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Surplus Facilities Management Program (SFMP)
Contract No. DE-AC05-81OR20722

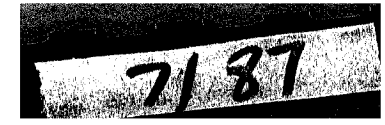
PERFORMANCE MONITORING REPORT FOR THE NIAGARA FALLS STORAGE SITE WASTE CONTAINMENT STRUCTURE

Lewiston, New York

Calendar Year 1986

July 1987

Bechtel National, Inc.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PERFORMANCE MONITORING REPORT
FOR THE NIAGARA FALLS STORAGE SITE
WASTE CONTAINMENT STRUCTURE
CALENDAR YEAR 1986

JULY 1987

Prepared for

UNITED STATES DEPARTMENT OF ENERGY

OAK RIDGE OPERATIONS OFFICE

Under Contract No. DE-AC05-81OR20722

By

M.G. Jones, C.R. Johnson, and J.A. Blanke

Bechtel National, Inc.

Oak Ridge, Tennessee

Bechtel Job No. 14501

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ABBREVIATIONS

cm	centimeter
ft	foot
FY	fiscal year
ha	hectare
in.	inch
km	kilometer
msl	mean sea level
µCi/ml	microcuries per milliliter
pCi/l	picocuries per liter

1.0 INTRODUCTION

A performance monitoring system has been developed for the Niagara Falls Storage Site (NFSS) Waste Containment Structure, which contains the soils contaminated with residual radioactive materials, rubble, and radioactive residues removed from various areas of the NFSS and vicinity properties during remedial action conducted by the Department of Energy (DOE) from 1982 through 1986. The design and construction of the containment structure have been previously documented (Refs. 1 and 2). The closure and post-closure activities have also been previously documented (Ref. 3).

The purpose of the performance monitoring system is to verify that the Waste Containment Structure's main engineering elements are functioning to minimize infiltration of rainfall; prevent pollution of groundwater; preclude formation of leachate; and prevent radon emanation. This report presents the findings of performance monitoring conducted at the Waste Containment Structure during calendar year 1986 to establish the base data for comparing future monitoring cycles.

The performance monitoring program is distinct from the environmental monitoring program conducted at the NFSS and will continue for a shorter time. The performance monitoring program will continue for a minimum of 5 years (FY 1987-91) but may be maintained for a longer period depending upon the results observed. To accurately evaluate the effectiveness of the containment facility, 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. In addition to the existing monitoring wells around the containment structure,

other wells will be installed to provide a ring of monitoring wells around the containment structure. Complete results of the environmental monitoring program are published annually in a separate report (Ref. 4). Summary information from the report is included in this document in Subsection 3.3.

This report includes a summary of the 1986 performance monitoring results, data for surface, subsurface, and environmental monitoring, conclusions based on recorded data (Ref. 5), comparisons with previous data, and actions required.

1.1 LOCATION AND DESCRIPTION

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

The Waste Containment Structure occupies 10 acres (4 ha) of the 191-acre (77.4-ha) NFSS. As shown in Figure 1-3, the Waste Containment Structure's 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 18 in. (45 cm) 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.

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

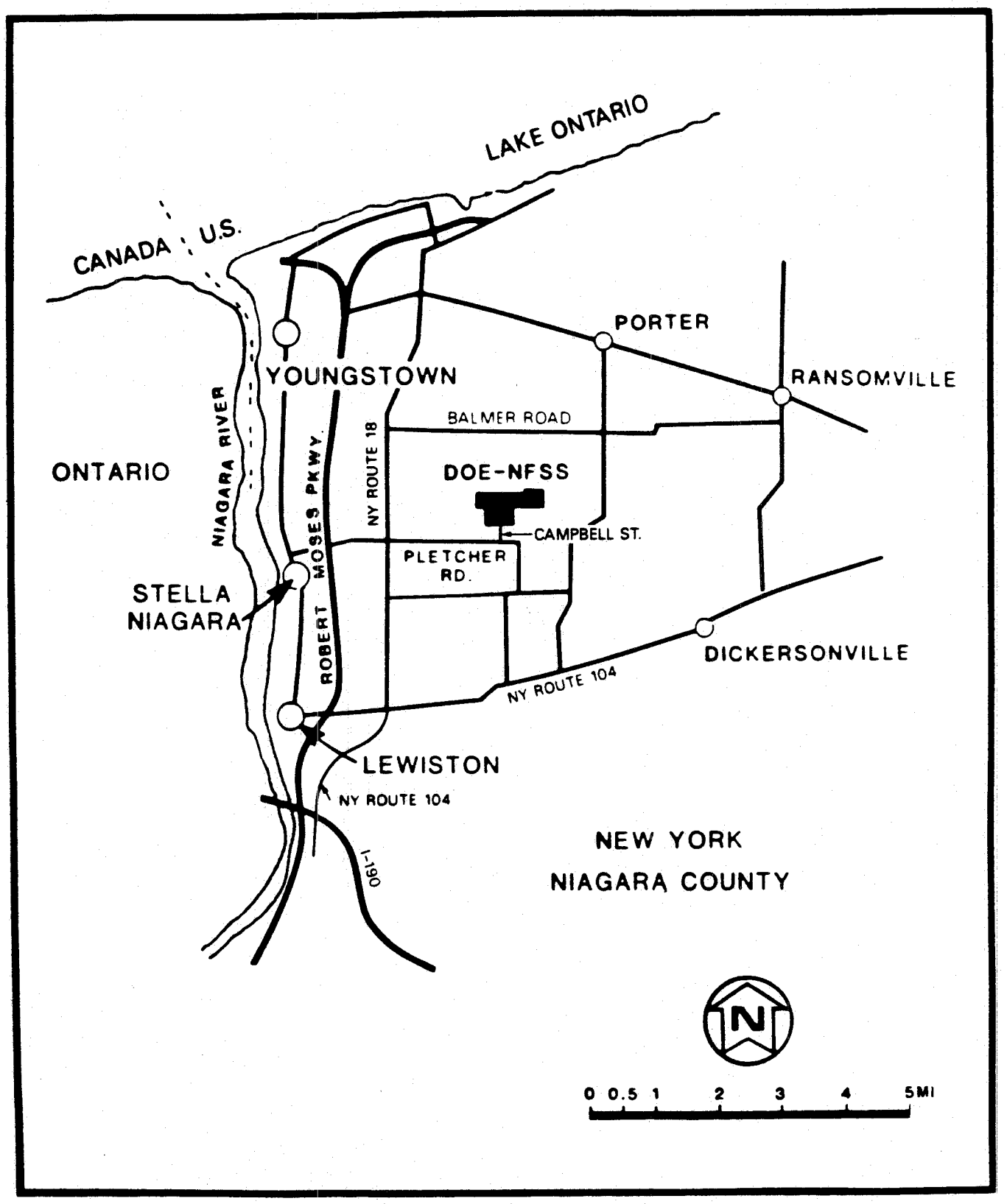

FIGURE 1-1 THE REGIONAL SETTING OF THE NFSS

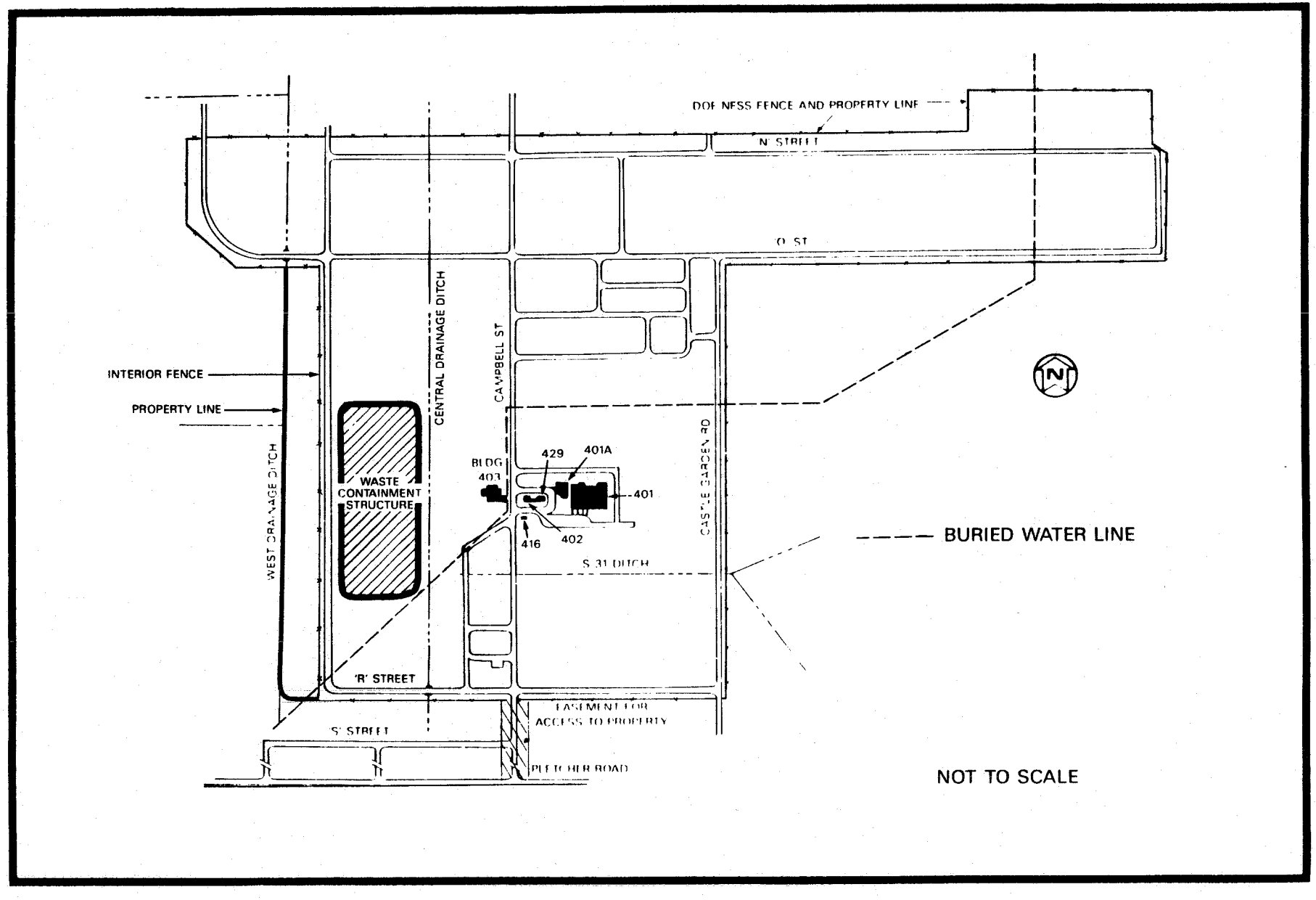

FIGURE 1-2 SITE PLAN OF THE NFSS

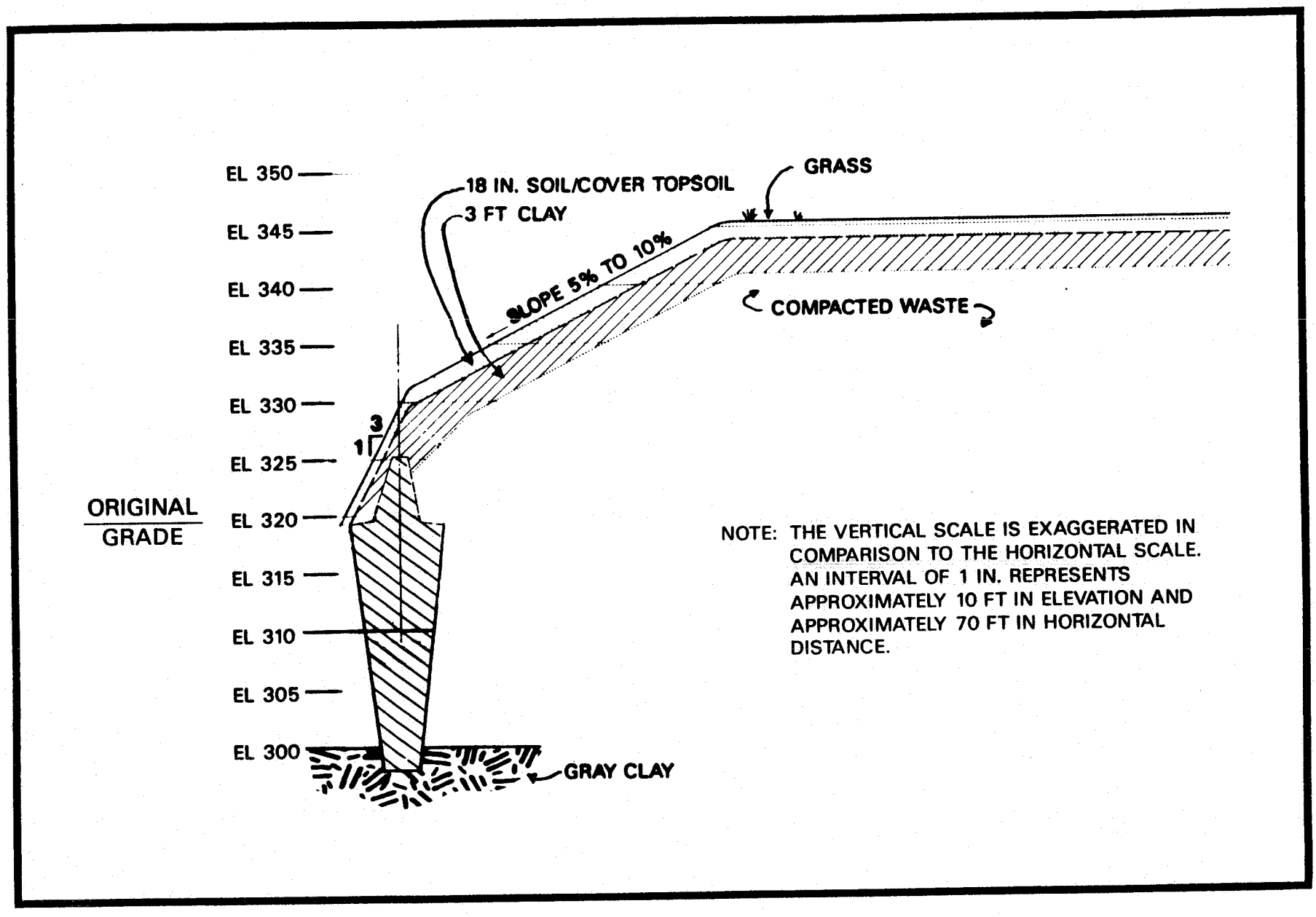

FIGURE 1-3 CROSS SECTION OF THE NFSS WASTE CONTAINMENT STRUCTURE

surface layer forms a protective blanket to maintain moisture within the clay layer and reduce the effect of frost heave. It also prevents drying that could result in the formation of tension cracks and provides a base for shallow-rooted grass. The clay layer, soil cover, and topsoil comprise the short-term closure system for the Waste Containment Structure.

1.2 OBJECTIVE

The primary objective of the performance monitoring program is early detection of trends that could indicate weaknesses developing in the containment structure. 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, subsurface as well as surface monitoring techniques are used. Possible indications of structural distress include:

- Differential settlement of the wastes
- Desiccation cracking of the clay cover
- Horizontal displacement
- Surface erosion
- Animal burrowing
- Deep-rooted vegetation
- Rapid rise of the potentiometric (saturated) surface inside the containment structure
- Residual reduction in soil density due to frost heave

2.0 SUMMARY OF PERFORMANCE MONITORING RESULTS

During 1986, the performance monitoring program at the NFSS was initiated to monitor the surface and subsurface conditions of the Waste Containment Structure. Surface techniques are used to check waste placement, the various layers of the containment facility cover, and surface drainage. Subsurface instrumentation monitors the performance of the gray clay unit and cutoff wall/dike.

Surface monitoring activities included a topographic survey, a walkover survey, and aerial photography. However, the aerial photographs of the cap were taken in the fall during closure activities, so the cap was not complete and the aerial photographs do not represent baseline data. Aerial photographs were taken again in early June 1987 to provide the required baseline photographic data. This aerial mapping will provide a reference for detection of changes in the surface contours of the Waste Containment Structure to supplement the information provided by the topographic and walkover surveys.

The topographic and walkover surveys were performed in the fall following closure of the containment structure. These activities have established the baseline for ensuing annual performance monitoring surveys. Data obtained represent the initial condition of the Waste Containment Structure and provide the basis for determining whether any actions are required. The results of the surface monitoring are discussed in Subsection 3.1, and actions required are discussed in Section 5.0.

Subsurface monitoring instrumentation includes vibrating wire pressure transducers (VWPTs) (to monitor pore water pressure) and a secondary system of pneumatic pressure transducers (PPTs), which provide a check on the operation of the VWPTs. The locations of these devices are shown in Figure 3-5. The PPTs were installed adjacent to three of the VWPTs. The PPTs had

only one reading in 1986, which was the initial reading in November after installation. Monthly readings are planned for the future. Daily readings of VWPTs began in November 1986 and will continue for one year to establish a baseline reading for the instruments. The frequency of readings will then be adjusted depending on results of the first year's operation.

Data collected during the 1986 monitoring period reflect the reestablishment of water levels that existed prior to instrument installation. Once stability has been reestablished, any further changes detected by the instruments will reflect changes within the wastes. Data are represented in graph form in Appendix A, and the results of the subsurface monitoring are discussed more fully in Subsection 3.2.

3.0 PERFORMANCE MONITORING DATA

This section provides the results of the 1986 performance monitoring program at the NFSS and a summary of the results of the environmental monitoring for calendar year 1986. The specific details of the performance monitoring system are provided in Reference 6. Complete environmental monitoring information is provided in Reference 4.

3.1 SURFACE MONITORING

3.1.1 Aerial Photography

An aerial survey of the cap surface was performed in October 1986 as the Waste Containment Structure was being completed. The northern section of the cap surface was complete at the time of the aerial survey, but the grading on the southern section of the cap surface was not complete. During the next aerial survey, to be performed in spring 1987, additional information will be obtained that will show the completed Waste Containment Structure. Thereafter, the survey will be flown at approximately the same time each year to optimize consistency in evaluating the mapped area.

Figure 3-1 shows the surface contours developed from the aerial survey of the Waste Containment Structure. The deviations in the contours located along the 3:1 slope on the east side of the Waste Containment Structure are not erosion problems but small trenches excavated to install the cables for the pressure transducers. An aerial view of the containment structure as it appeared in October 1986 is shown in Figure 3-2.

3.1.2 Topographic Survey

A topographic survey of the cap surface was performed in November 1986 on a predetermined grid. The grid layout utilized 100-ft spacing; north/south grid lines were designated with

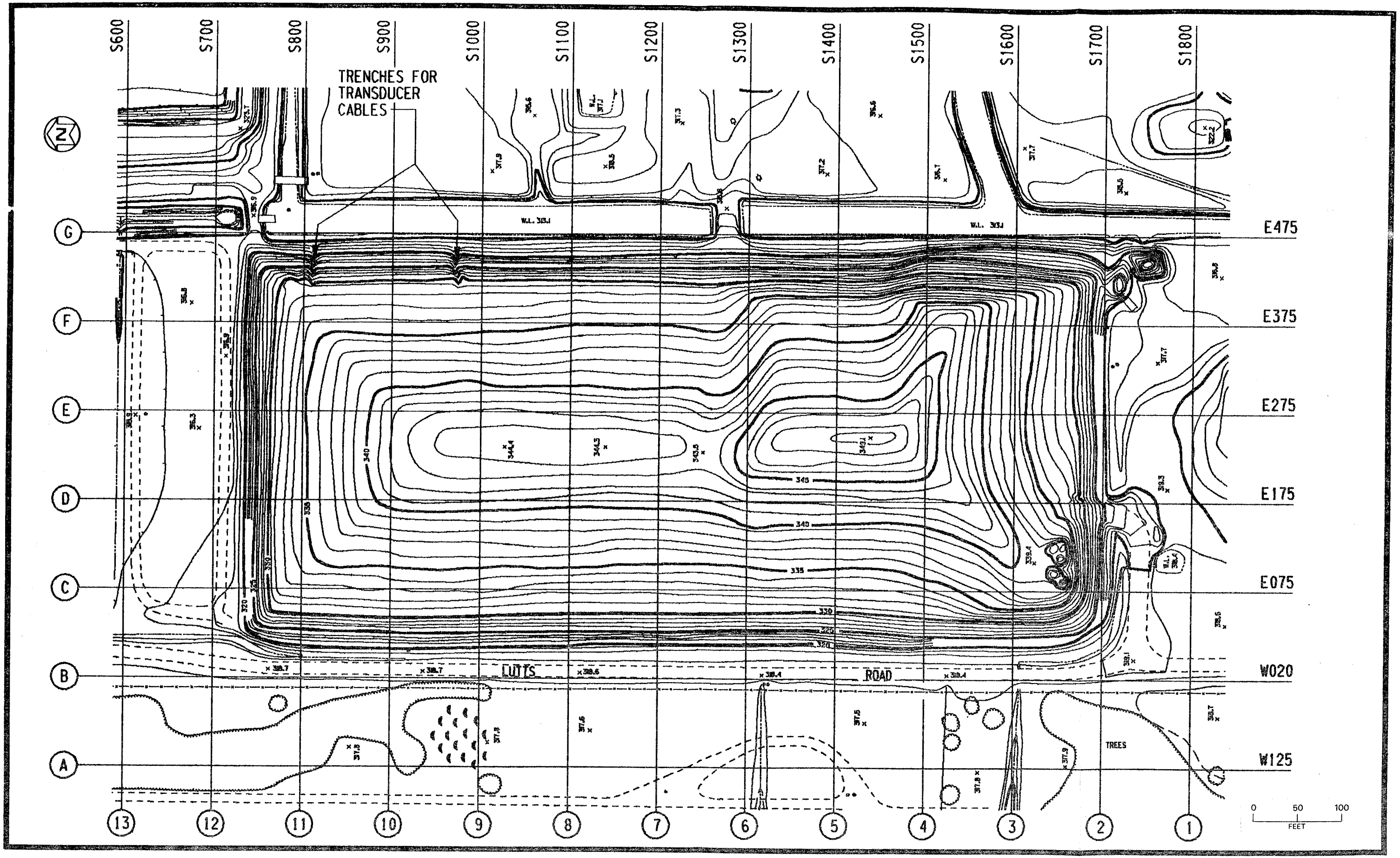

FIGURE 3-1 AERIAL MAPPING OF THE NFSS WASTE CONTAINMENT STRUCTURE

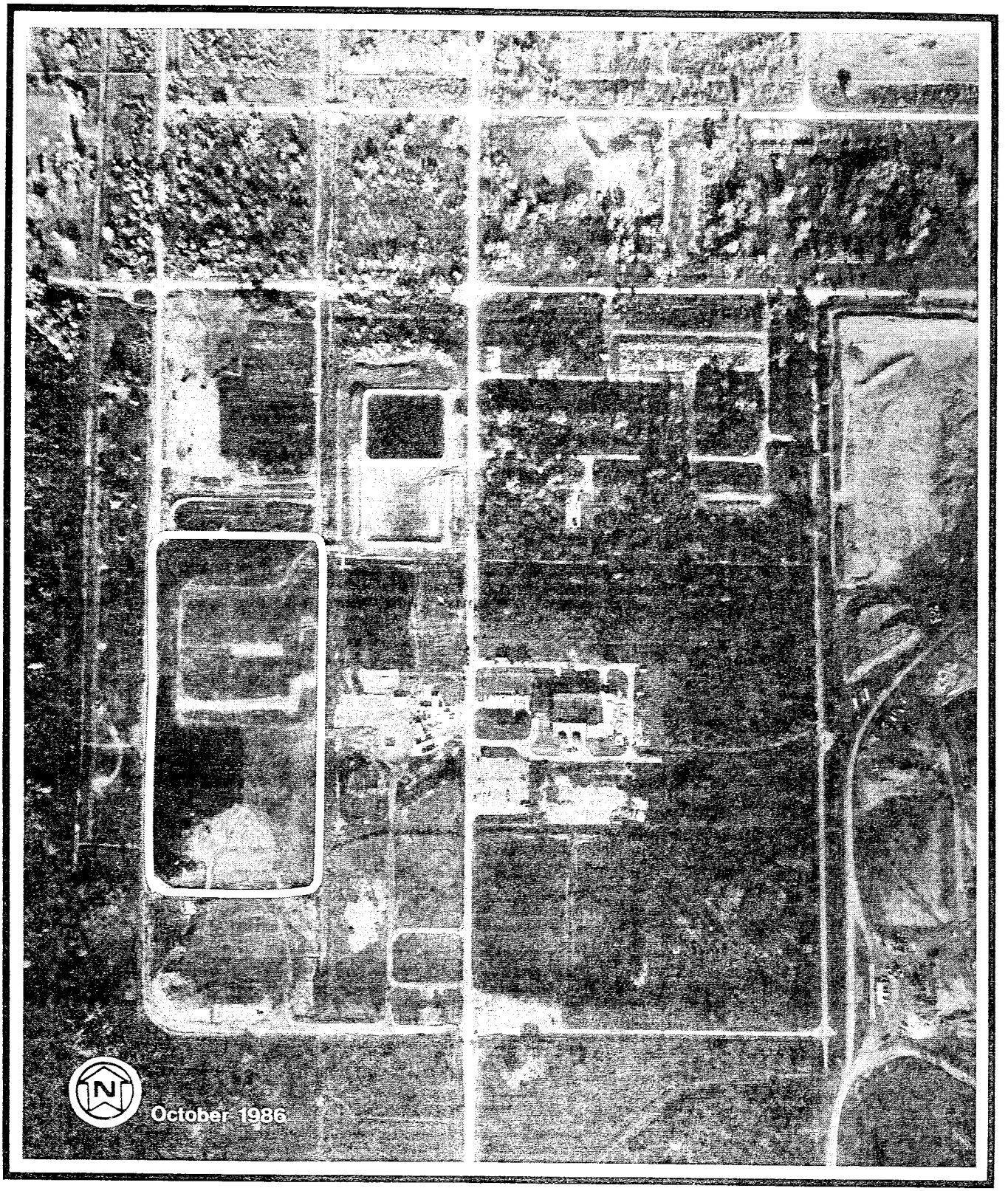

FIGURE 3-2 AERIAL VIEW OF THE NFSS WASTE CONTAINMENT STRUCTURE

alphabetic characters and east/west grid lines were designated with numeric characters, as shown on Figure 3-3. At each grid intersection on the top of the Waste Containment Structure, 2 in. by 2 in. by 8 in. wooden stakes were driven flush with the surface of the topsoil, and elevations were measured. The elevations obtained at these grid intersections are reported in Table 3-1. The stakes were left in place for future elevation comparisons.

Permanent benchmarks were installed at three grid intersections: S1800, W125; S600, W125; and S600, E375. The benchmarks have been 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. Each benchmark is a permanent concrete monument with a brass designation marker.

3.1.3 Walkover Survey

The walkover survey was performed November 17 and 18, 1986 by a team of engineering, geotechnical, construction, and site operations personnel (Ref. 5). The team evaluated the cap condition for settlement or movement, cracking, undesired plant growth, or other undesirable conditions. The walkover survey covered the Waste Containment Structure and the surrounding area (to about 100 ft from the toe of the cap). The survey was divided into four discrete areas of the Waste Containment Structure. These areas were: the periphery side slopes; areas over former structures and foundations (Buildings 410, 411, 413, 414, and 415); the general cap area; and the area surrounding the toe of the Waste Containment Structure.

To conduct the walkover survey, team members walked a pre-planned route based on the established grid that ensured a complete, systematic inspection of the cap. The survey team observed some minor irregularities on the Waste Containment Structure, as listed below:

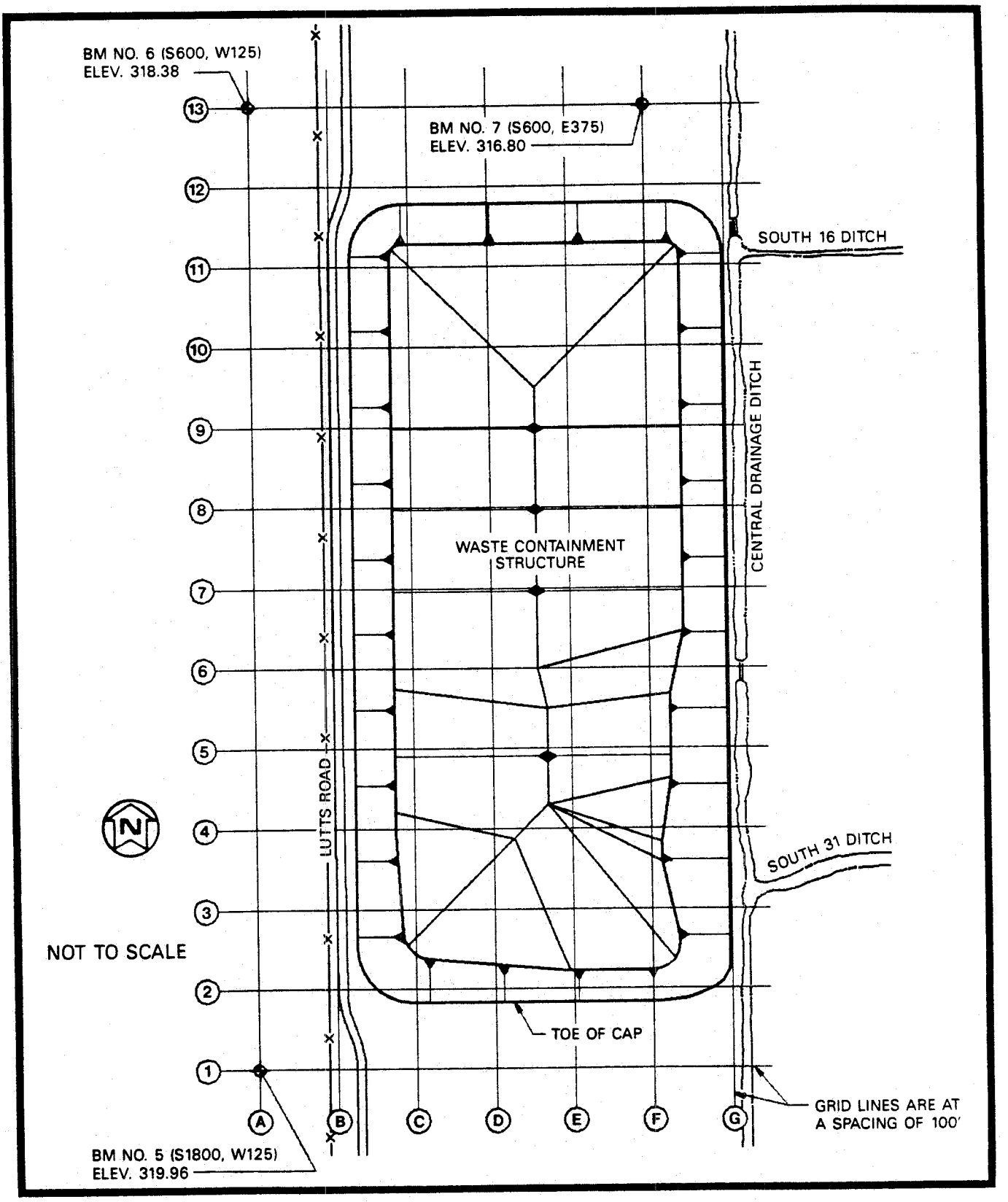

FIGURE 3-3 SURVEY GRID FOR THE NFSS WASTE CONTAINMENT STRUCTURE

TABLE 3-1

ELEVATIONS IN FEET (MSL) AT GRID INTERSECTIONS, NFSS WASTE CONTAINMENT STRUCTURE[a]

E/W Grid Lines[b]	N/S Grid Lines[b]			
	C(E075)	D(E175)	E(E275)	F(E375)
12 (S700)	318.2	317.2	317.1	317.2
11 (S800)	332.2	334.7	334.5	333.5
10 (S900)	333.9	341.2	341.7	334.6
9 (S1000)	333.6	341.8	343.1	334.5
8 (S1100)	333.1	341.4	342.5	334.9
7 (S1200)	333.0	341.2	342.3	335.0
6 (S1300)	333.6	342.4	344.7	337.5
5 (S1400)	333.7	343.2	347.4	339.6
4 (S1500)	334.5	343.2	347.1	343.3
3 (S1600)	338.8	339.8	337.5	337.8
2 (S1700)	323.1	321.2	319.9	320.5
1 (S1800)	320.2	320.5	321.4	317.6

[a]Elevations established during topographic survey, November 13-14, 1986.

[b]Coordinates of grid lines are in parentheses.

- Localized areas of sparse grass on the northern section of the cap
- Tire tracks on the topsoil
- Locations of large clods on the cap surface
- Water infiltration into geotechnical instrumentation manhole
- Poor drainage along the toe of the cap
- Isolated areas of erosion in the southern section of the cap (see Figure 3-4)

Photographs of these conditions are available in project files for future reference (Ref. 7). Actions required to correct the items noted are discussed in Section 5.0.

3.2 SUBSURFACE MONITORING

In fall 1986, 13 VWPTs and 3 PPTs were installed inside the Waste Containment Structure, as shown in Figure 3-5. The three PPTs were installed at the same elevation and in the same boreholes as VWPTs 1, 9, and 13. The PPTs provide a means for checking the operation of the VWPTs. The instrument number, grid location, recorder channel, ground surface elevation, and instrument elevation are summarized in Table 3-2.

The instruments were installed in boreholes drilled to the base of the wastes at the designated locations. Each instrument was installed 6 in. above the bottom of the borehole, then embedded in 3 ft of sand. A 1-ft thick bentonite seal was placed above the sand. The remaining portion of the borehole was filled with grout.

The instrument cables were then buried in trenches and routed to the termination point in Building 403. During installation, the cable from VWPT at Borehole 10 was accidentally cut at the ground surface, and the use of that instrument was terminated. A replacement instrument was installed adjacent to Borehole 10

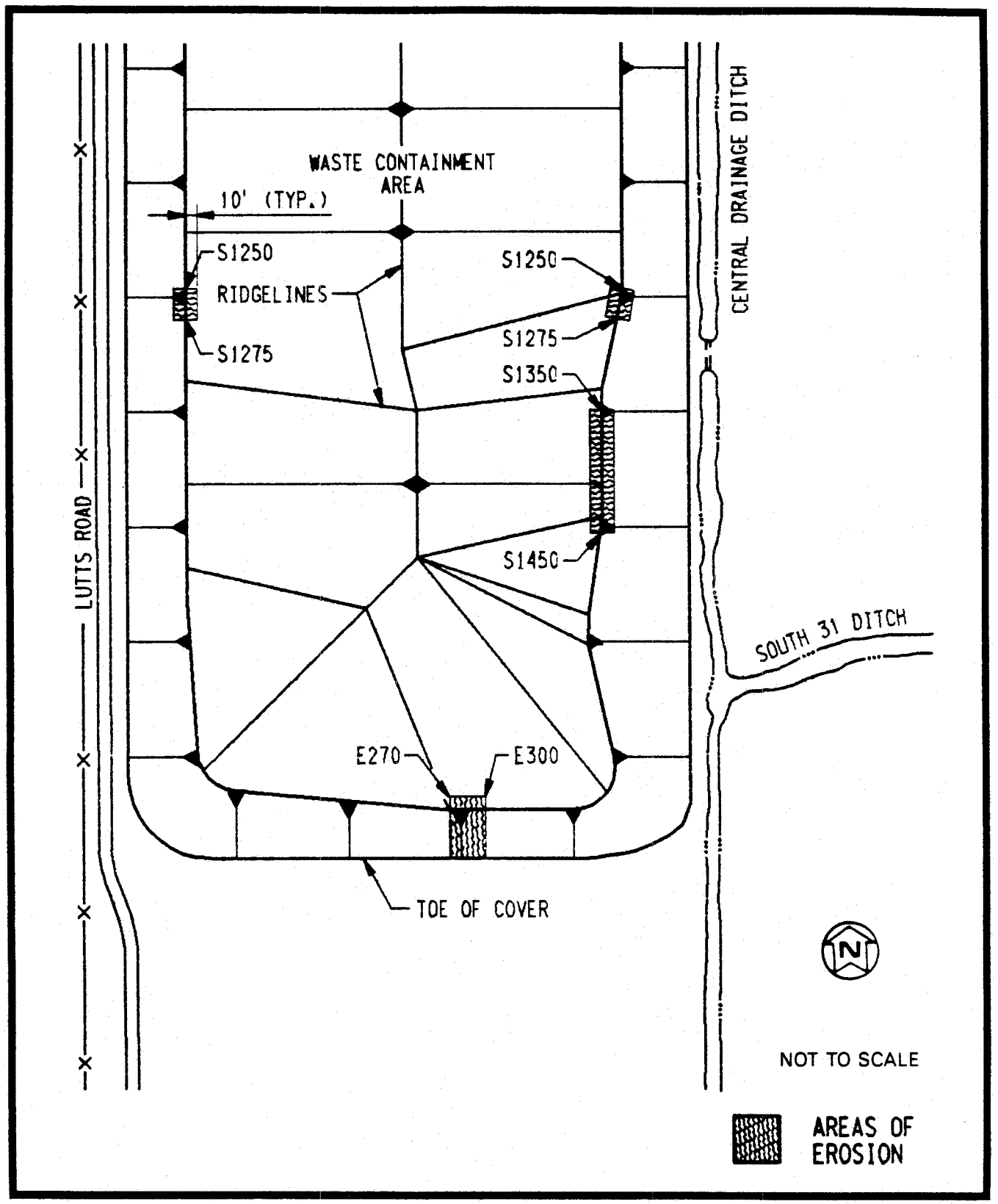

FIGURE 3-4 AREAS OF EROSION ON THE NFSS WASTE CONTAINMENT STRUCTURE SURFACE

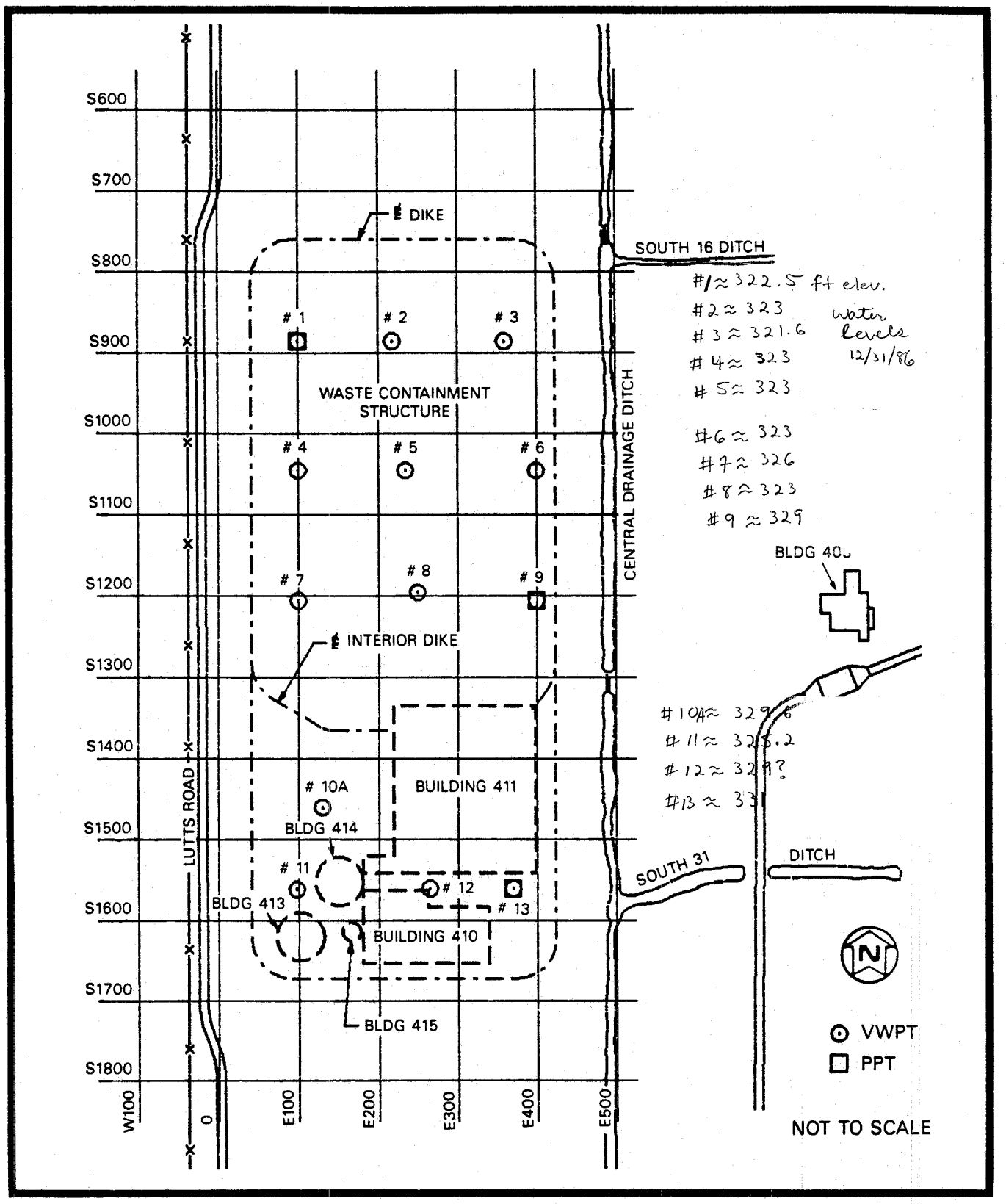

FIGURE 3-5 LOCATIONS OF VWPTs AND PPTs ON THE WASTE CONTAINMENT STRUCTURE

TABLE 3-2

SUMMARY OF SUBSURFACE MONITORING INSTRUMENTS

INSTRUMENT (BOREHOLE) NUMBER	SITE GRID COORDINATES		RECORDER CHANNEL	ELEVATION-FT (MSL)	
	SOUTH	EAST		GROUND (CAP) SURFACE	INSTRUMENT
1	885	100	11	335.2	321.7
2	885	220	12	341.4	321.2
3	885	360	13	335.6	320.6
4	1045	100	14	335.4	321.9
5	1045	235	15	344.9	321.1
6	1045	400	16	332.9	321.1
7	1205	100	17	335.3	321.1
8	1195	250	18	343.6	320.1
9	1205	400	19	334.8	323.1
10A	1460	130	10	338.9	328.1
11	1561	98	1	339.0	324.3
12	1560	265	2	341.4	329.9
13	1560	370	3	341.5	329.5

and was designated as Borehole 10A. Installation and connection of the instruments was completed November 3 and 4, 1986. Daily readings of the instruments began immediately and continued throughout the remainder of the calendar year. Instrument readings for calendar year 1986 are provided in graph format in Appendix A.

The early data obtained from the transducers will record the height of water above the instruments on a real-time basis. Knowing the water levels will provide the basis for early detection of a changing potentiometric surface within the containment structure. Significant change in water level may indicate a distressed condition in the Waste Containment Structure.

The data collected from the VWPTs during 1986 show increases in water levels at all locations except three. These increases reflect the reestablishment of the water levels that existed when the boreholes were made and the instruments were installed. The water levels will stabilize, slowly in some cases, at the pre-existing levels for each instrument location. Once stability has been reestablished, which will be apparent from the data record, any further changes in water level indicated by the instrument(s) will reflect changes within the wastes.

Though three VWPTs did not show an increase in water levels, these instruments also are to be considered as being in the process of reaching equilibrium with water levels existing in their surroundings. At the locations where these instruments were installed, water levels may be below, level with, or only slightly above the instruments.

3.3 ENVIRONMENTAL MONITORING

During 1986, environmental monitoring continued at the NFSS, the complete results of which are reported in the annual site

environmental monitoring report for calendar year 1986 (Ref. 4). This subsection summarizes the results of 1986 monitoring for radon and external gamma radiation levels and reports results of groundwater monitoring in the vicinity of the Waste Containment Structure.

3.3.1 Radon

Annual average concentrations of radon measured at the NFSS boundary in 1986 ranged from 1.7×10^{-10} uCi/ml to 3.6×10^{-10} uCi/ml (0.17 to 0.36 pCi/l). All levels were comparable to the background radon level, which was measured at 3.1×10^{-10} uCi/ml (0.31 pCi/l). For complete results, see the 1986 NFSS environmental monitoring report (Ref. 4).

3.3.2 External Gamma Radiation Levels

Annual average external gamma radiation levels at the NFSS site boundary ranged from background levels to 26 mR/yr above background, which was measured at 69 mR/yr. For complete results, see the 1986 NFSS environmental monitoring report (Ref. 4).

3.3.3 Groundwater Monitoring

During 1986, groundwater monitoring at the NFSS continued as part of the overall site environmental monitoring program, complete results of which are reported in the annual site environmental monitoring report for 1986 (Ref. 4). This subsection reports groundwater monitoring data from those wells adjacent to or in the near vicinity of the Waste Containment Structure. The location of these wells is shown in Figure 3-6. Concentrations of uranium and radium-226 in groundwater samples from these wells are reported in Table 3-3.

While Table 3-3 reports only 1986 data, the overall groundwater monitoring results from 1983 to 1986 have been basically the

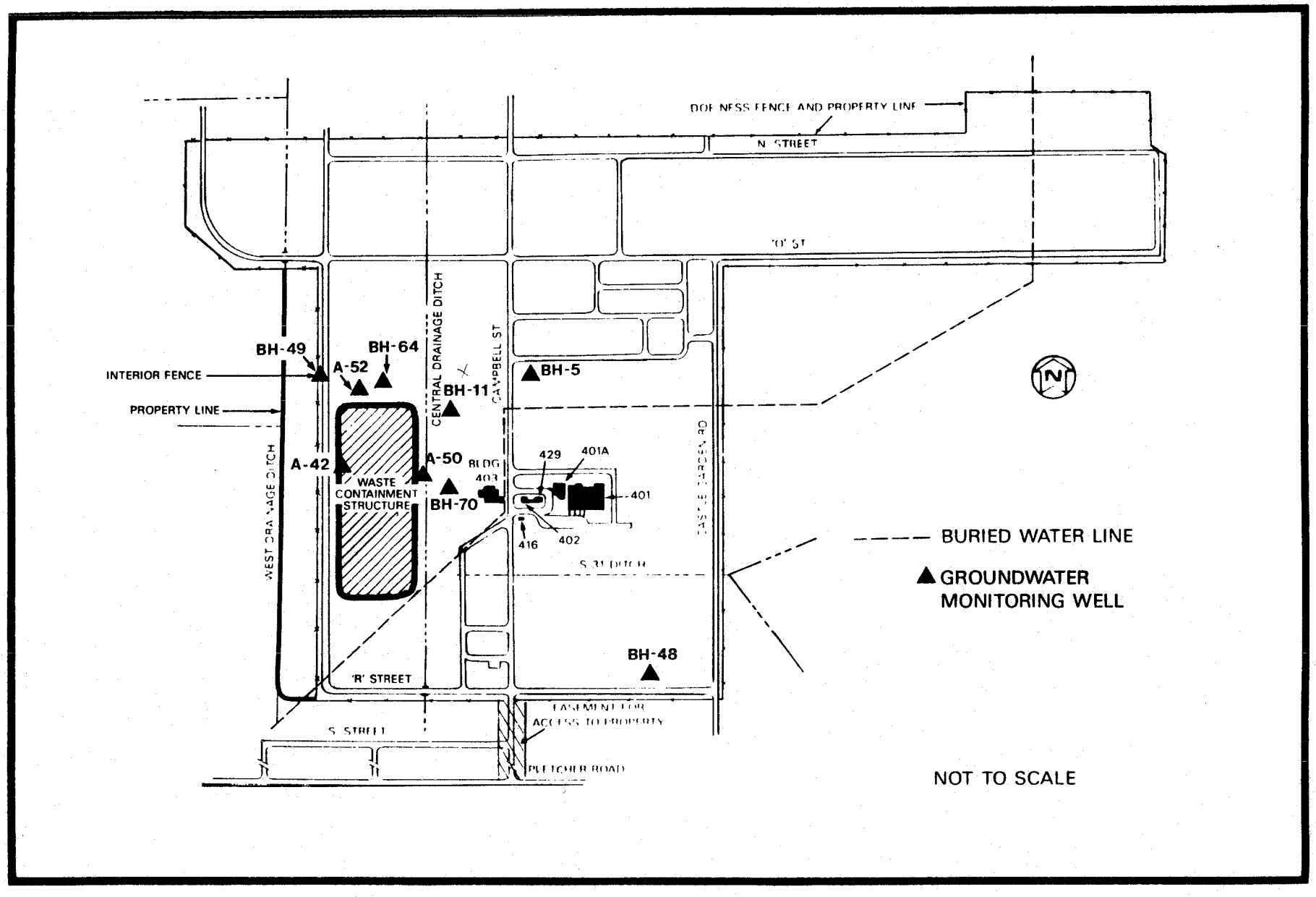

FIGURE 3-6 LOCATION OF NFSS GROUNDWATER MONITORING WELLS IN THE VICINITY OF THE WASTE CONTAINMENT STRUCTURE

TABLE 3-3

CONCENTRATIONS OF URANIUM AND RADIUM-226

IN GROUNDWATER AT THE NFSS, 1986

Sampling Location[a]	Concentration (10^{-9} uCi/ml)[b] Minimum	Maximum	Average
Uranium			
BH-5	<3	<3	<3
BH-48	<3	6	5
A-42	65	73	71
A-50	<3	5	4
BH-49	<3	<3	<3
A-52	13	19	17
BH-64	11	15	13
BH-70	<3	4	<3
BH-71	<3	<3	<3
Radium-226			
BH-5	0.3	0.7	0.5
BH-48	0.4	0.7	0.5
A-42	0.1	1.5	0.6
A-50	0.2	0.9	0.5
BH-49	0.1	0.5	0.2
A-52	0.2	0.3	0.3
BH-64	0.3	0.5	0.4
BH-70	0.3	0.6	0.5
BH-71	0.2	0.8	0.4

[a]Sampling locations are shown in Figure 3-6. Only those wells adjacent to or nearby the Waste Containment Structure are reported in this document. For complete site-wide results, see the 1986 Site Environmental monitoring report (Ref. 4).

[b]1 x 10^{-9} uCi/ml is equivalent to 1 pCi/l.

same (Ref. 4). Therefore, the 1986 data represent a well-established baseline condition upon which to base comparisons with future monitoring results. As reported earlier, the groundwater monitoring program will be greatly expanded in 1987, with the addition of the 36 new monitoring wells. The established data record and expanded monitoring program will provide the information necessary for quickly ascertaining any increases in radionuclide concentrations in groundwater.

4.0 COMPARISON WITH PREVIOUS DATA

Since the Waste Containment Structure was just completed in fall 1986, there are no previous data for comparison. As previously stated, the data obtained in calendar years 1986 and the 1987 aerial survey will establish the baseline for future performance monitoring, making possible the early detection of surface or subsurface changes that may indicate developing weakness in the Waste Containment Structure. To accurately evaluate the effectiveness of the containment facility, the data from both the performance monitoring system and the broader environmental monitoring program will be assessed.

For 1986, the environmental monitoring report shows there has been no change in the quality of the water collected from the groundwater wells surrounding the Waste Containment Structure. The report also shows that, regarding radon levels, external gamma radiation levels, and calculation of potential dose to the public, the NFSS is in compliance with the DOE radiation protection standard (Ref. 4).

5.0 ACTIONS REQUIRED

During the walkover survey in fall 1986, several conditions were identified as needing correction, as discussed in Subsection 3.1.3. Most of these conditions are easily correctable and/or preventable by routine maintenance (such as Items 1, 2, and 3 below). These routine items have been carefully noted in this report because of the importance of describing baseline conditions of the Waste Containment Structure. In future documents, routine maintenance items will not be reported in such detail.

The actions required to correct each condition noted in Subsection 3.1.3 are discussed below. The status of each action is also noted.

1. Include rolling, fertilizing, and herbicide treatment in the cap maintenance plan to improve grass cover, prevent clodding, and smooth tire tracks. This activity has been completed and will be a part of ongoing maintenance.

2. Fill in and reseed localized areas of erosion on the cap surface. This activity has been completed and will be a part of ongoing maintenance. (The seed and mulch for the southern section of the Waste Containment Structure had only recently been placed, so grass had not yet been established and localized erosion had occurred. With grass established in this area, erosion is expected to be minimal in future years.)

3. Install a watertight lid (marked "ELECTRIC") on the geotechnical instrumentation manhole to prevent water from becoming entrapped and freezing in the manhole, which could damage the instrumentation cables. During the winter, water was kept out of the manhole by pumping when necessary. A watertight lid will be installed during the summer of 1987.

4. Install drainage pipes under Lutts Road along the west side of the containment structure to provide drainage improvements for surface runoff. Regrade Lutts Road after improving the drainage system. A plan for this work is being developed, and the work will be performed during the summer of 1987.

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5. Trip Report, M.G. Jones, Bechtel National Inc., to File. "Walkover Survey for Waste Containment Structure at the Niagara Falls Storage Site, November 17-18, 1986," CCN 042360, December 23, 1986.

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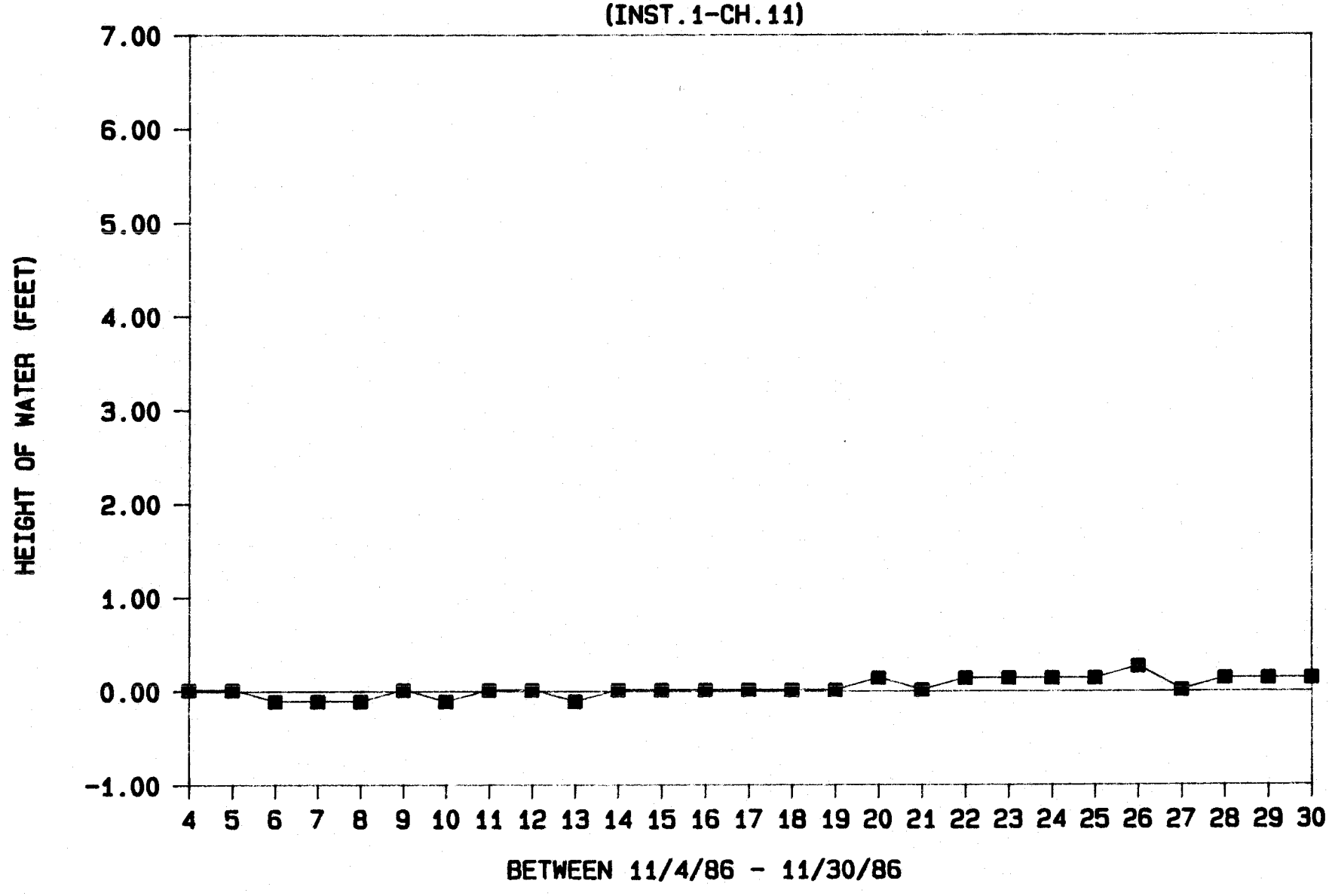
7. Memorandum, M.G. Jones, Bechtel National, Inc., to C.A. Knoke. "Improvement/Maintenance Scope of Work for NFSS Waste Containment Structure (with survey photographs)," CCN 044510, Oak Ridge, TN, April 28, 1986.

APPENDIX A

SUMMARY OF VIBRATING WIRE PRESSURE TRANSDUCER DATA FOR CALENDAR YEAR 1986

DAILY READING



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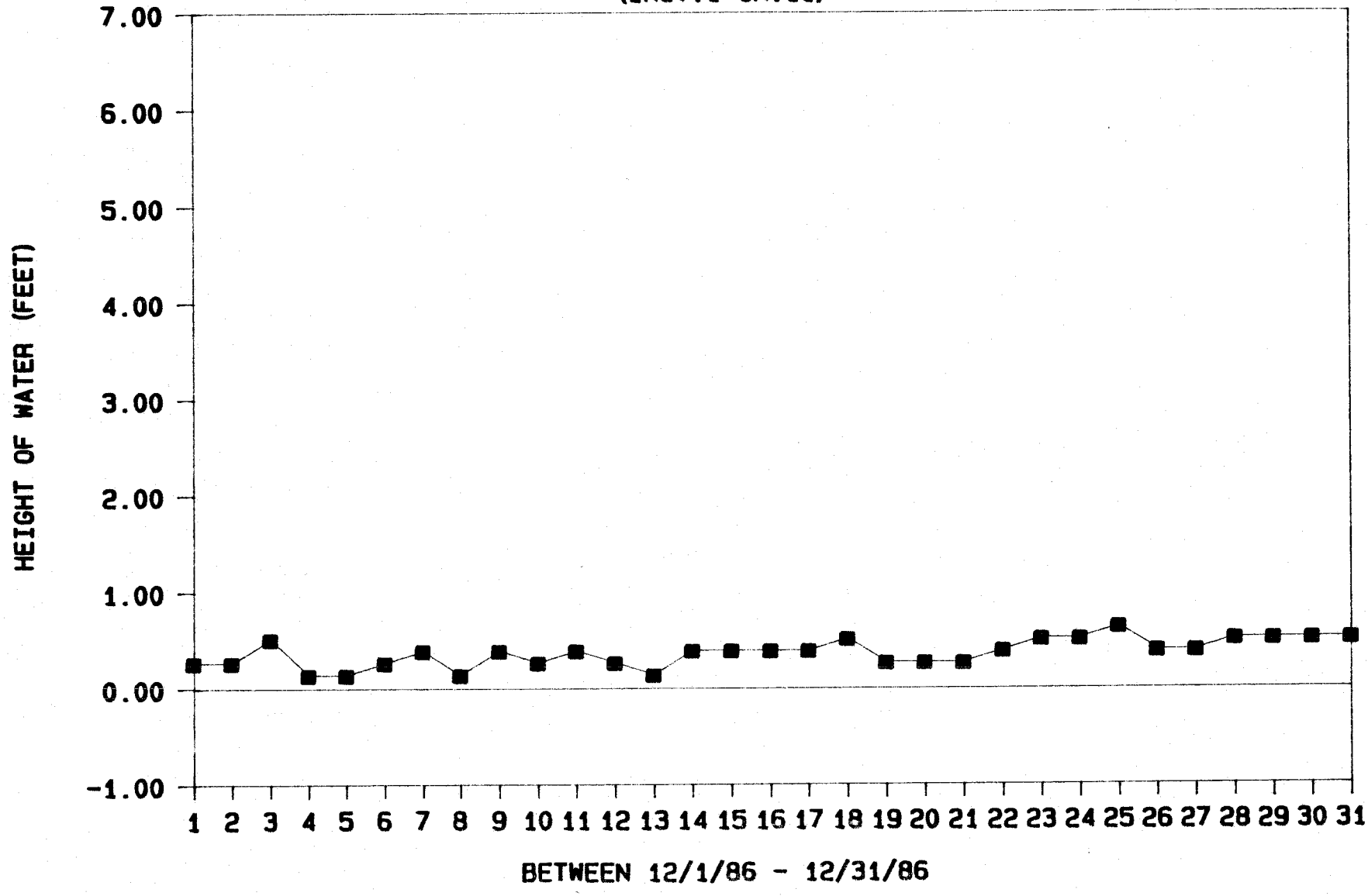

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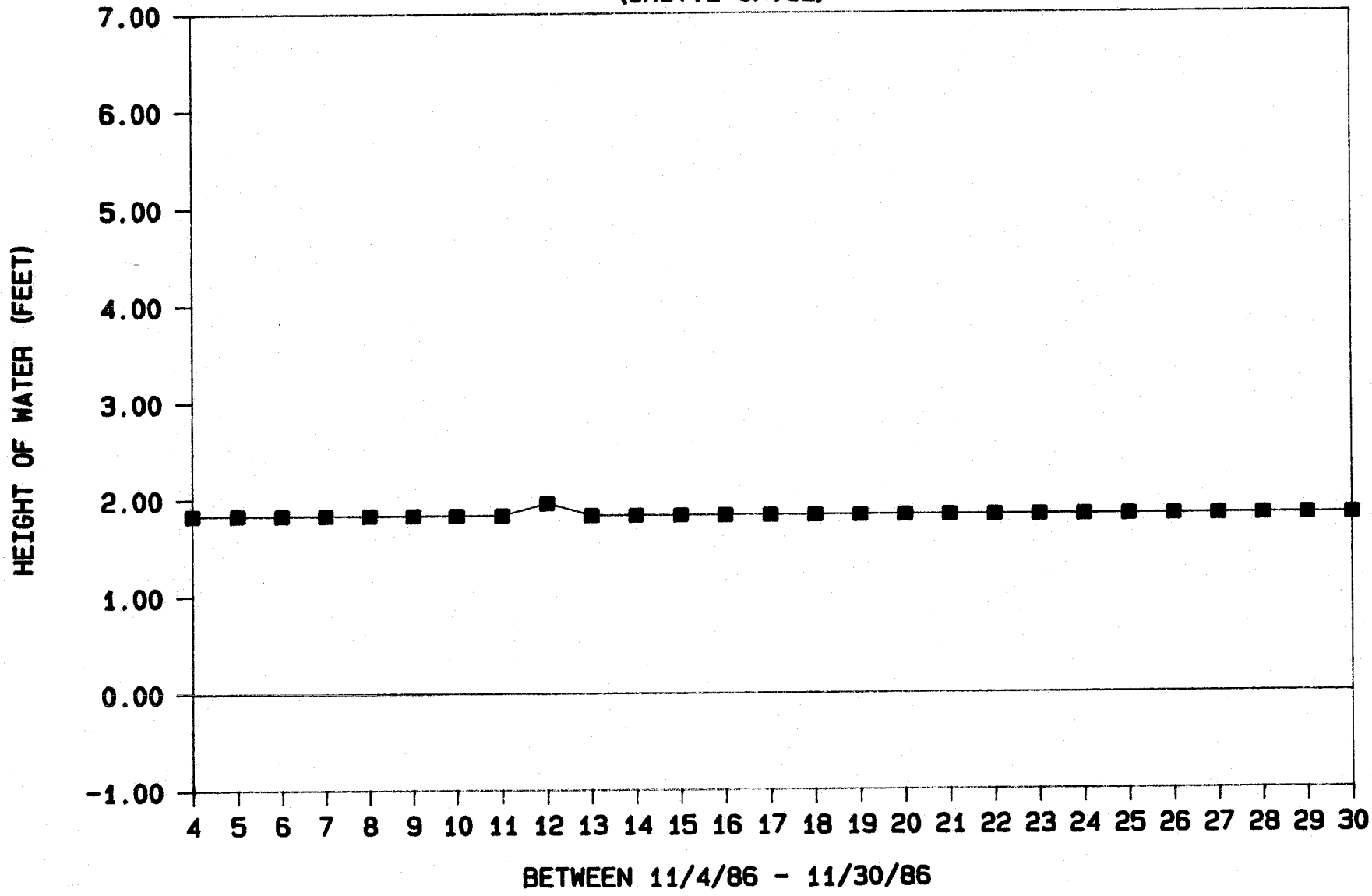

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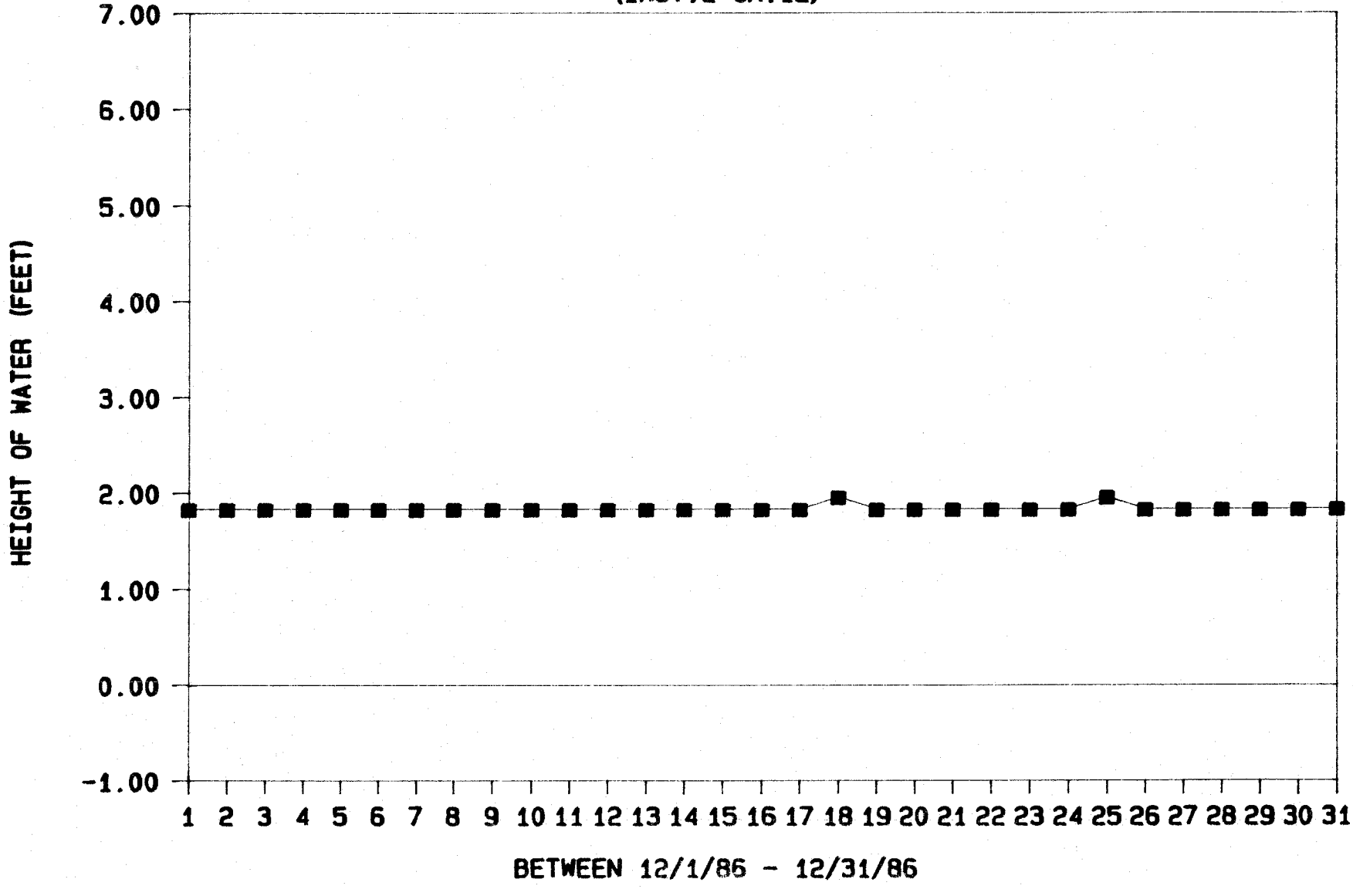

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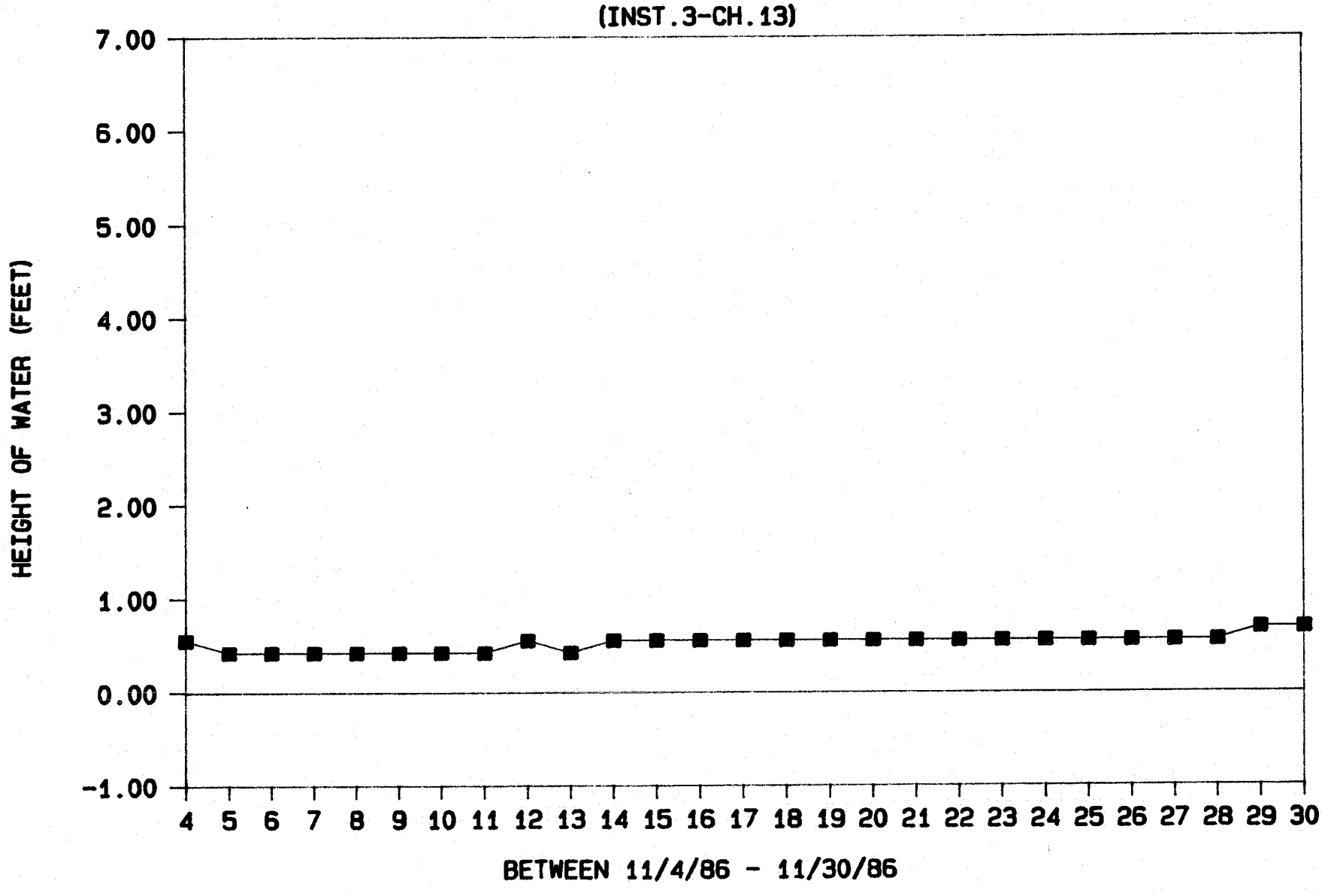
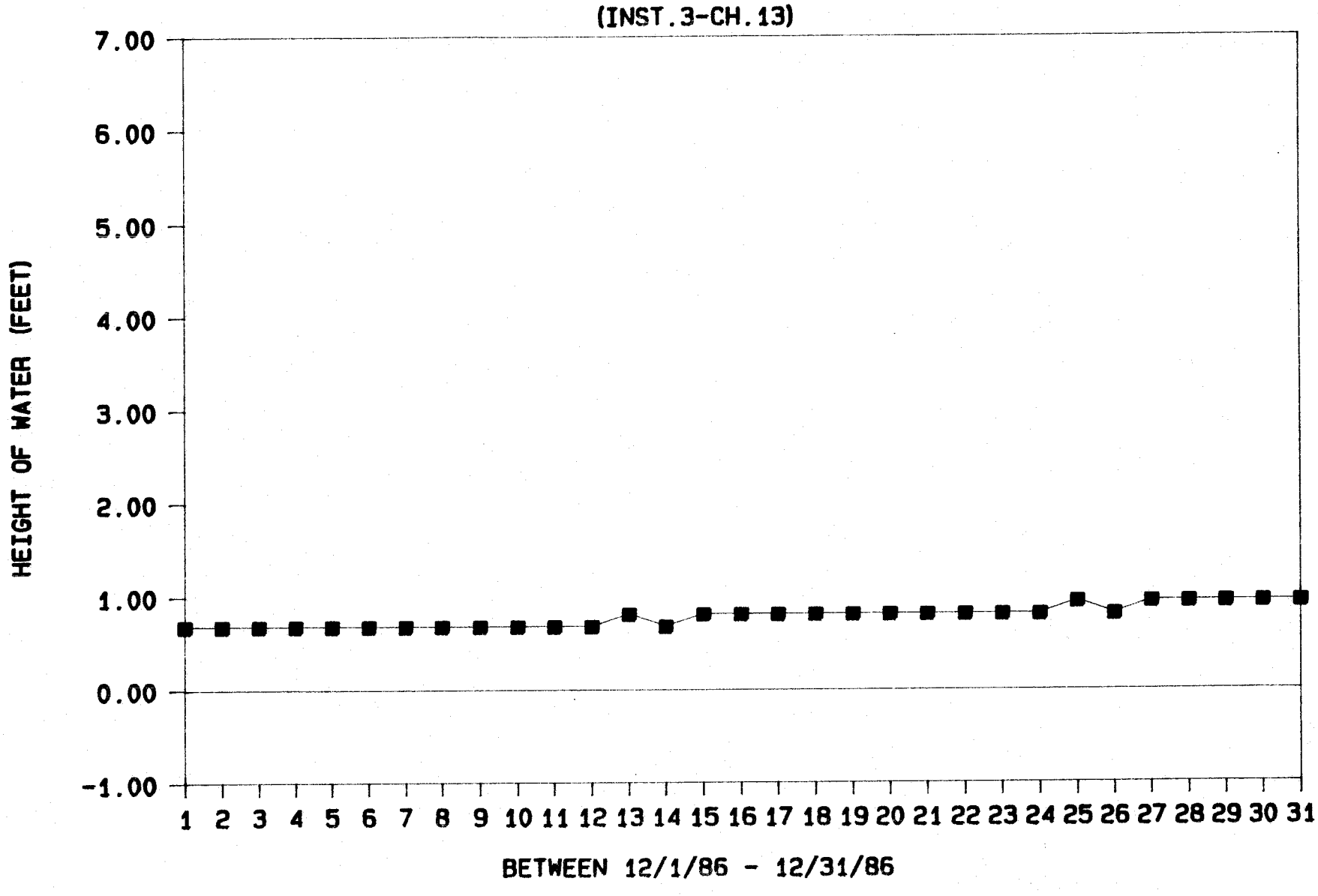
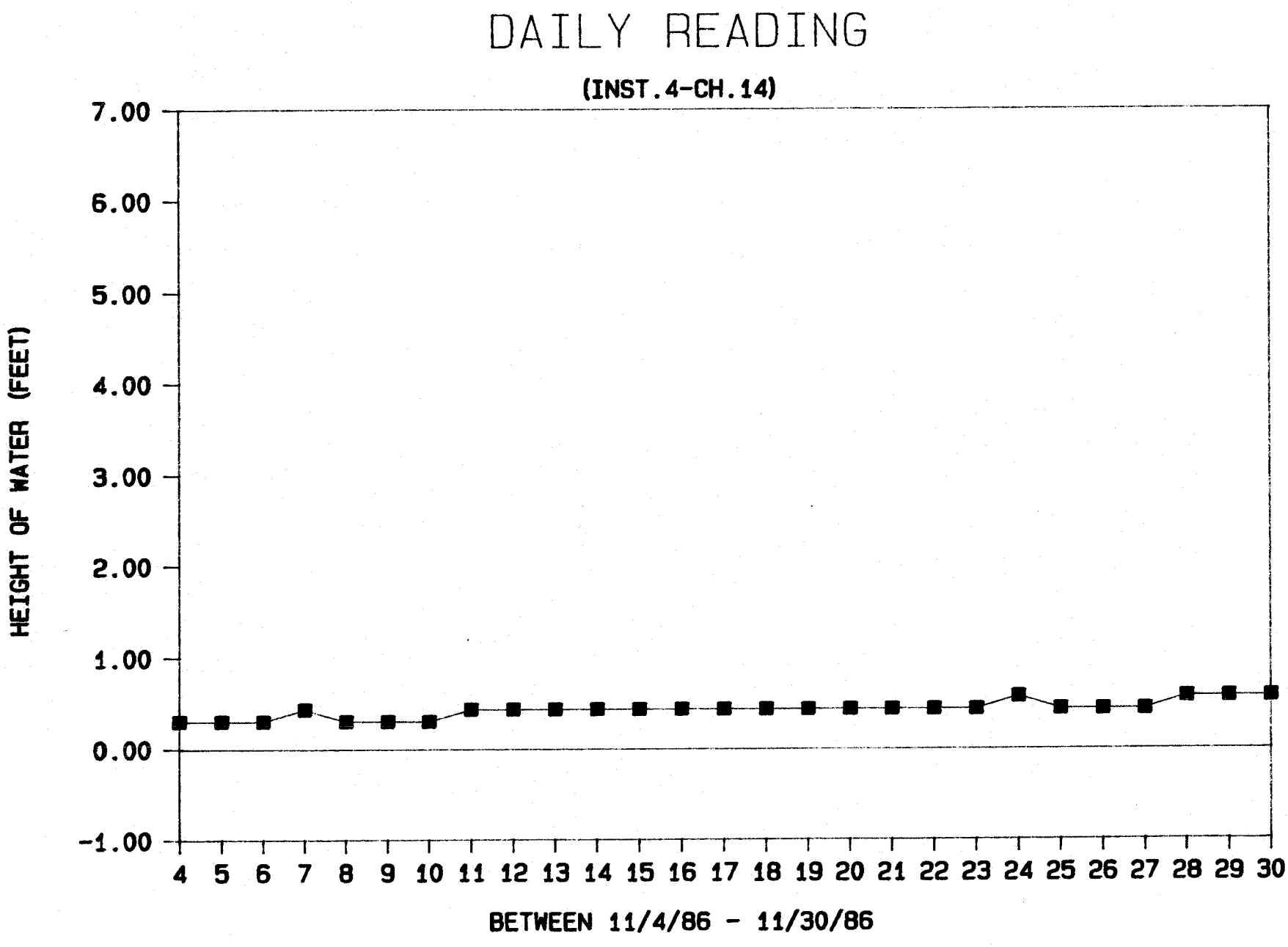
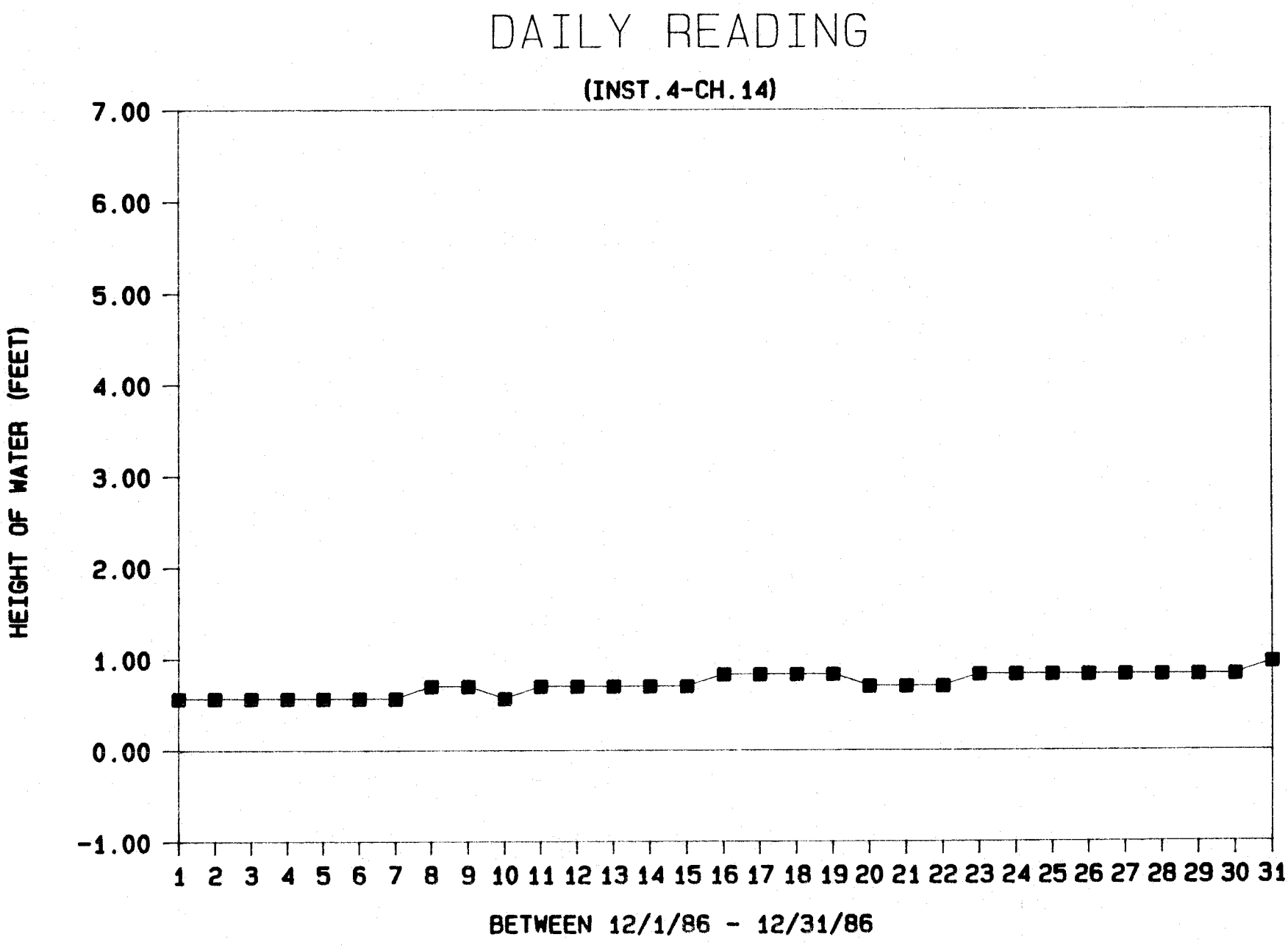


DAILY READING




DAILY READING
(INST.4-CH.14)
HEIGHT OF WATER (FEET)
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
BETWEEN 11/4/86 - 11/30/86


DAILY READING
(INST.4-CH.14)
HEIGHT OF WATER (FEET)
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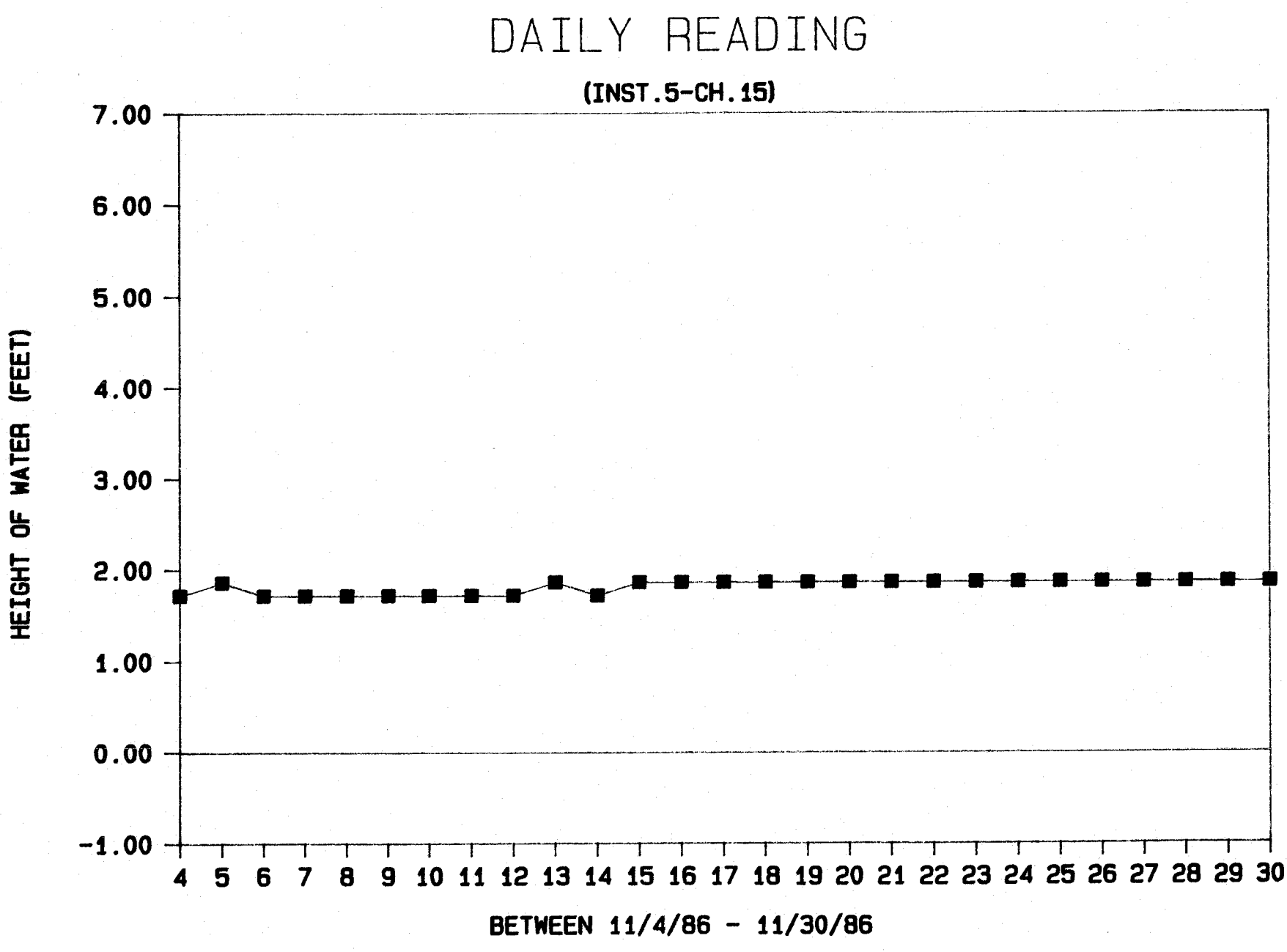
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
BETWEEN 12/1/86 - 12/31/86


DAILY READING
(INST.5-CH.15)
HEIGHT OF WATER (FEET)
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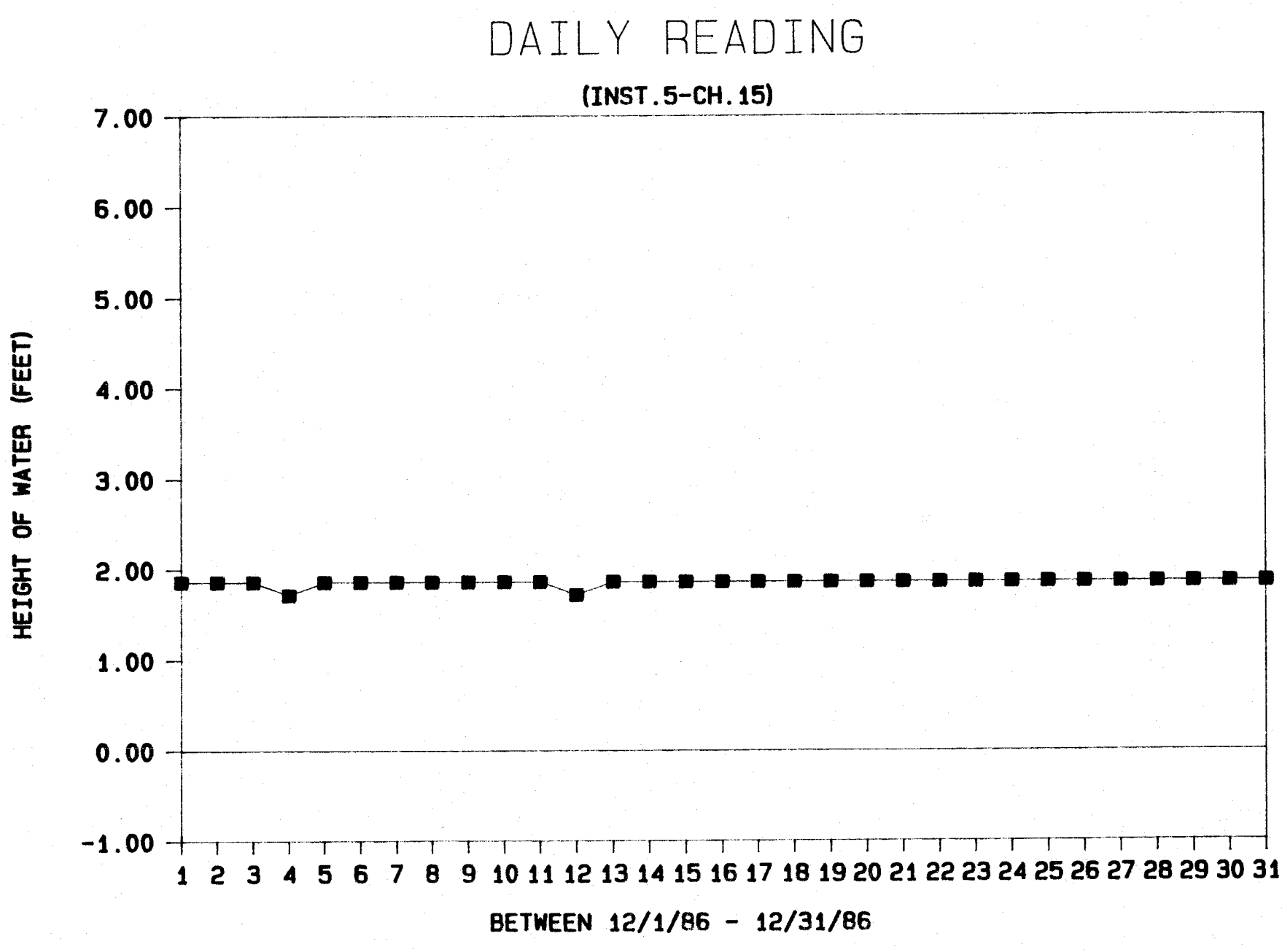
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
BETWEEN 11/4/86 - 11/30/86


DAILY READING
(INST.5-CH.15)
HEIGHT OF WATER (FEET)
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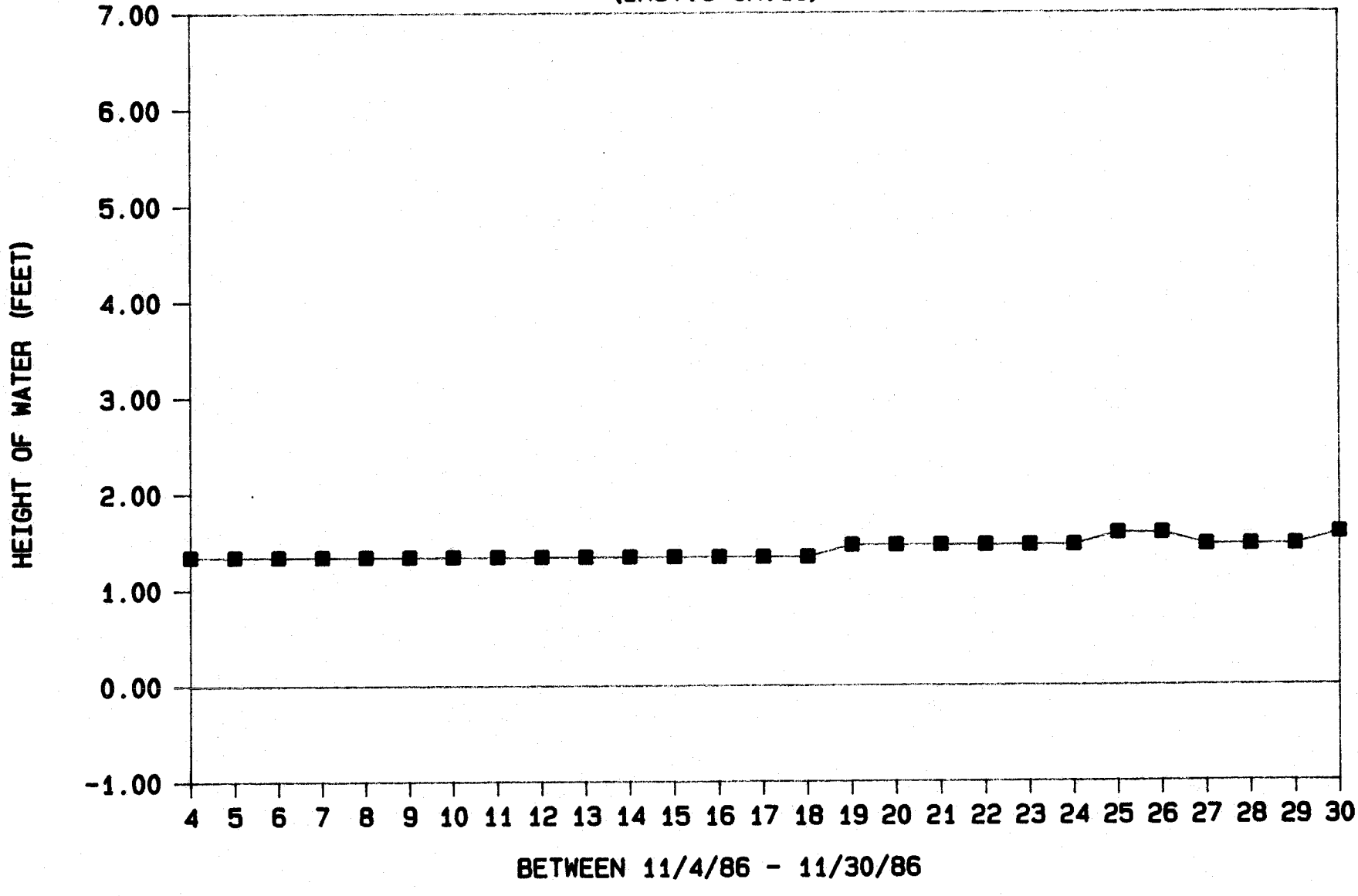
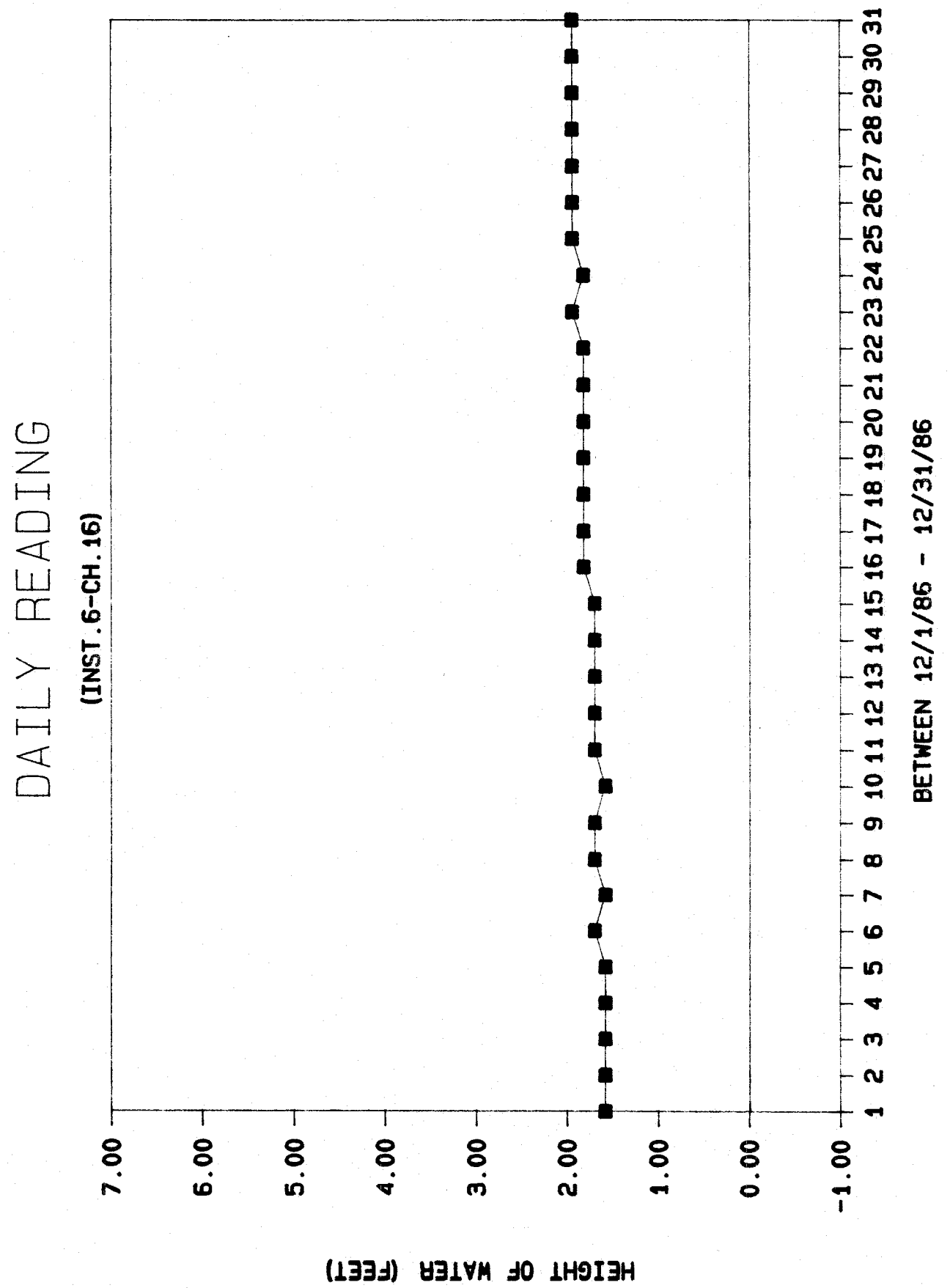
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
BETWEEN 12/1/86 - 12/31/86

DAILY READING

(INST.6-CH.16)




DAILY READING
(INST.6-CH.16)
HEIGHT OF WATER (FEET)
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3.00
2.00
1.00
0.00
-1.00
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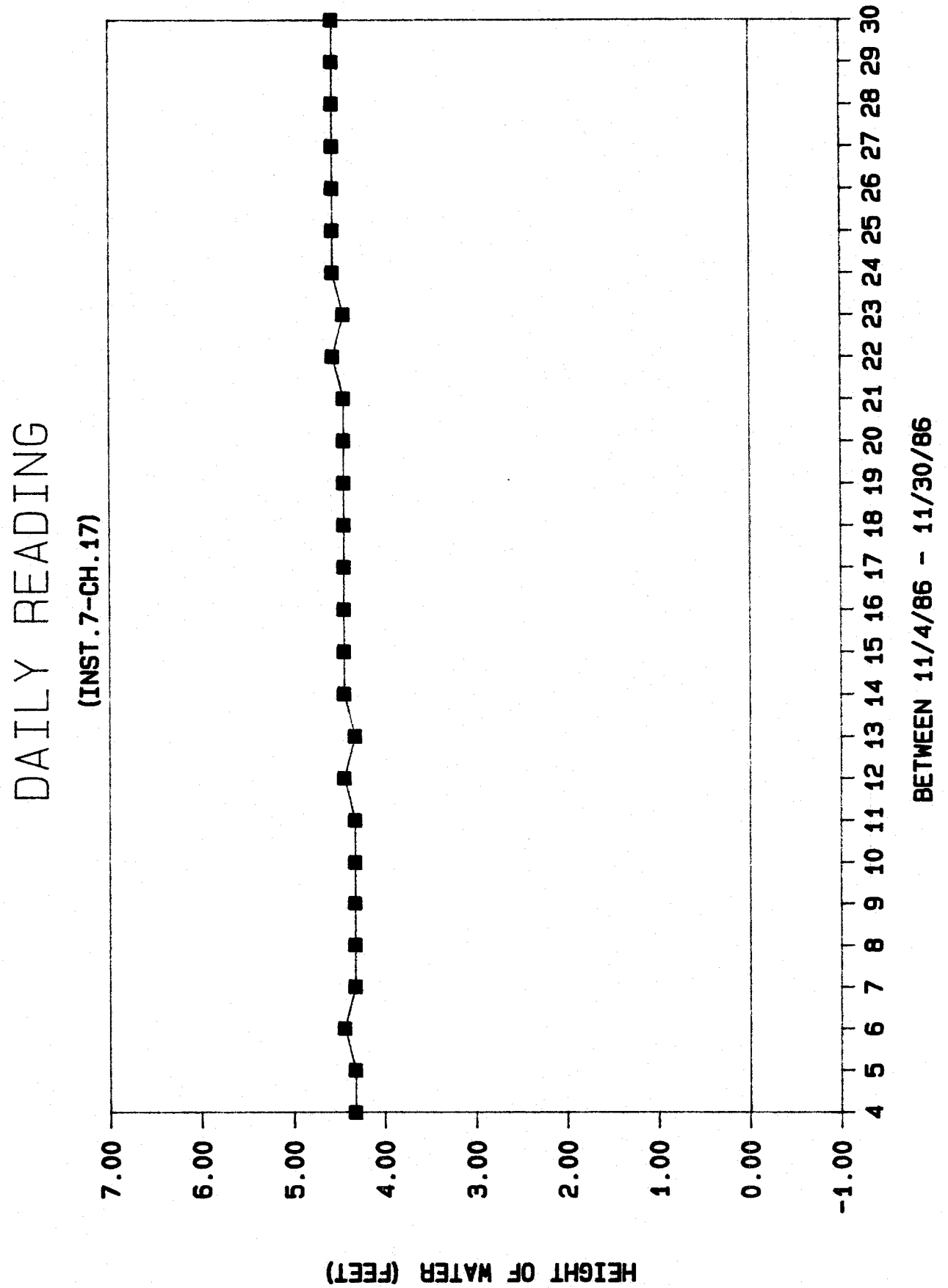
BETWEEN 12/1/86 - 12/31/86


DAILY READING
(INST.7-CH.17)
HEIGHT OF WATER (FEET)
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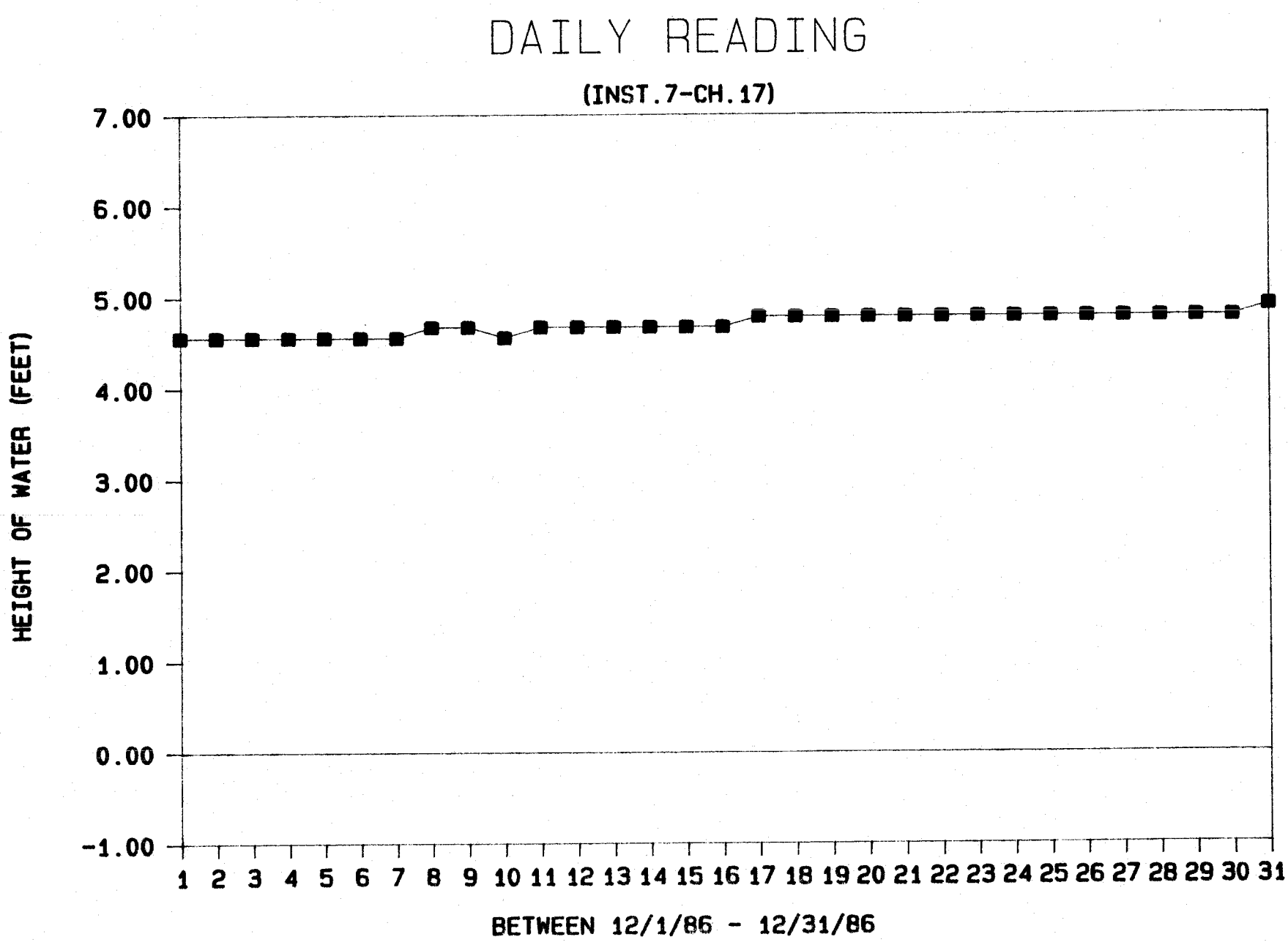
4.00
3.00
2.00
1.00
0.00
-1.00
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
BETWEEN 11/4/86 - 11/30/86


DAILY READING
(INST.7-CH.17)
HEIGHT OF WATER (FEET)
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4.00
3.00
2.00
1.00
0.00
-1.00
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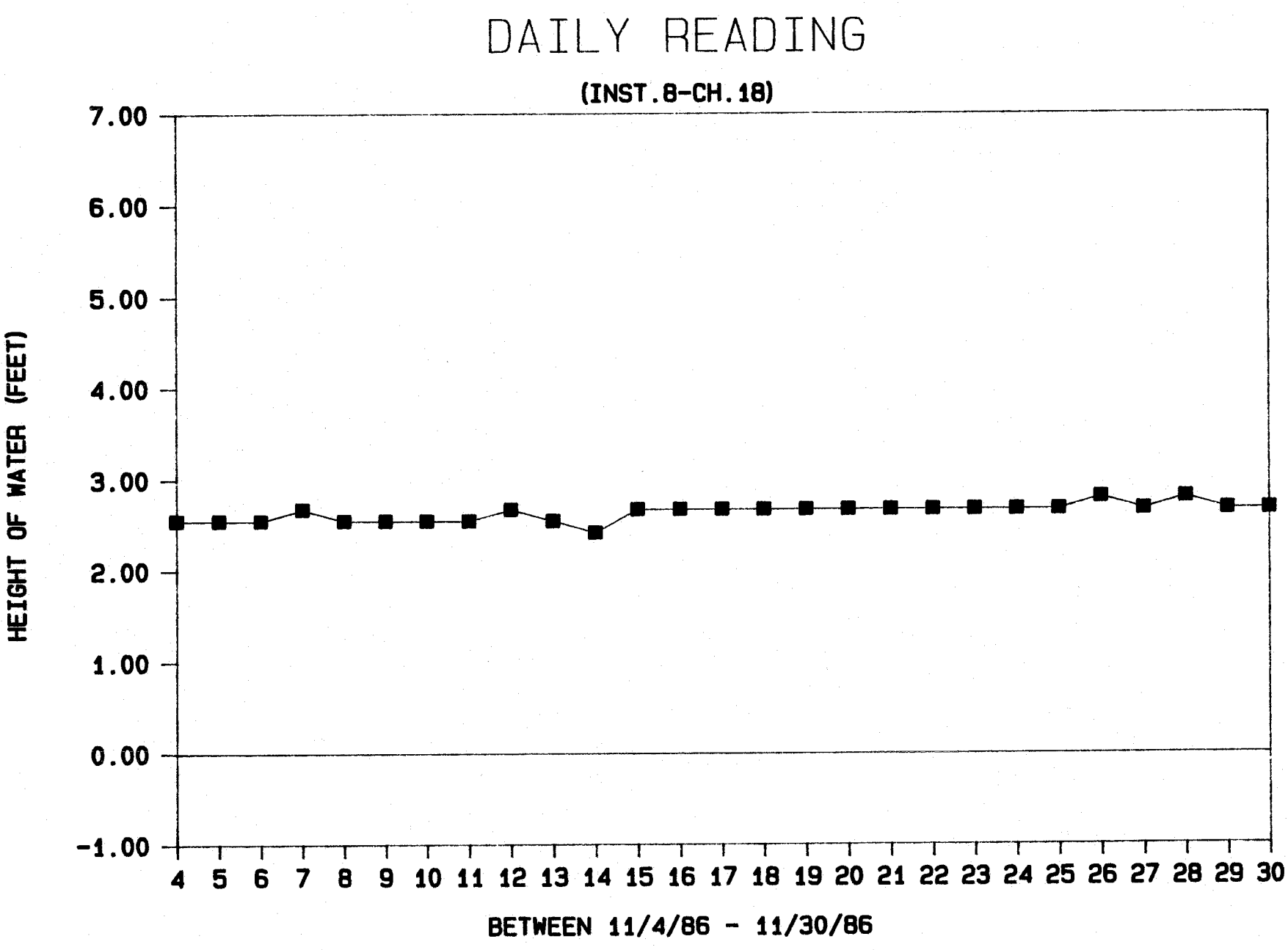
BETWEEN 12/1/86 - 12/31/86


DAILY READING
(INST.8-CH.18)
HEIGHT OF WATER (FEET)
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3.00
2.00
1.00
0.00
-1.00
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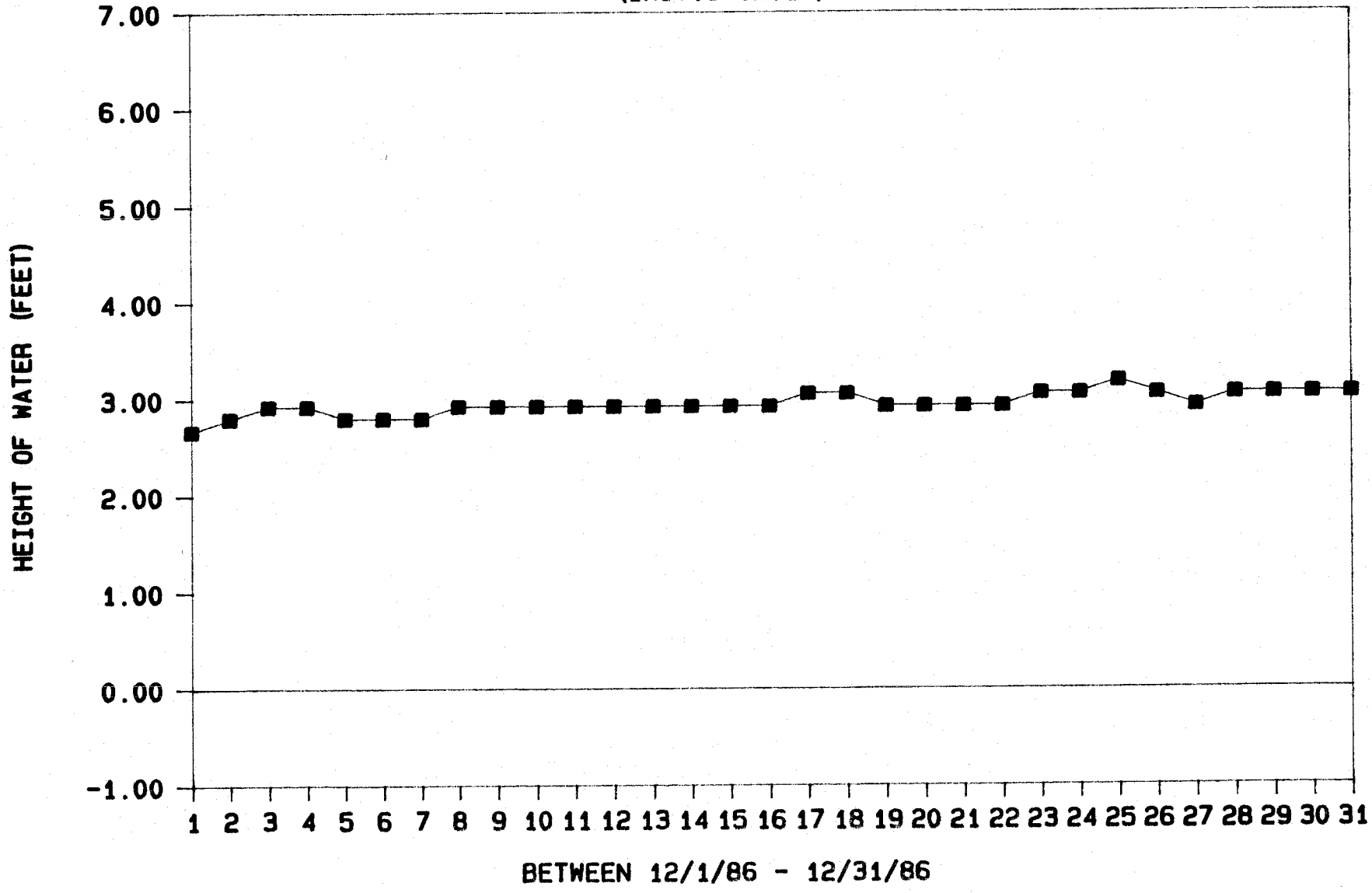
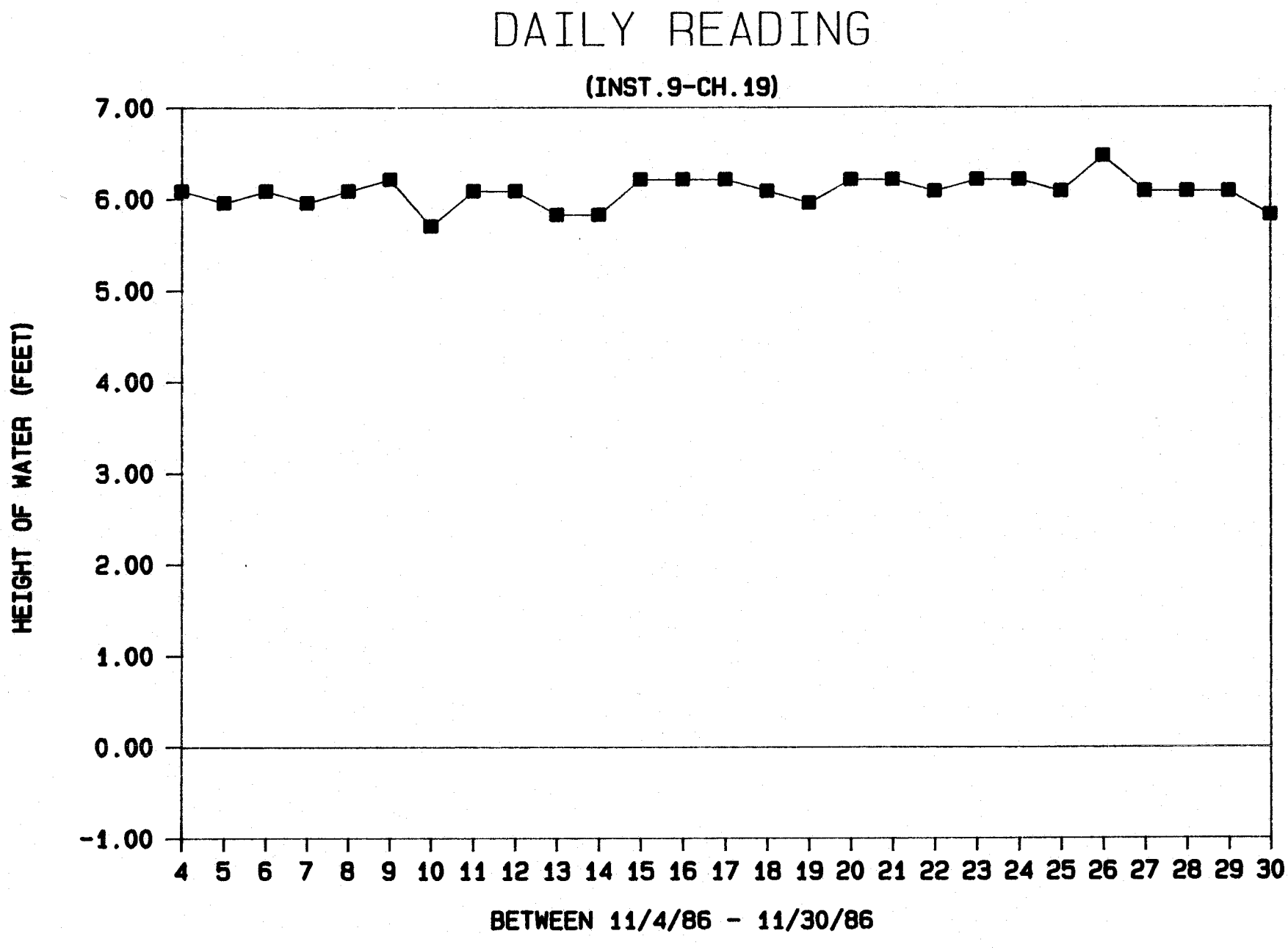
BETWEEN 11/4/86 - 11/30/86

DAILY READING

(INST.8-CH.18)




DAILY READING
(INST.9-CH.19)
HEIGHT OF WATER (FEET)
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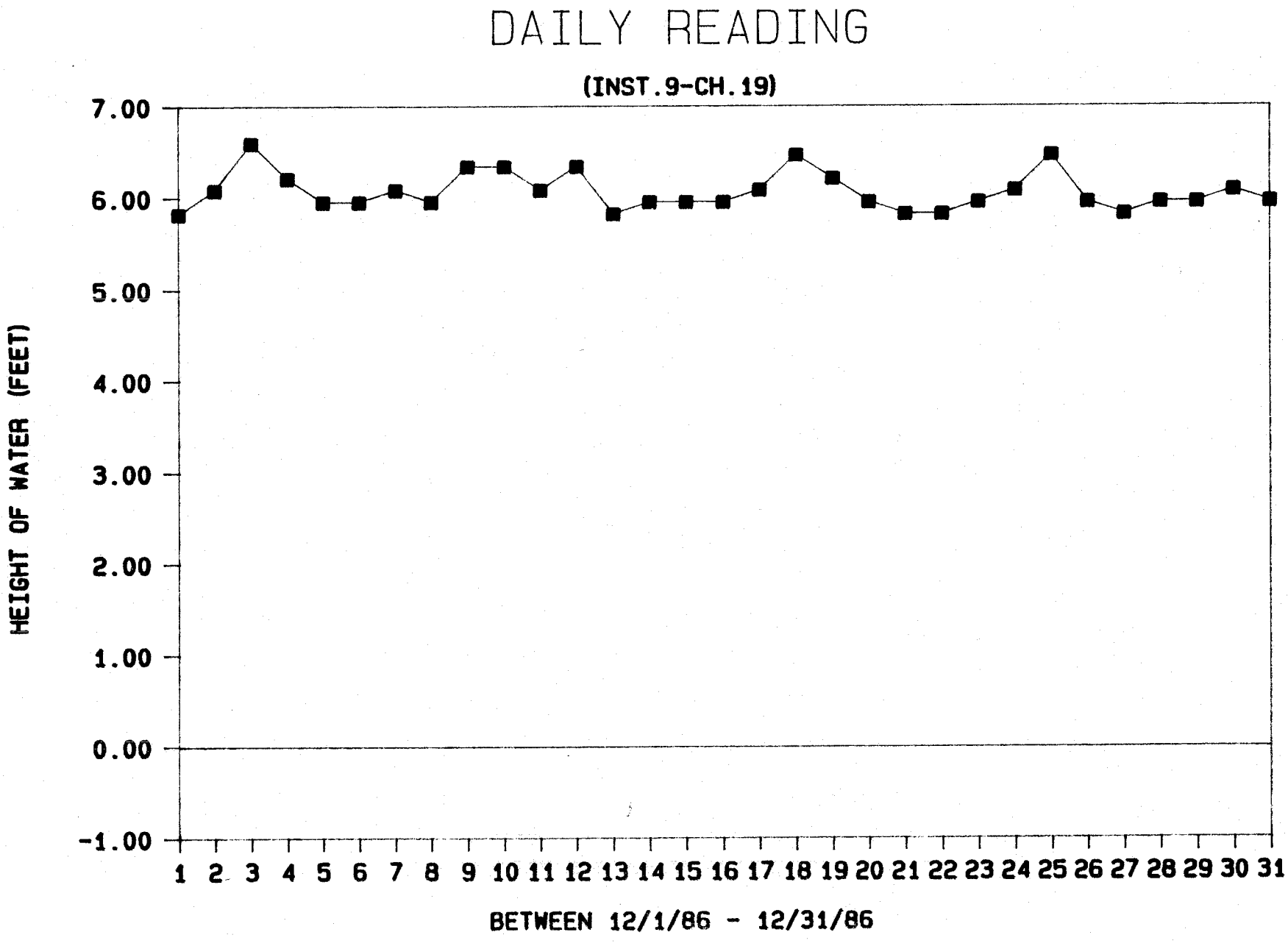
4.00
3.00
2.00
1.00
0.00
-1.00
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
BETWEEN 11/4/86 - 11/30/86


DAILY READING
(INST.9-CH.19)
HEIGHT OF WATER (FEET)
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3.00
2.00
1.00
0.00
-1.00
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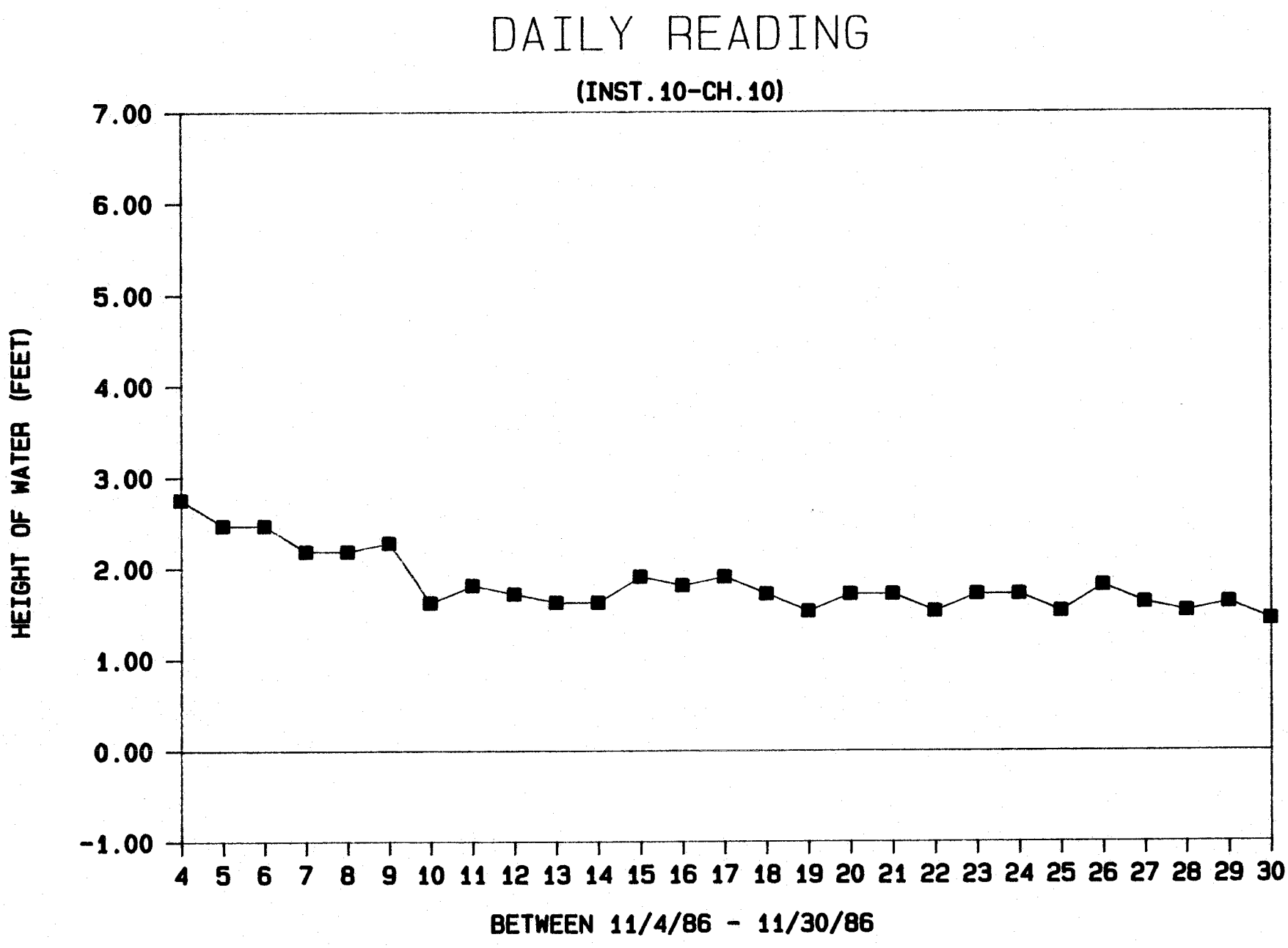
BETWEEN 12/1/86 - 12/31/86


DAILY READING
(INST.10-CH.10)
HEIGHT OF WATER (FEET)
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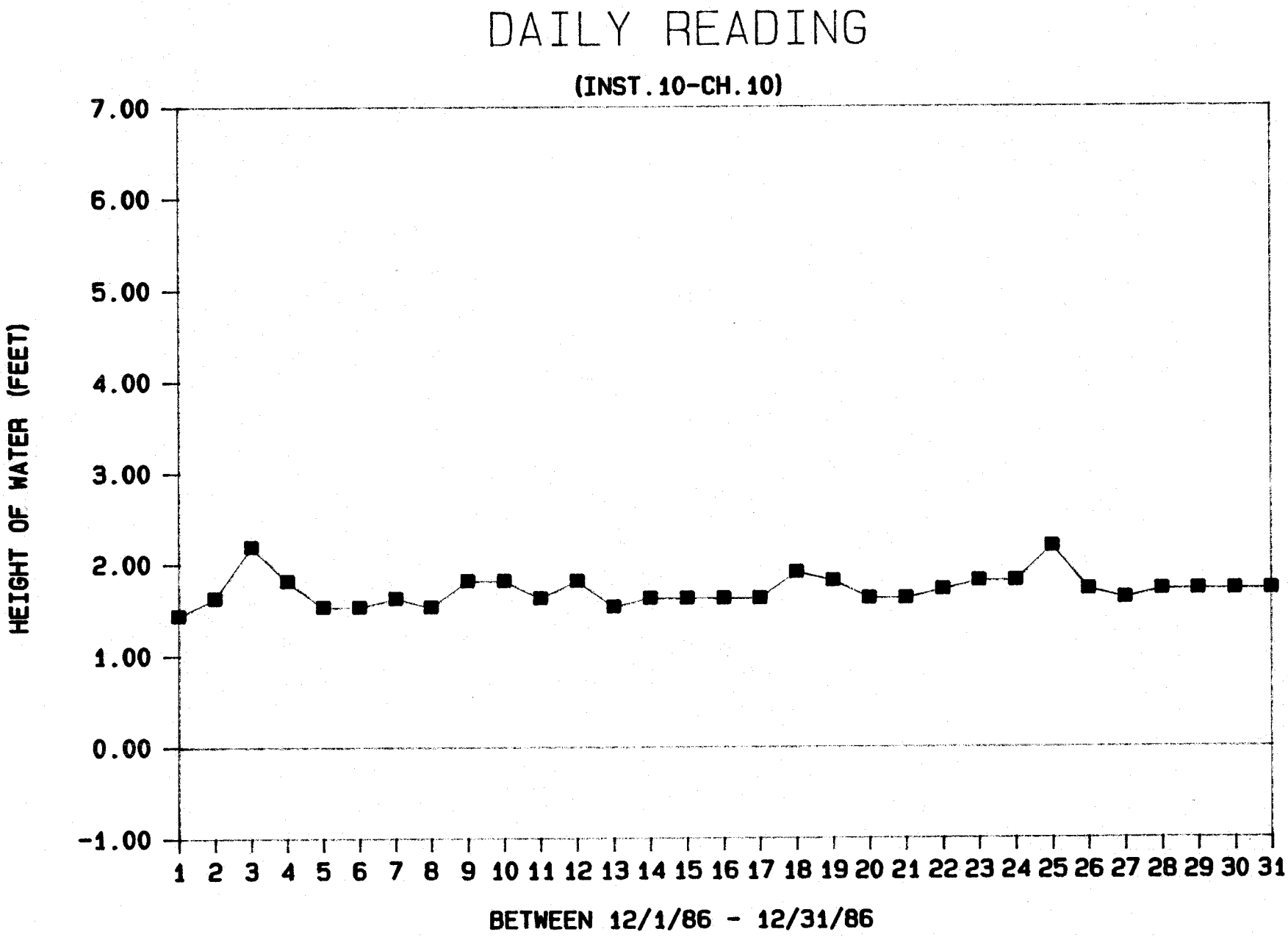
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
BETWEEN 11/4/86 - 11/30/86


DAILY READING
(INST.10-CH.10)
HEIGHT OF WATER (FEET)
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5.00
4.00
3.00
2.00
1.00
0.00
-1.00
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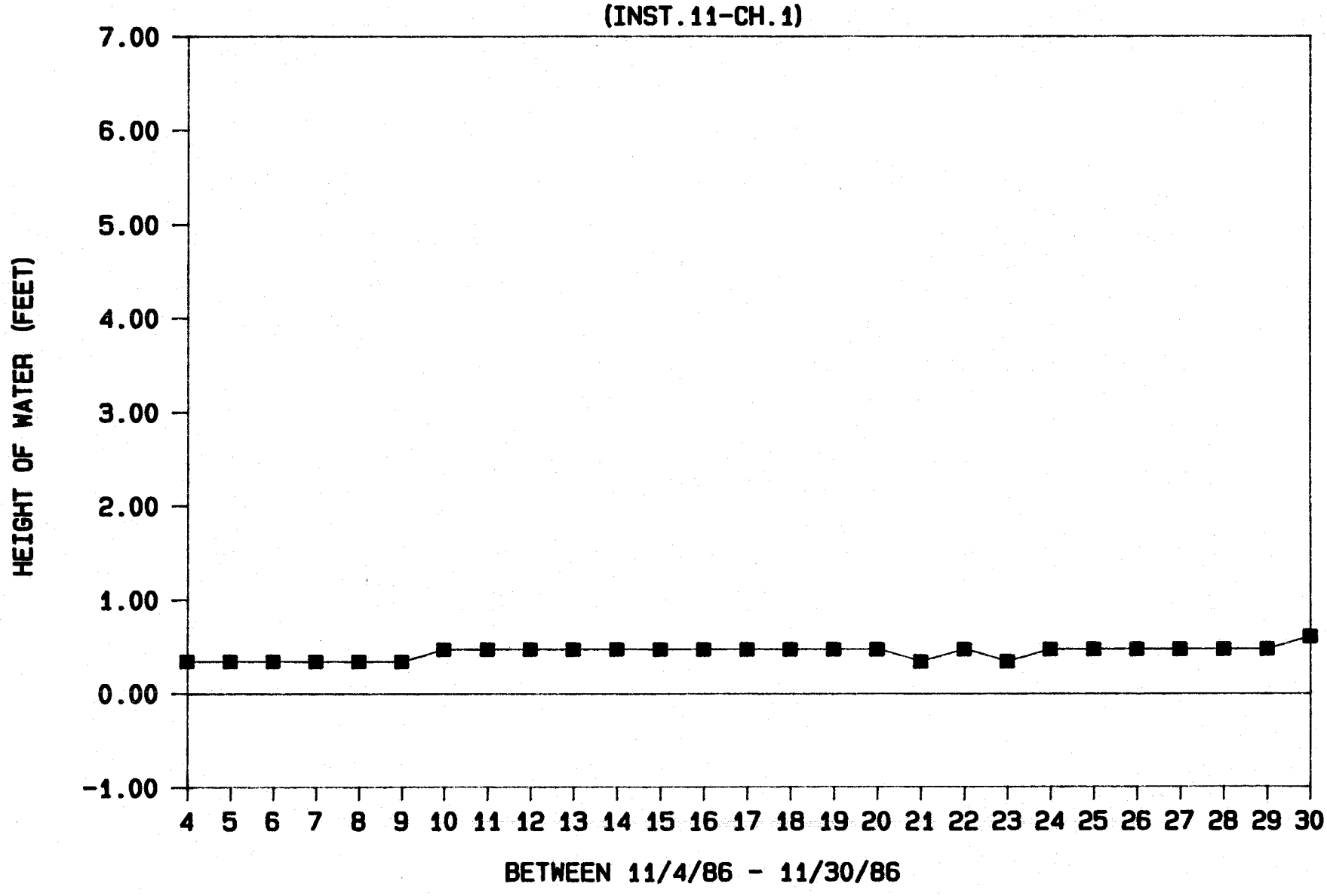
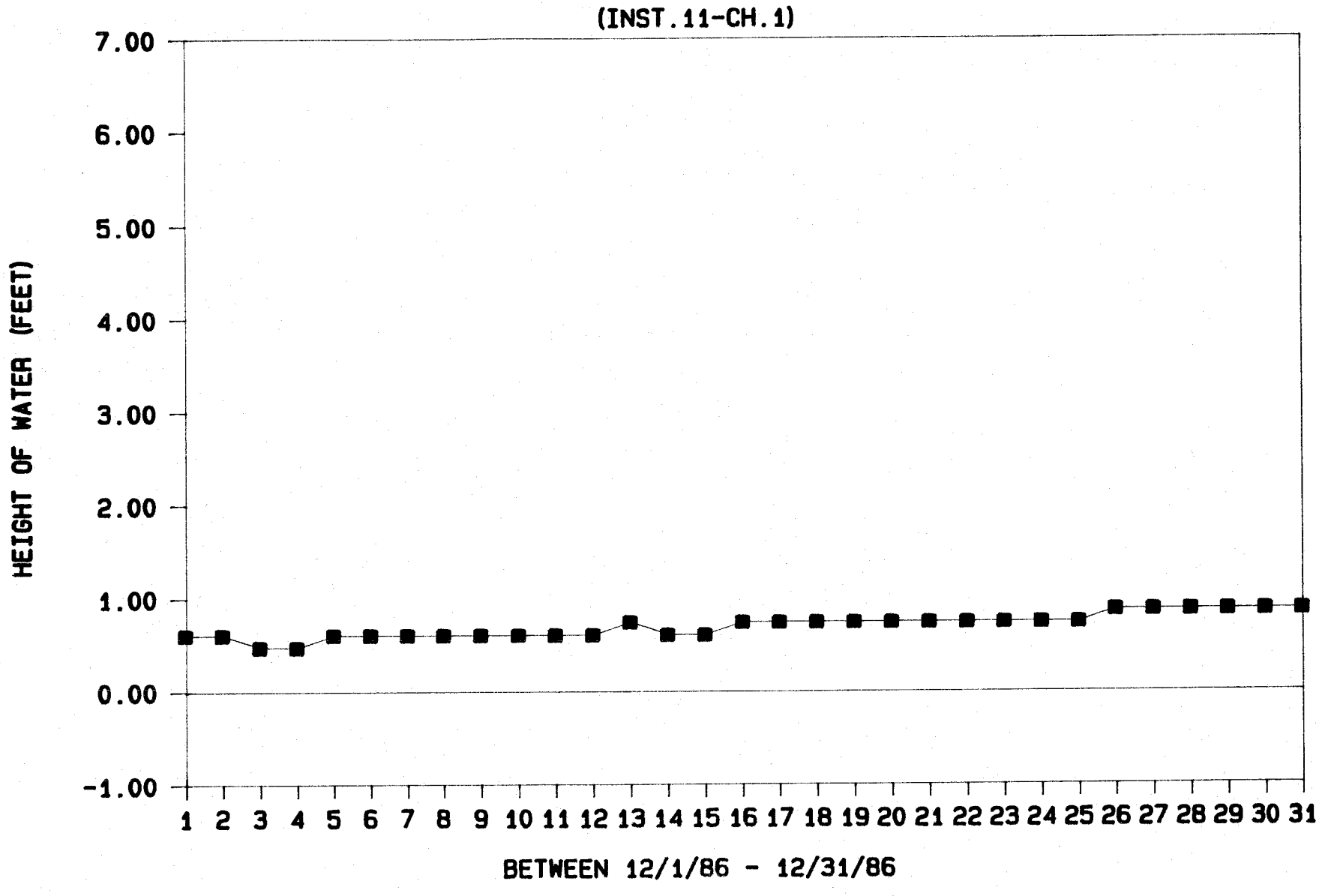
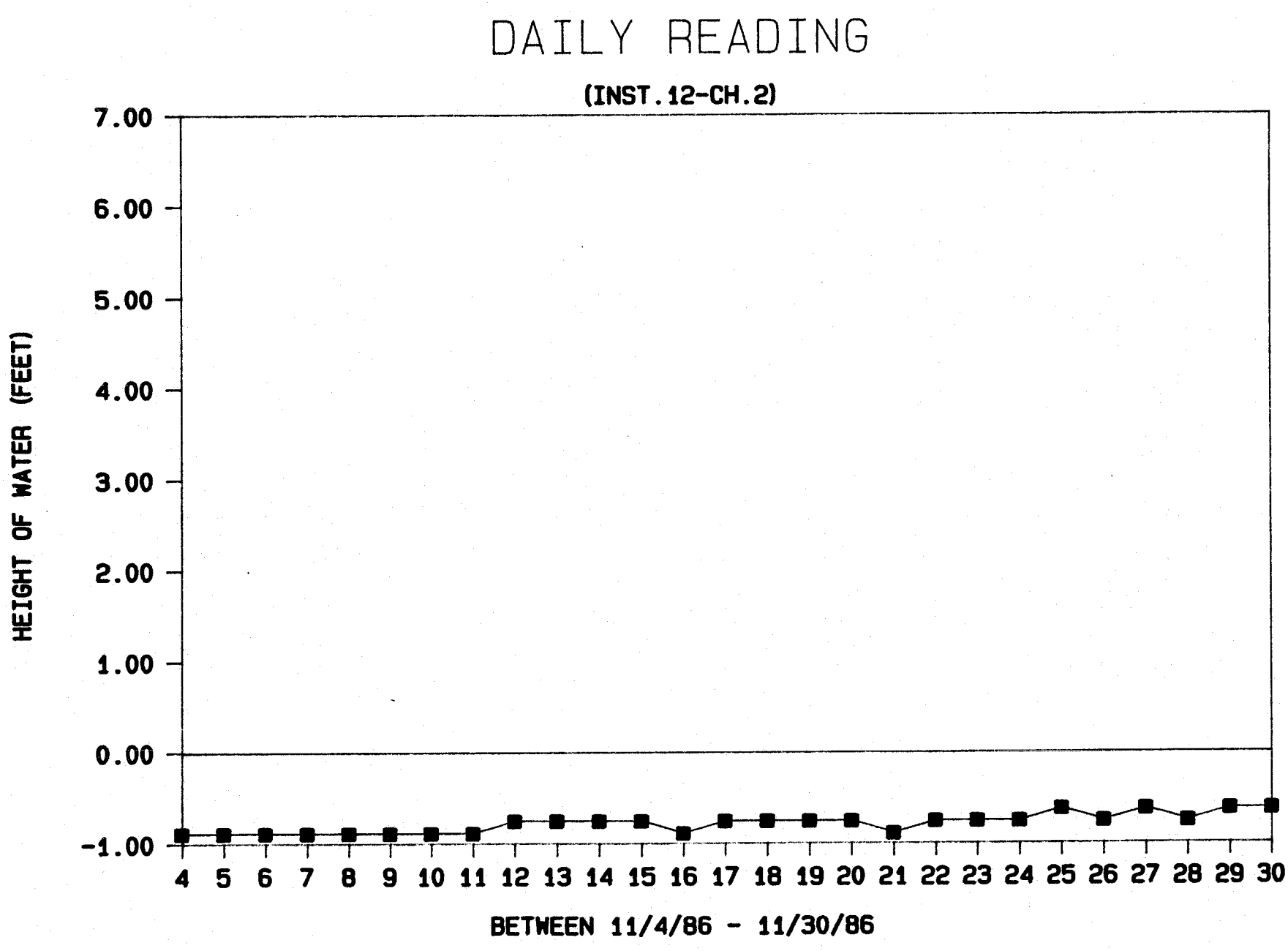
BETWEEN 12/1/86 - 12/31/86

DAILY READING



DAILY READING




DAILY READING
(INST.12-CH.2)
HEIGHT OF WATER (FEET)
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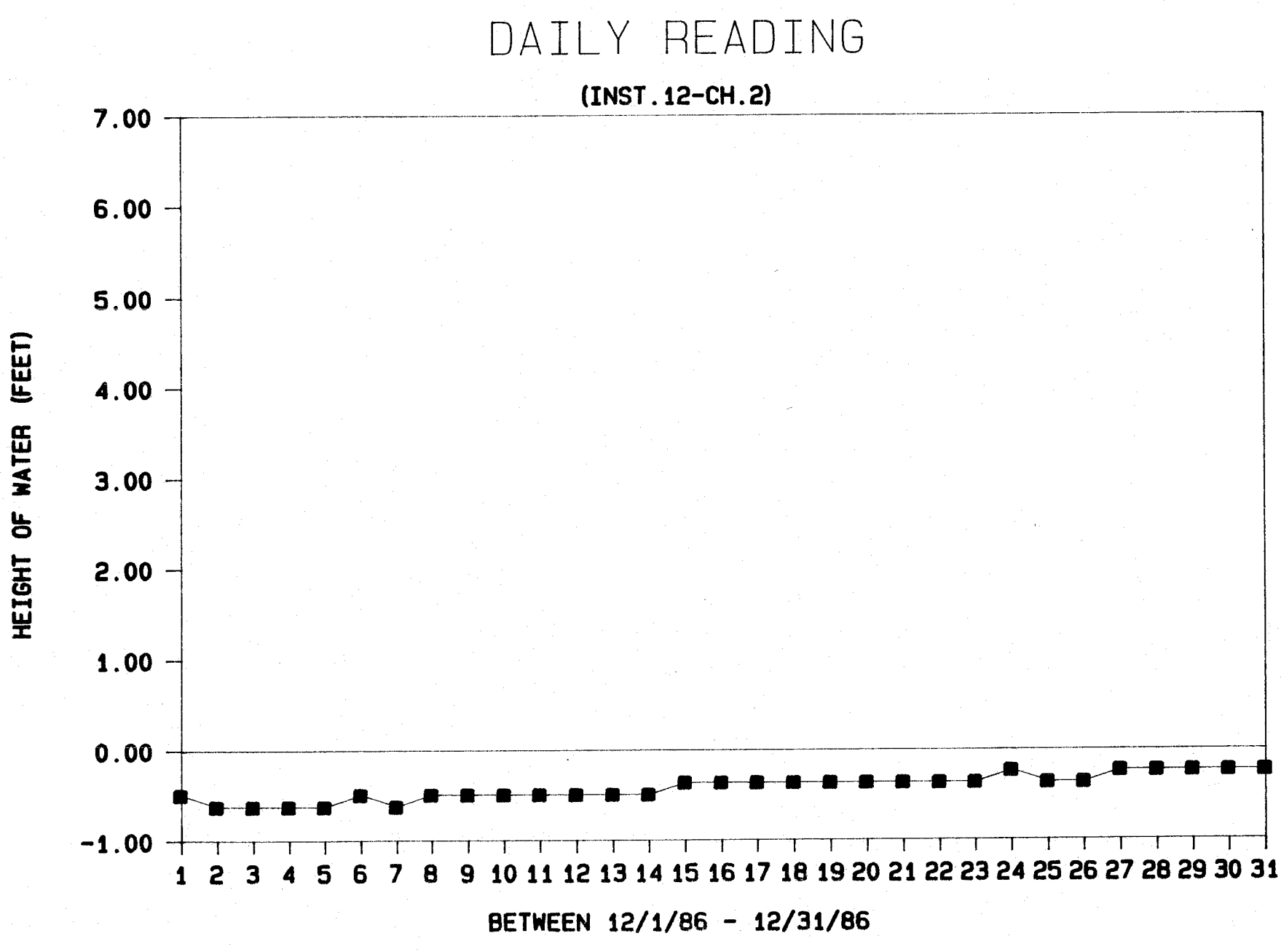
4.00
3.00
2.00
1.00
0.00
-1.00
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
BETWEEN 11/4/86 - 11/30/86


DAILY READING
(INST.12-CH.2)
HEIGHT OF WATER (FEET)
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2.00
1.00
0.00
-1.00
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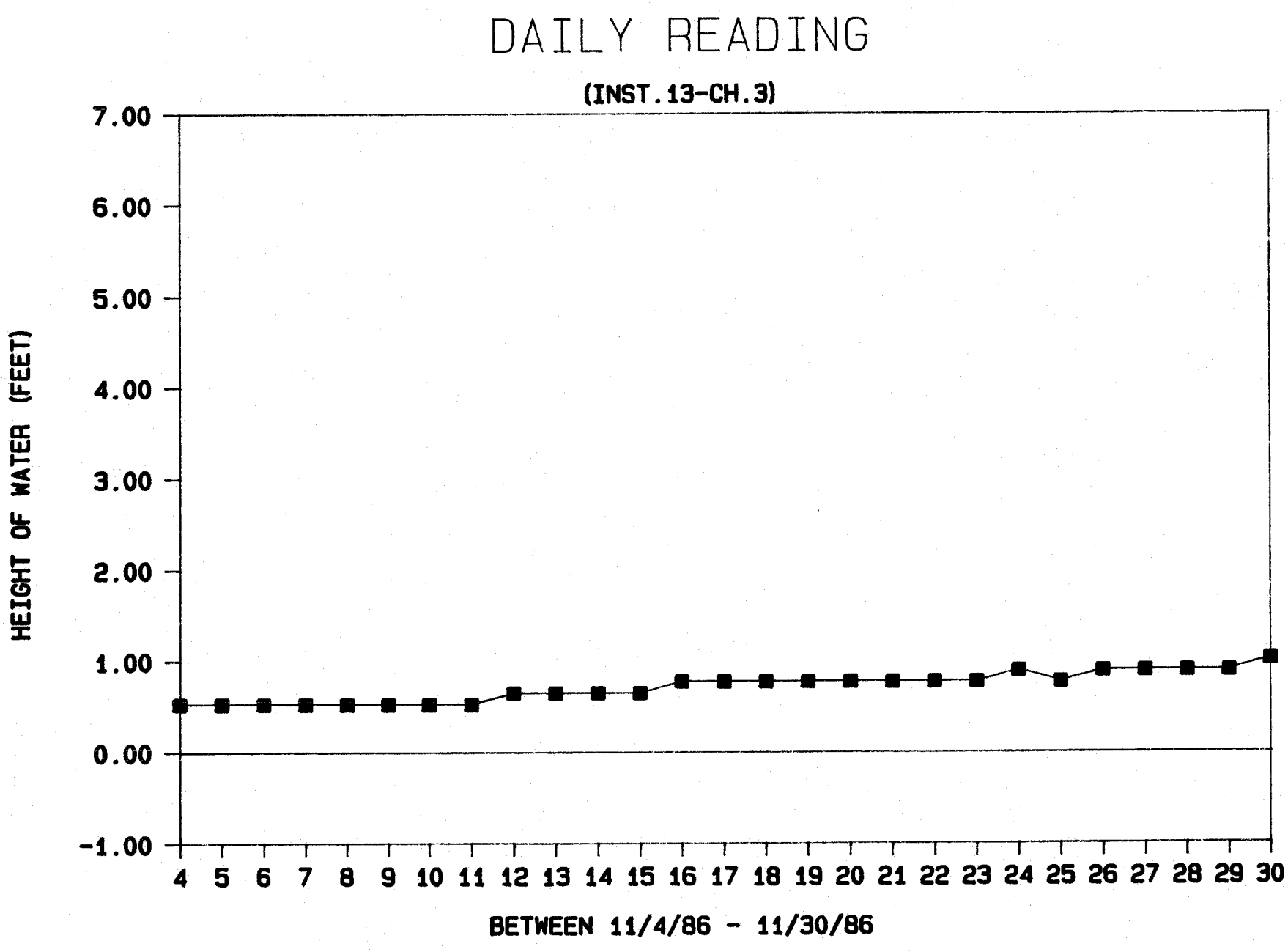
BETWEEN 12/1/86 - 12/31/86


DAILY READING
(INST.13-CH.3)
HEIGHT OF WATER (FEET)
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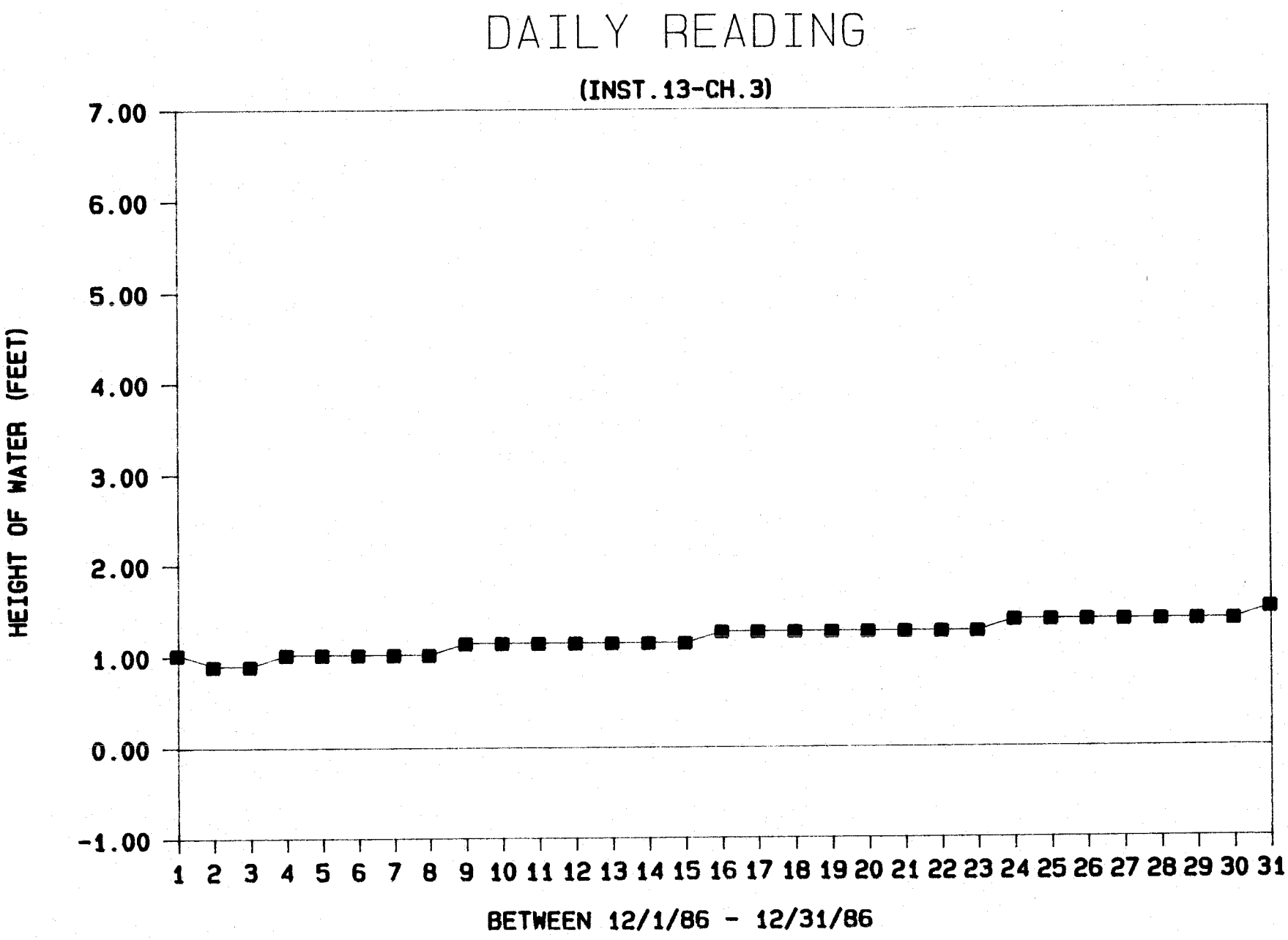
4.00
3.00
2.00
1.00
0.00
-1.00
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
BETWEEN 11/4/86 - 11/30/86


DAILY READING
(INST.13-CH.3)
HEIGHT OF WATER (FEET)
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4.00
3.00
2.00
1.00
0.00
-1.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
BETWEEN 12/1/86 - 12/31/86