GROUND WATER MANAGEMENT PLAN

1995

LOWER PLATTE SOUTH
NATURAL RESOURCES DISTRICT
3125 Portia
Lincoln, Nebraska

April, 1995

GROUND WATER MANAGEMENT PLAN

1995

LOWER PLATTE SOUTH
NATURAL RESOURCES DISTRICT
3125 Portia
Lincoln, Nebraska

April, 1995

STATE OF NEBRASKA

June 26, 1995

IN REPLY REFER TO:

E. Benjamin Nelson
Governor

DEPARTMENT OF WATER RESOURCES
J. Michael Jess
Director

301 Centennial Mall South
4th Floor

P.O. Box 94676
Lincoln, Nebraska
68509-4676

Phone
402/471-2363

Telefax
402/471-2900

Ted Wehrbein
Lower Platte South Natural Resources District
3125 Portia Street
Lincoln, NE 68581

Dear Mr. Wehrbein:

Evaluation of your Board's 1995 Ground Water Management Plan has been completed. This letter constitutes approval of your plan. While deficiencies identified by five state agencies are not found significant enough to deny approval of the plan, the Board is urged to incorporate their comments in future plan revisions.

Deliberation about one element of your plan was particularly lengthy and I believe warrants consideration by your Board. Misgivings were voiced about the Phase III trigger for the ground water management area. The trigger is 80% of the wells in an area or reservoir exceeding 80% of the maximum contaminant level (MCL). It was noted that the average contaminant level in an area could be significantly higher than MCL, and a significant number of wells could exceed MCL, before this trigger is tripped.

My impression after meeting with District staff is these scenarios are unlikely to occur based on the nature of aquifers in the area. Further, I was assured if the District does detect such conditions, revision of the ground water management plan would be initiated or localized management efforts would be conducted. Therefore, I view the District's reluctance to alter the Phase III trigger as a preference to maintain simplicity and clarity in the plan, rather than any effort to create loopholes or justify inaction on the part of the District. Expansion of this discussion in future revisions of the plan would reassure the public of the commitment I noted after meeting with District officials.

Sincerely,

J. Michael Jess
Director

JMJ:DV
cc/enc: Randy Wood
Jack Daniel
Dayle Williamson
Perry Wigley
Ross Lock
Keith Paulsen
Glenn Johnson

100 YEARS

1895-1995
100 Years of Water Resource Administration

1957-Present
Department of Water Resources

1933-1957
Department of Roads and Irrigation
Bureau of Irrigation, Water Power and Drainage

1919-1933
Department of Public Works
Bureau of Irrigation, Water Power and Drainage

1895-1919
State Board of Irrigation

GROUND WATER MANAGEMENT PLAN

1995

LOWER PLATTE SOUTH
NATURAL RESOURCES DISTRICT
3125 Portia
Lincoln, Nebraska

April, 1995

TABLE OF CONTENTS
Lower Platte South NRD
Ground Water Management Plan Update

		Page
1.0	Introduction	1
2.0	Description of the LPS NRD	3
2.1	Location	3
2.2	Climate	3
2.3	Surface Water Supplies	4
2.4	Population and Economic Base	6
2.5	Topography, Soils, Land Use	7
2.6	Crop Water Needs	7
2.7	Water Use	7
2.8	Water Conservation and Water Needs of Future Populations	9
2.9	Environmentally Sensitive Resources (Wetlands, Threatened & Endangered Species)	12
3.0	Geology and Ground Water Supplies	15
3.1	Introduction	15
3.2	Bedrock Deposits	16
3.3	Sand and Gravel Deposits	17
3.4	Sand and Gravel in Buried Bedrock Stream Channels (Paleo Valleys)	17
3.5	Sand and Gravel Lenses	18
3.6	Coarse Grained Sands in Present Day Valleys	18
4.0	Ground Water Reservoirs in the LPS NRD	19
4.1	General	19
4.2	Crete-Princeton-Adams	19
4.3	Dwight-Valparaiso	20
4.4	Waverly	20
4.5	Missouri River Valley	21
4.6	Platte River Valley	22
4.7	Dakota Aquifer	23
4.8	Remaining Area	23
5.0	Ground Water Levels	25
5.1	General Conditions	25
5.2	Ground Water Level Change	25
6.0	Ground Water Quality	27
6.1	General Conditions	27
6.2	Total Dissolved Solids	29

TABLE OF CONTENTS - CONTINUED

	Page
7.0 Vulnerability to Pollution	31
7.1 General	31
7.2 Topography	31
7.3 Recharge	31
7.4 Soils	32
7.5 Vadose Zone	34
7.6 Depth to Ground Water	34
7.7 DRASTIC	35
7.8 Land Use	36
8.0 Non-Point Source Pollution	39
8.1 General Conditions	39
8.2 Nitrate/Nitrogen	39
8.3 Other Agricultural Chemicals	41
9.0 Point Source Pollution	43
9.1 General	43
9.2 Underground Storage Tank Hydrocarbon Releases	43
9.3 Hazardous Waste Releases	44
9.4 National Pollution Discharge Elimination System (NPDES)	45
9.5 Nebraska Pretreatment Program	46
9.6 Other Potential Sources of Pollution	46
10.0 The Plan for LPS NRD Ground Water Management	49
10.1 Introduction	49
10.2 Ground Water Quantity & Quality Life Goals	51
10.3 Ground Water Management Strategy	52
References	67

TABLES

After Page

TABLE 1 - Ground Water Programs 1

TABLE 2 - Summary of Stream Mileage 4

TABLE 3 - Registered Wells by Use 7

TABLE 4 - Major Geologic Units 15

TABLE 5 - Principal Ground Water Reservoirs 19

TABLE 6 - Annual Average Ground Water Level Change 25

TABLE 7 - Safe Drinking Water Act Maximum Contaminant Levels for Selected Chemicals 29

TABLE 8 - Recommended Concentration Limits for Water Used for Livestock and Irrigation Crop Production 29

TABLE 9 - Summary of Landuse (1986) 36

TABLE 10 - Summary of Available Nitrate Water Quality Data 40

TABLE 11 - LPS NRD Water Quality Sampling Results 40

FIGURES

After Page

FIGURE 1 - Natural Resources District Boundaries 3

FIGURE 2 - Water Shed Boundaries 4

FIGURE 2A - Ground Water Use in LPS NRD 8

FIGURE 3 - Ground Water Reservoirs 8

FIGURE 4 - Registered Wells 8

FIGURE 5 - Cumulative Number of Registered Wells 8

FIGURE 6 - Registered Wells by Decade of Development 8

FIGURE 7 - Water Systems and Sources of Water Supply 8

FIGURE 8 - Distribution of Dakota Formation 16

FIGURE 9 - Geologic Cross-Section in CPA Ground Water Reservoir 19

FIGURE 10 - Geologic Cross-Section in DV Ground Water Reservoir 20

FIGURE 11 - Geologic Cross-Section of the Waverly GWR 21

FIGURE 12 - Hydrogeologic Cross-Sections Through Selected Location Across the Lower Platte Valley 22

FIGURE 13 - LPS NRD Monitoring Well Hydrographs from Four Ground Water Reservoirs 26

FIGURE 14 - Distribution of Total Dissolved Solids 30

FIGURE 15 - Landuse Map 32

FIGURE 16 - Generalized Soils Map 33

FIGURE 17 - Depth to Water 35

FIGURE 18 - Ground Water Pollution Potential (DRASTIC) 36

FIGURE 19 - Inventoried Dump Sites 37

FIGURES - CONTINUED

After Page

FIGURE 20 - Nitrate-Nitrogen Levels 39

FIGURE 21 - Nitrate-Nitrogen Levels - City of Lincoln 39

FIGURE 22 - Lancaster County Nitrate Levels for Real Estate Transfers .. 40

FIGURE 23 - Reported Pollution Point Sources 42

FIGURE 24 - Reported Pollution Point Sources - Lincoln Area 42

FIGURE 25 - Location and Results of Water Wells Sampled for VOC's in Lancaster County, NE, 1986 to 1990 44

FIGURE 26 - Example of Ground Water Quantity Established Saturated Thickness in a LPS NRD Designated Monitoring Well 62

APPENDICES

APPENDIX A - Definition of Ground Water - Related Terms

APPENDIX B - Hydrographs of LPS NRD Wells

APPENDIX C - LPS NRD Ground Water Monitoring Program Protocol

APPENDIX D - National Pollutant Discharge Elimination System (NPDES) Permits in LPS NRD

1.0 Introduction

The Lower Platte South Natural Resources District (LPS NRD) recognizes the value of quality ground water in sufficient quantities, perhaps more acutely than many other areas of the State where ground water of good quality is abundant. The ground water reservoirs in the LPS NRD are limited in size, distribution, and, in some areas, use is limited by quality. As a result, the LPS NRD is actively participating in programs designed to protect the limited ground water supplies through programs outlined in the Ground Water Management Plan approved by the Department of Water Resources (DWR) in 1985. A description of current LPS NRD ground water programs is provided in Table 1.

In 1991, the Nebraska Legislature enacted Legislative Bill 51 (LB51) which was subsequently amended in 1994 by Legislative Bill 480 (LB 480), which required the following actions by the LPS NRD:

> "prior to July 1, 1996, each district shall amend its ground water management plan to identify to the extent possible the levels and sources of ground water contamination within the area, ground water quality goals, long-term solutions necessary to prevent the levels of ground water contaminants from becoming too high and to reduce high levels sufficiently to eliminate health hazards, and practices recommended to stabilize, reduce, and prevent the occurrence, increase, or spread of ground water contamination."

This document is presented as an update of the 1985 plan adopted by the Board of Directors and approved by the Department of Water Resources (DWR). The Board of Directors of the LPS NRD contracted with HWS Consulting Group Inc. to assist in preparing the update of the existing plan; LPS NRD staff has prepared the re-submittal of this update. While the goal of this Amendment is to fulfill the intent of LB51, the LPS NRD staff and Directors also asked that HWS assist them in reorganizing and presenting the technical information included in the 1985 plan and to present this information in a format which is more understandable to those not trained in ground water hydrogeology. Therefore, discussion of the geology and ground water supplies

TABLE 1

LPS NRD Ground Water Programs

1. Well Decommissioning - Landowners with abandoned water wells on their property may enroll in this program. The LPS NRD hires a contractor each year to decommission these wells. The well decommissioning cost to the landowner is 25% not to exceed $150, the LPS NRD pays the amount that exceeds the $150 limit. In addition to the well decommissioning cost, landowner cost for removing water well pumps is 25% not to exceed $100 for pump pipes less than 2" diameter and $300 for pumps greater than 2" diameter. The LPS NRD reports every water well decommissioned in the program to the Department of Water Resources (DWR).

2. Well Abandonment Demonstrations - The LPS NRD cooperates with the University of Nebraska Extension Service, Department of Health and the Nebraska Well Drillers Association in sponsoring abandoned well decommissioning demonstrations to educate the public on the importance of properly decommissioning abandoned wells.

3. Wellhead Protection - The LPS NRD cooperated with the Lincoln-Lancaster County Health Department, Nemaha NRD, and NDEQ with the implementation of a Wellhead Protection Area program for community water suppliers within Lancaster County. The NRD is currently developing a Community Water System Protection program to assist community water suppliers with the assessment and inventory of potential or existing sources of contamination to community well fields and with the development of and implementation of management and contingency plans.

4. Solid Waste Monitoring - The LPS NRD will assist in the design of future landfills and monitor the closure of existing landfills within the district.

5. Chemigation - The LPS NRD administers the Nebraska Chemigation Act which includes the inspection, permitting, and reporting of chemical use in chemigation systems in the LPS NRD to NDEQ.

6. Ground Water Brochure - The LPS NRD developed and printed a ground water brochure to explain ground water in general terms.

7. BMP Cost Share Assistance - The LPS NRD cost shares with landowners on a variety of conservation practices that reduce the crop water usage and protect the soil and water resources in the LPS NRD.

8. Ground Water Level Monitoring - A network of 36 wells has been established to monitor water level changes from spring and fall, annually. Additional wells will be added upon establishment of the GWMA.

9. Ground Water Quality Monitoring - Baseline water quality sampling of wells has been conducted by the LPS NRD since 1984. Completed cooperative studies of ground water quality include Water Quality in the Lower Platte River Basin with Emphasis on Agrichemicals (Spalding 1990) and the Investigation and Evaluation of Agrichemical Transport Near Waverly, Nebraska (UNL Water Center 1993). There is an ongoing cooperative study with the United States Geological Survey (USGS). The scope of this study includes: monitoring network selection; water quality sampling; water level measurements; aquifer delineation; and saturated thickness determinations. Completion is scheduled for late 1996.

in the LPS NRD has been reorganized, updated, supported by maps and tables compiled from the best available data, and presented as a foundation for the Plan portion of this document. The reorganization was accomplished by incorporating comments of the reviewing agencies for the 1985 Plan at the time of its approval. An update of the 1985 Plan was completed and submitted to the Nebraska Department of Water Resources (DWR) for review and approval in June 1993. The Plan Update was reviewed by the Nebraska Natural Resources Commission (NNRC), the Nebraska Department of Health (NDOH), the Nebraska Department of Environmental Quality (NDEQ), the Nebraska Game and Parks Commission (NGPC), and the Conservation and Survey Division (C&SD), all of whose comments were provided to DWR. DWR added their comments and submitted a letter of disapproval of the Plan Update to the LPS NRD on September 23, 1993.

The current Plan Update herein acknowledges and responds to the written and verbal comments of the several state agencies, and incorporates additional data on ground water quantity and quality derived from studies and monitoring. Comments from public review of the Plan Update, at a hearing on April 10, 1995, were reviewed and considered by the LPS NRD. On April 19, 1995, the LPS NRD Board of Directors adopted this Update to the 1985 Ground Water Management Plan. A Glossary which defines ground water-related terms is provided in Appendix A for reference.

2.0 Description of the LPS NRD

2.1 Location

The Lower Platte South Natural Resources District is located in southeastern Nebraska (Figure 1). It shares borders with five other NRDs; the Papio-Missouri River and Lower Platte North NRDs to the north; the Upper Big Blue NRD to the west; and the Lower Big Blue and Nemaha NRDs to the south. Parts of the following six counties comprise the Lower Platte South NRD, encompassing a total area of 977,517 acres, Lancaster, Cass, Saunders, Seward, Butler, and Otoe. Furthermore, the Lower Platte South NRD comprises the southern portion of the Lower Platte River Basin and includes a portion of the Nemaha River Basin (Weeping Water watershed) along the southeastern part of the District.

There are 30 municipalities within the District. The largest of these is Lincoln (191,972), followed by Plattsmouth (6,412), Ashland (1,917), Waverly (1,869), Hickman (1,081), Weeping Water (1,008), and Louisville (998).

2.2 Climate

The climate of the LPS NRD has a humid continental climate. This climate is characterized by great seasonal differences in temperature with some precipitation throughout the year. The summers are generally hot with temperatures often topping 100°F. Winters are generally cold and dry with temperatures as low as -29°F.

The average annual precipitation is approximately 29 inches. Most of the precipitation is in the form of rain, with the greatest precipitation occurring between April and September. Average precipitation ranges from 28-30 inches. Average annual snowfall is 31 inches but can vary widely from year to year. The average length of snow cover is 42 days. Average monthly temperatures range from a low of 22°F in January to a high of 77°F in July. The growing season, or the average period between the last spring and the first fall frost is 165

LOWER PLATTE SOUTH NATURAL RESOURCES DISTRICT

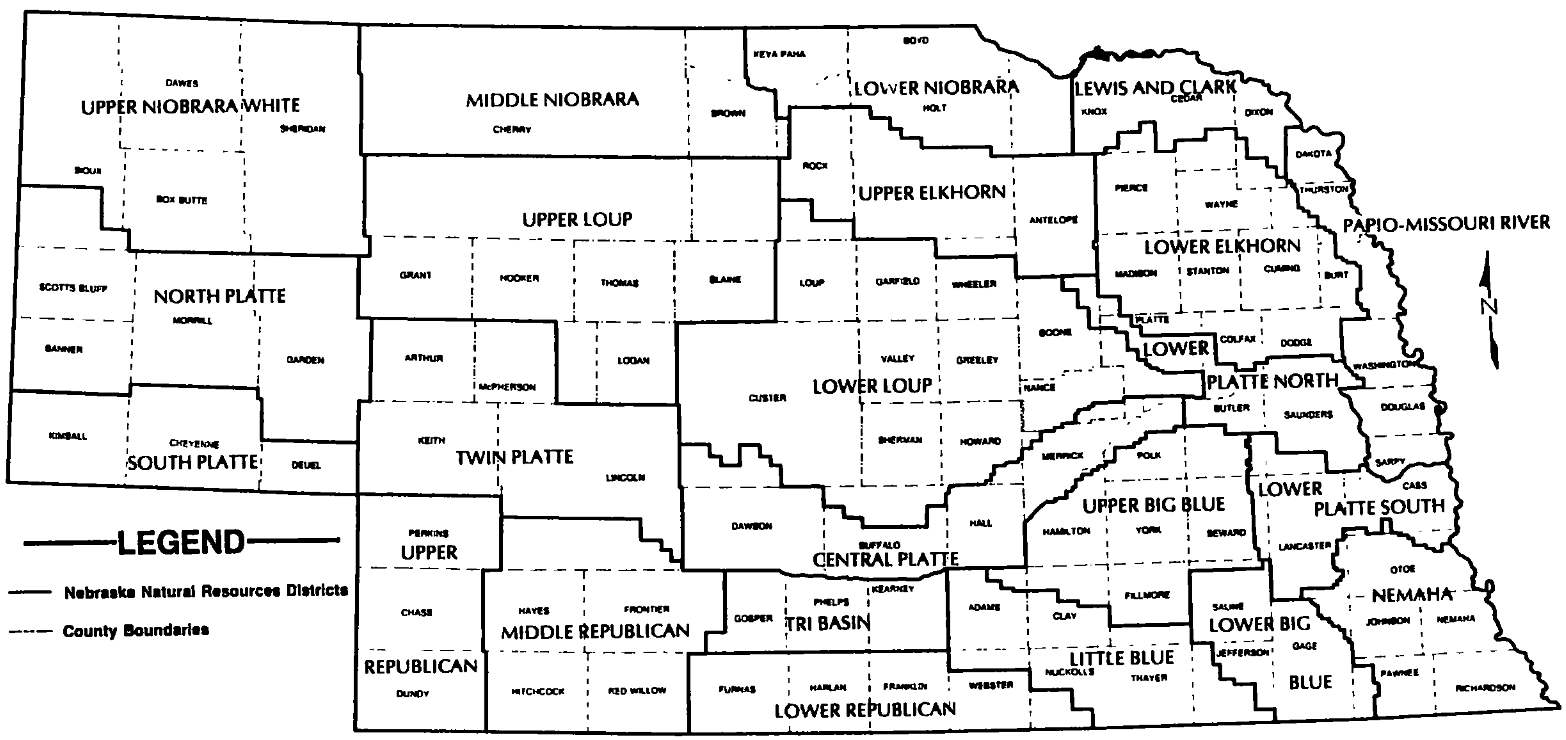


FIGURE 1

NATURAL RESOURCES DISTRICT BOUNDARIES

Nebraska Natural Resources Commission January 1989 days. Usually, 80 percent of the yearly precipitation occurs between April and September. The relatively high temperatures allow for substantial evaporation, especially during the summer. On the average, a small lake or pond will average 45 inches of evaporation loss per year.

2.3 Surface Water Supplies

The greatest extent of stream surface water supplies in the LPS NRD can be found in the Missouri and Platte Rivers which form the eastern and northeastern boundaries of the LPS NRD. Figure 2 displays the location of the individual watersheds within the LPS NRD and Table 2 summarizes stream mileage. Broken down into the constituent watersheds, the acreage is as follows:

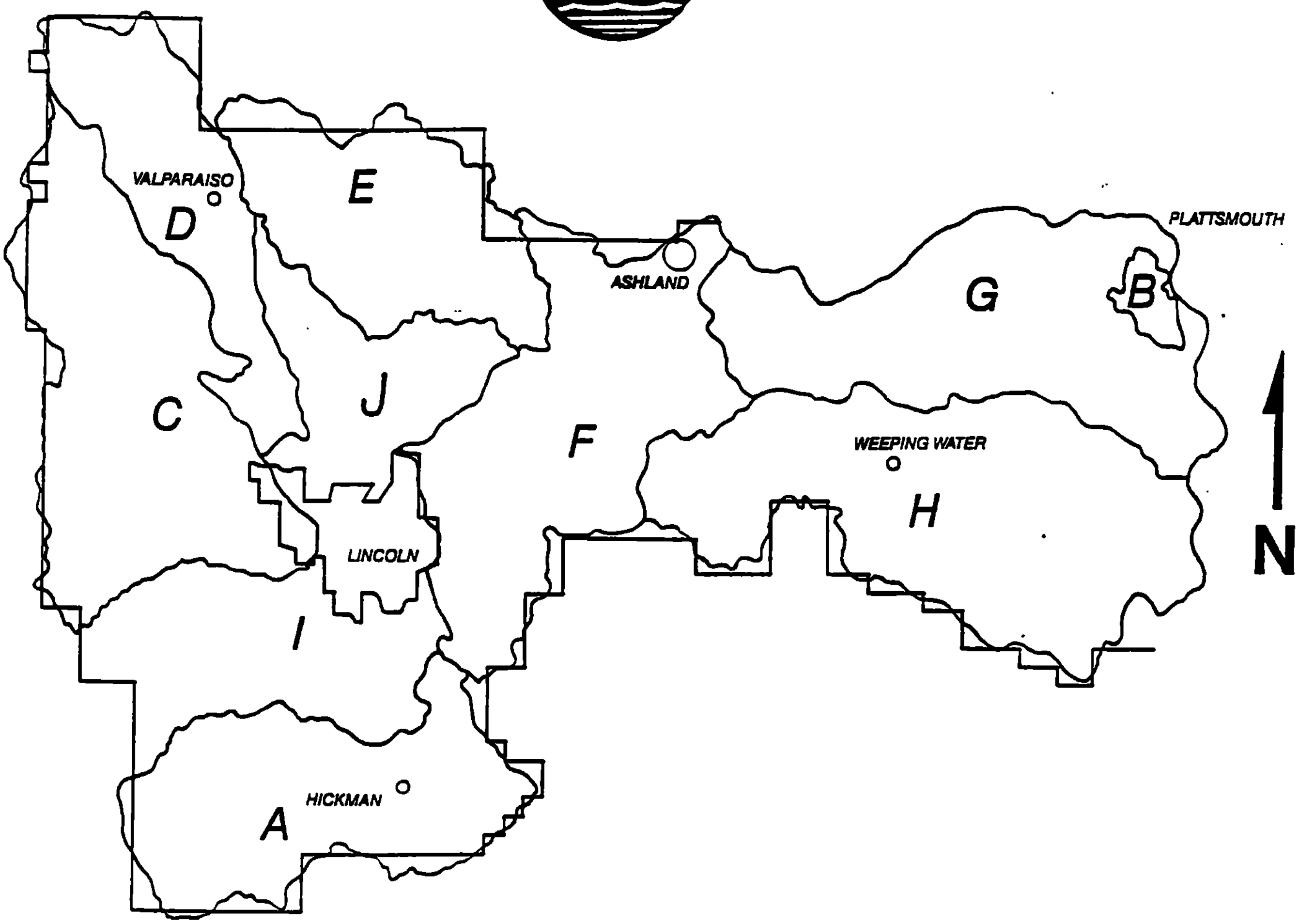
Oak-Middle	230,699 acres
Weeping Water	164,480 acres
Northeast Cass	136,180 acres
Stevens-Callahan	131,328 acres
Upper Salt	109,118 acres
Rock Creek	83,800 acres
North Oak	62,720 acres
Plattsmouth	2,465 acres

(Source: Lower Platte South Master Plan)

The surface water resources are primarily important for livestock, wildlife, and recreational uses. Except during times of heavy precipitation, streams are not filled to capacity and in most places stream flow is generally low. During parts of the year, many streams have no flow at all.

The low or no-flow streamflows can create several problems: supply of water for domestic, municipal, and industrial consumption may be reduced; water quality can deteriorate as the concentration of pollutants increases with decreased water flow; fish, wildlife and vegetation which depend on stream flow can be adversely affected; and recreational activities dependent upon stream flow may also be curtailed. In addition to the low rate of flow, pollution

LOWER PLATTE SOUTH
NATURAL RESOURCES DISTRICT



A	UPPER SALT
B	PLATTSMOUTH
C	OAK-MIDDLE CREEK
D	NORTH OAK
E	ROCK CREEK
F	STEVENS-CALLAHAN
G	NORTH EAST CASS
H	WEEPING WATER
I	UNNAMED
J	LITTLE SALT-JORDAN

FIGURE 2

LOWER PLATTE SOUTH NATURAL RESOURCES DISTRICT

WATERSHED BOUNDARIES

TABLE 2

Summary of Stream Mileage Within LPS NRD

Stream	1973 Mileage
Antelope Creek	5.2*
Bachelor Creek	6.0
Beal Slough	3.2*
Big Slough	7.9
Callahan Creek	4.5
Camp Creek	6.8
Cardwell Branch	2.7
Cascade Creek	3.6
Cedar Creek	9.9
Cedar Creek, South	9.2
Cheese Creek	4.6
Dead Man's Run	4.9*
Decker Creek	1.4
Dee Creek	5.4
Eight Mile Creek	1.7
Ervine Creek	2.6
Fountain Creek	2.4
Four Mile Creek	2.2
Goose Creek	4.5
Greenwood Creek	5.5
Haines Branch	13.6
Jordan Creek (Lancaster)	6.7
Jordan Creek (Otoe)	2.5
Little Salt Creek	6.9
Middle Creek	17.6
Middle Oak Creek	6.6
Mill Creek	2.0
Missouri River	25.0
North Oak Creek	20.8
Oak Creek	12.0
Olive Branch	11.1
Pawnee Creek	4.1
Platte River	28.2
Rakes Creek	3.4
Rock Creek	26.8
Rock Creek (Cass)	8.0
Salt Creek	44.3
Squaw Creek	1.7
Stevens Creek	7.7
Stove Creek	2.5
Turkey Creek	1.8
Wagon Tongue Creek	0.9
Weeping Water Creek	48.7
Weeping Water Creek, South Branch	25.7
West Oak Creek	4.1
Wittstruck Creek	1.2
Wolf Creek	3.0

*Mileage loss to channelization included. Source: NG&PC 1973 Basin Stream Surveys is also a problem for many streams in the LPS NRD. Sources of pollutants are municipal, industrial, and agricultural discharges. Municipal and industrial wastes from the urban areas are a major factor in stream pollution when the discharges are not adequately treated before release. Municipal and industrial point sources of pollution are regulated by permit systems.

Agricultural run-off containing fertilizers, nutrients, and pesticides also degrade water quality and has a negative effect on fish and wildlife downstream. Certain agricultural discharges are controlled by the National Pollution Discharge Elimination System (NPDES) permit programs (i.e., feedlot runoff) administered by the Nebraska Department of Environmental Quality (NDEQ).

Flood control reservoirs have been constructed on several of the tributaries of Salt Creek. Ten (10) U.S. Army Corp of Engineers reservoirs provide a total of 4,368 surface acres of water at the conservation pool level and an additional 140,000 acre feet of temporary flood storage. The water stored in these reservoirs serve both wildlife and recreation needs. Numerous other smaller flood control reservoirs and farm ponds are scattered throughout the LPS NRD which provide water for , livestock, wildlife, recreation, irrigation needs and possibly flood control.

2.4 Population and Economic Base

The population of the LPS NRD in 1990 was estimated to be 239,525, an increase of 9.6% over the 1980 census. In 1990, Lancaster County provided 88% of the LPS NRD's population, Cass County provided 9%, and the remaining 3% was provided by parts of Saunders, Seward, Butler, and Otoe Counties. Lincoln is the largest community in the LPS NRD, with a population of 191,972 in 1990, providing 80% of the LPS NRD's population. Plattsmouth is the second largest community with a population of 6,412.

Although agriculture accounts for the largest portion of the land area, the non-agricultural sector is the primary source of employment in the LPS NRD. Approximately 90% of the work force is engaged in the nonagricultural sector. If the present trends continue, there will be both an increasing work force and a shift from agricultural employment. The number of farms in the LPS NRD is declining at a rate of 1.8% annually (UNL Bureau of Business Research).

In the agricultural sector, the major activities are cattle and hog feeding, poultry and dairy production, and commercial grain farming. Dryland corn, sorghum, soybeans, wheat and alfalfa are the major crops. While the agricultural sector accounts for only a small percentage of the direct personal income in the LPS NRD, it is nevertheless a major factor influencing the growth of the other economic sectors. Therefore, in order to sustain a viable economy in the LPS NRD, sound resource management practices which maintain agricultural production are essential.

Lincoln is the primary trade and manufacturing center within the LPS NRD. Industries such as pharmaceuticals, flour milling, printing and publishing, cement production, and transportation equipment production can be found in this community. The economic outlook for the Lincoln area is good. There are some mining activities in portions of the LPS NRD. Sand, gravel, limestone, and clay are the primary materials quarried. Mining operations are most prevalent in Cass County. The combination of transportation access, geographic location, a growing labor force and a major university serve to spur economic growth for this LPS NRD.

2.5 Topography, Soils, and Land Use

Topography, soils, and land use are directly related to the distribution and quality of ground water supplies in the LPS NRD. Therefore, they are discussed in detail in the Section 7.0 of this document in order to properly present their relationship to the ground water resources of the LPS NRD.

2.6 Crop Water Needs

The major crops grown in the LPS NRD are corn, soybeans, sorghum and lesser amounts of wheat and alfalfa. Irrigation is utilized to supplement rainfall during dry spells on land with an available water source and distribution system. Listed below is the seasonal crop water use (Evapotranspiration) of the major crops grown in the LPS NRD (UNL NEBGUIDE G90-922, 1990).

CROP	INCHES/YEAR
Corn	25-28
Soybeans	22-25
Sorghum	20-23
Alfalfa	34-36
Wheat	16-18

2.7 Water Use

The use of water in the LPS NRD is limited by both quantity and quality of water available. The limited number of registered wells (1,060), (Table 3) and relatively few surface water permits (98) indicate that large-scale water resource development in LPS NRD has not occurred (Department of Water Resources, December, 1995). A representative summary of estimated water use in Lancaster and Cass counties is presented in (Figure 2A). While it was

TABLE 3

List of Registered Wells by USE located within the LPS NRD

Irrigation	347
Monitor	283
Public Water Supply with Spacing Protection	143
Domestic	127
Other	78
Commercial	30
Observation	18
Recovery	16
Public Water Supply without Spacing Protection	12
Injection	4
Livestock	2
Total	1060

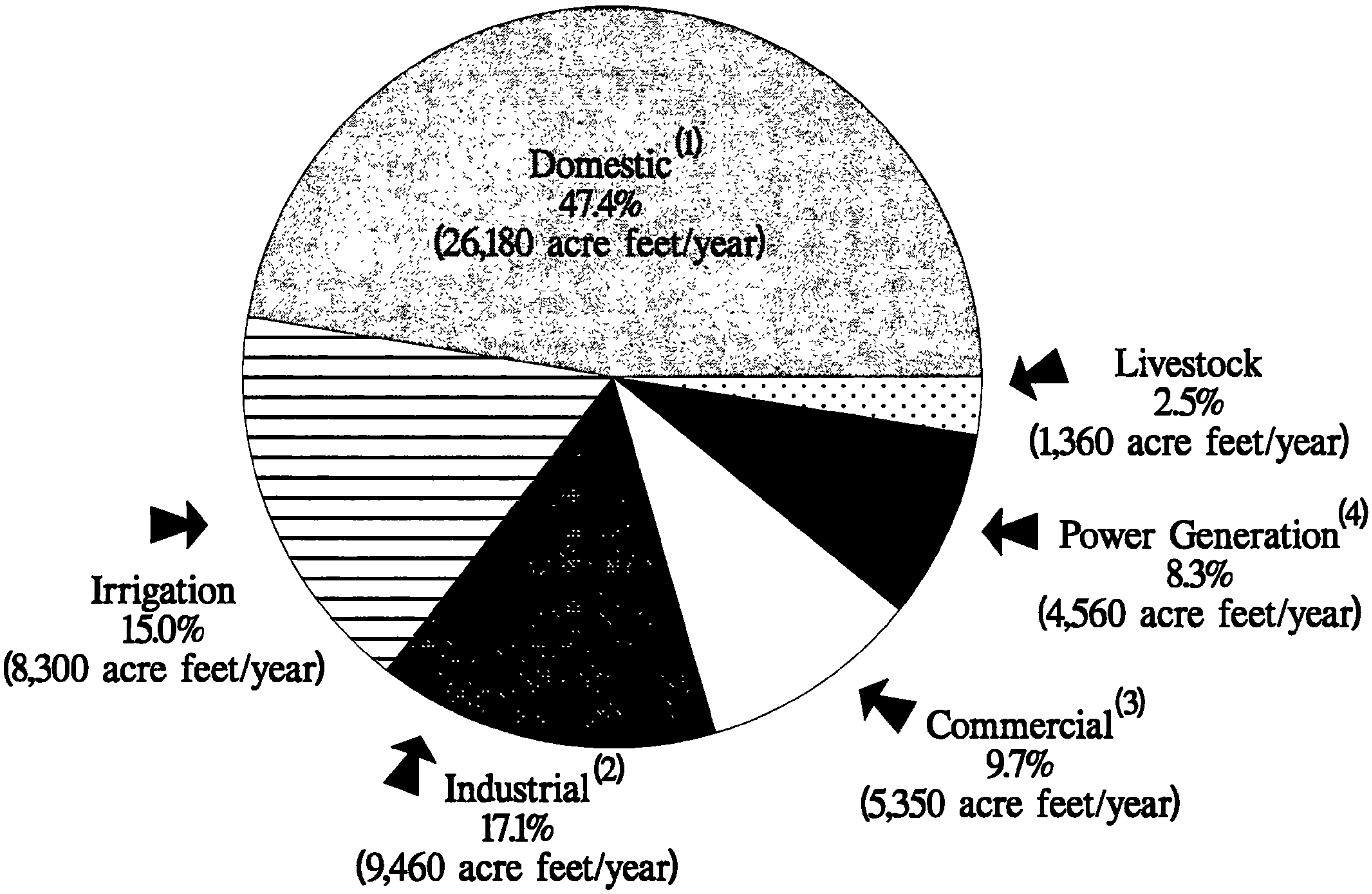
Source: Department of Water Resources, Registered Wells, 1995 not possible to include the portions of Butler, Seward, Saunders, and Otoe counties in the summary due to data availability considerations, a similar distribution on average is likely for those areas. Generally, the primary use of water in the LPS NRD is for municipal/domestic with industrial and irrigation use second and third, respectively.

Irrigation water use is generally from ground water source areas, and is primarily concentrated in the Waverly, Dwight-Valparaiso, and Crete-Princeton-Adams ground water reservoirs (Figure 3). Since actual irrigation water use figures are not available, the development of registered wells serves as an indicator of water use. Figures 4 and 5 illustrate that the development of wells in the NRD was gradual until 1970. Irrigation well development was most extensive in the 1950's and again in the 1970's, with secondary development in the 1960's and 1980's. Generally, the Waverly ground water reservoir appears to have been developed earliest with a large concentration of 1950's vintage wells (Figure 6). From Raymond north to Valparaiso is also a concentration of irrigation wells developed in the 1950's and 1960's. Most of the other reservoirs developed in the 1970's and 1980's.

The dramatic increase in the number of registered wells since 1991 is due to the passage of Legislative Bill (LB 131) which required all new water wells to be registered with the Department of Water Resources. Previously domestic, monitor, livestock, other, observation, recovery, injection and public water supply without spacing protection were not required previously to be registered.

Ground water is the principal source of drinking water supply for public drinking water systems in the LPS NRD. However, in many areas of the LPS NRD water must be brought from a source area (sometimes outside the LPS NRD) to serve the population. This is best illustrated by (Figure 7), which depicts the coverage of land area by Rural Water Districts, which were formed in response to a common need for a reliable supply of good quality water.

Total Ground Water Use = 55,210 acre feet/year



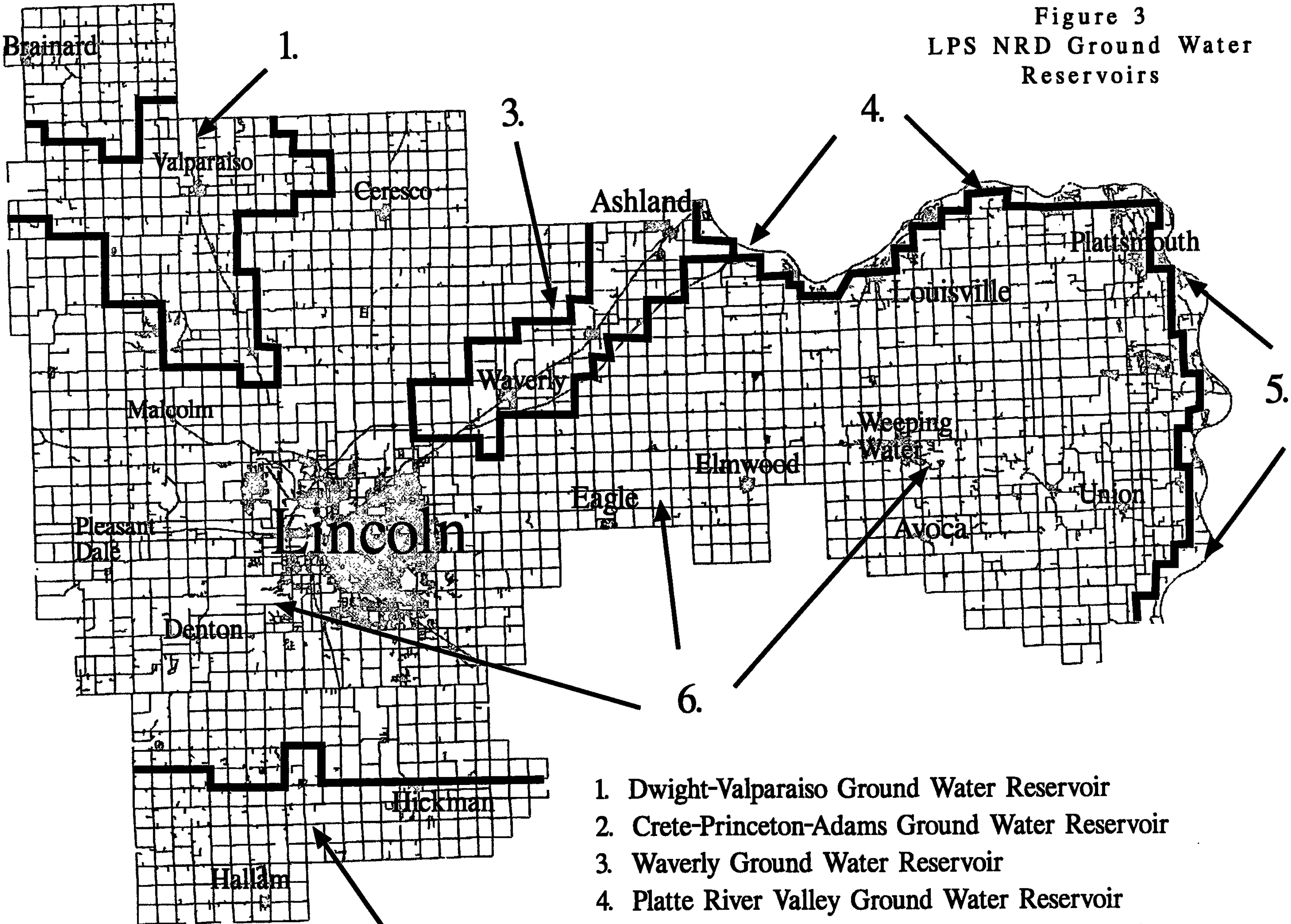
(1) Domestic Use - household, watering lawns & gardens (100 gallons per day/person)
(2) Industrial Use - manufacturing
(3) Commercial Use - restaurants, motels, businesses & gov't facilities
(4) Irrigation - based on 6.5 inches of water/acre

SURFACE WATER USE
- Mining (6,920 acre feet/year)
- Livestock (179 acre feet/year)
- Irrigation (3,027 acre feet/year) based on 9.5 inches of water/acre

* Information compiled by county (Cass and Lancaster)
Source: NE Natural Resources Commission 1994 Water Use in Nebraska

Figure 2a
LPS NRD Ground Water Use

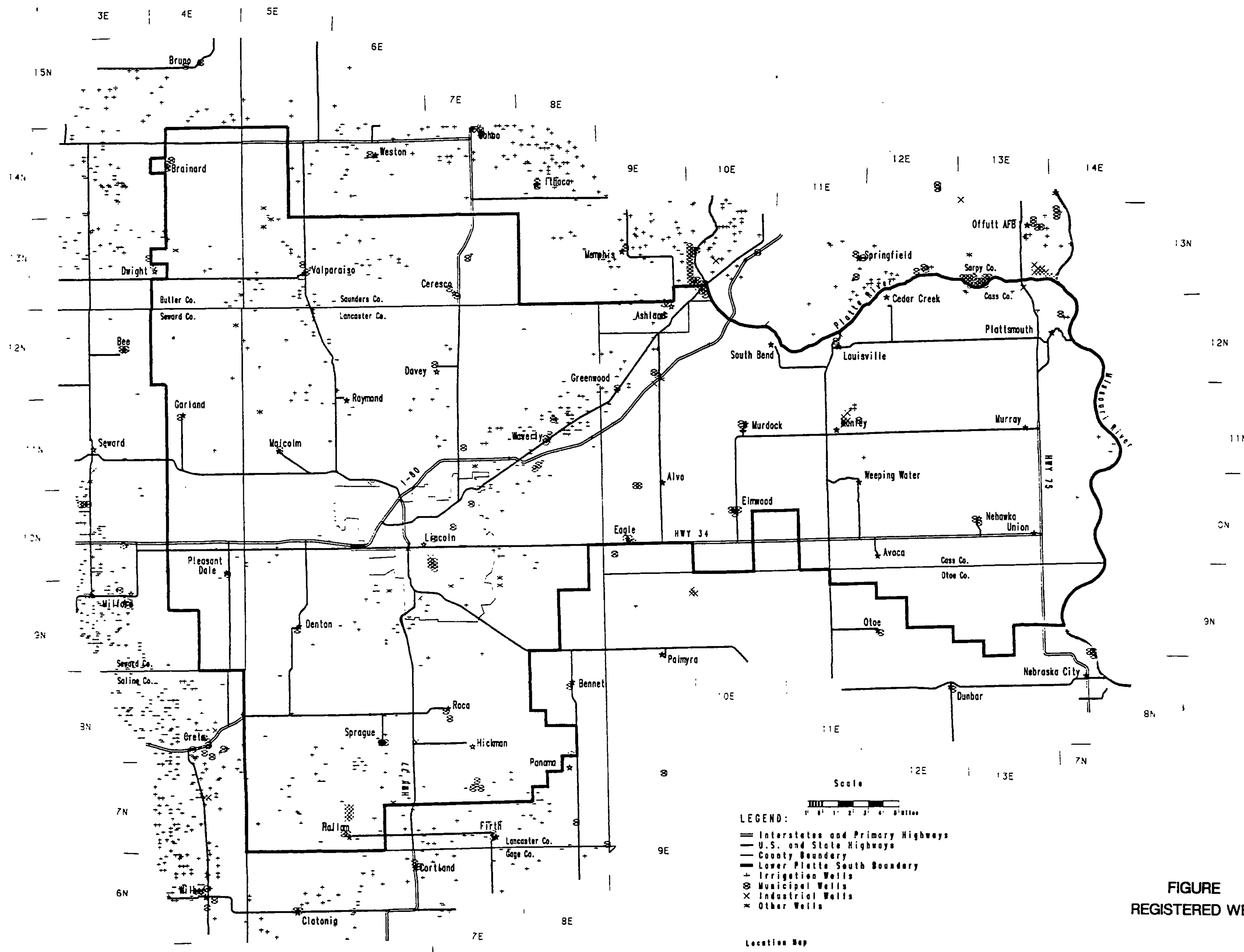
Figure 3
LPS NRD Ground Water Reservoirs



1. Dwight-Valparaiso Ground Water Reservoir
2. Crete-Princeton-Adams Ground Water Reservoir
3. Waverly Ground Water Reservoir
4. Platte River Valley Ground Water Reservoir
5. Missouri River Valley Ground Water Reservoir
6. Remaining Area

NEBRASKA NATURAL RESOURCES COMMISSION
DATA BANK

LOWER PLATTE SOUTH
NATURAL RESOURCES DISTRICT



Scale

1 0 1 2 3 4 5 Miles

LEGEND:

- Interstates and Primary Highways
- U.S. and State Highways
- County Boundary
- Lower Platte South Boundary
- + Irrigation Wells
- ⊗ Municipal Wells
- × Industrial Wells
- ✱ Other Wells

Location Map

NEBRASKA

Lower Platte South NRD

FIGURE 4
REGISTERED WELLS MAPS

Information Source:

Produced By - Nebraska Natural Resources Commission
Topographic Data - TIGER Files, U.S. Bureau of the Census, 1990
Wells Data - Nebraska Department of Water Resources
GIS Process - ARC/INFO
Processed - January, 1993

Lower Platte South
Natural Resources District

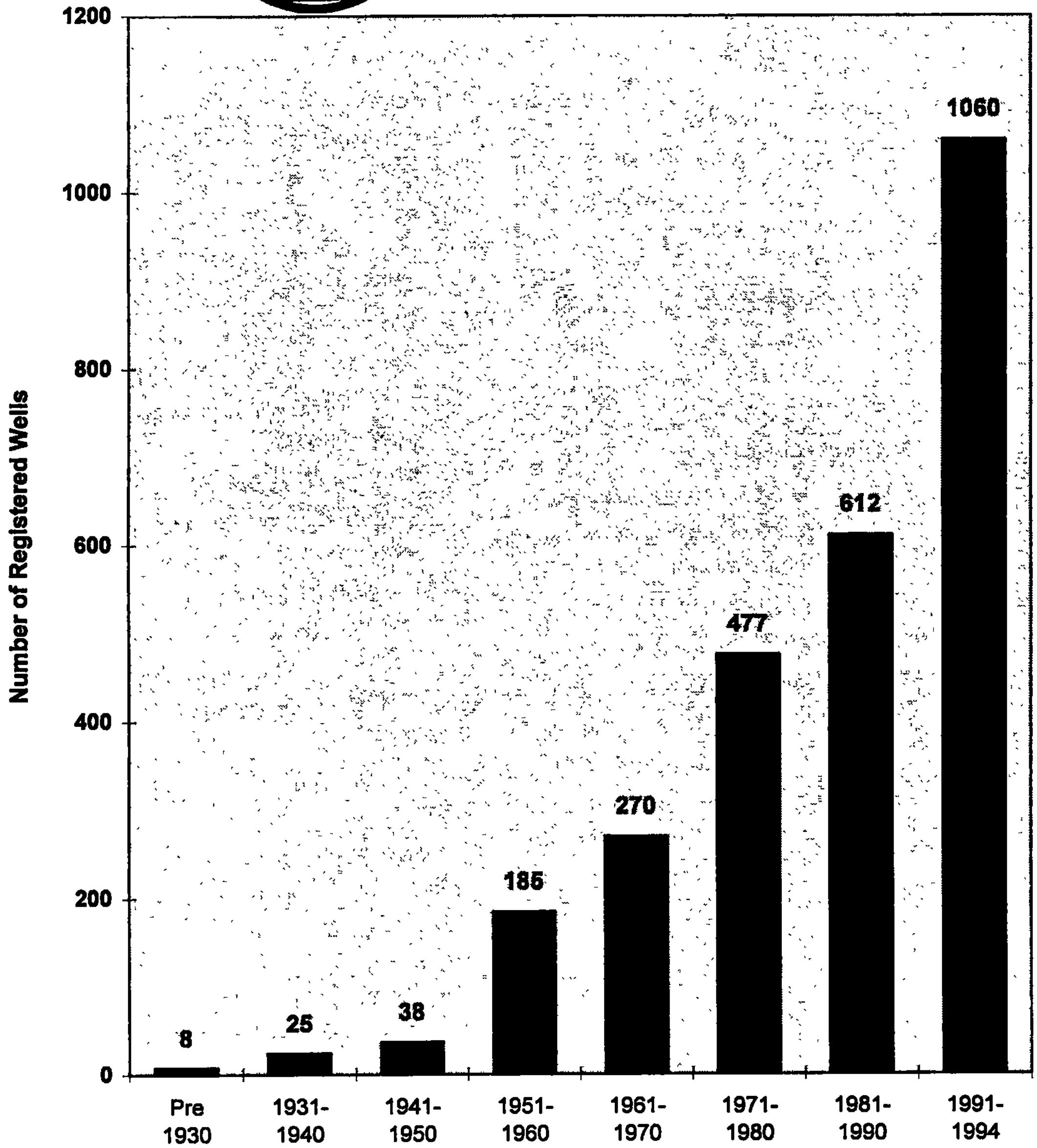


Figure 5
Cumulative Number of Registered Wells in the Lower Platte South NRD

Department of Water Resources 1995

NEBRASKA NATURAL RESOURCES COMMISSION
DATA BANK

LOWER PLATTE SOUTH
NATURAL RESOURCES DISTRICT

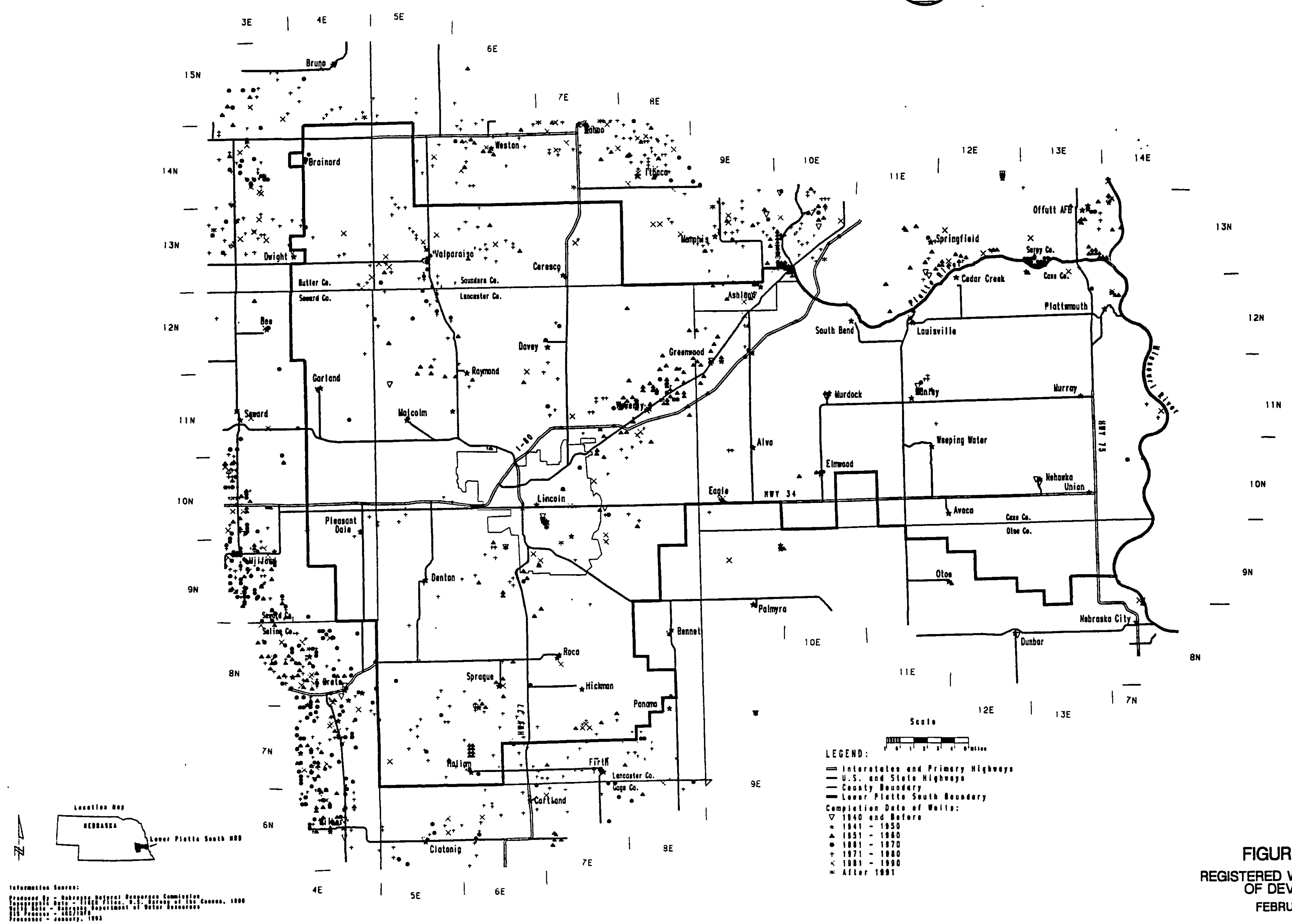
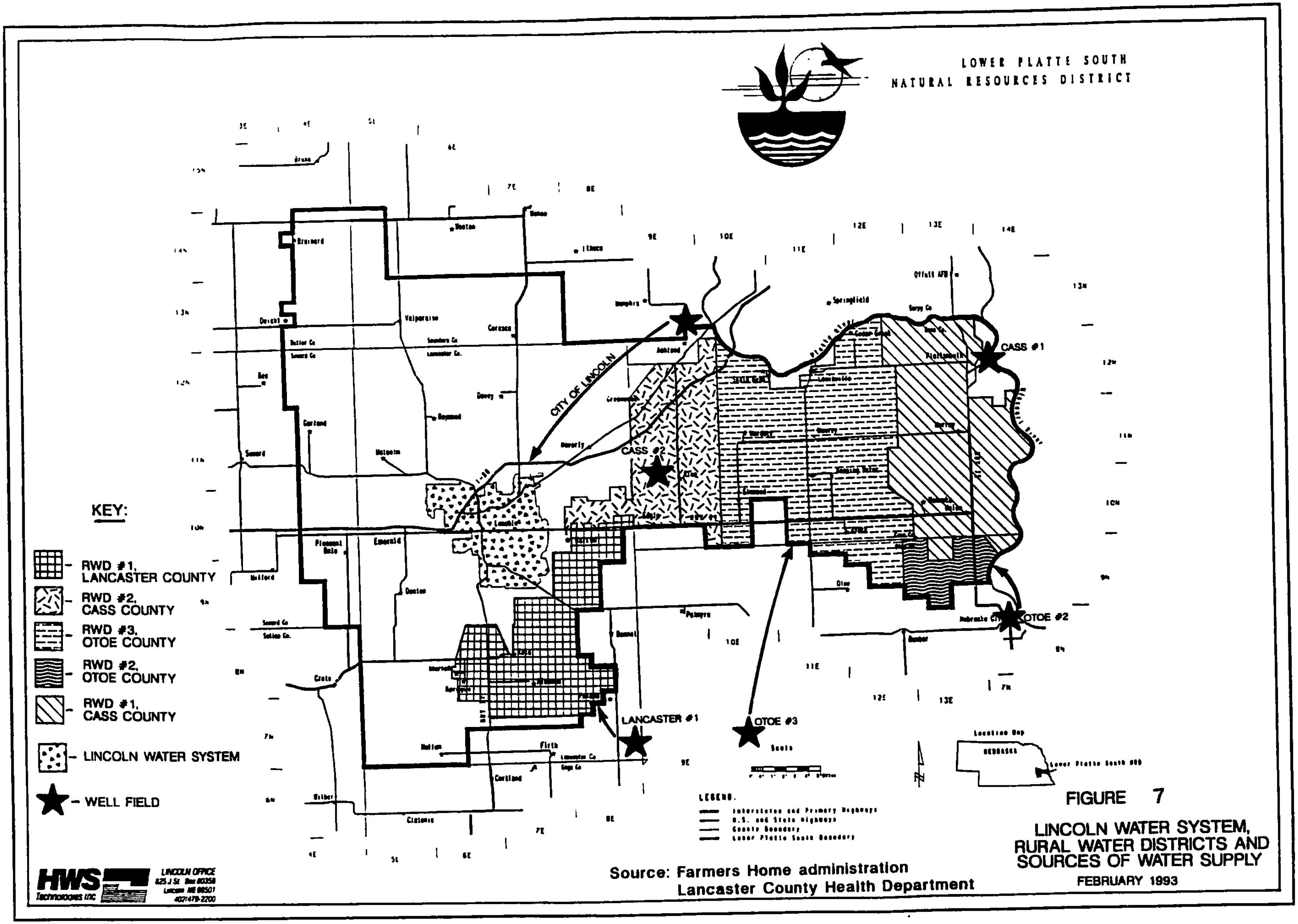


FIGURE 6

REGISTERED WELLS BY DECADE OF DEVELOPMENT

FEBRUARY 1993



Source: Farmers Home administration
Lancaster County Health Department

FIGURE 7

LINCOLN WATER SYSTEM, RURAL WATER DISTRICTS AND SOURCES OF WATER SUPPLY

FEBRUARY 1993

As is apparent from Figure 7, a large portion of the LPS NRD's population obtains their water from outside the LPS NRD's boundaries, and some water must be transported via pipeline a long distance. For example, the City of Lincoln obtains its water from near Ashland and pumps the water approximately 25 miles to Lincoln. This well field is located partially in the Lower Platte South NRD, Lower Platte North NRD and Papio-Missouri River NRD.

It is estimated that water demands for municipal and industrial use will increase over the next 30 years, while water demands for irrigation may increase slightly. Several of the RWD's are presently searching for supply sources for expansion and the City of Lincoln is currently expanding the capability of its well field to meet future needs. The LPS NRD recognizes the need for cooperative effort with surrounding NRD's to protect the water supply sources serving the majority of its population.

2.8 Water Conservation and Water Needs of Future Populations

Water Conservation is being promoted in the City of Lincoln primarily by the Water Conservation Task Force with the assistance of the Lincoln Public Works Department and the Lincoln Water System. This Task Force of approximately two dozen citizens includes representatives from nurseries, sod growers, lawn irrigation businesses, garden clubs, Lincoln Public Schools, UNL, landscape architects, home builders, naturalists, LPS NRD and many interested citizens.

The Water Conservation Task Force promotes wise water use by distributing information on drought resistant landscape plants, utilizes "Horace the Hippo" to inform the public about conserving water, sponsors a water conservation billboard that showcases art by local 5th graders, and works with local realtors on honoring a "Lawn of the Month", primarily based on water conservation efforts.

In 1994, Lincoln prepared a Water Management Plan. The purpose of the plan is to keep water use within pumping capacity and delivery capability of the system. The plan addresses a four phase action plan to curtail summer water use when use would exceed the capability of the water system. The Water Management Plan also has a Water Supply Restriction Plan to be implemented in emergency situations. This three level plan addresses the actions necessary to sustain life and maintain the health of the community under severe emergency conditions. None of the other approximately 36 community water systems in the LPS NRD responded that they had a written water conservation plan.

In response to NDEQ's Wellhead Protection Program, Lincoln developed a Contingency Plan addressing the necessary actions should large scale contamination occur at the Platte River Wellfield near Ashland. The plan explains that the Platte River Wellfield is currently separated into a wellfield on the west bank and an island wellfield in the middle of the river, with the long range plan to also add a wellfield on the east bank of the Platte River. "Since the Platte River separates the wellfields, should one or two of the wellfields become contaminated, the other should still be able to supply high quality water". Other options for the future water sources included the Platte River at the mouth of the Loup River near Columbus and surface water from the Missouri River north east of Ashland.

Most other communities have not identified alternate sources for their water supply or prepared written contingency plans. Those communities that have identified alternate sources mention drilling new wells or possibly purchasing water from a larger nearby community or rural water district.

Lincoln is planning for a population of approximately 261,200 by the year 2020 and that peak summer usage could approach 122.5 MGD (million gallons per day). Communities such as Waverly, Greenwood and Ashland are near the City of Lincoln's water line and technically could be provided water. At the present time Lancaster County Rural Water District #1 and Cass County Rural Water District #2 are considered by the City of Lincoln as being far from the finished water mains to be economically served.

A majority of the other community water supply systems responded that they anticipated minimal to slight growth and nearly stable water needs in the foreseeable future. Several others such as Hickman, Cass County RWD #1, Cass County RWD #2, and Lancaster County RWD #1 anticipated an increase in future water needs of at least 5% per year for the next 10-20 years.

2.9 Environmentally Sensitive Resources

The LPS NRD contains an abundance of natural resources, some of which are considered rare and possibly threatened by human activity. The LPS NRD contains a type of wetland that is rare and unique in Nebraska--the saline wetlands. Saline wetlands in Nebraska are few in number, essentially limited to the floodplains of Salt Creek and its tributaries in Lancaster and Saunders Counties. "They are Nebraska's most rare and most threatened natural community, truly the last of the least" (Nebraska Game and Parks Commission, 1991 p. 2). F.V. Hayden, a geologist who toured the region for the U.S.G.S. in 1867 documented the following observation:

"The Great Basin...covers an area of about 400 acres. The brine issues from a large number of places all over the surface, but in small quantities. All the salt water that comes to the surface from this basin unites in one stream, and we estimate the entire amount of water that flowed from this basin at from six to eight gallons per minute. The second salt basin lies between Oak and Salt Creeks and covers an area of two hundred acres. The third basin is on [lower] Little Salt Creek, called Kenosha Basin, and covers two hundred acres. Between Middle and Salt Creek are several small basins, covering 40 to 50 acres. From the surface of all these basins more or less springs ooze out.

Besides the numerous basins above mentioned, Salt Creek, Haye's [probably Haines] Branch, Middle Creek, Oak and Little Salt Creeks have each a dozen springs coming out near the water's edge. One spring on Salt Creek issues from a sand-rock [Dakota sandstone], and gushes forth with a stream as large as a man's arm, at the rate of four gallons a minute."

Other accounts describe a less well-watered basin, describing dry lake-beds with a layer of saline crystals. The source of water for these wetlands is the streams that originate from or flow through the Dakota sandstone. "The ultimate source of the saline waters though, lies deeper, in ancient shales laid down in Cretaceous times, the Age of Reptiles...when much of central North America was covered by a vast inland sea. In the 1860's, the salt resources were being commercially mined. However, the extent of the resource was limited for commercial production and mining was abandoned. Historically, the saline wetlands have been impacted by man through draining and filling. Today the marshes are considerably fewer in number and smaller in size. The channelization of Salt Creek also impacted the wetlands by downcutting Salt Creek and it's tributaries which has indirectly drained many of the wetlands.

The current relationship between the remaining wetlands and ground water is currently not documented. The relationship appears to be quite complex and site specific studies would be required.

The Nebraska Game and Parks Commission has identified a plant residing in the LPS NRD which is on the threatened and endangered species list, as described in a letter dated August 10, 1992, from the Nebraska Game and Parks Commission. There are confirmed records of the federally and state threatened western prairie-fringed orchid within the jurisdictional boundaries of Lower Platte South NRD. The western prairie-fringed orchid has been identified at two other sites west of Lincoln, one just west of Lincoln Airport and the other is located northwest of Pleasant Dale in Seward County.

In addition, potential habitat for the western prairie-fringed orchid may occur elsewhere within the LPS NRD. Potential orchid habitat would require further investigation to determine the presence of this plant. Habitat requirements and surveying methods for the western prairie-fringed orchid are described below.

The western prairie-fringed orchid (Plantanthera praeclara), a federally and state threatened plant is an inhabitant of native tallgrass wet meadows and mesic tallgrass prairies. Typical habitats are moderate to high quality meadows and prairies which have not been subjected to large scale disturbance such as plowing, extreme overgrazing, or heavy herbicide use. Potential habitats may have a history of light disturbance such as haying and/or grazing. This species initiates growth in late spring with flowering occurring in late June to early July. The optimum survey period is the last week of June through the first week of July. In some years, only vegetative growth occurs with no flowering. Under extremely unfavorable climatic conditions, such as drought, the plants may subsist subterraneously with no above ground growth for several years. Fluctuations in ground water levels could significantly impact the hydrology of local habitats occupied by the orchid. The LPS NRD recognizes:

1. The existence and/or potential existence of threatened species that may be affected by ground water levels, including the western prairie-fringed orchid.

2. That general protection of ground water quantity and quality has many benefits including protecting the habitats of threatened species listed above.

3. That any ground water management activities proposed in the plan may have some impact (positive or negative) on threatened species listed above.

4. Should specific adverse effects on threatened species listed in the plan from changing ground water levels be identified, the LPS NRD acknowledges the potential need to modify it's ground water management plan in the future. Such modifications should include actions within control or management areas consistent with the Nebraska Ground Water Management and Protection Act that could be taken by the LPS NRD to reduce adverse effects on species by maintaining a ground water level that will help sustain these species.

3.0 Geology and Ground Water Supplies

3.1 General Conditions

The State of Nebraska is located in the Central Stable Region of the North American continent. This region is the southern extension of the Canadian Shield which forms the core of North America. The basement rocks of the Canadian Shield are exposed in the area of the Great Lakes but are deeply buried in Nebraska. The basement rock in the LPS NRD consist of basalts, granites, and gabbros. The surface of the basement rock is generally characterized by broad uplifts and basins and is relatively stable.

Overlying the granitic basement rocks is bedrock consisting of limestones, shales, and minor sandstones. These bedrock deposits dip gently to the west and may be over 500 feet thick in the LPS NRD. Unconsolidated deposits of sand, gravel, silt, and clay rest upon the bedrock. These materials were deposited by glaciers and rivers and their thickness is quite variable. Glacial tills (clay, silt, sand) mantle the unconsolidated sediments or bedrock. Tills are thickest in the uplands and have been eroded away in many of the streams and river valleys. Loess is fine-grained windblown material which lies directly upon the till over much of the LPS NRD.

Most ground water wells in the LPS NRD are screened in unconsolidated sand and gravel deposits or in the bedrock Dakota Formation. Due to the presence of sufficient supplies of useable water in these materials, investigation of the potential for deeper bedrock aquifers has been limited. While some small-capacity wells have been developed in limestone, depths of most potential limestone aquifers are usually in excess of several hundred feet in the LPS NRD and water quality is generally poor. A summary of the major geologic units organized by age from most recent (top of chart) to oldest (bottom of chart), and their water bearing properties is presented on Table 4.

TABLE 4

MAJOR GEOLOGIC UNITS
LOWER PLATTE SOUTH NATURAL RESOURCE DISTRICT

System	Major Stratigraphic Units	Physical Characteristics	Water Supply Characteristics
Quaternary	Valley-fill deposits	Stream laid deposits of gravel, sand, silt and clay associated with modern streams and rivers.	Contributes significant amounts of water in the Platte and Missouri valleys. Lesser amounts of water are available from smaller streams and rivers within the NRD.
	Loess	Silt with lesser amounts of very fine sand and clay deposited as wind-blown dust.	Can transmit recharge to the groundwater. May provide small quantities of water to a few shallow stock or domestic wells.
	Till	Ice deposited silty, sandy clay with some gravel and larger pebbles and cobbles.	Relatively impermeable. Transmits water slowly to the groundwater. Small amounts of groundwater may be perched on the till. Sand deposits in the till may provide water to small capacity wells.
	Sand and gravel filled paleo-valleys	Stream-lain deposits of gravel, sand, silt and clays associated with ancient stream and river valleys.	Contributes relatively large amounts of water in Dwight-Valpraiso, Crete-Princeton and Waverly Aquifers.
Cretaceous	Dakota Formation	Sandstone and mudstones of varying thickness. Composition of Dakota can vary over short distances.	Sandstone deposits yield water of variable quality and quantity. Used as primary water source when other sources not available.
Permian	Chase Council Grove Admire		
Pennsylvanian	Waubansee Shawnee Douglas Lansing Kansas City Pleasanton Marmaton Cherokee	Marine deposits of limestone and shales and minor sandstone deposits.	Not considerd reliable water supply source within the NRD. Some Pennsylvanian rocks do yield water of varying quality and quantity.
Devonian, Silurian, and Ordovician.	Devonian Silurian Maquoketa Viola Decorah-Platteville St. Peter		
Cambrian	Bonneterre Lamotte		
Precambrian	Basement rock	Basalts, gabbros and granites.	Not considerd reliable water supply source within the NRD.

Source: Goodenkauf, 1978
Holly, 1980
Barnes and Bentall, 1968

3.2 Bedrock Deposits

Most bedrock units in eastern Nebraska are not considered a reliable source of ground water. A few low-capacity wells are developed in limestone units, for example, the Highway 77 Rest Area (3.5 miles north of Princeton) in Southern Lancaster County, and reportedly some domestic wells near Roca. One bedrock unit which does provide large quantities of useable ground water in some areas of the LPS NRD, however, is the Cretaceous Dakota Formation. The Dakota Formation is an important aquifer to those landowners lacking unconsolidated sediment deposits capable of yielding ground water.

The Dakota Formation is composed of interbedded sandstones, shaley sandstones, sandy shales, clayey shales (some carbonaceous), and siltstones. Unconsolidated to semi-consolidated sand, gravel, clay, and silt do occur, and thin beds of ironstone occur at some horizons. Concretions of ironstone and siltstone are common. Strata are unpredictable, owing to their origin as deposits in stream channels or near-shore marine environments. This results in inconsistent and unpredictable well yields and complex water quality conditions.

The Dakota Formation underlies most of the LPS NRD except for the east central and southeastern portions of Lancaster County, the eastern half of Cass County, and the entire portion of Otoe County that is within the LPS NRD (Figure 8). In these areas the Dakota Formation has been removed by erosion. The thickness of the formation ranges from absent on the eastern side of the LPS NRD to about 350 feet on the western side.

Lower Platte South
Natural Resources District

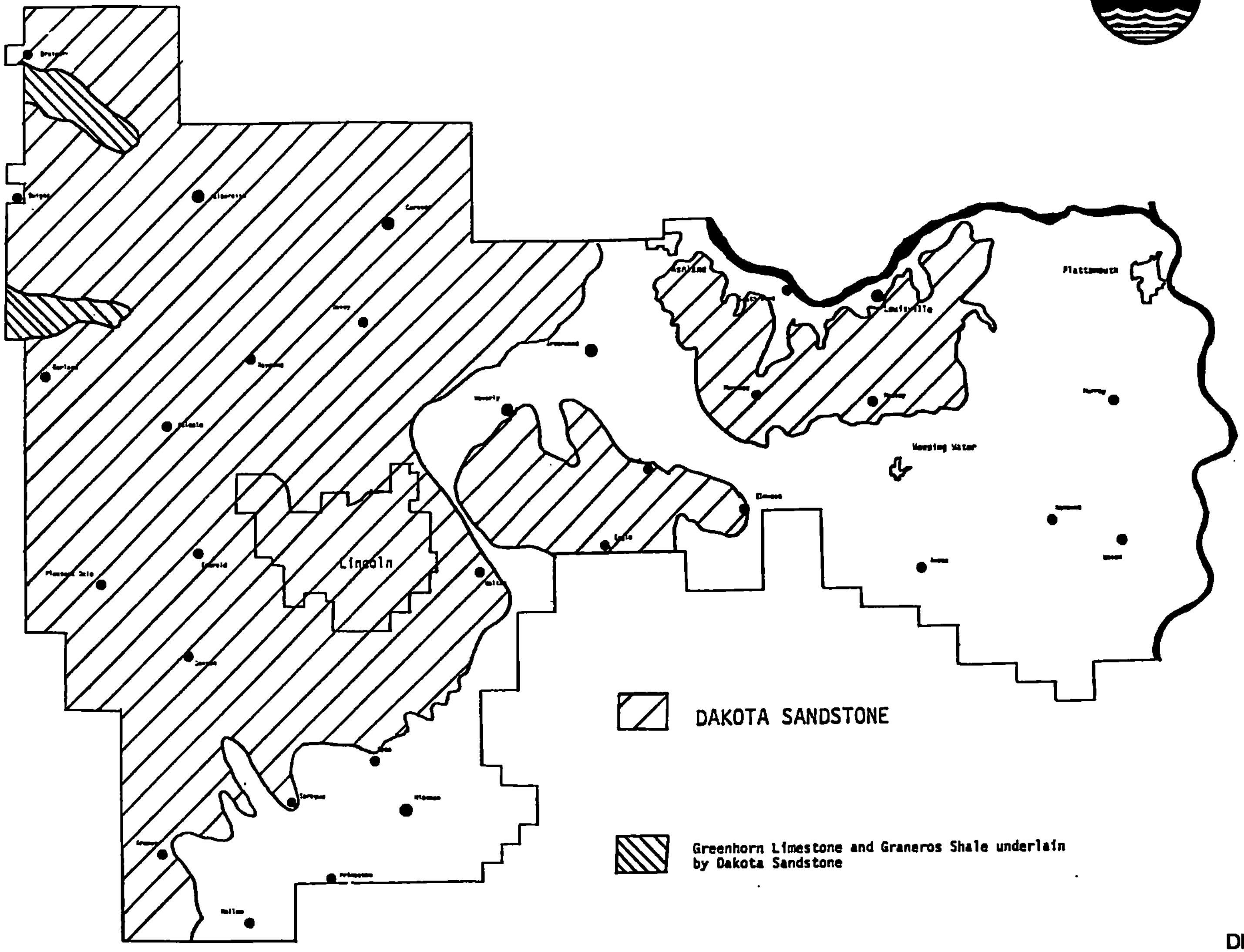


FIGURE 8

DISTRIBUTION OF DAKOTA FORMATION

3.3 Sand and Gravel Deposits

The most extensively used ground water supplies in the LPS NRD are found in the unconsolidated sand and gravel deposits. Three types of unconsolidated deposits have been identified and include:

1. Significant thicknesses of sand and gravel in buried bedrock channels,
2. Small sand and gravel lenses adjacent to or beneath glacial tills, and
3. Sands in valleys associated with modern streams.

The three types of deposits exist in a very complex relationship, with the possibility of any combination of them at a given location. Aquifers may be interconnected, and where two or more intersect, larger volumes of water generally are available.

3.4 Sand and Gravel in Buried Bedrock Stream Channels (Paleovalleys)

The location of current river valleys does not necessarily reflect the location of the ancient buried river valleys (paleovalleys). The bedrock surface consists of broad hills and valleys with variations in the surface of over 200 feet. (Goodenkauf, 1978; Holly, 1980). Coarse-grained stream/river sediments were deposited in the main bedrock channels and some of the tributary channels. These deposits range in thickness from less than 20 feet in some areas to approximately 300 feet thick in others and vary in width and length. In some areas, the deposits are over a mile wide and several miles long. The sands and gravels have greater transmissivity than surrounding materials and are generally considered to be an excellent source of useable ground water in the region. These aquifers may have transmissivity values of up to 150,000 gallons per day per foot (gpd/ft) (Ginsberg, 1983). Wells with transmissivities greater than 100,000 gpd/ft can typically pump 1,000 gallons per minute (GPM) with acceptable drawdown.

3.5 Sand and Gravel Lenses

Sand and gravel lenses in the till and small stream valley sand deposits are quite variable in vertical and lateral extent and yield. Being closer to the surface, they also tend to be susceptible to drought conditions. In many cases, volumes produced are sufficient for domestic wells but are limited for uses requiring large amounts of water. These shallow aquifers are also more susceptible to nitrate and pesticide contamination than deeper aquifers. These deposits are of limited extent, both laterally and vertically, and are able to store only small quantities of water. Due to the fine-grained materials surrounding and overlying these lenses, recharge to the sands and gravels is very slow. The lenses generally have transmissivities of less than 20,000 gpd/ft (Conservation and Survey Division, 1984) and usually are not sufficient for any purpose other than domestic use.

3.6 Coarse-Grained Sands in Present Day Valleys

Recent erosion in river valleys has produced the current topography of southeastern Nebraska. River sands are often too fine-grained or interbedded with clays to yield large volumes of water to wells. However, at some locations in the larger valleys, coarser-grained sediments can be found which yield large water supplies suitable for most uses.

The sand and gravel deposits in the present day Platte and Missouri River valleys are capable of yielding large amounts of useable water. These valleys are being used by the cities of Lincoln, Omaha, Cass County Rural Water District # 1, and Plattsmouth for their water supplies. These aquifers are 50 to 100 feet thick and are recharged in part by the adjacent river systems, thus quantities are sufficient for large-scale withdrawals. Transmissivities can range up to 100,000 gpd/ft, (Conservation and Survey, 1984). Water quality, however, may vary somewhat depending upon the season and changes in the streams water quality.

4.0 Ground Water Reservoirs in the LPS-NRD

4.1 General

There are five major ground water reservoirs identified by the LPS NRD which supply useable amounts of good quality ground water. The five ground water reservoirs all consist of sand and gravel deposits in buried paleovalleys or in present-day river valleys. The five ground water reservoirs are located on Figure 3, and their water bearing characteristics are summarized on (Table 5). The Remaining Area (Figure 3) includes the Dakota aquifer and other small aquifers (Table 5) not designated as part of any ground water reservoir. The Remaining Area is discontinuous in areal distribution and variable in water quantity and quality. For these reasons, the LPS NRD has grouped all areas not identified as "Ground Water Reservoirs" into the Remaining Area. Further small-scale well development is expected in the Remaining Area and the LPS NRD will delineate any additional areas or ground water reservoirs as better information becomes available.

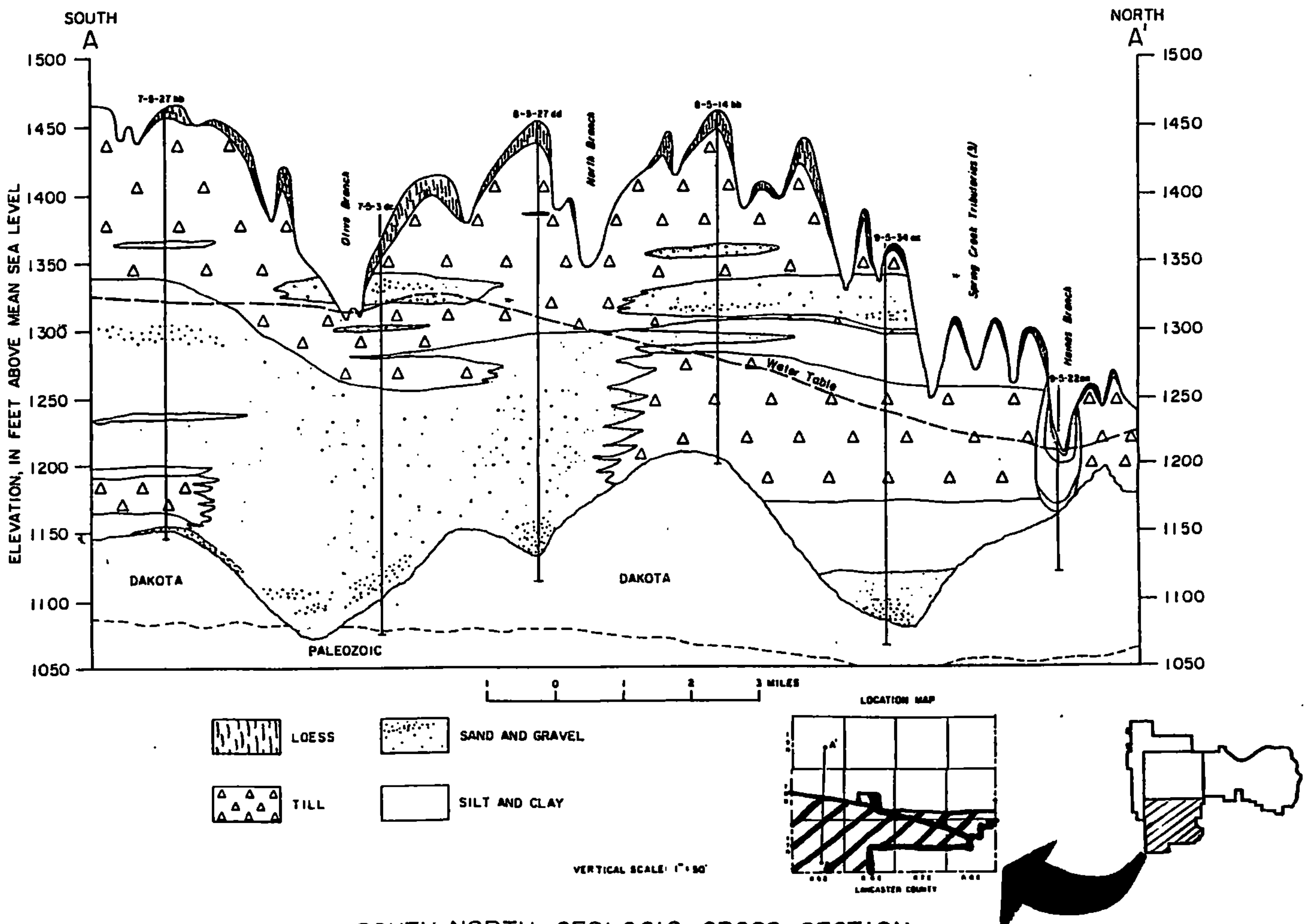
4.2 Crete-Princeton-Adams (CPA)

An area in the southwestern portion of Lancaster County makes up what is referred to as the Crete-Princeton-Adams Ground Water Reservoir (Area 2; Figure 3). This Ground Water Reservoir is so-named because it follows a paleovalley that enters Lancaster County from Saline County near Crete. This same paleovalley passes through Lancaster County and exits the LPS NRD near Princeton and continues into Gage County around Adams. A typical geologic cross-section showing the geologic sequence of materials deposits below the land surface is included as (Figure 9) to give the reader a "picture" of the subsurface. Most wells screened in this Ground Water Reservoir encounter interbedded clays and sands with the sand layers providing most of the water entering a well. These sand layers are overlain by thick units of silt and clay causing the CPA Ground Water Reservoir to be "confined" (under hydraulic pressure) (Goodenkauf, 1978).

Lower Platte South NRD
Principal Ground Water Reservoirs

Ground Water Reservoir	Geologic Material	Aquifer Type	Range of Sat. Thickness (ft.)	Transmissivity (gpd/ft)	Range of Depth to Water (ft)
Crete-Princeton-Adams (CPA)	Interbedded sand and gravel, silts and valleys	Confined Paleovalley	100-300+	20,000-200,000	50-100
Dwight-Valparaiso (DV)	Interbedded sand, sand and gravel, silts and clays	Confined Paleovalley	100-200	20,000-150,000	
Waverly	Interbedded sand, sand and gravel,silts and clays	Unconfined or semi-confined	Generally <100, some parts 100-300	20,000-100,000	10-100
Missouri River Valley (MRV)	Sand and gravel	Generally Unconfined Alluvial	0-100	0-400,000+	0-15
Platte River Valley	Sand and gravel	Generally Unconfined Alluvial	60-100	20,000-100,000	0-15
Bedrock Aquifers (Sandstone Lime-stone)	Sandstone, silt-stone and unconsolidated to semi-consolidated sand, gravel, clay, silt, and limestone	Generally Confined	0-100	0-50,000	
Other	Sand and gravel lenses in glacial till or along streams	Variable	Highly Variable	<20,000	Highly

LOWER PLATTE SOUTH
NATURAL RESOURCES DISTRICT



SOUTH-NORTH GEOLOGIC CROSS-SECTION
WESTERN LANCASTER COUNTY, NEBRASKA

FIGURE 9

GEOLOGIC CROSS-SECTION IN
CPA GROUNDWATER RESERVOIR

Source: Modified From
Goodenkauf, 1978

4.3 Dwight-Valparaiso (DV)

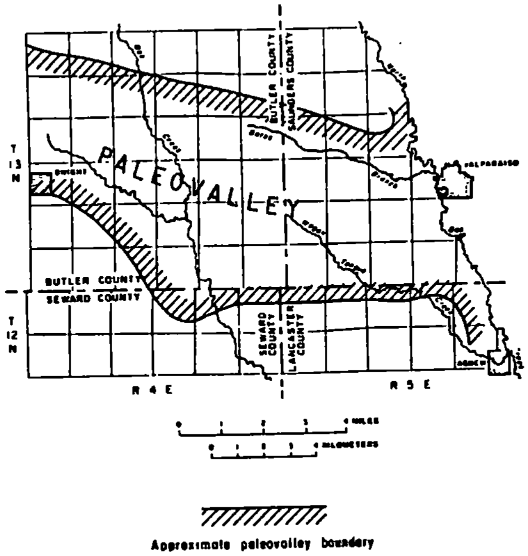
The Dwight-Valparaiso Ground Water Reservoir follows a paleovalley which enters the LPS NRD to the northwest, in Butler County near Dwight, Nebraska (Area 1; Figure 3) and extends to just west of Valparaiso. It also includes the North Oak Creek Valley north of Valparaiso and then south of Valparaiso to Raymond. The Dwight-Valparaiso Ground Water Reservoir also extends north and east of Valparaiso and includes portions of the Rock Creek Township. Even though the paleovalley varies in depth and thickness, it appears this entire area has hydraulically connected sand and gravel deposits (Figure 10).

The Dwight-Valparaiso Ground Water Reservoir is underlain by the Dakota Sandstone bedrock unit. The reservoir is composed of saturated sand and sand and gravel units, interbedded with and overlain by silt and clay. These deposits overlying the bedrock are as much as 455 feet thick in the uplands over the paleovalley (Ginsberg 1983). Typical geologic cross-sections showing the sequence of materials deposited below land surface is included as Figure 10. This reservoir is generally characterized as "confined" (like the Crete-Princeton-Adams Ground Water Reservoir).

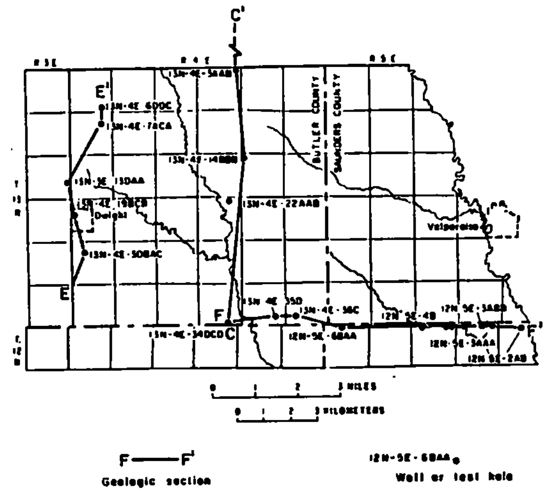
4.4 Waverly (WAV)

The Waverly Ground Water Reservoir extends from northeast of Lincoln in Lancaster County to the Ashland area in northwest Cass County (Area 3; Figure 3). Development of the Waverly Ground Water Reservoir for irrigation occurred generally during the 1950's and 1960's (Figure 6). The Waverly Ground Water Reservoir is the most intensively developed ground water reservoir in the LPS NRD. The two dominant bedrock units that form the base of the ground water reservoir are limestones or Dakota Sandstone. Nearly all of the usable ground water in the Waverly area occurs above these bedrock formations. The axis of a major bedrock paleovalley enters the area south of Malcolm, extends through northern Lincoln to Waverly, and

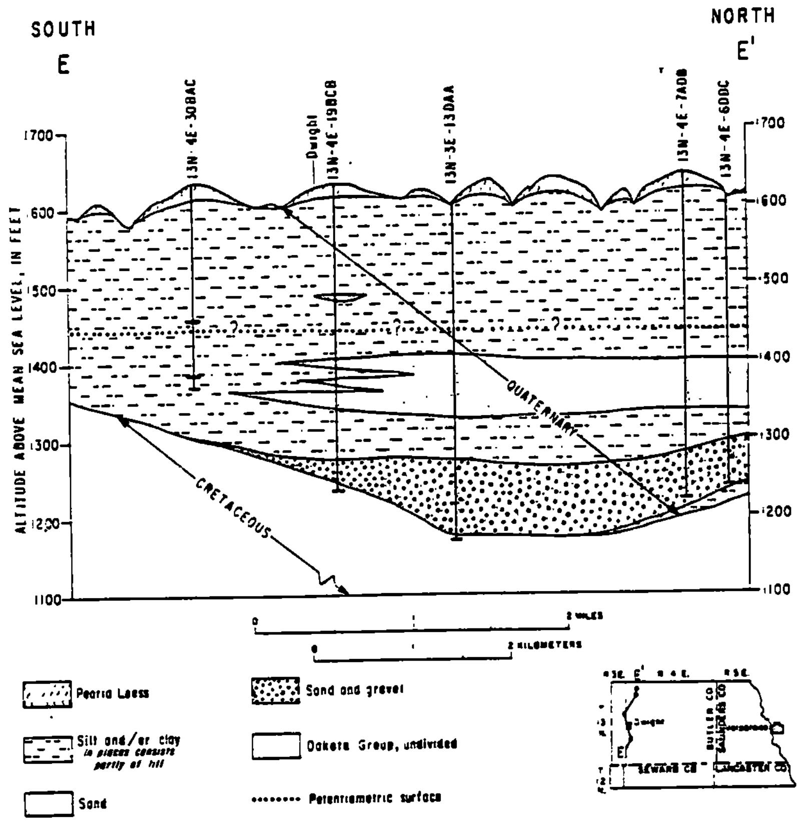
LOWER PLATTE SOUTH
NATURAL RESOURCES DISTRICT



Approximate boundary of the paleo-valley underlying the Dwight-Valparaiso area in Butler, Seward, Saunders, and Lancaster counties



Location of geologic sections in the Dwight-Valparaiso area in Butler, Seward, Saunders, and Lancaster counties



North-south geologic section through Dwight in southeastern Butler County

FIGURE 10

GEOLOGIC CROSS-SECTION IN DV GROUNDWATER RESERVOIR

Source: Ginsberg, 1983

then exits Lancaster County (Holly, 1980). The Waverly Ground Water Reservoir is composed of layers of saturated sands and sand and gravel interbedded with silts and clays which have been deposited in this paleovalley. A typical geologic cross-section showing the sequence of materials deposited below land surface is included as Figure 11.

The Waverly Ground Water Reservoir is considered an "unconfined" or "semi-confined" ground water reservoir. Unconfined means that the water table defines the upper limit of the aquifer and there is no artesian pressure created by an impermeable cap on the aquifer. Hydraulic pressure in the aquifer is therefore equal to atmospheric pressure. Semi-confined means there may be some areas where small pressures above atmospheric exist in the aquifer.

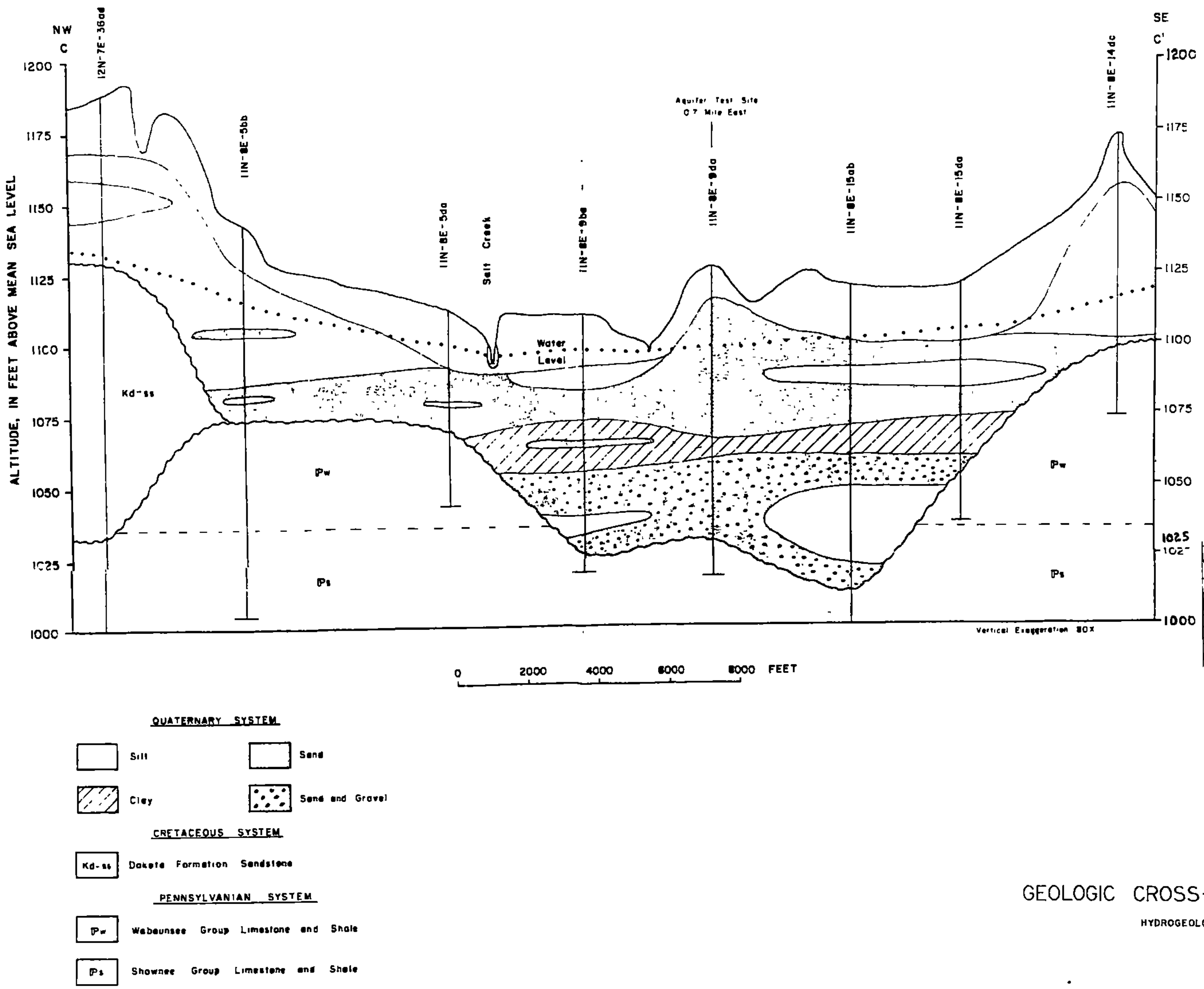
In addition to the large paleovalley aquifer in the Waverly Ground Water Reservoir, minor sand and gravel aquifers also occur. In some areas, the well yields are normally sufficient only for domestic uses. Marginal aquifers also occur in intertill sands and gravels throughout the ground water reservoir, however their yields are unpredictable.

4.5 Missouri River Valley (MRV)

The Missouri River Valley Ground Water Reservoir extends from the mouth of the Platte River (where it merges with the Missouri River northeast of Plattsmouth) to approximately 4 miles north of Nebraska City, Nebraska in northeast Otoe County (Area 5; Figure 3).

The base of the Missouri River Valley Ground Water Reservoir is bedrock composed of limestone interbedded with shales. The bedrock formation acts as a lower confining layer. Between bedrock and the nearly flat flood plain of the Missouri River Valley are unconsolidated sand and gravel deposits that can store and yield ground water to wells. Horizontal boundaries start at a center point in the river and extend to the base of the bluffs on the west side of the river. The vertical boundaries run from the bedrock surface to the top of the water table. The Missouri River Valley Ground Water Reservoir is an unconfined aquifer. Presently, the

LOWER PLATTE SOUTH
NATURAL RESOURCES DISTRICT



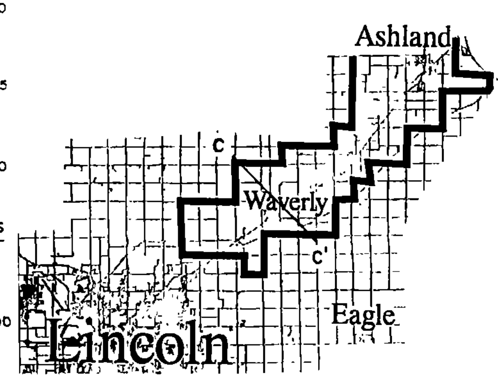


FIGURE 11

GEOLOGIC CROSS-SECTION OF THE WAVERLY AQUIFER

HYDROGEOLOGY OF NORTHERN LANCASTER COUNTY, NEBRASKA

DEAN E HOLLY

1980

Missouri River Valley Ground Water Reservoir has not been intensively developed for irrigation, due to the availability of surface water that is more economical to obtain and due to generally sufficient amounts of precipitation.

4.6 Platte River Valley (PRV)

The boundaries of the Platte River Valley Ground Water Reservoir are that portion of the Platte River Valley which borders the LPS NRD (Area 4; Figure 3). This Ground Water Reservoir begins just northeast of Ashland, at the NRD boundary shared with the Lower Platte North NRD, and continues eastward to the mouth of the Platte River near Plattsmouth.

The base of the Platte River Valley Ground Water Reservoir is bedrock composed primarily of limestone and shale. Between the bedrock and the nearly flat flood plain surface lies about 60 feet of unconsolidated saturated sand and gravel deposits. Although lenses of fine-grained sediment are present in places, these deposits are, for the most part, moderately coarse grained and are capable of yielding large amounts of water to high capacity wells. The cities of Lincoln and Omaha depend upon the Platte Valley Ground Water Reservoir for their public water supply needs. All of the available ground water in the Platte River Valley Ground Water Reservoir is considered to be under water table (or unconfined) conditions even though locally it may be confined under slight artesian pressure. Since the Platte River Valley Ground Water Reservoir is shared with the Papio Missouri River NRD, the LPS NRD portion is defined as extending from the middle of the river to the base of the bluffs on the south side of the Platte River Valley. The Platte River Valley covers approximately 12.5 square miles. The average valley width is 1-2 miles across. A typical geologic cross-section showing the sequence of materials deposited below land surface is included as Figure 12.

4.7 Dakota Aquifer (DAK)

LOWER PLATTE SOUTH
NATURAL RESOURCES DISTRICT

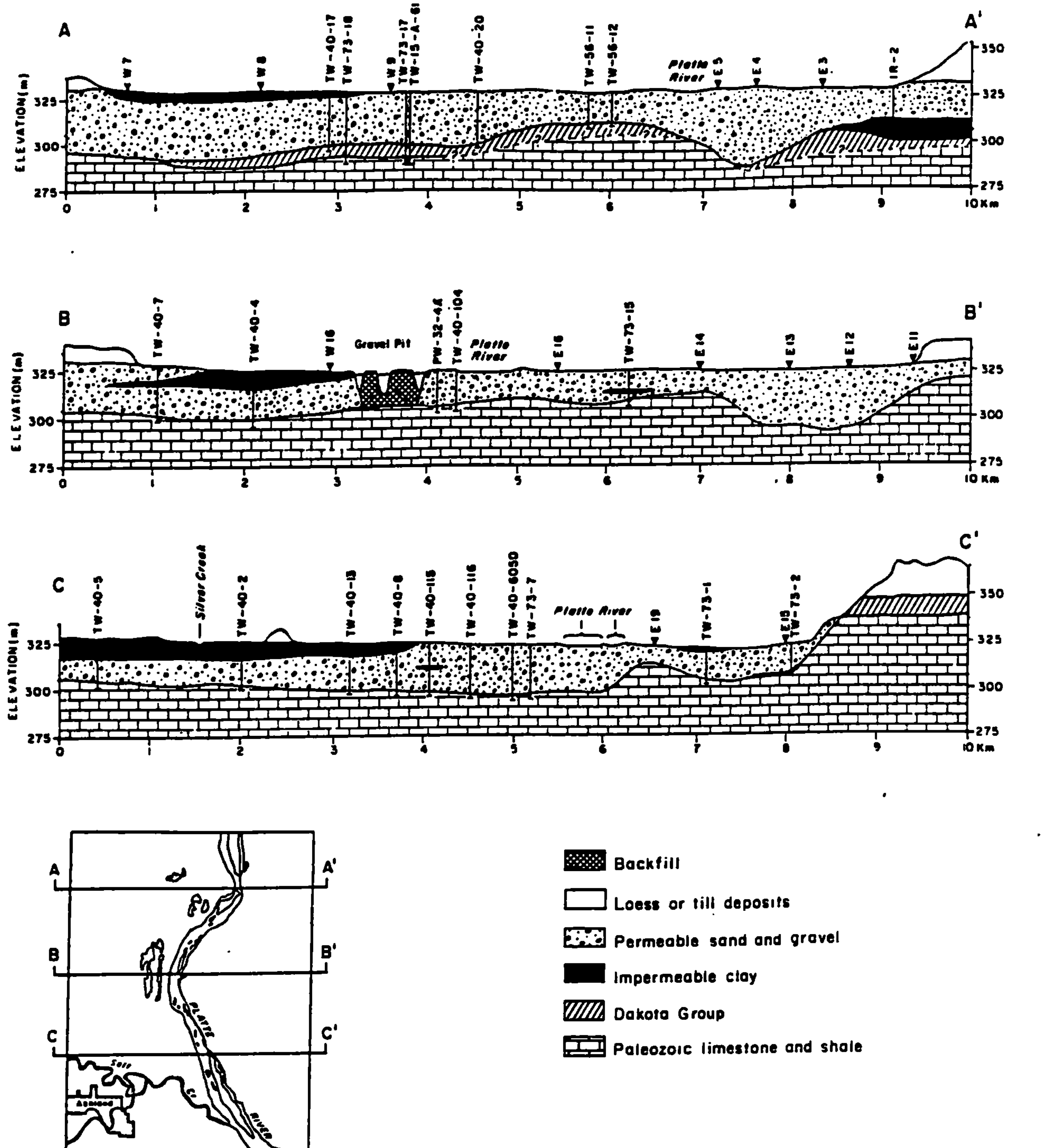


FIGURE 12

Hydrogeologic cross sections through selected locations across the lower Platte Valley study area.

Source: Jerry F. Ayers; 1989. "Application and Comparison of Shallow Seismic Methods in the Study of an Alluvial Aquifer". Groundwater Volume 27 Number 4 July-August 1989.

The Dakota Formation underlies a large part of the LPS NRD (Figure 8). Although quantity and quality of ground water from this bedrock formation vary, it is an asset to landowners with no other source of water economically available (Lawton, et. al, 1984). At the present time, numerous wells extend down into this formation, including municipal and irrigation wells. The LPS NRD included the Dakota Formation in the Remaining Area and has not identified it as a ground water reservoir primarily due to its unpredictable quantity and quality.

4.8 Remaining Area (RA)

The remaining portion of the LPS NRD consists of unconsolidated sediment deposits (located between the ground surface and the bedrock layers). The ground water supplies throughout the remainder of the LPS NRD do not occur in quantities equal to that of the five identified ground water reservoirs and the Dakota aquifer. These areas vary from having a limited supply to essentially no supply of ground water in some areas to having nearly no ground water at all.

The five major ground water reservoirs in the LPS NRD underlie approximately one-third of the total land area in the LPS NRD. The majority of the Remaining Area is underlain by the Dakota Sandstone bedrock formation (Figure 8) and limestone bedrock deposits. The Dakota was discussed previously in Section 4.7, and the limestone rocks are generally considered a poor source of ground water. Most wells tapping into bedrock limestone have low yields, and the ground water is commonly mineralized. Where the top of the limestone bedrock is fractured and jointed, small amounts of poor to fair quality water can be obtained.

Some other areas where useable amounts of water may be found are the area between Davey and Lincoln, and in sand deposits near streams. In these areas, ground water occurrence and use is greater than the rest of the Remaining Area but large volumes of ground water still do not occur in manageable supplies equal to those of the identified ground water reservoirs.

Smaller intermittent sand deposits may however supply adequate water for domestic, livestock, and some industrial purposes.

Approximately one-half of the Remaining Area is devoid of reliable useable water supplies, which explains the coverage of Rural Water Districts (RWD) which were formed to meet the needs of water users in these areas (Figure 7). Many of the wells in the areas covered by the RWDs are not a reliable source of water during dry periods because the quantities of ground water obtained are unpredictable.

5.0 Ground Water Levels
5.1 General Conditions

Water levels in 33 water wells are being measured as part of the LPS NRD water level monitoring program. In addition, three monitoring/observation wells within the LPS NRD are also being measured in conjunction with the U.S. Geological Survey and UNL Conservation and Survey Division. All wells are measured at least twice annually in Spring and Fall. The City of Lincoln also routinely measures water levels in their well field along the Platte River.

Permanent water level recording devices have been installed on selected wells which provide daily measurements. Recorder wells are located in the DV and CPA Ground Water Reservoirs. Installation of the recorder wells was a result of a cooperative effort between the U.S.G.S. and the LPS NRD.

"In 1930, the Conservation and Survey Division of the University of Nebraska and the U.S. Geological Survey began a cooperative water-level measurement program to observe and document, on a continuing basis, the changes in ground water levels throughout Nebraska. This program includes evaluation of the adequacy and accuracy of the water-level information collected and provides a means for data storage, retrieval, and dissemination. The period of record for many observation wells is too short to adequately determine long-term changes in water levels" (U.S. Geological Survey, 1991).

5.2 Ground Water Level Change

As of 1994, water levels have remained relatively stable in the LPS NRD. A summary of average annual changes in water levels within the LPS NRD is shown in Table 6. The Waverly GWR showed an average annual decrease of 0.16 feet since 1984, when monitoring began. Likewise, the Dwight-Valparaiso GWR and Dakota aquifer (Remaining Area) show average annual decreases of 0.34 feet and 0.11 feet since 1984, respectively. However, those

TABLE 6

Waverly Ground Water Reservoir

Depth to Water below Land Surface (feet)					Change in Water Levels (feet)		
DWR Registration Number	1984	1989	1993	1994	1984 to 1994	1989 to 1994	1993 to 1994
G-14159	19.02	20.86	22.31	18.57	0.45	2.29	3.74
A-6063	n/a	12.30	11.72	7.20	n/a	5.10	4.52
G-60727	17.68	20.01	24.59	17.61	0.07	2.40	6.98
G-13621	8.26	14.88	13.61	9.91	-1.65	4.97	3.70
G-00027	12.51	20.46	17.35	15.31	-2.80	5.15	2.04
G-20090	10.40	17.35	14.33	12.88	-2.48	4.47	1.45
11N-10E-10BA	n/a	37.75	37.99	34.82	n/a	2.93	3.17
G-12563	n/a	13.88	11.41	10.29	n/a	3.59	1.12
G-10889	5.37	12.57	12.13	8.61	-3.24	3.96	3.52
			Average Change		-1.61	3.87	3.36
			Average Annual Change		-0.16	0.77	3.36

Crete-Princeton-Adams Ground Water Reservoir

Depth to Water below Land Surface (feet)					Change in Water Levels (feet)		
DWR Registration Number	1984	1989	1993	1994	1984 to 1994	1989 to 1994	1993 to 1994
G-51298	n/a	n/a	162.73	162.59	n/a	n/a	0.14
G-01283	55.22	54.48	57.20	55.34	-0.12	-0.86	1.86
G-05399	n/a	74.78	58.52	57.49	n/a	17.29	1.03
G-58492	n/a	108.45	110.50	109.77	n/a	-1.32	0.73
G-23680	n/a	46.12	49.47	46.05	n/a	0.07	3.42
			Average Change		n/a	3.80	1.44
			Average Annual Change		n/a	0.76	1.44

Dwight-Valparaiso Ground Water Reservoir

Depth to Water below Land Surface (feet)					Change in Water Levels (feet)		
DWR Registration Number	1984	1989	1993	1994	1984 to 1994	1989 to 1994	1993 to 1994
G-40390	74.82	79.36	78.31	n/a	n/a	n/a	n/a
G-60001	n/a	74.78	80.84	n/a	n/a	n/a	n/a
G-43300	63.56	72.01	72.76	67.31	-3.75	4.70	5.45
G-69885	n/a	88.03	84.74	n/a	n/a	n/a	n/a
G-48577	33.82	36.62	37.44	36.81	-2.99	-0.19	0.63
G-47915	9.17	15.96	15.73	14.57	-5.40	1.39	1.16
			Average Change		-3.37	2.26	3.04
			Average Annual Change		-0.34	0.45	3.04

Missouri River Valley Ground Water Reservoir

Depth to Water below Land Surface (feet)					Change in Water Levels (feet)		
DWR Registration Number	1991	1992	1993	1994	1991 to 1994	1992 to 1994	1993 to 1994
G-67801	10.27	8.90	3.92	7.99	2.28	0.91	-4.07
G-74831	12.53	10.62	5.99	8.44	4.09	2.18	-2.45
10N 14E 21 CDA	9.61	8.13	3.40	7.55	2.06	0.58	-4.15
			Average Change		2.81	1.22	-3.56
			Average Annual Change		0.94	0.61	-3.56

Dakota Aquifer (Remaining Area)

Depth to Water below Land Surface (feet)					Change in Water Levels (feet)		
DWR Registration Number	1984	1989	1993	1994	1984 to 1994	1989 to 1994	1993 to 1994
G-35825	6.04	10.66	12.04	9.75	-3.71	0.91	2.29
G-06852	11.66	13.08	14.02	13.23	-1.57	-0.15	0.79
G-01317	8.28	10.96	11.67	9.50	-1.22	1.46	2.17
G-35393	37.04	39.85	39.46	37.88	-0.84	1.97	1.58
G-33896	63.00	60.76	66.19	63.64	-0.64	-2.88	2.55
G-50527B	49.83	50.25	49.70	48.50	1.33	1.75	1.20
G-20305	n/a	90.67	91.80	90.45	n/a	0.22	1.35
			Average Change		-1.11	0.47	1.70
			Average Annual Change		-0.11	0.09	1.70

Family Acres Wells (Remaining Area)

Depth to Water below Land Surface (feet)					Change in Water Levels (feet)		
DWR Registration Number	1991	1992	1993	1994	1991 to 1994	1992 to 1994	1993 to 1994
9N 7E 22 BB	165.29	166.40	165.81	165.76	-0.47	0.64	0.05
9N 7E 16 DAD	162.53	158.73	158.22	157.94	4.59	0.79	0.28
9N 7E 17 ADA	51.69	52.76	51.89	51.23	0.46	1.53	0.66
			Average Change		1.53	0.99	0.33
			Average Annual Change		0.51	0.49	0.33

three areas mentioned above show average annual increases ranging from 0.09 to 0.77 feet since 1989, possibly reflecting above normal precipitation and/or decreased withdrawals. Other areas such as the Family Acres Association wells (Remaining Area) show an average annual increase of 0.51 feet since 1984. The Crete-Princeton-Adams GWR shows an average annual increase of 0.76 feet since 1989, when monitoring began. The Missouri River Valley GWR shows an average annual increase of 0.94 feet since 1991.

Figure 13 shows examples of LPS NRD Monitoring Well hydrographs in 4 Ground Water Reservoirs and Remaining Area (WAV, DV, CPA, MRV & RA). Appendix B contains all LPS NRD hydrographs with spring and fall measurements for a period of six to twelve years, depending upon when the well was added to the LPS NRD monitoring network.

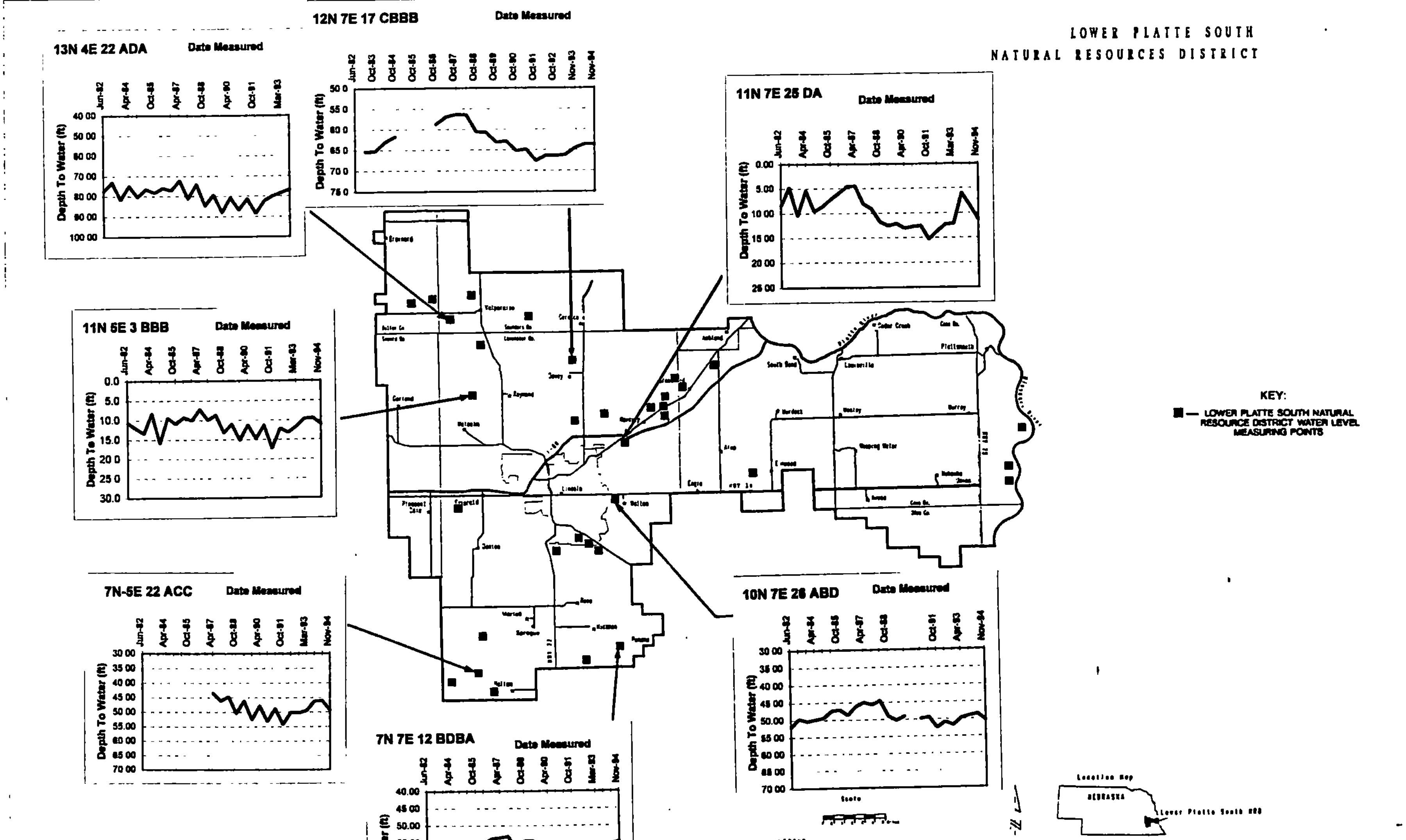


FIGURE 13

WATER LEVEL CHANGE LOWER PLATTE SOUTH MONITORING NETWORK

March 1994

SOURCE: Lower Platte South Natural Resource District

HWS Technologies Inc.

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501
402/479-2200

6.0 Ground Water Quality
6.1 General Conditions

Naturally occurring water quality in the Lower Platte South Natural Resource District can be characterized as highly variable in its chemical composition. The uses of water in the LPS NRD can be limited by not only the availability of the water supply, but where adequate water supplies are present, the quality may not be sufficient for the intended use. According to Engberg (1984), the LPS NRD's water supplies are somewhat hard, and generally high in iron and manganese. These characteristics may cause the water to be treated prior to use for drinking or industrial processes, but generally do not preclude its use for irrigation. For the most part, water quality in the sand and gravel alluvial aquifers and buried paleovalleys is quite good and useable for most purposes. The Dakota aquifer's water quality is highly variable and may contain relatively large concentrations of sodium and chloride. This difference in background water quality accounts, in part for the water development scenario in the LPS NRD.

"Water quality is one of the primary constraints on the use of the Dakota sandstones as a water supply source. The chemical quality of water from the Dakota may differ greatly from one location to another and also may differ with depth at any particular location. In some areas, the concentrations of certain chemical constituents exceed recommended drinking water guidelines or the water is of too poor quality for irrigation. Water quality differences in the Dakota are thought to be related to a number of factors, including: 1) depositional environment of the sandstones; 2) depth to the aquifers and thickness and lithology of overlying sediments; 3) interconnection with other aquifers; and 4) location with respect to recharge and discharge areas." (Lawton et. al. 1984)

Water quality data has been collected by a number of agencies for various purposes in the LPS NRD. A summary of available water quality data is given below.

City of Lincoln: Extensive water quality data has been collected by the City from their well field located along the Platte River at Ashland and from the Antelope well field in Lincoln. These results are maintained by the City in their own data files and are available to the LPS NRD upon request.

Lancaster County Health Department (LLCHD): The County requires yearly sampling for nitrates of all wells located within the City of Lincoln and a one-time sampling of all wells for nitrates located within a 3-mile radius of the City of Lincoln. In addition, nitrate samples collected for real estate transactions are also retained by the County. The LPS NRD and LLCHD have begun a joint effort to share and exchange water resource information.

State Department of Health: Municipal water supplies are sampled for a variety of parameters as required for the Safe Drinking Water Act. These samples are collected either at the tap or at the entry point to the distribution system. This data is maintained by the State and is available to the LPS NRD upon request.

University of Nebraska: The LPS NRD has participated in two studies conducted by the University of Nebraska. The first study, Water Quality in the Lower Platte River Basin with Emphasis on Agrichemicals (Spalding 1990) was conducted to document the water quality within the Lower Platte Valley. As part of this study, 93 wells were sampled by the LPS NRD in conjunction with UNL.

University of Nebraska: The second study, Investigation and Evaluation of Agrichemical Transport Near Waverly, Nebraska (Spalding 1994), was completed by the UNL Water Center and is a more detailed look at a study area within the Waverly Ground Water Reservoir. Four multi-level samplers were installed near two irrigation wells to obtain discrete ground water samples from different depths for nitrate-nitrogen and pesticides.

U.S. Geological Survey (USGS) Cooperative Study: The ongoing 3-year study identified and sampled approximately 60 suitable monitoring network wells. Saturated thickness and potentiometric maps are being produced along with estimates of approximate storage volumes of water for each ground water reservoir.

Lower Platte South NRD: The LPS NRD began sampling water wells in 1984. At that time, 14 wells were selected, sampled, and analyzed for 12 major cations and anions including nitrate. One of the above wells was also sampled for volatile organic compounds (VOCs). In 1986, one additional well was added to the original 14 wells and that well was sampled for nitrates. In 1988, 30 irrigation and domestic wells were sampled for nitrate-nitrogen, fecal coliform bacteria, iron, pH, calcium, manganese, alkalinity, chloride, sodium, hardness, fluoride, sulfate and total solids. All other sample results taken during studies are included within those studies.

As a frame of reference for understanding the significance of the water quality parameters and use limitations, Tables 7 & 8 present Safe Drinking Water Standards for Drinking Water Supplies and recommended limits for livestock and crop production.

6.2 Total Dissolved Solids (TDS)

The total concentration of dissolved inorganic material in water is expressed as Total Dissolved Solids (TDS). The concentrations are often given in parts per million (ppm). TDS is a good general indicator of water quality, reflecting in part the sodium content and degree of mineralization of the water. Water containing excessive amounts of TDS may be unsuitable for irrigation use, aesthetically unacceptable for drinking, and limited in its use for industrial purposes. The Safe Drinking Water Act sets a secondary limit for public drinking water supplies of 500 ppm for TDS. Generally water containing more than 1000 ppm TDS will likely cause

TABLE 7

Safe Drinking Water Act
Maximum Contaminant Levels (MCL)
for Selected Chemicals

Primary[1] MCL Contaminant	**MCLs (mg/L as stated)**
Inorganics	
Arsenic	0.05 as As
Barium	2.0 as Ba
Cadmium	0.005 as Cd
Chromium	0.1 as Cr
Fluoride	4.0 as F
Lead	0.05 as Pb
Mercury	0.002 as Hg
Nitrate	10.0 as N
Selenium	0.05 as Se
Silver	0.1 as Ag
Organics	
Chlorinated Hydrocarbons	
Endrin	0.002
Lindane	0.004
Methoxychlor	0.04
Toxaphene	0.003
Chlorophenoxys	
2,4-D	0.07
2,4,5-TP (Silvex)	0.01
Total Trihalomethanes	0.10

Secondary[2] MCL Contaminant	**SMCLs**
Chloride	250 mg/L
Color	15 color units
Copper	1 mg/L
Corrosivity	Noncorrosive
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Turbidity	1 -5 TU[A]
Odor	3 Ton[B]
pH	6.5 - 8.5
Sulfate	250 mg/L
Total Dissolved Solids	500 mg/L
Sodium	20 mg/L
Zinc	5 mg/L

[1]Health-related [2]Aesthetic

TABLE 8

Recommended Concentration Limits for Water Used for Livestock and Irrigation Crop Production

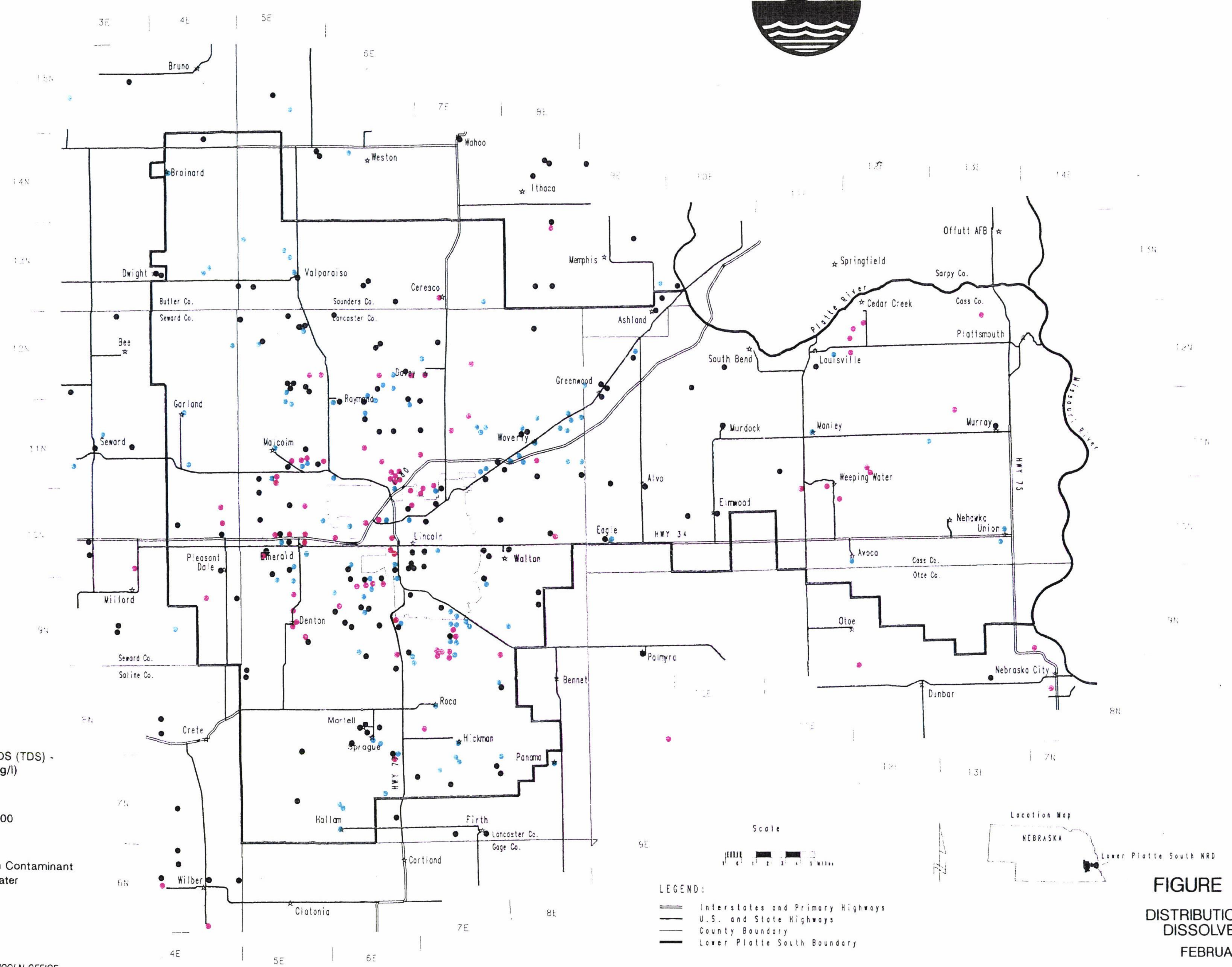
Constituent	Livestock Limits (mg/L)	Crops Limits (mg/L)
Total Dissolved Solids		
Small Animals	3000.0	
Poultry	5000.0	
Other Animals	7000.0	
Nitrate	45.0	
Arsenic	0.2	0.1
Boron	5.0	0.75
Cadmium	0.05	0.01
Chromium	1.0	0.1
Fluoride	2.0	1.0
Lead	0.1	5.0
Mercury	0.01	
Selenium	0.05	0.02

Source: Freeze & Cherry, 1979.

a taste or odor problem, or make the water unsuitable for domestic, industrial, or agricultural use. The general distribution of TDS within the LPS NRD is shown on Figure 14.

The distribution of TDS within the LPS NRD is dependent upon several factors including the geologic source of the water, the depth and construction of the well, and the rate at which the well is pumped. In general, higher TDS values are found in wells which are screened in the Dakota Sandstone. There are many areas in the LPS NRD where TDS in ground water exceeds 500 ppm. An area to the north and west of Lincoln as well as in parts of Cass County may produce water in excess of 1,000 ppm TDS.

LOWER PLATTE SOUTH NATURAL RESOURCES DISTRICT



KEY:

TOTAL DISSOLVED SOLIDS (TDS) - Parts Per Million (mg/l)

- ● — 0-500
- ● — 500-1000
- ● — >1000

500 mg/l - Secondary Maximum Contaminant Level For Drinking Water

HWS Technologies Inc.

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501
402/479-2200

FIGURE 14

DISTRIBUTION OF TOTAL DISSOLVED SOLIDS

FEBRUARY 1993

SOURCE: Lower Platte South NRD, Nebraska State Dept. Of Health, R.F. Spalding, UNL-Convervation And Survey Division

7.0 Vulnerability to Pollution

7.1 General

The vulnerability of ground water to spills and releases of contaminants or the application of fertilizers and pesticides is dependent upon many factors including the volume and type of the potential pollutant, and the subsurface hydrogeologic features of the area. Topography, recharge, soils, the vadose zone (unsaturated soils above the water table), and depth to water are several of the physical features which will influence whether a pollutant will impact ground water. A model named DRASTIC uses the parameters listed above and others to help predict the vulnerability of ground water to surface pollution in areas larger than 100 acres. The following sections discuss in detail some of the key parameters affecting pollution potential in the LPS NRD and concludes with results of the DRASTIC modeling done by Spalding (1990) in the Lower Platte River Basin study.

7.2 Topography

The slope of the land can affect the likelihood that a contaminant will run-off or will infiltrate to the ground water. Level land has a higher potential for pollution because neither the pollutant nor precipitation run-off as easily. The steeper the slope, the less opportunity for infiltration. Steeper topography can however, allow contaminants to run-off into surface water.

7.3 Recharge

Recharge is the principal vehicle for transporting a contaminant through the unsaturated zone to the water table. Recharge can originate in three ways: (1) natural recharge, which is precipitation infiltrating through the ground and percolating to the water table; (2) irrigation return flows; and (3) artificial recharge which augments precipitation. The greater the amount of recharge, the more water there is available for leaching and transport of a contaminant and the greater the potential for pollution. Recharge is one of the most difficult, if not the most difficult, hydrogeologic parameter to quantify largely because there is virtually no available data describing observed recharge rates in Nebraska.

The lowest recharge rates in the LPS NRD occur in the steep silty clay loam soils of the uplands. The highest recharge rates occur in areas where natural recharge on flat, silty, sandy soils is augmented by irrigation return flows. Irrigated lands where irrigation water may serve as potential recharge, are apparent on the land use map (Figure 15).

A river or stream can be a source of recharge to a ground water reservoir, or it can serve as a discharge point for ground water. The relationship is dependent upon the hydrology of both the ground water reservoir and the stream. The Lower Platte South NRD is located adjacent to the States two largest rivers, the Platte and the Missouri. The LPS NRD has two main watershed systems completely within its boundaries (Salt Creek and Weeping Water Creek), and shares the Platte River with the Papio-Missouri River NRD and the Missouri River with Iowa. The effect of these streams upon ground water recharge in the LPS NRD is unknown.

Reservoirs may also provide a source of recharge to ground water. The largest surface reservoirs within the LPS NRD are the ten Corp of Engineers Salt Valley Lakes which are located near Lincoln. Wildwood Reservoir, in northwestern Lancaster County and Beaver Lake, in northeastern Cass County. Again, the effect of these surface water reservoirs upon ground water recharge is not entirely known.

7.4 Soils

Soils significantly affect the amount of recharge to an aquifer and the ability of a contaminant to move vertically below the soil. "In general, the type of clay in the soil, the shrink/swell potential of the clay, and the grain size of the soil affect the soils capability to reduce the pollution potential. Generally, the less the clay shrinks and swells and the smaller the grain size, the less the pollution potential". (Spalding, 1990). The majority of the soils in the

NEBRASKA NATURAL RESOURCES COMMISSION
DATA BANK

LOWER PLATTE SOUTH
NATURAL RESOURCES DISTRICT

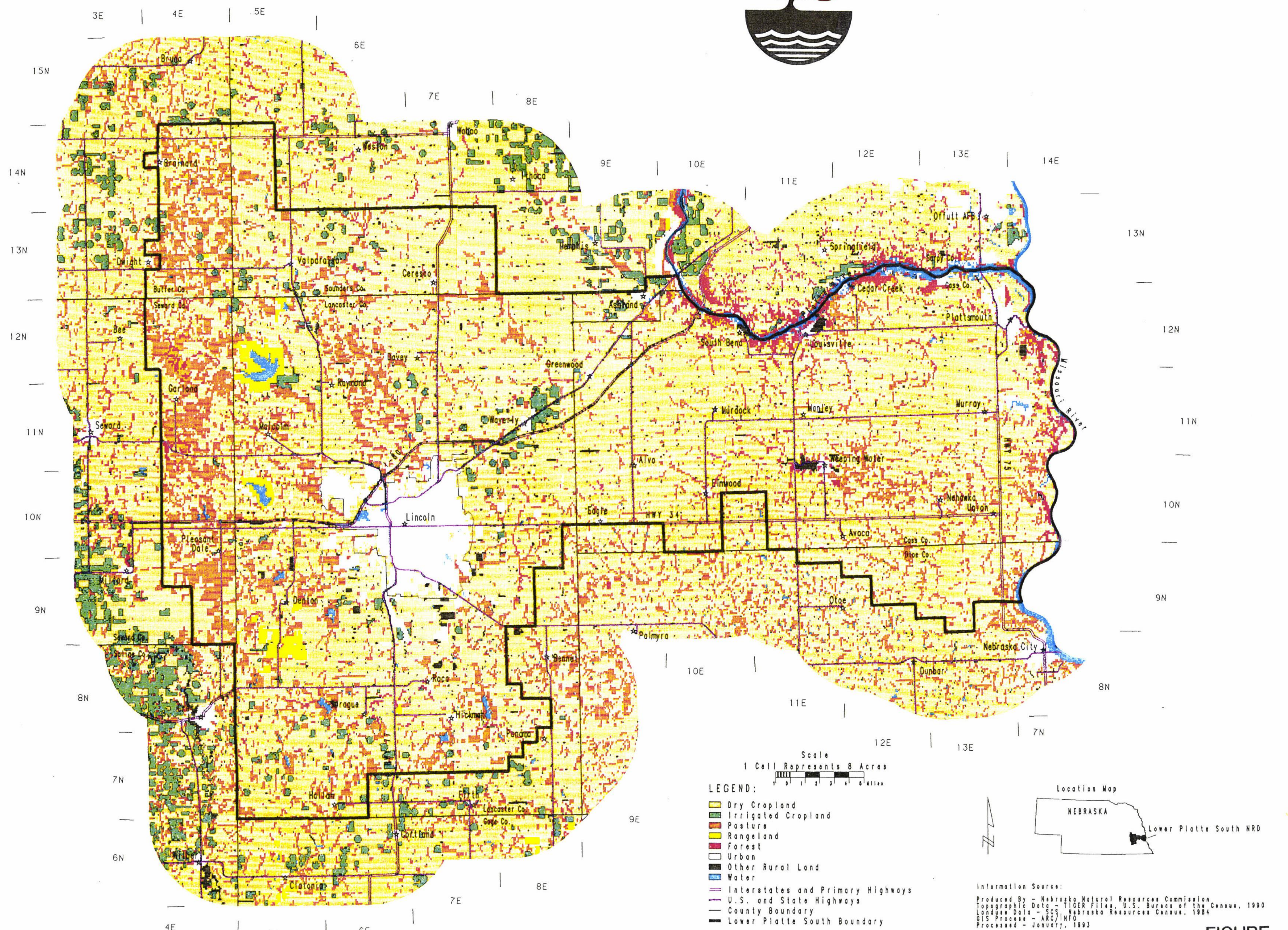


FIGURE 15

LANDUSE MAP

LPS NRD consist of at least 10 inches of clay loam and clayey subsoils which restrict the downward transport of contaminants. Soils in the stream and river valleys contain less restrictive soils and are more susceptible to pollution.

There are eleven major soil types within the LPS NRD. These soil types* are shown in Figure 16 and described below:

lbaton-Haynie Association	Deep, nearly level, poorly drained, clayey and well drained, silty soils formed in alluvium on bottom lands along the Missouri River: fine and coarse-silty
ıss-Inavale Association	Deep, nearly level to gently sloping, well and somewhat excessively drained, loamy and sandy soils formed in alluvium on bottom lands: along the Platte Valley.
a-Monona Association	Deep, strongly sloping to very steep, well to excessively drained, silty soils formed loess on bluffs overlooking the Platte and Missouri Valley: fine-silty.
ınnebec-Nodaway-Zook Assoc.	Deep, nearly level, moderately well and poorly drained, silty soils formed in alluvium on bottom lands throughout the LPS NRD: fine-silty and fine.
ipson-Benfield-Sogn Assoc.	Shallow and moderately deep, very gently sloping to steep, somewhat excessively and well drained, silty soils formed in shale and limestone on uplands along Weeping Water Creek: shallow, fine, and loamy.
arshall-Ponca Association	Deep, nearly level to moderately steep, well drained, silty soils formed in loess on uplands adjacent to the Platte and Missouri River Valleys: fine-silty.
ıarpsburg Association	Deep, nearly level to moderate steep, moderately well drained, silty soils formed in loess on uplands throughout much of the NRD: fine.
harpsburg-Fillmore Association	Deep, nearly level to gently sloping, moderately well and poorly drained, silty soils and silty soils with clayey subsoils formed in loess on high terraces and depressions adjacent to Salt Creek: fine.
ıarpsburg-Pawnee-Burchard Assoc.	Deep, nearly level to moderately steep, moderately well and well drained, silty soils and loamy soils with clayey subsoils and loamy soils formed in loess and glacial till on uplands north and west of Lincoln: fine and fine-loamy.
einauer-Pawnee-Burchard Assoc.	Deep, very gently sloping to very steep, somewhat excessively, moderately well and well drained, loamy soils and loamy soils with clayey subsoils formed in glacial till on uplands north and west of Raymond: fine and fine-loamy.
ymore-Pawnee Association	Deep, nearly level to strongly sloping, moderately well drained, silty and loamy soils with clayey subsoils formed in loess and glacial till on uplands in southern Cass County.

*Texture name in descriptive headings refers to that of surface layer of the major soils (Conservation and Survey, 1980).

NEBRASKA NATURAL RESOURCES COMMISSION
DATA BANK

LOWER PLATTE SOUTH
NATURAL RESOURCES DISTRICT

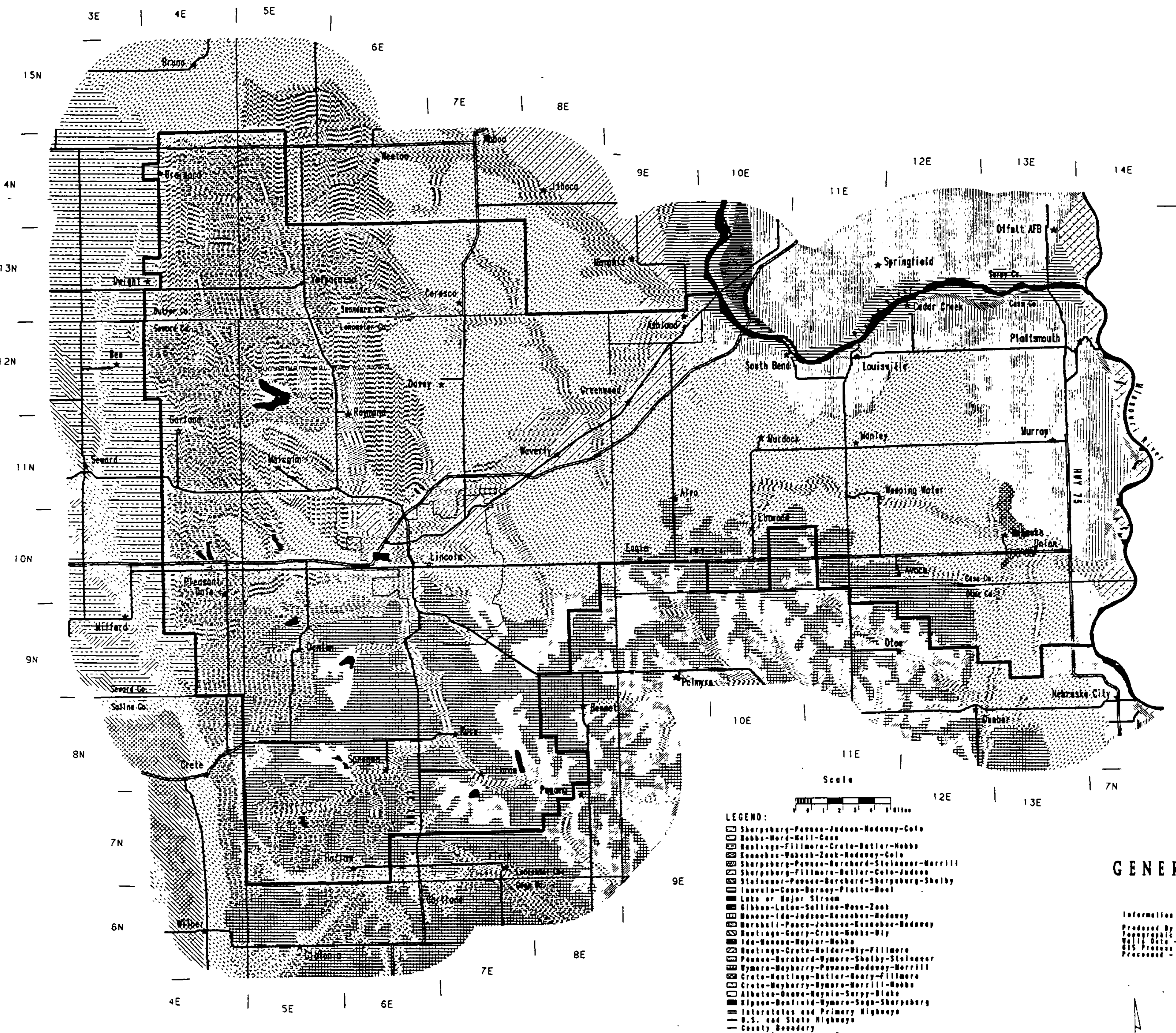
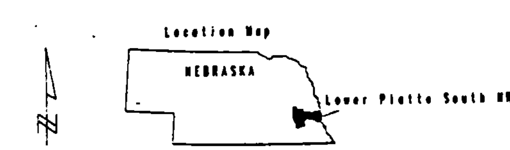


FIGURE 16

GENERALIZED SOILS MAP

Information Source:

Produced By - Nebraska Natural Resources Commission
Topographic Data - TIGER Files, U.S. Bureau of the Census, 1990
Soils Data - Nebraska Department of Water Resources
GIS Process - ARC/INFO
Processed - January, 1993



7.5 Vadose Zone

The DRASTIC model defines the vadose zone as the unsaturated area below the soil and above the water table. The type of material in the vadose zone determines its contaminant attenuation characteristics. While biodegradation, neutralization, mechanical filtration, chemical reaction, volatilization, and dispersion occur in the vadose zone, rates of volatilization and biodegradation decrease dramatically below the soil zone. The vadose media also control the path length and route of a contaminant and effect the time available for attenuation and the amount of material encountered. In general, the finer textured the media, the lower the pollution potential.

Clay and other fine grained material in the vadose zone will significantly impede the downward migration of contaminants from the surface to the ground water. Where the vadose zone is comprised of coarse grained sands or gravel, or where the water table is less than ten feet deep, contaminants leaching from the surface have a higher likelihood of impacting the ground water.

In general, shallow water tables and coarse grained vadose zone materials are more likely to occur in low lands along Salt Creek and its tributaries and also along the Platte and Missouri River Valleys. Thicker, fine grained vadose zones are more typical of upland areas throughout the LPS NRD (Spalding, 1990).

7.6 Depth to Ground Water

Depth to water can be defined as the distance between the land surface and the surface of the water table. It is a measurement of the total thickness of the geologic material through which a contaminant must move before reaching the ground water. As a general rule, the greater the depth to water, the longer the travel time in the unsaturated zone and the greater the opportunity for attenuation of a contaminant.

Figure 17 shows the relative depth to water within the LPS NRD (Spalding, 1990). Depth to water data were obtained from the U.S. Geological Survey, Conservation and Survey Division (CSD) ground water files and test hole logs, and irrigation and municipal well registrations. In those areas where these data sources did not provide adequate information, depths to water were calculated using topographic and regional water table maps.

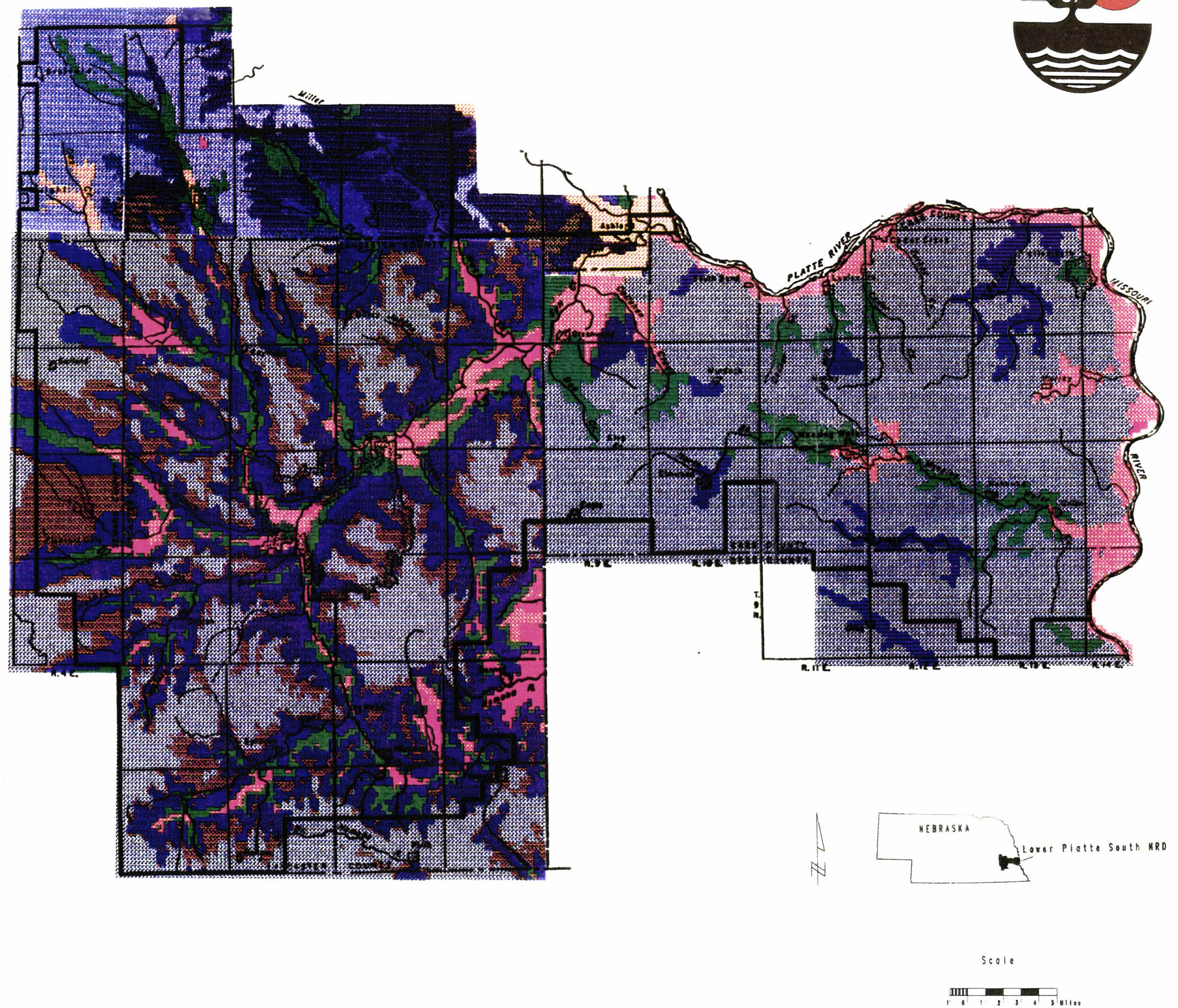
Depths to water range from less than 5 to greater than 100 feet in the LPS NRD. Shallow depths to water (<15 feet) occur in the Platte River Valley, the Missouri River valley, and along Salt Creek and its tributaries. The greater depths to water (>100 ft.) occur in the uplands of the majority of Cass and Otoe Counties and parts of Lancaster, Seward, Butler, and Saunders Counties.

7.7 DRASTIC

DRASTIC is a relatively new standardized methodology that estimates the susceptibility of ground water to pollution (i.e., pollution potential) in areas larger than 100 acres. DRASTIC is a screening tool that lends itself to mapping which in turn facilitates comparisons of the relative potential of pollution in different areas. Because it was developed to evaluate pollution potential in relatively large areas, DRASTIC is a first approximation prior to site assessment. For example, a waste disposal site could not be selected with DRASTIC but areas that are hydrogeologically unsuitable could be eliminated from further consideration and more promising areas identified. Other potential uses of DRASTIC include prioritizing areas for ground water monitoring and designating areas for ground water protection (Spalding, 1990).

DRASTIC is an acronym for the seven hydrogeologic factors, which are evaluated to determine the pollution potential of an aquifer. They are depth to water (D), net recharge (R), aquifer media (A), soil media (S), topography (T), impact of the vadose zone (I), and hydraulic conductivity of the aquifer (C). Each of these seven (7) factors has an associated weight factor

LOWER PLATTE SOUTH
NATURAL RESOURCES DISTRICT



KEY:

RANGES FOR DEPTH TO WATER

RANGE (Ft)
0 - 5
5 - 15
15 - 30
30 - 50
50 - 75
75 - 100
100+

FIGURE 17
DEPTH TO WATER

SOURCE: R.F. Spalding, M.E. Exner 1990

HWS Technologies Inc.
LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501
402/479-2200

and then each data point is given a ranking. Figure 18 shows the DRASTIC index map generated for the LPS NRD (Spalding, 1990). The lower the DRASTIC index number, the lower the vulnerability to pollution. The less vulnerable areas are shown in dark blue. The more vulnerable areas are shown in yellow and orange. As expected, based on the DRASTIC model, large areas of the LPS NRD have a low pollution potential because the uplands of the LPS NRD comprise a large portion of the land area and these areas have a low vulnerability.

The outlines of Salt Creek and Weeping Water Creek drainage systems are clearly outlined by a higher DRASTIC index compared to the surrounding uplands. The most potentially vulnerable areas are located along the Platte River. The higher potential areas are associated with these low lying river valleys.

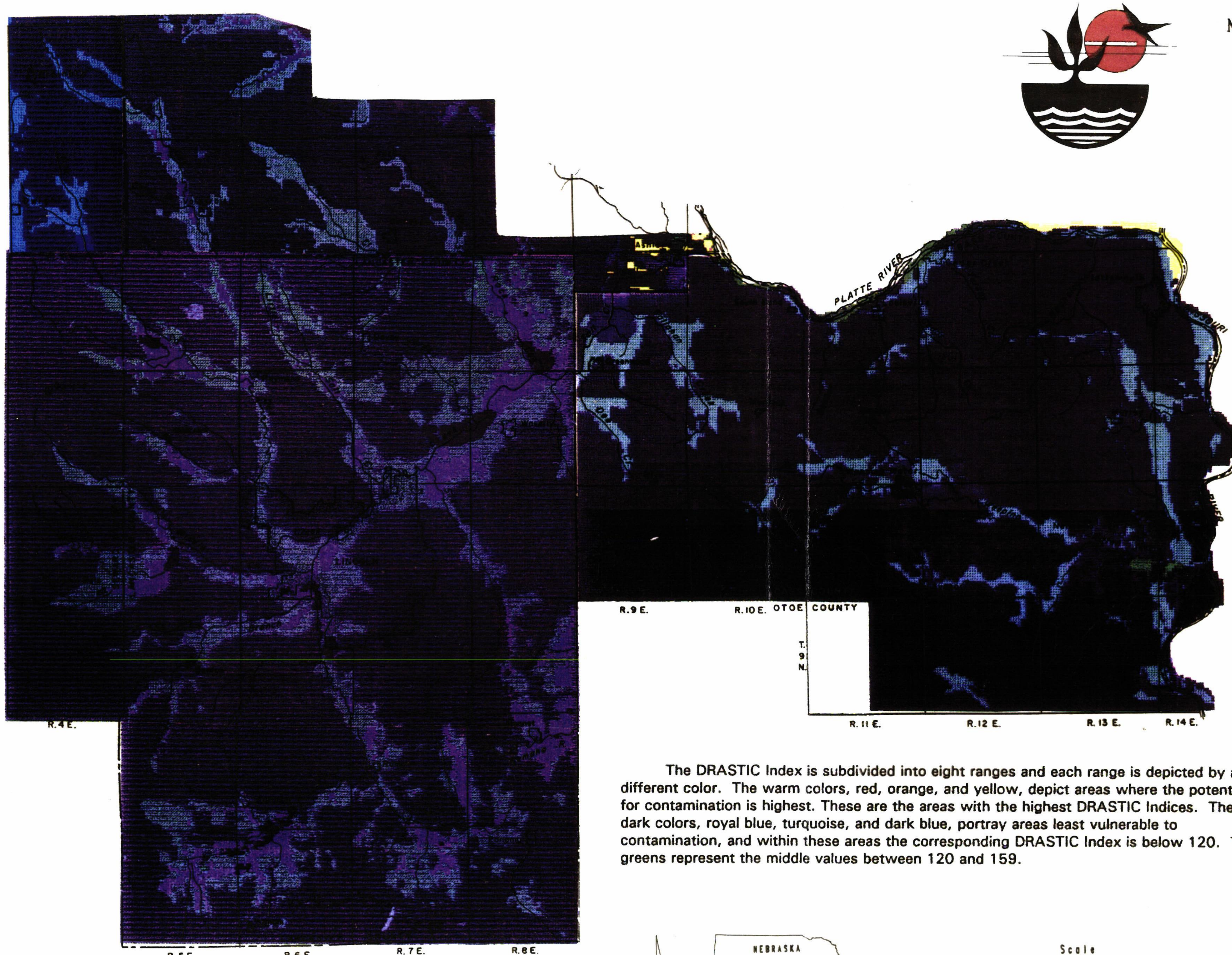
7.8 Land Use

The use of land overlying a ground water reservoir is often an important factor in the condition of the ground water resource. While many factors interact to determine the pollution potential of a ground water reservoir, the use of the land above it may directly influence water quality. An analysis of land use patterns in the LPS NRD is presented here as a foundation for analysis of its relationship to contamination.

In 1986 the USDA Soil Conservation Service conducted a Land Use Survey from their local field offices in an attempt to gain an accurate evaluation of current land use in Nebraska. Results of the survey for the LPS NRD and surrounding area are shown on Figure 15 and are summarized on Table 9.

The largest percentage of land use in the District is for agricultural purposes. Within this category, cultivated land accounts for approximately 75% of the total acreage of the District. Most of the remaining agricultural lands are used as pasture. The distribution of

LOWER PLATTE SOUTH
NATURAL RESOURCES DISTRICT



The DRASTIC Index is subdivided into eight ranges and each range is depicted by a different color. The warm colors, red, orange, and yellow, depict areas where the potential for contamination is highest. These are the areas with the highest DRASTIC Indices. The dark colors, royal blue, turquoise, and dark blue, portray areas least vulnerable to contamination, and within these areas the corresponding DRASTIC Index is below 120. The greens represent the middle values between 120 and 159.

Scale

FIGURE 18

GROUNDWATER POLLUTION POTENTIAL (DRASTIC)

SOURCE: R.F. Spalding,
M.E. Exner 1990

HWS Technologies Inc.
LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501
402/479-2200

TABLE 9

Lower Platte South NRD

Summary of Land Use (1986)

Land Use	Acres	Totals	Percentage
Non-Irrigated Cropland	757,346	**757,346**	70
Irrigated Cropland		**25,430**	2
Surface Irrigated Cropland	6,152		
Sprinkler Irrigated Cropland	19,278		
Non-Irrigated Other Land		**291,954**	28
Pasture	167,560		
Rangeland	10,416		
Forest	20,996		
Other Farmland	21,320		
Pits and Quarries	734		
Barren	1,284		
Urban/Built-Up	58,036		
Transportation	4,200		
Water	7,408		
Total Acres		**1,074,730**	

Source: Nebraska Natural Resources Commission Databank, Contributed by the USDA Soil Conservation Service from their Land Use Survey of Nebraska (1986).

irrigated crop land is a good indicator of the distribution of ground water reservoirs in the LPS NRD because water quality and quantity is sufficient for crop production.

Agricultural land use for crop production is often identified as the primary contributor to non-point source nitrate pollution. Commercial fertilizers applied to crops can leach through the soil profile and enter the ground water reservoir if physical conditions are favorable to leaching. The source of water which leaches the fertilizers can be from flooding, heavy rain, or over-application of irrigation water.

Only 2% of the LPS NRD land area is irrigated land and this is one reason why the LPS NRD does not have a widespread non-point source pollution problem. The area most intensively irrigated is in the Waverly Ground Water Reservoir, with the largest and oldest irrigated area dating back to the 1950's. Irrigation development in the Crete-Princeton-Adams and Dwight-Valparaiso Ground Water Reservoirs occurred later in the 1970's and 1980's, and is not as intense as the Waverly Ground Water Reservoir.

One type of land use which has been identified as a possible source area for ground water contamination are landfill or "dump" sites. Presently there are 2 licensed landfills in the LPS NRD (NDEQ file data), and an unknown number of unlicensed community "dumps". The NDEQ does not have a complete inventory of unlicensed dumps, however, the Lancaster County Sheriff's office conducted a "dump" survey in 1991-92. Identified sites are shown on Figure 19. The results of this survey indicate how widespread the dump distribution could be throughout the LPS NRD. The contents of these sites is not known, nor has their relationship to ground water identified. However, when siting a new well or investigating a well contamination problem, dump sites within a well's capture zone should be considered.

LOWER PLATTE SOUTH
NATURAL RESOURCES DISTRICT

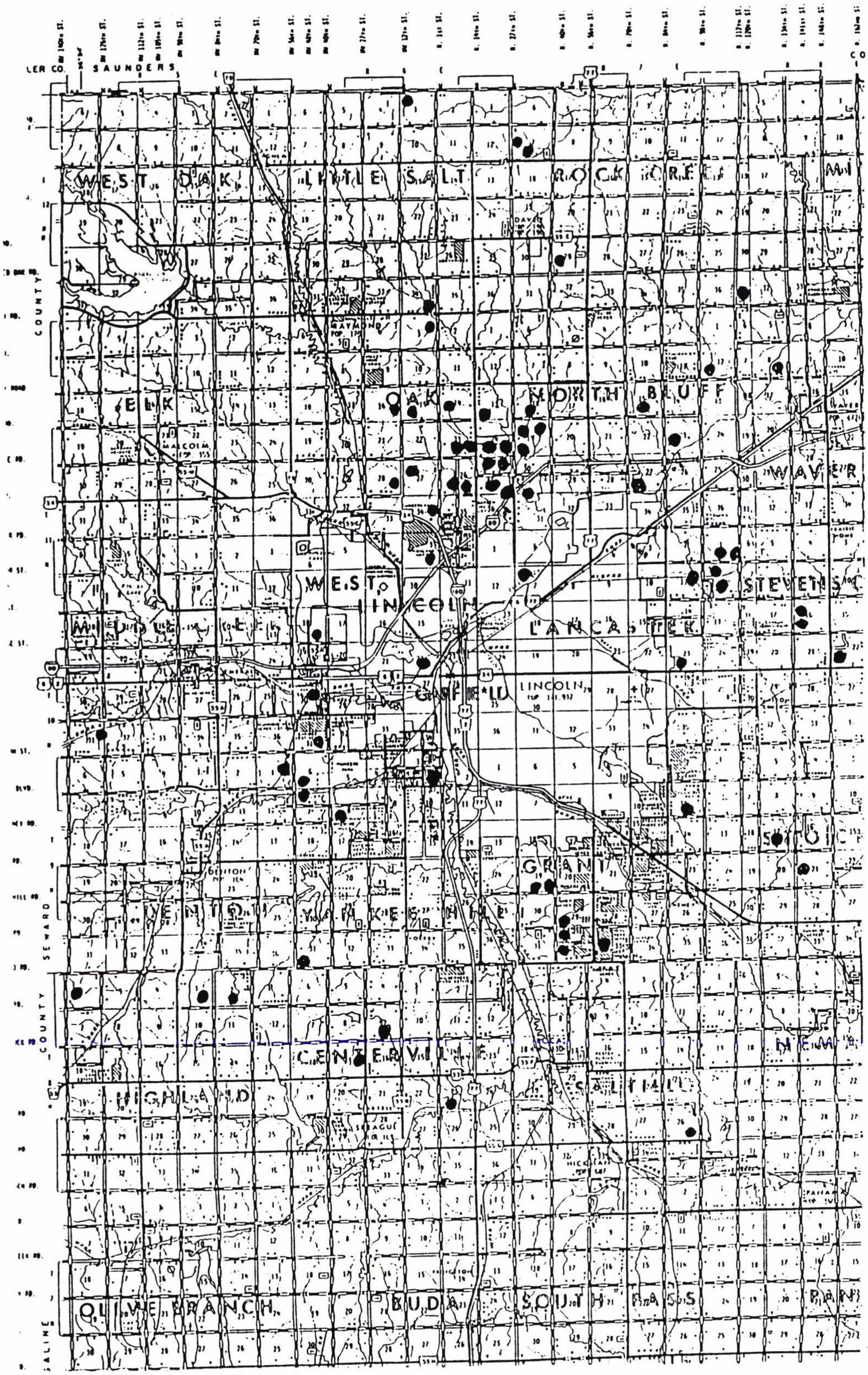


FIGURE 19

INVENTORIED DUMP SITES - 1991-1992

by Lancaster County Sheriffs Office

8.0 Non-Point Source Pollution

8.1 General Conditions

Non-point source pollution is generally defined as pollution from diffuse sources where no one point of release can be identified. While non-point source pollution can be related to weathering of minerals or soil erosion, human activities are commonly the originator for non-point source ground water pollution. The diffuse application of fertilizers, pesticides, and herbicides in agricultural operations account for large areas of land with soils containing these additives. If over application occurs, coupled with over-irrigation or heavy precipitation, these chemicals can leach to the ground water and contaminate it. In Nebraska, nitrate is the most common non-point source pollutant. Water quality studies conducted in the LPS NRD (Spalding 1990) concluded that widespread pesticide and herbicide contamination is not apparent in the LPS NRD, but there is evidence that some non-point pollution is present. The following discussion evaluates the extent of non-point contamination in the LPS NRD.

8.2 Nitrate/Nitrogen

Nitrates can be found in many areas in Nebraska. Sources of nitrates include breakdown of organic material in soils, human or animal wastes, and chemical fertilizers. When exposed to nitrate levels in excess of 10 mg/L in drinking water, infants may develop methemoglobinemia or "blue-baby" syndrome. The maximum contaminant limit for nitrate under the Safe Drinking Water Act is 10 ppm as nitrate-nitrogen (NO_3-N).

Non-point source nitrate pollution refers to large areas of elevated nitrate levels which are generally a result of widespread agricultural fertilizer application. If non-point source nitrate pollution is occurring, it is more likely to be associated with elevated levels of other agricultural chemicals such as atrazine.

Point source nitrate contamination is more localized and is generally associated with human or livestock waste migrating into shallow ground water. Poorly constructed or located domestic wells may have nitrate levels which greatly exceed the drinking water limit of 10 ppm. It may be difficult to distinguish between non-point and point source nitrate pollution unless an investigation is conducted.

The general distribution of nitrate-nitrogen within the LPS NRD is mapped on Figure 20. Elevated levels of nitrates are scattered throughout the LPS NRD. A majority of the wells with elevated nitrates are domestic or stock wells which may be the result of point source contamination. Sampling results in the Waverly Ground Water Reservoir show nitrate-nitrogen levels exceeding 10 ppm in several irrigation wells (Spalding, 1990). This prompted the LPS NRD to contract a study with the UNL Water Center which was started in 1992 and was completed in 1994. Study results indicate there are elevated nitrate-nitrogen levels in the study area, however, no cause to the contamination has been determined.

Three public water supply systems, Elmwood, Davey and Pleasant Dale have reported samples exceeding 10 ppm nitrate-nitrogen during the period 1988-95 (Department of Health, 1995). Other community water suppliers in the LPS NRD which historically have had elevated levels of nitrate have been able to significantly reduce or eliminate nitrate by abandoning older wells, installing new ones, and/or mixing water from different wells.

Figure 21 shows the distribution of nitrates in permitted wells within the City of Lincoln. These wells are generally used for domestic purposes. Elevated nitrate levels (4-8 ppm) are found in wells located in the north section of Lincoln and in various locations throughout the rest of Lincoln. The source of the nitrate within Lincoln is not determined.

The LPS NRD has spent many hours compiling domestic well nitrate sample data obtained for Lancaster County from the County Health Department. Over 1,200 records of water

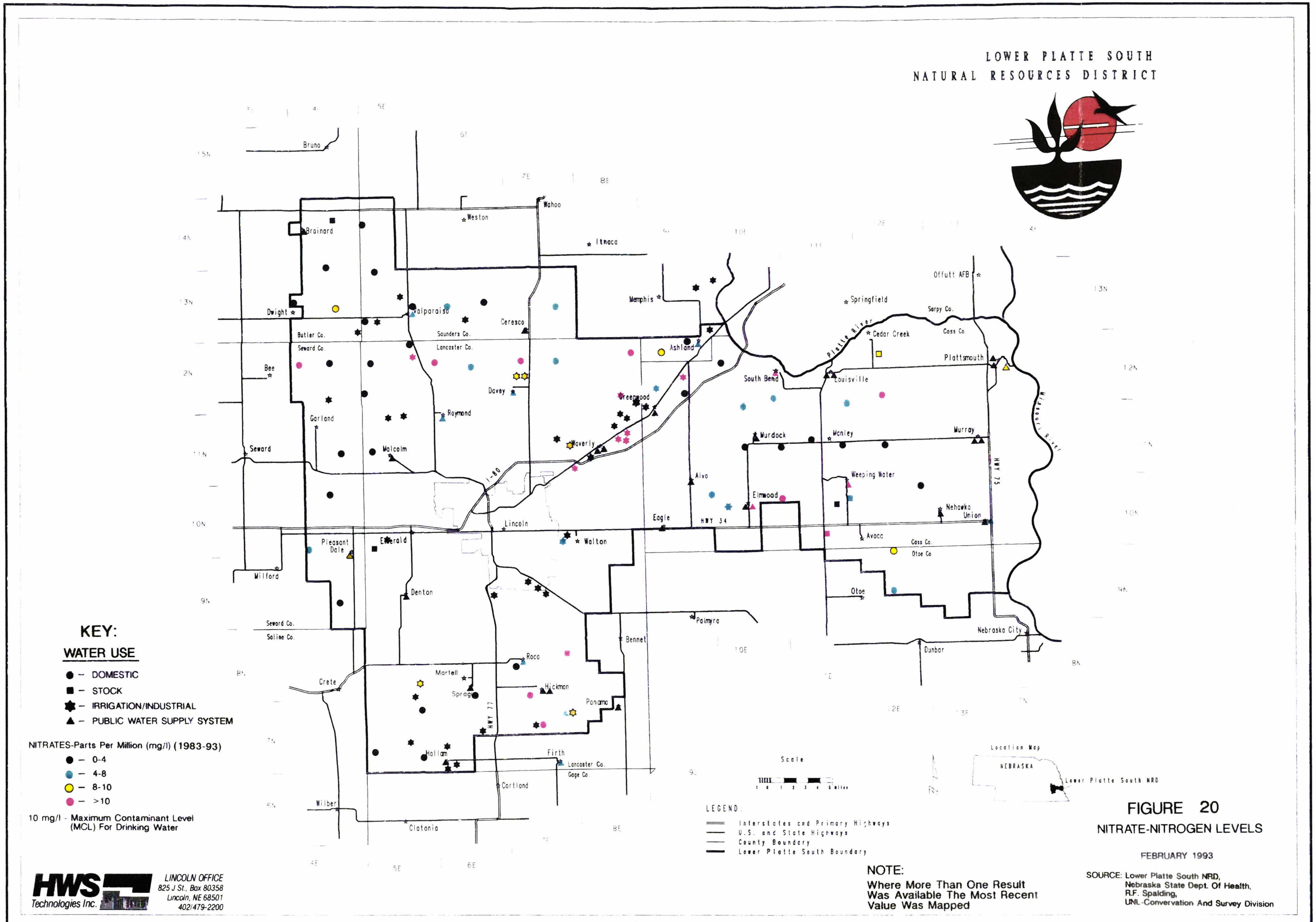


FIGURE 20

NITRATE-NITROGEN LEVELS

FEBRUARY 1993

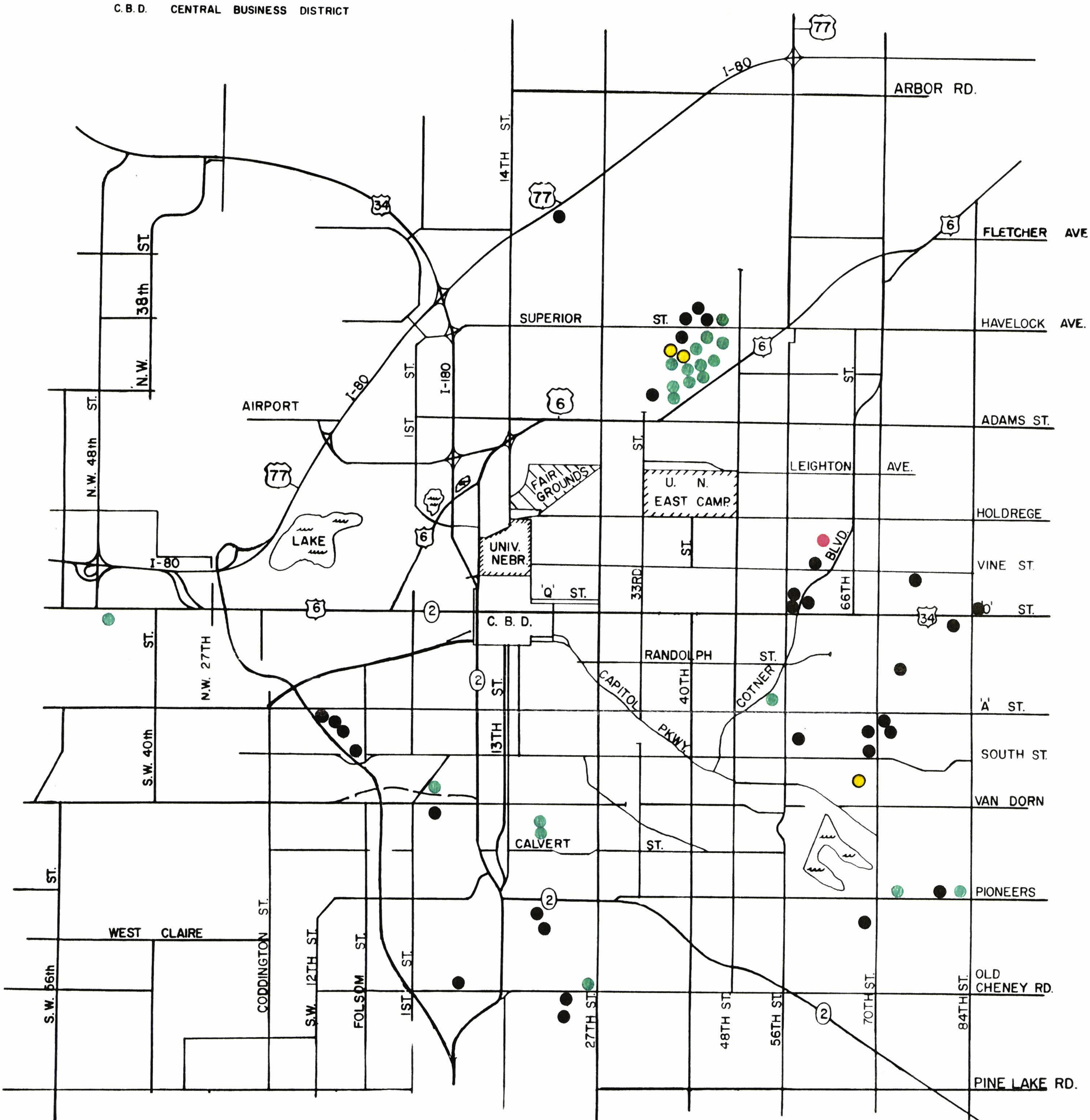
NOTE:
Where More Than One Result Was Available The Most Recent Value Was Mapped

SOURCE: Lower Platte South NRD, Nebraska State Dept. Of Health, R.F. Spalding, UNL-Conservation And Survey Division

LOWER PLATTE SOUTH
NATURAL RESOURCES DISTRICT

SCALE IN MILES
0 1 2

LEGEND:
6 U. S. HIGHWAYS
2 NEBRASKA HIGHWAYS
C. B. D. CENTRAL BUSINESS DISTRICT



KEY:

WATER USE

- ● – DOMESTIC
- ■ – STOCK
- ✱ – IRRIGATION/INDUSTRIAL
- ▲ – PUBLIC WATER SUPPLY SYSTEM

NITRATES-Parts Per Million (mg/l)

- ● – 0-4
- ● – 4-8
- ● – 8-10
- ● – >10

10 mg/l - Maximum Contaminant Level (MCL) For Drinking Water

FIGURE 21

NITRATE-NITROGEN LEVELS CITY OF LINCOLN

FEBRUARY 1993

SOURCE: Annually Permitted Wells Within The Lincoln City Limits, Lancaster County Dept. Of Health.

HWS Technologies Inc.
LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501
402/479-2200

sample analysis for nitrates were reviewed and compiled. The purpose of this effort was to determine if the individual drinking water supply wells in the county had a nitrate problem, and if so, the extent. Results of the data review are summarized on Figure 22. A total of 1,279 samples revealed that approximately 92% of the wells had nitrate concentrations of less than 8 ppm, with 84% less than 4 ppm. Only 71 samples (5.6%) exceeded the drinking water standard of 10 ppm, with 28 wells (2%) approaching the limit with greater than 8 ppm, but less than 10 ppm. Without more detail regarding well construction and location with respect to septic systems and/or feedlots it is difficult to draw many conclusions from this data other than that a widespread or intense contamination problem is not evident.

Nitrate water samples analysis results are available from a number of local and State agencies as part of ongoing programs or studies. The LPS NRD intends to coordinate with these agencies to develop a central repository of nitrate information for use by all. A summary of available data is given in Table 10. A summary of LPS NRD past water quality sampling results is presented in Table 11.

8.3 Other Agricultural Chemicals

In 1988 and 1989, the Lower Platte South NRD cooperated with other NRD's in the Lower Platte Valley Ground Water Quality Study (Spalding, 1990) to sample selected wells for atrazine. The study covered three Natural Resources Districts, and a total of 54 wells were sampled for atrazine. Thirteen wells were sampled in the Lower Platte South NRD, primarily concentrated in the Waverly Ground Water Reservoir, which was identified as a potentially vulnerable area. All wells sampled in the LPS NRD were below the proposed E.P.A. maximum contaminant level of 3 ppb. Atrazine was detected in seven of the ten irrigation wells sampled with detectable concentrations ranging from 0.02 to 0.08 ppb. These low concentrations were

Lower Platte South
Natural Resources District

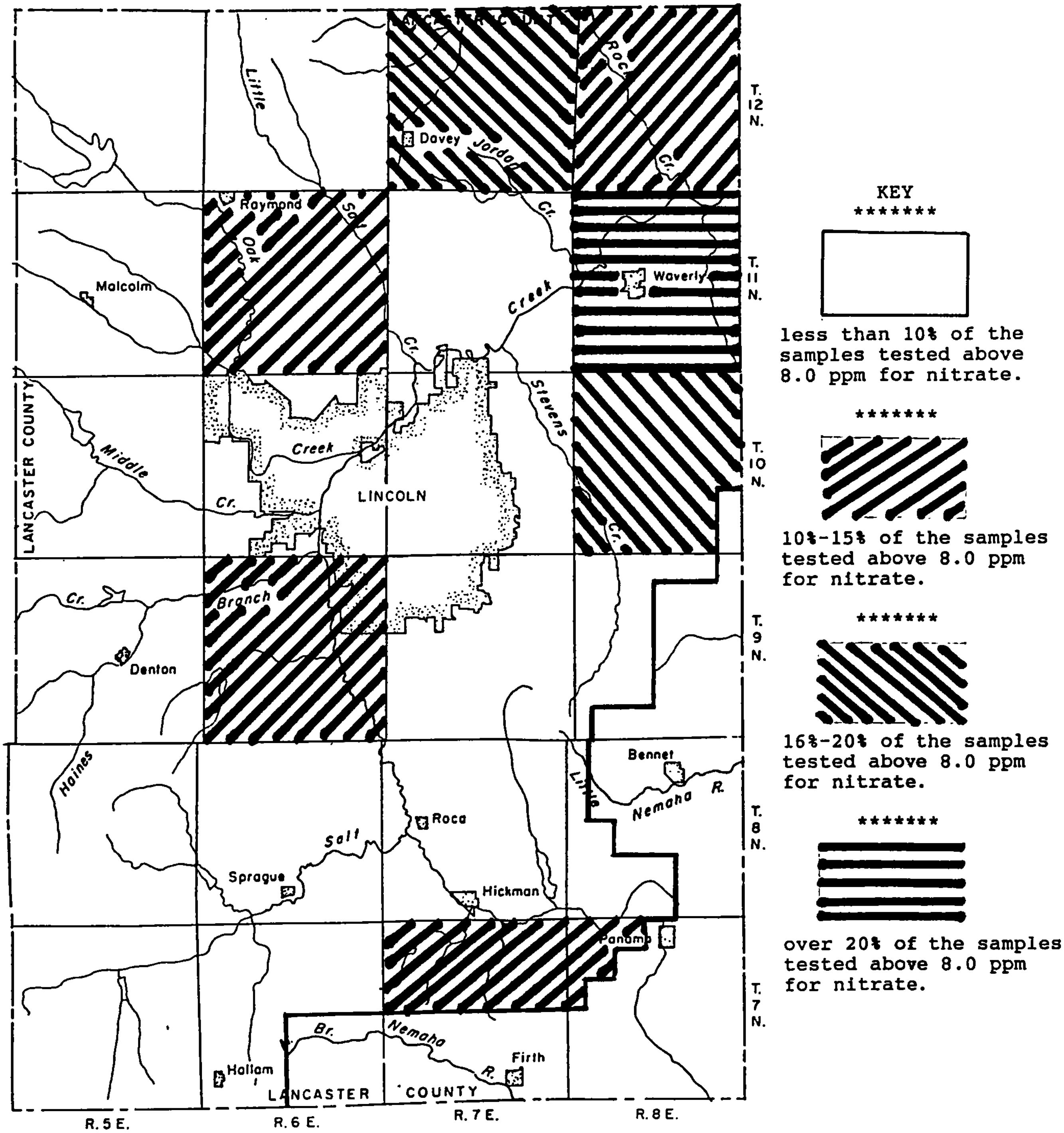


FIGURE 22

LANCASTER COUNTY NITRATE LEVELS FOR
REAL ESTATE TRANSFERS WITH PRIVATE WATER SUPPLIES
(approximately 1986-1993)

TABLE 10

Summary of Available Nitrate

Water Quality Data - Lower Platte South NRD

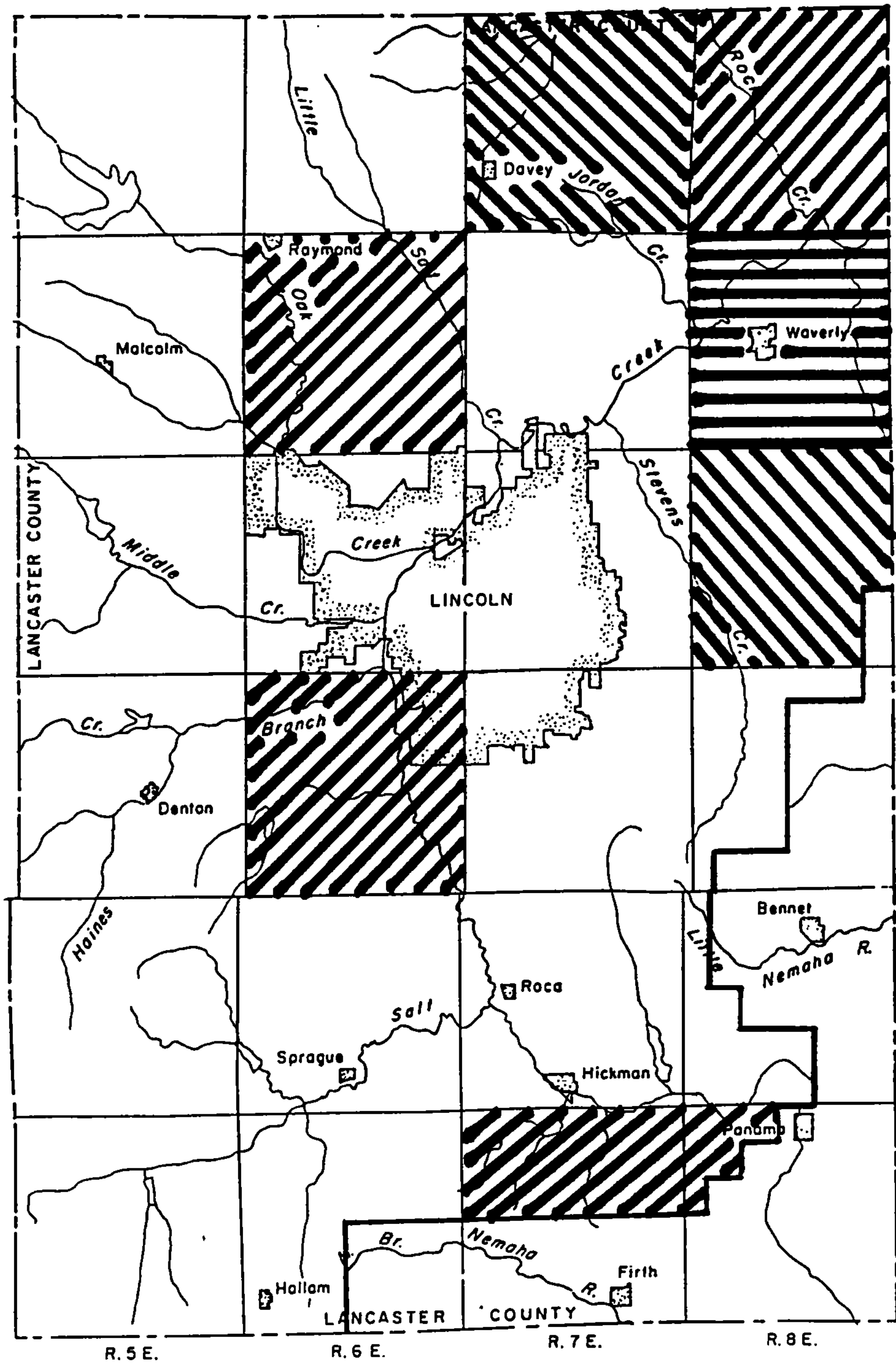
Agency	Location	Type of Data
City Lincoln	Ashland	Extensive water quality results Data maintained by City; available to LPS NRD upon request
	Antelope	Extensive water quality results Data maintained by City; available to LPS NRD upon request
Lincoln-Lancaster County Health	Within City Limit	1986-92 results for nitrate information at LPS NRD
	Within 3-mile limit	One time sampling at well completion--information at LPS NRD
	Real Estate Transfers LPS NRD	One time sample at transfer information on
University of NE and LPS NRD	Lower Platte Valley	Data from 1988-89 sampling Published by Spalding in 1990
UNL Water Center	Waverly, Nebraska	2 irrigation wells sampled in 1992 4 monitor wells sampled in 1992-93
Lower Platte South NRD	Entire NRD	15 wells sampled in 1984-86
USGS Coop Study	Entire NRD	55 wells sampled in 1994-95

Table 11
LPS NRD Water Quality Sample Results

T	R	SEC	1\4	DATE	Nitrate	Iron	ph	Ca	Mn	Alkalinity	Cl	Na	Hardness	Fluoride	Sulfate	Solids
7	5	22	ACC	Aug-05-1988	8.0		6.90			308			352			470
7	5	22	A	Sep-02-1988	25.1											
7	6	32	BCA	Aug-10-1988	0.1		7.30			424			368			512
7	6	15	DCC	Aug-11-1988	0.1	0.30	7.80	99	0.60	288	110	88	288	0.31	64	914
7	6	31	D	Aug-15-1988	0.1											
7	7	12	BDBA	Jul-27-1984	3.0	0.00	7.20	72	0.10	264	6	28	244	0.26	11	400
7	7	12	BDBA	Aug-02-1988	7.6					280			232			324
7	7	16	BAB	Aug-10-1988	3.1		7.10			328			328			450
7	7	16	B	Aug-15-1988	34.3											
8	5	35	CA	Aug-05-1988	0.1		7.50			280			264			390
8	5	26	D	Sep-02-1988	8.7											
9	6	23	AA	Aug-04-1988	2.8		6.70			264			352			552
9	7	16	DAD	Jul-27-1990	0.2	0.00	6.40	136	0.05	180	18	40	528	0.24	420	796
9	7	17	ADA	Jul-27-1990	0.0	0.00	6.70	101	0.42	276	20	29	348	0.29	112	448
9	7	22	BB	Jul-27-1990	0.1	0.10	6.20	142	0.05	156	24	43	496	0.24	410	776
10	5	29	DD	Jul-19-1984	2.0	0.20	7.40	86	0.00	292	30	45	300	0.34	52	382
10	5	29	DD	Mar-24-1988	2.0					300			284			392
10	5	29	D	Aug-16-1988	0.2											
10	7	26	DB	Jul-24-1984	0.2	0.10	7.60	100	0.00	256	16	38	388	0.35	105	452
10	7	26	DB	Jul-28-1988	3.6		6.90			260			296			462
10	10	17	BAA	Aug-04-1988	6.4		7.00			252			204			310
11	5	3	BBB	Jul-27-1984	0.1	0.10	6.90	77	0.30	360	56	101	268	0.57	47	618
11	5	3	BBB	Apr-15-1988	0.1		7.40			440			172			934
11	7	14	BBD	Jul-16-1984	2.0	0.00	7.20	83	0.00	300	58	104	272	1.00	56	596
11	7	25	DA	Jul-20-1984	11.0	0.00	7.20	64	0.00	216	12	46	232	0.35	49	390
11	7	14	BBD	Aug-05-1988	0.1		7.30			416			244			644
11	8	11	DC	Jul-27-1984	12.0	0.00	7.00	107	0.00	324	12	50	360	0.27	80	538
11	8	14	BBDA	Jul-30-1986	12.0	0.10	7.10	165	0.10	332	10	71	552	0.34	295	742
11	8	11	DC	Aug-02-1988	12.7		7.00			356			376			612
11	8	14	BBDA	Aug-02-1988	13.0					396			540			886
11	8	14	A	Aug-19-1988	10.9											
12	5	11	BB	Jul-19-1984	11.0	4.00	7.20	108	0.40	308	18	26	368	0.33	25	452
12	7	17	CD	Aug-13-1984	7.0	0.00	7.60	40	0.00	188	6	39	148	0.32	11	208
12	7	17	CD	Aug-04-1988	8.9		7.00			232			192			276
12	7	17	C	Aug-19-1988	37.7											
12	8	36	ADCD	Aug-09-1988	0.7					356			268			522
12	8	26	C	Aug-15-1988	13.1											
12	9	22	AA	Jul-30-1984	31.0	0.00	7.80	85	0.00	240	8	38	320	0.22	11	438
12	9	31	CBB	Jul-30-1984	0.1	1.41	7.30	74	1.41	332	10	76	260	0.42	49	486
12	9	31	CBB	Aug-02-1988	0.1					352			244			508
13	4	22	AD	Aug-13-1984	3.0	0.10	7.70	80	0.20	332	12	16	364	0.40	29	512
13	4	36	AAA	Aug-11-1988	0.1	0.81	7.80	91	0.50	284	6	17	252	0.28	54	376
13	5	15	BB	Aug-29-1984	0.1	0.40	7.00	99	1.40	340	16	20	368	0.37	36	514
13	5	15	BB	Aug-04-1988	0.1					420			376			514
13	5	29	BC	Aug-09-1988	0.1		7.20			300			304			348
13	6	28	AA	Aug-13-1984	3.0	0.00	7.30	50	0.00	172	6	20	228	0.29	34	442
13	6	28	AA	Jul-28-1988	1.6		7.10			264			228			290
13	6	28	A	Aug-17-1988	0.2											

detected in the areas of intensive corn production where atrazine is applied annually, which suggests contamination is non-point source. Atrazine was not detected in domestic wells.

Lower Platte South
Natural Resources District



KEY
****

less than 10% of the samples tested above 8.0 ppm for nitrate.

****

10%-15% of the samples tested above 8.0 ppm for nitrate.

****

16%-20% of the samples tested above 8.0 ppm for nitrate.

****

over 20% of the samples tested above 8.0 ppm for nitrate.

FIGURE 22

LANCASTER COUNTY NITRATE LEVELS FOR
REAL ESTATE TRANSFERS WITH PRIVATE WATER SUPPLIES
(approximately 1986-1993)

9.0 Point Source Pollution

9.1 General

Point source pollution generally impacts the quality of the ground water in localized areas. However, when these sites overlie potential drinking water supplies or are located adjacent to domestic or municipal wells, the impact of a spill or leak can affect larger populations. The following communities in the LPS NRD, Waverly, Ceresco, Hickman, Walton, Emerald, Elmwood, and Lincoln, have recently had their water supplies contaminated or threatened by point-source problems.

A large number of manufacturing facilities, petroleum handling facilities, and agricultural related businesses such as grain storage bins and fertilizer and pesticide storage facilities exist within the LPS NRD. Although new regulations and generally improved product and waste handling procedures have reduced the chances of a spill or release of contaminants from these type of activities, historically, numerous spills have been documented. Figures 23 and 24 show the location of these reported pollution spills within the LPS NRD and the City of Lincoln, respectively.

9.2 Underground Storage Tank Hydrocarbon Releases

This type of release generally involves a spill or leak from buried tanks at gasoline filling stations or industrial sites. Known as Leaking Underground Storage Tanks (LUST) they are regulated by the Nebraska Department of Environmental Quality (NDEQ) according to provisions of Nebraska Title's 118 and 126. Some LUST spills have been traced to locations that are no longer used as gas stations. In these cases the spills are known as "orphan tanks" and are also regulated and investigated by the NDEQ. It is not uncommon to have several LUST sites located within the same block on heavily used highways and streets.

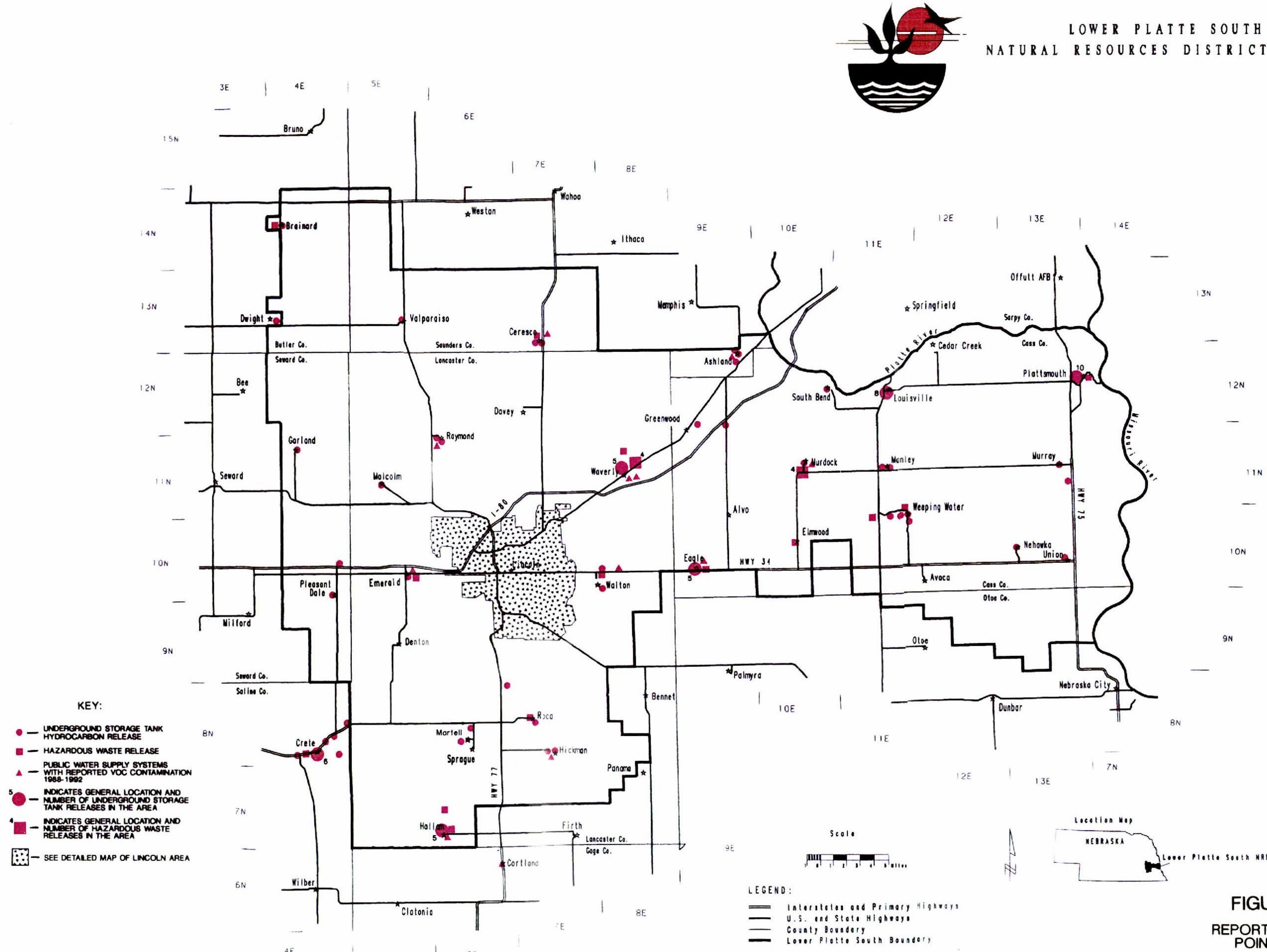


FIGURE 23

REPORTED POLLUTION POINT SOURCES

FEBRUARY 1993

SOURCE: Nebraska Dept. Of Environmental Quality, Environmental Protection Agency, Nebraska State Dept. Of Health

HWS Technologies Inc.
LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501
402/479-2200

LOWER PLATTE SOUTH NATURAL RESOURCES DISTRICT

SCALE IN MILES

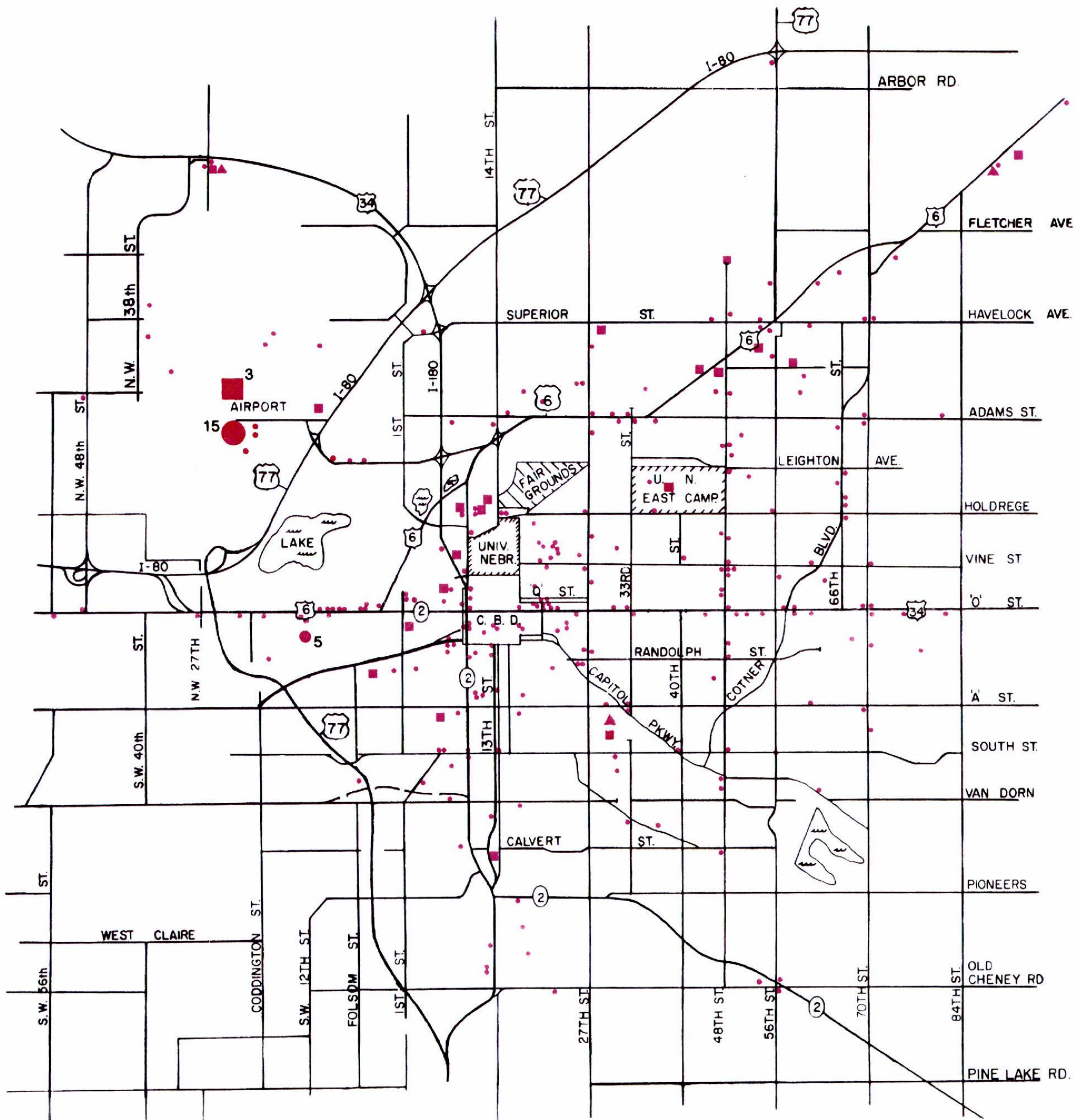
0 1 2

LEGEND:

6 U. S. HIGHWAYS

2 NEBRASKA HIGHWAYS

C.B.D. CENTRAL BUSINESS DISTRICT



KEY:

- • – UNDERGROUND STORAGE TANK HYDROCARBON RELEASE
- ■ – HAZARDOUS WASTE RELEASE
- ▲ – PUBLIC WATER SUPPLY SYSTEMS WITH REPORTED VOC CONTAMINATION 1988-1992
- ● 13 – INDICATES GENERAL LOCATION AND NUMBER OF UNDERGROUND STORAGE TANK RELEASES IN THE AREA
- ■ 5 – INDICATES GENERAL LOCATION AND NUMBER OF HAZARDOUS WASTE RELEASES IN THE AREA

N

FIGURE 24

REPORTED POLLUTION POINT SOURCES LINCOLN AREA

FEBRUARY 1993

SOURCE: Nebraska Dept. Of Environmental Quality, Environmental Protection Agency, Nebraska State Dept. Of Health

HWS Technologies Inc.

LINCOLN OFFICE
825 J St., Box 80358
Lincoln, NE 68501
402/479-2200

9.3 Hazardous Waste Releases

Hazardous waste releases are defined as those sites where contaminants other than petroleum have been found in the ground water. Such sites are often associated with manufacturing facilities or petrochemical or grain storage facilities. Hazardous waste sites are regulated in Nebraska by either the NDEQ according to provisions in Nebraska Titles 118 and 126 or by the EPA according to provisions of the Resource Conservation and Recovery Act (RCRA) or the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly referred to as "Superfund."

The Nebraska Department of Health (DOH) regularly tests public water supplies in the State for the presence of Volatile Organic Compounds (VOC's). These compounds are generally mobile in ground water and include many common solvents, degreasers, paint thinners, septic tank cleaners and grain fumigants. VOC's have increasingly been found in drinking water supplies. Public water supply systems in the LPS NRD which have reported VOC's in their tap water to the State Department of Health are also included on Figure 24. Some overlap may occur on this figure due to the fact that the water supply problem may be a result of the spill also mapped. The NDEQ is notified of these results and takes necessary ground water investigation and protection measures.

In 1986, the Lancaster County Department of Health began a sampling survey of drinking water wells in Lancaster County. The survey was designed to gather baseline data on VOC and pesticides contamination in the county's ground water/drinking water. Results of the survey were published by the Lincoln-Lancaster County Health Department in a report entitled "Ground Water Contamination by Volatile Organic Chemicals and Pesticides in Lancaster County, Nebraska," May, 1991. A total of 180 wells were tested from November, 1986 through February, 1990. The breakdown of well uses follows:

Community public water supply = 27;

Non-Community public water supply = 50;

Private urban water supplies = 17;

Private village water supplies = 38;

Private rural water supplies = 48.

A total of 39 wells (22%) of the wells tested contained detectable contamination. Figure 25 illustrates results of the sampling survey.

9.4 National Pollutant Discharge Elimination System (NPDES) Permit Program

The NPDES Permit Program controls the discharge of pollutants to waters of the State through establishing operational requirements and discharge limitations for municipal, industrial and commercial wastewater dischargers. There are over 750 facilities, excluding animal confinement operations, regulated under this program. In the LPS NRD, there are approximately 108 facilities, excluding animal confinement operations regulated under this program with 60 being located within three miles of Lincoln. A listing of the NPDES permits in LPS NRD can be found in Appendix D.

NPDES permits require the construction, operation and maintenance of wastewater treatment systems. Monitoring and inspections of regulated facilities are required to ensure compliance with permit conditions.

This program has protected and sustained the beneficial uses for the stream segments of the State. It has also assisted in bringing nonattainment areas (water quality limited stream segments) up to their designated beneficial use. Nebraska has the highest compliance rate of permitted facilities in EPA region VII (Iowa, Missouri, Kansas, and Nebraska).

9.5 Nebraska Pretreatment Program

LOWER PLATTE SOUTH
NATURAL RESOURCES DISTRICT

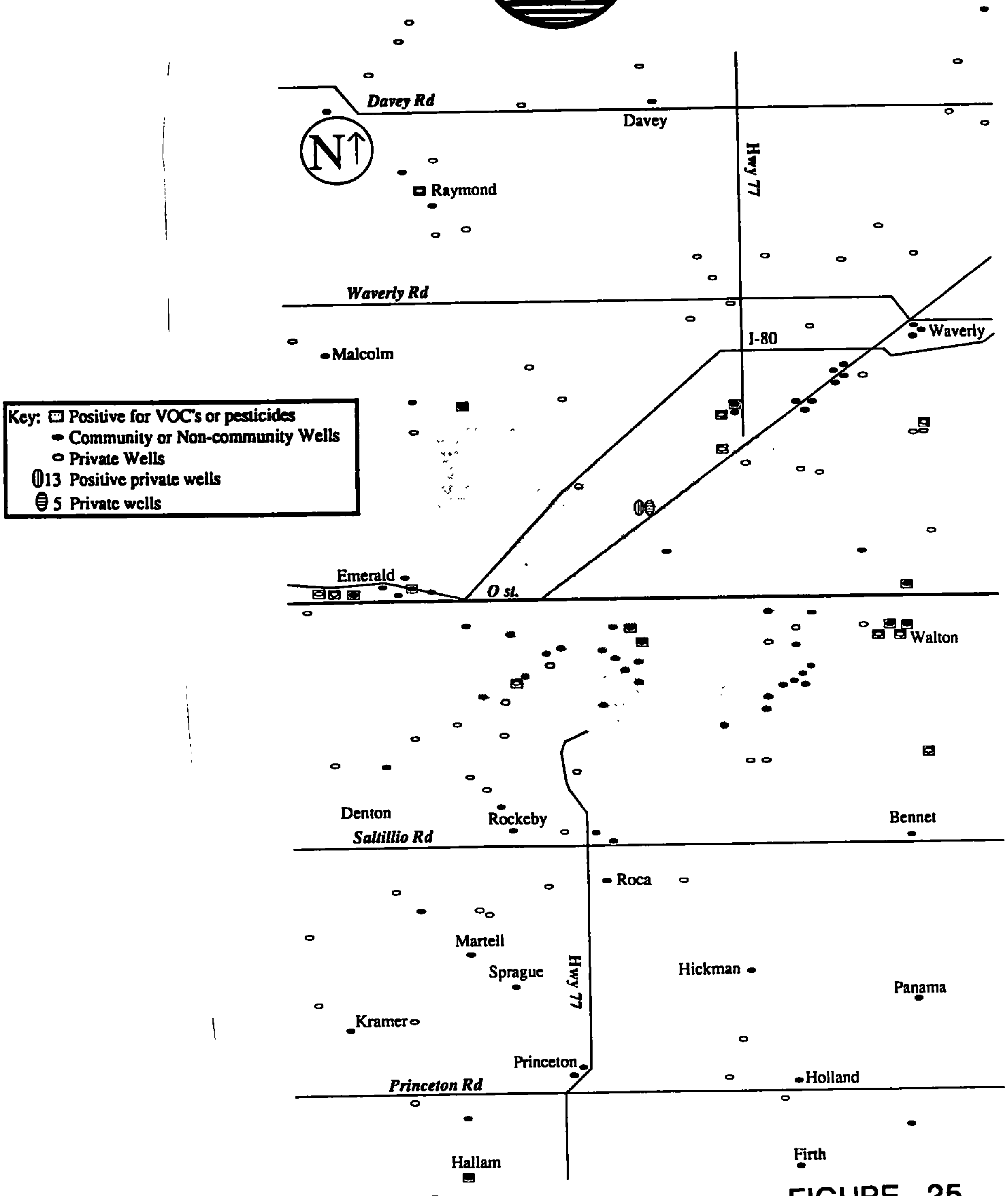


FIGURE 25

Location and Results of Water Wells Sampled for VOCs in Lancaster County, NE, 1986 to 1990

Source: Lincoln-Lancaster County Health Department. "Ground Water Contamination by Volatile Organic Chemicals and Pesticides in Lancaster County, Nebraska," May, 1991.

Pretreatment Program controls the discharge of industrial wastewaters to Publicly Owned Treatment Works (POTWs). Uncontrolled industrial discharges can cause serious problems at POTWs, including hazardous or explosive conditions in the collection system, inhibition of the biological wastewater treatment process, and contamination for wastewater sludge. Industrial pollutants can also pass through a POTW untreated causing problems in the receiving streams.

9.6 Other Potential Sources of Pollution

Identification of potential point sources of pollution is important to protection of ground water supplies. Ideally, all potential pollution sources would be identified on maps so that siting of a well could be completed taking these potential pollution sources into consideration. Unfortunately, information is limited for items such as feedlots, septic systems, and abandoned wells. At present, more site specific study is needed to inventory all potential pollution sources within a well's capture zone in order to protect the long-term viability of the well.

9.6.1 Feedlots

Presently, there are 51 feedlot operations located within the LPS NRD that are identified and regulated by the NDEQ for runoff (NDEQ files). The NDEQ estimates that this is only a small percentage of the total operations in the area. The principal pollutants associated with feedlots are nitrogen, phosphorus, chloride, organic materials, and microorganisms. High levels of livestock waste pollution may also cause discoloration, odor, and taste problems in drinking water supplies. The potential for ground water pollution will depend upon the management of the animal wastes to minimize the potential.

9.6.2 Private Septic System

A conventional private septic system consists of a septic tank and soil absorption field. Liquid waste flows from household tanks to the soil absorption field where it is purified as it filters through the soil. Soil type is crucial to this process however, since only certain types of soils can purify the effluent properly. A soil with large pores allows the effluent to move quickly and does not hold it long enough for complete purification before it hits ground water. For example, increased installation of septic systems for recreational households along the Platte River, where the water table is shallow and soils are coarse, may pose a potential pollution problem to water supplies. Where soils are too tight, septic system will not drain adequately and may break down or cause nuisance conditions. Pollutants of concern from septic systems are nitrate, bacteria, viruses, and hazardous chemicals.

The location of septic systems with respect to drinking water supply wells is crucial to whether they may cause contamination problems or not. Many domestic wells are located in close proximity to septic systems and can intercept contaminants. If the well is improperly constructed, the well may even serve as a conduit for pollution. Where local hydrogeology is suitable and the well and septic systems properly constructed, private septic systems may not cause ground water contamination problems.

There are presently no statistics which summarize the number of septic systems in the LPS NRD. Towns with wastewater collection and treatment plants are less likely to have septic system pollution, although municipal wastewater piping may leak locally and contaminate ground water. The greatest density of septic systems is on acreages in the vicinity of Lincoln, other subdivisions outside of the city's service area are developing utilizing a common disposal system. In most of these areas however, the community leach fields are developed in very tight soils and often the problem is that the soils won't accept the wastewater.

9.6.3 Improperly Abandoned Wells

Abandoned water wells can serve as a conduit for ground water pollution if they are inadequately sealed to prevent surface drainage of pollutants and the Nebraska Statute, R.R.S. 46-602 requires proper decommissioning of illegal water wells. The LPS NRD currently offers a well decommissioning cost-share program to assist landowners with proper decommissioning of illegal water wells on their property. Since 1990, the LPS NRD has provided cost-share assistance on 290 abandoned, illegal water wells. The Lincoln-Lancaster County Health Department (LLCHD) and the Nebraska Department of Health (NDOH) currently notifies landowners of illegal water wells on their property and their responsibility to decommission those wells in accordance with state regulations. Both agencies also inform the landowners that the LPS NRD does offer a cost-share assistance program to decommission illegal wells.

10.0 The Plan for LPS NRD Ground Water Management

10.1 Introduction

In 1985, the LPS NRD developed it's first Ground Water Management Plan, designed to satisfy requirements of the Nebraska Ground Water Management and Protection Act (Section 46-673.01-.04 of Nebraska Statutes). The Plan served as a foundation upon which the LPS NRD has built goals, programs, and policies to preserve the valuable resource. Since, nearly the entire population of the LPS NRD depends upon ground water for its source of water, the development and maintenance of a good solid plan is important for present and future members of the Board of Directors to understand the supply and its quality, as well as provide a tool for use in decision-making. This Plan section provides the framework for the LPS NRD's planning activities. It provides a discussion of its relationship to the overall LPS NRD mission, describes the LPS NRD's general strategy for ground water management, defines the goals for management of ground water in the LPS NRD, and details the objectives, programs, and policies designed to meet those goals.

During the planning process for the 1985 Plan, the Board of Directors anticipated that the demand for ground water would generally increase during the next 20 years in the LPS NRD. They anticipated the following development scenario:

> *Irrigation use will increase, but so will efficiency of water use.*
>
> *Individual domestic use will see little change because rural water districts are reaching out to these users and are providing water of better quality and quantity for them.*
>
> *Municipal use will increase.*
>
> *Industrial use will increase.*
>
> *Areas and the number of residents served by Rural Water Districts will increase.*

It has been ten years since this prediction was made and it appears to have been relatively on target. Irrigation well development has continued to rise (as shown by the number of irrigation wells). Municipal and Industrial water needs have increased, and are projected to continue to do so, which resulted in the City of Lincoln's drive to expand the capacity of the Ashland well field. Some growth in individual domestic use has occurred on the fringes of the Lincoln area, with the development of non-farm acreages, many of which are self-supplied and some are community water systems. Generally, Rural Water Districts (RWD) within the LPS NRD have experienced increases in population and service connections, with some RWD's expanding their water supply capacity to accommodate the demand. While the LPS NRD is largely overlain by Rural Water Districts (RWDs) and the area served by the Lincoln Water System, an additional RWD has been proposed and is under early stages of investigation to serve an area west of Lincoln whose water supply is limited by quality concerns.

During the update (1993) planning process, county officials within the LPS NRD and the Nebraska Bureau of Business Research, were contacted to gain insight into projected growth. While the type of information provided varied significantly, generally the following 20-year development scenario was expressed:

1) Farm populations will remain stable or decrease.
2) Non-farm residents will increase.
3) While the total number of farms will likely decrease, the land in agriculture will remain stable.

The dependency of water users in the LPS NRD on a sufficient supply of good quality water now and in the future has spurred the Board of Directors to adopt a policy of proactive ground water management. They recognize the time and resources required to correct a problem after it occurs or is allowed to continue, is substantial when compared to the cost of prevention and/or quick response.

10.2 Ground Water Quality and Quantity Life Goals

The LPS NRD developed a Master Plan for resources development in the late 1970's, which early on stated the following Goal and Objectives for water quantity, quality and pollution control:

GOAL: MAINTAIN THE QUANTITY AND QUALITY OF GROUND WATER FOR ANY BENEFICIAL USE IN CONFORMANCE WITH STATE STANDARDS.

Objective 1 - Protect ground water from point and non-point sources of pollutants, with effluent discharges meeting standards set by State or other agencies.

Objective 2 - Manage ground water quantity and quality levels through monitoring programs in compliance with Nebraska Ground Water Protection Standards and with provisions of Ground Water Management and Protection Act.

Objective 3 - Manage ground water for effective long-term conservation and utilization.

Objective 4 - Encourage proper development and conservation of ground water.

Objective 5 - Implement the policies in the District's Ground Water Management Plan and update as needed.

Objective 6 - Reduce potential for contamination by pesticides and fertilizers from chemigation through irrigation systems.

Objective 7 - Work collectively with other agencies to evaluate ground water quantity and quality data.

These management objectives to achieve the stated goal have been instrumental in guiding the allocation of the LPS NRD's financial and manpower resources, and serve as the foundation upon which the Ground Water Management Plan is built.

10.3 Ground Water Management Strategy

10.3.1 Intent

The Lower Platte South Board of Directors has taken a proactive approach to ground water management in the LPS NRD. In order for a proactive approach to be effective it is important to understand the existing geologic conditions which vary widely across the LPS NRD and the extent and cause of ground water quality and quantity problems. Once understood, solutions can be tailored to match the problems and can be implemented. The LPS NRD will protect the ground water resource from non point source pollution and ground water level declines by utilizing all of its technical, financial, and educational capabilities and its regulatory authorities. The LPS NRD will also assist other local entities to protect ground water from point source pollution.

The LPS NRD recognizes the need for a combination of approaches to manage its ground water resources. Historically, the LPS NRD has utilized primarily non-regulatory approaches, including: public education; encouragement of voluntary use of best management practices; governmental inter-agency coordination; monitoring to identify water quality and quantity problems; and inspection and demonstration (training) programs. These voluntary programs will continue until either ground water quality or quantity problems become known and are evaluated. Where problems arise the LPS NRD will first offer additional cost-share incentives and accelerate information and education activities in the affected area. If problems continue to worsen regulations will be implemented to protect the ground water resource.

To best respond to ground water quality or quantity problems the LPS NRD has determined that a Ground Water Management Area (GWMA) encompassing the entire LPS NRD will be established. Once the Ground Water Management Plan is approved by the Department of Water Resources the LPS NRD will begin the process of establishing the Ground Water

Management Area. The LPS NRD anticipates it will take 6-12 months to establish the Ground Water Management Area. Under a Ground Water Management Area, the LPS NRD will manage ground water by use of any one or a combination of the following means:

1) Allocating the total permissible withdrawal of ground water;
2) Rotation of use of ground water;
3) Well-spacing requirements pursuant to Section 46-673.12;
4) Reduction of irrigated acres;
5) Requiring the use of flow meters on wells;
6) Best management practices;
7) Requiring the analysis of water or deep soils for fertilizer and chemical content
8) Educational programs designed to protect water quality.

(Source: Laws 1982, LB375, 11;Laws 1986, LB894, 30;Laws 1991, LB51, 4;Laws 1993, LB439, 2;Laws 1993, LB131, 32.)

The LPS NRD has designated areas of management for both ground water quality and quantity, has established a limit "trigger" to the amount of contamination or decline that is allowed, and has developed actions to be implemented in three different Phases of management. The entire LPS NRD will be placed in Phase I of the Ground Water Management Area. If problems arise and a higher limit is reached this will trigger the actions called for in a higher Phase (II or III) of management.

10.3.2 Ground Water Quality

1) Designated Areas of Management

The ground water resources in the LPS NRD are widely varied from area to area, both in quantity and quality. The LPS NRD has established this plan to manage ground water quality in wellhead protection areas of community water systems, hereafter referred to as "Community Water System Protection Areas", "Ground Water Reservoirs", and the "Remaining Area".

The LPS NRD has designated the following five "Ground Water Reservoirs": Missouri River Valley, Platte River Valley, Waverly, Dwight-Valparaiso, and Crete-Princeton "Ground Water Reservoirs". (Figure 3)

The LPS NRD has also designated the balance of the LPS NRD, outside the five "Ground Water Reservoirs" as the "Remaining Area". The best available information indicates that portions of the "Remaining Area", including the Dakota Sandstone formation, can yield useable quantities of ground water. The natural quality and quantity of the ground water in the "Remaining Area" is highly variable.

The LPS NRD has designated, and will also delineate, "Community Water System Protection Areas" which will encompass the 20-year time-of-travel of water systems that are classified by EPA as a Community Water System. A 20 year time-of-travel refers to the amount of time it will take water or a contaminant to reach the wellhead site from the edge of the delineated area. Each designated area of management will be managed separately and have a monitoring network, components that will trigger phase determination, and management tools established to serve as the LPS NRD's plan for management.

The "Community Water System Protection Area" will automatically assume the phase designation of the "Ground Water Reservoir" or "Remaining Area" in which it is located unless the "Community Water System Protection Area" is at a higher phase of management.

2) Monitoring Network

Different levels of monitoring will be conducted in each designated area of management. The greatest level of monitoring will be within the "Community Water System Protection Areas" and the five designated "Ground Water Reservoirs", with less intense monitoring in the "Remaining Area". (see Appendix C)

All monitoring wells will be sampled at least annually for Phase determination. When more than one sample is taken from any well in a given year the quality results will be averaged. To ensure the LPS NRD's ability to sample production wells in a timely manner, long term agreements with landowners will be obtained. Past LPS NRD sampling efforts have been hampered by wet and dry climatic cycles and wells being rendered temporarily inactive as a result of the Conservation Reserve Program, land use changes, etc.

a) Community Water System Protection Areas

For each "Community Water System Protection Area", a monitoring well network will be established in cooperation with the community water supplier. At a minimum this network will include the water supplier's well(s) and possibly other registered wells, supplemented as necessary by dedicated monitoring wells. The LPS NRD will encourage the owner of each Community Water System to participate with the LPS NRD and share in the cost to install and monitor a system of dedicated detection wells.

b) Designated Ground Water Reservoirs

In the five designated "Ground Water Reservoirs", the LPS NRD will sample a minimum of one well per two mile grid. Existing wells to be sampled will be registered large capacity wells with yields greater than 50 gallons per minute (gpm) that are screened in the water bearing formation, as well as registered small capacity wells. In areas where existing wells are not available, the LPS NRD will install dedicated monitoring wells to complete the network.

c) Remaining Area

The LPS NRD will identify 20% of the registered large capacity wells, as spatially distributed as possible, to monitor long term trends and Phase determination in the "Remaining Area" of the LPS NRD.

3) Phase Determination Criteria - Water Quality Trigger

Upon establishment of the Ground Water Management Area (GWMA), the entire LPS NRD will be placed in Phase I.

For a designated area of management to move into another Phase, all of the following must occur based on samples from the monitoring network:

1) a monitoring network well meets or exceeds the percentage of the maximum contaminant level (MCL) for a contaminant that could potentially be from non point source pollution;

2) a set percentage of the monitoring network wells (% listed on the following page) within a designated area of management must be at or above the percentage of the maximum contaminant level (MCL);

3) an investigation (verification) of the area where the monitoring network well(s) exceed the percentage of maximum contaminant level (MCL) and percentage of monitoring network wells will have been conducted to verify the sample and identify contributing sources of pollution.

a) Percentage of Maximum Contamination Level (MCL)

The most current Safe Drinking Water Standards as set by the Nebraska Department of Health and the U.S.E.P.A. will be the official listing of the Maximum Contaminant Level (MCL) (Table 6). The Maximum Contaminant Level (MCL) will be the basis of management. Contaminants include all pollutants that are potentially from a non point source (i.e. Nitrate, pesticides, etc.) The following are the water quality levels for phase determination:

≤49% of the MCL - Phase I

50-79% of the MCL - Phase II

≥80% of the MCL - Phase III

b) Percentage of Monitoring Network Wells

In designated "Ground Water Reservoirs", "Community Water System Protection Areas" or the "Remaining Area", at least 50% of the wells in the monitoring network must be at/or above 50% of the MCL to initiate the verification component. In order for a designated "Ground Water Reservoir", "Community Water System Protection Area" or "Remaining Area" to qualify as Phase III, at least 80% of the samples in the monitoring network must be at/or above 80% of the MCL.

c) Verification

When the annual sampling of the monitoring network indicates that an area meets the Phase II or III requirements of both (a) and (b) above, the LPS NRD will conduct an investigation. This investigation will be conducted and completed within a two year period and will address but not be limited to:

- re-sampling all monitoring wells in the area,
- if N is a contaminant, determine if it is organic or inorganic,
- determine if contaminant(s) are from a point or nonpoint source,
- re-evaluate susceptibility of the vadose zone to nonpoint source pollution,

- install multi-level monitoring wells to evaluate the saturated zone,
- evaluate susceptibility of the monitoring well to preferential flow, and
- determine impacts of the ground water reservoirs' recharge areas.

4) Management Tools

Upon approval of the Ground Water Management Plan the LPS NRD will begin the process to establish a LPS NRD-wide Ground Water Management Area (GWMA). Within one year a Ground Water Management Area (GWMA) will be established and the following management actions will be taken for Ground Water Quality in each of the appropriate designated areas for Phase I, II, or III.

The GWMA will encompass the entire LPS NRD and the Phase Designations and Phase Actions will apply to both urban and rural lands.

Lower Platte South Natural Resources LPS NRD Ground Water Quality Phase 1 Area

Phase Area	Date To Begin	Phase Status	Phase Determination Criteria	The LPSNRD shall adopt all of the following Phase Actions as they apply toward appropriate urban and rural environments
Entire LPS NRD	1 Year after GWMP approved by DWR	Phase 1 Area	Entire LPS NRD is Phase 1 Area after GWMA designation by LPS NRD Board of Directors	1) Establish educational programs to protect water quality and quantity. 2) Formation of ground water advisory committee. 3) Establish, disseminate and demonstrate Best Management Practices (BMPs) and other management practices utilized to prevent or reduce present and future contamination of ground water. This will include, but not be limited to: irrigation scheduling; proper timing of fertilizer and pesticide application; proper chemigation and fertigation techniques; crop rotation; residue management; and contaminant source inventories. 4) Require permits for all new wells (> 50 gpm) prior to commencing construction of the new well, pursuant to Neb. Rev. Stat. § 46-659 (Cum. Supp. 1994) 5) Establish priorities for implementing dedicated monitoring well network, a Community Water Supply Protection Area program, best management practices demonstrations, and hydrogeologic research. 6) Report all ground water quality and quantity monitoring results to appropriate local, state and federal agencies. 7) Coordinate activities with local, state and federal agencies. 8) Disseminate ground water information to the public. 9) Conduct annual review to determine Phase 1 Actions effectiveness.

Lower Platte South Natural Resources LPS NRD Ground Water Quality Phase 2 Area

Phase Area	Date To Begin	Phase Status	Phase Determination Criteria	The LPSNRD shall adopt all of the following Phase Actions as they apply toward appropriate urban or rural environments
Any Designated Area of Management	1 Year after Phase Determination Criteria has been satisfied	Phase 2 Area	Upon completion of a verification study indicating at least 50% of the LPS NRD's monitoring network wells within a designated area of management are at or above 50% of the MCL for non-point source contaminant(s)	1) Continue all Phase 1 Actions 2) Establish cost-share programs to implement Best Management Practices (BMPs) and other management practices utilized to prevent or reduce present and future contamination of ground water. This will include, but not be limited to: irrigation scheduling; proper timing of fertilizer and pesticide application; proper chemigation and fertigation techniques; crop rotation; residue management; and contaminant source inventories. 3) Require educational certification programs for landowners/operators engaged in the use, application and storage of the contaminant(s). 4) Conduct annual review to determine Phase 2 Actions effectiveness.

Phase Area	Date To Begin	Phase Status	Phase Determination Criteria	The LPSNRD shall adopt all Phase Actions 1-9 as they apply toward appropriate urban or rural environments
Any Designated Area of Management	1 Year after Phase Determination Criteria has been satisfied	Phase 3 Area	Upon completion of a verification study indicating at least 80% of the LPS NRD's monitoring network wells within a designated area of management are at or above 80% of the MCL for any non-point source contaminant(s)	1) Continue all Phase 1 Actions 2) Continue all Phase 2 Actions (except no cost-share) 3) Require implementation of Best Management Practices (BMPs) and other management practices utilized to prevent or reduce present and future contamination of ground water. This will include, but not be limited to: irrigation scheduling; proper timing of fertilizer and pesticide application; proper chemigation and fertigation techniques; crop rotation; residue management; and contaminant source inventories. 4) Require landowners applying the contaminant(s) to conduct analysis of water and/or deep soils for the contaminant(s). 5) Prohibit the application of any contaminant(s) based on soil type, leachability of contaminant(s), contaminant level in water or soil samples, or recommended applications, during certain times of the year. 6) Require the use of inhibitors to reduce leaching of the contaminant(s). 7) Increase vadose zone monitoring to determine fate and quantity of contaminant(s). 8) Require landowners engaged in the use or application of the contaminant(s) to report water and soil sampling results annually to the LPS NRD. 9) Conduct annual review to determine Phase 3 Actions effectiveness.
				The LPSNRD shall adopt one or more of Phase Actions 10-14 as they apply toward appropriate urban or rural environments
				10) Allocating the total permissible withdrawal of ground water. 11) Rotation of use of ground water. 12) Well spacing requirements pursuant to Neb. Rev. Stat. § 46-673.12 (Cum. Supp. 1994). 13) Reduction of Irrigated Acres. 14) Require the use of flow meters on water wells.

10.3.3 Ground Water Quantity

1) Designated Areas of Management

The ground water resources in the LPS NRD are widely varied from area to area, both in quantity and quality. The LPS NRD has established this plan to manage ground water quantity in "Ground Water Reservoirs" and the "Remaining Area". The LPS NRD has designated the following five "Ground Water Reservoirs"; Missouri River Valley, Platte River Valley, Waverly, Dwight-Valparaiso, and Crete-Princeton "Ground Water Reservoir". (Figure 3)

The LPS NRD has also designated the balance of the LPS NRD, outside the five "Ground Water Reservoirs as the "Remaining Area". The best available information indicates that portions of the "Remaining Area", including the Dakota sandstone formation, can yield useable quantities of ground water. The natural quality and quantity of the ground water in the "Remaining Area" is highly variable. Each designated area of management will be managed separately and have a monitoring network, a set amount of decline that will serve as a trigger for each action, and specific actions for each phase of management.

2) Monitoring Network

The LPS NRD will monitor 20% of the registered large capacity wells in the "Remaining Area, and one well per two mile grid in the five designated "Ground Water Reservoirs". Existing wells to be sampled will be registered large capacity wells with yields greater than 50 gallons per minute (gpm) that are screened in the water bearing formation. In the five "Ground Water Reservoirs" where existing wells are not available, the LPS NRD will install dedicated wells and utilize them for both water quantity monitoring and water quality sampling. The saturated thickness will be established for each monitoring network well. The saturated thickness will be that vertical distance, measured in feet, between the base of the water bearing formation and the average spring static water level (Figure 26). For newer monitoring wells with less than five years of data the saturated thickness will be calculated using interpolated levels based on existing data.

3) Phase Determination Criteria - Water Quantity Trigger

Upon establishment of the Ground Water Management Area (GWMA), the entire LPS NRD will be placed in Phase I. The LPS NRD will continue to take spring water level readings from each of the LPS NRD monitoring network wells. For a designated area of management to move into another Phase, a set percentage of the monitoring network wells must have declined to a set percentage of the saturated thickness for a two consecutive year period (spring levels).

a) Triggers for Spring Static Water Level Decline

Phase I - Upon establishment of the Ground Water Management Area.

Phase II - When spring static water level elevations in 30% of the monitoring wells in that designated area of management have declined from the established upper elevation of the saturated thickness to an elevation that represents a ≥ *% reduction in the saturated thickness and have remained below that elevation for a two-consecutive-year period (spring levels). *See chart below for the *% for each designated area of management.

Phase III - When spring static water level elevations in 50% of the monitoring wells in that designated area of management have declined from the established upper elevation of the saturated thickness to an elevation that represents a ≥ *% reduction in the saturated thickness and have remained below that elevation for a two-consecutive-year period (spring levels).

* see chart on following page for the *% for each designated area of management.

GW Reservoir	Phase II	Phase III

Missouri River	**8%**	**15%**
Platte River	**8%**	**15%**
Waverly	**15%**	**30%**
Dwight-Valparaiso	**8%**	**15%**
Crete-Princeton	**8%**	**15%**
Remaining Area	**8%**	**15%**

(See Figure 26 LPS NRD Quantity Phase Determination)

4) Management Tools

Upon approval of the Ground Water Management Plan the LPS NRD will begin the process to establish a LPS NRD-wide Ground Water Management Area (GWMA). Within one year the Ground Water Management Area (GWMA) will be established and the following management actions will be taken for Ground Water Quantity in each of the appropriate designated areas for Phase I, II, or III.

The GWMA will encompass the entire LPS NRD and the Phase Designations and Phase Actions will apply on both urban and rural lands.

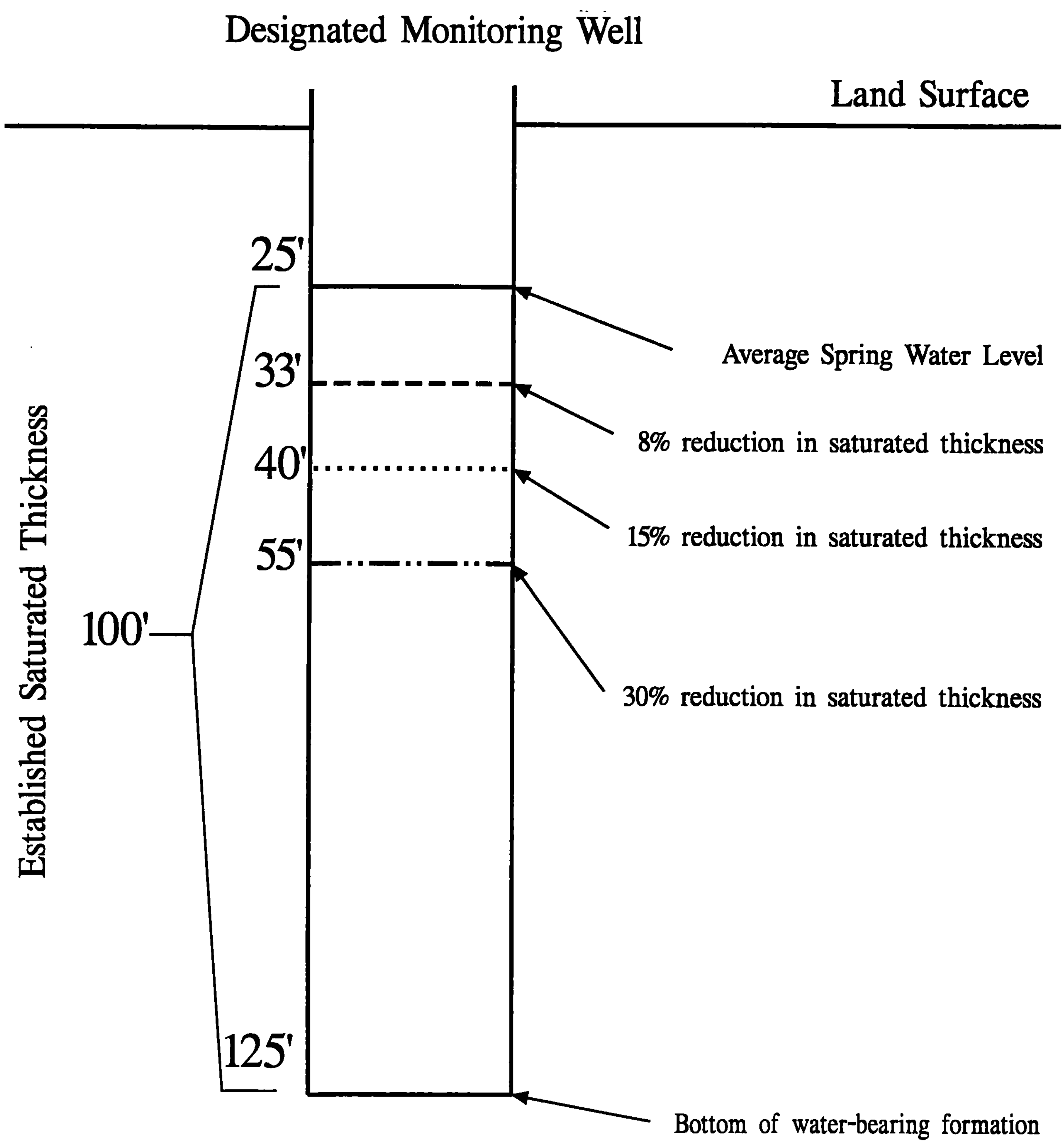


Figure 26
LPS NRD Quantity Phase Determination

Phase Area	Date To Begin	Phase Status	Phase Determination Criteria	The LPS NRD shall adopt all the following Phase Actions as they apply toward appropriate urban or rural environments
Entire LPS NRD	1 Year after GWMP approved by DWR	Phase 1 Area	Entire LPS NRD is Phase 1 Area after GWMA designation by LPS NRD Board of Directors	1) Establish educational programs to protect water quality and quantity. 2) Formation of ground water advisory committee. 3) Establish, disseminate and demonstrate Best Management Practices (BMPs) and other management practices utilized to prevent or reduce the depletion of ground water. This will include, but not be limited to: irrigation scheduling; land treatment; irrigation surge and pivot conversions; water return lines; wind breaks; proper chemigation and fertigation techniques; crop rotation; reuse systems; water use efficiency techniques and residue management. 4) Establish program for landowner cost-share and technical assistance flow meters and flow measurements for irrigation and commercial water wells. 5) Require permits for all new wells (> 50 gpm) prior to commencing construction of the new well, pursuant to Neb. Rev. Stat. § 46-659 (Cum. Supp. 1994) 6) Establish priorities for implementing dedicated monitoring well network, a Community Water Supply Protection Area program, best management practices demonstrations, and hydrogeologic research. 7) Report all ground water quality and quantity monitoring results to appropriate local, state and federal agencies. 8) Coordinate activities with local, state and federal agencies. 9) Disseminate ground water information to the public. 10) Conduct annual review to determine Phase 1 Actions effectiveness.

Phase Area	Date To Begin	Phase Status	Phase Determination Criteria		The LPS NRD shall adopt all of the following Phase Actions as they apply toward appropriate urban or rural environments
Any Designated Area of Management	1 Year after Phase Determination Criteria has been satisfied	Phase 2 Area	When spring static water elevations in 30% of the monitoring wells in that designated area of management have declined from the established upper elevation of the saturated thickness to an elevation that represents a ≥ *% reduction in the saturated thickness and has remained below that elevation for a two-consecutive -year period (spring levels). *** see below**		1) Continue all Phase 1 Actions 2) Establish cost-share programs to implement Best Management Practices (BMPs) and other management practices utilized to prevent or reduce the depletion of ground water. This will include, but not be limited to: irrigation scheduling; land treatment; irrigation surge and pivot conversions; water return lines; wind breaks; proper chemigation and fertigation techniques; crop rotation; reuse systems; water use efficiency techniques and residue management. 3) Require educational certification programs for water well system landowners and/or operators. 4) Continue cost-share program and require the use of flow meters or flow measurements for irrigation and commercial water wells. 5) Conduct annual review to determine Phase 2 Actions effectiveness.
			Waverly GWR	15%	
			Missouri River GWR	8%	
			Platte River GWR	8%	
			Crete-Princeton GWR	8%	
			Dwight-Valparaiso GWR	8%	
			Remaining Area	8%	

Phase Area	Date To Begin	Phase Status	Phase Determination Criteria		The LPS NRD shall adopt all Phase Actions 1-5 as they apply toward appropriate urban or rural environments
Any Designated Area of Management	1 Year after Phase Determination Criteria has been satisfied	Phase 3 Area	When spring static water elevations in 50% of the monitoring wells in that designated area of management have declined from the established upper elevation of the saturated thickness to an elevation that represents a ≥ *% reduction in the saturated thickness and has remained below that elevation for a two-consecutive -year period (spring levels). * see below		1) Continue all Phase 1 Actions 2) Continue all Phase 2 Actions (except no cost-share) 3) Require implementation of Best Management Practices (BMPs) and other management practices utilized to prevent or reduce the depletion of ground water. This will include, but not be limited to: irrigation scheduling; irrigation surge and pivot conversions; water return lines; proper chemigation and fertigation techniques; crop rotation; reuse systems; water use efficiency techniques and residue management. 4) Conduct annual review to determine Phase 3 Actions effectiveness. 5) Well spacing requirements pursuant to Neb. Rev. Stat. § 46-673.12 (Cum. Supp. 1994).
			Waverly GWR	30%	**The LPSNRD shall adopt one or more of Phase Actions 6-8**
			Missouri River GWR	15%	6) Allocating the total permissible withdrawal of ground water.
			Platte River GWR	15%	7) Rotation of use of ground water.
			Crete-Princeton GWR	15%	8) Reduction of Irrigated Acres.
			Dwight-Valparaiso GWR	15%	
			Remaining Area	15%	

REFERENCES

ASCS data-NRC databanks, 1984. Land Use in the Lower Platte South NRD - Map.

Ayers, Jerry F., 1991. Well-Head Protection Areas--Lincoln Well Field, Ashland, NE; Project Completion Report for the City of Lincoln Water System, Lincoln, NE.

Barnes, Ivan and Bentall, Ray, 1968. Water Mineral Relations of Quaternary Deposits in the Lower Platte River Drainage area in Eastern Nebraska. Geological Survey Water-Supply Paper 1859-D. U.S. Department of the Interior, Washington, DC.

Conservation and Survey Division Institute of Agriculture and Natural Resources, 1984. Handbook on the Preparation of Ground Water Management Plans. University of Nebraska-Lincoln. Association of Resources LPS NRDs, Lincoln, Nebraska.

Conservation and Survey Division, 1978. Water Resources of Seward County.

Conservation and Survey Division, 1980. General Soil Map of Lincoln Area - Nebraska.

Conservation and Survey Division, 1984. Handbook on the Preparation of Ground Water Management Plans (Map 3).

Department of Environmental Control, State of Nebraska and Conservation & Survey Division, 1980. Map: Configuration of the Water Table, spring 1979 Lincoln and Nebraska City Quadrangle. Institute of Agriculture and Natural Resources.

Department of Environmental Control, State of Nebraska and Conservation & Survey Division, 1980. Map: Thickness of Principal Aquifer, 1979 Fremont and Omaha Quadrangle. Institute of Agriculture and Natural Resources.

Department of Environmental Control, State of Nebraska and Conservation & Survey Division, 1980. Map: Thickness of Principal Aquifer, 1979 Lincoln and Nebraska City Quadrangle. Institute of Agriculture and Natural Resources.

Department of Environmental Quality, 1992. "LUST (Leaking Underground Storage Tanks) List."

Department of Environmental Quality, 1993. RCRA (Resource Conservation and Recovery Act) Files.

Department of Water Resources (DWR), 1995. Registered Wells Database.

Engberg, Richard A., 1984. Appraisal of Data for Ground-Water Quality in Nebraska. U.S. Geological Survey Water-Supply Paper 2245.

REFERENCES (CONTINUED)

Environmental Protection Agency, 1992. "CERCLIS (Comprehensive Environmental Response, Compensation and Liability Information System."

Farmers Home Administration, 1993. Map of Rural Water LPS NRD boundaries in Nebraska.

Freeze, R. Allen and Cherry, John A., 1979. Ground Water, Prentice-Hall Inc., Englewood Cliffs, New Jersey.

Nebraska Game and Parks Commission, 1991. Nebraska Salt Marshes: Last of the Least.

Nebraska Game and Parks Commission, 1973. Lower Platte Basin Stream Survey.

Nebraska Game and Parks Commission, 1973. Nemaha Basin Stream Survey.

Ginsberg, Marilyn H., 1983. Hydrogeology of Butler County, Nebraska. Nebraska Water Survey Paper 55. University of Nebraska-Lincoln.

Goodenkauf, Owen, 1978. Thesis: The Ground Water Geology of Southern Lancaster County, Nebraska.

Holly, Dean E., 1980. Thesis: The Hydrology of Northern Lancaster County, Nebraska.

Lancaster County Health Department, 1993. Domestic Well Nitrate Analyses File Data.

Lancaster County Sheriff, 1992. Inventory of Dump Sites in Nebraska (Map).

Lawton, Dennis, Goodenkauf, Owen, Hanson, B.V., and Smith, F.A., 1984. "Dakota Aquifers in Eastern Nebraska, Aspects of Water Quality and Use," Geohydrology of the Dakota Aquifer, Proceedings of the First C.V. Thesis Conferences on Geohydrology, National Water Well Association.

Lower Platte South NRD, 1995. Water Level Measurements Database.

Nebraska Department of Health, 1991. Analytical Results of Public Water Supply Systems, Lower Platte South NRD.

Nebraska Department of Health, 1992. "Analytical Results for Inorganic Chemicals from Public Water Systems."

Nebraska Department of Health, 1993. VOC analysis for Public Water Systems, (Database).

Nebraska Natural Resources Commission; 1994. "Estimated Water Use in Nebraska."

Spalding, Roy F., 1990. "Ground Water Quality in the Lower Platte River Basis with Emphasis on Agrichemicals."

U.S. Geological Survey and Conservation and Survey Division, 1993. Ground Water-Level Changes in Nebraska, 1992, Nebraska Water Survey Paper No. 72.

U.S. Geological Survey, 1994. Water Well Levels and Stream Flows Database.

UNL Bureau of Business Research, 1990 - Personal Communication With Dr. Merlin Erickson.

UNL NEBGUIDE G90-922, 1990. "Evapotranspiration (ET) for Crop Water Use."

UNL Department of Agriculture Meteorology, 1990. "Climatic Data Summary for NE 1990."

UNL Water Center, 1994. "Investigation and Evaluation of Agrichemical Transport Near Waverly, Nebraska", Progress Report.

APPENDIX A

Definition of Ground Water - Related Terms

DEFINITION OF GROUND WATER - RELATED TERMS

Aquifer - a water-bearing stratum of rock or sediment capable of yielding supplies of water.

Aquifer, Confined (or Artesian) - an aquifer overlain by a low permeability layer or layers, in which pressure head will force water to rise above the aquifer in which it is contained.

Aquifer, Perched - an aquifer containing unconfined ground water separated from an underlying body of ground water by an unsaturated zone.

Aquifer, Principal - the aquifer or combination of related aquifers in a given area which is the important economic source of water to wells--has been used, perhaps inaccurately, as synonymous with ground water reservoir.

Aquifer, Secondary - any aquifer other than the principal aquifer that is not the main source of water to wells in a given area e.g. includes perched aquifers, the Chadron Formation, the Dakota Sandstone in some areas, and several Paleozoic units.

Aquifer, Unconfined (or Water Table) - an aquifer in which the upper limit is the water table rather than an impermeable layer.

Bedrock - sequences of consolidated rock which outcrop at the surface or which underlie unconsolidated earth materials.

Chemigation - the application of crop nutrients or pesticides through an irrigation system.

Ground Water - water occupying voids within the saturated zone of a geologic stratum. This saturated zone is to be distinguished from an unsaturated or aeration zone where voids are filled with water and air.

Ground Water Model - a model designed to represent a simplified version of an actual, complex ground water system; may be mathematical or physical.

Hardness - the amount of certain dissolved minerals in water. Carbonate hardness refers to the hardness caused by calcium and magnesium bicarbonate; noncarbonate hardness is caused by calcium sulfate, calcium chloride, magnesium sulfate, and magnesium chloride in water.

Head - the height of a column of water, supported by static pressure, above a standard datum (usually mean sea level).

Hydraulic Conductivity - the capacity of a porous material to transmit water under a unit hydraulic gradient through a unit area. A measure of an aquifer's ability to transmit water.

Hydrograph - a graph which illustrates a specific hydrologic parameter such as water level, discharge, or velocity as a function of time.

Irrigation Efficiency - the rate at which water enters the soil under specified conditions.

Leaching - the downward transport of dissolved minerals in a soil by percolating water.

Loess - a wind deposited silt having little or no stratification.

Non-Point Source Pollution - pollution from diffuse sources where no one point of release can be identified.

Operator - shall mean that person having the most direct control over the day to day farming operation of the land concerned.

Parts Per Million (ppm) - a measure of the concentration of dissolved material in terms of a weight ratio. Roughly equivalent to milligrams per liter (mg/L).

Percolation - the downward movement of water through soil or other earth materials.

pH - a logarithmic measure of the relative acidity of water. Below 7 is increasingly acidic, 7 is neutral, and above 7 is increasingly alkaline (basic).

Piezometric (Potentiometric) Surface - the upper level to which a water level rises in a tightly cased well.

Point Source Pollution - pollution from discrete, identifiable locations which can usually be measured directly or otherwise quantified.

Pollution - the process of contaminating air, water, and land with impurities to a level that is undesirable.

Porosity - the proportion, commonly stated as a percentage, of the total volume of a rock material that consists of pore space or voids.

Precipitation - water in the form of hail, mist, rain, sleet, or snow that falls to the earth's surface.

Pressure Head - the height of a column of water which can be supported by the pressure at a given point.

Recovery of a Pumped Well - the rise of a water level in a well towards its pre-pumping elevation, which occurs after pumping ceases.

Reservoir (Ground Water) - for any given area the subsurface storage space between the potentiometric surface and the base of the principal aquifer--includes one or more aquifers and any associated fine-grained material (usually excludes any perched aquifer).

Soil - the upper layer of earth which can be cultivated and in which plants grow.

Static Water Level - the water level in a well before pumping occurs.

Transmissivity - a rate which quantifies the ability of an aquifer to transmit water.

Unsaturated Zone - porous earth materials which contain both air and water in their pore spaces. Sometimes called the vadose zone.

Vadose Zone - the unsaturated zone below the land surface and above the water table.

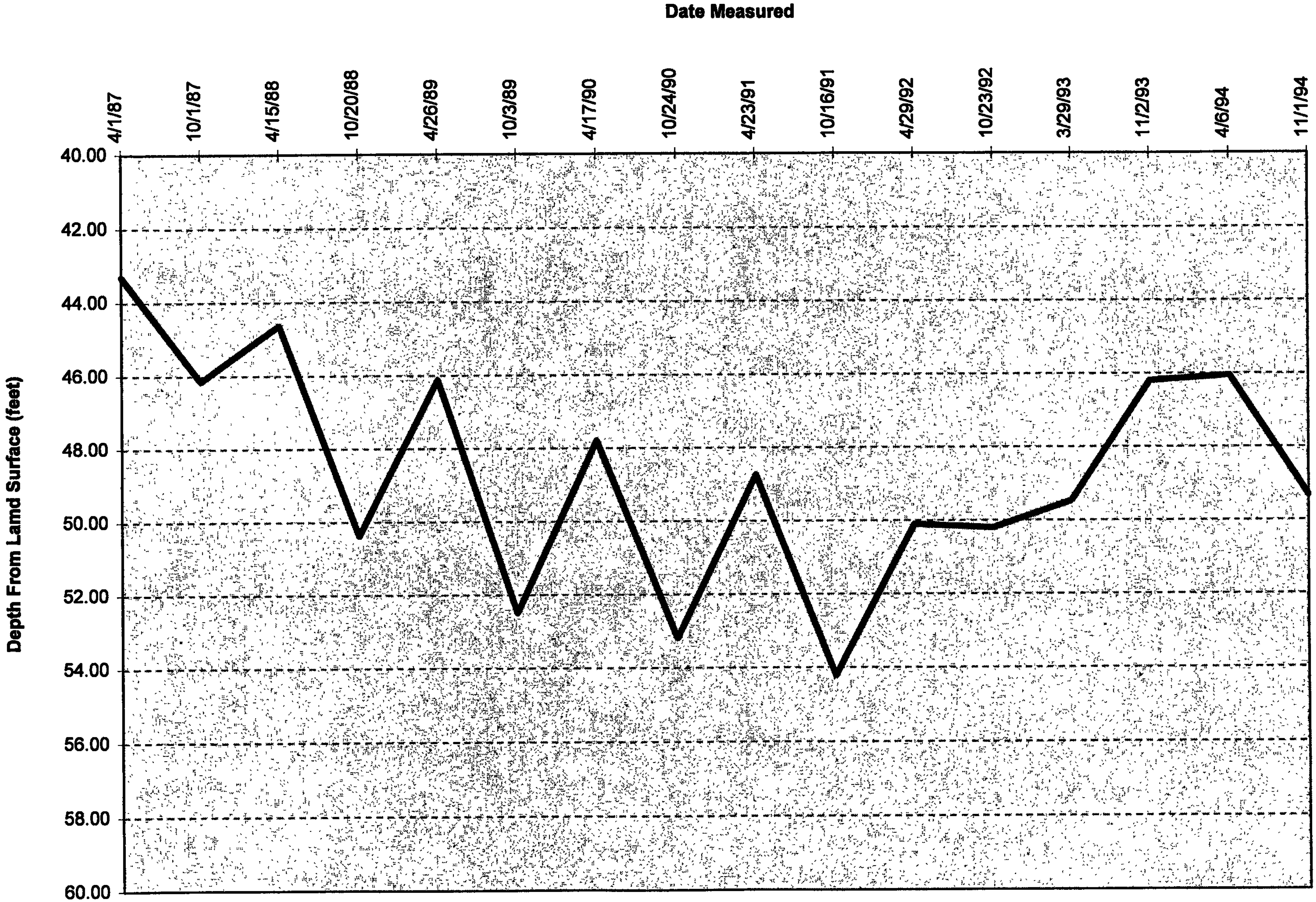
Water Table - the level below which the subsurface is saturated with water and at which the pressure head equals atmospheric pressure. A parameter associated with unconfined aquifers.

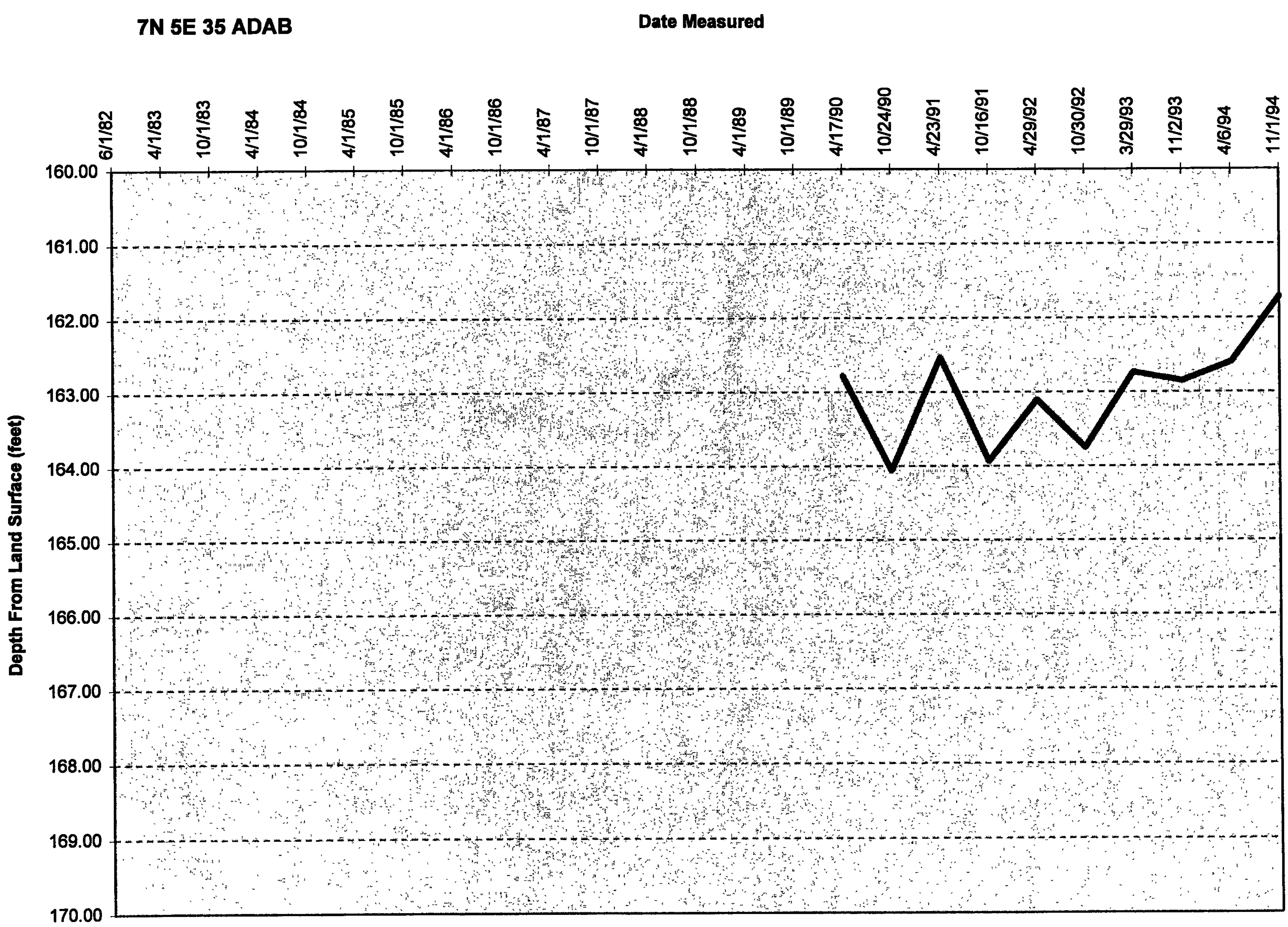
Zone of Saturation - porous earth materials, in which, all pore-spaces are filled with water.

APPENDIX B

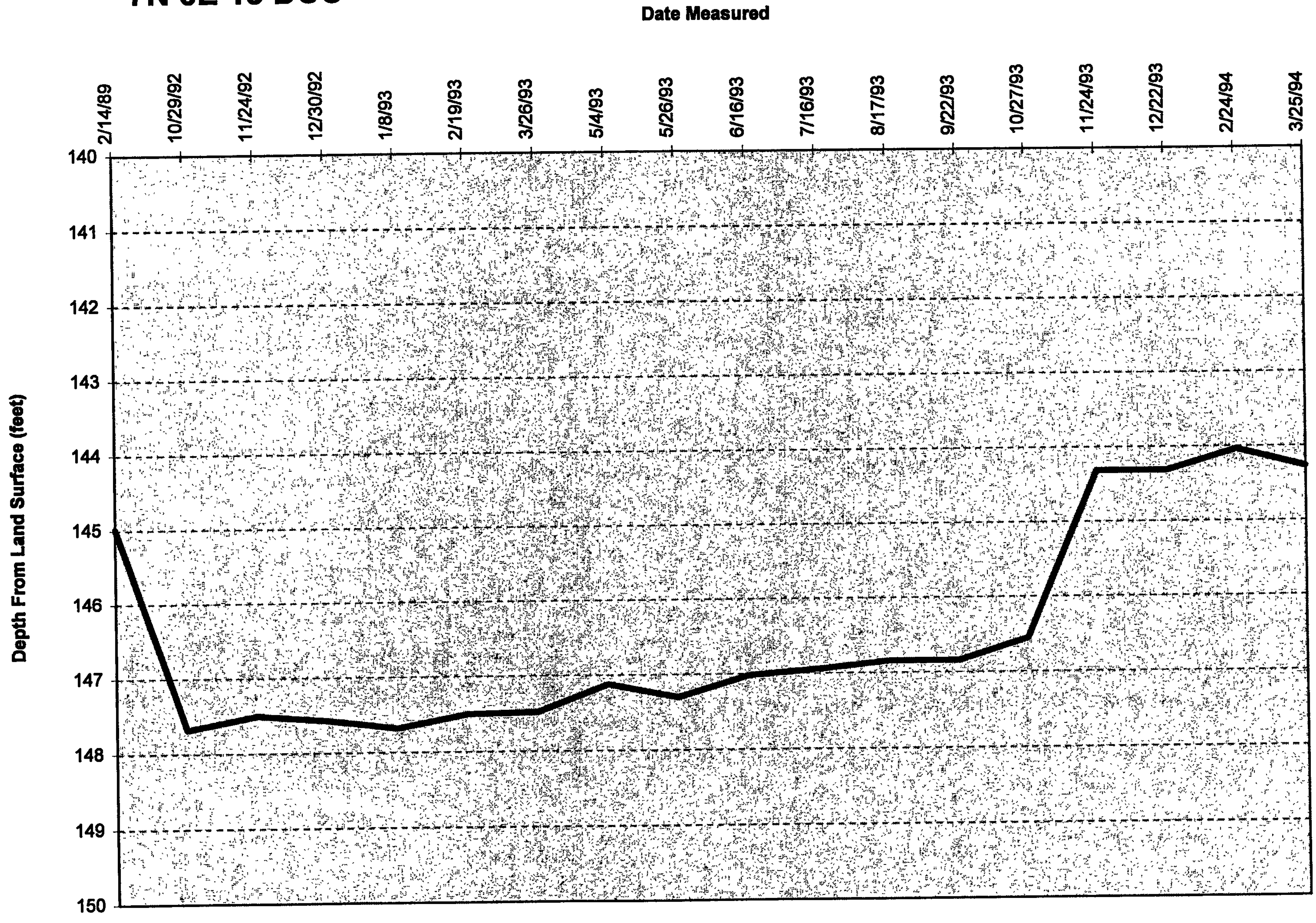
Hydrographs of LPS NRD Wells

7N 5E 22 ACC

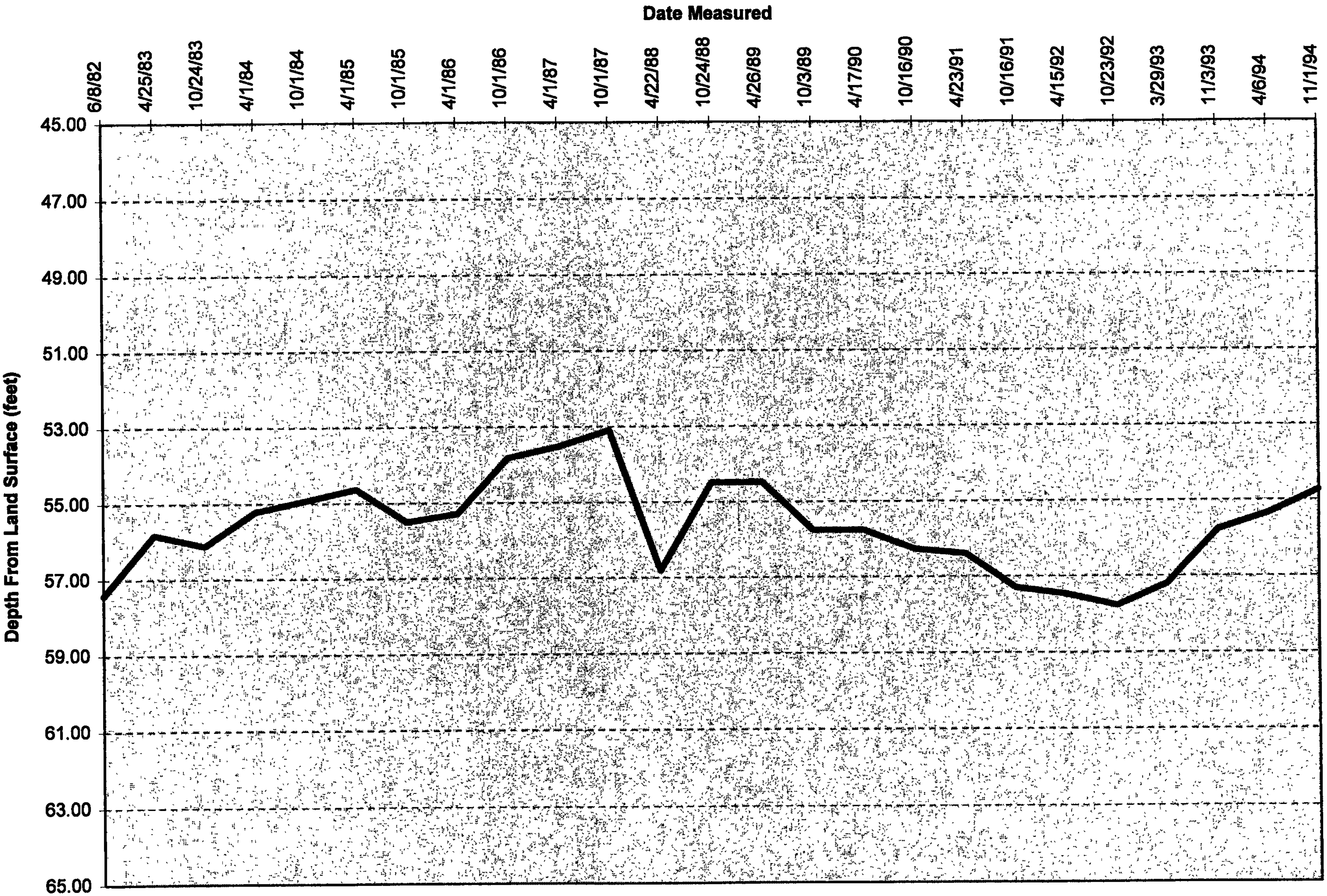

Date Measured
4/1/87
10/1/87
4/15/88
10/20/88
4/26/89
10/3/89
4/17/90
10/24/90
4/23/91
10/16/91
4/29/92
10/23/92
3/29/93
11/2/93
4/6/94
11/1/94
Depth From Lamd Surface (feet)
40.00
42.00
44.00
46.00
48.00
50.00
52.00
54.00
56.00
58.00
60.00


7N 5E 35 ADAB
Date Measured
Depth From Land Surface (feet)
160.00
161.00
162.00
163.00
164.00
165.00
166.00
167.00
168.00
169.00
170.00
6/1/82
4/1/83
10/1/83
4/1/84
10/1/84
4/1/85
10/1/85
4/1/86
10/1/86
4/1/87
10/1/87
4/1/88
10/1/88
4/1/89
10/1/89
4/17/90
10/24/90
4/23/91
10/16/91
4/29/92
10/30/92
3/29/93
11/2/93
4/6/94
11/1/94

7N 6E 15 DCC

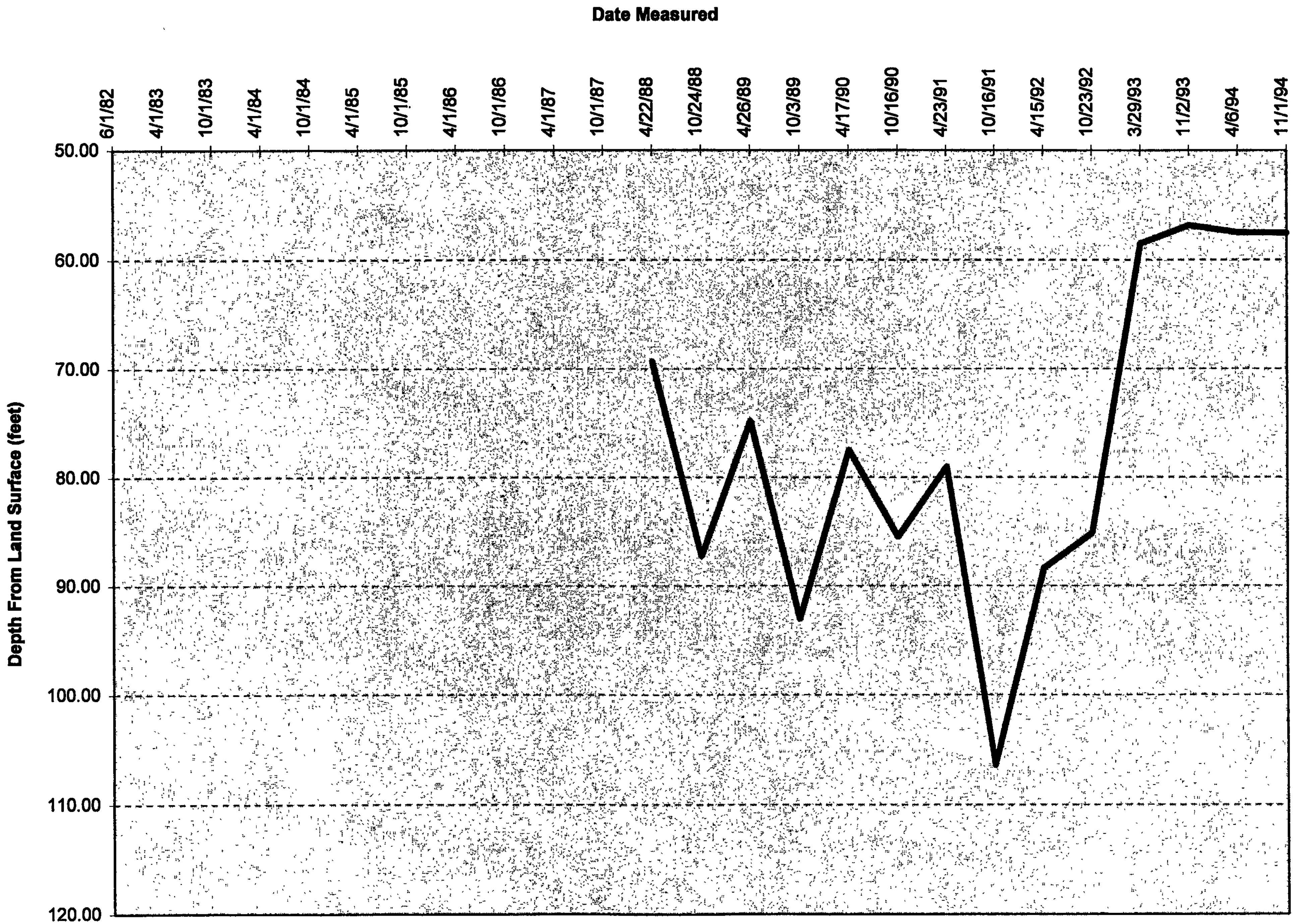

Date Measured
2/14/89
10/29/92
11/24/92
12/30/92
1/8/93
2/19/93
3/26/93
5/4/93
5/26/93
6/16/93
7/16/93
8/17/93
9/22/93
10/27/93
11/24/93
12/22/93
2/24/94
3/25/94
Depth From Land Surface (feet)
140
141
142
143
144
145
146
147
148
149
150

7N 7E 12 BDBA

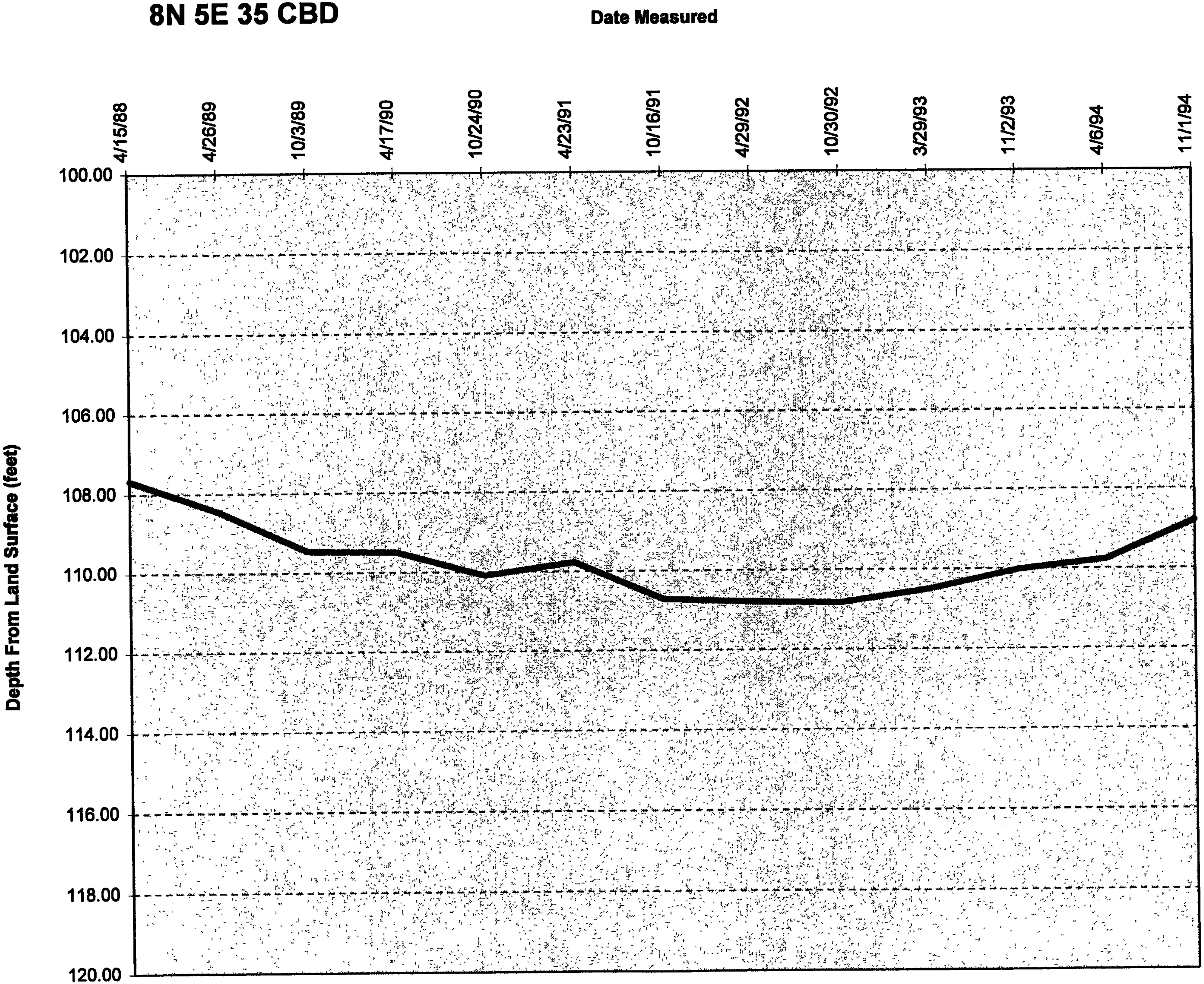


Date Measured
6/8/82
4/25/83
10/24/83
4/1/84
10/1/84
4/1/85
10/1/85
4/1/86
10/1/86
4/1/87
10/1/87
4/22/88
10/24/88
4/26/89
10/3/89
4/17/90
10/16/90
4/23/91
10/16/91
4/15/92
10/23/92
3/29/93
11/3/93
4/6/94
11/1/94
Depth From Land Surface (feet)
45.00
47.00
49.00
51.00
53.00
55.00
57.00
59.00
61.00
63.00
65.00

7N 7E 16 BAB

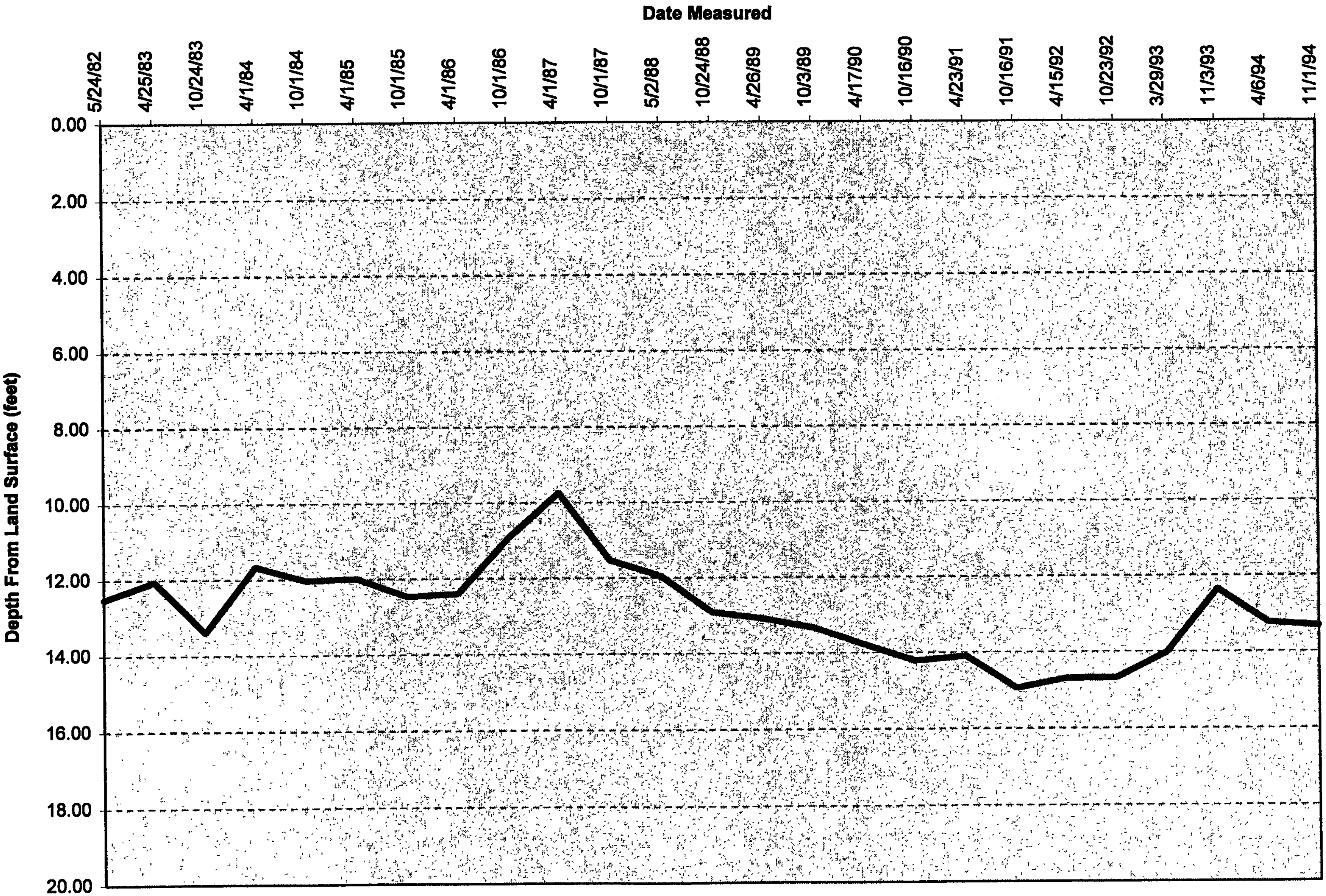

Date Measured
6/1/82
4/1/83
10/1/83
4/1/84
10/1/84
4/1/85
10/1/85
4/1/86
10/1/86
4/1/87
10/1/87
4/22/88
10/24/88
4/26/89
10/3/89
4/17/90
10/16/90
4/23/91
10/16/91
4/15/92
10/23/92
3/29/93
11/2/93
4/6/94
11/1/94
Depth From Land Surface (feet)
50.00
60.00
70.00
80.00
90.00
100.00
110.00
120.00

8N 5E 35 CBD



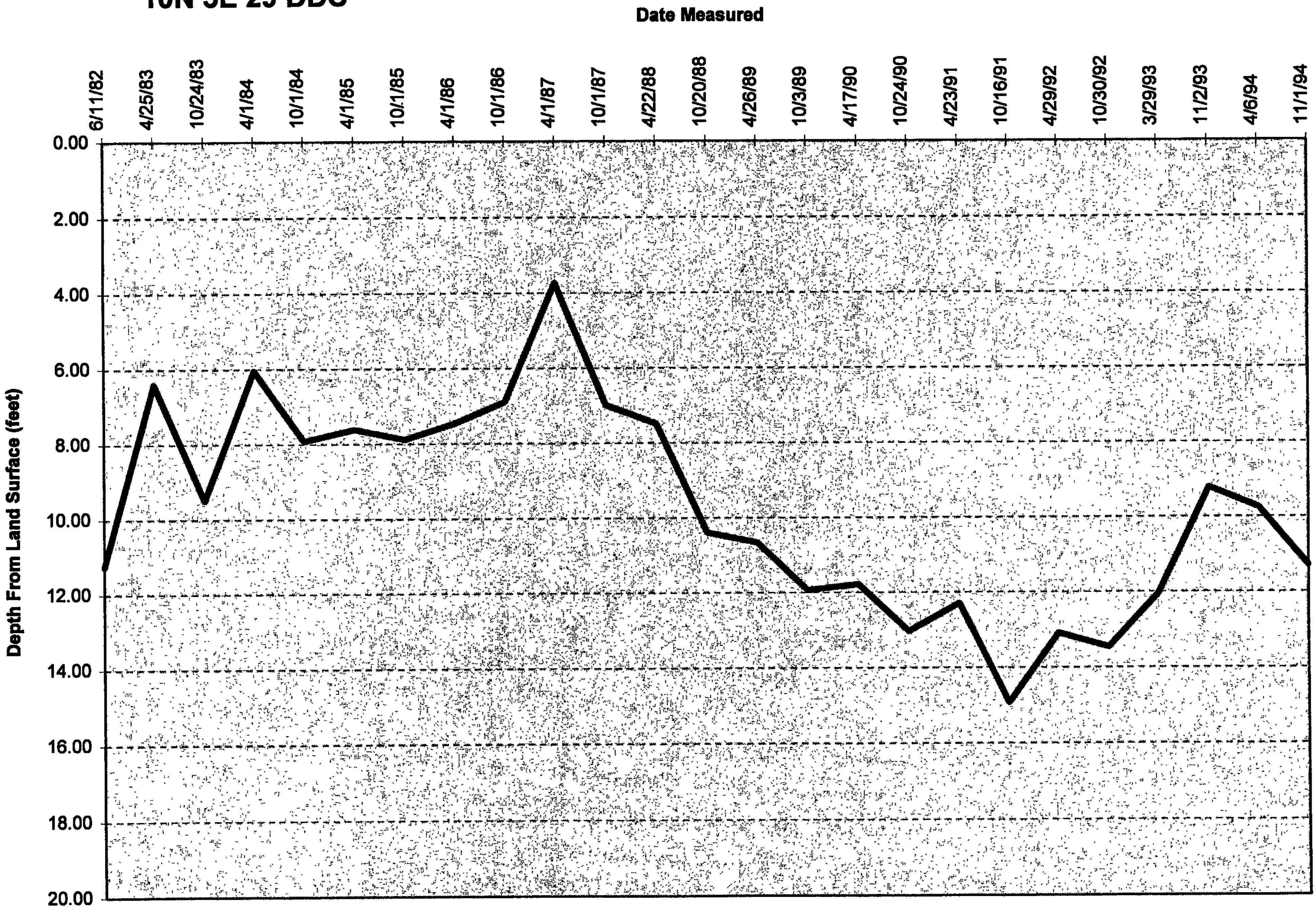
Date Measured
4/15/88
4/26/89
10/3/89
4/17/90
10/24/90
4/23/91
10/16/91
4/29/92
10/30/92
3/29/93
11/2/93
4/6/94
11/1/94
Depth From Land Surface (feet)
100.00
102.00
104.00
106.00
108.00
110.00
112.00
114.00
116.00
118.00
120.00

9N 6E 23 AAD

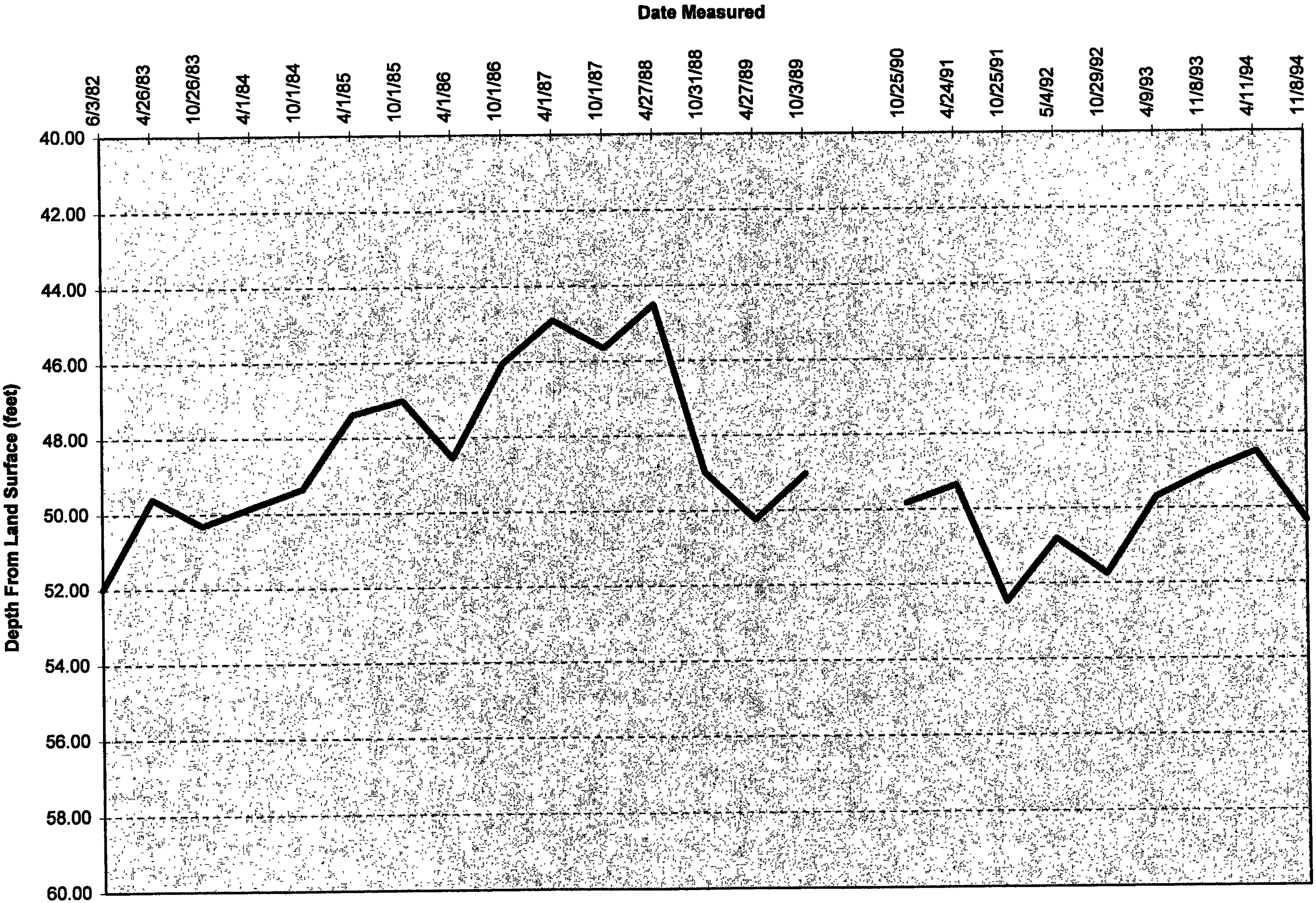


Date Measured
5/24/82
4/25/83
10/24/83
4/1/84
10/1/84
4/1/85
10/1/85
4/1/86
10/1/86
4/1/87
10/1/87
5/2/88
10/24/88
4/26/89
10/3/89
4/17/90
10/16/90
4/23/91
10/16/91
4/15/92
10/23/92
3/29/93
11/3/93
4/6/94
11/1/94
Depth From Land Surface (feet)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00

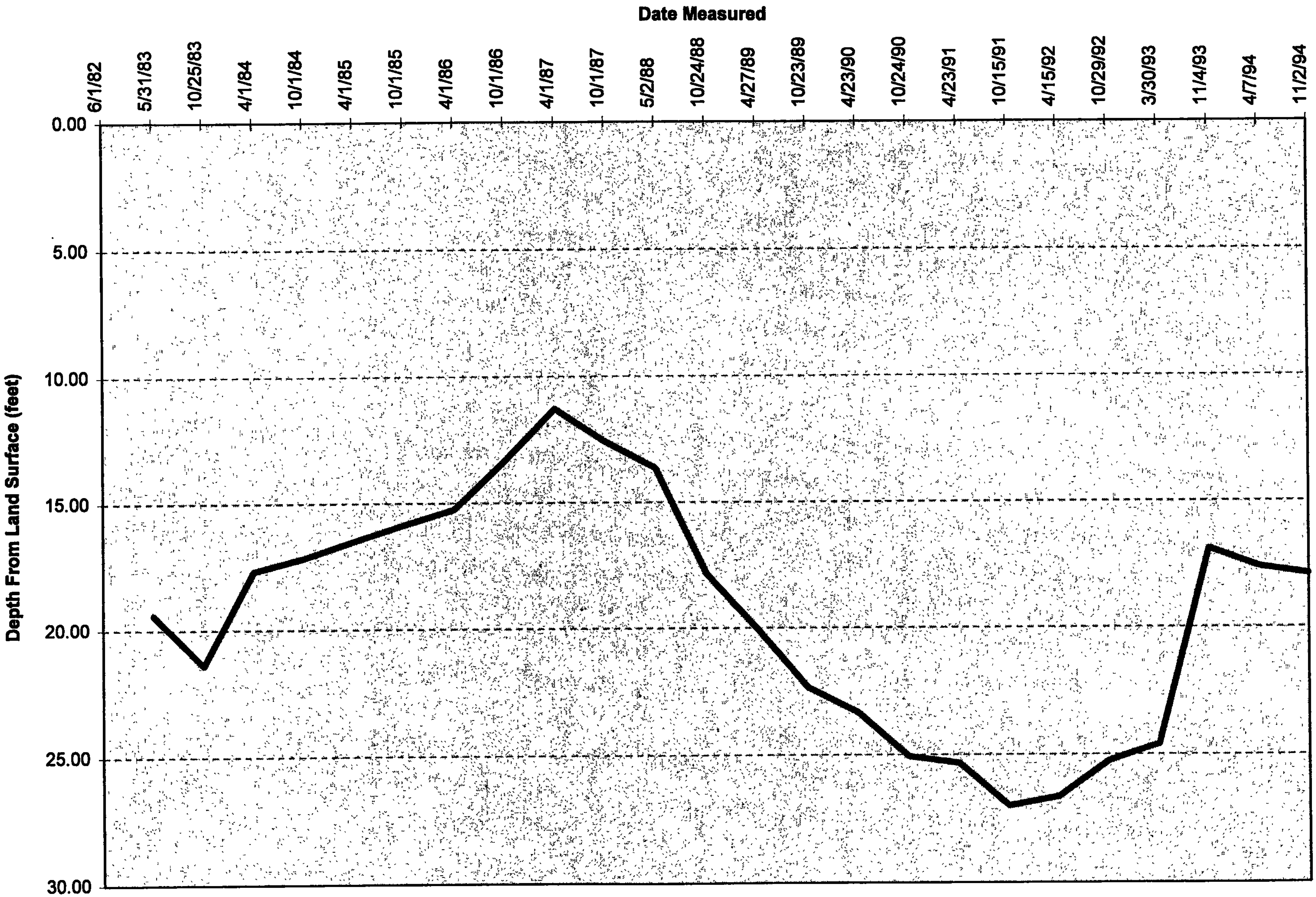
10N 5E 29 DDC

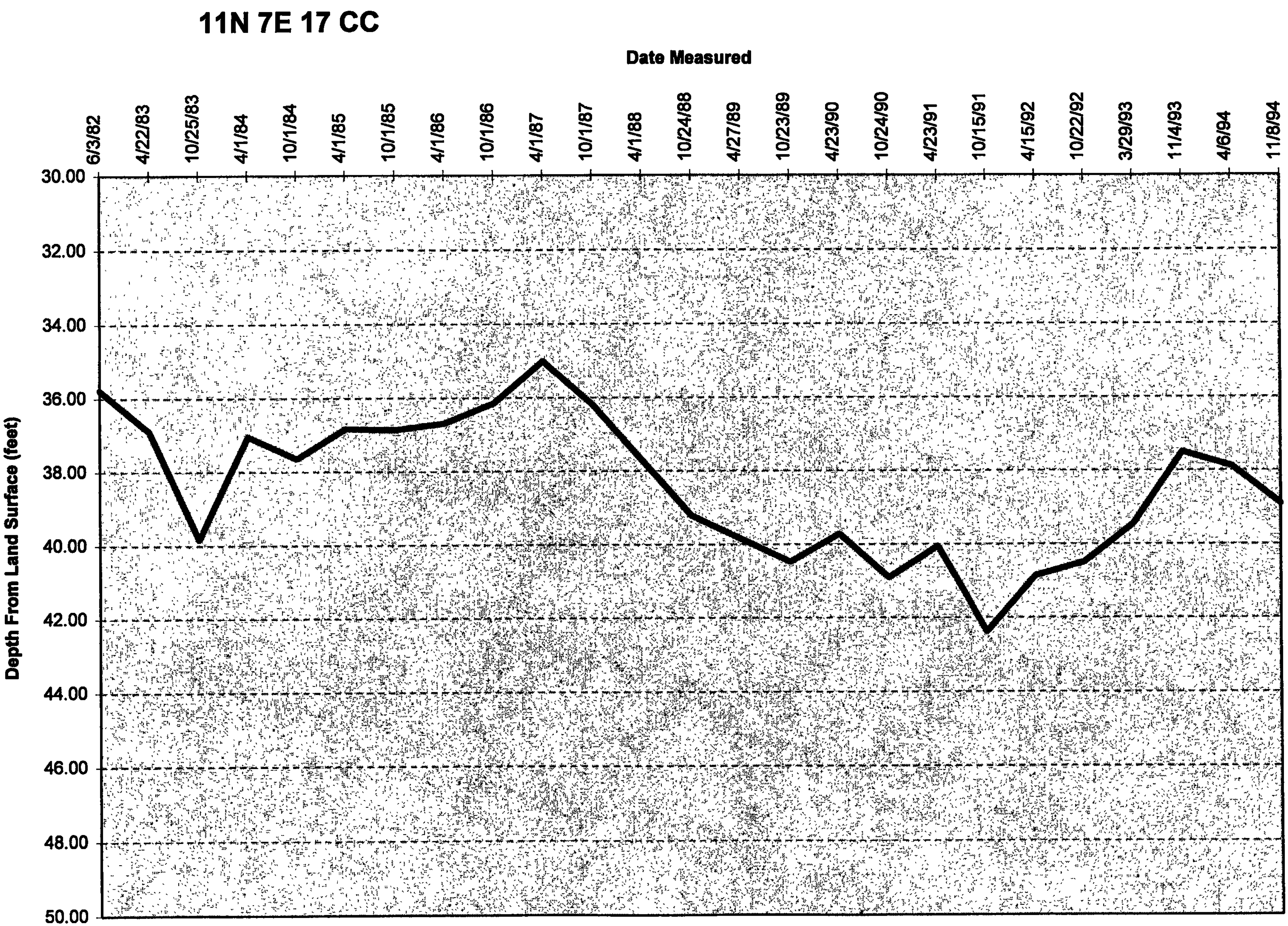

Date Measured
6/11/82
4/25/83
10/24/83
4/1/84
10/1/84
4/1/85
10/1/85
4/1/86
10/1/86
4/1/87
10/1/87
4/22/88
10/20/88
4/26/89
10/3/89
4/17/90
10/24/90
4/23/91
10/16/91
4/29/92
10/30/92
3/29/93
11/2/93
4/6/94
11/1/94
Depth From Land Surface (feet)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00

10N 7E 26 ABD

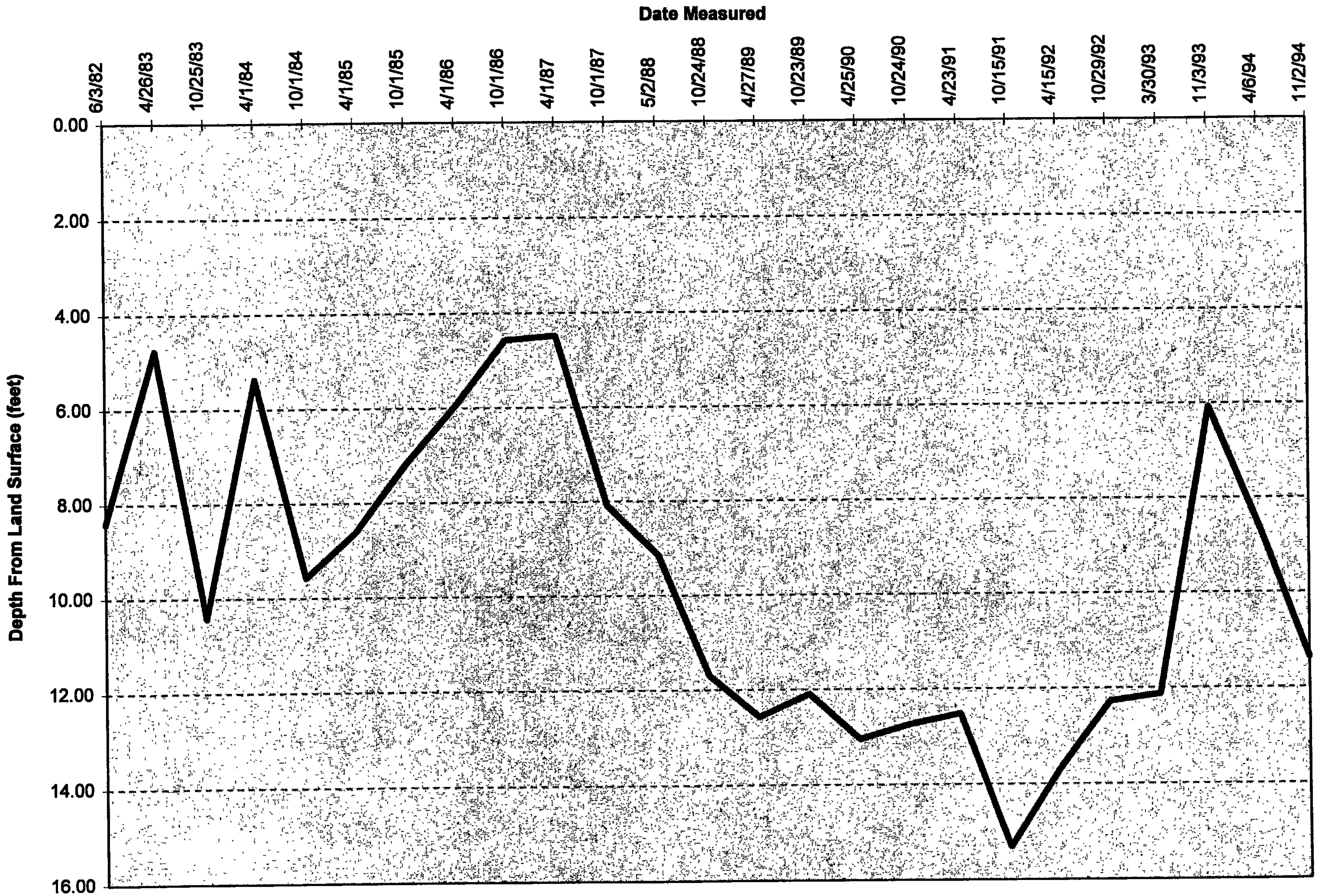

Date Measured
6/3/82
4/26/83
10/26/83
4/1/84
10/1/84
4/1/85
10/1/85
4/1/86
10/1/86
4/1/87
10/1/87
4/27/88
10/31/88
4/27/89
10/3/89
10/25/90
4/24/91
10/25/91
5/4/92
10/29/92
4/9/93
11/8/93
4/11/94
11/8/94
Depth From Land Surface (feet)
40.00
42.00
44.00
46.00
48.00
50.00
52.00
54.00
56.00
58.00
60.00

11N 7E 14 BBD


Date Measured
6/1/82
5/31/83
10/25/83
4/1/84
10/1/84
4/1/85
10/1/85
4/1/86
10/1/86
4/1/87
10/1/87
5/2/88
10/24/88
4/27/89
10/23/89
4/23/90
10/24/90
4/23/91
10/15/91
4/15/92
10/29/92
3/30/93
11/4/93
4/7/94
11/2/94
Depth From Land Surface (feet)
0.00
5.00
10.00
15.00
20.00
25.00
30.00

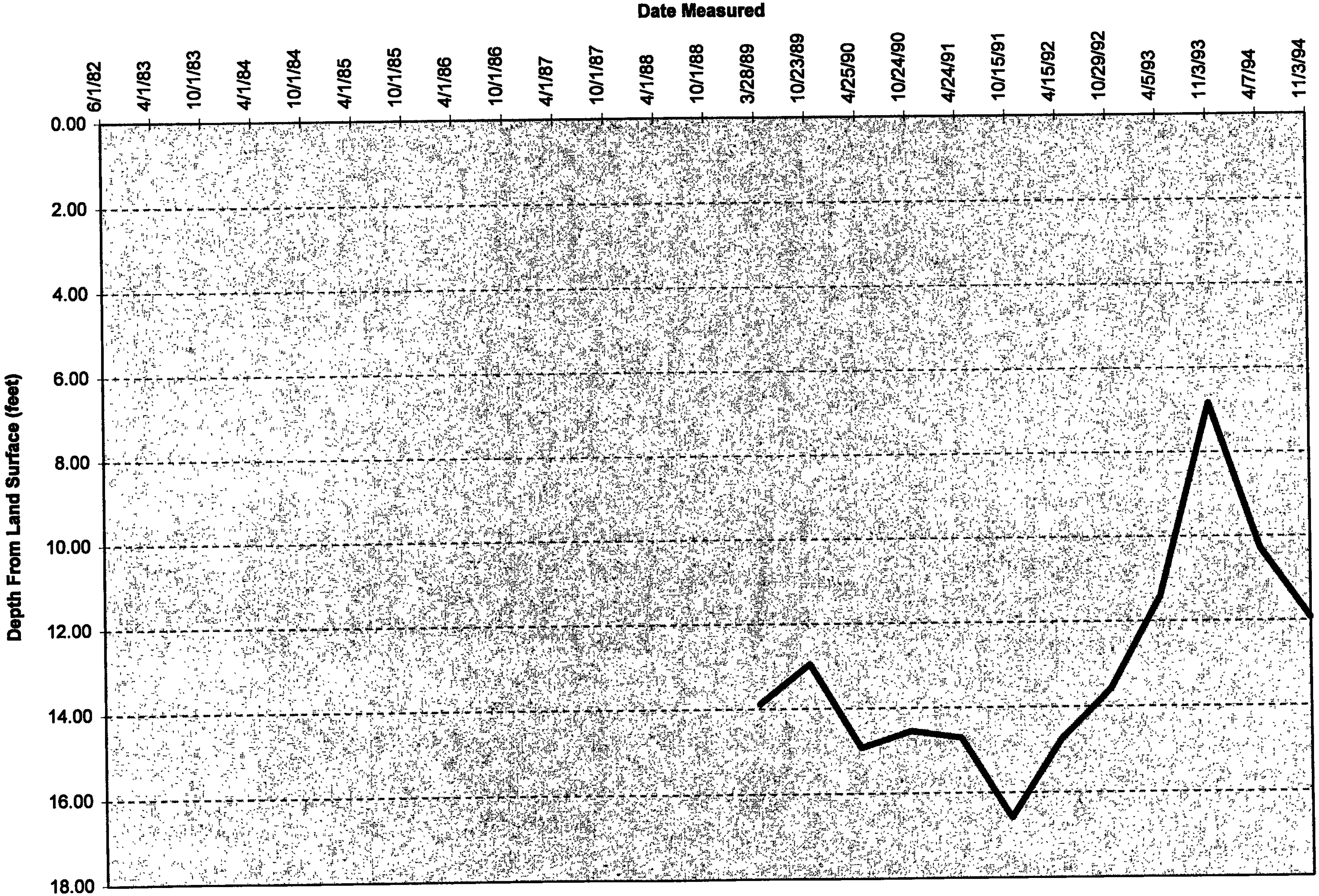

11N 7E 17 CC
Date Measured
6/3/82
4/22/83
10/25/83
4/1/84
10/1/84
4/1/85
10/1/85
4/1/86
10/1/86
4/1/87
10/1/87
4/1/88
10/24/88
4/27/89
10/23/89
4/23/90
10/24/90
4/23/91
10/15/91
4/15/92
10/22/92
3/29/93
11/4/93
4/6/94
11/8/94
Depth From Land Surface (feet)
30.00
32.00
34.00
36.00
38.00
40.00
42.00
44.00
46.00
48.00
50.00

11N 7E 25 DA

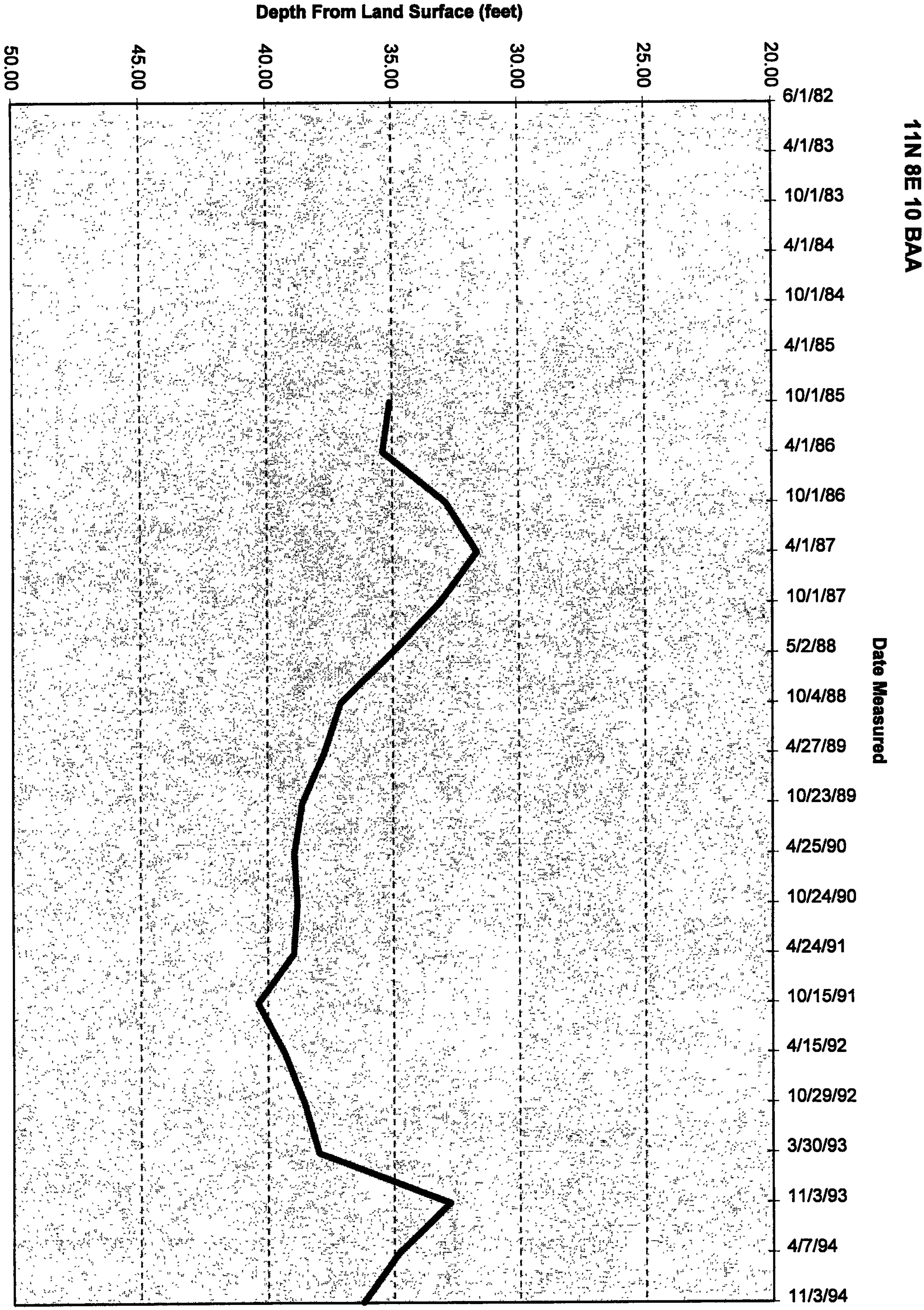


Date Measured
6/3/82
4/26/83
10/25/83
4/1/84
10/1/84
4/1/85
10/1/85
4/1/86
10/1/86
4/1/87
10/1/87
5/2/88
10/24/88
4/27/89
10/23/89
4/25/90
10/24/90
4/23/91
10/15/91
4/15/92
10/29/92
3/30/93
11/3/93
4/6/94
11/2/94
Depth From Land Surface (feet)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00

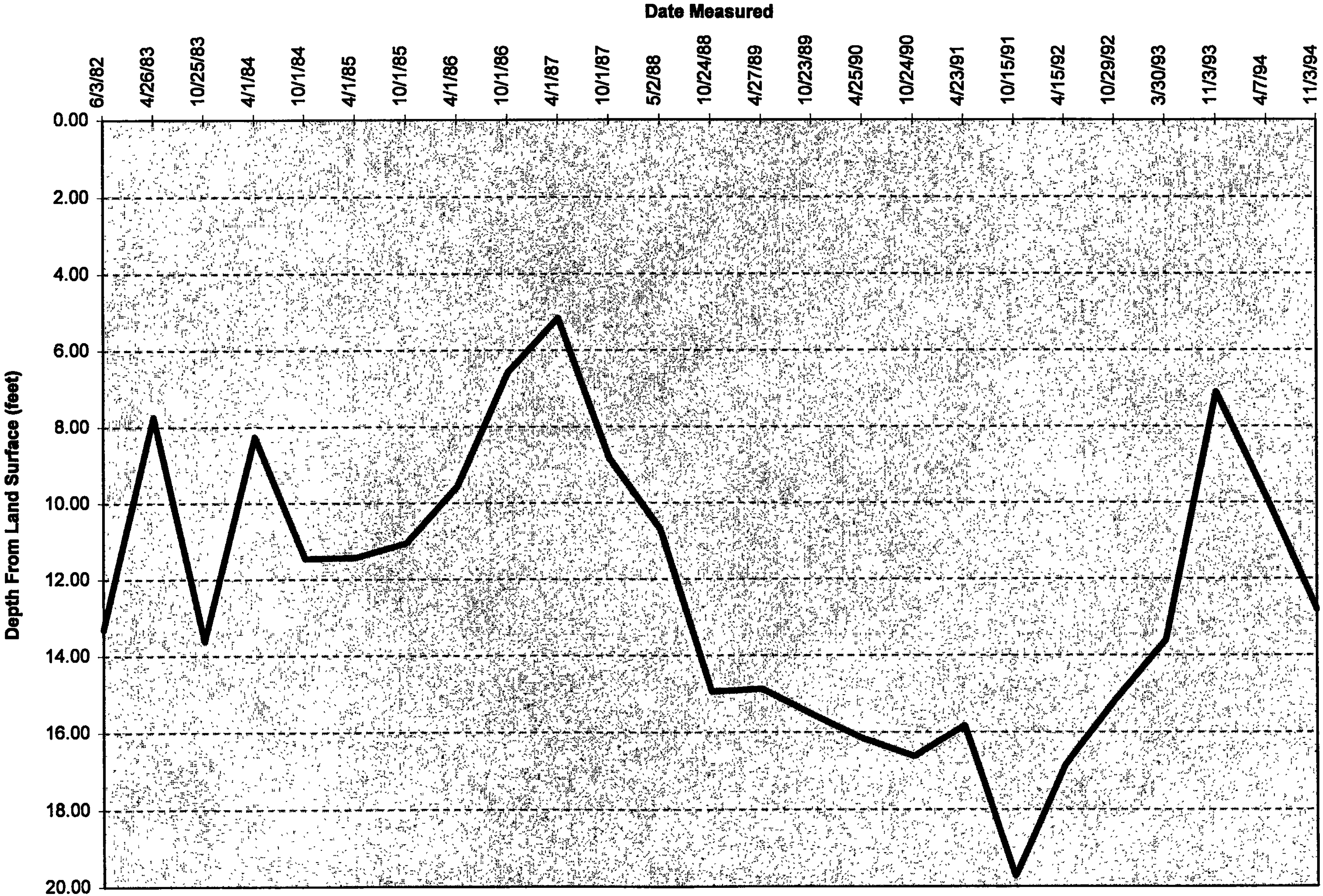
11N 8E 2 DC



Date Measured
6/1/82
4/1/83
10/1/83
4/1/84
10/1/84
4/1/85
10/1/85
4/1/86
10/1/86
4/1/87
10/1/87
4/1/88
10/1/88
3/28/89
10/23/89
4/25/90
10/24/90
4/24/91
10/15/91
4/15/92
10/29/92
4/5/93
11/3/93
4/7/94
11/3/94
Depth From Land Surface (feet)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00

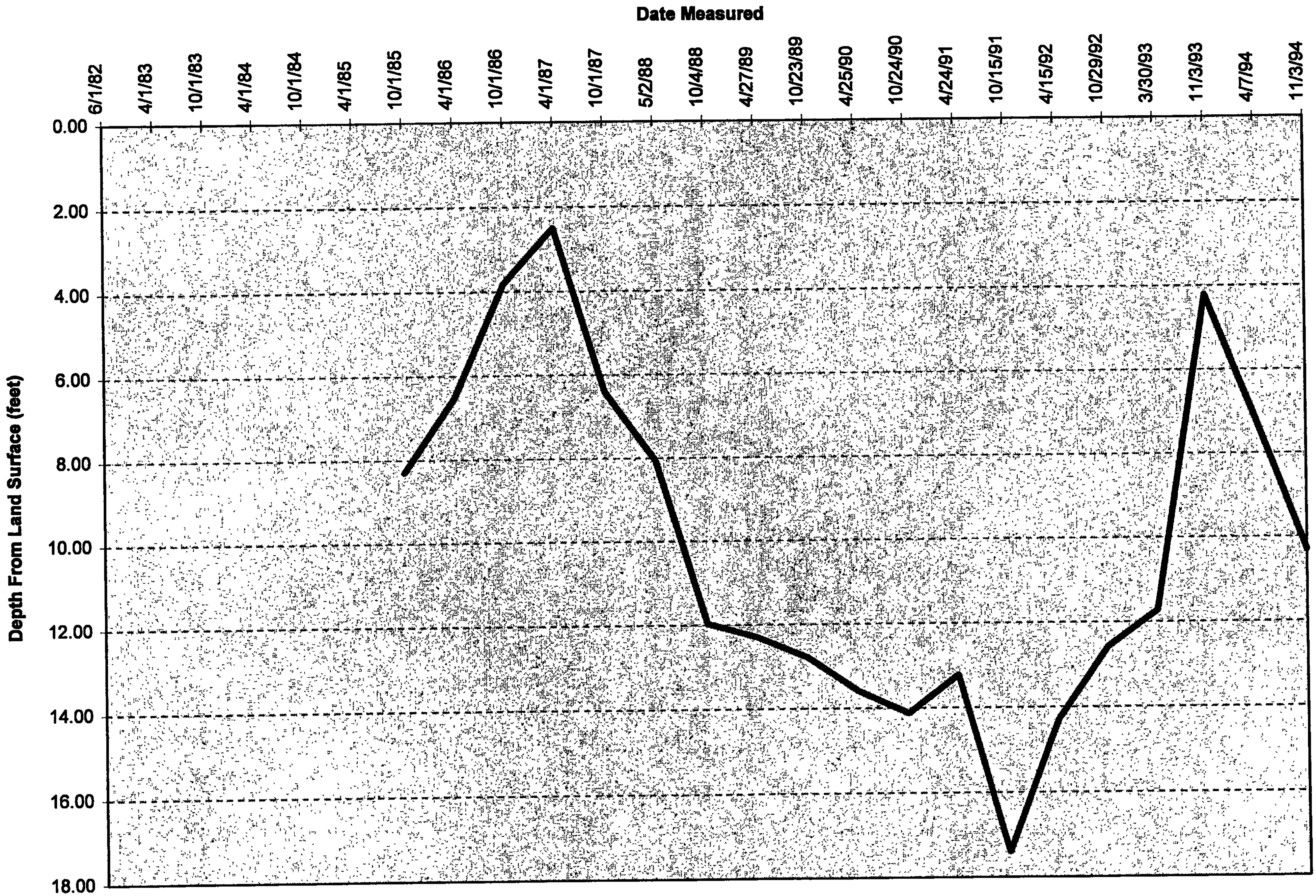

11N 8E 10 BAA
Depth From Land Surface (feet)
50.00
45.00
40.00
35.00
30.00
25.00
20.00
Date Measured
6/1/82
4/1/83
10/1/83
4/1/84
10/1/84
4/1/85
10/1/85
4/1/86
10/1/86
4/1/87
10/1/87
5/2/88
10/4/88
4/27/89
10/23/89
4/25/90
10/24/90
4/24/91
10/15/91
4/15/92
10/29/92
3/30/93
11/3/93
4/7/94
11/3/94

11N 8E 11 DCD

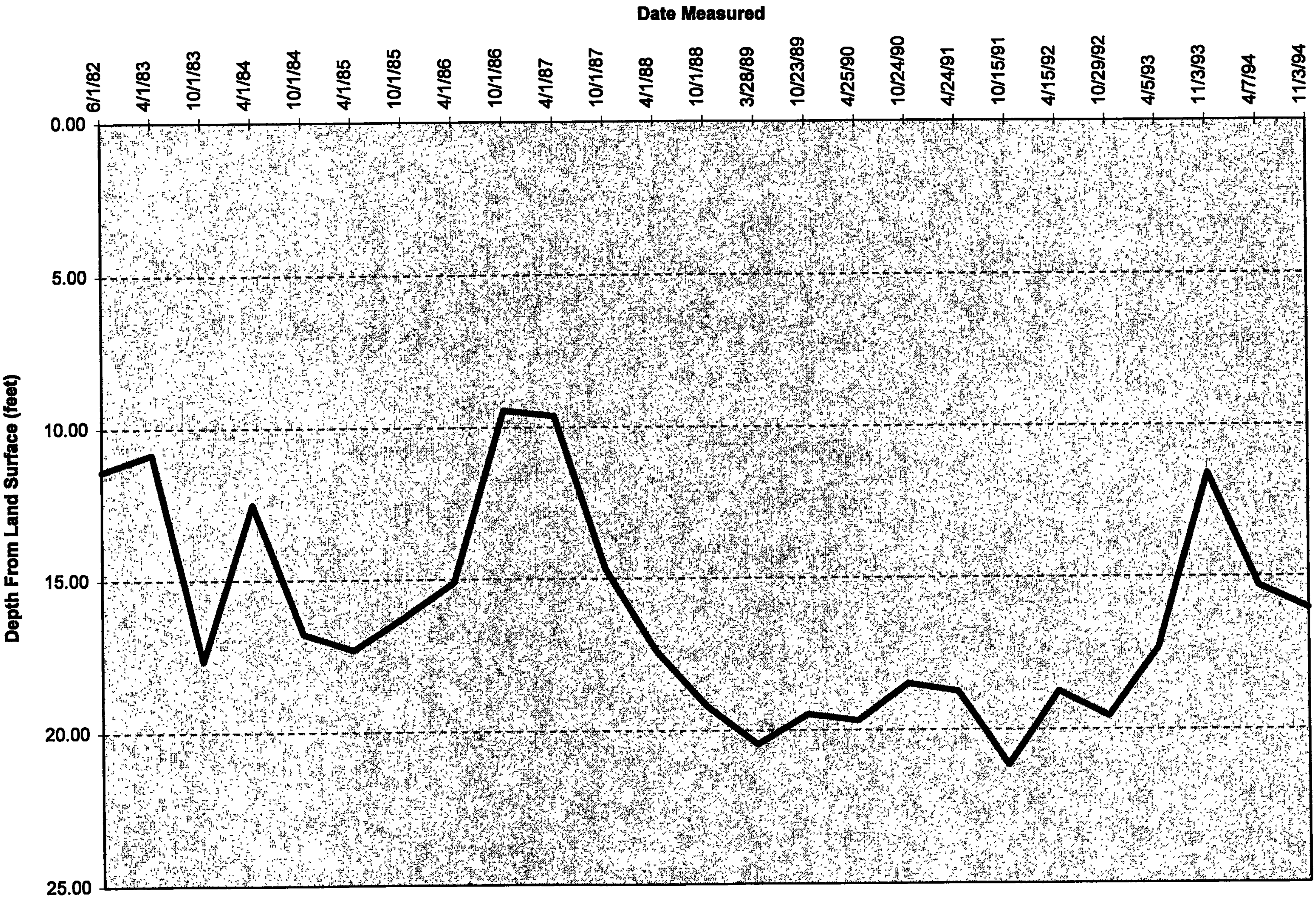


Date Measured
6/3/82
4/26/83
10/25/83
4/1/84
10/1/84
4/1/85
10/1/85
4/1/86
10/1/86
4/1/87
10/1/87
5/2/88
10/24/88
4/27/89
10/23/89
4/25/90
10/24/90
4/23/91
10/15/91
4/15/92
10/29/92
3/30/93
11/3/93
4/7/94
11/3/94
Depth From Land Surface (feet)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00

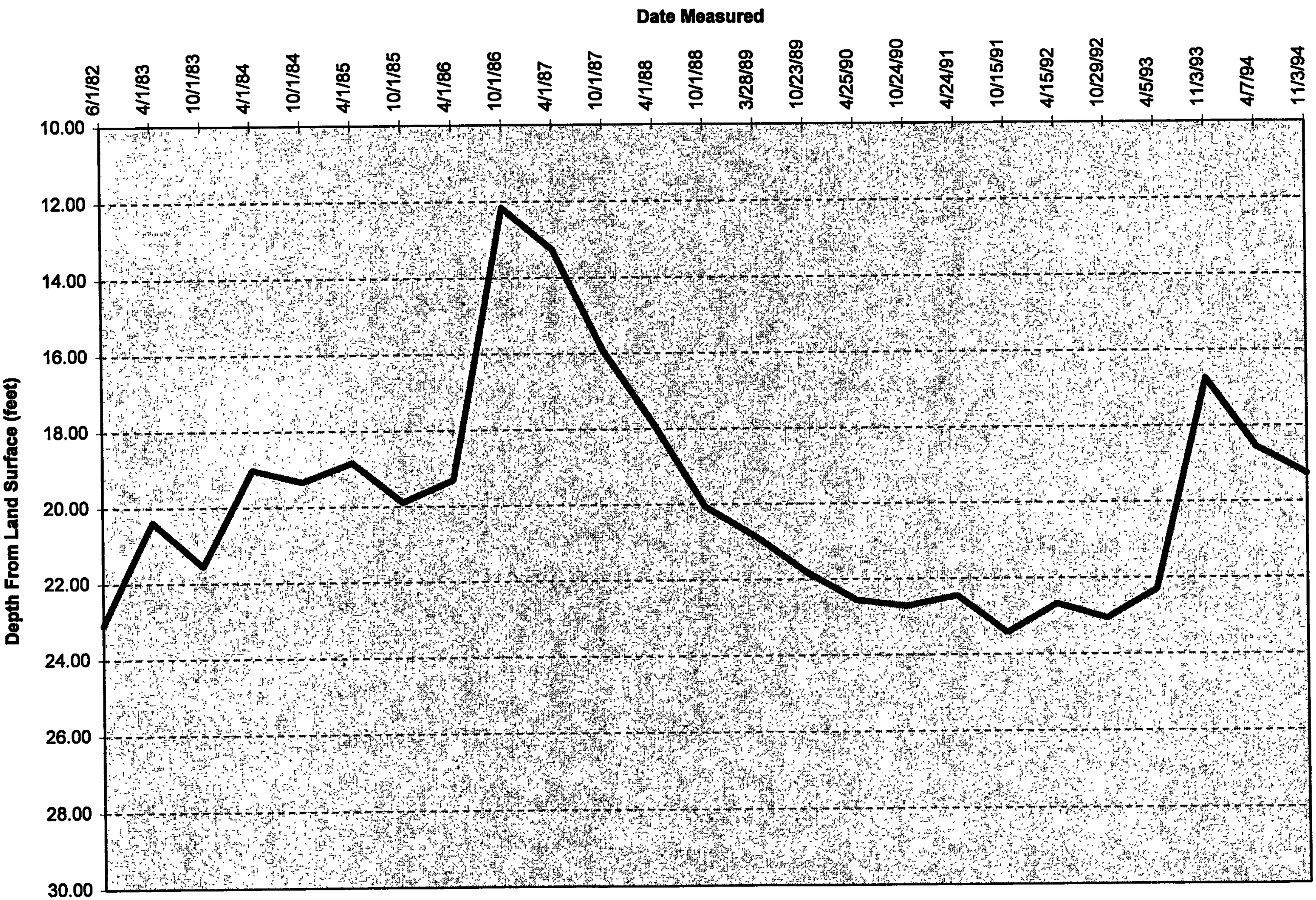
11N 8E 14 BBDA



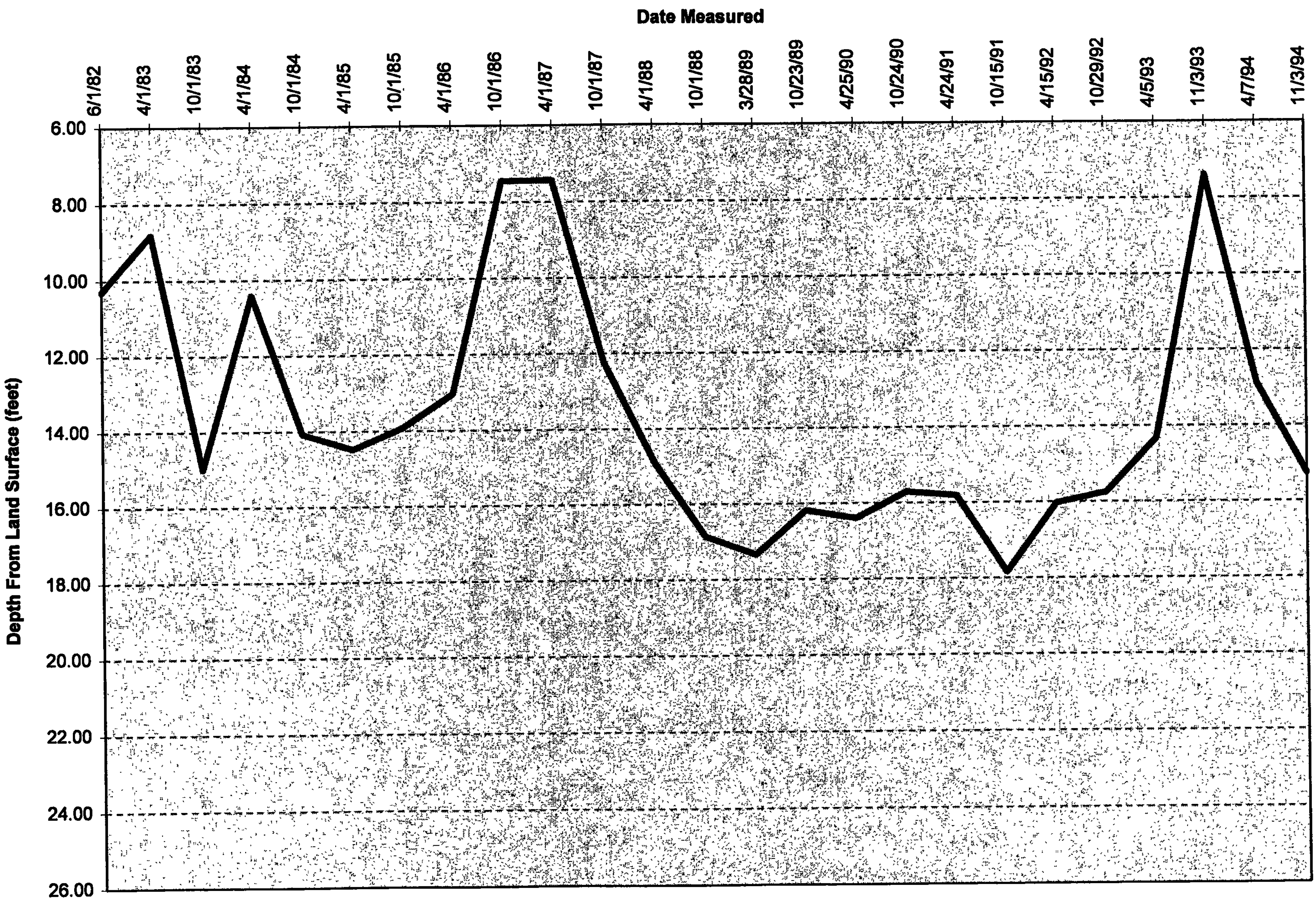
12N 8E 36 ADCD



12N 9E 22 AA

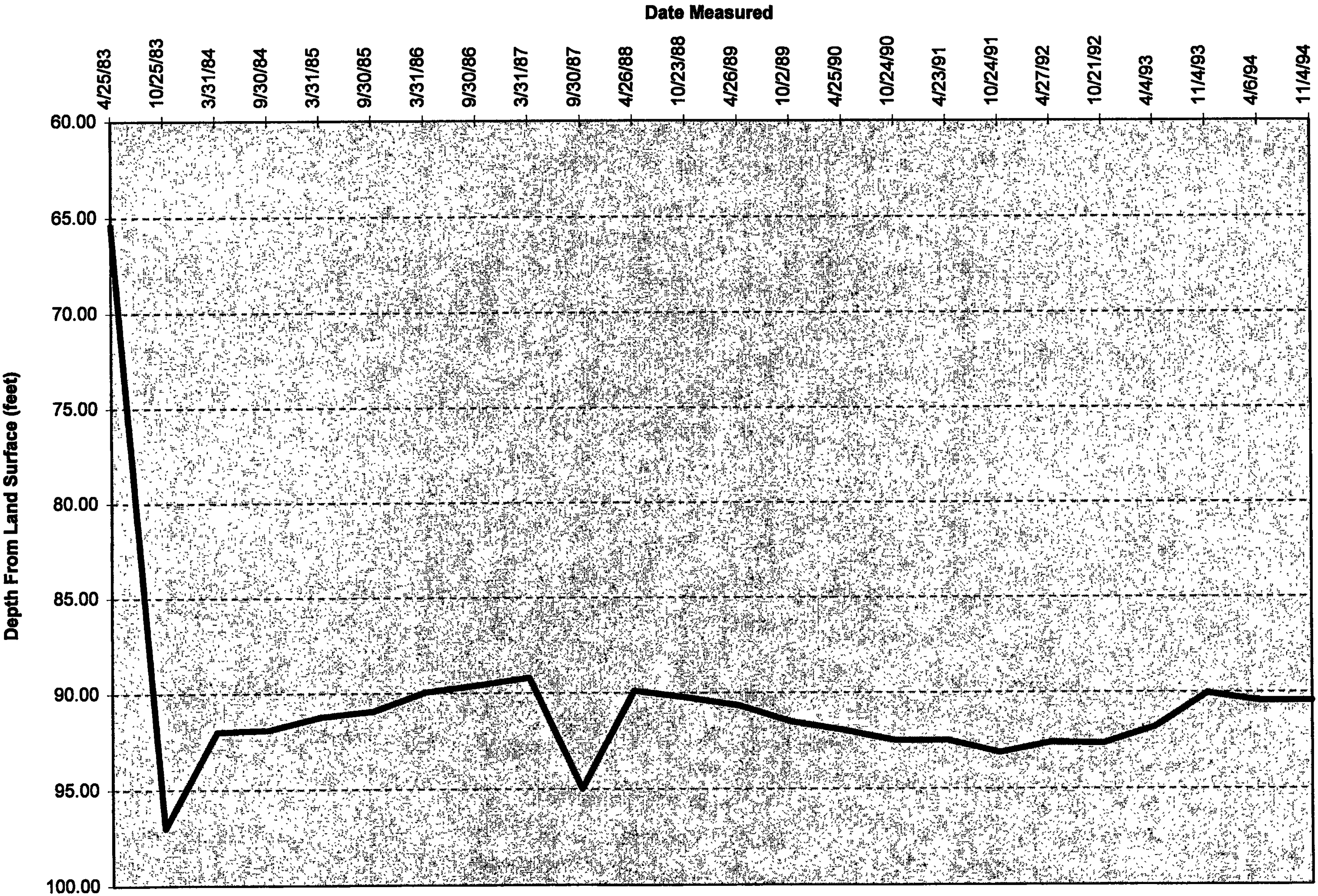

Date Measured
6/1/82
4/1/83
10/1/83
4/1/84
10/1/84
4/1/85
10/1/85
4/1/86
10/1/86
4/1/87
10/1/87
4/1/88
10/1/88
3/28/89
10/23/89
4/25/90
10/24/90
4/24/91
10/15/91
4/15/92
10/29/92
4/5/93
11/3/93
4/7/94
11/3/94
Depth From Land Surface (feet)
10.00
12.00
14.00
16.00
18.00
20.00
22.00
24.00
26.00
28.00
30.00

12N 9E 31 CBB

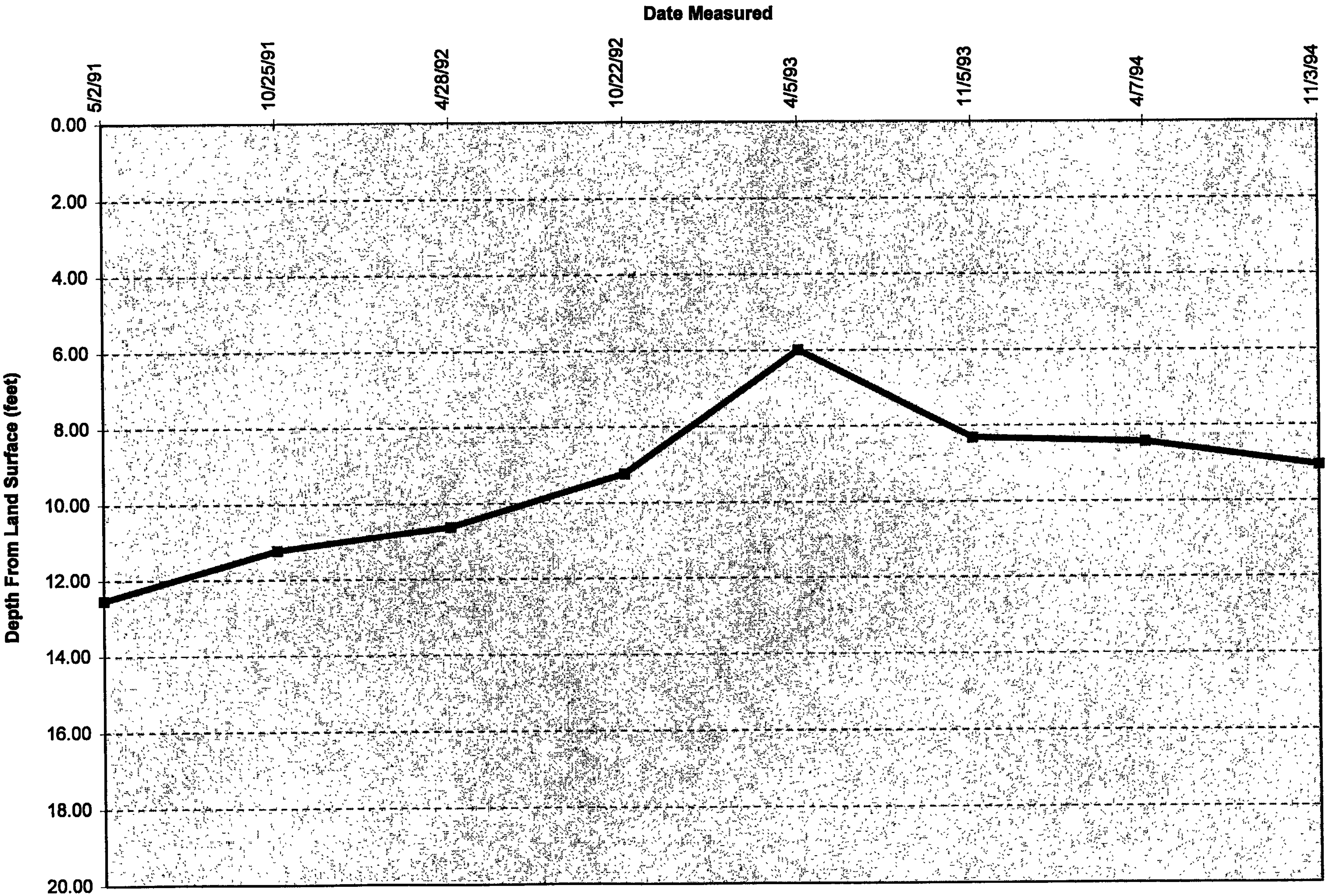


Date Measured
6/1/82
4/1/83
10/1/83
4/1/84
10/1/84
4/1/85
10/1/85
4/1/86
10/1/86
4/1/87
10/1/87
4/1/88
10/1/88
3/28/89
10/23/89
4/25/90
10/24/90
4/24/91
10/15/91
4/15/92
10/29/92
4/5/93
11/3/93
4/7/94
11/3/94
Depth From Land Surface (feet)
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
22.00
24.00
26.00

10N 10E 17 BAA

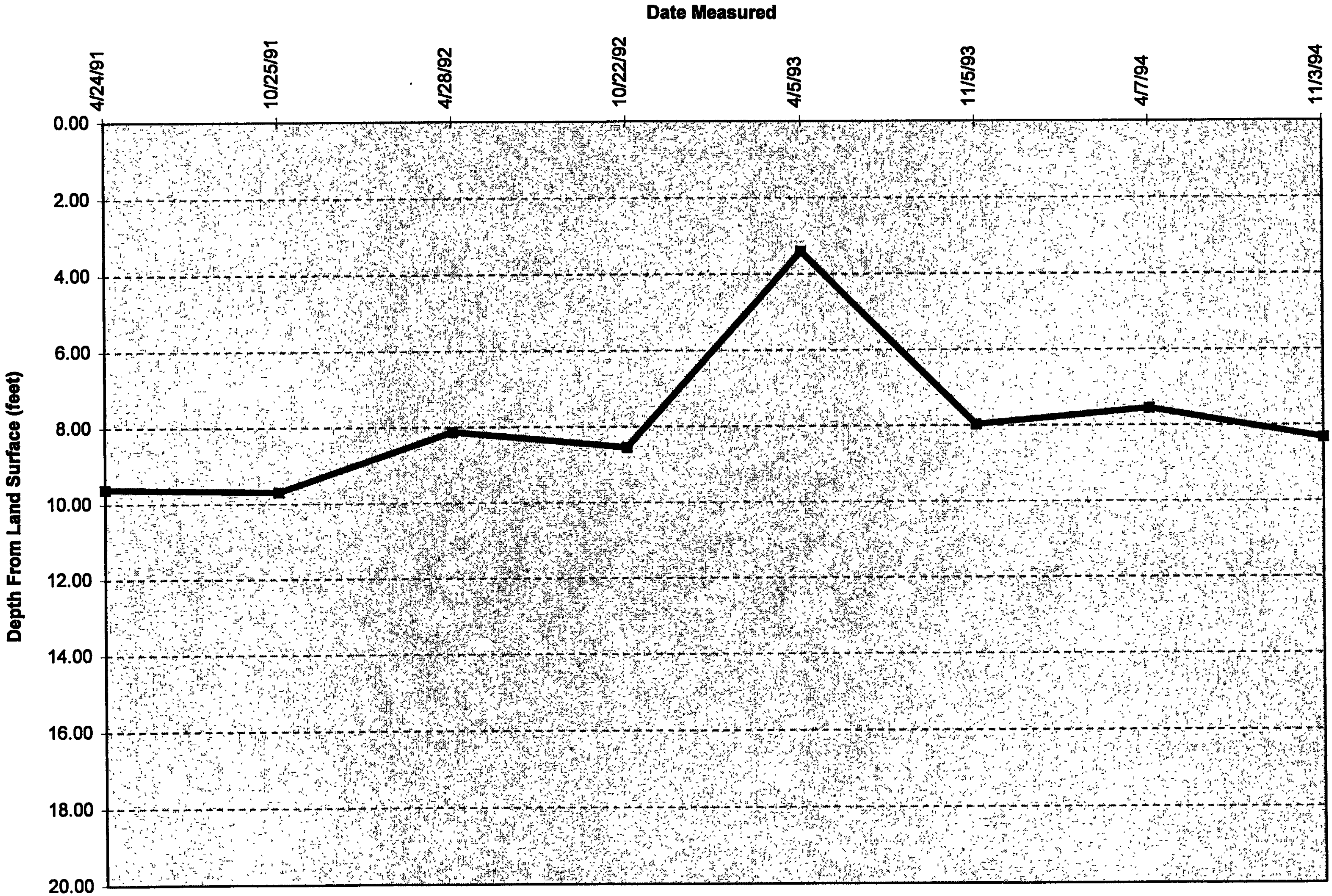


10N 14E 16 BB

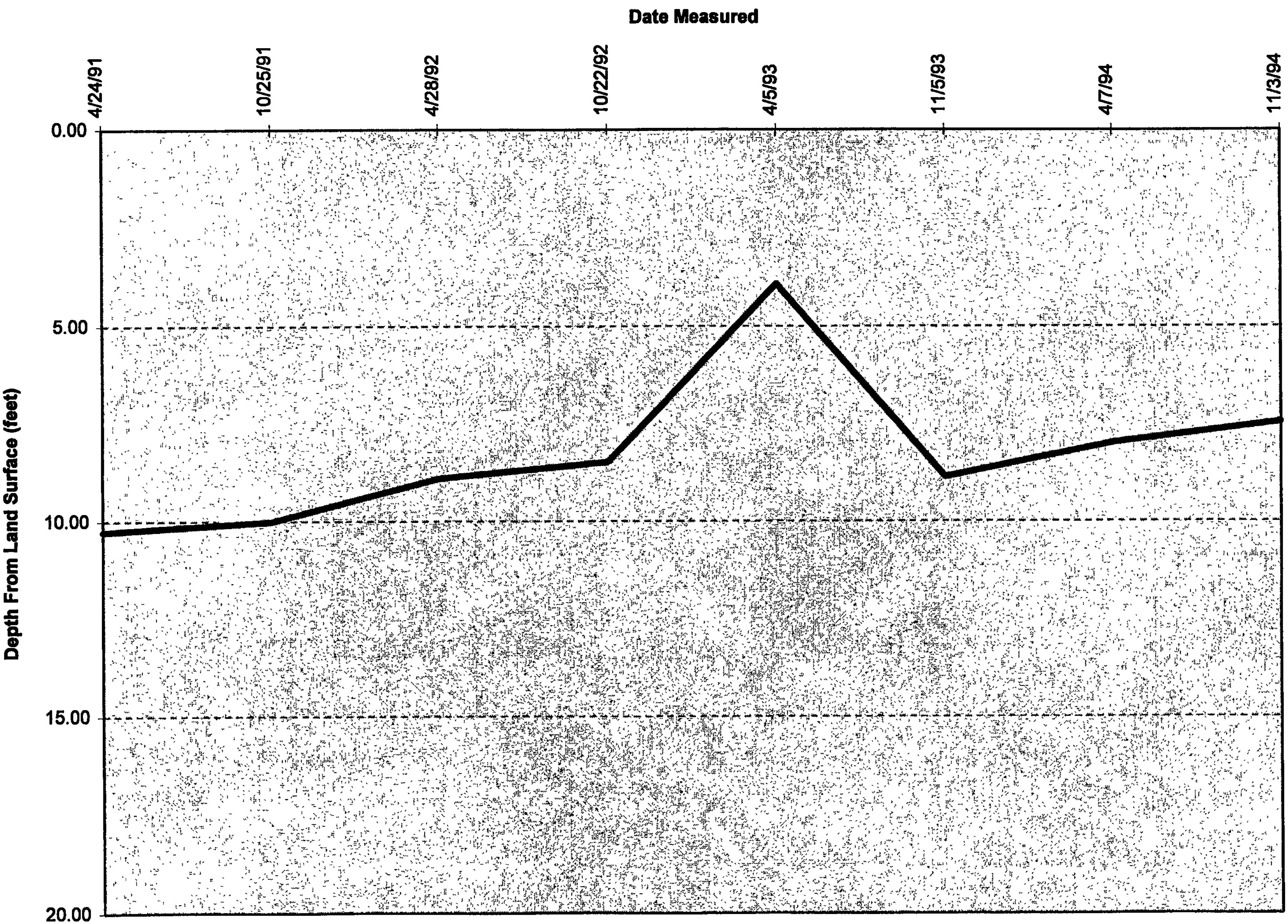


Date Measured
5/2/91
10/25/91
4/28/92
10/22/92
4/5/93
11/5/93
4/7/94
11/3/94
Depth From Land Surface (feet)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00

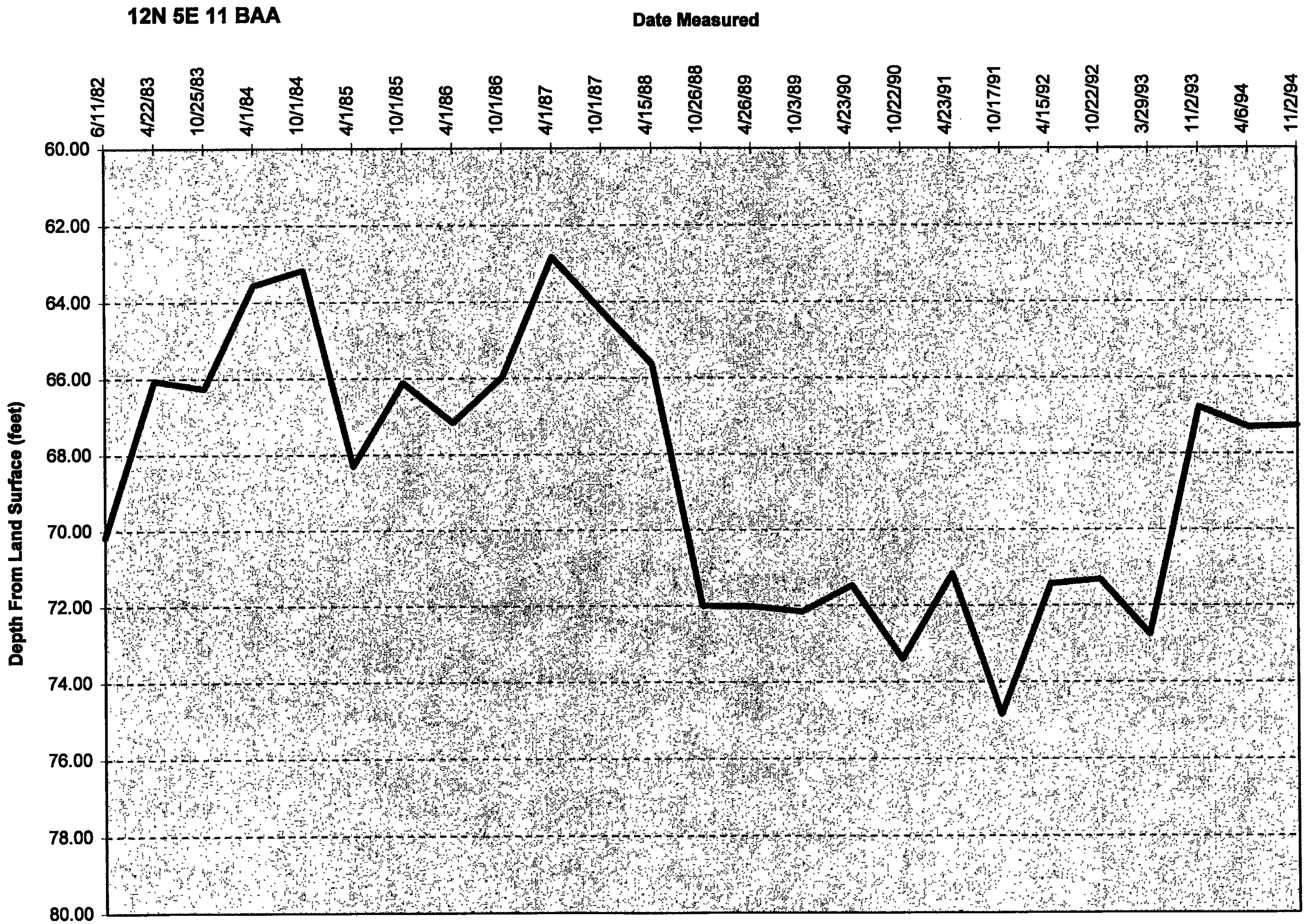
10N 14E 21 CDA

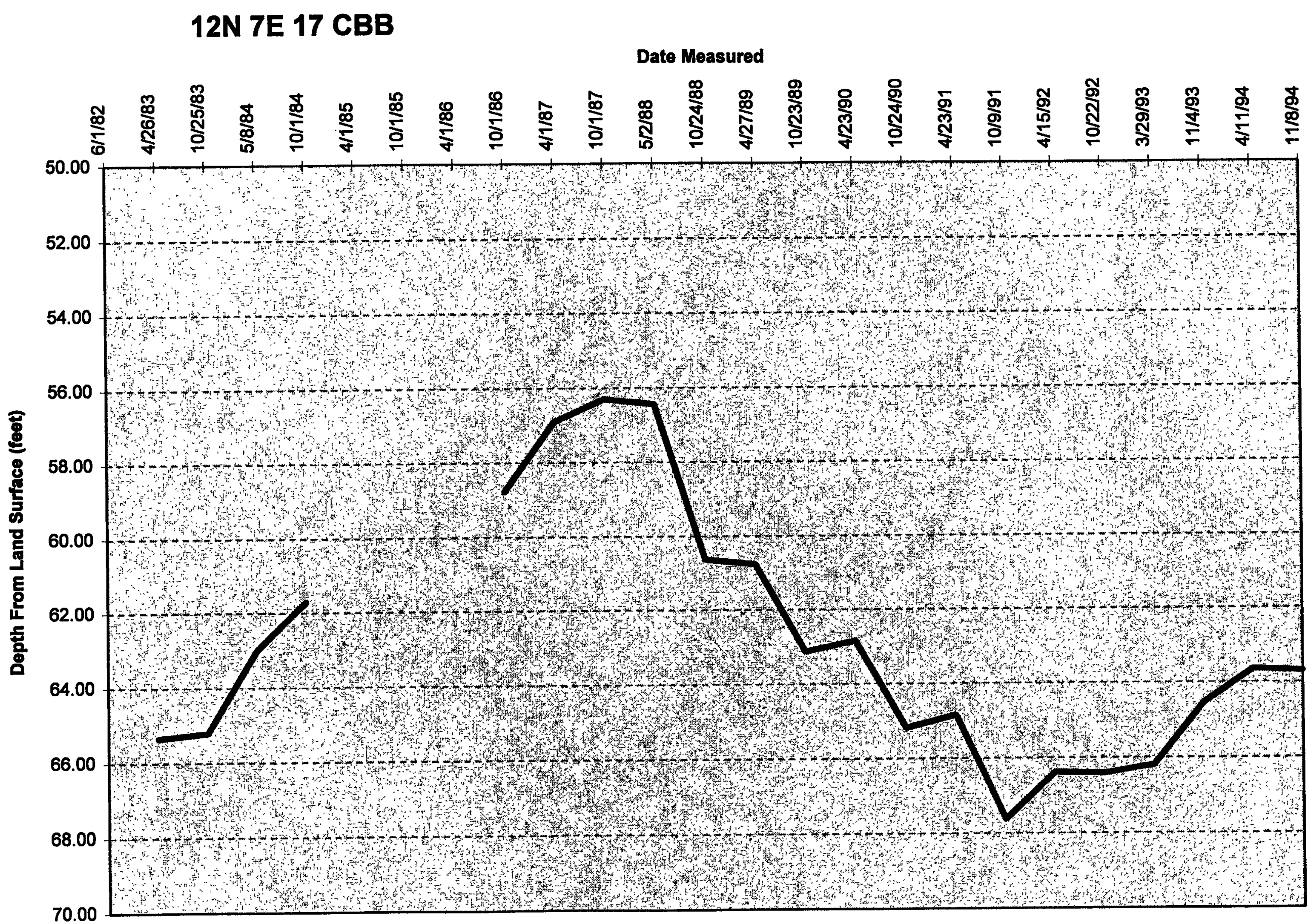


11-14-27 AA



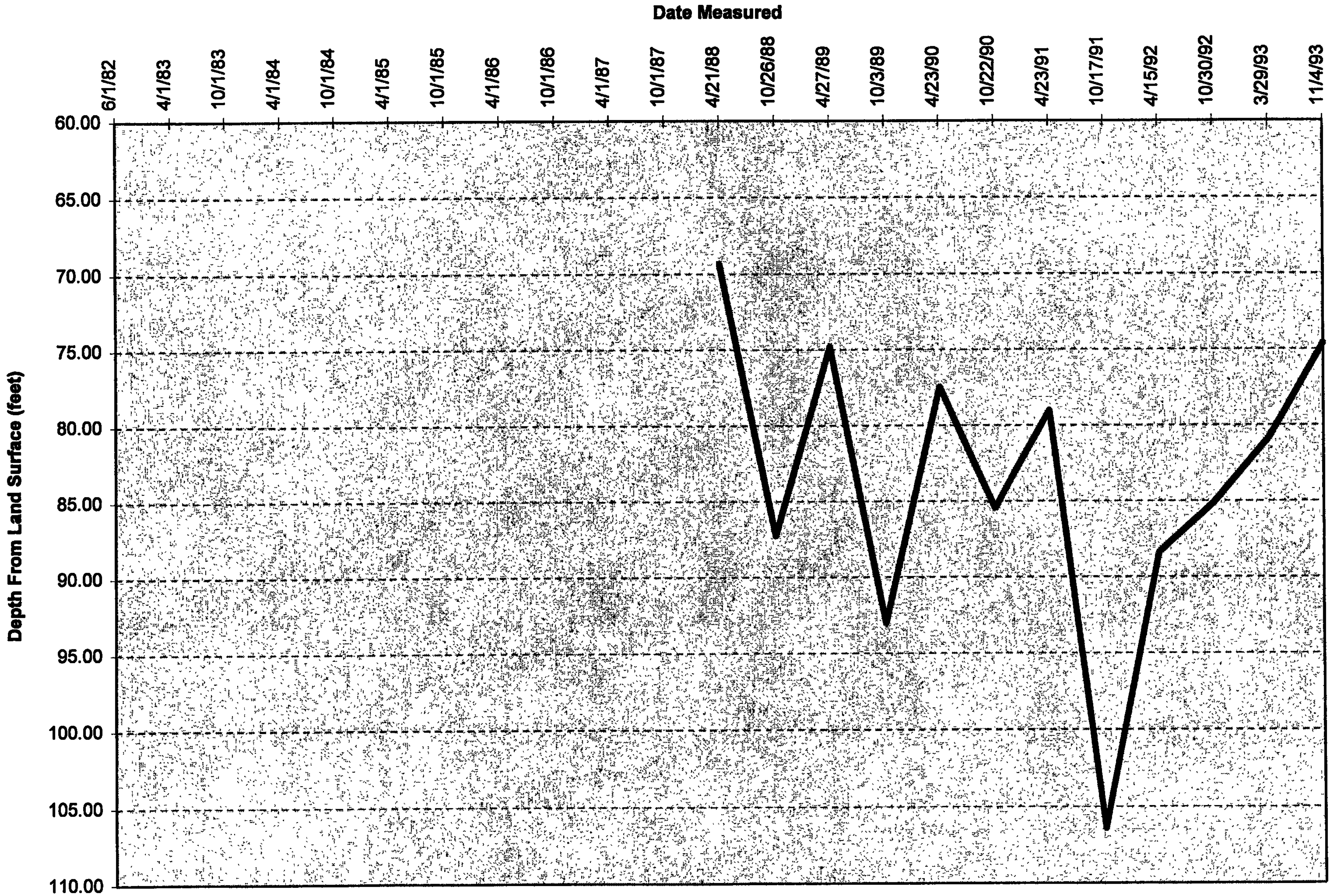
Date Measured
4/24/91
10/25/91
4/28/92
10/22/92
4/5/93
11/5/93
4/7/94
11/3/94
Depth From Land Surface (feet)
0.00
5.00
10.00
15.00
20.00


12N 5E 11 BAA
Date Measured
6/11/82
4/22/83
10/25/83
4/1/84
10/1/84
4/1/85
10/1/85
4/1/86
10/1/86
4/1/87
10/1/87
4/15/88
10/26/88
4/26/89
10/3/89
4/23/90
10/22/90
4/23/91
10/17/91
4/15/92
10/22/92
3/29/93
11/2/93
4/6/94
11/2/94
Depth From Land Surface (feet)
60.00
62.00
64.00
66.00
68.00
70.00
72.00
74.00
76.00
78.00
80.00



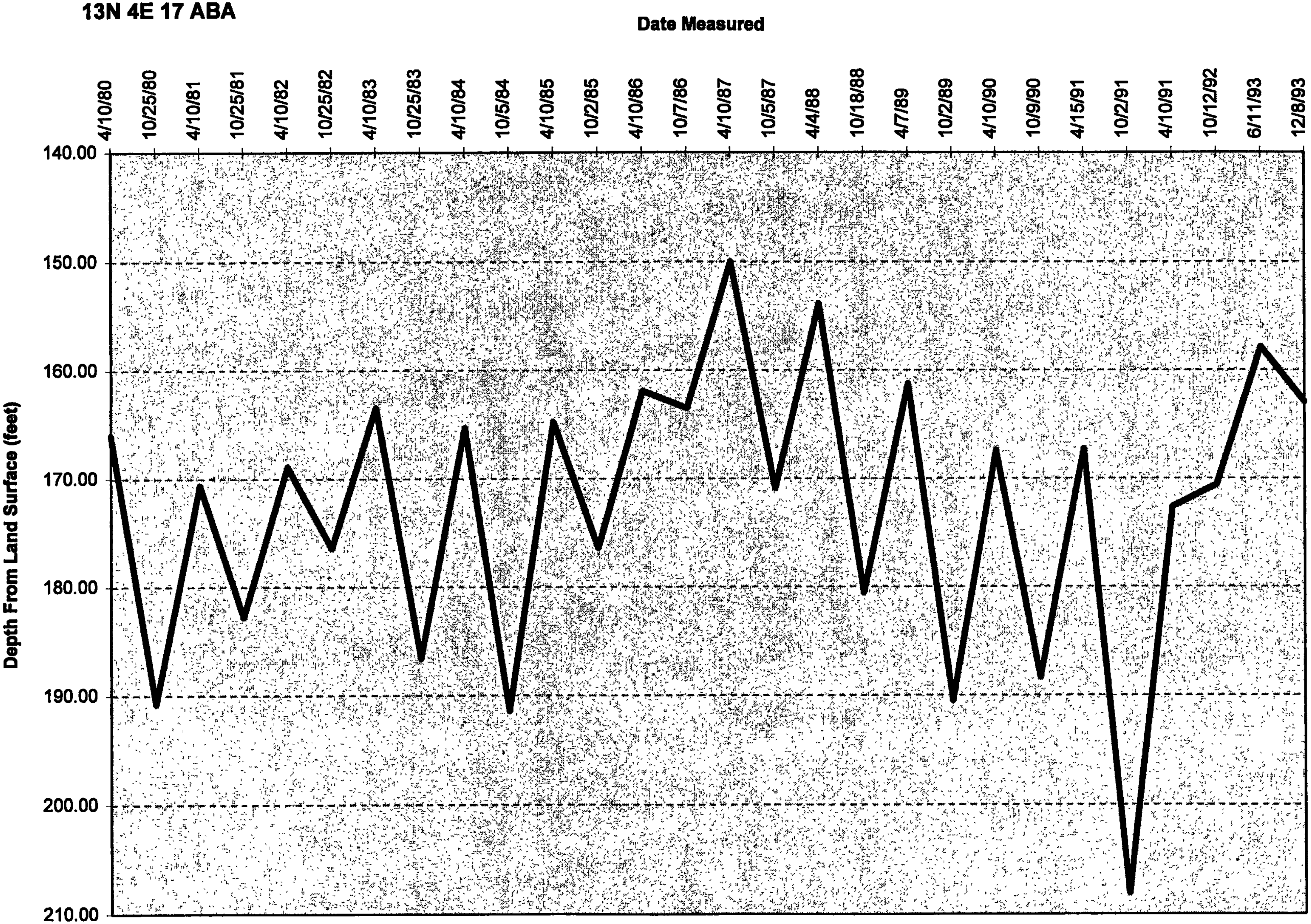
12N 7E 17 CBB
Date Measured
6/1/82
4/26/83
10/25/83
5/8/84
10/1/84
4/1/85
10/1/85
4/1/86
10/1/86
4/1/87
10/1/87
5/2/88
10/24/88
4/27/89
10/23/89
4/23/90
10/24/90
4/23/91
10/9/91
4/15/92
10/22/92
3/29/93
11/4/93
4/11/94
11/8/94
Depth From Land Surface (feet)
50.00
52.00
54.00
56.00
58.00
60.00
62.00
64.00
66.00
68.00
70.00

13N 4E 13 DDC

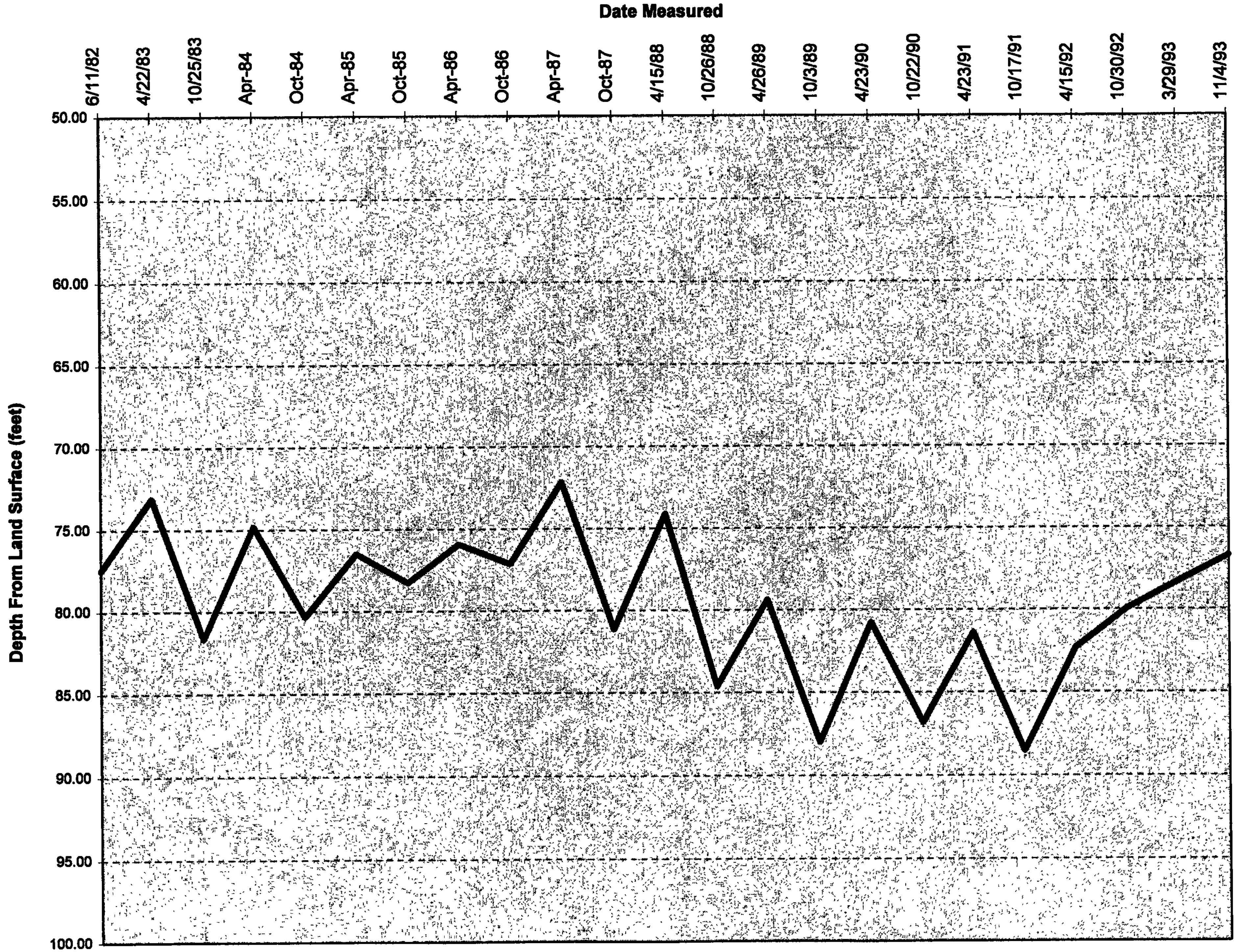


Date Measured
6/1/82
4/1/83
10/1/83
4/1/84
10/1/84
4/1/85
10/1/85
4/1/86
10/1/86
4/1/87
10/1/87
4/21/88
10/26/88
4/27/89
10/3/89
4/23/90
10/22/90
4/23/91
10/17/91
4/15/92
10/30/92
3/29/93
11/4/93
Depth From Land Surface (feet)
60.00
65.00
70.00
75.00
80.00
85.00
90.00
95.00
100.00
105.00
110.00

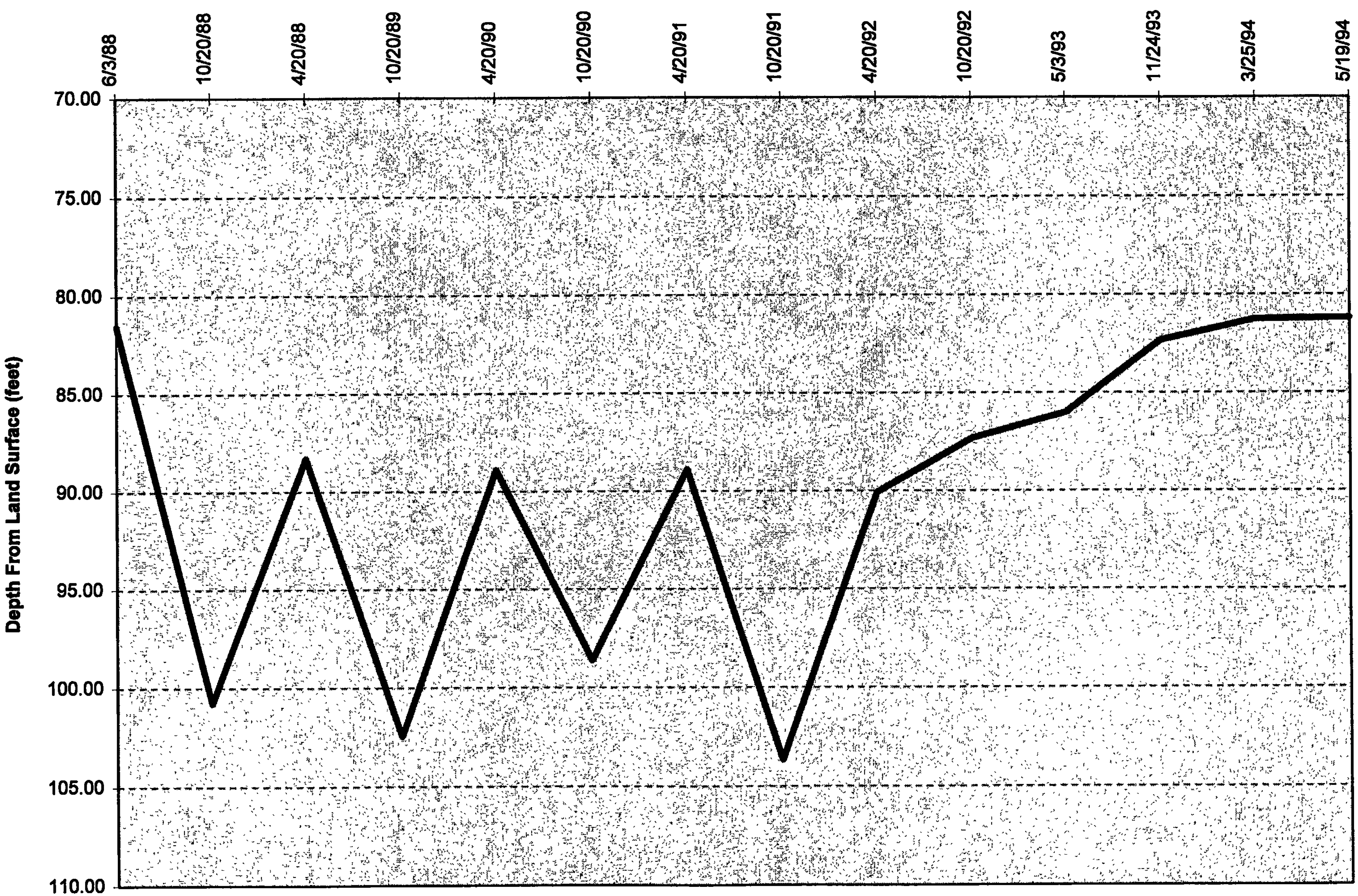
13N 4E 17 ABA


Date Measured
4/10/80
10/25/80
4/10/81
10/25/81
4/10/82
10/25/82
4/10/83
10/25/83
4/10/84
10/5/84
4/10/85
10/2/85
4/10/86
10/7/86
4/10/87
10/5/87
4/4/88
10/18/88
4/7/89
10/2/89
4/10/90
10/9/90
4/15/91
10/2/91
4/10/91
10/12/92
6/11/93
12/8/93
Depth From Land Surface (feet)
140.00
150.00
160.00
170.00
180.00
190.00
200.00
210.00

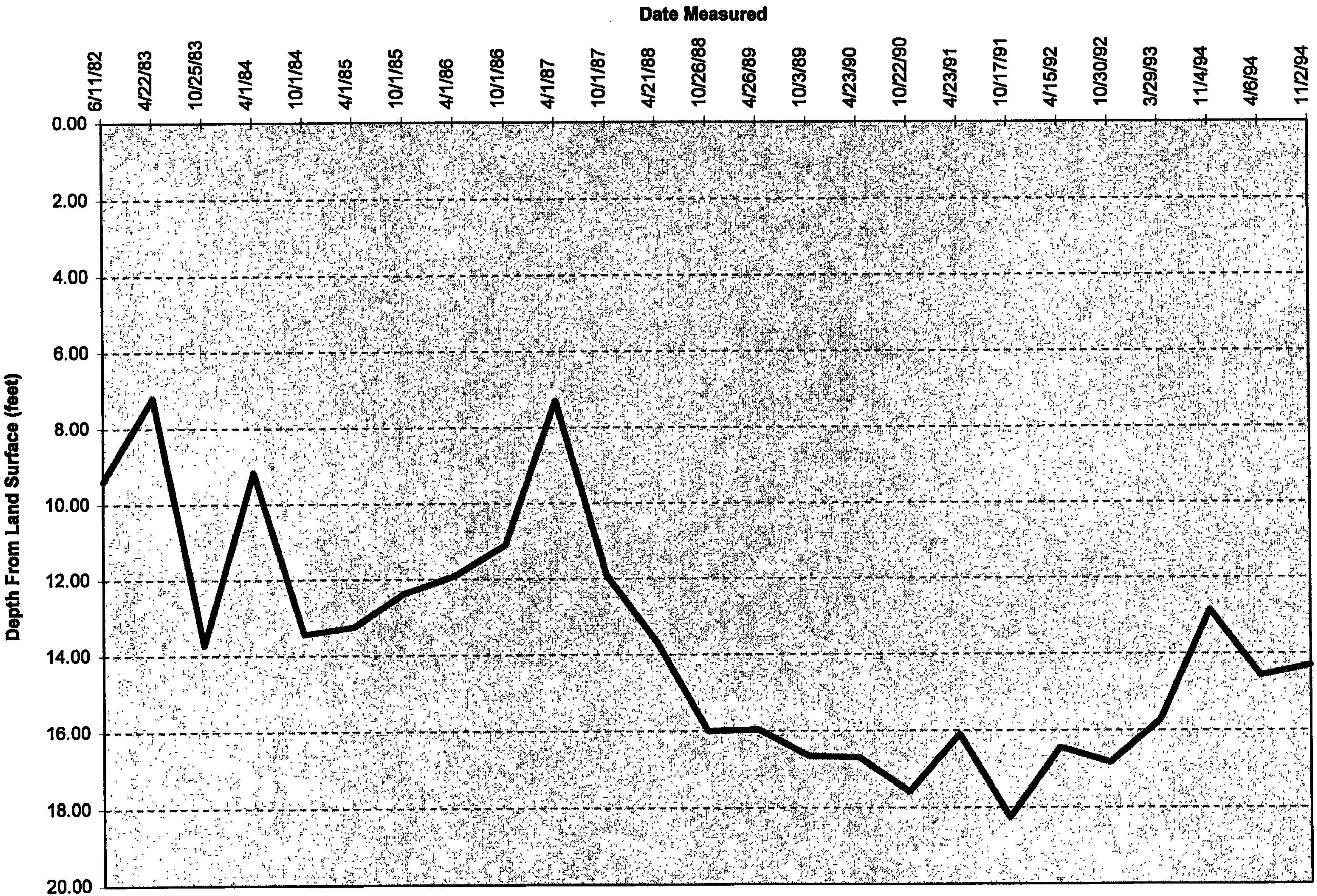
13N 4E 22 AD


Date Measured
6/11/82
4/22/83
10/25/83
Apr-84
Oct-84
Apr-85
Oct-85
Apr-86
Oct-86
Apr-87
Oct-87
4/15/88
10/26/88
4/26/89
10/3/89
4/23/90
10/22/90
4/23/91
10/17/91
4/15/92
10/30/92
3/29/93
11/4/93
Depth From Land Surface (feet)
50.00
55.00
60.00
65.00
70.00
75.00
80.00
85.00
90.00
95.00
100.00

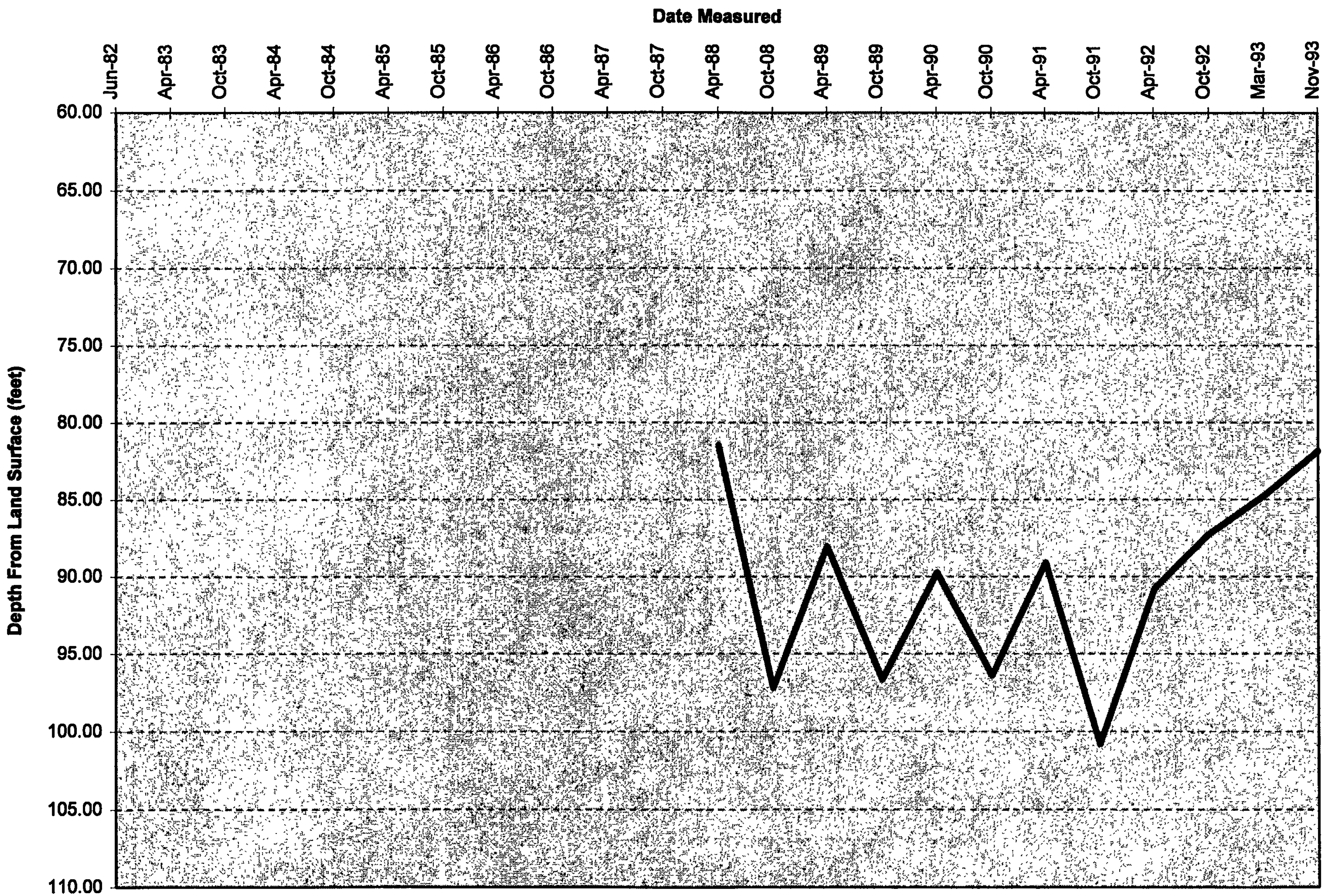
13N 4E 36 AAAA



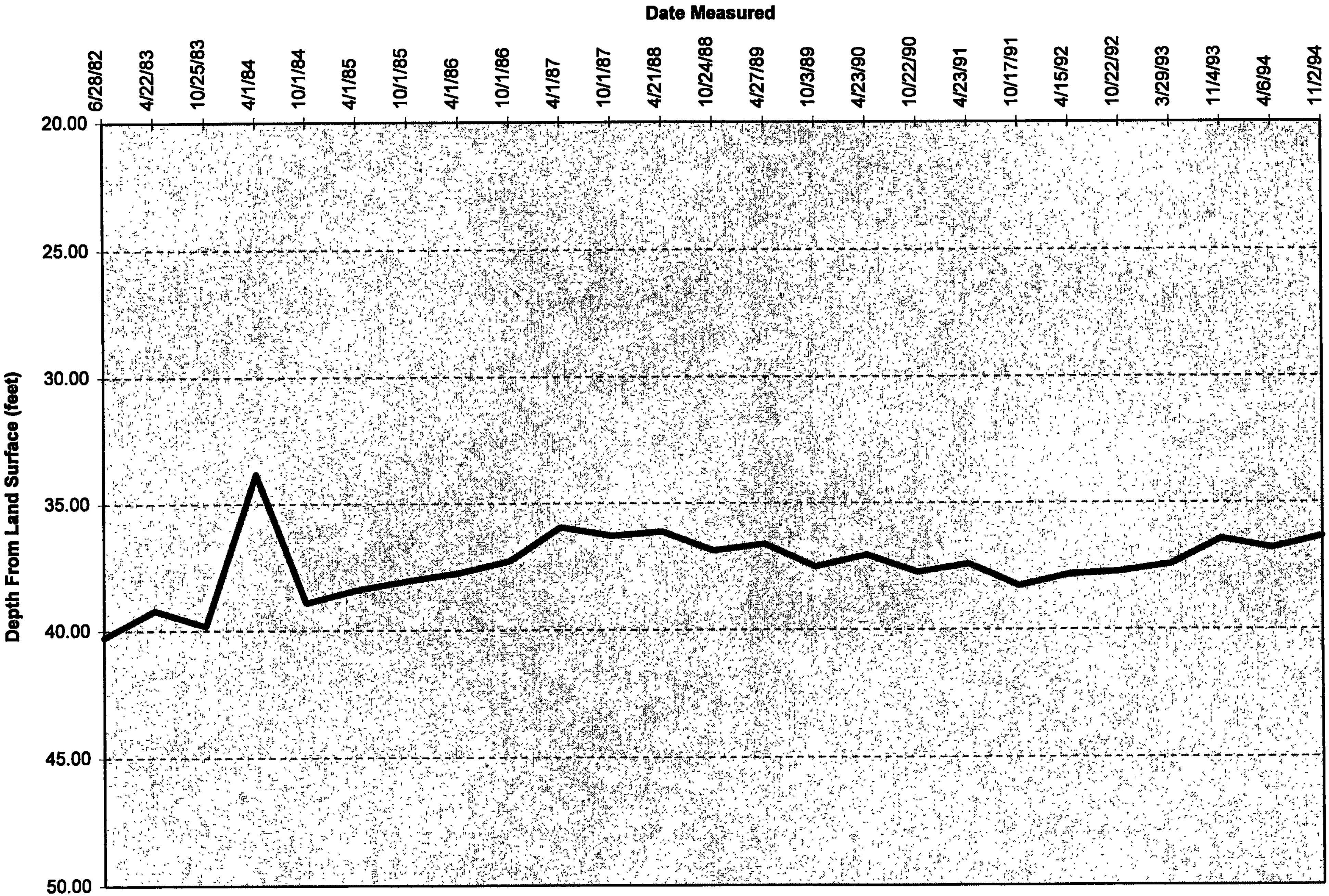
13N 5E 15 BBBB



13N 5E 29 BCA


Date Measured
Jun-82
Apr-83
Oct-83
Apr-84
Oct-84
Apr-85
Oct-85
Apr-86
Oct-86
Apr-87
Oct-87
Apr-88
Oct-08
Apr-89
Oct-89
Apr-90
Oct-90
Apr-91
Oct-91
Apr-92
Oct-92
Mar-93
Nov-93
Depth From Land Surface (feet)
60.00
65.00
70.00
75.00
80.00
85.00
90.00
95.00
100.00
105.00
110.00

13N 6E 28 AABB



APPENDIX C

LPS NRD Ground Water Monitoring Program Protocol

LOWER PLATTE SOUTH NRD-SAMPLING PROCEDURES

Before sampling:

1. Calibrate the instruments at every site.

2. Contact each well owner one or two day(s) in advance by phone to ensure that well can be sampled at the planned date. All or most well owners have been contacted in advance and permission has been obtained to sample the wells. Enclosed list lists the well owners, their phone numbers, and their addresses.

3. If well will not be running during the sampling period, call the owner of the alternate well. Registrations of alternate wells are attached to the primary well registrations.

4. Fill out site information section of the field sheet. Plot the well location on the topo map and label it on the map with field ID and date. On the topo map, draw the access roads to the well.

5. When possible, hook up the flow-through chamber as close to the wellhead as possible. Avoid taking a sample behind a chemigation valve, if present. Drain the flow-through chamber through the bottom valve, close the valve, then turn on the flow to supply the chamber with water. Limit the flow into the chamber to about 3 to 8 gal./min. If unable to use the flow chamber, e.g. in case of gravity flow irrigation systems or absence of spigot, remove the DO probe from the chamber, empty the chamber, and fill it through the open hole with water collected in the churn splitter. Then, read pH and conductivity values. Get the temperature with hand thermometer directly from the discharge. Try to get a DO reading inside the gated pipe.

6. Monitor the field measurements every 5 minutes for at least 10 minutes. They should stabilize to the tolerances listed on the field sheets. If not stable after 10 minutes, continue to monitor until stable within the acceptable tolerance levels. Note all measurements on the field sheet. Temperature is reported to the nearest half degree (13.5), pH can be listed to the nearest hundredth (7.01), DO is reported to the nearest tenth (6.4), and conductance is reported to 3 significant figures (1174 is reported as 1170). The final measurements will be used on the lab sheet.

7. Label the bottles with the field ID, e.g. M15, PO3, U11, E12, D13, legal location, lat., long., date, and time. The sample type, e.g. I or II, should be written on the neck of the plastic bottles.

8. Disconnect the flow-through chamber, leaving it full of water to keep the probes wet.

During Sampling:

1. Fill sample bottles at the well (do not collect sample from flow-through chamber). Ten bottles will be filled for Type II samples as indicated on the field sheets. Two bottles will be filled for Type I samples. Type II locations have field IDs from 1 through 9, e.g. EO9, PO6, etc. Type I samples have field IDs from 9 through 20 or 21, e.g. P12, E13, etc. Collect a duplicate sample every 10th Type II sample and every 10th Type I sample, starting from about your 5th sample.

2. Field rinse the RU and GCC bottles three times with well water before sample collection in the respective bottles.

3. Field rinse and fill the churn splitter.

4. Collect radon sample as described in the syringe method of the article of L. cecil and A. Yang (which is enclosed with your package). Put the end of the garden hose in the bottom of the churn splitter and adjust the flow so it runs slowly over the top of the churn splitter. Only collect radon samples on Monday, Tuesday, and Wednesday to ensure that radon samples will arrive on or before Thursday in the lab.

5. Field rinse churn splitter and fill once more for use for filtered samples.

6. Pump water with peristaltic pump from the churn splitter. Filter the FA, FC, FU, and FAR samples. Discard filter and rinse filter assembly with distilled water.

7. Add the following preservatives to the FC, FA, and FAR samples:

   250 mL FC bottle: use 1-1mL brown ampule with HgC12
   250 mL FA bottle: use 1-1mL HNO3 ampule
   1L FAR bottle: use 2-2mL HNO3 ampules
   2l FAR bottle: use 4-2 mL HNO3 ampules

WARNING!!!!!!!!!!!!!! :

AVOID INHALING PRESERVATIVES. AVOID SPILLAGE. DO NOT TOUCH CLOTHING OR EYES. DISPOSE OF ACID AND MERCURIC CHLORIDE AMPULES IN SEPARATE BOTTLES. KEEP BOTTLES CLOSED WHEN NOT IN USE.

8. Check whether all samples have been collected.

9. Refrigerate the FC and GCC samples.

10. Set aside the 1 L-FAR labeled "FOR RESTON".

11. Put the mailing tube with the scintillation vials in FEDERAL EXPRESS mail box. Use the pretyped labels. The federal express mail boxes can be delivered:

    a. In Omaha at 7128 F Street before 8:00 p.m. Go a block south of I-80 at the 72nd Street exit.

    b. In Lincoln at 3600 North 20th Street. Go 4 blocks north of Cornhusker Highway on 20th Street. The cross street is Fairfield Street.

After sampling:

1. Discuss sample sites at which samples could not be collected and to discuss future sample sites.

2. Fill out well schedules in the field as well as possible. Make sure to draw the location of the well on the well schedules. Staple well schedules of each site to their field sheets and their well registrations.

3. Check if lab sheets are completed correctly. Examples have been provided.

4. Run immuno assays for triazines as soon as possible as bottles arrive in the Lincoln office and send them as soon as possible to the Central Lab to allow timely extraction of the herbicides.

5. Send all other bottles to the Central Lab as soon as possible, except bottles labeled "RESTON". Reston bottles should be sent to Tom Kraemer in Reston.

Abbreviations:

RU- Raw, untreated
GCC- Filtered, chilled
FC- Filtered, chilled with $HgCl2$ (250 ml brown bottles)
FA- Filtered, acidified
FAR- Filtered, acidified, for rad chem
FU- Filtered, untreated

U.S. GEOLOGICAL SURVEY, WRD, GROUND-WATER QUALITY FIELD NOTES

BQA-1 3/92 (3rd printing, 1st ed.)

Proj. Name, No. ____________ Date ____________ Time ____________

Loc. Well No.

Composite Samples? ☐ YES ☐ NO

If YES, indicate;

Site I.D. ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Dates ____________

Times ____________

Sampled by ____________

SMS Cntrl. No. ____________

Record No.

Sample Purpose (71999) : ____________

WELL DATA

☐ Well ☐ Open Hole ☐ Spring

Altitude, ft (72000) ____.____

Static water level, ft (72019) ____.____

* Casing vol. (gal.) ____.____

Depth top sample interval (72015) ____.____

Dia. inside (in.) ____.____

Purge vol. (gal.) ____.____

Depth bottom sample interval (72016) ____.____

Screened/ open interval Top : ____.____ Bottom : ____.____

Allowable draw-down (ft.) ____.____

* Casing Vol. (gal.) = 0.0408 X Dia.^{2} (in.) X Height (ft) OR Cas. Vol. = H X F

Height = H = Well Depth - Static Water Level = ____.____ F = Casing volume factor

* VOLUME FACTORS

Dia. (in.)	Cas. Vol. Factor F
1.0	0.04
1.5	0.09
2.0	0.16
3.0	0.37
4.0	0.65
4.5	0.83
5.0	1.02
6.0	1.47
8.0	2.61
10.0	4.08
12.0	5.88
24.0	23.5
36.0	52.9

SAMPLING DATA

Location ____________ Date well last sampled ____________

Minutes pumped before sampling (72004) ____________ static water level when well last sampled ____.____

Sampler type (84164) ____________

4010 = thief
4020 = bailer
4025 = double-valve bailer
4100 = flowing well

PUMPS:
4030 = suction pump
4040 = submersible
4050 = squeeze
8010.0 = other

4060 = gas recip.
4070 = gas lift
4080 = peristaltic
4090 = jet

Sampling condition (72006) ____________

0.10 = site was being pumped
0.11 = site recently pumped

4. = flowing
8. = pumping
30. = seeping
31. = nearby well pumping

Sampler ID ____________

Sampler material : Stainless Steel Brass PVC Teflon Other ____________

Aquifer Name: ____________ GW Color ____________ Clarity ____________

Sample extracted and processed under ☐ oxygenated ☐ nonoxygenated conditions

Sample contact with : ☐ atmosphere ☐ oxygen ☐ nitrogen ☐ other

Weather: Clear Partly Cloudy Cloudy Light Medium Heavy Snow Rain Calm Light Breeze Very Gusty Windy Very Cold Warm Hot Other

SAMPLES COLLECTED

Nutrients ☐ TOC ☐

Major Ions ☐ DOC ☐

SOC ☐ Filt. ________ mL

BOD ☐ ________ ☐

COD ☐ ________ ☐

ORGANICS

Pesticide ☐

VOC ☐

BNA ☐

TR. ELEMENTS

Unfiltered ☐

Filtered ☐

________ ☐

Radiochemical ☐

Isotope ☐

________ ☐

☐

FIELD MEASUREMENTS

Q. Inst. (00059) ________ GPM

Temp. Water (00010) ________ °C

Temp. Air (00020) ________ °C

pH (00400) ________ units

Sp. Cond. (00095) ________ µS/cm 25°C

Dis. Oxy. (00300) ________ mg/L

DO Sat. (00301) ________ %

Bar. Press. (00025) ________ mm Hg

Eh (00090) ________ m volts

Alkalinity ( ) ________ mg/L

Bicarbonate ( ) ________ mg/L

Carbonate ( ) ________ mg/L

Hydroxide ( ) ________ mg/L

E. Coli (31633) ________ col./100 mL; Rmk ____

FC (31625) ________ col./100 mL; Rmk ____

FS (31673) ________ col./100 mL; Rmk ____

Other:

LABORATORY SCHEDULES

Lab Schedules Req. (or copy of lab request form attached ☐)

Lab Codes Add (A) Delete (D):

Remarks

Checked by Date

TEMPERATURE

Lab Thermometer ☐ Checked w/ASTM within ± 0.5°C; Date ____

Down-Hole Sensor ☐ Describe

AMPULE LOT NUMBERS: nitric acid ____ mercuric chloride ____

nitric acid/potassium dichromate

pH

Mtr W-no. METER Make/Model

electrode no. electrode type

pH Buffer	pH Buffer Temp °C	Initial Reading	Adj. Reading	millivolts (redox meas)	Remarks
__ . __ __					
__ . __ __					
__ . __ __					
__ . __ __					

☐ unfiltered sample ☐ filtered sample

Temp correction factors for buffers applied? ☐ YES ☐ NO

stirrer used? ☐ YES ☐ NO

If yes, ☐ magnetic stirrer ☐ manually stirred

pH subsample from or pH measurement location : Churn flow through chamber single point at ____ depth vertical avg of ____ points

Sample Temp = ____ °C

FIELD pH = ____ USE : ____

SPECIFIC CONDUCTANCE

Mtr W-no. METER Make/Model

probe no.

standard value	Temp Std °c	Initial Reading	Adj. Reading	Remarks

correction factor applied? ☐ YES ☐ NO

☐ auto temp compensated meter

☐ manual temp compensated meter

corr. factor = ____

SC subsample from or SC measurement location : Churn flow through chamber single point at ____ depth vertical avg of ____ points

FIELD CONDUCTANCE = ____ USE : ____

DISSOLVED OXYGEN W-no. ____ METER Make/Model ____

D.O. measurement location or D.O. subsample from : Churn flow through chamber single point at ____ depth vertical avg of ____ points

Calibration : BOD bottle

☐ Air Calibration in Water ☐ Air Calibration Chamber in Air

☐ Air-Saturation Deionized Water ☐ Calibration by Winkler Titration (attach Supplementary Winkler page)

D.O. Zero Check (using zero D.O. solution) ☐ YES ☐ NO

Thermister Check ☐ YES ☐ NO

BAR. PRESS ____ mm Hg; (mm = in. X 25.4)

Salinity Corr. Factor ____ H_2O Temp. ____ °C

Chart D.O. Sat. ____ mg/L

stirrer used? ☐ YES ☐ NO If yes, ☐ magnetic stirrer ☐ manually stirred

Meter D.O. Sat. ____ mg/L; Adjusted to ____ (if corr. factor applicable)

GROUND WATER D.O. = ____

QUALITY ASSURANCE SAMPLES

Were quality assurance samples collected?

☐ YES ☐ NO If YES indicate type(s) :

	Organic-free	DI	water from sampling site
Replicate	☐	☐	☐
Spike	☐	☐	☐
Field Blank	☐	☐	
Trip Blank	☐	☐	

Supplementary page w/additional QA sample info attached ☐

Other ☐ Indicate Type(s) :

Calibration Notes and Remarks

ALKALINITY

pH	△ pH	Vol acid DC or mL	△Vol acid DC or mL	△ pH / △ Vol acid

Acid: 1.60 N 0.1600 N 0.01639N OTHER ________

Acid Lot No. : ________

Sample Volume : ________mL

☐ Filtered ☐ Unfiltered

Sample stirred : ☐ magnetically ☐ manually

pH: Start ________ End ________

DC (Digital Counts) or
Vol. titrated at End Point near pH 8.3 : ________

Digital Counts or
Vol. titrated at End Point near pH 4.5 : ________

☐ Incremental Equivalence ☐ Fixed End Point ☐ Gran Titration

Date ________ Time ________

CALCULATIONS :

$$CO_3^{-2} = A \times \frac{F_1}{\text{mL sample}} \times CF \; *$$

$$HCO_3^{-1} = [B - 2(A)] \times \frac{F_2}{\text{mL sample}} \times CF; \; *$$

$$\text{ALKALINITY as } CaCO_3 = B \times \frac{F_3}{\text{mL sample}} \times CF \; *$$

A = DC or mLs acid from initial pH to endpoint near 8.3 = ________

B = DC or mLs acid from initial pH to endpoint near 4.5 = ________

* APPLY CORRECTION FACTOR (CF) IF ACID USED FOR BURETTE TITRATION HAS NONSTANDARD NORMALITY– CF = corr. factor = H_2SO_4 normality/0.01639

FACTORS	DIGITAL COUNT TITRATION (DC) Using 0.1600 normal	Using 1.60 normal
F_1	12.0	120
F_2	12.2	122
F_3	10.0	100

FACTORS	BURETTE TITRATION (mL) * Using ml of 0.01639 normal H_2SO_4
F_1	983.5
F_2	1000
F_3	820.2

(IMPORTANT : CF NOT APPLICABLE FOR THE DIGITAL TITRATION FACTORS SHOWN; use only with nonstandard normality BURETTE titration)

ALKALINITY ( ) ________ mg/L as $CaCO_3$

BICARBONATE ( ) ________ mg/L as HCO_3^{-1}

CARBONATE ( ) ________ mg/L as CO_3^{-2}

NOTE: ATTACH OUTPUT COPY IF ALKALINITY VALUES ARE CALCULATED USING A COMPUTER PROGRAM

OBSERVATIONS/CALCULATIONS :

Miscellaneous Section (Notes/Calculations/Well Purge Log & Etc.)

WELL PURGE LOG

Time	Water Level b/w MP LS	Draw Down feet 72040	Well Yield When Sampling gpm 00059	cfs	pH 00400	T °C 00010	SC 00095	DO 00300	

E. COLI (31633)

Time collected : ________

Time in @ 35°C : ________ Date : ________

Time in @ 44.5°C : ________

Time out : Date :

Vol. (mL)	Count	Used in calculation?	Remarks *
Blank			
Blank			

* Remarks 1 = Less than 2 = Greater than 0 = Est. ct. K = non ideal ct.

Incub. Time 2 hrs @ 35°C followed by : 20-24 hrs @ 44.5°C

filt. size ________

Ideal count 20-80 col.

E. COLI COUNT /100 mL______; Rmk_____

FECAL STREPTOCOCCI (31673)

Time collected : ________

Time in : ________ Date : ________

Time out : Date :

Vol. (mL)	Count	Used in calculation?	Remarks *
Blank			
Blank			

* Remarks 1 = Less than 2 = Greater than 0 = Est. ct. K = non ideal ct.

Incub. Time 46-50 hrs filt. size ________

Ideal count 20-100 col. Incub. Temp 35°C

FS COUNT / 100 mL______; Rmk_____

FECAL COLIFORM (31625)

Time collected : ________

Time in : ________ Date : ________

Time out : Date :

Vol. (mL)	Count	Used in calculation?	Remarks *
Blank			
Blank			

* Remarks 1 = Less than 2 = Greater than 0 = Est. ct. K = non ideal ct.

Incub. Time 22-26 hrs filt. size ________

Ideal count 20-60 col. Incub. Temp 44.5°C

FC COUNT / 100 mL______; Rmk_____

CALCULATIONS

★ U.S. GOVERNMENT PRINTING OFFICE: 1992-675-689

APPENDIX D

National Pollutant Discharge Elimination System (NPDES) Permits in LPS NRD

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) POINT SOURCE DISCHARGE

PERMIT #	FACILITY NAME	CITY
NE0121479	ALVO WWTF	ALVO
NE0111155	ASHLAND WTP	ASHLAND
NE0026107	ASHLAND WWTF	ASHLAND
NE0111341	MARTIN MARIETTA AGG-ASHLAND	ASHLAND
NE0113131	AVOCA WWTF	AVOCA
NE0042366	BRAINARD WWTF	BRAINARD
NE0219402	CEDAR CREEK WWTF	CEDAR CREEK
NE0046124	CERESCO WWTF	CERESCO
NE0129559	SID #5, LANCASTER COUNTY-CHENEY	CHENEY
NE0024295	DAVEY WWTF	DAVEY
NE0046141	DENTON WWTF	DENTON
NE0112127	ELMWOOD WWTF	ELMWOOD
NE0103128	WEYERS FARMS, INC.	ELMWOOD
NE0023931	GARLAND WWTF	GARLAND
NE0027367	GREENWOOD WWTF	GREENWOOD
NE0112950	SID #2 CASS/GREENWOOD INTERCHANGE	GREENWOOD
NE0028282	HALLAM WWTF	HALLAM
NE0111490	NPPD SHELDON STATION	HALLAM
NE0123170	CASEY'S GENERAL STORE	HICKMAN
NE0107271	HARLAN, DALE	HICKMAN
NE0046183	HICKMAN WWTF	HICKMAN
NE0035157	ARCHER DANIELS MIDLAND	LINCOLN
NE0113522	ARMY AIR SUPPORT FACILITY	LINCOLN
NE0121606	BRUNING HYDRAULICS	LINCOLN
NE0060054	BRUNSWICK CORP-NW 38TH	LINCOLN
NE0060062	BRUNSWICK CORP-SUPERIOR	LINCOLN
NE0123404	BURLINGTON NORTHERN-HAVELOCK	LINCOLN
NE0121428	COOK FAMILY FOODS	LINCOLN
NE0129526	CRETE CARRIER CORPORATION	LINCOLN
NE0000396	CUSHMAN	LINCOLN
NE0114618	DITEK CORPORATION	LINCOLN
NE0007901	DORSEY LABS	LINCOLN
NE0060119	DUNCAN AVIATION	LINCOLN
NE0111538	FISHER FOODS LTD.	LINCOLN
NE0001317	GOOCH FOODS, INC.	LINCOLN
NE0000400	GOODYEAR TIRE & RUBBER COMPANY	LINCOLN
NE0060101	HILL AERO, INC.	LINCOLN
NE0110841	HILLCREST COUNTRY CLUB	LINCOLN
NE0128082	INDUSTRIAL MACHINE SPECIALTIES	LINCOLN
NE0112046	INTERSTATE CAMP-A-WAY	LINCOLN
NE0060011	ISCO, INC.	LINCOLN
NE0127914	ISCO, INC.	LINCOLN
NE0129534	KART & PUTT	LINCOLN

NE0111139	KAWASAKI MOTORS CORPORATION	LINCOLN
NE0123722	LANCASTER CITY/COUNTY BUILDING	LINCOLN
NE0123935	LES ROKEBY PEAKING UNIT	LINCOLN
NE0060127	LESTER ELECTRICAL OF NE., INC.	LINCOLN
NE0113433	LINCOLN N STREET STORM SEWER	LINCOLN
NE0112488	LINCOLN NORTHEAST WWTF	LINCOLN
NE0114367	LINCOLN PLATING	LINCOLN
NE0001309	LINCOLN SNACK COMPANY	LINCOLN
NE0000990	LINCOLN STEEL CORPORATION	LINCOLN
NE0036820	LINCOLN THERESA WWTF	LINCOLN
NE0113921	LINCOLN WELDING SUPPLY COMPANY	LINCOLN
NE0122149	MERIDIAN PARK	LINCOLN
NE0129542	MERLE'S INC., EMERALD	LINCOLN
NE0114430	MOLEX	LINCOLN
NE0113824	NDOR LINCOLN WB RA	LINCOLN
NE0032093	NDOR DISTRICT OFFICE	LINCOLN
NE0033642	NEBCO, INC. #1	LINCOLN
NE0033651	NEBCO, INC. #2	LINCOLN
NE0113565	NE PENAL & CORRECTIONAL	LINCOLN
NE0122637	NEBRASKA BOILER CO., INC.	LINCOLN
NE0122068	NOTIFIER CORPORATION	LINCOLN
NE0121550	PARKWAY PHILLIPS 66 SERVICE STATION	LINCOLN
NE09124401	SHOEMAKER'S TRUCK STATION, INC.	LINCOLN
NE0129569	SID #6 LANCASTER COUNTY-EMERALD	LINCOLN
NE0112593	SID #2 PINE LAKE	LINCOLN
NE0112780	SKY RANCH ACRES	LINCOLN
NE0060305	SPECTRONICS CORPORATION	LINCOLN
NE0114383	SQUARE D	LINCOLN
NE0043371	TELEX COMMUNICATIONS, INC.	LINCOLN
NE0129577	TURNPIKE RESTAURANT	LINCOLN
NE0031623	UNL CITY POWER PLANT	LINCOLN
NE0031631	UNL EAST CAMPUS POWER PLANT	LINCOLN
NE0033014	VALLEY ICE COMPANY	LINCOLN
NE0124087	VANGUARD METAL BUILDERS-NEBR.	LINCOLN
NE0112933	VILLA DEL RAY WWTF	LINCOLN
NE0123315	WEST "O" PHILLIPS 66	LINCOLN
NE0446507	YANKEE HILL BRICK MFG. CO.	LINCOLN
NE0129593	YANKEE HILL EQUESTRIAN	LINCOLN
NE0000787	ASH GROVE CEMENT COMPANY	LOUISVILLE
NE0104167	BOND, LEON A.	LOUISVILLE
NE0024228	LOUISVILLE WWTF	LOUISVILLE
NE0105848	STABEN, ROBERT J.	LOUISVILLE
NE0024261	MALCOLM WWTF	MALCOLM
NE0042340	MANLEY WWTF	MANLEY
NE0042072	MURDOCK WWTF	MURDOCK
NE0032107	MURRAY WWTF	MURRAY
NE0102024	PULS, DELBERT O.	MURRAY
NE0085791	MURDOCK, CECIL	NEHAWKA

NE0025399	NEHAWKA WWTF	NEHAWKA
NE0050890	BEAVER LAKE ASSOCIATION	PLATTSMOUTH
NE0129411	COPPER DOLLAR COVE	PLATTSMOUTH
NE0114251	JOHNSON'S DEVELOPMENT	PLATTSMOUTH
NE0021121	PLATTSMOUTH WWTF	PLATTSMOUTH
NE0112437	SID #5 CASS, BUCCANEER BAY	PLATTSMOUTH
NE0045284	PLEASANT DALE STP	PLEASANT DALE
NE0129682	TWIN LAKES CAMPGROUND	PLEASANT DALE
NE0032085	NDOR PRINCETON RA	PRINCETON
NE0046281	RAYMOND WWTF	RAYMOND
NE0114227	ECOLOGICAL ENERGY, INC.	ROCA
NE0050261	ROCA WWTF	ROCA
NE0123102	WILLIAMS PIPELINE/WILLIAMS TERM	ROCA
NE0123064	SOUTH BEND LAKES, INC.	SOUTH BEND
NE0112054	SPRAGUE WWTF	SPRAGUE
NE0028118	UNION WWTF	UNION
NE0097365	KOMENDA, RICHARD	VALPARAISO
NE0112976	VALPARAISO WWTF	VALPARAISO
NE0113794	BROWNIE MFG. CO., INC.	VALPARAISO
NE0129585	WAVERLY FARMS	WAVERLY
NE0123013	WAVERLY SUPERFUND SITE	WAVERLY
NE0224406	WAVERLY WWTF	WAVERLY
NE0000388	MARTIN MARIETTA AGG-WEEPING WATER	WEEPING WATER
NE0046329	WEEPING WATER WWTF	WEEPING WATER