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Surplus Facilities Management Program (SFMP)
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PERFORMANCE MONITORING REPORT
FOR THE NIAGARA FALLS STORAGE SITE
WASTE CONTAINMENT STRUCTURE

Lewiston, New York

July-December 1988
and Calendar Year 1989

June 1990



Bechtel National, Inc.

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FOR THE NIAGARA FALLS STORAGE SITE
WASTE CONTAINMENT STRUCTURE,
LEWISTON, NEW YORK,
JULY - DECEMBER 1988 AND CALENDAR YEAR 1989

JUNE 1990

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CONTENTS

	<u>Page</u>
Figures	iv
Tables	v
Abbreviations	vi
Acronyms	vi
 1.0 INTRODUCTION	 1
1.1 LOCATION AND DESCRIPTION	2
1.2 PROGRAM OBJECTIVE	7
 2.0 SUMMARY OF PERFORMANCE MONITORING PROGRAM	 8
 3.0 PERFORMANCE MONITORING DATA	 11
3.1 SURFACE MONITORING	11
3.1.1 Aerial Photography	11
3.1.2 Grid Survey	11
3.1.3 Walkover Survey	23
3.2 SUBSURFACE MONITORING	27
3.3 ENVIRONMENTAL MONITORING	29
3.3.1 Radon Levels	29
3.3.2 External Gamma Radiation Levels	30
3.3.3 Surface Water and Sediment Sampling	30
3.3.4 Groundwater Sampling	33
 4.0 COMPARISON WITH PREVIOUS DATA	 41
 5.0 ACTIONS REQUIRED	 42
 REFERENCES	 43
 APPENDIX A - Summary of Vibrating Wire Pressure Transducer Data for July - December 1988 and Calendar Year 1989	 A-1

FIGURES

<u>Figure</u>	<u>Title</u>	<u>Page</u>
1-1	Regional Setting of NFSS	3
1-2	Site Plan of NFSS	4
1-3	Cross Section of the NFSS Waste Containment Structure	5
1-4	Orthographic Projection of the Waste Containment Structure	6
2-1	Locations of VWPTs and PPTs on the Waste Containment Structure	9
3-1	Aerial Contour Map of the NFSS Waste Containment Structure - November 1989	12
3-2	Aerial Photograph of the NFSS Waste Containment Structure - November 1989	13
3-3	Aerial Photograph of the NFSS Waste Containment Structure - October 1986	14
3-4	Survey Grid for the NFSS Waste Containment Structure	15
3-5	WCS Baseline Grid Survey, Fall 1986	19
3-6	WCS Comparison Grid Survey, Fall 1988	20
3-7	WCS Comparison Grid Survey, Spring 1989	21
3-8	WCS Comparison Grid Survey, Fall 1989	22
3-9	Areas of the WCS Requiring Maintenance Actions	25
3-10	Surface Water, Groundwater, and Sediment Sampling Locations at NFSS	31
3-11	Surface Water and Sediment Sampling Locations in the Vicinity of NFSS	32
3-12	Locations of NFSS Groundwater Monitoring Wells in the Vicinity of the Waste Containment Structure	38

TABLES

<u>Table</u>	<u>Title</u>	<u>Page</u>
3-1	Grid Surveys for the Niagara Falls Storage Site	17
3-2	Summary of Subsurface Monitoring Instruments - 1987	28
3-3	Concentrations of Uranium in NFSS Water Samples - July 1988 to October 1989	34
3-4	Concentrations of Radium-226 in NFSS Water Samples - July 1988 to October 1989	35
3-5	Concentrations of Uranium and Radium-226 in NFSS Sediment Samples - July 1988 to October 1989	36
3-6	Concentrations of Uranium in NFSS Containment Monitoring Wells - July 1988 to October 1989	39
3-7	Concentrations of Radium-226 in NFSS Containment Monitoring Wells - July 1988 to October 1989	40

ABBREVIATIONS

cm	centimeter
ft	foot
g	gram
ha	hectare
in.	inch
km	kilometer
L	liter
m	meter
mm	millimeter
mi	mile
μ Ci	microcurie
ml	milliliter
mrem	millirem
pCi	picocurie
yr	year

ACRONYMS

CFR	Code of Federal Regulations
DOE	Department of Energy
MSL	mean sea level
NFSS	Niagara Falls Storage Site
PPT	pneumatic pressure transducer
SFMP	Surplus Facilities Management Program
VWPT	vibrating wire pressure transducer
WCS	waste containment structure

1.0 INTRODUCTION

A performance monitoring program has been developed for the waste containment structure (WCS) at the Niagara Falls Storage Site (NFSS). The WCS contains soil contaminated with residual radioactive materials, rubble, and radioactive residues removed from various areas of NFSS and vicinity properties during remedial action conducted by the Department of Energy (DOE) from 1981 through 1986. NFSS is a part of the DOE Surplus Facilities Management Program (SFMP). The design and construction of the WCS and the closure and post-closure activities have been previously documented (Bechtel 1986a, 1986b).

The purpose of the performance monitoring program is to verify that the main engineering elements of the WCS are functioning to minimize infiltration of rainfall, prevent pollution of groundwater, and prevent radon emanation. This report presents the findings of performance monitoring conducted at the WCS during July through December 1988 and calendar year 1989. The data received during the initial performance monitoring period in 1986 established a baseline for the interpretations contained in this report (Bechtel 1987).

The performance monitoring program is distinct from the environmental monitoring program conducted at NFSS, and it will continue for a shorter time. The performance monitoring program will continue at least through 1991 (fiscal year 1987 to 1991), and may be maintained for a longer period depending on the results observed. To evaluate the effectiveness of the containment facility accurately, the data from both the performance monitoring program and from the broader environmental monitoring program must be assessed. The environmental monitoring program monitors radon concentrations in air; radium, uranium, and heavy metals concentrations in surface water, groundwater, and sediment; and external gamma radiation levels. It includes data from both the monitoring wells on and off site and the 36 wells added to the monitoring list since 1986. Complete results of the environmental

monitoring program are published annually in a separate report (Bechtel 1989a, 1990). Summary information from that report is included in this document in Subsection 3.3.

This report includes a summary of performance monitoring results for the last 6 months of 1988 and all of 1989. It contains data for surface, subsurface, and environmental monitoring; conclusions based on walkover surveys; comparisons with previous data; and actions required. The vibrating wire pressure transducer (VWPT) pore water pressure readings for this period have been expressed as hydraulic head and are plotted in Appendix A.

1.1 LOCATION AND DESCRIPTION

NFSS is a DOE surplus facility located in northwestern New York in the Township of Lewiston (Niagara County). The site is located in a generally rural setting approximately 6.4 km (4 mi) south of Lake Ontario and 16 km (10 mi) north of the City of Niagara Falls. NFSS and its regional setting are shown in Figure 1-1. Figure 1-2 is a site plan of NFSS featuring the WCS.

The WCS occupies 4 ha (10 acres) of the 77.4-ha (191-acre) NFSS. As shown in Figure 1-3, the WCS outer perimeter is formed by a dike and cutoff wall, each constructed of compacted clay and incorporated into the finished structure. The cutoff wall extends a minimum of 45 cm (18 in.) into an underlying gray clay unit. The gray clay unit and the cutoff wall/dike serve as adsorption barriers to vertical and horizontal migration of contaminants from the structure. Figure 1-4 presents an orthographic projection (in three views) of the WCS.

An engineered, compacted clay liner is placed immediately over the waste and extends beyond the perimeter dike, completely enclosing the waste. This clay liner is the principal barrier against moisture intrusion and radon emanation. The clay liner is covered with a surface layer of loosely compacted, 45-cm- (18-in.-) thick soil cover and topsoil. This surface layer forms a

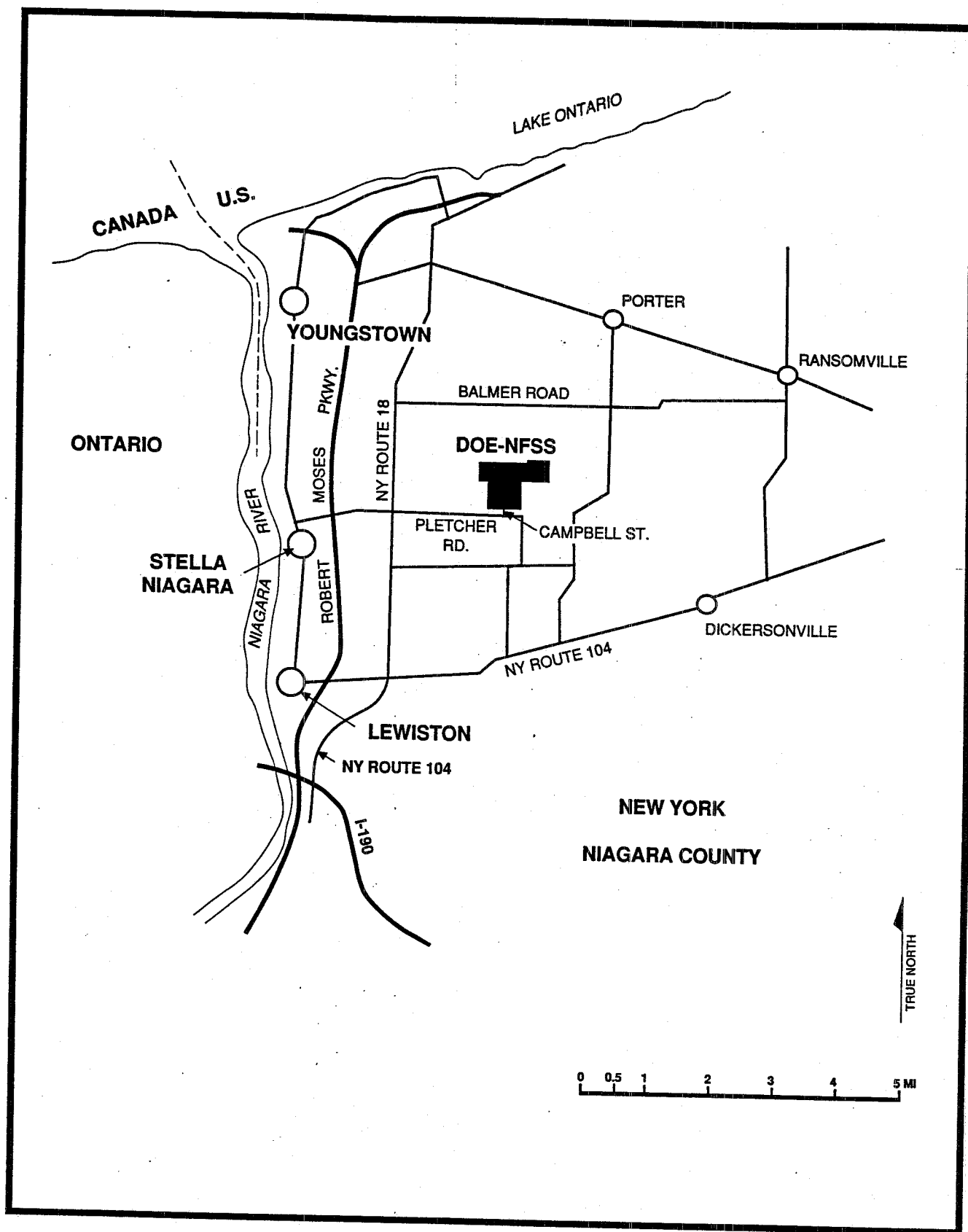


FIGURE 1-1 REGIONAL SETTING OF NFSS

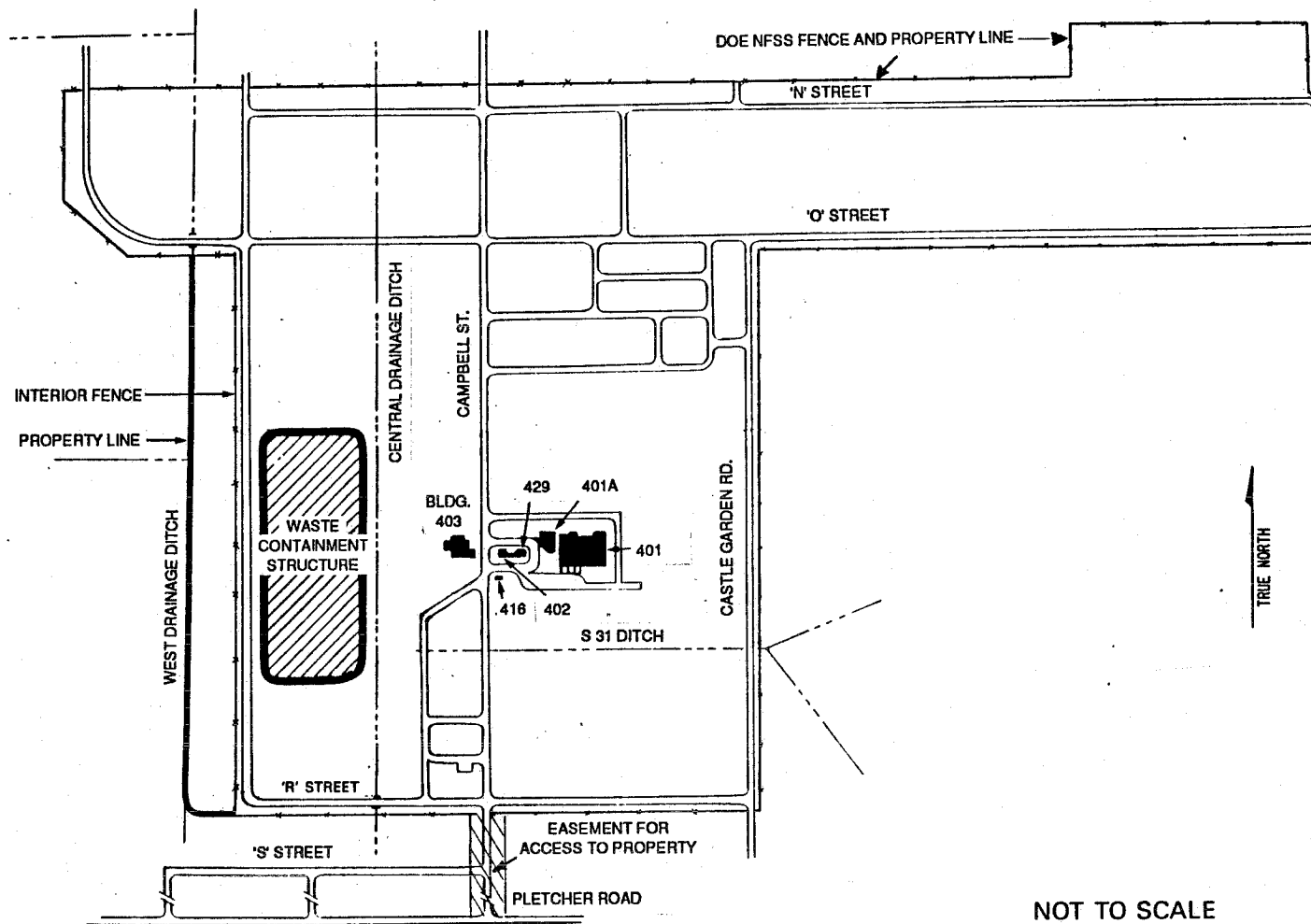


FIGURE 1-2 SITE PLAN OF NFSS

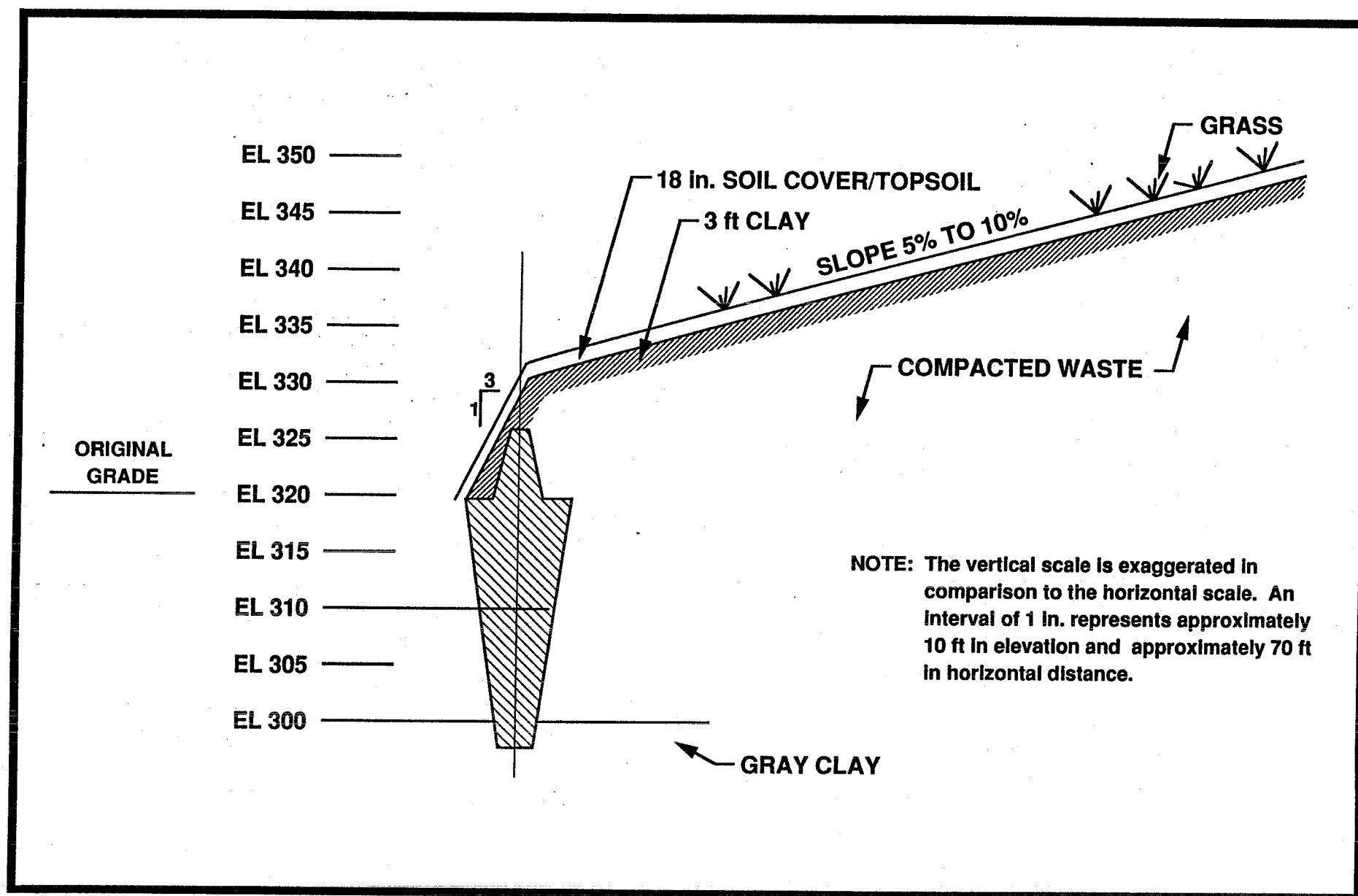
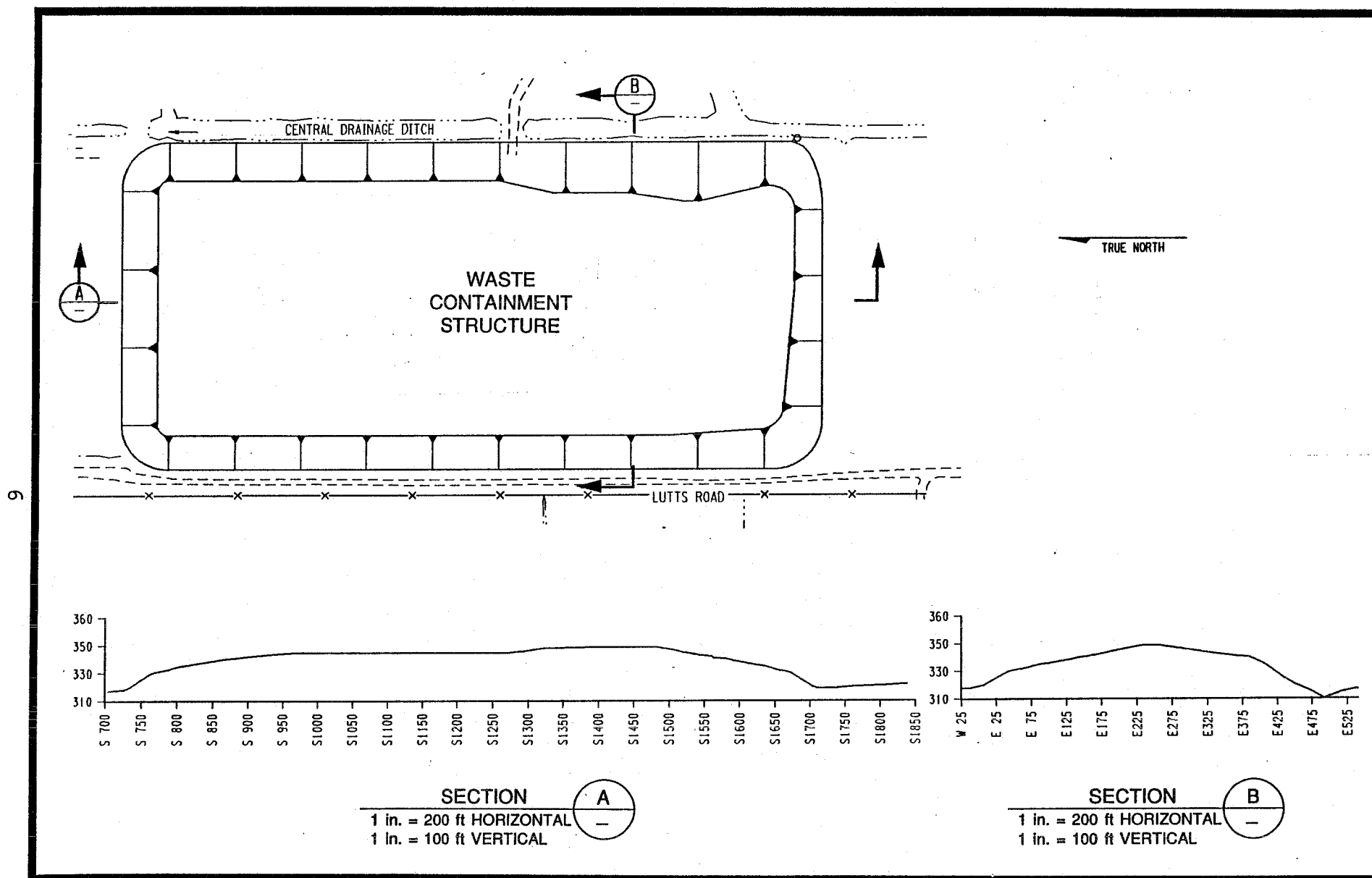


FIGURE 1-3 CROSS SECTION OF THE NFSS WASTE CONTAINMENT STRUCTURE



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FIGURE 1-4 ORTHOGRAPHIC PROJECTION OF THE WASTE CONTAINMENT STRUCTURE

protective blanket to maintain moisture and prevent drying that could result in the formation of tension cracks within the clay layer and to reduce the effects of frost. It also provides a base for shallow-rooted grass. The clay layer, soil cover, and topsoil compose the short-term closure system for the WCS.

1.2 PROGRAM OBJECTIVE

The primary objective of the performance monitoring program is the early detection of trends that could indicate weaknesses developing in the WCS. The monitoring system serves as the basis for a preventive maintenance program, allowing corrective action to be taken before the integrity of the structure is compromised. Consequently, surface and subsurface monitoring techniques are used. Possible indications of structural distress include:

- Differential settlement of the wastes
- Desiccation cracking of the clay cover
- Deep surface erosion
- Animal burrows
- Deep-rooted vegetation
- Rapid rise of the potentiometric (saturated) surface inside the containment structure
- Residual reduction in soil density caused by frost heave

2.0 SUMMARY OF PERFORMANCE MONITORING PROGRAM

The performance monitoring program at NFSS was initiated in November 1986 to monitor the surface and subsurface conditions of the WCS. Surface techniques were used to check waste placement, the various layers of the WCS cover, and surface drainage. Internal instrumentation monitors the performance of the clay cap, the gray clay unit, and the cutoff wall/dike.

Surface monitoring activities include topographic surveys, walkover surveys, and annual aerial photography. Initial aerial photographs were taken in early October 1986 to provide the required baseline photographic data. This aerial mapping provided a reference for detection of changes in the surface contours of the WCS to supplement the information provided by the topographic and walkover surveys.

The topographic and walkover surveys were initially performed in the fall of 1986, following closure of the WCS. These activities established the baseline for subsequent annual performance monitoring surveys. Data obtained at that time represented the initial condition of the WCS and provided the basis for determining whether any additional maintenance actions were required. As a result of the initial and subsequent walkovers, several actions have been taken to maintain the required performance results. These actions include adding topsoil to low areas, seeding and fertilizing, installing erosion control netting, and repairing well casings. The results of the surface monitoring are discussed in Subsection 3.1, and the actions required are discussed in Section 5.0.

Internal monitoring instrumentation includes VWPTs to monitor pore-water pressure and a secondary system of pneumatic pressure transducers (PPTs) to check on the operation of the VWPTs. The locations of these devices are shown in Figure 2-1. The PPTs were installed adjacent to three of the VWPTs, primarily to verify the results of the VWPTs. In the previous performance monitoring report, the PPT results were presented and indicated that the VWPTs were performing correctly (Bechtel 1989b). No PPT data are presented in this report.

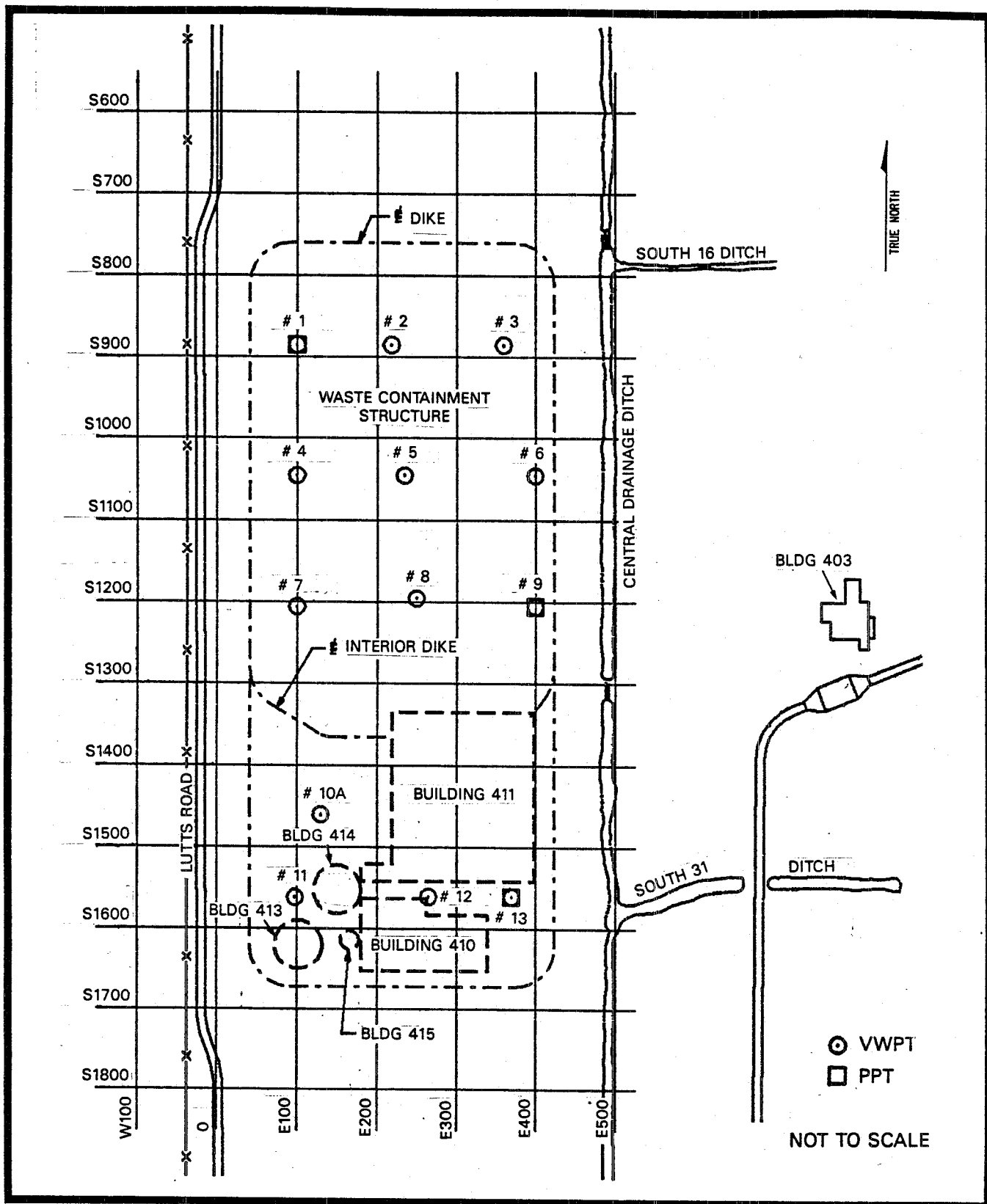


FIGURE 2-1 LOCATIONS OF VWPTs AND PPTs ON THE WASTE CONTAINMENT STRUCTURE

The VWPTs record readings automatically each day, and data for each instrument are compiled and analyzed monthly to detect any early indication of water accumulating inside the WCS. A summary of the data from the VWPTs is presented in Appendix A.

Walkover surveys and data collected from monitoring wells and VWPTs confirm that the WCS is functioning as predicted and is providing isolation for the waste.

3.0 PERFORMANCE MONITORING DATA

This section provides the results of the performance monitoring and a summary of the results of the environmental monitoring at NFSS for July to December 1988 and calendar year 1989. The specific details of the hydraulic head monitoring results for this period are provided in Appendix A. Complete environmental monitoring information is provided in the 1988 and 1989 environmental monitoring reports (Bechtel 1989a, 1990).

3.1 SURFACE MONITORING

3.1.1 Aerial Photography

The most recent aerial contour mapping of the WCS surface was performed in November 1989 (see Figure 3-1). The latest aerial photograph of the WCS was taken in November 1989 (see Figure 3-2). When compared with the October 1986 aerial photograph (Figure 3-3), the 1989 photograph clearly shows that formerly bare areas in the middle and at the south end of the WCS now have well-established turf. The water-holding ponds shown in the 1986 photograph have been filled and, therefore, are not in the 1989 view. The 1989 photograph documents the improved condition of the WCS as a result of maintenance performed under the performance monitoring program.

3.1.2 Grid Survey

The initial grid survey of the WCS surface was performed in 1986 on the predetermined grid shown in Figure 3-4. The grid layout used 30.5-m (100-ft) spacing. At each grid intersection, 5- by 5- by 20-cm (2- by 2- by 8-in.) wooden stakes were driven flush with the surface of the topsoil, and their elevations were measured. Subsequent grid surveys have been performed twice

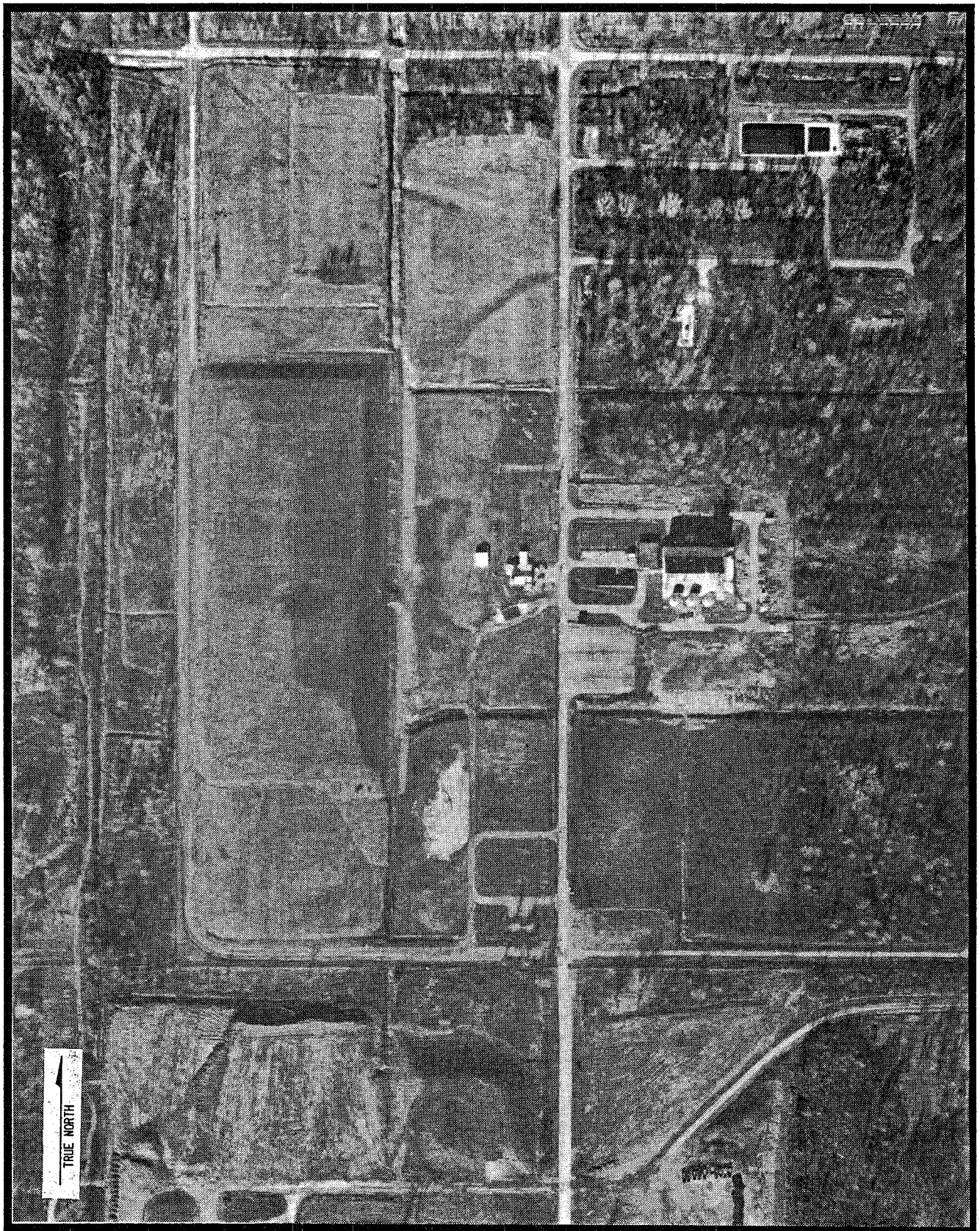


FIGURE 3-2 AERIAL VIEW OF THE NFSS WASTE CONTAINMENT STRUCTURE — NOVEMBER 1989

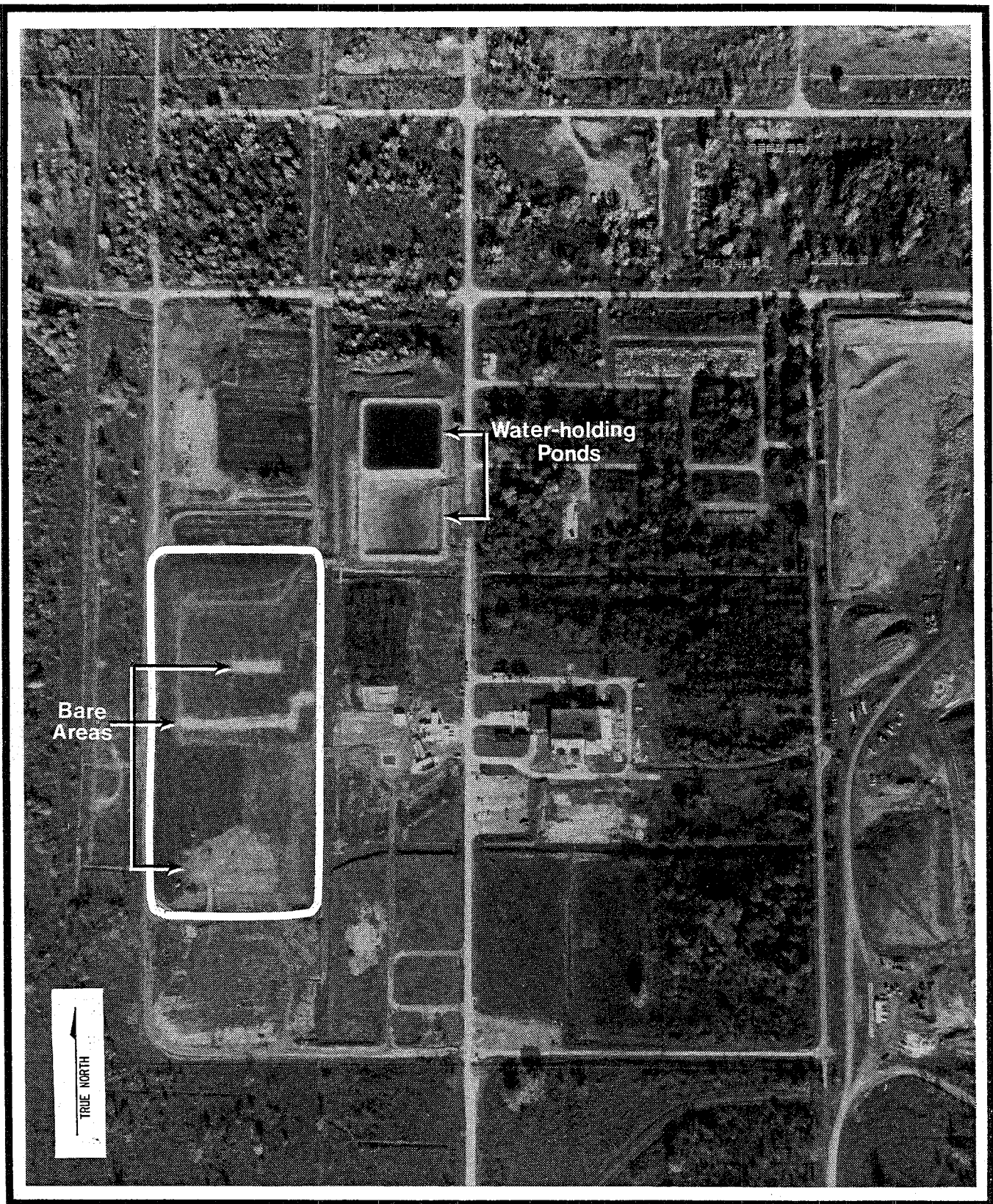
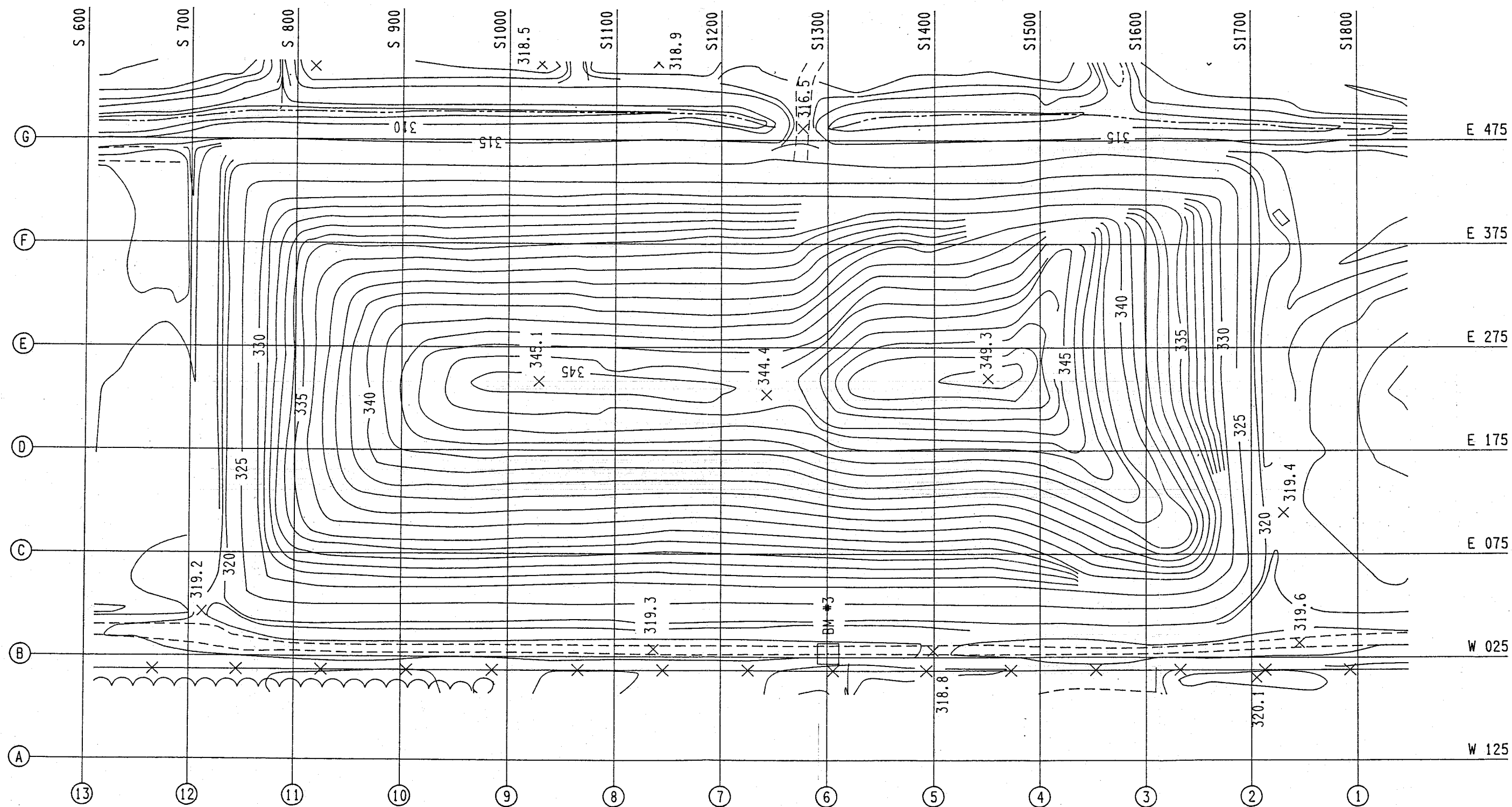


FIGURE 3-3 AERIAL VIEW OF THE NFSS WASTE CONTAINMENT STRUCTURE — OCTOBER 1986

TRUE NORTH



NOTE: ALL ELEVATIONS SHOWN AS FEET ABOVE MEAN SEA LEVEL (MSL)

FIGURE 3-1 AERIAL CONTOUR MAP OF THE NFSS WASTE CONTAINMENT STRUCTURE — NOVEMBER 1989

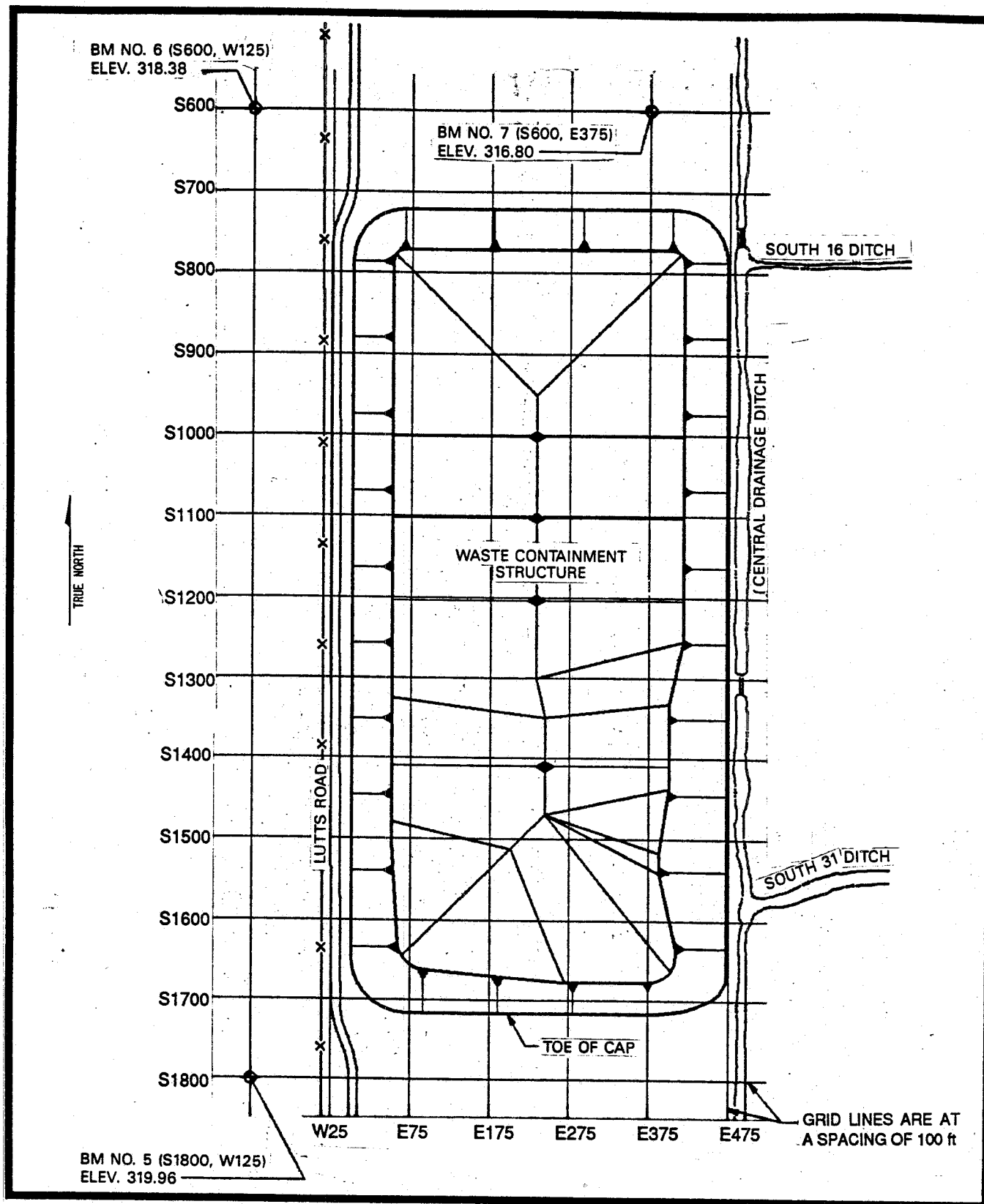


FIGURE 3-4 SURVEY GRID FOR THE NFSS WASTE CONTAINMENT STRUCTURE

each year and correspond to the annual spring and fall walkovers. The elevations and changes observed at these grid intersections are reported in Table 3-1 and represented in Figures 3-5 through 3-8.

Permanent bench marks were installed at three grid intersections: S1800, W125; S600, W125; and S600, E375. The bench marks are tied to the New York State Plane Coordinate System; the corresponding coordinates on this system are N1,170,797.56, E392,146.12; N1,171,997.47, E392,146.32; and N1,171,997.39, E392,646.28, respectively. Each bench mark is a permanent concrete monument with a brass designation marker.

Figures 3-5 through 3-8 are topographic representations of the elevations of the WCS as determined by the grid survey performed in conjunction with the fall and spring walkovers. Figure 3-5 represents the WCS in its original configuration or as-built conditions and is used as the baseline map. Figures 3-6 through 3-8 are topographic representations of the WCS as surveyed for the corresponding walkover using the grid survey program. In comparing each grid survey with the baseline survey established in 1986, there is evidence of some slight settlement occurring in the southern portion of the WCS. Specifically, grid intersection point S1500, E275 exhibits the largest settlement at 0.15 m (0.49 ft). This region of the WCS contains Building 411. During construction of the WCS, the foundation for Building 411 was used as the primary containment for the L-30, F-32, and K-65 residues. Continuing consolidation of the residue materials after placement probably accounts for the settlement.

The settlement rate in the southern portion of the WCS is expected to begin decreasing. The grid survey for the walkover conducted in spring 1990 will be closely observed to determine whether the current trend is continuing. Because the settlement from waste consolidation is general rather than isolated, and the WCS is an interim configuration, the settlement does not threaten the integrity of the WCS.

TABLE 3-1

GRID SURVEYS FOR THE NIAGARA FALLS STORAGE SITE

Page 1 of 2

Site Coordinates		Elevation (ft MSL) ^a			
South	East	10/14/86	10/7/88	4/24/89	9/25/89
700	75	318.20	318.04 [-0.16] ^b	318.15 [-0.05] ^b	318.17 [-0.03] ^b
700	175	317.20	317.04 [-0.16]	317.07 [-0.13]	317.06 [-0.14]
700	275	317.10	316.67 [-0.43]	316.56 [-0.54]	316.61 [-0.49]
700	375	317.10	315.99 [-1.21]	316.07 [-1.13]	316.06 [-1.14]
800	75	332.20	333.14 [+0.94]	333.16 [+0.96]	333.12 [+0.92]
800	175	334.70	334.62 [-0.08]	334.64 [-0.06]	334.58 [-0.12]
800	275	334.50	334.46 [-0.04]	334.46 [-0.04]	334.43 [-0.07]
800	375	333.50	333.55 [+0.05]	333.57 [+0.07]	333.49 [-0.01]
900	75	333.90	333.82 [-0.08]	333.85 [-0.05]	333.80 [-0.10]
900	175	341.20	341.20 [0.00]	341.26 [+0.06]	341.18 [-0.02]
900	275	341.70	341.69 [-0.01]	341.69 [-0.01]	341.62 [-0.08]
900	375	334.60	334.64 [+0.04]	334.64 [+0.04]	334.60 [0.00]
1000	75	333.60	333.56 [-0.04]	333.64 [+0.04]	333.60 [0.00]
1000	175	341.80	341.67 [-0.13]	341.73 [-0.07]	341.69 [-0.11]
1000	275	343.10	342.93 [-0.17]	342.96 [-0.14]	342.86 [-0.24]
1000	375	334.50	334.46 [-0.04]	334.43 [-0.07]	334.42 [-0.08]
1100	75	333.10	333.02 [-0.08]	333.05 [-0.05]	333.01 [-0.09]
1100	175	341.40	341.41 [+0.01]	341.43 [+0.03]	341.39 [-0.01]
1100	275	342.50	342.50 [0.00]	342.47 [-0.03]	342.42 [-0.08]
1100	375	334.90	334.84 [-0.06]	334.83 [-0.07]	334.78 [-0.12]
1200	75	333.00	332.95 [-0.05]	332.96 [-0.04]	332.96 [-0.04]
1200	175	341.20	341.15 [-0.05]	341.19 [-0.01]	341.14 [-0.06]
1200	275	342.30	342.24 [-0.06]	342.24 [-0.06]	342.22 [-0.08]
1200	375	335.00	334.91 [-0.09]	334.92 [-0.08]	334.88 [-0.12]
1300	75	333.60	333.56 [-0.04]	333.61 [+0.01]	333.65 [+0.05]
1300	175	342.40	342.40 [0.00]	342.40 [0.00]	342.40 [0.00]
1300	275	344.70	344.69 [-0.01]	344.64 [-0.06]	344.61 [-0.09]
1300	375	337.50	337.49 [-0.01]	337.50 [0.00]	337.45 [-0.05]
1400	75	333.70	333.66 [-0.04]	333.73 [+0.03]	333.69 [-0.01]
1400	175	343.20	343.11 [-0.09]	343.15 [-0.05]	343.12 [-0.08]
1400	275	347.40	347.12 [-0.28]	347.11 [-0.29]	346.99 [-0.41]
1400	375	339.60	339.47 [-0.13]	339.46 [-0.14]	339.42 [-0.18]
1500	75	334.50	334.43 [-0.07]	334.47 [-0.03]	334.42 [-0.08]
1500	175	343.20	343.05 [-0.15]	343.12 [-0.08]	343.05 [-0.15]
1500	275	347.10	346.70 [-0.40]	346.75 [-0.35]	346.61 [-0.49]
1500	375	343.30	343.18 [-0.12]	343.16 [-0.14]	343.09 [-0.21]

TABLE 3-1
(continued)

Page 2 of 2

Site Coordinates		Elevations (ft MSL) ^a			
South	East	10/14/86	10/7/88	4/24/89	9/25/89
1600	75	338.80	338.72 [-0.08] ^b	338.79 [-0.01] ^b	338.73 [-0.07] ^b
1600	175	339.80	339.65 [-0.15]	339.71 [-0.09]	339.66 [-0.14]
1600	275	337.50	337.43 [-0.07]	337.47 [-0.03]	337.43 [-0.07]
1600	375	337.80	337.67 [-0.13]	337.71 [-0.09]	337.67 [-0.13]
1700	75	323.10	322.98 [-0.12]	323.07 [-0.03]	323.07 [-0.03]
1700	175	321.20	321.07 [-0.13]	321.14 [-0.06]	321.11 [-0.09]
1700	275	319.90	319.79 [-0.11]	319.90 [0.00]	319.80 [-0.10]
1700	375	320.50	320.28 [-0.22]	320.33 [-0.17]	320.29 [-0.21]
1800	75	320.20	319.90 [-0.30]	320.03 [-0.17]	319.94 [-0.26]
1800	175	320.50	320.70 [+0.20]	320.84 [+0.34]	320.69 [+0.19]
1800	275	321.40	320.55 [-0.85]	320.68 [-0.72]	320.57 [-0.83]
1800	375	317.60	317.57 [-0.03]	317.64 [+0.04]	317.59 [-0.01]

^aFeet above mean sea level.

^bValues in brackets indicate changes in elevation from the 1986 survey.

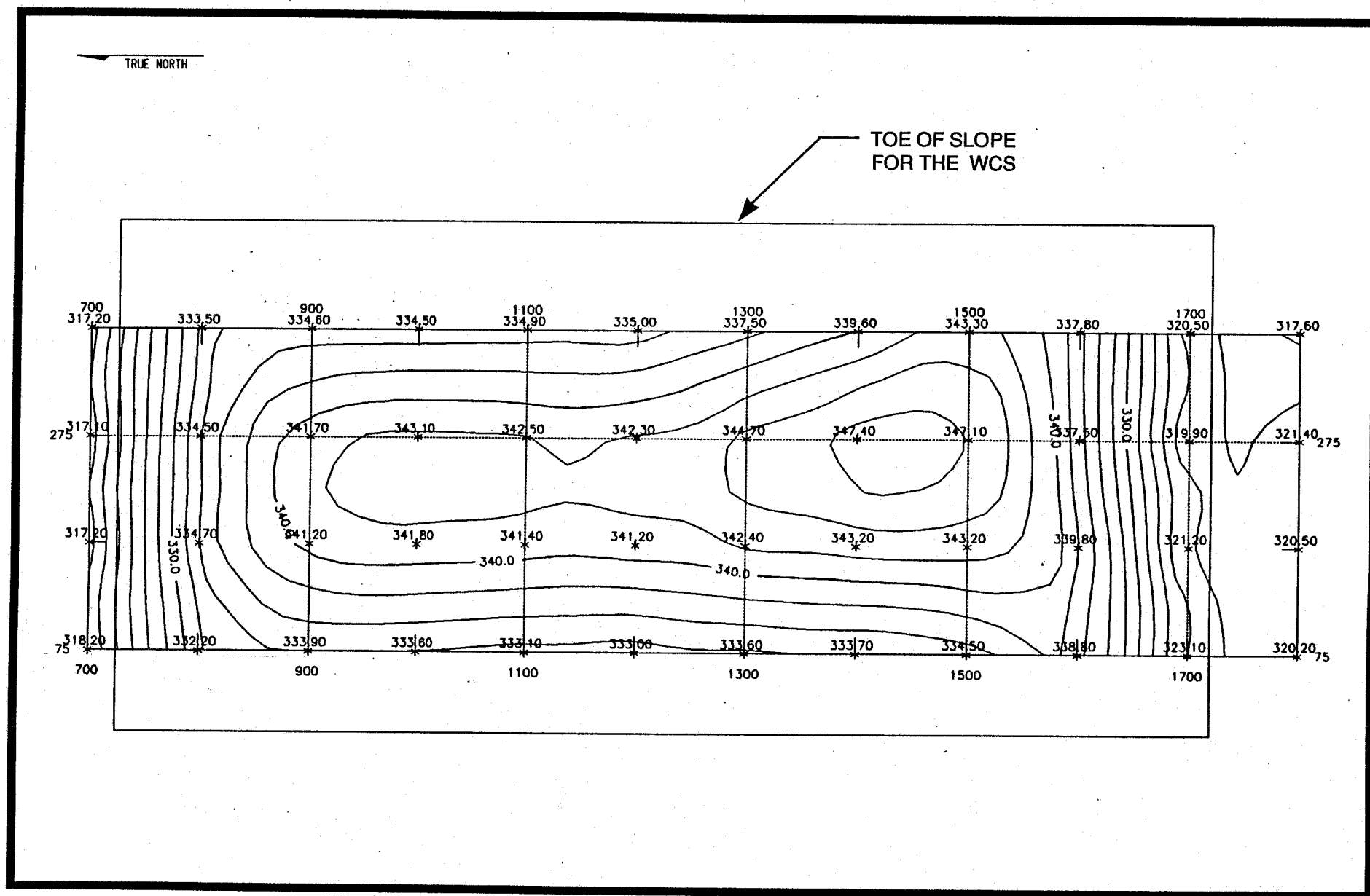


FIGURE 3-5 WCS BASELINE GRID SURVEY, FALL 1986

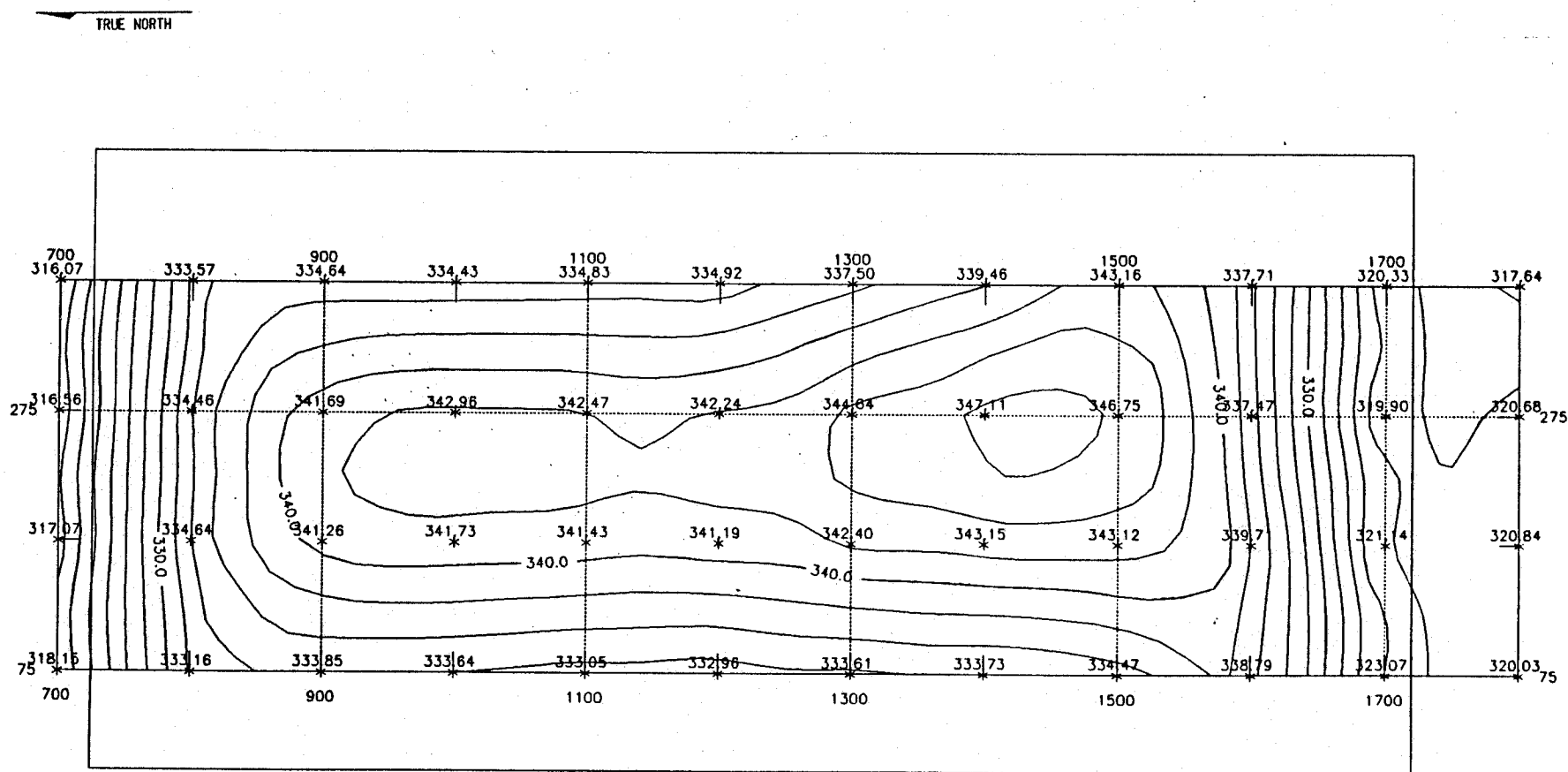


FIGURE 3-7 WCS COMPARISON GRID SURVEY, SPRING 1989

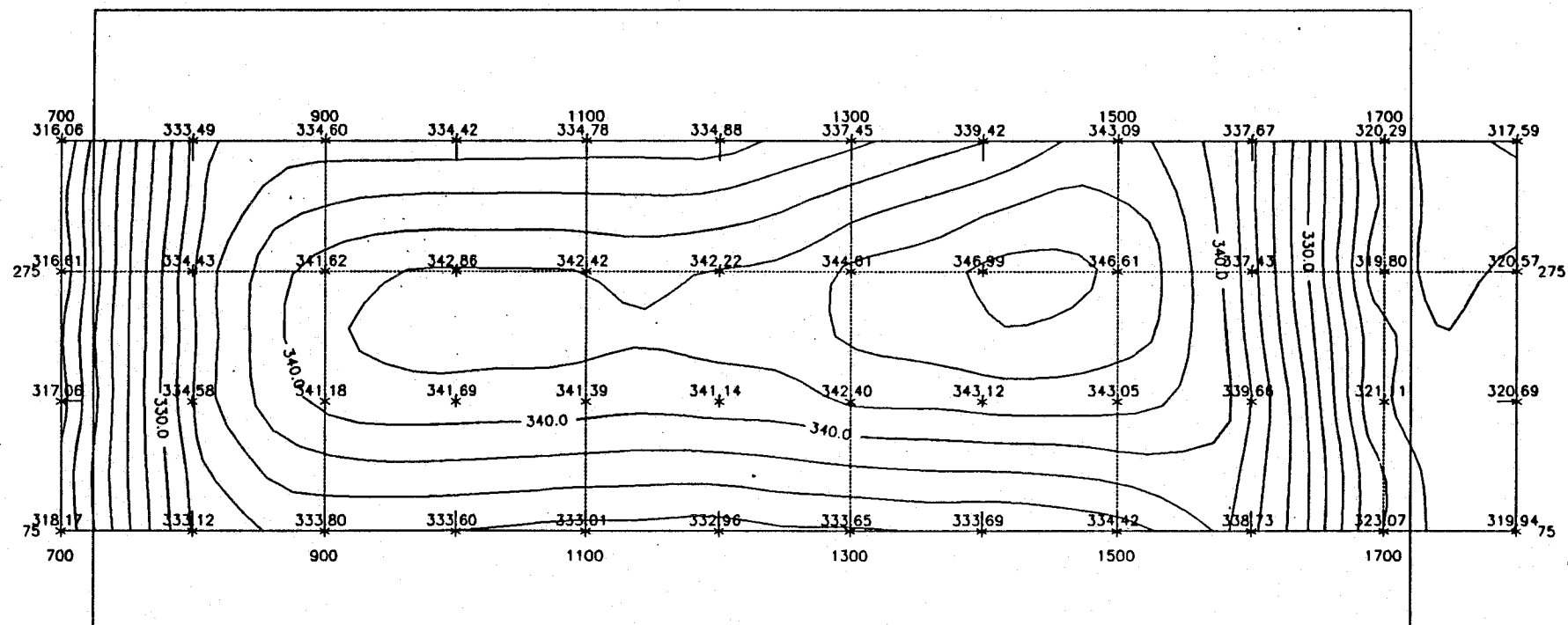


FIGURE 3-8 WCS COMPARISON GRID SURVEY, FALL 1989

3.1.3 Walkover Survey

The WCS walkover survey during the spring and fall of each year was developed as the means by which the WCS would be evaluated for overall performance. The walkover survey team consists of representatives from engineering, geology, and site operations. This section of the report presents the results of the fall 1988 and the spring and fall 1989 walkover surveys.

The initial walkover survey was performed on November 17 and 18, 1986. The survey team evaluated settlement or movement, cracking, undesired plant growth, or other undesirable conditions on the WCS cap. To conduct the walkover survey, team members walk a preplanned route, based on the established grid, that ensures complete and systematic inspection of the cap. The walkover survey generally covers the WCS area, major site drainage features, and other items determined by the team to be pertinent to site stability.

The NFSS walkovers detailed in this section were performed following the same walkover pattern used in previous performance appraisals. Close-spaced, north-south routes were followed starting at the southwest corner of the WCS. The walkover team members were free to adjust their routes along each traverse to view the cap surface in whatever detail seemed appropriate. Team members kept notes of conditions that required maintenance and placed pin-flag markers at those locations to assist the maintenance team in finding them.

Calendar year 1988

The fall 1988 walkover was conducted in October 1988. Overall, the cap was judged to be in better condition than in spring 1988.

During the walkover, the following anomalies of the topsoil cover were noted. Embedded debris (rock and organic material) now visible at the surface of the cover requires removal and backfilling of the resulting void. Also present on the topsoil

cover are patches of barren soil that require reseeding. Broad-leaved plants, such as clover and crown vetch, are emerging sporadically throughout the cap.

It has been noted that desiccation cracking has occurred in the past during times of drought (see Figure 3-9). Desiccation cracking was noted during the fall 1988 walkover; however, the cracking was beginning to mend. Desiccation cracking can be prevented by maintaining a good grass cover. The irrigation system currently used at the site is operated during dry periods to maintain the grass cover; however the system has been out of order at various times in the past. The system has been upgraded and should perform as required in the future.

During the fall 1988 walkover, several apparent depressions were noted that may require reexamination and possibly a 3-m (10-ft) grid survey to facilitate closer observation. The presence of swales in the surface of the WCS may indicate settling of the waste material. As indicated in the topographic illustrations in Subsection 3.1.2, there is general settlement of the waste material occurring in the area of Building 411 of the WCS.

The team members noted that repeated use of the WCS side slopes for vehicle access to the top of the pile has resulted in dead grass in the areas used. Because of the necessity for maintenance equipment to work on the pile, it is suggested that an access ramp be constructed at the west end of the north slope (see Figure 3-9).

Calendar year 1989

Walkovers were performed in April and October 1989. Turf condition has improved; however, localized areas with undesirable plants, erosion, insufficient grass, and desiccation cracks were identified.

Although broad-leaved plants continue to be of concern, a weed control program will be planned to eradicate the plants.

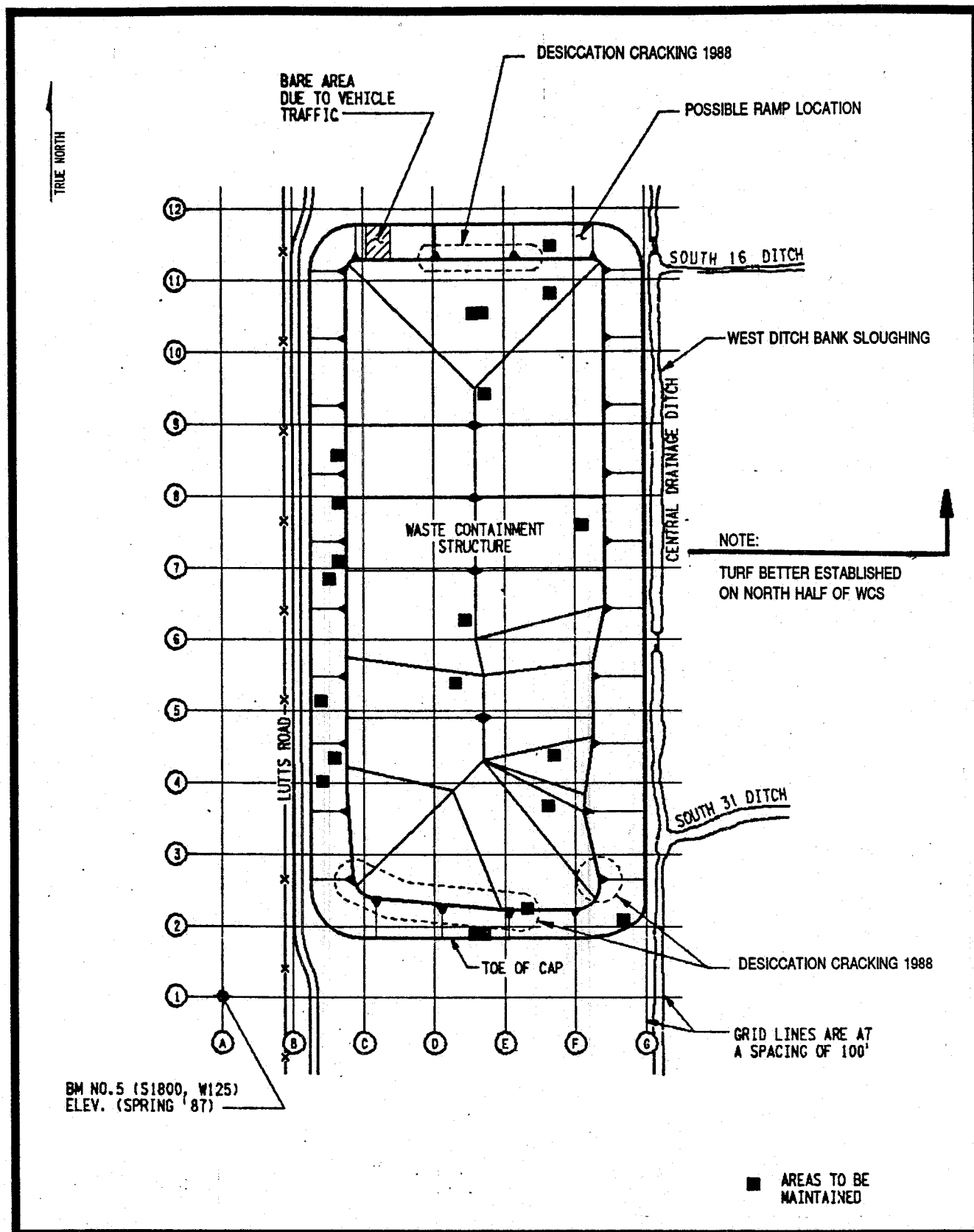


FIGURE 3-9 AREAS OF THE WCS REQUIRING MAINTENANCE ACTIONS

There is minor evidence of erosion of the topsoil cover on the WCS. Past erosion areas on the WCS have been successfully controlled and corrected. Uncontrolled drainage into the central drainage ditch along the west bank is causing erosion gullies up to 0.3 m (1 ft) deep.

Although the grass cover in 1989 was better than in previous walkovers, it still lacks denseness and vigor in some spots. Occasional bare patches exist and the periodic reseeding does not appear to have been effective. Desiccation cracks were observed in association with the patches of bare ground but are less prevalent than was observed during previous walkovers.

Areas of apparent settlement were observed in the spring 1989 walkover. The fall 1988 survey had indicated a potential need for a 3-m (10-ft) grid survey on specific areas of the WCS to check for settlement. However, because there was no visible evidence of settlement of the WCS during the fall 1989 walkover, that survey was not conducted. Areas identified from past walkovers were carefully examined, and no new evidence of settlement was found.

Several items were observed during past walkovers that need to be readdressed and evaluated for effectiveness. The central ditch has eroded areas that need to be stabilized with riprap or other erosion control methods. It has been proposed in past walkover reports to construct an access ramp to the WCS cap. The ramp would facilitate equipment access to the cap and prevent slope damage. Driving equipment to the top of the WCS has caused distressed areas of the grass cover on the side slope.

Water has accumulated in the geotechnical instrumentation manhole on the east side of the WCS. Infiltration may be occurring around the manhole cover and through the cable ports in the sidewalls. It is necessary that the manhole be pumped dry and the cable ports sealed. Poor surface drainage near this manhole increases the need to seal the ports.

3.2 SUBSURFACE MONITORING

In the fall of 1986, 13 VWPTs and 3 PPTs were installed inside the WCS, as shown in Figure 2-1. The three PPTs were installed at the same elevation and in the same boreholes as VWPTs 1, 9, and 13. The PPTs are used to check the operation and accuracy of the VWPTs. VWPT readings were initiated on November 4, 1986. Monthly readings of the PPTs began in July 1987. The data from the PPT readings indicated that the VWPTs are performing accurately; PPT data are not presented in this report. The instrument number, grid location, recorder channel, ground surface elevation, and instrument elevation are summarized in Table 3-2.

The VWPT data for this report includes readings from July 1988 through December 1989. The data from the VWPTs have been converted to hydraulic head and are plotted in Appendix A. In general, the plots exhibit a continuation of the seasonal trend observed in previous years. This trend is characterized by a maximum head elevation in early spring (March or April) and a minimum head elevation in the fall (September or October).

Exceptions to this trend were observed at VWPT-11 and VWPT-3 in the last half of 1989. VWPT-11 showed irregular readings beginning in February 1989, while VWPT-3 briefly exhibited irregular readings in the middle of September 1989. These two instruments, along with VWPT-12, eventually ceased to function. At present, it is uncertain whether the irregular readings observed at VWPT-11 and VWPT-3 are a result of actual pore pressure changes in the containment cell or represent a precursor to an electrical problem. Currently, the instruments are undergoing testing to determine the reason for the irregular readings and whether the instruments themselves are performing correctly.

To date, no data have been collected that exhibit any trends indicating weakness developing in the clay cap, the cutoff wall, the cutoff dike, or the gray clay unit.

TABLE 3-2
SUMMARY OF SUBSURFACE MONITORING INSTRUMENTS - 1987

Instrument (Borehole) Number	Site Grid Coordinates		Recorder Channel	Elevation (ft MSL) ^a		
	South	East		Ground (Cap)	Surface	Instrument ^b
1	885	100	11	335.2		321.2
2	885	220	12	341.4		320.7
3	885	360	13	335.6		320.1
4	1045	100	14	335.4		321.4
5	1045	235	15	344.9		320.6
6	1045	400	16	332.9		320.6
7	1205	100	17	335.3		320.6
8	1195	250	18	343.6		319.6
9	1205	400	19	334.8		322.6
10A ^c	1460	130	10	338.9		327.6
11	1561	98	1	339.0		323.8
12	1560	265	2	341.4		329.4
13	1560	370	3	341.5		329.0

^aFeet above mean sea level.

^bInstrument elevations for 1987 are based on as-built conditions. Instrument elevations for 1986 are based on design conditions.

^cInstrument 10 was damaged during construction; instrument 10A was installed as a replacement.

3.3 ENVIRONMENTAL MONITORING

NFSS environmental monitoring results summarized in this document are reported in the annual site environmental monitoring reports for calendar years 1988 and 1989 (Bechtel 1989a, 1990). This subsection presents the results of environmental monitoring for the last two quarters of 1988 and all four quarters of 1989 for radon and external gamma radiation levels, as well as radium-226 and uranium concentrations found in surface water, sediments, and groundwater adjacent to and in the vicinity of the WCS.

3.3.1 Radon Levels

Annual average concentrations of radon measured at the NFSS property line (see Figure 1-2) in 1989 ranged from 4.0×10^{-10} $\mu\text{Ci/ml}$ to 8.0×10^{-10} $\mu\text{Ci/ml}$ (0.4 to 0.8 pCi/L). The annual average background radon level was measured at 8×10^{-10} $\mu\text{Ci/ml}$ (0.8 pCi/L). Radon levels at the NFSS property line are indistinguishable from background levels.

Radon concentrations are determined using monitors purchased from the Terradex Corporation. These devices (Terradex Type F Track-Etch) consist of an alpha-sensitive film contained in a small plastic cup covered by a membrane through which radon can diffuse. Radon will diffuse through the membrane (in or out of the cup) when a concentration gradient exists; therefore, it will equilibrate with radon in the outside air. Alpha particles from the radioactive decay of radon and its daughters in the cup create tiny tracks when they collide with the film. When returned to Terradex from processing, the films are placed in a caustic etching solution to enlarge the tracks. The tracks can be counted under strong magnification. The number of tracks per unit area (i.e., tracks/mm²) is related through calibration to the concentration of radon in air.

Fresh Track-Etch monitors are obtained from Terradex each quarter. Site personnel place these units in each sampling location and return the exposed monitors to Terradex for analysis.

3.3.2 External Gamma Radiation Levels

Annual external gamma radiation levels at the NFSS property line (see Figure 1-2) ranged from background levels to 8 mrem/yr above background; the annual average was 77 mrem/yr. These levels are within the DOE guidelines of 100 mrem/yr.

External gamma radiation levels are measured by lithium fluoride thermoluminescent dosimeters. This system of measurement, used since 1988, uses tissue-equivalent dosimeters to provide values that are more realistic in terms of radiation dose to tissues of the body at a depth of 1 cm (0.4 in.). Each monitoring station contains a minimum of four dosimeters, which are exchanged after approximately one year of accumulated exposure. For example, a dosimeter placed in a station in October 1988 would be removed in October 1989 and replaced with a new dosimeter. Each dosimeter contains five individual lithium fluoride chips (each group of five chips preselected on the basis of having a reproducibility of ± 3 percent across a series of laboratory exposures), the responses of which are averaged. Analysis is performed by Thermo Analytical/Eberline. The average value is then corrected for the shielding effect of the shelter housing (approximately 8 percent). The corrected value is then converted to mrem/yr by dividing by the number of days of exposure and multiplying by 365 days.

3.3.3 Surface Water and Sediment Sampling

Surface water and sediment samples were collected at locations 9, 10, 11, 12, and 20 (Figures 3-10 and 3-11). Locations 12 and 20 are 1.6 and 3.2 km (1 and 2 mi) downstream, respectively, from the northern boundary of NFSS. Location 9 is a background location established at the South 31 ditch in October 1988. Locations 10 and 11 are in the central drainage ditch.

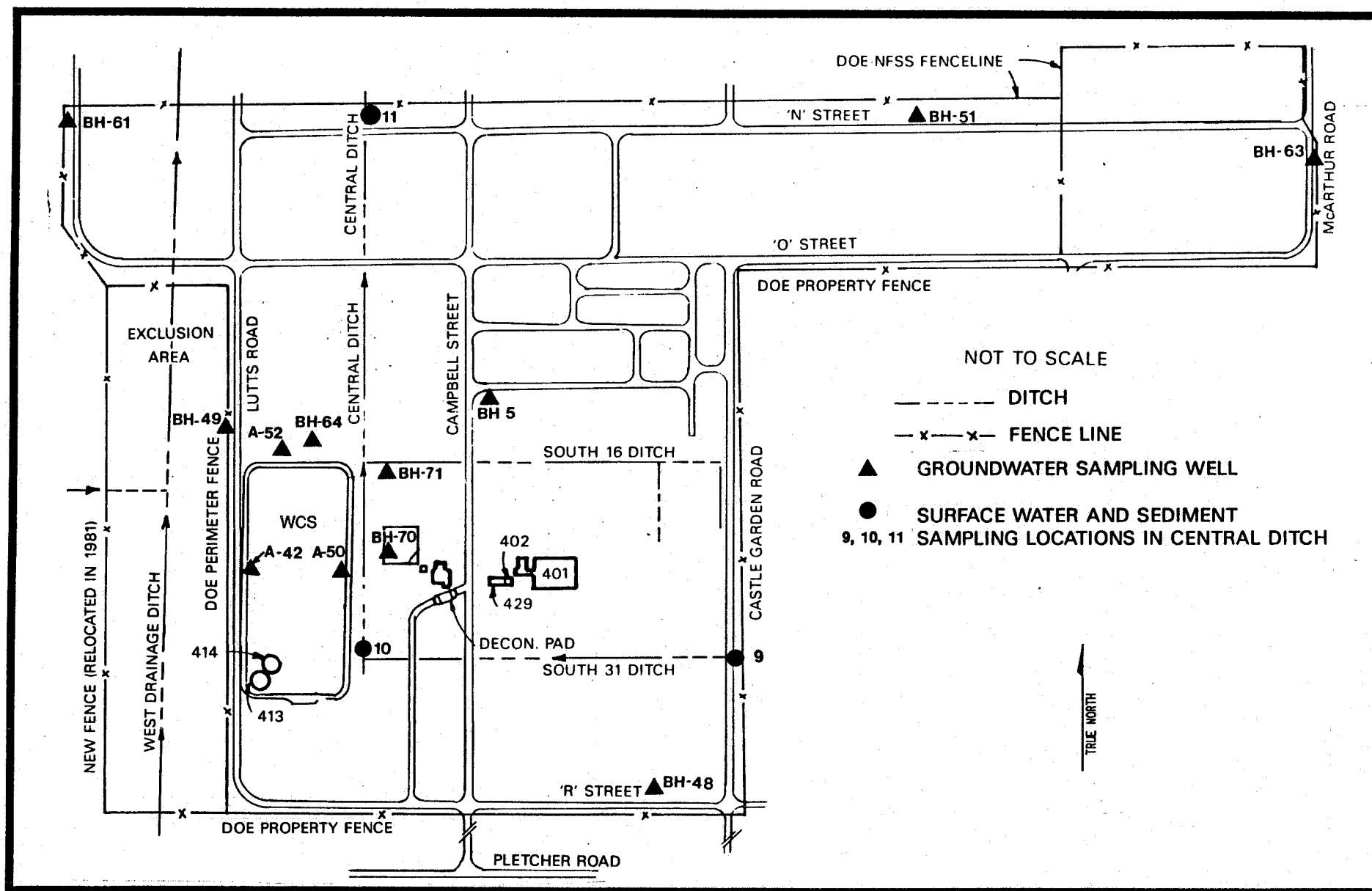


FIGURE 3-10 SURFACE WATER, GROUNDWATER, AND SEDIMENT SAMPLING LOCATIONS AT NFSS

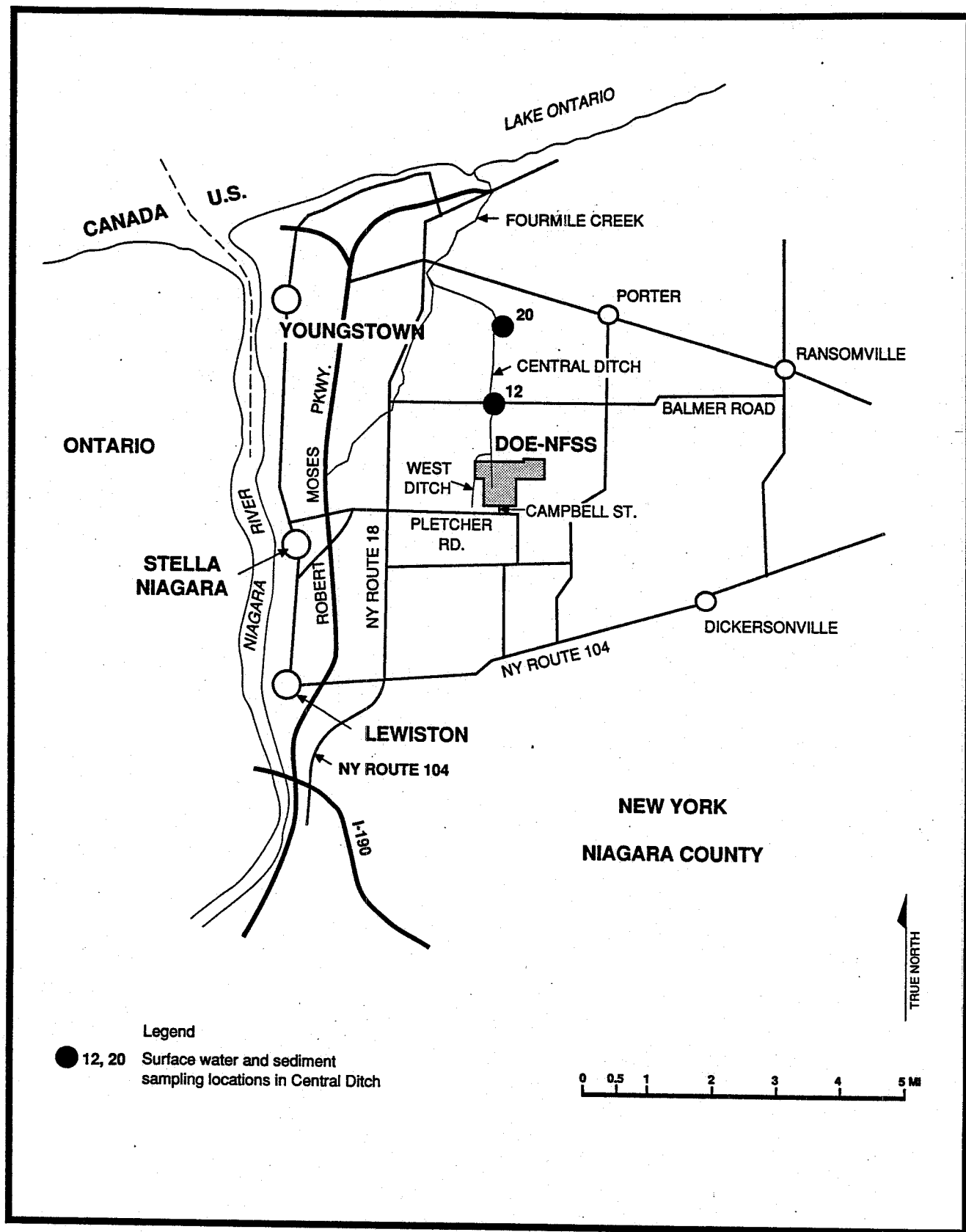


FIGURE 3-11 SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS IN THE VICINITY OF NFSS

Uranium and radium-226 results are presented in Tables 3-3, 3-4, and 3-5. Average uranium levels ranged from 9.0×10^{-9} to 2.1×10^{-8} $\mu\text{Ci/ml}$ (9 to 21 pCi/l) for surface water and from 1.5 to 6.8 pCi/g for sediments. Uranium levels measured in surface water are well within the DOE derived concentration guideline of 600 pCi/L. Currently, there are no guidelines established specifically for sediments, so guidelines for soil are often applied. Total uranium levels measured in sediments at NFSS are within the 90 pCi/g guideline established for the top 15 cm (5.9 in.) of soil.

DOE guidelines for radium-226 in water and soil are 100 pCi/L and 5 pCi/g, respectively. The maximum average radium-226 values of 1.2×10^{-9} $\mu\text{Ci/ml}$ (1.2 pCi/L) for surface water and 1.8 pCi/g for sediments are within the DOE guidelines and approximate background levels.

3.3.4 Groundwater Sampling

Groundwater samples were collected quarterly from 42 on-site wells. Sampling locations were selected based on the inventory of radioactive materials in various areas of the site and available hydrogeological data. Most of the monitoring wells are located near the WCS. Other wells are located upgradient and downgradient to provide background data and to monitor any migration of contaminants off site in the upper and lower groundwater systems. In late 1986, 36 wells were installed along the WCS perimeter to monitor its performance. These wells were added to the environmental monitoring program in April 1987.

Wells BH-5 and BH-48 monitor the lower groundwater system. Six on-site wells (BH-49, BH-51, BH-63, BH-64, BH-70, and BH-71 screened in the lower groundwater system) were monitored from 1983 through 1988 and then dropped from the program in January 1989. All parameters measured in these wells were consistently at or very close to background levels.

TABLE 3-3
CONCENTRATIONS OF URANIUM IN NFSS WATER SAMPLES -
JULY 1988 TO OCTOBER 1989

Sampling Location ^a	Concentration (10 ⁻⁹ μCi/ml) ^{b,c}						Avg.
	7/88	10/88	1/89	4/89	7/89	10/89	
<u>Surface Water</u>							
<u>On-Site</u>							
10	Dry	Ditch filled	Frozen	18	36	10	21
11	Dry	12	Frozen	16	18	14	15
<u>Off-Site</u>							
12	Dry	8	Frozen	13	9	9	10
20	Dry	10	Frozen	7	3	3	6
<u>Background^d</u>							
9	--	8	Frozen	13	11	3	9
<u>Groundwater</u>							
<u>On-Site</u>							
BH-5	<3	<3	18	4	<3	<3	6
BH-48	<3	3	<3	<3	10	<3	4
BH-61	<3	4	<3	<3	<3	<3	3
A-42	64	33	<3	100	85	80	61
A-50	<3	<3	<3	8	13	<3	6
BH-49	<3	7	--e	--e	--e	--e	5
BH-51	5	<3	--e	--e	--e	--e	4
BH-63	<3	<3	--e	--e	--e	--e	3
A-52	17	--f	<3	18	19	11	14
BH-64	7	<3	--e	--e	--e	--e	5
BH-70	<3	<3	--e	--e	--e	--e	3
BH-71	<3	<3	--e	--e	--e	--e	3

^aSampling locations are shown in Figures 3-10 and 3-11.

^b 1×10^{-9} $\mu\text{Ci/ml}$ is equivalent to 1 pCi/L.

^cMaximum allowable limit is 600 pCi/L per DOE Order 5400.5 (DOE 1990).

^dEstablished at South 31 ditch in October 1988.

^eDeemed stable (and low); dropped from program in fall 1989.

^fSample was sent to laboratory but was lost; no data received.

TABLE 3-4
CONCENTRATIONS OF RADIUM-226 IN NFSS WATER SAMPLES -
JULY 1988 TO OCTOBER 1989

Sampling Location ^a	Concentration (10 ⁻⁹ μ Ci/ml) ^{b, c}						
	7/88	10/88	1/89	4/89	7/89	10/89	Avg.
<u>Surface Water</u>							
<u>On-Site</u>							
10	Dry	Ditch filled	Frozen	0.3	0.9	0.6	0.5
11	Dry	1.1	Frozen	0.6	4.8	2.0	0.7
<u>Off-Site</u>							
12	Dry	0.4	Frozen	0.2	0.3	1.2	0.5
20	Dry	1.9	Frozen	0.2	0.4	0.8	0.8
<u>Background^d</u>							
9	--	0.2	Frozen	0.3	1.9	2.3	1.2
<u>Groundwater</u>							
<u>On-Site</u>							
BH-5	0.3	0.3	0.3	0.4	0.5	0.3	0.4
BH-48	0.8	0.7	0.8	0.5	0.8	0.6	0.7
BH-61	0.5	0.3	0.5	0.4	0.4	0.3	0.4
A-42	0.5	0.8	0.6	0.6	0.2	1.1	0.6
A-50	0.5	0.2	0.5	0.5	0.7	0.2	0.4
BH-49	0.6	0.2	--e	--e	--e	--e	0.4
BH-51	0.3	0.5	--e	--e	--e	--e	0.4
BH-63	0.5	0.4	--e	--e	--e	--e	0.5
A-52	0.3	--f	0.6	0.6	0.6	0.6	0.5
BH-64	0.7	0.4	--e	--e	--e	--e	0.6
BH-70	0.5	0.6	--e	--e	--e	--e	0.6
BH-71	0.4	0.2	--e	--e	--e	--e	0.3

^aSampling locations are shown in Figures 3-10 and 3-11.

^b1 x 10⁻⁹ μ Ci/ml is equivalent to 1 pCi/L.

^cMaximum allowable limit is 100 pCi/L per DOE Order 5400.5 (DOE 1990).

^dEstablished at South 31 ditch in October 1988.

^eDeemed stable (and low); dropped from program in fall 1989.

^fSample was sent to laboratory but was lost; no data received.

TABLE 3-5
CONCENTRATIONS OF URANIUM AND RADIUM-226 IN NFSS
SEDIMENT SAMPLES - JULY 1988 TO OCTOBER 1989

Sampling Location ^a	Concentration (pCi/g) ^b						
	7/88	10/88	1/89	4/89	7/89	10/89	Avg.
<u>Uranium</u>							
<u>On-Site</u>							
10	--C	2.7	Frozen	14.5	--C	3.2	6.8
11	--C	1.8	Frozen	1.5	2.5	2.4	2.1
<u>Off-Site</u>							
12	--C	1.7	Frozen	1.4	1.5	1.4	1.5
20	--C	1.4	Frozen	1.6	--C	1.4	1.5
<u>Background</u>							
9	--C	2.0	Frozen	2.4	--C	2.8	2.4
<u>Radium-226</u>							
<u>On-Site</u>							
10	--C	1.4	Frozen	3.0	--C	0.9	1.8
11	--C	1.4	Frozen	0.9	1.5	2.8	1.7
<u>Off-Site</u>							
12	--C	1.7	Frozen	0.5	0.9	0.9	1.0
20	--C	1.0	Frozen	0.8	--C	0.8	0.9
<u>Background</u>							
9	--C	1.3	Frozen	1.0	--C	1.0	1.1

^aSampling locations are shown in Figures 3-10 and 3-11.

^bFor the top 15 cm (5.9 in.) of soil, the maximum allowable concentration for natural uranium in soil at NFSS is 90 pCi/g (DOE 1988), and the maximum allowable concentration for radium-226 is 5 pCi/g (EPA 40 CFR §192.12).

^cSampling error (no sample).

Wells A-42, A-50, and A-52 also monitor the upper groundwater system around the WCS but are not among the 36 new wells. Well A-42 is drilled into a sand lens of unknown extent. The chemical, radiological, and hydrogeological characteristics of this well were investigated in December 1988. Results indicate that the sand lens monitored by this well is not in good hydraulic connection with the zones of completion in adjacent wells. Additionally, results of sequential sampling indicate that radioactive contamination in Well A-42 may be associated with contaminated soil in or near the well.

Background monitoring wells BH-48 and BH-61, which are installed in the lower groundwater system outside the WCS area, are upgradient and downgradient, respectively.

The locations of wells are shown in Figure 3-12 and previously in Figure 3-10. Corresponding data for uranium and radium-226 concentrations were reported in Tables 3-3 through 3-5 and in Tables 3-6 and 3-7. Although Tables 3-3 through 3-7 report sampling only for the last two quarters of 1988 and all four quarters of 1989, the overall groundwater and surface water monitoring results from 1983 to April of 1988 have been similar (Bechtel 1989a).

In general, the data reported in Tables 3-3 through 3-7 show a small seasonal fluctuation in the values; however, during the monitoring period no significant increases were detected. All of the values presented in the data tables are near background levels, with the exception of the samples collected from wells A-42 and A-52. All of the samples are well below DOE guidelines, with the maximum concentration of uranium in well A-42 being approximately 10 percent of DOE guidelines.

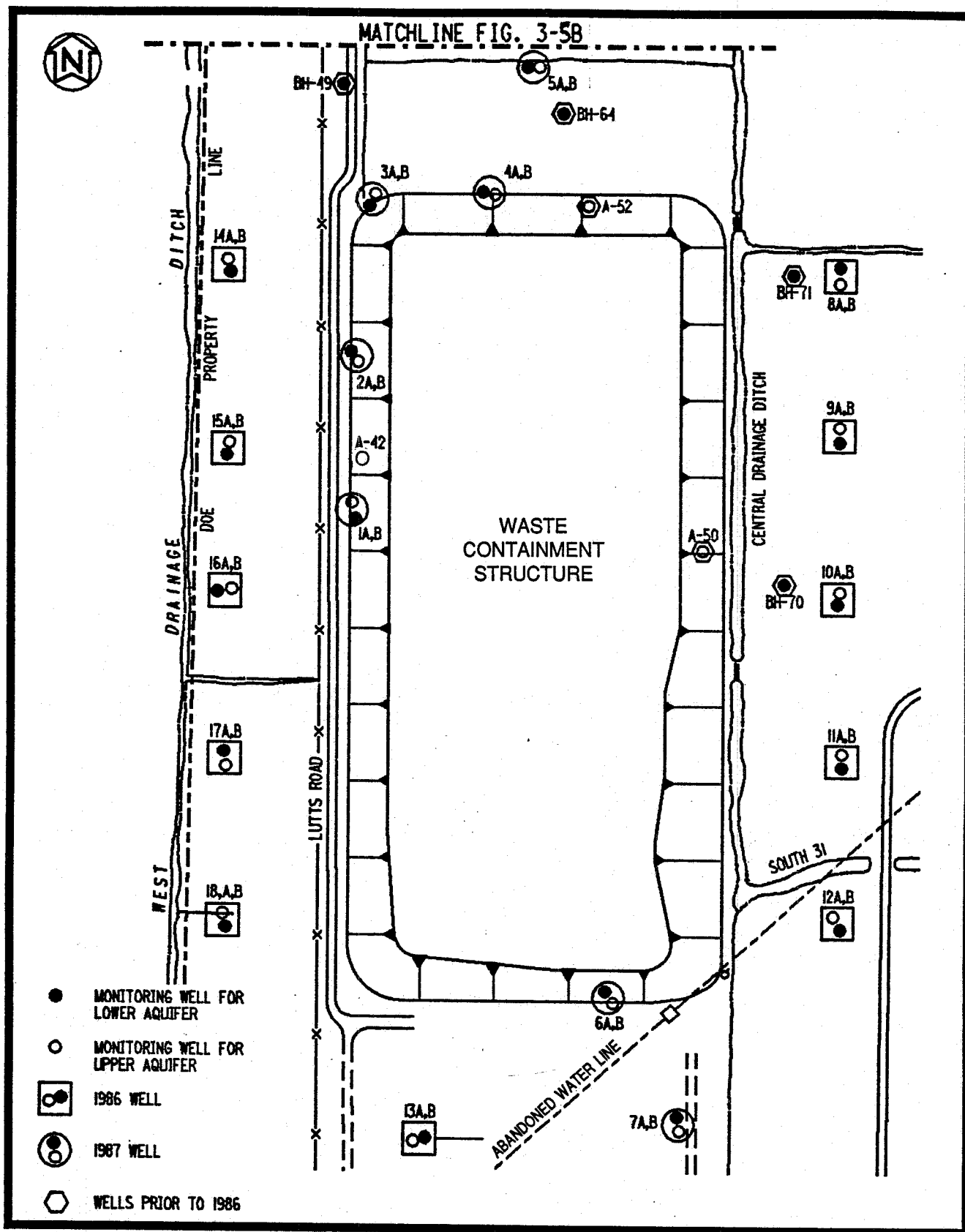


FIGURE 3-12 LOCATIONS OF NFSS GROUNDWATER MONITORING WELLS IN THE VICINITY OF THE WASTE CONTAINMENT STRUCTURE

TABLE 3-6
CONCENTRATIONS OF URANIUM IN NFSS CONTAINMENT
MONITORING WELLS - JULY 1988 TO OCTOBER 1989

Sampling Location ^a	Concentration (pCi/L)						Avg.
	7/88	10/88	1/89	4/89	7/89	10/89	
1A	<3	<3	3	<3	5	<3	4
1B	6	6	12	7	9	<3	7
2A	3	<3	<3	<3	5	<3	4
2B	9	9	9	9	12	7	9
3A	5	<3	5	9	9	8	7
3B	15	15	15	18	20	16	16
4A	<3	<3	<3	<3	3	<3	3
4B	8	9	11	8	5	<3	7
5A	5	<3	3	3	4	<3	4
5B	12	Dry	14	12	14	9	12
6A	<3	<3	<3	3	<3	<3	3
6B	13	15	15	12	18	9	14
7A	11	7	11	9	12	10	10
7B	5	<3	<3	3	4	3	4
8A	<3	3	9	4	<3	5	5
8B	17	26	16	22	22	20	20
9A	4	5	10	3	5	<3	5
9B	17	23	13	22	25	Dry	20
10A	<3	5	<3	<3	<3	<3	4
10B	3	5	3	7	12	7	6
11A	24	19	31	31	41	26	29
11B	<3	5	<3	<3	<3	<3	4
12A	5	7	<3	6	16	<3	7
12B	13	Dry	14	10	7	Dry	11
13A	3	5	<3	<3	<3	<3	3
13B	15	17	18	<3	26	19	16
14A	3	4	<3	<3	<3	<3	3
14B	5	8	3	8	7	3	6
15A	3	5	<3	<3	<3	<3	4
15B	7	Dry	11	27	8	9	12
16A	5	7	<3	<3	<3	3	4
16B	6	11	11	21	7	4	10
17A	<3	5	<3	<3	6	<3	4
17B	7	9	12	6	9	5	8
18A	3	16	9	3	<3	5	7
18B	17	5	26	8	25	18	17

^aSampling locations are shown in Figure 3-12.

^b1 x 10⁻⁹ µCi/ml is equivalent to 1 pCi/L.

^cMaximum allowable limit is 600 pCi/L per DOE Order 5400.5 (DOE 1990).

TABLE 3-7
CONCENTRATIONS OF RADIUM-226 IN NFSS CONTAINMENT
MONITORING WELLS - JULY 1988 TO OCTOBER 1989

Sampling Location ^a	Concentration (pCi/L)						Avg.
	7/88	10/88	1/89	4/89	7/89	10/89	
1A	0.3	0.3	0.5	0.3	0.4	1.4	0.5
1B	0.4	0.3	0.7	0.4	0.5	1.2	0.6
2A	0.5	0.2	0.5	0.1	0.3	0.7	0.4
2B	0.4	0.4	0.1	0.2	0.3	0.7	0.4
3A	0.3	0.4	0.5	0.4	0.4	1.0	0.5
3B	0.4	0.6	0.8	0.4	0.4	1.4	0.7
4A	0.5	0.3	0.4	0.3	0.3	1.0	0.5
4B	0.4	0.3	0.5	0.3	0.1	1.2	0.5
5A	0.3	0.7	0.5	0.2	0.2	0.8	0.5
5B	0.6	Dry	0.9	0.7	0.6	0.7	0.7
6A	0.4	0.4	0.4	0.4	0.3	0.9	0.5
6B	0.6	0.4	0.4	0.3	0.3	1.0	0.5
7A	0.7	0.9	0.9	0.8	1.0	1.4	1.0
7B	0.3	0.2	0.4	0.3	0.3	0.9	0.4
8A	0.5	0.1	0.7	0.4	0.4	1.0	0.5
8B	0.5	1.8	0.6	0.3	0.3	1.2	0.8
9A	0.4	0.3	0.5	0.4	0.4	0.8	0.5
9B	0.6	1.6	1.1	1.1	0.5	Dry	1.0
10A	0.3	0.3	0.5	0.2	0.2	0.6	0.4
10B	0.5	0.3	0.2	0.3	0.2	0.6	0.4
11A	0.6	1.0	0.7	0.4	0.8	1.3	0.8
11B	0.5	0.6	0.5	0.3	0.3	0.7	0.5
12A	0.6	0.7	0.6	0.4	0.4	0.5	0.5
12B	0.9	Dry	0.5	0.4	0.7	Dry	0.6
13A	0.6	0.6	0.5	0.4	0.6	1.0	0.6
13B	0.8	1.0	0.4	0.6	0.5	1.3	0.8
14A	0.7	0.6	0.3	0.2	0.4	0.2	0.4
14B	1.2	1.2	0.2	0.4	0.4	3.0	1.1
15A	0.6	0.6	0.5	0.3	0.5	0.5	0.5
15B	0.9	Dry	0.5	0.2	0.3	2.4	0.9
16A	0.4	0.5	0.3	1.0	0.3	0.4	0.5
16B	1.4	1.4	0.3	0.3	0.6	1.6	0.9
17A	0.6	0.4	0.3	0.2	0.4	0.3	0.4
17B	1.4	0.3	0.6	0.2	0.4	0.4	0.6
18A	0.5	0.8	0.3	0.3	0.5	0.2	0.4
18B	0.7	0.4	0.4	0.4	0.5	2.1	0.8

^aSampling locations are shown in Figure 3-12.

^b 1×10^{-9} $\mu\text{Ci/ml}$ is equivalent to 1 pCi/L.

^cMaximum allowable limit is 100 pCi/L per DOE Order 5400.5 (DOE 1990).

4.0 COMPARISON WITH PREVIOUS DATA

Surface conditions at the WCS have improved greatly since performance monitoring began in November 1986. Turf conditions are generally good over the entire WCS. There are bare areas, but these are significantly fewer and smaller than have been observed in any previous year. There are bare areas and wheel tracks on the northwest access slope of the WCS where the irrigation vehicle and other vehicles have been repeatedly driven up and down the slope.

There are no areas on the WCS with visible drainage or erosion problems. However, the west side slope of the central drainage ditch in the area of the WCS has eroded and has degraded to an unsatisfactory condition. There is no visible evidence of new settlement of the WCS. In addition, the settlement survey results indicate only minor fluctuations (see Table 3-1). With the present topographic data available at the WCS, there does not appear to be a significant trend other than a consolidation of the waste in the area of Building 411, and the settlement appears to be general rather than isolated.

The 1989 environmental monitoring report shows that there has been no change in the quality of the water collected from the groundwater wells surrounding the WCS. The report also shows that NFSS is in compliance with the DOE radiation protection standard regarding radon levels, external gamma radiation levels, radioactive contamination of sediments and surface water runoff, and calculation of potential dose to the public (Bechtel 1990).

A trend toward water-level equalization within the WCS has continued as predicted. The grass covering the WCS is maturing and appears to be limiting erosion. The desiccation cracking in the topsoil first observed in 1987 worsened in 1988 because of drought but has since improved significantly.

5.0 ACTIONS REQUIRED

Items requiring action were noted during the three walkovers from June 1988 through October 1989. These items have been discussed thoroughly and could potentially jeopardize the integrity of the WCS. Follow-up reviews will be taken to ensure appropriate consideration of these actions. Those actions that need to be considered are:

- Stabilize the side slopes on the central drainage ditch
- Design and construct an access ramp to facilitate vehicle access to the top of the WCS
- Pump water out of the geotechnical instrument manhole and seal the cable ports and any other leaks
- Review the turf management program to determine the appropriate steps necessary to correct and improve the condition of the turf
- Continue turf management as required; correct the general lack of vigor of the turf to minimize desiccation cracks and erosion
- Implement an appropriate weed control program, as required, and follow up on designated treatment areas
- Perform diagnostic testing on the geotechnical internal monitoring instruments to determine the cause of irregular readings for three of the instruments; once identified, correct the problem

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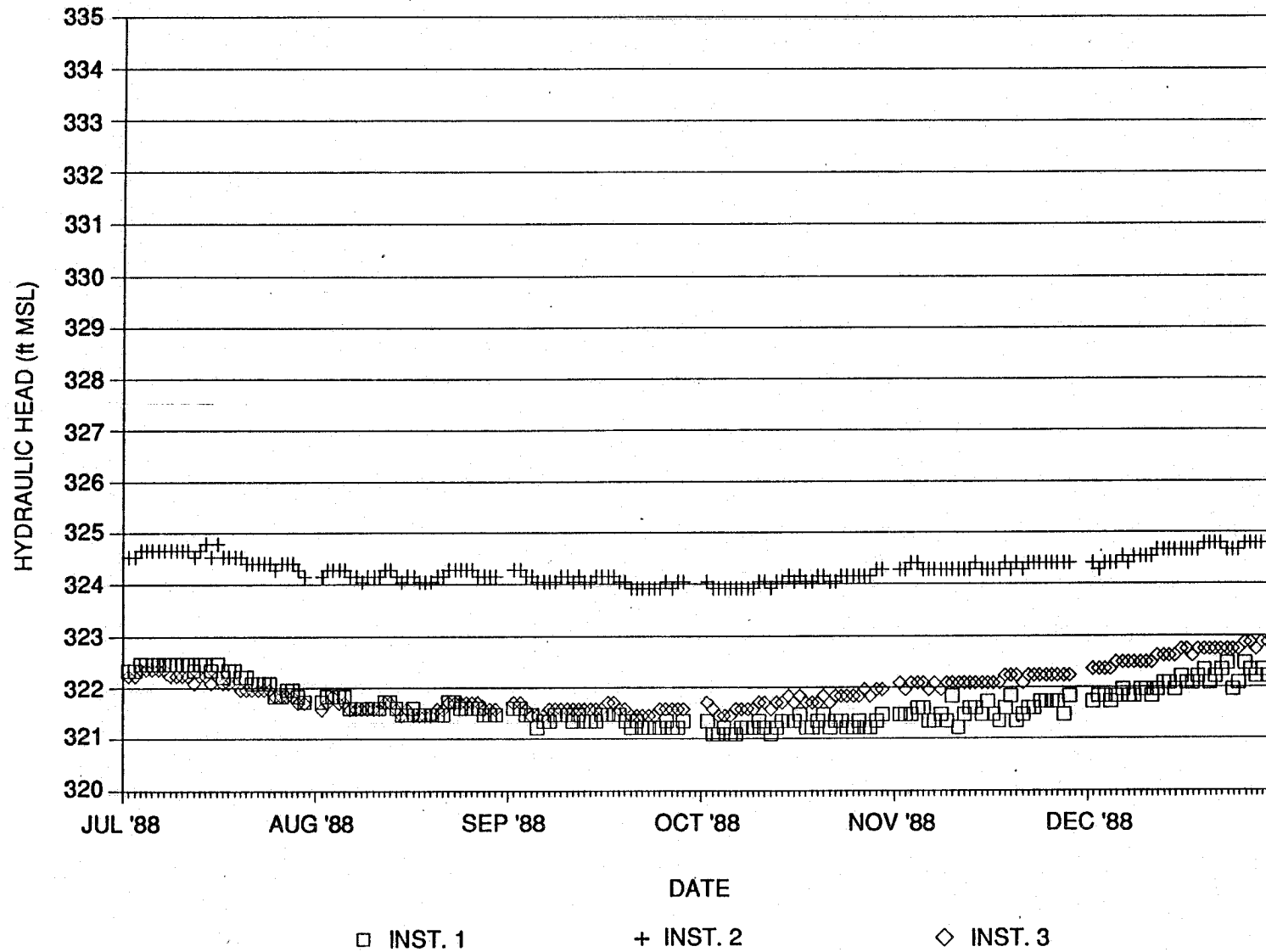
APPENDIX A

SUMMARY OF VIBRATING WIRE PRESSURE TRANSDUCER DATA
FOR JULY - DECEMBER 1988
AND CALENDAR YEAR 1989

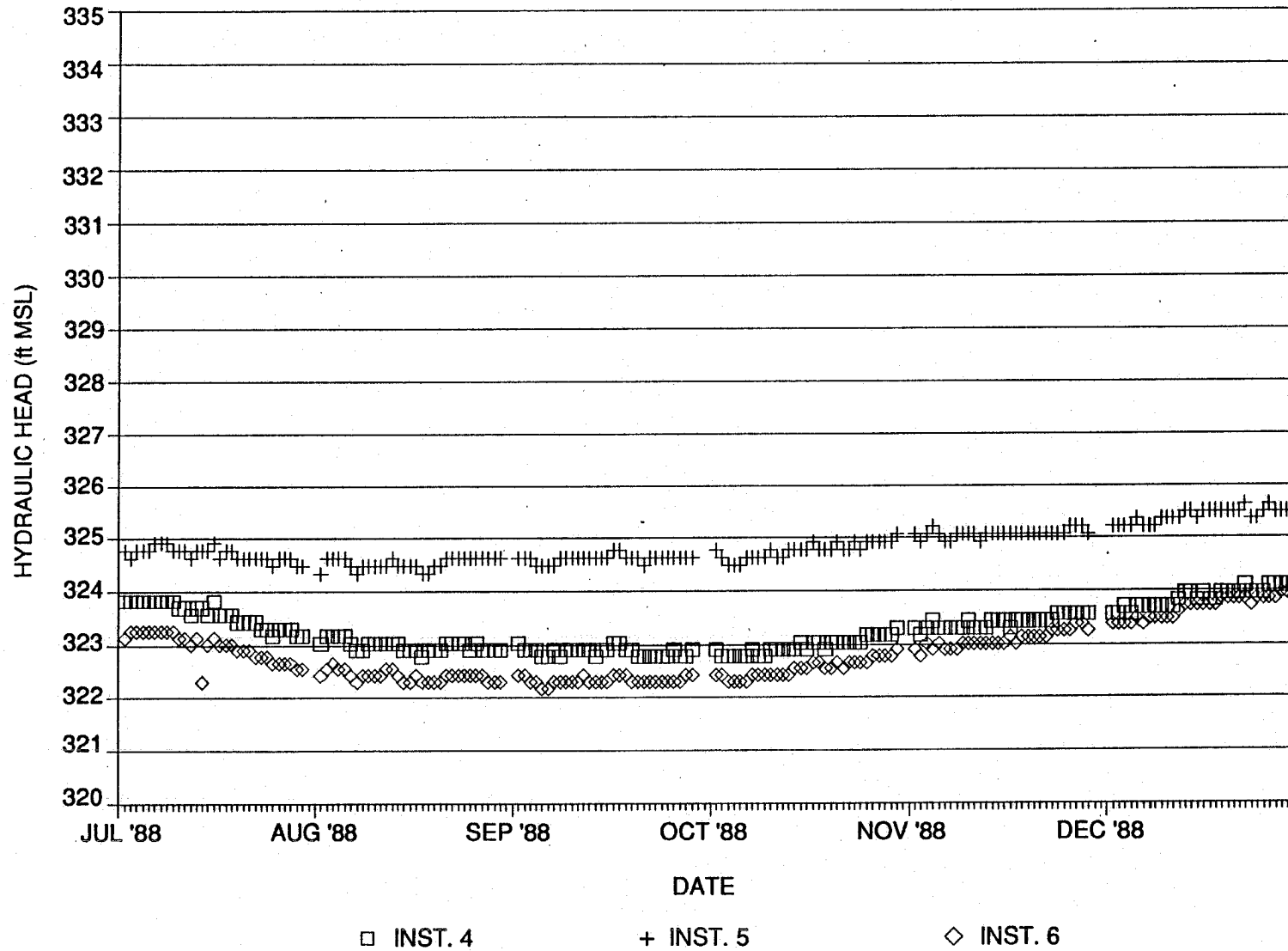
A-1

VWPT DATA FOR NFSS

SECOND HALF — 1988

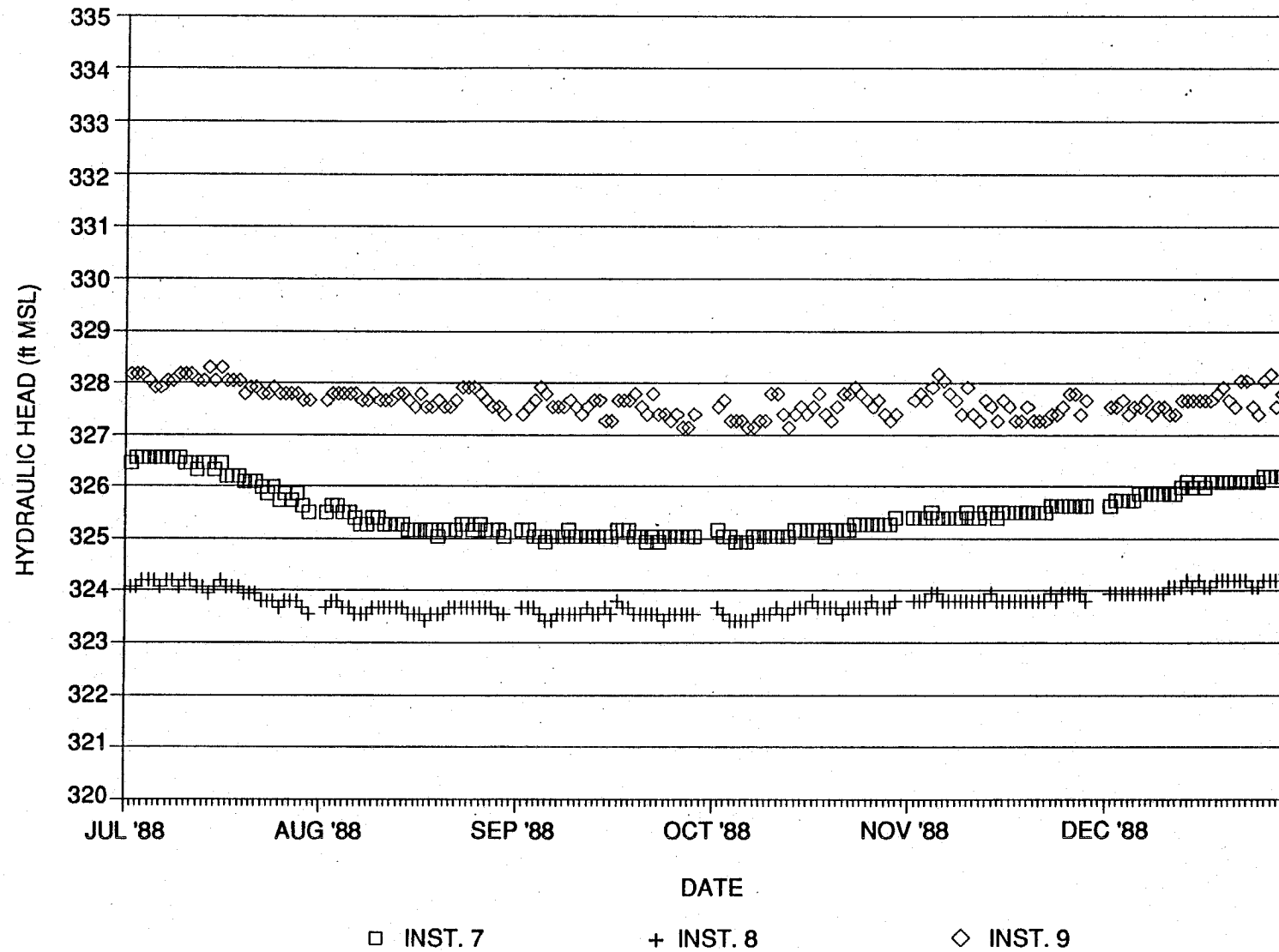


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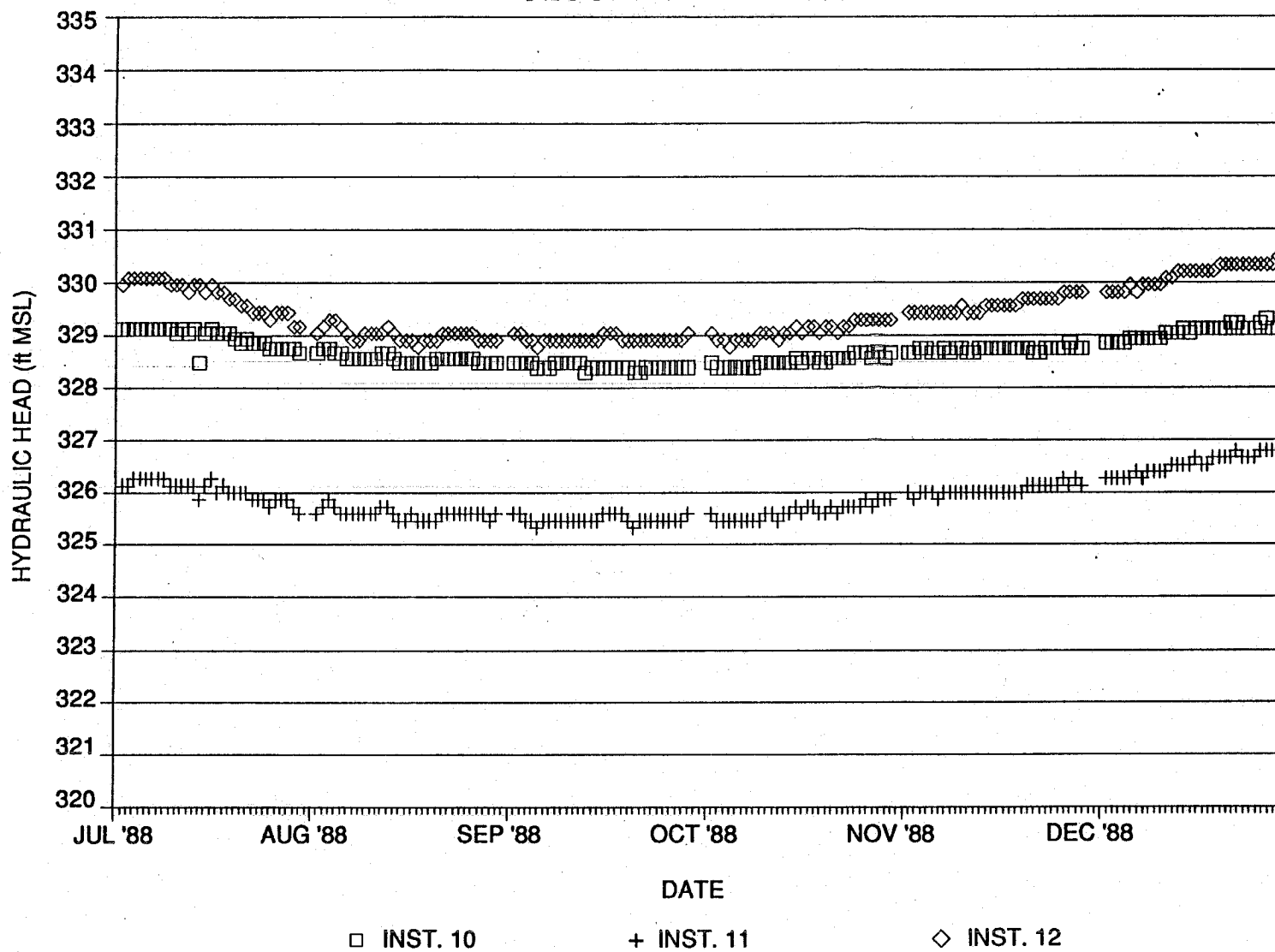


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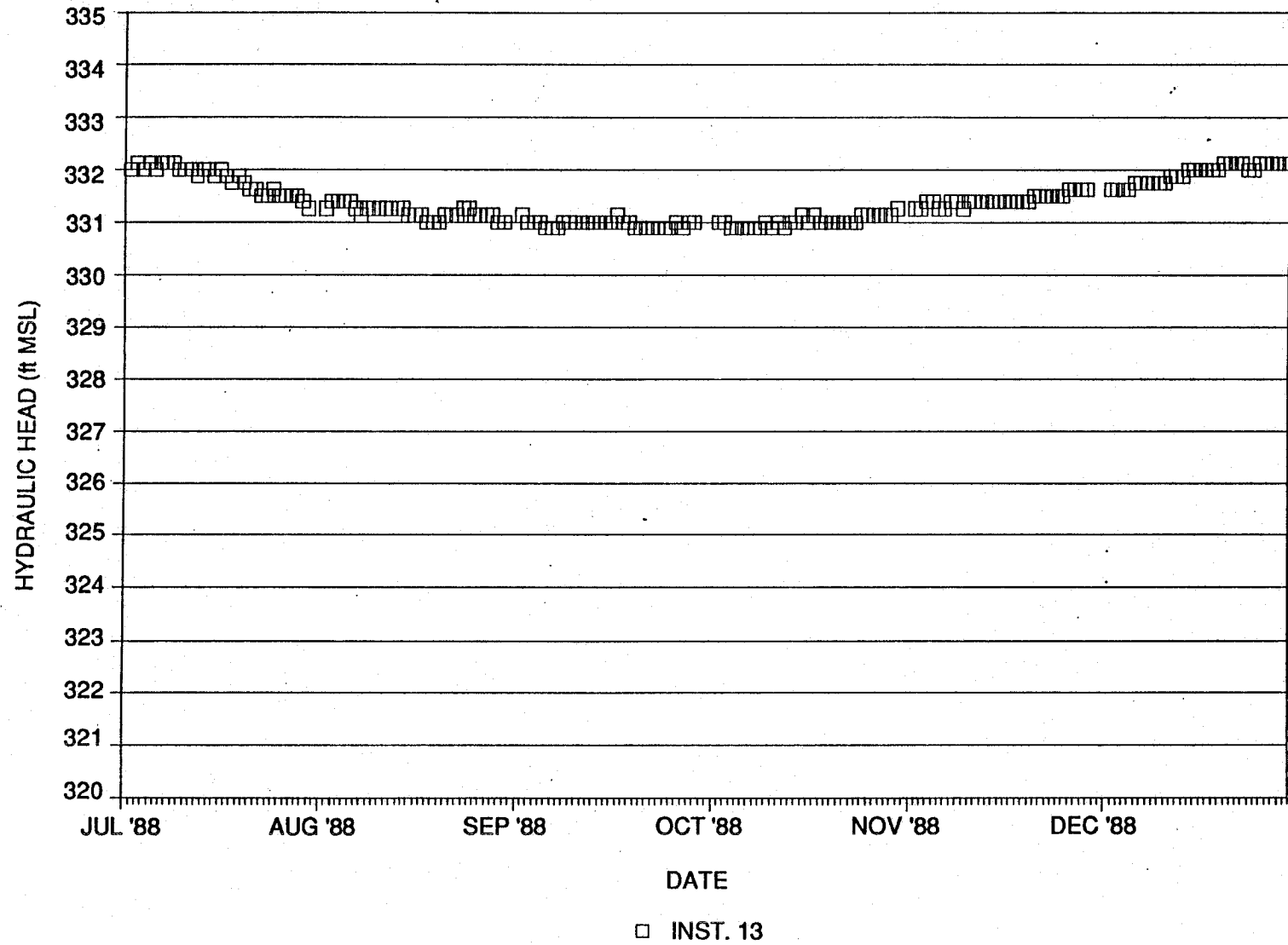


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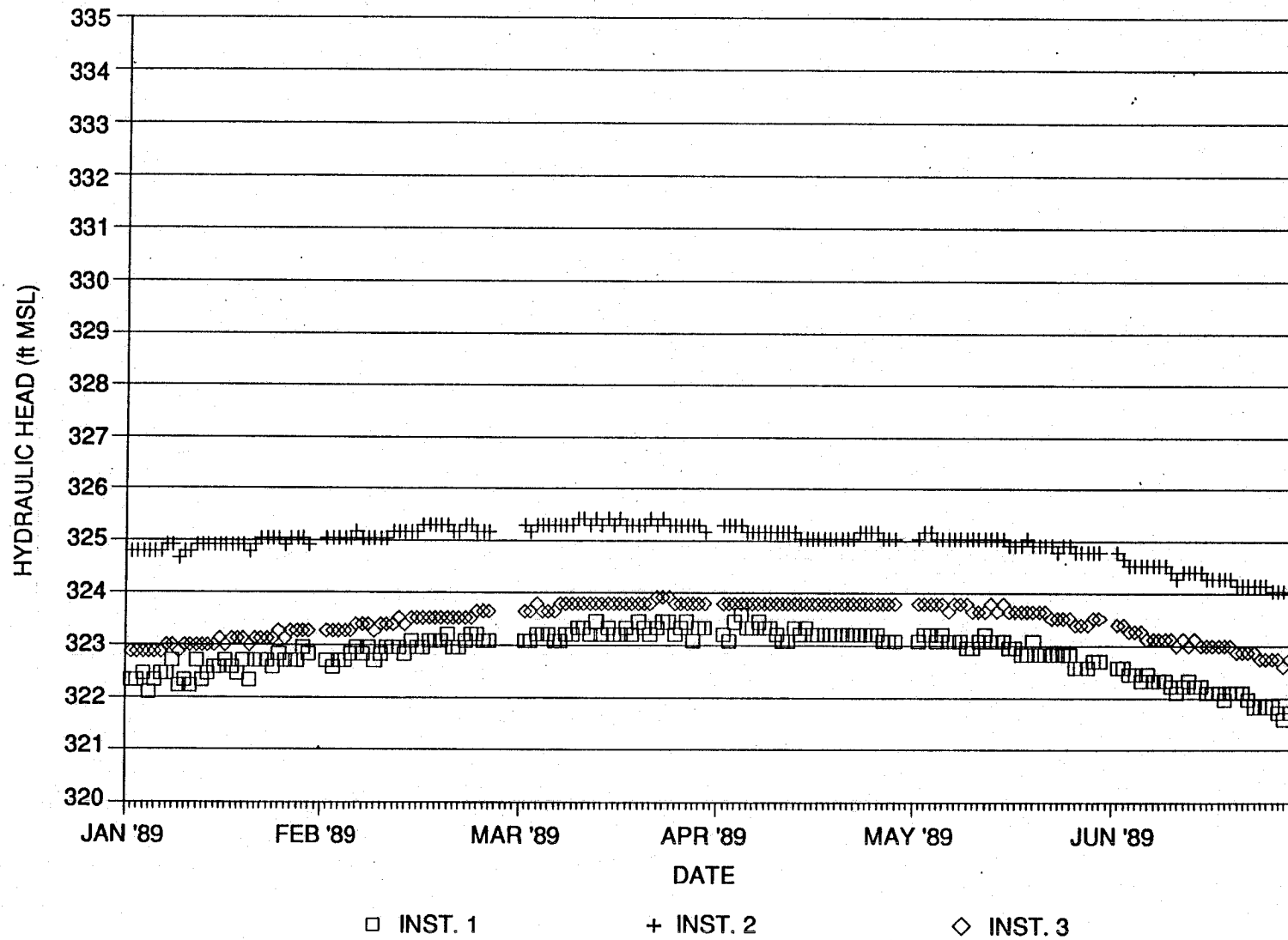
VWPT DATA FOR NFSS

SECOND HALF — 1988



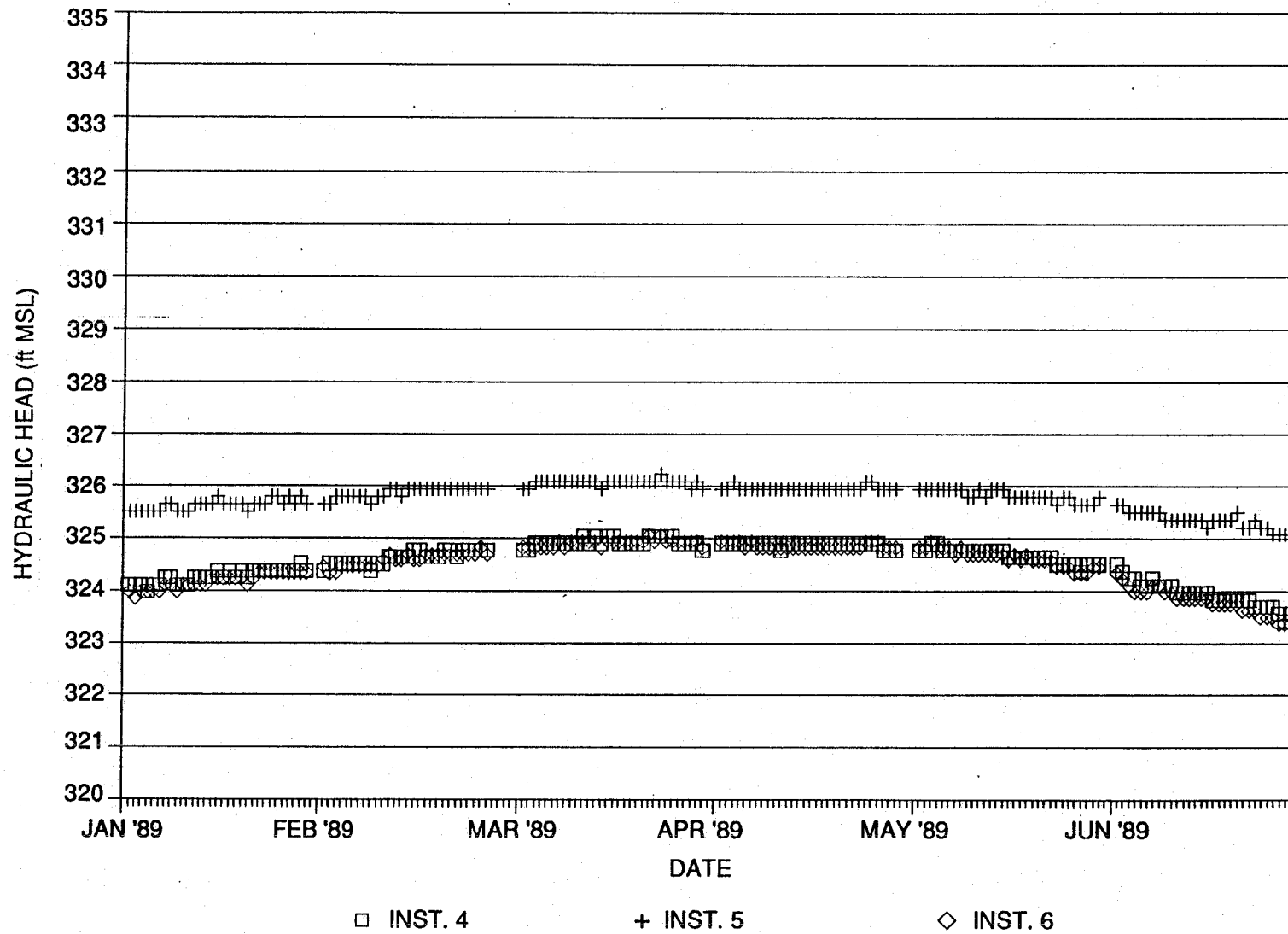
VWPT DATA FOR NFSS

FIRST HALF — 1989



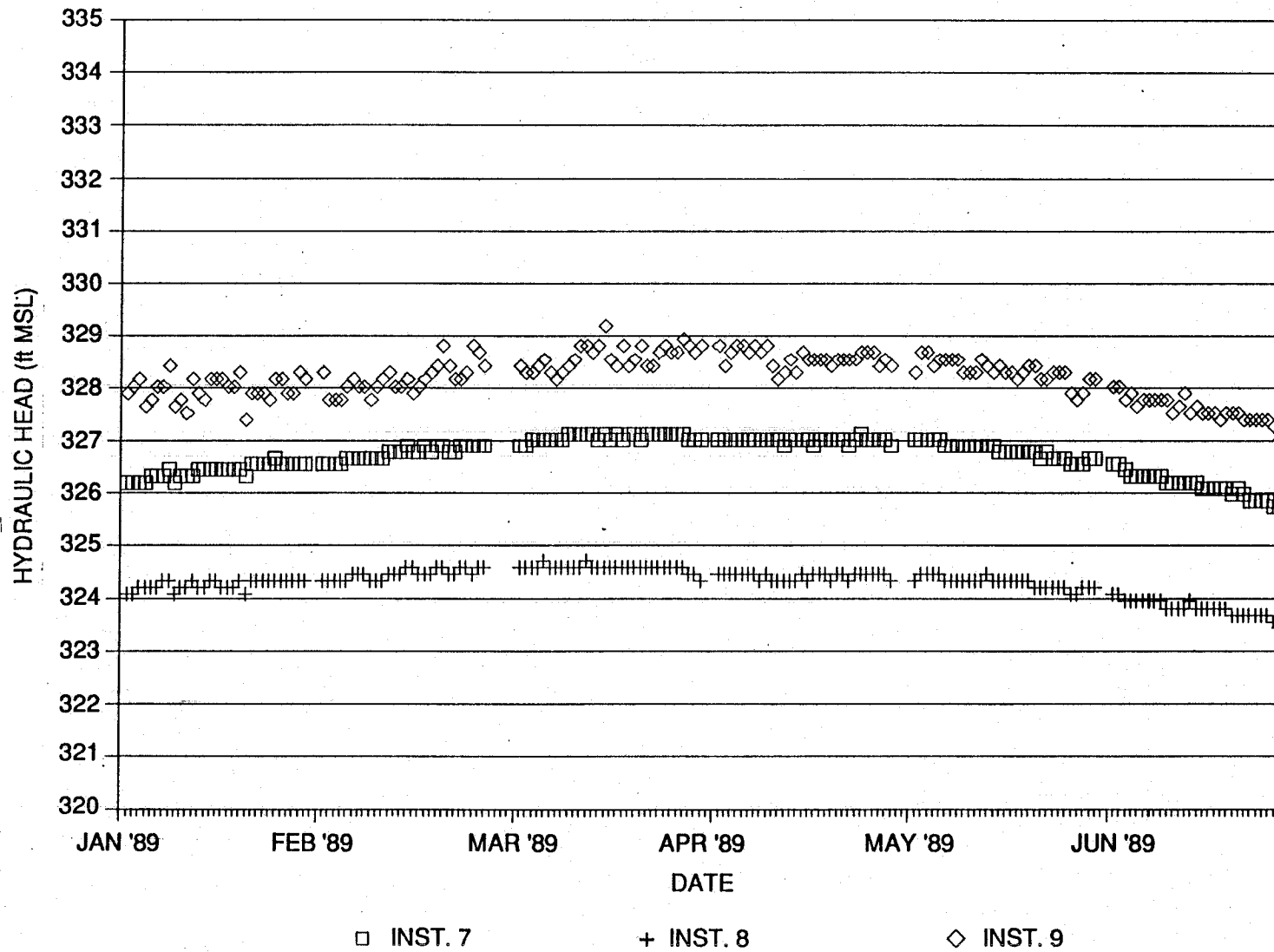
VWPT DATA FOR NFSS

FIRST HALF — 1989



VWPT DATA FOR NFSS

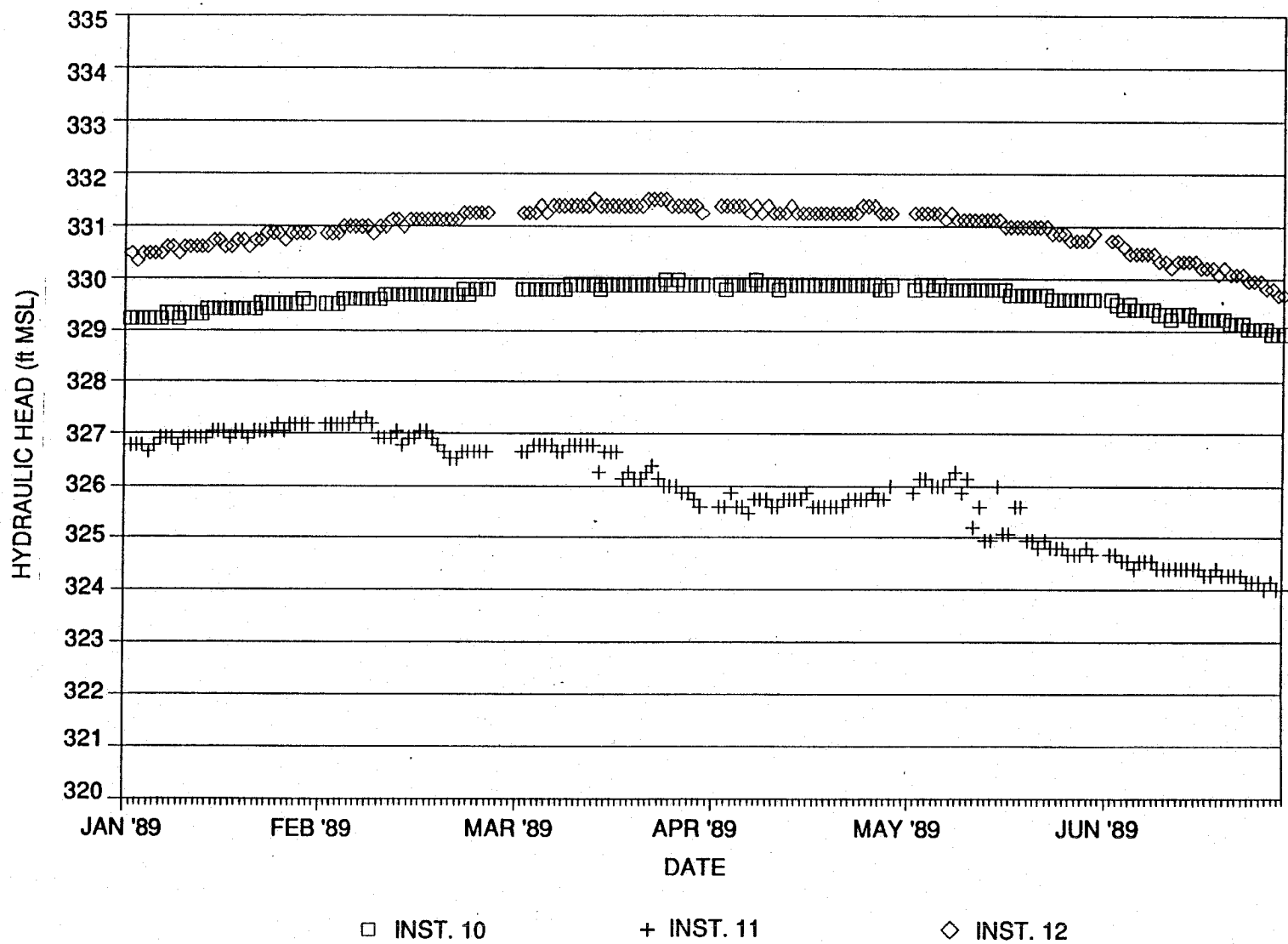
FIRST HALF — 1989



A-9

VWPT DATA FOR NFSS

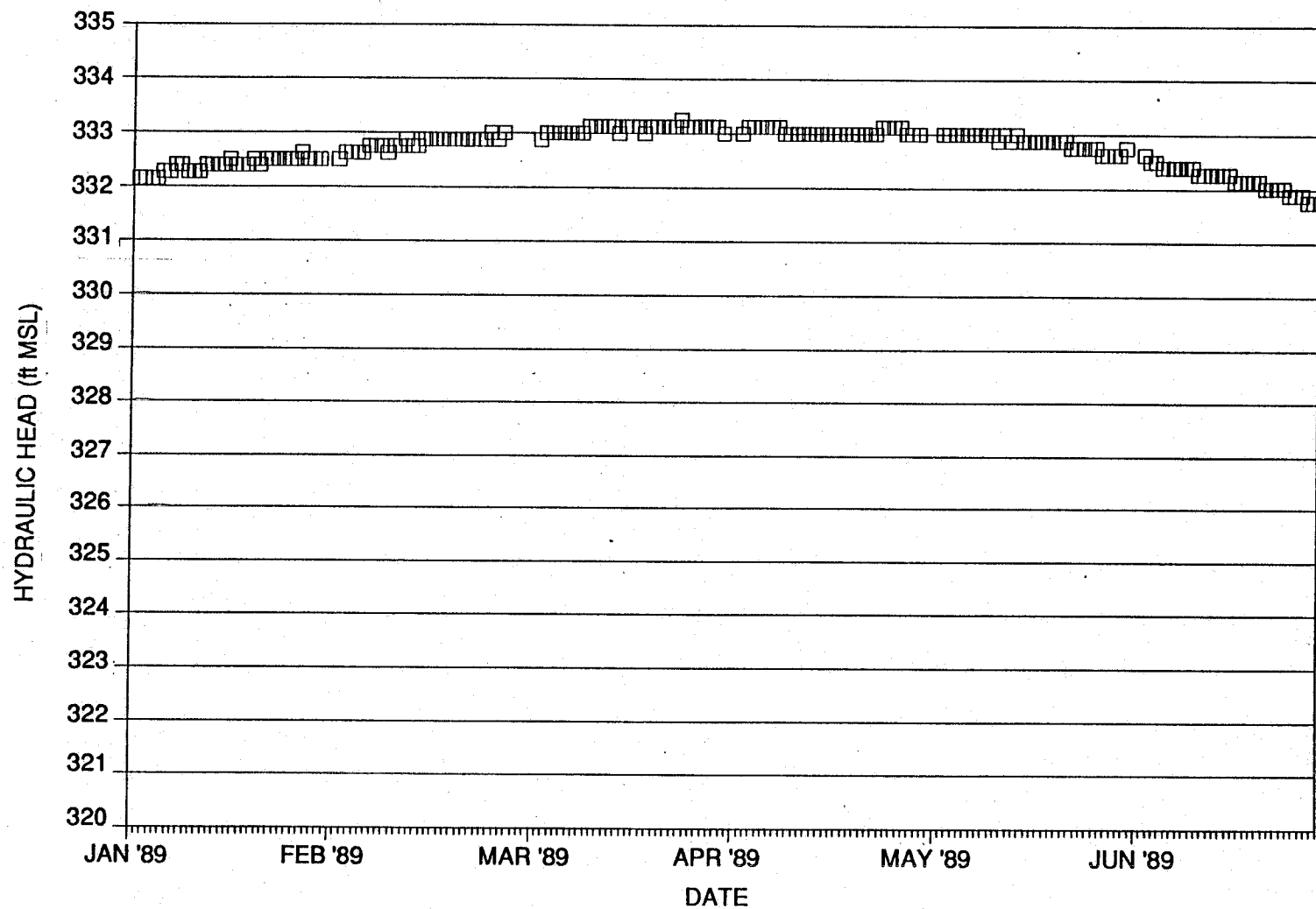
FIRST HALF — 1989



A-10

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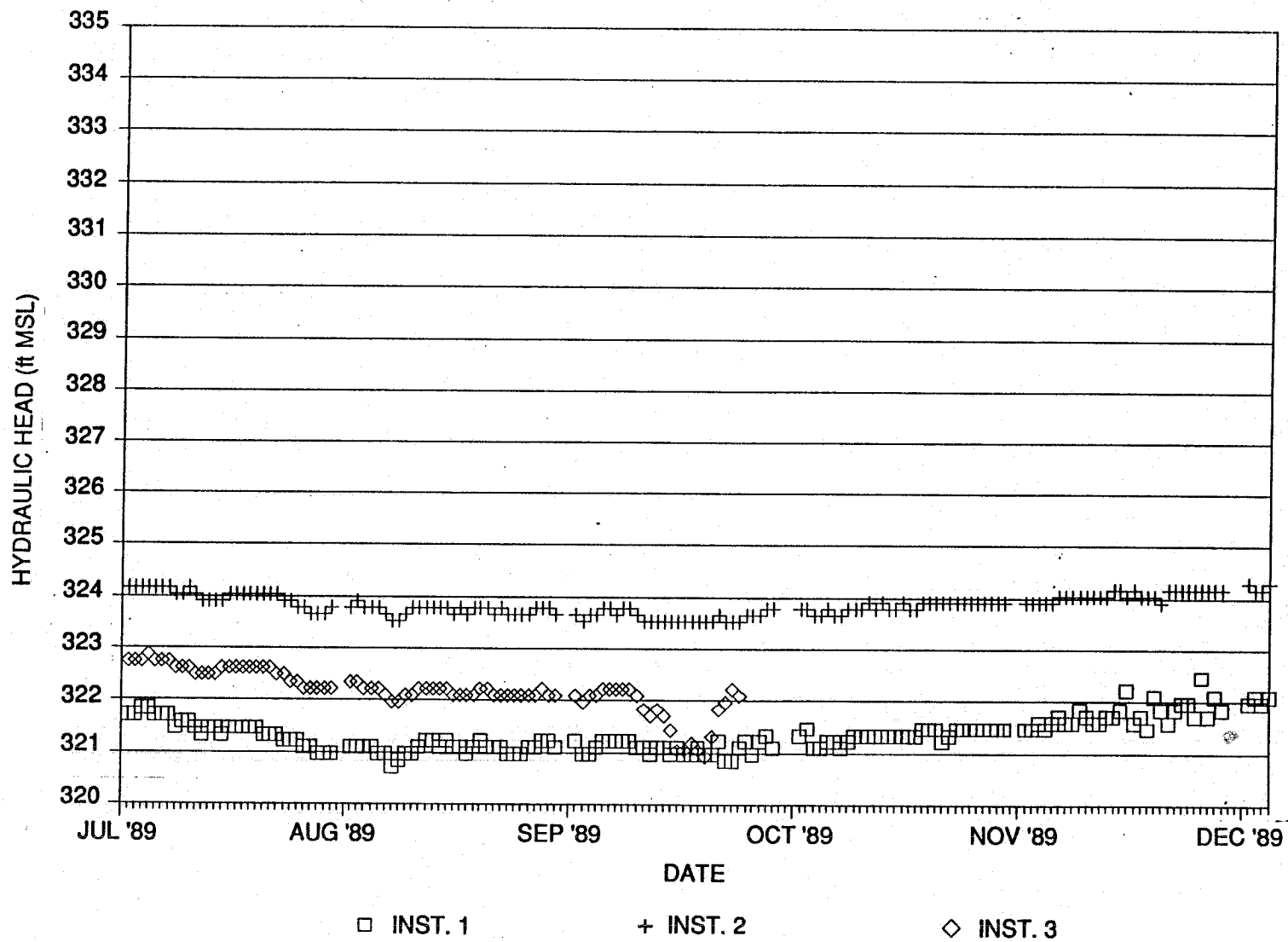
FIRST HALF — 1989



□ INST. 13

VWPT DATA FOR NFSS

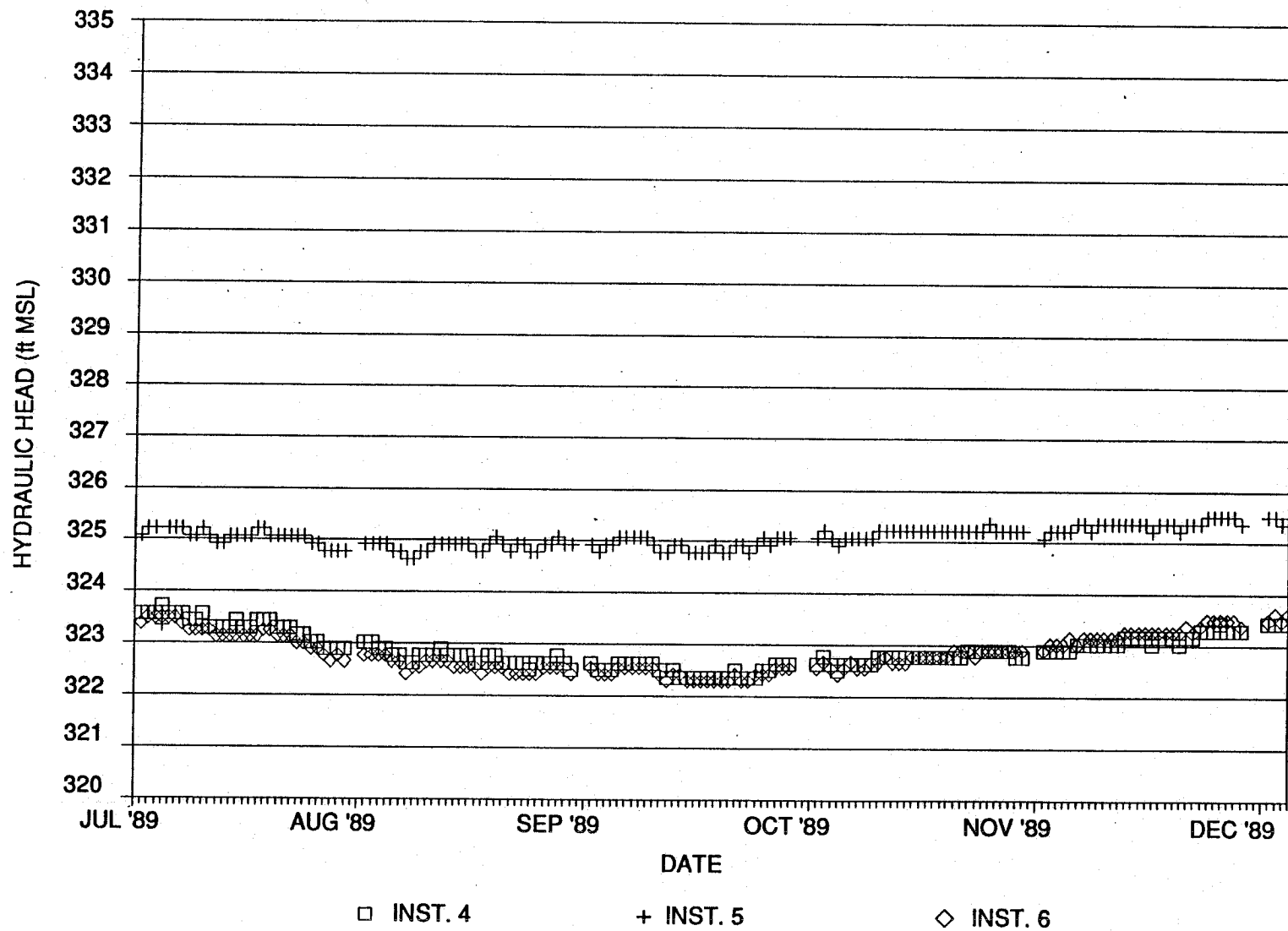
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A-11

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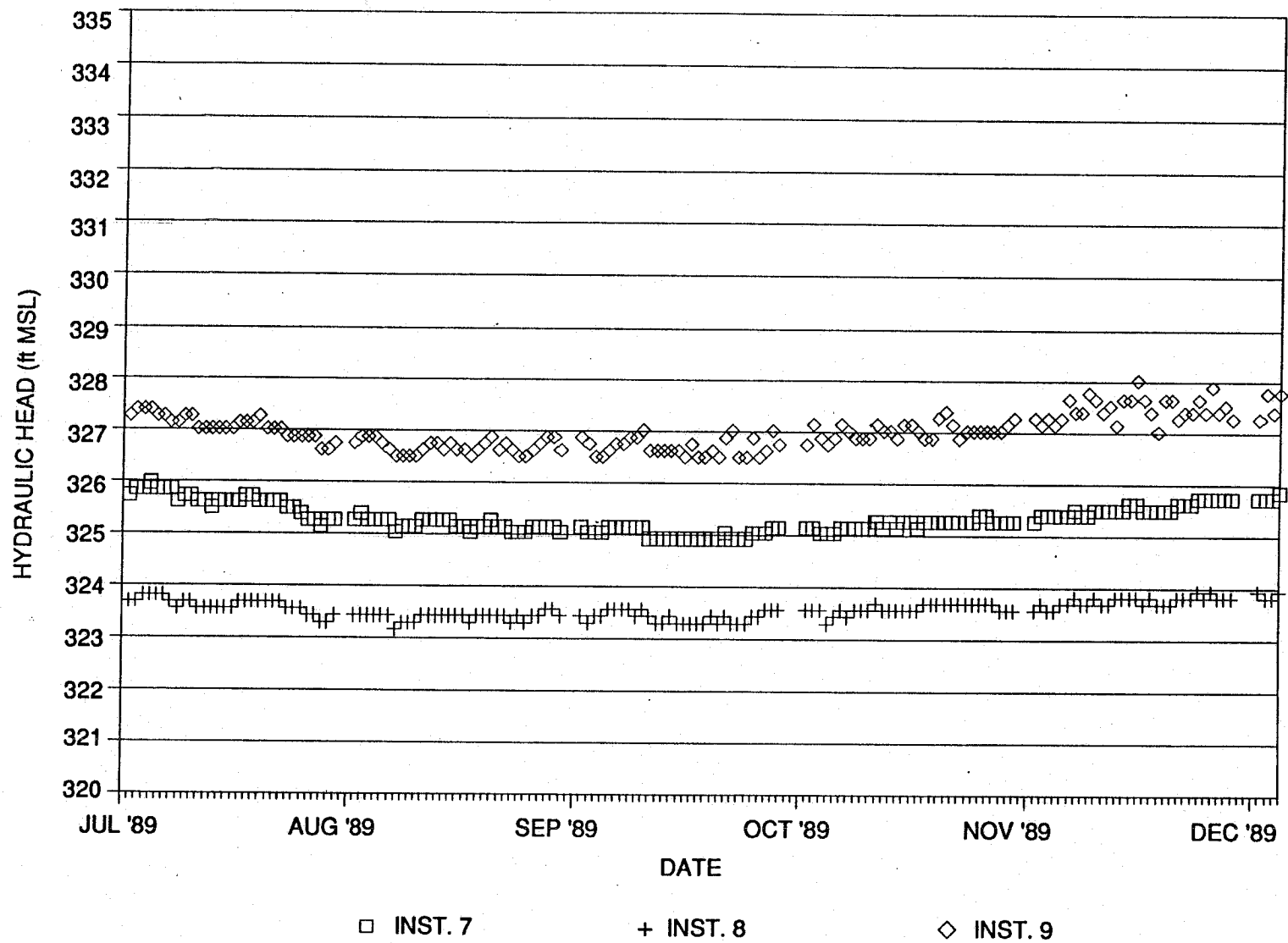
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A-12

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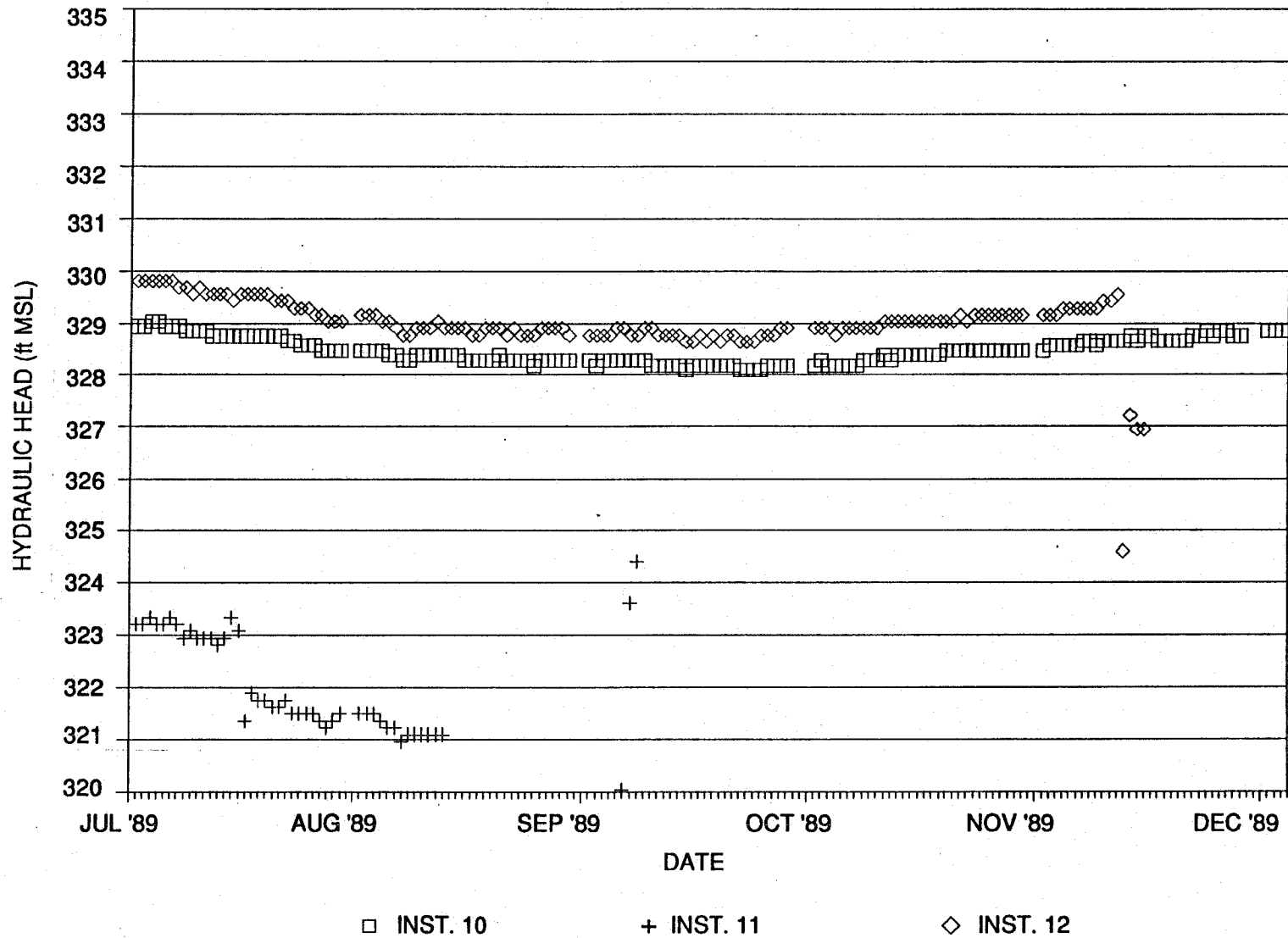
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A-13

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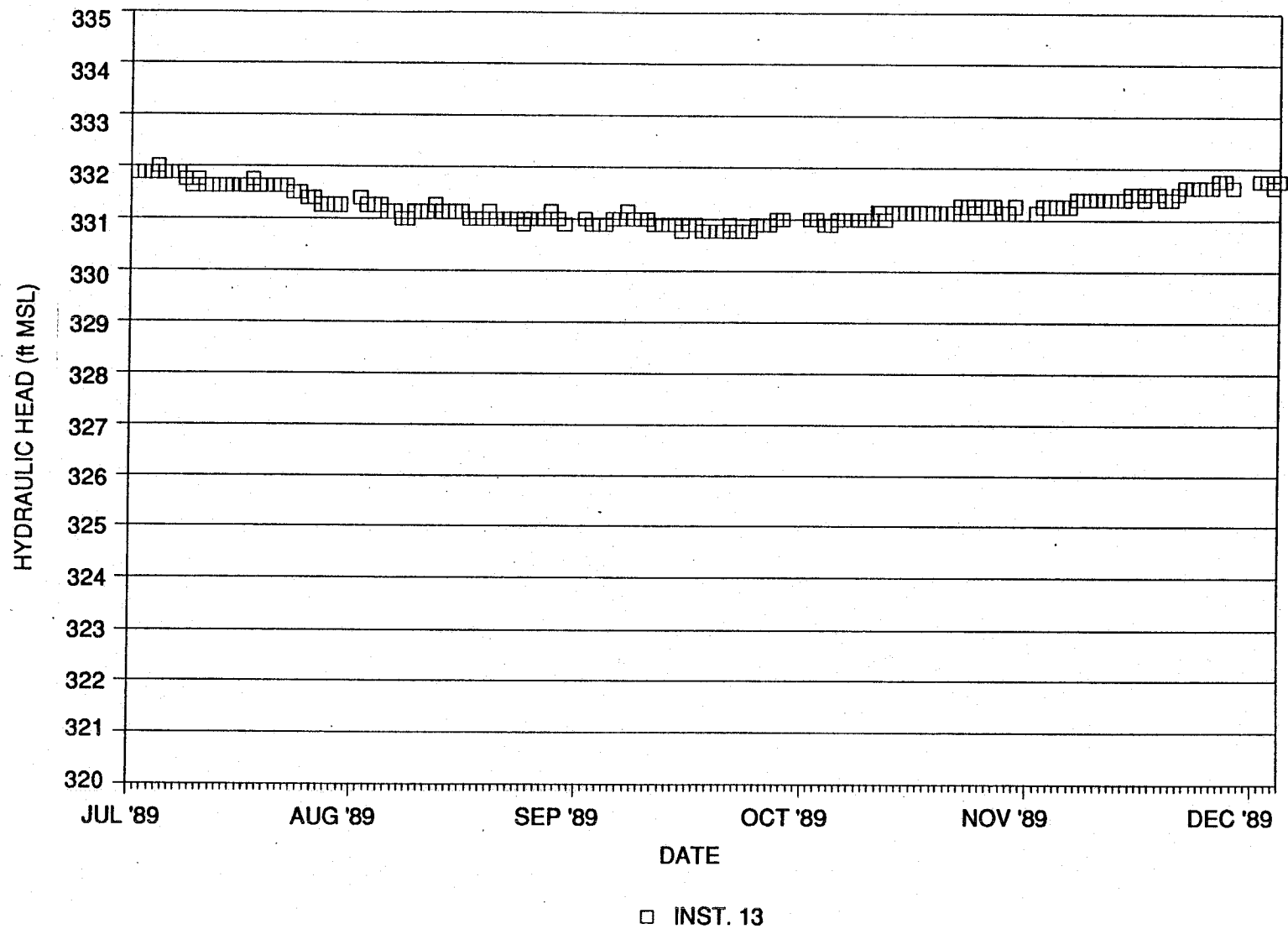
SECOND HALF — 1989



A-14

VWPT DATA FOR NFSS

SECOND HALF — 1989



A-15