PNNL-16069

Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

# Development of Historical Water Table Maps of the 200 West Area of the Hanford Site (1950-1970)

T. M. Kinney
J. P. McDonald

September 2006

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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# Summary

A series of detailed historical water-table maps for the 200 West Area of the Hanford Site was made to aid interpretation of contaminant distribution in the upper aquifer. The contaminants are the result of disposal of large volumes of waste to the ground during Hanford Site operations, which began in 1944 and continued into the mid-1990s. Examination of the contaminant plumes that currently exist on site shows that the groundwater beneath the 200 West Area has deviated from its pre-Hanford west-to-east flow direction during the past 50 years. By using historical water-level measurements from wells around the 200 West Area, it was possible to create water-table contour maps that show probable historic flow directions. These maps are more detailed than previously published water-table maps that encompass the entire Hanford Site.

The water-table maps in this paper, focusing on just the 200 West Area, were contoured at 1-meter (3.28-foot) intervals and demonstrate the effects that specific waste disposal sites had on the water-table elevation and groundwater flow direction. Seven maps were created for years that would provide the best representation of significant water-table changes. Time periods of significant changes were identified by examining historical water-level measurements that were taken periodically throughout the area. During the 1950s, groundwater elevation and flow direction changed rapidly; so water-table maps were made at 2-year intervals for the period 1950 to 1960. After the 1950s, far less rapid changes occurred in the water table, so maps were made at 5-year intervals from 1960 to 1970. This project ended with 1970 because detailed water-table maps of the 200 West Area already exist for years after 1970.

The new series of maps show that the groundwater flow direction changed significantly between 1950 and 1970, shifting at some times and places 180 degrees from pre-Hanford flow directions. The changes in flow direction can be explained by examining the volumes of effluent disposed to specific water sites. The new series of maps will be valuable as a reference during the clean up process of the Hanford Site.

# Acknowledgments

This work was prepared in partial fulfillment of the requirements of the U. S. Department of Energy, Office of Science Community College Initiative Program under the direction of Duane Horton in the Environmental Characterization and Risk Assessment Group at Pacific Northwest National Laboratory.

The first author would like to thank the U. S. Department of Energy and the Office of Science for the opportunity to participate in the Community College Initiative Program at Pacific Northwest National Laboratory. Special thanks go to mentor, Duane Horton, for the encouragement and guidance he provided during the ten week program. In addition, thanks to John McDonald for the endless supply of hydrogeological knowledge he supplied; Chris Newbill for always helping out with mapping and GIS; and thanks, also, to Royace Aikin and Dale Johns for the work they did to make this internship possible.

- T. M. Kinney

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# Table

# 1.0 Introduction

Plutonium production at the Hanford Site created large amounts of low-level liquid waste. This waste was disposed of in cribs, trenches, ditches, and ponds in many operational areas on the Hanford Site. One such area was the 10.4-square-kilometer (4-square-mile) 200 West Area (Figure 1). There were more than 80 low-level waste disposal sites in the 200 West Area prior to 1975 (Anderson 1976). Most of the waste infiltrated the soil column beneath unlined disposal facilities, and some has entered the groundwater.

The exact amount of waste disposed of in the 200 West Area through 1970 is not certain. Relying on the data available, however, it is possible that more than 240 billion liters (63 billion gallons) of waste were discharged to ground (Anderson 1976). Large amounts of liquid waste were disposed of in fairly short time periods and at relatively small disposal sites. This caused the water table to rise beneath those waste disposal sites that received appreciable amounts of waste, creating mounds on the water table. The mounds disrupted the pre-Hanford Site west-to-east groundwater flow direction as groundwater was forced to flow radially outward from the mounds (downgradient).

Historical water-table maps of the entire Hanford Site created by Kipp and Mudd (1974) demonstrate the effect mounds had on groundwater flow directions. However, these maps show only the effects of exceptionally large waste disposal sites throughout the entire Hanford Site and do not focus on any specific areas within the site. In addition, the older maps were contoured with 3.048-meter (10-foot) intervals and do not show details for specific areas of the Hanford Site. This report presents water-table maps with 1-meter (3.28-foot) intervals focusing on the 200 West Area to depict more accurately the gradient and flow direction in this area between 1950 and 1970. These maps will allow for further interpretation of contaminant distribution, thus contributing to the ongoing cleanup process at the Hanford Site.

# 2.0 Materials and Methods

The new water-table maps were created using historical water-level measurements from various wells in and around the 200 West Area. All water levels used for this study were obtained from the HydroDat database, maintained by PNNL, which contains records of water-level measurements for the Hanford Site from 1949 to the present. Detailed water-table maps of the 200 West Area already exist for post-1970, so this project focused on 1950 through 1970. A series of seven maps was produced to gain a more complete understanding of the rapid changes that occurred in the water table during this 20-year period. Because there were significant changes in the water table during the 1950s, as shown by periodic water level measurements, maps were made at 2-year intervals for the 1950s to document these changes. Post-1960 changes in the water table were less significant and far less rapid so maps were made at 5-year intervals from 1960 to 1970. Data were obtained from HydroDat, and water-table maps prepared, for December 1951, July 1954, May 1956, September 1958, December 1960, August 1965, and May 1970.

These dates were chosen based on which month in a given year had the most available data as well as providing the best spatial well coverage of the 200 West Area.

Wells suitable for water-table mapping were chosen based on depth, the length of the screened interval exposed to water, and whether or not they were drilled through the Ringold Formation lower mud unit, which is composed of fine grained particles and creates locally confining conditions. If a well was drilled deep enough to penetrate the lower mud unit and enter the Ringold Formation confined aquifer, the water-level measurements will not be indicative of the actual water table because of pressure differences between the upper, unconfined aquifer and the lower, confined aquifers (Freeze and Cherry 1979). Also, there may be vertical flow within wells having long screen intervals that can lead to misleading water-table measurements (Elci et al. 2003). For this reason, wells that were screened over an interval of more than 40 meters (130 feet) were generally not used. A shorter screen interval would have been preferable, but this would have resulted in many more wells being excluded since many older wells have large open intervals. However, measurements from wells that were drilled slightly deeper than desirable were used in areas where no other wells were available. Information about wells, including depth and screened interval length, was obtained from the Hanford Well Information System (maintained by Fluor Hanford, Inc.) which allows access to as-built diagrams and driller's logs for the wells.

To identify outlying water-level measurements, hydrographs of each well were created using data from HydroDat (Figure 2). Hydrographs show water-level measurement trends through time and allow the viewer to easily identify outlying measurements. Off-trend measurements were removed from the data set. However, measurements that were only slightly off trend were used in areas where no other data were available. Table 1 shows the total number of wells that were used for each map and Figure 3 shows a map of the 200 West Area with locations of all of the wells used for this study. All water-level data used are in Appendix A.

After the data had been thoroughly screened, base maps were created for each of the seven time periods using a Geographic Information System[1] (GIS). The base maps showed water-level elevations at appropriate well locations overlain on a map of the 200 West Area. Contour lines were drawn by hand, with a 1-meter (3.28-foot) contour interval. Linear interpolation defined the approximate location of contour lines; however, strict interpolation sometimes resulted in unexplainable oddities in the water-table map and thus was not always appropriate. Knowledge of waste disposal locations and amounts of waste disposed of provided rough estimates as to how the water table probably looked during specific time frames and was used as a guide when strict linear interpolation failed and contour lines had to be adjusted.

The hand-contoured maps were created as accurately as possible using the data and methods available. The maps were then scanned and a computer program was used to digitize the contours[2]. The X and Y coordinates defining the contours were then converted to Washington State Plane Coordinates and entered into the GIS) which was used to smooth the contours and produce the final maps.

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[1] ARC/INFO, Version 9.0, developed by Environmental Systems Research Institute, Inc. (ESWR).
[2] Engauge Digitizer, Version 2.14, GNU public license.

# 3.0 Results

The water-table maps in this report show how the water table beneath the 200 West Area of the Hanford Site was affected by waste disposal between 1950 and 1970. The maps show the progression of the effects that infiltration of liquid waste had on the water table, the approximate location and size of groundwater mounds that formed, as well as changes in the direction of groundwater flow at a given location and point in time. Prior to the start of Hanford site operations in 1944, the groundwater flow direction in the 200 West Area was inferred to be west to east (Kipp and Mudd 1974).

The first water-table map in the series, December 1951 (Figure 4), clearly shows a groundwater mound forming below the 216-T-4 Pond (T Pond) in the northwest portion of the 200 West Area. By this time, T Pond had received approximately 17.4 billion liters (4.6 billion gallons) of liquid waste (Anderson 1976). The flow direction lines around the T Pond mound in Figure 4 show that groundwater was forced to flow in a radial manner away from the center of the groundwater mound in all directions, at some points flowing west directly opposite the pre-Hanford flow direction. This map suggests that the T Pond mound overpowered any influence on the water table from other waste disposal sites that were in use in the 200 West Area prior to 1951.

The series of maps in Figures 4 through 10 show that a large groundwater mound beneath the 216-U-10 Pond (U Pond) in the southwest portion of the area began to form in 1954 and contributed to the enormous effects of the already existent T Pond mound. During the 1950s, the two groundwater mounds merge to become one large, elongated mound with a saddle in the water table between the two ponds (Figures 4 and 5). In the mid-1950s, because of the combined influence of the two ponds and the length of the saddle that had been formed, groundwater began to once again flow west to east in the eastern half of the 200 West Area (Figures 5 and 6). This was short lived; by 1958 the mound beneath U Pond became the dominate influence on the water table, and the influence from T Pond ceased. This occurred because the discharge volume to T Pond was significantly reduced (Figure 11). The maps also reveal that beneath T Pond and U Pond, water levels rose approximately 4 meters (13 feet) and 16 meters (52.5 feet), respectively, between December 1951 and May of 1956 as a result of the waste discharged in these areas. During this time (1951-1956), the U Pond mound grew at a rapid pace, while the T Pond mound had already developed before water levels in the 200 West Area began to be monitored; thus, the two mounds were nearly the same elevation but were growing at different rates during this time frame.

Changes in the appearance of the water table are fairly insignificant between 1960 and 1970. The main change observable in the maps is that the magnitude of the hydraulic gradient east of U Pond becomes smaller with time. However, the water levels continued to rise slightly, reaching nearly 147 meters (482 feet) above mean sea level at the well closest to the pond in May of 1970 (Figure 10). In addition, the maps of 1960, 1965, and 1970 (Figures 8, 9, and 10) show a slight mound forming near the 216-S-11 pond just south of U Pond.

# 4.0 Discussion and Conclusion

The new series of water-table maps show the major changes that occurred to the water table beneath the 200 West Area of the Hanford Site between 1950 and 1970. Gaps and inconsistencies in the historical water-level measurements for the 200 West Area are possible sources of uncertainty in the water-level interpretations. For instance, Figure 6 shows that in 1958 T Pond had ceased to influence the water table and that U Pond became the dominate influence over the water table. This does not mean that the T Pond mound disappeared from the water table. Figure 11 shows that T Pond was not active between 1957 and 1959; however, 1 or 2 years of inactivity probably would not be enough time for a mound the size of the T Pond mound to completely dissipate. Thus, it is likely a combination of insufficient water-level data around T Pond and the continuing growth of the U Pond mound that suggest that T Pond no longer influences the water table in 1958, rather than the groundwater mound actually disappearing altogether.

The same is true for earlier years (Figure 4) when U Pond was active but the water-table map shows no evidence of influence. The apparent lack of influence from U Pond has not been explained; however, U Pond didn't receive as much waste prior to 1952 as T Pond. Figure 11 shows that T Pond received approximately double the amount of waste that U Pond received, which would make the influence of U Pond secondary to that of T Pond. U Pond had begun to influence the water-table by 1954, at which time the discharges to U Pond were more than double the previous charges to T Pond.

The water-table map of 1951 (Figure 4) shows that the mound beneath T Pond is slightly elongated. This could be a result of the lack of data to the north of the pond or, more likely, a combination of the lack of data and the large amounts of waste that were discharged into the 216-T-32 (27.4 million liters [7.2 million gallons]) and 216-T-7 (110 million liters [26.4 million gallons]) cribs (DOE/RL-91-61), located just to the south of T Pond, prior to 1951 (Anderson 1976). Considering the size of the mound below T Pond and the location of the two cribs in relation to it, it is very probable that waste from the cribs, upon reaching groundwater, was simply assimilated into the larger mound, elongating the original mound from T Pond southward.

The saddle that formed between T Pond and U Pond (Figures 5 and 6) created a change in groundwater flow direction as well. One can see that water would be moving away from the mounds in all directions, as well as into the saddle between the two ponds. There is a point within the saddle where the flow of water divides, with some moving east and some moving west. This point is known as a stagnation point. Figures 5 and 6 show that water is flowing into the saddle and being diverted either east or west as it nears this point of stagnation. The exact location of the stagnation point is not known, thus the groundwater flow direction near the center of the saddle is uncertain.

Between 1960 and 1970 the 216-S-11 pond had a discernable impact on the water table (Figures 8, 9, and 10). However, the impact was small in comparison to the U Pond mound to the north. This is because the 216-S-11 pond received much less effluent than U Pond. From 1960 through 1970, the 216-S-11 pond received 1.6 billion liters (430 million gallons) of waste compared to 31.6 billion liters (8.3 billion gallons) received by U Pond (Anderson 1976).

Several additional sites near the 216-S-11 pond also received liquid waste; most notable are the 216-S-16 and 216-S-17 ponds and the 216-S-5 and 216-S-6 cribs (not shown on Figure 3). The 216-S-17 pond and the cribs are near the 216-S-11 pond, but the 216-S-16 pond is located about 1.5 km east of 216-S-11. By 1970, these sites combined had received 49.3 billion liters (13.0 billion gallons) of waste, compared to 114 billion liters (30.1 billion gallons) received by U Pond (Anderson 1976). Therefore, the 216-S ponds and cribs did not have the same impact on the water table as U Pond. However, from 1960 through 1970, the 216-S-16 pond received as much liquid effluent as U Pond had during this time period: 31.7 billion liters (8.4 billion gallons) for the 216-S-16 pond and 31.6 billion liters (8.3 billion gallons) for U Pond (Anderson 1976). Thus, the 216-S-16 pond may have significantly influenced the water table during the 1960s. It is possible that the mound beneath U Pond in Figures 8, 9, and 10 should be elongated to the southwest toward the 216-S-16 pond or a saddle may have been present in the water table between these sites, similar to that which occurred between T Pond and U Pond in the 1950s (Figures 5 and 6). However, historical water-level data are not available near the 216-S-16 pond, so its influence on the water table cannot be specifically mapped.

Overall the new series of maps provides a detailed history of the impacts that liquid waste disposal had on the groundwater table beneath the 200 West Area. This includes changes in water levels and flow directions as well as the impacts of specific waste disposal sites such as T Pond and U Pond. The information provided by the series of maps can be used in the future to help with interpretation of contaminant sources and clean up of the Hanford Site. The maps can be used determine historic groundwater flow rates and directions. For instance, in December 1951 groundwater flow near T Pond (WMA T) can be estimated at a velocity between 17 and 409 meters per year (56 and 1,340 feet per year)[3] much faster than the current estimated velocity of that area which ranges from 0.3 to 11 meters per year (0.8 to 35 feet per year) (Hartman et al. 2006). This information could then be used to track specific contaminants as they traveled in the groundwater. The new series of maps will help the U.S. Department of Energy (DOE) meet its goals which include remediation of high-risk waste sites, shrinking the contaminated areas, and remediation of groundwater.

# 5.0 References


Anderson JD. 1976. *Input and Decayed Values of Radioactive Liquid Wastes Discharged to the Ground in the 200 Areas Through 1975*. ARH-CD-745, Atlantic Richfield Hanford Company, Richland, Washington.

DOE/RL-91-61, Rev. 0. 1992. *T Plant Source Aggregate Area Management Study Report.* U.S. Department of Energy, Richland Operations, Richland, Washington.

Elci A, GP Flach, and FJ Molz. 2003. "Detrimental Effects of Natural Vertical Head Gradients on Chemical and Water Level Measurements in Observation Wells: Identification and Control." *Journal of Hydrology* 281:70-81.

Freeze RA and JA Cherry. 1979. *Groundwater*. Prentice-Hall, New Jersey.


[3] Assumed a hydraulic conductivity of 1 to 8 m/d, an effective porosity range of 0.1 to 0.3, and a hydraulic gradient of 0.014 calculated from the December 1951 map.

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Kipp KC and RD Mudd. 1974. *Selected Water Table Maps and Well Hydrographs for the Hanford Reservation, 1944-1973*. BNWL-B-360, Pacific Northwest Laboratories, Battelle Memorial Institute, Richland, Washington.

Poston TM, RW Hanf, and RL Dirkes. 2005. *Hanford Site Environmental Report for Calendar Year 2004.* PNNL-15222, Pacific Northwest National Laboratory, Richland, Washington.

**Table 1**. Number of Wells Used for Water-Table Maps

| Map | Number of Wells Used |
|---|---|
| December 1951 | 16 |
| July 1954 | 24 |
| May 1956 | 32 |
| September 1958 | 23 |
| December 1960 | 23 |
| August 1965 | 30 |
| May 1970 | 30 |

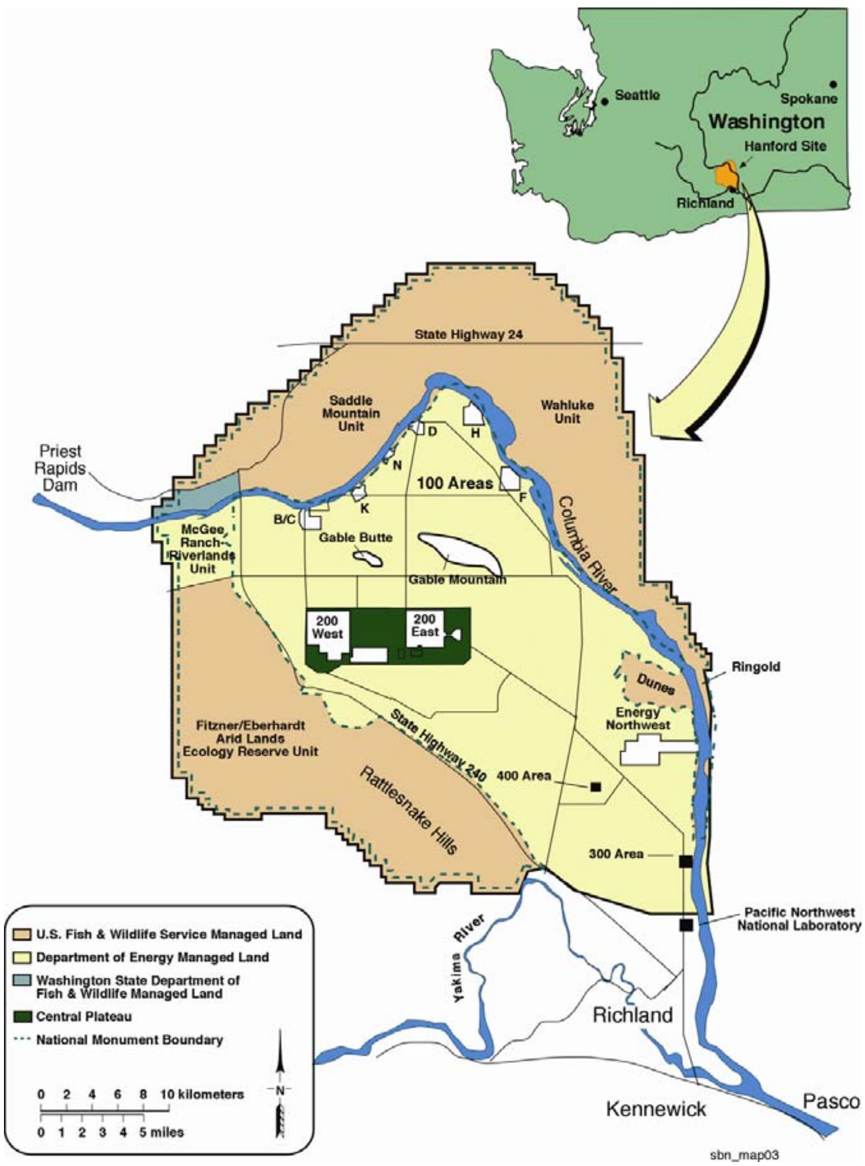


**Figure 1**. The Hanford Site is Located in South Central Washington. The 200 West Area is located in the western portion of the Hanford Site (from Poston et al. 2005).

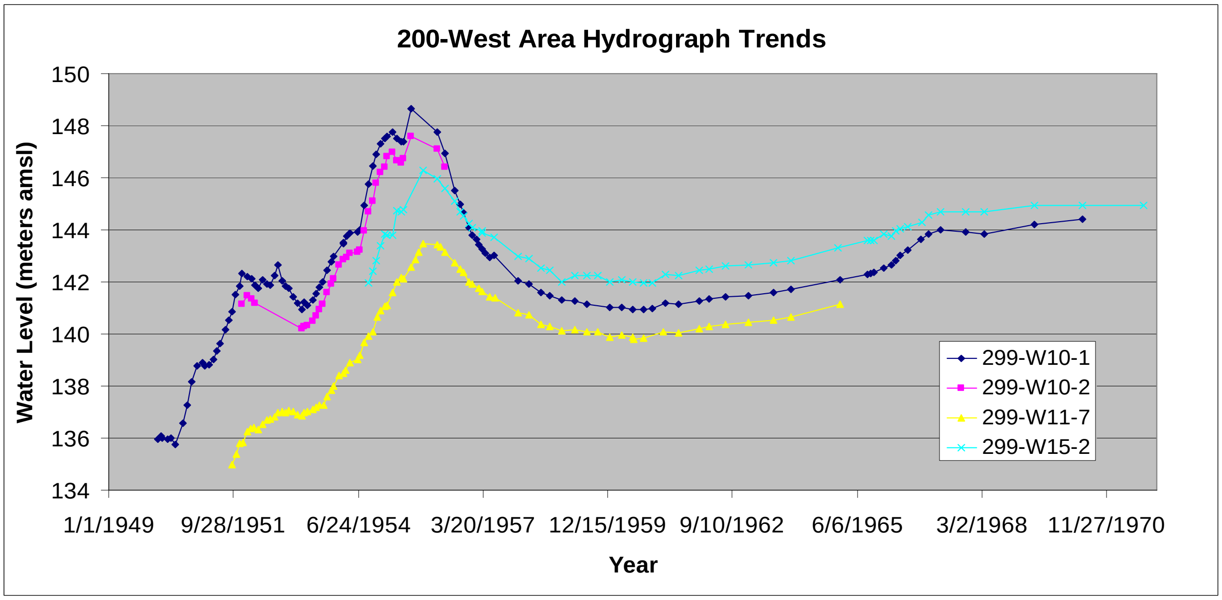


**Figure 2**. Hydrographs Showing Water-Level Trends for Wells in the 200 West Area (meters, North American Vertical Datum of 1988)

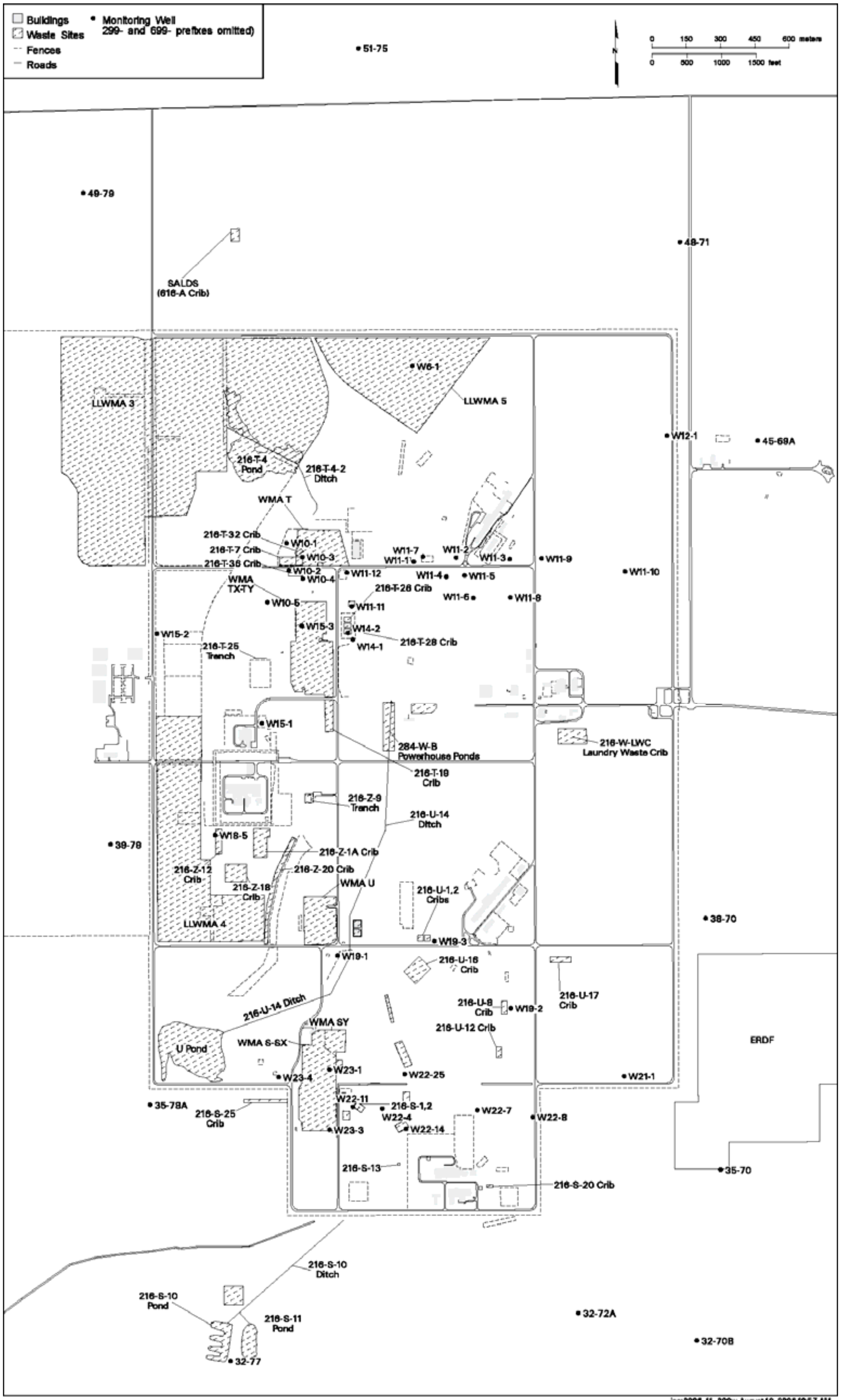


**Figure 3**. Map of 200 West Area with the Monitoring Wells Used in the Study

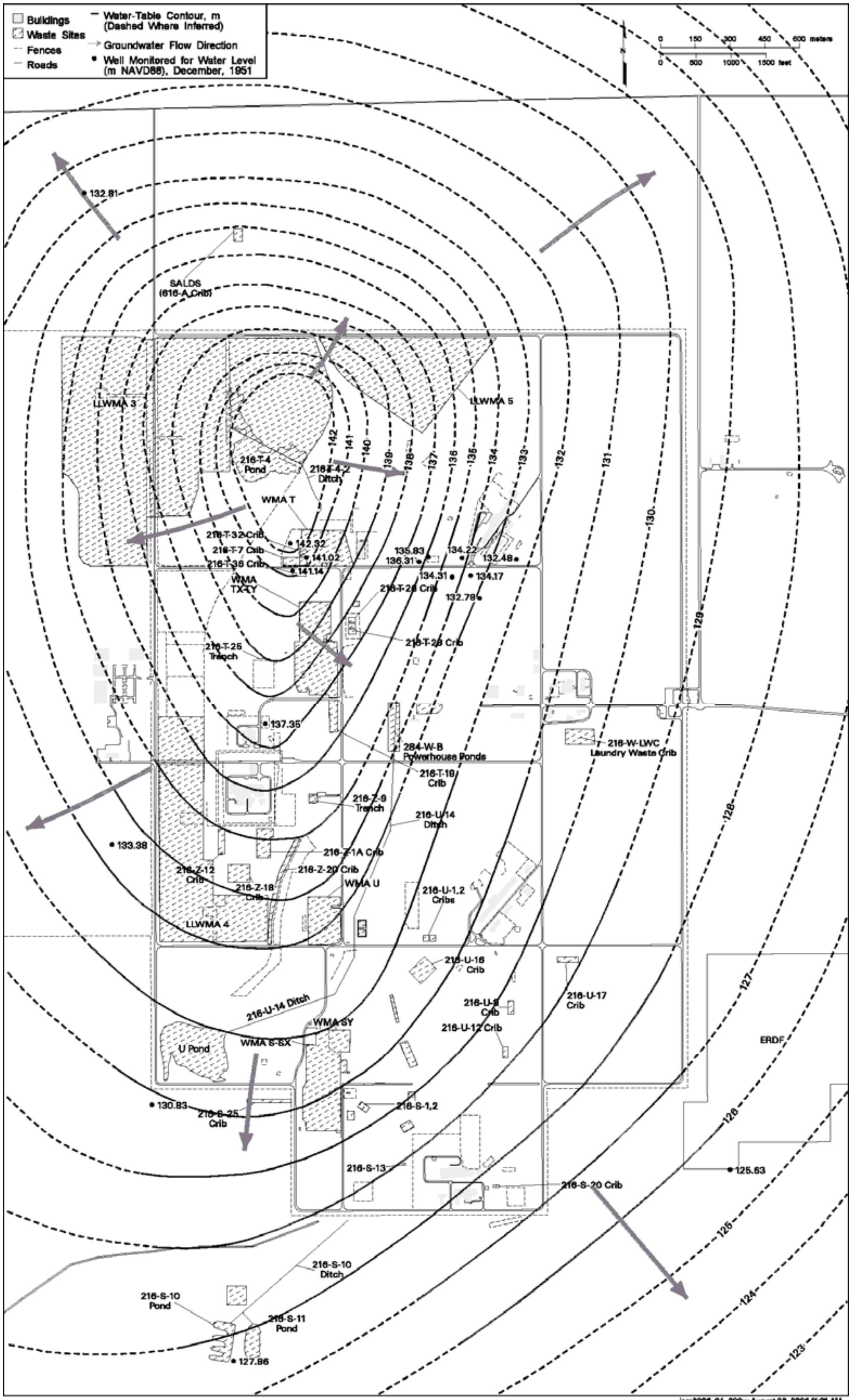


**Figure 4**. Water-Table Map of the 200 West Area, December 1951

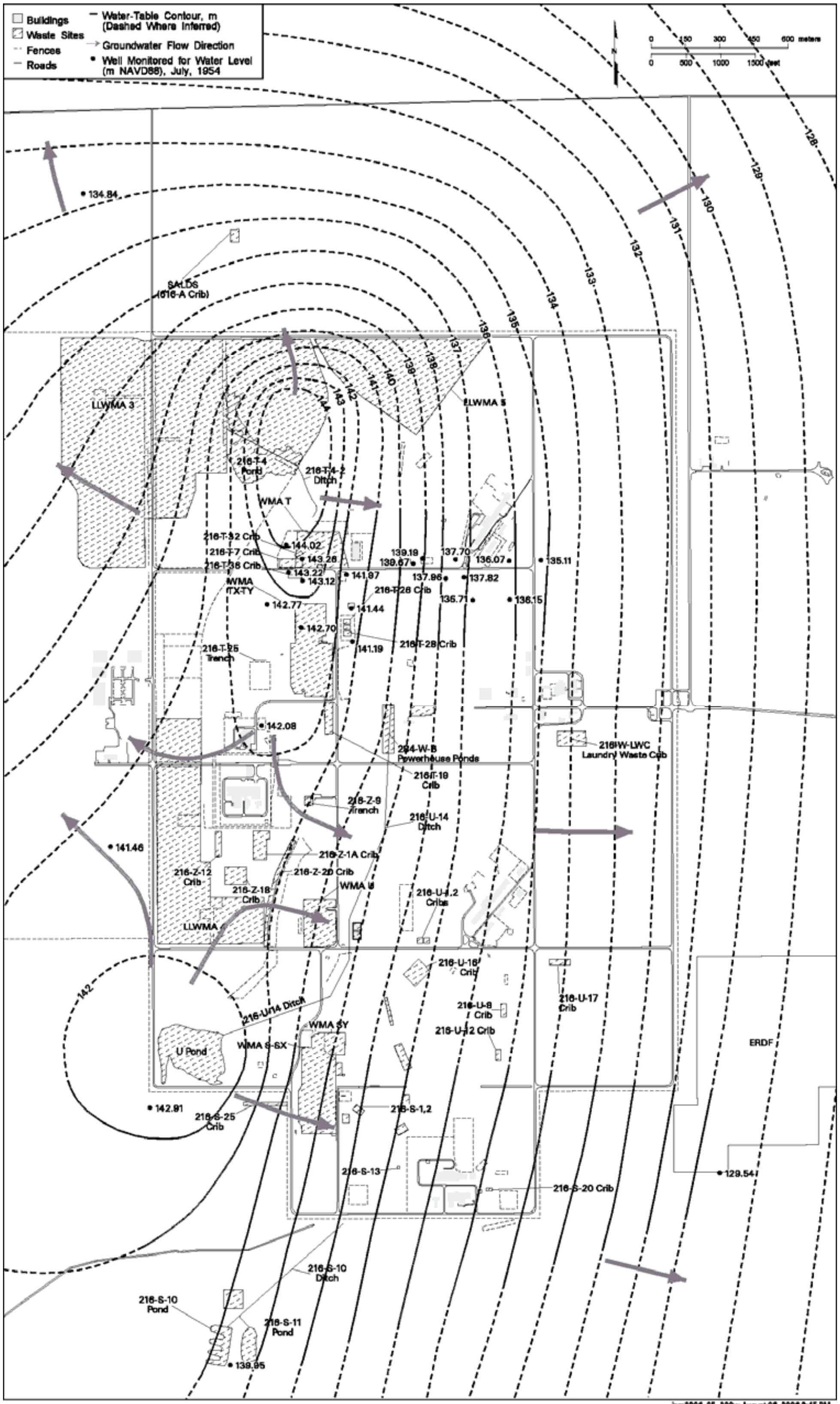


**Figure 5**. Water-Table Map of the 200 West Area, July 1954

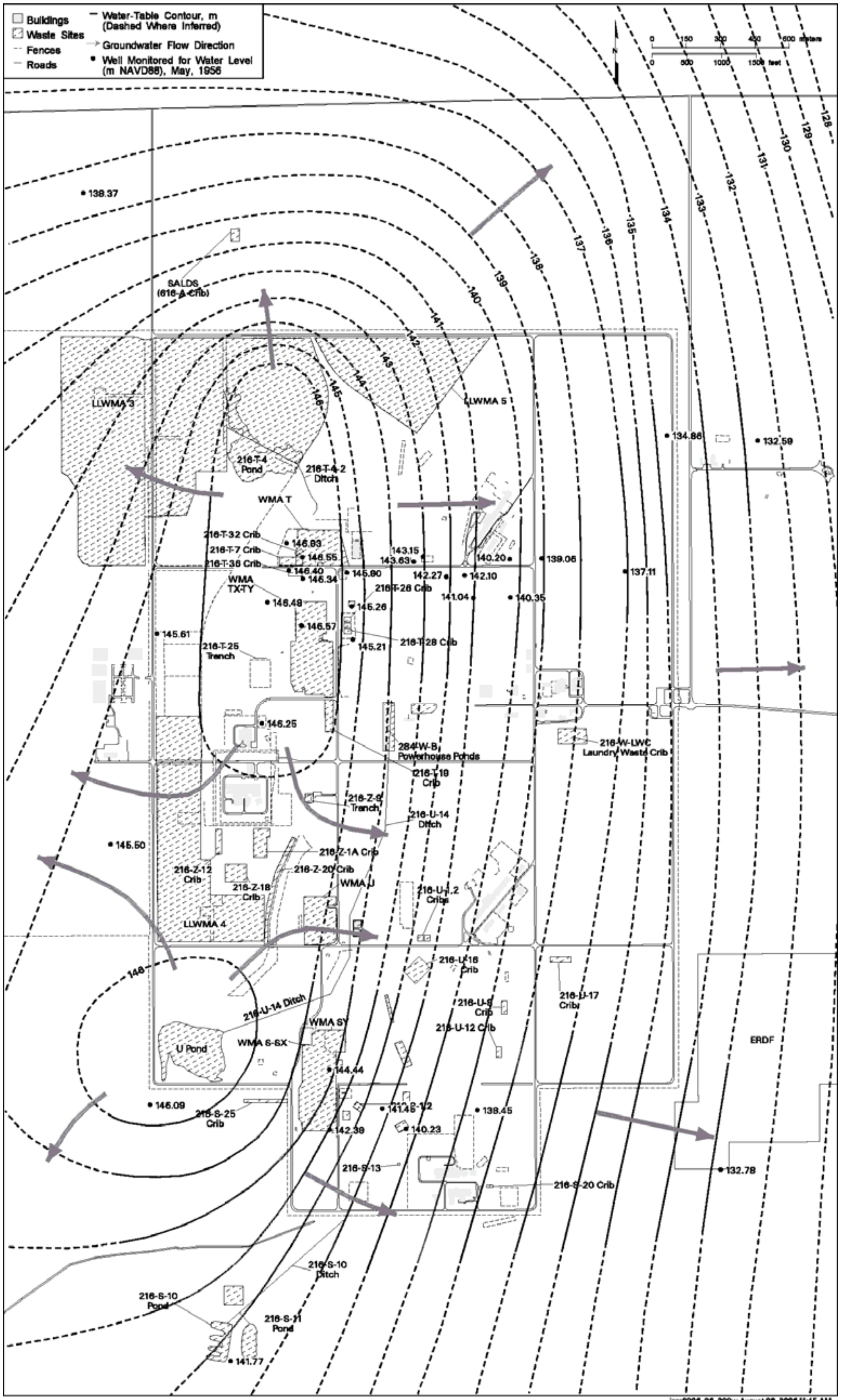


**Figure 6**. Water-Table Map of 200 West Area, May 1956

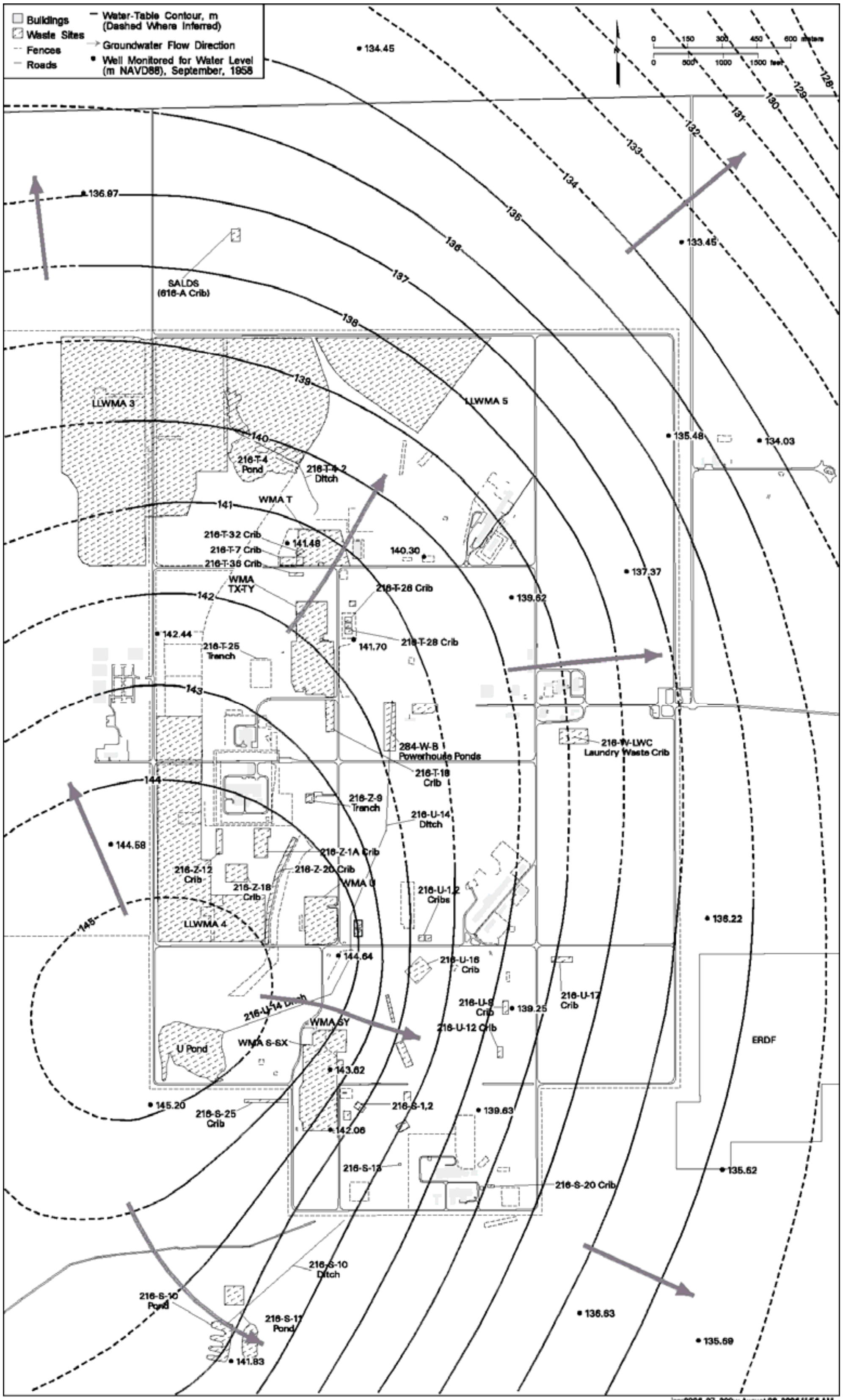


**Figure 7**. Water-Table Map of 200 West Area, September 1958

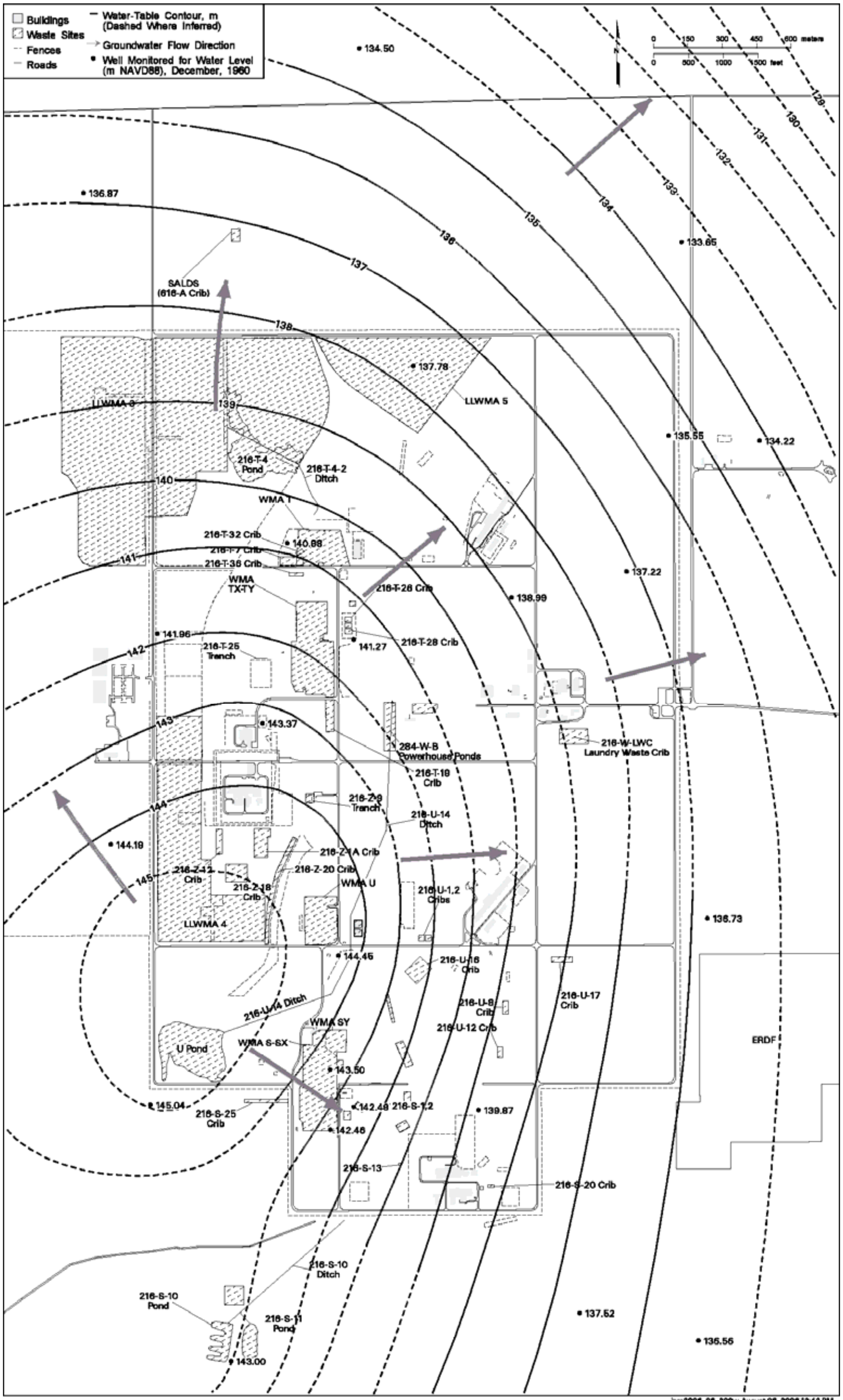


**Figure 8**. Water-Table Map of 200 West Area, December 1960

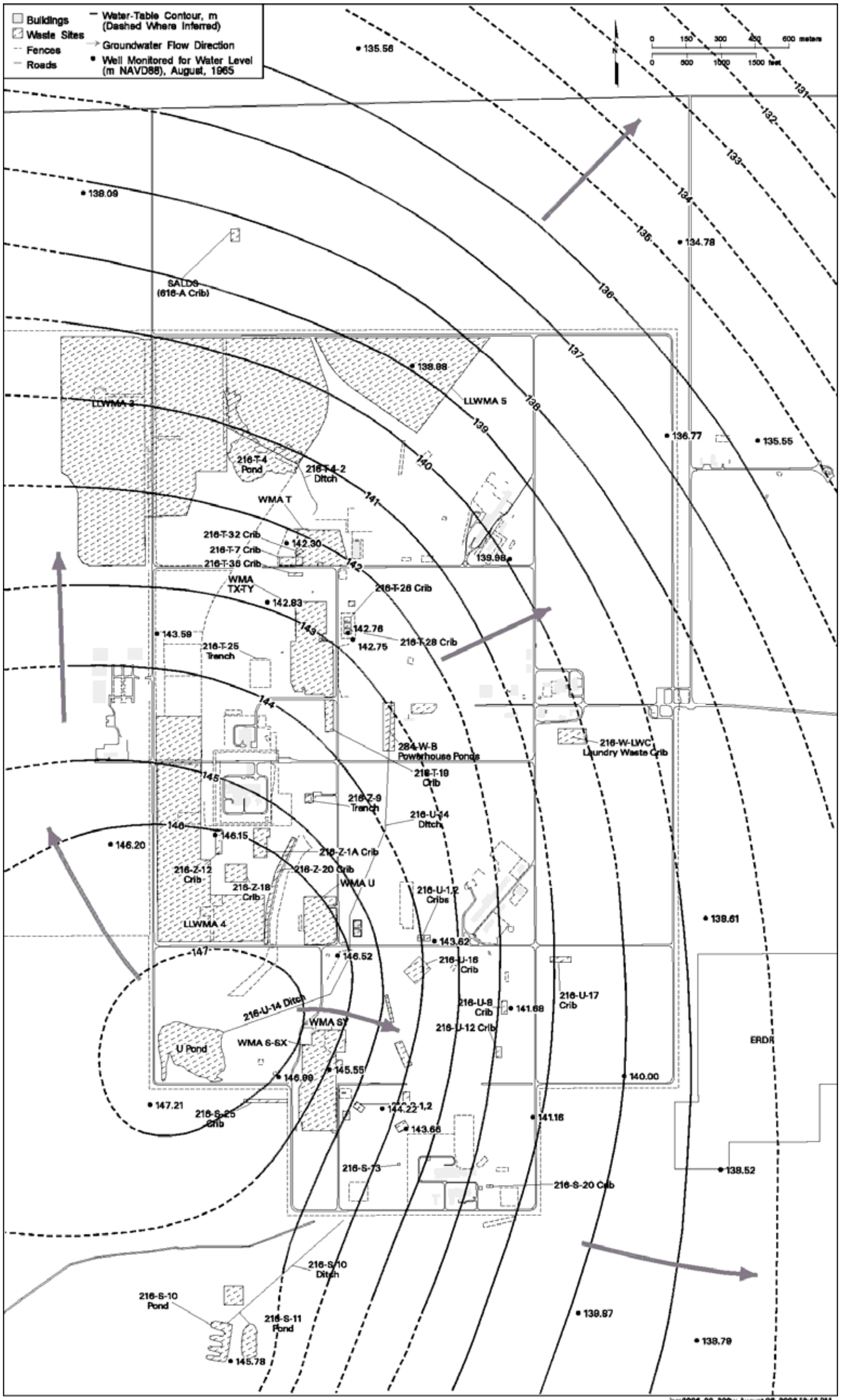


**Figure 9**. Water-Table Map of 200 West Area, August 1965

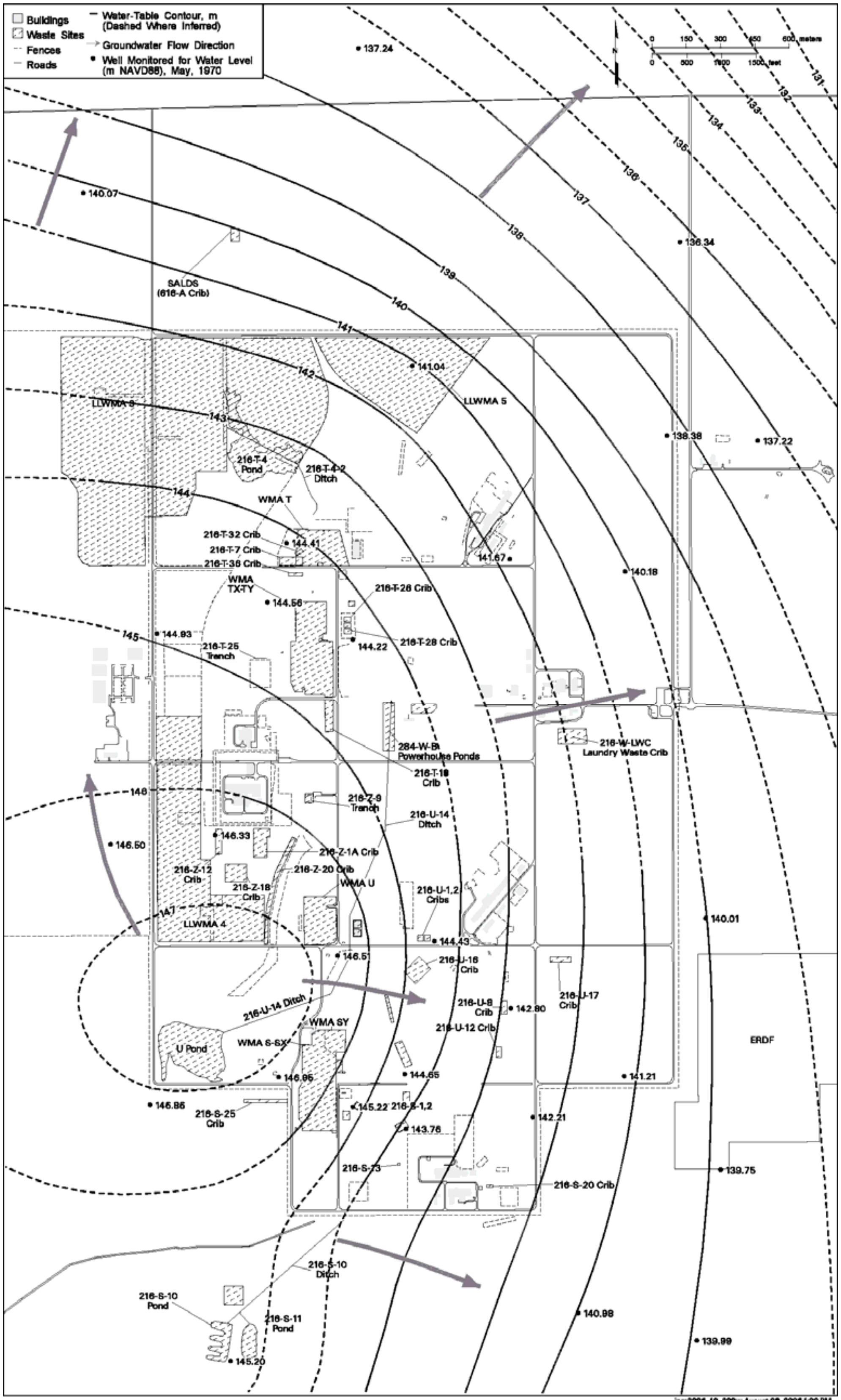


**Figure 10**. Water-Table Map of 200 West Area, May 1970

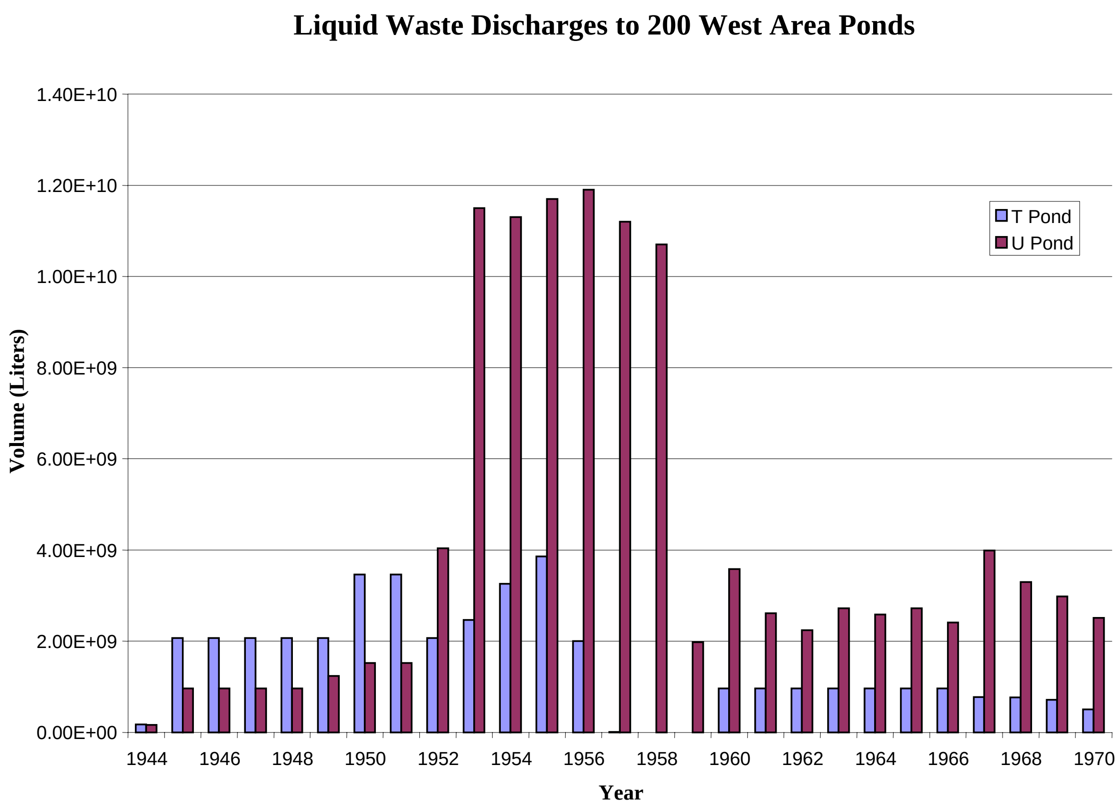


**Figure 11**. Comparison of Liquid Waste Discharged to T Pond and U Pond through 1970 (from Anderson 1976)

# Appendix

# Appendix

The following table lists all water-level data used for this study.

| Well Name | Water Level (meters amsl)[a] |
|---|---|
| **December 1951** | |
| 299-W10-1 | 142.32 |
| 299-W10-2 | 141.14 |
| 299-W10-3 | 141.02 |
| 299-W11-1 | 136.31 |
| 299-W11-2 | 134.22 |
| 299-W11-3 | 132.48 |
| 299-W11-4 | 134.31 |
| 299-W11-5 | 134.17 |
| 299-W11-6 | 132.79 |
| 299-W11-7 | 135.83 |
| 299-W15-1 | 137.35 |
| 699-32-77 | 127.86 |
| 699-35-70 | 125.63[b] |
| 699-35-78A | 130.83[b] |
| 699-39-79 | 133.38 |
| 699-49-79 | 132.81 |
| **July 1954** | |
| 299-W10-1 | 144.02 |
| 299-W10-2 | 143.22 |
| 299-W10-3 | 143.26 |
| 299-W10-4 | 143.12 |
| 299-W10-5 | 142.77 |
| 299-W11-1 | 139.67 |
| 299-W11-11 | 141.44 |
| 299-W11-12 | 141.97 |
| 299-W11-2 | 137.70 |
| 299-W11-3 | 136.07 |
| 299-W11-4 | 137.96 |
| 299-W11-5 | 137.82 |
| 299-W11-6 | 136.71 |
| 299-W11-7 | 139.19 |
| 299-W11-8 | 136.15 |
| 299-W11-9 | 135.11 |
| 299-W14-1 | 141.19 |
| 299-W15-1 | 142.08 |
| 299-W15-3 | 142.70 |
| 699-32-77 | 139.95 |
| 699-35-70 | 129.54 |
| 699-35-78A | 142.91 |

| Well Name | Water Level (meters amsl)[a] |
|---|---|
| 699-39-79 | 141.46 |
| 699-49-79 | 134.84 |
| **May 1956** | |
| 299-W10-1 | 146.93 |
| 299-W10-2 | 146.40 |
| 299-W10-3 | 146.55 |
| 299-W10-4 | 146.34 |
| 299-W10-5 | 146.48 |
| 299-W11-1 | 143.63 |
| 299-W11-10 | 137.11 |
| 299-W11-11 | 145.26 |
| 299-W11-12 | 145.90 |
| 299-W11-3 | 140.20 |
| 299-W11-4 | 142.27 |
| 299-W11-5 | 142.10 |
| 299-W11-6 | 141.04 |
| 299-W11-7 | 143.15 |
| 299-W11-8 | 140.35 |
| 299-W11-9 | 139.06 |
| 299-W12-1 | 134.86 |
| 299-W14-1 | 145.21 |
| 299-W15-1 | 146.25 |
| 299-W15-2 | 145.61 |
| 299-W15-3 | 146.57 |
| 299-W22-14 | 140.23 |
| 299-W22-4 | 141.45 |
| 299-W22-7 | 138.45 |
| 299-W23-1 | 144.44 |
| 299-W23-3 | 142.39 |
| 699-32-77 | 141.77 |
| 699-35-70 | 132.78 |
| 699-35-78A | 146.09 |
| 699-39-79 | 145.50 |
| 699-45-69A | 132.59 |
| 699-49-79 | 138.37 |
| **September 1958** | |
| 299-W10-1 | 141.48 |
| 299-W11-10 | 137.37 |
| 299-W11-7 | 140.30 |
| 299-W11-8 | 139.62 |
| 299-W12-1 | 135.48 |
| 299-W14-1 | 141.70 |
| 299-W15-2 | 142.44 |
| 299-W19-1 | 144.64 |
| 299-W19-2 | 139.25 |
| 299-W22-7 | 139.63 |
| 299-W23-1 | 143.62 |

| Well Name | Water Level (meters amsl)[(a)] |
|---|---|
| 299-W23-3 | 142.06 |
| 699-32-70B | 135.69 |
| 699-32-72A | 136.63 |
| 699-32-77 | 141.83 |
| 699-35-70 | 135.62 |
| 699-35-78A | 145.20 |
| 699-38-70 | 136.22 |
| 699-39-79 | 144.58 |
| 699-45-69A | 134.03 |
| 699-48-71 | 133.45 |
| 699-49-79 | 136.97 |
| 699-51-75 | 134.45 |
| **December 1960** | |
| 299-W10-1 | 140.98 |
| 299-W11-10 | 137.22 |
| 299-W11-8 | 138.99 |
| 299-W12-1 | 135.55 |
| 299-W14-1 | 141.27 |
| 299-W15-1 | 143.37 |
| 299-W15-2 | 141.96 |
| 299-W19-1 | 144.45 |
| 299-W22-11 | 142.49 |
| 299-W22-7 | 139.87 |
| 299-W23-1 | 143.50 |
| 299-W23-3 | 142.46 |
| 299-W6-1 | 137.78 |
| 699-32-70B | 136.56 |
| 699-32-72A | 137.52 |
| 699-32-77 | 143.00 |
| 699-35-78A | 145.04 |
| 699-38-70 | 136.73 |
| 699-39-79 | 144.19 |
| 699-45-69A | 134.22 |
| 699-48-71 | 133.65 |
| 699-49-79 | 136.87 |
| 699-51-75 | 134.50 |
| **August 1965** | |
| 299-W10-1 | 142.30 |
| 299-W10-5 | 142.83 |
| 299-W11-3 | 139.98 |
| 299-W12-1 | 136.77 |
| 299-W14-1 | 142.75 |
| 299-W14-2 | 142.76 |
| 299-W15-2 | 143.59 |
| 299-W18-5 | 146.15 |
| 299-W19-1 | 146.52 |
| 299-W19-2 | 141.68 |

| Well Name | Water Level (meters amsl)[(a)] |
|---|---|
| 299-W19-3 | 143.62 |
| 299-W21-1 | 140.00 |
| 299-W22-14 | 143.66 |
| 299-W22-4 | 144.22 |
| 299-W22-8 | 141.16 |
| 299-W23-1 | 145.55 |
| 299-W23-4 | 146.99 |
| 299-W6-1 | 138.98 |
| 699-29-78 | 146.57 |
| 699-32-70B | 138.79 |
| 699-32-72A | 139.87 |
| 699-32-77 | 145.78 |
| 699-35-70 | 138.52 |
| 699-35-78A | 147.21 |
| 699-38-70 | 138.61 |
| 699-39-79 | 146.20 |
| 699-45-69A | 135.55 |
| 699-48-71 | 134.78 |
| 699-49-79 | 138.09 |
| 699-51-75 | 135.56 |
| **May 1970** | |
| 299-W10-1 | 144.41 |
| 299-W10-5 | 144.56 |
| 299-W11-10 | 140.18 |
| 299-W11-3 | 141.67 |
| 299-W12-1 | 138.38 |
| 299-W14-1 | 144.22 |
| 299-W15-2 | 144.93 |
| 299-W18-5 | 146.33 |
| 299-W19-1 | 146.51 |
| 299-W19-2 | 142.80 |
| 299-W19-3 | 144.43 |
| 299-W21-1 | 141.21 |
| 299-W22-11 | 145.22 |
| 299-W22-14 | 143.76 |
| 299-W22-25 | 144.65 |
| 299-W22-8 | 142.21 |
| 299-W23-4 | 146.95 |
| 299-W6-1 | 141.04 |
| 699-29-78 | 145.81 |
| 699-32-70B | 139.99 |
| 699-32-72A | 140.98 |
| 699-32-77 | 145.20 |
| 699-35-70 | 139.75 |
| 699-35-78A | 146.86 |
| 699-38-70 | 140.01 |
| 699-39-79 | 146.50 |

| Well Name | Water Level (meters amsl)[a] |
|---|---|
| 699-45-69A | 137.22 |
| 699-48-71 | 136.34 |
| 699-49-79 | 140.07 |
| 699-51-75 | 137.24 |

(a) Meters above mean sea level (North American Vertical Datum of 1988).
(b) Average of November 1951 and January 1952 measurements.

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