Gilcrest/LaSalle Pilot Project
Hydrogeologic Characterization Report

Prepared for:
The Colorado Division of Water Resources and
The Colorado Water Conservation Board

By

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Golden, Colorado
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COLORADO GEOLOGICAL SURVEY

EXECUTIVE SUMMARY

The Gilcrest/LaSalle Hydrogeologic Characterization is a component of the Gilcrest/LaSalle Pilot Project conducted by the Colorado Division of Water Resources (DWR) and funded by the Colorado Water Conservation Board (CWCB). The Gilcrest/LaSalle Pilot Project goal is to evaluate high groundwater conditions in the South Platte alluvial aquifer near Gilcrest and LaSalle, Colorado, as shown in Figures E1 and E2 (Study Area). For this study the Colorado Geological Survey (CGS) compiled, analyzed, and reinterpreted existing hydrogeologic data from previously published regional studies.

Through integration of previous investigations with new analysis, CGS has added significantly to the Study Area hydrogeologic characterization, and provided insight into the South Platte alluvial aquifer depositional model, particularly with respect to discontinuous low permeability beds within the central portion of the alluvial aquifer, and lower permeability beds on the aquifer flanks.

Specifically, the CGS hydrogeologic characterization presented herein has:

1. Developed a hydrograph template to facilitate HydroBase data analysis;
2. Refined alluvial aquifer extent mapping;
3. Combined surficial geology from different sources to revise surficial mapping;
4. Refined the bedrock and alluvial surface geologic mapping;
5. Refined the alluvial aquifer lithologic and depositional conceptual models;
6. Compiled driller's logs from 448 boreholes into a digital lithologic dataset;
7. Developed updated localized time-series water table contour and depth-to-groundwater maps;
8. Evaluated groundwater flow in detail;
9. Identified local-scale water level data gaps;
10. Identified existing candidate wells for additional water level monitoring and aquifer testing.

Additionally, this study has determined that, despite a large number and distribution of wells monitored, the overall data set contains significant gaps in data continuity and location. These data gaps limit the ability to analyze detailed long-term groundwater level trends throughout the entire study area and to map detailed water table surfaces across portions of the Study Area during long periods.

In the Study Area the South Platte alluvial aquifer is a heterogeneous geologic unit composed of interbedded gravel, sand, silt, and clay filling an irregularly shaped paleovalley incised into low-permeability bedrock (Figure E3). Highly permeable coarse-grained material dominates the central portion of the aquifer and is interbedded with lenses of less permeable fine-grained material. On the aquifer flanks, sheetwash deposits derived from the fine-grained Laramie Formation or loess form low-permeability deposits locally overlain by sand and loess. Aquifer thickness exceeds 100 feet in the deepest portions of the aquifer; however the majority of the alluvial sediments are 45 to 85 feet thick. Using spring 2012 water levels, the groundwater volume stored in the alluvial aquifer in the Study Area was estimated at 320,000 acre feet.

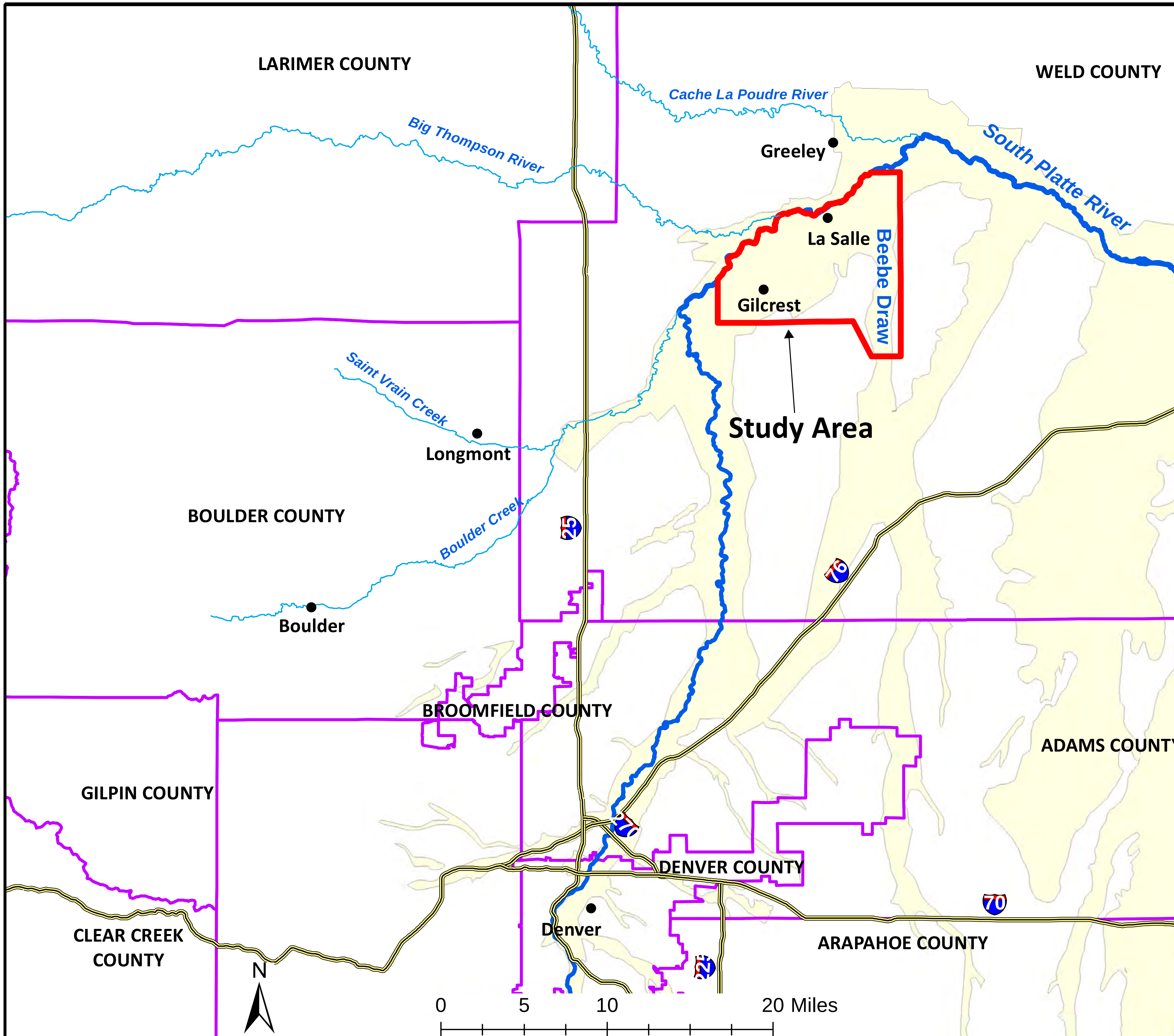
Hydraulic conductivity values from nine aquifer tests range from 385 to 1,270 feet/day (Table 1). Specific yield values from five of the aquifer tests have a bimodal distribution averaging 0.04 and 0.15, indicating localized semi-confined and unconfined conditions, respectively. Transmissivity values from the same locations range from 40,000 to 350,000 gallons per day per foot

Groundwater level measurements were compiled from 136 wells (Figure E4) with a combined period of record from 1929 to 2013 (Table 2). In the central and northeast portions of the Study Area historic groundwater level data indicate a relatively stable trend over the period of record (Figures E5 and E6, respectively). In the western portion of the Study Area groundwater levels have declined from the 1940s until the early 2000s, when levels began to rise, however groundwater levels are still 5 to 8 feet below the 1940s levels (Figure E7).

As shown in Figure E8, shallow groundwater occurs along three distinct alignments in the Study Area: the floodplain immediately adjacent to the South Platte River, Beebe Draw from Milton Reservoir to the vicinity of Lower Latham Reservoir, and the upper terraced portion of the alluvial valley flank below the Platte Valley Canal and the Evans Ditch. All of these areas have historic shallow groundwater conditions as indicated by features such as drainage canals, mapped wetlands and depth to groundwater maps from previous investigations using data from the 1950s and 1970s (Smith 1964, Colton 1978).

Groundwater enters the Study Area as underflow at the hydraulically upgradient (southwest) end of the Study Area, underflow from the south in the Beebe Draw alluvial aquifer, and as recharge from infiltration of precipitation and irrigation, seepage from recharge ponds and irrigation ditches, and other surface water sources. Groundwater flow in the central portion of the Study area is generally subparallel to the South Platte River, and has a strong northward flow component throughout the entire study area. This indicates that while groundwater will eventually discharge to the South Platte River, a significant groundwater flow component is downstream and subparallel to the river. Groundwater flows preferentially through the aquifer via the zone of highest transmissivity underlying the center of the alluvial valley, generally along the US Highway 85 alignment (Figure E9). Groundwater leaves the Study Area as downgradient underflow, water well pumping consumptive use, evapotranspiration, and discharge to the river. Annual groundwater underflow through the Study Area is estimated at 10,500 acre-feet and storage is estimated at 320,000 acre feet.

The frequency of groundwater level data collection has been very irregular since the measurement record began in 1929 (Table 2). The most significant temporal data gaps are prior to 1965, 1980 through 1994, and 2005 through 2006. Despite a large number and wide distribution of wells that have been measured (Figure E4), none of the wells monitored have a continuous measurement record and almost all wells monitored before 1994 have at least one decade-long interval during which no measurements are available. Additionally, many wells shown in Figure E4 may provide a short period of record from long ago, but are currently unavailable for future measurement, have not been measured for decades, or outside of areas relevant to evaluating high groundwater conditions. Areas where groundwater level data are lacking include: 1) in the northeast part of the Study Area, 2) south and southwest of LaSalle, 3) the vicinity of Lower Latham Reservoir, and 4) a three-mile long band north of Gilcrest (Figure E10). Aquifer property data are available from 11 aquifer tests in or adjacent to the Study Area, however a full three-dimensional understanding of aquifer properties is needed to understand the lateral and vertical heterogeneity of aquifer hydraulic conductivity and specific yield.



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

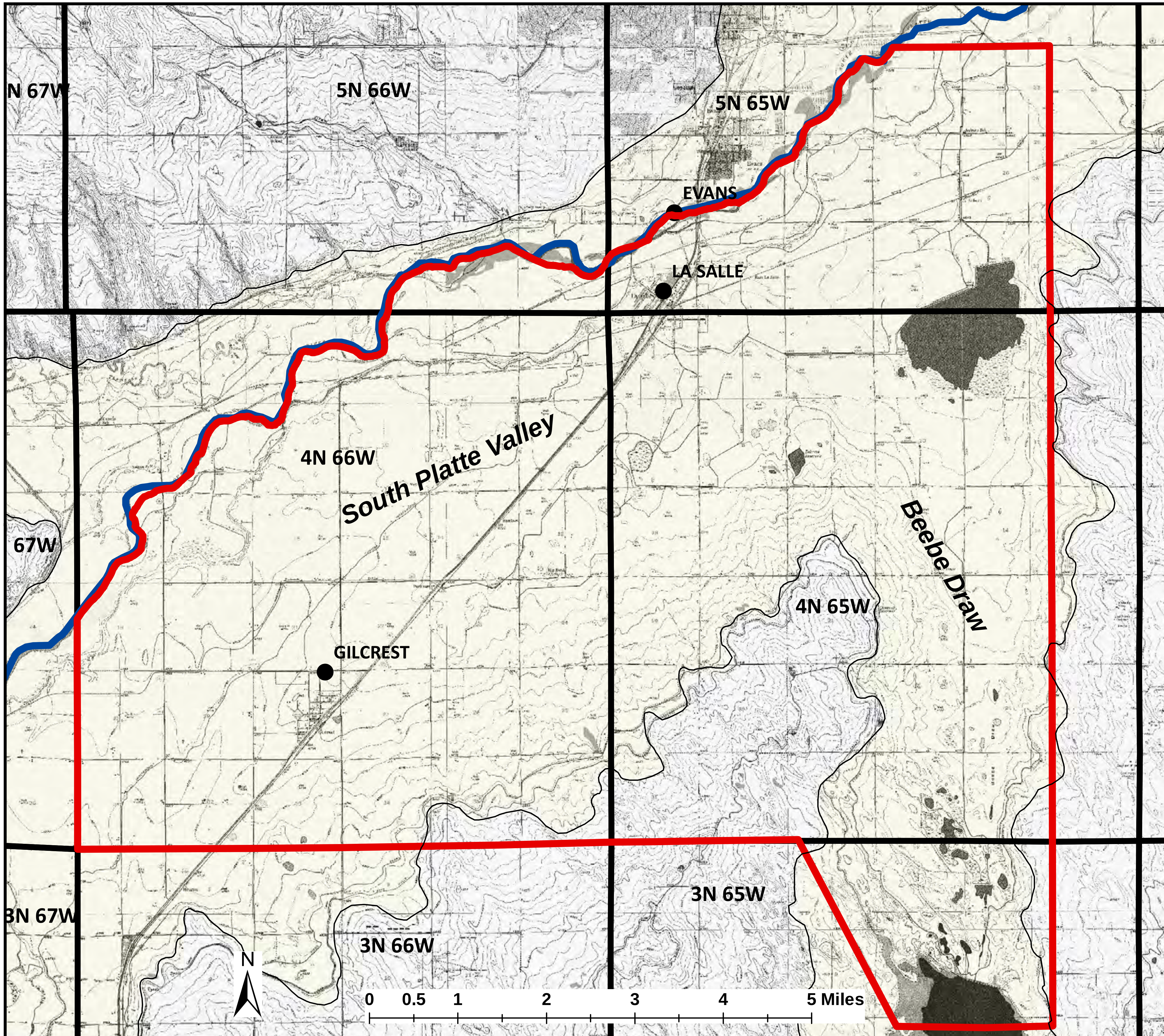
Legend

- Study Area Boundary
- County Boundary
- Alluvial Aquifer Extent (SPDSS)
- City
- South Platte River
- River/Creek
- Interstate

*Data Source Reference:

Regional Alluvial Aquifer Mapping From SPDSS (2012)

Figure E1
Study Area Location Map



Gilcrest/Lasalle Pilot Project Hydrogeologic Characterization Report

Legend

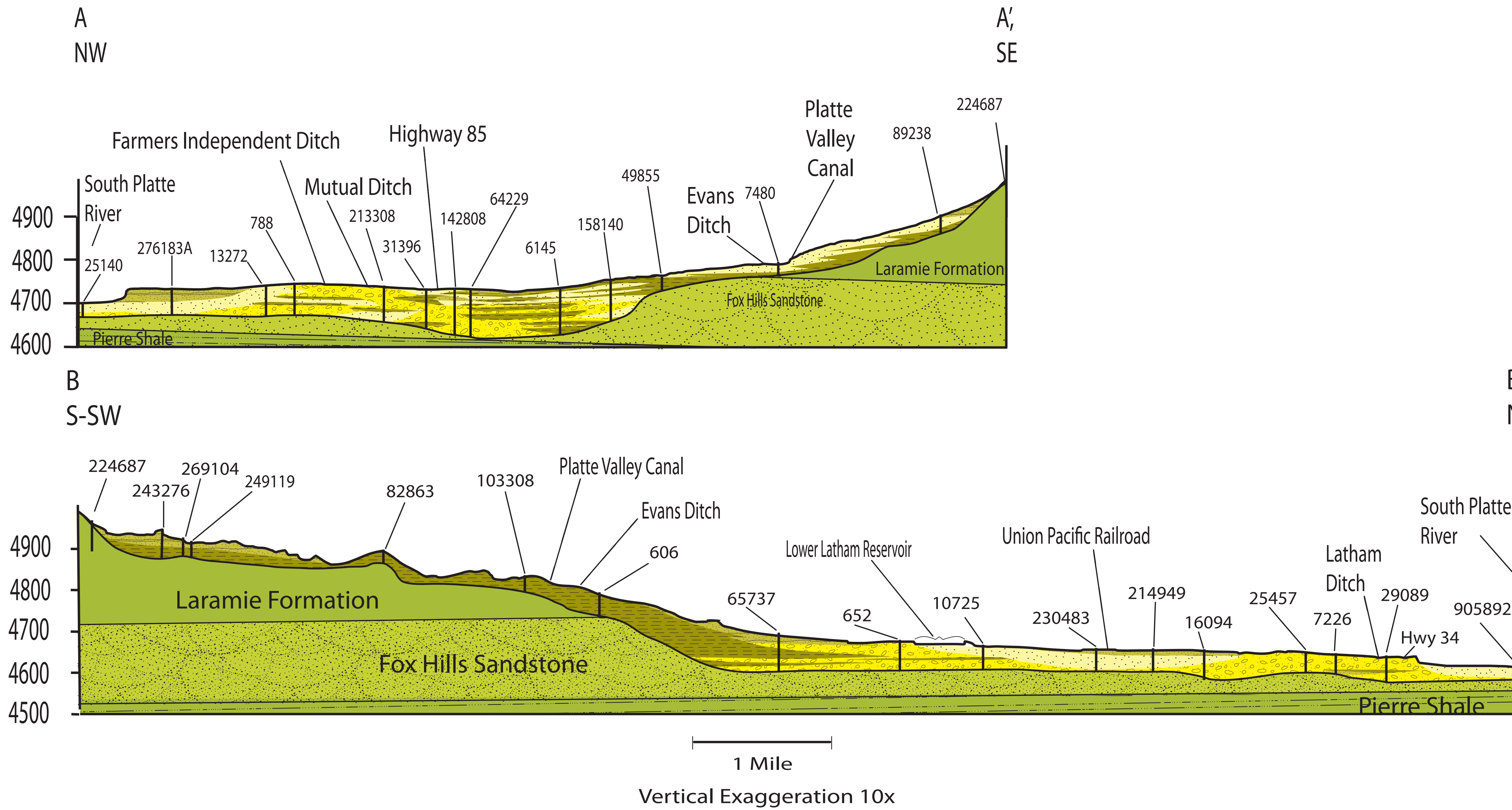
- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Data Source:

Study Area Alluvial Aquifer Extent Mapping
By Colorado Geological Survey, Revised
From SPDSS Regional Mapping

Basemap: 1:24,000 Scale
Colorado County Wide
Digital Raster Graphics

Figure E2
Study Area Map and Alluvial Aquifer Extent



See Figure 3 and 4 for cross-section locations.

Alluvial deposits:

- Silt and clay
- Sand and silt
- Sand and gravel
- Gravel

Bedrock Formations:

- Laramie Formation
- Fox Hills Sandstone
- Pierre Shale

158140 Well used for geologic description with DWR permit number

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Figure E3
Alluvial Aquifer Cross Sections

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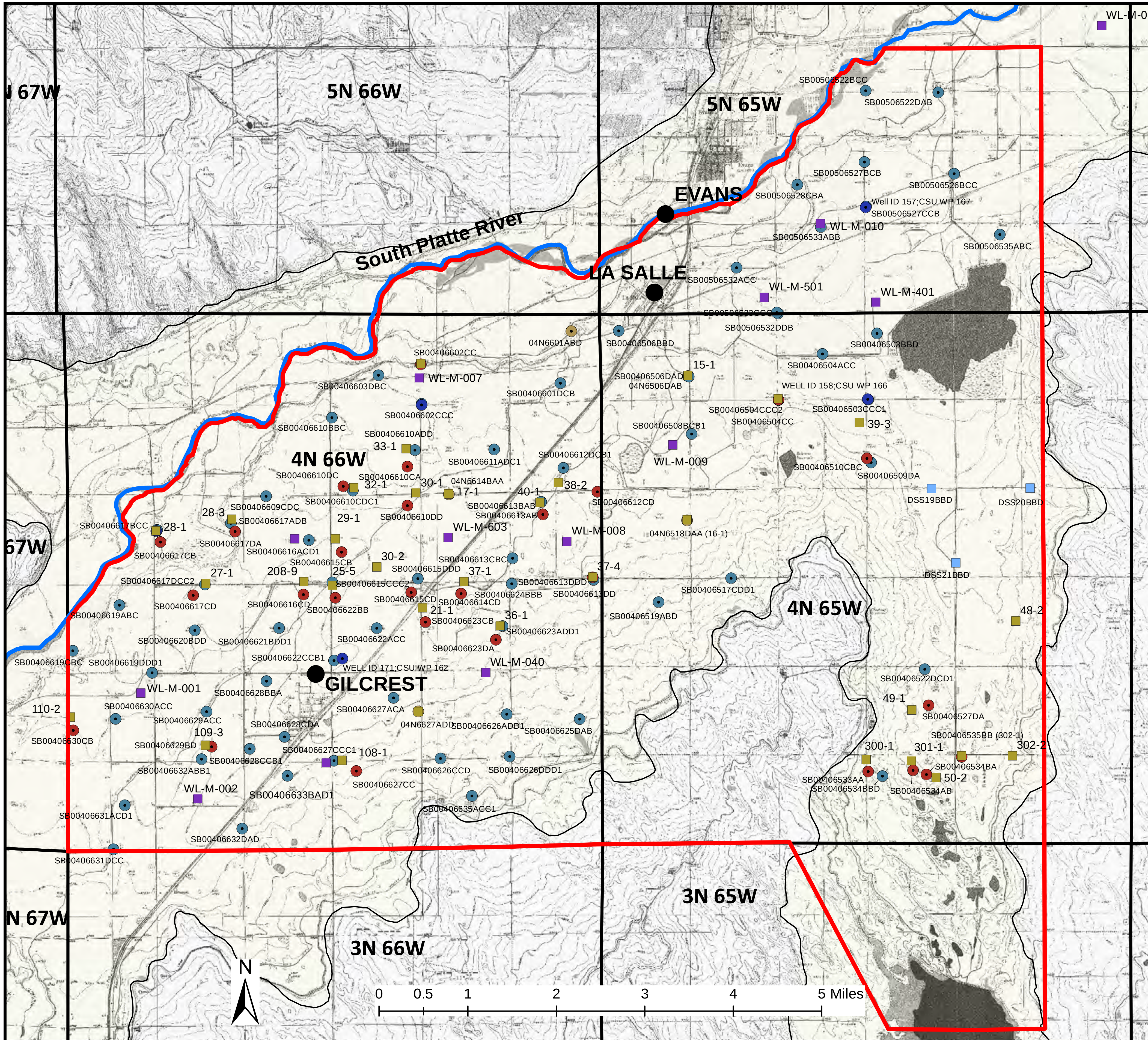

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Wells Used for Contours 2002 - 2013

- CCWCD
- CDA
- SPDSS

Wells with Historical WL Data

- CCWCD
- CSU
- DWR
- USGS

CCWCD-Central Colorado Water Conservancy District
CDA- Colorado Department of Agriculture
CSU- Colorado State University
DWR- Colorado Division of Water Resources
SPDSS- South Platte Decision Support System
USGS- United States Geological Survey

Figure E4
Groundwater Level Monitoring Wells

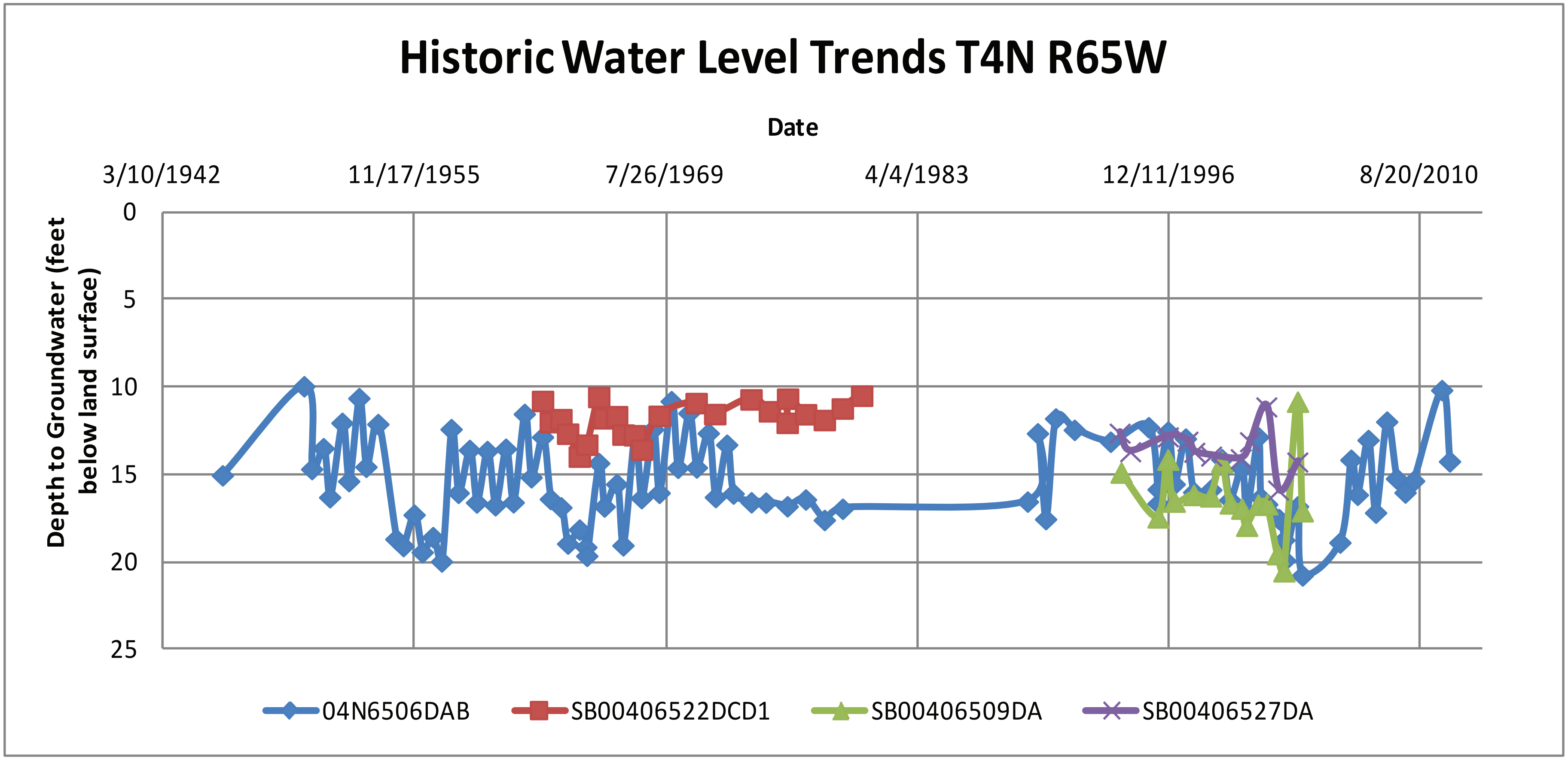

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Figure E5
Groundwater Level Trends for T4N R65W

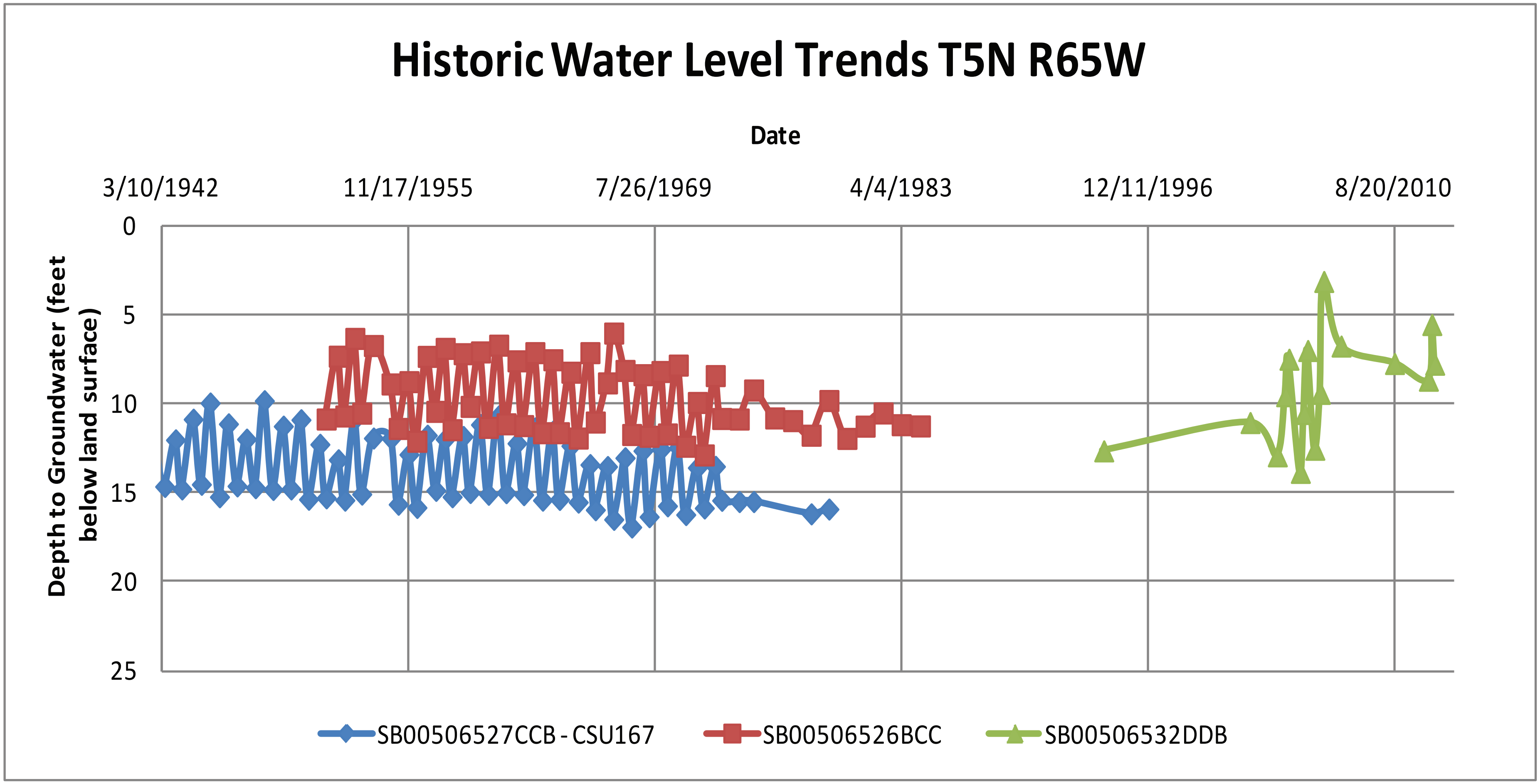

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Figure E6
Groundwater Level Trends for T5N R65W

Historic Water Level Trends T4N R66W

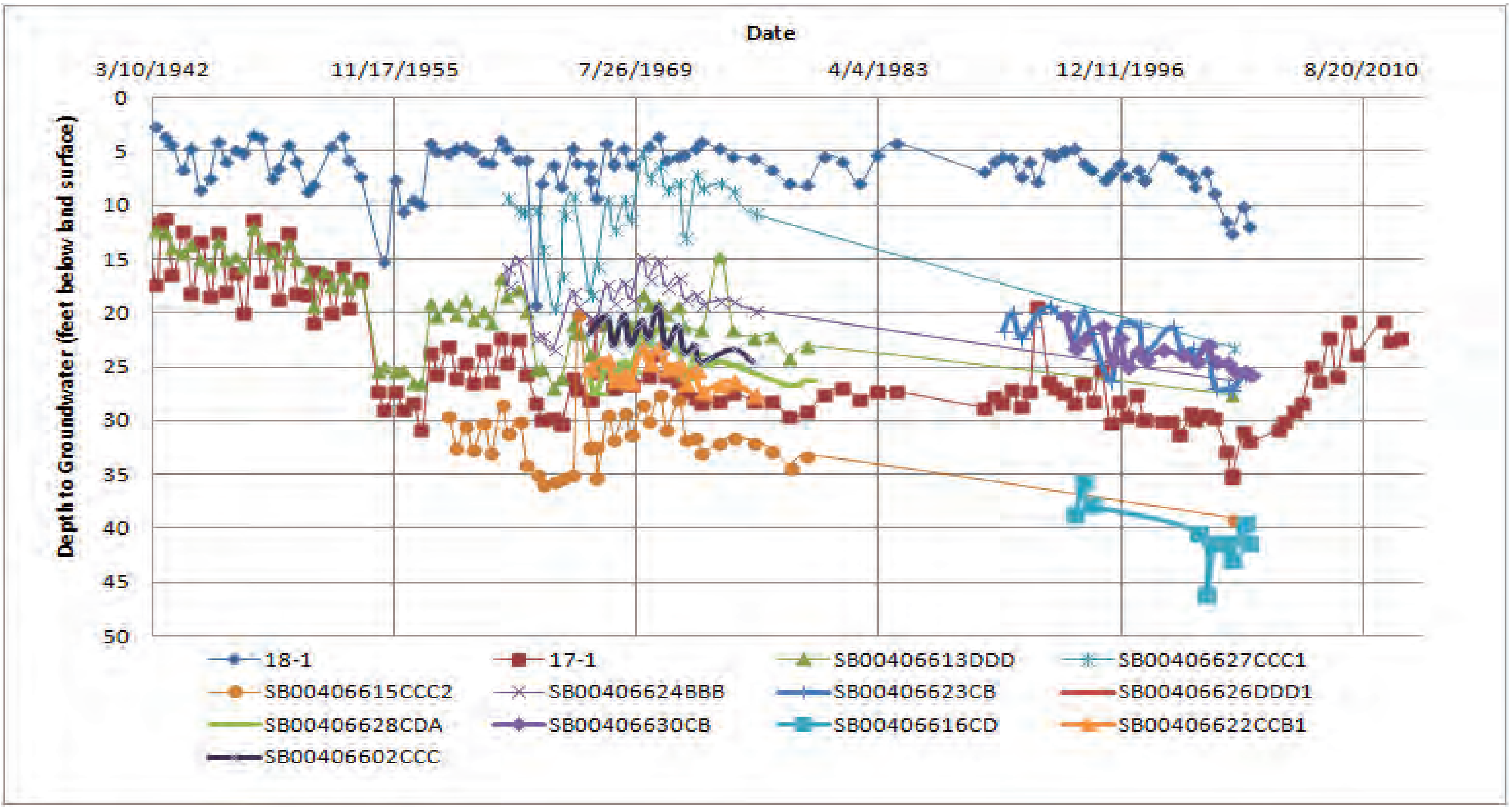

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Figure E7
Groundwater Level Trends for T4N R66W

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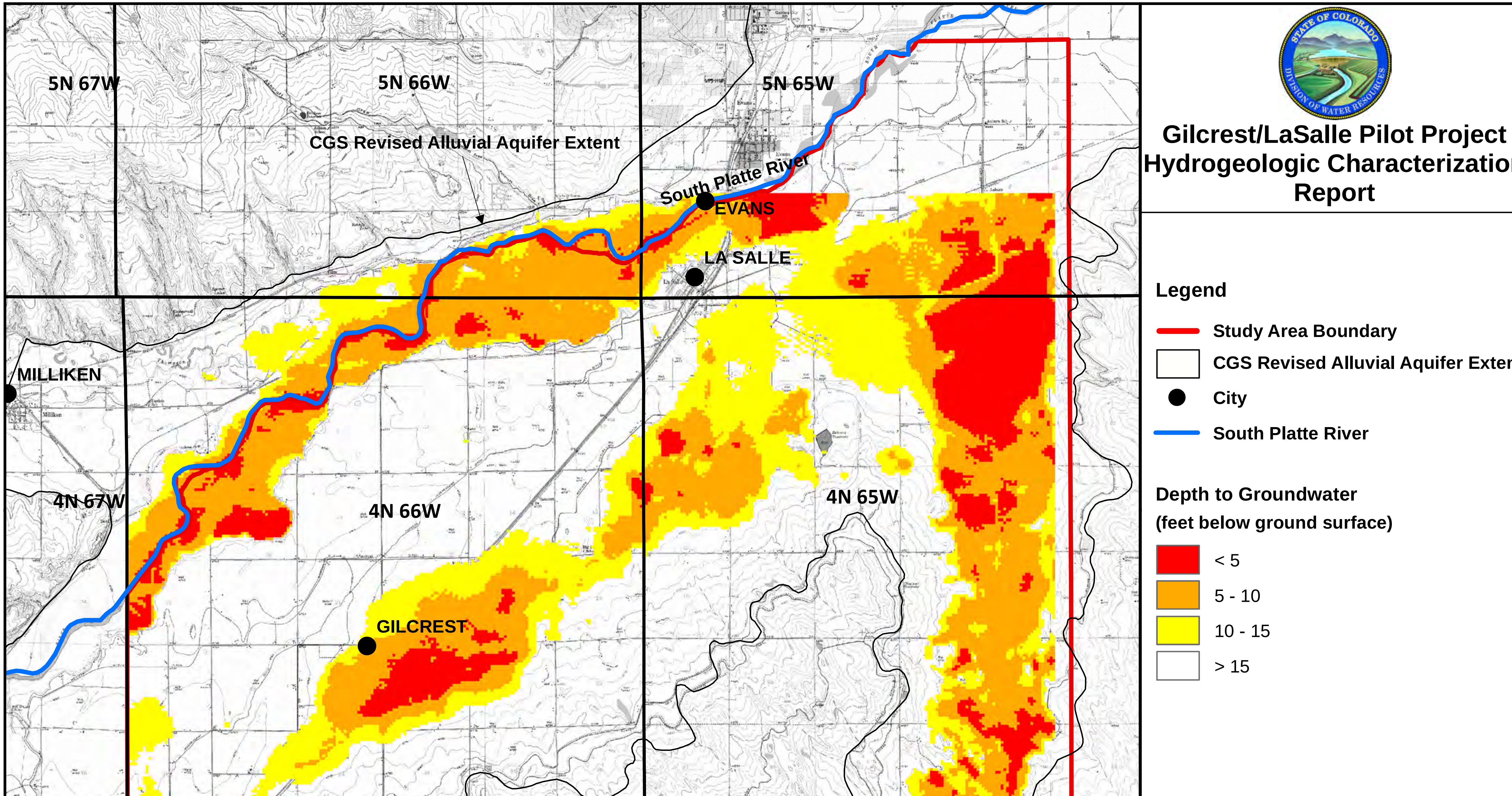
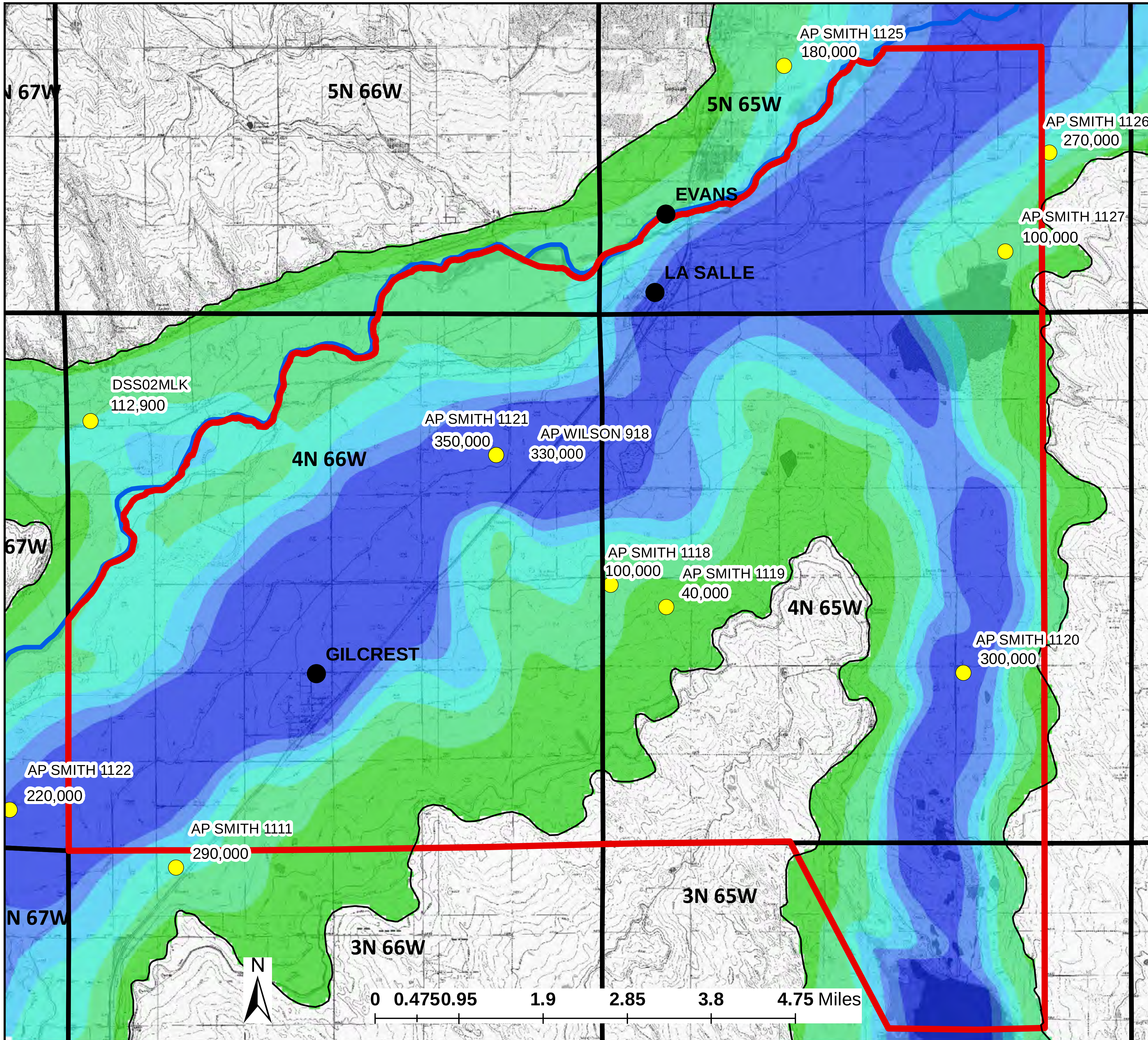


Figure E8
Depth-to-Groundwater Map for Spring 2012



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Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Transmissivity

AP SMITH 1127 **(Aquifer Test ID)**
100,000 **(Transmissivity gpd/ft)**

Computed Transmissivity (gpd/ft)

- < 50,000
- 50,000 - 150,000
- 150,000 - 200,000
- 200,000 - 250,000
- 250,000 - 300,000
- > 300,000

Transmissivity color map computed as a product of hydraulic conductivty and saturated thickness rasters (converted units from ft^2/d to gpd/ft).

Figure E9 Transmissivity Map

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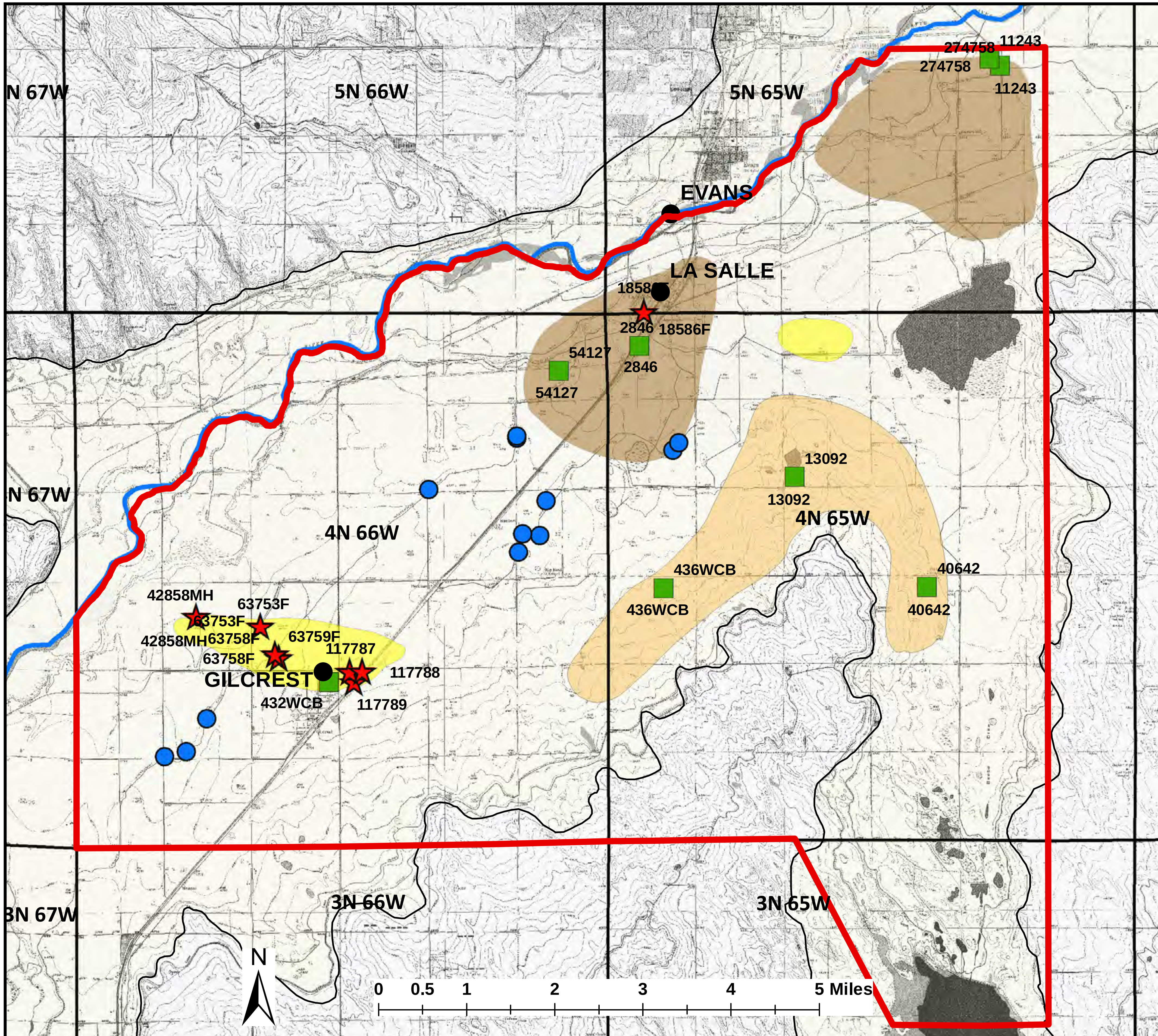

Legend

- Study Area boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Monitoring Candidate Wells

By use

- Stock
- Other

Aquifer Test Candidate Wells

- Candidate Well

Water Level Monitoring Area Ranking

- First Rank
- Second Rank
- Third Rank

Figure E10
Areas for Additional Aquifer Data and Groundwater Level Monitoring

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    2. ArcGIS Map Projects
    3. Lithologic Database: (GL_AppB3_LithDatabase.accdb)
C. Time-Series Historic Groundwater Elevation Contour Maps (Digital Only)
D. Time-Series Historic Groundwater Level Hydrographs (Digital Only)
E. Hydrographs and Hydrograph Template Development (Digital Only)
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G. Irrigation Ditches, Reservoirs, Ponds and Recharge Structures

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This project was made possible by funding from the Colorado Water Conservation Board (CWCB) as requested by the Colorado Division of Water Resources. The DWR, particularly Mr. Ralf Topper, provided initial scoping and guidance throughout the progress of this project. Mr. Topper and Mr. Andy Moore of CWCB provided helpful and insightful review of this report. The Colorado Geological Survey appreciates the contribution of Mr. Randy Ray of the Central Colorado Water Conservancy District, and Mr. Karl Mauch of the Colorado Department of Agriculture for access to CCWCD and CDA groundwater level data. Mr. Robert Longenbaugh graciously provided background on historic data collection activities for water well elevations and insight into historic and current water level conditions and data sources in the region. Ms. Megan Carroll provided helpful feedback used to refine the Hydrograph Template Tool.

CGS appreciates the assistance and cooperation of the towns of Gilcrest and LaSalle for providing information on their operations and the impact of high groundwater.

INTRODUCTION

STUDY PURPOSE AND SCOPE

Landowners in the Gilcrest/LaSalle area (Figure 1) have reported high groundwater conditions resulting in property damage. In response, the Colorado Water Conservation Board (CWCB) has provided funding to the Colorado Division of Water Resources (DWR) to conduct the Gilcrest/LaSalle Groundwater Pilot Project (Pilot Project), an independent analysis of the groundwater hydrology (hydrogeology) in the area. The Pilot Project objective is to identify relationships between the climate, geology, hydrology, and water management practices and groundwater levels in the area. The full Gilcrest/LaSalle Pilot Project scope of work includes 11 tasks and is presented in Appendix A. The Colorado Geological Survey (CGS) performed the study presented herein to characterize the Pilot Project Study Area (Study Area) hydrogeology by completing the following component tasks:

- Task 1 – Acquire existing groundwater level data and identify existing wells suited for monitoring
- Task 2 – Identify groundwater level data gaps
- Task 4 – Compile aquifer hydrologic property data
- Task 5 – Characterize the hydrogeology of the alluvial aquifer within the study area

This report documents findings of the four tasks performed by the CGS. Tasks related to stream flow, diversions, irrigation practices, and climate were performed by other entities. Geographic Information System (GIS) deliverables including a geodatabase, GIS source files for all maps presented, the lithologic database, and an electronic version of this report are in Appendix B, groundwater time-series elevation maps in digital format are in Appendix C, historical hydrographs in digital format are in Appendix D, a description of hydrograph tool development is included as Appendix E, and time-series depth-to-groundwater maps in digital format are in Appendix F. A map showing locations of major irrigation canals, drainage ditches, ponds, and recharge structures is presented as Appendix G. All digital format deliverables are on a DVD in a pocket in the back of hard copy versions of this report or can be accessed online via the CGS website at http://coloradogeologicalsurvey.org/.

PREVIOUS WORK

The Study Area has been the subject of previous regional investigations, many of which have been compiled, supplemented by field investigations, and converted to GIS datasets as part of the South

Platte Decision Support System (SPDSS) project developed by the CWCB during the 2000s (CDM 2005, 2006a, 2006b, 2006c). This hydrogeologic characterization builds on previous regional investigation findings by providing greater detail using additional data from multiple sources.

Smith et al (1964) developed one of the earliest detailed hydrogeologic descriptions of the Study Area and mapped areas of shallow groundwater using data from as early as 1957. As groundwater use expanded and groundwater's interaction with surface water was recognized, the United States Geological Survey (USGS), in cooperation with CWCB, prepared a series of map sets as open file reports throughout the South Platte River Basin (Hurr and Schneider, 1972). The map sets include contour maps showing bedrock surface configuration, the historic groundwater elevations, aquifer saturated thickness, transmissivity, and estimated stream depletion factor distribution in the aquifer. These digitized maps and other data available from the SPDSS project have provided the foundation for understanding hydrogeologic conditions in this reach of the South Platte River alluvial aquifer. Colton (1978) mapped the regional surficial geology at a 1:100,000 scale as part of a series of maps by USGS that includes depth-to-groundwater mapping and water well yields (Hillier and Schneider 1979a and 1979b). Robson, Albert, and Heiny prepared a series of USGS hydrologic atlases (Robson, et al., 2000a, 2000b) for the South Platte alluvial aquifer including the Study Area providing data on alluvial aquifer thickness, bedrock surface, and water table elevation. These atlases were incorporated into the SPDSS study, described below, that makes up the foundation of this hydrogeologic characterization.

Colorado's Decision Support System is being developed by CWCB with DWR cooperation for each of Colorado's major water basins. The South Platte Decision Support System (SPDSS) has been in development since approximately 2000 and has entailed collection and compilation of geologic and hydrologic data and collection of new data. The SPDSS project also digitized existing map sets by Hurr and Schneider (1972) and made these data sets publicly available. As part of the SPDSS, all available published data, and a significant amount of data not previously in the public domain, were compiled and synthesized to provide a comprehensive data set for the South Platte River Basin between South Denver and Nebraska. The SPDSS program identified data gaps throughout this region and implemented piezometer installation and high-capacity well aquifer testing (CDM 2005), water level compilation and monitoring (CDM 2006a), alluvial aquifer geometry synthesis (CDM 2006b), alluvial aquifer property compilation (CDM 2006c) and regional groundwater model development (CDM Smith 2013). SPDSS GIS data products (CWCB 2013) provide much of the basis for the CGS hydrogeologic characterization documented here.

CGS CONTRIBUTIONS TO STUDY AREA HYDROGEOLOGIC CHARACTERIZATION

The CGS has taken regional-scale hydrogeologic data available from the SPDSS, DWR, CCWCD, and other sources and developed a refined understanding of the South Platte alluvial aquifer in the Gilcrest/LaSalle Study Area. Data from HydroBase, DWR well permits, and other sources have been interpreted to develop a more highly detailed set of maps and also time-series maps and hydrographs from the Study Area than were previously available. Specifically, the CGS hydrogeologic characterization presented herein has:

1. Developed a hydrograph template to facilitate HydroBase data analysis;
2. Refined alluvial aquifer extent mapping;
3. Combined surficial geology from different sources to revise surficial mapping;
4. Refined the bedrock and alluvial surface geologic mapping;
5. Refined the alluvial aquifer lithologic and depositional conceptual models;
6. Compiled driller's logs from 448 boreholes into a digital lithologic dataset;
7. Developed updated localized time-series water table contour and depth-to-groundwater maps;
8. Evaluated groundwater flow in detail;
9. Identified local-scale water level data gaps;
10. Identified existing candidate wells for additional water level monitoring and aquifer testing.

HYDROGEOLOGIC CHARACTERIZATION

This section describes the geologic and hydrologic framework of the Study Area. It integrates results from the earlier investigations with new analysis.

STUDY AREA GEOGRAPHIC SETTING

The Study Area is in rural Weld County, Colorado, in the South Platte River valley (Figure 1). The Study Area consists of approximately 78 square miles and lies south and southwest of Greeley along US Highway 85. The roughly triangular shaped Study Area includes the towns of Gilcrest and LaSalle and is bounded on the northwest by the South Platte River. The Study Area includes the South Platte River alluvial valley, consisting of the adjacent floodplain and upper terraces, and the lower reach of Beebe Draw. Study Area topography varies from flat to gently rolling terrain with a low northeast trending ridge separating the South Platte alluvial valley from Beebe Draw (Figure 2).

The South Platte alluvial aquifer underlies most of the Study Area and varies from zero to more than 100 feet thick. The alluvial aquifer fills a channel incised into bedrock of the Upper Cretaceous Laramie Formation shale and underlying Fox Hills Sandstone. Bedrock outcrops in several locations along the ridge separating the South Platte alluvial valley from Beebe Draw. The Study Area lies at the northern portion of the Denver Basin and on the south flank of the Greeley Arch.

Irrigated agriculture plays an important role in the Study Area's water balance. The Study Area includes Milton, Behrens, Chestnut, and Lower Latham Reservoirs, the Speer Canal, Platte Valley Canal, Evans No. 2 Ditch, Farmers Independent Ditch, Western Mutual Ditch, Union Ditch, Latham Ditch, Godfrey Ditch, and the, Gilmore Ditch as shown in Appendix G. In addition to surface water diversions, agricultural groundwater pumping from the highly productive alluvial aquifer plays an important role in the Study Area hydrology, with many production wells capable of producing more than 1,000 gallons per minute (gpm).

Several seepage canals such as the Lower Latham Drain traverse the low-lying flood plain to provide drainage in areas of historic high water table conditions near the South Platte River. In addition to irrigation and seepage from reservoirs and ditches, which percolates into the aquifer, since 2002 many ponds for augmentation recharge have been constructed within the Study Area, increasing from approximately 35 ponds in 2002 to over 70 ponds in 2012 as indicated by aerial photograph analysis using historical imagery. The evaluation method did not indicate whether ponds were installed specifically for augmentation recharge, however, for the purpose of this report it will be assumed that most, if not all, of the ponds mapped are used to recharge the aquifer for South Platte River stream flow augmentation or otherwise result in aquifer recharge. Surface water used for stream flow augmentation is diverted from the South Platte River at times of low demand and recharged at locations from which the water will return to the river during times of high surface water demand. This allows well operators to pump groundwater out of priority without injuring senior surface water rights holders downstream. The locations of recharge ponds and other recharge structures, ditches, reservoirs, and the quantity of water recharged are important for interpreting groundwater level and flow conditions. A map showing reservoirs, major irrigation ditches, ponds and other recharge structures in the Study Area vicinity is included as Appendix G.

STUDY AREA GEOLOGIC CONCEPTUAL MODEL

Figure 3 shows the surficial geology based on Smith (1964) and Colton (1978) and modified to include surficial deposits relevant to this study. Colton's 1:100,000 scale map is the most detailed published surficial geologic map encompassing the Study Area. Subsurface interpretation was performed by creating a database from geologic descriptions in DWR water well permit files. Borehole geologic log locations used for lithologic characterization are shown in Figure 4 and the Microsoft Access (MS Access) database is included in Appendix B. Geologic cross-sections through the Study Area are shown in Figure 5.

Geologic material descriptions in the many logs obtained from the water well completion records vary considerably due to inconsistency among logging personnel; mostly water well drillers. To standardize and simplify interpretation, lithologies were grouped into the following general types after Lindsey (2005) and modified for this study: topsoil, gravel, sand, sand and silt, silt and clay, and bedrock. The database is limited to information from the well intervals through the alluvium; deeper bedrock descriptions are not included.

The relevant surficial geologic units mapped in the Study Area (Figure 3) are described by Colton (1978) and Smith (1964) and modified for this hydrogeologic characterization as described below. Minor isolated deposits unlikely to be in hydrologic communication with the aquifer are not described in detail below. It should be noted that Colton (1978) and Smith (1964) mapped much larger areas and descriptions may include unit thicknesses and localized characteristics observed outside the Study Area.

Surface Topography

The Study Area topography is characterized by broad fluvial valley gently sloping upward away from the South Platte River to low hills along the southwest valley flank and a low ridge separating the South Platte Valley from Beebe Draw (Figure 2). Only the alluvial valley surface overlying the aquifer will be discussed here. The highest portion of the alluvial valley in the Study Area is the ridge separating the main South Platte Valley from Beebe Draw which has an elevation of approximately 4, 950 feet above mean sea level (ft MSL), and the lowest portion is in the northeast portion at approximately 4,620 ft MSL. The valley floor elevation in Beebe Draw is approximately 4,800 ft MSL where it enters the southeast corner of the Study Area and approximately 4,680 ft MSL at the confluence with the South Platte River alluvial valley, near Lower Latham Reservoir. The South Platte River alluvial valley generally slopes 10 to 20 feet per mile to the northeast across the Study Area. The only relatively steep terrain in the alluvial valley occurs at the slopes (risers) separating adjacent alluvial terraces. Wetlands and depressions related to subtle topographic variations are shown on historic USGS topographic maps along with irrigation canals and drains.

Several alluvial terraces have been identified in geologic mapping by Colton (1978) and Smith (1964). These terraces are typically identified by broad, flat, gently sloping surfaces interrupted by risers above South Platte River. Surface topography is important with respect to shallow water table conditions. Changes in surface topography above a shallow, gently sloping water table can bring the land surface in contact with the water table. Of particular interest are locations at the foot of risers between terraces such as west of LaSalle where the Lower Latham Drain follows the base of the riser. Figure 6 illustrates the relationship between topography and shallow groundwater.

Primary Study Area Geologic Units

The bedrock formations listed below only outcrop in limited extent within the Study Area however these units underlie the eolian and alluvial deposits.

Laramie Formation (Kl) – The upper part, 600-650 feet thick, is mostly gray claystone, shale, sandy shale, and scattered lenticular beds of sandstone and lignite. The lower part, about 75 to 120 feet thick, is light-gray to light yellowish-gray sandstone and sandy shale interbedded with clay, shale, and several beds of coal.

Fox Hills Sandstone (Kfh) – The upper part consists of cross-bedded tan sandstone. Grades downward into brown, fine-grained silty sandstone interbedded with gray fissile shale. Locally it may contain thin coal beds. The thickness of this unit is about 300 to 500 feet.

Pierre Shale (Kp) –Marine shale mainly deposited in outer and deeper marine environments. The Pierre Shale deposits are intercalated with shallow to coastal marine sediments (Dechesne et al, 2011). The contact between the Fox Hills Sandstone and underlying Pierre Shale is gradational consisting of sandstone interbedded with shale and shale becoming more prevalent at greater depth. Though the Pierre Shale does not outcrop in the Study Area, this formation comprises the lower-most confining unit among the hydrogeologically significant strata present.

Overlying the bedrock is a series of unconsolidated geologic units that comprise the South Platte alluvial aquifer in the Study Area. These geologic units influence the groundwater flow, aquifer productivity, and groundwater levels.

Slope Wash Deposits (Qsw) – This unit is a modification based on mapping by Smith (1964) who describes slope wash as consisting of gravel and sand interbedded with clay and silt feathering out against upland areas, but lapping onto, and interlayering with, stream deposited valley fill deposits. Slope wash deposits are likely mobilized from uplands by precipitation resulting in sheet flow events and deposited below on gentler slopes.

Unnamed 3rd Level Terrace (Qt3) – This unit is based on physiographic evaluation of the Study Area and is mapped by Smith (1964) as present in the western and southwestern portion of the Study Area.

Eolian Deposits (Qe) – (windblown clay, silt [loess], and sand) Light-brown to reddish-brown to olive-gray deposits of windblown clay, silt, and sand mainly as sand dunes in the east half of the area but also as a blanket of loess between the Front Range and the South Platte River. Loess is as much as 15 feet thick but generally is less than 3 feet thick; sand dunes are as much as 50 feet thick but generally are less than 15 feet thick.

Post-Piney Creek Alluvium (Qpp) – Dark-gray humic, sandy to gravelly alluvium. This unit underlies flood plains of major streams and terraces less than 10 feet above stream level. Thickness is from 5 to 15 feet.

Piney Creek Alluvium (Qpc) – Dark-gray humic sandy to gravelly alluvium containing organic matter. Underlies terraces whose surfaces are 10 to 20 feet above a nearby flood plain. Areas underlain by this formation along the South Platte River were partly flooded in 1965, again in 1973, and very likely in 2013).

Broadway Alluvium (Qtb) – Sand and gravel deposited by the South Platte River and its tributaries. Well-sorted and well-stratified sand and fine gravel. Along the South Platte River, Broadway Alluvium is as much as 125 feet thick but averages approximately 35 feet thick.

South Platte Alluvial Valley Surficial Deposits

The South Platte alluvial aquifer consists of Quaternary-age unconsolidated alluvial deposits filling a paleo-channel incised into Upper Cretaceous-age mudstones and sandstones of the Laramie Formation and Fox Hills Sandstone. The alluvial aquifer deposits consist of gravel, sand, silt and distinct silt and clay layers generally deposited by flowing water. These deposits are comprised primarily of material from the eroding mountains to the west where the main rivers and streams originate. However, local ephemeral streams and slope wash contribute material eroded from the mudstone-dominant Laramie Formation and coarse-grained material from older high terrace deposits.

The topography and unconsolidated sedimentary deposits of the South Platte River Basin record a gradual progression of incision overprinted by cycles in alluvial sediment supply. These cycles are associated with periods of glacial advance and retreat (Lindsey and others, 2005) and have resulted in a series of terraces flanking the modern stream course. The lowest terraces lie closest to the river and are youngest; older terraces step upward in elevation above the youngest. Many of these Quaternary terraces are identified in the Study Area (Figure 3). Upper Holocene Post-Piney Creek alluvium fills the lowest floodplain of the South Platte River with the next step up to Upper Holocene Piney Creek alluvium (Colton, 1978). Above the Piney Creek alluvium and covering the largest part of the alluvial aquifer in the Study Area, is a terrace identified by Colton (1978) and Smith (1964) as Pleistocene-age Broadway alluvium. Smith (1964) also identified an intermediate terrace between the Piney Creek and Broadway terraces. The alluvial valley topography indicates another possible terrace, above the Broadway terrace, just south and west of Gilcrest. Smith (1964) identified this as the “3rd Unnamed Terrace” as shown in Figure 3. All of these terraces are believed to overlie and be hydraulically connected with the alluvial aquifer.

Colton (1978) also mapped several isolated occurrences of older Slocum, Verdos and Rocky Flats alluvium on uplands above the South Platte valley and Beebe Draw. These higher gravelly deposits contribute coarser grained material to side tributary wash and slope wash deposits flanking the southeastern edge of the main South Platte alluvial valley and are likely to have only limited hydraulic connection, if any, with the main alluvial aquifer.

Locally, eolian sand and loess blanket both alluvium and bedrock. In other places, slope wash deposits consisting of fine-grained sediments spill from hillsides across lower terraces. Eolian and slope wash deposit thicknesses are generally 20 feet or less; yet, these deposits can conceal the contacts between adjacent terraces as well as contacts between alluvium and bedrock. On uplands covered with permeable deposits, a thin layer of alluvium or eolian sediment above less permeable bedrock of the Laramie Formation exists and can locally be saturated, however this is not considered to be a significant aquifer in the Study Area.

Bedrock Topography and Geology

Figure 7 shows the bedrock surface elevation contours with bedrock subcrop geology concealed beneath Quaternary valley fill deposits. Contouring of the bedrock surface accommodates 309 data points in the Study Area with a refined conceptual model and greater detail than previous investigations. The refined conceptual model identifies individual incised tributary paleochannels within a broad paleovalley now filled with alluvial deposits. Bedrock formations in the Study Area have only limited exposure due to a blanket of eolian deposits in the uplands and valley fill deposits in the alluvial valley. As seen in Figure 7, the bedrock surface topography underlying the alluvial valley is irregular and asymmetrical with approximately 380 feet of relief. This buried topography consists of a broad paleovalley incised by buried paleochannels, shown in Figure 7, and described below:

- Big Thompson Paleochannel – This paleochannel is northwest of the Study Area and aligns with the modern Big Thompson River valley, joining with the South Platte River paleochannel.
- South Platte Paleochannel – This paleochannel aligns with the modern South Platte River channel along the northwestern Study Area boundary.
- Gilcrest Paleochannel – This paleochannel extends from the southwestern Study Area corner, passes below Gilcrest and meanders under US Highway 85 until it joins the South Platte Paleochannel just northeast of LaSalle.
- Beebe Draw Paleochannel – This paleochannel aligns with the modern Beebe Draw valley joining the South Platte Paleochannel northeast of LaSalle.
- Tributary Paleochannels – these three paleochannels extend from dry washes descending from the highlands along the southeast flank of the South Platte alluvial valley about three miles southeast of US Highway 85, and continue below the alluvium to form a scalloped subsurface bedrock topography on the southeast side of the now-filled paleovalley.

At the time of maximum incision, when the paleochannels were carved into the bedrock and prior to deposition of the alluvial valley fill, an ancestral Big Thompson River may have carved the northern Big Thompson paleochannel. At about the same time the ancestral South Platte River carved the Beebe Draw paleochannel (Smith 1964) and later the South Platte and Gilcrest paleochannels. Additionally, prior to the paleovalley filling with sediment, tributary paleochannels were incised by erosion into the bedrock channel walls, with landslides possibly causing the scalloped bedrock topography. Cross-section A-A' illustrates the deeper Gilcrest paleochannel which is offset from the modern river alignment (Figure 5).

The deepest and most extensive paleochannel underlies the modern course of Beebe Draw. The presence of a deep bedrock paleochannel in Beebe Draw is consistent with interpretation by Smith (1964) of an ancestral South Platte River channel in Beebe Draw.

Several tributary paleochannels enter the Gilcrest paleochannel from the south. Smaller tributaries along the southeastern portion of the main paleovalley create a scalloped edge to the buried topography similar to, and aligned with, the scalloped topography of the hills rising above the terraces southeast of the river valley.

The bedrock geology underlying the alluvial aquifer consists of Laramie Formation and Fox Hills Sandstone subcrops dipping gently to the southeast. This subcrop pattern is based on a projection from the subsurface using geophysical logs combined with surface outcrop patterns (Dechesne and others, 2011). The subcropping Fox Hills Sandstone appears to correspond to the scalloped buried bench along the southern perimeter of the alluvial valley which may have been a resistant bluff at the time of deepest incision (Figure 7). Using a Fox Hills Sandstone average thickness of 200 feet, the paleochannel should not extend into the underlying Pierre Shale in the Study Area. It is possible, however, that the Fox Hills Sandstone includes shale layers (Dechesne and others, 2011). Shale layers exposed within the buried paleochannels could have created a very landslide-prone topography at the time of maximum incision resulting in the presence of very localized bedrock highs in the paleovalley. Elements of the buried topography suggest the possibility of landslide scarps and hummocky deposits further complicating the bedrock surface geometry. The very irregular buried topography is significant in that the irregularity may affect groundwater movement through the alluvial aquifer.

Bedrock aquifer permeability is two to three orders or magnitude lower than the overlying alluvial aquifer. The influence of groundwater flow between the bedrock and alluvial aquifers is expected to be insignificant with respect to the Pilot Project goals and will not be addressed in this study.

Alluvial Aquifer Depositional Setting

Figure 4 provides alluvial aquifer cross sections, Figure 8 shows the unconsolidated Quaternary deposit thickness, and Figure 9 shows the saturated alluvial aquifer thickness. The alluvial aquifer consists of a package of unconsolidated alluvial sediments filling a broad paleovalley incised into a highly irregular bedrock surface, as described above. Locally the unconsolidated alluvial sediment thickness can exceed 100 feet, however, most of the Quaternary sediments are between 45 and 85 feet thick (Figure 8). Alluvial aquifer saturated thickness (Figure 9) was determined by subtracting the bedrock surface (Figure 7) from the water table surface determined using the spring 2012 groundwater level (Figure 10) raster map using GIS. An important aspect of the alluvial aquifer depositional setting is the relationship of a historic main river channel fed by small tributaries and slope wash from uplands along the sides. The river deposited bed load sediments dominated by sand and gravel from distant sources, while the small ephemeral tributaries and slope wash carried much finer grained material derived from shale and mudstone outcrops and eolian deposits above the alluvial valley. Cross-Section B-B’ (Figure 5) illustrates the geometry of deposits produced in this environment. Coarser-grained sand and gravel prevail in the central part of the aquifer while finer-grained silt and clay dominate the sides, lapping down from the adjacent slopes and inter-fingering with the coarser grained central alluvium. Layers of silt and clay in this deeper part of the alluvium suggest that local mudstone-dominant tributaries fed this area after the river channel migrated to the northwest.

The aquifer depositional history impacts two important alluvial aquifer characteristics in the Study Area. First, alluvium in the central portion of the aquifer is more permeable due to the dominance of coarser-grained material, as shown in Figure 5. Second, the aquifer contains laterally discontinuous layers of finer-grained material derived from slopewash and inflow from minor ephemeral tributaries. Fine-grained interbedding results in a stratified aquifer system with localized semi-confined conditions in underlying aquifer units. These low-permeability semi-confining units can prevent recharge from infiltrating to the deeper aquifer thus causing perched water table conditions.

CGS Revised Alluvial Aquifer Extent

Figure 2 shows the CGS revised alluvial aquifer extent. This new alluvial aquifer extent was derived from the intersection of the new bedrock topography raster map described above and a water table surface based on spring 2012 groundwater elevations, when water levels were high. As a conservative measure, 10 feet was added to the 2012 groundwater surface elevations to obtain a reasonable maximum saturated aquifer extent. The revised CGS alluvial aquifer extent provides much higher level of resolution than the regional SPDSS mapping shown in Figure 1 (CDM 2006b) or the active groundwater model extent portrayed by CDM Smith (2013).

Hydraulic Conductivity, Specific Yield, and Transmissivity

Figures 11 and 12 present the aquifer hydraulic conductivity and specific yield, and transmissivity (aquifer properties), respectively. Table 1 summarizes aquifer test data in the Study Area vicinity.

The 11 hydraulic conductivity values used for the contours shown in Figure 11 were obtained from the SPDSS database (CWCB, 2013) and derived from aquifer tests performed in wells pumping from 385 to 1,284 gpm. Permeability data derived from specific capacity tests were not used in this analysis. Hydraulic conductivity values are the basis for the aquifer permeability presented herein.

Hydraulic conductivity values in and adjacent to the Study Area range from 134 to 1,270 feet/day. Point data and contouring presented in Figure 11 indicate a linear zone of highest hydraulic conductivity extending through the alluvial valley axis from the Study Area’s southwest corner to the northeast corner, with a second linear zone of high hydraulic conductivity extending along the middle of Beebe Draw and joining with the South Platte alluvial valley immediately west of Lower Latham Reservoir. This hydraulic conductivity distribution is consistent with the alluvial aquifer depositional model described above, in which the alluvial valley margins are dominated by fine-grained slopewash and the central portion of the valley consists of more permeable sand and gravel deposited by the ancestral South Platte River.

Five specific yield values are available in and adjacent to the Study Area (Figure 11, Table 1). Specific yield values range from 0.02 to 0.15 and, while there are no apparent geographic trends, the values exhibit a bimodal distribution with the three lower values averaging 0.04 and the two higher values averaging 0.15. The lower values indicate the presence of semi-confined conditions, likely resulting from silt and clay layers within the aquifer overlying the more productive sands and gravels. The higher specific yield values are consistent with unconfined conditions in a sand and gravel dominated aquifer. These types of conditions are consistent with the aquifer depositional model described above.

The mapped transmissivity distribution was obtained from calculations using raster maps and is shown as a color fill diagram in Figure 12. Due to water table fluctuations, and thus saturated aquifer thickness variability, the mapped transmissivity distribution was calculated by multiplying the interpolated hydraulic conductivity distribution by the aquifer thickness determined from spring of 2012 groundwater levels. The eleven transmissivity point values were obtained from the SPDSS database and are not corrected for variation in aquifer saturated thickness and may vary from the color-fill mapping.

Transmissivity in and adjacent to the Study Area ranges from 40,000 to greater than 350,000 gallons per day per foot. The transmissivity distribution indicates a zone of high transmissivity one to two miles wide trending from north of Gilcrest, sub-parallel to, and crossing the US Highway 85 alignment, to south of LaSalle. As with hydraulic conductivity, the mapped transmissivity distribution indicates the highest values are along the axis of the main South Platte alluvial valley, and along the middle of Beebe Draw. This transmissivity distribution is also consistent with the alluvial aquifer depositional model and aquifer geometry described above.

GROUNDWATER LEVELS

Water level data have been compiled from multiple sources to develop a time-series of water table maps, historical hydrographs for wells with 10 or more data points, and a time-series of depth-to-groundwater maps (Appendices C, D, and F). Groundwater level measurements were obtained from 136 wells with a combined period of record from 1929 to 2013. Table 2 graphically presents the availability of all groundwater level data in the Study Area and Figure 13 shows well locations from which groundwater level data were obtained. A groundwater level elevation contour map from the spring of 2012, featuring groundwater levels measured during a recent period of high water table conditions, is provided as Figure 10. The complete time-series of groundwater level elevation contour maps are presented in Appendix B and includes spring 1967, fall 1970, spring and fall 1997, spring and fall 2002, spring and fall 2012, and spring 2013.

Groundwater level data sources include:

- Central Colorado Water Conservancy District (CCWCD),
- Colorado Department of Agriculture (CDA),
- DWR HydroBase database which contains data from:
    - Historic Colorado State University monitoring program wells
    - South Platte Decision Support System (SPDSS) wells
    - Other wells including those monitored by USGS

The availability of historic groundwater level data is summarized in Table 2. The history of groundwater level monitoring in the Study Area is described below in the Data Gaps discussion. Groundwater elevation contour maps were prepared for select years after 1967 in which sufficient data were available to depict water table conditions in the Study Area.

A time-series set of groundwater elevation contour maps were prepared to depict groundwater conditions throughout the period of record with years with sufficient data for contouring (Appendix C). Maps were prepared for either spring, fall, or an average of all data available for a given year. Spring groundwater level maps present data from March and April of a given year and fall groundwater level maps present data from September and October of a given year. The groundwater elevation contour maps for 1967 and 1970 show the earliest groundwater level data for a "dry" and a "wet" year, respectively. Groundwater elevation contour maps were prepared for 1997 to depict spring and fall water table conditions during a “wet” year, and other maps were prepared as data were available to add to the historical record.

Depth-to-Groundwater maps were created for spring and fall only for years for which both seasons could be contoured. These maps were prepared by subtracting raster images of water table elevation maps from the surface elevation digital elevation model (DEM). The depth-to-groundwater maps are classified using colors that only display areas where depth to water is 15 feet or less and presented by different colors representing groundwater depths of 0 – 5 feet, 5 – 10 feet, and 10 – 15 feet below ground surface (bgs).

<u>Groundwater Level Trends</u>

Groundwater level trends were evaluated by township within the Study Area. Groundwater level data are graphed as depth bgs at the respective wells and are included as Figures 14 through 16. Seasonal fluctuations in groundwater levels are commonly observed at many monitoring wells due to the effects of seasonal pumping and seasonal fluctuations in surface water recharge from ditches and irrigated fields during irrigation. Analysis presented below deals only with long-term trends. Despite a large number of wells present in each of the townships, inconsistencies in the monitoring data availability significantly limit the number of wells suitable for long-term trend evaluation, particularly in Townships 4N R65W and 5N R65W.

Township 4 North, Range 65 West

Figure 14 presents hydrographs from select wells in T4N R65W, a township in the central portion of the Study Area including the South Platte alluvial valley and Beebe Draw. Groundwater level data from monitoring well 004N6506DAB, in Section 6 at the southwest end of LaSalle, provides the longest record in this area and exhibits a relatively stable long-term trend with seasonal fluctuations apparent in years with spring and fall groundwater level data. Groundwater levels in this area show relative stability.

Township 4 North, Range 66 West

Figure 15 presents hydrographs from select wells in T4N R66W. This township in the western portion of the Study Area includes most of the terraced area southeast of the South Platte River near Gilcrest. Groundwater levels are typified by the trends observed at Well 17-1, monitored by CCWCD. Well 17-1, in Section 14, has the greatest period of record and is the only well in T4N R66W with long-term data and also data extending beyond 2004. Groundwater levels exhibit seasonal variability, with a long-term downward trend from approximately fifteen feet bgs in 1942, to approximately 35 feet bgs in 2004. A significant decline is apparent during severe drought in the mid-1950s. From 2004 on, groundwater levels at well 17-1 have risen almost 12 to 15 feet, yet are still more than five feet lower than groundwater levels measured in the 1940s.

Township 5 North, Range 65 West

Figure 16 presents hydrographs from select wells in T5N R65W, in the northeast portion of the Study Area. Groundwater level records are available either for the period up until the mid-1980s or after the mid-1990s. This township includes the area downgradient of Lower Latham Reservoir and the town of LaSalle. Groundwater level data from wells SB00506527CCB and SB00506526BCC, hydraulically downgradient of Lower Latham Reservoir, are relatively stable over their respective periods of record. Groundwater level data from well SB00506532DDB, approximately mid-way between Lower Latham Reservoir and LaSalle, display a very irregular hydrograph which may be due to inconsistent data collection or significant seasonal water table fluctuations.

<u>Depth-to-Groundwater Trends</u>

Depth-to-groundwater maps for the same spring or fall measurement periods shown in groundwater elevation contour maps were generated by subtracting groundwater level elevation raster data sets from the land surface DEM. The complete time-series depth-to-groundwater maps are provided in

Appendix F and Figure 17 presents the depth-to-groundwater map for spring 2012, when groundwater levels were relatively high.

Areas with shallow groundwater (less than ten feet bgs) occur along three distinct alignments in the Study Area. The first area is in the floodplain immediately adjacent to the South Platte River in the lowest terrace in the Study Area. The presence of mapped wetlands and the Lower Latham Drain indicate historic shallow groundwater conditions in this area.

The second shallow groundwater area is in Beebe Draw between Milton Reservoir and Lower Latham Reservoir. The presence of mapped wetlands, multiple ponds, and a seep ditch indicate historic shallow groundwater conditions in this area.

The third shallow groundwater area lies on the upper terraced area of the alluvial valley flank below the Platte Valley Canal and the Evans Ditch, along and to the southeast of US Highway 85. This area is transitional from the Broadway terrace to the alluvial valley flank and covered with slopewash deposits described in the conceptual model section (Figure 3). Several small wetlands are mapped in this area indicating the historical presence of shallow groundwater in this area.

In addition to mapped wetlands and historic features, depth-to-groundwater mapping by Smith (1964), using 1957 measurements, and Hillier and Schneider (1979a), using data from the mid-1970s, indicate areas with shallow groundwater generally consistent with shallow groundwater areas mapped herein. Robson, et al. (2000a, 2000b) provide depth-to-groundwater mapping discretized only to 20 foot depth-to-groundwater contour intervals, these maps generally include the areas of shallow groundwater described above.

Evaluation of time-series depth-to-groundwater maps (Appendix F) and historic mapping indicates that all of these areas have experienced shallow groundwater since at least the 1950s. The main differences in the shallow groundwater distribution can be seen in years such as 1967 and 2002, during severe drought. During these times the extent of shallow groundwater in the third area, along the upper alluvial valley flank, is greatly diminished.

GROUNDWATER FLOW

Groundwater elevation contour maps depicting groundwater elevations since 1967 generally show a very similar water table configuration at the Study Area scale. Groundwater elevation contours presented in Figure 10 indicate that groundwater flow is from the flanks of the alluvial aquifer generally toward the South Platte River. In general, groundwater enters the Study Area as underflow originating at the hydrologically upgradient end (southwest) of the Study Area, and the mouth of Beebe Draw. Additionally, water enters the aquifer via recharge from infiltration of precipitation and irrigation, seepage from recharge ponds or canals, and other surface sources.

Groundwater leaves the Study Area as downgradient underflow through the aquifer, water well pumping, evapotranspiration, and discharge to the South Platte River. Groundwater flow in the central portion of the Study area is generally subparallel to the South Platte River, and throughout the entire study area has a strong northward flow component. The groundwater flow lines shown in Figure 10 indicate that while groundwater will travel along a path subparallel to the river before eventually discharging to the South Platte River.

Groundwater will preferentially flow through the areas of highest transmissivity and can be expected to be highest through the transmissive sands and gravels in paleochannels described above. Constrictions of the high transmissivity zone, imposed by bedrock highs or low-permeability sediments, will limit the aquifer’s capacity to transmit groundwater.

Groundwater flow may result in localized high water table conditions by the following mechanisms. First, low-permeability beds near the land surface, such as silt and clay lenses and sheetwash deposits shown in Figure 5, will prevent surface recharge from flowing vertically into deeper portions of the aquifer. Locally these beds may be overlain by more permeable sands or gravels. Where permeable beds overlying silt or clay lenses or sheetwash deposits thin or pinch out in the direction of groundwater flow the depth to groundwater can be expected decrease and groundwater may eventually discharge to the surface. Available borehole lithologic data, generally, collected by water well drillers focused on aquifer materials in the deeper, more highly productive portions of the aquifer, may not provide sufficient detail or have resolution needed to relate localized low permeability lenses to shallow groundwater.

Second, where groundwater flowing laterally passes beneath risers between terraces, as shown in Figure 6, or more subtle topographic changes, the groundwater may come close to or intersect the land surface. This condition will result in shallow groundwater or groundwater discharge to the surface, respectively. Currently-available topographic data may not be sufficient to determine areas of subtle land surface changes needed to relate land surface changes to areas of shallow groundwater.

ALLUVIAL AQUIFER UNDERFLOW AND STORAGE

An integration of aquifer transmissivity across the South Platte alluvial aquifer near LaSalle is was used to approximate underflow through the aquifer between the confluence with the Big Thompson River and the Cache la Poudre River. Underflow was calculated assuming a uniform hydraulic gradient of 0.0015 and an integration of the aquifer transmissivity based on saturated thickness from spring 2012. The resulting underflow estimated though this transect is approximately 10,500 acre feet per year. Underflow will change along the aquifer length based on aquifer transmissivity and hydraulic gradient. This variability needs to be taken into consideration when assessing depth to water conditions as they pertain to local pumping and recharge activities. Assuming a constant permeability (hydraulic conductivity) through the entire aquifer thickness, as aquifer recharge increases, rising groundwater levels result in an increased saturated thickness and thus increased transmissivity, allowing more water to flow through a given transect of the aquifer.

Using a specific yield of 0.15 calculated from aquifer pumping tests performed in the Study Area vicinity and the aquifer saturated thickness calculated from spring 2012 groundwater levels, the volume of groundwater in storage within the alluvial aquifer in the Study Area was approximately 320,000 acre-feet. The specific yield value used represents unconfined conditions and is interpreted as more representative of the alluvial aquifer effective porosity than values reflecting semi-confined conditions.

DATA GAP EVALUATION

The data available for the Study Area contain significant temporal and spatial data gaps. Temporal data gaps in the groundwater level record are described below and illustrated in the groundwater level data summarized in Table 2. The possibility that additional historic data suitable for use exists is not likely. Spatial data gaps can be filled by using existing wells or installing new monitoring wells.

Temporal Groundwater Level Data Gaps

Table 2 lists Study Area wells monitored by DWR, CCWCD, CDA, SPDSS, and others by township and section and illustrates the period of record available for each well. The earliest groundwater level data available are from 1929 and very few wells have a continuous record for the entire period. Only four wells, 17-1, 16-1, 15-1, and 18-1, have relatively continuous depth-to-water measurements dating to 1930 and continuing to present, or near present, and provide valuable information on continuous historical trends. In the late 1940s, monitoring began at eight more wells and several additional wells were monitored beginning in the early 1960s. An aggressive data collection effort by Colorado State University between 1965 and 1975 provides a significant addition to the available data (Longenbaugh, 2013). Between the mid-1979s and the mid-1990s few wells were monitored, resulting in a significant data gap with several consecutive years in which no groundwater level data were collected in the Study Area. From 1994 until 2013, data collection has been performed at many wells in the Study Area, however a significant data gap in exists during 2005 - 2006.

In addition to sporadic groundwater level monitoring programs throughout much of the period of record, data interpretation is limited by inconsistency between different monitoring programs in the Study Area. The DWR, CCWCD and historic CSU monitoring programs have typically monitored groundwater levels during spring and fall, before and after heavy groundwater pumping during the irrigation season. Until recently when monthly and automated groundwater level monitoring began, the CDA groundwater monitoring has historically been in June and July during the peak period of groundwater pumping. These temporal data limitations result in generally insufficient data to fully contour high-resolution groundwater levels for many years or seasons during the period of record.

Spatial Groundwater Level Data Gaps

Areas with insufficient groundwater level data are shown in Figure 18. Significant groundwater level data gaps are in the northeast part of the Study Area, south and southwest of LaSalle, three miles east of LaSalle, and an area north of Gilcrest. Priorities were assigned to groundwater level data gap areas based on the monitoring well distribution and availability, and presence of high water table conditions.

Aquifer Property Data Gaps

The CGS scope provided for additional aquifer testing at up to two wells made available by CCWCD, if found beneficial for the study. Candidate wells were identified by CCWCD, however the existing aquifer property data distribution (Figures 11 and 12) is primarily in the vicinity of CCWCD aquifer test candidate wells, therefore additional testing was not performed as it would have duplicated existing data. Due to aquifer heterogeneity identified in the Study Area, hydraulic conductivity is expected to be quite variable such that one or two additional point data values are not likely to significantly change the overall understanding of aquifer properties. Rather, a broad three-dimensional (3-D) characterization of aquifer properties throughout the alluvial aquifer in the Study Area is needed.

SUMMARY AND CONCLUSIONS

The study documented herein is a component of the Gilcrest/LaSalle Pilot Project, funded by the CWCB and conducted by the DWR, to analyze the hydrology in the Study Area and identify relationships between the climate, geology, hydrology, and water management practices and high groundwater conditions. CGS compiled published hydrogeologic data and obtained unpublished data from entities monitoring groundwater in the Study Area. This report provides new insight into the South Platte alluvial aquifer depositional model, particularly with respect to discontinuous low permeability beds within the central portion of the alluvial aquifer and lower permeability bedding on the aquifer sides.

The approximately 78 square mile Study Area lies south and southwest of Greeley along Highway 85 and consists of generally flat to gently rolling terrain underlain by the South Platte and Beebe Draw alluvial aquifers. Irrigated agriculture plays an important role in the Study Area's water balance and the Study Area includes reservoirs, large irrigation canals, over 70 recharge structures, and drainage ditches.

Surficial geology consists mainly of terrace and eolian deposits with localized bedrock outcrops (Figure 3). The South Platte alluvial aquifer is a heterogeneous geologic unit composed of interbedded gravel, sand, silt, and clay filling an irregularly shaped paleovalley with multiple paleochannels incised into low-permeability bedrock (Figures 5 and 7). Highly permeable coarse-grained material dominates the central portion of the aquifer and is interbedded with lenses of less permeable fine-grained material resulting in a stratified aquifer system. On the aquifer flanks, sheetwash deposits derived from the fine-grained Laramie Formation and reworked eolian sediments form low-permeability deposits overlain locally by sand and loess. Aquifer thickness exceeds 100 feet in the deepest portions of the aquifer, however the majority of the alluvial sediments are approximately 45 to 85 feet thick.

Hydraulic conductivity values from eleven aquifer test locations range from 385 to 1,270 feet/day (Table 1, Figure 11). Specific yield values from the same locations have a bimodal distribution averaging 0.04 and 0.15, indicating distinct localized semi-confined and unconfined conditions, respectively. Transmissivity values from the same aquifer test locations range from 40,000 to 350,000 gallons per day per foot (Table 1, Figure 12).

Groundwater level measurements were obtained from 136 wells (Figure 13) with a combined period of record from 1929 to 2013 (Table 2). Data were provided by CCWCD, CDA, and the DWR's HydroBase. In the central and northeast portions of the Study Area historic groundwater level data indicate a relatively stable trend over the period of record, as shown in Figures 14 and 16, respectively. In the western portion of the Study Area, groundwater levels have declined from the 1940s until the early 2000s, when levels began to rise, however groundwater levels are still 5 to 8 feet below the 1940s levels as shown in Figure 15.

Shallow groundwater occurs along three distinct alignments in the Study Area: the floodplain immediately adjacent to the South Platte River, in Beebe Draw from Milton Reservoir to the vicinity of Lower Latham Reservoir, and the upper terraced portion of the alluvial valley flank below the Platte Valley Canal (Figure 17). All of these areas have historic shallow groundwater conditions as indicated by features such as mapped wetlands and drainage canals and / or depth to groundwater maps from previous reports using data from the 1950s and 1970s (Smith 1964, Hillier and Schneider 1979a).

Groundwater enters the Study Area as underflow at the hydraulically upgradient (southwest) end of the Study Area, underflow from the south in the Beebe Draw alluvial aquifer, and as recharge from infiltration of precipitation and irrigation, seepage from recharge ponds and irrigation ditches, and other surface water sources. Groundwater flow in the central portion of the Study area is generally subparallel to the South Platte River, and has a strong northward flow component throughout the entire study area. This indicates that while groundwater will eventually discharge at the South Platte River, a significant groundwater flow component is downstream and subparallel to the river. Groundwater flows preferentially through the aquifer via the zone of highest transmissivity underlying the center of the alluvial valley, generally along the US Highway 85 alignment (Figure 12). Groundwater leaves the Study Area as downgradient underflow, water well pumping consumptive use, evapotranspiration, and discharge to the river. Annual groundwater underflow through the Study Area is estimated at 10,500 acre-feet; groundwater storage in the alluvial aquifer is estimated at 320,000 acre feet.

Data gap evaluation indicates the frequency of groundwater level data collection has been very irregular since measurement began in 1929 (Table 2). The most significant temporal data gaps are prior to 1965, 1980 through 1994, and 2005 through 2006. Despite a large number and wide distribution of wells that have been measured (Figure 13), none of the wells monitored have a continuous measurement record and almost all wells monitored before 1994 have at least one decade-long interval from which no measurements are available. Additionally, many wells shown in Figure 13 may provide a short period of record from long ago, but are currently unavailable for future measurement, have not been measured for decades, or are outside of areas relevant to evaluating high groundwater conditions. These data gaps limit the ability to analyze detailed long-term groundwater level trends throughout the entire study area and to map detailed water table surfaces across portions of the Study Area and over long historic periods.

Areas in which groundwater level data are lacking include: 1) in the northeast part of the Study Area, 2) south and southwest of LaSalle, 3) the vicinity of Lower Latham Reservoir, and 4) a three-mile long band north of Gilcrest (Figure 18).

Aquifer property data are available from nine aquifer tests in or adjacent to the Study Area, however a full three-dimensional understanding of aquifer properties is needed to understand the lateral and vertical heterogeneity of aquifer hydraulic conductivity and specific yield.

RECOMMENDATIONS

This hydrogeologic characterization provides a revised and refined interpretation of existing data, presents a refined aquifer depositional model, and adds significant lithologic and water level data in a format suitable for a three-dimensional digital aquifer model. However, full understanding of hydrogeologic factors contributing to shallow groundwater would be greatly assisted by four types of additional study: 1) groundwater level monitoring in data-sparse areas, 2) detailed characterization of the lithologic distribution in three dimensions, 3) three-dimensional aquifer property characterization, and 4) more detailed definition of surface geology and subtle topographic features.

ADDITIONAL GROUNDWATER LEVEL MONITORING

Additional groundwater monitoring sites combined with expanded continuous groundwater level recording will allow better observation of changing groundwater levels in the alluvial aquifer as the Pilot Study progresses and expanded monitoring can also guide groundwater management strategies. Figure 18 was prepared to show areas recommended for additional groundwater level monitoring and CCWCD wells available for aquifer testing. Areas are ranked as first, second, or third to optimize resources. The urgency with which additional monitoring should be performed in these areas, or equipment deployed, is subjective and depends on resource availability. Wells are shown that could be outfitted with automated water level data loggers or measured on a monthly, or more frequent basis assuming resources are available. Candidate monitoring wells are ranked and well permit and owner information are presented in Table 3.

Monitoring wells should be located away from ditches, canals, ponds, or active pumping wells if possible. Candidate monitoring wells are identified as "stock" or "other" and are not likely to be equipped with pumps. Geologic logging and installation of nested piezometers should also be performed in areas of high water table conditions to evaluate the presence of confining layers and to provide data on vertical groundwater flow. Data loggers can capture localized and immediate effects of pumping and recharge from irrigation and detailed seasonal fluctuations. Because the effects of pumping or recharge are not entirely clear with respect to shallow groundwater conditions, dedicated monitoring wells should be equipped with a transducer for at least one year to determine the extent to which groundwater levels are controlled by local or seasonal recharge or well pumping.

Additional monitoring equipment is recommended in three rankings of data gap areas within the Study Area (Figure 18) based on available monitoring data and proximity to areas of shallow water table conditions. The first groundwater level data gap for which significant data do not exist is in the northeast of the Study Area, north of Lower Latham Reservoir in T5N R65W, in Sections 26, 27, 28, 32, 33, 34, 35. The second groundwater level data gap is near the town of LaSalle in T4N 66W, sections 1 and 12, in T4N 65W, in Sections 6 and 7, and T5N R65W, section 31. The third groundwater level data gap is north of Gilcrest in township T4N 66W, Sections 20, 21, 22, 28 & 27. Candidate monitoring wells are presented in Table 3 and Figure 18.

THREE-DIMENSIONAL LITHOLOGIC CHARACTERIZATION

General lithologic data from almost 450 driller's logs have been compiled by CGS into a digital data set (Appendix B-3) which can be used to provide a 3-dimensional understanding of how aquifer materials are distributed. This information, or a location-specific subset thereof, should be input to a three-dimensional geologic visualization program and evaluated to determine whether this information is useful to gain a detailed understanding of aquifer characteristics influencing groundwater flow and shallow water table conditions. This evaluation should be coupled with additional subsurface lithologic logging and geophysical investigation described below.

Figure 18 identifies areas for additional groundwater level monitoring. The first-ranked areas near LaSalle and north of Latham Reservoir are areas where additional borehole data would benefit aquifer characterization.

EXPANDED AQUIFER PROPERTY CHARACTERIZATION

This hydrogeologic characterization indicates the presence of localized silts and clays interbedded with aquifer sands and gravels throughout much of the aquifer resulting in significant aquifer property heterogeneity. This heterogeneity affects groundwater flow pathways both as underflow and as the aquifer's ability to allow recharge to migrate into deeper, more highly transmissive portions of the aquifer where groundwater can migrate more quickly out of the system. The next level of characterization should address better definition of the three-dimensional aquifer property heterogeneity. This effort may include surface and/or borehole geophysical investigations combined with additional confirmatory lithologic logging and/or comparison to existing location-specific data. Geophysical pilot tests evaluating the relation of geophysical findings to more traditional borehole logging and aquifer test values should be carried out in areas of reported shallow groundwater. Any geophysical investigations should be calibrated with field lithologic descriptions and pilot testing.

Recommended parameters for aquifer property characterization include hydraulic conductivity/transmissivity and specific yield. Data presented in this report include low specific yield values indicating semi-confined conditions. The presence of confining layers overlying the more transmissive portion of the aquifer has significant implications for local responses to recharge and development of shallow groundwater conditions. However, water level monitoring has not been performed in the Study Area at sufficient vertical resolution (using nested piezometers) to evaluate vertical groundwater gradients and the potential for perched water table conditions. An objective of three-dimensional characterization would be to better define variability in the specific yield and hydraulic conductivity throughout the aquifer. These heterogeneities likely result in localized preferential pathways or contributing to, or mitigating, the potential for high groundwater conditions.

DETAILED SURFACE MAPPING

Surface topography and near-surface geology appear to be the constraints that control the location of shallow groundwater conditions. Better resolution of both will help water managers, planners and users understand how changing groundwater levels may lead to expanded, or previously unrecognized areas with shallow groundwater. In the late fall of 2013 the U.S. Army Corps of Engineers, in conjunction with Colorado Department of Transportation, and CWCB, obtained high resolution LiDAR topographic data over the entire South Platte River Basin to assess the impacts of the September 2013 flooding. This imagery will be very useful in mapping subtle changes in surface topography and should be incorporated into the Pilot Study.

Features that can be mapped with LiDAR include:

- Terrace sequences
- Alluvial fan complexes
- Slopewash aprons
- Landslide complexes

The alluvial aquifer edge and its transition to the bedrock upland would also be better defined by detailed surface mapping. The area of greatest concern extends from the US Highway 85 alignment to the upland to the southeast where this transition is generally concealed by eolian and slopewash deposits. This is an area where seepage from irrigation canals recharges the alluvial aquifer. Understanding the nature of the contact between the alluvial aquifer and the less-permeable underlying bedrock is important to mapping groundwater pathways into the aquifer. The LiDAR imagery combined with field mapping and borehole log assessment will advance this objective.

Springs and seeps should also be mapped in greater detail throughout the Study Area. Using the National Hydrography Dataset as a starting point, high-resolution color or infrared imagery can be used to determine the presence of shallow water table conditions due to presence of lush vegetation or temperature contrasts, respectively. Spring and seep locations can guide subsurface lithologic characterization described above and also be combined with high-resolution topographic data to refine the model developed herein.

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TABLES

Table 1, Aquifer Property Data Summary
Gilcrest/Lasalle Pilot Project
Hydrogeologic Characterization Report

Aquifer Test ID	Date	Drawdown (ft)	Test Flow Rate (gpm)	Test Duration (hrs)	Well Depth (ft bgs)	Saturated Thickness (ft)	Transmisivity (gpd/ft)	Hydraulic Conductivity (ft/d)	Specific Capacity (gpm/ft)	Specific Yield	Township	Range	Section	q160	q40	q10
AP_SMITH_1111	8/6/57	24	1,220	8	78	56	290,000	695	51		3 N	66 W	5	NW	NW	NE
AP_SMITH_1118	7/19/57	12	385	4	56	36	100,000	374	32		4 N	65 W	18	SW	SW	SW
AP_SMITH_1119	7/12/57	31	430	8	48	39	40,000	134	14		4 N	65 W	19	NE	NW	SE
AP_SMITH_1120	9/14/56	11	1,240	10	74	64	300,000	628	113		4 N	65 W	23	SW	SW	SW
AP_SMITH_1121	7/11/57	9	1,110	12	72	37	350,000	1,270	123	0.03	4 N	66 W	11	NE	SE	SW
AP_SMITH_1122	7/30/57	10	980	12	58	36	220,000	816	98	0.02	4 N	67 W	36	NW	SE	SW
AP_SMITH_1125	7/25/57	10	975	4	112	78	180,000	307	97		5 N	65 W	21	NW	NW	NW
AP_SMITH_1126	8/9/57	15	1,050	7	45	62	270,000	588	70	0.15	5 N	65 W	25	NW	NW	NW
AP_SMITH_1127	7/27/57	30	700	14	60	40	100,000	334	23	0.06	5 N	65 W	35	NE	NW	SW
AP_WILSON_918	7/22/57		1,110		71	37	330,000	1,192	129		4 N	66 W	11	NE	SE	SW
DSS02MLK	12/16/03	4	1,284	69	44	32	112,900	480	289	0.14	4 N	66 W	7	NW	NE	SW

Data Source: All Data from SPDSS Database, Downloaded from Colorado Water Conservation Board Descision Support System website

Table 2, Historic Groundwater Level Data Summary
Gilcrest/Lasalle Pilot Project
Hydrogeologic Characterization Report

Township/Range	SEC.	Well Name
T4N/ R65W	3	SB00406503BBD
	3	SB00406503CCC1
	4	SB00406504ACC
	4	39-1
	4	SB00406504CCC2
	6	15-1
	6	SB00406506BBD
	6	04N6506DAB
	6	SB00406506DAD
	7	WL-M-009
	8	SB00406508BCB1
	9	39-3
	9	SB00406509DA
	10	SB00406510CBC
	14	DSS20BBD
	14	DSS21BBD
	15	DSS19BBD
	17	SB00406517CDD1
	18	16-1
	19	SB00406519ABD
	22	SB00406522DCD1
	23	48-2
	27	SB00406527DA
	27	49-1
	33	300-1
	33	SB00406533AA
	34	SB00406534AB
	34	301-1
	34	SB00406534BA
	34	SB00406534BBD
	35	302-2
	35	302-1
	35	SB00406535BB
	37	50-2
T4N/ R66W	1	04N6601ABD
	01	SB00406601DCB
	02	SB00406602CCC
	02	SB00406602CC
	3	WL-M-007
	03	SB00406603DBC
	10	SB00406610ADD
	10	SB00406610BBC
	10	33-1
	10	30-1
	10	SB00406610DD
	10	32-1
	10	SB00406610DC
	10	SB00406610CA
	10	SB00406610CDC1
	11	SB00406611ADC1
	12	SB00406612DCB1
	12	38-2
	12	SB00406612CD
	13	SB00406613AB
	13	SB00406613BAB
	13	WL-M-008
	13	37-4
	13	SB00406613DDD
	13	SB00406613DD
	13	SB00406613CBC
	14	17-1
	14	40-1
	14	WL-M-002
	14	WL-M-603
	14	37-1
	14	SB00406614CD
	14	WL-M-001
	15	25-5
	15	SB00406615DDD
	15	29-1
	15	SB00406615CB
	15	30-2
	15	SB00406615CD
	15	SB00406615CCC2
	16	SB00406616ACD1
	16	WL-M-006A
	16	208-9
	16	SB00406616CD
	17	SB00406617ADB
	17	28-3
	17	SB00406617DA
	17	SB00406617DCC2
	17	28-1
	17	SB00406617CB
	17	27-1
	17	SB00406617CD
	19	SB00406619ABC
	19	SB00406619DDD1
	19	SB00406619CBC
	20	SB00406620BDD
	21	SB00406621BDD1
	22	SB00406622ACC
	22	SB00406622BB
	22	SB00406622CCB1
	23	36-1
	23	SB00406623ADD1
	23	SB00406623DA
	23	21-1
	24	SB00406624BBB
	25	SB00406625DAB
	26	SB00406626ADD1
	26	WL-M-040
	26	SB00406626DDD1
	26	109-3
	26	SB00406626CCD
	27	SB00406627ACA
	27	18-1
	27	108-1
	27	SB00406627CCC1
	27	SB00406627CC
	28	SB00406628BBA
	28	SB00406628CDA
	28	SB00406628CCB1
	29	SB00406629ACC
	29	SB00406629BD
	30	SB00406630ACC
	31	SB00406631DCC
	30	SB00406630CB
	30	110-2
	31	SB00406631ACD1
	32	SB00406632ABB1
	32	SB00406632DAD
	33	WL-M-003A
	33	SB00406633BAD1
	35	SB00406635ACC1
T5N/ R65W	4	WL-M-015
	13	WL-M-011
	22	SB00506522BCC
	22	SB00506522DAB
	26	SB00506526BCC
	27	SB00506527BCB
	27	SB00506527CCB
	28	WL-M-010
	28	SB00506528CBA
	32	SB00506532ACC
	32	WL-M-501
	32	SB00506532DDB
	33	SB00506533ABB
	33	SB00506533CCC
	34	WL-M-401
	35	SB00506535ABC

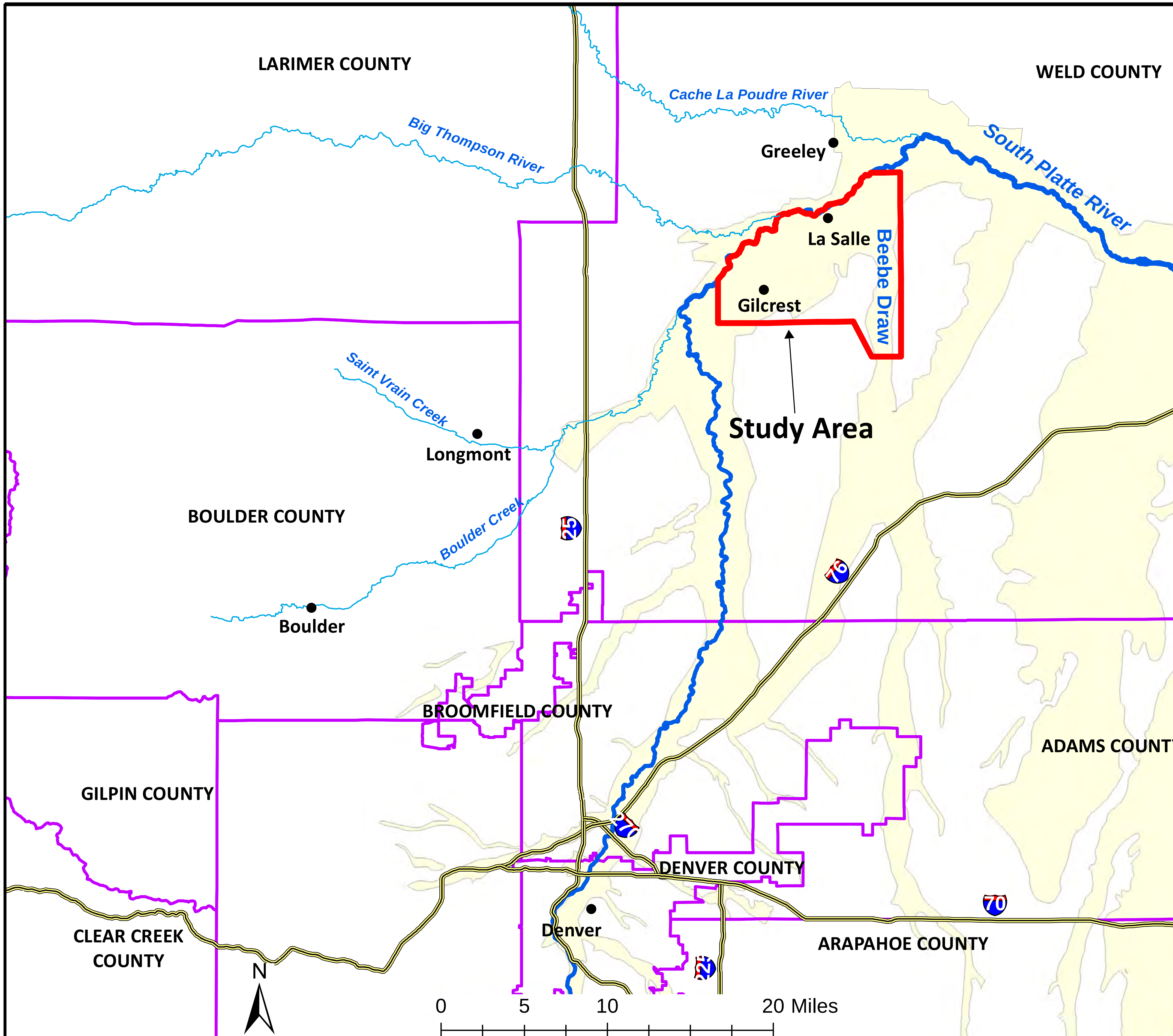
Note: Bars indicate years with records available for each well.

Table 3, Candidate Wells for Additional Monitoring
Gilcrest/Lasalle Pilot Project
Hydrogeologic Characterization Report

RECEIPT	PERMIT NO.		RANKING	USE	OWNER	TOWNSHIP		RANGE		SEC	Q160	Q40	UTM X	UTM Y
9064763	54127		first	STOCK	MILLER FEED LOT	4	N	66	W	1	NE	NE	523290	4465422
9058963	2846		first	STOCK	COLORADO FERTILIZER & CHEMI	4	N	65	W	6	NW	SE	524760	4465874
3615040	274758		first	STOCK	CONNELLY JAMES H & CYNTHIA A	5	N	65	W	23	NW	NE	531347	4470992
9060612	11243		first	STOCK	ROSS WILLIAM	5	N	65	W	23	NW	NE	531158	4471115
9062525	18586	F	first	OTHER	RAINS DARRELL	5	N	65	W	31	SW	SE	524840	4466498
0042858	42858	MH	second	OTHER	TPI PETROLEUM INC	4	N	66	W	20	NW	SE	516662	4460931
0544115E	63759	F	second	OTHER	CCWCD	4	N	66	W	21	SW	SE	518170	4460178
0544115D	63758	F	second	OTHER	CCWCD	4	N	66	W	21	SW	SW	518103	4460244
0544114G	63753	F	second	OTHER	CCWCD	4	N	66	W	21	NW	SW	517833	4460762
9066307	117789		second	OTHER	GILCREST SANITATION DIST.	4	N	66	W	27	NW	NW	519540	4459737
9066306	117787		second	OTHER	GILCREST SANITATION DIST.	4	N	66	W	27	NW	NW	519469	4459931
0914651	117788		second	OTHER	GILCREST SANITATION DISTRICT	4	N	66	W	27	NW	NE	519698	4459934
C620432	432	WCB	second	STOCK	MCLEOD ROYAL	4	N	66	W	28	NE	NE	519090	4459738
9061471	13092		third	STOCK	KNAUB OLIVER & KNAUB CLARA M	4	N	65	W	9	SW	SW	527599	4463483
C620436	436	WCB	third	STOCK	MCMILLAN WARREN	4	N	65	W	19	NE	NW	525205	4461454
9064193	40642		third	STOCK	GRANT ARENS TRUST & RENA F ARENS TRUST	4	N	65	W	22	NE	NW	530018	4461476

CCWCD - Cental Colorado Water Conservancy District

FIGURES



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

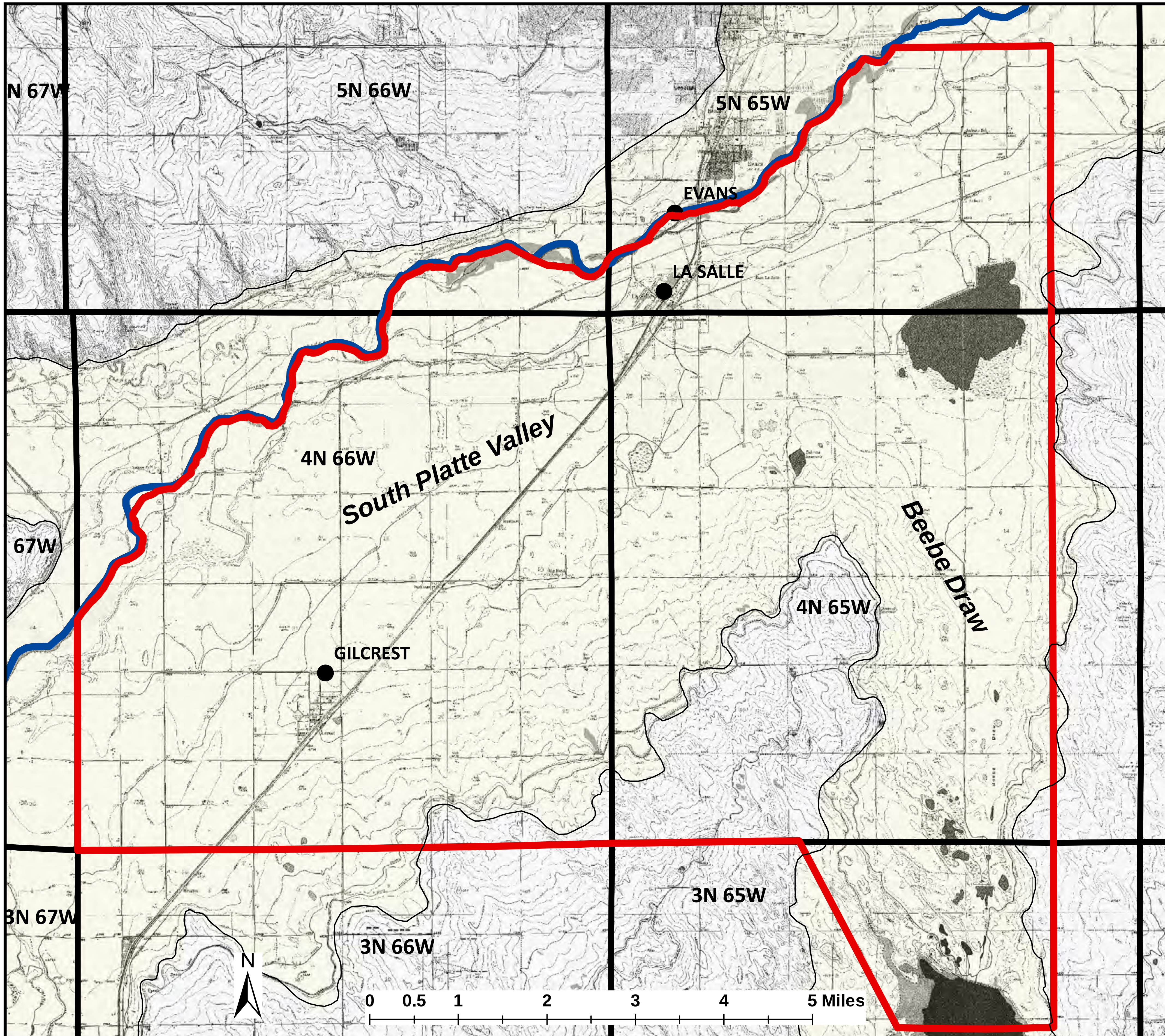
Legend

- Study Area Boundary
- County Boundary
- Alluvial Aquifer Extent (SPDSS)
- City
- South Platte River
- River/Creek
- Interstate

*Data Source Reference:

Regional Alluvial Aquifer Mapping From SPDSS (2012)

Figure 1
Study Area Location Map



Gilcrest/Lasalle Pilot Project Hydrogeologic Characterization Report

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

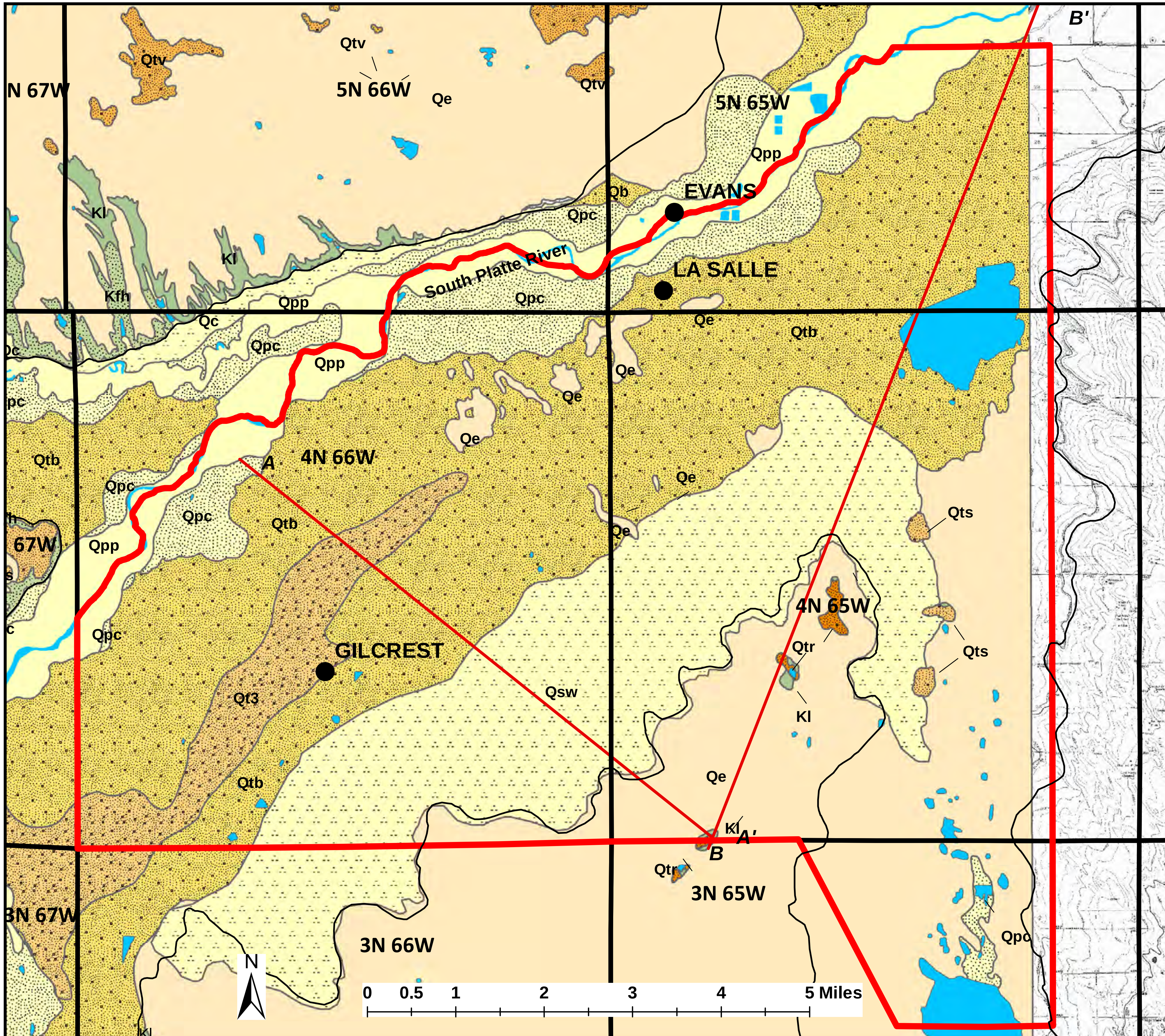
Data Source:

Study Area Alluvial Aquifer Extent Mapping By Colorado Geological Survey, Revised From SPDSS Regional Mapping

Basemap: 1:24,000 Scale Colorado County Wide Digital Raster Graphics

Figure 2
Study Area Map and Alluvial Aquifer Extent

Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report



Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River
- Water
- Cross Section Lines

Unconsolidated Sediments

- Slope wash deposits (Qsw)
- Un-named 3rd level terrace (Qt3)
- Colluvium (Qc)
- Eolian deposits (Qe)
- Post-Piney Creek alluvium (Qpp)
- Piney Creek alluvium (Qpc)
- Broadway terrace alluvium (Qtb)
- Slocum terrace alluvium (Qts)
- Verdos terrace alluvium (Qtv)
- Rocky Flats terrace alluvium (Qtr)

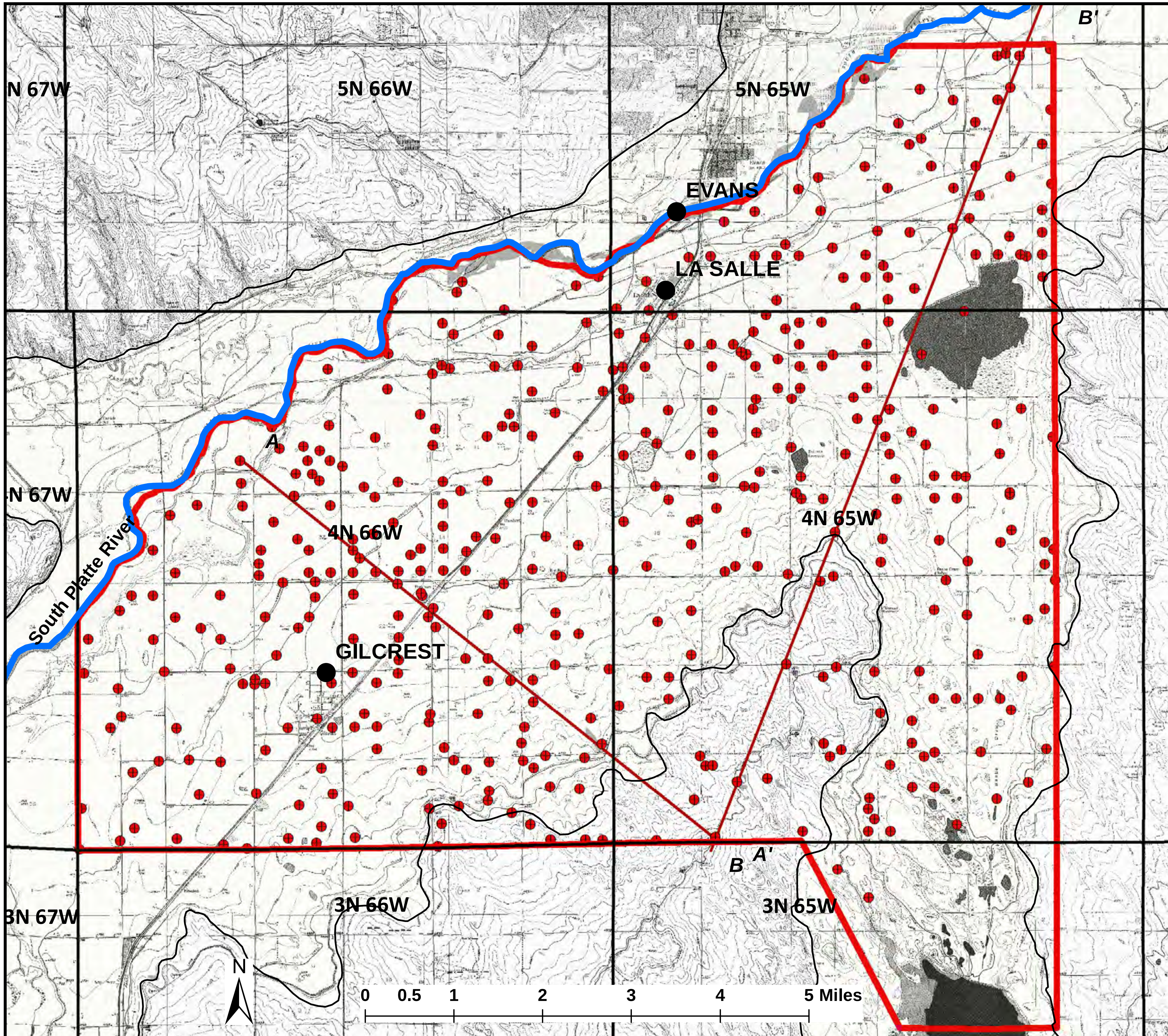
Bedrock Formations

- Laramie Formation (Kl)
- Fox Hills Sandstone (Kfh)

Data Source:

Geologic units are modified from Colton (1978) Smith and others (1964) for this study by the CGS.

Figure 3
Surface Geologic Map



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

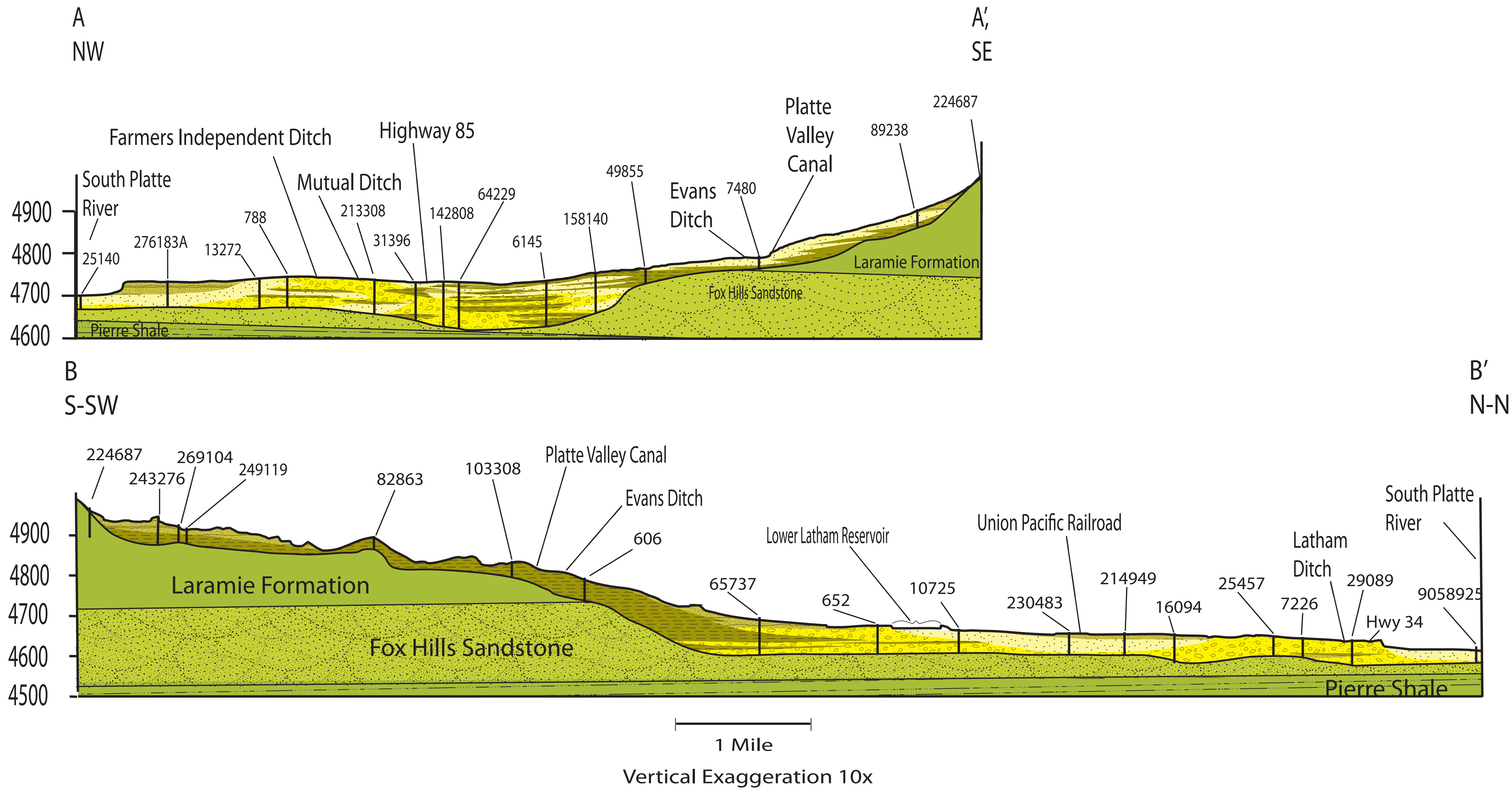
Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River
- Wells with Geologic Data
- Cross Section Lines

Data Source:

DWR Well Permit Files

Figure 4
Lithologic Characterization Borehole Locations



See Figure 3 and 4 for cross-section locations.

Alluvial deposits:

- Silt and clay
- Sand and silt
- Sand and gravel
- Gravel

Bedrock Formations:

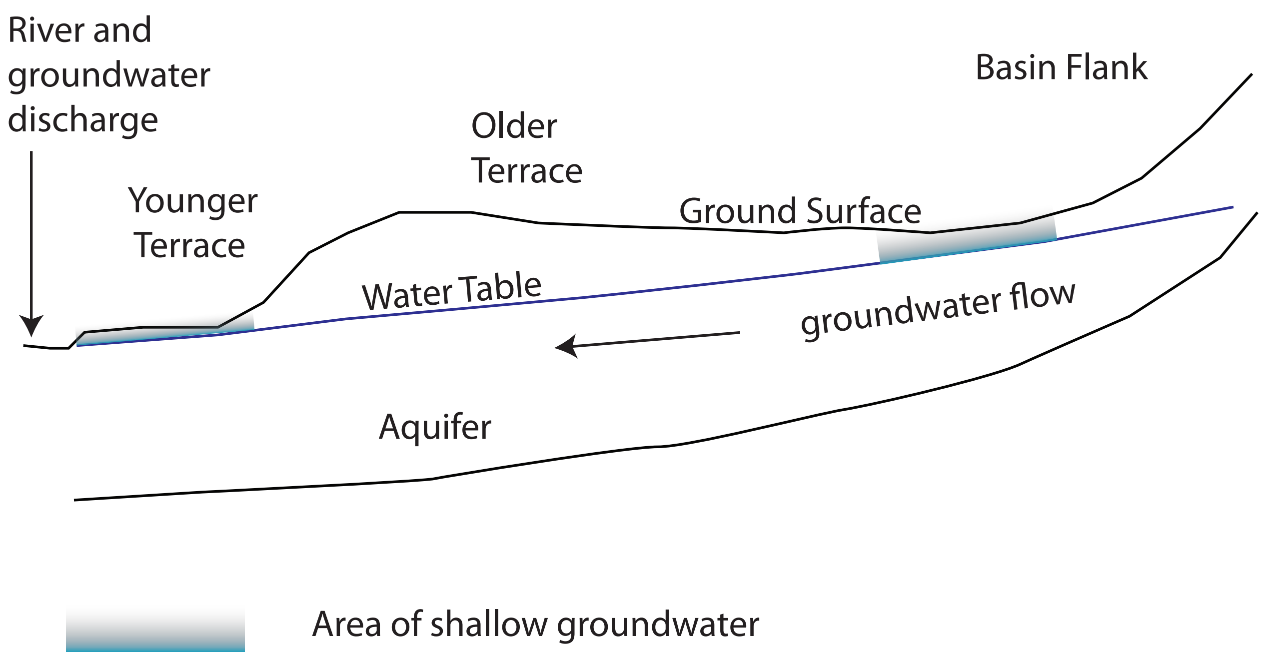
- Laramie Formation
- Fox Hills Sandstone
- Pierre Shale

158140 Well used for geologic description with DWR permit number

Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Figure 5
Alluvial Aquifer Cross Sections

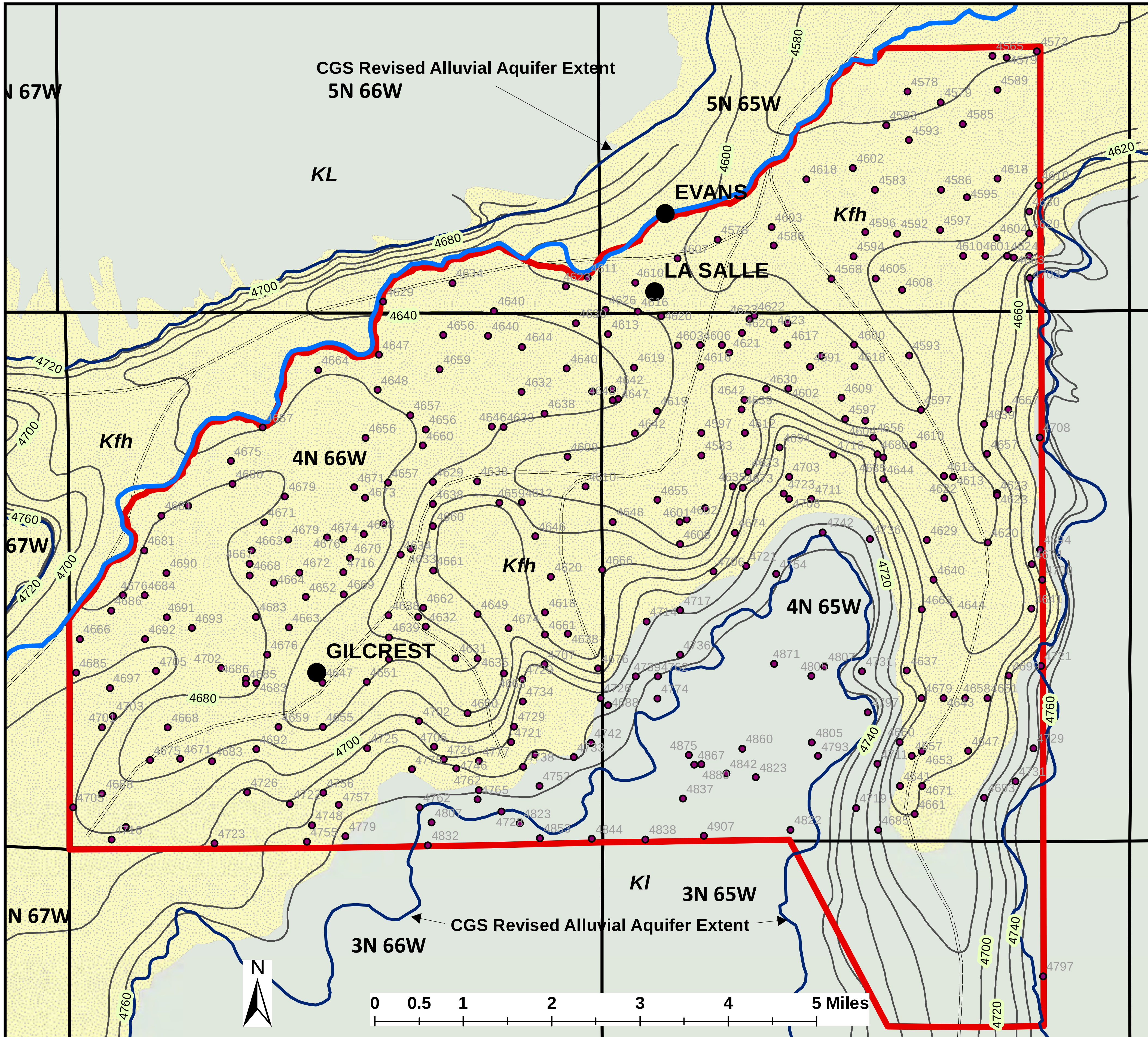
Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report



Schematic diagram, not to scale.

Figure 6

Diagram Relating Topographic Change to Shallow Groundwater



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River
- Buried Paleo-Channel
- Bedrock elevation contour (ft MSL) 20 ft Contour Interval
- 4614 Bedrock Elevation Data Point

Bedrock Formation

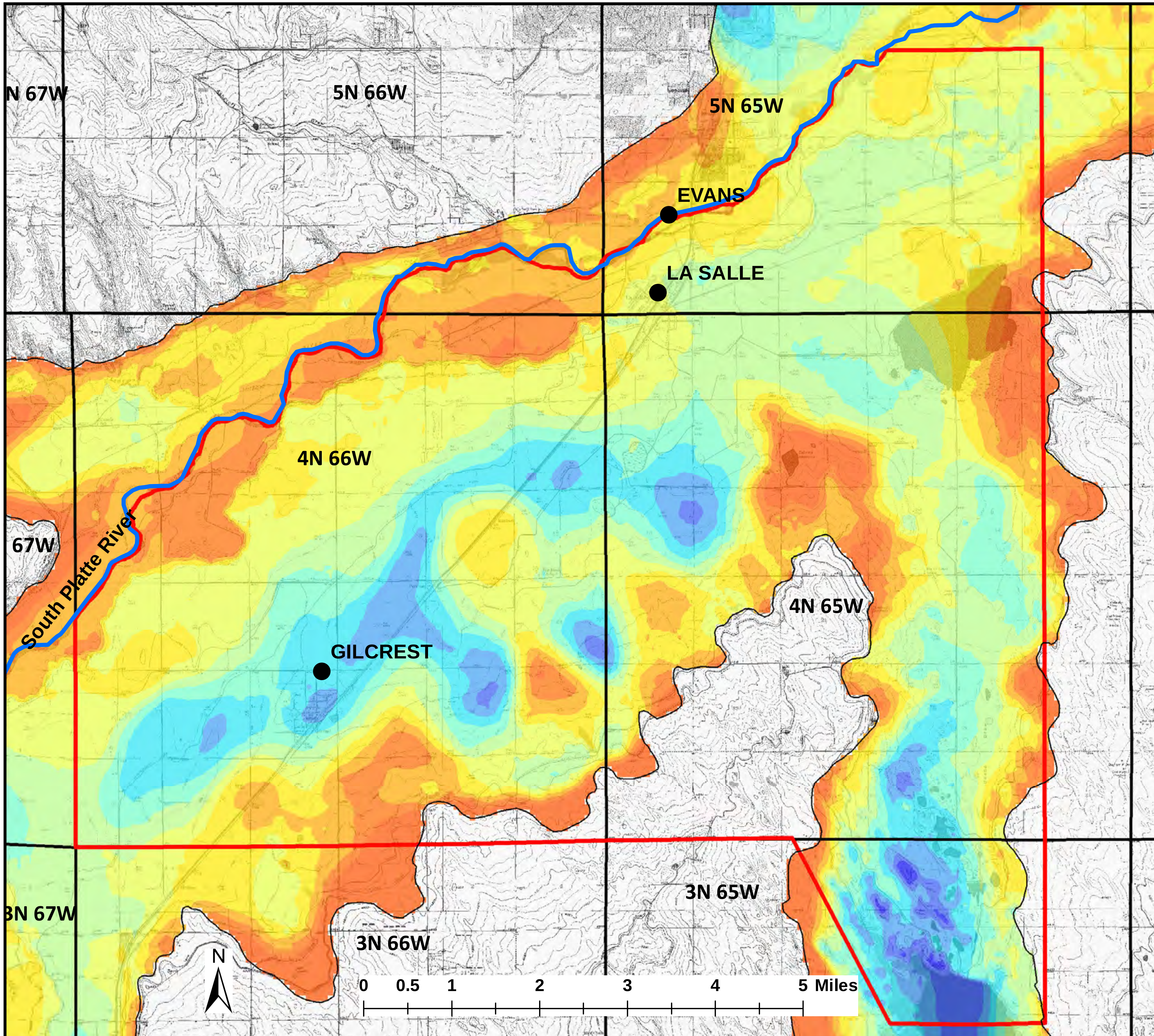
- Laramie Formation
- Fox Hills Sandstone

Data Source:

CGS Revised Bedrock Surface Elevation Dataset

Figure 7
Bedrock Elevation Contour Map

Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report



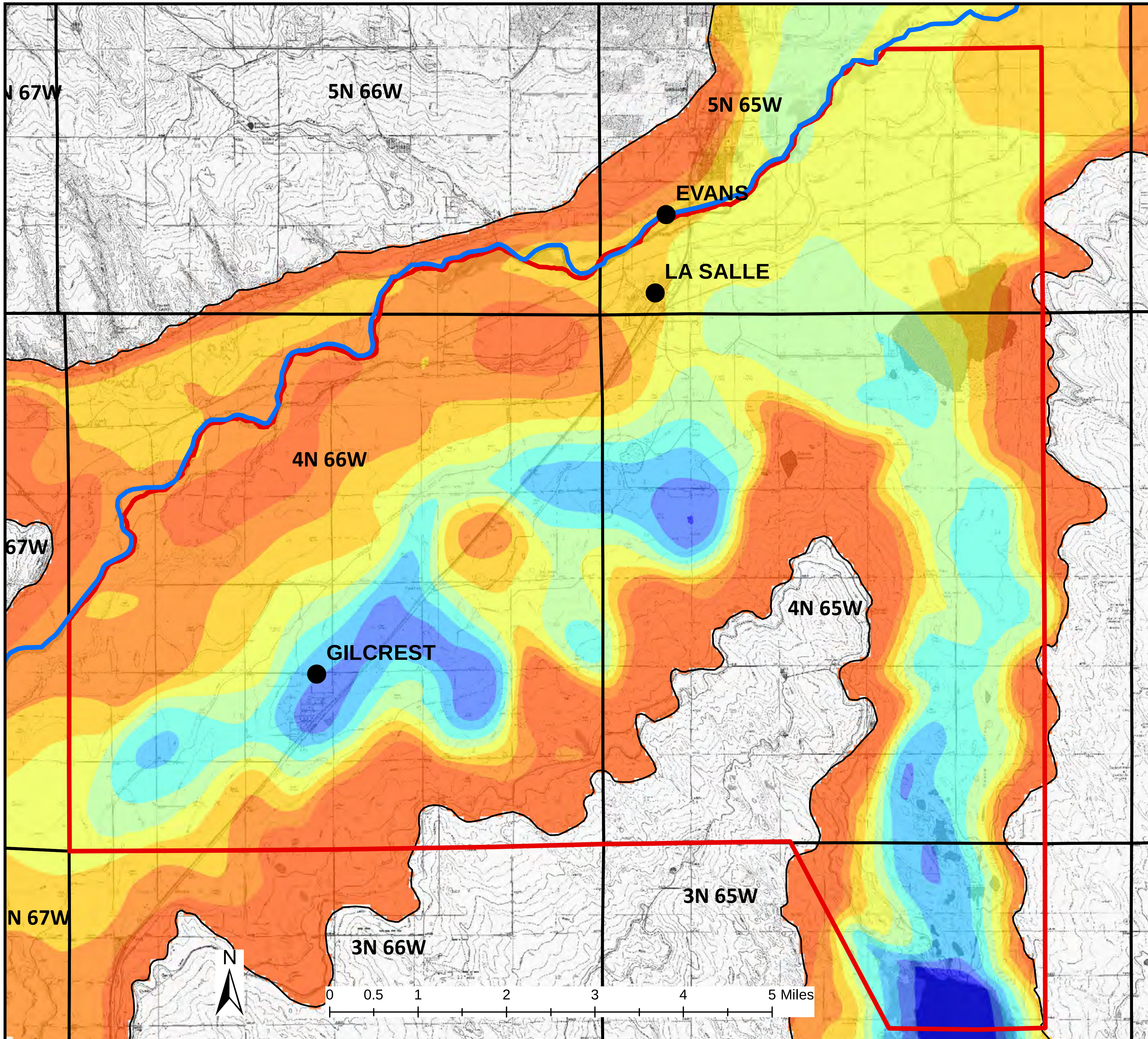
Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Unconsolidated Quaternary Deposit Thickness (ft.)

- < 25
- 25 - 35
- 35 - 45
- 45 - 55
- 55 - 65
- 65 - 75
- 75 - 85
- 85 - 95
- 95 - 105
- 105 - 115
- 115 - 120

Figure 8
Unconsolidated Quaternary Deposit Thickness Map



Gilcrest/LaSalle Pilot Project Hydrogeological Characterization Report

Legend

- Study Area Boundary
- Extent of Saturated Alluvium
- City
- South Platte River

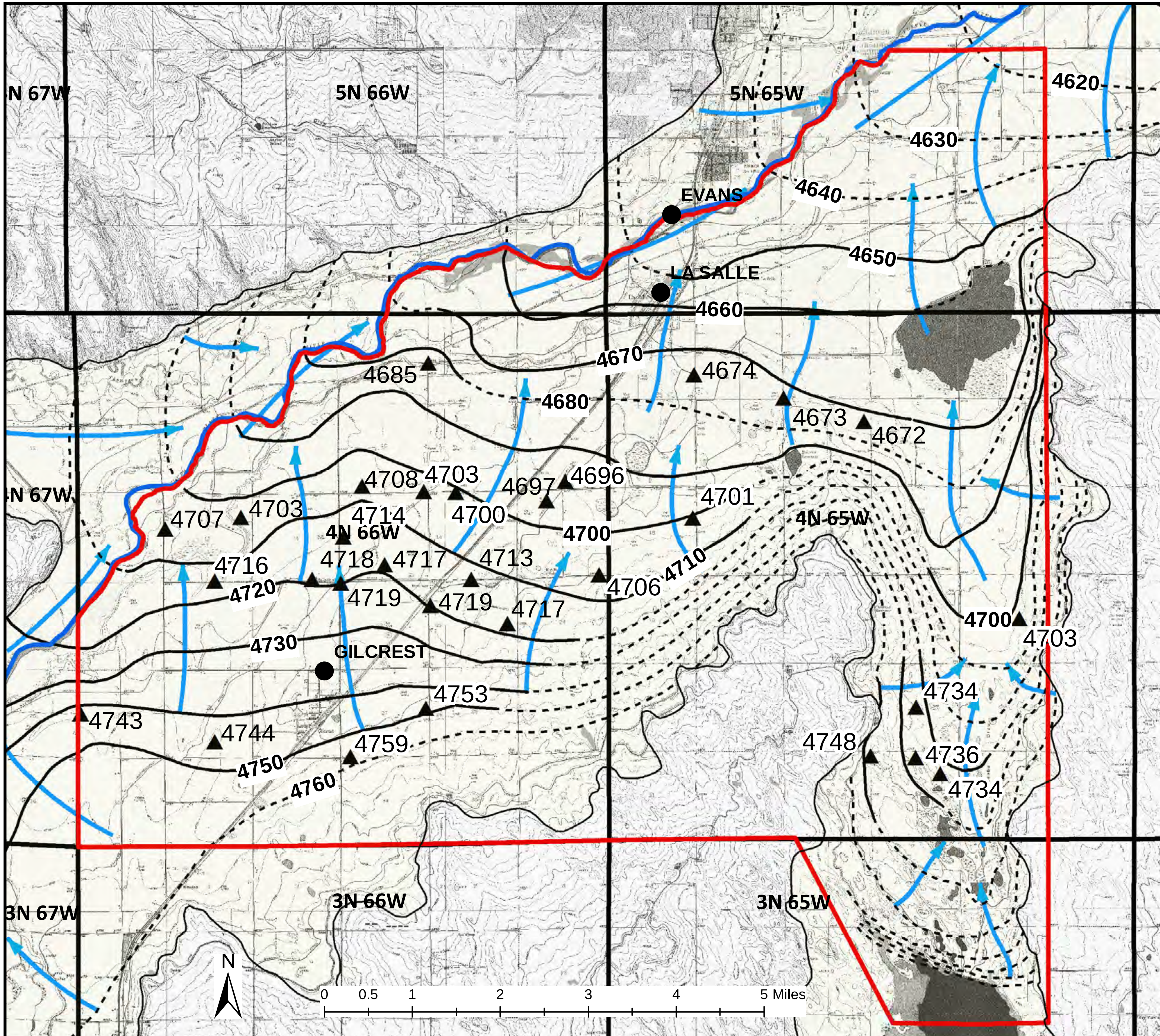
Saturated Thickness (ft.)

- < 25
- 25 - 35
- 35 - 45
- 45 - 55
- 55 - 65
- 65 - 75
- 75 - 85
- 85 - 95
- 95 - 105

Data Source:

Alluvial Aquifer Saturated Thickness
Based on Spring 2012 Water Level Elevations

Figure 9
Alluvial Aquifer Saturated Thickness



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

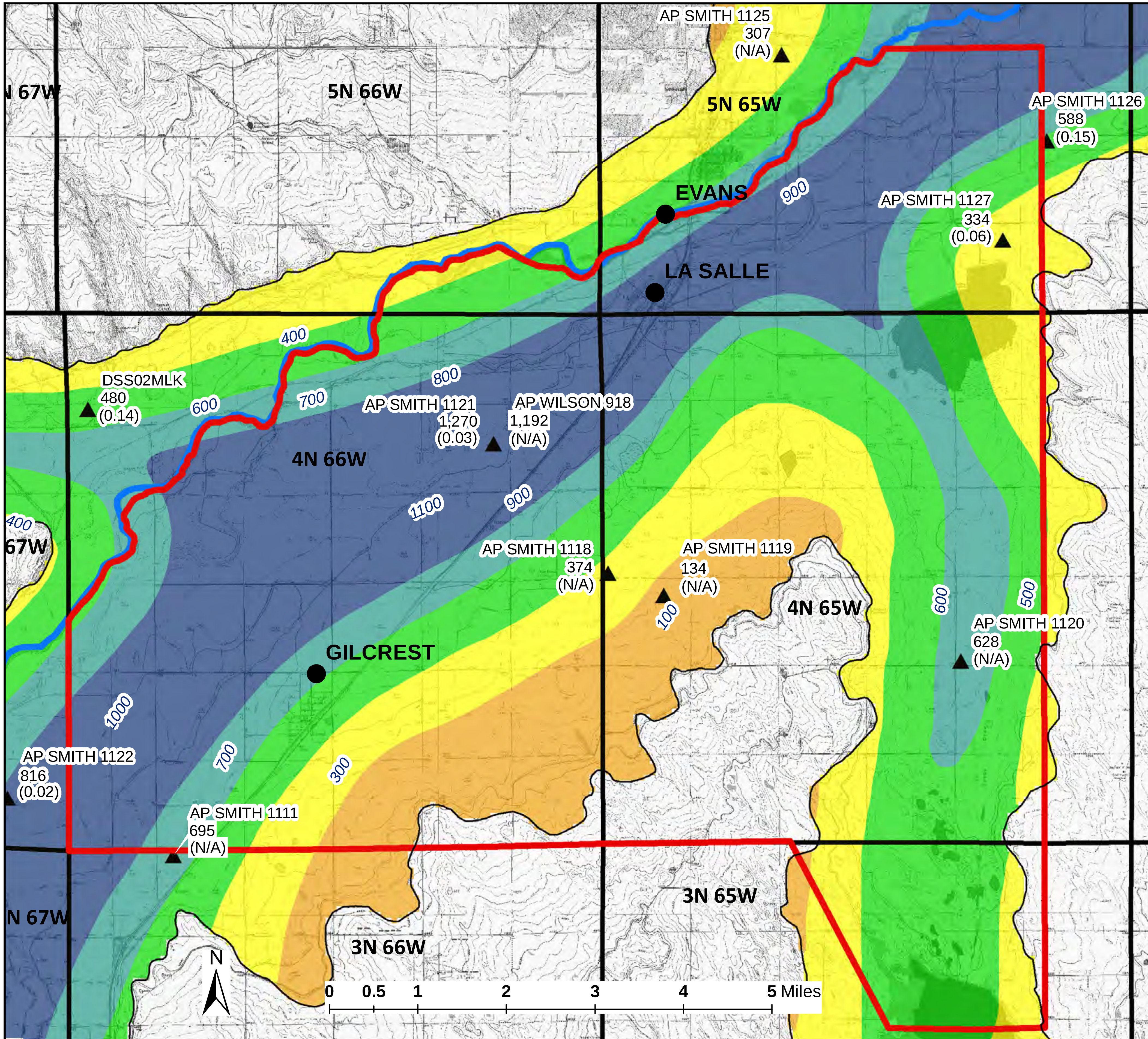
Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River
- Groundwater Flow Direction
- 4701 Well Groundwater Elevation (ft.)

Water Level Elevation Contour (ft.)

- Elevation
- (Dashed Where Inferred)
- 10' Contour Interval

Figure 10
Groundwater Elevation Contour Map
Spring 2012



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Legend

- Study Area Boundary
- CGS Revised Saturated Alluvium
- City
- South Platte River
- AP SMITH 1127 **Aquifer Test ID**
- 334 **Hydraulic Conductivity (ft/d)**
- (0.06) **Specific Yield**

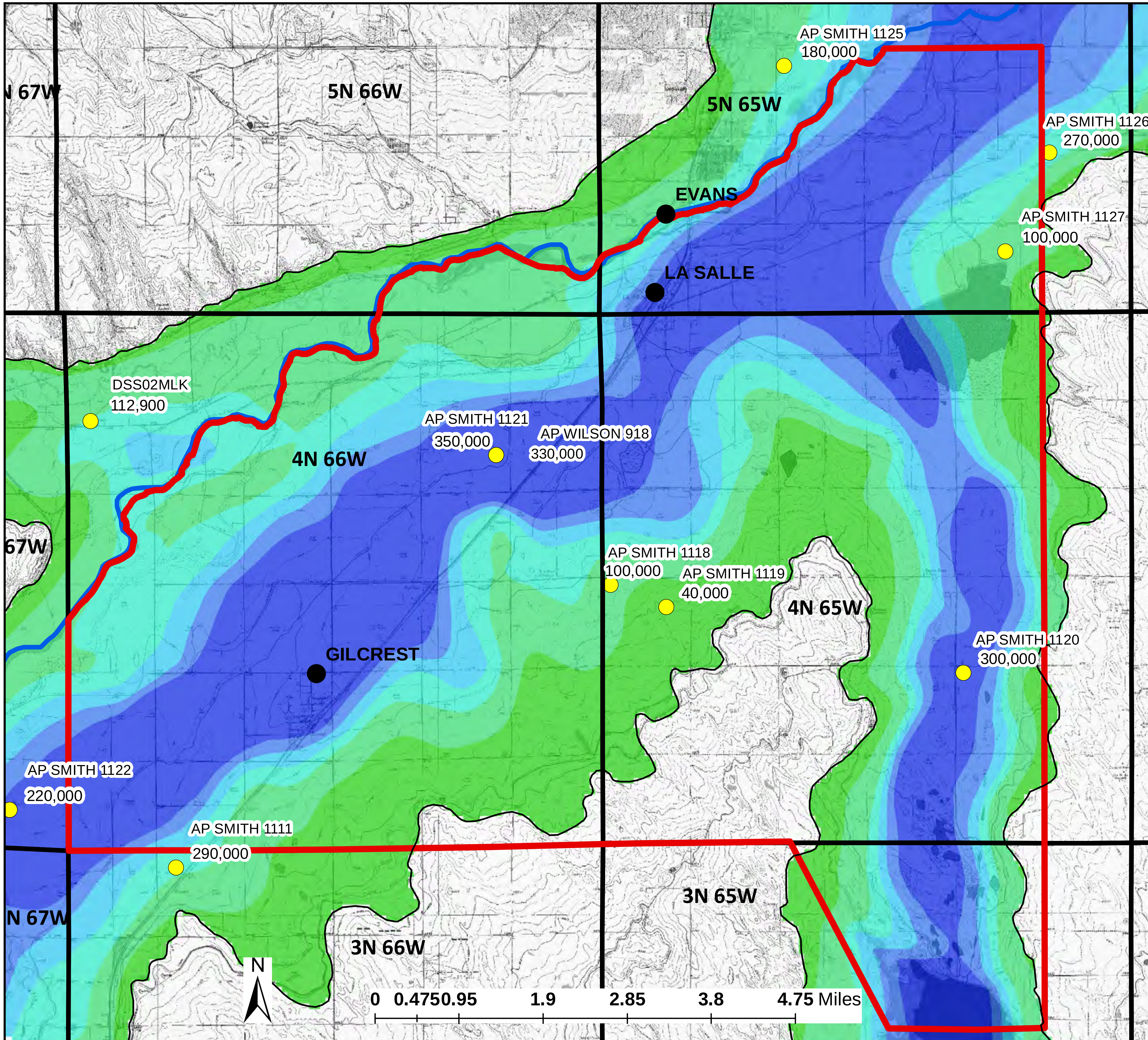
Hydraulic Conductivity Distribution ft/day

- < 200
- 200 - 400
- 400 - 600
- 600 - 800
- > 800

Data Source:

Hydraulic conductivity values from aquifer pumping tests. Data source SPDSS.

Figure 11
Hydraulic Conductivity and Specific Yield Map



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Transmissivity

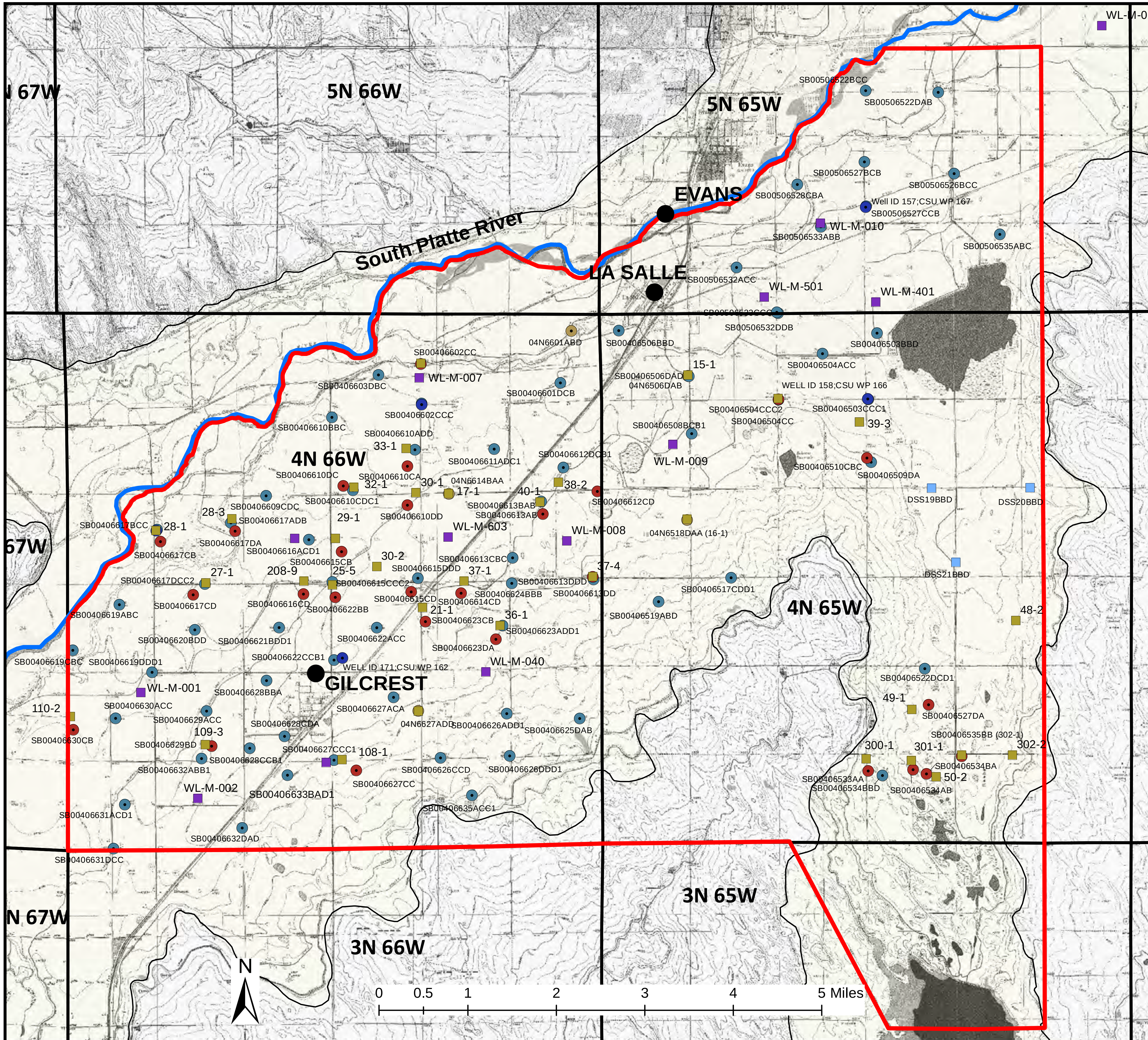
AP SMITH 1127 (Aquifer Test ID)
100,000 (Transmissivity gpd/ft)

Computed Transmissivity (gpd/ft)

- < 50,000
- 50,000 - 150,000
- 150,000 - 200,000
- 200,000 - 250,000
- 250,000 - 300,000
- > 300,000

Transmissivity color map computed as a product of hydraulic conductivty and saturated thickness rasters (converted units from ft^2/d to gpd/ft).

Figure 12 Transmissivity Map



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Wells Used for Contours 2002 - 2013

- CCWCD
- CDA
- SPDSS

Wells with Historical WL Data

- CCWCD
- CSU
- DWR
- USGS

CCWCD-Central Colorado Water Conservancy District
CDA- Colorado Department of Agriculture
CSU- Colorado State University
DWR- Colorado Division of Water Resources
SPDSS- South Platte Decision Support System
USGS- United States Geological Survey

Figure 13
Groundwater Level Monitoring Wells

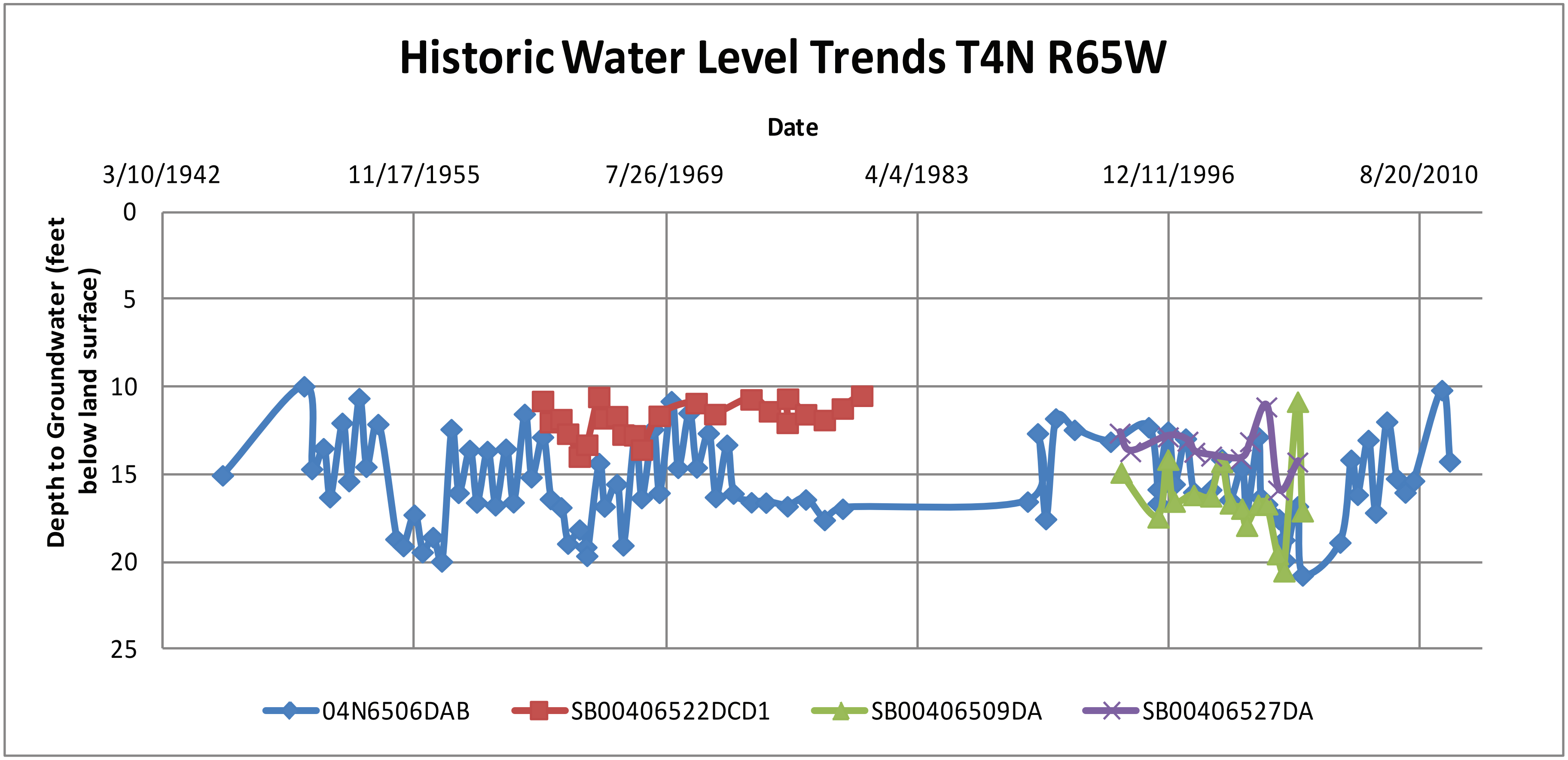
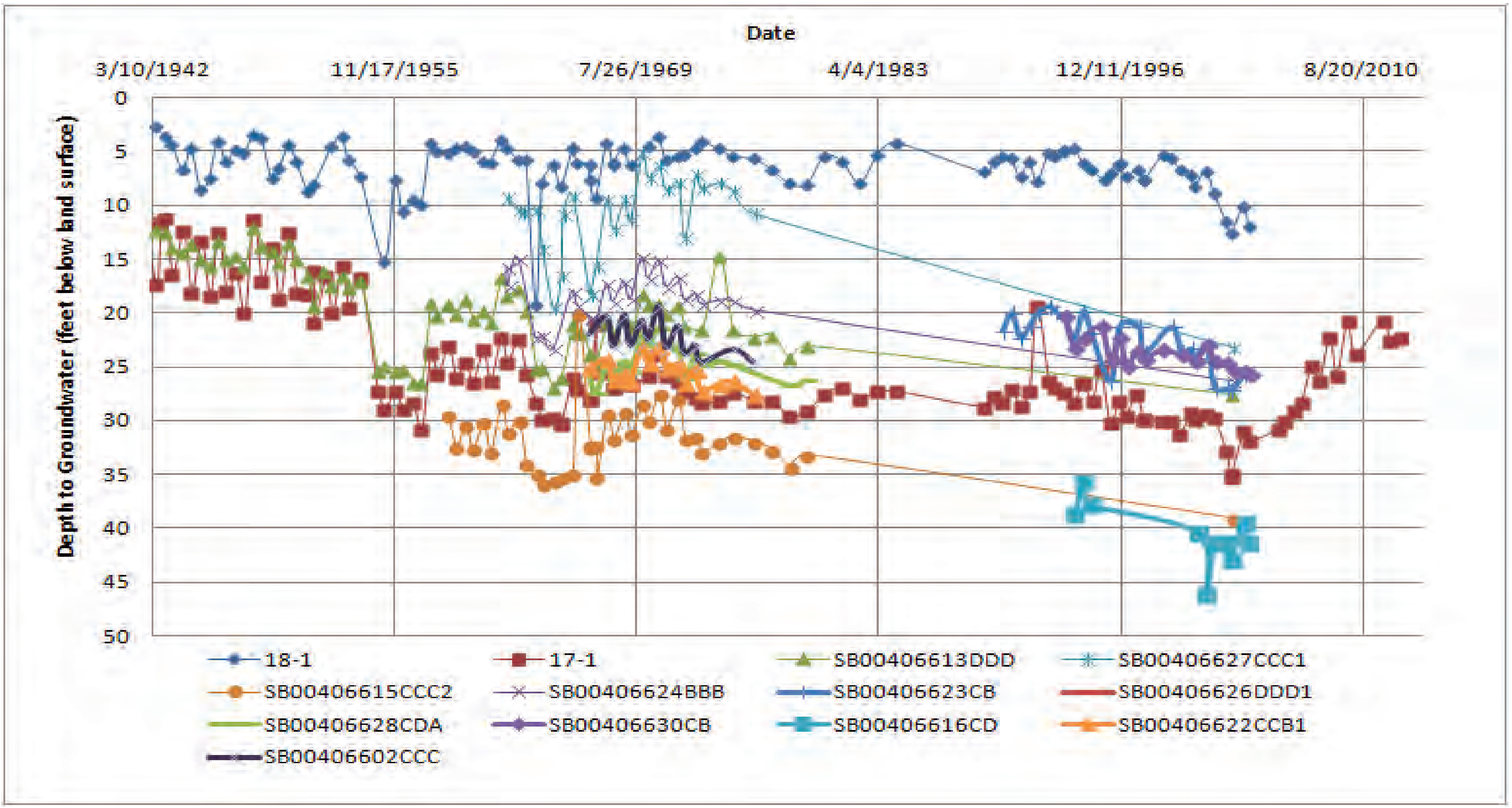


Figure 14
Groundwater Level Trends for T4N R65W

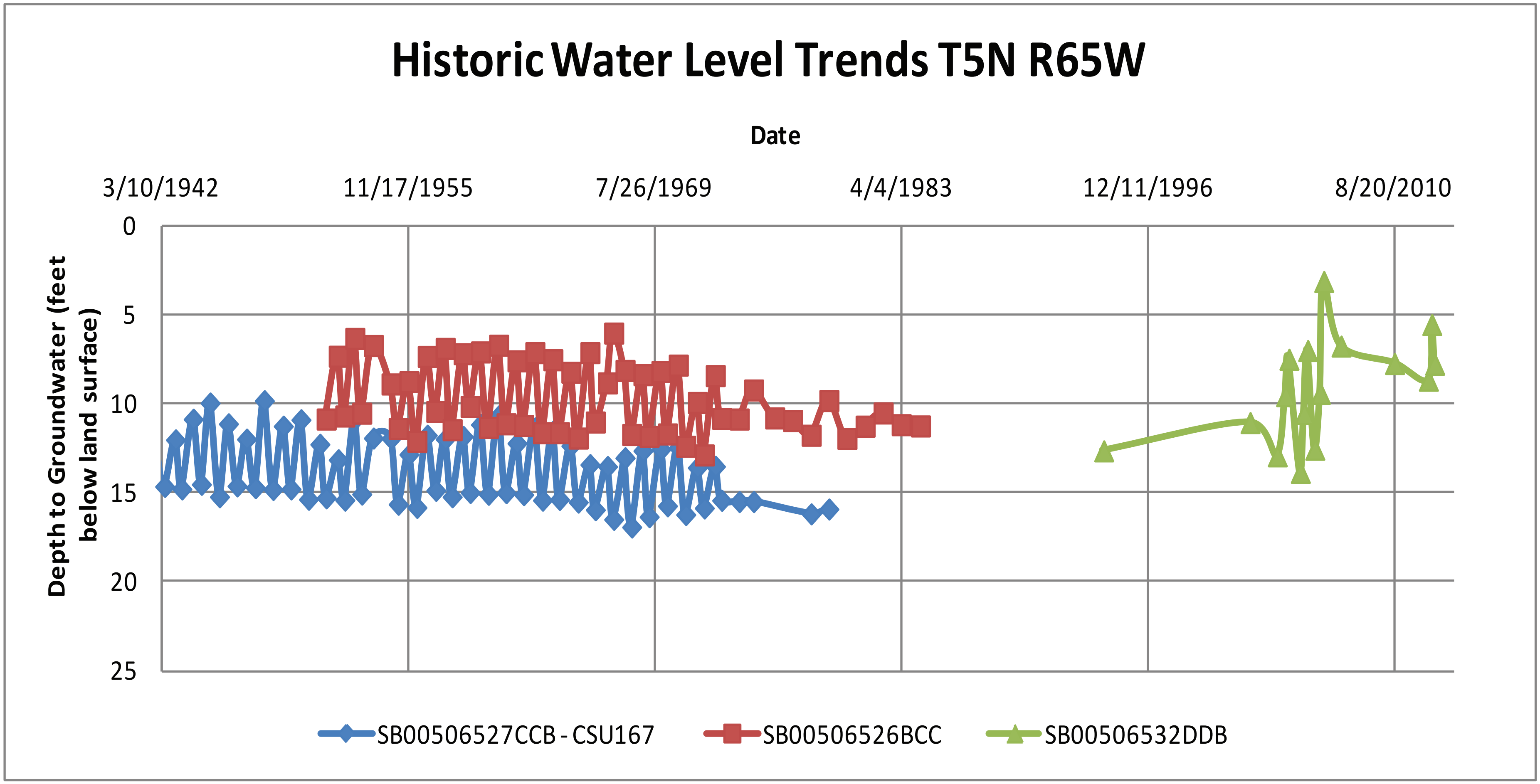
Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Historic Water Level Trends T4N R66W



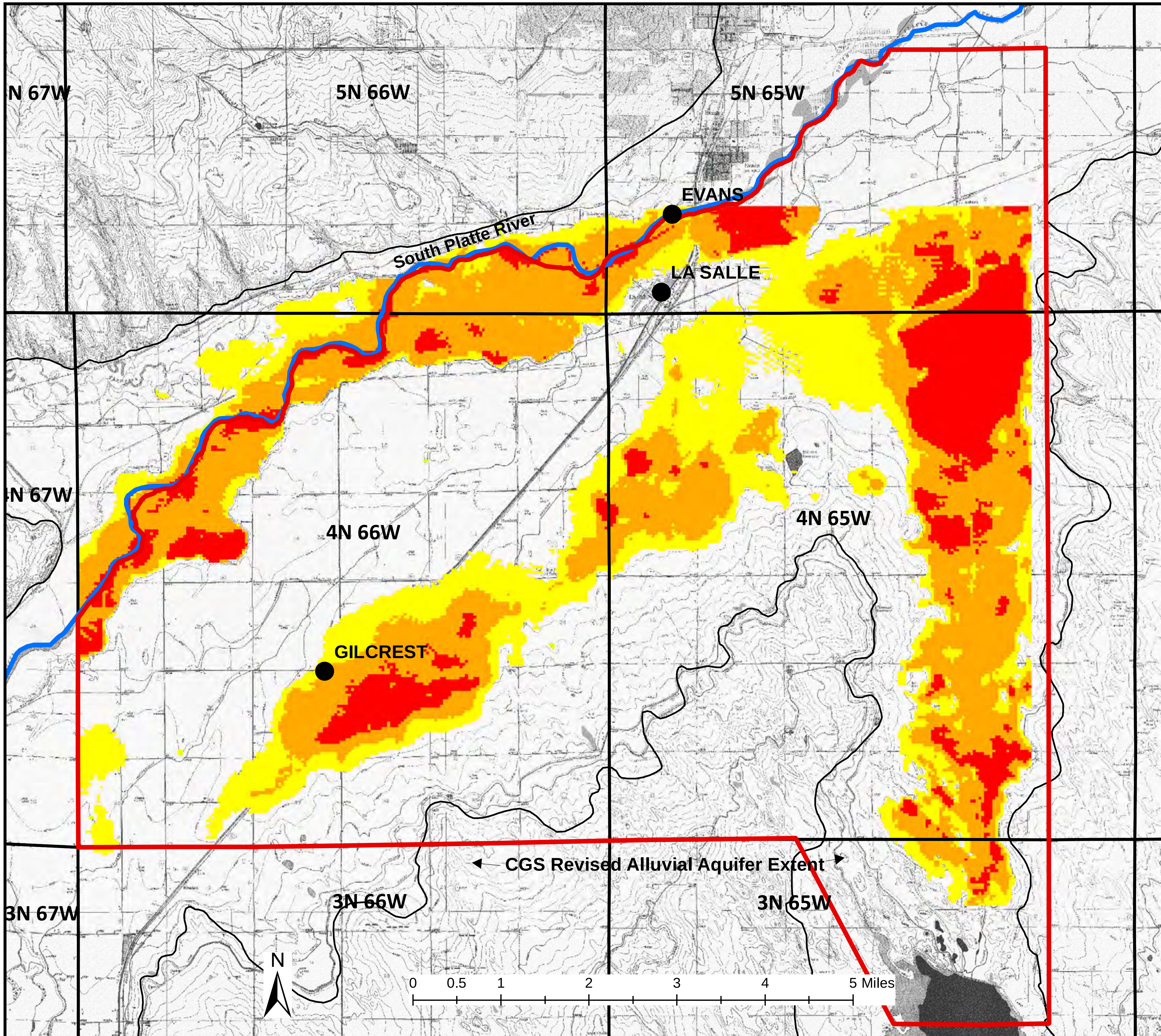
Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Figure 15
Groundwater Level Trends for T4N R66W



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Figure 16
Groundwater Level Trends for T5N R65W



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

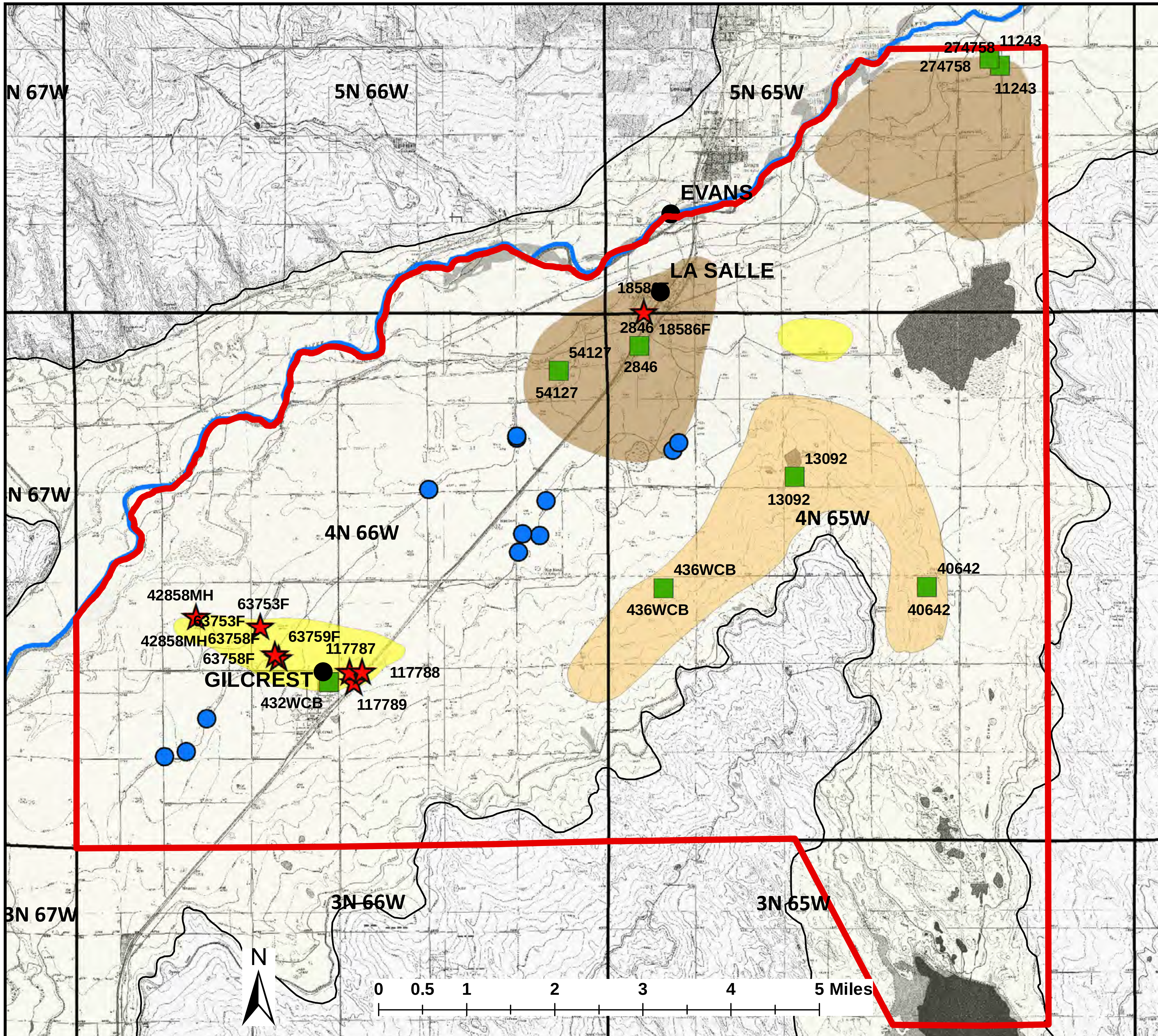
Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Depth to Groundwater
feet below ground surface

- < 5
- 5 - 10
- 10 - 15
- > 15

Figure 17
Depth to Groundwater Map for Spring 2012



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Legend

- Study Area boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Monitoring Candidate Wells

By use

- Stock
- Other

Aquifer Test Candidate Wells

- Candidate Well

Water Level Monitoring Area Ranking

- First Rank
- Second Rank
- Third Rank

Figure 18
Areas for Additional Aquifer Data and Groundwater Level Monitoring

APPENDICES

Appendix A
Gilcrest/LaSalle Pilot Project Scope of Work

Gilcrest/LaSalle Groundwater Investigation Pilot Project
Hydrogeologic Characterization Report

Gilcrest/LaSalle Pilot Project Scope of Work

NOTE: CGS Hydrogeologic Characterization tasks presented in **large bold font**):

Tasks

1. Acquire existing water level data and identify wells suited for monitoring

a. Compile water level data acquired by others

b. Identify existing alluvial wells that could be monitored and instrumented

2. Identify water level data gaps both in time and location

3. Formulate and implement a water level monitoring plan (min. 2 years)

4. Compile existing aquifer properties data and conduct new pump tests

5. Characterize the hydrogeology of the alluvial aquifer in the study area

6. Monitor and record South Platte stream flow, ditch and canal diversions, and diversion to recharge ponds

7. Monitor and record groundwater withdrawals by large-capacity wells.

8. Compile local climate data

9. Compile and analyze decreed augmentation plans within study area.

10. Integrate datasets, produce GIS coverages and maps and identify causal relationships.

11. Produce a report of findings and recommendations.

Source: Topper, R., 2013. CWCB/DWR Gilcrest/La Salle Groundwater Investigation. Initial Presentation by Ralf Topper, CPG, on January 24, 2013. Downloaded 3/6/14 from: http://water.state.co.us/DivisionsOffices/Div1SPlatteRiverBasin/Pages/GilcrestLaSalleGroundwaterPilotProject.aspx

APPENDICES

Appendices B ï F, Provided digitally on DVD in Pocket

Appendix B
GIS Data (On DVD)

ArcGIS Geodatabase Sets
ArcGIS Map Projects
Lithologic Database

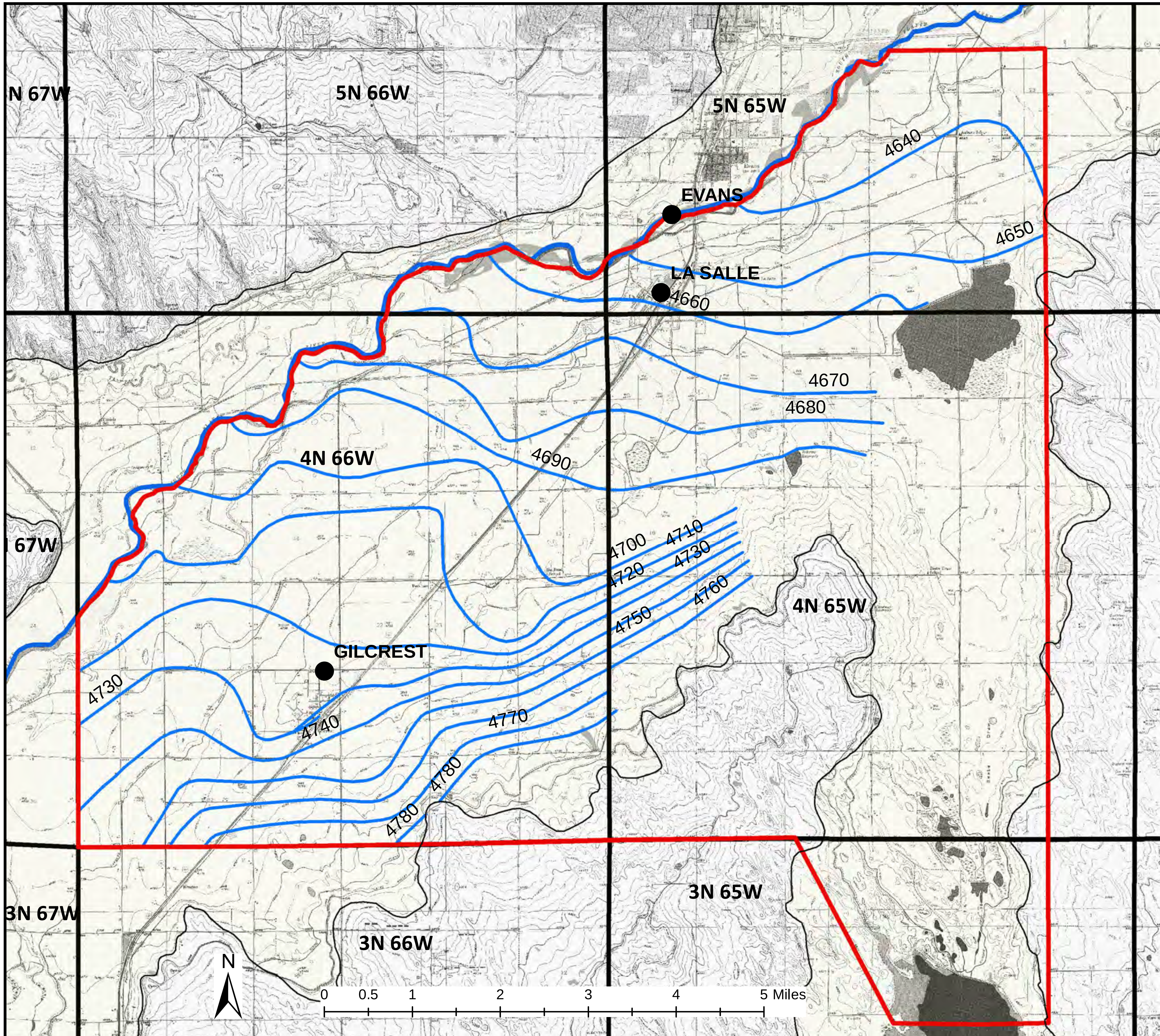
Appendix C
Time-Series Historic Groundwater Elevation Contour Maps

Gilcrest/LaSalle Groundwater Investigation Pilot Project
Hydrogeologic Characterization Report

(Note: this appendix provided in digital format only, these maps were originally provided to DWR with Task 1 and 2 Deliverable, June 2013)

Time-Series Groundwater Elevation Contour Map Notes

- Elevations based on well site ground surface elevation minus depth to water
- Spatial and temporal data are limited for some time periods mapped
- Data averaged for ‘annual’ groundwater levels vs. determining
  ‘spring and fall’ from mixed data.
- Note that Spring and Fall trends are not clear in data
  until 2008 and variation is generally less than 5 ft.



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

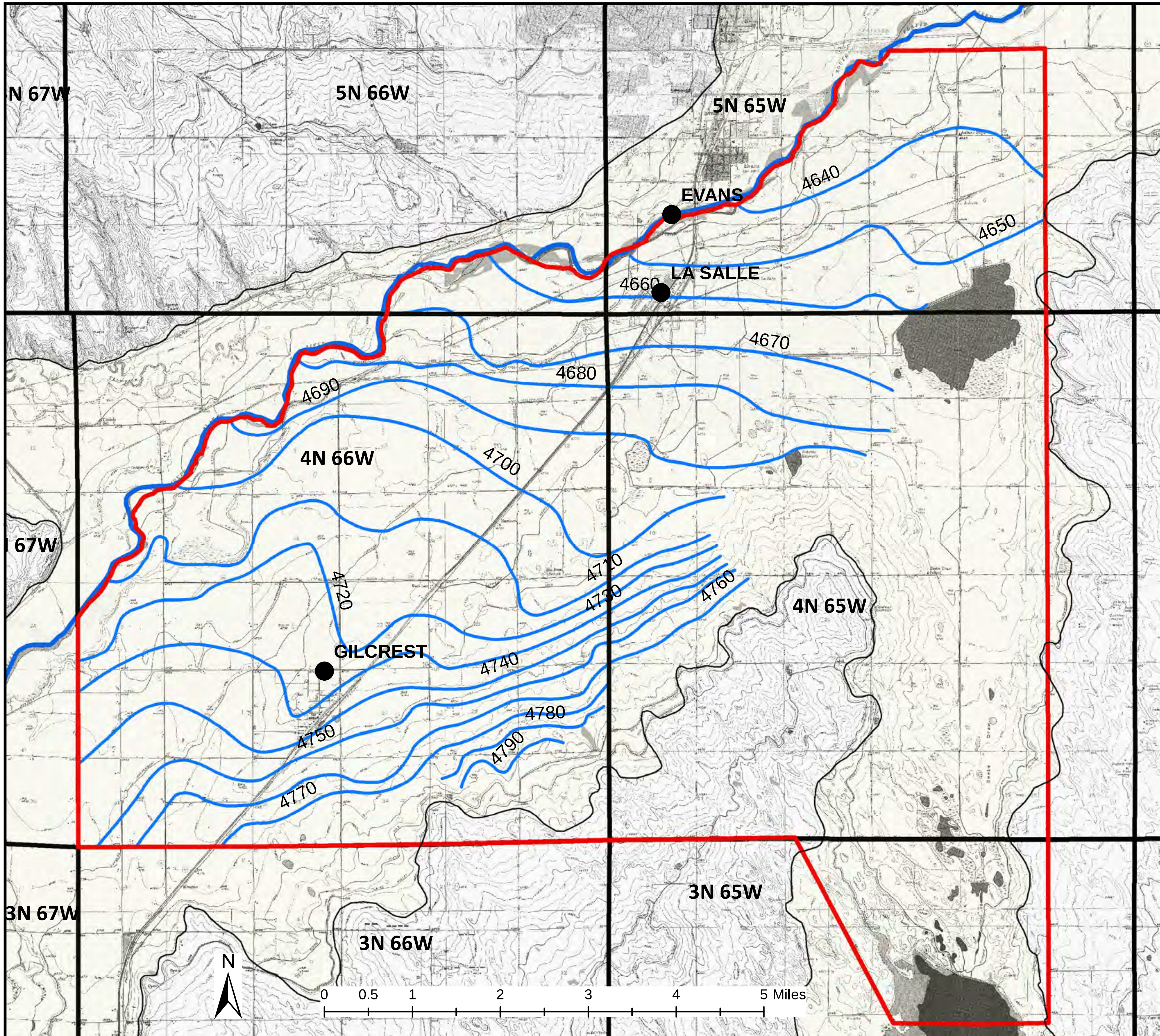
Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval

1967 Spring

Appendix C
Time-Series Historic
Groundwater Elevation Contour Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

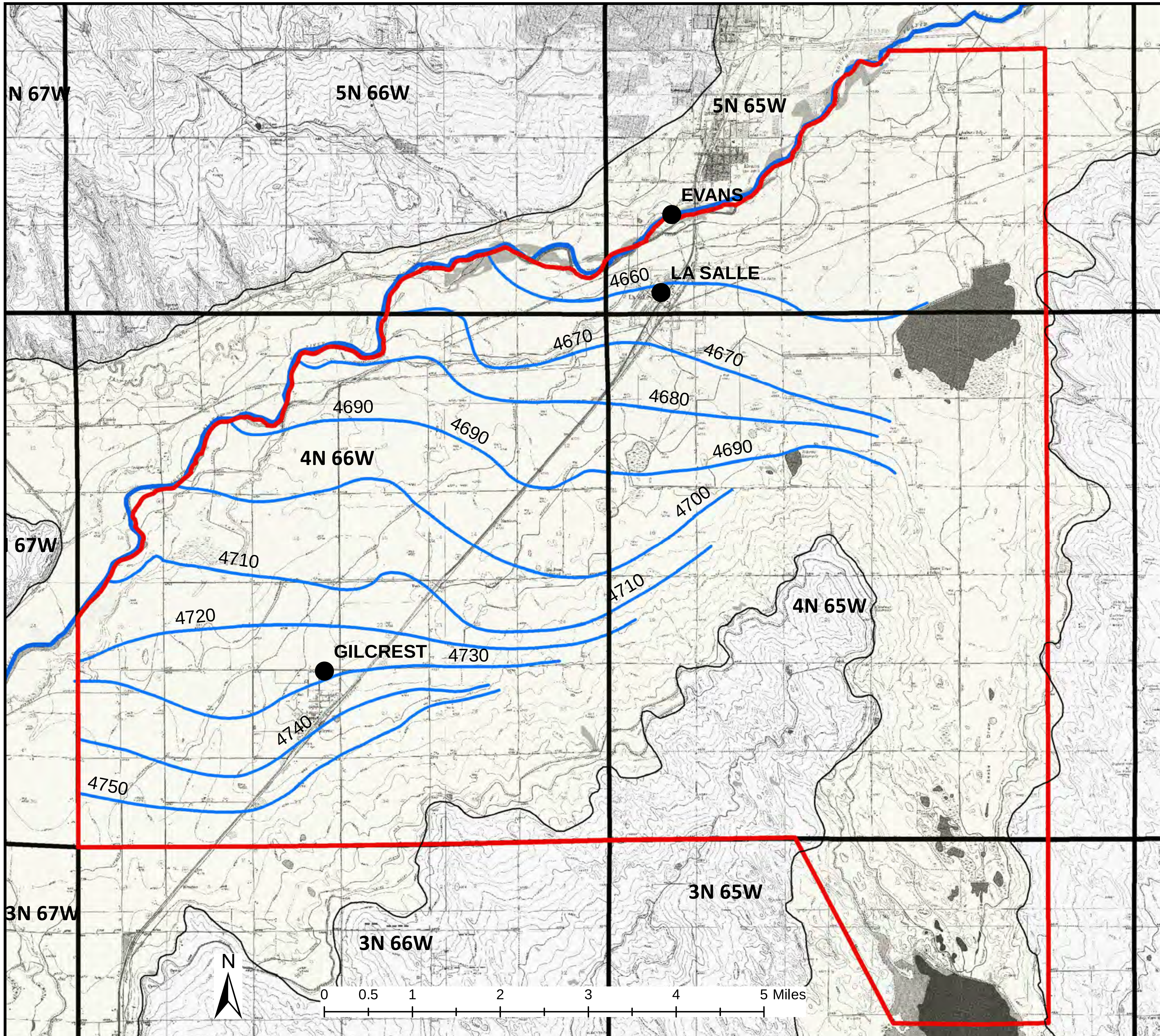
Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval

1970 Fall

Appendix C
Time-Series Historic
Groundwater Elevation Contour Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

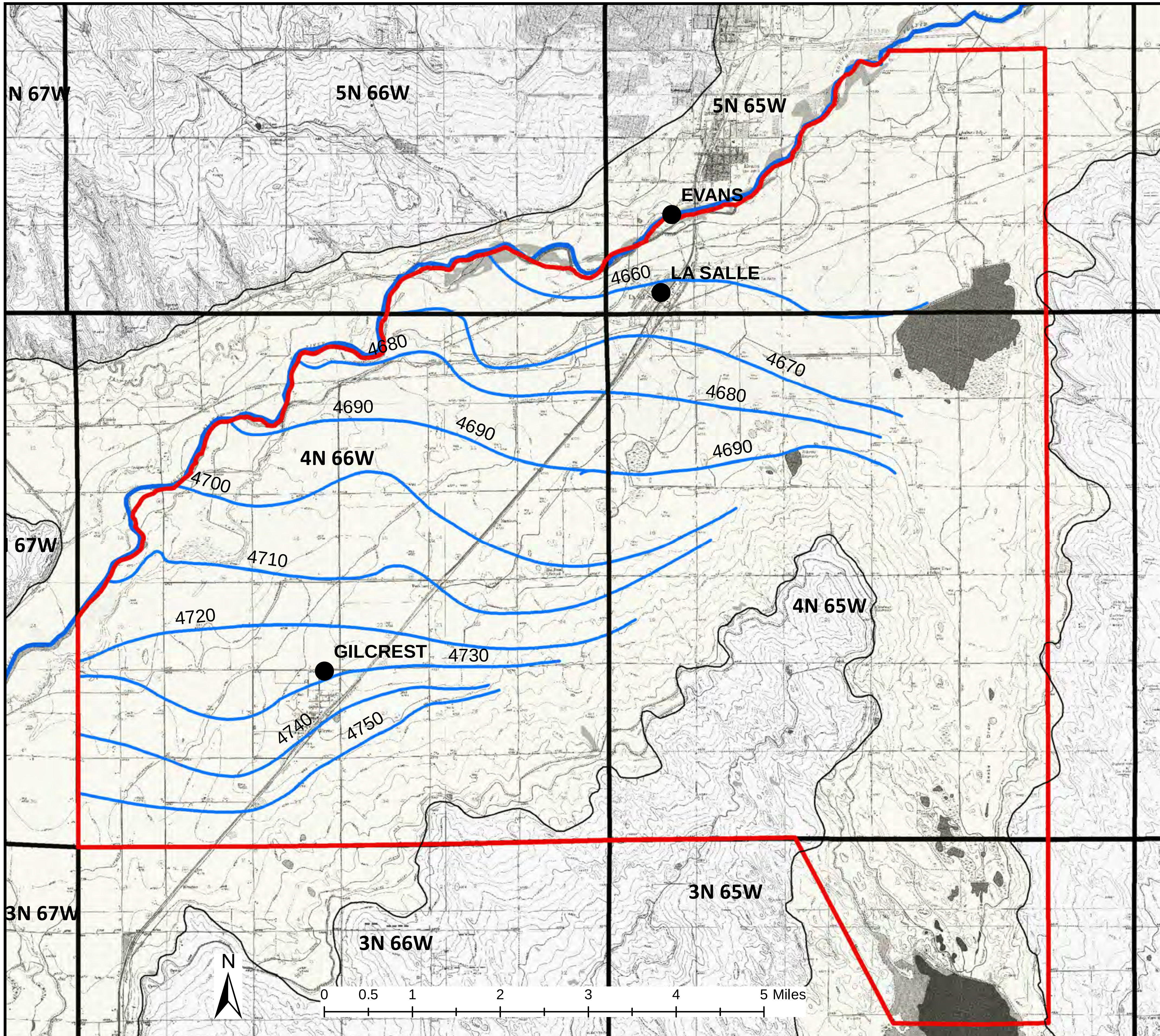
Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval

- 1997 Spring

Appendix C
Time-Series Historic
Groundwater Elevation Contour Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Legend

Study Area Boundary

CGS Revised Alluvial Aquifer Extent

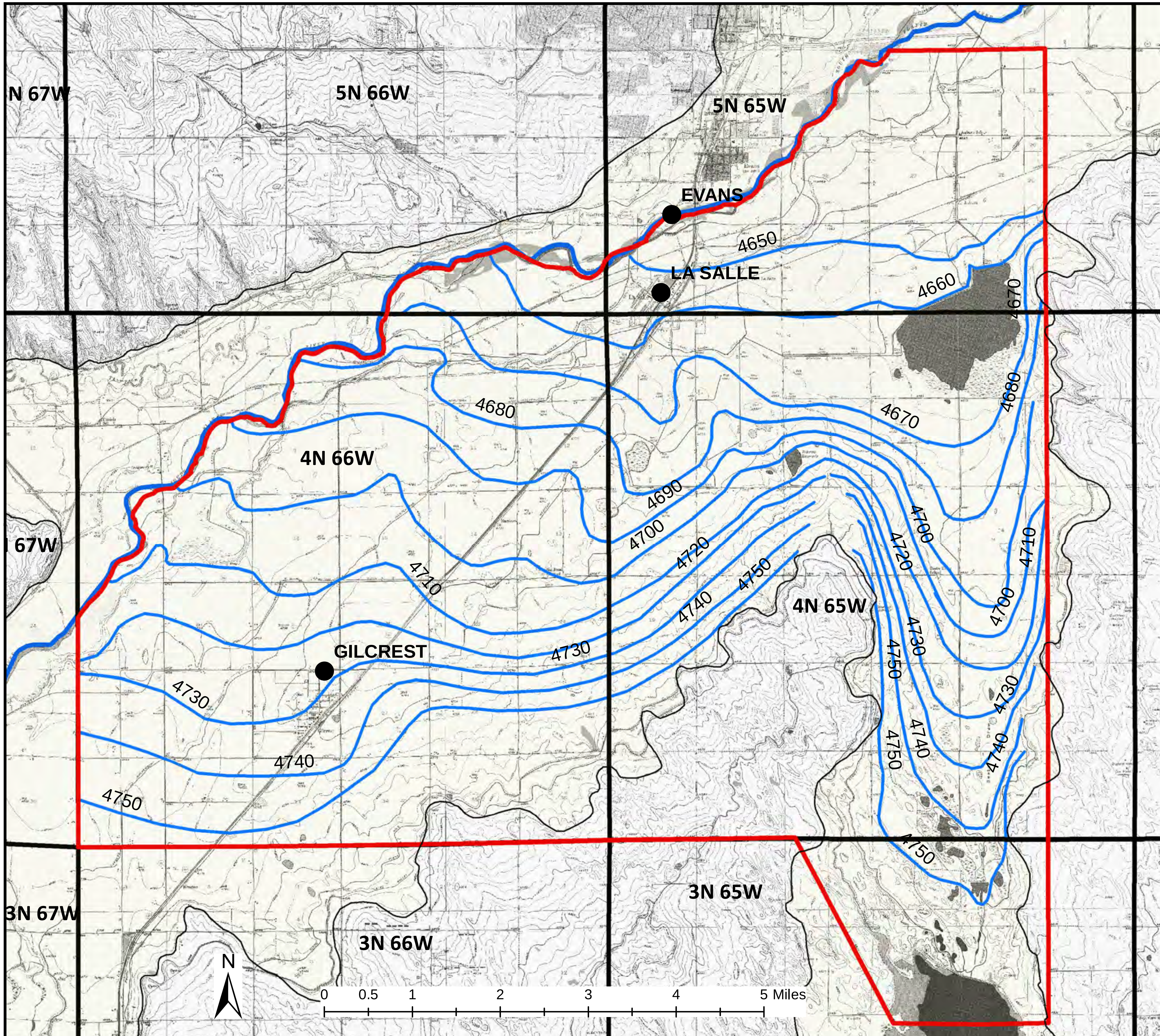
City

South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval

1997 Fall

Appendix C
Time-Series Historic
Groundwater Elevation Contour Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

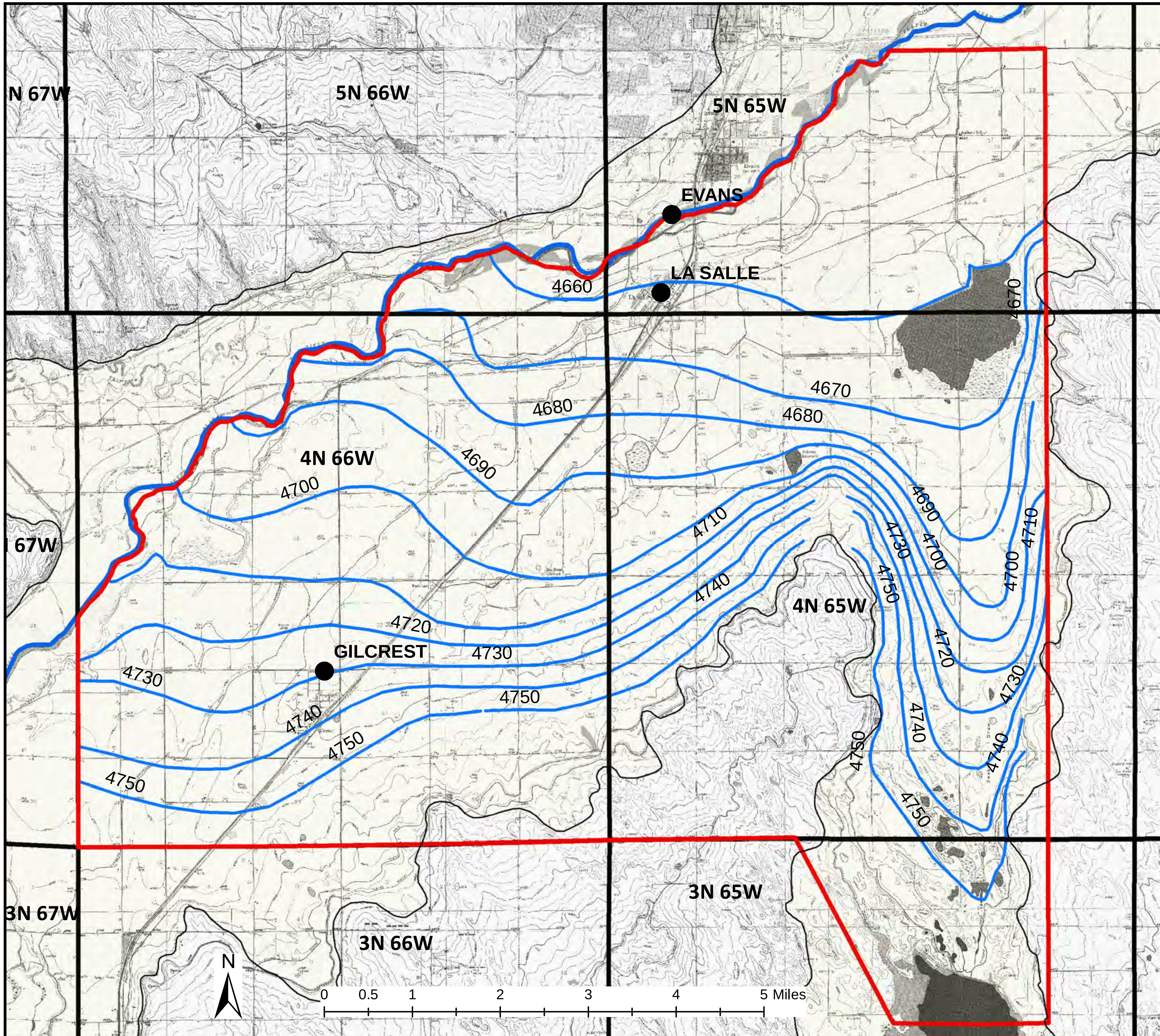
Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval

2001

Appendix C
Time-Series Historic
Groundwater Elevation Contour Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

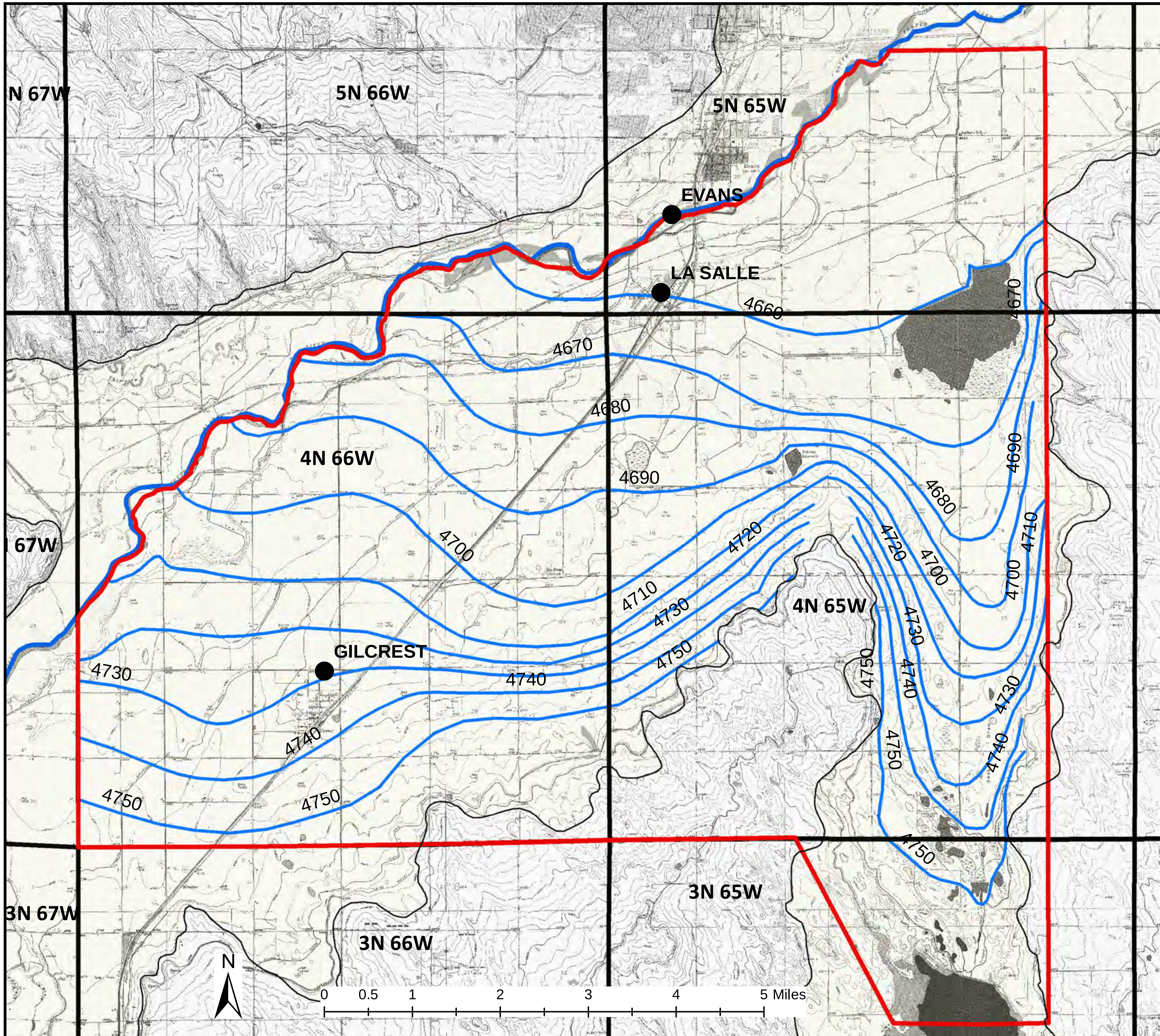
Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval

- 2002 Spring

Appendix C
Time-Series Historic
Groundwater Elevation Contour Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

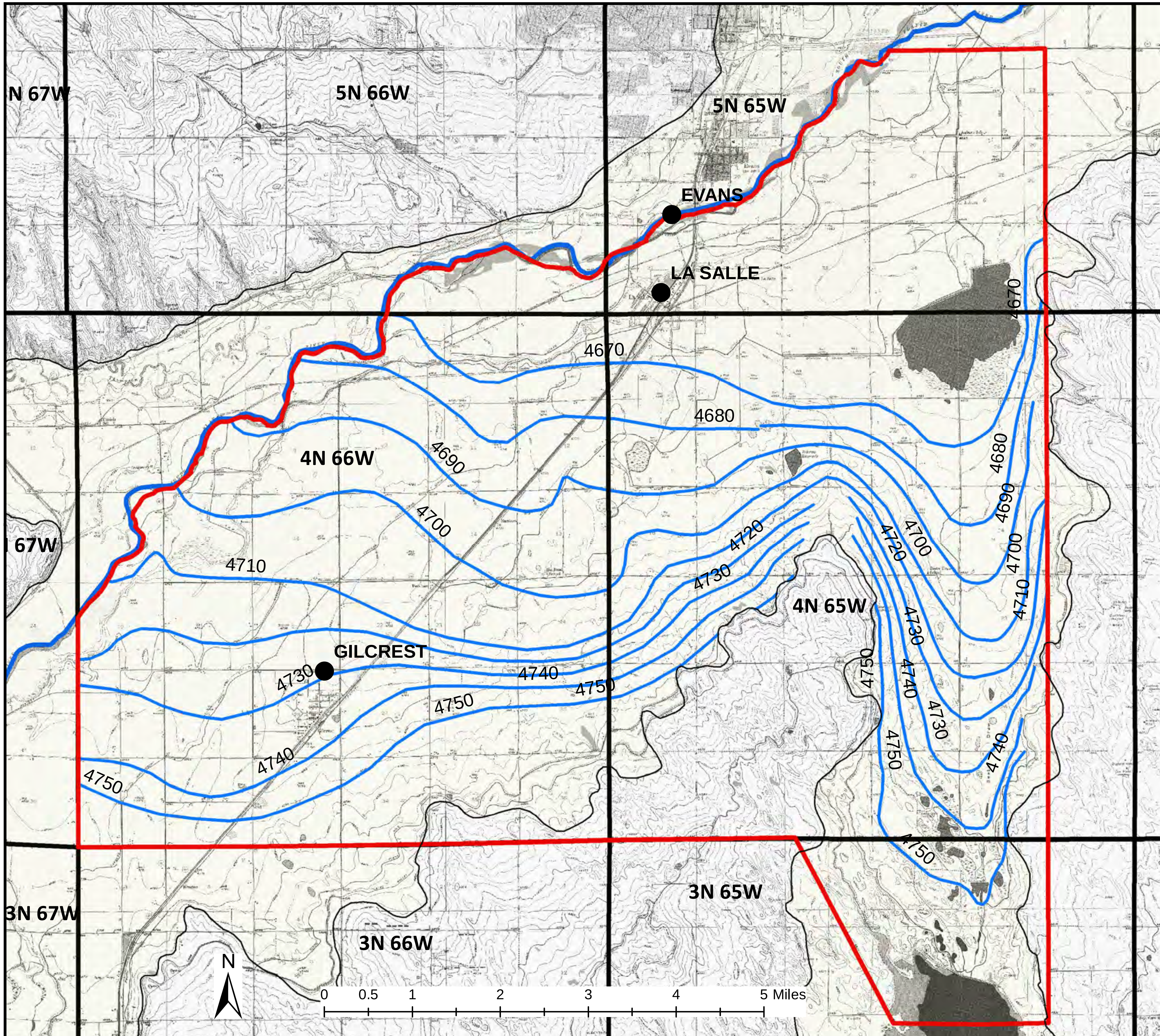
Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval

2002 Fall

Appendix C
Time-Series Historic
Groundwater Elevation Contour Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Legend

Study Area Boundary

CGS Revised Alluvial Aquifer Extent

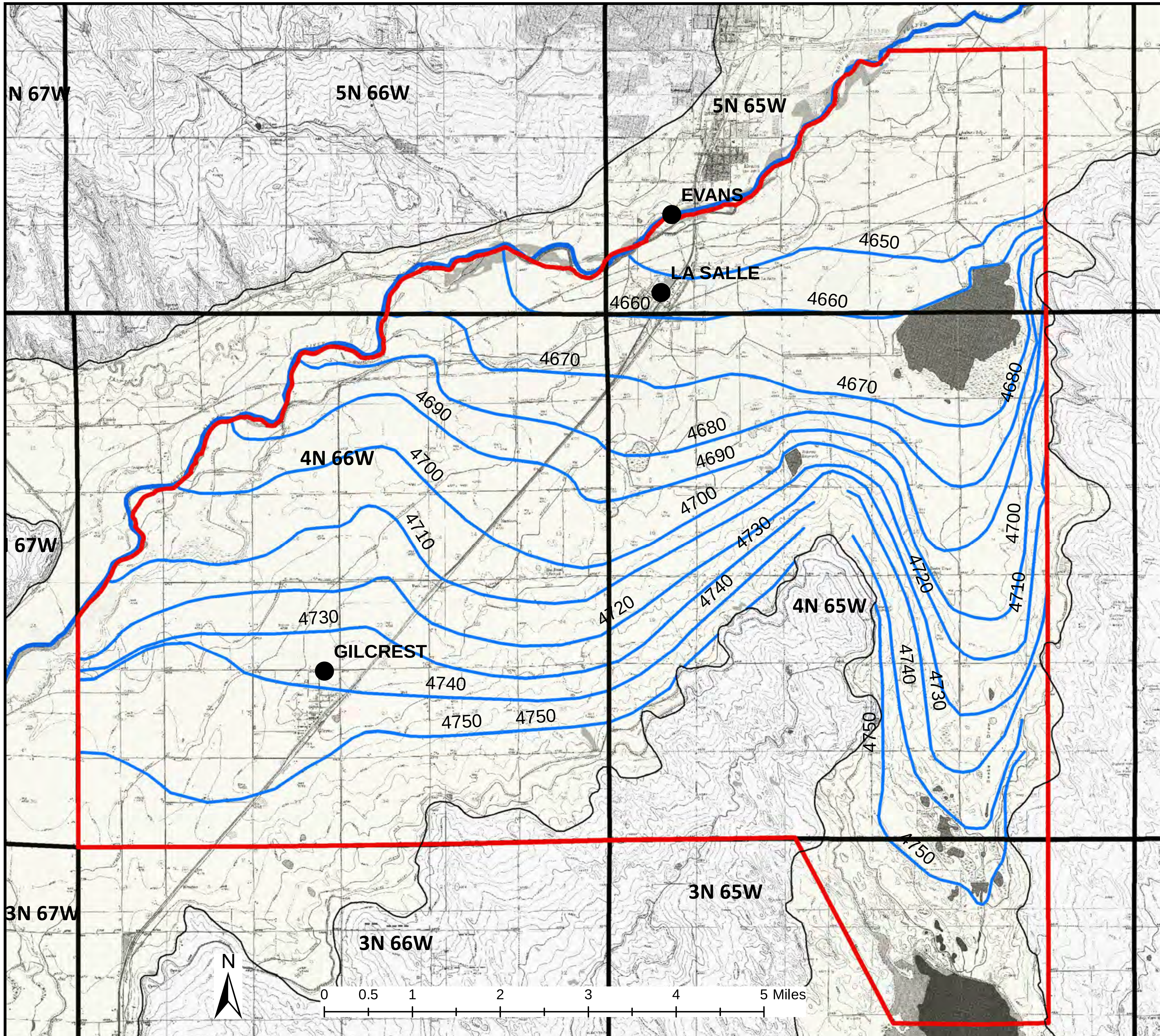
City

South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval

2003

Appendix C
Time-Series Historic
Groundwater Elevation Contour Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

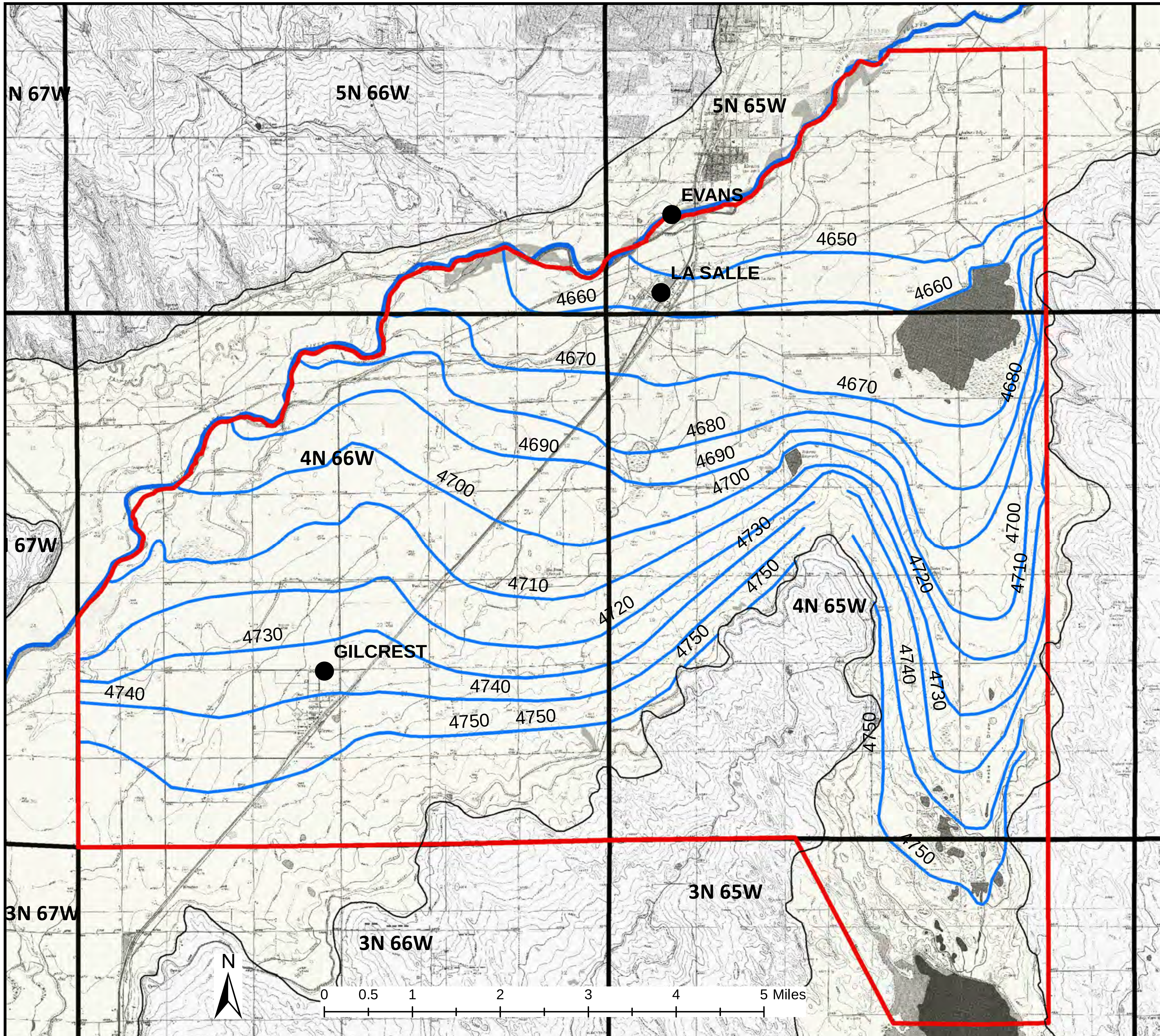
Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval

- 2007

Appendix C
Time-Series Historic
Groundwater Elevation Contour Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

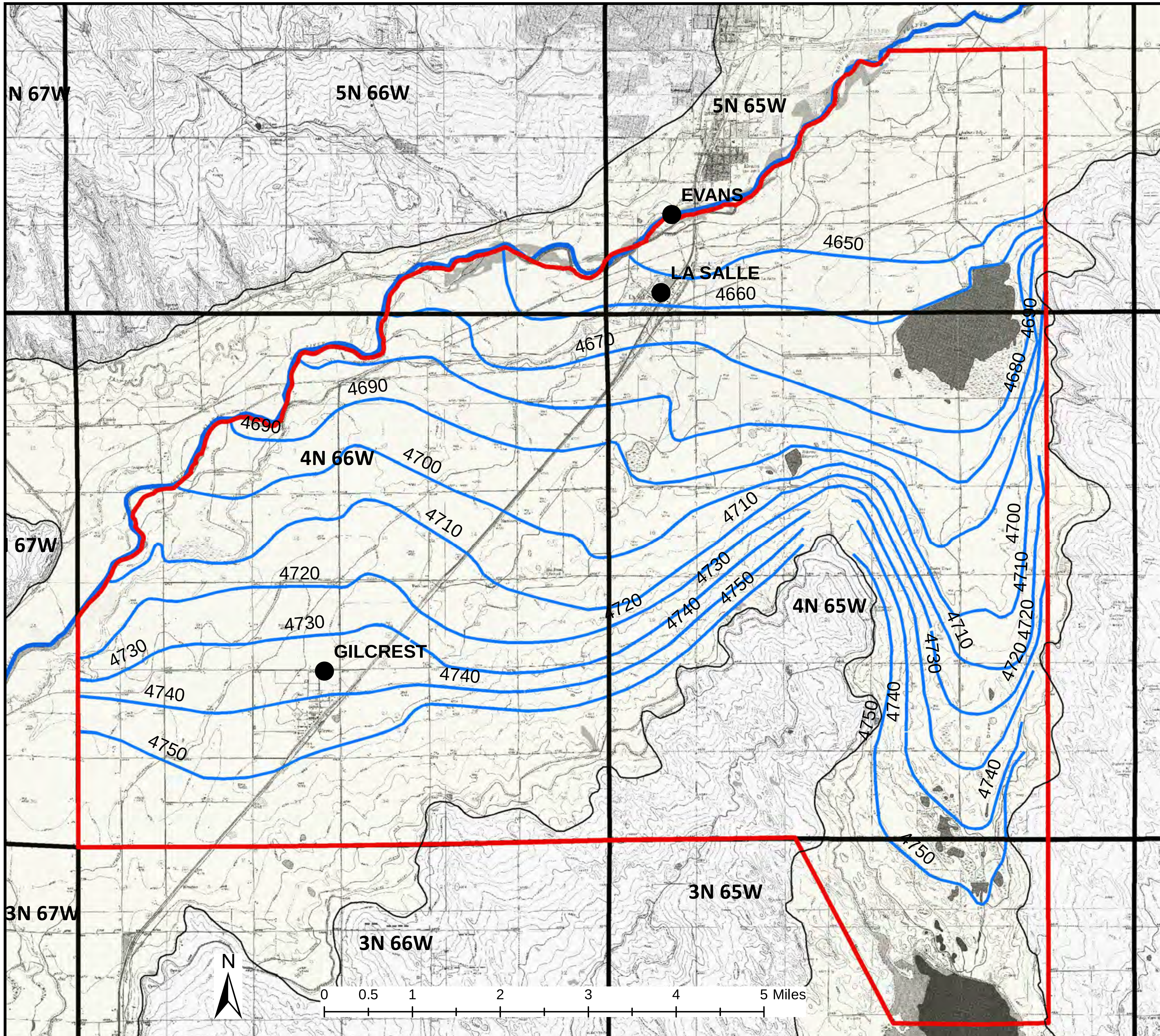
Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval

2008

Appendix C
Time-Series Historic
Groundwater Elevation Contour Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

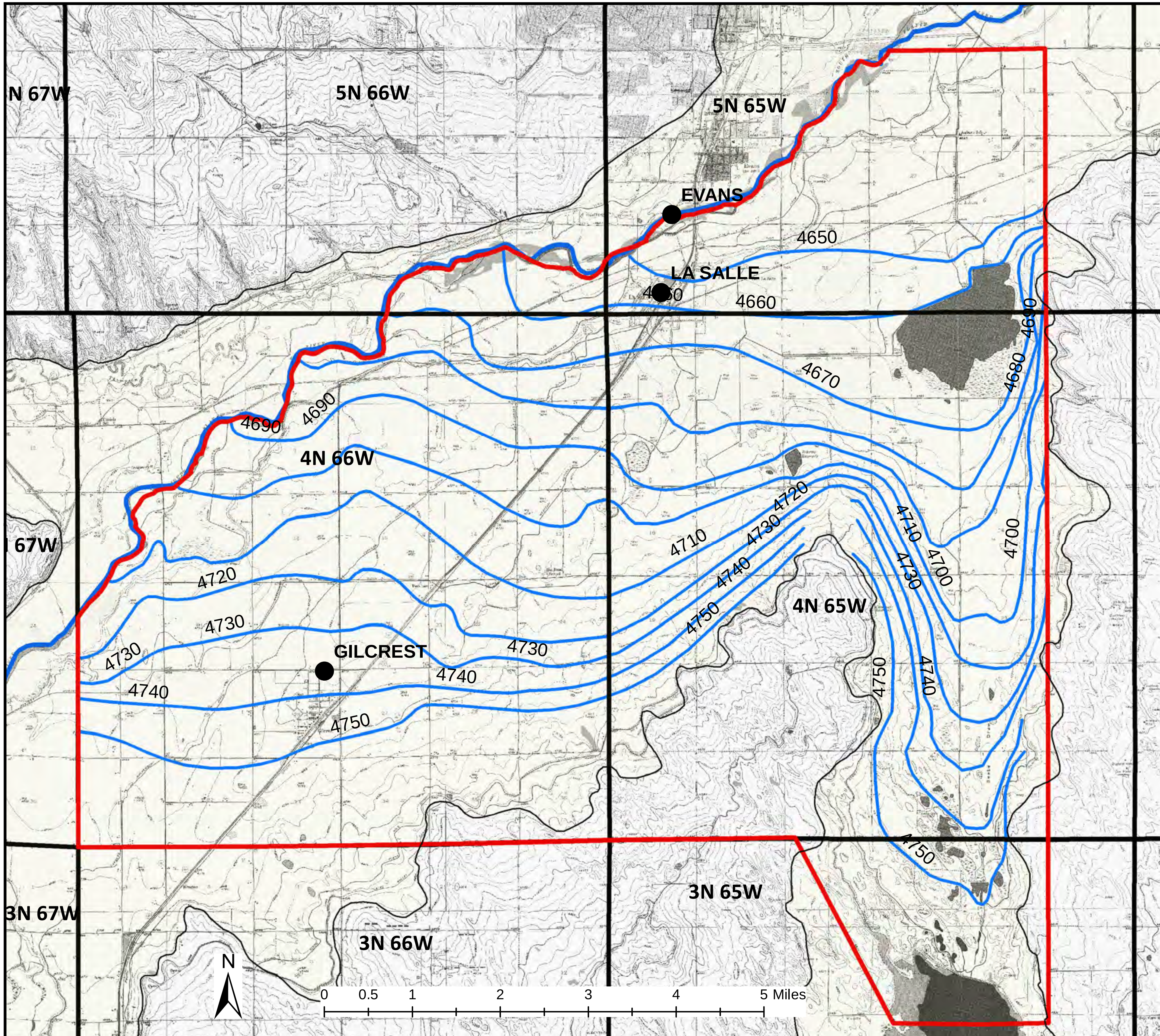
Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval

2009

Appendix C
Time-Series Historic
Groundwater Elevation Contour Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

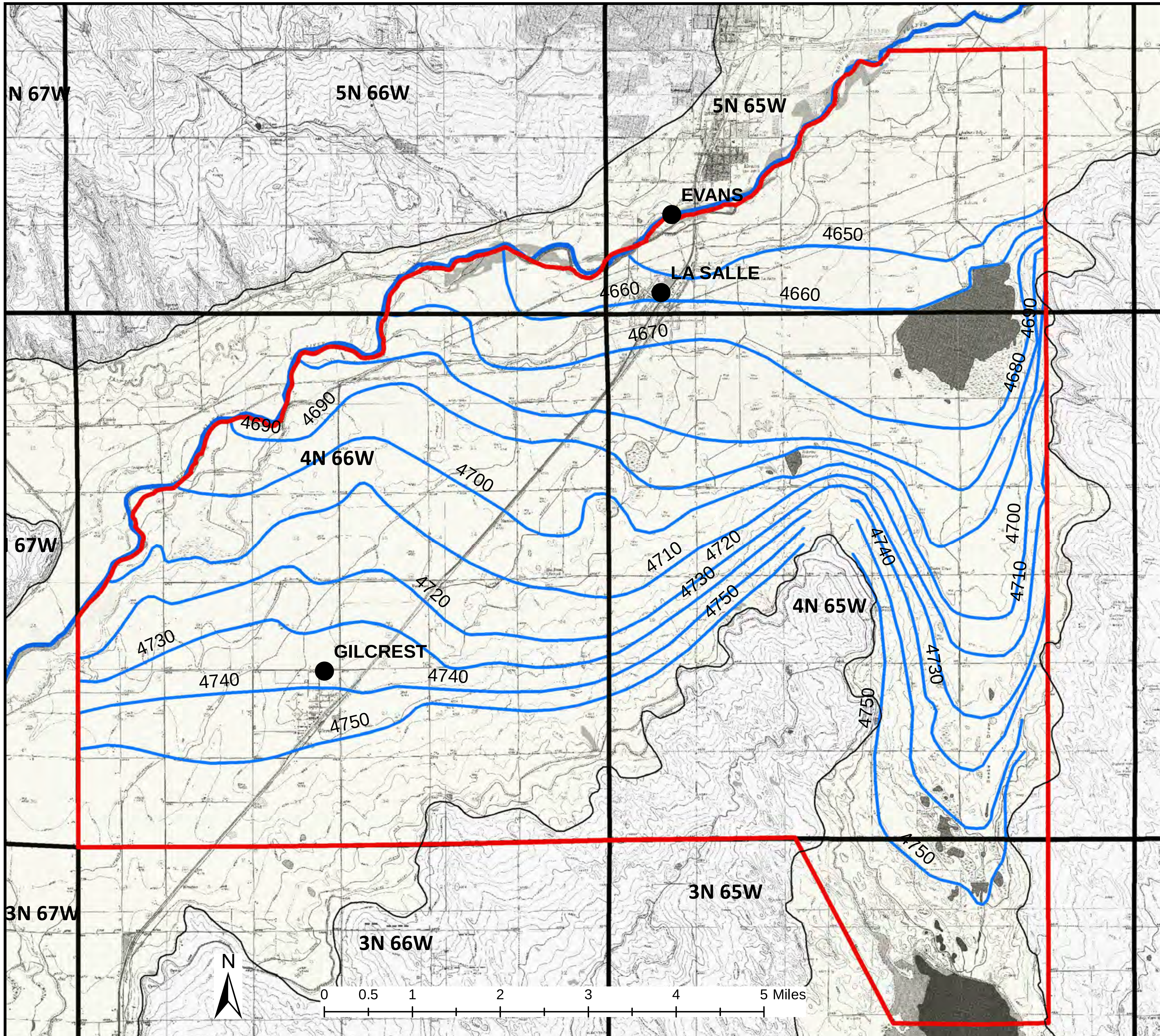
Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval

- **2010**

Appendix C
Time-Series Historic Groundwater Elevation Contour Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

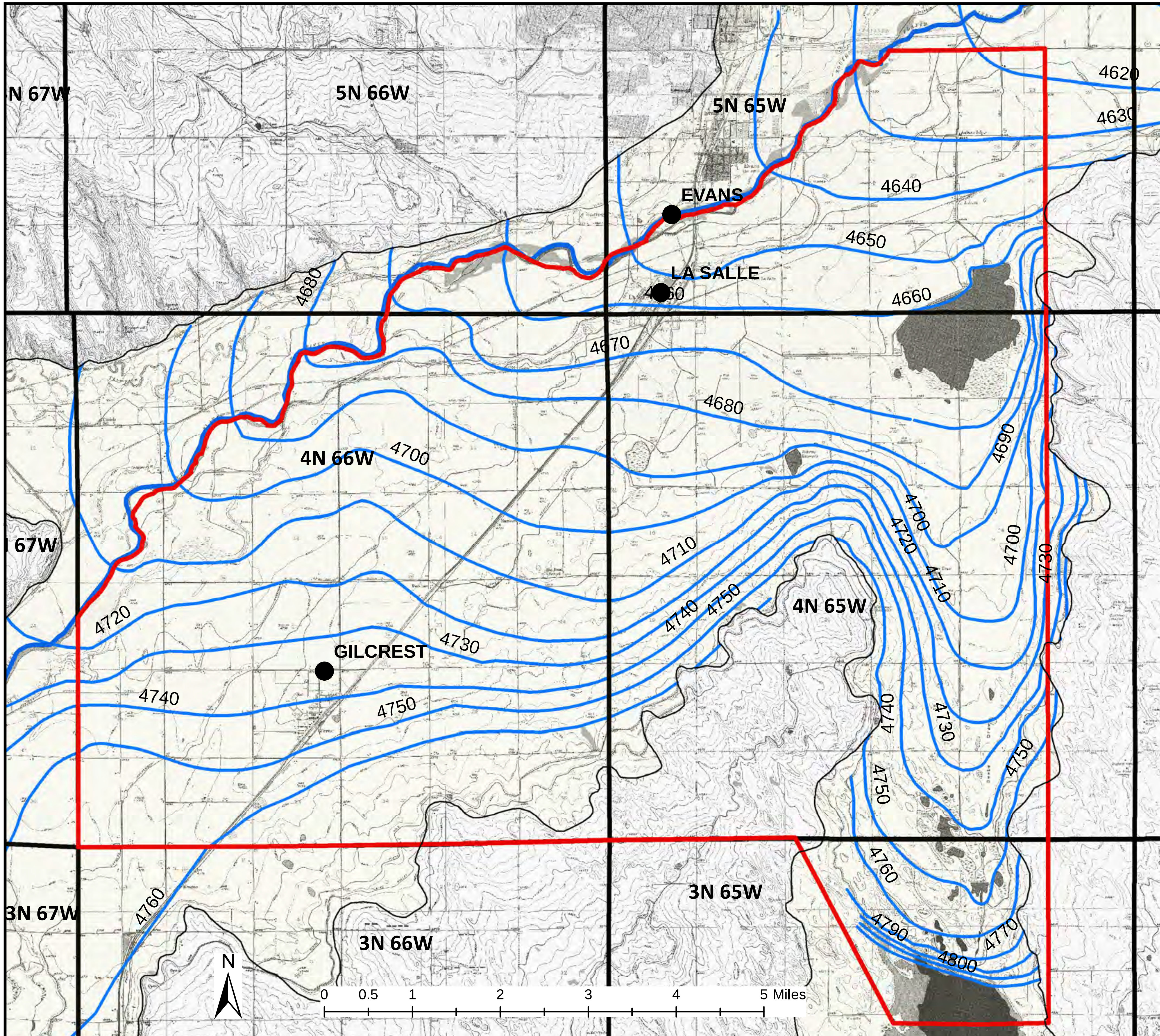
Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval

2011

Appendix C
Time-Series Historic
Groundwater Elevation Contour Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Legend

Study Area Boundary

CGS Revised Alluvial Aquifer Extent

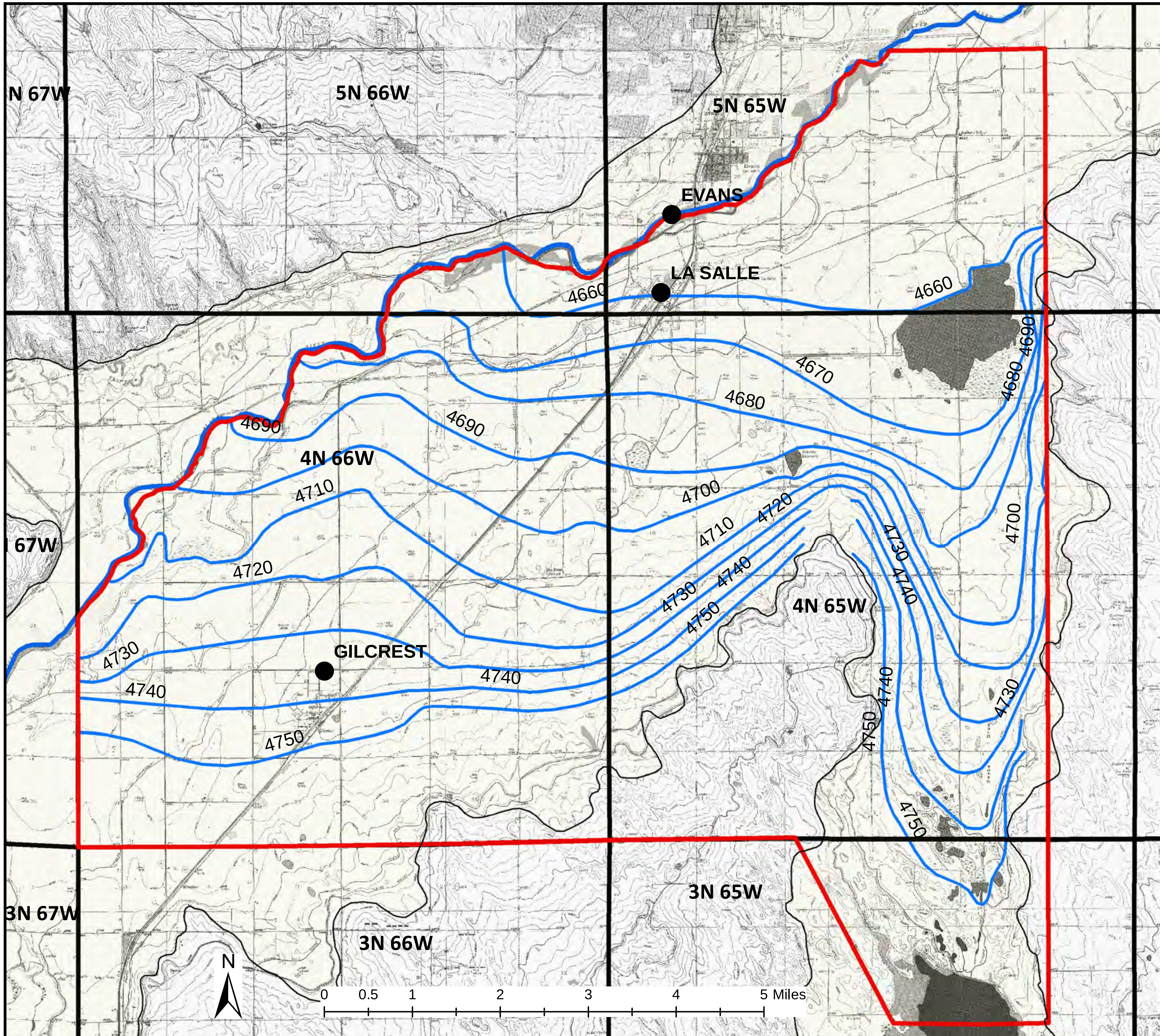
City

South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval

2012 Spring

Appendix C
Time-Series Historic
Groundwater Elevation Contour Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

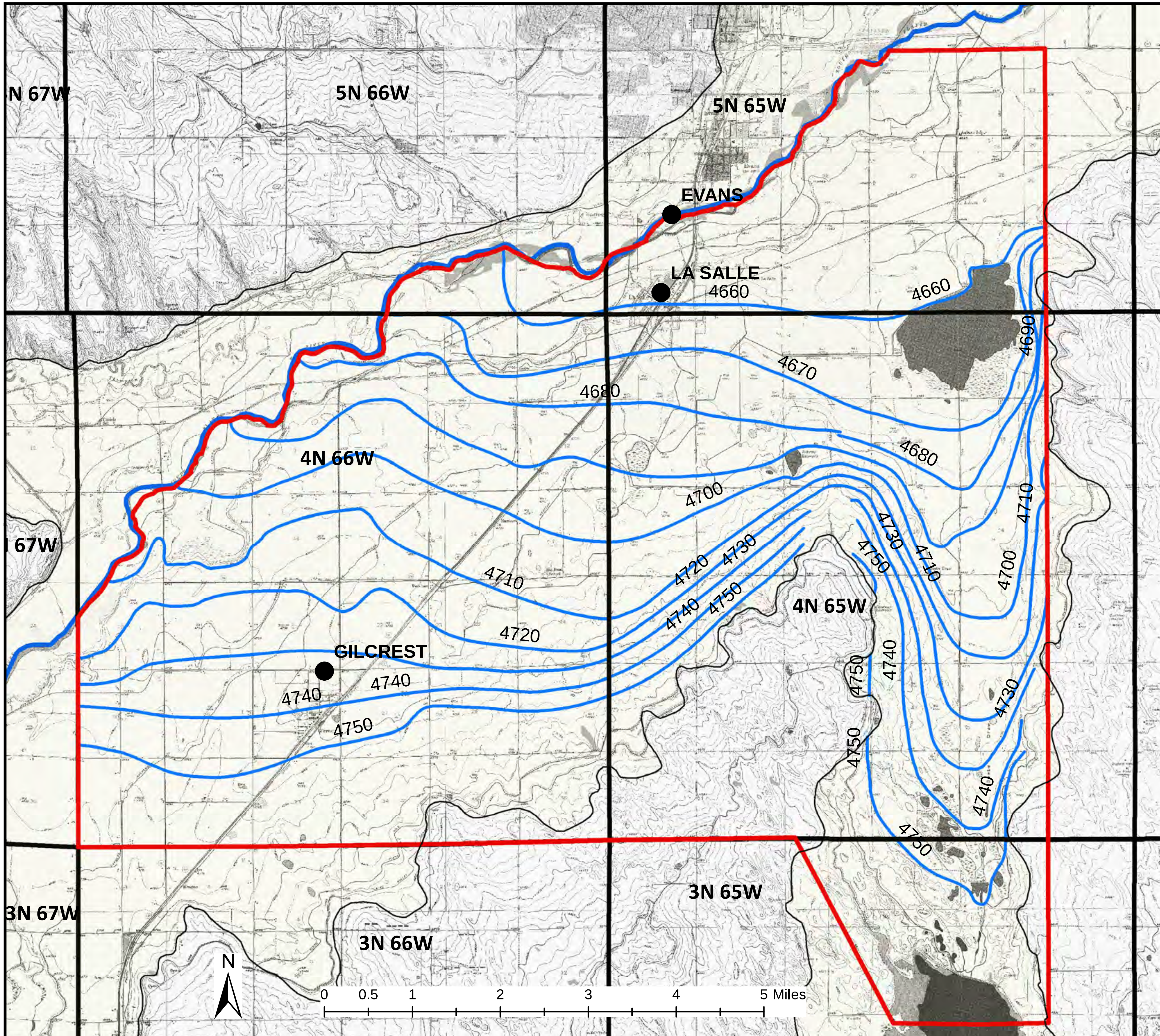
Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval

2012 Fall

Appendix C
Time-Series Historic
Groundwater Elevation Contour Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval

2013

Appendix C
Time-Series Historic Groundwater Elevation Contour Maps

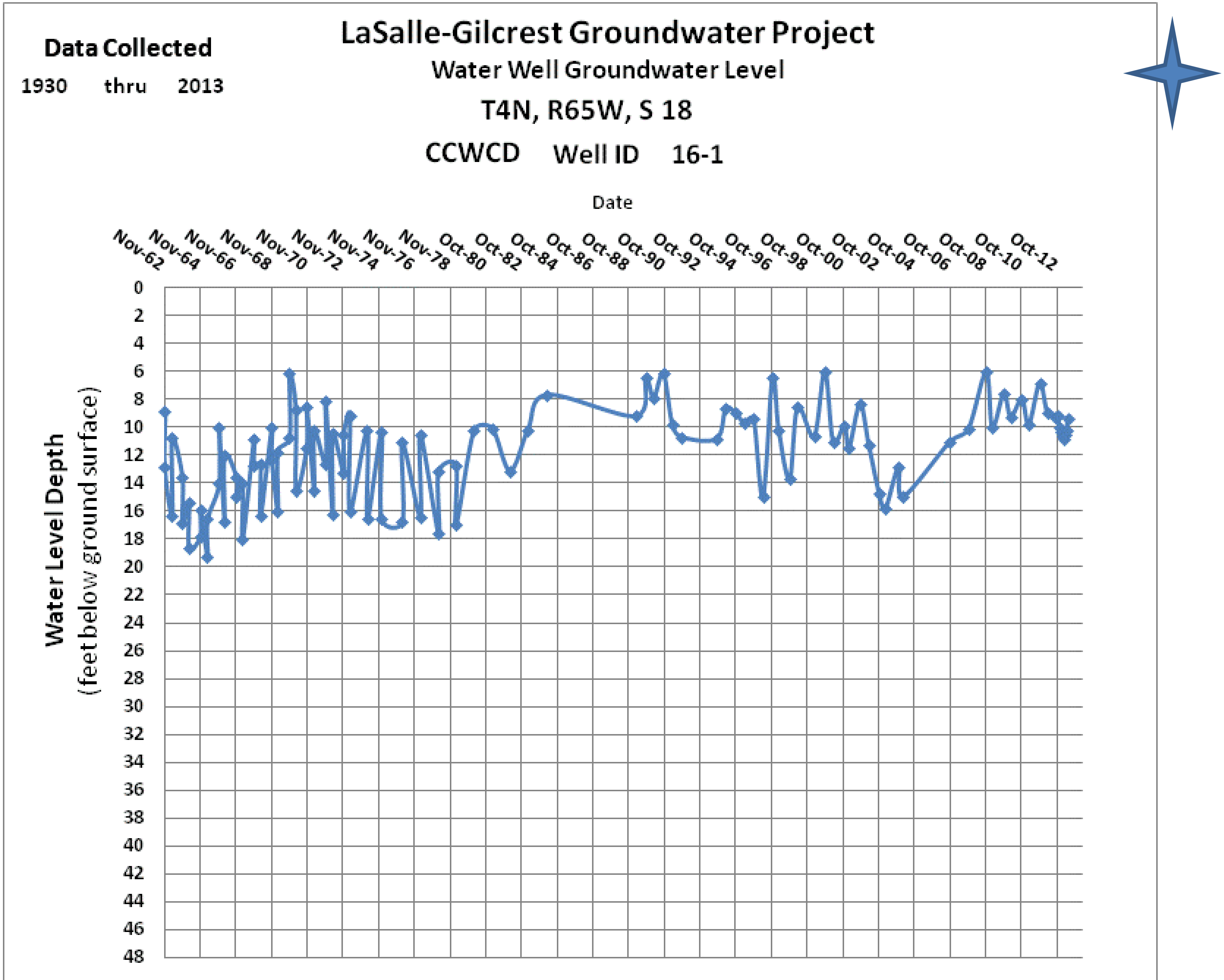
Appendix D
Time-Series Historic Groundwater Level Hydrographs

Gilcrest/LaSalle Groundwater Investigation Pilot Project
Hydrogeologic Characterization Report

(Note: this appendix provided in digital format only, these hydrographs were originally submitted to DWR with Task 1 and 2 Deliverable, June 2013)

Hydrograph Contents

- Hydrographs in order by Township/Range/Section
- Each hydrograph contains in text format
  - Label showing years for which data was collected e.g. 1942-2003
  - The location of the well in Township/ Range / Section
  - The data source for the well:
    - CCWCD – Colorado Central Water Conservation District
    - CDA – Colorado Department of Agriculture
    - DWR_Dat –Data obtained from DWR Data Search
    - USGS – United States Geological Survey website.
  - Y axis is from 0 ft (surface) to 48 ft below ground surface.
  - X axis ranges from 1962 to 2013 in the first group of slides.
  - Slides marked with a star indicate wells with a larger span of data.
    - Files with an alternate X axis are shown again in a second group of wells with the broader set of data.



Data Collected
1930 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R65W, S 18
CCWCD Well ID 16-1
Date
Nov-62 Nov-64 Nov-66 Nov-68 Nov-70 Nov-72 Nov-74 Nov-76 Nov-78 Oct-80 Oct-82 Oct-84 Oct-86 Oct-88 Oct-90 Oct-92 Oct-94 Oct-96 Oct-98 Oct-00 Oct-02 Oct-04 Oct-06 Oct-08 Oct-10 Oct-12
Water Level Depth
(feet below ground surface)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48


Data Collected
1994 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R65W, S 23
CCWCD Well ID 48-2
Date
Jan-65
Jan-67
Dec-68
Dec-70
Dec-72
Dec-74
Dec-76
Dec-78
Dec-80
Dec-82
Dec-84
Dec-86
Dec-88
Dec-90
Dec-92
Dec-94
Dec-96
Dec-98
Dec-00
Dec-02
Dec-04
Dec-06
Dec-08
Dec-10
Dec-12
Water Level Depth
(feet below ground surface)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48


Data Collected
1994 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R65W, S 27
CCWCD Well ID 49-1
Date
Jan-65
Jan-67
Dec-68
Dec-70
Dec-72
Dec-74
Dec-76
Dec-78
Dec-80
Dec-82
Dec-84
Dec-86
Dec-88
Dec-90
Dec-92
Dec-94
Dec-96
Dec-98
Dec-00
Dec-02
Dec-04
Dec-06
Dec-08
Dec-10
Dec-12
Water Level Depth
(feet below ground surface)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
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34
36
38
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42
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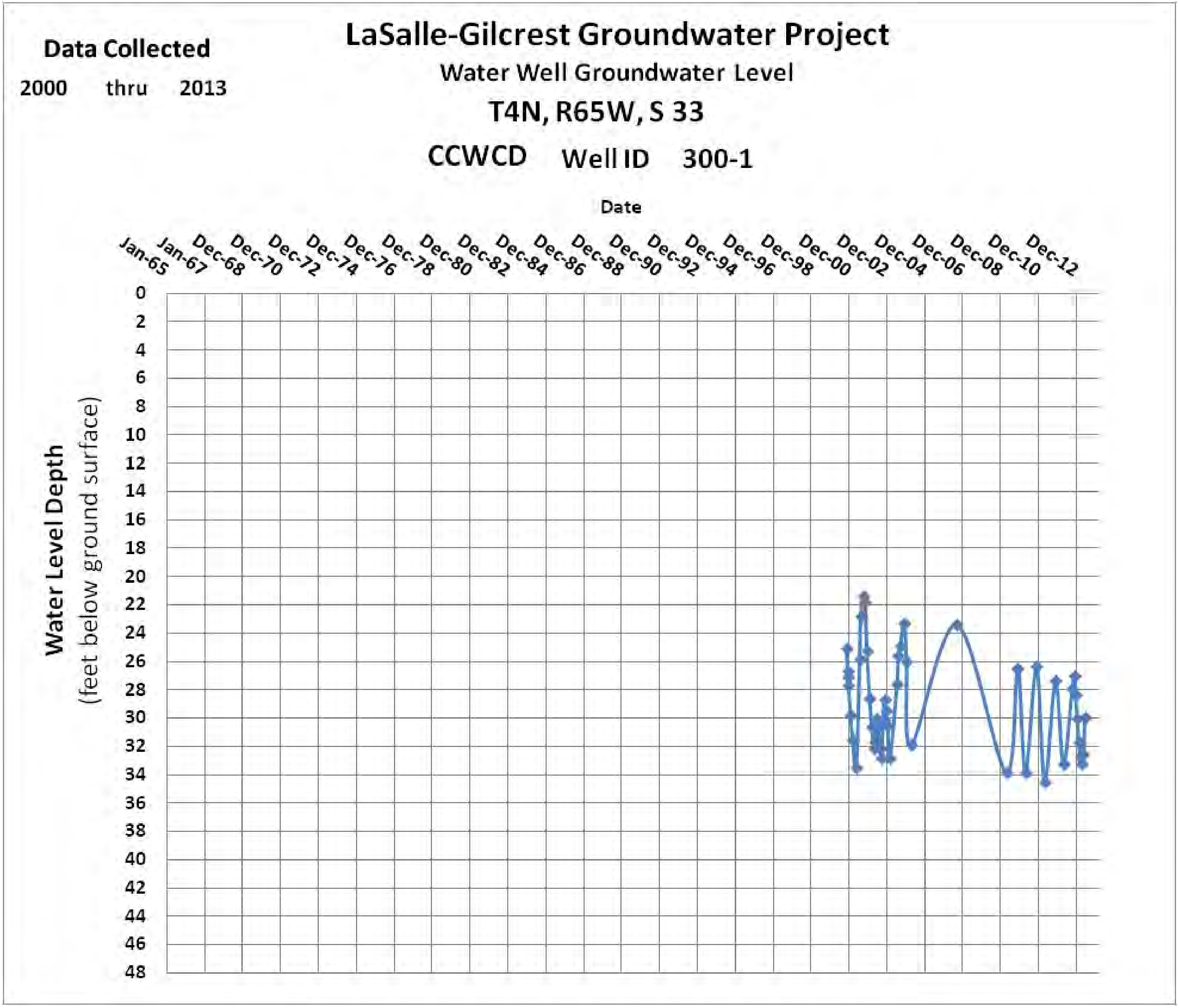
46
48



Data Collected
2000 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R65W, S 33
CCWCD Well ID 300-1
Date
Jan-65 Jan-67 Dec-68 Dec-70 Dec-72 Dec-74 Dec-76 Dec-78 Dec-80 Dec-82 Dec-84 Dec-86 Dec-88 Dec-90 Dec-92 Dec-94 Dec-96 Dec-98 Dec-00 Dec-02 Dec-04 Dec-06 Dec-08 Dec-10 Dec-12
Water Level Depth
(feet below ground surface)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48


Data Collected
2000 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R65W, S 34
CCWCD Well ID 301-1
Date
Jan-65
Jan-67
Dec-68
Dec-70
Dec-72
Dec-74
Dec-76
Dec-78
Dec-80
Dec-82
Dec-84
Dec-86
Dec-88
Dec-90
Dec-92
Dec-94
Dec-96
Dec-98
Dec-00
Dec-02
Dec-04
Dec-06
Dec-08
Dec-10
Dec-12
Water Level Depth
(feet below ground surface)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48

Data Collected

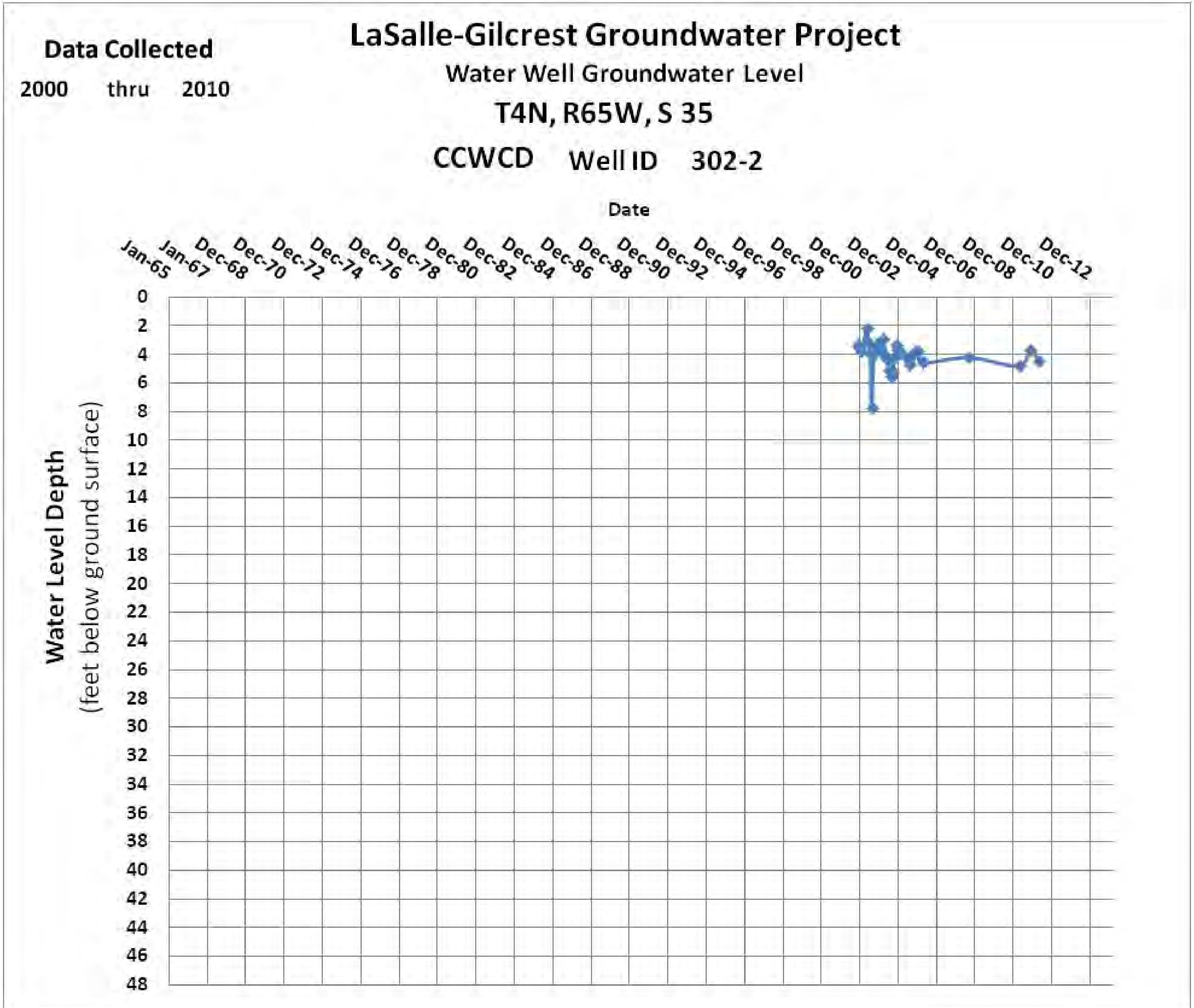
2000 thru 2010

LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

T4N, R65W, S 35

CCWCD Well ID 302-1



Data Collected
2000 thru 2010
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R65W, S 35
CCWCD Well ID 302-2
Date
Jan-65
Jan-67
Dec-68
Dec-70
Dec-72
Dec-74
Dec-76
Dec-78
Dec-80
Dec-82
Dec-84
Dec-86
Dec-88
Dec-90
Dec-92
Dec-94
Dec-96
Dec-98
Dec-00
Dec-02
Dec-04
Dec-06
Dec-08
Dec-10
Dec-12
Water Level Depth
(feet below ground surface)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48

LaSalle-Gilcrest Groundwater Project

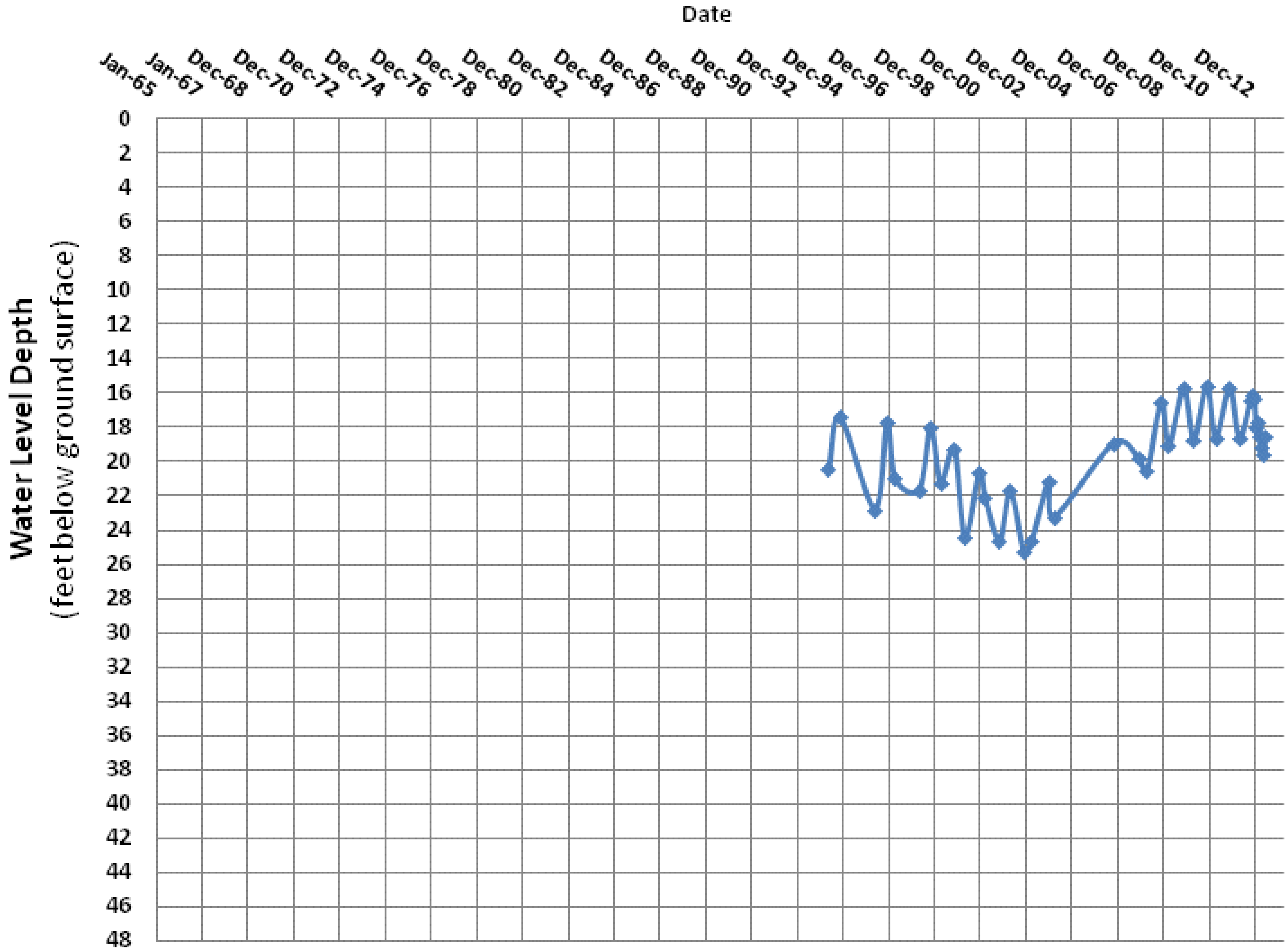
Data Collected

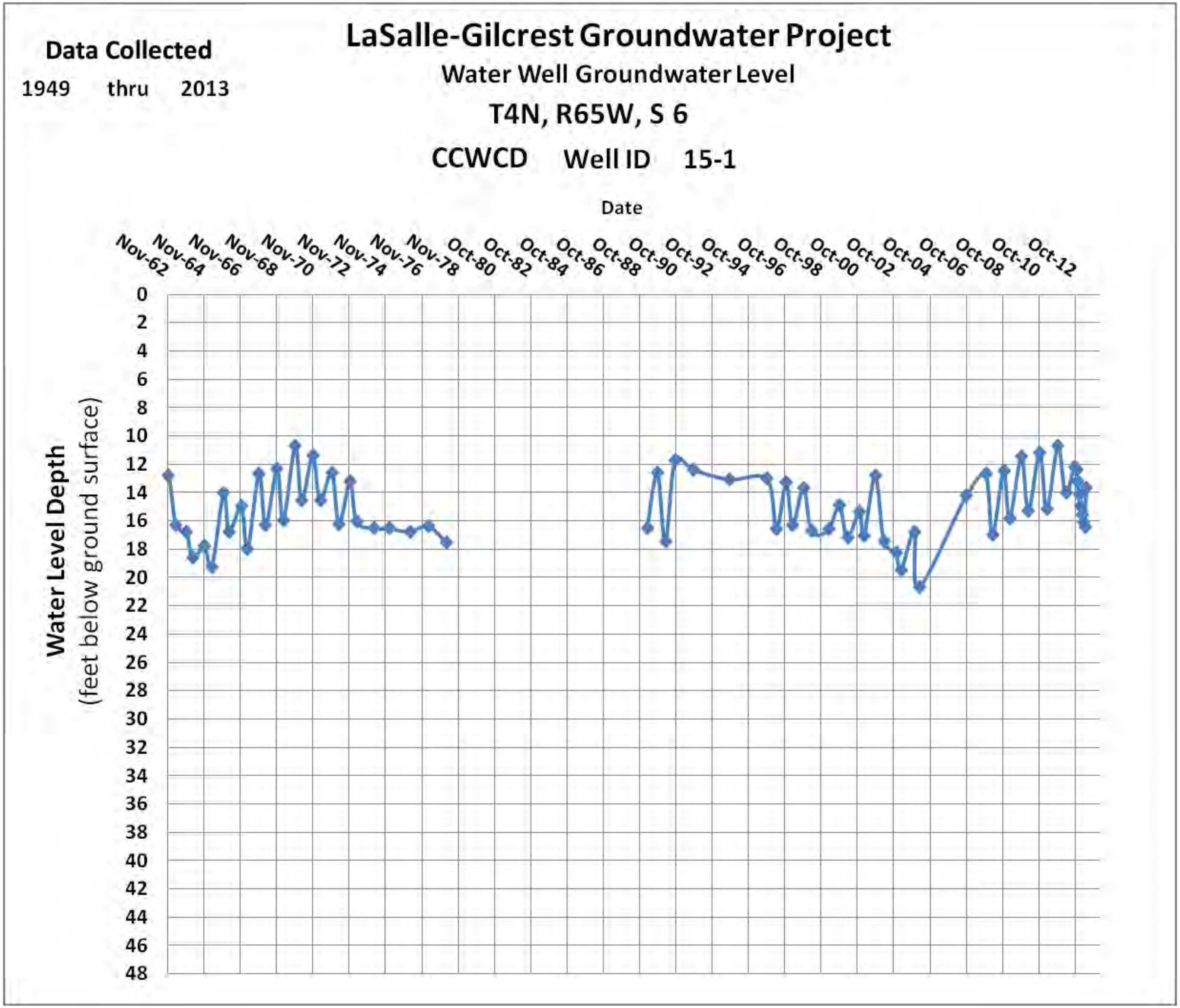
1994 thru 2013

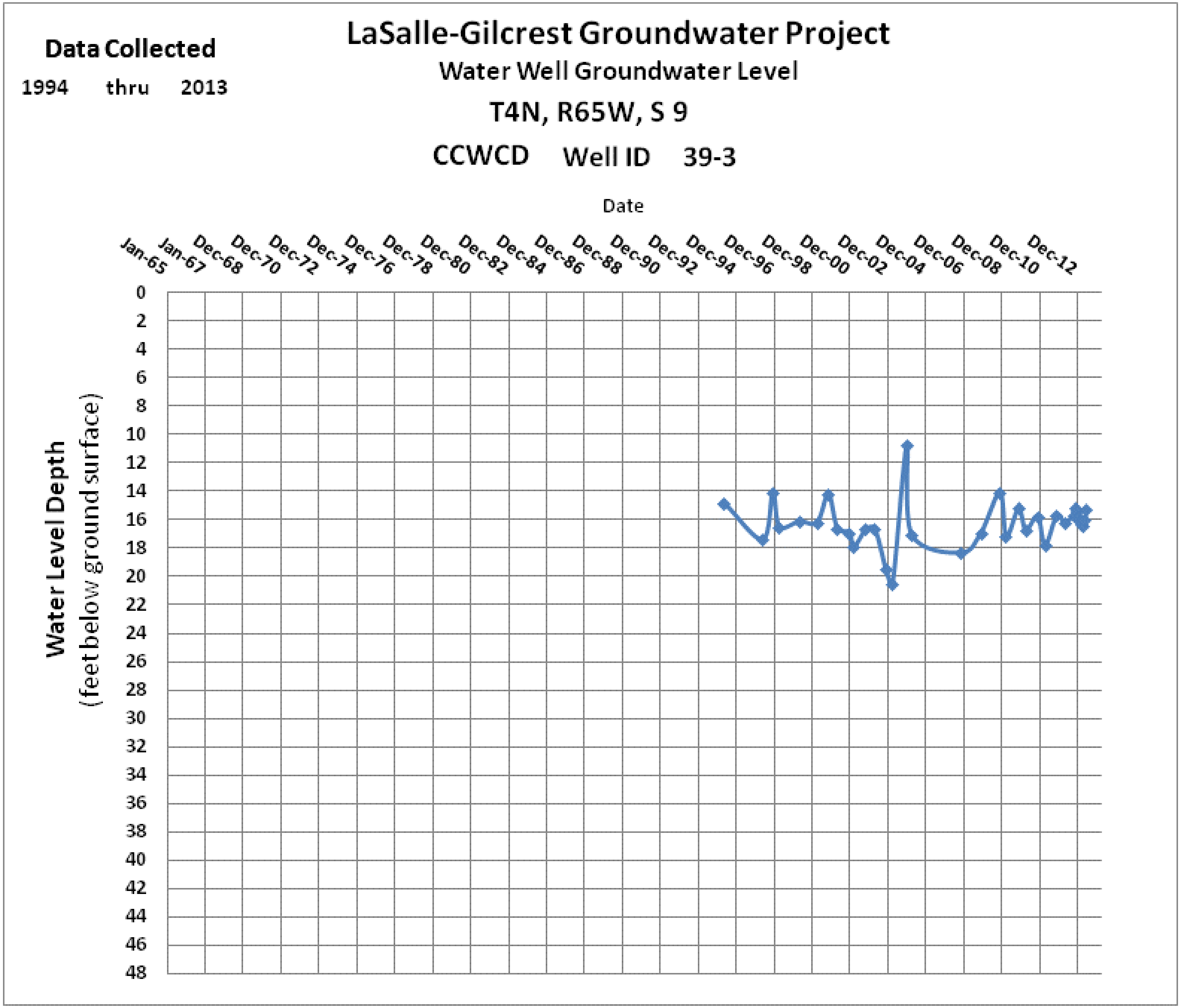
Water Well Groundwater Level

T4N, R65W, S 4

CCWCD Well ID 39-1




Data Collected
1949 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R65W, S 6
CCWCD Well ID 15-1
Date
Nov-62 Nov-64 Nov-66 Nov-68 Nov-70 Nov-72 Nov-74 Nov-76 Nov-78 Oct-80 Oct-82 Oct-84 Oct-86 Oct-88 Oct-90 Oct-92 Oct-94 Oct-96 Oct-98 Oct-00 Oct-02 Oct-04 Oct-06 Oct-08 Oct-10 Oct-12
Water Level Depth
(feet below ground surface)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48



Data Collected
1994 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R65W, S 9
CCWCD Well ID 39-3
Date
Jan-65
Jan-67
Dec-68
Dec-70
Dec-72
Dec-74
Dec-76
Dec-78
Dec-80
Dec-82
Dec-84
Dec-86
Dec-88
Dec-90
Dec-92
Dec-94
Dec-96
Dec-98
Dec-00
Dec-02
Dec-04
Dec-06
Dec-08
Dec-10
Dec-12
Water Level Depth
(feet below ground surface)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48

Data Collected

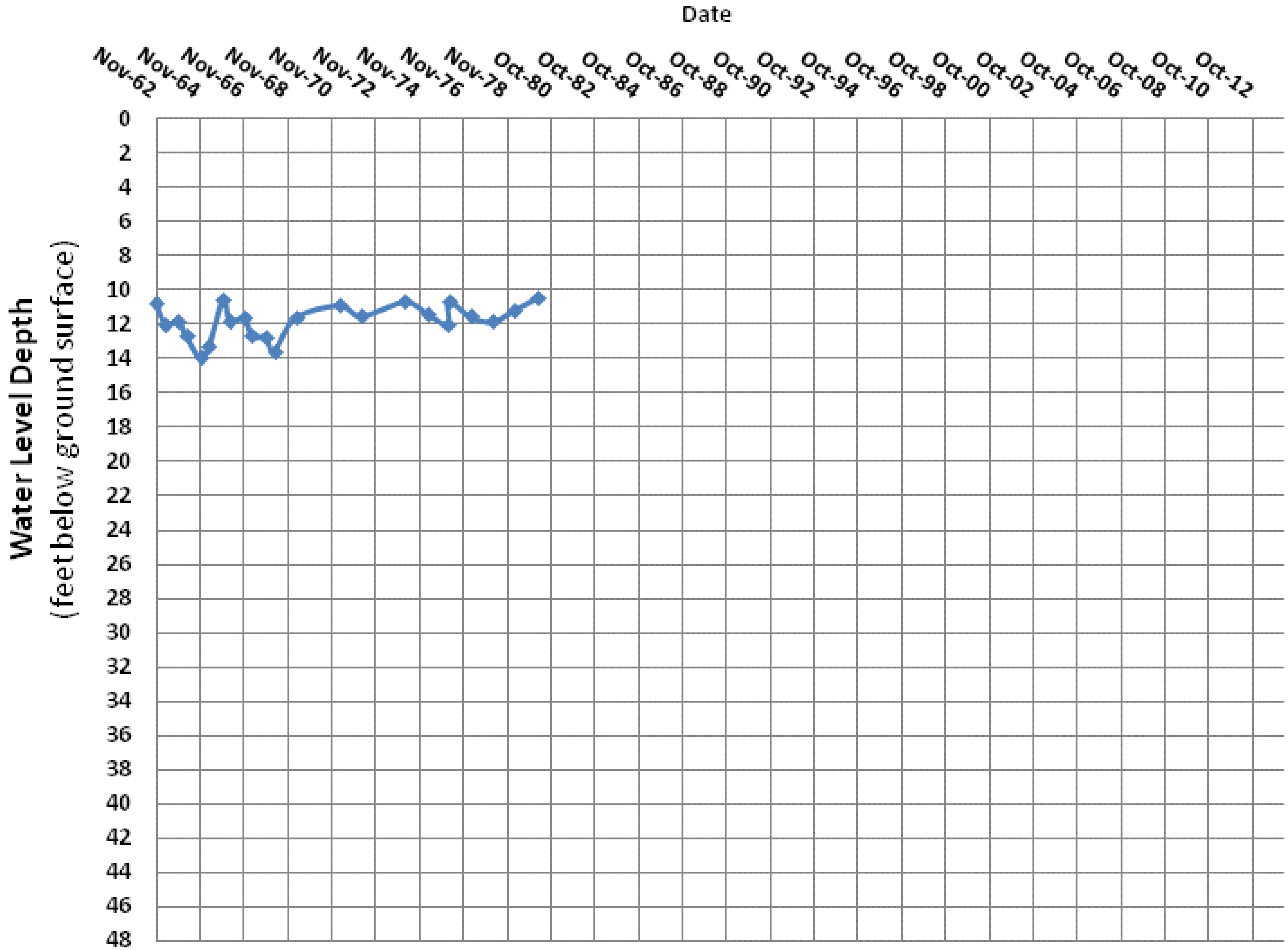
1962 thru 1980

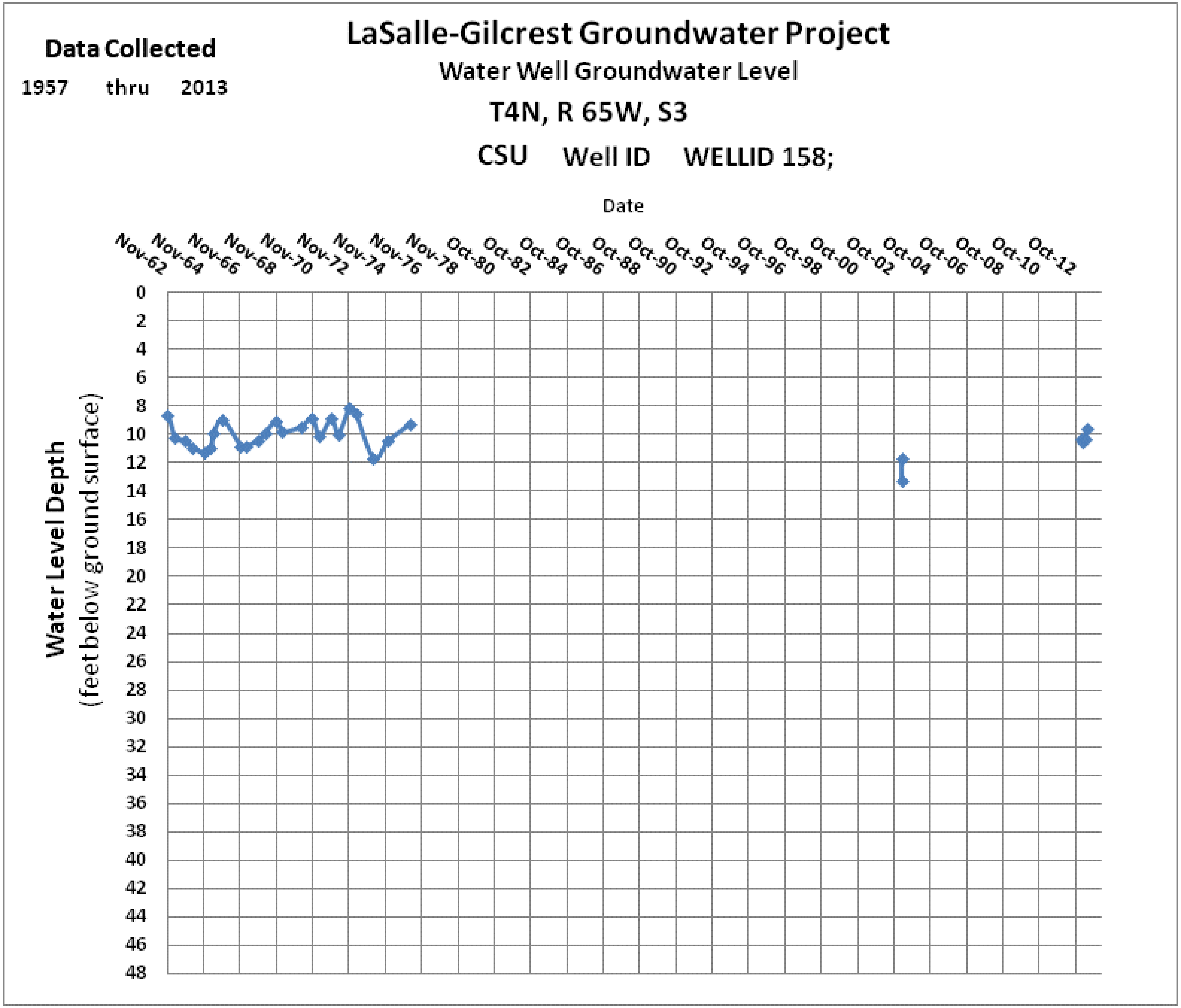
LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

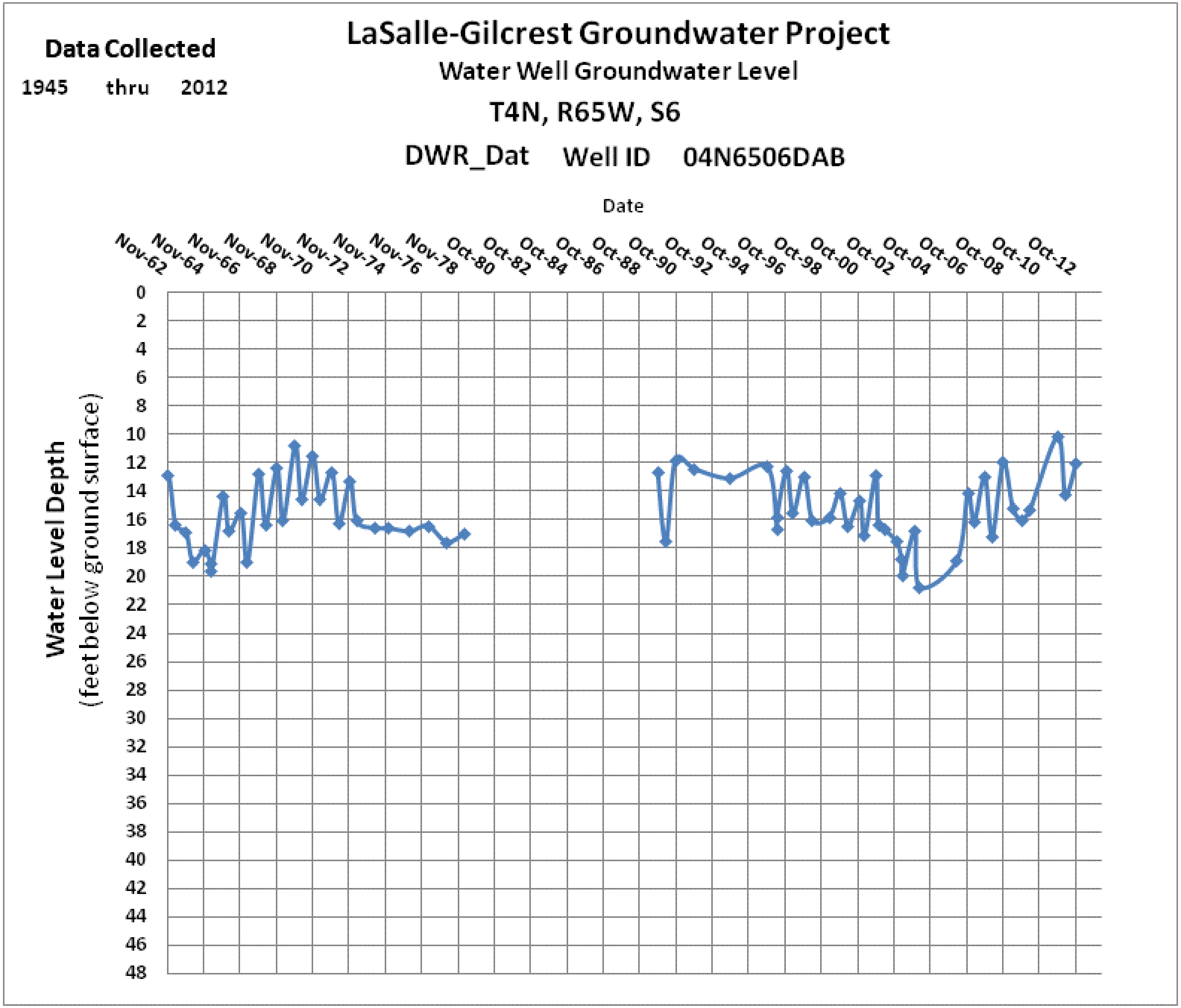
T4N, R65W, S22

from Well ID SB00406522DCD





Data Collected
1957 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R 65W, S3
CSU Well ID WELLID 158;
Date
Nov-62 Nov-64 Nov-66 Nov-68 Nov-70 Nov-72 Nov-74 Nov-76 Nov-78 Oct-80 Oct-82 Oct-84 Oct-86 Oct-88 Oct-90 Oct-92 Oct-94 Oct-96 Oct-98 Oct-00 Oct-02 Oct-04 Oct-06 Oct-08 Oct-10 Oct-12
Water Level Depth
(feet below ground surface)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48



Data Collected
1945 thru 2012
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R65W, S6
DWR_Dat Well ID 04N6506DAB
Date
Nov-62 Nov-64 Nov-66 Nov-68 Nov-70 Nov-72 Nov-74 Nov-76 Nov-78 Oct-80 Oct-82 Oct-84 Oct-86 Oct-88 Oct-90 Oct-92 Oct-94 Oct-96 Oct-98 Oct-00 Oct-02 Oct-04 Oct-06 Oct-08 Oct-10 Oct-12
Water Level Depth
(feet below ground surface)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48

LaSalle-Gilcrest Groundwater Project

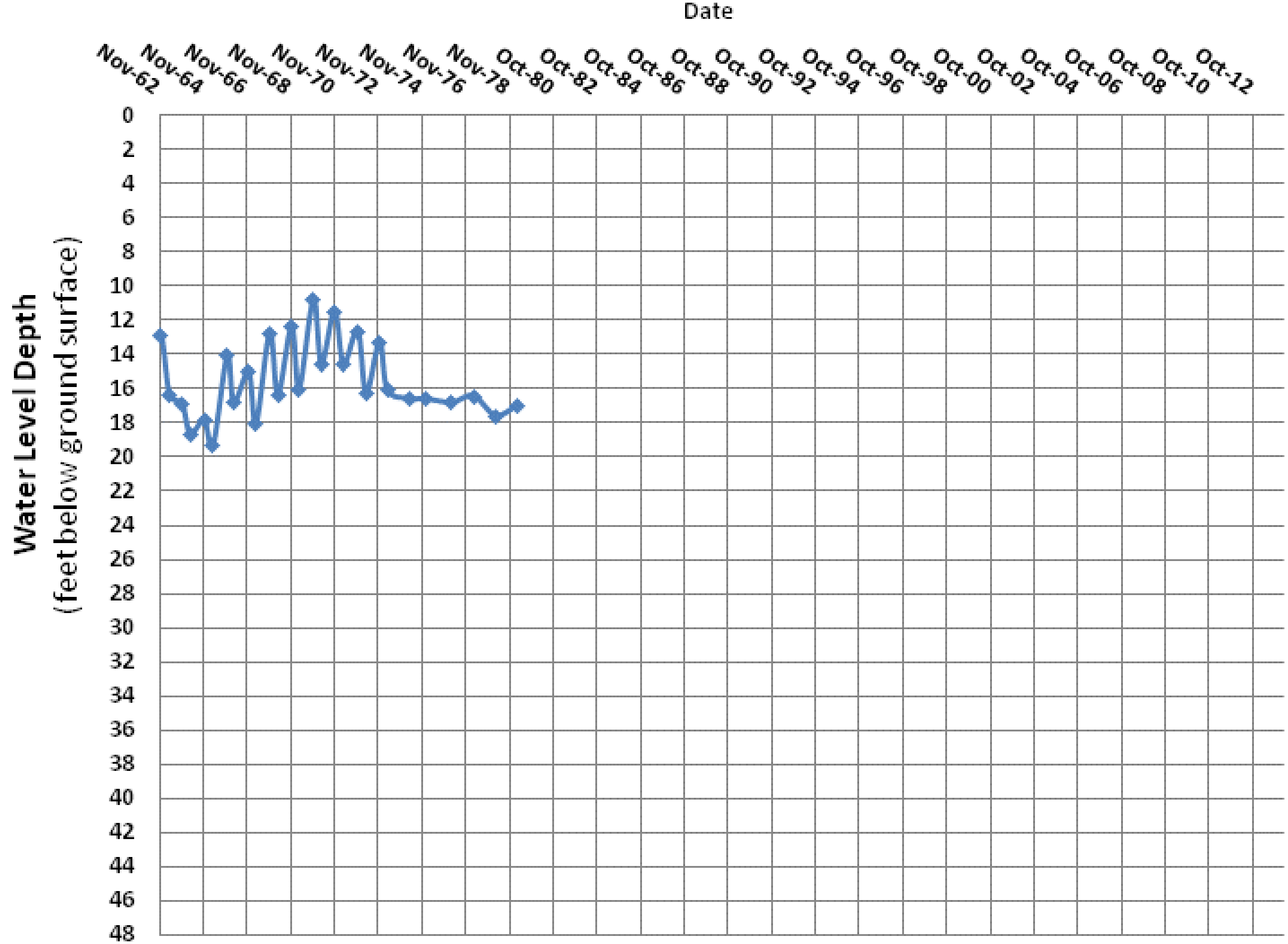
Data Collected

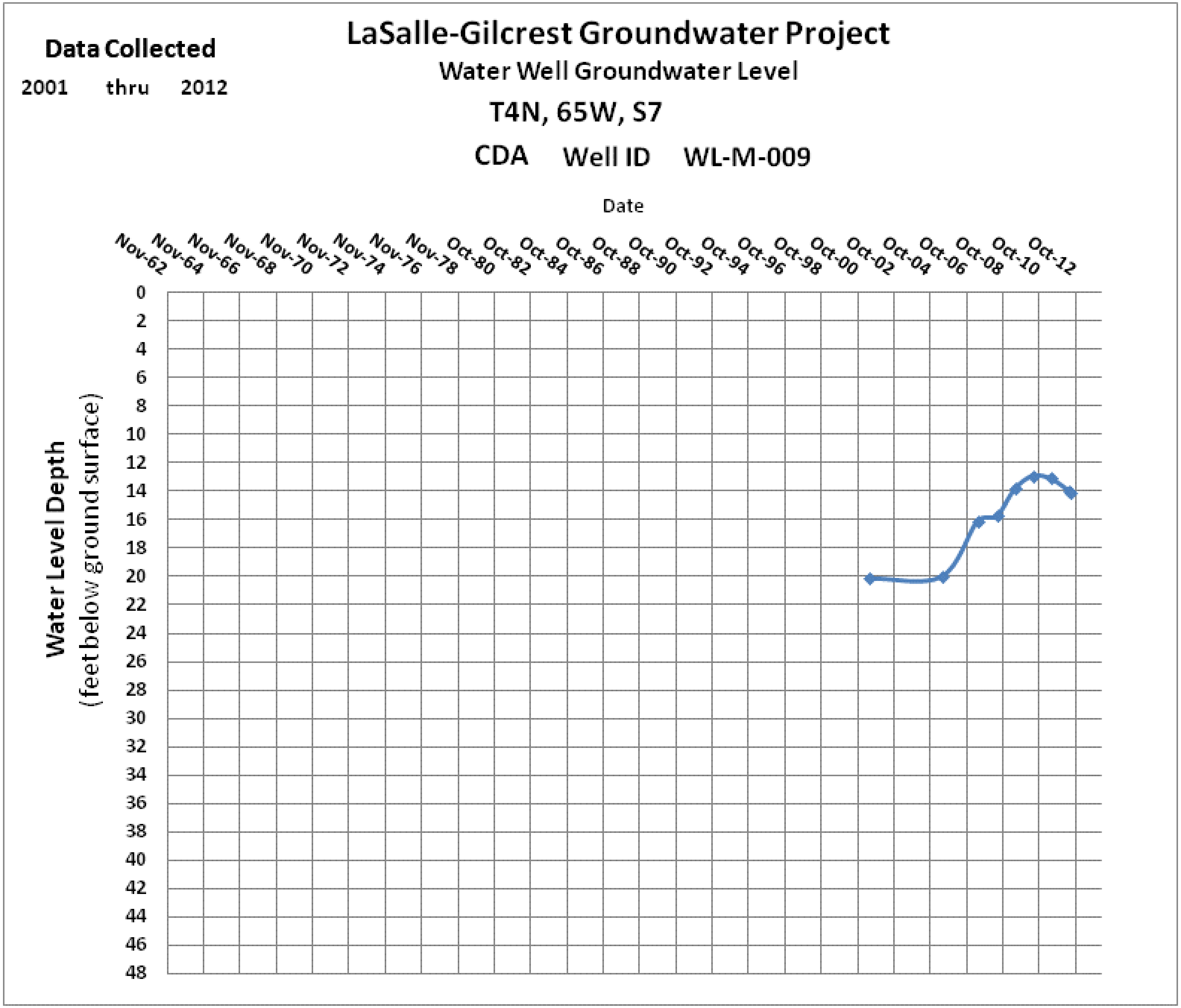
1949 thru 1979

Water Well Groundwater Level

T4N, R65W, S6

DWR_Dat Well ID SB00406506DA





Data Collected
2001 thru 2012
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, 65W, S7
CDA Well ID WL-M-009
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
0
2
4
6
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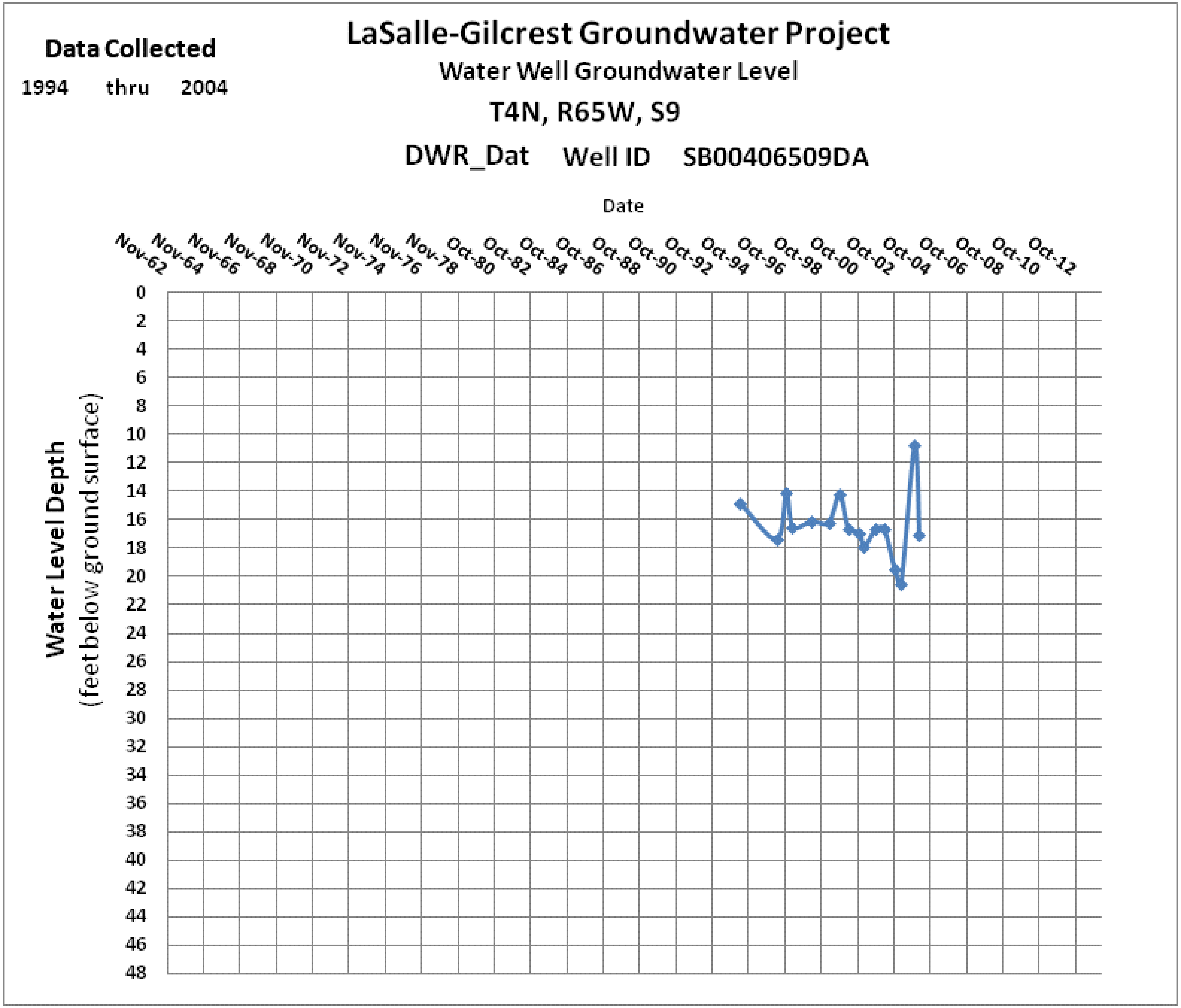

Data Collected
1994 thru 2004
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R65W, S9
DWR_Dat Well ID SB00406509DA
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
0
2
4
6
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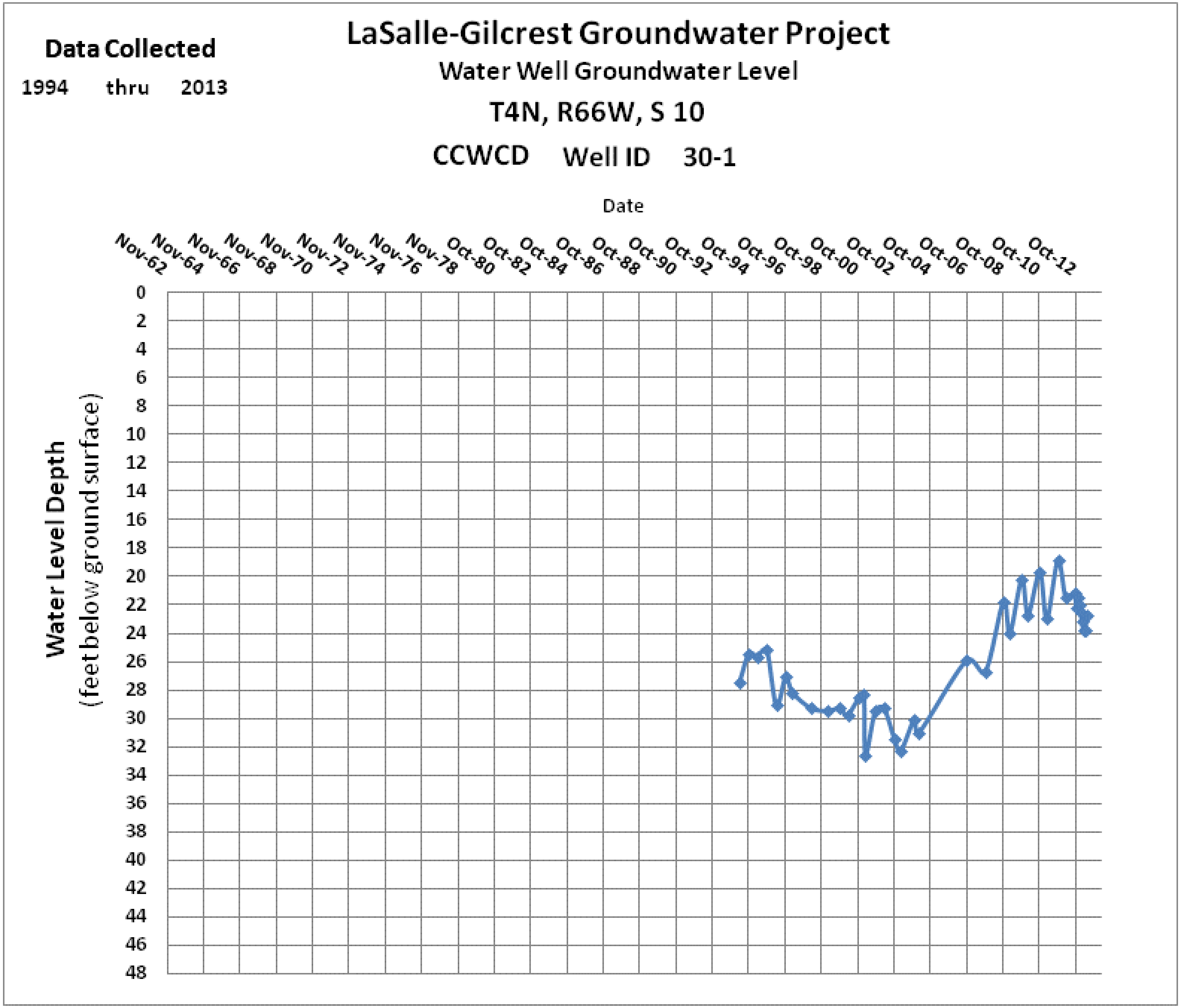

Data Collected
1994 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S 10
CCWCD Well ID 30-1
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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8
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12
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38
40
42
44
46
48

Data Collected

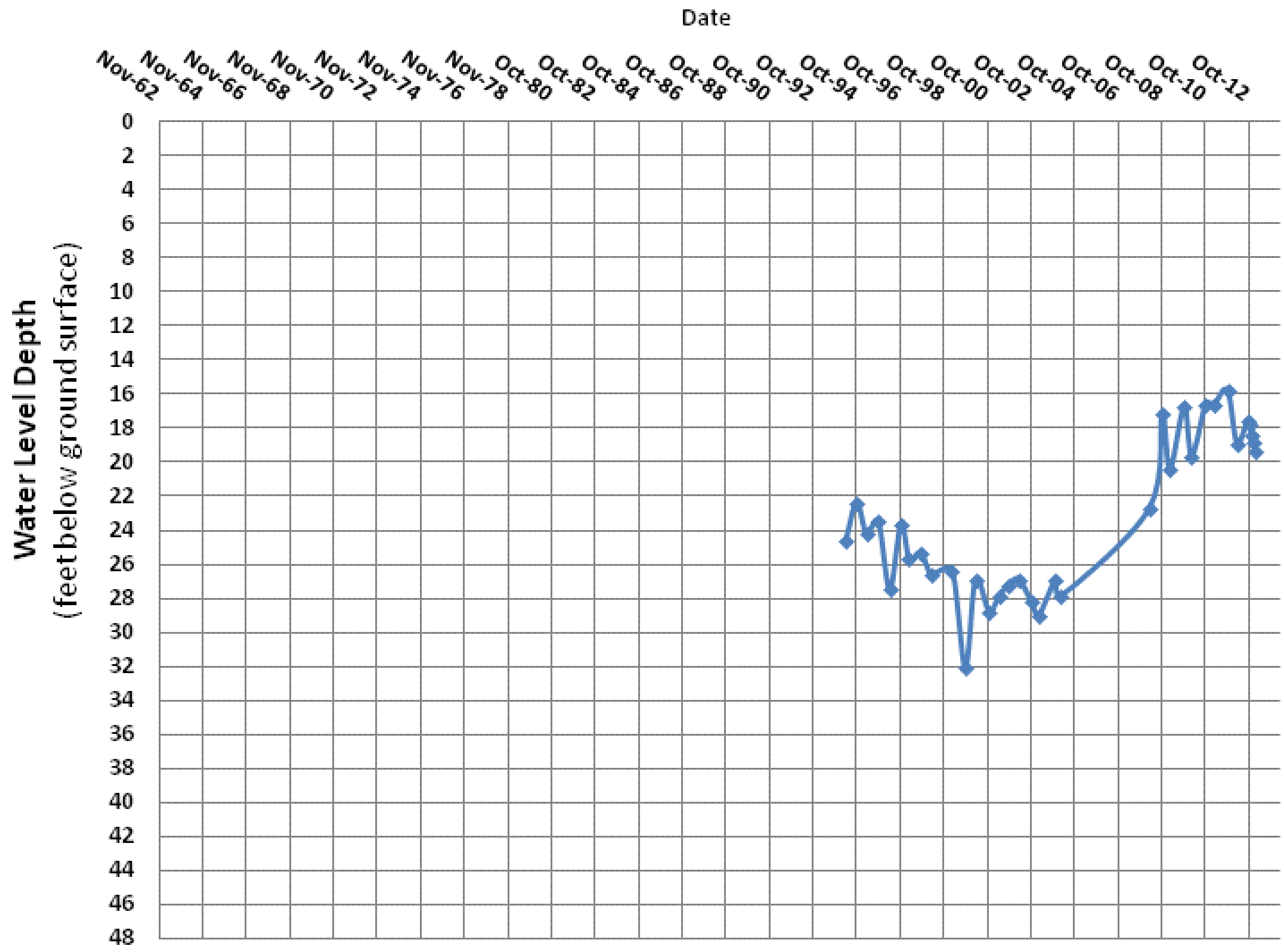
1994 thru 1900

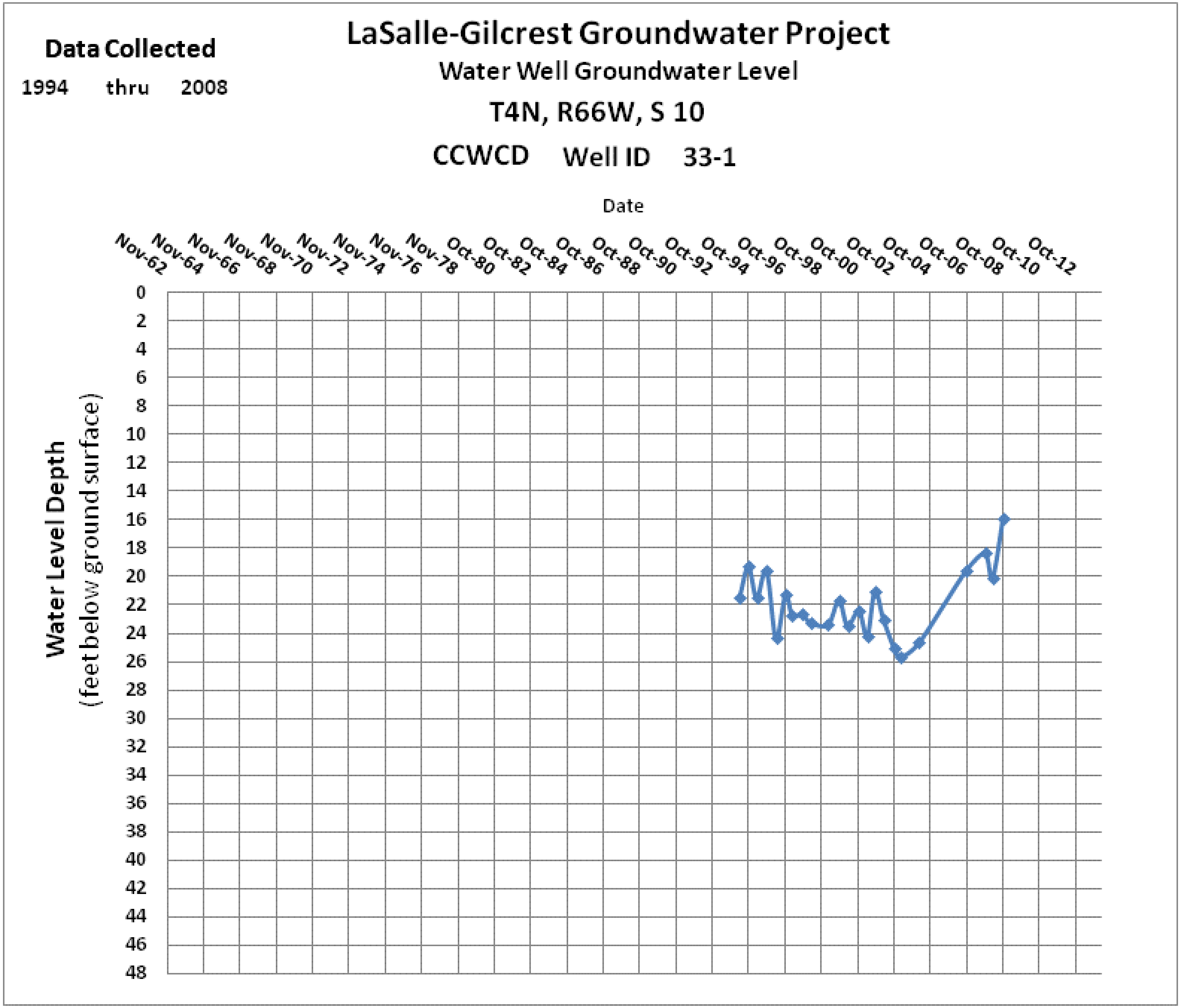
LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

T4N, R66W, S 10

CCWCD Well ID 32-1





Data Collected
1994 thru 2008
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S 10
CCWCD Well ID 33-1
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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12
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32
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42
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48

LaSalle-Gilcrest Groundwater Project

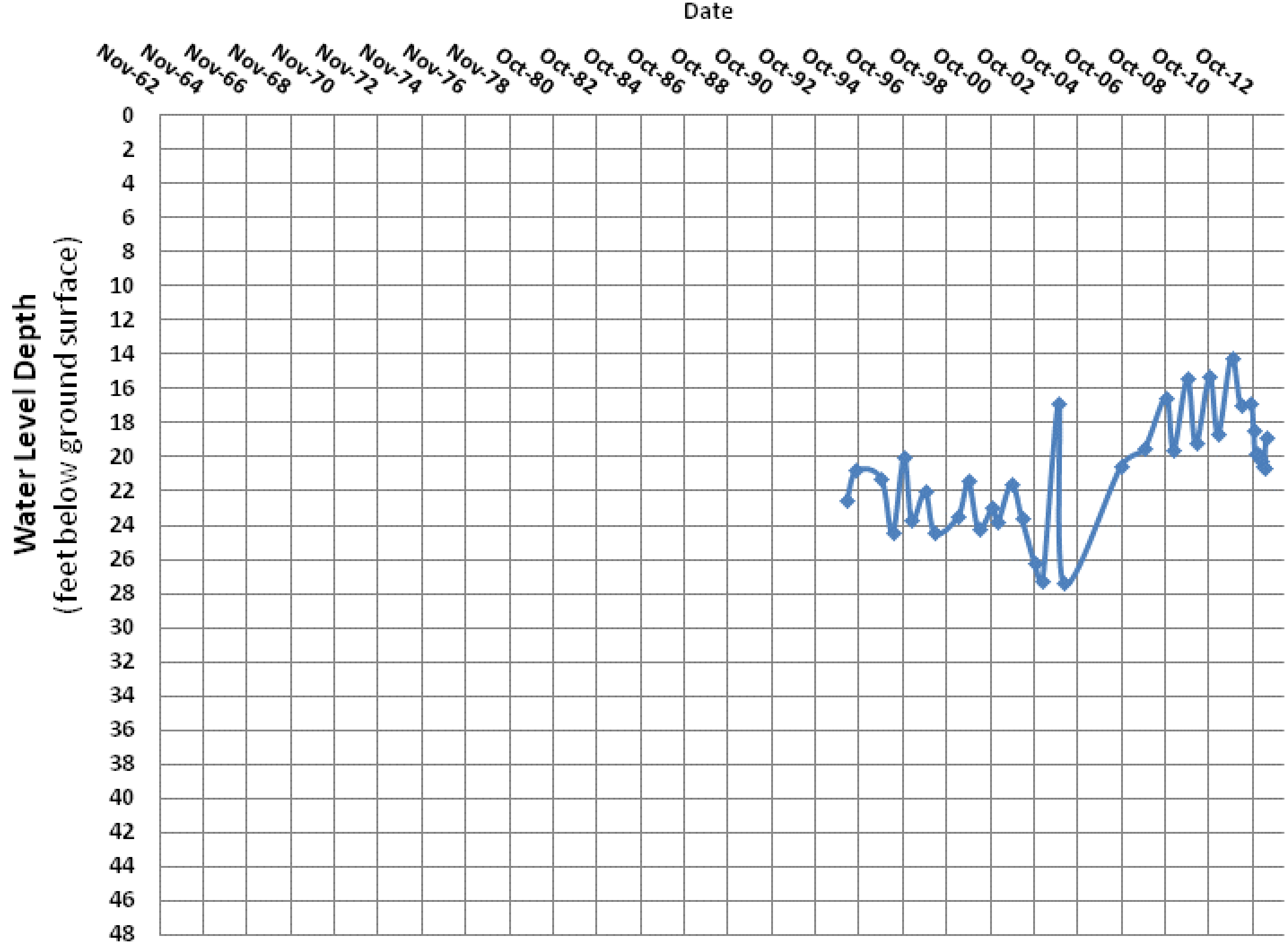
Data Collected

1994 thru 2013

Water Well Groundwater Level

T4N, R66W, S 12

CCWCD Well ID 38-2



Data Collected

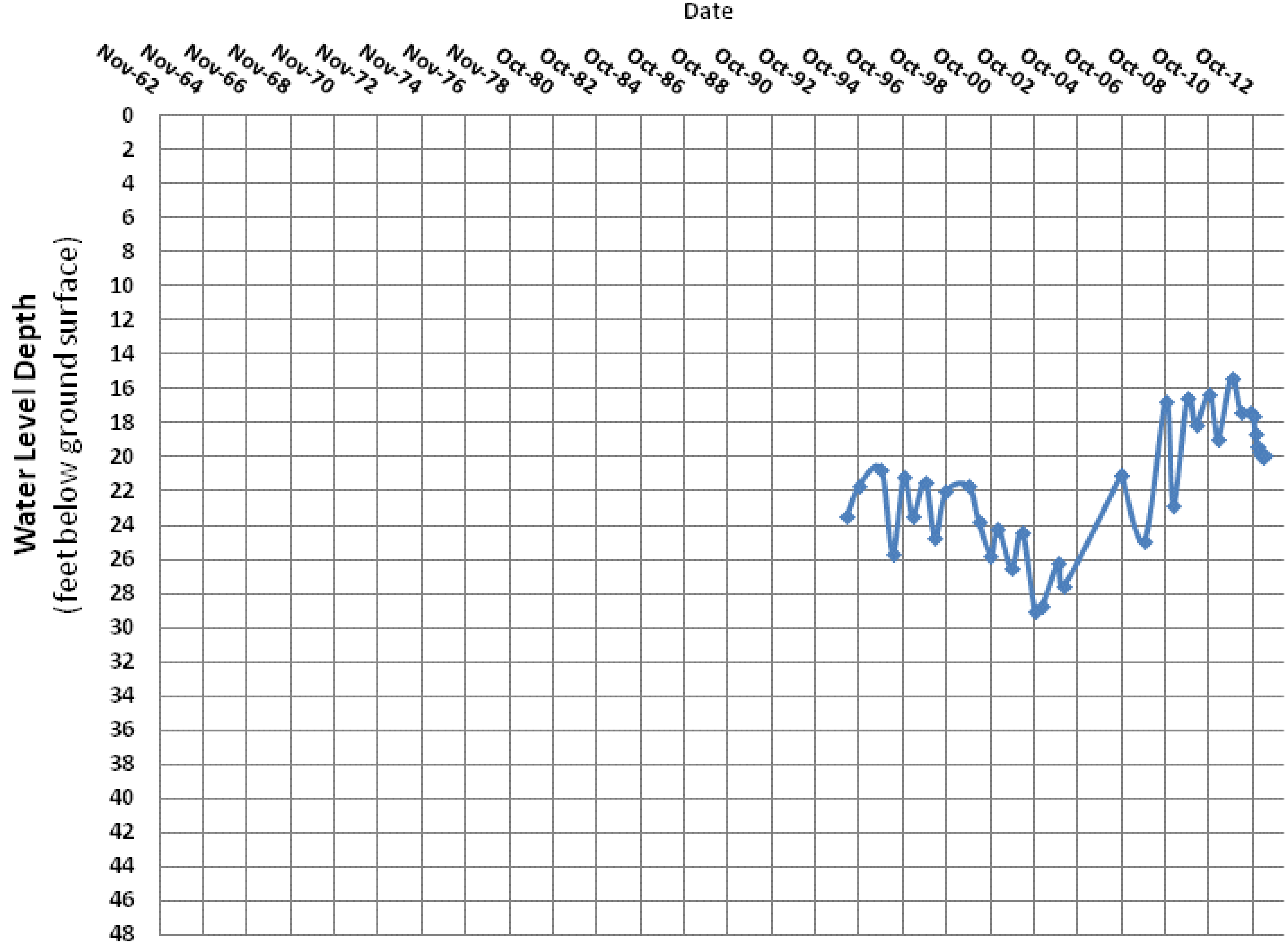
1994 thru 2013

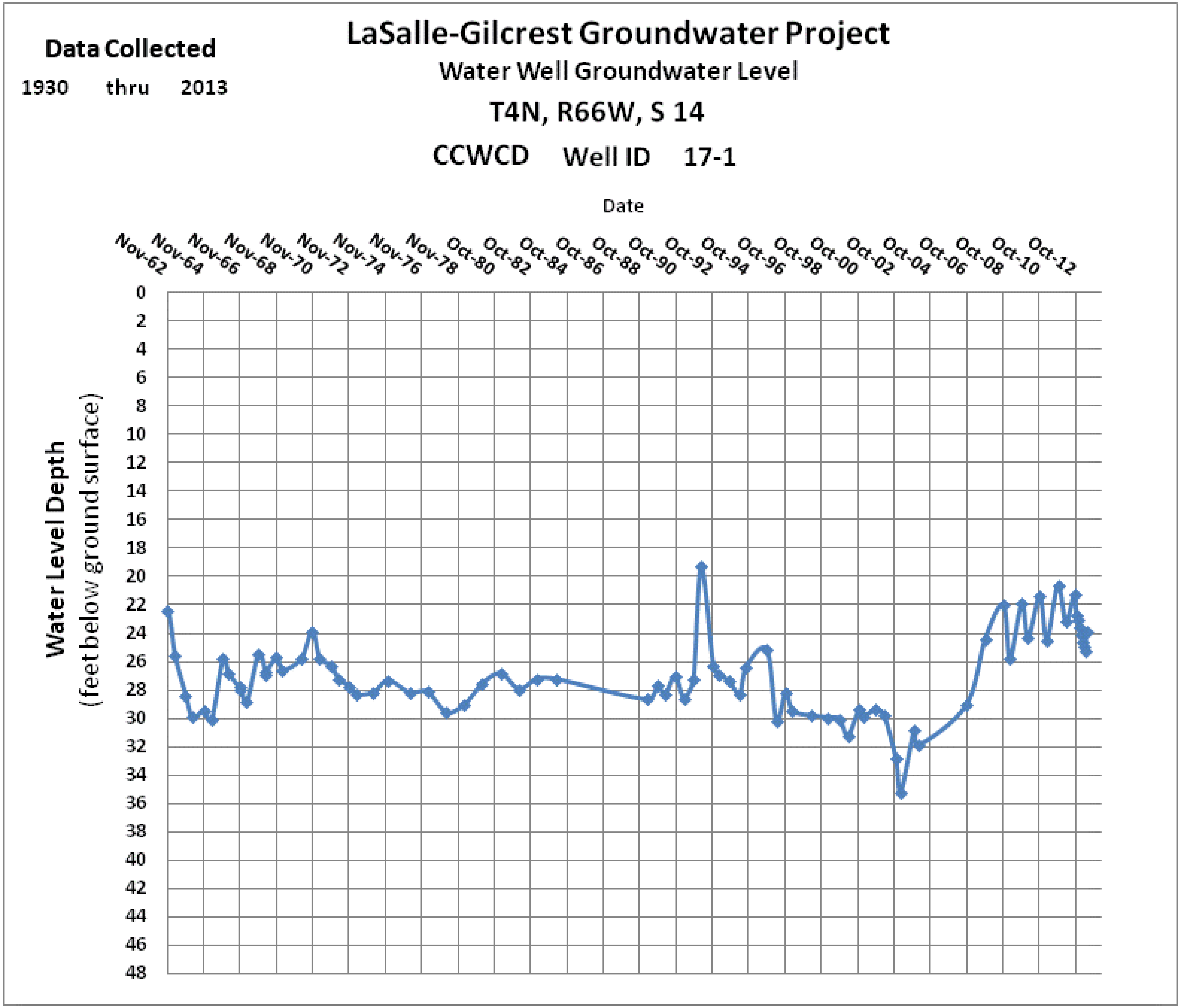
LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

T4N, R66W, S 13

CCWCD Well ID 37-4





Data Collected
1930 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S 14
CCWCD Well ID 17-1
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
0
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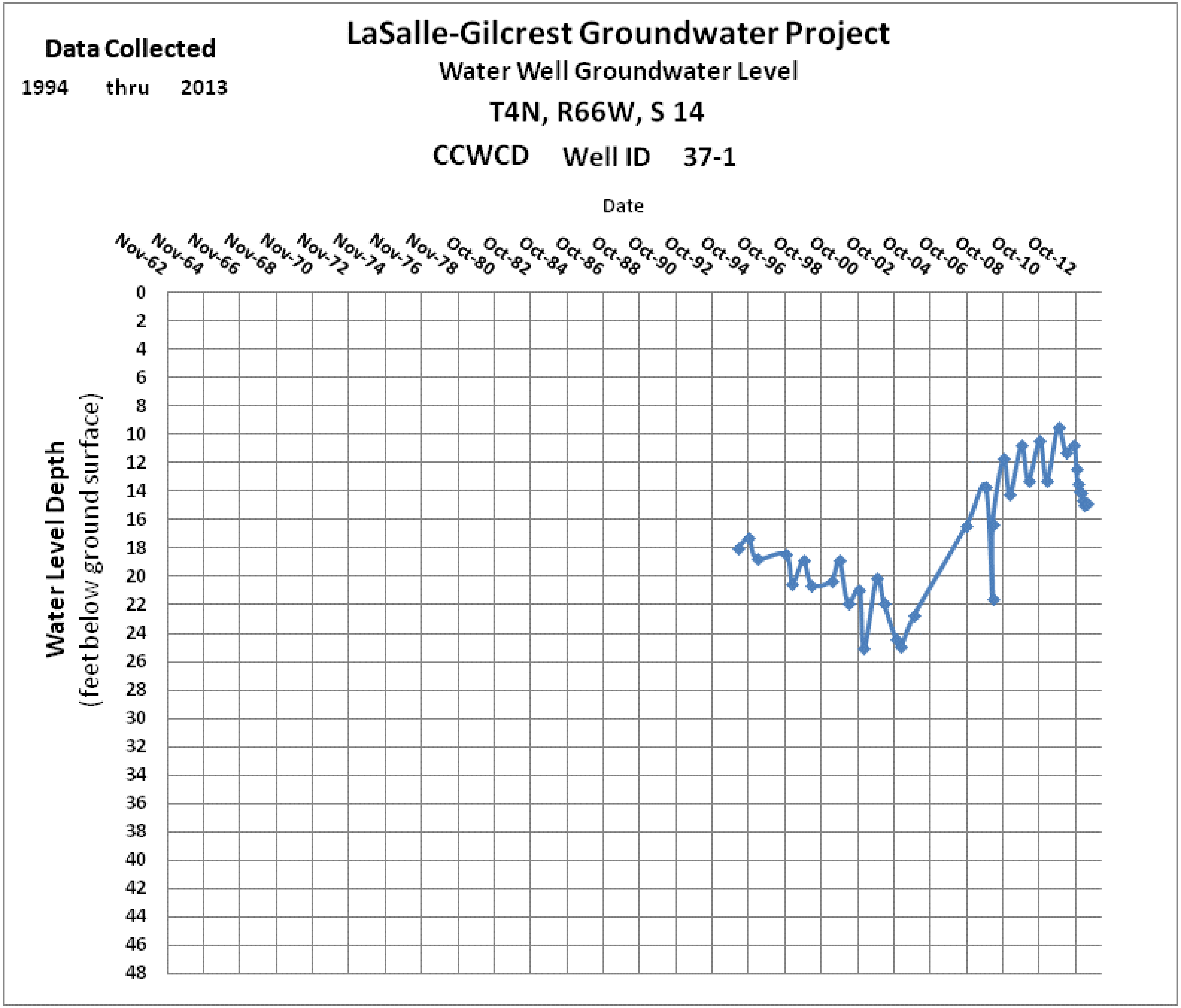

Data Collected
1994 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S 14
CCWCD Well ID 37-1
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
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Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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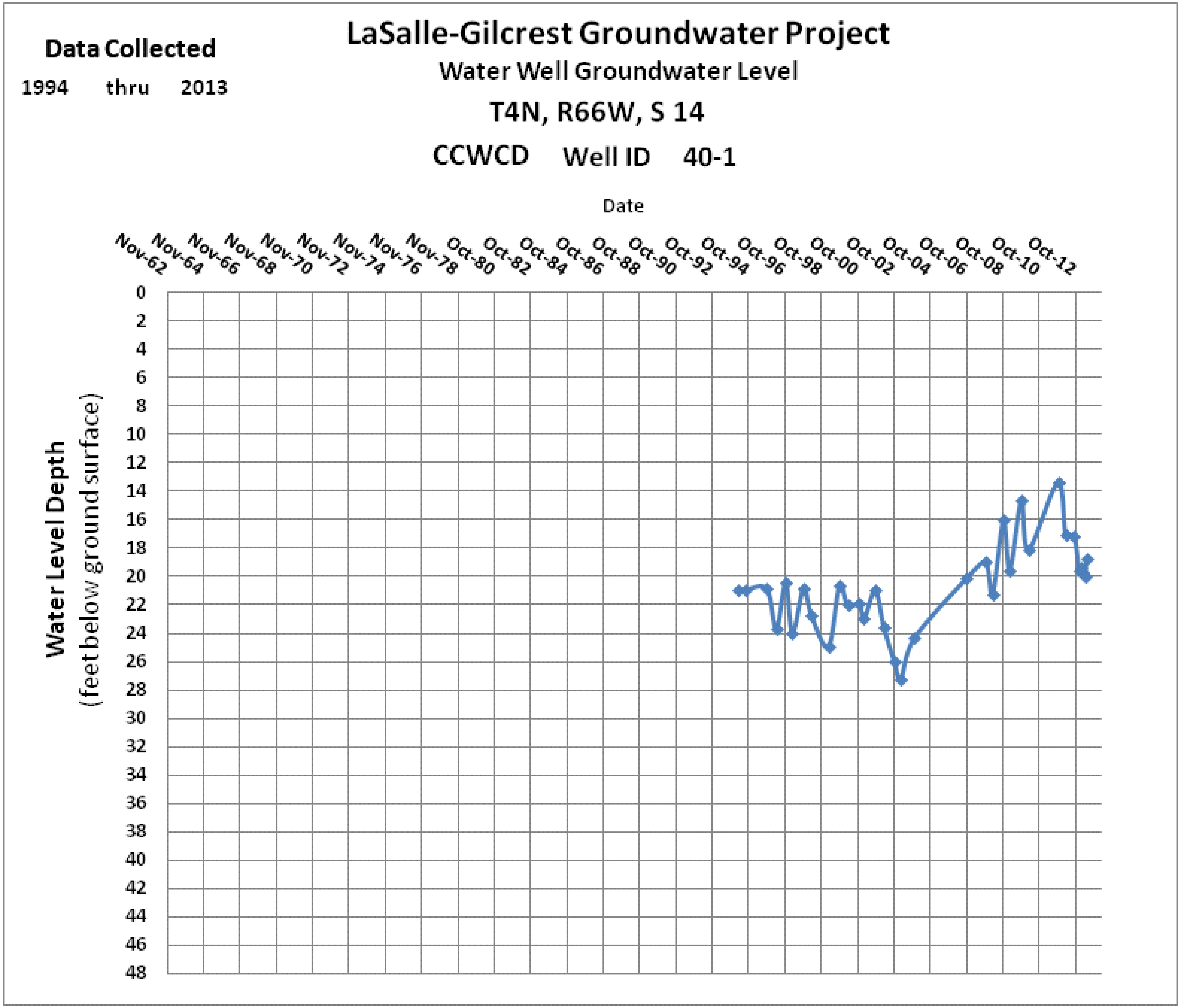
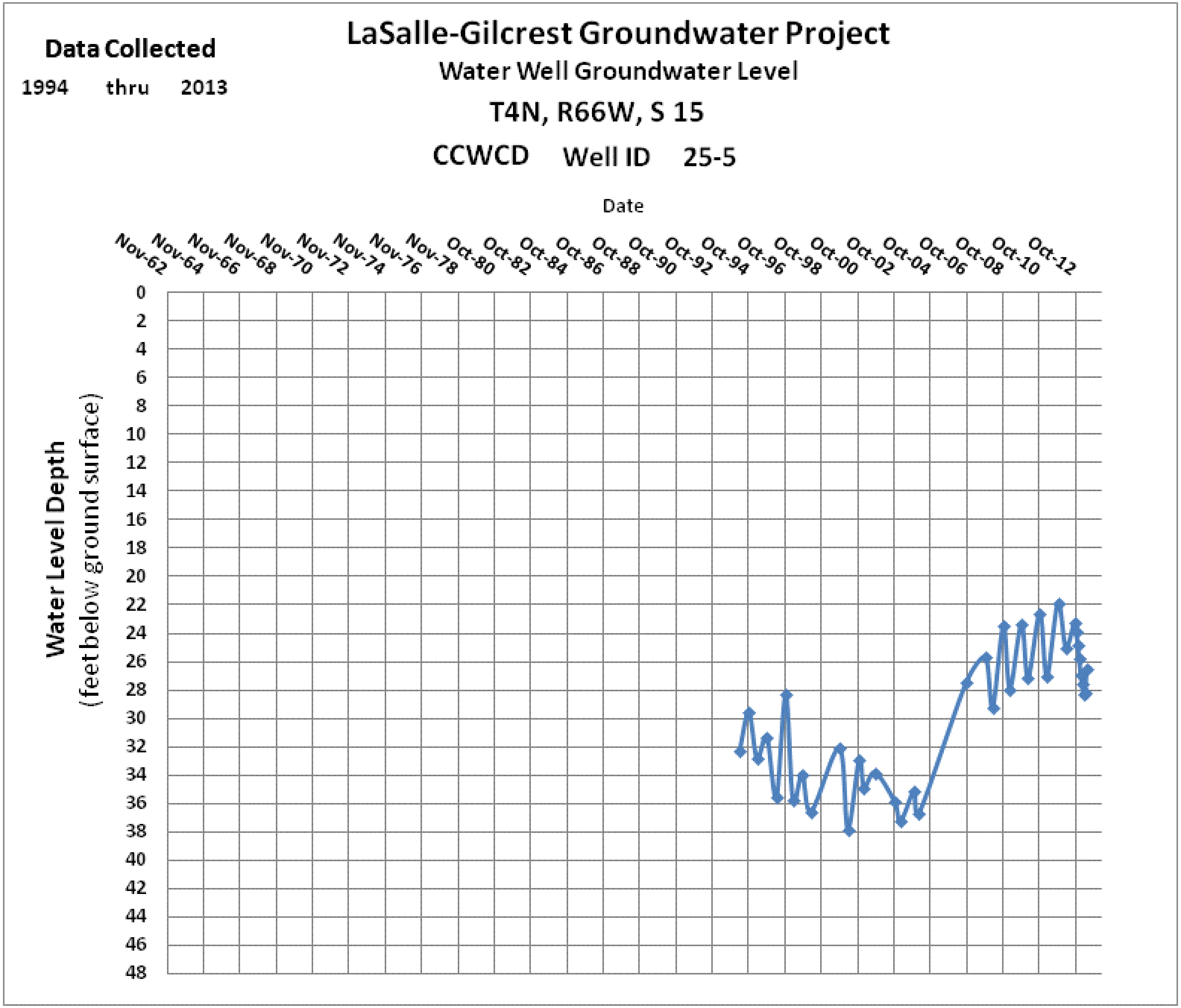

Data Collected
1994 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S 14
CCWCD Well ID 40-1
Date
Nov-62 Nov-64 Nov-66 Nov-68 Nov-70 Nov-72 Nov-74 Nov-76 Nov-78 Oct-80 Oct-82 Oct-84 Oct-86 Oct-88 Oct-90 Oct-92 Oct-94 Oct-96 Oct-98 Oct-00 Oct-02 Oct-04 Oct-06 Oct-08 Oct-10 Oct-12
Water Level Depth
(feet below ground surface)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48



Data Collected
1994 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S 15
CCWCD Well ID 25-5
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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LaSalle-Gilcrest Groundwater Project

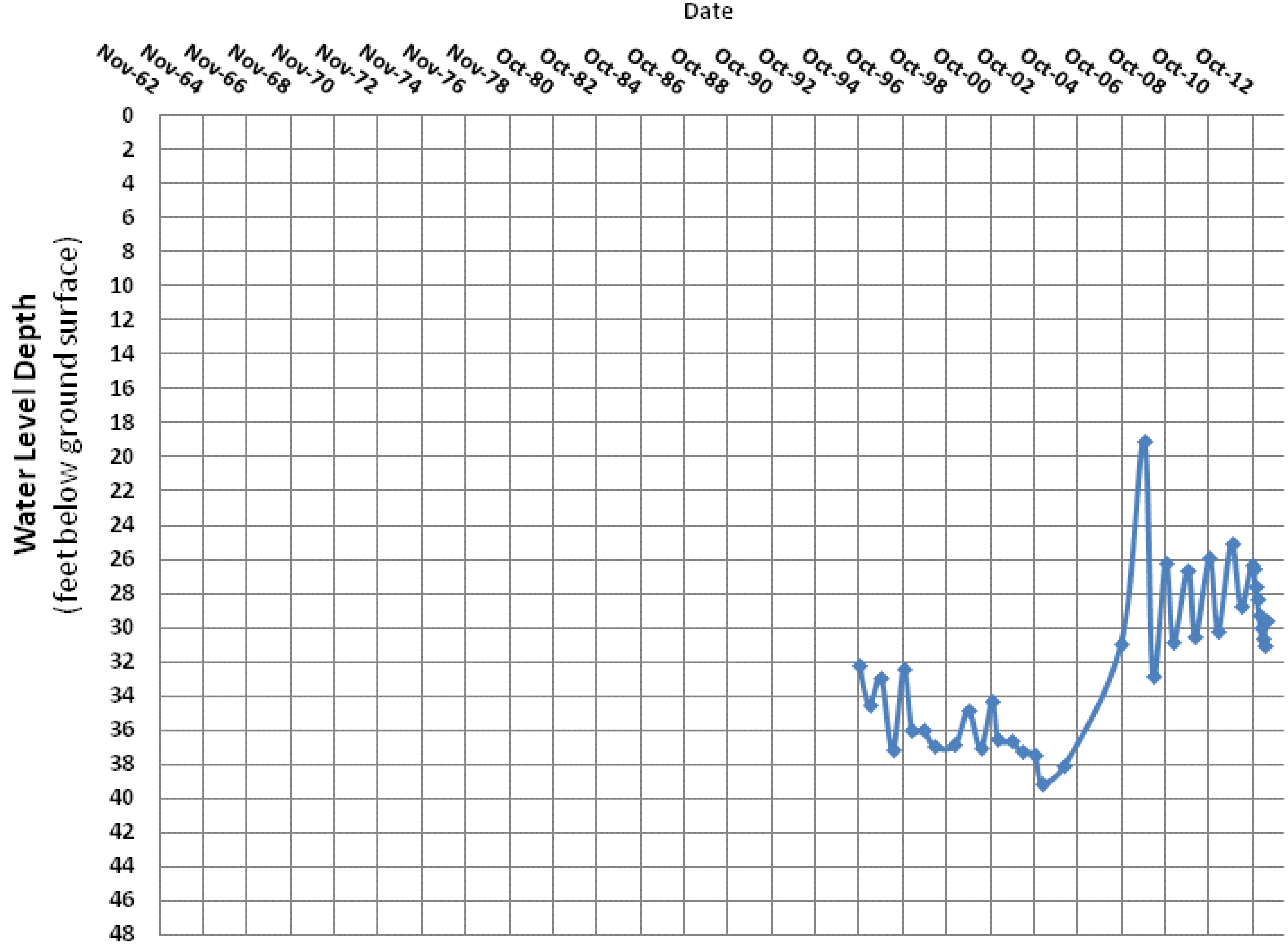
Water Well Groundwater Level

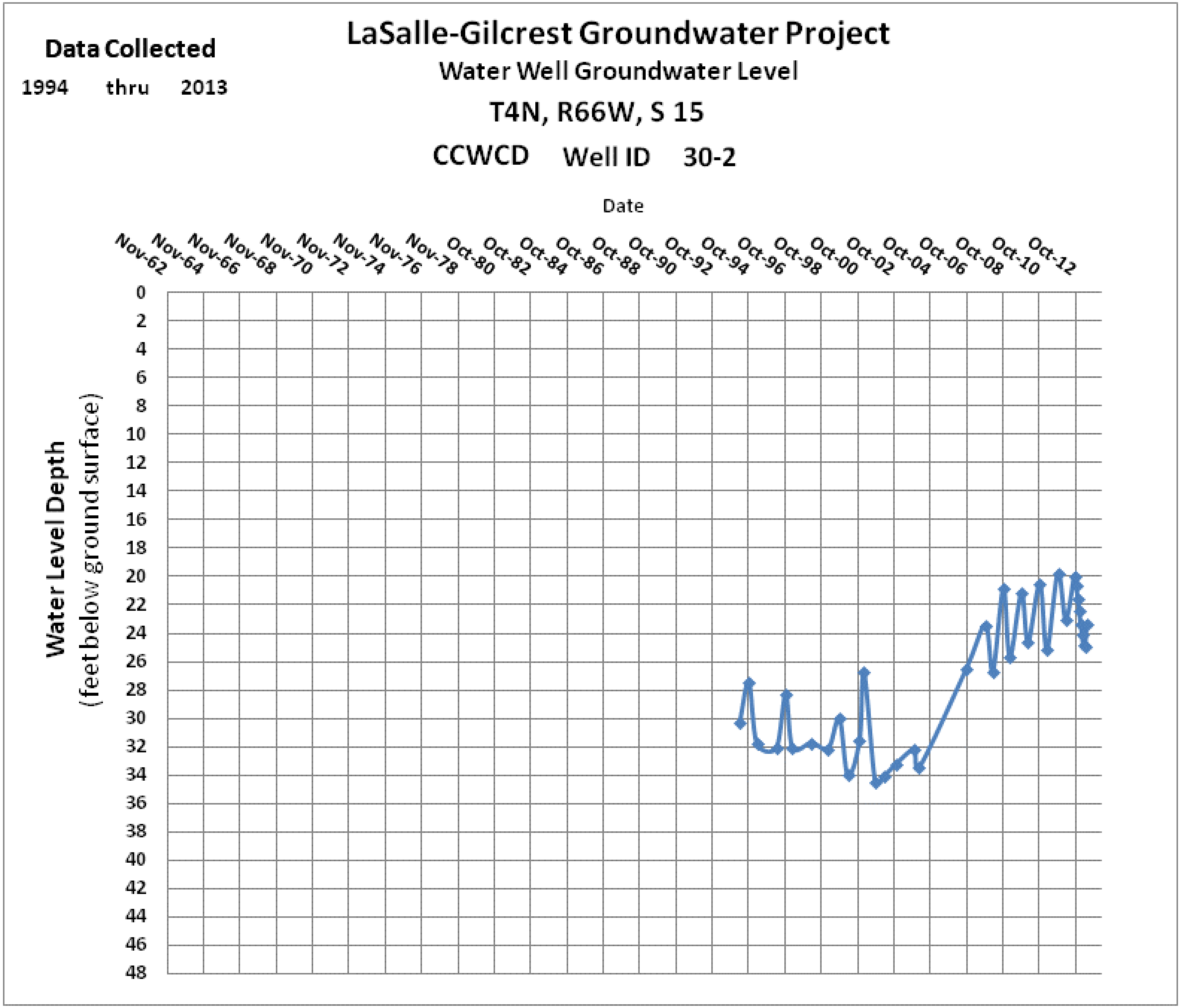
T4N, R66W, S 15

CCWCD Well ID 29-1

Data Collected

1994 thru 2013




Data Collected
1994 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S 15
CCWCD Well ID 30-2
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
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Oct-82
Oct-84
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Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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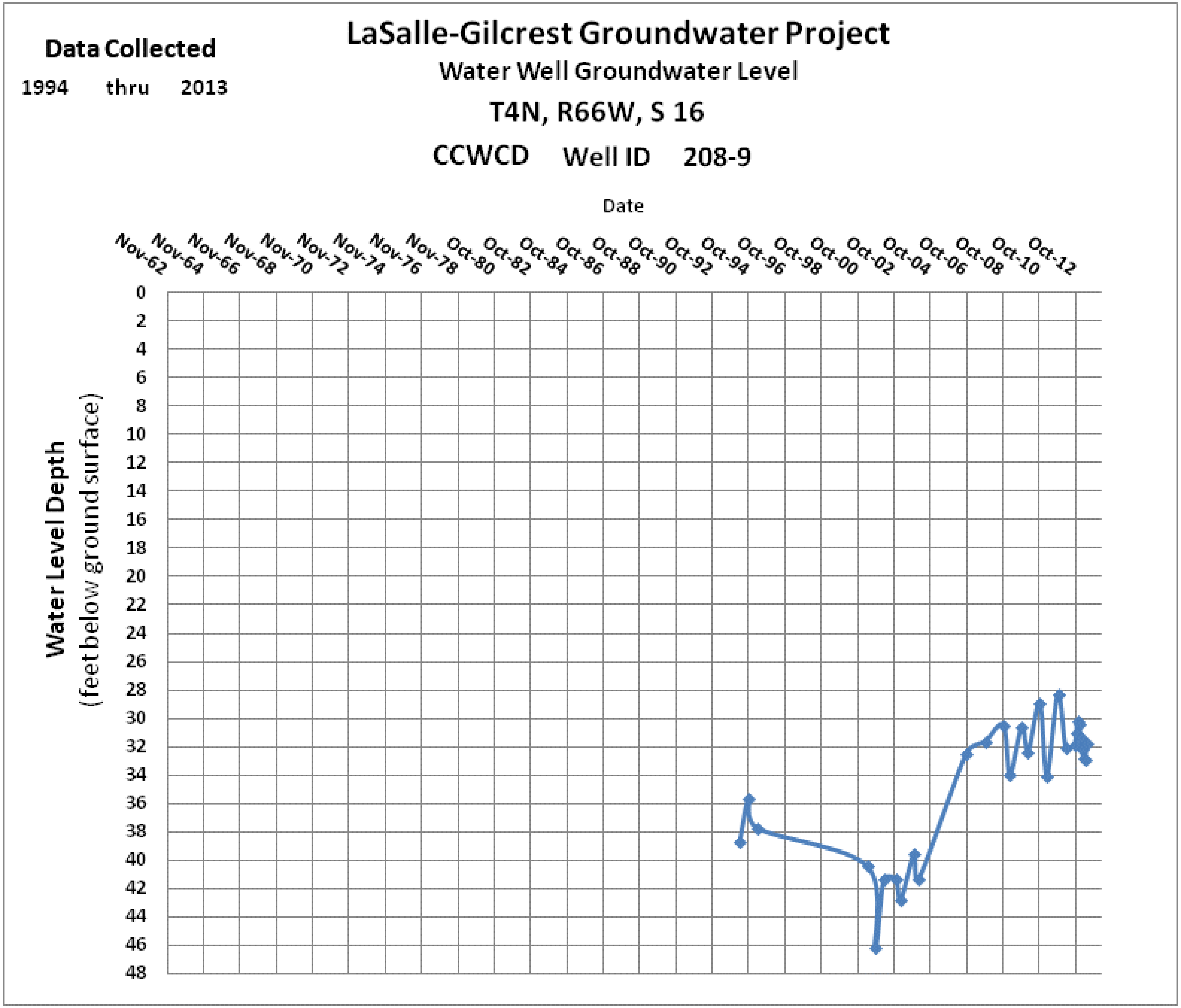
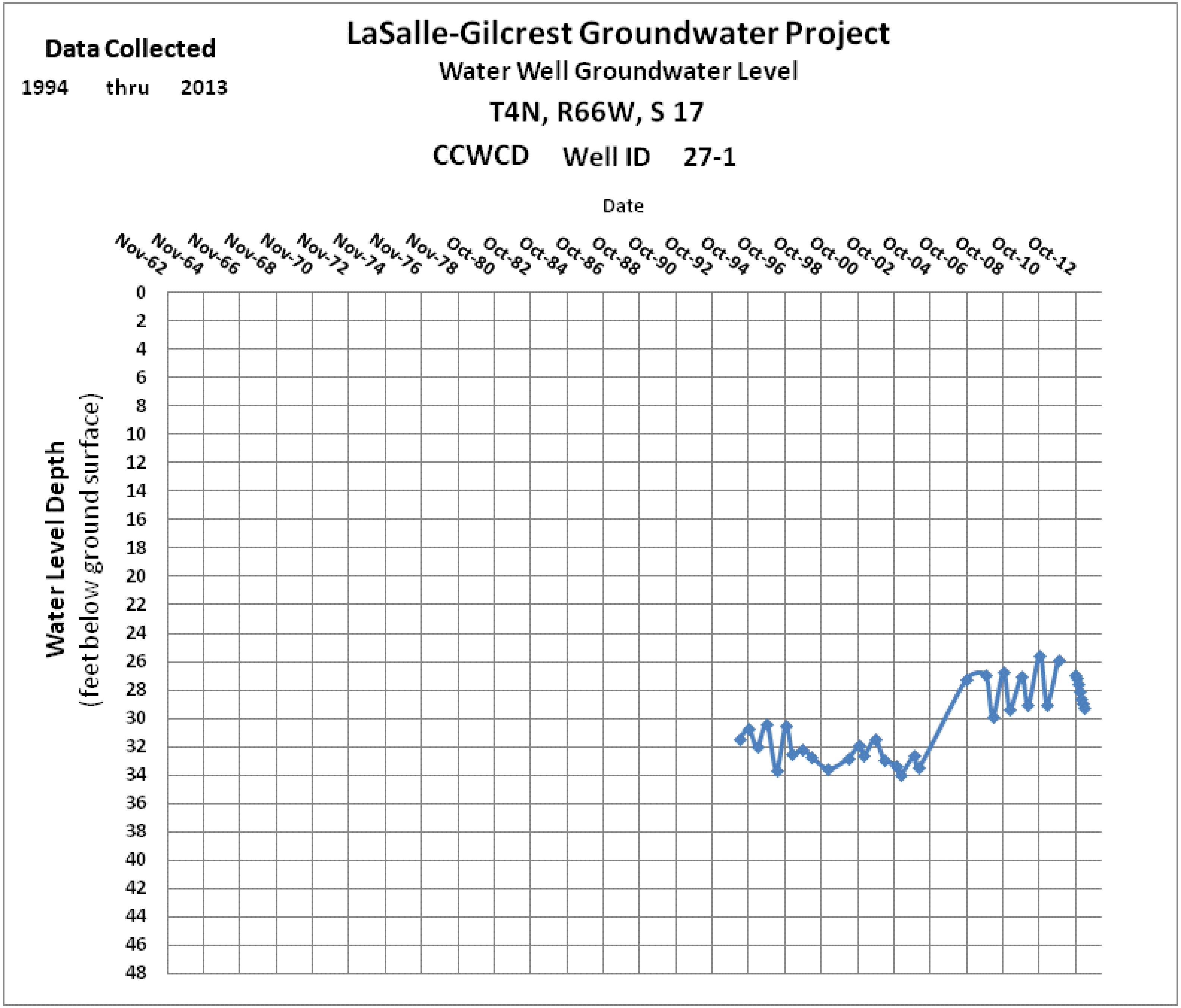

Data Collected
1994 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S 16
CCWCD Well ID 208-9
Date
Nov-62 Nov-64 Nov-66 Nov-68 Nov-70 Nov-72 Nov-74 Nov-76 Nov-78 Oct-80 Oct-82 Oct-84 Oct-86 Oct-88 Oct-90 Oct-92 Oct-94 Oct-96 Oct-98 Oct-00 Oct-02 Oct-04 Oct-06 Oct-08 Oct-10 Oct-12
Water Level Depth
(feet below ground surface)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48



Data Collected
1994 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S 17
CCWCD Well ID 27-1
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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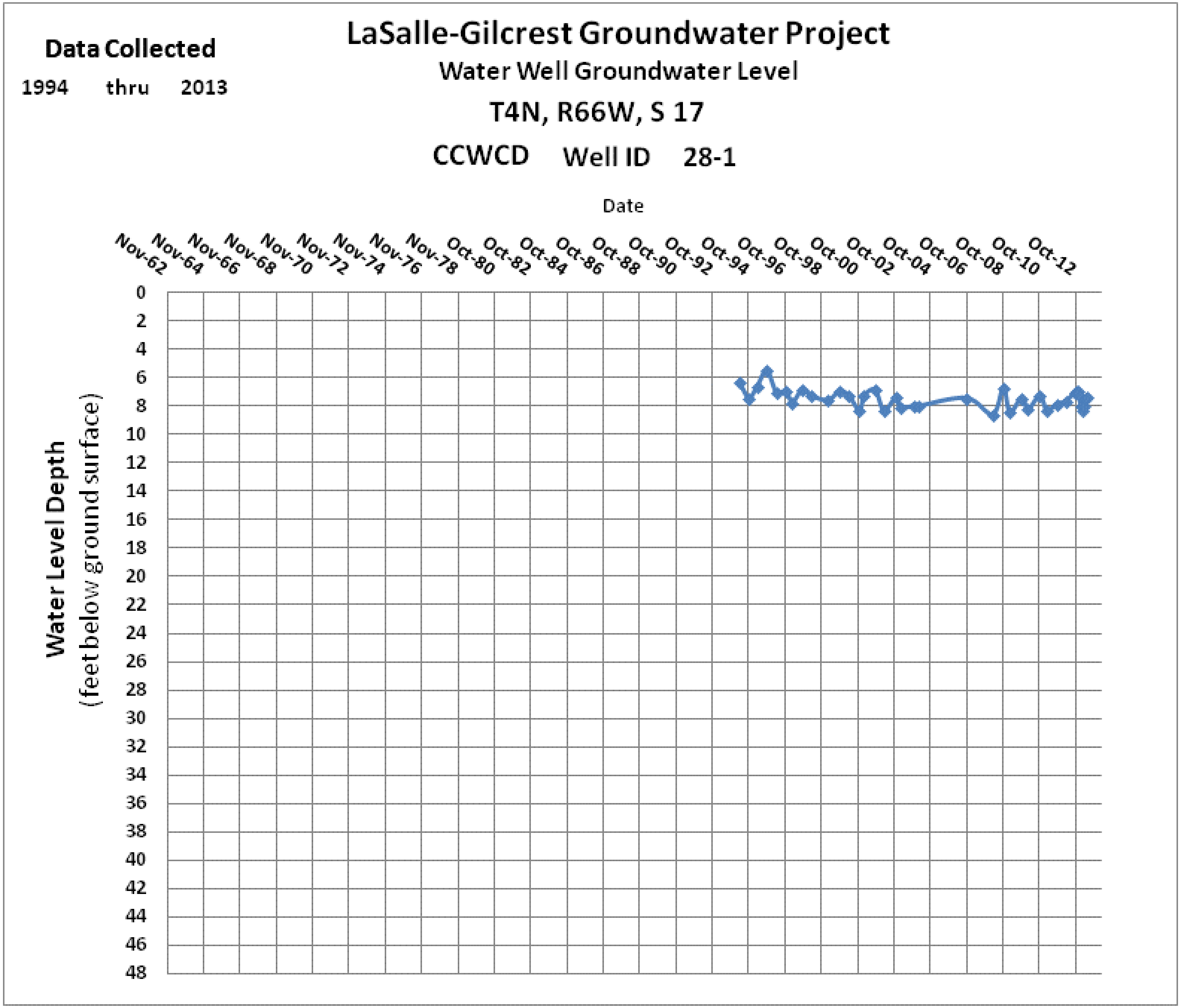

Data Collected
1994 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S 17
CCWCD Well ID 28-1
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
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Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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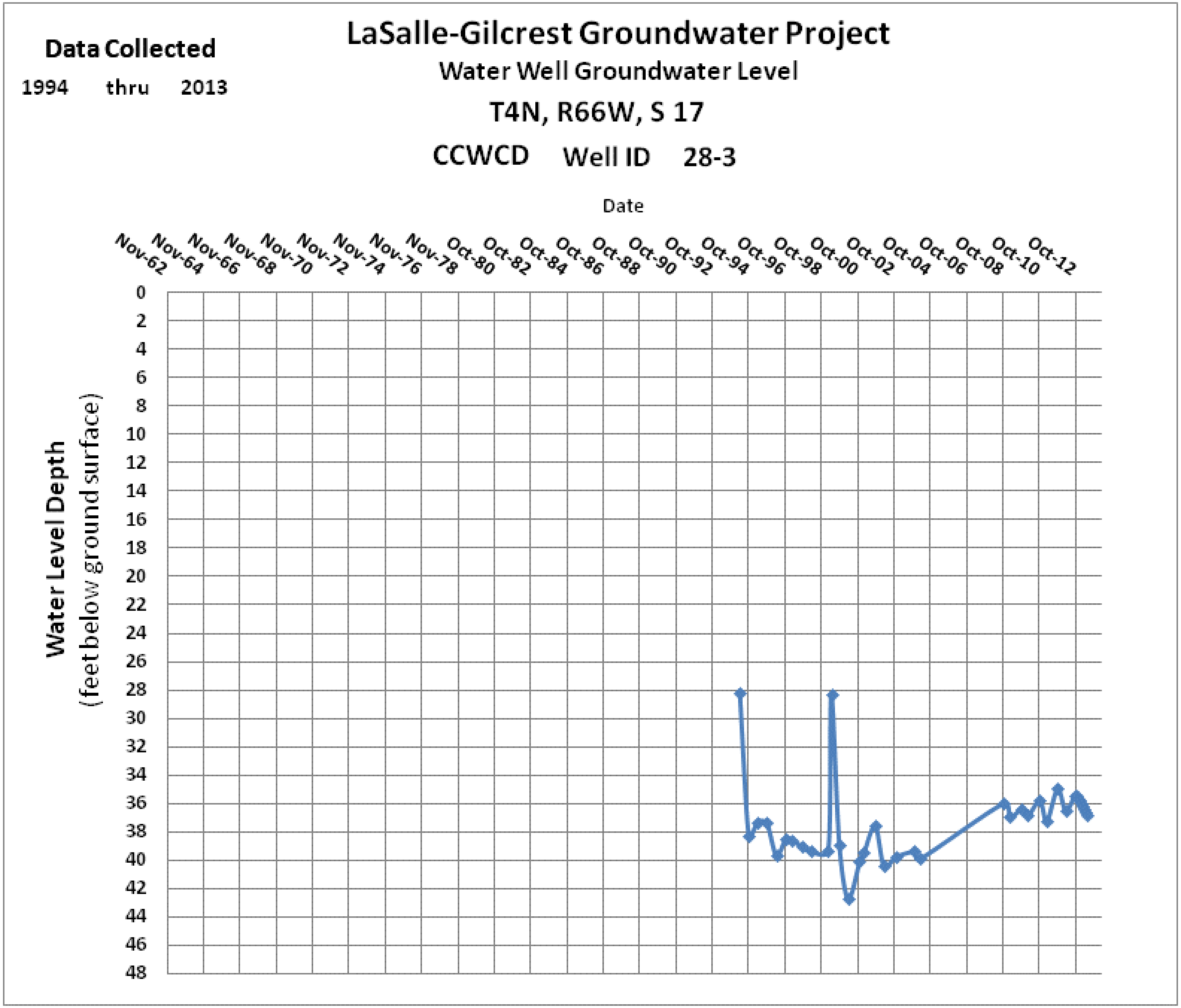

LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S 17
CCWCD Well ID 28-3
Data Collected
1994 thru 2013
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
0
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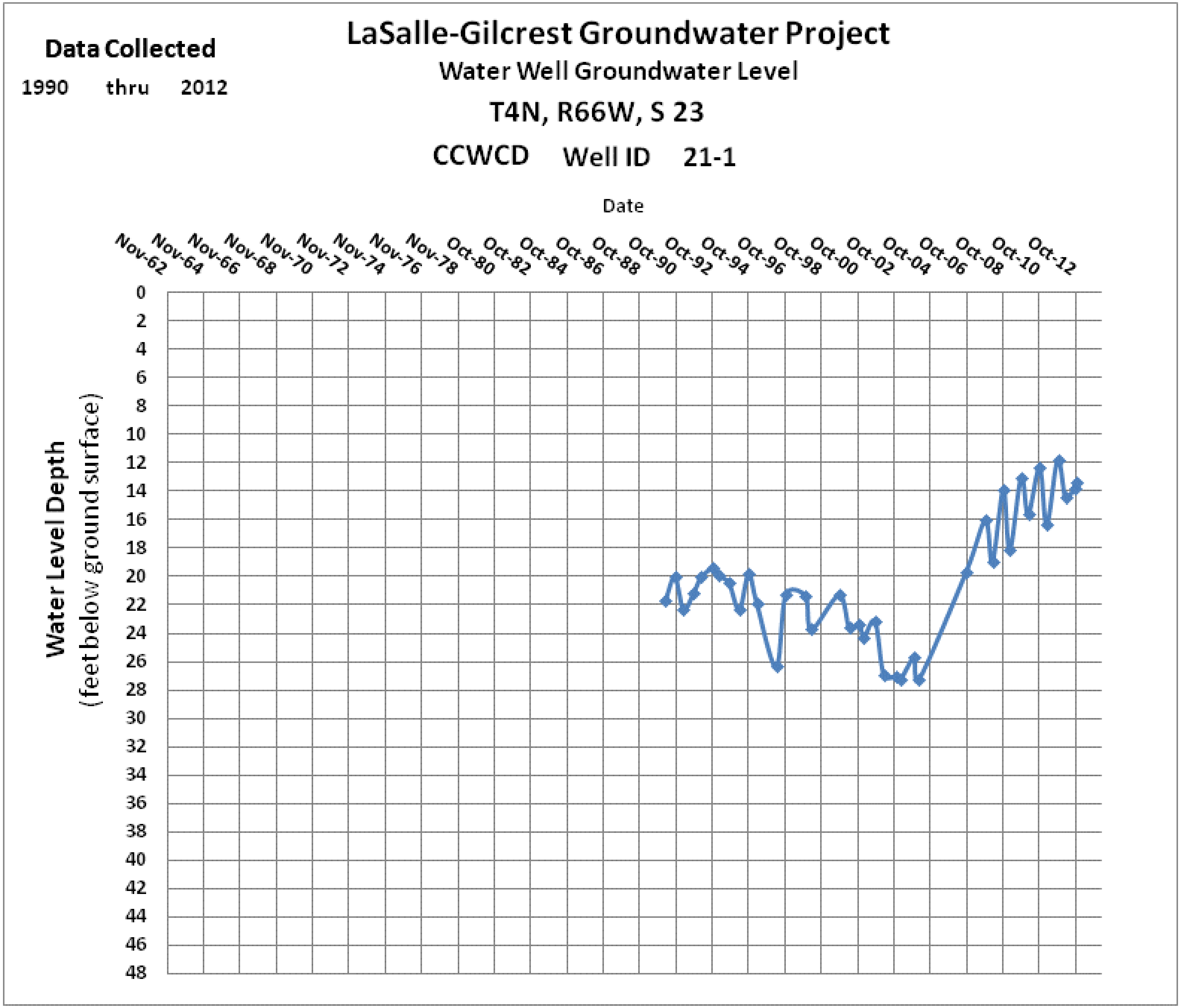
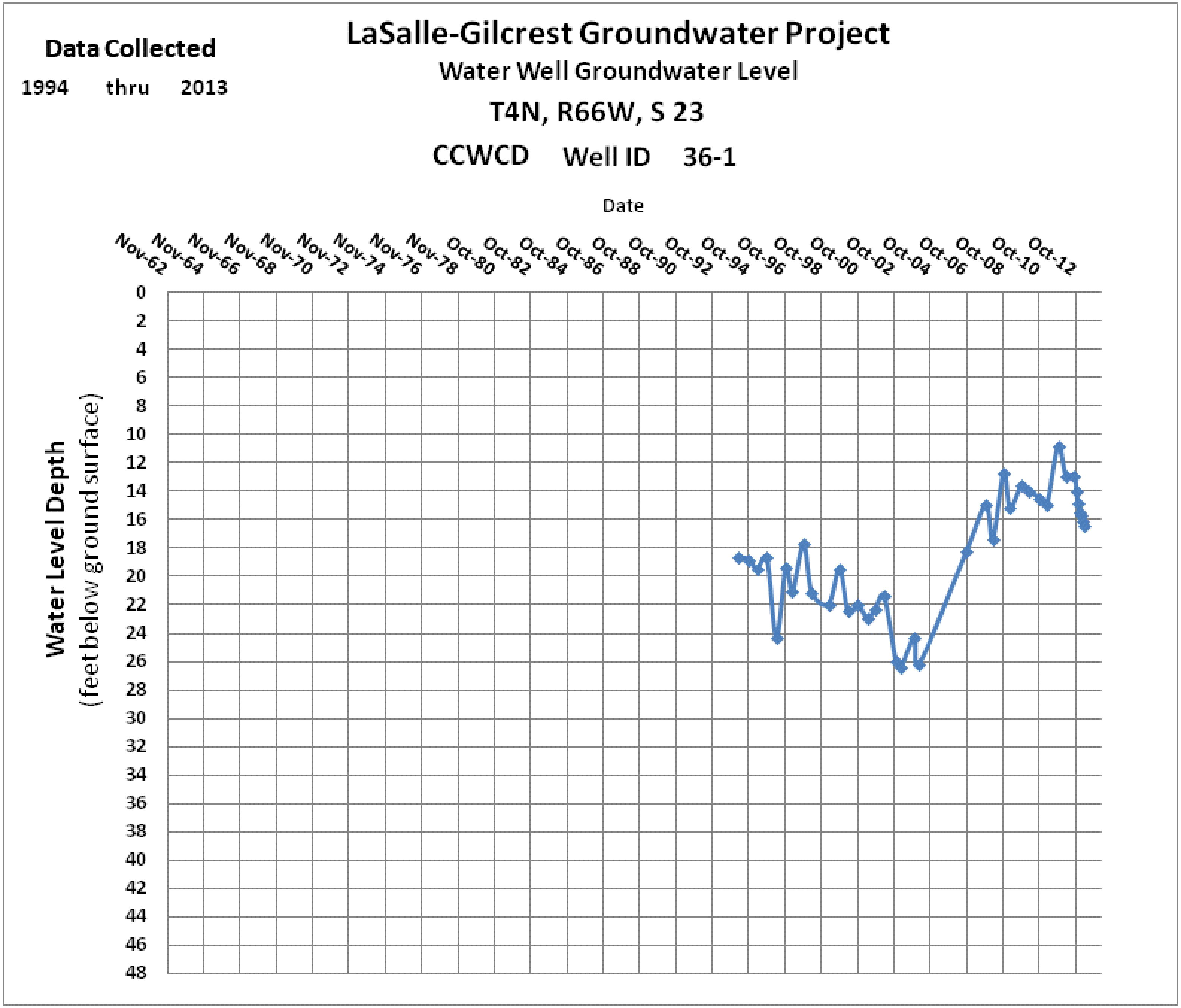


Data Collected
1990 thru 2012
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S 23
CCWCD Well ID 21-1
Date
Nov-62 Nov-64 Nov-66 Nov-68 Nov-70 Nov-72 Nov-74 Nov-76 Nov-78 Oct-80 Oct-82 Oct-84 Oct-86 Oct-88 Oct-90 Oct-92 Oct-94 Oct-96 Oct-98 Oct-00 Oct-02 Oct-04 Oct-06 Oct-08 Oct-10 Oct-12
Water Level Depth
(feet below ground surface)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48


Data Collected
1994 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S 23
CCWCD Well ID 36-1
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
0
2
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20
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24
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28
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32
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42
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48

Data Collected

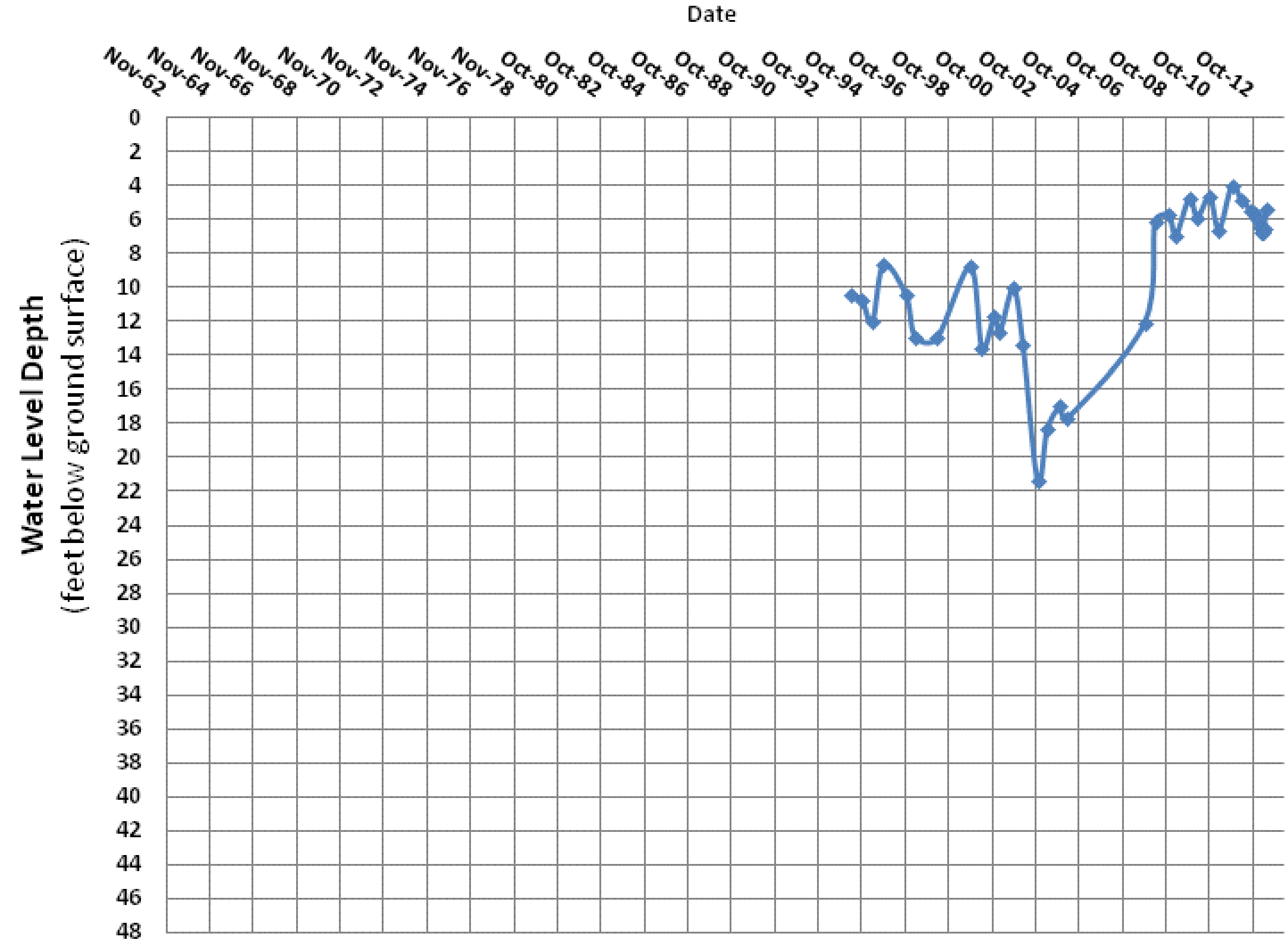
1994 thru 2013

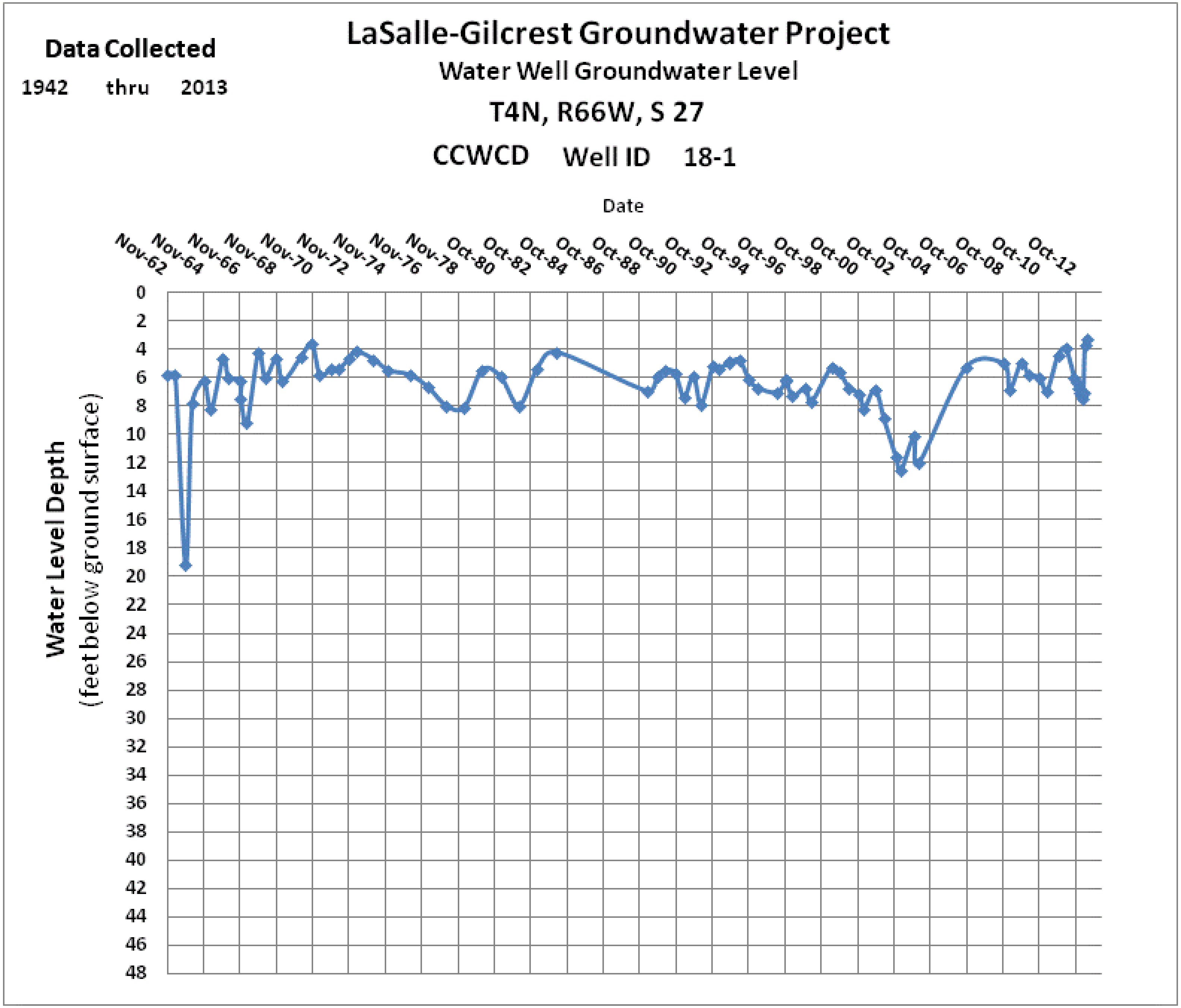
LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

T4N, R66W, S 27

CCWCD Well ID 108-1





Data Collected
1942 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S 27
CCWCD Well ID 18-1
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
0
2
4
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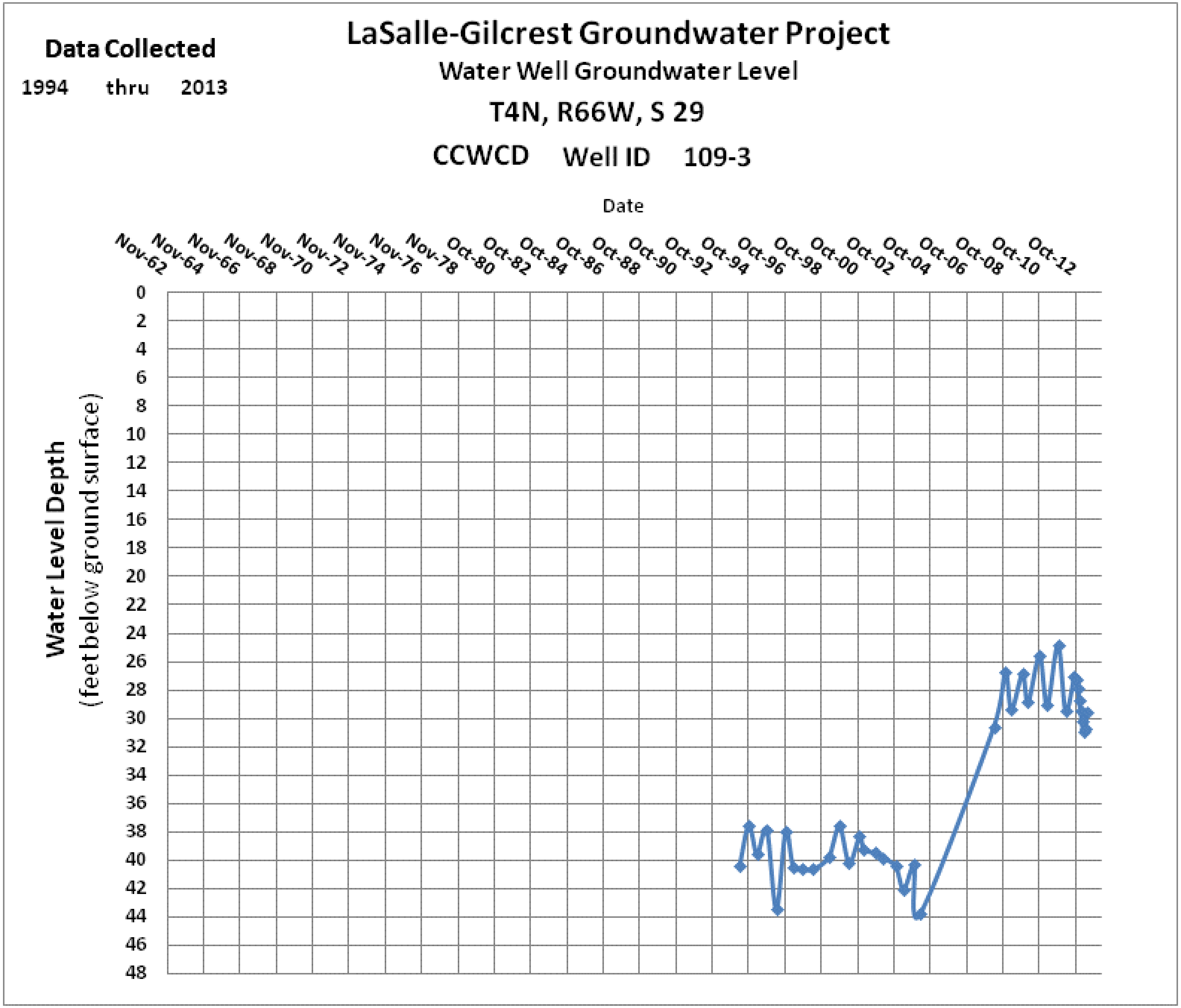

Data Collected
1994 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S 29
CCWCD Well ID 109-3
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
0
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44
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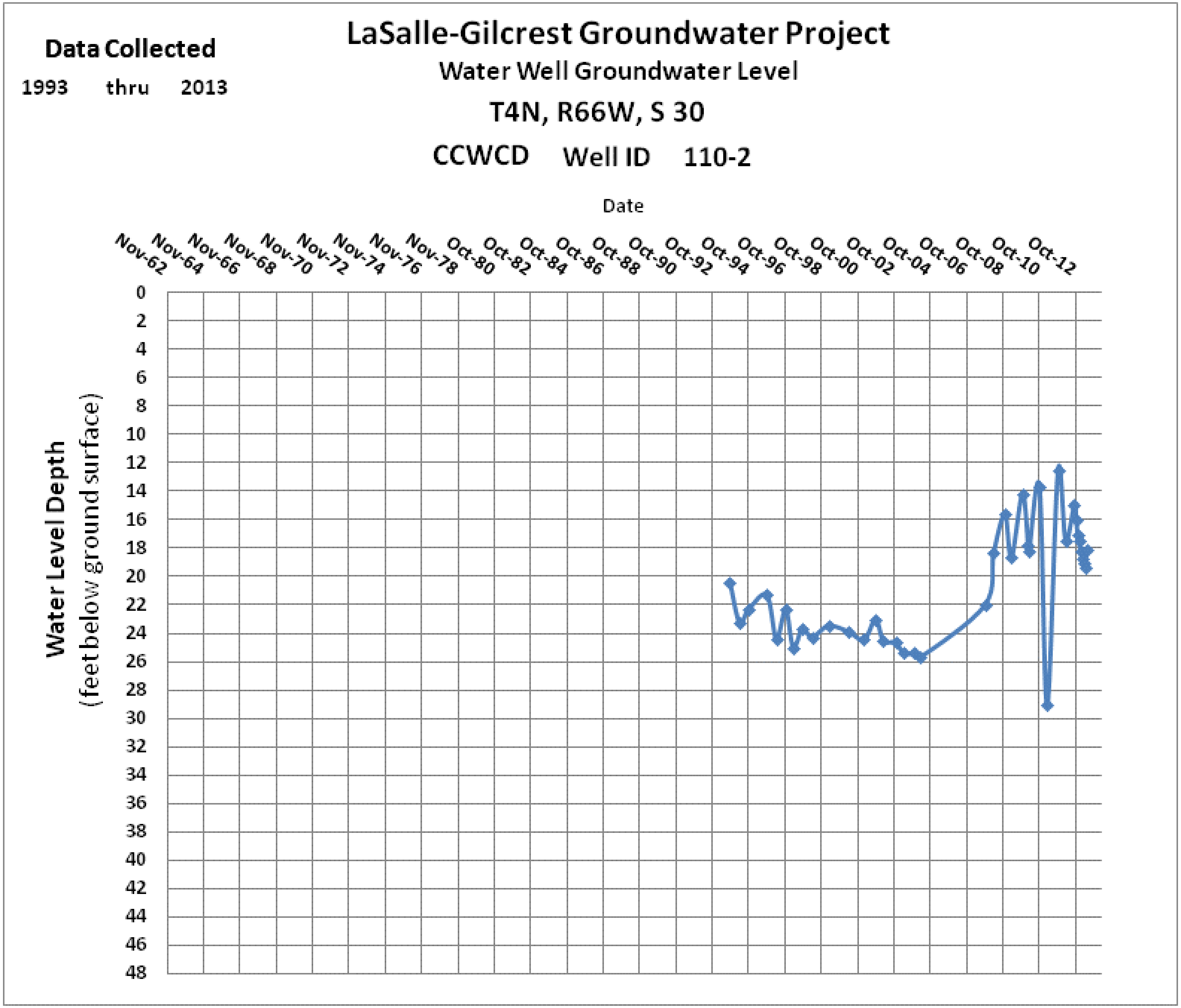
Data Collected
1993 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S 30
CCWCD Well ID 110-2
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
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Oct-86
Oct-88
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Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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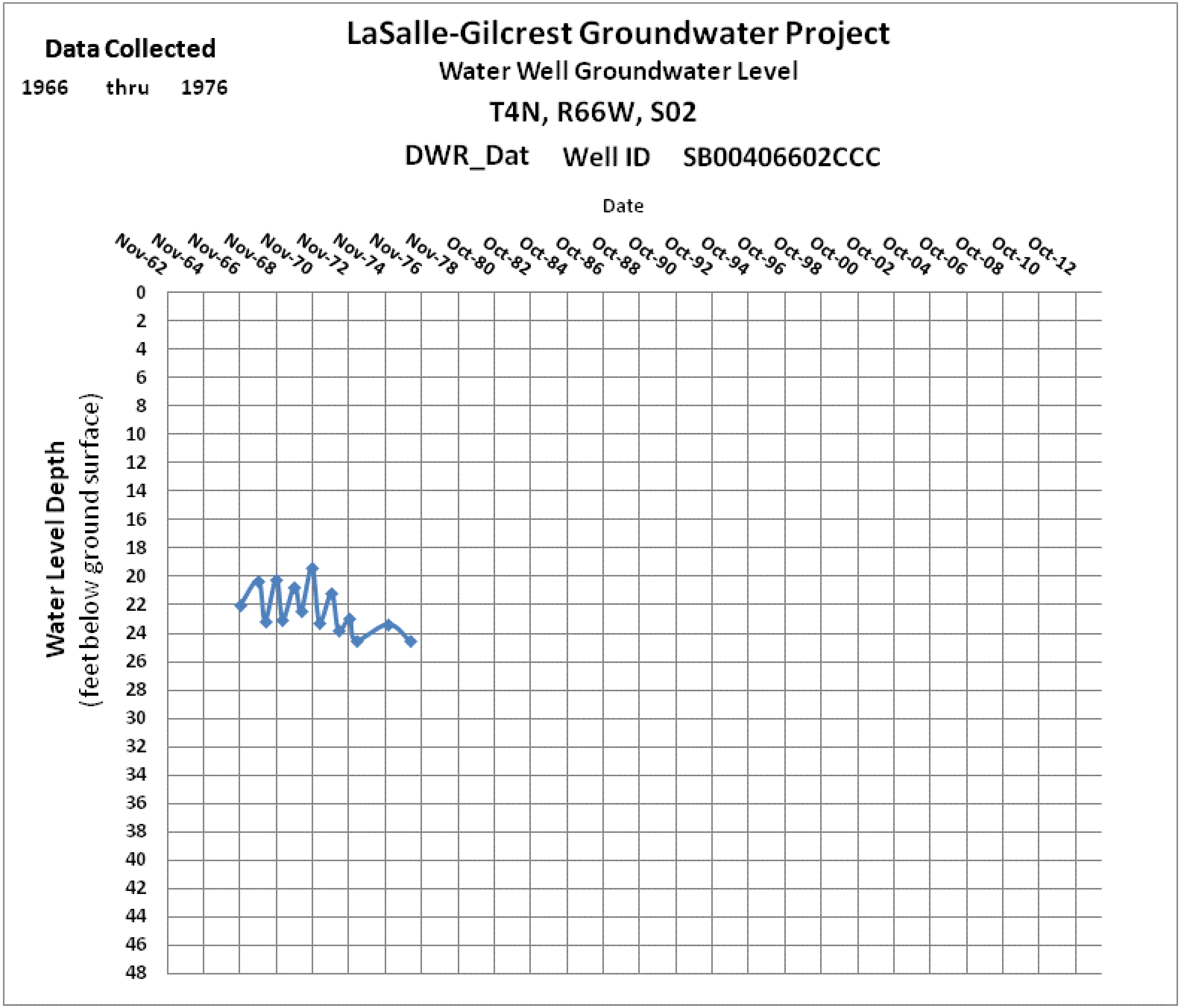
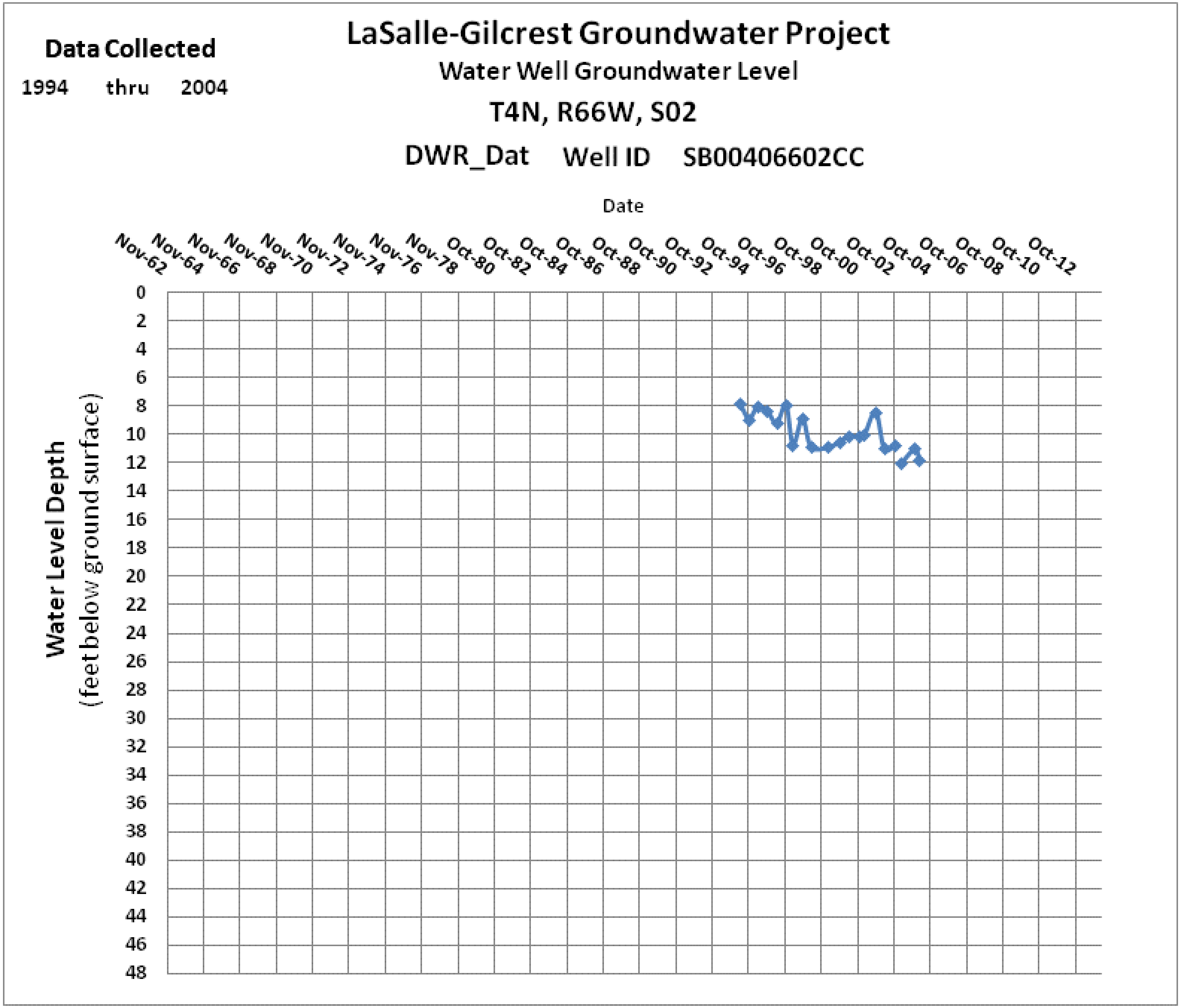
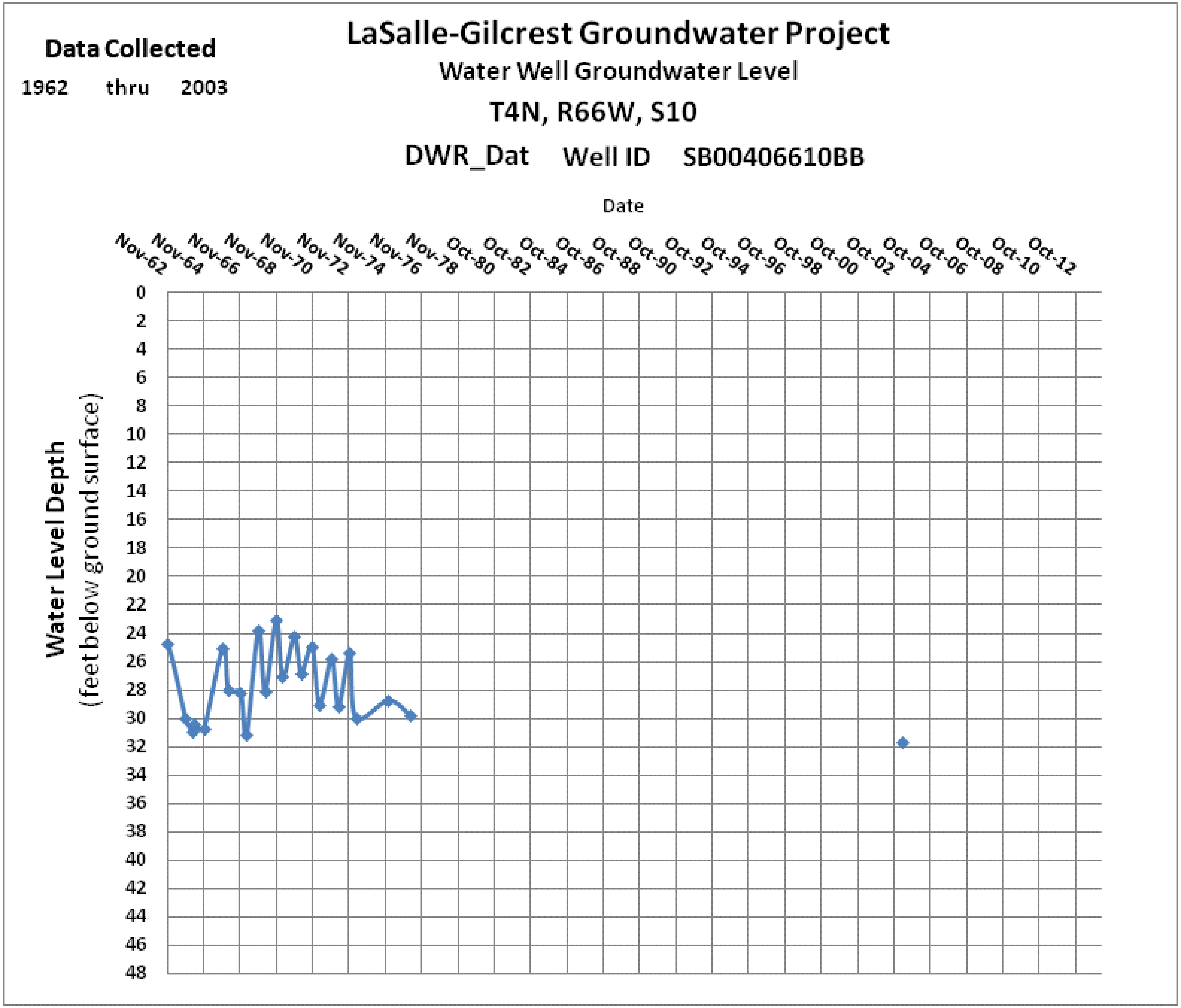


Data Collected
1966 thru 1976
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S02
DWR_Dat Well ID SB00406602CCC
Date
Nov-62 Nov-64 Nov-66 Nov-68 Nov-70 Nov-72 Nov-74 Nov-76 Nov-78 Oct-80 Oct-82 Oct-84 Oct-86 Oct-88 Oct-90 Oct-92 Oct-94 Oct-96 Oct-98 Oct-00 Oct-02 Oct-04 Oct-06 Oct-08 Oct-10 Oct-12
Water Level Depth
(feet below ground surface)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48


Data Collected
1994 thru 2004
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S02
DWR_Dat Well ID SB00406602CC
Date
Nov-62 Nov-64 Nov-66 Nov-68 Nov-70 Nov-72 Nov-74 Nov-76 Nov-78 Oct-80 Oct-82 Oct-84 Oct-86 Oct-88 Oct-90 Oct-92 Oct-94 Oct-96 Oct-98 Oct-00 Oct-02 Oct-04 Oct-06 Oct-08 Oct-10 Oct-12
Water Level Depth
(feet below ground surface)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48


Data Collected
1962 thru 2003
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S10
DWR_Dat Well ID SB00406610BB
Date
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Nov-64
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Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
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Oct-84
Oct-86
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Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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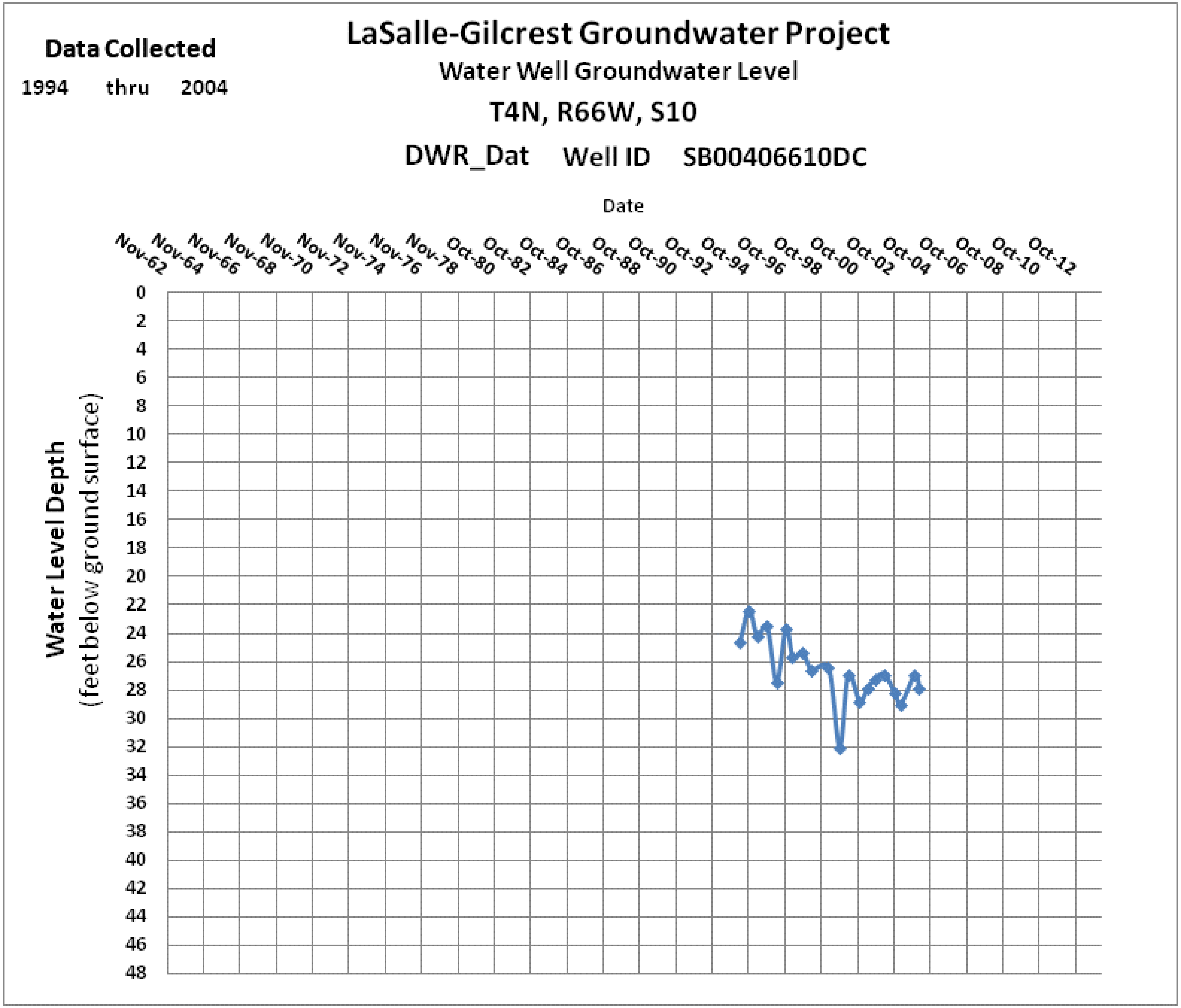

Data Collected
1994 thru 2004
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S10
DWR_Dat Well ID SB00406610DC
Date
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Nov-64
Nov-66
Nov-68
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Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
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Oct-96
Oct-98
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Oct-02
Oct-04
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Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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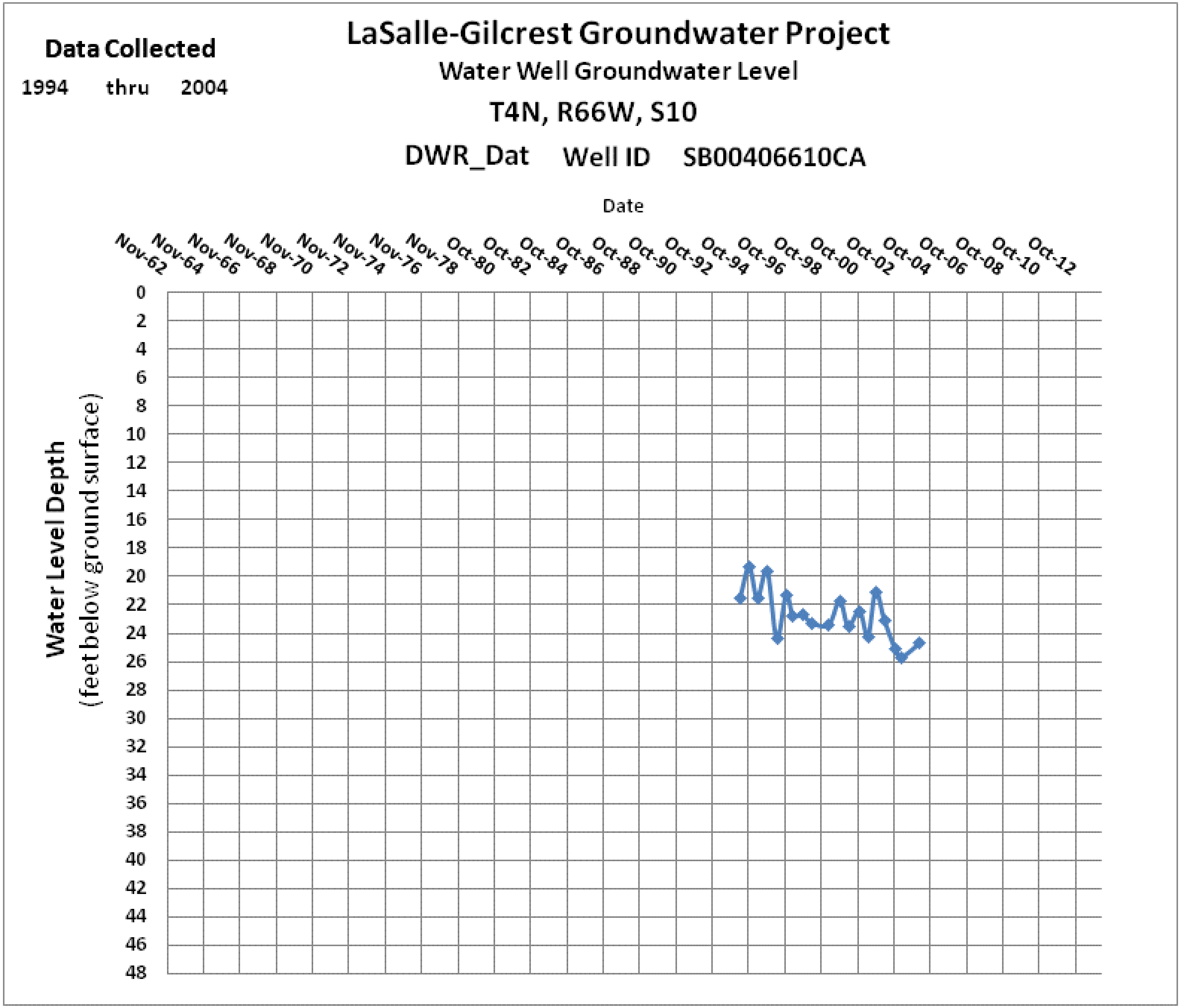


Data Collected
1994 thru 2004
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S10
DWR_Dat Well ID SB00406610CA
Date
Nov-62 Nov-64 Nov-66 Nov-68 Nov-70 Nov-72 Nov-74 Nov-76 Nov-78 Oct-80 Oct-82 Oct-84 Oct-86 Oct-88 Oct-90 Oct-92 Oct-94 Oct-96 Oct-98 Oct-00 Oct-02 Oct-04 Oct-06 Oct-08 Oct-10 Oct-12
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
Water Level Depth
(feet below ground surface)

LaSalle-Gilcrest Groundwater Project

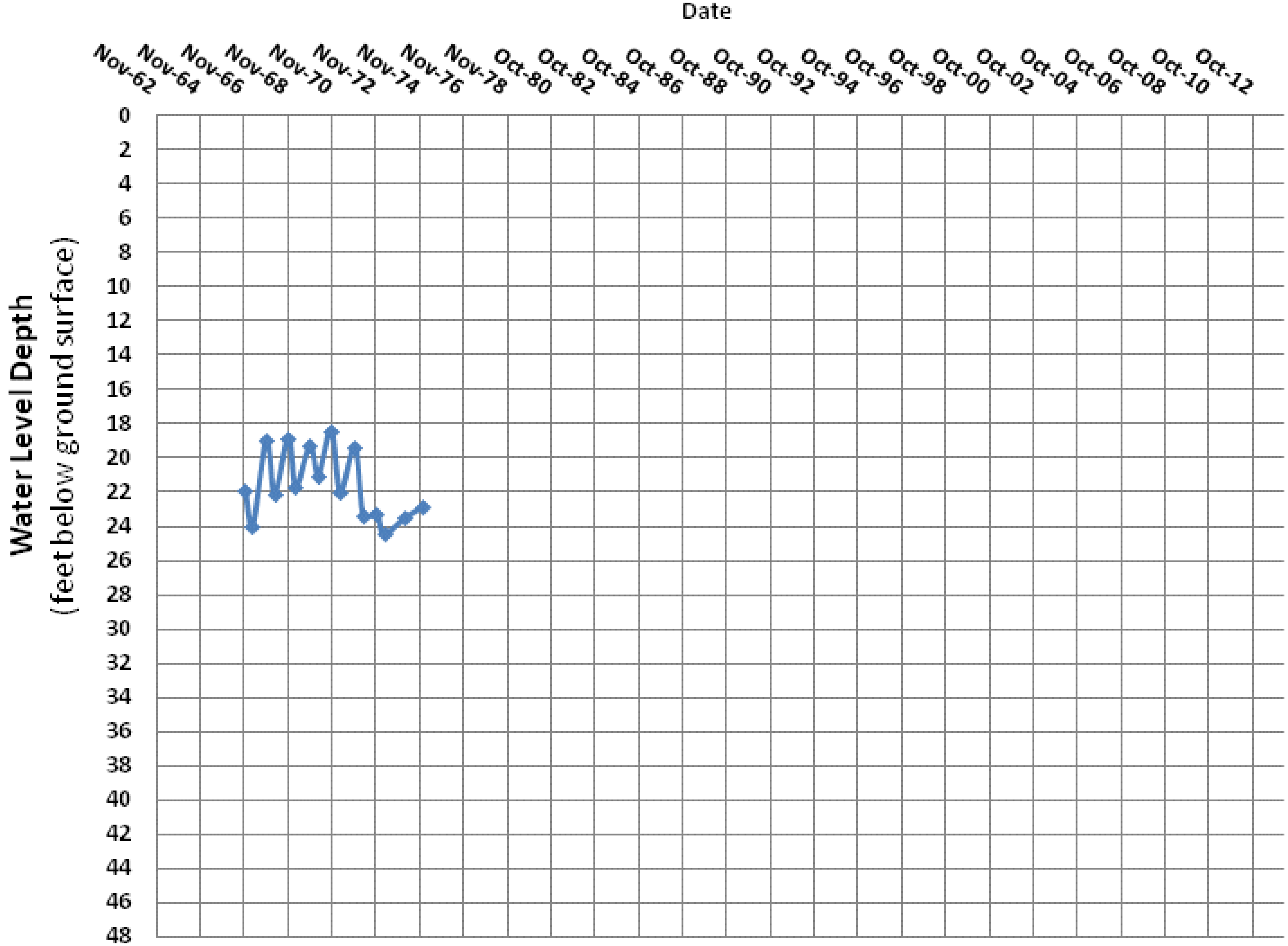
Data Collected

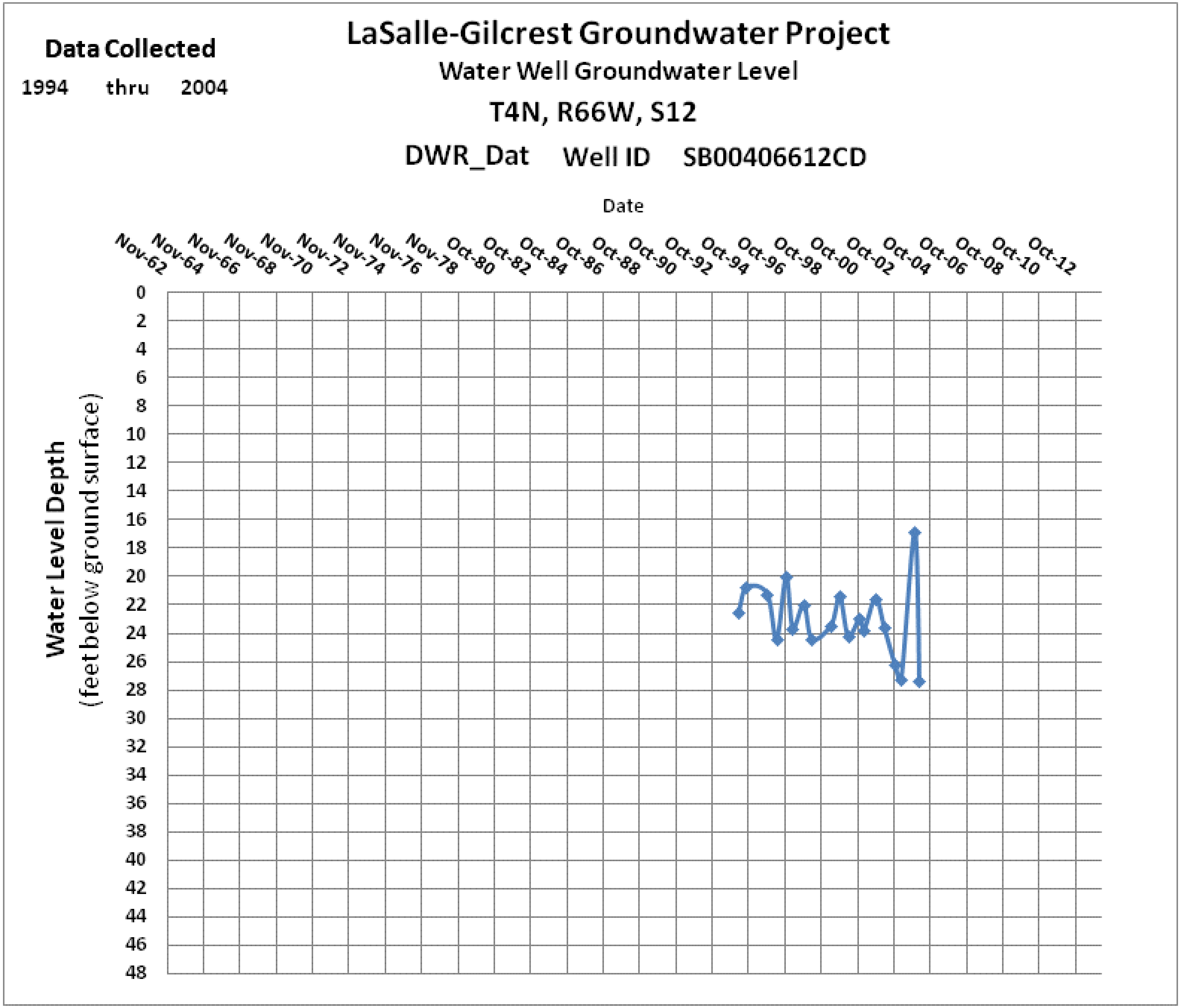
1966 thru 1975

Water Well Groundwater Level

T4N, R66W, S10

DWR_Dat Well ID SB00406610CDC




Data Collected
1994 thru 2004
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S12
DWR_Dat Well ID SB00406612CD
Date
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Nov-70
Nov-72
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Nov-76
Nov-78
Oct-80
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Oct-02
Oct-04
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Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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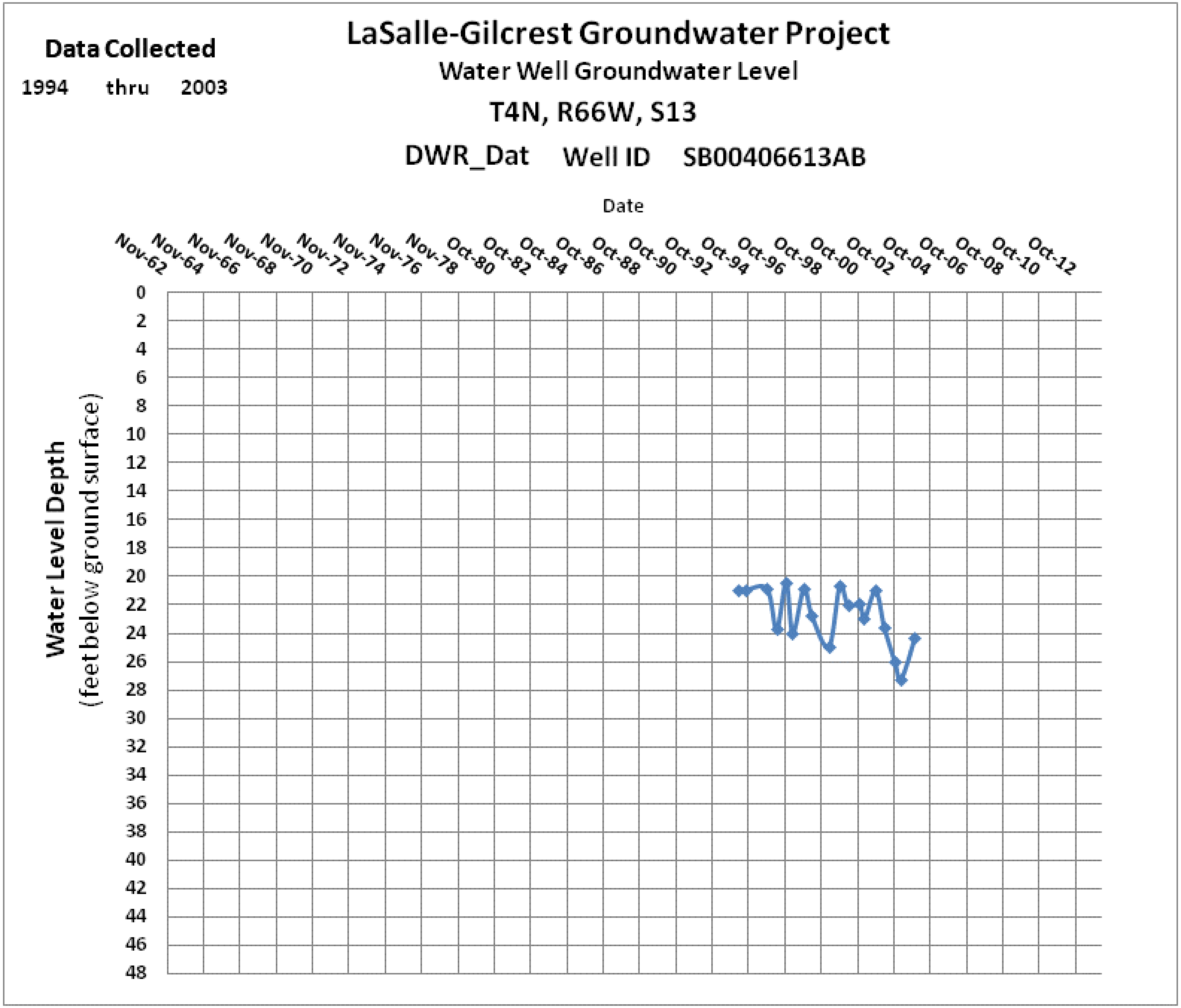

Data Collected
1994 thru 2003
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S13
DWR_Dat Well ID SB00406613AB
Date
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Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
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Oct-80
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Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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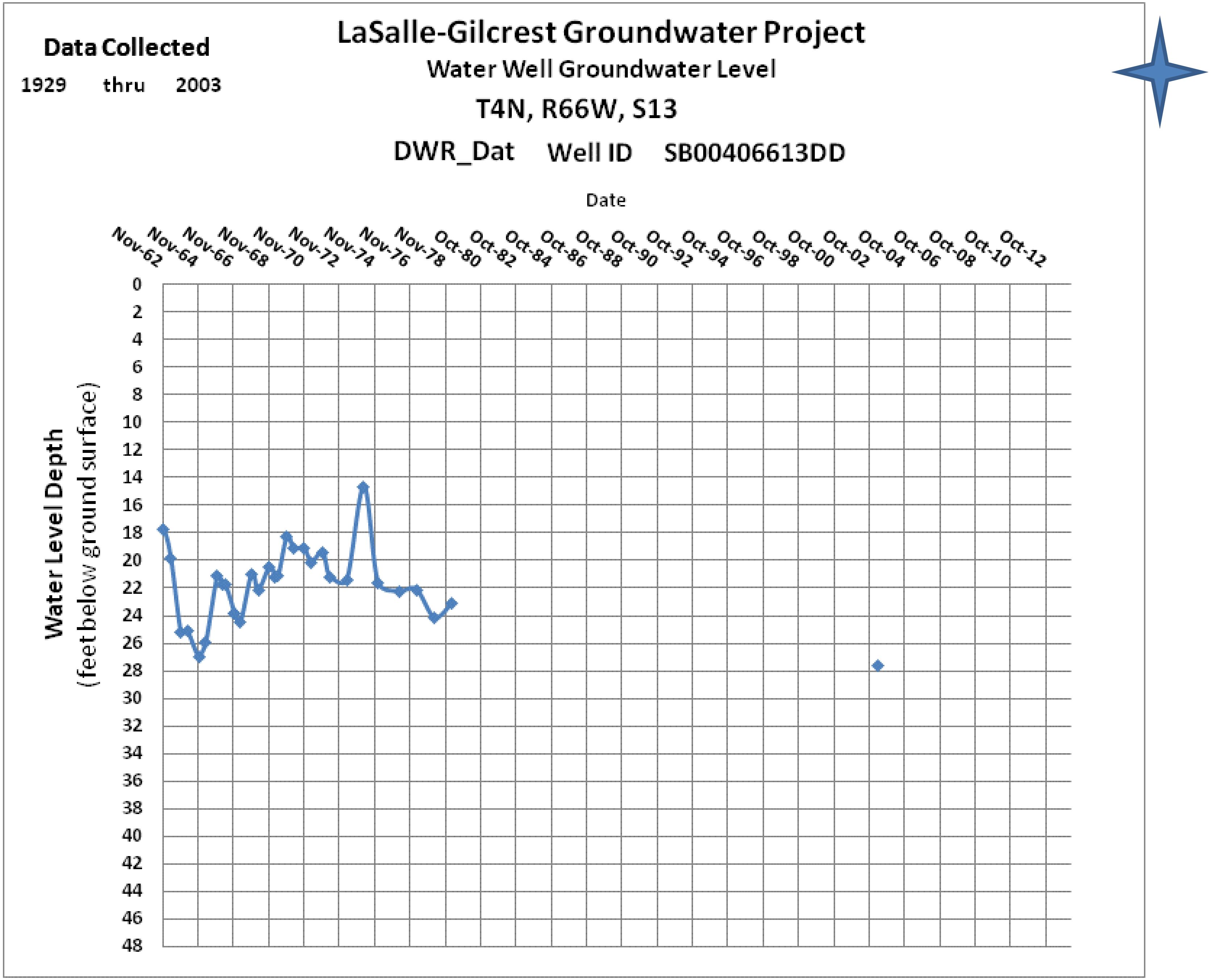

Data Collected
1929 thru 2003
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S13
DWR_Dat Well ID SB00406613DD
Date
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Nov-66
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Nov-72
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Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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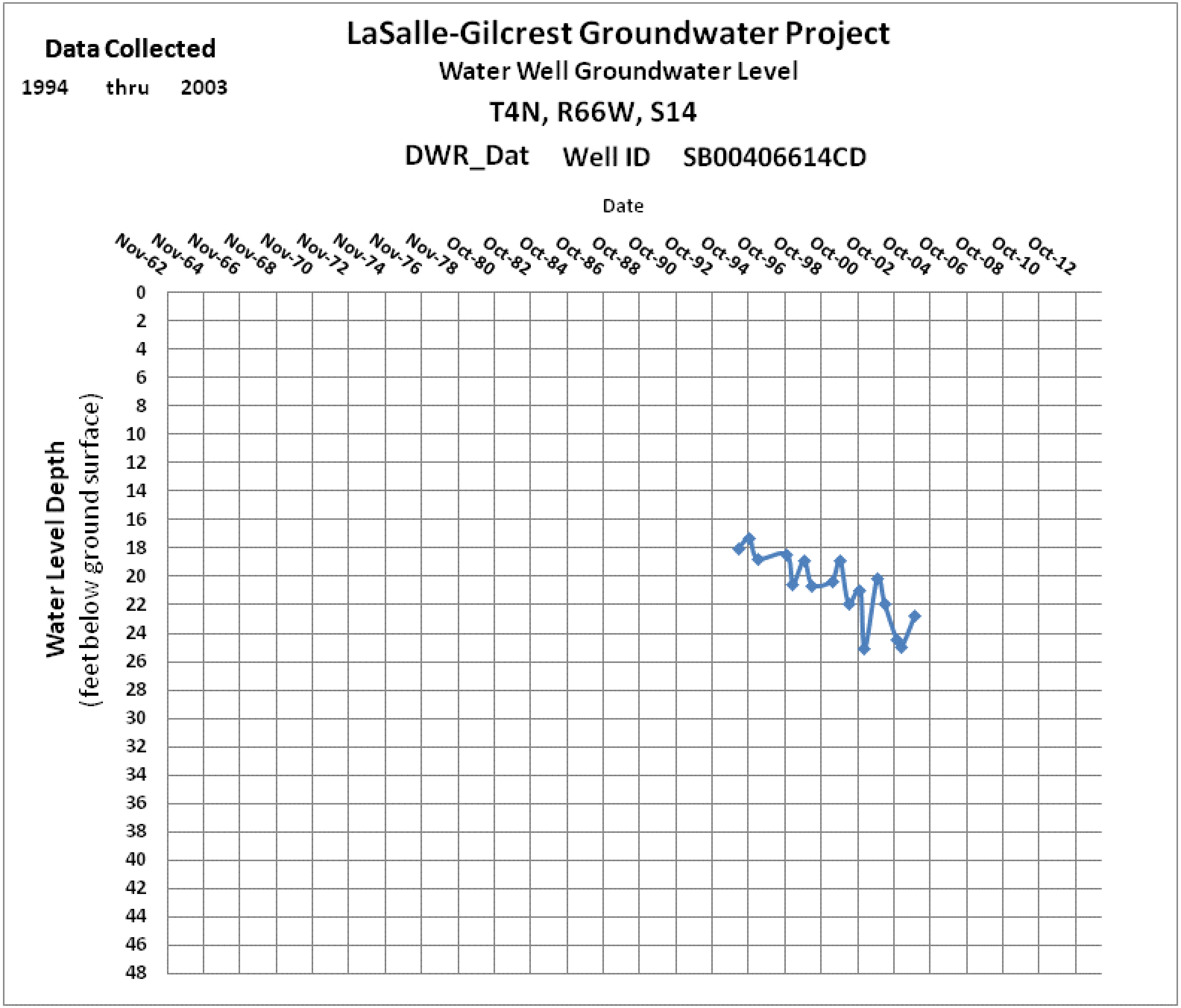
Data Collected
1994 thru 2003
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S14
DWR_Dat Well ID SB00406614CD
Date
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Nov-66
Nov-68
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Nov-76
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Oct-04
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Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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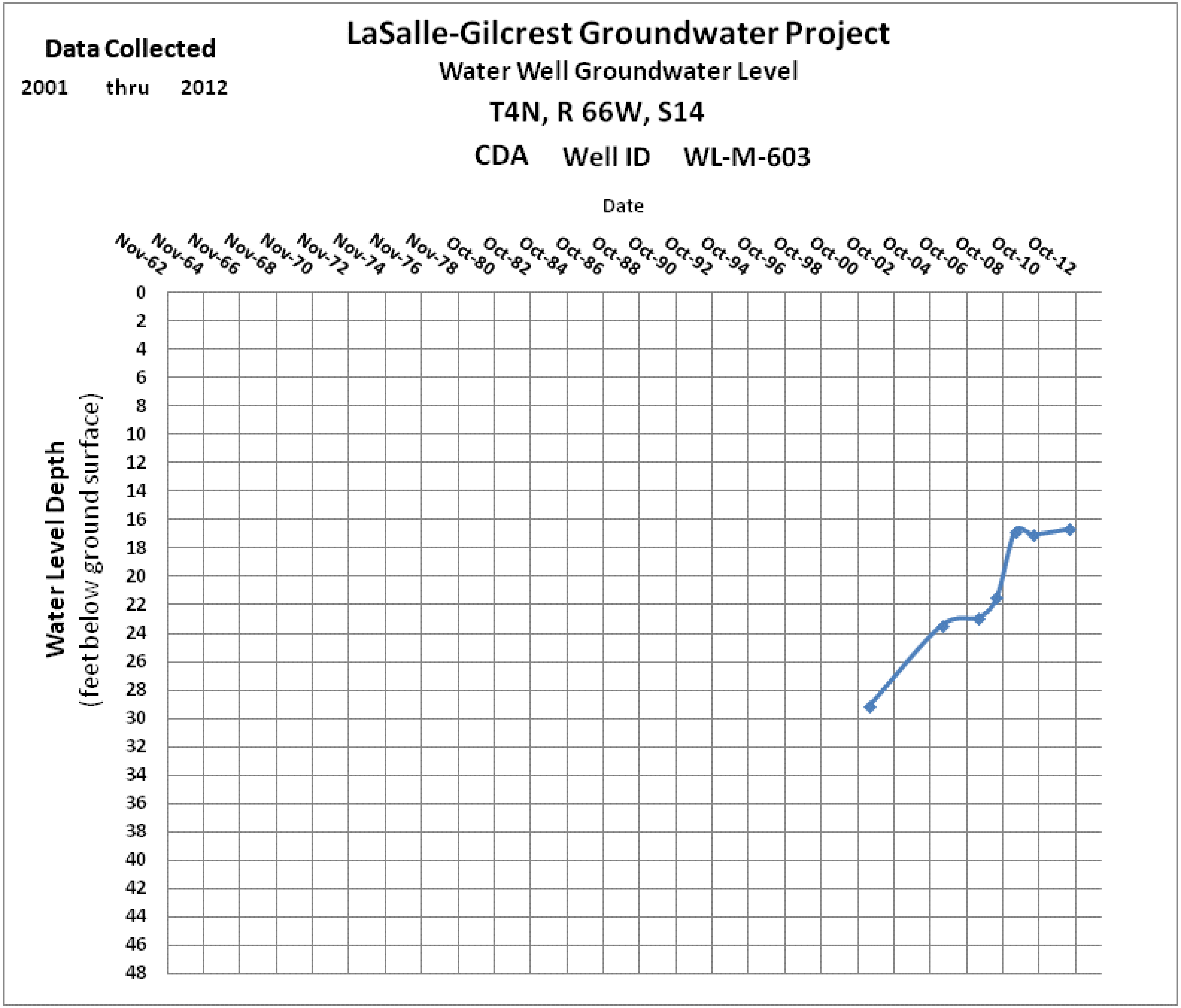
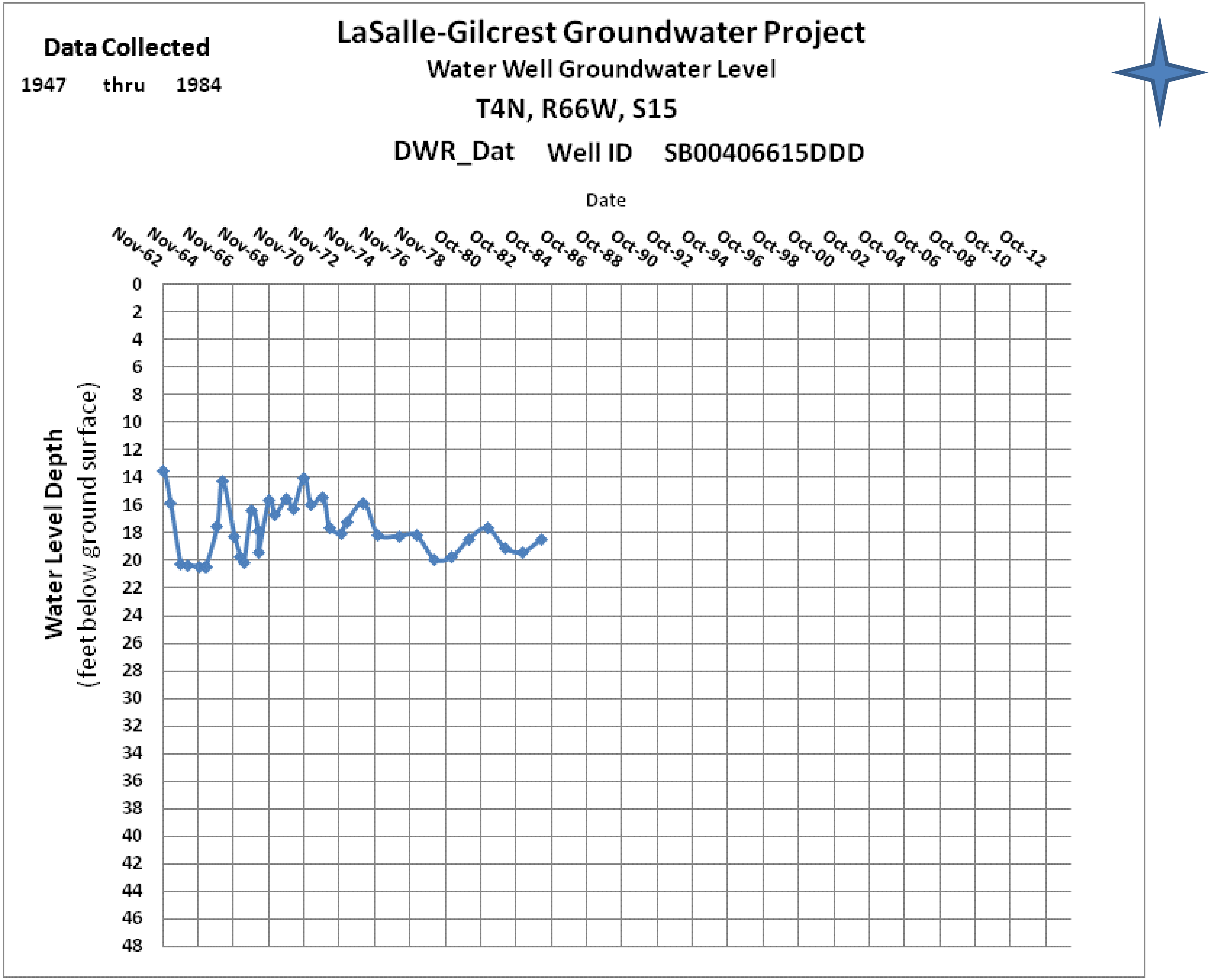
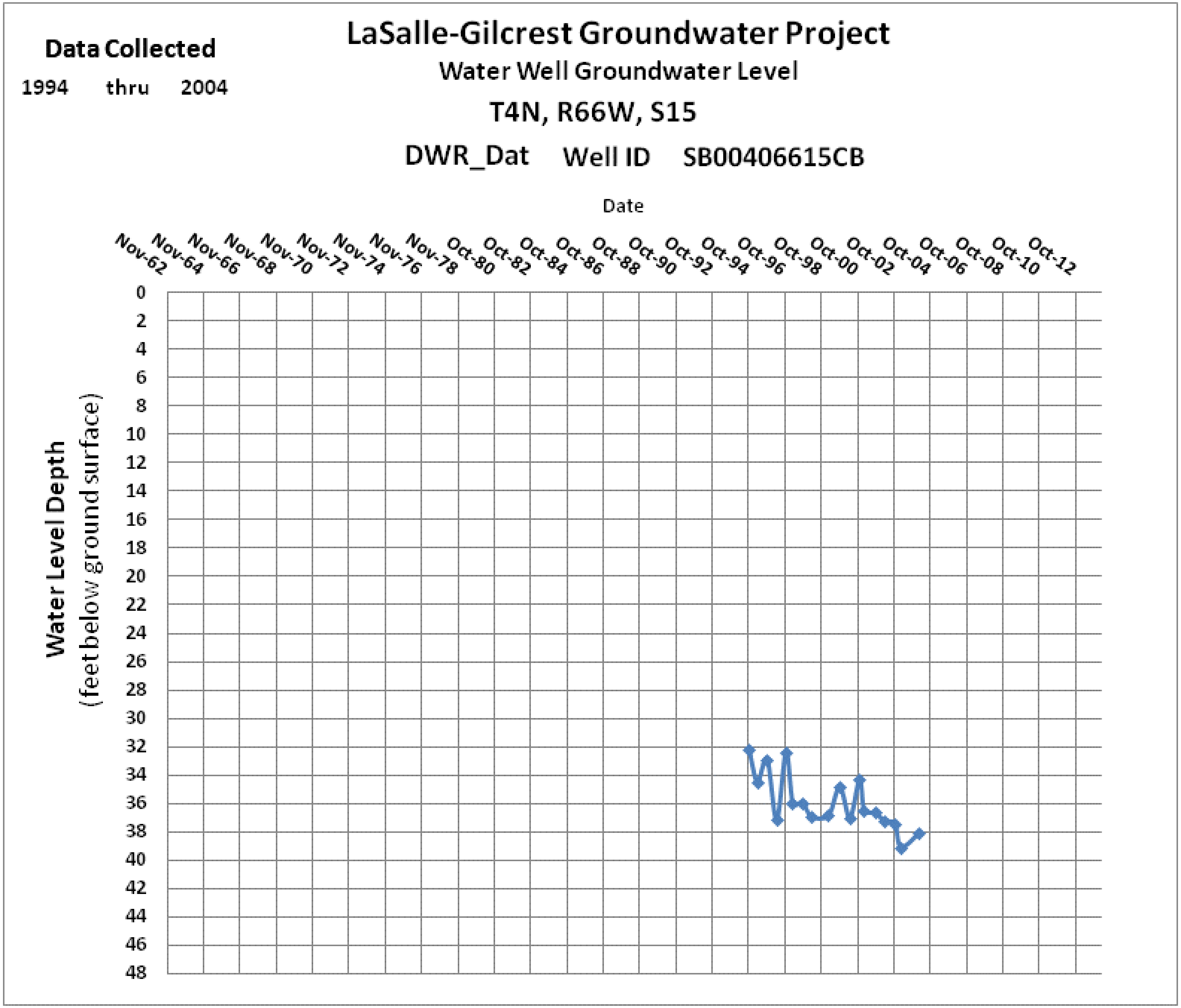


Data Collected
2001 thru 2012
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R 66W, S14
CDA Well ID WL-M-603
Date
Nov-62 Nov-64 Nov-66 Nov-68 Nov-70 Nov-72 Nov-74 Nov-76 Nov-78 Oct-80 Oct-82 Oct-84 Oct-86 Oct-88 Oct-90 Oct-92 Oct-94 Oct-96 Oct-98 Oct-00 Oct-02 Oct-04 Oct-06 Oct-08 Oct-10 Oct-12
Water Level Depth
(feet below ground surface)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48



Data Collected
1947 thru 1984
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S15
DWR_Dat Well ID SB00406615DDD
Date
Nov-62 Nov-64 Nov-66 Nov-68 Nov-70 Nov-72 Nov-74 Nov-76 Nov-78 Oct-80 Oct-82 Oct-84 Oct-86 Oct-88 Oct-90 Oct-92 Oct-94 Oct-96 Oct-98 Oct-00 Oct-02 Oct-04 Oct-06 Oct-08 Oct-10 Oct-12
Water Level Depth
(feet below ground surface)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48


Data Collected
1994 thru 2004
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S15
DWR_Dat Well ID SB00406615CB
Date
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Nov-64
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Nov-68
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Nov-72
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Oct-04
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Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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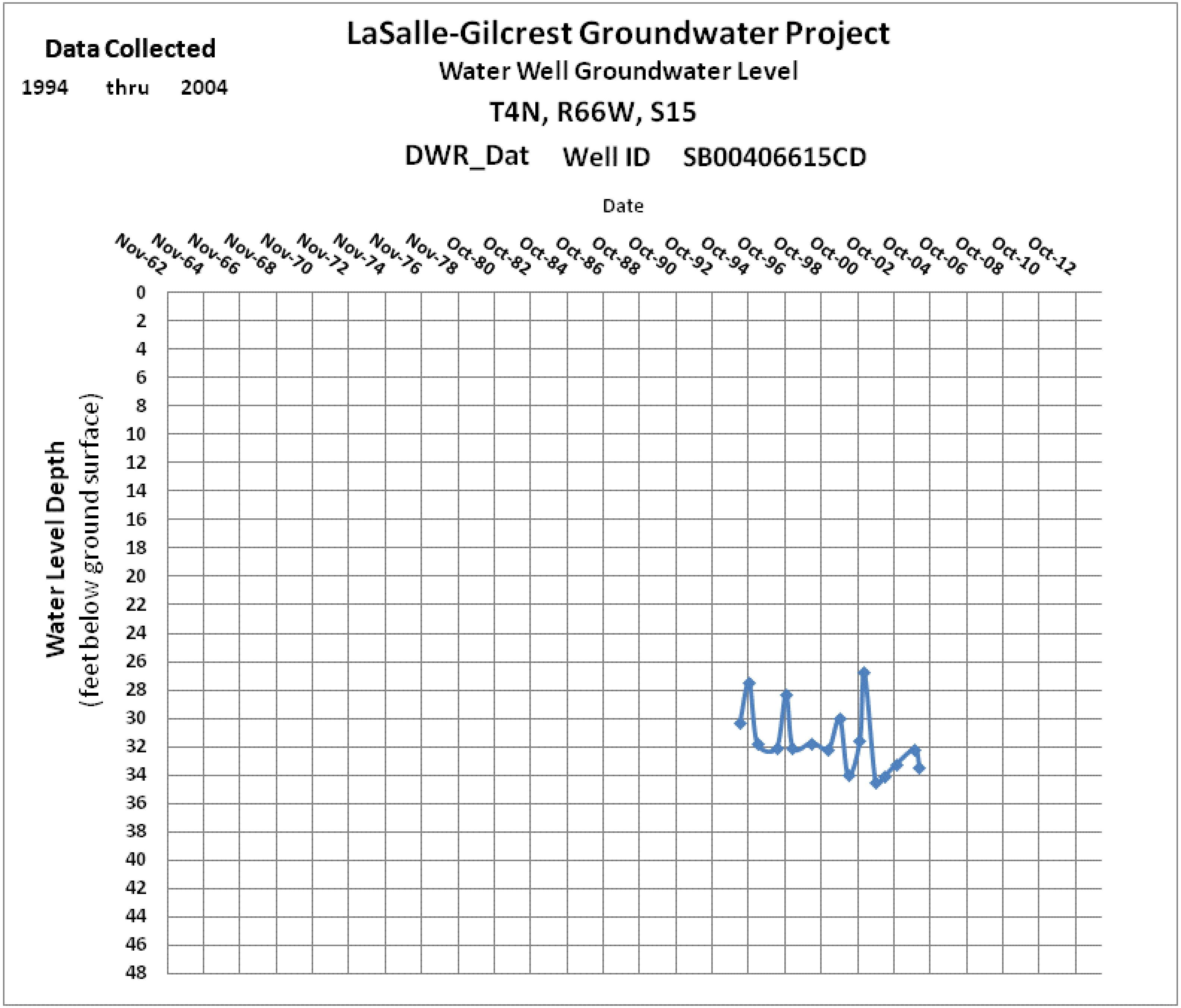
Data Collected
1994 thru 2004
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S15
DWR_Dat Well ID SB00406615CD
Date
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Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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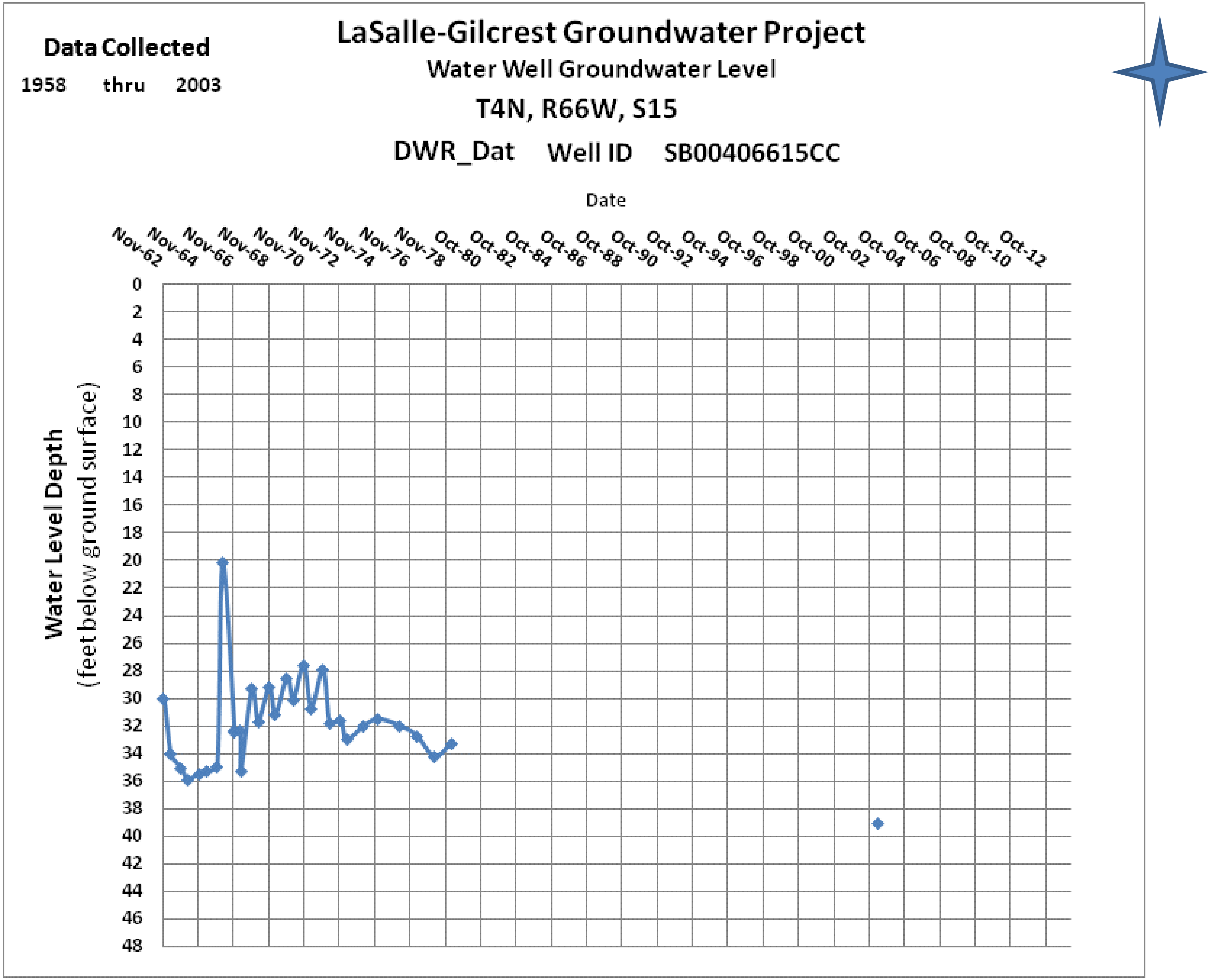
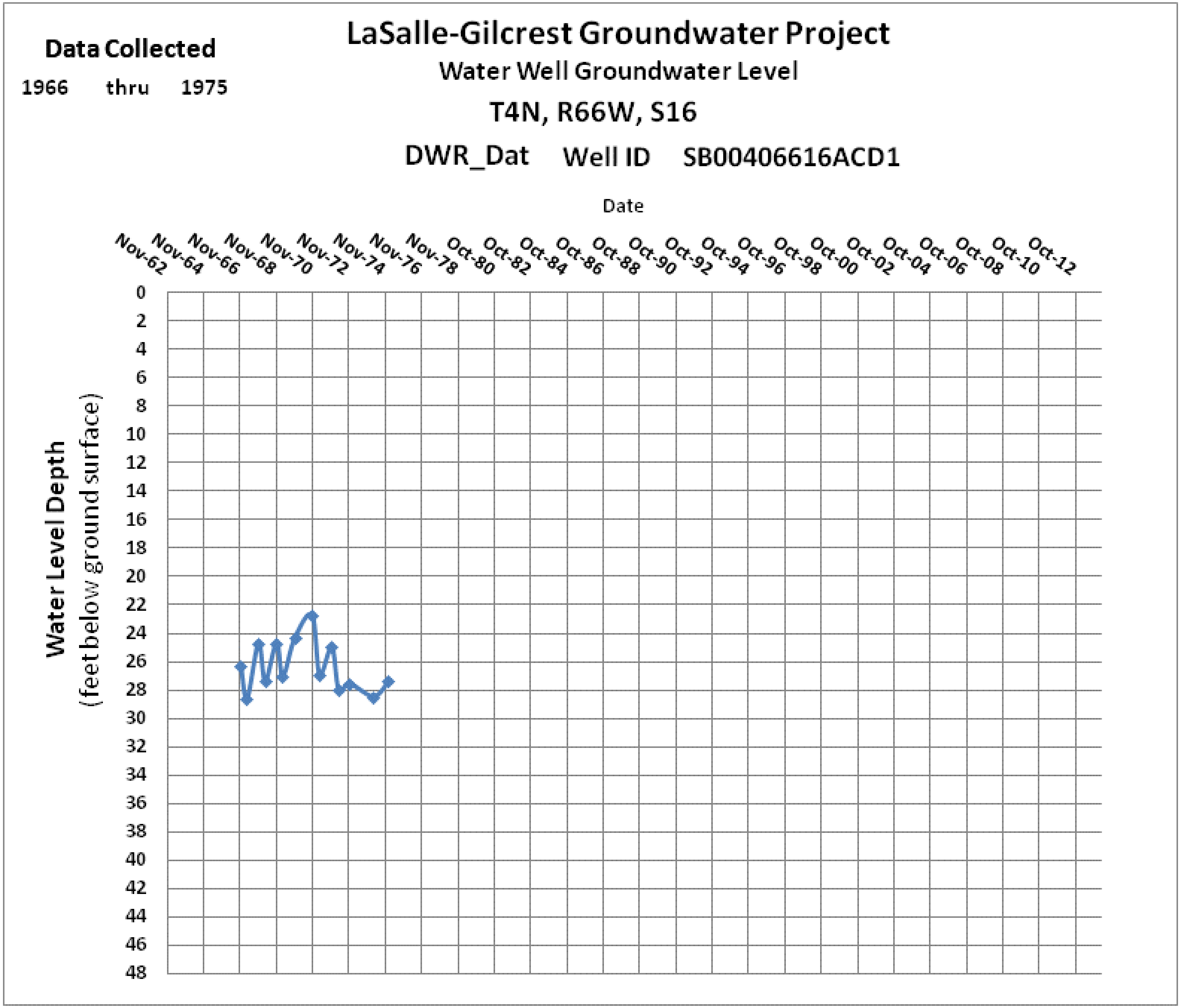


Data Collected
1958 thru 2003
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S15
DWR_Dat Well ID SB00406615CC
Date
Nov-62 Nov-64 Nov-66 Nov-68 Nov-70 Nov-72 Nov-74 Nov-76 Nov-78 Oct-80 Oct-82 Oct-84 Oct-86 Oct-88 Oct-90 Oct-92 Oct-94 Oct-96 Oct-98 Oct-00 Oct-02 Oct-04 Oct-06 Oct-08 Oct-10 Oct-12
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
Water Level Depth
(feet below ground surface)



Data Collected
1966 thru 1975
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S16
DWR_Dat Well ID SB00406616ACD1
Date
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Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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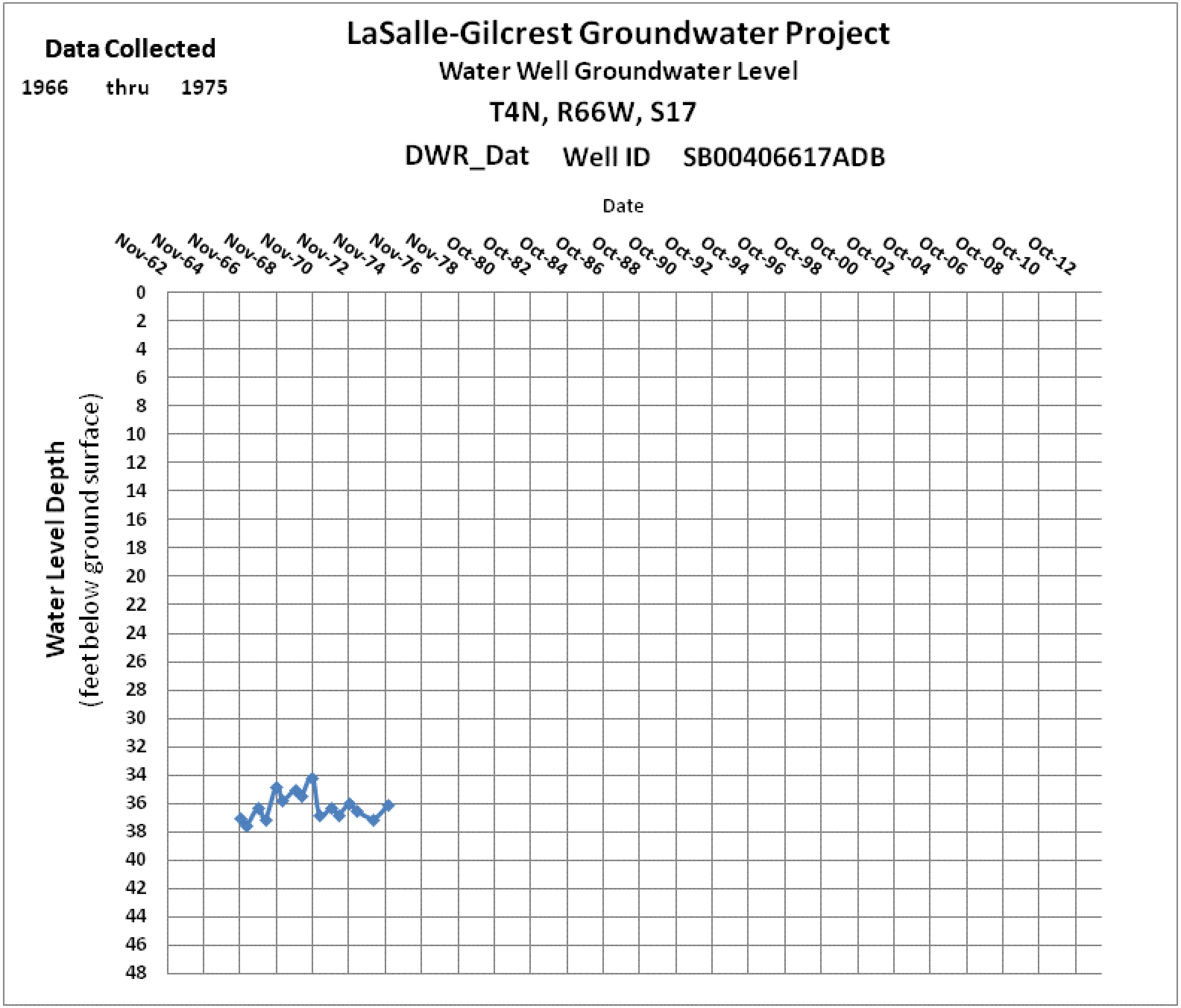

Data Collected
1966 thru 1975
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S17
DWR_Dat Well ID SB00406617ADB
Date
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Oct-00
Oct-02
Oct-04
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Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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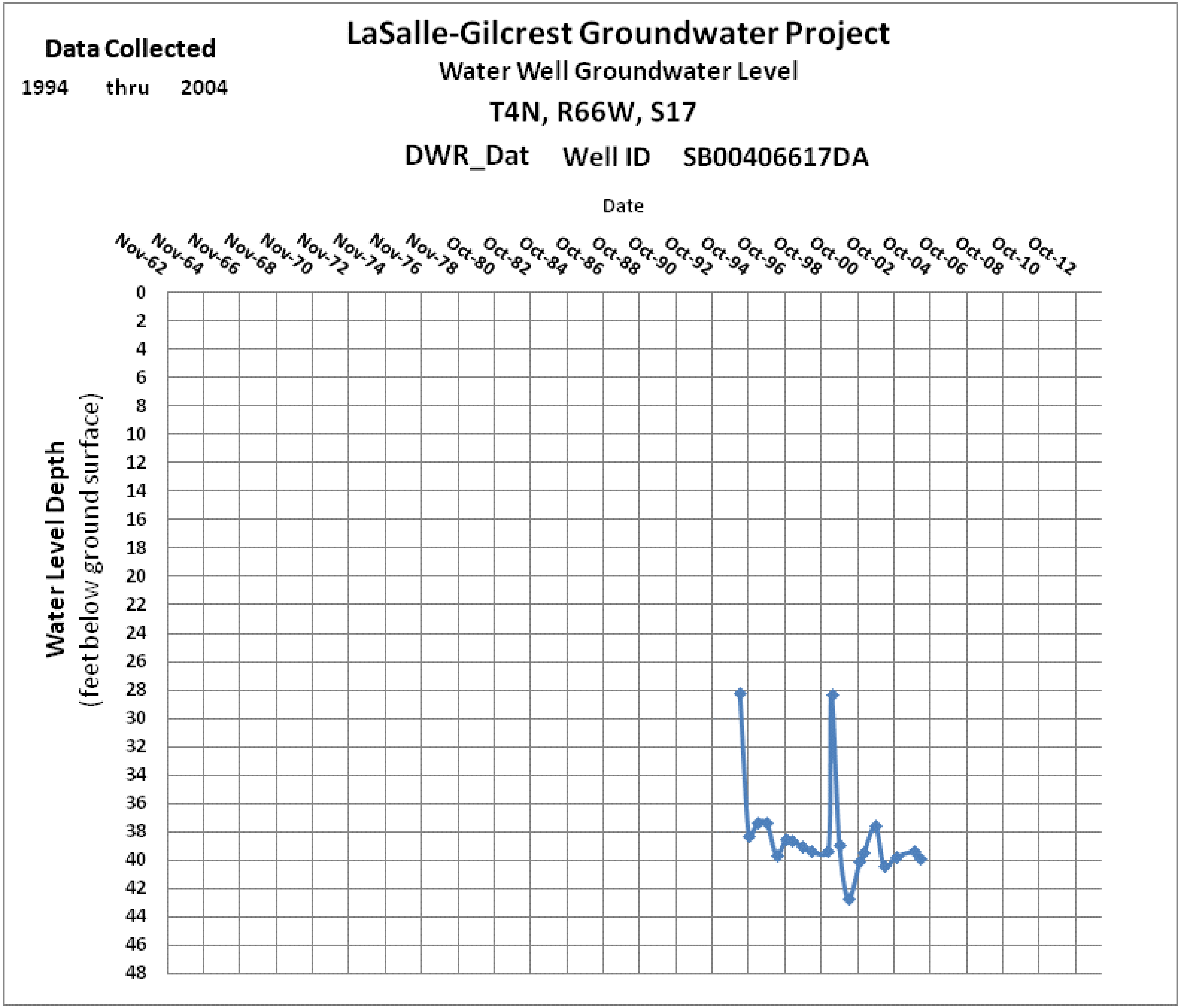
Data Collected
1994 thru 2004
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S17
DWR_Dat Well ID SB00406617DA
Date
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Nov-68
Nov-70
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Oct-12
Water Level Depth
(feet below ground surface)
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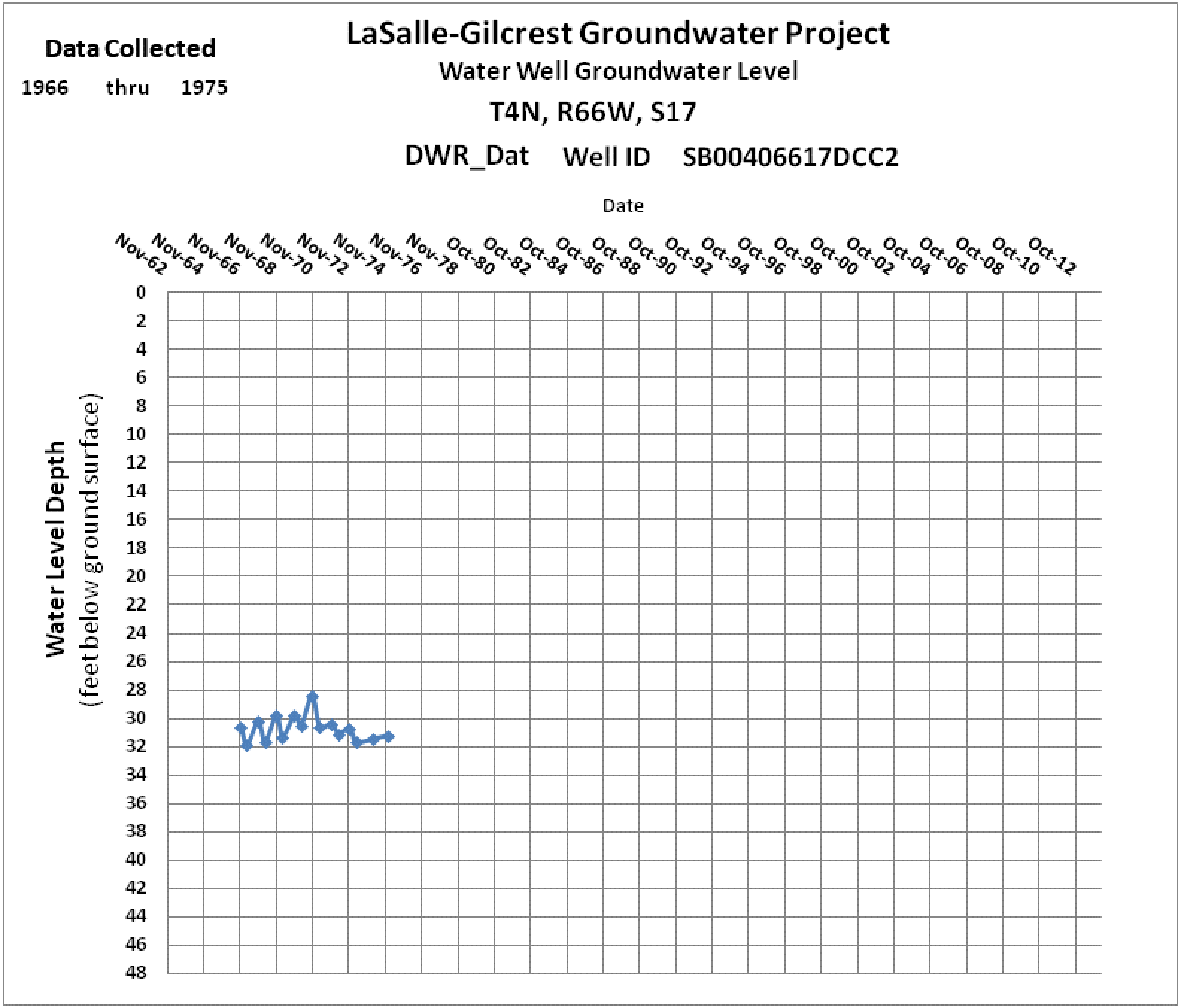

Data Collected
1966 thru 1975
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S17
DWR_Dat Well ID SB00406617DCC2
Date
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Oct-12
Water Level Depth
(feet below ground surface)
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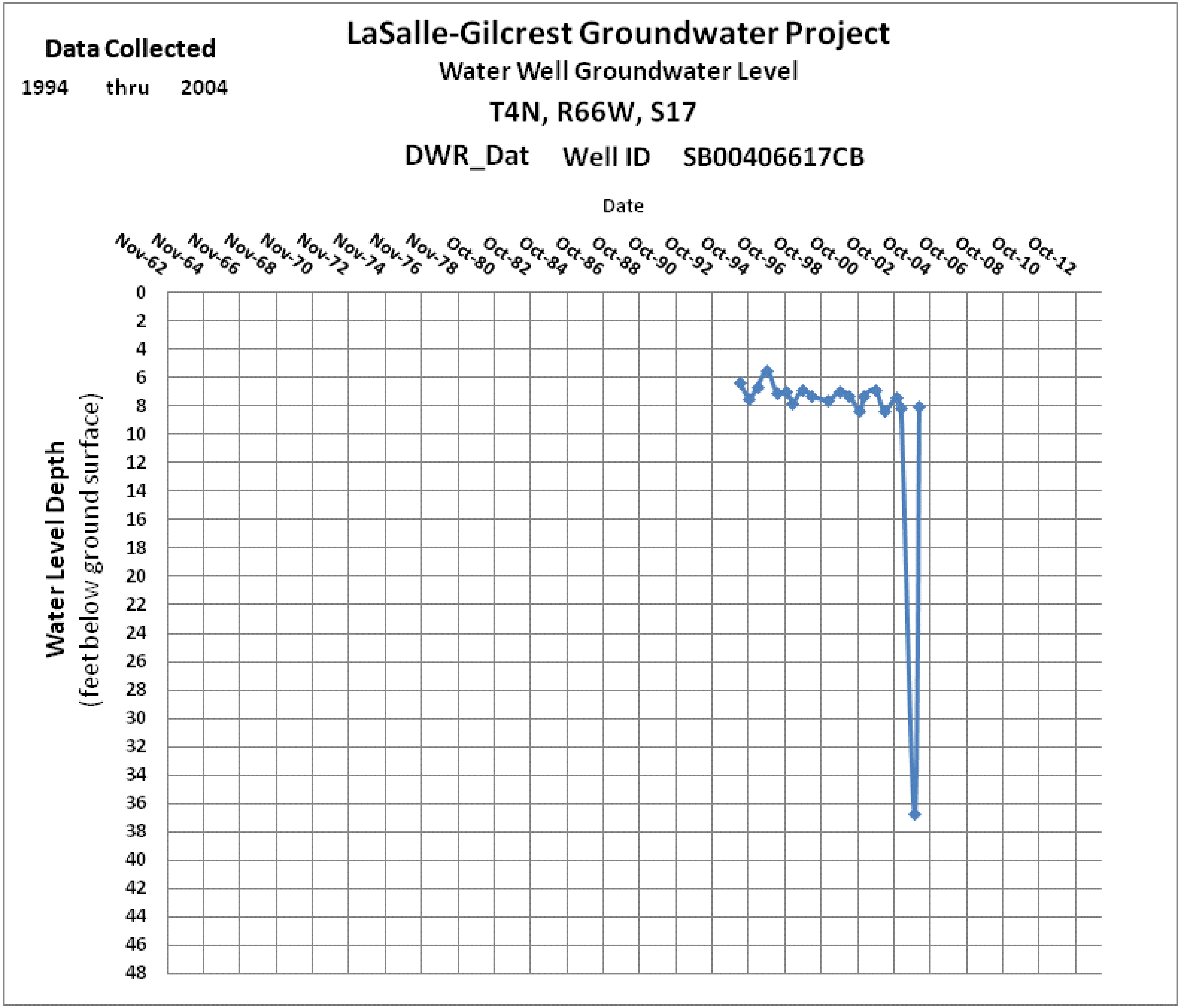

Data Collected
1994 thru 2004
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S17
DWR_Dat Well ID SB00406617CB
Date
Nov-62
Nov-64
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Oct-94
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Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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LaSalle-Gilcrest Groundwater Project

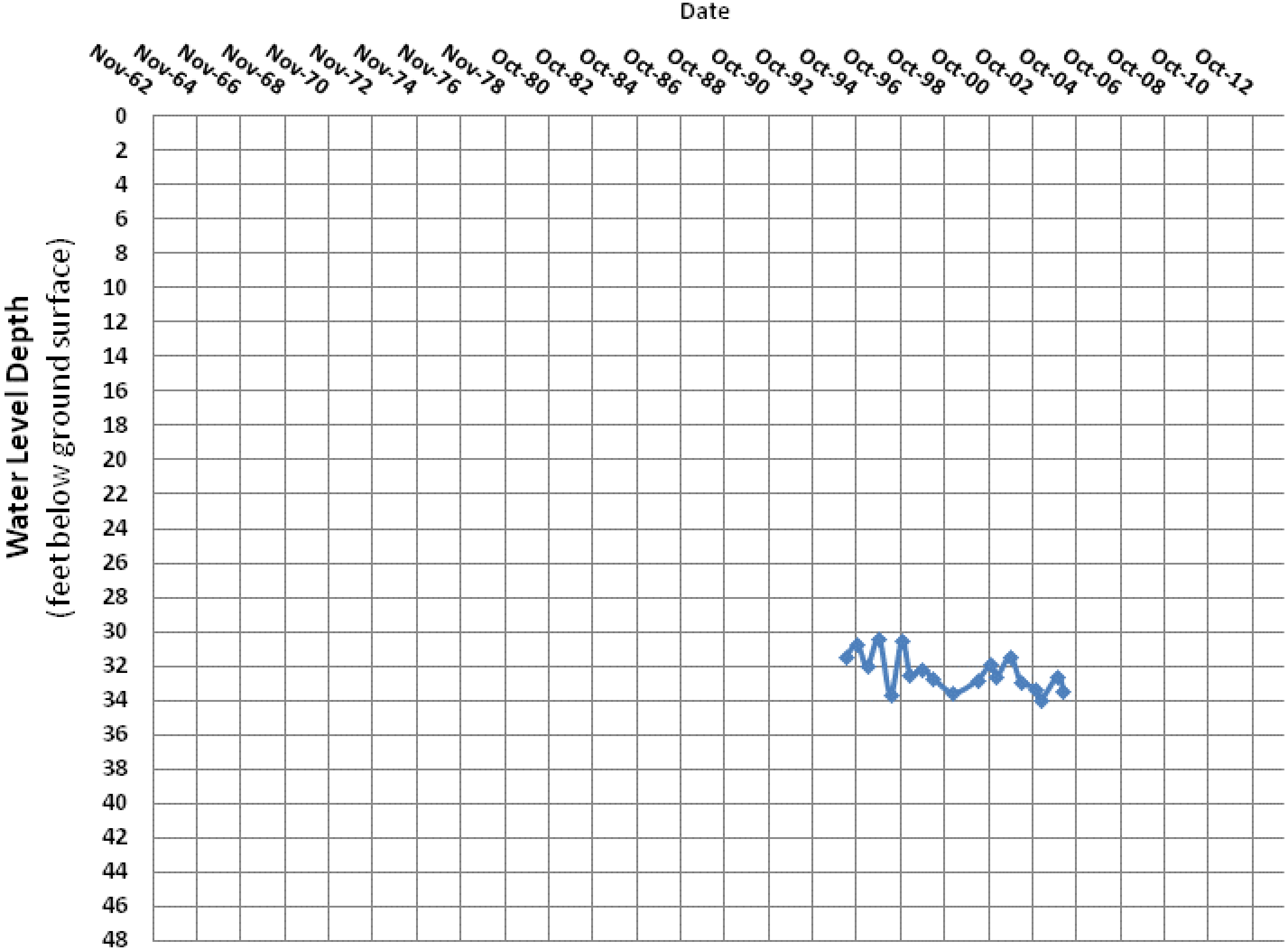
Data Collected

1994 thru 2004

Water Well Groundwater Level

T4N, R66W, S17

DWR_Dat Well ID SB00406617CD



LaSalle-Gilcrest Groundwater Project

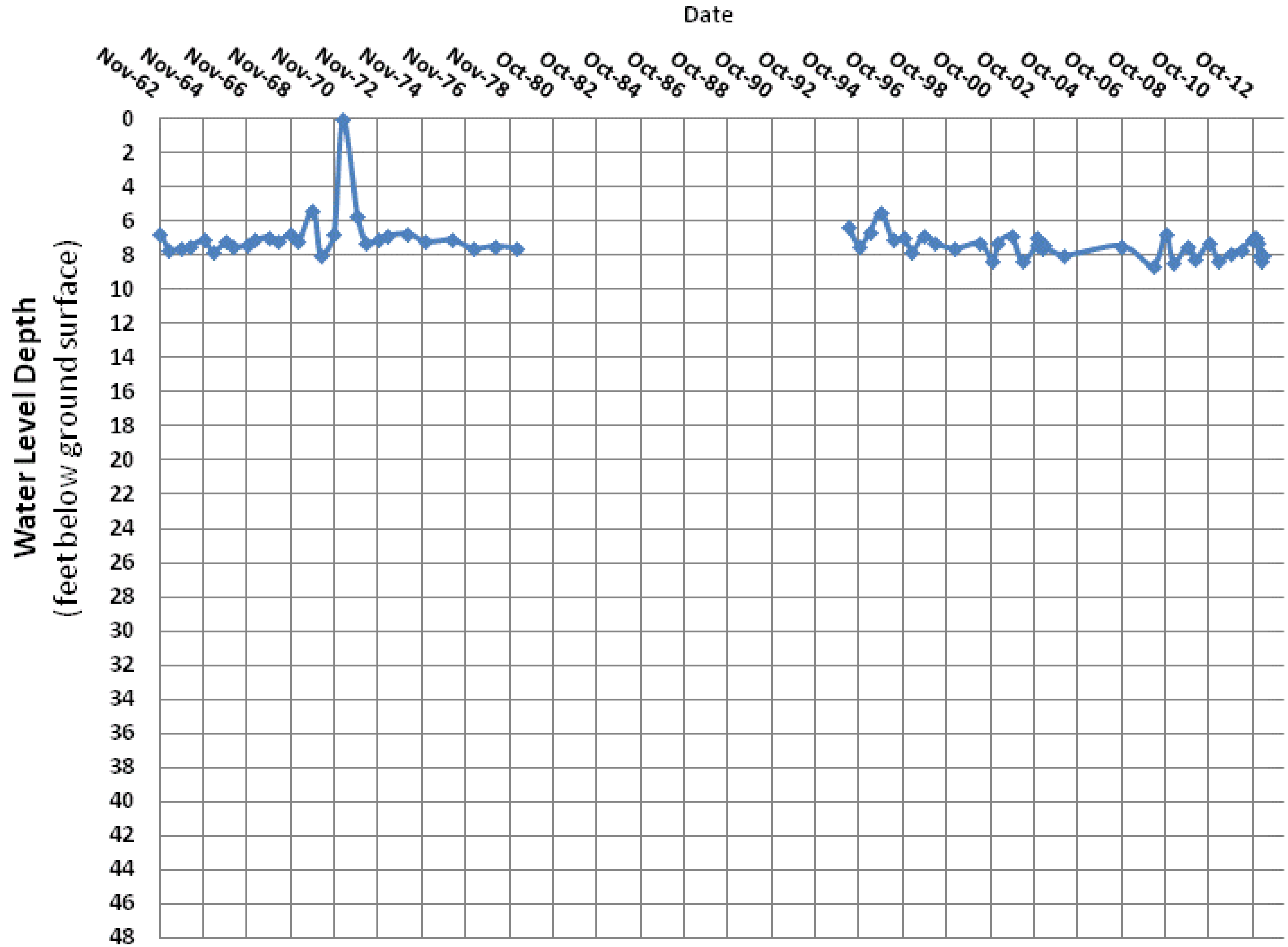
Data Collected

1929 thru 2013

Water Well Groundwater Level

T4N, R 66W, S17

CSU Well ID WELLID 176;



LaSalle-Gilcrest Groundwater Project

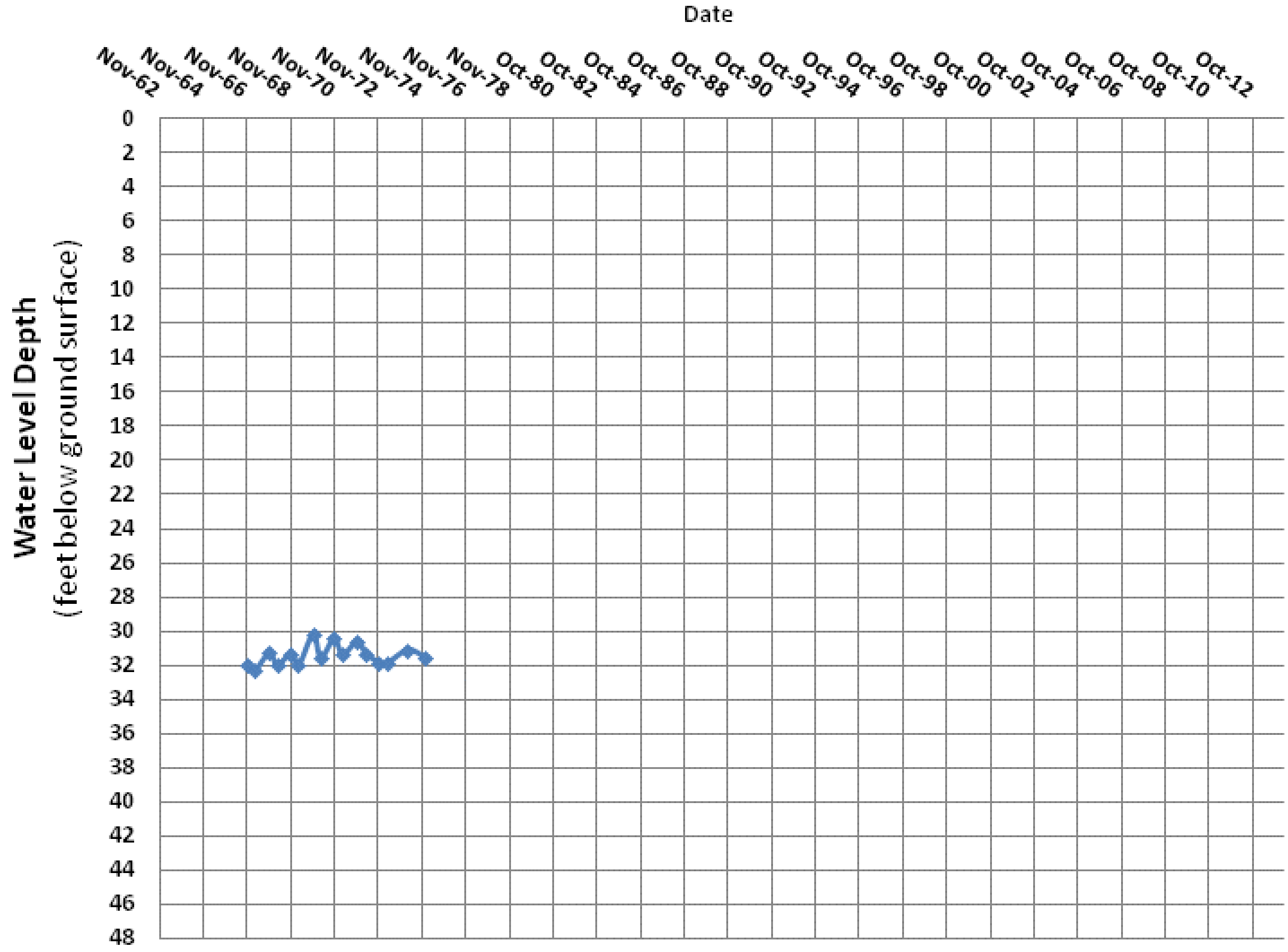
Data Collected

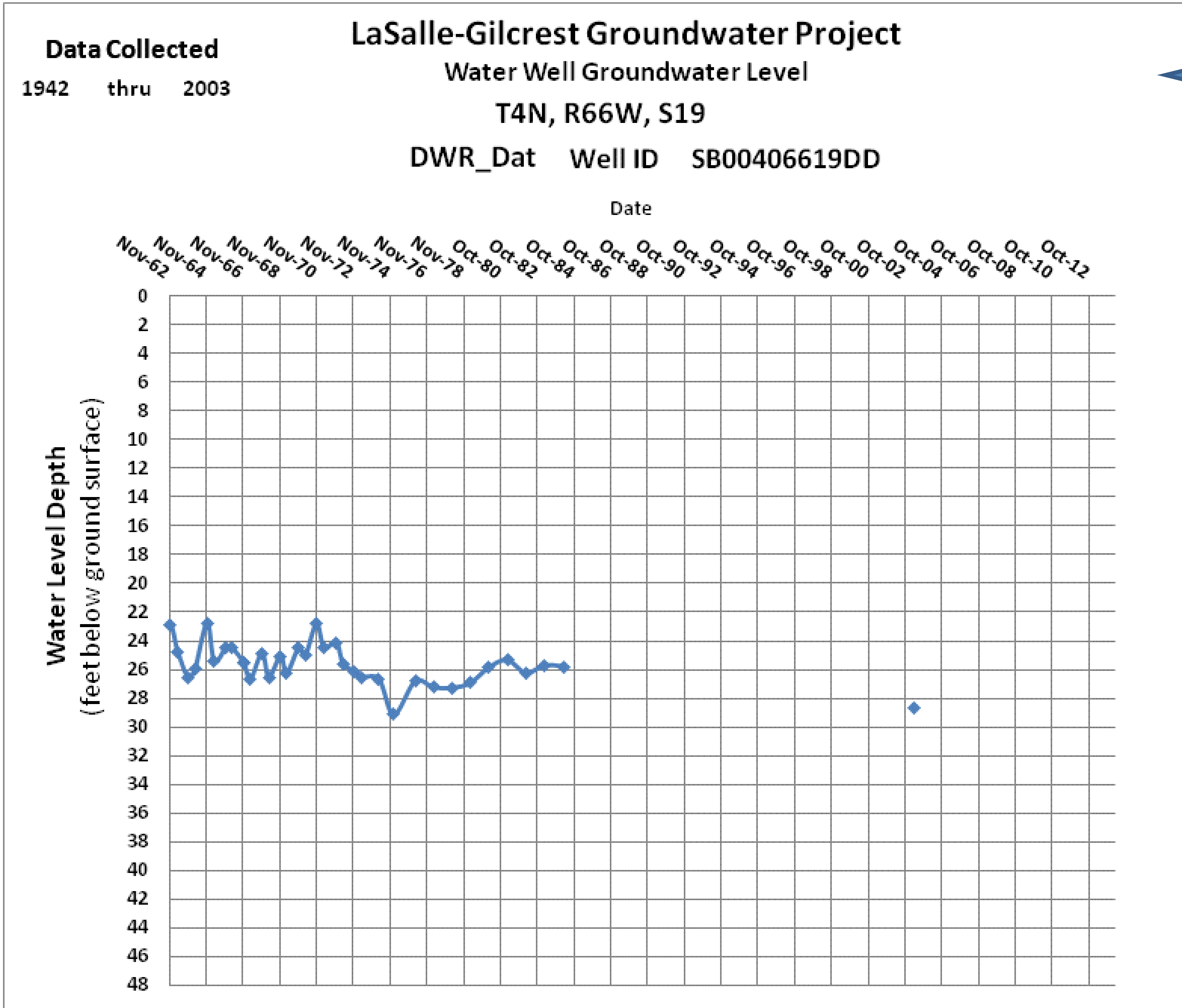
1966 thru 1975

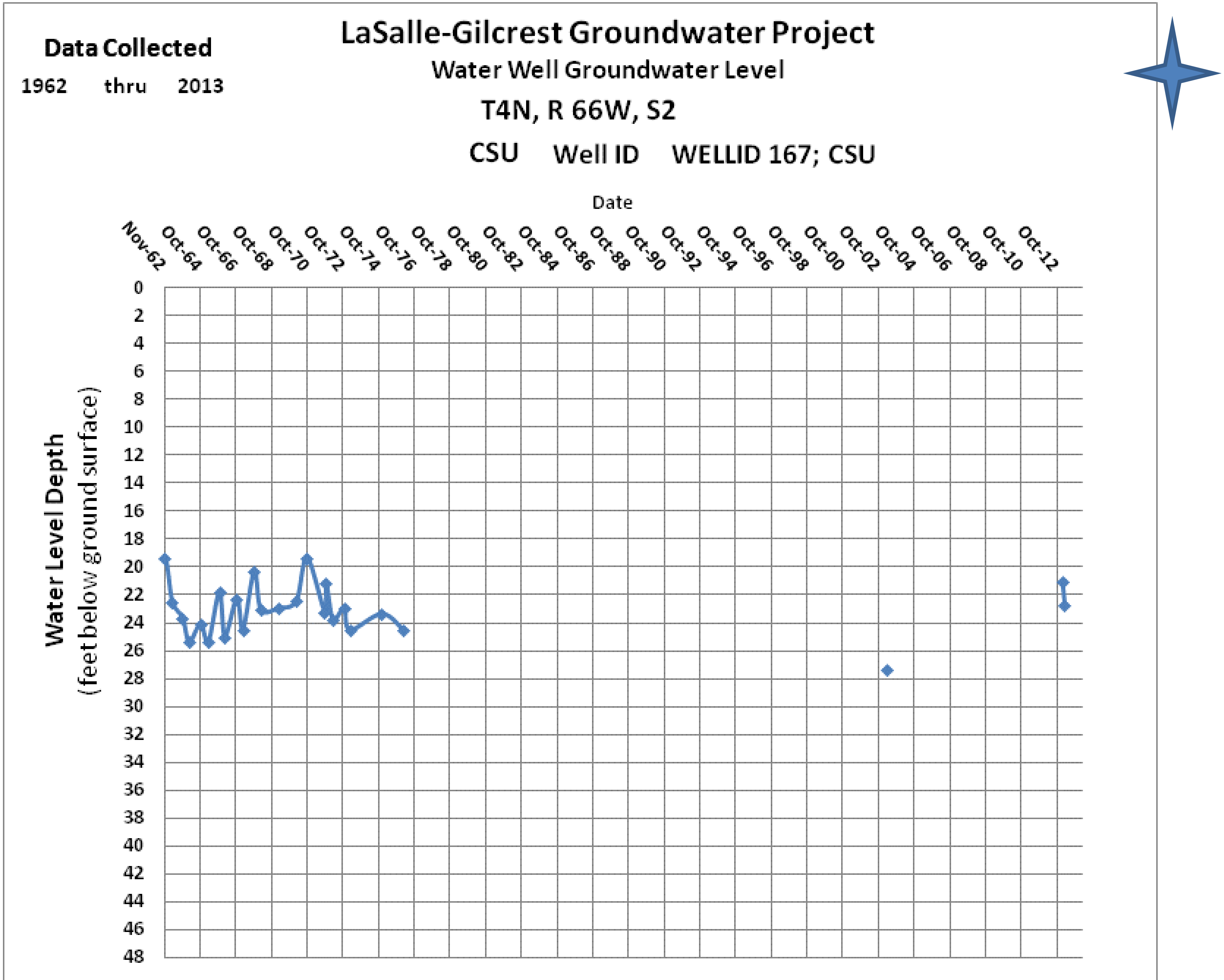
Water Well Groundwater Level

T4N, R66W, S19

DWR_Dat Well ID SB00406619ABC




LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S19
DWR_Dat Well ID SB00406619DD
Data Collected
1942 thru 2003
Date
Nov-62 Nov-64 Nov-66 Nov-68 Nov-70 Nov-72 Nov-74 Nov-76 Nov-78 Oct-80 Oct-82 Oct-84 Oct-86 Oct-88 Oct-90 Oct-92 Oct-94 Oct-96 Oct-98 Oct-00 Oct-02 Oct-04 Oct-06 Oct-08 Oct-10 Oct-12
Water Level Depth
(feet below ground surface)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48


Data Collected
1962 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R 66W, S2
CSU Well ID WELLID 167; CSU
Date
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Oct-64
Oct-66
Oct-68
Oct-70
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Oct-74
Oct-76
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Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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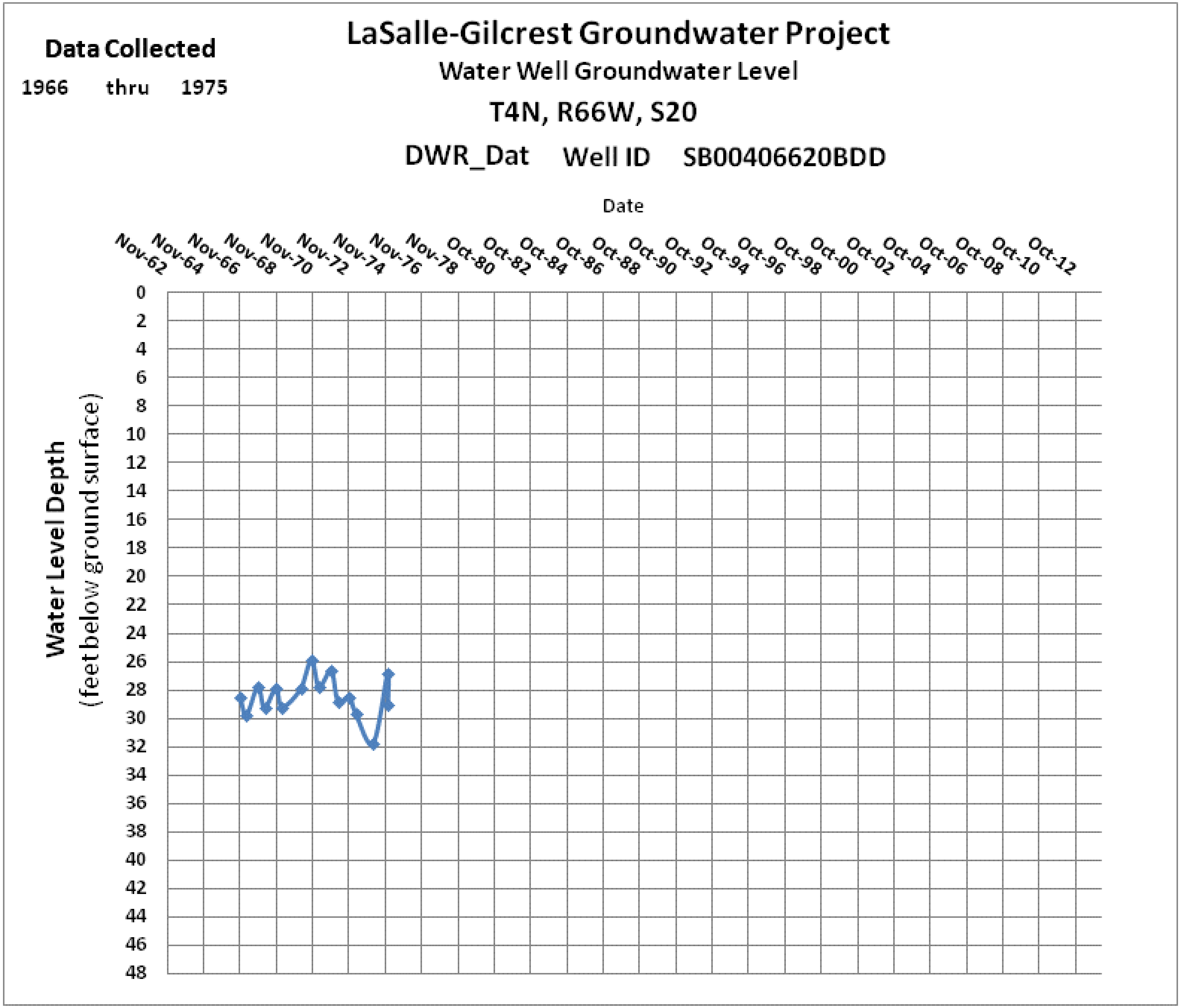
Data Collected
1966 thru 1975
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S20
DWR_Dat Well ID SB00406620BDD
Date
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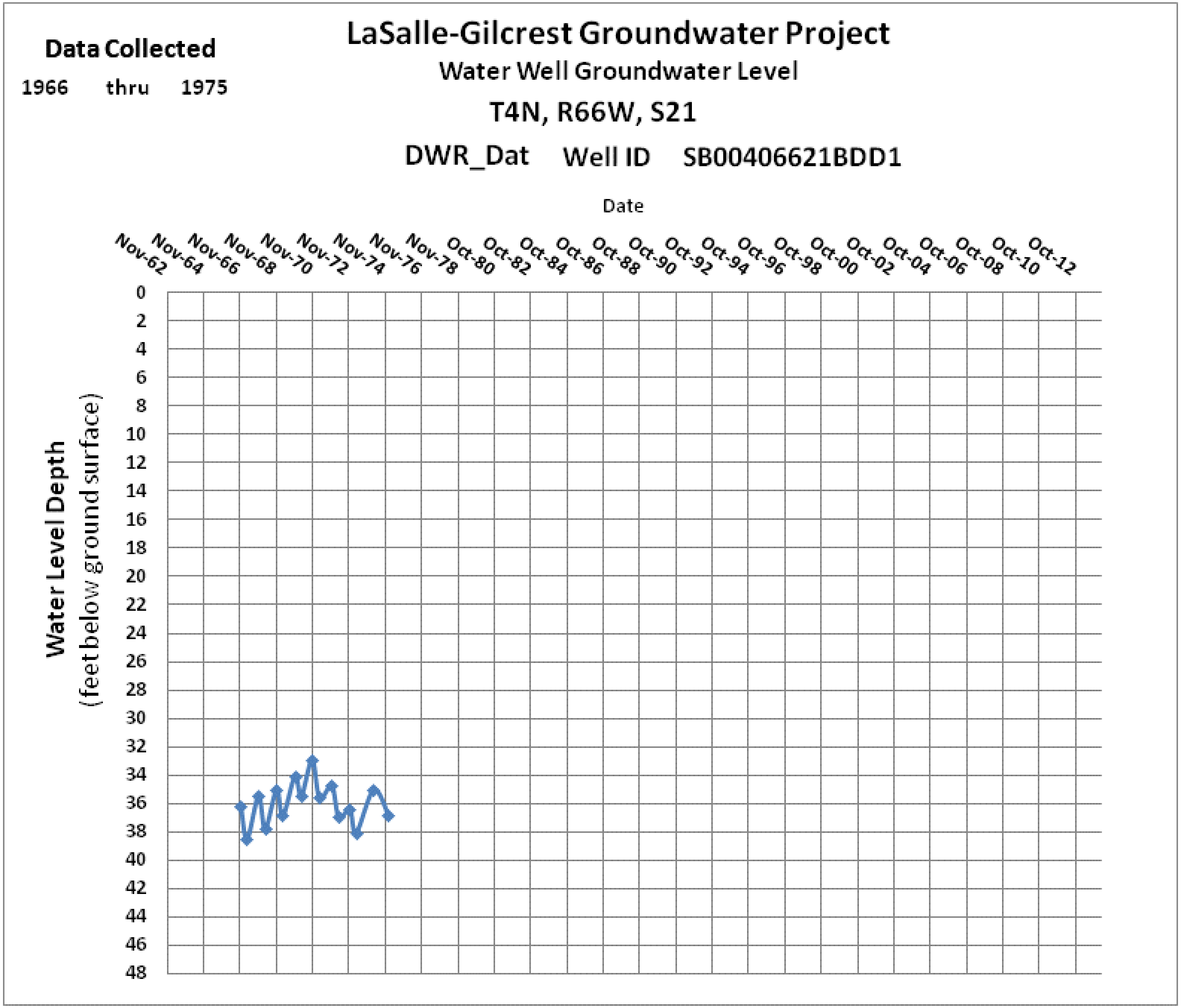
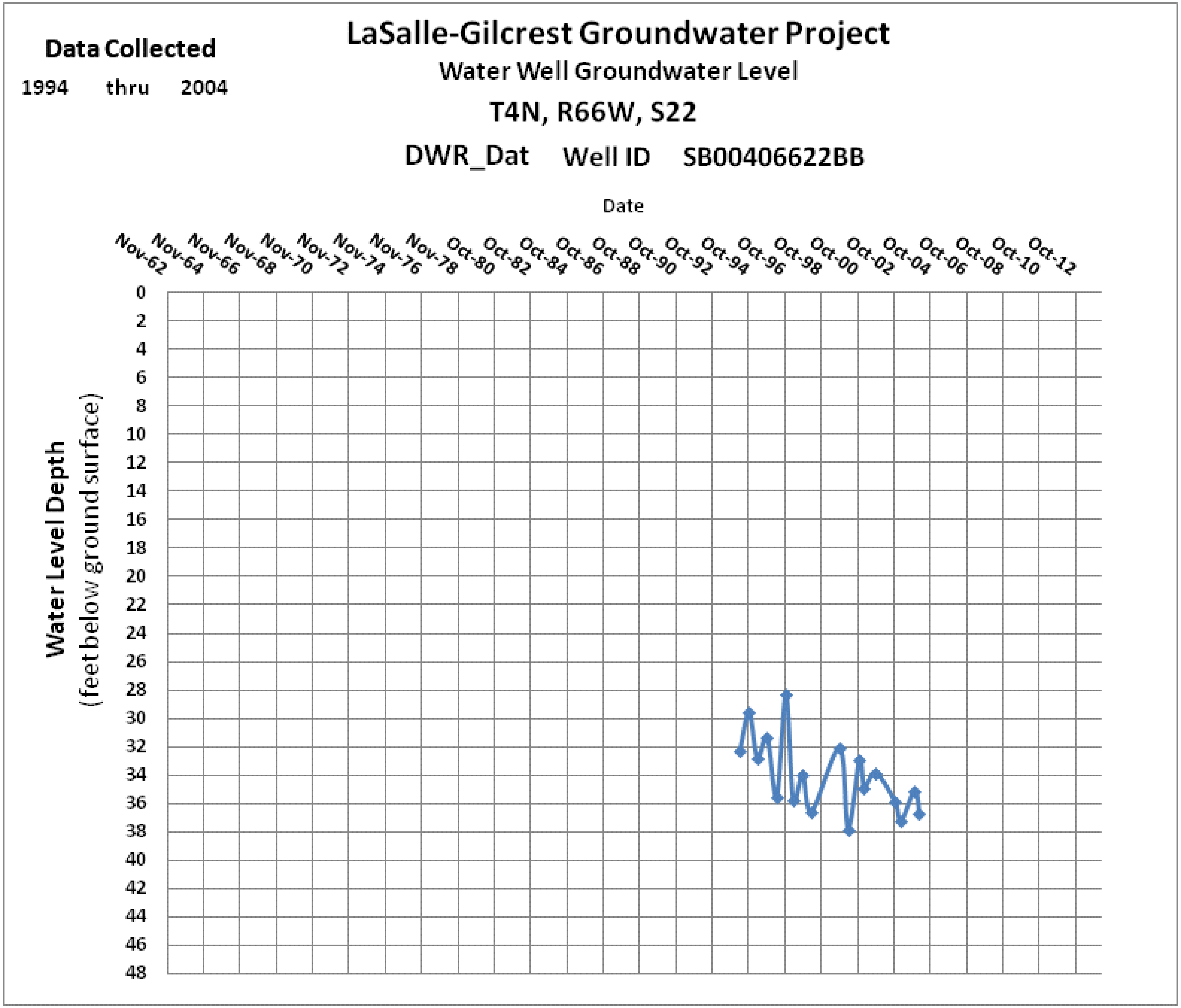
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48



Data Collected
1966 thru 1975
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S21
DWR_Dat Well ID SB00406621BDD1
Date
Nov-62 Nov-64 Nov-66 Nov-68 Nov-70 Nov-72 Nov-74 Nov-76 Nov-78 Oct-80 Oct-82 Oct-84 Oct-86 Oct-88 Oct-90 Oct-92 Oct-94 Oct-96 Oct-98 Oct-00 Oct-02 Oct-04 Oct-06 Oct-08 Oct-10 Oct-12
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
Water Level Depth
(feet below ground surface)



Data Collected
1994 thru 2004
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S22
DWR_Dat Well ID SB00406622BB
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
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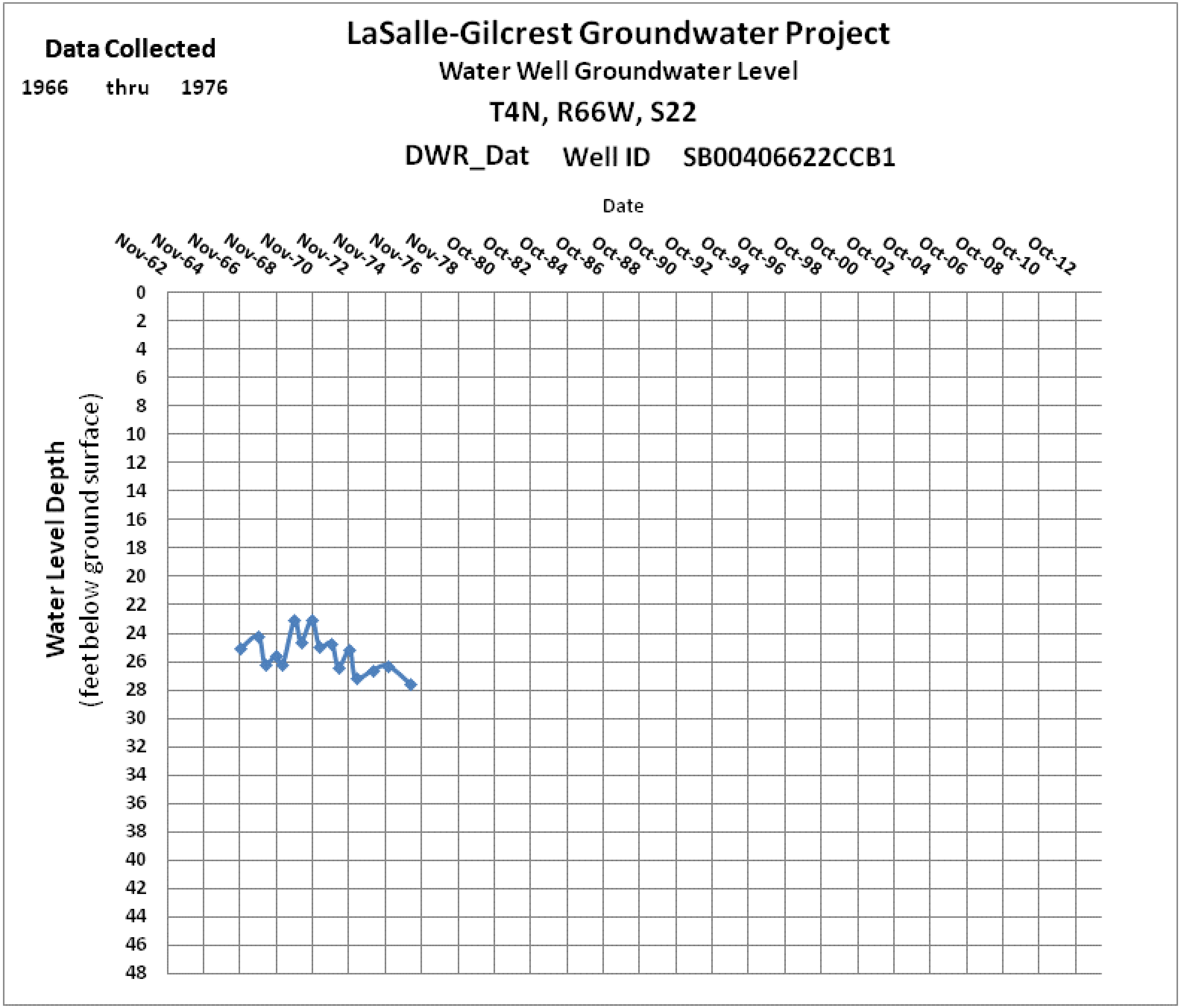
34
36
38
40
42
44
46
48


Data Collected
1966 thru 1976
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S22
DWR_Dat Well ID SB00406622CCB1
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
0
2
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6
8
10
12
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16
18
20
22
24
26
28
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34
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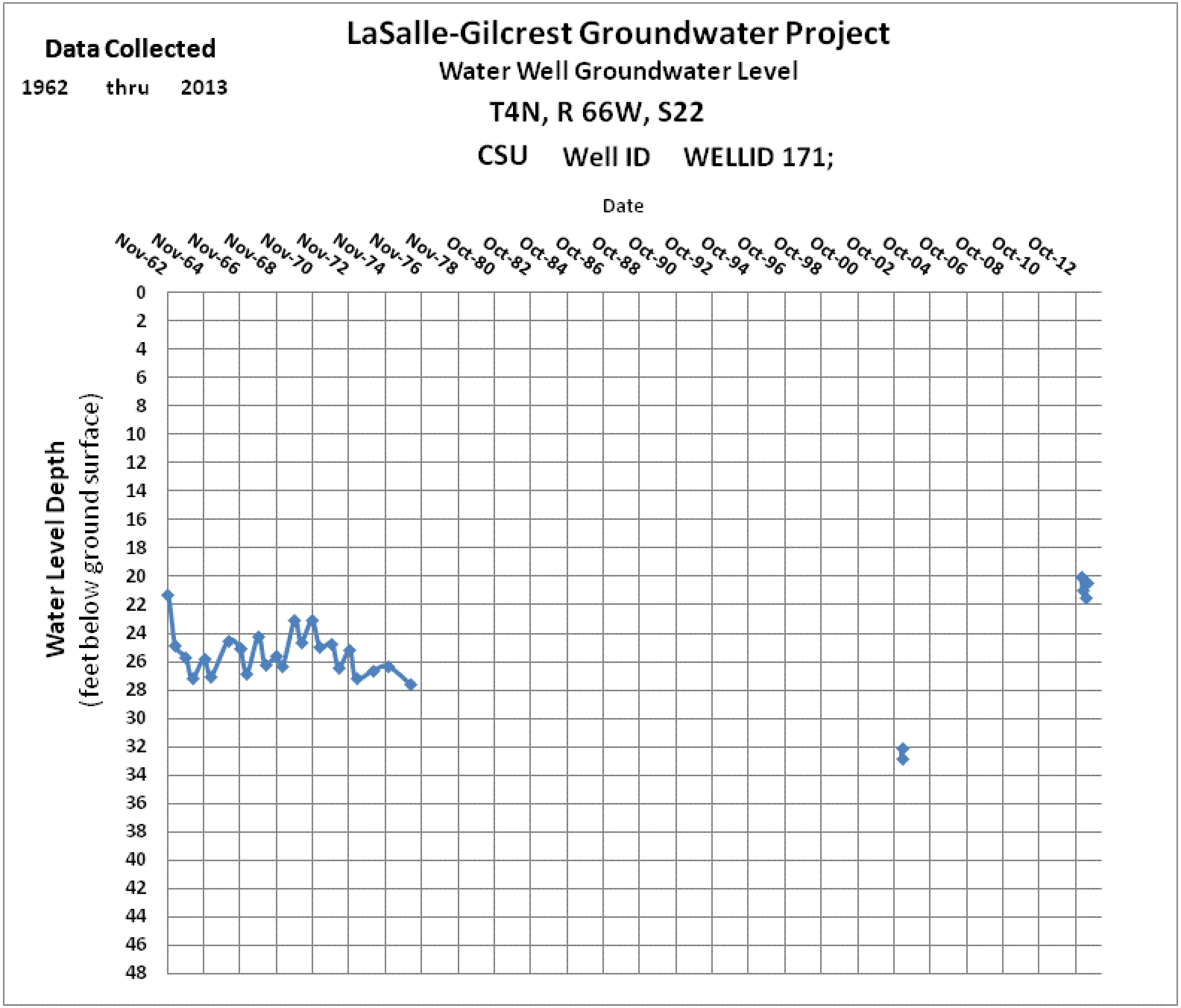
40
42
44
46
48


Data Collected
1962 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R 66W, S22
CSU Well ID WELLID 171;
Date
Nov-62 Nov-64 Nov-66 Nov-68 Nov-70 Nov-72 Nov-74 Nov-76 Nov-78 Oct-80 Oct-82 Oct-84 Oct-86 Oct-88 Oct-90 Oct-92 Oct-94 Oct-96 Oct-98 Oct-00 Oct-02 Oct-04 Oct-06 Oct-08 Oct-10 Oct-12
Water Level Depth
(feet below ground surface)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48

Data Collected

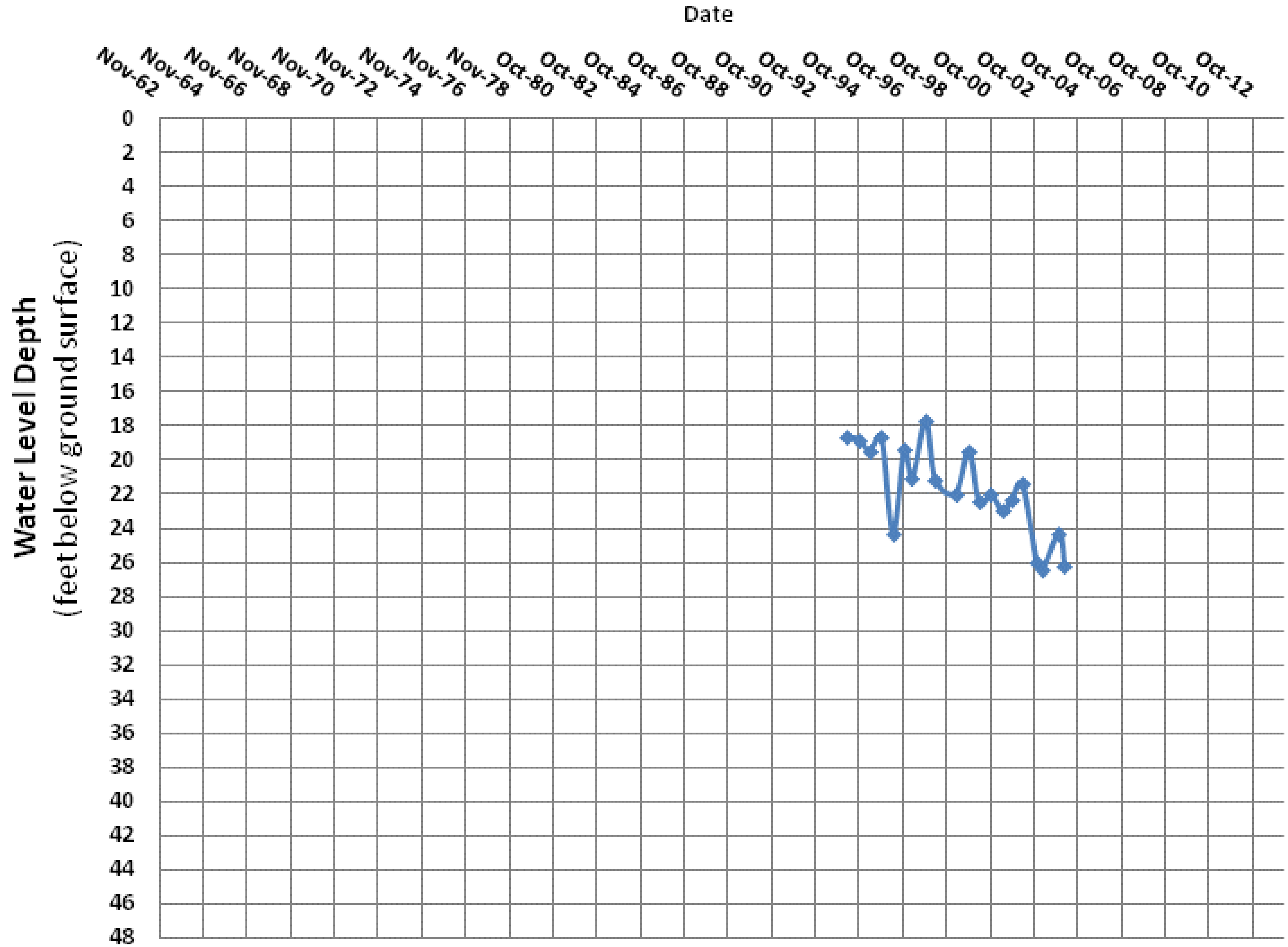
1994 thru 2004

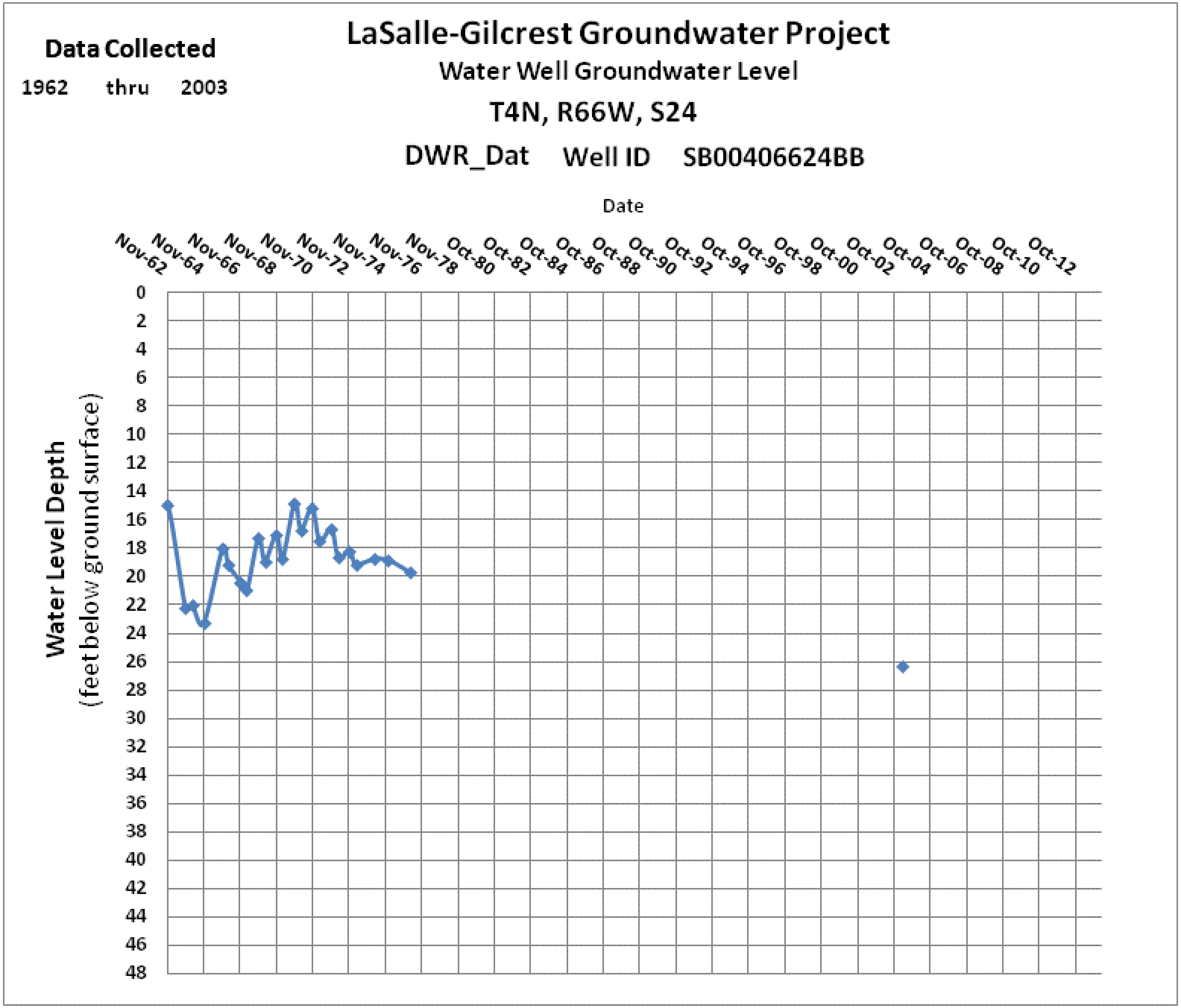
LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

T4N, R66W, S23

DWR_Dat Well ID SB00406623DA





Data Collected
1962 thru 2003
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S24
DWR_Dat Well ID SB00406624BB
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
0
2
4
6
8
10
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20
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40
42
44
46
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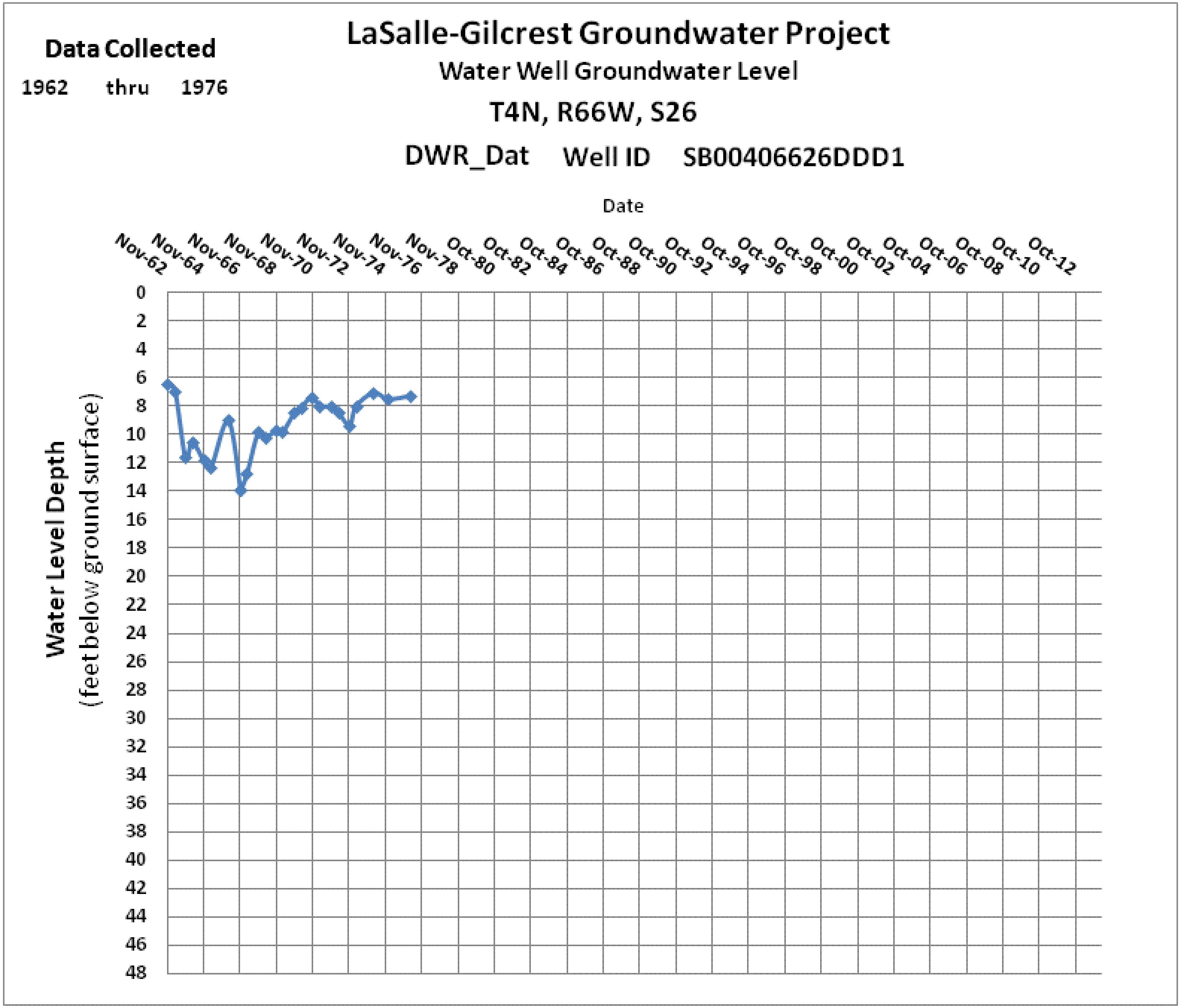
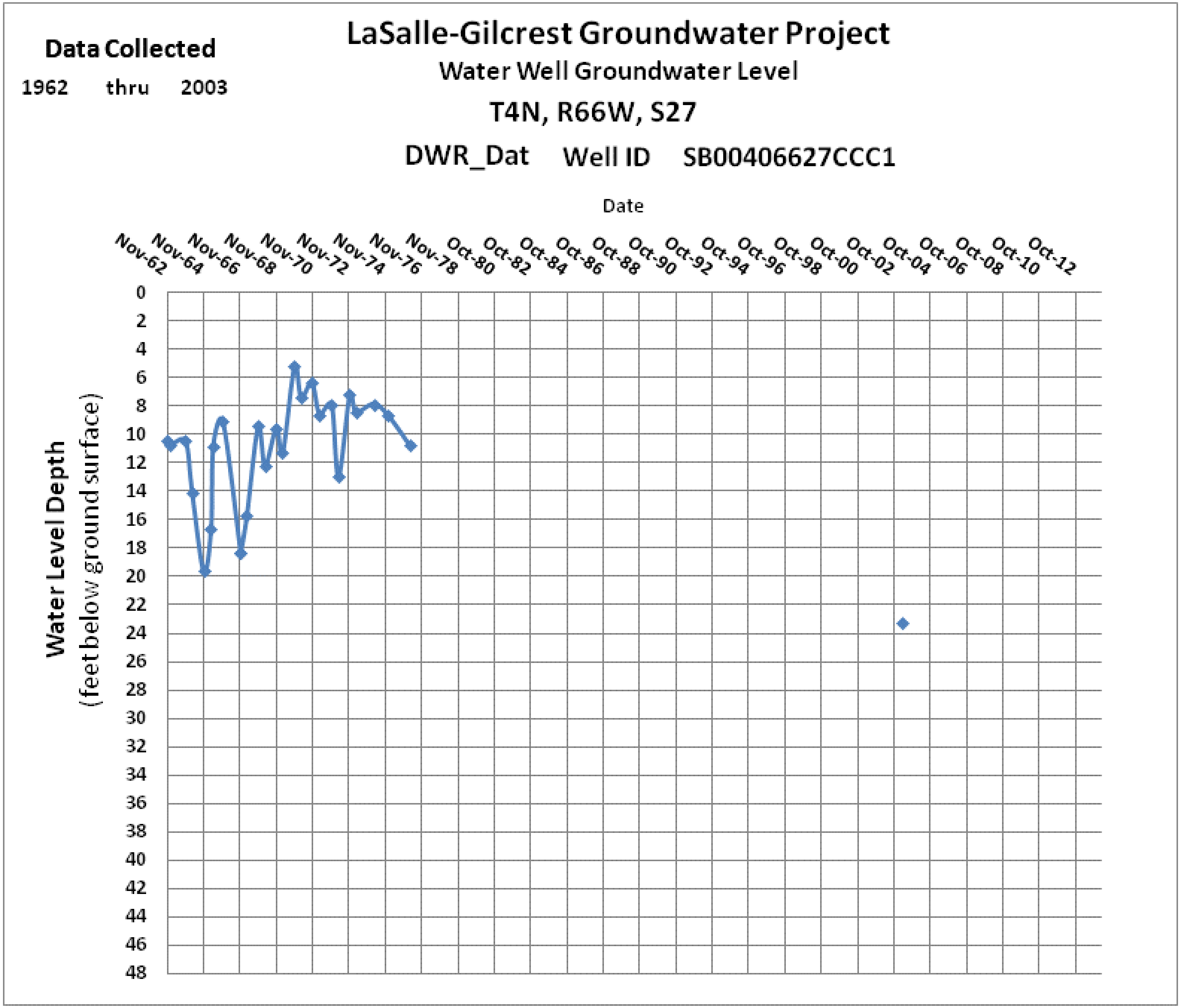

Data Collected
1962 thru 1976
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S26
DWR_Dat Well ID SB00406626DDD1
Date
Nov-62 Nov-64 Nov-66 Nov-68 Nov-70 Nov-72 Nov-74 Nov-76 Nov-78 Oct-80 Oct-82 Oct-84 Oct-86 Oct-88 Oct-90 Oct-92 Oct-94 Oct-96 Oct-98 Oct-00 Oct-02 Oct-04 Oct-06 Oct-08 Oct-10 Oct-12
Water Level Depth
(feet below ground surface)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48



Data Collected
1962 thru 2003
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S27
DWR_Dat Well ID SB00406627CCC1
Date
Nov-62 Nov-64 Nov-66 Nov-68 Nov-70 Nov-72 Nov-74 Nov-76 Nov-78 Oct-80 Oct-82 Oct-84 Oct-86 Oct-88 Oct-90 Oct-92 Oct-94 Oct-96 Oct-98 Oct-00 Oct-02 Oct-04 Oct-06 Oct-08 Oct-10 Oct-12
Water Level Depth
(feet below ground surface)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48

Data Collected

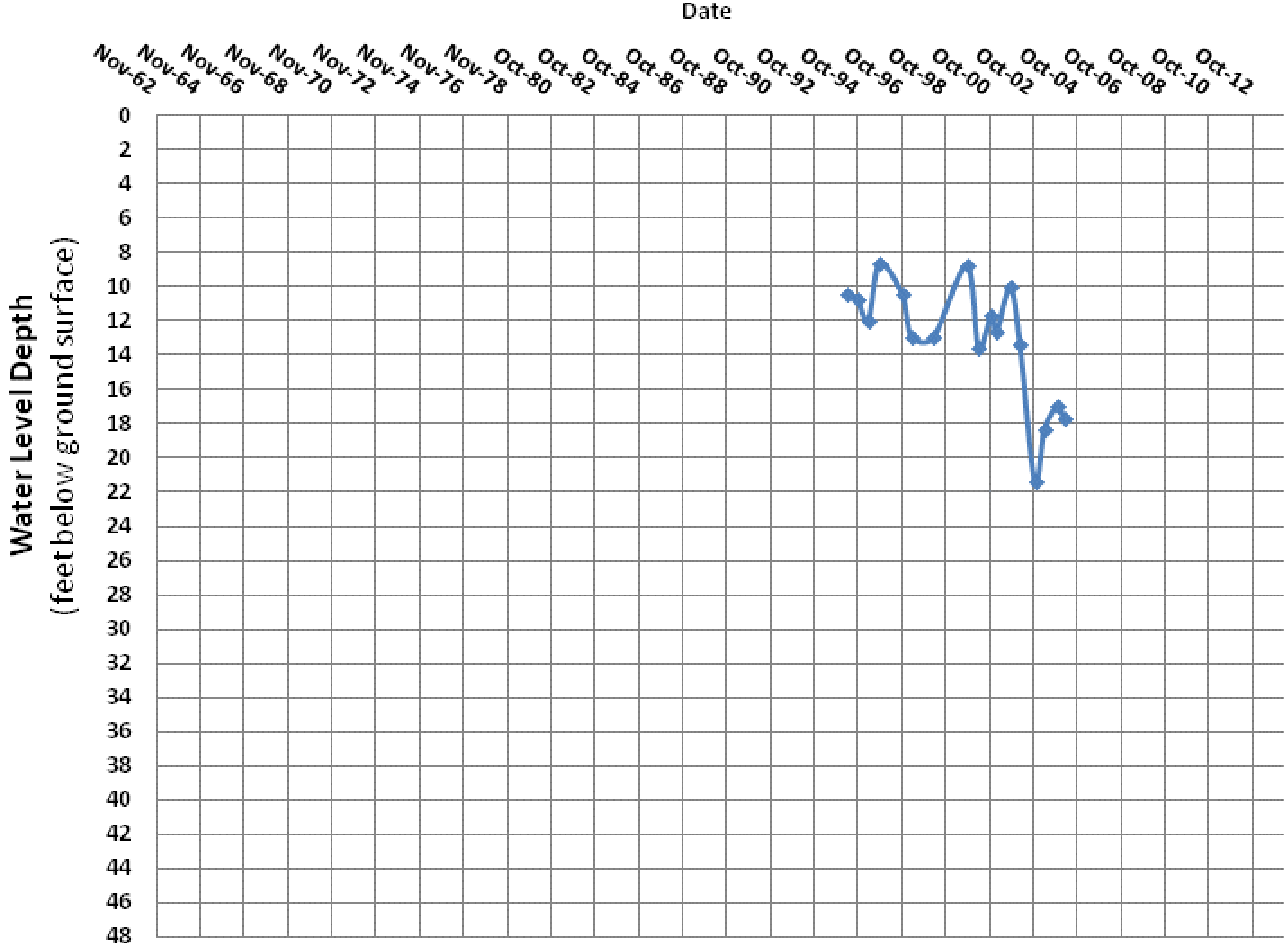
1994 thru 2004

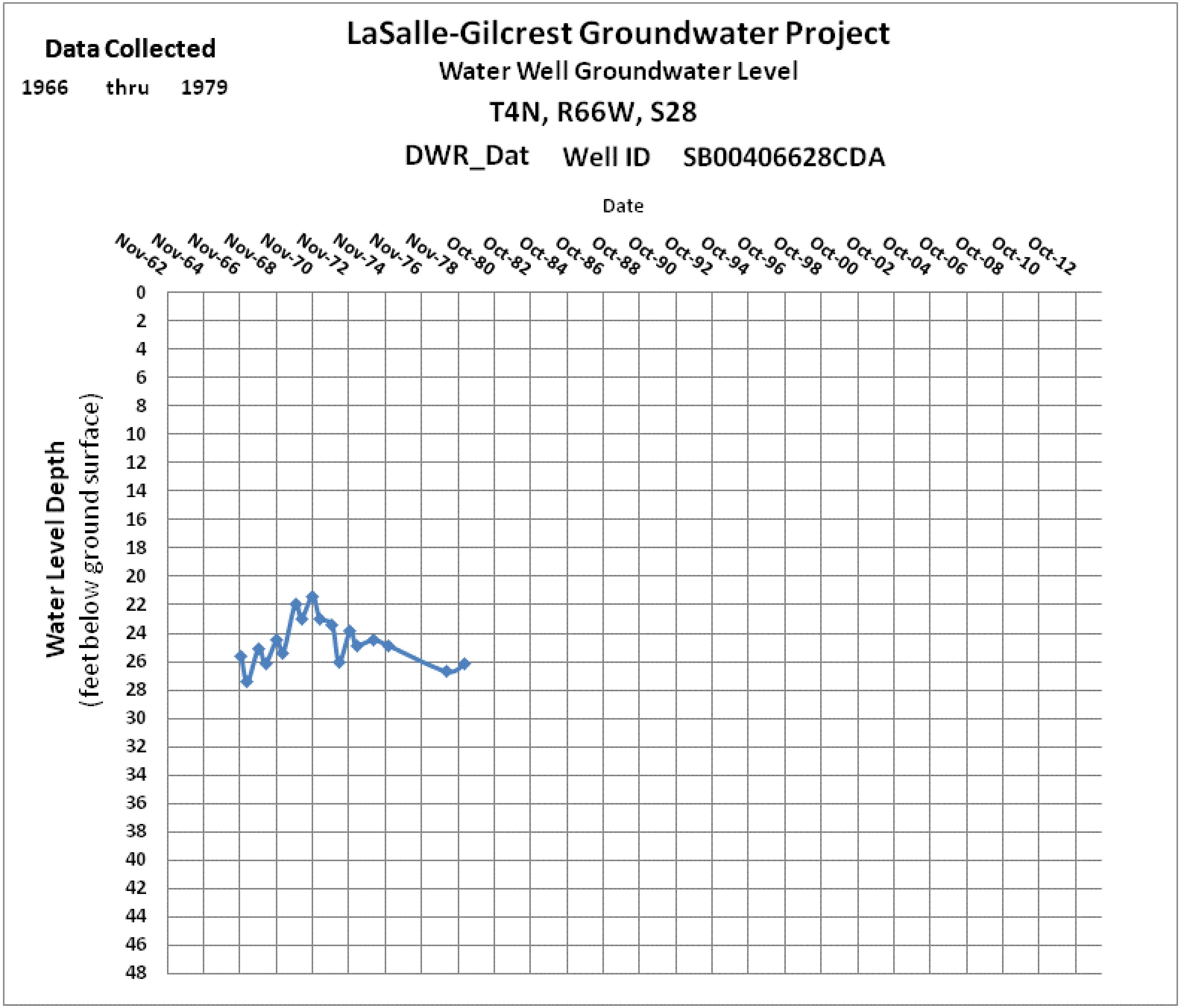
LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

T4N, R66W, S27

DWR_Dat Well ID SB00406627CC





Data Collected
1966 thru 1979
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S28
DWR_Dat Well ID SB00406628CDA
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
0
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LaSalle-Gilcrest Groundwater Project

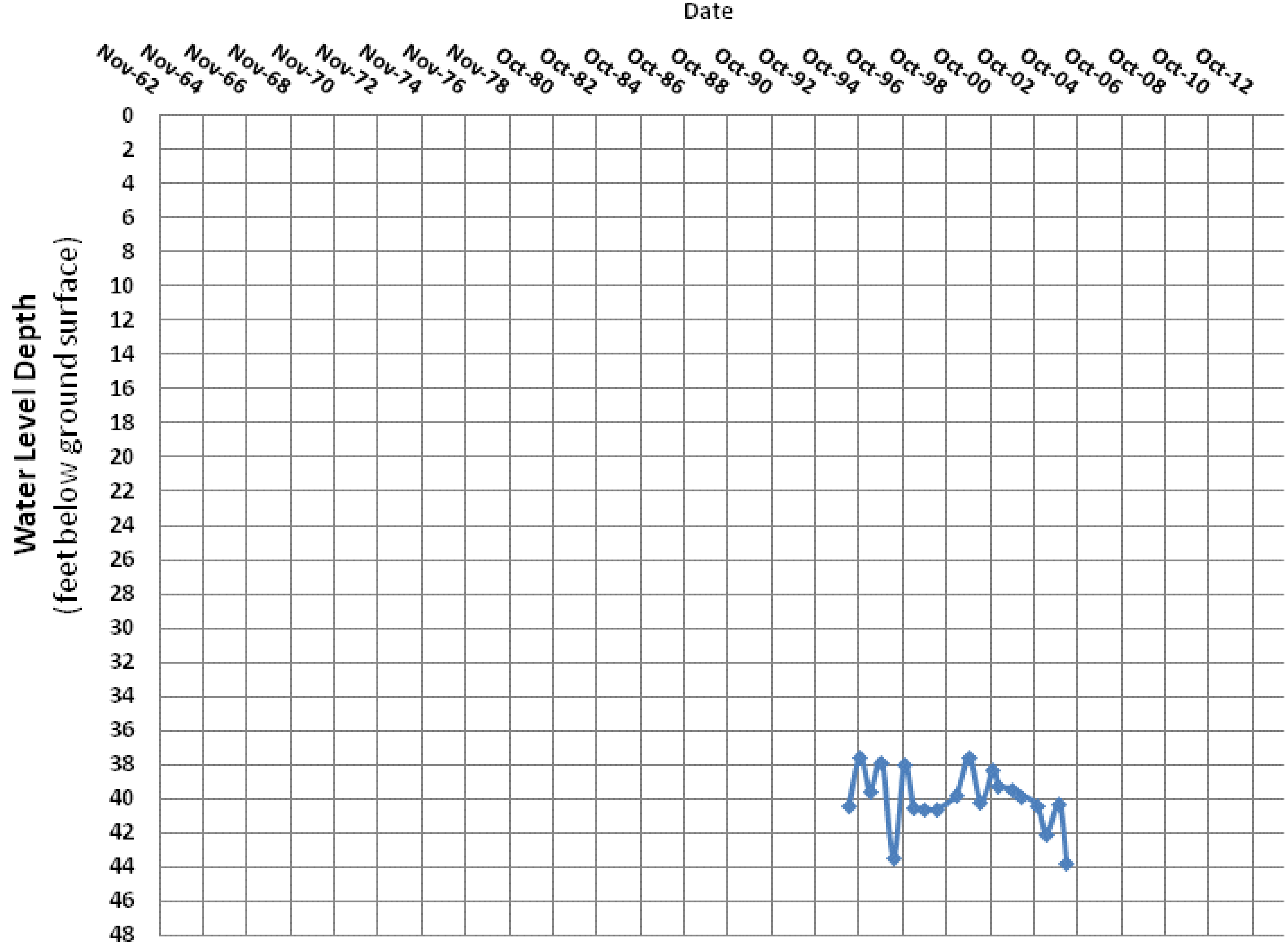
Water Well Groundwater Level

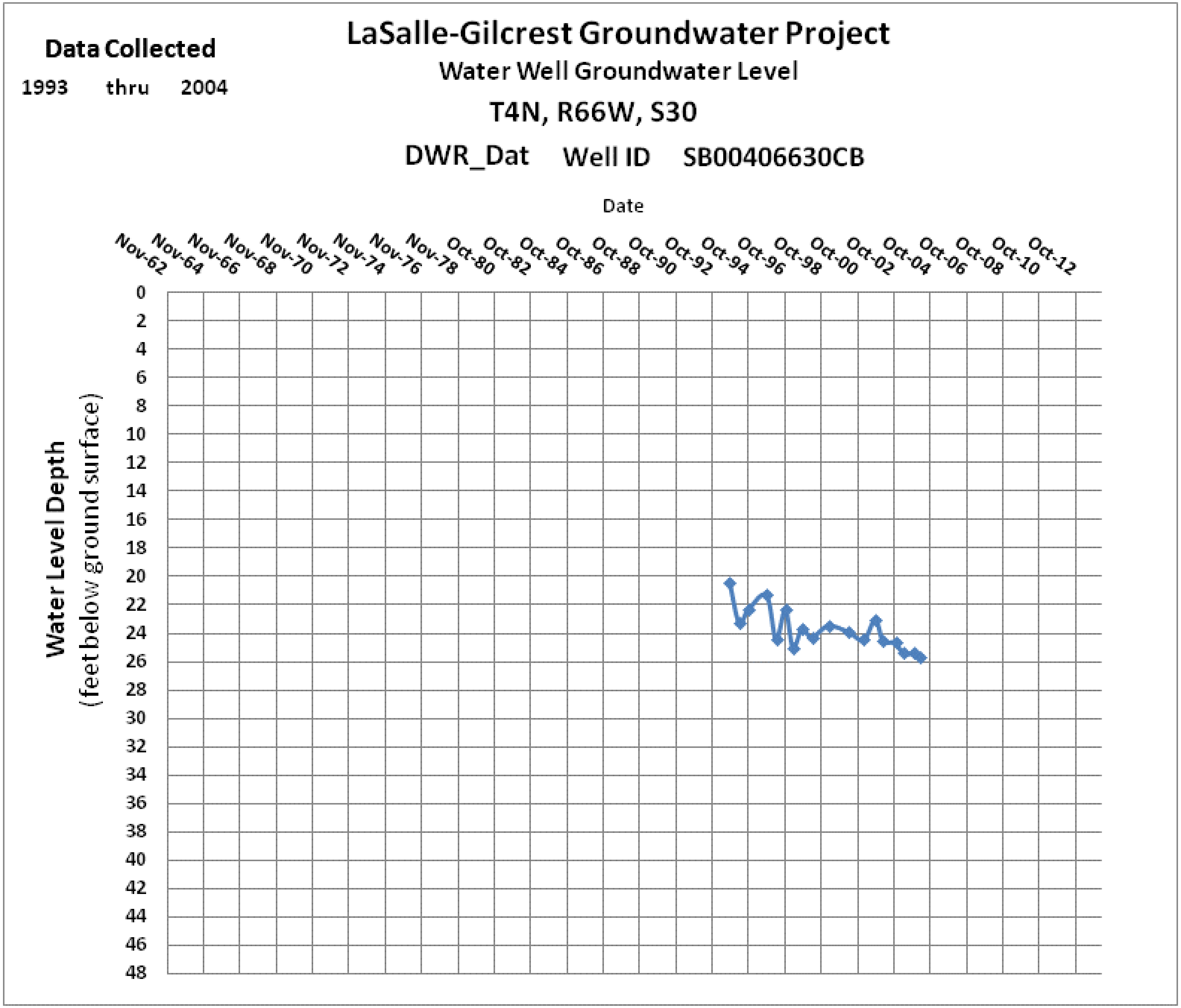
T4N, R66W, S29

DWR_Dat Well ID SB00406629BD

Data Collected

1994 thru 2004





Data Collected
1993 thru 2004
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S30
DWR_Dat Well ID SB00406630CB
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
0
2
4
6
8
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12
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18
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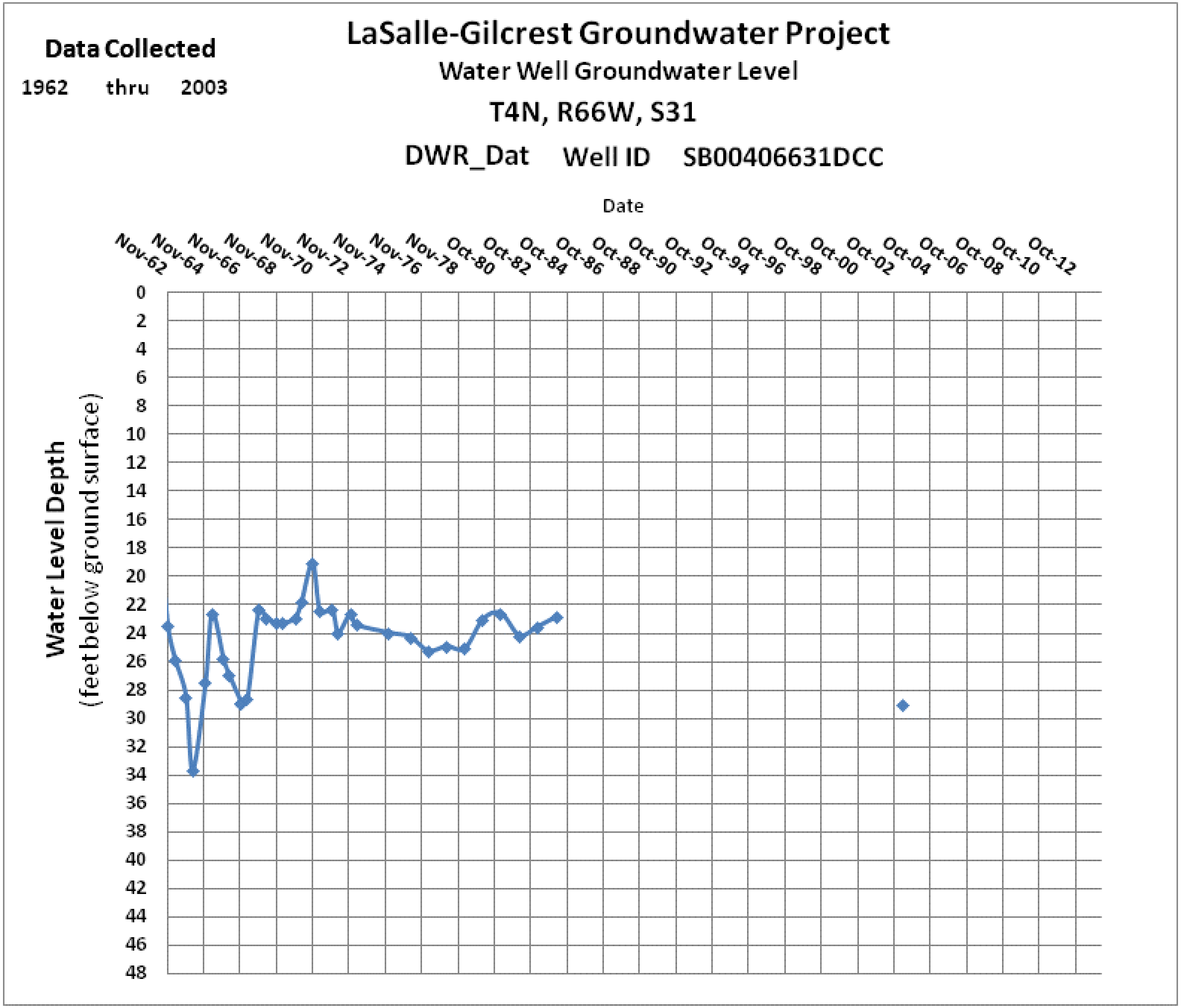
26
28
30
32
34
36
38
40
42
44
46
48



Data Collected
1962 thru 2003
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S31
DWR_Dat Well ID SB00406631DCC
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
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42
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46
48

Data Collected

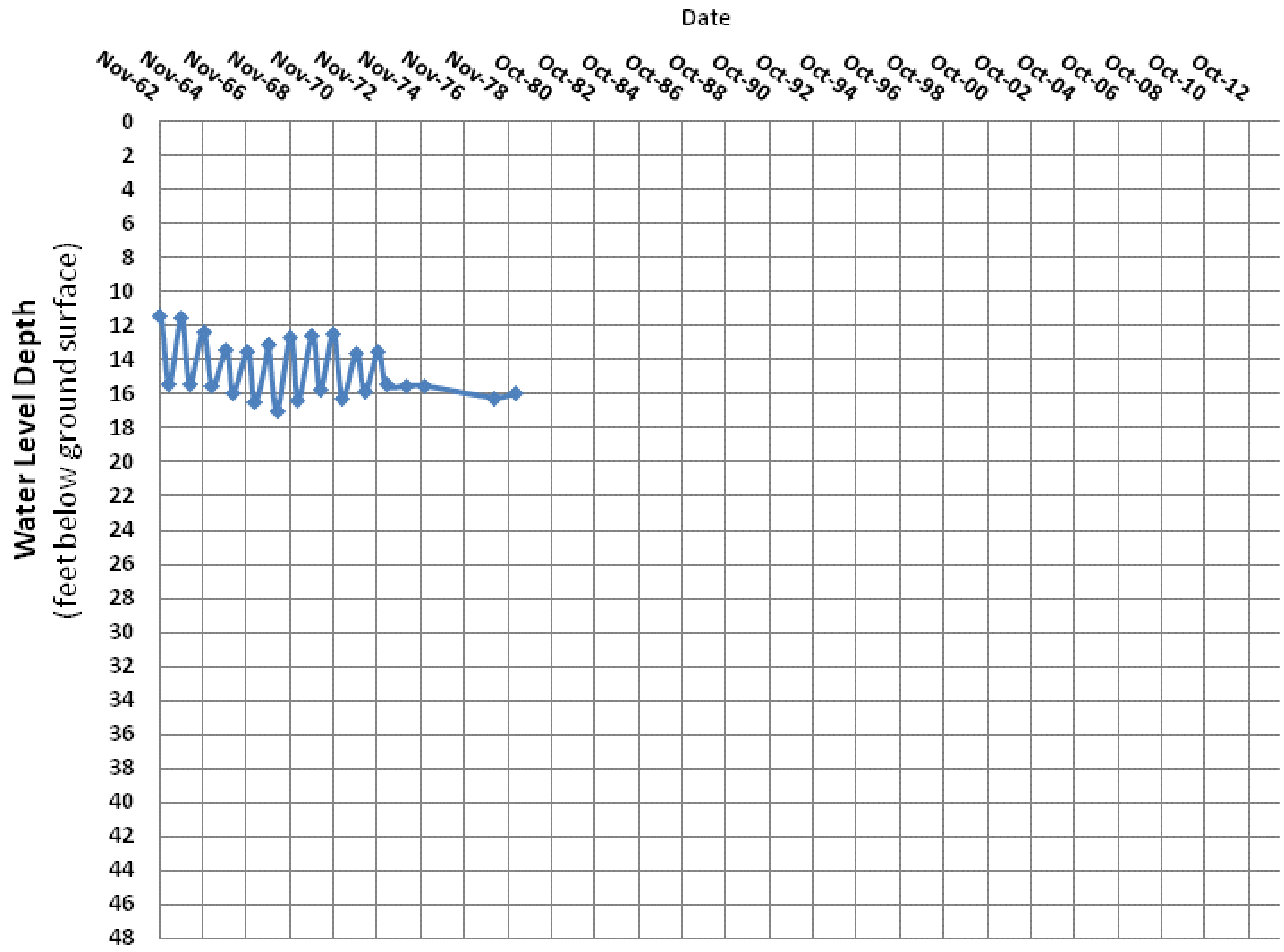
1941 thru 1979

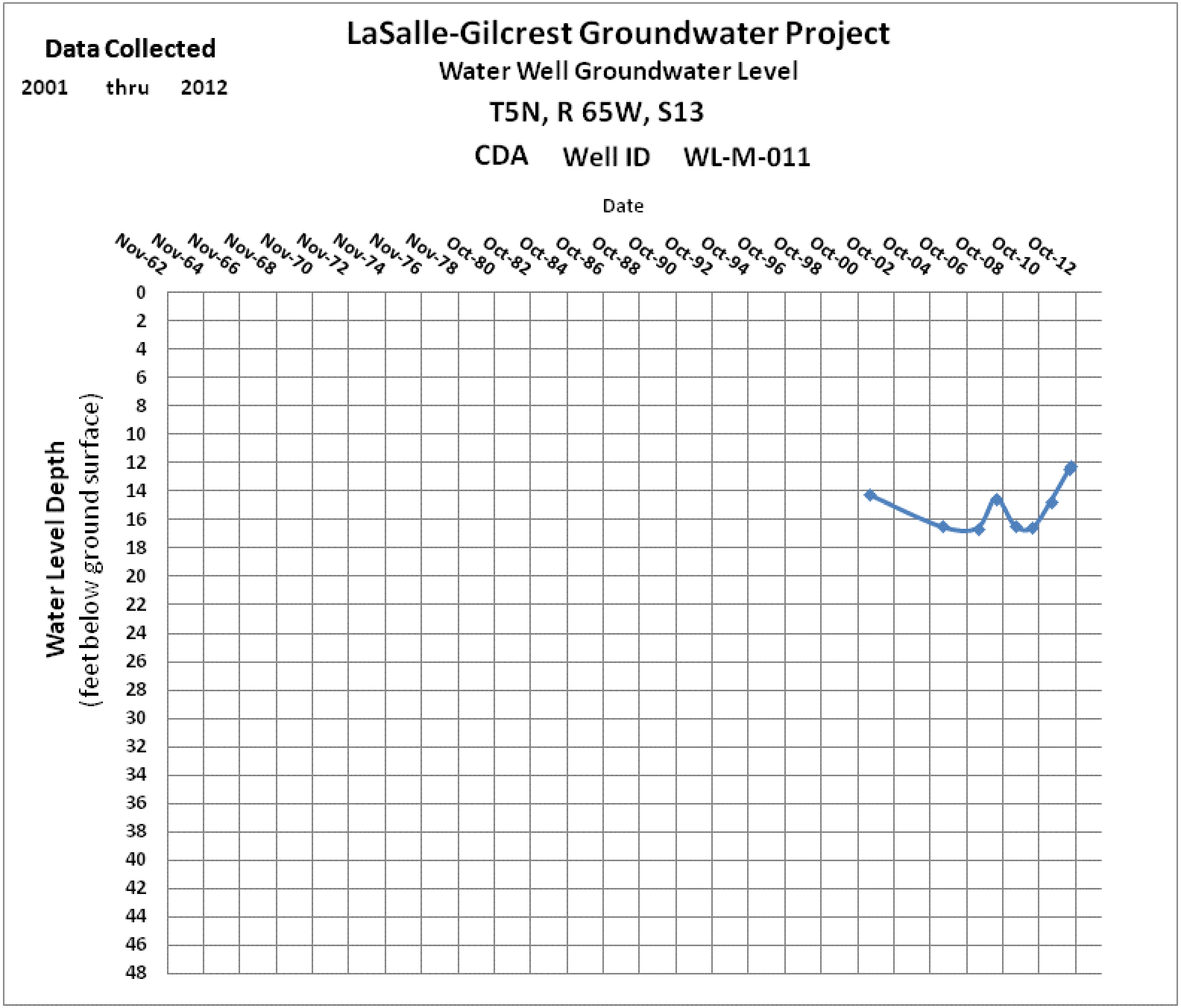
LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

T5N R65W S27

DWR_Dat Well ID SB00506527CC





Data Collected
2001 thru 2012
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T5N, R 65W, S13
CDA Well ID WL-M-011
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
0
2
4
6
8
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36
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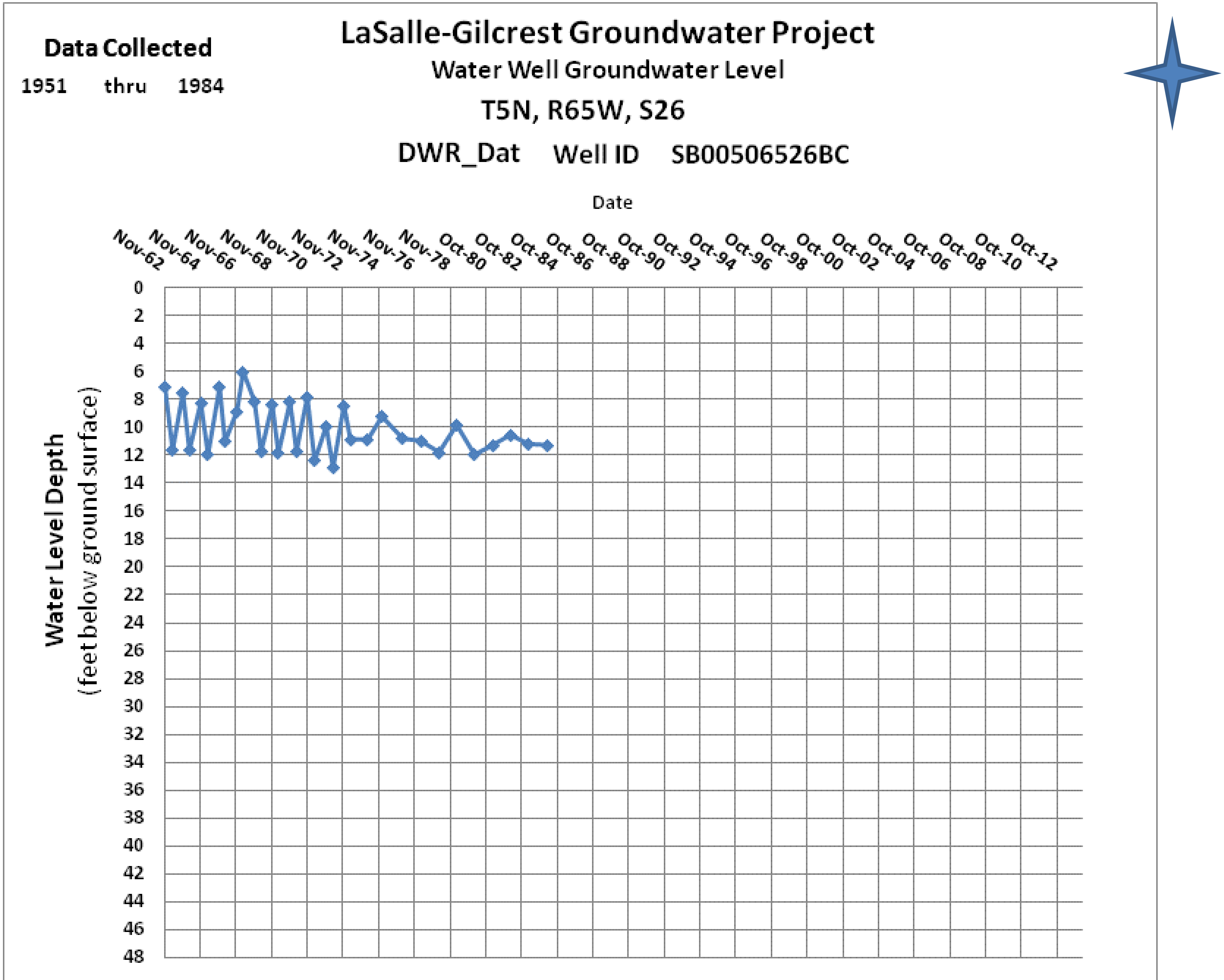

Data Collected
1951 thru 1984
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T5N, R65W, S26
DWR_Dat Well ID SB00506526BC
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
0
2
4
6
8
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12
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16
18
20
22
24
26
28
30
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34
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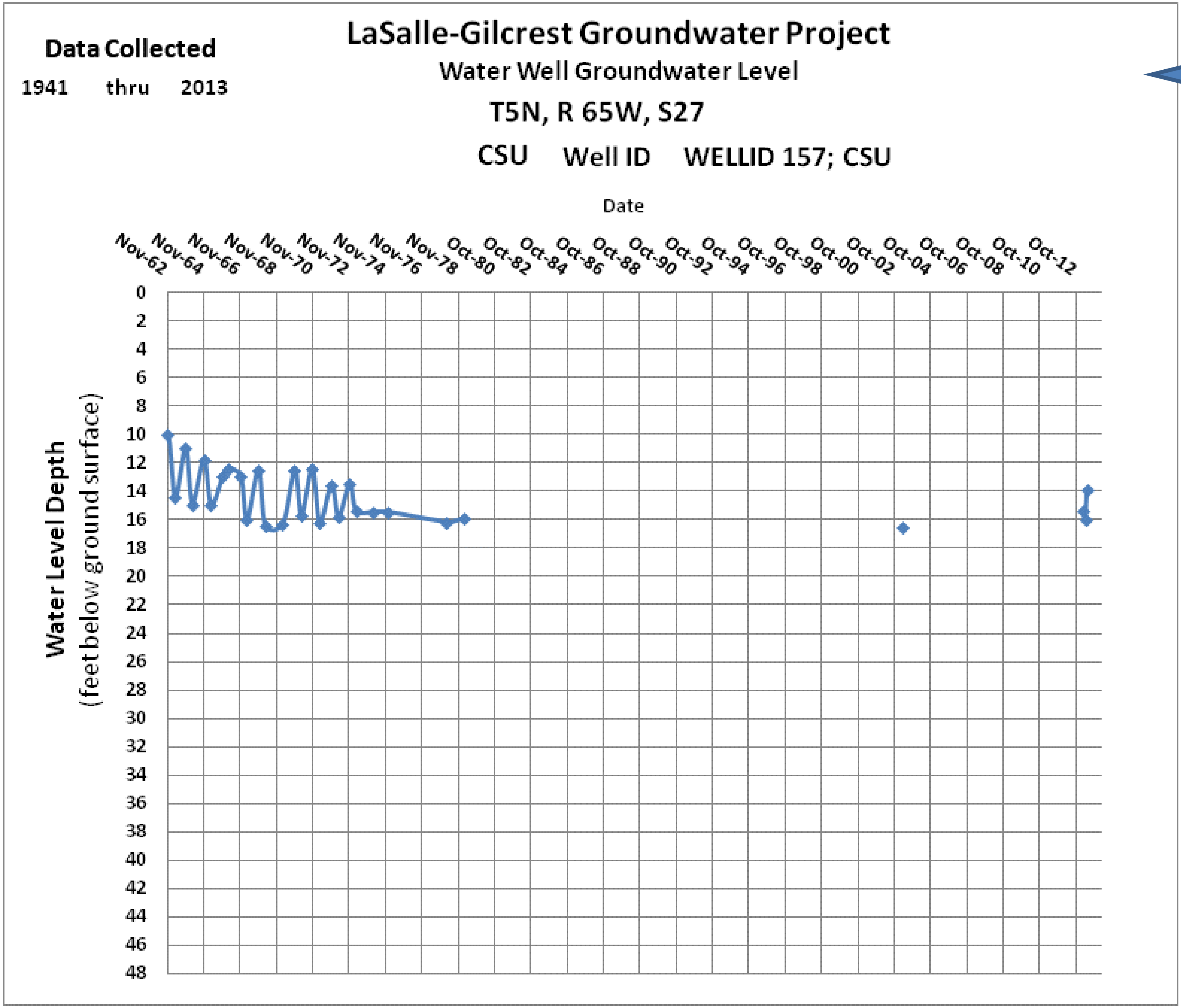
40
42
44
46
48


Data Collected
1941 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T5N, R 65W, S27
CSU Well ID WELLID 157; CSU
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
0
2
4
6
8
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12
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16
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46
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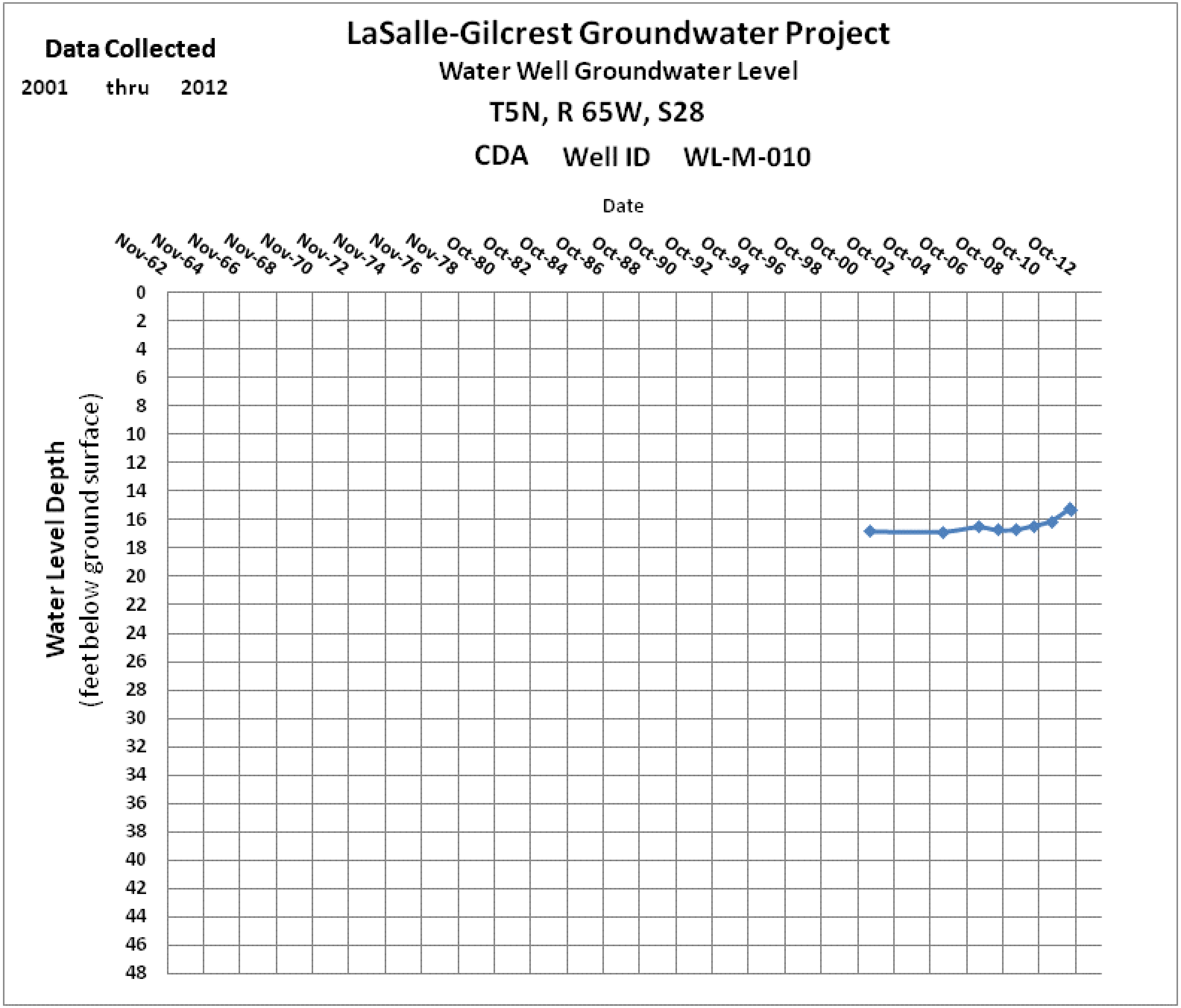
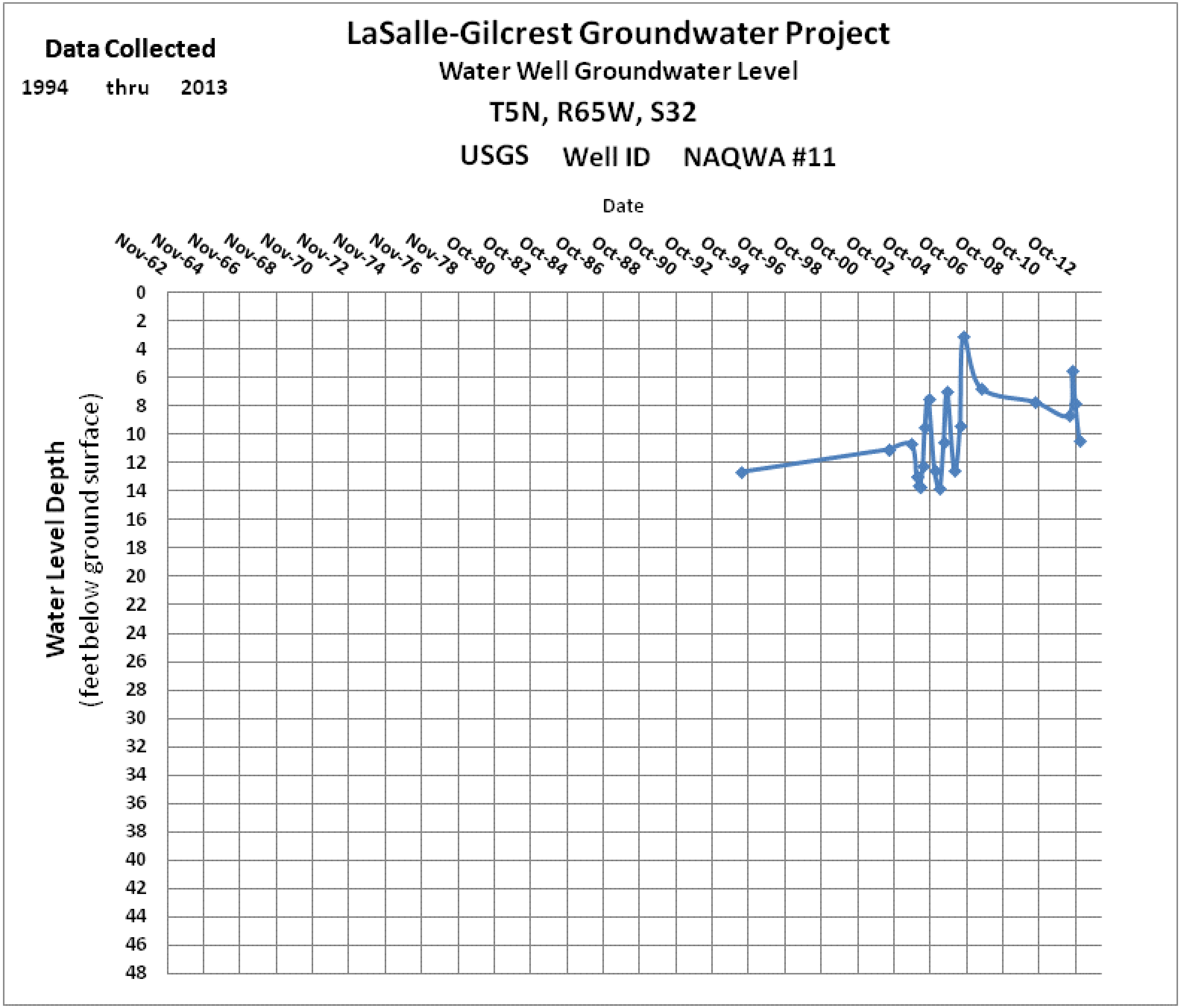

LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T5N, R 65W, S28
CDA Well ID WL-M-010
Data Collected
2001 thru 2012
Date
Nov-62 Nov-64 Nov-66 Nov-68 Nov-70 Nov-72 Nov-74 Nov-76 Nov-78 Oct-80 Oct-82 Oct-84 Oct-86 Oct-88 Oct-90 Oct-92 Oct-94 Oct-96 Oct-98 Oct-00 Oct-02 Oct-04 Oct-06 Oct-08 Oct-10 Oct-12
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
Water Level Depth
(feet below ground surface)



Data Collected
1994 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T5N, R65W, S32
USGS Well ID NAQWA #11
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
0
2
4
6
8
10
12
14
16
18
20
22
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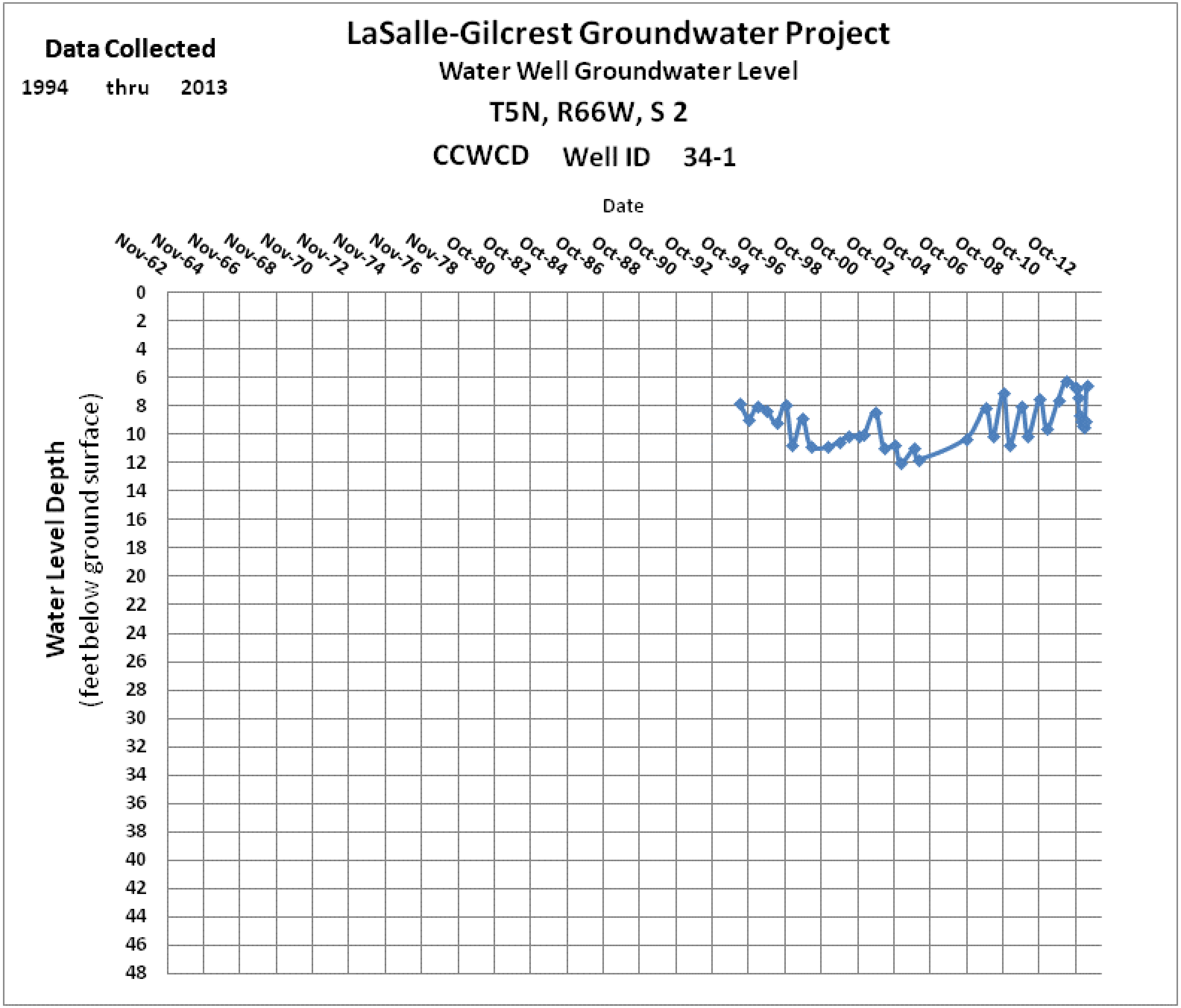
40
42
44
46
48


Data Collected
1994 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T5N, R66W, S 2
CCWCD Well ID 34-1
Date
Nov-62
Nov-64
Nov-66
Nov-68
Nov-70
Nov-72
Nov-74
Nov-76
Nov-78
Oct-80
Oct-82
Oct-84
Oct-86
Oct-88
Oct-90
Oct-92
Oct-94
Oct-96
Oct-98
Oct-00
Oct-02
Oct-04
Oct-06
Oct-08
Oct-10
Oct-12
Water Level Depth
(feet below ground surface)
0
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4
6
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10
12
14
16
18
20
22
24
26
28
30
32
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36
38
40
42
44
46
48

Wells with data earlier than 1962

- Shown above on the same axis with other wells .
- Duplicated here on an extended from 1930 - 2013 axis for analysis of the entire date range.

Data Collected

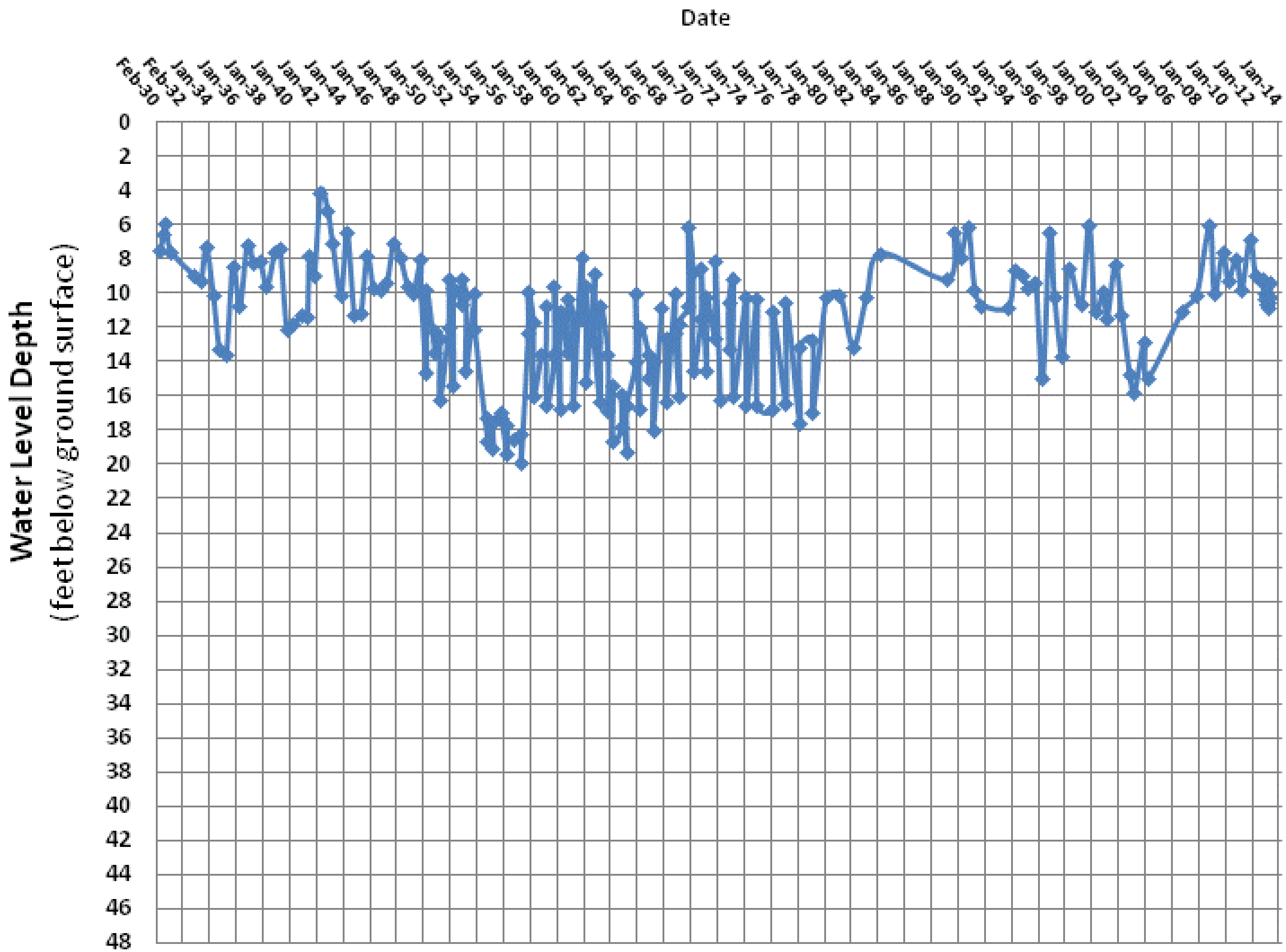
1930 thru 2013

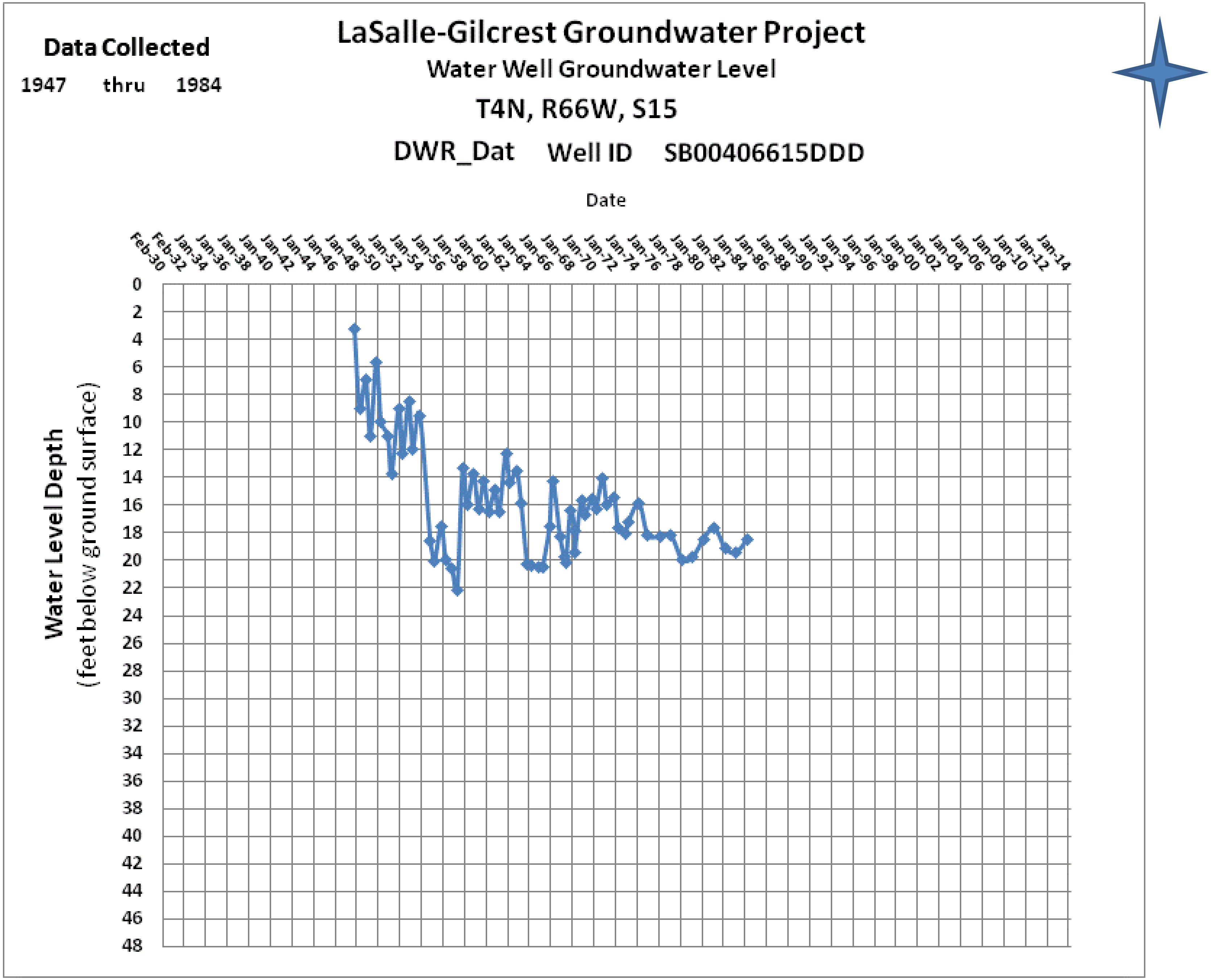
LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

T4N, R65W, S 18

CCWCD Well ID 16-1




Data Collected
1947 thru 1984
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S15
DWR_Dat Well ID SB00406615DDD
Date
Water Level Depth
(feet below ground surface)

Data Collected

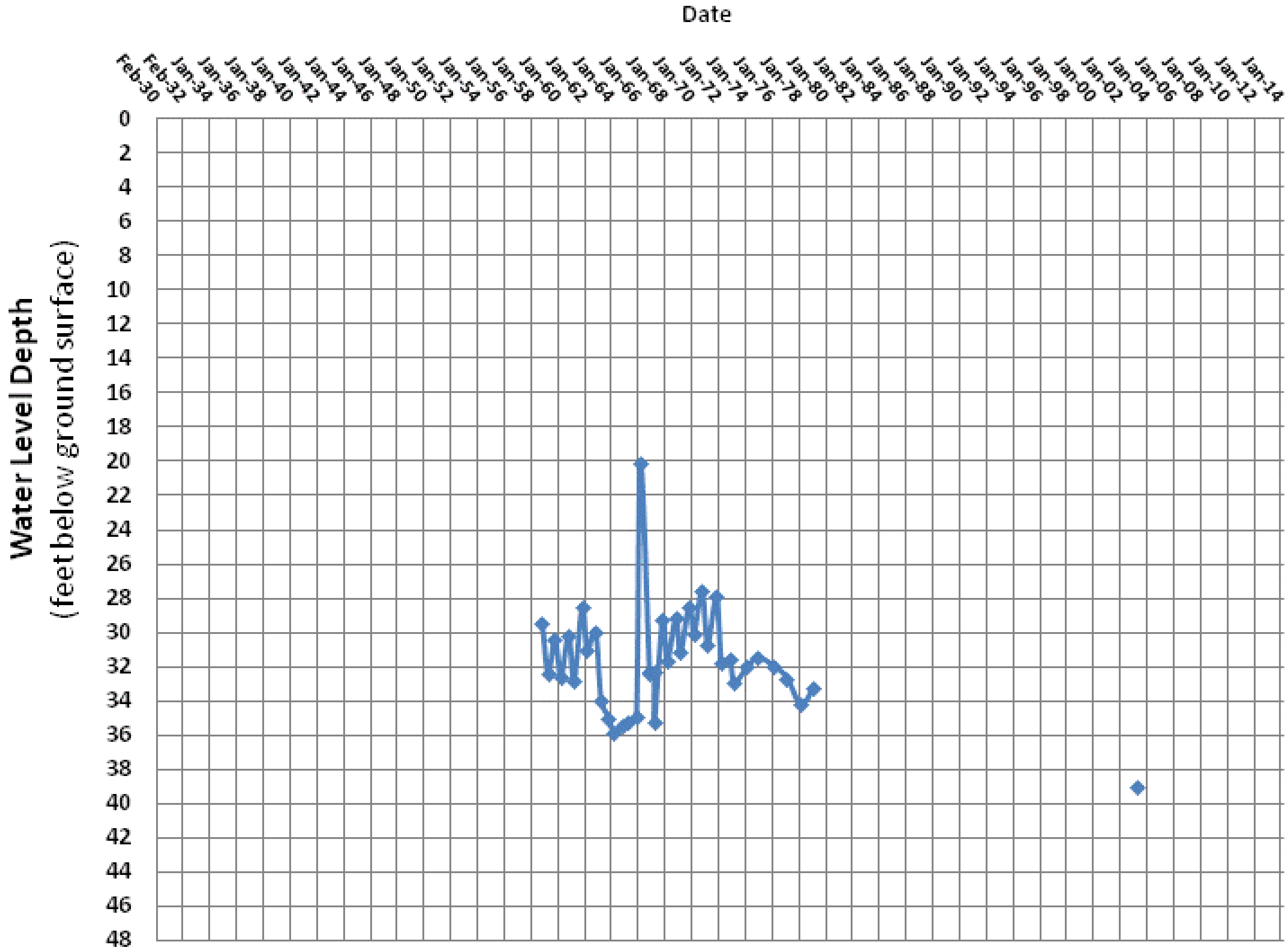
1958 thru 2003

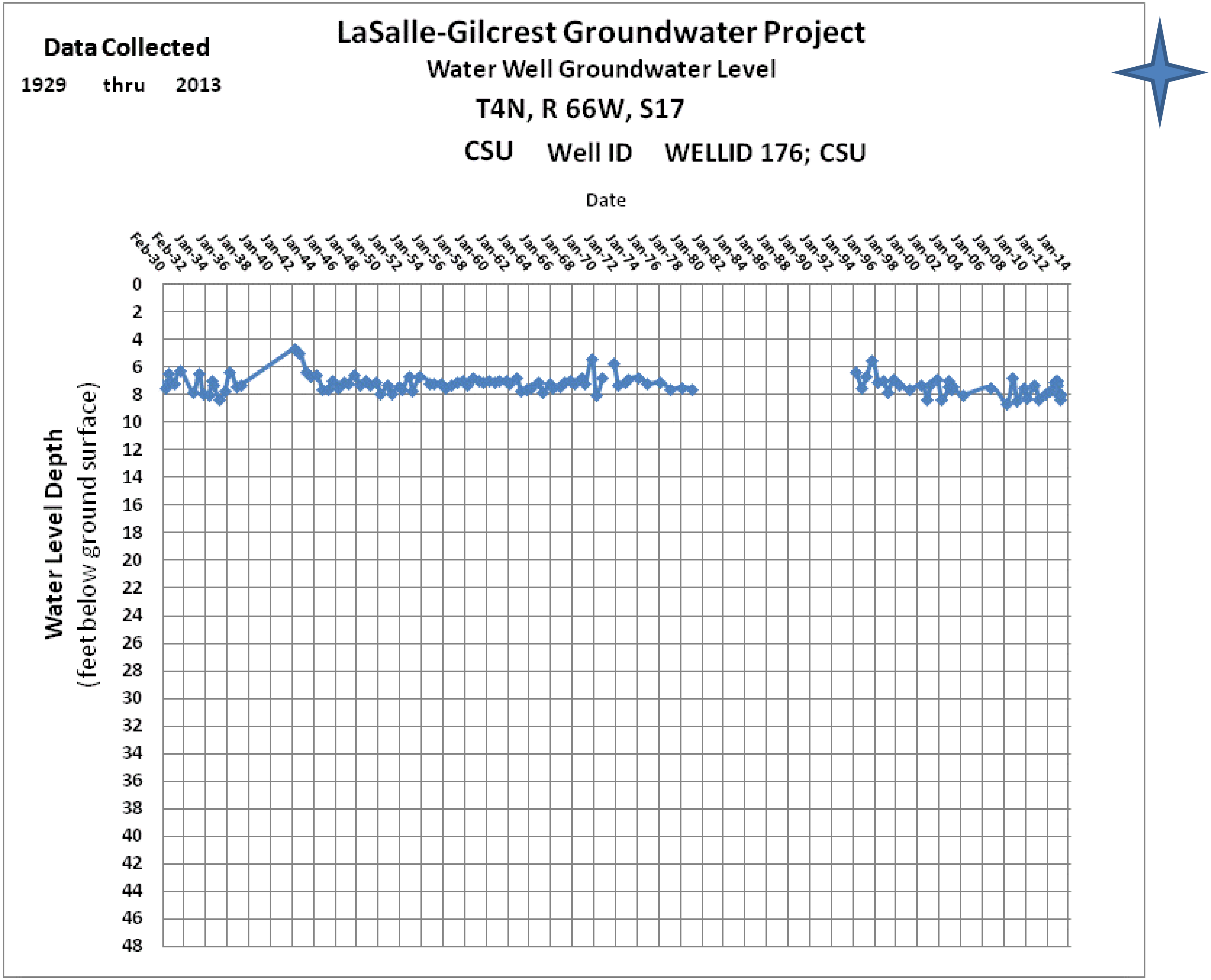
LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

T4N, R66W, S15

DWR_Dat Well ID SB00406615CCC2





Data Collected
1929 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R 66W, S17
CSU Well ID WELLID 176; CSU
Date
Feb-30
Feb-32
Jan-34
Jan-36
Jan-38
Jan-40
Jan-42
Jan-44
Jan-46
Jan-48
Jan-50
Jan-52
Jan-54
Jan-56
Jan-58
Jan-60
Jan-62
Jan-64
Jan-66
Jan-68
Jan-70
Jan-72
Jan-74
Jan-76
Jan-78
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Water Level Depth
(feet below ground surface)
0
2
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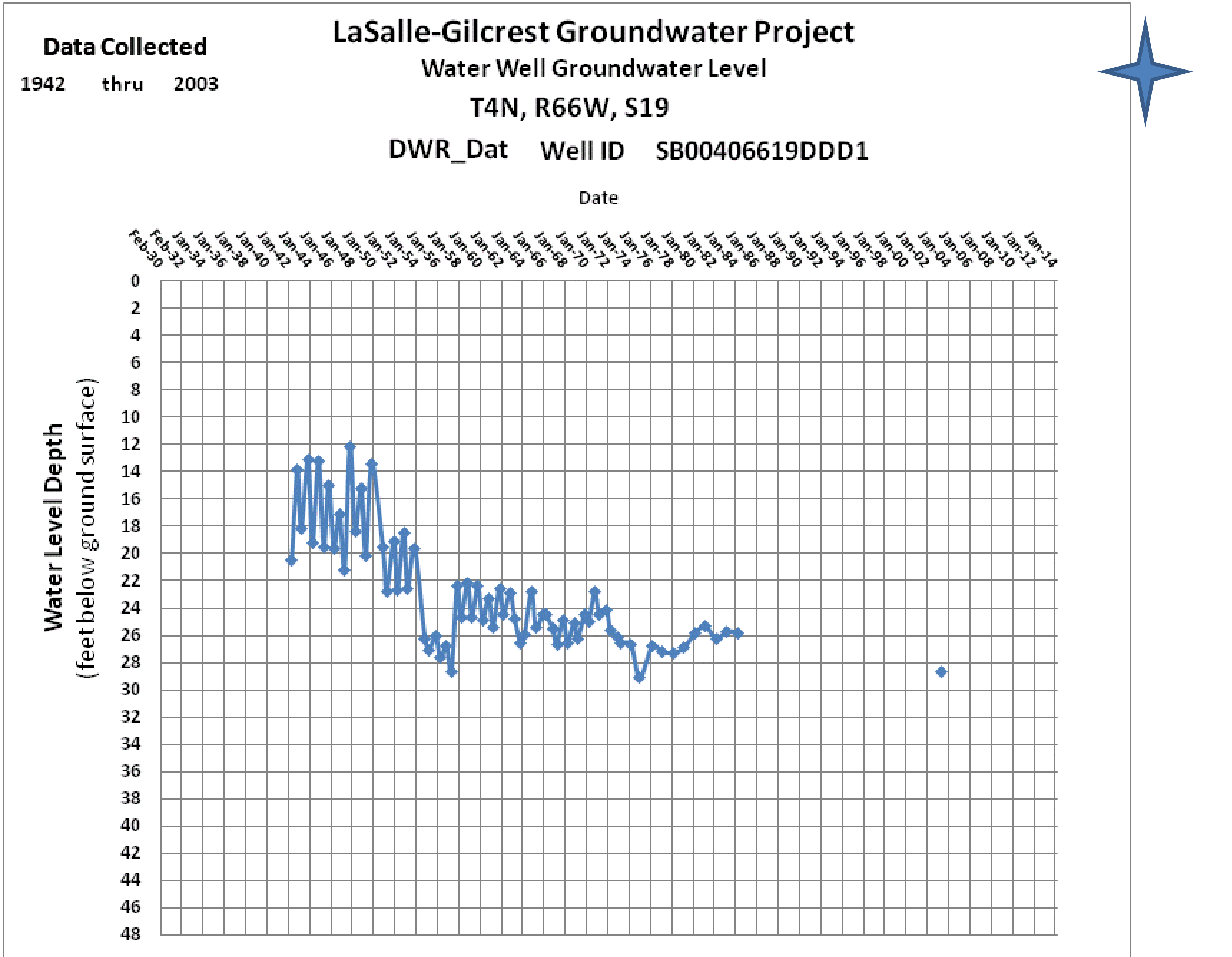

Data Collected
1942 thru 2003
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T4N, R66W, S19
DWR_Dat Well ID SB00406619DDD1
Date
Feb-30 Feb-32 Jan-34 Jan-36 Jan-38 Jan-40 Jan-42 Jan-44 Jan-46 Jan-48 Jan-50 Jan-52 Jan-54 Jan-56 Jan-58 Jan-60 Jan-62 Jan-64 Jan-66 Jan-68 Jan-70 Jan-72 Jan-74 Jan-76 Jan-78 Jan-80 Jan-82 Jan-84 Jan-86 Jan-88 Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12 Jan-14
Water Level Depth
(feet below ground surface)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48

Data Collected

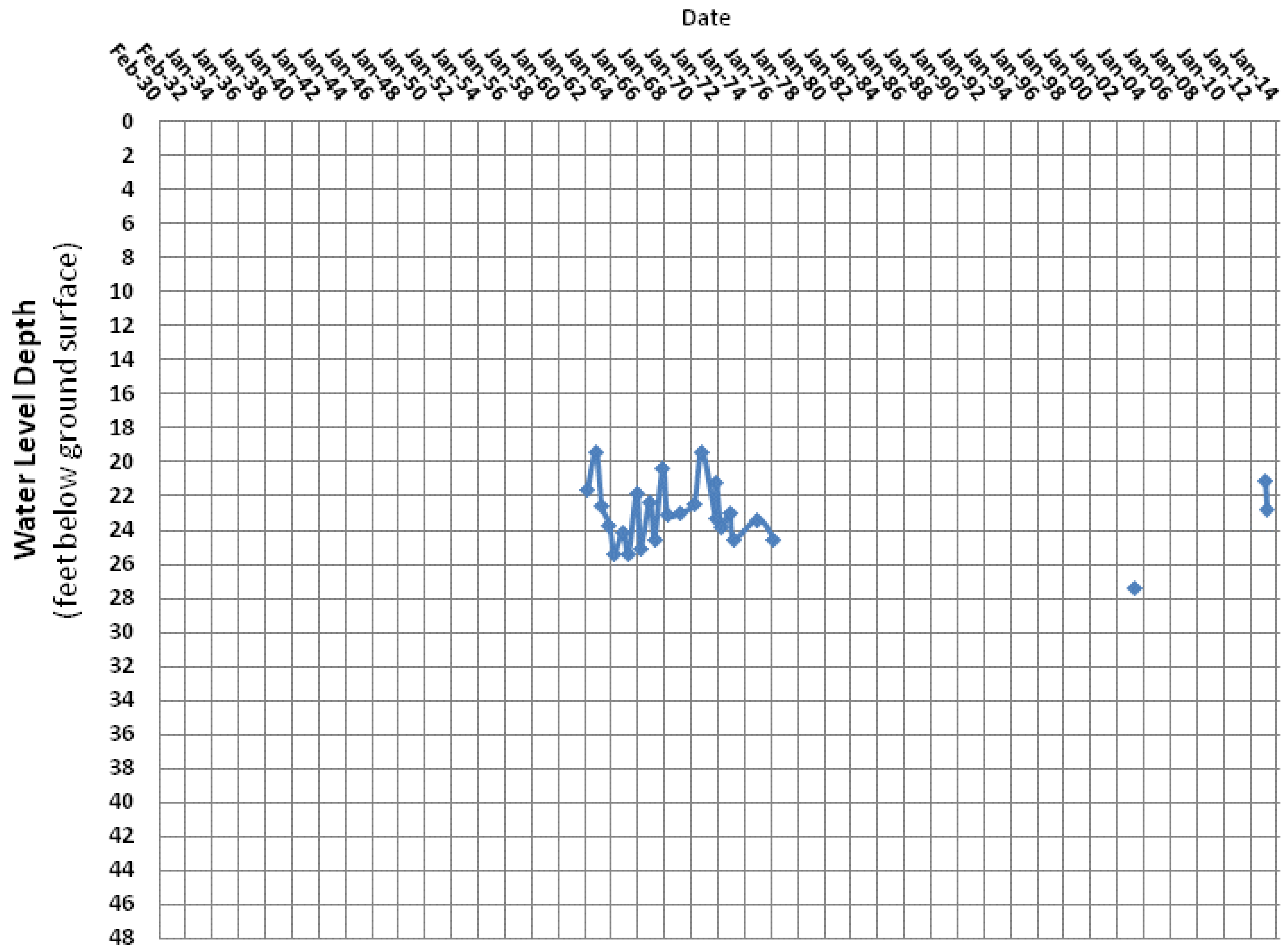
1962 thru 2013

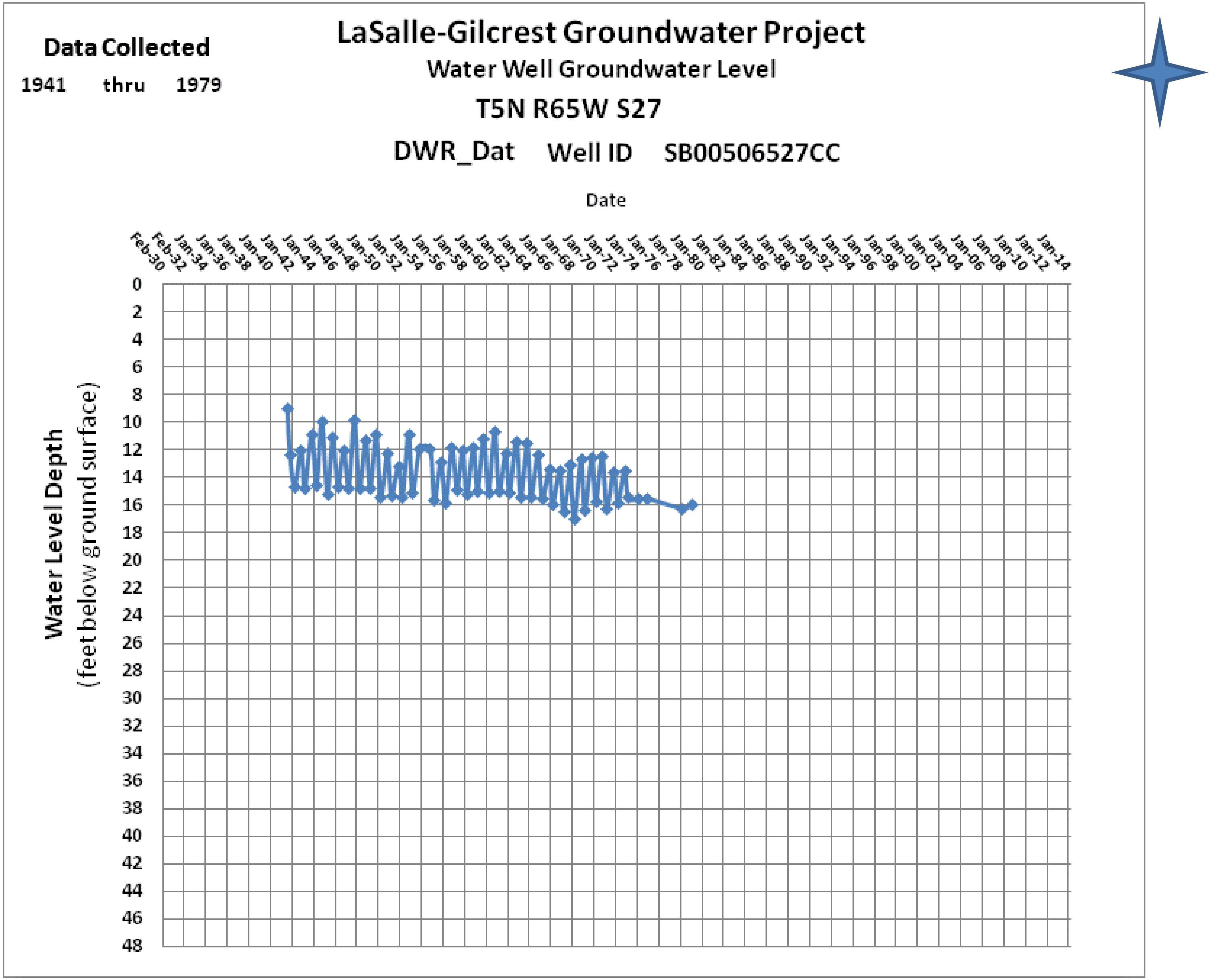
LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

T4N, R 66W, S2

CSU Well ID WELLID 167; CSU




Data Collected
1941 thru 1979
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T5N R65W S27
DWR_Dat Well ID SB00506527CC
Date
Feb-30 Feb-32 Jan-34 Jan-36 Jan-38 Jan-40 Jan-42 Jan-44 Jan-46 Jan-48 Jan-50 Jan-52 Jan-54 Jan-56 Jan-58 Jan-60 Jan-62 Jan-64 Jan-66 Jan-68 Jan-70 Jan-72 Jan-74 Jan-76 Jan-78 Jan-80 Jan-82 Jan-84 Jan-86 Jan-88 Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12 Jan-14
Water Level Depth
(feet below ground surface)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48

Data Collected

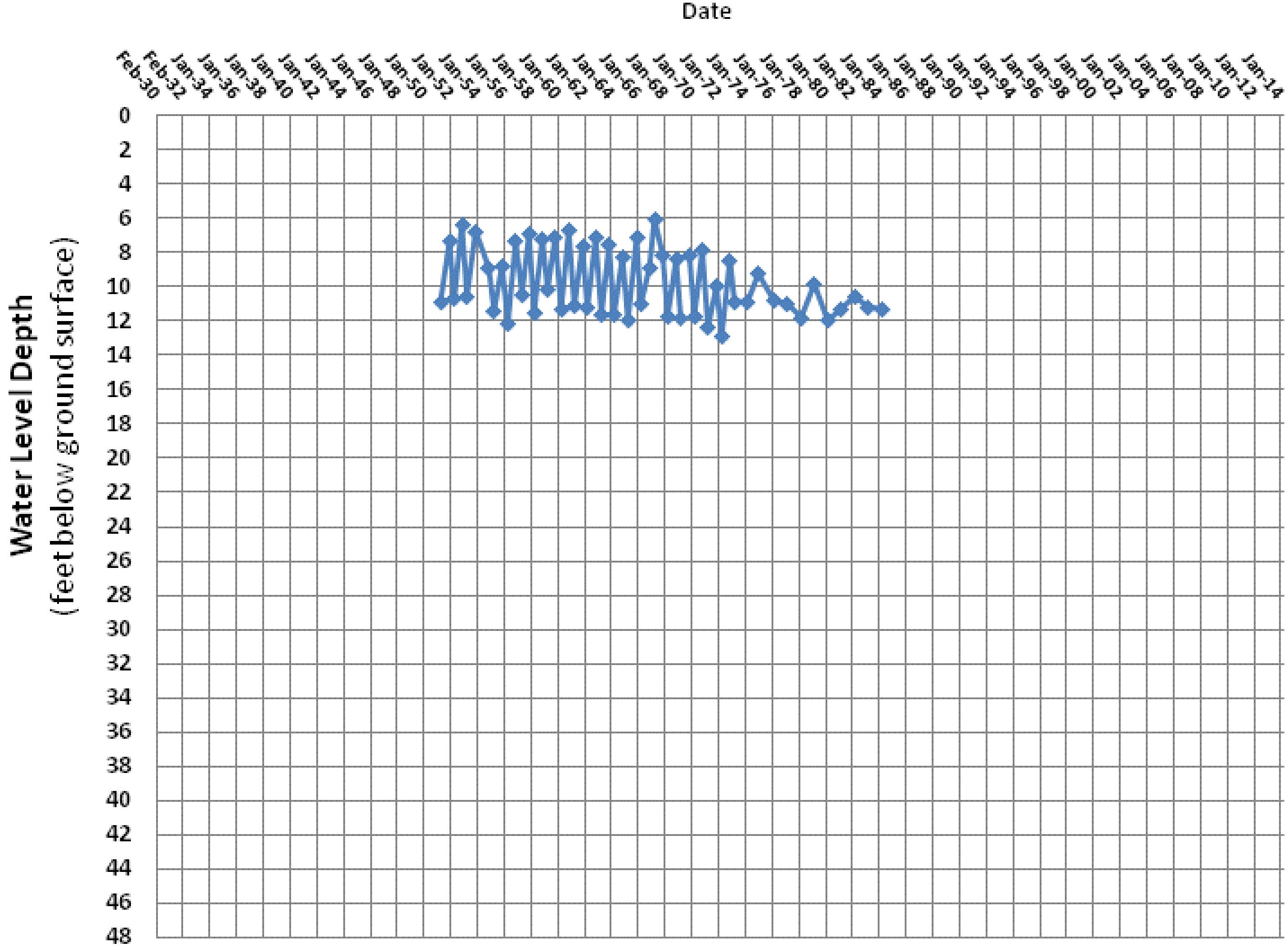
1951 thru 1984

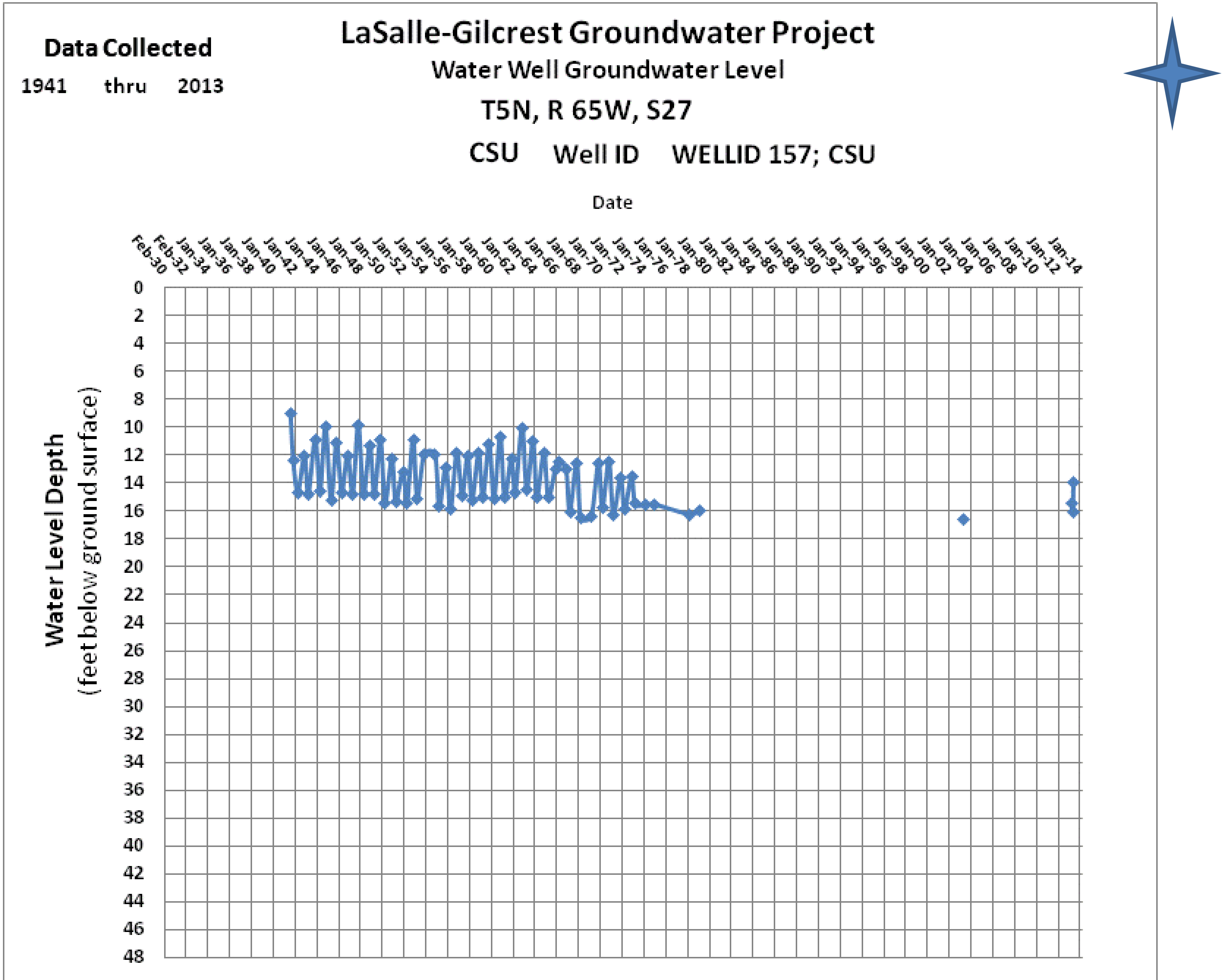
LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

T5N, R65W, S26

DWR_Dat Well ID SB00506526BC



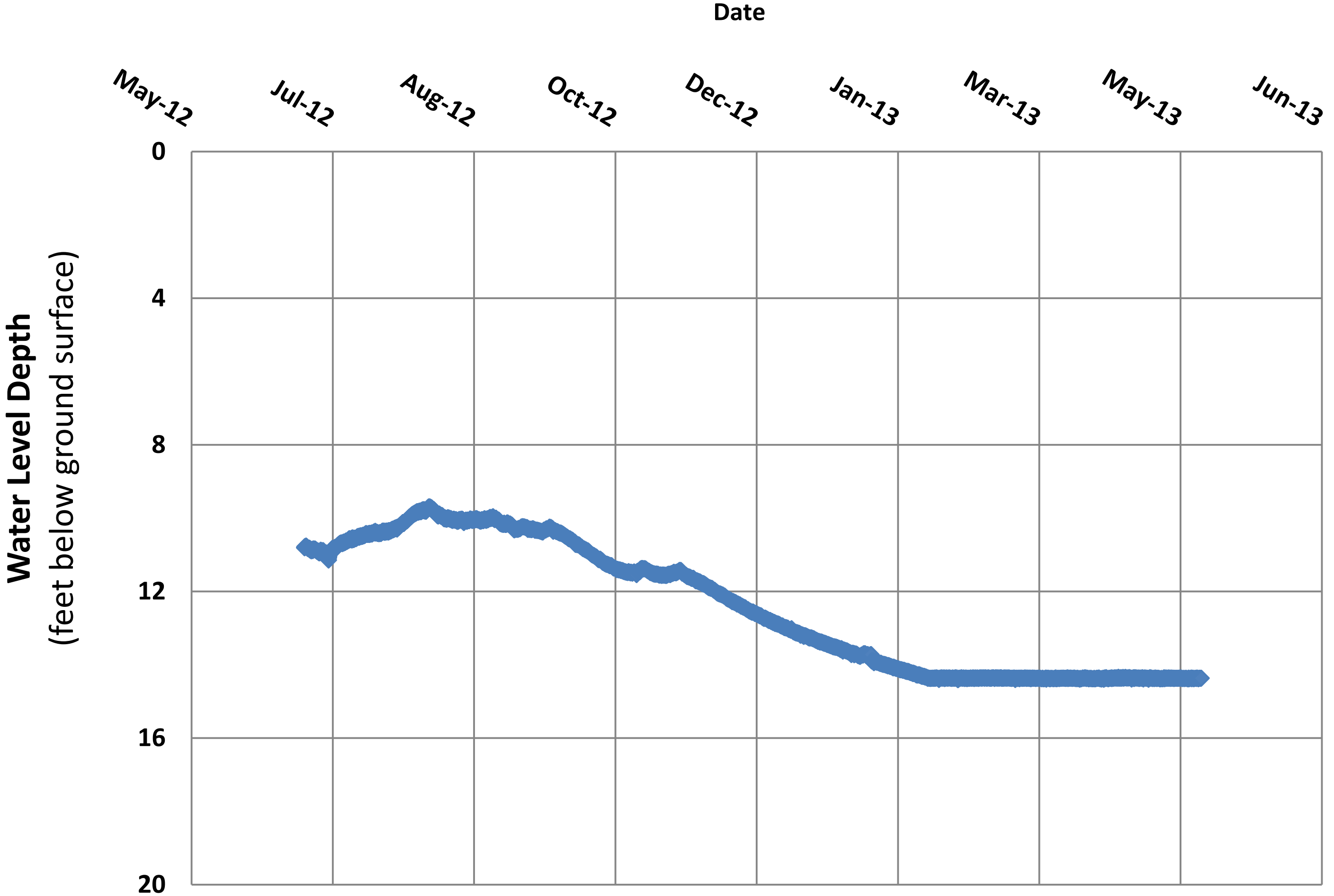

Data Collected
1941 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T5N, R 65W, S27
CSU Well ID WELLID 157; CSU
Date
Feb-30
Feb-32
Jan-34
Jan-36
Jan-38
Jan-40
Jan-42
Jan-44
Jan-46
Jan-48
Jan-50
Jan-52
Jan-54
Jan-56
Jan-58
Jan-60
Jan-62
Jan-64
Jan-66
Jan-68
Jan-70
Jan-72
Jan-74
Jan-76
Jan-78
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Jan-14
Water Level Depth
(feet below ground surface)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48

Wells with Transducer Data

LaSalle-Gilcrest Groundwater Project

Data Collected
2012 thru 2013

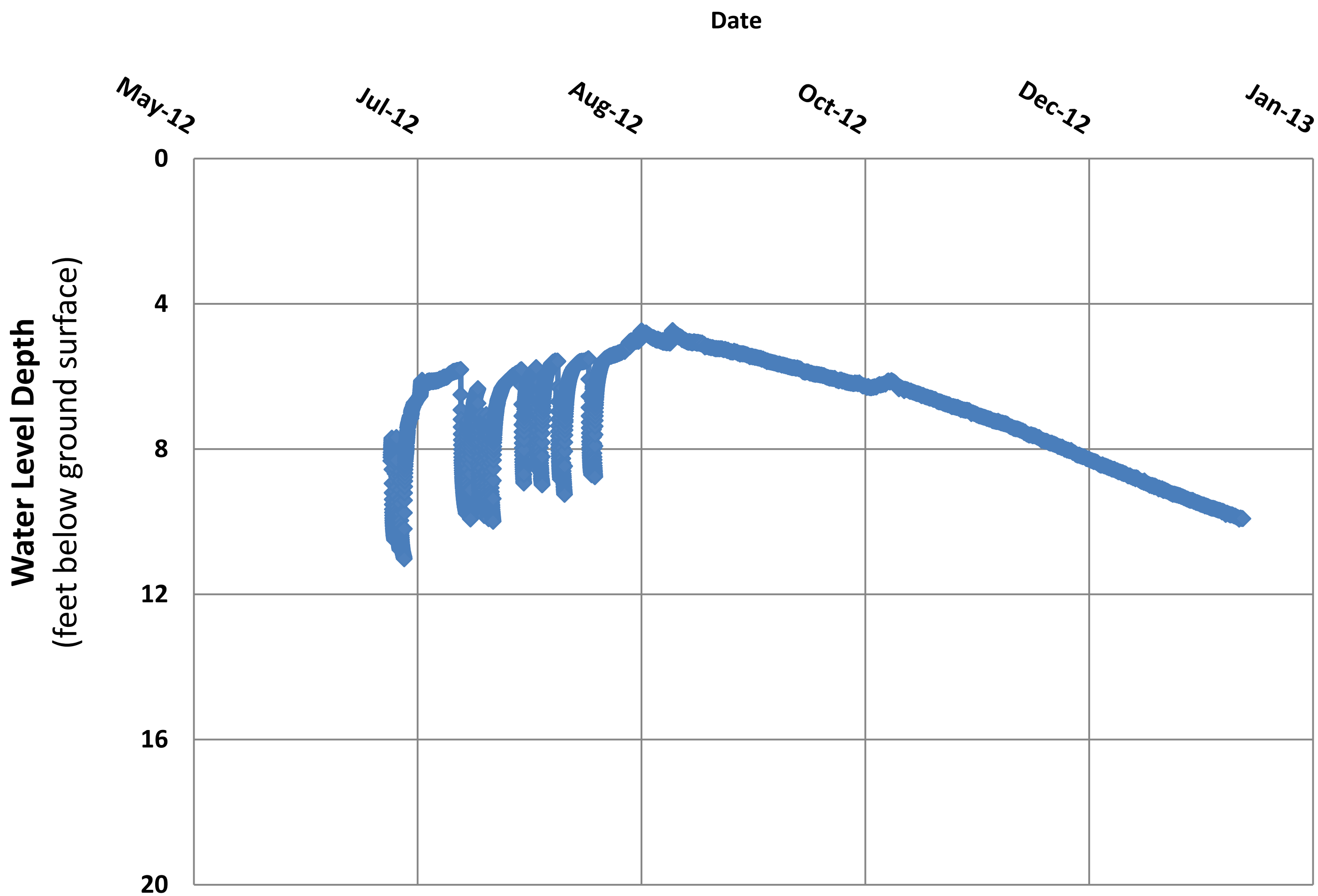
Water Well Groundwater Level
T5N, R 65W, S32
CDA Well ID WL-M-501



LaSalle-Gilcrest Groundwater Project

Data Collected
2012 thru 2013

Water Well Groundwater Level
T2N, R 66W, S6
CDA Well ID WL-M-901



Data Collected

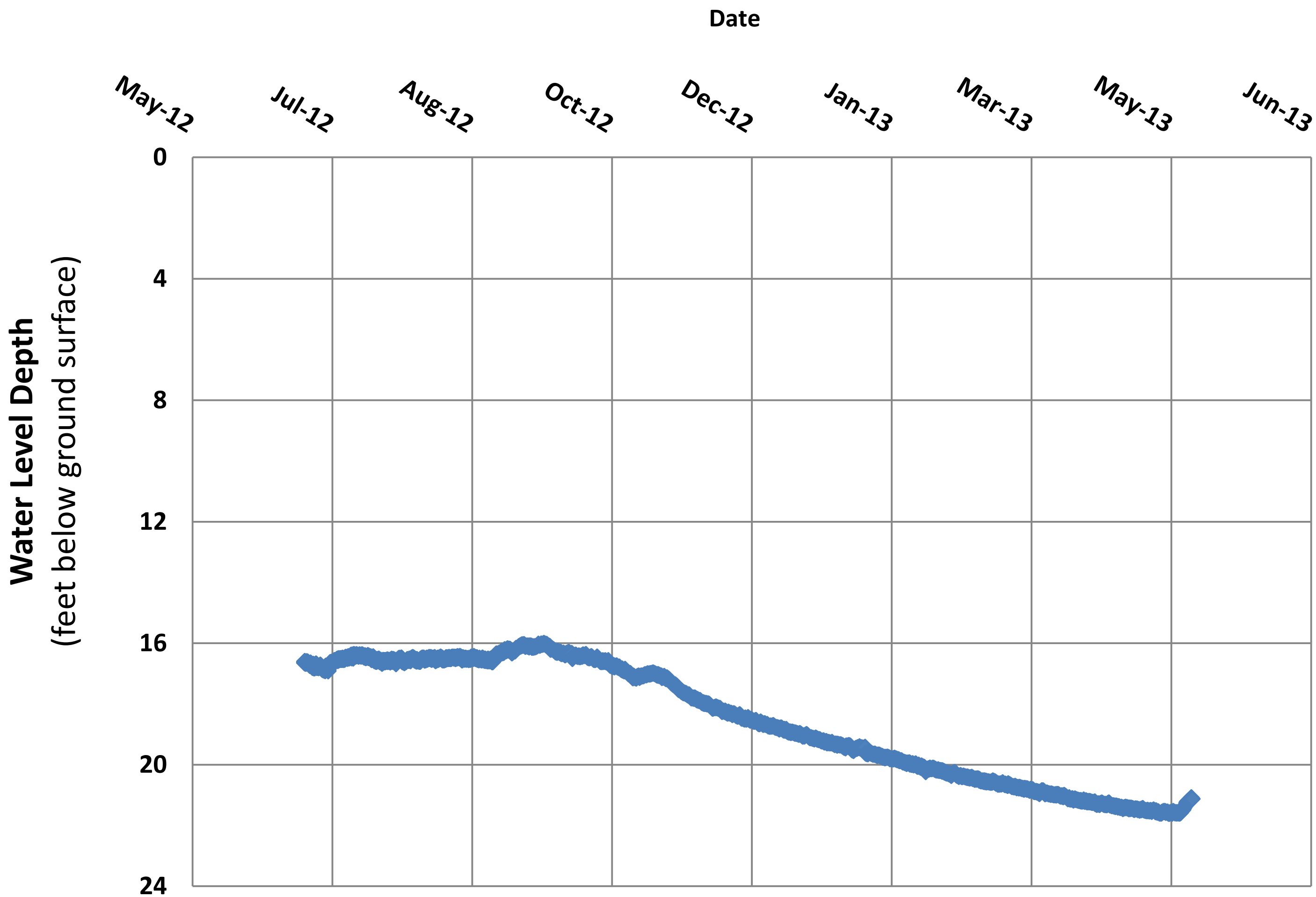
2012 thru 2013

LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

T4N, R 66W, S14

CDA Well ID WL-M-603



Data Collected

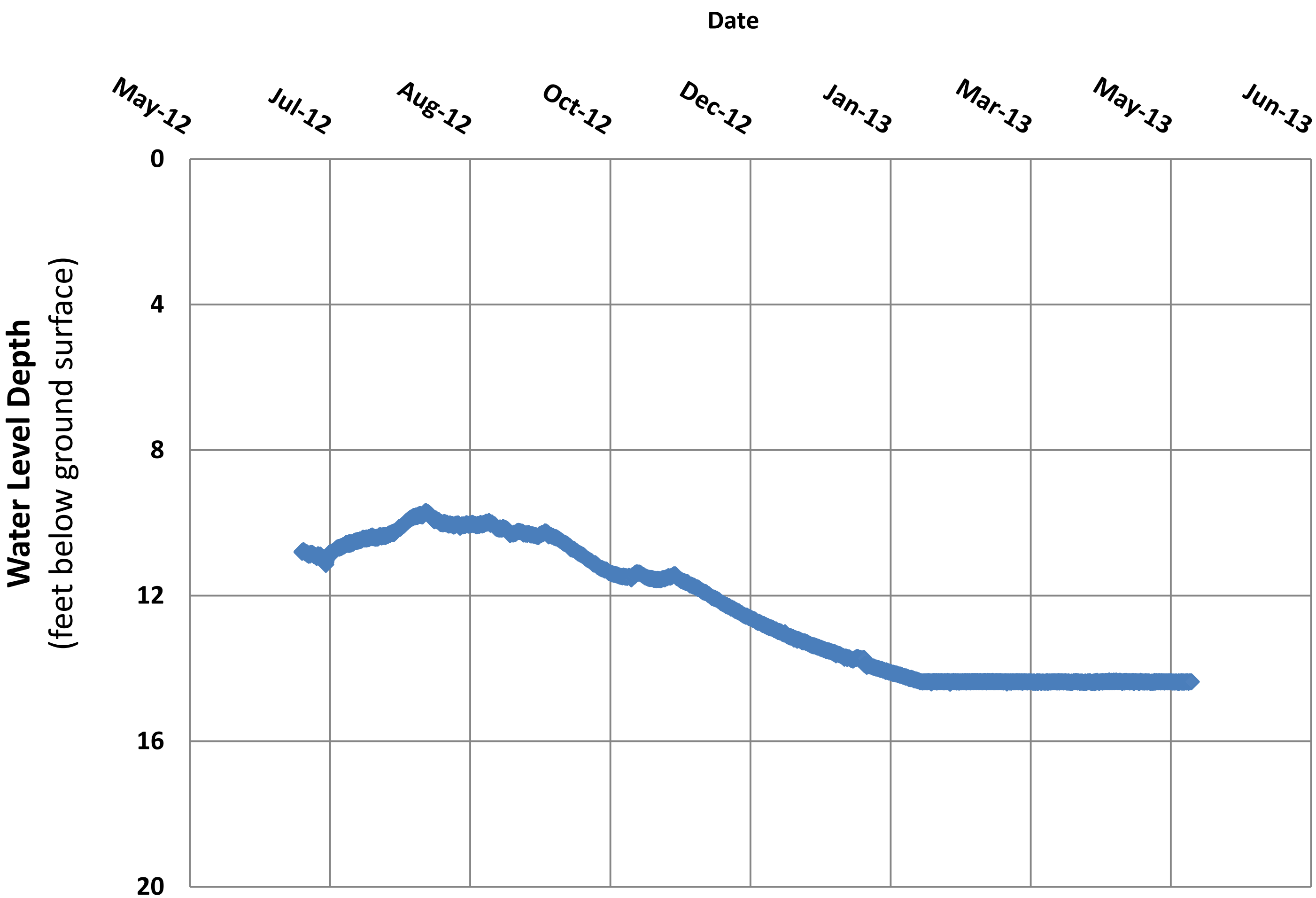
2012 thru 2013

LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

T5N, R 65W, S32

CDA Well ID WL-M-501



Data Collected

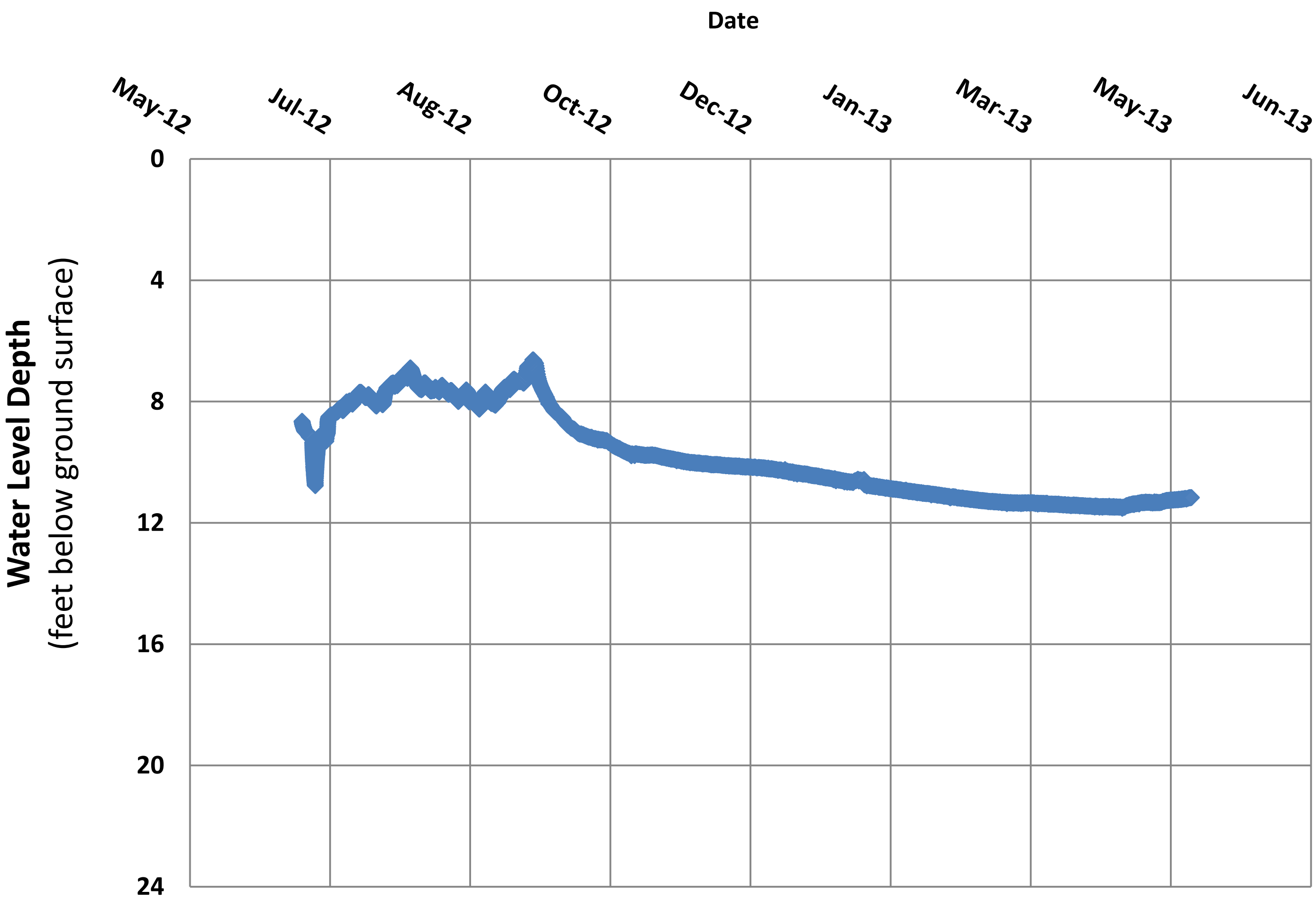
2012 thru 2013

LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

T5N, R 65W, S34

CDA Well ID WL-M-401



Data Collected

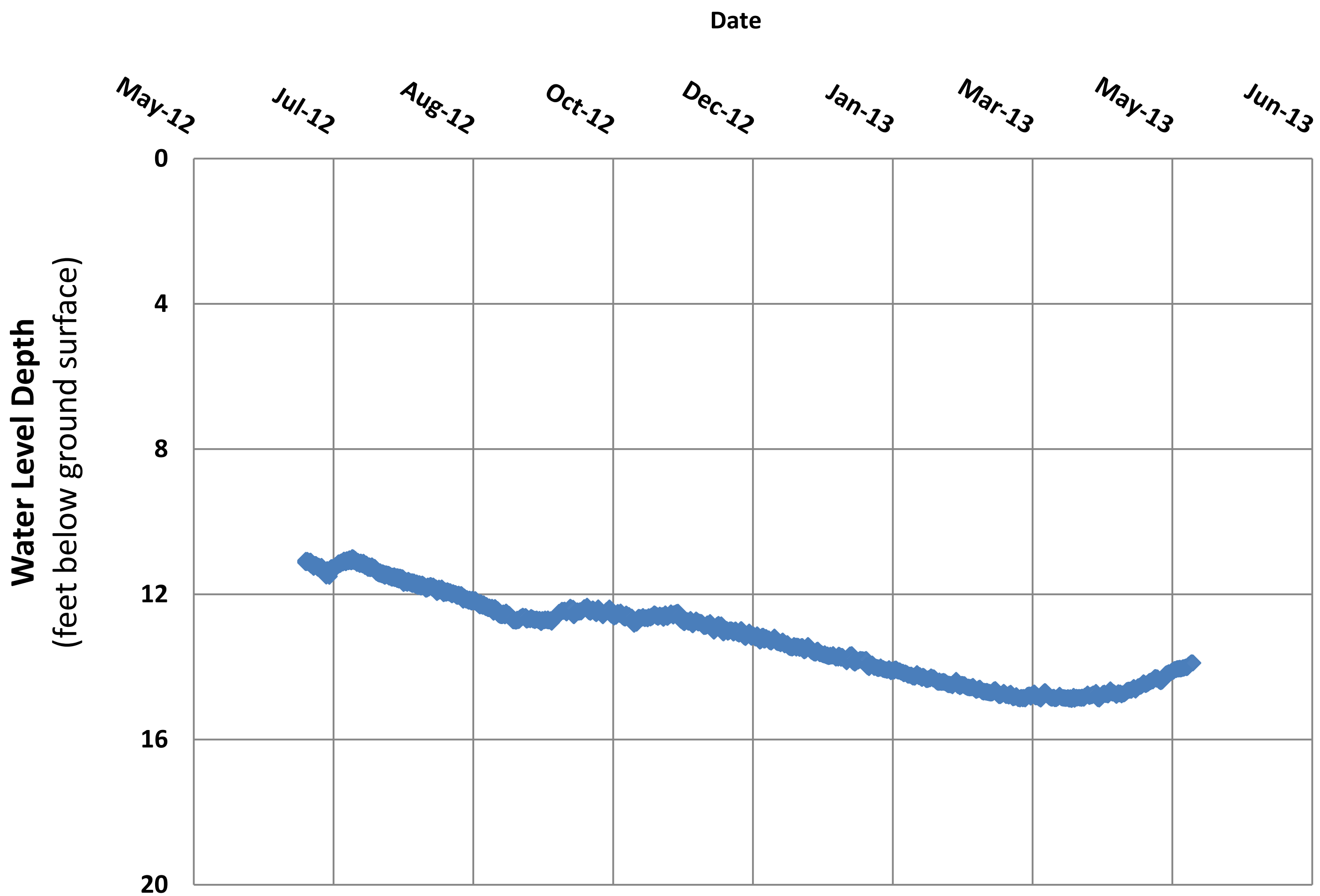
2012 thru 2013

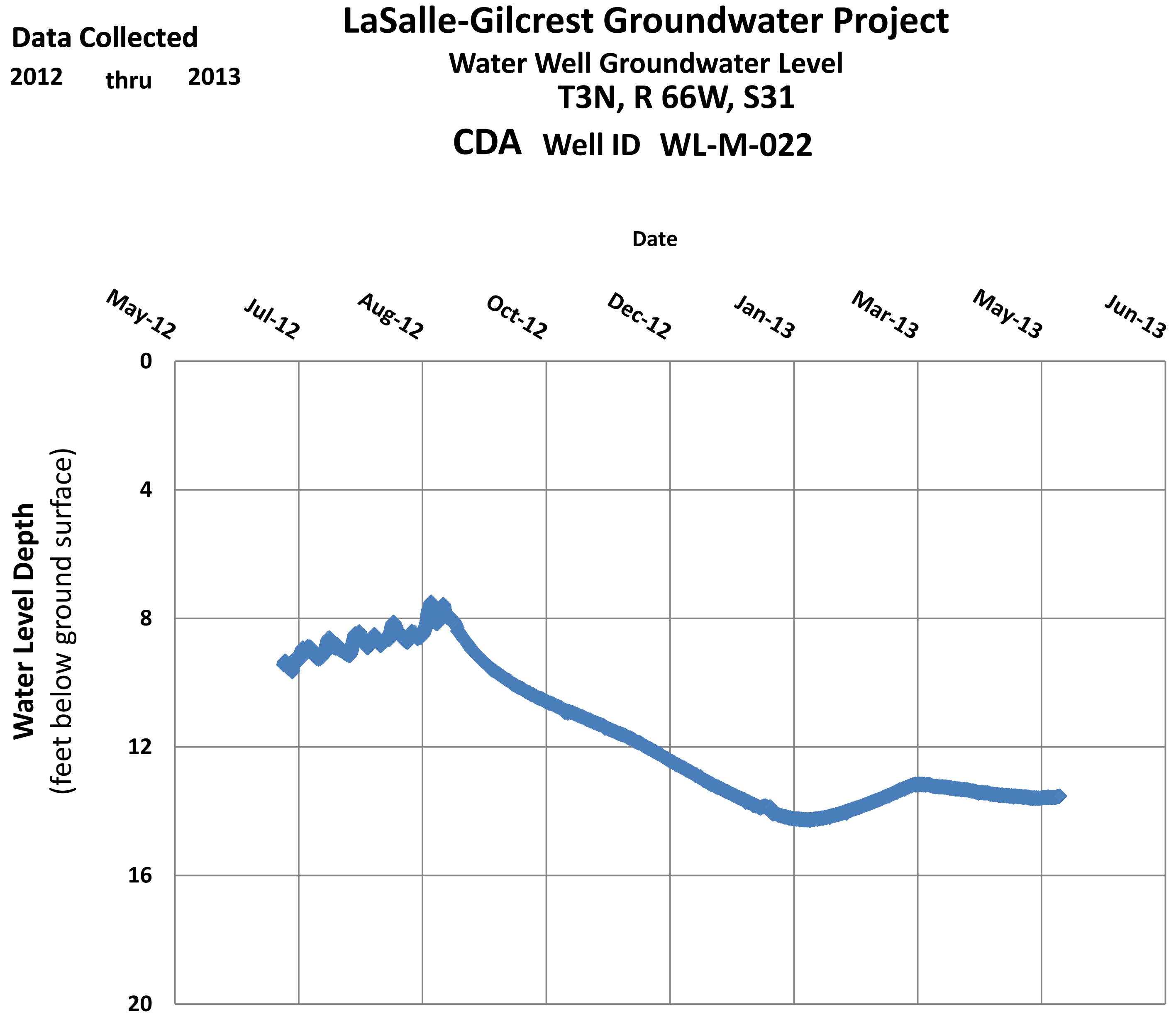
LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

T4N, R 66W, S26

CDA Well ID WL-M-040



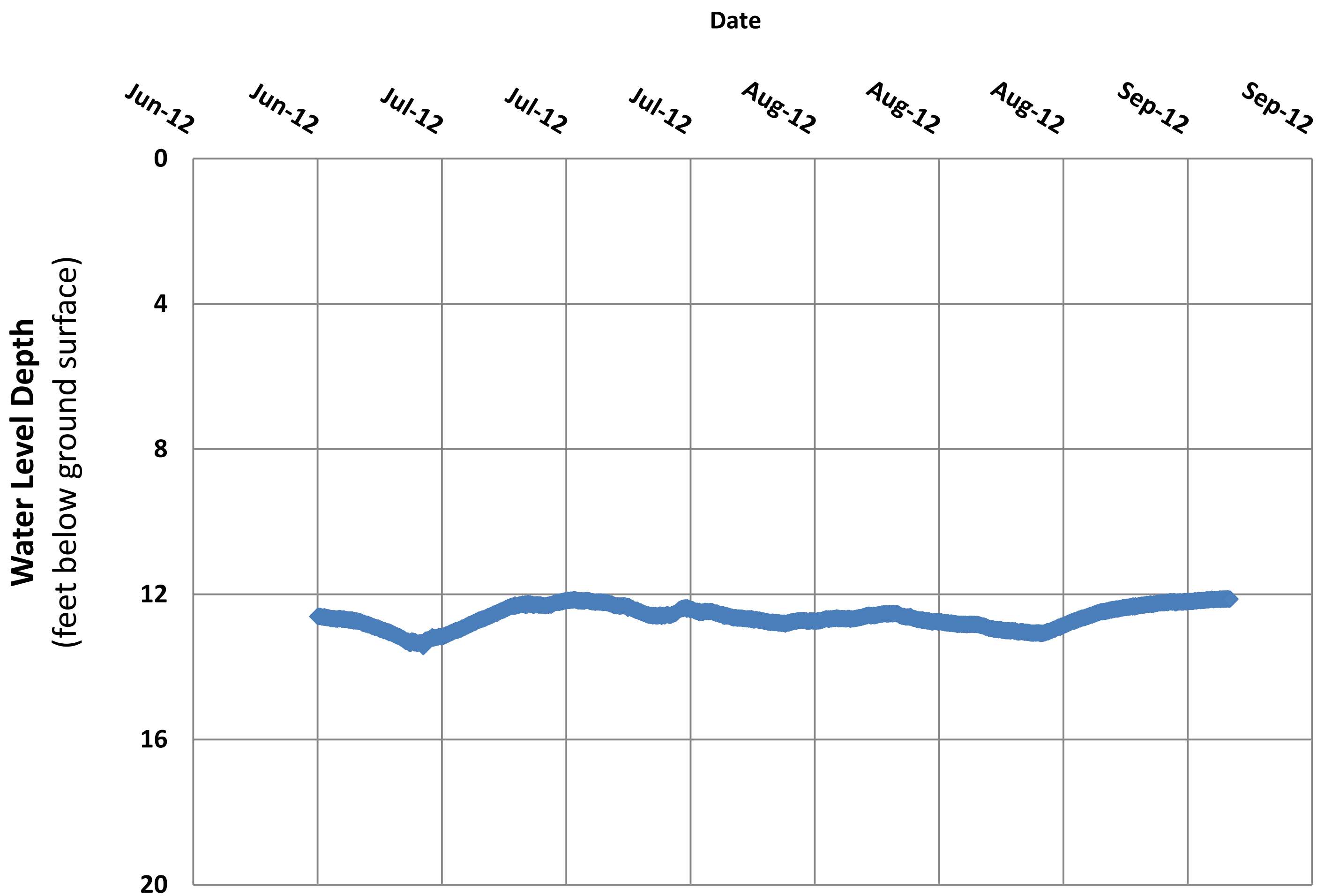


Data Collected
2012 thru 2013
LaSalle-Gilcrest Groundwater Project
Water Well Groundwater Level
T3N, R 66W, S31
CDA Well ID WL-M-022
Date
May-12
Jul-12
Aug-12
Oct-12
Dec-12
Jan-13
Mar-13
May-13
Jun-13
0
4
8
12
16
20
Water Level Depth
(feet below ground surface)

LaSalle-Gilcrest Groundwater Project

Data Collected
2012 thru 2012

Water Well Groundwater Level
T5N, R 65W, S13
CDA Well ID WL-M-011



Data Collected

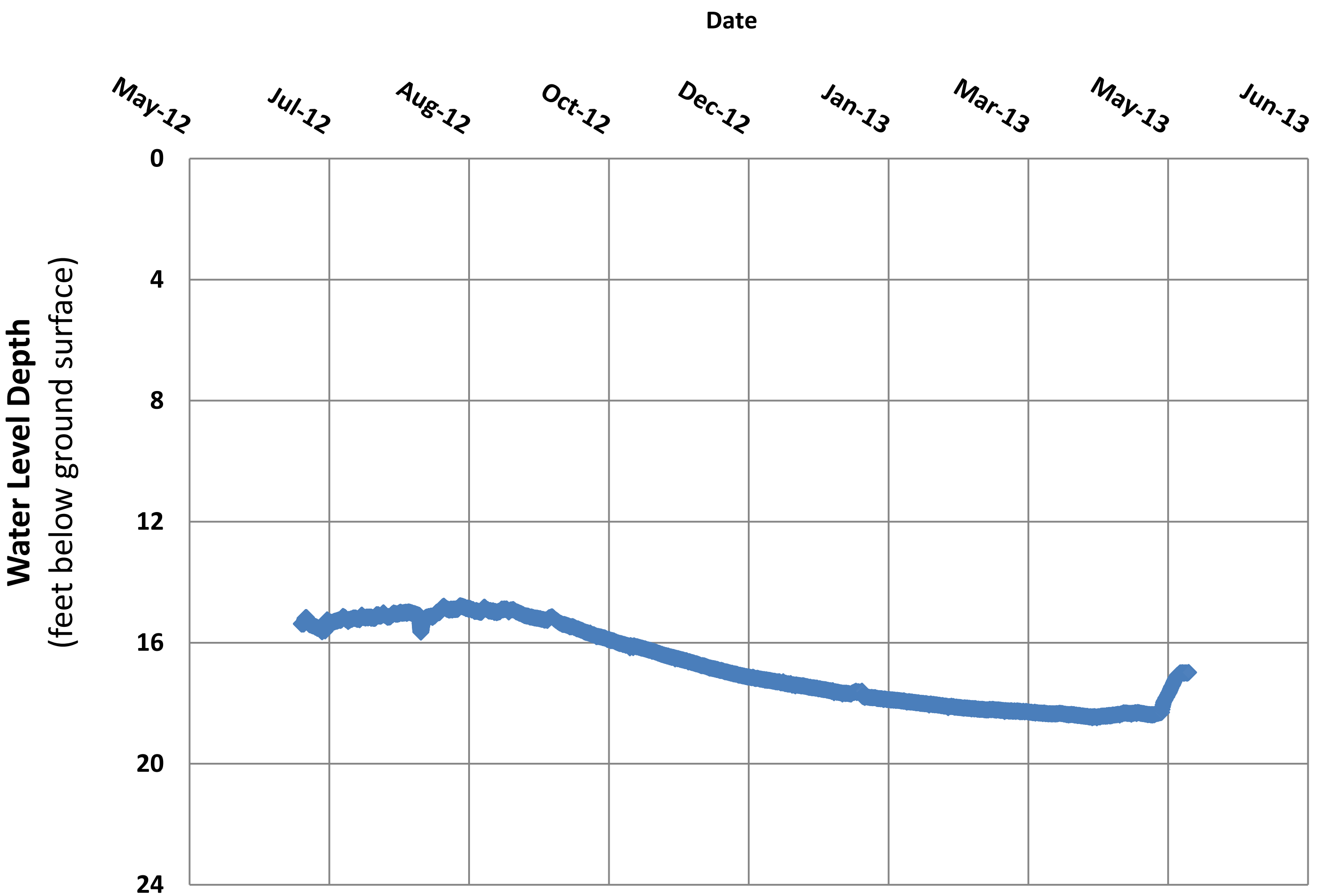
2012 thru 2013

LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

T5N, R 65W, S28

CDA Well ID WL-M-010



Data Collected

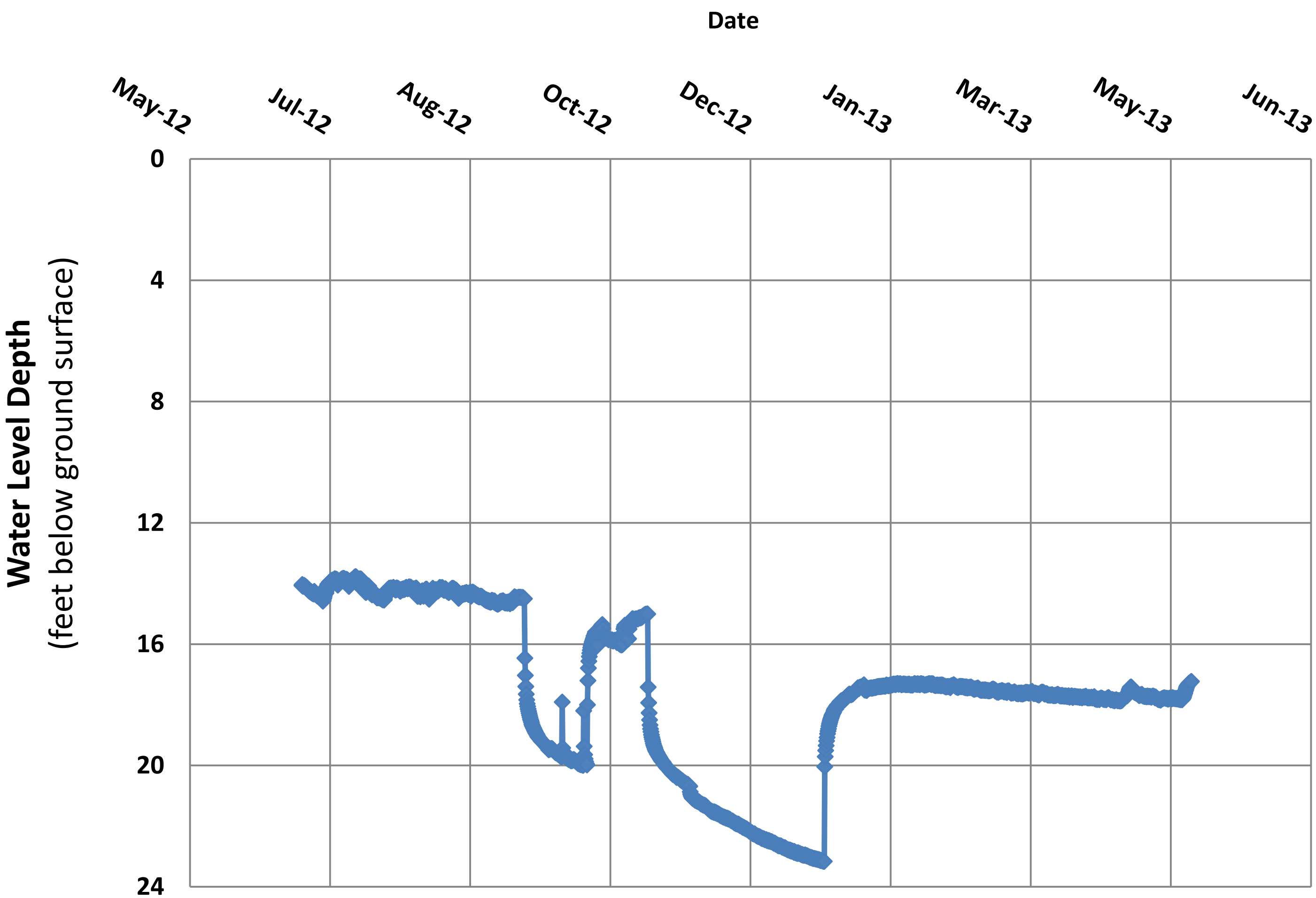
2012 thru 2013

LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

T4N, 65W, S7

CDA Well ID WL-M-009



Data Collected

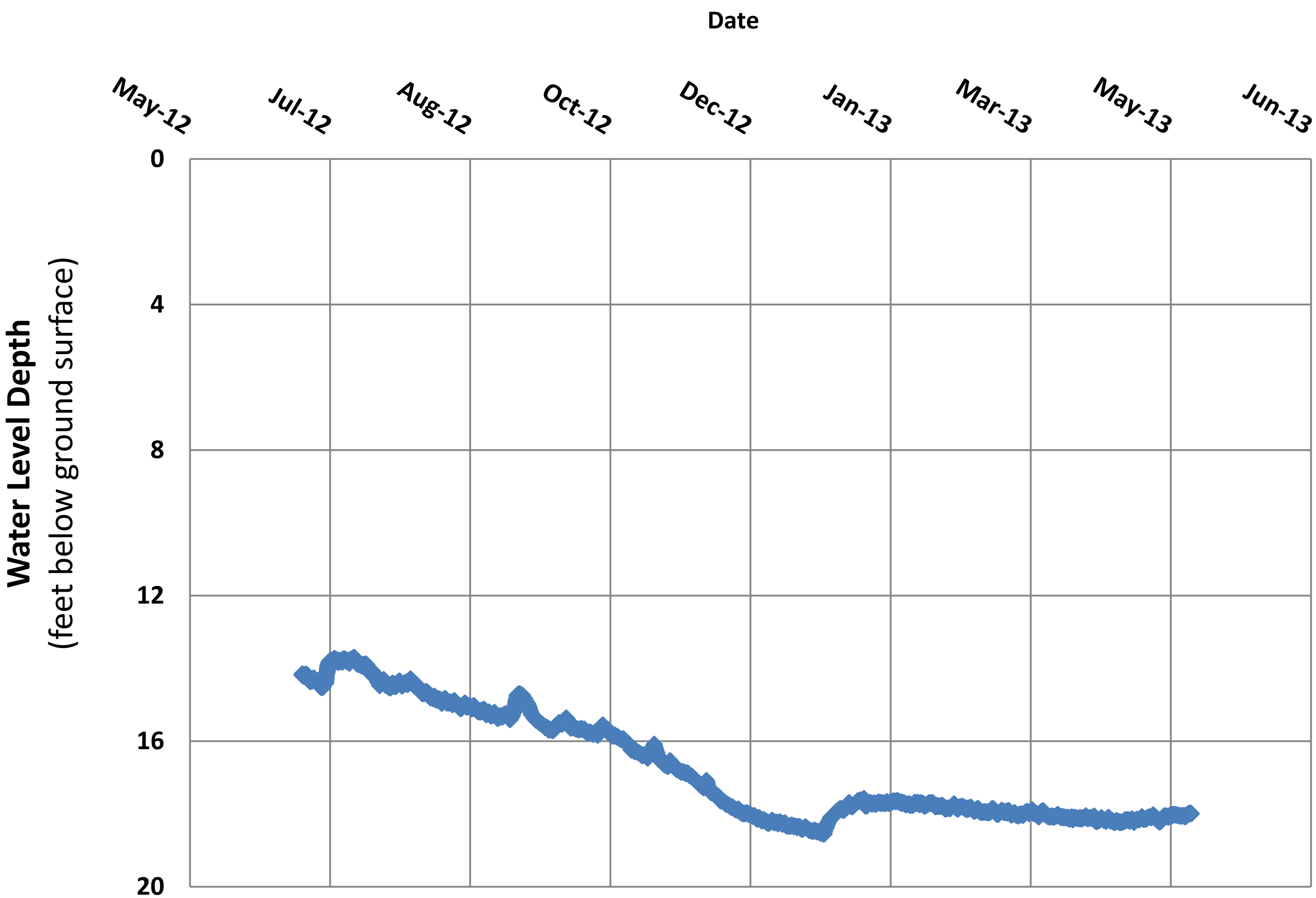
2012 thru 2013

LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

TN4, R 66W, S13

CDA Well ID WL-M-008



Data Collected

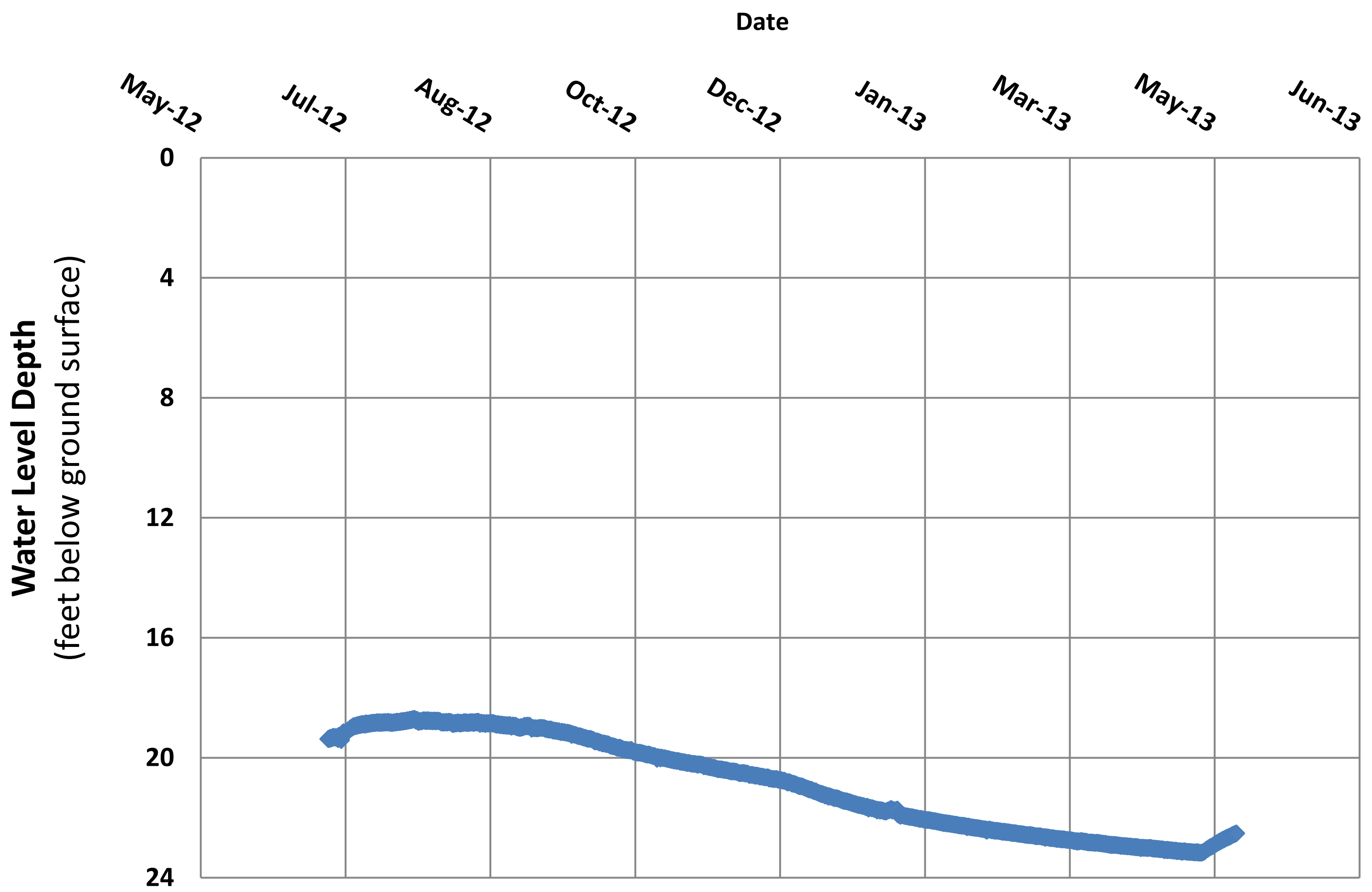
2012 thru 2013

LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

T4N, R 66W, S3

CDA Well ID WL-M-007



LaSalle-Gilcrest Groundwater Project

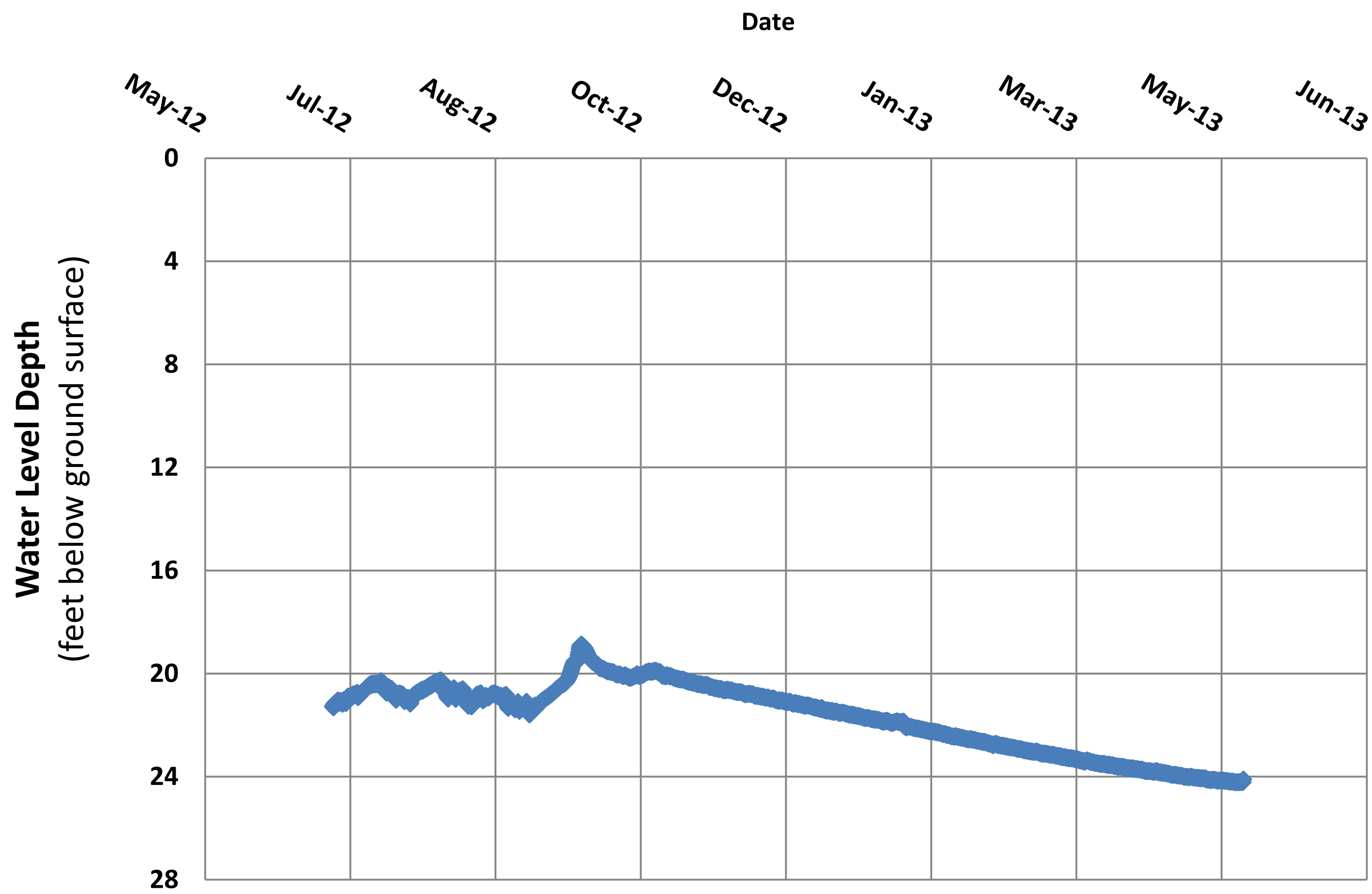
Data Collected

2012 thru 2013

Water Well Groundwater Level

T4N, R 66W, S16

CDA Well ID WL-M-006A



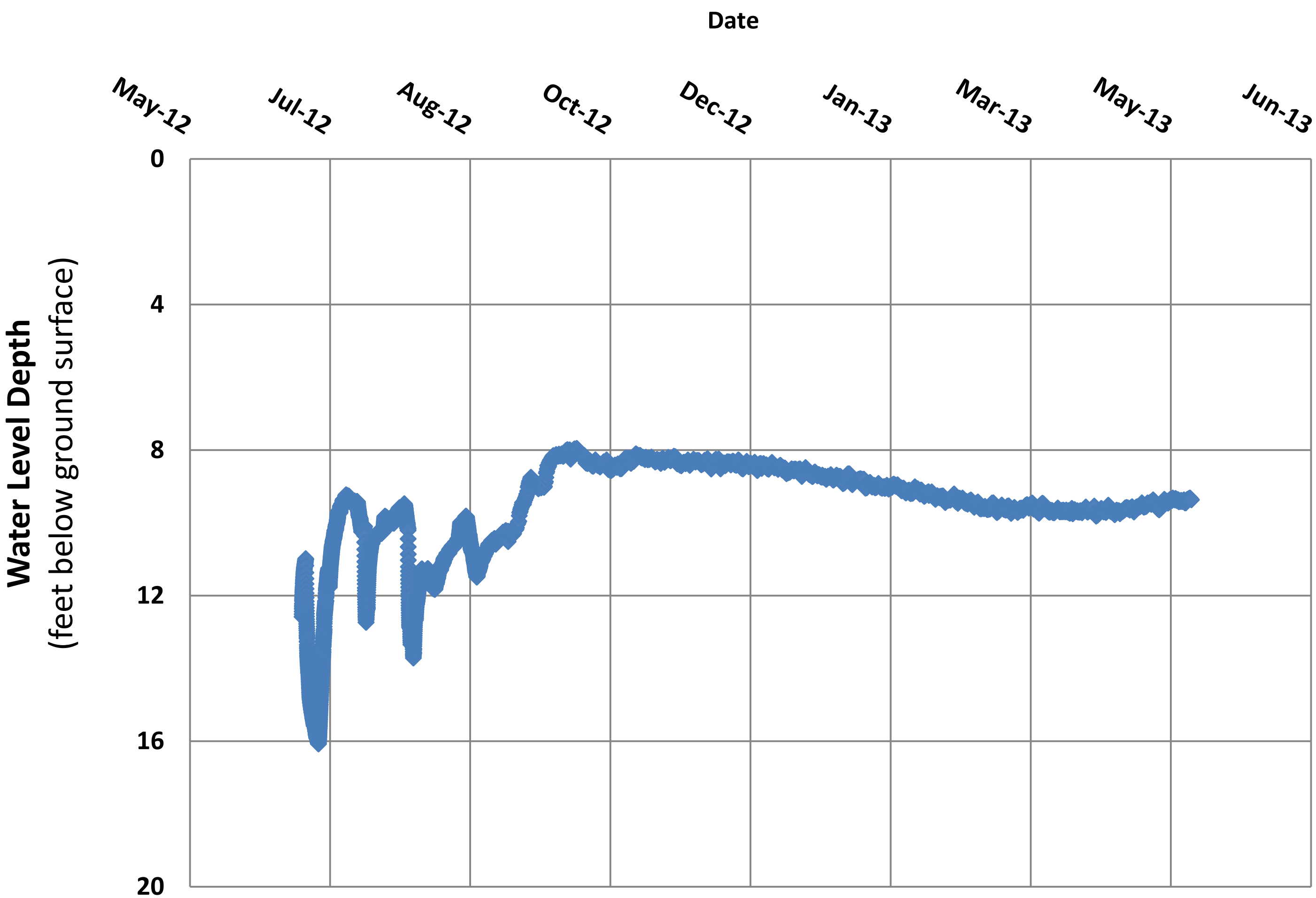
Data Collected
2012 thru 2013

LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

T4N, R 66W, S33

CDA Well ID WL-M-003A



LaSalle-Gilcrest Groundwater Project

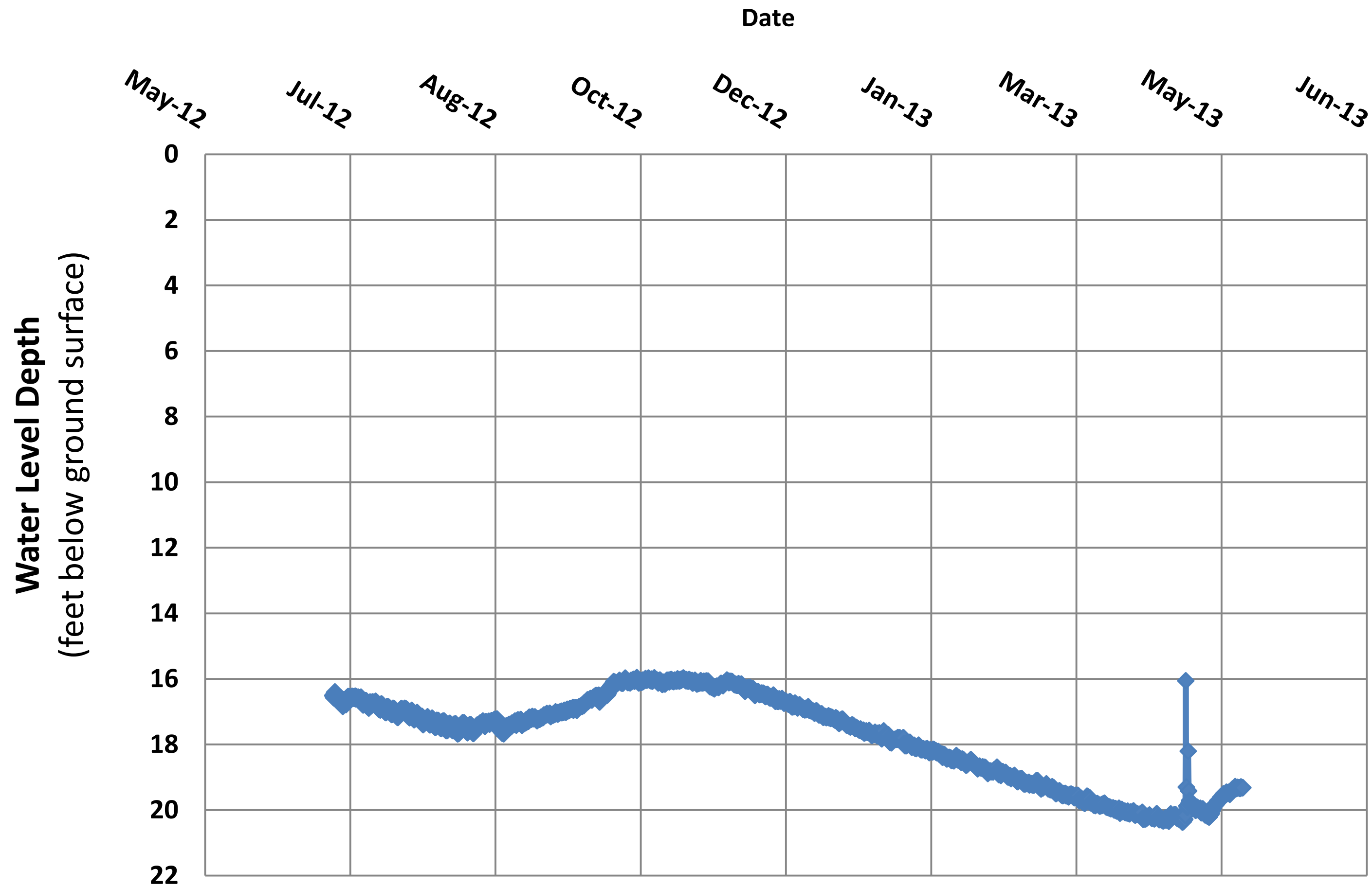
Data Collected

2012 thru 2013

Water Well Groundwater Level

T4N, R66W, S32

CDA Well ID WL-M-002



Data Collected

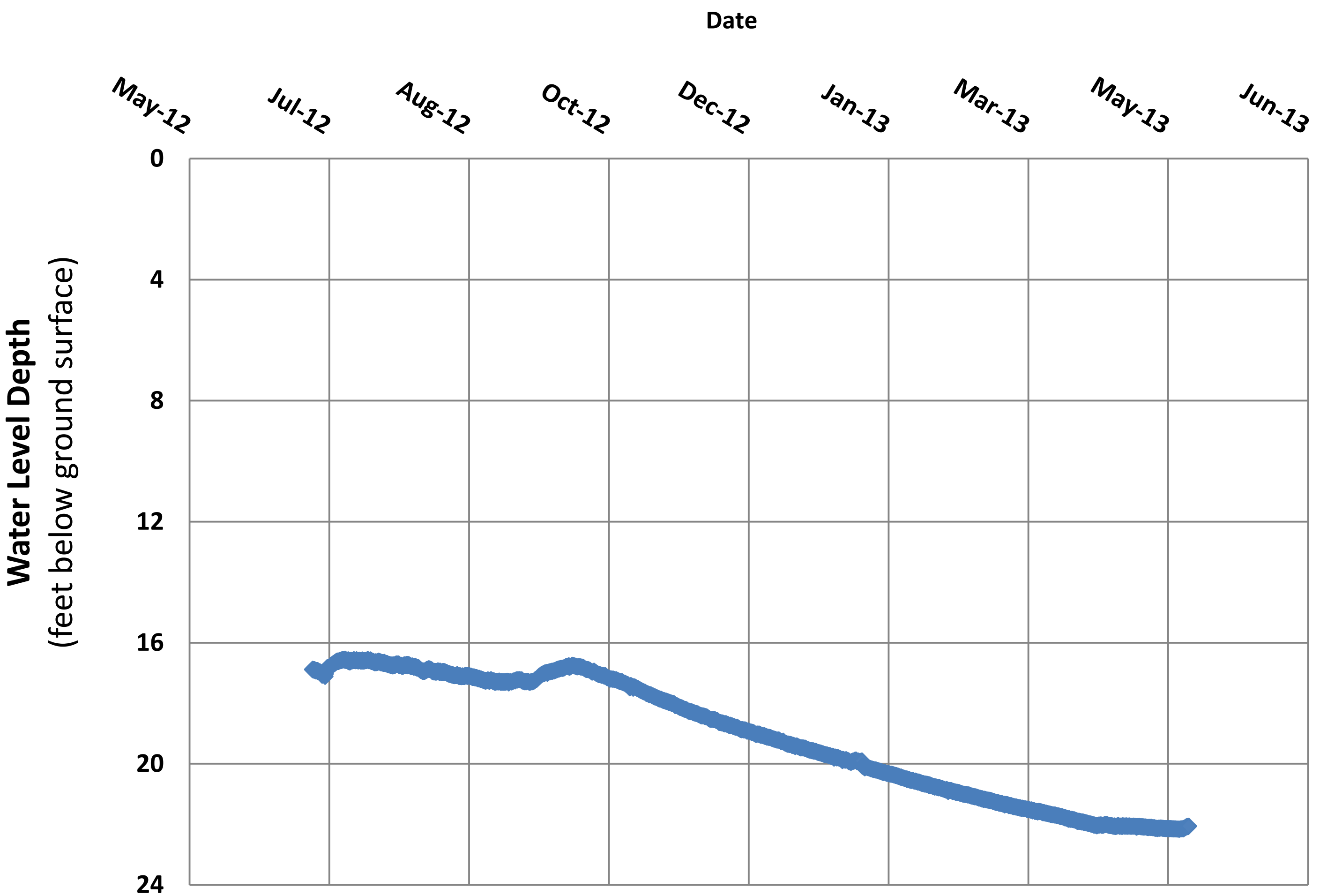
2012 thru 2013

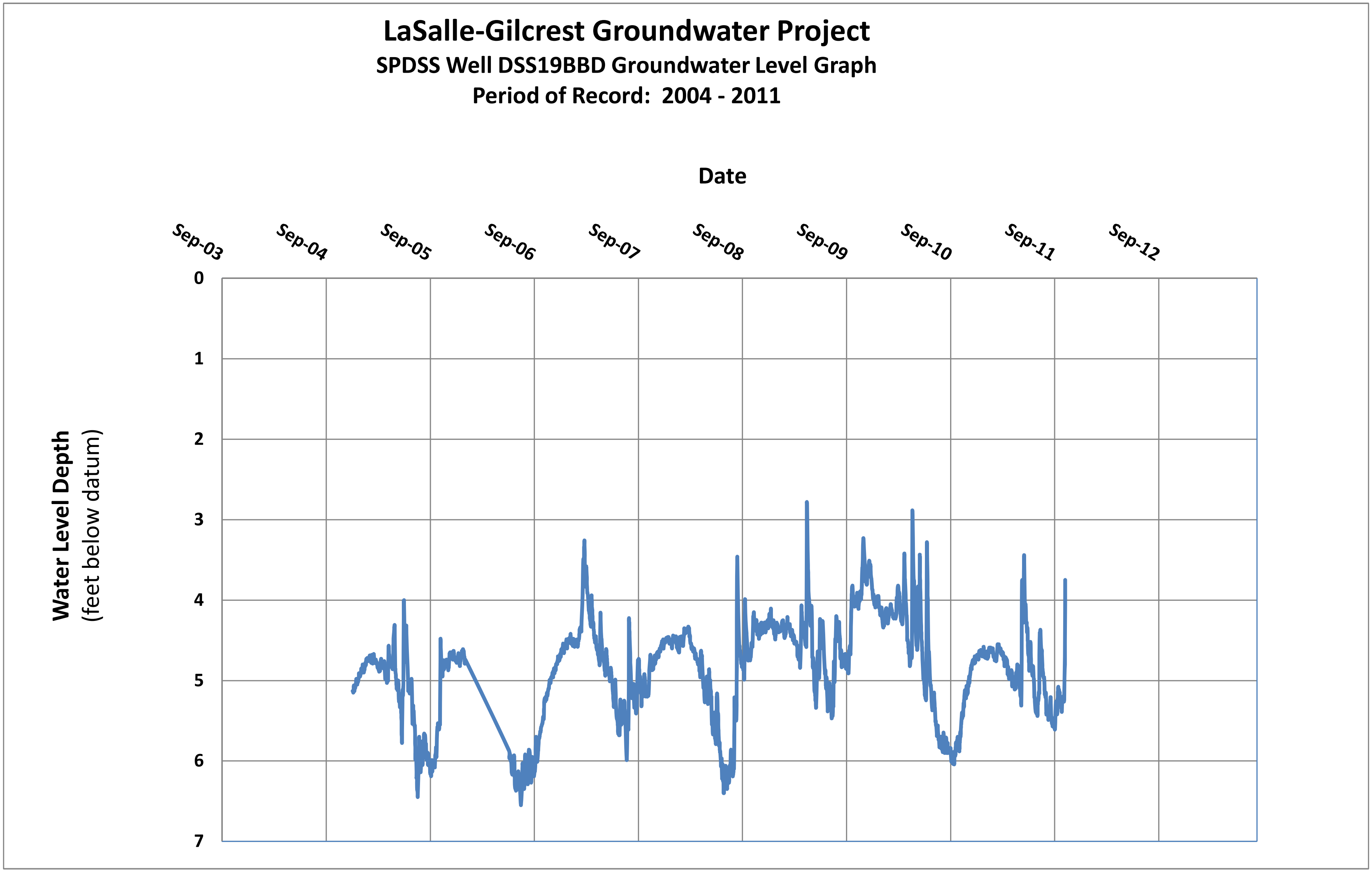
LaSalle-Gilcrest Groundwater Project

Water Well Groundwater Level

T4N, R66W, S30

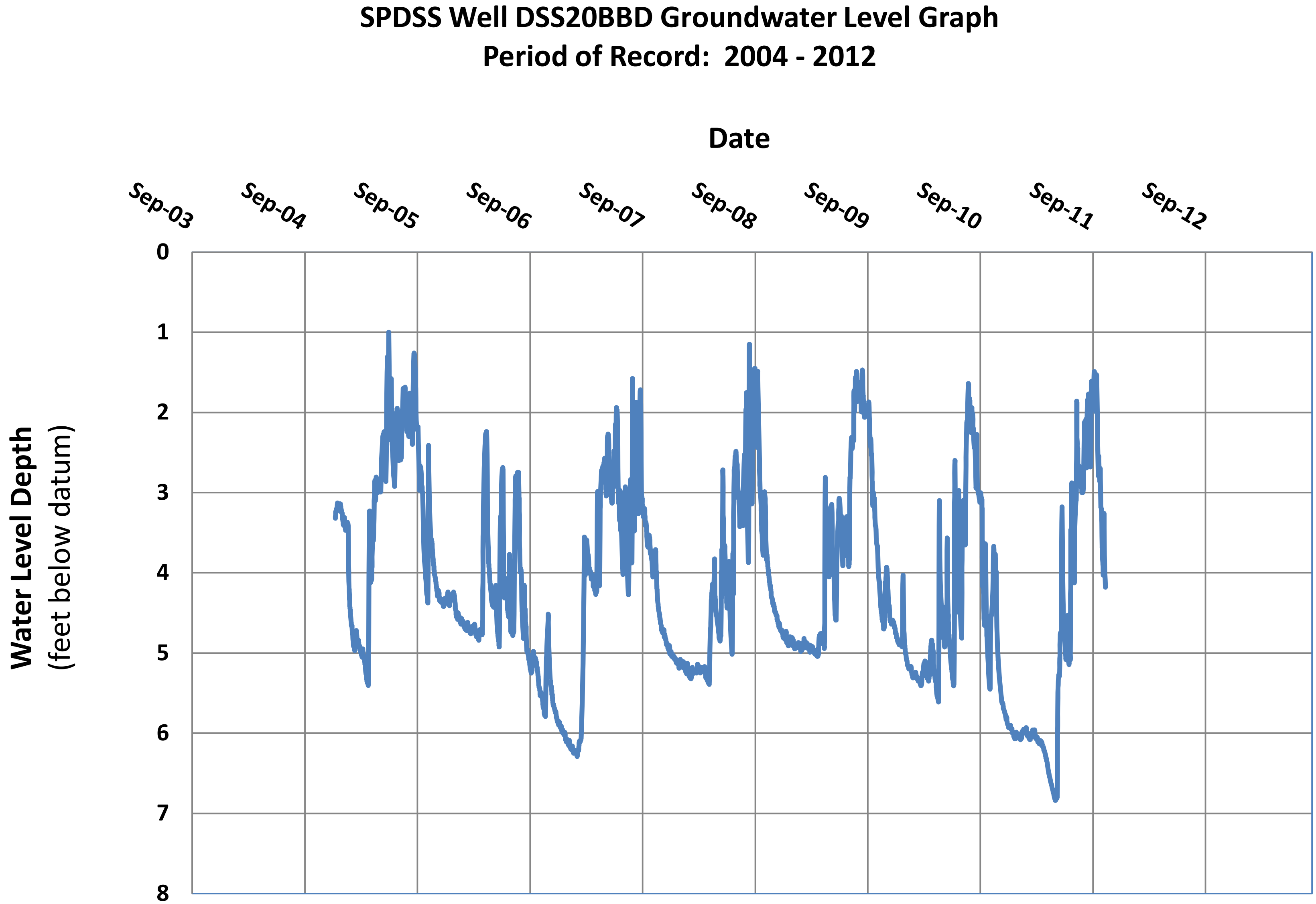
CDA Well ID WL-M-001





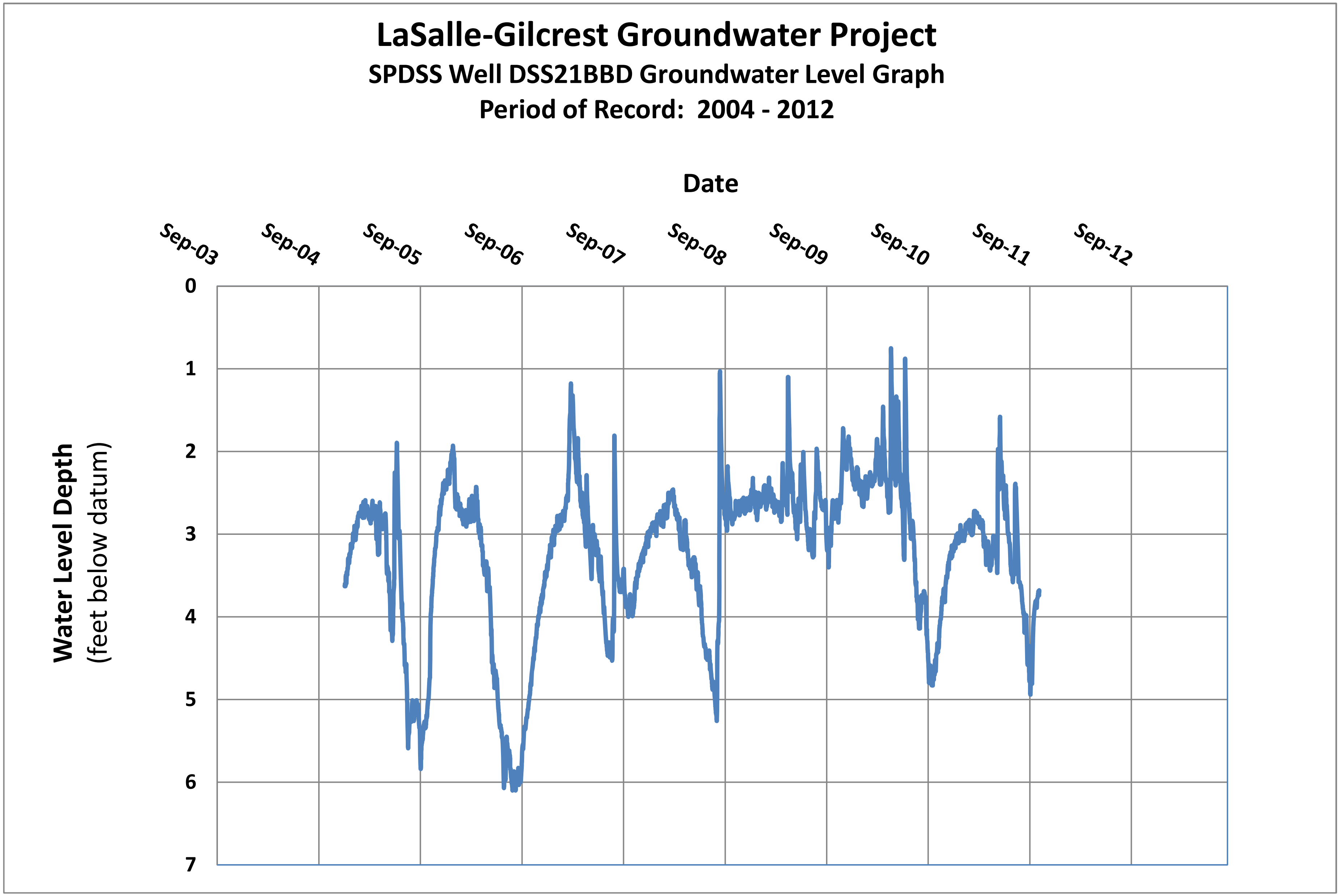
Data Provided by Colorado Division of Water Resources
Project Funded by Colorado Water Conservation Board

LaSalle-Gilcrest Groundwater Project



Data Provided by Colorado Division of Water Resources

Project Funded by Colorado Water Conservation Board



Data Provided by Colorado Division of Water Resources
Project Funded by Colorado Water Conservation Board

Appendix E
Historical Groundwater Hydrograph Development

Gilcrest/La Salle Groundwater Investigation Pilot Project
Hydrogeologic Characterization Report

(Note: this appendix provided in digital format only)

Historical Groundwater Hydrograph Development

Groundwater level data for the hydrographs were obtained from the sources listed below. A location map of the wells with data in the database is included as Figure 14.

- Central Colorado Water Conservation District (CCWCD),
- Colorado Department of Agriculture (CDA),
- DWR Hydrobase which contains data from
    - Colorado State University
    - South Platte Decision Support System (SPDSS) wells
    - Other wells including USGS

Data have been compiled into an Excel spreadsheet format with active data tables and hydrographs. Native data include: well name, date observed, depth-to-water (ft), Event ID, and observational notes. Calculated data are on a separate tab and includes water level elevations. A separate well data table includes: well ID, well owner, location description for hydrograph, well elevation, well name, permit number, township/range/section, and northing and easting in UTM NAD 83. Table E1 lists metadata for the hydrograph template.

Data for wells with water level measurements taken on a monthly or periodic basis are recorded in the Active Data tab. For wells equipped with transducers, which produce large amounts of data due to frequent data recording, data are recorded in separate, individual tabs labeled by well name. This difference in display and management between monthly data and hourly or daily data are due to the risk of reaching “a maximum-allowable-records” if all records for transducers were to be combined on one tab.

The format for data in Hydrobase is a table consisting of Date, Depth to water (ft), Elevation of WL (ft) and a Calculated Change (ft) value. This format dictated is used in the Hydrograph Template tool that CGS created in Microsoft Excel. Hydrographs for wells that are in Hydrobase, having more than 10 data points from 1929 to 2012, have been added to the Hydrograph Template tool for completeness. Hydrographs for wells with more than 10 data points are included in Appendix D.

Water level elevations have been estimated using a 2005 Digital Elevation Model (DEM) from the United States Geological Survey (USGS) which has a vertical accuracy of +/- 2.44 ft. It is assumed that data from Hydrobase have been corrected for stick-up of the well casing above ground surface. Data from CDA and CCWCD include corrections to account for measuring point height.

Data have been quality checked by comparing the depth to water value with the mean of data collected over the well's history. Where a data point is more than 2 standard deviations from the mean, it was removed from the water level elevation map. This errant data is also removed from the Active Data tab in the Hydrograph database and graph creation tool and placed on an errata tab.

Other data errors are not as easily identified. Some errors could arise from a number of potential sources including manner in which the original data value was collected and subsequent transference of data. In our analysis we have identified the following potential sources of error:

- Differences in measurement devices (tape, transducer, sounder, etc.);
- Inconsistency in measurement datum and poor record of datum used (ground level vs top of casing);
- For transducer data, measurements are typically of pressure at the transducer in pounds per square inch which are converted to feet of water over the transducer. This is calculated to depth from the surface using transducer depth setting. The result depends on accurate record of the depth of the transducer setting or referenced static water level.
- Transducer calibration uses an initial water level that can be incorrect;
- Accurate elevation data for the datum. Very few wells have been surveyed and most elevations in the database have been estimated from topographic maps or a digital elevation model. This type of estimate assumes that the location is accurate.

<u>Table E1, Historical Groundwater Hydrograph Development</u>

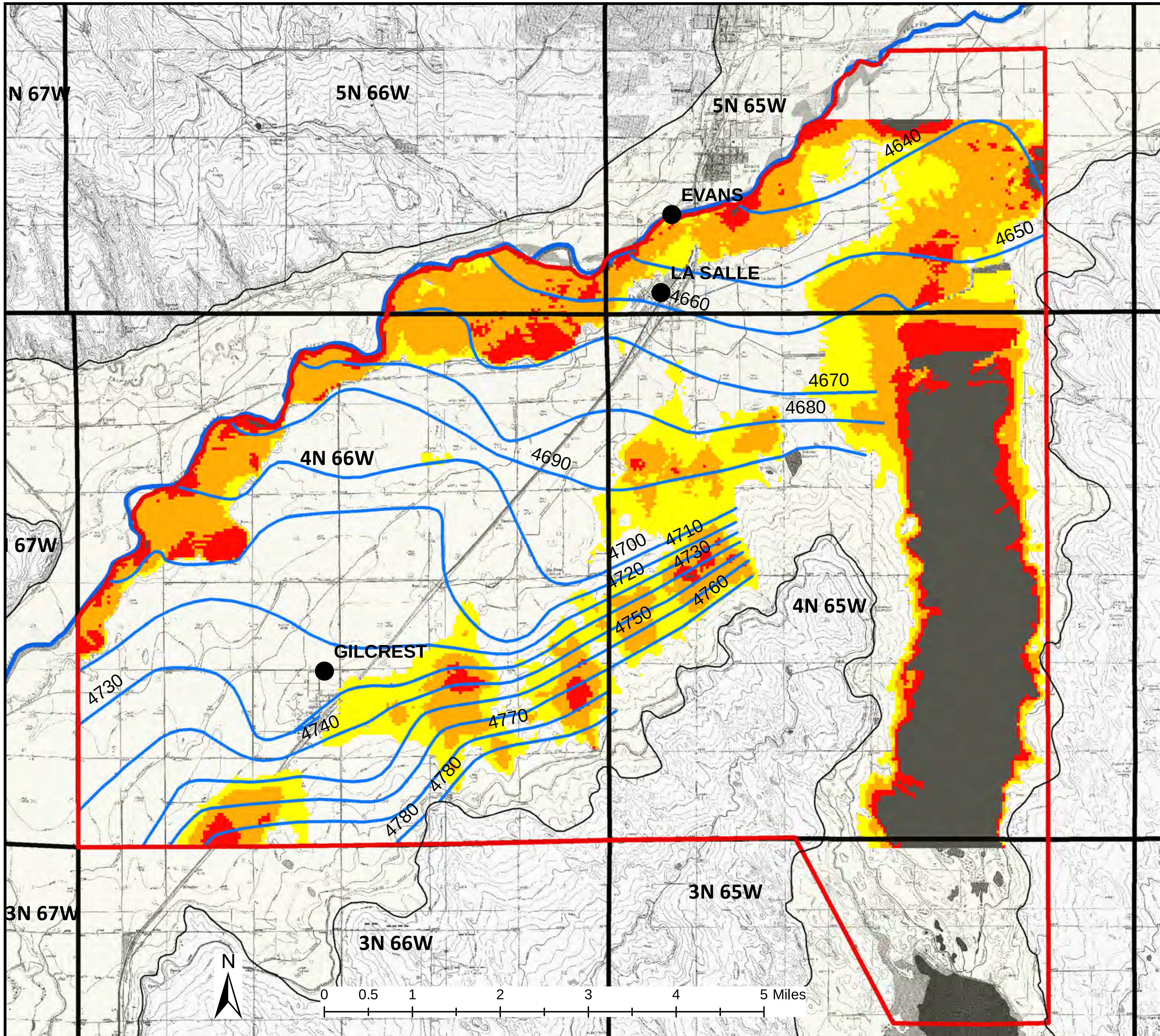
Hydrograph Template Metadata

Tab Name	**Content/ Function**
README	An operator's guide to using the spreadsheet tool.
Template-monthly data	Graphing template for wells with monthly data. Dynamic. Queries active data and well info tables. Fields are: Date, Depth to Water, Groundwater Elevation, Min Date (in Jullian format), Max Date (in Jullian format), Location information.
Template - Transducer Data	Graphing template for wells with transducer data. Not dynamic data. Queries only well info table for header data. Fields are: Date, Depth to Water (**not queried. DTW data must be entered here**) , Groundwater Elevation, Min Date (in Jullian format), Max Date (in Jullian format), Location information.
Activedata	Contains compiled water level data for LaSalle/Gilcrest area from multiple sources. Fields included are: well name, date observed, depth to water (ft), Event ID, and observational notes
WellInfo	Contains header information for wells having active data.
Example (monthly well)	An example graph for a well with Monthly Data.
Graph DSS 19	Transducer data graph.
Graph DSS 20	Transducer data graph.
Graph DSS 21	Transducer data graph.
WL-M-901 Transducer	Transducer data graph.
WL-M-603 Transducer	Transducer data graph.
WL-M-501 Transducer	Transducer data graph.
WL-M-401 Transducer	Transducer data graph.
WL-M-040 Transducer	Transducer data graph.
WL-M-022 Transducer	Transducer data graph.
WL-M-011 Transducer	Transducer data graph.
WL-M-10 Transducer	Transducer data graph.
WL-M-009 Transducer	Transducer data graph.
WL-M-008 Transducer	Transducer data graph.
WL-M-007 Transducer	Transducer data graph.
WL-M-006A Transducer	Transducer data graph.
WL-M-003A Transducer	Transducer data graph.
WL-M-002 Transducer	Transducer data graph.
WL-M-002 Transducer	Transducer data graph.
Eratta	Data points removed because their value is > 2 std deviations from the trend.
scratchpad	Add graphs, summarize, etc. This is a working space for the table 'owner'.
Well - No Owner or Location inf	Alternate Template for wells with no Owner or Location information. For reformatting the graph without altering the initial 'Template' tab.

Appendix F
Time-Series Depth-to-Groundwater Maps

Gilcrest/La Salle Groundwater Investigation Pilot Project
Hydrogeologic Characterization Report

(Note: this appendix provided in digital format only)



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Legend

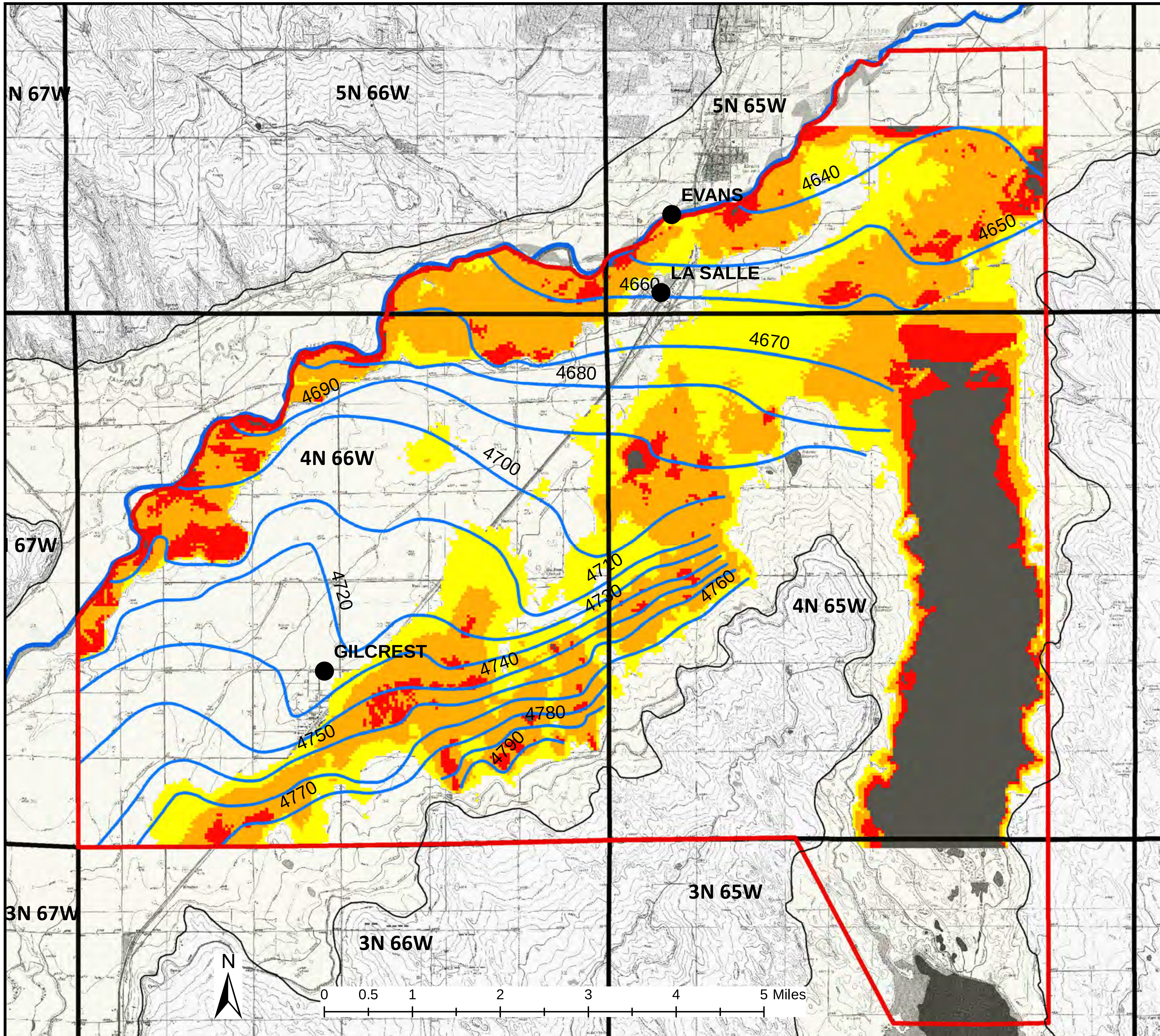
- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval
1967 Spring

Depth to Water (ft)

- 0-0.5
- 0.5 - 5
- 5.000000001 - 10
- 10.00000001 - 15
- 15.00000001 - 20

Appendix F
Time-Series Historic
Depth to Water Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

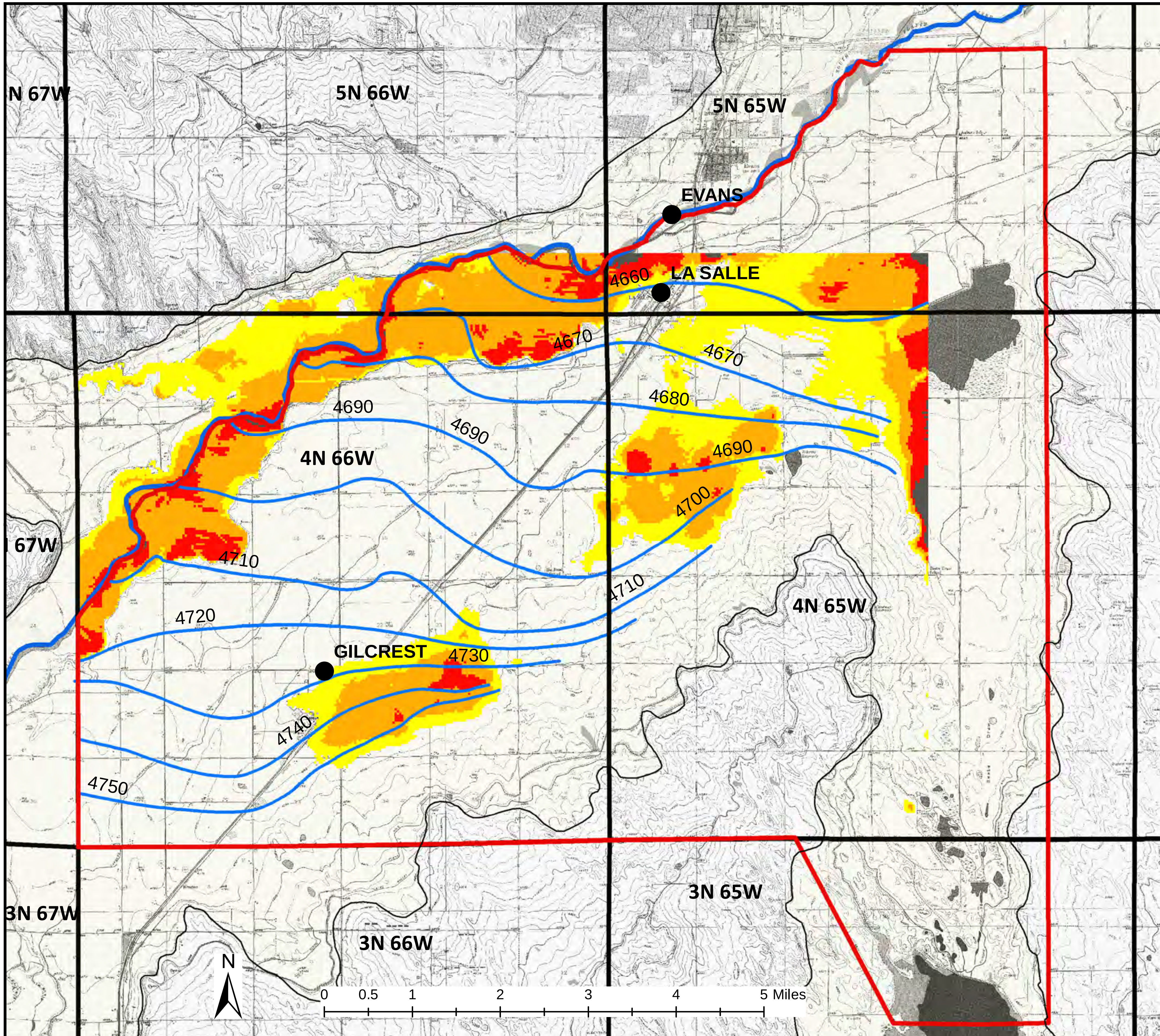
Water Level Elevation Contour (ft.)
10' Contour Interval

1970 Fall

Depth to Water (ft)

- 0-0.5
- 0.5 - 5
- 5.000000001 - 10
- 10.00000001 - 15
- 15.00000001 - 20

Appendix F
Time-Series Historic Depth to Water Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

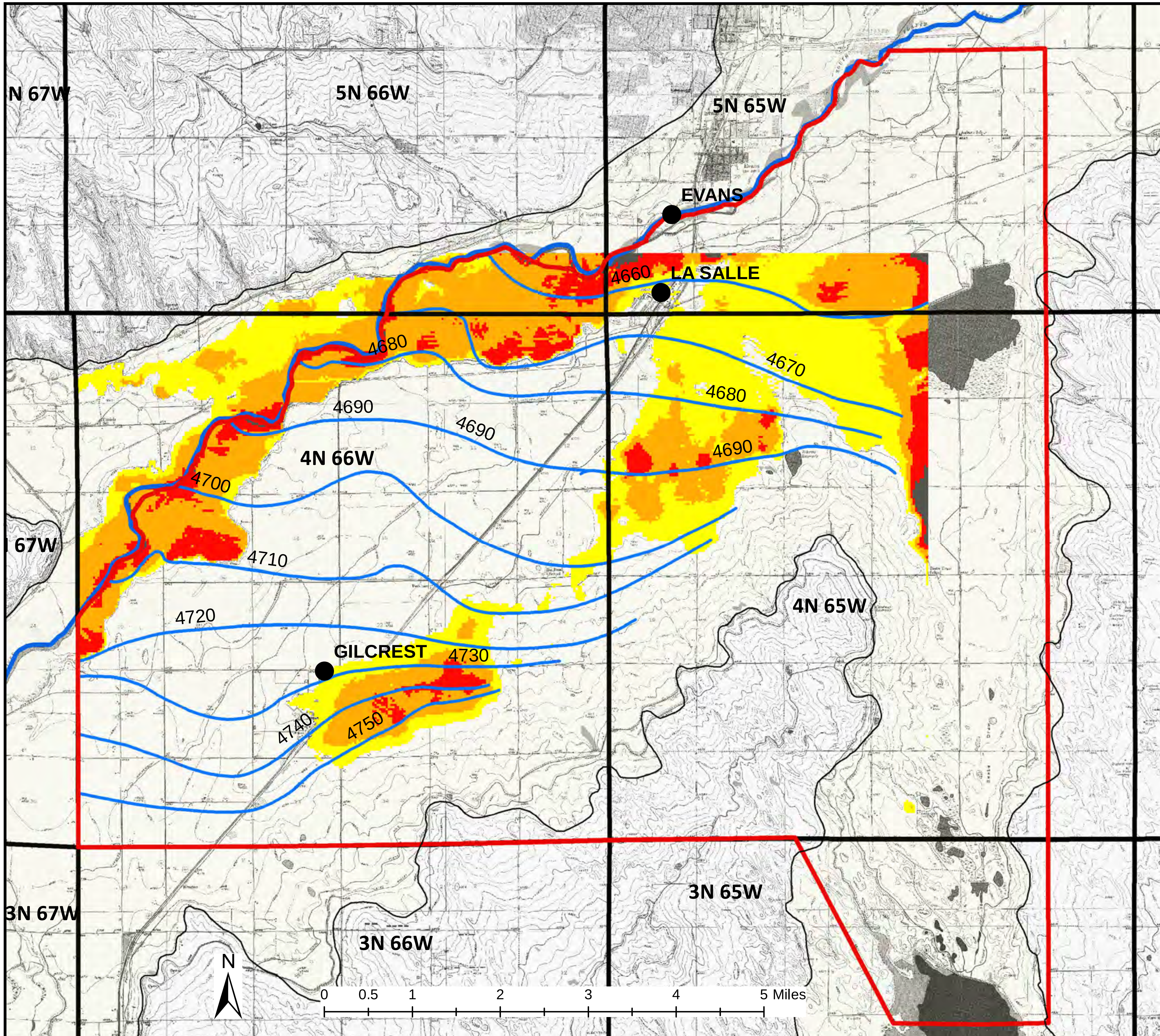
Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval
- 1997 Spring

Depth to Water (ft)
- 0-0.5
- 0.5 - 5
- 5.000000001 - 10
- 10.00000001 - 15
- 15.00000001 - 20

Appendix F
Time-Series Historic Depth to Water Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Legend

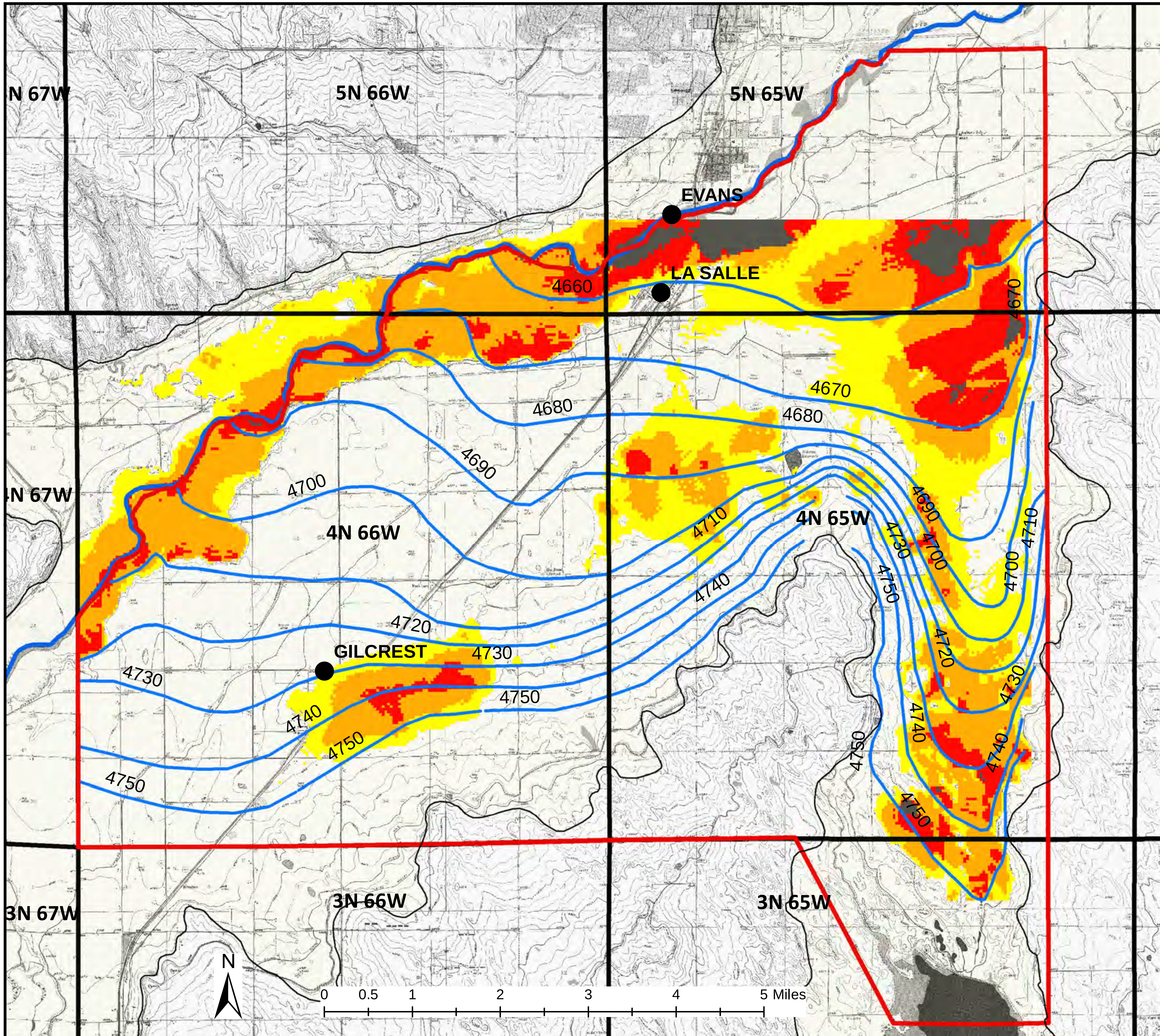
- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval
1997 Fall

Depth to Water (ft)

- 0-0.5
- 0.5 - 5
- 5.000000001 - 10
- 10.00000001 - 15
- 15.00000001 - 20

Appendix F
Time-Series Historic Depth to Water Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Legend

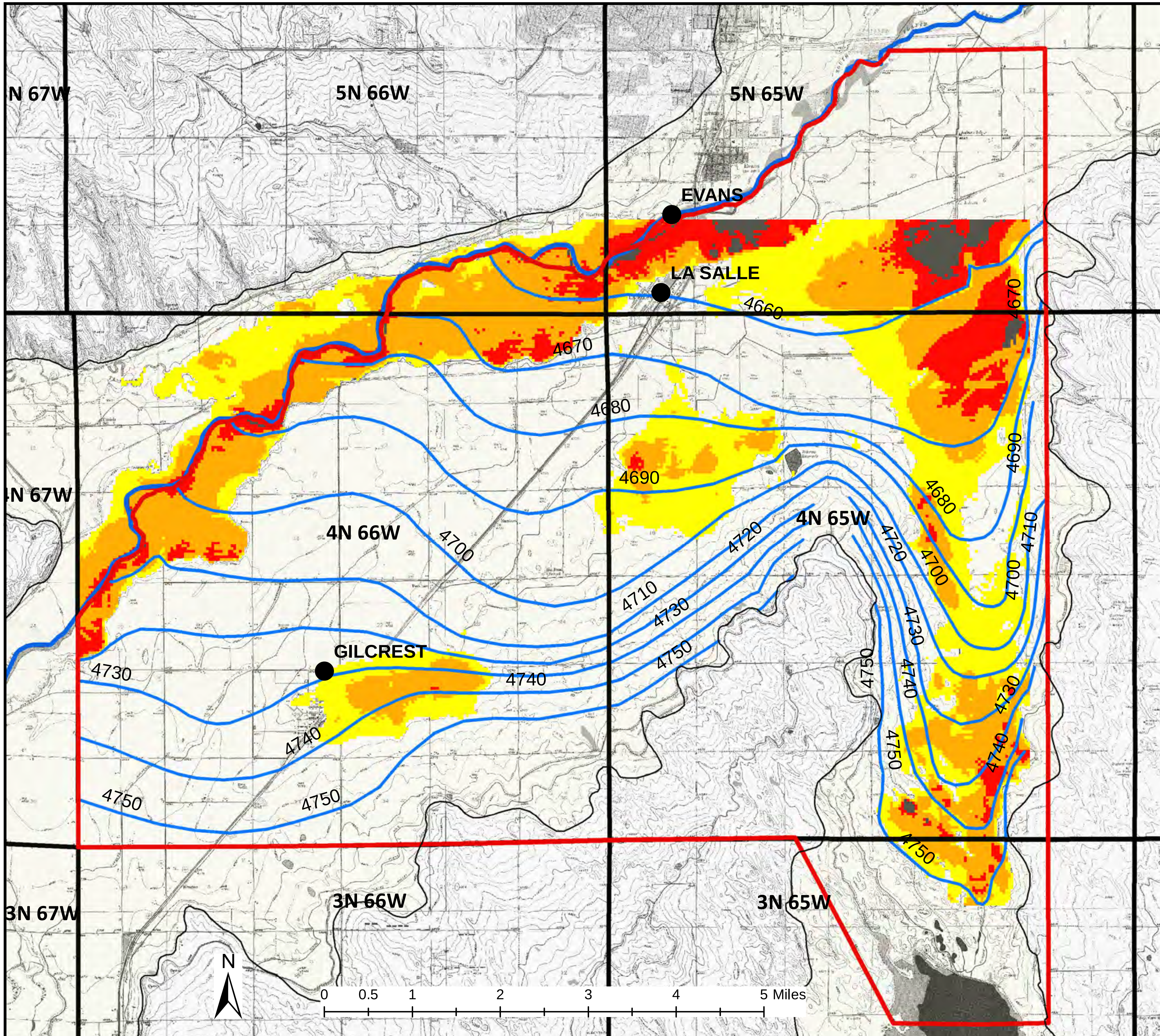
- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval
2002 Spring

Depth to Water (ft)

- 0-0.5
- 0.5 - 5
- 5.000000001 - 10
- 10.00000001 - 15
- 15.00000001 - 20

Appendix F
Time-Series Historic
Depth to Water Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Legend

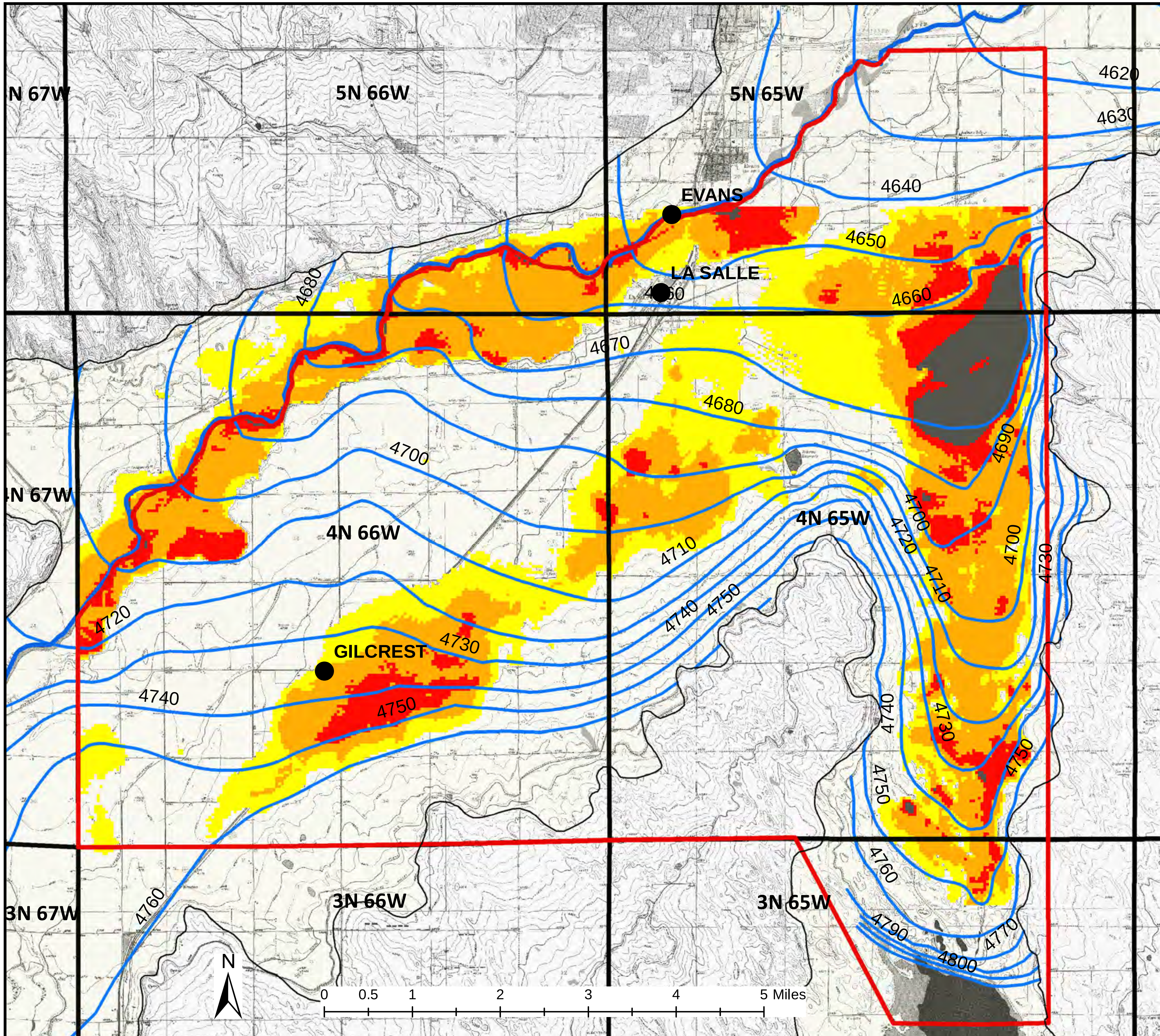
- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval
2002 Fall

Depth to Water (ft)

- 0-0.5
- 0.5 - 5
- 5.000000001 - 10
- 10.00000001 - 15
- 15.00000001 - 20

Appendix F
Time-Series Historic
Depth to Water Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Legend

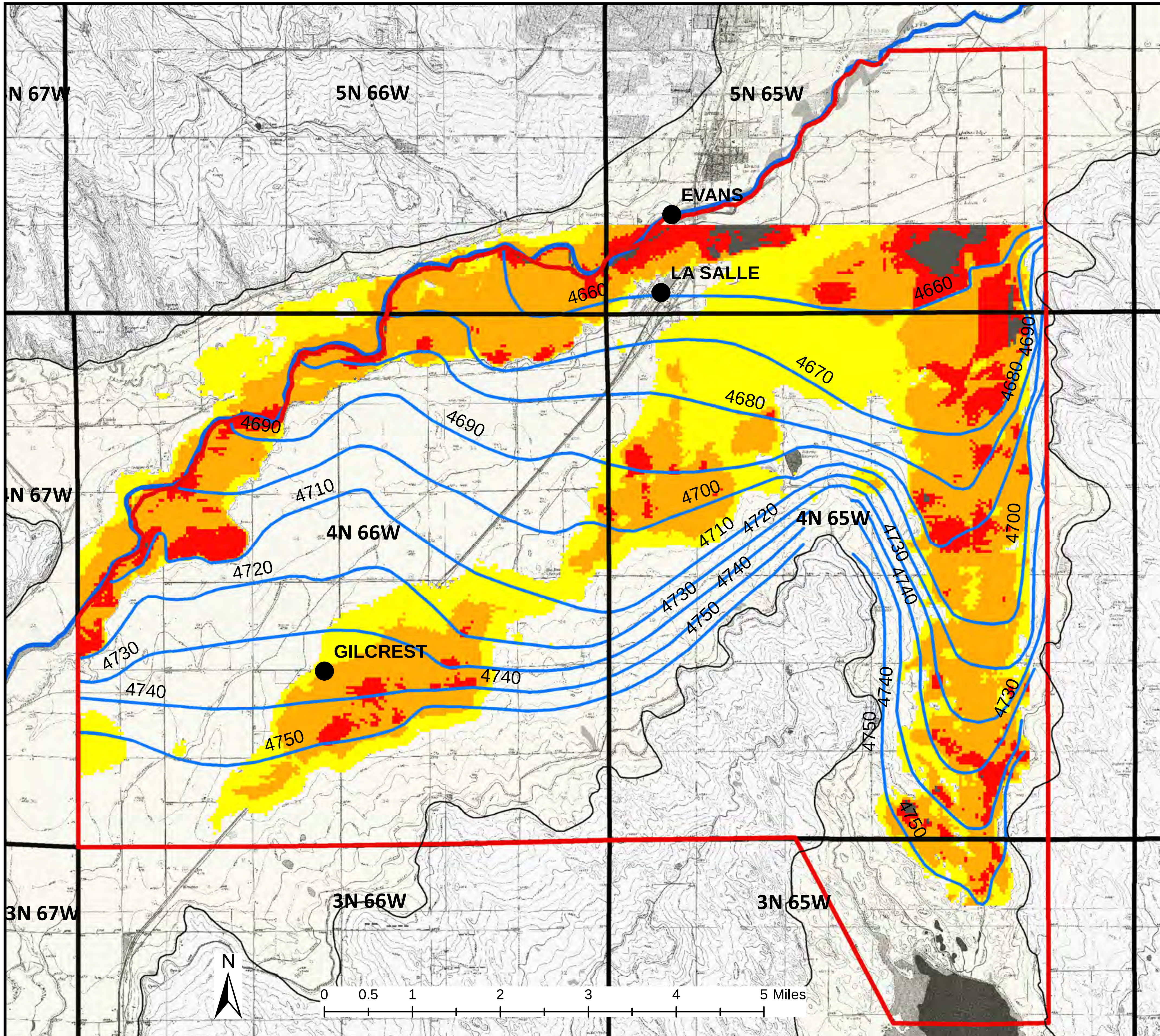
- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval
2012 Spring

Depth to Water (ft)

- 0-0.5
- 0.5 - 5
- 5.000000001 - 10
- 10.00000001 - 15
- 15.00000001 - 20

Appendix F
Time-Series Historic
Depth to Water Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Legend

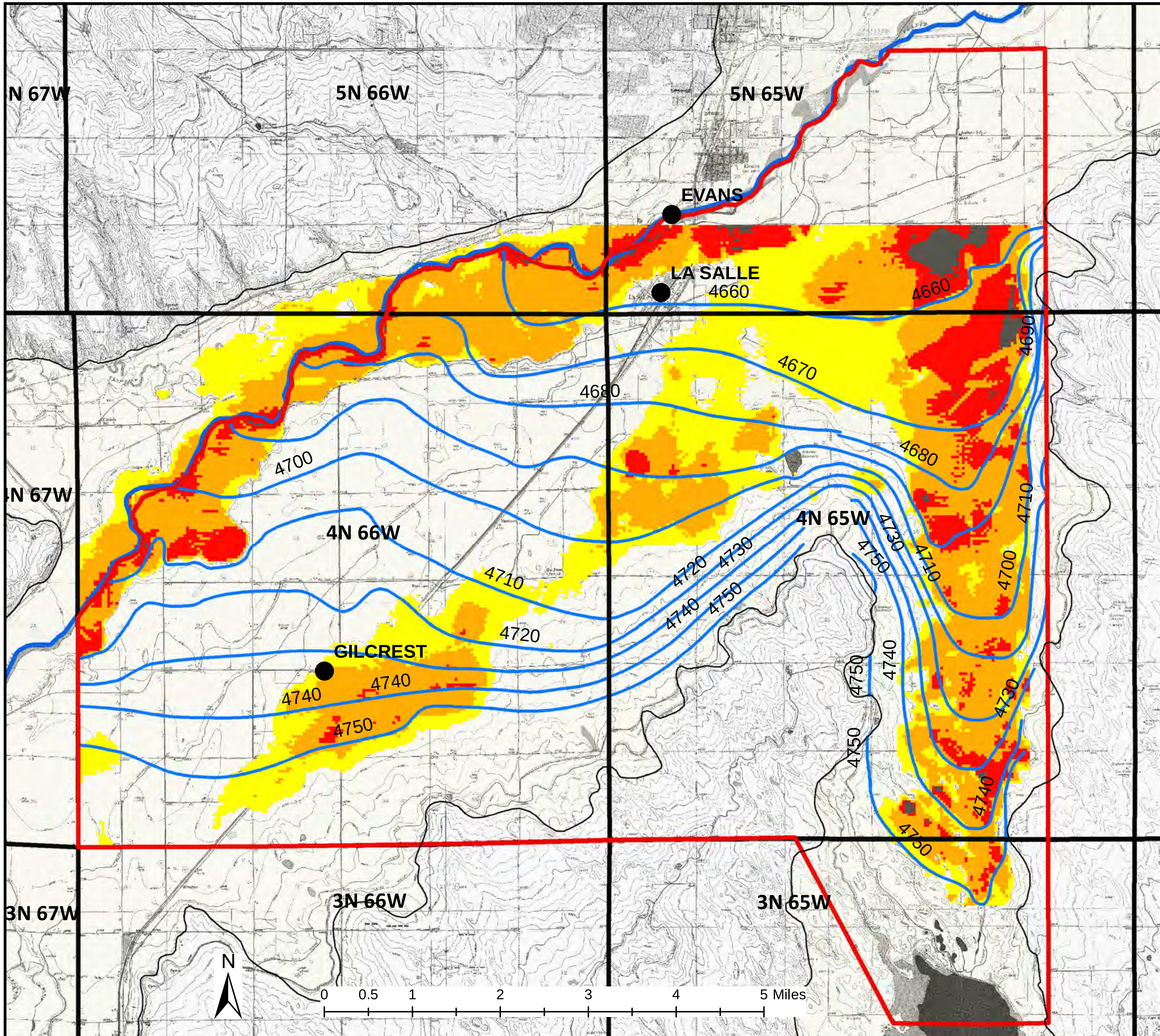
- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval
2012 Fall

Depth to Water (ft)

- 0-0.5
- 0.5 - 5
- 5.000000001 - 10
- 10.00000001 - 15
- 15.00000001 - 20

Appendix F
Time-Series Historic
Depth to Water Maps



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Legend

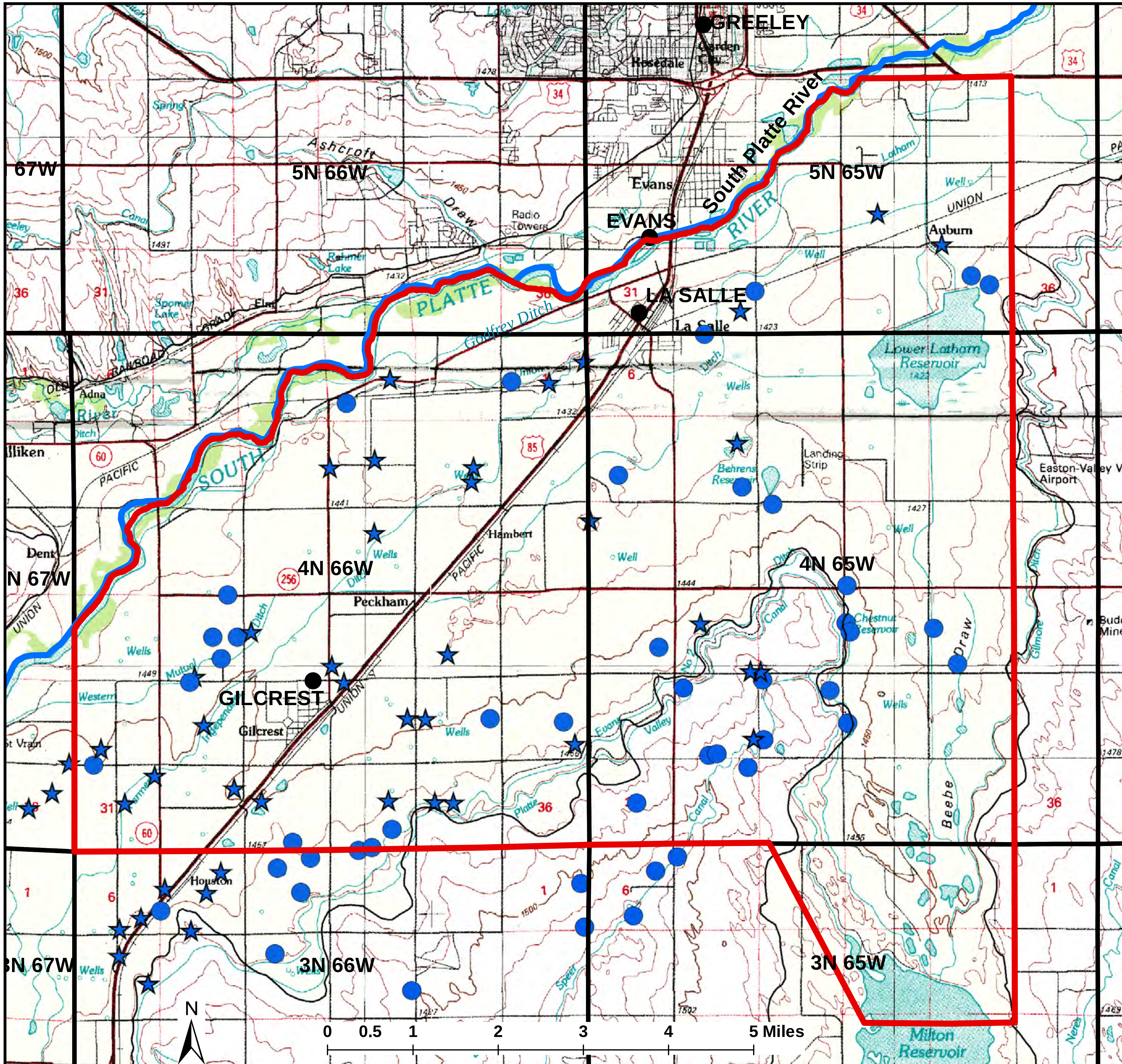
- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River

Water Level Elevation Contour (ft.)
10' Contour Interval
- 2013

Depth to Water (ft)
- 0-0.5
- 0.5 - 5
- 5.000000001 - 10
- 10.00000001 - 15
- 15.00000001 - 20

Appendix F
Time-Series Historic
Depth to Water Maps

APPENDIX G



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- City
- South Platte River
- Ponds Built Between 2002 and 2012
- Ponds in Place in 2002

Notes:
Locations mapped using Google Earth historical imagery. Basemap contours in meters, map used to show surface water features.

Appendix G
Irrigation Ditches, Reservoirs, Ponds and Recharge Structures

COLORADO GEOLOGICAL SURVEY

1801 19th Street
Golden, Colorado 80401
Phone: 303.384.2655

Serving the people of Colorado
Director, Karen Berry

TECHNICAL MEMORANDUM

Date: **June 15, 2015**

To: **Andy Moore, Senior Water Resource Specialist**
Colorado Water Conservation Board

From: **Lesley A. Sebol, PhD, Hydrogeologist**
Peter E. Barkmann, Supervisor Hydrogeologist
Colorado Geological Survey

Re: 2015 Addendum to the Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

This technical memorandum presents the 2015 addendum for the Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report. Specifically, it includes a brief description of activities undertaken to generate additional groundwater maps using new 2013 and 2014 water level data provided by Ralph Topper on April 15, 2015, and the findings.

Methods

Water levels were mapped in the same Study Area limits as in the Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report, except for wells in Beebe Draw (in the southeastern section of the Study Area). For consistency, contour process and generation of the depth-to-groundwater rasters followed the same general steps as the original report. Beebe Draw was excluded from this addendum as it is not the current focus of interest, which remains water level changes near the towns of Gilcrest and LaSalle. A total of 43 wells (for which 2013 and/or 2014 data were available) were used for generating groundwater contours (Figure TM2015-1). Contours between the wells with data and the South Platte River were adjusted to reflect topography using the 1:24,000 topographic maps. Contours were not adjusted to account for specific recharge ponds or drainage ditches. Adjustment for specific recharge ponds and ditches would require detailed analysis of flow rates and timing, which was beyond the scope of this effort.

Groundwater elevation contours were generated for the spring and fall in both 2013 and 2014 (Figures TM2015-2, TM2015-3, Figure TM2015-6, and TM2015-7). Water level data were chosen from the spring and fall months having the greatest number of wells which exhibited minimum and maximum levels, respectively. Many of the wells are measured only once a month and the majority are measured within a single day. Thus, low water levels were mapped using data from May 3, 2013 and April 15, 2014, and high water levels from September 23, 2013 and September 17, 2014 (Table 1). These data were then used to generate depth-to-groundwater and water level change maps between Spring 2013 to 2014 and also Fall 2013 to 2014 (Figures TM2015-4, TM2015-5, Figure TM2015-8, and TM2015-9).

Depth-to-groundwater maps were prepared by subtracting ArcGIS raster images of the 2013 and 2014 water table elevation maps from the 10-meter surface elevation digital elevation model (DEM) updated to 2013. The depth-to-groundwater raster images are classified using colors that only display areas where depth to water is 15 feet or less and presented by different colors representing groundwater depths of <0.5 feet, 0.5 – 5 feet, 5 – 10 feet, and 10 – 15 feet below ground surface (bgs). The depth-to-groundwater rasters were also clipped to an area with sufficient water level data for contouring. Additionally, water level changes at the wells on the 2014 maps, are symbolized by direction of change and magnitude. Blue circles show rising water, with larger circles indicating greater rises. Green, for the fall data only, show the few wells with falling water levels.

Observations

1. The fall 2013 data were measured about two weeks after the 2013 flood event, and water levels in about 18 of the 43 wells appeared to have been elevated (showed a short duration slight to moderate peak). As a result, water level rises from fall 2013 to 2014 might be biased low.

2. The area with the greatest change for both spring and fall is around Section 21 of 4N 66W, just north of Gilcrest. This is an area where groundwater has been relatively deep, but for the fall 2014 data it did rise to the 5 to 10 foot range. Based on information provided by Ralph Topper on June 9, 2015, the most likely reason is the Haren Recharge Facility, which started diverting in summer of 2013, and has put about 8,000 acre-feet (AF) of water into the ground. It is now the biggest recharge facility in the Study Area.

3. New to the 2014 and 2014 data is that the depth to groundwater is less than 0.5 feet to the east of Gilcrest, and that area exhibited an expansion from fall 2013 to fall 2014. Additionally, in that same area, the areal limits for water depths of less than five feet has expanded since 2012.

Attachments:

Table 2015TM-1	Summary of 2013 and 2014 Groundwater Data Used to Generate Figures
Figure 2015TM-1	Groundwater Level Monitoring Wells
Figure 2015TM-2	Groundwater Elevation Contour Map 2013 Spring
Figure 2015TM-3	Groundwater Elevation Contour Map 2014 Spring
Figure 2015TM-4	Groundwater Depth Map 2013 Spring
Figure 2015TM-5	Groundwater Depth Map 2014 Spring with 2013 to 2014 Change
Figure 2015TM-6	Groundwater Elevation Contour Map 2013 Fall
Figure 2015TM-7	Groundwater Elevation Contour Map 2014 Fall
Figure 2015TM-8	Groundwater Depth Map 2013 Fall
Figure 2015TM-9	Groundwater Depth Map 2014 Fall with 2013 to 2014 Change

GIS Database:

- Well point data
- Water level elevation contours (4)
- Depth-to-groundwater raster images (4)

Table 2015TM-1. Summary of 2013 and 2014 Groundwater Data Used to Generate Figures

		Ground	Depth to Water				Water Elevation				Difference	
	Township	Surface	2013 Spring	2013 Fall	2014 Spring	2014 Fall	2013 Spring	2013 Fall	2014 Spring	2014 Fall	2013 to 2014	
Well Name	& Range	Elevation*	3-May-13	23-Sep-13	15-Apr-14	17-Sep-14	3-May-13	23-Sep-13	15-Apr-14	17-Sep-14	Spring	Fall
108-1	T4N R65W	4688.91	6.50	1.72	5.32	3.20	4758.15	4762.93	4759.33	4761.45	1.2	-1.5
109-3	T4N R65W	4708.91	30.77	26.64	27.42	25.33	4743.16	4747.29	4746.51	4748.60	3.4	1.3
110-2	T4N R66W	4723.90	19.35	11.76	17.06	12.35	4741.58	4749.17	4743.87	4748.58	2.3	-0.6
144-4	T4N R66W	4756.89	12.67	7.95	11.95	8.05	4626.24	4630.96	4626.96	4630.86	0.7	-0.1
15-1	T4N R66W	4744.93	16.47	10.73	14.11	9.32	4672.44	4678.18	4674.80	4679.59	2.4	1.4
16-1	T4N R66W	4744.93	10.26	6.35	8.49	5.06	4698.65	4702.56	4700.42	4703.85	1.8	1.3
17-1	T4N R66W	4714.93	25.30	21.38	23.14	18.61	4698.60	4702.52	4700.76	4705.29	2.2	2.8
18-1	T4N R66W	4740.93	3.65	2.75	2.85	3.28	4753.24	4754.14	4754.04	4753.61	0.8	-0.5
208-9	T4N R66W	4742.93	32.95	27.89	24.88	19.96	4717.98	4723.04	4726.05	4730.97	8.1	7.9
25-5	T4N R66W	4724.90	28.25	23.00	22.80	17.15	4716.68	4721.93	4722.13	4727.78	5.4	5.9
27-1	T4N R66W	4740.93	29.64	25.75	26.54	23.52	4715.29	4719.18	4718.39	4721.41	3.1	2.2
28-1	T4N R66W	4726.93	7.45	4.37	7.30	6.85	4707.48	4710.56	4707.63	4708.08	0.1	-2.5
28-3	T5N R66W	4692.12	36.67	34.30	33.56	N/A	4704.26	4706.63	4707.37	N/A	3.1	N/A
29-1	T4N R66W	4730.19	31.05	25.55	25.70	19.96	4711.88	4717.38	4717.23	4722.97	5.4	5.6
30-1	T4N R66W	4724.92	23.83	19.90	21.26	17.12	4701.07	4705.00	4703.64	4707.78	2.6	2.8
30-2	T4N R66W	4723.91	24.98	19.92	21.20	16.30	4715.95	4721.01	4719.73	4724.63	3.8	3.6
32-1	T4N R66W	4713.22	N/A	16.95	17.68	13.41	N/A	4709.98	4709.25	4713.52	N/A	3.5
34-1	T4N R65W	4691.91	9.05	5.73	7.18	4.55	4683.07	4686.39	4684.94	4687.57	1.9	1.2
36-1	T4N R65W	4687.98	15.89	12.05	13.49	9.60	4714.30	4718.14	4716.70	4720.59	2.4	2.4
37-1	T4N R66W	4714.91	14.80	10.70	11.87	8.44	4710.12	4714.22	4713.05	4716.48	2.9	2.3
37-4	T4N R66W	4764.65	19.91	16.36	17.44	14.68	4704.00	4707.55	4706.47	4709.23	2.5	1.7
38-2	T4N R66W	4773.93	20.62	16.62	17.17	14.17	4692.60	4696.60	4696.05	4699.05	3.4	2.4
39-1	T4N R66W	4760.93	19.60	13.70	17.65	13.29	4672.31	4678.21	4674.26	4678.62	2.0	0.4
39-3	T5N R65W	4638.91	16.05	12.29	15.62	12.66	4671.93	4675.69	4672.36	4675.32	0.4	-0.4
40-1	T4N R66W	4750.93	20.00	15.73	15.97	13.23	4694.91	4699.18	4698.94	4701.68	4.0	2.5
NAQWA #11	T4N R66W	4712.91	12.85	4.36	12.40	4.06	4658.53	4667.02	4658.98	4667.32	0.4	0.3
Well ID 157;CSU WP 167	T4N R66W	4744.93	16.00	9.45	14.95	8.06	4643.91	4650.46	4644.96	4651.85	1.1	1.4
Well ID 158;CSU WP 166	T4N R65W	4681.91	10.27	7.67	9.83	8.00	4671.64	4674.24	4672.08	4673.91	0.4	-0.3
Well ID 167;CSU WP 157	T5N R65W	4659.91	22.24	19.40	20.74	17.54	4690.67	4693.51	4692.17	4695.37	1.5	1.9
Well ID 171;CSU WP 162	T5N R65W	4671.38	21.48	16.82	17.85	13.56	4723.45	4728.11	4727.08	4731.37	3.6	3.3
WL-M-001	T4N R66W	4756.93	22.13	15.71	19.04	14.50	4734.80	4741.22	4737.89	4742.43	3.1	1.2
WL-M-002	T4N R66W	4772.93	19.89	Error	Error	Error	4753.04	Error	Error	Error	Error	Error
WL-M-003A	T4N R66W	4763.93	9.40	5.33	7.77	4.99	4754.53	4758.60	4756.16	4758.94	1.6	0.3
WL-M-006A	T4N R66W	4738.93	24.12	17.48	14.89	7.74	4714.81	4721.45	4724.05	4731.19	9.2	9.7
WL-M-007	T4N R66W	4707.56	23.05	19.40	21.60	18.28	4684.51	4688.16	4685.96	4689.28	1.5	1.1
WL-M-008	T4N R66W	4715.72	18.08	14.39	15.47	12.46	4697.64	4701.33	4700.25	4703.27	2.6	1.9
WL-M-009	T4N R65W	4695.91	17.78	14.22	14.59	11.49	4678.13	4681.69	4681.32	4684.42	3.2	2.7
WL-M-010	T5N R65W	4663.91	18.29	14.62	17.06	14.25	4645.62	4649.29	4646.85	4649.66	1.2	0.4
WL-M-011	T5N R65W	4632.08	18.00	10.06	17.49	9.29	4614.08	4622.02	4614.60	4622.79	0.5	0.8
WL-M-040	T4N R66W	4742.91	14.23	10.26	12.04	N/A	4728.68	4732.65	4730.87	N/A	2.2	N/A
WL-M-401	T5N R65W	4667.91	11.29	7.48	10.67	6.88	4656.62	4660.43	4657.24	4661.03	0.6	0.6
WL-M-501	T5N R65W	4670.91	14.37	9.37	14.37	8.44	4656.54	4661.54	4656.54	4662.47	0.0	0.9
WL-M-603	T4N R66W	4725.99	21.54	18.31	N/A	N/A	4704.45	4707.68	N/A	N/A	N/A	N/A

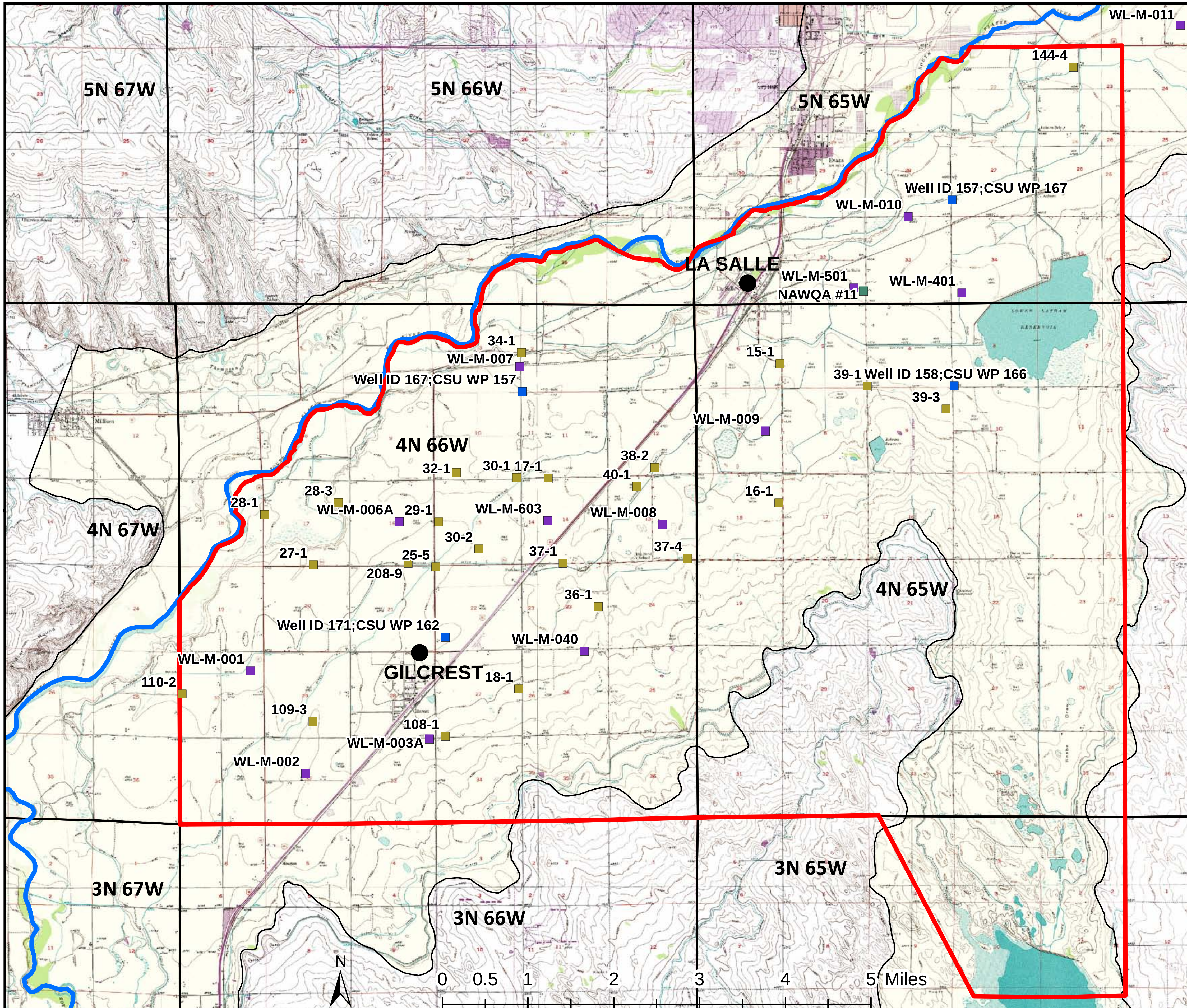
Notes:

* Ground surface elevation derived from 2013 digital elevation model (DEM).

N/A = no data (not measured)

Error = no data due to data logger malfunctioning

Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report Addendum



Legend

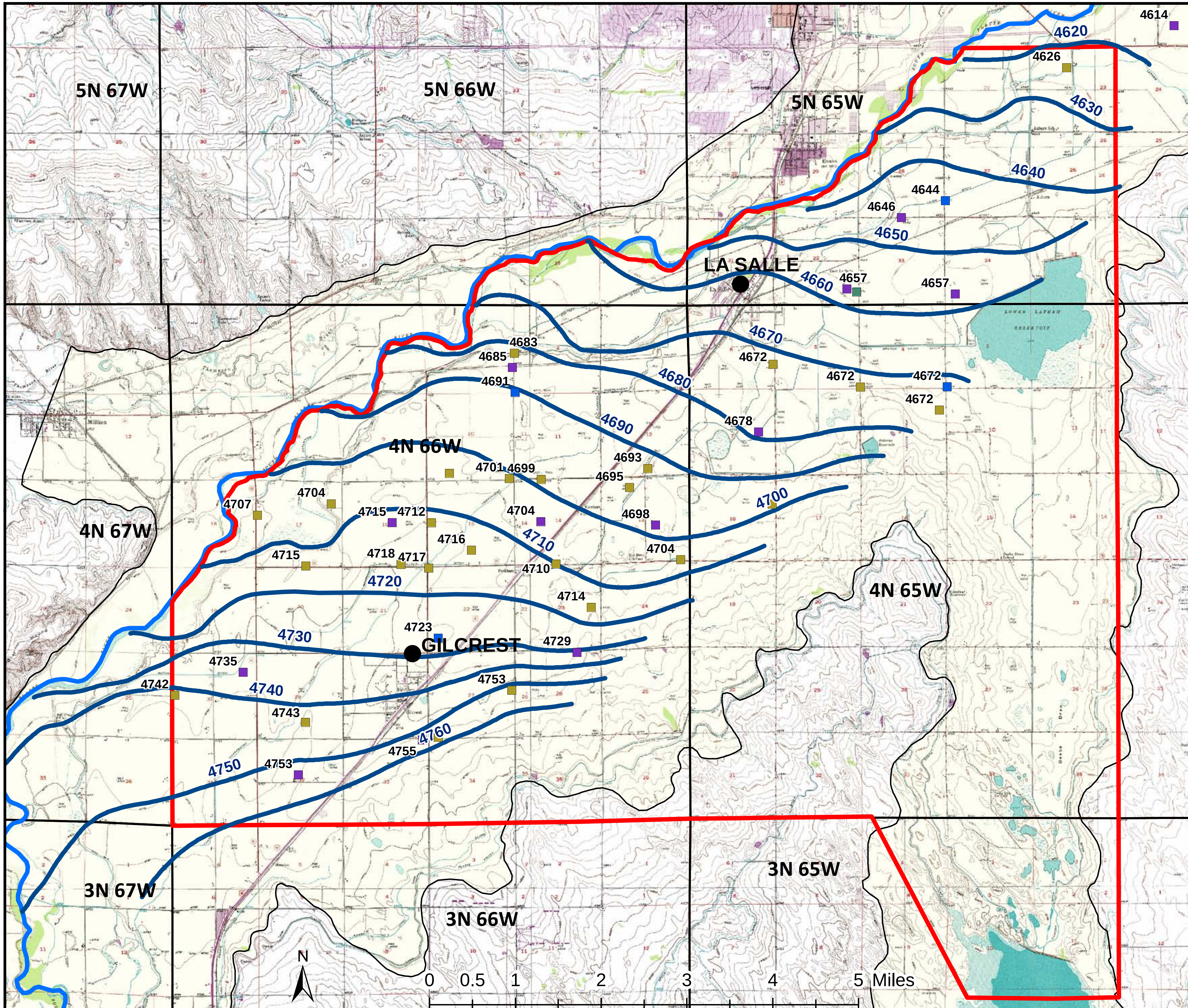
- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- Cities
- South Platte River

Wells Used for Contours 2013-2014

- CCWCD
- CDA
- CSU
- USGS

CCWCD-Central Colorado Water Conservancy District
CDA- Colorado Department of Agriculture
CSU- Colorado State University
USGS- United States Geological Survey

Figure TM2015-1
Groundwater Level Monitoring Wells



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report Addendum

Legend

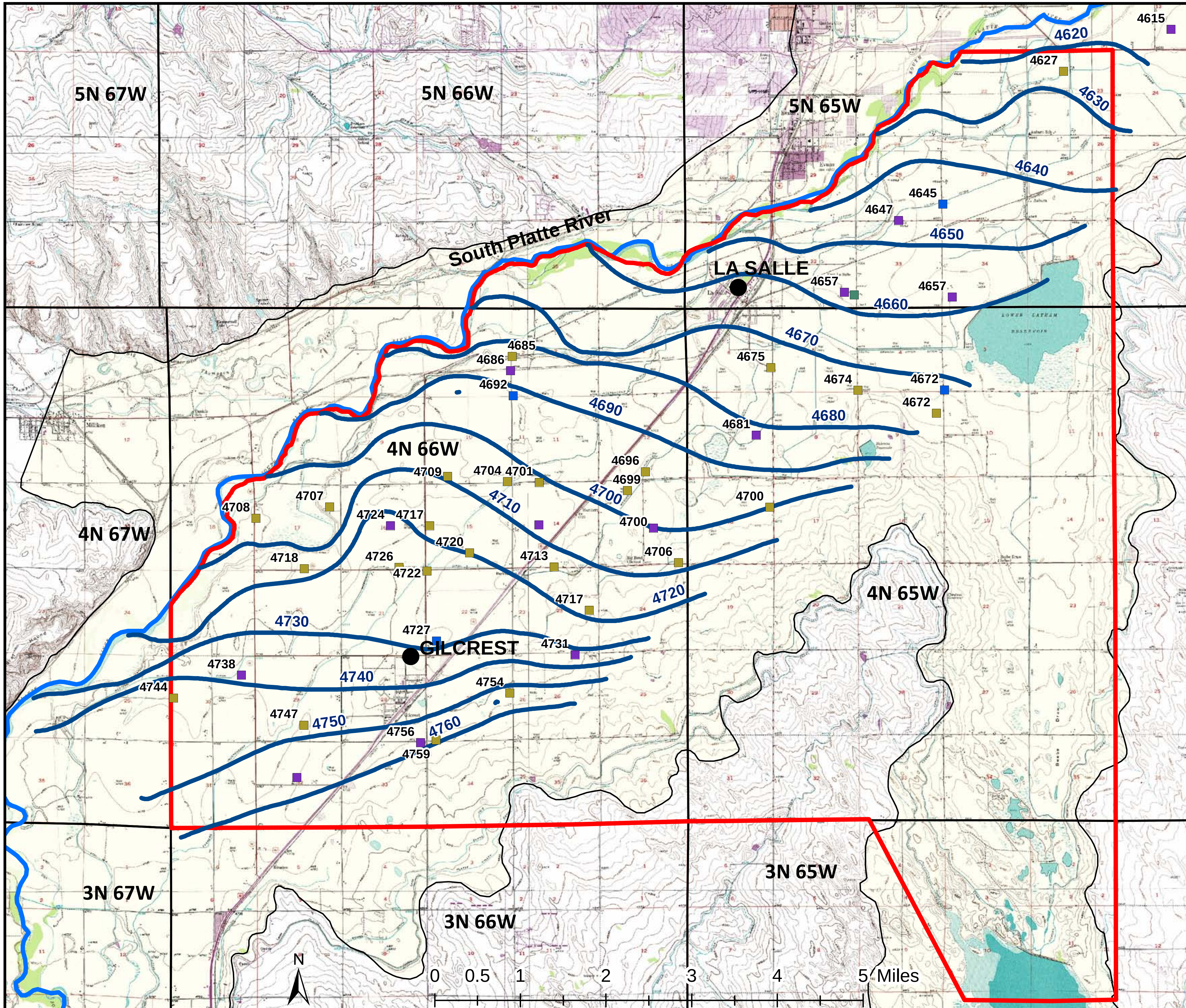
- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- Cities
- South Platte River

Wells Used for Contours 2013-2014

- CCWCD
- CDA
- CSU
- USGS
- Groundwater Contour (ft) 2013 Spring

CCWCD-Central Colorado Water Conservancy District
CDA- Colorado Department of Agriculture
CSU- Colorado State University
USGS- United States Geological Survey

Figure TM2015-2
Groundwater Elevation Contour Map
2013 Spring



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report Addendum

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- Cities
- South Platte River

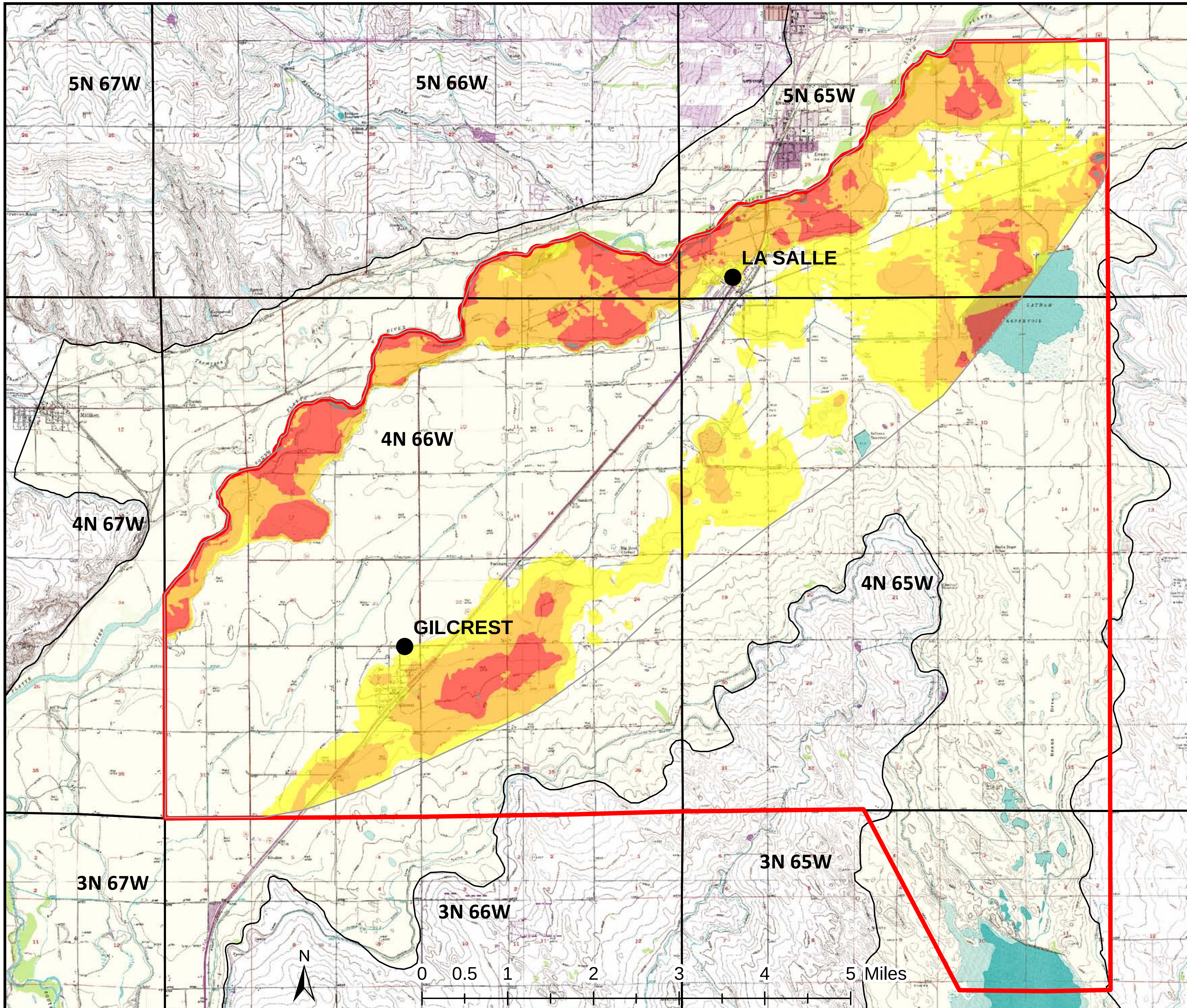
Wells Used for Contours 2013-2014

- CCWCD
- CDA
- CSU
- USGS
- Groundwater Contour (ft) 2014 Spring

CCWCD-Central Colorado Water Conservancy District
CDA- Colorado Department of Agriculture
CSU- Colorado State University
USGS- United States Geological Survey

Figure TM2015-3
Groundwater Elevation Contour Map
2014 Spring

Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report Addendum



Legend

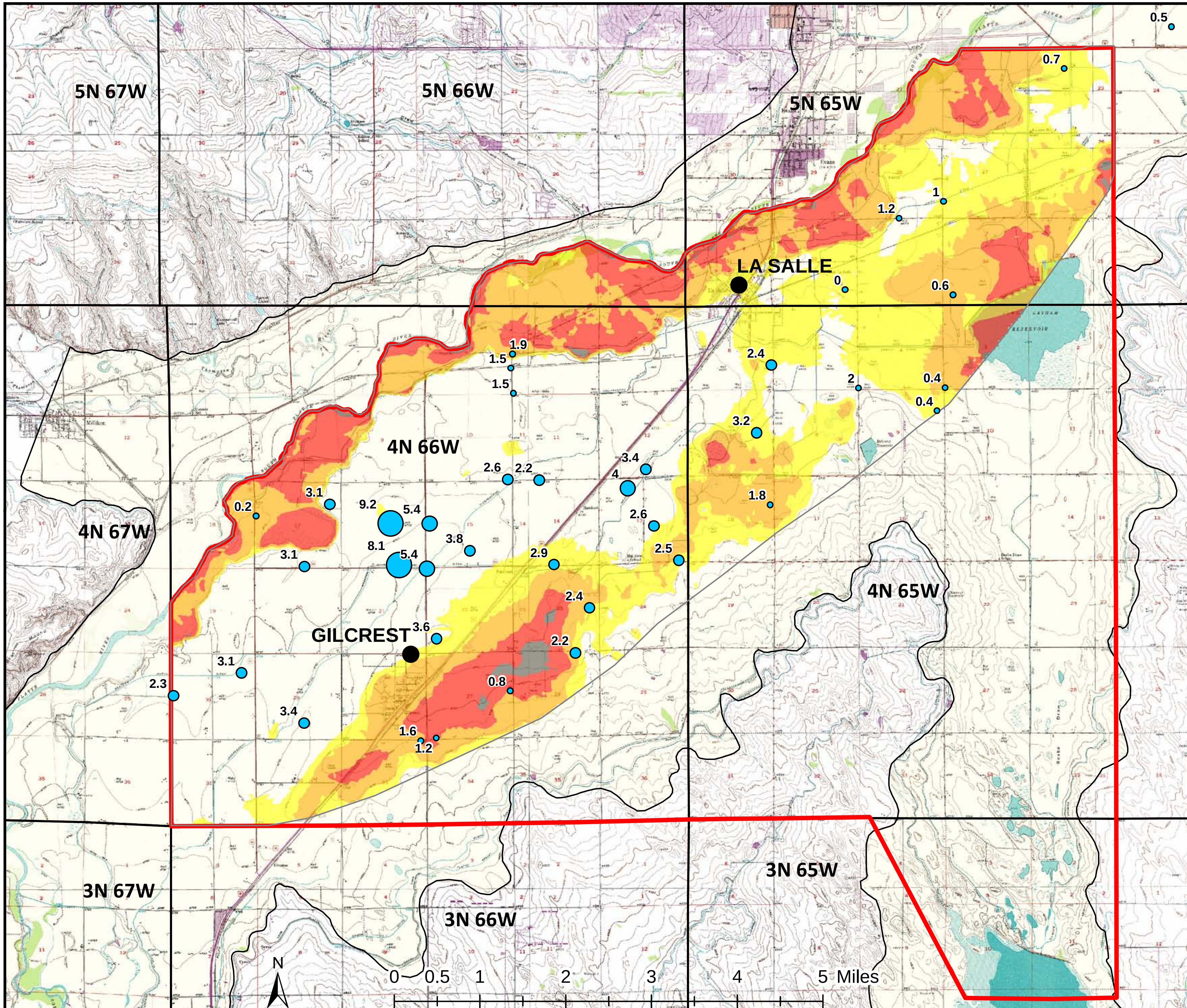
- Cities
- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- Area With Data For Raster Creation

Groundwater Depth

(below ground surface)

- < 0.5 ft
- 0.5 - 5 ft
- 5 - 10 ft
- 10 - 15 ft
- > 15 ft

Figure TM2015-4
Groundwater Depth Map
2013 Spring



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report Addendum

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- Cities
- Area With Data For Raster Creation

Groundwater Depth

(below ground surface)

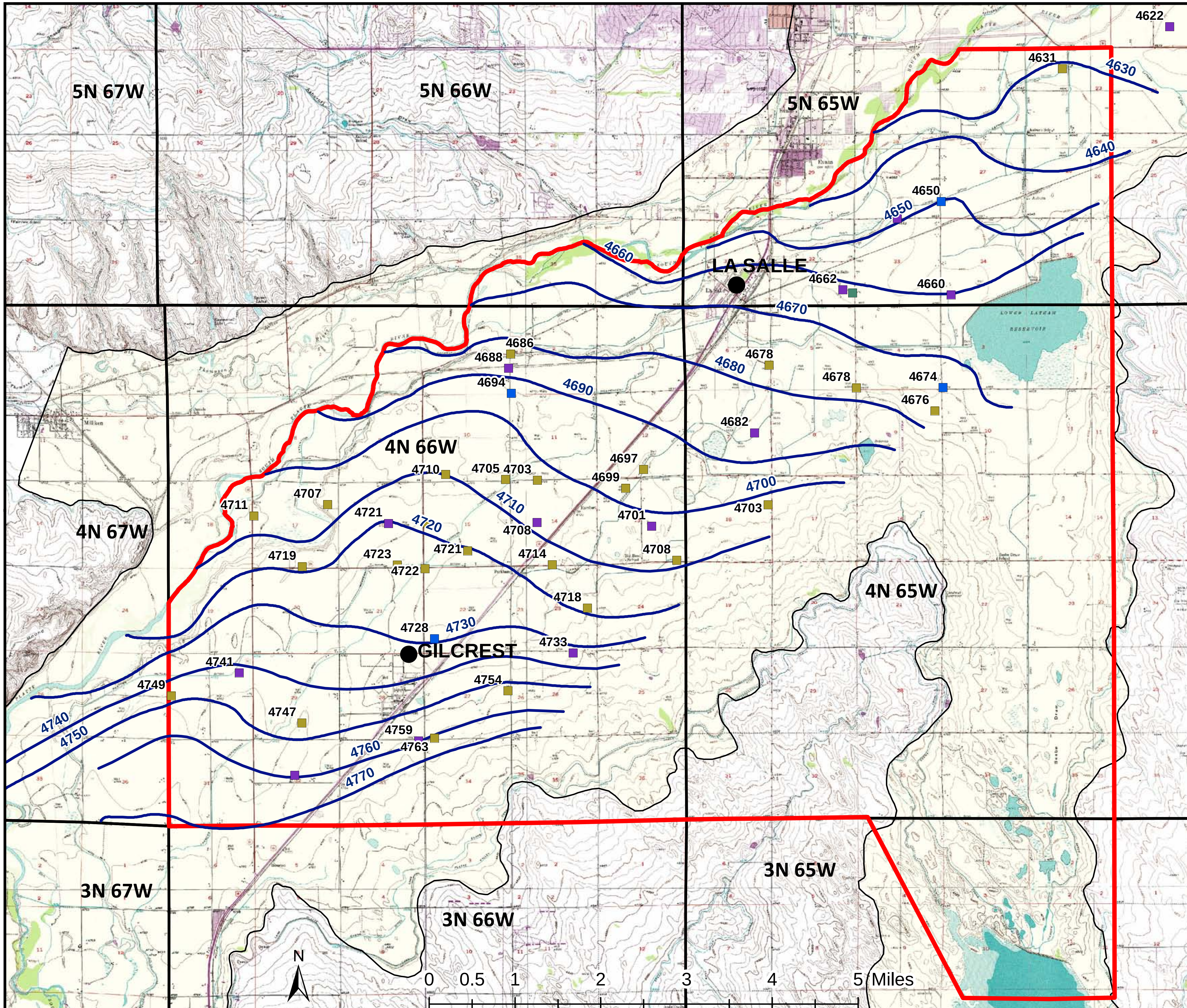
- < 0.5 ft
- 0.5 - 5 ft
- 5 - 10 ft
- 10 - 15 ft
- > 15 ft

Spring 2013-2014 Water Level Changes

Rising Levels in Wells

- < 2 ft
- 2- 4 ft
- 4 - 6 ft
- 6 - 8 ft
- 8 - 10 ft

Figure TM2015-5
Groundwater Depth Map
2014 Spring
With 2013 to 2014 Change



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report Addendum

Legend

Study Area Boundary

CGS Revised Alluvial Aquifer Extent

Cities

Wells Used for Contours 2013-2014

CCWCD

CDA

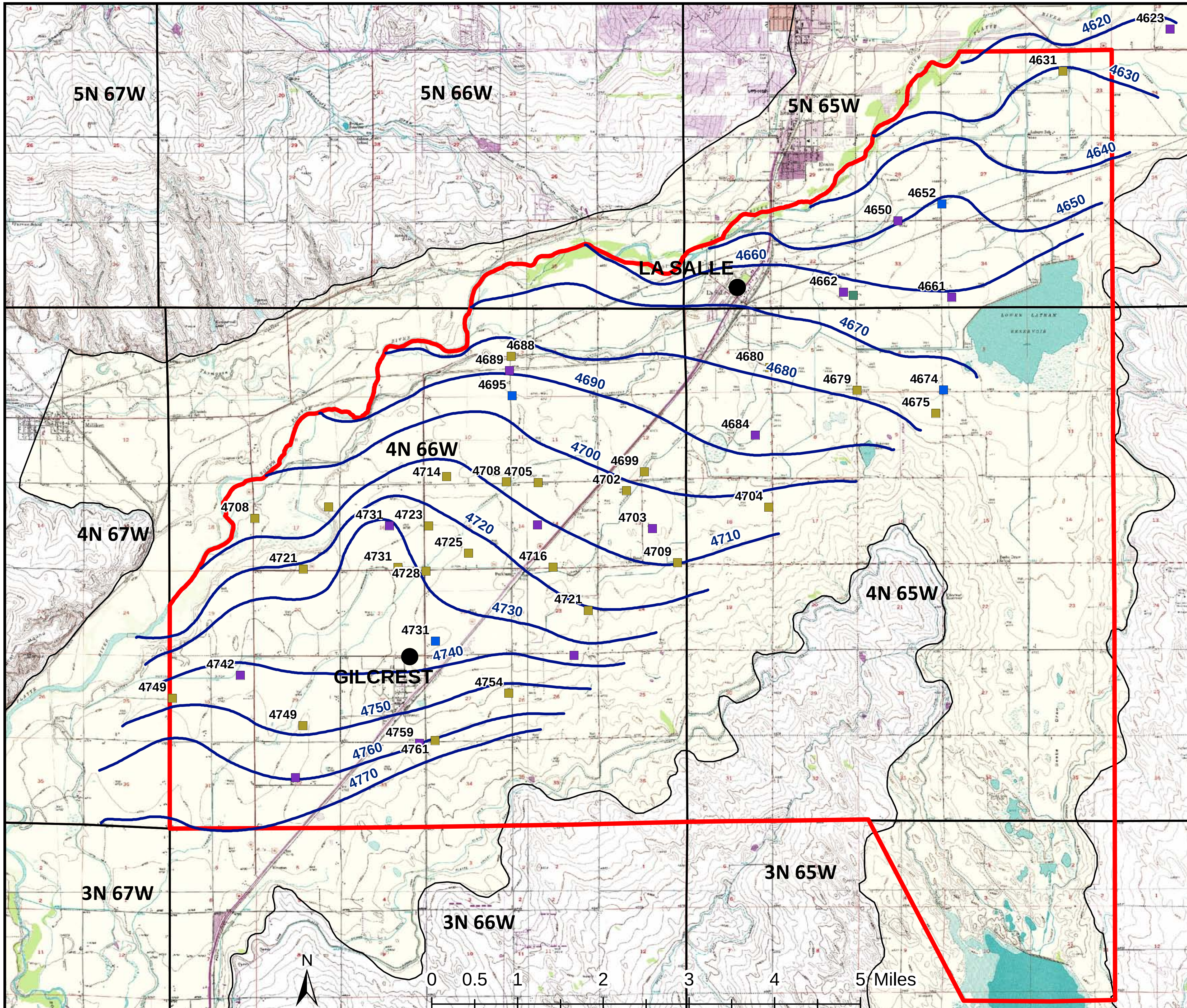
CSU

USGS

Groundwater Contour 2013 Fall

CCWCD-Central Colorado Water Conservancy District
CDA- Colorado Department of Agriculture
CSU- Colorado State University
USGS- United States Geological Survey

Figure TM2015-6
Groundwater Elevation Contour Map
2013 Fall



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report Addendum

Legend

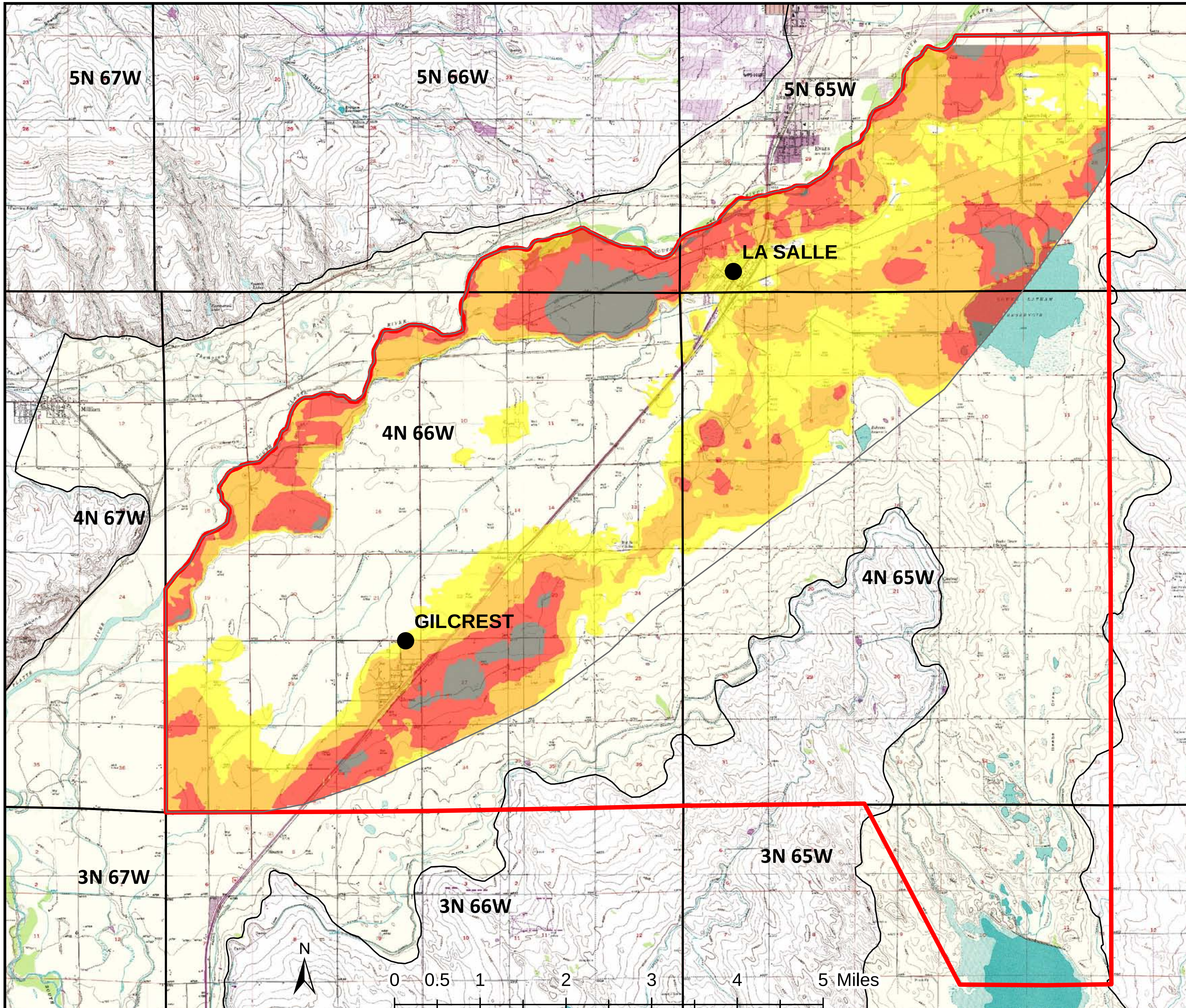
- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- Cities

Wells Used for Contours 2013-2014

- CCWCD
- CDA
- CSU
- USGS
- Groundwater Contour 2014 Fall

CCWCD-Central Colorado Water Conservancy District
CDA- Colorado Department of Agriculture
CSU- Colorado State University
USGS- United States Geological Survey

Figure TM2015-7
Groundwater Elevation Contour Map
2014 Fall



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report Addendum

Legend

Study Area Boundary

CGS Revised Alluvial Aquifer Extent

Cities

Area With Data For Raster Creation

Groundwater Depth

(below ground surface)

< 0.5 ft

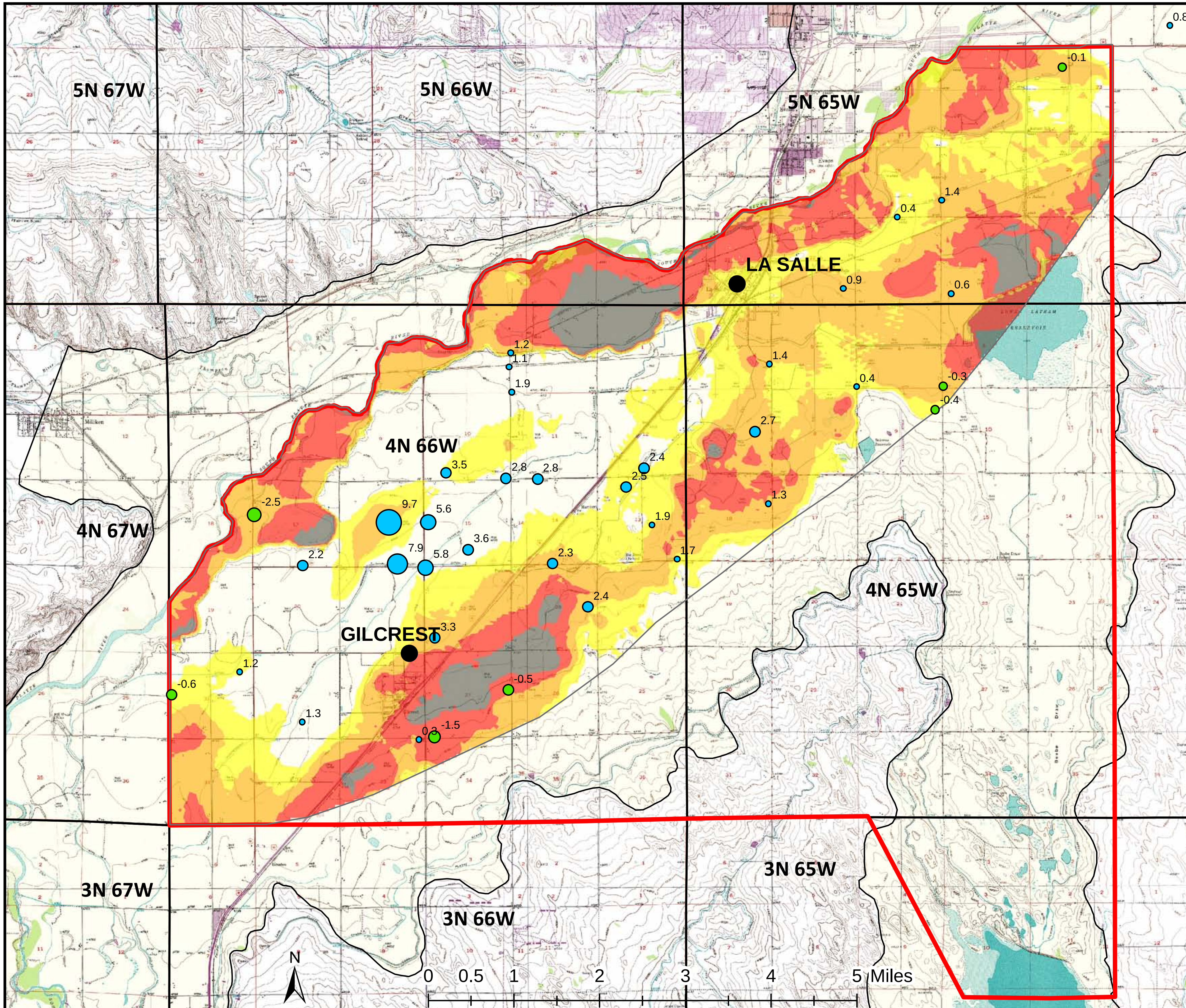
0.5 - 5 ft

5 - 10 ft

10 - 15 ft

> 15 ft

Figure TM2015-8
Groundwater Depth Map
2013 Fall



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report Addendum

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- Cities
- Area With Data For Raster Creation

Groundwater Depth
(below ground surface)

- < 0.5 ft
- 0.5 - 5 ft
- 5 - 10 ft
- 10 - 15 ft
- > 15 ft

Fall 2013-2014 Water Level Changes

Rising Levels in Wells	Falling Levels in Wells
< 2 ft	<-0.5 ft
2- 4 ft	-1 to -0.5 ft
4 - 6 ft	-2 to -1 ft
6 - 8 ft	> -2 ft
8 - 10 ft	

Figure TM2015-9
Groundwater Depth Map
2014 Fall
With 2013 to 2014 Change

COLORADO GEOLOGICAL SURVEY

1801 19th Street
Golden, Colorado 80401
Phone: 303.384.2655

Serving the people of Colorado
Director, Karen Berry

TECHNICAL MEMORANDUM

Date: **October 3, 2017**

To: **Andy Moore, Senior Water Resource Specialist**
Colorado Water Conservation Board (CWCB)

From: **Lesley A. Sebol, PhD, Hydrogeologist**
Peter E. Barkmann, Supervisor Hydrogeologist
Colorado Geological Survey (CGS)

Re: 2017 Addendum to the Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report

This technical memorandum presents the 2017 addendum for the Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report. Specifically, it includes a brief description of activities undertaken to generate additional spring and fall groundwater maps using new 2015, 2016 and 2017 (spring only) water level data, and the findings. Water level data were provided by Erik Skeie of CWCB and Kevin Donegan of Colorado Division of Water Resources (DWR) in July and August of 2017. This addendum is a follow up to the prior 2015 Addendum to the Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report (hereafter referred to as the 2015 Addendum). Incorporated herein are previously presented 2014 water level data which were used to calculate differences with the new 2015 data, as shown in Table 2017TM-1.

Methods

Similar to the prior 2015 Technical Memorandum Addendum, water levels were mapped in the same study area limits as in the Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report, excluding wells in Beebe Draw (in the southeastern section of the study area). Beebe Draw was again excluded from this addendum as it is not the current focus of interest, which remains water level changes near the towns of Gilcrest and LaSalle. For consistency, contour process and generation of the depth-to-groundwater rasters followed the same general steps as the original report and 2015 Addendum. Using 2015 Lidar, the South Platte River shown on the figures was adjusted to follow the center of the apparent main channel, showing its current post-September 2013 flood pattern. The study area boundary was slightly adjusted to follow the outside of this new river line.

A maximum of 59 wells were used for generating groundwater contours (Figure TM2017-1). This total includes data for 20 new wells in the Gilcrest area whose data was sourced from the Town of Gilcrest, DWR and Colorado State University (CSU). The date these new wells began to be monitored is variable (Table 2017TM-1). As a result, the fall 2015 mapping is the first to incorporate some of the wells but all 20 were available by the fall 2016 mapping. Four wells (28-1, 28-3, WL-M-040, and WL-M-60) which had data in the 2015 Addendum were removed because data were no longer available beginning in 2015.

Ground surface elevations were obtained for the 20 new wells and updated for the remaining wells using the most recent (June 2015) Lidar elevations (preferentially in areas having Lidar coverage) or alternatively the 10-meter surface elevation digital elevation model (DEM) updated to 2015. Previously, the 2013 10-meter DEM had been used for the whole study area. Table TM2017-2 provides a comparison of the previous and current well elevations and identifies by color coding whether the Lidar or 10-meter DEM elevation was used at each well.

Groundwater elevation contours were generated for the spring and fall of 2015 and 2016 and the spring of 2017 (Figures TM2017-2 through TM2017-6). Water level data were chosen from the spring and fall months having the greatest number of wells exhibiting minimum and maximum levels, respectively. Thus, low water levels were mapped using data from March 23, 2015, March 25, 2016, and March 30, 2017, and high water levels from September 22, 2015 and September 23, 2016 (Table 2017TM-1). Data measurement frequency at the wells varied between daily and monthly. Some wells were instrumented with data loggers, but others had manual measurements. However, there were data available at all the wells either on or within two to three days of the above chosen dates.

Although not shown on the maps, lidar elevations were obtained for 15 points evenly spaced along the newly adjusted South Platte River line. These elevations were incorporated into the groundwater contours to adjust the contours between the wells with data and the river. Contours were manually adjusted around the edge of Lower Latham Reservoir, which has a recorded elevation of 4,664 feet on the topographic map. This elevation fit nicely with groundwater elevation data from the nearest well WL-M-401. Elsewhere, contours were not adjusted to account for specific recharge ponds or drainage ditches because this would require detailed analysis of water levels, flow rates and timing, which was beyond the scope of this effort.

Groundwater data were used to generate depth-to-groundwater and water level change maps between Spring 2014 to 2015, Fall 2014 to 2015, Spring 2015 to 2016, Fall 2015 to 2016, and Spring 2016 to 2017 (Figures TM2017-7 through TM2017-11). Depth-to-groundwater maps were prepared by subtracting ArcGIS raster images of the 2015, 2016 and spring 2017 water table elevation maps from the 2015 surface 10-meter DEM. The depth-to-groundwater raster images are classified using colors that only display areas where depth to water is 15 feet or less and presented by different colors representing groundwater depths of <0.5 feet, 0.5 – 5 feet, 5 – 10 feet, and 10 – 15 feet below ground surface (bgs). The depth-to-groundwater raster images were also clipped to follow the river line. Additionally, water level changes at the wells on these maps, are symbolized by direction of change and magnitude. Purple circles show rising water levels and green circles show falling water levels at the wells, with larger circles indicating greater rising or falling values at the wells.

Observations

1. The 20 new wells which began to be added in late 2015 were clustered around Gilcrest and groundwater elevations in these wells generally agreed with each other and others nearby, except two which had anomalously higher groundwater elevations for each measuring event (RE1 and MW3). Both of these wells had groundwater elevations that averaged about 4 feet higher than nearby wells. Their ground surface elevation used in the calculations did not appear anomalous. Therefore, groundwater contours were manually adjusted near these wells to reduce the impact of these anomalies.

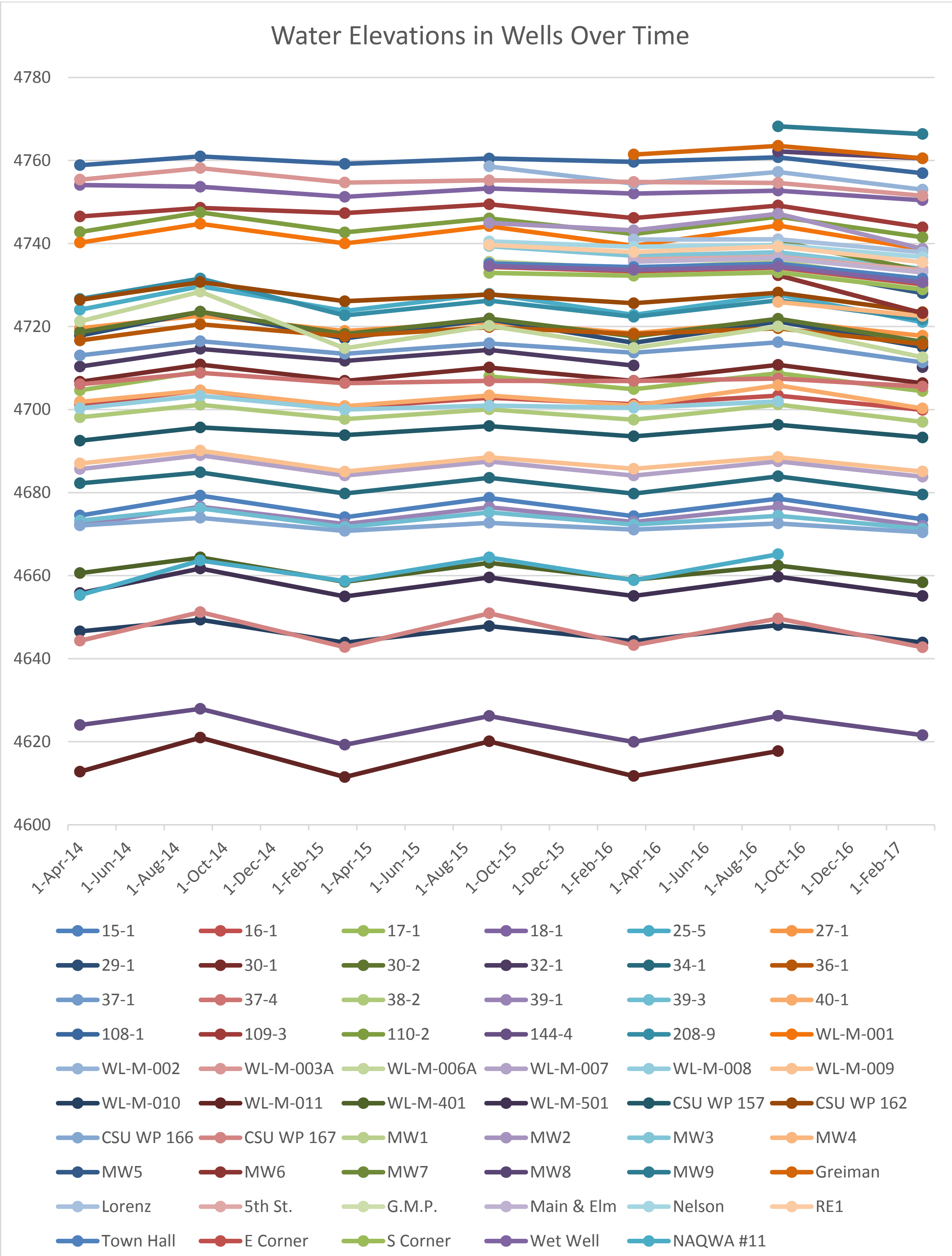
2. Similar to the 2013 and 2014 data, the depth to groundwater east/northeast of Gilcrest is either less than 0.5 feet or is in the range of 0.5 to 5 feet. Possible recharge sources located in this area include the Bolander Seep (aka Big Bend Drain) and Schmidt recharge ponds #1, #2, and #3 (Figure TM2017-1). The area with less than 0.5 foot groundwater depths was centered over the boundary of Sections 23 and 26 of 4N 66W, and exhibited expansions each fall relative to spring. Additionally, the areal limits for water depths of less than five feet appeared largest in the fall of 2016. Within Gilcrest, the depth to groundwater remains in the 5 – 10 and 10 – 15 feet ranges.

3. The Haren Recharge Facility located in Section 16 of 4N 66W, which started diverting in summer of 2013, remains the largest recharge facility in the study area (Figure TM2017-1). Groundwater levels just west of the Haren Recharge Facility in the area below the river bluff/terrace remain less than 0.5 feet year round. Similarly, west/southwest of LaSalle also below the river bluff/terrace groundwater levels remain less than 0.5 feet year round although the extent expands slightly in the fall versus spring. Possible recharge sources here include the Loeffler and Miller recharge ponds and the Union Ditch.

4. Annual water level changes between spring 2015 and spring 2014 predominately dropped and where they rose the amount was less than 1.4 feet (except one well east of LaSalle at 3.37 feet). Also, between fall 2015 and fall 2014 water levels dropped at all wells except for two with nominal rises of less than one foot. Water levels between spring 2016 and spring 2015 predominantly rose (n=23 versus n=14) although the maximum rise was only 0.81 feet. Between fall 2016 and fall 2015 water level differences were mixed (n=26 versus n=21) and the maximum water level rise versus drop was 2.45 versus 2.36 feet, respectively. Water levels between spring 2017 and spring 2016 predominantly dropped at all but two wells, and the maximum drop in levels was 4.45 feet. Summary statistics of the rise and fall of water levels in the wells are provided in the table below, where (n) is the number of wells with measurements.

Water Levels in Wells Statistics							
Annual Difference		**Max. Rise**	**Avg. Rise**	**(n)**	**Max. Fall**	**Avg. Fall**	**(n)**
2015 to 2014	**Spring**	3.37	0.93	10	-6.48	-1.55	27
	Fall	0.83	0.63	3	-8.23	-1.60	35
2016 to 2015	**Spring**	0.81	0.39	23	-1.16	-0.55	14
	Fall	2.45	0.52	26	-2.36	-0.59	21
2017 to 2016	**Spring**	1.64	0.82	2	-4.45	-1.65	48

5. Regional water elevations for all the wells during the 2015 through 2017 study period (and including 2014) are shown in the graph below. The overall trend in the majority of wells is nearly flat other than the Spring low and Fall high level fluctuations, indicating that the regional pattern dominates.


Water Elevations in Wells Over Time
4780
4760
4740
4720
4700
4680
4660
4640
4620
4600
1-Apr-14
1-Jun-14
1-Aug-14
1-Oct-14
1-Dec-14
1-Feb-15
1-Apr-15
1-Jun-15
1-Aug-15
1-Oct-15
1-Dec-15
1-Feb-16
1-Apr-16
1-Jun-16
1-Aug-16
1-Oct-16
1-Dec-16
1-Feb-17
15-1
16-1
17-1
18-1
25-5
27-1
29-1
30-1
30-2
32-1
34-1
36-1
37-1
37-4
38-2
39-1
39-3
40-1
108-1
109-3
110-2
144-4
208-9
WL-M-001
WL-M-002
WL-M-003A
WL-M-006A
WL-M-007
WL-M-008
WL-M-009
WL-M-010
WL-M-011
WL-M-401
WL-M-501
CSU WP 157
CSU WP 162
CSU WP 166
CSU WP 167
MW1
MW2
MW3
MW4
MW5
MW6
MW7
MW8
MW9
Greiman
Lorenz
5th St.
G.M.P.
Main & Elm
Nelson
RE1
Town Hall
E Corner
S Corner
Wet Well
NAQWA #11

Attachments:

Table TM2017-1	Summary of 2015, 2016 and Spring 2017 Groundwater Data
Table TM2017-2	Comparison of Ground Surface Elevations
Figure TM2017-1	Groundwater Level Monitoring Wells
Figure TM2017-2	Groundwater Elevation Contour Map 2015 Spring
Figure TM2017-3	Groundwater Elevation Contour Map 2015 Fall
Figure TM2017-4	Groundwater Elevation Contour Map 2016 Spring
Figure TM2017-5	Groundwater Elevation Contour Map 2016 Fall
Figure TM2017-6	Groundwater Elevation Contour Map 2017 Spring
Figure TM2017-7	Groundwater Depth Map 2015 Spring, With 2014 to 2015 Change
Figure TM2017-8	Groundwater Depth Map 2015 Fall, With 2014 to 2015 Change
Figure TM2017-9	Groundwater Depth Map 2016 Spring, With 2015 to 2016 Change
Figure TM2017-10	Groundwater Depth Map 2016 Fall, With 2015 to 2016 Change
Figure TM2017-11	Groundwater Depth Map 2017 Spring, With 2016 to 2017 Change

GIS Database:

Well point data,
Water level elevation contours (5), and
Depth-to-groundwater raster images (5)

Table 2017TM-1. Summary of 2015, 2016 and Spring 2017 Groundwater Data

Well Name	Source	Township & Range	Latitude	Longitude	UTM-x	UTM-y	2017 Ground Surface Elevation*	Depth to Water							Water Elevation							Difference				
								2014 Spring	2014 Fall	2015 Spring	2015 Fall	2016 Spring	2016 Fall	2017 Spring	2014 Spring	2014 Fall	2015 Spring	2015 Fall	2016 Spring	2016 Fall	2017 Spring	2014 to 2015		2015 to 2016		2016 to 2017
								15-Apr-14	17-Sep-14	23-Mar-15	22-Sep-15	25-Mar-16	23-Sep-16	30-Mar-17	15-Apr-14	17-Sep-14	23-Mar-15	22-Sep-15	25-Mar-16	23-Sep-16	30-Mar-17	Spring	Fall	Spring	Fall	Spring
15-1	CCWCD	T4N R66W	40.33838	-104.69683	525750	4465360	4688.59	14.11	9.32	14.53	9.87	14.28	10.05	15.00	4674.48	4679.27	4674.06	4678.72	4674.31	4678.54	4673.59	-0.42	-0.55	0.25	-0.18	-0.72
16-1	CCWCD	T4N R66W	40.31478	-104.69717	525730	4462740	4709.65	8.49	5.06	9.20	6.81	8.39	6.28	9.75	4701.16	4704.59	4700.45	4702.84	4701.26	4703.37	4699.90	-0.71	-1.75	0.81	0.53	-1.36
17-1	CCWCD	T4N R66W	40.31908	-104.74815	521397	4463200	4727.76	23.14	18.61	n/a	19.75	22.85	19.00	23.32	4704.62	4709.15	n/a	4708.01	4704.91	4708.76	4704.44	n/a	-1.14	n/a	0.75	-0.47
18-1	CCWCD	T4N R66W	40.28344	-104.75476	520847	4459250	4756.93	2.85	3.28	5.70	3.69	4.91	4.21	6.50	4754.08	4753.65	4751.23	4753.24	4752.02	4752.72	4750.43	-2.85	-0.41	0.79	-0.52	-1.59
25-5	CCWCD	T4N R66W	40.30413	-104.77302	519289	4461540	4746.85	22.80	17.15	23.10	18.96	24.04	19.15	25.80	4724.05	4729.70	4723.75	4727.89	4722.81	4727.70	4721.05	-0.30	-1.81	-0.94	-0.19	-1.76
27-1	CCWCD	T4N R66W	40.30454	-104.80011	516986	4461580	4746.13	26.54	23.52	27.20	25.04	27.73	24.76	28.36	4719.59	4722.61	4718.93	4721.09	4718.40	4721.37	4717.77	-0.66	-1.52	-0.53	0.28	-0.63
29-1	CCWCD	T4N R66W	40.31177	-104.77239	519340	4462390	4743.54	25.70	19.96	26.40	21.82	27.44	22.31	28.50	4717.84	4723.58	4717.14	4721.72	4716.10	4721.23	4715.04	-0.70	-1.86	-1.04	-0.49	-1.06
30-1	CCWCD	T4N R66W	40.31922	-104.75513	520804	4463220	4727.96	21.26	17.12	21.05	17.83	21.04	17.20	21.60	4706.70	4710.84	4706.91	4710.13	4706.92	4710.76	4706.36	0.21	-0.71	0.01	0.63	-0.56
30-2	CCWCD	T4N R66W	40.30716	-104.76356	520092	4461880	4739.86	21.20	16.30	21.65	17.93	22.25	18.00	23.50	4718.66	4723.56	4718.21	4721.93	4717.61	4721.86	4716.36	-0.45	-1.63	-0.60	-0.07	-1.25
32-1	CCWCD	T4N R66W	40.32012	-104.76840	519677	4463310	4728.03	17.68	13.41	16.30	13.65	17.43	n/a	17.82	4710.35	4714.62	4711.73	4714.38	4710.60	n/a	4710.21	1.38	-0.24	-1.13	n/a	-0.39
34-1	CCWCD	T4N R65W	40.34041	-104.75400	520894	4465570	4689.42	7.18	4.55	9.65	5.87	9.67	5.50	9.90	4682.24	4684.87	4679.77	4683.55	4679.75	4683.92	4679.52	-2.47	-1.32	-0.02	0.37	-0.23
36-1	CCWCD	T4N R65W	40.29741	-104.73716	522338	4460800	4730.13	13.49	9.60	12.49	10.28	11.96	10.56	14.37	4716.64	4720.53	4717.64	4719.85	4718.17	4719.57	4715.76	1.00	-0.68	0.53	-0.28	-2.41
37-1	CCWCD	T4N R66W	40.30474	-104.74491	521677	4461610	4724.91	11.87	8.44	11.47	8.97	11.20	8.70	13.55	4713.04	4716.47	4713.44	4715.94	4713.71	4716.21	4711.36	0.40	-0.53	0.27	0.27	-2.35
37-4	CCWCD	T4N R66W	40.30544	-104.71739	524016	4461700	4723.53	17.44	14.68	17.17	16.63	16.65	16.05	18.00	4706.09	4708.85	4706.36	4706.90	4706.88	4707.48	4705.53	0.27	-1.95	0.52	0.58	-1.35
38-2	CCWCD	T4N R66W	40.32084	-104.72462	523396	4463400	4715.31	17.17	14.17	17.60	15.26	17.77	14.10	18.30	4698.14	4701.14	4697.71	4700.05	4697.54	4701.21	4697.01	-0.43	-1.09	-0.17	1.16	-0.53
39-1	CCWCD	T4N R66W	40.33449	-104.67757	527388	4464930	4689.88	17.65	13.29	17.45	13.42	16.94	13.30	17.95	4672.23	4676.59	4672.43	4676.46	4672.94	4676.58	4671.93	0.20	-0.13	0.51	0.12	-1.01
39-3	CCWCD	T5N R65W	40.33057	-104.66021	528864	4464500	4688.87	15.62	12.66	17.20	13.64	16.60	14.46	17.60	4673.25	4676.21	4671.67	4675.23	4672.27	4674.41	4671.27	-1.58	-0.98	0.60	-0.82	-1.00
40-1	CCWCD	T4N R66W	40.31766	-104.72861	523058	4463050	4717.83	15.97	13.23	16.99	14.43	16.90	11.98	17.55	4701.86	4704.60	4700.84	4703.40	4700.93	4705.85	4700.28	-1.02	-1.20	0.09	2.45	-0.65
108-1	CCWCD	T4N R65W	40.27549	-104.77104	519465	4458360	4764.18	5.32	3.20	5.00	3.71	4.53	3.42	7.25	4758.86	4760.98	4759.18	4760.47	4759.65	4760.76	4756.93	0.32	-0.51	0.47	0.29	-2.72
109-3	CCWCD	T4N R65W	40.27807	-104.80025	516981	4458640	4773.93	27.42	25.33	26.62	24.50	27.78	24.78	30.05	4746.51	4748.60	4747.31	4749.43	4746.15	4749.15	4743.88	0.80	0.83	-1.16	-0.28	-2.27
110-2	CCWCD	T4N R66W	40.28272	-104.82911	514527	4459150	4759.83	17.06	12.35	17.15	13.79	17.54	13.37	18.34	4742.77	4747.48	4742.68	4746.04	4742.29	4746.46	4741.49	-0.09	-1.44	-0.39	0.42	-0.80
144-4	CCWCD	T4N R66W	40.38838	-104.63177	531253	4470930	4635.96	11.95	8.05	16.71	9.77	16.04	9.75	14.40	4624.01	4627.91	4619.25	4626.19	4619.92	4626.21	4621.56	-4.76	-1.72	0.67	0.02	1.64
208-9	CCWCD	T4N R66W	40.30478	-104.77916	518767	4461610	4751.52	24.88	19.96	28.84	25.28	29.19	25.20	29.79	4726.64	4731.56	4722.68	4726.24	4722.33	4726.32	4721.73	-3.96	-5.32	-0.35	0.08	-0.60
WL-M-001	CDA	T4N R66W	40.28657	-104.81403	515808	4459580	4759.25	19.04	14.50	19.23	15.09	19.77	14.91	20.64	4740.21	4744.75	4740.02	4744.16	4739.48	4744.34	4738.61	-0.18	-0.58	-0.55	0.18	-0.87
WL-M-002	CDA	T4N R66W	40.26922	-104.80188	516845	4457660	4772.93	Error	Error	Error	14.37	18.50	15.68	19.95	Error	Error	Error	4758.56	4754.43	4757.25	4752.98	n/a	n/a	n/a	-1.32	-1.45
WL-M-003A	CDA	T4N R66W	40.27503	-104.77450	519171	4458310	4763.15	7.77	4.99	8.48	7.93	8.32	8.57	11.65	4755.38	4758.16	4754.67	4755.22	4754.83	4754.58	4751.50	-0.70	-2.94	0.15	-0.63	-3.33
WL-M-006A	CDA	T4N R66W	40.31180	-104.78103	518606	4462390	4736.13	14.89	7.74	21.37	15.98	21.30	16.12	23.54	4721.24	4728.39	4714.76	4720.15	4714.83	4720.01	4712.59	-6.48	-8.23	0.07	-0.14	-2.23
WL-M-007	CDA	T4N R66W	40.33800	-104.75438	520862	4465300	4707.26	21.60	18.28	23.16	19.78	23.16	19.75	23.44	4685.66	4688.98	4684.10	4687.48	4684.10	4687.51	4683.82	-1.56	-1.50	-0.01	0.03	-0.28
WL-M-008	CDA	T4N R66W	40.31125	-104.72288	523547	4462340	4715.78	15.47	12.46	15.79	14.84	15.36	13.84	n/a	4700.31	4703.32	4699.99	4700.94	4700.42	4701.94	n/a	-0.32	-2.39	0.43	1.00	n/a
WL-M-009	CDA	T4N R65W	40.32697	-104.70010	525477	4464090	4701.61	14.59	11.49	16.56	13.09	15.88	13.06	16.53	4687.02	4690.12	4685.05	4688.52	4685.73	4688.55	4685.08	-1.97	-1.60	0.68	0.03	-0.66
WL-M-010	CDA	T5N R65W	40.36317	-104.66840	528155	4468120	4663.62	17.06	14.25	19.77	15.78	19.40	15.54	19.74	4646.56	4649.37	4643.85	4647.84	4644.22	4648.08	4643.88	-2.71	-1.53	0.36	0.24	-0.34
WL-M-011	CDA	T5N R65W	40.39538	-104.60798	533269	4471720	4630.26	17.49	9.29	18.80	10.18	18.54	12.54	n/a	4612.77	4620.97	4611.46	4620.08	4611.72	4617.72	n/a	-1.31	-0.89	0.26	-2.36	n/a
WL-M-401	CDA	T5N R65W	40.35020	-104.65658	529164	4466680	4671.26	10.67	6.88	12.77	8.19	12.27	8.85	12.90	4660.59	4664.38	4658.49	4663.07	4658.99	4662.41	4658.36	-2.10	-1.31	0.50	-0.65	-0.63
WL-M-501	CDA	T5N R65W	40.35112	-104.68045	527137	4466780	4670.15	14.37	8.44	15.17	10.59	15.05	10.42	15.05	4655.78	4661.71	4654.98	4659.56	4655.10	4659.73	4655.10	-0.81	-2.16	0.12	0.17	0.00
CSU WP 157	CSU	T5N R65W	40.33378	-104.75380	520913	4464830	4713.23	20.74	17.54	19.40	17.21	19.68	16.90	19.97	4692.49	4695.69	4693.83	4696.02	4693.55	4696.33	4693.26	1.34	0.33	-0.28	0.31	-0.29
CSU WP 162	CSU	T5N R65W	40.29226	-104.77093	519470	4460220	4744.26	17.85	13.56	18.17	16.57	18.65	16.10	20.80	4726.41	4730.70	4726.09	4727.69	4725.61	4728.16	4723.46	-0.32	-3.01	-0.48	0.47	-2.15
CSU WP 166	CSU	T4N R65W	40.33449	-104.65840	529016	4464940	4681.91	9.83	8.00	11.15	9.20	10.85	9.35	11.50	4672.08	4673.91	4670.76	4672.71	4671.06	4672.56	4670.41	-1.32	-1.20	0.30	-0.15	-0.65
CSU WP 167	CSU	T4N R66W	40.36596	-104.65863	528983	4468430	4659.26	14.95	8.06	16.49	8.34	16.02	9.60	16.53	4644.31	4651.20	4642.77	4650.92	4643.24	4649.66	4642.73	-1.54	-0.28	0.47	-1.26	-0.51
MW1	CSU	T4N R66W	40.28800	-104.76800	519720	4459750	4741.93	n/a	n/a	n/a	6.31	7.94	6.23	11.34	n/a	n/a	n/a	4735.62	4733.99	4735.70	4730.59	n/a	n/a	n/a	0.08	-3.40
MW2	CSU	T4N R66W	40.28290	-104.76800	519722	4459180	4749.13	n/a	n/a	n/a	4.19	5.97	1.96	10.41	n/a	n/a	n/a	4744.94	4743.16	4747.17	4738.72	n/a	n/a	n/a	2.23	-4.45
MW3	CSU	T4N R66W	40.28970	-104.76600	519890	4459940	4742.92	n/a	n/a	n/a	3.56	5.88	5.04	9.01	n/a	n/a	n/a	4739.36	4737.04	4737.88	4733.91	n/a	n/a	n/a	-1.48	-3.13
MW4	CSU	T4N R66W	40.30263	-104.75642	520700	4461380	4731.93	n/a	n/a	n/a	n/a	n/a	6.02	9.39	n/a	n/a	n/a	n/a	n/a	4725.91	4722.54	n/a	n/a	n/a	n/a	n/a
MW5	CSU	T4N R66W	40.30152	-104.76388	520066	4461250	4738.93	n/a	n/a	n/a	n/a	n/a	4.64	10.89	n/a	n/a	n/a	n/a	n/a	4734.29	4728.04	n/a	n/a	n/a	n/a	n/a
MW6	CSU	T4N R66W	40.30075	-104.77158	519412	4461160	4742.93	n/a	n/a	n/a	n/a	n/a	10.58	19.72	n/a	n/a	n/a	n/a	n/a	4732.35	4723.21	n/a	n/a	n/a	n/a	n/a
MW7	CSU	T4N R66W	40.28976	-104.78735	518075	4459940	4759.93	n/a	n/a	n/a	n/a	n/a	19.41	26.46	n/a	n/a	n/a	n/a	n/a	4740.52	4733.47	n/a	n/a	n/a	n/a	n/a
MW8	CSU	T4N R66W	40.27767	-104.75866	520517	4458600	4767.66	n/a	n/a	n/a	n/a	n/a	5.48	7.15	n/a	n/a	n/a	n/a	n/a	4762.18	4760.51	n/a	n/a	n/a	n/a	n/a
MW9	CSU	T4N R66W	40.27846	-104.75405	520909	4458690	4770.88	n/a	n/a	n/a	n/a	n/a	2.68	4.52	n/a	n/a	n/a	n/a	n/a	4768.20	4766.36	n/a	n/a	n/a	n/a	n/a
Greiman	DWR	T4N R66W	40.27651	-104.76466	520007	4458470	4766.83	n/a	n/a	n/a	n/a	5.40	3.30	6.30	n/a	n/a	n/a	n/a	4761.43	4763.53	4760.53	n/a	n/a	n/a	n/a	-0.90
Lorenz	DWR	T4N R66W	40.28658	-104.76061	520349	4459590	4744.00	n/a	n/a	n/a	n/a	3.05	3.00	6.10	n/a	n/a	n/a	n/a	4740.95	4741.00	4737.90	n/a	n/a	n/a	n/a	-3.05
5th St.	Gilcrest	T4N R66W	40.28067	-104.78066	518646	4458933	4753.93	n/a	n/a	n/a	n/a	17.80	17.14	20.35	n/a	n/a	n/a	n/a	4736.13	4736.79	4733.58	n/a	n/a	n/a	n/a	-2.55
G.M.P.	Gilcrest	T4N R66W	40.28754	-104.77331	519269	4459700	4742.93	n/a	n/a	n/a	n/a	10.36	8.81	13.13	n/a	n/a	n/a	n/a	4732.57	4734.12	4729.80	n/a	n/a	n/a	n/a	-2.77
Main & Elm	Gilcrest	T4N R66W	40.28266	-104.77968	518729	4459150	4750.93	n/a	n/a	n/a	n/a	15.32	14.43	17.89	n/a	n/a	n/a	n/a	4735.61	4736.50	4733.04	n/a	n/a	n/a	n/a	-2.57
Nelson	Gilcrest	T4N R66W	40.28017	-104.78260	518481	4458877	4754.93	n/a	n/a	n/a	14.42	15.72	15.28	18.19	n/a	n/a	n/a	4740.51	4739.21	4739.65	4736.74	n/a	n/a	n/a	-0.86	-2.47
RE1	Gilcrest	T4N R66W	40.29118	-104.77722	518935	4460100	4746.93	n/a	n/a	n/a	7.28	9.00	7.65	11.44	n/a	n/a	n/a	4739.65	4737.93	4739.28	4735.49	n/a	n/a	n/a	-0.37	-2.44
Town Hall	Gilcrest	T4N R66W	40.28381	-104.77693	518962	4459280	4749.11	n/a	n/a	n/a	13.93	14.81	13.98	17.59	n/a	n/a	n/a	4735.18	4734.30	4735.13	4731.52	n/a	n/a	n/a	-0.05	-2.78
E Corner	Gilcrest	T4N R66W	40.28967	-104.76826	519698	4459930	4741.93	n/a	n/a	n/a	7.57	8.62	7.72	11.75	n/a	n/a	n/a	4734.36	4733.31	4734.21	4730.18	n/a	n/a	n/a	-0.15	-3.13
S Corner	Gilcrest	T4N R66W	40.28790	-104.77012	519540	4459740	4742.92	n/a	n/a	n/a	10.02	10.70	9.89	14.01	n/a	n/a	n/a	4732.90	4732.22	4733.03	4728.91	n/a	n/a	n/a	0.13	-3.31
Wet Well	Gilcrest	T4N R66W	40.28965	-104.77095	519469	4459930	4741.93	n/a	n/a	n/a	7.36	8.30	7.45	11.31	n/a	n/a	n/a	4734.57	4733.63	4734.48	4730.62	n/a	n/a	n/a	-0.09	-3.01
NAQWA #11	USGS	T4N R66W	40.35061	-104.67831	527318	4466720	4667.70	12.40	4.06	9.03	3.32	8.82	2.55	n/a	4655.30	4663.64	4658.67	4664.38	4658.88	4665.15	n/a	3.37	0.74	0.21	0.77	n/a

Notes: * Ground surface elevation in feet, revised in 2017 using 2015 Lidar (where available) and 2015 digital elevation model (DEM).

N/A = well not installed or no data (not measured) at the time of the sampling event; Error = no data due to data logger malfunctioning.

Table 2017TM-2. Comparison of Ground Surface Elevations.

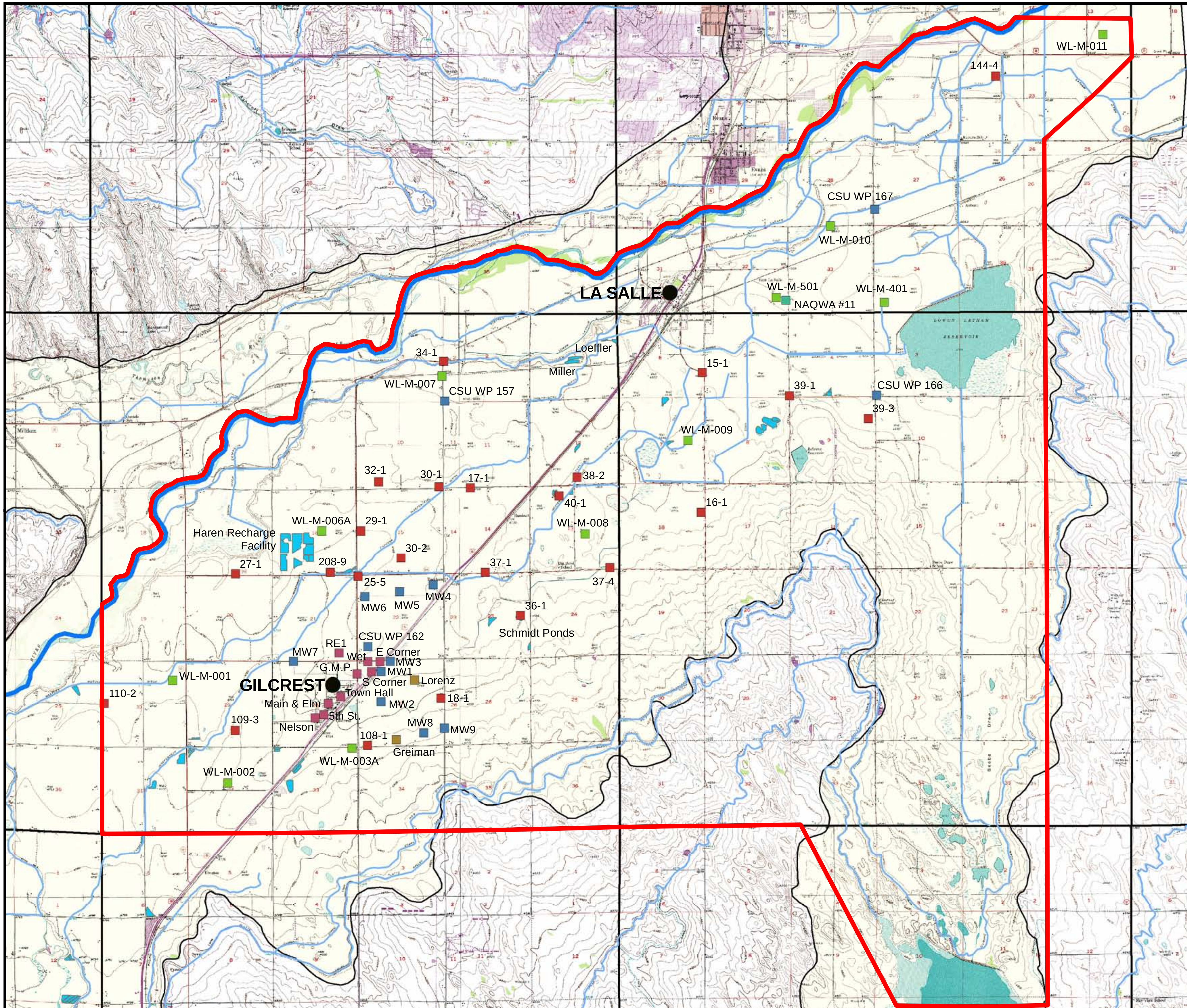
Source	Well ID	UTM_x	UTM_y	previous GS Elev. 2013 DEM in TM2015	new Lidar 2015 GS Elev.	new DEM 10m 2015 GS Elev.	selected GS Elev. Revised 2017	calculated 2015-2013 DEM difference	calculated 2015 DEM -2015 Lidar difference	NOT USE from CDA GS Elev.	calculated CDA-2017 Elev. difference
CCWCD	15-1	525750	4465360	4688.91	4688.59	4689.04	4688.59	0.13	0.45		
CCWCD	16-1	525730	4462740	4708.91	n/c	4709.65	4709.65	0.74			
CCWCD	17-1	521397	4463200	4723.90	4727.76	4728.68	4727.76	4.78	0.92		
CCWCD	18-1	520847	4459250	4756.89	n/c	4756.93	4756.93	0.04			
CCWCD	25-5	519289	4461540	4744.93	4746.85	4745.44	4746.85	0.51	-1.41		
CCWCD	27-1	516986	4461580	4744.93	4746.13	4746.23	4746.13	1.30	0.10		
CCWCD	29-1	519340	4462390	4742.93	4743.54	4742.62	4743.54	-0.31	-0.92		
CCWCD	30-1	520804	4463220	4724.90	4727.96	4728.03	4727.96	3.13	0.07		
CCWCD	30-2	520092	4461880	4740.93	4739.86	4739.56	4739.86	-1.37	-0.30		
CCWCD	32-1	519677	4463310	4726.93	4728.03	4728.61	4728.03	1.68	0.58		
CCWCD	34-1	520894	4465570	4692.12	4689.42	4689.83	4689.42	-2.29	0.41		
CCWCD	36-1	522338	4460800	4730.19	n/c	4730.13	4730.13	-0.06			
CCWCD	37-1	521677	4461610	4724.92	n/c	4724.91	4724.91	-0.01			
CCWCD	37-4	524016	4461700	4723.91	n/c	4723.53	4723.53	-0.38			
CCWCD	38-2	523396	4463400	4713.22	4715.31	4714.82	4715.31	1.60	-0.49		
CCWCD	39-1	527388	4464930	4691.91	4689.88	4690.47	4689.88	-1.44	0.59		
CCWCD	39-3	528864	4464500	4687.98	n/c	4688.87	4688.87	0.89			
CCWCD	40-1	523058	4463050	4714.91	4717.83	4718.25	4717.83	3.34	0.42		
CCWCD	108-1	519465	4458360	4764.65	n/c	4764.18	4764.18	-0.47			
CCWCD	109-3	516981	4458640	4773.93	n/c	4773.93	4773.93	0.00			
CCWCD	110-2	514527	4459150	4760.93	4759.83	4760.16	4759.83	-0.77	0.33		
CCWCD	144-4	531253	4470930	4638.91	4635.96	4636.43	4635.96	-2.48	0.47		
CCWCD	208-9	518767	4461610	4750.93	4751.52	4751.73	4751.52	0.80	0.21		
CDA	WL-M-001	515808	4459580	4756.93	4759.25	4756.62	4759.25	-0.31	-2.63	4771.18	11.93
CDA	WL-M-002	516845	4457660	4772.93	n/c	4772.93	4772.93	0.00		4786.02	13.09
CDA	WL-M-003A	519171	4458310	4763.93	n/c	4763.15	4763.15	-0.78		4776.81	13.66
CDA	WL-M-006A	518606	4462390	4738.93	4736.13	4736.12	4736.13	-2.81	-0.01	4738.94	2.81
CDA	WL-M-007	520862	4465300	4707.56	4707.26	4707.29	4707.26	-0.27	0.03	4716.10	8.84
CDA	WL-M-008	523547	4462340	4715.72	n/c	4715.78	4715.78	0.06		4733.27	17.49
CDA	WL-M-009	525477	4464090	4695.91	4701.61	4700.9	4701.61	4.99	-0.71	4711.72	10.11
CDA	WL-M-010	528155	4468120	4663.91	4663.62	4664.21	4663.62	0.30	0.59	4673.14	9.52
CDA	WL-M-011	533269	4471720	4632.08	4630.26	4630.25	4630.26	-1.83	-0.01	4643.82	13.56
CDA	WL-M-401	529164	4466680	4667.91	4671.26	4672.1	4671.26	4.19	0.84	4684.39	13.13
CDA	WL-M-501	527137	4466780	4670.91	4670.15	4669.64	4670.15	-1.27	-0.51	4679.65	9.50
CSU	CSU WP 157	520913	4464830	4712.91	4713.23	4713.02	4713.23	0.11	-0.21		
CSU	CSU WP 162	519470	4460220	4744.93	n/c	4744.26	4744.26	-0.67			
CSU	CSU WP 166	529016	4464940	4681.91	n/c	4681.91	4681.91	0.00			
CSU	CSU WP 167	528983	4468430	4659.91	4659.26	4659.33	4659.26	-0.58	0.07		
USGS	NAQWA #11	527318	4466720	4670.33	4667.70	4667.76	4667.70		0.06		
CSU	MW1	519720	4459750	n/a	n/c	4741.93	4741.93				
CSU	MW2	519722	4459180	n/a	n/c	4749.13	4749.13				
CSU	MW3	519890	4459940	n/a	n/c	4742.92	4742.92				
CSU	MW4	520700	4461380	n/a	n/c	4731.93	4731.93				
CSU	MW5	520066	4461250	n/a	n/c	4738.93	4738.93				
CSU	MW6	519412	4461160	n/a	n/c	4742.93	4742.93				
CSU	MW7	518075	4459940	n/a	n/c	4759.93	4759.93				
CSU	MW8	520517	4458600	n/a	n/c	4767.66	4767.66				
CSU	MW9	520909	4458690	n/a	n/c	4770.88	4770.88				
DWR	Greiman	520007	4458470	n/a	n/c	4766.83	4766.83				
DWR	Lorenz	520349	4459590	n/a	n/c	4744.00	4744.00				
Gilcrest	5th St.	518646	4458933	n/a	n/c	4753.93	4753.93				
Gilcrest	G.M.P.	519269	4459700	n/a	n/c	4742.93	4742.93				
Gilcrest	Main & Elm	518729	4459150	n/a	n/c	4750.93	4750.93				
Gilcrest	Nelson	518481	4458877	n/a	n/c	4754.93	4754.93				
Gilcrest	RE1	518935	4460100	n/a	n/c	4746.93	4746.93				
Gilcrest	Town Hall	518962	4459280	n/a	n/c	4749.11	4749.11				
Gilcrest	E Corner	519698	4459930	n/a	n/c	4741.93	4741.93				
Gilcrest	S Corner	519540	4459740	n/a	n/c	4742.92	4742.92				
Gilcrest	Wet Well	519469	4459930	n/a	n/c	4741.93	4741.93				

NOTES:

n/c = Lidar does not cover area of the well; n/a =not applicable due to being new well.

Red font is new well for 2015-2017.

NAQWA #11 elevation from USGS NWIS website = 4670.33; was 4671.38 in TM2015 from 2013 10m DEM,
but the shape file from DNR had 4667.67.



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report 2017 Addendum

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- Recharge Ponds
- Canals
- South Platte River
- Cities

Wells Used for Contours 2015-2017

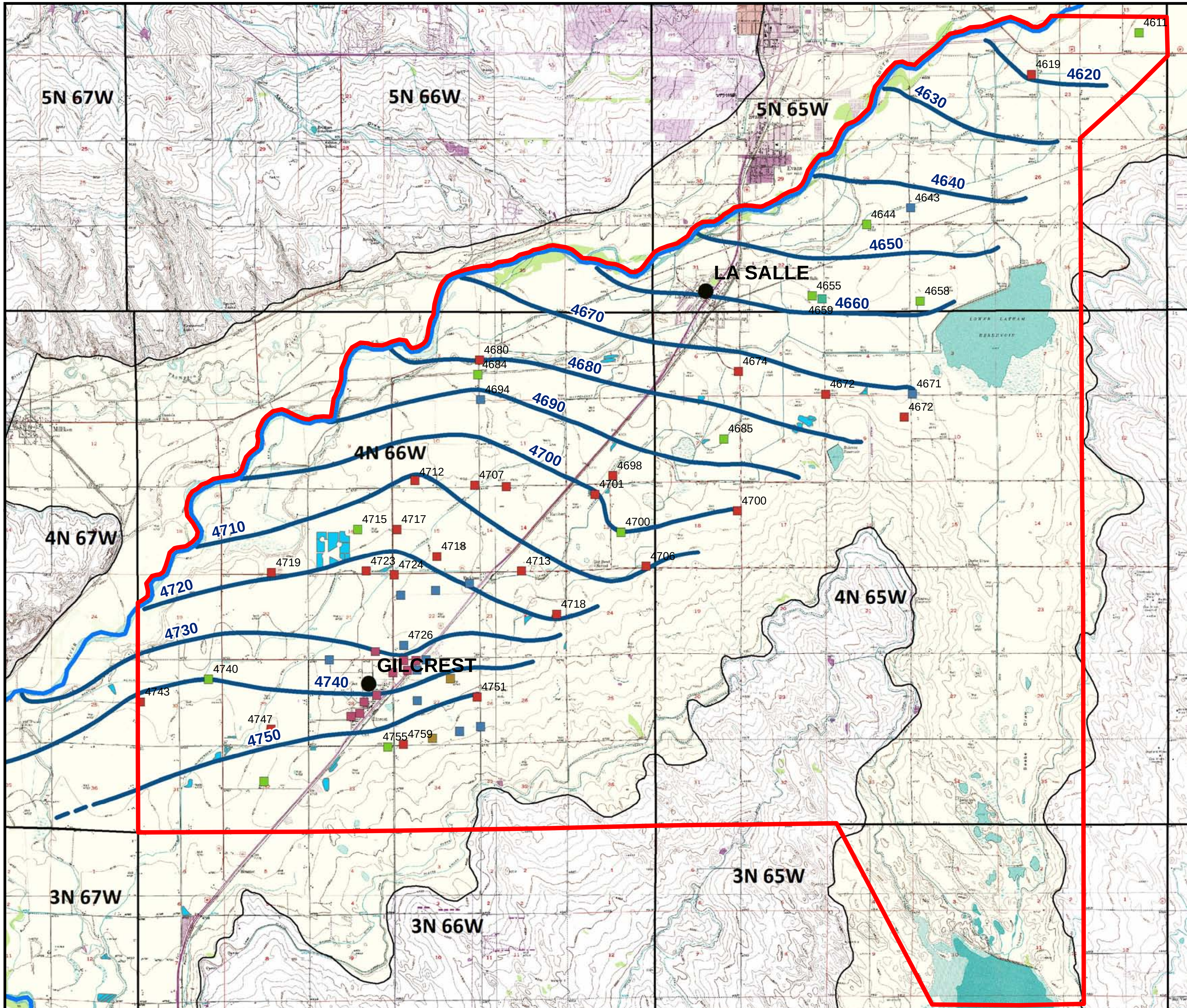
- CCWCD
- CDA
- CSU
- DWR
- Gilcrest
- USGS

CCWCD: Central Colorado Water Conservancy District
CDA: Colorado Department of Agriculture
CSU: Colorado State University
DWR: Colorado Division of Water Resources
Gilcrest: Town of Gilcrest
USGS: United States Geological Survey

0 0.5 1 2 Miles

N

Figure TM2017-1
Groundwater Level Monitoring Wells



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report 2017 Addendum

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- Recharge Ponds
- South Platte River
- Cities

Wells Used for Contours 2015-2017

- CCWCD
- CDA
- CSU
- DWR
- Gilcrest
- USGS
- GW contour (ft) 2015 Spring

Wells without an adjacent groundwater elevation either did not exist or have data at the time of the measuring event.

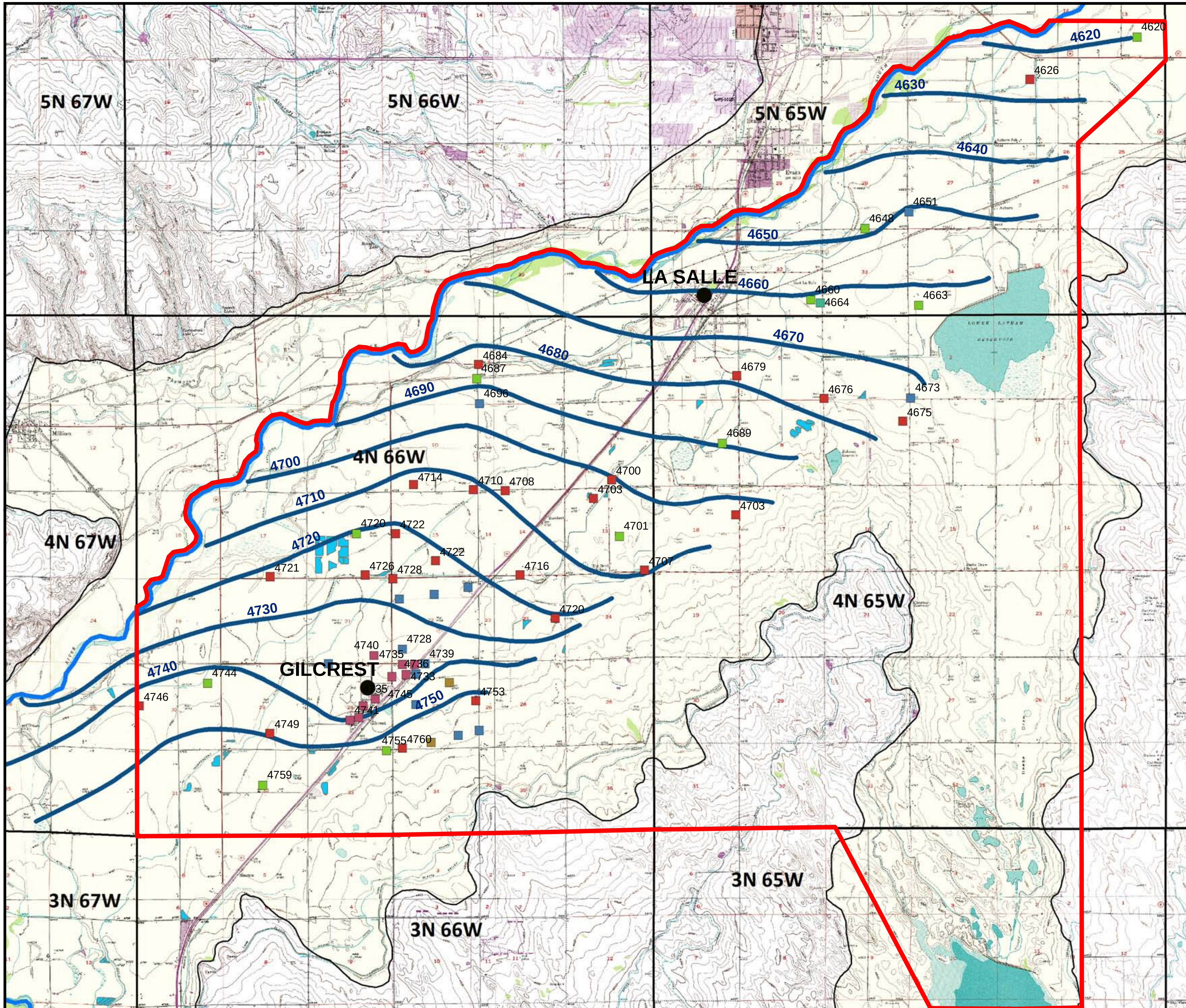
CCWCD: Central Colorado Water Conservancy District
CDA: Colorado Department of Agriculture
CSU: Colorado State University
DWR: Colorado Division of Water Resources
Gilcrest: Town of Gilcrest
USGS: United States Geological Survey

0 0.5 1 2 Miles

N

Figure TM2017-2
Groundwater Elevation Contour Map
2015 Spring

Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report 2017 Addendum



Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- Recharge Ponds
- South Platte River
- Cities

Wells Used for Contours 2015-2017

- CCWCD
- CDA
- CSU
- DWR
- Gilcrest
- USGS
- GW contour (ft) 2015 Fall

Wells without an adjacent groundwater elevation either did not exist or have data at the time of the measuring event.

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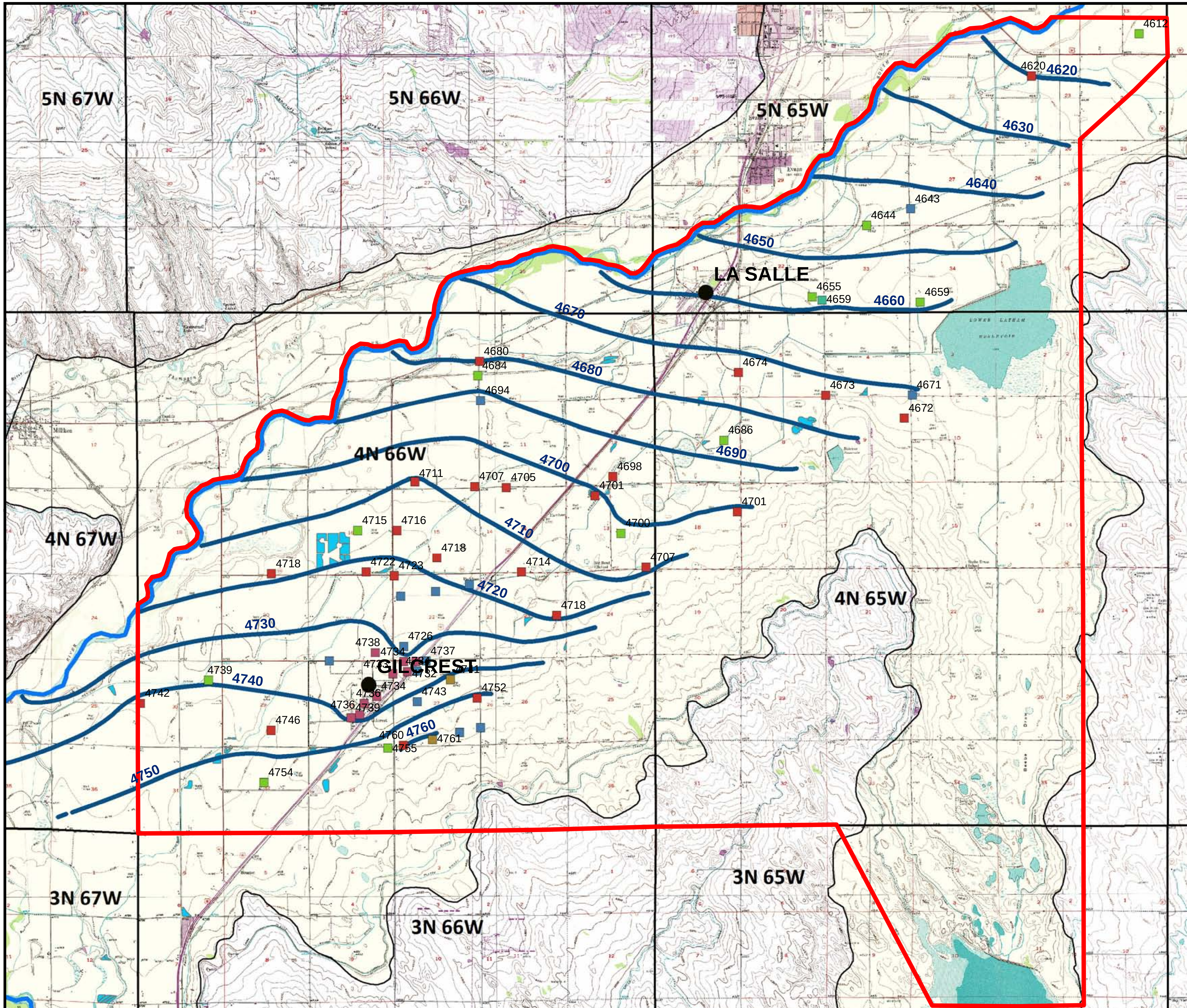
Gilcrest: Town of Gilcrest
USGS: United States Geological Survey

0 0.5 1 2 Miles

N

Figure TM2017-3
Groundwater Elevation Contour Map
2015 Fall



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report 2017 Addendum

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- Recharge Ponds
- South Platte River
- Cities

Wells Used for Contours 2015-2017

- CCWCD
- CDA
- CSU
- DWR
- Gilcrest
- USGS
- GW Contour (ft) 2016 Spring

Wells without an adjacent groundwater elevation either did not exist or have data at the time of the measuring event.

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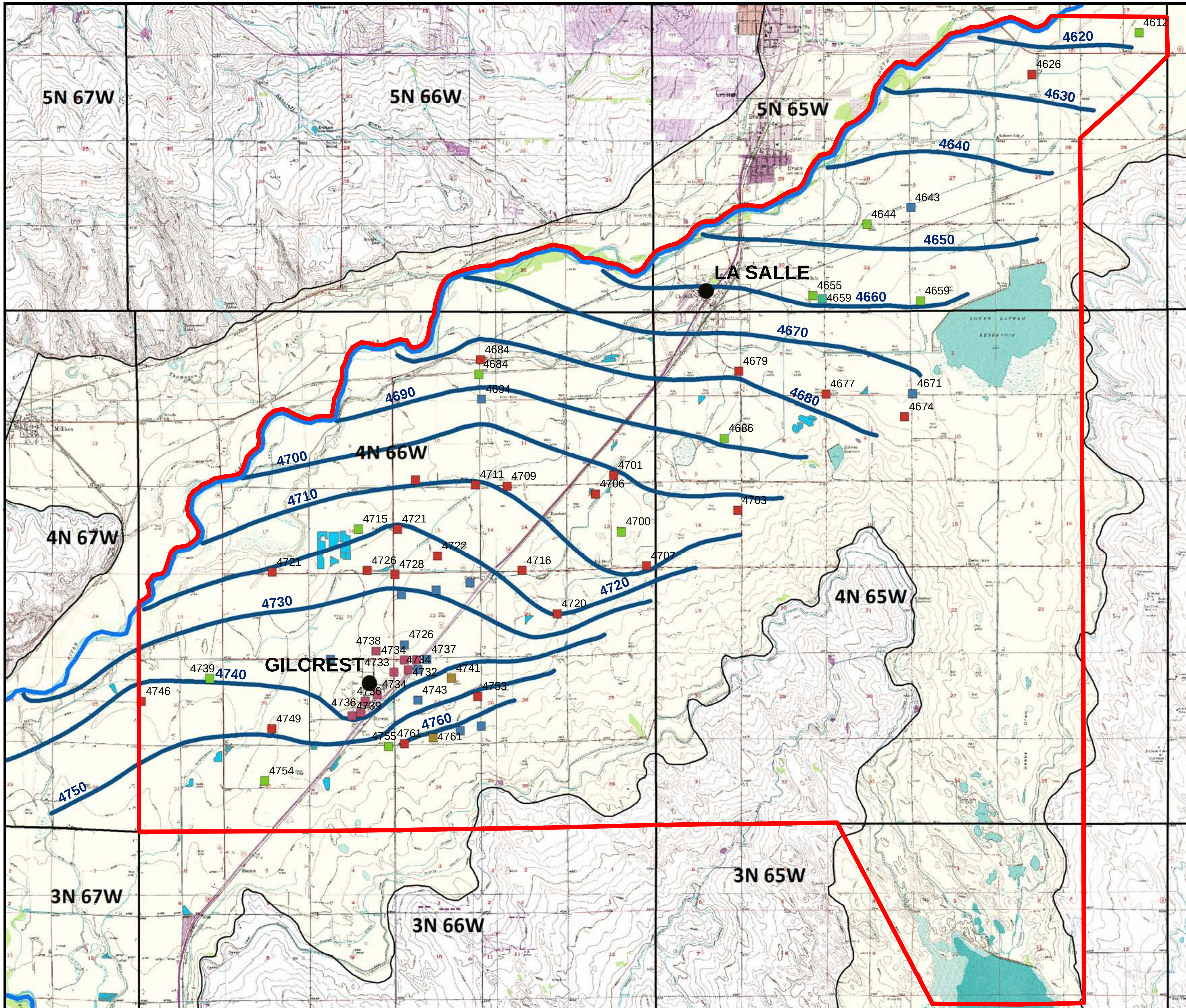
0 0.5 1 2 Miles

N

Figure TM2017-4
Groundwater Elevation Contour Map
2016 Spring



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report 2017 Addendum

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- Recharge Ponds
- South Platte River
- Cities

Wells Used for Contours 2015-2017

- CCWCD
- CDA
- CSU
- DWR
- Gilcrest
- USGS
- GW Contour (ft) 2016 Fall

Wells without an adjacent groundwater elevation either did not exist or have data at the time of the measuring event.

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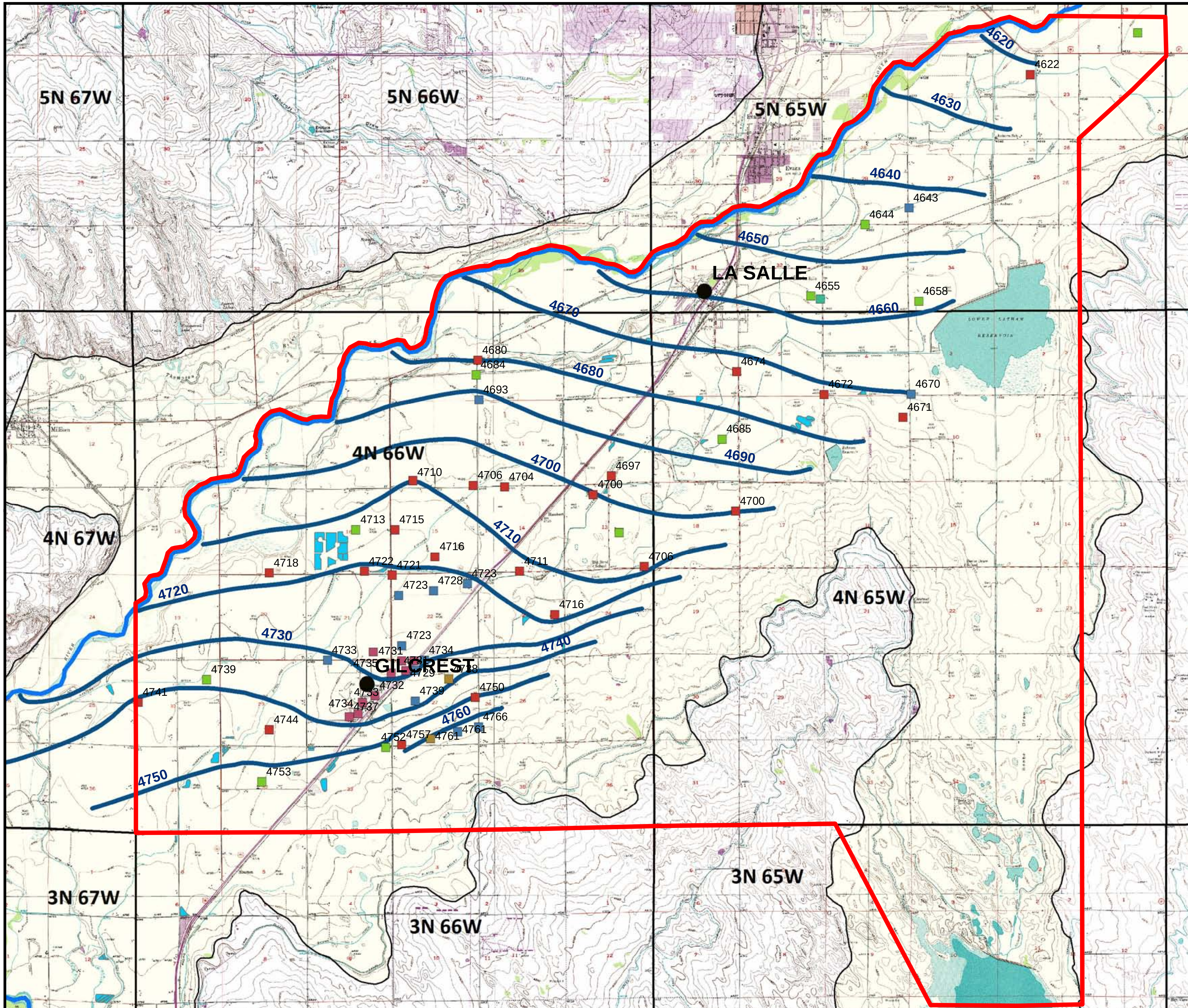
0 0.5 1 2 Miles

N

Figure TM2017-5
Groundwater Elevation Contour Map 2016 Fall



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report 2017 Addendum

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- Recharge Ponds
- South Platte River
- Cities

Wells Used for Contours 2015-2017

- CCWCD
- CDA
- CSU
- DWR
- Gilcrest
- USGS
- GW Contour (ft) 2017 Spring

Wells without an adjacent groundwater elevation either did not exist or have data at the time of the measuring event.

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CDA: Colorado Department of Agriculture
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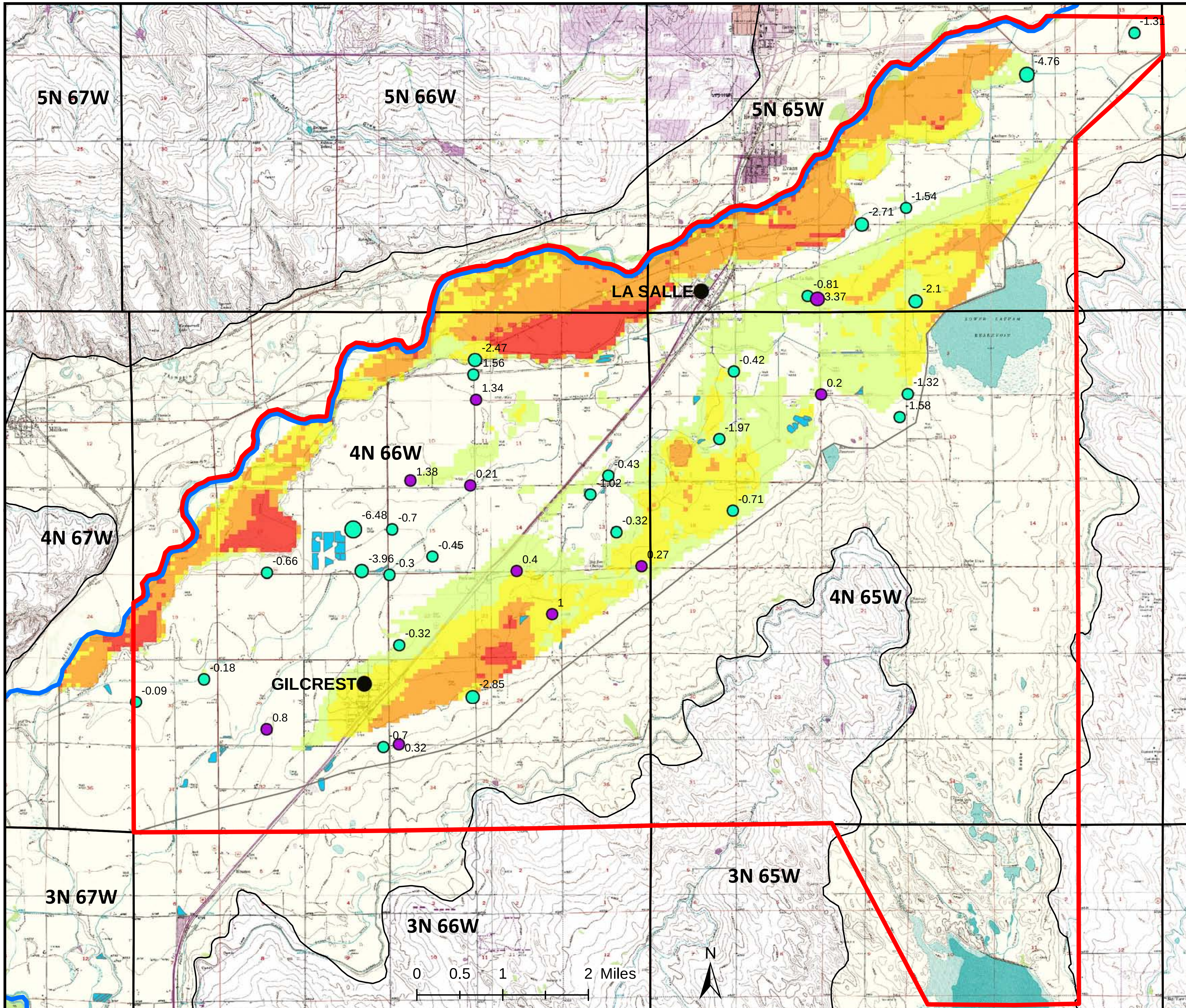
DWR: Colorado Division of Water Resources
Gilcrest: Town of Gilcrest
USGS: United States Geological Survey

0 0.5 1 2 Miles

N

Figure TM2017-6
Groundwater Elevation Contour Map
2017 Spring



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report Addendum

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- Max Data Area For Raster Creation
- Recharge Ponds
- Cities

Groundwater Depth

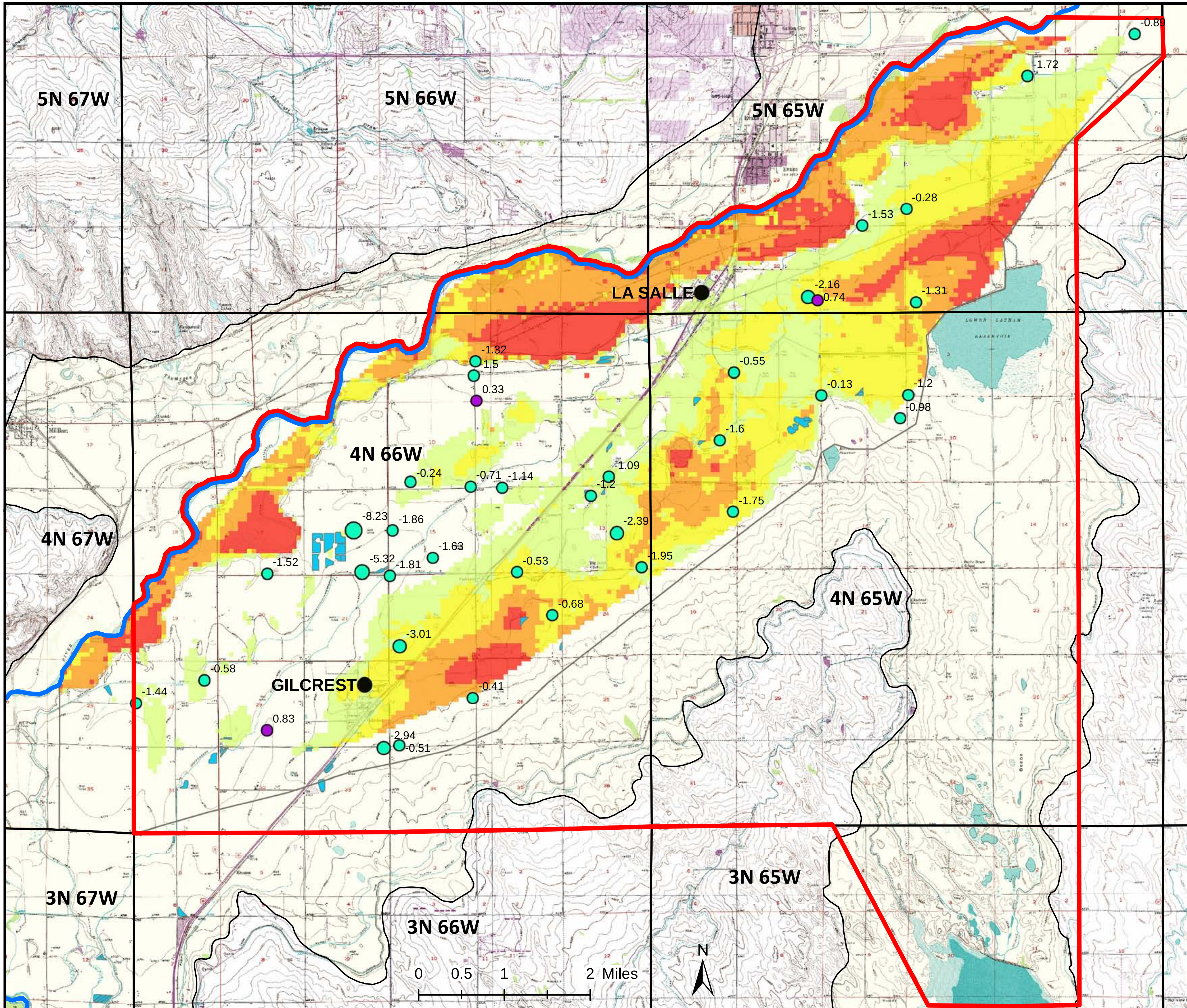
(below ground surface)

- < 0.5 ft
- 0.5 - 5 ft
- 5 - 10 ft
- 10 - 15 ft
- > 15 ft

Spring 2014-2015 Water Level Changes

Rising Levels in Wells	Falling Levels in Wells
0 - 2 ft	-2 to 0 ft
2 - 4 ft	-4 to -2 ft
	-6 to -4 ft
	> -6 ft

Figure TM2017-7
Groundwater Depth Map
2015 Spring
With 2014 to 2015 Change



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report Addendum

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- Max Data Area For Raster Creation
- Recharge Ponds
- Cities

Groundwater Depth

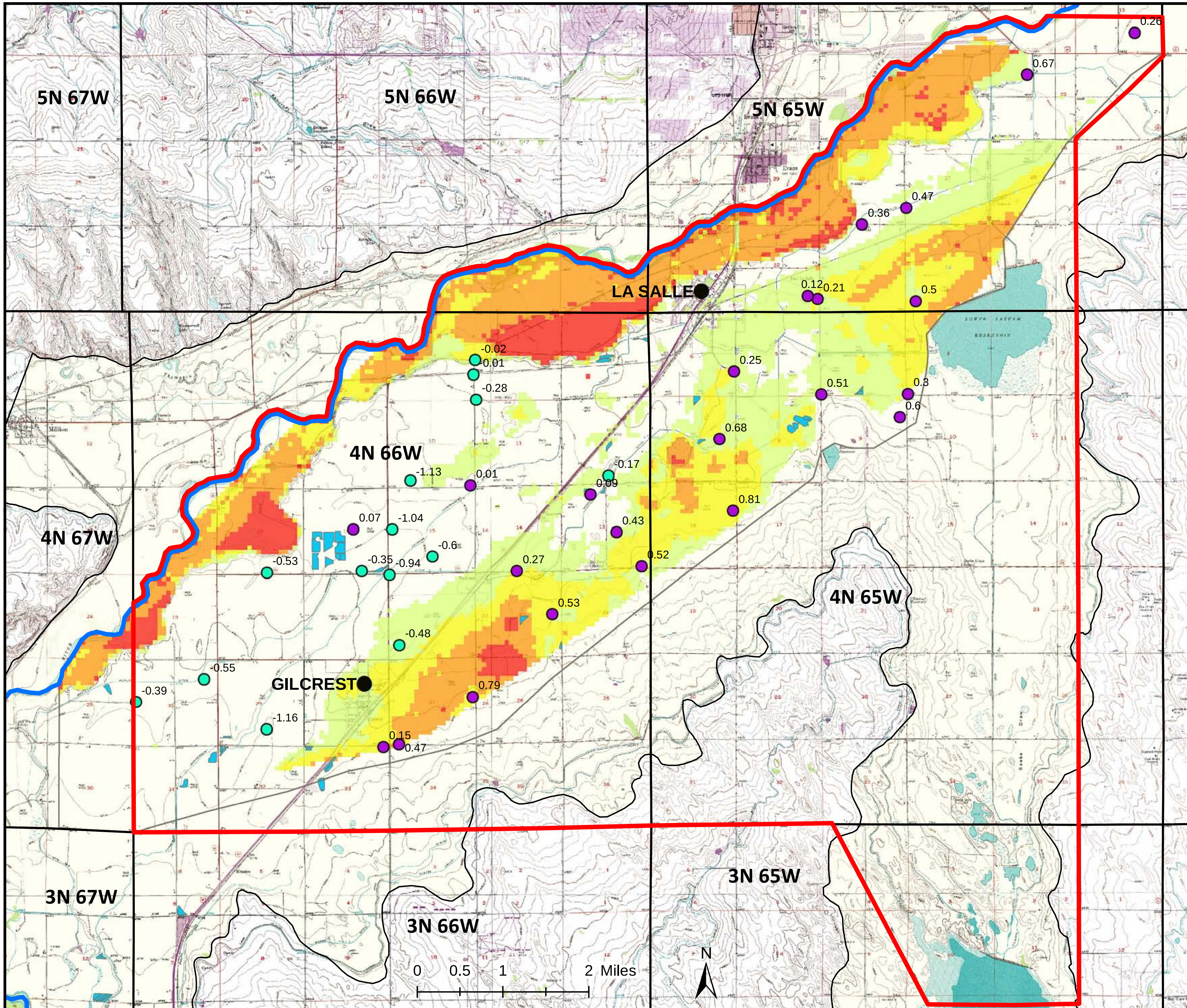
(below ground surface)

- < 0.5 ft
- 0.5 - 5 ft
- 5 - 10 ft
- 10 - 15 ft
- > 15 ft

Fall 2014-2015 Water Level Changes

Rising Levels in Wells	Falling Levels in Wells
0 - 2 ft	-2 to 0 ft
2 - 4 ft	-4 to -2 ft
	-6 to -4 ft
	> -6 ft

Figure TM2017-8
Groundwater Depth Map
2015 Fall
With 2014 to 2015 Change



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report Addendum

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- Max Data Area For Raster Creation
- Recharge Ponds
- Cities

Groundwater Depth

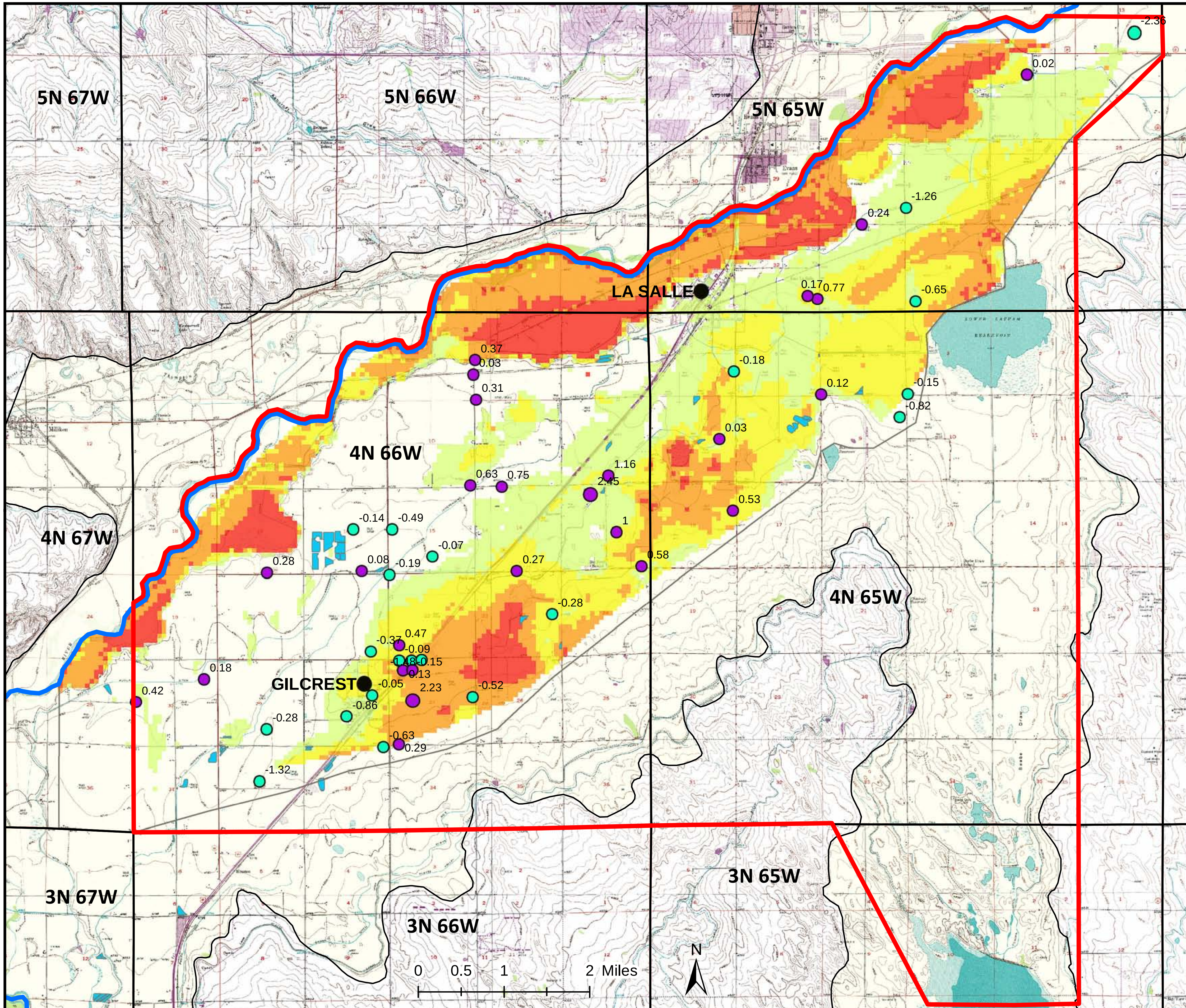
(below ground surface)

- < 0.5 ft
- 0.5 - 5 ft
- 5 - 10 ft
- 10 - 15 ft
- > 15 ft

Spring 2015-2016 Water Level Changes

Rising Levels in Wells	Falling Levels in Wells
0 - 2 ft	-2 to 0 ft
2 - 4 ft	- 4 to -2 ft
	-6 to -4 ft
	> -6 ft

Figure TM2017-9
Groundwater Depth Map
2016 Spring
With 2015 to 2016 Change



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report Addendum

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- Max Data Area For Raster Creation
- Recharge Ponds
- Cities

Groundwater Depth

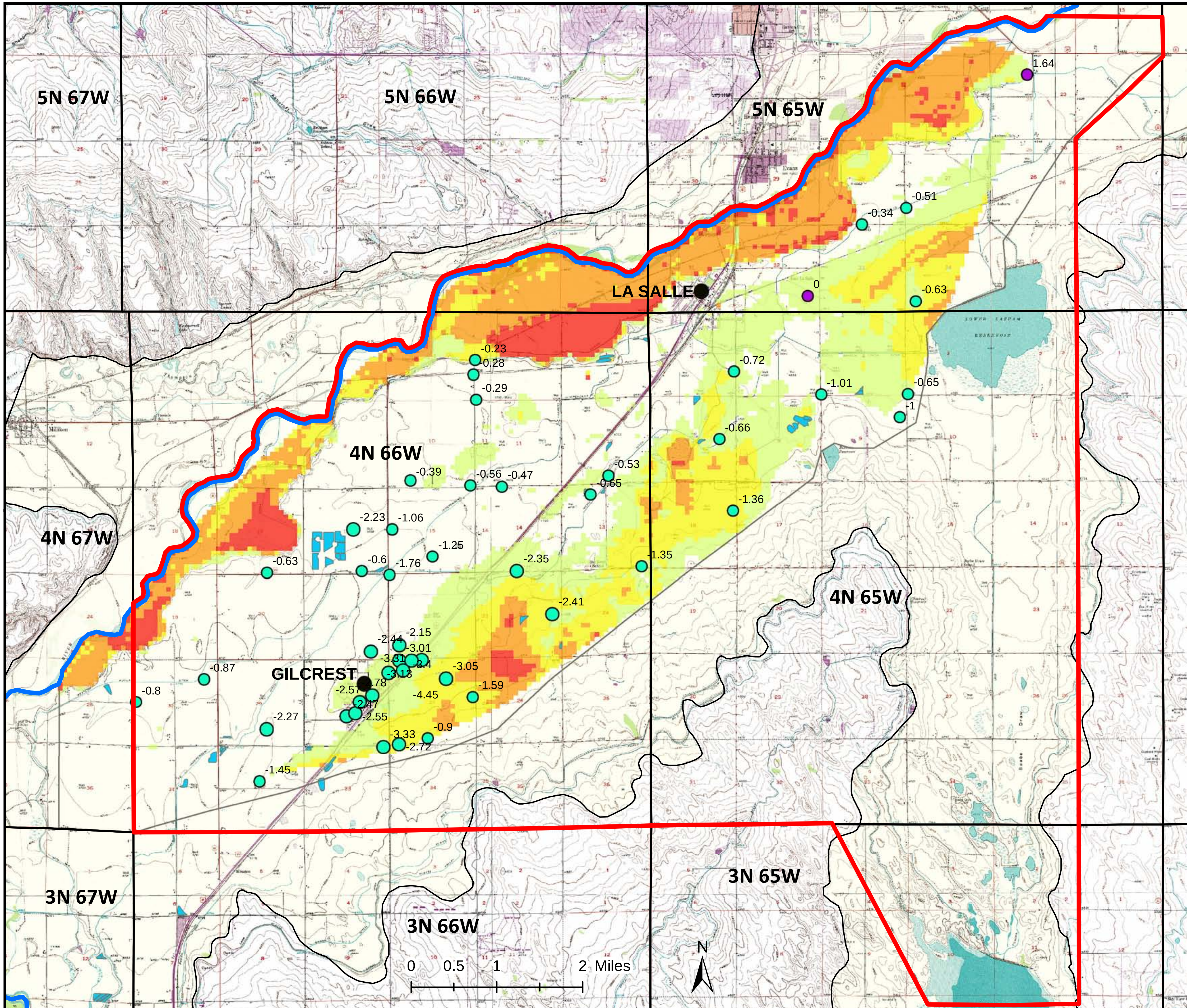
(below ground surface)

- < 0.5 ft
- 0.5 - 5 ft
- 5 - 10 ft
- 10 - 15 ft
- > 15 ft

Fall 2015-2016 Water Level Changes

Rising Levels in Wells	Falling Levels in Wells
0 - 2 ft	-2 to 0 ft
2 - 4 ft	-4 to -2 ft
	-6 to -4 ft
	> -6 ft

Figure TM2017-10
Groundwater Depth Map
2016 Fall
With 2015 to 2016 Change



Gilcrest/LaSalle Pilot Project Hydrogeologic Characterization Report Addendum

Legend

- Study Area Boundary
- CGS Revised Alluvial Aquifer Extent
- Max Data Area For Raster Creation
- Recharge Ponds
- Cities

Groundwater Depth

(below ground surface)

- < 0.5 ft
- 0.5 - 5 ft
- 5 - 10 ft
- 10 - 15 ft
- > 15 ft

Spring 2016-2017 Water Level Changes

Rising Levels in Wells	Falling Levels in Wells
0 - 2 ft	-2 to 0 ft
2 - 4 ft	-4 to -2 ft
	-6 to -4 ft
	> -6 ft

Figure TM2017-11
Groundwater Depth Map
2017 Spring
With 2016 to 2017 Change