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▶AUTHOR **CATO, REBECCA** ▶TO **FILE** ▶DATE **01/22/04**

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INDIVIDUAL ASSIGNED TO ACTION DEPARTMENT

ACTION REQUIRED

DUE DATE ACTION ITEM LOG NUMBER

CLOSE ACTION ITEM

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COMPLETION DATE APPROVAL

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Stoller
Weldon Spring Site

established 1959

Memorandum

DATE: January 21, 2004

TO: File

FROM: Rebecca Cato RCC 1/21/04

SUBJECT: Evaluation of Unweathered Wells at the Chemical Plant

An evaluation of the unweathered wells present at the chemical plant was made in support of the *Proposed Plan for Final Remedial Action for the GWOU*. Of the 9 unweathered wells at the site, 3 of these wells display suspect hydrologic conditions and groundwater quality. This evaluation included review of construction history of these 3 wells, hydrologic behavior of wells in the unweathered unit (existing and abandoned), and groundwater quality in the unweathered and comparisons with nested weathered wells (existing and abandoned).

It was concluded that although these 3 wells were constructed to monitor the unweathered unit, it is likely that the wells are influenced by the overlying weathered unit. Either due to poor well construction/design or deterioration, the screened intervals are not isolated to the unweathered unit only. Therefore, these 3 wells do not adequately monitor the water quality of the unweathered unit.

If you have any questions or comments, please contact me at 926-7038.

ATTACHMENT: Technical evaluation and associated figures (14)

Distribution: Administrative Record for the GWOU - 2 copies

EVALUATION OF UNWEATHERED WELLS AT THE CHEMICAL PLANT

Historically, 22 wells have been utilized at the Weldon Spring site to characterize and monitor the groundwater quality in the unweathered portion of the Burlington-Keokuk Limestone (Fig. 1). Thirteen of these wells have been abandoned due to soil remediation activities or construction activities at the site. Of the remaining 9, three of these wells display suspect hydrologic conditions and groundwater quality.

Presently, three unweathered wells (MW-3024, MW-3026, and MW-4011) show impact from past operations at the chemical plant and former ordnance works. Several factors, such as groundwater elevations, chemical data, well construction, and behavior of other nearby unweathered wells were taken into account to determine whether these wells are impacted by groundwater from the overlying weathered unit or if they represent the groundwater quality in the unweathered unit.

1.0 CONSTRUCTION HISTORY

1.1 MW-3024

This well was installed on the east side of Raffinate Pit 3 in 1993 (Fig. 1). It was a retrofit of MW-3008, an open hole well that was 101 ft deep and extended 27 ft into the unweathered portion of the Burlington-Keokuk Limestone (Fig. 2). The well was installed in the original 3-inch borehole. A shale trap was placed 77 ft below the ground surface and a bentonite pellet seal and grout were placed above the trap to seal the well. No filter pack was used; rather a "filter sock" was placed over the 2-inch PVC materials to filter materials from the groundwater. Water levels in this unweathered well were similar to those measured in MW-3008 and were 1 to 2 feet higher than those measured in an adjacent weathered well (MW-3025) that was installed at the same time (Fig. 3).

This well was damaged in 1996 by heavy equipment. The well was reinstalled in the original location. The borehole was reamed to 6 inches to a depth of 97 feet below the ground surface and extends 23 ft into the unweathered unit. A 10-ft screen was installed and the filter pack extended 3 ft above the top of the screen (Fig. 4). Water levels in the newly constructed well dropped approximately 10 feet (Fig. 3).

1.2 MW-3026

This well was installed on the southwest side of Raffinate Pit 4 in 1993 (Fig. 1). It was a retrofit of MW-3009, an open hole well that was 99 ft deep and extended 43 ft into the unweathered unit (Fig. 5). The well was installed in the original 3-inch borehole. A shale trap was placed 75 ft below the ground surface and a bentonite pellet seal and grout were placed above the trap to seal the well. No filter pack was used; rather a "filter sock" was placed over the 2-inch PVC materials to filter materials from the groundwater. Water levels in this unweathered well were similar to those measured in MW-3009. Water level in an adjacent weathered well (MW-3023) that was installed at the same time were 3 to 4 feet higher (Fig. 6).

STATE OF MISSOURI
REBECCA C CATO
REGISTERED GEOLOGIST
1-21-04

1.3 MW-4011

This well was installed in 1988 and is located north of Raffinate Pit 4 and west of the Ash Pond area on the Army property. The well is 79 feet deep and extends 20 ft into the unweathered unit. The well is constructed of 2-inch stainless steel materials with a 10-ft screen. The filter pack extends 1.5 ft above the top of the screen and a 3 ft bentonite pellet seal was installed (Fig. 7).

2.0 GROUNDWATER ELEVATIONS

A potentiometric surface map using the average groundwater elevation in 2002 for the unweathered unit is attached (Fig. 8). This map shows a ridge with its axis along a line connecting wells MW-3024, MW-3026, and MW-D025 (army well). As a comparison, a potentiometric map of the unweathered was constructing using data from 1992 (Fig. 9), a period when more wells screened in the unweathered were available. This map shows a similar ridge trending through the Raffinate Pit area; however, the water levels in the vicinity of the pits were lower (e.g., MW-3002 = 596.6 ft). If recharge from the raffinate pits had an impact on the groundwater elevations in the unweathered unit, it would be expected that the water levels would have decreased after removal. Review of several of the existing unweathered wells (MW-3006 and MW-4007) in the vicinity of the raffinate pits indicates slight decreases in water levels, likely due to removal of he recharge from the pits. This would indicate that the higher groundwater elevations measured in MW-3024 and MW-3026 are likely too high (> 600 ft) to represent the head within the unweathered unit.

Comparison of the groundwater elevation in MW-4011 with surrounding unweathered wells shows that the water level is 4 to 10 feet higher in MW-4011. The water levels measured in MW-4011 fit more in line with nearby weathered monitoring wells. This would indicate that the groundwater elevations in MW-4011 are likely too high to represent the head within the unweathered unit.

Hydrographs of the unweathered wells over time were evaluated to determine patterns in water level fluctuations and similar behavior among the unweathered wells (Figs. 10 and 11). Wells located away from the raffinate pits were evaluated first due to possible influences of recharge from the pits. Generally, the unweathered wells exhibit similar groundwater fluctuations over time. Wells in close proximity to the raffinate pits deviated from the pattern during the period of time the pits were used for water storage (early to mid 1990's).

After reconstruction of MW-3024 in 1996, the changes in water level generally followed those of the other unweathered wells; however, larger fluctuations were observed (Fig. 3). Monitoring well MW-3026 did not fit the typically patterns observed in the other unweathered wells and indicated an larger downward trend in water level, similar to those observed in the weathered wells in this area (Fig. 6). Monitoring well

MW-4011 also deviates from the typically pattern showing larger fluctuations in groundwater levels and an overall increasing trend in water levels (Fig. 12).

3.0 GROUNDWATER QUALITY

Nitrate concentrations in MW-3008 ranged between 4,000 mg/l to 6,000 mg/l from 1987 through 1989. In 1990, concentrations ranged between 600 mg/l to 1,000 mg/l. After installation of MW-3024, nitrate concentrations were within the same range. Concentrations measured in the reinstalled MW-3024 were similar to those measured earlier. A downward trend has been observed at this location. Presently, nitrate ranges between 100 mg/l to 300 mg/l. TCE was initially observed in MW-3024 prior to reinstallation in 1997. TCE has recently been detected (2000) at levels up to 6 μg/l. Uranium levels greater than background (0.93 pCi/l) for the weathered Burlington-Keokuk Limestone have been observed in both MW-3008 and MW-3024. After reinstallation in 1997, uranium levels increased to greater than 50 pCi/l. Nitroaromatic compounds (2,4-DNT and 2,6-DNT) have consistently been observed in both MW-3008 and MW-3024.

Nitrate concentrations in MW-3009 ranged from 2 mg/l to 560 mg/l. Three results during 1987 through 1993 ranged between 1000 and 3000 mg/l. Review of groundwater elevations does not indicate a correlation with high or low water levels. After installation of MW-3026, nitrate levels ranged between 100 and 250 mg/l. Nitroaromatic compounds (1,3,5-TNB, 2,4-DNT, and 2,6-DNT) have consistently been observed in both MW-3009 and MW-3026. Uranium levels in both MW-3009 and MW-3026 have been higher than background for the weathered Burlington–Keokuk Limestone.

The nitroaromatic compound 2,6-DNT has consistently been detected in MW-4011. Nitrate has ranged between 10 and 300 mg/l. Uranium has consistently been greater than background for the weathered Burlington–Keokuk Limestone prior to 1999.

Review of the other unweathered wells at the site, both active and abandoned, indicates that the groundwater in the unweathered unit has been slightly impacted. Uranium levels and nitrate concentrations greater than background have been observed, however, widespread impact and concentrations greater than MCLs have not been seen. Sporadic detects of nitroaromatic compounds have been reported, but with no consistency. Elevated nitrates were reported in MW-2016 (1988), but this location was abandoned due to well integrity.

Two other weathered/unweathered well pairs were located adjacent to the raffinate pits – MW-3001/MW-3002 (abandoned) and MW-3003/MW-3006/MW-3023 (existing). At these two locations, the weathered well has (or had) substantial amounts of nitrate (maximum > 1000 mg/l); however, the unweathered pair has no nitrate impact (< 4 mg/l) (Figs. 13 and 14).

4.0 SUMMARY AND CONCLUSIONS

4.1 Summary for the Unweathered Unit

- Groundwater quality data for the unweathered wells at the site indicate limited impact from past operations at the chemical plant or former ordnance works.

- At locations where significant groundwater impact has occurred in the weathered unit, nested unweathered wells show no or limited vertical migration of contaminants.

- Hydrographs of the unweathered wells over time show similar behavior or patterns in groundwater fluctuations among the unweathered wells.

4.2 Summary for MW-3024, MW-3026, and MW-4011

- Groundwater elevations in MW-3024, MW-3026, and MW-4011 are higher than those typically measured in the unweathered Burlington-Keokuk Limestone at the chemical plant indicating that although these wells are constructed to monitor the unweathered unit, it is likely that the monitoring intervals are influence by the overlying weathered unit.

- Changes in groundwater elevation in MW-3024, MW-3026, and MW-4011 do not follow the pattern observed in the remainder of the unweathered wells at the chemical plant. These three wells showed larger fluctuations in groundwater elevation similar to larger fluctuations observed in wells screened in the weathered unit.

- MW-3026 shows a decline in groundwater levels typical of those observed in the weathered unit after dewatering and removal of the raffinate pits.

- Monitoring wells MW-3024, MW-3026, and MW-4011 have consistently exhibited elevated levels of nitrate and nitroaromatics. Uranium levels observed in these wells are above background levels for the weathered unit of the Burlington-Keokuk Limestone.

4.3 Conclusions

Monitoring wells MW-3024, MW-3026, and MW-4011 do not adequately monitor the groundwater quality in the unweathered unit. Either due to poor well construction or design or deterioration, the screened intervals are not isolated to the unweathered unit only. Downward movement of contaminated groundwater from the overlying weathered unit past the seal of the well impacts these wells. This is reflected in the higher groundwater elevations measured in these wells and the analytical data that indicates groundwater impact in the unweathered unit.

LIST OF FIGURES

Figure 1	Unweathered Wells at the Weldon Spring Site.
Figure 2	Borehole Diagram – MW-3024
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Figure 4	Borehole Diagram – MW-3024 (Reinstallation)
Figure 5	Borehole Diagram – MW-3026
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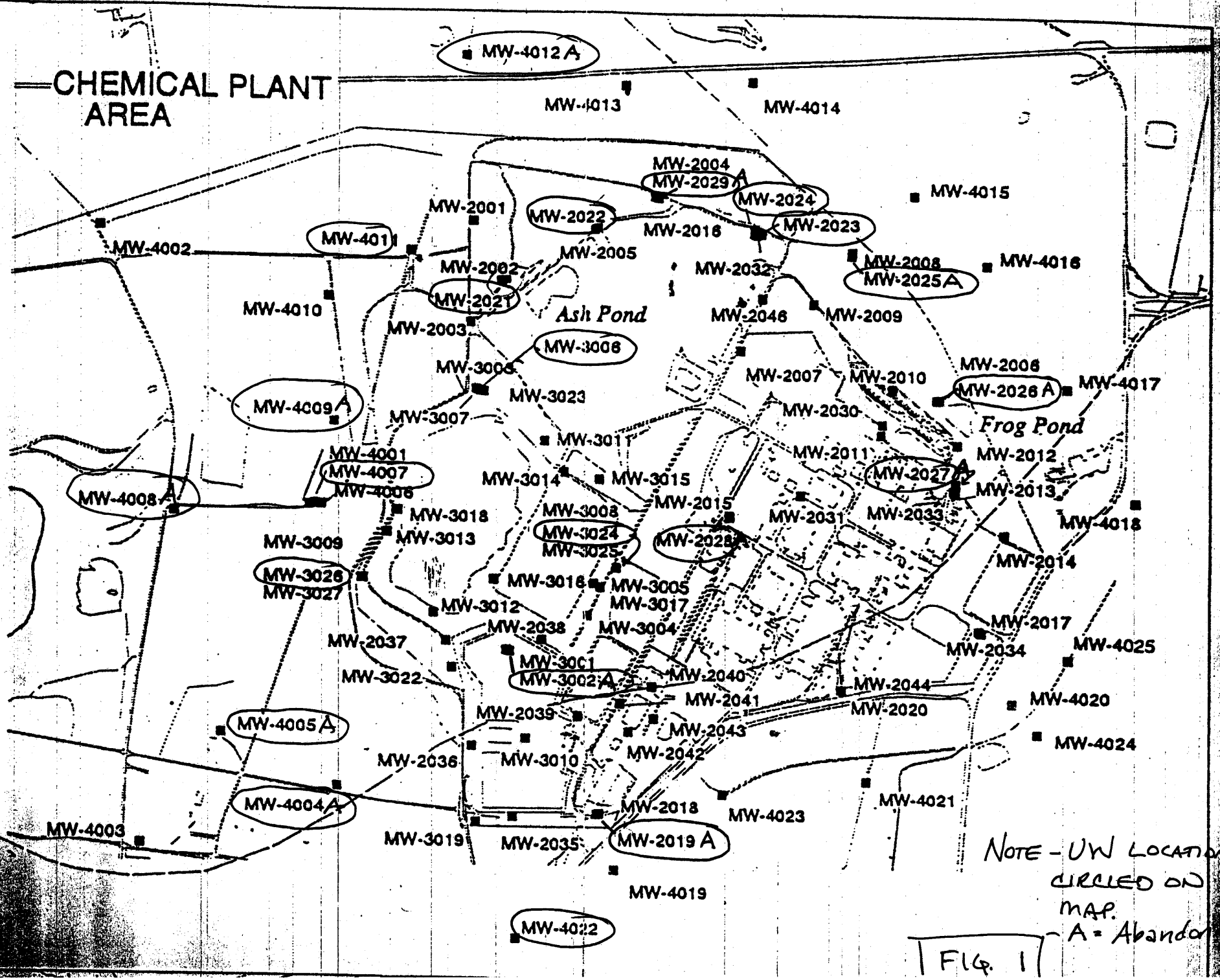
Figure 8	Potentiometric Surface – Unweathered Unit - 2002
Figure 9	Potentiometric Surface – Unweathered Unit - 1992
Figure 10	Hydrograph – 2000-Series Unweathered Wells
Figure 11	Hydrograph – 3000 and 4000-Series Unweathered Wells
Figure 12	Hydrograph – MW-4011
Figure 13	Nitrate – Time vs. Concentration Graph – MW-3001/MW-3002
Figure 14	Nitrate – Time vs. Concentration Graph – MW-3003/MW-3006/MW-3023



NOTE - UW LOCATIONS CIRCLED ON MAP.
- A = Abandon

FIG. 1

BOREHOLE DIAGRAM

MW-3024 r

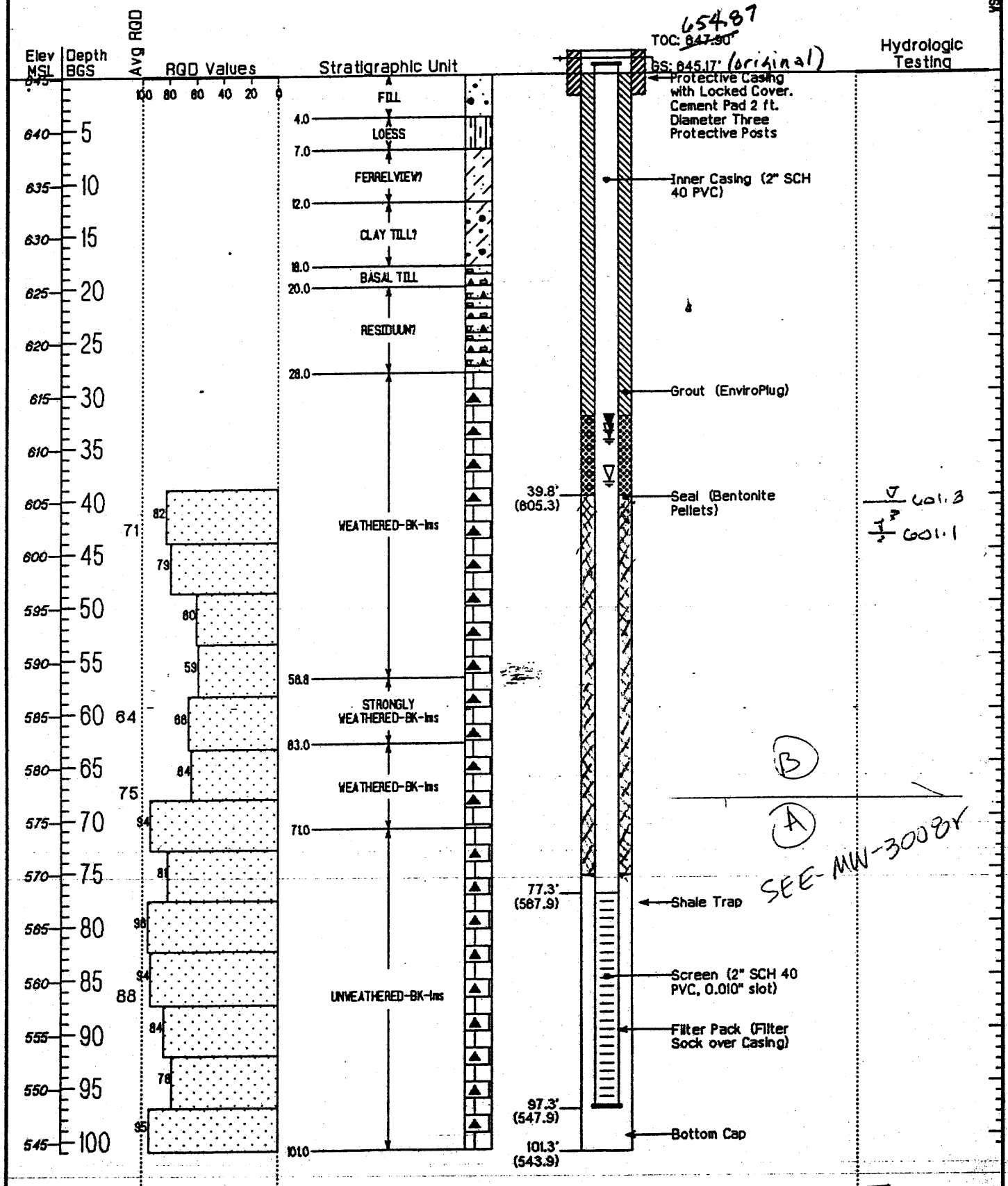
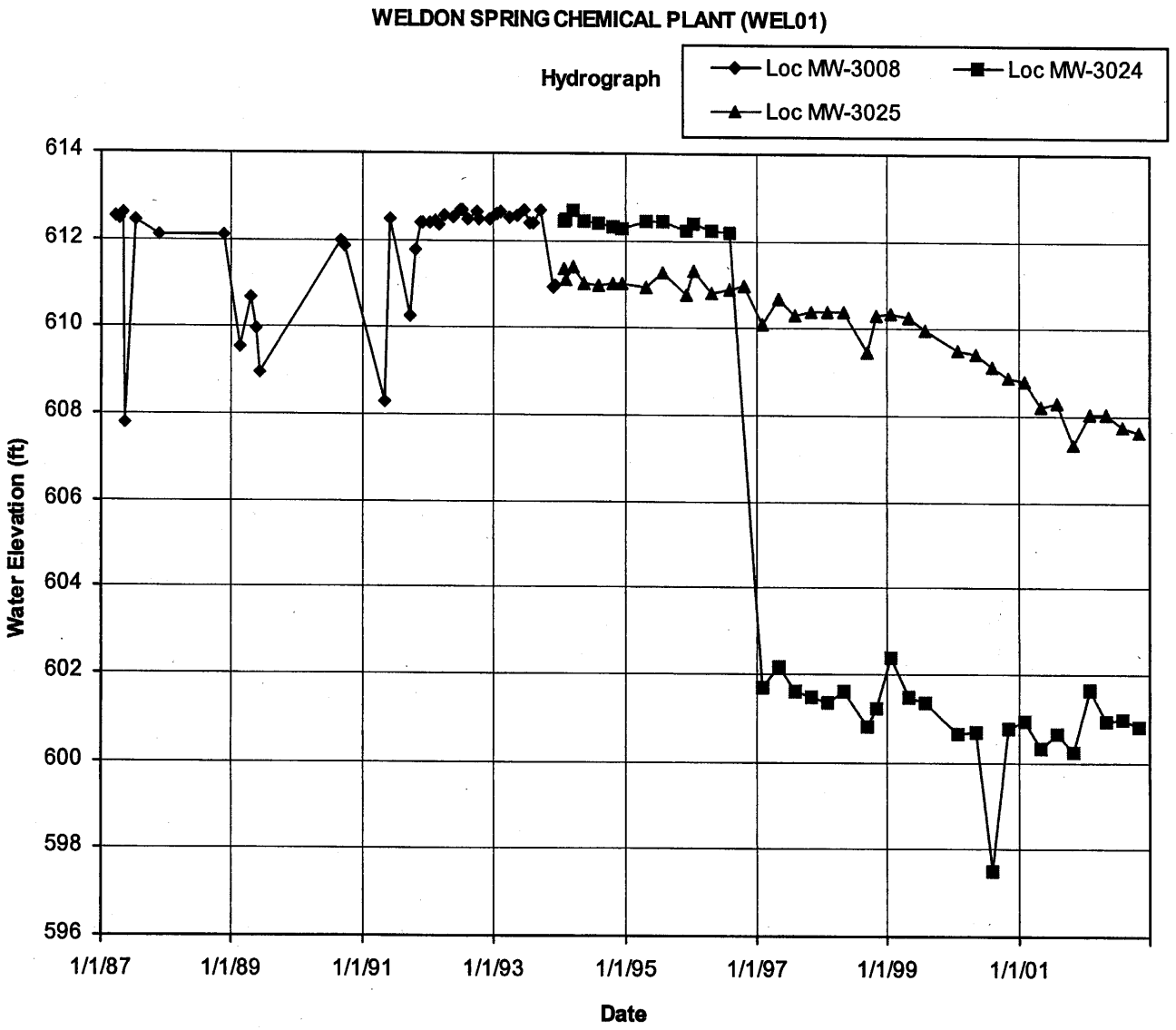


FIG 2



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MW-3008/MW-3024/MW-3025 FIG. 3

WELDON SPRING SITE REMEDIAL ACTION PROJECT
MONITORING WELL INSTALLATION DIAGRAM

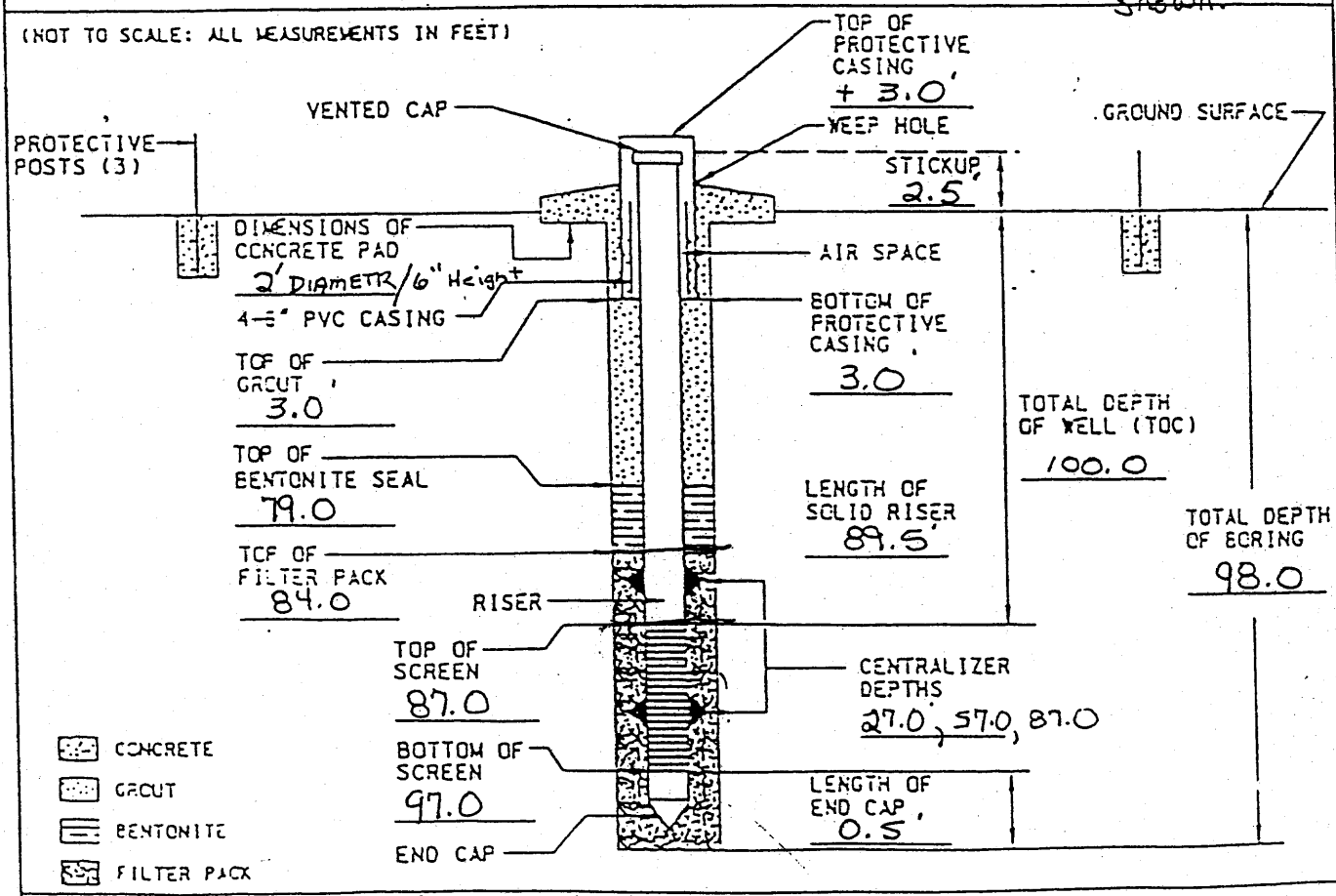
PROJECT NAME MW-3024 REPAIR WORK PACKAGE NO. 420
WELL NO. MW-3024 WELL LOCATION EAST OF PIT #3
DATE 11-08-96 TIME 1300 HRS. COORDINATES N: E:

GROUND SURFACE ELEVATION
TOP OF SCREEN ELEVATION
REFERENCE POINT ELEVATION
TYPE FILTER PACK SAND GRADATION 10/20
FILTER PACK MANUFACTURER BEST SAND
SCREEN MATERIAL PVC
MANUFACTURER BOART-LONGYEAR
SCREEN DIAMETER 2.0" SLOT SIZE .010"
RISER MATERIAL PVC
MANUFACTURER BOART-LONGYEAR
RISER DIAMETER 2.0"
DRILLING TECHNIQUE 6 1/4" I.D. H.S.A. to 23.0'
6.0" Air Rotary to 98.0'
AUGER/BIT SIZE AND TYPE

BENTONITE TYPE GROUT-WELL/ENVIROPLUG
MANUFACTURER WYO-BEN
GROUT TYPE GROUT-WELL/ENVIROPLUG
MANUFACTURER WYO-BEN
GROUT WEIGHT 9.4 to 9.7 lbs./gal.
BOREHOLE DIAMETER 10 1/4" O.D.
FIELD REPRESENTATIVE John C. Bostwick
DRILLING CONTRACTOR GEOTECHNOLOGY, INC.
AMOUNT BENTONITE USED 6 bags at 50 lbs. each
AMOUNT CEMENT USED bags at 80 lbs. each
AMOUNT SAND USED 5 bags at 50 lbs. each
STATIC WATER LEVEL (>24 hrs. after dev.)
MEASURED ON (date/time)

REMARKS ~~NONE~~ NB Originally installed as B-19A, retrofitted to MW-3008, retrofitted again to MW-3024, damaged and reinstalled as shown.

(NOT TO SCALE: ALL MEASUREMENTS IN FEET)



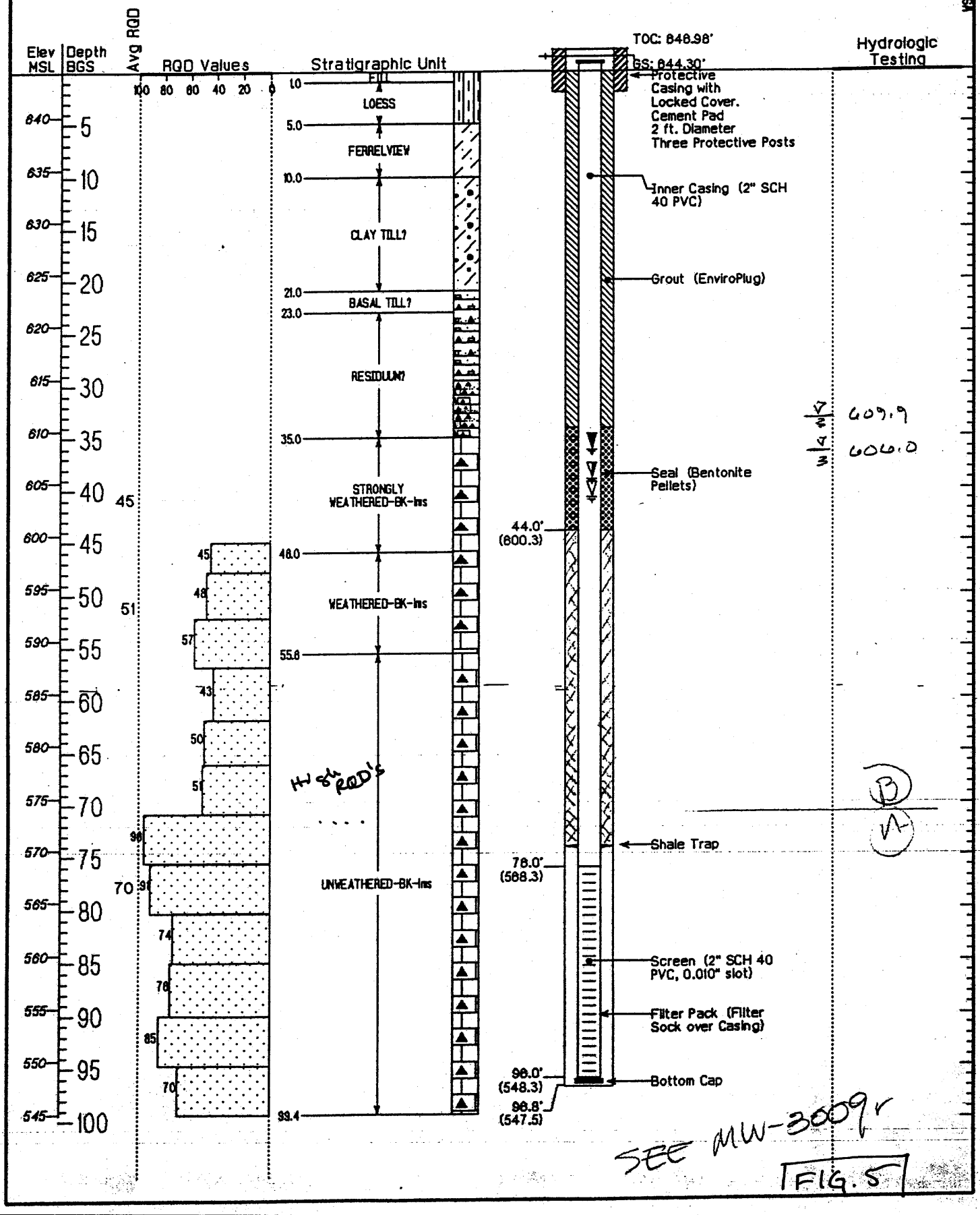
QA/QC
DRILLER: Paul Guertein INSPECTOR: John C. Bostwick
DISCREPANCIES: CHECKED BY: DATE:

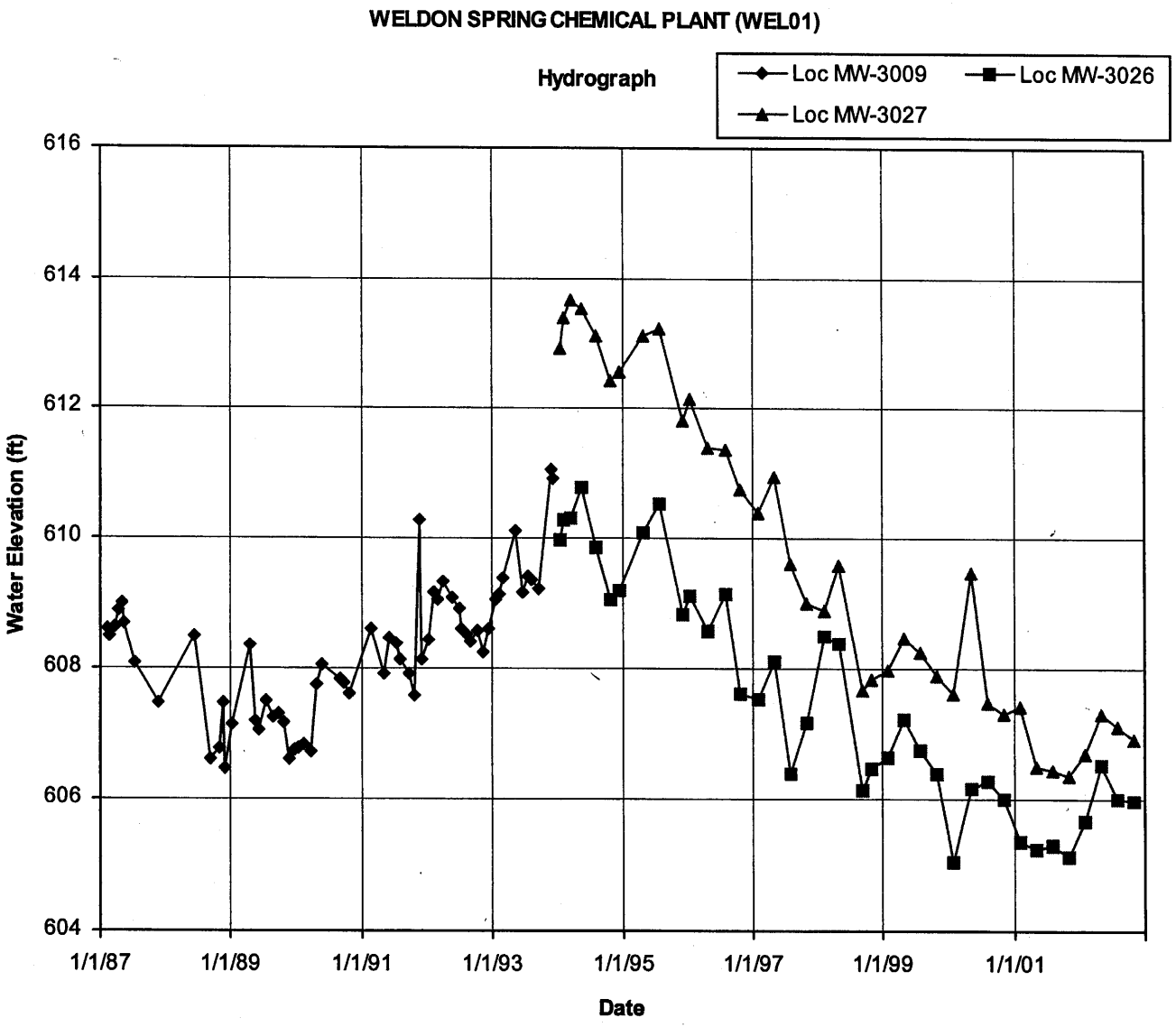
N/P1/CS2/0495
04/03/95

FIG. 4

BOREHOLE DIAGRAM

MW-3026 r





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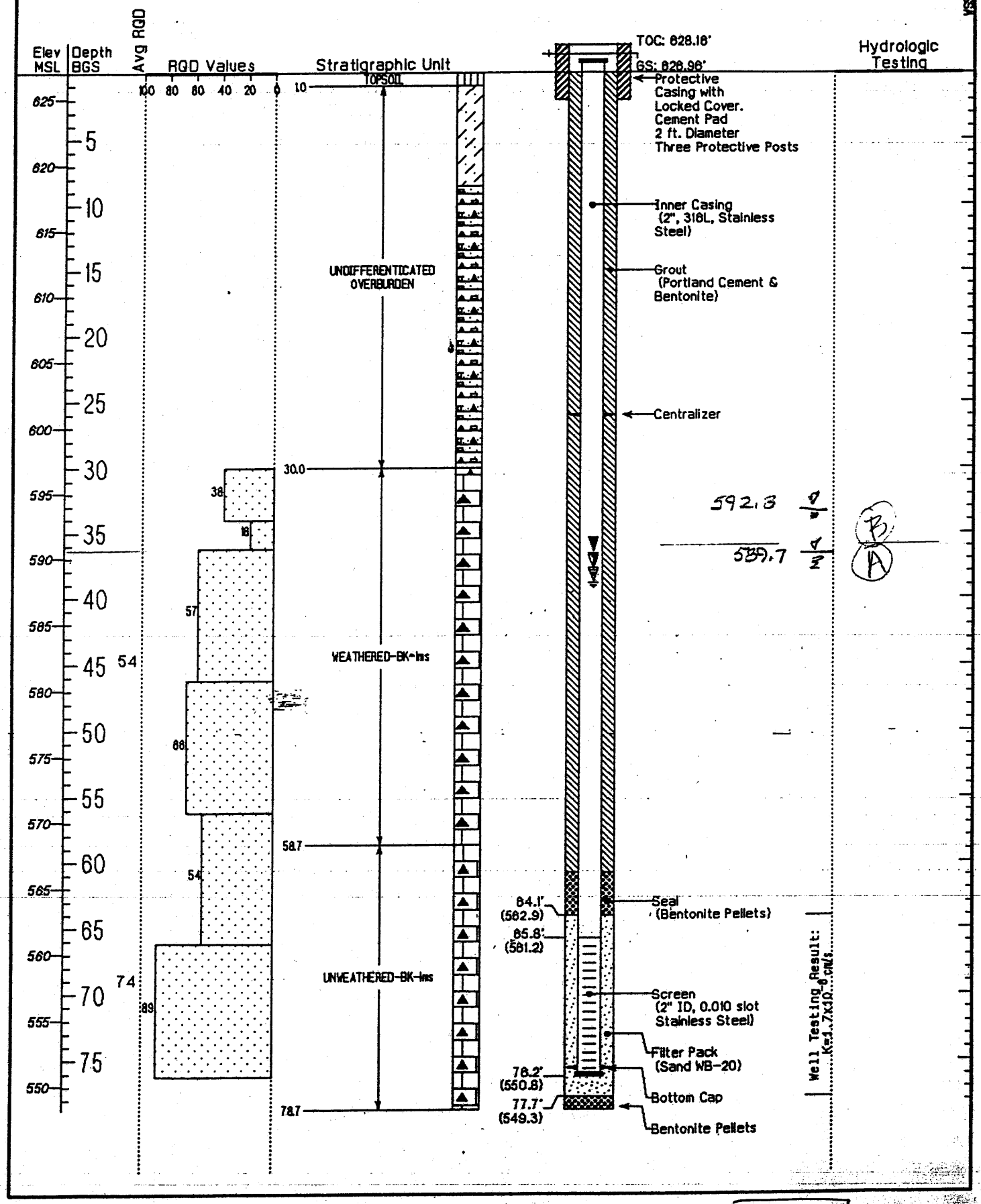
MW-3009/MW-3026/MW-3027

FIG. 6

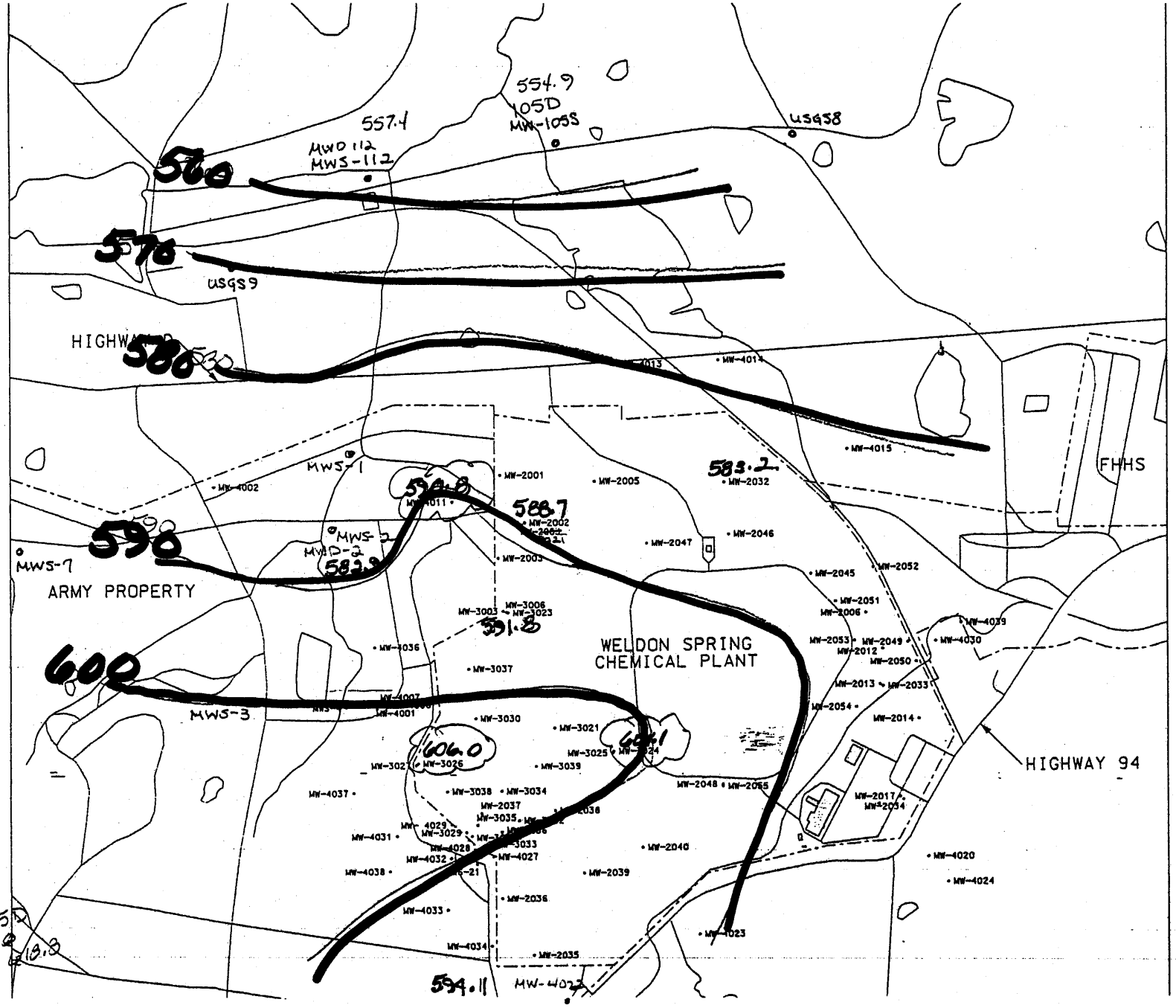
BOREHOLE DIAGRAM

MW-4011



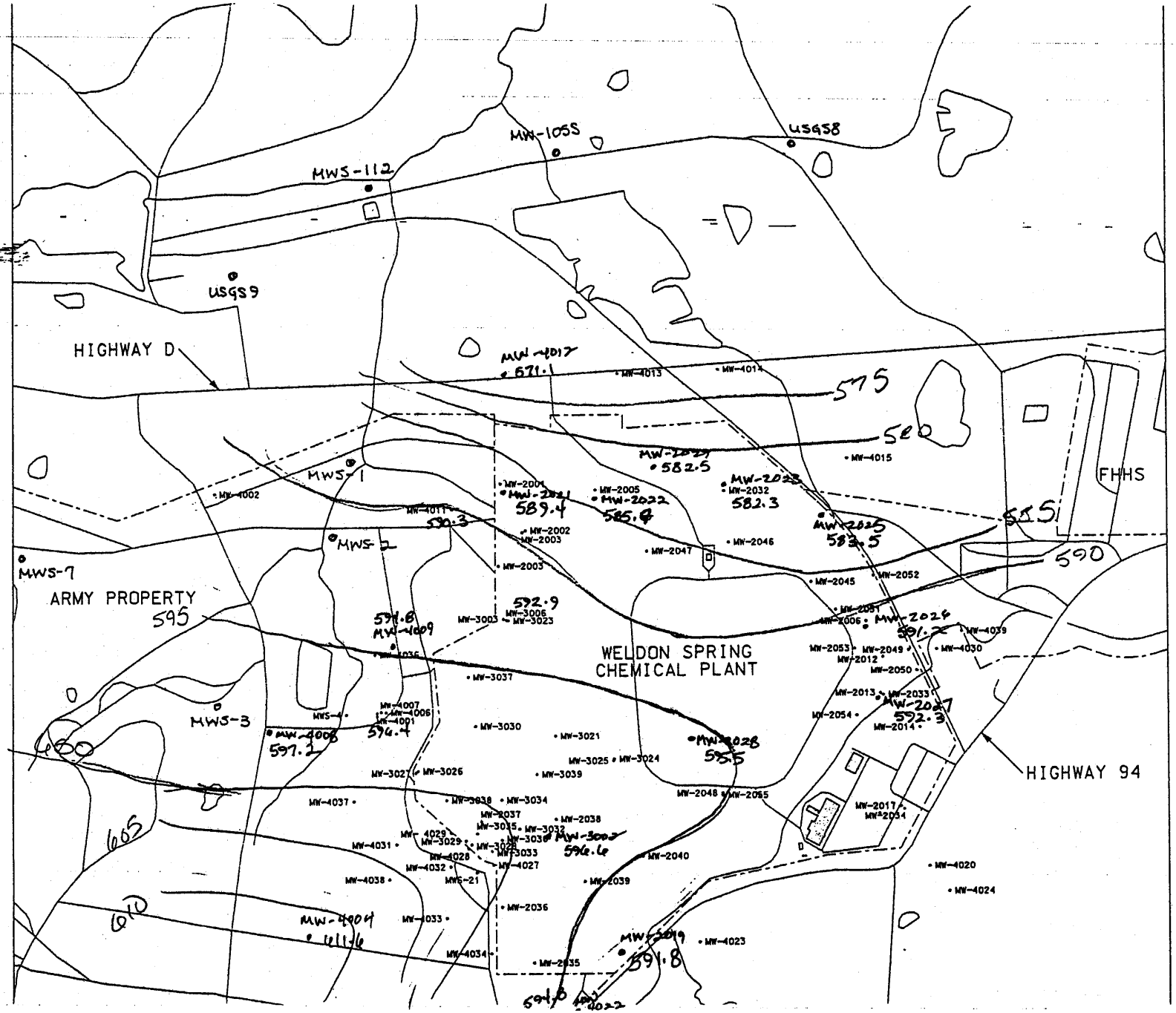
▽minimum ▼maximum ▼average

FIG. 7



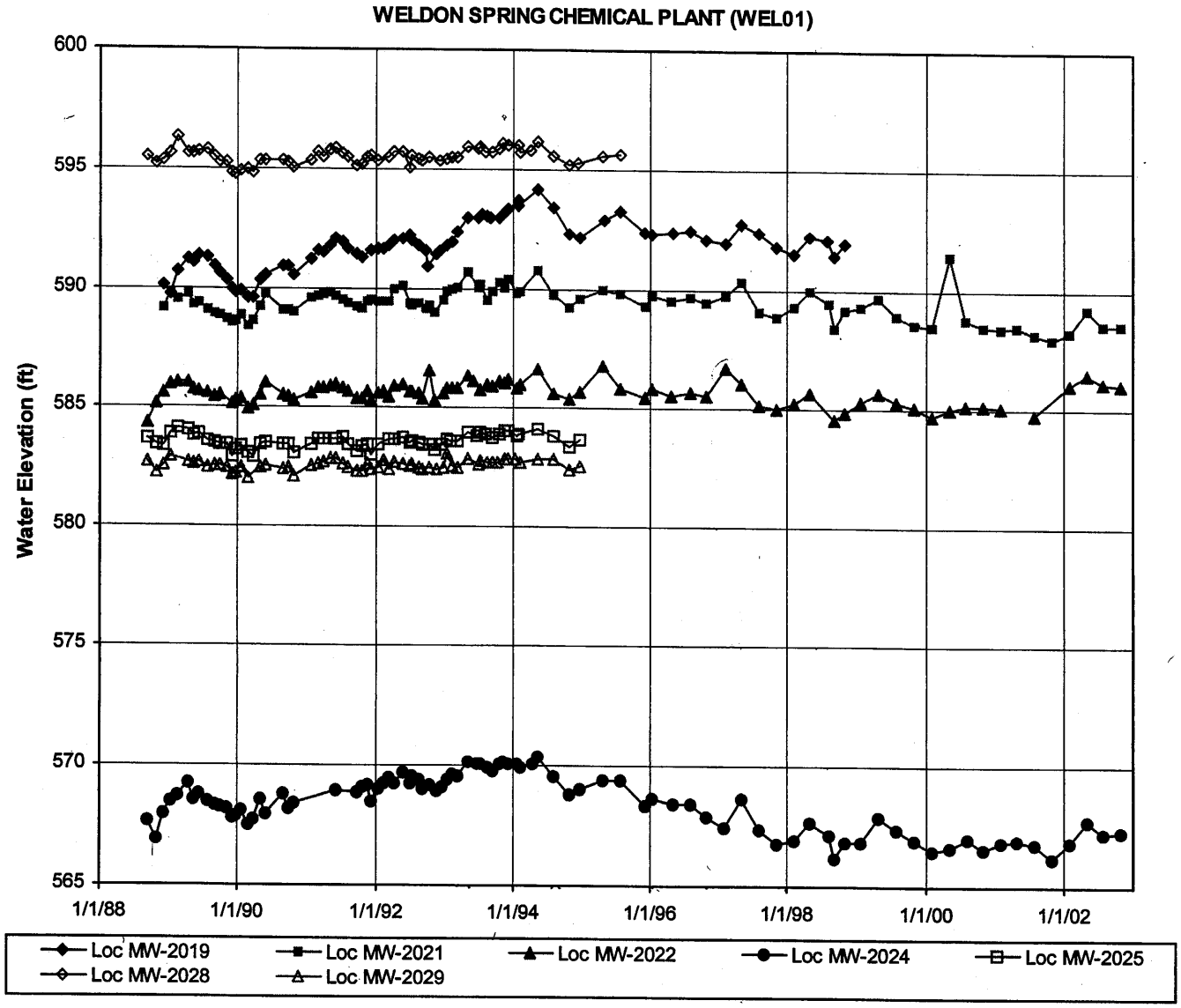
P. SURF
UW
2002

FIG. 8



P. SURF
UW
1992

FIG. 9



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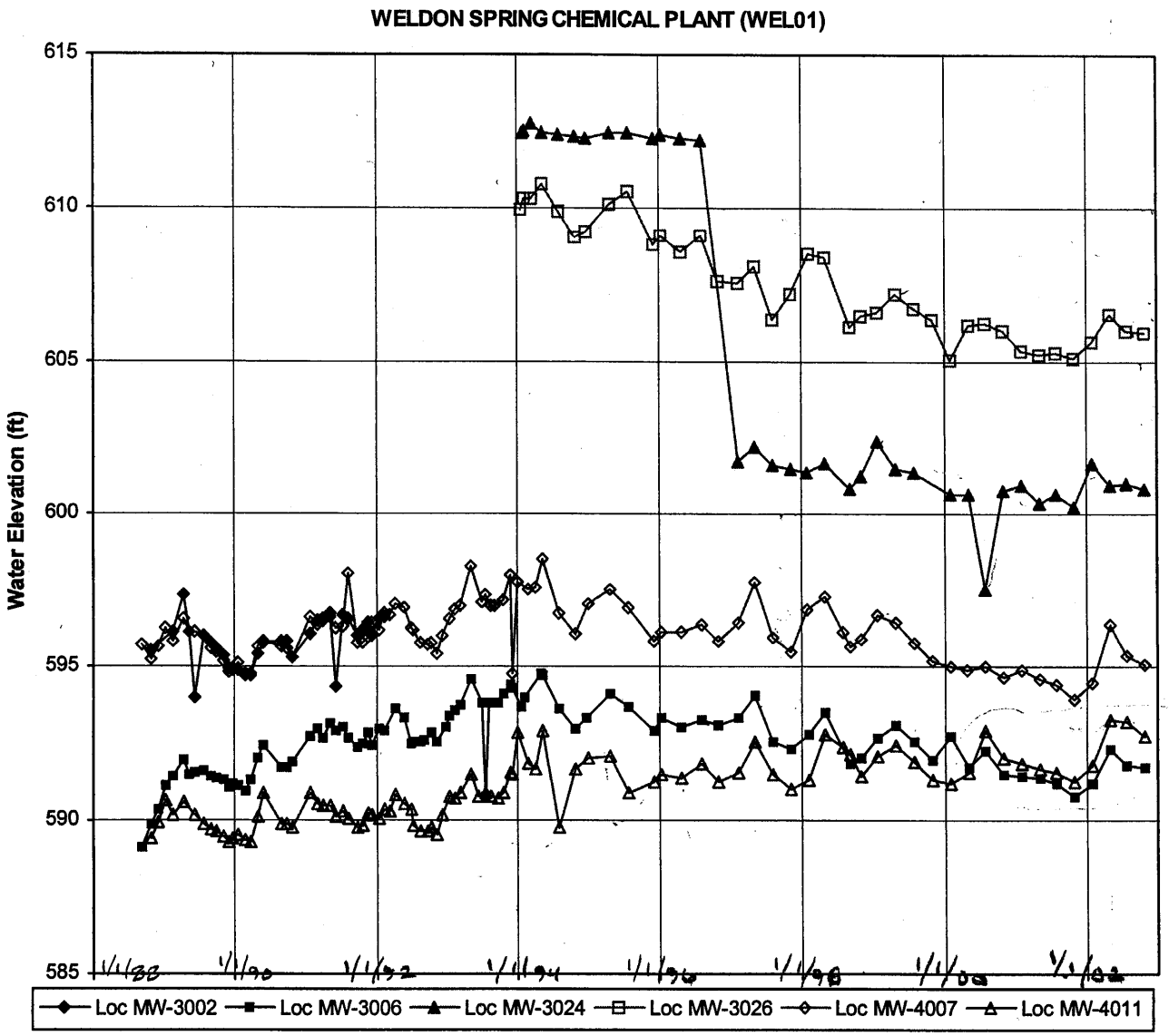
HYDROGRAPH 2000-SERIES WELLS

FIG. 10



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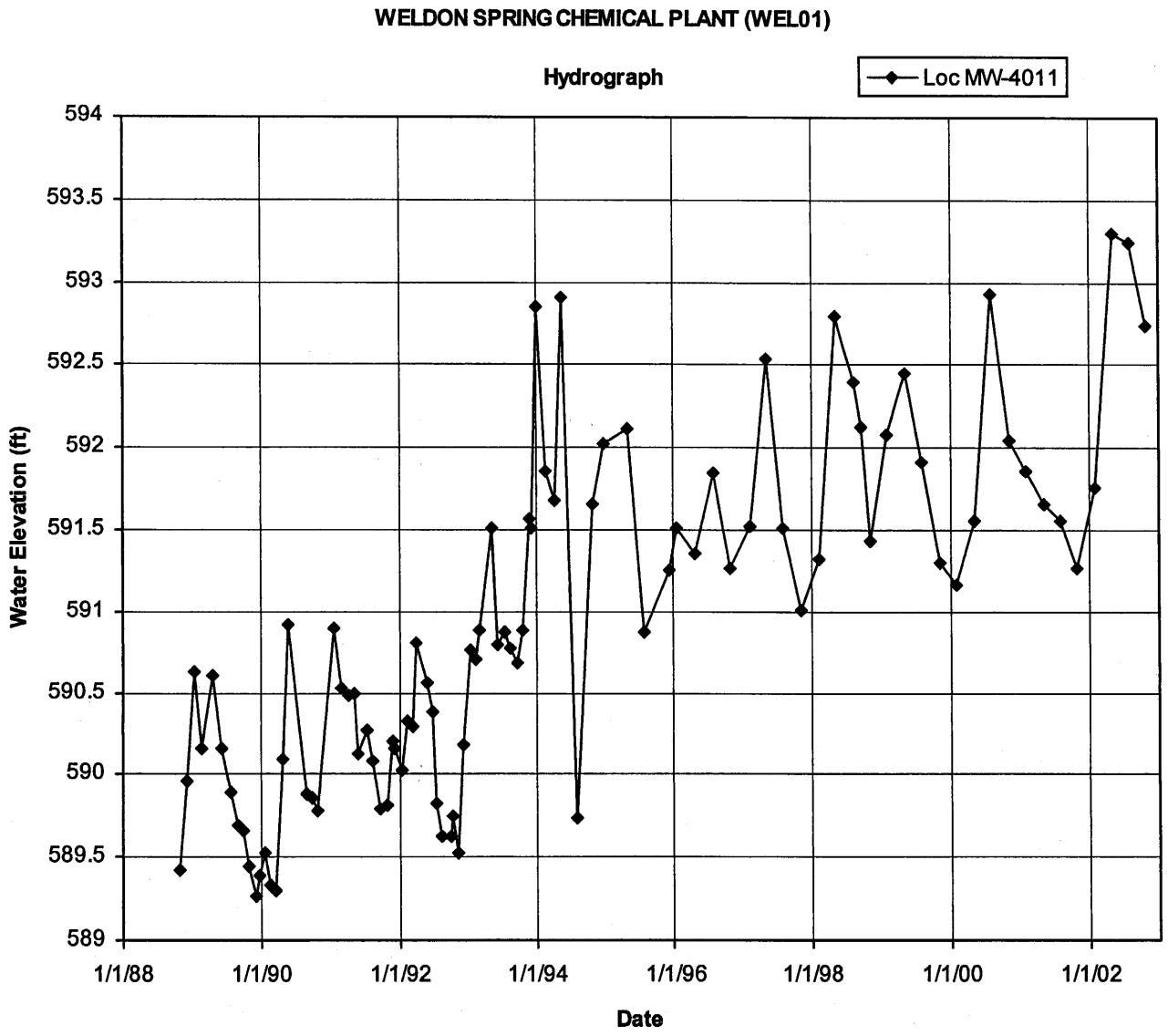
HYDROGRAPH 3000& 4000-SERIES WELLS

FIG. 11



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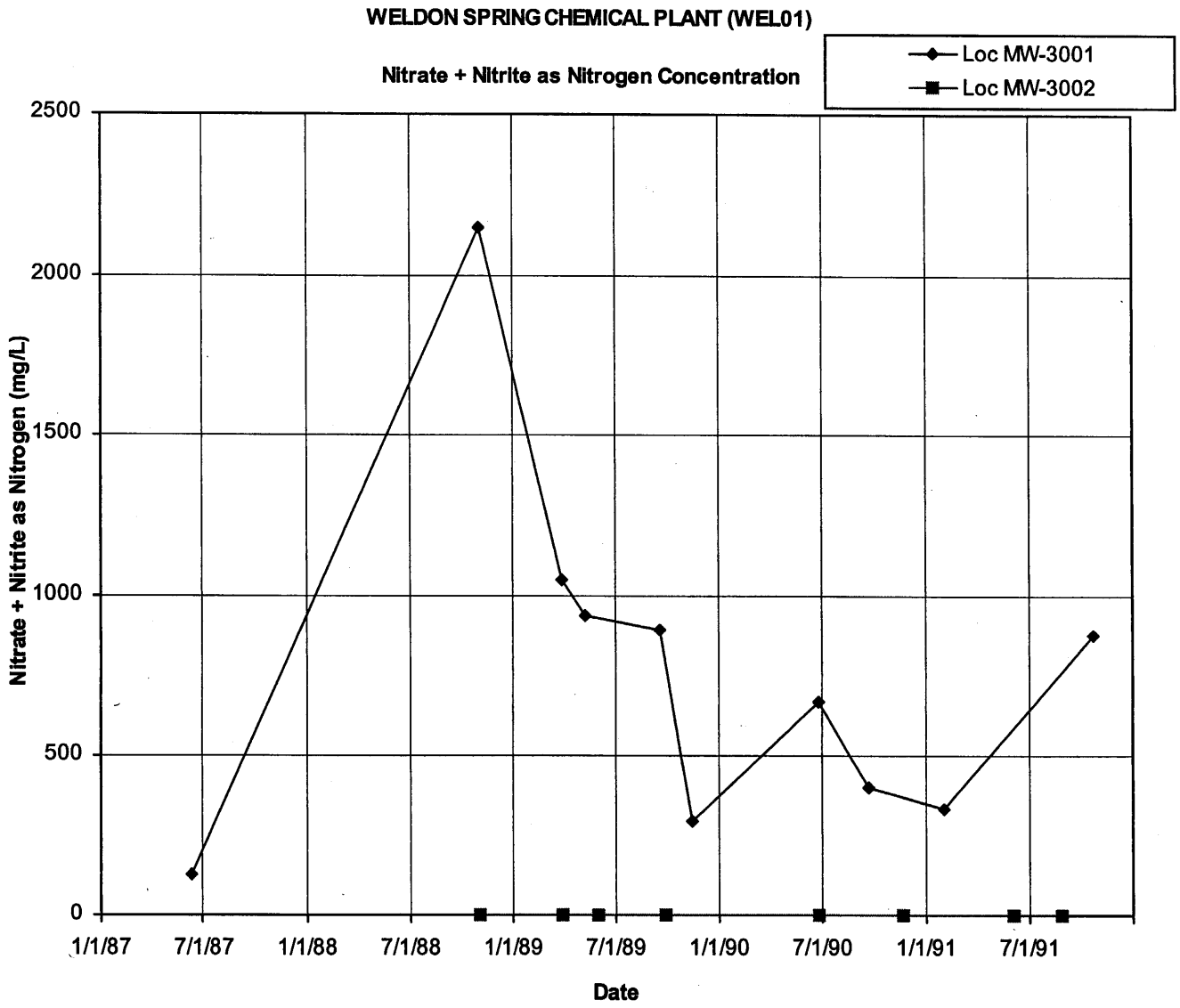
HYDROGRAPH - MW-4011

FIG. 12



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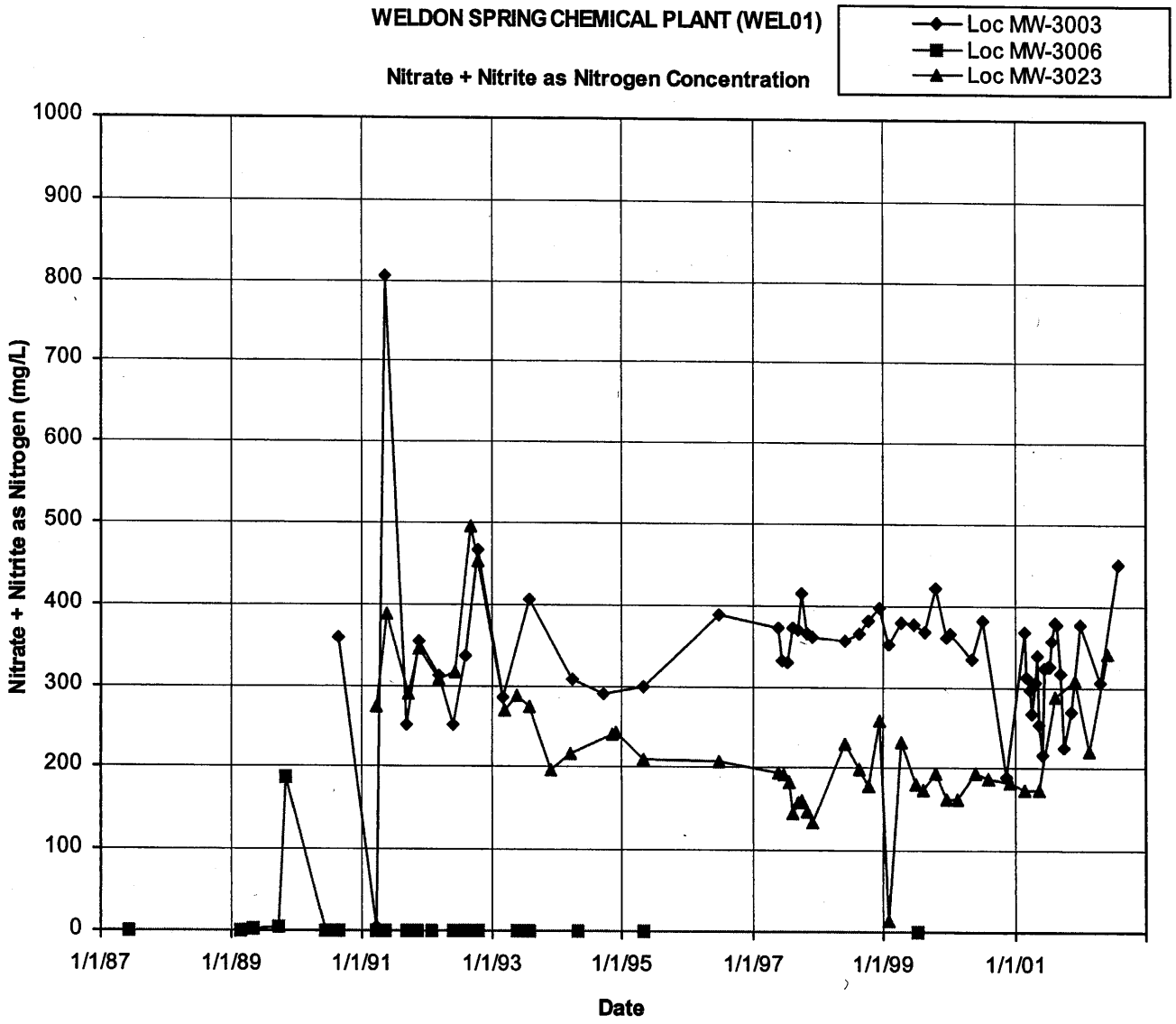
NITRATE
T VS. CONC - MW 3001/3002
[FIG. 13]



2/19/2003 8:20 am

NITRATE
T. VS CONC - MW 3003/3006/3023
[FIG. 14]