CHAPTER 3.0
GROUNDWATER MONITORING

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3.0 GROUNDWATER MONITORING

3.1 Aquifer Identification

The unconfined aquifer in the 100-N Area is located primarily in the upper part of the Ringold Formation (sands and gravels) and is approximately 12 to 15 m (40 to 50 ft) thick. The base of the aquifer is believed to be a laterally continuous clay-rich unit containing a series of paleosols. Lithologies in this unit range from clay and silt to sand. Most of the wells in the 100-N Area did not penetrate through the clay layer; therefore, the thickness of the clay-rich unit is unknown at most locations.

The water table is approximately 21 to 23 m (69 to 75 ft) below land surface near 1301-N and approximately 23 m (75 ft) below land surface near 1325-N. Water levels have returned to these "pre-Hanford" levels after years of groundwater mounding caused by artificial recharge from the units and other effluent disposal in the 100-N Area.

A representative range of transmissivity estimates for the unconfined aquifer in the 100-N Area is 93 to 560 m2/day (1,000 to 6,030 ft2/day) throughout most of that area. Wells in the northwest portion seem to show a higher transmissivity (up to 1,900 m2/day [20,500 ft2/day]). These values correspond to horizontal hydraulic conductivity of 6 to 37 m/day (20 to 121 ft/day), and 120 m/day (394 ft/day) in the northwest portion. Specific yield is estimated at 0.1 to 0.3.

Hartman and Lindsey (1993) describe the hydrogeology of the 100-N Area in more detail.

3.2 Interim Status Groundwater Monitoring

Groundwater monitoring began at 1301-N and 1325-N in December 1987. The original monitoring networks were modified over the years as water levels declined and new wells were installed to replace dry wells.

After the first year of groundwater monitoring at 1301-N, specific conductance in one downgradient well was found to be elevated above background (i.e., upgradient) levels. A groundwater quality assessment program was initiated (Gilmore and Jensen 1989). The assessment program found no evidence that dangerous waste or dangerous waste constituents from 1301-N had entered the groundwater (Hartman 1992). Rather, the elevated specific conductance was caused by sulfate/sodium-contaminated groundwater coming from the nearby 1324-N/NA site. In 1992, the groundwater monitoring program at 1301-N reverted to an indicator parameter monitoring program, as described in 40 CFR 265.93(d)(6). An additional upgradient well was added to the network to reflect the influence of 1324-N/NA. New critical mean values were established for indicator parameters, and the site remains in indicator evaluation status.

Some contamination has been detected in the groundwater under or near the 1301-N and 1325-N units. Two dangerous waste constituents, nitrate and chromium, were found to be at levels above the maximum containment levels (MCL) (Hartman and Dresel, 1997). Nitrate levels above the MCL of 44 mg/L were observed in well 199-N-3 and 199-N-32 in 1996. Well 199-N-3 monitors the 1301-N unit and well 199-N-32 monitors the 1325-N unit. Nitrate values from nearby wells monitoring the same interval are not above the MCL. Chromium concentrations above the MCL of 0.1 mg/L have been observed in wells 199-N-33 and well 199-N-80 in 1996. Well 199-N-33 monitors the 1325-N unit. The 1996 data from well 199-N-33 is considered anomalous. Well 199-N-80 monitors the bottom zone of the unconfined aquifer and is located downgradient from 1301-N. Wells monitoring the upper part of the unconfined aquifer for 1301-N do not have values of chromium above the MCLs. Although contamination has been detected as described, the interim status groundwater monitoring configuration did not identify these constituents as releases attributable to operation of, or residual contamination in, the 1301-N and 1325-N units through statistical analysis of upgradient versus downgradient wells.

The 1325-N unit has been monitored under an indicator evaluation program throughout its history of *Resource Conservation and Recovery Act of 1976* (RCRA) monitoring. Wells were added or deleted from the network to reflect changing conditions.

Groundwater is monitored under several programs in addition to the RCRA in the 100-N Area. The most significant programs in terms of numbers of wells and analytes are those of the RCRA, sitewide surveillance, and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Sampling and analysis for RCRA, CERCLA, and sitewide surveillance monitoring have been coordinated for several years to avoid duplication. However, this coordination did not include the planning stages of the monitoring programs.

In an attempt to reduce redundancy further and make monitoring more efficient, representatives of the various contractors involved in 100-N groundwater monitoring held a series of workshops to consolidate and streamline monitoring. Monitoring networks were redesigned to disseminate information for all programs as efficiently as possible, and constituent lists were trimmed to the constituents of concern. Sampling frequency also decreased in some cases. Sampling trips and analytical costs are divided among data users. Borghese et al. (1996) describe the well and constituent lists for the combined program. That document does not include requirements for sampling and analysis protocols, QC, or statistical evaluations. Hartman (1996a) presents a revised groundwater-monitoring plan for the RCRA program, and this is summarized in the following section.

3.2.1 Well Location and Design

The monitoring network for 1301-N includes two upgradient wells and three downgradient wells (Figure 3.1, Table 3.1). All of the wells monitor the unconfined aquifer. As-built diagrams are included in Hartman (1996a). One of the downgradient wells, 199-N-105A, is an extraction well for the CERCLA pump-and-treat system. This well is screened across the entire thickness of the uppermost aquifer (7.3 m [24 ft]) instead of just the top 3.0 to 4.6 m (10 to 15 ft) of the aquifer like the other wells. Because it is an extraction well, 199-N-105A will pull in water from beneath a large area of the 1301-N Trench, making it a useful monitoring well

The construction of some of the 1301-N wells does not meet Washington Administrative Code (WAC) requirements (Table 3.1). Wells 199-N-2 and 199-N-3 have perforated, carbon steel casing and no annular seals. However, these wells appear to yield representative data, and installing new wells is not warranted. Ecology has accepted the data from these and other wells since RCRA monitoring began at the 100-N Area in 1987.

The monitoring network for 1325-N will include one upgradient and three downgradient wells (refer to Figure 3.1 and Table 3.1). Treated water from the CERCLA pump-and-treat system is injected into well 199-N-29 near the 1325-N. Well 199-N-28 is used by the RCRA program to monitor potential effects of injected water; it is not being used in statistical evaluations.

3.2.2 Sampling and Analysis Plan

The *Groundwater Monitoring Plan for the 1301-N, 1325-N, and 1324-N/NA Sites* (Hartman 1996b) describes the sampling and analysis plan for RCRA monitoring. Groundwater is sampled for the constituents listed in Table 3.2. Indicator parameters are analyzed semiannually; additional parameters are analyzed annually.

Groundwater sampling procedures, sample collection documentation, and chain-of-custody requirements are described in Environmental Investigation Instructions (EII) (WHC-CM-7-7), The Environmental Activities Procedural Manual (WHC-CM-7-8), and in the Quality Assurance Project Plan for Groundwater Monitoring Activities Managed by Westinghouse Hanford Company (WHC 1995). Work by other contractors is conducted to their equivalent approved standard operating procedures. Procedures for field measurements (pH, conductivity, turbidity) are specified in WHC-CM-7-8 and in the user's manuals for the meters used. Analytical methods are selected from those provided in Test Methods for Evaluating Solid Wastes (EPA 1990) as specified by WHC (1995) or its most recent revision.

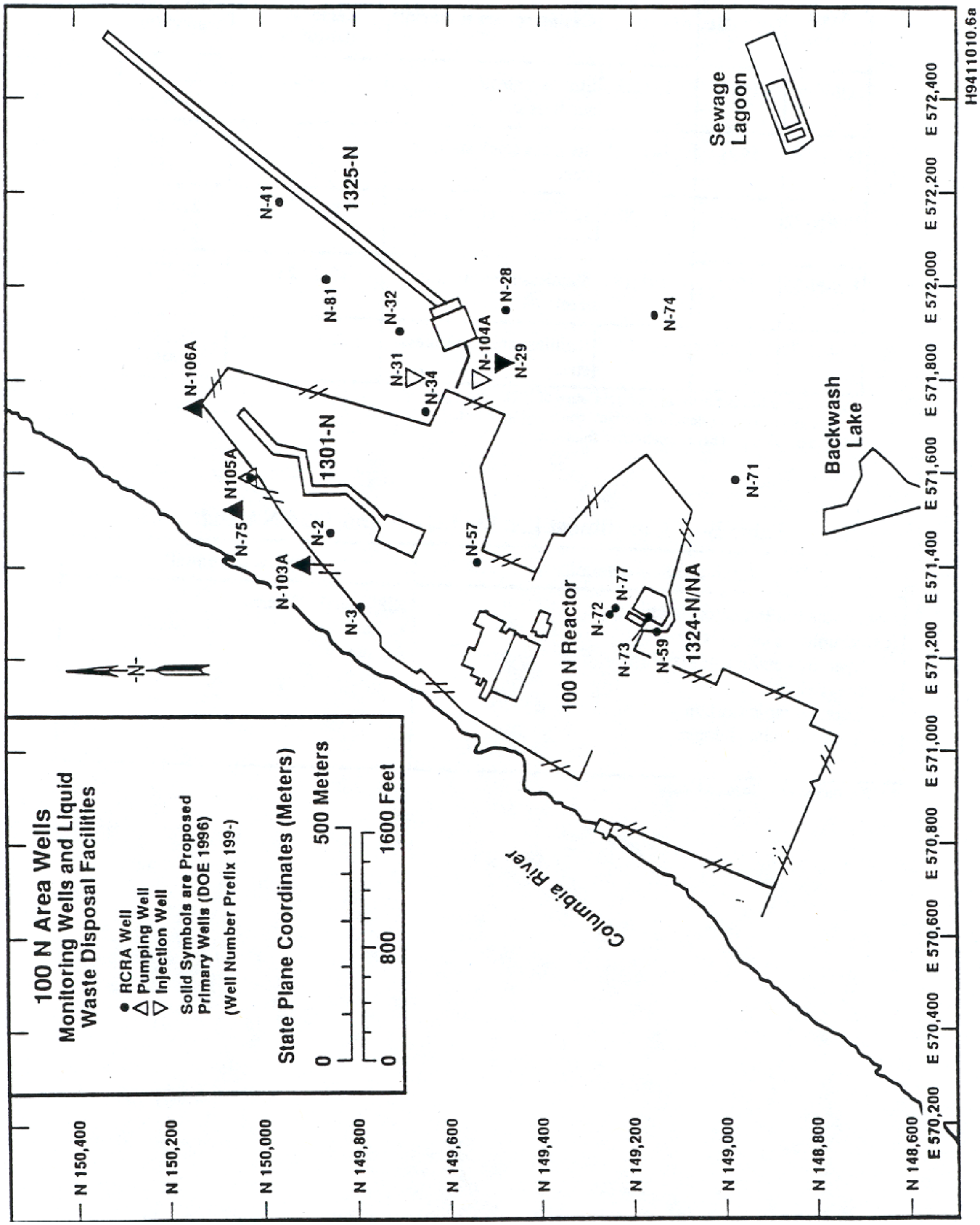

Figure 3.1. Proposed RCRA Groundwater Monitoring Network for the 1324-N and 1324-NA Units

3.2.3 Quality Assurance and Quality Control

Quality assurance (QA) requirements are defined in the *Westinghouse Hanford Company Quality Assurance Manual* (WHC-CM-4-2) or equivalent procedures, and Article 31 of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1994). Additional requirements for QA and QC are included in WHC (1995) or its' most recent revision.

Table 3.1. Proposed RCRA Groundwater Monitoring Networks for the 1301 N and 1325-N Liquid Waste Disposal Facilities

Well Number	Proposed Network	Drill Date	Elev. T.O.C.[a] (m)	Casing/Screen Materials	Screened or perf'd depth[b] (m)	Depth to Water[c] (m)
199-N-2	1301-N	1964	140.129	Carbon steel/ perf'd casing; no annular seal	10.7 - 28.0	21.010(6/96)
199-N-3	1301-N	1964	140.015	Carbon steel/ perf'd casing; no annular seal	10.4 - 27.7	20.793(6/96)
199-N-28	1325-N[d]	1983	141.647	Carbon steel/ stainless steel w/ packer; surface seal	14.32 - 25.3	23.311(9/94)
199-N-32	1325-N	1983	140.990	Carbon steel/ stainless steel w/ packer; surface seal	13.4 - 24.1	22.357(3/96)
199-N-34	1301-N	1983	140.247	Carbon steel/ stainless steel w/ packer; surface seal	10.4 - 23.5	21.732(3/96)
199-N-41	1325-N	1984	139.626	Carbon steel/ stainless steel w/ packer; surface seal	16.2 - 22.3	21.193(3/96)
199-N-57	1301-N	1987	139.671	Stainless steel/ stainless steel; full annular seal	17.7 - 22.3	20.708(3/96)
199-N-74	1325-N	1991	139.482	Stainless steel/ stainless steel; full annular seal	18.0 - 24.4	20.537(6/96)
199-N-81	1325-N	1993	142.067	Stainless steel/stainless steel	21.3 - 27.4	22.552(3/96)
199-N-105A	1301-N	1995	140.655	Stainless steel/ stainless steel; full annular seal	21.0 - 28.7	21.220(7/95)

[a] Surveyed to North American Vertical Datum of 1988.
[b] Approximate depth below land surface; converted from feet.
[c] Depth below top of casing; converted from feet.
[d] Well 199-N-28 to be used for supplemental information; no statistical evaluations.

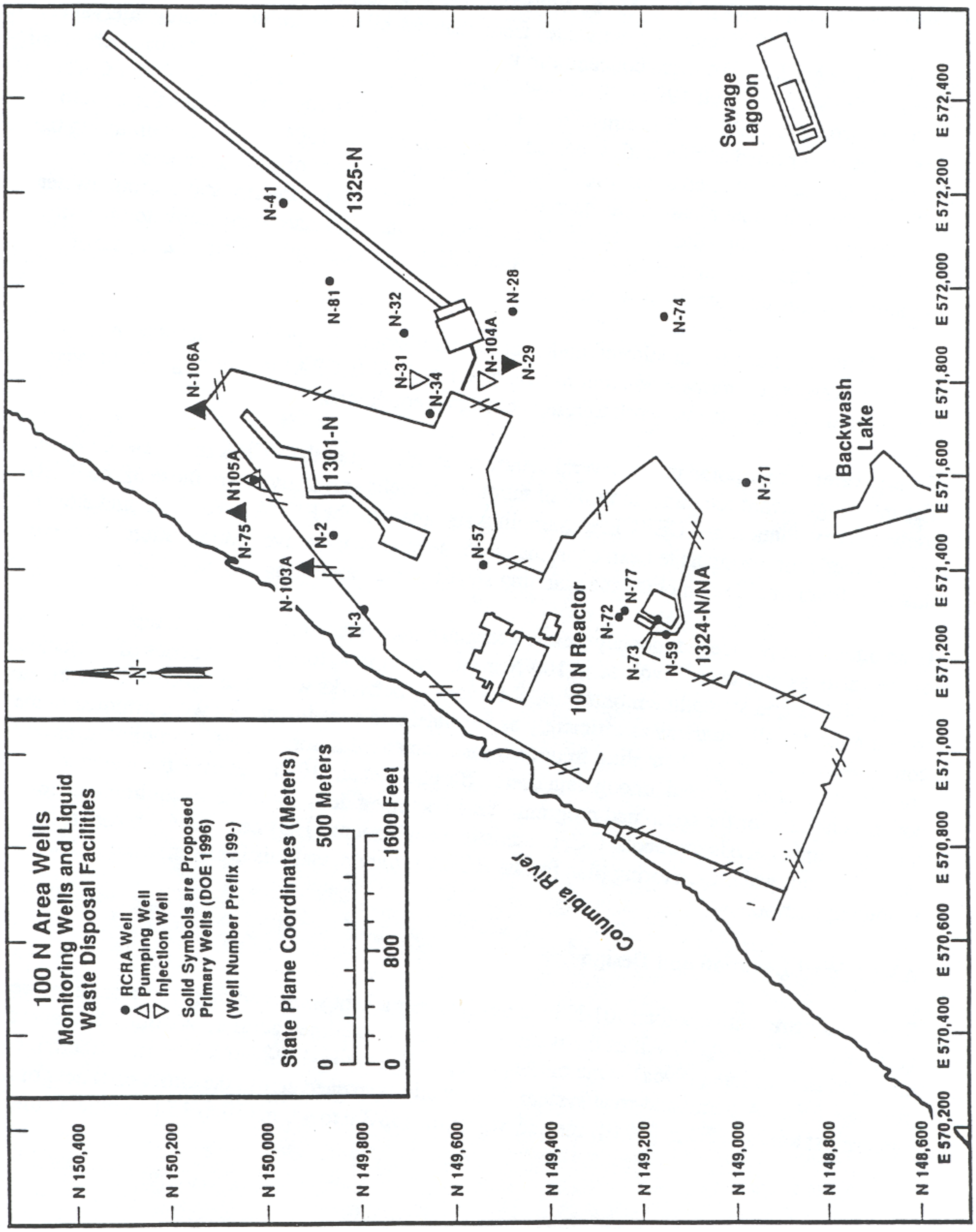

Figure 3.2. Proposed RCRA Groundwater Monitoring Network for the 1301 N and 1325 N Units

Table 3.2. Constituent List for 1301-N and 1325-N

Analyzed Semiannually	Analyzed Annually
Contamination Indicator Parameters (Quadruplicate samples):	ICP Metals (filtered)
Specific conductance (field)	Anions
pH (field)	Alkalinity
Total Organic Carbon	
Total Organic Halogen	
Turbidity (field)	

ICP = Inductively Coupled Plasma

3.3 Results of Groundwater Monitoring

3.3.1 Potentiometric Level

At various times in the history of waste disposal at the 100-N Area, groundwater mounds formed beneath 1301-N and 1325-N. Changes in water levels are illustrated in Figure 3.2. Water levels have returned to "pre-Hanford" levels in the 100-N Area but are still affected by changes in river stage and, recently, by the operation of pumping and injection wells.

Water levels are measured in all wells before sampling. Many of the wells in the 100-N Area are also measured as part of the site-wide semiannual water level program (Serkowski et al. 1995). The Environmental Restoration Contractor has equipped about 20 wells with pressure transducers and data loggers. Any of the data described above can be used to construct water table maps to aid in determining groundwater flow directions.

During average or low river stage, natural groundwater flow is toward the northwest beneath 1301-N. When river stage is high, the gradient is reversed, and there is a potential for water to flow out of the river into the aquifer. Groundwater flow beneath 1325-N is toward the north regardless of river stage.

A groundwater pump-and-treat system has been in operation in the 100-N Area since August 1995. DOE-RL (1996b) reports the results of an evaluation of the first phase of the system's operation. Data from a network of transducers were used to construct water table maps and estimate capture zones.

Pumping of wells between 1301-N and the Columbia River has created a groundwater depression. Groundwater flows toward the pumping wells from the river and from beneath 1301-N. Treated water is injected into a well near 1325-N.

Vertical groundwater gradients are not well defined in the 100-N Area. There is no significant difference in head between wells completed at the top and bottom of the unconfined aquifer. There does appear to be an upward gradient immediately adjacent to the river. Water levels in deeper wells were consistently higher than shallow wells or the river, indicating an upward gradient (Gilmore et al. 1991).

3.3.2 Groundwater Quality

Groundwater quality in the unconfined aquifer beneath the 100-N Area has been affected by 1301-N, 1325-N, and the 1324-NA Percolation Pond. In addition, various leaks and spills may have affected soil or groundwater chemistry (DOE-RL 1991). Data from RCRA sampling and analysis are reported electronically in the Hanford Environmental Information System database. Interpretation of the data is included in annual reports (Hartman 1996a).

The indicator parameters at the 1301-N and 1325-N units are specific conductance, pH, total organic carbon (TOC), and total organic halogens (TOX) (40 CFR 265.92[b][3]). Groundwater is also analyzed for other constituents that were discharged to the 1301-N and 1325-N units during their use. These analytes include nitrate, chromium, phosphate, lead, and cadmium. Samples have also been analyzed for mercury and volatile organics in the past. Chromium, lead, and cadmium (in filtered samples), phosphate, or volatile organics have not been detected in 1301-N or 1325-N groundwater in significant concentrations. Nitrate increased in some wells near 1301-N and 1325-N during 1995, exceeding the drinking water standard in wells 199-N-2 and 199-N-3. One well southwest (upgradient) of 1301-N also had nitrate above the standard. Concentrations decreased in wells 199-N-2 and 199-N-3 in early 1996, but increased in excess of the drinking water standard in well 199-N-32. The source of nitrate is unknown.

While the 1301-N and 1325-N units were in use, they introduced radioactive constituents, primarily tritium and strontium-90, to the groundwater. These are not considered dangerous waste constituents under interim status RCRA regulations, but were monitored by RCRA in the past because they are the primary contaminants originating from the units.

3.4 Groundwater Monitoring During Closure

3.4.1 Monitoring Program

Groundwater monitoring will be done in accordance with the existing groundwater-monitoring program (Borghese, et. al 1996).

3.4.2 Inspection, Maintenance, and Replacement of Wells

Each time a well is sampled, the wellhead and associated structures are inspected. Problems with the pump or with the sample (e.g., excessive turbidity) are also noted. Repairs are made according to approved contractor procedures. Subsurface inspection and maintenance is performed on a 3- to 5-year schedule, or as needed to repair problems identified during sampling.

If a monitoring well becomes unsuitable for use, the monitoring program will be reevaluated to determine if a new or existing well should be substituted.

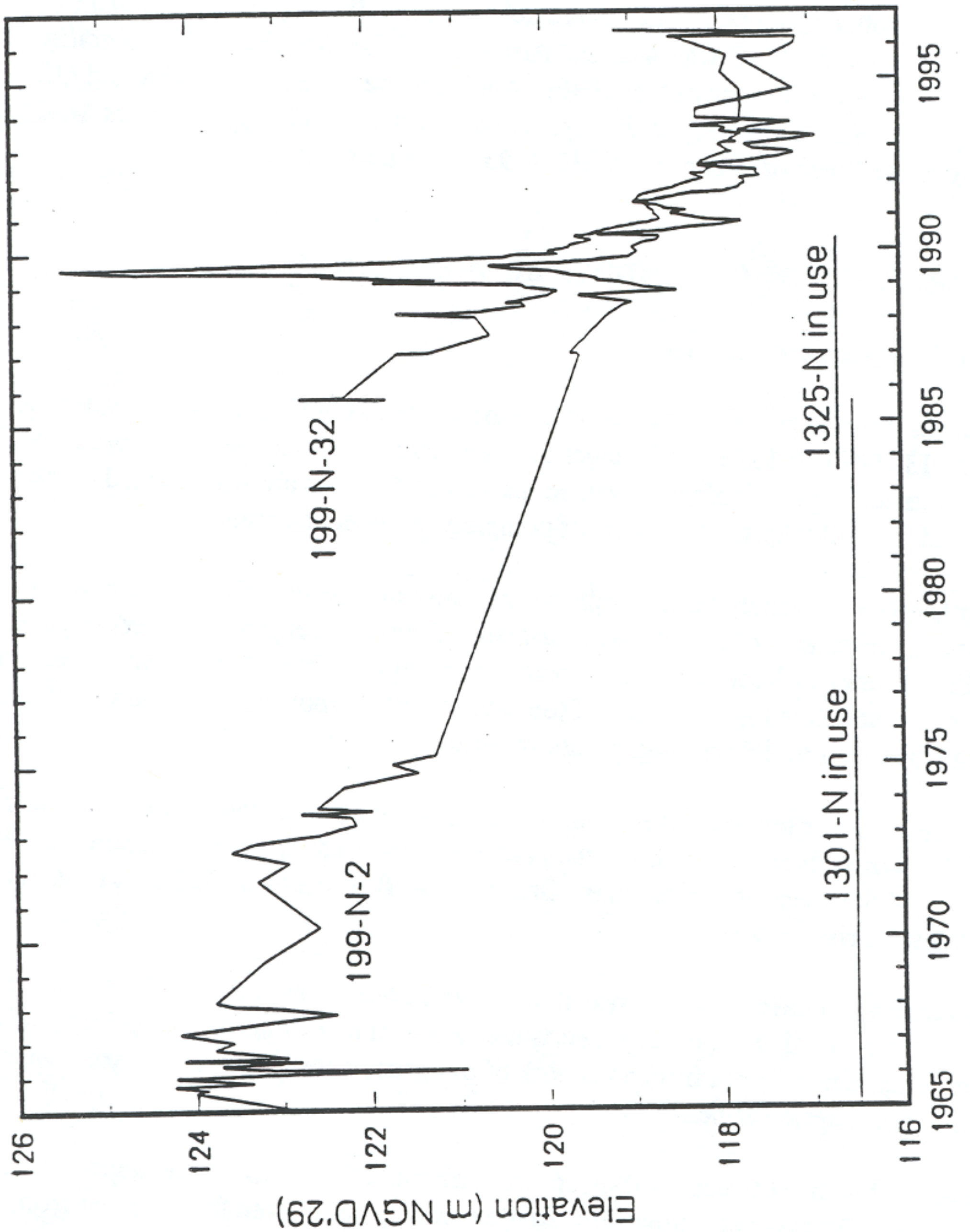

Figure 3.3. Water Level Changes in Groundwater Below 1301-N and 1325-N