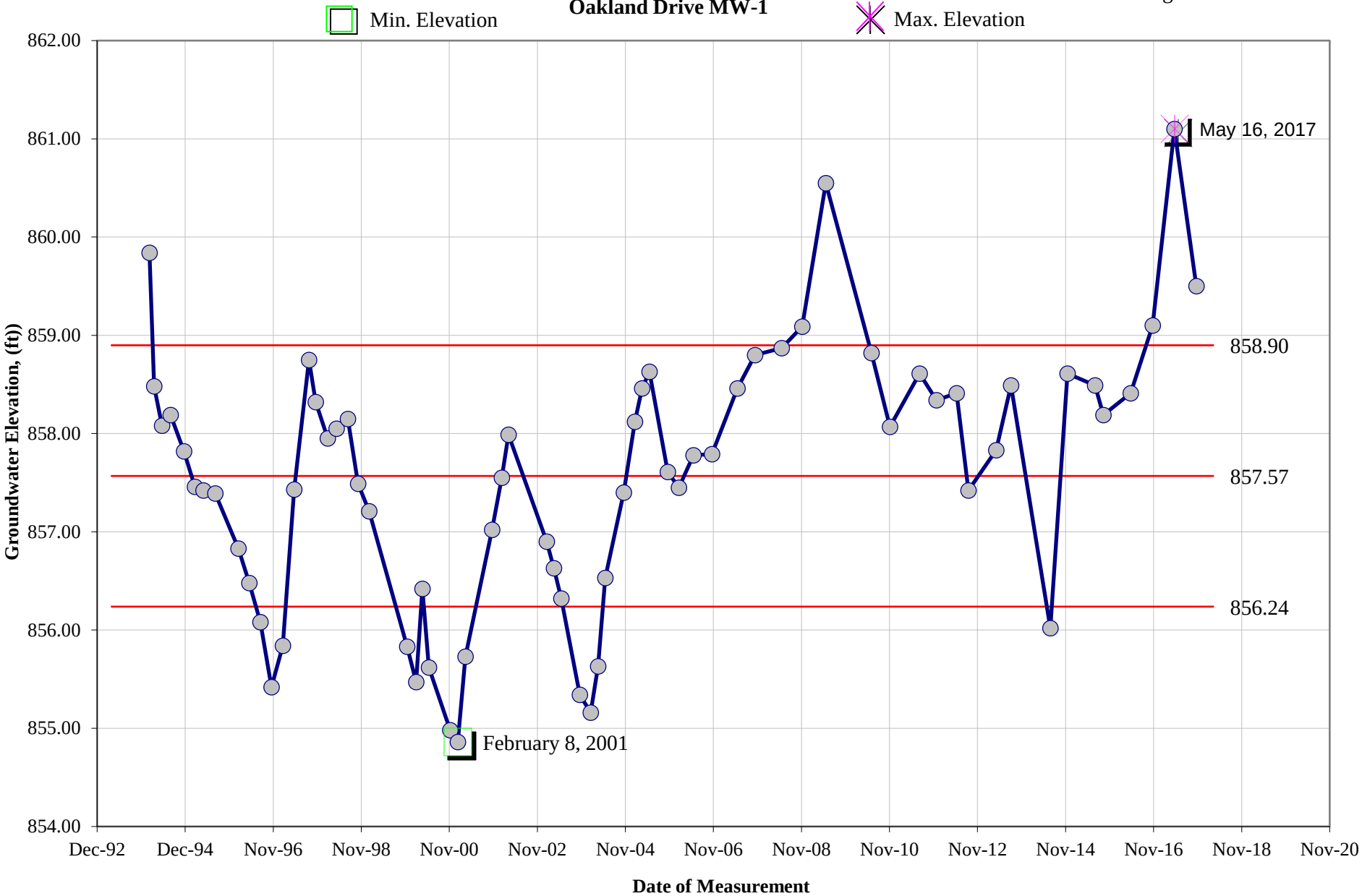
Observed Max: 855.51
Observed Min: 849.79
Range: 5.72 ft



Mean + Std. Dev: 858.90
Mean: 857.57
Mean - Std. Dev: 856.24

City of Portage Retention Basins
Historic Summary of Elevation Data

Observed Max: 861.10
Observed Min: 854.86
Range: 6.24 ft



Mean + Std. Dev: 858.71

Mean: 857.47

Mean - Std. Dev: 856.22

City of Portage Retention Basins

Historic Summary of Elevation Data

Observed Max: 860.49

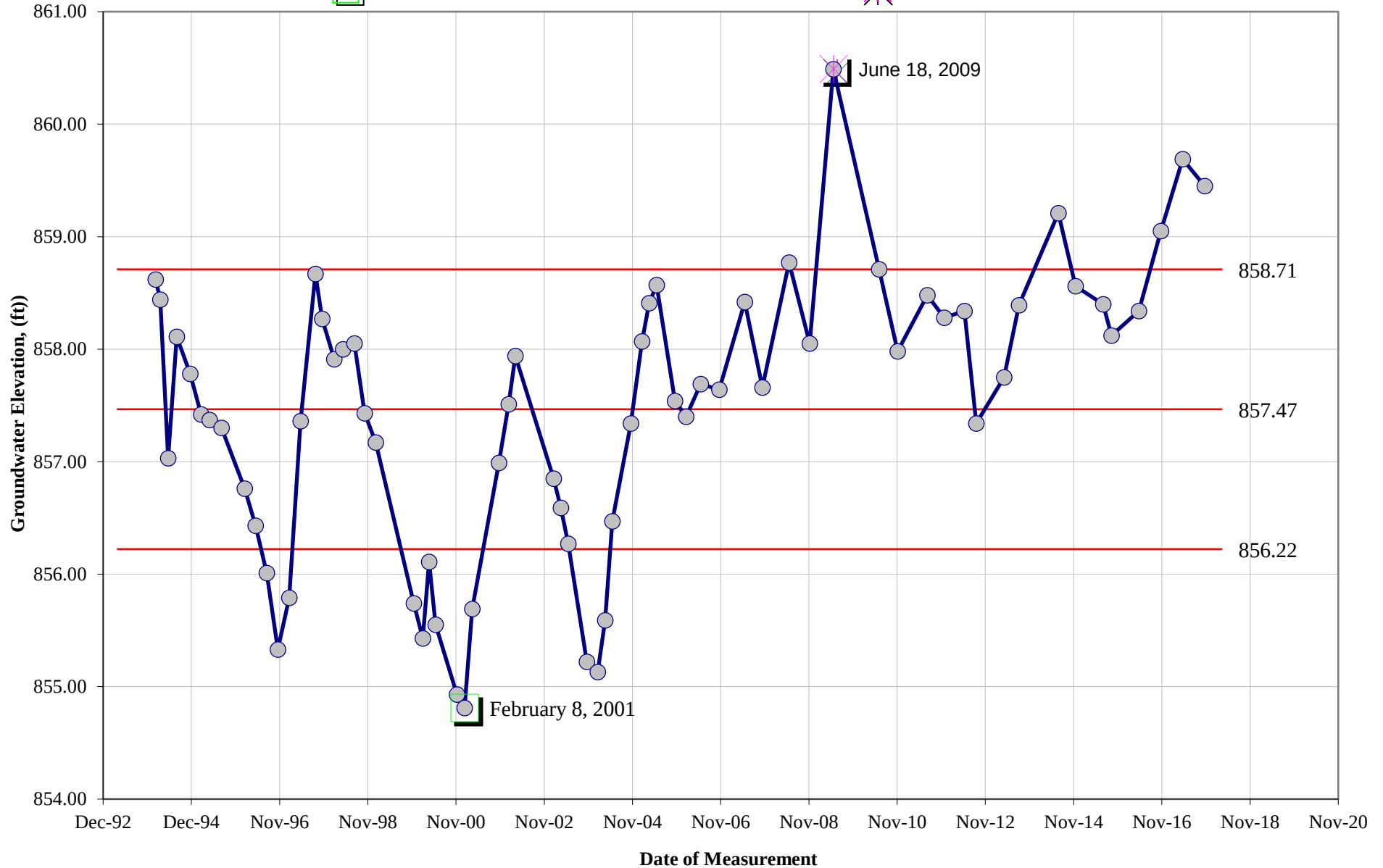
Observed Min: 854.81

Range: 5.68 ft

Oakland Drive MW-2

Min. Elevation

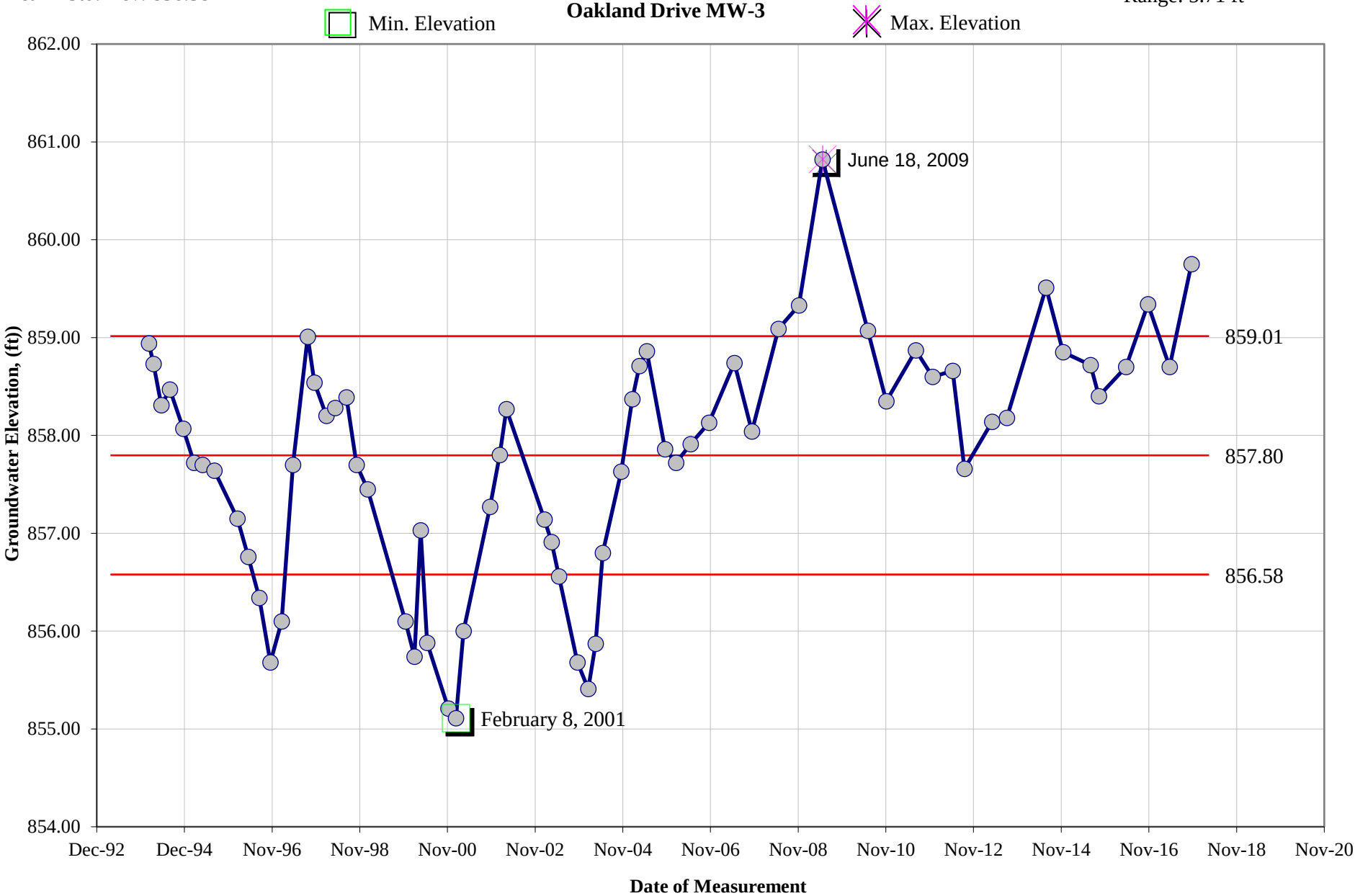
Max. Elevation



Mean + Std. Dev: 859.01
Mean: 857.80
Mean - Std. Dev: 856.58

City of Portage Retention Basins
Historic Summary of Elevation Data

Observed Max: 860.82
Observed Min: 855.11
Range: 5.71 ft



Mean + Std. Dev: 859.84

Mean: 858.50

Mean - Std. Dev: 857.16

City of Portage Retention Basins

Historic Summary of Elevation Data

Observed Max: 861.50

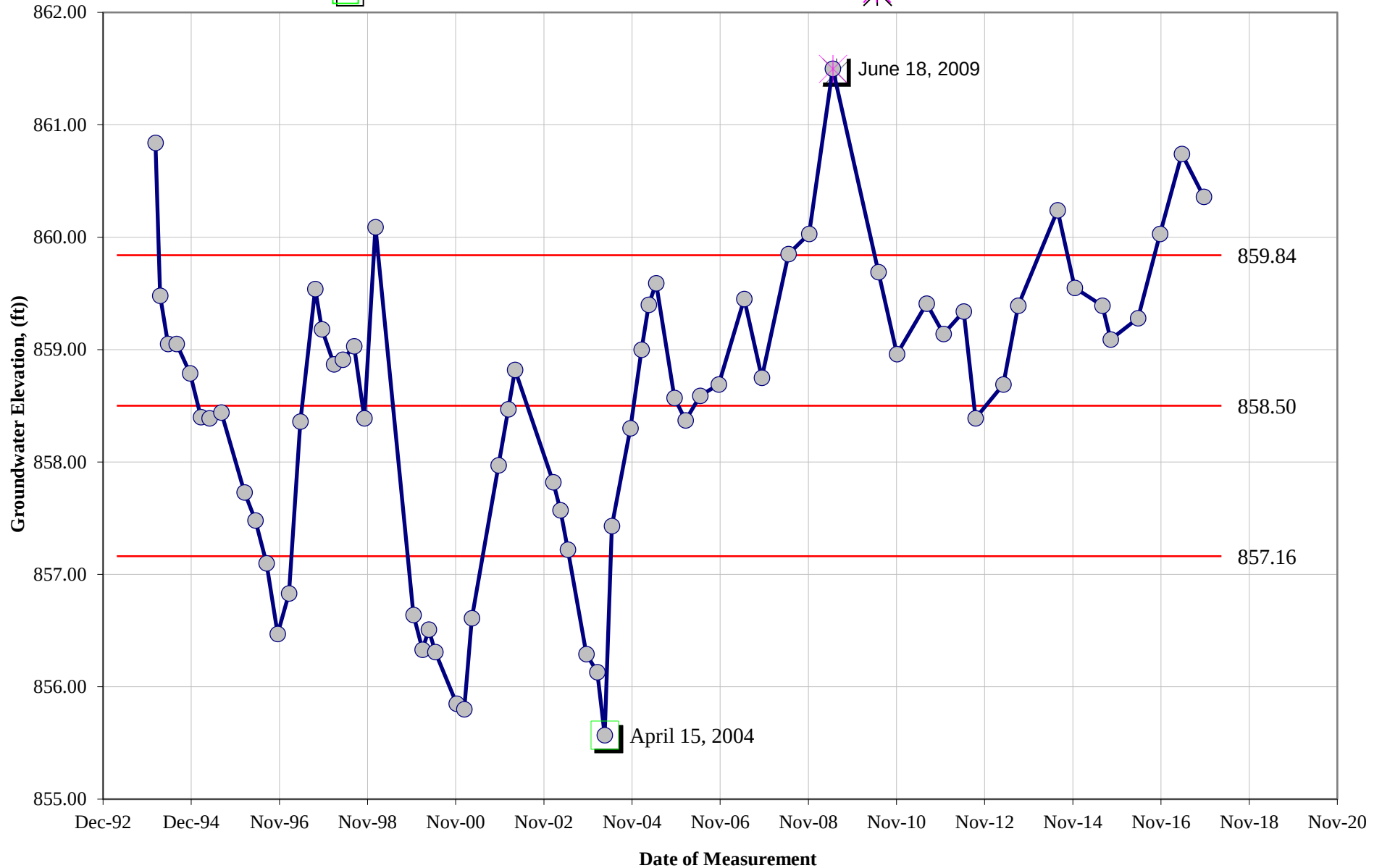
Observed Min: 855.57

Range: 5.93 ft

Oakland Drive MW-4

Min. Elevation

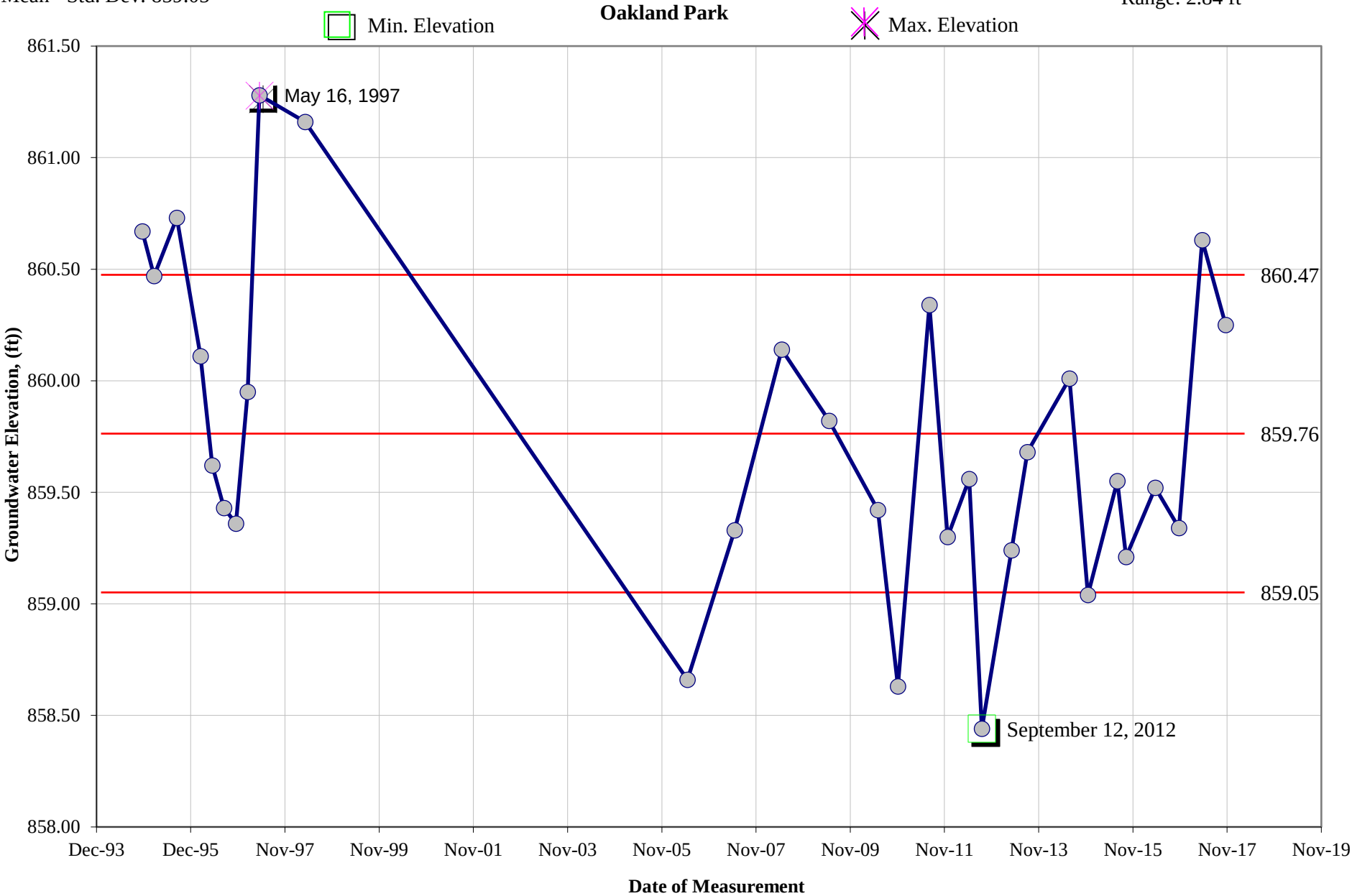
Max. Elevation



Mean + Std. Dev: 860.47
Mean: 859.76
Mean - Std. Dev: 859.05

City of Portage Retention Basins
Historic Summary of Elevation Data

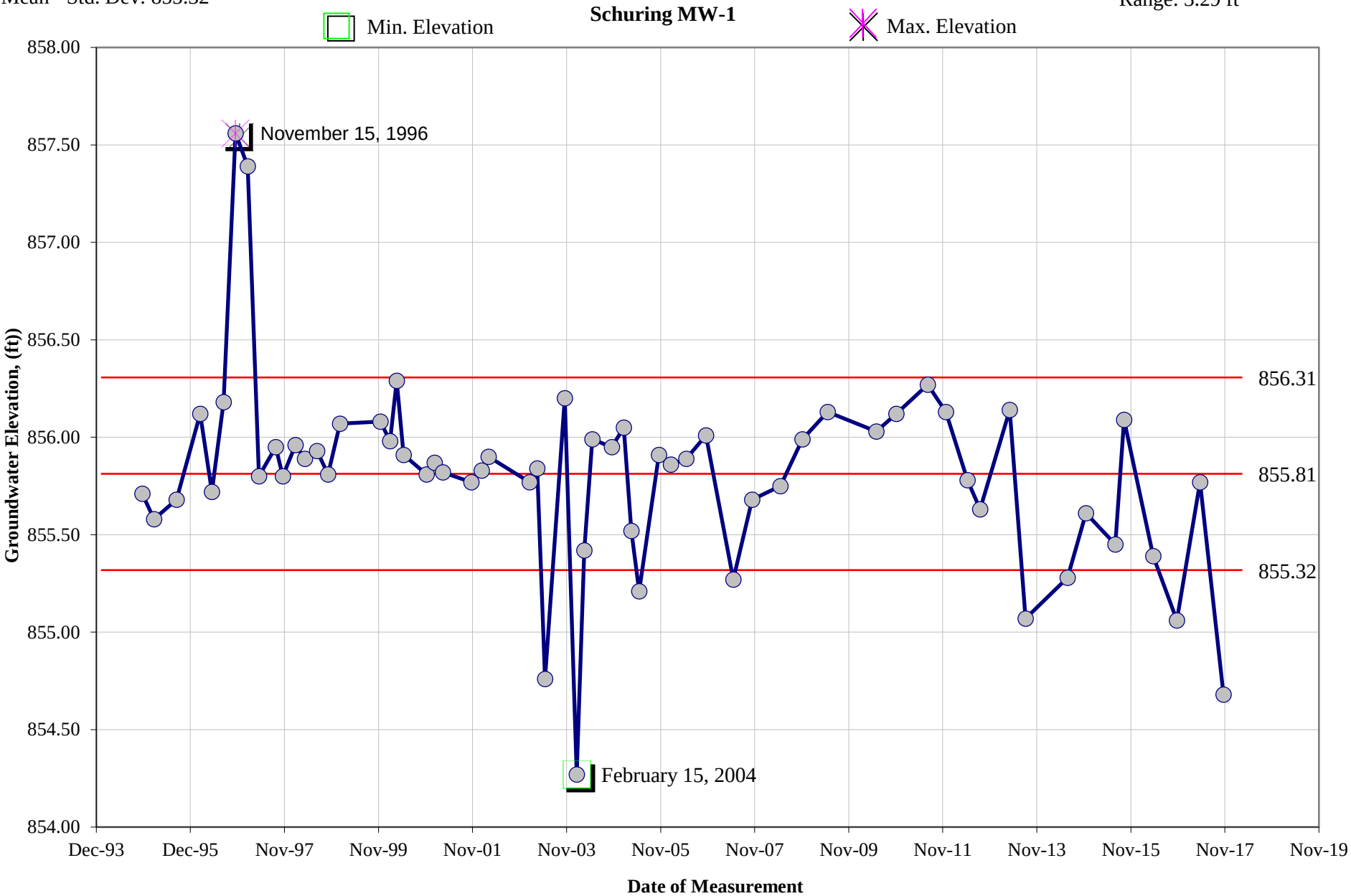
Observed Max: 861.28
Observed Min: 858.44
Range: 2.84 ft



Mean + Std. Dev: 856.31
Mean: 855.81
Mean - Std. Dev: 855.32

City of Portage Retention Basins
Historic Summary of Elevation Data

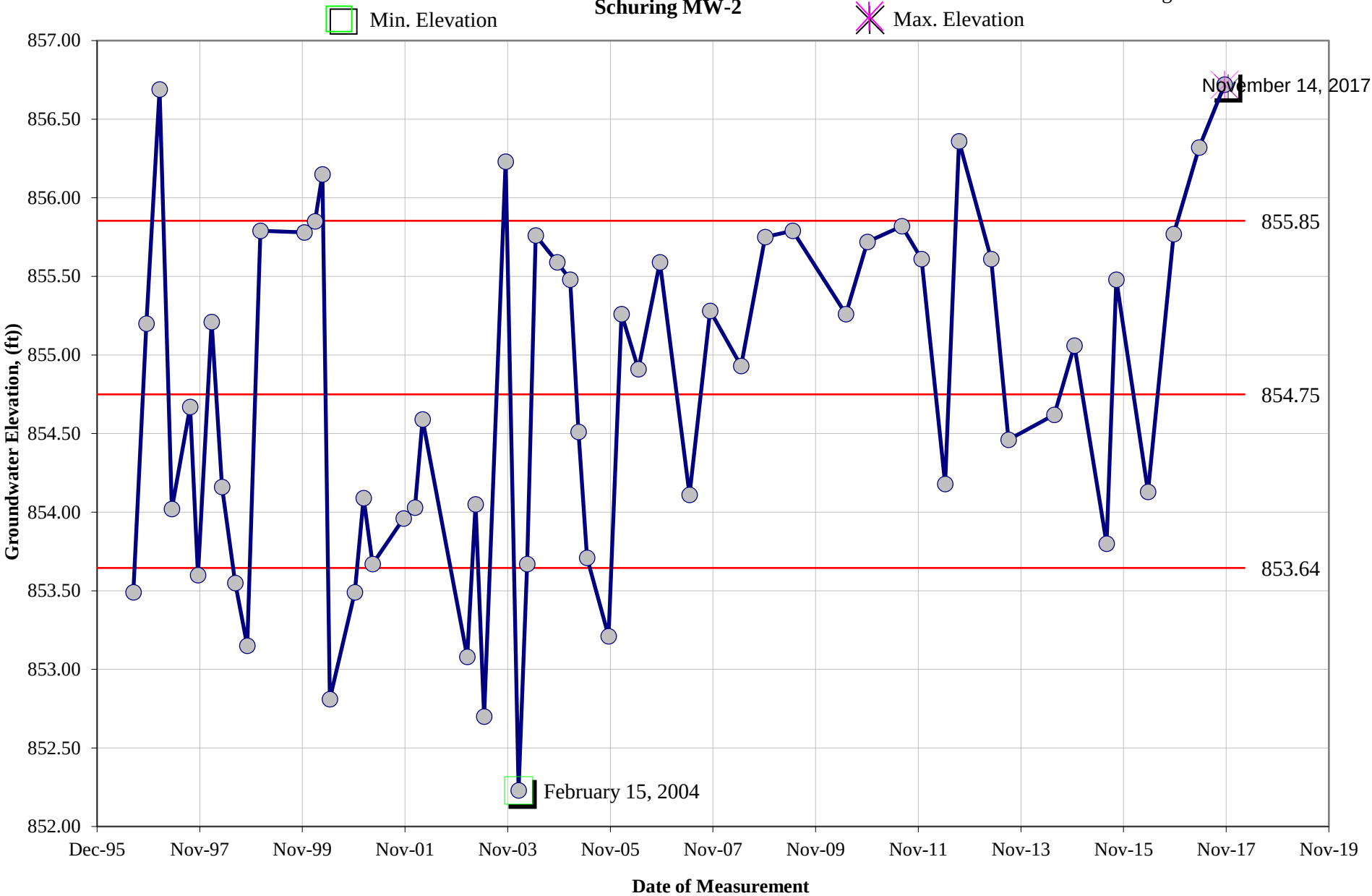
Observed Max: 857.56
Observed Min: 854.27
Range: 3.29 ft



Mean + Std. Dev: 855.85
Mean: 854.75
Mean - Std. Dev: 853.64

City of Portage Retention Basins
Historic Summary of Elevation Data

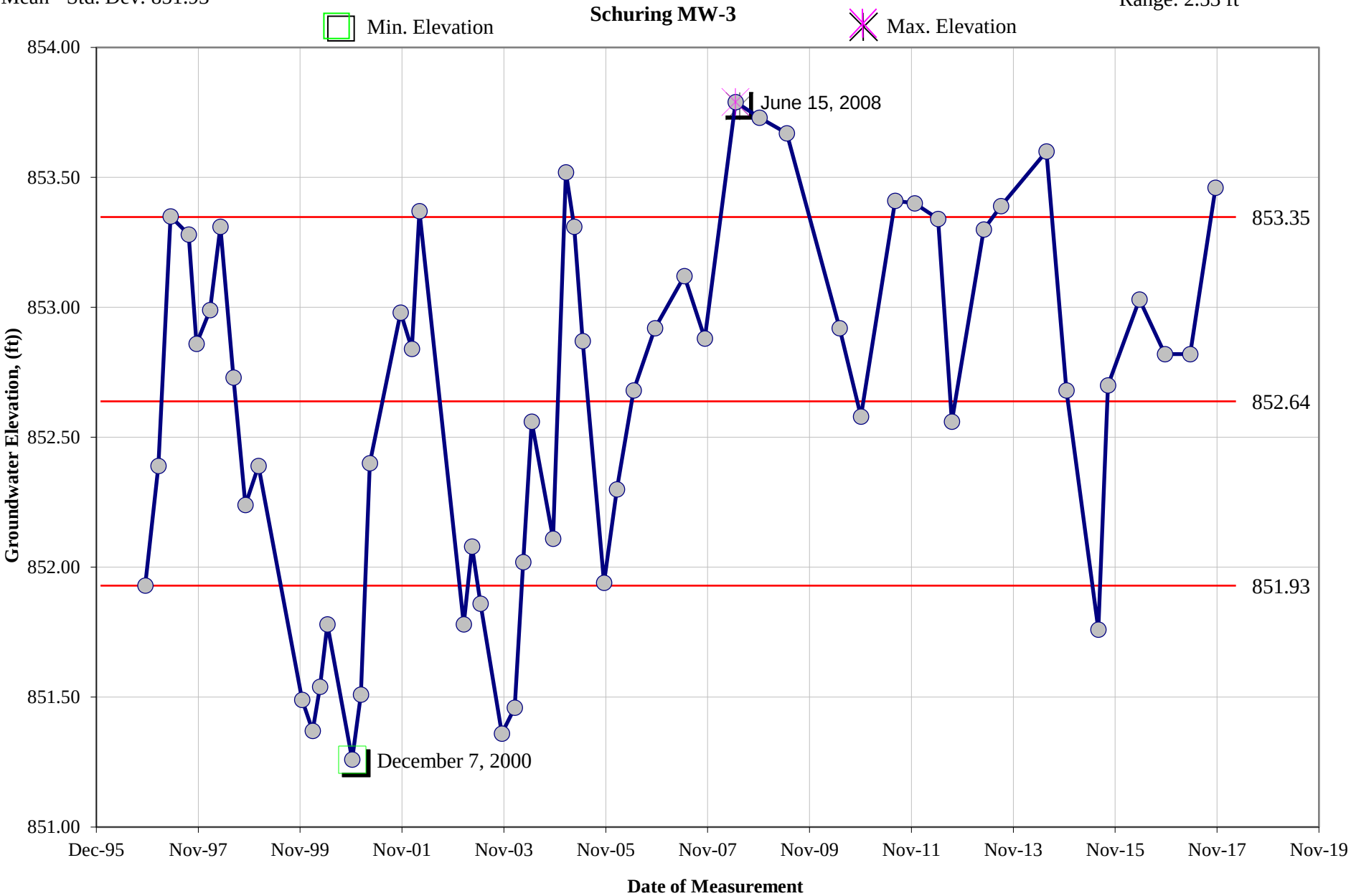
Observed Max: 856.72
Observed Min: 852.23
Range: 4.49 ft



Mean + Std. Dev: 853.35
Mean: 852.64
Mean - Std. Dev: 851.93

City of Portage Retention Basins
Historic Summary of Elevation Data

Observed Max: 853.79
Observed Min: 851.26
Range: 2.53 ft



Mean + Std. Dev: 858.95

Mean: 857.99

Mean - Std. Dev: 857.04

City of Portage Retention Basins

Historic Summary of Elevation Data

Observed Max: 859.35

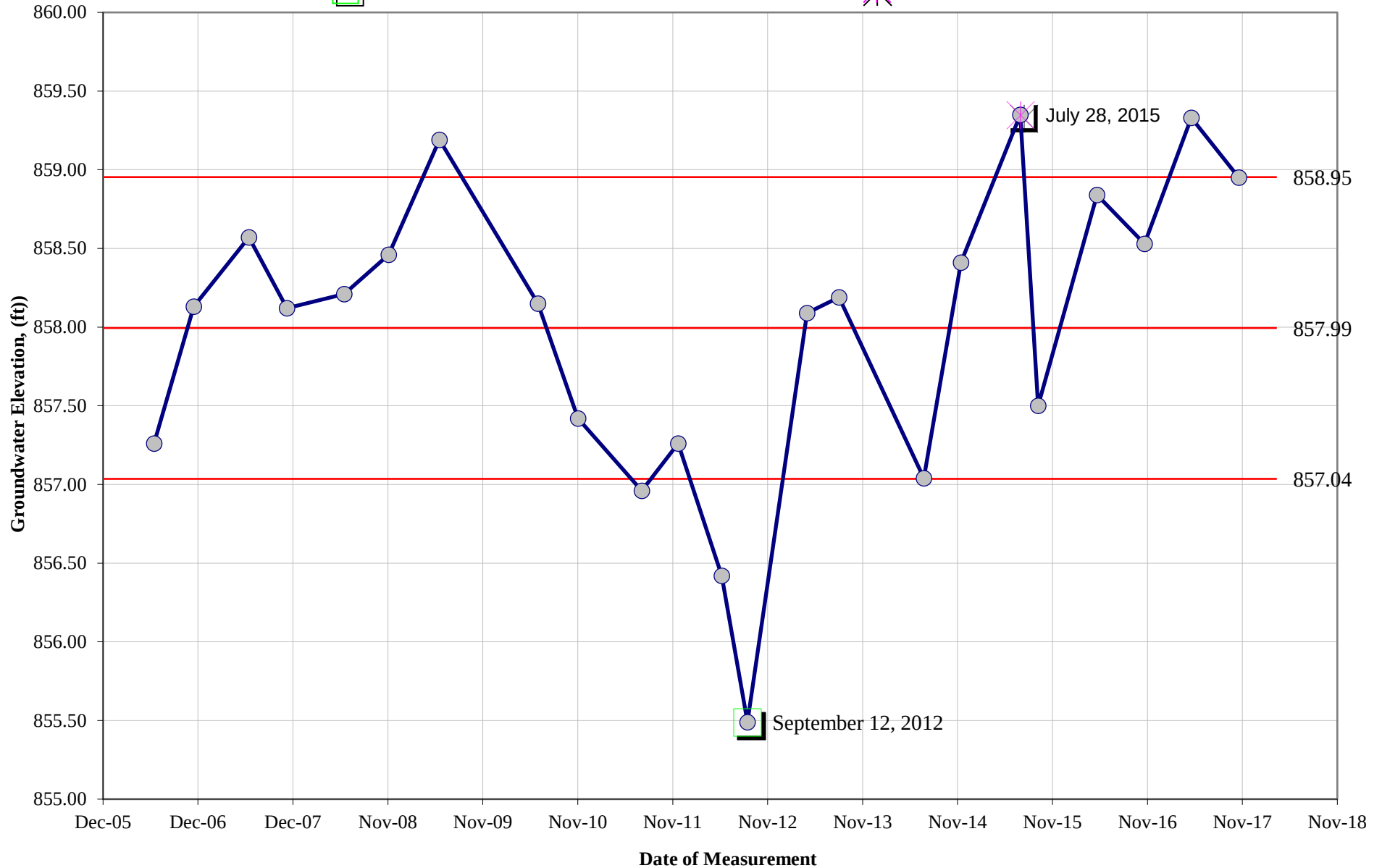
Observed Min: 855.49

Range: 3.86 ft

Shuman MW-1

Min. Elevation

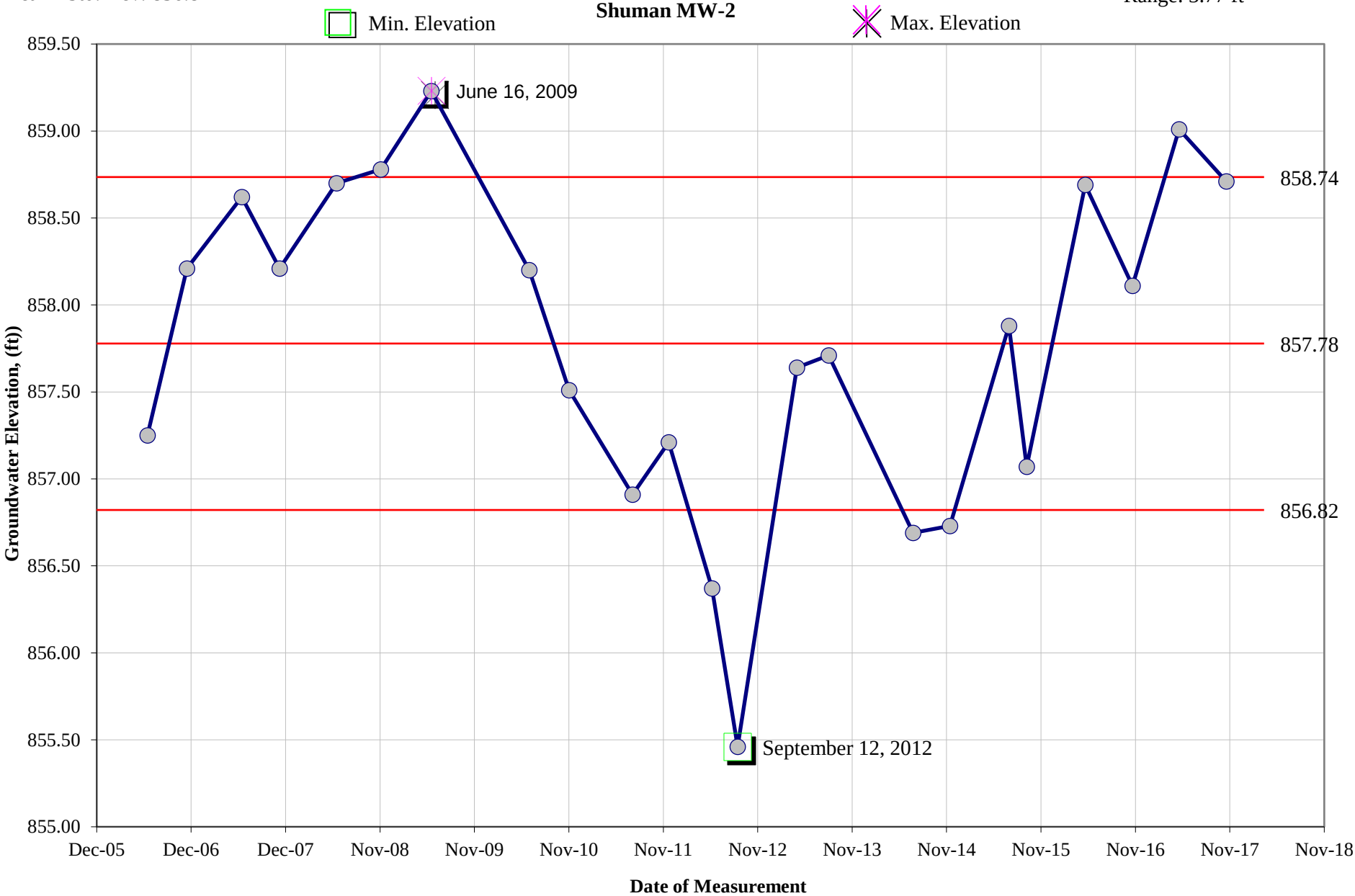
Max. Elevation



Mean + Std. Dev: 858.74
Mean: 857.78
Mean - Std. Dev: 856.82

City of Portage Retention Basins
Historic Summary of Elevation Data

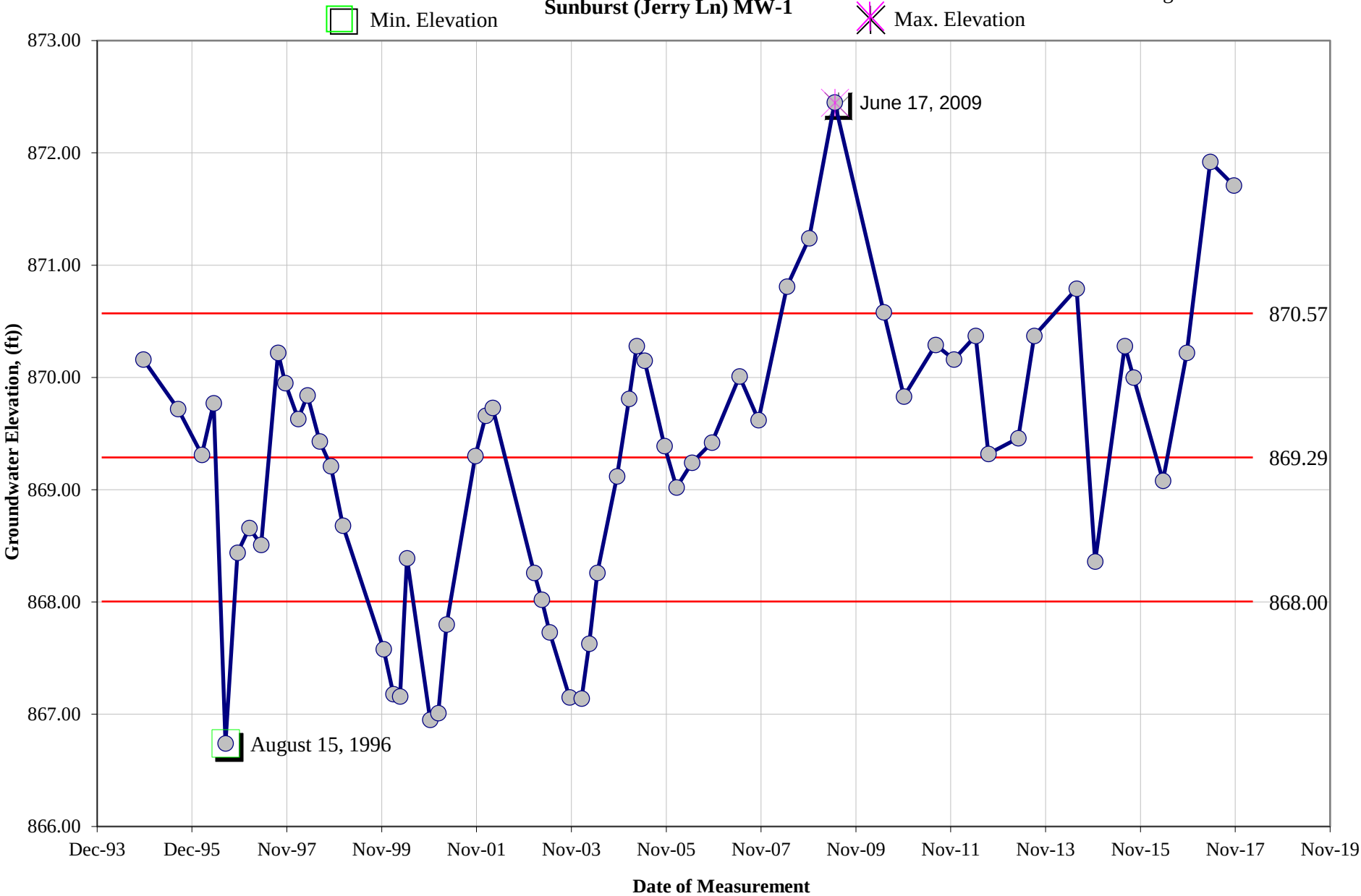
Observed Max: 859.23
Observed Min: 855.46
Range: 3.77 ft



Mean + Std. Dev: 870.57
Mean: 869.29
Mean - Std. Dev: 868.00

City of Portage Retention Basins
Historic Summary of Elevation Data

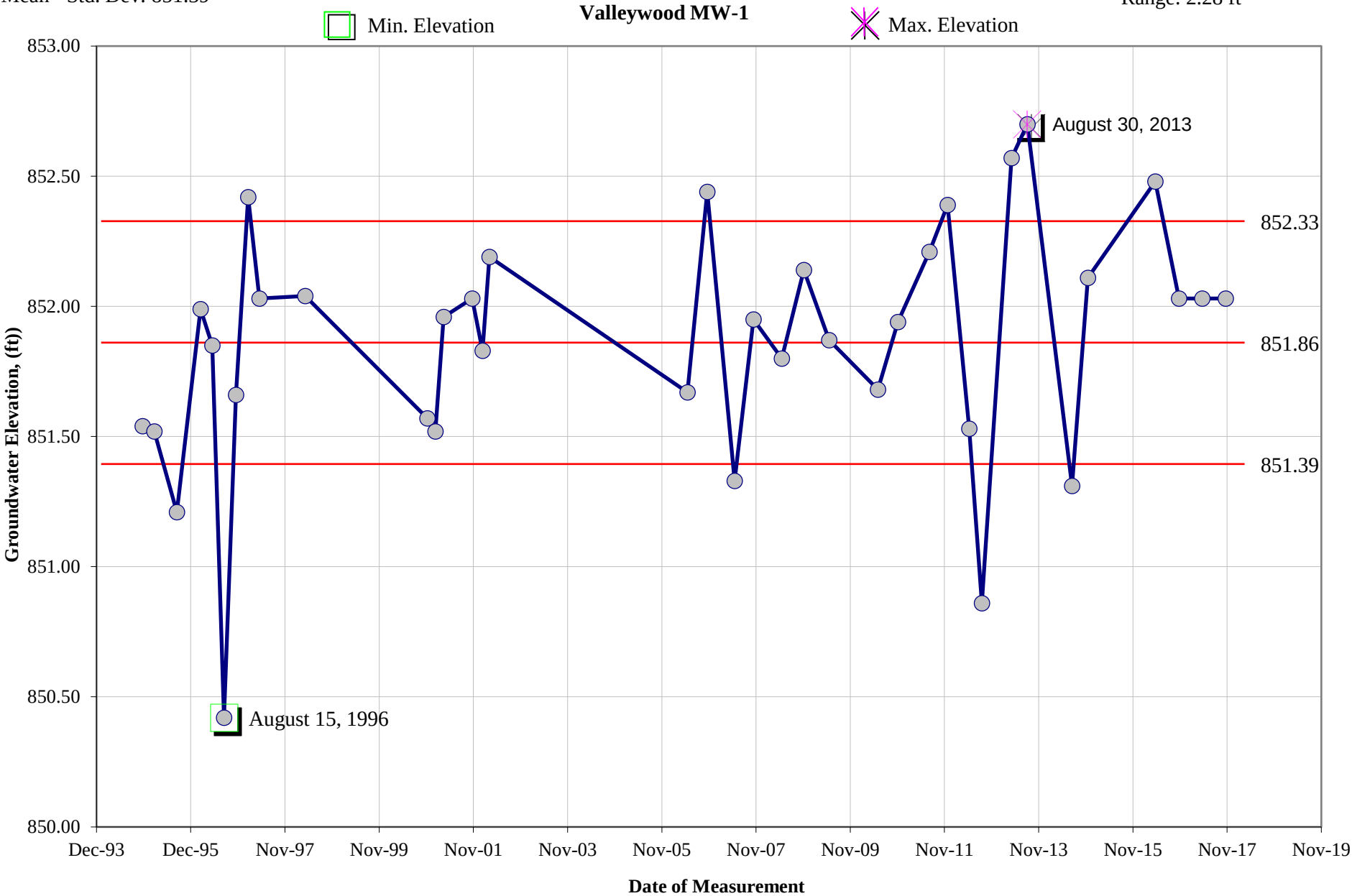
Observed Max: 872.45
Observed Min: 866.74
Range: 5.71 ft



Mean + Std. Dev: 852.33
Mean: 851.86
Mean - Std. Dev: 851.39

City of Portage Retention Basins
Historic Summary of Elevation Data

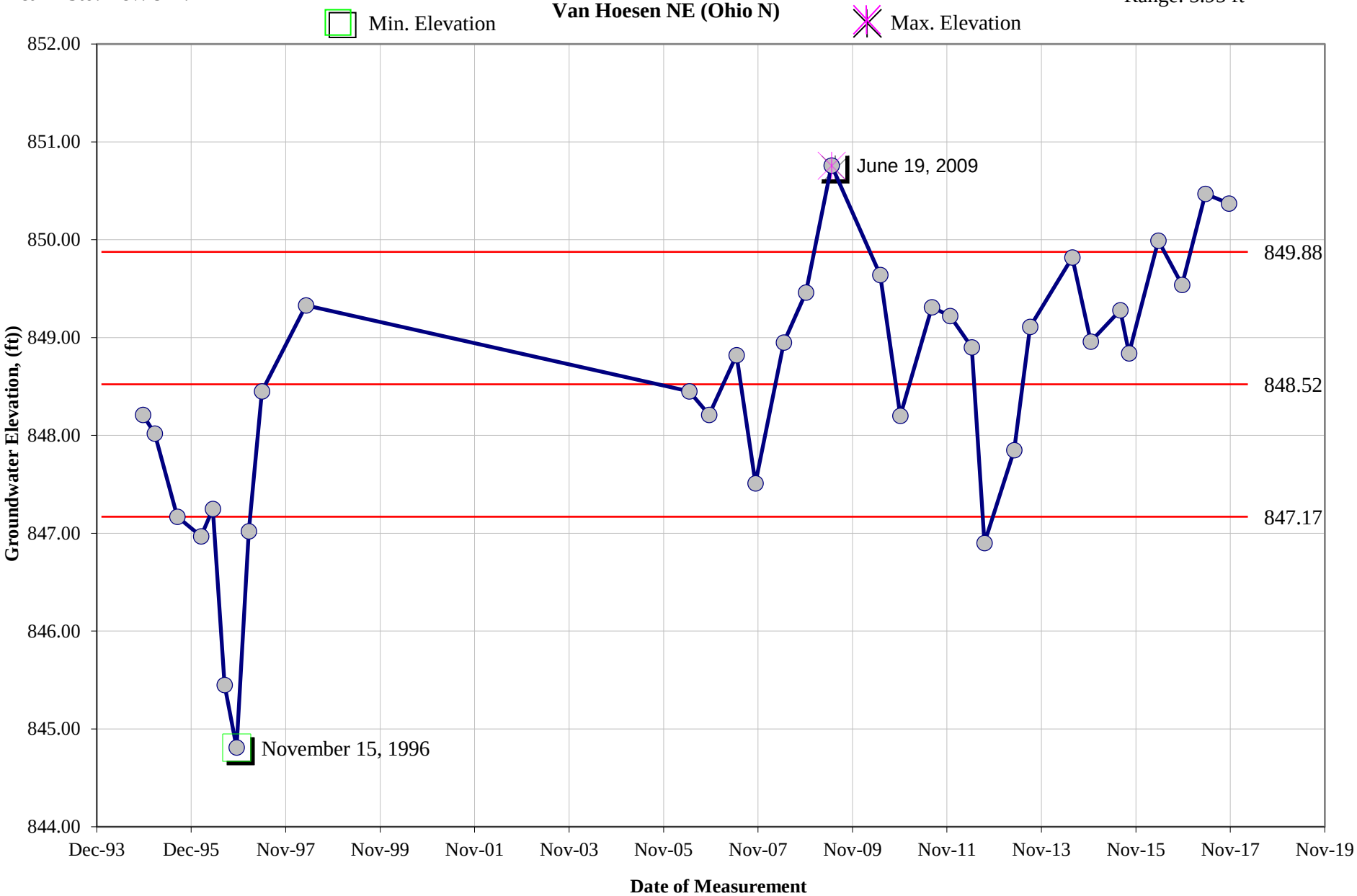
Observed Max: 852.70
Observed Min: 850.42
Range: 2.28 ft



Mean + Std. Dev: 849.88
Mean: 848.52
Mean - Std. Dev: 847.17

City of Portage Retention Basins
Historic Summary of Elevation Data

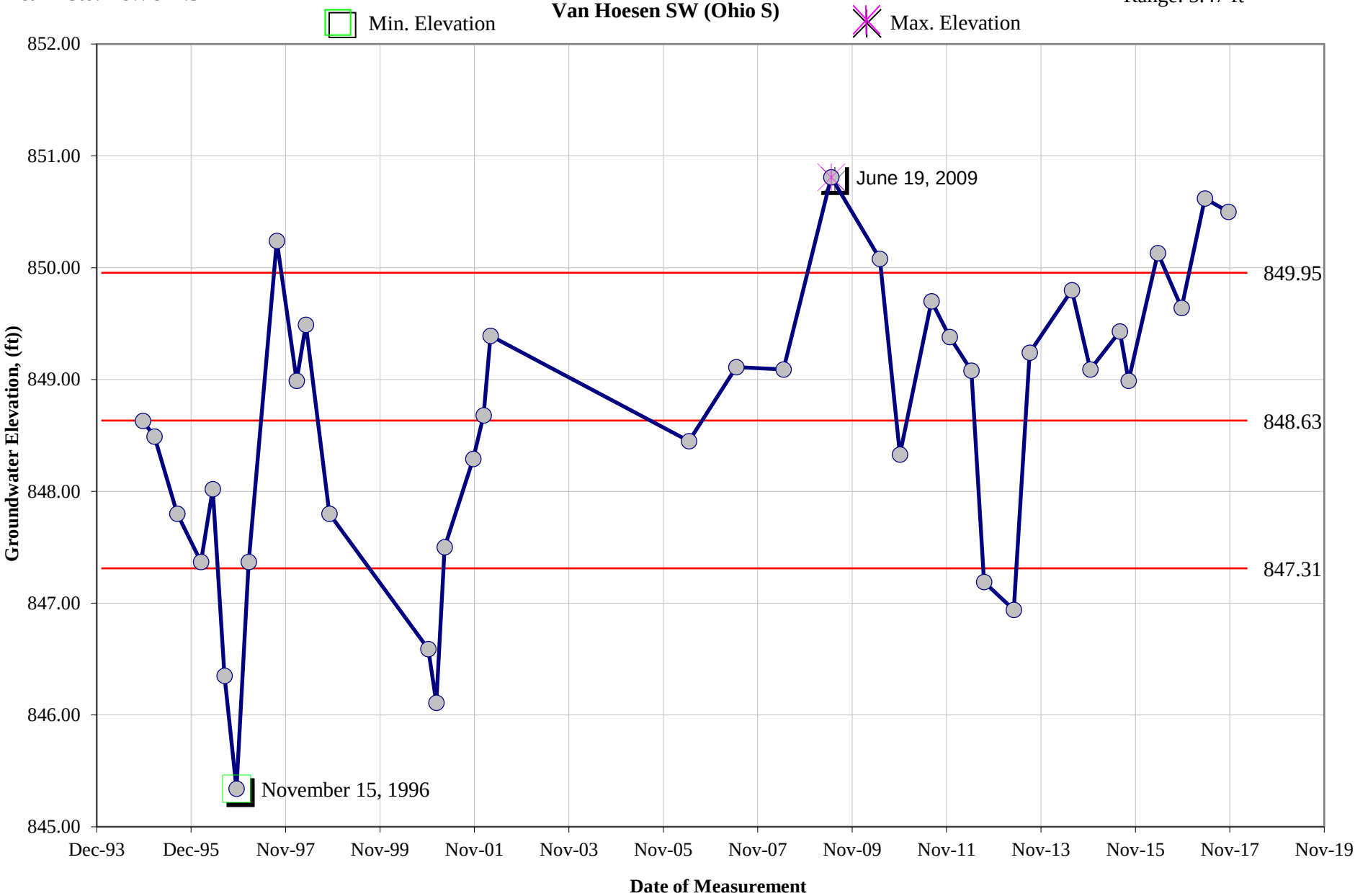
Observed Max: 850.76
Observed Min: 844.81
Range: 5.95 ft



Mean + Std. Dev: 849.95
Mean: 848.63
Mean - Std. Dev: 847.31

City of Portage Retention Basins
Historic Summary of Elevation Data

Observed Max: 850.81
Observed Min: 845.34
Range: 5.47 ft



Mean + Std. Dev: 854.60

Mean: 853.36

Mean - Std. Dev: 852.12

City of Portage Retention Basins

Historic Summary of Elevation Data

Observed Max: 855.11

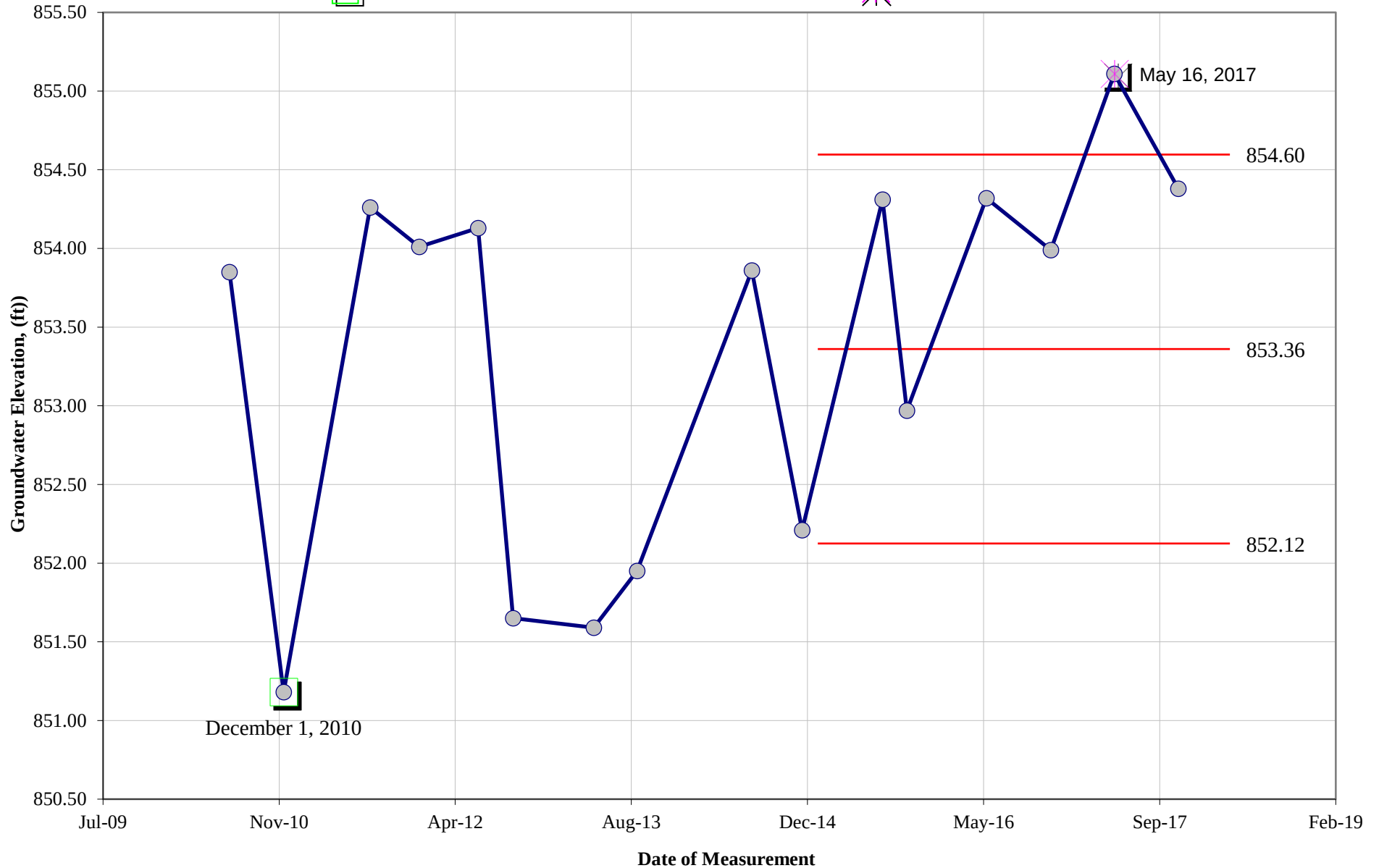
Observed Min: 851.18

Range: 3.93 ft

Wapiti Street MW-1

Min. Elevation

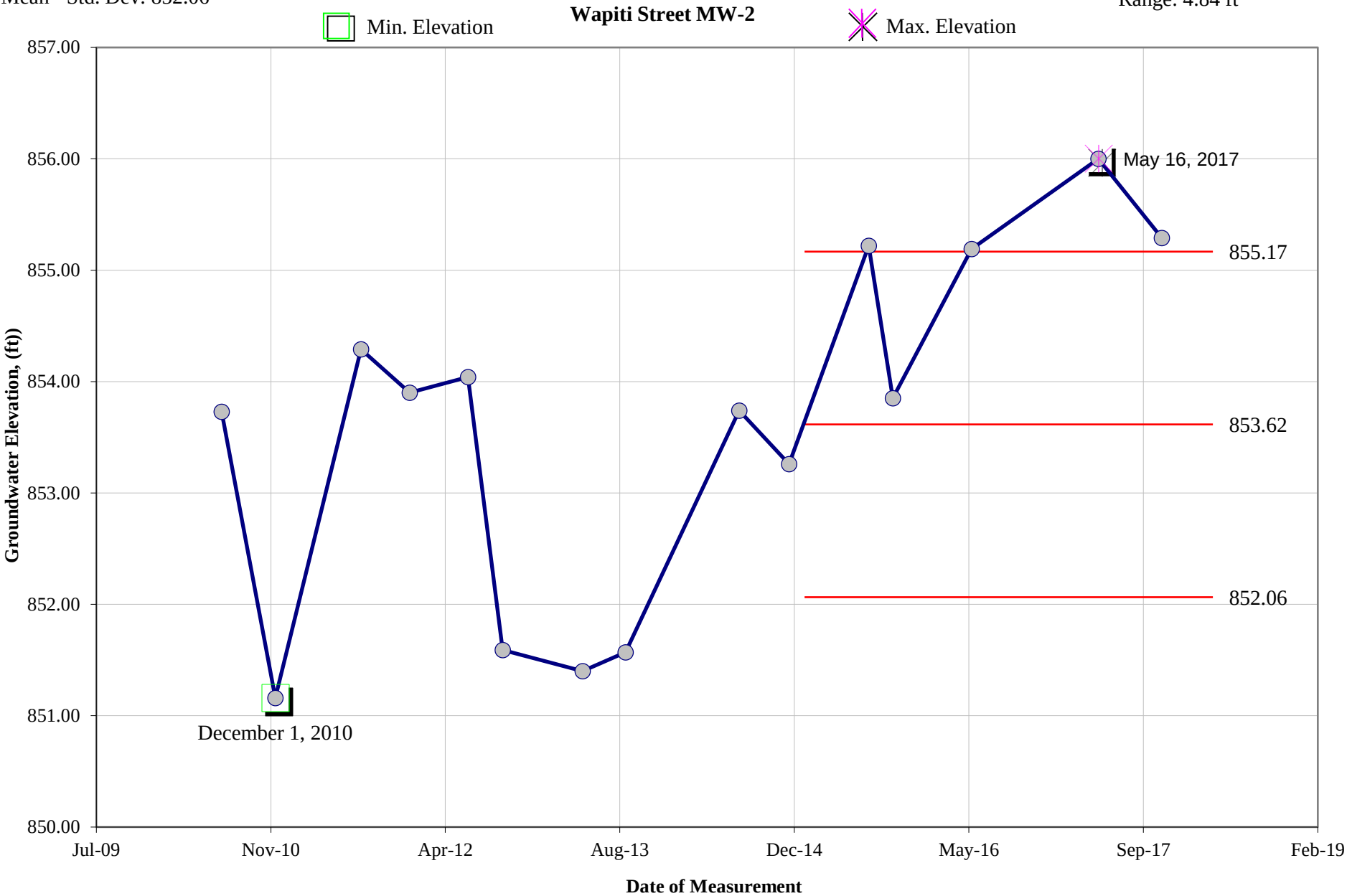
Max. Elevation



Mean + Std. Dev: 855.17
Mean: 853.62
Mean - Std. Dev: 852.06

City of Portage Retention Basins
Historic Summary of Elevation Data

Observed Max: 856.00
Observed Min: 851.16
Range: 4.84 ft



Mean + Std. Dev: 868.09

Mean: 866.87

Mean - Std. Dev: 865.64

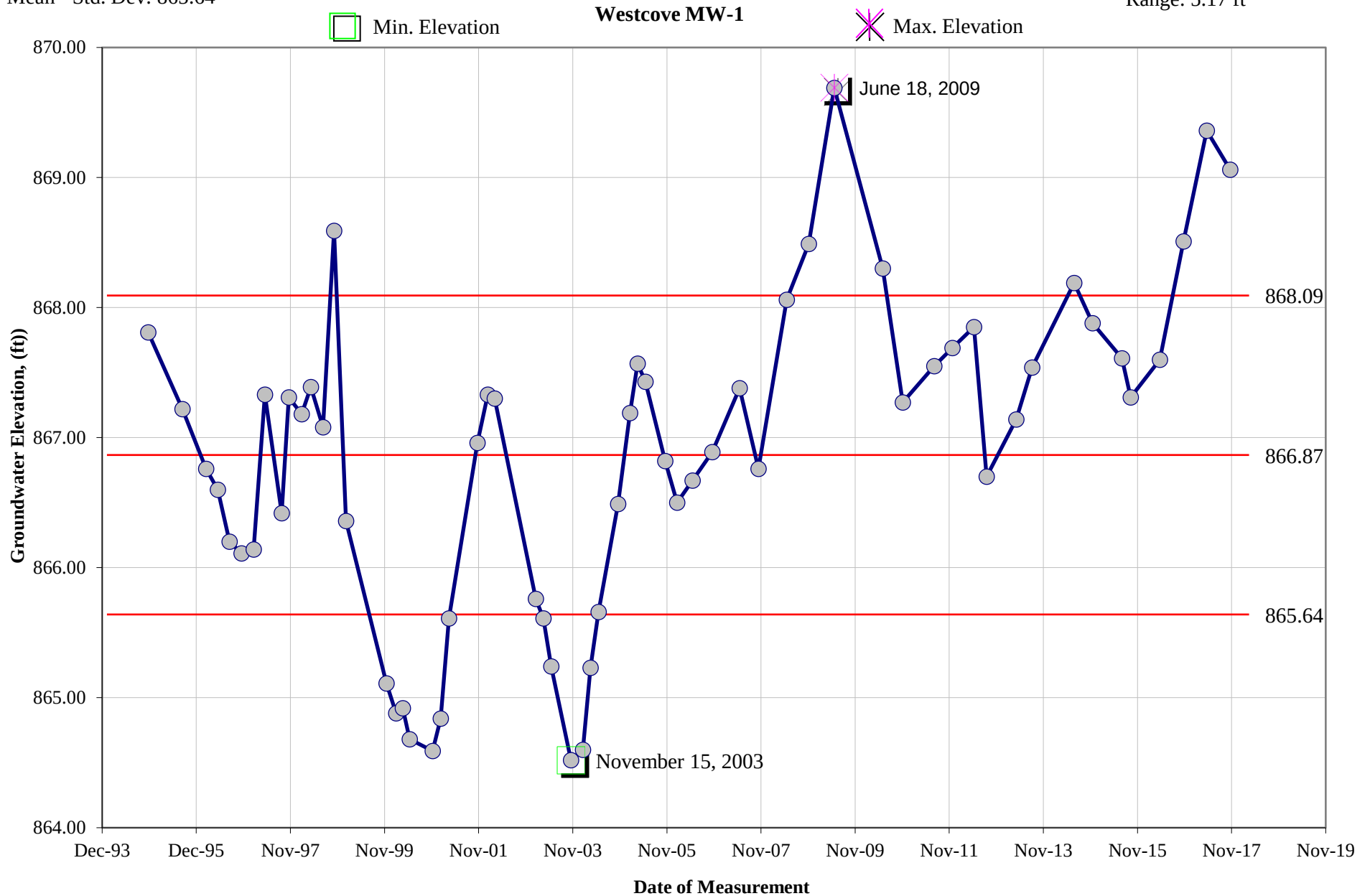
City of Portage Retention Basins

Historic Summary of Elevation Data

Observed Max: 869.69

Observed Min: 864.52

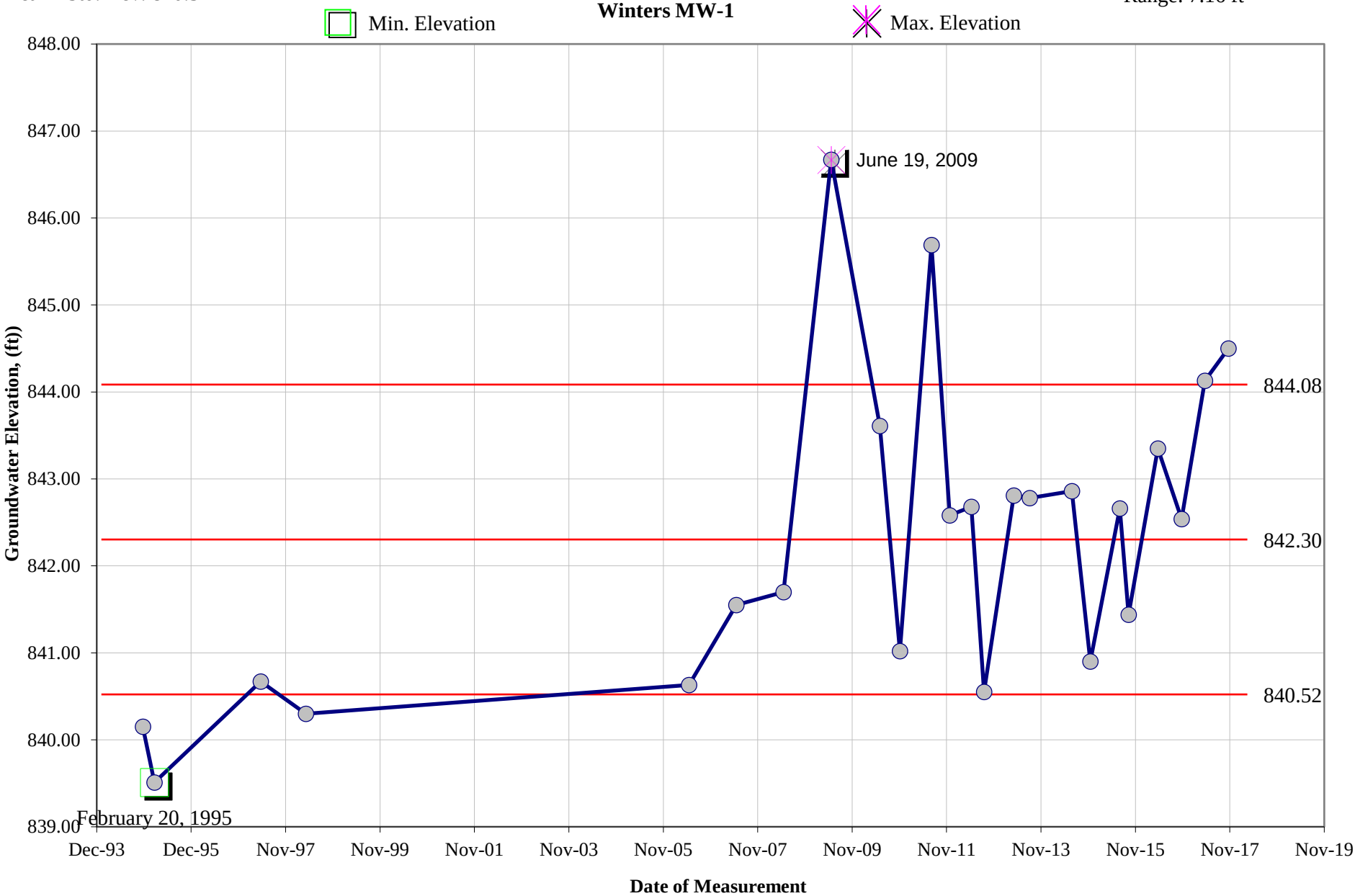
Range: 5.17 ft



Mean + Std. Dev: 844.08
Mean: 842.30
Mean - Std. Dev: 840.52

City of Portage Retention Basins
Historic Summary of Elevation Data

Observed Max: 846.67
Observed Min: 839.51
Range: 7.16 ft



APPENDIX D

CONTAMINANT CONCENTRATION

TABLES

Portage Outfall Sampling
Portage, MI
01SES1
Chemical Concentration Data

[illegible]

DF: Dilution Factor

* - DF:10

**Portage Outfall Sampling
Portage, MI
15NWS1
Chemical Concentration Data**

[illegible]

DF: Dilution Factor

* - DF:10

**Portage Outfall Sampling
Portage, MI
16NWS2
Chemical Concentration Data**

[illegible]

DF: Dilution Factor

* - DF:10

Portage Outfall Sampling
Portage, MI
16SES1
Chemical Concentration Data

[illegible]

DF: Dilution Factor

* - DF:10

**Portage Outfall Sampling
Portage, MI
21NWS3
Chemical Concentration Data**

[illegible]

DF: Dilution Factor

* - DF:10