GEI Consultants, Inc.

INSTRUMENTATION APPENDIX TO PERIODIC INSPECTION REPORT NO. 5 HOPKINTON LAKE DAM HOPKINTON, NEW HAMPSHIRE

Submitted to:

Department of the Army
New England District
Corps of Engineers

1021 Main Street
Winchester, MA 01890-1970
(781) 721-4000

November 1997
Project 97487

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Gillian Gregory
Gillian M. Gregory, Ph.D.
Project Manager

EXECUTIVE SUMMARY

This report provides a summary and evaluation of geotechnical instrumentation of the Hopkinton Lake Dam in Hopkinton, New Hampshire. The Hopkinton Lake Dam was constructed for flood control purposes and is a rolled earth fill with rock slope protection.

Geotechnical instrumentation at the dam consists of eight crest monuments, 22 piezometers, and seventeen tilt plates. The tilt plates are discussed in a separate report prepared by the Corps of Engineers (COE). In addition, there are also eight relief wells located on the downstream berm. Plate 2 shows the locations of the geotechnical instrumentation.

Crest Monuments

Eight crest monuments (Mons. 1 through 8) were installed in September 1985. There are also four control points labeled "SCOTT", B(H514), C, and D composed of brass discs set in ledge or concrete. Surveys for horizontal control were performed by the COE in 1986, 1991, and 1996. Vertical movement surveys were performed in 1985, 1986, 1991, and 1996. Survey data are presented on Plates 12 and 13. Computed horizontal and vertical movements were small with a range of horizontal movement from 0.010 to 0.037 foot (0.1 to 0.4 inch) between 1991 and 1996. Given the fact that visual inspections by the COE have shown no evidence of adverse movements at the dam, this amount of movement is not considered significant. The maximum net vertical movement recorded since 1985 is 0.082 foot (less than 1 inch) of settlement. This amount of settlement is close to the margin of error for the survey and thus is considered to be insignificant.

Piezometers

There are currently 22 piezometers installed at the dam. Five of these piezometers were installed since the last periodic inspection. These five piezometers were installed in three boreholes located along a cross section at about Station 5+25. Two piezometers were installed in a borehole located on the upstream slope, two in a borehole located on the downstream slope, and one in a borehole located on the downstream toe. The piezometer locations are shown on Plate 2. Table 1 gives the station, offsets, boring numbers, and elevations of key piezometer features. Plates 9, 10, and 11 give the engineering logs of the boreholes and piezometers. Plates 14 and 19 show a cross section through the dam at Station 5+25, showing the piezometer locations and piezometer data. Plates A.1 through A.48 show the boring logs, piezometer logs, and the results of the falling head tests on the piezometers. Data for the other 17 piezometers are shown on Plates 15, 17, and 18.

The COE project personnel measured piezometer pore water elevations according to the reading schedule shown on Plate B.3 from January 1992 through April 1997. Table 2 lists measured pore water depths in the piezometers from January 1992 through April 1997. Table 3 lists measured pore water elevations in the piezometers from January 1992 through April 1997. Table 3 data are plotted as time histories on Plates C.1 through C.6. Plates D.1 through D.6 contain the piezometer time history data for the high pool event in October 1996. Plates E.1 through E.22 show plots of piezometer pore water elevation vs. pool elevation.

An average piezometer pore water elevation was calculated for each piezometer based on the monthly data excluding the daily data collected during high pool periods. Table 4 lists the selected piezometer data used to calculate the average piezometer levels along with the calculated averages. Based on the plots of piezometer pore water elevation vs. pool elevation, projections were made of the likely piezometer pore water elevations for a flood pool at spillway crest. These projections are shown on Plates E.1 through E.22 and are listed in Table 8. Plates 15, 17, 18, and 19 show the average piezometer water levels, the maximum piezometer water levels recorded during the October 1996 high pool event, and the projected piezometer water levels for a flood reaching spillway crest for several cross sections and profiles.

Relief Wells

The COE project personnel measured relief well water elevations according to the reading schedule provided as Plate B.3 from January 1992 through April 1997. Table 5 lists measured water depths in the relief wells from January 1992 through April 1997. Table 6 lists measured water elevations in the relief wells from January 1992 through April 1997. Table 6 data are plotted as time histories on Plate F.1. Plate G.1 contains the relief well time history data for the high pool event in October 1996. Plates H.1 through H.8 show plots of relief well water elevation vs. pool elevation.

An average relief well water elevation was calculated for each relief well based on the monthly data excluding the daily data collected during high pool periods. Table 7 lists the selected relief well data used to calculate the average water levels along with the calculated averages. Based on the plots of relief well water elevation vs. pool elevation, projections were made of the likely relief well water elevations for a flood pool at spillway crest. These projections are shown on Plates H.1 through H.8 and are listed in Table 8. Plate 16 shows the average relief well water levels, the maximum relief well water levels recorded during the October 1996 high pool event, and the projected relief well water levels for a flood reaching spillway crest.

Conclusions and Recommendations

Based on past performance of the dam and on the performance of the instrumentation to date, the Hopkinton Lake Dam appears to be suitably instrumented. Existing instrumentation indicates that the dam embankment is functioning suitably relative to seepage and crest movements.

Comparison of data between 1991 and 1996 indicates horizontal displacements in the range of 0.010 to 0.037 foot (0.1 to 0.4 inch). The crest monument data show that movements are generally small and, taken together with past COE visual inspection reports indicating no evidence of adverse movements, can be considered insignificant. The maximum net vertical movement recorded since 1985 is 0.082 foot (less than 1 inch) of settlement. This amount of settlement is close to the margin of error for the survey and thus is considered to be insignificant.

The crest monuments should continue to be surveyed and evaluated on the current schedule of once every five years just prior to the periodic inspection.

We consider the number of piezometers installed to be adequate unless physical evidence of unusual seepage patterns observed in the future indicates the need for additional instrumentation.

The current schedule of monitoring the piezometers is adequate.

PREFACE

Purpose and Scope

This report provides a summary and evaluation of geotechnical instrumentation of the Hopkinton Lake Dam in Hopkinton, New Hampshire.

GEI performed the following work:

a) Reviewed Periodic Inspection Reports 1 through 5 and data provided by the U.S. Army Corps of Engineers (USACE) on August 19, 1997. (Tasks 1 and 2)

b) Prepared an instrumentation general plan in a Microstation drawing file. (Task 3)

c) Prepared drafted engineering logs and piezometer logs, profiles, and cross sections in Microstation drawing files. (Tasks 4 and 5)

d) Prepared Lotus 1-2-3 plots of piezometer data. (Task 6)

e) Prepared a phreatic surface plan in a Microstation drawing file. (Task 7)

f) Prepared survey data and horizontal and vertical movement plots in Microstation drawing files. (Task 8)

g) Prepared this report summarizing Tasks 1-8). (Task 9)

Project Personnel

Gillian M. Gregory	Project Manager
Carolyn Lewis	Civil Engineer
Dana MacLeod	Lead Drafter
R. Lee Wooten	In-House Reviewer

Elevation Datum

All elevations in this report are referenced to National Geodetic Vertical Datum (NGVD).

Limitations

Our professional services for this project have been performed in accordance with generally accepted engineering practices. No other warranty, expressed or implied, is made.

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1. PROJECT PERFORMANCE

The dam performance is rated as good based on the instrumentation data compiled to date. Crest monument data indicate that horizontal displacements between 1991 and 1996 are in the range of 0.010 to 0.037 feet (0.1 to 0.4 inch). The maximum net settlement since 1985 is 0.082 foot (less than one inch). The piezometer readings, including the new piezometers, and dam performance indicate that the impervious central core is sufficient to lower the pore pressures and exit gradients so that seepage is safely exiting at the toe of the dam.

2. GENERAL PROJECT DESCRIPTION

2.1 History

2.1.1 General

The Hopkinton Lake Dam project is part of one of the four reservoir projects that have been constructed in the Merrimack River Basin by the Corps of Engineers for flood control and other purposes.

Hopkinton Lake Dam is located in the town of Hopkinton on the Contoocook River, approximately 18 miles southwest from the confluence of the Contoocook and Merrimack Rivers at Penacook, New Hampshire (Plate 1). Construction of the project was started in November 1959 and completed in July 1963. An upstream permanent pool is kept at approximately El. 380.0 feet NGVD. The downstream forebay pool created by the Hoague-Sprague Dam has an average elevation near 380.0 feet NGVD. The Hopkinton Lake Dam project was designed and built as part of the overall Hopkinton-Everett reservoir system.

2.1.2 High Pools

a. April 1996 Flood: The embankment was subjected to its highest impoundment to date with a maximum water surface elevation of 415.8 feet NGVD, stage 49.8 feet (0.2 foot below the spillway crest), 95% full. The embankment performed satisfactorily during this impoundment. The dam was inspected at the time of the flood by an Emergency Response Team from Geotechnical Engineering Division (GED). A small boil was reported at the base of the left downstream abutment. Also, several small clear seeps were observed emerging along the base of the downstream left abutment above El. 384 feet, NGVD. These seepage flows were attributed to groundwater draining off the left abutment and not seepage through the dam embankment. No abnormal seepage conditions such as piping, boils from through seepage, or sinkholes were observed by the team or reported by the Project Manager.

b. June 1984 Flood: During June 1984, the embankment was subjected to its second highest impoundment to date with a maximum water surface of 407.5 feet NGVD, stage 41.5 feet (8.5 feet below spillway crest). The dam was inspected at the time of the flood by an Emergency Response Team from Geotechnical Engineering Division (GED). No abnormal seepage conditions such as piping, boils, or sinkholes were observed then by the team or subsequently reported by the Project Manager.

c. March 1990 Pool: During March 1990, the embankment was subjected to its highest impoundment since piezometers 3 through 11 were installed in 1987 and 1988. The maximum water surface during this small event was at El. 397.2 feet NGVD, stage 31.2 (18.8 feet below the spillway crest).

d. August 1991 Pool: During the August 1991 event, the embankment was subjected to an impoundment of 394.6 feet NGVD, stage 28.6 feet (21.4 feet below spillway crest). The dam was inspected at the time by an Emergency Response Team from Geotechnical Engineering Division (GED). No abnormal seepage conditions such as piping, boils, or sinkholes were observed then by the team or subsequently reported by the Project Manager. During this time the forebay pool was empty (July 9 to October 24, for maintenance), which caused the water elevations in the piezometers and relief wells on the left side of the outlet channel to drop.

e. October 1996 Pool: During October 1996 the embankment was subjected to an impoundment of 403.2 feet NGVD, stage 37.2 feet (12.8 feet below spillway crest).

The instrumentation evaluation in this report is based on Piezometer 1 - 11 readings from 1992 to the present and Piezometers 13A and B, 14A and B and 15 from 1994 to the present. In addition, a review was made of piezometer data reported in the prior report (Ref. 4[1]).

[1] References are listed at the end of this report.

2.2 Geology and Foundations

2.2.1 General

The Hopkinton Reservoir occupies low, flat, relatively wide areas in the pre-glacial Contoocook Valley, which has been generally deeply filled with outwash deposits and till. The entire reservoir was occupied during the recessional phase of the last glaciation by connected pools or sluggish-current lakes impounded behind ice and debris barriers that caused temporary damming and diversion of the natural drainage. In the areas occupied by the transient pools, deposits of sand, silt, and gravel occur. Till and till-covered bedrock hills that rise above the lowlands form the perimeter of the reservoir (Ref. 1).

2.2.2 Site Geology

The Contoocook River flows in a deep, narrow valley entrenched in till. The right abutment rises steeply from the edge of the river; the left abutment is less steep and rises from a narrow floodplain that occupies the left side of the valley bottom. Bedrock is deeply buried at the site occurring throughout at depths of up to 90 feet. The overburden is generally till that is overlain on the abutments by a thin blanket of silt or fine sand and in the valley bottom by variable, thin deposits of recent alluvial, mostly sands and gravels (see Plates 4A and 4B) (Ref. 1).

A plan of subsurface explorations performed for the original design of the dam is shown on Plate 3. The piezometer installation plan and relief well plan is shown on Plate 2. Plates 5A-11 show engineering logs for original foundation exploration borings, for piezometer borings, and for relief wells. Engineering log sections and a section with the highest piezometric and relief well levels from significant pool events are shown on Plates 14-21.

2.3 Dam and Appurtenant Structures Description

The dam embankment is a rolled earth fill with rockfill slope protection. It is 790 feet long with a maximum height of 73 feet above streambed. The top minimum elevation is 437.5 feet NGVD. Plates 21-28 contain a general plan and typical sections of the dam. The dam consists of a homogeneous section of impervious fill, with its slopes protected with a quarry-run type rock on gravel backing. Embankment seepage is controlled by a gravel chimney located near the center of the embankment and connected to a horizontal downstream pervious blanket. Foundation relief wells were provided at the downstream toe to control potential seepage and uplift development. The outlet works, located in the dam on the left bank of the river, consists of an approach channel, gate tower, three conduits, stilling basin, an outlet channel, and a forebay pool.

The Hoague-Sprague Dam located immediately downstream of the dam is used to supply water to the nearby paper mill.

The spillway is a concrete, trapezoidal weir (ogee section) founded on rock and is located in Dike H-3, located about 8,000 feet east of Hopkinton Dam (See Plate 1). Top elevation is El. 416 feet NGVD, and the crest length is 300 feet.

Instrumentation to monitor dam performance at Hopkinton Lake Dam consists of 8 crest monuments, 17 tilt plates, and 22 piezometers. There are also eight relief wells located along the downstream berm. A general plan of instrumentation is shown on Plate 2. There is no instrumentation at dikes H-2 and H-3.

3. INSTRUMENTATION

3.1 Crest Monuments

Eight survey crest monuments were installed at the dam and initially surveyed in September 1985 by contract. Other surveys were also done in March 1986, April 1991, and March 1996. The crest monuments are Corps of Engineers' brass discs set in 10 feet of NX steel casing filled with concrete and labeled Mon. 1 to Mon. 8. The crest monuments were installed flush with the ground surface in the middle of the sidewalk on the downstream side of the dam crest. The location of all crest survey monuments are shown on Plate 12. Four control points have been installed for monitoring movements of the dam, Mon. "Scott", B (H514), C, and D (Plate 12). All control points are assumed to be fixed reference points. The current standards and procedures employed for crest monument surveys at Hopkinton Lake Dam are contained on Plates B.1 and B.2.

3.2 Piezometers

3.2.1 PZ-1 and PZ-2

PZ-1 and PZ-2 are open-type piezometers located at the bottom and ends of the foundation drain beneath the stilling basin; they were installed during construction of the stilling basin (see Plate 25). The piezometers were installed to measure the hydrostatic pressures at the bottom and at each end of the foundation drain located 15 feet below the base of the stilling basin.

3.2.2 PZ-3 to PZ-11

Twelve piezometers (PZ-3A to PZ-8B) were installed (two in each borehole) in September 1987 along the downstream berm (see Plate 2). The piezometers are labeled PZ-3A, 3B, 4A, 4B, 5A, 5B, 6A, 6B, 7A, 7B, 8A, and 8B. Three piezometers (PZ-9, 10, and 11) were installed in 1988 along the east outlet retaining wall and Hoague-Sprague forebay dike to aid in the analysis of the movement of the stilling basin and east outlet retaining wall. All piezometers are Casagrande-type with 3/4-inch, PVC riser pipe and are manually read using an M-Scope Water Level Indicator.

3.2.3 PZ-13 to PZ-15

Five piezometers were installed in 1993, two each in two boreholes (PZ-13A and B, PZ-14A and B) and one in a third borehole (PZ-15). The locations are shown on Plate 2.

Boring logs and piezometer installation logs are shown on Plates A.1 through A.48. Graphic logs for the three borings and five piezometers are shown on Plates 9-11. The piezometers are Casagrande-type with 3/4 inch, PVC riser pipe and are manually read using an M-Scope Water Level Indicator.

Piezometer data, including piezometer location (station and offset), piezometer tip and tip elevation, and the zone/material where the tip is located, are included in Table 1.

3.3 Relief Wells

There are connected deposits of laminated fine sand and clay and stratified sands and gravels within and under the glacial till (Plates 4A and 4B). The relief wells were installed during construction of the dam to relieve potential development of hydrostatic pressures in the deposits within and under the till. The wells are 8 inches in diameter, approximately 74 feet deep, and discharge into the rockfill adjacent to the forebay pool. The wood stave screens are 24 feet in length and surrounded by 40 feet of gravel pack. A detail of the wells is shown on Plate 25. The location plan is shown on Plate 2. The water surface in each well is read with an M-Scope Water Level Indicator.

3.4 Tilt Plates

Seventeen tilt plates were installed in 1989 to monitor the movement of the east outlet channel and stilling basin retaining walls. Tilt plate data obtained through 1996 were reported and evaluated by COE in Ref. 5.

4. DATA COLLECTION, INTERPRETATION, AND EVALUATION

4.1 Crest Monuments

4.1.1 Data Collection

The results of the crest monument surveys are shown on Plates 12 and 13. Distances between control points and the crest monuments for the survey performed March 1996 along with the coordinates and elevations of control points (which are assumed to be fixed reference points) and crest monuments are also shown on Plate 12. Computed horizontal and vertical movements of each monument are plotted on Plate 13.

4.1.2 Interpretation and Evaluation

All four surveys were performed using an electronic distance meter (EDM) with Third Order, Class II accuracy (1:5000) for horizontal measurements and Third Order, Class I accuracy (1:10,000) for vertical measurements according to the standards and procedures outlined on Plates B.1 and B.2.

a. Vertical Movement: The surveys indicate that the total vertical movement of any one crest monument was limited to or less than 0.082 foot (less than one inch) between 1985 and 1996 (Plate 13). This range of movement is close to the margin of error for the survey methods; therefore, it is possible that no rise or settlement occurred at all. The magnitude of vertical movement is so minute that it is considered negligible, regardless of whether the readings were a result of embankment settlement or settlement of the monument itself.

   The rises and settlements just described are within the margin of error for the survey methods used, and it is likely that no rise or settlement actually occurred. The magnitude of any of the vertical movements are so small that they may be considered negligible, regardless of whether the movements are considered actual rise or settlement of the embankment or of the monument itself.

b. Horizontal Movements: The horizontal movement surveys, performed using a combination of trilateration angles, show the range of movement from 0.010 to 0.037 foot (0.1 to 0.4 inch) between 1991 and 1996 (Plate 13). According to COE, there was no physical evidence of movement, such as slumps, scarps, cracks, or depressions, at any monument that would indicate movement of any significant magnitude in the embankment. The computed movement was attributed to the survey accuracy or natural soil adjustment. The 1996 survey showed random movement between 1991 and 1996 in the upstream direction of Mons. 1, 2, 3, 7, and 8, where Mons. 4, 5, and 6 showed slight movement in the downstream direction. In any event, the small amount of movement recorded and the lack of any other manifestation of movement of the embankment leads to the conclusion that no significant movement of the dam is occurring at this time. From the data that have been acquired to date, it is concluded that there has been insignificant horizontal movement within the embankment, and any recorded movements are probably due to instrument error.

4.2 Piezometers

4.2.1 Data Collection

a. Location Maps: A general plan of the project showing the location of the active piezometers and the corresponding identification number for each piezometer is provided to project personnel to eliminate identification and data recording inaccuracies.

b. Data Collection Tables: A table listing the piezometer identification number, stationing and offset, as well as piezometer top and tip elevations is also provided for recording and submitting piezometer readings.

c. Reading Schedule (See Plate B.3): Piezometer monitoring at Hopkinton Lake Dam has been maintained by project personnel since the installation of the piezometers in 1987. The minimum piezometer reading schedule presently in effect is as follows:

(1) Routine: During periods when the reservoir is at or below the 22-foot stage (El. 387.5 feet NGVD), readings should be made by the project manager at least once a month. When access to instruments is made hazardous by snow or ice, the readings may be deferred until safe access is possible.

(2) High Pool: During periods when the reservoir level (includes rising and falling pools) is above the 22-foot stage, readings should be made on a daily basis. Pool elevations should be recorded simultaneously with

piezometer, relief well, and tail water pool readings. On a falling pool, piezometer readings should continue for approximately five days after the pool has returned to its normal elevation.

d. Special Conditions: If unusual changes in readings develop or if piezometers become inoperable, Geotechnical Engineering Division should be contacted.

Readings obtained from the piezometers are compiled in Table 2. Pertinent information includes the date of reading, pool elevation, and depth to water below the top of the piezometer riser pipe. Actual water elevations for each piezometer are in Table 3.

4.2.2 Interpretation and Evaluation

a. Presentation of Data: Numerous plots have been developed to display the piezometric data. All the plots were developed using Lotus 1-2-3 computer software spreadsheet.

Time-history plots for the years 1992-1997 for each piezometer are included as Plates C.1 through C.6. A time-history plot was developed for the October 1996 flood event for each piezometer and presented as Plates D.1 through D.6. X-Y plots of piezometer water elevations vs. pool elevation developed for each piezometer are included as Plates E.1 through E.22. These plots reflect all piezometric data collected between 1992 and 1997. Also plotted on Plates E.1 through E.22 is a projection of the piezometric elevation corresponding to a pool at spillway crest.

b. Individual Piezometer Response: All pertinent information (station, offset, top and tip elevations, zone and material type where tip is located) for each piezometer is listed in Table 1 and shown graphically on cross sections on Plates 14 through 19. Falling head tests were performed immediately after completion of installation. These tests confirmed that all piezometers are in working order. The results of these tests for PZ-13A & B, PZ-14A & B and PZ-15 are shown on Plates A.17 - A.18, A.34 - A.35, and A.48.

(1) PZ-1: Piezometer 1 is located on the downstream side of the dam adjacent to the east stilling basin wall with its tip at the bottom and end of the foundation drain beneath the stilling basin at El. 331.0. The piezometer tip is surrounded by a sand filter extending from El. 329.0 to 337.0. The piezometer extends through the concrete base slab and compacted impervious fill zone of the forebay dike (Plates 18, 25, 27, and 28). The piezometer was installed at the same time the dam was constructed to measure the hydrostatic pressure in the foundation drain under the stilling basin. Material surrounding the tip is fine filter fill. The normal water

level in PZ-1 ranges from El. 363.5 to about El. 369 for the period 1992 to 1997 (Plate C.1). This compares to elevations of 364 to 367 reported for the period 1987 to 1991 (Ref. 4). The reading of El. 375.4 on April 3, 1993 (Table 3) appears to be an error. Inspection of the depth readings for that date (Table 2) shows that the readings for PZ-1 and PZ-2 were probably reversed on the data sheets. According to the prior report (Ref. 4), the foundation drain under the stilling basin, where PZ-1 and PZ-2 tips are located, is directly connected to the tailwater by an outlet into the stilling basin at El. 363.0, and the piezometric level in PZ-1 tends to respond more to tailwater than to pool level. The piezometric level in PZ-1 does increase in response to rise in pool level, but the response is somewhat dampened. Plate D.1 shows the piezometric response to the pool level and the spillway discharge during the October 1996 flood, the response being similar to that of the 1987 flood (Plate 18, Ref. 4). Plate E.1 shows the piezometric level plotted against pool elevation. The plot shows a projection of piezometric level for a pool at spillway crest. The projected elevation for pool at spillway crest for PZ-1 is 369.4.

(2) PZ-2: PZ-2 is also located on the downstream side of the dam adjacent to the stilling basin's west wall with its tip at El. 330.0. This piezometer is similar to PZ-1 in construction (Plate 25) and response to a rising pool. Normal water level in PZ-2 from 1992 to 1997 also ranges from El. 363.5 to about El. 369, compared to 364 to 367 for the period 1987 to 1991 (Plate C.1). The reading of El. 358.8 on April 3, 1993 (Table 3) appears to be an error as explained above. Response of PZ-2 to rising pool and spillway discharge is also similar to PZ-1 (Plate D.1). The projected piezometric level in PZ-2 with pool level at spillway crest is 369.3 (Plate E.2).

(3) PZ-3A: PZ-3A is located on the downstream berm, near the left abutment with its tip in foundation soils at El. 305.7. The tip is surrounded by filter sand extending from El. 303.5 to 321.2, which is capped with a 4.5-foot bentonite seal. The foundation material that influences the response of PZ-3A is a gray silty (25-35%) SAND with gravel (5-15%) with large cobble fragments (SM). The normal groundwater level in PZ-3A ranges from El. 375 to El. 377 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 375.5 to 377.0 from 1987 to 1991. The time-history plots (Plates C.2 and D.2) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. The projected piezometric elevation with pool level at spillway crest is 379.2 (Plate E.3).

(4) PZ-4A: PZ-4A is located on the downstream berm, left of the outlet, with its tip in foundation soils at El. 305.7. The tip is surrounded by filter sand extending from El. 304.7 to 321.2, which is capped with a 4-foot bentonite seal. The foundation material that influences the response of PZ-4A is a gray-brown silty (22%) SAND with gravel (7%) and a trace of clay (SM). The normal groundwater level in PZ-4A ranges from El. 370 to El. 372 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 369 to 372.0 from 1987 to 1991. The time-history plots (Plates C.2 and D.2) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. The projected piezometric elevation with pool level at spillway crest is 374.7 (Plate E.4).

(5) PZ-5A: PZ-5A is located on the downstream berm to the right of the outlet, with its tip in foundation soils at El. 305.6. The tip is surrounded by filter sand extending from El. 304.2 to 321.1, which is capped with a 4.1-foot bentonite seal. The foundation material that influences the response of PZ-5A is a gray sandy (48%) SILT with a trace of gravel (ML). The normal groundwater level in PZ-5A ranges from El. 368 to El. 370 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 368 to 371 from 1987 to 1991. The time-history plots (Plates C.2 and D.2) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. The projected piezometric elevation with pool level at spillway crest is 372.8 (Plate E.5).

(6) PZ-6A: PZ-6A is located on the downstream berm to the right of the outlet, with its tip in foundation soils at El. 305.9. The piezometer tip is surrounded by filter sand extending from El. 304.5 to 320.4, which is capped with a 5.1-foot bentonite seal. The foundation material that influences the response of PZ-6A is a gray-brown silty (25-35%) SAND with rock fragments (SM). The normal groundwater level in PZ-6A ranges from El. 368 to El. 371 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 369 to 371 from 1987 to 1991. The time-history plots (Plates C.2 and D.2) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. The projected piezometric elevation with pool level at spillway crest is 373.0 (Plate E.6).

(7) PZ-7A: PZ-7A is located on the downstream berm to the right of the outlet, with its tip in foundation soils at El. 305.2. The piezometer tip is surrounded by filter sand extending from El. 304.2 to 320.2, which is

capped with a 5.0-foot bentonite seal. The foundation material that influences the response of PZ-7A is a gray-brown silty (10-20%) GRAVEL with sand (5-15%) and rock fragments (GM). The normal groundwater level in PZ-7A ranges from El. 368.2 to El. 371 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 369 to 371 from 1987 to 1991. The time-history plots (Plates C.2 and D.2) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. The projected piezometric elevation with pool level at spillway crest is 372.9 (Plate E.7).

(8) PZ-8A: PZ-8A is located on the downstream berm to the right of the outlet, with its tip in foundation soils at El. 305.5. The piezometer tip is surrounded by filter sand extending from El. 304.5 to 320.8, which is capped with a 10.7-foot bentonite seal. The foundation material that influences the response of PZ-8A is a gray-brown silty (23-30%) SAND with gravel (SM). The normal groundwater level in PZ-8A ranges from El. 367 to El. 370 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 368 to 370 from 1987 to 1991. The time-history plots (Plates C.2 and D.2) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. An unusually high reading recorded on 2/5/96 appears to be the result of transposing the data for PZ-8A and PZ-8B on the data sheets. The projected piezometric elevation with pool level at spillway crest is 372.1 (Plate E.8).

(9) PZ-15: PZ-15 is located on the downstream berm to the right of the outlet, with its tip in foundation soils at El. 301. The piezometer tip is surrounded by filter sand extending from El. 299 to 334, which is capped with a 6-foot bentonite seal. The foundation materials that influence the response of PZ-15 are stratified silty sands with rock fragments (SM) and some varved clay. The normal groundwater level in PZ-15 ranges from El. 370 to El. 377 over the period 1994 to 1997 (Table 4). It is not clear why there was a significant drop in piezometric level during August and September 1994. The time-history plots (Plates C.2 and D.2) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. The projected piezometric elevation with pool level at spillway crest is 378.1 (Plate E.9).

(10) PZ-3B: PZ-3B is located on the downstream berm, near the left abutment, with its tip in foundation soils at El. 349.7. The piezometer tip is

surrounded by filter sand extending from El. 348.7 to 358.7, which is capped with a 3-foot bentonite seal. The foundation material that influences the response of PZ-3B is a gray, silty (31%) SAND with clay (SC-SM). The normal groundwater level in PZ-3B ranges from El. 375.5 to El. 377.5 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 375 to 377 from 1987 to 1991. The time-history plots (Plates C.3 and D.3) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. The projected piezometric elevation with pool level at spillway crest is 379.7 (Plate E.10).

(11) <u>PZ-4B</u>: PZ-4B is located on the downstream berm, left of the outlet, with its tip in foundation soils at El. 349.7. The piezometer tip is surrounded by filter sand extending from El. 348.7 to 358.7, which is capped with a 5-foot bentonite seal. The foundation material that influences the response of PZ-4B is a gray, silty (13%) SAND with gravel (SM). The normal groundwater level in PZ-4B ranges from El. 367.5 to El. 370.5 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 368 to 370 from 1987 to 1991. The time-history plots (Plates C.3 and D.3) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. The projected piezometric elevation with pool level at spillway crest is 373.3 (Plate E.11).

(12) <u>PZ-5B</u>: PZ-5B is located on the downstream berm to the right of the outlet, with its tip in foundation soils at El. 349.6. The piezometer tip is surrounded by filter sand extending from El. 348.6 to 359.1, which is capped with a 1.8-foot bentonite seal. The foundation material that influences the response of PZ-5B is a gray, silty (31%) SAND with clay (14%) and a trace of gravel (SC-SM). The normal groundwater level in PZ-5B ranges from El. 379.5 to El. 382 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 378 to 381 from 1987 to 1991. The time-history plots (Plates C.3 and D.3) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. A sharp dip in the data on 4/9/94 may be due to an error in recording the depth (a depth of 0.97 foot may have been recorded as 9.7 feet). There are also two low readings in the spring of 1996 that are unexplained. The projected piezometric elevation with pool level at spillway crest is 382.5 (Plate E.12).

(13) PZ-6B: PZ-6B is located on the downstream berm to the right of the outlet, with its tip in foundation soils at El. 349.9. The piezometer tip is surrounded by filter sand extending from El. 348.9 to 358.9, which is capped with a 3.6-foot bentonite seal. The foundation material that influences the response of PZ-6B is a gray, silty (28%) SAND with clay (10%) and gravel (5%) (SM). The normal groundwater level in PZ-6B ranges from El. 378.5 to El. 380.5 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 378 to 380 from 1987 to 1991. The time-history plots (Plates C.3 and D.3) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. The projected piezometric elevation with pool level at spillway crest is 382.9 (Plate E.13).

(14) PZ-7B: PZ-7B is located on the downstream berm to the right of the outlet, with its tip in foundation soils at El. 349.2. The piezometer tip is surrounded by filter sand extending from El. 348.2 to 359.2, which is capped with a 2-foot bentonite seal. The foundation material that influences the response of PZ-7B is a gray, silty (15%) clayey (14%) SAND with gravel (23%) (SC-SM). The normal groundwater level in PZ-7B ranges from El. 378.5 to El. 380.8 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 378 to 381 from 1987 to 1991. The time-history plots (Plates C.3 and D.3) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. The projected piezometric elevation with pool level at spillway crest is 382.9 (Plate E.14).

(15) PZ-8B: PZ-8B is located on the downstream berm to the right of the outlet, with its tip in foundation soils at El. 349.5. The piezometer tip is surrounded by filter sand extending from El. 348.5 to 358.5, which is capped with a 6-foot bentonite seal. The foundation material that influences the response of PZ-8B is a gray, sandy (43%) SILT with clay (18%) and a trace of gravel (ML). The normal groundwater level in PZ-8B ranges from El. 379.5 to El. 382 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 379 to 381 from 1987 to 1991. The time-history plots (Plates C.3 and D.3) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. The projected piezometric elevation with pool level at spillway crest is 382.4 (Plate E.15).

(16) PZ-9: PZ-9 is located on the downstream dike adjacent to the stilling basin's east outlet channel wall with its tip in foundation soils at El. 340.0. The piezometer tip is located below the outlet wall base slab on the outlet channel side of the wall's seepage cutoff key and is surrounded by filter sand extending from El. 337 to 349, which is capped with a 2-foot bentonite seal. The foundation material that influences the response of PZ-9 is a gray SAND with silt (5-15%) and gravel (10-20%) (SP-SM). The normal groundwater level in PZ-9 ranges from El. 364 to El. 367.5 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 364 to 367 from 1987 to 1991. The time-history plots (Plates C.4 and D.4) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. The projected piezometric elevation with pool level at spillway crest is 369.4 (Plate E.16).

(17) PZ-10: PZ-10 is located on the downstream dike adjacent to the stilling basin's east outlet channel wall with its tip in foundation soils at El. 323.7. The piezometer tip is surrounded by filter sand extending from El. 322.2 to 337.5, which is capped with a 1.7-foot bentonite seal. The foundation material that influences the response of PZ-10 is a gray silty (32%) SAND with gravel (14%) (SM). The normal groundwater level in PZ-10 ranges from El. 367.1 to El. 369.7 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 368 to 370 from 1987 to 1991. The time-history plots (Plates C.4 and D.4) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. The projected piezometric elevation with pool level at spillway crest is 372.6 (Plate E.17).

(18) PZ-11: PZ-11 is located on the downstream dike adjacent to the stilling basin's east wing wall with its tip in foundation soils at El. 354.2. The piezometer tip is located below the wall base slab similar to PZ-9 and is surrounded by filter sand extending from El. 349.8 to 358.2, which is capped with a 2-foot bentonite seal. The foundation material that influences the response of PZ-11 is a gray silty (36%) SAND with fine gravel (6%) (SM). The normal groundwater level in PZ-11 ranges from El. 365 to El. 368 over the period 1992 to 1997 (Table 4). This compares to a range of from El. 365 to 367 from 1987 to 1991. The time-history plots (Plates C.4 and D.4) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. There is one high reading in March 1992 and one low reading in May 1994 that cannot be explained. The projected piezometric elevation with pool level at spillway crest is 370.8 (Plate E.18).

(19) PZ-13A: PZ-13A is located on the upstream slope of the embankment with its tip in foundation soils at El. 299. The piezometer tip is surrounded by filter sand extending from El. 297 to 315, which is capped with a 6-foot bentonite seal. The foundation materials that influence the response of PZ-13A are a dark gray, silty (25-35%) SAND with gravel (15-25%) (SM) and a brown sandy 30-40%) CLAY with little gravel (CL). The normal groundwater level in PZ-13A ranges from El. 370 to El. 373 over the period 1994 to 1997 (Table 4). The time-history plots (Plates C.5 and D.5) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. An unusually high reading on 4/30/96 may be the result of transposing the depths recorded for PZ-13A and PZ-13B. The projected piezometric elevation with pool level at spillway crest is 375.3 (Plate E.19).

(20) PZ-14A: PZ-14A is located on the downstream slope of the embankment with its tip in foundation soils at El. 303. The piezometer tip is surrounded by filter sand extending from El. 300 to 320, which is capped with a 6-foot bentonite seal. The foundation material that influences the response of PZ-14A is a brown clayey (10-20%) SAND with gravel (15-25%) (SC). The normal groundwater level in PZ-14A ranges from El. 369.2 to El. 372 over the period 1994 to 1997 (Table 4). The time-history plots (Plates C.5 and D.5) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. An unusual reading on 4/30/96 may be the result of transposing the depths recorded for PZ-14A and PZ-14B. The projected piezometric elevation with pool level at spillway crest is 374.2 (Plate E.20).

(21) PZ-13B: PZ-13B is located on the upstream slope of the embankment with its tip near the boundary between embankment and foundation soils at El. 368. The piezometer tip is surrounded by filter sand extending from El. 366 to 374, which is capped with a 4-foot bentonite seal. The foundation materials that influence the response of PZ-13B are a dark gray. silty (25-35%) SAND with gravel (15-25%) (SM) and a brown sandy (30-40%) CLAY with little gravel (CL). The normal groundwater level in PZ-13B was difficult to estimated due to the scatter in the data (Table 3 and Plate C.6). The time-history plots (Plates C.6 and D.6) appear to indicate piezometric levels higher than pool level. An unusually low reading on 4/30/96 may be the result of transposing the depths recorded for PZ-13A and PZ-13B. Also, the readings for PZ-13B and PZ-14B may have been

transposed on 4/25/97. Due to the large scatter in the data (Plate E.21), the projected piezometric elevation with pool level at spillway crest was not estimated.

(22) PZ-14B: PZ-14B is located on the downstream slope of the embankment with its tip near the boundary between embankment and foundation soils at El. 369. The piezometer tip is surrounded by filter sand extending from El. 367 to 377, which is capped with a 6-foot bentonite seal. The foundation material that influences the response of PZ-14B is a brown, medium to fine SAND with a trace of silt (SP). The normal groundwater level in PZ-14B ranges from El. 380 to El. 384 over the period 1994 to 1997 (Table 4). The time-history plots (Plates C.6 and D.6) show a rise in piezometric elevation with rise in pool level, with a lag of a couple of days in response. An unusual reading on 4/30/96 may be the result of transposing the depths recorded for PZ-14A and PZ-14B. Also, the readings for PZ-13B and PZ-14B may have been transposed on 4/25/97. The projected piezometric elevation with pool level at spillway crest is 382.6 (Plate E.22).

c. Profile Evaluation

(1) Downstream Berm: Piezometers 3 through 8 are all located along the downstream berm, all in the same profile (Plate 15). Time history data for the deep piezometers (PZ-3A, PZ-4A, PZ-5A, PZ-6A, PZ-7A, PZ-8A, and PZ-15) are shown together on Plates C.2 and D.2 for the past five years and for the high pool event, respectively. Time history data for the shallow piezometers (PZ-3B, PZ-4B, PZ-5B, PZ-6B, PZ-7B, and PZ-8B) are shown together on Plates C.3 and D.3 for the past five years and for the high pool event, respectively. The data show responses similar to those shown in the prior periodic inspection report (Ref. 4). Both the deep and shallow piezometers respond to changes in pool elevation.

For the piezometers to the right of the outlet and stilling basin, piezometric levels in the deep piezometers were 10 to 12 feet lower than in the shallower piezometers, indicating that the downstream forebay pool affects the shallow (B) piezometers more than the deeper (A) piezometers, and that there is not a significant artesian condition in the gravels underlying the dam. Water levels in the deep piezometers averaged about 367 to 371, an elevation that is probably close to the groundwater levels that would have existed prior to dam construction. Water levels in PZ-3A and PZ-15 are typically about 5 feet higher than in the other deep piezometers to the right of the stilling basin. This may indicate that these two piezometers are founded in similar strata or that PZ-3A is influenced by the abutment and PZ-15 is influenced by recharge from relief well RW-2. Relief Well RW-2 is closer to PZ-15 than any other relief well is to an adjacent piezometer. Therefore, it is possible that there would be a recharge effect at PZ-15 that might not be evident at other piezometers. Average readings for PZ-5B, PZ-6B, PZ-7B, and PZ-8B are in the range of 379 to 381 over the past five years.

Piezometers PZ-3A&B and PZ-4A&B are located to the left of the outlet and stilling basin. Piezometric levels in the deep piezometers to the left of the outlet appear to be about 2 to 5 feet higher than the levels in the deep piezometers to the right of the outlet and stilling basin. Piezometric levels in PZ-4B are about 2 feet lower than in PZ-4A, indicating that the levels in PZ-4B appear to be influenced by the foundation drains for the adjacent stilling basin. Piezometric levels for PZ-3A and PZ-3B are very similar over the five years. The level in PZ-3A is 5 to 7 feet higher than for the deep piezometers in the valley bottom, indicating some influence from the left abutment. The level in PZ-3B is 3 to 5 feet lower than for the shallow piezometers in the valley bottom, indicating less of a connection with the forebay reservoir.

(2) <u>Station 5+25</u>: Piezometers PZ-13A&B, PZ-14A&B, and PZ-15 were installed during 1993 at approximately Sta. 5+25 (Plate 19). Time history data are shown together on Plates C.5 and D.5 for the past four years and for the high pool event, respectively. Normal piezometric levels in deep piezometers PZ-13A and PZ-14A are close to or lower than pre-existing ground levels, indicating that there is not a significant artesian condition in the gravels underlying the dam. As described above, PZ-15 may be influenced by RW-2, resulting in higher piezometric levels than in PZ-13A or PZ-14A. Piezometric levels in PZ-13B typically respond closely to fluctuations in the pool level as would be expected, although there is a lot of scatter in the data. Piezometric levels are generally about 5 feet higher in PZ-13B than in PZ-14B. As would be expected, the compacted pervious fill drain layer affects the response of PZ-14B, limiting piezometric levels to an elevation corresponding to the top of the drain layer (Plate 19).

As shown on Plate 19, piezometric levels during the October 1996 high pool event rose by 2 to 4 feet in the three deep piezometers. The piezometric level in PZ-14B rose by less than 2 feet and appears to be controlled by the compacted pervious fill drain layers, as expected. The piezometric level in PZ-13B rose during the high pool event, but, as shown on Table 3, the high piezometric level of El. 409 occurred four days prior to the high pool of El. 403.2. This indicates that rainfall may be infiltrating the piezometer, producing high piezometric readings in advance of the high pool. An estimated phreatic surface is shown on Plate 19 for the October 1996 high pool event. We have shown the location of the phreatic surface upstream of the dam centerline based on the average piezometric level in PZ-13B during the high pool event (about El. 390), rather than the suspect peak reading of El. 409. However, it should be noted that it is difficult to determine where this phreatic surface should be shown due to the transient nature of flood events.

(3) East Outlet Channel Wall: PZ-9, PZ-10, and PZ-11 are located along the east stilling basin wall (Plate 17). Piezometric levels in these piezometers were similar, with PZ-10 having slightly higher levels than PZ-9 and PZ-11. According to Ref. 4, the responses of these piezometers are related to discharges in the outlet channel. The responses over the past five years are consistent with those reported in Ref. 4 (see Plates C.4 and D.4).

(4) Stilling Basin Cross Section: PZ-1 and PZ-2 are located on either side of the stilling basin (Plate 18) with their tips in the fine filter material beneath the stilling basin. According to Ref. 4, the responses of these two piezometers are affected more by the discharge rates and height of water in the stilling basin than the pool level. The responses of PZ-1 and PZ-2 are very similar to one another, as expected, and are consistent with data reported in the prior periodic inspection report (Ref.4).

Maximum piezometer levels recorded during the October 1996 high pool event are shown on Plate 20. However, because the piezometer levels were so similar, it was not possible to show groundwater contours.

4.3 Relief Wells

4.3.1 Data Collection

Water surface elevations for relief wells are collected in the same manner as the piezometer data as described in subsection 4.2.1. However, very little data have been collected since October, 1994. Relief well depths and elevations are given in Tables 6 and 7, respectively. Time-history plots of all eight relief wells are shown on Plate F.1. A time-history plot for the October 1996 high pool event is shown on Plate G.1. Relief well elevation vs. pool elevation plots are included as Plates H.1 - H.8.

4.3.2 Interpretation and Evaluation

Based on the soil profile, only RW-1, RW-4, and RW-8 intercept the gravel layer below the dam (Plate 16). The others are located in the glacial till. The strata surrounding RW-6 are questionable; the log for the relief well indicates a gravelly (water-bearing) river bed sand, while the adjacent boring log indicates glacial till.

During January 1994, the relief wells were flushed (Ref. 6). Up to 7.7 feet of sediment was removed from the wells. Based on drawings showing design well depths (Plates 16 and 25), it appears that between 0.5 and 3.5 feet of sediment may have remained at the bottom of the wells after flushing. This amounts to 2 to 15% of the well screen length compared to 25 to 50% reported for the prior periodic inspection (Ref. 4). It was stated in Ref. 4 that the gravel pack is of too fine a gradation for the well screens size, and thus it is possible that slightly more sediment is in the wells in 1997 than in 1994. It was also reported in Ref. 4 that inspection by a down-hole camera in 1992 had indicated a significant build-up of mineral deposits on the well screens that would restrict flow into the wells.

Relief wells 2 through 8 are located on the downstream toe berm to the left of the stilling basin outlet. They respond only slightly to rising pool elevation and generally remain at about El. 380 to 382 (Plate F.1). In addition, the water levels change only slightly when the pool was drawn down to El. 365 in mid-1993. The forebay pool elevation is generally at 381± feet. The T-invert outlet of RW-2 through RW-8 is at El. 375 according to as-built plans (Plate 25). With the forebay pool above the relief well outlet elevation, water from the forebay pool can back up into the relief wells. It would thus be difficult to determine whether any water is flowing into the relief wells from the underlying gravel layer.

RW-1 is located to the right of the stilling basin outlet. It appears not to be influenced by the forebay pool, and water levels in RW-1 generally range from El. 369 to 371. The water levels respond slightly more to changes in pool elevation than do RW-2 through RW-8 (Plates F.1 and G.1). The levels are at about the level of natural groundwater prior to construction of the dam.

A plot of water elevation vs. pool elevation was prepared for each relief well (Plates H.1 to H.8). These show the projected reading if the upstream pool were to reach spillway crest elevation of 416.0 feet. Projected elevations are shown in Table 8.

5. CONCLUSIONS

5.1 General

Based on past performance of the dam and on the performance of the instrumentation to date, the Hopkinton Lake Dam appears to be suitably instrumented. Existing instrumentation indicates that the dam embankment is functioning suitably relative to seepage and crest movements.

5.2 Crest Monuments

5.2.1 Schedule

The planned schedule for crest monument surveys for the Hopkinton Lake Dam is once every five years, which coincides with the periodic inspection schedule. This schedule is adequate unless physical evidence of embankment movement is found or the next scheduled survey results in unusual readings. Therefore, the next scheduled survey should be performed in 2001, just prior to the periodic inspection.

5.2.2 Evaluation of Adequacy

The number and locations of the crest monuments are adequate to evaluate embankment movements. Comparison of data between 1991 and 1996 indicates horizontal displacements in the range of 0.010 to 0.037 foot (0.1 to 0.4 inch). Measured settlements since 1985 are less than 0.082 foot (1 inch). In the absence of any reported physical evidence to indicate embankment movement, these displacements and settlements are not considered significant.

5.2.3 Recommendations

The crest monuments should continue to be surveyed and evaluated on the current schedule.

5.3 Piezometers

5.3.1 Schedule

The current schedule of monitoring the piezometers is adequate.

5.3.2 Evaluation of Adequacy

The shallow (B) piezometers along the downstream toe berm appear to be influenced by the downstream forebay pool more than the upstream Hopkinton Lake Dam. The deep (A) piezometers have piezometric levels close to pre-existing ground and about 7 to 9 feet lower than the shallow piezometers. According to the prior report (Ref. 4), although levels in the "B" piezometers dropped when the forebay pool was emptied, the "B" levels were still higher than the "A" levels, indicating that the downstream forebay pool affects the shallow (B) piezometers more than the deeper (A) piezometers and that there is not a significant artesian condition in the gravels underlying the dam. Data from new piezometers installed in 1993 tends to confirm this. Piezometric levels in the upstream embankment respond to the pool level, while piezometric levels in the downstream embankment are controlled by the drain layer. Piezometers near the outlet channel and stilling basin appear to be influenced by the discharge through the channel and drainage layers beneath the structures. Piezometers to the left of the outlet are not affected by the forebay pool but do respond to changes in the level of Hopkinton Lake. Piezometric levels in the PZ-3A&B piezometers also appear influenced by the nearby abutment, as the levels are slightly higher than in the PZ-4A&B piezometers. The piezometric level in PZ-15 may be influenced by recharge from adjacent relief well RW-2.

Existing piezometers appear adequate to characterize piezometric levels at Hopkinton Lake Dam.

5.3.3 Recommendations

The piezometric levels should continue to be recorded and evaluated on the current schedule.

5.4 Relief Wells

5.4.1 Schedule

The current schedule of monitoring the relief wells is adequate.

5.4.2 Evaluation of Adequacy

The relief wells were originally installed to relieve possible uplift pressures under the dam. A gravel layer with a hydraulic connection to the reservoir was thought to exist under the dam footprint. Based on review of the piezometric data to date, it appears that without a permanent upstream pool, significant artesian pressures do not exist under the dam, and thus the relief wells may not be needed. In addition, water levels in the forebay pool are higher than the T-invert outlets of the wells, and thus the wells may be acting as gravity injection wells, as indicated by piezometric levels at PZ-15.

5.4.3 Recommendations

The relief well water levels should continue to be recorded and evaluated on the current schedule.

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TABLE 1 - PIEZOMETER DATA - MATERIAL ZONES
Instrumentation Appendix
Hopkinton Lake Dam, Hopkinton, New Hampshire

Piez. No.	Station	CL Offset (1) (feet)	Riser Pipe Top Elevation (feet-NGVD)	Piezometer Tip Elevation (feet-NGVD)	Zone	Material Tip Is Located In
PZ-1	5+58	213	376.3	331.00	Drain	Filter Sand
PZ-2	6+49	213	384.7	330.00	Drain	Filter Sand
PZ-3A	7+07	155	385.10	305.70	Foundation	Gray Silty SAND (SM)
PZ-3B	7+07	155	385.10	349.70	Foundation	Gray Silty SAND w/Clay (SC-SM)
PZ-4A	6+43	155	385.10	305.70	Foundation	Gray Br. Silty SAND w/Gravel (SM)
PZ-4B	6+43	155	385.10	349.70	Foundation	Gray Silty SAND w/Gravel (SM)
PZ-5A	5+02	155	385.00	305.60	Foundation	Gray Sandy SILT (ML)
PZ-5B	5+02	155	385.00	349.60	Foundation	Gray Silty SAND w/Clay (SC-SM)
PZ-6A	4+50	155	385.30	305.90	Foundation	Gray Br. Silty SAND (SM)
PZ-6B	4+50	155	385.30	349.90	Foundation	Gray Silty SAND w/Clay (SM)
PZ-7A	4+02	155	384.60	305.20	Foundation	Gray Br. Silty GRAVEL (GM)
PZ-7B	4+02	155	384.60	349.20	Foundation	Gray Silty Clayey SAND (SC-SM)
PZ-8A	2+53	155	384.90	305.50	Foundation	Gray Br. Silty SAND w/Gravel (SM)
PZ-8B	2+53	155	384.90	349.50	Foundation	Gray Sandy SILT (ML)
PZ-9	5+47	275	384.80	340.50	Foundation	Gray SAND w/Silt (SP-SM)
PZ-10	5+28	318	384.70	323.80	Foundation	Gray Silty SAND w/Gravel (SM)
PZ-11	5+08	357	384.10	353.10	Foundation	Gray Silty SAND w/Gravel (SM)
PZ-13A	5+25	59	417.7	299.0	Foundation	Brown SAND w/Silt (SP-SM)
PZ-13B	5+25	59	417.8	368	Embankment	Dark Brown Sandy SILT, Trace Gravel (ML)
PZ-14A	5+25	73	417.7	303	Foundation	Brown Clayey Sand w/Trace Gravel (SC)
PZ-14B	5+25	73	417.8	369	Embankment	Brown, M-F SAND w/Trace Silt (SP)
PZ-15	5+25	155	384.3	301	Foundation	Gray Varved Clay w/M-F SAND (CL)

Note: (1) All piezometers are located downstream of the crest, except PZ-13A and PZ-13B.

TABLE 2 - PIEZOMETER DEPTH READINGS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

DEPTH READINGS, METERS

DATE	POOL EL	PZ-1	PZ-2	PZ-3A	PZ-3B	PZ-4A	PZ-4B	PZ-5A	PZ-5B	PZ-6A	PZ-6B	PZ-7A	PZ-7B	PZ-8A	PZ-8B	PZ-9	PZ-10	PZ-11	PZ-13A	PZ-13B	PZ-14A	PZ-14B	PZ-15
01/31/92	382.70	6.36	3.88	2.74	2.79	4.38	5.28	4.84	1.08	4.81	1.58	4.50	1.34	4.96	0.91	6.27	5.00	5.75	NA	NA	NA	NA	NA
03/03/92	383.00	6.32	3.82	2.80	2.86	4.38	5.23	4.85	0.96	4.85	1.57	4.55	1.33	5.04	0.90	6.20	5.02	0.90	NA	NA	NA	NA	NA
03/12/92	388.96	5.42	2.91	2.36	2.54	3.80	4.59	4.36	1.18	4.40	1.42	4.25	1.29	4.74	1.90	5.40	4.42	4.70	NA	NA	NA	NA	NA
03/13/92	388.73	5.41	2.92	2.25	2.55	3.75	4.55	4.35	1.00	4.41	1.45	4.24	1.20	4.72	0.96	5.38	4.41	4.72	NA	NA	NA	NA	NA
03/14/92	386.90	5.43	2.92	2.21	2.56	3.71	4.55	4.33	1.04	4.43	1.51	4.26	1.22	4.72	0.90	5.34	4.36	4.71	NA	NA	NA	NA	NA
03/15/92	384.85	5.76	3.26	2.31	2.65	3.87	4.72	4.58	1.04	4.56	1.54	4.36	1.28	4.83	0.90	5.61	4.56	4.98	NA	NA	NA	NA	NA
03/16/92	385.12	5.76	3.26	2.41	2.69	3.97	4.90	4.55	1.00	4.60	1.52	4.40	1.27	4.95	0.90	5.69	4.63	5.05	NA	NA	NA	NA	NA
03/17/92	383.50	5.77	3.30	2.45	2.72	4.00	4.88	4.57	1.05	4.64	1.55	4.40	1.30	4.88	0.90	5.68	4.65	5.05	NA	NA	NA	NA	NA
03/18/92	382.48	6.14	3.65	2.59	2.78	4.20	5.07	4.73	1.08	4.74	1.64	4.49	1.38	4.94	0.90	6.02	4.88	5.25	NA	NA	NA	NA	NA
03/19/92	382.80	6.35	3.87	2.73	2.80	4.37	5.20	4.83	1.10	4.80	1.60	4.50	1.36	4.97	0.90	6.24	5.01	5.55	NA	NA	NA	NA	NA
03/20/92	382.60	6.40	3.90	2.87	2.81	4.40	5.24	4.86	1.10	4.83	1.64	4.53	1.38	4.97	0.90	6.27	5.04	5.55	NA	NA	NA	NA	NA
04/03/92	384.20	5.92	3.31	2.49	2.56	4.06	4.89	4.58	1.02	4.57	PI	4.33	1.25	4.78	PI	5.84	4.68	5.12	NA	NA	NA	NA	NA
04/30/92	380.98	5.80	3.33	2.43	2.36	4.03	4.85	4.67	1.71	4.72	1.92	4.40	1.65	4.88	1.58	5.75	4.71	5.16	NA	NA	NA	NA	NA
06/02/92	384.96	5.60	2.98	2.60	2.23	4.08	4.80	4.70	1.60	4.70	1.92	4.40	1.72	4.98	1.50	5.69	4.70	5.14	NA	NA	NA	NA	NA
07/01/92	380.15	6.39	3.90	2.90	2.80	4.50	5.30	5.03	1.73	5.02	2.05	4.71	1.80	5.20	1.60	6.32	5.15	5.75	NA	NA	NA	NA	NA
08/04/92	380.12	6.38	3.87	2.95	2.77	4.55	5.30	5.08	1.71	5.09	2.05	4.78	1.81	5.25	1.61	6.32	5.20	5.75	NA	NA	NA	NA	NA
09/01/92	380.00	6.38	3.88	3.00	2.82	4.55	5.33	5.11	1.71	5.12	2.08	4.82	1.85	5.32	1.63	6.33	5.23	5.71	NA	NA	NA	NA	NA
09/28/92	380.57	6.10	3.60	2.87	2.75	4.40	5.17	5.00	1.53	5.02	1.95	4.79	1.70	5.28	1.48	6.07	5.06	5.45	NA	NA	NA	NA	NA
10/30/92	382.12	6.35	3.86	3.00	2.82	4.57	5.33	5.11	1.15	5.15	1.60	4.87	1.34	5.45	1.08	6.31	5.18	5.62	NA	NA	NA	NA	NA
11/30/92	384.00	5.62	3.12	2.47	2.40	3.99	4.70	4.57	1.02	4.62	1.52	4.41	1.25	4.92	1.03	5.49	4.62	5.02	NA	NA	NA	NA	NA
12/31/92	384.00	6.00	3.50	2.70	2.75	4.23	5.02	4.75	0.90	4.77	1.42	4.50	1.12	5.03	0.90	5.91	4.85	5.40	NA	NA	NA	NA	NA
01/29/93	384.00	6.22	3.72	2.59	2.70	4.22	5.02	4.78	0.96	4.78	1.48	4.51	1.16	5.02	PF	6.03	4.93	5.50	NA	NA	NA	NA	NA
03/01/93	382.10	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	NA	NA	NA	NA	NA
03/31/93	393.50	5.34	2.85	2.23	2.40	3.79	4.31	4.23	0.95	4.26	1.35	4.04	1.09	4.59	0.85	5.30	4.28	4.80	NA	NA	NA	NA	NA
04/01/93	398.30	6.13	3.64	2.36	2.24	4.02	4.56	4.39	0.94	4.26	1.24	3.94	0.97	4.47	0.88	6.00	4.66	5.54	NA	NA	NA	NA	NA
04/02/93	402.50	5.44	2.95	2.22	2.15	3.75	4.38	4.18	PF	4.12	1.15	3.81	0.85	4.38	PF	5.45	4.27	4.99	NA	NA	NA	NA	NA
04/03/93	402.90	2.84	5.33	2.05	2.15	3.55	4.23	4.09	PF	4.09	1.15	3.80	0.83	4.37	PF	5.37	4.18	4.84	NA	NA	NA	NA	NA
04/04/93	402.40	5.10	2.62	1.92	2.19	3.42	4.12	4.03	PF	4.16	1.18	3.84	0.87	4.39	PF	5.07	4.06	4.60	NA	NA	NA	NA	NA
04/05/93	401.20	4.81	2.32	1.84	2.22	3.31	4.00	4.04	PF	4.14	1.22	4.01	0.92	4.58	PF	4.79	3.95	4.24	NA	NA	NA	NA	NA
04/06/93	400.10	4.80	2.29	1.82	2.26	3.28	4.00	4.01	PF	4.13	1.22	3.99	0.94	4.15	PF	4.78	3.95	4.25	NA	NA	NA	NA	NA
04/07/93	398.00	4.69	2.21	1.78	2.30	3.24	3.96	4.00	PF	4.12	1.31	3.99	1.01	4.51	PF	4.68	3.89	1.06	NA	NA	NA	NA	NA
04/08/93	365.50	4.63	2.18	1.79	2.34	3.22	3.94	3.98	0.92	4.14	1.34	4.00	1.01	4.52	PF	4.61	3.96	3.99	NA	NA	NA	NA	NA
04/09/93	365.50	4.70	2.26	1.79	2.39	3.25	3.98	4.04	0.95	4.19	1.40	4.08	1.09	4.55	PF	4.66	3.92	3.99	NA	NA	NA	NA	NA
04/10/93	365.50	5.16	2.64	1.93	2.37	3.46	4.18	4.26	0.99	4.24	1.43	4.06	1.12	4.55	PF	5.15	4.17	4.45	NA	NA	NA	NA	NA
04/11/93	365.50	4.34	2.84	2.03	2.07	3.59	4.24	4.17	0.95	4.19	1.35	3.97	1.05	4.45	0.84	5.25	4.24	4.72	NA	NA	NA	NA	NA
04/12/93	365.50	6.15	3.65	2.00	2.10	3.70	4.24	4.20	0.93	4.10	1.24	3.87	0.98	4.33	0.87	5.80	4.55	5.30	NA	NA	NA	NA	NA
04/13/93	365.50	6.05	3.58	2.18	1.97	3.89	4.38	4.27	0.94	4.13	1.16	3.79	0.85	4.27	0.83	5.92	4.54	5.48	NA	NA	NA	NA	NA
04/14/93	365.50	3.84	2.55	1.91	1.89	3.39	4.01	3.93	0.91	3.94	1.11	3.70	0.81	4.23	0.81	5.03	5.04	3.96	NA	NA	NA	NA	NA
04/15/93	365.50	4.81	2.31	1.74	1.88	3.23	3.89	3.86	0.95	3.92	1.14	3.73	0.83	4.24	0.82	4.80	3.83	4.29	NA	NA	NA	NA	NA
04/16/93	365.50	4.75	2.26	1.66	1.89	3.16	3.81	3.84	0.95	3.92	1.16	3.74	0.84	4.24	0.85	4.72	3.80	4.18	NA	NA	NA	NA	NA
04/17/93	365.50	4.90	2.35	1.70	1.85	3.20	3.84	3.87	0.95	3.92	1.16	3.76	0.85	4.23	0.84	4.84	3.89	4.33	NA	NA	NA	NA	NA
04/18/93	365.50	4.88	2.39	1.68	1.74	3.20	3.80	3.85	0.90	3.90	1.17	3.71	0.85	4.21	1.15	4.84	3.85	4.33	NA	NA	NA	NA	NA
04/19/93	365.50	4.79	2.28	1.64	1.75	3.16	3.77	4.83	0.94	3.89	1.15	3.71	0.83	4.21	0.91	4.76	3.80	4.25	NA	NA	NA	NA	NA
04/20/93	365.50	4.73	2.21	1.60	1.82	3.11	3.73	3.82	0.98	3.90	1.18	3.74	0.85	4.23	0.92	4.69	3.78	4.10	NA	NA	NA	NA	NA
04/21/93	365.50	4.65	2.16	1.60	1.85	3.10	3.74	3.82	0.98	3.92	1.20	3.78	0.87	4.25	0.91	4.63	3.73	4.01	NA	NA	NA	NA	NA
04/22/93	365.50	4.65	2.17	1.60	1.89	3.10	3.75	3.85	0.98	3.97	1.23	3.81	0.89	4.30	0.93	4.62	3.76	4.00	NA	NA	NA	NA	NA
04/23/93	365.50	4.72	2.30	1.68	1.86	3.17	3.87	3.90	0.97	4.01	1.27	3.85	0.90	4.32	0.91	4.70	3.83	4.16	NA	NA	NA	NA	NA
04/24/93	365.50	4.76	2.28	1.77	1.92	3.21	3.94	3.96	0.99	4.06	1.32	3.91	0.94	4.40	0.92	4.76	4.88	4.28	NA	NA	NA	NA	NA
04/25/93	365.50	4.88	2.41	1.79	2.05	3.30	4.04	4.04	1.06	4.10	1.40	4.00	1.07	4.45	1.00	4.85	3.97	4.37	NA	NA	NA	NA	NA
04/26/93	365.50	4.93	2.49	1.88	2.19	3.35	4.12	4.09	1.08	4.21	1.44	4.04	1.11	4.50	1.01	4.91	4.02	4.42	NA	NA	NA	NA	NA
04/27/93	365.50	5.09	2.63	1.95	2.01	3.50	4.28	4.21	1.03	4.31	1.43	4.12	1.06	4.57	0.92	5.07	4.16	4.64	NA	NA	NA	NA	NA
04/28/93	365.50	5.23	2.71	2.01	2.03	3.58	4.33	4.24	1.06	4.30	1.46	4.11	1.10	4.56	0.96	5.20	4.22	4.75	NA	NA	NA	NA	NA
04/29/93	365.50	5.30	2.82	2.05	2.09	3.61	4.39	4.27	1.04	4.34	1.44	4.12	1.08	4.55	0.94	5.27	5.26	5.82	NA	NA	NA	NA	NA
04/30/93	365.50	5.34	2.84	2.08	2.05	3.64	4.44	4.32	1.08	4.37	1.50	4.15	1.13	4.59	1.01	5.34	4.31	4.88	NA	NA	NA	NA	NA
05/01/93	365.50	5.83	3.33	2.22	2.26	3.85	4.65	4.52	1.63	4.56	1.97	4.31	1.63	4.71	1.57	5.69	4.60	5.30	NA	NA	NA	NA	NA
05/02/93	365.50	4.82	3.35	2.32	2.29	3.94	4.71	4.53	1.50	4.51	1.85	4.26	1.52	4.66	1.44	5.76	4.60	5.34	NA	NA	NA	NA	NA
05/28/93	365.50	6.40	3.90	2.81	2.75	4.45	5.25	4.98	1.66	4.94	2.06	4.63	1.84	5.08	1.62	6.32	5.09	5.85	NA	NA	NA	NA	NA
07/01/93	365.50	6.37	3.89	2.98	2.90	4.57	5.33	5.13	1.68	5.12	2.08	4.83	1.77	5.34	1.62	6.35	5.20	5.78	NA	NA	NA	NA	NA
07/31/93	365.50	6.26	3.77	3.02	2.95	4.56	5.33	5.12	1.59	5.14	1.98	4.88	1.62	5.40	1.52	6.33	5.18	5.66	NA	NA	NA	NA	NA
09/01/93	380.19	6.30	3.81	3.09	3.03	4.61	5.36	5.18	1.62	5.20	2.01	4.94	1.71	5.49	1.56	6.27	5.23	5.66	NA	NA	NA	NA	NA
09/29/93	380.18	6.36	3.88	3.15	2.77	4.77	5.36	5.20	1.66	5.20	2.09	4.91	1.82	5.45	1.64	6.37	5.28	5.70	NA	NA	NA	NA	NA
11/02/93	383.13	6.24	3.75	3.07	2.72	4.55	5.26	4.99	1.01	5.00	1.53	4.70	1.22	5.25	0.98	6.21	5.12	5.55	NA	NA	NA	NA	NA
12/01/93	384.10	5.61	3.12	2.57	2.45	4.01	4.77	4.50	1.01	4.60	1.50	4.48	1.20	5.02	1.00	5.60	4.62	5.08	NA	NA	NA	NA	NA
12/29/93	383.50	6.40	3.90	2.80	2.62	4.42	5.20	4.78	1.07	4.80	1.54	4.54	1.25	5.02	1.05	6.25	5.02	5.70	NA	NA	NA	NA	NA
02/01/94	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 2 - PIEZOMETER DEPTH READINGS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

DEPTH READINGS, METERS

DATE	POOL EL	PZ-1	PZ-2	PZ-3A	PZ-3B	PZ-4A	PZ-4B	PZ-5A	PZ-5B	PZ-6A	PZ-6B	PZ-7A	PZ-7B	PZ-8A	PZ-8B	PZ-9	PZ-10	PZ-11	PZ-13A	PZ-13B	PZ-14A	PZ-14B	PZ-15
03/01/94	383.10	NA	NA	3.09	2.88	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
04/01/94	385.00	5.36	PI	2.21	2.19	3.72	4.35	4.21	PI	4.30	1.62	4.11	1.33	4.78	PI	5.27	4.30	4.99	13.72	9.51	13.89	11.04	PI
04/07/94	389.90	5.23	2.76	1.99	1.76	3.52	4.03	4.01	1.00	4.05	1.41	3.87	1.16	4.38	PI	5.16	4.12	4.79	13.33	9.28	13.62	10.91	1.98
04/08/94	389.80	4.75	2.35	1.84	1.78	3.28	3.83	3.86	1.00	3.99	1.42	3.86	1.15	4.37	PI	4.78	3.85	4.33	13.31	8.67	13.53	11.13	1.90
04/09/94	389.09	4.79	2.33	1.80	1.80	3.28	3.84	3.87	9.70	4.00	1.40	3.90	1.12	4.40	PI	4.75	3.90	4.30	13.42	9.32	13.60	11.00	1.86
04/10/94	385.70	4.88	2.37	1.84	1.84	3.33	3.95	3.97	1.10	4.10	1.51	3.97	1.26	4.44	PI	4.84	3.97	4.43	13.68	10.95	13.55	9.33	1.98
04/11/94	387.39	4.92	2.43	1.91	1.90	3.36	3.98	3.95	0.92	4.06	1.43	3.95	1.16	4.42	1.15	4.90	3.98	4.55	13.45	9.10	13.65	11.05	1.93
04/12/94	386.35	5.00	2.50	1.91	1.93	3.41	4.02	3.99	0.99	4.10	1.46	3.95	1.20	4.44	1.03	4.95	4.00	4.57	13.50	8.89	13.68	11.02	1.98
04/13/94	385.10	5.00	2.50	1.92	1.92	3.45	4.06	4.00	1.06	4.15	1.50	4.00	1.25	4.45	1.12	4.95	4.05	4.63	13.60	8.75	13.73	10.95	2.04
04/14/94	386.00	4.88	2.42	1.90	1.80	3.39	3.95	3.90	1.00	4.00	1.48	3.87	1.20	4.35	1.03	4.85	3.92	4.60	13.40	9.11	13.63	10.93	1.92
04/15/94	385.22	4.90	2.35	1.85	1.75	3.30	3.90	3.90	1.05	4.04	1.50	3.90	1.25	4.40	1.10	4.80	3.90	4.41	13.50	6.20	13.60	11.00	2.00
04/16/94	385.04	4.91	2.40	1.83	1.76	3.33	3.93	3.90	1.01	4.02	1.46	3.87	1.20	4.36	1.04	4.85	3.93	4.51	13.06	10.89	13.42	5.64	2.00
04/17/94	385.21	4.91	2.43	1.86	1.74	3.33	3.90	3.89	0.99	3.99	1.44	3.86	1.19	4.34	1.02	4.92	3.92	4.52	13.39	10.97	13.59	3.86	2.00
04/18/94	384.47	5.00	2.50	1.87	1.78	3.37	3.97	3.95	1.06	4.06	1.50	3.92	1.24	4.38	1.09	4.91	3.99	4.59	13.47	4.78	13.65	10.98	2.08
04/19/94	383.12	5.48	2.98	2.05	1.94	3.66	4.29	4.14	1.11	4.21	1.56	3.98	1.29	4.46	1.12	5.38	4.26	5.08	13.57	7.58	13.83	11.00	2.18
05/02/94	383.51	5.97	3.48	2.53	2.22	4.13	4.80	4.54	1.41	4.56	1.84	4.30	1.57	4.77	1.43	5.90	4.68	5.55	13.34	6.47	14.20	11.30	2.46
05/24/94	382.56	6.12	3.63	2.63	2.39	4.25	4.92	4.62	1.46	4.62	1.90	4.33	1.64	4.78	1.49	6.05	4.79	6.67	13.97	9.26	14.26	11.23	2.64
06/27/94	380.05	6.37	3.89	2.96	2.74	4.55	5.22	4.93	1.65	4.98	2.02	4.72	1.81	5.20	1.62	6.31	5.10	5.79	14.38	5.24	14.61	11.47	2.95
08/01/94	379.88	6.35	3.86	3.30	2.78	4.60	5.26	5.01	1.59	5.03	2.03	4.77	1.80	5.25	1.62	6.28	5.13	5.63	14.46	9.48	14.66	11.50	4.59
09/01/94	379.80	6.40	3.91	3.14	2.90	4.68	5.32	5.06	1.62	5.10	2.06	4.80	1.85	5.30	1.65	6.35	5.20	5.76	14.50	9.46	14.72	11.51	3.92
10/03/94	382.18	6.33	3.84	3.05	2.68	4.58	5.22	4.90	1.00	4.95	1.56	4.64	1.36	5.16	1.05	6.27	5.01	5.60	14.37	9.50	14.56	11.15	2.65
10/28/94	382.11	6.32	3.85	3.01	2.80	4.60	5.30	4.95	1.02	5.00	1.60	4.72	1.38	5.27	1.07	6.30	5.15	5.65	14.44	9.71	14.62	11.05	2.10
12/02/94	384.05	6.40	3.88	3.07	3.77	4.59	5.27	4.79	1.77	4.84	1.88	4.86	1.61	5.10	1.27	6.30	5.10	5.72	14.42	9.08	14.62	11.43	2.11
03/02/95	382.78	PI	PI	2.90	2.80	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
03/28/95	383.84	5.75	3.27	2.44	2.45	4.00	4.68	4.47	0.89	4.49	1.40	4.29	1.15	4.79	0.89	5.63	4.57	5.22	13.90	9.76	14.15	10.82	1.97
05/01/95	381.76	6.44	3.93	2.75	2.70	4.51	5.19	5.07	1.37	5.09	1.91	4.80	1.63	5.20	1.55	6.18	5.29	5.80	14.30	10.66	14.63	10.95	2.93
05/26/95	380.96	6.40	3.90	2.90	2.78	4.51	5.20	4.95	1.55	5.00	2.00	4.71	1.80	5.16	1.60	6.20	5.13	5.76	14.35	10.97	14.65	11.41	2.90
06/27/95	379.60	6.40	3.91	3.03	2.97	4.65	5.33	5.10	1.70	5.15	2.13	4.90	1.91	5.38	1.72	6.30	5.23	5.80	14.51	10.38	14.80	11.57	3.26
07/26/95	379.21	6.36	3.87	3.15	2.98	4.68	5.35	5.05	1.56	5.21	2.02	4.97	1.81	5.47	1.60	6.26	5.25	5.69	14.59	10.41	14.85	11.25	3.06
08/31/95	380.02	6.25	3.78	3.17	2.98	4.70	5.38	5.16	1.65	5.25	2.10	4.96	1.89	5.45	1.70	6.21	5.25	5.74	14.88	14.46	14.61	11.00	3.34
09/29/95	380.16	6.30	3.81	3.20	2.96	4.69	5.37	5.16	1.45	5.25	2.04	5.00	1.84	5.53	1.58	6.15	5.37	5.74	14.64	10.58	14.90	11.55	3.22
10/29/95	389.70	5.05	2.59	2.37	2.06	3.72	4.20	4.24	0.96	4.33	1.35	4.18	1.11	4.73	1.00	5.02	4.23	4.52	13.65	3.90	13.90	10.97	2.56
10/30/95	388.53	4.95	2.40	2.24	2.10	4.12	3.59	4.18	0.91	4.33	1.33	4.20	1.11	4.85	0.98	5.90	4.14	4.25	13.75	5.85	13.90	11.01	2.64
10/31/95	385.80	5.03	2.50	2.25	2.22	3.64	3.34	4.30	0.94	4.45	1.42	4.31	1.18	4.92	0.96	4.99	4.26	4.43	13.90	7.97	14.02	11.96	2.62
11/01/95	386.91	5.15	2.64	2.32	2.26	3.72	4.30	4.31	0.89	4.42	1.35	4.77	1.14	4.78	0.91	5.08	4.31	4.78	13.85	9.46	14.00	11.85	2.69
11/02/95	383.17	5.23	2.75	2.36	2.98	3.80	4.45	4.37	1.04	4.50	1.43	4.32	1.25	4.81	1.00	5.20	4.37	4.71	14.00	9.03	14.10	10.93	2.50
11/03/95	385.81	4.98	2.50	2.25	2.00	3.61	4.17	4.20	0.90	4.32	1.35	4.20	1.15	4.70	0.93	4.96	4.20	4.42	13.72	6.00	13.90	10.82	2.40
11/04/95	386.35	5.04	3.54	2.24	2.04	3.65	3.19	4.23	0.86	4.35	1.32	4.13	1.09	4.68	0.87	5.04	4.23	4.51	13.73	7.11	13.98	10.88	2.31
11/05/95	385.03	5.27	2.83	2.28	2.14	3.78	4.30	4.25	0.89	4.39	1.34	4.14	1.12	4.69	0.92	5.20	4.34	4.69	13.80	8.16	14.00	10.91	2.44
11/06/95	384.85	5.50	3.03	2.38	2.20	3.86	4.55	4.37	0.94	4.47	1.38	4.24	1.15	4.74	0.93	5.39	4.48	4.90	13.90	9.44	14.10	8.90	2.52
11/07/95	384.53	5.65	3.18	2.44	2.28	3.95	4.55	4.44	0.91	4.52	1.38	4.28	1.18	4.78	0.94	5.53	4.56	5.14	14.91	9.64	14.81	10.30	2.59
11/13/95	388.50	5.12	2.63	2.32	1.98	3.73	4.26	4.22	0.90	4.30	1.31	4.10	1.10	4.60	0.95	5.10	4.24	4.66	13.61	6.96	13.90	10.91	2.52
11/14/95	384.91	5.10	2.60	2.21	2.03	3.62	4.25	4.22	0.93	5.34	1.38	4.20	1.15	4.65	0.95	5.05	5.05	4.55	13.85	8.50	13.95	11.85	2.50
11/15/95	389.71	5.18	2.71	2.30	1.82	3.73	4.27	4.20	0.97	4.26	1.33	4.04	1.09	4.52	0.96	5.14	4.25	4.73	13.60	4.20	13.70	10.71	2.54
11/16/95	390.03	5.05	2.49	2.10	1.82	3.54	4.06	4.09	0.91	4.18	1.32	3.98	1.08	4.49	0.91	4.99	4.10	4.45	13.54	6.82	13.82	10.89	2.45
11/17/95	389.65	5.00	2.45	2.07	1.87	3.49	4.13	4.08	0.88	4.18	1.29	3.99	1.06	4.48	0.90	4.95	4.10	4.37	13.55	7.98	13.75	10.30	2.45
11/18/95	386.62	5.00	2.46	2.08	2.01	3.54	4.14	4.26	0.89	4.27	1.34	4.10	1.12	4.57	0.89	4.95	4.15	4.47	13.71	8.98	13.87	10.85	2.46
11/19/95	384.58	5.22	2.72	2.17	2.10	3.70	4.32	4.25	0.96	4.35	1.40	4.15	1.18	4.61	0.90	5.17	4.28	4.81	14.90	9.52	14.78	10.25	2.53
11/20/95	383.30	5.38	2.89	2.28	2.14	3.79	4.48	4.31	0.98	4.40	2.42	4.17	1.18	4.64	0.93	5.31	4.34	4.93	13.89	8.54	14.08	10.82	2.57
11/21/95	383.60	5.34	2.85	2.24	2.15	3.76	4.42	4.33	0.96	4.44	1.44	4.19	1.22	4.66	0.98	5.27	4.33	4.87	13.81	8.86	14.03	10.86	2.67
11/22/95	385.66	5.65	3.09	2.34	2.14	3.86	4.51	4.33	0.99	4.38	1.41	4.14	1.19	4.61	0.96	5.48	4.43	5.05	13.80	8.63	14.05	10.30	2.66
12/27/95	383.09	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
01/22/96	389.05	5.16	2.64	2.17	2.43	3.62	4.29	4.20	0.93	4.32	1.36	4.16	1.14	4.67	0.92	5.08	4.22	4.64	13.67	10.41	13.90	10.93	PF
01/23/96	388.20	5.09	2.58	2.12	2.42	3.60	4.30	4.20	0.95	4.32	1.38	4.19	1.16	4.67	0.95	5.04	4.21	4.63	13.74	10.34	13.90	10.90	2.45
01/24/96	384.67	5.19	2.71	2.12	2.44	3.63	4.37	4.22	1.09	4.36	1.48	4.22	1.25	4.70	0.96	5.11	4.21	4.72	13.86	10.08	13.99	10.91	2.40
01/25/96	390.00	5.18	2.67	2.28	2.30	3.70	4.35	4.23	0.85	4.30	1.32	4.12	1.10	4.61	0.87	5.13	4.25	4.71	13.65	7.28	13.92	11.02	2.37
01/26/96	388.85	4.90	2.28	2.05	2.25	3.48	4.12	4.10	0.90	4.20	1.32	4.10	1.12	4.62	0.90	4.85	4.05	4.41	13.62	6.55	13.80	11.06	2.30
01/27/96	386.67	4.99	2.46	2.01	2.33	3.48	4.16	4.15	0.98	4.29	1.42	4.15	1.20	4.62	0.99	4.93	4.13	4.48	13.87	10.87			2.33
01/28/96	391.02	5.16	2.80	2.01	2.00	3.52	4.11	4.05	0.90	4.10	1.30	3.92	1.10	4.43	0.88	5.08	4.12	4.63	13.44	5.56	13.70	10.94	2.21
01/29/96	393.59	5.11	2.67	1.97	1.92	3.46	3.99	3.98	0.88	4.03	1.26	3.86	1.04	4.36	0.88	5.03	4.06	4.57	13.60	6.37	13.67	10.98	2.18
01/30/96	393.86	4.87	2.41	1.81	1.88	3.29	3.85	3.86	0.85	3.95	1.21	3.80	0.98	4.29	0.86	4.81	3.86	4.24	13.29	7.40	13.55	10.76	2.19
01/31/96	391.20	4.93	2.43	1.82	1.95	3.31	3.91	3.94	0.91	4.08	1.28	3.91	1.04	4.38	0.90	4.85	3.95	4.16	13.47	8.54	13.67	10.87	2.28
02/01/96	386.03	5.02	2.55	1.92	2.16	3.46	4.16	4.15	0.98	4.29	1.42	4.11	1.20	4.55	0.98	4.95	4.11	4.40	13.78	9.58	13.87	10.97	2.42
02/02/96	383.94	5.28	2.79	2.09	2.28	3.66	4.40	4.28	0.98	4.29	1.50	4.18	1.28	4.62	0.97	5.21	4.29	4.85	13.83	9.87	14.00	10.95	2.43
02/03/96	383.50	5.56	3.10	2.20	2.32	3.80	4.51	4.32	1.00	4.40	1.52	4.16	1.30	4.61	1.00	5.47	4.42	5.10	PI	PI	PI	PI	2.50
02/04/96	384.10	5.05	3.60	2.34	2.40	4.05	4.17	4.49	PI	4.48	1.50	4.20	1.29	4.63	0.94	5.90	4.67	5.58	PI	PI	PI	PI	2.52

TABLE 2 - PIEZOMETER DEPTH READINGS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

DEPTH READINGS, METERS

DATE	POOL EL	PZ-1	PZ-2	PZ-3A	PZ-3B	PZ-4A	PZ-4B	PZ-5A	PZ-5B	PZ-6A	PZ-6B	PZ-7A	PZ-7B	PZ-8A	PZ-8B	PZ-9	PZ-10	PZ-11	PZ-13A	PZ-13B	PZ-14A	PZ-14B	PZ-15
02/05/96	384.56	5.80	3.33	2.39	2.43	4.00	4.70	4.48	0.93	4.50	1.49	4.24	1.27	0.86	4.67	5.68	4.60	5.35	PI	PI	PI	PI	2.58
02/06/96	383.90	6.24	3.76	2.49	2.51	4.17	4.89	4.59	PI	4.59	1.55	4.31	1.32	4.72	PI	6.07	4.81	5.70	PI	PI	PI	PI	2.72
02/08/96	384.60	6.12	3.64	2.56	2.58	4.21	4.94	4.60	PI	4.60	1.46	4.28	1.18	4.47	PI	5.97	4.77	5.62	PI	PI	PI	PI	2.71
02/28/96	383.60	5.38	2.84	2.13	2.51	3.68	4.43	4.26	0.81	4.34	1.51	4.14	1.29	4.61	0.85	5.26	4.31	4.84	13.75	10.15	13.97	10.90	2.74
03/28/96	384.30	5.80	3.30	2.40	2.50	4.00	4.72	4.48	0.97	4.50	1.45	4.29	1.25	4.75	0.87	5.70	4.60	5.22	13.88	10.38	14.15	10.95	2.80
04/17/96	395.00	6.40	3.95	2.20	1.65	3.98	4.30	4.22	4.41	4.10	1.16	3.67	0.92	4.41	0.98	6.12	4.62	5.69	13.10	4.63	13.75	10.24	2.73
04/18/96	400.10	6.36	3.90	2.15	1.60	3.95	4.26	4.20	4.39	4.00	1.15	3.65	0.90	4.12	0.96	6.10	4.60	5.67	13.04	4.61	13.72	10.20	2.70
04/20/96	401.40	4.77	2.17	1.57	1.63	3.08	3.61	3.67	0.85	3.74	1.04	3.58	0.76	4.06	0.86	4.67	3.68	4.01	13.08	8.80	13.10	10.72	2.16
04/22/96	397.10	4.87	2.28	1.60	1.83	3.19	3.76	3.84	0.91	3.94	1.20	3.77	0.94	4.20	0.91	4.76	3.83	4.09	13.80	10.50	13.02	8.99	2.27
04/23/96	395.60	4.82	2.33	1.66	1.79	3.21	3.82	3.82	0.89	3.93	1.18	3.77	0.92	4.24	0.80	4.74	3.78	4.06	13.56	10.79	13.43	8.21	2.08
04/24/96	395.60	4.91	2.46	1.72	1.71	3.26	3.83	3.90	0.81	4.00	1.23	3.89	0.91	4.30	0.80	4.82	3.87	4.12	13.63	10.76	13.51	6.78	2.10
04/25/96	389.90	4.98	2.41	1.89	1.91	3.43	4.09	4.07	1.92	4.20	1.39	4.05	1.18	4.47	0.92	4.96	4.08	4.30	13.71	7.83	13.95	10.92	2.21
04/26/96	386.40	5.03	2.50	1.89	1.98	3.42	4.17	4.16	0.99	4.30	1.47	4.17	1.28	4.53	0.99	5.00	4.21	4.40	13.76	8.42	13.85	10.84	2.28
04/27/96	386.89	5.17	2.69	1.99	2.02	3.52	4.20	4.12	0.91	4.20	1.38	4.04	1.16	4.49	0.90	5.10	4.13	4.66	13.83	10.93	13.66	8.90	2.18
04/28/96	384.23	5.46	3.00	2.12	2.13	3.65	4.36	4.23	0.96	4.32	1.44	4.14	1.22	4.55	0.93	5.35	4.31	4.92	13.80	9.10	13.98	11.00	2.24
04/29/96	383.50	5.48	2.99	2.15	2.19	3.74	4.45	4.31	0.96	4.39	1.47	4.24	1.26	4.61	0.96	5.39	4.37	5.01	13.93	9.19	14.03	10.92	2.31
04/30/96	384.30	5.49	3.01	2.16	2.06	3.74	4.46	4.27	0.93	4.32	1.43	4.13	1.22	4.54	0.93	5.39	4.35	4.99	8.30	10.80	10.34	13.80	2.26
06/04/96	380.57	6.45	3.96	2.76	2.57	4.45	5.14	4.85	1.56	4.83	1.98	4.50	1.75	4.87	1.58	6.32	5.03	5.85	NA	NA	NA	NA	NA
07/01/96	380.00	6.45	3.96	2.92	2.81	4.56	5.26	4.97	1.59	4.98	2.02	4.69	1.80	5.08	1.60	6.34	5.14	5.83	14.37	10.05	14.66	11.43	3.07
07/29/96	380.29	6.47	3.99	2.99	2.79	4.61	5.29	5.00	1.62	4.98	2.05	4.70	1.83	5.10	1.63	6.35	5.16	5.87	14.40	10.20	14.71	11.50	2.79
08/28/96	380.11	6.38	3.90	3.06	3.00	4.64	5.34	5.13	1.65	5.16	2.09	4.93	1.88	5.36	1.69	6.29	5.24	5.78	14.53	10.51	14.81	11.53	2.78
09/29/96	379.91	6.35	3.86	3.12	2.91	4.66	5.35	5.12	1.65	5.16	2.11	4.93	1.90	5.37	1.67	6.27	5.24	5.75	14.84	11.60	14.56	9.60	2.84
10/21/96	392.44	6.02	3.53	2.72	2.34	4.20	4.76	4.46	0.90	4.39	1.29	4.17	1.06	4.68	0.91	5.91	4.75	5.39	13.53	2.76	14.00	11.01	2.27
10/22/96	401.65	6.05	3.57	2.49	1.83	4.05	4.29	4.29	0.88	4.16	1.11	3.88	0.87	4.40	0.88	5.91	4.63	5.40	13.20	6.48	13.83	10.90	2.20
10/23/96	401.80	4.94	2.44	2.21	1.75	3.54	3.94	3.93	0.83	3.95	1.00	3.75	0.74	4.28	0.85	4.93	3.99	4.29	13.20	11.58	13.53	10.88	1.95
10/24/96	403.17	4.95	2.45	1.98	1.85	3.39	3.85	3.90	0.87	3.99	1.04	3.80	0.79	4.32	0.85	4.89	3.97	4.25	13.30	8.20	13.55	10.85	1.95
10/25/96	401.36	4.97	2.40	1.96	2.00	3.40	3.90	4.00	0.85	4.05	1.11	3.90	0.87	4.40	0.90	4.87	4.00	4.10	13.43	8.85	13.74	10.90	1.97
10/26/96	401.00	4.95	2.41	1.98	2.10	3.44	3.98	4.03	0.87	4.15	1.20	3.99	0.92	4.48	0.88	4.90	4.03	4.15	13.58	8.80	13.76	10.95	1.97
10/27/96	397.60	4.96	2.43	2.01	2.16	3.47	4.04	4.11	0.91	4.22	1.24	4.05	1.00	4.53	0.92	4.92	4.08	4.16	13.69	8.57	13.83	10.90	2.01
10/28/96	393.85	5.04	2.43	2.07	2.23	3.53	4.12	4.31	0.95	4.51	1.33	4.41	1.09	4.95	0.97	4.96	4.19	4.05	13.95	8.30	14.04	10.87	2.10
10/29/96	386.84	5.05	2.50	2.20	2.42	3.65	4.35	4.40	1.01	4.61	1.45	4.47	1.22	4.90	0.97	5.01	4.29	4.25	14.22	8.26	14.23	11.02	2.10
10/30/96	383.80	5.44	2.96	2.41	2.54	3.92	4.68	4.51	0.94	4.69	1.51	4.50	1.29	4.94	0.95	5.37	4.58	4.84	14.26	8.24	14.34	10.86	2.21
10/31/96	383.53	5.65	3.16	2.51	2.55	4.06	4.78	4.60	0.97	4.68	1.51	4.50	1.32	4.92	0.96	5.56	4.65	5.04	14.18	8.29	14.35	10.94	2.30
11/01/96	383.70	6.21	3.74	2.60	2.55	4.22	4.90	4.68	0.99	4.68	1.52	4.42	1.30	4.86	0.99	6.05	4.90	5.50	14.11	8.41	14.41	10.97	2.42
11/02/96	384.50	5.89	3.40	2.36	2.54	4.18	4.87	4.60	0.89	4.69	1.44	4.40	1.23	4.84	0.92	5.80	4.75	5.28	14.20	8.42	14.35	10.95	2.36
11/03/96	383.40	6.26	3.75	2.73	2.60	4.33	5.02	4.76	0.98	4.78	1.52	4.50	1.31	4.90	1.02	6.10	4.98	5.52	14.20	8.55	14.48	10.99	2.52
11/10/96	389.60	4.97	2.49	2.42	2.40	3.80	4.50	4.28	0.88	4.35	1.22	4.15	1.00	4.62	0.80	5.05	4.22	4.65	13.71	5.82	13.98	10.87	2.22
11/11/96	386.60	5.26	2.80	2.28	2.36	3.65	4.38	4.24	0.84	4.38	1.30	4.20	1.10	4.72	0.85	5.20	4.30	4.65	14.80	7.95	PI	PI	2.25
11/12/96	386.10	4.99	2.52	2.18	2.32	3.58	4.28	4.20	0.76	4.32	1.27	4.20	1.04	4.70	0.80	4.97	4.22	4.50	13.77	9.05	13.93	10.89	2.17
11/13/96	383.65	5.28	2.78	2.25	2.38	3.75	4.45	4.33	0.95	4.49	1.43	4.32	1.23	4.79	0.97	5.23	4.39	4.75	13.95	9.27	14.10	10.92	2.32
11/14/96	383.80	5.30	2.81	2.29	2.40	3.75	4.46	4.36	0.90	4.49	1.40	4.33	1.19	4.82	0.93	5.23	4.39	4.79	13.91	9.39	14.09	10.87	2.30
11/15/96	384.22	5.86	3.35	2.40	2.45	4.03	4.71	4.54	0.97	4.58	1.46	4.38	1.27	4.87	0.98	5.72	4.67	5.30	13.95	9.52	14.15	10.95	2.41
11/29/96	383.81	5.98	3.48	2.58	2.52	4.18	4.90	4.62	0.95	4.64	1.46	4.40	1.27	4.85	0.97	5.88	4.77	5.38	14.10	8.50	14.43	10.94	2.50
12/31/96	385.42	5.35	2.86	2.08	1.95	3.64	4.32	4.21	0.90	4.26	1.37	4.07	1.16	4.51	0.91	5.27	4.27	4.79	PI	PI	PI	PI	2.24
03/31/97	391.09	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
04/21/97	398.04	5.01	2.52	1.98	1.59	3.45	3.99	3.88	0.88	3.85	1.11	3.73	0.85	4.11	0.88	4.97	4.95	4.50	13.10	7.00	13.55	10.80	2.40
04/22/97	398.20	4.80	2.33	1.65	1.60	3.15	3.70	3.72	0.85	3.79	1.08	3.60	1.83	4.09	0.87	3.72	3.75	4.22	13.01	7.80	13.40	10.70	2.30
04/23/97	397.03	4.82	2.31	1.62	1.68	3.26	3.85	3.78	0.87	3.84	1.13	3.68	0.88	4.15	0.88	4.74	3.79	4.23	13.20	8.47	13.52	10.72	2.35
04/24/97	394.28	4.70	2.22	1.63	1.80	3.15	3.80	3.82	0.83	3.94	1.17	3.78	0.92	4.25	0.84	4.65	3.75	4.15	13.33	8.59	13.52	10.82	2.32
04/25/97	392.17	4.80	2.31	1.70	1.94	3.21	3.90	3.92	0.85	4.03	1.24	3.90	1.00	4.34	0.85	4.72	3.85	4.23	13.65	10.87	13.50	8.60	2.40
04/26/97	385.98	5.02	2.56	1.82	2.08	3.40	4.17	4.12	0.96	4.28	1.40	4.11	1.15	4.50	0.93	4.97	4.07	4.45	13.85	8.70	13.90	10.90	2.52
04/27/97	383.05	5.47	2.96	2.09	2.22	3.33	4.50	4.32	0.90	4.37	1.46	4.35	1.26	4.58	0.89	5.37	4.34	4.83	13.83	8.80	14.07	10.90	2.66
04/28/97	383.35	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
04/29/97	385.02	5.25	2.78	2.10	1.88	3.64	4.32	4.20	0.87	4.25	1.38	4.05	1.18	4.49	0.90	5.20	4.22	4.66	13.92	10.87	13.65	5.86	2.61
04/30/97	383.52	5.36	2.85	2.09	1.94	3.76	4.36	4.25	0.99	4.32	1.48	4.12	1.21	4.52	1.02	5.28	4.30	4.75	13.72	7.87	13.98	10.85	2.70

CODES:
PD= Piezometer Dry
PI=Piezometer Inaccessible

PU=Personnel Unavailable to take readings
PF=Piezometer Frozen
NA=Information not Given

TABLE 3 - ACTUAL PIEZOMETER WATER ELEVATIONS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Lake Dam, Hopkinton, New Hampshire

PIEZOMETER WATER SURFACE ELEVATION, FEET-NGVD

DATE	POOL EL	PZ-1	PZ-2	PZ-3A	PZ-3B	PZ-4A	PZ-4B	PZ-5A	PZ-5B	PZ-6A	PZ-6B	PZ-7A	PZ-7B	PZ-8A	PZ-8B	PZ-9	PZ-10	PZ-11	PZ-13A	PZ-13B	PZ-14A	PZ-14B	PZ-15
01/31/92	382.70	363.8	363.6	376.1	375.9	370.7	367.8	369.1	381.5	369.5	380.1	369.8	380.2	368.6	381.9	364.2	368.3	365.2	NA	NA	NA	NA	NA
03/03/92	382.70	364.0	363.8	375.9	375.7	370.7	367.9	369.1	381.9	369.4	380.1	369.7	380.2	368.4	381.9	364.5	368.2	381.1	NA	NA	NA	NA	NA
03/12/92	388.96	366.9	366.8	377.4	376.8	372.6	370.0	370.7	381.1	370.9	380.6	370.7	380.4	369.3	378.7	367.1	370.2	368.7	NA	NA	NA	NA	NA
03/13/92	388.73	366.9	366.7	377.7	376.7	372.8	370.2	370.7	381.7	370.8	380.5	370.7	380.7	369.4	381.8	367.1	370.2	368.6	NA	NA	NA	NA	NA
03/14/92	386.90	366.9	366.7	377.8	376.7	372.9	370.2	370.8	381.6	370.8	380.3	370.6	380.6	369.4	381.9	367.3	370.4	368.6	NA	NA	NA	NA	NA
03/15/92	384.85	365.8	365.6	377.5	376.4	372.4	369.6	370.0	381.6	370.3	380.2	370.3	380.4	369.1	381.9	366.4	369.7	367.8	NA	NA	NA	NA	NA
03/16/92	385.12	365.8	365.6	377.2	376.3	372.1	369.0	370.1	381.7	370.2	380.3	370.2	380.4	368.7	381.9	366.1	369.5	367.5	NA	NA	NA	NA	NA
03/17/92	383.50	365.8	365.5	377.1	376.2	372.0	369.1	370.0	381.6	370.1	380.2	370.2	380.3	368.9	381.9	366.2	369.4	367.5	NA	NA	NA	NA	NA
03/18/92	382.48	364.6	364.3	376.6	376.0	371.3	368.5	369.5	381.5	369.7	379.9	369.9	380.1	368.7	381.9	365.0	368.7	366.9	NA	NA	NA	NA	NA
03/19/92	382.80	363.9	363.6	376.1	375.9	370.8	368.0	369.2	381.4	369.6	380.1	369.8	380.1	368.6	381.9	364.3	368.3	365.9	NA	NA	NA	NA	NA
03/20/92	382.60	363.7	363.5	375.7	375.9	370.7	367.9	369.1	381.4	369.5	379.9	369.7	380.1	368.6	381.9	364.2	368.2	365.9	NA	NA	NA	NA	NA
04/03/92	384.20	365.3	365.4	376.9	376.7	371.8	369.1	370.0	381.7	370.3	PI	370.4	380.5	369.2	PI	365.6	369.3	367.3	NA	NA	NA	NA	NA
04/30/92	380.98	365.7	365.4	377.1	377.4	371.9	369.2	369.7	379.4	369.8	379.0	370.2	379.2	368.9	379.7	365.9	369.2	367.2	NA	NA	NA	NA	NA
06/02/92	384.96	366.3	366.5	376.6	377.8	371.7	369.4	369.6	379.8	369.9	379.0	370.2	379.0	368.6	380.0	366.1	369.3	367.2	NA	NA	NA	NA	NA
07/01/92	380.15	363.7	363.5	375.6	375.9	370.3	367.7	368.5	379.3	368.8	378.6	369.1	378.7	367.8	379.7	364.1	367.8	365.2	NA	NA	NA	NA	NA
08/04/92	380.12	363.8	363.6	375.4	376.0	370.2	367.7	368.3	379.4	368.6	378.6	368.9	378.7	367.7	379.6	364.1	367.6	365.2	NA	NA	NA	NA	NA
09/01/92	380.00	363.8	363.6	375.3	375.8	370.2	367.6	368.2	379.4	368.5	378.5	368.8	378.5	367.4	379.6	364.0	367.5	365.4	NA	NA	NA	NA	NA
09/28/92	380.57	364.7	364.5	375.7	376.1	370.7	368.1	368.6	380.0	368.8	378.9	368.9	379.0	367.6	380.0	364.9	368.1	366.2	NA	NA	NA	NA	NA
10/30/92	382.12	363.9	363.6	375.3	375.8	370.1	367.6	368.2	381.2	368.4	380.1	368.6	380.2	367.0	381.4	364.1	367.7	365.7	NA	NA	NA	NA	NA
11/30/92	384.00	366.3	366.1	377.0	377.2	372.0	369.7	370.0	381.7	370.1	380.3	370.1	380.5	368.8	381.5	366.8	369.5	367.6	NA	NA	NA	NA	NA
12/31/92	384.00	365.0	364.8	376.2	376.1	371.2	368.6	369.4	382.0	369.6	380.6	369.8	380.9	368.4	381.9	365.4	368.8	366.4	NA	NA	NA	NA	NA
01/29/93	384.00	364.3	364.1	376.6	376.2	371.3	368.6	369.3	381.9	369.6	380.4	369.8	380.8	368.4	PF	365.0	368.5	366.1	NA	NA	NA	NA	NA
03/01/93	382.10	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	NA	NA	NA	NA	NA
03/31/93	393.50	367.2	366.9	377.8	377.2	372.7	371.0	371.1	381.9	371.3	380.9	371.3	381.0	369.8	382.1	367.4	370.7	368.4	NA	NA	NA	NA	NA
04/01/93	398.30	364.6	364.4	377.4	377.8	371.9	370.1	370.6	381.9	371.3	381.2	371.7	381.4	370.2	382.0	365.1	369.4	365.9	NA	NA	NA	NA	NA
04/02/93	402.50	366.9	366.6	377.8	378.0	372.8	370.7	371.3	PF	371.8	381.5	372.1	381.8	370.5	PF	366.9	370.7	367.7	NA	NA	NA	NA	NA
04/03/93	402.90	375.4	358.8	378.4	378.0	373.5	371.2	371.6	PF	371.9	381.5	372.1	381.9	370.6	PF	367.2	371.0	368.2	NA	NA	NA	NA	NA
04/04/93	402.40	368.0	367.7	378.8	377.9	373.9	371.6	371.8	PF	371.7	381.4	372.0	381.7	370.5	PF	368.2	371.4	369.0	NA	NA	NA	NA	NA
04/05/93	401.20	368.9	368.7	379.1	377.8	374.2	372.0	371.7	PF	371.7	381.3	371.4	381.6	369.9	PF	369.1	371.7	370.2	NA	NA	NA	NA	NA
04/06/93	400.10	369.0	368.8	379.1	377.7	374.3	372.0	371.8	PF	371.7	381.3	371.5	381.5	371.3	PF	369.1	371.7	370.2	NA	NA	NA	NA	NA
04/07/93	398.00	369.3	369.0	379.3	377.6	374.5	372.1	371.9	PF	371.8	381.0	371.5	381.3	370.1	PF	369.4	371.9	380.6	NA	NA	NA	NA	NA
04/08/93	365.50	369.5	369.1	379.2	377.4	374.5	372.2	371.9	382.0	371.7	380.9	371.5	381.3	370.1	PF	369.7	371.7	371.0	NA	NA	NA	NA	NA
04/09/93	365.50	369.3	368.9	379.2	377.3	374.4	372.0	371.7	381.9	371.6	380.7	371.2	381.0	370.0	PF	369.5	371.8	371.0	NA	NA	NA	NA	NA
04/10/93	365.50	367.8	367.6	378.8	377.3	373.7	371.4	371.0	381.8	371.4	380.6	371.3	380.9	370.0	PF	367.9	371.0	369.5	NA	NA	NA	NA	NA
04/11/93	365.50	370.5	367.0	378.4	378.3	373.3	371.2	371.3	381.9	371.6	380.9	371.6	381.2	370.3	382.1	367.6	370.8	368.6	NA	NA	NA	NA	NA
04/12/93	365.50	364.5	364.3	378.5	378.2	373.0	371.2	371.2	381.9	371.8	381.2	371.9	381.4	370.7	382.0	365.8	369.8	366.7	NA	NA	NA	NA	NA
04/13/93	365.50	364.8	364.6	377.9	378.6	372.3	370.7	371.0	381.9	371.7	381.5	372.2	381.8	370.9	382.2	365.4	369.8	366.1	NA	NA	NA	NA	NA
04/14/93	365.50	372.1	367.9	378.8	378.9	374.0	371.9	372.1	382.0	372.4	381.7	372.5	381.9	371.0	382.2	368.3	368.2	371.1	NA	NA	NA	NA	NA
04/15/93	365.50	368.9	368.7	379.4	378.9	374.5	372.3	372.3	381.9	372.4	381.6	372.4	381.9	371.0	382.2	369.1	372.1	370.0	NA	NA	NA	NA	NA
04/16/93	365.50	369.1	368.9	379.7	378.9	374.7	372.6	372.4	381.9	372.4	381.5	372.3	381.8	371.0	382.1	369.3	372.2	370.4	NA	NA	NA	NA	NA
04/17/93	365.50	368.6	368.6	379.5	379.0	374.6	372.5	372.3	381.9	372.4	381.5	372.3	381.8	371.0	382.1	368.9	371.9	369.9	NA	NA	NA	NA	NA
04/18/93	365.50	368.7	368.5	379.6	379.4	374.6	372.6	372.4	382.0	372.5	381.5	372.4	381.8	371.1	381.1	368.9	372.1	369.9	NA	NA	NA	NA	NA
04/19/93	365.50	369.0	368.8	379.7	379.4	374.7	372.7	369.2	381.9	372.5	381.5	372.4	381.9	371.1	381.9	369.2	372.2	370.2	NA	NA	NA	NA	NA
04/20/93	365.50	369.2	369.0	379.9	379.1	374.9	372.9	372.5	381.8	372.5	381.4	372.3	381.8	371.0	381.9	369.4	372.3	370.6	NA	NA	NA	NA	NA
04/21/93	365.50	369.4	369.2	379.9	379.0	374.9	372.8	372.5	381.8	372.4	381.4	372.2	381.7	371.0	381.9	369.6	372.5	370.9	NA	NA	NA	NA	NA
04/22/93	365.50	369.4	369.2	379.9	378.9	374.9	372.8	372.4	381.8	372.3	381.3	372.1	381.7	370.8	381.8	369.6	372.4	371.0	NA	NA	NA	NA	NA
04/23/93	365.50	369.2	368.8	379.6	379.0	374.7	372.4	372.2	381.8	372.1	381.1	372.0	381.6	370.7	381.9	369.4	372.1	370.5	NA	NA	NA	NA	NA
04/24/93	365.50	369.1	368.8	379.3	378.8	374.6	372.2	372.0	381.8	372.0	381.0	371.8	381.5	370.5	381.9	369.2	368.7	370.1	NA	NA	NA	NA	NA
04/25/93	365.50	368.7	368.4	379.2	378.4	374.3	371.8	371.7	381.5	371.8	380.7	371.5	381.1	370.3	381.6	368.9	371.7	369.8	NA	NA	NA	NA	NA
04/26/93	365.50	368.5	368.1	378.9	377.9	374.1	371.6	371.6	381.5	371.5	380.6	371.3	381.0	370.1	381.6	368.7	371.5	369.6	NA	NA	NA	NA	NA
04/27/93	365.50	368.0	367.7	378.7	378.5	373.6	371.1	371.2	381.6	371.2	380.6	371.1	381.1	369.9	381.9	368.2	371.1	368.9	NA	NA	NA	NA	NA
04/28/93	365.50	367.5	367.4	378.5	378.4	373.4	370.9	371.1	381.5	371.2	380.5	371.1	381.0	369.9	381.8	367.7	370.9	368.5	NA	NA	NA	NA	NA
04/29/93	365.50	367.3	367.0	378.4	378.2	373.3	370.7	371.0	381.6	371.1	380.6	371.1	381.1	370.0	381.8	367.5	367.4	365.0	NA	NA	NA	NA	NA
04/30/93	365.50	367.2	367.0	378.3	378.4	373.2	370.5	370.8	381.5	371.0	380.4	371.0	380.9	369.8	381.6	367.3	370.6	368.1	NA	NA	NA	NA	NA
05/01/93	365.50	365.6	365.4	377.8	377.7	372.5	369.8	370.2	379.7	370.3	378.8	370.5	379.3	369.4	379.7	366.1	369.6	366.7	NA	NA	NA	NA	NA
05/02/93	365.50	368.9	365.3	377.5	377.6	372.2	369.6	370.1	380.1	370.5	379.2	370.6	379.6	369.6	380.2	365.9	369.6	366.6	NA	NA	NA	NA	NA
05/28/93	365.50	363.7	363.5	375.9	376.1	370.5	367.9	368.7	379.6	369.1	378.5	369.4	378.6	368.2	379.6	364.1	368.0	364.9	NA	NA	NA	NA	NA
07/01/93	365.50	363.8	363.5	375.3	375.6	370.1	367.6	368.2	379.5	368.5	378.5	368.8	378.8	367.4	379.6	364.0	367.6	365.1	NA	NA	NA	NA	NA
07/31/93	365.50	364.2	363.9	375.2	375.4	370.1	367.6	368.2	379.8	368.4	378.8	368.6	379.3	367.2	379.9	364.0	367.7	365.5	NA	NA	NA	NA	NA
09/01/93	380.19	364.0	363.8	375.0	375.2	370.0	367.5	368.0	379.7	368.2	378.7	368.4	379.0	366.9	379.8	364.2	367.5	365.5	NA	NA	NA	NA	NA
09/29/93	380.18	363.8	363.6	374.8	376.0	369.4	367.5	367.9	379.6	368.2	378.4	368.5	378.6	367.0	379.5	363.9	367.4	365.4	NA	NA	NA	NA	NA
11/02/93	383.13	364.2	364.0	375.0	376.2	370.2	367.8	368.6	381.7	368.9	380.3	369.2	380.6	367.7	381.7	364.4	367.9	365.9	NA	NA	NA	NA	NA
12/01/93	384.10	366.3	366.1	376.7	377.1	371.9	369.4	370.2	381.7	370.2	380.4	369.9	380.7	368.4	381.6	366.4	369.5	367.4	NA	NA	NA	NA	NA
12/29/93	383.50	363.7	363.5	375.9	376.5	370.6	368.0	369.3	381.5	369.6	380.2	369.7	380.5	368.4	381.5	364.3	368.2	365.4	NA	NA	NA	NA	NA
02/01/94		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 3 - ACTUAL PIEZOMETER WATER ELEVATIONS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Lake Dam, Hopkinton, New Hampshire

PIEZOMETER WATER SURFACE ELEVATION, FEET-NGVD

DATE	POOL EL	PZ-1	PZ-2	PZ-3A	PZ-3B	PZ-4A	PZ-4B	PZ-5A	PZ-5B	PZ-6A	PZ-6B	PZ-7A	PZ-7B	PZ-8A	PZ-8B	PZ-9	PZ-10	PZ-11	PZ-13A	PZ-13B	PZ-14A	PZ-14B	PZ-15
03/01/94	383.10	NA	NA	375.0	375.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
04/01/94	385.00	367.1	PI	377.8	377.9	372.9	370.8	371.2	PI	371.2	380.0	371.1	380.2	369.2	PI	367.5	370.6	367.7	372.9	386.8	372.2	381.7	PI
04/07/94	389.90	367.5	367.2	378.6	379.3	373.6	371.9	371.8	381.7	372.0	380.7	371.9	380.8	370.5	PI	367.9	371.2	368.4	374.2	387.6	373.1	382.1	377.8
04/08/94	389.80	369.1	368.6	379.1	379.3	374.3	372.5	372.3	381.7	372.2	380.6	371.9	380.8	370.6	PI	369.1	372.1	369.9	374.2	389.6	373.4	381.4	378.1
04/09/94	389.09	369.0	368.7	379.2	379.2	374.3	372.5	372.3	353.2	372.2	380.7	371.8	380.9	370.5	PI	369.2	371.9	370.0	373.9	387.4	373.2	381.8	378.2
04/10/94	385.70	368.7	368.5	379.1	379.1	374.2	372.1	372.0	381.4	371.8	380.3	371.6	380.5	370.3	PI	368.9	371.7	369.6	373.0	382.1	373.3	387.3	377.8
04/11/94	387.39	368.6	368.3	378.8	378.9	374.1	372.0	372.0	382.0	372.0	380.6	371.6	380.8	370.4	381.1	368.7	371.6	369.2	373.8	388.1	373.0	381.6	378.0
04/12/94	386.35	368.3	368.1	378.8	378.8	373.9	371.9	371.9	381.8	371.8	380.5	371.6	380.7	370.3	381.5	368.6	371.6	369.1	373.6	388.8	372.9	381.7	377.8
04/13/94	385.10	368.3	368.1	378.8	378.8	373.8	371.8	371.9	381.5	371.7	380.4	371.5	380.5	370.3	381.2	368.6	371.4	368.9	373.3	389.3	372.8	382.0	377.6
04/14/94	386.00	368.7	368.4	378.9	379.2	374.0	372.1	372.2	381.7	372.2	380.4	371.9	380.7	370.6	381.5	368.9	371.8	369.0	373.9	388.1	373.1	382.0	378.0
04/15/94	385.22	368.6	368.6	379.0	379.4	374.3	372.3	372.2	381.6	372.0	380.4	371.8	380.5	370.5	381.3	369.1	371.9	369.6	373.6	397.7	373.2	381.8	377.7
04/16/94	385.04	368.6	368.4	379.1	379.3	374.2	372.2	372.2	381.7	372.1	380.5	371.9	380.7	370.6	381.5	368.9	371.8	369.3	375.1	382.3	373.8	399.4	377.7
04/17/94	385.21	368.6	368.3	379.0	379.4	374.2	372.3	372.2	381.8	372.2	380.6	371.9	380.7	370.7	381.6	368.7	371.8	369.3	374.0	382.0	373.2	405.2	377.7
04/18/94	384.47	368.3	368.1	379.0	379.3	374.0	372.1	372.0	381.5	372.0	380.4	371.7	380.5	370.5	381.3	368.7	371.6	369.0	373.7	402.3	373.0	381.9	377.5
04/19/94	383.12	366.7	366.5	378.4	378.7	373.1	371.0	371.4	381.4	371.5	380.2	371.5	380.4	370.3	381.2	367.1	370.7	367.4	373.4	393.1	372.4	381.8	377.1
05/02/94	383.51	365.1	364.9	376.8	377.8	371.5	369.4	370.1	380.4	370.3	379.3	370.5	379.4	369.2	380.2	365.4	369.3	365.9	374.1	396.8	371.2	380.8	376.2
05/24/94	382.56	364.6	364.4	376.5	377.3	371.2	369.0	369.8	380.2	370.1	379.1	370.4	379.2	369.2	380.0	364.9	369.0	362.2	372.1	387.6	371.0	381.1	375.6
06/27/94	380.05	363.8	363.5	375.4	376.1	370.2	368.0	368.8	379.6	369.0	378.7	369.1	378.7	367.8	379.6	364.1	368.0	365.1	370.7	400.8	369.9	380.3	374.6
08/01/94	379.88	363.9	363.6	374.3	376.0	370.0	367.8	368.6	379.8	368.8	378.6	368.9	378.7	367.7	379.6	364.2	367.9	365.6	370.5	386.9	369.7	380.2	369.2
09/01/94	379.80	363.7	363.5	374.8	375.6	369.7	367.6	368.4	379.7	368.6	378.5	368.9	378.5	367.5	379.5	364.0	367.6	365.2	370.3	387.0	369.5	380.1	371.4
10/03/94	382.18	363.9	363.7	375.1	376.3	370.1	368.0	368.9	381.7	369.1	380.2	369.4	380.1	368.0	381.5	364.2	368.3	365.7	370.8	386.8	370.0	381.3	375.6
10/28/94	382.11	364.0	363.7	375.2	375.9	370.0	367.7	368.8	381.7	368.9	380.1	369.1	380.1	367.6	381.4	364.1	367.8	365.6	370.5	386.1	369.8	381.6	377.4
12/02/94	384.05	363.7	363.6	375.0	372.7	370.0	367.8	369.3	379.2	369.4	379.1	368.7	379.3	368.2	380.7	364.1	368.0	365.3	370.6	388.2	369.8	380.4	377.4
03/02/95	382.78	PI	PI	375.6	375.9	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
03/28/95	383.84	365.8	365.6	377.1	377.1	372.0	369.7	370.3	382.1	370.6	380.7	370.5	380.8	369.2	382.0	366.3	369.7	367.0	372.3	386.0	371.4	382.4	377.8
05/01/95	381.76	363.6	363.4	376.1	376.2	370.3	368.1	368.4	380.5	368.6	379.0	368.9	379.3	367.8	379.8	364.5	367.3	365.1	371.0	383.0	369.8	382.0	374.7
05/26/95	380.96	363.7	363.5	375.6	376.0	370.3	368.0	368.8	379.9	368.9	378.7	369.1	378.7	368.0	379.7	364.5	367.9	365.2	370.8	382.0	369.7	380.5	374.8
06/27/95	379.60	363.7	363.5	375.2	375.4	369.8	367.6	368.3	379.4	368.4	378.3	368.5	378.3	367.2	379.3	364.1	367.5	365.1	370.3	383.9	369.2	379.9	373.6
07/26/95	379.21	363.8	363.6	374.8	375.3	369.7	367.5	368.4	379.9	368.2	378.7	368.3	378.7	367.0	379.7	364.3	367.5	365.4	370.0	383.8	369.1	381.0	374.3
08/31/95	380.02	364.2	363.9	374.7	375.3	369.7	367.4	368.1	379.6	368.1	378.4	368.3	378.4	367.0	379.3	364.4	367.5	365.3	369.1	370.6	369.9	381.8	373.3
09/29/95	380.16	364.0	363.8	374.6	375.4	369.7	367.5	368.1	380.2	368.1	378.6	368.2	378.6	366.8	379.7	364.6	367.1	365.3	369.9	383.3	368.9	380.0	373.7
10/29/95	389.70	368.1	367.8	377.3	378.3	372.9	371.3	371.1	381.9	371.1	380.9	370.9	381.0	369.4	381.6	368.3	370.8	369.3	373.1	405.2	372.2	381.9	375.9
10/30/95	388.53	368.5	368.4	377.8	378.2	371.6	373.3	371.3	382.0	371.1	380.9	370.8	381.0	369.0	381.7	365.4	371.1	370.2	372.8	398.8	372.2	381.8	375.6
10/31/95	385.80	368.2	368.1	377.7	377.8	373.2	374.1	370.9	381.9	370.7	380.6	370.5	380.7	368.8	381.8	368.4	370.7	369.6	372.3	391.9	371.8	378.7	375.7
11/01/95	386.91	367.8	367.6	377.5	377.7	372.9	371.0	370.9	382.1	370.8	380.9	368.9	380.9	369.2	381.9	368.1	370.6	368.4	372.5	387.0	371.9	379.0	375.5
11/02/95	383.17	367.5	367.3	377.4	375.3	372.6	370.5	370.7	381.6	370.5	380.6	370.4	380.5	369.1	381.6	367.7	370.4	368.6	372.0	388.4	371.5	382.0	376.1
11/03/95	385.81	368.4	368.1	377.7	378.5	373.3	371.4	371.2	382.0	371.1	380.9	370.8	380.8	369.5	381.8	368.5	370.9	369.6	372.9	398.3	372.2	382.4	376.4
11/04/95	386.35	368.2	364.7	377.8	378.4	373.1	374.6	371.1	382.2	371.0	381.0	371.0	381.0	369.5	382.0	368.3	370.8	369.3	372.9	394.7	371.9	382.2	376.7
11/05/95	385.03	367.4	367.0	377.6	378.1	372.7	371.0	371.1	382.1	370.9	380.9	371.0	380.9	369.5	381.9	367.7	370.5	368.7	372.6	391.2	371.9	382.1	376.3
11/06/95	384.85	366.7	366.4	377.3	377.9	372.4	370.2	370.7	381.9	370.6	380.8	370.7	380.8	369.3	381.8	367.1	370.0	368.0	372.3	387.0	371.5	388.7	376.0
11/07/95	384.53	366.2	365.9	377.1	377.6	372.1	370.2	370.4	382.0	370.5	380.8	370.6	380.7	369.2	381.8	366.7	369.7	367.2	369.0	386.4	369.2	384.1	375.8
11/13/95	388.50	367.9	367.7	377.5	378.6	372.9	371.1	371.2	382.0	371.2	381.0	371.1	381.0	369.8	381.8	368.1	370.8	368.8	373.2	395.2	372.2	382.1	376.0
11/14/95	384.91	368.0	367.8	377.8	378.4	373.2	371.2	371.2	381.9	367.8	380.8	370.8	380.8	369.6	381.8	368.2	368.1	369.2	372.5	390.1	372.0	379.0	376.1
11/15/95	389.71	367.7	367.4	377.6	379.1	372.9	371.1	371.2	381.8	371.3	380.9	371.3	381.0	370.1	381.8	367.9	370.8	368.6	373.3	404.2	372.9	382.8	376.0
11/16/95	390.03	368.1	368.1	378.2	379.1	373.5	371.8	371.6	382.0	371.6	381.0	371.5	381.1	370.2	381.9	368.4	371.2	369.5	373.5	395.6	372.5	382.2	376.3
11/17/95	389.65	368.3	368.3	378.3	379.0	373.6	371.5	371.6	382.1	371.6	381.1	371.5	381.1	370.2	381.9	368.6	371.2	369.8	373.4	391.8	372.7	384.1	376.3
11/18/95	386.62	368.3	368.2	378.3	378.5	373.5	371.5	371.0	382.1	371.3	380.9	371.1	380.9	369.9	382.0	368.6	371.1	369.4	372.9	388.5	372.3	382.3	376.2
11/19/95	384.58	367.6	367.4	378.0	378.2	373.0	370.9	371.1	381.9	371.0	380.7	371.0	380.7	369.8	381.9	367.8	370.7	368.3	369.0	386.8	369.3	384.3	376.0
11/20/95	383.30	367.0	366.8	377.6	378.1	372.7	370.4	370.9	381.8	370.9	377.4	370.9	380.7	369.7	381.8	367.4	370.5	367.9	372.3	390.0	371.6	382.4	375.9
11/21/95	383.60	367.2	366.9	377.8	378.0	372.8	370.6	370.8	381.9	370.7	380.6	370.9	380.6	369.6	381.7	367.5	370.5	368.1	372.6	388.9	371.8	382.3	375.5
11/22/95	385.66	366.2	366.2	377.4	378.1	372.4	370.3	370.8	381.8	370.9	380.7	371.0	380.7	369.8	381.8	366.8	370.2	367.5	372.6	389.7	371.7	384.1	375.6
12/27/95	383.09	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
01/22/96	389.05	367.8	367.6	378.0	377.1	373.2	371.0	371.2	381.9	371.1	380.8	371.0	380.9	369.6	381.9	368.1	370.9	368.9	373.1	383.8	372.2	382.0	PF
01/23/96	388.20	368.0	367.8	378.1	377.2	373.3	371.0	371.2	381.9	371.1	380.8	370.9	380.8	369.6	381.8	368.3	370.9	368.9	372.8	384.1	372.2	382.1	376.3
01/24/96	384.67	367.7	367.4	378.1	377.1	373.2	370.8	371.2	381.4	371.0	380.4	370.8	380.5	369.5	381.8	368.0	370.9	368.6	372.4	384.9	371.9	382.1	376.4
01/25/96	390.00	367.7	367.5	377.6	377.6	373.0	370.8	371.1	382.2	371.2	381.0	371.1	381.0	369.8	382.0	368.0	370.8	368.6	373.1	394.1	372.1	381.7	376.5
01/26/96	388.85	368.6	368.8	378.4	377.7	373.7	371.6	371.5	382.0	371.5	381.0	371.1	380.9	369.7	381.9	368.9	371.4	369.6	373.2	396.5	372.5	381.6	376.8
01/27/96	386.67	368.3	368.2	378.5	377.5	373.7	371.5	371.4	381.8	371.2	380.6	371.0	380.7	369.7	381.7	368.6	371.1	369.4	372.4	382.3			376.7
01/28/96	391.02	367.8	367.1	378.5	378.5	373.6	371.6	371.7	382.0	371.8	381.0	371.7	381.0	370.4	382.0	368.1	371.2	368.9	373.8	399.8	372.9	382.0	377.0
01/29/96	393.59	367.9	367.5	378.6	378.8	373.7	372.0	371.9	382.1	372.1	381.2	371.9	381.2	370.6	382.0	368.3	371.4	369.1	373.3	397.1	372.9	381.9	377.1
01/30/96	393.86	368.7	368.4	379.2	378.9	374.3	372.5	372.3	382.2	372.3	381.3	372.1	381.4	370.8	382.1	369.0	372.0	370.2	374.3	393.7	373.3	382.6	377.1
01/31/96	391.20	368.5	368.3	379.1	378.7	374.2	372.3	372.1	382.0	371.9	381.1	371.8	381.2	370.5	381.9	368.9	371.7	370.5	373.7	390.0	372.9	382.2	376.8
02/01/96	386.03	368.2	367.9	378.8	378.0	373.7	371.5	371.4	381.8	371.2	380.6	371.1	380.7	370.0	381.7	368.6	371.2	369.7	372.7	386.6	372.3	381.9	376.4
02/02/96	383.94	367.4	367.1	378.2	377.6	373.1	370.7	371.0	381.8	371.2	380.4	370.9	380.4	369.7	381.7	367.7	370.6	368.2	372.5	385.6	371.9	382.0	376.3
02/03/96	383.50	366.5	366.1	377.9	377.5	372.6	370.3	370.8	381.7	370.9	380.3	371.0	380.3	369.8	381.6	366.9	370.2	367.4	PI	PI	PI	PI	376.1
02/04/96	384.10	368.1	364.5	377.4	377.2	371.8	371.4	370.3	PI	370.6	380.4	370.8	380.4	369.7	381.8	365.4	369.4	365.8	PI	PI	PI	PI	376.0

TABLE 3 - ACTUAL PIEZOMETER WATER ELEVATIONS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Lake Dam, Hopkinton, New Hampshire

PIEZOMETER WATER SURFACE ELEVATION, FEET-NGVD

DATE	POOL EL	PZ-1	PZ-2	PZ-3A	PZ-3B	PZ-4A	PZ-4B	PZ-5A	PZ-5B	PZ-6A	PZ-6B	PZ-7A	PZ-7B	PZ-8A	PZ-8B	PZ-9	PZ-10	PZ-11	PZ-13A	PZ-13B	PZ-14A	PZ-14B	PZ-15
02/05/96	384.56	365.7	365.4	377.3	377.1	372.0	369.7	370.3	381.9	370.5	380.4	370.7	380.4	382.1	369.6	366.2	369.6	366.5	PI	PI	PI	PI	375.8
02/06/96	383.90	364.2	364.0	376.9	376.9	371.4	369.1	369.9	PI	370.2	380.2	370.5	380.3	369.4	PI	364.9	368.9	365.4	PI	PI	PI	PI	375.4
02/08/96	384.60	364.6	364.4	376.7	376.6	371.3	368.9	369.9	PI	370.2	380.5	370.6	380.7	370.2	PI	365.2	369.0	365.7	PI	PI	PI	PI	375.4
02/28/96	383.60	367.0	367.0	378.1	376.9	373.0	370.6	371.0	382.3	371.1	380.3	371.0	380.4	369.8	382.1	367.5	370.6	368.2	372.8	384.7	372.0	382.1	375.3
03/28/96	384.30	365.7	365.5	377.2	376.9	372.0	369.6	370.3	381.8	370.5	380.5	370.5	380.5	369.3	382.0	366.1	369.6	367.0	372.4	383.9	371.4	382.0	375.1
04/17/96	395.00	363.7	363.3	377.9	379.7	372.0	371.0	371.2	370.5	371.8	381.5	372.6	381.6	370.4	381.7	364.7	369.5	365.4	374.9	402.8	372.7	384.3	375.3
04/18/96	400.10	363.8	363.5	378.0	379.9	372.1	371.1	371.2	370.6	372.2	381.5	372.6	381.6	371.4	381.8	364.8	369.6	365.5	375.1	402.9	372.8	384.4	375.4
04/20/96	401.40	369.0	369.2	379.9	379.8	375.0	373.3	373.0	382.2	373.0	381.9	372.9	382.1	371.6	382.1	369.5	372.6	370.9	375.0	389.1	374.8	382.7	377.2
04/22/96	397.10	368.7	368.8	379.9	379.1	374.6	372.8	372.4	382.0	372.4	381.4	372.2	381.5	371.1	381.9	369.2	372.1	370.7	372.6	383.5	375.1	388.4	376.9
04/23/96	395.60	368.9	368.7	379.7	379.2	374.6	372.6	372.5	382.1	372.4	381.4	372.2	381.6	371.0	382.3	369.2	372.3	370.8	373.4	382.6	373.7	391.0	377.5
04/24/96	395.60	368.6	368.2	379.5	379.5	374.4	372.5	372.2	382.3	372.2	381.3	371.8	381.6	370.8	382.3	369.0	372.0	370.6	373.2	382.7	373.5	395.7	377.4
04/25/96	389.90	368.4	368.4	378.9	378.8	373.8	371.7	371.6	378.7	371.5	380.7	371.3	380.7	370.2	381.9	368.5	371.3	370.0	372.9	392.3	372.0	382.1	377.0
04/26/96	386.40	368.2	368.1	378.9	378.6	373.9	371.4	371.4	381.8	371.2	380.5	370.9	380.4	370.0	381.7	368.4	370.9	369.7	372.8	390.4	372.4	382.3	376.8
04/27/96	386.89	367.7	367.5	378.6	378.5	373.6	371.3	371.5	382.0	371.5	380.8	371.3	380.8	370.2	381.9	368.1	371.1	368.8	372.5	382.1	373.0	388.7	377.1
04/28/96	384.23	366.8	366.5	378.1	378.1	373.1	370.8	371.1	381.9	371.1	380.6	371.0	380.6	370.0	381.8	367.2	370.6	368.0	372.6	388.1	371.9	381.8	377.0
04/29/96	383.50	366.7	366.5	378.0	377.9	372.8	370.5	370.9	381.9	370.9	380.5	370.7	380.5	369.8	381.8	367.1	370.4	367.7	372.2	387.8	371.8	382.1	376.7
04/30/96	384.30	366.7	366.4	378.0	378.3	372.8	370.5	371.0	381.9	371.1	380.6	371.0	380.6	370.0	381.8	367.1	370.4	367.7	390.7	382.6	383.9	372.6	376.9
06/04/96	380.57	363.5	363.3	376.0	376.7	370.5	368.2	369.1	379.9	369.5	378.8	369.8	378.9	368.9	379.7	364.1	368.2	364.9	NA	NA	NA	NA	NA
07/01/96	380.00	363.5	363.3	375.5	375.9	370.1	367.8	368.7	379.8	369.0	378.7	369.2	378.7	368.2	379.7	364.0	367.8	365.0	370.8	385.0	369.7	380.4	374.2
07/29/96	380.29	363.5	363.2	375.3	375.9	370.0	367.7	368.6	379.7	369.0	378.6	369.2	378.6	368.2	379.6	364.0	367.8	364.8	370.7	384.5	369.5	380.2	375.1
08/28/96	380.11	363.8	363.5	375.1	375.3	369.9	367.6	368.2	379.6	368.4	378.4	368.4	378.4	367.3	379.4	364.2	367.5	365.1	370.2	383.5	369.2	380.1	375.2
09/29/96	379.91	363.9	363.6	374.9	375.6	369.8	367.5	368.2	379.6	368.4	378.4	368.4	378.4	367.3	379.4	364.2	367.5	365.2	369.2	379.9	370.0	386.4	375.0
10/21/96	392.44	364.9	364.7	376.2	377.4	371.3	369.5	370.4	382.0	370.9	381.1	370.9	381.1	369.5	381.9	365.4	369.1	366.4	373.5	408.9	371.9	381.8	376.9
10/22/96	401.65	364.8	364.6	376.9	379.1	371.8	371.0	370.9	382.1	371.7	381.7	371.9	381.7	370.5	382.0	365.4	369.5	366.4	374.6	396.7	372.4	382.1	377.1
10/23/96	401.80	368.5	368.3	377.8	379.4	373.5	372.2	372.1	382.3	372.3	382.0	372.3	382.2	370.9	382.1	368.6	371.6	370.0	374.6	380.0	373.4	382.2	377.9
10/24/96	403.17	368.5	368.3	378.6	379.0	374.0	372.5	372.2	382.1	372.2	381.9	372.1	382.0	370.7	382.1	368.8	371.7	370.2	374.3	391.1	373.3	382.3	377.9
10/25/96	401.36	368.4	368.4	378.7	378.5	373.9	372.3	371.9	382.2	372.0	381.7	371.8	381.7	370.5	381.9	368.8	371.6	370.6	373.8	389.0	372.7	382.1	377.8
10/26/96	401.00	368.5	368.4	378.6	378.2	373.8	372.0	371.8	382.1	371.7	381.4	371.5	381.6	370.2	382.0	368.7	371.5	370.5	373.3	389.1	372.7	382.0	377.8
10/27/96	397.60	368.4	368.3	378.5	378.0	373.7	371.8	371.5	382.0	371.5	381.2	371.3	381.3	370.0	381.9	368.7	371.3	370.5	373.0	389.9	372.4	382.1	377.7
10/28/96	393.85	368.2	368.3	378.3	377.8	373.5	371.6	370.9	381.9	370.5	380.9	370.1	381.0	368.7	381.7	368.5	371.0	370.8	372.1	390.8	371.7	382.2	377.4
10/29/96	386.84	368.1	368.1	377.9	377.2	373.1	370.8	370.6	381.7	370.2	380.5	369.9	380.6	368.8	381.7	368.4	370.6	370.2	371.2	390.9	371.1	381.7	377.4
10/30/96	383.80	366.9	366.6	377.2	376.8	372.2	369.7	370.2	381.9	369.9	380.3	369.8	380.4	368.7	381.8	367.2	369.7	368.2	371.1	391.0	370.8	382.3	377.0
10/31/96	383.53	366.2	365.9	376.9	376.7	371.8	369.4	369.9	381.8	369.9	380.3	369.8	380.3	368.8	381.8	366.6	369.4	367.6	371.4	390.8	370.7	382.0	376.8
11/01/96	383.70	364.3	364.0	376.6	376.7	371.3	369.0	369.6	381.8	369.9	380.3	370.1	380.3	369.0	381.7	364.9	368.6	366.1	371.6	390.4	370.5	381.9	376.4
11/02/96	384.50	365.4	365.1	377.4	376.8	371.4	369.1	369.9	382.1	369.9	380.6	370.2	380.6	369.0	381.9	365.8	369.1	366.8	371.3	390.4	370.7	382.0	376.6
11/03/96	383.40	364.2	364.0	376.1	376.6	370.9	368.6	369.4	381.8	369.6	380.3	369.8	380.3	368.8	381.6	364.8	368.4	366.0	371.3	389.9	370.3	381.8	376.0
11/10/96	389.60	368.4	368.1	377.2	377.2	372.6	370.3	371.0	382.1	371.0	381.3	371.0	381.3	369.7	382.3	368.2	370.9	368.8	372.9	398.9	371.9	382.2	377.0
11/11/96	386.60	367.4	367.1	377.6	377.4	373.1	370.7	371.1	382.2	370.9	381.0	370.8	381.0	369.4	382.1	367.7	370.6	368.8	369.3	391.9	PI	PI	376.9
11/12/96	386.10	368.3	368.0	377.9	377.5	373.4	371.1	371.2	382.5	371.1	381.1	370.8	381.2	369.5	382.3	368.5	370.9	369.3	372.7	388.3	372.1	382.2	377.2
11/13/96	383.65	367.4	367.2	377.7	377.3	372.8	370.5	370.8	381.9	370.6	380.6	370.4	380.6	369.2	381.7	367.6	370.3	368.5	372.1	387.6	371.5	382.1	376.7
11/14/96	383.80	367.3	367.1	377.6	377.2	372.8	370.5	370.7	382.0	370.6	380.7	370.4	380.7	369.1	381.8	367.6	370.3	368.4	372.3	387.2	371.6	382.2	376.8
11/15/96	384.22	365.5	365.3	377.2	377.1	371.9	369.6	370.1	381.8	370.3	380.5	370.2	380.4	368.9	381.7	366.0	369.4	366.7	372.1	386.8	371.4	382.0	376.4
11/29/96	383.81	365.1	364.9	376.6	376.8	371.4	369.0	369.8	381.9	370.1	380.5	370.2	380.4	369.0	381.7	365.5	369.0	366.4	371.6	390.1	370.5	382.0	376.1
12/31/96	385.42	367.1	366.9	378.3	378.7	373.2	370.9	371.2	382.0	371.3	380.8	371.2	380.8	370.1	381.9	367.5	370.7	368.4	PI	PI	PI	PI	377.0
03/31/97	391.09	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
04/21/97	398.04	368.3	368.0	378.6	379.9	373.8	372.0	372.3	382.1	372.7	381.7	372.4	381.8	371.4	382.0	368.5	368.5	369.3	374.9	395.0	373.3	382.5	376.4
04/22/97	398.20	369.0	368.7	379.7	379.9	374.8	373.0	372.8	382.2	372.9	381.8	372.8	378.6	371.5	382.0	372.6	372.4	370.3	375.2	392.4	373.8	382.8	376.8
04/23/97	397.03	368.9	368.7	379.8	379.6	374.4	372.5	372.6	382.1	372.7	381.6	372.5	381.7	371.3	382.0	369.2	372.3	370.2	374.6	390.2	373.4	382.7	376.6
04/24/97	394.28	369.3	369.0	379.8	379.2	374.8	372.6	372.5	382.3	372.4	381.5	372.2	381.6	371.0	382.1	369.5	372.4	370.5	374.2	389.8	373.4	382.4	376.7
04/25/97	392.17	369.0	368.7	379.5	378.7	374.6	372.3	372.1	382.2	372.1	381.2	371.8	381.3	370.7	382.1	369.3	372.1	370.2	373.1	382.3	373.5	389.7	376.4
04/26/97	385.98	368.2	367.9	379.1	378.3	373.9	371.4	371.5	381.9	371.3	380.7	371.1	380.8	370.1	381.8	368.5	371.3	369.5	372.5	389.5	372.2	382.1	376.0
04/27/97	383.05	366.8	366.6	378.2	377.8	374.2	370.3	370.8	382.0	371.0	380.5	370.3	380.5	369.9	382.0	367.2	370.5	368.3	372.5	389.1	371.6	382.1	375.6
04/28/97	383.35	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
04/29/97	385.02	367.5	367.2	378.2	378.9	373.2	370.9	371.2	382.1	371.4	380.8	371.3	380.7	370.2	381.9	367.7	370.9	368.8	372.2	382.3	373.0	398.7	375.7
04/30/97	383.52	367.1	366.9	378.2	378.7	372.8	370.8	371.1	381.8	371.1	380.4	371.1	380.6	370.1	381.6	367.5	370.6	368.5	372.9	392.2	371.9	382.3	375.4

CODES:
PD= Piezometer Dry
PI=Piezometer Inaccessible
PU=Personnel Unavailable to take readings
PF=Piezometer Frozen
NA=Information not Given

TABLE 4 - AVERAGE WATER LEVELS FOR EACH PIEZOMETER
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

		POREWATER ELEVATION FOR NORMAL POOL, FT-NGVD									
DATE	POOL EL	PZ-1	PZ-2	PZ-3A	PZ-3B	PZ-4A	PZ-4B	PZ-5A	PZ-5B	PZ-6A	PZ-6B
31-Jan-92	382.70	363.8	363.6	376.1	375.9	370.7	367.8	369.1	381.5	369.5	380.1
03-Mar-92	382.70	364.0	363.8	375.9	375.7	370.7	367.9	369.1	381.9	369.4	380.1
03-Apr-92	384.20	365.3	365.4	376.9	376.7	371.8	369.1	370.0	381.7	370.3	PI
30-Apr-92	380.98	365.7	365.4	377.1	377.4	371.9	369.2	369.7	379.4	369.8	379.0
02-Jun-92	384.96	366.3	366.5	376.6	377.8	371.7	369.4	369.6	379.8	369.9	379.0
01-Jul-92	380.15	363.7	363.5	375.6	375.9	370.3	367.7	368.5	379.3	368.8	378.6
04-Aug-92	380.12	363.8	363.6	375.4	376.0	370.2	367.7	368.3	379.4	368.6	378.6
01-Sep-92	380.00	363.8	363.6	375.3	375.8	370.2	367.6	368.2	379.4	368.5	378.5
28-Sep-92	380.57	364.7	364.5	375.7	376.1	370.7	368.1	368.6	380.0	368.8	378.9
30-Oct-92	382.12	363.9	363.6	375.3	375.8	370.1	367.6	368.2	381.2	368.4	380.1
30-Nov-92	384.00	366.3	366.1	377.0	377.2	372.0	369.7	370.0	381.7	370.1	380.3
31-Dec-92	384.00	365.0	364.8	376.2	376.1	371.2	368.6	369.4	382.0	369.6	380.6
29-Jan-93	384.00	364.3	364.1	376.6	376.2	371.3	368.6	369.3	381.9	369.6	380.4
01-Mar-93	382.10	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
02-May-93	365.50	368.9	365.3	377.5	377.6	372.2	369.6	370.1	380.1	370.5	379.2
28-May-93	365.50	363.7	363.5	375.9	376.1	370.5	367.9	368.7	379.6	369.1	378.5
01-Jul-93	365.50	363.8	363.5	375.3	375.6	370.1	367.6	368.2	379.5	368.5	378.5
31-Jul-93	365.50	364.2	363.9	375.2	375.4	370.1	367.6	368.2	379.8	368.4	378.8
01-Sep-93	380.19	364.0	363.8	375.0	375.2	370.0	367.5	368.0	379.7	368.2	378.7
29-Sep-93	380.18	363.8	363.6	374.8	376.0	369.4	367.5	367.9	379.6	368.2	378.4
02-Nov-93	383.13	364.2	364.0	375.0	376.2	370.2	367.8	368.6	381.7	368.9	380.3
01-Dec-93	384.10	366.3	366.1	376.7	377.1	371.9	369.4	370.2	381.7	370.2	380.4
29-Dec-93	383.50	363.7	363.5	375.9	376.5	370.6	368.0	369.3	381.5	369.6	380.2
01-Feb-94	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01-Mar-94	383.10	NA	NA	375.0	375.7	NA	NA	NA	NA	NA	NA
01-Apr-94	385.00	367.1	PI	377.8	377.9	372.9	370.8	371.2	PI	371.2	380.0
02-May-94	383.51	365.1	364.9	376.8	377.8	371.5	369.4	370.1	380.4	370.3	379.3
24-May-94	382.56	364.6	364.4	376.5	377.3	371.2	369.0	369.8	380.2	370.1	379.1
27-Jun-94	380.05	363.8	363.5	375.4	376.1	370.2	368.0	368.8	379.6	369.0	378.7
01-Aug-94	379.88	363.9	363.6	374.3	376.0	370.0	367.8	368.6	379.8	368.8	378.6
01-Sep-94	379.80	363.7	363.5	374.8	375.6	369.7	367.6	368.4	379.7	368.6	378.5
03-Oct-94	382.18	363.9	363.7	375.1	376.3	370.1	368.0	368.9	381.7	369.1	380.2
28-Oct-94	382.11	364.0	363.7	375.2	375.9	370.0	367.7	368.8	381.7	368.9	380.1
02-Dec-94	384.05	363.7	363.6	375.0	372.7	370.0	367.8	369.3	379.2	369.4	379.1
02-Mar-95	382.78	PI	PI	375.6	375.9	PI	PI	PI	PI	PI	PI
28-Mar-95	383.84	365.8	365.6	377.1	377.1	372.0	369.7	370.3	382.1	370.6	380.7
01-May-95	381.76	363.6	363.4	376.1	376.2	370.3	368.1	368.4	380.5	368.6	379.0
26-May-95	380.96	363.7	363.5	375.6	376.0	370.3	368.0	368.8	379.9	368.9	378.7
27-Jun-95	379.60	363.7	363.5	375.2	375.4	369.8	367.6	368.3	379.4	368.4	378.3
26-Jul-95	379.21	363.8	363.6	374.8	375.3	369.7	367.5	368.4	379.9	368.2	378.7
31-Aug-95	380.02	364.2	363.9	374.7	375.3	369.7	367.4	368.1	379.6	368.1	378.4
29-Sep-95	380.16	364.0	363.8	374.6	375.4	369.7	367.5	368.1	380.2	368.1	378.6
07-Nov-95	384.53	366.2	365.9	377.1	377.6	372.1	370.2	370.4	382.0	370.5	380.8
22-Nov-95	385.66	366.2	366.2	377.4	378.1	372.4	370.3	370.8	381.8	370.9	380.7
27-Dec-95	383.09	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
08-Feb-96	384.60	364.6	364.4	376.7	376.6	371.3	368.9	369.9	PI	370.2	380.5
28-Feb-96	383.60	367.0	367.0	378.1	376.9	373.0	370.6	371.0	382.3	371.1	380.3
28-Mar-96	384.30	365.7	365.5	377.2	376.9	372.0	369.6	370.3	381.8	370.5	380.5
30-Apr-96	384.30	366.7	366.4	378.0	378.3	372.8	370.5	371.0	381.9	371.1	380.6
04-Jun-96	380.57	363.5	363.3	376.0	376.7	370.5	368.2	369.1	379.9	369.5	378.8
01-Jul-96	380.00	363.5	363.3	375.5	375.9	370.1	367.8	368.7	379.8	369.0	378.7
29-Jul-96	380.29	363.5	363.2	375.3	375.9	370.0	367.7	368.6	379.7	369.0	378.6
28-Aug-96	380.11	363.8	363.5	375.1	375.3	369.9	367.6	368.2	379.6	368.4	378.4
29-Sep-96	379.91	363.9	363.6	374.9	375.6	369.8	367.5	368.2	379.6	368.4	378.4
03-Nov-96	383.40	364.2	364.0	376.1	376.6	370.9	368.6	369.4	381.8	369.6	380.3
29-Nov-96	383.81	365.1	364.9	376.6	376.8	371.4	369.0	369.8	381.9	370.1	380.5
31-Dec-96	385.42	367.1	366.9	378.3	378.7	373.2	370.9	371.2	382.0	371.3	380.8
31-Mar-97	391.09	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
30-Apr-97	383.52	367.1	366.9	378.2	378.7	372.8	370.8	371.1	381.8	371.1	380.4
Average Water level:	381.28	364.71	364.40	376.02	376.38	370.89	368.54	369.23	380.62	369.43	379.46

CODES:
PD= Piezometer Dry
PI=Piezometer Inaccessible
PU=Personnel Unavailable to take readings
PF=Piezometer Frozen
NA=Information not Given

TABLE 4 - AVERAGE WATER LEVELS FOR EACH PIEZOMETER
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

POREWATER ELEVATION FOR NORMAL POOL, FT-NGVD

DATE	POOL EL	PZ-7A	PZ-7B	PZ-8A	PZ-8B	PZ-9	PZ-10	PZ-11	PZ-13A	PZ-13B	PZ-14A
31-Jan-92	382.70	369.8	380.2	368.6	381.9	364.2	368.3	365.2	NA	NA	NA
03-Mar-92	382.70	369.7	380.2	368.4	381.9	364.5	368.2	381.1	NA	NA	NA
03-Apr-92	384.20	370.4	380.5	369.2	PI	365.6	369.3	367.3	NA	NA	NA
30-Apr-92	380.98	370.2	379.2	368.9	379.7	365.9	369.2	367.2	NA	NA	NA
02-Jun-92	384.96	370.2	379.0	368.6	380.0	366.1	369.3	367.2	NA	NA	NA
01-Jul-92	380.15	369.1	378.7	367.8	379.7	364.1	367.8	365.2	NA	NA	NA
04-Aug-92	380.12	368.9	378.7	367.7	379.6	364.1	367.6	365.2	NA	NA	NA
01-Sep-92	380.00	368.8	378.5	367.4	379.6	364.0	367.5	365.4	NA	NA	NA
28-Sep-92	380.57	368.9	379.0	367.6	380.0	364.9	368.1	366.2	NA	NA	NA
30-Oct-92	382.12	368.6	380.2	367.0	381.4	364.1	367.7	365.7	NA	NA	NA
30-Nov-92	384.00	370.1	380.5	368.8	381.5	366.8	369.5	367.6	NA	NA	NA
31-Dec-92	384.00	369.8	380.9	368.4	381.9	365.4	368.8	366.4	NA	NA	NA
29-Jan-93	384.00	369.8	380.8	368.4	PF	365.0	368.5	366.1	NA	NA	NA
01-Mar-93	382.10	PI	PI	PI	PI	PI	PI	PI	NA	NA	NA
02-May-93	365.50	370.6	379.6	369.6	380.2	365.9	369.6	366.6	NA	NA	NA
28-May-93	365.50	369.4	378.6	368.2	379.6	364.1	368.0	364.9	NA	NA	NA
01-Jul-93	365.50	368.8	378.8	367.4	379.6	364.0	367.6	365.1	NA	NA	NA
31-Jul-93	365.50	368.6	379.3	367.2	379.9	364.0	367.7	365.5	NA	NA	NA
01-Sep-93	380.19	368.4	379.0	366.9	379.8	364.2	367.5	365.5	NA	NA	NA
29-Sep-93	380.18	368.5	378.6	367.0	379.5	363.9	367.4	365.4	NA	NA	NA
02-Nov-93	383.13	369.2	380.6	367.7	381.7	364.4	367.9	365.9	NA	NA	NA
01-Dec-93	384.10	369.9	380.7	368.4	381.6	366.4	369.5	367.4	NA	NA	NA
29-Dec-93	383.50	369.7	380.5	368.4	381.5	364.3	368.2	365.4	NA	NA	NA
01-Feb-94	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01-Mar-94	383.10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01-Apr-94	385.00	371.1	380.2	369.2	PI	367.5	370.6	367.7	372.9	386.8	372.2
02-May-94	383.51	370.5	379.4	369.2	380.2	365.4	369.3	365.9	374.1	396.8	371.2
24-May-94	382.56	370.4	379.2	369.2	380.0	364.9	369.0	362.2	372.1	387.6	371.0
27-Jun-94	380.05	369.1	378.7	367.8	379.6	364.1	368.0	365.1	370.7	400.8	369.9
01-Aug-94	379.88	368.9	378.7	367.7	379.6	364.2	367.9	365.6	370.5	386.9	369.7
01-Sep-94	379.80	368.9	378.5	367.5	379.5	364.0	367.6	365.2	370.3	387.0	369.5
03-Oct-94	382.18	369.4	380.1	368.0	381.5	364.2	368.3	365.7	370.8	386.8	370.0
28-Oct-94	382.11	369.1	380.1	367.6	381.4	364.1	367.8	365.6	370.5	386.1	369.8
02-Dec-94	384.05	368.7	379.3	368.2	380.7	364.1	368.0	365.3	370.6	388.2	369.8
02-Mar-95	382.78	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
28-Mar-95	383.84	370.5	380.8	369.2	382.0	366.3	369.7	367.0	372.3	386.0	371.4
01-May-95	381.76	368.9	379.3	367.8	379.8	364.5	367.3	365.1	371.0	383.0	369.8
26-May-95	380.96	369.1	378.7	368.0	379.7	364.5	367.9	365.2	370.8	382.0	369.7
27-Jun-95	379.60	368.5	378.3	367.2	379.3	364.1	367.5	365.1	370.3	383.9	369.2
26-Jul-95	379.21	368.3	378.7	367.0	379.7	364.3	367.5	365.4	370.0	383.8	369.1
31-Aug-95	380.02	368.3	378.4	367.0	379.3	364.4	367.5	365.3	369.1	370.6	369.9
29-Sep-95	380.16	368.2	378.6	366.8	379.7	364.6	367.1	365.3	369.9	383.3	368.9
07-Nov-95	384.53	370.6	380.7	369.2	381.8	366.7	369.7	367.2	369.0	386.4	369.2
22-Nov-95	385.66	371.0	380.7	369.8	381.8	366.8	370.2	367.5	372.6	389.7	371.7
27-Dec-95	383.09	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
08-Feb-96	384.60	370.6	380.7	370.2	PI	365.2	369.0	365.7	PI	PI	PI
28-Feb-96	383.60	371.0	380.4	369.8	382.1	367.5	370.6	368.2	372.8	384.7	372.0
28-Mar-96	384.30	370.5	380.5	369.3	382.0	366.1	369.6	367.0	372.4	383.9	371.4
30-Apr-96	384.30	371.0	380.6	370.0	381.8	367.1	370.4	367.7	390.7	382.6	383.9
04-Jun-96	380.57	369.8	378.9	368.9	379.7	364.1	368.2	364.9	NA	NA	NA
01-Jul-96	380.00	369.2	378.7	368.2	379.7	364.0	367.8	365.0	370.8	385.0	369.7
29-Jul-96	380.29	369.2	378.6	368.2	379.6	364.0	367.8	364.8	370.7	384.5	369.5
28-Aug-96	380.11	368.4	378.4	367.3	379.4	364.2	367.5	365.1	370.2	383.5	369.2
29-Sep-96	379.91	368.4	378.4	367.3	379.4	364.2	367.5	365.2	369.2	379.9	370.0
03-Nov-96	383.40	369.8	380.3	368.8	381.6	364.8	368.4	366.0	371.3	389.9	370.3
29-Nov-96	383.81	370.2	380.4	369.0	381.7	365.5	369.0	366.4	371.6	390.1	370.5
31-Dec-96	385.42	371.2	380.8	370.1	381.9	367.5	370.7	368.4	PI	PI	PI
31-Mar-97	391.09	PI	PI	PI	PI	PI	PI	PI	PI	PI	PI
30-Apr-97	383.52	371.1	380.6	370.1	381.6	367.5	370.6	368.5	372.9	392.2	371.9
Average Water level:	381.28	369.57	379.58	368.33	380.54	365.03	368.52	366.27	371.78	386.15	370.73

CODES:
PD= Piezometer Dry
PI=Piezometer Inaccessible
PU=Personnel Unavailable to take readings
PF=Piezometer Frozen
NA=Information not Given

TABLE 4 - AVERAGE WATER LEVELS FOR EACH PIEZOMETER
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

POREWATER ELEVATION FOR NORMAL POOL, FT-NGVD

DATE	POOL EL	PZ-14B	PZ-15
31-Jan-92	382.70	NA	NA
03-Mar-92	382.70	NA	NA
03-Apr-92	384.20	NA	NA
30-Apr-92	380.98	NA	NA
02-Jun-92	384.96	NA	NA
01-Jul-92	380.15	NA	NA
04-Aug-92	380.12	NA	NA
01-Sep-92	380.00	NA	NA
28-Sep-92	380.57	NA	NA
30-Oct-92	382.12	NA	NA
30-Nov-92	384.00	NA	NA
31-Dec-92	384.00	NA	NA
29-Jan-93	384.00	NA	NA
01-Mar-93	382.10	NA	NA
02-May-93	365.50	NA	NA
28-May-93	365.50	NA	NA
01-Jul-93	365.50	NA	NA
31-Jul-93	365.50	NA	NA
01-Sep-93	380.19	NA	NA
29-Sep-93	380.18	NA	NA
02-Nov-93	383.13	NA	NA
01-Dec-93	384.10	NA	NA
29-Dec-93	383.50	NA	NA
01-Feb-94	NA	NA	NA
01-Mar-94	383.10	NA	NA
01-Apr-94	385.00	381.7	PI
02-May-94	383.51	380.8	376.2
24-May-94	382.56	381.1	375.6
27-Jun-94	380.05	380.3	374.6
01-Aug-94	379.88	380.2	369.2
01-Sep-94	379.80	380.1	371.4
03-Oct-94	382.18	381.3	375.6
28-Oct-94	382.11	381.6	377.4
02-Dec-94	384.05	380.4	377.4
02-Mar-95	382.78	PI	PI
28-Mar-95	383.84	382.4	377.8
01-May-95	381.76	382.0	374.7
26-May-95	380.96	380.5	374.8
27-Jun-95	379.60	379.9	373.6
26-Jul-95	379.21	381.0	374.3
31-Aug-95	380.02	381.8	373.3
29-Sep-95	380.16	380.0	373.7
07-Nov-95	384.53	384.1	375.8
22-Nov-95	385.66	384.1	375.6
27-Dec-95	383.09	PI	PI
08-Feb-96	384.60	PI	375.4
28-Feb-96	383.60	382.1	375.3
28-Mar-96	384.30	382.0	375.1
30-Apr-96	384.30	372.6	376.9
04-Jun-96	380.57	NA	NA
01-Jul-96	380.00	380.4	374.2
29-Jul-96	380.29	380.2	375.1
28-Aug-96	380.11	380.1	375.2
29-Sep-96	379.91	386.4	375.0
03-Nov-96	383.40	381.8	376.0
29-Nov-96	383.81	382.0	376.1
31-Dec-96	385.42	PI	377.0
31-Mar-97	391.09	PI	PI
30-Apr-97	383.52	382.3	375.4
Average Water level	381.28	381.19	375.10

CODES:
PD= Piezometer Dry
PI=Piezometer Inaccessible
PU=Personnel Unavailable to take readings
PF=Piezometer Frozen
NA=Information not Given

TABLE 5 - RELIEF WELL DEPTH READINGS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

		DEPTH READINGS, METERS							
DATE	POOL EL	RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	RW-7	RW-8
01/31/92	382.70	4.80	1.10	1.34	1.32	1.36	1.24	1.04	1.22
03/03/92	383.00	4.78	1.08	1.30	1.33	1.29	1.22	1.10	1.21
03/12/92	388.96	4.22	1.80	1.57	1.35	1.55	1.97	1.28	1.32
03/13/92	388.73	4.15	1.30	PI	PI	PI	PI	PI	PI
03/14/92	386.90	4.09	PI	PI	PI	PI	PI	PI	PI
03/15/92	384.85	4.21	PI	PI	PI	PI	PI	PI	PI
03/16/92	385.12	4.37	PI	PI	PI	PI	PI	PI	PI
03/17/92	383.50	4.42	PI	PI	PI	PI	PI	PI	PI
03/18/92	382.48	4.58	PI	PI	PI	PI	PI	PI	PI
03/19/92	382.80	4.80	PI	PI	PI	PI	PI	PI	PI
03/20/92	382.60	4.81	PI	PI	PI	PI	PI	PI	PI
04/03/92	384.20	4.50	1.50	1.95	1.90	2.00	1.46	1.25	1.90
04/30/92	380.98	4.42	1.93	2.20	2.09	2.14	2.07	1.86	2.12
06/02/92	384.96	4.52	2.00	2.30	2.25	2.30	2.30	2.10	2.30
07/01/92	380.15	4.90	1.98	2.22	2.12	2.19	2.13	1.91	2.13
08/04/92	380.12	4.93	1.99	2.23	2.15	2.20	2.12	1.92	2.15
09/01/92	380.00	4.95	2.00	2.25	2.15	2.20	2.15	1.95	2.18
09/28/92	380.57	4.77	1.83	2.10	2.00	2.04	1.98	1.77	2.00
10/30/92	382.12	4.93	1.40	1.64	1.56	1.61	1.54	1.37	1.56
11/30/92	384.00	4.43	1.40	1.62	1.54	1.59	1.53	1.32	1.54
12/31/92	384.00	4.68	PF	PF	PF	PF	PF	PF	PF
01/29/93	384.00	4.63	PF	PF	PF	PF		PF	PF
03/01/93	382.10	PI	PI	PI	PI	PI	PI	PI	PI
03/31/93	393.50	4.12	PF	PF	PF	PF	PF	PF	PF
04/01/93	398.30	4.47	PF	PF	PF	PF	PF	PF	PF
04/02/93	402.50	4.24	PF	PF	PF	PF	PF	PF	PF
04/03/93	402.90	3.99	PF	PF	PF	PF	PF	PF	PF
04/04/93	402.40	3.84	PF	PF	PF	PF	PF	PF	PF
04/05/93	401.20	3.72	PF	PF	PF	PF	PF	PF	PF
04/06/93	400.10	3.68	PF	PF	PF	PF	PF	PF	PF
04/07/93	398.00	3.63	PF	PF	PF	PF	PF	PF	PF
04/08/93	365.50	3.61	PF	PF	PF	PF	PF	PF	PF
04/09/93	365.50	3.62	PF	PF	PF	PF	PF	PF	PF
04/10/93	365.50	3.84	PF	PF	PF	PF	PF	PF	PF
04/11/93	365.50	4.01	1.75	1.60	2.04	1.55	1.50	1.25	1.85
04/12/93	365.50	4.01	1.80	2.10	1.97	2.02	2.02	1.30	1.90
04/13/93	365.50	4.32	1.90	2.15	2.05	2.10	2.05	1.25	1.85
04/14/93	365.50	4.50	1.29	1.91	1.87	1.89	1.99	1.24	1.79
04/15/93	365.50	3.65	1.31	1.74	1.80	1.51	1.93	1.24	1.80
04/16/93	365.50	3.56	1.30	1.71	1.76	1.51	1.80	1.25	1.55
04/17/93	365.50	3.64	1.30	1.79	1.81	1.50	1.90	1.25	1.50
04/18/93	365.50	3.60	1.29	1.67	1.45	1.50	1.85	1.24	1.44
04/19/93	365.50	3.56	1.31	1.55	1.46	1.50	1.89	1.24	1.45
04/20/93	365.50	3.51	1.30	1.55	1.46	1.51	1.80	1.25	1.47
04/21/93	365.50	3.50	1.31	1.56	1.47	1.52	1.80	1.25	1.48
04/22/93	365.50	3.48	1.32	1.57	1.48	1.54	1.80	1.27	1.49
04/23/93	365.50	3.57	1.30	1.55	1.45	1.50	1.75	1.23	1.44
04/24/93	365.50	3.60	1.31	1.55	1.47	1.51	1.44	1.25	1.45

TABLE 5 - RELIEF WELL DEPTH READINGS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

		DEPTH READINGS, METERS							
DATE	POOL EL	RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	RW-7	RW-8
04/25/93	365.50	3.69	1.39	1.64	1.54	1.60	1.52	1.33	1.56
04/26/93	365.50	3.73	1.38	1.62	1.53	1.59	1.52	1.31	1.44
04/27/93	365.50	3.89	1.30	1.55	1.46	1.51	1.44	1.23	1.45
04/28/93	365.50	3.96	1.33	1.58	1.50	1.53	1.47	1.26	1.48
04/29/93	365.50	4.00	1.31	1.56	1.46	1.51	1.44	1.23	1.45
04/30/93	365.50	4.03	1.39	1.63	1.54	1.60	1.53	1.32	1.53
05/01/93	365.50	4.19	1.97	2.20	2.12	2.17	2.11	1.90	2.10
05/02/93	365.50	4.34	1.83	2.08	1.98	2.03	1.97	1.76	1.98
05/28/93	365.50	4.85	1.98	2.23	2.14	2.19	2.12	1.92	2.14
07/01/93	365.50	4.94	1.98	2.22	2.13	2.18	2.12	1.91	2.13
07/31/93	365.50	4.94	1.87	2.11	2.02	2.07	2.01	1.80	2.02
09/01/93	380.19	5.00	1.91	2.15	2.07	2.11	2.05	1.85	2.07
09/29/93	380.18	5.15	1.98	2.22	2.14	2.20	2.10	1.93	2.14
11/02/93	383.13	4.95	1.30	1.55	1.46	1.51	1.45	1.25	1.46
12/01/93	384.10	4.42	1.35	1.60	1.52	1.57	1.50	1.30	1.50
12/29/93	383.50	4.82	PI	PI	PI	PI	PI	PI	PI
02/01/94	NA	NA	NA	NA	NA	NA	NA	NA	NA
03/01/94	383.10	NA	NA	NA	NA	NA	NA	NA	NA
04/01/94	385.00	4.36	PI	PI	PI	PI	PI	PI	PI
04/07/94	389.90	4.16	1.42	2.13	2.06	2.06	2.00	1.60	2.00
04/08/94	389.80	3.91	1.42	2.15	2.00	2.04	1.91	1.53	1.91
04/09/94	389.09	3.87	1.40	2.10	2.00	2.00	1.93	1.30	1.90
04/10/94	385.70	3.95	1.50	2.04	2.05	2.08	2.00	1.50	1.82
04/11/94	387.39	4.00	1.40	2.00	2.00	2.15	2.00	1.50	1.95
04/12/94	386.35	4.02	1.40	2.04	1.94	2.02	2.00	1.30	1.82
04/13/94	385.10	4.05	1.50	2.05	2.05	2.05	1.95	1.41	1.95
04/14/94	386.00	4.00	1.40	2.15	2.00	2.10	1.90	1.32	1.85
04/15/94	385.22	3.93	2.10	1.40	1.60	2.10	2.00	2.20	1.45
04/16/94	385.04	3.95	1.41	1.65	1.56	1.61	1.55	1.34	1.55
04/17/94	385.21	3.95	1.39	1.63	1.54	1.60	1.54	1.32	1.54
04/18/94	384.47	4.00	1.46	1.70	1.61	1.66	1.60	1.39	1.60
04/19/94	383.12	4.31	1.49	1.72	1.64	1.69	1.63	1.42	1.63
05/02/94	383.51	4.80	1.80	2.05	1.96	2.01	1.95	1.74	1.96
05/24/94	382.56	4.94	1.96	2.09	2.00	2.05	2.00	1.79	2.00
06/27/94	380.05	5.23	1.97	2.21	2.13	2.17	2.11	1.91	2.13
08/01/94	379.88	5.29	1.99	2.22	2.15	2.18	2.13	1.92	2.17
09/01/94	379.80	5.35	2.00	2.25	2.15	2.20	2.15	1.95	2.16
10/03/94	382.18	5.28	1.40	1.65	1.55	1.60	1.55	1.33	1.56
10/28/94	382.11	NA	NA	NA	NA	NA	NA	NA	NA
12/02/94	384.05	NA	NA	NA	NA	NA	NA	NA	NA
03/02/95	382.78	NA	NA	NA	NA	NA	NA	NA	NA
03/28/95	383.84	NA	NA	NA	NA	NA	NA	NA	NA
05/01/95	381.76	NA	NA	NA	NA	NA	NA	NA	NA
05/26/95	380.96	NA	NA	NA	NA	NA	NA	NA	NA
06/27/95	379.60	NA	NA	NA	NA	NA	NA	NA	NA
07/26/95	379.21	NA	NA	NA	NA	NA	NA	NA	NA
08/31/95	380.02	NA	NA	NA	NA	NA	NA	NA	NA
09/29/95	380.16	NA	NA	NA	NA	NA	NA	NA	NA
10/29/95	389.70	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 5 - RELIEF WELL DEPTH READINGS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

		DEPTH READINGS, METERS							
DATE	POOL EL	RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	RW-7	RW-8
10/30/95	388.53	NA	NA	NA	NA	NA	NA	NA	NA
10/31/95	385.80	NA	NA	NA	NA	NA	NA	NA	NA
11/01/95	386.91	NA	NA	NA	NA	NA	NA	NA	NA
11/02/95	383.17	NA	NA	NA	NA	NA	NA	NA	NA
11/03/95	385.81	NA	NA	NA	NA	NA	NA	NA	NA
11/04/95	386.35	NA	NA	NA	NA	NA	NA	NA	NA
11/05/95	385.03	NA	NA	NA	NA	NA	NA	NA	NA
11/06/95	384.85	NA	NA	NA	NA	NA	NA	NA	NA
11/07/95	384.53	NA	NA	NA	NA	NA	NA	NA	NA
11/13/95	388.50	NA	NA	NA	NA	NA	NA	NA	NA
11/14/95	384.91	NA	NA	NA	NA	NA	NA	NA	NA
11/15/95	389.71	NA	NA	NA	NA	NA	NA	NA	NA
11/16/95	390.03	NA	NA	NA	NA	NA	NA	NA	NA
11/17/95	389.65	NA	NA	NA	NA	NA	NA	NA	NA
11/18/95	386.62	NA	NA	NA	NA	NA	NA	NA	NA
11/19/95	384.58	NA	NA	NA	NA	NA	NA	NA	NA
11/20/95	383.30	NA	NA	NA	NA	NA	NA	NA	NA
11/21/95	383.60	NA	NA	NA	NA	NA	NA	NA	NA
11/22/95	385.66	NA	NA	NA	NA	NA	NA	NA	NA
12/27/95	383.09	NA	NA	NA	NA	NA	NA	NA	NA
01/22/96	389.05	NA	NA	NA	NA	NA	NA	NA	NA
01/23/96	388.20	NA	NA	NA	NA	NA	NA	NA	NA
01/24/96	384.67	NA	NA	NA	NA	NA	NA	NA	NA
01/25/96	390.00	NA	NA	NA	NA	NA	NA	NA	NA
01/26/96	388.85	NA	NA	NA	NA	NA	NA	NA	NA
01/27/96	386.67	NA	NA	NA	NA	NA	NA	NA	NA
01/28/96	391.02	NA	NA	NA	NA	NA	NA	NA	NA
01/29/96	393.59	NA	NA	NA	NA	NA	NA	NA	NA
01/30/96	393.86	NA	NA	NA	NA	NA	NA	NA	NA
01/31/96	391.20	NA	NA	NA	NA	NA	NA	NA	NA
02/01/96	386.03	NA	NA	NA	NA	NA	NA	NA	NA
02/02/96	383.94	NA	NA	NA	NA	NA	NA	NA	NA
02/03/96	383.50	NA	NA	NA	NA	NA	NA	NA	NA
02/04/96	384.10	NA	NA	NA	NA	NA	NA	NA	NA
02/05/96	384.56	NA	NA	NA	NA	NA	NA	NA	NA
02/06/96	383.90	NA	NA	NA	NA	NA	NA	NA	NA
02/08/96	384.60	NA	NA	NA	NA	NA	NA	NA	NA
02/28/96	383.60	NA	NA	NA	NA	NA	NA	NA	NA
03/28/96	384.30	NA	NA	NA	NA	NA	NA	NA	NA
04/17/96	395.00	NA	NA	NA	NA	NA	NA	NA	NA
04/18/96	400.10	NA	NA	NA	NA	NA	NA	NA	NA
04/20/96	401.40	NA	NA	NA	NA	NA	NA	NA	NA
04/22/96	397.10	NA	NA	NA	NA	NA	NA	NA	NA
04/23/96	395.60	NA	NA	NA	NA	NA	NA	NA	NA
04/24/96	395.60	NA	NA	NA	NA	NA	NA	NA	NA
04/25/96	389.90	NA	NA	NA	NA	NA	NA	NA	NA
04/26/96	386.40	NA	NA	NA	NA	NA	NA	NA	NA
04/27/96	386.89	NA	NA	NA	NA	NA	NA	NA	NA
04/28/96	384.23	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 5 - RELIEF WELL DEPTH READINGS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

		DEPTH READINGS, METERS							
DATE	POOL EL	RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	RW-7	RW-8
04/29/96	383.50	NA	NA	NA	NA	NA	NA	NA	NA
04/30/96	384.30	NA	NA	NA	NA	NA	NA	NA	NA
06/04/96	380.57	NA	NA	NA	NA	NA	NA	NA	NA
07/01/96	380.00	NA	NA	NA	NA	NA	NA	NA	NA
07/29/96	380.29	NA	NA	NA	NA	NA	NA	NA	NA
08/28/96	380.11	NA	NA	NA	NA	NA	NA	NA	NA
09/29/96	379.91	NA	NA	NA	NA	NA	NA	NA	NA
10/21/96	392.44	NA	NA	NA	NA	NA	NA	NA	NA
10/22/96	401.65	4.72	1.25	1.50	1.42	1.46	1.40	1.18	1.41
10/23/96	401.80	4.22	1.22	1.47	1.39	1.44	1.37	1.16	1.37
10/24/96	403.17	4.00	1.25	1.47	1.40	1.43	1.37	1.15	1.40
10/25/96	401.36	4.00	1.25	1.50	1.40	1.45	1.38	1.20	1.40
10/26/96	401.00	4.00	1.27	1.51	1.40	1.45	1.40	1.20	1.41
10/27/96	397.60	4.05	NA	NA	NA	NA	NA	NA	NA
10/28/96	393.85	4.10	1.33	1.57	1.49	1.53	1.47	1.37	1.43
10/29/96	386.84	4.23	1.29	1.53	1.46	1.50	1.45	1.43	1.45
10/30/96	383.80	4.52	1.30	1.55	1.46	1.51	1.45	1.23	1.45
10/31/96	383.53	4.54	1.31	1.56	1.47	1.52	1.47	1.24	1.46
11/01/96	383.70	4.83	1.30	1.52	1.46	1.52	1.45	1.23	1.43
11/02/96	384.50	4.80	1.27	1.57	1.42	1.48	1.41	1.20	1.41
11/03/96	383.40	4.96	1.36	1.61	1.51	1.57	1.51	1.30	1.51
11/10/96	389.60	4.51	1.14	1.38	1.30	1.34	1.27	1.06	1.27
11/11/96	386.60	4.25	1.16	1.42	1.33	1.38	1.32	1.12	1.32
11/12/96	386.10	4.17	1.15	1.38	1.30	1.35	1.28	1.10	1.30
11/13/96	383.65	4.35	1.20	1.57	1.38	1.41	1.38	1.15	1.37
11/14/96	383.80	4.36	1.27	1.48	1.42	1.47	1.40	1.20	1.42
11/15/96	384.22	4.40	1.30	1.48	1.45	1.48	1.42	1.25	1.46
11/29/96	383.81	4.82	NA	NA	NA	NA	NA	NA	NA
12/31/96	385.42	NA	NA	NA	NA	NA	NA	NA	NA
03/31/97	391.09	NA	NA	NA	NA	NA	NA	NA	NA
04/21/97	398.04	NA	NA	NA	NA	NA	NA	NA	NA
04/22/97	398.20	NA	NA	NA	NA	NA	NA	NA	NA
04/23/97	397.03	NA	NA	NA	NA	NA	NA	NA	NA
04/24/97	394.28	NA	NA	NA	NA	NA	NA	NA	NA
04/25/97	392.17	NA	NA	NA	NA	NA	NA	NA	NA
04/26/97	385.98	NA	NA	NA	NA	NA	NA	NA	NA
04/27/97	383.05	NA	NA	NA	NA	NA	NA	NA	NA
04/28/97	383.35	NA	NA	NA	NA	NA	NA	NA	NA
04/29/97	385.02	NA	NA	NA	NA	NA	NA	NA	NA
04/30/97	383.52	NA	NA	NA	NA	NA	NA	NA	NA

CODES:
PD= Piezometer Dry
PI=Piezometer Inaccessible
PF=Piezometer Frozen
NA=Information not Given

TABLE 6 - ACTUAL RELIEF WELL WATER ELEVATIONS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

		RELIEF WELL WATER SURFACE ELEVATION, FEET-NGVD							
DATE	POOL EL	RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	RW-7	RW-8
01/31/92	382.70	370.9	382.8	382.8	382.6	382.1	382.8	382.9	383.1
03/03/92	382.70	370.9	382.9	382.9	382.5	382.4	382.9	382.7	383.1
03/12/92	388.96	372.8	380.5	382.0	382.5	381.5	380.4	382.1	382.8
03/13/92	388.73	373.0	382.1	PI	PI	PI	PI	PI	PI
03/14/92	386.90	373.2	PI	PI	PI	PI	PI	PI	PI
03/15/92	384.85	372.8	PI	PI	PI	PI	PI	PI	PI
03/16/92	385.12	372.3	PI	PI	PI	PI	PI	PI	PI
03/17/92	383.50	372.1	PI	PI	PI	PI	PI	PI	PI
03/18/92	382.48	371.6	PI	PI	PI	PI	PI	PI	PI
03/19/92	382.80	370.9	PI	PI	PI	PI	PI	PI	PI
03/20/92	382.60	370.8	PI	PI	PI	PI	PI	PI	PI
04/03/92	384.20	371.8	381.5	380.8	380.7	380.0	382.1	382.2	380.9
04/30/92	380.98	372.1	380.1	380.0	380.0	379.6	380.1	380.2	380.1
06/02/92	384.96	371.8	379.8	379.7	379.5	379.1	379.4	379.4	379.6
07/01/92	380.15	370.5	379.9	379.9	379.9	379.4	379.9	380.0	380.1
08/04/92	380.12	370.4	379.9	379.9	379.8	379.4	379.9	380.0	380.0
09/01/92	380.00	370.4	379.8	379.8	379.8	379.4	379.8	379.9	379.9
09/28/92	380.57	370.9	380.4	380.3	380.3	379.9	380.4	380.5	380.5
10/30/92	382.12	370.4	381.8	381.8	381.8	381.3	381.8	381.8	382.0
11/30/92	384.00	372.1	381.8	381.9	381.8	381.4	381.9	382.0	382.0
12/31/92	384.00	371.2	PF	PF	PF	PF	PF	PF	PF
01/29/93	384.00	371.4	PF	PF	PF	PF	386.9	PF	PF
03/01/93	382.10	PI	PI	PI	PI	PI	PI	PI	PI
03/31/93	393.50	373.1	PF	PF	PF	PF	PF	PF	PF
04/01/93	398.30	371.9	PF	PF	PF	PF	PF	PF	PF
04/02/93	402.50	372.7	PF	PF	PF	PF	PF	PF	PF
04/03/93	402.90	373.5	PF	PF	PF	PF	PF	PF	PF
04/04/93	402.40	374.0	PF	PF	PF	PF	PF	PF	PF
04/05/93	401.20	374.4	PF	PF	PF	PF	PF	PF	PF
04/06/93	400.10	374.5	PF	PF	PF	PF	PF	PF	PF
04/07/93	398.00	374.7	PF	PF	PF	PF	PF	PF	PF
04/08/93	365.50	374.8	PF	PF	PF	PF	PF	PF	PF
04/09/93	365.50	374.7	PF	PF	PF	PF	PF	PF	PF
04/10/93	365.50	374.0	PF	PF	PF	PF	PF	PF	PF
04/11/93	365.50	373.4	380.7	382.0	380.2	381.5	382.0	382.2	381.0
04/12/93	365.50	373.4	380.5	380.3	380.4	380.0	380.3	382.0	380.9
04/13/93	365.50	372.4	380.2	380.1	380.2	379.7	380.2	382.2	381.0
04/14/93	365.50	371.8	382.2	380.9	380.8	380.4	380.4	382.2	381.2
04/15/93	365.50	374.6	382.1	381.5	381.0	381.6	380.6	382.2	381.2
04/16/93	365.50	374.9	382.1	381.6	381.1	381.6	381.0	382.2	382.0
04/17/93	365.50	374.7	382.1	381.3	381.0	381.7	380.7	382.2	382.2
04/18/93	365.50	374.8	382.2	381.7	382.1	381.7	380.8	382.2	382.4
04/19/93	365.50	374.9	382.1	382.1	382.1	381.7	380.7	382.2	382.3
04/20/93	365.50	375.1	382.1	382.1	382.1	381.6	381.0	382.2	382.3
04/21/93	365.50	375.1	382.1	382.1	382.1	381.6	381.0	382.2	382.2
04/22/93	365.50	375.2	382.1	382.0	382.0	381.5	381.0	382.1	382.2
04/23/93	365.50	374.9	382.1	382.1	382.1	381.7	381.2	382.3	382.4

TABLE 6 - ACTUAL RELIEF WELL WATER ELEVATIONS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

		RELIEF WELL WATER SURFACE ELEVATION, FEET-NGVD							
DATE	POOL EL	RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	RW-7	RW-8
04/24/93	365.50	374.8	382.1	382.1	382.1	381.6	382.2	382.2	382.3
04/25/93	365.50	374.5	381.8	381.8	381.8	381.4	381.9	381.9	382.0
04/26/93	365.50	374.4	381.9	381.9	381.9	381.4	381.9	382.0	382.4
04/27/93	365.50	373.8	382.1	382.1	382.1	381.6	382.2	382.3	382.3
04/28/93	365.50	373.6	382.0	382.0	382.0	381.6	382.1	382.2	382.2
04/29/93	365.50	373.5	382.1	382.1	382.1	381.6	382.2	382.3	382.3
04/30/93	365.50	373.4	381.8	381.9	381.8	381.4	381.9	382.0	382.1
05/01/93	365.50	372.9	379.9	380.0	379.9	379.5	380.0	380.1	380.2
05/02/93	365.50	372.4	380.4	380.4	380.4	379.9	380.4	380.5	380.6
05/28/93	365.50	370.7	379.9	379.9	379.9	379.4	379.9	380.0	380.1
07/01/93	365.50	370.4	379.9	379.9	379.9	379.4	379.9	380.0	380.1
07/31/93	365.50	370.4	380.3	380.3	380.3	379.8	380.3	380.4	380.5
09/01/93	380.19	370.2	380.1	380.1	380.1	379.7	380.2	380.2	380.3
09/29/93	380.18	369.7	379.9	379.9	379.9	379.4	380.0	380.0	380.1
11/02/93	383.13	370.4	382.1	382.1	382.1	381.6	382.1	382.2	382.3
12/01/93	384.10	372.1	382.0	382.0	381.9	381.4	382.0	382.0	382.2
12/29/93	383.50	370.8	PI	PI	PI	PI	PI	PI	PI
02/01/94		NA	NA	NA	NA	NA	NA	NA	NA
03/01/94	383.10	NA	NA	NA	NA	NA	NA	NA	NA
04/01/94	385.00	372.3	PI	PI	PI	PI	PI	PI	PI
04/07/94	389.90	373.0	381.7	380.2	380.1	379.8	380.3	381.1	380.5
04/08/94	389.80	373.8	381.7	380.1	380.3	379.9	380.6	381.3	380.8
04/09/94	389.09	373.9	381.8	380.3	380.3	380.0	380.6	382.0	380.9
04/10/94	385.70	373.6	381.5	380.5	380.2	379.8	380.3	381.4	381.1
04/11/94	387.39	373.5	381.8	380.6	380.3	379.5	380.3	381.4	380.7
04/12/94	386.35	373.4	381.8	380.5	380.5	380.0	380.3	382.0	381.1
04/13/94	385.10	373.3	381.5	380.5	380.2	379.9	380.5	381.7	380.7
04/14/94	386.00	373.5	381.8	380.1	380.3	379.7	380.7	382.0	381.0
04/15/94	385.22	373.7	379.5	382.6	381.7	379.7	380.3	379.1	382.3
04/16/94	385.04	373.6	381.8	381.8	381.8	381.3	381.8	381.9	382.0
04/17/94	385.21	373.6	381.8	381.9	381.8	381.4	381.8	382.0	382.0
04/18/94	384.47	373.5	381.6	381.6	381.6	381.2	381.7	381.7	381.9
04/19/94	383.12	372.5	381.5	381.6	381.5	381.1	381.6	381.6	381.8
05/02/94	383.51	370.9	380.5	380.5	380.5	380.0	380.5	380.6	380.7
05/24/94	382.56	370.4	380.0	380.3	380.3	379.9	380.3	380.4	380.5
06/27/94	380.05	369.4	379.9	379.9	379.9	379.5	380.0	380.0	380.1
08/01/94	379.88	369.2	379.9	379.9	379.8	379.4	379.9	380.0	380.0
09/01/94	379.80	369.0	379.8	379.8	379.8	379.4	379.8	379.9	380.0
10/03/94	382.18	369.3	381.8	381.8	381.8	381.4	381.8	381.9	382.0
10/28/94	382.11	NA	NA	NA	NA	NA	NA	NA	NA
12/02/94	384.05	NA	NA	NA	NA	NA	NA	NA	NA
03/02/95	382.78	NA	NA	NA	NA	NA	NA	NA	NA
03/28/95	383.84	NA	NA	NA	NA	NA	NA	NA	NA
05/01/95	381.76	NA	NA	NA	NA	NA	NA	NA	NA
05/26/95	380.96	NA	NA	NA	NA	NA	NA	NA	NA
06/27/95	379.60	NA	NA	NA	NA	NA	NA	NA	NA
07/26/95	379.21	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 6 - ACTUAL RELIEF WELL WATER ELEVATIONS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

DATE	POOL EL	RELIEF WELL WATER SURFACE ELEVATION, FEET-NGVD							
		RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	RW-7	RW-8
08/31/95	380.02	NA	NA	NA	NA	NA	NA	NA	NA
09/29/95	380.16	NA	NA	NA	NA	NA	NA	NA	NA
10/29/95	389.70	NA	NA	NA	NA	NA	NA	NA	NA
10/30/95	388.53	NA	NA	NA	NA	NA	NA	NA	NA
10/31/95	385.80	NA	NA	NA	NA	NA	NA	NA	NA
11/01/95	386.91	NA	NA	NA	NA	NA	NA	NA	NA
11/02/95	383.17	NA	NA	NA	NA	NA	NA	NA	NA
11/03/95	385.81	NA	NA	NA	NA	NA	NA	NA	NA
11/04/95	386.35	NA	NA	NA	NA	NA	NA	NA	NA
11/05/95	385.03	NA	NA	NA	NA	NA	NA	NA	NA
11/06/95	384.85	NA	NA	NA	NA	NA	NA	NA	NA
11/07/95	384.53	NA	NA	NA	NA	NA	NA	NA	NA
11/13/95	388.50	NA	NA	NA	NA	NA	NA	NA	NA
11/14/95	384.91	NA	NA	NA	NA	NA	NA	NA	NA
11/15/95	389.71	NA	NA	NA	NA	NA	NA	NA	NA
11/16/95	390.03	NA	NA	NA	NA	NA	NA	NA	NA
11/17/95	389.65	NA	NA	NA	NA	NA	NA	NA	NA
11/18/95	386.62	NA	NA	NA	NA	NA	NA	NA	NA
11/19/95	384.58	NA	NA	NA	NA	NA	NA	NA	NA
11/20/95	383.30	NA	NA	NA	NA	NA	NA	NA	NA
11/21/95	383.60	NA	NA	NA	NA	NA	NA	NA	NA
11/22/95	385.66	NA	NA	NA	NA	NA	NA	NA	NA
12/27/95	383.09	NA	NA	NA	NA	NA	NA	NA	NA
01/22/96	389.05	NA	NA	NA	NA	NA	NA	NA	NA
01/23/96	388.20	NA	NA	NA	NA	NA	NA	NA	NA
01/24/96	384.67	NA	NA	NA	NA	NA	NA	NA	NA
01/25/96	390.00	NA	NA	NA	NA	NA	NA	NA	NA
01/26/96	388.85	NA	NA	NA	NA	NA	NA	NA	NA
01/27/96	386.67	NA	NA	NA	NA	NA	NA	NA	NA
01/28/96	391.02	NA	NA	NA	NA	NA	NA	NA	NA
01/29/96	393.59	NA	NA	NA	NA	NA	NA	NA	NA
01/30/96	393.86	NA	NA	NA	NA	NA	NA	NA	NA
01/31/96	391.20	NA	NA	NA	NA	NA	NA	NA	NA
02/01/96	386.03	NA	NA	NA	NA	NA	NA	NA	NA
02/02/96	383.94	NA	NA	NA	NA	NA	NA	NA	NA
02/03/96	383.50	NA	NA	NA	NA	NA	NA	NA	NA
02/04/96	384.10	NA	NA	NA	NA	NA	NA	NA	NA
02/05/96	384.56	NA	NA	NA	NA	NA	NA	NA	NA
02/06/96	383.90	NA	NA	NA	NA	NA	NA	NA	NA
02/08/96	384.60	NA	NA	NA	NA	NA	NA	NA	NA
02/28/96	383.60	NA	NA	NA	NA	NA	NA	NA	NA
03/28/96	384.30	NA	NA	NA	NA	NA	NA	NA	NA
04/17/96	395.00	NA	NA	NA	NA	NA	NA	NA	NA
04/18/96	400.10	NA	NA	NA	NA	NA	NA	NA	NA
04/20/96	401.40	NA	NA	NA	NA	NA	NA	NA	NA
04/22/96	397.10	NA	NA	NA	NA	NA	NA	NA	NA
04/23/96	395.60	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 6 - ACTUAL RELIEF WELL WATER ELEVATIONS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
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		RELIEF WELL WATER SURFACE ELEVATION, FEET-NGVD							
DATE	POOL EL	RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	RW-7	RW-8
04/24/96	395.60	NA	NA	NA	NA	NA	NA	NA	NA
04/25/96	389.90	NA	NA	NA	NA	NA	NA	NA	NA
04/26/96	386.40	NA	NA	NA	NA	NA	NA	NA	NA
04/27/96	386.89	NA	NA	NA	NA	NA	NA	NA	NA
04/28/96	384.23	NA	NA	NA	NA	NA	NA	NA	NA
04/29/96	383.50	NA	NA	NA	NA	NA	NA	NA	NA
04/30/96	384.30	NA	NA	NA	NA	NA	NA	NA	NA
06/04/96	380.57	NA	NA	NA	NA	NA	NA	NA	NA
07/01/96	380.00	NA	NA	NA	NA	NA	NA	NA	NA
07/29/96	380.29	NA	NA	NA	NA	NA	NA	NA	NA
08/28/96	380.11	NA	NA	NA	NA	NA	NA	NA	NA
09/29/96	379.91	NA	NA	NA	NA	NA	NA	NA	NA
10/21/96	392.44	NA	NA	NA	NA	NA	NA	NA	NA
10/22/96	401.65	371.1	382.3	382.3	382.2	381.8	382.3	382.4	382.5
10/23/96	401.80	372.8	382.4	382.4	382.3	381.9	382.4	382.5	382.6
10/24/96	403.17	373.5	382.3	382.4	382.3	381.9	382.4	382.5	382.5
10/25/96	401.36	373.5	382.3	382.3	382.3	381.8	382.4	382.4	382.5
10/26/96	401.00	373.5	382.2	382.2	382.3	381.8	382.3	382.4	382.5
10/27/96	397.60	373.3	NA	NA	NA	NA	NA	NA	NA
10/28/96	393.85	373.1	382.0	382.0	382.0	381.6	382.1	381.8	382.4
10/29/96	386.84	372.7	382.2	382.2	382.1	381.7	382.1	381.6	382.3
10/30/96	383.80	371.8	382.1	382.1	382.1	381.6	382.1	382.3	382.3
10/31/96	383.53	371.7	382.1	382.1	382.1	381.6	382.1	382.2	382.3
11/01/96	383.70	370.8	382.1	382.2	382.1	381.6	382.1	382.3	382.4
11/02/96	384.50	370.9	382.2	382.0	382.2	381.7	382.3	382.4	382.5
11/03/96	383.40	370.3	381.9	381.9	381.9	381.4	381.9	382.0	382.1
11/10/96	389.60	371.8	382.7	382.7	382.6	382.2	382.7	382.8	382.9
11/11/96	386.60	372.7	382.6	382.5	382.5	382.1	382.6	382.6	382.8
11/12/96	386.10	372.9	382.6	382.7	382.6	382.2	382.7	382.7	382.8
11/13/96	383.65	372.3	382.5	382.0	382.4	382.0	382.4	382.5	382.6
11/14/96	383.80	372.3	382.2	382.3	382.2	381.8	382.3	382.4	382.4
11/15/96	384.22	372.2	382.1	382.3	382.1	381.7	382.2	382.2	382.3
11/29/96	383.81	370.8	NA	NA	NA	NA	NA	NA	NA
12/31/96	385.42	NA	NA	NA	NA	NA	NA	NA	NA
03/31/97	391.09	NA	NA	NA	NA	NA	NA	NA	NA
04/21/97	398.04	NA	NA	NA	NA	NA	NA	NA	NA
04/22/97	398.20	NA	NA	NA	NA	NA	NA	NA	NA
04/23/97	397.03	NA	NA	NA	NA	NA	NA	NA	NA
04/24/97	394.28	NA	NA	NA	NA	NA	NA	NA	NA
04/25/97	392.17	NA	NA	NA	NA	NA	NA	NA	NA
04/26/97	385.98	NA	NA	NA	NA	NA	NA	NA	NA
04/27/97	383.05	NA	NA	NA	NA	NA	NA	NA	NA
04/28/97	383.35	NA	NA	NA	NA	NA	NA	NA	NA
04/29/97	385.02	NA	NA	NA	NA	NA	NA	NA	NA
04/30/97	383.52	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 6 - ACTUAL RELIEF WELL WATER ELEVATIONS FROM JANUARY 1992 TO APRIL 1997
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

		RELIEF WELL WATER SURFACE ELEVATION, FEET-NGVD							
DATE	POOL EL	RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	RW-7	RW-8

CODES:

PD= Piezometer Dry
PI=Piezometer Inaccessible

PF=Piezometer Frozen
NA=Information not Given

TABLE 7 - AVERAGE WATER LEVELS FOR EACH RELIEF WELL
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

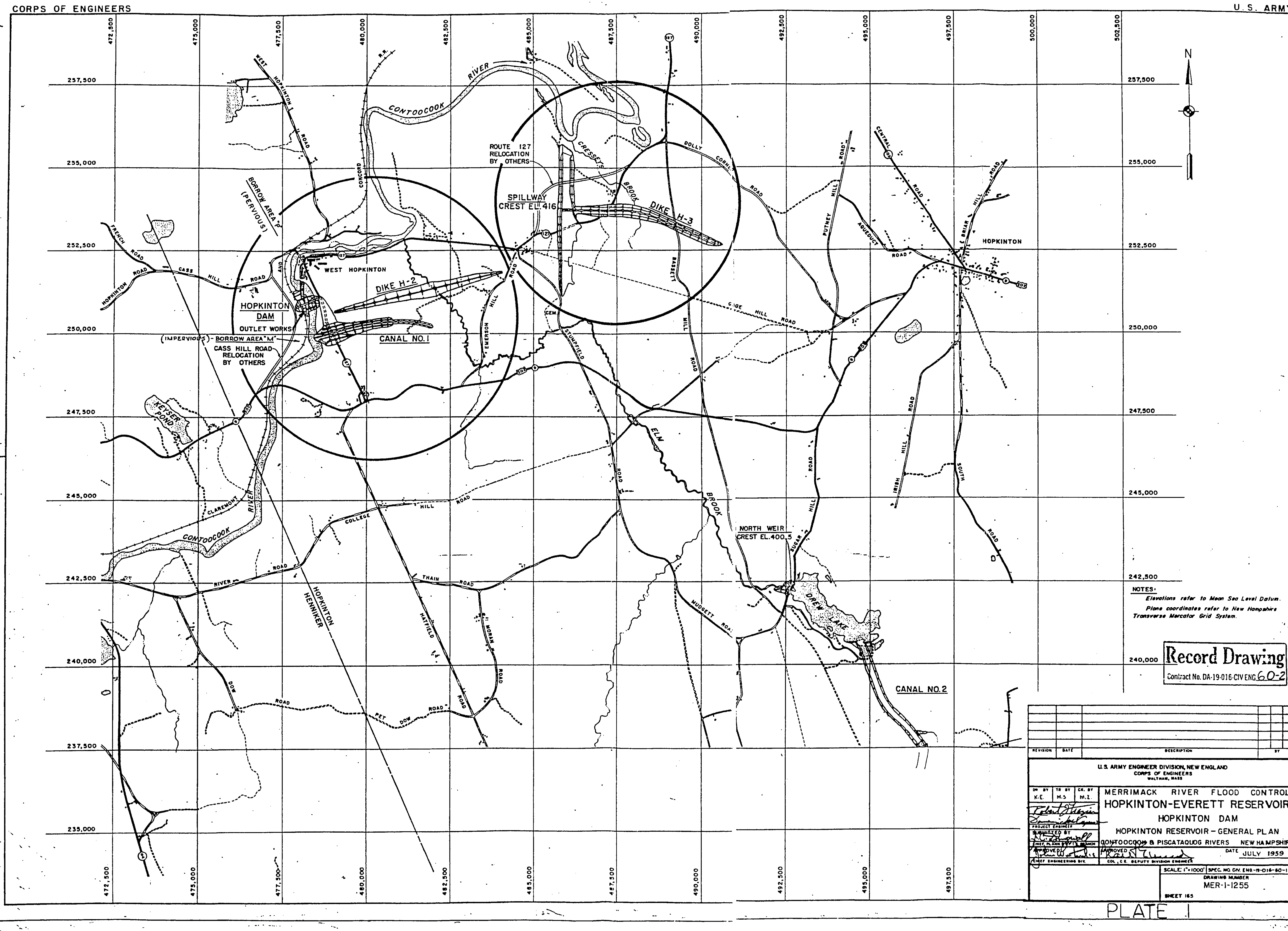
		POREWATER ELEVATION FOR NORMAL POOL, FT-NGVD							
DATE	POOL EL	RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	RW-7	RW-8
31-Jan-92	382.70	370.9	382.8	382.8	382.6	382.1	382.8	382.9	383.1
03-Mar-92	382.70	370.9	382.9	382.9	382.5	382.4	382.9	382.7	383.1
03-Apr-92	384.20	371.8	381.5	380.8	380.7	380.0	382.1	382.2	380.9
30-Apr-92	380.98	372.1	380.1	380.0	380.0	379.6	380.1	380.2	380.1
02-Jun-92	384.96	371.8	379.8	379.7	379.5	379.1	379.4	379.4	379.6
01-Jul-92	380.15	370.5	379.9	379.9	379.9	379.4	379.9	380.0	380.1
04-Aug-92	380.12	370.4	379.9	379.9	379.8	379.4	379.9	380.0	380.0
01-Sep-92	380.00	370.4	379.8	379.8	379.8	379.4	379.8	379.9	379.9
28-Sep-92	380.57	370.9	380.4	380.3	380.3	379.9	380.4	380.5	380.5
30-Oct-92	382.12	370.4	381.8	381.8	381.8	381.3	381.8	381.8	382.0
30-Nov-92	384.00	372.1	381.8	381.9	381.8	381.4	381.9	382.0	382.0
31-Dec-92	384.00	371.2	PF	PF	PF	PF	PF	PF	PF
29-Jan-93	384.00	371.4	PF	PF	PF	PF	386.9	PF	PF
01-Mar-93	382.10	PI	PI	PI	PI	PI	PI	PI	PI
02-May-93	365.50	372.4	380.4	380.4	380.4	379.9	380.4	380.5	380.6
28-May-93	365.50	370.7	379.9	379.9	379.9	379.4	379.9	380.0	380.1
01-Jul-93	365.50	370.4	379.9	379.9	379.9	379.4	379.9	380.0	380.1
31-Jul-93	365.50	370.4	380.3	380.3	380.3	379.8	380.3	380.4	380.5
01-Sep-93	380.19	370.2	380.1	380.1	380.1	379.7	380.2	380.2	380.3
29-Sep-93	380.18	369.7	379.9	379.9	379.9	379.4	380.0	380.0	380.1
02-Nov-93	383.13	370.4	382.1	382.1	382.1	381.6	382.1	382.2	382.3
01-Dec-93	384.10	372.1	382.0	382.0	381.9	381.4	382.0	382.0	382.2
29-Dec-93	383.50	370.8	PI	PI	PI	PI	PI	PI	PI
01-Feb-94	NA	NA	NA	NA	NA	NA	NA	NA	NA
01-Mar-94	383.10	NA	NA	NA	NA	NA	NA	NA	NA
01-Apr-94	385.00	372.3	PI	PI	PI	PI	PI	PI	PI
02-May-94	383.51	370.9	380.5	380.5	380.5	380.0	380.5	380.6	380.7
24-May-94	382.56	370.4	380.0	380.3	380.3	379.9	380.3	380.4	380.5
27-Jun-94	380.05	369.4	379.9	379.9	379.9	379.5	380.0	380.0	380.1
01-Aug-94	379.88	369.2	379.9	379.9	379.8	379.4	379.9	380.0	380.0
01-Sep-94	379.80	369.0	379.8	379.8	379.8	379.4	379.8	379.9	380.0
03-Oct-94	382.18	369.3	381.8	381.8	381.8	381.4	381.8	381.9	382.0
28-Oct-94	382.11	NA	NA	NA	NA	NA	NA	NA	NA
02-Dec-94	384.05	NA	NA	NA	NA	NA	NA	NA	NA
02-Mar-95	382.78	NA	NA	NA	NA	NA	NA	NA	NA
28-Mar-95	383.84	NA	NA	NA	NA	NA	NA	NA	NA
01-May-95	381.76	NA	NA	NA	NA	NA	NA	NA	NA
26-May-95	380.96	NA	NA	NA	NA	NA	NA	NA	NA
27-Jun-95	379.60	NA	NA	NA	NA	NA	NA	NA	NA
26-Jul-95	379.21	NA	NA	NA	NA	NA	NA	NA	NA
31-Aug-95	380.02	NA	NA	NA	NA	NA	NA	NA	NA
29-Sep-95	380.16	NA	NA	NA	NA	NA	NA	NA	NA
07-Nov-95	384.53	NA	NA	NA	NA	NA	NA	NA	NA
22-Nov-95	385.66	NA	NA	NA	NA	NA	NA	NA	NA
27-Dec-95	383.09	NA	NA	NA	NA	NA	NA	NA	NA
08-Feb-96	384.60	NA	NA	NA	NA	NA	NA	NA	NA
28-Feb-96	383.60	NA	NA	NA	NA	NA	NA	NA	NA
28-Mar-96	384.30	NA	NA	NA	NA	NA	NA	NA	NA
30-Apr-96	384.30	NA	NA	NA	NA	NA	NA	NA	NA
04-Jun-96	380.57	NA	NA	NA	NA	NA	NA	NA	NA
01-Jul-96	380.00	NA	NA	NA	NA	NA	NA	NA	NA
29-Jul-96	380.29	NA	NA	NA	NA	NA	NA	NA	NA
28-Aug-96	380.11	NA	NA	NA	NA	NA	NA	NA	NA
29-Sep-96	379.91	NA	NA	NA	NA	NA	NA	NA	NA
03-Nov-96	383.40	370.3	381.9	381.9	381.9	381.4	381.9	382.0	382.1
29-Nov-96	383.81	370.8	NA	NA	NA	NA	NA	NA	NA
31-Dec-96	385.42	NA	NA	NA	NA	NA	NA	NA	NA
31-Mar-97	391.09	NA	NA	NA	NA	NA	NA	NA	NA
30-Apr-97	383.52	NA	NA	NA	NA	NA	NA	NA	NA
Average Water level	381.28	370.76	380.74	380.71	380.68	380.22	381.01	380.84	380.89

CODES:
PD= Piezometer Dry
PI=Piezometer Inaccessible
PU=Personnel Unavailable to take readings
PF=Piezometer Frozen
NA=Information not Given

TABLE 8 - PREDICTED PIEZOMETER AND RELIEF WELL WATER ELEVATIONS
Instrumentation Appendix Report
Hopkinton Dam, Hopkinton, New Hampshire

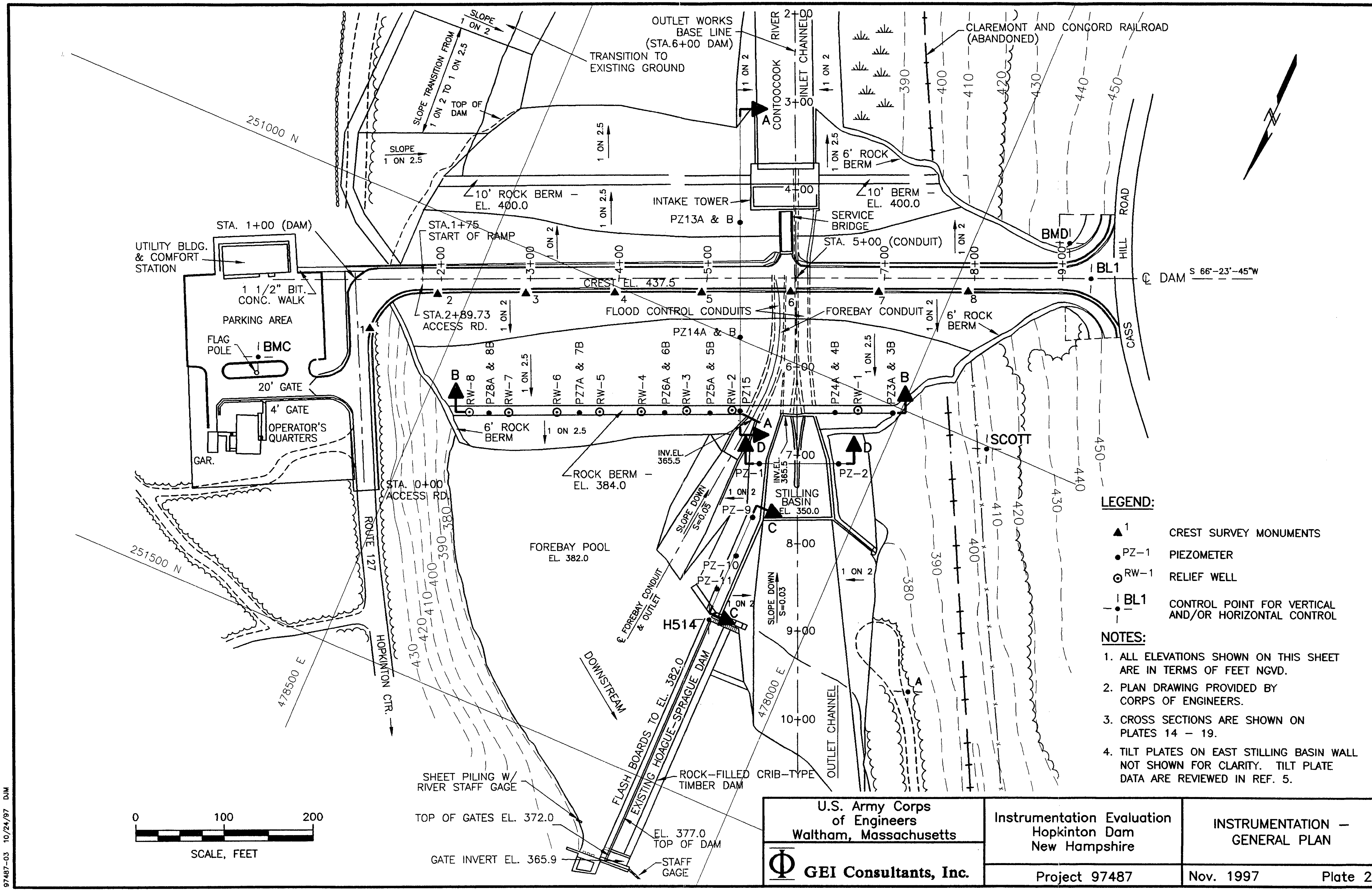
Piezometer	Projected Piezometer Elevation for Reservoir at El. 416
PZ-1	369.4
PZ-2	369.3
PZ-3A	379.2
PZ-3B	379.7
PZ-4A	374.7
PZ-4B	373.3
PZ-5A	372.8
PZ-5B	382.5
PZ-6A	373.0
PZ-6B	382.9
PZ-7A	372.9
PZ-7B	382.9
PZ-8A	372.1
PZ-8B	382.4
PZ-9	369.4
PZ-10	372.6
PZ-11	370.8
PZ-13A	375.3
PZ-13B	NP
PZ-14A	374.2
PZ-14B	382.6
PZ-15	378.1
RW-1	373.8
RW-2	382.4
RW-3	382.6
RW-4	382.6
RW-5	382.2
RW-6	382.7
RW-7	382.6
RW-8	382.7

NOTE
NP = Not predicted due to scatter in data.



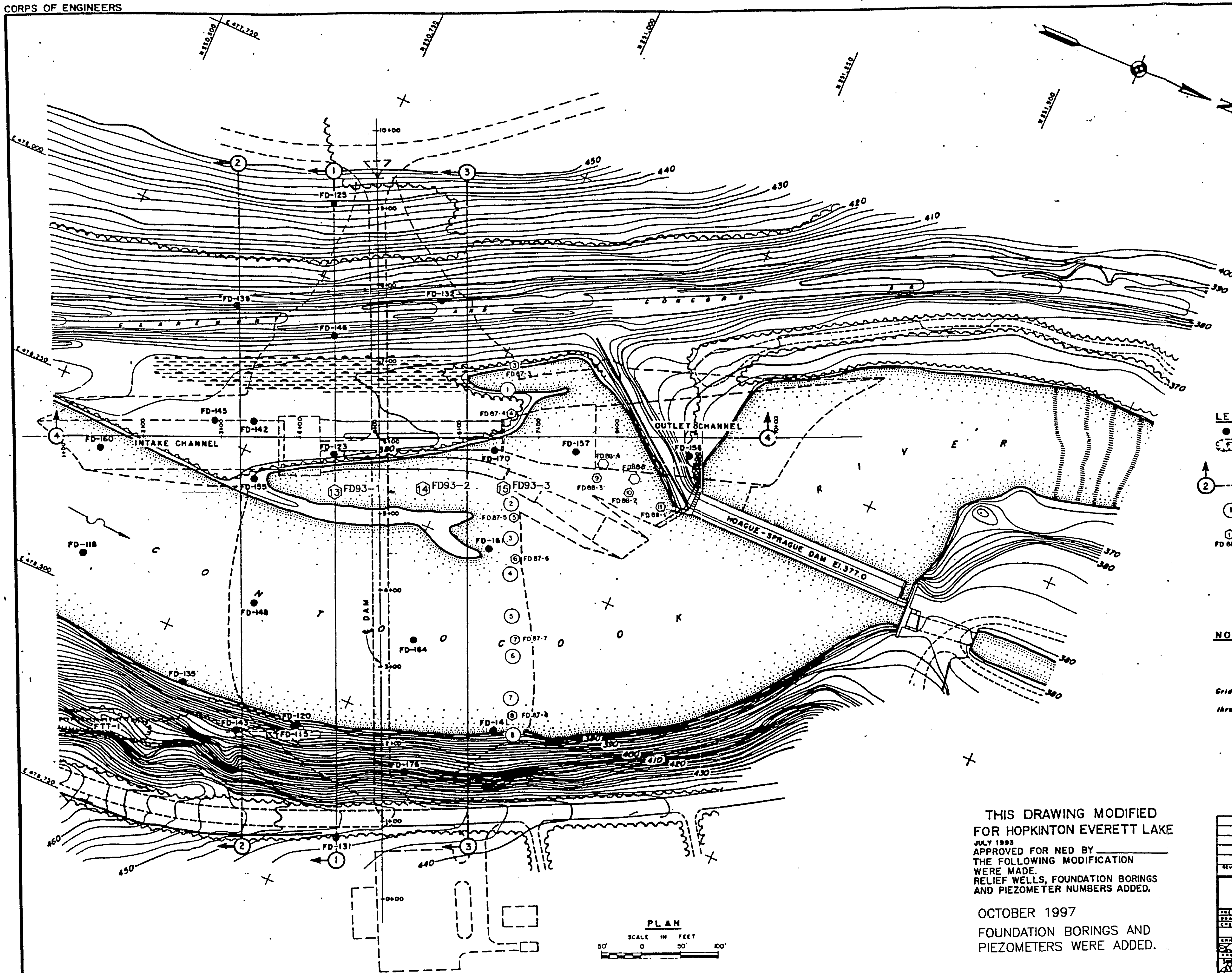
CORPS OF ENGINEERS
U.S. ARMY
N
CONTOOCOOK RIVER
ROUTE 127 RELOCATION BY OTHERS
SPILLWAY CREST EL. 416
DIKE H-3
CRESSEY'S BROOK
DOLLY CORNER ROAD
BORROW AREA "P" (PERVIOUS)
WEST HOPKINTON
DIKE H-2
HOPKINTON DAM
OUTLET WORKS
(IMPERVIOUS) - BORROW AREA "M"
CASS HILL ROAD RELOCATION BY OTHERS
CANAL NO. 1
HOPKINTON
GAGE HILL ROAD
EMERSON HILL ROAD
STUMPFIELD ROAD
BASSETT MILL ROAD
KEYSER POND
FRENCH ROAD
CASS HILL ROAD
HOPKINTON ROAD
ELM BROOK
CLAREMONT
CONTOOCOOK RIVER
COLLEGE HILL ROAD
RIVER ROAD
THAIN ROAD
HOPKINTON HENNIKER
HATFIELD
WOMAN ROAD
MUDGETT ROAD
NORTH WEIR CREST EL. 400.5
SUGAR HILL ROAD
DREW LAKE
CANAL NO. 2
DOW ROAD
PET DOW ROAD
PUTNEY HILL ROAD
AQUEDUCT ROAD
CENTRAL ROAD
BRIAR HILL ROAD
IRISH HILL ROAD
SOUTH ROAD
NOTES:
Elevations refer to Mean Sea Level Datum.
Plane coordinates refer to New Hampshire Transverse Mercator Grid System.
Record Drawing
Contract No. DA-19-016-CIV ENG 60-2
REVISION
DATE
DESCRIPTION
BY
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS
MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
HOPKINTON RESERVOIR - GENERAL PLAN
CONTOOCOOK & PISCATAQUOG RIVERS NEW HAMPSHIRE
DATE JULY 1959
SCALE: 1"=1000'
DRAWING NUMBER
MER-1-1255
SHEET 165
PLATE I

165


OUTLET WORKS BASE LINE (STA.6+00 DAM)
CLAREMONT AND CONCORD RAILROAD (ABANDONED)
TRANSITION TO EXISTING GROUND
SLOPE 1 ON 2
SLOPE TRANSITION FROM 1 ON 2 TO 1 ON 2.5
TOP OF DAM
SLOPE 1 ON 2.5
CONTOOCOOK RIVER
INLET CHANNEL
6' ROCK BERM
10' ROCK BERM – EL. 400.0
10' BERM – EL. 400.0
INTAKE TOWER
SERVICE BRIDGE
PZ13A & B
STA. 1+00 (DAM)
STA.1+75 START OF RAMP
STA. 5+00 (CONDUIT)
UTILITY BLDG. & COMFORT STATION
1 1/2" BIT. CONC. WALK
BMD
BL1
CASS HILL ROAD
℄ DAM S 66°-23'-45"W
CREST EL. 437.5
FLOOD CONTROL CONDUITS
FOREBAY CONDUIT
STA.2+89.73 ACCESS RD.
PARKING AREA
PZ14A & B
FLAG POLE
BMC
20' GATE
4' GATE
OPERATOR'S QUARTERS
GAR.
RW-8 PZ8A & 8B RW-7 RW-6 PZ7A & 7B RW-5 RW-4 PZ6A & 6B RW-3 PZ5A & 5B RW-2 PZ15 PZ4A & 4B RW-1 PZ3A & 3B
6' ROCK BERM
ROCK BERM – EL. 384.0
INV.EL. 365.5
SLOPE DOWN S=0.05
PZ-1
PZ-2
PZ-9
PZ-10
PZ-11
STILLING BASIN EL. 350.0
SCOTT
STA. 0+00 ACCESS RD.
ROUTE 127
FOREBAY POOL EL. 382.0
℄ FOREBAY CONDUIT & OUTLET
H514
SLOPE DOWN S=0.03
DOWNSTREAM
HOPKINTON CTR.
251000 N
251500 N
478500 E
478000 E
FLASH BOARDS TO EL. 382.0
EXISTING HOAGUE-SPRAGUE DAM
ROCK-FILLED CRIB-TYPE TIMBER DAM
OUTLET CHANNEL
SHEET PILING W/ RIVER STAFF GAGE
TOP OF GATES EL. 372.0
GATE INVERT EL. 365.9
EL. 377.0 TOP OF DAM
STAFF GAGE
0 100 200
SCALE, FEET
LEGEND:
CREST SURVEY MONUMENTS
PZ-1 PIEZOMETER
RW-1 RELIEF WELL
BL1 CONTROL POINT FOR VERTICAL AND/OR HORIZONTAL CONTROL
NOTES:
1. ALL ELEVATIONS SHOWN ON THIS SHEET ARE IN TERMS OF FEET NGVD.
2. PLAN DRAWING PROVIDED BY CORPS OF ENGINEERS.
3. CROSS SECTIONS ARE SHOWN ON PLATES 14 – 19.
4. TILT PLATES ON EAST STILLING BASIN WALL NOT SHOWN FOR CLARITY. TILT PLATE DATA ARE REVIEWED IN REF. 5.
U.S. Army Corps of Engineers Waltham, Massachusetts
GEI Consultants, Inc.
Instrumentation Evaluation Hopkinton Dam New Hampshire
Project 97487
INSTRUMENTATION – GENERAL PLAN
Nov. 1997
Plate 2
97487-03 10/24/97 DJM

CORPS OF ENGINEERS

U. S. ARMY



THIS DRAWING MODIFIED FOR HOPKINTON EVERETT LAKE
JULY 1993
APPROVED FOR NED BY ______
THE FOLLOWING MODIFICATION WERE MADE.
RELIEF WELLS, FOUNDATION BORINGS AND PIEZOMETER NUMBERS ADDED.

OCTOBER 1997
FOUNDATION BORINGS AND PIEZOMETERS WERE ADDED.

LEGEND

- ● FD — Foundation Test Boring (1957-58)
- FTT — Foundation Test Trench (1957-58)
- (2)---(2) Geologic Section
- (1) Relief Well Location
- (1) FD 88-1 Foundation Boring (1988) - Piezometer number

NOTES

Elevations refer to Mean Sea Level Datum.

Contour interval is 2 feet.

Plan prepared from Plane Table Survey, Corps of Engineers, 1958.

Plane coordinates refer to New Hampshire Transverse Mercator Grid System.

For Record of Foundation Explorations, see Sheets No. 179 thru 190.

For Geologic Sections, see Sheets No. 173 and 174.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
BOSTON, MASS.

MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
PLAN OF FOUNDATION EXPLORATIONS
CONTOOCOOK AND PISCATAQUOG RIVERS N.H.

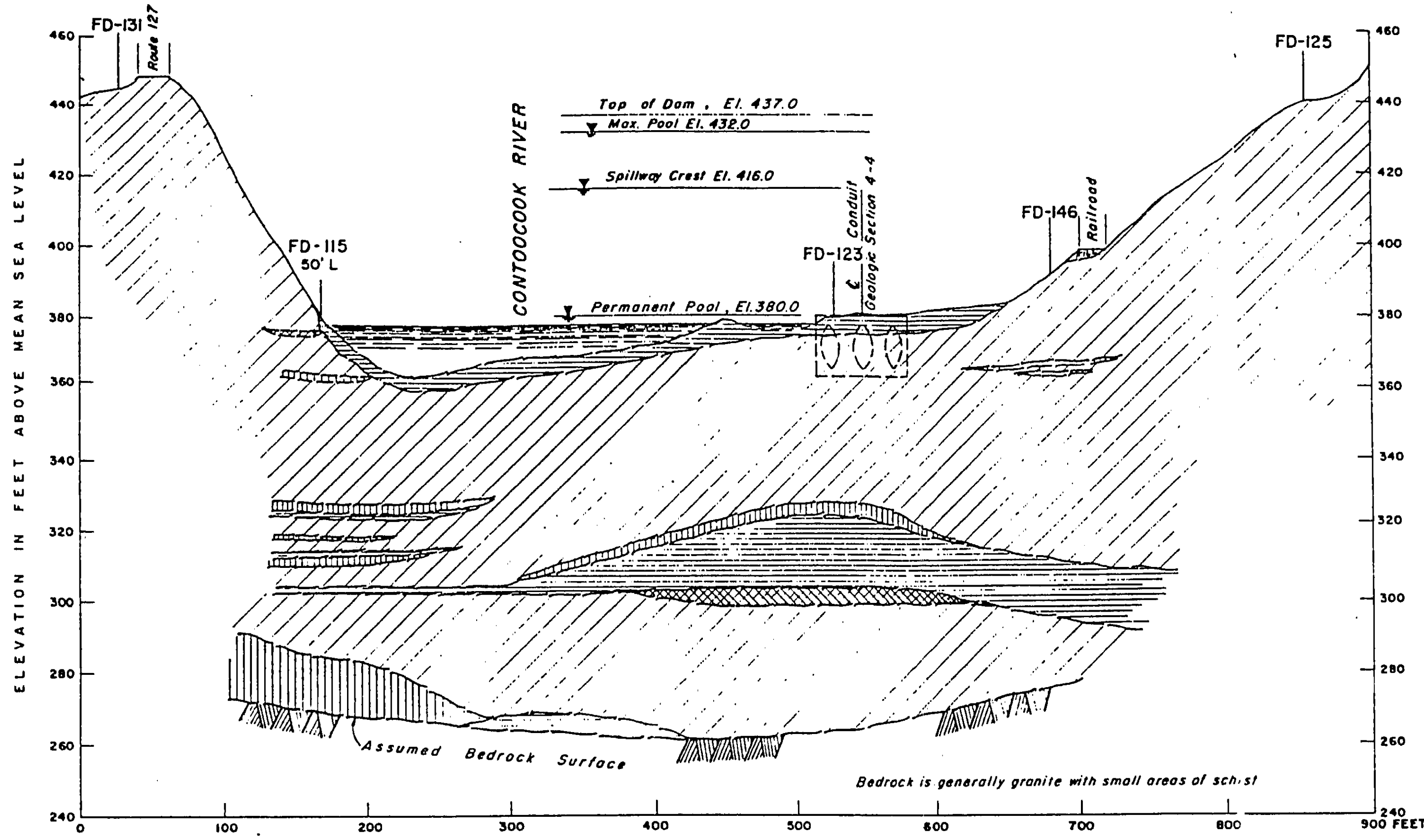
DATE JULY 1959

SCALE AS SHOWN | SPEC. NO CIV ENG-19-016-60-1

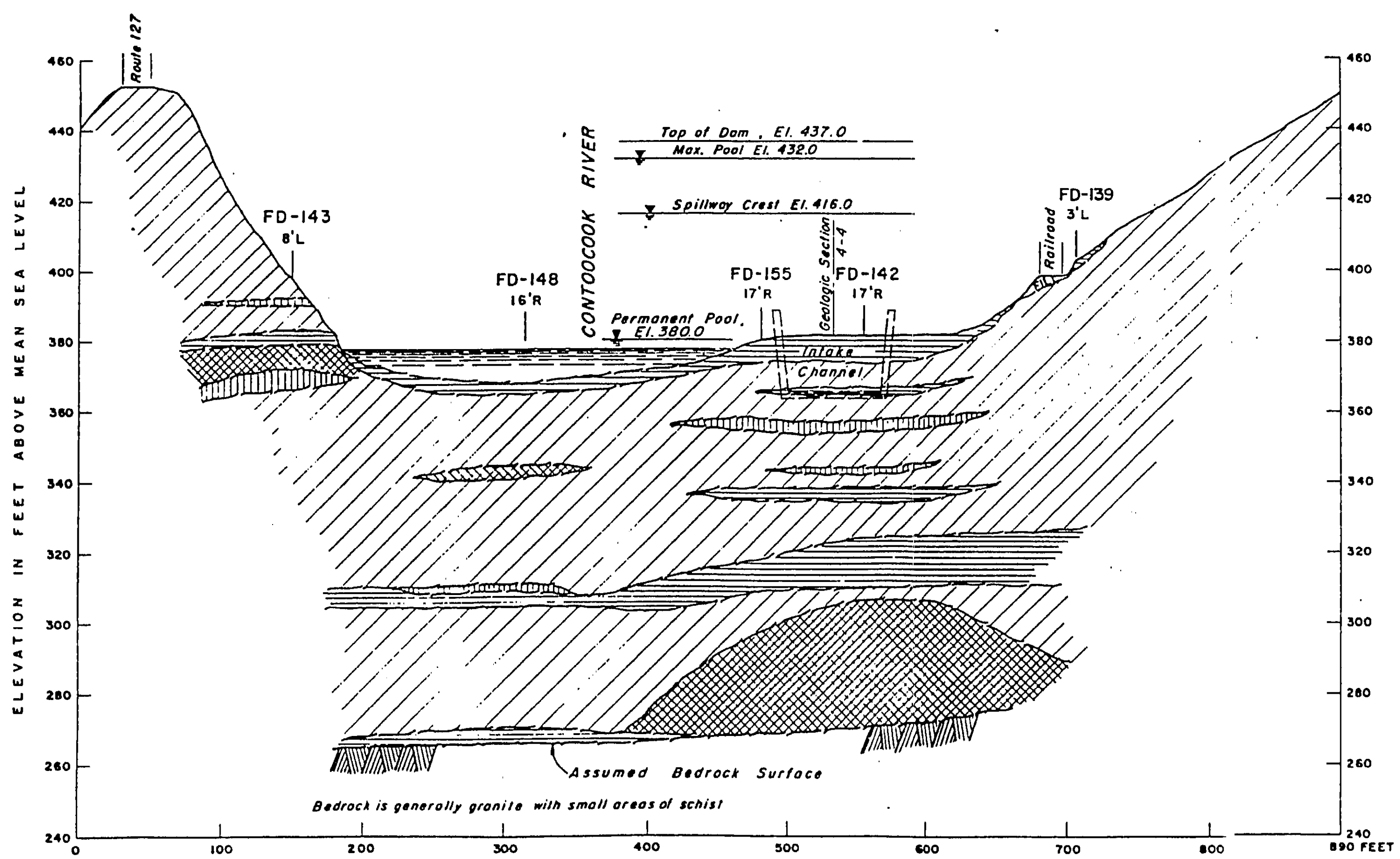
DRAWING NUMBER MER-2-1030

SHEET 168

PLATE 3



GEOLOGIC SECTION 1-1, 55' UPSTREAM FROM ℄ DAM
(LOOKING UPSTREAM)



GEOLOGIC SECTION 2-2, 175' UPSTREAM FROM ℄ DAM
(LOOKING UPSTREAM)

LEGEND

- TILL, a hetrogeneous mixture of variable gravelly, silty to clayey SAND with cobbles and boulders.
- Variable gravelly, silty and clayey SAND (TILL) with numerous thin laminae of sand, silt and clay
- Laminated SILT and CLAY
- Variable SAND and GRAVEL, ranging from silty SAND to sandy GRAVEL

Record Drawing
Contract No. DA 19-016-CIV ENG 60-2

NOTES

For Record of Foundation Explorations, see Sheets No. 179 thru 190.

For Location of Geologic Sections, see Sheet No. 168.

This drawing is presented for general information and is to be considered only as a supplement to the records of exploration in other contract drawings. Geologic sections shown hereon are the Government interpretation of subsurface conditions believed to exist at and between borings. Variations between elevations, composition and structure of the individual formations as represented hereon and as actually encountered in the progress of the work are to be anticipated.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

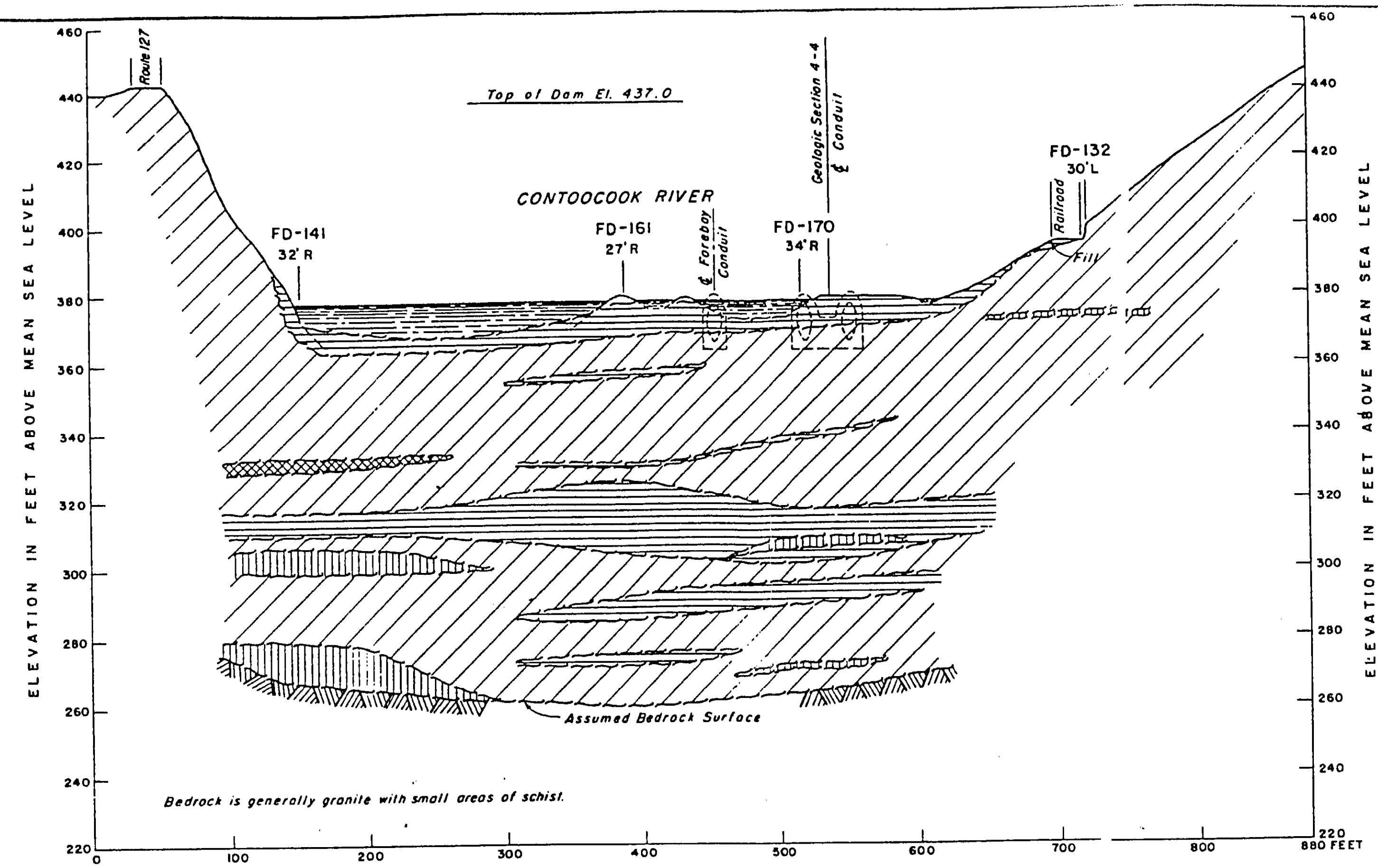
PREPARED BY M A V
DRAWN BY W K
CHECKED BY R C G
CHIEF N.E.D. LABORATORIES
PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANN & RPT'S BRANCH
APPROVED
CHIEF ENGINEERING DIV.

MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
GEOLOGIC SECTIONS 1-1 AND 2-2
CONTOOCOOK AND PISCATAQUOG RIVERS N. H.

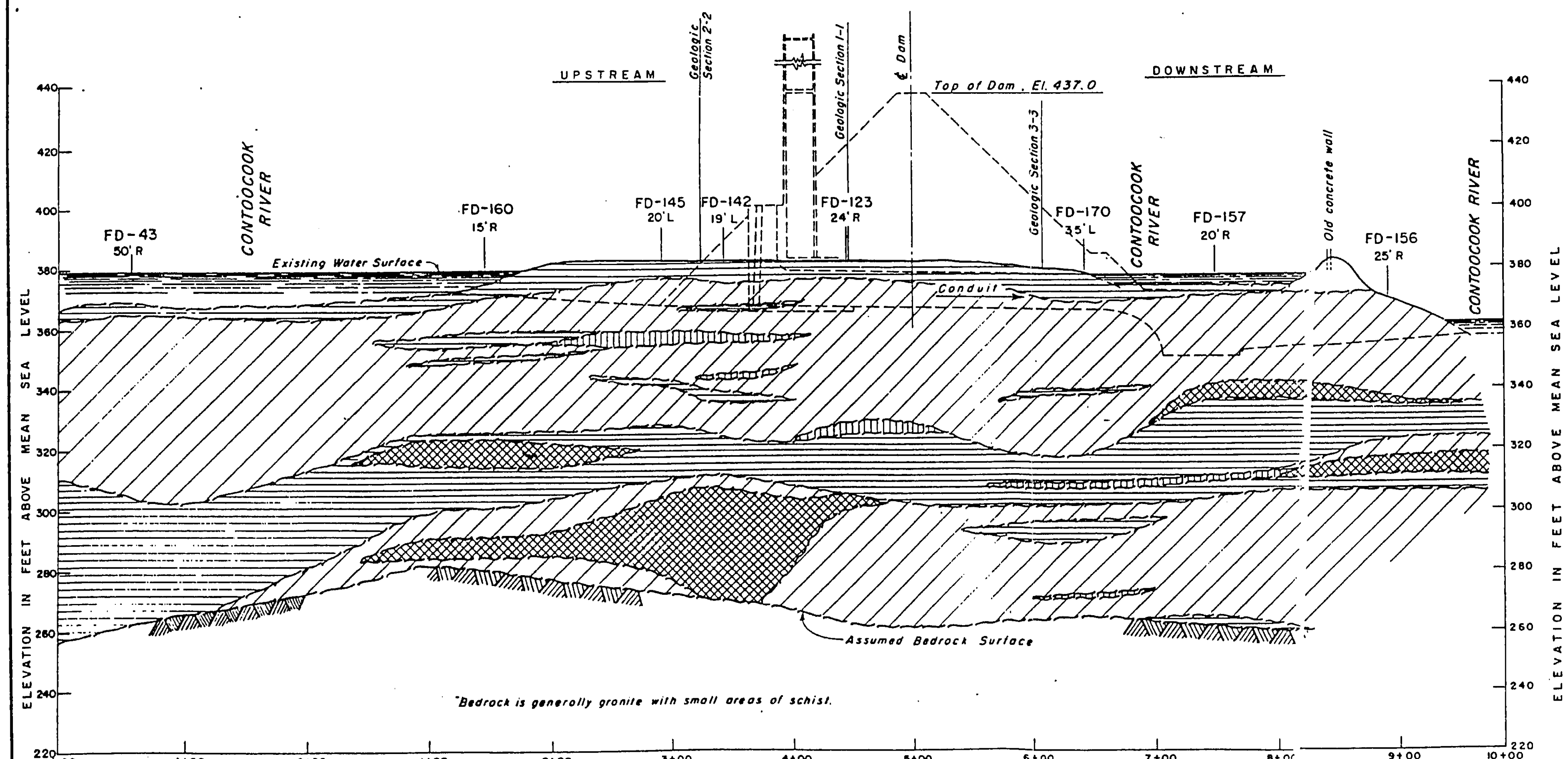
APPROVED
COL., C.E. DEPUTY DIVISION ENGINEER
DATE JUNE 1959

SCALE AS SHOWN | SPEC NO CIV ENG-19-016-60-1
DRAWING NUMBER
MER-2-1036
SHEET 173

PLATE 4A



GEOLOGIC SECTION 3-3, 110' DOWNSTREAM FROM ¢ DAM
(LOOKING UPSTREAM)



GEOLOGIC SECTION 4-4, ALONG ¢ OF CONDUIT
(LOOKING WEST)

LEGEND

- *TILL, a hetrogeneous mixture of variable gravelly, silty to clayey SAND with cobbles and boulders.*
- *Variable gravelly, silty and clayey SAND (TILL) with numerous thin laminae of sand, silt and clay*
- *Laminated SILT and CLAY*
- *Variable SAND and GRAVEL, ranging from silty SAND to sandy GRAVEL*

Record Drawing
Contract No. DA-19-016-CIVENG-60-2

NOTES

For Record of Foundation Explorations, see Sheets No. 179 thru 190.

For Location of Geologic Sections, see Sheet No. 168.

This drawing is presented for general information and is to be considered only as a supplement to the records of exploration in other contract drawings. Geologic sections shown hereon are the Government interpretation of subsurface conditions believed to exist at and between borings. Variations between elevations, composition and structure of the individual formations as represented hereon and as actually encountered in the progress of the work are to be anticipated.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

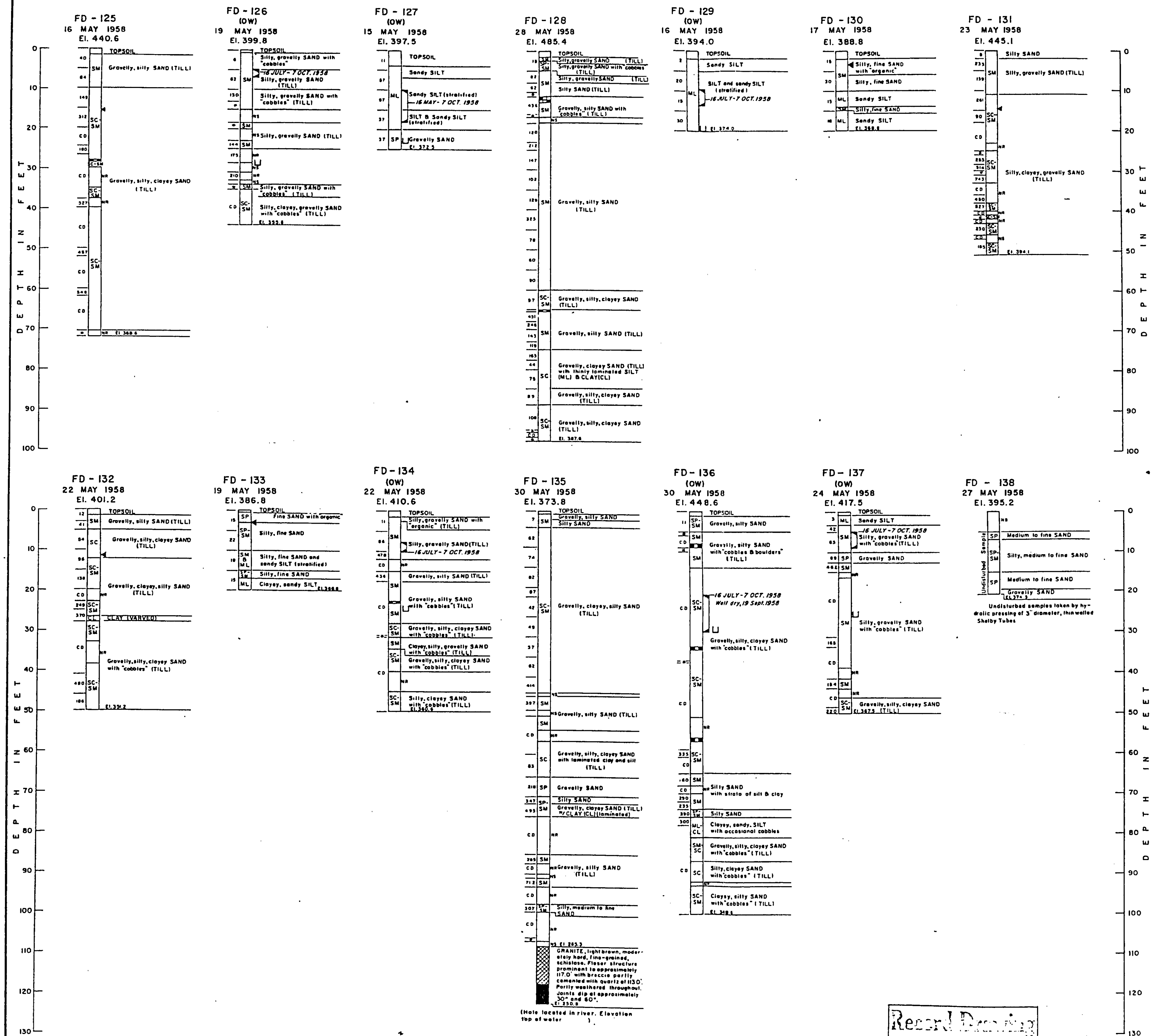
PREPARED BY H.A.V.
DRAWN BY W.R.
CHECKED BY R.C.G.
CHIEF N.E.D. LABORATORIES
PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANNING & DESIGN BRANCH
APPROVED
CHIEF ENGINEERING DIV.
APPROVED
COL., C.E. DEPUTY DIVISION ENGINEER

MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
GEOLOGIC SECTIONS 3-3 AND 4-4
CONTOOCOOK AND PISCATAQUOG RIVERS N.H.

DATE JUNE 1959

SCALE AS SHOWN | SPEC. NO CIV ENG. 19-016-60-1
DRAWING NUMBER MER-2-1037
SHEET 174

PLATE 4B



LEGEND FOR GRAPHIC LOGS

FD - 135 — Foundation Test Boring (1957-58)
(OW) — Observation well installed.
30 MAY 1958 — Date exploration completed.
El. 373.8 — Elevation of ground surface during time of exploration.

- Maximum artesian head.
- Subsurface water level in boring at time of exploration.
- Range of subsurface water during period of observation.
- Artesian flow encountered.
- SP — Group letter symbol according to Unified Soil Classification System.
- NR — No Recovery or unsatisfactory soil samples recovered.
- Bottom of observation well.
- NS — Not Sampled. Hole advanced by Core-drilling, blasting and/or wash boring due to operational difficulty.
- CD — Sampling in overburden by the Core-drill Method.
- 24 — Blows per foot of penetration considered most representative, usually within a 5-foot drive, using a 300 or 350 pound hammer with a free fall of about 18 inches on a 2½" I.D. or 3" O.D. and/or 2" I.D. or 2½" O.D. size sample spoon equipped with a beveled and sharpened drive shoe.
- * — Blow count not recorded or not considered representative.
- Cobble or boulder (Core-drilled).
- Cobbles or boulders, continuous or nested (Core-drilled and/or blasted and chopped).
- El. 296.6 Elevation of bedrock surface.
- Rock core recovery 0 - 25%
- Rock core recovery 25 - 50%
- Rock core recovery 50 - 75%
- Rock core recovery 75 - 90%
- Rock core recovery 90 - 100%
- El. 276.6 Elevation of bottom of exploration

Loss in gpm

NPT — No Pressure Test Performed. Asterisk denotes that section could not be sealed for testing.

40 psi — Constantly maintained pressure for 1 to 5 minutes. Volume loss in gallons per minute under constant pressure, tested continuously in 5 foot sections. Scale expanded from 0 gpm to 1 gpm for clarification of low pressure losses.

Water levels recorded during subsurface explorations seldom correspond with the natural level of free ground water, except in extensive and thick deposits of sands and gravels which are sufficiently pervious to permit rapid stabilization of water levels in the exploratory hole. Absence of subsurface water level in the graphic log of any exploration is not necessarily to be construed that ground water will not be encountered in excavation at that location.

While the borings are representative of subsurface conditions at their respective locations and for their respective vertical reaches, local minor variations characteristic of the overburden and rocks of this region are anticipated, and if encountered, such variations will not be considered as differing "materially" from represented conditions within the purview of Article 4 of the Contract.

NOTE

Elevations refer to Mean Sea Level Datum.

INDEX FOR LOCATION OF FOUNDATION EXPLORATIONS

Hopkinton Dam - FD-125, FD-131, FD-132 and FD-135, see Sheet No. 168.

Canal No. 1 - FD-126, FD-127, FD-128, FD-129, FD-130, FD-133, FD-134, FD-136 and FD-137, see Sheet No. 169.

Spillway - FD-138, see Sheet No. 171.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

PREPARED BY H. A. V.
DRAWN BY H. C. S.
CHECKED BY R. C. 4
CHIEF R.E.D. LABORATORIES
PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANN. & RPT'S BRANCH
APPROVED:
CHIEF ENGINEERING DIV.

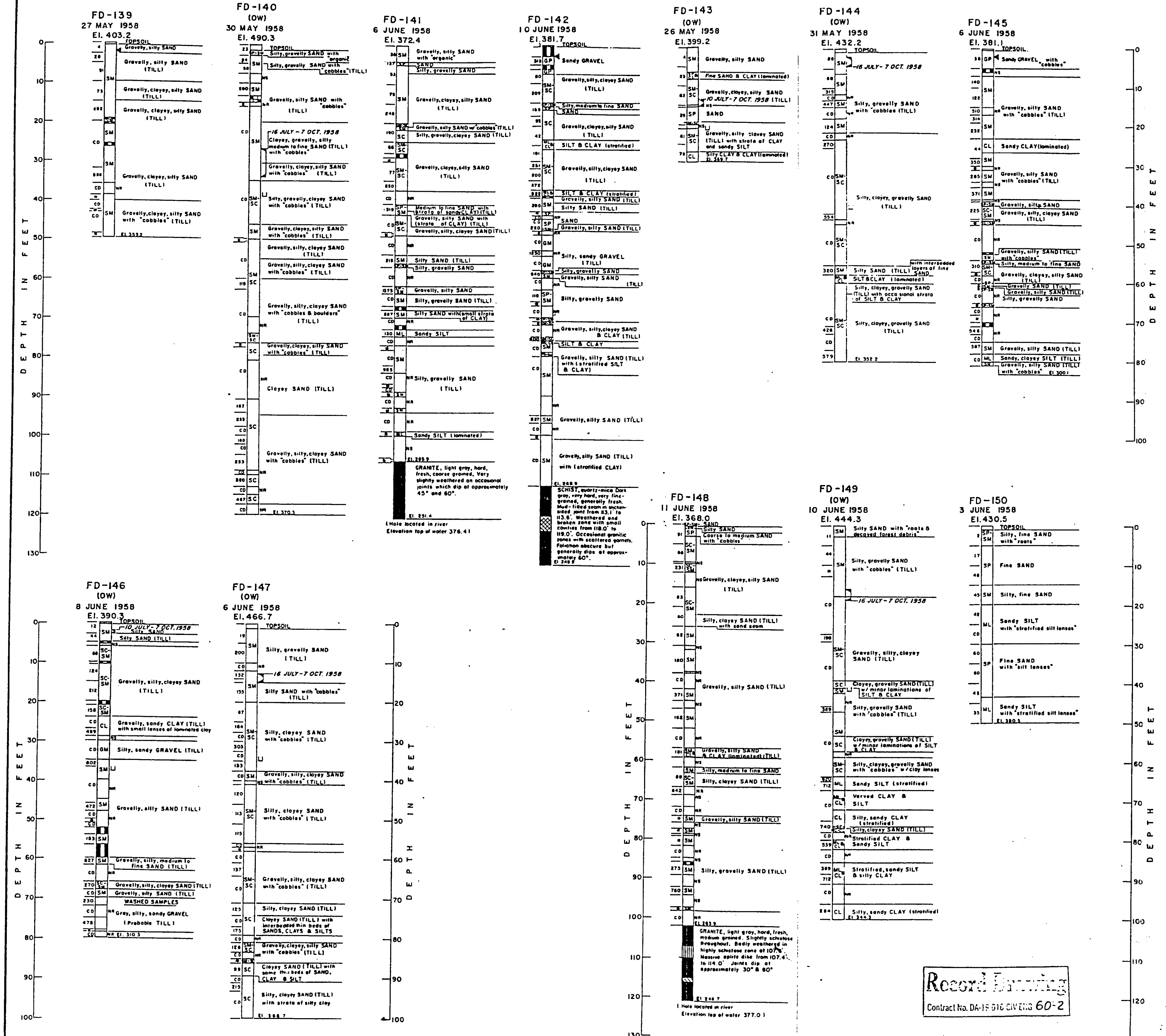
MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
RECORD OF FOUNDATION EXPLORATIONS
NO. 7
CONTOOCOOK AND PISCATAQUOG RIVERS N.H.

APPROVED
COL., C.E. DEPUTY DIVISION ENGINEER
DATE JULY 1959

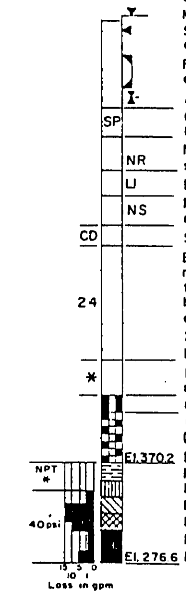
SCALE AS SHOWN | SPEC NO CIV ENG -19-016-60-1
DRAWING NUMBER MER-2-1048
SHEET 185

Record Drawing
Contract No. DA-19-016-CIVENG-60-2

U. S. ARMY



LEGEND FOR GRAPHIC LOGS



FD-140	Foundation Test Boring (1957-1958)
(OW)	Observation well installed.
30 MAY 1958	Date exploration completed.
El. 490.3	Elevation of ground surface during time of exploration.
	Maximum artesian head.
	Subsurface water level boring at time of exploration.
	Range of subsurface water during period of observation.
	Artesian flow encountered.
SP	Group letter symbol according to Unified Soil Classification System.
NR	No Recovery or unsatisfactory soil samples recovered.
U	Bottom of observation well.
NS	Not Sampled. Hole advanced by Core-drilling, blasting and/or wash boring due to operational difficulty.
CD	Sampling in overburden by the Core-drill Method.
24	Blows per foot of penetration considered most representative usually within a 5-foot drive using a 300 or 350 pound hammer with a free fall of about 18 inches on a 2½" I.D. or 3" O.D. and/or 2" I.D. or 2½" O.D. sample spoon equipped with a beveled and sharpened drive shoe.
*	Blow count not recorded or not considered representative.
	Cobble or boulder (Core-drilled.)
	Cobbles or boulders, continuous or nested (Core-drilled and/or blasted and chopped.)
El. 370.2	Elevation of bedrock surface.
	Rock core recovery 0 – 25 %
	Rock core recovery 25 – 50 %
	Rock core recovery 50 – 75 %
	Rock core recovery 75 – 90 %
	Rock core recovery 90 – 100 %
El. 276.6	Elevation of bottom of exploration.

NPT *	No Pressure Test Performed. Asterisk denotes that section could not be sealed for testing.
40 psi	Constantly maintained pressure for 1 to 5 minutes.
	Volume loss in gallons per minute under constant pressure, tested continuously in 5 foot sections. Scale expanded from 0 gpm to 1 gpm for clarification of low pressure losses.

Water levels recorded during subsurface explorations seldom correspond with the natural level of free ground water, except in extensive and thick deposits of sands and gravels which are sufficiently pervious to permit rapid stabilization of water levels in the exploratory hole. Absence of subsurface water level in the graphic log of any exploration is not necessarily to be construed that ground water will not be encountered in excavation at that location.

While the borings are representative of subsurface conditions at their respective locations and for their respective vertical reaches, local minor variations characteristic of the overburden and rocks of this region are anticipated, and if encountered, such variations will not be considered as differing "materially" from represented conditions within the purview of Article 4 of the Contract.

NOTES

Elevations refer to Mean Sea Level Datum.

INDEX FOR LOCATION OF FOUNDATION EXPLORATIONS

Hopkinton Dam, FD-139, FD-141, FD-142, FD-143, FD-145, FD-146 and FD-148, see Sheet No. 168.

Canal No. 1, FD-140, FD-144, FD-147 and FD-149, see Sheet No. 169

Dike H-2, FD-150, see Sheet No. 170.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

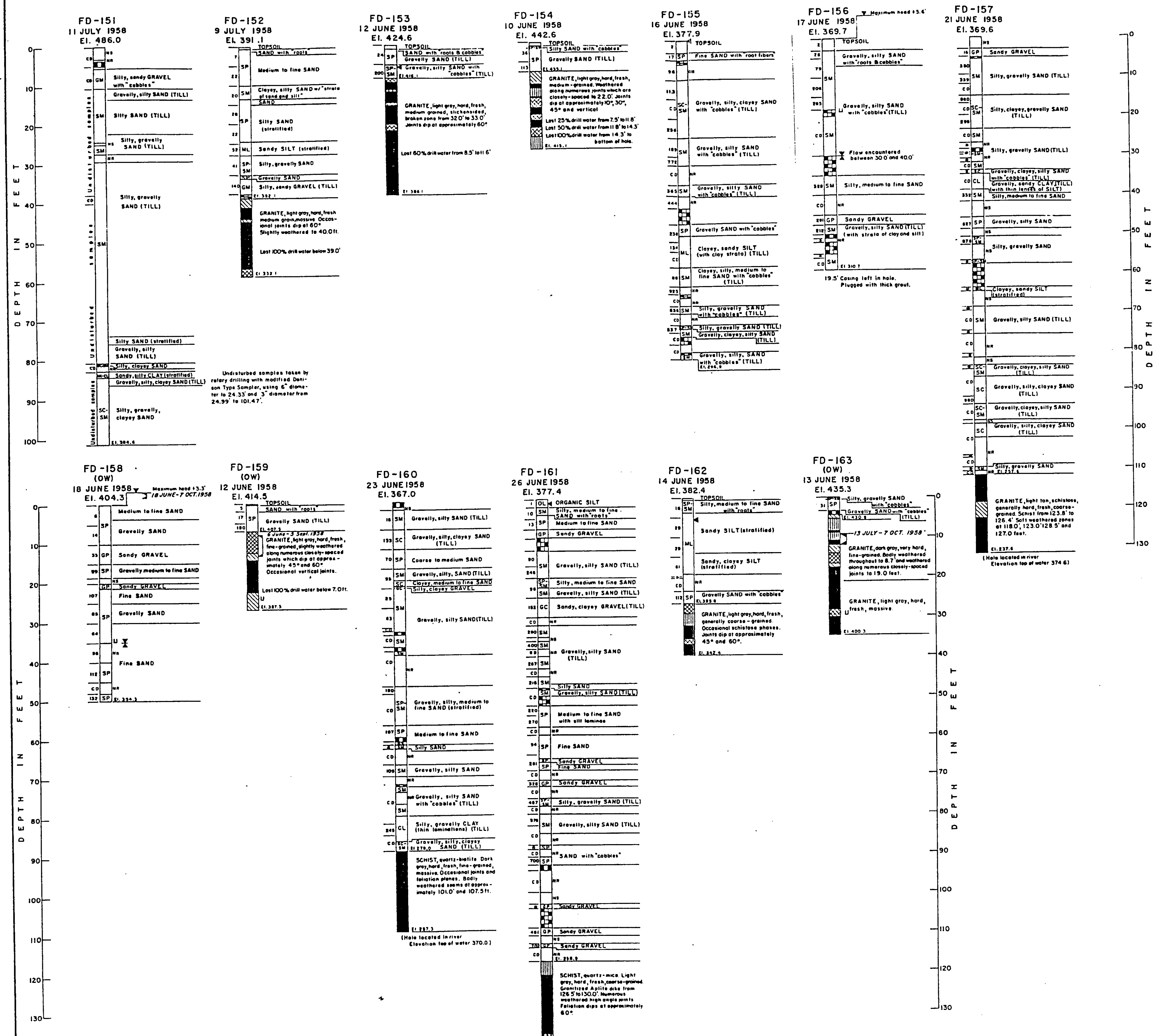
PREPARED BY H. A. Y.
DRAWN BY H. C. S.
CHECKED BY R. C. B.
CHIEF, R.E.D. LABORATORIES
PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANN & ENG'G BRANCH
APPROVED
CHIEF ENGINEERING DIV.

MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
RECORD OF FOUNDATION EXPLORATIONS
NO. 8
CONTOOCOOK AND PISCATAQUOG RIVERS N.H.

APPROVED
COL., C.E. DEPUTY DIVISION ENGINEER
DATE JULY 1959

SCALE AS SHOWN | SPEC NO. CIV ENG-19-016-60-1
DRAWING NUMBER
MER-2-1049
SHEET 186

Record Drawing
Contract No. DA-19-016 CIV ENG 60-2



LEGEND FOR GRAPHIC LOGS

- **FD-153** — Foundation Test Boring (1957-58)
- **(OW)** — Observation well installed.
- **12 JUNE 1958** — Date exploration completed.
- **El. 424.6** — Elevation of ground surface during time of exploration.
- Maximum artesian head.
- Subsurface water level in boring at time of exploration.
- Range of subsurface water during period of observation.
- Artesian flow encountered.
- **SP** — Group letter symbol according to Unified Soil Classification System.
- **NR** — No Recovery or unsatisfactory soil samples recovered.
- **U** — Bottom of observation well.
- **NS** — Not Sampled. Hole advanced by Core-drilling, blasting and/or wash boring due to operational difficulty.
- **CD** — Sampling in overburden by the Core-drill Method.
- **24** — Blows per foot of penetration considered most representative usually within a 5-foot drive using a 300 or 350 pound hammer with a free fall of about 18 inches on a 2½" I.D. or 3" O.D. and/or 2" I.D. or 2½" O.D. sample spoon equipped with a beveled and sharpened drive shoe.
- ***** — Blow count not recorded or not considered representative.
- Cobble or boulder (Core-drilled.)
- Cobbles or boulders, continuous or nested (Core-drilled and/or blasted and chopped.)
- **El. 416.1** — Elevation of bedrock surface.
- Rock core recovery 0 - 25 %
- Rock core recovery 25 - 50 %
- Rock core recovery 50 - 75 %
- Rock core recovery 75 - 90 %
- Rock core recovery 90 - 100 %
- **El. 368.1** — Elevation of bottom of exploration.

NPT, 40psi, 15 5 0, 10 1, Loss in gpm

- **NPT *** — No Pressure Test Performed. Asterisk denotes that section could not be sealed for testing.
- **40 psi** — Constantly maintained pressure for 1 to 5 minutes.
- Volume loss in gallons per minute under constant pressure, tested continuously in 5 foot sections. Scale expanded from 0 gpm to 1 gpm for clarification of low pressure losses.

Water levels recorded during subsurface explorations seldom correspond with the natural level of free ground water, except in extensive and thick deposits of sands and gravels which are sufficiently pervious to permit rapid stabilization of water levels in the exploratory hole. Absence of subsurface water level in the graphic log of any exploration is not necessarily to be construed that ground water will not be encountered in excavation at that location.

While the borings are representative of subsurface conditions of their respective locations and for their respective vertical reaches, local minor variations characteristic of the overburden and rocks of this region are anticipated, and if encountered, such variations will not be considered as differing "materially" from represented conditions within the purview of Article 4 of the Contract.

NOTES

Elevations refer to Mean Sea Level Datum.

INDEX FOR LOCATION OF FOUNDATION EXPLORATIONS

Hopkinton Dam - FD-155, FD-156, FD-157, FD-160 and FD-161, see Sheet No. 168

Canal No. 1 - FD-151, see Sheet No. 169

Dike H-3 - FD-158 and FD-162, see Sheet No. 172

Spillway - FD-152, FD-153, FD-154, FD-159 and FD-163, see Sheet No. 171

Contract No. DA 19 016 ... 60-2

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

PREPARED BY H. A. V.
DRAWN BY H. C. S.
CHECKED BY R. C. S.
CHIEF N E D LABORATORIES
PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANN & RPT'S BRANCH
APPROVED
CHIEF ENGINEERING DIV.

MERRIMACK RIVER FLOOD CONTROL

HOPKINTON-EVERETT RESERVOIR

HOPKINTON DAM

RECORD OF FOUNDATION EXPLORATIONS NO. 9

CONTOOCOOK AND PISCATAQUOG RIVERS N.H.

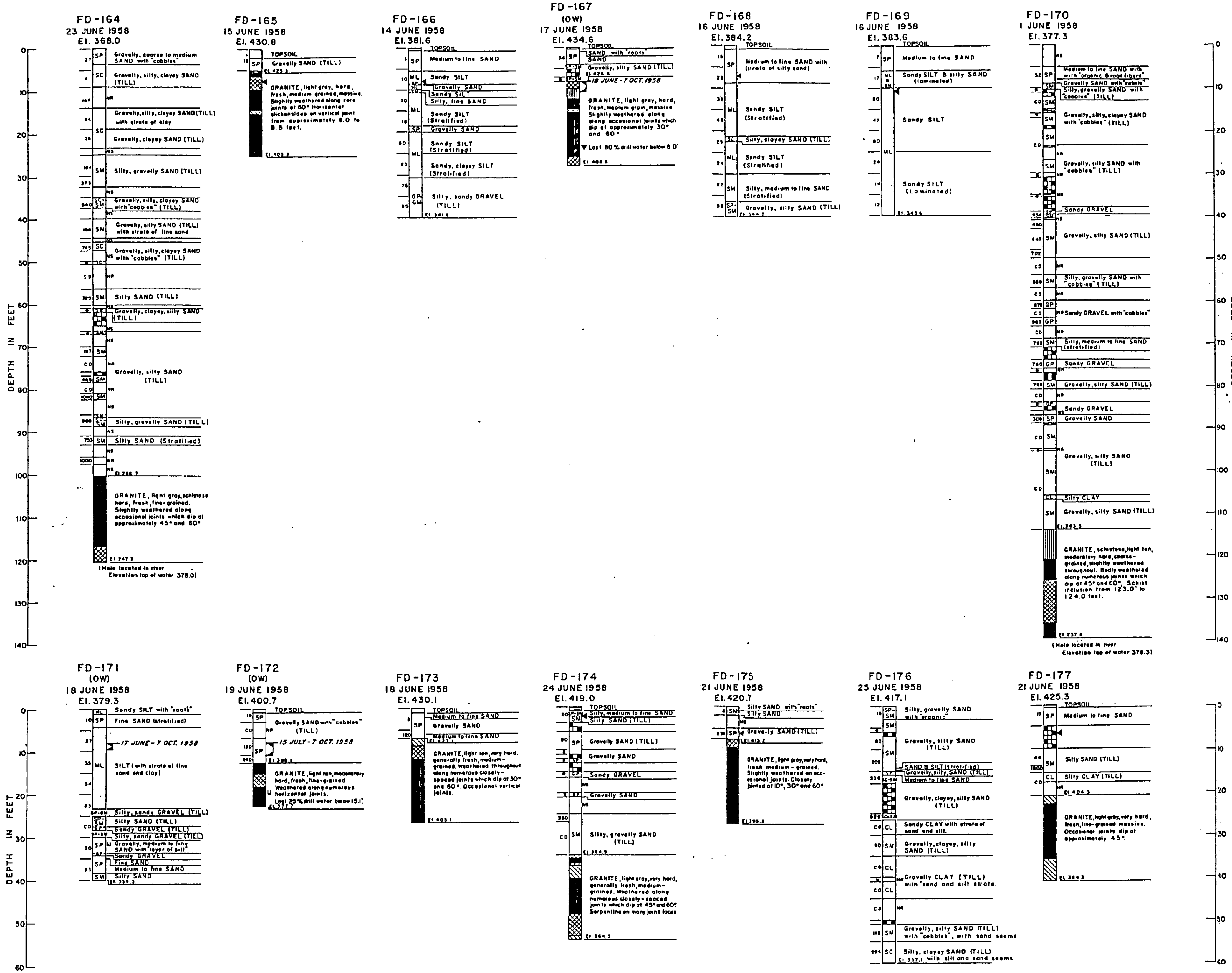
APPROVED
COL., C.E. DEPUTY DIVISION ENGINEER

DATE JULY 1959

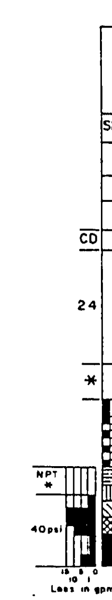
SCALE AS SHOWN | SPEC NO CIV ENG-19-016-60-1

DRAWING NUMBER MER-2-1050

SHEET 187



LEGEND FOR GRAPHIC LOGS



- FD-170 — Foundation Test Boring (1957-58)
- (OW) — Observation well installed.
- 1 JUNE 1958 — Date exploration completed.
- El. 377.3 — Elevation of ground surface during time of exploration.
- Maximum artesian head.
- Subsurface water level boring at time of exploration.
- Range of subsurface water during period of observation.
- Artesian flow encountered.
- SP — Group letter symbol according to Unified Soil Classification System.
- NR — No Recovery or unsatisfactory soil samples recovered.
- Bottom of observation well.
- NS — Not Sampled. Hole advanced by Core-drilling, blasting and/or wash boring due to operational difficulty.
- CD — Sampling in overburden by the Core-drill Method.
- 24 — Blows per foot of penetration considered most representative usually within a 5-foot drive using a 300 or 350 pound hammer with a free fall of about 18 inches on a $2\frac{1}{2}$" I.D. or 3" O.D. and/or 2" I.D. or $2\frac{1}{2}$" O.D. sample spoon equipped with a beveled and sharpened drive shoe.
- * — Blow count not recorded or not considered representative.
- Cobble or boulder (Core-drilled.)
- Cobbles or boulders, continuous or nested (Core-drilled and/or blasted and chopped.)
- El. 370.2 — Elevation of bedrock surface.
- Rock core recovery 0 - 25 %
- Rock core recovery 25 - 50 %
- Rock core recovery 50 - 75 %
- Rock core recovery 75 - 90 %
- Rock core recovery 90 - 100 %
- El. 276.6 — Elevation of bottom of exploration.

NPT * — No Pressure Test Performed. Asterisk denotes that section could not be sealed for testing.

40 psi — Constantly maintained pressure for 1 to 5 minutes.

Volume loss in gallons per minute under constant pressure, tested continuously in 5 foot sections. Scale expanded from 0 gpm to 1 gpm for clarification of low pressure losses.

Water levels recorded during subsurface explorations seldom correspond with the natural level of free ground water, except in extensive and thick deposits of sands and gravels which are sufficiently pervious to permit rapid stabilization of water levels in the exploratory hole. Absence of subsurface water level in the graphic log of any exploration is not necessarily to be construed that ground water will not be encountered in excavation at that location.

While the borings are representative of subsurface conditions at their respective locations and for their respective vertical reaches, local minor variations characteristic of the overburden and rocks of this region are anticipated, and if encountered, such variations will not be considered as differing "materially" from represented conditions within the purview of Article 4 of the Contract.

NOTES

Elevations refer to Mean Sea Level Datum.

INDEX FOR LOCATION OF FOUNDATION EXPLORATIONS

Hopkinton Dam - FD-164, FD-170, and FD-176, see Sheet No. 168

Dike H-3 - FD-165, FD-166, FD-168, FD-169, FD-171 and FD-172, see Sheet No. 172

Spillway - FD-167, FD-173, FD-174, FD-175 and FD-177, see Sheet No. 171

Record Drawing
Contract No. [illegible] 60-2

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

PREPARED BY H A V
DRAWN BY R A W
CHECKED BY R C G
CHIEF R.E.D. LABORATORIES
PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANN. & RPT'S BRANCH
APPROVED
CHIEF ENGINEERING DIV.
APPROVED
COL., C.E. DEPUTY DIVISION ENGINEER

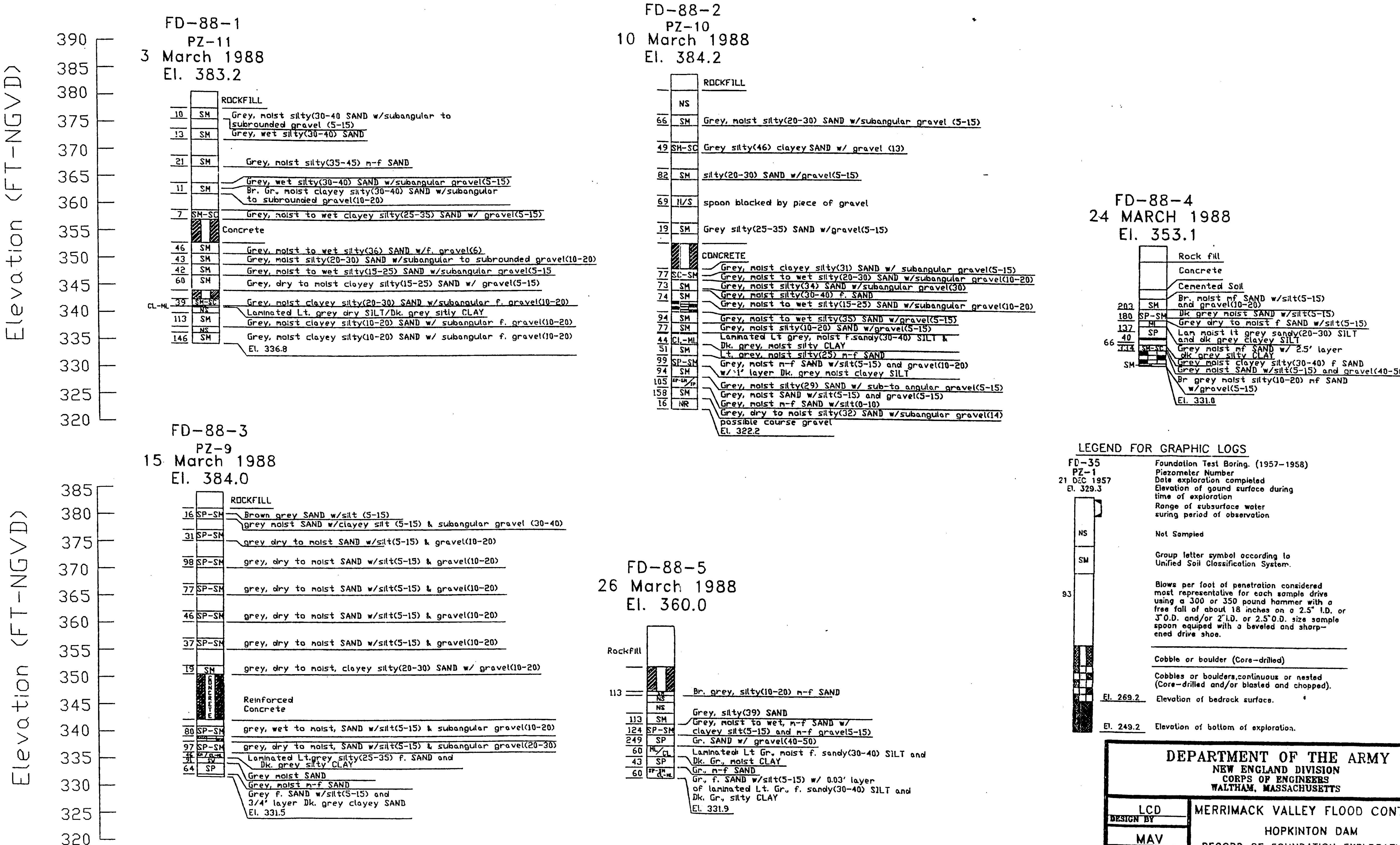
MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
RECORD OF FOUNDATION EXPLORATIONS NO. 10
CONTOOCOOK AND PISCATAQUOG RIVERS N.H.

DATE JULY 1959

SCALE AS SHOWN | SPEC. NO. CIV ENG.-19-016-60-1

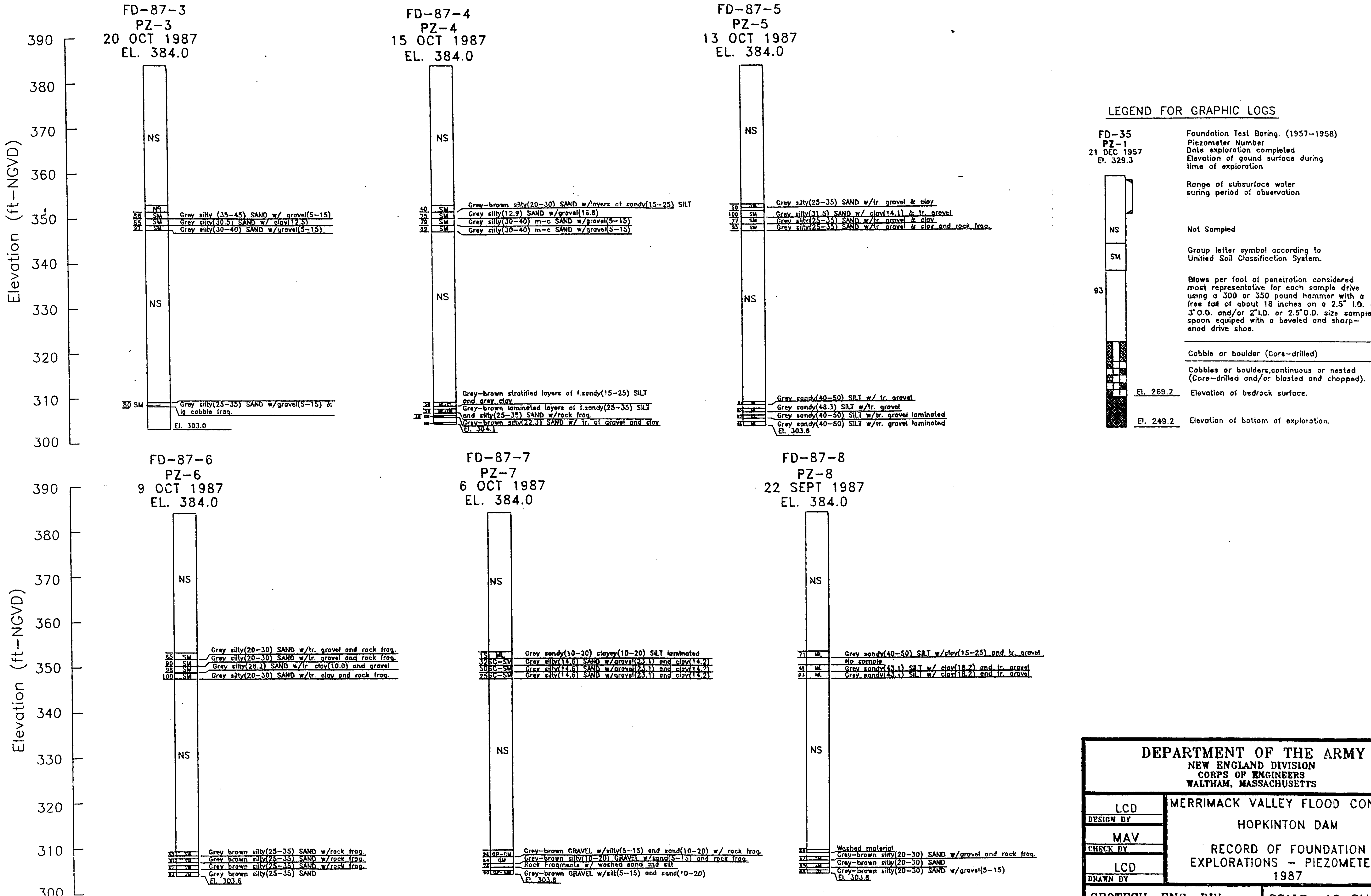
DRAWING NUMBER
MER-2-1051

SHEET 188



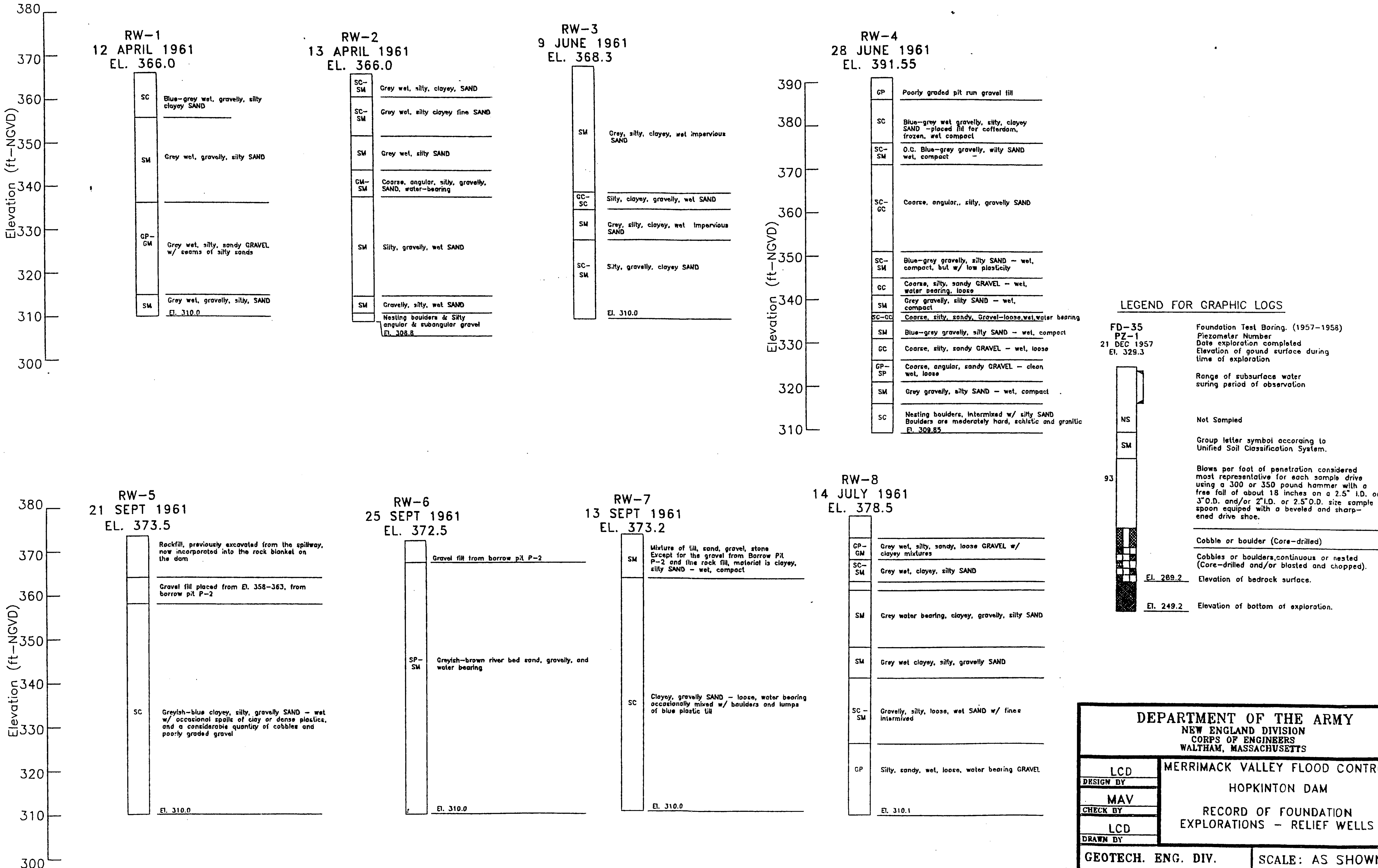
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

LCD DESIGN BY	MERRIMACK VALLEY FLOOD CONTROL HOPKINTON DAM RECORD OF FOUNDATION EXPLORATIONS 1988
MAV CHECK BY	
LCD DRAWN BY	
GEOTECH. ENG. DIV. PLATE NO. 6	SCALE: AS SHOWN DATE: JULY 1993



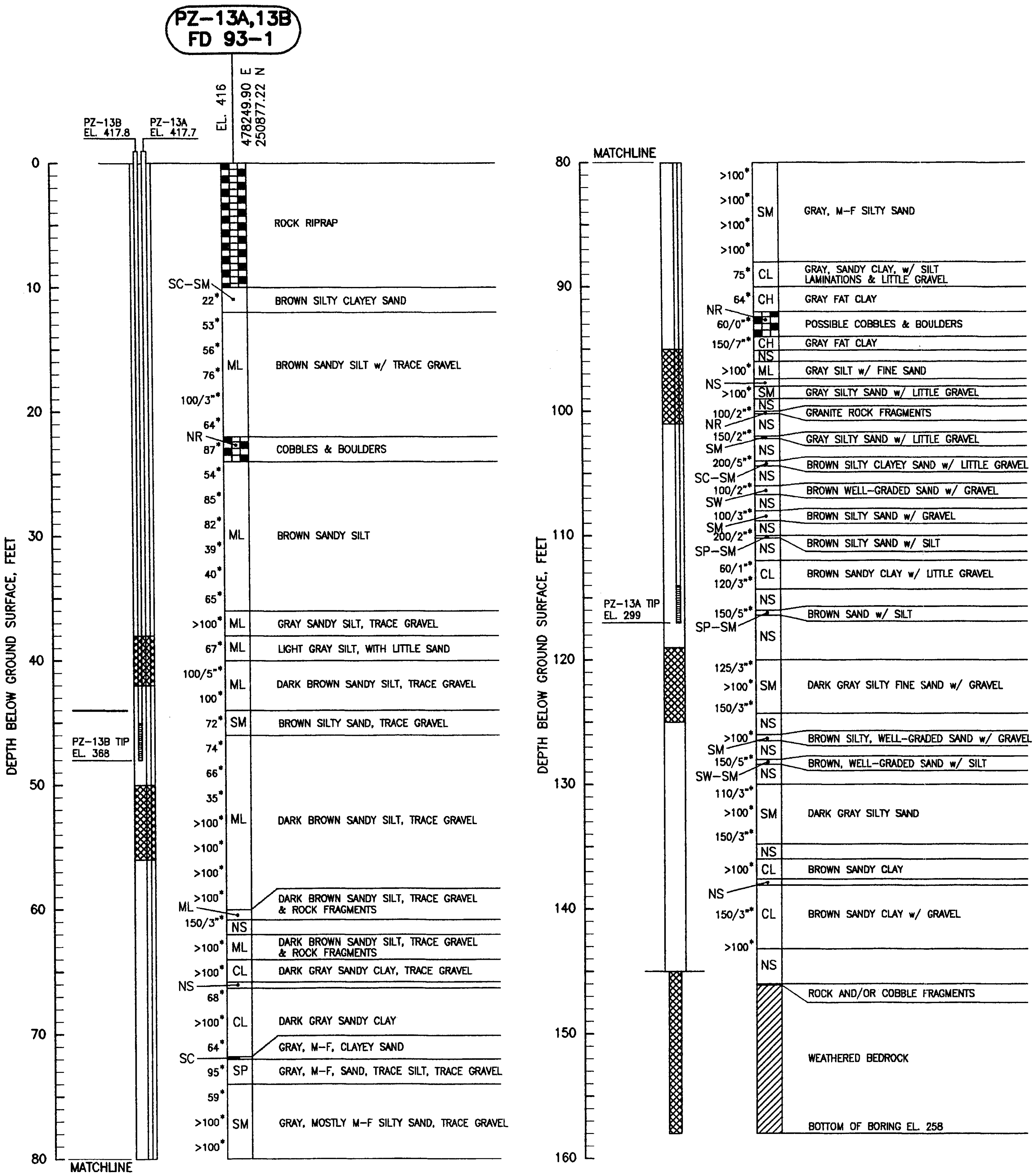
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

LCD DESIGN BY	MERRIMACK VALLEY FLOOD CONTROL
MAV CHECK BY	HOPKINTON DAM
LCD DRAWN BY	RECORD OF FOUNDATION EXPLORATIONS - PIEZOMETERS 1987
GEOTECH. ENG. DIV. PLATE NO. 7	SCALE: AS SHOWN DATE: JULY 1993

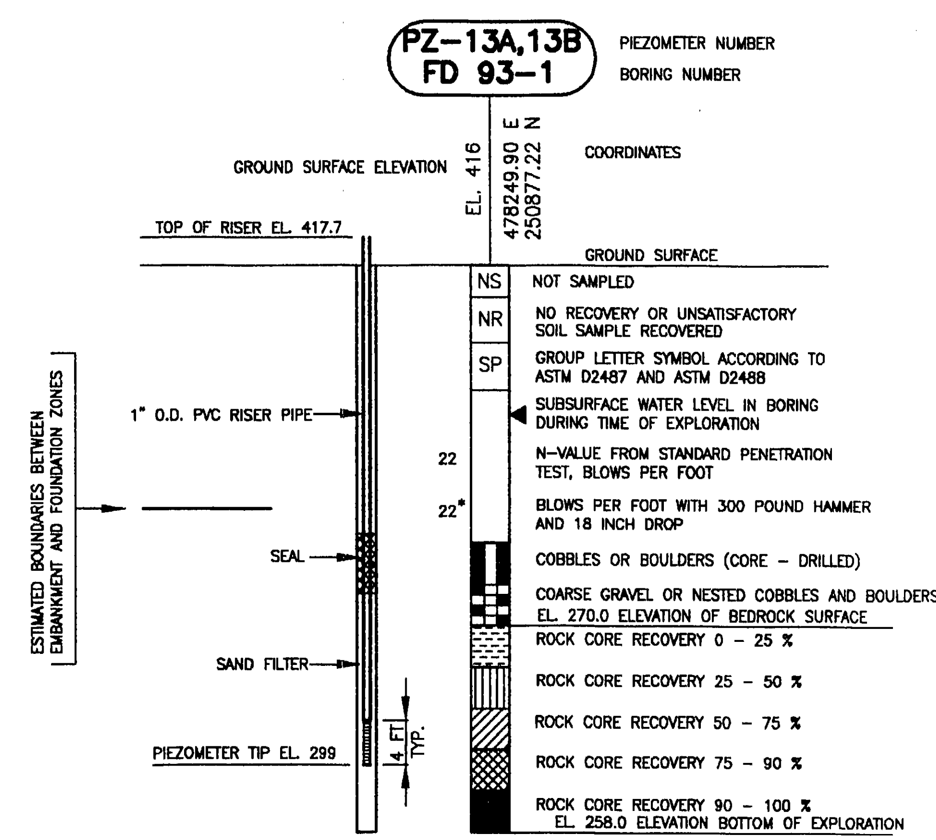


DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

LCD DESIGN BY MAV CHECK BY LCD DRAWN BY	MERRIMACK VALLEY FLOOD CONTROL HOPKINTON DAM RECORD OF FOUNDATION EXPLORATIONS - RELIEF WELLS
GEOTECH. ENG. DIV. PLATE NO. 8	SCALE: AS SHOWN DATE: JULY 1993



LEGEND FOR GRAPHIC LOG



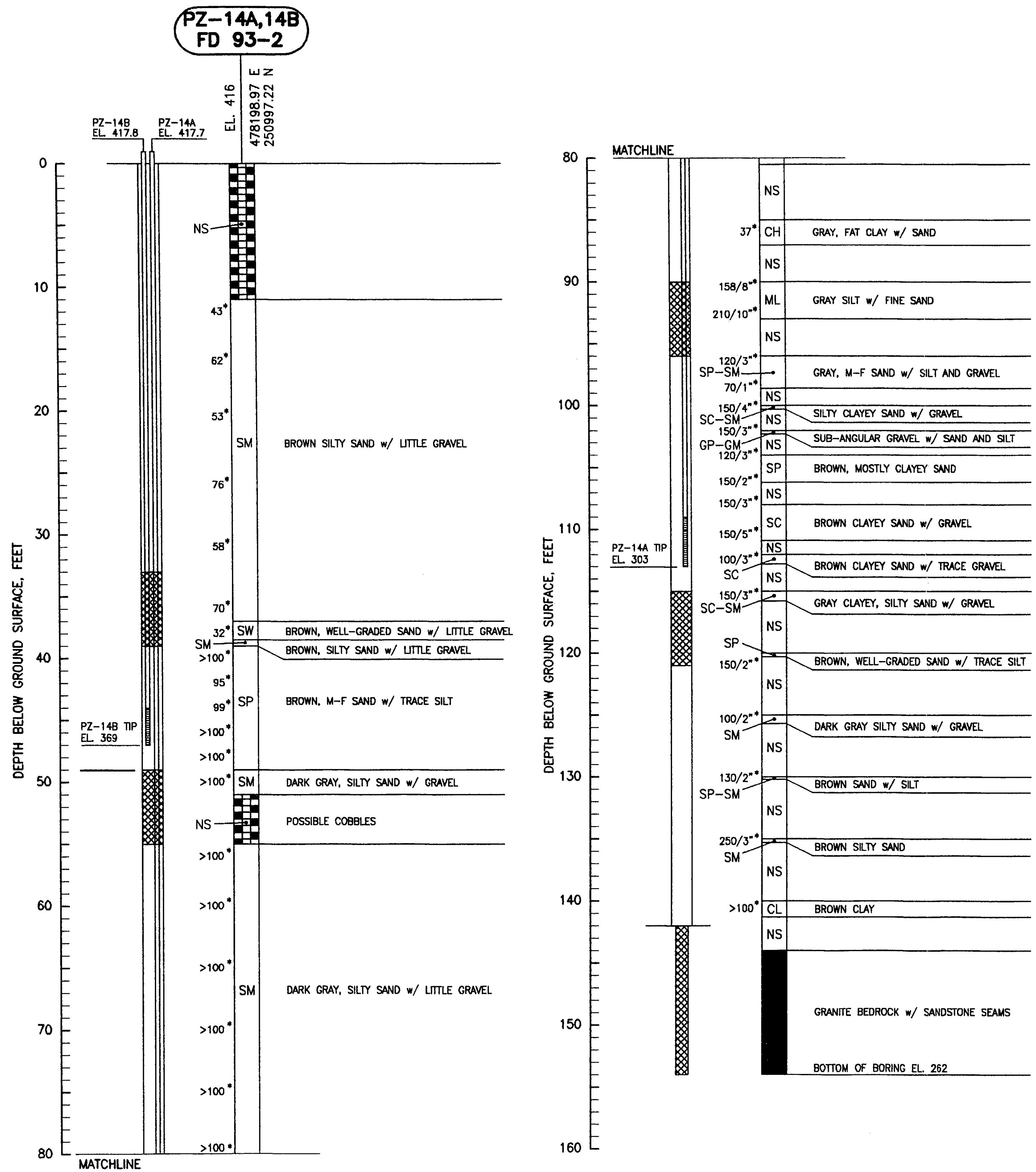
NOTES:

1. SEE PLATE 2 FOR BORING LOCATIONS.
2. ELEVATIONS REFER TO NATIONAL GEODETIC VERTICAL DATUM (NGVD) OF 1929.

0 10 20 FEET
1" = 10'

U.S. Army Corps of Engineers Waltham, Massachusetts	Instrumentation Evaluation Hopkinton Dam New Hampshire	ENGINEERING LOGS FD 93-1
GEI Consultants, Inc.	Project 97487	Nov. 1997 Plate 9

97487-04 11/20/97 DJM



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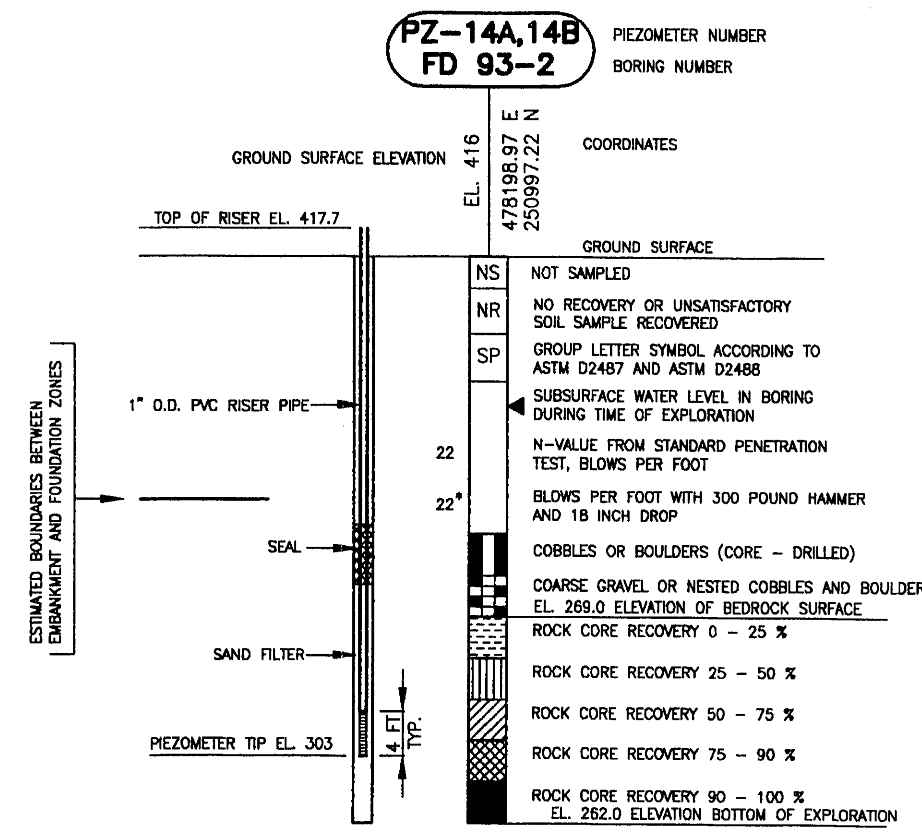
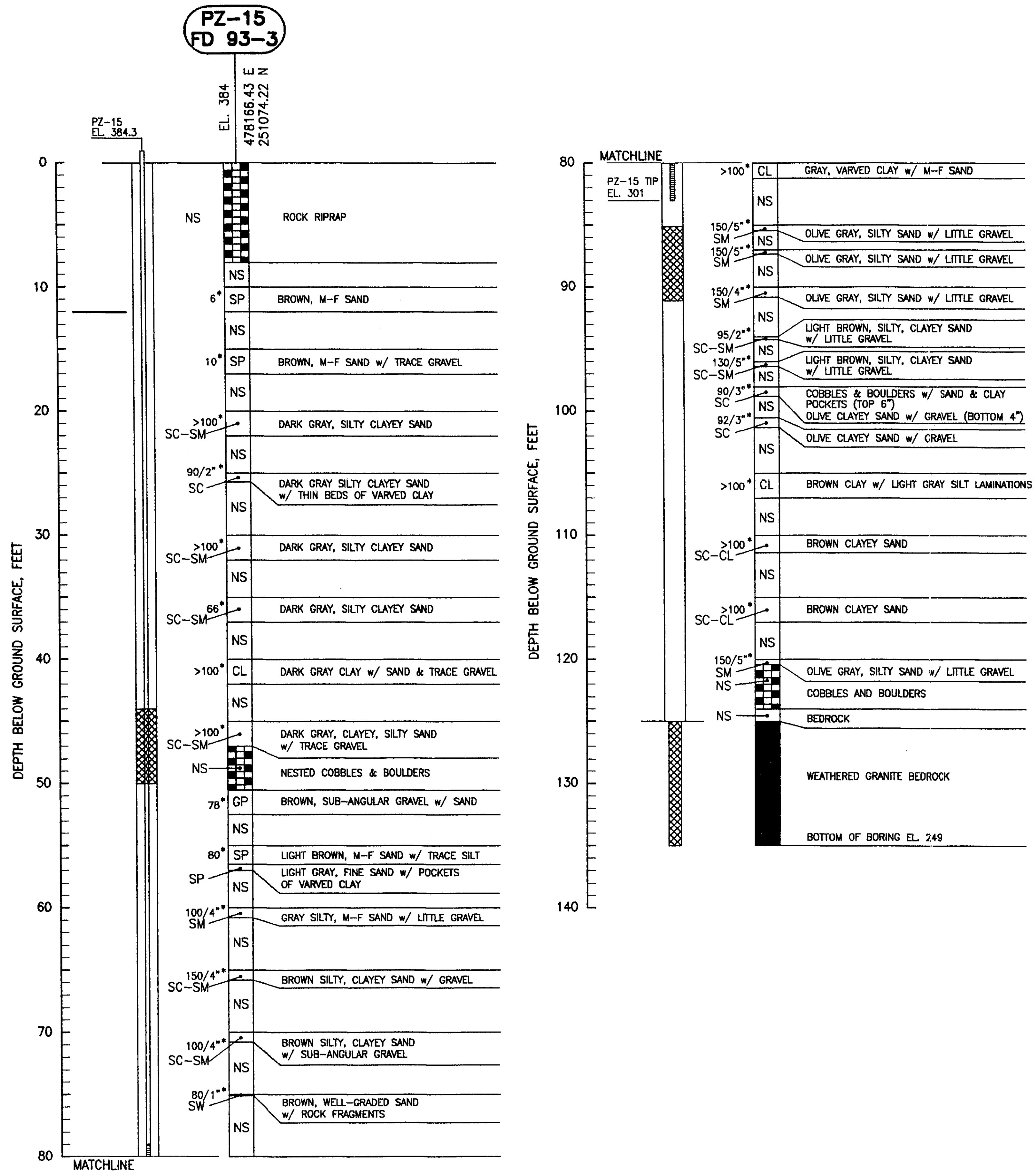


NOTES:

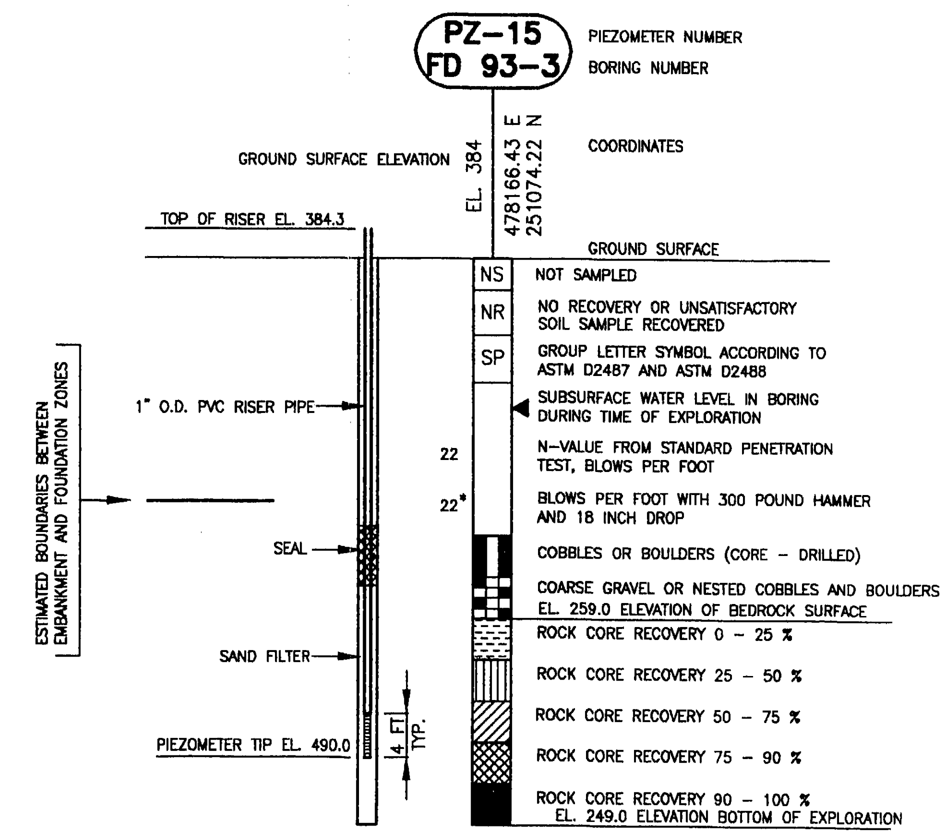
1. SEE PLATE 2 FOR BORING LOCATIONS.
2. ELEVATIONS REFER TO NATIONAL GEODETIC VERTICAL DATUM (NGVD) OF 1929.

0 10 20 FEET
1" = 10'

U.S. Army Corps of Engineers Waltham, Massachusetts / GEI Consultants, Inc.	Instrumentation Evaluation Hopkinton Dam New Hampshire	ENGINEERING LOGS FD 93-2
	Project 97487	Nov. 1997 Plate 10

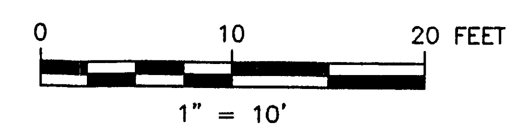


LEGEND FOR GRAPHIC LOG



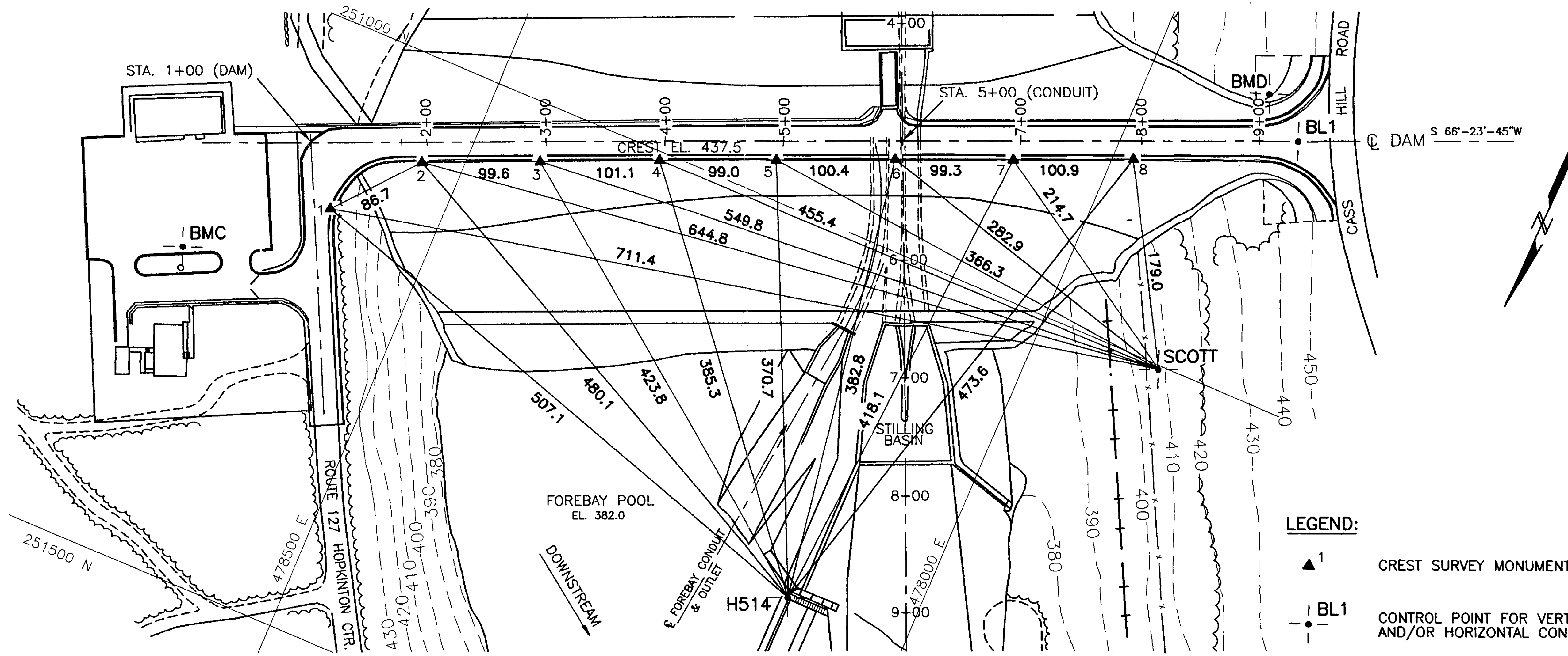
NOTES:

1. SEE PLATE 2 FOR BORING LOCATIONS.
2. ELEVATIONS REFER TO NATIONAL GEODETIC VERTICAL DATUM (NGVD) OF 1929.



U.S. Army Corps of Engineers Waltham, Massachusetts	Instrumentation Evaluation Hopkinton Dam New Hampshire	ENGINEERING LOGS FD 93-3
Φ GEI Consultants, Inc.	Project 97487	Nov. 1997 Plate 11

97487-04 11/20/97 DJM



LEGEND:

▲1 CREST SURVEY MONUMENTS

BL1 CONTROL POINT FOR VERTICAL AND/OR HORIZONTAL CONTROL

CREST MONUMENT COORDINATE DATA												
	SEPTEMBER 1985			MARCH 1986			APRIL 1991			MARCH 1996		
MON.#	NORTHING	EASTING	ELEVATION	NORTHING	EASTING	ELEVATION	NORTHING	EASTING	ELEVATION	NORTHING	EASTING	ELEVATION
1	N/R	N/R	440.975	251153.912	478589.5210	441.016	251153.931	478589.5480	441.058	251153.8947	478589.5397	441.057
2	N/R	N/R	440.590	251087.633	478533.5630	440.636	251087.676	478533.5790	440.670	251087.6544	478533.5795	440.664
3	N/R	N/R	439.660	251047.923	478442.2240	439.695	251047.945	478442.2640	439.729	251047.9249	478442.2695	439.719
4	N/R	N/R	438.135	251007.180	478349.6520	438.157	251007.172	478349.6860	438.198	251007.1779	478349.6942	438.188
5	N/R	N/R	437.710	250967.770	478258.7720	437.731	250967.759	478258.8240	437.782	250967.7658	478258.8316	437.762
6	N/R	N/R	437.840	250927.540	478166.8330	437.869	250927.514	478166.8860	437.910	250927.5253	478166.8962	437.887
7	N/R	N/R	438.480	250888.384	478075.6580	438.492	250888.357	478075.6810	438.539	250888.3538	478075.6906	438.518
8	N/R	N/R	441.300	250847.888	478983.2110	441.312	250847.849	477983.2610	441.352	250847.8451	477983.2733	441.332

CONTROL POINTS COORDINATE DATA			
CONTROL POINT	NORTHING	EASTING	ELEVATION
SCOTT	251003.225	477894.302	N/R
H514(B)	251305.341	478105.628	N/R
BMC	N/R	N/R	438.27
BMD	N/R	N/R	440.50
BL1	N/R	N/R	441.27

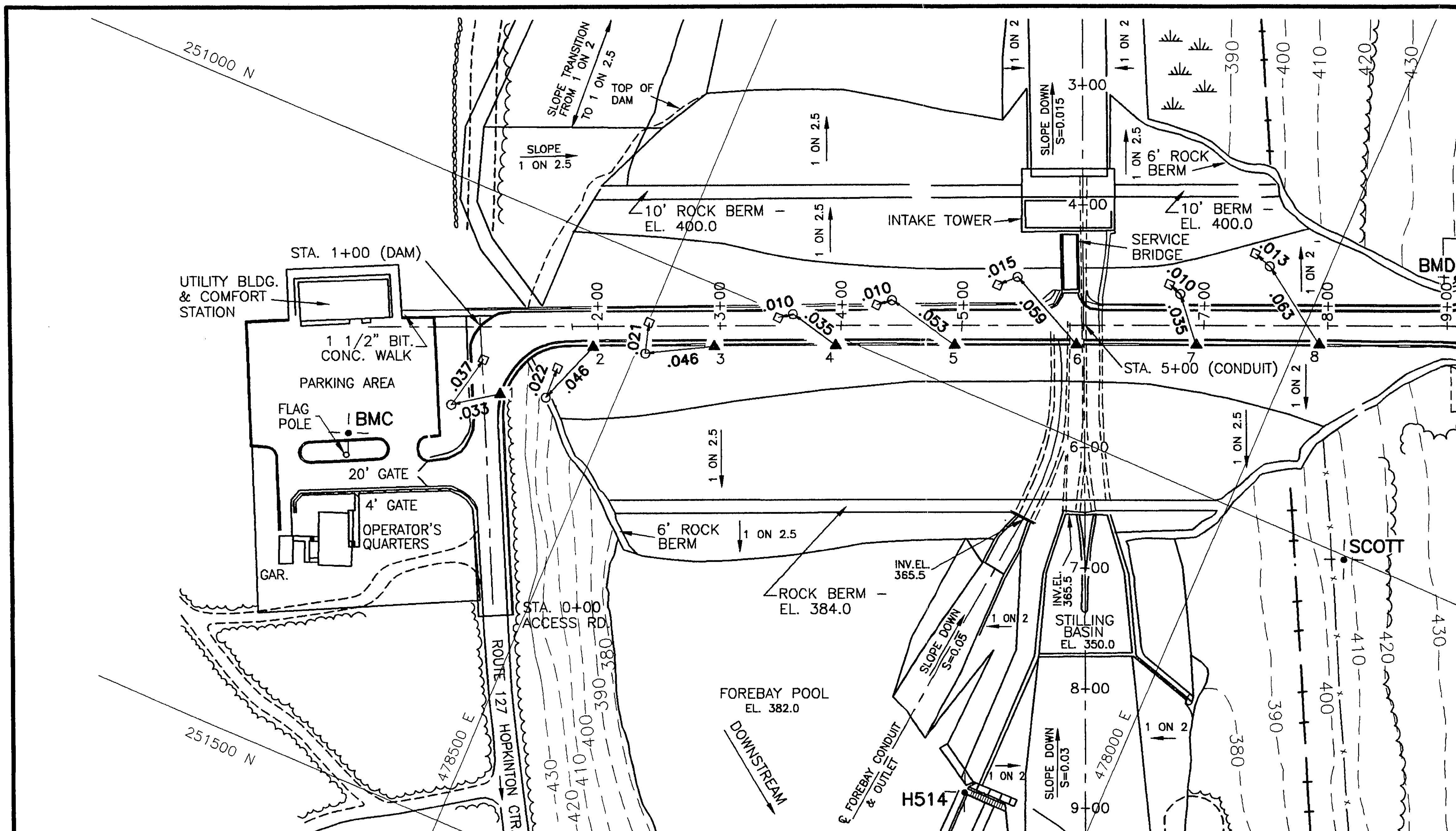
NOTES:

1. ALL ELEVATIONS SHOWN ON THIS SHEET ARE IN TERMS OF FEET NGVD.
2. BASE PLAN AND SURVEY DATA PROVIDED BY CORPS OF ENGINEERS.
3. MEASUREMENTS SHOWN ARE FROM MARCH 1996 SURVEY. REFER TO SURVEY BOOK FC 183 AND PLAN-SUR-612 FOR DESCRIPTION AND LOCATION OF CONTROL POINTS. BOOK STORED IN NEDED DESIGN BRANCH, SURVEY UNIT. PLAN STORED IN NEDED, DESIGN BRANCH, CIVIL LAYOUT SECTION.
4. N/R INDICATES INFORMATION NOT RECORDED.
5. ALL DISTANCES SHOWN ARE IN FEET

0 100 200
SCALE, FEET

U.S. Army Corps of Engineers Waltham, Massachusetts / GEI Consultants, Inc.	Instrumentation Evaluation Hopkinton Dam New Hampshire	CREST SURVEY MONUMENTS: GENERAL LAYOUT, LOCATION & SURVEY DATA
	Project 97487	Nov. 1997 Plate 12

97487-11 10/24/97 DJM

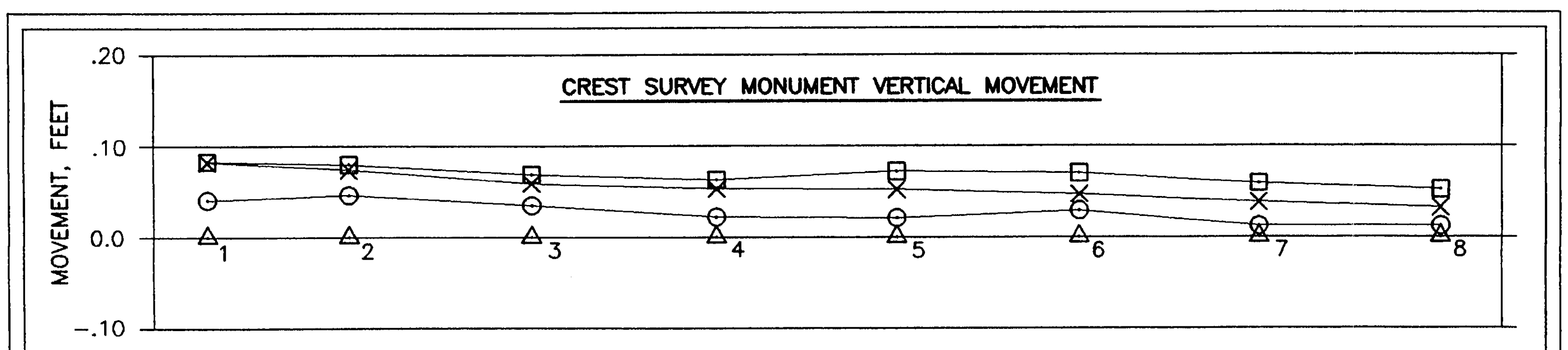


LEGEND:

- ▲[1] CREST SURVEY MONUMENTS
- BL1 CONTROL POINT FOR VERTICAL AND/OR HORIZONTAL CONTROL
- .037 DIRECTION OF HORIZONTAL MOVEMENT 1986 – 1991 SCALE: 1 INCH = 0.08 FEET
- .033 DIRECTION OF HORIZONTAL MOVEMENT 1991 – 1996 SCALE: 1 INCH = 0.08 FEET

NOTES:

1. ALL ELEVATIONS SHOWN ON THIS SHEET ARE IN TERMS OF FEET NGVD.
2. PLAN DRAWING PROVIDED BY CORPS OF ENGINEERS.



LEGEND FOR VERTICAL MOVEMENT	
SYMBOL	DESCRIPTION
△	CREST MONUMENT SURVEY INITIAL ELEVATION SEPT. 1985
⊙	CREST MONUMENT SURVEY MARCH 1986
⊡	CREST MONUMENT SURVEY APRIL 1991
×	CREST MONUMENT SURVEY MARCH 1996

0 0.08 0.16
HORIZONTAL MOVEMENT SCALE, FEET 1" = 0.08'

0 100 200
PLAN SCALE, FEET 1" = 100'

U.S. Army Corps of Engineers
Waltham, Massachusetts

Φ GEI Consultants, Inc.

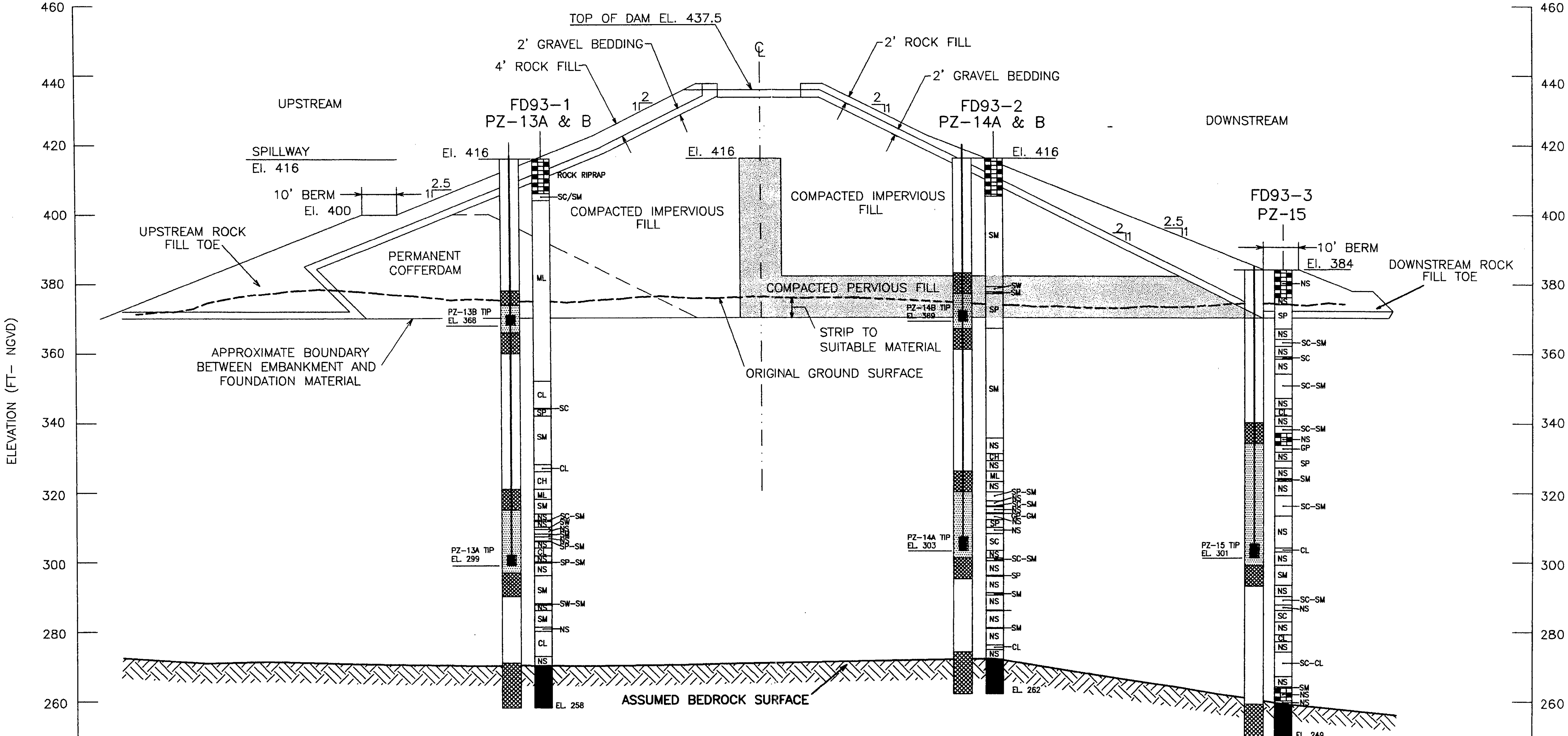
Instrumentation Evaluation
Hopkinton Dam
New Hampshire

Project 97487

CREST SURVEY MONUMENTS: HORIZONTAL & VERTICAL MOVEMENTS

Nov. 1997 Plate 13

97487-12 10/29/97 DJM



SECTION A-A – STATION 5+25 HOPKINTON DAM

0 30 60

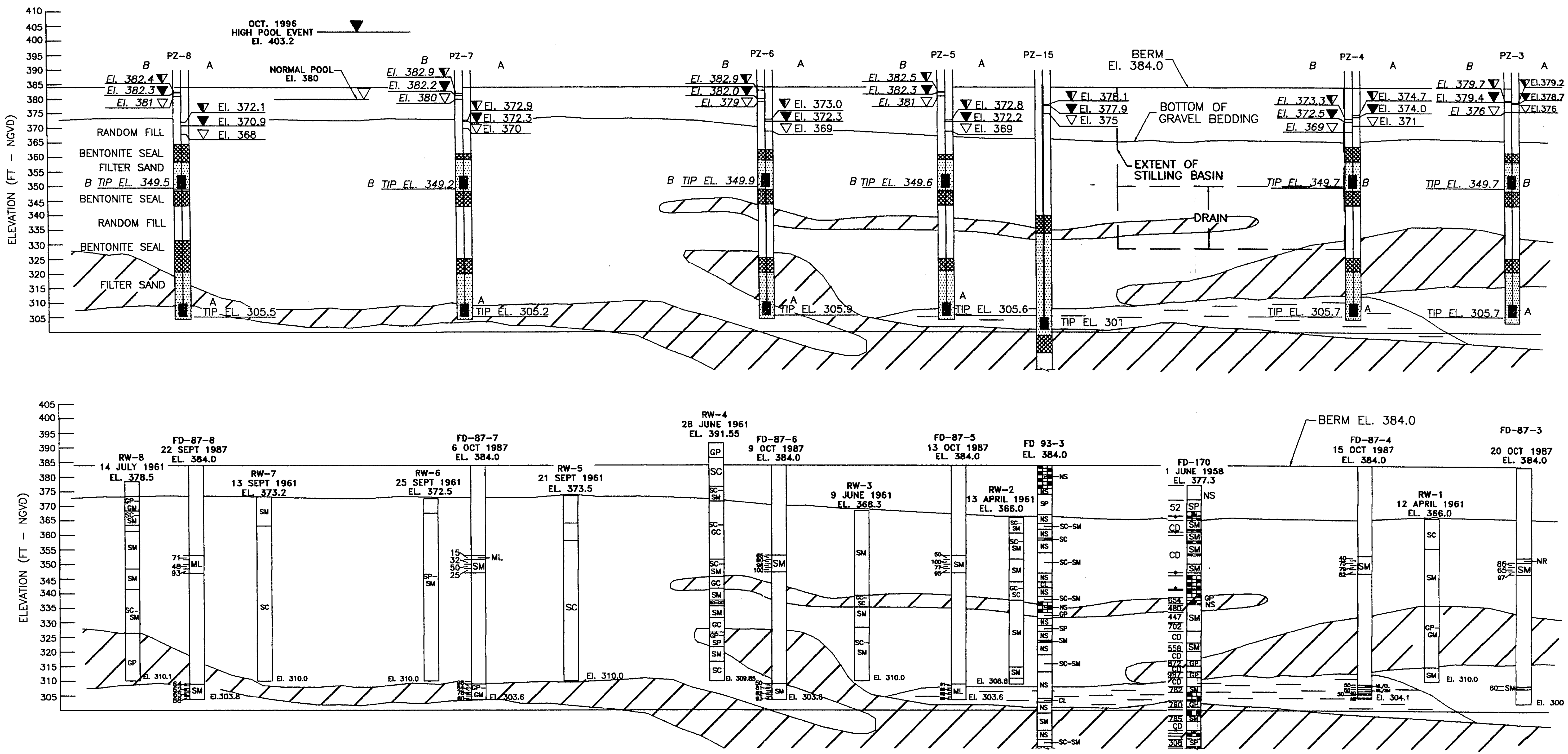
SCALE, FEET

NOTES:

1. ALL ELEVATIONS ARE IN FEET NGVD.
2. SEE PLATES 9 – 11 FOR COMPLETE LOG DETAILS.
3. SECTION BASED ON DRAWING PROVIDED BY CORPS OF ENGINEERS.

U.S. Army Corps of Engineers Waltham, Massachusetts	Instrumentation Evaluation Hopkinton Dam New Hampshire	STATION 5+25
GEI Consultants, Inc.	Project 97487	Nov. 1997 Plate 14

97487-13 11/20/97 DJM



SECTION B–B ALONG DOWNSTREAM BERM

(LOOKING UPSTREAM)

SCALE, FEET: 0 — 35 — 70

LEGEND:

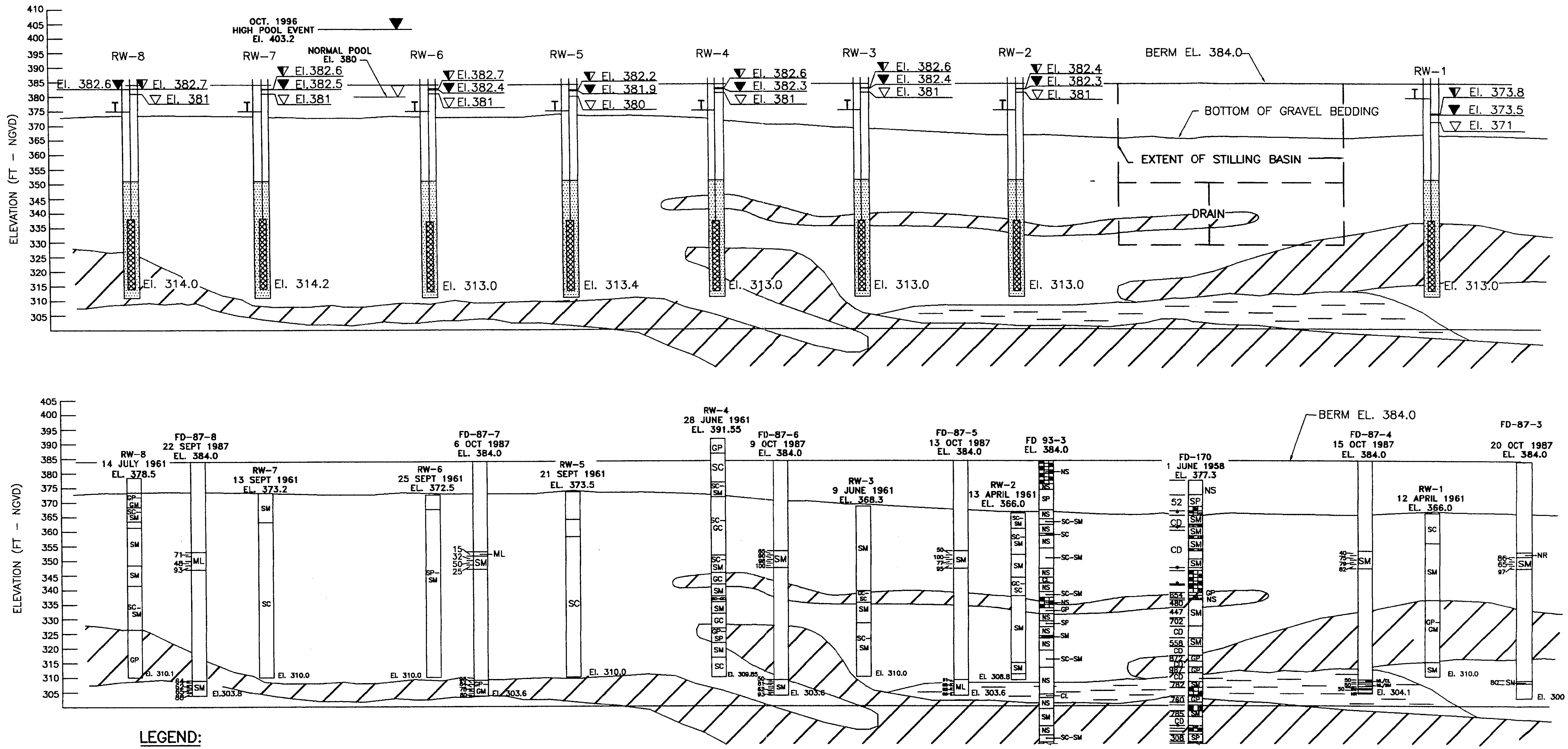
- POORLY GRADED SANDS AND GRAVELS
- SILTY, CLAYEY SANDS AND GRAVELS, TILL
- STRATIFIED FINE SAND AND SILT
- ▼ PROJECTED PIEZOMETER READINGS
- ▼ MAXIMUM RECORDED GROUNDWATER ELEVATION DURING OCTOBER 1996 HIGH POOL EVENT
- ▽ AVERAGE NORMAL GROUNDWATER ELEVATION (DATA FROM 1992–1997)

NOTES:

1. SEE PLATES 5A – 11 FOR COMPLETE BORING LOGS
2. SECTION DRAWING PROVIDED BY CORPS OF ENGINEERS.
3. PIEZOMETER CONSTRUCTION DETAILS SHOWN FOR PZ-8, TYPICAL FOR ALL PIEZOMETERS.

U.S. Army Corps of Engineers Waltham, Massachusetts GEI Consultants, Inc.	Instrumentation Evaluation Hopkinton Dam New Hampshire Project 97487	DOWNSTREAM BERM PROFILE WITH PIEZOMETRIC PORE WATER LEVELS FROM PIEZOMETERS Nov. 1997 Plate 15

97487-05 11/20/97 DJM



LEGEND:

- POORLY GRADED SANDS AND GRAVELS
- SILTY, CLAYEY SANDS AND GRAVELS, TILL
- STRATIFIED FINE SAND AND SILT
- T — T-OUTLET ELEVATION RW-1 EL. 379 : RW-2-8 EL. 375
- PROJECTED RELIEF WELL READINGS
- MAXIMUM RELIEF WELL READING TO DATE DURING OCTOBER 1996 HIGH POOL EVENT
- AVERAGE NORMAL RELIEF WELL READING (DATA FROM 1992-1997)

SECTION B-B ALONG DOWNSTREAM BERM

(LOOKING UPSTREAM)

0 35 70

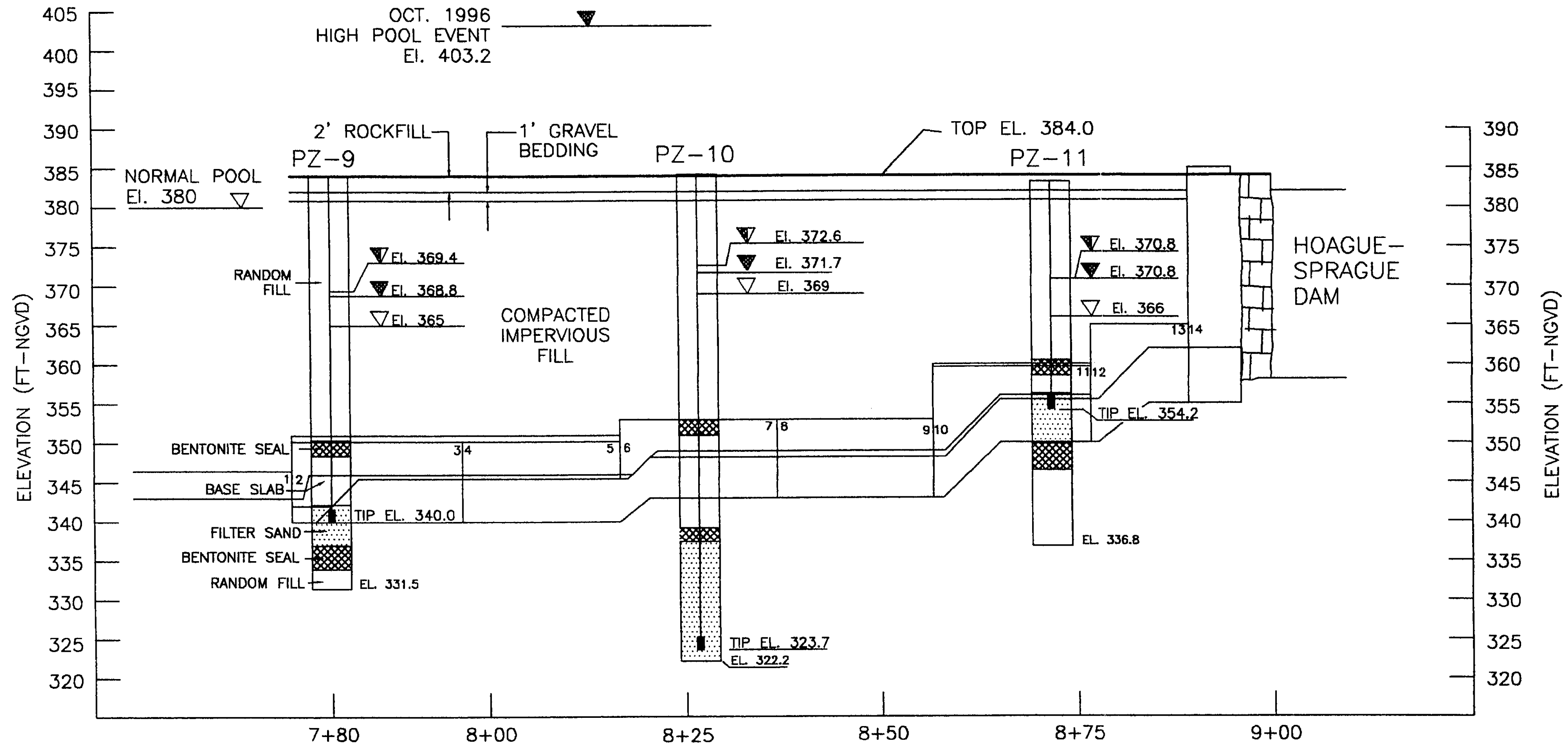
SCALE, FEET

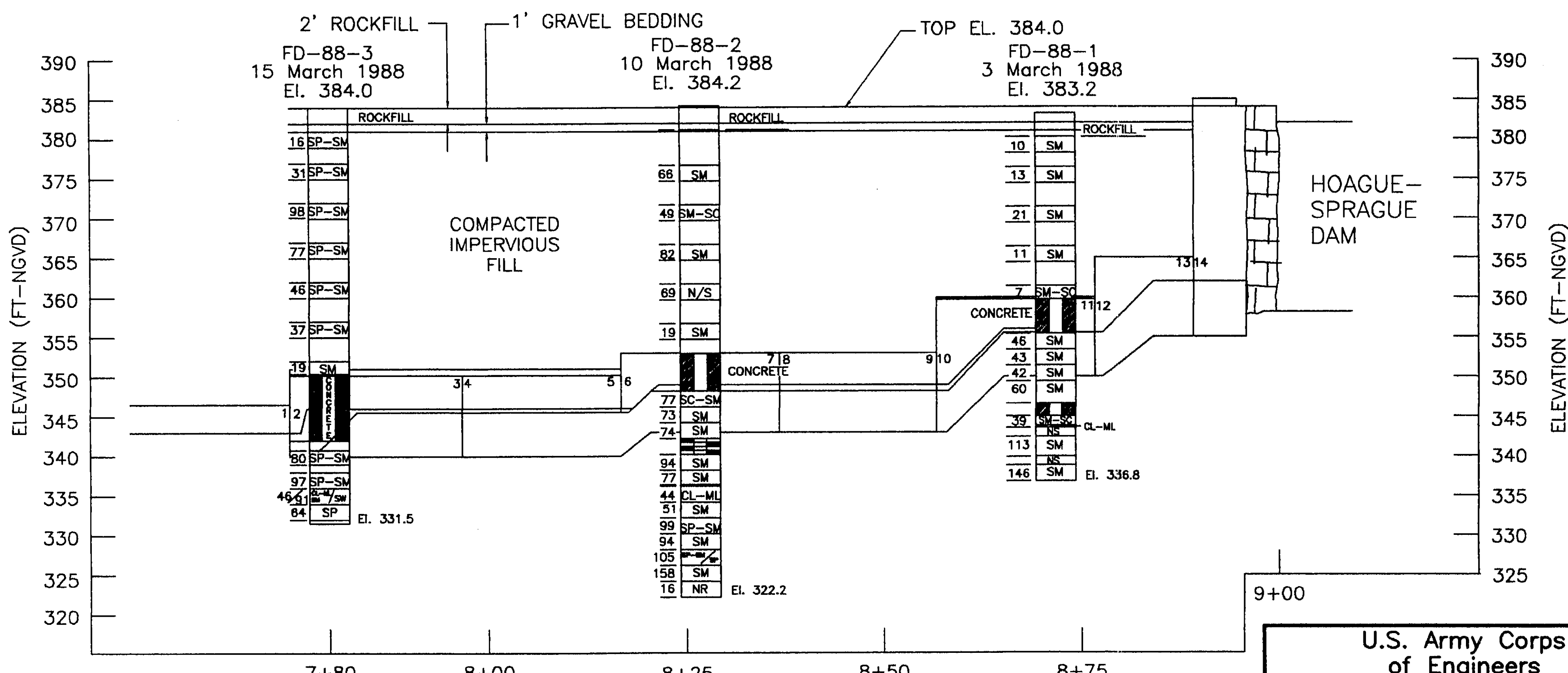
NOTES:

1. SEE PLATE 25 FOR RELIEF WELL DETAILS
2. SEE PLATES 5A - 11 FOR COMPLETE BORING LOGS
3. SECTION DRAWING PROVIDED BY CORPS OF ENGINEERS.

U.S. Army Corps of Engineers Waltham, Massachusetts	Instrumentation Evaluation Hopkinton Dam New Hampshire	DOWNSTREAM BERM PROFILE WITH PIEZOMETRIC PORE WATER LEVELS FROM RELIEF WELLS
GEI Consultants, Inc.	Project 97487	Nov. 1997 Plate 16

97487-06 11/20/97 DJM





SECTION C-C ALONG EAST OUTLET CHANNEL WALL
(LOOKING TOWARDS LEFT ABUTMENT)

LEGEND:

▼ PROJECTED PIEZOMETER READINGS

▼ MAXIMUM RECORDED GROUNDWATER ELEVATION DURING OCTOBER 1996 HIGH POOL EVENT

▽ AVERAGE NORMAL GROUNDWATER ELEVATION (DATA FROM 1992-1997)

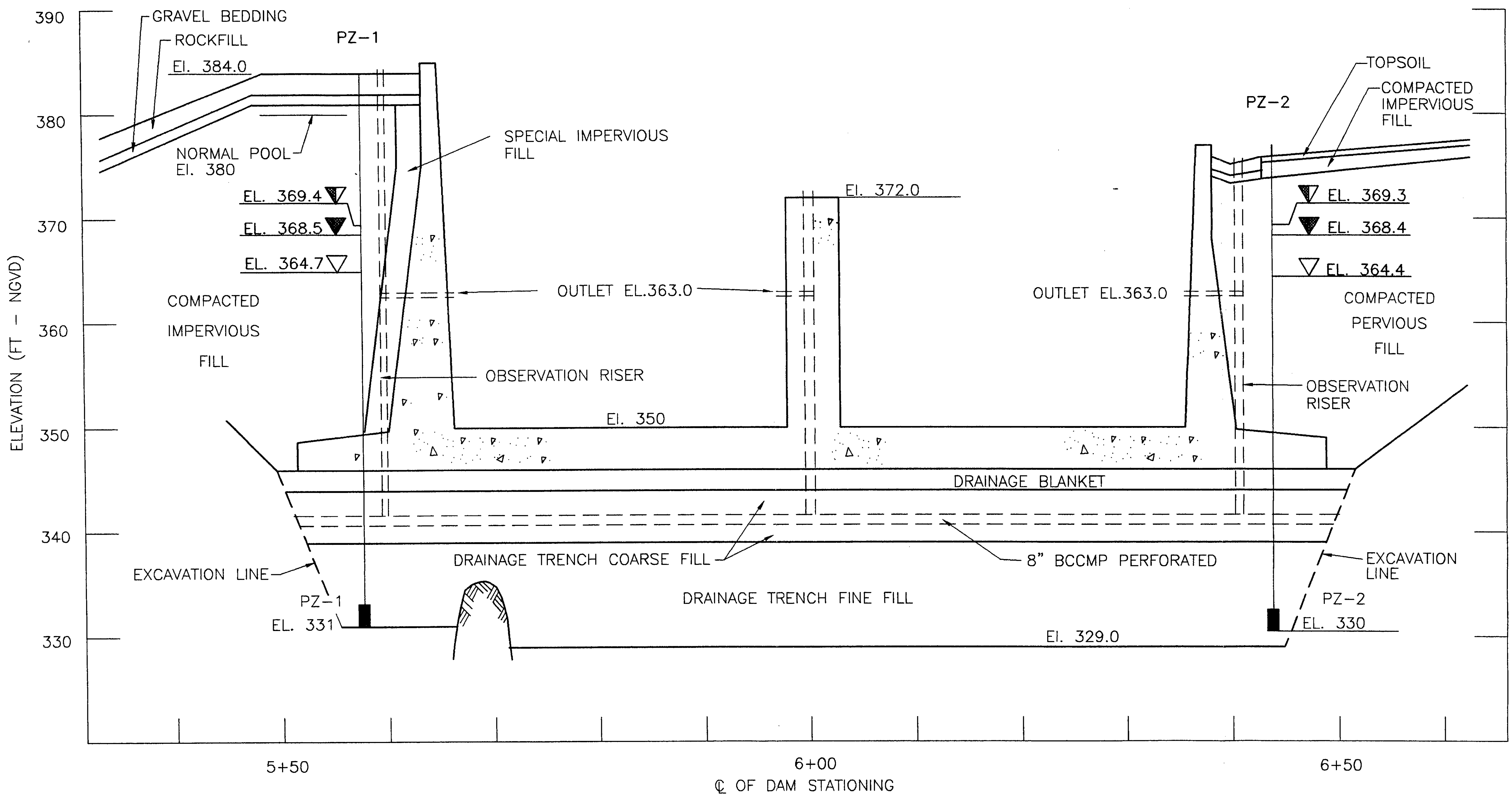
NOTES:

1. SEE PLATE 6 FOR COMPLETE LOG DETAILS.
2. SECTION DRAWING PROVIDED BY CORPS OF ENGINEERS.
3. PIEZOMETER CONSTRUCTION DETAILS SHOWN FOR PZ-9 TYPICAL FOR ALL PIEZOMETERS.

0 20 40
SCALE, FEET

U.S. Army Corps of Engineers Waltham, Massachusetts	Instrumentation Evaluation Hopkinton Dam New Hampshire	EAST OUTLET CHANNEL WALL
GEI Consultants, Inc.	Project 97487	Nov. 1997 Plate 17

97487-08 11/20/97 DJM



SECTION D–D THROUGH STILLING BASIN
(LOOKING UPSTREAM)

0 10 20
SCALE, FEET

LEGEND:

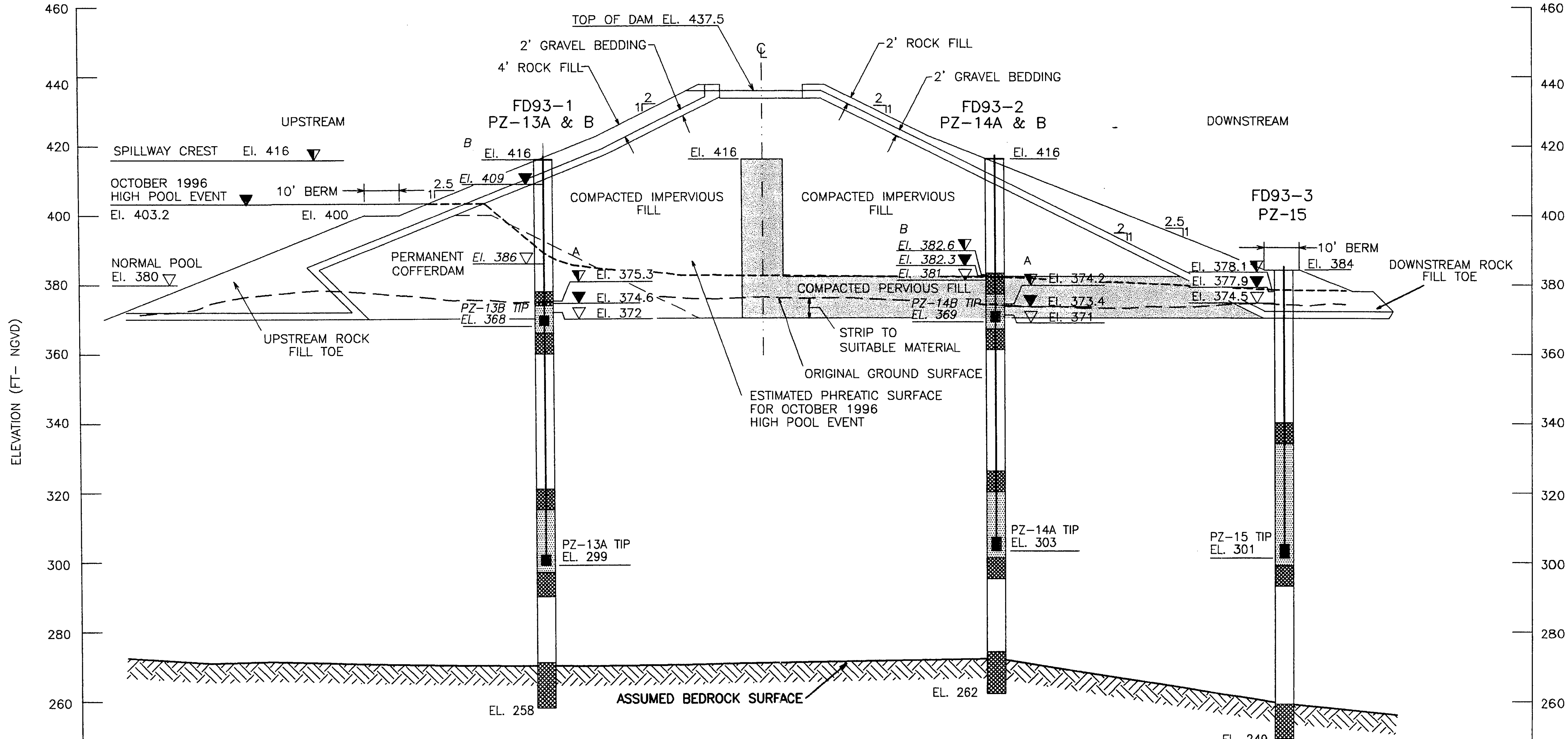
- PROJECTED PIEZOMETER READINGS
- MAXIMUM RECORDED GROUND WATER ELEVATION DURING OCTOBER 1996 HIGH POOL EVENT
- AVERAGE NORMAL GROUND WATER ELEVATION (DATA FROM 1992–1997)

NOTES:

1. SECTION DRAWING PROVIDED BY CORPS OF ENGINEERS.

U.S. Army Corps of Engineers Waltham, Massachusetts	Instrumentation Evaluation Hopkinton Dam New Hampshire	STILLING BASIN CROSS SECTION
GEI Consultants, Inc.	Project 97487	Nov. 1997 Plate 18

97487-09 10/27/97 DJM



SECTION A-A – STATION 5+25 HOPKINTON DAM

LEGEND:

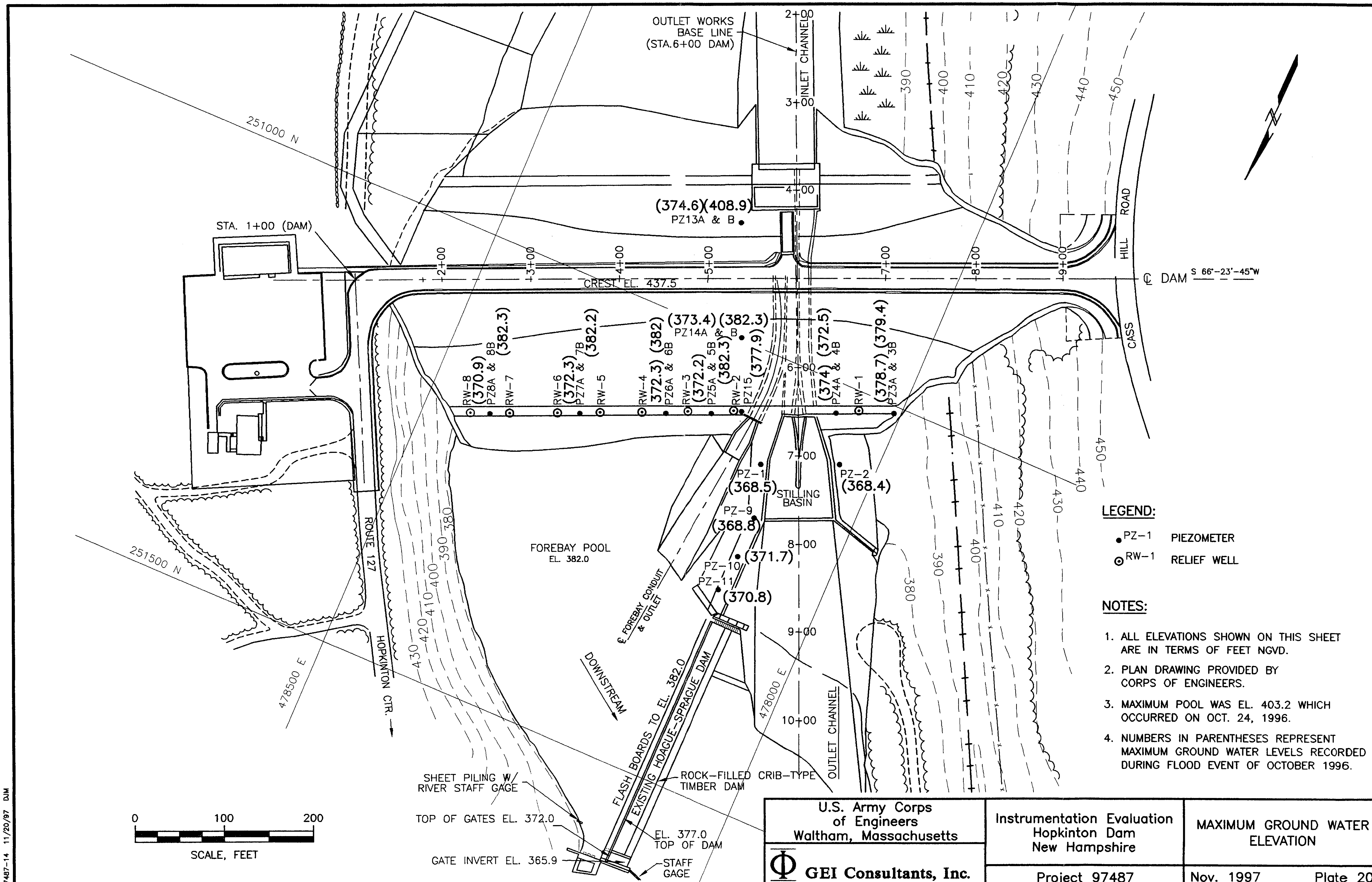
- ▼ PROJECTED PIEZOMETER READINGS
- ▼ MAXIMUM RECORDED GROUND WATER ELEVATION DURING OCTOBER 1996 HIGH POOL EVENT
- ▽ AVERAGE NORMAL GROUND WATER ELEVATION (DATA FROM 1994–1997)
- ---- ESTIMATED PHREATIC SURFACE, OCTOBER 1996 HIGH POOL EVENT

NOTES:

1. ALL ELEVATIONS ARE IN FEET NGVD.
2. SEE PLATES 9 – 11 FOR COMPLETE LOG DETAILS.
3. SECTION BASED ON DRAWING PROVIDED BY CORPS OF ENGINEERS.
4. NO PROJECTION OF PIEZOMETRIC ELEVATION WAS MADE FOR PZ-13B DUE TO SCATTER OF DATA

U.S. Army Corps of Engineers Waltham, Massachusetts	Instrumentation Evaluation Hopkinton Dam New Hampshire	STATION 5+25 WITH PIEZOMETRIC PORE WATER LEVELS
GEI Consultants, Inc.	Project 97487	Nov. 1997 Plate 19

97487-10 11/20/97 DJM



LEGEND:

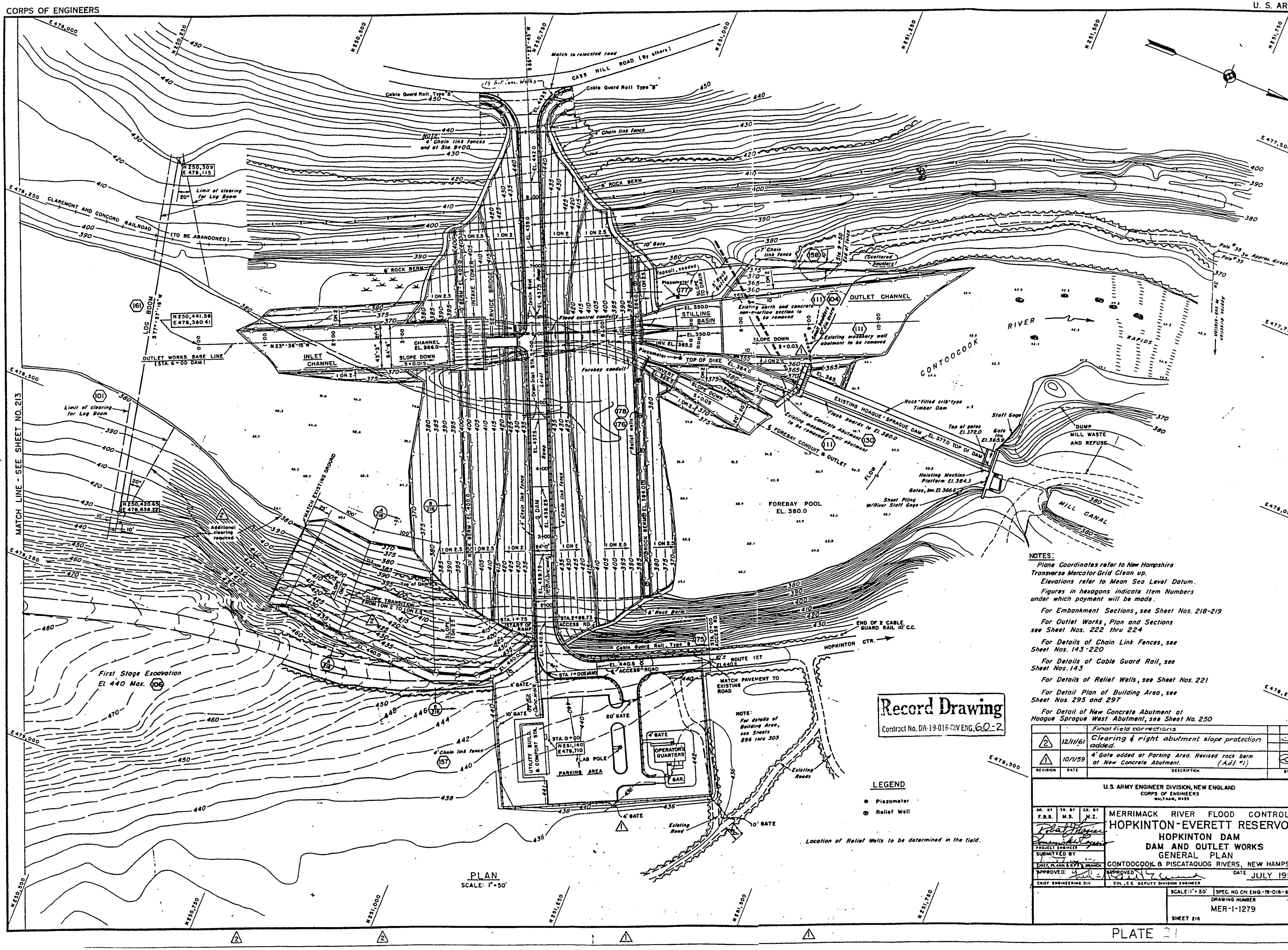
● PZ-1 PIEZOMETER

⊙ RW-1 RELIEF WELL

NOTES:

1. ALL ELEVATIONS SHOWN ON THIS SHEET ARE IN TERMS OF FEET NGVD.
2. PLAN DRAWING PROVIDED BY CORPS OF ENGINEERS.
3. MAXIMUM POOL WAS EL. 403.2 WHICH OCCURRED ON OCT. 24, 1996.
4. NUMBERS IN PARENTHESES REPRESENT MAXIMUM GROUND WATER LEVELS RECORDED DURING FLOOD EVENT OF OCTOBER 1996.

U.S. Army Corps of Engineers Waltham, Massachusetts	Instrumentation Evaluation Hopkinton Dam New Hampshire	MAXIMUM GROUND WATER ELEVATION
GEI Consultants, Inc.	Project 97487	Nov. 1997 Plate 20



NOTES:

Plane Coordinates refer to New Hampshire Transverse Mercator Grid Clean up.

Elevations refer to Mean Sea Level Datum.

Figures in hexagons indicate Item Numbers under which payment will be made.

For Embankment Sections, see Sheet Nos. 218-219

For Outlet Works, Plan and Sections see Sheet Nos. 222 thru 224

For Details of Chain Link Fences, see Sheet Nos. 143-220

For Details of Cable Guard Rail, see Sheet Nos. 143

For Details of Relief Wells, see Sheet Nos. 221

For Detail Plan of Building Area, see Sheet Nos. 295 and 297

For Detail of New Concrete Abutment at Hoague Sprague West Abutment, see Sheet No. 250

Record Drawing
Contract No. DA-19-016-CIV ENG. 60-2

LEGEND

- Piezometer
- Relief Well

Location of Relief Wells to be determined in the field.

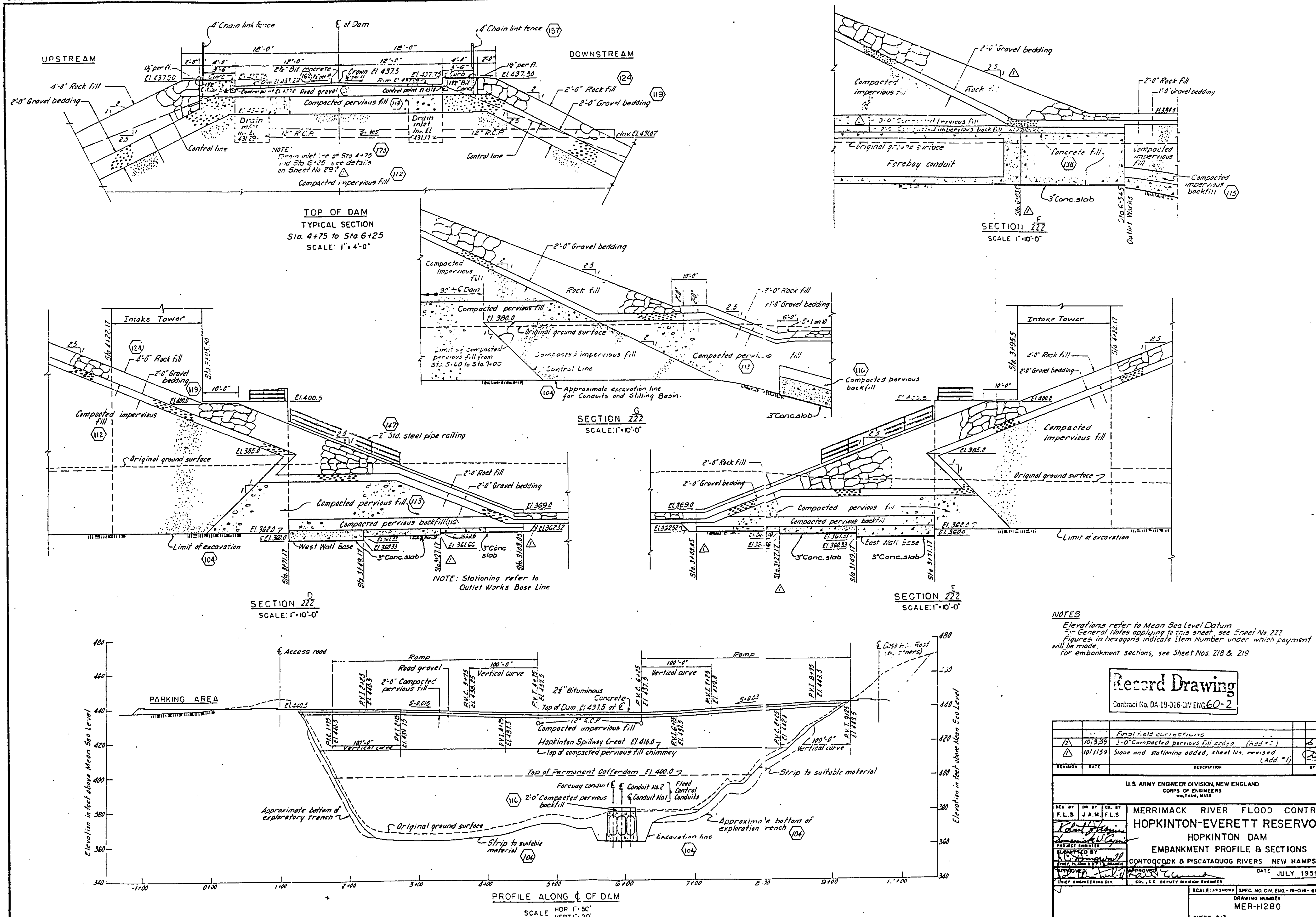
Final field corrections

REVISION	DATE	DESCRIPTION	BY
2	12/11/61	Clearing & right abutment slope protection added.	
1	10/1/59	4' Gate added at Parking Area. Revised rock berm at New Concrete Abutment. (Adj. #1)	

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
DAM AND OUTLET WORKS
GENERAL PLAN
CONTOOCOOK & PISCATAQUOG RIVERS, NEW HAMPSHIRE

DR. BY F.B.S. | TR. BY M.S. | CK. BY M.Z.
PROJECT ENGINEER
SUBMITTED BY
CHIEF, PLANN. & ENG. BRANCH
APPROVED: CHIEF ENGINEERING DIV.
APPROVED: COL., C.E. DEPUTY DIVISION ENGINEER
DATE JULY 1959
SCALE: 1"=50' | SPEC. NO. CIV. ENG.-19-016-60-1
DRAWING NUMBER MER-1-1279
SHEET 216



NOTES
Elevations refer to Mean Sea Level Datum
For General Notes applying to this sheet, see Sheet No. 222
Figures in hexagons indicate Item Number under which payment will be made.
For embankment sections, see Sheet Nos. 218 & 219

Record Drawing
Contract No. DA-19-016-CIV ENG 60-2

REVISION	DATE	DESCRIPTION	BY
		Final field corrections	
2	10/9/59	3'-0" Compacted pervious fill added (Add. #2)	
1	10/11/59	Slope and stationing added, sheet No. revised (Add. #1)	

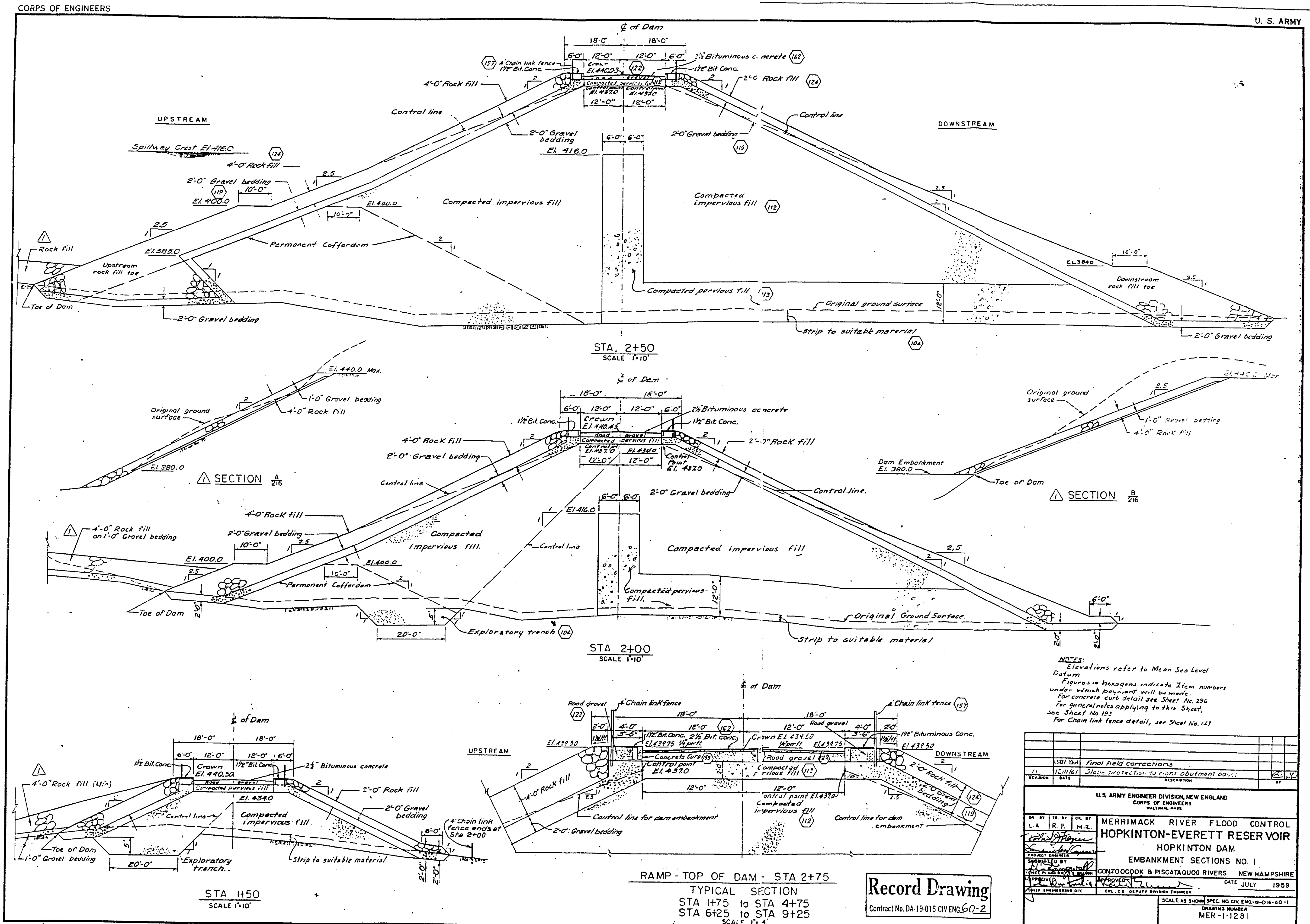
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DES. BY F.L.S. DR. BY J.A.M. CK. BY F.L.S.

MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
EMBANKMENT PROFILE & SECTIONS
CONTOOCOOK & PISCATAQUOG RIVERS NEW HAMPSHIRE

DATE JULY 1959
SCALE: AS SHOWN SPEC. NO. CIV. ENG.-19-016-60-1
DRAWING NUMBER MER-1-1280
SHEET 217

PLATE 22


℄ of Dam
UPSTREAM
DOWNSTREAM
Spillway Crest El 416.0
4'-0" Rock fill
2'-0" Gravel bedding
El. 400.0
Compacted impervious fill
Compacted pervious fill
Permanent Cofferdam
Upstream rock fill toe
Toe of Dam
Original ground surface
Strip to suitable material
Downstream rock fill toe
Control line
2½" Bituminous concrete
1½" Bit Conc.
4' Chain link fence
Crown El. 440.0
STA. 2+50
SCALE 1"=10'
SECTION A/216
SECTION B/216
El. 440.0 Max.
1'-0" Gravel bedding
Dam Embankment El. 380.0
Exploratory trench
STA 2+00
SCALE 1"=10'
STA 1+50
SCALE 1"=10'
RAMP - TOP OF DAM - STA 2+75
TYPICAL SECTION
STA 1+75 to STA 4+75
STA 6+25 to STA 9+25
SCALE 1"=4'
Road gravel
Concrete Curb
Control line for dam embankment
NOTES:
Elevations refer to Mean Sea Level Datum
Figures in hexagons indicate Item numbers under which payment will be made.
For concrete curb detail see Sheet No. 296
For general notes applying to this Sheet, see Sheet No 193
For Chain link fence detail, see Sheet No. 143
Final field corrections
Slope protection to right abutment added
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
EMBANKMENT SECTIONS NO. 1
CONTOOCOOK & PISCATAQUOG RIVERS NEW HAMPSHIRE
DATE JULY 1959
SCALE AS SHOWN SPEC. NO. CIV. ENG-19-016-60-1
DRAWING NUMBER MER-1-1281
SHEET 218
Record Drawing
Contract No. DA-19-016 CIV ENG 60-2

CORPS OF ENGINEERS

U. S. ARMY

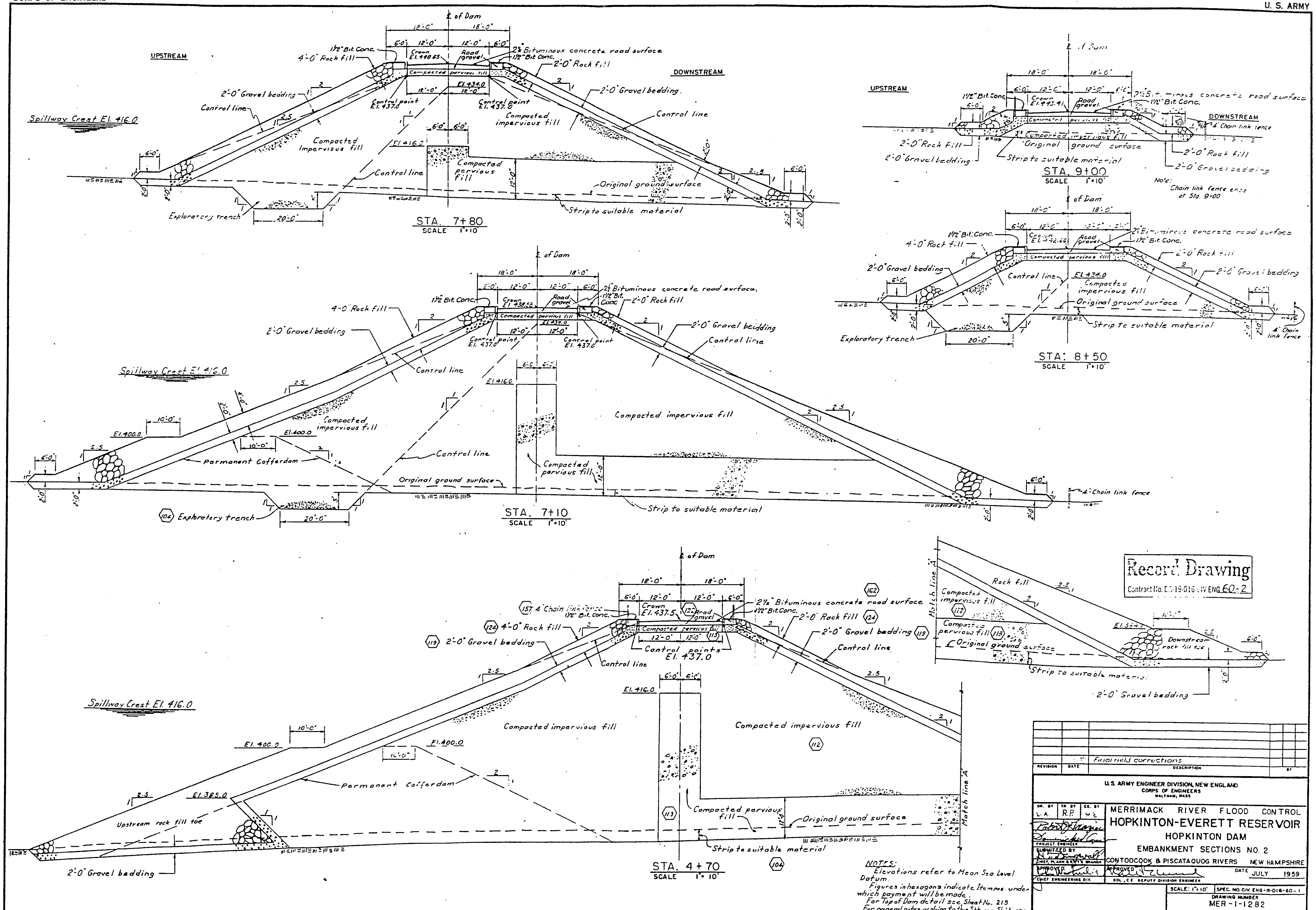
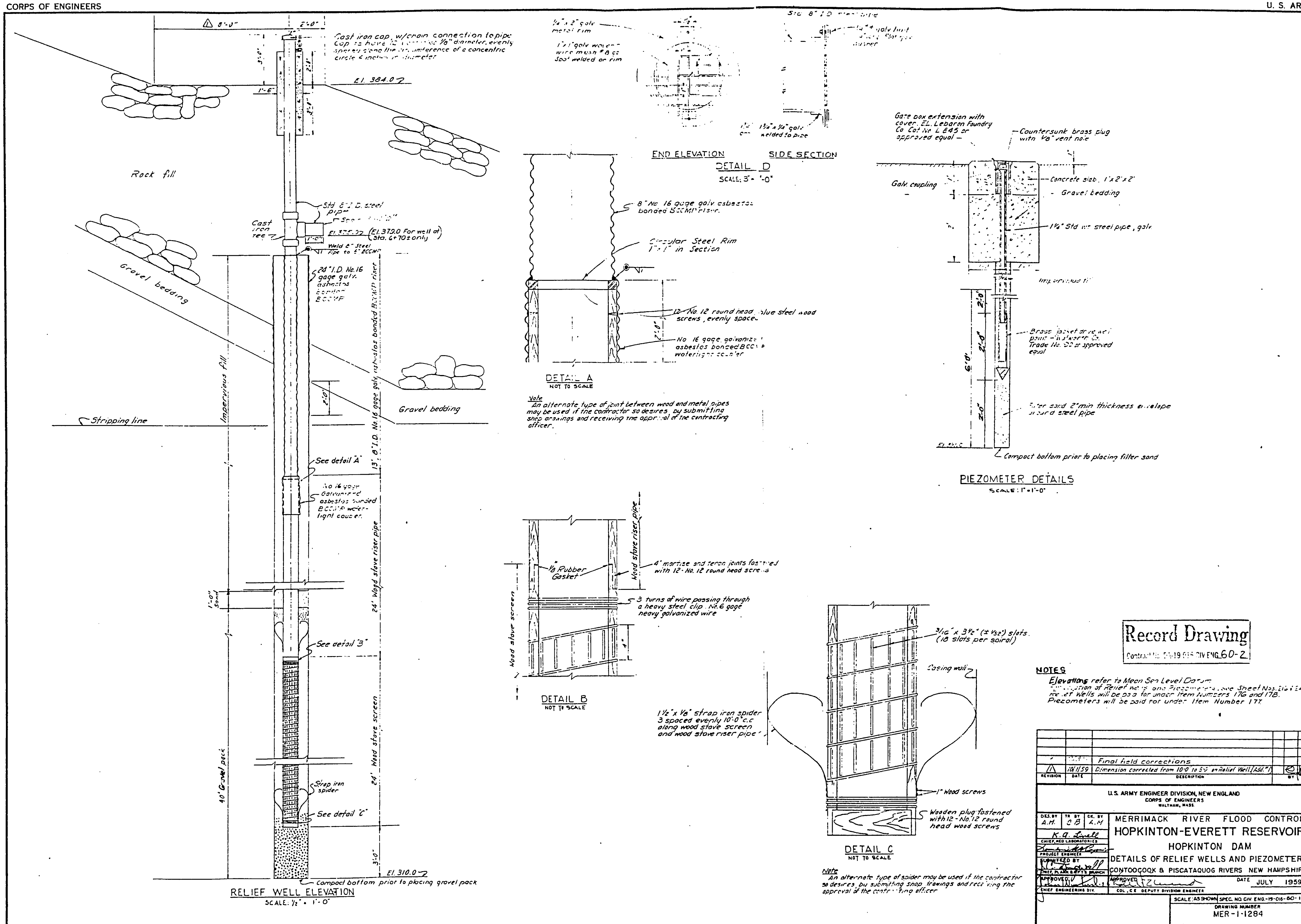
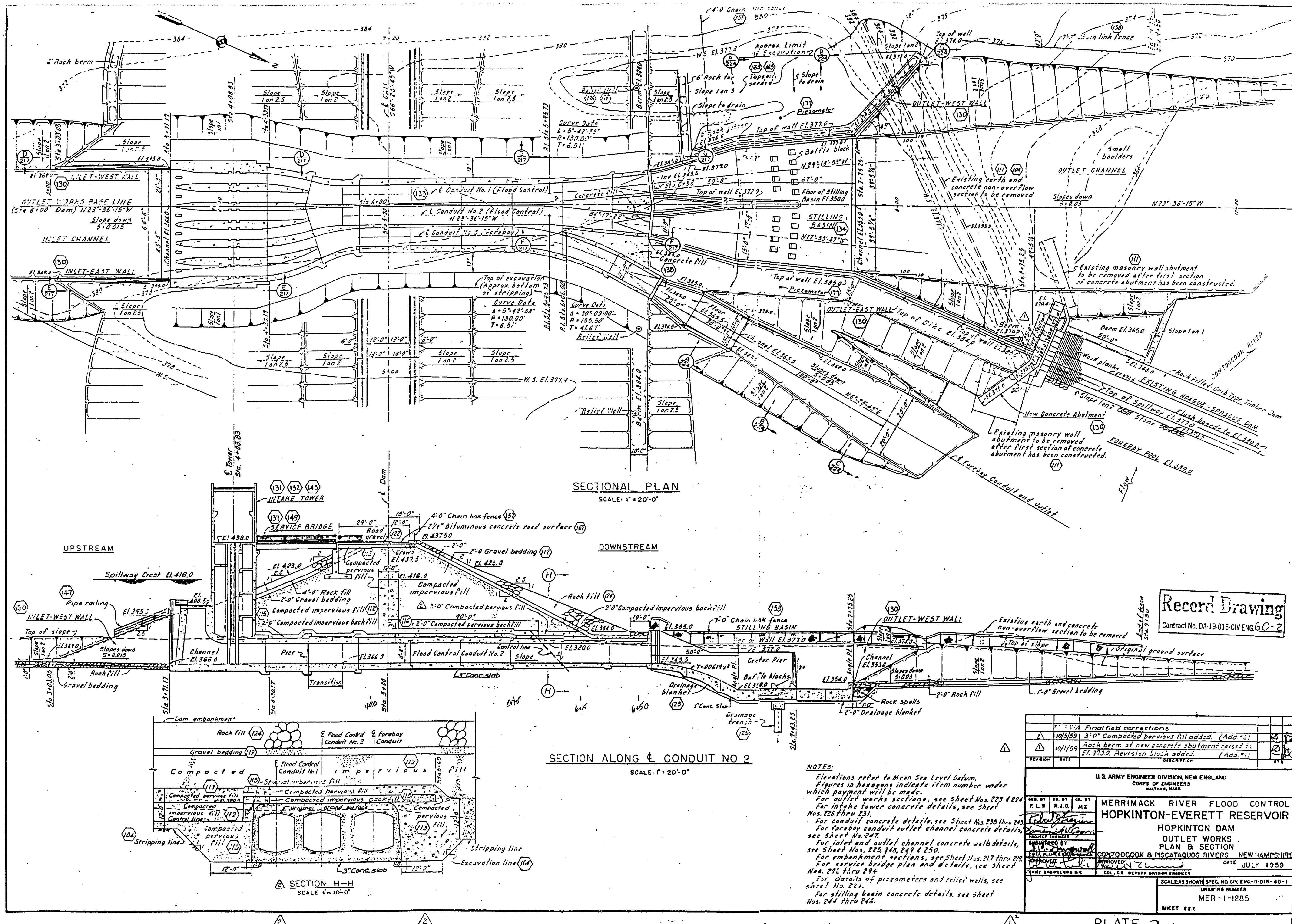


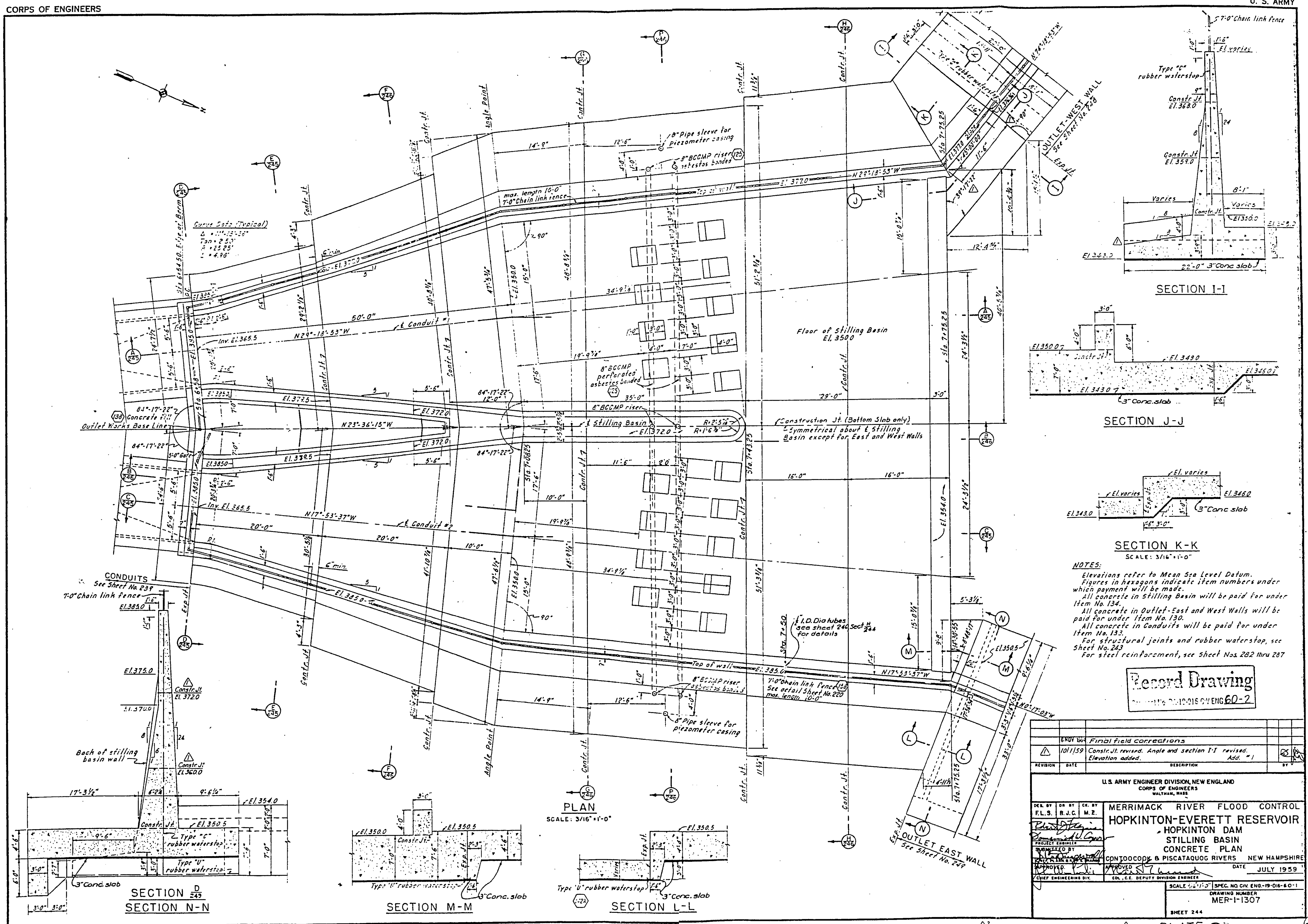
PLATE 24

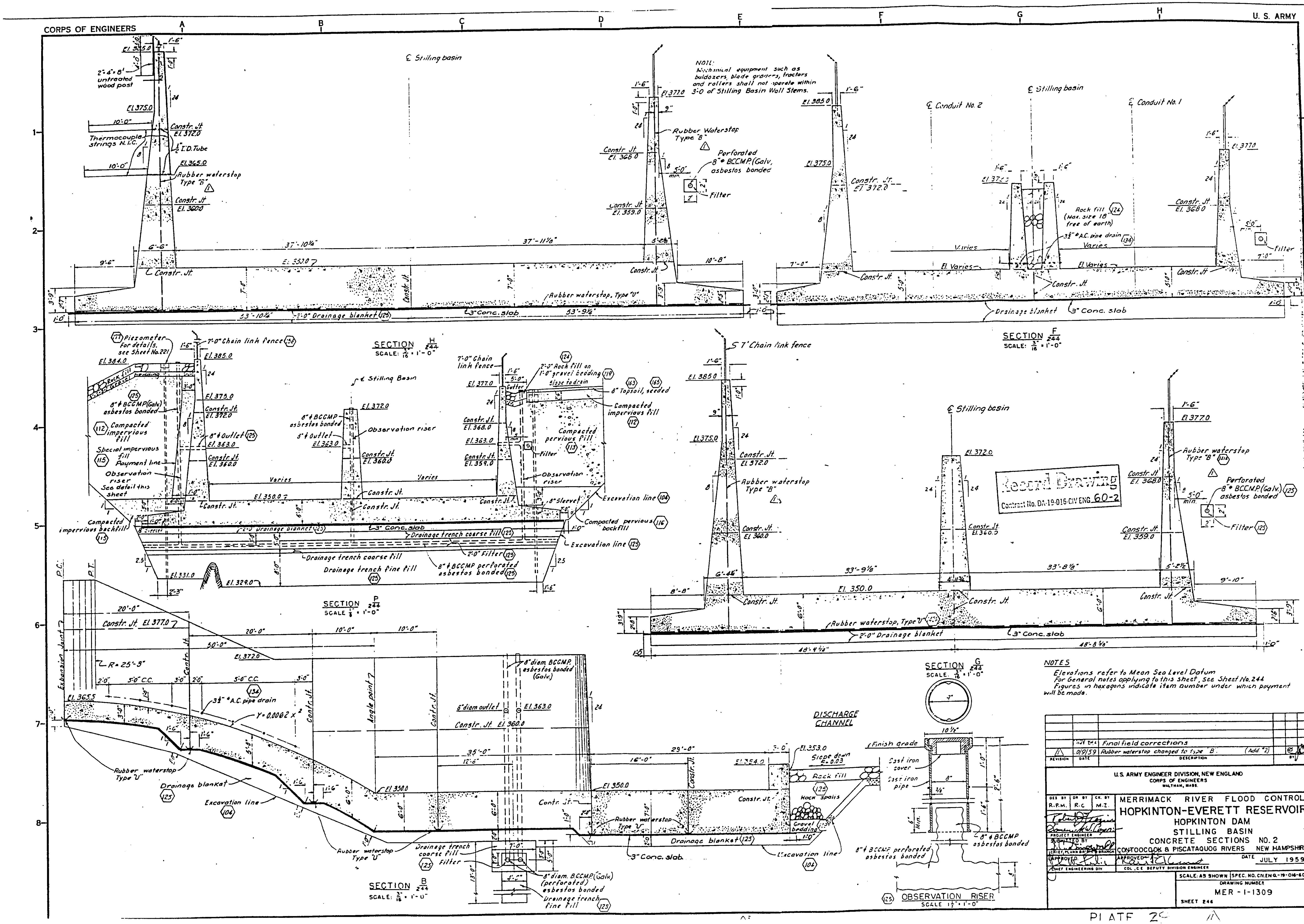

Cast iron cap, w/chain connection to pipe
El. 384.0
Rock fill
Gravel bedding
Impervious fill
Stripping line
Cast iron tee
El. 373.0 For well at Sta. 6+70 only
24" I.D. No. 16 gage galv. asbestos bonded BCCMP
See detail "A"
No. 16 gage galvanized asbestos bonded BCCMP watertight coupler
24' Wood stave riser pipe
1'-0" Sand
See detail "B"
24' Wood stave screen
40' Gravel pack
Strap iron spider
See detail "C"
El. 310.0
Compact bottom prior to placing gravel pack
RELIEF WELL ELEVATION
SCALE: 1/2" = 1'-0"
END ELEVATION
SIDE SECTION
DETAIL D
SCALE: 3" = 1'-0"
8" No. 16 gage galv. asbestos bonded BCCMP riser
Circular Steel Rim 1" x 1" in Section
No. 12 round head blue steel wood screws, evenly spaced
No. 16 gage galvanized asbestos bonded BCCMP watertight coupler
DETAIL A
NOT TO SCALE
Note
An alternate type of joint between wood and metal pipes may be used if the contractor so desires, by submitting shop drawings and receiving the approval of the contracting officer.
1/8" Rubber Gasket
4" mortise and tenon joints fastened with 12 - No. 12 round head screws
3 turns of wire passing through a heavy steel clip. No. 6 gage heavy galvanized wire
Wood stave screen
Wood stave riser pipe
DETAIL B
NOT TO SCALE
3/16" x 3 1/2" (± 1/32") slots. (18 slots per spiral)
Casing wall
1 1/2" x 1/8" strap iron spider 3 spaced evenly 10'-0" c.c. along wood stave screen and wood stave riser pipe
1" Wood screws
Wooden plug fastened with 12 - No. 12 round head wood screws
DETAIL C
NOT TO SCALE
Note
An alternate type of spider may be used if the contractor so desires, by submitting shop drawings and receiving the approval of the contracting officer.
Gate box extension with cover. EL. Lebaron Foundry Co. Cat. No. L 245 or approved equal
Countersunk brass plug with 1/8" vent hole
Galv. coupling
Concrete slab, 1' x 2' x 2'
Gravel bedding
1 1/4" Std wt steel pipe, galv.
Impervious fill
Brass jacket drive well point
Filter sand 2" min thickness envelope around steel pipe
Compact bottom prior to placing filter sand
PIEZOMETER DETAILS
SCALE: 1" = 1'-0"
Record Drawing
NOTES
Elevations refer to Mean Sea Level Datum.
Relief Wells will be paid for under Item Numbers 17G and 17B.
Piezometers will be paid for under Item Number 17T.
Final field corrections
10/1/59 Dimension corrected from 10'-0" to 5'-0" on Relief Well
REVISION DATE DESCRIPTION BY
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
DETAILS OF RELIEF WELLS AND PIEZOMETERS
CONTOOCOOK & PISCATAQUOG RIVERS NEW HAMPSHIRE
DATE JULY 1959
SCALE: AS SHOWN
SPEC. NO. CIV ENG.-19-016-60-1
DRAWING NUMBER MER-1-1284
SHEET 221



SECTIONAL PLAN
SCALE: 1" = 20'-0"
OUTLET WORKS BASE LINE (Sta 6+00 Dam) N23°-36'-15"W
INLET CHANNEL
INLET-WEST WALL
INLET-EAST WALL
℄ Conduit No. 1 (Flood Control)
℄ Conduit No. 2 (Flood Control)
℄ Conduit No. 3 (Forebay)
STILLING BASIN
OUTLET-WEST WALL
OUTLET-EAST WALL
OUTLET CHANNEL
Existing earth and concrete non-overflow section to be removed
Existing masonry wall abutment to be removed after first section of concrete abutment has been constructed.
New Concrete Abutment
EXISTING HOAGUE-SPRAGUE DAM
CONTOOCOOK RIVER
FOREBAY POOL El. 380.0
℄ Forebay Conduit and Outlet
Flow
SECTION ALONG ℄ CONDUIT NO. 2
SCALE: 1" = 20'-0"
UPSTREAM
DOWNSTREAM
INTAKE TOWER
SERVICE BRIDGE
Spillway Crest El. 416.0
SECTION H-H
SCALE 1" = 10'-0"
Record Drawing
Contract No. DA-19-016-CIV ENG 60-2
Final field corrections
10/9/59 3'-0" Compacted pervious fill added. (Add. #2)
10/1/59 Rock berm at new concrete abutment raised to El. 379.0. Revision block added. (Add. #1)
NOTES:
Elevations refer to Mean Sea Level Datum.
Figures in hexagons indicate item number under which payment will be made.
For outlet works sections, see Sheet Nos. 223 & 224.
For intake tower concrete details, see Sheet Nos. 226 thru 231.
For conduit concrete details, see Sheet Nos. 238 thru 243.
For forebay conduit outlet channel concrete details, see Sheet No. 247.
For inlet and outlet channel concrete walls details, see Sheet Nos. 225, 248, 249 & 250.
For embankment sections, see Sheet Nos. 217 thru 219.
For service bridge plan and details, see Sheet Nos. 292 thru 294.
For details of piezometers and relief wells, see sheet No. 221.
For stilling basin concrete details, see sheet Nos. 244 thru 246.
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
OUTLET WORKS
PLAN & SECTION
CONTOOCOOK & PISCATAQUOG RIVERS NEW HAMPSHIRE
JULY 1959
SCALE AS SHOWN SPEC. NO. CIV. ENG-19-016-60-1
DRAWING NUMBER
MER-1-1285
SHEET 222

PLATE 2


PLAN
SCALE: 3/16" = 1'-0"
SECTION I-I
SECTION J-J
SECTION K-K
SCALE: 3/16" = 1'-0"
SECTION D/245
SECTION N-N
SECTION M-M
SECTION L-L
OUTLET-WEST WALL See Sheet No. 248
OUTLET EAST WALL See Sheet No. 249
CONDUITS See Sheet No. 239
Floor of Stilling Basin El. 350.0
Construction Jt. (Bottom Slab only) ℄ Symmetrical about ℄ Stilling Basin except for East and West Walls
Outlet Works Base Line
NOTES:
Elevations refer to Mean Sea Level Datum.
Figures in hexagons indicate item numbers under which payment will be made.
All concrete in Stilling Basin will be paid for under Item No. 134.
All concrete in Outlet-East and West Walls will be paid for under Item No. 130.
All concrete in Conduits will be paid for under Item No. 133.
For structural joints and rubber waterstop, see Sheet No. 243
For steel reinforcement, see Sheet Nos. 282 thru 287
Record Drawing
Final field corrections
10/1/59 Constr. Jt. revised. Angle and section I-I revised. Elevation added. Add. #1
REVISION DATE DESCRIPTION BY
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
STILLING BASIN
CONCRETE PLAN
CONTOOCOOK & PISCATAQUOG RIVERS NEW HAMPSHIRE
DES. BY F.L.S. DR. BY R.J.C. CK. BY M.Z.
DATE JULY 1959
SPEC. NO. CIV. ENG-19-016-60-1
DRAWING NUMBER MER-1-1307
SHEET 244


CORPS OF ENGINEERS
U. S. ARMY
℄ Stilling basin
NOTE:
Mechanical equipment such as buldozers, blade graders, tractors and rollers shall not operate within 3'-0 of Stilling Basin Wall Stems.
2"-4"-8' untreated wood post
Thermocouple strings N.I.C.
Rubber waterstop Type "B"
Constr. Jt.
Perforated 8" ø BCCMP (Galv.) asbestos bonded
Filter
℄ Conduit No. 2
℄ Conduit No. 1
Rock fill (Max. size 18" free of earth)
3½" ø A.C. pipe drain
Varies
El. Varies
Rubber waterstop, Type "U"
2'-0" Drainage blanket
3" Conc. slab
SECTION H/244
SCALE: 3/16" = 1'-0"
SECTION F/244
SCALE: 3/16" = 1'-0"
7'-0" Chain link fence
Piezometer For details, see Sheet No. 221
8" ø BCCMP (Galv.) asbestos bonded
Compacted impervious fill
Special impervious fill
Payment line
Observation riser See detail this sheet
Observation riser
8" ø Outlet
5" ø Outlet
℄ Stilling Basin
2'-0" Rock fill on 1'-0" gravel bedding
6" Topsoil, seeded
Compacted impervious fill
Compacted pervious fill
6" Sleeve
Excavation line
Compacted pervious backfill
Compacted impervious backfill
Drainage trench coarse fill
2'-0" Filter
Drainage trench fine fill
8" ø BCCMP perforated asbestos bonded
SECTION P/244
SCALE: 1/8" = 1'-0"
Record Drawing
Contract No. DA-19-016-CIV ENG 60-2
Expansion joint
Angle point
R = 25'-3"
Y = 0.0062 X²
6" diam. outlet
8" diam. BCCMP asbestos bonded (Galv.)
DISCHARGE CHANNEL
Slope down 5 = 0.03
Rock fill
Rock spalls
Gravel bedding
Drainage blanket
Excavation line
SECTION B/244
SCALE: 3/16" = 1'-0"
8" diam. BCCMP (Galv.) (perforated) asbestos bonded
SECTION G/244
SCALE: 3/16" = 1'-0"
Finish grade
Cast iron cover
Cast iron pipe
8" ø BCCMP asbestos bonded
8" ø BCCMP perforated asbestos bonded
OBSERVATION RISER
SCALE 1½" = 1'-0"
NOTES
Elevations refer to Mean Sea Level Datum
For General notes applying to this sheet, See Sheet No. 244
Figures in hexagons indicate item number under which payment will be made.
Final field corrections
Rubber waterstop changed to type "B".
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
STILLING BASIN
CONCRETE SECTIONS NO. 2
CONTOOCOOK & PISCATAQUOG RIVERS NEW HAMPSHIRE
DATE JULY 1959
SCALE: AS SHOWN
DRAWING NUMBER
MER-1-1309
SHEET 246
PLATE

CORPS OF ENGINEERS, U. S. ARMY

NEW ENGLAND DIVISION

FOUNDATION AND MATERIALS BRANCH

FIELD LOG OF TEST BORING

Site HOPKINTON DAM EXPLORATION PROGRAM

PROJECT NO. DACW33-93-D-0004

Page 1 of ___ Pages

Hole No. FD93-1 Diam. (Casing) 4"HW 5"PW

Boring Started OCTOBER 5, 1993

Co-ordinates: N 250817.22 E 478249.90

Boring Completed OCTOBER 19, 1993

Drilled by ROB PRICE DARIUS WINTERS (ATL)

Report Submitted ___

Purpose of Exploration TO DETERMINE SUBSURFACE MATERIAL TYPES AND DISTRIBUTION AS WELL AS INSTALLATION OF PIEZOMETERS FOR DETERMINATION OF FOUNDATION PHREATIC SURFACES

Elevation Top of Hole 416 NGVD (~~M.S.L.~~)

Total Overburden Drilled 144.5 Feet

Elevation Top of Rock 271.5 NGVD (~~M.S.L.~~)

Elevation Bottom of Hole 258 NGVD (~~M.S.L.~~)

Total Rock Drilled 13.5 Feet

Total Depth of Hole 158 Feet

Core Recovered 65 %

Core Recovered 6 Ft.: 6 in Diam. 2.1 In.

Soil Samples 2½ In. Diam. 68 No.

Soil Samples ___ In. Diam. ___ No.

Casing Left in Place 0 Feet

PIEZOMETERS PROTECTED WITH 10 FEET 4" DIA STEEL CASING (2 FT. STICK UP)

Water Table Depth -46 FT.

Depth From	Depth To	Method of Drilling and Type of Bit Used
0	158	ROTARY-WASH

INDEX

Ground Water	___	Back of Page	___
Boring Location Sketch	___	Back of Page	___
Overburden Record	___	Page	___
Rock Drilling	___	Page	___
___		Page	___
___		Page	___
___		Page	___

Prepared by Tom Eldridge Field Data ___ Lab. Data ___

Submitted by ___

NED FORM DEC 63 121

REPLACES EDITION OF JUN 51 WHICH MAY BE USED UNTIL EXHAUSTED

PLATE A.1

U.S. ARMY
CORPS OF ENGINEERS
NEW ENGLAND DIVISION

FIELD LOG OF TEST BORING

Site HOPKINTON DAM — Page 1 of 10 Pages

Boring No. FD93-1 Desig. FD93-B Diam. (Casing) 5" PW & 4" HW

Co-ordinates: N 250877.22 E 478249.90

Elevation Top of Boring 416 NGVD	Hammer Wt. 300	Boring Started 10/5/93	
Total Overburden Drilled 144.5 Feet	Hammer Drop 18"	Boring Completed 10/19/93	
Elevation Top of Rock 271.5 NGVD	Casing Left		
Total Rock Drilled 13.5 Feet	Subsurface Water Data	Page	
Elevation Bottom of Boring 258 NGVD	Obs. Well		
Total Depth of Boring 158 Feet	Drilled By ROB PRYCE, DARIUS WINTERS		
Core Recovered 65 % No. Boxes 1	Mfg. Des. Drill CME-55		
Core Recovered 6 Ft 6" Diam. 2-1 In.	Inspected By: MARK WILBUR T ELDRIDGE		
Soil Samples 2½ In. Diam. 68 No.	Classification By: MARK WILBUR T ELDRIDGE		
Soil Samples In. Diam. No.	Classification By:		

Elev.	Depth (ft)	Core/Sample No.	Size	Depth Range	Blows per ft / Core Rec'y	Sampling and Coring Operations	Classification of Materials
							Rock Riprap
406	10			10.0 to 12.0	15	300 lb HAMMER 18" DROP NW ROD 2½ ID SPLIT SPOON	10 FT — Br. Silty, Clayey (30-40) SAND
	11	S-1			12, 10, 13		(SC/SM)
	12			12.0 to 14.0	20		12' — Br. Sandy (30-40) SILT w/ tr. Gravel (0-5)
	13	S-2			29, 24, 26	SIMILAR PROCEDURE ROLLER BIT & WASH TO 14'	
	14			14.0 to 16.0	11		
	15	S-3			34, 22, 28	300 lb HAMMER, 18" DROP NW ROD 2½" I.D. SPLIT SPOON, SPUN/WASH PW CASING TO 15'	
	16			16.0 to 18.0	34		
	17	S-4			35, 41, 46	SIMILAR PROCEDURE	(ML)
398	18						

GENERAL REMARKS: 10' OVERBURDEN, NO SAMPLING REQUIRED. REMOVED 2' OF RIP-RAP BY HAND SPUN PW (5") CASING TO -10' DEPTH. ROLLER BIT & WASH TO -10' DEPTH

NED Form 58 (Test)

Boring No. FD93-1

PLATE A.2

DEPTH (ft.)	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
398 18				10		Br. Sandy (30-40) SILT with Gravel (0-5)
				21		
19	S-5			100/3"	REFUSAL @19.3' (POSSIBLE COBBLE) INSTALL ROLLER BIT SPIN CASING TO 20'	
20			20.0	23		20' (ML)
			TO	27		
21	S-6		22.0	37	300 lb HAMMER, 18" DROP NW ROD, 2½" I.D. SPLIT SPOON	
				38		
22			22.0	37		COBBLES & BOULDERS
				23	SIMILAR PROCEDURE	
23	S-7		TO	64	ROLLER BIT & WASH 20-24'	
			24.0	57		
24			24.0	19		Br. Sandy (30-40) SILT
				24	300 lb HAMMER, 18" DROP	
25	S-8		TO	30	NW ROD, 2½" I.D. SPLIT SPOON (END OF WORK DAY 7:00 PM)	
			26.0	43		
26			26.0	47	SPUN/WASH PW CASING TO 25'	
			TO	49		
27	S-9			36	300 lb HAMMER, 18" DROP	
			28.0	31	NW ROD, 2½" I.D. SPLIT SPOON	
28			28.0	35		
			TO	37		
29	S-10			45	SIMILAR PROCEDURE	
			30.0	33	SPUN/WASH PW CASING TO 30', 3RD GEAR, RELATIVELY EASY DRILLING, INSTALL ROLLER BIT & WASH 26 TO 30'	
30			30.0	23		(ML)
			TO	27		
31	S-11		32.0	12	300 lb HAMMER, 18" DROP	
				14	NW ROD, 2½" I.D. SPLIT SPOON	
32			32.0	23		
				16		
33	S-12		TO	24	SIMILAR PROCEDURE	
			34.0	20	SPUN/WASH PW CASING 30 TO 34', 3RD GEAR RELATIVELY	
382 34				32	EASY DRILLING, INSTALL ROLLER	
				32	BIT & WASH TO 35'	

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Boring No. FD93-1

DEPTH	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
382 — 34			34.0		300 lb Hammer, 18" Drop NW ROD 2½" split spoon sampler	Br. Sandy (30-40) SILT
35	S-13		TO 36.0	33		
				26		(ML)
36			36.0	46	36'	Gr. Sandy (35-45) SILT w/little Gravel (0-10)
			TO	65	Similar procedure	
37	S-14		38.0	47		
				52		(ML)
38			38.0	42	--	Lt. Gr. SILT w/little Sand (0-10)
			TO	28		
39	S-15		40.0	39		
				45		(ML)
40			40. TO 40.9	100 / 10⁄5"	300 lb Hammer, 18" Drop NX ROD 2½", split spoon Sampler. Refusal @ 40.9' Install Roller Bit and Advance through 5" cobble	Dk. Br. Sandy (25-35) SILT w/tr. Gravel (ML)
41	S-16					(NS)
42			42.0	29		Dk. Br. Sandy (25-35) SILT w/tr. Gravel
			TO	37	similar procedure	
43	S-17		44.0	63		
				59		(ML)
44			44.0	35		Br. Silty (30-40) SAND w/tr. Gravel
				35		
45	S-18		TO	37		
			46.0	48		(SM)
46			46.0	21	300# Hammer, 18" Drop NX ROD, 2½" ID split Spoon Sampler	Dk. Br. Sandy (25-35) SILT w/tr. Gravel, slightly plastic
				23		
47	S-19		TO	51		
			48.0	34		(ML)
48			48.0	35	48'	
				22		
49	S-20		TO	44	Similar procedure	
			50.0	49	Spun/wash PW (5") casing to 45', Install Roller Bit and Advance to 50' 3rd Gear, relatively easy Drilling	
366 — 50						

EL :58A(Test)

Boring No. FD93-1

PLATE A.4

DEPTH (ft.)	CORE/SAMPLE No.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
366 — 50–52	S-21		50.0 TO 52.0	22, 22, 13, 24	300 lb HAMMER, 18" DROP NX ROD, 2½" I.D. SPLIT SPOON SAMPLER	Dk. Br. Sandy (25-35) SILT with Gravel, Slightly plastic
52–54	S-22		52.0 TO 54.0	26, 39, 87, 76	SIMILIAR PROCEDURE. SPUN/WASH PW (5") CASING TO 50' (STOPPAGE of WORK DAY). ROLLER BIT & WASH TO -54'	
54–56	S-23		54.0 TO 56.0	29, 92, 65, 164	300 lb. HAMMER 18 in. DROP NX ROD 2½" I.D. SPLIT SPOON. 3⅞" ROLLER BIT & WASH TO -56 FT.	
56–58	S-24		56.0 TO 58.0	33, 250, 120, 177	300 lb. HAMMER 18 IN DROP NX ROD 2½" I.D. SPLIT SPOON. SPIN & WASH 5" PW CASING 5 FT. TO -55 FT. ROLLER BIT & WASH TO -58 FT.	(ML)
58–60	S-25		58.0 TO 60.0	60, 60, 110, 148	300 lb. HAMMER 18 IN DROP NX ROD 2½" I.D. SPLIT SPOON. ROLLER BIT & WASH TO -60 FT.	
60–62	S-26		60.0 TO 60.8	95, 150/3	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON. ROLLER BIT & WASH TO -62 FT. WASH WITH DRILLING MUD TO CLEAR CAVINGS & WASH	Dk. Br. Sandy (25-35) SILT with Gravel & Rock Frags (10-20) (ML) (NS)
62–64	S-27		62.0 TO 64.0	73, 71, 73, 78	ADVANCE 5" PW CASING TO -62 FT. / ROLLER BIT & WASH. 300 lb HAMMER 18 IN. DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Br. Sandy (25-35) SILT with Gravel & Rock Frags. (10-20) (ML)
64–66 — 350	S-28		64.0 TO 65.8	46, 46, 70, 120/3	300 lb HAMMER 18 IN. DROP NW ROD 2½" I.D. SPLIT SPOON. SPIN & WASH 5" PW CASING TO -65 FT.	Dk. Gr. Sandy (15-25) CLAY with Gravel (CL) (NS)

N... 58A (Test)

Boring No. PD93-1

DEPTH (ft.)	CORE/SAMPLE No.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
66 (350' EL.)	S-29		66.0 To 68.0	20, 26, 42, 53	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Dk Gr. Sandy (25-35) CLAY
67						
68	S-30		68.0 To 69.8	88, 70, 137, 160/3	300 lb HAMMER 18 IN. DROP NW ROD 2½" I.D. SPLIT SPOON; SPIN & WASH 5" PW CASING TO -70 FT.	(CL)
69						
70	S-31A		70.0 To 72.0	19, 25, 39	300 lb HAMMER 18 IN. DROP NW ROD 2½" I.D. SPLIT SPOON	
71	S-31B			43		
72	S-32		72.0 To 74.0	34, 38, 57, 52	300 lb. HAMMER 18 IN. DROP NW ROD 2½" I.D. SPLIT SPOON; ADVANCE 5" PW CASING TO -75 FT.	Gr. m-f Clayey (25-35) SAND (SC); Gr. m-f SAND w/ tr. silt & tr. Gravel (SP)
73						
74 (74')	S-33		74.0 To 76.0	26, 37, 52, 50	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON; ROLLER BIT/WASH TO -76 FT.	Gr. mostly f. silty (20-30) SAND w/ tr. gravel, slightly plastic
75						
76	S-34		76.0 To 78.0	47, 75, 100, 150	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON; ROLLER BIT & WASH TO -78 FT	(SM)
77						
78	S-35		78.0 To 79.2	44, 57, 100/2 BOULDER REFUSAL	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON; INSERT 4" HW CASING INTO BORE HOLE AND SPIN/WASH TO -79.5 FT. ROLLER BIT W/ 3⅞" BIT TO -80 FT. 3RD GEAR 3/4 THROTTLE	
79 (336.8)						
80 (336' EL.)	S-36		80.0 To 81.3	73, 65, 160/4	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON; ROLLER BIT/WASH TO -82 FT.	Gr. m-f Silty (15-35) SAND (SM)
81						(NS)
82						

NED Form 58A (Test)

Boring No. FD 93-1

PLATE A.6

334'

DEPTH	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
82	S-37		82.0 to 84.0	46, 60, 66, 72	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON. SPIN/WASH HW CASING TO -84 FT. 3RD GEAR 3/4 throttle moderately DIFFICULT DRILLING	Gr. m-f Silty (15-25) SAND (SM)
84	S-38		84.0 to 86.0	56, 85, 133, 138	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON. ROLLER BIT TO -86 FT. AND WASH	
86	S-39		86.0 to 88.0	58, 82, 95, 95	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON. SPIN/WASH HW CASING TO -88 Ft.	
88 (CT 12)	S-40		88.0 to 90.0	31, 35, 40, 38	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON. SPIN/WASH CASING TO 90 FT.	Gr. Sandy (15-25) CLAY w/silt lamin & little gravel (5-15) (CL)
90	S-41		90.0 to 92.0	18, 26, 33, 132	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON. ROLLER BIT/WASH TO 92 FT	Gr. fat CLAY (CH)
92	S-42			60/0	300 lb HAMMER 18 IN DROP NW ROD. ROLLER BIT THROUGH 9" BOULDER	Possible Cobbles & Boulders (NR)
94	S-43		94.0 to 95.1	25, 50, 100/1	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON. SPIN, WASH CASING TO -95'. ROLLER BIT & WASH TO -96'	Gr. fat CLAY (CH); (NS)
96			96.0 to 97.4	33, 68, 200/5	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON. ROLLER BIT TO -98 FT.	Gr. SILT w/f. Sand (20-30) (ML); (NS)
98						

318'

ED Form 53A (Test)

Boring No. FO 93-1

ELEV	DEPTH FT.	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
318	98	S-45		98.0 TO 99.0	76 / 164	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Gr. Silty (20-30) SAND w/little Gravel (5-15) (SM)
	99				~~60/0~~	~~ADVANCE CASING TO -100 FT.~~	(NS)
316	100	S-46		100 TO 100.2	100/2 Bouncing REF	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Granite Rock Frags
	101					ROLLER BIT & WASH TO -102'	(NS)
	102	S-47		102.0 TO 102.2	171 / 150/2	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Gr. Silty (20-30) SAND w/little Gravel (5-15) (SM)
	103					ROLLER BIT & WASH BOREHOLE TO -104 FT.	(NS)
	104	S-48		104.0 TO 104.4	200/5	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Silty, Clayey (21) SAND w/little Gravel (10) (SC/SM)
	105					ROLLER BIT/WASH BORING TO -104 FT.	(NS)
	106	S-49		106.0 TO 106.7	151 / 100/2	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Well-graded SAND w/Gravel (10-20) (SW)
	107					ROLLER BIT/WASH BORING TO -108 FT.	(NS)
	108	S-50		108.0 TO 108.8	70 / 100/3	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Silty (15-25) SAND w/Gravel (15-25) (SM)
	109					SPIN/WASH 4" HW CASING TO -110 FT. ROLLER BIT WASH CASING TO -110 FT.	(NS)
OCT 13	110	S-51		110.0 TO 110.2	200/2	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. SAND w/Silt (5-15) (SP-SM)
	111					ROLLER BIT & WASH BOREHOLE TO -112' 3RD GEAR ½-¾ throttle RELATIVELY DIFFICULT DRILLING	(NS)
	112	S-52		112.0 TO ~~113.1~~ 112.6	145 / 60/1	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Sandy (30-40) CLAY w/little Gravel (0-10) (CL)
	113					ROLLER BIT & WASH TO -114 FT.	(NS)
302	114						

NED Form 58A (Test)

Boring No. FD 93-1

PLATE A.8

302

DEPTH Ft.	CORE/SAMPLE No.	SIZE	DEPTH RANGE	BLOWS PER FT CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
114	S-53		114.0 TO 114.3	120/3 Bouncing REF	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Sandy (30-40) CLAY with little Gravel (0-10) (CL)
115					ADVANCE 4" CASING, SPIN/WASH TO -115 FT. ROLLER BIT TO -116 FT.	(NS)
116	S-54		116.0 TO 116.4	150/5	300 lb HAMMER 18 IN. DROP NW ROD 2½" I.D. SPLIT SPOON	Br. SAND w/Silt (B) (SP-SM)
117–119				↓	ROLLER BIT, WASH BOREHOLE TO -118 FT. DIFFICULT DRILLING & BOUNCING OF RIG. CONTINUE ROLLER BIT & WASH through Cobble & GRAVEL TO -120 FT. SPIN & WASH HW CASING TO -120 FT. DIFFICULT - 4TH GEAR 3/4 THROTTLE	(NS)
120	S-55		120.0 TO 120.3	125 125/3	300 lb HAMMER 18 IN DROP NW ROD 2½" SPLIT SPOON	Dk. Gr. Silty (25-35) f. SAND w/Gravel (15-25) (SM)
121					ROLLER BIT TO -122 FT. 121 2ND GEAR ½-¾ throttle	(NS)
122	S-56		122.0 TO 123.0	101 246	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. Silty (25-35) f. SAND w/Gravel (15-25) (SM)
123					ROLLER BIT BOREHOLE & WASH TO -124 FT.	(NS)
124	S-57		124.0 TO 124.3	150/3	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. Silty (25-35) f. SAND w/Gravel (15-25) (SM)
125					ROLLER BIT & WASH TO -126 FT. SHAKING/ROCKING	(NS)
126	S-58		126.0 TO 126.5	170 REF	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Silty (10-20) Well-graded SAND w/Gravel (10-20) (SM)
127					ROLLER BIT & WASH BOREHOLE RELATIVELY DIFFICULT TO -128 FT.	(NS)
128	S-59		128.0 TO 128.4	150/5	300 lb. HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Well-graded SAND w/Silt (5-15) (SW-SM)
129					SPUN/WASHED HW CASING TO 130 FT. ROLLER BIT TO SAME	(NS)
286 — 130						

ED Form 58A (Test)

Boring No. FD 93-1

PLATE A.9

DEPTH	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
286 — 130	S-60		130.0 TO 130.8	110 110/3	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. Silty (30-40) SAND (SM)
131					ROLLER BIT & WASH TO -132'	(NS)
132	S-61		132.0 TO 132.4	157/6	300 lb HAMMER 18 IN. DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. Silty (30-40) SAND (SM)
133					ROLLER BIT & WASH BOREHOLE TO -134' 2ND GEAR ¾ throttle MODERATE DRILLING	(NS)
134	S-62		134.0 TO 134.8	102 150/3	300 lb. HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. Silty (30-40) SAND (SM)
135					ROLLER BIT & WASH BOREHOLE TO -136' 135.5'	(NS)
136	S-63		136.0 TO 137.6	34 59 112 60/1	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Sandy (25-35) CLAY (CL)
137					ROLLER BIT & WASH TO -138'	(NS)
138	S-64		138.0 TO 139.6	54 60 130 60/1	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Sandy (25-35) CLAY w/Gravel (5-15) (CL)
139					ROLLER BIT & WASH TO -140 FT.	(NS)
140	S-65		140.0 TO 140.8	64 150/3	300 lb HAMMER 18 in DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Sandy (25-35) CLAY w/Gravel (5-15) (CL)
141					ROLLER BIT & WASH TO -142.0'	(NS)
142	S-66	420	142.0 TO 143.2	76 97 150/2	300 lb Hammer 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Sandy (25-35) CLAY w/Gravel (5-15) (CL)
143–145					ROLLER BIT & WASH TO -146 FT. -144.5' through COBBLES?	(NS)
270 — 146						

NED Form 58A (Test)

Boring No. FD 93-1

PLATE A.10

Elev.	DEPTH	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
270	146	S-67		146.0 P 146.1	90/1	300 lb HAMMER 18 IN DROP NW ROD 2½" SPLIT SPOON	Rock and/or Cobble Fragments
	147					ADVANCE NW CASING (HOLE NOT STAYING OPEN & ROLLER BIT BINDING UP) TO -144.5' DEPTH	(NS)
	148					INCREASE throttle speed @ -143.5' DEPTH	
	149				42" REC 70%	CORE ROCK WITH NX SIZE CORE BARREL DIAMOND BIT 1st 5 FT RUN DRILL TIME: 11 min 30 SEC	
	150				R-1	CORE ROCK BETWEEN -148 FT TO -153'	
	151				RQD <10%		
	152						
263	153						Weathered Bedrock
	154				R-2 36" REC	2ND 5 FT. RUN NX SIZE CORE BARREL W DIAMOND BIT	
	155				60%	DRILL TIME: 10 min 30 SEC. CORED ROCK BETWEEN -153 FT. TO -158 FT.	
	156				RQD 0		
	157						
258	158					TERMINATE BORING @ -158.0 FT.	

NED Form 58A (Test)

Boring No. F093-1

PLATE A.12

FIELD LOG OF TEST BORING IN ROCK

SITE Hopkinton Dam HOLE NO. FD 93-1 PAGE (1)

	DATE	DEPTH FT. FROM	DEPTH FT. TO	RUN FT.	RUN REC'V'Y FT.	REC'V'Y %	DRILLING BEHAVIOR: FEED	DRILLING BEHAVIOR: WATER	DRILLING BEHAVIOR: REASON FOR PULL	ACTUAL DRILLING TIME	BIT NO. SIZE AND TYPE	ADDITIONAL REMARKS
R-1	OCT 14	148.0	153.0	5 Ft	3-5 FT.	70		NO WATER LOSS		11 min 30 SEC.	NX CORE DIAMOND	RQD = 10 WEATHERED GRANITE
R-2	OCT 15	153.0	158.0	5 FT.	3 FT.	60				10 min 30 SEC.	NX CORE DIAMOND	RQD = 0 WEATHERED GRANITE

TOTAL BED ROCK DRILLED 10 FEET

TOTAL BED ROCK RECOVERED 6.5 FEET

BED ROCK RECOVERY 65 PERCENT

DRILLER ROB PRICE

INSPECTOR TOM ELDRIDGE

NED FORM DEC 63 130

[illegible] MAY BE USED UNTIL EXHAUSTED

Site: HOPKINTON DAM

Boring No: FD 93-1

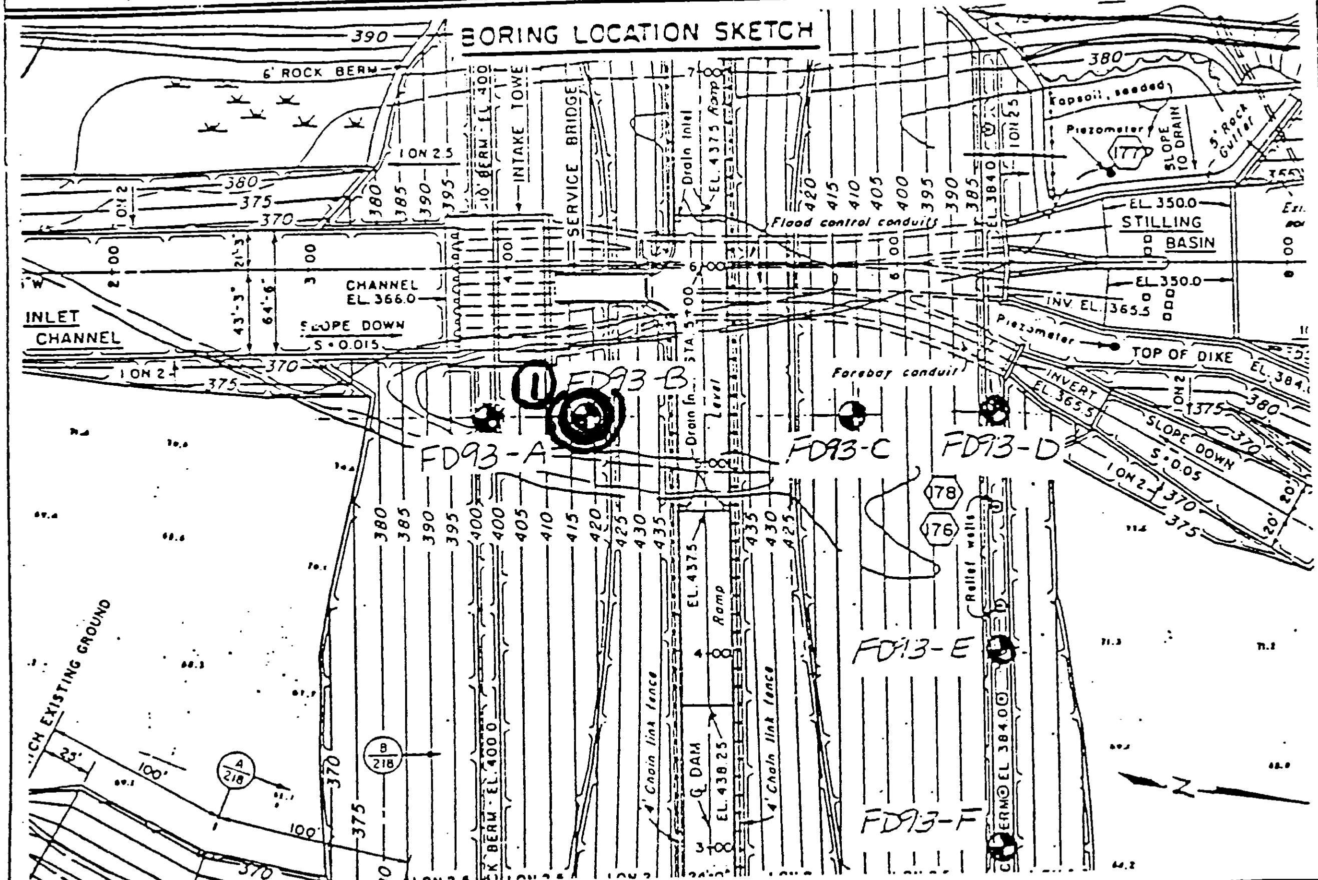
SUBSURFACE WATER OBSERVATIONS

DATE	TIME	DEPTH-BOT. OF CASING	DEPTH-BOT. OF BORING	DEPTH TO WATER	ELEVATION WATER	REMARKS
10/5	700PM	20	26	5.5		INDUCED
10/6	700AM	20	26	5.5		
10/6	700PM	50	54	8.5		
10/7	730AM	50	54	8.9		
10/7	630PM	65	66	6.7		
10/8	700AM	65	66	12.5		
10/8	100PM	75	80	10.7		
10/11	1230PM	75	80	39.5		
10/11	700PM	84	88	14.1		INDUCED
10/12	700AM	84	88	29.0		
10/12	630PM	110	109	2.5		INDUCED
10/13	730AM	110	109	45.9		
10/13	630PM	120	128.5	30.7		INDUCED
10/14	730AM	120	128.5	47.5		
10/14	630PM	144.5	153.0	25.3		INDUCED

Note: Depths are in feet below original ground

10/15 700Am 144.5 153.0 45.5

BORING LOCATION SKETCH



PIEZOMETER INSTALLATION REPORT

PROJECT: HOPKINTON DAM | DATE. NOVEMBER 11, 1993

LOCATION (STA): 5+25 | OFFSET FROM CENTER LINE: 60' UPSTREAM | PIEZ NO.: 13-A

PIEZ TYPE: CASAGRANDE W 3/4" I.D PVC RISER | DEPTH OF PIEZ: 117' | RISER PIPE DIAM: 3/4" I.D.

PIEZ TIP SET IN (SOIL TYPE): SP-SM TO GP-GM | SOIL SAMPLE NO.: S-46 TO S-54 | BORING DIAM: 4 IN.

METHOD OF INSTALLATION: ROTARY WASH BORING

TYPE OF PROTECTION FOR PIEZ: 4" DIA STEEL CASING | VENT: THREADED LOCKING CAP

GROUND ELEV.: 416' (NGVD) | ELEV. TOP OF RISER: 417.9 | ELEV PIEZ TIP: 299'

FILTER: #20 SILICA SAND | FROM ELEV: 297' | TO ELEV: 315'

SEAL: PELTONITE "PELLETS" | FROM ELEV: 291' 315' | TO ELEV: 297' 321'

INSTALLED BY: ATLANTIC TESTING LABS | CONTRACT NO.: DACW33-93-D-0004 | FOREMAN: T ELDRIDGE

DATE OF INSTALLATION: OCTOBER 18, 1993 | DATE OF OBSERVATIONS: NOVEMBER 11, 199_

METHOD OF TESTING PIEZ.: FALLING HEAD

TIME 221	ELAPSED TIME MINUTES	DEPTH TO WATER FEET	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER FEET	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER FEET
221 39	0.5	11.80	241	20.0	45.06			
222	1.0	19.06	251	30.0	45.72			
224	3.0	32.32						
226	5.0	37.70						
231	10.0	42.72						

REMARKS:

PIEZOMETRIC HEAD @ START OF TEST -46.62 FT.

Tom Eldridge
INSPECTOR

PLATE A.14

PIEZOMETER INSTALLATION REPORT

PROJECT: HOPKINTON DAM | DATE. NOVEMBER 11, 1993

LOCATION (STA): 5+25 | OFFSET FROM CENTER LINE: 60' UPSTREAM | PIEZ NO.: 13-B

PIEZ TYPE: CASAGRANDE @ 3/4" I.D. PVC RISER | DEPTH OF PIEZ: -48 FT. | RISER PIPE DIAM: 3/4" I.D.

PIEZ TIP SET IN (SOIL TYPE): SP-SM | SOIL SAMPLE NO.: S-17 TO S-20 | BORING DIAM: 5 IN.

METHOD OF INSTALLATION: ROTARY WASH BORING

TYPE OF PROTECTION FOR PIEZ: 4" DIA STEEL CASING | VENT: threaded locking CAP

GROUND ELEV.: 416' (NGVD) | ELEV. TOP OF RISER: 418.0 | ELEV PIEZ TIP: 368'

FILTER: #20 SILICA SAND | FROM ELEV: 366' | TO ELEV: 374'

SEAL: BENTONITE "PELLETS" | FROM ELEV: 360' 374' | TO ELEV: 366' 378'

INSTALLED BY: ATLANTIC TESTING LABS | CONTRACT NO.: DACW33-93-D-0004 | FOREMAN: T. ELDRIDGE

DATE OF INSTALLATION: OCTOBER 19, 1993 | DATE OF OBSERVATIONS: NOVEMBER 11, 1993

METHOD OF TESTING PIEZ.: FALLING HEAD

TIME 256	ELAPSED TIME MINUTES	DEPTH TO WATER FEET	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER FEET	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER FEET
256 30	0.5	1.52	316	20.0	5.34			
257	1.0	2.10	326	30.0	6.18			
259	3.0	2.78						
301	5.0	3.26						
306	10.0	4.12						

REMARKS:

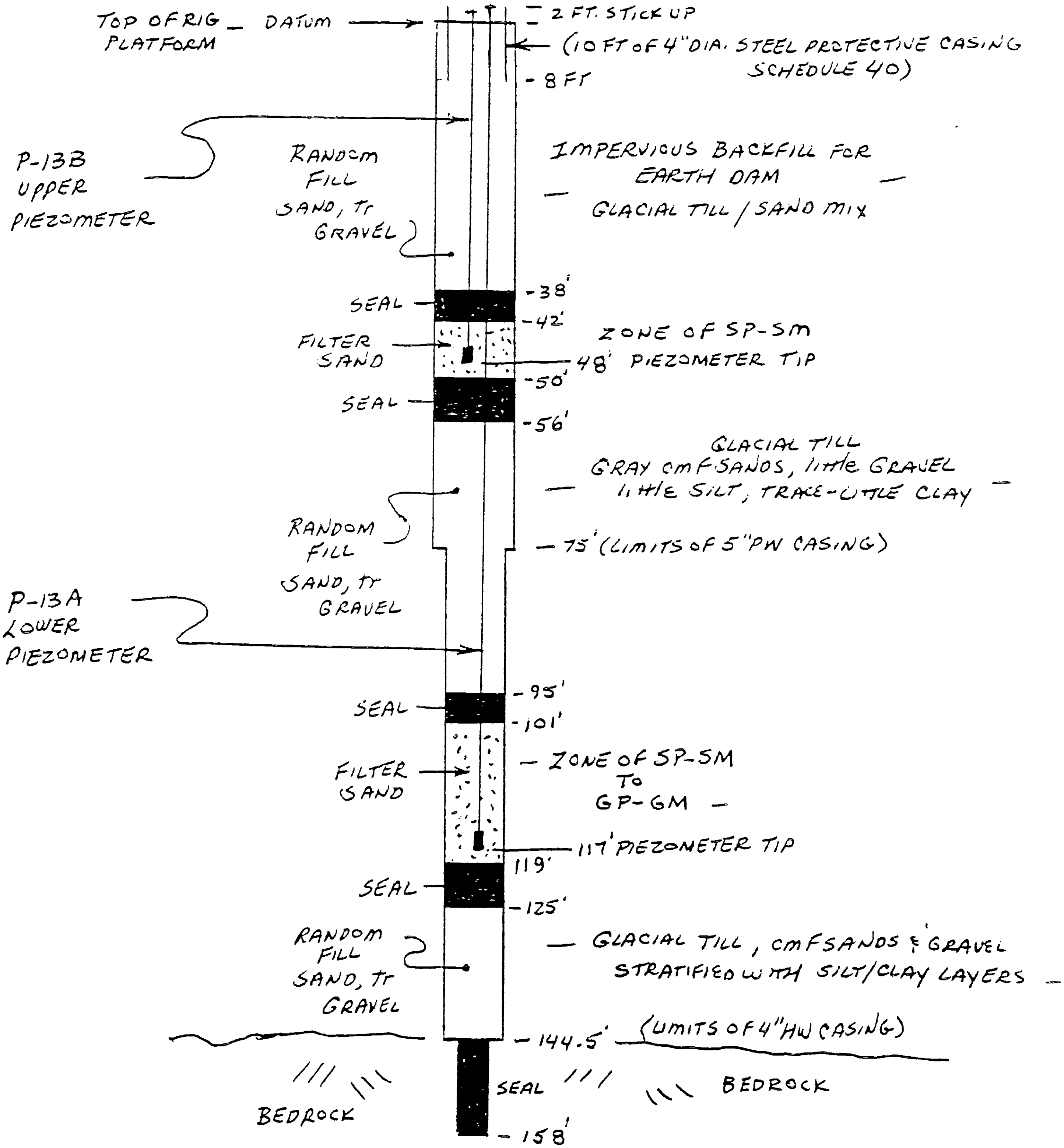
PIEZOMETRIC HEAD @ START OF TEST -35.1 FT.

Tom Eldridge
(INSPECTOR)

PLATE A.15

TEST BORING
FD 93-1

PIEZOMETER STICK UP -
P-13B 22"
P-13A 20"



CASAGRANDE TYPE PIEZOMETERS
WITH 3/4" I.D. PVC RISERS
SCHEDULE 80

BENTONITE SEALS
#20 SILICA SAND - FILTER SAND
RANDOM FILL IS ALL PURPOSE SAND
60 lb bAGS & BANK RUN
SAND-GRAVEL

PLATE A.16

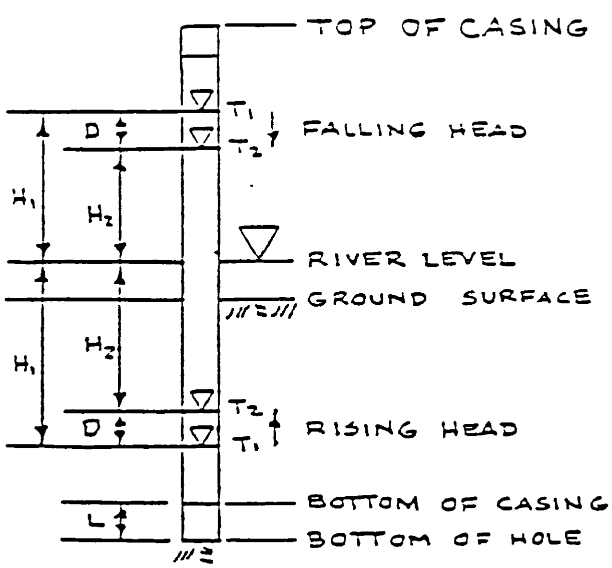
FIELD PERMEABILITY TEST RESULTS

DATE: NOV 11, 1993	BORING NO: FD93-1	DEPTH: 117 FT.	INSPECTOR: T ELDRIDGE	
D_o = 1.0	D_i = 0.75	L = 216 IN.	H_1 = 46.62 FT.	m = 3

FALLING HEAD				RISING HEAD			
ELAPSED TIME $(t_2 - t_1)$	ΔD $(H_2 - H_1)$	H_2 $(H_1 - D)$	K_H	ELAPSED TIME $(t_2 - t_1)$	D $(H_2 - H_1)$	H_2 $(H_1 - D)$	K
0.5	11.80	34.82	2.26×10^{-5}				
1.0	19.06	27.56	2.04×10^{-5}				
3.0	32.32	14.30	1.53×10^{-5}				
5.0	37.70	8.92	1.28×10^{-5}				
10.0	42.72	3.90	9.6×10^{-6}				
20.0	45.06	1.56	6.6×10^{-6}				
30.0	45.72	0.90	5.1×10^{-6}				

NOTES: PIEZOMETER 13-A

SCHEMATIC



SYMBOLS

D_o = OUTSIDE DIAMETER OF CASING

D_i = INSIDE DIAMETER OF CASING (

L = LENGTH OF SAMPLE (CM)

m = TRANSFORMATION RATIO

H = PIEZOMETRIC HEAD

T = TIME (SEC.)

k_h = HORIZONTAL PERMEABILITY (CM

D = CHANGE IN H

$$K_h = \frac{D_i^2 \ln\left[\frac{mL}{D_o} + \sqrt{1 + \left(\frac{mL}{D_o}\right)^2}\right]}{8 \cdot L \cdot (t_2 - t_1)} \ln \ldots$$

$$K_h = \frac{D_i^2 \cdot \ln\left(\frac{2mL}{D_o}\right)}{8 \cdot L \cdot (t_2 - t_1)} \ln \frac{H_1}{H_2} \quad \text{for} \quad \frac{mL}{D_o} > \ldots$$

PLATE A.17

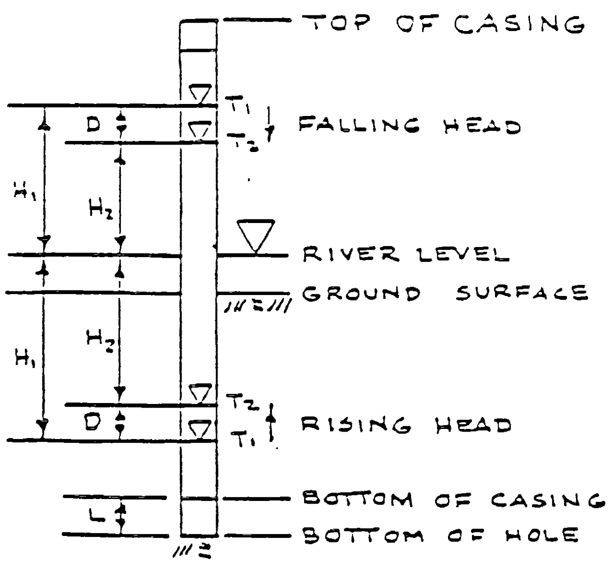
FIELD PERMEABILITY TEST RESULTS

DATE: NOV 11, 1993	BORING NO: FD93-1	DEPTH: 48 FT.	INSPECTOR: T ELDRIDGE	
D_o = 1.0	D_i = 0.75	L = 96 IN.	H_1 = 35.1 FT.	m = 3

FALLING HEAD				RISING HEAD			
ELAPSED TIME $(t_2 - t_1)$	ΔD $(H_2 - H_1)$	H_2 $(H_1 - D)$	K_H	ELAPSED TIME $(t_2 - t_1)$	ΔD $(H_2 - H_1)$	H_2 $(H_1 - D)$	K_H
0.5	1.52	33.58	6.8×10^{-6}				
1.0	2.10	33.0	4.7×10^{-6}				
3.0	2.78	32.32	2.1×10^{-6}				
5.0	3.26	31.84	1.5×10^{-6}				
10.0	4.12	30.98	9×10^{-7}				
20.0	5.34	29.76	6×10^{-7}				
30.0	6.18	28.92	5×10^{-7}				

NOTES: PIEZOMETER 13-B

SCHEMATIC



SYMBOLS

D_o = OUTSIDE DIAMETER OF CASING
D_i = INSIDE DIAMETER OF CASING (
L = LENGTH OF SAMPLE (CM)
m = TRANSFORMATION RATIO
H = PIEZOMETRIC HEAD
T = TIME (SEC.)
K_h = HORIZONTAL PERMEABILITY (CM
D = CHANGE IN H

$$K_h = \frac{D_i^2 \ln\left[\frac{mL}{D_o} + \sqrt{1+\left(\frac{mL}{D_o}\right)^2}\right]}{8 \cdot L \cdot (t_2 - t_1)} \ln$$

$$K_h = \frac{D_i^2 \cdot \ln\left(\frac{2mL}{D_o}\right)}{8 \cdot L \cdot (t_2 - t_1)} \ln \frac{H_1}{H_2} \quad \text{for } \frac{mL}{D_o} >$$

PLATE A.18

CORPS OF ENGINEERS, U. S. ARMY
NEW ENGLAND DIVISION
FOUNDATION AND MATERIALS BRANCH

FIELD LOG OF TEST BORING

Site: HOPKINTON DAM EXPLORATION PROGRAM

PROJECT NO. DACW 33-93-D-0004

Page 1 of ___ Pages

Hole No. FD93-2 Diam. (Casing) 4"HW 5"PW

Boring Started: OCTOBER 21, 1993

Co-ordinates: N 250997.22 E 478198.97

Boring Completed: NOVEMBER 2, 1993

Drilled by: ROB PRICE, DARIUS WINTERS (ATL)

Report Submitted: ___

Purpose of Exploration: TO DETERMINE SUBSURFACE MATERIAL TYPES AND DISTRIBUTION AS WELL AS INSTALLATION OF PIEZOMETERS FOR DETERMINATION OF FOUNDATION PHREATIC SURFACES

Elevation Top of Hole: 416 NGVD

Total Overburden Drilled: 142 Feet

Elevation Top of Rock: 274 NGVD

Elevation Bottom of Hole: 262 NGVD

Total Rock Drilled: 12 Feet

Total Depth of Hole: 154 Feet

Core Recovered: 100 %

Core Recovered: 10 Ft.: 0 Diam. 2-1 In.

Soil Samples: 2 1/2 In. Diam. 37 No.

Soil Samples: ___ In. Diam. ___ No.

Casing Left in Place: 0 Feet

PIEZOMETERS PROTECTED WITH 10 FT. OF 4" DIA STEEL CASING (2 FT. STICK UP)

Water Table Depth: -36 FT.

Depth From	Depth To	Method of Drilling and Type of Bit Used
0	154	ROTARY-WASH

INDEX

Ground Water ___ Back of Page ___
Boring Location Sketch ___ Back of Page ___
Overburden Record ___ Page ___
Rock Drilling ___ Page ___
___ Page ___
___ Page ___
___ Page ___

Prepared by: Tom Eldealde (Field Data) ___ Lab. Data

Submitted by: ___

NED FORM DEC 63 121

REPLACES EDITION OF JUN 51 WHICH MAY BE USED UNTIL EXHAUSTED

U. S. ARMY
CORPS OF ENGINEERS
NEW ENGLAND DIVISION

FIELD LOG OF TEST BORING

Site HOPKINTON DAM Page 1 of 9 Pages

Boring No FD93-2 Desig. FD93-C Diam. (Casing) 5"PW, 4"HW

Co-ordinates: N 250997.22 E 478198.97

Elevation Top of Boring 416 NGVD
Total Overburden Drilled 142 Feet
Elevation Top of Rock 274 NGVD
Total Rock Drilled 12 Feet
Elevation Bottom of Boring 262 NGVD
Total Depth of Boring 154 Feet
Core Recovered 100 % No. Boxes 1
Core Recovered 10 Ft: — Diam. 2.1 In.
Soil Samples 2½ In. Diam. 37 No.
Soil Samples ___ In. Diam. ___ No.

Hammer Wt. 300 lb Boring Started 10/21/93
Hammer Drop 18 IN. Boring Completed 11/2/93
Casing Left ___
Subsurface Water Data ___ Page ___
Obs. Well ___
Drilled By ROB PRICE, DARIUS WINTERS
Mfg. Des. Drill CME 55 TRUCK MOUNT
Inspected By: T ELDRIDGE
Classification By: T ELDRIDGE
Classification By: ___

408 OCT 21

DEPTH	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE REC'VY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
10					ROLLER BIT (3 7/8" DIA) & WASH TO -11 FT. REL. DIFFICULT DRILLING	(NS)
11	S-1		11.0 TO 13.0	18, 24, 19, 27	300 lb. HAMMER 18 IN. DROP 2½" I.D. SPLIT SPOON NW ROD	Br. Silty (30-40) SAND w/little Gravel (5-15) (SM)
12					ROLLER BIT & WASH TO -15 FT.	
13						
14					SPIN & WASH 5" CASING TO -15 FT.	(NS)
15 (OCT 22)	S-2		15.0 TO 17.0	15, 35, 27, 34	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Silty (30-40) SAND w/little-Gravel (5-15) (SM)
16					SPIN & WASH 5" CASING TO -20 FT.	
17						
18						(NS)
19						
20 (393)						

GENERAL REMARKS:
BOREHOLE STARTED USING P-SIZE CORE BARREL INSIDE 4 IN. CASING, DRILLING THROUGH ROCK RIP-RAP. 5 IN. PW SIZE CASING W/ DIAMOND CUTTING SHOE WAS SPUN AND WASHED 10 FT.

Elev.	DEPTH	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
393	20	S-3		20.0 TO 22.0	33, 30, 23, 25	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON. ADVANCE CASING, SPIN/WASH TO -25 FT.	Br. Silty (30-40) SAND w/little Gravel (5-15) (SM)
	21–24						(NS)
	25	S-4		25.0 To 27.0	41, 30, 46, 37	300 lb. HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON. ADVANCE CASING, SPIN/WASH TO -30 FT.	Br. Silty (30-40) SAND w/little Gravel (5-15) (SM)
	27–29					3RD GEAR ½-¾ throttle MODERATE DRILLING. ROLLER BIT & WASH CLEAN TO -30 FT DIFFICULT, SLOW DRILLING	(NS)
383	30	S-5		30.0 TO 32.0	20, 23, 25, 33	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Silty (30-40) SAND w/little Gravel (5-15) (SM)
	32–34					ROLLER BIT & WASH BOREHOLE TO -35 FT.	(NS)
378	35	S-6		35.0 TO 37.0	32, 27, 43, 35	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Silty (30-40) SAND w/little Gravel (5-15) (SM)
376	37						

ED Form 53A (Test)

Boring No. FD 93-2

PLATE A.21

	DEPTH	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
376	37	S-7A		37.0 TO 39.0	34, 19, 13, 22	300 lb HAMMER 18 in DROP NW ROD 2½" SPLIT SPOON. SPIN & WASH CASING TO -39 FT.	Br. Well-graded SAND w/little Gravel (0-40) (SW)
	38	S-7B					38.5' Br. Silty (30-40) SAND w/little Gravel (5-15) (SM)
OCT 25 374	39	S-8		39.0 TO 41.0	57, 68, 62, 71	300 lb HAMMER 18 in DROP NW ROD 2½" I.D. SPLIT SPOON. ROLLER BIT & WASH TO -41 FT.	39' Br. m-f SAND w/tr. Silt
	40						
	41	S-9		41.0 TO 43.0	29, 43, 52, 60	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON. ROLLER BIT & WASH TO -43 FT	
	42						
	43	S-10		43.0 TO 45.0	22, 36, 63, 98	300 lb HAMMER 18 in DROP NW ROD 2½" I.D. SPLIT SPOON. ROLLER BIT & WASH TO -45'. SPIN & WASH PW CASING TO -45. 3RD-4TH GEAR ½-¾ THROTTLE	(SP)
	44						
	45	S-11		45.0 TO 47.0	38, 47, 55, 72	300 lb HAMMER RELEASY 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON SAMPLER	
	46						
	47	S-12		47.0 TO 49.0	25, 41, 74, 202	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON. ROLLER BIT & WASH TO -49'	
	48						
364	49	S-13		49.0 TO 51.0	43, 61, 42, 47	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON. SPUN & WASHED PW CASING TO -50'	49' Dk. Gr. Silty (30-40) SAND w/Gravel (10-20) (SM)
	50						
	51						
	52					ROLLER BIT & WASH CLEAN TO -55 FT.	Poss. Cobbles (NS)
	53						
359	54						

NED ... 58A (Test)

Boring No. FD93-2

PLATE A.22

359

DEPTH	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
54					ROLLER BIT & WASH TO -55 FT.	(NS)
55	S-14		55.0 TO 56.3	36 80 100/3 (6%)	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON. SPIN/WASH PW CASING TO -55'. MODERATE DRILLING	Dk. Gr. Silty (30-40) SAND w/Gravel (10-20) (SM)
56–59					ROLLER BIT & WASH TO -60 FT. DIFFICULT @ TIMES	(NS)
60	S-15		60.0 TO 61.6	52 88 99 60/1	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. Silty (30-40) SAND w/Gravel (10-20) (SM)
62–64					ASSEMBLE & ADVANCE 4" HW CASING TO -65 FT. ROLLER BIT & WASH TO -65 FT.	(NS)
65	S-16		65.0 TO 67.0	95 84 135 142	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON. ADVANCE HW CASING TO -70 FT. CLEAN, WASH @ ROLLER BIT	COBBLE w/Dk. Gr. Silty (15-25) SAND (20-30) & little Gravel (0-10) (COBBLE)
68–69						(NS)
70	S-17		70.0 TO 71.8	41 30	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. Silty (30-40) SAND w/little Gravel (0-10) (SM)
71						

26

342

ED Form 58A (Test)

Boring No. FD 93-2

342

DEPTH	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECV'Y	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
71	S-17		70.0 TO 71.5	88 100/3 (60%)	ROLLER BIT & WASH TO -75 FT. W/ NEW 3 7/8" BIT INSTALLED	Dk. Gr. Silty (30-40) SAND w/little Gravel (0-10) (SM)
72						
73						
74						(NS)
75	S-18		75.0 TO 76.2	79 136 120/2	300 lb HAMMER 18 IN. DROP NW ROD 2 1/2" I.D. SPLIT SPOON	Dk. Gr. Silty (30-40) SAND w/little Gravel (0-10) (SM)
76						
77					ADVANCE CASING TO -80 FT. ROLLER BIT & WASH TO -80 FT. RELATIVELY DIFFICULT DRILLING	
78						(NS)
79						
80	S-19		80.0 TO 80.25	150/3 (BOUNC REF)	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLIT SPOON	Dk. Gr. Silty (30-40) SAND w/little Gravel (0-10) (SM)
81					ADVANCE ROLLER BIT & WASH TO -85 FT. DIFFICULT DRILLING	
82						
83						
84						(NS)
85	S-20		85.0 TO 87.0	14 14 23 43	300 lb HAMMER 18 IN DROP NW ROD 2 1/2" I.D. SPLIT SPOON 86' SPIN/WASH HW CASING TO -85 FT.	Gr. Fat CLAY w/ SAND (10-20) (CH)
86 (327)						
87					ROLLER BIT & WASH TO -90 FT.	(NS)
88 (325)						

NED Form 53A (Test)

Boring No. FD 93-2

DEPTH		CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
325	88						
	89					ROLLER BIT & WASH TO -90 FT. RELATIVELY EASY DRILLING	(NS)
	90	S-21		90.0 TO 91.2	40 78 80/2 BOUNCING REFUSAL	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Gr. SILT W/f. SAND (15-25) (ML)
	91					SPIN & WASH HW CASING TO -90 FT. ROLLER BIT CLEAN TO -92 FT.	(NS)
	92	S-22		92.0 TO 93.3	33 90 120/4 BOUNC REF	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Gr. SILT W/f. SAND (15-25) (ML)
	93					ADVANCE CASING TO -95 FT.	
	94					ADVANCE WITH ROLLER BIT & WASH TO -96 FT.	(NS)
	95					DRILLER NOTICE CHANGE 95.5'	(NS)
317	96	S-23		96.0 TO 96.8	58 120/3 BOUN-REF	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Gr. m-f SAND W/Silt (5-15) & Gravel (10-20) (SP-SM)
OCT 27	97					ROLLER BIT / WASH TO -98 FT.	(NS)
	98	S-24		98.0 TO 98.6	158 70/1	300 lb HAMMER 18 IN DROP NW ROD 2½" SPLIT SPOON	Gr. m-f SAND W/Silt (5-15) & Gravel (10-20) (SP-SM)
	99						(NS)
	100	S-25		100.0 TO 100.3	150/4	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Silty Clayey (12) SAND W/Gravel (16) (SC/SM)
	101					SPIN/WASH HW CASING CLEAN W ROLLER BIT & WASH	(NS)
	102	S-26		102.0 TO 102.3	150/3	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Subang. GRAVEL W/Sand (35-45) and Silt (5-15) (GP-GM)
	103						
	104	S-27		104.0 TO 104.3	120/3	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	(NS) Br., mostly c. SAND (SP)
308	105						

VED ... 58A (Test)

Boring No. FD 93-2

PLATE A.25

Elev.	DEPTH (ft.)	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
308	105					SPIN/WASH CASING TO -105 FT.	(NS)
	106	S-28		106.0 TO 106.2	150/2	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. mostly C. SAND (SP)
	107					ROLLER BIT & WASH TO -108 FT.	(NS)
305	108	S-29		108.0 TO 108.8	109 150/3	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	108 Br. Clayey (10-20) SAND w/Gravel (15-25) (SC)
	109					SPIN/WASH HW CASING TO -110 FT.	(NS)
	110	S-30		110.0 TO 110.9	90 150/5	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Clayey (13) SAND w/Gravel (22) (SC)
	111					ROLLER BIT & WASH BOREHOLE TO -112 FT.	(NS)
	112	S-31		112.0 TO 112.2	65 100/3 BNC REF	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Clayey (10-20) SAND w/tr. Gravel (SC)
	113					SPIN/WASH HW CASING TO -115 FT.	
	114					3RD GEAR - ¾ throttle	(NS)
298	115	S-32		115.0 TO 115.8	131 150/3	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Gr. Clayey, Silty (25-35) SAND w/Gravel (15-25) (SC-SM)
	116						
	117					ADVANCE BORING USING ROLLER BIT & WASH	
	118					2ND GEAR	(NS)
	119					½-¾ throttle	
	120	S-33		120.0 TO 120.2	150/2 BOUNCING REFUSAL	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Well-graded SAND w/tr. Silt (SP)
	121					SPIN/WASH HW CASING TO -120 FT.	
291	122						(NS)

NED Form 58A (Test)

Boring No. FD 93-2

PLATE A.26

291

Depth Ft.	Core/Sample No.	Size	Depth Range	Blows per Ft / Core Recvy	Sampling and Coring Operations	Classification of Materials
122–124					ROLLER BIT & WASH ADVANCE TO -125 FT. RELATIVELY DIFFICULT DRILLING	(NS)
125	S-34		125.0 TO 125.1	175 100/2	300 lb HAMMER 18 in DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. Silty (20-30) SAND w/Gravel (15-15) (SM)
126 (OCT 28)						
127–129					ROLLER BIT & WASH ADVANCING TO -130 FT.	(NS)
130	S-35		130.0 TO 130.2	130/2	300 lb HAMMER 18 in DROP NW ROD 2½" I.D. SPLIT SPOON	Gr. SAND w/Silt (5-15) (SP-SM)
131–134					ROLLER BIT & WASH TO -135 FT.	(NS)
135	S-36		135.0 TO 135.3	250/3 BNC REF	300 lb HAMMER 18 in DROP NW ROD 2½" I.D. SPLIT SPOON	Gr. Silty (15-25) SAND (SM)
136–139					SPIN & WASH CASING TO -137 FT. MODERATE TO SLOW 3RD GEAR ½-¾ throttle	(NS)

274

Form 58A(Test)

Boring No. FD 43-2

Elev.	Depth (ft)	Core/Sample No.	Size	Depth Range	Blows per ft / Core Recvy	Sampling and Coring Operations	Classification of Materials
274	139					Roller bit & wash advance to -140 ft.	(NS)
	140	S-37		140.0 to 141.3	60 90 125/4	300 lb hammer 18 in drop NW rod 2½" I.D. split spoon	Gr. CLAY (CL)
	141–144					Roller bit & wash to -142 ft. "Bedrock encountered" Continue roller bit -2 ft. into rock Advance HW casing to -142 ft.	Granite Bedrock (NS)
	144–149				R-1 60" Rec 100% RQD 33⅓	Core rock with NX size core barrel, diamond bit. Run-1 drill time: 14 min. Core rock between -144 ft. to -149'	Granite Bedrock w/a few seams bedded sandstone
263	149–154				R-2 60" Rec 100% RQD 92	Run-2 NX size core barrel, with diamond bit. Drill time: 24 min. Core rock between -149' to -154'	Granite Bedrock sandstone seams
259	154					Terminate boring @ -154 ft.	

Form 5BA(Test)

Boring No. FD 93-2

PLATE A.28

FIELD LOG OF TEST BORING IN ROCK

SITE HOPKINTON DAM HOLE NO. FD 93-2 PAGE 2

	DATE	DEPTH FT. FROM	DEPTH FT. TO	RUN FT.	RUN REC'V'Y FT.	REC'V'Y %	DRILLING BEHAVIOR: FEED	DRILLING BEHAVIOR: WATER	DRILLING BEHAVIOR: REASON FOR PULL	ACTUAL DRILLING TIME	BIT NO. SIZE AND TYPE	ADDITIONAL REMARKS
R-1	OCT 28	144.0	149.0	5 FT.	5 FT	100%		NO WATER LOSS		14 MIN.	NX CORE DIAMOND	RQD=33 WEATHERED GRANITE
R-2	OCT 28	149.0	154.0	5 FT.	5 FT.	100%				24 MIN.	NX CORE DIAMOND	RQD= 92 GRANITE (SANDSTONE SEAMS)

TOTAL BED ROCK DRILLED 10 FEET

TOTAL BED ROCK RECOVERED 10 FEET

BED ROCK RECOVERY 100 PERCENT

DRILLER ROB PRICE

INSPECTOR TOM ELDRIDGE

NED FORM DEC 61 130

[illegible]

Site: *HOPKINTON DAM*

Boring No: *FD 93-2*

SUBSURFACE WATER OBSERVATIONS

DATE	TIME	DEPTH-BOT. OF CASING	DEPTH-BOT. OF BORING	DEPTH TO WATER	ELEVATION WATER	REMARKS
10/25	1230PM	39	39	34.2		
10/25	630AM	55	62	12.2		(INDUCED)
10/26	700AM	55	62	34.5		
10/26	615PM	95	97	25.5		(INDUCED)
10/27	715AM	95	97	35.5		
10/27	600PM	120	126	25.8		(INDUCED)
10/28	715AM	120	126	37.5		
10/28	600PM	142	154	24.3		(INDUCED)

Note: Depths are in feet below original ground

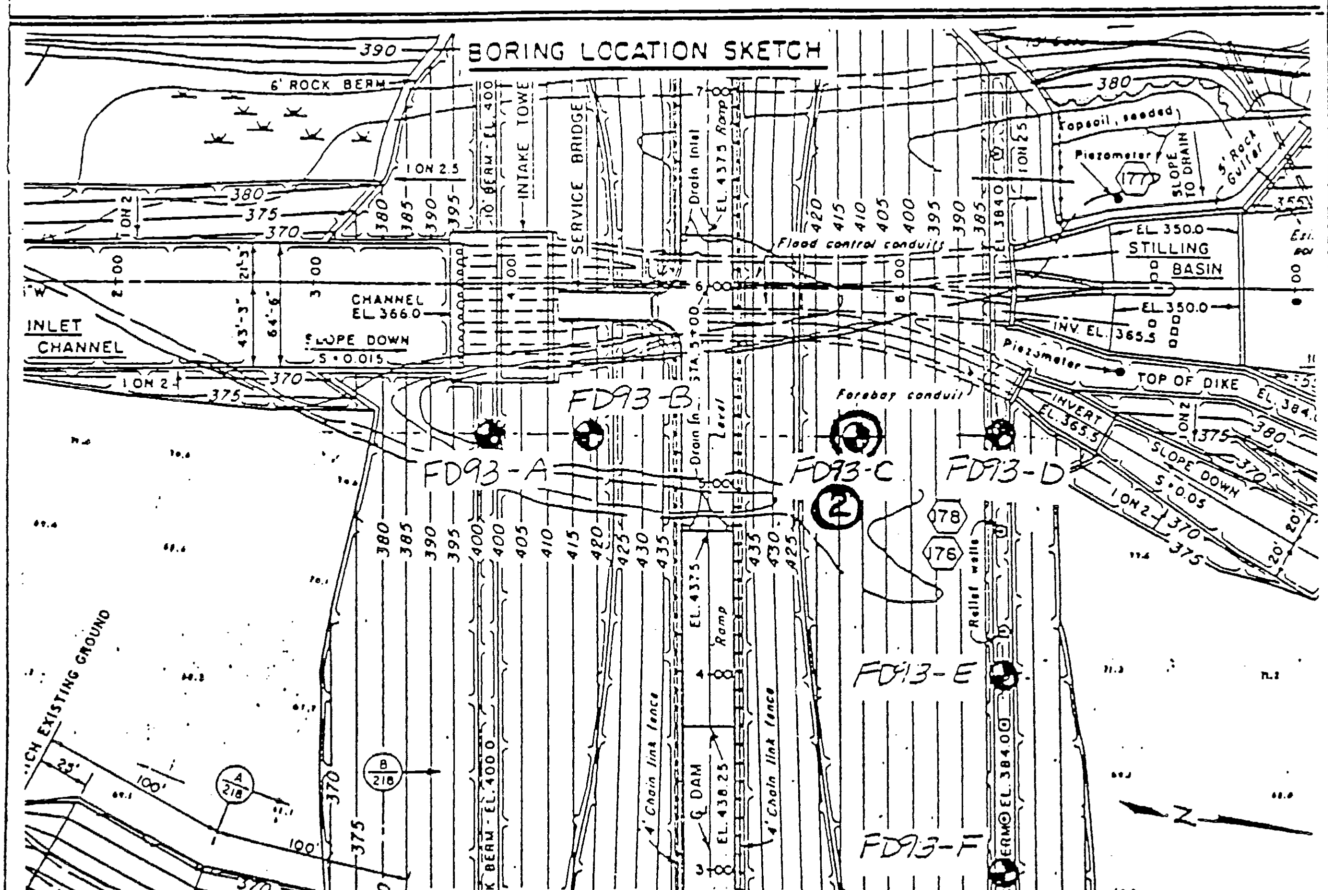


PLATE A.30

PIEZOMETER INSTALLATION REPORT

PROJECT: HOPKINTON DAM EXPLORATION PROGRAM | DATE: NOVEMBER 2, 1993

LOCATION (STA): 5+25 | OFFSET FROM CENTER LINE: 75' DOWNSTREAM | PIEZ NO.: 14-A

PIEZ TYPE: CASAGRADE @ 3/4" I.D. PVC RISER | DEPTH OF PIEZ: −113 FT. | RISER PIPE DIAM: 3/4" I.D.

PIEZ TIP SET IN (SOIL TYPE): SP-SM | SOIL SAMPLE NO.: S-23 TO S-31 | BORING DIAM: 4"

METHOD OF INSTALLATION: ROTARY WASH BORING

TYPE OF PROTECTION FOR PIEZ: 4" STEEL CASING | VENT: THREADED LOCKING CAP

GROUND ELEV.: 416' (NGVD) | ELEV. TOP OF RISER: 417.8' | ELEV PIEZ TIP: 303'

FILTER: #20 SILICA SAND | FROM ELEV: 301' | TO ELEV: 320'

SEAL: BENTONITE PELLETS | FROM ELEV: 295' 320' | TO ELEV: 301' 326'

INSTALLED BY: ATLANTIC TESTING LABS | CONTRACT NO.: DACW 33-93-D-0004 | FOREMAN: T. ELDRIDGE

DATE OF INSTALLATION: NOVEMBER 2, 1993 | DATE OF OBSERVATIONS: NOV 2, 1993

METHOD OF TESTING PIEZ.: FALLING HEAD

TIME 205	ELAPSED TIME MINUTES	DEPTH TO WATER FEET	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER FEET	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER FEET
205 30	0.5	8.75	225	20.0	43.14			
206	1.0	13.45	235	30.0	43.66			
208	3.0	25.90						
210	5.0	32.82						
215	10.0	40.14						

REMARKS:

PIEZOMETRIC HEAD @ −49.22 FT. @ START OF TEST

Tom Eldridge
INSPECTOR

PLATE A.31

PIEZOMETER INSTALLATION REPORT

PROJECT: HOPKINTON DAM EXPLORATION PROGRAM | DATE. NOVEMBER 2, 1993

LOCATION (STA): 5+25 | OFFSET FROM CENTER LINE: 75' DOWNSTREAM | PIEZ NO.: 14-B

PIEZ TYPE: CASAGRANDE @ 3/4" I.D. PVC RISER | DEPTH OF PIEZ: -47 FT. | RISER PIPE DIAM: 3/4" I.D.

PIEZ TIP SET IN (SOIL TYPE): SP | SOIL SAMPLE NO.: S-8 TO S-12 | BORING DIAM: 5 IN.

METHOD OF INSTALLATION: ROTARY WASH BORING

TYPE OF PROTECTION FOR PIEZ: 4" STEEL CASING | VENT: threaded locking Cap

GROUND ELEV.: 416' (NGVD) | ELEV. TOP OF RISER: 417.9' | ELEV PIEZ TIP: 369'

FILTER: #20 SILICA SAND | FROM ELEV: 367' | TO ELEV: 377'

SEAL: BENTONITE PELLETS | FROM ELEV: 361' 377' | TO ELEV: 367' 383'

INSTALLED BY: ATLANTIC TESTING LABS | CONTRACT NO.: DACW33-93-D-0004 | FOREMAN: T. ELDRIDGE

DATE OF INSTALLATION: NOVEMBER 2, 1993 | DATE OF OBSERVATIONS: NOV 2, 1993

METHOD OF TESTING PIEZ.: FALLING HEAD

TIME 247	ELAPSED TIME MINUTES	DEPTH TO WATER FEET	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER FEET	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER FEET
24730	0.5	19.30	307	20.0	35.22			
248	1.0	23.75	317	30.0	35.70			
250	3.0	30.32						
252	5.0	32.35						
257	10.0	34.16						

REMARKS:

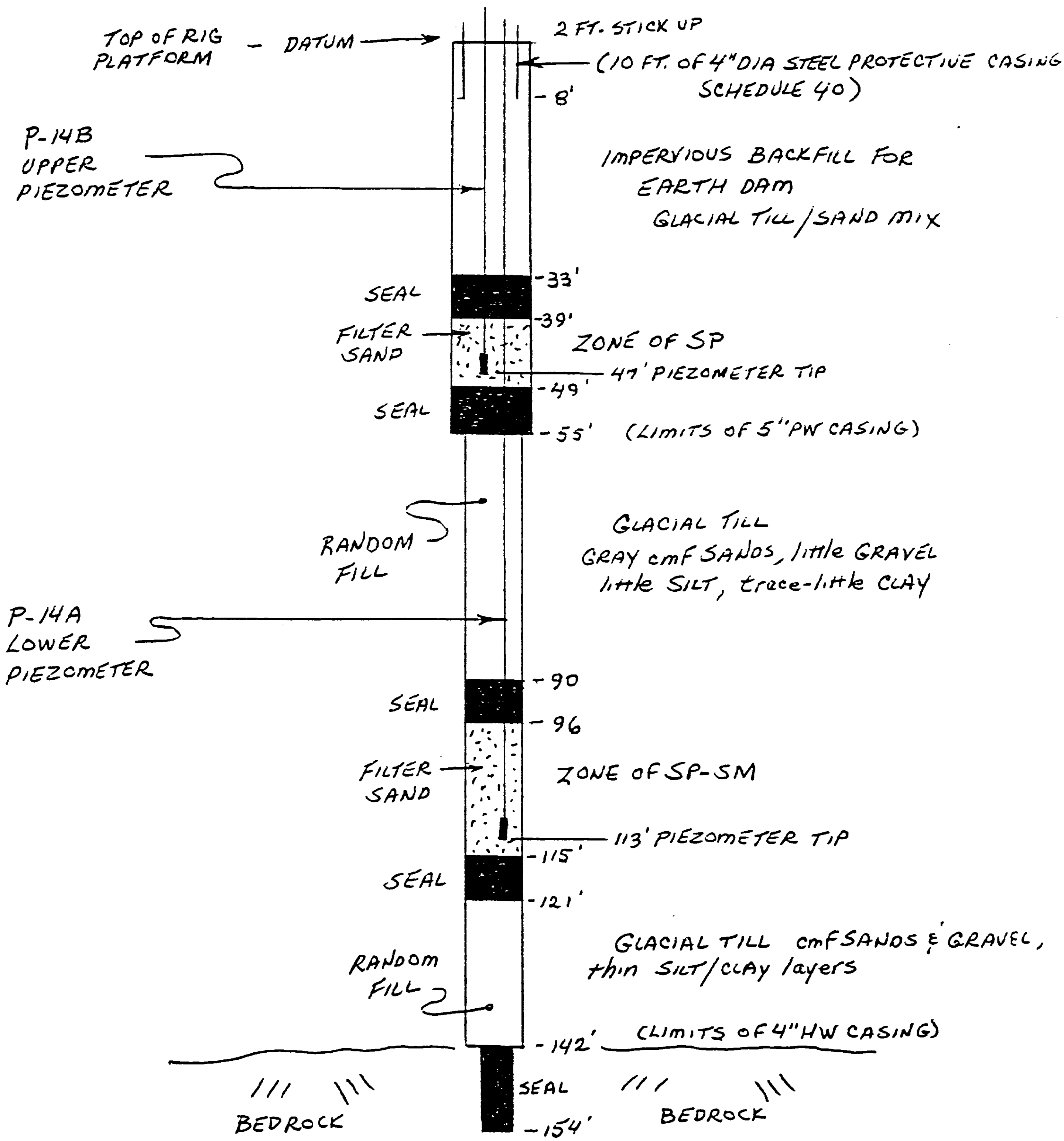
PIEZOMETRIC HEAD @ -37.44 FT. @ START OF TEST

Tom Eldridge
INSPECTOR

PLATE A.32

TEST BORING
FD 93-2

PIEZOMETER STICK UP –
P-14B – 22 IN.
P-14A – 20 IN.



CASAGRANDE TYPE PIEZOMETERS WITH 3/4" I.D. PVC RISERS SCHEDULE 80

BENTONITE SEALER – PELTONITE "PELLETS"
FILTER SAND – #20 SILICA SAND
RANDOM FILL – ALL PURPOSE SAND 60 lb BAGS

PLATE A.33

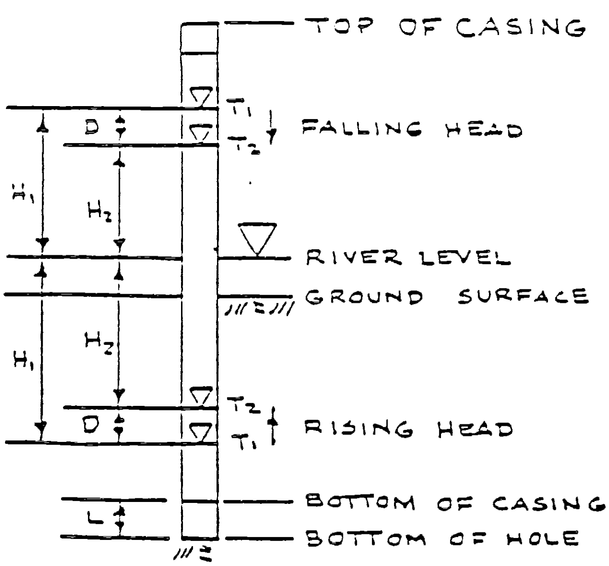
FIELD PERMEABILITY TEST RESULTS

DATE: 11/2/93	BORING NO: FD 93-2	DEPTH: ~49 FT.	INSPECTOR: TE	
D_o = 1.0 IN.	D_i = 0.75 IN.	L = 120 IN.	H_1 = 37.44 FT.	m = 3

FALLING HEAD				RISING HEAD			
ELAPSED TIME MIN ($t_2 - t_1$)	ΔD ($H_2 - H_1$)	H_2 FT (H_1 − D)	K_H IN/SEC	ELAPSED TIME ($t_2 - t_1$)	ΔD ($H_2 - H_1$)	H_2 (H_1 − D)	K_H
0.5	−19.30	18.14	9.31×10^{-5}				
1.0	−23.75	13.69	6.46×10^{-5}				
3.0	−30.32	7.12	3.55×10^{-5}				
5.0	−32.35	5.09	2.56×10^{-5}				
10.0	−34.16	3.28	1.56×10^{-5}				
20.0	−35.22	2.22	9.0×10^{-6}				
30.0	−35.70	1.74	6.5×10^{-6}				

NOTES: PIEZOMETER 14-B
MINUTES AND FEET WERE CONVERTED TO SECONDS AND INCHES FOR HORIZONTAL PERMEABILITY COEFFICIENT

SCHEMATIC



SYMBOLS

D_o = OUTSIDE DIAMETER OF CASING
D_i = INSIDE DIAMETER OF CASING (
L = LENGTH OF SAMPLE (CM)
m = TRANSFORMATION RATIO
H = PIEZOMETRIC HEAD
T = TIME (SEC.)
k_h = HORIZONTAL PERMEABILITY (CM
D = CHANGE IN H

$$k_h = \frac{D_i^2 \ln\left[\frac{mL}{D_o} + \sqrt{1 + \left(\frac{mL}{D_o}\right)^2}\right]}{8 \cdot L \cdot (t_2 - t_1)} \ln$$

$$k_h = \frac{D_i^2 \cdot \ln\left(\frac{2mL}{D_o}\right)}{8 \cdot L \cdot (t_2 - t_1)} \ln \frac{H_1}{H_2} \quad \text{for } \frac{mL}{D_o} >$$

PLATE A.35

CORPS OF ENGINEERS, U. S. ARMY

NEW ENGLAND DIVISION

FOUNDATION AND MATERIALS BRANCH

FIELD LOG OF TEST BORING

Site HOPKINTON DAM

PROJECT NO. DACW 33-93-D-0004

Page 1 of ___ Pages

Hole No. FD 93-3 Diam. (Casing) 4" HW 5" PW

Boring Started NOVEMBER 3, 1993

Co-ordinates: N 251074.22 E 478166.43

Boring Completed NOVEMBER 11, 1993

Drilled by ATLANTIC TESTING LABS

Report Submitted ___

Purpose of Exploration TO DETERMINE SUBSURFACE MATERIAL TYPES AND DISTRIBUTIONS, AND INSTALLATION OF PIEZOMETERS FOR DETERMINATION OF FOUNDATION PHREATIC SURFACES

Elevation Top of Hole 384 NGVD

Total Overburden Drilled 124 Feet

Elevation Top of Rock 260 NGVD

Elevation Bottom of Hole 249 NGVD

Total Rock Drilled 11 Feet

Total Depth of Hole 135 Feet

Core Recovered 100 %

Core Recovered 10 Ft.: – Diam. 2.1 In.

Soil Samples 2 1/2 In. Diam. 29 No.

Soil Samples ___ In. Diam. ___ No.

Casing Left in Place 0 Feet

PIEZOMETERS PROTECTED WITH 5 FEET 4" DIA STEEL CASING (GROUTED IN HOLE)

Water Table Depth ~3.5 Ft

Depth From	Depth To	Method of Drilling and Type of Bit Used
0	135	ROTARY-WASH BORING

INDEX

Ground Water	___	Back of Page	___
Boring Location Sketch	___	Back of Page	___
Overburden Record	___	Page	___
Rock Drilling	___	Page	___
___		Page	___
___		Page	___
___		Page	___

Prepared by Tom ELDRIDGE Field Data ___ Lab. Data ___

Submitted by ___

NED FORM DEC 63 121

REPLACES EDITION OF JUN 51 WHICH MAY BE USED UNTIL EXHAUSTED

PLATE A.36

U. S. ARMY
CORPS OF ENGINEERS
NEW ENGLAND DIVISION

FIELD LOG OF TEST BORING

Site HOPKINTON DAM Page 1 of 8 Pages

Boring No FD93-3 Desig. FD 93-D Diam. (Casing) 5" PW

Co-ordinates: N 251074.22 E 478166.43

Elevation Top of Boring	384 ~~M.S.L.~~ NGVD	Hammer Wt.	300 lb
Total Overburden Drilled	124 Feet	Hammer Drop	18 IN
Elevation Top of Rock	260 ~~M.S.L.~~	Casing Left	
Total Rock Drilled	11 Feet	Boring Started	NOV 3, 1993
Elevation Bottom of Boring	249 ~~M.S.L.~~	Boring Completed	NOV 11, 1993
Total Depth of Boring	135 Feet	Subsurface Water Data	Page
Core Recovered	100 % No. Boxes 1	Obs. Well	
Core Recovered	10 Ft : – Diam. 2.1 in.	Drilled By	ROB PRYCE, DARIUS WINTERS
Soil Samples	2 1/2 In. Diam. 29 No.	Mfg. Des. Drill	CME 55 TRUCK MOUNT
Soil Samples	In. Diam. No.	Inspected By	T ELDRIDGE
		Classification By	T ELDRIDGE
		Classification By	

NOV 3 384

374 NOV 4

DEPTH	1'S	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE REC'VY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
						0-8 FT ROCK RIP RAP CHANGE @ -8 FT. BEGIN SAMPLE @ -10 FT.	(NS)
10		S-1		10.0	6	300 lb HAMMER 18 IN. DROP	Br. m-f SAND
				TO	6	NW ROD 2 1/2" I.D. SPLIT SPOON	
11				12.0	4		(SP)
					4	SPIN & WASH PW CASING TO -15 FT. EASY DRILLING	
12							
13							(NS)
14							
15		S-2		15.0	4	300 lb HAMMER 18 IN. DROP	Br. m-f SAND w/trace Gravel
				TO	3	NW ROD 2 1/2" I.D. SPLIT SPOON	
16				17.0	3		(SP)
					5	SPIN & WASH PW CASING TO -20 FT.	
17						3RD - 4TH GEAR 3/4 throttle	
18						DRILLING CHANGE	(NS)
19							

GENERAL REMARKS:
ADVANCED BORING THROUGH ROCK RIP RAP
A 3 7/8" ROLLER BIT WAS USED TO PENETRATE AND BREAK THROUGH ROCK / 10 FT. OF PW SIZE
. CASING WAS ADVANCED

NED FORM 55B (Test)

Boring No. FD 93-3

DEPTH	1"	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
19						INSTALL ROLLER BIT CLEAN WASH PW CASING TO -20 FT.	(NS)
364 20		S-3		40 80 80 130	20.0 TO 22.0	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. Silty Clayey (30-40) SAND (SC/SM)
21							
22						ROLLER BIT & WASH TO -25 FT. 2ND GEAR ½-¾ throttle	
23							(NS)
24							
25		S-4		45 90/2	25.0 TO 25.7	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. Silty Clayey (25-35) SAND within beds of Varved Clay (20-30) (SC)
26						REPLACE SAW SHOE ON 4" HW CASING	
27						SPIN CASING TO -30 FT.	
28						CLEAN/WASH W ROLLER BIT TO -30 FT.	(NS)
29							
30		S-5		30.0 TO 32.0	33 57 88 97	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. Silty Clayey (30-40) SAND (SC/SM)
31						SPIN/WASH HW CASING TO -35 FT	
32						MODERATE DRILLING	
33							(NS)
34							
35		S-6		35.0 TO 37.0	21 32	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Dk. Gr. Silty Clayey (30-40) SAND (SC/SM)
348 36							

NED Form 58A (Test)

Boring No. FD 93-3

PLATE A.38

348

DEPTH		CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
36		S-6		35.9 TO 37.0	34, 40	ADVANCE HW CASING AND ROLLER BIT/WASH TO -40 FT.	Dk. Gr. Silty, Clayey (30-40) SAND (SC/SM)
37–39							(NS)
40		S-7		40.0 TO 42.0	55, 63, 68, 61	300 lb HAMMER 18 IN. DROP NW ROD 2½" I.D. SPLIT-SPOON	Dk. Gr. CLAY W/Sand (30-40) Etr. Gravel (CL)
42–44						ROLLER BIT & WASH TO -45 FT.	(NS)
45		S-8		45.0 TO 47.0	52, 70, 65, 71	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLITSPOON	Dk. Gr. Clayey, Silty (30-40) SAND W/tr. Gravel (SC/SM)
47–50						ROLLER BIT & WASH TO -50 FT. ADVANCE 4" CASING TO -50 FT.	Nested Cobbles & Boulders Cobbles
50.5		S-9A		50.5 TO 52.5	72, 57, 21, 19	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLITSPOON	Gr. Subang. GRAVEL W/Sand (10-20) (GP)
52.5		S-9B					Lt. Gr. Varved CLAY (CH)
53							

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EU-...-58A(Test)

Boring No. FO 93-3

PLATE A.39

DEPTH		CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
331	53						
	54					ADVANCE BORING WITH ROLLER BIT / WASH TO -55 FT.	(NS)
	55	S-10A		55.0 TO 57.0	55, 19, 31, 49	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLITSPOON	Lt. Gr. m-f SAND w/tr. Silt (SP)
	56						
	57	S-10B			130		Lt. Gr. f. SAND within pockets of Varved Clay (25-35) (SP)
	58					ADVANCE HW CASING TO -60 FT.	
	59					ROLLER BIT & WASH TO -60 FT.	(NS)
	60	S-11		60.0 TO 60.8	100, 100/4, REF	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLITSPOON	Gr. Silty (15-25) m-f SAND w/little Gravel (0-10) (SM)
	61					ROLLER BIT/WASH TO -65 FT.	
	62						
	63						(NS)
	64						
	65	S-12		65.0 TO 65.8	70, 150/4	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLITSPOON	Br. Silty, Clayey (23) SAND w/few Gravel (14) (SC/SM)
	66						
	67					SPIN/WASH HW CASING TO -65 FT. EASY TO MOD. DIFFICULT WHERE COBBLES ARE ENCOUNTERED ½-¾ THROTTLE 3RD-4TH GEAR	
	68						(NS)
	69						
314	70						

ED Form 53A (Test)

Boring No. FD 93-3

PLATE A.40

NOV 5 314

DEPTH	1"	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
70		S-13		70.0 TO 70.8	135 100/4	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Silty, Clayey (10-20) SAND w/ Subang. Gravel (15-25) (SC/SM)
71						MC SAND IN CUTTINGS FROM ROLLER BIT 2 -70 FT.	
72						SPIN/WASH HW CASING TO -75 FT.	
73						MODERATE DRILLING CLEAN WITH ROLLER BIT	(NS)
74							
75		S-14		75.0 TO 75.1	80/1 BAKING REF	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. well-graded SAND w/Rock Frags (40-50) (SW)
76						ROLLER BIT & WASH TO -80 FT.	
77						½-¾ throttle 2ND GEAR VARYING TO CONDITION	
78							(NS)
79							
80		S-15		80.0 TO 81.2	60 114 100/2	80' 300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Gr. Varved CLAY w/m-f Sand (15-25) (CL)
81							
82						ROLLER BIT THEN ADVANCE CASING TO -85 FT.	
83						WASH BORING ↓	(NS)
84							
85		S-16		85.0 TO 85.4	150/5 REF	85' 300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Olive Gr. Silty (15-25) SAND w/little Gravel (0-10) (SM)
86							(NS)
87							

NOV 8

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NED Form 58A (Test)

Boring No. FD 93-3

Elev.	Depth	No.	Size	Depth Range	Blows per ft / Core Recvy	Sampling and Coring Operations	Classification of Materials
291	87	S-17		87.0 to 87.3	150/3	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Olive Gr. Silty (15-25) SAND w/little Gravel (0-10) (SM)
	88					ROLLER BIT & WASH TO -90 FT.	
	89						(NS)
	90	S-18		90.0 to 90.8	119 150/4	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Olive Gr. Silty (15-25) SAND w/little Gravel (0-10) (SM)
	91–93					ADVANCE BORING By ROLLER BIT/WASH TO -94 FT.	(NS)
290	94	S-19		94.0 to 94.2	95/2 BNC REF	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Lt. Br. Silty, Clayey (30-40) w/little Gravel (0-10) (SC/SM)
	95					ROLLER BIT/WASH TO -96 FT.	(NS)
	96	S-20		96.0 to 96.4	130/5 BNC REF	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Lt. Br. Silty, Clayey (30-40) SAND w/little Gravel (0-10) (SC/SM)
	97					ROLLER BIT/WASH TO -98 FT.	(NS)
286	98	S-21A		98.0 to 98.8	80 90/3	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	COBBLES & BOULDERS w/Sand (25-35) & Clay Pockets (15-35)
285	99	S-21B				98.5	Olive Clayey (30-40) SAND w/Gravel (10-20) (SC)
	100					ROLLER BIT/WASH TO -100.5 FT.	(NS)
	101	S-22		100.5 to 101.3	75 92/3	300 lb HAMMER 18 IN. DROP NW ROD 2½" I.D. SPLIT SPOON	Olive Clayey (30-40) SAND w/Gravel (10-20) (SC)
NOV 9	102						
	103						(NS)
280	104						

ED Form 58A (Test)

Boring No. ED 93-3

PLATE A.42

280

Nov 9

DEPTH		CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
104						ROLLER BIT & WASH TO -105 FT.	(NS)
105		S-23		105.0 TO 107.0	26, 49, 111, 102	300 lb HAMMER 18 IN. DROP NW ROD 2½" I.D. SPLIT SPOON	Br. CLAY with gr. Silt Laminations (CL)
106							
107						ROLLER BIT & WASH TO -110 FT. HOLE STAYS OPEN	(NS)
108							
109							
110		S-24		110.0 TO 111.4	47, 65, 150/5	300 lb HAMMER 18 IN. DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Clayey (40-50) SAND (SC/CL)
111							
112						ROLLER BIT & WASH TO -115 FT. HOLE PLUGS / CLEAN OUT @ ROLLER BIT. ADVANCE HW CASING, SPIN/WASH TO -115 FT.	(NS)
113							
114							
115		S-25		115.0 TO 117.0	49, 65, 84, 135	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Br. Clayey (40-50) SAND (SC/CL)
116							
117						ROLLER BIT & WASH TO -120 FT. 2ND GEAR ½-¾ throttle	(NS)
118							
119							
120		S-26		120.0 TO 120.4	150/5	300 lb HAMMER 18 IN DROP NW ROD 2½" I.D. SPLIT SPOON	Olive Gr. Silty (20-30) SAND with little Gravel (0-10) (SM)
121							

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NED Form 53A (Test)

Boring No. FD93-3

Elev.	DEPTH	CORE/SAMPLE NO.	SIZE	DEPTH RANGE	BLOWS PER FT / CORE RECVY	SAMPLING AND CORING OPERATIONS	CLASSIFICATION OF MATERIALS
263	121					ROLLER BIT/WASH TO -124 ± SPIN/WASH HW CASING TO -125 FT – SEAT IN TO ROCK	
	122						
	123						COBBLES/ BOULDERS (NS)
260	124						
259	125						BEDROCK (NS)
	126				R-1 60" REC 100%	CORE ROCK WITH NX SIZE CORE BARREL, DIAMOND BIT RUN-1 (5 FT) DRILLING TIME 15 MIN. – NO WATER LOSS –	
	127						
	128				RQD 93		
	129						WEATHERED GRANITE BEDROCK
	130						
	131				R-2 60" REC 100%	RUN-2 (5 Ft) DRILLING TIME 10 MIN 30 SEC. –NO WATER LOSS	
	132						
	133				RQD 60		
	134						
249	135					BORING TERMINATED @ -135'	

ED Form 58A (Test)

Boring No. FD 93-3

Site: *HOPKINTON DAM*
Boring No: *FD93-3*

SUBSURFACE WATER OBSERVATIONS

DATE	TIME	DEPTH-BOT. OF CASING	DEPTH-BOT. OF BORING	DEPTH TO WATER	ELEVATION WATER	REMARKS
11/5	630AM	70	66	-3.2'		
11/5	1230PM	85	85	-10.5'		(INDUCED)
11/8	1200	85	85	-14.5'		
11/8	500PM	85	101	-12.3'		(INDUCED)
11/9	630AM	85	101	-6.6'		
11/9	500PM	125	135	-18.0'		(INDUCED)
11/10	630AM	125	135	-15.9'		

Note: Depths are in feet below original ground

BORING LOCATION SKETCH

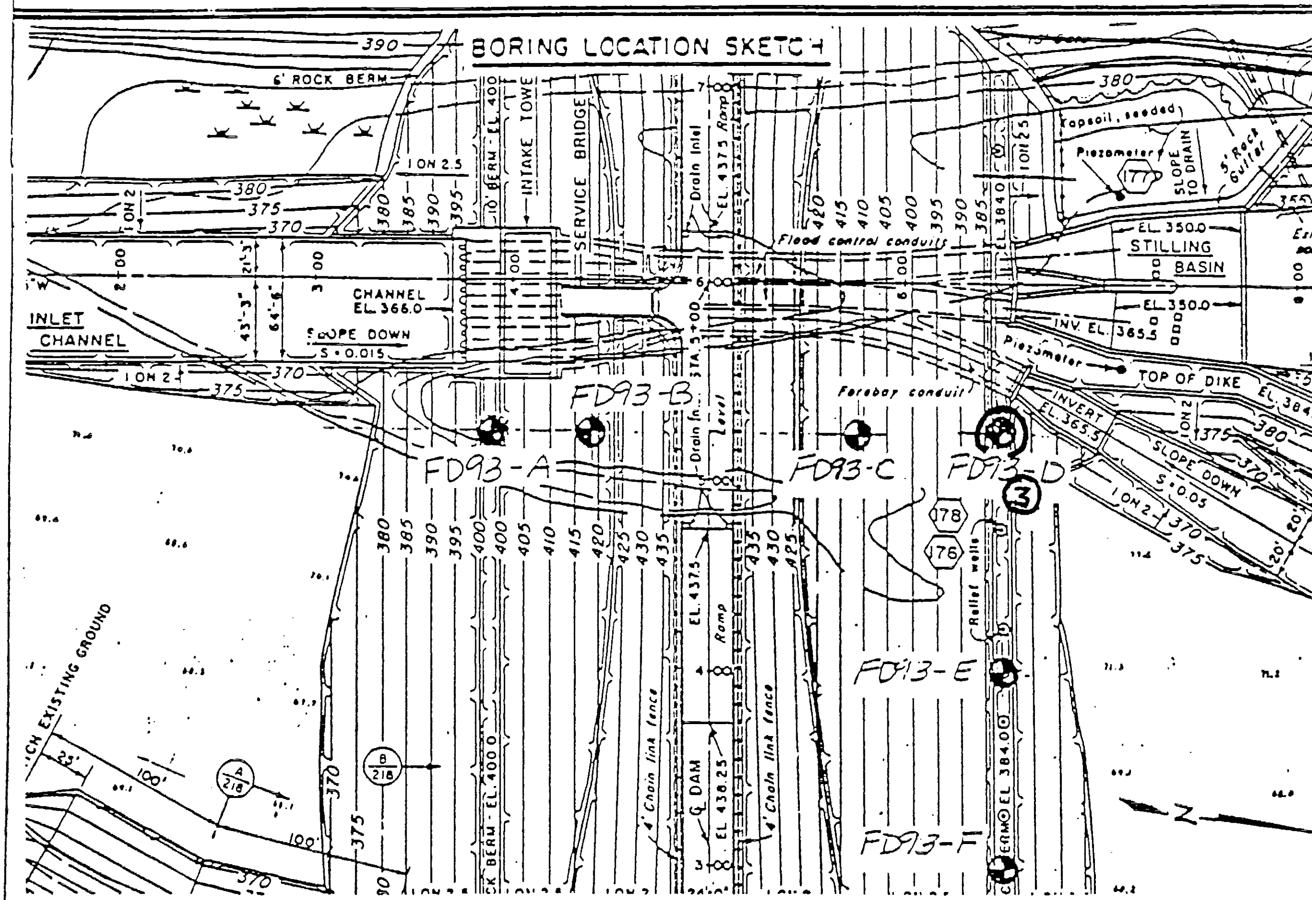


PLATE A.45

PIEZOMETER INSTALLATION REPORT

PROJECT: HOPKINTON DAM | DATE. NOVEMBER 11, 1993

LOCATION (STA): 5+25 OFFSET FROM CENTER LINE: 150' DOWNSTREAM PIEZ NO.: PZ-15

PIEZ TYPE: CASAGRANDE @ 3/4" I.D PVC RISER DEPTH OF PIEZ: -83 FEET RISER PIPE DIAM: 3/4" I.D.

PIEZ TIP SET IN (SOIL TYPE): SP-SM STRATIFIED SOIL SAMPLE NO.: S-9A TO S-15 BORING DIAM: 4"

METHOD OF INSTALLATION: ROTARY WASH BORING

TYPE OF PROTECTION FOR PIEZ: 4" DIA STEEL CASING VENT: threaded locking CAP

GROUND ELEV.: 384' (NGVD) ELEV. TOP OF RISER: 384.3' ELEV PIEZ TIP: 301'

FILTER: #20 SILICA SAND FROM ELEV: 299' TO ELEV: 334'

SEAL: BENTONITE "PELLETS" FROM ELEV: ~~334'~~ 293' TO ELEV: ~~340'~~ 299'

INSTALLED BY: ATLANTIC TESTING LABSS CONTRACT NO.: DACW33-93-D-0004 FOREMAN: T ELDRIDGE

DATE OF INSTALLATION: NOVEMBER 10, 1993 DATE OF OBSERVATIONS: NOVEMBER 11, 1993

METHOD OF TESTING PIEZ.: FALLING HEAD

TIME 1019	ELAPSED TIME MINUTES	DEPTH TO WATER FEET	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER FEET	TIME	ELAPSED TIME MINUTES	DEPTH TO WATER FEET
1019[30]	0.5	3.28	1039	20.0	—			
1020	1.0	4.69	1049	30.0	—			
1022	3.0	5.74						
1024	5.0	5.80						
1029	10.0	5.80						

REMARKS:

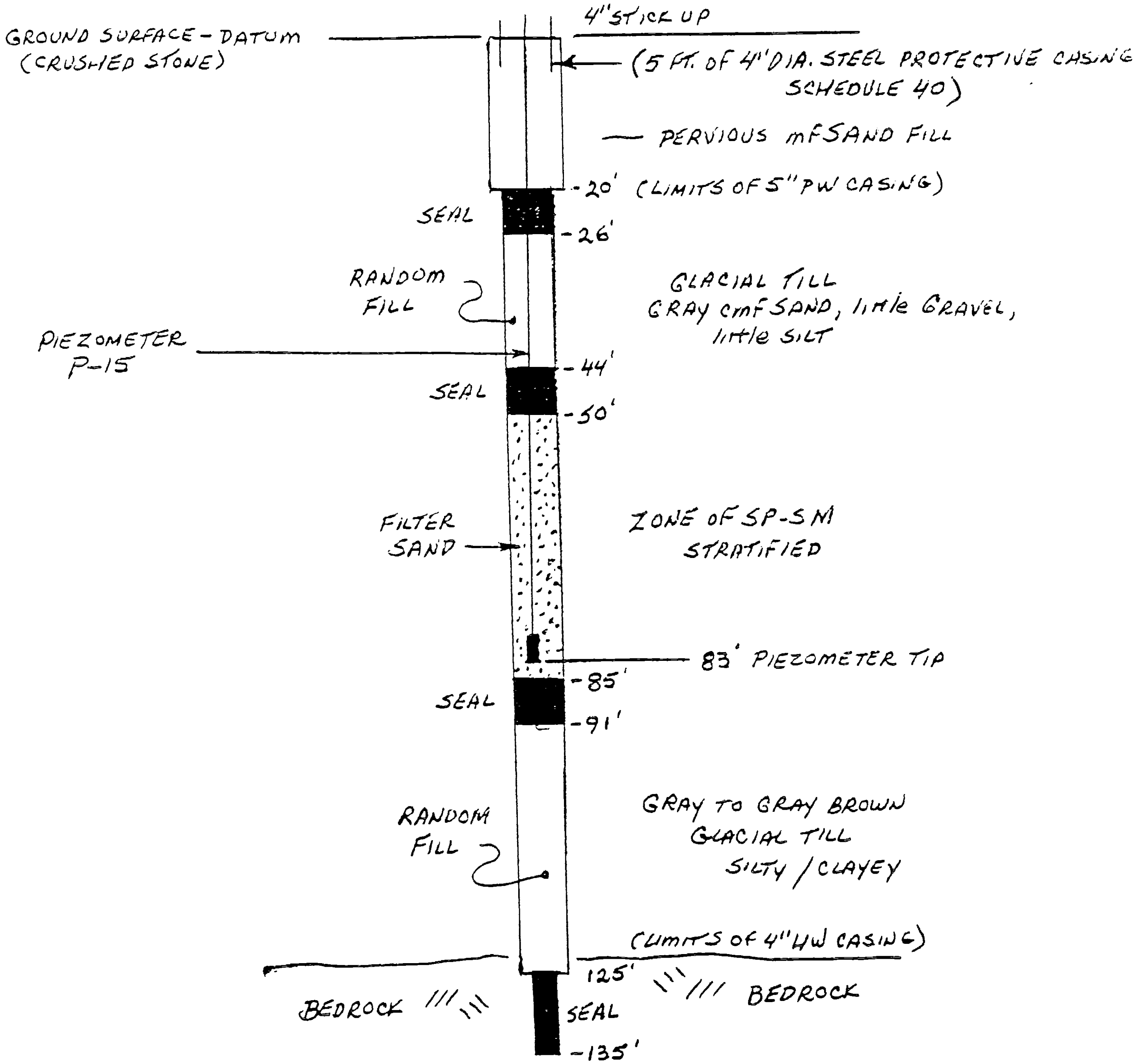
– PIEZOMETRIC HEAD @ START OF TEST –5.90 FT.

– THE AVERAGE of 2 RUNS with SIMILAR RESULTS EACH RUN

Tom Eldridge

INSPECTOR

TEST BORING
FD 93-3



CASAGRANDE TYPE PIEZOMETER WITH 3/4" I.D. PVC RISER SCHEDULE 80

BENTONITE SEALER - PECTONITE "PELLETS
FILTER SAND - #20 SILICA SAND
RANDOM FILL - #4 SILICA SAND

PLATE A.47

FIELD PERMEABILITY TEST RESULTS

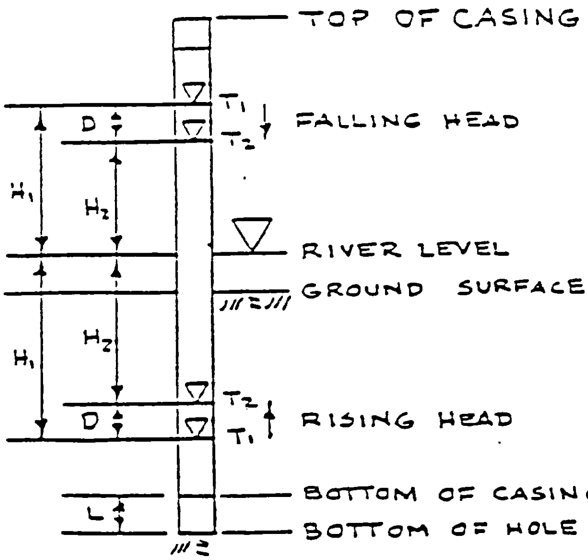
DATE: Nov 11, 1993	BORING NO: FD93-3	DEPTH: 83 FT.	INSPECTOR: T ELDRIDGE	
D_o = 1.0	D_i = 0.75	L = 420 IN.	H_1 = 5.90 FT.	m = 3

FALLING HEAD				RISING HEAD			
ELAPSED TIME $(t_2 - t_1)$	ΔD $(H_2 - H_1)$	H_2 $(H_1 - D)$	K_H	ELAPSED TIME $(t_2 - t_1)$	D $(H_2 - H_1)$	H_2 $(H_1 - D)$	K_H
0.5	3.28	2.62	3.54×10^{-5}				
1.0	4.69	1.21	3.46×10^{-5}				
3.0	5.74	0.16	2.62×10^{-5}				
5.0	5.80	0.10	1.78×10^{-5}				
10.0	5.80	0.10	8.9×10^{-6}				
20.0			—				
30.0			—				

NOTES: PIEZOMETER 15

EXPERIENCED MORE DOWNHOLE PRESSURE IN THIS BORING COMPARED TO OTHERS WHEN SETTING PIEZOMETER

SCHEMATIC



SYMBOLS

D_o = OUTSIDE DIAMETER OF CASING

D_i = INSIDE DIAMETER OF CASING (c

L = LENGTH OF SAMPLE (CM)

m = TRANSFORMATION RATIO

H = PIEZOMETRIC HEAD

T = TIME (SEC.)

K_h = HORIZONTAL PERMEABILITY (CM

D = CHANGE IN H

$$K_h = \frac{D_i^2 \ln\left[\frac{mL}{D_o} + \sqrt{1 + \left(\frac{mL}{D_o}\right)^2}\right]}{8 \cdot L \cdot (t_2 - t_1)} \ln$$

$$K_h = \frac{D_i^2 \cdot \ln\left(\frac{2mL}{D_o}\right)}{8 \cdot L \cdot (t_2 - t_1)} \ln \frac{H_1}{H_2} \quad \text{for} \quad \frac{mL}{D_o} >$$

PLATE A.48

Standard 1

The following standards and procedures are employed for Crest Monument Surveys at **Hopkinton Lake Dam.**

STANDARDS FOR SETTLEMENT SURVEYS

1. Control points are stamped brass disks preferably set in a ledge area. Where no ledge is available, they are set in concrete bounds placed flush with the ground.

2. Control points are set in areas such that the maximum possible number of crest monuments on the dam are visible.

3. Control points are tied into four reference points by distance. This provides a check each time they are occupied for settlement surveys or allow them to be replace if found to be destroyed.

4. Distances are read and recorded between settlement bounds. Both distance and angle are read and recorded from the control points that are being occupied to locate each settlement bound on the dam.

5. In locating each settlement bound, a control point will be occupied setting 0-00'-00" (referenced line of site) on a second control point, reading and recording both interior and exterior angle closure, along with distances through each settlement bound located on the dam. Each settlement bound is located from a minimum of two control points. These locations are third order, class II survey with relative accuracies of not less than 1 part in 5,000.

6. Levels are run from control points through each settlement bound on the dam with a return run back into the control points to check the elevation closure on the run. Closure tolerance should be no greater than 0.05'. These levels are third order, class I survey with relative accuracies not less than 1 part in 10,000.

7. Crest monument surveys are performed using Topcon EDM Total Stations and recording both horizontal angles and horizontal distances.

PROCEDURE FOLLOWED FOR SETTLEMENT SURVEYS

The horizontal and vertical monitoring plan for settlement bound movement points employed a combination of triangulation and trilateration angle and distance techniques to survey the control network. Control points, in the form of stamped brass disks, were placed on the dam structure in a location that is clearly visible from the control points. Horizontal coordinates of the control points are based on the State Plane Coordinate System. Elevations of the control points are bawd on the National Geodetic Vertical Datum (NGVD). Control points are occupied utilizing an EDM Total Station; observed distances and angles (interior and exterior angles), between control points and settlement bound establishing permanent bench marks. Standard leveling techniques are followed. Levels are double run and the means of the front and back runs were computed and recorded.

DATA ADJUSTMENT

A combination of triangulation and trilateration surveying techniques are applied. Each crest monument is located from two control points and two sets of coordinates are calculated using adjusted field angles and compliments and EDM distances. The two sets of coordinates are averaged to give a net result. The averaged coordinates are then established on each settlement bound for use in determining shifts in the dam surface structure over a period of years by comparing repetitive surveys.

HOPKINTON DAM
MERRIMACK RIVER BASIN

Reading Schedule for Piezometers

General. Piezometers are utilized to measure groundwater levels and pore pressures ..th in the foundation and embankments of earth and rockfill dams. Experience has shown that installation of piezometers in earth fills and their foundation provides significant data indicating the magnitude and distribution of pore pressures and their variations with time and also patterns of seepage, zones of potential piping, and the effectiveness of underseepage control measures.

2. Piezometer Readings. At the present time, files are maintained for dams which have operating piezometers and most of the data is put on the computer. Data is transmitted to GEB in writing by the project manager. Piezometer data should be reduced in the field and each reading compared with previous data; thus, if a piezometer has an unusual reading, the reading can be checked immediately. Pool elevations, tailwater elevations, measuring weir discharge quantities, and rainfall data should be recorded simultaneously with piezometer readings.

a. Reading Schedules.

(1) Routine. During periods when the reservoir is at or below the 22 foot stage (Elev 388) readings should be made by the project manager at least once a month. When access to instruments is made hazardous by snow or ice, the readings may be deferred until safe access is possible.

(2) High Pool. During periods when the reservoir level (includes rising and falling pools) is above the 22 foot stage, readings should be made on a daily basis. Pool elevations and all the other information requested in paragraph 2 above should be recorded simultaneously with piezometer readings. On a falling pool, piezometer readings ..ould continue for approximately five days after the pool has returned to its normal elevation.

b. Data Collection.

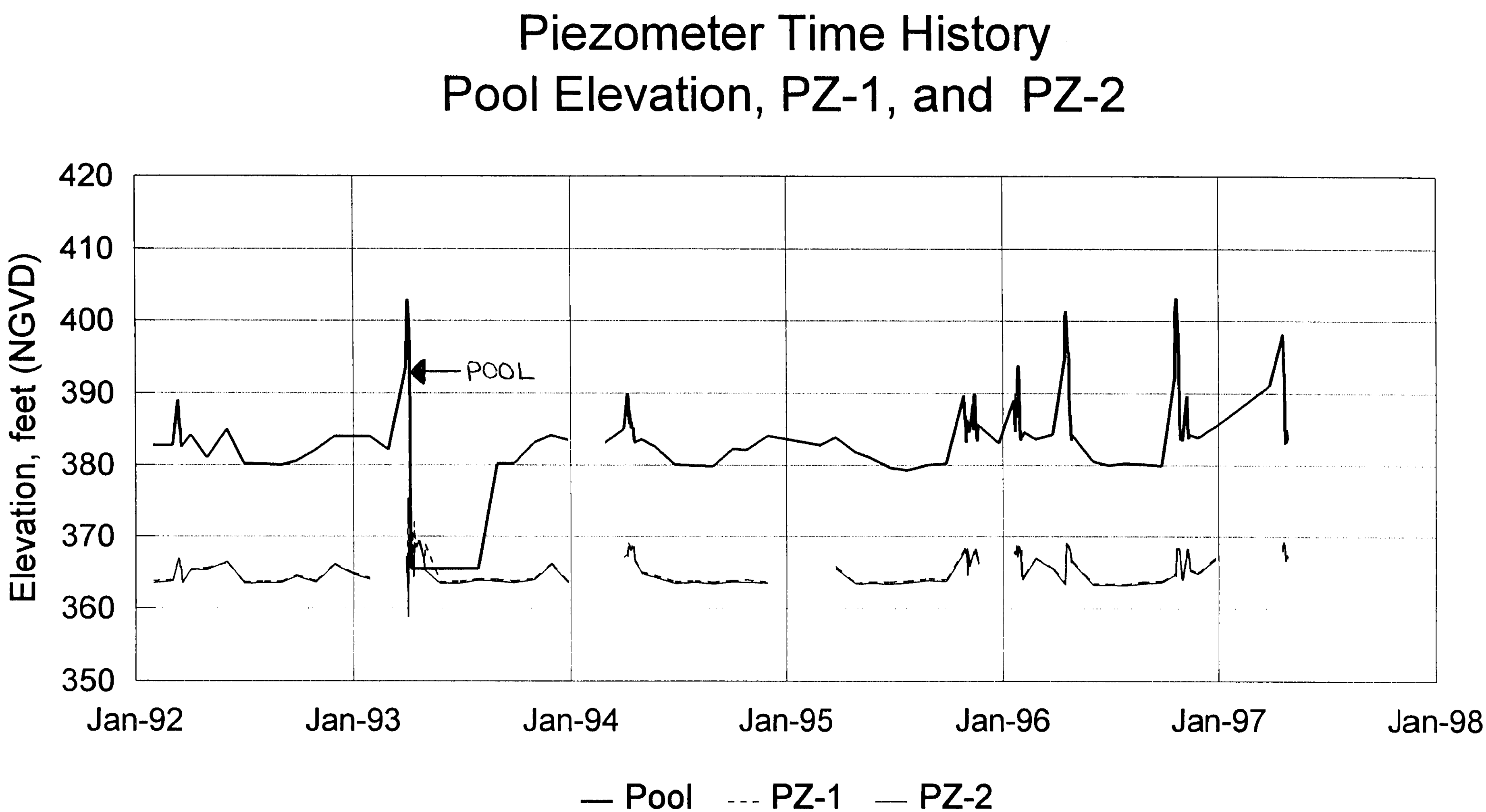
(1) Location Maps. A general plan of the project showing the location of the active piezometers and the corresponding identification number for each piezometer is provided to eliminate identification and data recording inaccuracies.

(2) Data Collection Tables. A table listing the piezometer identification number, stationing and offset, as well as piezometer top and tip elevations is also provided for recording and submitting piezometer readings. It should be noted that when two piezometers are located in the same protective casing, each shall be designated with a number as well as an "A" or "B". The letter "A" will indicate the deeper piezometer riser and the letter "B" shall designate the more shallow riser for each such location. All piezometers shall be clearly labeled with the appropriate identification number and letter (if required). These labels shall be installed inside of the protective casings and attached to each respective piezometer riser by the project manger.

(3) Destination. All data should be sent to the following address on the first of each month.

U.S. Army Corps of Engineers
New England Division
CENED-ED-GD
424 Trapello Road
Waltham, MA. 02254-9149
RE: PIEZOMETERS

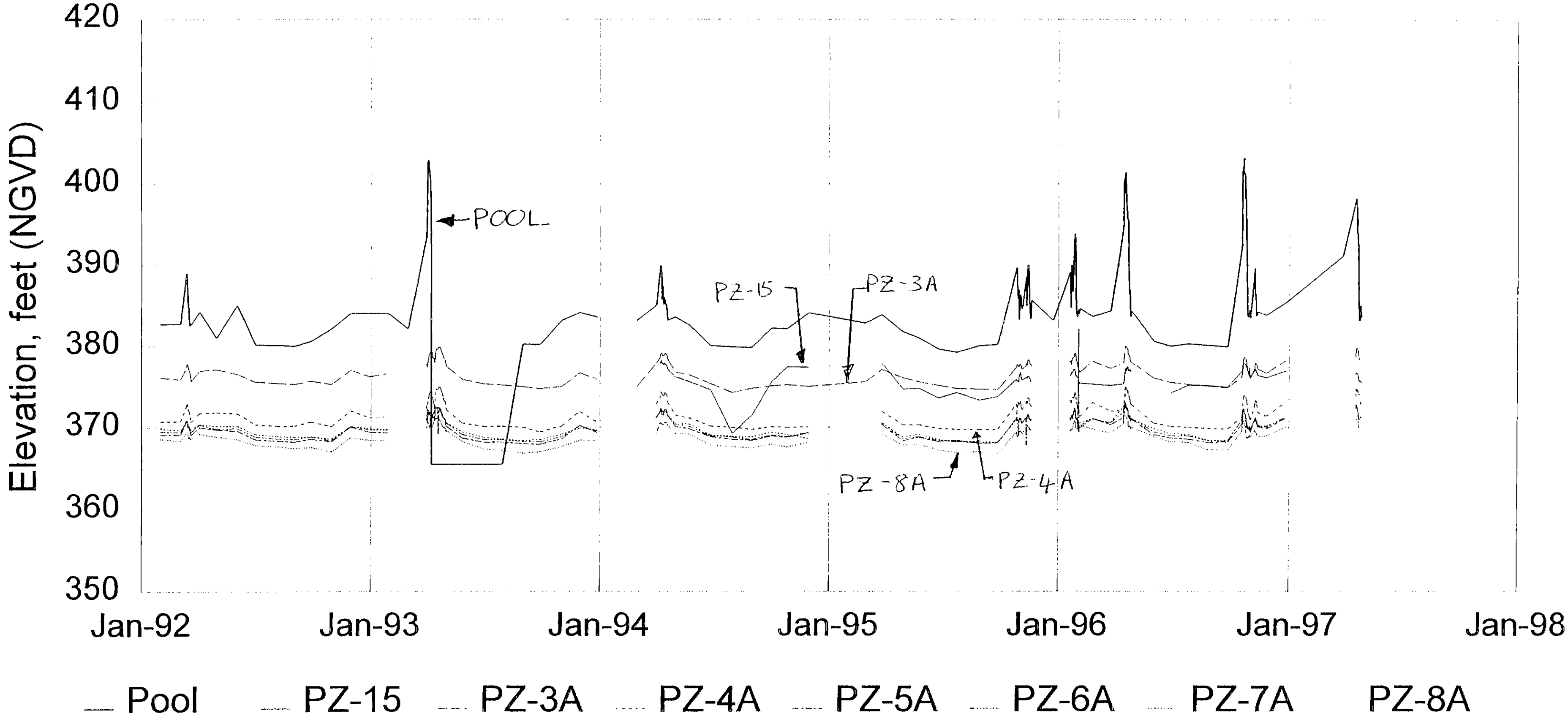
(4) Special Conditions. If unusual changes in readings develop or if piezometers become inoperable, Geotechnical Engineering Branch should be contacted.



Note: Elevations at PZ-1 and PZ-2 were similar, therefore these lines plot on top of each other

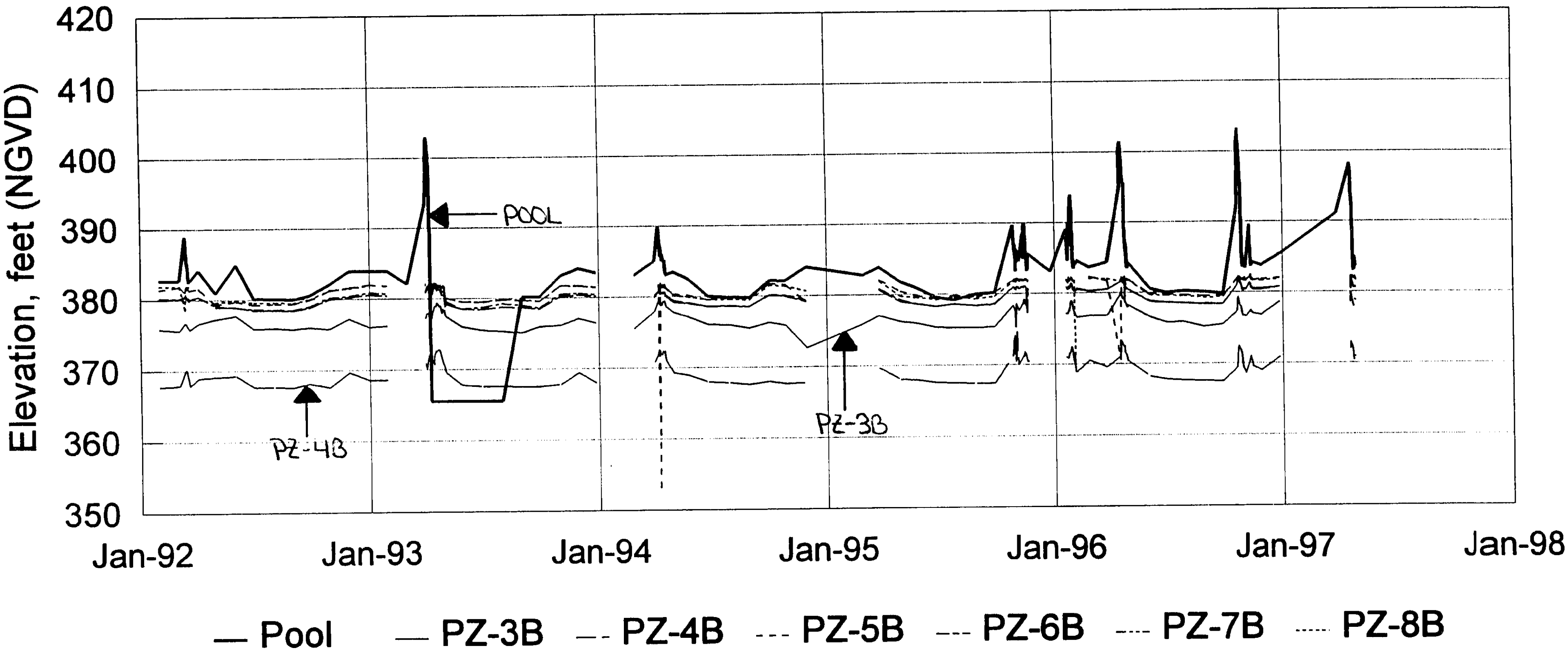
Piezometer Time History

Pool Elev, PZ-15, PZ-3A, PZ-4A, PZ-5A, PZ-6A, PZ-7A, and PZ-8A



Note: Elevations at PZ-5A, PZ-6A, and PZ-7A were similar, therefore these lines plot on top of each other

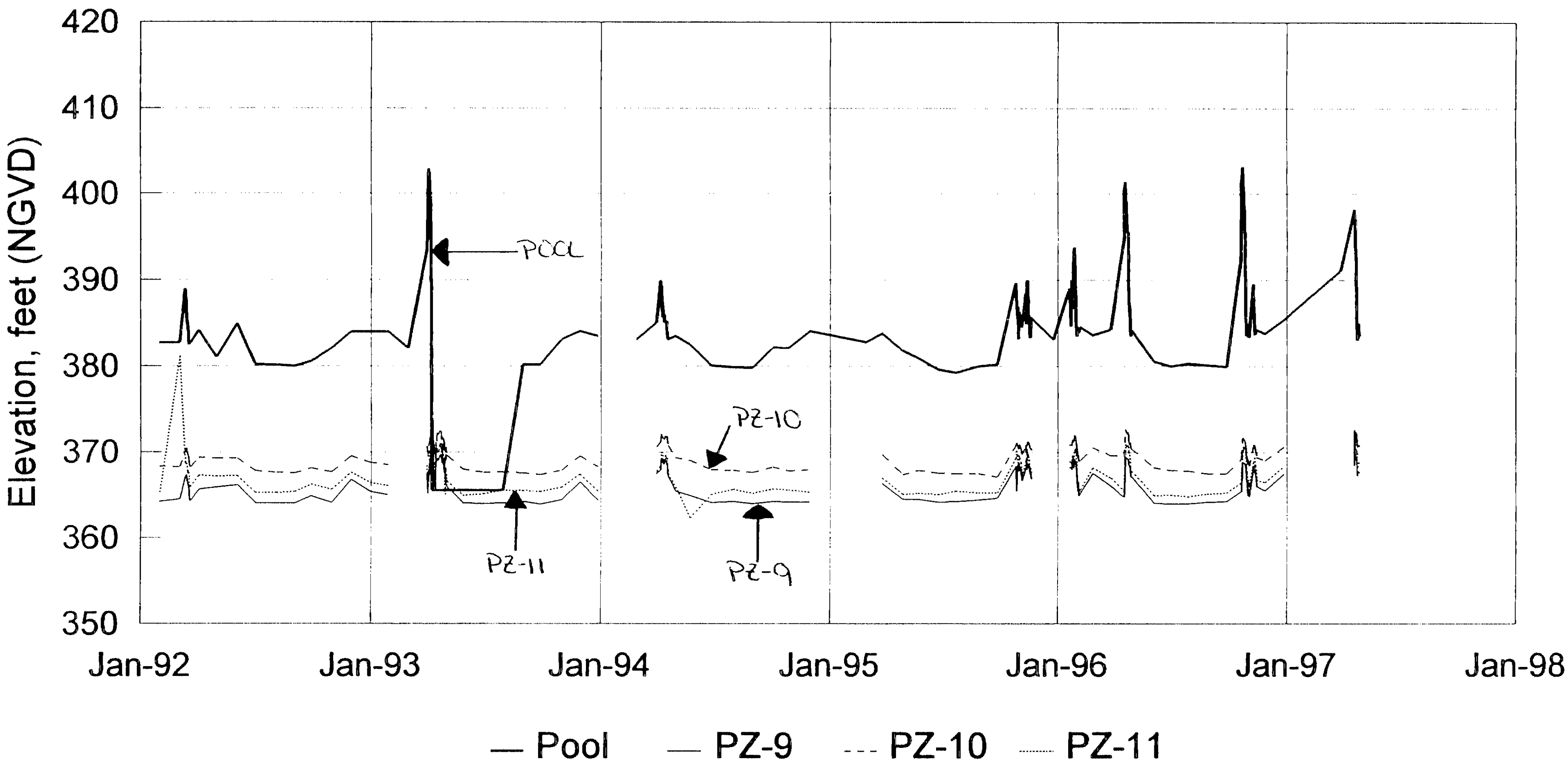
Piezometer Time History
Pool Elev, PZ-3B, PZ-4B, PZ-5B, PZ-6B, PZ-7B, and PZ-8B



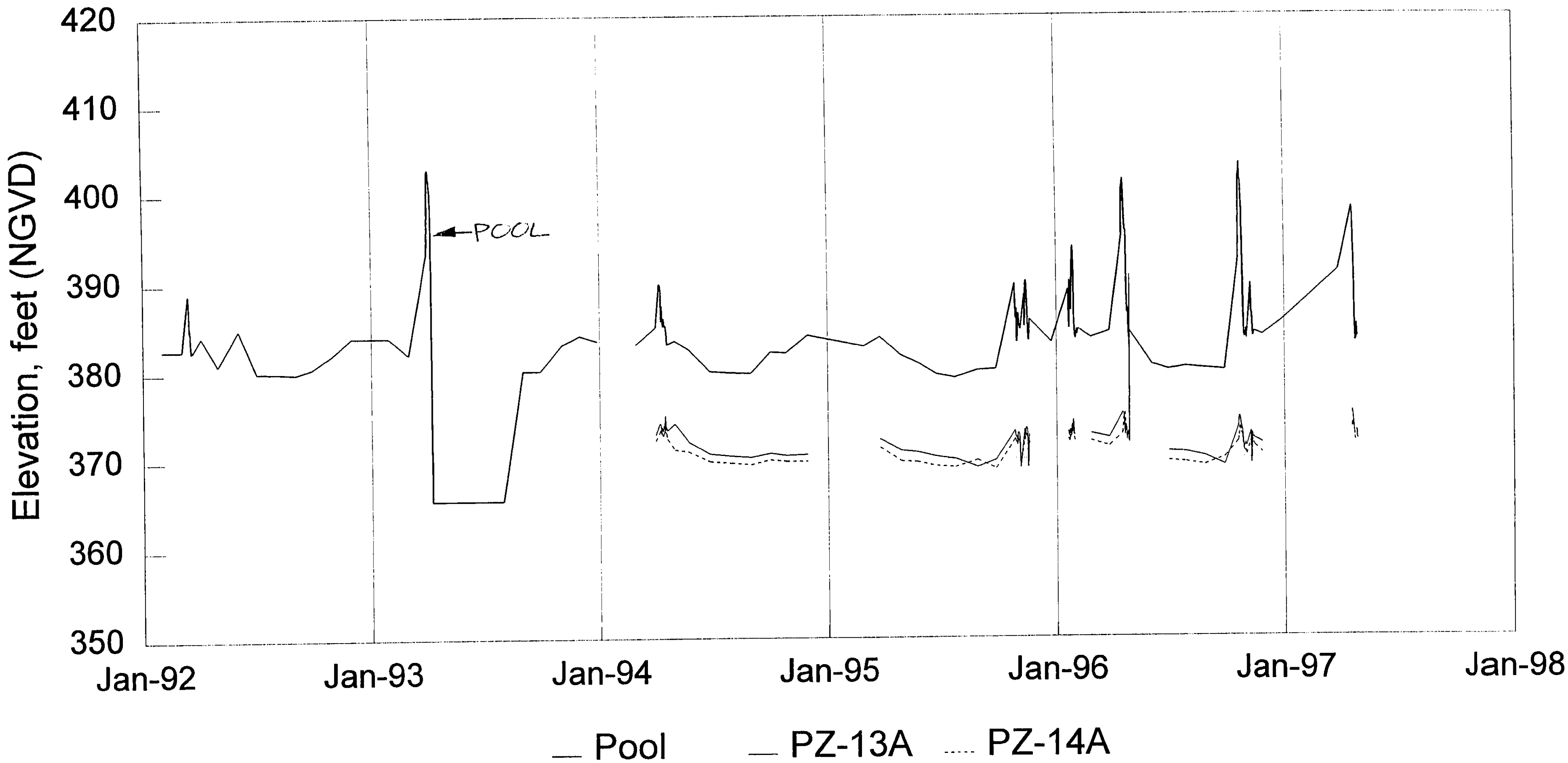
Note: Elevations at PZ-5B and PZ-8B were similar, therefore these lines plot on top of each other

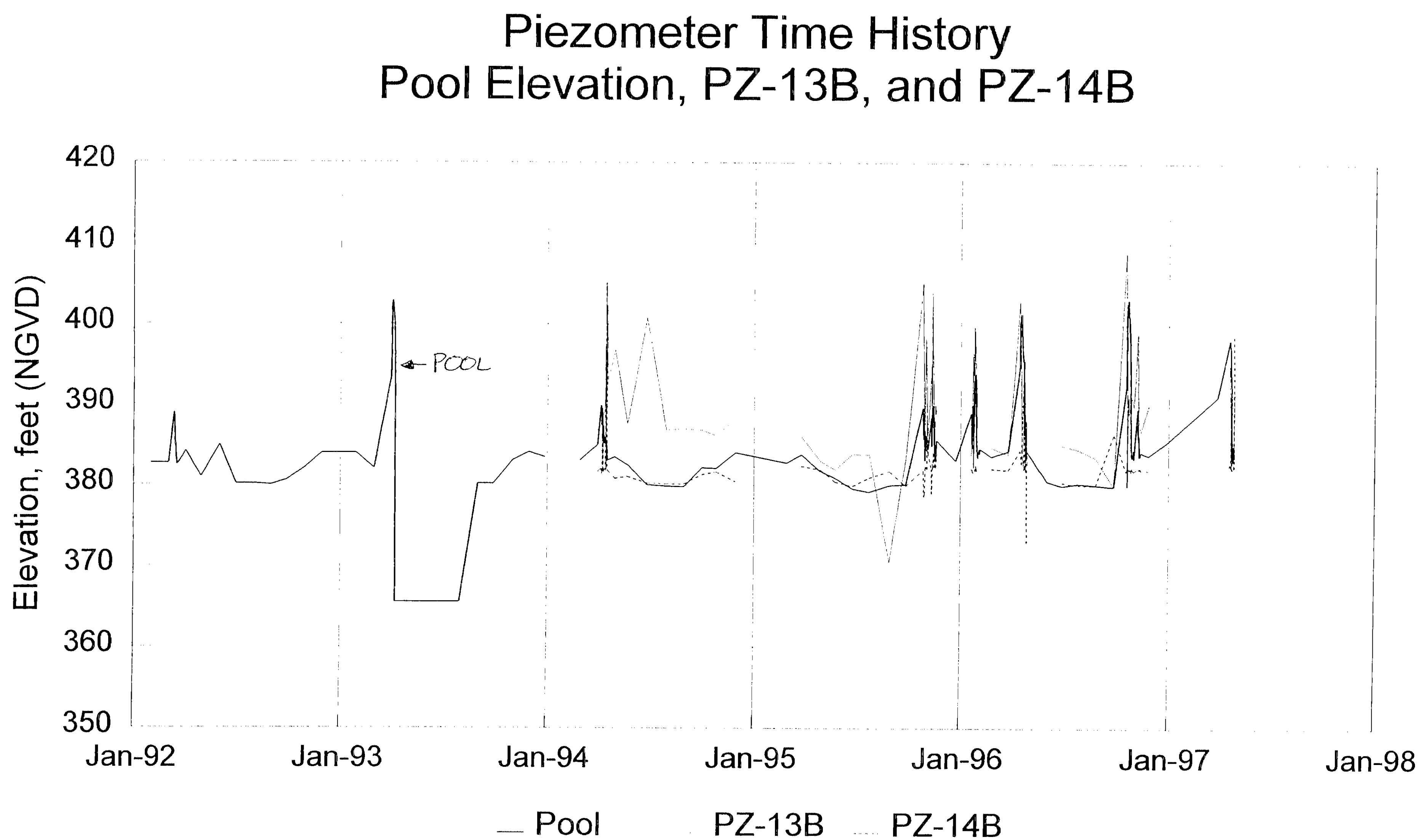
Note: Elevations at PZ-6B and PZ-7B were similar, therefore these lines plot on top of each other

Piezometer Time History
Pool Elevation, PZ-9, PZ-10, and PZ-11



Piezometer Time History
Pool Elevation, PZ-13A, and PZ-14A

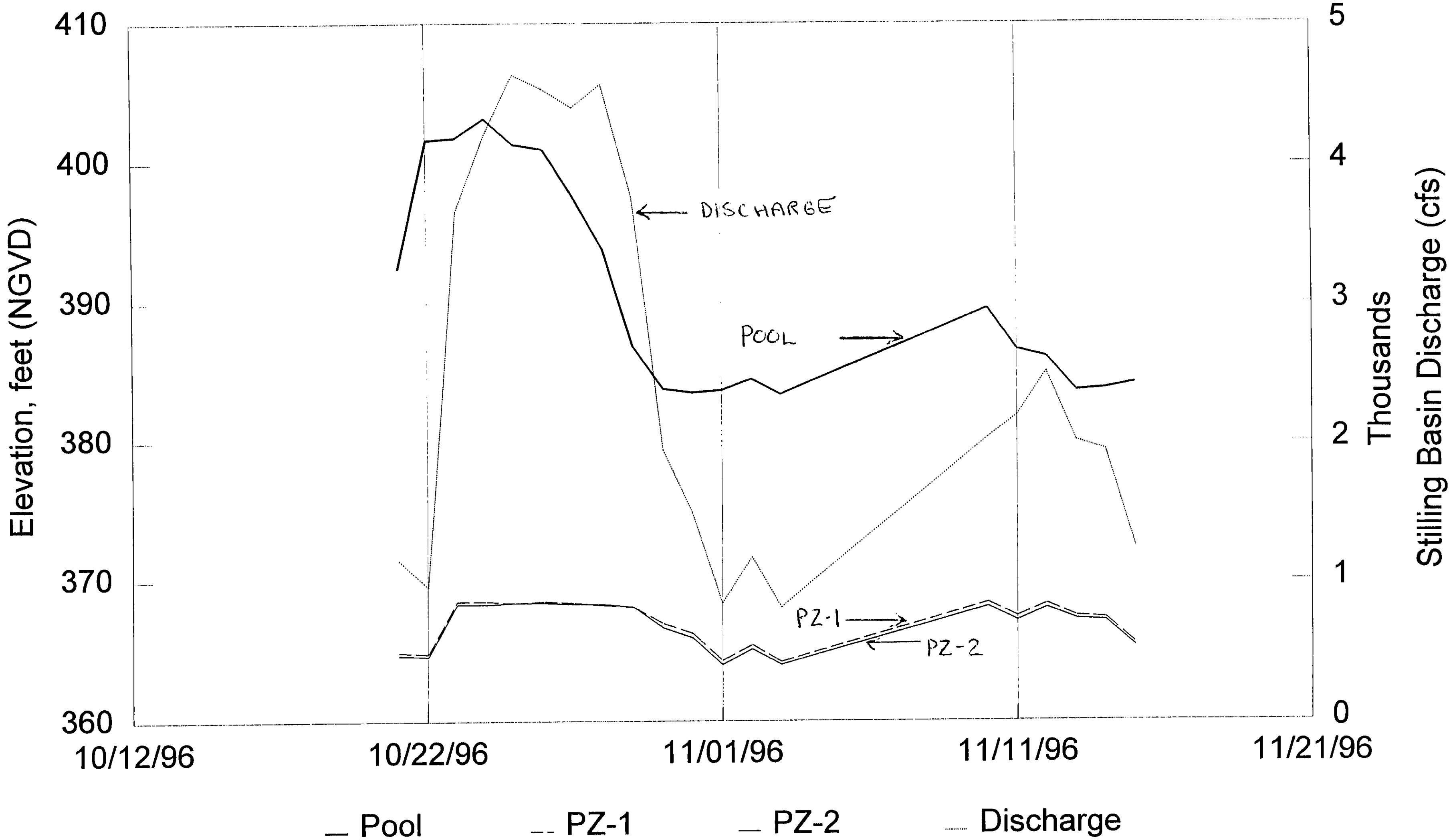




Piezometer Time History
Pool Elevation, PZ-13B, and PZ-14B
420
410
400
390
380
370
360
350
Elevation, feet (NGVD)
POOL
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Pool
PZ-13B
PZ-14B

October 1996 High Pool Event

Pool Elevation, PZ-1, PZ-2 and Stilling Basin Discharge



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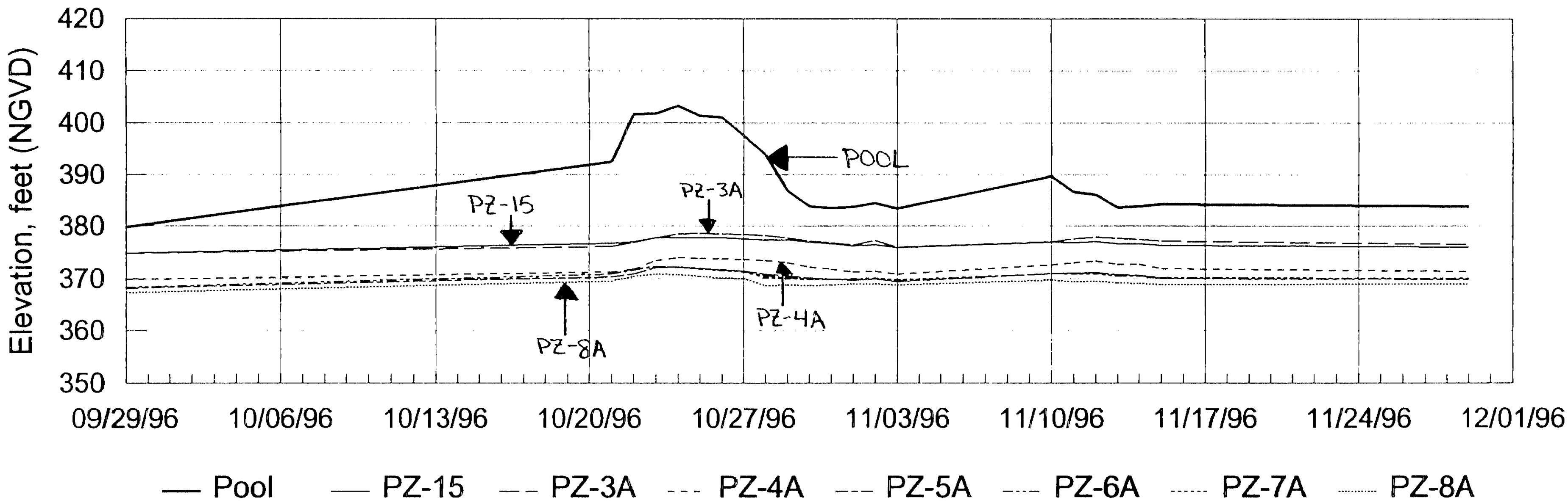
Hopkinton Dam

Project 97487

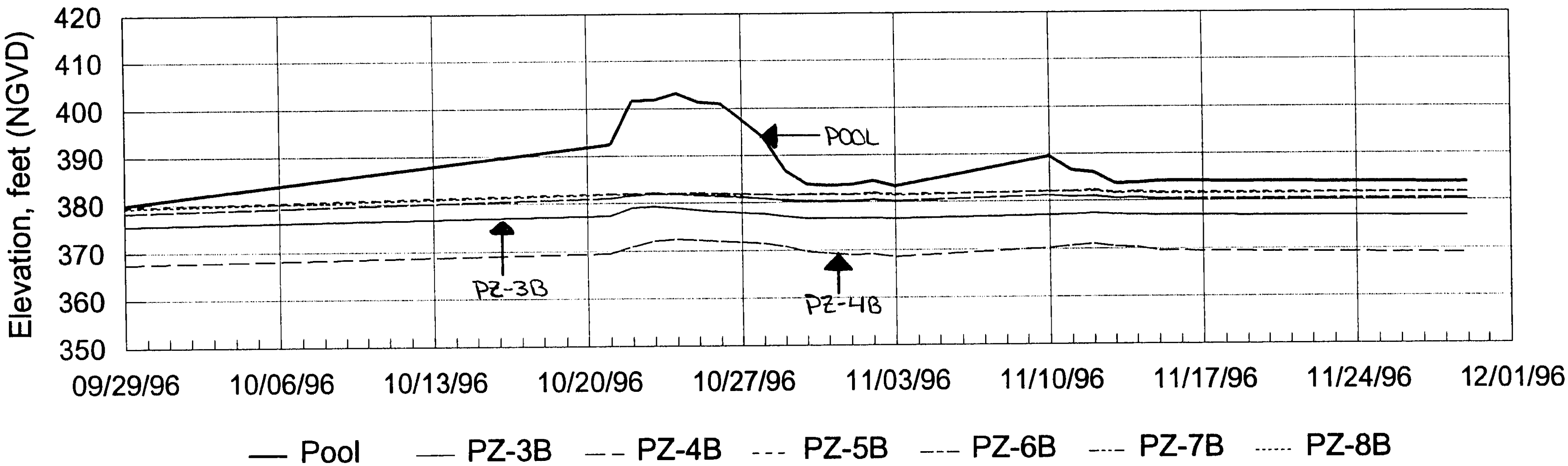
PLATE D.1

October 1996 High Pool Event
Pool Elev, PZ-15, PZ-3A, PZ-4A, PZ-5A, PZ-6A, PZ-7A, and PZ-8A



Note: Elevations at PZ-5A, PZ-6A, and PZ-7A were similar, therefore these lines plot on top of each other

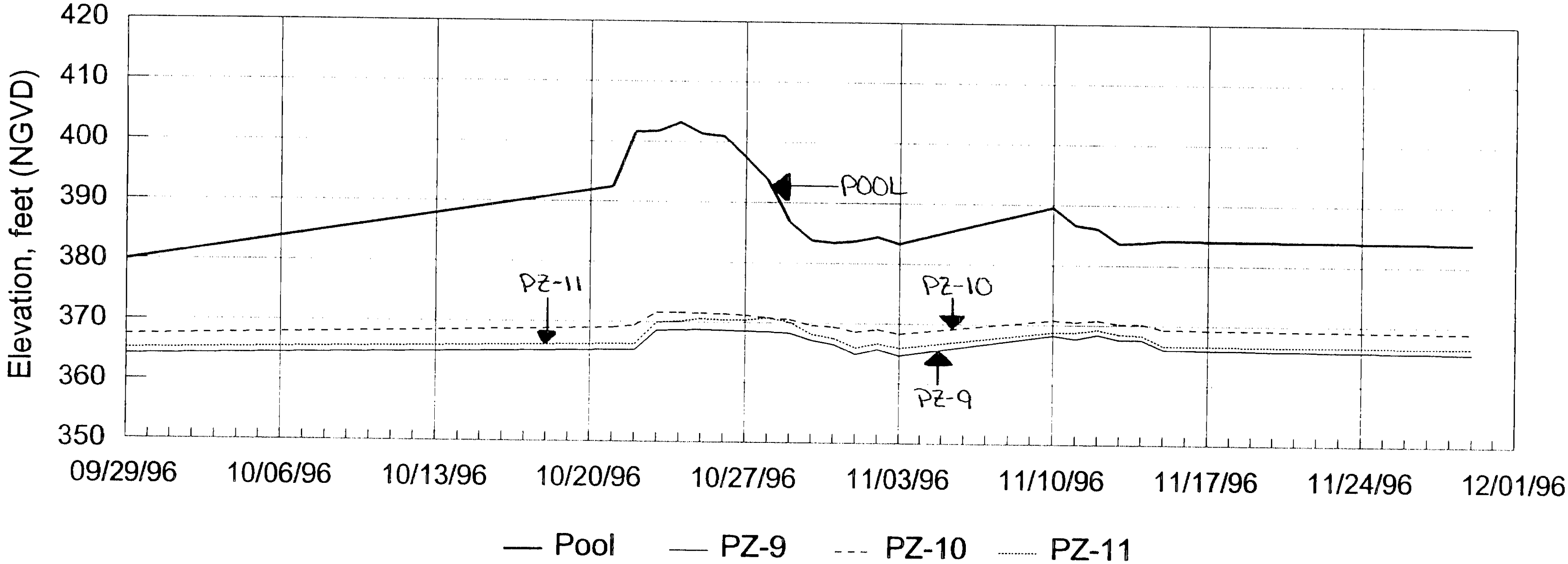
October 1996 High Pool Event
Pool Elev, PZ-3B, PZ-4B, PZ-5B, PZ-6B, PZ-7B, and PZ-8B



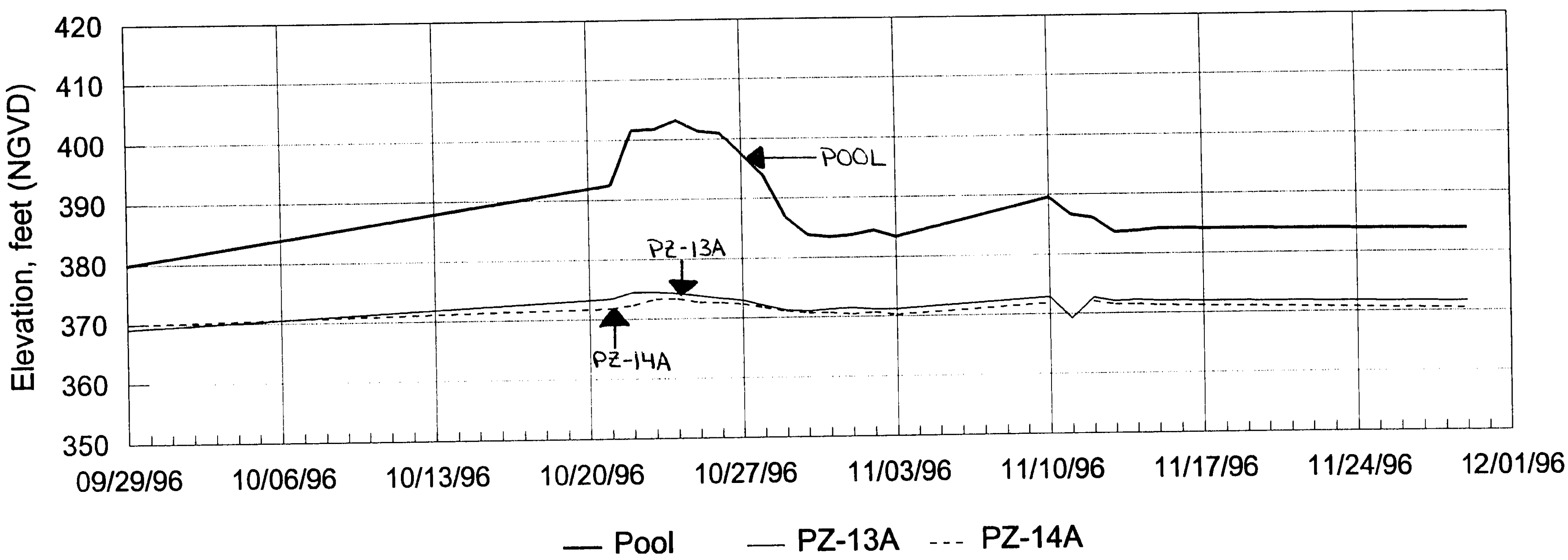
Note: Elevations at PZ-5B and PZ-8B were similar, therefore these lines plot on top of each other

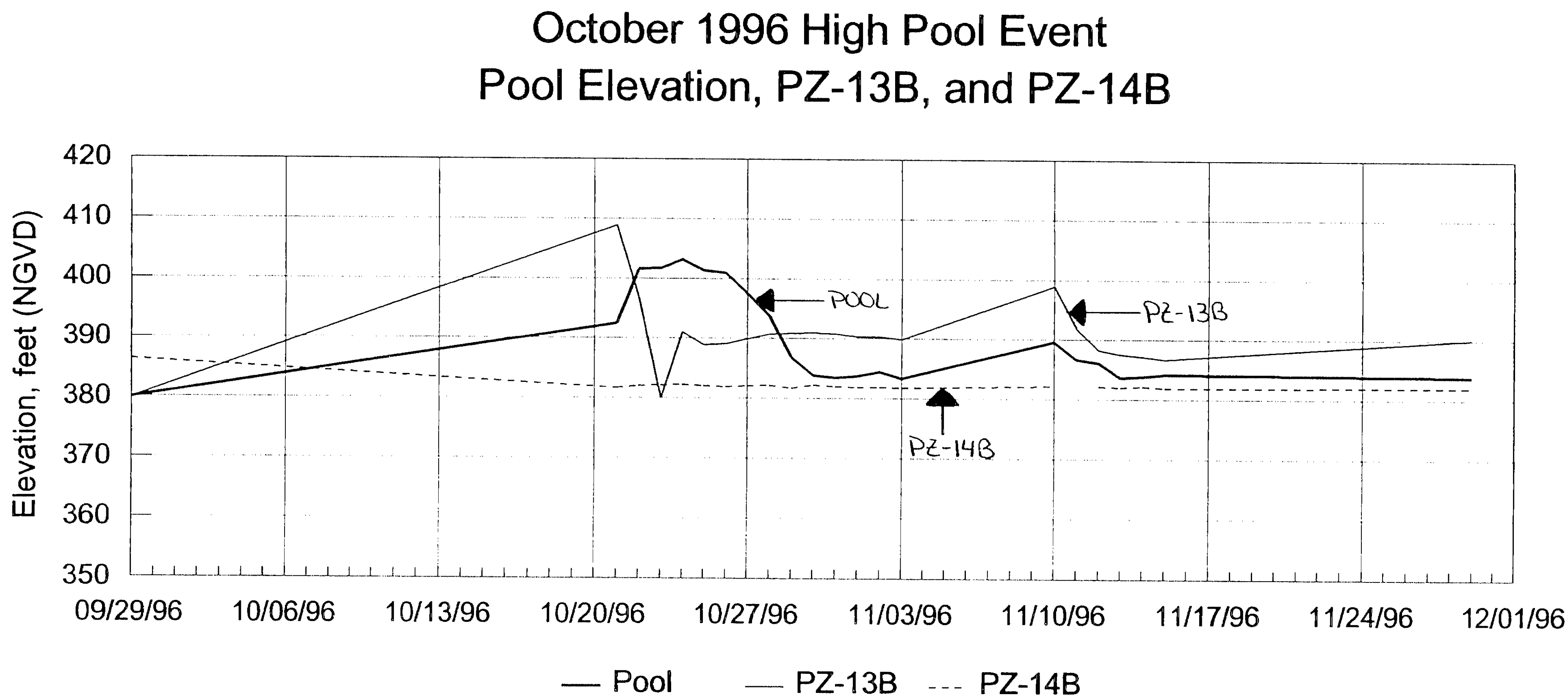
Note: Elevations at PZ-6B and PZ-7B were similar, therefore these lines plot on top of each other

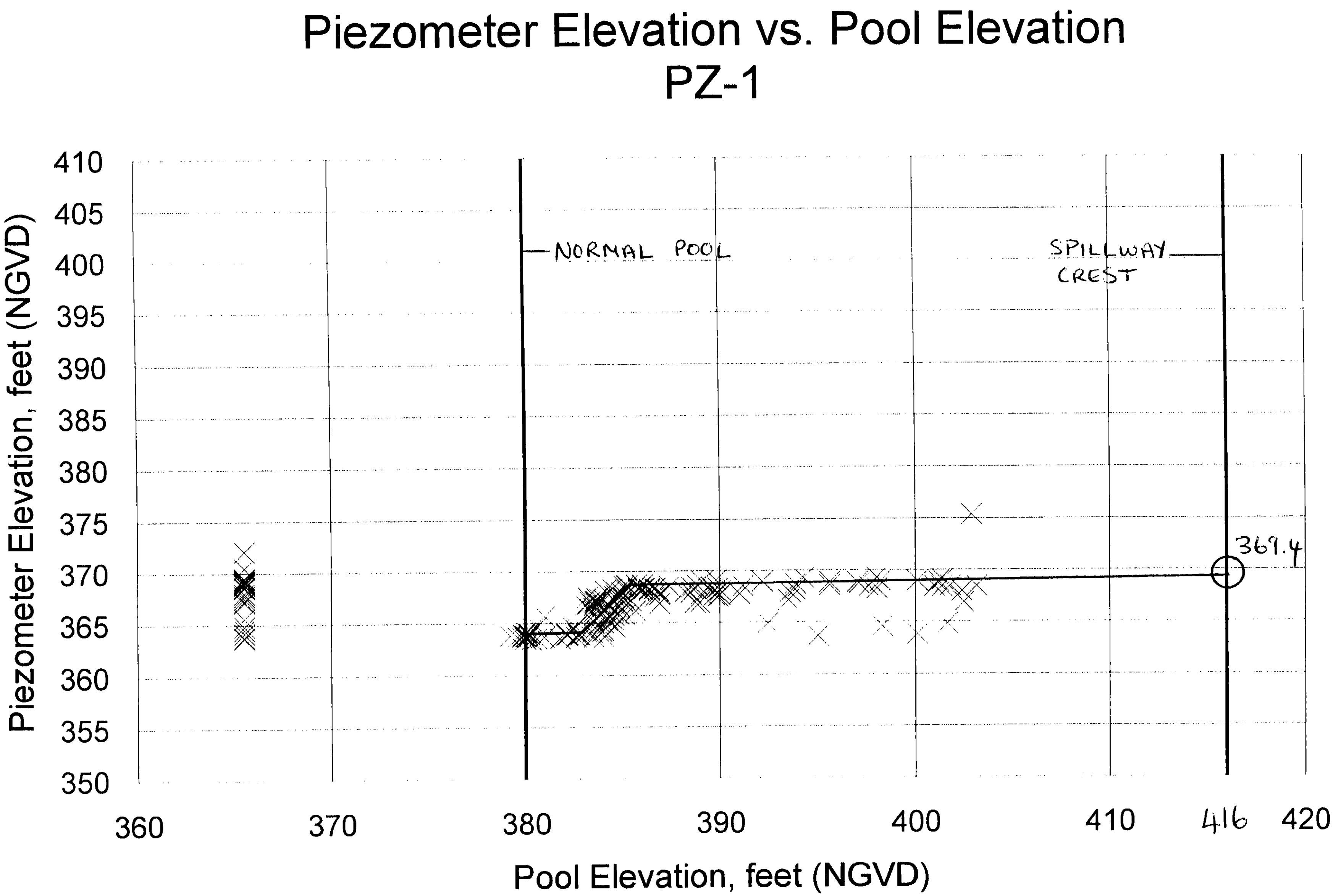
October 1996 High Pool Event
Pool Elevation, PZ-9, PZ-10, and PZ-11



October 1996 High Pool Event
Pool Elevation, PZ-13A, and PZ-14A




October 1996 High Pool Event
Pool Elevation, PZ-13B, and PZ-14B
Elevation, feet (NGVD)
420
410
400
390
380
370
360
350
09/29/96
10/06/96
10/13/96
10/20/96
10/27/96
11/03/96
11/10/96
11/17/96
11/24/96
12/01/96
POOL
PZ-13B
PZ-14B
Pool
PZ-13B
PZ-14B



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Hopkinton Dam

Project 97487

PLATE E.1

Piezometer Elevation vs. Pool Elevation
PZ-2

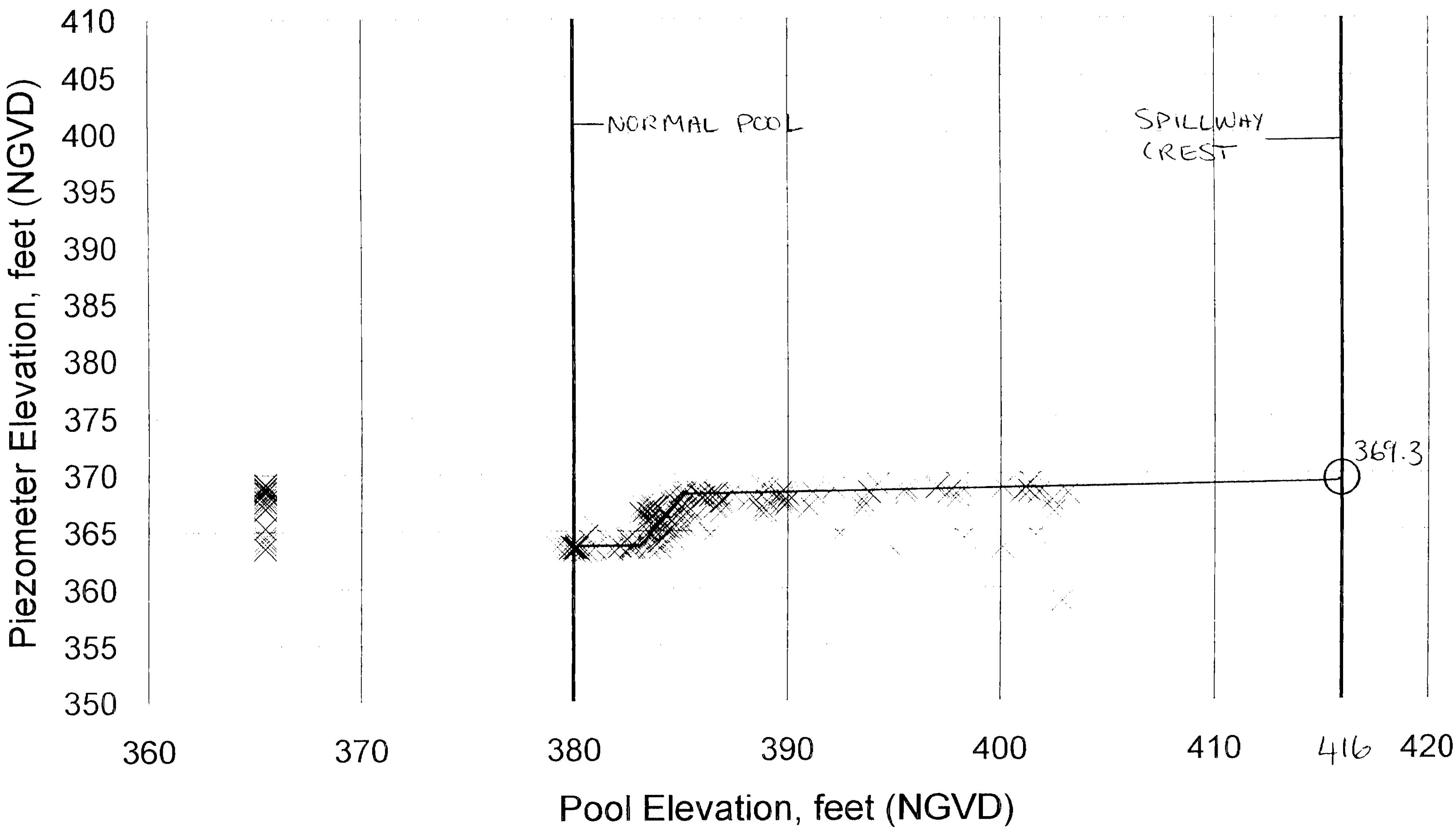

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PLATE E.2

Piezometer Elevation vs. Pool Elevation
PZ-3A

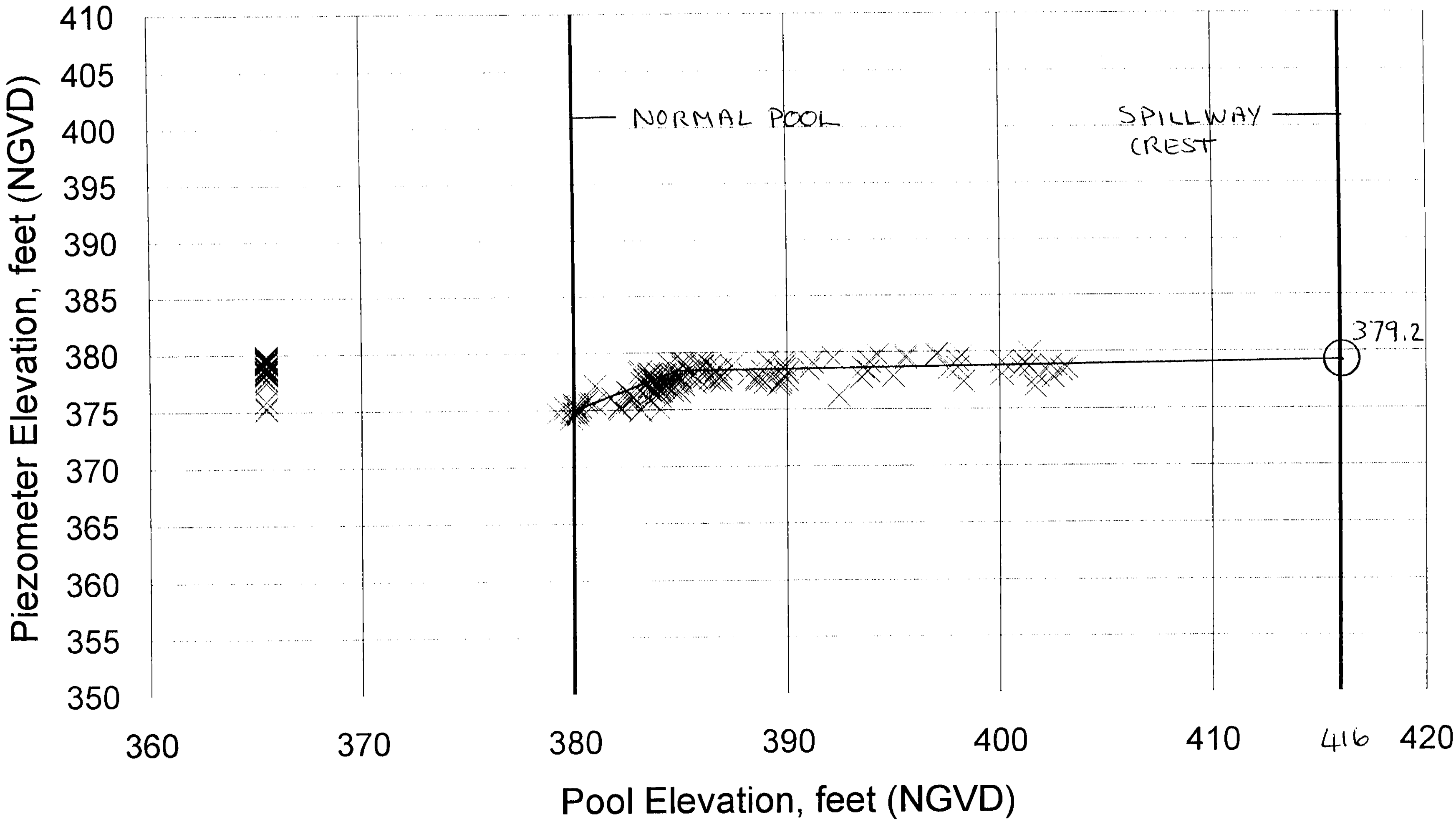

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PLATE E.3

Piezometer Elevation vs. Pool Elevation
PZ-4A

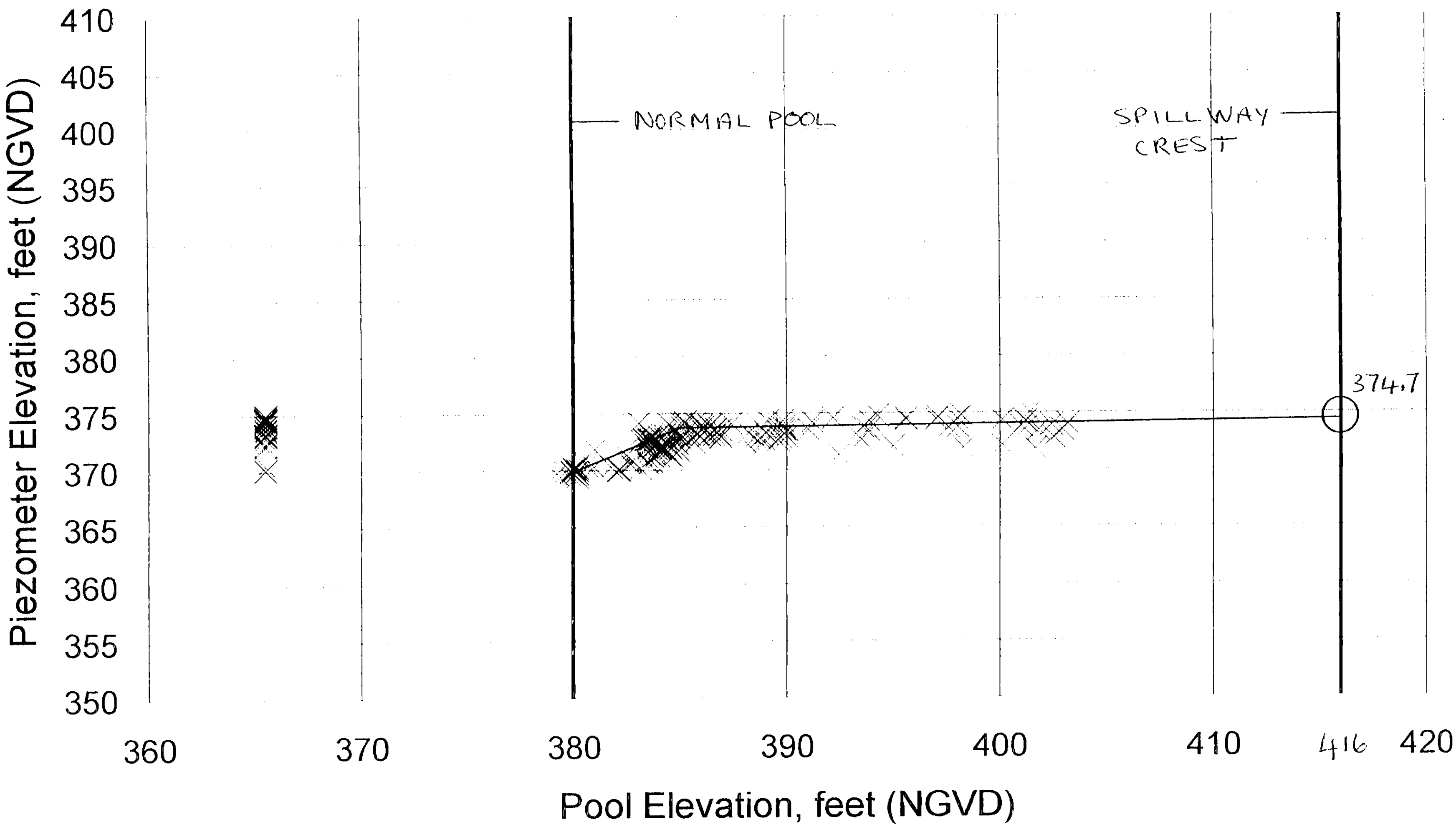

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PLATE E.4

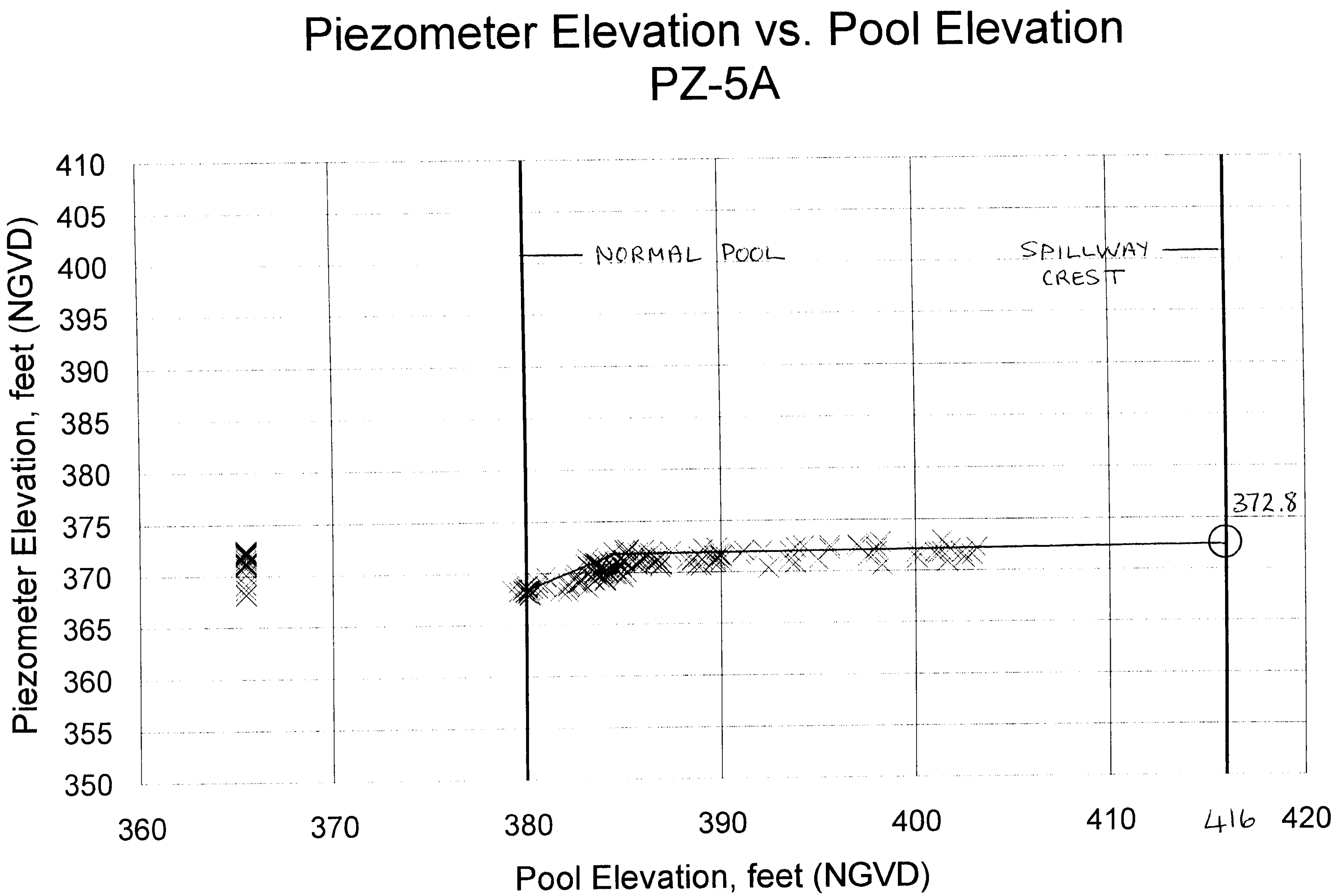

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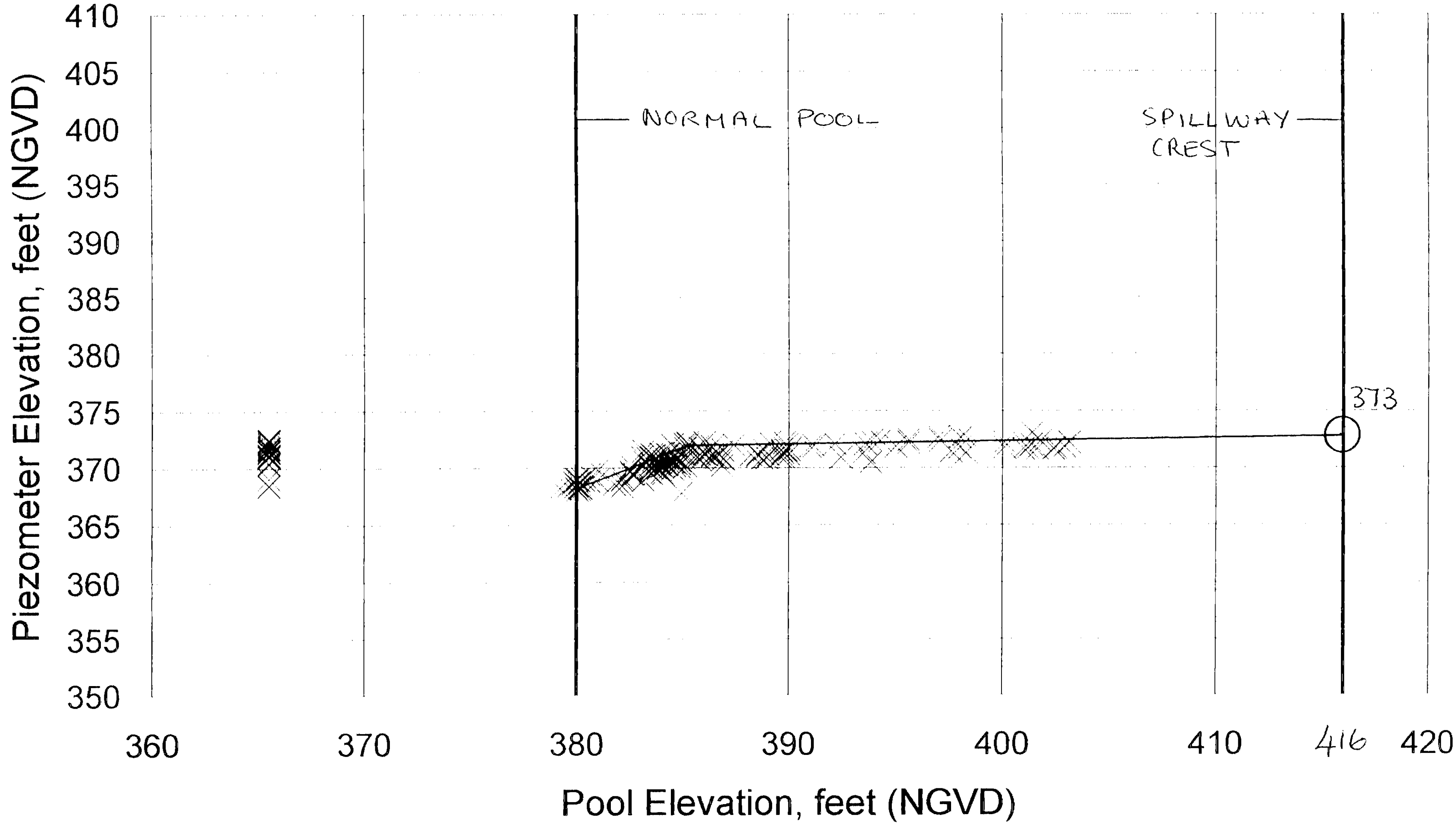
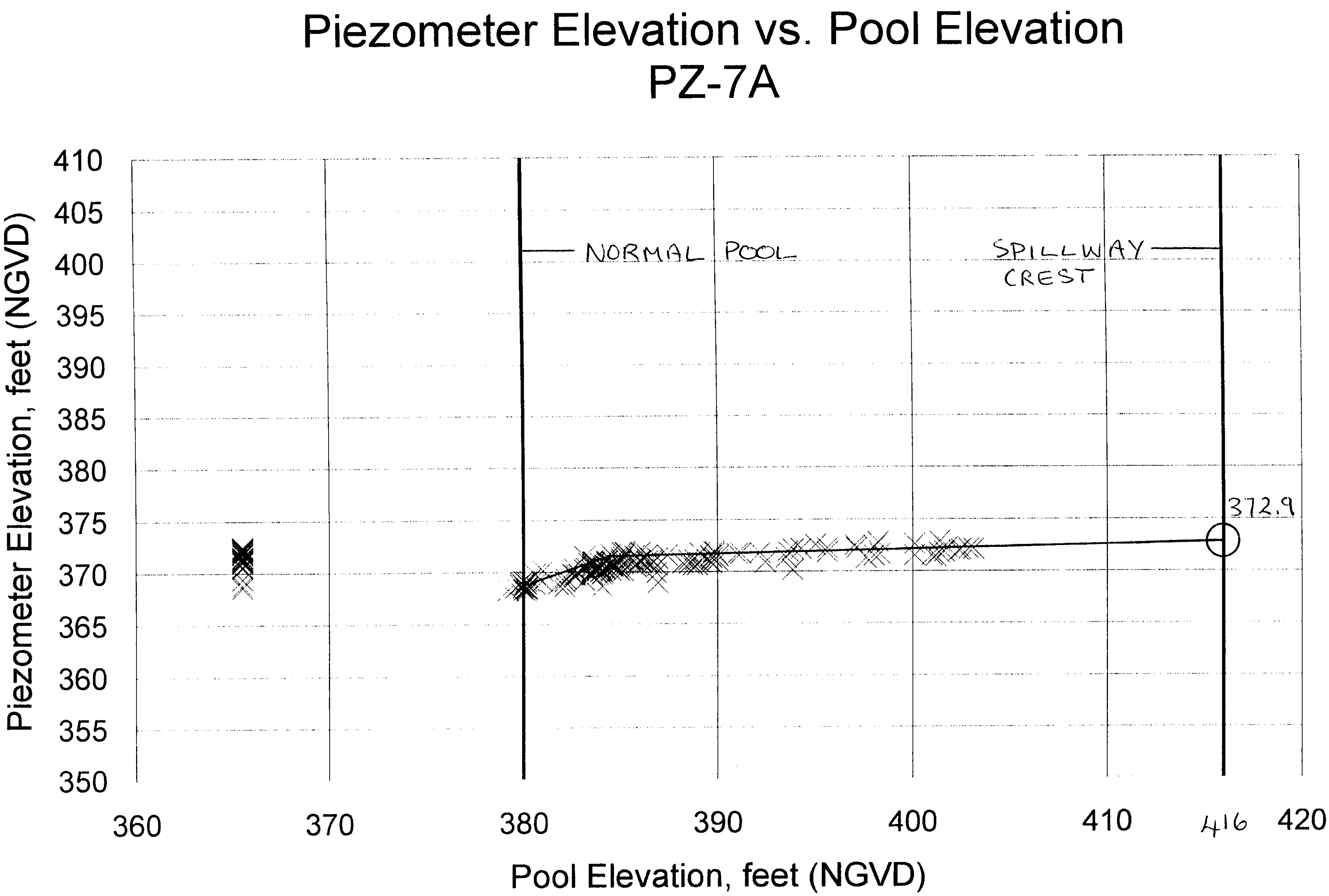
PLATE E.5

Piezometer Elevation vs. Pool Elevation
PZ-6A





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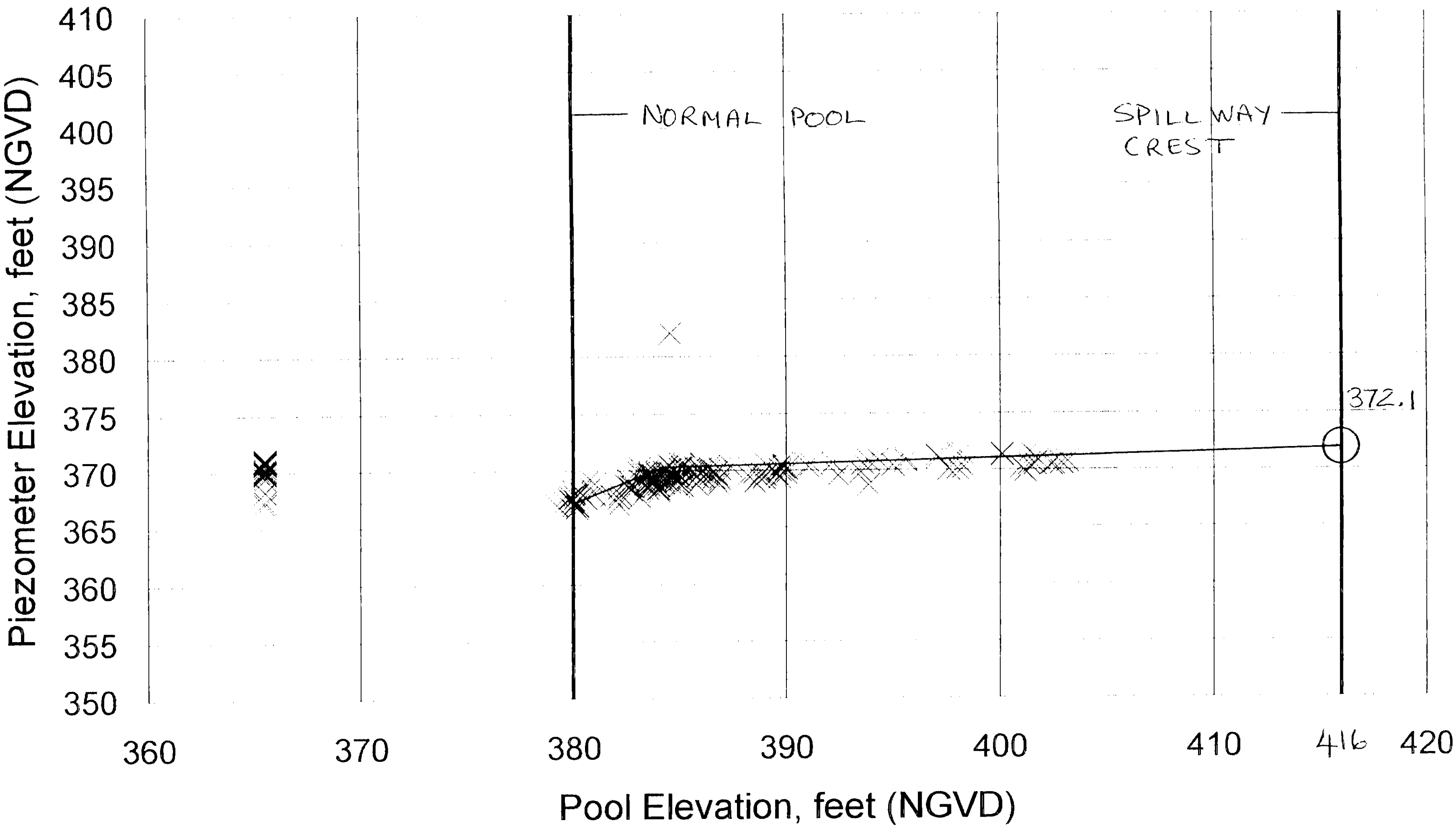
Hopkinton Dam

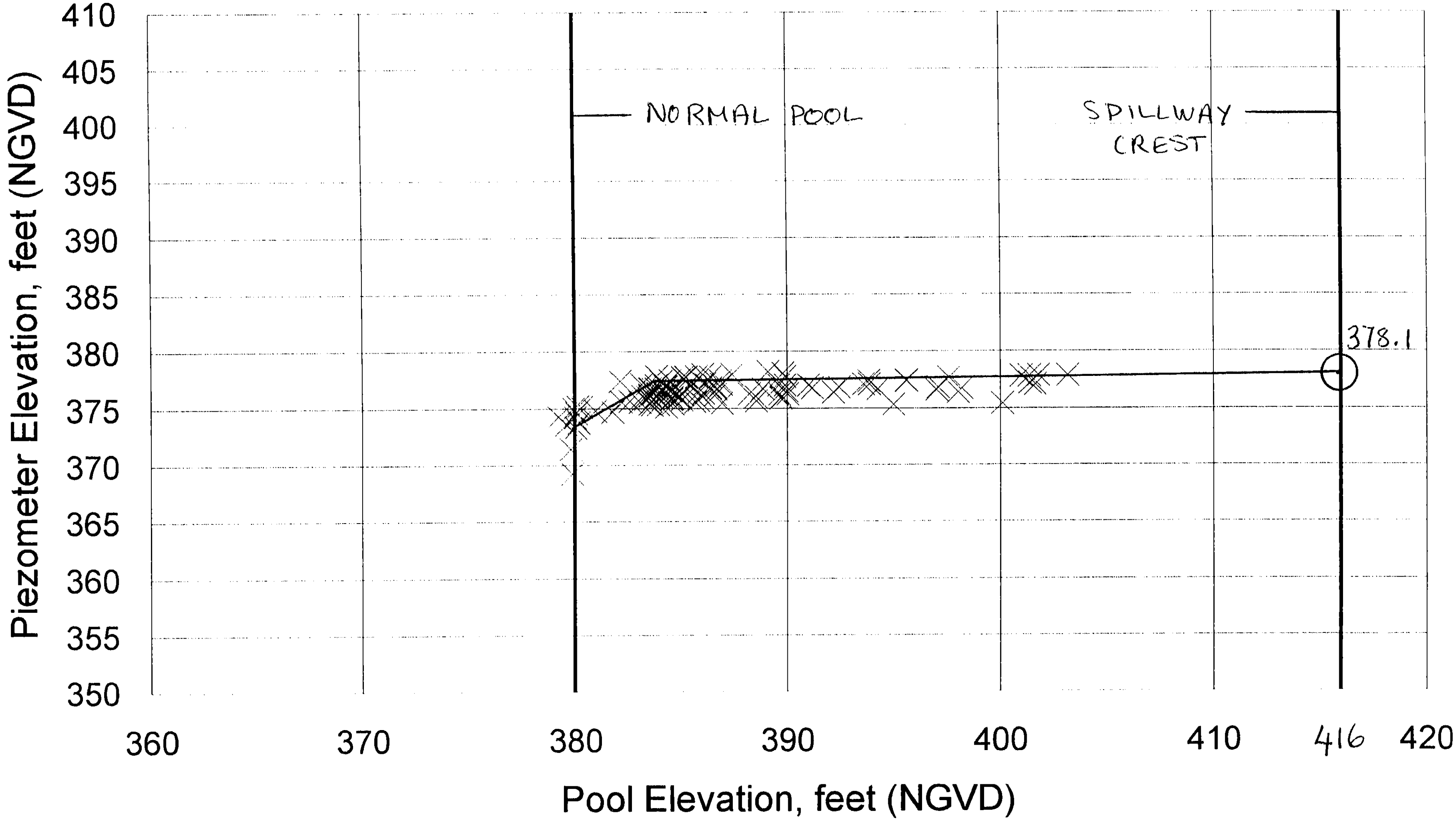
Project 97487

PLATE E.7

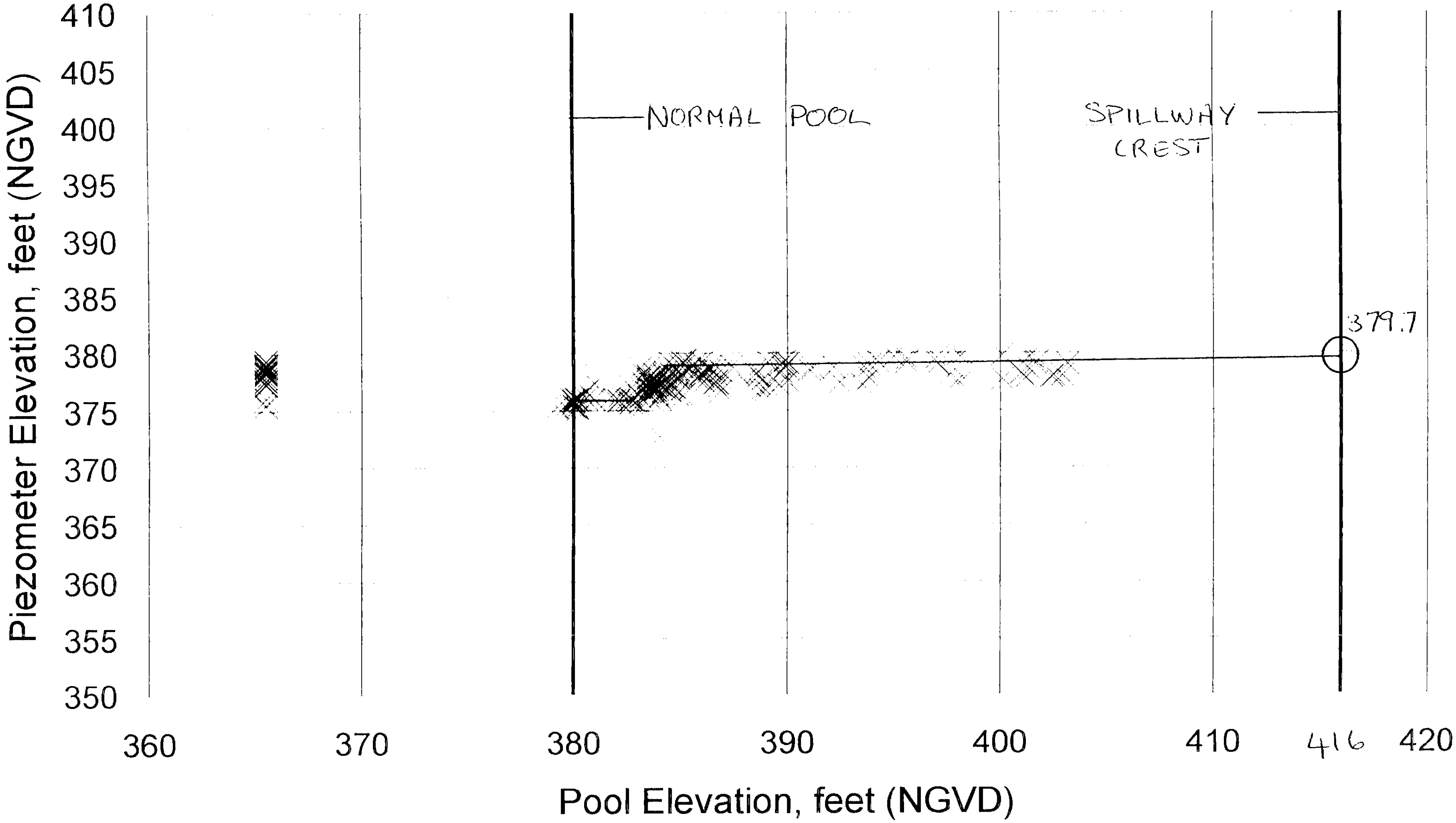
Piezometer Elevation vs. Pool Elevation
PZ-8A

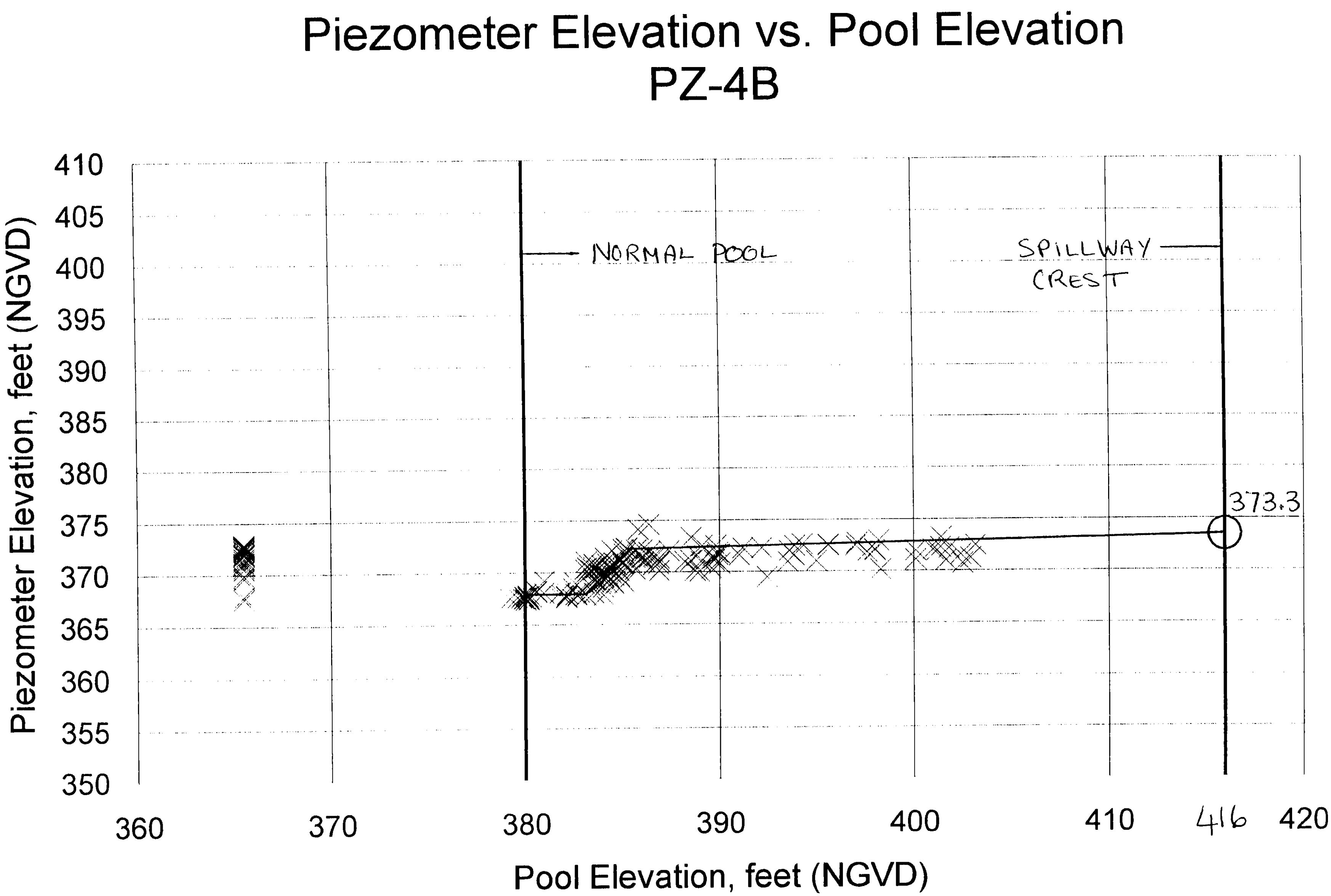


Piezometer Elevation vs. Pool Elevation
PZ-15



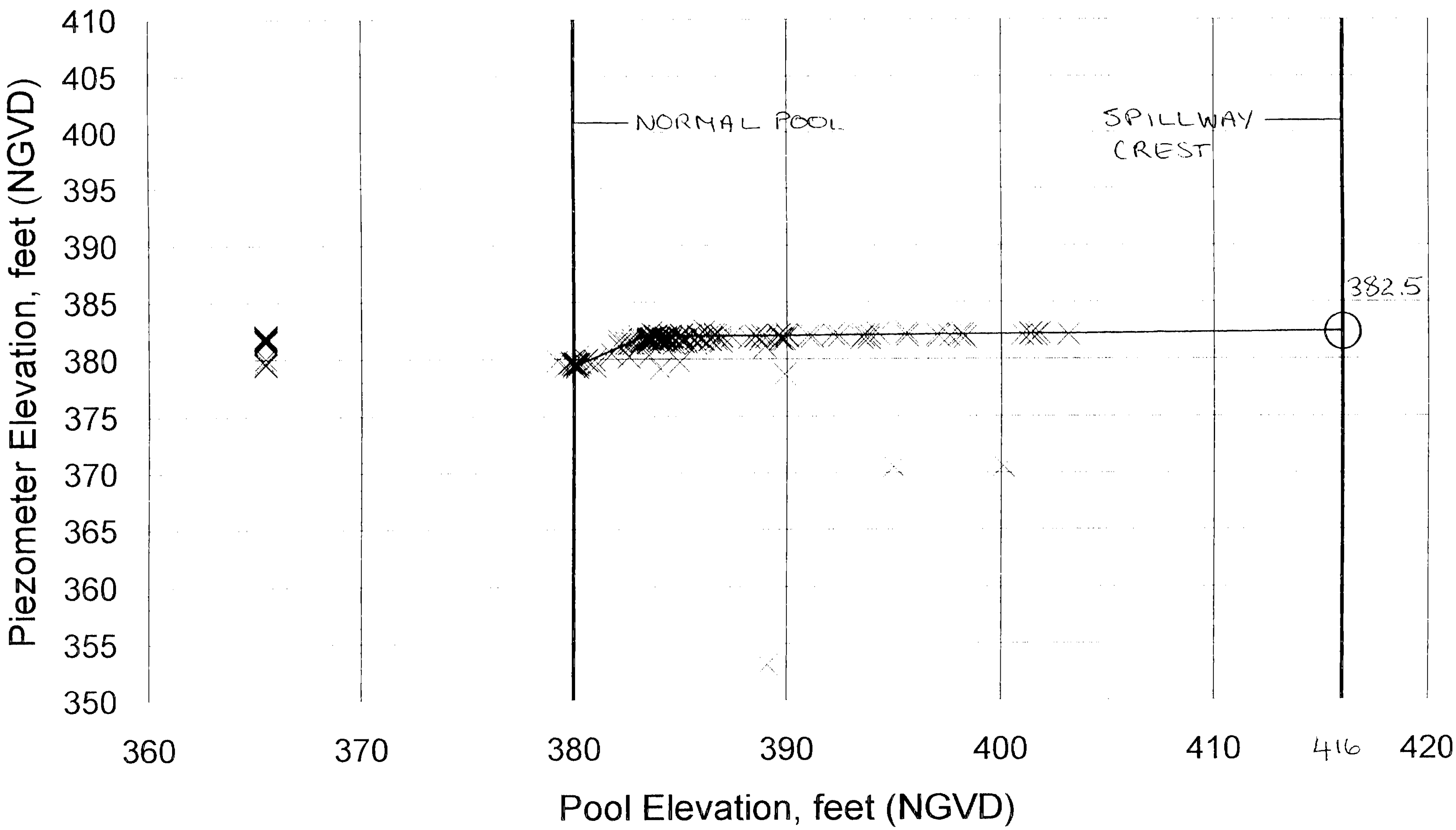
Piezometer Elevation vs. Pool Elevation
PZ-3B



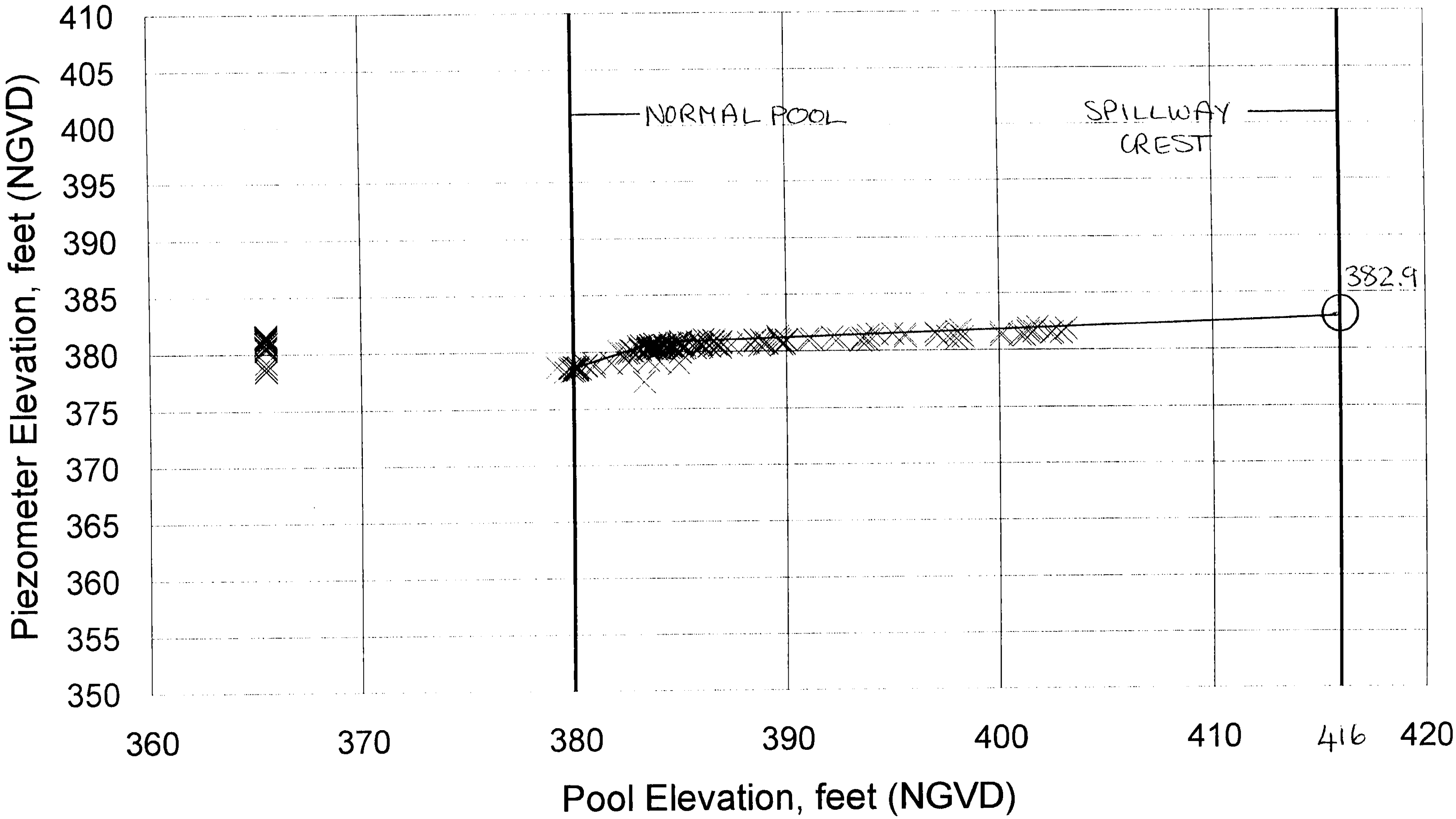


Piezometer Elevation vs. Pool Elevation
PZ-4B
Piezometer Elevation, feet (NGVD)
410
405
400
395
390
385
380
375
370
365
360
355
350
NORMAL POOL
SPILLWAY CREST
373.3
360
370
380
390
400
410
416
420
Pool Elevation, feet (NGVD)

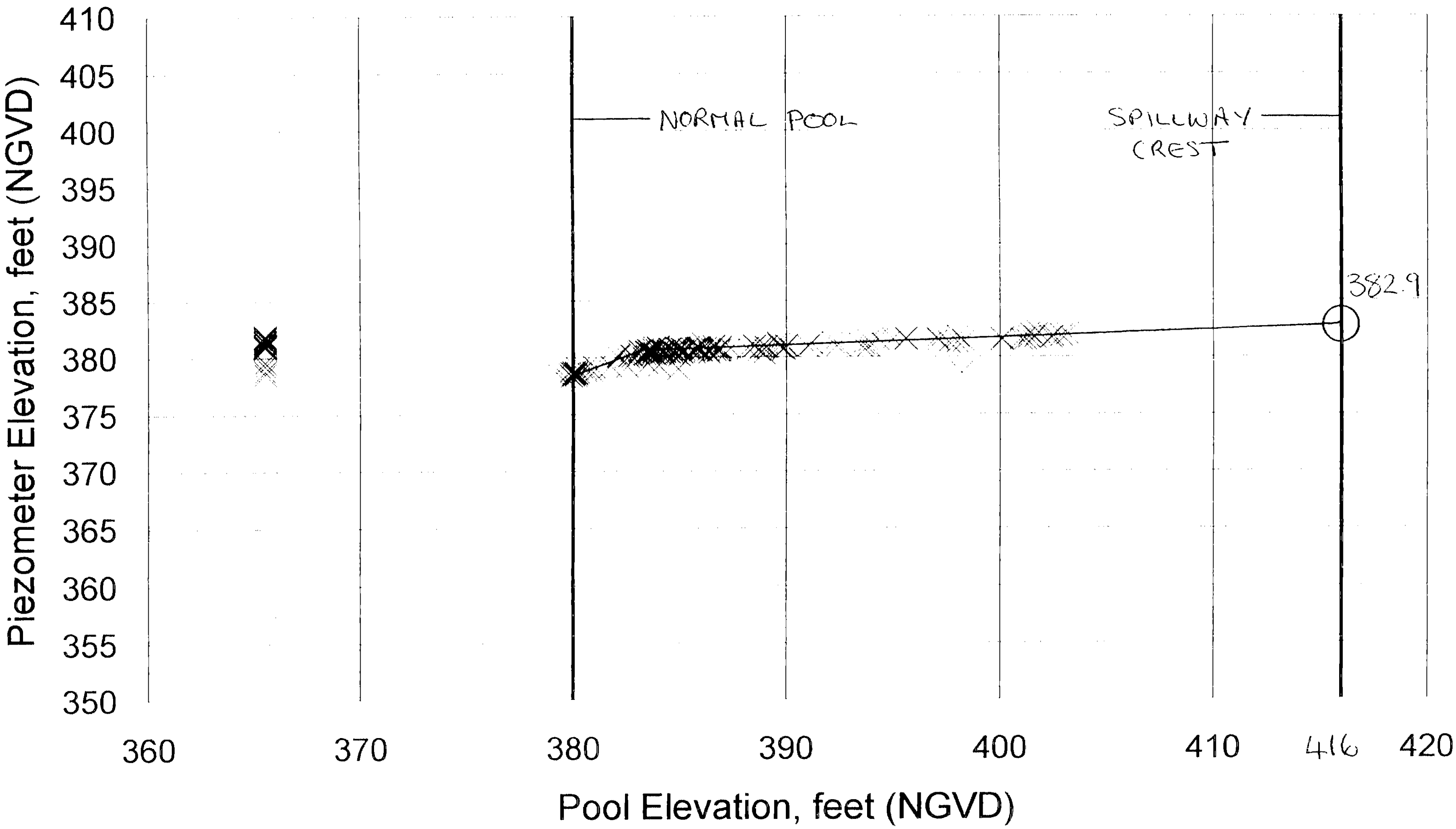
Piezometer Elevation vs. Pool Elevation
PZ-5B



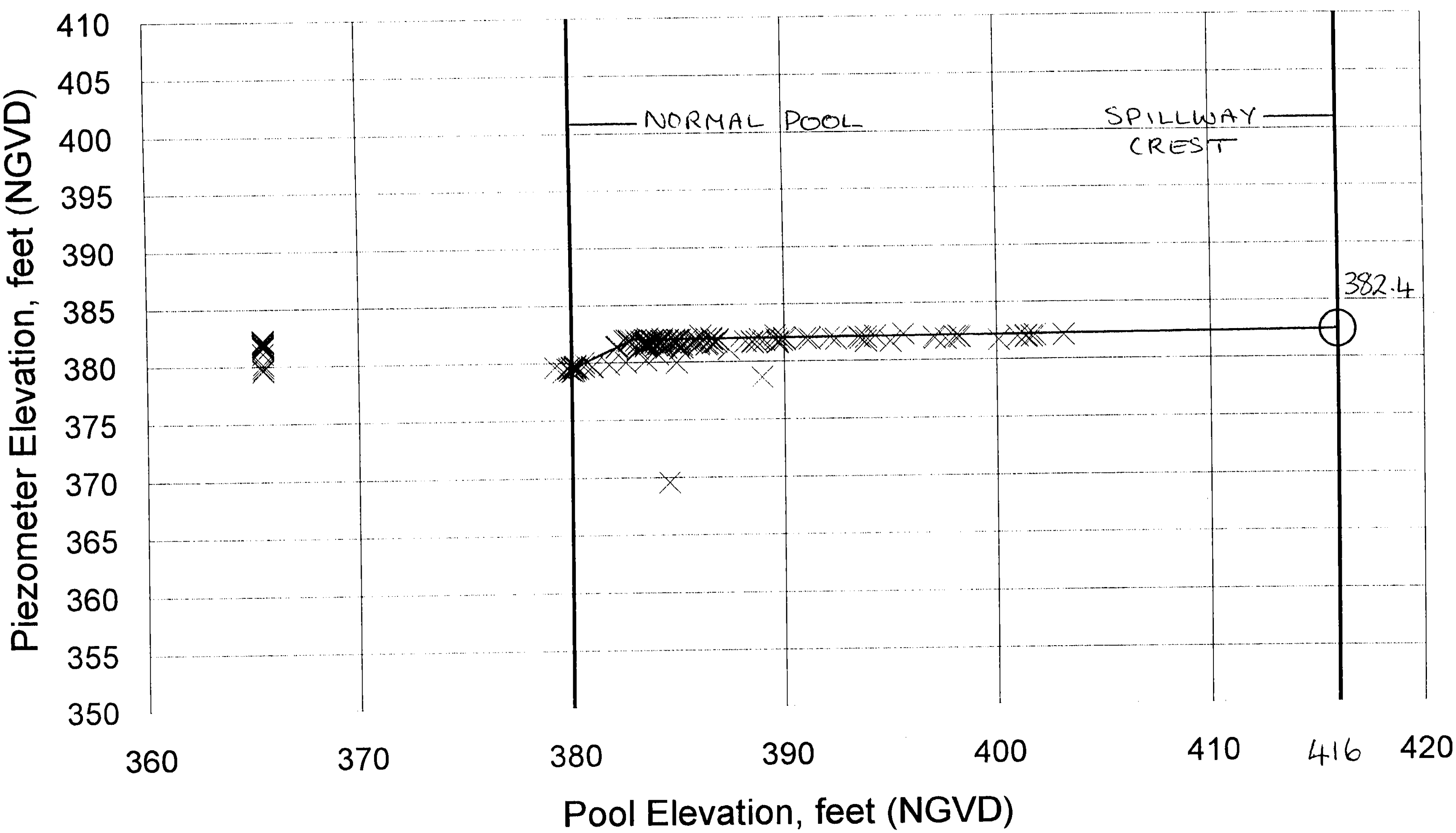
Piezometer Elevation vs. Pool Elevation
PZ-6B



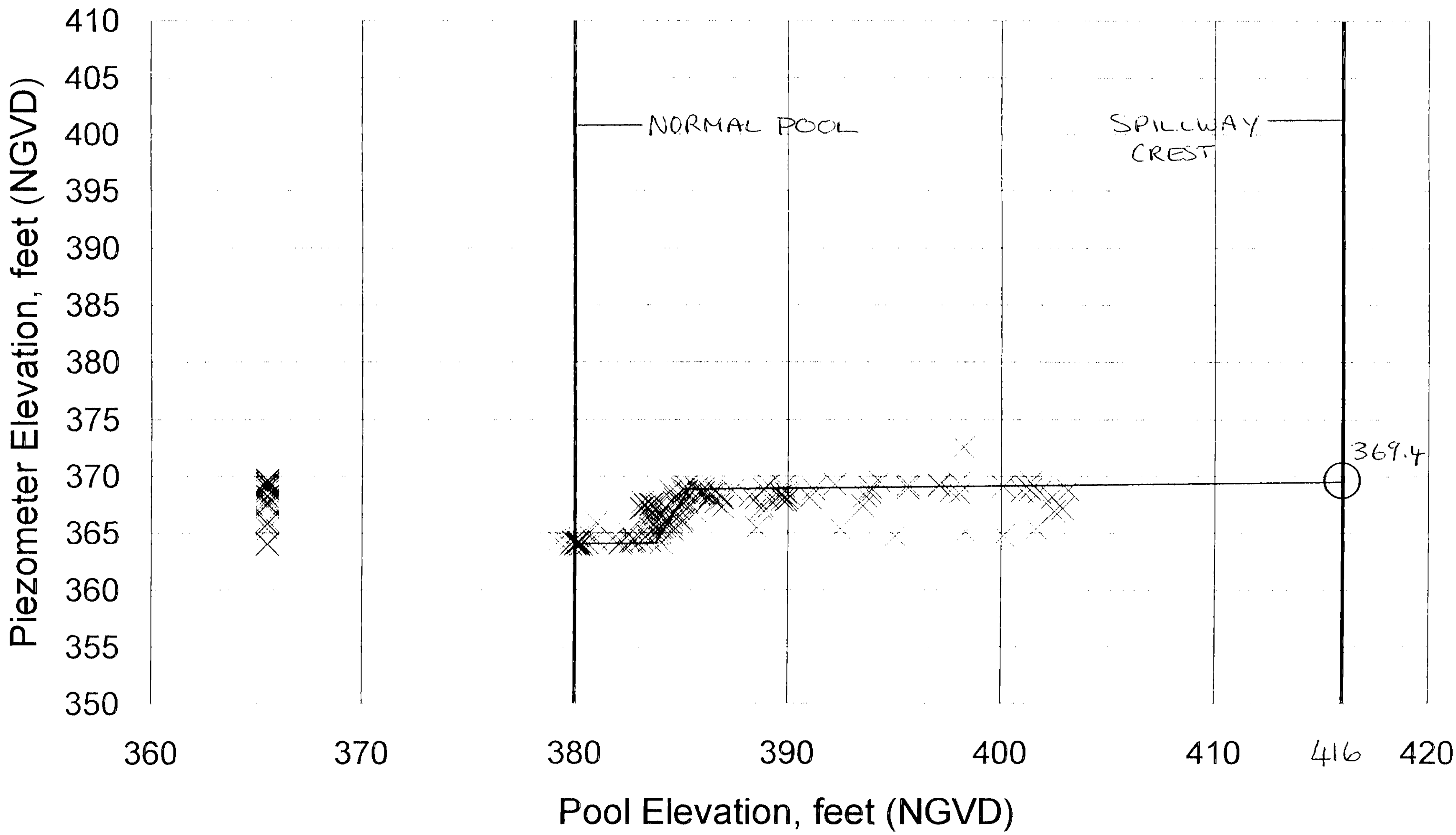
Piezometer Elevation vs. Pool Elevation
PZ-7B



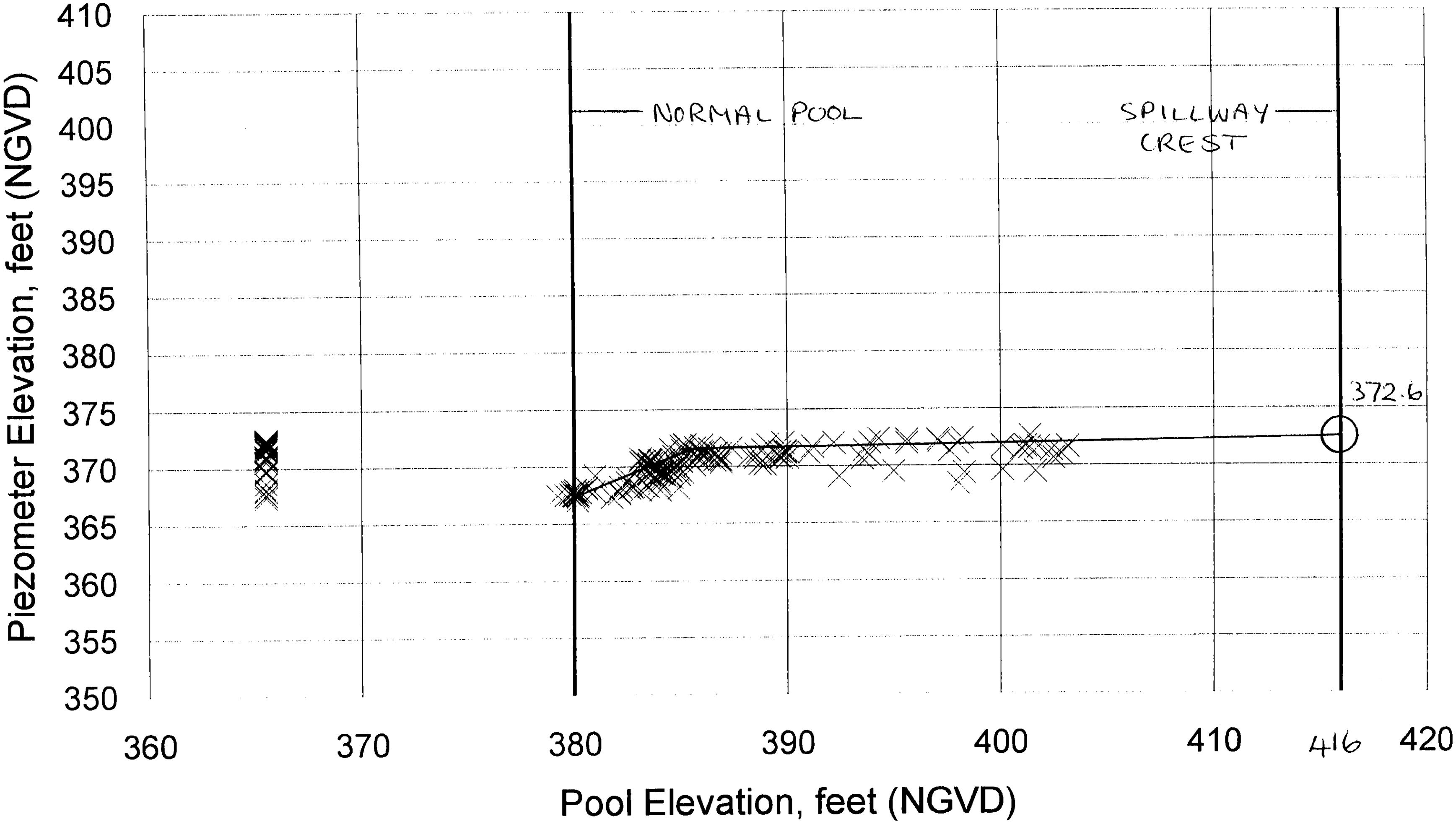
Piezometer Elevation vs. Pool Elevation
PZ-8B



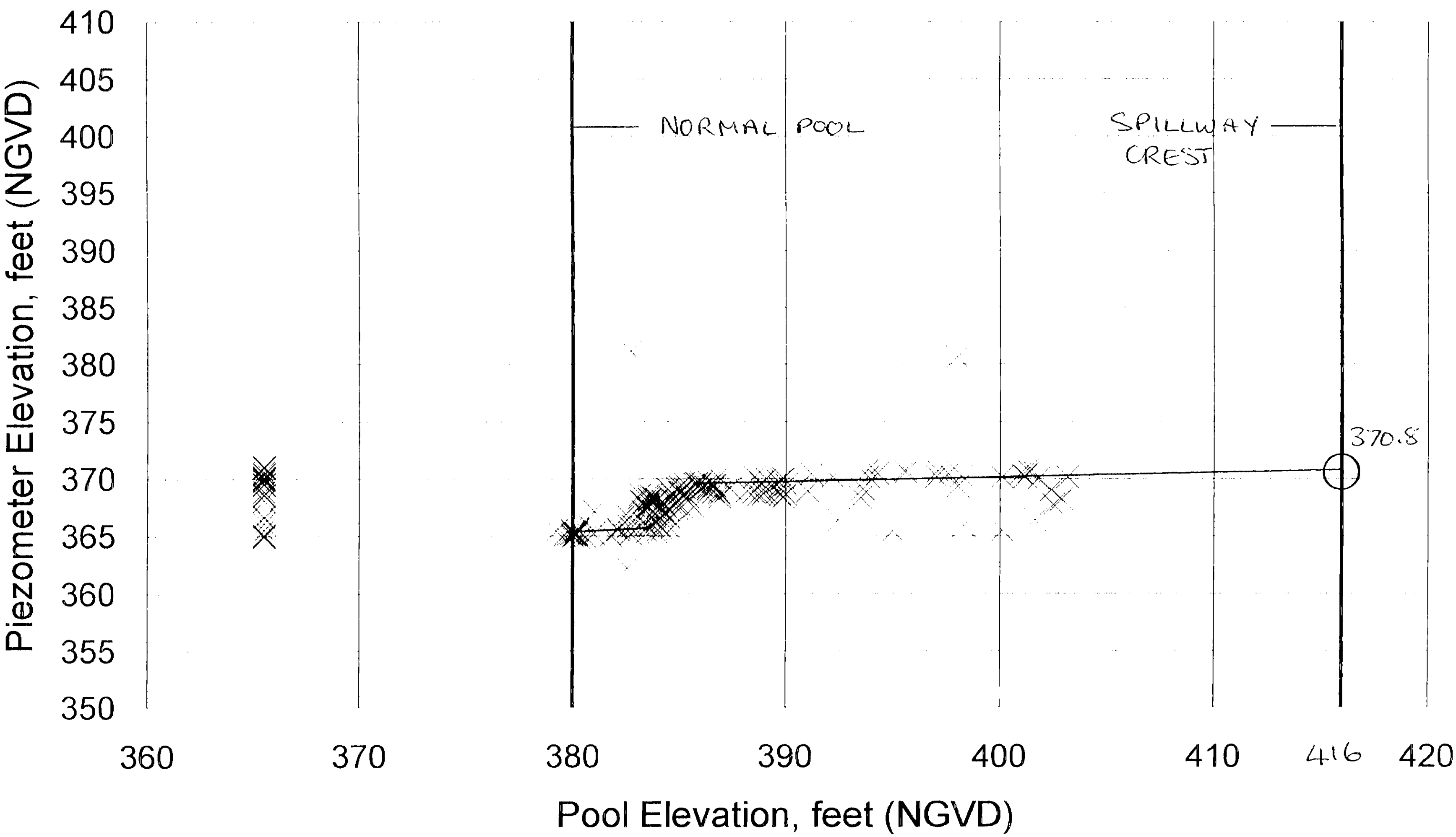
Piezometer Elevation vs. Pool Elevation
PZ-9



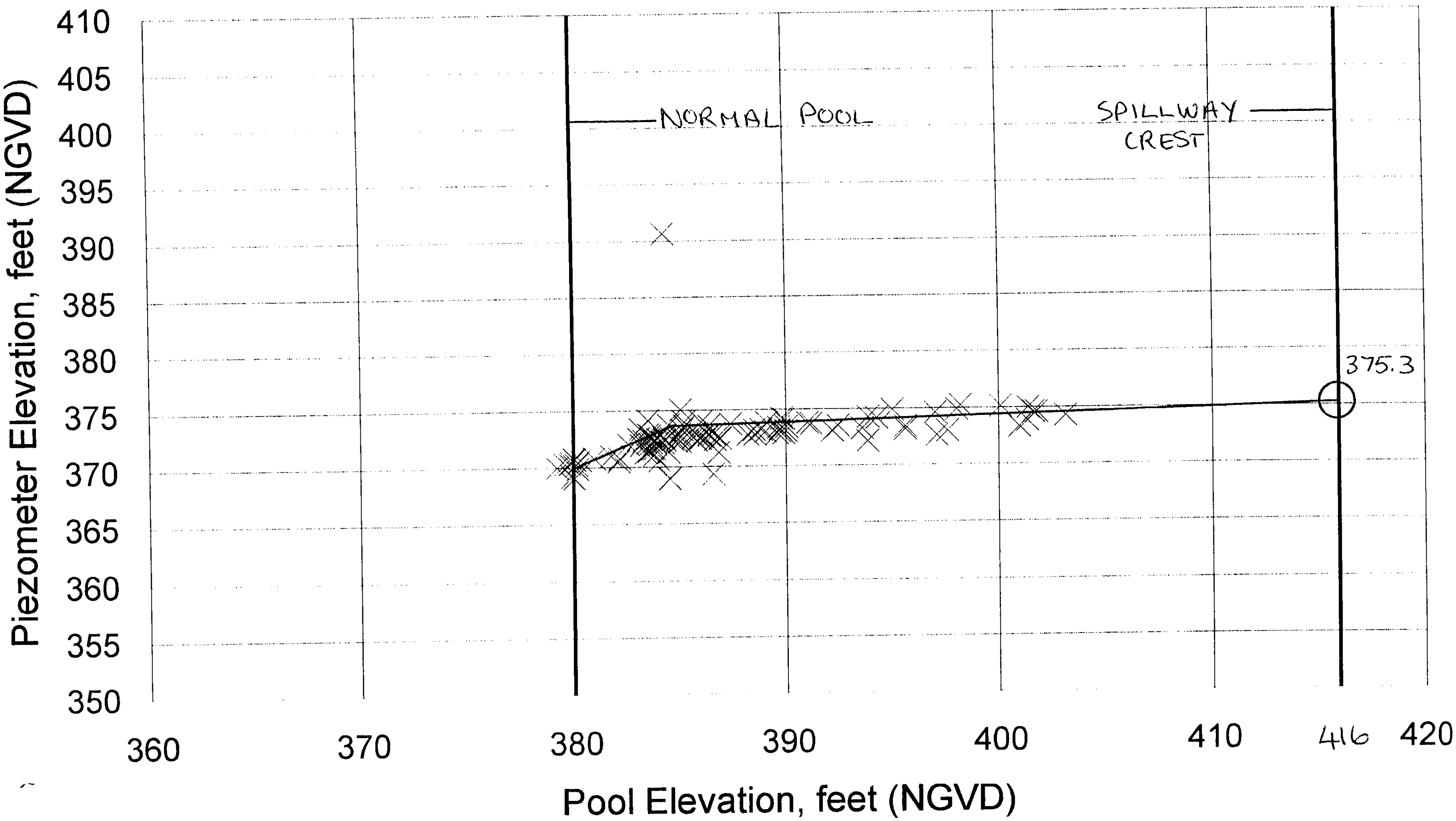
Piezometer Elevation vs. Pool Elevation
PZ-10



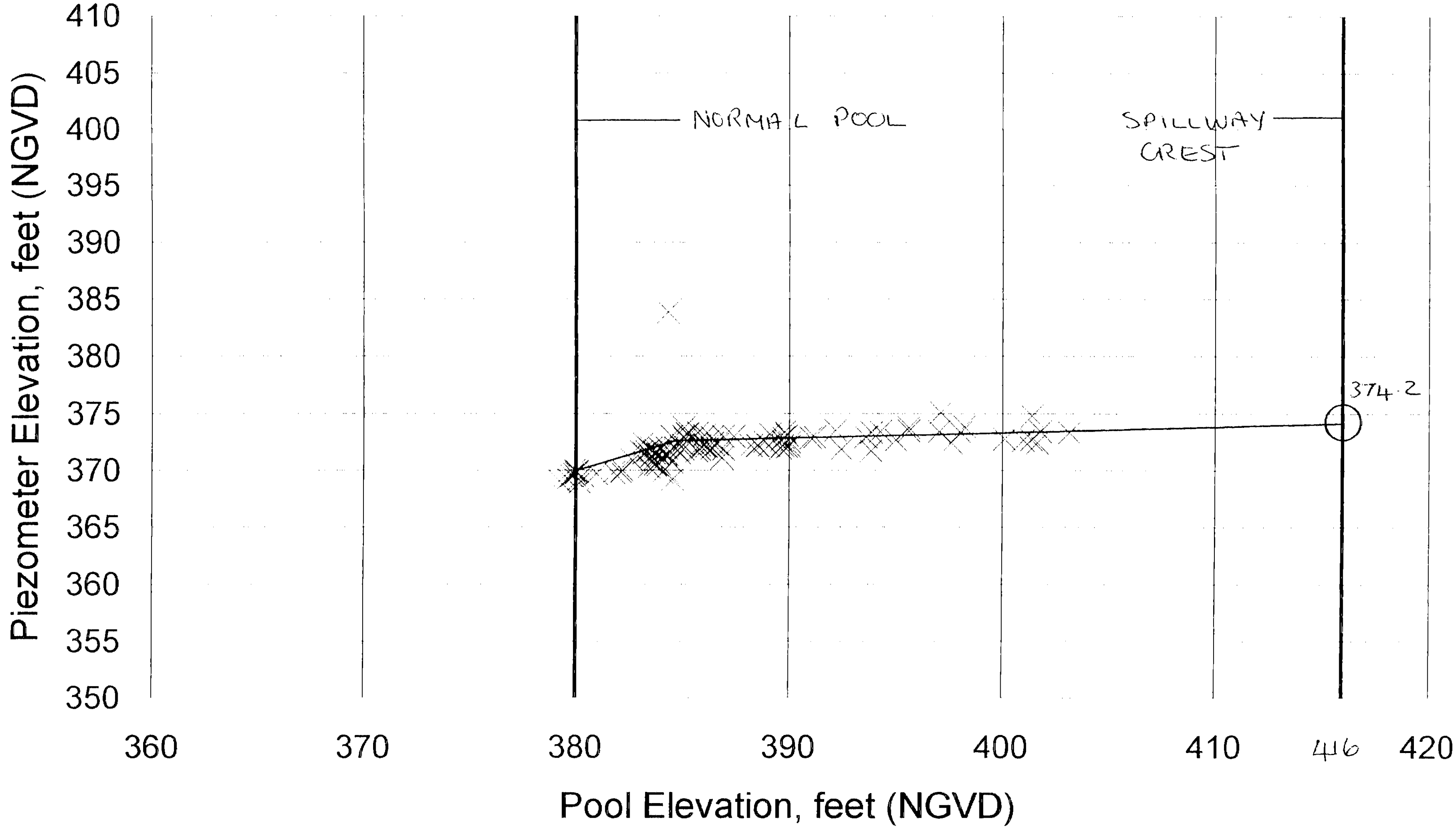
Piezometer Elevation vs. Pool Elevation
PZ-11



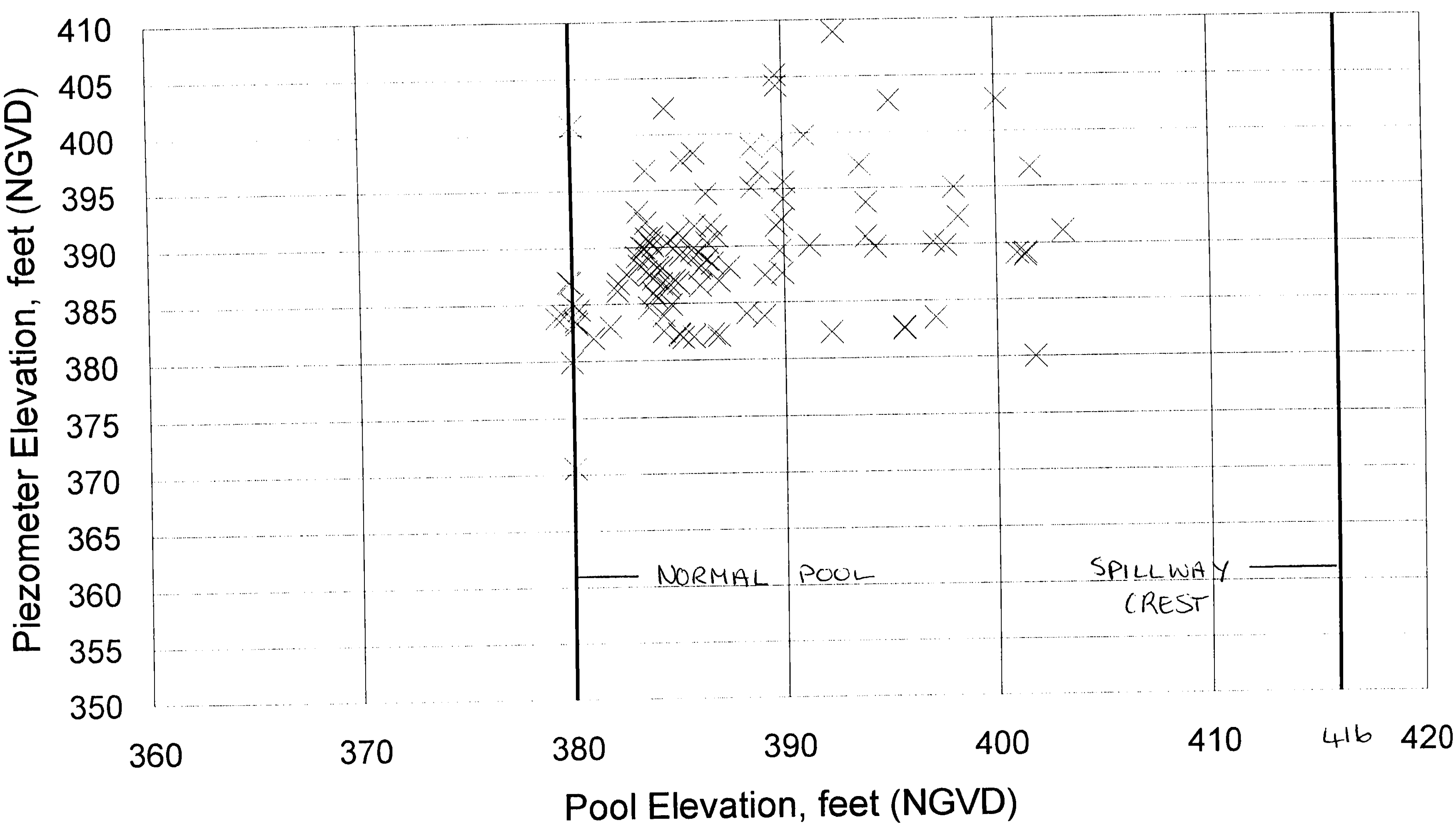
Piezometer Elevation vs. Pool Elevation
PZ-13A



Piezometer Elevation vs. Pool Elevation
PZ-14A



Piezometer Elevation vs. Pool Elevation
PZ-13B



Piezometer Elevation vs. Pool Elevation
PZ-14B

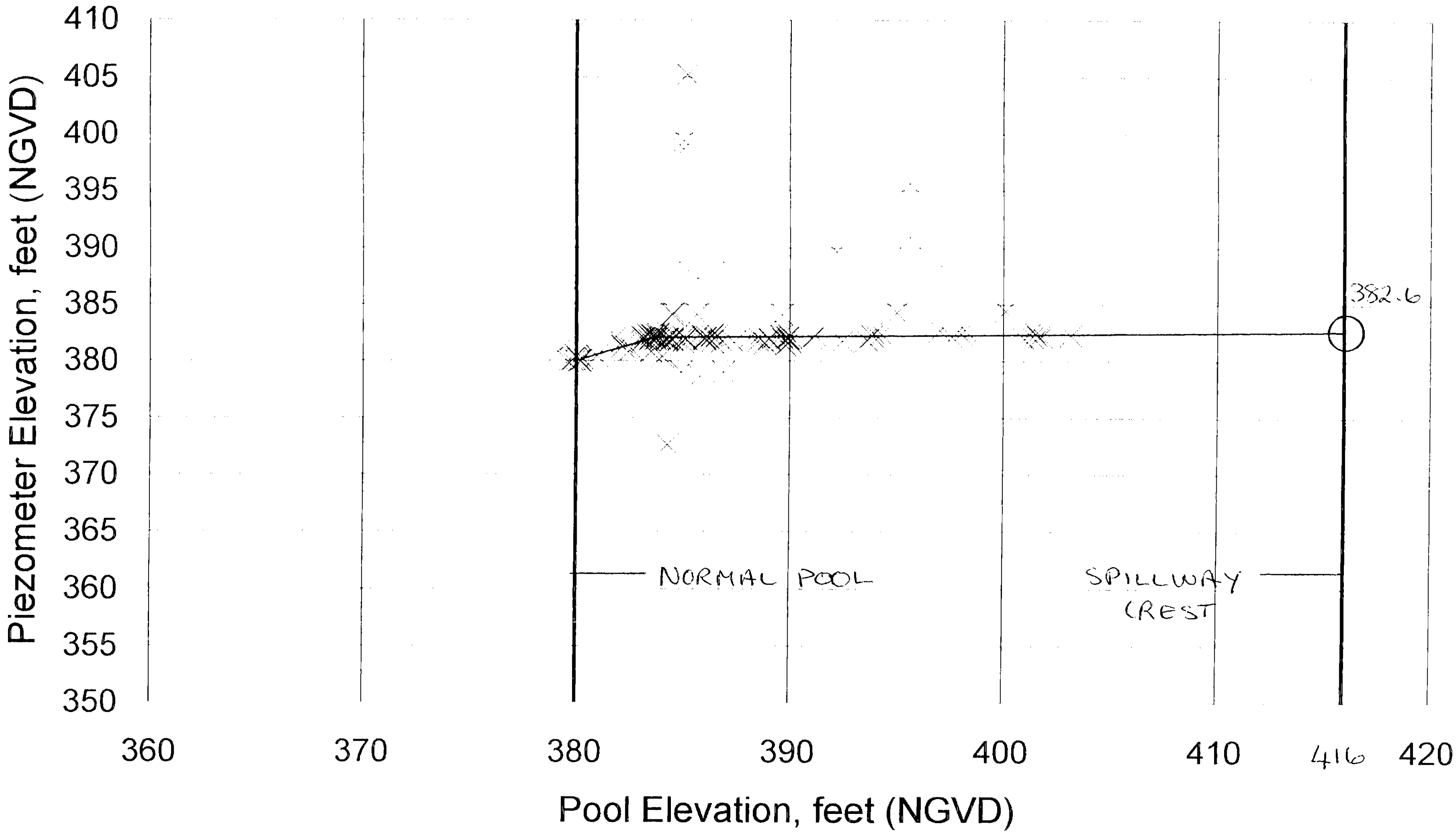
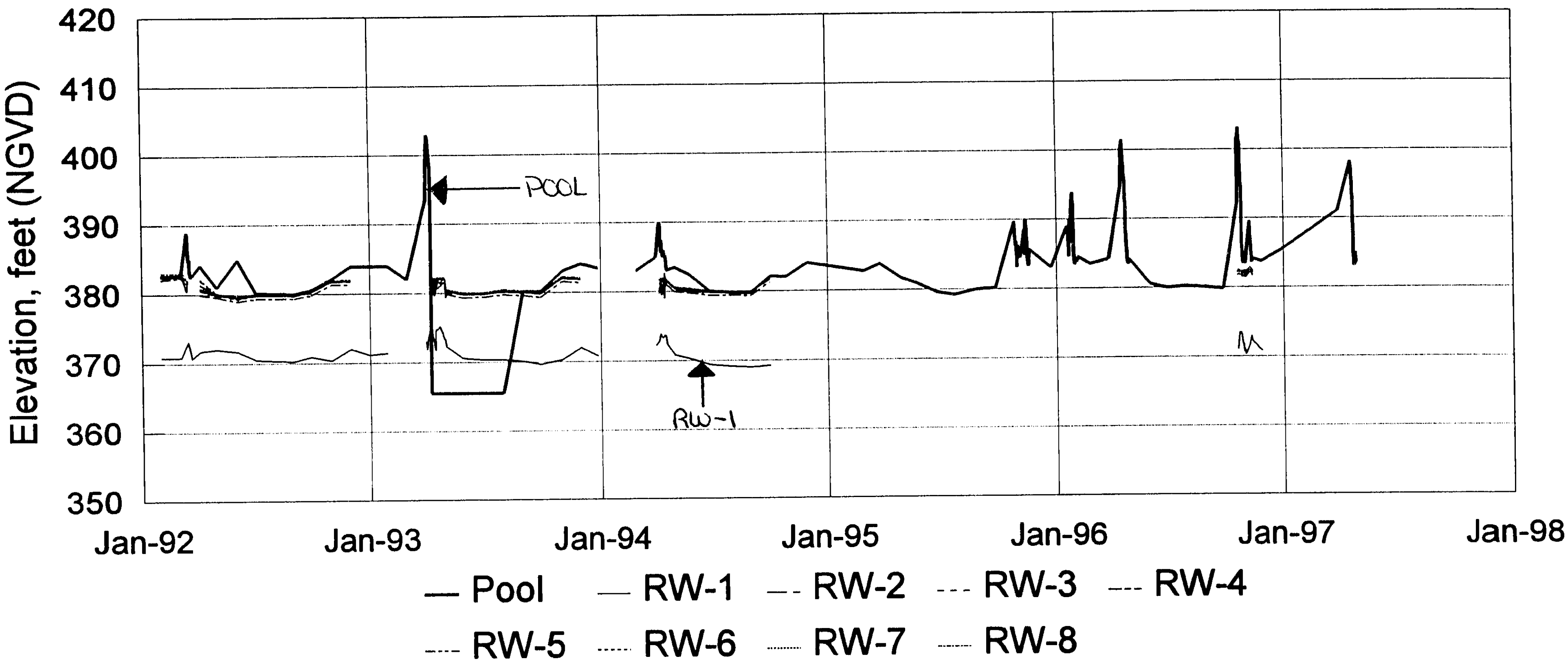


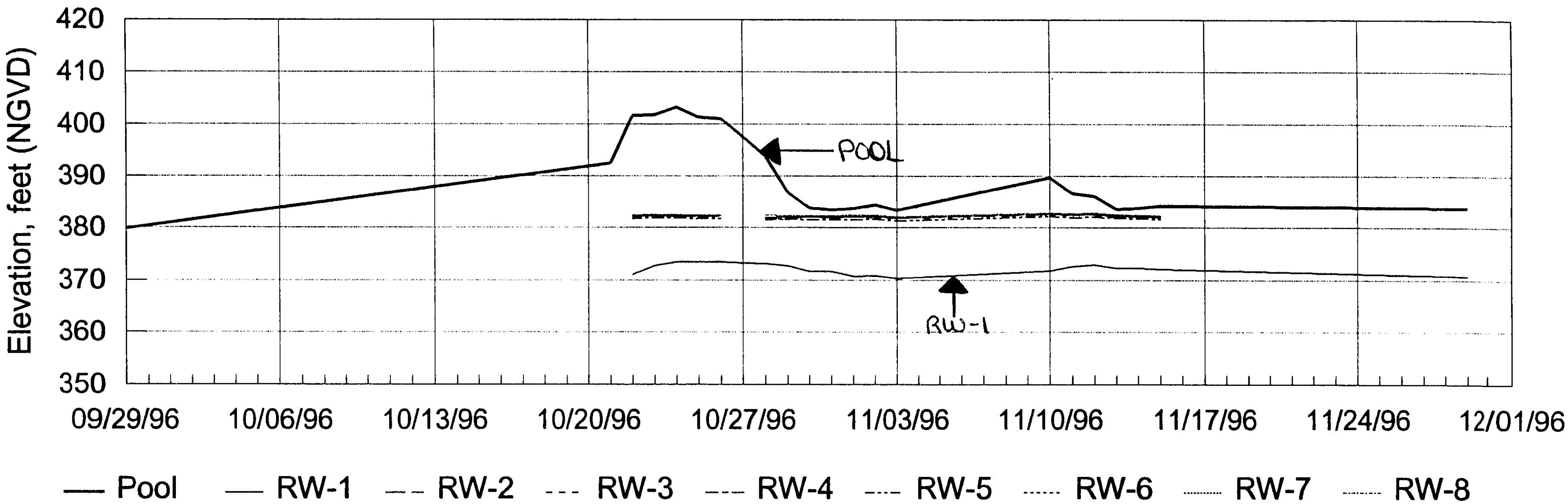
PLATE E.22

Piezometer Time History
Pool, RW-1, RW-2, RW-3, RW-4, RW-5, RW-6, RW-7, AND RW-8



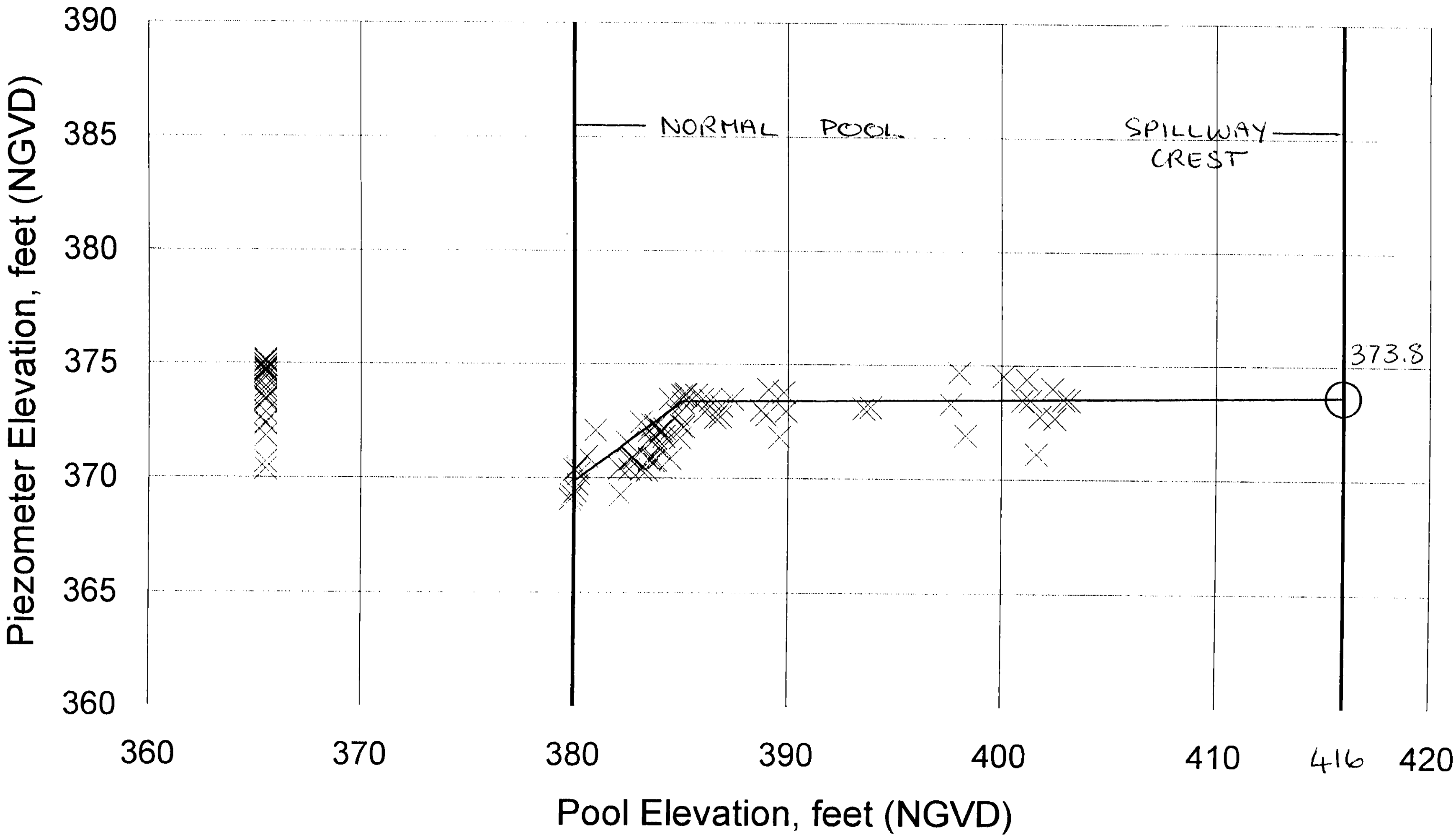
Note: Elevations at RW-2, RW-3, RW-4, RW-5, RW-6, RW-7, and RW-8 were similar, therefore these lines plot on top of each other

October 1996 High Pool Event
Pool Elev, RW-1, RW-2, RW-3, RW-4, RW-5, RW-6, RW-7, and RW-8



Note: Elevations at RW-2, RW-3, RW-4, RW-5, RW-6, RW-7, and RW-8 were similar, therefore these lines plot on top of each other

Piezometer Elevation vs. Pool Elevation
RW-1



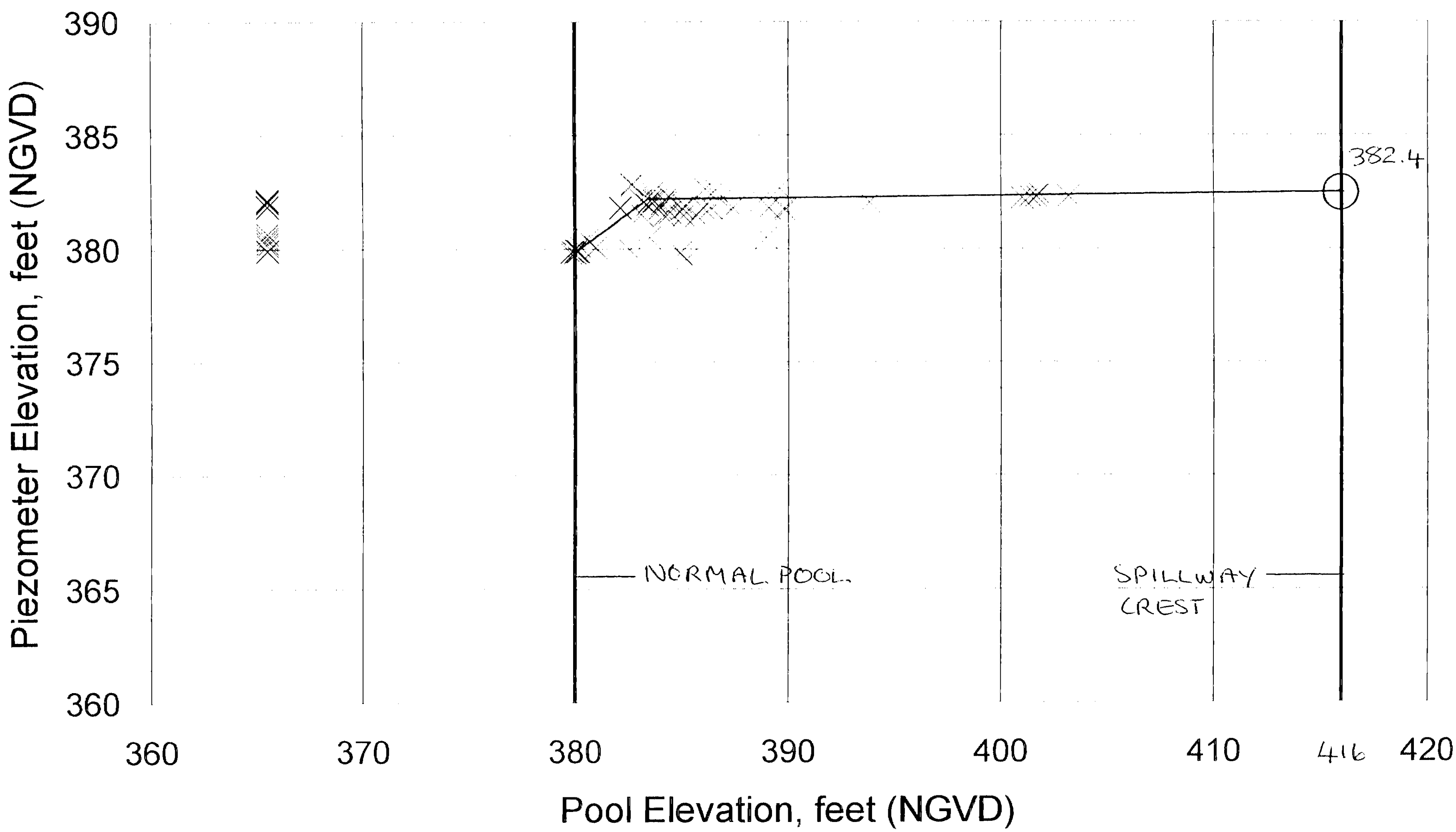
GEI Consultants, Inc.

Hopkinton Dam

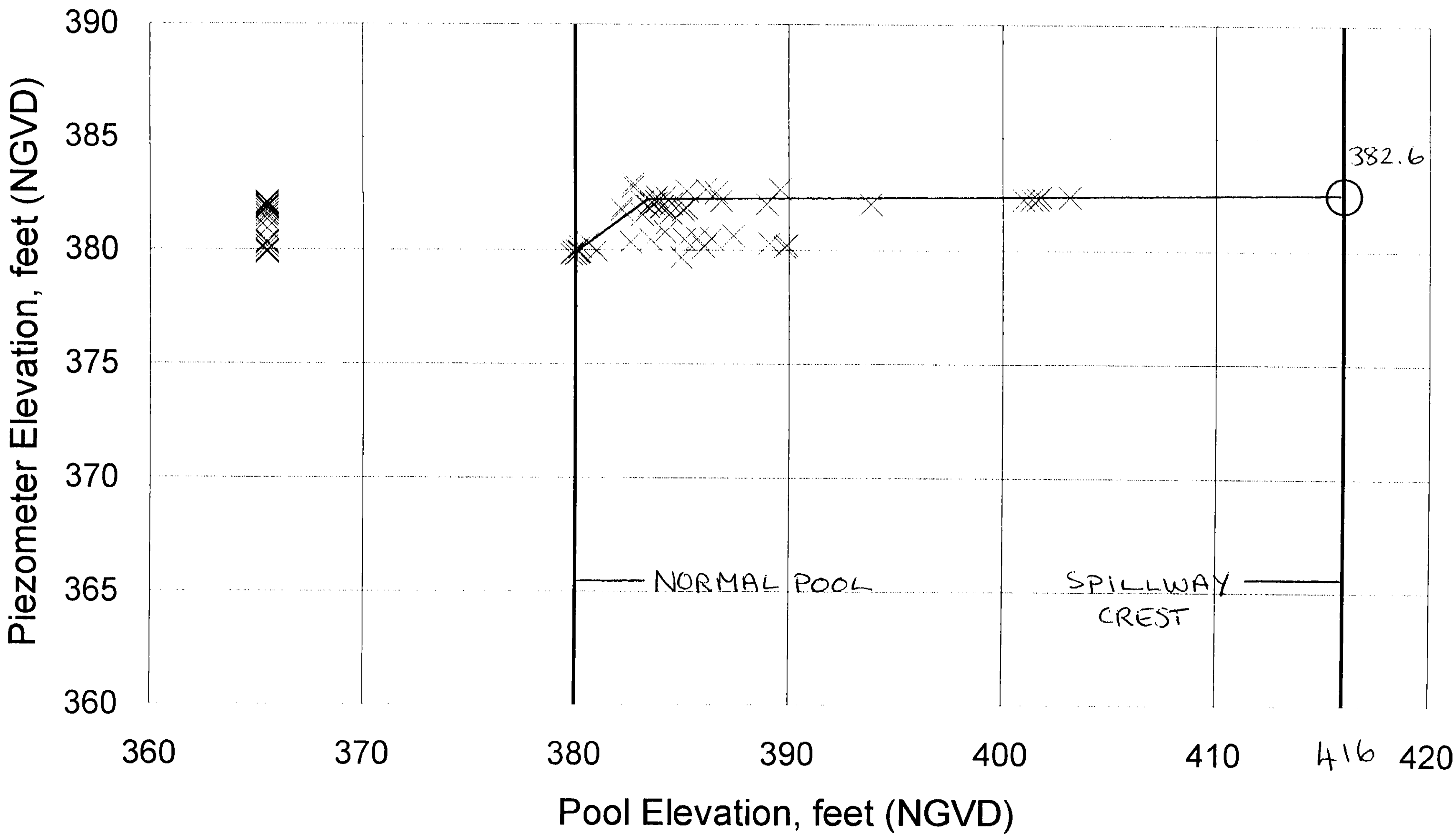
Project 97487

PLATE H.1

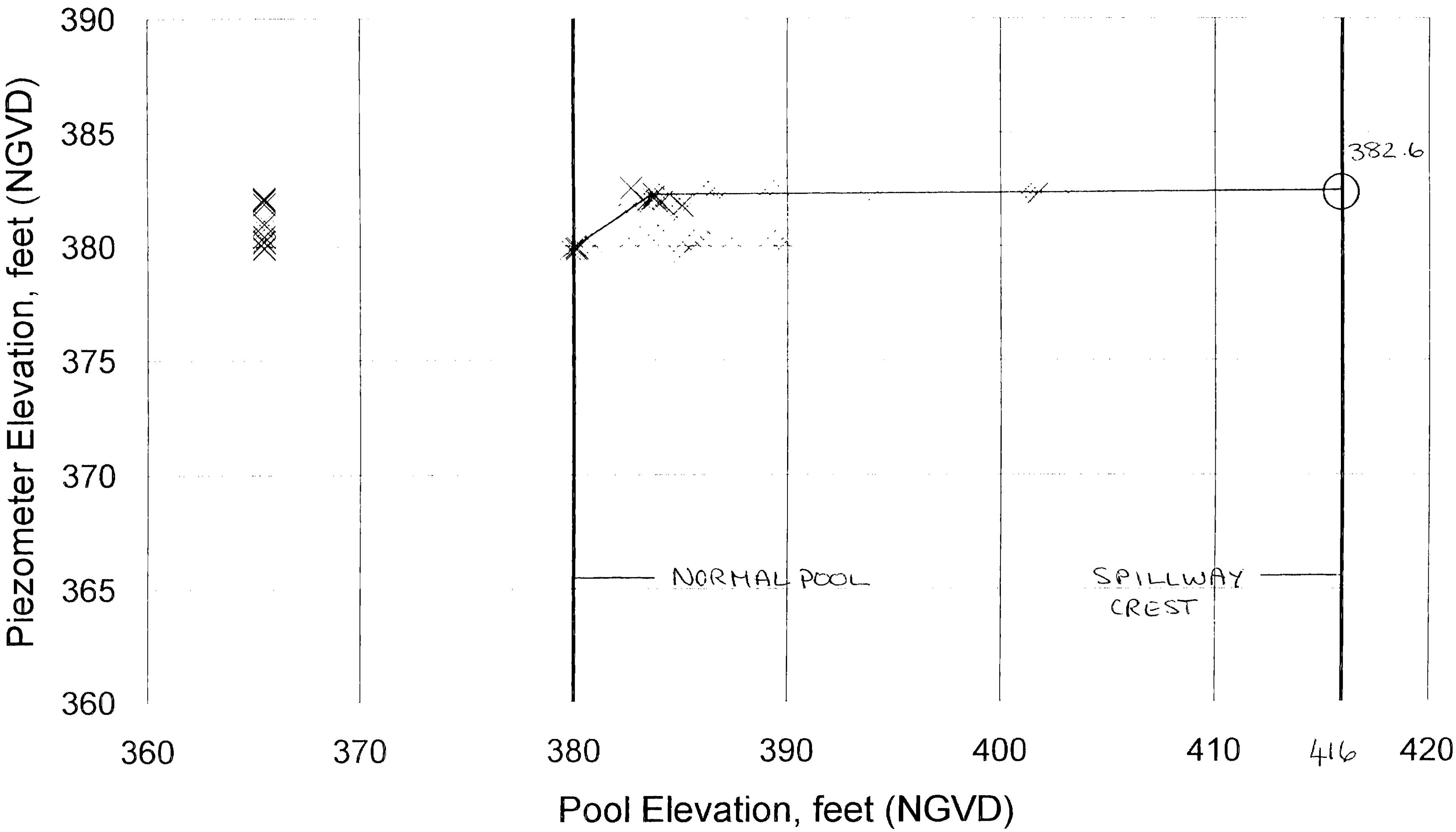
Piezometer Elevation vs. Pool Elevation
RW-2



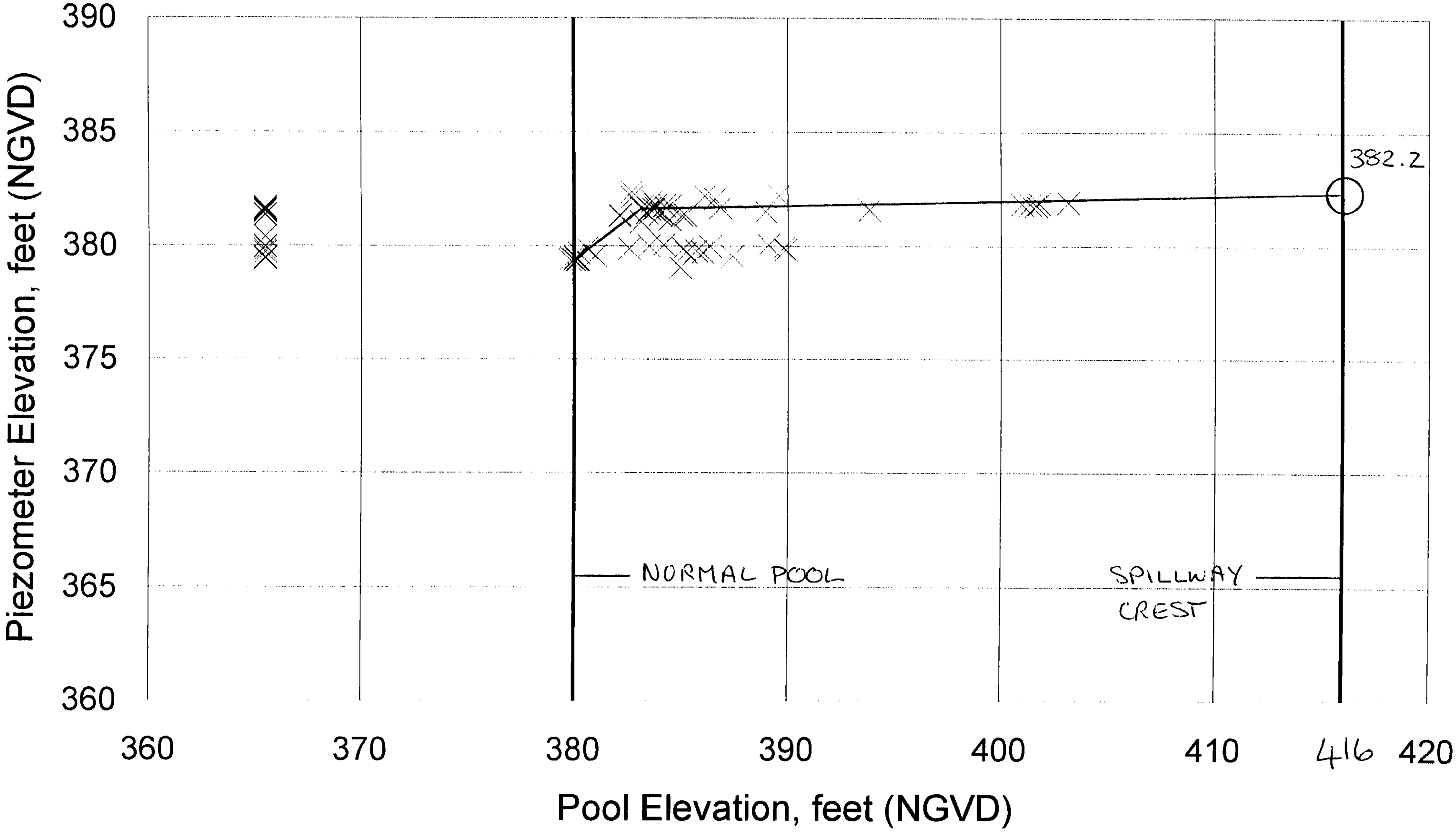
Piezometer Elevation vs. Pool Elevation
RW-3



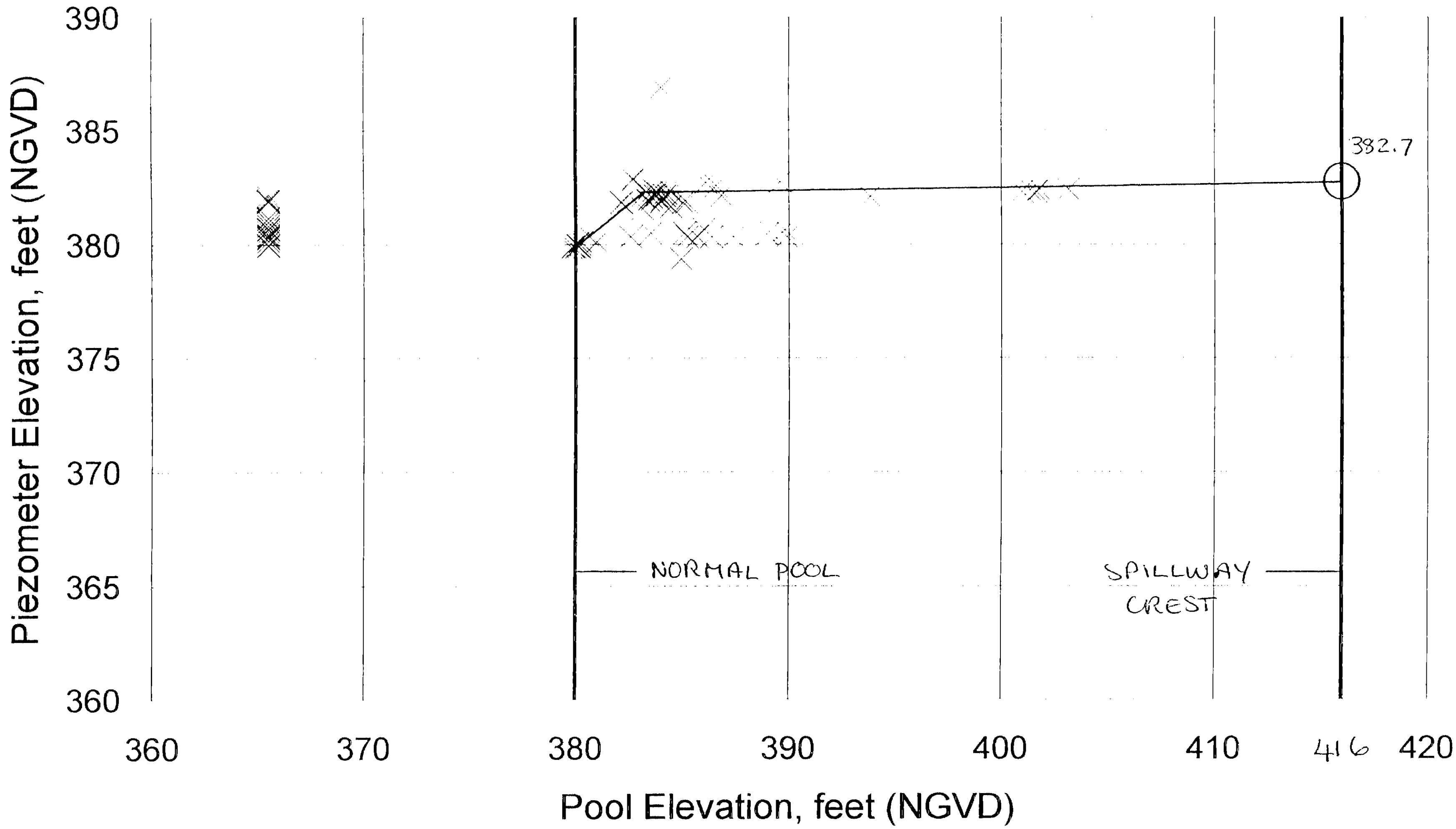
Piezometer Elevation vs. Pool Elevation
RW-4



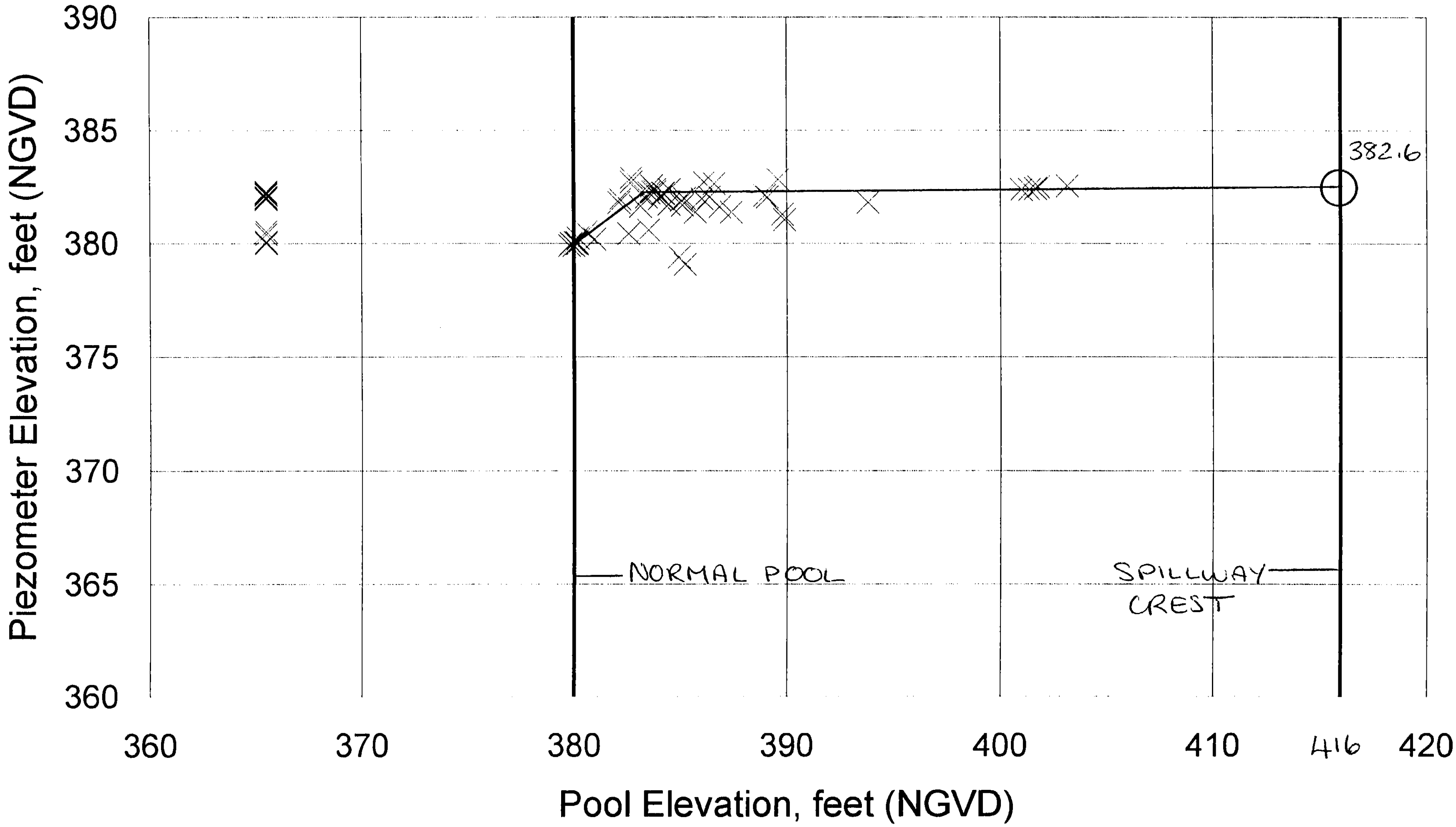
Piezometer Elevation vs. Pool Elevation
RW-5



Piezometer Elevation vs. Pool Elevation
RW-6



Piezometer Elevation vs. Pool Elevation
RW-7



Piezometer Elevation vs. Pool Elevation
RW-8