BURNS McDONNELL

January 15, 2018

Mr. John Moeschen
United States Army Corps of Engineers
8901 South 154th Street, Suite 1
Omaha, NE 68138-3621

Re: MUD Platte West Well Field 2017 Nebraska Ordnance Plant Groundwater Report

To Mr. John Moeschen:

Attached, please find one CD copy and one bound hard copy of the following document; 2017 Nebraska Ordnance Plant Groundwater Report. Burns & McDonnell (BMcD) prepared this report and completed the associated work which summarizes the groundwater conditions observed near the Platte West well field during the 2017 water year (October 2016 through September 2017).

The report was prepared by BMcD under direction of the Metropolitan Utilities District (MUD). The document was developed to fulfill the groundwater monitoring and modeling requirements prescribed in MUD's Section 404 Individual Permit (199910085). The report is submitted by MUD for review by the Omaha District of the Corps of Engineers. Consistent with past years, we are also transmitting one CD and one bound copy of the report to the USACE Kansas City District (to Ms. Janet Mathews-Flynn, the Former Nebraska Ordnance Plant Site project manager). The Quality Control Summary Reports (QCSRs), which document the results of the bi-annual groundwater sampling events, are only included in the CD copies of the report. This change was made to promote sustainable printing practices. If you have any questions regarding any of the information presented please do not hesitate to call me at (816) 448-7591.

Sincerely,

Luca DeAngelis, P.E., P.G.
Associate Geological Engineer
NE Professional Env Engineer No. E-12739
NE Professional Geologist No. 328

Enclosure (1 CD and 1 report copy)
cc: Kevin Tobin, Superintendent Platte West Plant
Janet Mathews-Flynn, FNOP Project Manager USACE Kansas City

2017 Annual Nebraska Ordnance Plant Groundwater Report

for the

Platte West Water
Production Facilities

Metropolitan Utilities District Omaha Nebraska

Project No. 101060

January 2018

2017 Annual Nebraska Ordnance Plant Groundwater Report

Prepared for

Metropolitan Utilities District Omaha Nebraska
Platte West Water
Production Facilities
Omaha, Nebraska

Project No. 101060

January 2018

prepared by

Burns & McDonnell Engineering Company, Inc.
Kansas City, Missouri 64114

CERTIFICATION

Metropolitan Utilities District Omaha Nebraska
2017 Annual Nebraska Ordnance Plant Groundwater Report
Project No. 101060

Certification

I hereby certify, as a Professional Engineer and Professional Geologist in the state of Nebraska, that the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by the Metropolitan Utilities District Omaha Nebraska or others without specific verification or adaptation by the Engineer.

Luca DeAngelis, P.E., P.G. (Nebraska)

Date: 1-15-2018

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LIST OF ABBREVIATIONS

Abbreviation or Term

Alluvium: Unconsolidated terrestrial sediment composed of sorted or unsorted sand, gravel, and clay that has been deposited by water.

ARM: Absolute residual mean error. The ARM error represents the average of the absolute values of the differences between forecast and the corresponding observation.

Aquifer: An underground geological formation, or group of formations, containing water. Aquifers are sources of groundwater for wells and springs.

bgs: Below ground surface

BMcD: Burns & McDonnell

CENWK: Kansas City District Corps of Engineers

CENWO: Omaha District Corps of Engineers

COCs: Contaminants of Concern

Drawdown: The drop in the water table or level of water in the ground when water is being pumped from a well.

EIS: Environmental Impact Statement

FEIS: Final Environmental Impact Statement

Flood plain: The flat or nearly flat land along a river or stream or in a tidal area that is covered by water during a flood.

FNOP: Former Nebraska Ordnance Plant

gpm: Gallons per minute

Hydraulic conductivity (K): The rate at which water can move through a permeable medium. (i.e. the coefficient of permeability.)

Hydrogeology: The geology of ground water, with particular emphasis on the chemistry and movement of water.

LPNNRD: Lower Platte North Natural Resources District

LWS: Lincoln Water System

mgd: Million gallons per day

MODFLOW: Groundwater flow model developed by McDonald and Harbaugh (1988) with the USGS.

MODPATH: Groundwater particle tracking model developed by Pollock (1989) with the USGS.

MUD: Metropolitan Utilities District

NDMC: National Drought Mitigation Center

NDNR: Nebraska Department of Natural Resources

NOAA: National Oceanic and Atmospheric Administration

NOPGR: Nebraska Ordnance Plant Groundwater Report

Potentiometric surface: The surface to which water in an aquifer can rise by hydrostatic pressure.

QCSR: Quality Control Summary Report

RDX: Hexahydro-1,3,5-trinitro-1,3,5-triazine

Riverbed conductance: A numerical parameter used by MODFLOW to calculate the leakage between the river and the aquifer.

ROD: Record of Decision

TCE: Trichloroethylene

Unconfined aquifer: An aquifer containing water that is not under pressure; the water level in a well is the same as the water table outside the well.

UNLCSD: University of Nebraska – Lincoln Conservation and Survey Division

USACE: U.S. Army Corp of Engineers

USEPA: United States Environmental Protection Agency

USGS: U.S. Geological Survey

VOCs: Volatile Organic Compound

WFCP: Well Field Contingency Plan

EXECUTIVE SUMMARY

The Metropolitan Utilities District (MUD), Omaha, Nebraska, was issued a Section 404 Individual Permit (Permit) in 2003, from the Omaha District Corps of Engineers (CENWO) for the development of the Platte West Water Production Facilities Project (Project). The Project consists of a well field and water treatment facility that develops groundwater from the Platte River alluvial aquifer for potable use within the Greater Omaha Metropolitan area. One of the Permit's requirements is the development of an annual report that summarizes the groundwater quality and elevation data which are collected from wells within the well field's groundwater monitoring network. An additional requirement of the permit is the semi-annual updating of an existing groundwater model and reporting of those updates. The general purpose of these Permit Conditions is to ensure that the operation of the well field does not impact the contaminant plumes or the remediation efforts at the Former Nebraska Ordnance Plant (FNOP).

The purpose of this document, the Nebraska Ordnance Plant Groundwater Report (NOPGR), is to fulfill this annual reporting requirement. The objective of the NOPGR is to use available hydrogeologic data, both physical and chemical, as well as groundwater modeling to evaluate the potential impact of the operations of the well field on the aquifer and, more specifically, on the contaminant plumes and remediation efforts at the FNOP. The first NOPGR was developed in 2008 to comply with the Permit condition and a NOPGR has been submitted annually since. Extensive post audit groundwater modeling work has been conducted to evaluate the performance of the groundwater model and these post audits are documented in the 2009 through 2013 NOPGRs. These model post audits showed that the groundwater modeling predictions presented in the *Phase II Platte West Well Field Groundwater Modeling Study* (Chatman and Associates, Inc., 2005) were reasonable approximations of how the aquifer would respond to the pumping from the well field.

WELL FIELD PUMPING

The Project well field began pumping operations in February 2009 and has continued operations through the end of this reporting period (September 2017), completing the ninth calendar year of operation. The 2017 NOPGR reporting period was characterized by climactic conditions that led to relatively high water production from the Platte West well field. The average annual pumping rate for the 2017 water year was 35.9 million gallons per day (mgd). Water production for the 2017 water year was below the record high production year of 2011 (37.2 mgd for the 2011USGS water year) and the permitted water use for the Project of 53 mgd, as defined in Nebraska Department of Natural Resources (NDNR) water use permits.

The climatic conditions that contributed to the relatively high pumping included below average precipitation at beginning of summer and streamflow declines in the Platte River from May through June.

GROUNDWATER LEVEL ELEVATIONS

As with all previous NOPGR updates, continuous groundwater elevation monitoring was conducted at all of the monitoring wells that are located within the well field monitoring network. The monitoring network is shown on Figure 3-1 and consists of 38 monitoring wells that are equipped with pressure transducers. These monitoring wells are operated and maintained by one of three organizations: Lower Platte North Natural Resource District (LPNNRD), MUD, or the Kansas City District Corps of Engineers (CENWK). All data provided to Burns & McDonnell by MUD, CENWK, and the LPNNRD as of December 30, 2017 have been used to develop the hydrographs presented within this report.

The updated hydrographs show that water level elevations at the start of the 2017 NOPGR reporting period rebounded from the low groundwater level elevations observed in 2012 and 2013 and were approaching the water level elevations observed before the well field started pumping in 2009. Relatively high well field pumping which occurred during the summer of 2017 contributed to a short term drop in water level elevations near the well filed, but aquifer levels did not approach the low conditions observed in 2013. Near the end of the summer, water level elevations began to rebound in response to a decline in well field pumping, above normal precipitation, and a return to normal streamflow conditions in the Platte River.

In addition to the updated monitoring well hydrographs, a potentiometric surface map for March 2017 was developed using approximately 190 monitoring wells that included data collected by CENWK, LPNNRD, and MUD (see Figure 3-2). The pattern and shape of the potentiometric surface in the Todd Valley, where the majority of the FNOP site is located, has not changed due to the operation of the well field. Groundwater flow directions along the eastern perimeter of the FNOP site have not changed as a result of well field pumping. The March 2017 potentiometric surface indicates there has been little to no change in the contour intervals near the MUD well field since pumping began in 2009 and that the well field continues to remain hydraulically cross-gradient of the FNOP site.

WATER QUALITY SAMPLING

As with all previous NOPGR updates, two rounds of groundwater sampling were conducted during this NOPGR reporting period (May and September 2017). None of the compounds assigned a cleanup goal in the FNOP Record of Decision (ROD) were detected above their reporting limit during either 2017 sampling event. The September 2017 water quality sampling event did indicate several low-level detections of explosive compounds that were all flagged with data qualifies and a detection of PCE, which is not a compound that is not associated with the FNOP site. The results of the 2017 sampling events continued a recent pattern of intermittent low-level detections for explosive compounds that, with few exceptions, have been flagged with laboratory data qualifies and are inconsistent from one sampling event to the next.

GROUNDWATER MODEL UPDATE

The groundwater flow model was updated to reflect the average pumping rate for the 2017 water year for each of the production wells in the well field. The model was run assuming steady state conditions to develop an estimate of the aquifer drawdown that resulted from pumping the well field during the 2017 NOPGR reporting period. The drawdown attributable to well field pumping in 2017 is consistent with previous modeling and smaller than the cone of depression estimated for the maximum permitted operating conditions, which was originally presented in the Phase II steady state model (CAI, 2005).

SUMMARY

The hydraulic data collected as part of this and previous NOPGR updates continues to support the conclusion that the groundwater flow direction in the Todd Valley aquifer has not changed due to the operation of the well field. Well hydrographs and groundwater modeling performed support the conclusion that the hydraulic influence of the well field does not extend much beyond the location of wells MW94-3, MW94-5, MW94-6, MW06-27, and MW06-28, which are located approximately one mile from well field property boundary. The hydraulic and chemical data collected to date, as well as the modeling analyses performed, continue to support the conclusion that pumping from the Platte West well field is not adversely impacting the FNOP containment system efforts.

1.0 INTRODUCTION

The Metropolitan Utilities District (MUD) is responsible for providing potable water to the Greater Omaha (Nebraska) Metropolitan area. Based on the continuing growth in population and water demands in Greater Omaha, and constraints on supplies, MUD previously determined that a potential long-term shortage in water existed. To remedy this situation, the District studied various alternatives and selected a source of water from the Platte River valley west of Omaha as the best alternative, known as the Platte West Well Field (well field). Construction of the well field and associated water treatment facilities was completed in July 2008. The well field consists of 42 production wells that pump water from the Platte River alluvial aquifer. The completion of the Platte West water production facilities has increased MUD's peak day raw water capacity by 100 million gallons per day (mgd) to the current maximum of approximately 334 mgd. MUD maintains water rights from the Nebraska Department of Natural Resources (NDNR) that permit the use of surface water and groundwater for the well field. The use of Platte River surface water is permitted through an induced groundwater recharge permit (A-173178). Water Right A-17356, a ground water permit under the Municipal and Rural Domestic Ground Water Transfer Act, limits the combined pumping rate from the well field. The limits placed by this permit are: a maximum instantaneous pumping rate not to exceed 104 mgd and a total annual average pumping rate not to exceed 52 mgd.

The installation of transmission pipelines for the well field necessitated crossing the Platte River, Elkhorn River, and associated wetlands; therefore, MUD obtained a Clean Water Act Section 404 Permit (No. 199910085), referred to as Permit in this document. The Permit is administered by the Omaha District Corps of Engineers (CENWO). One of the Permit's requirements is an annual report concerning the Former Nebraska Ordnance Plant (FNOP). The FNOP site occupies approximately 17,250 acres located one-half mile south of Mead, in Saunders County, Nebraska. Groundwater contaminants in the form of explosives (associated with loading, assembling, and packing of munitions at four bomb load lines) and chlorinated solvents (associated with Atlas missile activities), underlie portions of the FNOP site. These groundwater contaminants are contained on site by a series of pumping wells, maintained by the United States Army Corps of Engineers (USACE). All but one (1) of the FNOP containment wells are installed in the Todd Valley aquifer, which is an ancestral channel of the Platte River that is filled primarily with alluvial sand. One FNOP containment well (EW-1R) is installed in the Platte River alluvial aquifer.

The purpose of this document, the Nebraska Ordnance Plant Groundwater Report (NOPGR), is to fulfill the annual reporting requirement. The objective of the NOPGR is to use available hydrogeologic data, both physical and chemical, as well as groundwater modeling to evaluate the impact of the operations of the well field on the aquifer and, more specifically, on the contaminant plumes and remediation efforts at the FNOP. The remainder of this section provides a general discussion of the project background and describes the overall purpose of work presented within this report.

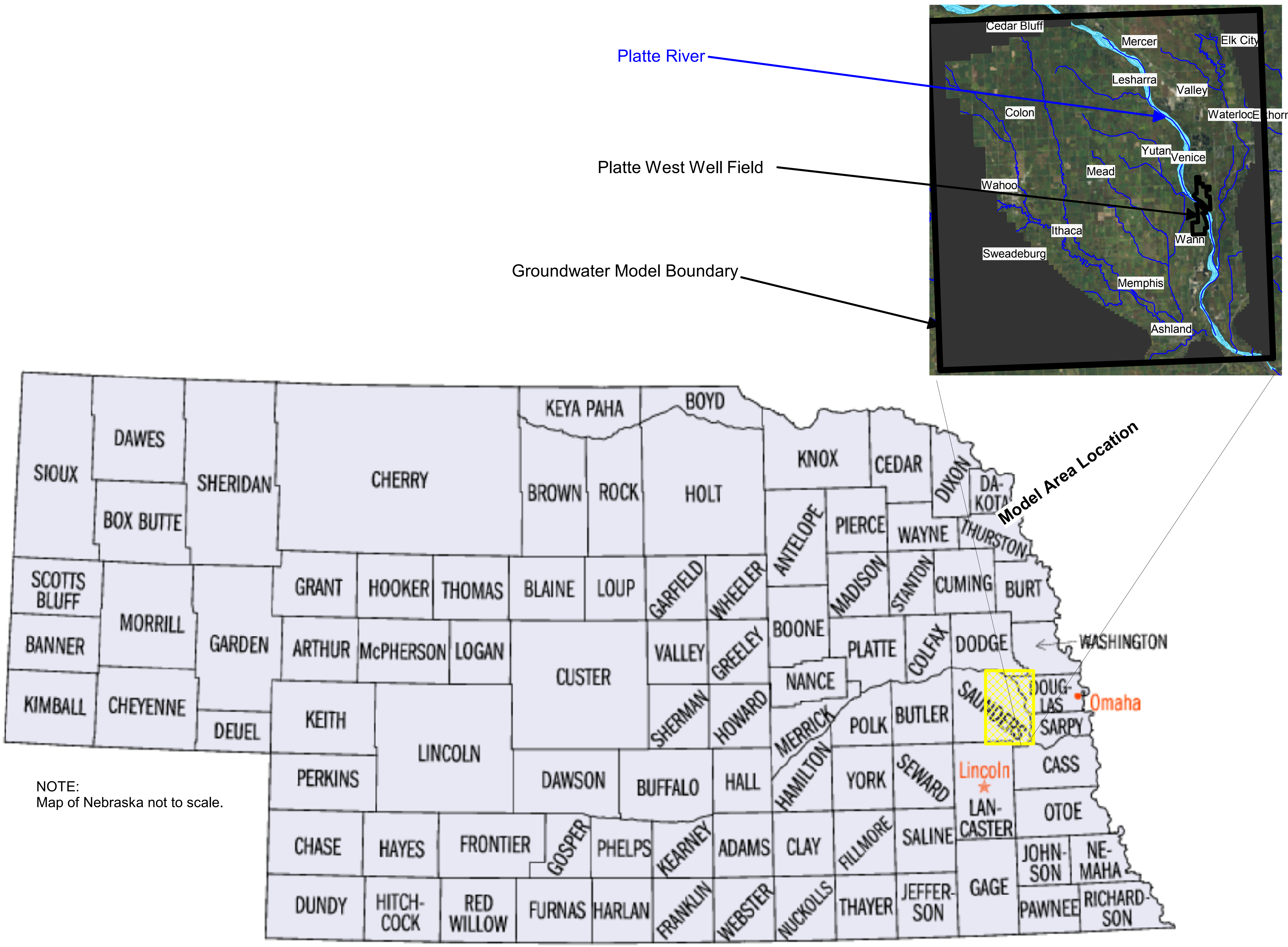
1.1 Project Location

The well field is located on 2,230 acres of land in southeastern Nebraska encompassing both sides of the Platte River in Douglas and Saunders Counties. The raw water is delivered to a treatment plant in western Douglas County through a 3.5-mile long, 72-inch diameter pipeline. Treatment plant construction was completed in the summer of 2008. The treatment plant is located northeast of the intersection of Q and 216th Streets. The well field and study area locations are shown of Figure 1-1.

1.2 Permit Reporting Requirements

Section H of the Permit describes specific post-start up conditions that are required for operation of the well field. This NOPGR was developed to address Section H Permit Condition 62, which relates to the annual reporting of water quality and hydraulic data collected from wells within the well field's monitoring network. An additional requirement of the permit is semi-annual updating of an existing groundwater model and reporting of those updates in the annual groundwater report (NOPGR). The general purpose of the Permit Conditions described in Section H is to ensure that the operations of the well field do not impact the contaminant plumes or the remediation efforts at the FNOP. The following section presents a summary of Section H Permit Condition 62, as they relate to the development of the NOPGR:

- Condition 62a – MUD will collect potentiometric surface elevation data on a monthly basis, for a period of at least one year after the startup of the well field. The potentiometric data will be obtained from monitoring wells located in coordination with the USACE.
- Condition 62b – MUD will collect groundwater samples for chemical analysis on a semi-annual basis from monitoring wells located in coordination with the USACE.
- Condition 62c – MUD will update the existing groundwater model on a semi-annual basis using data collected from the monitoring program to evaluate the potential impact of the well field on the operations at the FNOP.
- Condition 62f – MUD will develop the NOPGR to summarize the activities described in the above conditions. The NOPGR will be submitted on an annual basis for review by the Corps of Engineers, with the first NOPGR due within one year of well field startup.



METROPOLITAN UTILITIES DISTRICT

Platte West Well Field
Nebraska Ordnance Plant
Groundwater Report

Figure 1-1
Platte West Well Field
Groundwater Model Boundaries

BURNS & McDONNELL

1.3 Summary of Previous Modeling

The groundwater modeling activities presented in this NOPGR are continuations of previous well field modeling activities that started in 1993 with the development of the Pre-Design model documented in the *Preliminary Engineering Study and Pre-Design Report* (HDR, 1993). The Pre-Design model was modified and improved during the Environmental Impact Statement (EIS) process, ultimately evolving into the model presented in the Final Environmental Impact Statement (FEIS) (Burns & McDonnell, 2002).

Prior to well field construction and startup, a more comprehensive groundwater modeling effort was undertaken by MUD. This effort used the results of the work presented in the FEIS as a point of departure to develop a groundwater model capable of depicting the influence, if any, of the well field on the FNOP contaminant plumes, the FNOP operating remedial system, and other area water users. The groundwater model was developed to simulate various operating scenarios and estimate the impact of an operational well field on water levels in the aquifer. This modeling effort was undertaken in phases, with the phases of work and associated major deliverables summarized below:

- Phase I - Well Field Installation and Assessment, completed December 2004.
- Phase II - Operations Assessment and Planning, January 2005 through December 2005.
- Phase III - Well Field Pre-Start-Up Support July 2005 through August 2008.
- Phase IV - Well Field Operations 2008 and Post Start-Up (ongoing).

The Permit describes specific numerical groundwater modeling tasks which are presented in Conditions 61 (c) and 62 (c) of Section H of the Permit. To date, three major groundwater modeling efforts have been developed to satisfy the requirements of the Permit and to develop an operational tool for MUD. The Phase I modeling effort is summarized in the *Well Field Groundwater Modeling Study* (Chatman and Associates, Inc., 2004). The Phase II modeling effort is summarized in the *Phase II Platte West Well Field Groundwater Modeling Study* (Chatman and Associates, Inc., 2005). These reports provide definition of the location and extent of the Platte Valley aquifer, from which the MUD well field obtains water, and of the Todd Valley aquifer, which contains the FNOP contaminant plumes and remedial system.

As part of the Phase III project activities, the transmissivity of the aquifer near the well field was better quantified by analyzing the 48-hour aquifer tests performed on 32 of the 42 new production wells. These tests were performed using a minimum of three (3) observation wells, and were analyzed using the

Cooper-Jacob distance drawdown method (Cooper-Jacob, 1946). The results of this analysis were presented as an Appendix to the 2008 NOPGR (Layne Christensen, 2009).

Also part of the Phase III activities, a detailed aquifer test and groundwater modeling exercise was performed to better quantify the degree of interconnection between the Platte River and the alluvial aquifer. The results of this activity were presented in *Induced Infiltration Aquifer Test - Riverbed Conductance Summary Report Saunders County Test* (Layne Christensen, 2008a), and were included as an Appendix to the 2008 NOPGR.

1.3.1 Phase IV Groundwater Model Post Audit

The following section describes the modeling and reporting activities which have taken place after the well field began operating in February 2009.

1.3.1.1 2009 NOPGR Summary

The 2009 NOPGR (HDR, 2010) was structured as a model post audit to evaluate the ability of the groundwater model to reproduce the observed aquifer response to the first eight (8) months of well field pumping (February through September 2009). During this period, the well field pumping rate averaged 36.8 mgd. To accomplish this objective, the monthly average flow rate for each of the 42 production wells was input into the model and the model was run to simulate transient conditions, using twelve one-month stress periods that represented the October 2008 to September 2009 reporting period. The model-predicted drawdown was compared to the observed drawdown at 19 monitoring well sites equipped with pressure transducers/data loggers.

The results of the 2009 NOPGR post audit showed that the groundwater model accurately predicted the impact of well field operations on the Platte Valley alluvial aquifer. The transient drawdown hydrographs generated for 19 monitoring wells showed that the model accurately reproduced both the observed rate of expansion and the overall magnitude of the cone of depression created by operating the well field. Most observed drawdown values fell near or within the appropriate contour interval of the model-predicted drawdown for the end of September 2009 pumping period (Figure 5-4 in 2009 NOPGR). The groundwater model post audit conducted as part of the 2009 NOPGR validated the ability of the groundwater model to accurately reproduce the impact of well field pumping on the water level elevations in the Platte Valley alluvial aquifer.

1.3.1.2 2010 NOPGR Summary

The predictive capability of the model was further evaluated in the 2010 NOPGR (HDR, 2011). The 2010 NOPGR was conducted as an extension of the model post audit performed in 2009 by increasing the length of the model simulation to 24 one-month stress periods, representing the groundwater conditions from October 2008 to September 2010. To further test the predictive capabilities of the groundwater model MUD shut off all nine pumping wells located in Section 19 (in Saunders County) from the beginning of November 2009 through the end of February 2010. Before that time, the Section 19 wells had operated from February 11, 2009 through November 2009.

The observed aquifer recovery, and the model simulation of the prolonged shut down of the Section 19 wells, was presented in hydrographs that were summarized on Figure 5-3 of the 2010 NOPGR. These hydrographs illustrated the groundwater model's accurate reproduction of both the drawdown in the aquifer that was induced when the well field began operations in February 2009, and the recovery in the aquifer that occurred when all wells in Section 19 (Saunders County) were shut off from November 2009 through the end of February 2010. This extended model post audit confirmed that the groundwater model accurately predicts the magnitude and pattern of groundwater elevation changes around the well field. These analyses provide confirmation that the aquifer parameters and degree of interconnection between the river boundary and the aquifer used in the groundwater model are appropriate.

1.3.1.3 2011 NOPGR Summary

The 2011 NOPGR further extended the model post audit performed in 2009 and 2010 reports by increasing the length of the model simulation to 36 one-month stress periods, representing the groundwater conditions from October 2008 to September 2011. This extended model post audit continued to show a strong correlation between the transient model-calculated and observed water levels measured in monitoring wells located near the well field. Observed groundwater elevations, chemical sampling data, and updated groundwater model results for the 2011 water year were presented in the 2011 NOPGR (HDR, 2012). MUD addressed comments provided by the USACE on the draft of this document and the document was eventually approved as final.

1.3.1.4 2012 NOPGR Summary

Observed groundwater elevations, chemical sampling data, and updated groundwater model results for the 2012 water year were presented in the 2012 NOPGR (HDR, 2013). USACE provided comments on the 2012 NOPGR report to MUD via email communication dated June 27, 2013. The 2013 NOPGR addresses the USACE comments on the 2012 NOPGR report. A final version of the 2012 NOPGR was not produced, with the intention of incorporating the 2012 report comments into the 2013 NOPGR.

1.3.1.5 2013 NOPGR Summary

Observed groundwater elevations, chemical sampling data, and updated groundwater model results for the 2013 water year were presented in the 2013 NOPGR (HDR, 2014). Review comments were not provided by USACE.

1.3.1.6 2014 NOPGR Summary

Observed groundwater elevations, chemical sampling data, and updated groundwater model results for the 2014 water year were presented in the 2014 NOPGR (HDR, 2015). The only significant change from previous NOPGR submittals was the inclusion of a revised Well Field Contingency Plan (WFCP). A review of the draft 2014 NOPGR, including the revised WFCP, was completed with the Omaha District Corps of Engineers (CENWO) and the Kansas City District Corps of Engineers (CENWK) via conference call on May 27, 2015. MUD addressed the comments provided, which included a final revised WFCP, and submitted a final NOPGR (on June 2, 2015) that addressed the comments provided by the CENWO and CENWK representatives.

1.3.1.7 2015 NOPGR Summary

Following the submittal of the 2015 NOPGR, BMcD identified an error in the groundwater elevation hydrograph of monitoring well MW-110A. BMcD submitted a supplemental hydrograph for the well in March 2017.

1.3.1.8 2016 NOPGR Summary

Comments on the 2016 NOPGR were provided by CENWK via email on January 31, 2017. MUD addressed the comments provided via a response letter (dated February 22, 2017).

1.4 References to Previous Modeling Reports

As previously stated, the NOPGR is a submittal required by the Permit and is a continuation of a series of modeling studies and reports, of which the first report was developed in 2004. The NOPGRs are a summary of the hydrogeologic data collected during a one-year monitoring period and a summary of the update of an existing groundwater model. Given the ongoing nature of the modeling activities and the numerous modeling related submittals that have been completed during the life cycle of the well field project, it is not practical to include a detailed summary of all model construction, calibration, sensitivity, and post audit analyses performed from 2003 through present day. If specific questions related to model construction, calibration, or sensitivity analysis arise during the review of the current NOPGR, it is assumed the reviewers of this document have access to copies of the previous groundwater modeling reports. The most comprehensive reference on model construction, model calibration, sensitivity analyses (both of calibration residuals and model predictions), and predictive analyses performed can be found in the Phase II modeling report, the *Platte West Well Field Groundwater Modeling Study* (Chatman and Associates, Inc., 2005). Previous reports that document the efforts associated with the model construction, calibration, and post-audit efforts include:

- Phase I Baseline Groundwater Modeling Report: *Well Field Groundwater Modeling Study* (Chatman and Associates, Inc., 2004);
- Phase II Groundwater Modeling Report: *Phase II Platte West Well Field Groundwater Modeling Study* (Chatman and Associates, Inc., 2005);
- 2008 NOPGR (Layne Christensen, 2009);
- 2009 NOPGR (HDR, 2010);
- 2010 NOPGR (HDR, 2011); and
- 2011 NOPGR (HDR, 2012).

These documents are stored on the MUD website http://www.mudomaha.com, and can be located using the website search tool.

1.4.1 Reporting Period

The reporting period for the 2017 NOPGR report coincides with the United States Geological Survey (USGS) Water Year, from October 1 of the previous year to September 30 of the current year. This reporting period was also used in past NOPGR reports with the exception of the 2012 NOPGR report, which used a reporting period of October 1 of 2011 through the end of August 2012.

2.0 WELL FIELD PUMPING

Intermittent well field pumping began in July 2008 from both the Douglas and Saunders County sides of the well field. Much of the well field pumping conducted in July and August 2008 was related to: filling plant basins, testing plant equipment, and shakedown testing of the overall well field, piping, and treatment process. Pumping associated with shakedown testing continued through the middle of October 2008. The well field did not operate from mid-November 2008 to mid-February 2009.

The well field began pumping operations on February 11, 2009 and has continued operations through the end of this reporting period (September 2017), completing the ninth calendar year of operation. Each supply well in the well field is equipped with an individual flow meter, which allows for accurate measurement of individual well flow rates. The well field Supervisory Control and Data Acquisition (SCADA) system tracks total flow from each well, in mgd. Those daily data are provided by MUD to Burns & McDonnell (BMcD) and are used to calculate the pumping rates input into the NOPGR modeling update. A chart illustrating the monthly well field pumping rate for the duration of well field operations, including the 2017 reporting period has been included as Figure 2-1.

As in past years, pumping on an annual basis was well below the regulated NDNR water use permits. The average annual pumping rate for the 2017 USGS water year was 35.9 mgd. Water production for the 2017 USGS water year was below both the record high production year of 2011 (37.2 mgd for the 2011 USGS water year) and the regulated annual average flow of 52 mgd. For the 2017 reporting period, the average monthly pumping rate fluctuated from a low of 23.1 mgd, recorded in October 2017, to a high of 54.5 mgd recorded in July 2017. Average monthly flow rates are summarized in Table 2-1 below.

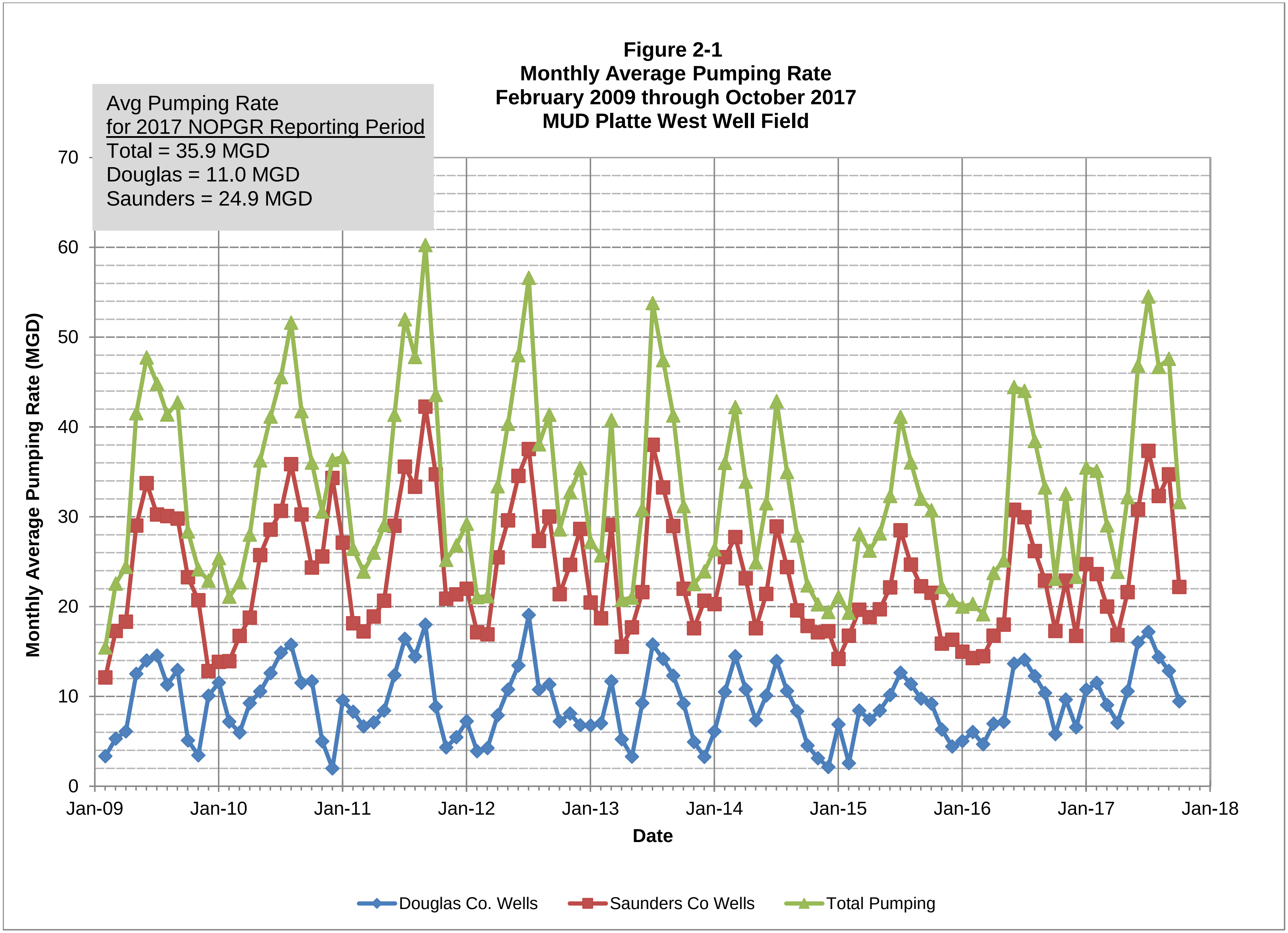


Figure 2-1
Monthly Average Pumping Rate
February 2009 through October 2017
MUD Platte West Well Field
Avg Pumping Rate
for 2017 NOPGR Reporting Period
Total = 35.9 MGD
Douglas = 11.0 MGD
Saunders = 24.9 MGD
Monthly Average Pumping Rate (MGD)
0
10
20
30
40
50
60
70
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Date
Douglas Co. Wells
Saunders Co Wells
Total Pumping

Table 2-1: Average Well Field Pumping Rate by Month

Year	2016			2017								
Month	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP
Douglas Co. Monthly Average Pumping (mgd)	5.81	9.65	6.56	10.76	11.52	9.057	7.05	10.58	16.01	17.19	14.37	12.85
Saunders Co. Monthly Average Pumping (mgd)	17.30	22.91	16.75	24.73	23.61	20.00	16.83	21.62	30.82	37.33	32.33	34.74
Totalized Well Field Monthly Average Pumping, (mgd)	23.1	32.6	23.3	35.5	35.1	29.1	23.9	32.2	46.8	54.5	46.7	47.6
Percentage of Well Field Flow from Douglas Co.	25.1%	29.6%	28.2%	30.3%	32.8%	31.2%	29.5%	32.9%	34.2%	31.5%	30.8%	27.0%

2.1 Pumping Distribution

The operational plan for the well field was to simultaneously pump water from both the Douglas County and Saunders County sides of the well field at an approximate distribution of 35 and 65 percent of total pumping, respectively. This pumping distribution is not a condition of the Permit, but rather a design concept for how the well field and treatment plant would be operated. As shown in Table 2-1 above, the well field was operated with an average pumping distribution of approximately 30.3 percent of the total flow being supplied by the Douglas County side of the well field. As operated, the average daily pumping distribution was 11.0 mgd from the Douglas County wells and 24.9 mgd from the Saunders County wells. This pumping distribution will continue to fluctuate seasonally, depending on several variables including water demand, streamflow, and other climatic conditions.

3.0 HYDROLOGIC DATA ANALYSIS

The following section presents an analysis of the hydrologic data collected as part of the monitoring program associated with the operation of the well field. The data includes pre- and post-well field startup conditions and are comprised of water levels collected at observation wells and stream stage and flow data collected at existing USGS stream gages.

MUD began collecting water levels from monitoring wells located in Douglas, Sarpy, and Saunders Counties in 1990. The monitoring well network was expanded in Douglas and Saunders Counties in 1995, and later expanded again with the addition of new monitoring wells in 2004 through 2006. Monitoring wells MW14-32, MW14-33 and MW14-34 were added to the monitoring well network in 2014 as part of the Well Field Contingency Plan monitoring program. All monitoring wells currently located in MUD’s groundwater monitoring network are illustrated on Figure 3-1. Initially, water levels were measured manually at regular time intervals using electronic water level indicators; however, in 2004 MUD began equipping all of their monitoring wells with pressure transducers/data loggers. Each pressure transducer/data logger collects and records a water level measurement at least once per day. Presently, MUD continues to make manual water level measurements, typically twice a year, to check the accuracy of the pressure transducers/data loggers. The more recent water level data collection program, initiated as part of the Permit operating conditions, supplements the historical data collected by MUD and was evaluated in context with the more than 20 years of historical water level data collected prior to operation of the well field. Appendix 3-1 includes updated historical hydrographs from eight (8) monitoring wells in Douglas County (MW90-4, MW90-5, MW90-6, MW90-7, MW90-12, MW90-13, MW94-1, and MW94-2) and six (6) monitoring wells in Saunders County (MW90-10, MW94-3, MW94-4, MW94-5, MW94-6, and MW94-7). Appendix 3-2 contains updated hydrographs from several monitoring wells (listed in Section 3.2.1 below) in Douglas and Saunders Counties, which include water level data beginning in 2007 or 2008. The updated hydrographs presented in Appendix 3-1 and Appendix 3-2 includes water level data through the end of the current NOPGR reporting period (September 2017).

The objective of the analysis presented in the NOPGR is to use the hydrologic data and analyses presented in this section to evaluate potential impacts to the FNOP contaminant plumes and hydraulic containment system which could occur as a result of well field pumping. Because the FNOP contaminant plumes and hydraulic containment system are located in Saunders County, and the Platte River forms a hydraulic divide between Saunders and Douglas Counties, only hydrologic data from Saunders County were incorporated into the analysis of well field impact. Data collected from the Douglas County side of the well field have been included in the NOPGR to evaluate the overall performance of the groundwater model. However, these data are not relevant to issues related to the FNOP site.

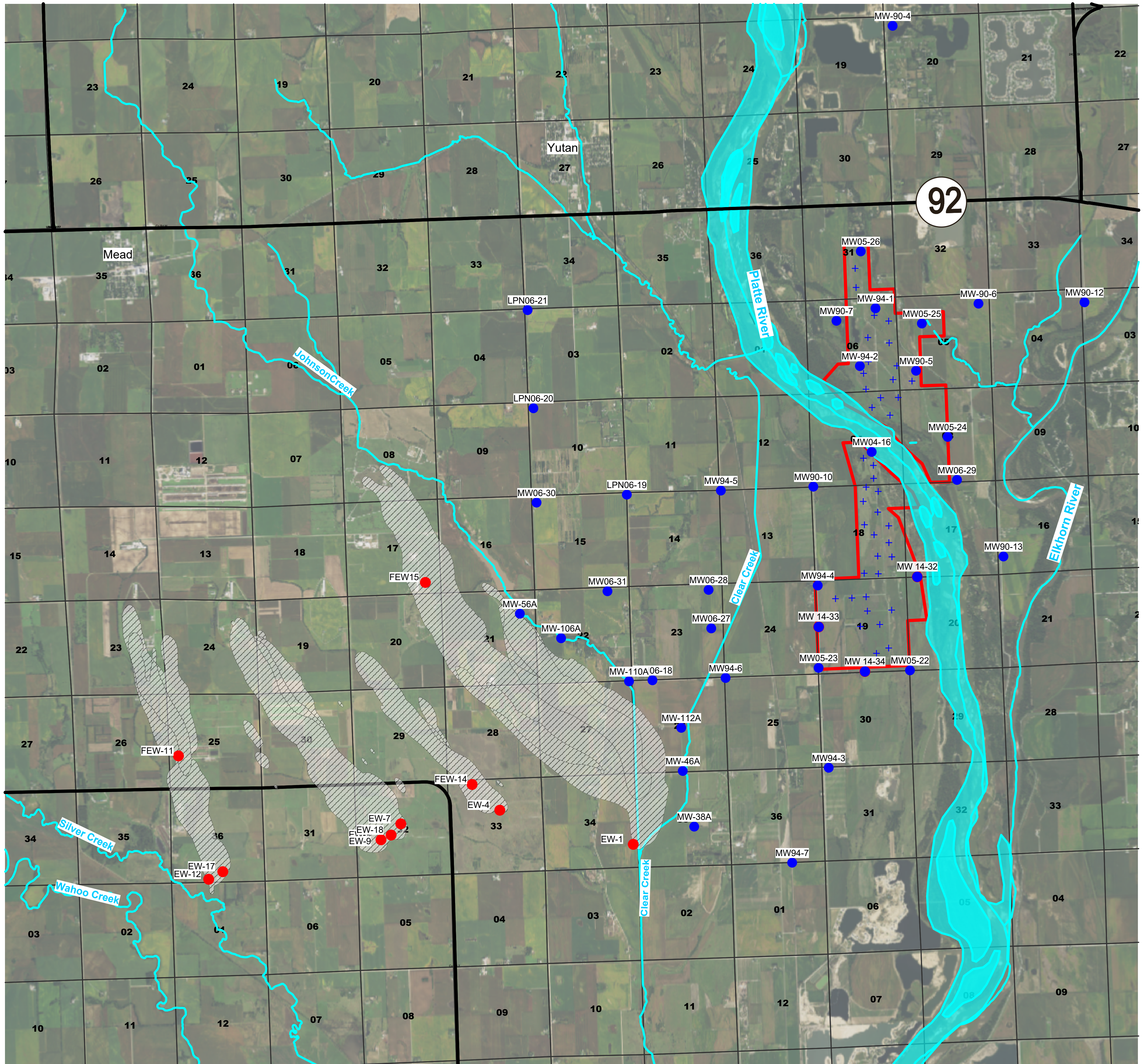


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Figure 3-1
Groundwater Monitoring Network

LEGEND:

MW94-5 — Transducer Equipped Monitoring Well

+ — Platte West Well Field Water Supply Well

FNOP Containment/Focused Extraction Well (Operating During 2016/2017)

FNOP Site Combined TCE and RDX Plumes

MAP SCALE (feet)

0 3000 6000

1 inch = 6,000 feet

3.1 New Hydrologic Data

Water level measurements were collected and recorded at all wells located in the monitoring network that was developed in cooperation with the USACE, as prescribed by Permit Condition 62a. The monitoring network is shown on Figure 3-1 and consists of 38 monitoring wells equipped with pressure transducers. The monitoring wells are operated and maintained by one of three organizations: Lower Platte North Natural Resource District (LPNNRD), MUD, or the USACE.

In addition to the 38 wells shown on Figure 3-1, transducer data were also available from MW90-9, which MUD resumed monitoring in 2016. This well is located in Douglas County, several miles northeast of the well field (Figure 3-2). Water level measurement was also resumed at well MW90-3, which is located south of Valley. This well is monitored by the USGS and the Papio Missouri NRD as part of a program to study aquifers levels. These data can be accessed on the groundwater section of the USGS website under site number 1757096202501. The following sections describe the hydrologic data that were utilized to evaluate the impact of the well field on the Platte Valley alluvial aquifer.

3.1.1 Hydrograph Interpretations

A water level hydrograph was plotted for each monitoring well equipped with a pressure transducer, and is included in Appendix 3-1 or Appendix 3-2. In Douglas County, these wells include: MW05-24, MW05-25, MW05-26, MW06-29, MW90-4, MW90-5, MW90-6, MW90-7, MW90-12, MW90-13, MW94-1, and MW94-2. In Saunders County, these wells include: MW04-16, MW05-22, MW05-23, MW06-27, MW06-28, MW06-30, MW06-31, MW14-32, MW14-33, MW14-34, MW90-10, MW94-3, MW94-4, MW94-5, MW94-6, and MW94-7. Water level monitoring equipment errors experienced during the 2017 NOPGR reporting period included:

- MW90-12 – A new data logging cycle did not start correctly in May; therefore, Summer and Fall data were not collected.
- MW90-4 – The data logger failed during Summer 2017.

No other significant equipment errors were observed during the 2017 water year in the wells that are maintained by MUD.

Hydrographs were also generated for wells located in Saunders County that are not operated and maintained by MUD. These include wells MW06-18, MW06-19, MW06-20, and MW06-21, which are operated and maintained by the LPNNRD, and wells MW-38A, MW-46A, MW-56A, MW-106A, MW-110A, and MW-112A which are maintained by the USACE. These wells are all part of the well field monitoring well network, shown on Figure 3-1.

Manual water level elevations for the USACE wells were obtained from the FNOP water level database, which is available online on the FNOP project website. All data provided to BMcD by MUD, USACE, and the LPNNRD as of December 30, 2017 have been used to develop the hydrographs presented in this section.

3.1.1.1 Response of Wells near Well Field

The updated hydrographs for the monitoring wells located less than one mile from the well field illustrate that, prior to the start of the 2017 NOPGR monitoring period (October 2016), groundwater levels near the well field had generally recovered from the low conditions observed in the Fall of 2013. This general recovery trend is evident in the hydrographs for MW90-10, MW94-3, MW94-4, MW04-16, MW05-22, MW05-23, MW90-5, MW94-1, and MW94-2. Relatively high well field pumping in the summer of 2017 contributed to a short term drop in water level elevations near the well filed, but aquifer levels did not approach the low conditions observed in 2013. Near the end of the Summer of 2017, water level elevations near the well field began to rebound in response to a decline in well field pumping and above normal precipitation. Climatic conditions which contributed to the water level recovery are discussed later in this section.

3.1.1.2 Response of Wells Over One Mile from Well Field

Monitoring wells located more than one mile from the boundary of the well field that are owned and operated by MUD include MW94-5, MW94-6, MW94-7, MW06-27 and MW06-28. The hydrographs developed for these wells illustrate that water level elevations approximately one mile from the well field had recovered (approximately) to pre-well field pumping levels (pre-February 2009) prior to the start of the 2017 irrigation season. This recovery trend in the groundwater levels at these four monitoring well sites was largely attributed to the absence of a sharp water level decline caused by a nearby irrigation well (an irrigation pumping signal) for several years. Irrigation pumping signals returned in these wells for the first time in several years during the summer of 2017.

The monitoring wells operated and maintained by the USACE and LPNNRD have historically shown impact from near-by irrigation pumping and have shown no signs of being impacted by well field operations. In most of these wells, pumping associated with the irrigation season causes the water level elevations to decline, followed by a period of water level recovery after the irrigation season is complete. Review of these hydrographs indicates that nearly all of the monitoring wells had experienced significant water level recovery since the sharp declines in water level elevation observed in the summer of 2012 through 2014. Prior to the start of the 2017 irrigation pumping season, water levels had recovered to pre-2012 drought conditions at most of these monitoring well sites.

The groundwater level fluctuation observed at these monitoring well sites are highly influenced by the presence or absence of seasonal irrigation pumping or climatic conditions and are not related to the operation of the well field. This statement is supported by the hydraulic monitoring data and groundwater modeling presented within this (and previous) NOPGR updates.

3.1.2 Potentiometric Surface Contour

Contours of the potentiometric surface of the Platte Valley alluvial aquifer and the Todd Valley aquifer were developed using data collected during the LPNNRD-coordinated water level monitoring event conducted at the end of March 2017. A potentiometric surface map is shown on Figure 3-2. Water level measurements are taken by the following organizations in an effort to better document the potentiometric surface within Saunders County:

- LPNNRD;
- MUD;
- CENWK; and
- USGS.

Approximately 190 monitoring wells were used to develop the potentiometric surface map of the study area, the locations of which are shown on Figure 3-2 along with the elevation of the measured water level. Previous NOPGR submittals included numerous potentiometric surface maps, including several developed before the well field was constructed, for comparison purposes. The magnitude and direction of the hydraulic gradient presented on Figure 3-2 continues to be very similar to previous potentiometric surface maps generated by others and as part of the previous NOPGR reports, including:

- Availability of Water in Eastern Saunders County, Nebraska (Souders, 1967);
- Configuration of the Water Table, 1995 (Nebraska Department of Natural Resources, 1995);
- Phase II Platte West Well Field Groundwater Modeling Study (Chatman and Associates, Inc., 2005);
- 2006 Groundwater Modeling Report Operable Unit No. 2 (URS, 2006); and
- Previous NOPGR studies.

The potentiometric surface of the Platte Valley and Todd Valley aquifers presented on Figure 3-2 illustrates that the well field continues to remain hydraulically cross-gradient of the FNOP site after eight years of continuous pumping from the MUD Saunders County wells. The pattern and shape of the potentiometric surface in the Todd Valley, where the majority of the FNOP site is located, has not changed due to the operation of the well field. Groundwater flow directions along the eastern perimeter of the FNOP site have not changed as a result of well field pumping. The March 2017 potentiometric surface is nearly identical to that developed for the March 2012, March 2013, March 2014, March 2015, and March 2016 water level events, with little to no change in the contour intervals near the MUD well field since pumping began in 2009.

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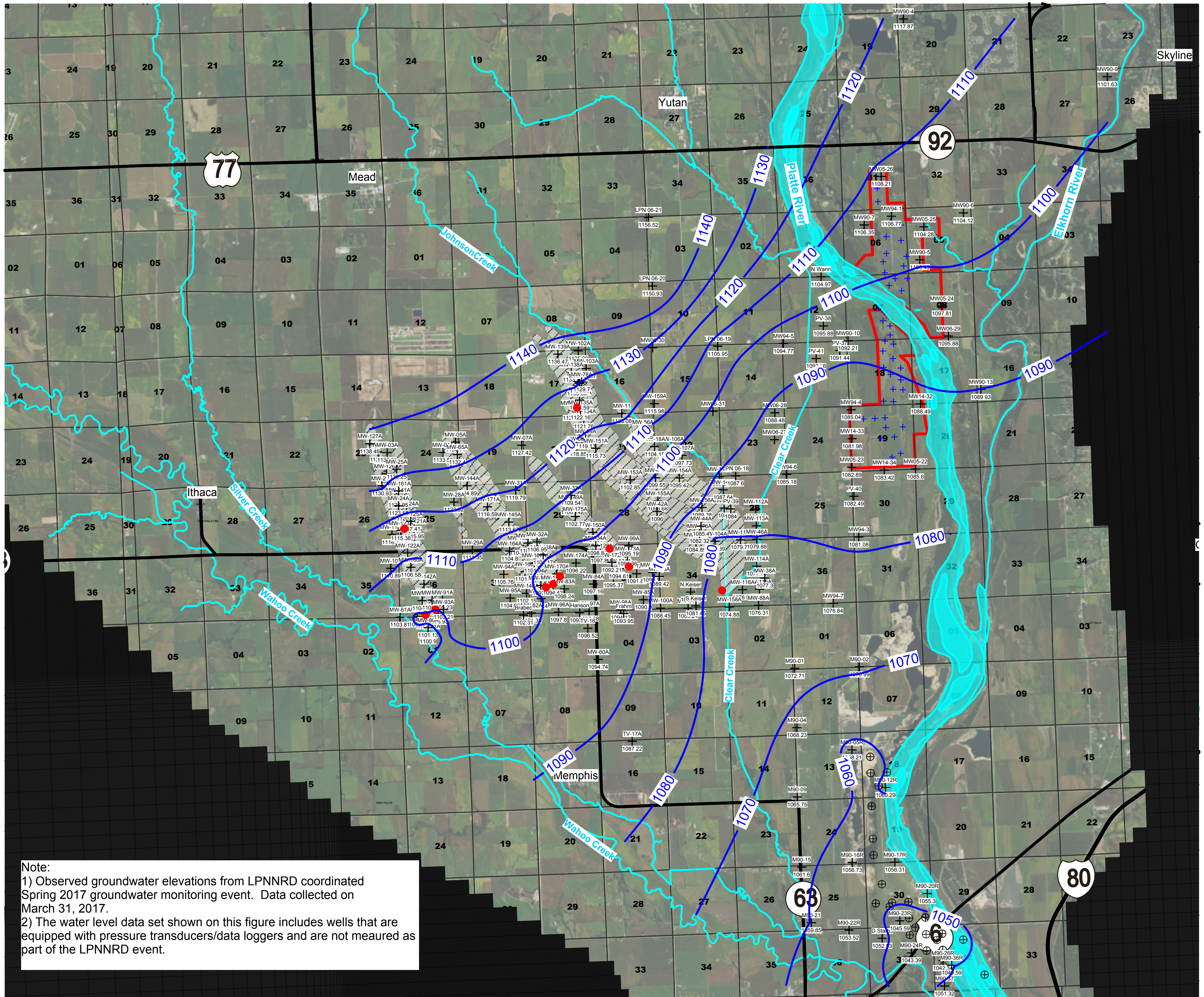
Figure 3-2
March 2017 Observed Potentiometric Surface (ft msl)



LEGEND:

- MW06-29 / 1095.88 — Observation Well with Measured Water Level Elevation in ft msl
- Interpreted Potentiometric Surface Elevation Contour (ft msl) Contour Interval = 10 feet
- FNOP Site Combined TCE and RDX Plumes

Pumping Wellfields Operating During March 2017 Water Level Event

- Platte West Well Field Boundary
- Platte West Well Field Well
- FNOP Containment/Focused Extraction Well (Operating During 2016/2017)
- Ashland City Well/Lincoln Well Field Well

MAP SCALE (feet)
0 4000 8000

N

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3.1.3 Well Field Contingency Plan Levels

A WFCP was developed by MUD in 2008 to address one of the Permit requirements for the well field. The objective of the WFCP was to use hydraulic data from the monitoring network to evaluate potential impact on the FNOP site from well filed pumping. Water quality monitoring is also included in the WFCP; however, the focus of the WFCP is monitoring groundwater elevation data and comparing that data to predicted water level changes resulting from well field pumping.

During the development of the 2012, 2013, and 2014 NOPGR reports, MUD noted impacts on groundwater elevations observed within the monitoring network resulting from the increased development of center pivot irrigation within the Platte River alluvial aquifer. The impact of this increased irrigation pumping within the WFCP monitoring network prompted MUD to revisit the hydraulic monitoring trigger levels developed in the original WFCP (Layne Christensen, 2008b). As a result, MUD developed a revised WFCP that shifts the focus of the water level monitoring network to wells that are located closer to the well field. The objective of the revised WFCP was to modify the existing hydraulic monitoring program in a way that reduced the impact from local irrigation. The revised protocol for monitoring water level elevations around the well field was approved by CENWO and CENWEK in June 2015. The 2015 NOPGR was the first NOPGR to use the voluntary trigger values developed in the revised WFCP.

Groundwater elevation hydrographs for the four existing Sentry (formerly Priority One) monitoring wells (MW90-10, MW94-4, MW05-22, and MW05-23) and the three newest Sentry monitoring wells (MW14-32, MW14-33, and MW14-34) are presented in Appendix 3-3. These hydrographs illustrate the historical groundwater elevations measured near the well field, along with each monitoring well's Tier I and Tier II trigger values. The groundwater elevations measured in the WFCP Sentry monitoring wells are well above than the Tier I or Tier II groundwater elevations established for each respective well, meaning neither the Tier I or Tier II levels were triggered in 2015 or 2017. This is likely due to a combination of climatic and water demand related factors; primarily, decreased well field pumping and decreased regional irrigation pumping resulting from an above average precipitation and streamflow year.

3.2 Climatic Conditions and Streamflow

During this NOPGR reporting period, eastern Nebraska continued its sustained recovery from the 2012 drought, as determined by the National Drought Mitigation Center (NDMC, 2015). Precipitation in 2017 was characterized as average, with below average precipitation at beginning of Summer and higher than average precipitation during the end of Summer. Streamflow conditions for the 2017 water year were characterized as normal by the USGS, with only a brief period of below normal streamflow in the Platte River (early Summer).

3.2.1 Streamflow

Streamflow conditions within the study area were evaluated using data posted and distributed by USGS National Water Information System (USGS, 2017). To evaluate the streamflow conditions of local water bodies near the well field, hydrologic data was obtained from the following USGS gaging stations:

- Platte River – at Leshara, and
- Elkhorn River – at Waterloo.

Hydrographs for each of the listed USGS gauge sites are provided in Appendix 3-4. Streamflow conditions in the Platte River were normal to above normal throughout the majority of the 2017 water year, although streamflow declines were observed during May and June. Streamflow conditions rebounded in July and were normal to above normal for the remainder of the NOPGR reporting periods. Streamflow conditions in the Elkhorn River was above normal conditions throughout all of the 2017 water year, with high streamflow observed during the summer months of 2017. The normal to above normal streamflow conditions contributed to the sustained recovery from the 2012 drought.

3.2.1.1 Platte River

Using the USGS provisional data, the calculated mean flow for the 2017 water year for the stream gage on the Platte River near Leshara, NE (06796500) was over 5,211 cubic feet per second (cfs). According to the USGS flow duration curve for this station, this flow is significantly higher than the fifty percent exceedance flow of 4,420 cfs over the period of record (water years 1994 to 2015). The stream flow observed in 2017 is significantly higher than the median stream flow observed in the drought years of 2012 and 2013, which was 3,407 and 3,301 cfs, respectively (USGS water data report 2013). As shown on Figure 3-3, streamflow conditions for the Platte River during the 2017 water year can generally be characterized as normal.

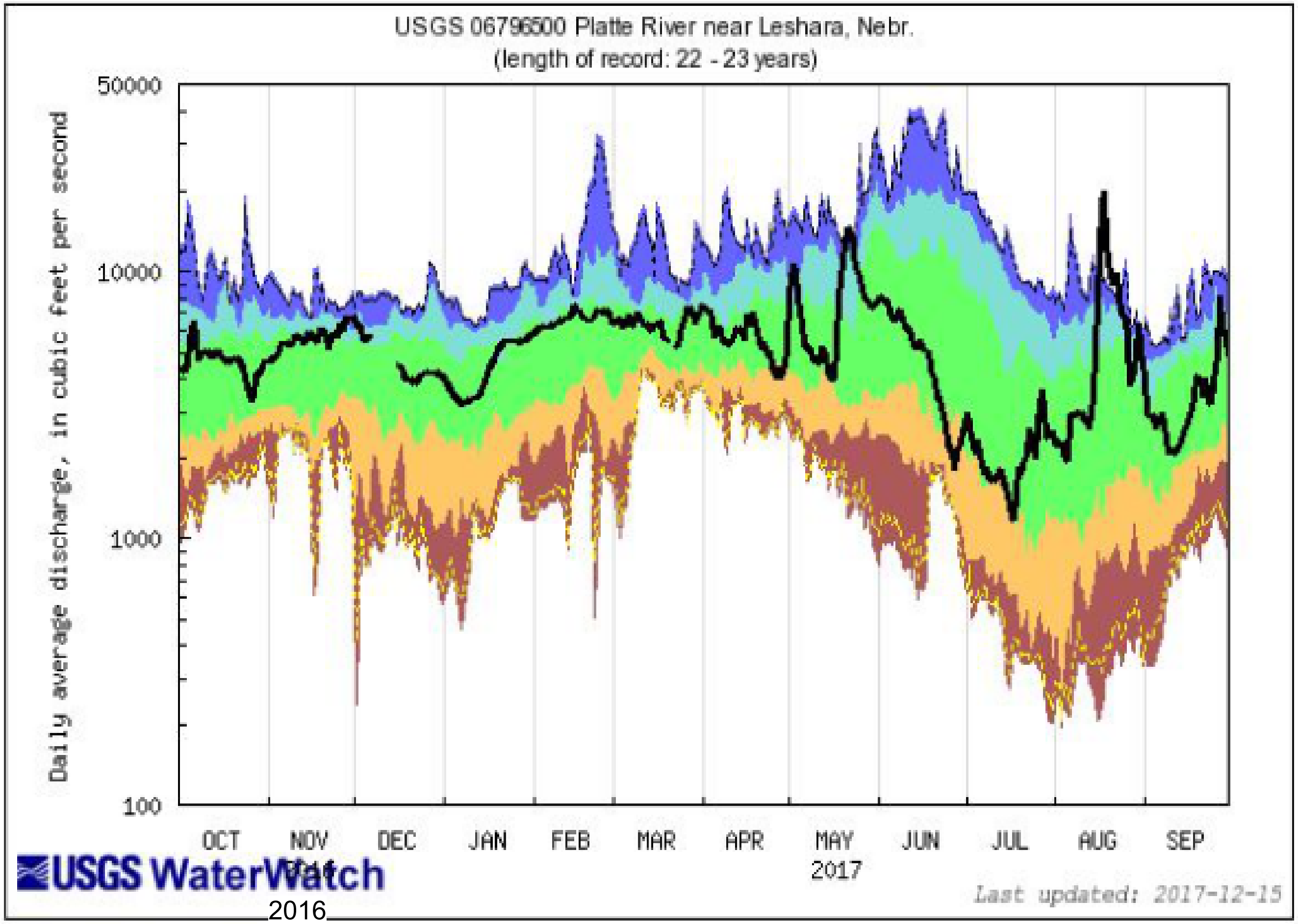
3.2.1.2 Elkhorn River

The mean flow for the 2017 water year for the USGS gage on the Elkhorn River at Waterloo (06800500) was 2,463 cfs. This flow is higher than the 50 percent exceedance flow of 806 cfs over the period of record (water year 1928 to 2015) according to the USGS flow duration curve for this station. Stream flow conditions for the Elkhorn River during the 2017 water year can be characterized as above normal to much above normal during the majority of the year (Figure 3-4).

3.2.2 Precipitation and Temperature

Additional hydrological data collected during the 2017 NOPGR included monthly total precipitation and monthly average ambient air temperature. The monthly total precipitation and monthly average ambient air temperature were both obtained from the weather station at Fremont Municipal Airport in Fremont, Nebraska. The 2017 precipitation and temperature data and the historical average monthly precipitation and temperature have been graphed over time (Figure 3-5). As shown, the precipitation in 2017 was characterized as average, with below average precipitation at beginning of Summer and higher than average precipitation during the end of Summer. Average ambient air temperature in 2017 fell within the expected monthly high and low temperature range, based on historical averages.

Observed Streamflow 2017 Water Year



Explanation - Percentile classes					
lowest-10th percentile	10-24	25-75	76-90	90th percentile -highest	Flow
Much below normal	Below normal	Normal	Above normal	Much above normal	

Note:
Source of graph is:
http://waterwatch.usgs.gov/

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Figure 3-3
Streamflow Duration Hydrograph
for the Platte River at Leshara

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Observed Streamflow 2017 Water Year

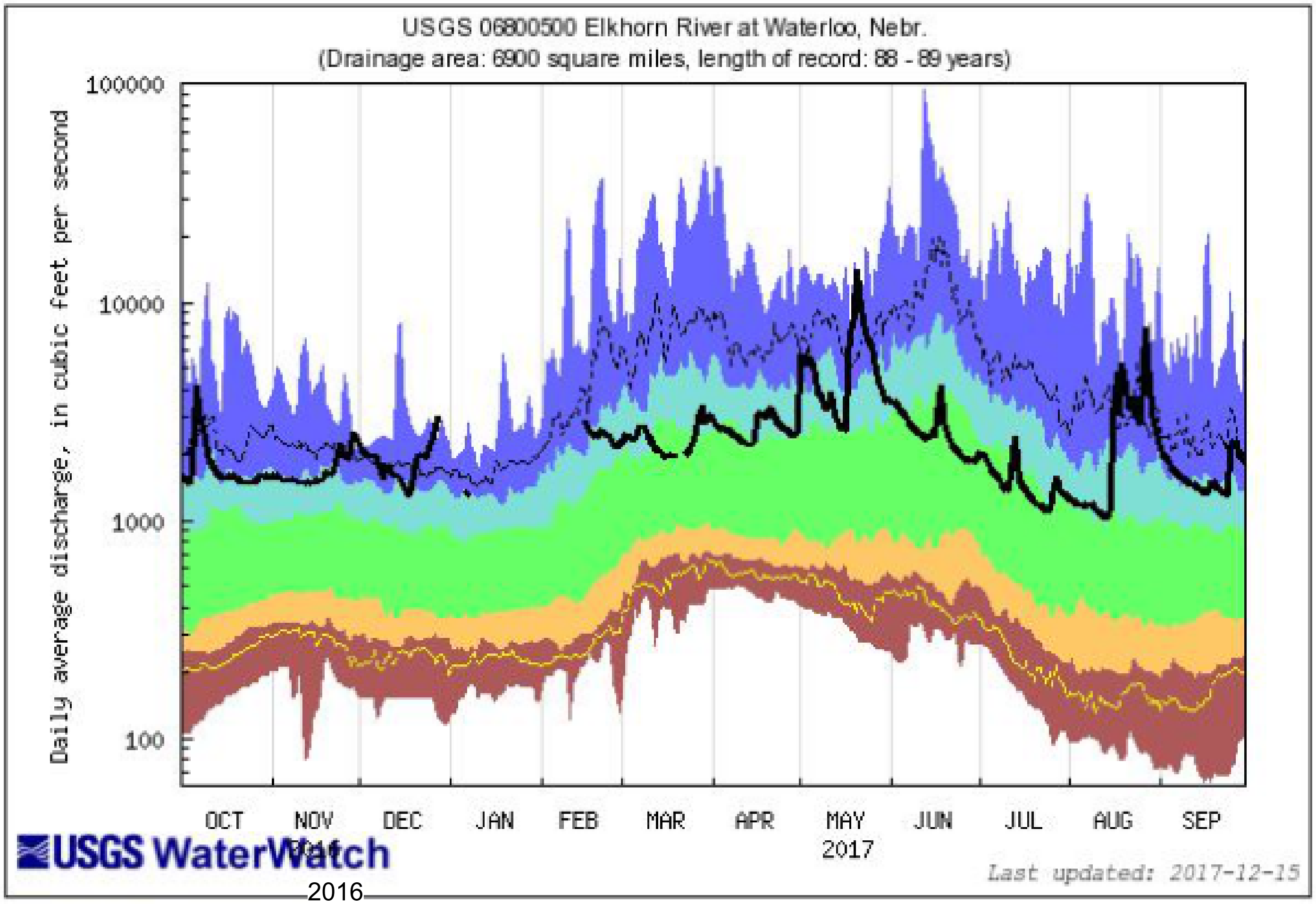

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Figure 3-4
Streamflo Duration Hydrograph for the Elkhorn River at Waterloo

Explanation - Percentile classes					
lowest-10th percentile	10-24	25-75	76-90	90th percentile -highest	Flow
Much below normal	Below normal	Normal	Above normal	Much above normal	

Note:
Source of graph is:
http://waterwatch.usgs.gov/

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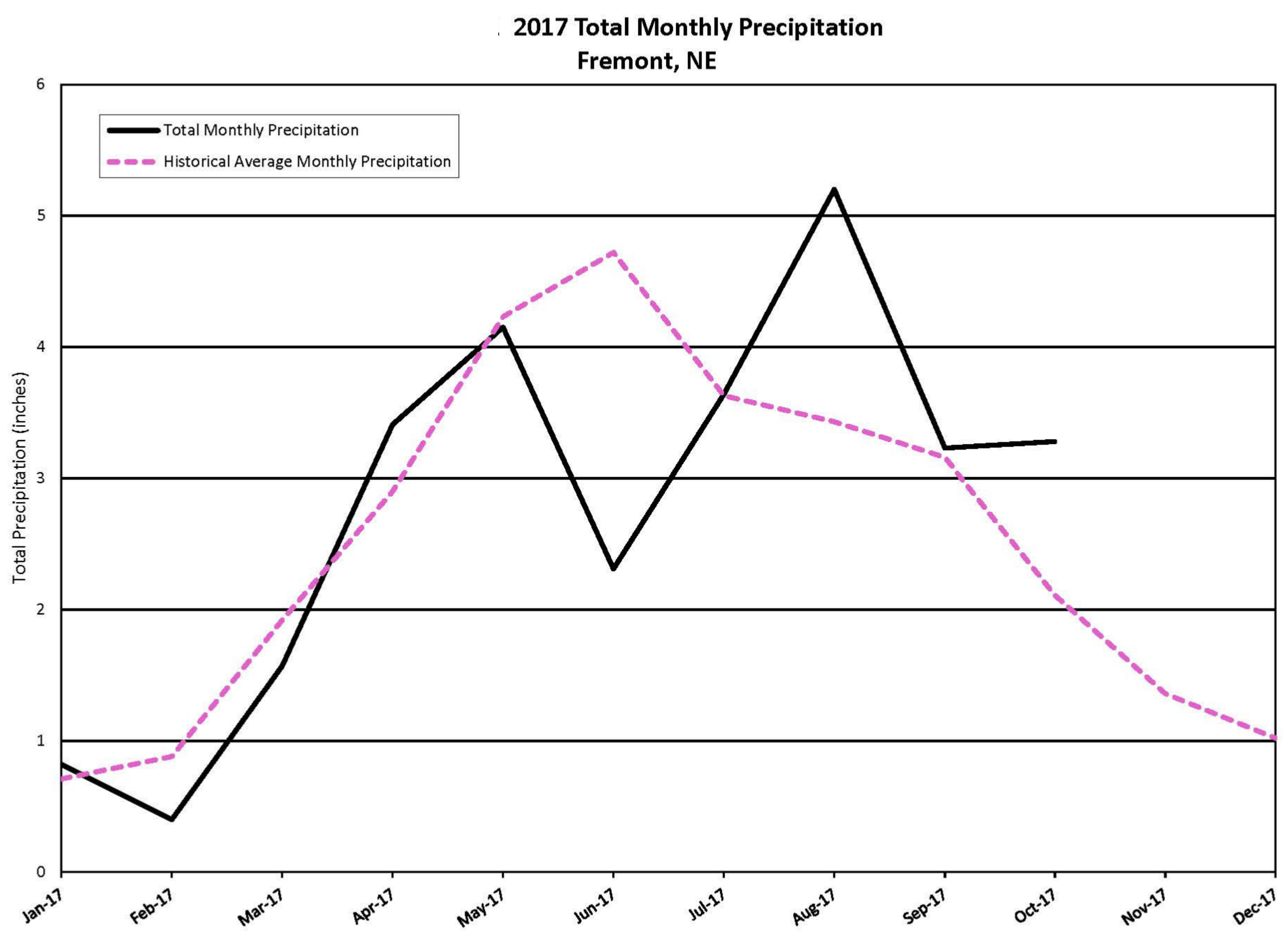
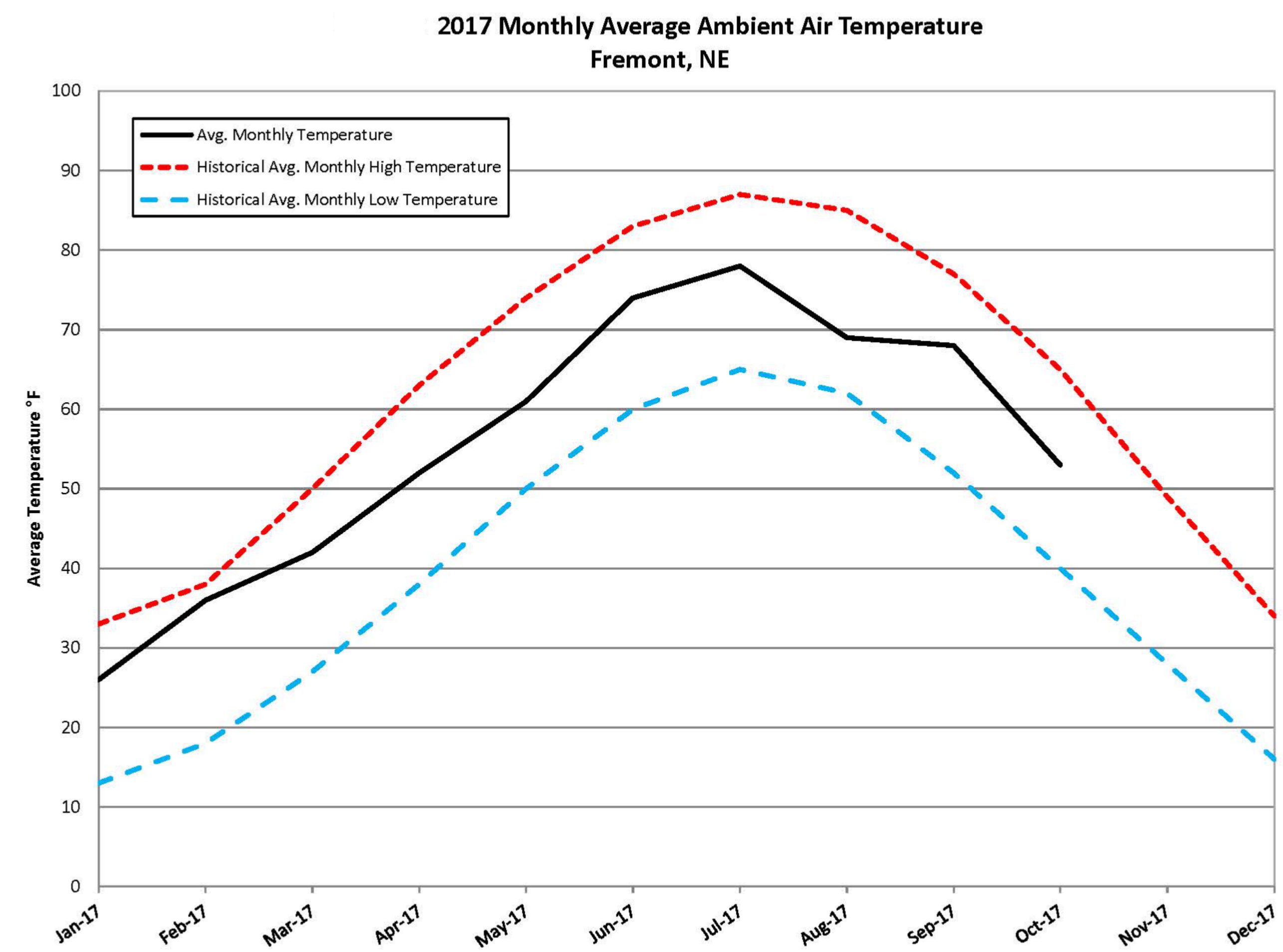
Figure 3-5
Climatic Data Near Well Field

Monthly Precipitation



Monthly Temperature



Note:
The Temperature and Precipitation Data Shown Were Collected from a Weather Station at the Fremont Municipal Airport in Fremont, Nebraska.

4.0 WATER QUALITY DATA ANALYSIS

The following section presents an analysis of the groundwater quality data collected as part of the monitoring program associated with the operation of the well field. The groundwater quality data collected includes pre- and post-well field startup data and consists of groundwater samples collected from wells that are part of the monitoring network that was developed in coordination with the USACE. The objective of the analysis presented in this NOPGR is to evaluate the potential impact of well field operations on the travel path of the FNOP contaminant plumes and the remediation efforts at the FNOP site.

4.1 Baseline FNOP Plume

A total of seven chemicals were assigned cleanup goals for the FNOP site by the United States Environmental Protection Agency (USEPA) in the Record of Decision (ROD) document. Three of these chemicals are classified as volatile organic compounds (VOCs) and the other four chemicals are classified as explosives. Trichloroethylene (TCE) is the most commonly detected VOC at the site and is used as an indicator for VOCs at the site. Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) is the most commonly detected explosive compound in groundwater at the FNOP site and is used as an indicator for explosives in groundwater at the site. Site-specific cleanup goals and details on the use of RDX and TCE as indicator compounds to define the extent of groundwater contamination at the FNOP site can be found in the 2009 Containment Evaluation (ECC, 2010).

As required by the Permit, MUD requested and obtained the most recent interpretation of the extent of the FNOP contaminant plumes. This interpretation of the current understanding of the extent of the FNOP plumes, as provided by CENWK for 2017, is presented in Appendix 4-1. Email correspondence with the FNOP project manager confirmed that this interpretation was appropriate for use in the 2017 NOPGR.

4.1.1 Historical Water Quality Data

A groundwater quality monitoring program was initiated by MUD in 2005 to collect background and pre-well field startup groundwater chemistry data from wells located within MUD's groundwater monitoring network. These data are summarized in the following monitoring reports:

- 2005 Annual Groundwater Monitoring Report (MUD, 2006);
- 2006 Annual Groundwater Monitoring Report (MUD, 2007);
- 2007 Annual Groundwater Monitoring Report (MUD, 2008); and
- 2008 Annual Groundwater Monitoring Report (MUD, 2009).

The post-startup groundwater chemistry data collection program supplements the historical data collected by MUD since 2005 and was evaluated in context with the data collected prior to the well field startup.

4.1.2 2017 NOPGR Water Quality Data

Water quality samples have been collected by MUD in select monitoring wells as part of each of the NOPGR efforts completed since the startup of the well field. The sampling events have typically included a Spring and Fall event for each calendar year. The wells that have been sampled as part of this program include MW06-18A and B, MW06-30A and B, and MW06-31A and B and the MW-39 well cluster consisting of MW-39A and MW-39D. The MW-39 well cluster was abandoned in 2012 after an evaluation of the FNOP monitoring well network by CENWK; therefore, this well cluster is no longer sampled by MUD. The results of these water quality samples are presented in the 2017 NOPGR reports.

Under an agreement with MUD, Olsson Associates (OA) conducted two rounds of groundwater sampling during this reporting period: May 2017 and September 2017. The wells sampled by OA include wells: MW06-18A and B, MW06-30A and B, and MW06-31 A and B. The locations of these wells are shown on Figure 3-1. The groundwater samples collected from the wells were analyzed for VOCs and for explosives. All laboratory analyses were performed by Test America, Inc. of Burlington, Vermont.

The results of both the May 2017 and September 2017 sampling events are summarized by OA in a Quality Control Summary Report (QCSR), which are included in Appendix 4-2. Complete sampling results are presented in Tables 3-3 and 3-4 of the QCSRs. A summary of the sampling events is presented below:

- May 2017 event - there were no unqualified VOC or explosive compounds detected above the reporting limits.
- September 2017 event. There were no unqualified VOC or explosive compounds detected above the reporting limits, except for tetrachloroethene (PCE) and 4-Nitrotoluene. PCE was detected at a concentration of 1.5 micrograms per liter (µg/L) in well MW06-30A, and 4-Nitrotoluene was detected at a concentration of 0.32 µg/L in well MW06-31A. PCE and 4-Nitrotoluene are not a Chemicals of Concern (COC) listed in the ROD for the FNOP site.

4.2 Laboratory Result Considerations

The monitoring wells discussed in Section Four have been sampled twice per year since 2008. No detections of 4-Nitrotoluene (confirmed through additional sampling) had been reported until the May 2016 sampling event. The May 2016 included detections of 4-Nitrotoluene in samples collected from wells MW06-31A and MW06-30A. Based on an evaluation of that QCSR, BMcD determined that those results were a false positive. The reasoning behind that determination was submitted to CENWK in a comment response letter dated (February 22, 2017).

The water quality sampling events performed in the 2016 and 2017 NOPGR have produced intermittent low-level detections of explosive compounds that have typically been flagged with data qualifies and are inconsistent from one sampling event to the next. A summary of information that should be considered while reviewing these water quality data is presented below.

Historical Data

- These monitoring wells have been sampled twice per year since 2008. No detections of 4-Nitrotoluene (confirmed through additional sampling) had been reported until the May 2016 sampling event.
- Four of the six wells sampled in May 2016 indicated a detection of 4-Nitrotoluene, yet none of the wells sampled in October 2016 had a detection of 4-Nitrotoluene.
- No detections of 4-Nitrotoluene were reported in the May 2017 sampling event, but detections were reported in a sample collected during the September 2017 event.

Laboratory Concerns (May 2016 Sampling Event)

- Samples AMW06-018-052016 and AMW06-218-052016 are a primary sample and field duplicate. While 4-Nitrotoluene was detected in the primary sample, it was non-detect in the duplicate sample. The lack of reproducibility in results calls into question the reported 4-nitrotoluene detections.
- All but one of the 4-Nitrotoluene detections were qualified "p" due to difficulties in reproducing results between the primary and confirmation gas chromatography column used for analysis. While the lower detected value was reported, this points to problems with reproducibility of results. Similar difficulties were noted in the batch quality control samples such as the laboratory control sample and matrix spike/matrix spike duplicate.

Laboratory Concerns (September 2017 Sampling Event)

In the September 2017 sampling event, 4-Nitrotoluene was detected above the laboratory reporting limit in well MW06-31A. Following a review of this the September 2017 QCSR, several laboratory concerns were identified. Those concerns are summarized below.

- Several explosive compounds other than 4-Nitrotoluene are reported as detections in Table 3-2 of the September 2017 QCSR. All results, other than 4-Nitrotoluene in MW06-31A, were reported with "J" qualifiers.
    - A "J" flag indicates a low-level detection between the method detection limit (MDL) and reporting limit (RL). The numerical result attached to detections at this low of a concentration should be considered estimated.
- With a few exceptions, detections of explosive compounds in the September 2017 sampling event were flagged "p", which indicates variability between results on the primary gas chromatography column and secondary chromatography column. The "p" flagged detections were confirmed but there is uncertainty in the concentration. This is further indicated by many of these detections also being flagged "J" as a low-level detection between the MDL and RL (see above).
- HMX and RDX were identified in the sample AMW06-030-092017 as flagged detections. The lab method blanks have contamination of HMX and RDX at concentrations similar to the field sample, indicating the possibility of a false positive. The method blank is used to evaluate contamination resulting from the sample preparation and analytical procedure. Method blank contamination is summarized below:
    - HMX = 0.0410 J µg/L and 0.0478 J µg/L
    - RDX = 0.0546 J µg/L and 0.0559 J µg/L

4.3 2017 Water Quality Summary

The September 2017 water quality sampling event indicated several low-level detections of explosive compounds that were all flagged with data qualifies and a detection of PCE, which is not a compound that is not associated with the FNOP site. The method blanks for the sample collected from MW06-30A contained detections of HMX and RDX at concentrations similar to what was reported in the sample, indicating these results are questionable and should be considered false positives. The results of the 2017 sampling events continued a recent pattern of intermittent low-level detections for explosive compounds that, with few exceptions, have been flagged with data qualifies and are inconsistent from one sampling event to the next.

The FNOP indicator compounds or contaminants of concern (COCs), TCE and RDX, were not detected above their reporting limit in any of the samples collected during either sampling event completed in 2017. Additionally, none of the other compounds assigned a cleanup goal in the ROD were detected above their reporting limit during either 2017 sampling event.

5.0 GROUNDWATER MODEL SIMULATIONS

As discussed in Section One, a groundwater flow model was developed to help predict the impact of the Platte West well field once it began operating. The model updates performed as part of the 2017 NOPGR incorporate the well field pumping and hydrologic data presented in Sections Two and Three of this report to evaluate the impact of well field operations on the potentiometric surface of the Platte Valley and Todd Valley aquifers.

5.1 Model Period Structure

The accuracy of the groundwater model was demonstrated in the 2009 through 2013 NOPGR modeling evaluations, which were developed as model post audits and were performed under transient conditions. In 2014, the NOPGR groundwater modeling evaluation was modified to simulate steady state conditions. This change was made because well field pumping has remained fairly consistent from year to year, and the cone of depression generated from well field pumping was relatively stable. The average annual total well field pumping rate as summarized below in Table 5-1.

Table 5-1: Average Annual Total Well Field Pumping by USGS Water Year

Water Year	Average Annual Pumping (mgd)
2009*	35.1
2010	32.4
2011	37.2
2012	35.4
2013	33.8
2014	31.5
2015	27.2
2016	28.5
2017	35.9

*February 2009 through September 2009 only

As a result of the relatively consistent pumping rate, the drawdown induced by pumping from the well field has stabilized at most of the monitoring well sites located near the well field and is approaching a near steady state condition. For this report, near steady state is described as a condition where the water level (or drawdown) induced by the initial well field pumping has stabilized, and water level changes are now occurring within a bracketed range of water level elevations that were previously observed at the specific monitoring well. This near steady state condition indicates that long term water level decline is not occurring. The hydrographs presented in Section 3.2.1.1confirm this near steady condition.

5.2 Steady State Evaluation

BMcD updated the groundwater model to include the 2017 NOPGR average pumping rate for each production well, and then ran the model at steady state conditions to estimate the drawdown that was induced by well field pumping during this reporting period. The following procedure was used to update the steady state model:

1. Revised the pumping rate for each MUD production well to reflect the 2017 NOPGR reporting period average pumping rate for that well.
2. Input the 2017 average pumping rate for the NOPGR containment wells and focused extraction wells.
3. Ran the model assuming steady state conditions.
4. Extracted the model predicted drawdown and compared to historical model predictions.

No changes were made to the model parameterization of the steady state model other than what is described above. The Phase II steady state model was developed assuming normal streamflow (and steady) conditions in the Platte River, which at the development of that model was a streamflow of approximately 4,600 cfs at the Leshara gage.

5.2.1 Steady State Model Results

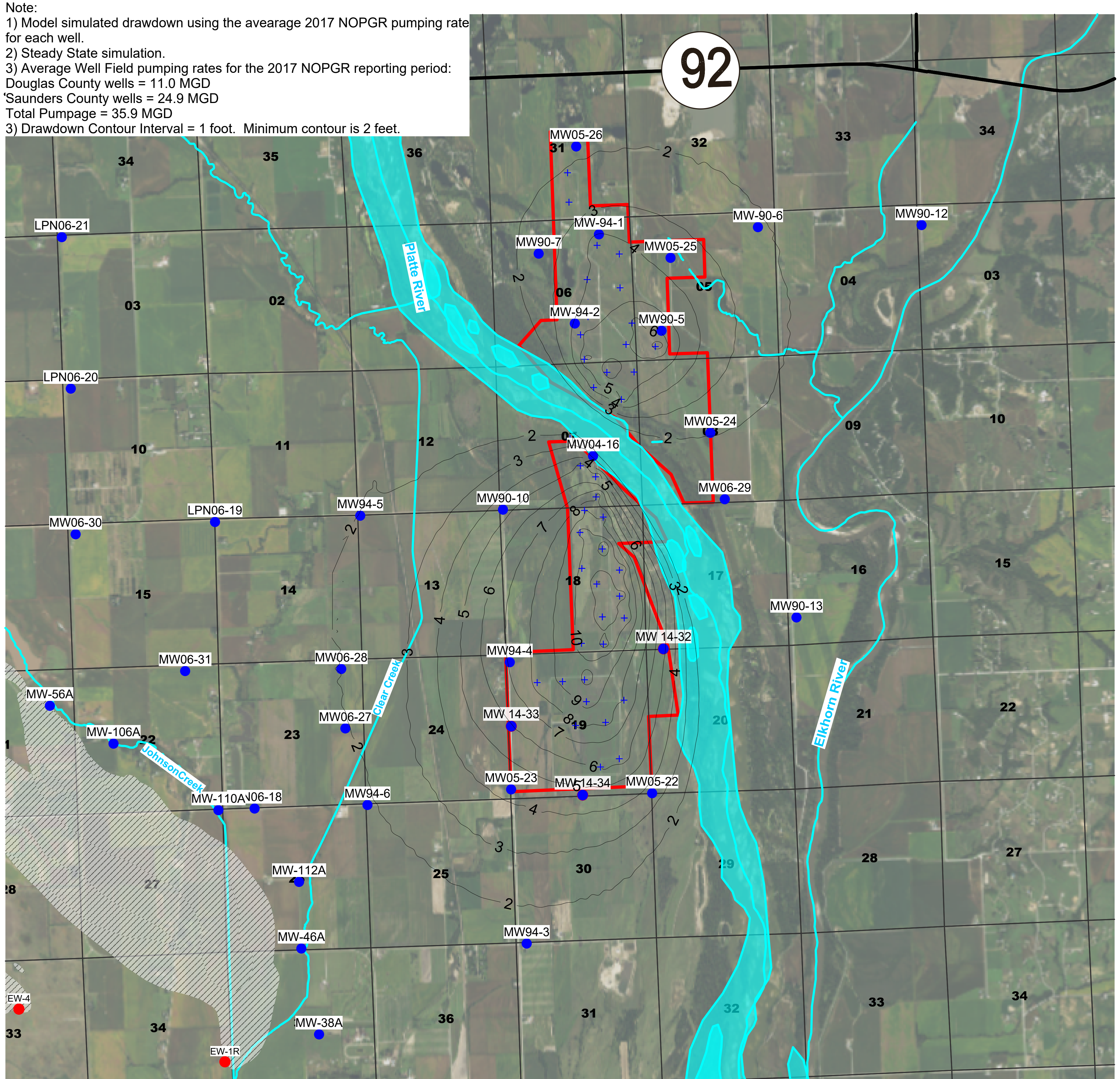
Figure 5-1 presents the average aquifer drawdown that resulted from operating the well field during the 2017 water year. The model predictions indicate appreciable drawdown occurring in wells that are located within one (1) mile of the well field, and then decreasing drawdown with increasing distance from the well field. The cone of depression presented in Figure 5-1 is consistent with previous modeling and smaller than the cone of depression estimated for the maximum permitted operating conditions. The maximum operating condition simulations were originally presented in the Phase II steady state model (CAI, 2005). For those simulations, the total well field pumping rate was 52 mgd and included 33 mgd of pumping from the Saunders County wells. During the 2017 water year, the Saunders County wells were operated at 24.9 mgd, which is approximately 75 percent of the modeled flow rate used in the maximum design scenario.

5.3 Particle Tracking

NOPGR reports from 2009 through 2014 included a particle tracking simulation, performed using the MODPATH code, to illustrate the model-predicted travel path of hypothetical groundwater particles located along the perimeter of the FNOP contaminant plumes. The particle tracking simulation was performed using transient conditions for the full length of well field operations through the 2014 reporting period, and included the reported pumping from the FNOP wells and Platte West well field wells from October 2008 to September 2014. These simulations showed that operation of the well field did not alter the well-documented historical flow path of the contaminant plumes located on the eastern edge of the FNOP site.

Since the average 2017 NOPGR well field pumping rate (by USGS water year) is lower than the maximum average annual pumping rate observed to date (2011), a particle tracking simulation was not performed as part of the 2017 NOPGR. Particle tracking will be revisited in future NOPGR updates if there is a substantial increase in well field pumping relative to the peak year pumping that was experienced in 2011.

Note:
1) Model simulated drawdown using the avearage 2017 NOPGR pumping rate for each well.
2) Steady State simulation.
3) Average Well Field pumping rates for the 2017 NOPGR reporting period:
Douglas County wells = 11.0 MGD
'Saunders County wells = 24.9 MGD
Total Pumpage = 35.9 MGD
3) Drawdown Contour Interval = 1 foot. Minimum contour is 2 feet.



METROPOLITAN
UTILITIES DISTRICT

Platte West Well Field
Nebraska Ordnance Plant
Groundwater Report

Figure 5-1
Model Predicted Steady State Drawdown for NOPGR 2017 Reporting Period

LEGEND:

MW05-22 — Transducer Equipped Observation Well

Platte West Well Field Well

FNOP Containment/Focused Extraction Well (Operating During 2017)

FNOP Site Combined TCE and RDX Plumes

Model Predicted Drawdown (ft msl) Contour Interval is one foot.

MAP SCALE (feet)

0 4000 8000

N

BURNS & McDONNELL

5.4 Forecasted Operations

The intent of the forecast models was to simulate the response of the aquifer based on projected pumping rates from MUD and also based on projected climatic conditions. Actual well field pumping rates vary depending on water demand. As of the development of this report MUD anticipates operating the well field in a manner that is consistent with previous years.

NOPGR reports from 2009 through 2013 included a section for forecasted modeling simulations; however, forecast, modeling simulations were not included beginning with the 2014 NOPGR. The projected well field pumping rates for 2018 are less than the peak year pumping that was experienced in 2011. The five (5) years of operational data presented in the 2009 through 2014 NOPGRs provide real world data on the aquifer response to this type of pumping stress from the well field and developing forecast model simulations would provide little to no benefit. Therefore, because no significant increase in well field pumping is anticipated, forecast model simulations were not developed for this NOPGR. Forecast modeling will be revisited in future NOPGR updates if there is a substantial increase projected in well field pumping.

6.0 SUMMARY AND CONCLUSIONS

The 2017 NOPGR is a continuation of the annual reporting structure developed for the previous NOGPRs (2008 through 2015). The objective of the NOPGR is to use available hydrogeologic data, both physical and chemical, as well as groundwater modeling to evaluate the impact of the operations of the well field on the aquifer and, more specifically, on the contaminant plumes and remediation efforts at the FNOP. The 2017 NOPGR included a summary of well field pumping data, an evaluation of water level measurements collected from the CENWK and MUD monitoring well networks, a summary of the semi-annual groundwater sampling results, and an update of the groundwater flow model. By including all of these components in the 2017 NOPGR, MUD has developed a document that meets the requirements of the Permit.

6.1 Climatic Conditions and Well Field Pumping

The average annual pumping rate for the 2017 USGS water year was 35.9 mgd. Water production for the 2017 USGS water year was below both the record high production year of 2011 (37.2 mgd for the 2011 USGS water year) and the regulated annual average flow of 52 mgd.

The 2017 NOPGR reporting period was characterized by climatic conditions that can be generalized as average. The precipitation in 2017 was characterized as average, with below average precipitation at beginning of Summer and higher than average precipitation during the end of Summer. Average ambient air temperature in 2017 fell within the expected monthly high and low temperature range, based on historical averages. Streamflow conditions in the Platte River were normal to above normal throughout the majority of the 2017 water year, although streamflow declines were observed during May and June. Streamflow conditions rebounded in July and were normal to above normal for the remainder of the NOPGR reporting periods. Streamflow conditions in the Elkhorn River was above normal conditions throughout all of the 2017 water year, with high streamflow observed during the summer months of 2017.

6.2 Groundwater Levels

Hydrographs for the monitoring wells located less than one mile from the well field illustrate that, prior to the start of the 2017 NOPGR monitoring period (October 2016), groundwater levels near the well field had generally recovered from the low conditions observed in the Fall of 2013. Relatively high well field pumping in the summer of 2017 contributed to a short term drop in water level elevations near the well filed, but aquifer levels did not approach the low conditions observed in 2013. Near the end of the Summer of 2017, water level elevations near the well field began to rebound in response to a decline in well field pumping and above normal precipitation. Climatic conditions which contributed to the continued water level recovery include higher than average precipitation and stream flow during the late Summer months of 2017.

The rebound in groundwater elevation from the low points observed in 2012 and 2013 was also observed in a majority of the monitoring wells that are located further than one mile from the well field and closer to the FNOP site. The general rebounding trend occurred even though the majority of these wells showed evidence of irrigation pumping during the early Summer months of 2017. Irrigation pumping signals returned in many of these monitoring wells for the first time in several years during the summer of 2017. The monitoring wells operated and maintained by the USACE and LPNNRD have historically shown impact from near-by irrigation pumping and have shown no signs of being impacted by well field operations. This statement is supported by the hydraulic monitoring data and groundwater modeling presented within this (and previous) NOPGR updates.

6.2.1 Potentiometric Surface

A potentiometric surface map was developed using approximately 190 monitoring wells which included data collected by CENWK, LPNNRD, USGS and MUD. The potentiometric surface of the Platte Valley and Todd Valley aquifers presented on Figure 3-2 illustrates that the well field remains hydraulically cross-gradient of the FNOP site. The March 2017 potentiometric surface is nearly identical to that developed for previous water level events conducted in March (see the March 2012 through March 2016 examples), with little to no change in the contour intervals near the MUD well field. From this analysis, it can be concluded that the groundwater flow directions along the eastern perimeter of the FNOP site have not changed as a result of well field pumping.

6.3 Groundwater Model Update

The groundwater flow model was updated to reflect the average pumping rate for the 2017 water year for each of the production wells in the well field. The model was run assuming steady state conditions to develop an estimate of the aquifer drawdown that resulted from pumping the well field during the 2017 NOPGR reporting period. The drawdown attributable to well field pumping in 2017 is consistent with previous modeling and smaller than the cone of depression estimated for the maximum permitted operating conditions, which was originally presented in the Phase II steady state model (CAI, 2005).

6.4 Groundwater Elevation and Chemical Sampling

Groundwater elevation and groundwater chemical sampling data collected from the MUD monitoring well network were evaluated and summarized as part of the 2017 NOPGR. The following presents a summary of those data.

6.4.1.1 Summary of Contingency Plan Water Levels

As noted in Section 3, a revised WFCP was developed in 2014 to address the increased irrigation pumping within the WFCP monitoring network. The revised WFCP established new hydraulic trigger elevations for the sentry monitoring wells located near the well field. The 2017 water level elevations were higher than the Tier I and Tier II trigger levels for all of the sentry monitoring wells that are part of the WFCP monitoring network, meaning neither Tier I or Tier II levels were triggered in 2017.

6.4.1.2 Summary of Chemical Sampling

Two rounds of groundwater sampling were conducted during this NOPGR reporting period, in May and September 2017. The FNOP indicator compounds or contaminants of concern (COCs), TCE and RDX, were not detected above their reporting limit in any of the samples collected during either sampling event. Additionally, none of the other compounds assigned a cleanup goal in the ROD were detected above their reporting limit during either 2017 sampling event.

6.5 Conclusions

The hydraulic data collected as part of this and previous NOPGR updates continues to support the conclusion that the groundwater flow direction in the Todd Valley aquifer has not changed due to the operation of the well field. The interpreted potentiometric surfaces from October 2008, March 2009, March 2010, March 2011, March 2012, August 2012, March 2013, March 2014, March 2015, March 2016 and March 2017 demonstrate that the well field continues to remain hydraulically up-gradient and cross-gradient of the FNOP site.

The groundwater modeling results presented in Figure 5-1 illustrate the drawdown which can be attributed to well field pumping during the 2017 NOPGR reporting period. This groundwater modeling, along with the well hydrographs, support the conclusion that the hydraulic influence of well field does not extend much beyond the location of wells MW94-3, MW94-5, MW94-6, MW06-27, and MW06-28. ranges from approximately one (1) to two (2) feet of drawdown at these monitoring well locations. These observations are also consistent with the steady state groundwater modeling predictions developed as part of the Phase II model (CAI, 2005), which was constructed as part of the well field design process.

Regular chemical groundwater monitoring has been performed at several key monitoring wells located between the well field and the FNOP site. To date, no detections of the FNOP COCs (TCE and RDX) have been observed in these wells that are above reporting limits or have been validated through confirmation sampling.

The groundwater model post audit presented in the 2009, 2010, and 2011 NOPGR and the current period analysis presented in the 2012, 2013, 2014, 2015, 2016 and 2017 NOPGR reports have shown that the groundwater modeling predictions presented in the *Phase II Platte West Well Field Groundwater Modeling Study* (Chatman and Associates, Inc., 2005) were reasonable approximations of how the aquifer would respond to the pumping from the Platte West well field. The hydraulic and chemical data collected to date, as well as the modeling analyses performed, support the conclusion that pumping from the Platte West well field is not adversely impacting the FNOP containment system efforts.

6.6 Future Updates

Future submittals of the NOPGR will remain consistent with the format of this submittal unless comments are provided which require a re-evaluation of the report format.

7.0 REFERENCES

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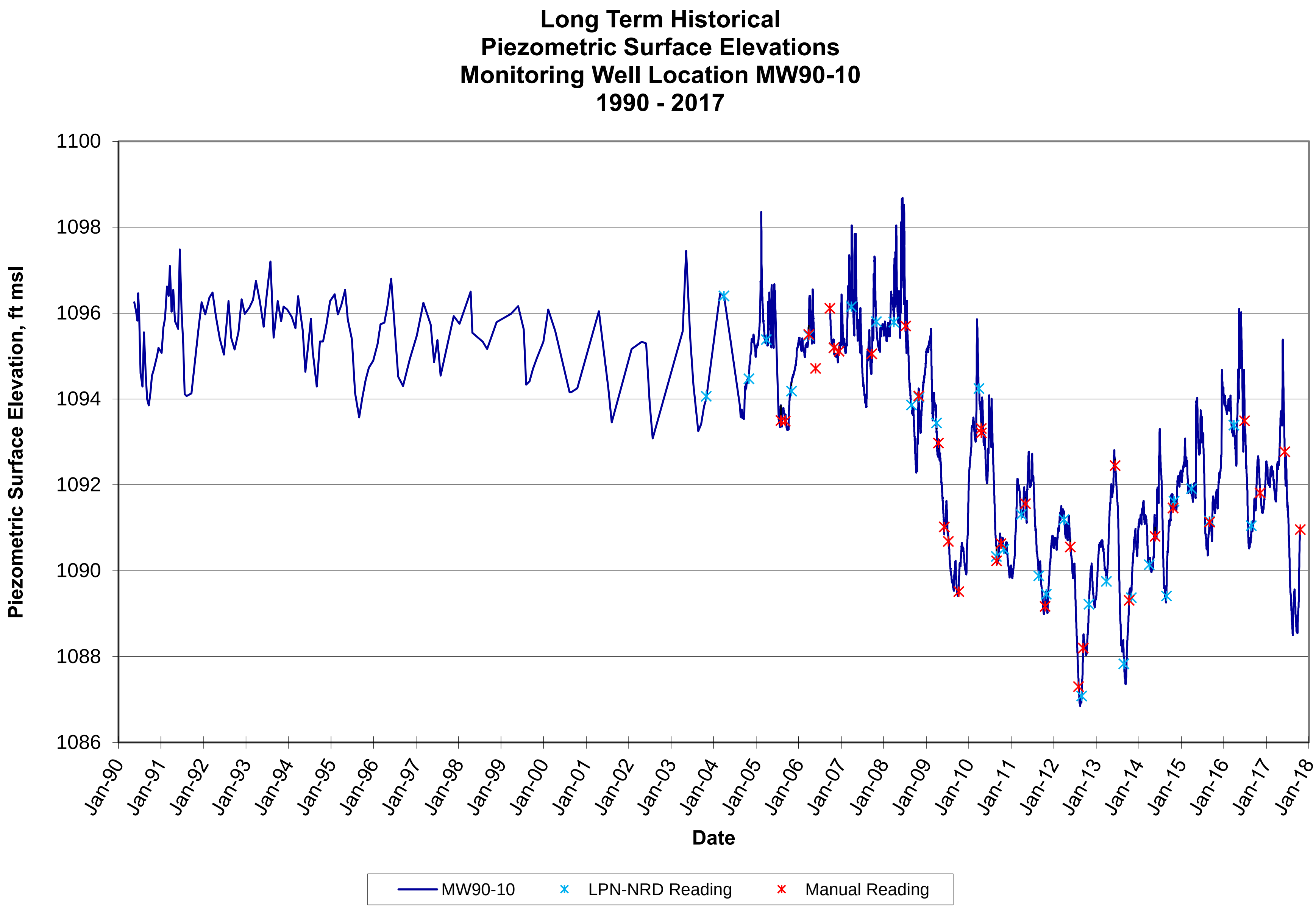
APPENDIX 3-1 - LONGTERM HISTORICAL MONITORING WELL HYDROGRAPHS

Saunders County Wells



Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location MW90-10
1990 - 2017
Piezometric Surface Elevation, ft msl
1100
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1096
1094
1092
1090
1088
1086
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
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Jan-08
Jan-09
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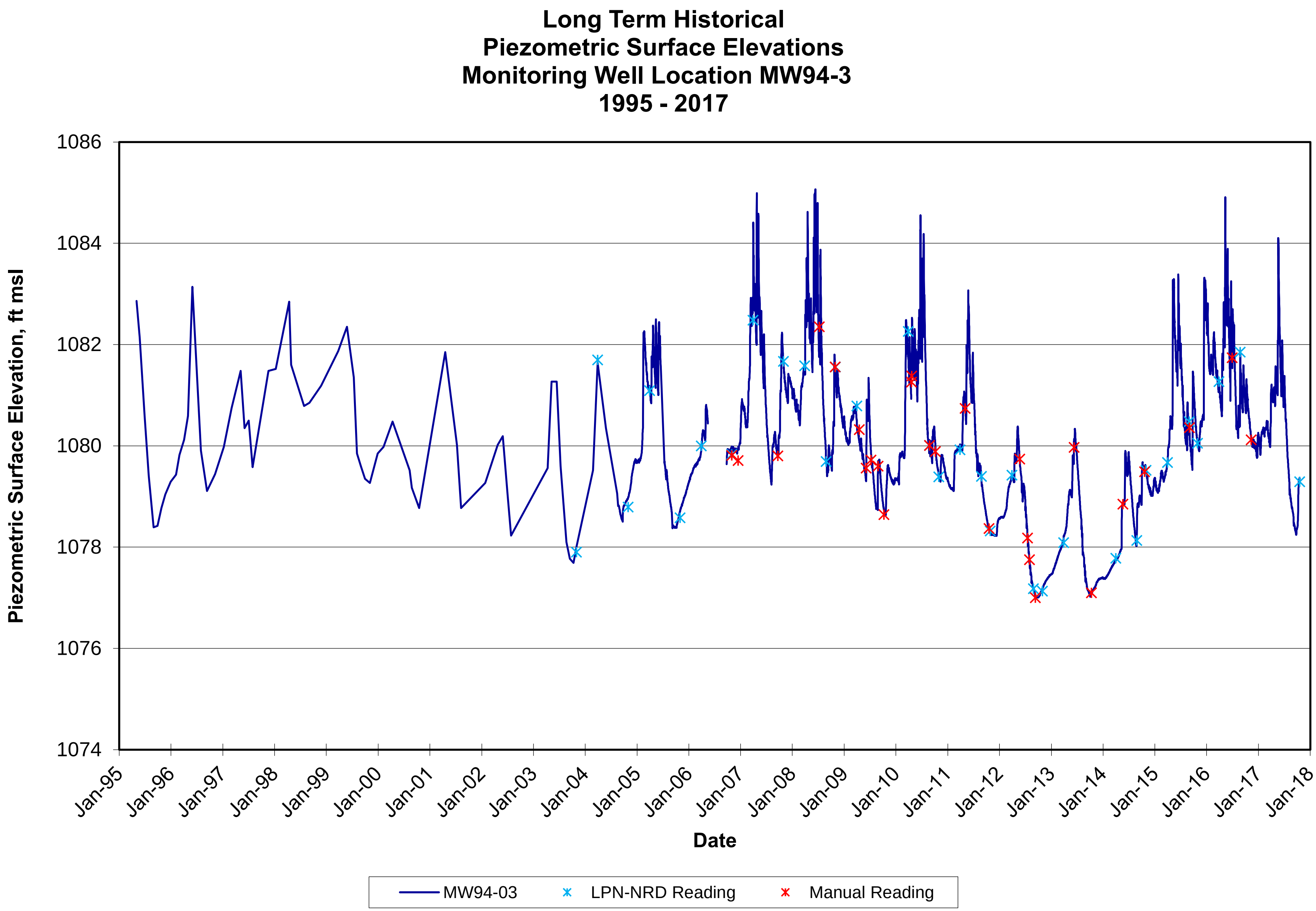
Date
MW90-10
LPN-NRD Reading
Manual Reading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Monitoring Well Location MW94-3
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Piezometric Surface Elevation, ft msl
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1082
1080
1078
1076
1074
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
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Jan-10
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Jan-16
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Jan-18
Date
MW94-03
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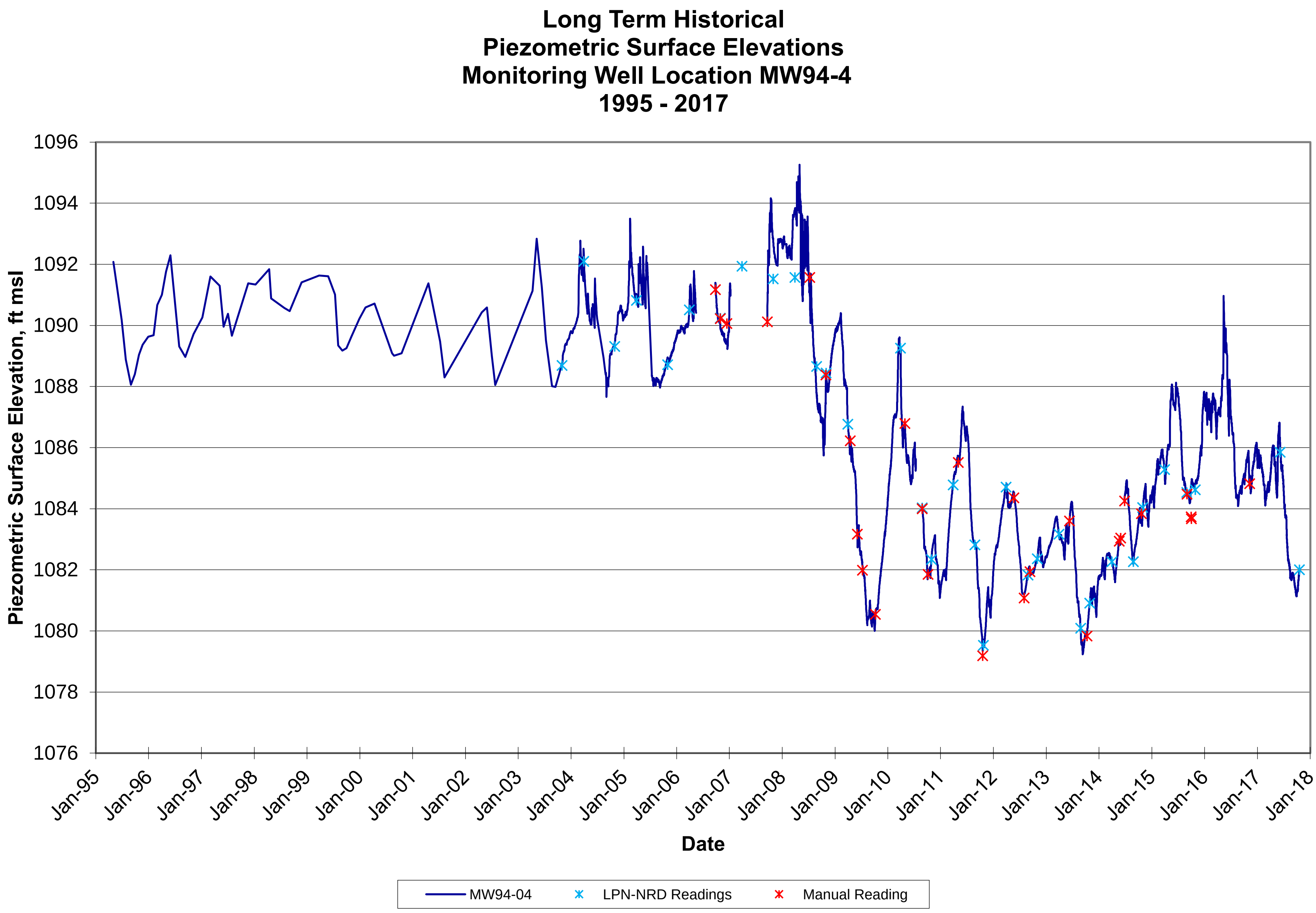
Manual Reading



Long Term Historical
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Monitoring Well Location MW94-4
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Piezometric Surface Elevation, ft msl
1096
1094
1092
1090
1088
1086
1084
1082
1080
1078
1076
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
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Jan-14
Jan-15
Jan-16
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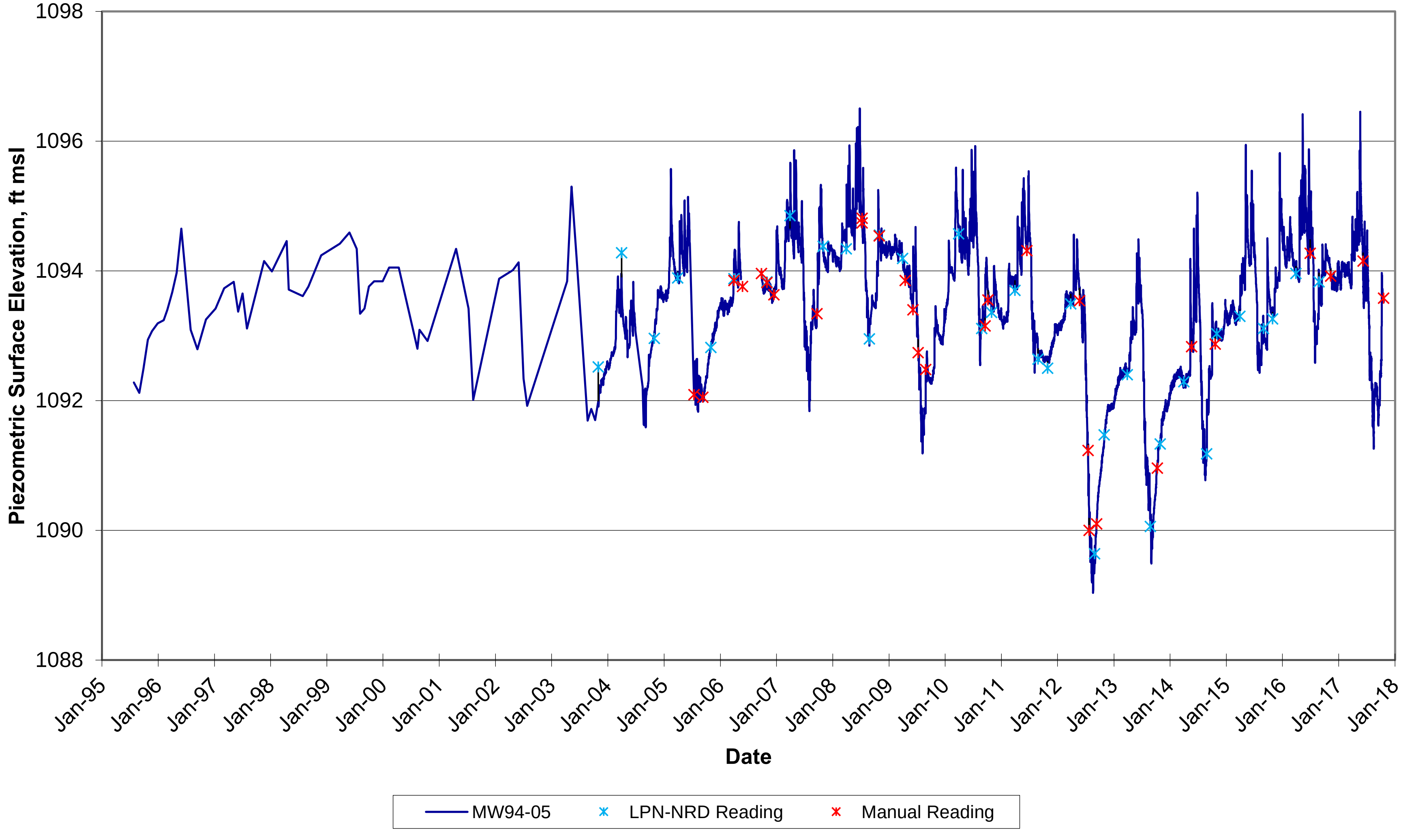
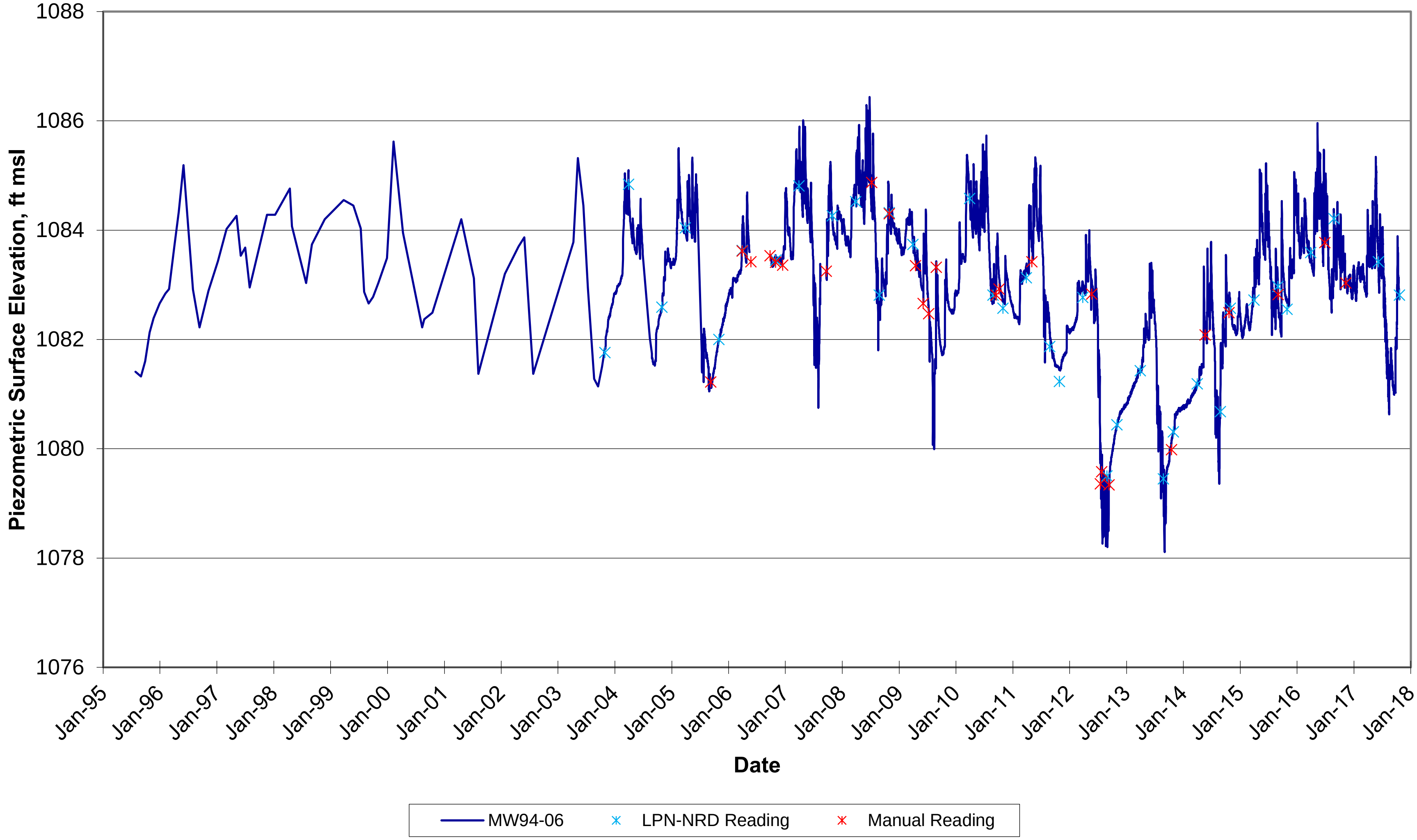
Date
MW94-04
LPN-NRD Readings
Manual Reading

Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location MW94-5
1995 - 2017



Long Term Historical Piezometric Surface Elevations Monitoring Well Location MW94-6 1995 - 2017



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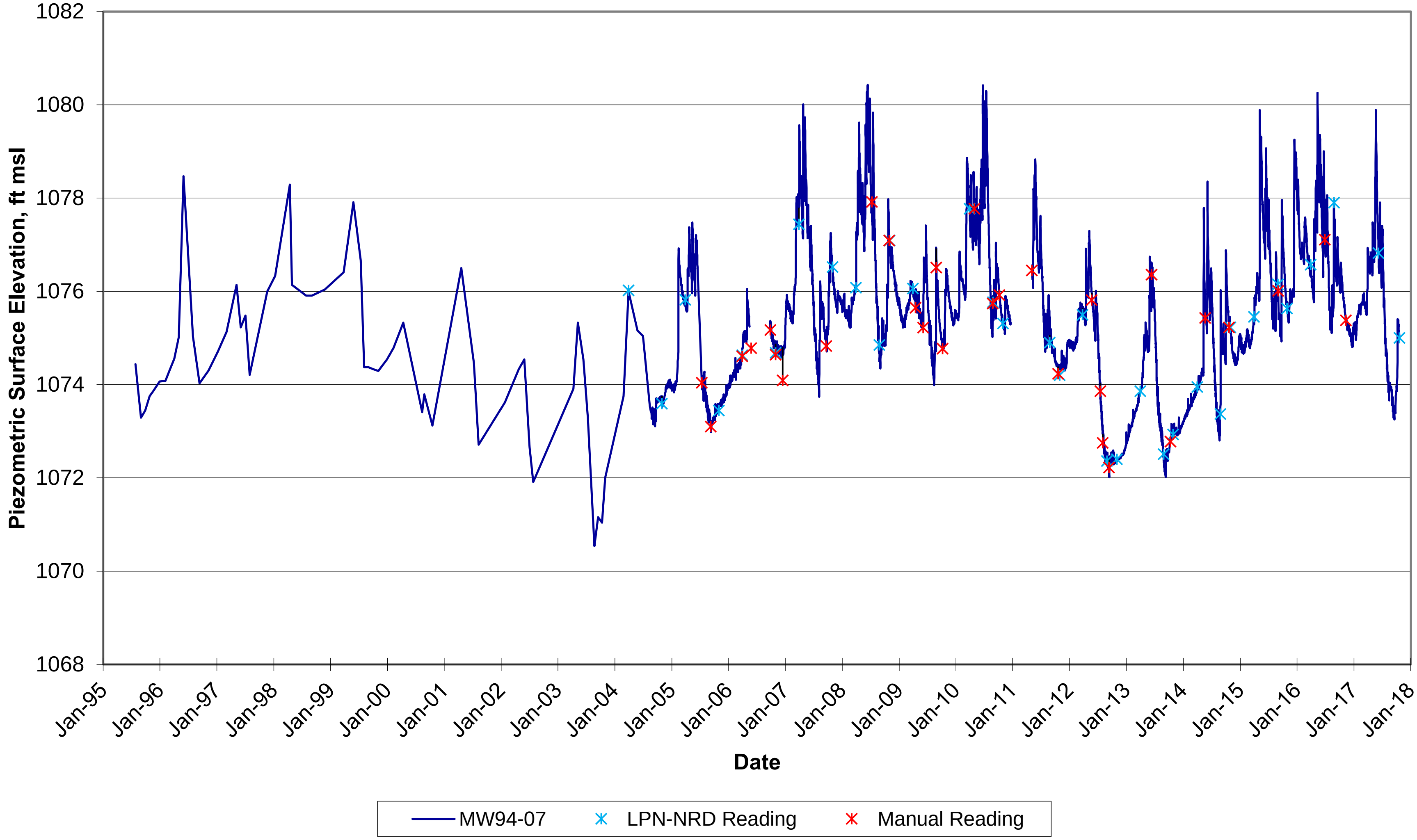
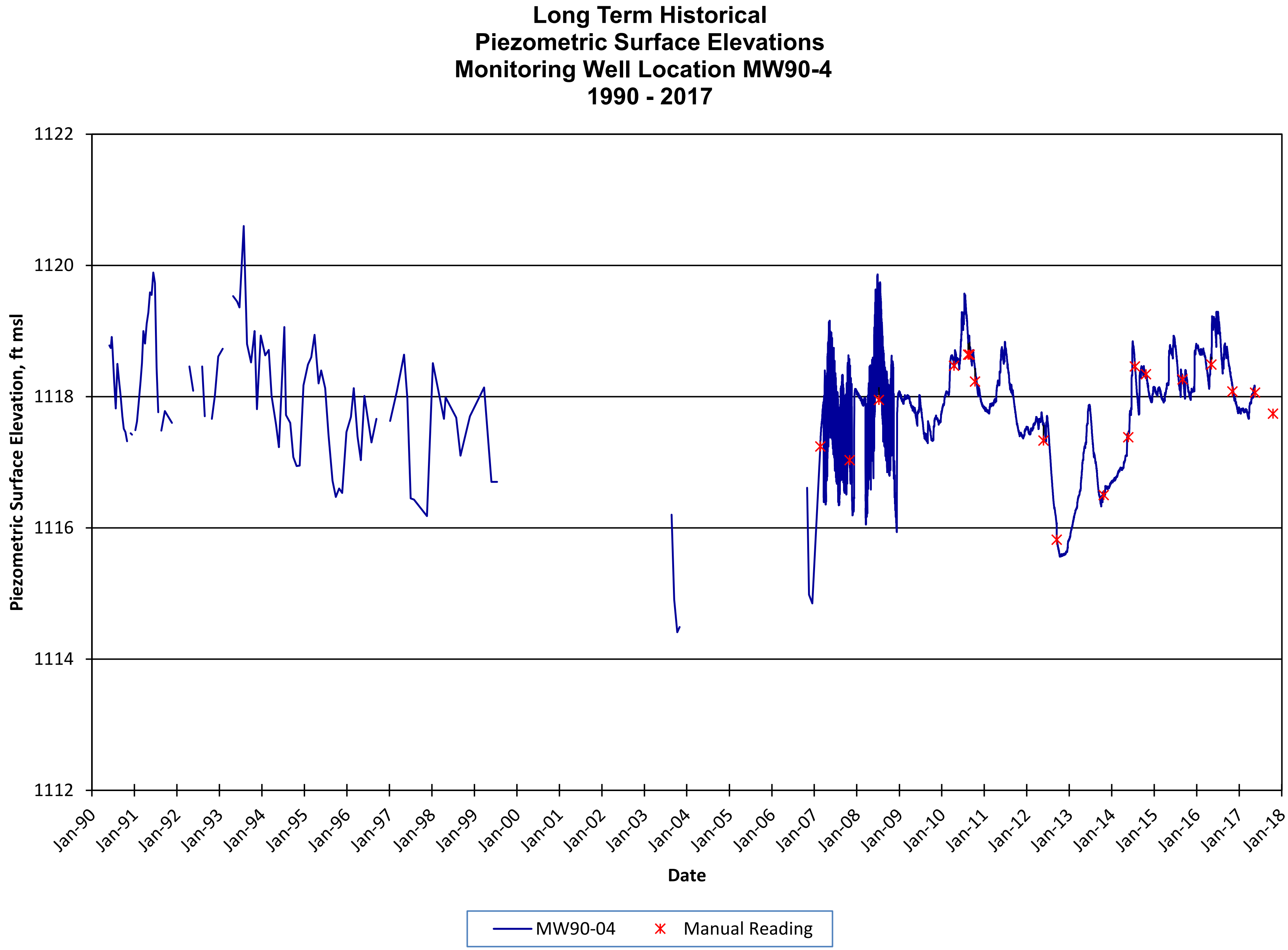


Douglas County Wells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Piezometric Surface Elevation, ft msl
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1116
1114
1112
Jan-90
Jan-91
Jan-92
Jan-93
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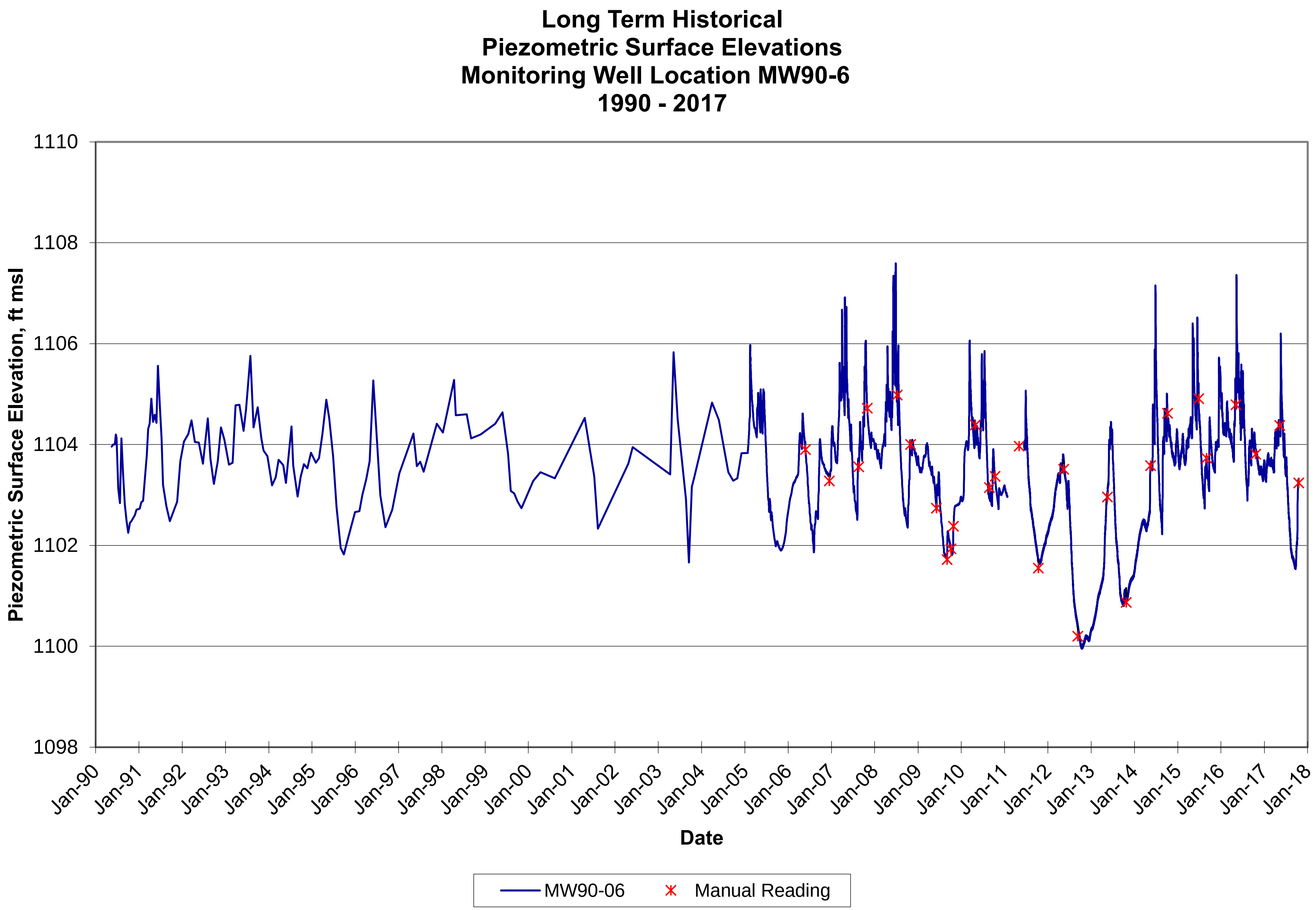

Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location MW90-6
1990 - 2017
Piezometric Surface Elevation, ft msl
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1108
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1104
1102
1100
1098
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
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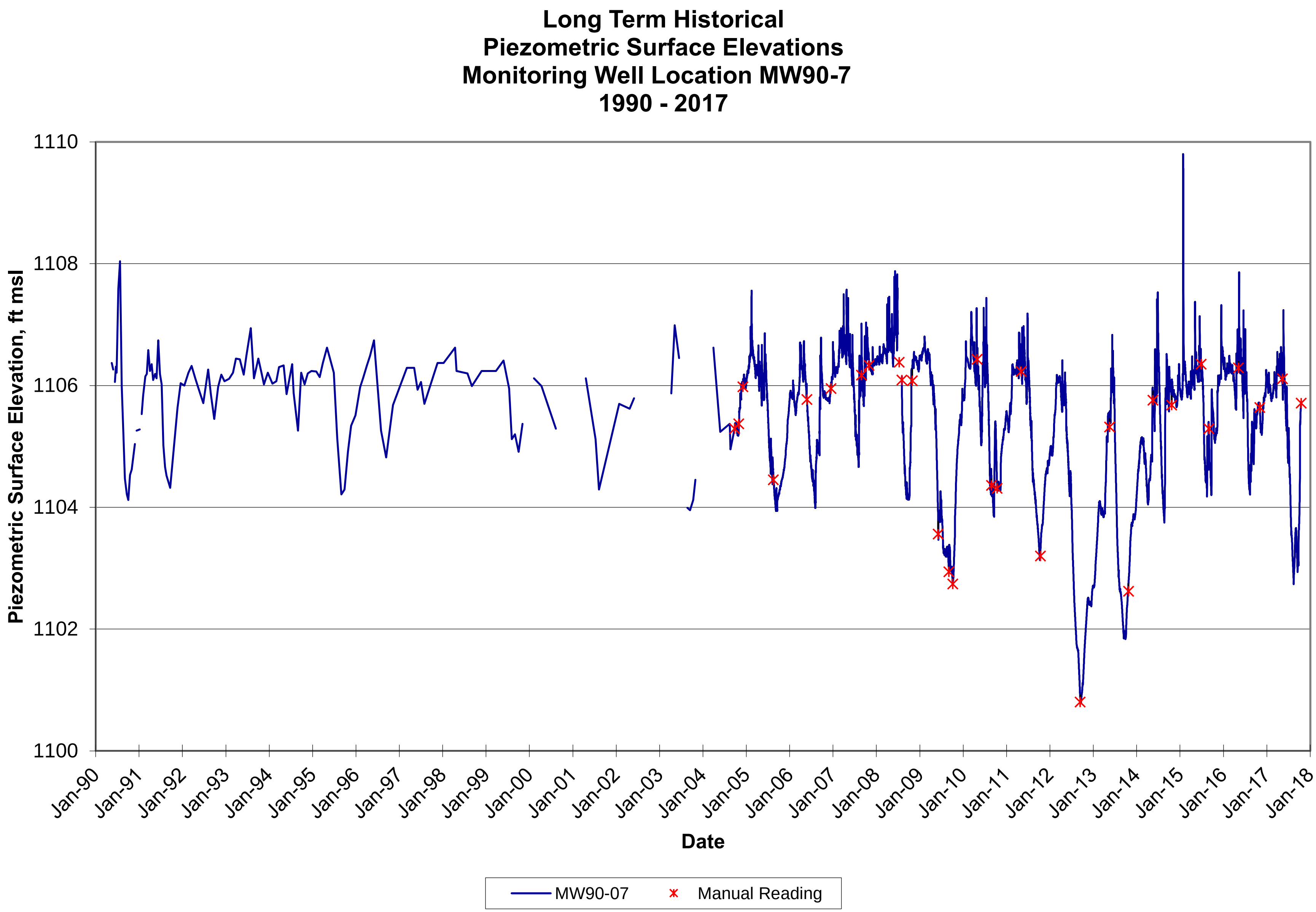
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Monitoring Well Location MW90-7
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Piezometric Surface Elevation, ft msl
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1104
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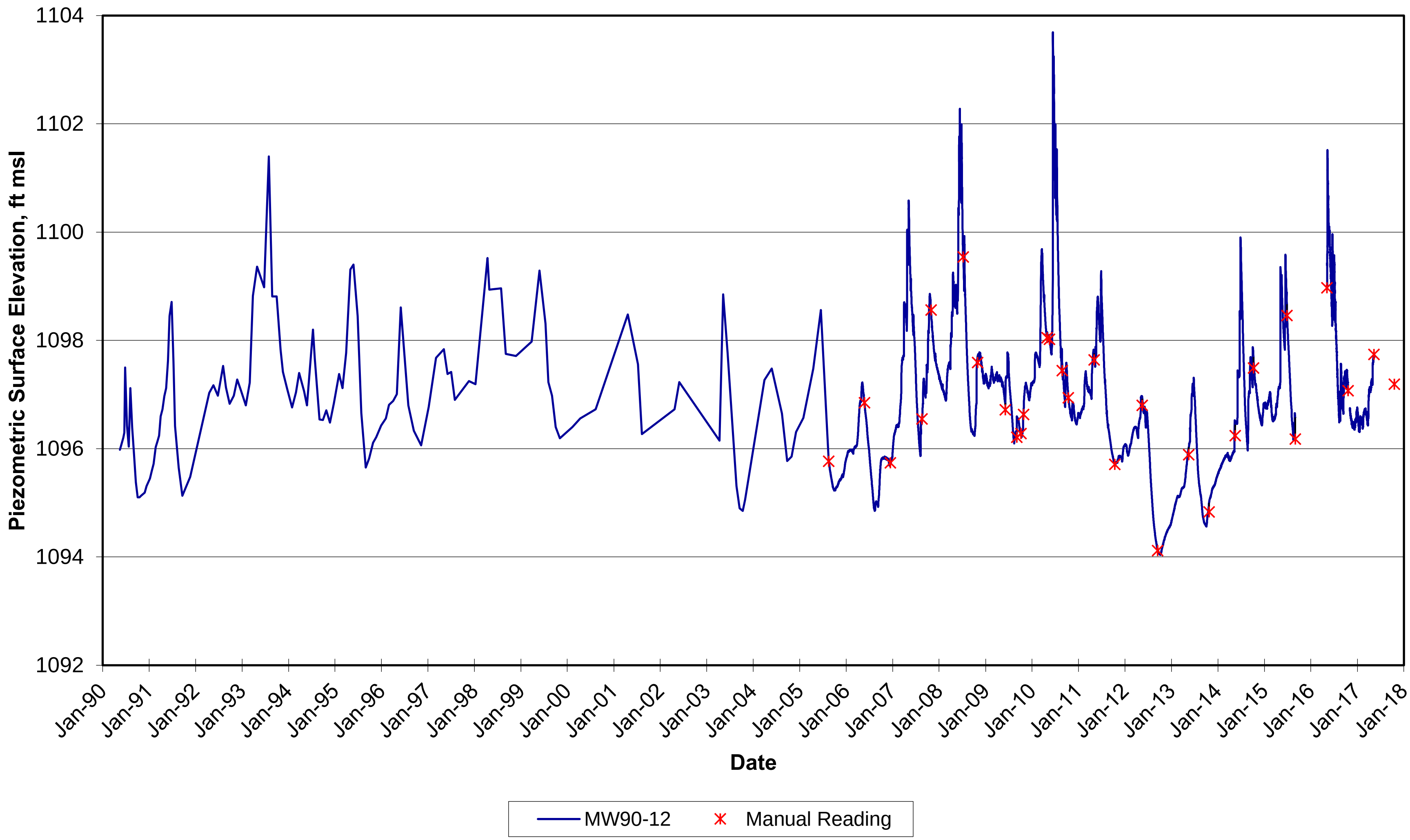
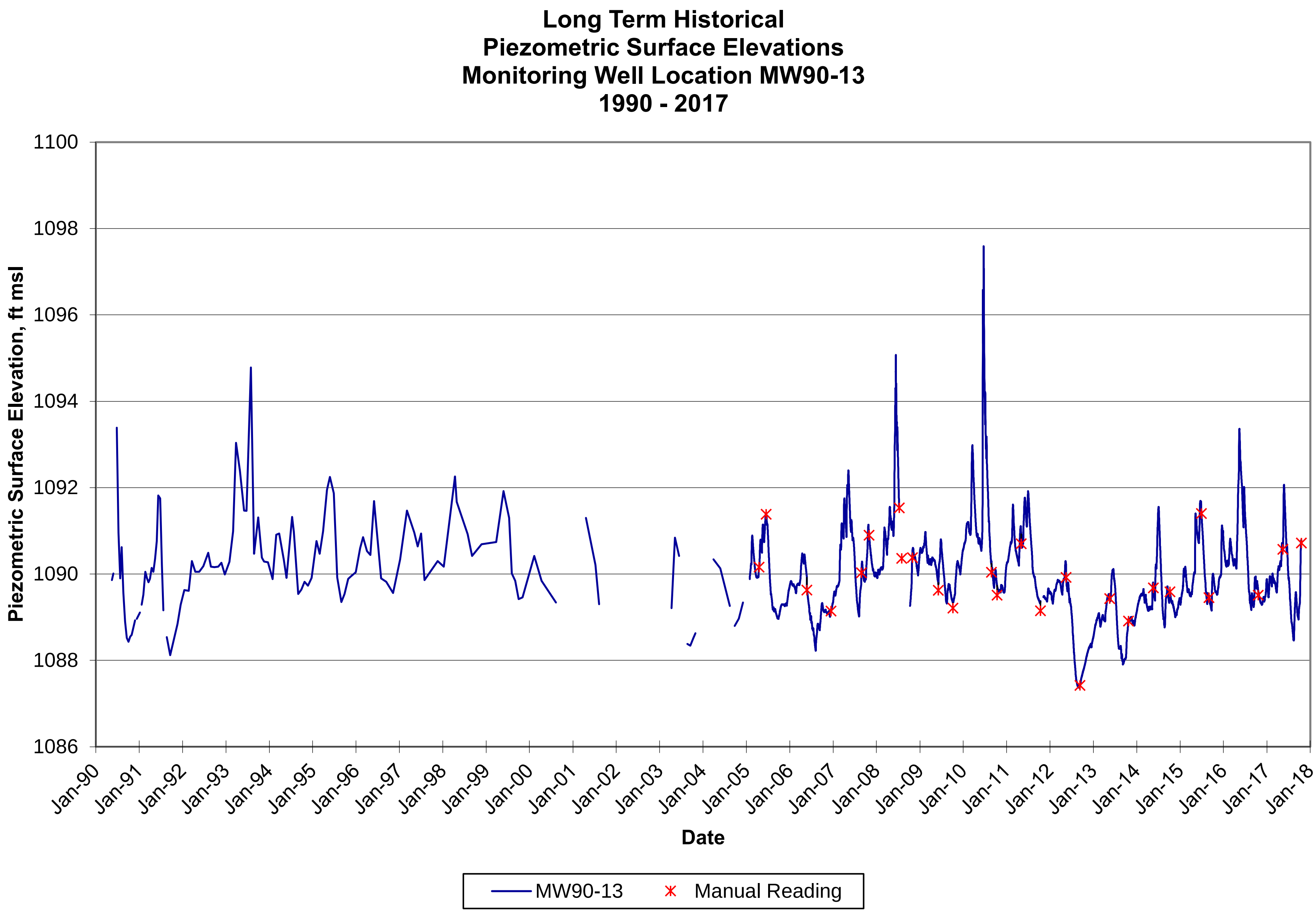
1990 - 2017

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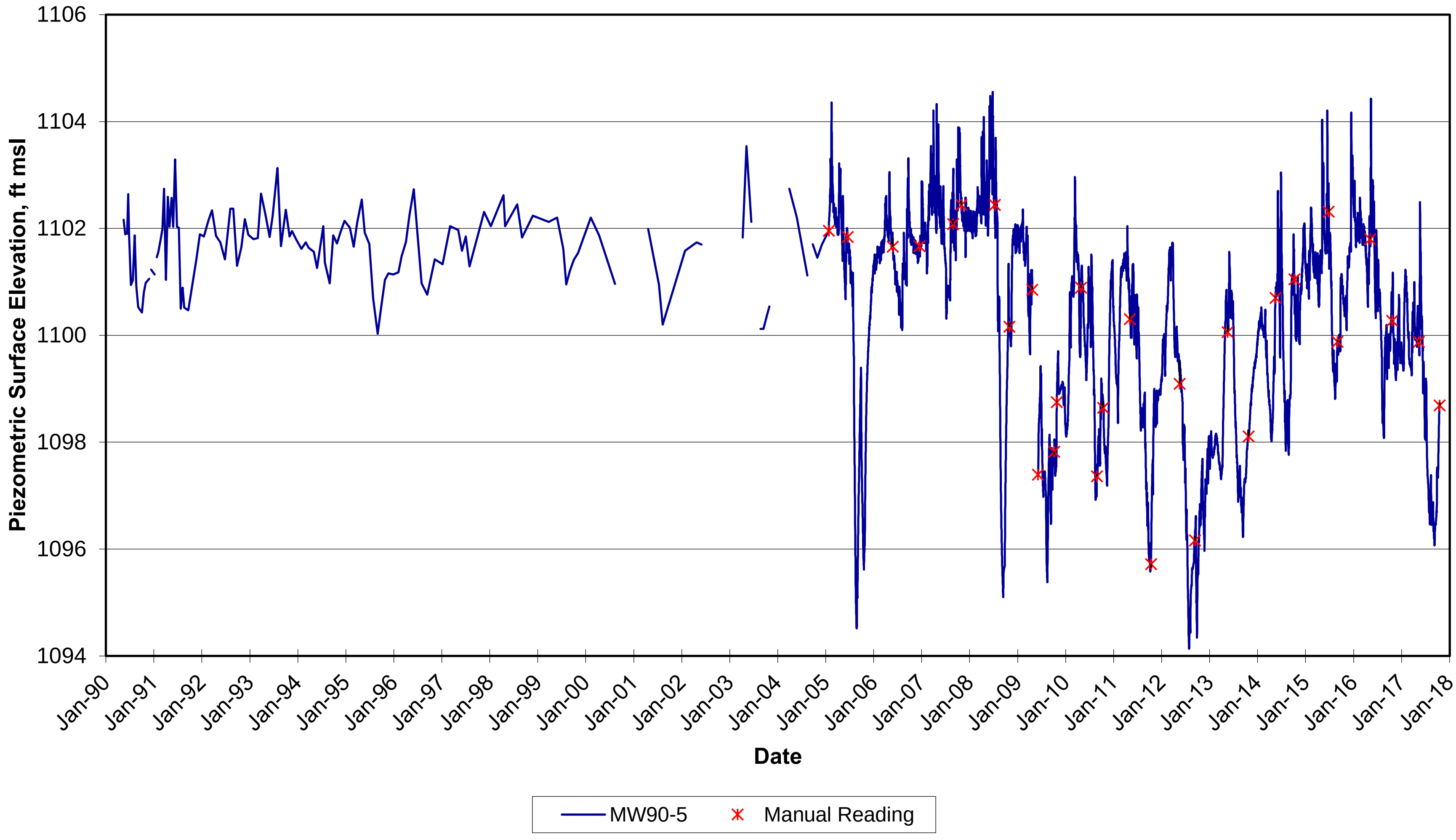
Manual Reading

Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location MW90-5
1990 - 2017



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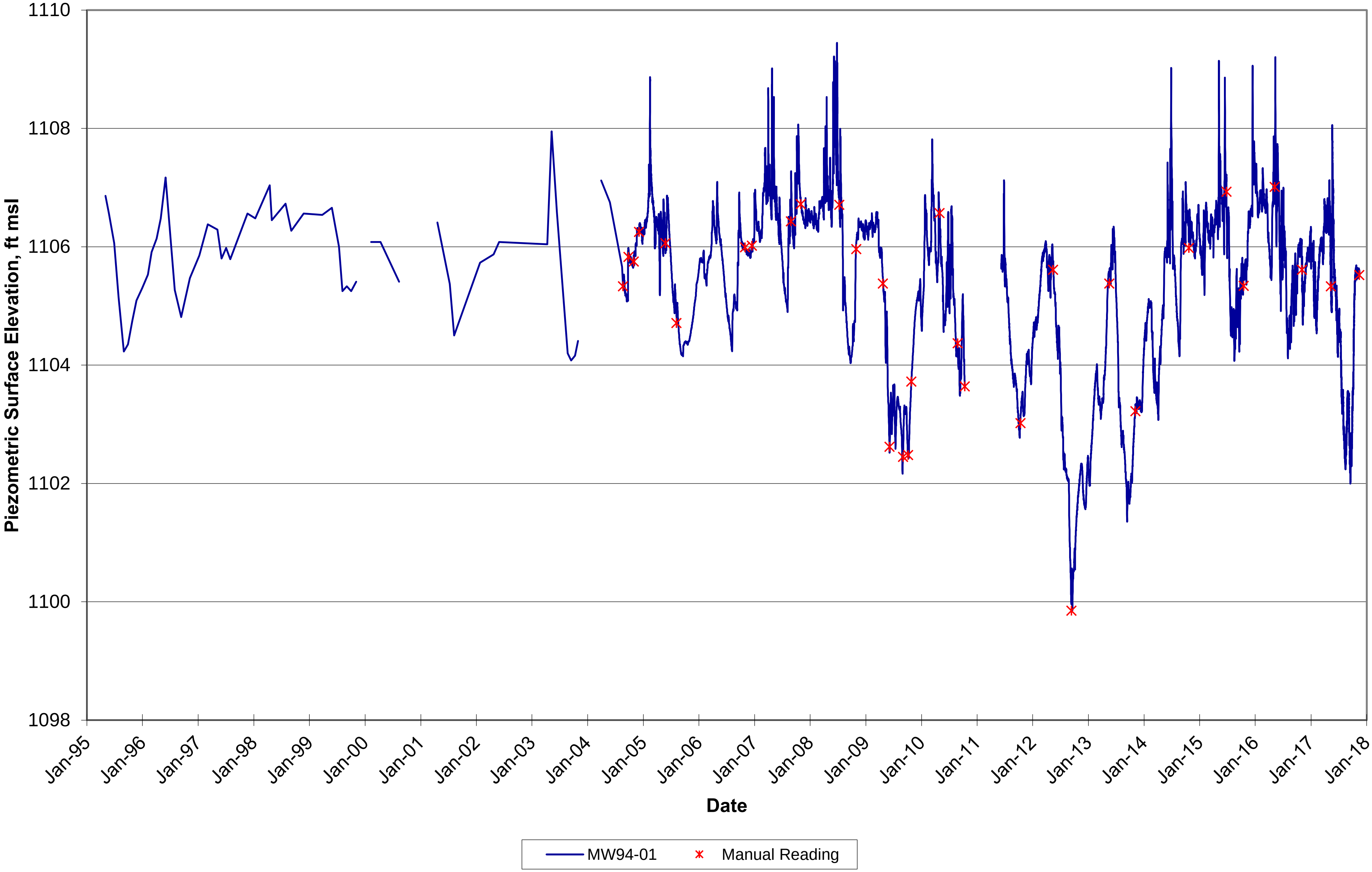

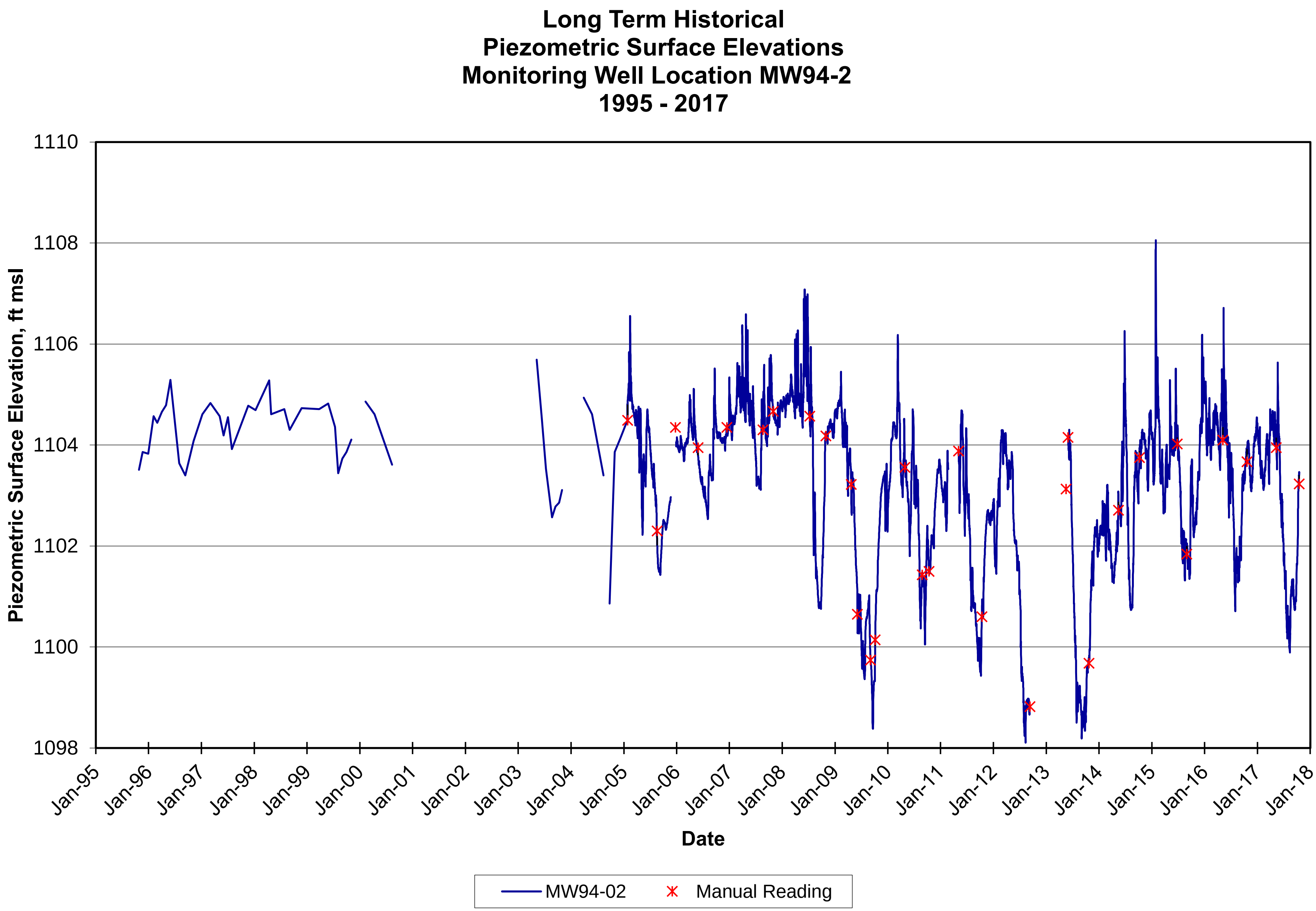

Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location MW94-2
1995 - 2017
Piezometric Surface Elevation, ft msl
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Date
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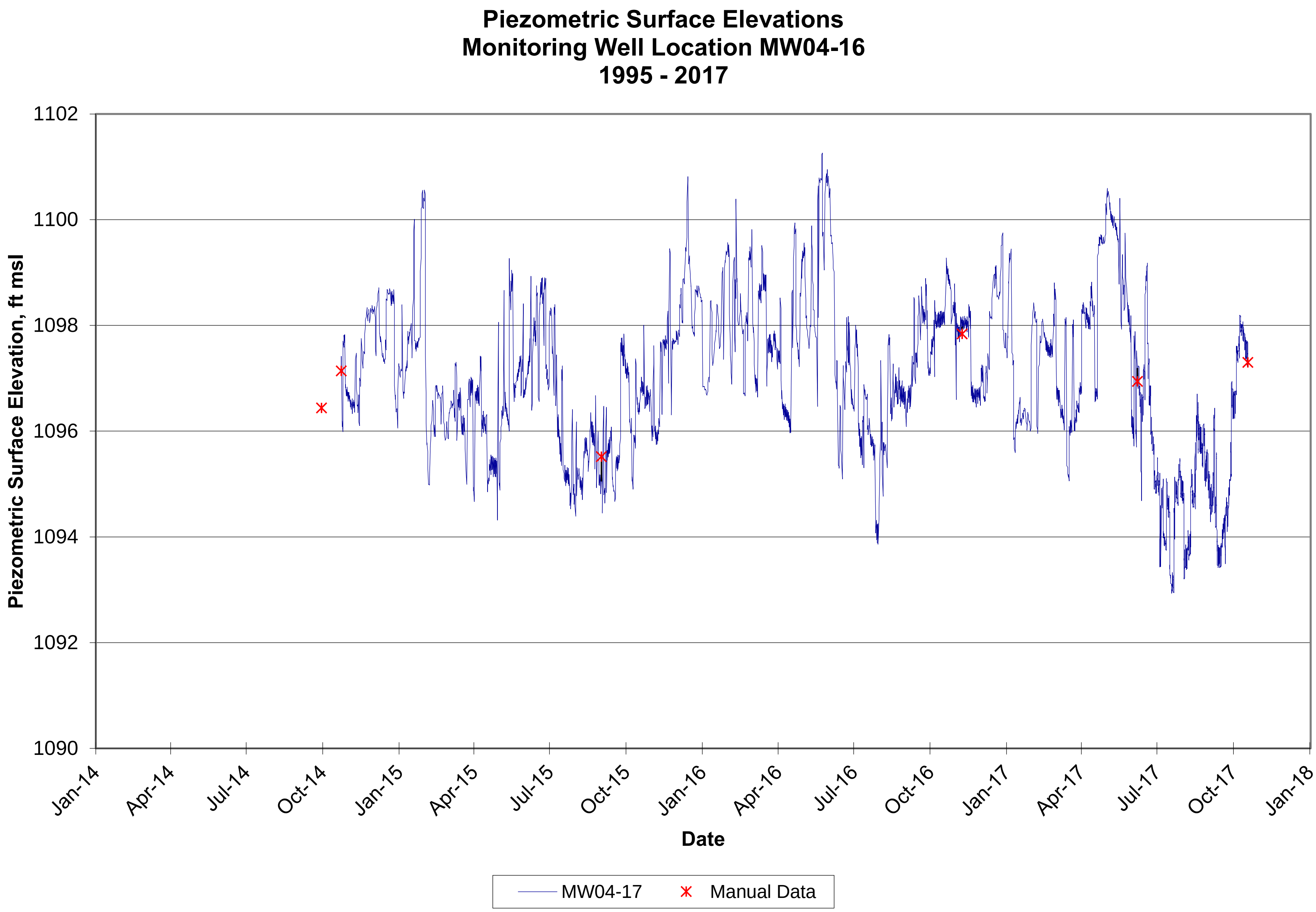
Manual Reading

APPENDIX 3-2 - 2008 – 2017 DATA MONITOING WELL HYDROGRAPHS

Saunders County Wells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Piezometric Surface Elevation, ft msl
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Apr-15
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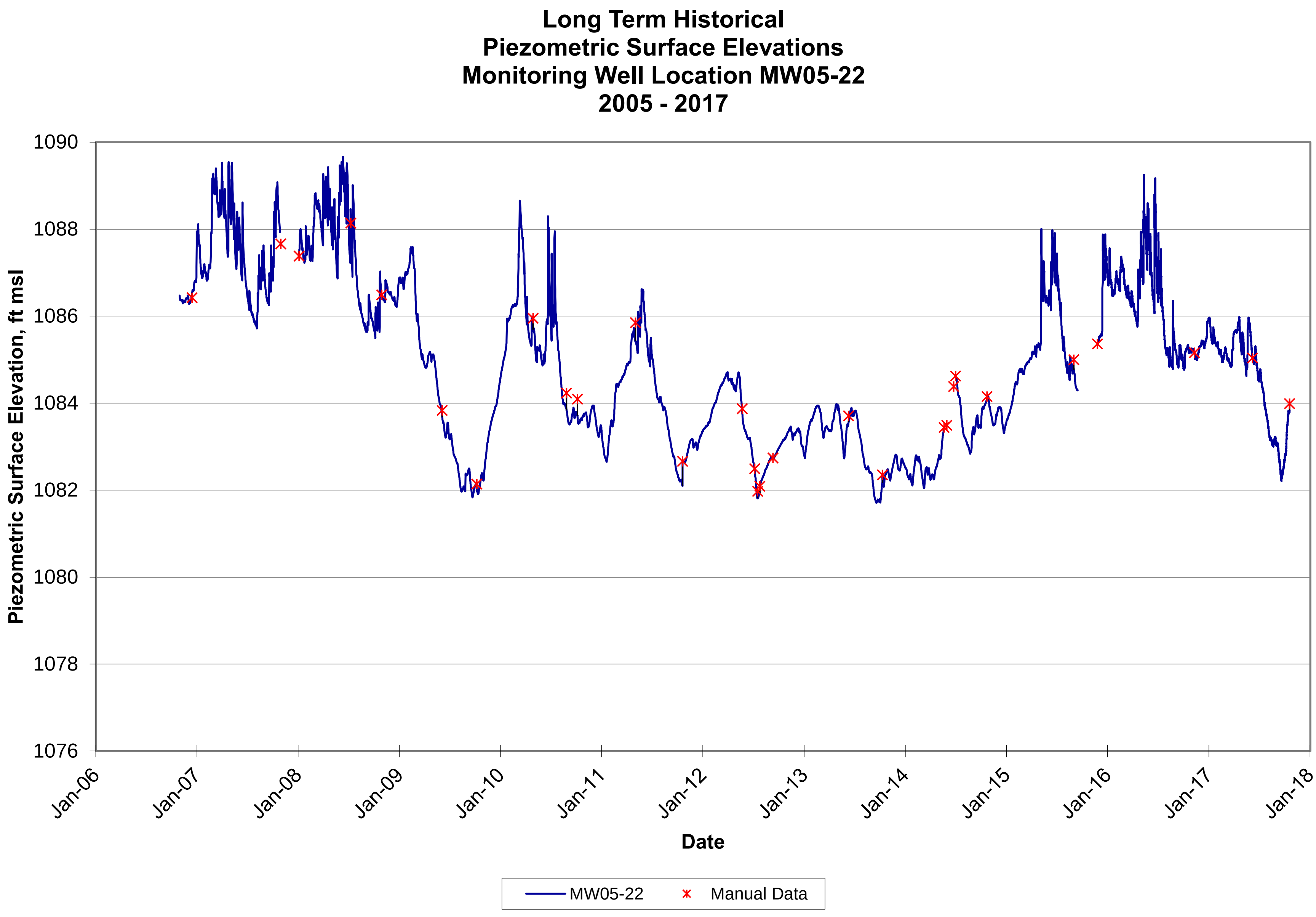
Manual Data


Long Term Historical
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Monitoring Well Location MW05-22
2005 - 2017
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1088
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1080
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Jan-06
Jan-07
Jan-08
Jan-09
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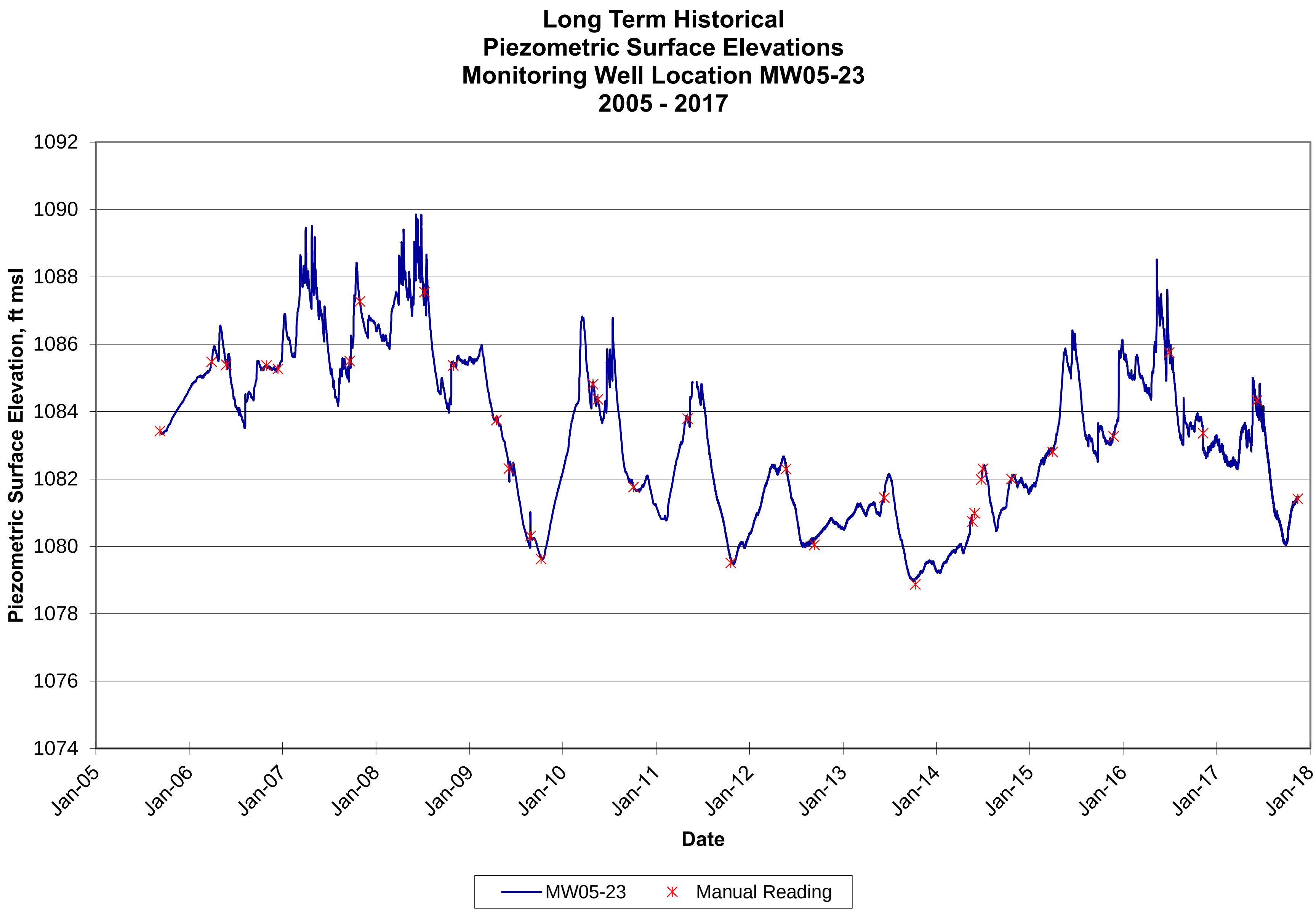
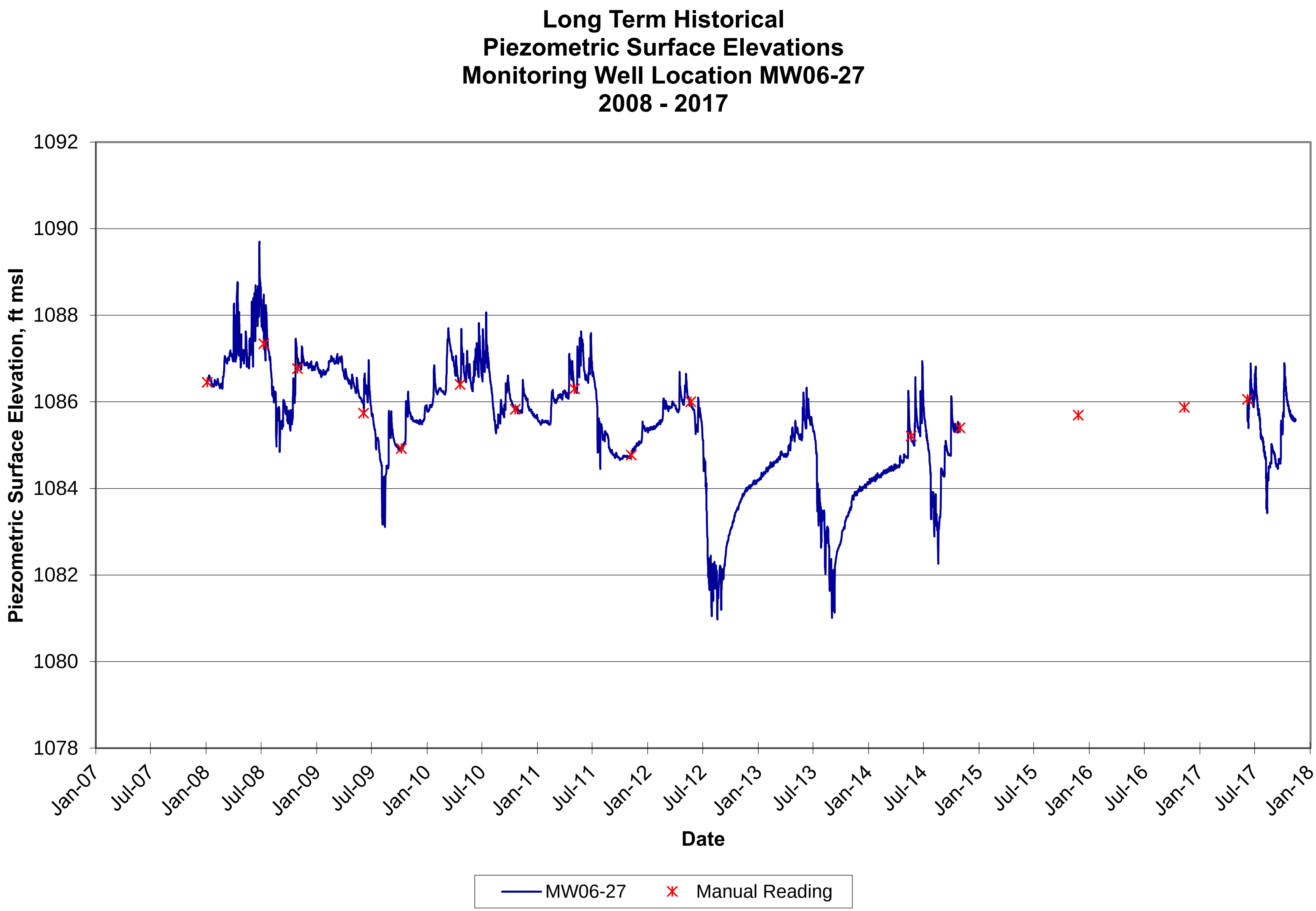
MW05-22
Manual Data

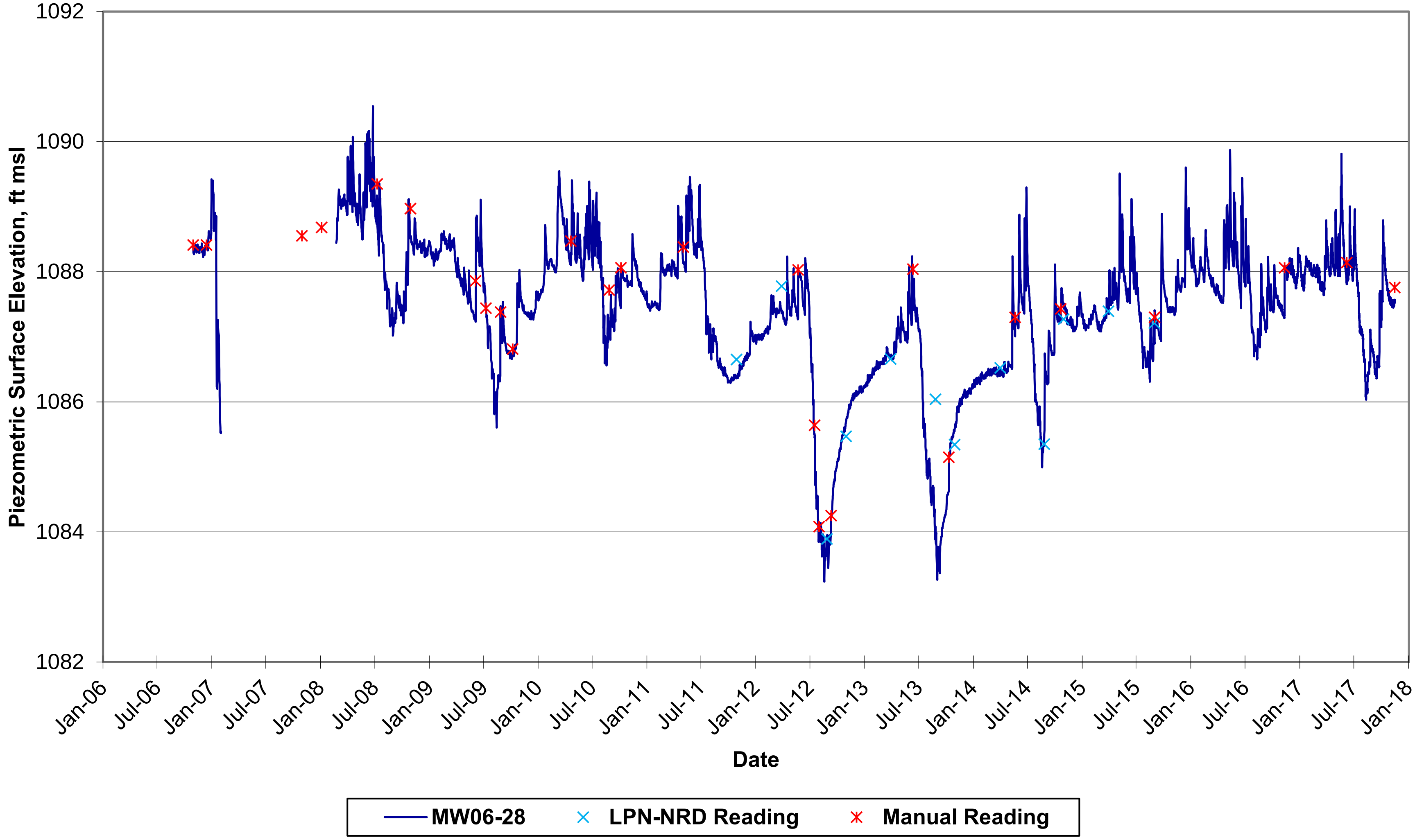


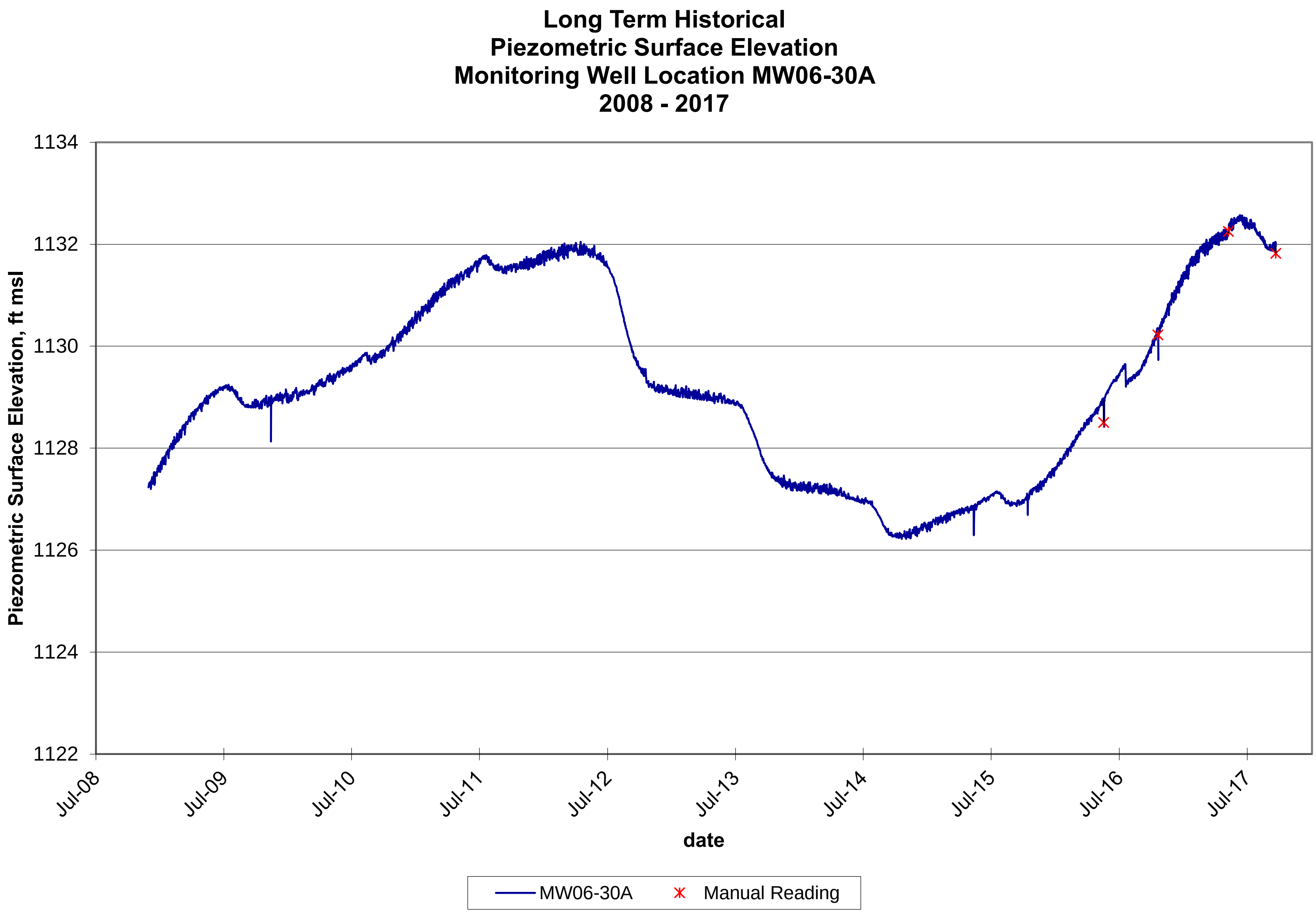
Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location MW05-23
2005 - 2017
Piezometric Surface Elevation, ft msl
1092
1090
1088
1086
1084
1082
1080
1078
1076
1074
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Date
MW05-23
Manual Reading



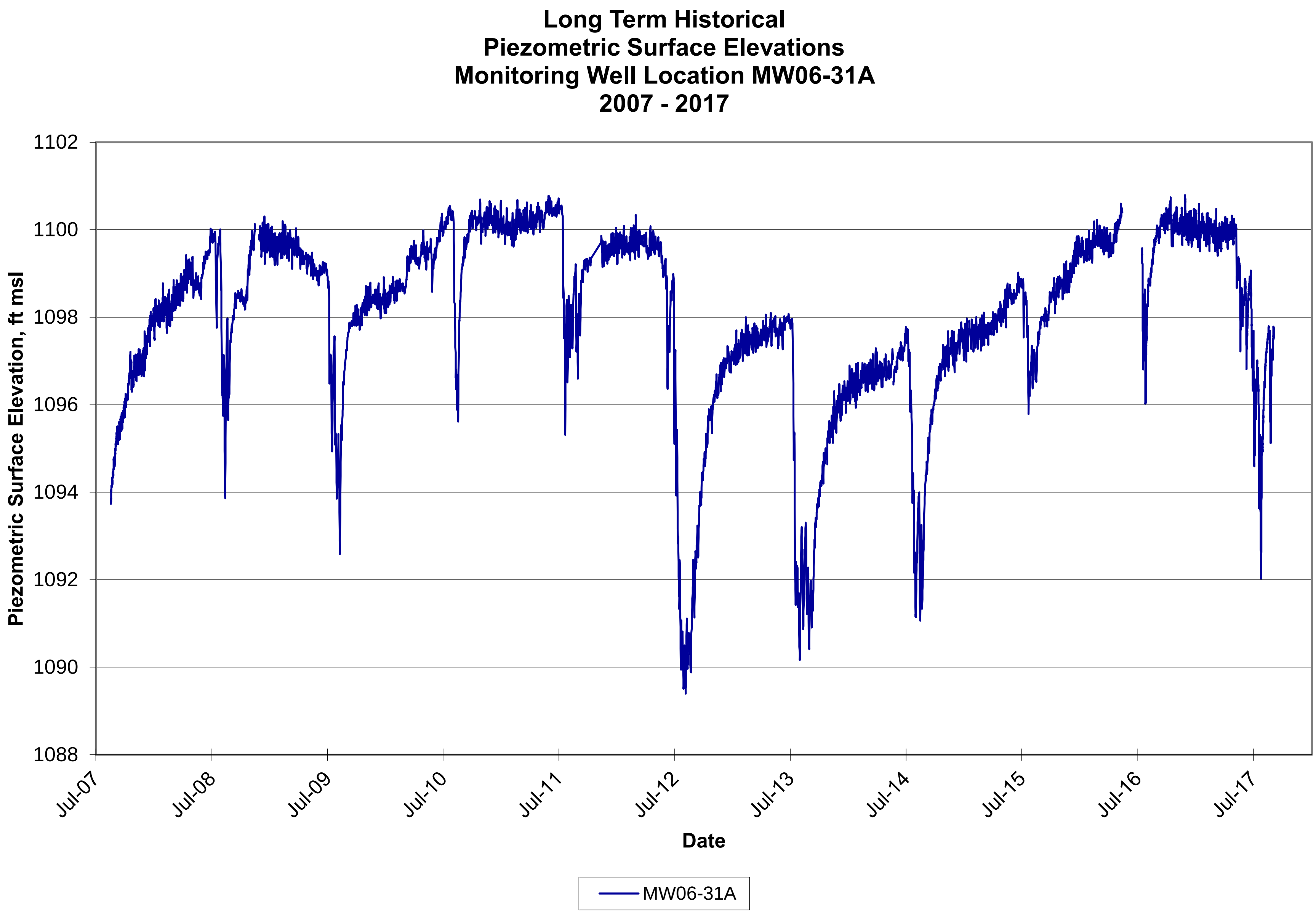
Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location MW06-27
2008 - 2017
Piezometric Surface Elevation, ft msl
1092
1090
1088
1086
1084
1082
1080
1078
Jan-07
Jul-07
Jan-08
Jul-08
Jan-09
Jul-09
Jan-10
Jul-10
Jan-11
Jul-11
Jan-12
Jul-12
Jan-13
Jul-13
Jan-14
Jul-14
Jan-15
Jul-15
Jan-16
Jul-16
Jan-17
Jul-17
Jan-18
Date
MW06-27
Manual Reading

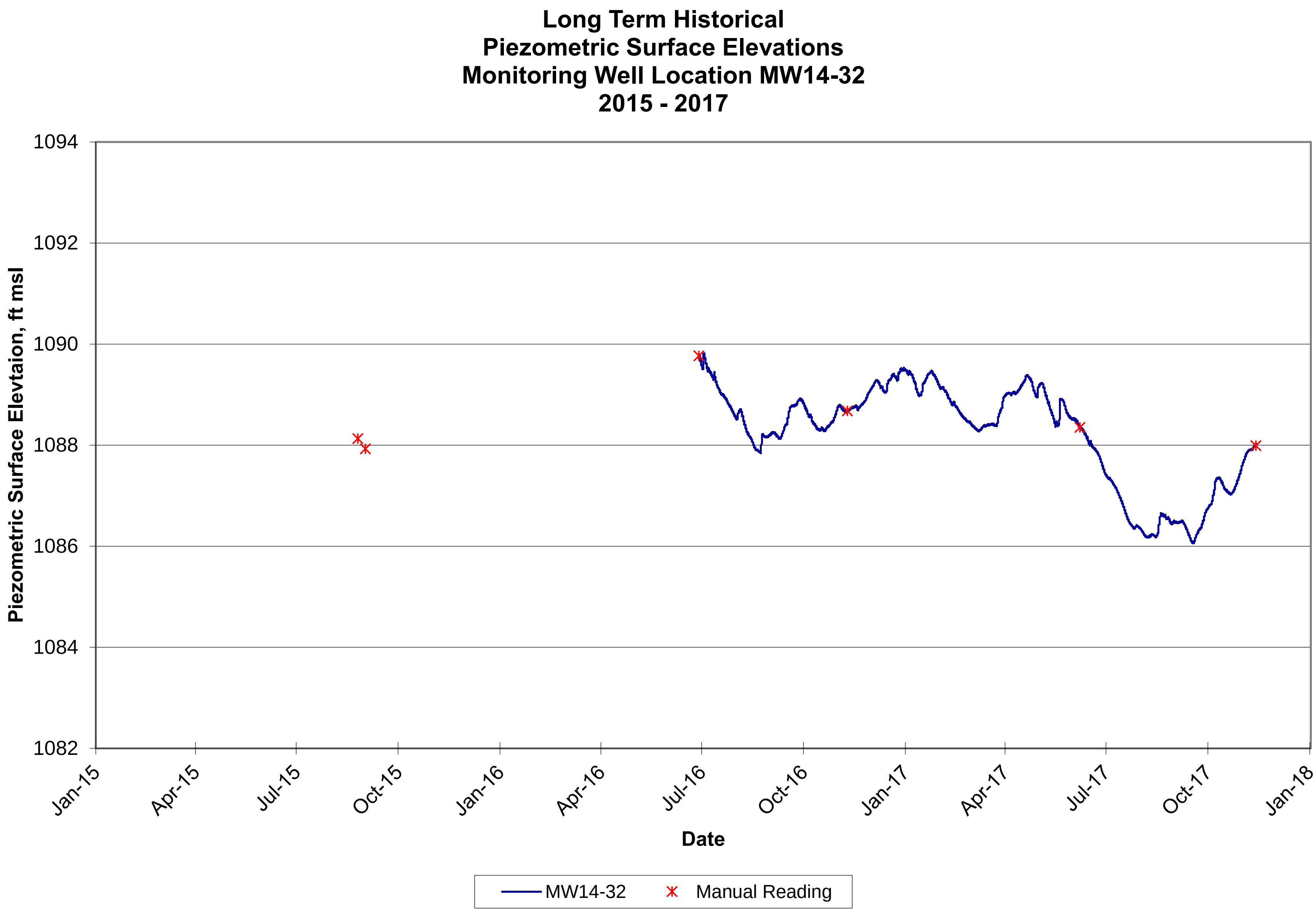
Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location MW06-28
2006 - 2017

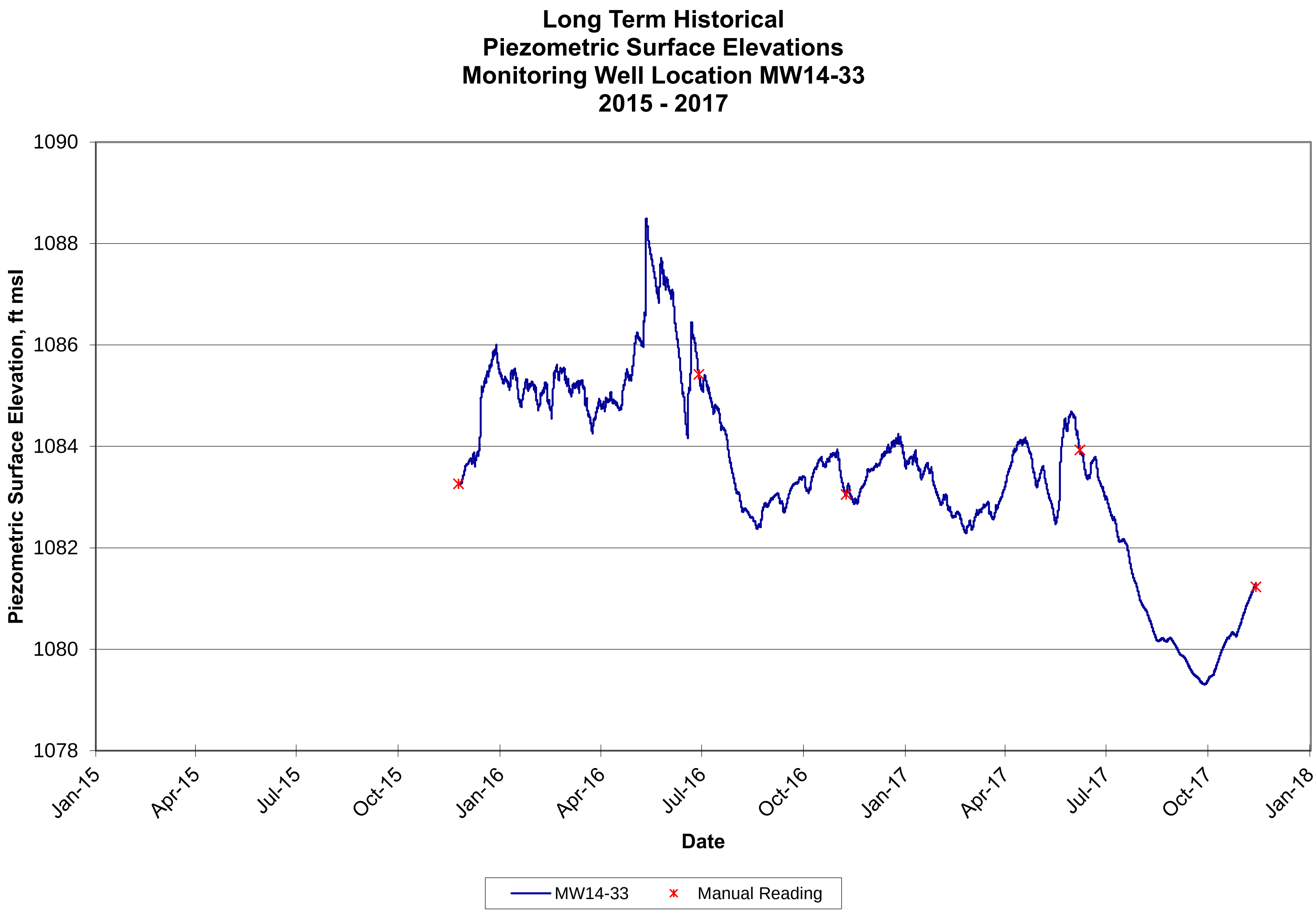




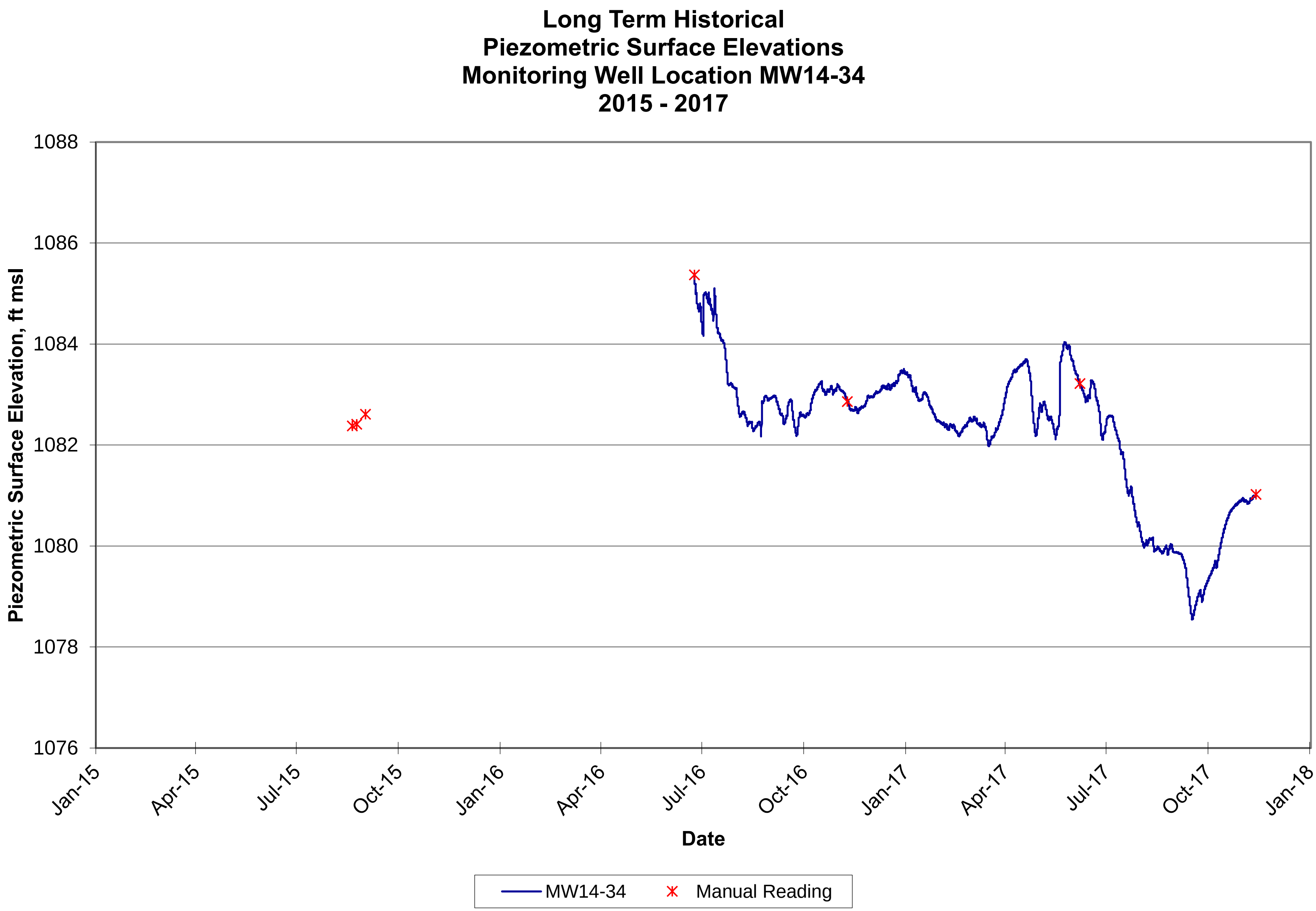
Long Term Historical
Piezometric Surface Elevation
Monitoring Well Location MW06-30A
2008 - 2017
Piezometric Surface Elevation, ft msl
1134
1132
1130
1128
1126
1124
1122
Jul-08
Jul-09
Jul-10
Jul-11
Jul-12
Jul-13
Jul-14
Jul-15
Jul-16
Jul-17
date
MW06-30A
Manual Reading

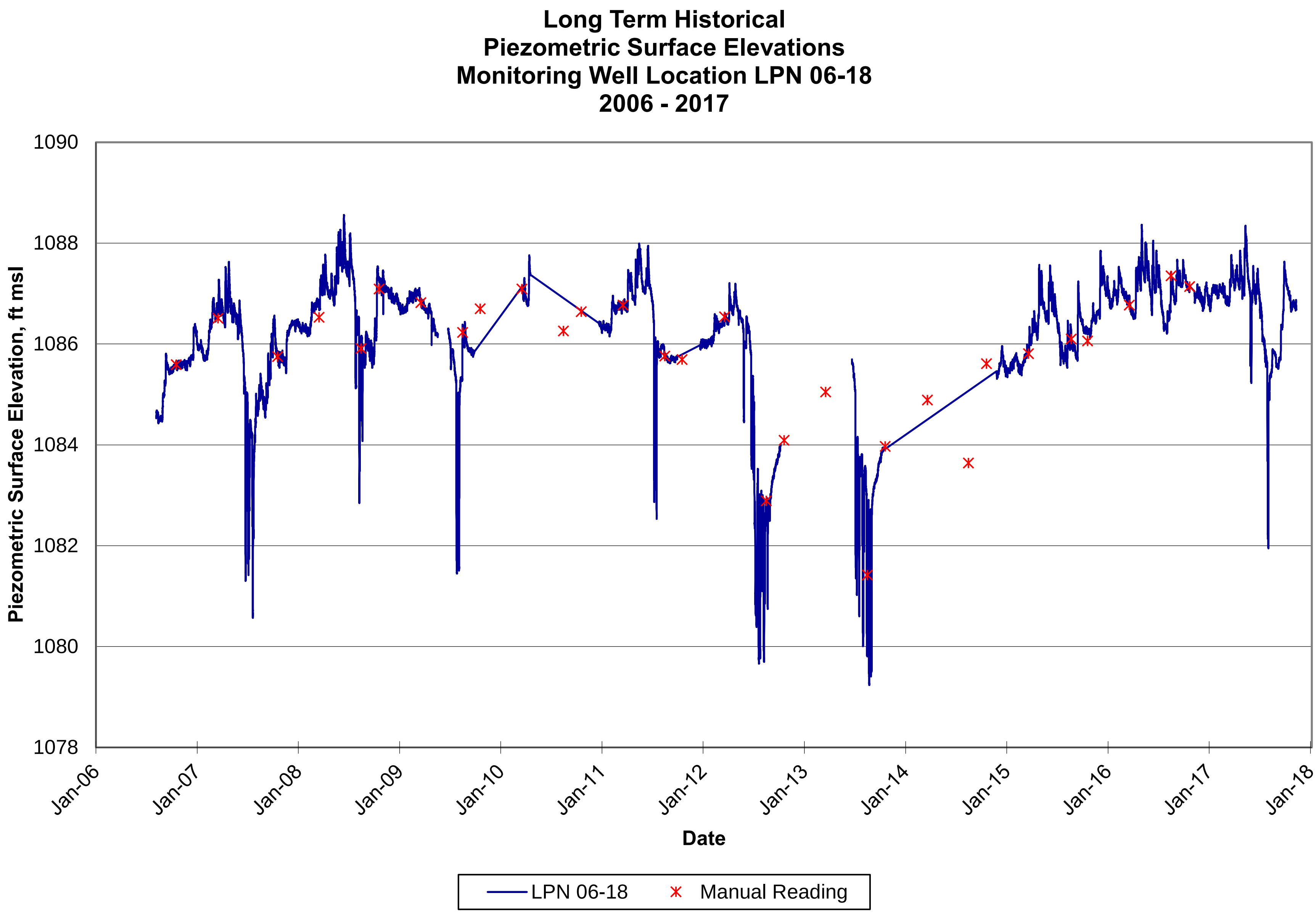

Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location MW06-31A
2007 - 2017
Piezometric Surface Elevation, ft msl
1102
1100
1098
1096
1094
1092
1090
1088
Jul-07
Jul-08
Jul-09
Jul-10
Jul-11
Jul-12
Jul-13
Jul-14
Jul-15
Jul-16
Jul-17
Date
MW06-31A


Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location MW14-32
2015 - 2017
Piezometric Surface Elevtaion, ft msl
1094
1092
1090
1088
1086
1084
1082
Jan-15
Apr-15
Jul-15
Oct-15
Jan-16
Apr-16
Jul-16
Oct-16
Jan-17
Apr-17
Jul-17
Oct-17
Jan-18
Date
MW14-32
Manual Reading

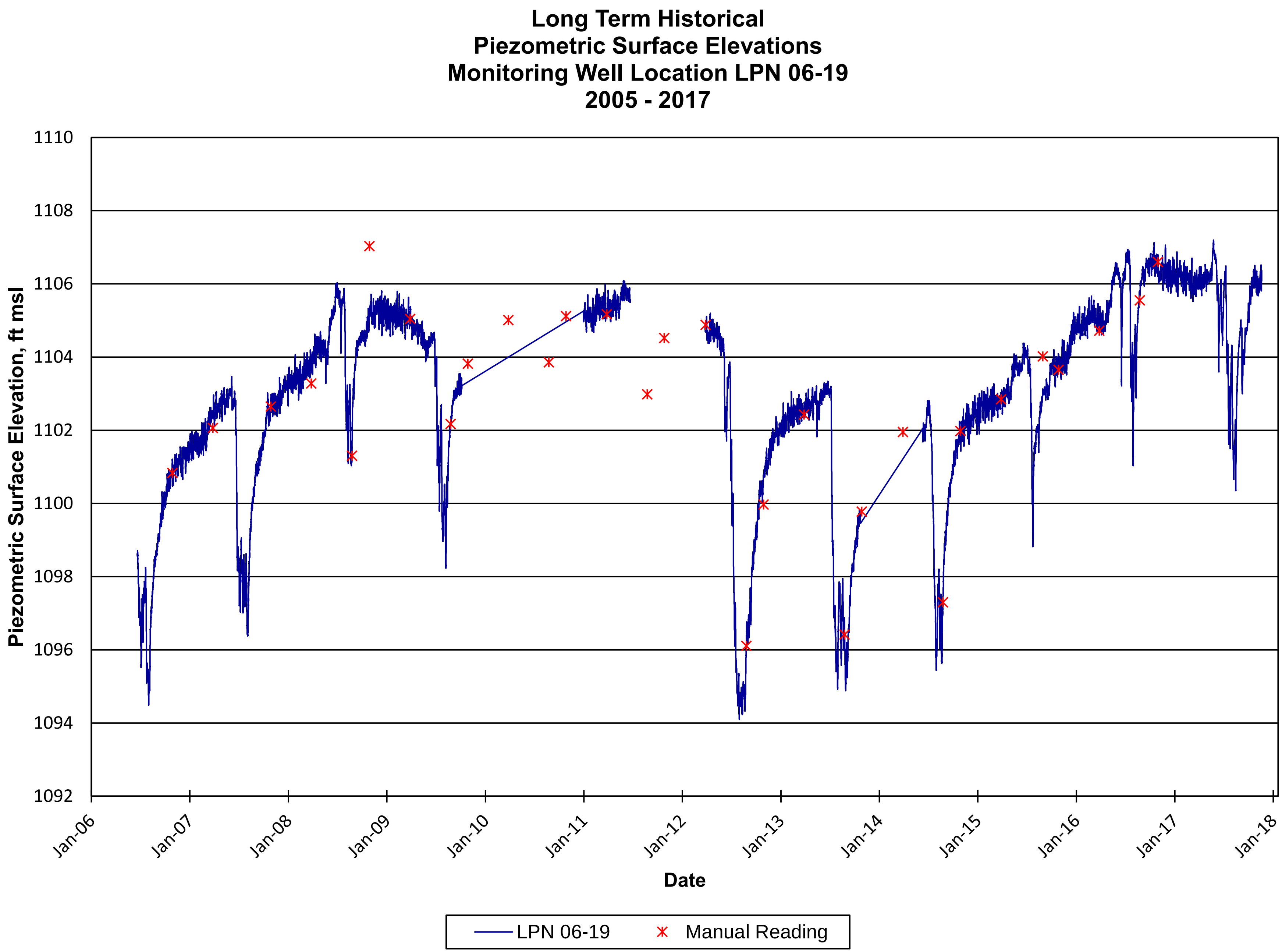


Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location MW14-33
2015 - 2017
Piezometric Surface Elevation, ft msl
1090
1088
1086
1084
1082
1080
1078
Jan-15
Apr-15
Jul-15
Oct-15
Jan-16
Apr-16
Jul-16
Oct-16
Jan-17
Apr-17
Jul-17
Oct-17
Jan-18
Date
MW14-33
Manual Reading

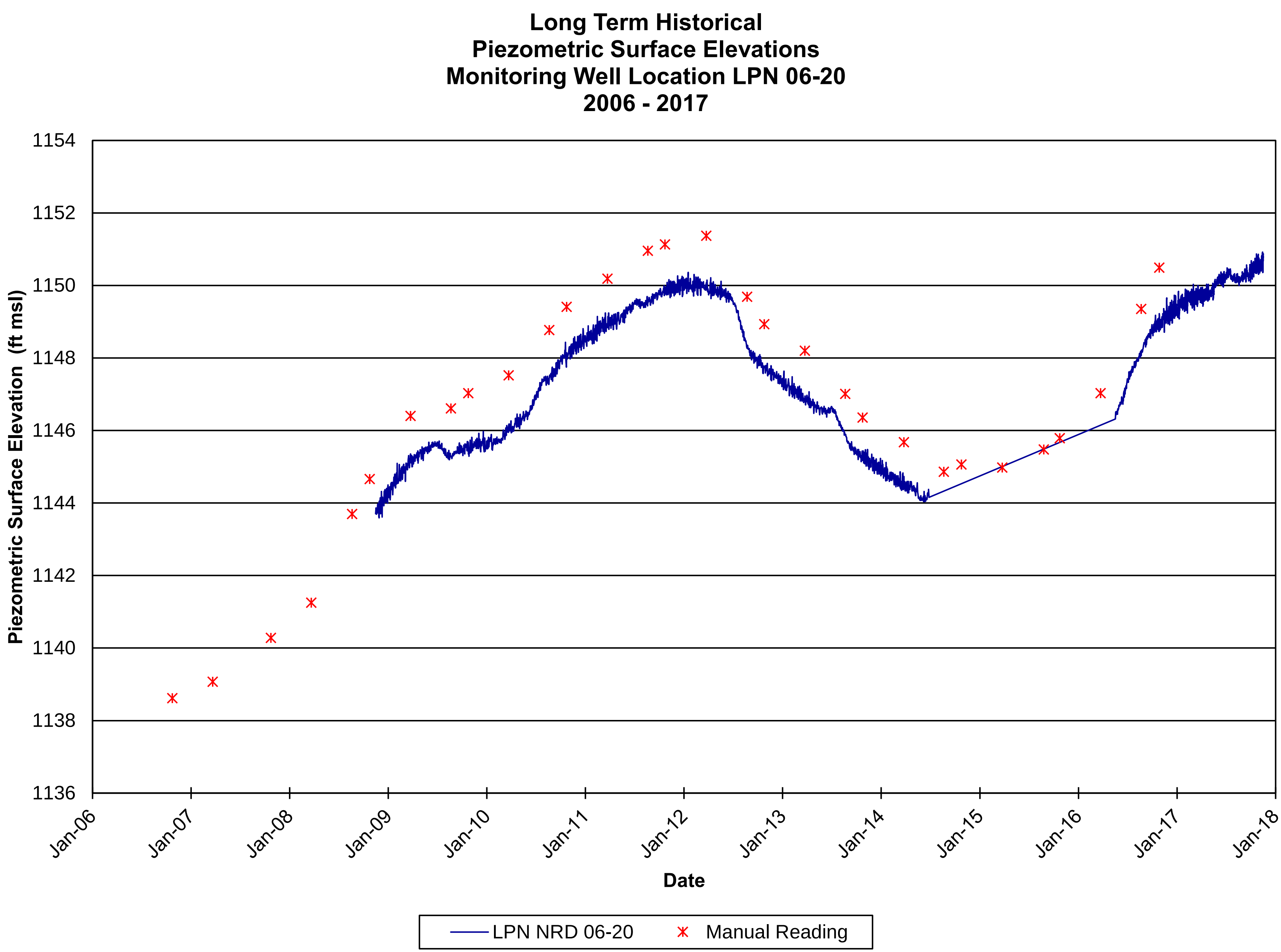

Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location MW14-34
2015 - 2017
Piezometric Surface Elevation, ft msl
1088
1086
1084
1082
1080
1078
1076
Jan-15
Apr-15
Jul-15
Oct-15
Jan-16
Apr-16
Jul-16
Oct-16
Jan-17
Apr-17
Jul-17
Oct-17
Jan-18
Date
MW14-34
Manual Reading



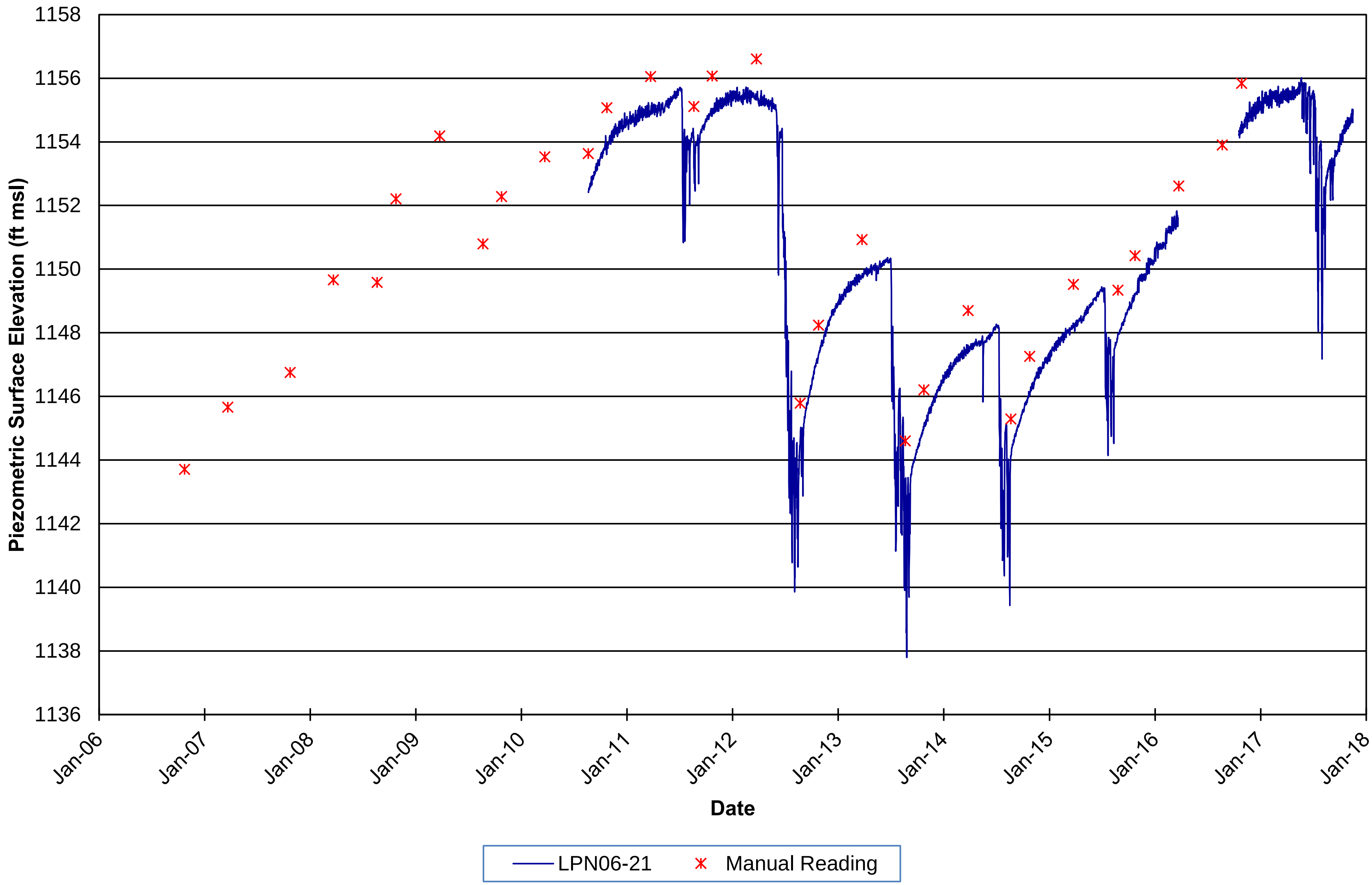
Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location LPN 06-18
2006 - 2017
Piezometric Surface Elevation, ft msl
1090
1088
1086
1084
1082
1080
1078
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Date
LPN 06-18
Manual Reading

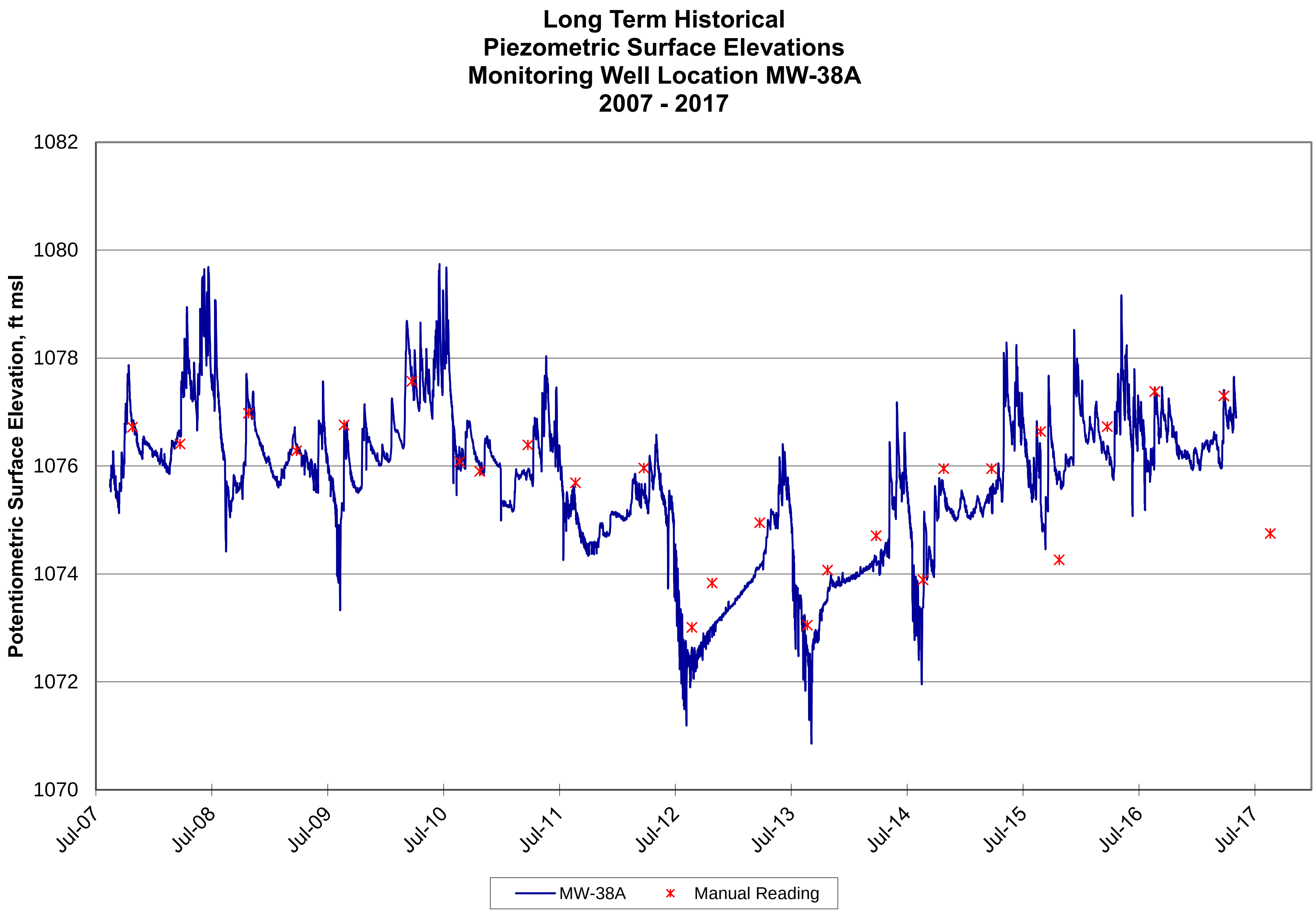


Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location LPN 06-19
2005 - 2017
Piezometric Surface Elevation, ft msl
1110
1108
1106
1104
1102
1100
1098
1096
1094
1092
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Date
LPN 06-19
Manual Reading

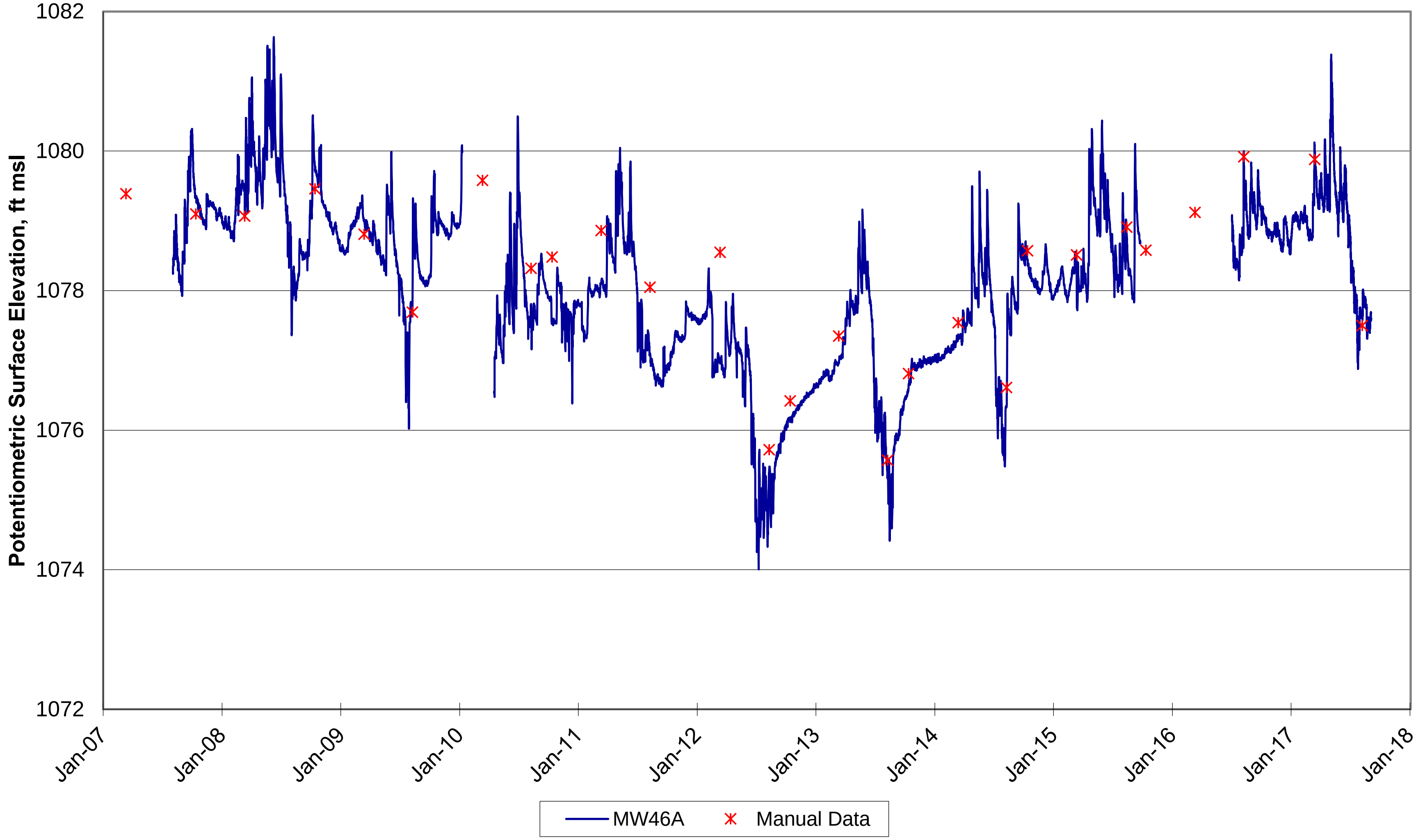

Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location LPN 06-20
2006 - 2017
Piezometric Surface Elevation (ft msl)
1154
1152
1150
1148
1146
1144
1142
1140
1138
1136
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Date
LPN NRD 06-20
Manual Reading

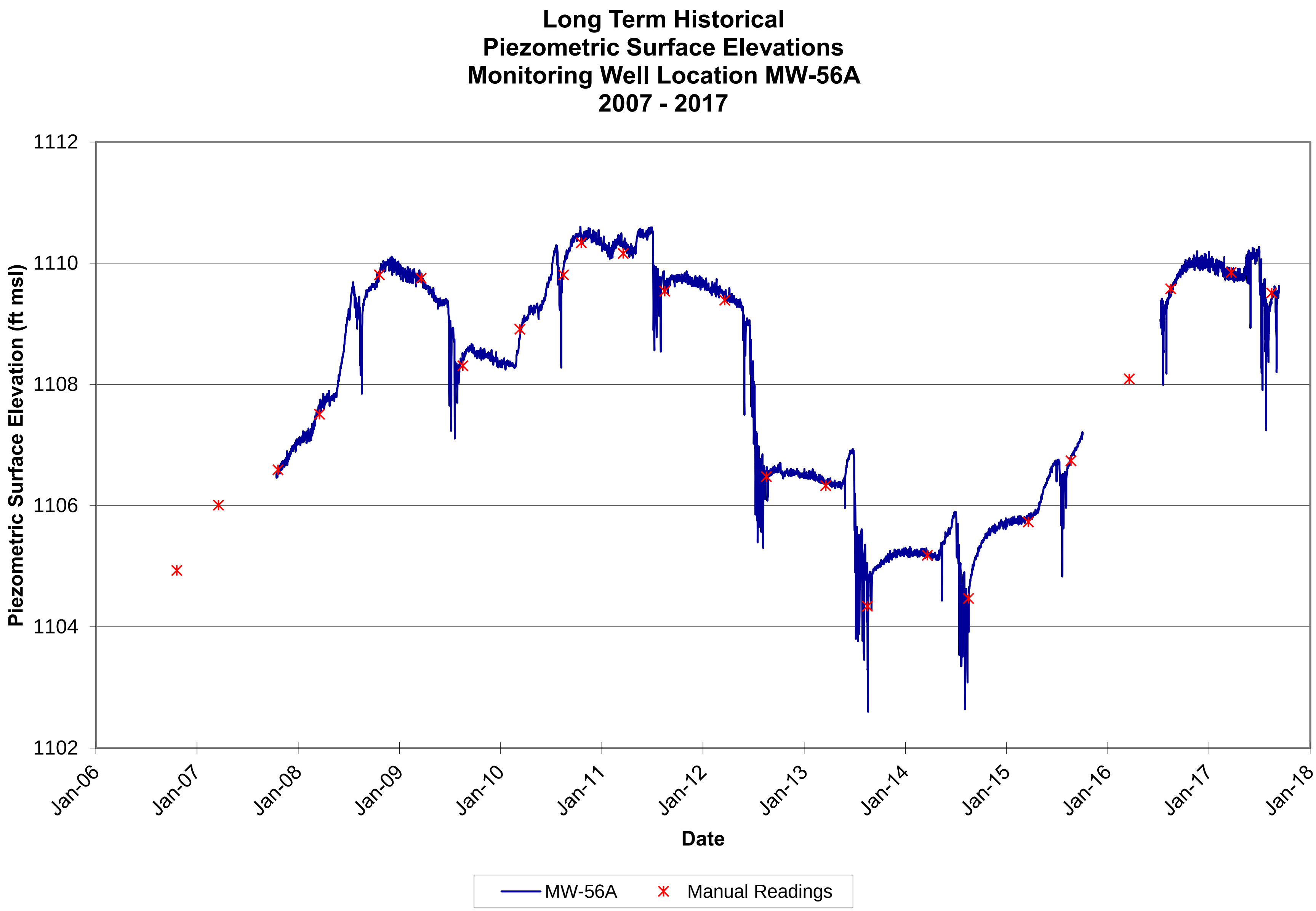
Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location LPN06-21
2007 - 2017

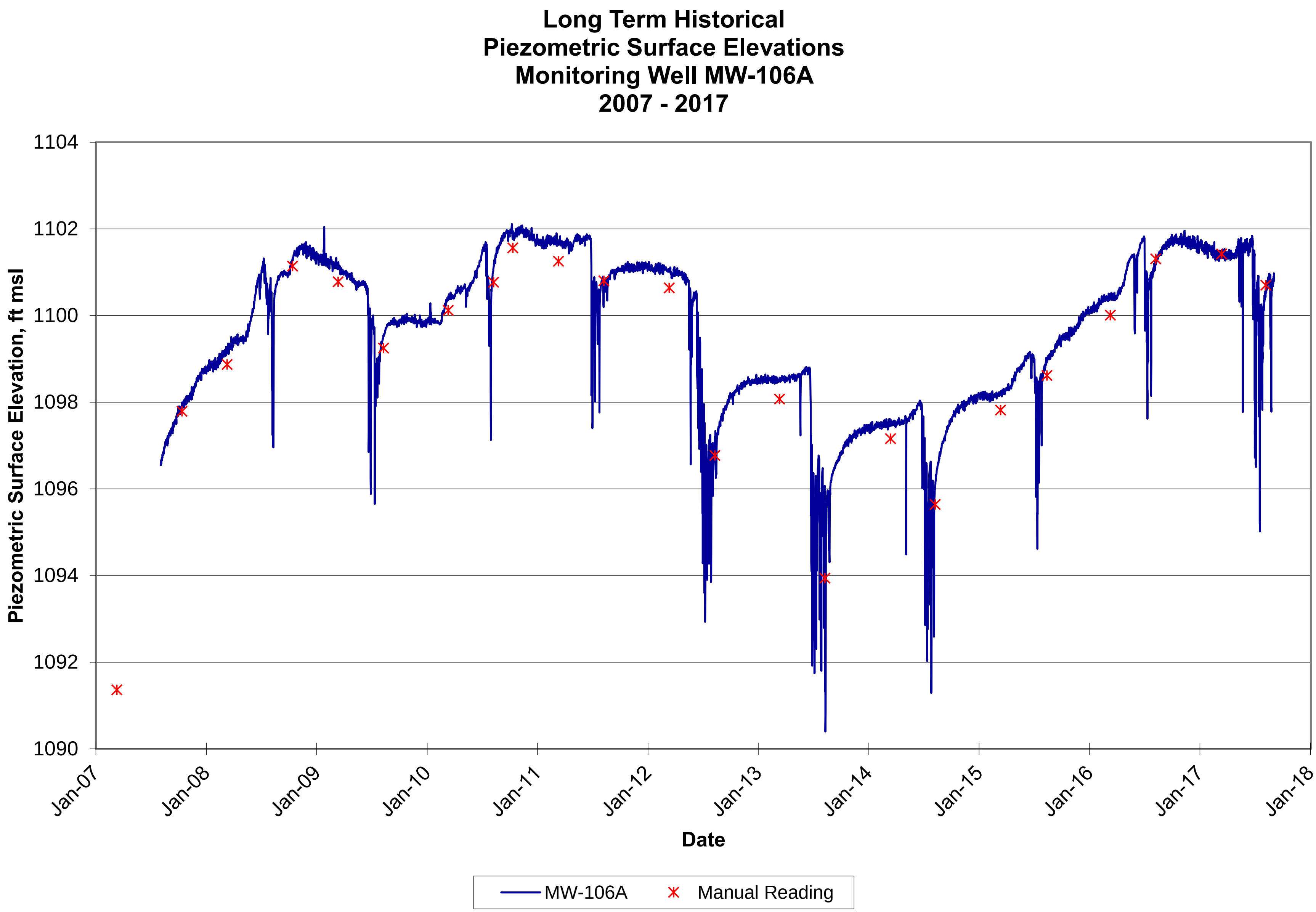



Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location MW-38A
2007 - 2017
Potentiometric Surface Elevation, ft msl
1082
1080
1078
1076
1074
1072
1070
Jul-07
Jul-08
Jul-09
Jul-10
Jul-11
Jul-12
Jul-13
Jul-14
Jul-15
Jul-16
Jul-17
MW-38A
Manual Reading

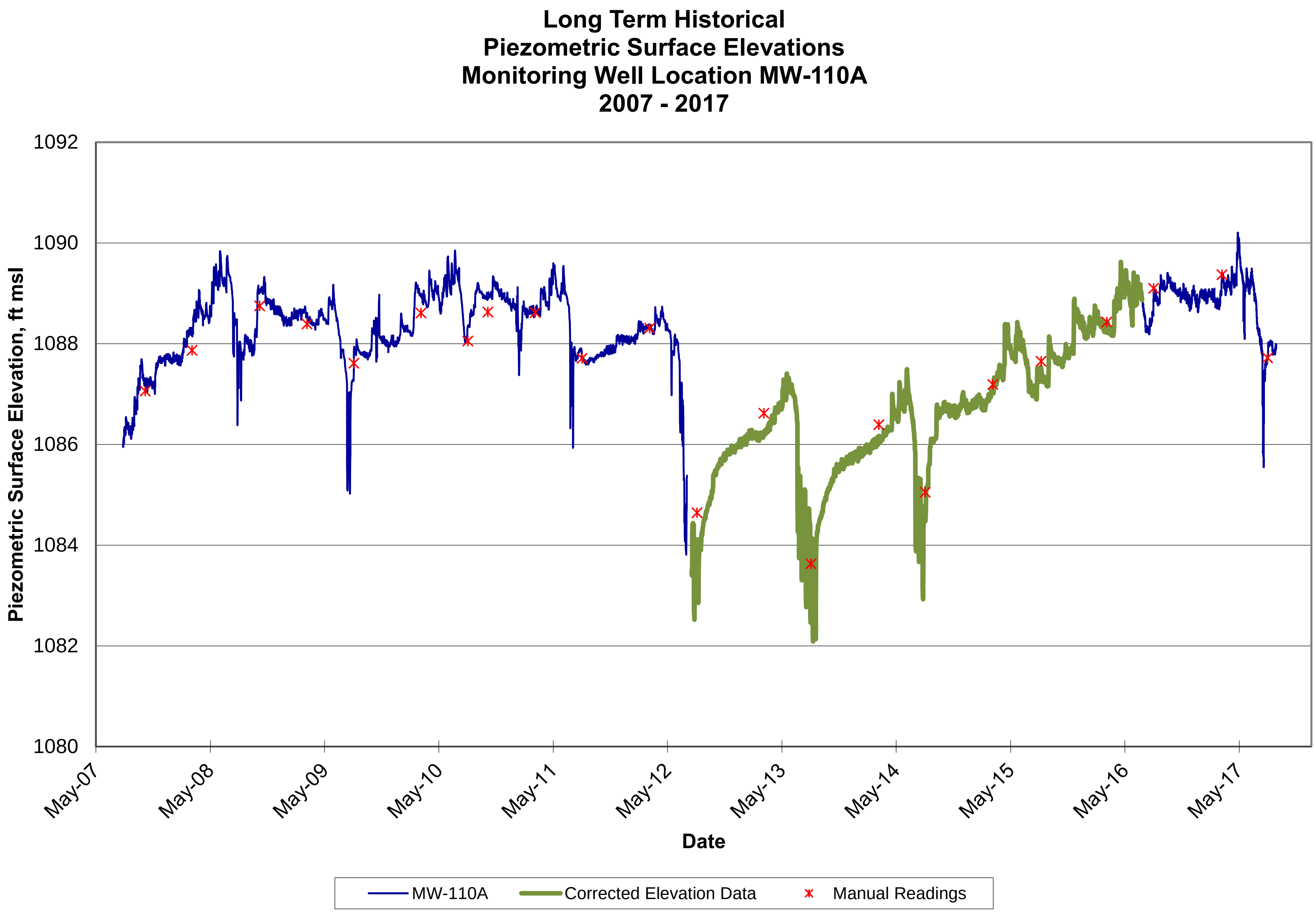
Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location MW-46A
2007 - 2017

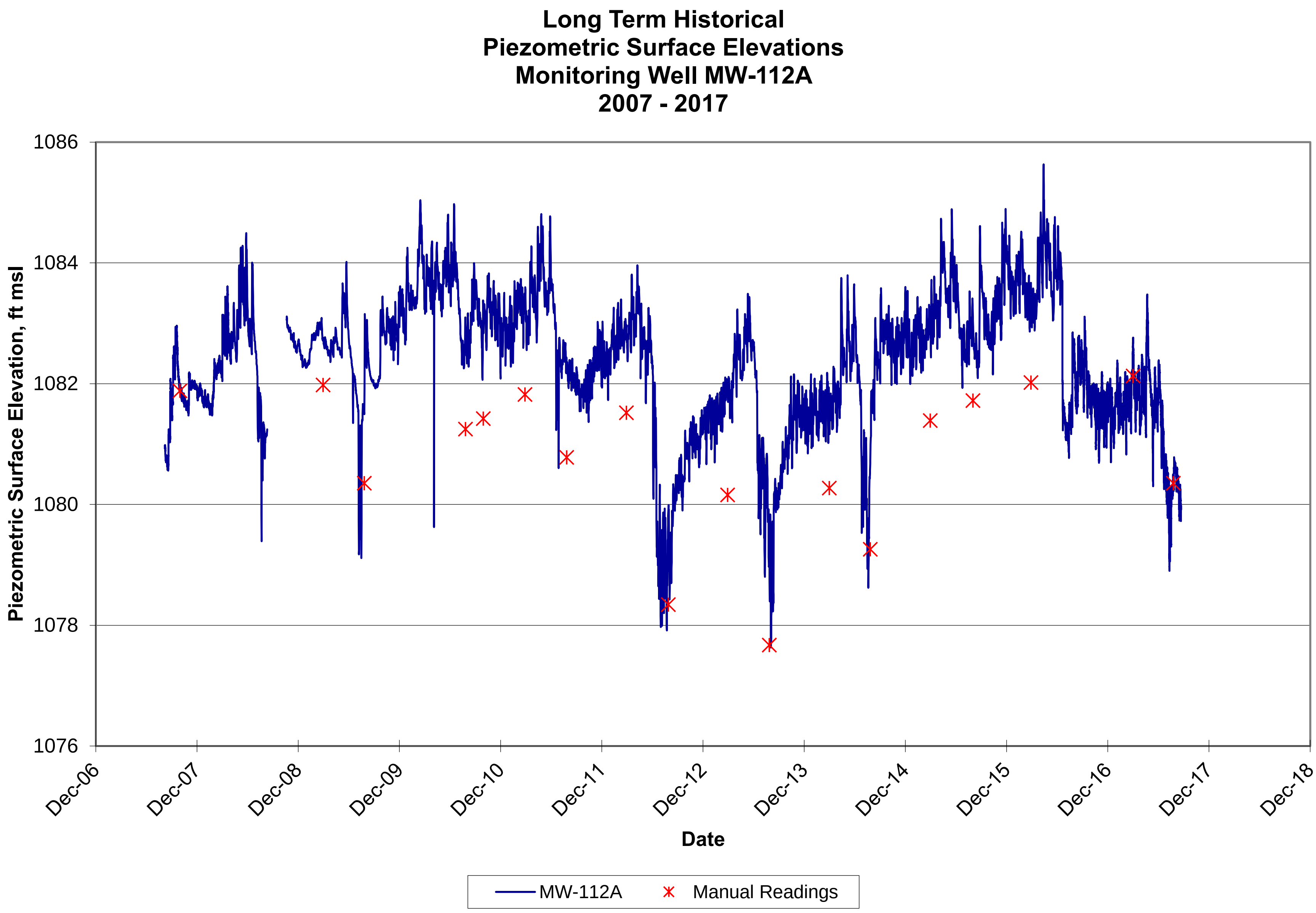



Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location MW-56A
2007 - 2017
1112
1110
1108
1106
1104
1102
Piezometric Surface Elevation (ft msl)
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Date
MW-56A
Manual Readings



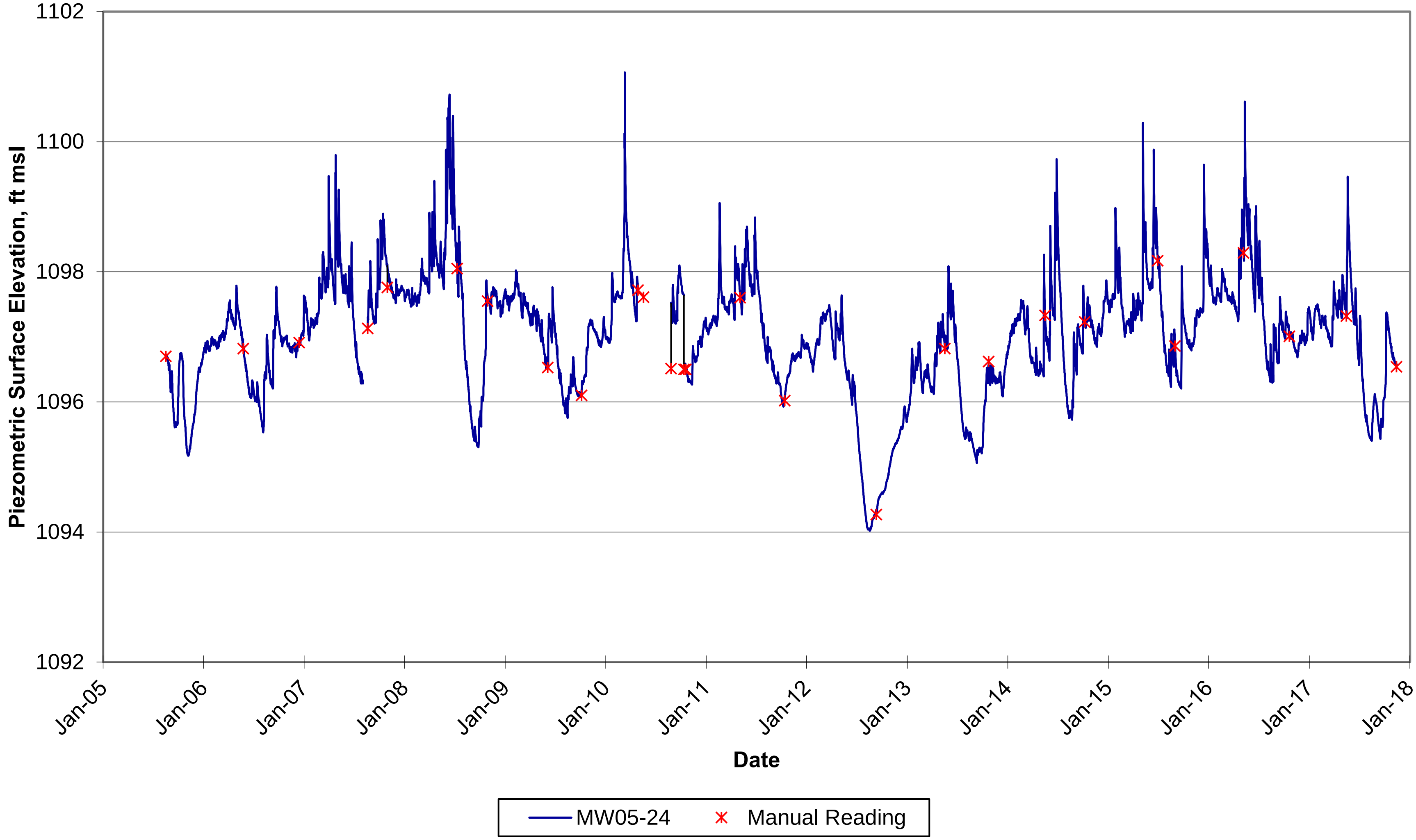
Long Term Historical
Piezometric Surface Elevations
Monitoring Well MW-106A
2007 - 2017
1104
1102
1100
1098
1096
1094
1092
1090
Piezometric Surface Elevation, ft msl
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Date
MW-106A
Manual Reading

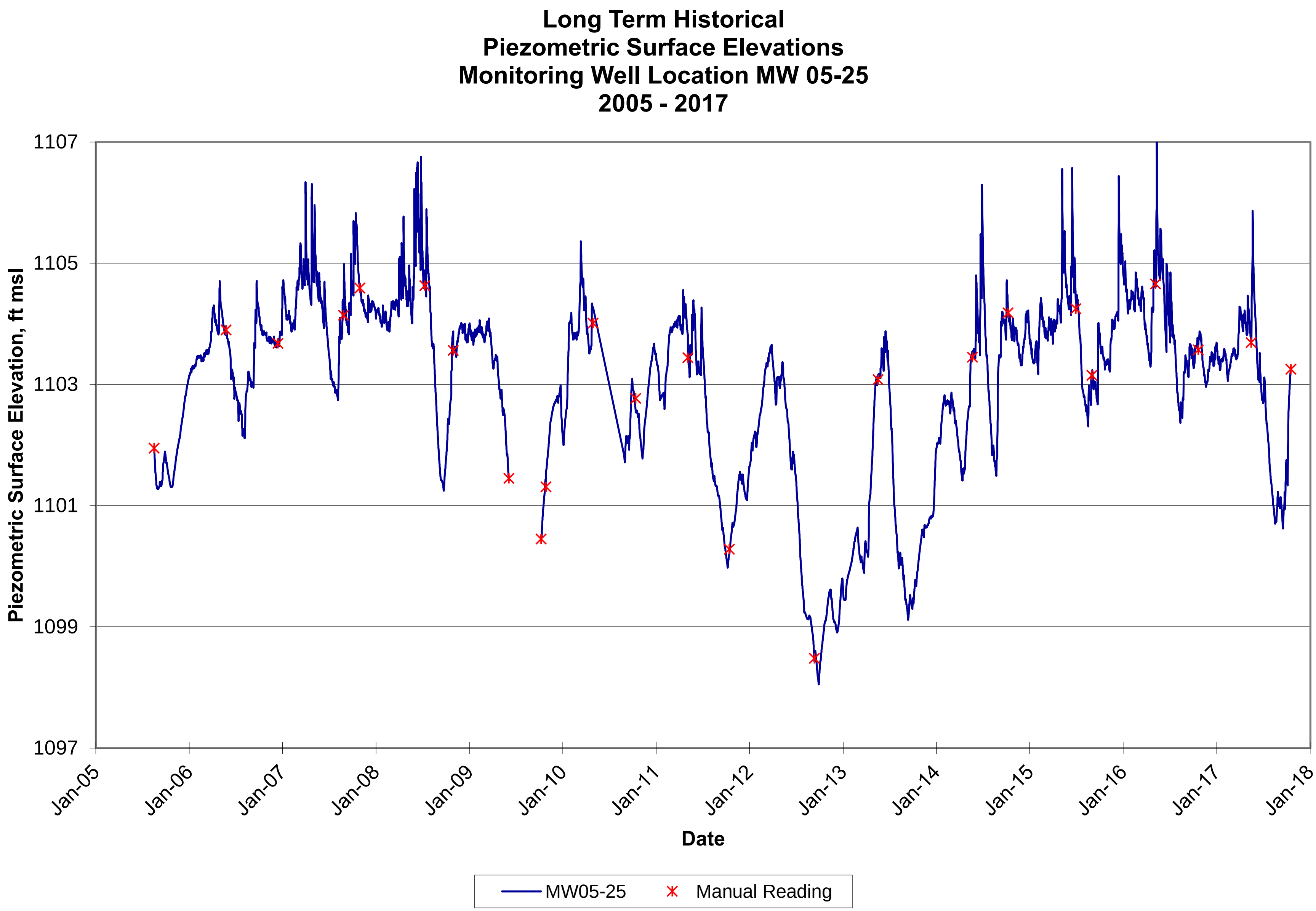

Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location MW-110A
2007 - 2017
1092
1090
1088
1086
1084
1082
1080
Piezometric Surface Elevation, ft msl
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
May-15
May-16
May-17
Date
MW-110A
Corrected Elevation Data
Manual Readings


Long Term Historical
Piezometric Surface Elevations
Monitoring Well MW-112A
2007 - 2017
Piezometric Surface Elevation, ft msl
1086
1084
1082
1080
1078
1076
Dec-06
Dec-07
Dec-08
Dec-09
Dec-10
Dec-11
Dec-12
Dec-13
Dec-14
Dec-15
Dec-16
Dec-17
Dec-18
Date
MW-112A
Manual Readings

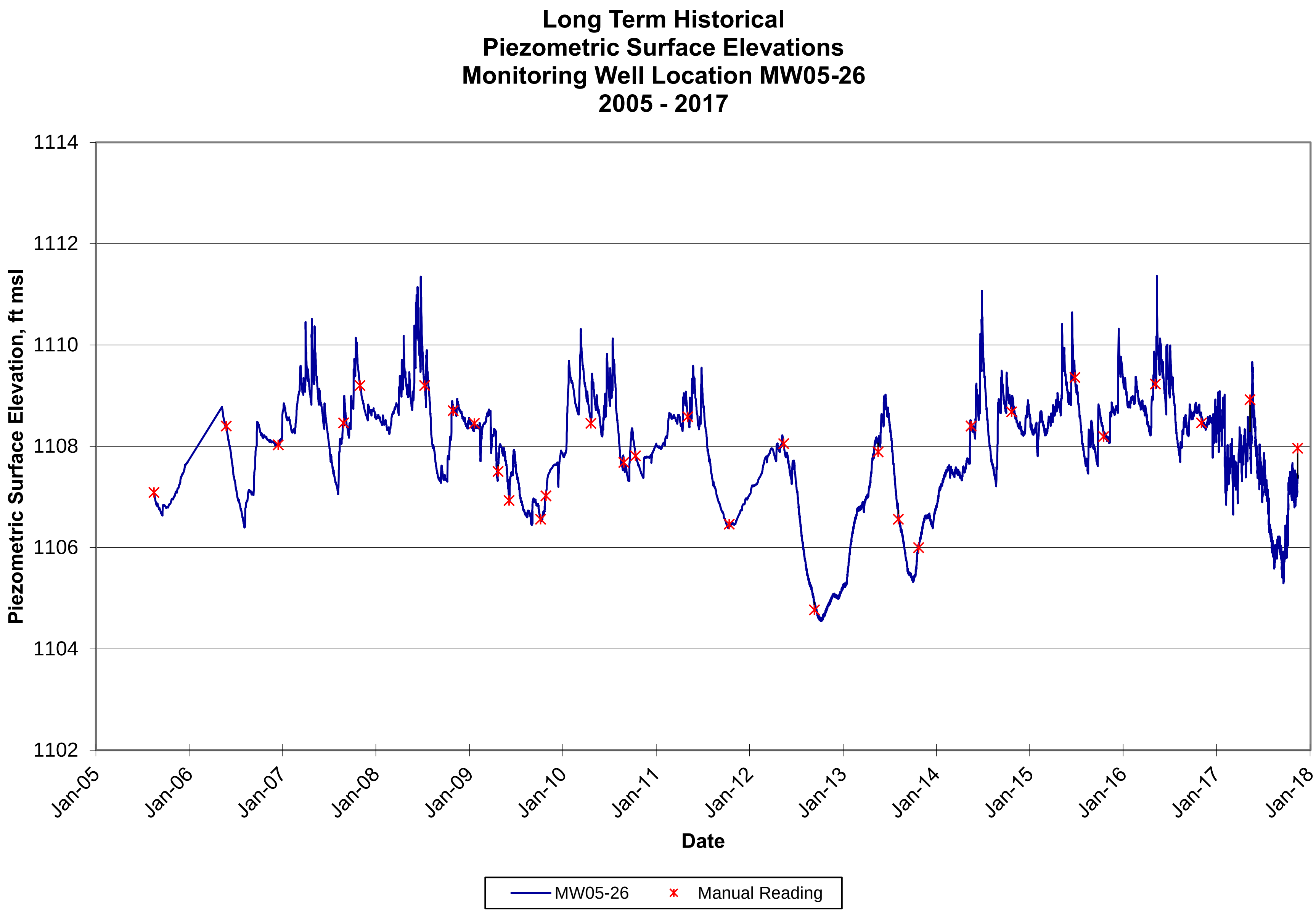
Douglas County Wells

Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location MW05-24
2005 - 2017

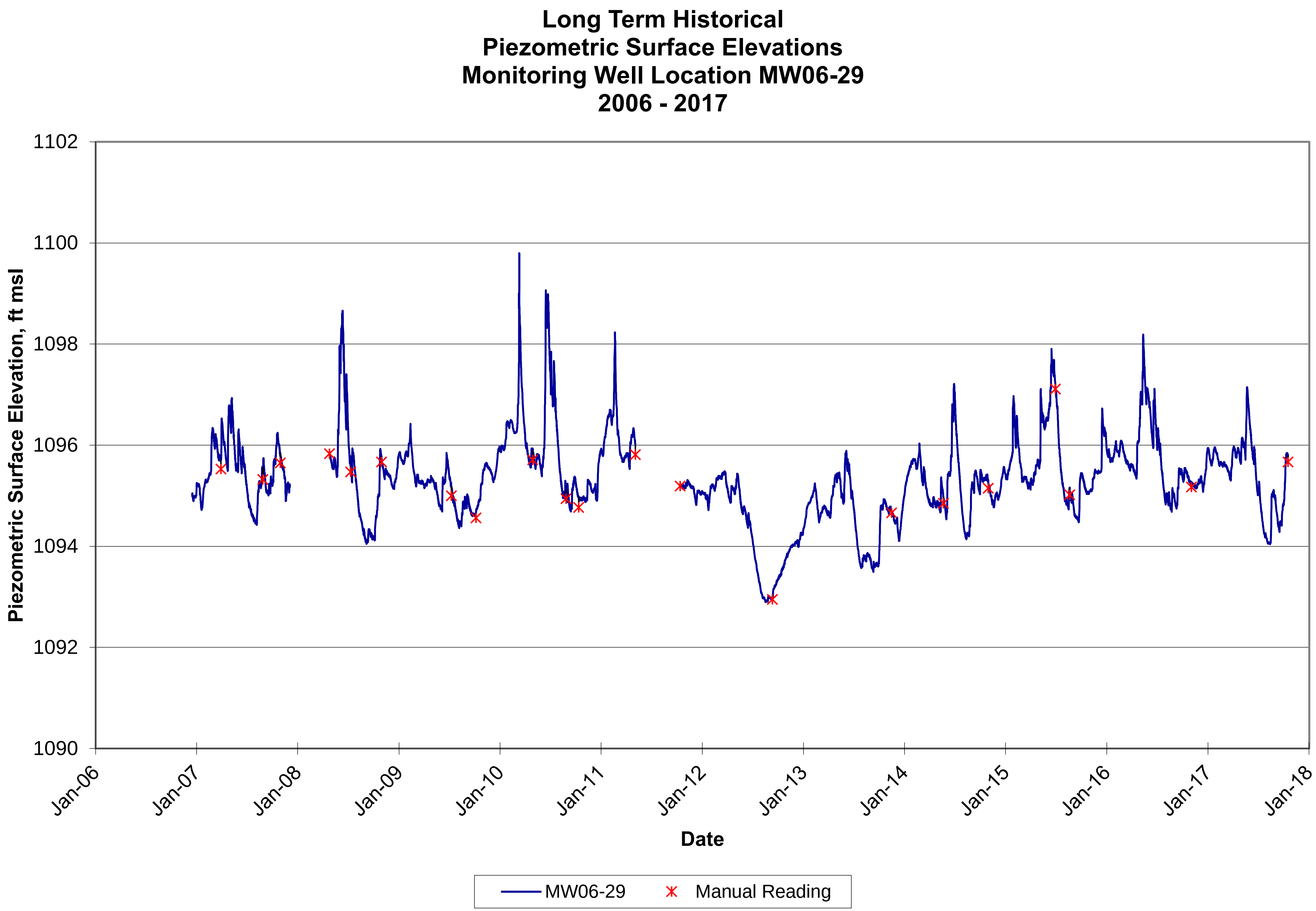




Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location MW 05-25
2005 - 2017
Piezometric Surface Elevation, ft msl
1107
1105
1103
1101
1099
1097
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Date
MW05-25
Manual Reading

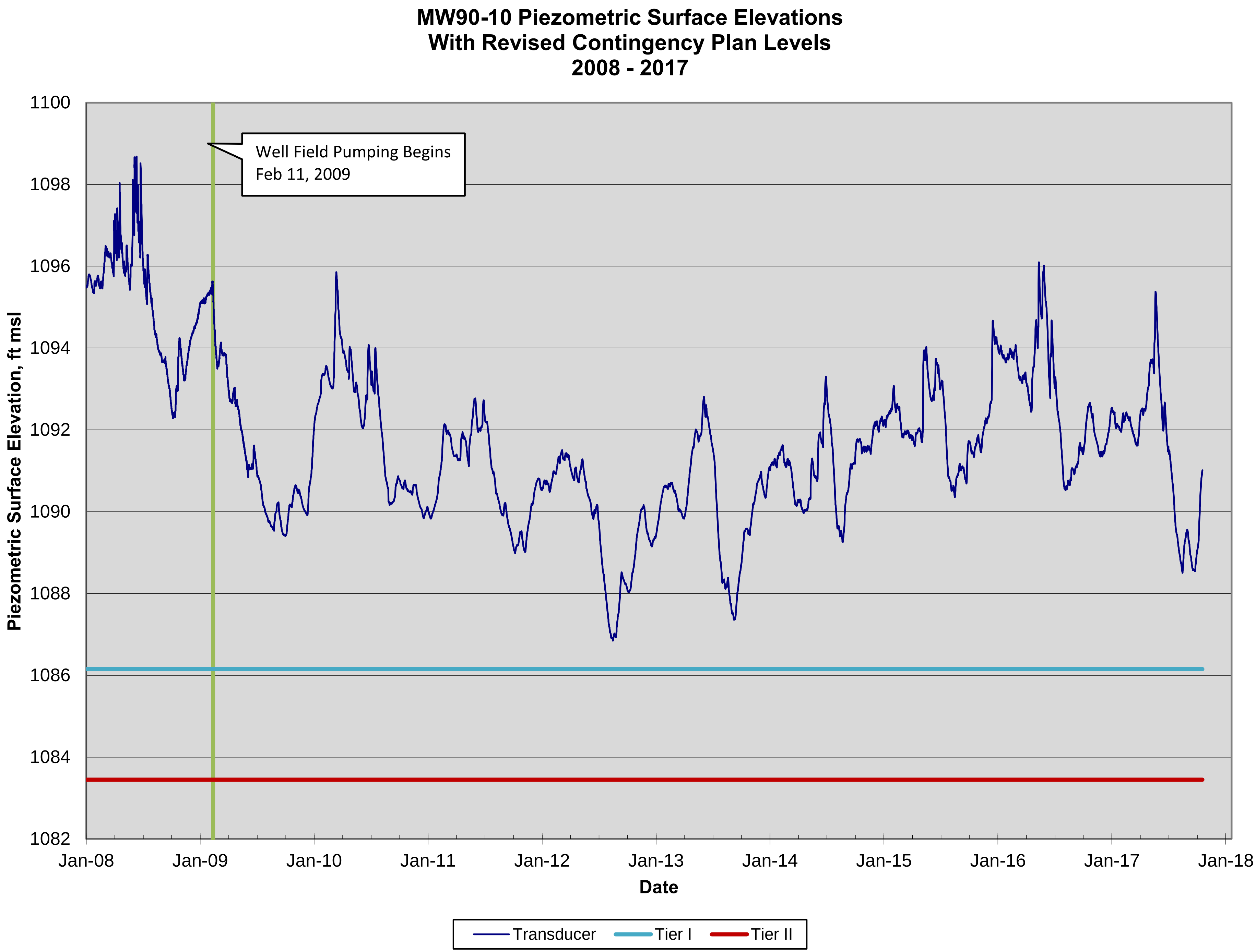


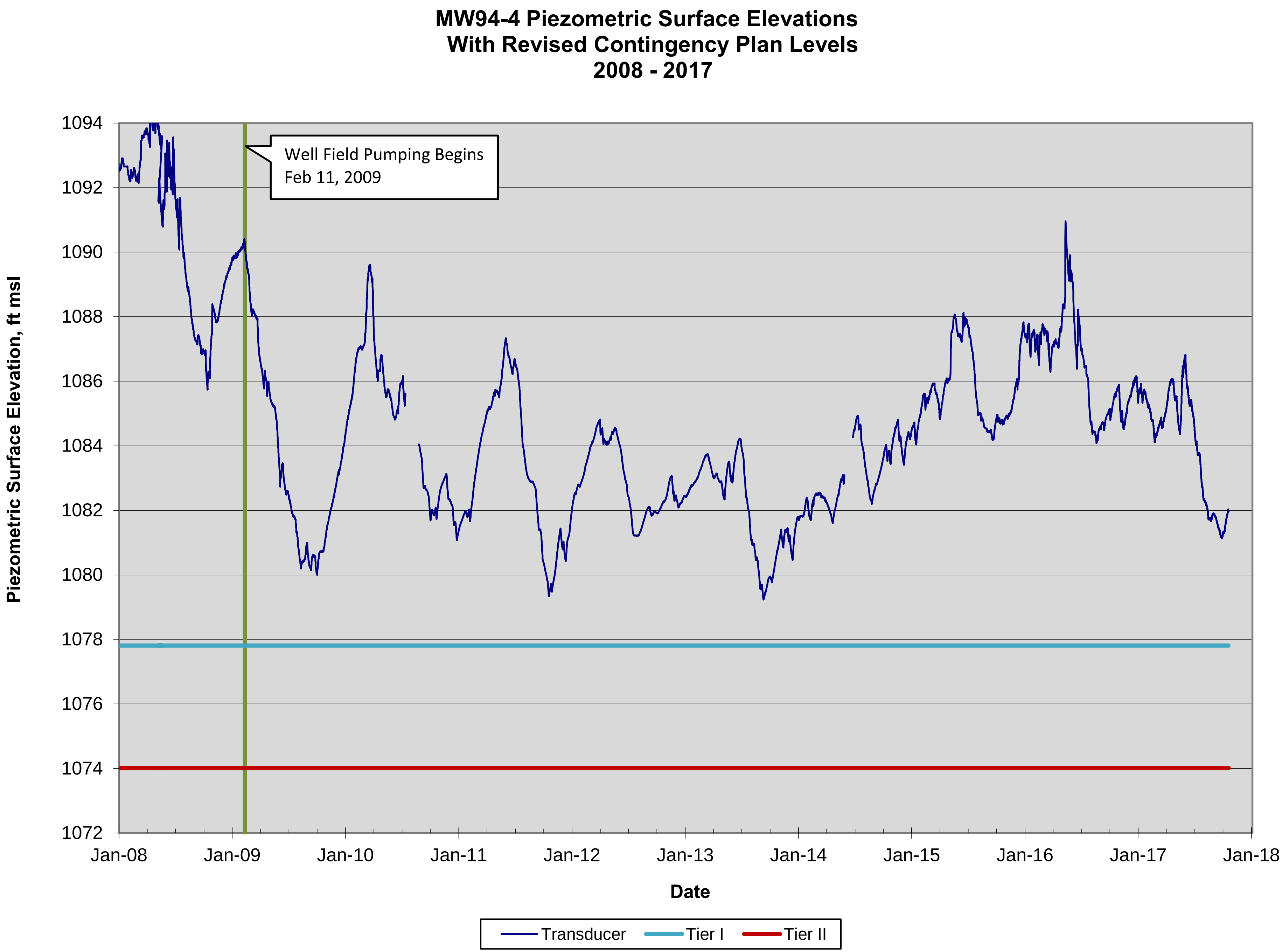
Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location MW05-26
2005 - 2017
Piezometric Surface Elevation, ft msl
1114
1112
1110
1108
1106
1104
1102
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Date
MW05-26
Manual Reading



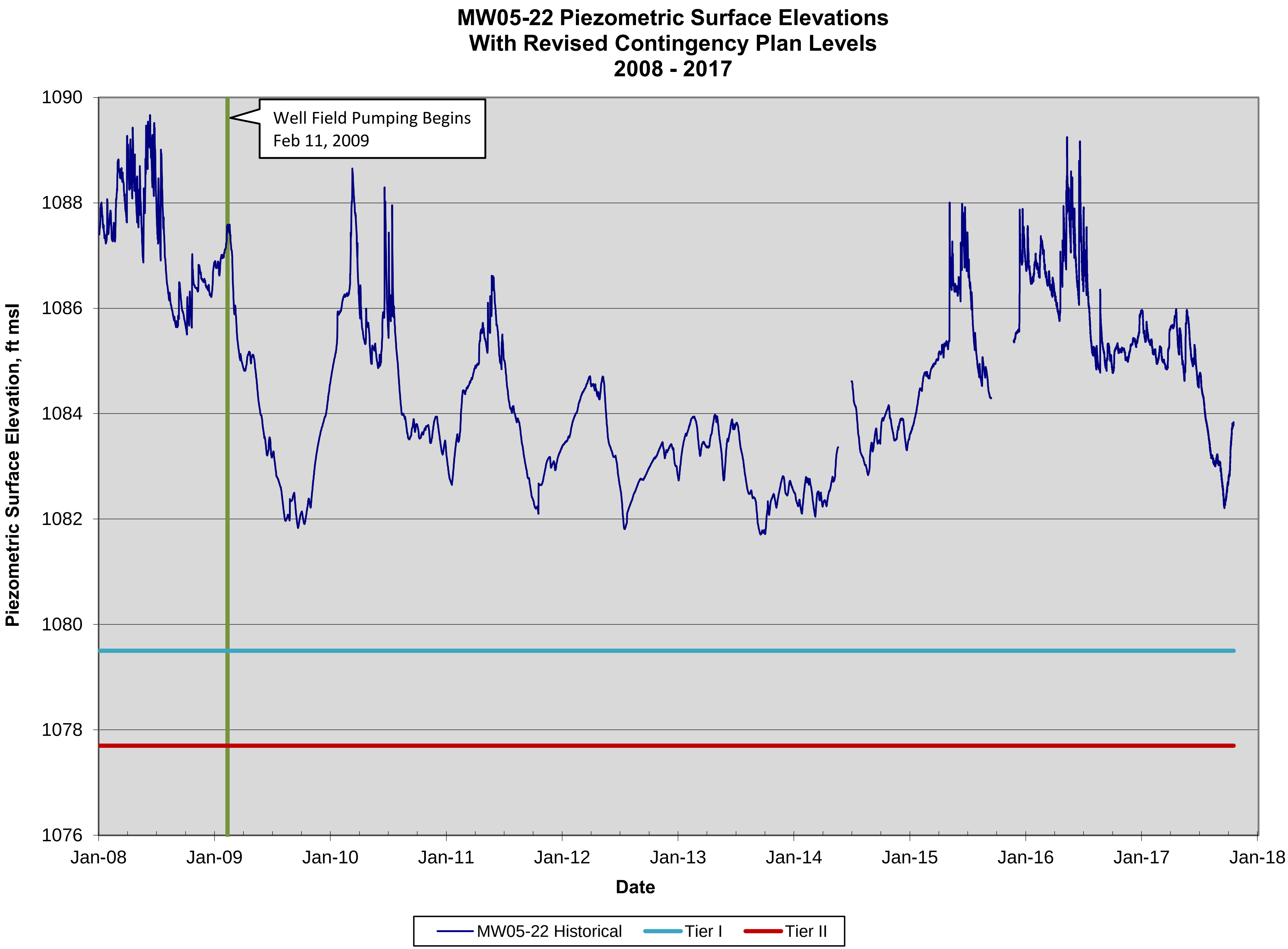
Long Term Historical
Piezometric Surface Elevations
Monitoring Well Location MW06-29
2006 - 2017
Piezometric Surface Elevation, ft msl
1102
1100
1098
1096
1094
1092
1090
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Date
MW06-29
Manual Reading

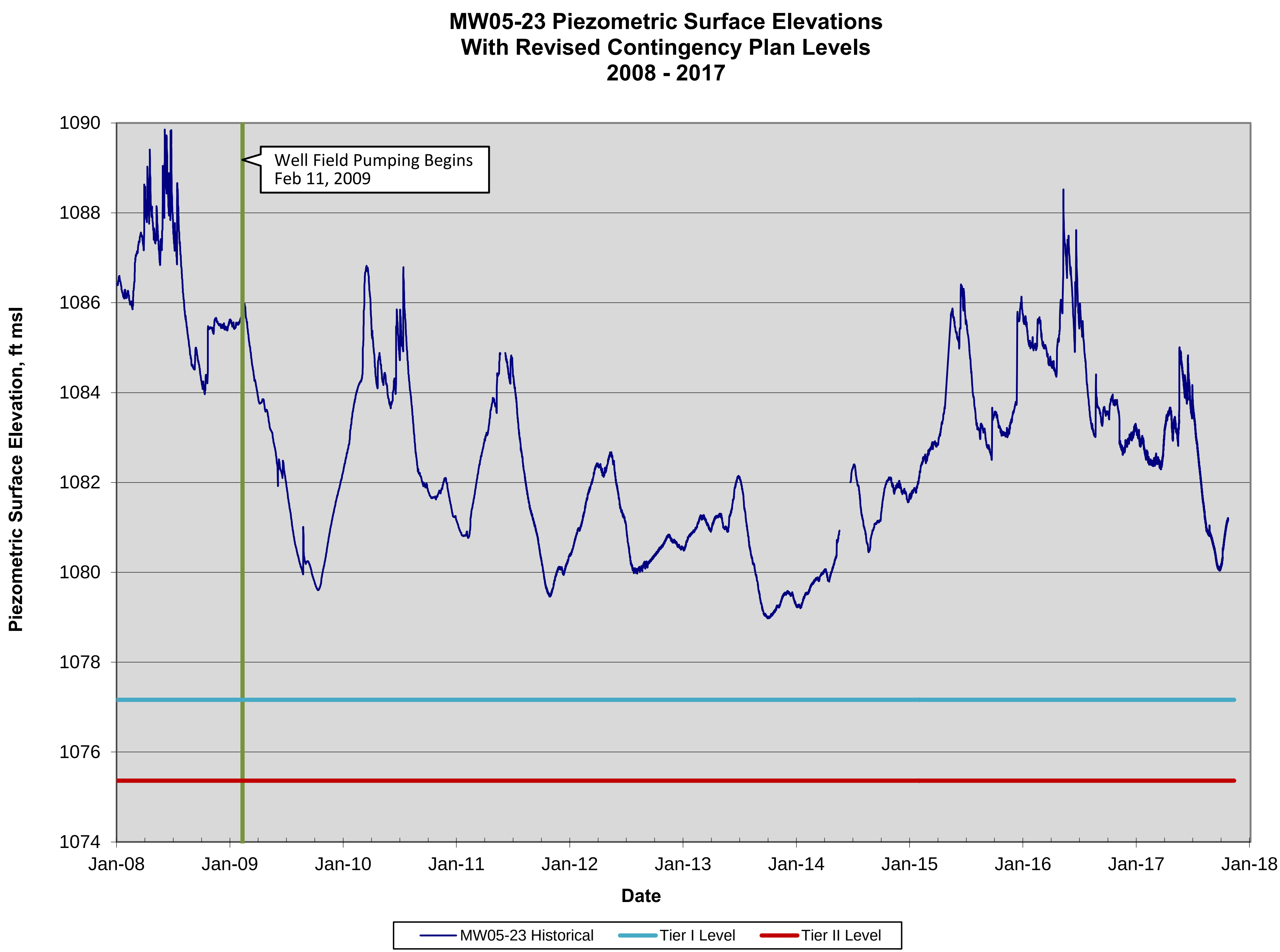
APPENDIX 3-3 - CONTINGENCY PLAN WELL HYDROGRAPHS


MW90-10 Piezometric Surface Elevations
With Revised Contingency Plan Levels
2008 - 2017
Well Field Pumping Begins
Feb 11, 2009
Piezometric Surface Elevation, ft msl
1100
1098
1096
1094
1092
1090
1088
1086
1084
1082
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Date
Transducer
Tier I
Tier II

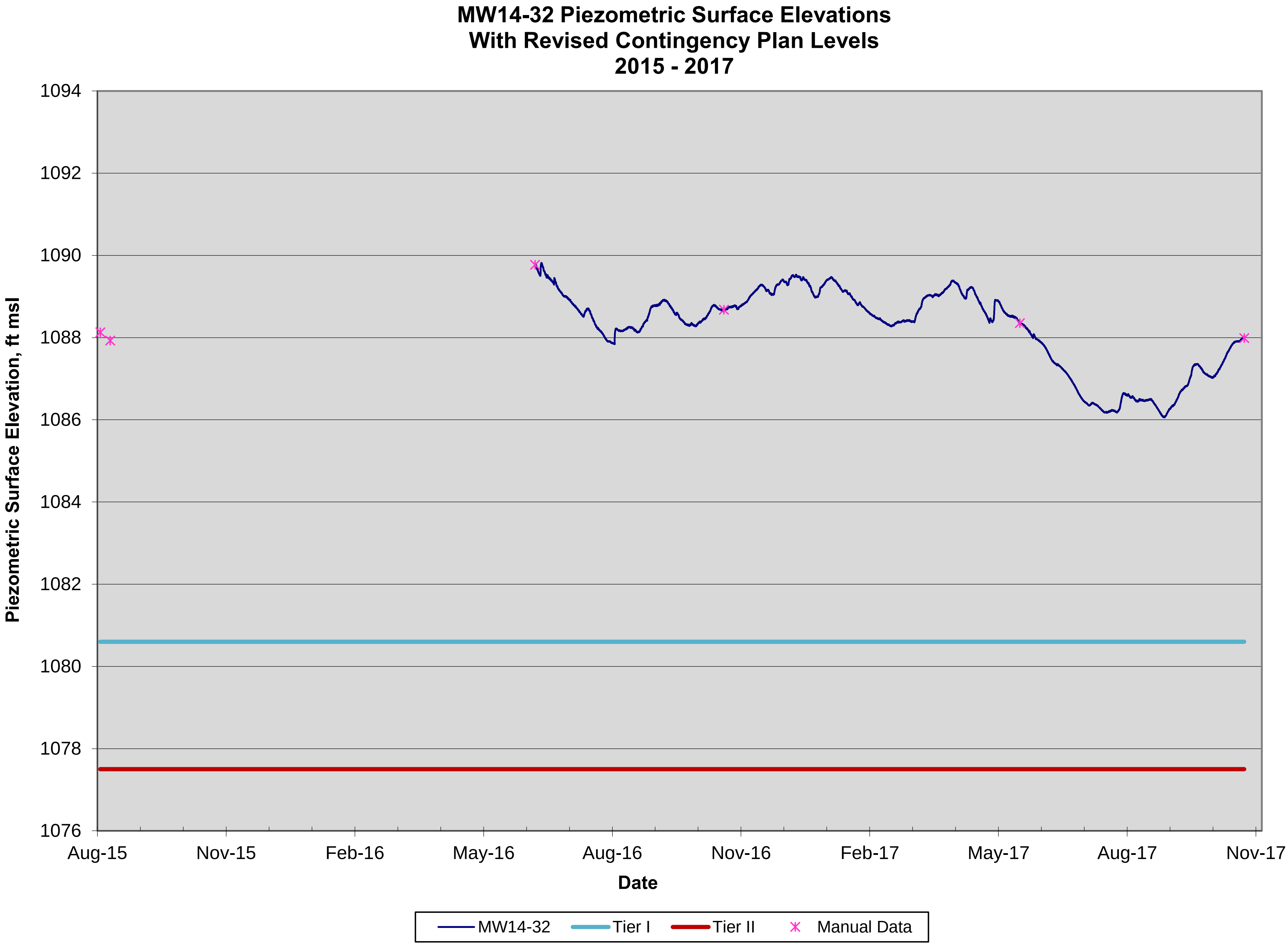


MW94-4 Piezometric Surface Elevations
With Revised Contingency Plan Levels
2008 - 2017
Well Field Pumping Begins
Feb 11, 2009
Piezometric Surface Elevation, ft msl
1094
1092
1090
1088
1086
1084
1082
1080
1078
1076
1074
1072
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Date
Transducer
Tier I
Tier II

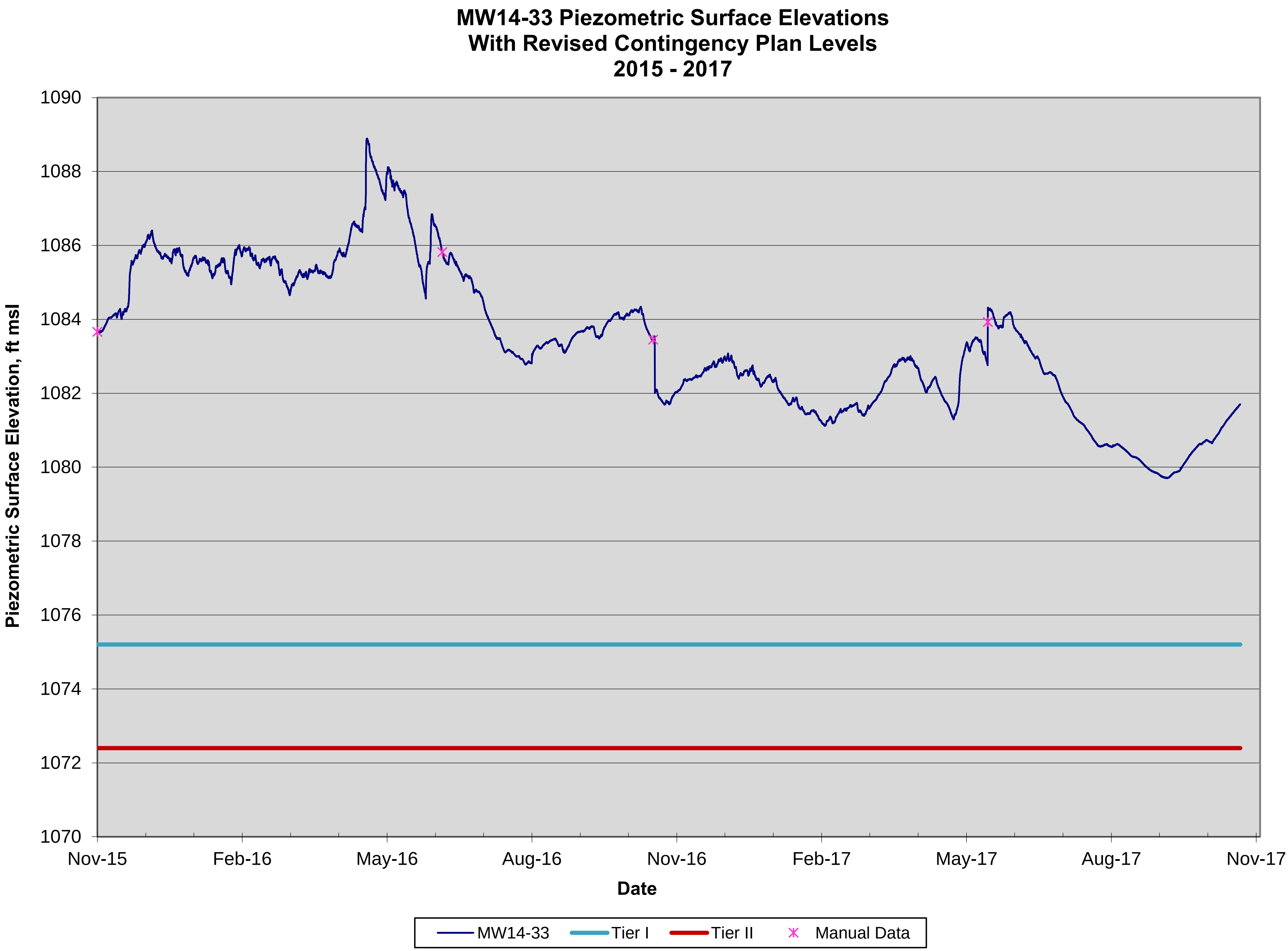

MW05-22 Piezometric Surface Elevations
With Revised Contingency Plan Levels
2008 - 2017
Well Field Pumping Begins
Feb 11, 2009
Piezometric Surface Elevation, ft msl
1090
1088
1086
1084
1082
1080
1078
1076
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Date
MW05-22 Historical
Tier I
Tier II



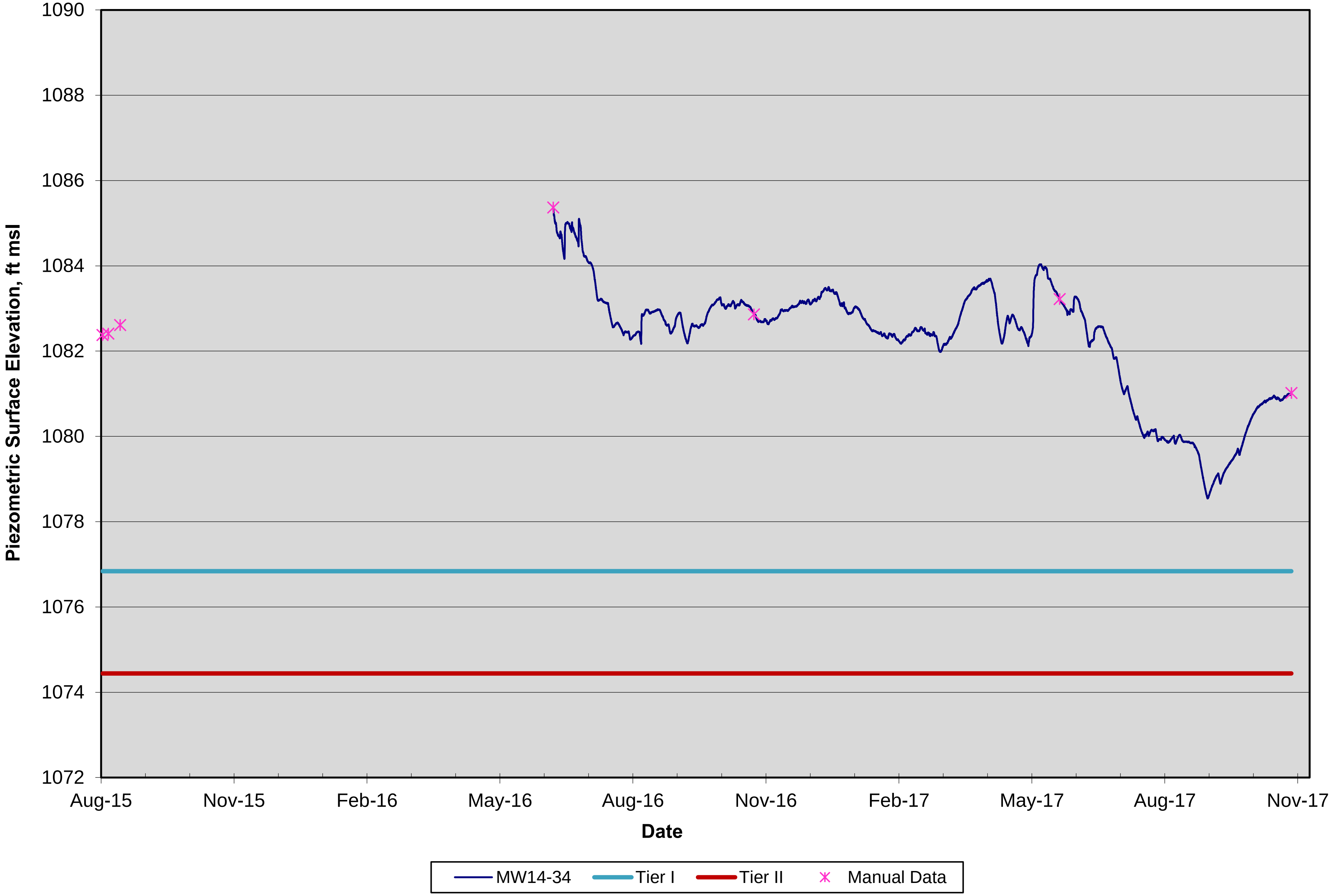
MW05-23 Piezometric Surface Elevations
With Revised Contingency Plan Levels
2008 - 2017
Well Field Pumping Begins
Feb 11, 2009
Piezometric Surface Elevation, ft msl
1090
1088
1086
1084
1082
1080
1078
1076
1074
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Date
MW05-23 Historical
Tier I Level
Tier II Level



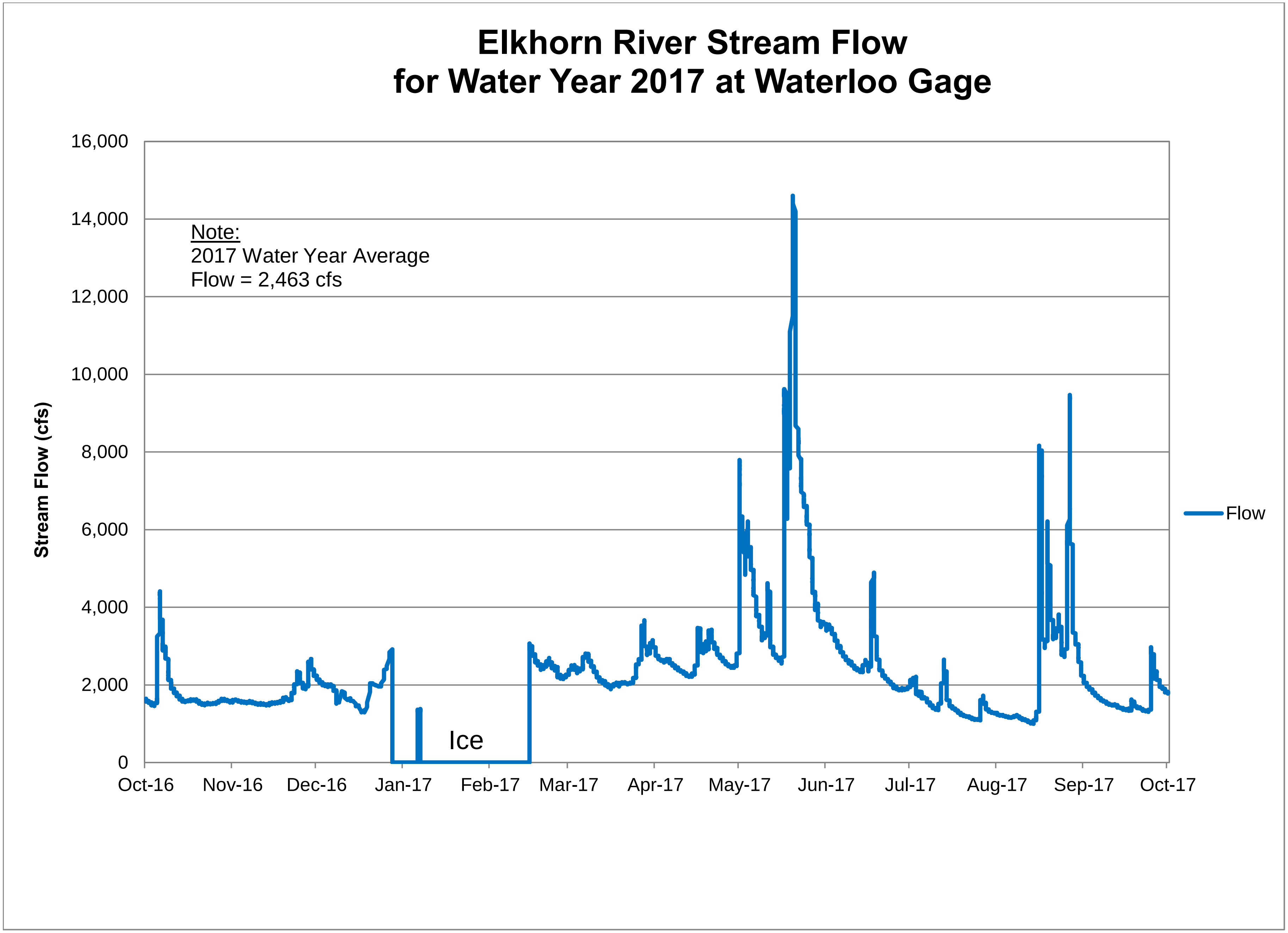
MW14-32 Piezometric Surface Elevations
With Revised Contingency Plan Levels
2015 - 2017
Piezometric Surface Elevation, ft msl
1094
1092
1090
1088
1086
1084
1082
1080
1078
1076
Aug-15
Nov-15
Feb-16
May-16
Aug-16
Nov-16
Feb-17
May-17
Aug-17
Nov-17
Date
MW14-32
Tier I
Tier II
Manual Data


MW14-33 Piezometric Surface Elevations
With Revised Contingency Plan Levels
2015 - 2017
Piezometric Surface Elevation, ft msl
1090
1088
1086
1084
1082
1080
1078
1076
1074
1072
1070
Nov-15
Feb-16
May-16
Aug-16
Nov-16
Feb-17
May-17
Aug-17
Nov-17
Date
MW14-33
Tier I
Tier II
Manual Data

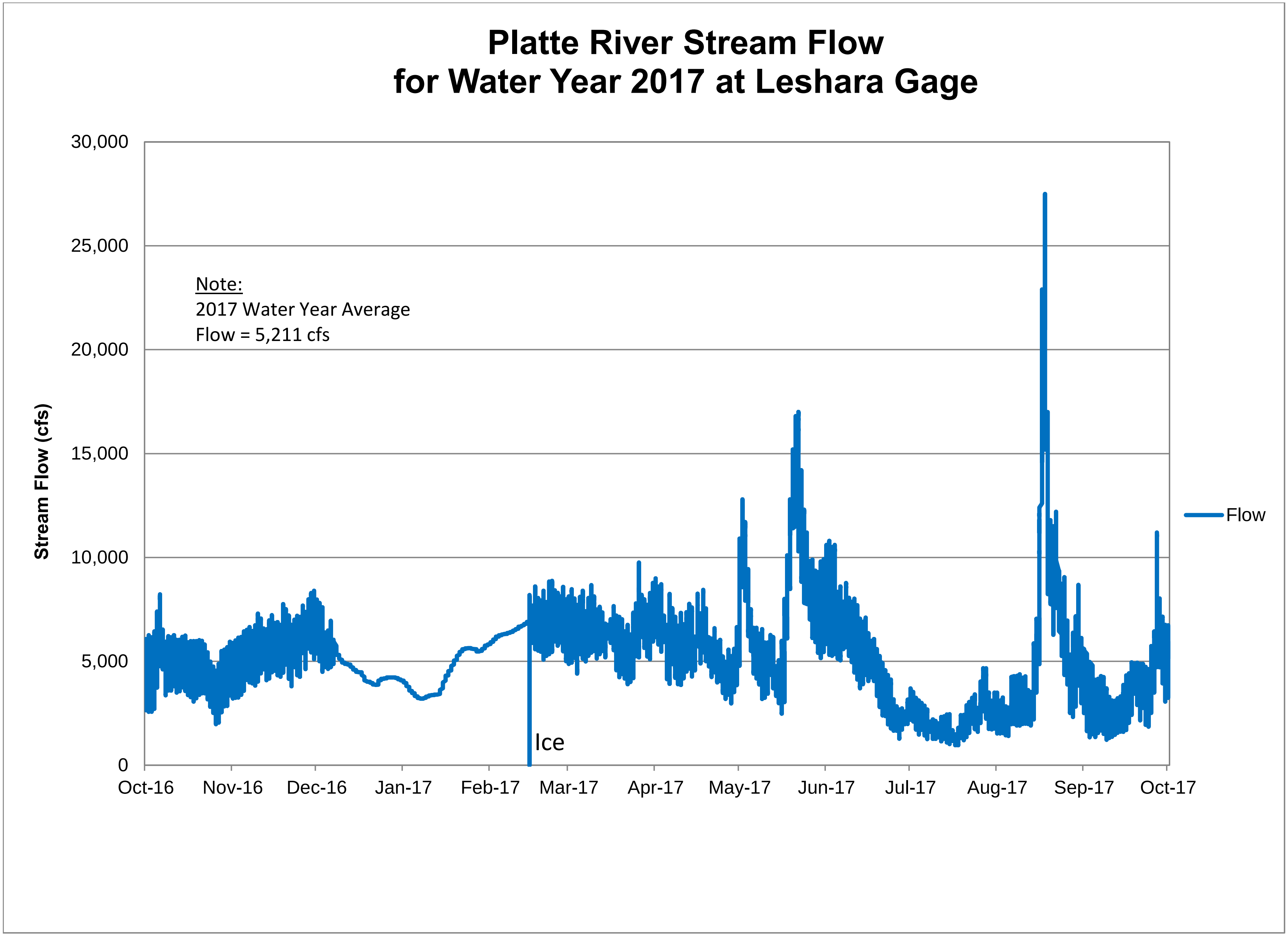
MW14-34 Piezometric Surface Elevations
With Revised Contingency Plan Levels
2015 - 2017



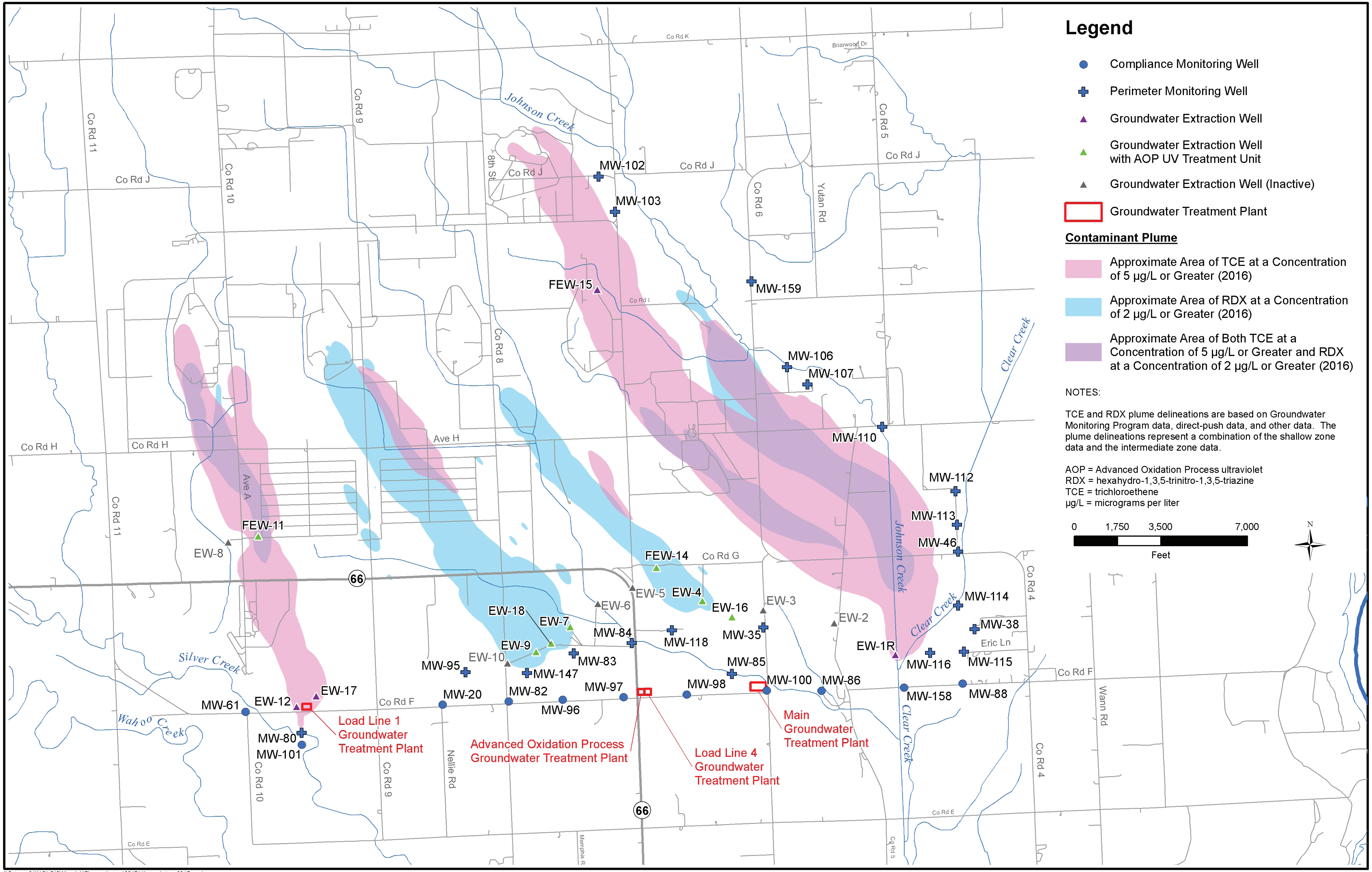
APPENDIX 3-4 - PLATTE AND ELKHORN RIVER STREAMFLOW DATA



Elkhorn River Stream Flow
for Water Year 2017 at Waterloo Gage
Note:
2017 Water Year Average
Flow = 2,463 cfs
Ice
Stream Flow (cfs)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Flow


Platte River Stream Flow
for Water Year 2017 at Leshara Gage
Note:
2017 Water Year Average
Flow = 5,211 cfs
Ice
Stream Flow (cfs)
30,000
25,000
20,000
15,000
10,000
5,000
0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
Oct-17
Flow

APPENDIX 4-1 - FNOP PLUME BASELINE



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APPENDIX 4-2 - CHEMICAL SAMPLING DATA

Provided electronically