FINAL

2010 NEBRASKA ORDNANCE PLANT GROUNDWATER REPORT

METROPOLITAN UTILITIES DISTRICT WELL FIELD, NEBRASKA

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STANDARD LIST - GLOSSARY OF TERMS AND ABBREVIATIONS

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. Are sources of groundwater for wells and springs.

bgs: Below Ground Surface

CENWK: Kansas City District Corps of Engineers

CENWO: Omaha District Corps of Engineers

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

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

NDNR: Nebraska Department of Natural Resources

NOPGR: Nebraska Ordnance Plant Groundwater Report

NRMS: Normalized root mean square error. The NRMS error is the standard deviation of a series of measurements divided by the range of observed values.

NWIS: National Water Information System

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

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.

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

USACE: U.S. Army Corp of Engineers

USEPA: United States Environmental Protection Agency

USGS: U.S. Geological Survey

1 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. As a result, this project has increased MUD's peak day raw water capacity by 100 million gallons per day (mgd) to the current maximum of approximately 334 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 battery of pumping wells, maintained by the United States Army Corps of Engineers (USACE).

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. The report is organized as follows:

- **Section 1** – Introduction
- **Section 2** – Well Field Pumping
- **Section 3** – Hydrologic Data Analysis
- **Section 4** – Water Quality Data Analysis
- **Section 5** – Groundwater Model Simulations
- **Section 6** – Summary and Conclusions

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 well field consists of 42 production wells that pump water from the Platte River alluvial aquifer. The raw water is delivered to a new 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 on a 158 acre site northeast of the intersection of Q and 216th Streets. The well field and study are 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 groundwater data collected from wells within the well field's monitoring network. An additional requirement of the permit is semi-annual updating of the 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 are 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 NOGPR 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.

1.3 SUMMARY OF PREVIOUS MODELING

The groundwater modeling activities presented in this NOPGR are a continuation 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, two 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 *Platte West Well Field/Groundwater Modeling Study* (Chatman and Associates, Inc., 2005).

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 the 32 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 Phase IV post-well field startup modeling activities were summarized in the 2009 NOPGR, which was structured as a model post audit. Model post audits are performed to evaluate the predictive capabilities of groundwater models. The purpose of the 2009 NOPGR post audit was to check the accuracy of the model predicted water level elevations and aquifer drawdown against measured data collected from monitoring wells located within a few miles of the well field. The essential component to the post audit was to input the actual flow rates for each production well and then compare the model-predicted drawdown to the observed drawdown at 19 monitoring well sites equipped with pressure transducers/data loggers. A second component of the post audit was to compare the model-predicted potentiometric surface to the observed potentiometric surface for an available data set, collected at the end of March 2009 when the well field had been operating for approximately one and a half months. The third component of the post audit procedure was to compare the model-predicted well field drawdown as presented in the Phase I model (predicted in 2003) to the observed drawdown in the aquifer (observed in 2009).

The results of the post audit show that the groundwater model accurately predicted the impact of well field operations on the Platte River 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. 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 River alluvial aquifer.

1.4 SCOPE OF SERVICES

In accordance with the Permit, a third party consultant is to assist MUD in the preparation of the NOPGR. This scope of services includes evaluation of hydraulic and water quality data to determine the impact of the well field on both the groundwater elevations and chemistry of the aquifer, as well as updating the existing groundwater flow model. In accordance with the Permit, the groundwater model was developed to depict the influence, if any, of the well field on the FNOP contaminant plumes, the FNOP operating remedial system, and other area water users. Additionally, 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.

1.4.1 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 analyses performed from 2003 through 2009. If specific questions related to model construction, calibration, or sensitivity analysis arise during the review of the 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).

If copies are not available to the reviewer, the documents can be downloaded on the MUD website, at the following URL:

- Phase I report:http://www.mudomaha.com/plattewest/documents/2004/11.04/report1.pdf
- Phase II report:http://www.mudomaha.com/plattewest/documents/2005/10.05/report.pdf
- 2008 NOPGR:http://www.mudomaha.com/plattewest/documents/2009/08.groundwater.report.pdf
- 2009 NOPGRhttp://www.mudomaha.com/plattewest/documents/2010/09.report.figures.tables.pdf

1.4.2 REPORTING PERIOD

The reporting period for this NOPGR coincides with the United States Geological Survey (USGS) 2010 Water Year, from October 1(of 2009) to September 30 of the following year (2010). This reporting period structure will be used in future model update reports.

2 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 the reporting period of September 2010. 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 HDR and are used to calculate the pumping rates input into the NOPGR modeling update. A chart illustrating the daily well field pumping rate for the 2010 water year has been included as Figure 2-1.

For the 2010 water year, the total daily pumping rate fluctuated from a low of 15 mgd, recorded in October 2009 to a high of 71 mgd recorded in August 2010. The average daily pumping rate, an average of the data presented on Figure 2-1, observed over the twelve month pumping period was 32.6 mgd. Average monthly flow rates are summarized in the table below.

Table 2-1 Average Well Field Pumping Rate by Month (Oct 2009 to Sep 2010)

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep
Douglas Co. Monthly Average Pumping (mgd)	5.1	3.5	10.1	11.6	7.2	5.9	9.3	10.6	12.6	14.9	15.8	11.5
Saunders Co. Monthly Average Pumping (mgd)	23.3	20.7	12.8	13.9	13.9	16.7	18.8	25.7	28.6	30.7	35.9	30.3
Totalized Well Field Monthly Average Pumping, (mgd)	28.4	24.2	22.9	25.5	21.1	22.6	28.1	36.3	41.2	45.55	51.7	41.8
Percentage of Well Field Flow from Douglas Co.	18.0	14.5	44.1	45.5	34.1	26.1	33.1	29.2	30.6	32.6	30.5	27.5

2.1 PUMPING DISTRIBUTION

The operational plan for well field has always been 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. As shown in the table above (Table 2-1), the pumping distribution for the 2010 water year remained close to the design distribution, with an average of 30.4 percent of the total flow being supplied by the Douglas County side of the well field. As operated, the average daily pumping distribution was 9.9 mgd from the Douglas County wells and 22.7 mgd from the Saunders County wells.

2.1.1 SAUNDERS COUNTY SECTION 19 WELLS

The water supply wells located in Section 19 (Saunders County) were classified as storage wells in EIS groundwater flow model (Burns & McDonnell, 2002), meaning that the majority of the water pumped by these wells was removed from aquifer storage and not from induced infiltration of the Platte River. The importance of these wells in limiting the extents of the cone of depression in Saunders County was noted during the Phase I groundwater modeling activities, (Chatman and Associates, Inc., 2004). As a result of the Phase I modeling, three water supply wells planned in the southwest portion of Section 19 were moved towards the river, decreasing the total number of wells in this section from 12 to nine (9).

To evaluate the recovery of the aquifer from extended pumping, and to test the ability of the groundwater model to reproduce the aquifer recovery, MUD shut off all nine pumping wells located in Section 19 from the beginning of November 2009 through the end of February 2010. Previously, 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 wells in Section 19 is discussed in detail in Sections Three and Five of this report.

3 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 gauges.

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. 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 the 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 at least twice yearly 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 15 to 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 (MW 90-4; MW90-5, MW 90-6, MW 90-7, MW 90-12, MW 90-13, MW 94-1, and MW 94-2) and six (6) monitoring wells in Saunders County (MW 90-10, MW 94-3, MW 94-4, MW 94-5, MW 94-6, and MW 94-7). The updated hydrographs presented in Appendix 3-1 include water level data through the end of the NOPGR reporting period.

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.

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 41 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. 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. In Douglas County, these wells include: MW90-5, MW90-6, MW90-7, MW90-12, MW90-13, MW94-1, MW94-2, MW05-24, MW05-25, MW05-26, and MW06-29. In Saunders County, these wells include: MW90-10, MW94-3, MW94-4, MW94-5, MW94-6, MW94-7, MW04-17, MW05-22, MW05-23, MW06-27, MW06-28, MW06-30, and MW06-31. These wells are all operated and maintained by MUD. Monitoring wells MW04-17, MW05-24, and MW-05-25 experienced transducer failures during the 2010 reporting period. New pressure transducers/data loggers were installed in each of these wells after the failure of the installed equipment was noted; however, due to the transducer failures, some data gaps exist in the hydrographs generated for these wells.

Hydrographs were also generated for wells located in Saunders County that are not operated and maintained by MUD. These include the following wells, which are operated and maintained by the USACE: MW-56A, MW-106A, MW-110A, and MW-112A. Additionally, the following wells, which are operated and maintained by the LPNNRD, were included in the analysis: MW06-18, MW06-19, MW06-20, and MW06-21. Some gaps exist in the data sets available for the wells that are not owned or maintained by MUD. All data provided to HDR as of January 4, 2011 has been used to develop the hydrographs presented in this section.

3.1.1.1 RESPONSE OF WELLS NEAR WELL FIELD

Focused water level hydrographs, (January 2009 through September 2010) for each of the above listed wells have been included in Appendix 3-2. The impact of well field pumping on groundwater levels in the monitoring wells near the well field is clearly observed from February 2009 through November 2009. In November 2009, pumping from the supply wells in Section 19 stopped and water levels begin to recover almost immediately in response to the reduction in pumping. This groundwater recovery is most easily observed in the monitoring wells located closest to the well field, which include MW90-10, MW94-4, MW05-22, and MW05-23. Groundwater levels in the monitoring wells located near the well field continued to recover at a near linear rate until approximately March 2010, when high streamflow values observed in the Platte River caused the river stage to increase, which in turn caused a sudden and brief recharge spike in the groundwater elevations near the well field. Following March 2010, water levels near the well field declined for a period of time in response to pumping, but then recovered again in June in response to a second high streamflow event. The short duration groundwater recharge events that occur as a result of the rise in river stage are best observed in the hydrographs for MW94-3, MW94-4, MW05-22, and MW05-23.

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 MW94-3, MW94-5, MW 94-6, MW94-7, MW06-27, and MW06-28. The hydrographs developed for these wells show little to no long term changes in water level elevation that can be attributed to well field pumping. For each of these monitoring well sites, there is less than a one foot difference between the water level elevation measured before the well field started and the water level elevation measured at the end of September 2010. For the pumping that has occurred to date, this group of monitoring wells provides a clear delineation of the maximum extent of the cone of depression created by well field pumping, and the recovery of water levels that occurred during the period of high streamflow and limited pumping from Section 19.

Most of the monitoring wells operated and maintained by the USACE and LPNNRD are impacted by local irrigation pumping, and show 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. Careful review of these hydrographs shows that no long term changes in water level elevation have occurred that can be attributed to well field pumping.

3.1.2 POTENTIOMETRIC SURFACE

Contours of the potentiometric surface of the Platte River alluvial aquifer and the Todd Valley aquifer were developed using data collected during the LPNNRD coordinated water level monitoring event, using data collected at the end of March 2010. Water level measurements are taken by the following organizations in an effort to better document the potentiometric surface within Saunders County:

- LPNNRD,
- MUD,
- Kansas City District Corps of Engineers (CENWK), and
- United States Geological Survey (USGS).

Approximately 160 monitoring wells were used to develop the potentiometric surface map of the study area, the locations of which are shown on Figure 3-2. The magnitude and direction of the hydraulic gradient presented on Figure 3-2 are very similar to previous pre-pumping potentiometric surface maps generated by others, including:

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

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 one year of continuous pumping at an average flow rate of 34 mgd, including 24 mgd from 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.

Potentiometric surface maps created as part of previous NOPGR submittals have been included in Appendix 3-3 for comparison. As shown, the magnitude and direction of the hydraulic gradient as interpreted for March 2010 are consistent with previous interpretations from October 2008 and March 2009.

3.1.3 Contingency Plan Action Levels

Table 3-1 compares the observed water level elevations at each Well Field Contingency Plan monitoring well to the Tier 1 and Tier 2 action levels identified in that document (Layne Christensen, 2008b). In the Well Field Contingency Plan, a Tier 1 trigger level was defined as the water surface elevation that is one (1) foot lower than the anticipated post-startup groundwater elevation and a Tier 2 trigger level included the plausible additional lowering of the water surface elevation due to the natural seasonal changes on the groundwater levels. It is assumed the reviewers of this report have access to a copy of the Well Field Contingency Plan. If a copy is not available, the document can be downloaded on the MUD website, at the following URL:

- http://www.mudomaha.com/plattewest/documents/2008/wellfield.contingency.10.10.pdf

As shown on Table 3-1, only one water level elevation, observed at MW90-10 was below it's well specific Tier 1 value. However, the water level elevation at this well never dropped below the Tier 2 trigger level, therefore no further action is required by MUD at this time. The evaluation process followed to reach this conclusion is presented on the Tier 1 flow chart in the Well Field Contingency Plan (Layne Christensen, 2008b).

3.1.4 STREAMFLOW CONDITIONS

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

- Platte River – at Leshara;
- Platte River – at Venice (near the well field);
- Platte River – at Ashland; and
- Elkhorn River at Waterloo.

The locations of the USGS gauging stations are shown on Figure 3-5 of the Phase II modeling report; *Platte West Well Field/Groundwater Modeling Study* (Chatman and Associates, Inc., 2005). The Leshara gauge records stream discharge and stage, while the Venice gauge only records stream stage. The data obtained from the USGS gauging stations were used to develop a streamflow hydrograph and stage elevation hydrograph for each station, when applicable.

A shown on the hydrographs in Appendix 3-4, stream flow conditions for the 2010 water year within the study area reflected average (50 percent exceedance) streamflow conditions for most of the year, as defined in Section Two of the Phase II modeling study (Chatman and Associates, Inc., 2005). However, there were two significant short term high streamflow events on the Platte River that caused the river stage to increase, resulting in short periods of groundwater recharge. The high streamflow events were observed in March and June of 2010 and lasted approximately one month each. Streamflow values as high as 44,000 cfs were recorded at the Leshara gauge on the Platte River. The groundwater recharge that resulted from these high streamflow events was short lived as can be seen by reviewing the hydrographs presented in Appendix 3-2.

Streamflow conditions on the Elkhorn river also reflected average or above average stage and discharge conditions for much of the year. As with the Platte River, two high streamflow events were observed in the Elkhorn River, occurring in March and June of 2010. However, unlike the Platte River, the flooding which occurred in June 2010 set records for stream elevations at several upstream gauging stations. At the Waterloo gauge, stream discharge reached a near historic high of over 50,000 cfs. During this summer flood, stream stage increased over 10 feet during the June 2010 flooding. The June flood created a significant short duration groundwater recharge event for alluvial aquifer in Douglas County. The impact of the high stream elevations on groundwater can best be observed by reviewing the hydrographs for wells MW90-12 and MW90-13. The groundwater recharge event resulting from the June flood was short lived, as groundwater elevations had returned to normal conditions in September 2010. Flooding on the Elkhorn River did not impact groundwater elevations in the alluvial aquifer in Saunders County.

4 WATER QUALITY DATA ANALYSIS

The following section presents an analysis of the groundwater chemistry data collected as part of the monitoring program associated with the operation of the well field. The groundwater water 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 monitoring network includes wells owned by MUD and wells owned by CENWK. 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 or the remediation efforts at the FNOP site. Because the FNOP contaminant plumes and hydraulic containment system are located in Saunders County, only water quality data from Saunders County were incorporated into the analysis.

4.1 BASELINE FNOP PLUME

Prior to well field operations, MUD obtained the most recent interpretation of the extent of the FNOP contaminant plumes, as defined by CENWK. This interpretation of the pre-well field startup extent of the contaminant plumes is defined as the "plume baseline" as defined by CENWK in August 2008, and is presented in Appendix 4-1. Correspondence with CENWK indicates that the plume extents presented in Appendix 4-2 remain appropriate for use in the 2010 NOPGR.

4.1.1 HISTORICAL WATER QUALITY DATA

A groundwater quality monitoring program was initiated by MUD in 2005 to collect background, 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); and
- 2007 Annual Groundwater Monitoring Report (MUD, 2008).

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 2009 NOPGR WATER QUALITY DATA

Under an agreement with MUD, ASW Associates, Inc. (ASW) conducted two rounds of groundwater samples during this reporting period: May 2009 and November 2009. The wells sampled by ASW include wells MW-39, MW06-18, MW06-30, and MW06-31. The locations of these wells are shown on Figure 3-1. Shallow and deep samples were collected from these wells sites and were analyzed for volatile organic compounds (VOCs) by Environmental Protection Agency (EPA) SW-846 Method 8260B and for explosives by EPA SW-846 Method 8330. All laboratory analyses were performed by Test America, Inc. The samples were analyzed by Test America of Burlington, Vermont (ASW explosive samples) and Test America of Savannah, Georgia (ASW VOC samples).

The FNOP Contaminants of Concern (COCs), trichloroethene (TCE) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), were not detected above their method detection limit in any of the samples collected during the May 2009 sampling event. However, TCE and RDX were detected in samples collected from wells MW06-18S, MW06-18D, MW06-31A, and MW06-31B during the November 2009 sampling event. In response to the detections observed in the November 2009 sampling event, a monitoring well re-sampling event was performed by ASW in February 2010. CENWK personnel accompanied ASW field staff during the re-sampling event and collected a split sample of each groundwater sample collected. CENWK staff maintained custody of the split samples until shipment. The samples were analyzed by three separate labs: Test America of Burlington, Vermont (ASW explosive samples), Test America of

Savannah, Georgia (ASW VOC samples), and Test America St. Louis, Missouri (all CEWEK samples). No FNOP COCs were detected above their respective method detection limits in any of the samples collected (both ASW and CENWK samples) during the February 2010 re-sampling event.

The results of the February 2010 re-sampling event indicated that the detections from the November 2009 sampling event were invalid and were likely a result of a laboratory or field sampling error. However, to be cautious, the USACE placed wells MW06-18S, MW06-18D, MW06-31A, and MW06-31B into their regular quarterly groundwater monitoring program beginning in Spring 2010. These wells have been sampled twice as part of the USACE quarterly monitoring program, once in May 2010 (Second Quarter Event) and once in August 2010 (Third Quarter Event). No FNOP COCs have been detected above their respective method detection limits during the May or August quarterly monitoring events (ECC, 2010). A link to the reports which summarize this chemical data is provided (http://www.nwk.usace.army.mil/projects/mead/techinfo-samplingresults.cfm).

4.1.3 2010 NOPGR Water Quality Data

ASW Associates, Inc. (ASW) conducted two rounds of groundwater samples during this reporting period: May 2010 and Fall 2010. The wells sampled by ASW include wells MW-39, MW06-18, MW06-30, and MW06-31. The locations of these wells are shown on Figure 3-1. Shallow and deep samples were collected from these wells sites and were analyzed for volatile organic compounds (VOCs) by Environmental Protection Agency (EPA) SW-846 Method 8260B and for explosives by EPA SW-846 Method 8330.

The results of each sampling event were summarized by ASW in a Quality Control Summary Report (QCSR). The QCSR for the May 2010 sampling events has been included in Appendix 4-2. The QCSR for the Fall 2010 Monitoring Well Sampling Event was not received in time for inclusion in the report and will be included as a Supplement to this report when available. The FNOP COCs were not detected above their method detection limit in any sample.

5 GROUNDWATER MODEL SIMULATIONS

As discussed in Section One, a groundwater flow model was developed to help predict the impact of an operating Platte West well field. The model updates performed as part of the 2010 NOPGR incorporated 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 alluvial aquifer. By incorporating pumping and hydrologic data into the model, the model simulations presented in this NOPGR are essentially an extension of the model post audit performed in 2009.

5.1 LOOK BACK AND FORECAST STRUCTURE

The 2010 NOPGR and other future NOPGR's will continue to evaluate the predictive capabilities of the groundwater model by comparing model predictions to observed data. In addition, MUD plans to also use the NOPGR to forecast the aquifer response to the planned pumping for the upcoming reporting cycle. To accomplish both the comparison (look back) and forecasting objectives, the 2010 NOPGR was structured as follows:

- Look back period – October 2009 to September 2010 of the current reporting period. For this time period the model was updated with real world pumping rates and model-predicted results were compared to actual field data. The approach for this portion of the model update will be similar to the post audit approach presented in the 2009 NOPGR.
- Forecast period – October 2010 to April 2011 of the future reporting cycle. This time period will be used to predict aquifer behavior based on estimated future well field flow rates. The well field flow rates will be based on forecasted water demand and the availability of other MUD facilities to provide water. For example, if a large maintenance project is planned for either the Florence or Platte South treatment plants, then higher than normal flow rates will be estimated for the Platte West well field.

5.2 LOOK BACK PERIOD (OCTOBER 2009 TO SEPTEMBER 2010)

The look back evaluation period of October 2009 through September 2010 was evaluated by extending the transient model simulations presented in the 2009 NOPGR to include September 2010. This was done by extending the transient model simulations presented in the 2009 NOPGR from 12 months to 24 months. The SCADA system installed by MUD provides high quality data on the actual pumping distribution in the well field. To best represent the actual well field pumping, the transient groundwater model was discretized into 24, one (1) month stress periods that represent the October 2008 to September 2010 pumping period. Each monthly stress period was further discretized into ten time steps. The addition of 12 stress periods to the model was the *only* change made to the groundwater model before the look back analysis was performed. Other than a change in the hydraulic conductivity of the uplands area, the groundwater model presented in the 2009 NOPGR is the same groundwater model summarized in the Phase II *Platte West Well Field/Groundwater Modeling Study* (Chatman and Associates, Inc., 2005). The model presented in the 2009 NOPGR is the model that was used to perform the analyses presented within this document.

Streamflow conditions and river boundary elevations for the two year simulation were assigned assuming average annual flow conditions in the Platte River, as described in the Phase II model (Chatman and Associates, Inc., 2005). The selection of average stream flow conditions was based on the streamflow data presented in Appendix 3-4. The exception to the average annual stream conditions were the two high stream flow events observed in 2010. To capture these high streamflow events, the model river boundary elevations for the Platte River was increased for the stress periods representing December 2009 through March 2010 and June 2010 to reflect the stage changes observed in the Platte River at the Venice gauge.

Changes in the Elkhorn River stage were based on the river stage elevations observed at the stream gauge located near Waterloo.

Once the changes to the length of the transient model run and the modification of the river stages were made, the following steps were performed to complete the model look back analysis:

1. Input the actual average monthly pumping rate for each supply well in the Platte West well field. These data were supplied by MUD. Well specific monthly flow rates are presented in Table 5-1.
2. Input the actual average monthly pumping rate for each FNOP hydraulic containment or focused extraction well. These data were supplied by ECC, a subcontractor to the CENWK. Well specific monthly flow rates for the FNOP pumping wells are presented in Table 5-1.
3. Run the groundwater model.
4. Compare the model-predicted groundwater elevations versus the observed groundwater elevations for the March 2010 stress period. Over 160 monitoring well sites were available for this synoptic comparison. The data were collected as part of the March 2010 LPNNRD coordinated groundwater monitoring event and also included water level elevation data from the MUD Douglas County monitoring wells.
5. Compare the model-predicted groundwater elevation hydrographs versus the observed groundwater elevation hydrographs at each monitoring well site within the monitoring network operated and maintained by MUD.
6. Review the model predictions and compare to observed data. Perform a “goodness of fit” evaluation.
7. Look for areas where the model predictions could be improved and modify boundary conditions or aquifer parameters if necessary.
8. Re-run model and re-evaluate results.

5.3 LOOK BACK PERIOD RESULTS

The following sections describe the results of the look back period analysis from October 2009 to September 2010.

5.3.1 COMPARISON TO END OF MARCH WATER LEVEL ELEVATIONS

Water level elevation data collected as part of the LPNNRD coordinated water level monitoring event, performed at the end of March, 2010, were used as the first check of model performance for the look back period. Water level elevations collected from the MUD Douglas County monitoring network were added to the LPNNRD data set to create a data set of over 160 water level elevation measurements available for this comparison. These data were used to check the ability of the model to reproduce post-well field startup water level elevations. The water level elevations were collected after the well field had been operating for 13 months at an average flow rate of 30.4 mgd (average from February 2009 through March 2010). Complicating the analysis is the fact that the pumping wells in Section 19 (Saunders County) were shut off from November 2009 to February 2010. During this time, pumping from Saunders County was shifted to wells located closer to the river. The result of this shift in pumping was a recovery of water level elevations around the perimeter of the well field. Evaluating the ability of the groundwater model to capture this recovery is a good check of the aquifer parameters (transmissivity and specific yield) used in the groundwater model. An additional complication to the water level data set is that the water level elevations for the monitoring wells near the well field were impacted by the March 2010 river stage increase. Figure 5-1 maps a comparison of simulated and observed groundwater levels for March 2010.

The first model run completed to evaluate the model predicted potentiometric surface at the end of March 2010 produced a set of calibration statistics including a normalized root mean square (NRMS) error of 1.75 percent and an absolute residual mean (ARM) error of 2.5 feet. Both of these values are within the pre-established calibration objectives of the Phase II groundwater modeling effort, which specified a NRMS error of less than 5 percent and an ARM error of less than 10 feet, and were similar to the final calibrated values of the Phase II model (NRMS error of 1.4 percent and ARM error of 2.1 feet). Most importantly, near the well field the water level elevations predicted by the model after over one year of pumping were generally within one or two feet of the observed water level elevation.

Table 5-2 presents the final model-predicted and observed water level elevations for March 2010 groundwater elevation data set. Figure 5-1 presents a plot of the observed versus predicted water level elevations for the March 2010 data set. The best fit regression equation presented on Figure 5-2 approximates the ideal conditions in which the observed versus predicted plot is represented by a line with a slope of one and an intercept of zero. Figure 5-2b presents a plot of the residual error versus the observed water level elevation, which should have no bias in the distribution of the error. As shown, there is no discernable bias in the error distribution presented in Figure 5-2b over the range of groundwater elevations that are observed at the FNOP and well field sites (1,150 to 1,080 ft msl). At calibration targets where the measured groundwater elevation is between 1,040 and 1,060 ft msl, the model tended to over predict the groundwater elevation. These monitoring well sites are mostly located near the Lincoln well field and are impacted by pumping from that well field. The pumping rates in the Lincoln well field were not updated for this analysis.

It is important to note that the data set used to perform the 2010 NOPGR look back calibration check included: over one year of 30.4 mgd average pumping from the well field, pumping from several FNOP containment wells that were not installed or operating when the original model was constructed and calibrated, and water level data from numerous new FNOP monitoring wells that were not included in the Phase I and Phase II model calibration effort.

5.3.2 MODEL-PREDICTED VS OBSERVED HYDROGRAPHS

Model-predicted versus observed groundwater elevation hydrographs were created for 16 monitoring well sites near the well field to evaluate the ability of the groundwater model to predict changes in groundwater elevations caused by well field pumping and changes in the Platte River stage. The observed groundwater elevations were obtained from the pressure transducers/data loggers installed in the monitoring wells. The pressure transducers collect and record, at a minimum, one water level elevation measurements per day. The hydrographs present the observed and model predicted groundwater elevations from February 2009 through September 2010 and are included in Appendix 5-1. As constructed, the model cannot reflect short term fluctuations in groundwater elevation since the pumping and boundary conditions are changed only on a monthly basis. A graphical summary of the comparison hydrographs is presented on Figure 5-3.

Saunders County Monitoring Network

On the Saunders County side of the well field, the model-predicted and observed hydrographs nearly overlap at the monitoring well sites that border the well field (MW90-10 MW94-4, MW05-22, and MW05-23). As shown in the hydrographs for these wells, the groundwater model was able to accurately reproduce both the drawdown that occurred in the aquifer from February to October 2009, and the recovery which occurred in the aquifer from November 2009 through March 2010. The recovery observed in the aquifer occurred in response to the reduction in pumping from the Saunders County well field side and the shut down of pumping wells located in Section 19.

The pattern and shape of the model predicted groundwater elevation hydrographs closely mimics that of the observed data, indicating that the aquifer parameters and degree of interconnection between the river boundary and the aquifer are very accurate. The model accurately predicted both the observed rate of expansion and the overall magnitude of the cone of depression that occurred as a result of well field pumping. Additionally, the model was able to accurately capture the rate of aquifer recovery that occurred as a result of the shut down of the pumping wells located in Section 19.

Further from the well field, the model-predicted hydrograph for MW94-3, MW94-5, MW94-6, and MW06-28 also indicate a good general match between the model predicted and observed groundwater level elevations. At these well sites, the pattern and shape of the model predicted hydrographs closely resembles the observed data. The observed data at these sites indicates that there is less that a one foot difference between the groundwater level elevation observed before the well field began pumping and the groundwater level elevation observed at the end of September 2010. This group of monitoring wells provides a clear delineation of the maximum extent of the cone of depression created by well field pumping.

Douglas County Monitoring Network

On the Douglas County side of the well field, there is generally good agreement between the model-predicted and observed hydrographs at the monitoring well sites that border the well field (MW90-5, MW90-7, MW94-1, MW94-2, MW05-24, and MW05-25). At most of these monitoring well sites, the model predictions closely resemble the observed data. However, at some of the monitoring well sites, the model appears to under predict the groundwater elevation (over predict drawdown) by one to two feet. At these well sites, it appears the model may be over predicting drawdown within the well field or not capturing the recovery that occurs as wells are turned on and off. Review of the observed data for all of the well sites that border the Douglas County portion of the well field indicate that the cone of depression generated for these wells is limited and does not extend very far outside of the well field property boundary.

5.3.3 OBSERVED AND PREDICTED DRAWDOWN

Table 5-3 and Figure 5-4 summarize the model-predicted and observed drawdown that can be calculated using the hydrographs presented in Appendix 5-1. As shown on Figure 5-4 most observed drawdown values for the monitoring wells in Saunders County fall within the appropriate contour interval of the model-predicted drawdown for the end of September 2010 stress period.

As noted in the hydrograph comparison summary, the groundwater model slightly over predicts the drawdown induced by the pumping wells in Douglas County. The extents of the model predicted cone of depression at for the end of September 2010 stress period are larger than data from the monitoring network indicates.

5.3.4 COMPARISON TO STEADY STATE DRAWDOWN PREDICTIONS

Both the Phase I and Phase II models predicted the maximum extent of the well field cone of depression by performing steady state simulations assuming a maximum annual average well field pumping rate of 52 mgd, with a pumping distribution of 18.2 mgd from the Douglas County wells and 33.8 mgd from the Saunders County wells. The 52 mgd flow rate was selected for the steady state simulations because it is equal to the maximum annual average flow rate permitted for the well field. The average daily flow rate for the Saunders County pumping wells since the well field began operations in February 2009 was 23.5 mgd, which is approximately 70 percent of the 33.8 mgd flow rate for the Saunders County wells used in the Phase I and II steady state simulations.

Figure 5-5 presents the Phase I and Phase II model-predicted steady state drawdown contours overlain onto a contour of the observed drawdown for September 2010. The contour of the observed drawdown is an interpretation of the observed drawdown data presented in Table 5-3 and on Figure 5-4 and 5-5. The one (1) foot observed drawdown contour for the Saunders County side of the well field falls within the maximum extents of the steady state model-predicted contours from the Phase I and Phase II model reports. The smaller size of the observed cone of depression, as compared to the steady state cone of depression, is due in part to the fact that pumping from the well field has been below the maximum permitted value of 52 mgd.

On the Douglas County side of the well field, the observed cone of depression is also smaller than the maximum extents of the steady state cone of depression presented on Figure 5-5. The average daily flow rate for the Douglas County pumping wells since the well field began operations in February 2009 was 9.9 mgd, which is approximately 54 percent of the 18.2 mgd flow rate for the Douglas County wells used in the Phase I and II steady state simulations. The smaller size of the observed cone of depression, as compared to the steady state cone of depression, is partially a result of the fact that pumping from the well field has been below the maximum permitted value of 52 mgd.

5.3.5 PARTICLE TRACKING

A transient particle tracking simulation was performed using MODPATH 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 for the full length of the reporting period and included the reported pumping from the FNOP wells and Platte West well field wells from October 2008 to September 2010 (Table 5-1). The results of the particle tracking simulation are presented on Figure 5-6. As shown, operation of the well field has not altered the well documented historical flow path of the contaminant plumes located on the eastern edge of the FNOP site. The model predicts each particle will travel approximately 800 feet during the one-year length reporting period, which equates to an advective groundwater flow rate of approximately 2.2 ft/day. The modeled groundwater flow velocity for the Todd Valley aquifer is consistent with the 2 ft/day value published by CENWK for Todd Valley aquifer near the FNOP site (URS, 2009).

5.4 MODEL FORECAST PREDICTIONS

The forecast model period of October 2010 to April 2011 was used to generate predications on aquifer response to planned well field pumping for this period of time. The model forecast period includes two months, October and November 2010, where actual MUD pumping rates and pumping distribution were available for input into the groundwater model. Pumping rates for December 2010 through April 2011 were estimated by MUD based on forecasted water demand and the availability of other MUD facilities to provide water. Pumping rates for November and December are higher than well field pumping rates from last year due to the Platte South water production facility being out of service during that time. MUD anticipates that pumping will return to more normal conditions in January, when it is anticipated that the Platte South facility will be available again. Pumping rates by county well field are summarized in the table below.

Table 5-4

Forecasted Well Field Pumping Rates October 2010 to April 2011

Month	Douglas County Pumping (mgd)	Saunders County Pumping (mgd)	Total Pumping (mgd)
October 2010	11.7	24.4	36.1
November 2010	5	25.6	30.6
December 2010	1	35	36
January 2011	6	18	24
February 2011	8	18	24
March 2011	8	21	24
April 2011	10	24	34

For the forecast model scenario, pumping rates for the FNOP well field were held constant at the September 2010 pumping rate reported for those wells. Stage elevations for the river boundaries were input assuming average annual flow conditions, as described in the Phase II model (Chatman and Associates, Inc., 2005).

5.4.1 Forecast Model Potentiometric Surface Map

The model-predicted potentiometric surface for the last time step of each stress period is presented in Appendix 5-2. This figure represents the model-predicted potentiometric surface for the end of each month in the forecast period (April 2011). The model predicted potentiometric surface is a function of the distribution of pumping assumed in the well field and change if wells other than those modeled are used to achieve similar well field flows. The forecast model run assumed that a mix of storage and river wells would be used to achieve the projected well field flow rates. However, it is possible that the well field will be operated to allow water levels in the aquifer to recover during the winter months is a manner similar to 2009, when the production wells in Section 19 were shut off for a period of four (4) months.

Review of the predictions indicates that there are changes in both the 1,090 and 1,080 ft msl potentiometric surface contour intervals in April 2011. These changes are limited to the Platte River alluvial aquifer and do not extend into the Todd Valley aquifer. The most pronounced change occurs to the 1,090 ft msl contour which is displaced northward towards the river. It is important to note that no changes in the potentiometric surface of the Todd Valley aquifer are predicted by the model, and the flow direction in the Todd Valley aquifer is not altered by operation of the well field.

6 SUMMARY AND CONCLUSIONS

The Platte West well field began continuous pumping operations on February 11, 2009 and continued operations until the end of the NOPGR reporting period (September 30, 2010). For the 2010 water year, the total daily pumping rate fluctuated from a low of 15 mgd, recorded in October 2009 to a high of 71 mgd recorded in August 2010. The average daily pumping rate, an average of the data presented on Figure 2-1, observed over the twelve month pumping period was 32.6 mgd. Since startup in February 2009, the well field has averaged a 32.9 mgd total pumping rate, with 23.5 mgd from the Saunders County wells.

The objective of the 2010 NOPGR is to analyze available hydraulic and water quality data to determine the impact of the Platte West well field on both the groundwater elevations and chemistry of the Platte River and Todd Valley alluvial aquifers, and to determine any potential negative impact on the FNOP contaminant plumes or the FNOP operating remedial system. To achieve this objective, HDR studied: MUD's water supply well pumping records, pressure transducer data from monitoring wells in the MUD, LPNNRD, and USACE monitoring network, one synoptic water level data set which consisted of water level elevations collected from over 160 monitoring wells, Platte River flow and stage data from three (3) stream gauges, Elkhorn River data from one (1) stream gauge, and one round of chemical sampling. These data were then used to update the groundwater flow model presented in the 2009 NOPGR with 2010 well field pumping and hydrologic data.

A post audit of the groundwater flow model was presented in the 2009 NOPGR which evaluated the predictive capabilities of the groundwater model against eight months of operational data. The results of the post audit showed that the groundwater model accurately reproduced the observed drawdown in the Platte River alluvial aquifer that was induced by well field operations. The 2010 NOPGR continued to evaluate the predictive capabilities of the groundwater model by comparing model predictions to observed data during a look back period, which consisted from October 2009 through September 2010. The look back analysis presented in this document is in effect an extension of the post audit performed in 2009. The following tasks were completed as part of the look back analysis:

1. Extend the model simulation time to include 24 stress periods (October 2008 to September 2009).
2. Input the actual average monthly pumping rate for each supply well in the Platte West well field. These data were supplied by MUD. Well specific monthly flow rates are presented in Table 5-1.
3. Input the actual average monthly pumping rate for each FNOP hydraulic containment or focused extraction well. These data were supplied by ECC, a subcontractor to the CENWK. Well specific monthly flow rates for the FNOP pumping wells are presented in Table 5-1.
4. Run the groundwater model.
5. Compare the model-predicted groundwater elevations versus the observed groundwater elevations for the March 2010 stress period. Over 160 monitoring well sites were available for this synoptic comparison. The data were collected as part of the March 2010 LPNNRD coordinated groundwater monitoring event and also included water level elevation data from the MUD Douglas County monitoring wells.
6. Compare the model-predicted groundwater elevation hydrographs versus the observed groundwater elevation hydrographs at each monitoring well site within the monitoring network operated and maintained by MUD.
7. Review the model predictions and compare to observed data. Perform a "goodness of fit" evaluation.

6.1 SUMMARY OF RESULTS

The 2010 NOPGR used available hydrogeologic data in the form of groundwater elevations, streamflow values, and groundwater quality data, as well as groundwater modeling to evaluate the impact of the operations of the well field on the Platte River and Todd Valley alluvial aquifers. The hydraulic data and updated groundwater flow model were used to evaluate any potential negative impact on the FNOP contaminant plumes or the FNOP operating remedial system. The following section summarizes the results of the 2010 NOPGR analysis.

6.1.1 SUMMARY OF MODEL PERFORMANCE

The predictive capability of the model was evaluated by comparing model predicted results against observed data. The results of the look back analysis showed that the groundwater model continues to be an accurate tool for use in predicting the response of the alluvial aquifer to changes in well field pumping. A summary of the groundwater model versus measured data comparisons is presented below.

Hydrograph Comparison for Wells Located Near the Well Field

The summary comparison hydrographs presented on Figure 5-3 illustrate the ability of the model to accurately reproduce 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 water supply wells in Section 19 (Saunders County) were shut off from November 2009 through March 2010. These hydrographs, which are also presented in Appendix 5-1, show that the groundwater model accurately predicts the magnitude and pattern of groundwater elevation changes around the well field. Figure 5-4 presents the model predicted and observed drawdown for September 2010. Most of the observed drawdown values for the monitoring wells in Saunders County fall within the appropriate contour interval of the model-predicted drawdown for the end of September 2010 stress period. 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.

Comparisons of Potentiometric Surfaces After One Year of Pumping

Evaluating the ability of the groundwater model to predict groundwater elevations away from the well field was checked using data collected as part of the LPNNRD coordinated water level monitoring event, performed at the end of March, 2010. Including data from the MUD Douglas County monitoring network, a total of 160 water level elevation data points were available for this comparison. The water level elevations were collected after the well field had been operating for over a 13 month period at an average flow rate of 30.4 mgd (average from February 2009 through March 2010). Complicating the analysis is the fact that the pumping wells in Section 19 (Saunders County) were shut off from November 2009 to February 2010. During this time, pumping from Saunders County was shifted to wells located closer to the river. The result of this shift in pumping was a recovery of water level elevations around the perimeter of the well field. The first model run completed to evaluate the model predicted potentiometric surface at the end of March 2010 produced a model run with a normalized root mean square (NRMS) error of 1.75 percent and an absolute residual mean (ARM) error of 2.5 feet. Both of these values were within the pre-established calibration objectives of the Phase II groundwater modeling effort, which specified a NRMS error of less than 5 percent and an ARM error of less than 10 feet, and were similar to the final calibrated values of the Phase II model (NRMS error of 1.4 percent and ARM error of 2.1 feet). Other than inputting the new pumping and hydrologic data into the groundwater model, no changes to the groundwater model presented in the 2009 NOPGR were made prior to performing these model evaluations.

Comparison to Predicted Extent of Cone of Depression

Both the Phase I and Phase II models predicted the maximum extent of the well field cone of depression by performing steady state simulations assuming a maximum annual average well field pumping rate of 52 mgd, with a pumping distribution of 18.2 mgd from the Douglas County wells and 33.8 mgd from the Saunders County wells. The 52 mgd flow rate was selected for the steady state simulations because it is equal to the maximum annual average flow rate permitted for the well field. The average daily flow rate for the Saunders County pumping wells since the well field began operations in February 2009 was 23.5 mgd, which is approximately 70 percent of the 33.8 mgd flow rate for the Saunders County wells used in the Phase I and II steady state simulations. Figure 5-5 presents the Phase I and Phase II model-predicted steady state drawdown contours overlain onto a contour of the observed drawdown for September 2010. The one (1) foot observed drawdown contour for the Saunders County side of the well field falls within the maximum extents of the steady state model-predicted contours from the Phase I and Phase II model reports. The smaller size of the observed cone of depression, as compared to the steady state cone of depression, can be attributed to pumping from the well field which has been below the maximum permitted value of 52 mgd.

6.1.2 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 2010 NOPGR. The following presents a summary of those data.

Summary of Contingency Plan Water Levels

The water level elevations observed at each of the Well Field Contingency Plan (Layne Christensen, 2008b) hydraulic monitoring wells were compared to their respective Tier 1 and Tier 2 trigger point. Only one water level elevation (MW90-10) was below the well specific Tier 1 value. However, the water level elevation at this well never dropped below the Tier 2 trigger level, therefore no further action is required by MUD at this time. The evaluation process followed to reach this conclusion is presented on the Tier 1 flow chart in the Well Field Contingency Plan (Layne Christensen, 2008b).

Summary of Chemical Data

Chemical data from one round of MUD groundwater sampling were reviewed as part of this NOPGR. The wells sampled by as part of this event include the deep and shallow wells located at MW-39, MW06-18, MW06-30, and MW06-31 monitoring sites. Additionally, two quarterly groundwater monitoring events conducted by the USACE were reviewed. The USACE included MW06-18S, MW06-18D, MW06-31A, and MW06-31B into their regular quarterly groundwater monitoring program beginning in Spring 2010. No detections of the FNOP COCs (TCE and RDX) were observed in the May 2010 MUD sampling event. No FNOP COCs have been detected above their respective method detection limits during the May or August quarterly USACE monitoring events (ECC, 2010).

6.2 CONCLUSIONS

Since startup in February 2009, the well field has averaged a 32.9 mgd total pumping rate, with 23.5 mgd from the Saunders County wells, which is below the maximum design pumping rate of the well field. The hydraulic data collected as part of this and other previous NOPGR reports clearly show that the groundwater flow direction in the Todd Valley aquifer has not changed due to the operation of the well field. Both the interpreted potentiometric surface from October 2008, March 2009, and March 2010 indicate that the well field continues to remain hydraulically upgradient and cross-gradient of the FNOP site.

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, which includes two quarterly events (May or August 2010) conducted by the USACE.

The look back analysis performed, which extended the model post audit presented in the 2009 NOPGR, has shown that the groundwater flow model is a good tool that can be used to accurately predict the response of the alluvial aquifer to changes in well field pumping. The post audit presented in the 2009 NOPGR and the look back analysis presented in this 2010 NOPGR 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.

6.3 FUTURE UPDATES

The 2011 NOPGR will continue to review the available hydraulic and water quality data to evaluate the impact of the Platte West well field pumping on both the groundwater elevations and chemistry of the Platte River and Todd Valley alluvial aquifers. The 2011 NOPGR will also continue to test the predictive capabilities of the groundwater model by comparing model predictions to observed data. It is anticipated that the comparison (look back) and forecasting periods in the 2011 NOPGR will be structured as follows:

- Look back period - April to October of the current reporting period.
- Forecast period – October to April of the future reporting cycle.

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FIGURES

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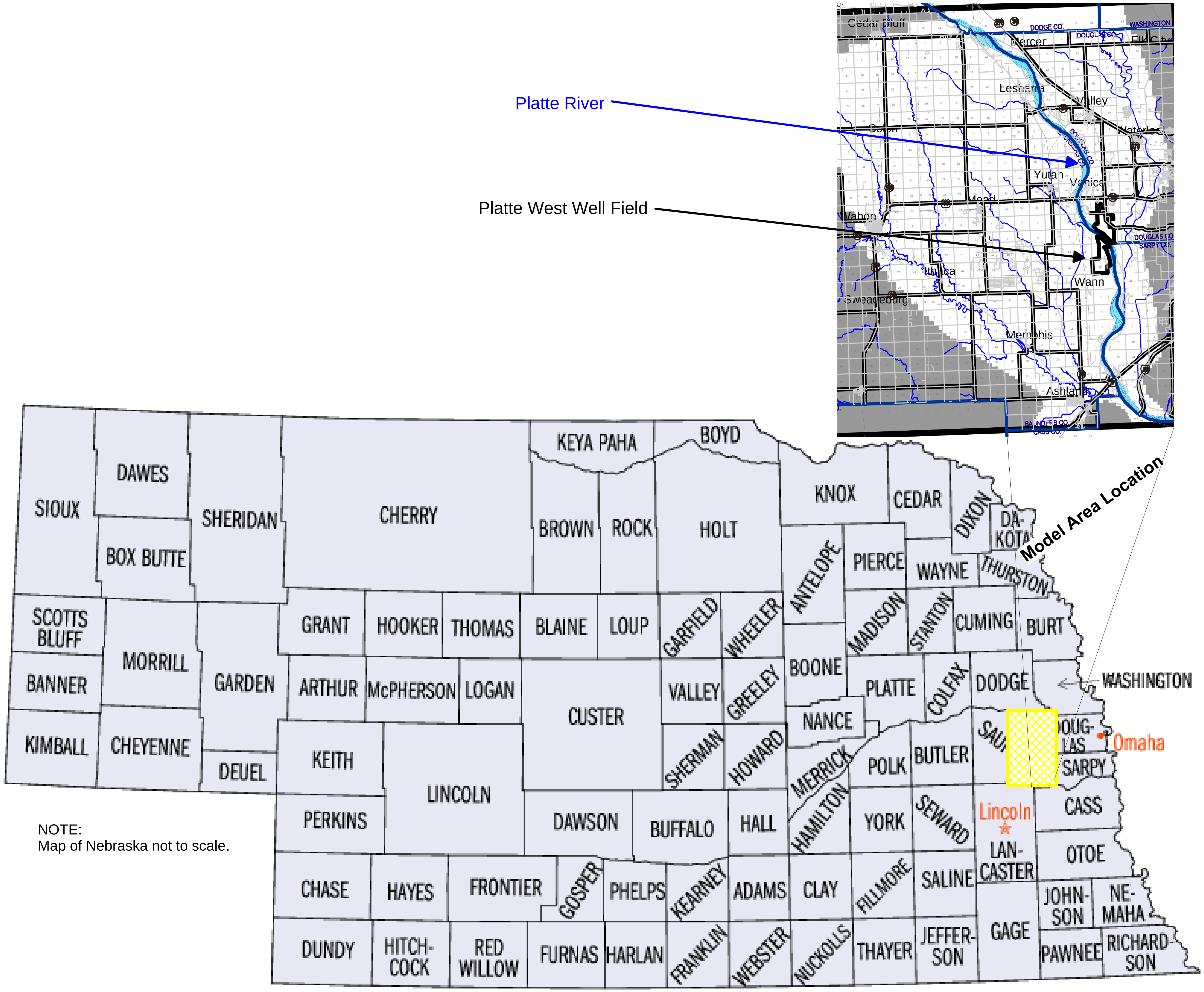
Platte West Well Field
Nebraska Ordnance Plant
Groundwater Report

Figure 1-1
Platte West Well Field
Groundwater Model Boundaries



NOTE:
Map of Nebraska not to scale.

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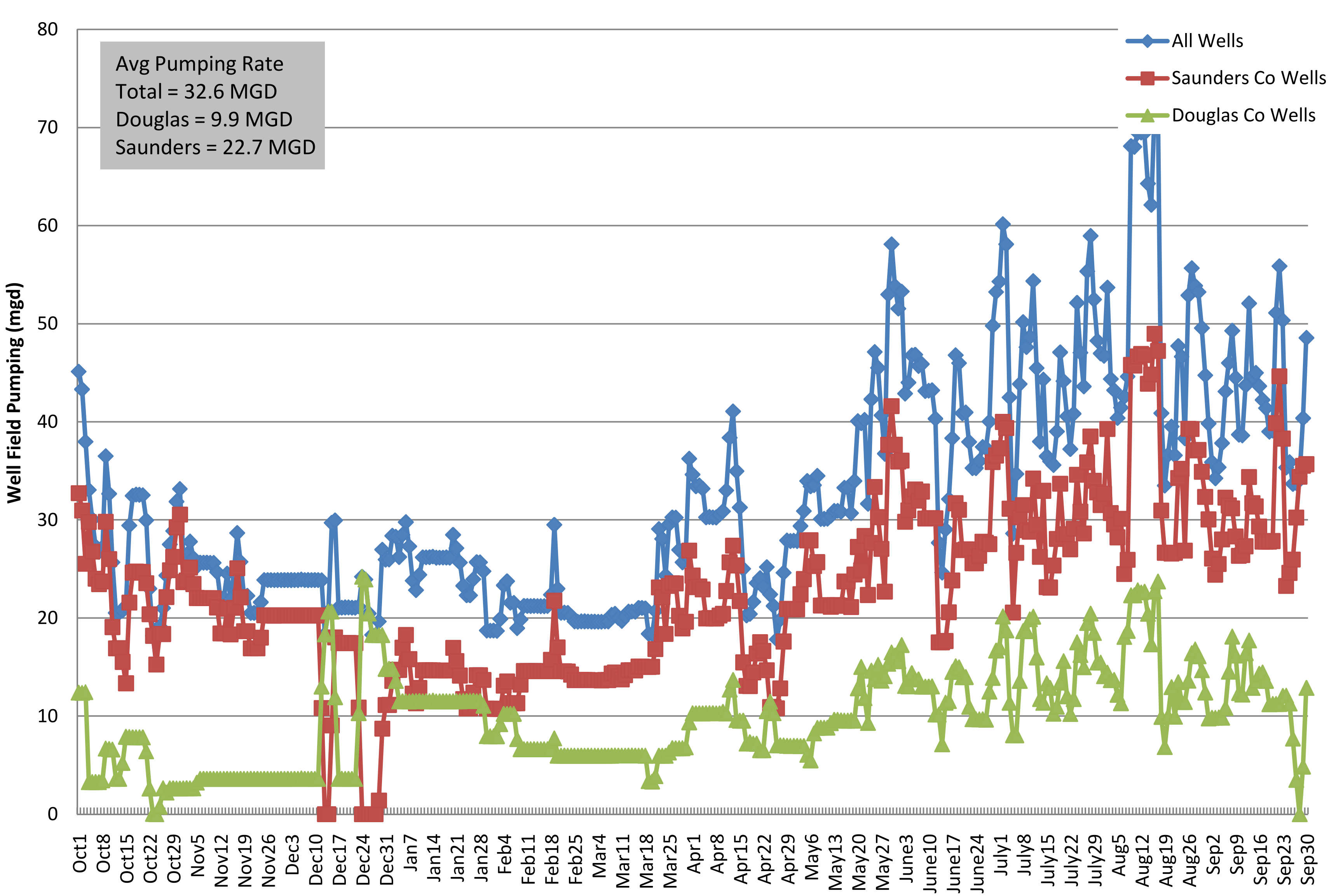
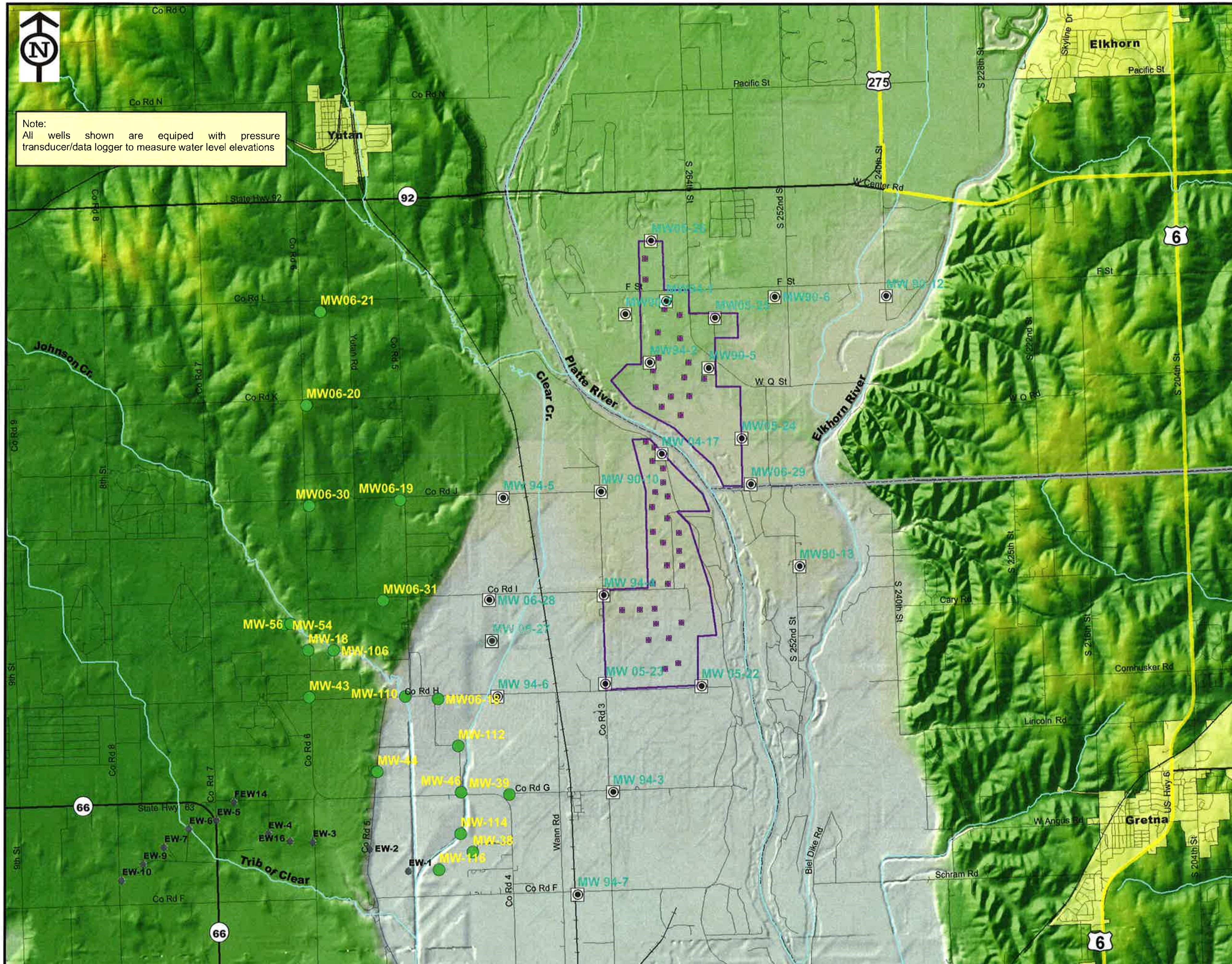
Figure 2-1
Daily Pumping Rate (MGD)
October 2009 - September 2010
MUD Platte West Well Field





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Platte West Well Field
Nebraska Ordnance Plant
Groundwater Report

Figure 3-1:
Groundwater Monitoring Network

Legend

- Monitoring Wells Maintain by LPNNRD or USACE
- Monitoring Wells Maintain by MUD
- FNOP Pumping Wells
- MUD Pumping Wells
- Stream
- MUD Well Field
- Railroad

Highway

- Interstate
- US
- State
- Local
- County Boundary
- City

0 0.5 1 Miles

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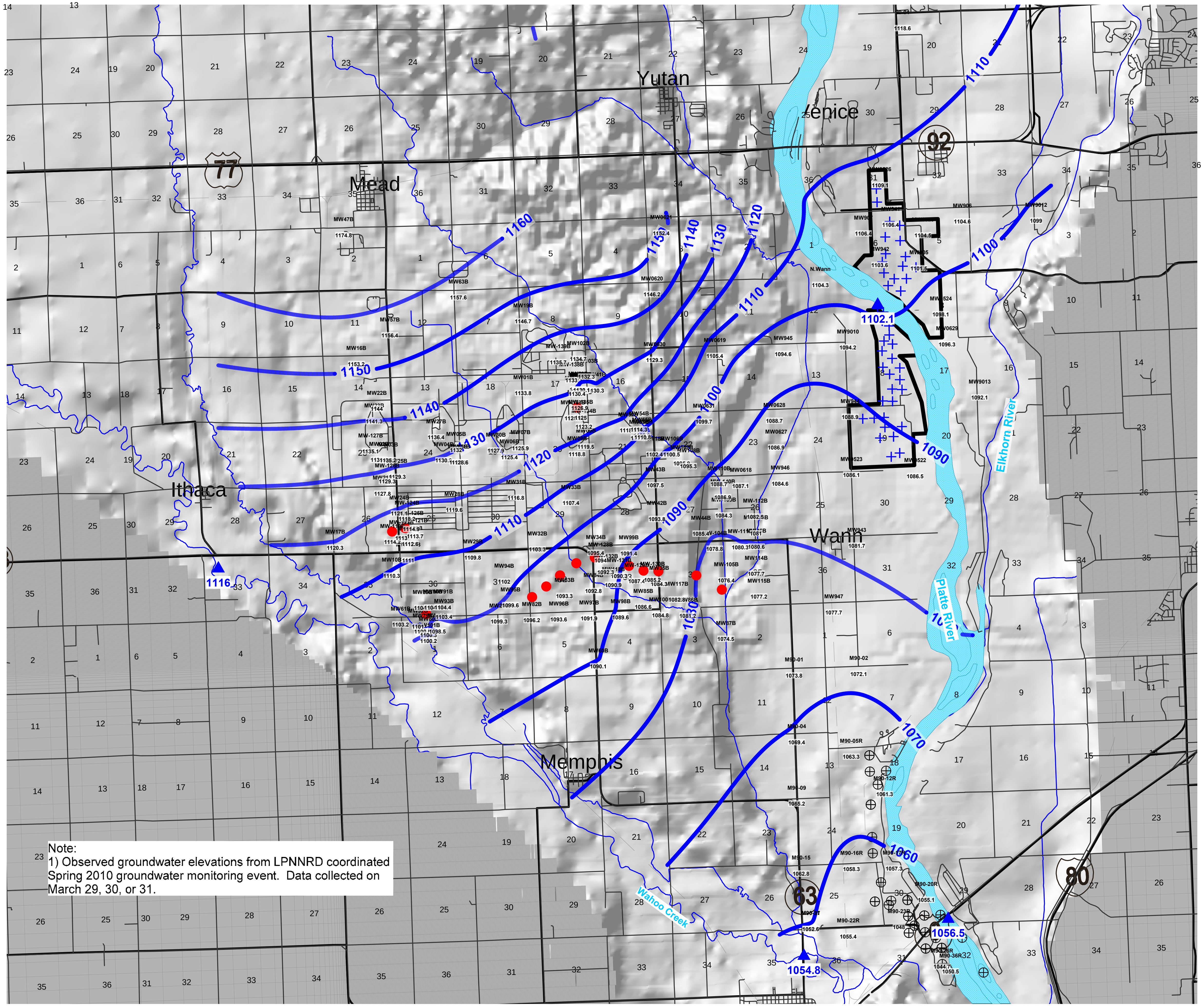

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Platte West Well Field
Nebraska Ordnance Plant
Groundwater Report

Figure 3-2
March 2010 Observed
Potentiometric Surface (ft msl)

LEGEND:

MW94-5 / 1094.6 — Observation Well with Measured Water Level Elevation in ft msl

Interpreted Potentiometric Surface Elevation Contour (ft msl)

Contour Interval = 10 feet

1102.1 — USGS Gauging Station with Stream Elevation (ft msl)

Pumping Wellfields Operating During March 2010 Water Level Event

Platte West Well Field Boundary

Platte West Well Field Well

FNOP Containment/Focused Extraction Well

Ashland City Well/Lincoln Well Field Well

MAP SCALE (feet)

0 4000 8000

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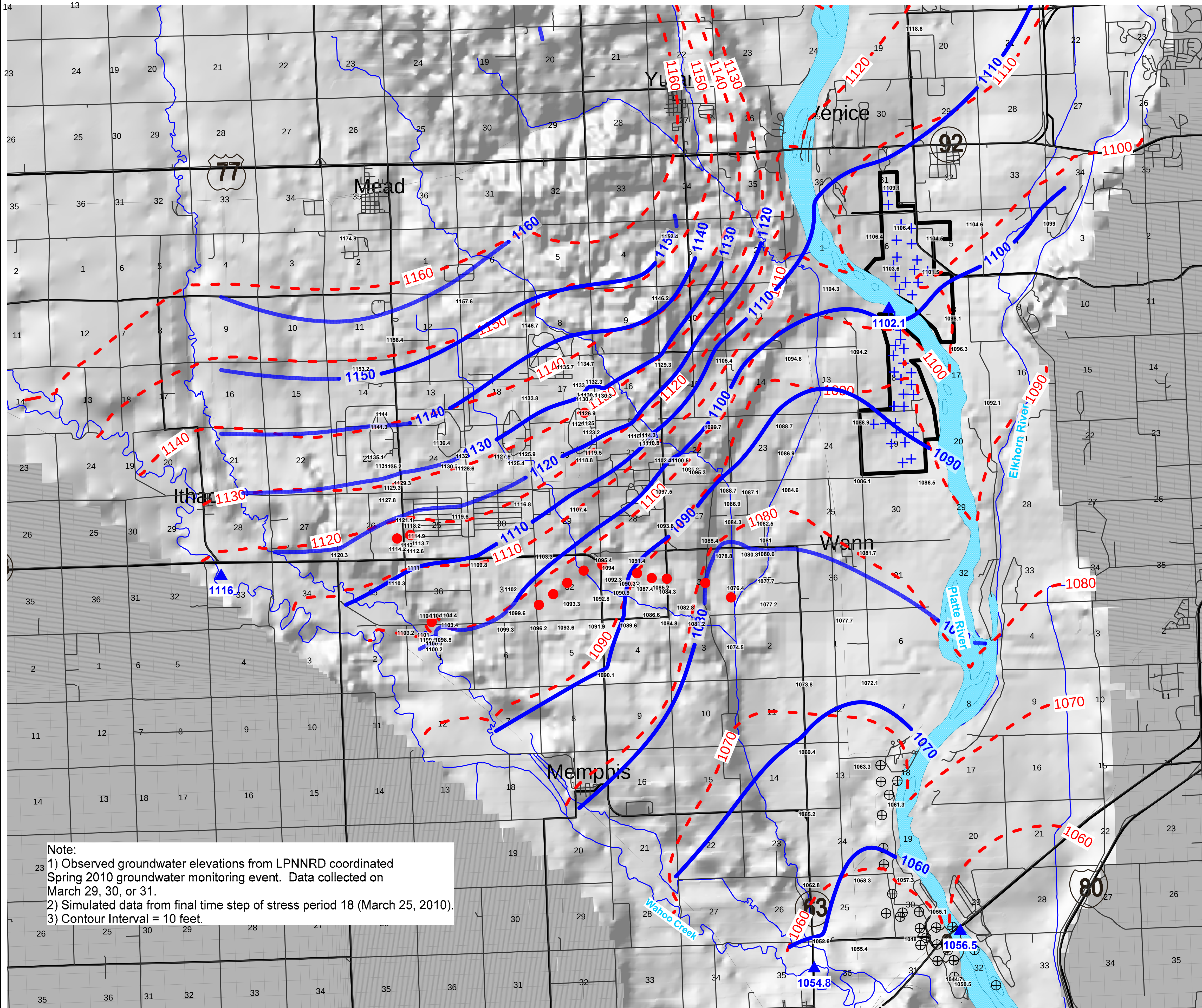

Note:
1) Observed groundwater elevations from LPNNRD coordinated Spring 2010 groundwater monitoring event. Data collected on March 29, 30, or 31.
2) Simulated data from final time step of stress period 18 (March 25, 2010).
3) Contour Interval = 10 feet.

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Platte West Well Field
Nebraska Ordnance Plant
Groundwater Report

Figure 5-1
Comparison of Simulated and Observed Potentiometric Surfaces (ft msl) for March 2010

LEGEND:

- 1094.6 — Observation Well with Measured Water Level Elevation in ft msl
- Interpreted Potentiometric Surface Elevation Contour (ft msl)
- Simulated Potentiometric Surface Elevation Contour (ft msl)
- 1102.1 — USGS Gauging Station with Stream Elevation (ft msl)

Pumping Wellfields Operating During March 2010 Water Level Event

- Platte West Well Field Boundary
- Platte West Well Field Well
- FNOP Containment/Focused Extraction Well
- Ashland City Well/Lincoln Well Field Well

MAP SCALE (feet)
0 4000 8000

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January 2011

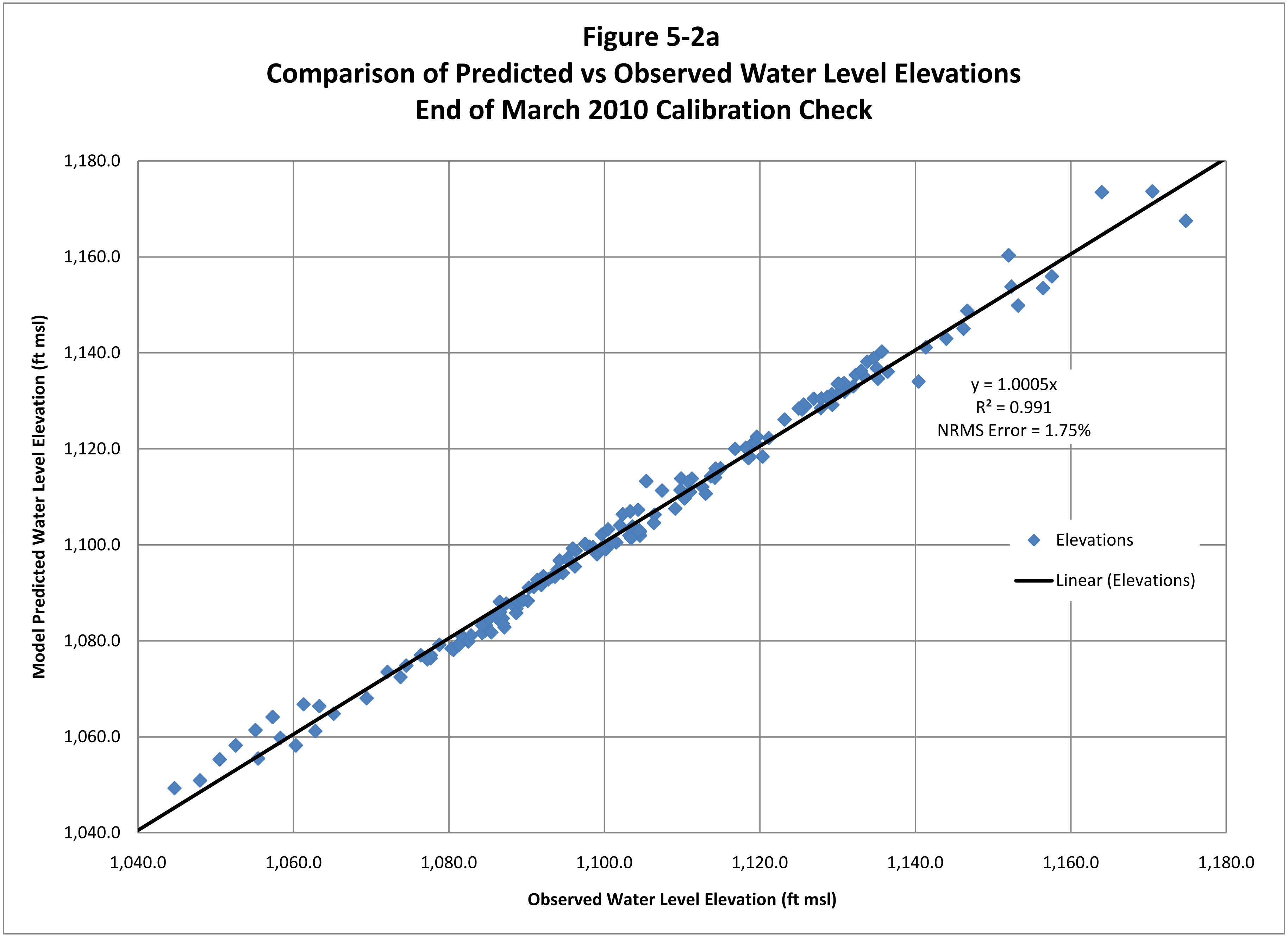
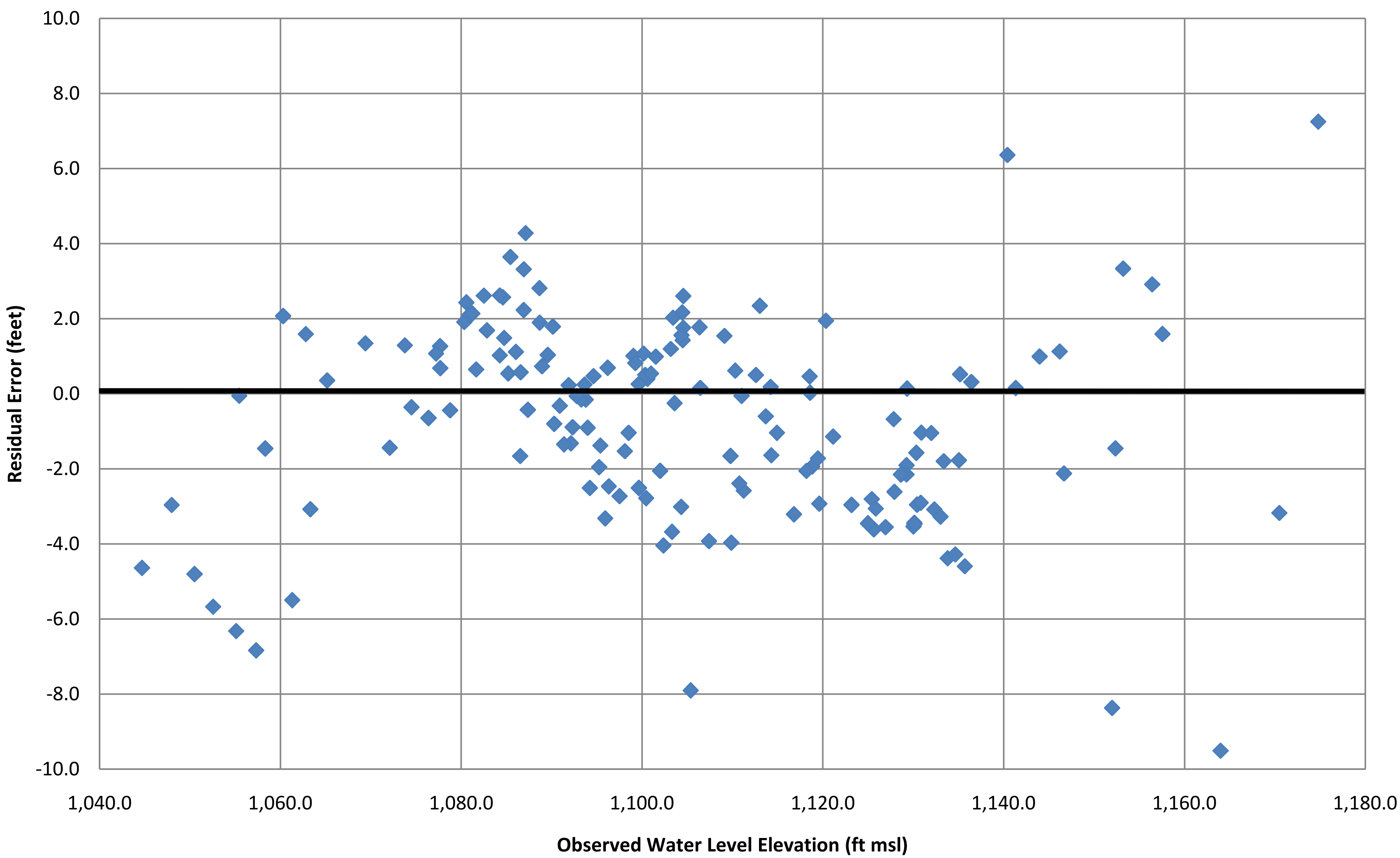
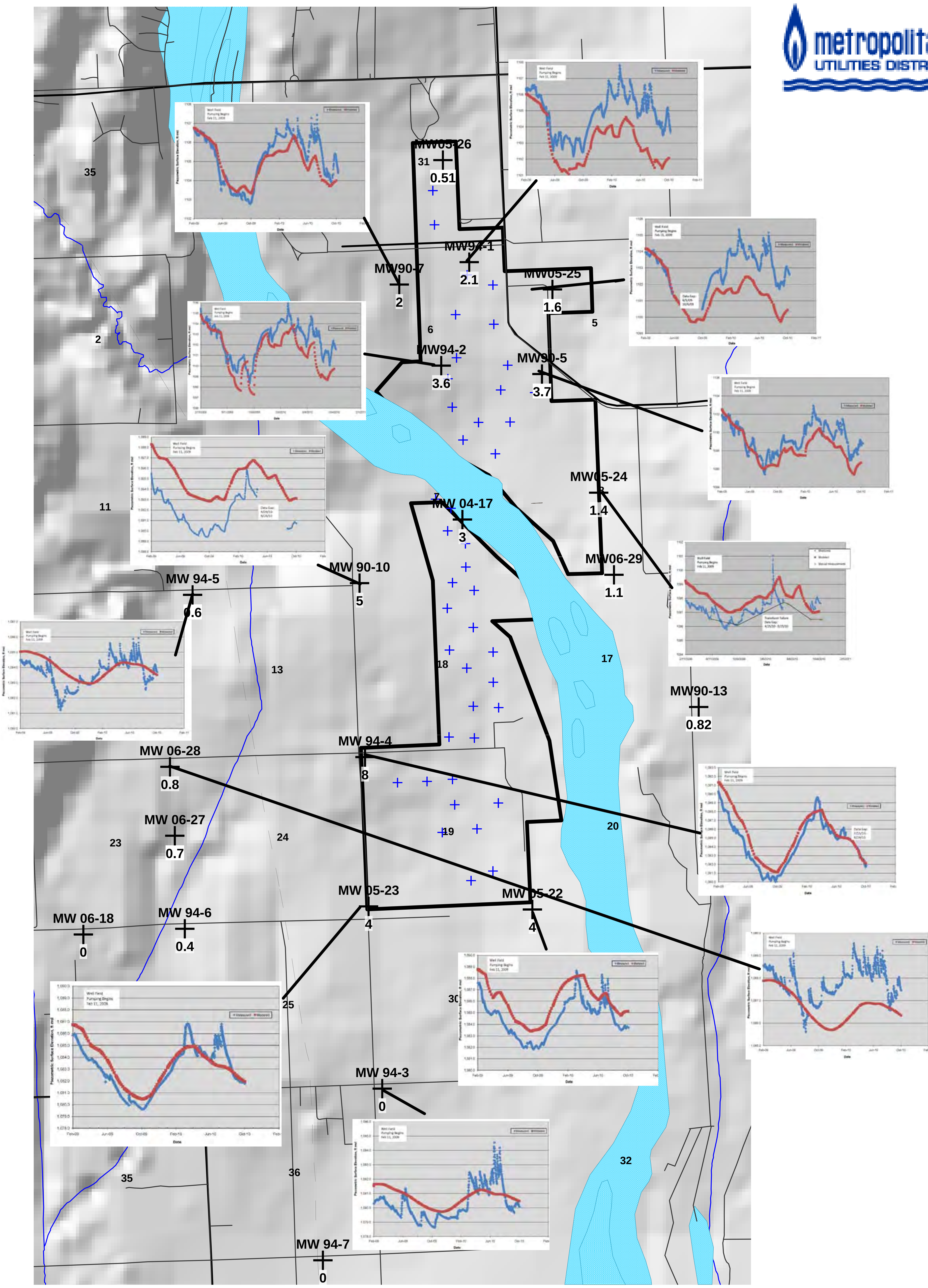


Figure 5-2a
Comparison of Predicted vs Observed Water Level Elevations
End of March 2010 Calibration Check
1,180.0
1,160.0
1,140.0
1,120.0
1,100.0
1,080.0
1,060.0
1,040.0
Model Predicted Water Level Elevation (ft msl)
1,040.0
1,060.0
1,080.0
1,100.0
1,120.0
1,140.0
1,160.0
1,180.0
Observed Water Level Elevation (ft msl)
y = 1.0005x
R² = 0.991
NRMS Error = 1.75%
Elevations
Linear (Elevations)

Figure 5-HŌ
Comparison of Residual Error vs Observed Water Level Elevation
End of March 2010 Calibration Check





Note:
1) Full size hydrographs presented in Appendix 5-1.
2) Hydrographs show measured groundwater elevation in blue and model predicted groundwater elevation in red.
3) Hydrographs developed for two year simulation.

MAP SCALE (feet)

0 3000 6000

LEGEND:

MW90-5 / 4 — Transducer Equipped Observation Well with Measured Drawdown in feet

Platte West Well Field Boundary

Platte West Well Field Pumping Well

Figure 5-3
Summary of Model Predicted and Observed Hydrographs for MUD Observation Wells Near Well Field

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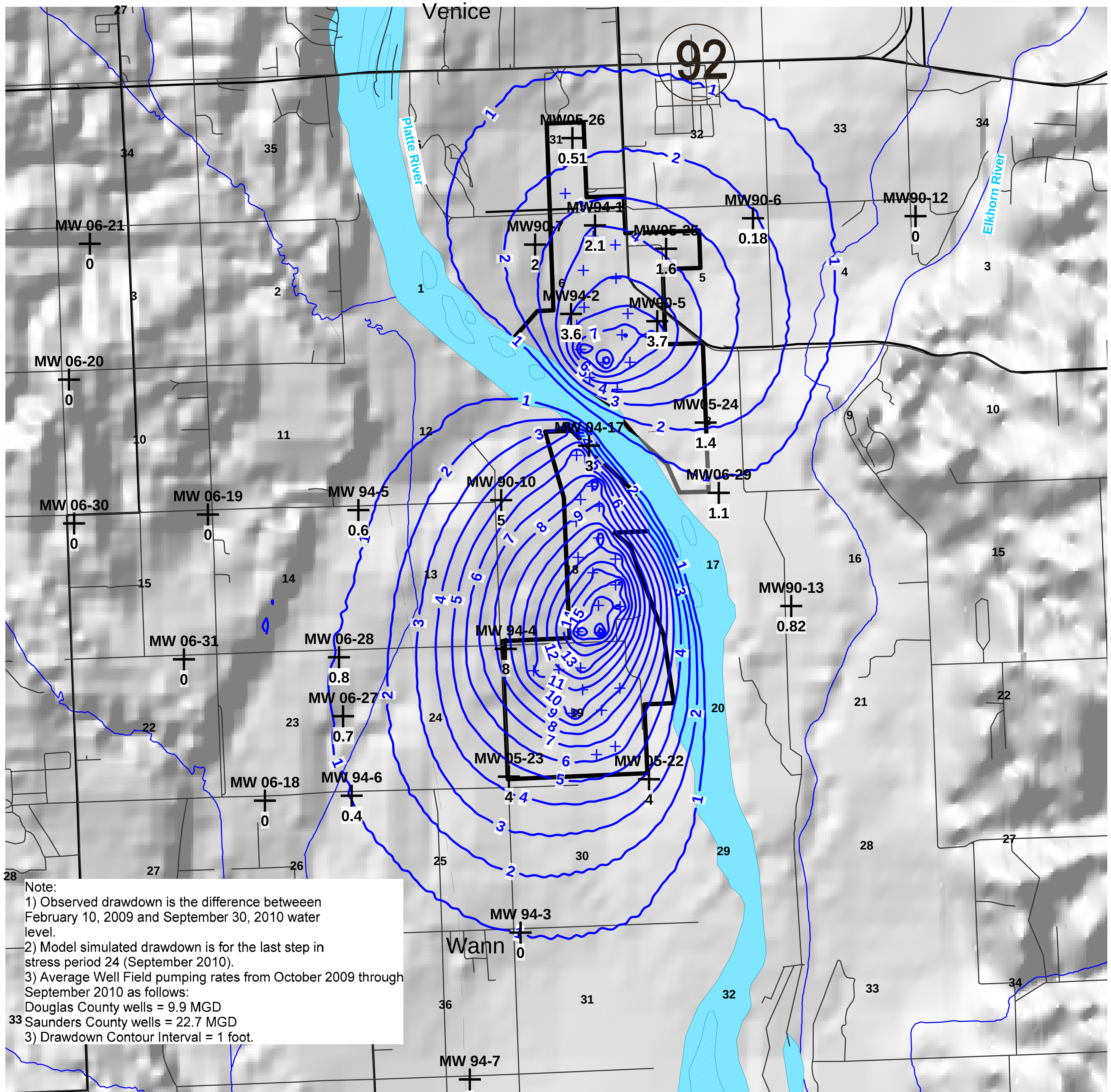
Platte West Well Field
Nebraska Ordnance Plant
Groundwater Report

Figure 5-4
Comparison of Model Predicted and Observed Drawdown After 20 Months of Pumping



Note:
1) Observed drawdown is the difference betweeen February 10, 2009 and September 30, 2010 water level.
2) Model simulated drawdown is for the last step in stress period 24 (September 2010).
3) Average Well Field pumping rates from October 2009 through September 2010 as follows:
Douglas County wells = 9.9 MGD
Saunders County wells = 22.7 MGD
3) Drawdown Contour Interval = 1 foot.

LEGEND:

MW90-5 / 4 — Transducer Equipped Observation Well with Measured Drawdown in feet

Model Predicted Drawdown (ft msl)

Drawdown Contour Interval = 1 foot

Platte West Well Field Boundary

Platte West Well Field Pumping Well

MAP SCALE (feet)

0 4000 8000

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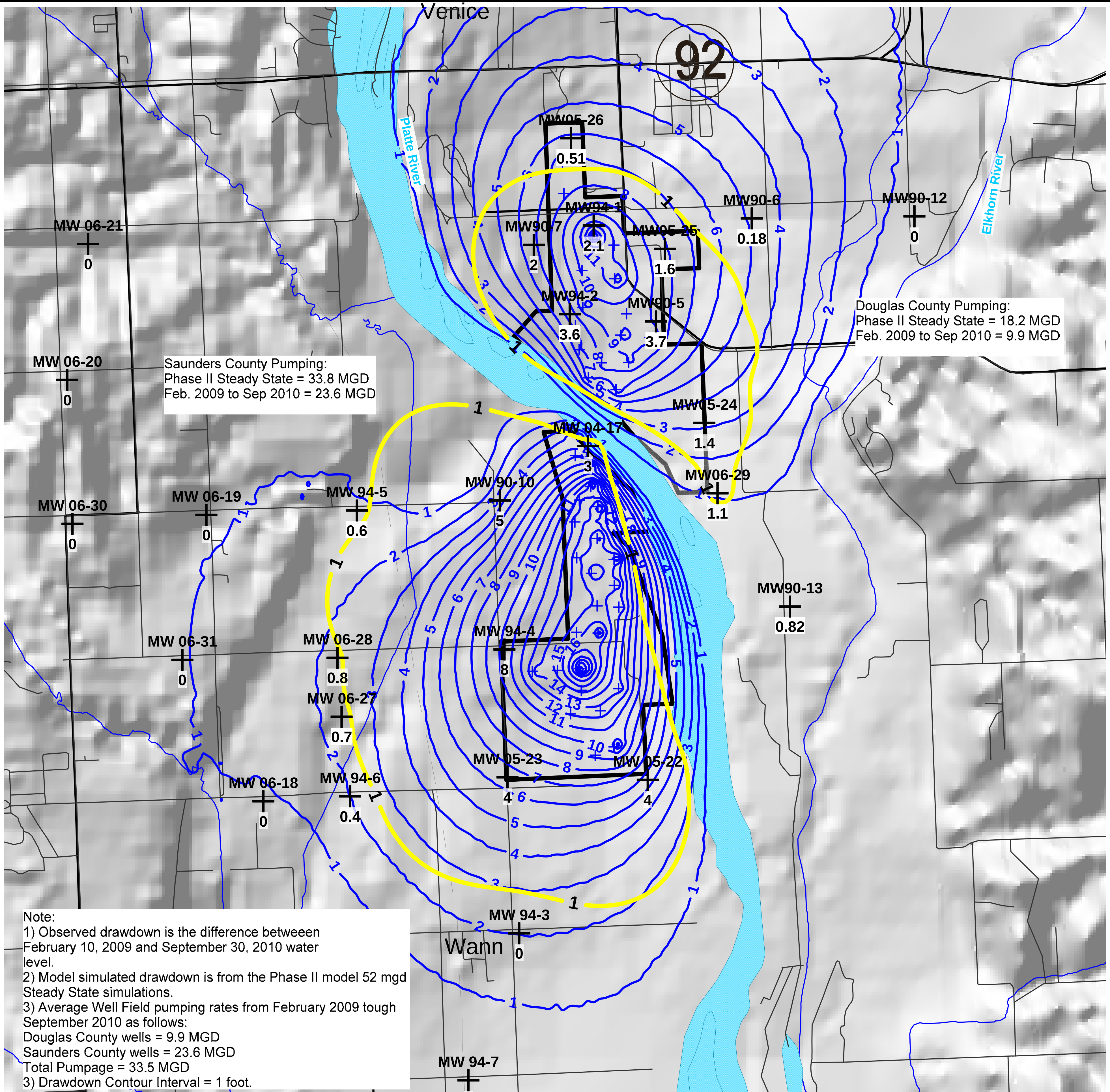

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Platte West Well Field
Nebraska Ordnance Plant
Groundwater Report

Figure 5-5
Comparison of Observed Well Field Drawdown and Phase II Model Steady State Drawdown

LEGEND:

- MW90-5 / 4 — Transducer Equipped Observation Well with Measured Drawdown in feet
- Model Predicted Drawdown (ft msl) - 52 mgd steady state simulations
- Interpreted Extents of Observed Well Field Cone of Depression (1 foot Drawdown Contour)
- Platte West Well Field Boundary
- Platte West Well Field Pumping Well

MAP SCALE (feet)

0 4000 8000

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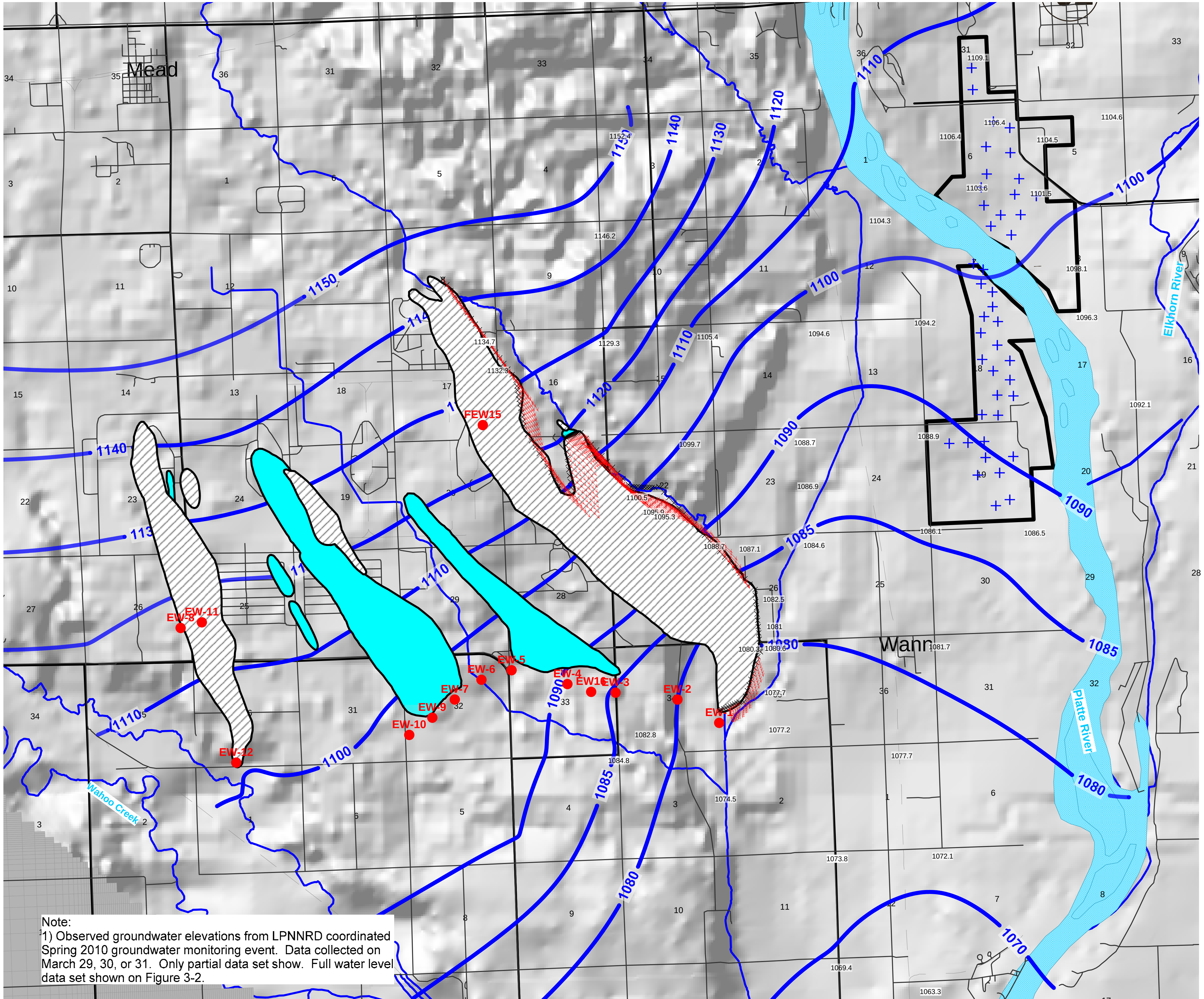

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Platte West Well Field
Nebraska Ordnance Plant
Groundwater Report

Figure 5-6
Transient Particle Tracking Results
(October 2008 to September 2010)

LEGEND:

1094.2 — Observation Well with Measured Water Level Elevation in ft msl (March 2010)

Interpreted Potentiometric Surface Elevation Contour (ft msl) - March 2010

MODPATH Particle Starting Location

Two Year Particle Trace (MODPATH)

TCE Plume

RDX Plume

Pumping Wellfields Operating During MODFLOW/MODPATH Simulation

Platte West Well Field Boundary

Platte West Well Field Well

FNOP Containment/Focused Extraction Well

MAP SCALE (feet)

0 5000 10000

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TABLES

Table 3-1
Well Field Contingency Plan
Trigger Level Comparison
Nebraska Ordnance Plant Groundwater Report

Monitoring Well ID	Priority Well Designation	Measured (Feb/10/2009) Pre-Startup Groundwater Elevation (ft msl)	Lowest Measured Water Level Elevation for 2010 Reporting Period	Water Level Elevation 10/1/2010	Tier 1 Trigger Level (ft msl)	Is Lowest Measured Post Startup Water Level Elevation Below Tier 1 (Y/N)	Tier 2 Trigger Level (ft msl)	Is Lowest Measured Post Startup Water Level Elevation Below Tier 2 (Y/N)	Notes
MW 90-10	Priority Three	1095.5	1,089.4	1,090.8	1,091.0	**Y**	1,089.0	N	Well impacted by irrigation pumping
MW 94-3	Priority One	1080.2	1,078.6	1,080.2	1,076.5	N	1,074.5	N	
MW 94-4	Priority Three	1090.3	1,080.0	1,081.9	1,079.0	N	1,077.0	N	
MW 94-5	Priority One	1094.4	1,092.3	1,093.8	1,091.5	N	1,089.5	N	
MW 94-6	Priority One	1083.8	1,081.7	1,083.3	1,080.0	N	1,078.0	N	
MW 94-7	Priority Two	1075.4	1,074.8	1,076.2	1,073.5	N	1,071.5	N	
MW 04-17[A]	Priority Three	1100.8	1,096.1	1,097.9	1,094.5	N	1,092.5	N	
MW 05-22	Priority Three	1087.4	1,081.8	1,083.8	1,080.0	N	1,078.0	N	
MW 05-23	Priority Three	1085.7	1,079.6	1,081.9	1,078.0	N	1,076.0	N	
MW 06-18[B,C]	Priority Two	1086.8	1,085.5	1,086.9	1,084.0	N	1,082.0	N	
MW 06-19[B,D]	Priority Two	1105.3	1,100.7	1,105.4	1,100.0	N	1,098.0	N	
MW 06-20[B]	Priority Two	1144.7	1,145.3	1,147.8	1,137.0	N	1,135.0	N	
MW 06-21[B,E]	Priority Two	1152.7	1,150.4	1,153.3	1,143.0	N	1,141.0	N	
MW 06-27[B]	Priority One	1086.8	1,084.9	1,086.2	1,081.8	N	1,079.8	N	
MW 06-28[B]	Priority One	1088.4	1,086.6	1,087.6	1,085.0	N	1,083.0	N	
MW 06-30[B,F]	Priority Two	1128.1	1,128.1	1,129.4	1,125.5	N	1,123.5	N	
MW 06-31[B,F]	Priority Two	1099.0	1,097.7	1,098.6	1,096.7	N	1,094.7	N	

Notes:
Tier 1 Trigger Level =The Anticipated Post Startup Groundwater Elevation minus one foot.
Tier 2 Trigger Level = The Tier 1 Trigger Level minus the Natural Groundwater Fluctuation
A) Transducer failure June 2009 - April 2010
B) Hydrograph shows impact of local irrigation
C) Data not available October 2009 - March 2010
D) Data not available October 2009 - April 2010
E) Data not available October 2009 - August 2010
F) Data set provided to 5/27/2010

Table 5-1
Average Monthly Flow Rate (gpm)
Wells in Transient Simulation
Nebraska Ordnance Plant Groundwater Report

Year	2008			2009												2010								
Model Stress Period Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Stress Period Month	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP
USACE FNOP Wells (rate in gpm)																								
EW-1	361.3	206.1	193.4	193.4	202.6	211.7	216.6	212.4	207.6	166.5	169.4	185.3	167.5	174.2	170.1	165.6	161.2	155.5	150.2	145.3	142.2	136.0	165.3	167.1
EW-2	156.5	158.4	155.0	151.4	152.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EW-3	276.6	278.7	276.6	277.2	277.3	284.9	292.1	289.3	283.0	297.9	285.6	284.0	305.3	271.1	302.2	305.9	296.4	298.8	303.5	304.0	305.0	139.0	309.0	304.8
EW-4	99.4	93.6	95.4	93.2	86.3	92.8	92.4	92.6	90.7	88.2	86.9	85.8	78.8	81.6	80.8	81.5	79.5	78.8	78.4	77.5	76.9	310.0	78.4	78.5
EW-5	184.6	182.6	180.9	180.0	179.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EW-6	264.9	263.9	262.3	262.7	264.0	267.2	275.1	271.6	272.1	69.1	68.4	74.2	59.9	67.8	69.7	71.1	70.9	64.6	56.8	57.6	53.8	77.0	54.8	55.7
EW-7	317.7	316.8	310.5	320.0	323.0	332.5	307.2	302.6	307.1	299.4	298.2	304.3	289.5	290.5	293.6	296.1	288.5	290.6	291.6	293.0	295.3	40.0	305.6	301.9
EW-9	162.5	163.4	163.3	164.8	162.3	167.5	172.2	170.3	171.9	144.0	143.3	145.5	147.2	141.4	141.2	141.9	141.5	143.7	145.6	147.9	147.1	300.0	148.7	149.2
EW-10	417.0	413.3	415.3	416.8	417.8	418.9	419.9	419.6	412.7	415.5	407.8	389.8	560.5	394.5	398.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EW-11	567.0	565.9	558.1	559.9	553.1	548.4	541.4	534.6	534.2	543.1	545.2	539.4	264.8	541.6	541.5	539.3	533.0	539.9	547.1	545.3	536.6	144.0	542.7	562.6
EW-12	325.0	325.0	325.0	325.0	325.0	325.0	325.0	325.0	325.0	214.0	214.0	214.0	207.0	325.1	325.1	325.0	325.2	322.6	324.2	324.8	312.0	557.0	284.4	269.9
EW-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	192.7	199.4	195.9	191.1	492.7	187.5	189.5	190.8	187.7	190.0	193.3	194.6	196.1	306.0	207.1	209.1
EW-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	373.9	373.7	374.0	396.6	492.9
EW-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	162.8	101.9	97.1	96.8	112.1	88.2	94.6	93.3	87.9	85.8	86.0	87.6	92.1	368.0	120.2	121.7
Platte West Douglas County Wells (rate in gpm)																								
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	482.5	0.0	0.0	5.4	0.0	4.3	0.2	1.1	0.0	0.0	0.0	18.1	568.1	1,486.8	2,340.5	2,351.9	2,280.8
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	883.7	703.9	764.3	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	3.2	472.7	603.9	1,014.6	34.1	448.8
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	398.3	579.4	24.2	331.5	0.0	0.9	0.0	0.0	0.0	0.0	0.0	16.2	3.1	88.4	78.0	0.4	0.9
5	0.0	0.0	0.0	0.0	241.3	214.6	413.9	7.2	0.0	33.4	4.0	3.2	0.2	0.0	172.3	0.0	0.0	0.0	14.4	2.7	75.2	68.5	0.0	0.7
6	0.0	0.0	0.0	0.0	0.0	0.7	436.3	1,248.0	998.4	453.6	1,312.5	575.0	700.5	0.0	622.8	194.4	1,348.7	0.0	1,019.2	264.6	866.0	447.4	1,446.9	354.6
7	0.0	0.0	0.0	0.0	0.0	0.0	0.2	129.0	260.0	342.5	0.0	506.7	0.2	0.0	0.2	0.0	0.2	0.0	8.8	1,069.7	0.0	207.2	69.4	122.0
8	0.0	0.0	0.0	0.0	0.0	51.1	125.5	389.8	25.0	119.2	709.9	468.1	532.5	268.1	234.1	0.0	625.5	1,296.6	0.2	409.9	0.0	18.4	35.6	23.4
9	0.0	0.0	0.0	0.0	0.0	0.0	146.5	44.1	359.3	102.2	0.2	1,081.3	224.2	0.0	0.0	0.0	0.0	0.0	0.0	6.0	67.6	1,843.4	547.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	191.3	103.0	1,187.7	1,341.4	810.4	0.2	0.0	0.0	2.0	0.0	0.0	13.9	1,173.4	90.3	755.4	2,143.8	94.7
11	0.0	0.0	0.0	0.0	0.0	562.7	0.0	38.3	1,315.5	2,077.5	424.1	1,589.8	0.2	0.0	867.2	0.0	0.0	490.4	1,459.5	447.4	111.1	3.6	265.9	386.6
12	0.0	0.0	0.0	0.0	643.8	154.1	689.1	1,840.1	1,983.3	1,854.6	388.0	1,848.1	669.4	0.0	1,193.8	2,987.7	270.1	0.0	247.7	937.9	468.3	439.5	1,397.8	1,959.5
13	0.0	0.0	0.0	0.0	99.7	0.0	90.5	382.6	420.1	0.0	4.9	0.0	0.2	0.0	0.0	0.0	0.0	0.0	273.8	293.5	2,419.7	416.2	383.5	743.1
14	0.0	0.0	0.0	0.0	771.8	0.0	0.0	651.9	236.1	1,305.8	1,112.2	408.8	310.9	0.0	467.5	0.0	2,094.2	2,256.7	0.0	6.5	890.7	1,697.1	298.8	56.7
15	0.0	0.0	0.0	0.0	433.0	0.0	689.6	247.8	428.2	181.0	233.2	639.1	0.0	0.0	108.9	0.0	0.0	0.0	0.9	1,312.1	1,578.2	401.4	711.9	431.5
16	0.0	0.0	0.0	0.0	0.0	701.6	844.9	1,043.9	849.1	1,115.8	786.5	1,054.6	1,101.7	2,133.1	2,500.0	2,320.6	426.8	0.0	903.0	4.9	0.0	290.1	757.2	1,091.0
17	0.0	0.0	0.0	0.0	133.9	1,991.3	809.0	706.3	1,453.5	544.6	1,193.8	0.0	0.2	0.0	831.8	2,515.2	224.7	104.4	2,443.3	358.9	0.0	318.5	505.2	0.5
Platte West Saunders County Wells (rate in gpm)																								
30	0.0	0.0	0.0	0.0	8.7	0.0	477.5	1,158.8	542.8	798.8	580.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,431.5	2,112.9	2,498.6	271.3	483.9	863.9
31	0.0	0.0	0.0	0.0	269.8	2,173.6	696.5	159.5	682.4	1,251.8	1,002.5	0.0	1,417.3	1,884.5	201.6	1,876.1	2,070.9	435.3	0.0	310.0	190.3	0.0	504.0	1,872.7
32	0.0	0.0	0.0	0.0	0.0	0.0	609.7	782.0	1,377.8	544.4	1,071.2	1,610.6	0.2	0.0	0.0	0.0	155.5	350.8	162.3	1,809.8	749.1	1,082.2	917.1	1,020.8
33	0.0	0.0	0.0	0.0	0.0	0.0	86.6	1,022.2	1,215.7	0.0	1,213.3	2,282.2	896.7	492.8	1,412.4	0.0	0.0	1,485.0	1,217.8	1,415.8	979.2	2,111.1	1,712.4	1,442.1
34	0.0	0.0	0.0	0.0	0.5	0.0	607.4	1,733.6	1,301.2	1,603.5	1,203.6	0.0	340.7	1,441.4	166.9	1,776.2	0.0	695.1	1,068.1	671.6	2,123.6	1,374.6	963.9	949.5
35	0.0	0.0	0.0	0.0	0.0	0.0	738.7	1,512.5	1,250.7	712.1	818.8	1,219.2	2,113.4	0.0	83.3	2,393.4	2,498.5	1,738.1	0.0	0.9	65.5	1,029.6	2,397.4	1,326.4
36	0.0	0.0	0.0	0.0	482.6	596.1	1,548.6	525.3	1,447.7	1,241.0	1,779.8	725.5	0.4	1,511.8	0.0	0.0	115.8	1,071.0	951.6	2,718.9	154.2	365.1	0.0	951.6
37	0.0	0.0	0.0	0.0	934.5	553.8	1,293.3	1,488.8	720.8	737.2	0.0	1,783.6	1,452.7	1,012.3	624.6	0.0	0.0	1,340.7	1,297.9	266.4	2,533.6	1,400.5	1,309.4	2,131.9
38	0.0	0.0	0.0	0.0	836.8	1,406.4	237.5	0.2	260.0	519.0	900.8	617.1	1,620.7	0.0	0.0	2,124.3	2,467.0	556.2	0.0	152.6	0.0	1,176.1	1,962.6	49.1
39	0.0	0.0	0.0	0.0	135.7	0.0	0.0	934.4	1,266.2	0.0	1,097.2	0.0	353.5	2,299.8	1,463.0	0.0	0.0	0.2	880.1	815.6	378.0	947.1	2,233.6	1,690.3
40	0.0	0.0	0.0	0.0	605.7	1,864.5	258.6	564.7	350.7	1,384.0	105.1	1,853.2	45.5	1,166.7	1,030.2	1,448.5	409.5	0.0	0.0	1,078.4	2,047.2	1,656.1	682.3	1,799.3
41	0.0	0.0	0.0	0.0	914.2	0.0	603.0	337.4	1,202.5	847.0	948.9	299.3	73.5	0.0	0.0	0.0	0.0	145.6	296.1	48.2	0.0	229.8	912.4	1,685.9
42	0.0	0.0	0.0	0.0	247.0	0.0	0.0	1,254.5	532.6	1,308.5	552.9	0.0	1,233.4	1,120.1	1,518.4	0.0	0.0	0.0	783.1	1,009.0	122.0	193.3	1,057.3	572.9
43	0.0	0.0	0.0	0.0	837.5	0.0	0.0	540.3	675.5	659.9	532.9	1,606.3	594.5	1,159.3	0.0	0.0	0.0	0.0	0.0	7.4	1,015.3	2,218.2	1,244.2	0.0
44	0.0	0.0	0.0	0.0	512.9	0.0	229.2	506.0	1,274.5	1,393.8	819.0	632.2	0.0	1,141.9	838.5	0.0	1,595.0	755.8	493.5	739.0	861.3	0.0	669.6	0.0
45	0.0	0.0	0.0	0.0	840.8	0.0	665.5	1,191.5	1,719.9	1,505.8	869.0	227.8	1,096.6	59.0	629.9	0.0	0.0	460.1	0.0	1,136.2	1,997.9	2,381.0	1,967.1	916.0
46	0.0	0.0	0.0	0.0	0.0	0.0	591.9	939.7	502.1	499.6	411.7	1,044.0	717.1	252.5	0.0	0.0	352.7	835.6	600.9	882.4	2,068.3	959.7	1,700.5	1,410.4
47	0.0	0.0	0.0	0.0	0.0	961.7	844.0	675.4	1,134.5	770.6	937.7	0.0	532.7	0.0	0.0	0.0	0.0	521.1	606.9	38.1	647.0	724.0	539.2	111.6
48	0.0	0.0	0.0	0.0	230.9	1,528.2	0.0	827.1	1,216.0	876.8	893.4	918.1	553.8	0.0	71.2	0.0	0.0	195.6	0.0	592.1	453.2	579.3	807.1	254.4
49	0.0	0.0	0.0	0.0	705.4	516.6	1,112.3	520.4	491.4	490.8	1,173.6	1,061.8	379.3	766.2	863.8	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	443.9	989.7	0.0	330.4	72.2	1,208.1	402.8	814.4	152.3	0.0	0.0	0.0	0.0	66.8	839.4	467.3	461.3	0.0	528.4	1,165.0
51	0.0	0.0	0.0	0.0	206.6	517.9	0.0	0.0	0.0	0.0	1,204.5	2,243.5	1,529.8	0.0	0.0	0.0	0.0	552.6	1,097.7	404.6	38.0	1,011.0	1,171.6	1.9
52	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	334.7	1,035.6	0.0	1.4	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
53	0.0	0.0	0.0	0.0	0.0	0.0	527.8	1,582.7	1,744.4	423.8	848.8	0.0	0.2	70.8	0.0	0.0	0.0	321.2	0.0	194.7	224.8	997.5	605.1	107.9
54	0.0	0.0	0.0	0.0	0.0	436.8	1,096.3	369.8	1,253.2	379.3	768.1	1,172.7	153.0	0.0	0.0	0.0	0.0	95.4	995.4	0.0	0.0	587.6	143.8	648.8
55	0.0	0.0	0.0	0.0	194.7	454.3	492.4	1,207.0	875.5	824.4	758.5	593.8	906.4	0.0	0.0	0.0	0.0	0.0	314.1	994.6	238.0	0.0	384.9	38.9

Note: Well flow rate in gpm

Table 5-2
Transient Calibration Check
End of March 2010 Data Set
Nebraska Ordnance Plant Groundwater Report

Calibration Target Name	Monitoring Entity	Simulation Time (Days)	Easting (State Plane NAD 27)	Northing (State Plane NAD 27)	Measured Groundwater Elevation (ft msl)	Model Computed Groundwater Elevation (ft msl)	Residual (feet)
N.Wann	LPNNRD	540	2,865,005.94	575,909.14	1,104.33	1,107.34	-3.01
MW 06-18	LPNNRD	540	2,858,537.81	559,602.81	1,087.13	1,082.85	4.28
MW 06-19	LPNNRD	540	2,856,439.03	570,147.27	1,105.38	1,113.28	-7.90
MW 06-20	LPNNRD	540	2,851,337.32	575,150.79	1,146.20	1,145.07	1.13
MW 06-21	LPNNRD	540	2,852,088.15	580,124.31	1,152.37	1,153.82	-1.45
M90-01	LWS	540	2,862,871.03	544,204.31	1,073.76	1,072.47	1.29
M90-02	LWS	540	2,868,115.93	544,331.20	1,072.09	1,073.52	-1.43
M90-04	LWS	540	2,863,082.51	538,790.22	1,069.40	1,068.05	1.35
M90-05R	LWS	540	2,867,507.17	537,608.56	1,063.32	1,066.39	-3.07
M90-09	LWS	540	2,863,082.52	533,799.10	1,065.17	1,064.81	0.36
M90-12R	LWS	540	2,870,221.82	534,567.36	1,061.30	1,066.79	-5.49
M90-15	LWS	540	2,863,438.99	528,119.80	1,062.81	1,061.22	1.59
M90-16R	LWS	540	2,867,529.30	528,495.41	1,058.32	1,059.77	-1.45
M90-17R	LWS	540	2,870,977.08	528,518.69	1,057.31	1,064.14	-6.83
M90-20R	LWS	540	2,873,598.21	525,980.78	1,055.10	1,061.42	-6.32
M90-21	LWS	540	2,864,221.99	523,622.73	1,060.30	1,058.23	2.07
M90-22R	LWS	540	2,867,266.88	523,017.60	1,055.44	1,055.49	-0.05
M90-23R	LWS	540	2,871,378.78	523,773.72	1,047.97	1,050.93	-2.96
M90-26R	LWS	540	2,874,868.33	520,558.52	1,044.69	1,049.32	-4.63
M90-36R	LWS	540	2,875,572.09	520,179.04	1,050.50	1,055.30	-4.80
M90-37	LWS	540	2,864,221.99	523,622.73	1,052.56	1,058.23	-5.67
MW 90-04	MUD	540	2,871,671.66	596,763.10	1,118.59	1,118.56	0.03
MW 05-22	MUD	540	2,872,691.47	560,389.20	1,086.52	1,088.18	-1.66
MW 05-23	MUD	540	2,867,529.52	560,485.81	1,086.05	1,084.94	1.12
MW 052-4	MUD	540	2,874,780.60	573,532.12	1,098.10	1,099.63	-1.53
MW 05-25	MUD	540	2,873,323.13	579,940.15	1,104.45	1,102.28	2.17
MW 05-26	MUD	540	2,869,870.32	584,015.91	1,109.12	1,107.57	1.54
MW 06-27	MUD	540	2,861,420.46	562,713.05	1,086.91	1,084.68	2.23
MW 06-28	MUD	540	2,861,268.74	564,887.69	1,088.68	1,086.78	1.90
MW 06-29	MUD	540	2,875,281.39	571,101.58	1,096.32	1,098.79	-2.46
MW 90-10	MUD	540	2,867,239.25	570,835.00	1,094.23	1,096.74	-2.51
MW 90-12	MUD	540	2,882,513.22	581,139.14	1,099.05	1,098.04	1.01
MW 90-13	MUD	540	2,877,933.87	566,775.03	1,092.14	1,093.45	-1.32
MW 90-5	MUD	540	2,872,994.66	577,270.86	1,101.52	1,100.53	0.99
MW 90-6	MUD	540	2,876,522.67	581,063.47	1,104.57	1,101.96	2.61
MW 90-7	MUD	540	2,868,496.45	580,093.27	1,106.45	1,106.29	0.16
MW 94-1	MUD	540	2,870,701.45	580,798.87	1,106.36	1,104.59	1.78
MW 94-2	MUD	540	2,869,819.46	577,535.46	1,103.61	1,103.85	-0.25
MW 94-3	MUD	540	2,867,957.97	554,740.57	1,081.65	1,081.00	0.65
MW 94-4	MUD	540	2,867,416.89	565,193.33	1,088.94	1,088.21	0.73
MW 94-5	MUD	540	2,861,981.46	570,309.03	1,094.63	1,094.16	0.47
MW 94-6	MUD	540	2,861,735.50	559,782.49	1,084.61	1,082.04	2.57
MW 94-7	MUD	540	2,866,088.77	549,329.74	1,077.65	1,076.38	1.27
MW 01B	USACE	540	2,840,885.09	567,128.96	1,133.82	1,138.19	-4.38
MW 02B	USACE	540	2,829,187.41	561,711.47	1,133.38	1,135.17	-1.79
MW 03B	USACE	540	2,829,920.58	561,676.92	1,135.18	1,134.66	0.52
MW 04B	USACE	540	2,834,431.35	561,683.27	1,130.89	1,131.93	-1.03
MW 05B	USACE	540	2,835,439.22	562,515.41	1,132.00	1,133.04	-1.04
MW 06-30	USACE	540	2,851,545.76	569,819.86	1,129.32	1,129.18	0.14
MW 06-31	USACE	540	2,855,554.00	564,811.82	1,099.65	1,102.16	-2.51
MW 06B	USACE	540	2,839,767.55	561,916.79	1,125.42	1,128.22	-2.80
MW 07B	USACE	540	2,840,664.36	562,662.12	1,125.85	1,128.91	-3.05
MW 08B	USACE	540	2,845,258.28	562,178.32	1,118.83	1,120.76	-1.93
MW 09B	USACE	540	2,845,970.53	562,789.63	1,119.46	1,121.18	-1.72
MW 100B	USACE	540	2,852,025.31	549,090.35	1,084.75	1,083.26	1.49
MW 101B	USACE	540	2,833,212.33	547,001.72	1,100.17	1,099.10	1.07
MW 102B	USACE	540	2,845,357.38	569,899.96	1,134.65	1,138.92	-4.27

Table 5-2
Transient Calibration Check
End of March 2010 Data Set
Nebraska Ordnance Plant Groundwater Report

Calibration Target Name	Monitoring Entity	Simulation Time (Days)	Easting (State Plane NAD 27)	Northing (State Plane NAD 27)	Measured Groundwater Elevation (ft msl)	Model Computed Groundwater Elevation (ft msl)	Residual (feet)
MW 103B	USACE	540	2,846,016.55	568,464.89	1,132.34	1,135.42	-3.08
MW -104B	USACE	540	2,856,424.81	554,493.11	1,078.77	1,079.21	-0.44
MW -105B	USACE	540	2,857,368.77	551,934.07	1,076.38	1,077.02	-0.64
MW 106B	USACE	540	2,852,927.61	562,154.88	1,100.46	1,103.24	-2.78
MW 107B	USACE	540	2,853,758.20	561,430.68	1,095.93	1,099.25	-3.32
MW 108B	USACE	540	2,854,299.94	561,201.61	1,095.26	1,097.21	-1.95
MW -109B	USACE	540	2,857,164.63	557,187.86	1,084.27	1,081.65	2.62
MW 10B	USACE	540	2,830,214.37	552,306.40	1,110.31	1,109.69	0.62
MW 110B	USACE	540	2,856,771.63	559,725.53	1,088.65	1,085.83	2.82
MW -111B	USACE	540	2,858,495.16	554,623.07	1,080.34	1,078.42	1.91
MW -112B	USACE	540	2,859,724.40	557,100.57	1,082.50	1,079.88	2.62
MW -113B	USACE	540	2,859,770.24	555,744.96	1,080.95	1,078.84	2.11
MW 114B	USACE	540	2,859,796.21	552,470.65	1,077.68	1,076.99	0.69
MW 115B	USACE	540	2,860,015.46	550,611.41	1,077.22	1,076.15	1.07
MW 117B	USACE	540	2,853,355.99	550,359.29	1,082.84	1,081.15	1.69
MW 118B	USACE	540	2,848,205.83	551,544.99	1,090.90	1,091.22	-0.32
MW -119B	USACE	540	2,830,279.12	555,041.08	1,114.23	1,114.04	0.18
MW -120B	USACE	540	2,831,709.69	554,877.90	1,112.59	1,112.09	0.50
MW -121B	USACE	540	2,832,120.27	555,508.17	1,113.69	1,114.29	-0.60
MW -122B	USACE	540	2,831,561.05	553,554.15	1,111.01	1,111.06	-0.05
MW -123B	USACE	540	2,831,005.72	555,352.38	1,113.03	1,110.69	2.35
MW -124B	USACE	540	2,831,457.44	556,937.28	1,118.19	1,120.24	-2.05
MW -125B	USACE	540	2,831,812.69	556,100.22	1,114.93	1,115.97	-1.04
MW -126B	USACE	540	2,829,850.48	559,966.18	1,129.26	1,131.16	-1.90
MW -127B	USACE	540	2,828,504.17	562,391.75	1,135.05	1,136.82	-1.77
MW -128B	USACE	540	2,847,171.83	553,541.80	1,093.99	1,094.89	-0.90
MW -129B	USACE	540	2,850,095.27	551,871.04	1,087.37	1,087.79	-0.42
MW -130B	USACE	540	2,851,383.92	551,977.63	1,085.20	1,084.66	0.54
MW -131B	USACE	540	2,848,674.49	552,279.14	1,090.28	1,091.08	-0.80
MW -132B	USACE	540	2,847,585.82	552,602.96	1,092.32	1,093.21	-0.89
MW -133B	USACE	540	2,844,926.81	565,090.40	1,125.64	1,129.24	-3.60
MW -134B	USACE	540	2,845,813.48	564,407.37	1,123.18	1,126.14	-2.96
MW -135B	USACE	540	2,845,555.57	565,129.09	1,124.99	1,128.44	-3.45
MW -136B	USACE	540	2,845,473.46	565,918.05	1,126.94	1,130.49	-3.55
MW -137B	USACE	540	2,845,262.64	567,063.27	1,130.42	1,133.37	-2.95
MW -138B	USACE	540	2,844,801.27	568,179.22	1,133.02	1,136.29	-3.27
MW -139B	USACE	540	2,843,728.98	569,644.38	1,135.70	1,140.29	-4.59
MW -140B	USACE	540	2,857,085.24	558,668.09	1,086.92	1,083.60	3.32
MW 16B	USACE	540	2,827,337.78	569,495.55	1,153.23	1,149.89	3.34
MW 17B	USACE	540	2,825,626.36	554,577.56	1,120.35	1,118.40	1.95
MW 18B	USACE	540	2,851,544.45	562,146.71	1,102.37	1,106.41	-4.04
MW 19B	USACE	540	2,840,881.25	572,964.16	1,146.68	1,148.80	-2.12
MW 20B	USACE	540	2,838,933.64	548,584.71	1,099.26	1,098.43	0.82
MW 21B	USACE	540	2,829,472.98	558,977.64	1,127.84	1,128.51	-0.67
MW 22B	USACE	540	2,829,008.62	565,861.51	1,143.98	1,142.98	1.00
MW 23B	USACE	540	2,828,790.83	564,843.04	1,141.34	1,141.18	0.16
MW 24B	USACE	540	2,830,829.78	557,353.91	1,121.14	1,122.28	-1.14
MW 25B	USACE	540	2,830,678.70	560,332.12	1,129.26	1,131.41	-2.15
MW 27B	USACE	540	2,833,818.22	563,538.65	1,136.43	1,136.12	0.31
MW 28B	USACE	540	2,835,291.28	557,659.95	1,119.61	1,122.53	-2.92
MW 29B	USACE	540	2,836,792.75	553,789.95	1,109.79	1,111.44	-1.65
MW 30B	USACE	540	2,838,667.84	562,464.03	1,127.92	1,130.53	-2.61
MW 31B	USACE	540	2,840,297.92	558,625.90	1,116.81	1,120.02	-3.21
MW 32B	USACE	540	2,842,034.29	554,444.72	1,103.32	1,106.99	-3.67
MW 33B	USACE	540	2,844,762.58	558,214.62	1,107.41	1,111.33	-3.92
MW 34B	USACE	540	2,846,780.11	554,160.62	1,095.39	1,096.76	-1.37
MW 35B	USACE	540	2,851,918.85	551,643.79	1,084.27	1,083.24	1.03
MW 40B	USACE	540	2,845,424.82	567,320.75	1,130.83	1,133.73	-2.90
MW 41B	USACE	540	2,846,780.49	567,351.07	1,130.34	1,131.91	-1.57
MW 42B	USACE	540	2,851,740.82	556,909.42	1,093.78	1,093.93	-0.15

Table 5-2
Transient Calibration Check
End of March 2010 Data Set
Nebraska Ordnance Plant Groundwater Report

Calibration Target Name	Monitoring Entity	Simulation Time (Days)	Easting (State Plane NAD 27)	Northing (State Plane NAD 27)	Measured Groundwater Elevation (ft msl)	Model Computed Groundwater Elevation (ft msl)	Residual (feet)
MW 43B	USACE	540	2,851,616.68	559,646.40	1,097.51	1,100.23	-2.72
MW 44B	USACE	540	2,855,304.15	555,720.97	1,085.44	1,081.79	3.65
MW 46B	USACE	540	2,859,808.47	554,663.47	1,080.57	1,078.14	2.43
MW 47B	USACE	540	2,826,309.96	579,958.22	1,174.80	1,167.55	7.25
MW 52B	USACE	540	2,849,403.65	564,111.78	1,118.54	1,118.08	0.46
MW 53B	USACE	540	2,850,281.25	563,493.93	1,111.25	1,113.83	-2.58
MW 54B	USACE	540	2,850,283.99	564,183.45	1,114.30	1,115.94	-1.64
MW 55B	USACE	540	2,850,523.07	563,700.11	1,109.87	1,113.83	-3.96
MW 56B	USACE	540	2,850,591.56	563,542.72	1,110.77	1,113.15	-2.38
MW 57B	USACE	540	2,830,062.81	571,816.51	1,156.44	1,153.53	2.91
MW 60B	USACE	540	2,846,983.29	544,941.78	1,090.14	1,088.35	1.79
MW 61B	USACE	540	2,830,940.69	548,340.72	1,103.19	1,101.99	1.20
MW 63B	USACE	540	2,835,629.91	574,893.38	1,157.57	1,155.98	1.59
MW 65B	USACE	540	2,835,572.46	561,508.11	1,128.78	1,130.90	-2.12
MW 71B	USACE	540	2,835,761.83	561,505.99	1,128.63	1,130.78	-2.15
MW 72B	USACE	540	2,845,340.40	567,422.72	1,140.42	1,134.06	6.36
MW 73B	USACE	540	2,845,470.05	567,266.40	1,130.02	1,133.55	-3.53
MW 74B	USACE	540	2,845,503.17	567,292.30	1,130.13	1,133.57	-3.43
MW 76B	USACE	540	2,845,567.14	567,339.71	1,130.13	1,133.59	-3.45
MW 77B	USACE	540	2,845,598.95	567,364.21	1,130.13	1,133.60	-3.47
MW 78B	USACE	540	2,845,632.32	567,388.04	1,130.14	1,133.61	-3.47
MW 79B	USACE	540	2,832,721.50	547,776.26	1,100.60	1,100.20	0.40
MW 80B	USACE	540	2,833,207.98	547,492.63	1,100.34	1,099.83	0.51
MW 81B	USACE	540	2,833,929.67	547,784.05	1,098.52	1,099.56	-1.04
MW 82B	USACE	540	2,841,586.66	548,702.49	1,096.20	1,095.50	0.70
MW 83B	USACE	540	2,844,236.44	550,664.03	1,093.28	1,093.43	-0.15
MW 84B	USACE	540	2,846,589.84	551,059.84	1,092.78	1,092.84	-0.06
MW 85B	USACE	540	2,850,626.18	549,771.71	1,086.57	1,085.99	0.58
MW 86B	USACE	540	2,854,241.31	549,058.22	1,081.23	1,079.09	2.14
MW 87B	USACE	540	2,857,332.22	547,181.15	1,074.50	1,074.86	-0.36
MW 89B	USACE	540	2,832,713.86	549,685.68	1,104.50	1,103.07	1.43
MW 90B	USACE	540	2,833,532.25	549,724.53	1,104.57	1,102.81	1.76
MW 91B	USACE	540	2,834,373.84	549,738.96	1,104.37	1,102.81	1.56
MW 92B	USACE	540	2,832,343.46	548,167.31	1,101.00	1,100.46	0.54
MW 93B	USACE	540	2,834,455.31	548,967.55	1,103.44	1,101.41	2.03
MW 94B	USACE	540	2,839,343.46	551,825.99	1,102.00	1,104.05	-2.05
MW 95B	USACE	540	2,839,855.57	549,895.92	1,099.63	1,099.37	0.26
MW 96B	USACE	540	2,843,770.92	548,751.45	1,093.64	1,093.39	0.25
MW 97B	USACE	540	2,846,236.67	548,841.02	1,091.89	1,091.66	0.23
MW 98B	USACE	540	2,848,794.05	548,938.21	1,089.57	1,088.53	1.04
MW 99B	USACE	540	2,849,456.00	554,118.04	1,091.37	1,092.71	-1.34
4.11E+14	USGS	540	2,807,174.59	580,062.31	1,170.50	1,173.67	-3.17
4.11E+14	USGS	540	2,835,554.08	586,298.91	1,164.00	1,173.50	-9.50
4.12E+14	USGS	540	2,852,324.47	591,951.91	1,152.00	1,160.36	-8.36
4.12E+14	USGS	540	2,820,159.35	591,641.25	1,197.00	1,184.94	12.06
4.12E+14	USGS	540	2,797,928.89	598,283.84	1,216.00	1,204.86	11.14
4.12E+14	USGS	540	2,835,205.54	609,476.66	1,205.00	1,198.91	6.09
4.12E+14	USGS	540	2,798,536.75	616,733.65	1,239.00	1,229.52	9.48
4.12E+14	USGS	540	2,831,630.66	622,263.94	1,190.00	1,203.41	-13.41
4.12E+14	USGS	540	2,813,075.46	622,488.07	1,231.00	1,231.71	-0.71
4.12E+14	USGS	540	2,819,035.86	623,399.87	1,231.00	1,228.86	2.14
4.12E+14	USGS	540	2,801,334.85	622,092.67	1,245.00	1,235.43	9.57
4.12E+14	USGS	540	2,811,741.67	632,569.35	1,228.00	1,241.79	-13.79

Summary Statistics	
Residual Mean	-0.50
Abs. Res. Mean	2.50
Sum of Squares	2135.30
RMS Error	3.50
Min. Residual	-13.79
Max. Residual	12.06
Range in Observations	200.31
Scaled RMS	1.75%

Table 5-3
Comparison of Model Predicted to Observed Drawdown
February 11 through September 30, 2010 Pumping Period
Pressure Transducer Equipped Monitoring Well Network
Nebraska Ordnance Plant Groundwater Report

Monitoring Well ID	Measured (Feb/10/2009) Pre-Startup Groundwater Elevation (ft msl)	Water Level Elevation 9/22/2010 (Equal to Simulation Day 720)	Observed Change in Groundwater Level Elevation (feet) February to September	Model Predicted Drawdown (feet) - Transient Two Year Model (End of September 2010 Stress Period, Simulation Day 720)	Difference Between Model Predicted and Observed Drawdown (Feet)	Comment
Douglas County Monitoring Wells						
MW90-13	1,090.8	1,090.0	0.82	-0.17	-0.99	Well is located near a center pivot irrigation well. OUTSIDE Well Field Cone of Depression
MW90-5	1,102.0	1,098.4	3.67	5.62	1.95	
MW90-6	1,103.6	1,103.4	0.18	2.02	1.84	
MW90-7	1,106.7	1,104.7	1.99	2.76	0.77	
MW94-1	1,106.5	1,104.4	2.07	3.92	1.85	
MW94-2	1,105.0	1,101.4	3.62	5.15	1.53	
MW05-26	1,108.5	1,107.9	0.51	1.70	1.19	
MW05-24	1,097.9	1,096.5	1.42	2.20	0.78	Transducer Failure - March 2010 through August 2010
MW05-25	1,104.0	1,102.5	1.56	3.73	2.17	Transducer Failure - June 2009 through October 2009
MW06-29	1,096.3	1,095.2	1.12	0.84	-0.28	
Saunders County Monitoring Wells						
MW 90-10	1,095.5	1,090.8	4.7	4.8	0.1	
MW 94-3	1,080.3	1,080.2	0.0	1.1	1.0	
MW 94-4	1,090.4	1,081.9	8.5	8.8	0.3	
MW 94-5	1,094.4	1,093.8	0.6	0.8	0.2	Well is impacted by irrigation.
MW 94-6	1,083.8	1,083.3	0.4	1.1	0.7	
MW 94-7	1,075.4	1,076.2	-0.8	0.0	0.8	
MW 04-17	1,100.7	1,097.9	2.7	3.9	1.1	Transducer Failure - June 2009 through April 2010
MW 05-22	1,087.4	1,083.8	3.6	3.5	-0.1	
MW 05-23	1,085.7	1,081.9	3.9	4.5	0.7	
MW 06-18+	1,086.8	1,086.9	-0.1	0.4	0.5	Impacted by irrigation - OUTSIDE Well Field Cone of Depression
MW 06-19+	1,105.3	1,105.4	-0.1	Outside cone of depression	NA	Impacted by irrigation - OUTSIDE Well Field Cone of Depression
MW 06-20+	1,144.7	1,147.8	-3.1	Outside cone of depression	NA	Impacted by irrigation - OUTSIDE Well Field Cone of Depression
MW 06-21+	1,152.7	1,153.3	-0.6	Outside cone of depression	NA	Impacted by irrigation - OUTSIDE Well Field Cone of Depression
MW 06-27+	1,086.9	1,086.2	0.7	1.2	0.5	Impacted by irrigation but INSIDE Well Field Cone of Depression
MW 06-28+	1,088.4	1,087.6	0.8	1.2	0.3	Impacted by irrigation but INSIDE Well Field Cone of Depression
MW 06-30+	1,128.1	1,129.4	-1.3	Outside cone of depression	NA	Impacted by irrigation - OUTSIDE Well Field Cone of Depression
MW 06-31+	1,099.0	1,098.6	0.4	Outside cone of depression	NA	Impacted by irrigation - OUTSIDE Well Field Cone of Depression

Notes:

All monitoring wells equipped with pressure transducers/data loggers

Difference Between Model Predicted and Observed Drawdown (Feet), Positive Value = Model Overestimates Drawdown

Difference Between Model Predicted and Observed Drawdown (Feet), Negative Value = Model Underestimates Drawdown

+ Hydrograph shows impact of local irrigation