Summary of Final Remedial Action Alternative Selection

Flemington Landfill

New Hanover County

North Carolina

I. Site Location and Description

Flemington Landfill is located in New Hanover County, North Carolina, approximately one mile northwest of the City of Wilmington, on a peninsula that is bounded on the west by the Cape Fear River and on the east by the Northeast Cape Fear River (Figure 1). The landfill site is approximately 71 acres in size. The landfill was operated by Waste Industries, Inc. from August 1973 to June 1979. It received both domestic and industrial solid waste. The land on which the landfill was developed, was leased from the Royal family by Waste Industries on March 12, 1973. Waste Industries was given permits to operate the landfill by both New Hanover County and the State of North Carolina in the spring of 1973.

The landfill was initially operated as an area fill, and then as a trench-type landfill. The landfill was worked in phases (Figure 2). Deposition of waste first occurred in the northeast part of the site, followed by the southern part and lastly, the northwest part.

While it is known that both domestic and industrial solid waste were disposed at the landfill, exact information on types and volumes of waste disposed is not available.

Groundwater monitoring at the site started in October 1973 when the State of North Carolina installed six monitoring wells in the area of Phase I of the landfill (see Figure 2). Between 1973 and 1978, the State installed a total of 13 monitoring wells at the site.

Located east and southeast of the landfill is the community of Flemington. From the beginning of the community until the completion of a County water system in February 1981, drinking water in the community was obtained from individual private wells. Some of these wells were located very near the landfill.

II. Legal History

In early 1978, Waste Industries proposed to expand the area of the landfill. In April 1978, data from monitoring wells located between the landfill and some private wells suggested the presence of a water quality problem. In August 1978 in response to these events and complaints from local residents, the State began a groundwater study to determine what effect the landfill was having on local groundwater quality. This study consisted of the installation of 30 monitoring wells and the sampling of a total of 50 private wells in the Flemington community. The results of this study were published as Investigation No. 16 (NRCD, 1978). The report concluded, in part, that leachate from the landfill had affected groundwater quality in the area including four private water supply wells.

In response to further community complaints, the Environmental Protection Agency (EPA) conducted three groundwater quality investigations in the area of the landfill during 1979. The first was conducted in May 1979 (EPA, 1979a). The second was conducted in July 1979 (EPA, 1979b). And the most comprehensive one was conducted in September 1979 (EPA, 1979c). These investigations concluded that the landfill leachate had affected groundwater quality in the area of the landfill.

Based on results of these groundwater studies conducted by the State of North Carolina in 1978 and by EPA in 1979, the United States on behalf of EPA filed a civil lawsuit (80-4-CIV-7) under Section 7003 of the Resource Conservation and Recovery Act (RCRA) on January 11, 1980, alleging that the operation of the landfill had contaminated groundwater beneath the landfill and that the migration of this contaminated water posed an imminent and substantial endangerment to human health and the environment in the area of the landfill.

In January 1981, EPA's lawsuit was dismissed by the U.S. District Court. In May 1984 the U.S. Court of Appeals for the Fourth Circuit reversed the lower court's decision to dismiss the suit and remanded the case back to the District Court. On August 5, 1987, a Partial Consent Decree between the United States (on behalf of EPA) and the Settling Defendants was entered by the District Court.

The Partial Consent Decree required the Settling Defendants to do the following:

1. Provide an alternative drinking water supply system on an as-needed basis for present and future users in the projected path of the

contaminant plume.

2. Design, construct and maintain reasonable site security and access control measures.

3. Construct and maintain a vegetative soil cover over the site's surface.

4. Implement and maintain institutional controls that regulate (1) the withdrawal of groundwater from the contaminant plume, and from its projected path, by residential, commercial, or industrial users; and (2) the excavation of the site and areas of contamination associated with the site.

5. Implement an investigation to assess fully the nature and extent of subsurface contamination associated with the site.

6. If needed, implement a bioassay program to assess fully the harm or potential harm releases from the site pose to local wetlands.

7. Conduct a study to identify remedial action alternatives that address the conditions at the site and study area.

On May 16, 1989, the Settling Defendants submitted to EPA a report titled "Assessment Of The Hydrogeology And Extent Of Subsurface Contamination At The Flemington Landfill" by the consulting firm P.E. LaMoreaux & Associates. This report was submitted in response to Paragraph IV.H. of the Partial Consent Decree.

EPA conducted a thorough review of this report and on September 20, 1990, public noticed its preliminary decision on remedial action alternative for the Flemington Landfill Site. On September 26, 1990, EPA held an informal information meeting at the New Hanover County Public Library. The Agency gave the public 30 days to comment on the preliminary decision. The Agency did not receive any significant comments from the public on the preliminary decision.

III. Groundwater Studies

III.1 PELA Groundwater Study

To comply with the Partial Consent Decree requirement that a subsurface contamination investigation be conducted, the Settling Defendants contracted with the consulting firm P.E.

LaMoreaux & Associates, Inc. of Tuscaloosa, Alabama (PELA) to conduct a subsurface investigation in accordance with Exhibit 6 of the Partial Consent Decree.

The investigation was conducted in phases. Phase I consisted of the installation of 15 piezometers (small diameter monitoring wells used for collecting water level data only) and 17 monitoring wells (for collecting water level data and water samples). After review of data from these wells, Phase II was finalized. Phase II consisted of the installation of 12 additional monitoring wells and conducting aquifer tests. Phase III consisted of groundwater quality sampling quarterly for one year. EPA approved and overviewed the implementation of each phase of the investigation. The results of the investigation are contained in a report titled "Assessment Of The Hydrogeology And Extent Of Subsurface Contamination At The Flemington Landfill" (PELA, 1989).

The 29 monitoring wells were installed in well nests at 11 locations in and around the landfill (Figure 3). Each well nest consists of one deep well (e.g. MW-1D) completed into the Peedee formation and one intermediate well completed into the lower part of the Quaternary age sands (e.g. MW-1I). At some locations, the greater thickness of the Quaternary sands required the installation of a shallow well (e.g. MW-1S) into the upper part of the unit.

III.1.1 Evaluation of Investigation Data

The PELA investigation collected geologic, hydrologic, and groundwater quality data by using the following methods:

1. geologic data

    - review of geologic literature published on the area;
    - examination of soil samples collected by using split-spoon sampler and Christenson wireline core system during drilling of the deep well (e.g. MW-1D) at each well nest;
    - borehole geophysical logging during each deep monitor well installation;

2. hydrologic data

    - periodic measurement of water levels in piezometers and monitoring wells;

- use of continuous water-level recorders to measure water levels in selected wells;
- conducting slug and pumping tests on selected monitoring wells;

3. water quality data

- quarterly groundwater sampling for one year.

III.1.2 Geologic Data

A review of the geologic data reveals that the Flemington area is underlain by approximately 1,100 feet of sediment that ranges in age from Cretaceous to Tertiary (Figure 4). The deepest and oldest formation sampled by PELA during the installation of the monitoring wells was the upper part of the Peedee formation. The lithology of this part of the Peedee was found to be an olive-gray to dark greenish-gray sand that grades from a medium-grain to a silty, fine-grain as depth increases. The sand grains are generally subangular, and moderately to well sorted. In most of the borings that were advanced into the Peedee, the Peedee was found to contain zones where sand grains had been cemented with a calcareous material thereby forming an indurated (hard) sandstone. It appears that the Peedee sediments were deposited in a lagoonal or regressive marine environment.

The Peedee is overlain by Quaternary age sands. These sands appear to have been deposited in a marine to brackish, transgressive environment. These sands were deposited in multiple cycles. Each cycle consists of a fining-upward sediment sequence that grades from granule size with coarse-grained sand, to a medium-grained sand containing glauconite. At the beginning of the deposition of the Quaternary sands, the surface of the underlying Peedee was eroded and the eroded Peedee material was redeposited with the Quaternary sands. This process gave a greenish color to the Quaternary sediments immediately above the Peedee/Quaternary contact, thereby making it difficult to visually pick the location of the contact in some borings. The Quaternary sands that did not contain Peedee sediment were a yellowish-gray to a grayish-orange in color. Zones of calcareous cemented sandstone in the lower part of the Quaternary sands were detected in some borings. The thickness of the Quaternary sands varied across the site due to erosion.

The Quaternary sands are overlain by eolian (wind blown) sand that is probably late Pleistocene or younger in age.

This eolian sand consists of white to light-gray, coarse to medium grained, moderately to well sorted, subangular, frosted, quartz grains. Where present, the thickness of this sand is two to three feet.

The geologic data collected during this investigation compares reasonably well with data collected in previous investigations. It is important to note that previous investigations had reported a thicker section of eolian sand than what was found during this investigation. This lead previous investigators to conclude that the sediments beneath the landfill had greater hydraulic properties than those determined during this investigation.

III.1.3 Hydrologic Data

A review of the hydrologic data reveals that the shallow aquifer in the Flemington area is contained in the upper part of the Peedee formation and the overlying Quaternary sands. Groundwater in the aquifer is under water table conditions, and is recharged by rain water that falls in the area and percolates into the ground. A topographically high area extending down the center of the peninsula is the recharge area for local groundwater. Under natural conditions, groundwater flows outward from this recharge area to discharge areas adjacent to rivers that bound the peninsula. The water level data collected by continuous water level recorders on wells MW-1D, MW-3D and MW-5D clearly shows that the water table rises and falls in response to local rainfall events. Because of their limited areal extent, the sandstone zones found in the Peedee and the lower part of the Quaternary sands do not restrict groundwater from flowing between these units.

During the investigation, water level data were collected from the piezometers and the monitoring wells. Data collected on November 21, 1987 and August 11, 1988 were entered into a commercial graphics software package called "SURFER" by Golden Software, Inc. The software interpolated water level elevations between wells and drew a water level elevation map for each date (see Figures 5 & 6).

The contour lines depicted on Figures 5 & 6 are equipotential lines; that is, lines that connect interpolated points between wells that have the same water level elevation. Groundwater flows from areas of high potential energy to areas of low potential energy due to the influence of gravity. The area of high groundwater elevation depicted on these maps is also the area where groundwater has high potential energy and areas of low elevation are areas where groundwater has low potential

energy; therefore, by drawing flow lines at right angles to the equipotential lines, the direction of groundwater flow in the area of the landfill is depicted on these maps.

These maps are interpreted to show that although there was a change in groundwater elevation between the two sampling events, groundwater flow directions did not change. In the area of the landfill, groundwater flows from the north to the southeast and southwest.

To determine how the data from these events compared with water level data from previous sampling events, the water level data reported in the September 1979 EPA study (EPA, 1979c) were entered into "SURFER" and Figure 7 is the resulting water level map. Figure 7 depicts groundwater flowing from the northwest to the southeast and east. This map compares reasonably well with Figures 5 & 6, in that all three maps depict groundwater flowing from a northerly to a southerly direction. The difference between the 1979 data and the PELA investigation data is probably due to changes in groundwater use in the area. In 1979, there were numerous private and commercial wells withdrawing groundwater in the area. At the time of the PELA investigation, wells in areas east and south of the landfill were not being used because the County is now supplying water to these areas. Figures 5 & 6 depict groundwater flow under natural conditions, whereas Figure 7 depicts groundwater flow that probably was affected by groundwater withdrawal in the area.

Groundwater flow within an aquifer is a three dimensional process. In areas where aquifer recharge or discharge is occurring, groundwater flow is the result of water moving both vertically and horizontally through the geologic formation that contains the aquifer. In areas between recharge and discharge zones, groundwater movement is primarily horizontal through the formation. The rate and direction at which groundwater moves through an aquifer is dependent upon the hydraulic characteristics of the material that makeup the geologic formation and the locations of the aquifer's recharge and discharge zones.

The construction of two or more monitoring wells close together, with each well open to a different vertical section of an aquifer, is called a "well nest". Well nests are used to sample water levels and water quality at different depths within an aquifer.

During the PELA investigation, ten well nests were installed near the landfill and one was installed in an undisturbed area of the landfill (Figure 3). Each well nest consists of one "deep zone" well (e.g. MW-1D) completed into the Peedee

formation and one "intermediate zone" well completed into the lower part of the Quaternary age sands (e.g. MW-1I). At some locations, the thickness of the Quaternary sands was great enough to require the installation of a "shallow zone" well (e.g. MW-1S) into the upper part of the sand unit.

A review of water level data from well nests MW-1 and MW-2 shows a potential for groundwater beneath the landfill to flow from the shallow zone downward to the intermediate zone. Water from the deep zone also has the potential to flow upward to the intermediate zone. Due to erosion of the Quaternary sands, the areal extent of the shallow zone is limited. Due to the fine grain nature of the deep zone sands, the ability of the deep zone to transmit water rapidly is limited. Given these facts, it appears that the intermediate zone is the primary zone for groundwater movement beneath and away from the landfill site.

Figure 8 is a water level map using November 1987 data from the intermediate zone wells. The map depicts groundwater flowing from the north to the south and southeast.

III.1.4 Water Quality Data

Upon completion of the eleven well nests by PELA, a second Defendants' consultant, Industrial and Environmental Analysts, Inc. (IEA) conducted a groundwater sampling and analysis program to collect groundwater quality data in the area of the landfill. This program consisted of four quarterly samplings from the eleven well nests and eight existing wells. This sampling program was approved and its implementation was overviewed by EPA. As a lab check, during each sampling event, EPA obtained split samples from selected wells and these samples were analyzed at EPA's Region IV laboratory in Athens, Georgia. EPA's analytical data compared well with IEA's data.

Water samples from the well nests were analyzed for the following:

- metals
- nutrients
- volatile organic compounds
- major cations & anions
- chemical oxygen demand (COD)
- total organic compounds (TOC)

- pH, specific conductance, temperature

In addition to the above parameters, during the third quarter water samples from wells MW-1I, MW-2S, MW-2I, MW-3I, MW-10I, and MW-10D were analyzed for the Hazardous Substance List contained in Appendix V of Exhibit 6 of the Partial Consent Decree.

During the fourth quarter, water samples from wells MW-1I and MW-2I were analyzed for the RCRA 40 C.F.R. Part 264, Appendix IX parameters. Also during fourth quarter a water sample from county water supply well 1 was analyzed for the parameters listed in paragraph 2.

Each quarter, water samples from the existing wells Q-1, Q-6, R-19, R-34, R-36, R-43, R-57, and R-59 were analyzed for the following parameters:

- pH
- specific conductance
- TOC
- COD
- ammonia
- nitrate-nitrite
- chloride

A review of the water quality data collected during the sampling and analysis program was conducted to determine what impact the landfill is presently having on local groundwater quality. This review consisted of tabulating the data, looking for trends in the data, and comparing the data to health based and environmental based limits established for specific parameters.

III.1.5 Drinking Water Standards for Inorganic Parameters

The data was first evaluated to see if any inorganic parameters exceed the Maximum Contaminant Levels (MCL's) established under the Safe Drinking Water Act. These MCL's are listed in two groups, Primary MCL's (40 C.F.R. Part 141, Subpart B) and Secondary MCL's (40 C.F.R. Part 143.3). The Primary MCL's are set to protect human health and the Secondary MCL's are set to protect the aesthetics of the drinking water.

The only parameter found to be above an inorganic Primary MCL was nitrate in samples collected during the first quarter from well MW-9S and first and third quarters from well MW-9I. The MCL for nitrate is 10 mg/l. The first quarter nitrate value for well MW-9S was 14 mg/l. The first and third quarter values for well MW-9I were 16 mg/l and 12 mg/l. These wells are outside of the landfill.

To determine if the landfill is the source of the nitrate detected in samples from these wells, the software package "SURFER" was used to evaluate the nitrate data. First, an average nitrate concentration value was calculated for each of the wells completed into the intermediate zone of the aquifer. These wells were chosen because the intermediate zone is the primary zone for groundwater movement beneath and away from the landfill. Next, these averaged values were entered into "SURFER". The software was used to interpolate nitrate concentrations between wells and to draw an isopleth map (Figure 9). An isopleth map depicts lines of equal concentration, in this case, lines of equal nitrate concentration. This map shows that in the intermediate zone, nitrate concentrations are high near well MW-9I and are low in the area of the landfill; therefore, the landfill probably is not the source of the nitrate detected in samples from wells MW-9S and MW-9I.

Values for iron and manganese were found to be above Secondary MCL's (0.3 mg/l for iron / 0.05 mg/l for manganese) in most of the samples collected during the program. The highest value for iron was 110 mg/l (third quarter / Well MW-3I) and for manganese was 4.6 mg/l (first quarter / well MW-5I).

Concentrations of iron and manganese occur naturally in most groundwaters because most geologic formations contain iron and manganese bearing minerals. Over time, the iron and manganese in these minerals are dissolved by the groundwater in the formations. To determine if the landfill has contributed to the levels of iron and manganese detected in the groundwater, isopleth maps (Figures 10 and 11) were drawn in the same way as Figure 9 by entering into "SURFER" the averaged iron and manganese values for the intermediate wells.

A review of Figure 10 clearly shows that the landfill has contributed to the iron concentration in the groundwater in the area south of the landfill. A review of Figure 11 is not so clear, while the averaged concentration for manganese in samples from well MW-5I (2.2 mg/l) is the same as the averaged manganese concentration in samples from well MW-2I (a well located in an undisturbed area of the landfill), the averaged manganese concentrations

for samples from wells MW-10I and MW-3I (wells located at the downgradient edge of the landfill) are much less (1.03 mg/l and 0.27 mg/l). It is unclear if the averaged manganese concentrations detected in samples from wells MW-2I and MW-5I are the result of releases from the landfill or are naturally occurring values.

III.1.6 Organic Compounds

Extensive groundwater sampling for organic compounds was conducted during the IEA sampling and analysis program. During the study, groundwater samples were routinely analyzed for 35 volatile organic compounds. Based on the results of these analyses, 6 monitoring wells (MW-1I, MW-2I, MW-2S, MW-3I, MW-10I, MW-10D) were selected during third quarter to be tested for 65 extractable organic compounds. During the fourth quarter two wells (MW-1I and MW-2I) were selected to be tested for the RCRA 40 C.F.R. Part 264, Appendix IX list of parameters. The Appendix IX list contains 222 parameters, of which 203 are organic compounds.

A review of the organic data shows that organic compounds were detected in samples from 9 of the 29 monitoring wells (MW-1I, MW-1S, MW-2I, MW-2S, MW-3I, MW-10D, MW-10I, MW-10S, MW-11D). In samples from 6 of these monitoring wells (MW-1I, MW-2S, MW-3I, MW-10I, MW-10S, MW-11D), one or more organic compounds were consistently measured above detection limits. In samples from 3 of these monitoring wells (MW-1I, MW-2I, MW-2S) significant concentrations of organics were detected.

The following organic compounds were detected during the study:

- benzene
- chlorobenzene
- ethyl benzene
- 1,1-dichloroethane
- trans-1,2-dichloroethene
- methylene chloride
- total xylene
- 1,1,1-trichloroethane

Of the above organics, benzene and trans-1,2-dichloroethene

were detected at or above health or environmental based limits. Benzene was detected above the drinking water MCL (0.005 mg/l) in samples from wells MW-2S (0.005 mg/l to 0.008 mg/l) and MW-2I (0.006 mg/l to 0.008 mg/l). Trans-1,2-dichloroethene was detected above the proposed MCL (0.100 mg/l) in samples from well MW-1I (0.078 mg/l to 0.170 mg/l). The 0.100 mg/l MCL was proposed by EPA on May 22, 1989 (54 Fed. Reg. page 22064). It should be noted that during the study, EPA obtained three split samples from well MW-1I, and the 1,2-dichloroethene detected in these samples was determined by EPA to be cis-1,2-dichloroethene. The MCL for cis-1,2-dichloroethene is 0.070 mg/l. The value for cis-1,2-dichloroethene in the split samples ranged from 0.072 mg/l to 0.150 mg/l. This discrepancy between labs is not considered to be significant.

The concentration of chlorobenzene in samples from well MW-3I ranged form 0.014 mg/l to 0.060 mg/l and in samples from well MW-10I ranged from 0.007 mg/l to 0.009 mg/l. These values are well below the Agency's health based limit of 0.140 mg/l for chlorobenzene. This limit was calculated for drinking water using the reference dose for chlorobenzene contained in the Integrated Risk Information System Data Base.

III.1.7 Comparison Of Study Data With Previous Studies

To develop a general sense of how the groundwater quality data from the PELA investigation compares with data from previous studies, averaged values for TOC, specific conductance and chloride data collected during the PELA investigation were compared with data from EPA's September 1979 study (EPA,1979c). The September study was chosen because it was the most comprehensive study done by EPA in 1979. The parameters TOC, specific conductance and chloride were chosen because they are generally unaffected by well construction materials (a concern expressed by the Defendants with the galvanized casing used to construct the private wells); they are general indicators of water quality; and these were the only parameters that the existing wells (Q-1, Q-6, R-19, R-34, R-36, R-43, R-57, R-59) were sampled for during both the PELA study and the EPA study.

To evaluate the data, a series of isopleth maps were generated by entering the data from the intermediate zone wells into "SURFER". Figure 12a depicts averaged concentrations for TOC from the PELA study and Figure 12b depicts TOC concentrations from the EPA study. Figures 13a & 13b depict specific conductance and Figures 14a & 14b depict chloride.

A review of Figures 12a & 12b shows that in 1979 the highest concentration of TOC was beneath the landfill; whereas today, there has been a significant decrease in TOC concentration beneath the landfill and some increase in TOC concentrations in the area south and southeast of the landfill. Also in 1979 it appears that groundwater high in TOC value was moving away from the landfill to the southeast; whereas today, groundwater high in TOC appears to be moving to the south and southwest.

A review of Figures 13a & 13b shows that in 1979 the highest concentration of chloride was beneath the landfill and in the area southeast of the landfill. It appears that groundwater high in chloride was moving away from the landfill to the southeast. Today, there has been a decrease in chloride concentration beneath the landfill and in the area southeast of the landfill. It now appears that groundwater with elevated chloride is moving to the southwest.

Figures 14a & 14b depict values of specific conductance. Specific conductance is a measure of a water sample's ability to conduct an electric current. This ability is related to the chemical content of the water sample. Water low in chemical content will have a low specific conductance (< 100 micromhos/centimeter (umhos/cm); whereas, water high in chemical content will have a high specific conductance (> 1000 umhos/cm). It is very important to understand that specific conductance does not identify the chemicals dissolved in the water sample.

A review of Figures 14a & 14b shows that in 1979 the groundwater beneath the landfill measured high in specific conductance and the water appears to have been moving to the southeast. Today, the specific conductance of the groundwater beneath the landfill has decreased and now it appears that the water is moving to the southwest.

The review of these maps (Figures 12a to 14b) shows a good correlation between the data collected in 1979 and the PELA study. The review shows that with the closing of the landfill, there has been some improvement in the quality of the groundwater beneath the landfill as the amount of leachable material in the landfill becomes exhausted. The review also shows a change in groundwater flow direction probably due to changes in groundwater use in the area.

III.2 December 1990 Groundwater Study

On October 25, 1990, representatives of EPA, Department of Justice and the Settling Defendants met to discuss the

Agency's preliminary decision on remedial action at the site. During this meeting, the Settling Defendants proposed to do an additional round of groundwater sampling of selected monitoring wells. EPA agreed with this proposal and on November 7, 1990, the Settling Defendants submitted to EPA for approval a plan for conduction the additional sampling. On December 4, 1990, EPA approved the plan and during December 17-19, 1990, the samples were collected. On February 4, 1991, the Settling Defendants submitted the analytical results.

The December sampling event consisted of collecting groundwater samples from wells MW-1I, MW-2S, MW-3I, MW-5I, MW-6I, MW-71, MW-8I, MW-9I, MW-10S, MW-10I, and MW-11I. The samples were analyzed for volatile organic compounds, major cation and anions, nitrate/nitrite, pH, specific conductance, COD, and TOC. Before being sampled, the wells were redeveloped and allow to recover and stabilize for 24 hours.

During the sampling event, EPA representatives together with an EPA contractor were present to observe the sampling and to collect split samples from wells MW-1I, MW-2I, MW-91, and MW-10I.

III.2.1 Sampling Results

The sampling results from this event were consistent with those of the PELA Groundwater Study. Volatile organic compounds benzene, chlorobenzene, and xylenes were detected in wells MW-2S, MW-2I, and MW-3I. Benzene and chlorobenzene were detected in well MW-10I.

III.3 North Carolina Division of Environmental Management Groundwater RS Designation Boundary and Monitoring Plan

During 1992, the North Carolina Division of Environmental Management (NCDEM) installed 17 monitoring wells in the area of the Flemington Landfill site as part of the RS Designation Boundary and Monitoring Plan for the Cape Fear/Northeast Cape Fear Peninsula Area. These wells were installed in well nests at 5 locations to the northeast, north, northwest, and west of the landfill (Figure 15).

During the month of September, 1992, NCDEM sampled these new wells and analyzed for pH, specific conductance, TOC, alkalinity, nitrates/nitrites, selected metals, base/neutral/extractable organics and other chemical constituents. During the month of November, 1992, a second round of sampling was conducted of selected wells (r-106, r-

107, q-34, q-35, q-37, q-38, q-39).

During the November sampling event, water level data were collected from all of the state monitoring wells and the monitoring wells installed by the Settling Defendants. Utilizing this water level data, the "SURFER" software was used to develop a water elevation map (see Figure 15). This map is interpreted to show that in the area of the landfill, groundwater continues to flow from the north to the southeast.

III.3.1 Sampling Results

Low levels of organics were detected in several wells during this study. Well r-106 was the only well in which significant amounts of organics were detected. Concentrations of benzene ranged from 0.180 mg/l to 0.260 mg/l and the concentrations of chlorobenzene ranged from 0.380 mg/l to 0.780 mg/l. The drinking water MCL for benzene is 0.005 mg/l and the Agency's health based limit for chlorobenzene is 0.140 mg/l.

A review of Figure 15 indicates that well r-106 is located in a hydraulically upgradient direction from the landfill. This would indicate that the landfill may not be the source of organics detected well r-106. The detection of organics in this well indicates that there may have been a separate release of organics in the area northeast of the landfill.

IV. Summary and Conclusions

The purpose for the PELA investigation was to evaluate the hydrogeology and the extent of the subsurface contamination in the area of the Flemington landfill. This investigation was done in accordance with Exhibit 6 of the Consent Decree and was overviewed by EPA. The data from this investigation together with the data from the December 1990, Groundwater Study and the State Groundwater RS Designation Study have been used as a basis for evaluating the need for remedial action at and in the area of the landfill and to determine the need for a bioassay program in the wetlands.

EPA has evaluated the PELA investigation data together with the data from the December 1990, Groundwater Study and the State Groundwater RS Designation Study and EPA has determined the following:

1. The landfill is underlain by sediments that range in age from Cretaceous to Tertiary. The shallow aquifer beneath the site is contained in the upper

part of the Peedee formation and the overlying Quaternary age sands. In some areas the Quaternary sands are overlain by eolian sands. The thickness of the eolian sand is not as great as was stated in earlier reports. This is an important point, because in earlier reports it was assumed that the shallow aquifer was contained in the eolian sand. The eolian sand appears to have a greater hydraulic conductivity than the underlying Quaternary sands; therefore, previous investigators predicted more rapid movement of groundwater beneath and away from the landfill than present data indicates.

2. In the landfill, groundwater within the shallow aquifer has the potential to move downward through the upper Quaternary sands to the lower Quaternary sands (the intermediate zone) and upward from the Peedee sands to the intermediate zone. It appears that the intermediate zone is the primary zone for groundwater movement beneath and away from the landfill; therefore, it is the primary zone for contaminant movement.

3. Groundwater movement in the area of the landfill is from the north to the southeast, south, and southwest. Rate of groundwater movement appears to be lower than previously reported because of the low hydraulic gradient across the landfill and the moderate value of the Quaternary sands' hydraulic conductivity.

4. Water quality data does indicates that the landfill has affected the quality of the groundwater beneath the landfill and in areas immediately southeast, south, and southwest of the landfill. The landfill has changed the aesthetic quality of the groundwater. Presently, there does not appear to be any widespread organic chemical problem associated with releases from the landfill.

5. The groundwater data from the State RS Designation Boundary and Monitoring Plan indicates that there may have been a release(s) of organic chemicals from an unknown source(s) located in the area northeast of the landfill. It appears that the PELA investigation may have also detected this organic release but because the investigation was designed to detect releases from the landfill, the data was interpreted to mean that the landfill was releasing organics.

6. In accordance with paragraph IV.F. of the Partial Consent Decree, EPA has determined that a bioassay program as described in Exhibit 7 of the Partial Consent Decree is not needed. This determination is based on the groundwater quality results from well nest MW-7 and the results of a wetland impact study (EPA, 1989) conducted by Region IV's Ecological Support Branch.

7. In the 1990 Preliminary Decision of Remedial Action Alternative document, the Agency proposed to require the Settling Defendants to conduct 30 years of groundwater monitoring. The Agency's determination that additional monitoring was needed was based on the fact that the PELA investigation had detected organics. EPA had interpreted this detection to mean that the organics may have been released from the landfill.

   Now that the Agency has had an opportunity to review the data collected as part of the State RS Designation Boundary and Monitoring Plan, the Agency has determined that it is no longer appropriate to require the Settling Defendants to conduct 30 years of monitoring. This determination is based on the Agency's interpretation that the State data indicates that there may have been a release(s) of organic chemicals from an unknown source(s) located in the area northeast of the landfill. However, as a conservative measure, the Agency has determined that the Settling Defendants must do additional groundwater monitoring to ensure that the landfill is not the source of the release.

   The Agency has determined that the Settling Defendants must conduct 3 years of annual groundwater monitoring of selected landfill wells. If at the end of the 3 year period, it is determined that a significant increase in contamination has been detected by the monitoring and it is determined that the landfill is the source of the contamination, the Settling Defendants shall conduct 2 years of additional monitoring.

V. Final Decision on Remedial Action

In accordance with paragraph IV.H. of the Partial Consent Decree, EPA has reviewed the results of the Settling Defendants' study and their evaluation of remedial action

alternatives. Additionally, EPA has made an independent evaluation of the study data. EPA has also evaluated the data from the December 1990, Groundwater Study and the State Groundwater RS Designation Study.

In accordance with paragraphs IV.H. and VI.A. of the Partial Consent Decree, EPA has made a final decision that groundwater remedial action is not needed at the Flemington Landfill site.

This final decision is based on the following:

1. Although organics have been detected in the area of the landfill, it appears that the landfill is not the source of these organics.

2. It does not appear that the nitrate detected above the MCL limit was released from the landfill (see Figure 9).

3. Two chemical parameters (iron and manganese) were detected above the Secondary MCL. While it is clear that the landfill is releasing iron to the groundwater, it is unclear about manganese (see Figure 11). The concentrations of iron and manganese make the groundwater aesthetically unsuitable as a source of drinking water but do not pose a health threat. The only way to remove the iron and manganese would be by pumping and treating the groundwater. It is more economical to supply water low in iron and manganese to the community.

4. Drinking water of good quality is presently being supplied to the community by the County.

5. As an institutional control to regulate the withdrawal of groundwater in the area of the landfill, the State has propose a "RS" boundary designation and a groundwater monitoring plan under authority of 15A N.C. Administrative Code 2L .0104. This designation will serve as a warning that groundwater within the boundary may not be suitable for use as a drinking water supply without treatment.

6. As an institutional control, the County has developed and passed an ordinance (County Code, Chapter 12, Article VIII, Sections 12-67 et seq.) that requires the permitting of all new well construction in the area of the landfill.

7. Based on the PELA study data and EPA's Wetland Impact Study, releases from the landfill presently do not pose a threat to wetlands in the area.

VI. Additional Monitoring

In its "Final Decision on Remedial Action Alternative," EPA determined that an additional three years of groundwater monitoring is required at the Flemington Landfill. This determination is based on the following:

1. The PELA investigation and the State Groundwater RS Designation Study detected contaminants that could pose a threat if their concentrations were to significantly increase in the future.

2. The PELA data appears to indicate that organic concentrations were decreasing during the investigation. Additional data is needed to determine if this is a continuing trend.

3. As contaminants from the landfill move to the south and southwest, continued monitoring is needed to ensure that releases from Flemington Landfill will not impact local wetlands.

EPA has determined that the following additional monitoring activities will be performed at the site:

1. Annual monitoring of wells MW-1I, MW-2S, MW-2I, MW-3I, MW-10I.

2. Groundwater samples from the wells identified in item 1 above shall be analyzed for the following:

   a. all volatile organic compounds listed in Appendix VI of Exhibit VI to the Partial Consent Decree;

   b. major cations and anions (carbonate, bicarbonate, sulfate, calcium, sodium, chloride);

   c. nutrients (nitrate and nitrite);

   d. pH, specific conductance, Chemical Oxygen Demand ("COD") and Total Organic Carbon ("TOC").

3. The above sampling shall utilize the same well

purging and sample collection protocol used during the 1987/1988 quarterly sampling, as set forth in Exhibit VI to the Partial Consent Decree.

4. The Settling Defendants shall also measure and record the water levels in all monitoring wells and piezometers remaining open and accessible during each sampling event.

5. The first sampling event shall occur no later than 90 days following the entry to the Final Consent Decree. Subsequent sampling events shall occur within 90 days of the anniversary date of the first event.

6. After three years of monitoring, the Settling Defendants shall prepare a report detailing and summarizing the results of the above sampling events. This report must contain data sufficient for EPA to determine whether a significant increase in contamination has occurred at the landfill site, and whether such increase in contamination at the landfill site is attributable to offsite contamination.

EPA has made a final decision that the above monitoring shall be conducted for the next three years. In the event the three years of groundwater monitoring indicate that a significant increase in contamination has occurred at the landfill site which is not attributable to the offsite contamination, the monitoring activities above will be extended for an additional period of two years. This period of monitoring is protective of human health and the environment.

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North Carolina Department of Natural Resources and Community Development, 1978,Groundwater conditions in the Flemington area of New Hanover County with emphasis on effect of the landfill: Report of Investigation No. 16, 41 p.

P.E. LaMoreaux & Associates, Inc., 1989, Assessment of the hydrogeology and extent of subsurface contamination at the Flemington Landfill, May 2, 1989: Consultant report prepared for the Settling Defendants in Civil Action No. 80-4-CIV-7, 91 p.

U.S. Environmental Protection Agency, 1979a, Final report--well-water samples, area of New Hanover County Landfill, Wilmington, North Carolina--sampling period, April 18-19, 1979: Internal agency report to the Air and Hazardous Materials Division.

U.S. Environmental Protection Agency, 1979b, Hazardous waste site investigation, New Hanover County, Flemington Landfill, July 1979: Internal agency report to the Air and Hazardous Materials Division.

U.S. Environmental Protection Agency, 1979c, Hazardous waste site investigation, New Hanover County, Flemington Landfill, September 1979: Internal agency report to the Air and Hazardous Materials Division.

U.S. Environmental Protection Agency, 1989, Wetland Impact Study, Flemington Landfill, Wilmington, N.C., March 1989: Internal agency report to the Waste Management Division.

FIGURES

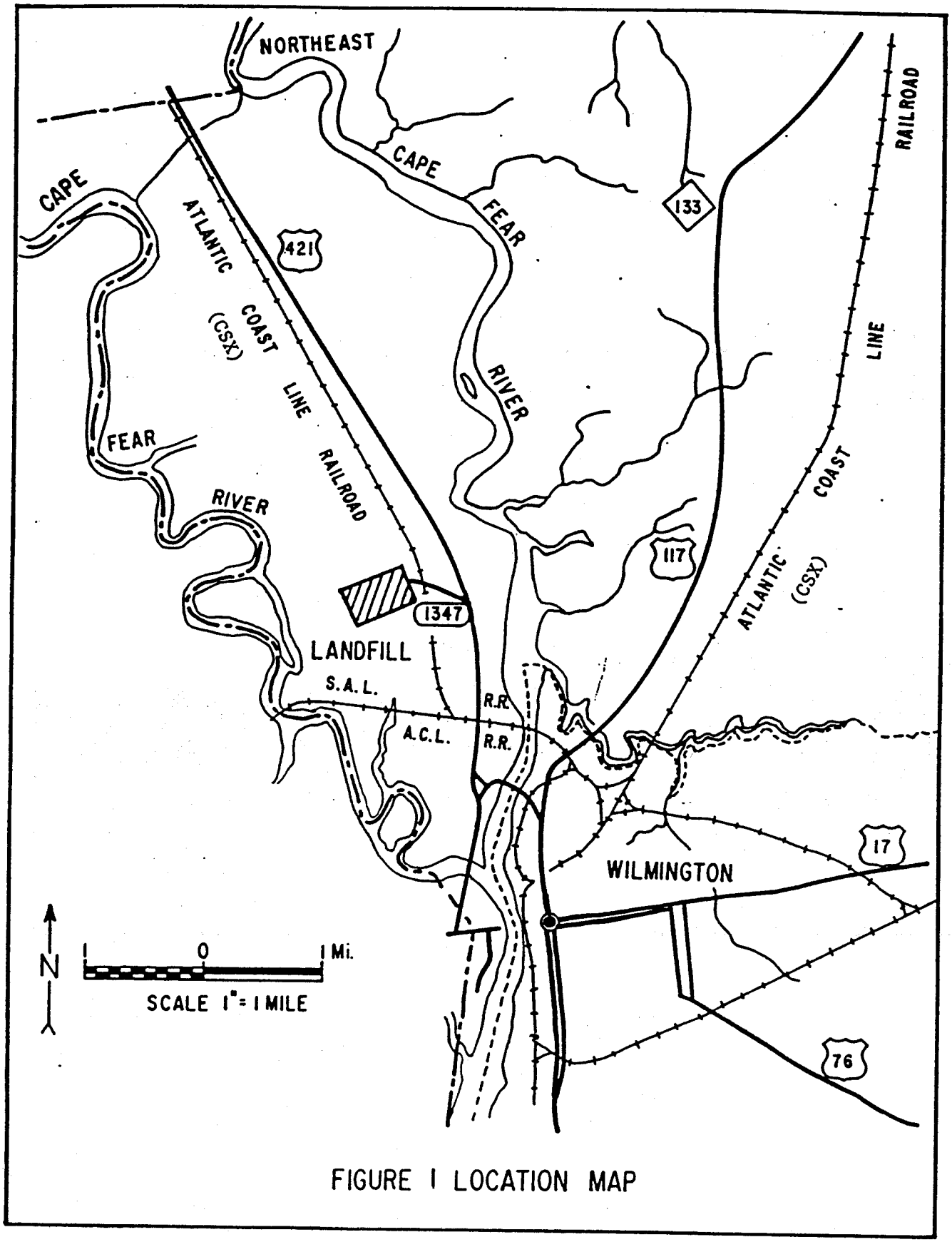


FIGURE 1 LOCATION MAP

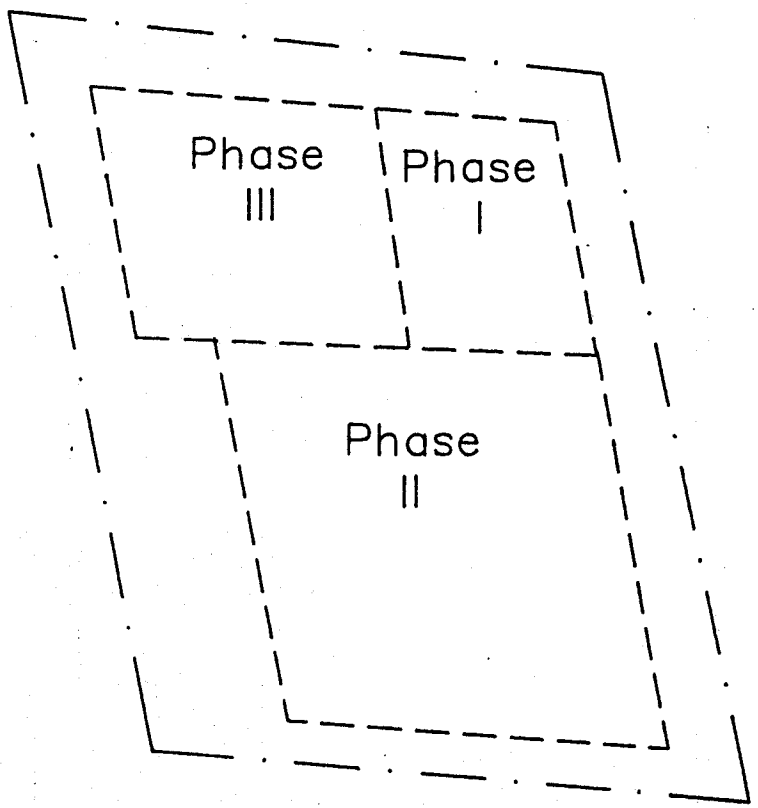


Figure 2

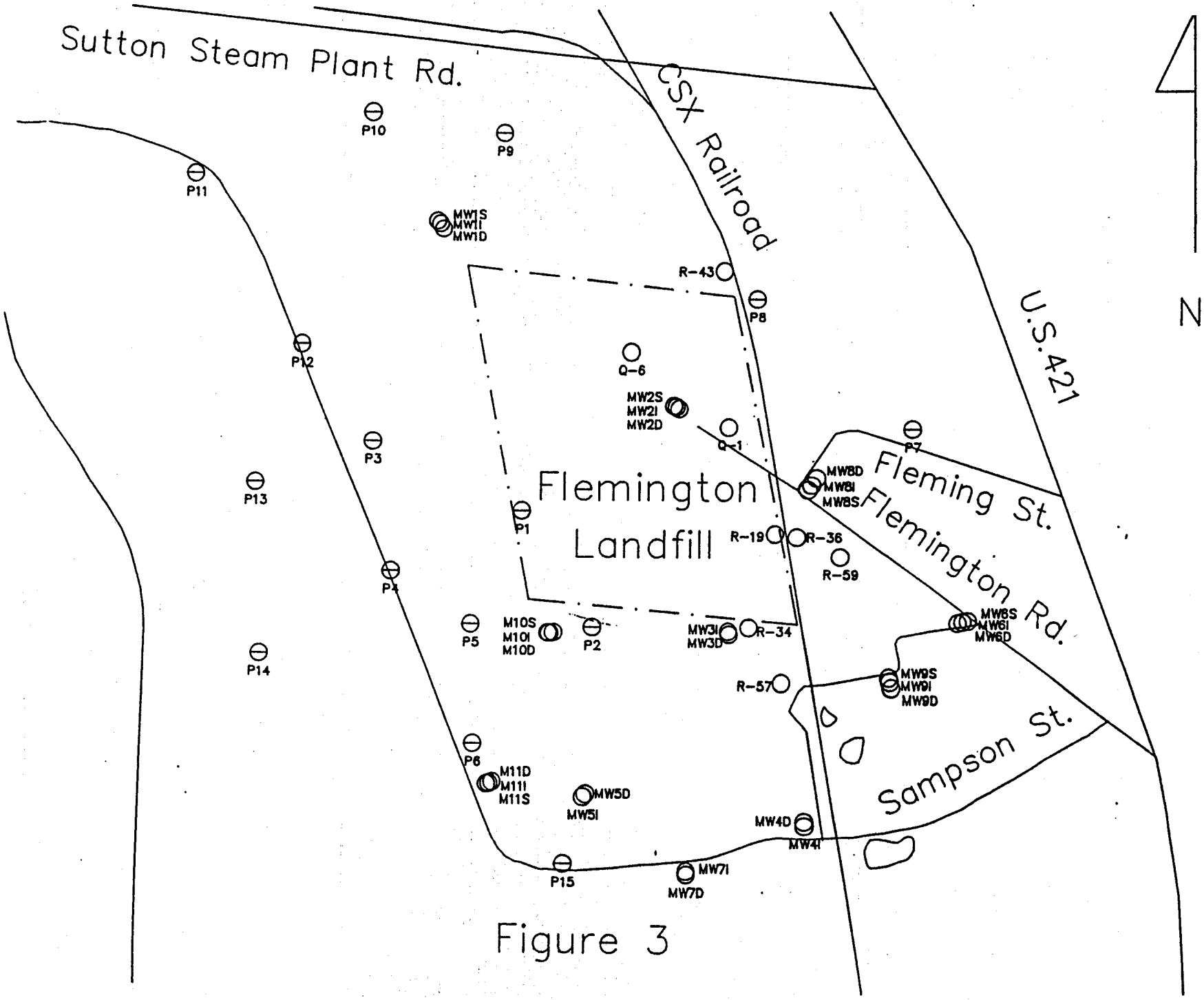
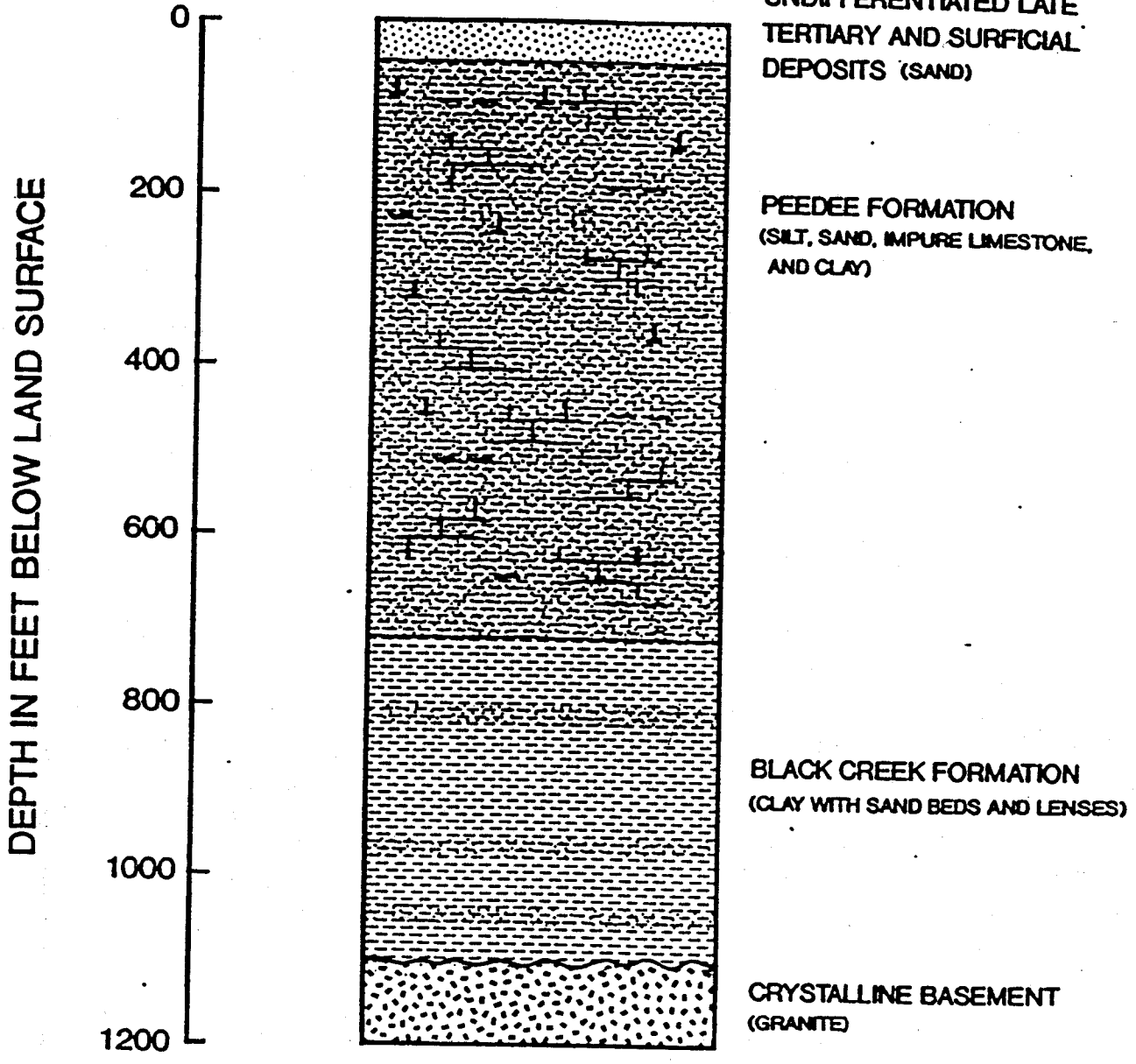

Sutton Steam Plant Rd.
CSX Railroad
U.S.421
N
Flemington Landfill
Fleming St.
Flemington Rd.
Sampson St.
P10
P9
P11
MW1S
MW1I
MW1D
R-43
P8
P12
Q-6
MW2S
MW2I
MW2D
Q-1
P7
P3
MW8D
MW8I
MW8S
P13
P1
R-19
R-36
R-59
P4
MW6S
MW6I
MW6D
P5
M10S
M10I
M10D
P2
MW3I
MW3D
R-34
P14
R-57
MW9S
MW9I
MW9D
P6
M11D
M11I
M11S
MW5D
MW5I
MW4D
MW4I
P15
MW7I
MW7D

Figure 3

Figure 4

GENERALIZED STRATIGRAPHIC COLUMN FOR THE FLEMINGTON AREA, NORTH CAROLINA.

(MODIFIED FROM BAIN, 1970)



EXPLANATION

SAND

CRYSTALLINE ROCK

IMPURE LIMESTONE

CLAY

CALCAREOUS MATERIAL

SILT

UNCOMFORMITY

Prepared by:
P.E. LAMOREAUX & ASSOCIATES, INC.

Figure 5 11-1987 Water Levels (MSL)

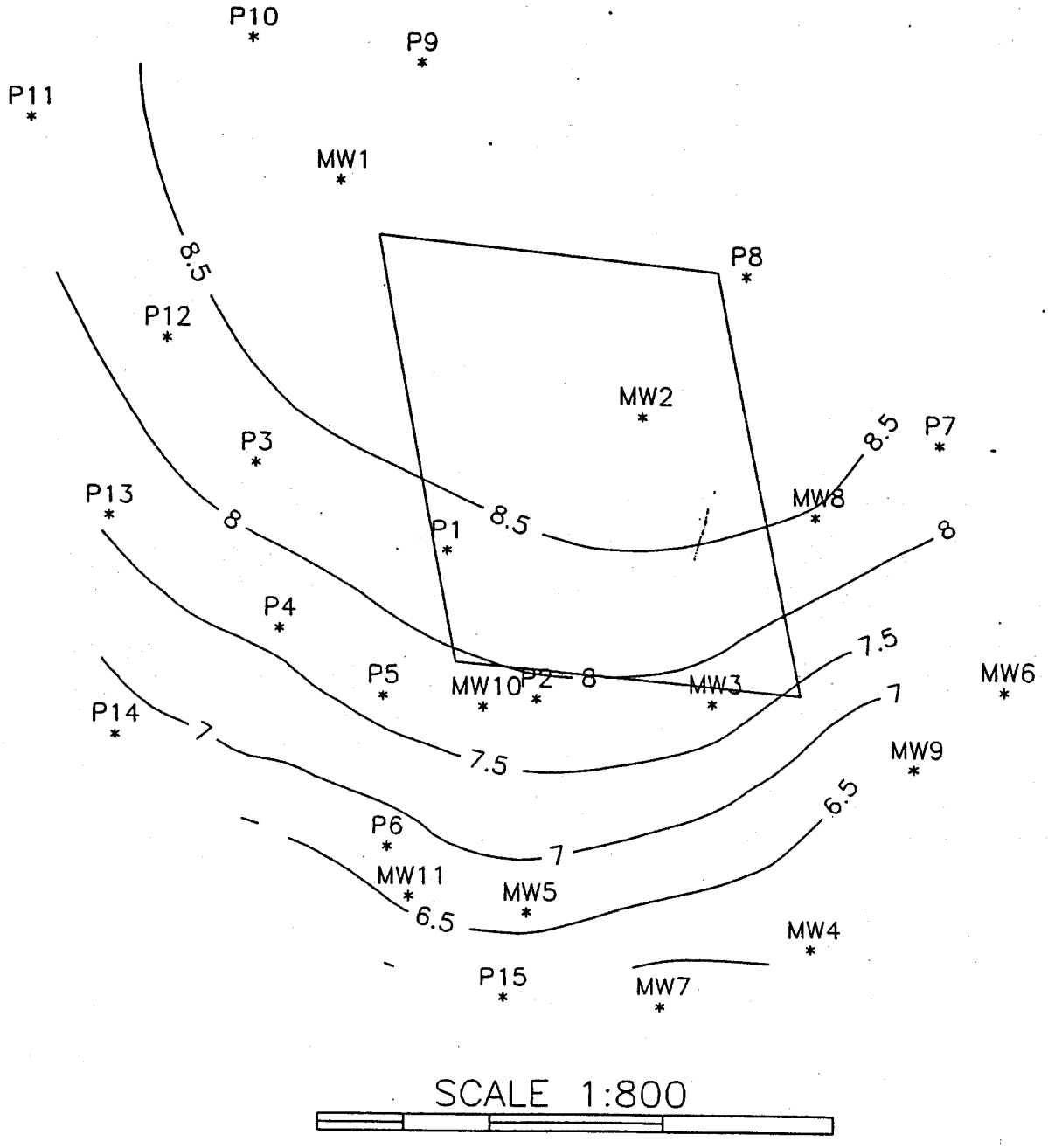


Figure 6 08-1988 Water Levels (MSL)

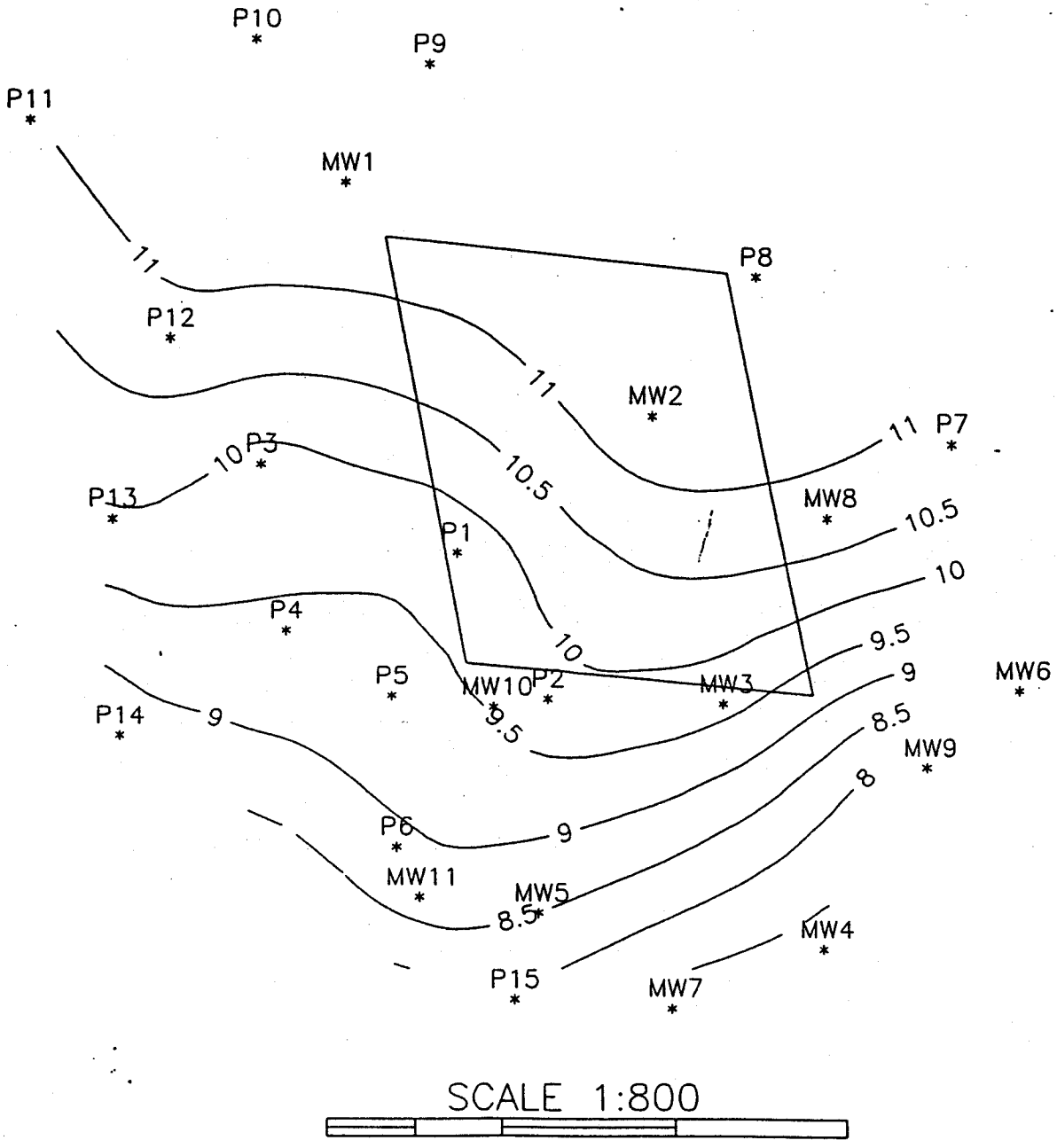
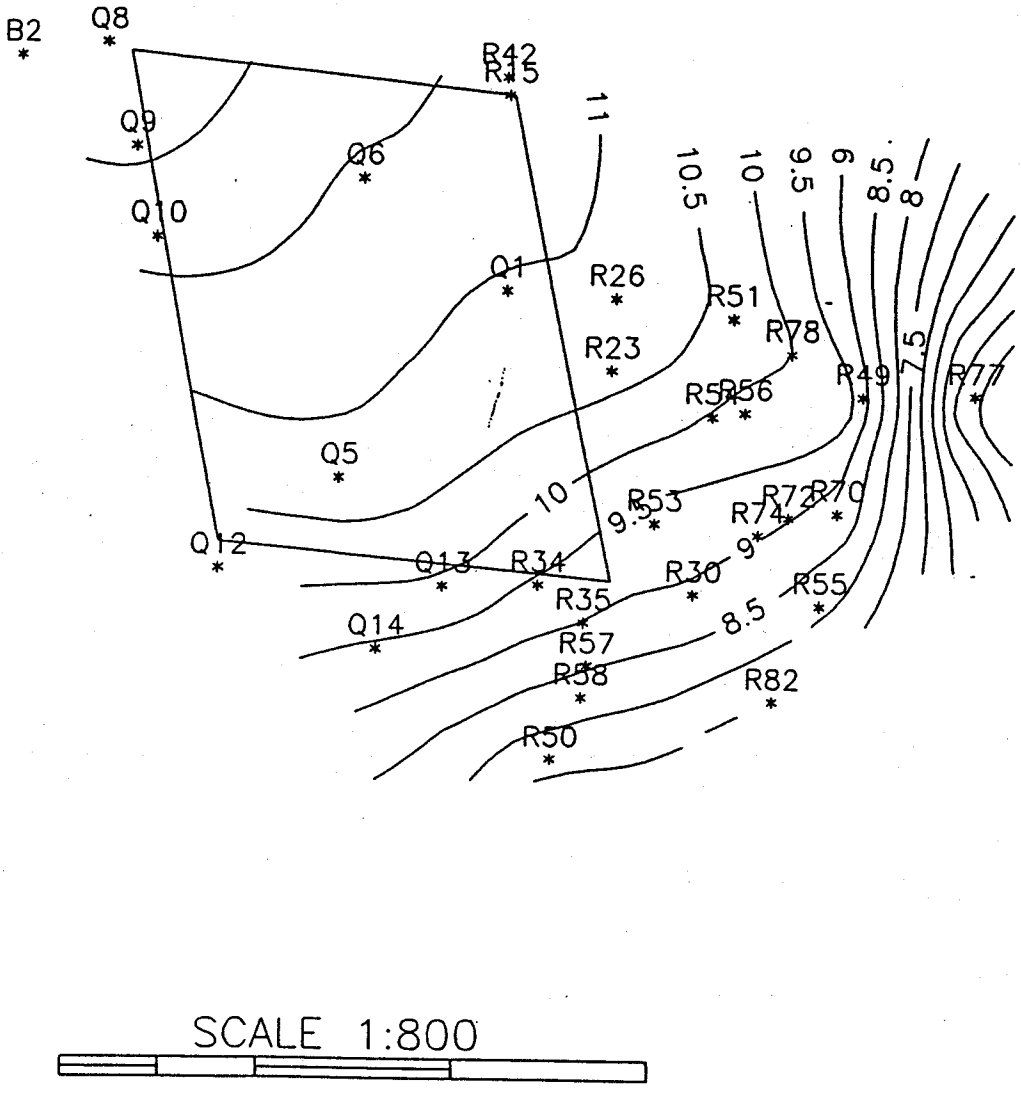


Figure 7 09–1979 Water Levels (MSL)



SCALE 1:800

Figure 8 11-1987 Inter. Water Levels (MSL)

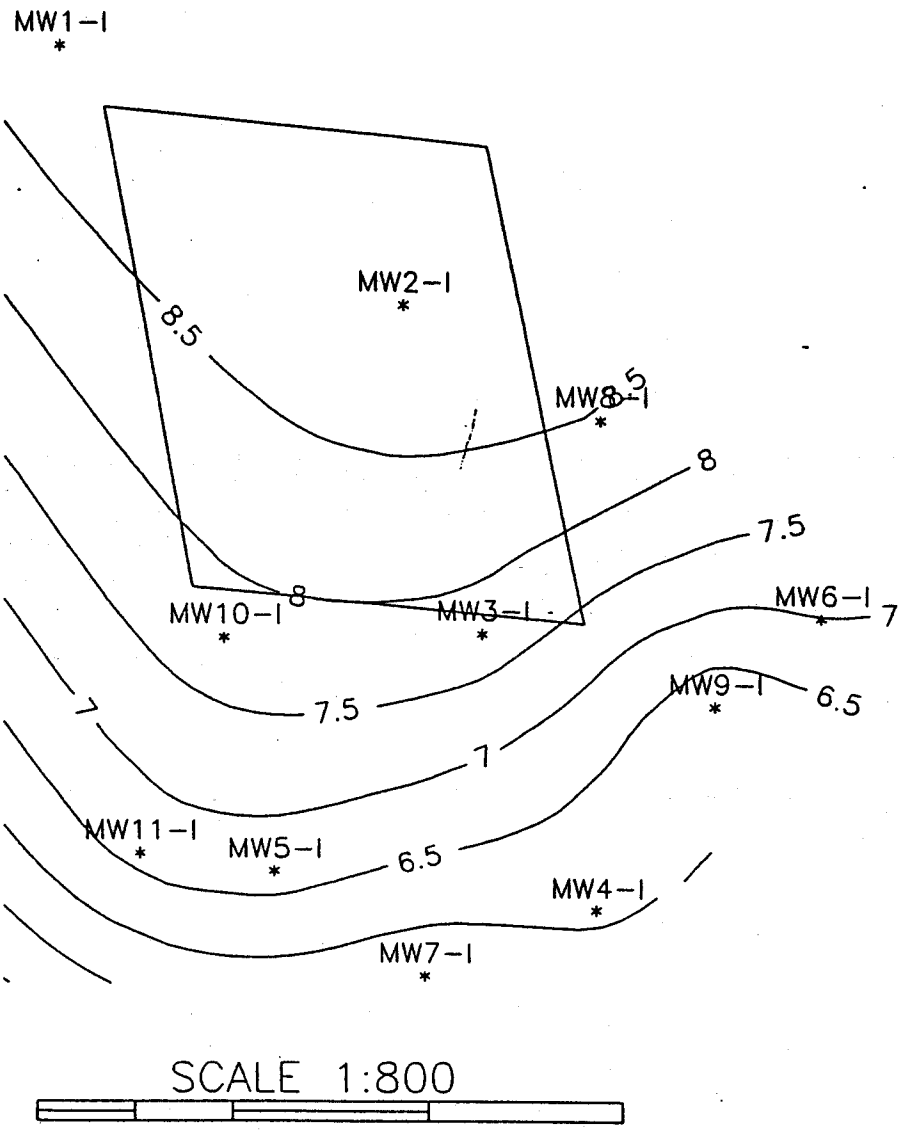


Figure 9 Averaged Nitrate (mg/l)

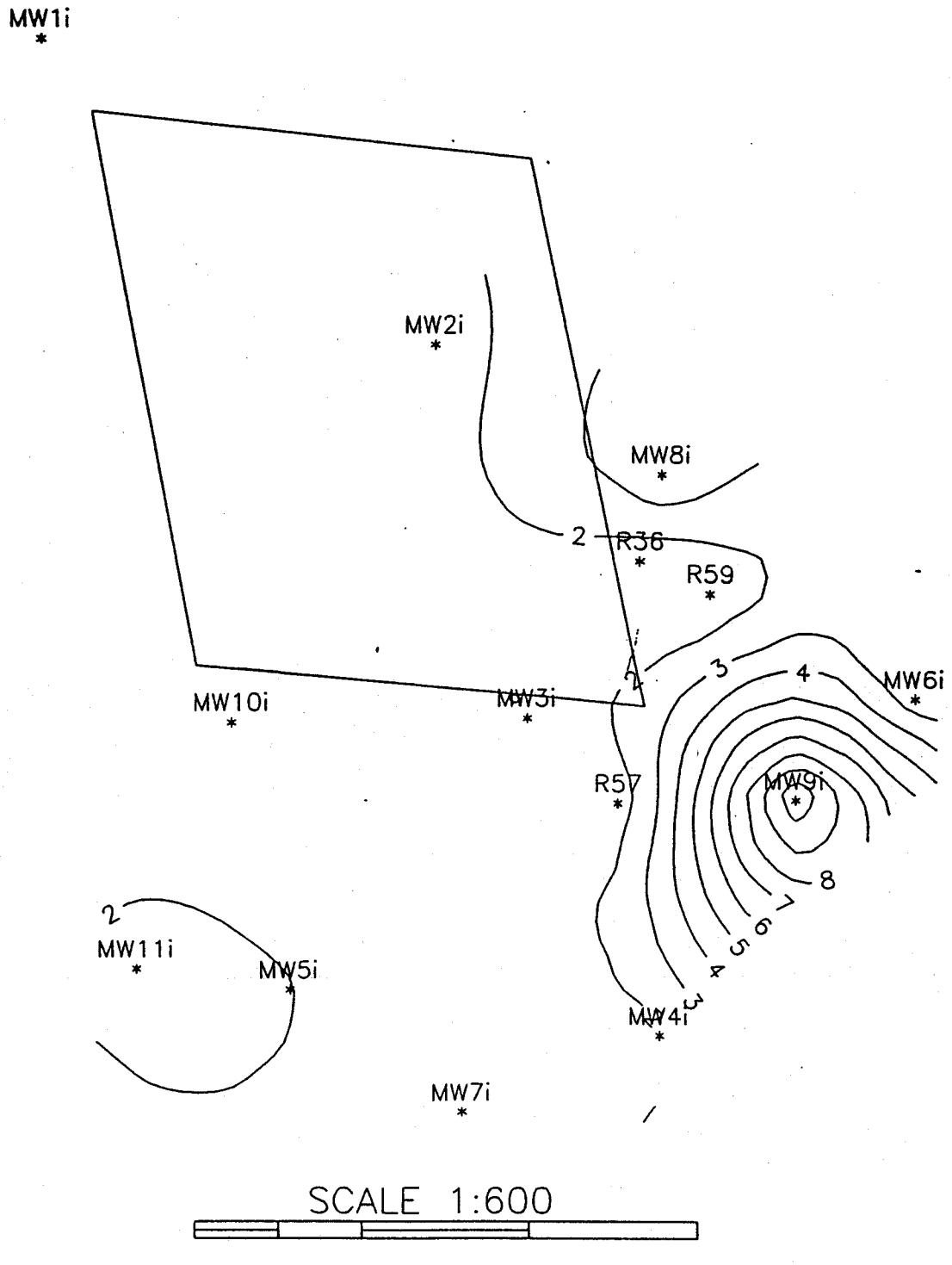


Figure 10 Averaged Iron (mg/l)

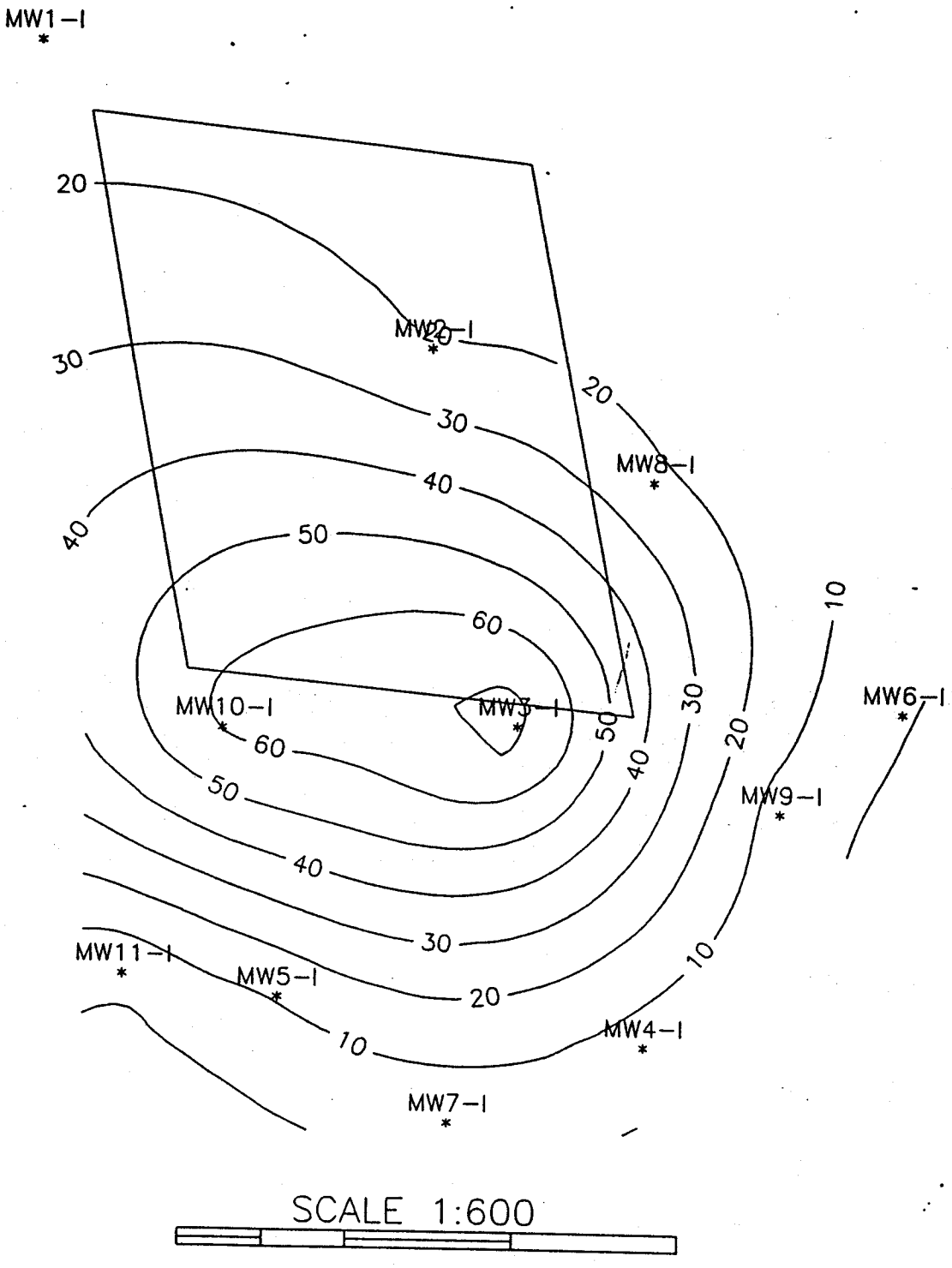


Figure 11 Averaged Manganese (mg/l)

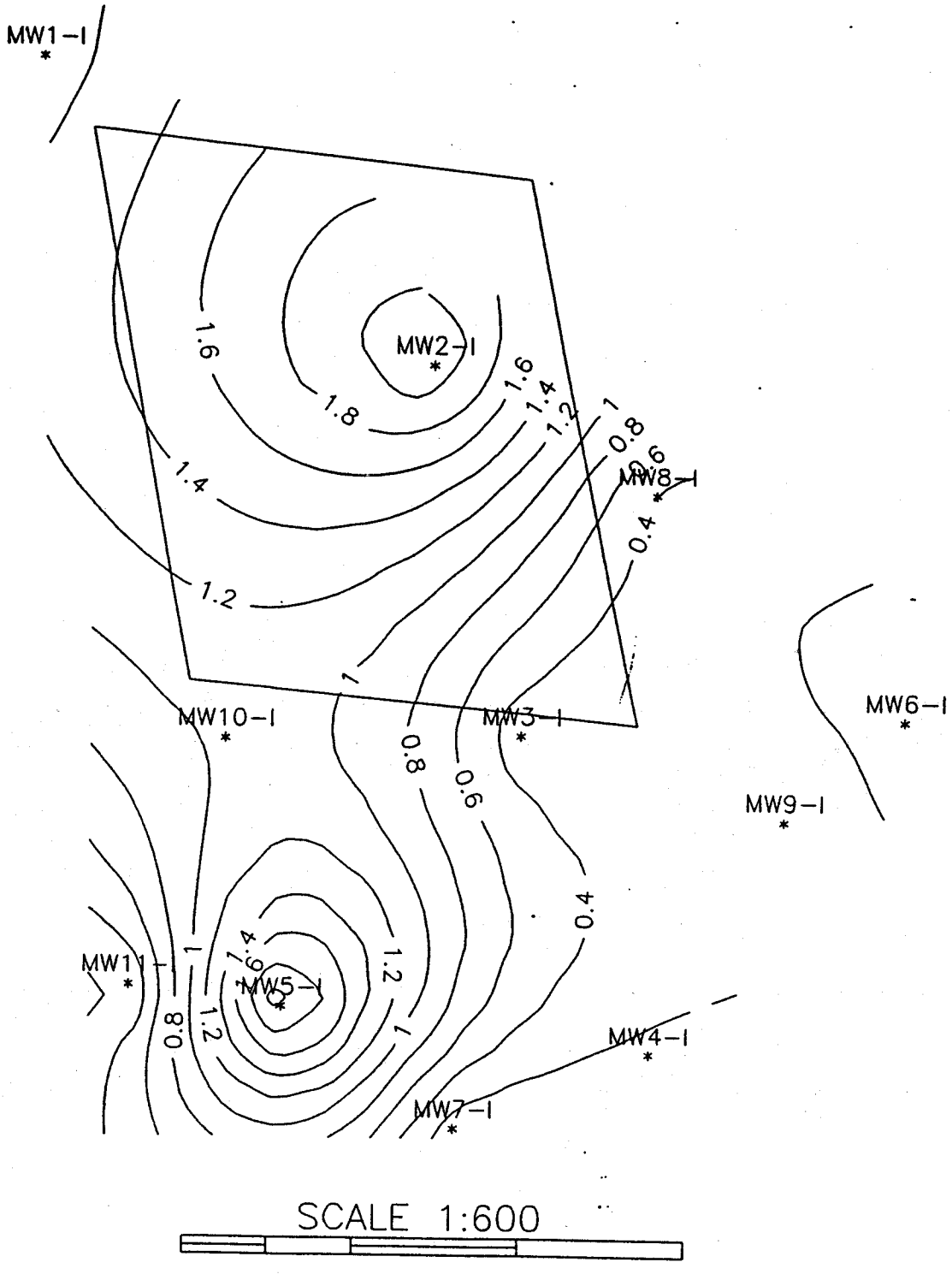


Figure 12a PELA Study Av. TOC (mg/l)

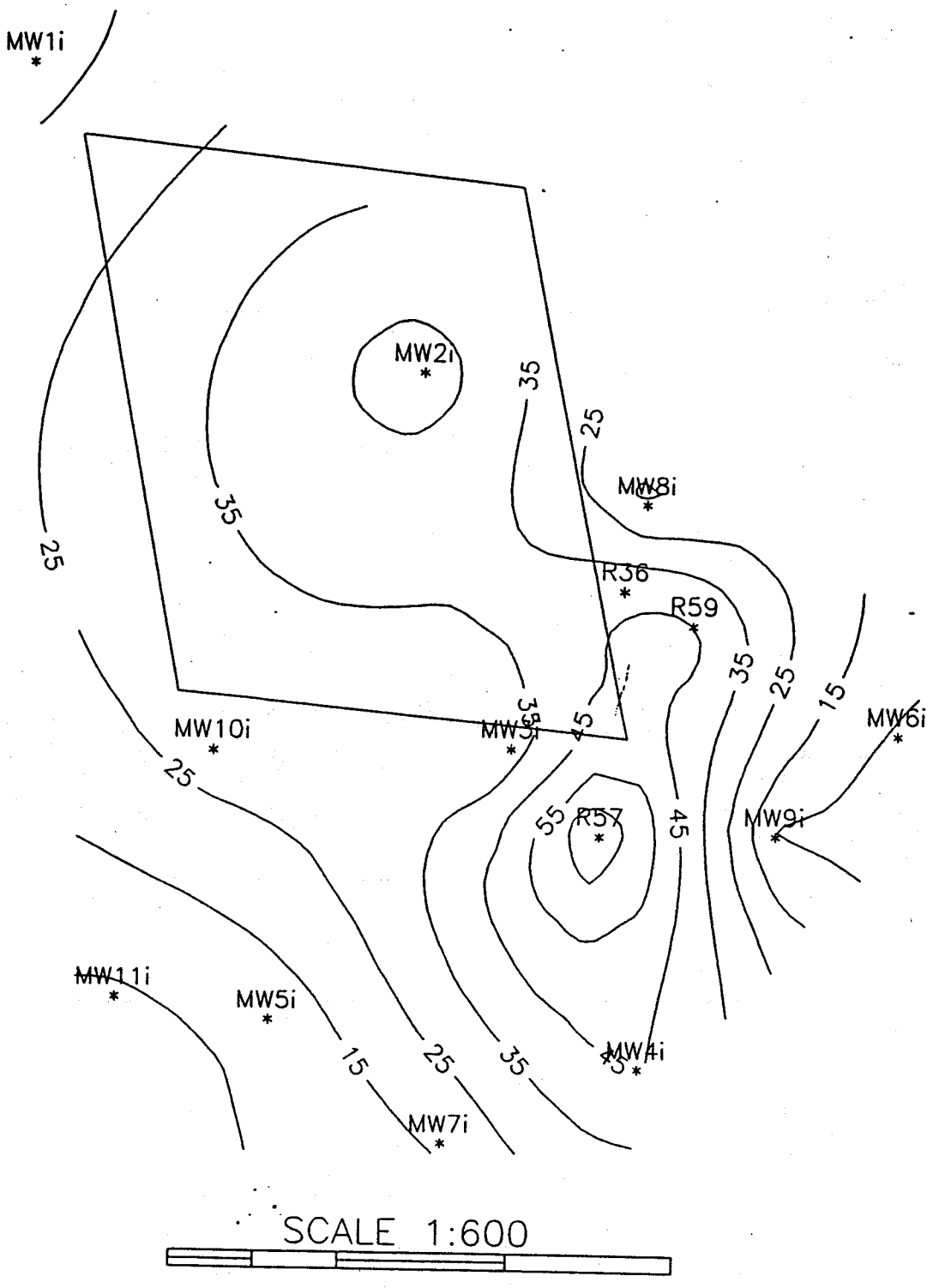


Figure 12b 09-1979 TOC Date (mg/l)

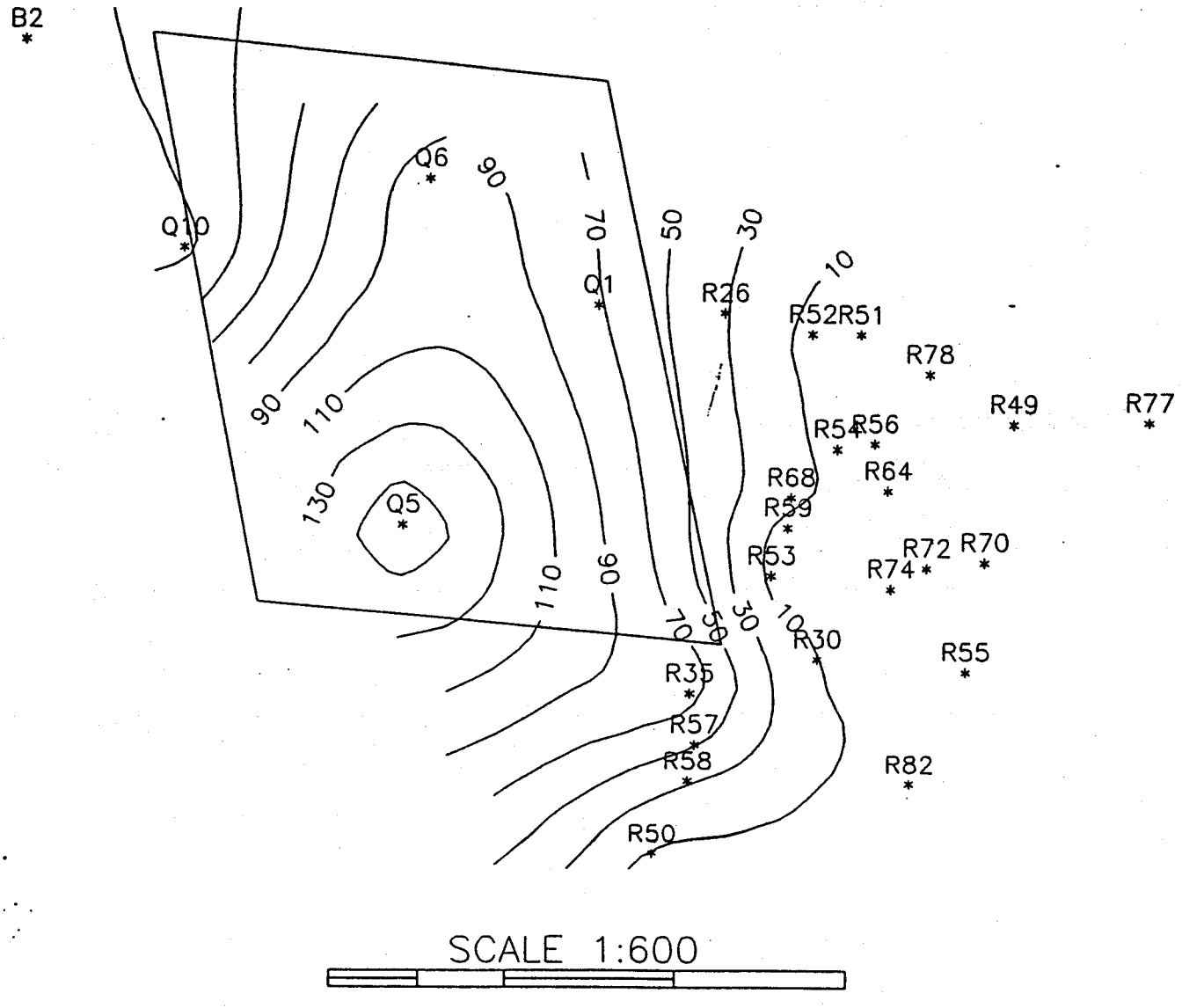


Figure 13a PELA Study Av. Sp.C. (umhos/cm)

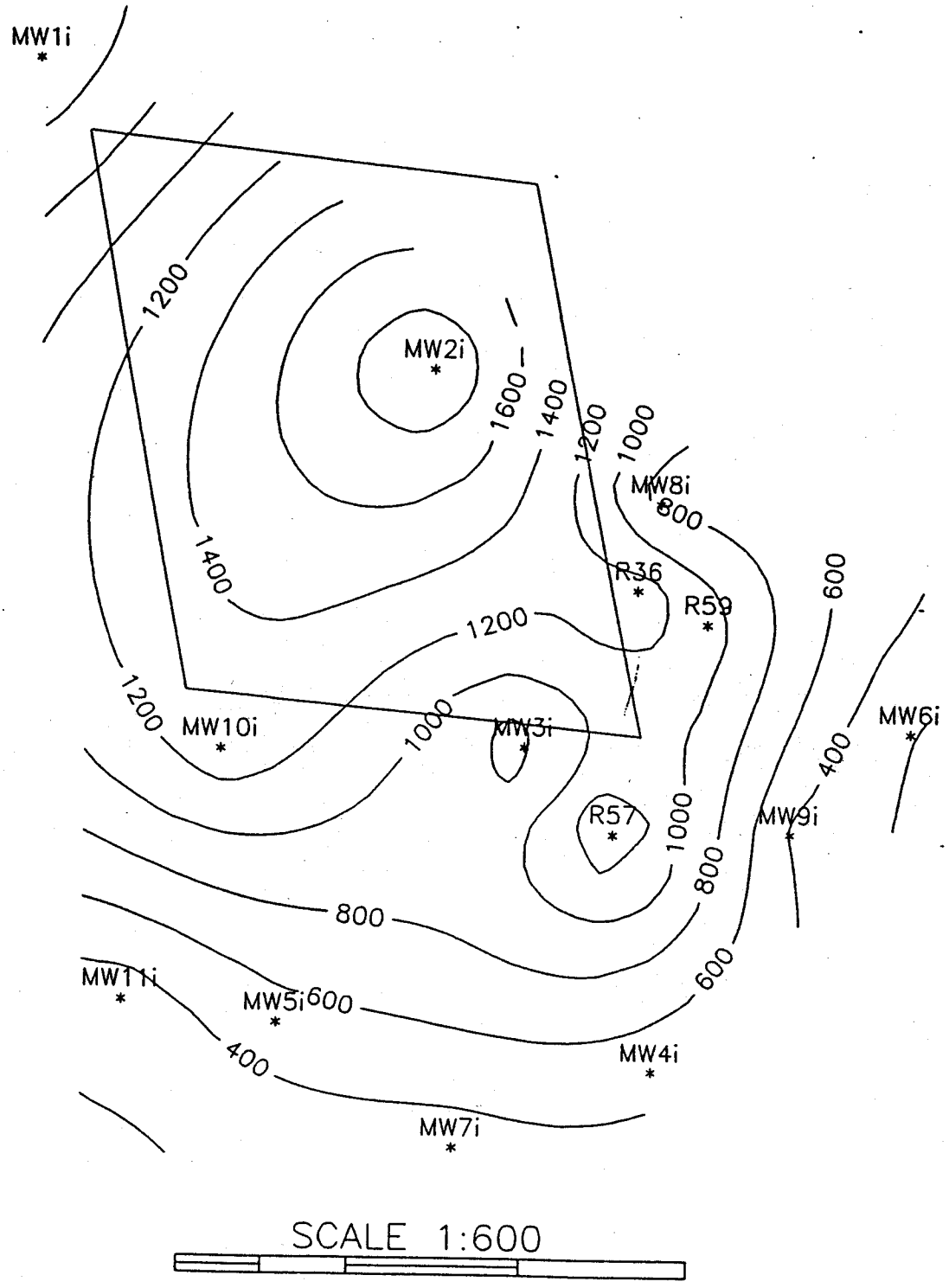


Figure 13b 09-1979 Sp.C. Data (umhos/cm)

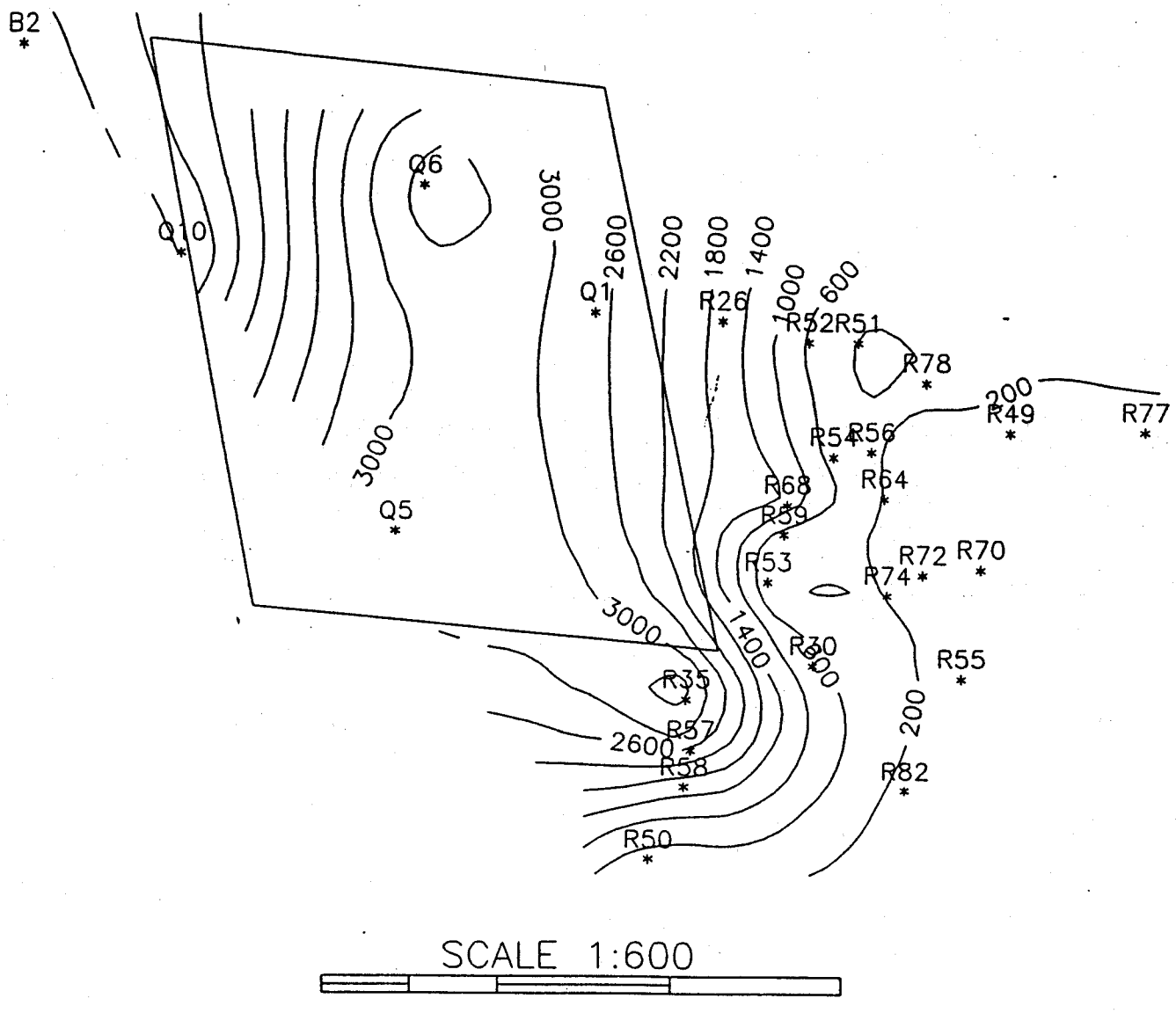


Figure 14a PELA Study Av. Chloride (mg/l)

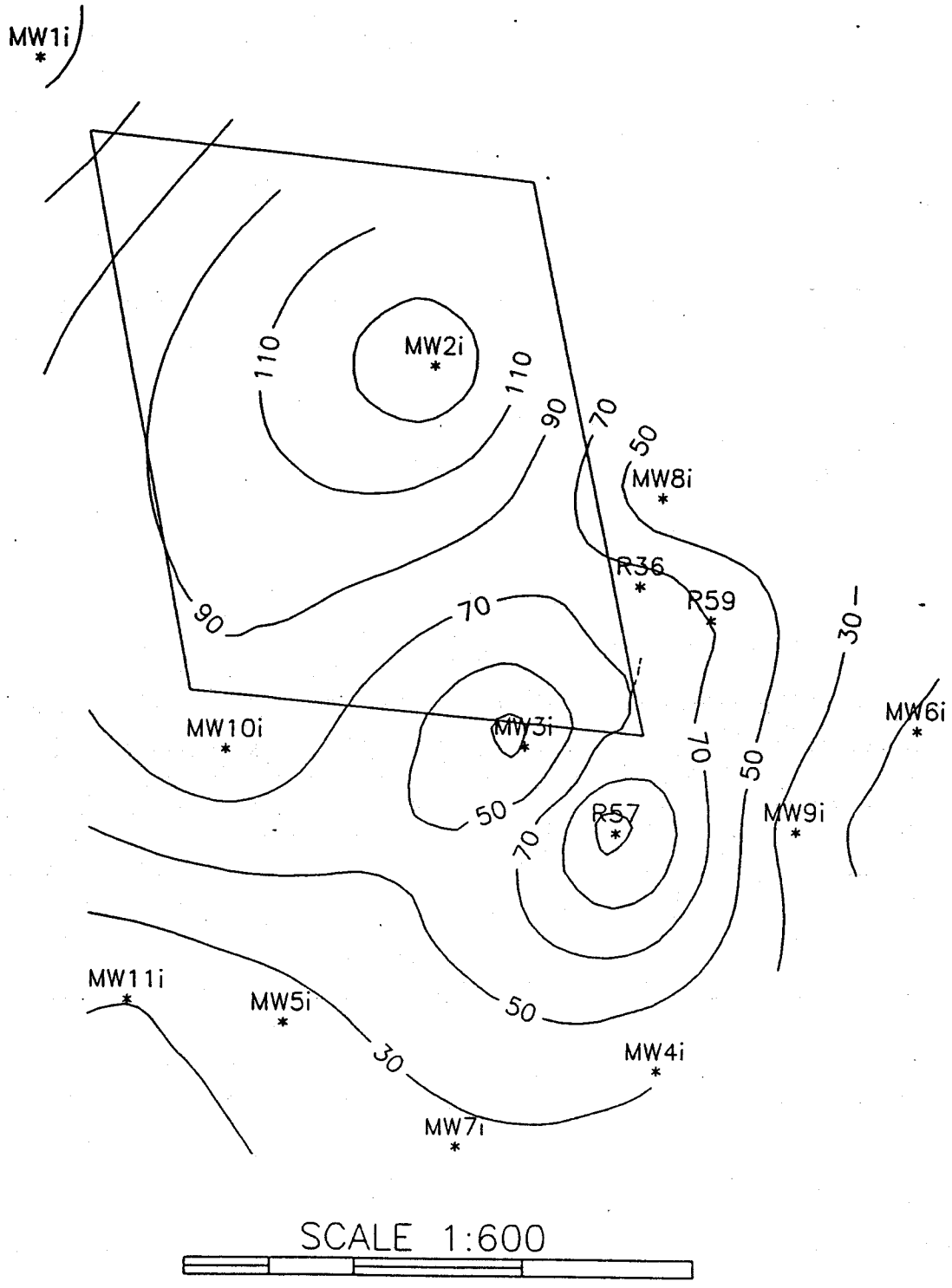


Figure 14b 09–1979 Chloride Data (mg/l)

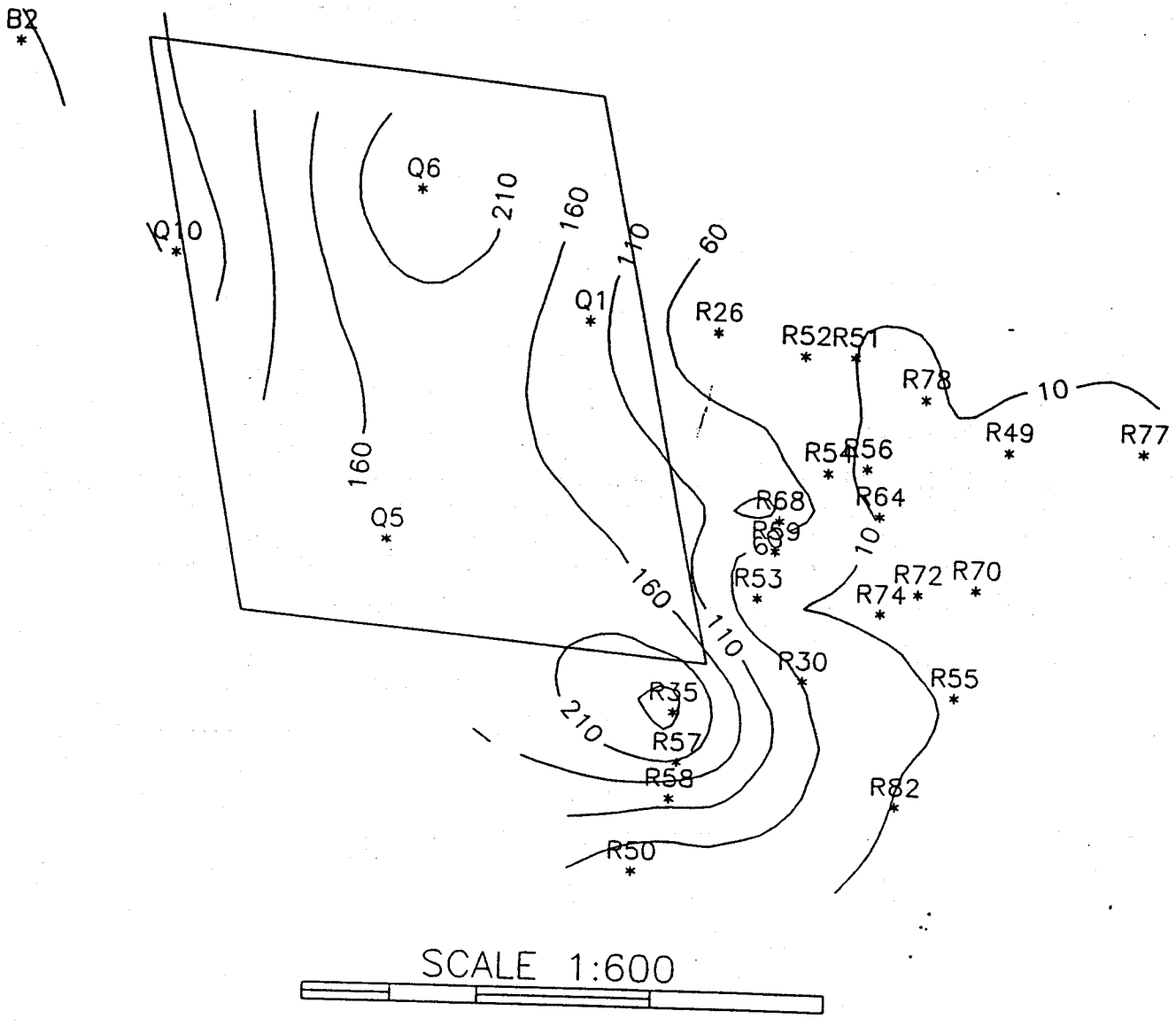


Figure 15 1992 Water Levels (MSL)