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Technical Memorandum

To
Joseph DeMorett, Water Supply Manager
Madison Water Utility
119 East Olin Avenue
Madison, WI 53713

Subject
Casing Extension Assessment
Element 1: Feasibility Check
Unit Well 15
3900 East Washington Avenue, Madison, Wisconsin
AECOM Project No. 60263461

From

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Date
August 6, 2012

This memorandum describes our assessment of the feasibility of extending the Unit Well 15 casing through the Eau Claire Shale to determine whether casing extension would be a reliable alternative to treatment for reducing or eliminating tetrachloroethylene (PCE) concentrations in groundwater pumped from Unit Well 15.

Location and Background Information

Unit Well 15 is located at 3900 East Washington Avenue in the northeastern part of the City of Madison. The site is in the SW¼, SE¼ of the SW¼, of Section 28, Township 8 North, Range 10 East, Dane County, Wisconsin. The location of Unit Well 15 and other water system facilities in the City of Madison are illustrated on Figure 1.

Unit Well 15 was drilled in 1965. The well is pumped year-round and serves the "East Washington corridor including Westchester Gardens, Mayfair Park, Bluff Acres, Carpenter-Ridgeway, Ellen Park, and Emerson East neighborhoods. Well 15 also serves the High Crossing area located east of Interstate 90/94" (MWU, 2011).

Volatile organic compounds (VOCs), including PCE, trichloroethylene (TCE), and 1,1,1-trichloroethane (1,1,1-TCA) have been detected in Unit Well 15 since the early 1990s. PCE concentrations in the well have generally increased from below 1 microgram per liter (µg/L) in the early 1990s to 3 to 4 µg/L between 2008 and 2011. The maximum contaminant level established by the United States Environmental Protection Agency for PCE is 5 µg/L. The concentrations of TCE and 1,1,1-TCA have been detected below their respective MCLs, and concentrations have generally decreased or stabilized since 1996.

UNIT WELL 15

The formation log prepared by the Wisconsin Geological & Natural History Survey (WGNHS) indicates that Unit Well 15 was drilled to a depth of 753 feet. A test hole (WGNHS Log DN-916) was drilled at a location 10 feet southeast of Well 15 and was drilled to a depth of 785 feet (WGNHS Log DN-930). Unit Well 15 is cased with 24-inch diameter casing, which is grouted to a depth of 172 feet. Unit Well 15 is open to the lower bedrock (Mount Simon Formation) aquifer and the upper bedrock (Wonewoc Formation) aquifer. Unit Well 15 was televised on May 5, 2009, and the depth of Well 15 at that time was 687 feet. Fill has sloughed into the well and filled the bottom 66 feet of the borehole.

Sandstone is the uppermost bedrock. The test hole log (WGNHS Log DN-916) indicates that sandstone was encountered at a depth of 115 feet. The 2010 version of WGNHS Log DN-930 for Well 15 indicates that unlithified (drift) extends to a depth of 123 feet.

Unit Well 15 was initially test pumped at a rate 2,400 gallons per minute (gpm) and there was 94 feet of drawdown, resulting in a specific capacity of 25.5 gallons per minute per foot (gpm/ft) of drawdown. At the time of construction (November 1965) the static water level in Unit Well 15 was approximately 47 feet below ground. Construction reports and formation logs prepared by the WGNHS for Well 15 (WGNHS Log DN-930) and the test well (WGNHS Log DN-916) are contained in Appendix A.

HYDROGEOLOGIC CONDITIONS

Topography and Drainage

The natural ground surface at Unit Well 15 is glacial till (Clayton and Attig, 1997). The topography at Unit Well 15 is low relief hills that are sloping toward the west, southwest, and south. Small southwest-northeast trending drumlins cross the area 1 to 1.5 miles southwest, south, and southeast of Unit Well 15. There are no surface waters in the immediate vicinity of Unit Well 15, but there is a small intermittent drainage stream located 2,000 feet east of Unit Well 15 that flows south and then southwest and eventually discharges to Lake Monona. The ground surface elevation at Unit Well 15 is approximately 886 feet above mean sea level (MSL). Drainage is southwesterly toward Lake Monona.

Geology

The area was glaciated by the Green Bay Lobe during the last part of the Wisconsin Glaciation. The rocks and unlithified deposits in the area range from Precambrian basement rocks to recent soils. The bedrock from oldest to youngest includes Precambrian rock, and Cambrian age sandstone, shale and dolomite.

A geological cross-section through former Unit Well 3 (WGNHS Log DN-50), Town of Burke Test Well 2 (WGNHS Log DN-113), Unit Well 15 (WGNHS Log DN-930), Town of Burke Test Hole (WGNHS Log DN-143), Test Hole 15 (WGNHS Log DN-847) and Town of Burke Municipal Well (WGNHS Log DN-1100) is presented in Figure 2. Formation logs for strata encountered in Unit Well 15 and Test Hole 15 (WGNHS Log DN916) are in Appendix A. The line of cross-section is illustrated in Figure 3. The stratigraphic sequence encountered in the wells is briefly described in the following.

Precambrian Basement Bedrock

Precambrian bedrock was not encountered in Unit Well 15, but was encountered in former City of Madison Unit Well 3 and the Town of Burke Municipal Well. At former Unit Well 3 the formation is described as felsite. At the Town of Burke Municipal Well the formation is described as shale and schist.

Cambrian Bedrock

Cambrian age rocks encountered in Unit Well 15 include, in ascending order, Mount Simon Formation, Eau Claire Formation, and the Wonewoc Formation. These formations form the Elk Mound Group.

Cambrian age rocks are relatively flat lying in the Madison area in the east-west direction and dip slightly toward the south. The cross-section illustrates relatively flat lying formation in the southwest to northeast direction, other than at the Town of Burke Municipal Well where the formation flexes upward. The flexure may be the result of an inaccurate surface elevation at the well. The thicknesses of deep rock units are relatively consistent in the Madison area. The thicknesses of the shallow bedrock units vary because they are the upper erosional surfaces. For example, the Tunnel City Group strata are missing at Unit Well 15, but are present in other nearby wells.

A buried bedrock valley is illustrated on Figure 2. The preglacial buried bedrock valley was eroded through the Upper Cambrian age bedrock formations and extends into the upper part of the Mount Simon Formation. The location of the buried bedrock valley is illustrated on Figures 4 and 5.

A green-gray shale and sandy, dolomitic shale layer is laterally extensive beneath the majority of the City of Madison, but is absent at some locations, such as in the buried valleys illustrated on Figures 4 and 5. The shale occurs in the upper part of the Eau Claire Formation. The shale is thickest in the western, southern, and southeastern parts of the City, and thins toward the northeast. The formation log for the Well 15 Test Hole indicates that scattered, thin, inter bedded shale layers were encountered in sandstone over the interval of 225 to 390 feet. A prominent shale layer is not described in the Unit Well 15 formation log.

The WGNHS classified the rock in Unit Well 15 from 225 to 250 feet depth as the Eau Claire Formation. The WGNHS provided shape files for the Eau Claire Shale unit. The estimated top and bottom elevations for the shale layer are illustrated in Figures 4 and 5 and indicate that the shale layer occurs over the interval of approximately 242.5 to 246 feet depth. On the basis of the elevations the shale layer is approximately 3.5 feet thick at Unit Well 15.

A gamma log for Unit Well 15 (included in Appendix B), indicates a distinctive shaley unit over the interval of approximately 239 to 247 feet depth. A video record of Unit Well 15 shows thin shale pieces resting on enlarged bedding plane surfaces at depths of approximately 242, 246, 251.5, 257.5, and 260 feet.

Unlithified Deposits

Bedrock is mantled by unlithified glacial till. Clayton and Attig (1997) classify the local near surface unlithified deposits in the immediate vicinity of Unit Well 15 as part of the Horicon Member of the Holy Hill Formation. Clayton and Attig (1997) report that the near surface formation at Unit Well 15 is uniform subglacial till.

The WGNHS described the unlithified formation from the ground surface to a depth of 115 feet as light yellow, medium to coarse-grained sand, with a trace of fine sand and dolomitic gravel.

The soil at the Unit Well 15 is classified as the Dodge silt loam (DnB) (2 to 6 percent slopes). The Dodge silt loam is deep, well drained, and moderately sloping on glaciated uplands. The sandy loam substratum has a permeability of 2 to 6.3 inches per hour (in/hr), and the overlying silt/sandy/clay loam has a permeability of 0.63 to 2 in/hr (USDA, 1978). Other nearby soils are the Dresden silt loam (DsB), Ringwood silt loam (RnB), and the St. Charles silt loam (ScB). These silt loams have permeabilities of 0.63 to 2 in/hr (USDA, 1978).

The DnB, DsB, RnB, and ScB have good contaminant attenuation potential (DCRPC, 1999). The DCRPC assigned a risk classification of moderate to high from surface activities in the Unit Well 15 area on the basis of several factors including soil properties (DCRPC, 1999).

Hydrogeology

In the study area, groundwater occurs within the lower bedrock aquifer, the upper bedrock aquifer, and the unlithified (sand and gravel) aquifer. The unlithified aquifer is thin, is not laterally extensive and is not used for water supply in the Well 15 area. Unit Well 15 is open to both the upper and lower bedrock aquifers. Following is a brief discussion about the aquifers:

Lower Bedrock Aquifer

The lower bedrock aquifer occurs in the Mount Simon Formation and lower part of the Eau Claire Formation. The Precambrian bedrock is the base of the lower bedrock aquifer and the shaley layer in the Eau Claire Formation is the upper confining unit. Water occurs within horizontal and vertical fractures, along enlarged bedding planes, in solution enlarged cavernous areas, and between sand grains in the aquifer. The saturated thickness of the lower bedrock aquifer is estimated to be 500 feet thick at Unit Well 15. The Unit Well 15 borehole has fill from 687 feet to the bottom of the well (753 feet), so the open saturated thickness is approximately 444 feet. The hydraulic conductivity of the lower bedrock aquifer is approximately 10 feet per day (ft/day) (Krohelski et. al., 2000). Unit Well 15 is cased to a depth of 172 feet, which is 70 feet above the Eau Claire shale confining layer; therefore, Unit Well 15 is also open to a large portion of the upper bedrock aquifer.

Water levels measured in Unit Well 15 should be representative of the composite upper and lower bedrock aquifers. At the time of construction in 1965, the static water level in Unit Well 15 was about 47 feet below ground level (approximately 839 feet above MSL). On May 5, 2009, at the time of televising Unit Well 15 the static water level in the well was approximately 43 feet below ground level (45 feet below the top of casing) (approximately 843 feet MSL). Figure 6 illustrates the simulated potentiometric surface in the lower bedrock (Mount Simon) aquifer (DCRPC, 2004). Unit Well 15 is located near the pumping center and the groundwater flow direction toward Unit Well 15 is from radially around the well, with long-term flow from the northwest, northeast and east. Figure 6 illustrates the potentiometric surface elevation in the vicinity of Unit Well 15 at approximately 840 feet above MSL.

Upper Bedrock Aquifer

The upper bedrock aquifer occurs in the upper part of the Eau Claire Formation above the shaley layer and within the Wonewoc Formation and Tunnel City Group strata (where present). Water occurs within fractures, along enlarged bedding planes, and between sand grains in the sandstone.

At Unit Well 15, the thickness of the bedrock formation above the shaley layer is 116 feet and the saturated thickness of the upper bedrock aquifer is also 116 feet. Figure 7 (DCRPC, 2004) illustrates the simulated potentiometric (water table) surface in the upper bedrock aquifer and unlithified (sand and gravel) aquifer. The elevation of the static water level in Unit Well 15 is assumed to be the elevation of the potentiometric surface (approximately 840 feet above MSL) in the combined upper bedrock aquifer and lower bedrock aquifer. Figure 7 illustrates the elevation of the simulated potentiometric surface in the upper bedrock aquifer (water table) at Unit Well 15 in 2000 was slightly less than 860 feet above MSL indicating a vertically downward hydraulic gradient.

Unlithified Aquifer

The potentiometric surface occurs at an elevation of about 843 feet above MSL (2009), which is within the unlithified formation at Unit Well 15. The unlithified formation above the upper bedrock is medium grained sand with some gravel and the upper bedrock surface is sandstone, and therefore the unlithified aquifer and the upper bedrock aquifer are likely rapidly hydraulically connected. The hydraulic gradient between the unlithified aquifer and the upper bedrock aquifer is vertically downward.

At Unit Well 15, groundwater flow in the unlithified aquifer is southwesterly toward Lakes Mendota and Monona. Surface elevations of Lakes Mendota and Monona are approximately 849 and 845 feet above MSL, respectively.

Groundwater Flow System

Average annual precipitation in the City of Madison area is approximately 30 to 30.5 inches per year (Cline, 1965; Cotter et. al., 1969). Cline (1965) estimated that the amount of recharge to the groundwater reservoir in the Upper Yahara River basin was approximately 6 inches/year (in/yr). Swanson (1996) estimated that the recharge rate in Dane County ranges from 0.3 to 6.7 in/yr and has an average value of 2.6 in/yr. Precipitation infiltrates through the till layer, and recharges the unlithified and shallow bedrock aquifers. In some areas, a small percentage of water moves downward from the upper bedrock aquifer through the Eau Claire confining layer and into the lower bedrock aquifer. Figure 8 illustrates the location of Unit Well 15 and areas of recharge to and discharge from the lower bedrock (Mount Simon) aquifer (Bradbury et. al, 1999; DCRPC, 2004). Unit Well 15 is located near a recharge area. Discharge from the unlithified and shallow bedrock aquifers is to pumping wells and/or to surface waters (lakes, streams, and wetlands). Discharge from the lower bedrock aquifer is primarily to pumping wells.

Unit Well 15 Capture Zones

Unit Well 15 capture zones and the approximate location of the edge of the Eau Claire Shale along the eastern side of the buried bedrock valley (west of Unit Well 15) are illustrated on Figure 9. Note that two zones of contribution (ZOC) for 5- and 50-year time-of-travel (TOT) capture zones are illustrated on Figure 9. The most extensive 50-year TOT ZOC was delineated by assuming a 100 percent design capacity pumping rate of 3 million gallons per day (MGD), which is very conservatively large. The less extensive 50-year TOT ZOC was estimated by assuming a 50-percent design capacity pumping rate of 1.5 MGD, and is more representative of the historical pumping of Unit Well 15.

On the basis of groundwater flow modeling results (Unit Well 15 capture zones) and the estimated location of the buried bedrock valley, groundwater flow from the buried bedrock valley is not captured by Unit Well 15 within a 50-year TOT period. On the basis of available data, the Eau Claire Shale is laterally extensive across the areas delineated for both 50-year TOT ZOCs and where present, has the potential to be an effective barrier to vertical flow of groundwater between the Upper Bedrock Aquifer and the Lower Bedrock Aquifer.

Video Record Review

Unit Well 15 was televised on May 5, 2009. All measurements reported in the video are referenced to the top of the well casing. Descending and ascending views of the borehole were provided. Depths varied depending on the direction of logging. A summary of depths for various features for descending and ascending views are provided in Table 1.

Table 1
Summary of Depths
Madison Unit Well 15 Televising 05 May 2009

Feature	Horizontal View Descending Depth[1] (Feet)	Horizontal View Ascending Depth[1] (Feet)
Bottom of Steel Well Casing	173.5	170.4
Bedding Plane with Shale Pieces Sitting on Ledge	244.1	241.3
Bedding Plane with Shale Pieces Sitting on Ledge	353.7	351.2
Bottom of Well	687	687

[1] Reference is top of well casing (May 2009)

An illustration of the features observed from the bottom of the well casing to a depth of 430 feet is illustrated on Figure 10. The figure shows the interval evaluated for the casing extension. Depths indicated on Figure 10 descriptions are referenced to ascending borehole views plus 1.5 feet unless otherwise indicated (“down” view). As previously mentioned, gamma logging of Unit Well 15, indicates a distinctive shaley unit over the interval of approximately 239 to 247 feet depth. This correlates with video observations of thin shale pieces resting on enlarged bedding plane surfaces at depths of approximately 242 and 246 feet, and is interpreted by the WGNHS as the Eau Claire Shale layer. Other ledges with shale pieces resting on them were observed at approximately 251.5, 257.5, and 260 feet depth.

A few vertical fractures were observed at depths of approximately 180, 247.5, 257.5, 277, 283 to 286, 295, 305, 346 to 350, 359 to 365, 383, 390, and 415 feet. In the video view the fractures are short segments (2 to 6 feet length) that range from hairline to enlarged (1/2 to 2 inches) sizes.

Below 430 feet depth the video record shows vertical fractures (enlarged in places) extending from 591 to the bottom of the well at 687 feet. Single and double fractures extend through the borehole as evidenced by fractures in opposite sides of the borehole walls. An enlarged bedding plane is at 638 feet, and very large open areas (cavernous-like) extend from approximately 648 to the bottom of the well.

Assuming the original drilled depth of Unit Well 15 is 753 feet, there was 66 feet of fill in the well on May 5, 2009.

WELL PLUMBNESS AND ALIGNMENT

The digital version of the WGNHS Log No. DN-930 for Unit Well 15 indicates that an alignment test was performed in the well to a depth of 329 feet. The WGNHS was contacted about the alignment log and provided the test record to AECOM. A copy of the alignment test data is contained in Appendix C. The alignment test was performed on July 13, 1965. The diameter of the hang point and the height of the hang point are not reported, therefore the validity of the analysis results are uncertain. The diameter of Unit Well 15 is 24 inches to 172 feet, and 22-inches to 753 feet. The alignment test record indicates that the casing was not grouted at the time of the test.

Figures in Appendix C illustrate the plumbness and alignment of the ungrouted casing assuming a hang point of 25 feet, which is the standard when performing plumbness and alignment testing according to the AWWA method. If a hang-point less than 25 feet was used, the amount of deflection will be greater than calculated using a 25 foot hang point.

On the basis of the available data and the analysis using an assumed hang point, the plumbness and alignment of the casing and borehole tested to a depth of 329 feet may not conform to the AWWA standard. This is uncertain because not all of the testing variables (such as the hang point) are known.

The inside diameter of the casing is 23-inch (I.D.), and the diameter of the lower borehole is 22-inch. Figures in Appendix C showing the east-west and north-south planes illustrate that a 12-inch diameter column pipe and pump bowl fit comfortably in the casing and borehole to the depth tested. Also, use of the well for the past 47 years has demonstrated that a pump and discharge column pipe have fit in the 24-inch O.D. (23-inch I.D.) casing without any deflection or unusual wear.

Lining the borehole will require that a 1.5-inch diameter annular space be provided between the liner casing and the existing 23-inch I.D. steel casing and 22-inch diameter open borehole for placement of neat cement. An 18-inch O.D. (17.25-inch I.D.) steel casing will provide the required annular space between the casing and the lower 22-inch diameter borehole.

It is recommended that the plumbness and alignment of the existing well be tested prior to lining Unit Well 15, to ensure that a lineshaft turbine pump and column of the required size will fit in the reconstructed well without deflecting from a straight line, after an 18-inch O.D. liner has been grouted in-place.

FEASIBILITY OF CASING EXTENSION

On the basis of available data it appears that the upper and lower bedrock aquifers should be isolated by placing grouted casing through the Eau Claire Formation and into the upper 10 to 15 feet of the Mount Simon Formation. Shale layers were observed in the Eau Claire Formation and the layers correlate to the gamma logging performed by the WGNHS. The shale layers are thin, but based upon the shape file information about the shale that was provided by the WGNHS; the shale layers are laterally extensive around Unit Well 15 and across the areas delineated for both 50 year TOT ZOCs as illustrated on Figure 9. The shale layers pinch out at a location approximately two miles northeast (upgradient) of Unit Well 15, and are missing in the buried bedrock valleys located west (downgradient and sidegradient) of Unit Well 15. On the basis of available data the shale layers should be effective barriers to vertical flow of groundwater from the Upper Bedrock Aquifer downward into the Lower Bedrock Aquifer. It is assumed that the test hole (WGNHS Log DN-916) that was drilled at a location 10 feet southeast of Well 15 was properly abandoned and will not act as a conduit between the upper and lower bedrock aquifers.

Several enlarged (eroded) bedding planes and aligned secondary porosity features (vugs and porosity channels) are encountered in the Eau Claire Formation interval and in the upper part of the Mount Simon Formation. On the basis of the review of the video record it does not appear that vertical fractures connect the majority of bedding planes and secondary porosity features. It appears that packers placed between enlarged bedding planes could isolate the upper and lower bedrock aquifers in the well. The feasibility of casing extension should be further evaluated by placing inflatable packers in the borehole at depths of 248 and 261 feet. It is assumed that the packers will have a minimum length of 2 feet. The locations of the proposed packers are illustrated on Figure 11. Over the interval of 248 to 250 feet the borehole is slightly rough and is characterized by intergranular porosity and occasional small vugs. Over the interval 261 to 263 feet the borehole is moderately rough texture with patchy scale.

Placing grouted casing to a depth of 263 feet will close-off the productive Wonewoc Formation and significant primary and secondary porosity features in the upper part of the Mount Simon Formation. This will result in a decrease in the specific capacity and efficiency of Unit Well 15. The specific capacity of Unit Well 15 at the time of construction was 25.5 gpm/ft of drawdown. Large secondary porosity features (enlarged vertical fractures, bedding planes and enlarged borehole (cavernous) areas are apparent in the lower bedrock aquifer below the proposed casing extension interval and should be major pathways for supplying significant volumes of water to the well.

STEPS TO FURTHER EVALUATE CASING EXTENSION IN UNIT WELL 15

1. Inform Wisconsin DNR about the planned work in Unit Well 15.

2. Mechanically clean the well by brushing the borehole and casing.

3. Bail the fill out of Unit Well 15 (there was 66 feet of fill in the well on May 5, 2009).

4. Perform a plumbness and alignment test per AWWA standards on the full depth of the well.

5. Run clean potable water into the well (10 gpm) for up to 24 hours to clear the water in the well. Televise the well using a sidewall view to confirm the depths for placement of the packers.

6. Construct and develop monitoring wells near Unit Well 15 completed to depths of 225 and 275 feet for evaluating leakage across the Eau Claire semi-confining layer.

7. Install a test pump, packers, airline, stilling tube, and pressure transducers in the well.

8. Pump the well at 2,000 gpm for a minimum of 36 hours, measure water levels in the Upper and Lower Bedrock aquifers in Unit Well 15 during the pre-, test-pumping, and post-pumping periods, collect water samples. Field analyze water samples for general parameters. Laboratory analyze water samples for Safe Drinking Water Act (SDWA) parameters.

9. Evaluate the effectiveness of the packers seal in Unit Well 15 and the leakage between the Upper Bedrock Aquifer and the Lower Bedrock Aquifer.

10. Determine the specific capacity of the Lower Bedrock Aquifer, sand pumping, and water quality.

11. Remove the test pump, disinfect Unit Well 15.

12. Evaluate the data and determine whether to proceed with grouting a liner casing in Unit Well 15.

AECOM appreciates the opportunity to assist Madison Water Utility with this project. If you have any questions, please contact Joel at (715) 342-3040 or Tom at (715) 342-3031.

Enclosures: Figures 1 through 11
Appendix A – Construction Reports and Formation Logs
Appendix B – Geophysical Logs
Appendix C – Plumbness and Alignment Test Data and Analyses
Appendix D - References

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FIGURES

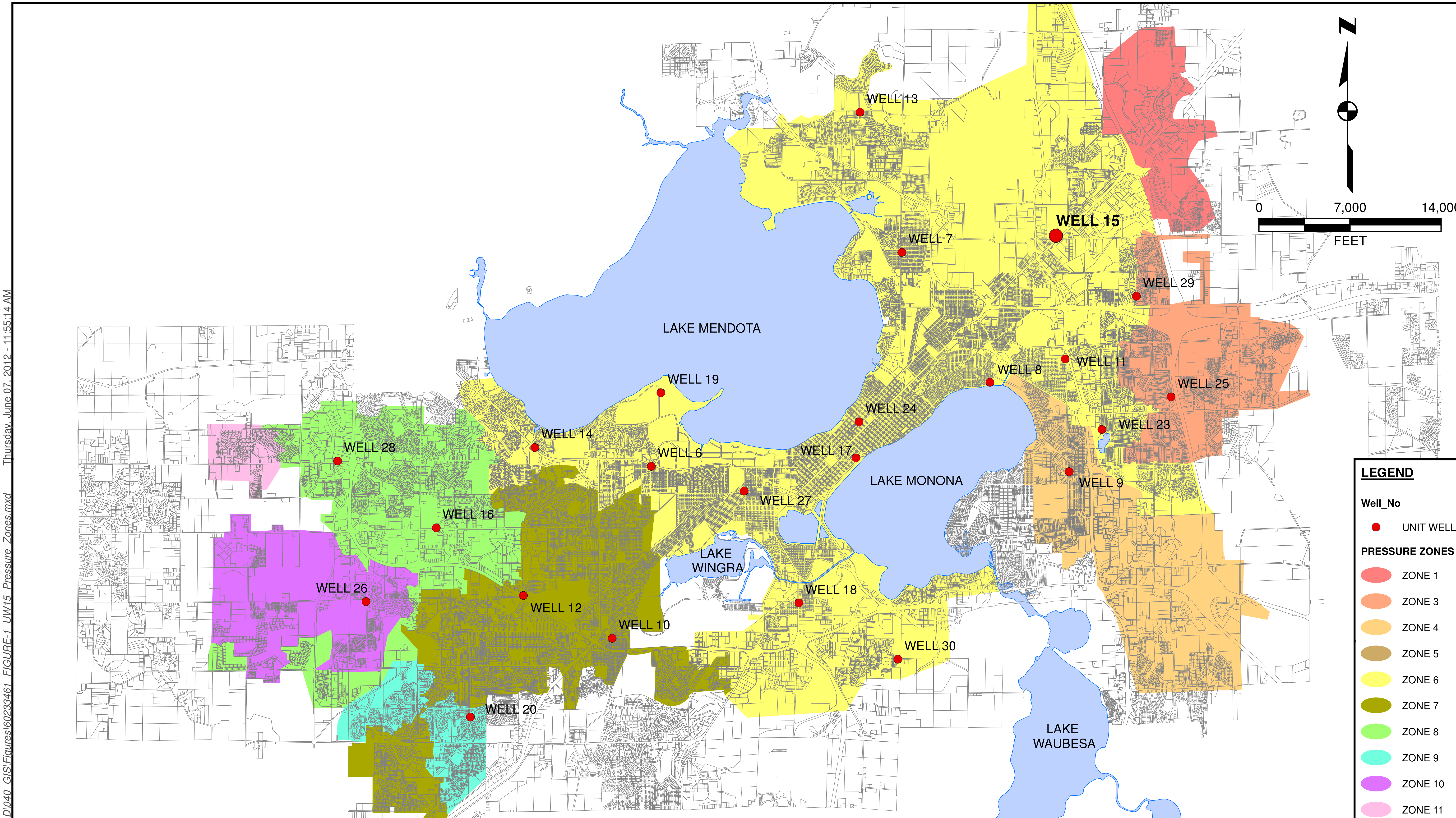
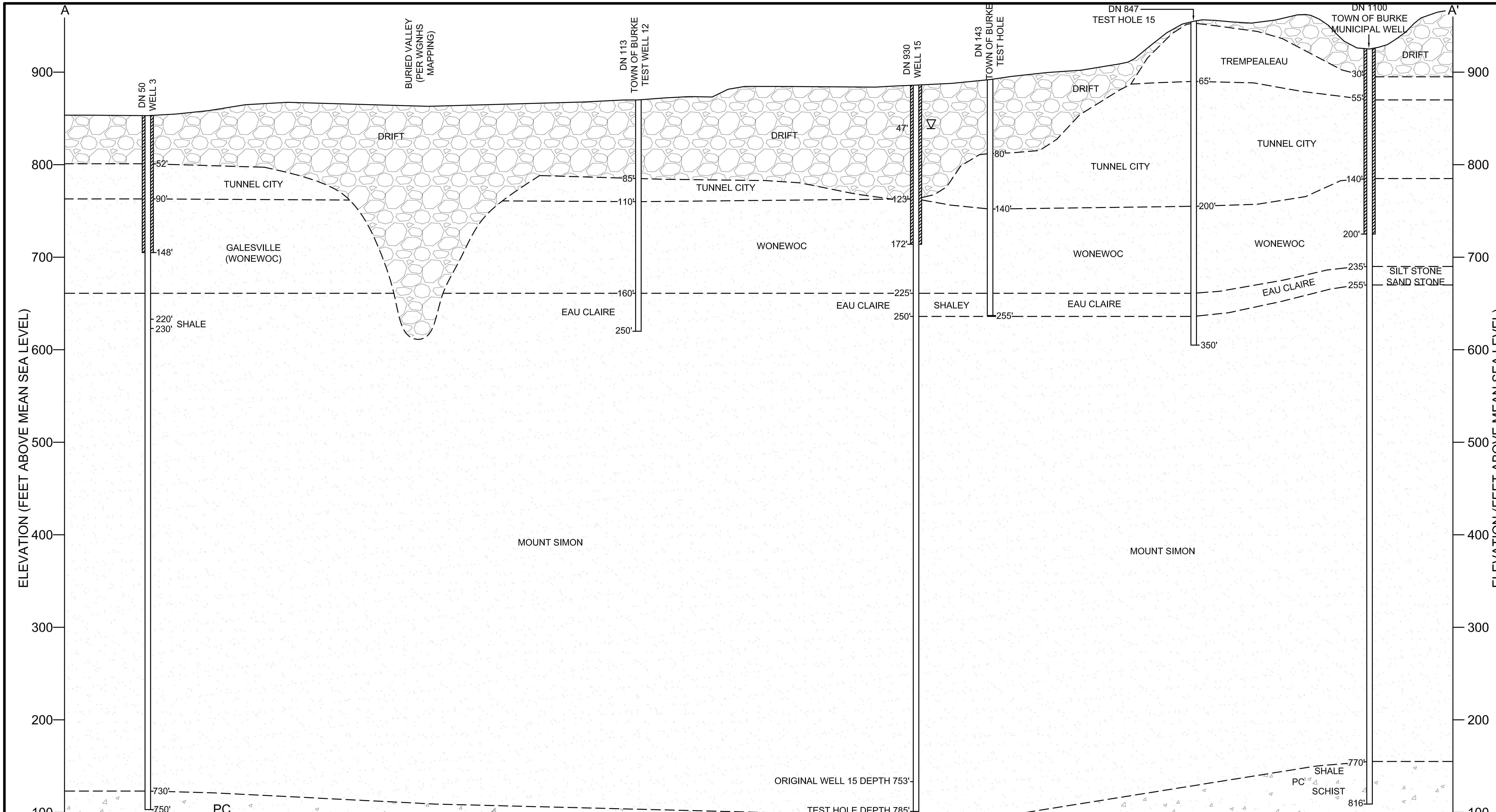


FIGURE 1
LOCATION OF UNIT WELL 15
MADISON WATER UTILITY
MADISON, WISCONSIN

60263461



LEGEND

WELL

WELL CASING

POTENTIOMETRIC SURFACE DEPTH (FEET) (AT TIME OF CONSTRUCTION)

OPEN BOREHOLE

750' WELL DEPTH (FEET)

0' 2,000'

HORIZONTAL SCALE
1" = 2,000'
VERTICAL EXAGGERATION = 20X

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FIGURE 2
GEOLOGIC CROSS-SECTION
THROUGH UNIT WELL 15
MADISON, WISCONSIN

60263461

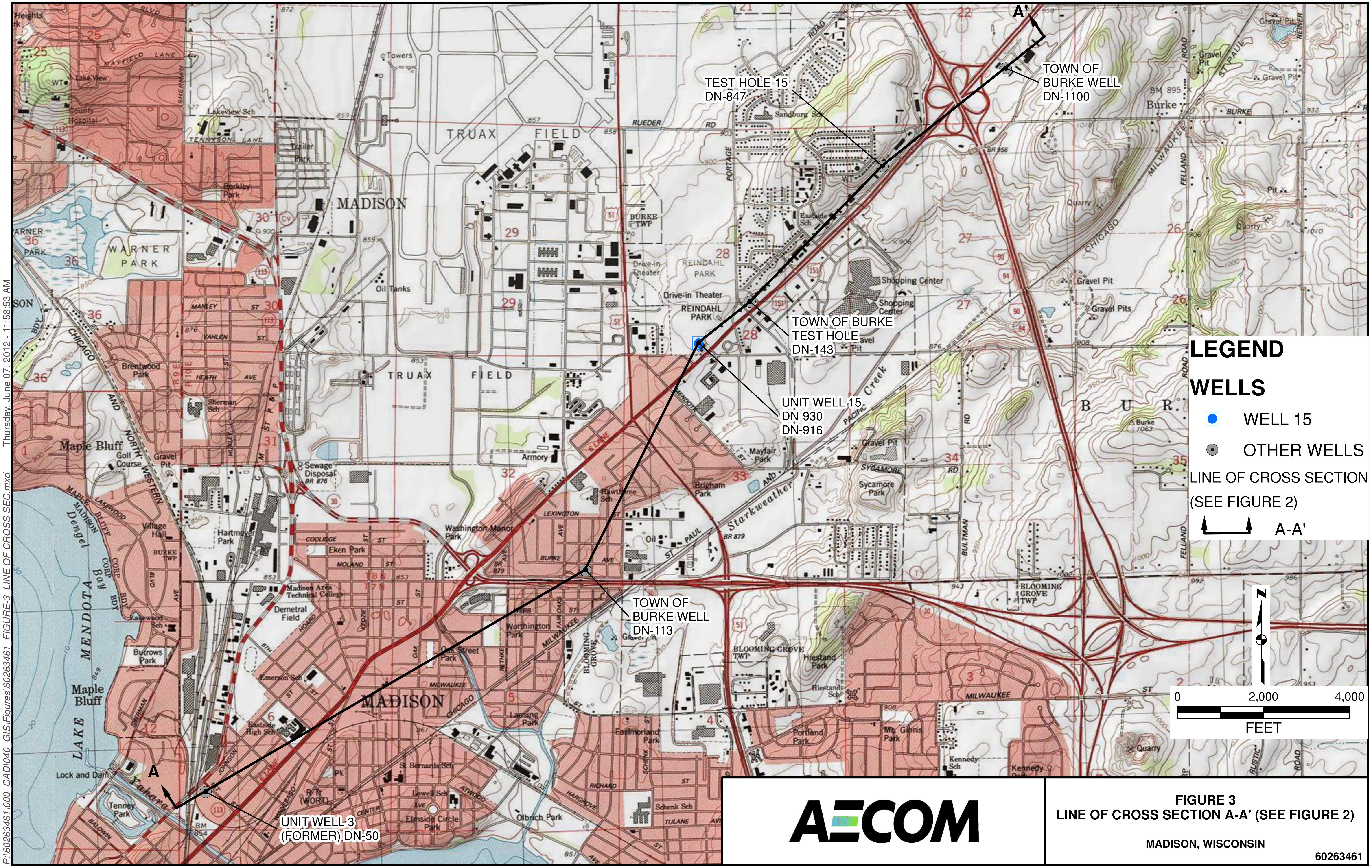

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FIGURE 3
LINE OF CROSS SECTION A-A' (SEE FIGURE 2)

MADISON, WISCONSIN

60263461

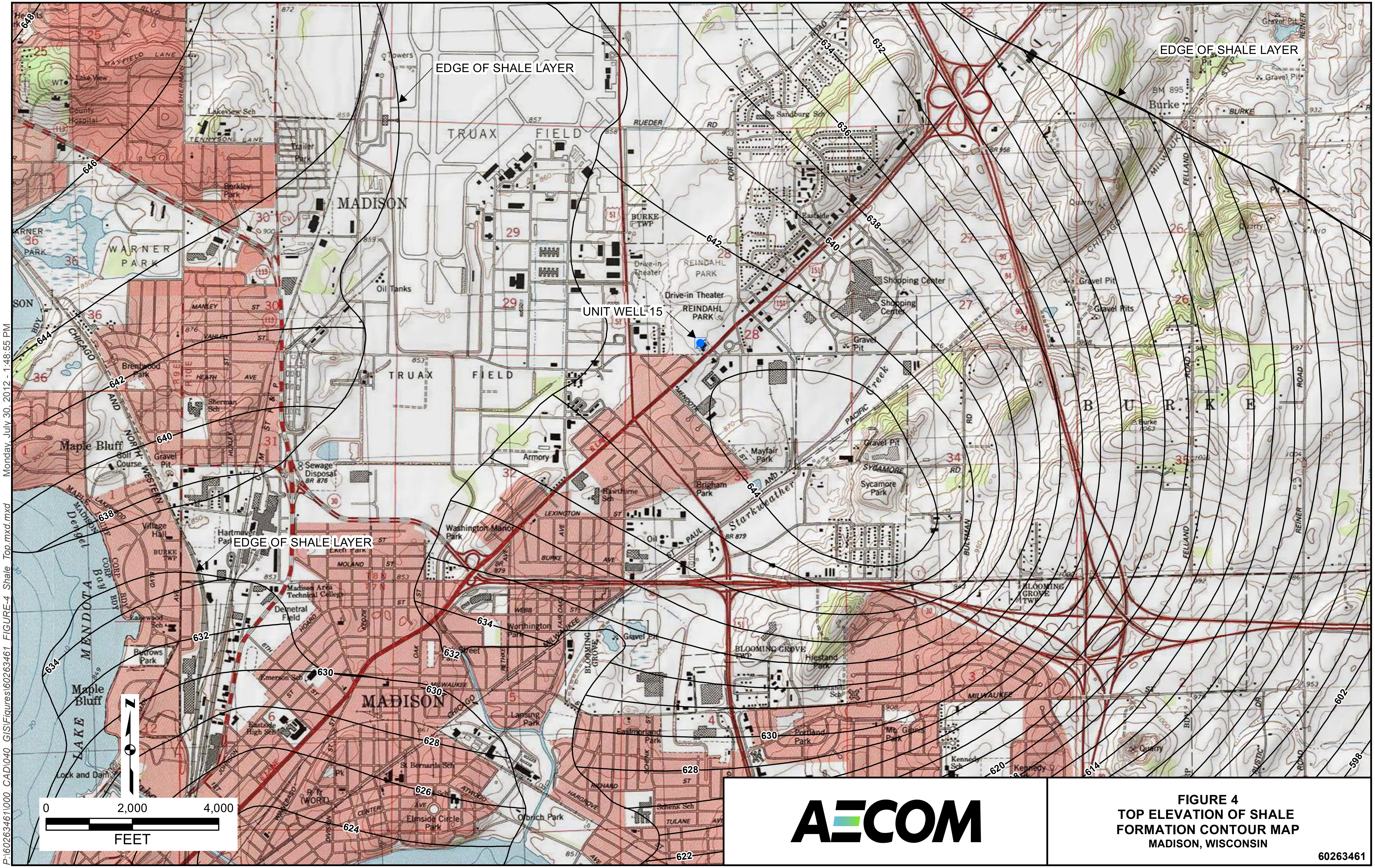

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FIGURE 4
TOP ELEVATION OF SHALE FORMATION CONTOUR MAP
MADISON, WISCONSIN

60263461

P:\60263461\000 CAD\040 GIS\Figures\60263461 FIGURE-4 Shale Top.mxd.mxd Monday, July 30, 2012 - 1:48:55 PM

P:\60263461\000 CADI040 GIS\Figures\60263461 FIGURE-5 Shale Bot.mxd Friday, July 27, 2012 - 9:18:34 AM

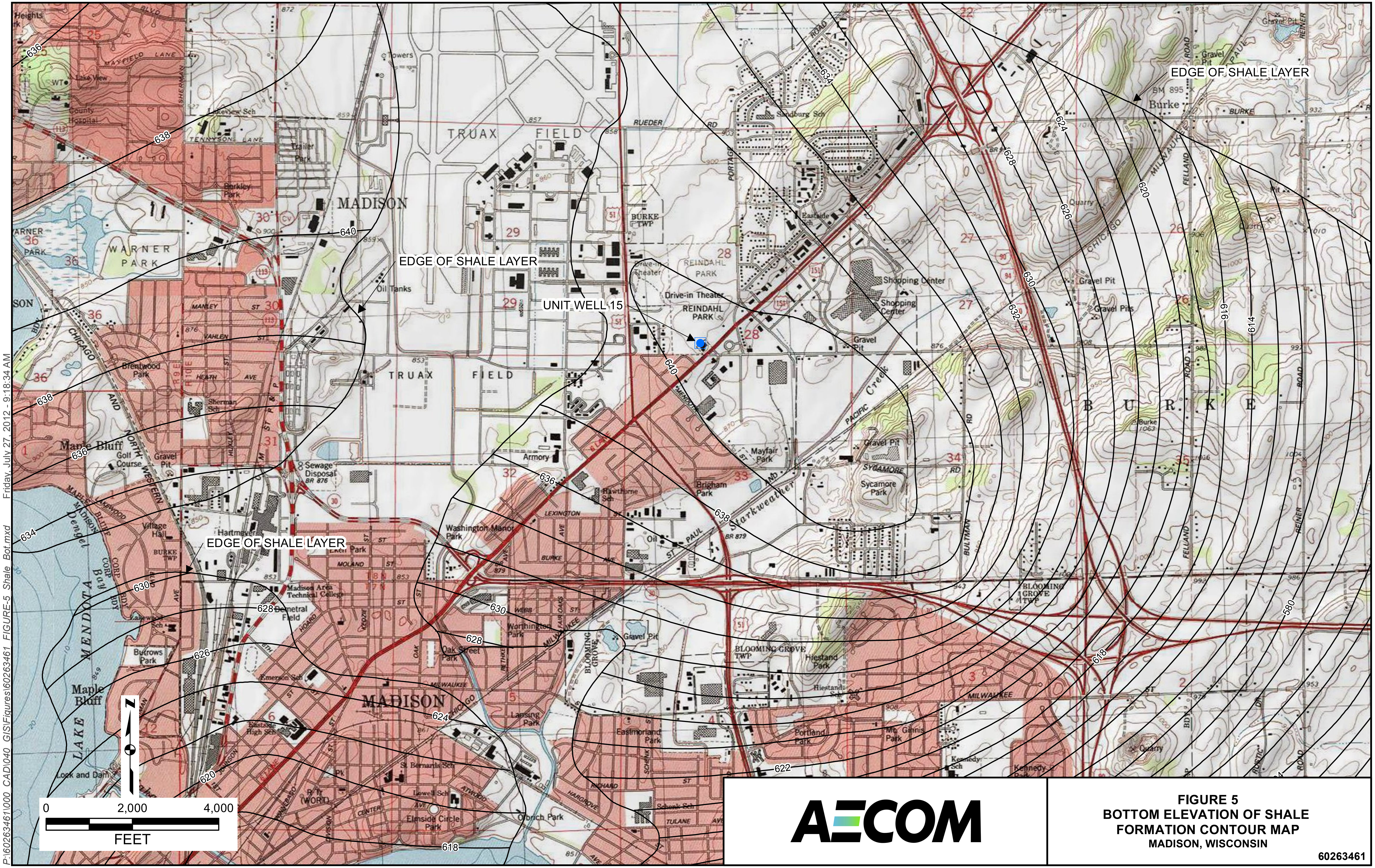

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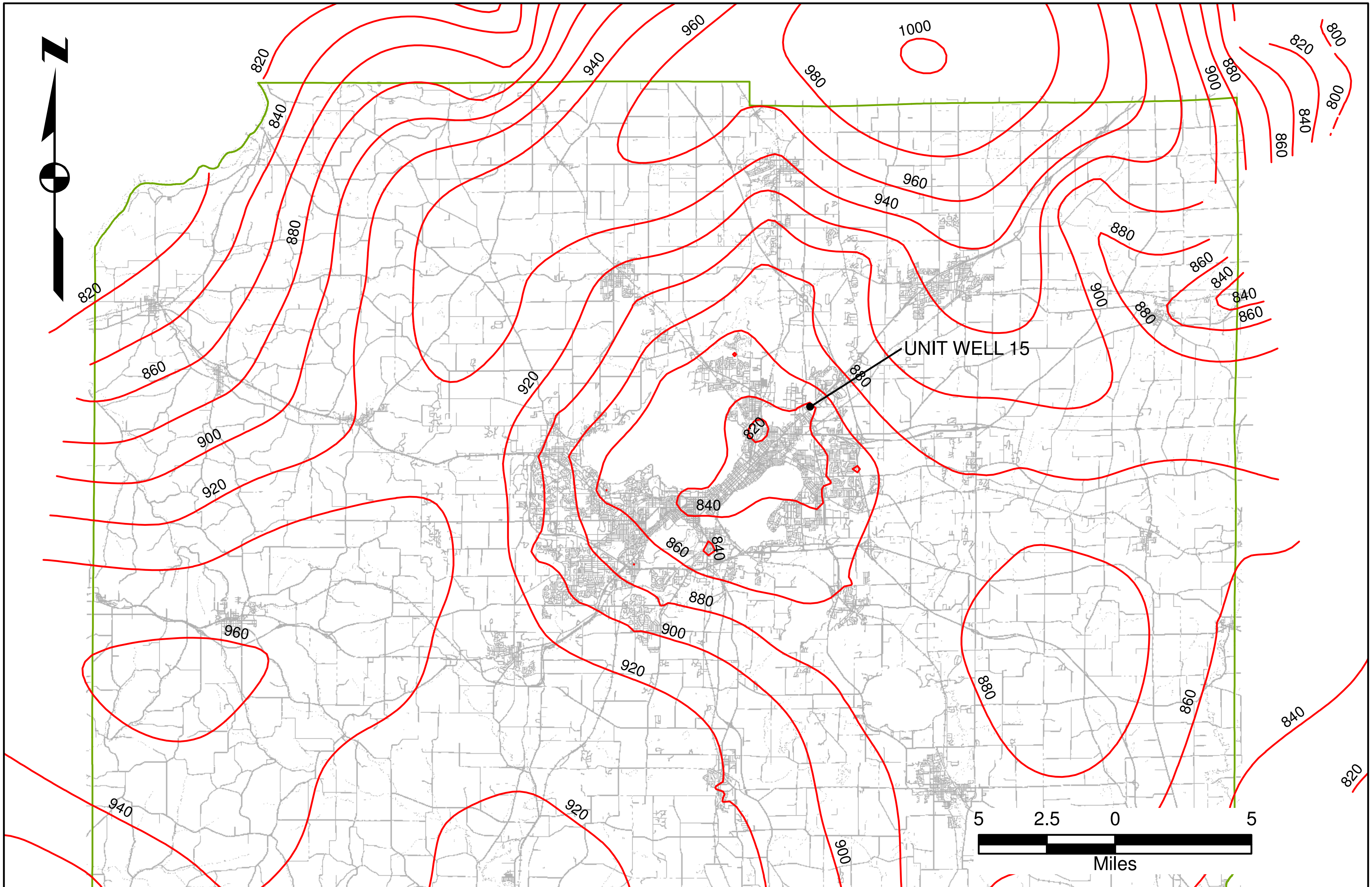
FIGURE 5
BOTTOM ELEVATION OF SHALE FORMATION CONTOUR MAP
MADISON, WISCONSIN

60263461



REFERENCE SOURCE:
DCRPC, 2004

CONTOURS SHOWN = FT
ABOVE MEAN SEA LEVEL

AECOM

FIGURE 6
UNIT WELL 15
SIMULATED 2000 HEADS IN MT. SIMON AQUIFER
MADISON WATER UTILITY
MADISON, WISCONSIN

60263461

P:\60263461\000_CAD\040_GIS\Figures\60263461_FIGURE-7-UW15_WATER-TBL.mxd Thursday, June 07, 2012 - 8:15:55 AM

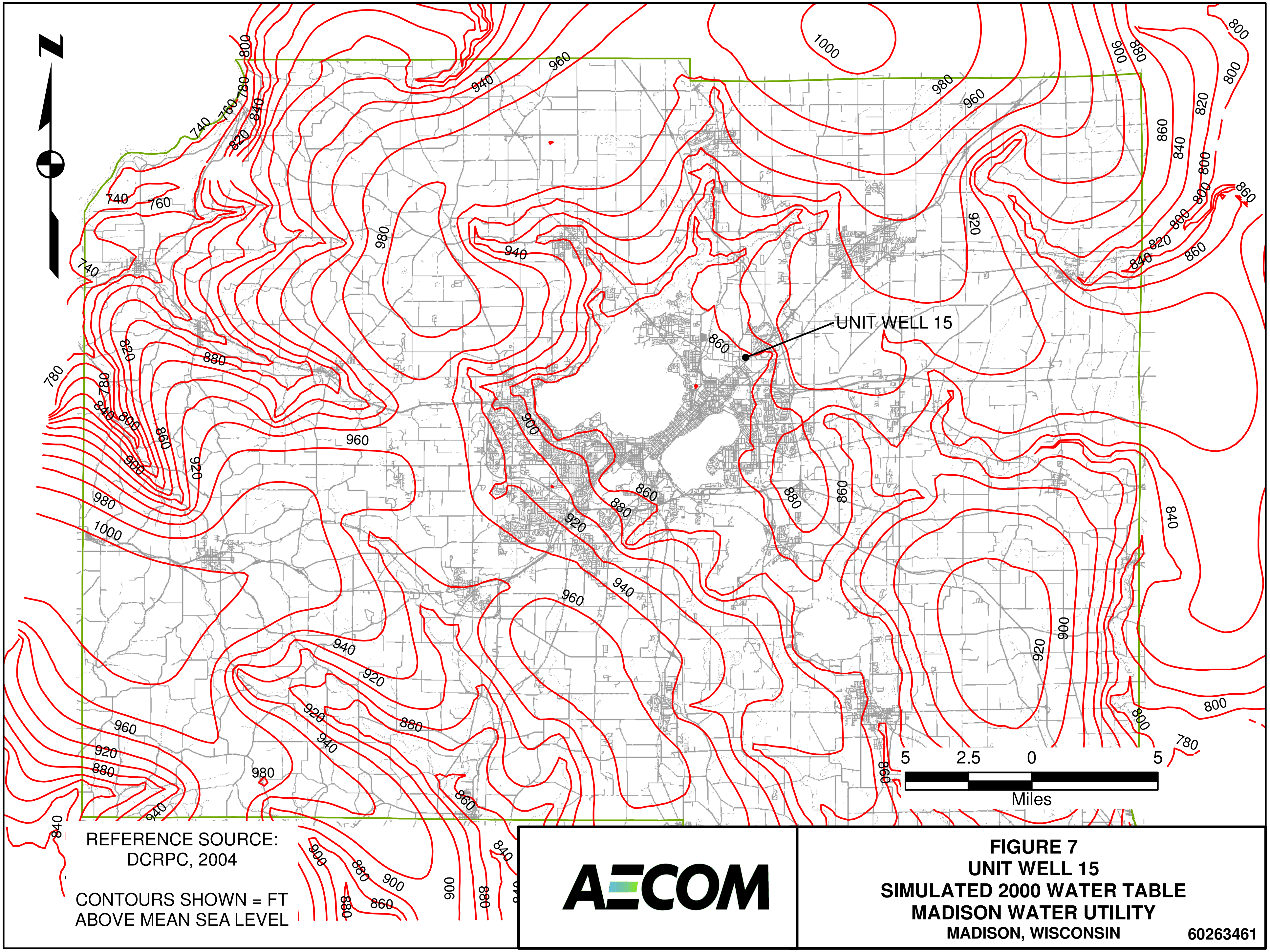
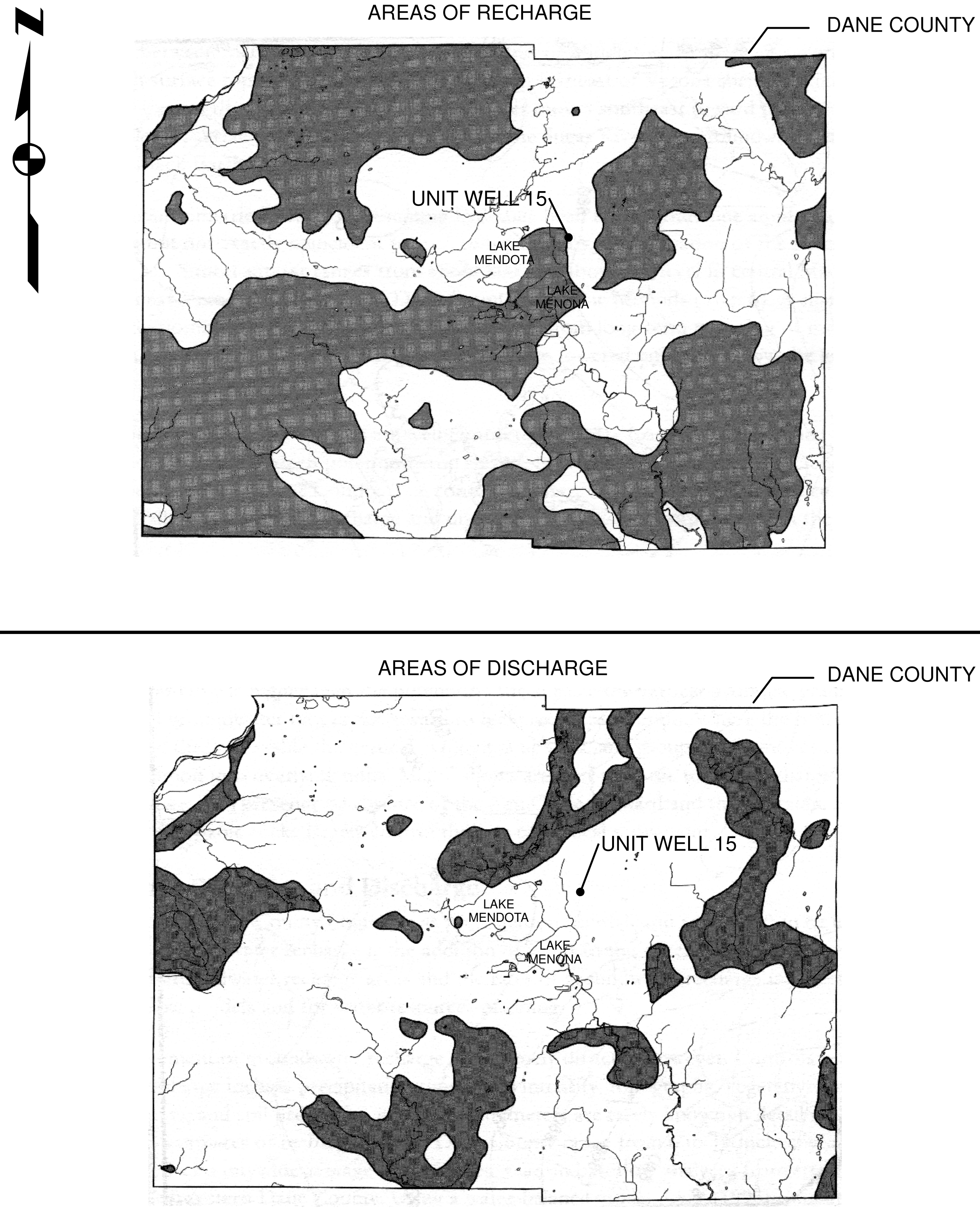


FIGURE 7
UNIT WELL 15
SIMULATED 2000 WATER TABLE
MADISON WATER UTILITY
MADISON, WISCONSIN
60263461



REFERENCE SOURCE:
HYDROGEOLOGY OF DANE COUNTY,
BRADBURY, ET. AL., 1999

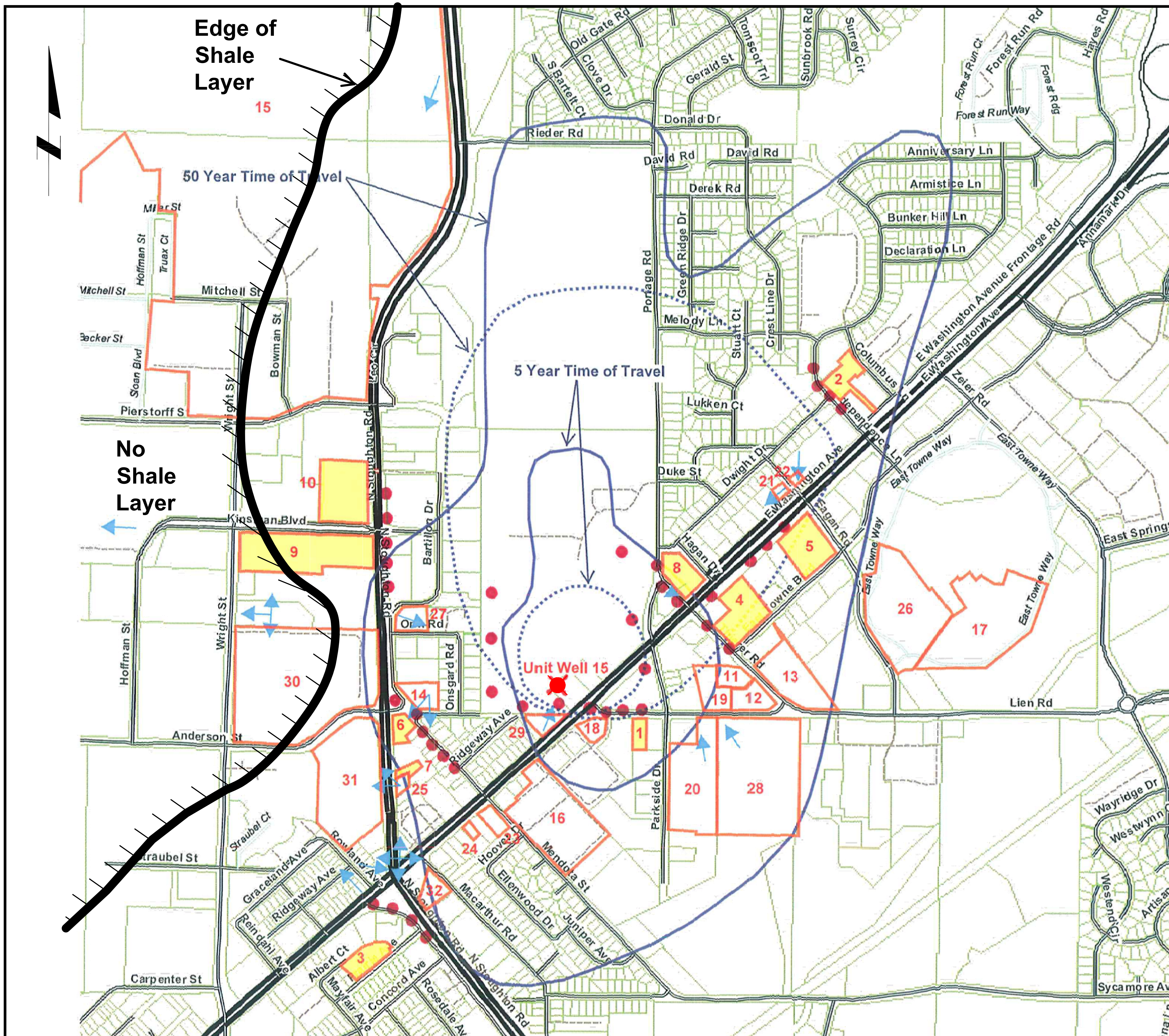
9 4.5 0 9
Miles

AECOM

FIGURE 8
AREAS OF RECHARGE TO AND DISCHARGE FROM THE MT. SIMON AQUIFER
MADISON WATER UTILITY
MADISON, WISCONSIN

60263461

P:\60263461\000_CAD\040_GIS\Figures\60263461_FIGURE-8-UW15_REC-DISC.mxd Thursday, June 07, 2012 - 8:15:28 AM



Estimated zone of contribution assuming 100% design capacity pumping rate (3 million gallons per day).

Estimated zone of contribution assuming 50% design capacity pumping rate (1.5 million gallons per day).

Note: Zones of contribution/times of travel based off figures included in the Unit Well 15 Wellhead Protection Plan dated October 2003 and prepared by Strand Associates, Inc.

Estimated shallow groundwater flow direction based on a review of the WDNR GIS Registry and/or Leaking Underground Storage Tank and Environmental Repair Program case file information

Sites recommended for initial Field Screening Investigation

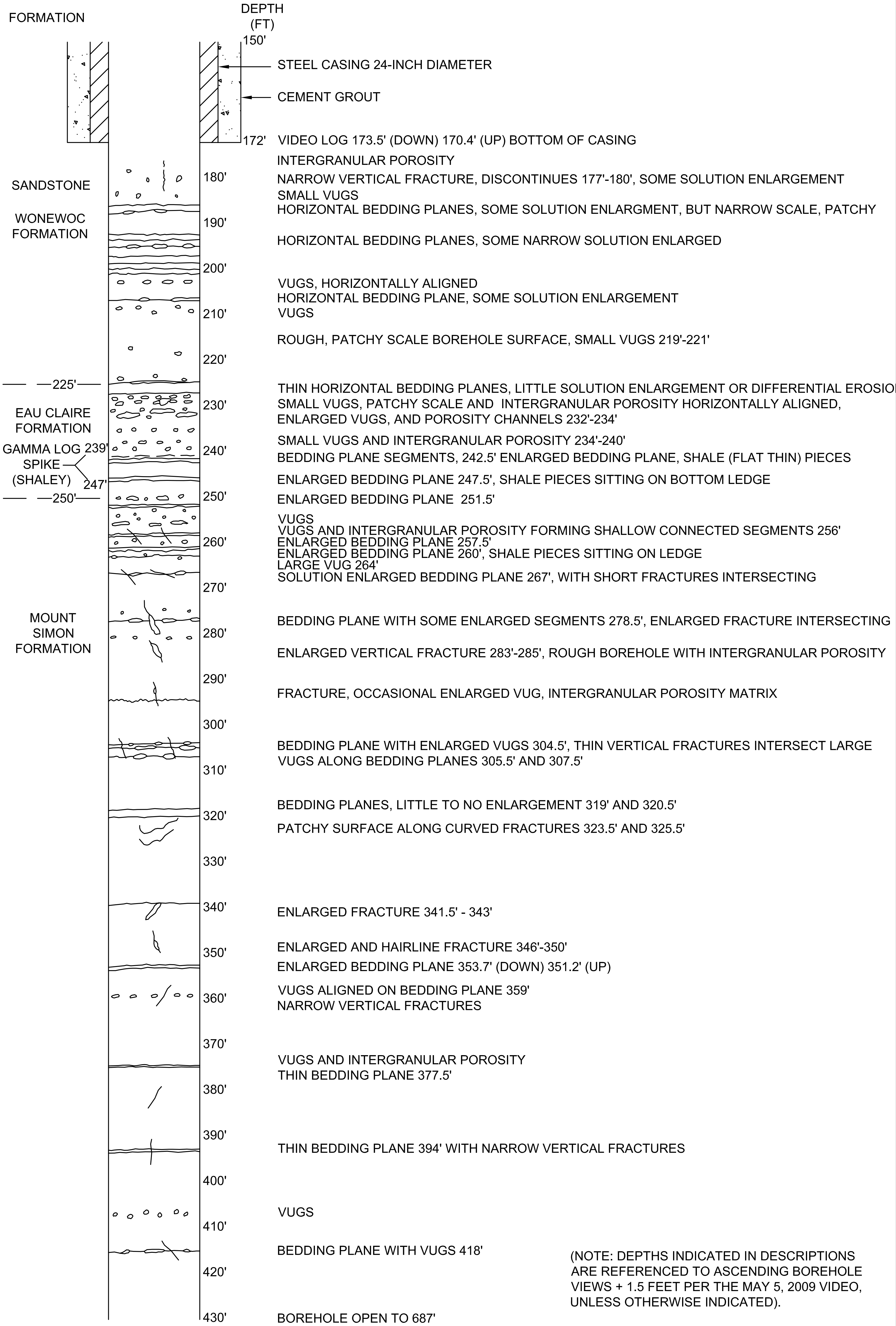
Sites (site order based on likelihood of impact to unit well 15)

1. **Former Day One Formal Wear**
2. **Whistle Stop Cleaners**
3. **Former Duraclean and Johnny on the spot**
4. **Former Sherman Williams**
5. **Former Kline Cleaners**
6. **Former Paul's Classic Cleaners**
7. **Former Wickcraft Manufacturing Company**
8. **Offfice Depot**
9. **Bell Laboratories**
10. **Former Print Tech**
11. **Kline cleaners**
12. **Former RTRV Partnership Landfill**
13. **Former Russ Darrow Landfill**
14. **Zimbrick Body Shop**
15. **Dane County Regional Airport**
16. **Hy-Vee**
17. **Former Prange Way**
18. **Mobil Gas Station**
19. **Madison Gas and Electric**
20. **Amcor Flexibles Healthcare**
21. **BP Gas Station**
22. **Stanton Optical**
23. **Goodyear Service**
24. **Midas**
25. **Former Clark Oil Station**
26. **Sears**
27. **Planned Parenthood of Wisconsin**
28. **Thermastor**
29. **Capitol Britton Station**
30. **Madison Area Technical college**
31. **Virent Energy**
32. **Tires plus**

AECOM

FIGURE 9
UNIT WELL 15 CAPTURE ZONES
MADISON WATER UTILITY
MADISON, WISCONSIN

60263461



(NOTE: DEPTHS INDICATED IN DESCRIPTIONS ARE REFERENCED TO ASCENDING BOREHOLE VIEWS + 1.5 FEET PER THE MAY 5, 2009 VIDEO, UNLESS OTHERWISE INDICATED).

AECOM

FIGURE 10
ANALYSIS OF UNIT WELL 15 BOREHOLE CASING EXTENSION ASSESSMENT
MADISON, WISCONSIN

60263461

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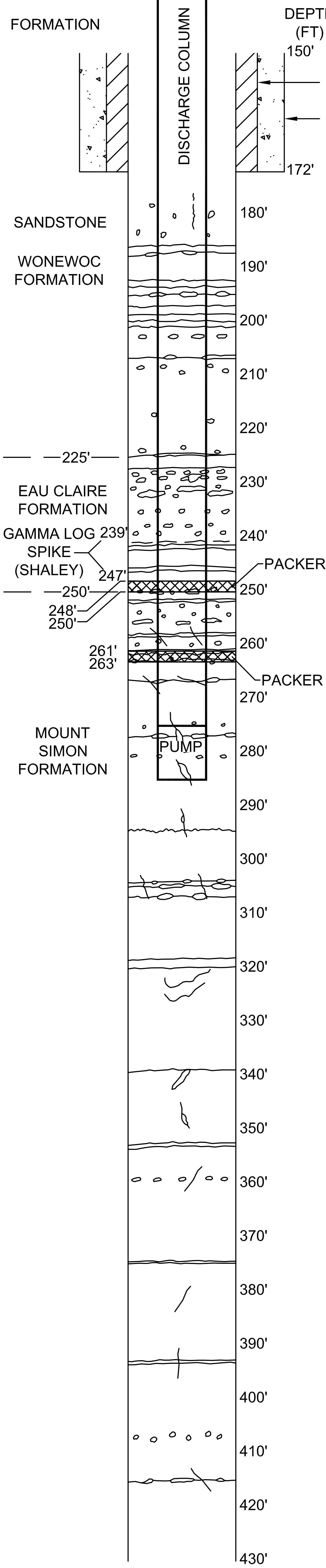

STEEL CASING 24-INCH DIAMETER

CEMENT GROUT

VIDEO LOG 173.5' (DOWN) 170.4' (UP) BOTTOM OF CASING
INTERGRANULAR POROSITY
NARROW VERTICAL FRACTURE, DISCONTINUES 177'-180', SOME SOLUTION ENLARGEMENT
SMALL VUGS
HORIZONTAL BEDDING PLANES, SOME SOLUTION ENLARGMENT, BUT NARROW SCALE, PATCHY

HORIZONTAL BEDDING PLANES, SOME NARROW SOLUTION ENLARGED

VUGS, HORIZONTALLY ALIGNED
HORIZONTAL BEDDING PLANE, SOME SOLUTION ENLARGEMENT
VUGS

ROUGH, PATCHY SCALE BOREHOLE SURFACE, SMALL VUGS 219'-221'

THIN HORIZONTAL BEDDING PLANES, LITTLE SOLUTION ENLARGEMENT OR DIFFERENTIAL EROSIO
SMALL VUGS, PATCHY SCALE AND INTERGRANULAR POROSITY HORIZONTALLY ALIGNED,
ENLARGED VUGS, AND POROSITY CHANNELS 232'-234'

SMALL VUGS AND INTERGRANULAR POROSITY 234'-240'
BEDDING PLANE SEGMENTS, 242.5' ENLARGED BEDDING PLANE, SHALE (FLAT THIN) PIECES

ENLARGED BEDDING PLANE 247.5', SHALE PIECES SITTING ON BOTTOM LEDGE

ENLARGED BEDDING PLANE 251.5'

VUGS
VUGS AND INTERGRANULAR POROSITY FORMING SHALLOW CONNECTED SEGMENTS 256'
ENLARGED BEDDING PLANE 257.5'
ENLARGED BEDDING PLANE 260', SHALE PIECES SITTING ON LEDGE
LARGE VUG 264'
SOLUTION ENLARGED BEDDING PLANE 267', WITH SHORT FRACTURES INTERSECTING

BEDDING PLANE WITH SOME ENLARGED SEGMENTS 278.5', ENLARGED FRACTURE INTERSECTING

ENLARGED VERTICAL FRACTURE 283'-285', ROUGH BOREHOLE WITH INTERGRANULAR POROSITY

FRACTURE, OCCASIONAL ENLARGED VUG, INTERGRANULAR POROSITY MATRIX

BEDDING PLANE WITH ENLARGED VUGS 304.5', THIN VERTICAL FRACTURES INTERSECT LARGE
VUGS ALONG BEDDING PLANES 305.5' AND 307.5'

BEDDING PLANES, LITTLE TO NO ENLARGEMENT 319' AND 320.5'

PATCHY SURFACE ALONG CURVED FRACTURES 323.5' AND 325.5'

ENLARGED FRACTURE 341.5' - 343'

ENLARGED AND HAIRLINE FRACTURE 346'-350'
ENLARGED BEDDING PLANE 353.7' (DOWN) 351.2' (UP)

VUGS ALIGNED ON BEDDING PLANE 359'
NARROW VERTICAL FRACTURES

VUGS AND INTERGRANULAR POROSITY
THIN BEDDING PLANE 377.5'

THIN BEDDING PLANE 394' WITH NARROW VERTICAL FRACTURES

VUGS

BEDDING PLANE WITH VUGS 418'

BOREHOLE OPEN TO 687'

(NOTE: DEPTHS INDICATED IN DESCRIPTIONS ARE REFERENCED TO ASCENDING BOREHOLE VIEWS + 1.5 FEET PER THE MAY 5, 2009 VIDEO, UNLESS OTHERWISE INDICATED).

AECOM

FIGURE 11
PROPOSED LOCATIONS OF
PACKERS IN UNIT WELL 15
MADISON, WISCONSIN

60263461

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APPENDIX A

CONSTRUCTION REPORTS AND FORMATION LOGS

UNIVERSITY OF WISCONSIN GEOLOGICAL & NATURAL HISTORY SURVEY
1815 University Avenue, Madison, Wisconsin 53706

Log No. Dn-930
Issued: Aug., 1967

Well name: Sunnyside School, City of Madison, Wisc. Unit Well #15

County: Dane

Owner.... City of Madison, Wis.
Address.. City-County Bldg., Madison, Wis.

Driller.. Milaeger Well & Pump Co.
Engineer.

Completed... 11/2/65
Field check.
Altitude....
Use......... Municipal
Static w. l. - 47 feet
Spec. cap... 25.5

R. 10E.
T. 8 N.
Sec. 28

Quad. Sun Prairie

Drill Hole						Casing & Liner Pipe or Curbing							
Dia.	from	to	Dia.	from	to	Dia.	Wgt.& Kind	from	to	Dia.	Wgt.& Kind	from	to
30"	0	125'				30"		0	125				
29"	125'	172'				24"		+24"	172				
22"	172'	753'											

Grout: Kind	from	to
Cement grout	0	172'

Samples from 300' to 750' Date received: 9/16/65
Sample Nos. 258090 to 258179 Examined by: Janet Olmstead Date: 3/20/66
Formations: #Franconia, Ironton, Galesville, Eau Claire, Mt. Simon

Remarks: Well tested for 25 hours at 2400 gpm with 94 feet of drawdown. Driller reports a total depth of 753'. Additional information: Detailed pumping tests, water analysis, and alignment tests. #Driller reports Drift 0-123', Sandstone 123-300'; samples destroyed.

LOG OF WELL:

	300	0-300	300		No Samples
FRANCONIA		300-305	5		Ss,gry or,M,P dol-cem&VP lim-&pyr-cem,ltl fn&C;ltl pnk dol&Fe stn
		305-310	5		Ss,gry or,M,P dol-cem&VP lim-&pyr-cem,mch fn,ltlC;ltl pnk or dol & Fe stn
		310-355	45		Ss,gry or,M,rnd,F srtg,P dol-cem VP lim-cem, mch fn,ltl C, tr VC; ltl pnk or dol&Fe stn
		355-360	5		Ss,Vpl or,fn,mch M,ltl C,tr VC;tr pnk or dol & Fe stn
		360-365	5		Ss,pl gry or,M,V dol-cem,mch fn, ltl C & Vfn; tr pnk or dol&Fe stn
		365-370	5		Ss,pl gry or,M,sndy dol aggs(lim)mch fn,ltlC;ltlFe stn& or dol
		370-375	5		Ss,pl gry or,M,sndy dol aggs(lim)mch fn,ltlC;ltl Fe stn, or dol& Vpl gn sndy sh
		375-380	5		Dol,pl gry or,fn,sndy dol aggs(lim)mchM,ltlC;As above
		380-385	5		Ss,pl gry yl or,M,VP lim-&Si-cem,mch C, ltl fn & Vfn
		385-390	5		Ss,Vpl pnk or,M,P dol-&Si-cem,mch C,ltlfn&Vfn;ltl sndy pnk dol
		390-395	5		Ss,Vpl pnk or,fn,mch M,ltl C&Vfn;tr dol, gn sh & Fe stn
		395-400	5		Ss,Vpl pnk or,M,P dol-cem,mch fn,ltl C & Vfn;ltl sndy pnk or dol
		400-405	5		Ss,pl gry or pnk,M,rnd,F srtg,mch fn, ltl C & Vfn; tr dol
		405-410	5	G	Ss,pl gry or,M,mch fn,ltlC & Vfn; tr dol & glauc
		410-420	10	G	Ss,pl gry or,M,VP lim- &P dol-cem,mch fn,ltlC&Vfn;ltl sndy dol&st tr glauc
		420-425	5		Ss,gry or,M,VP dol-&lim-cem,ltl fn&C,trVfn;ltl sndy dol,mchFestn
		425-430	5		Ss,gry or,M,VP lim-cem,ltl fn,C&VC;mch Fe stn, tr lim
		430-435	5		Ss,pl gry or,fn,VP lim-cem,mch M,ltlC&Vfn; ltl Fe stn
		435-440	5		Ss,Vpl or,M,VP pyr-cem,mch fn,ltlC;ltl Fe stn, tr buff dol
		440-450	10		Ss,Vpl or,M,Srnd,P srtg,VP pyr-cem,trC&fn; tr foss
		450-470	20		Ss, pl gry or,M,Srnd, P srtg,VP lim-cem,tr C & fn; tr foss
	180	470-480	10		Ss, Vpl or, M & fn, Srnd, P srtg, VP lim-cem,tr C & Vfn;

Log No. Dn-930

Well name Sunny side School, City of Madison, Wisc. Unit Well #15
Sample Nos. 258090 to 258179

Formation	Thickness	Depth	Ft	Lith.	Description
IR	10'	480-485	5	G	Ss, Vpl or, M & C, Srnd, P srtg, VP lim-cem; tr buff dol & glauc
		485-490	5	G	Ss, Vpl or, M & C, Srnd, P srtg, VP lim-cem, tr fn; tr foss&glauc
GALESVILLE	100'	490-500	10	G	Ss, Vlt gry or, M, Srnd, P srtg, VP lim-cem, tr fn, Vfn, & C; tr foss, glauc & loose dol
		500-505	5	G	Ss, Vlt or pnk, M, Srnd, P srtg, VP lim-cem, tr fn&C; tr pyr cem, glauc, foss
		505-525	20		Ss, Vlt or pnk, M, Srnd, P srtg, VP lim-cem, tr fn & C; tr foss
		525-540	15		Ss, Vlt or pnk, M&fn, Sang Srnd, P srtg, VP lim-cem, tr C; tr cvd cht & loose dol
		540-570	30		Ss, Vlt or pnk, M & fn, Sang Srnd, P srtg, VP lim-cem, tr C & Vfn; tr cvd cht foss
		570-575	5	G	Ss, lt or, M&fn, VP-lim-cem, tr C&Vfn; tr cvd cht foss&loose dol&glauc
		575-580	5		Ss, pl or pnk, M&fn, VP lim-cem, trC&Vfn; tr cvd cht foss&loose dol
		580-590	10		Ss, pl or pnk, M&fn, VP lim-cem, tr D & Vfn; tr cvd cht foss
EAU CLAIRE	125'	590-595	5		Ss, pl or pnk, M&fn, VP lim-cem, tr C & Vfn; tr cvd cht foss
		595-600	5		Ss, pl or pnk, M&fn, VP lim-cem, tr C; tr loose dol & cvd cht foss
		600-605	5		Ss, pl or pnk, M, Sang Srnd, P srtg, VP lim-cem, trC; tr loose dol&cht foss
		605-610	5		Ss, pl or pnk, M&fn, Vp lim-cem, tr C & Vfn; tr loose dol & cht foss
		610-615	5		Ss, pl or pnk, M&fn, VP lim-cem, tr C, ltl Vfn; tr loose dol&cht foss
		615-620	5		Ss, Vlt gry or, fn, Sang Srnd, P srtg, tr C, M & Vfn; tr cht foss
		620-635	15		Ss, Vlt gry or, fn, Sang Srnd, P srtg, VP lim-cem, tr C, M&Vfn; tr cht foss
		635-640	5		Ss, Vpl rd, fn, tr C, M&Vfn; ltl mxd sty sh, tr loose dol
		640-645	5		Ss, lt bn, M&fn, tr C, Vfn&VC; ltl mxd sty sh, tr loose dol
		645-660	15		Ss, Vpl bn, fn, Sang Srnd, P srtg, tr C, Vfn&M; tr cht foss & loose dol
		660-665	5		Ss, lt gry or, M, Sang Srnd, P srtg, tr C & fn; tr cht foss
		665-680	15		Ss, lt gry or, M&fn, Sang Srnd, P srtg, tr C & Vfn; tr cht foss
		680-690	10		Ss, Vpl or, fn, Sang Srnd, P srtg, tr M & Vfn; tr cht foss
		690-700	10		Ss, Vpl or, M&fn, trC, VC&Vfn; tr cht foss & loose dol
		700-705	5	G	Ss, lt gry or, M&fn, Sang Srnd, P srtg, trC, VC&Vfn; tr glauc
		705-710	5	G	Ss, lt bn, M&fn, tr C, VC&Vfn; trVfn qtz gvl, loose dol, sts, glauc&calc
		710-715	5	G	Ss, dk gry or, M, trC, VC, Vfn; tr Vfn qtz gvl & glauc
MTS	35'	715-720	5	G	Ss, lt rd or, M&C, trC, VC&Vfn; trVfn qtz gvl, loose dol, sts, glauc&calc
		720-730	10		Ss, lt gry or, C&VC, Sang, P srtg, trM&fn; tr Vfn qtz gvl
		730-735	5		Ss, bn&mxd clr, M&C, trVC&fn; mstly hrd sts&rd sh, tr qtz gvl
		735-740	5		Ss, bn&mxd clr, M&C, trVC&fn; mstly hrd sts&rd sh, tr qtz gvl
		740-745	5		Ss, bn&mxd clr, M&C, trVC&fn; mstly hrd sts, tr qtz gvl
		745-750	5		Ss, bn&mxd clr, M&C, tr VC & fn; mstly hrd sts

END OF WELL

City of Madison, Sunnyside School Test Hole
SW 1/4, SE 1/4, SW 1/4, Sec. 28, T 8N, R 10E
Milaeger Well & Pump, Driller - Fall 1964
Sample Nos. 249187-249397, Examined by M.E. Ostrom - 11-12-64

DRIFT		0-30	30	Snd, lt yl bn, mxd, M, Srnd, Psrtg, tr fn, C, Vfn, mch dol, cl, st
		30-50	20	Snd, lt yl bn, mxd, M, Srnd, Psrtg, tr fn, C, Vfn, mch dol, cl, st
		50-75	25	Snd, lt yl bn, mxd, M, Srnd, Pssrtg, tr fn, C, Vfn, mch dol, trVfn gvl
		75-80	5	Snd, lt yl bn, mxd, M, Srnd, Psrtg, tr fn, C, Vfn, mch dol
		80-85	5	Snd, lt yl bn, mxd, M, Srnd, trC, fn, Vfn, mch dol, st
		85-90	5	Snd, mxd, lt yl bn, M, Srnd, Psrtg, trC, fn, Vfn, mch dol
		90-100	10	Snd, mxd, M, Srnd, trC, fn, Vfn, mch dol
		100-105	5	Snd, mxd, M, Srnd, Psrtg, trC, fn, Vfn, mch dol, st
		105-110	5	Snd, mxd, M, Srnd, Psrtg, trC, fn, Vfn, mch dol, tr clt
	115	110-115	5	Snd, mxd, M, Srnd, Psrtg, trC, fn, Vfn, mst dol, mch st
DRESBACH UNDIFF		115-125	10	Ss , mxd, M, Srnd, Psrtg, trC, fn, Vfn, mch dol
		125-130	5	Ss , Vlt yl bn, M, Srnd, Psrtg, trC, fn, Vfn, tr dol
		130-135	5	Ss , Vlt yl bn, M, C, Srnd, Psrtg, tr fn, Vfn, tr dol
		135-140	5	Ss , Vlt yl bn, M, Srnd, Psrtg, tr fn, Vfn, C, tr dol
		140-155	15	Ss , wh, M, Srnd, Psrtg, tr fn, Vfn, C, tr dol
		155-160	5	Ss , Vlt yl bn, M, fn, Srnd, Psrtg, trC, Vfn, mch dol
		160-165	5	Ss , Vlt yl bn, M, Srnd, Psrtg, trC, Vfn, fn, mch dol
		165-170	5	Ss , lt yl bn, M, C, Srnd, Psrtg, tr fn, tr calc. dol
		170-175	5	Ss , lt yl bn, M, C, Srnd, Psrtg, tr fn, tr dol
		175-180	5	Ss , lt yl bn, M, C, Srnd, Psrtg, tr fn, tr dol, stnd pyr
		180-190	10	Ss , lt yl bn, M, Srnd, Psrtg, tr fn, C, Vfn, slt tr dol, stnd pyr
		190-195	5	Ss , mxd, fn, Srnd, Psrtg, trM, Vfn, slt tr dol, stnd pyr
		195-205	10	Ss , lt yl bn, fn, Vfn, Srnd, Psrtg, trM, slt trC, slt tr dol, stnd pyr
		205-210	5	Ss , lt yl bn, M, Srnd, Psrtg, tr fn, Vfn, tr stnd pyr
		210-215	5	Ss, lt yl bn, M, Srnd, tr fn, Vfn, tr stnd pyr, dol
		215-220	5	Ss, lt yl bn, M, Srnd, Psrtg, tr fn, Vfn, C, dol, calc
		220-225	5	Ss, Vlt yl bn, M, Rnd, tr fn, Vfn, mch dol, tr stnd pyr
		225-235	10	Ss, Vlt yl bn, M, Rnd, Psrtg, tr fn, Vfn, mch dol, tr stnd pyr, tr sh
		235-250	15	Ss, Vlt yl rd, M, Rnd, Psrtg, VP, Fe, tr fn, Vfn, tr dol, sh
		250-255	5	Ss, Vlt yl rd, M, Rnd, tr fn, Vfn, tr dol, sh, pyr
		255-265	10	Ss, Vlt rd yl bn, M, Rnd, Psrtg, tr fn, Vfn, tr dol, sh, pyr
		265-270	5	Ss, Vlt yl bn, M, Srnd, tr fn, Vfn, C, tr dol, sh, pyr
		270-285	15	Ss, Vlt yl bn, M, Srnd, Psrtg, VP, Fe, tr fn, Vfn, C, tr pyr, stnd, sh, slt dol
		285-310	25	Ss, Vlt yl bn, M, Rnd, Psrtg, VP, Fe, tr fn, C, tr dol, stnd pyr, sh
		310-330	20	Ss, Vlt yl bn, M, Rnd, Psrtg, tr fn, Vfn, tr dol, stnd pyr, sh
		330-345	15	Ss, Vlt yl bn, M, Rnd, Psrtg, tr fn, tr dol, stnd pyr, sh
		345-350	5	Ss, Vlt yl bn, M, Rnd, tr fn, C, slt trVfn, tr dol

City of Madison, Sunnyside School Test Hole
Sample Nos. 249187-249397

DRESBACH UNDIFF

350-355	5	Ss,clear wh,M,Rnd,tr fn,C,Vfn,mch pyr,(stnd)
355-360	5	Ss,Vlt yl bn,M,Rnd,Psrtg,tr fn,C,slt trVfn
360-365	5	Ss,Vlt rd bn,M,Rnd,tr fn,C,tr stnd pyr,dol,cht
365-370	5	Ss,Vlt rd bn,M,Rnd,tr fn,C,tr stnd pyr,dol,
370-375	5	Ss,lt yl rd bn,M,Rnd,Psrtg,tr fn,C,Vfn,tr stnd pyr
375-380	5	Ss,lt yl rd bn,M,fn,Rnd,trVfn,C,tr stnd pyr,sh
380-390	10	tr dol,sn Ss,lt yl bn,M,Rnd,trVfn,C,fn,tr stnd pyr,slt
390-400	10	tr dol Ss,Vlt yl bn,M,Rnd,Psrtg,trVfn,C,fn,mch stnd pyr,
400-410	10	tr dol Ss,Vlt yl bn,M,Rnd,Psrtg,trVfn,C,fn,tr stnd pyr,
410-415	5	Ss,Vlt yl bn,M,Rnd,trVfn,fn,tr stnd pyr,dol
415-420	5	Ss,Vlt yl bn,M,Srnd,Psrtg,trVfn,fn,tr dol,calc
420-425	5	Ss,Vlt yl bn,M,Rnd,slt tr fn,C,tr dol,calc,
425-430	5	Ss,Vlt yl bn,M,Rnd,Psrtg,tr fn,C,tr stnd pyr
430-435	5	Ss,lt yl bn,M,Rnd,Psrtg,tr fn,C,slt trVfn
435-440	5	Ss,lt yl bn,M,Rnd,tr fn,slt trVfn,tr stnd pyr
440-445	5	Ss,Vlt yl,M,Rnd,tr fn,slt trVfn,tr stnd pyr
445-460	15	Ss,wh,M,Rnd,Psrtg,tr fn,Vfn,tr stnd pyr
460-465	5	Ss,wh mot,lt yl,M,Srnd,Psrtg,tr fn,slt trVfn
465-470	5	Ss,wh mot,lt yl,M,Srnd,Psrtg,tr fn,C,tr stnd pyr
470-475	5	Ss,wh mot,lt yl,M,Srnd,Psrtg,tr fn,C,tr stnd pyr
475-480	5	Ss,Vlt yl bn,M,tr fn,C,slt tr Vfn,tr stnd pyr
480-485	5	Ss,Vlt yl bn,M,C,Rnd,Psrtg,tr fn,tr stnd pyr
485-490	5	Ss,Vlt yl bn,M,Rnd,Psrtg,tr fn,C,tr stnd pyr
490-495	5	Ss,lt yl bn,M,Rnd,VP,Fe,tr fn,C,tr stnd pyr
495-500	5	Ss,Vlt yl bn,M,Srnd,tr fn,C,Vfn,tr stnd pyr
500-520	20	Ss,lt yl,M,Srnd,Psrtg,tr fn,C,tr stnd pyr, slt tr cht
520-535	15	slt tr cht Ss,lt yl,C,Fn,Srnd,Psrtg,trM,Vfn,tr stnd pyr,
535-545	10	slt tr cht Ss,Vlt yl bn,M,Srnd,Psrtg,tr fn,Vfn,tr stnd pyr,
545-550	5	Ss,Vlt yl bn,M,fn,Srnd,Psrtg,trVfn,tr stnd pyr
550-555	5	Ss,lt yl bn,M,fn,Srnd,Psrtg,trVfn,slt trC
555-560	5	Ss,lt yl bn,M,fn,Srnd,Psrtg,trVfn,slt trC,
560-565	5	Ss,lt yl bn,M,Srnd,trVfn,fn,tr stnd pyr,slt tr cht
565-570	5	Ss,Vlt yl bn,M,tr fn,C,tr stnd pyr
570-575	5	Ss,Vlt yl bn,M,C,Srnd,VP,Fe,tr fn,slt trVfn
575-585	10	pyr,cht Ss,Vlt yl bn,fn,Vfn,Srnd,Psrtg,slt trM,tr stnd
585-590	5	Ss,Vlt yl bn,M,Srnd,tr fn,Vfn,slt trC,tr pyr
590-595	5	Ss,Vlt yl bn,M,Fn,Srnd,slt trC,Vfn,tr stnd pyr
595-600	5	Ss,Vlt yl bn,M,Srnd,Psrtg,trC,Vfn,fn,tr st[illegible] pyr
600-610	10	Ss,Vlt yl bn,M,fn,Srnd,Psrtg,trVfn,tr stnd pyr
610-615	5	Ss,Vlt yl bn,M,Srnd,trVfn,fn,C,tr stnd pyr,cht
615-620	5	Ss,Vlt yl bn,M,fn,S nd,trVfn,tr stnd pyr,cht
620-630	10	cht Ss,Vlt yl bn,fn,Srnd,Psrtg,trM,Vfn,tr stnd pyr,
630-635	5	Ss,Vlt yl bn,M,fn,Srnd,Psrtg,trVfn,slt trC,pyr
635-640	5	Ss,Vlt yl bn,M,Srnd,Psrtg,trC,fn,slt trC
640-645	5	Ss,lt rd,M,C,Srnd,Psrtg,trVC,Vfn,fn,mch sts
645-655	10	foss Ss,Vlt rd,M,Srnd,Psrtg,tr fn,Vfn,tr sts,stnd pyr,
655-665	10	pyr,slt tr cht Ss,Vlt pl pnk yl,M,Srnd,Psrtg,trfn,Vfn,tr stnd
665-670	5	Ss,Vlt yl bn,M,fn,Srnd,Psrtg,slt trVfn,tr stnd pyr
670-675	5	Ss,Vlt yl bn,M,trVfn,fn,slt trC,tr stnd pyr
675-685	10	Ss,Vlt pl pnk yl,M,tr fn,slt trVfn,C,tr stnd pyr
685-690	5	Ss,Vlt yl bn,fn,Srnd,trM,tr stnd pyr,slt tr foss
690-700	10	Ss,Vlt pl pnk yl,fn,Srnd,Psrtg,trM,Vfn,slt tr pyr,

City of Madison, Sunnyside School Test Hole
Sample Nos. 249187-249397

		700-705	5		Ss, Vlt pl pnk yl, M, fn, Srnd, trVfn, slt trC,
		705-710	5		Ss, Vlt pl pnk yl, M, Srnd, Psrtg, trVfn, fn, tr stnd pyr
		710-715	5		Ss, Vlt yl bn, M, Srnd, tr fn, C, slt trVfn, VC, cht
DRESBACH		715-720	5		Ss, Vlt yl bn, C, Sang, tr fn, M, VC, slt trVfn, cht
		720-725	5		Ss, lt yl rd, C, Sang, Psrtg tr fn, M, VC, trVfn qtz gvl
		725-730	5		Ss, lt yl rd, C, Ang, trVC, M, tr stnd pyr, cht
		730-735	5		Ss, Vlt yl, C, Ang, Psrtg, trVC, M, fn, tr stnd pyr, cht
		735-740	5		Ss, Vlt yl, M, Sang, tr fn, Vfn, tr stnd pyr, cht
		740-745	5		Ss, Mrd, C, Rnd, trM, fn, VC, tr sh, Vfn gvl, pyr
		745-750	5		Sh, Vmxd, Si, P, mchSs, sts
		750-765	15		Sts, mxd, Si, P, mchSs, tr sh, pyr
		765-770	5		Sts, mxd, Si, P, mchSs, calc, tr sh, pyr, dol
UNDIF		770-780	10		Sts, mxd, Si, P, mchSs, calc, tr sh, dol, Vfn gvl
	670	780-785	5		No Sample

Formations: Drift, Dresbach

Well Construction Report

WISCONSIN UNIQUE WELL NUMBER **BF515**

State of Wi-Private Water Systems-DG/2
Department Of Natural Resources, Box 7921
Madison, WI 53707

Form 3300-77A (Rev 12/00)

Depth 753 FT

Property Owner: MADISON, CITY OF
Telephone Number: 608 – 266 – 4656
Mailing Address: 523 E MAIN ST

City	State	Zip Code
MADISON	WI	53703

County of Well Location: 13 DANE
Co Well Permit No: W
Well Completion Date: November 2, 1965

1. Well Location
C T=Town C=City V=Village of MADISON
Fire#
Street Address or Road Name and Number: 3900 E WASHINGTON ST #15
Subdivision Name | Lot# | Block #
Gov't Lot or SE 1/4 of SW 1/4 of Section 28 T8 N R10 E
Latitude Deg. Min. Sec.
Longitude Deg Min. Sec.
Lat/Long Method

Well Constructor: MILAEGER WELL @
License #: 82
Facility ID (Public): 113022470
Address: 20950 ENTERPRISE AVE
Public Well Plan Approval#: 65-0114

City	State	Zip Code
BROOKFIELD	WI	53045

Date Of Approval: 03/25/1965
Hicap Permanent Well #: 77135
Common Well #: 015
Specific Capacity: 25.5 gpm/ft

2. Well Type 1 1=New 2=Replacement 3=Reconstruction (See item 12 below)
of previous unique well # ________ constructed in 0
Reason for replaced or reconstructed Well?
1 1=Drilled 2=Driven Point 3=Jetted 4=Other

3. Well Serves # of homes and or (eg: barn, restaurant, church, school, industry, etc.)
M M=Munic O=OTM N=NonCom P=Private Z=Other X=NonPot A=Anode L=Loop H=Drillhole
High Capacity: Well? Property?

4. Is the well located upslope or sideslope and not downslope from any contamination sources, including those on neighboring properties?
Well located in floodplain?
Distance in feet from well to nearest: (including proposed)

1. Landfill
2. Building Overhang
3. 1=Septic 2= Holding Tank
4. Sewage Absorption Unit
5. Nonconforming Pit
6. Buried Home Heating Oil Tank
7. Buried Petroleum Tank
8. 1=Shoreline 2= Swimming Pool
9. Downspout/ Yard Hydrant
10. Privy
11. Foundation Drain to Clearwater
12. Foundation Drain to Sewer
13. Building Drain 1=Cast Iron or Plastic 2=Other
14. Building Sewer 1=Gravity 2=Pressure 1=Cast Iron or Plastic 2=Other
15. Collector Sewer: ___ units ___ in . diam.
16. Clearwater Sump
17. Wastewater Sump
18. Paved Animal Barn Pen
19. Animal Yard or Shelter
20. Silo
21. Barn Gutter
22. Manure Pipe 1=Gravity 2=Pressure 1=Cast iron or Plastic 2=Other
23. Other manure Storage
24. Ditch
25. Other NR 812 Waste Source

5. Drillhole Dimensions and Construction Method

Dia.(in.)	From (ft)	To (ft)
30.0	surface	125
29.0	125	172
22.0	172	753

Upper Enlarged Drillhole / Lower Open Bedrock
– 1. Rotary - Mud Circulation
– 2. Rotary - Air
– 3. Rotary - Air and Foam
– 4. Drill-Through Casing Hammer
– 5. Reverse Rotary
– 6. Cable-tool Bit _____ in. dia
– 7. Temp. Outer Casing _____ in. dia. _____ depth ft. Removed ?
Other

8. Geology

Geology Codes	Type, Caving/Noncaving, Color, Hardness, etc	From (ft.)	To (ft.)
---	DRIFT	Surface	300
O-N-	SANDSTONE-FRANCONIAN	300	375
-NL-	DOLOMITE-FRANCONIAN	375	380
-N-	SANDSTONE-FRANCONIAN	380	480
O-N-	SANDSTONE-IRONTON	480	490
P-N-	SANDSTONE-GALESVILLE	490	590
-N-	SANDSTONE-EAU CLAIRE	590	715
O-N-	SANDSTONE-MT SIMON	715	730
O-NH	SANDSTONE/SHALE/SILTSTONE-	730	740
-NM	SANDSTONE/SILTSTONE-MT	740	753

6. Casing Liner Screen

Dia. (in.)	Material, Weight, Specification Manufacturer & Method of Assembly	From (ft.)	To (ft.)
		surface	

Dia.(in.)	Screen type, material & slot size	From	To

9. Static Water Level
47.0 feet B ground surface A=Above B=Below

10. Pump Test
Pumping level 141.0 ft. below surface
Pumping at 2400.GPM 25.0 Hrs

11. Well Is: 0 in. Grade A=Above B=Below
Developed?
Disinfected?
Capped?

7. Grout or Other Sealing Material

Method	Kind of Sealing Material	From (ft.)	To (ft.)	# Sacks Cement
		surface		

12. Did you notify the owner of the need to permanently abandon and fill all unused wells on this property?
If no, explain

13. Initials of Well Constructor or Supervisory Driller — Date Signed
Initials of Drill Rig Operator (Mandatory unless same as above) — Date Signed

Additonal Comments?
Owner Sent Label? Y
Variance Issued?
More Geology?

Wisconsin Geological & Natural History Survey
3817 Mineral Point Road, Madison, WI 53705

WG&NHS Log No: DN -930

Title: Geologic Log

Site Name: Madison City Well #15

Owner: City of Madison
Address: 523 E. Main Street
Madison, WI 53703
Driller(s): Milaeger Well & Pump Co., Inc.
Engineer:

Location: **SW, NW, NW, SE, SW, SE, SW, Sec. 28, T8N, R10E**

Topo Name: Madison East
Sample Nos.: 258090-258179
Perm No.: 77135
WI-Unique ID#: BF515

Samples Rec'd:
9/16/1965 300' to 750'

Studied By:
Janet M. Olmstead 300' to 750'

County: DANE
Completed: 11/2/1965
Field Check: WG&NHS - KMF
6/27/88
Elevation: 886 ±0'
Well Use: municipal
Static Level: 47'

Pump Test:
Pumped at 2400 GPM for 24 hrs. with 94 ft. of drawdown.
On 11/2/1965

Drill Hole Dimensions

Diameter	From	To
30"	0'	125'
29"	125'	172'
22"	172'	753'

Drilling Method

Method	From	To

Grout

Kind	From	To
Cement	0'	172'

Open Interval Characteristics

Diameter	From	To	Opening Type
22"	172'	753'	bedrock

Casing & Liner Information

Diameter	From	To	Casing	Weight
24"	+2'	172'	Steel	
30"	0'	125'	Steel	

Types of records available for this site (* indicates indexing term):

Caliper log, Gamma log, Spontaneous potential log, Normal resistivity log, Single-point resistivity log, *geophysical log(s) exist, Well construction report - original, Geologic log, *municipal well, *subsurface boring (non-core) site, Fluid conductivity log, Detailed hour-by-hour pump test data, Fluid temperature log, Drill cuttings available, *lower drillhole samples only

Formations:

Quaternary, Wonewoc Formation, Eau Claire Formation, Mount Simon Formation

Log Comments:

Pumphouse is located about 60 feet west of the former Sunnyside School building.
Test hole (DN-916) for Well #15 was located about 10 feet to the southeast of Well #15.
Pumping test log, alignment test to 329.375', and water quality test available.
Samples 0-300' were destroyed by vandals on the night of 9/8/1965.

This geologic log has undergone basic review. Some information may need to be added or further reviewed. If essential information is missing or incorrect, please contact WG&NHS at rpeters@wisc.edu or (608)-263-7387.

Version tracking:
4/1/1966 Analog version
3/8/2010 Initial digital version

Wisconsin Geological & Natural History Survey

3817 Mineral Point Road, Madison, WI 53705

WG&NHS Log No: DN -930

Title: Geologic Log

Site Name: Madison City Well #15

Owner: City of Madison
Address: 523 E. Main Street
Madison, WI 53703
Driller(s): Milaeger Well & Pump Co., Inc.
Engineer:

Location: **SW, NW, NW, SE, SW, SE, SW, Sec. 28, T8N, R10E**

Topo Name: Madison East
Sample Nos.: 258090-258179
Perm No.: 77135
WI-Unique ID#: BF515

Samples Rec'd:
9/16/1965 300' to 750'

Studied By:
Janet M. Olmstead 300' to 750'

County: DANE
Completed: 11/2/1965
Field Check: WG&NHS - KMF
6/27/88
Elevation: 886 ±0'
Well Use: municipal
Static Level: 47'

Pump Test:
Pumped at 2400 GPM for 24 hrs. with 94 ft. of drawdown.
On 11/2/1965

Drill Hole Dimensions

Diameter	From	To
30"	0'	125'
29"	125'	172'
22"	172'	753'

Drilling Method

Method	From	To

Grout

Kind	From	To
Cement	0'	172'

Open Interval Characteristics

Diameter	From	To	Opening Type
22"	172'	753'	bedrock

Casing & Liner Information

Diameter	From	To	Casing	Weight
24"	+2'	172'	Steel	
30"	0'	125'	Steel	

Types of records available for this site (* indicates indexing term):

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Formations:

Quaternary, Wonewoc Formation, Eau Claire Formation, Mount Simon Formation

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Pumping test log, alignment test to 329.375', and water quality test available.
Samples 0-300' were destroyed by vandals on the night of 9/8/1965.

This geologic log has undergone basic review. Some information may need to be added or further reviewed. If essential information is missing or incorrect, please contact WG&NHS at rpeters@wisc.edu or (608)-263-7387.

Version tracking:

4/1/1966 Analog version
3/8/2010 Initial digital version

Site Name: Madison City Well #15

Title: Geologic Log

	Depths	Graphic	RockType	Color	Mode	Range	Miscellaneous Characteristics
Quaternary	0-123		NO SAMPLE				Driller reports drift.
Wonewoc Formation	123-225		NO SAMPLE				Driller reports sandstone.

Site Name: Madison City Well #15

Title: Geologic Log

	Depths	Graphic	RockType	Color	Mode	Range	Miscellaneous Characteristics
Wonewoc Formation	123-225		NO SAMPLE				Driller reports sandstone.
Eau Claire Formation	225-250		NO SAMPLE				Driller reports sandstone. Eau Claire Formation boundaries are based on the gamma log run by WG&NHS.
Mount Simon Formation	250-300		NO SAMPLE				Driller reports sandstone.

Site Name: Madison City Well #15

Title: Geologic Log

	Depths	Graphic	RockType	Color	Mode	Range	Miscellaneous Characteristics
	250-300		NO SAMPLE				Driller reports sandstone.
	300-305		sandstone	gray orange	M	Fn/C	Rounded. Fair sorting. Poor dolomite cement and very poor limonite and pyrite cement. Little pink orange dolomite and iron stain. Trace green shale and silt.
	305-310		sandstone	gray orange	M	Fn/C	Rounded. Fair sorting. Poor dolomite cement and very poor limonite and pyrite cement. Little pink orange dolomite and iron stain.
	310-315		sandstone	gray orange	M	Fn/C	Rounded. Fair sorting. Poor dolomite cement and very poor limonite cement. Little pink orange dolomite and iron stain.
	315-320		sandstone	gray orange	M	Fn/VC	Rounded. Fair sorting. Poor dolomite cement and very poor limonite cement. Little pink orange dolomite and iron stain.
	320-325		sandstone	light gray orange	M	Fn/VC	Rounded. Fair sorting. Poor dolomite cement and very poor limonite cement. Little pink orange dolomite and iron stain. Trace green shale.
	325-330		sandstone	light gray orange	M	Fn/VC	Rounded. Fair sorting. Poor dolomite cement and very poor limonite cement. Little pink orange dolomite and iron stain.
	330-335		sandstone	gray orange	M	Fn/VC	Rounded. Fair sorting. Poor dolomite cement and very poor limonite cement. Little pink orange dolomite and iron stain. Trace caved chert.
	335-340		sandstone	gray orange	M	Fn/VC	Rounded. Fair sorting. Poor dolomite cement and very poor limonite cement. Little pink orange dolomite and iron stain.
	340-345		sandstone	very pale yellow orange	M	Fn/VC	Rounded. Fair sorting. Poor dolomite cement and very poor limonite cement. Little pink orange dolomite and iron stain.
Mount Simon Formation	345-350		sandstone	gray orange	M	Fn/VC	Rounded. Fair sorting. Poor dolomite cement and very poor limonite cement. Little pink orange dolomite and iron stain.
	350-355		sandstone	very pale orange	M	Fn/VC	Rounded. Fair sorting. Poor dolomite cement and very poor limonite cement. Trace pink orange dolomite and iron stain.
	355-360		sandstone	very pale orange	Fn	Fn/VC	Rounded. Poor sorting. Trace pink orange dolomite and iron stain.
	360-365		sandstone	pale gray orange	M	Vfn/C	Rounded. Poor sorting. Very dolomitic cementing. Trace iron stain.
	365-370		sandstone	pale gray orange	M	Vfn/C	Rounded. Poor sorting Sandy dolomite aggregates (limonite). Little iron stain and orange dolomite.
	370-375		sandstone	pale gray orange	M	Vfn/C	Rounded. Fair sorting. Sandy dolomite aggregates (limonite). Little iron stain, orange dolomite and very pale green sandy shale.
	375-380		dolomite	pale gray orange	Fn	Fn/C	Rounded. Fair sorting. Sandy dolomite aggregates (limonie). Litle iron stain, very pale green sandy shale.
	380-385		sandstone	pale gray yellow orange	M	Vfn/C	Rounded. Poor sorting. Very poor limonite and silica cementing.
	385-390		sandstone	very pale pink orange	M	Vfn/C	Rounded. Poor sorting. Poor dolomite and silica cement. Little sandy pink orange dolomite.
	390-395		sandstone	very pale pink orange	Fn	Vfn/C	Rounded. Poor sorting. Trace dolomite, green shale and iron staining.
	395-400		sandstone	very pale pink orange	M	Vfn/C	Rounded. Poor sorting. Poor dolomite cementing. Little sandy pink orange dolomite.
	400-405		sandstone	pale gray orange pink	M	Vfn/C	Rounded. Poor sorting. Trace dolomite.
	405-410		sandstone	pale gray orange	M	Vfn/C	Rounded. Poor sorting. Trace dolomite and glauconite.
	410-415		sandstone	pale gray orange	M	Vfn/C	Rounded. Poor sorting. Very poor limonite and poor dolomite cementing. Little sandy dolomite and silt. Trace glaucontie and limonite.
	415-420		sandstone	pale gray orange mot gray orange	M	Vfn/C	Rounded. Poor sorting. Very poor limonite and poor dolomite cementing. Little sandy dolomite and silt. Trace glaucontie and limonite.

Title: Geologic Log

	Depths	Graphic	RockType	Color	Mode	Range	Miscellaneous Characteristics
	420-425		sandstone	gray orange	M	Vfn/C	Rounded. Poor sorting. Very poor dolomite and limonite cemet. Much iron stain. Little sandy dolomite. Trace limonite.
	425-430		sandstone	gray orange	M	Fn/VC	Subrounded. Poor sorting. Very poor limonite cementing. Much iron stain. Trace limonite.
	430-435		sandstone	pale gray orange	Fn	Vfn/C	Subrounded. Poor sorting. Very poor limonite cementing. Little iron stain.
	435-440		sandstone	very pale orange	M	Fn/C	Rounded. Poor sorting. Very poor pyrite cementing. Little iron staining. Trace buff dolomite.
	440-445		sandstone	very pale orange	M	Fn/C	Subrounded. Poor sorting. Very poor pyrite cementing. Trace fossils.
	445-450		sandstone	very pale orange	M	Fn/C	Subrounded. Poor sorting. Very poor pyrite cementing. Trace fossils.
	450-455		sandstone	pale gray orange	M	Fn/C	Subrounded. Poor sorting. Very poor limonite cementing. Trace fossils.
	455-460		sandstone	very pale gray orange	M	Fn/C	Subrounded. Poor sorting. Very poor limonite cementing. Trace fossils.
	460-465		sandstone	very pale orange	M	Fn/C	Subrounded. Poor sorting. Very poor limonite cementing. Trace fossils.
	465-470		sandstone	very pale orange	M	Fn/C	Subrounded. Poor sorting. Very poor limonite cementing. Trace fossils.
	470-475		sandstone	very pale orange	Fn/M	Vfn/C	Subrounded. Poor sorting. Very poor limonite cementing.
	475-480		sandstone	very pale yellow orange	Fn/M	Vfn/C	Subrounded. Poor sorting. Very poor limonite cementing.
	480-485		sandstone	very pale orange	M/C	M/C	Subrounded. Poor sorting. Very poor limonite cementing. Trace buff dolomite and glauconite.
	485-490		sandstone	very pale orange	M/C	Fn/C	Subrounded. Poor sorting. Very poor limonite cementing. Trace fossils and glauconite.
Mount Simon Formation	490-495		sandstone	very light gray orange	M	Vfn/C	Subrounded. Poor sorting. Very poor limonite cementing. Trace fossils, glauconite and loose dolomite.
	495-500		sandstone	very light orange pink	M	Vfn/C	Subrounded. Poor sorting. Very poor limonite cementing. Trace fossils, glauconite and loose dolomite.
	500-505		sandstone	very light orange pink	M	Fn/C	Suborunded. Poor sorting. Very poor limonite cementing. Trace pyrite cement, glauconite and fossils.
	505-510		sandstone	very light orange pink	M	Fn/C	Suborunded. Poor sorting. Very poor limonite cementing. Trace fossils.
	510-515		sandstone	very light orange pink	M	Fn/C	Suborunded. Poor sorting. Very poor limonite cementing. Trace fossils.
	515-520		sandstone	very light orange pink	M	Fn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace chert, fossils.
	520-525		sandstone	very light orange pink	Fn/M	Fn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace chert, loose dolomite.
	525-530		sandstone	very light orange pink	Fn/M	Fn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace chert, loose dolomite.
	530-535		sandstone	very light orange pink	Fn/M	Fn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace chert, loose dolomite.
	535-540		sandstone	very light orange pink	Fn/M	Fn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace chert, fossils, loose dolomite.
	540-545		sandstone	very light orange pink	Fn/M	Vfn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace chert, fossils, loose dolomite.
	545-550		sandstone	very light orange pink	Fn/M	Vfn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace chert, fossils, loose dolomite.
	550-555		sandstone	very light orange pink	Fn/M	Vfn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace chert, fossils, loose dolomite.
	555-560		sandstone	very light gray orange	Fn/M	Vfn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace chert, fossils, loose dolomite.

Title: Geologic Log

	Depths	Graphic	RockType	Color	Mode	Range	Miscellaneous Characteristics
	560-565		sandstone	light orange	Fn/M	Vfn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace chert, fossils, loose dolomite.
	565-570		sandstone	light orange	Fn/M	Vfn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace chert, fossils, loose dolomite.
	570-575		sandstone	light orange	Fn/M	Vfn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace chert, fossils, loose dolomite.
	575-580		sandstone	pale orange pink	Fn/M	Vfn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace chert, fossils, loose dolomite.
	580-585		sandstone	pale orange pink	Fn/M	Vfn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace chert, fossils.
	585-590		sandstone	pale orange pink	Fn/M	Vfn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace chert, fossils.
	590-595		sandstone	pale orange pink	Fn/M	Vfn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace chert, fossils.
	595-600		sandstone	pale orange pink	Fn/M	Vfn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace loose dolomite, chert, fossils.
	600-605		sandstone	pale orange pink	M	M/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace loose dolomite, chert, fossils.
	605-610		sandstone	pale orange pink	Fn/M	Vfn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace loose dolomite, chert, fossils.
	610-615		sandstone	pale orange pink	Fn/M	Vfn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace loose dolomite, chert, fossils.
	615-620		sandstone	light gray orange	Fn	Vfn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace loose dolomite, chert, fossils.
	620-625		sandstone	very light gray orange	Fn	Vfn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace loose dolomite, chert, fossils.
Mount Simon Formation	625-630		sandstone	very light gray orange	Fn	Vfn/C	Subangular and subrounded. Poor sorting. Very poor limonite cementing. Trace loose dolomite, chert, fossils.
	630-635		sandstone	very light gray orange	Fn	Vfn/C	Subangular and subrounded. Poor sorting. Trace chert fossils.
	635-640		sandstone	very pale red	Fn	Vfn/C	Subangular and subrounded. Poor sorting. Little mixed silty shale. Trace loose dolomite.
	640-645		sandstone	light brown	Fn/M	Vfn/VC	Subangular and subrounded. Poor sorting. Little mixed silty shale. Trace loose dolomite.
	645-650		sandstone	very pale brown	Fn	Vfn/C	Subangular and subrounded. Poor sorting. Trace chert fossils and loose dolomite.
	650-655		sandstone	light gray orange	Fn	Vfn/C	Subangular and subrounded. Poor sorting. Trace chert fossils.
	655-660		sandstone	light gray orange	Fn	Vfn/C	Subangular and subrounded. Poor sorting. Trace chert fossils.
	660-665		sandstone	light gray orange	M	Fn/C	Subangular and subrounded. Poor sorting. Trace chert fossils.
	665-670		sandstone	light gray orange	Fn/M	Vfn/C	Subangular and subrounded. Poor sorting. Trace chert fossils.
	670-675		sandstone	light gray orange	Fn/M	Vfn/VC	Subangular and subrounded. Poor sorting. Trace chert fossils.
	675-680		sandstone	very pale orange	Fn/M	Vfn/VC	Subangular and subrounded. Poor sorting. Trace chert fossils, loose dolomite, silty shale.
	680-685		sandstone	very pale orange	Fn	Vfn/M	Subangular and subrounded. Poor sorting. Trace chert fossils.
	685-690		sandstone	very pale orange	Fn	Vfn/M	Subangular and subrounded. Poor sorting. Trace chert fossils.
	690-695		sandstone	very pale orange	Fn/M	Vfn/VC	Subangular and subrounded. Poor sorting. Trace chert fossils and loose dolomite.
	695-700		sandstone	very pale orange	Fn/M	Vfn/VC	Subangular and subrounded. Poor sorting. Trace chert fossils and loose dolomite.

Title: Geologic Log

	Depths	Graphic	RockType	Color	Mode	Range	Miscellaneous Characteristics
	700-705		sandstone	light gray orange	Fn/M	Vfn/VC	Subangular and subrounded. Poor sorting. Trace glauconite.
	705-710		sandstone	light brown	Fn/M	Vfn/VC	Subangular and subrounded. Poor sorting. Trace quartz gravel (granules), chert, silt and glauconite.
	710-715		sandstone	dark gray orange	M	Vfn/VC	Subangular and subrounded. Poor sorting. Trace quartz gravel (granules), glauconite.
	715-720		sandstone	light red orange	M/C	Vfn/VC	Subangular and subrounded. Poor sorting. Trace quartz gravel (granules), loose dolomite, siltstone, glauconite and calcite.
Mount Simon Formation	720-725		sandstone	light gray orange	C/VC	Fn/VC	Subangular. Poor sorting. Trace quartz gravel (granules).
	725-730		sandstone	light gray orange	C/VC	Fn/VC	Subangular. Poor sorting. Trace quartz gravel (granules).
	730-735		sandstone	brown & mixed	M/C	Fn/VC	Subangular. Poor sorting. Mostly hard siltstone. Trace quartz gravel.
	735-740		sandstone	brown & mixed	M/C	Fn/VC	Subangular. Poor sorting. Mostly hard siltstone and red shale. Trace quartz gravel.
	740-745		sandstone	brown & mixed	M/C	Fn/VC	Subangular. Poor sorting. Mostly hard sitlstone. Trace quartz gravel.
	745-750		sandstone	brown & mixed	M/C	Fn/VC	Subangular. Poor sorting. Mostly hard sitlstone.

AECOM

APPENDIX B

GEOPHYSICAL LOGS

WGNHS Geophysical Logs

WELL ID: DN-930

WELL NAME: MWU #15

DATE:

LOCATION: Sec28, T8N R10E
Quarter, Section, Township, Range/ LAT-LONG/ WTM

County: Dane

Elevation: 886 ft

Well Depth (Logger):

Logged by:

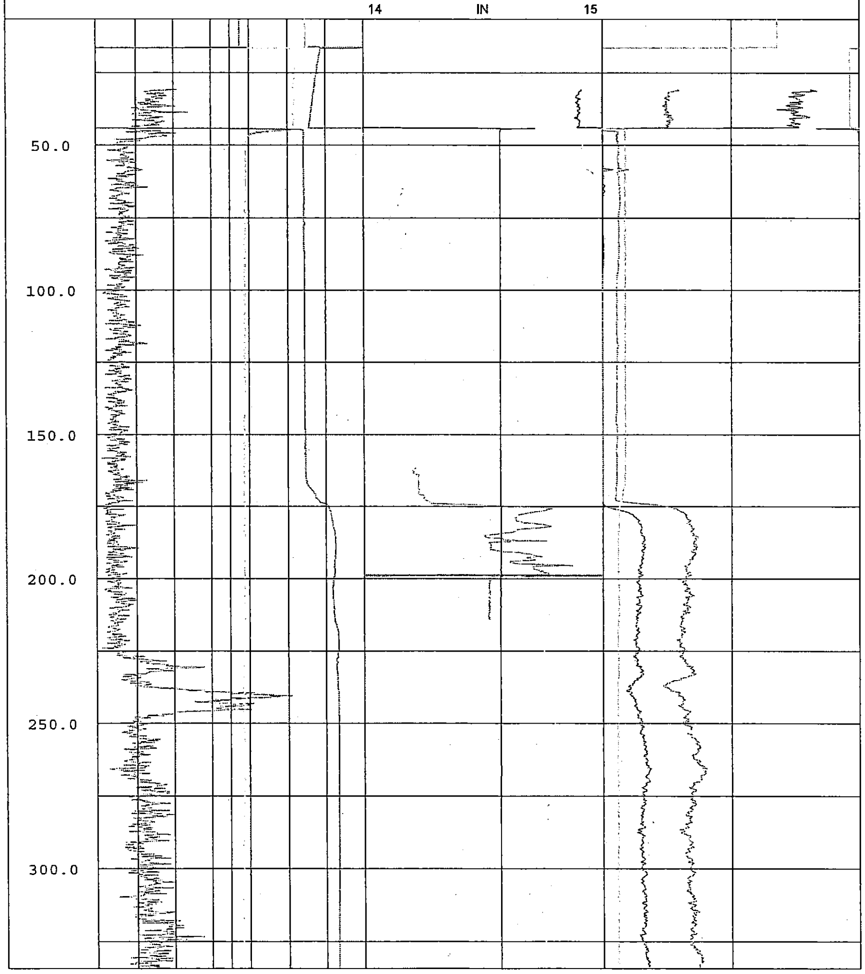
Depth to Water: **Casing Depth:** **Casing Stick-up:**

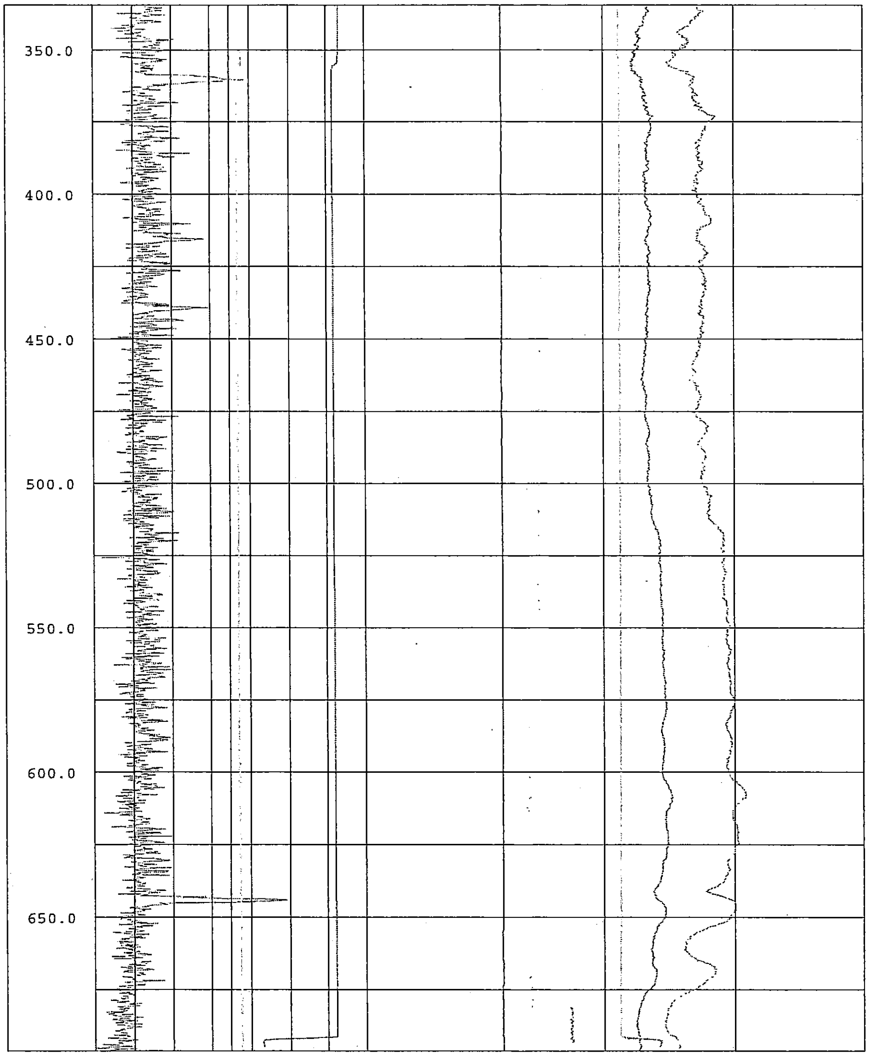
Comment:

LOGS COLLECTED:

Gamma	X	Fluid Conductivity	X
Caliper	X	Flow Meter- HeatPulse	
Single Point Resistivity	X	Flow Meter- Spinner	
Self Potential	X	Optical Borehole Imager	
Normal Resistivity	X	Acoustic Borehole Imager	
Fluid Temperature	X	OTHER:	

Depth	Gamma	SP	R8
1ft:500ft	0 CPS 70	0 MV 1000	0 OHM-M 200
	TEMP	SPR	R32
	0 DEG_C 20	-40000 OHM 30000	0 OHM-M 1000
	COND	Caliper	F-Res
	-1000 US/CM 1000	14 IN 15	0 OHM-M 200
		Caliper#2	
		14 IN 15	




350.0
400.0
450.0
500.0
550.0
600.0
650.0

APPENDIX C

PLUMBNESS AND ALIGNMENT TEST DATA AND ANALYSES

DN-930

Madison Water Utility -Sunnyside Well Alignment Test
July 13, 1965 - casing not grouted

	Depth	N(act)	E
1.	0	0	0
2.	9'-8¼"	3/16"	1/4"
3.	19-4½	3/16	3/8
4.	29-0-3/4	0	5/8
5.	38-9	0	25/32
6.	48-5-¼	0	3/4
7.	58-1½	0	1-5/16
8.	67-9-3/4	½	1¼
9.	77-6	9/32	1-11/16
10.	87-2¼	0	1-9/16
11.	96-10½	0	1-23/32
12.	106-6-3/4	3/8	1-7/8
13.	116-3	13/32	2-1/32
14.	125-11¼	7/8	2-3/16
15.	135-7½	15/16	2-11/32
16.	145-3-3/4	1"	2-15/16
17.	155-0	1-1/16	3-3/16
18.	164-8¼	1-1/8	3-3/8
19.	174-4½	1-3/8	3-9/16
20.	184-0-3/4	1¼	3-3/4
21.	193-9	1-5/16	3-15/16
22.	203-5¼	1-3/8	4-1/8
23.	213-1½	1-7/16	4-5/16
24.	222-9-3/4	2¼	4½
25.	232-6	2-11/32	4-11/16
26.	242-2¼	2-7/16	4-7/8

	Depth	N (act)	E
27.	251-10½	1-11/16	4-7/32
28.	261-6-3/4	2-5/8	5¼
29.	271-3	2-23/32	5-7/16
30.	281-11¼	3-3/4	5-5/8
31.	290-7½	3-7/8	5-13/16
32.	300-3/4	5"	6"
33.	310	5-5/32	6-3/16
34.	319-8¼	6-3/8	7-7/16
35.	329'-4½"	6-9/16"	7-21/32"

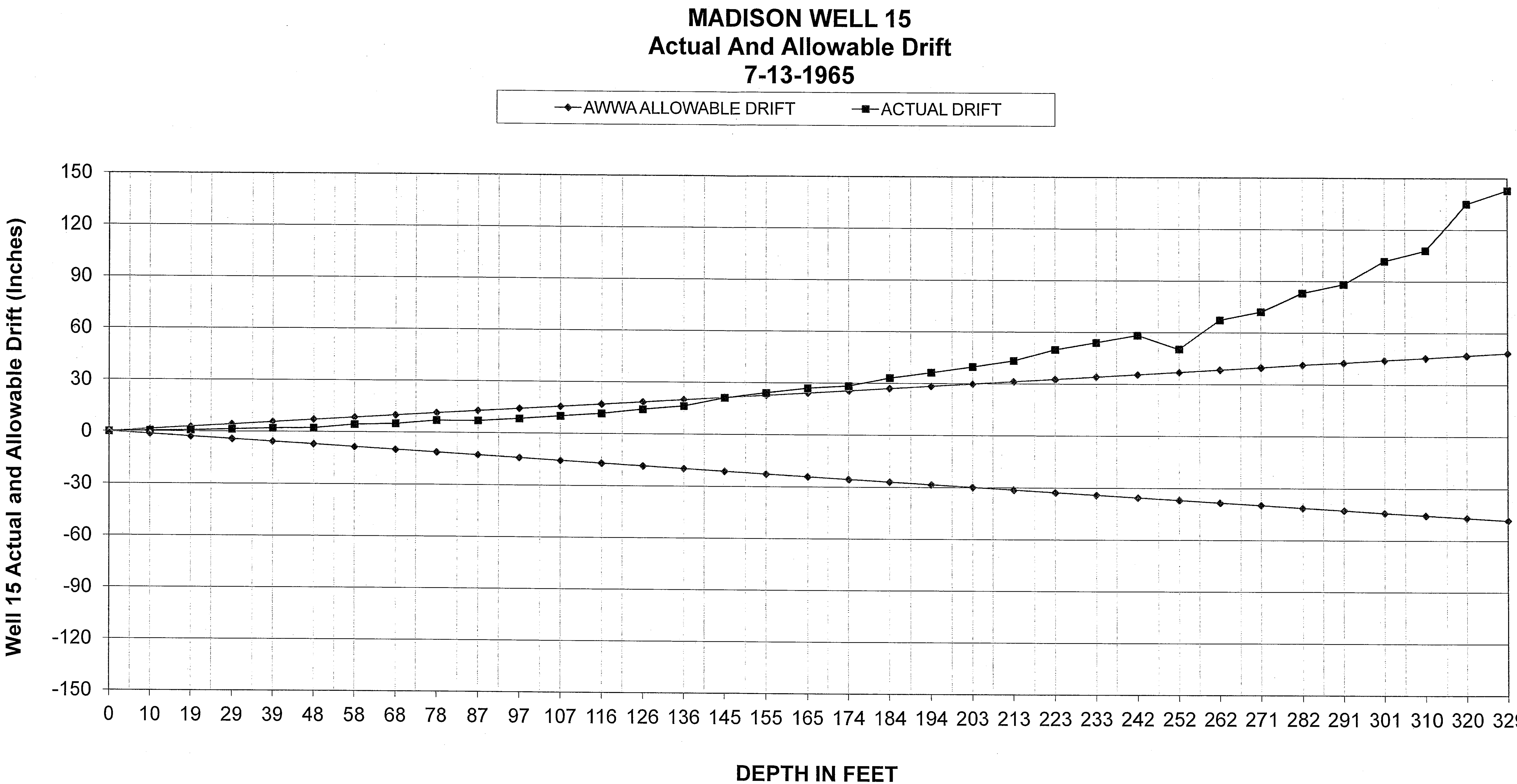
AWWA A100 Plumbness and Alignment Test
MADISON WELL 15

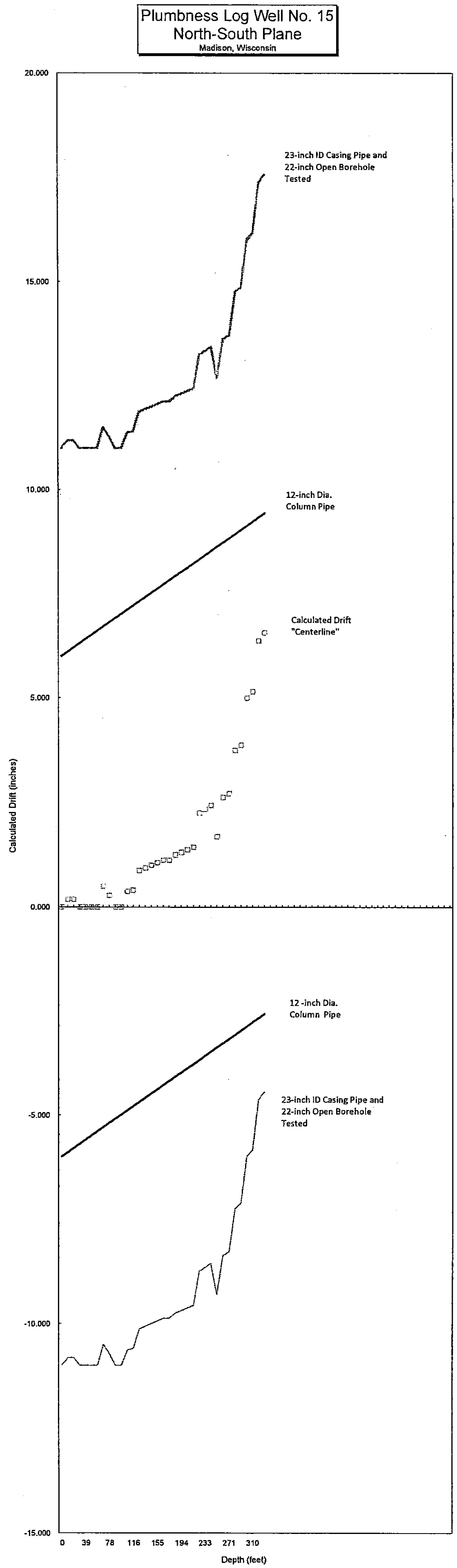
Contractor: Mileager Well Drilling
Well No.: 15
Engineer:

Date: July 13, 1965
Casing Diameter 22.00
Hang Point (Ft): 25.000

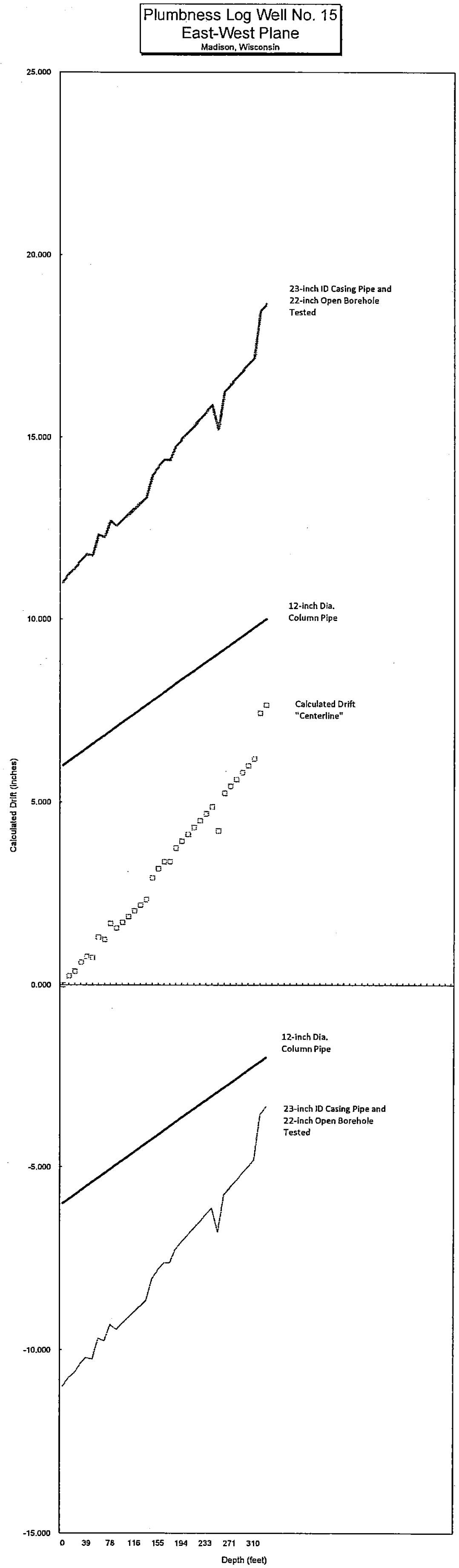
Total Depth: 329
Depth Increment: 10

DEPTH (Feet Below Top of Casing)	FIELD DATA IN SIXTEENTHS INCH				DEFLECTION OF PLUMB LINE FROM CENTER (Inches)		ALIGNMENT (Inches)			AWWA ACTUAL DRIFT LIMIT (Inches)
	North	South	East	West	North/South	East/West	North/South	East/West	Actual Drift (inches)	
0					0.000	0.000	0.000	0.000	0.000	0.000
9.71	3		4		0.188	0.250	0.260	0.347	0.434	1.424
19.38	3		6		0.188	0.375	0.333	0.666	0.744	2.843
29.06		0	10		0.000	0.625	0.000	1.352	1.352	4.262
38.75		0	12.5		0.000	0.781	0.000	1.992	1.992	5.684
48.44		0	12		0.000	0.750	0.000	2.203	2.203	7.105
58.13		0	21		0.000	1.313	0.000	4.364	4.364	8.526
67.81	8		20		0.500	1.250	1.856	4.641	4.998	9.946
77.5	5		27		0.281	1.688	1.153	6.919	7.014	11.367
87.19			25		0.000	1.563	0.000	7.012	7.012	12.789
96.88			27.5		0.000	1.719	0.000	8.379	8.379	14.210
106.56	6		30		0.375	1.875	1.973	9.867	10.062	15.630
116.25	7		32.5		0.406	2.031	2.295	11.477	11.704	17.051
125.94	14		35		0.875	2.188	5.283	13.207	14.225	18.472
135.63	15		37.5		0.938	2.344	6.024	15.059	16.219	19.893
145.31	16		47		1.000	2.938	6.812	20.011	21.139	21.313
155	17		51		1.063	3.188	7.650	22.950	24.191	22.734
164.69	18		54		1.125	3.375	8.536	25.608	26.993	24.156
174.35	18		54		1.125	3.375	8.971	26.912	28.368	25.573
184.06	20		60		1.250	3.750	10.453	31.359	33.055	26.997
193.75	21		63		1.313	3.938	11.484	34.453	36.317	28.418
203.48	22		66		1.375	4.125	12.566	37.699	39.738	29.845
213.13	23		69		1.438	4.313	13.692	41.077	43.299	31.261
222.81	36		72		2.250	4.500	22.303	44.606	49.871	32.680
232.5	38		75		2.344	4.688	24.141	48.281	53.980	34.102
242.19	39		78		2.438	4.875	26.051	52.102	58.252	35.523
251.88	27		67.5		1.688	4.219	18.689	46.724	50.323	36.944
261.56	42		84		2.625	5.250	30.089	60.178	67.281	38.364
271.25	44		87		2.719	5.438	32.217	64.434	72.040	39.785
281.94	60		90		3.750	5.625	46.041	69.062	83.002	41.353
290.63	62		93		3.875	5.813	48.923	73.384	88.197	42.628
300.75	80		96		5.000	6.000	65.150	78.180	101.768	44.112
310	83		99		5.156	6.188	69.094	82.913	107.928	45.469
319.69	102		119		6.375	7.438	87.896	102.545	135.060	46.890
329.38	105		122.5		6.563	7.656	93.025	108.529	142.941	48.311


MADISON WELL 15
Actual And Allowable Drift
7-13-1965
AWWA ALLOWABLE DRIFT
ACTUAL DRIFT
Well 15 Actual and Allowable Drift (Inches)
150
120
90
60
30
0
-30
-60
-90
-120
-150
0 10 19 29 39 48 58 68 78 87 97 107 116 126 136 145 155 165 174 184 194 203 213 223 233 242 252 262 271 282 291 301 310 320 329
DEPTH IN FEET



Plumbness Log Well No. 15
North-South Plane
Madison, Wisconsin
20.000
15.000
10.000
5.000
0.000
-5.000
-10.000
-15.000
Calculated Drift (inches)
23-inch ID Casing Pipe and
22-inch Open Borehole
Tested
12-inch Dia.
Column Pipe
Calculated Drift
"Centerline"
12 -inch Dia.
Column Pipe
23-inch ID Casing Pipe and
22-inch Open Borehole
Tested
0
39
78
116
155
194
233
271
310
Depth (feet)



Plumbness Log Well No. 15
East-West Plane
Madison, Wisconsin
25.000
20.000
15.000
10.000
5.000
0.000
-5.000
-10.000
-15.000
Calculated Drift (Inches)
23-inch ID Casing Pipe and
22-inch Open Borehole
Tested
12-inch Dia.
Column Pipe
Calculated Drift
"Centerline"
12-inch Dia.
Column Pipe
23-inch ID Casing Pipe and
22-inch Open Borehole
Tested
0
39
76
116
155
194
233
271
310
Depth (feet)

APPENDIX D

REFERENCES

REFERENCES

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