FOUNDATION INSTRUMENTATION REPORT
SUPPLEMENT FOR RESPONSES TO
NRC QUESTIONS 241.3 and 241.4

Submitted to:

Arizona Nuclear Power Project

Ertec Project No. 80-155

August 26, 1981

TABLE OF CONTENTS

LIST OF TABLES

FIGURES

FOUNDATION INSTRUMENTATION REPORT

1.0 INTRODUCTION

This report presents the results of the heave, settlement, and subsidence monitoring program implemented at the Palo Verde Nuclear Generating Station, plus an evaluation of the data obtained through February, 1981. The purpose of this evaluation is to verify compliance with the settlement related design criteria presented in the FSAR and to determine the degree of conservatism of the Heave/Settlement analysis presented in Appendix 2AA, Amendment 18, of the PVNGS Units 1, 2, and 3 PSAR.

2.0 COMPONENTS OF FOUNDATION INSTRUMENTATION PROGRAM

The heave, settlement, and subsidence instrumentation consists of four component systems: extensometers, mechanical rebound anchors, settlement markers, and subsidence network benchmarks. Table 1 details the type of response being monitored and the frequency of monitoring schedule for each system. In the past, the extensometers and settlement markers have, in some cases, been monitored more frequently than specified.

Extensometer data provides a continuous record of foundation heave and recompression settlements from pre-excavation to the present. Mechanical rebound anchors and settlement markers provide supplemental data from several locations during excavation and recompression. Thus, redundant data are available during excavation and recompression to insure accuracy and to provide backup in the event of a malfunction in one of the systems.

A brief description of each component system follows:

A. Extensometers with remote electronic readout capability are utilized to monitor both heave resulting from excavation and recompression settlements resulting from structural loading. As shown in Figure 1, extensometers were installed in six locations; three near the containment centers of each of Units 1, 2, and 3; two more at selected points in

Unit 1; and additional backup sensor (E-6) near the containment center in Unit 3. At installations MPE-1 through MPE-5, three sensors were anchored in a boring to monitor relative movement at three elevations of the foundation soil relative to a bedrock anchor in the bottom of the boring. The upper sensor at each installation was typically anchored at a depth of a few feet below the estimated bottom of the excavation, in order to monitor the full amount of heave and recompression settlement. The upper sensors at four of the installations (MPE-1, -3, -4, and -5) were damaged during construction. With the exception of the upper sensor at MPE-5, the damaged sensors were reset and re-anchored into the soil. The damaged upper sensor of MPE-5, however, was reset and cast directly into the containment foundation concrete. At the time the upper sensor at MPE-5 was reset, an additional installation, designated E-6, was installed nearby as a backup. This installation contains only one sensor, which is anchored in the soil a few feet below the excavation bottom. Extensometer deflection records are presented in Figures 3 through 8.

B. Mechanical rebound anchors (MRA) were used to monitor heave by optical survey methods during excavation. Six rebound anchors (MRA) were installed in each powerblock excavation, at locations shown in Figure 1. For each powerblock, the respective rebound anchors (MRA) provided data throughout excavation and were abandoned shortly after the excavations were completed. Each MRA installation consisted of a three-foot long stainless steel pin, embeded in soil at the bottom of a cased borehole. The top of the pin was typically located 2.5 feet below the bottom of excavation and served as a reference point for elevation measurement.

C. Settlement markers are pins installed in structural members of critical structures to monitor settlements by optical surveying methods. Forty-nine markers are to be installed in each powerblock, at locations shown

in Figure 2. Settlement marker pins are installed on a structure after a portion of that structure is already in place and therefore, provides only a partial record of settlement. Based on concrete schedules, settlement markers have been installed on structures that ranged from roughly 30 - 100 percent complete at the time of installation. As of December 1980, construction had progressed to the point where all of the 49 markers in Unit 1, 40 of the 49 markers in Unit 2, and 26 of the 49 markers in Unit 3, had been installed.

D. Subsidence monitoring benchmarks have been established to monitor regional subsidence at the site relative to two benchmarks on rock outcrops. The locations of the benchmarks used are shown in Figure 57.

3.0 FINDINGS

A detailed evaluation of instrumentation data and construction load-history was performed to verify compliance to design criteria and to determine the conservatism of the heave/settlement analysis. Details of the evaluation are presented in the following sections. The more significant results are summarized below:

- Post-construction settlements measured to date are small, ranging from negligible to 0.9 inches. These settlements are consistent with the load history and are well within the 1.5 inch maximum specified as a design criterion.

- Post-construction differential settlements measured to date between adjacent structures range from negligible to approximately 0.2 inches. This range is well within the 0.5 inch maximum specified as a design criterion.

- Total recompression settlements measured to date at four major structures range between 1.9 and 4.7 inches, or roughly 38 to 67 percent of the corresponding settlements predicted in the heave/settlement analysis.

- Maximum heave measured during and after excavation ranged between 1.8 and 2.9 inches, which is typically on the order of one-third of predicted values.

3.1 Heave Resulting From Excavation

All powerblock excavations had been completed as of July, 1978. Heave during excavation was monitored independently by both the multi-position extensometers (MPE) and the mechanical rebound anchors (MRA). MPE and MRA data from the early stages of construction (pre-excavation and excavation) are presented in Figures 3 through 26. MPE data show a response conistent with the loading history. The loading history is presented in the form of construction milestones noted on the instrument plots. At each MPE location, the shallower sensors report more movement than the deeper sensors, as expected. MRA data also show a response consistent with the loading history.

Results of the heave monitoring program are summarized in Figure 27. The majority of the summarized heave data was obtained from MRA records. These records show consistent values for comparable locations at each of the three units. Observed maximum heave ranges from 1.8 inches in Unit 1 to 2.9 inches in Unit 3. The main reason that the measured heave is progressively greater from Unit 1 to Unit 3 is that construction begam almost immediately after excavation in Unit 1, while Units 2 and 3 excavations remained open for progressively longer periods of time prior to start of construction.

The measured values of heave are typically on the order of one-third of the values predicted by heave-settlement analysis presented in Appendix 2AA of the PVNGS 1, 2, and 3, PSAR. The overestimation of heave is attributed in two factors. First, compressibility parameters were derived from laboratory oedometer tests that have been known to overestimate the compressibility of overconsolidated soils (Terzaghi and Peck, 1967; Peck, 1977). Second, the entire soil column was conservatively assumed to be saturated under water table conditions even though it is known that a perched groundwater condition exists at the site.

3.2 Recompression Settlements

3.2.1 Load History:

The construction status and total foundation loading at the three units as of December 1980, was as follows:

- Unit 1 - Backfill and concrete placement was essentially complete.
- Unit 2 - Backfill was essentially complete and approximately 89 percent of the total scheduled concrete had been placed in the powerblock structures.

- Unit 3 - Backfilling was in progress and approximately 46 percent of the total scheduled concrete had been placed in the powerblock structures.

A summary of the construction status of each individual powerblock structure as of December 1980, is presented in Table 2.

The settlement analysis presented in the PSAR was based on a construction sequence projected in 1976. A comparison of actual construction sequence vs. the projected construction sequence of the individual structures is presented in Table 3. The loading magnitude and sequence assumed in the heave/settlement analysis was in general overall agreement with the actual observed loading history. However, for certain structures and/or short time internals, the actual loading sequence deviates somewhat from the assumed sequence.

For a given structure, the amount and timing of settlement is influenced by the foundation loading and construction sequence of adjacent structures. Therefore, a small change from projected loading sequence will result in slight changes in the expected settlements. For most structures this effect was found to be negligible, but the affects of changes in loading sequences did result in slightly larger than predicted post-construction settlements for a few structures. This effect is discussed in detail in section 3.2.3.

3.2.2 Total Settlements:

An evaluation of recompression settlement data was made using both settlement marker and extensometer records obtained at four major structures for which data was available for both types of instruments. These four structures were in the Unit 1 Containment, Unit 1 Auxiliary Building, Unit 2 Containment,and Unit 3 Containment.

As noted previously, the extensometers recorded essentially the complete recompression settlements while the settlement markers, installed at a later date, provided only a partial record. To evaluate if the two methods provided consistent measurements, a comparison was made of settlements recorded over the period that both types of instruments were in use. Comparisons for the four locations described above are presented in Table 4. The data indicates that, with the exception of Unit 3, the

extensometers recorded less settlement than the settlement markers. Table 4 presents a conservative estimate of settlements based on the comparisons of extensometer and optical survey data. The total extensometer-measured settlements at Units 1 and 2 were multiplied by a correction factor, because at those locations the settlement markers showed a slightly higher rate of movement than the extensometers. At Unit 3, the extensometer-measured settlements were very close to the settlement marker movements and therefore no correction factor was applied.

The explanation for the extensometers at Units 1 and 2 generally reporting less movement than the settlement markers may be related to one or more of the following factors:

- o a compliance mismatch between the soil and the cement/bentonite grout column encasing the instruments,
- o large strains might have occurred in the few feet of soil between the top of the upper sensors and the base of the overlying structures,
- o slippage in the anchorage of sensors to the soils or of the anchor plates to bedrock.

3.2.3 Post-Construction Settlements:

As of February 1981, all of the major structures in the Unit 1 powerblock were essentially complete, while only two structures in the Unit 2 powerblock were complete. Measured post-construction settlements for these structures is presented in Table 5.

The measured post-construction settlements ranged from negligible for the Unit 1 Radwaste Building to 0.9 inches for the Unit 1 Control Building. All of these settlements are less than the 1½ inch maximum specified as a design criterion. As can be seen in Table 5, post-construction settlements have been slightly more than predicted at certain structures. The reason for the slightly increased settlement is due to differences between the actual construction schedule and the projected schedule. Structures that were completed earlier than modeled, or are adjacent to structures that were completed later than modeled, are subjected to increased

adjacent loading effects. This situation results in an increase in expected settlements. Specifically, the Unit 1 Control Building and Units 1, 2, and 3 Turbine Buildings were completed earlier than scheduled in the analysis and, therefore, experienced larger than predicted post-construction settlements. The Unit 1 Fuel Building is adjacent to a heavy structure (the containment) that was completed later than modeled in the analysis. Thus, the increased adjacent loading effects resulted in higher than predicted post-construction settlements for the Fuel Building. On the other hand, the Units 1, 2, and 3 Main Steam Support Structure will be completed much later than modeled in the analysis and post-construction settlements are much smaller than predicted in the heave/ settlement analysis.

Total post construction differential settlements monitored to date between completed adjacent powerblock structures are shown in Table 6. The measured post-construction differential settlements have been less than the 1/2 inch allowable maximum specified as a design criterion. Some of the measured post-construction differential settlements are slightly greater than predicted, probably due to differences between the actual and assumed loading history and/or dificulty in accurately surveying such small movements.

The primary purpose of the specified 1/2 inch maximum post-construction differential settlement between adjacent structures is to limit deflections across critical piping connections. After installation, deflections across piping connections are monitored and pipe stresses are computed. If stress become high, adjustments will be made to relieve stresses. Because of the small movements to date, no adjustments have been necessary.

3.3 Subsidence

Data from the subsidence monitoring network has been collected for the time period February 1977 through March 1981. Movement of the survey benchmarks within the subsidence monitoring network, relative to benchmarks established on bedrock have been measured to within an accuracy of approximately ± 0.25 inch. Results of the subsidence network monitoring program are presented in Figure 57. Locations of subsidence monitoring benchmarks are shown in Figure 56.

The benchmark monitoring data from all areas except Unit 2 exhibit random scatter within the accuracy of the survey with no measurable subsidence over the period monitored. At Unit 2, the downward movement measured is believed due to the proximity of the benchmark used to the edge of the excavation, and the resulting backfill-induced settlements. In order to avoid this problem in the future, new benchmarks have been established farther from the powerblock excavations at Unit 1, 2, and 3. These new benchmarks are designated PV-5, PV-6, and PV-7, respectively. The initial elevation readings for these new benchmarks were surveyed in March 1981.

4.0 CONCLUSIONS

Based on the evaluation of foundation instrumentation monitoring data presented in this report, the following conclusions are drawn:

A. The total post-construction settlements for all powerblock structures are expected to be less than 1½ inch maximum specified as a design criterion.

B. Total post-construction differential settlements between adjacent powerblock structures due to static loading are expected to be less than the allowable ½ inch design criterion.

C. The heave and total recompression settlement estimates presented in Appendix 2AA of the PVNGS Units 1, 2, and 3 PSAR are conservatively high.

D. No measurable subsidence of the site relative to bedrock outcrops has been observed through March 1981.

5.0 REFERENCES

Peck, R.G., Pitfalls of Overconservatism in Geotechnical Engineering, Civil Engineering Magazine, February 1977.

Terzaghi, K., and Peck, R.G., Soil Mechanics in Engineering Practice, J. Wiley and Sons, Inc., New York, 1967.

TABLE

SUBSURFACE INSTRUMENTATION DETAILS

INSTRUMENTATION SYSTEM NAME	RESPONSE BEING MONITORED			MINIMUM SPECIFIED MONITORING FREQUENCY-TIME BETWEEN READINGS	
	HEAVE RESULTING FROM EXCAVATION	RECOMPRESSION DUE TO STRUCTURAL AND BACKFILL LOADING	REGIONAL SUBSIDENCE		
Extensometers (MPE, E)	X	X	X	1) Pre-excavation, excavation, pouring of overlying foundations.	-1 week
				2) The following 18 months.	-1 month
				3) Until end of construction.	-3 months
				4) After end of construction.	-1 year
				5) After first 1 year reading.	-5 years
Mechanical Rebound Anchors (MRA)	X			1) Pre-excavation, excavation.	-1 week
Settlement Markers		X	X	1) 18 months following first concrete placement for given structure.	-1 month
				2) Until end of construction of the last major powerblock structure.	-3 months
				3) After end of construction.	-1 year
				4) After first 1 year readings.	-5 years
Subsidence Monitoring Network			X	1) During construction.	-1 year
				2) After end of construction	-5 years

TABLE 2

CONSTRUCTION STATUS

December, 1980[1]

Structure	Percent of Total Concrete Installed		
	Unit 1	Unit 2	Unit 3
Containment	100	86	43
Main Steam SS	97	97	0
Auxiliary	100	96	49
Control	100	93	24
Turbine	100	100	97
Fuel	99	65	3
Radwaste	100	76	7
Diesel Generator	100	97	0

[1] Based on "Monthly Progress Report", Bechtel File D.4.12.

TABLE 3

COMPARISON OF LOADING HISTORY ASSUMED IN SETTLEMENT

ANALYSIS VS. ACTUAL PROJECTED LOADING HISTORY

Structure	Load Intensity (ksf)		Construction Sequence[1] (months)							
			Analysis		Unit 1		Unit 2		Unit 3	
	analysis	actual	start	end	start	end	start	end	start	end
Containment	7.3	7.9	0	36	0	42	1	47	1	43
Main Steam SS	5.6	7.1	8	18	25	46	23	41	20	44
Auxiliary	6.8	6.2	2	30	0	36	0	44	0	44
Control	3.3	3.3	10	34	11	26	14	44	10	35
[illegible]bine	3.0	3.0	4	34	1	26	4	24	4	24
Fuel	5.6	5.3	18	42	19	43	30	46	30	45
Radwaste	3.0	3.0	14	38	19	51	28	46	28	46
Diesel Generator	2.2	3.1	15	30	18	30	26	46	26	41

[1] Construction sequence for the units based on "Project Milestone Schedule", Bechtel Drawing No. SCH-20-3, Status as of February 28, 1981, and supplemented with concrete placement schedules. Month "0" corresponds to September, 1976, for Unit 1; July, 1977, for Unit 2; and May 1979, for Unit 3.

TABLE 4

ACTUAL VS. PREDICTED RECOMPRESSION SETTLEMENTS

Structure	Location	Time Interval[1]						
		t_1 to t_2			t_0 to t_2			
		Measured Partial Settlement ρMPE[2] (inches)	Measured Partial Settlement ρSM[3] (inches)	Correction Factor $f = \frac{\rho SM}{\rho MPE}$	Measured Settlement ρMPE (inches)	Assumed Actual Settlement $\rho = \rho MPE \times f$ (inches)	Approximate Analysis Settlement $\rho calc$ (inches)	$\frac{\rho}{\rho calc}$
Unit 1 Containment Bldg.	MPE-1	0.97	1.6	1.65	1.72	2.8	7.4	0.38
Unit 1 Auxiliary Bldg.	MPE-3	0.70	1.4	2.00	1.20	2.4	5.8	0.41
Unit 2 Containment Bldg.	MPE-4	0.89	2.1	2.36	2.00	4.7	7.0	0.67
Unit 3 Containment Bldg.	MPE-5,E-6	0.80	0.5	=[4]	1.95	1.9[4]	3.9	0.49

[1] t_0 = date when structural loading began (forming and pouring) for a given structure
t_1 = date when settlement marker pins were installed on a given partially completed structure
t_2 = end of December, 1980

[2] ρMPE = settlement measured by multi-position extensometer (MPE)

[3] ρSM = settlement measured by nearby settlement markers (SM)

[4] No correction factor applied because $\rho MPE > \rho SM$; therefore, actual settlement ρ was assumed equal to ρMPE

TABLE 5

POST CONSTRUCTION SETTLEMENTS

Powerblock Unit No.	Structure	Approximate Number of Months Structure Completed[1]	Range of Post Construction Settlement[3] Since Structure Completed (inches)	Total Predicted Post Construction Settlement (inches)
1	Containment	11	0.2	0.4 to 0.5
1	Auxiliary Bldg.	17	negligible to 0.4	0.2 to 0.6
1	Main Steam Support Structure	7	0.1	1.1 to 1.4
1	Control Building	27	0.5 to 0.9	0.2
1	Radwaste Building	2	negligible	0.1 to 0.2
1	Diesel Generator Building	23	0.3[2]	0.2 to 0.3
1	Fuel Building	10	0.2 to 0.3	negligible to 0.1
1	Turbine Building	27	negligible to 0.5	0.1 to 0.3
1	Essential Spray Ponds	10	negligible to 0.3	0.1 to 0.4
1	Reactor Make-up Tank	10	0.1	0.2
2	Main Steam Support Structure	2	0.1	1.1 to 1.4
2	Turbine Building	19	negligible to 0.5	0.1 to 0.3

[1]As of February, 1981

[2]Settlement markers were installed after completion of the structure. The number shown is an estimate based on extrapolation of data.

[3]Based on settlement marker data.

TABLE 6

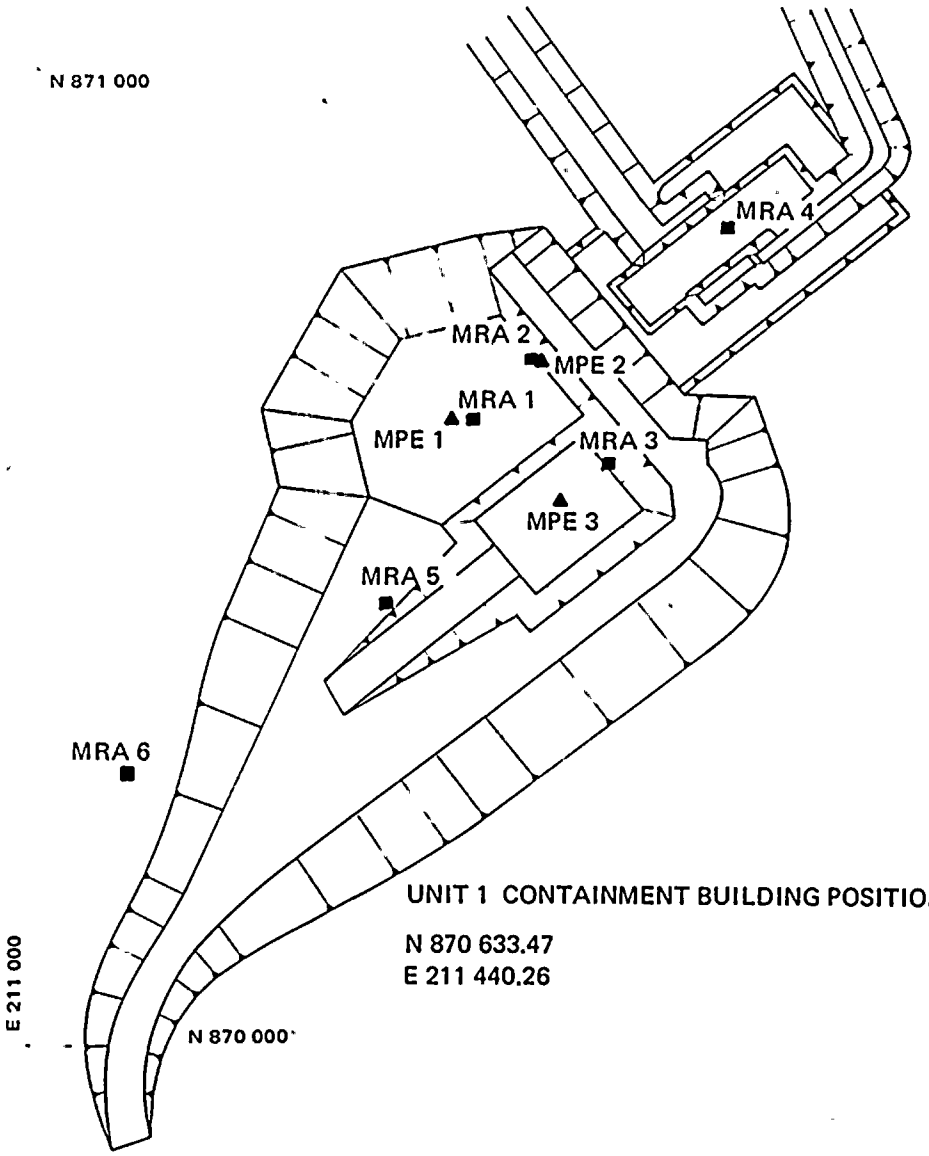
POST CONSTRUCTION DIFFERENTIAL SETTLEMENTS BETWEEN ADJACENT STRUCTURES

Powerblock Unit No.	Adjacent Structures		Approximate Number of Months both Structures Complete [1]	Settlement Marker Points Compared		Post-Construction Differential Settlement Between Settlement Markers (inches)	Predicted Post-Construction Differential Settlements (inches)
	Structure A	Structure B		Structure A	Structure B		
1	Containment Building	Main Steam Support Structure	7	U1-SM-20 U1-SM-25	U1-SM-19 U1-SM-19	negligible negligible	negligible negligible
1	Containment Building	Fuel Building	10	U1-SM-24 U1-SM-24	U1-SM-28 U1-SM-29	0.1 0.1	negligible negligible
1	Auxiliary Building	Control Building	17	U1-SM-21 U1-SM-22	U1-SM-37 U1-SM-36	0.1 negligible	negligible negligible
1	Auxiliary Building	Radwaste Building	2	U1-SM-22 U1-SM-23 U1-SM-23	U1-SM-31 U1-SM-31 U1-SM-30	negligible negligible negligible	0.1 0.1 -
1	Auxiliary Building	Turbine Building	17	U1-SM-21	U1-SM-10	0.1	-
1	Main Steam Support Structure	Turbine Building	7	U1-SM-19 U1-SM-19	U1-SM- 8 U1-SM-11	0.1 0.1	negligible negligible
1	Control Building	Diesel Generator Building	23	U1-SM-34 U1-SM-34	U1-SM-52 U1-SM-50	_ [2] _ [2]	negligible negligible
2	Main Steam Support Structure	Turbine Building	2	U2-SM-19 U2-SM-10	U2-SM- 9 U2-SM-10	0.1 0.1	negligible negligible

[1] As of February, 1981

[2] Complete record not available for points U1-SM-50 and U1-SM-52

UNIT 1

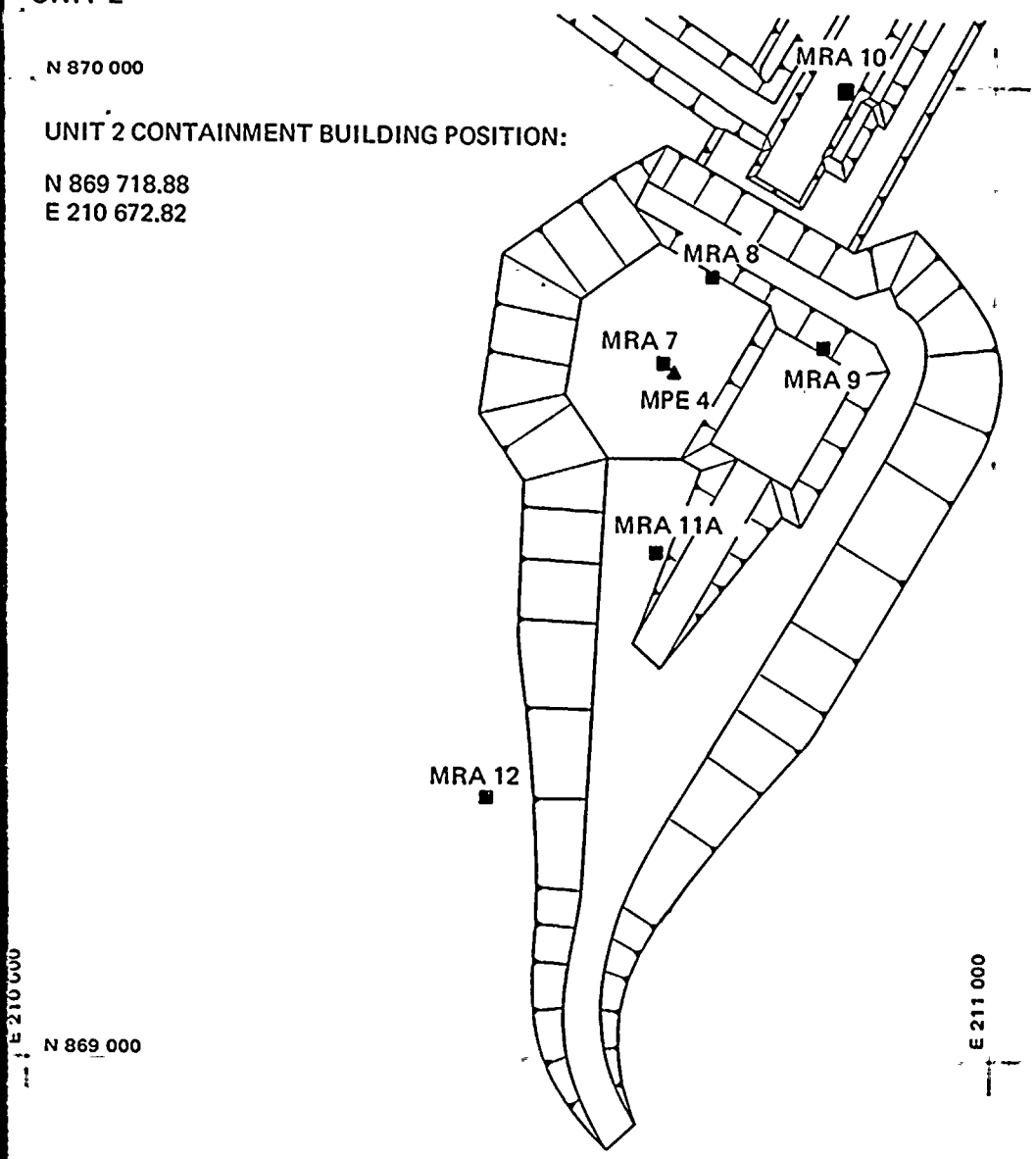


UNIT 1 CONTAINMENT BUILDING POSITION:

N 870 633.47
E 211 440.26

COORDINATES					
MPE 1	N 870 630.09 E 211 426.01	MRA 1	N870 637.58 E 211 438.15	MRA 4	N870 839.11 E 211 684.98
MPE 2	N870 690.44 E 211 508.77	MRA 2	N870 696.21 E 211 504.53	MRA 5	N870 456.20 E 211 353.28
MPE 3.	N 870 551.17 E 211 528.37	MRA 3	N870 592.35 E 211 578.82	MRA 6	N870 277.36 E211 099.44

UNIT 2

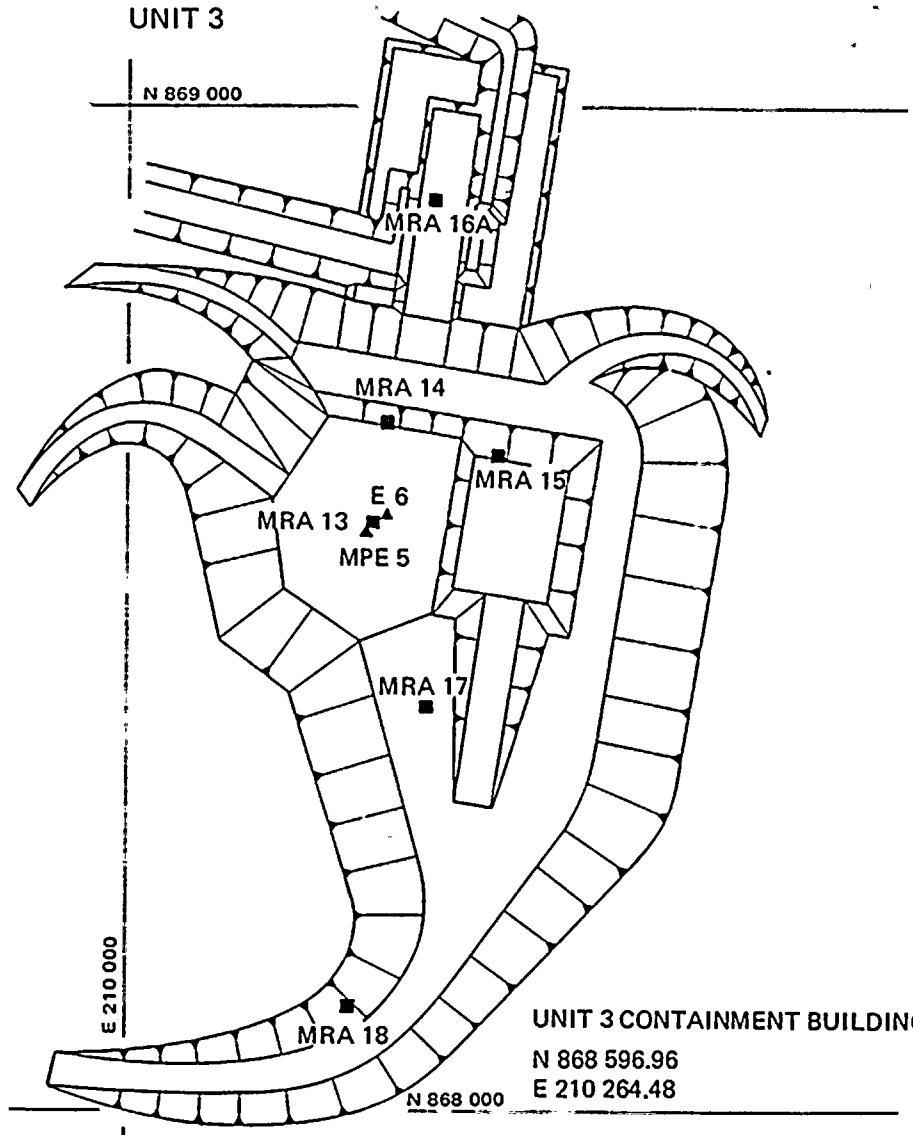


UNIT 2 CONTAINMENT BUILDING POSITION:

N 869 718.88
E 210 672.82

COORDINATES					
MPE 4	N 869 710.03 E 210 880.51	MRA 7	N 869 706.80 E 210 653.71	MRA 10	N 869 996.11 E 210 833.08
		MRA 8	N 869 802.36 E 210 709.37	MRA 11A	N 869 522.58 E 210 651.71
		MRA 9	N 869 728.54 E 210 817.01	MRA 12	N 869 266.91 E 210 475.34

UNIT 3



UNIT 3 CONTAINMENT BUILDING POSITION:

N 868 596.96
E 210 264.48

COORDINATES					
MPE 5	N 868 583.86 E 210 255.83	MRA 13	N 868 578.55 E 210 251.13	MRA 16A	N 868 912.27 E 210 319.79
E 6	N 868 596.61 E 210 275.72	MRA 14	N 868 687.13 E 210 270.41	MRA 17	N 868 405.50 E 210 311.82
		MRA 15	N 868 654.92 E 210 396.75	MRA 18	N 868 104.87 E 210 234.03

▲ MPE E EXTENSOMETER

■ MRA MECHANICAL REBOUND ANCHOR

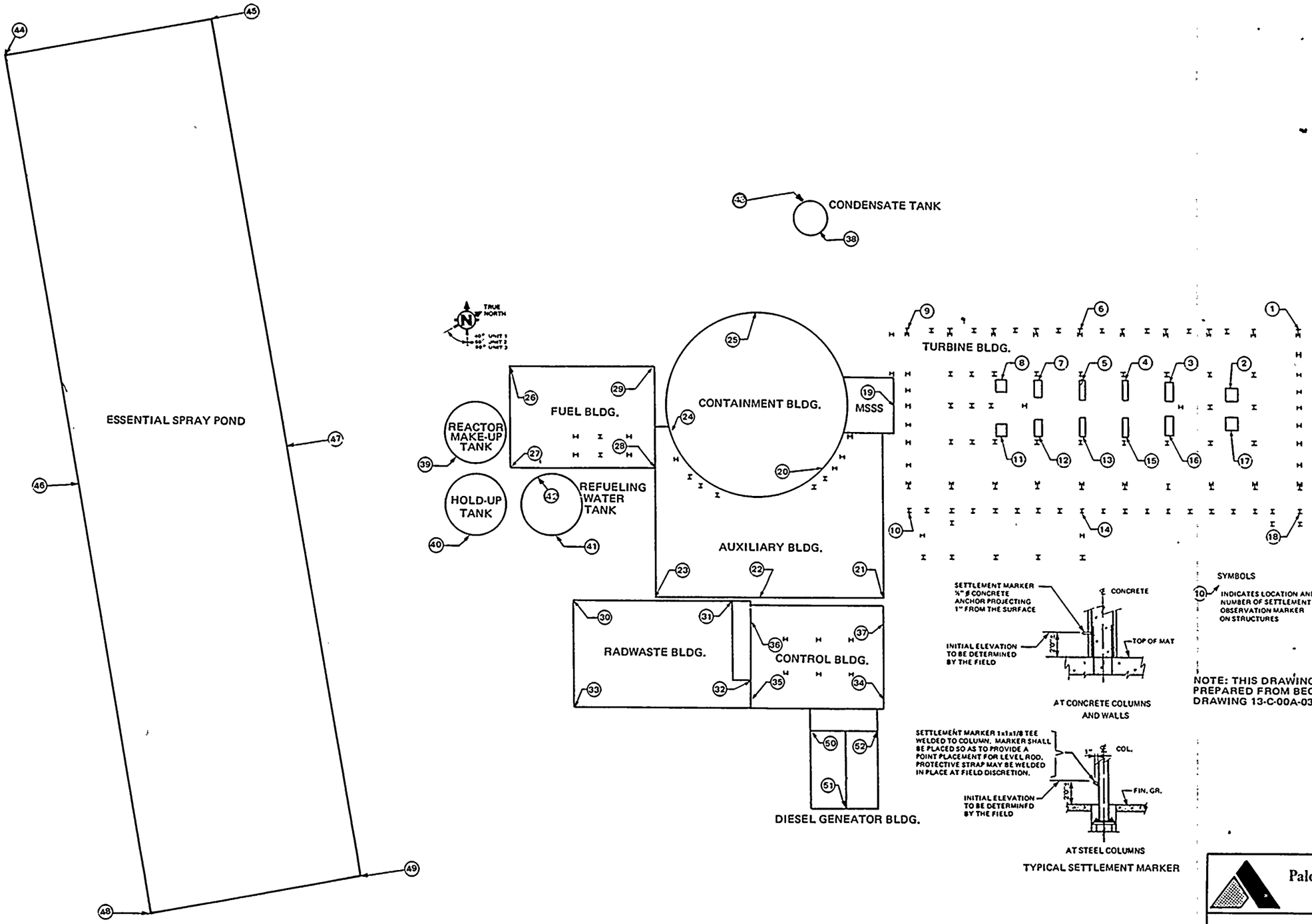
NOTE: COORDINATES ARE BASED ON ARIZONA STATE PLANE COORDINATE SYSTEM

8109220505

Palo Verde Nuclear Generating Station
FSAR

HEAVE/SETTLEMENT MONITORING LOCATIONS

FIGURE 1

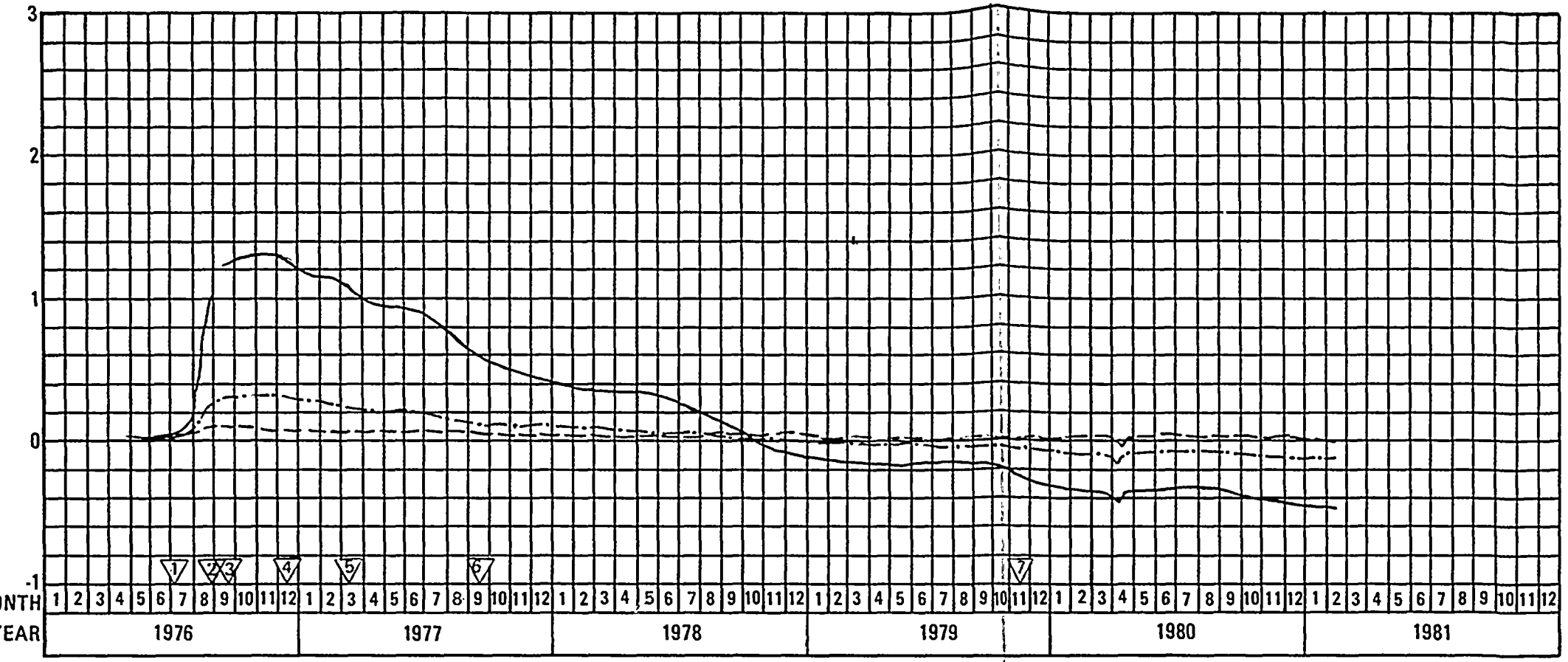


NOTE: THIS DRAWING PREPARED FROM BECHTEL DRAWING 13-C-00A-030.

Palo Verde Nuclear Generating Station
FSAR

SETTLEMENT MARKER LOCATION PLAN

FIGURE 2



CONSTRUCTION MILESTONES

1. EXCAVATION STARTED 7-2-76
2. EXCAVATION COMPLETED 8-30-76
3. FORMING AND CONCRETE POURING BEGUN 9-76
4. REACTOR PIT COMPLETED 12-17-76
5. TENDON GALLERY SLAB COMPLETED 3-4-77
6. BASE MAT AND BACKFILL TO TOP OF BASEMENT COMPLETED 7-29-77
7. INTERIOR CONCRETE COMPLETE 3-80

LOCATION: UNIT 1 NEAR CENTER OF CONTAINMENT BUILDING

COORDINATES: N870,630 E211,426

SENSOR NUMBER	ELEVATION (FT. MSL)	DEPTH, (FT)
—— 6	902	55
—·— 8	823	134
— — 7	728	229
ANCHOR	611	346

REMARKS

SENSOR NO. 6 WAS EXPOSED BY EXCAVATION FOR THE CONTAINMENT CONSTRUCTION KEY 8-28-76, AND WAS RESET ON 9-8-76 AT A DEPTH OF 56 FEET BELOW FINISH GRADE.

8109220505 - 02

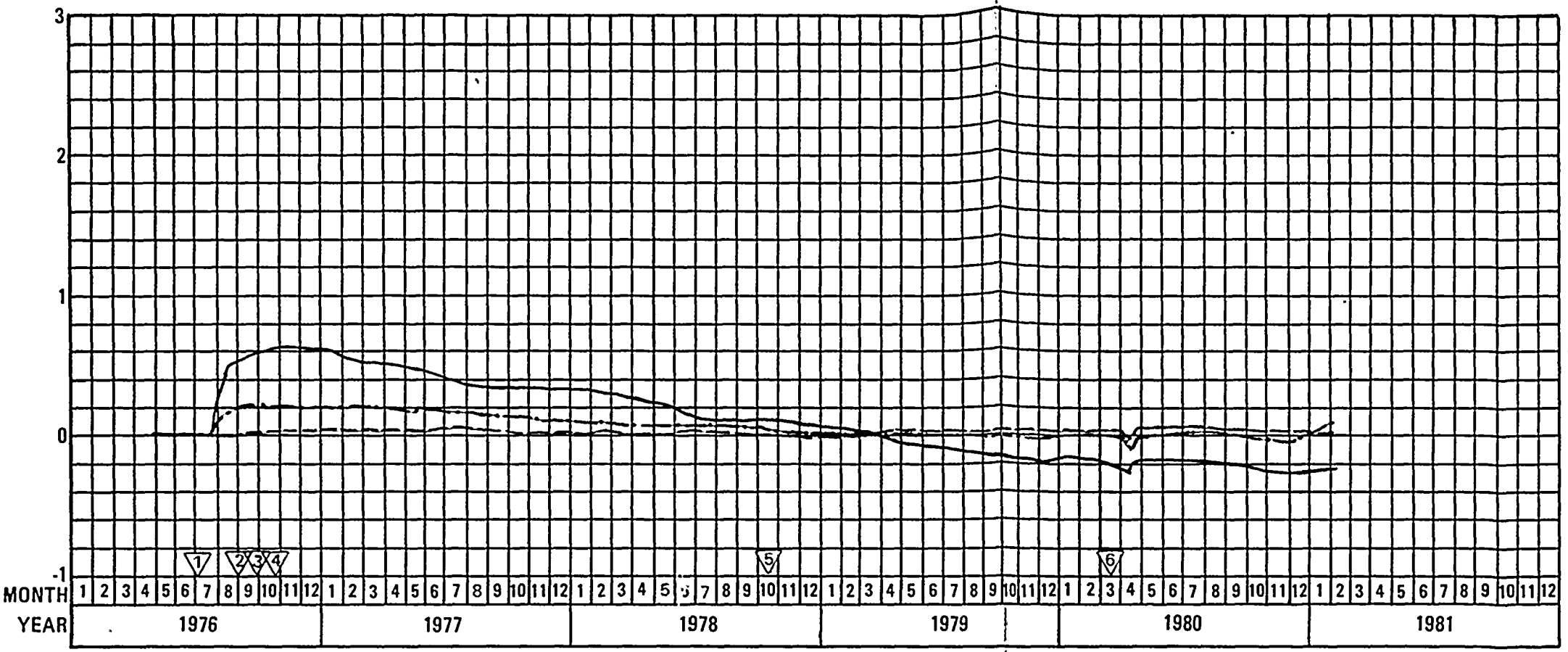
Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MPE-1
Figure 3

Project Number 76-056-10

COMPILED BY _____ CHECKED BY _____ DRAWN BY _____ APPROVED BY _____

COMPILED BY _____ DRAWN BY D.A. Williams, 5/81 CHECKED BY L. Stavenau, 5-8-81 APPROVED BY _____



CONSTRUCTION MILESTONES

1. EXCAVATION STARTED 7-2-76
2. EXCAVATION COMPLETED 8-30-76
3. CONTAINMENT FORMING AND CONCRETE POURING BEGUN 9-76
4. REINFORCED EARTH WALL COMPLETED 10-18-76
5. MAIN STEAM SUPPORT STRUCTURE (MSSS) FORMING AND POURING BEGUN 10-78
6. CONTAINMENT INTERIOR CONCRETE COMPLETE 3-80

LOCATION: UNIT 1, BETWEEN CONAINMENT AND TURBINE BUILDING

COORDINATES: N870,690 E211,509

SENSOR NUMBER	ELEVATION (FT. MSL)	DEPTH (FT)
——— 12	900	57
—·— 11	821	136
— — — 10	731	226
ANCHOR	600	357

8109220505-03

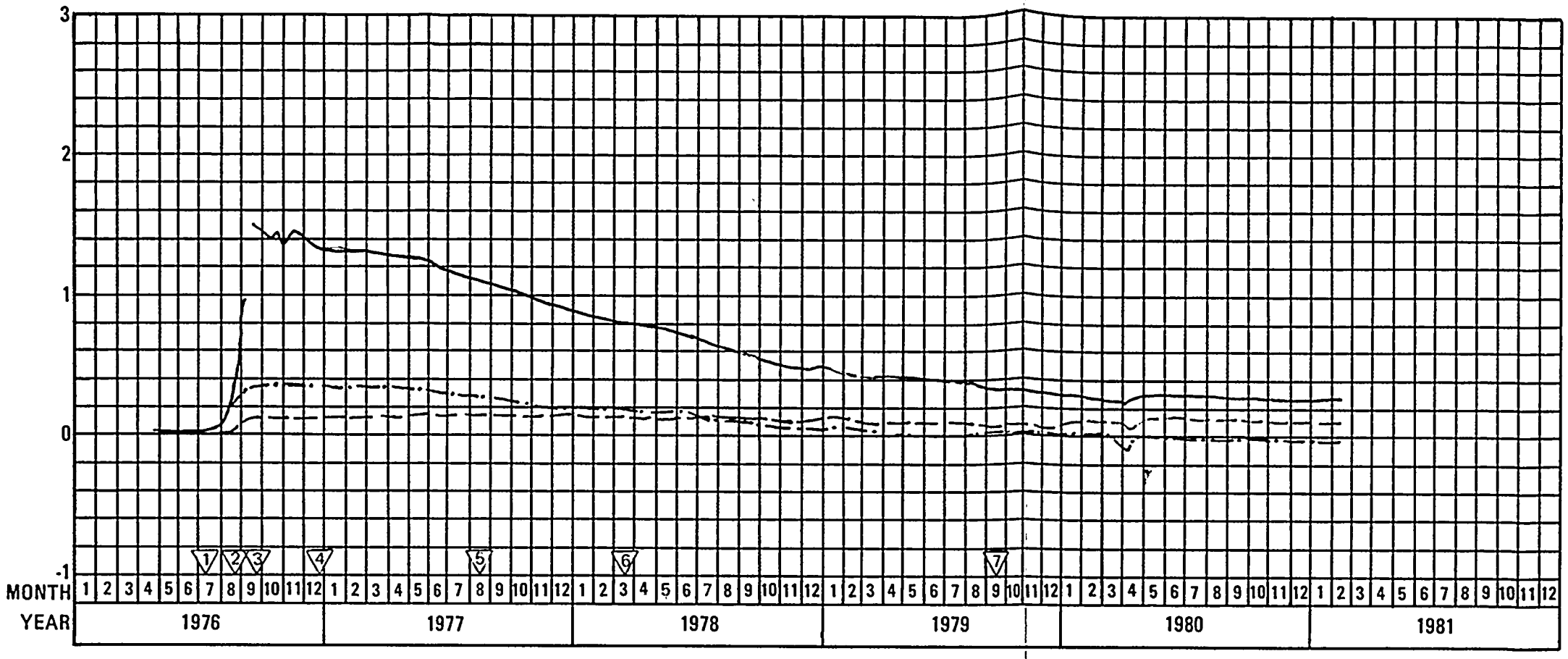
Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION- RECORD

MPE-2

Figure 4

Project Number 76 056 10



CONSTRUCTION MILESTONES

1. EXCAVATION STARTED 7-2-76
2. EXCAVATION COMPLETED 8-30-76
3. FORMING AND POURING BEGUN 9-76
4. LOWER BASE MAT COMPLETED 11-26-76
5. UPPER BASE MAT COMPLETED 8-12-77
6. LOWER BASEMENT WALLS COMPLETE UP TO FINISH GRADE 3-24-78
7. STRUCTURE ESSENTIALLY COMPLETE 9-79

LOCATION: UNIT1, NEAR CENTER OF AUXILIARY BUILDING

CORRDINATES: N870,551 E211,528

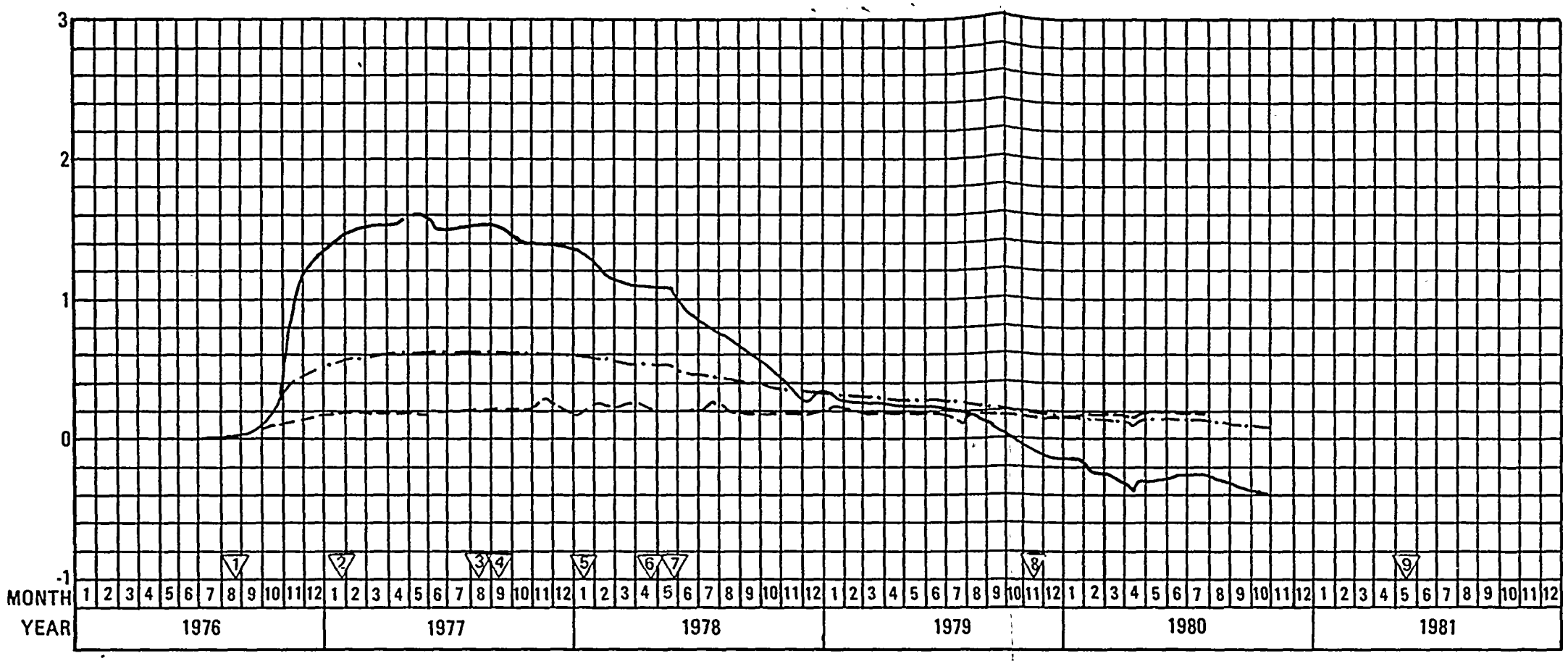
SENSOR NUMBER	ELEVATION (FT. MSL)	DEPTH (FT)	REMARKS
—— 3	886	71	SENSOR NO. 3 WAS EXPOSED BY SUMP PIT EXCAVATION 8-20-76, AND WAS RESET
—·— 2	824	133	ON 9-8-76 AT A DEPTH OF 72 FEET BELOW FINISH GRADE.
— — 1	744	213	
ANCHOR	613	344	

8109220505-04

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MPE-3
Figure 5

COMPILED BY _____ DRAWN BY _____ CHECKED BY _____ APPROVED BY _____



CONSTRUCTION MILESTONES

1. EXCAVATION STARTED 8-18-76
2. EXCAVATION COMPLETED 1-30-77
3. FORMING AND POURING BEGUN 8-77
4. REACTOR PIT BASE MAT COMPLETED 9-9-77
5. REACTOR PIT AND TENDON GALLERY WALLS COMPLETED 1-13-78
6. BASE MAT COMPLETED 4-30-78
7. BACKFILL COMPLETED TO TOP OF BASE MAT 5-26-78
8. APPROXIMATELY 75% OF SCHEDULED CONTAINMENT CONCRETE POURED AS OF 11-79
9. COMPLETE INTERIOR CONCRETE 5-81

LOCATION: UNIT 2, NEAR CENTER OF CONTAINMENT BUILDING

COORDINATES: N869,710 E210,660

SENSOR NUMBER	ELEVATION (FT. MSL)	DEPTH (FT)
15	900	54
5	825	129
13	745	209
ANCHOR	624	330

REMARKS

SENSOR NO. 15 WAS EXPOSED IN CONTAINMENT KEY EXCAVATION 4-28-77 ±, AND RESET ON 5-4-77 AT A DEPTH OF 55

COMPILED BY _____ DRAWN BY D.A. Williams, 5/81 CHECKED BY S. Hain 5/81 APPROVED BY _____

8109220505-05

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MPE-4
Figure 6

Form Number 76 056 10

CONSTRUCTION MILESTONES

1. EXCAVATION STARTED 12-19-77
2. EXCAVATION STOPPED AT ELEVATION 913 FOR DEWATERING 2-1-78
3. EXCAVATION DEEPENED TO ELEVATION 904, 4-5-78
4. EXCAVATION COMPLETED 7-1-78
5. FORMING AND POURING BEGUN 6-79
6. INTERIOR CONCRETE COMPLETE 3-83

8109220505-06

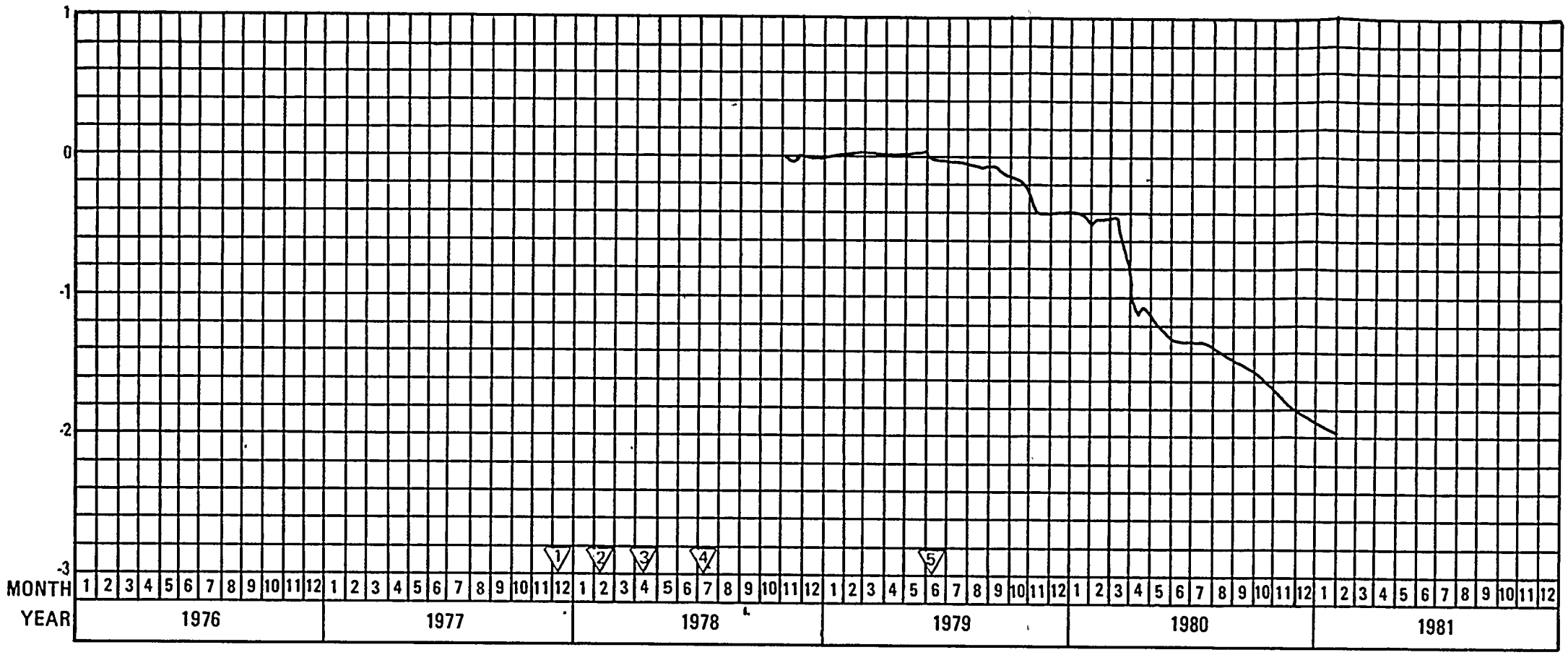
LOCATION: UNIT 3, NEAR CENTER OF CONTAINMENT BUILDING
COORDINATES: N 868, E 210,256

SENSOR NO.	ELEVATION (FT. MSL)	DEPTH (FT.)	REMARKS
—·— 16	895	56	SENSOR NO. 4 BECAME INOPERATIVE BEFORE ANY HEAVE WAS MEASURED. SENSOR NO. 16 WAS DAMAGED DURING CONSTRUCTION. IT WAS RESET AND CAST DIRECTLY INTO CONTAINMENT MAT CONCRETE IN LATE OCTOBER, 1978.
— — — 14	820	131	
——— 4	730	221	
ANCHOR	646	306	

Arizona Nuclear Power Project
Palo Verde Nuclear Generating Station
Units 1, 2 & 3

GROUND DEFLECTION RECORD
MPE--5

Figure 7



CONSTRUCTION MILESTONES

1. EXCAVATION STARTED 12-19-77
2. EXCAVATION STOPPED AT ELEV. 913 FOR DEWATERING 2-1-78
3. EXCAVATION DEEPENED TO ELEV. 904 4-5-78
4. EXCAVATION COMPLETED 7-1-78
5. FORMING AND POURING BEGUN 6-79
6. INTERIOR CONCRETE COMPLETE 3-83

LOCATION: UNIT 3, APPROX. 24' NE OF CONTAINMENT BUILDING CENTER

COORDINATES: N868,597 E210,276

SENSOR NUMBER	ELEVATION (FT. MSL)	DEPTH (FT)
17	886	65

COMPILED BY _____ DRAWN BY J. D. Williams 5/82 CHECKED BY S. Haines 5/84 APPROVED BY _____

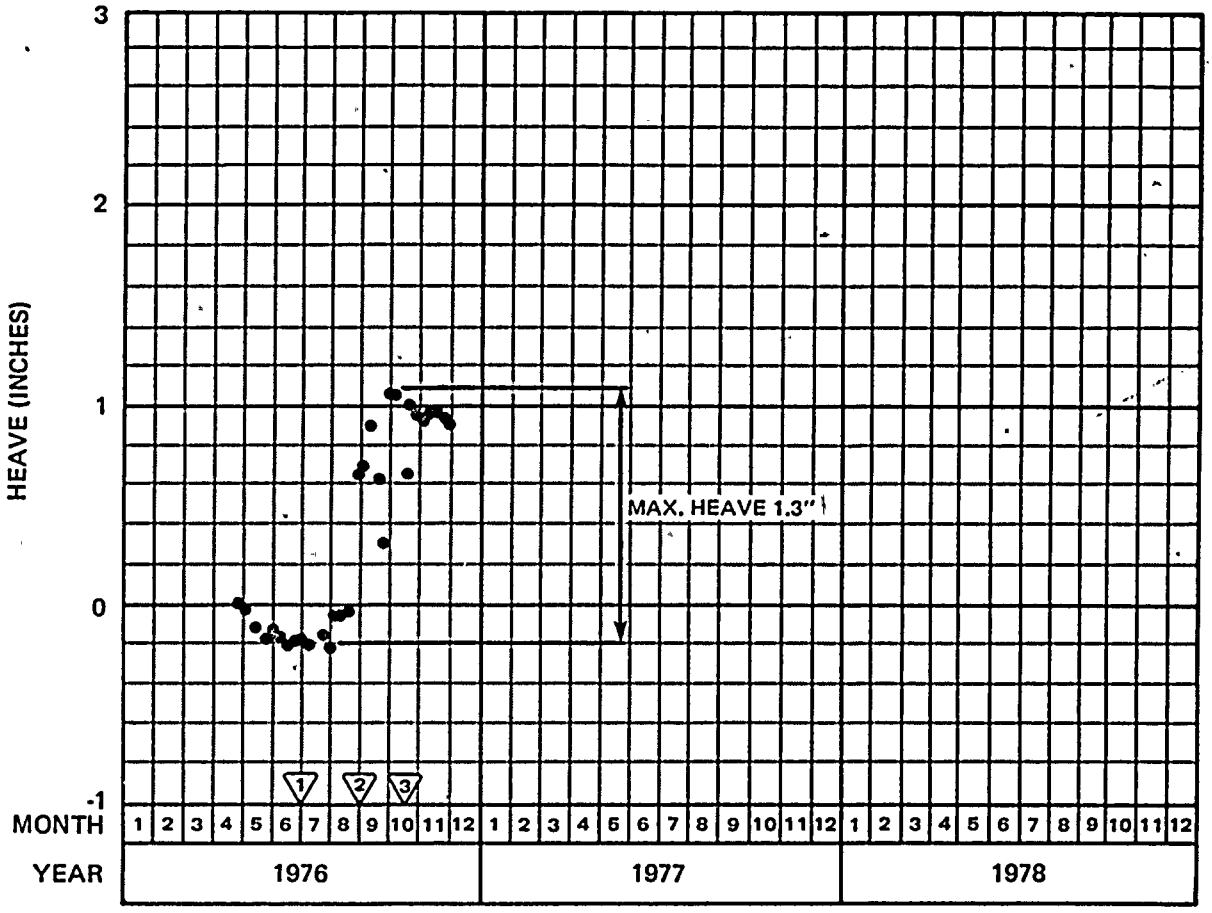
8109220505-07

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD

MPE-6
Figure 8

Project Number 79 056 10



CONSTRUCTION MILESTONES

1. EXCAVATION STARTED 7-2-76
2. EXCAVATION COMPLETED 8-30-76
3. REINFORCED EARTH WALL COMPLETED 10-18-76

LOCATION: UNIT 1, BETWEEN CONTAINMENT AND TURBINE BUILDING

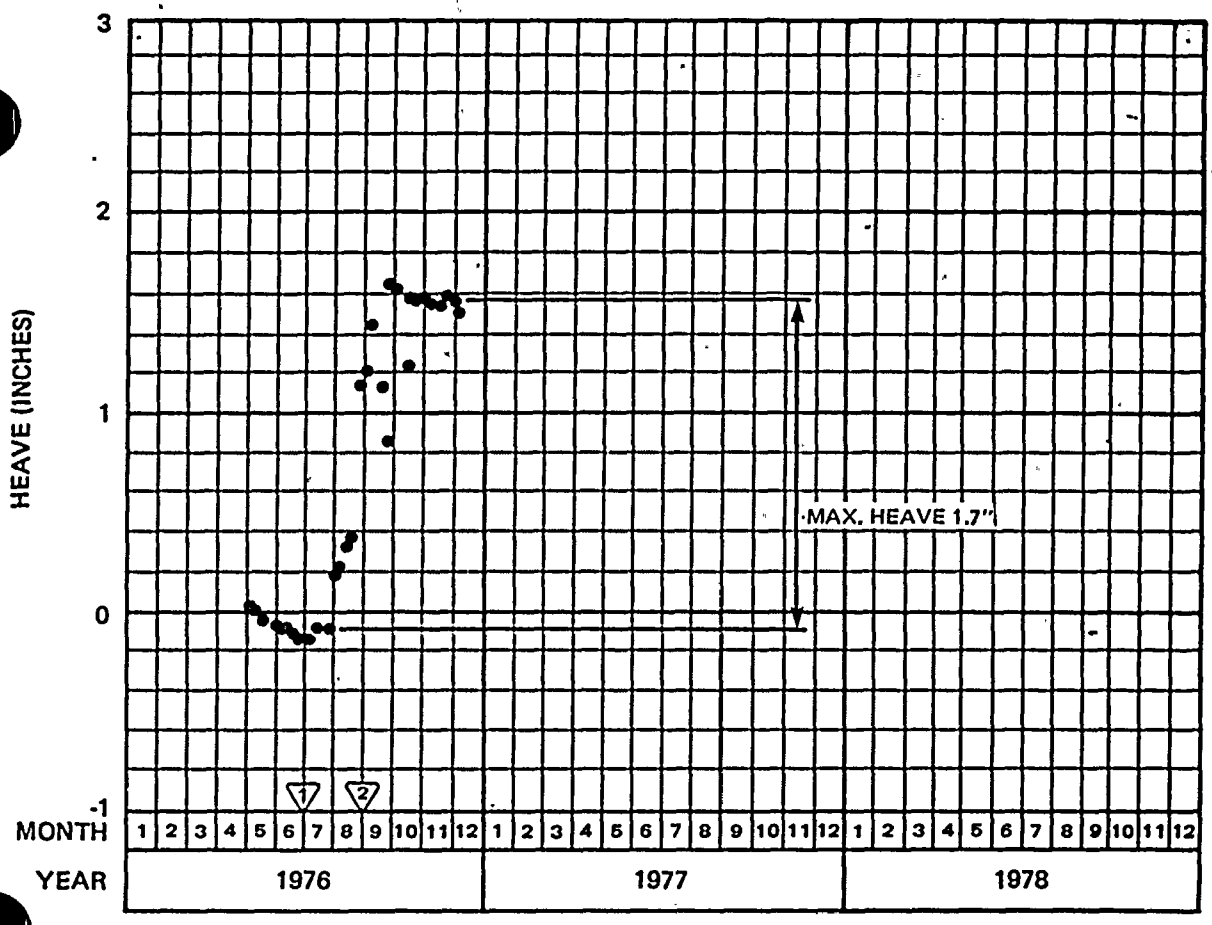
COORDINATES: N 870 692, E 211 501

TOP OF ANCHOR ELEVATION: 905 FT. MSL

TOP OF ANCHOR DEPTH: 52 FT. BELOW FINISH GRADE

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MRA-2
FIGURE 10



CONSTRUCTION MILESTONES

1 EXCAVATION STARTED 7-2-76

2 EXCAVATION COMPLETED 8-30-76

LOCATION: UNIT 1, NEAR CENTER OF CONTAINMENT BUILDING

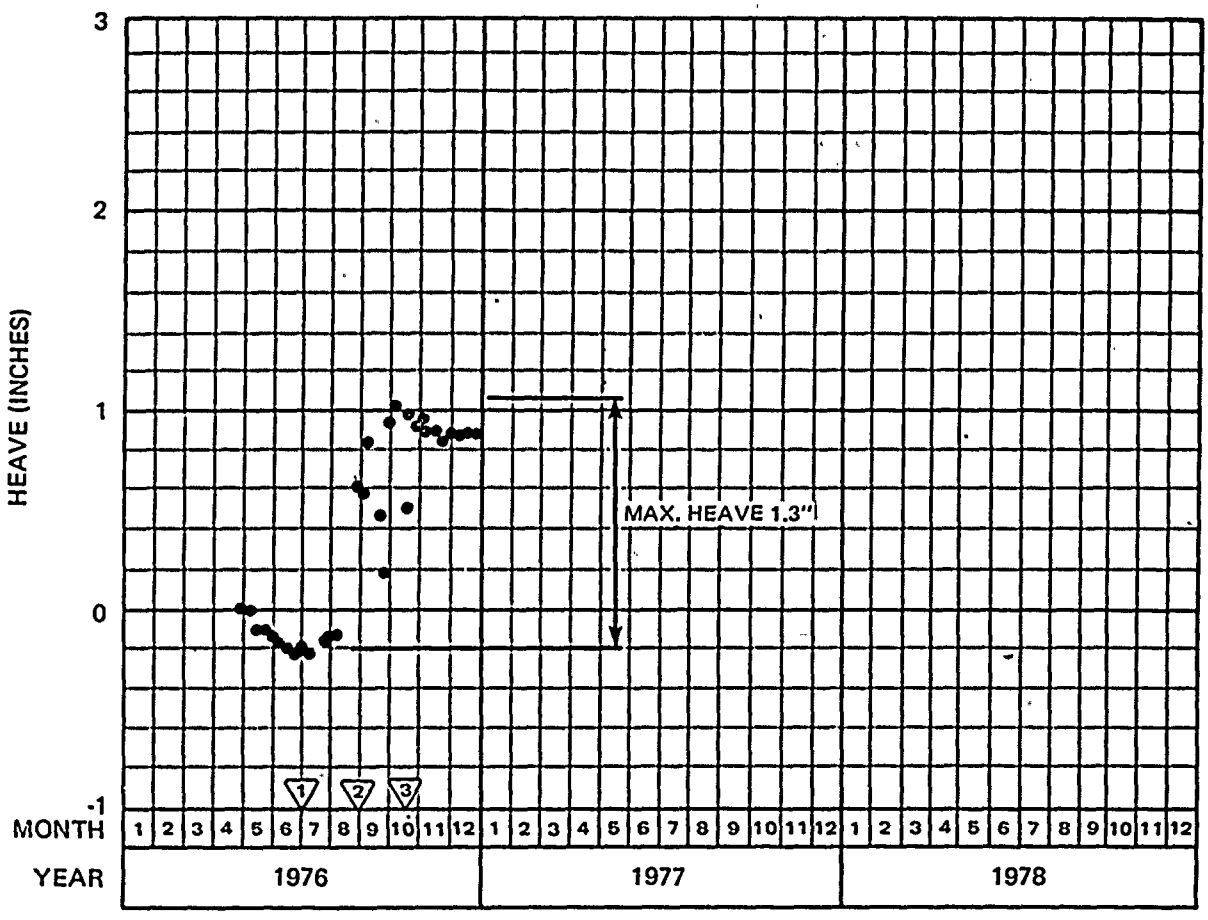
COORDINATES: N 879 638, E 211 438

TOP OF ANCHOR ELEVATION: 904 FT. MSL

TOP OF ANCHOR DEPTH: 53 FT. BELOW FINISH GRADE

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MRA-1
FIGURE 9



CONSTRUCTION MILESTONES

1. EXCAVATION STARTED 7-2-76
2. EXCAVATION COMPLETED 8-30-76
3. REINFORCED EARTH WALL COMPLETED 10-18-76

LOCATION: UNIT 1, NORTHEAST SIDE OF AUXILIARY BUILDING

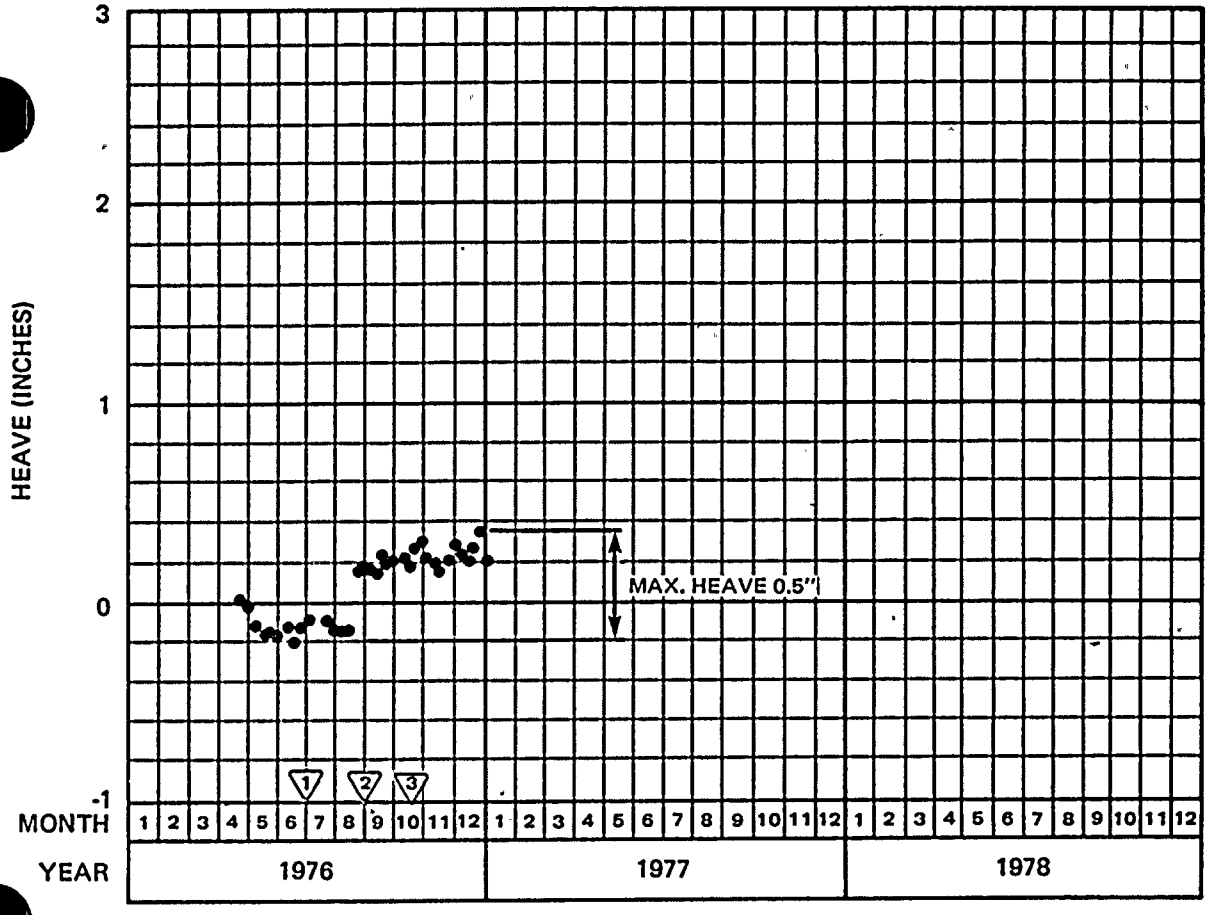
COORDINATES: N 870 592, E 211 579

TOP OF ANCHOR ELEVATION: 888 FT. MSL

TOP OF ANCHOR DEPTH: 69 FT. BELOW FINISH GRADE

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MRA-3
FIGURE 11



CONSTRUCTION MILESTONES

1. EXCAVATION STARTED 7-2-76
2. EXCAVATION COMPLETED 8-30-76
3. REINFORCED EARTH WALL COMPLETED 10-18-76

LOCATION: UNIT 1, TURBINE BUILDING

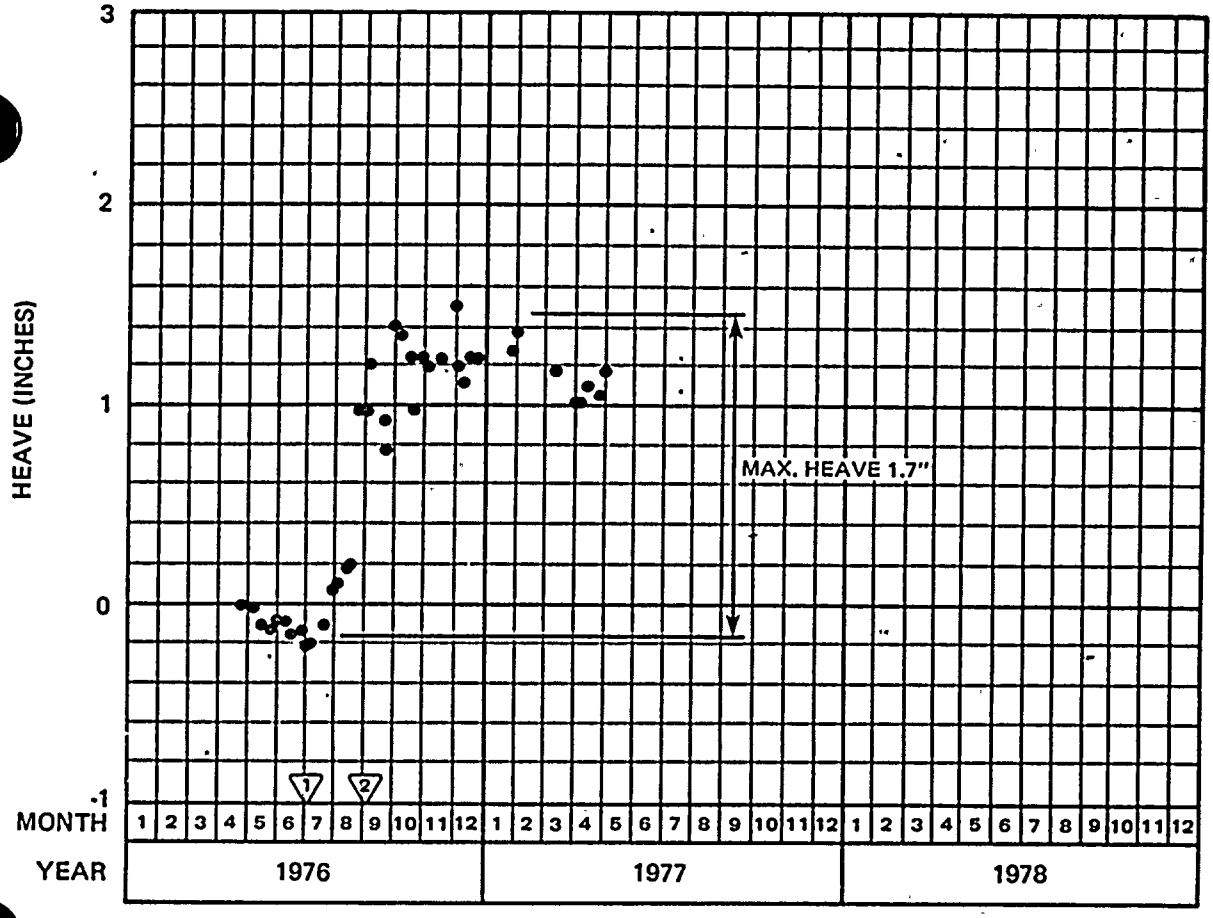
COORDINATES: N 870 839, E 211 685

TOP OF ANCHOR ELEVATION: 938 FT. MSL

TOP OF ANCHOR DEPTH: 19 FT. BELOW FINISH GRADE

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MRA-4
FIGURE 12



CONSTRUCTION MILESTONES

① EXCAVATION STARTED 7-2-76

② EXCAVATION COMPLETED 8-30-76

LOCATION: UNIT 1, BETWEEN FUEL AND RADWASTE BUILDINGS

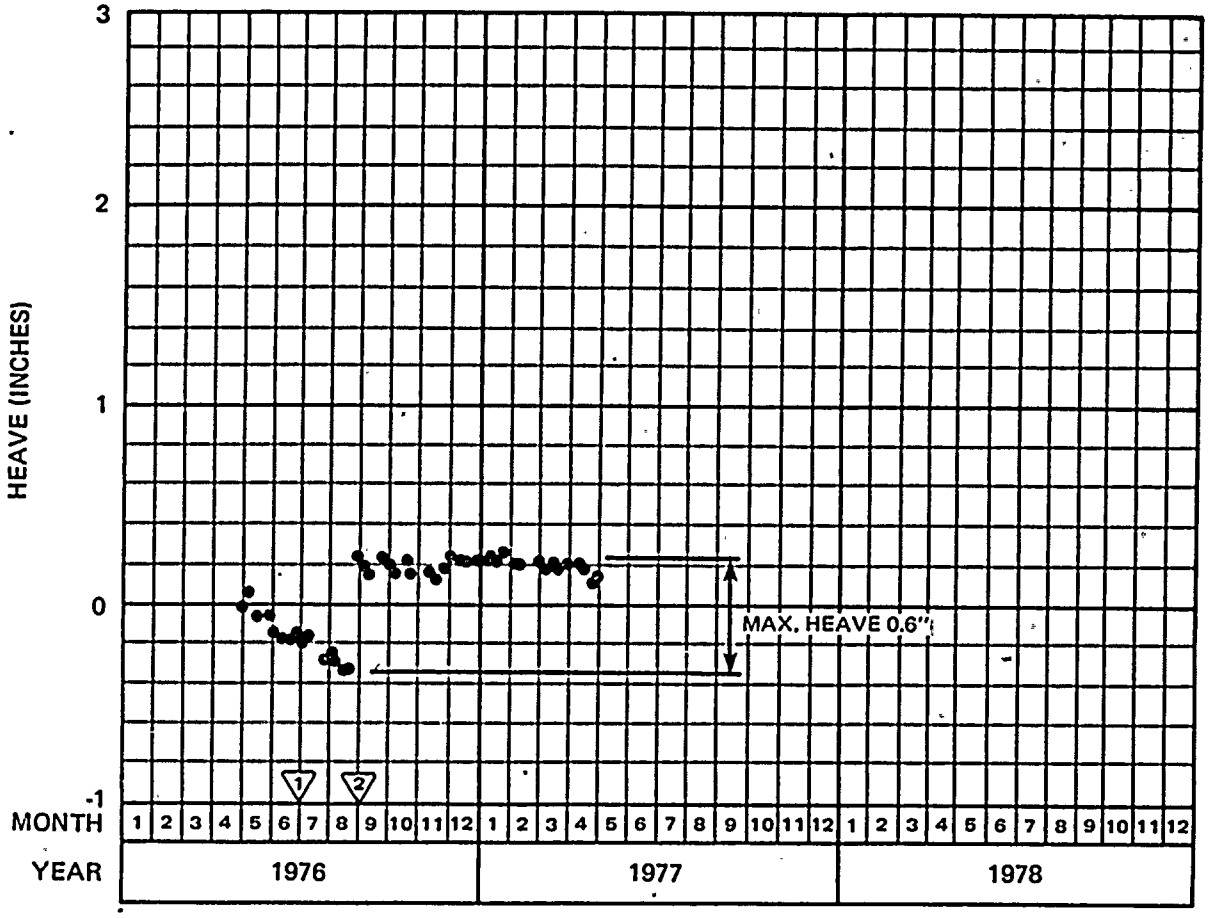
COORDINATES: N 870 456, E 211 353

TOP OF ANCHOR ELEVATION: 895 FT. MSL

TOP OF ANCHOR DEPTH: 62 FT. BELOW FINISH GRADE

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MRA-5
FIGURE 13



CONSTRUCTION MILESTONES

1. EXCAVATION STARTED 7-2-76
2. EXCAVATION COMPLETED 8-30-76

LOCATION: UNIT 1, SPRAY PONDS

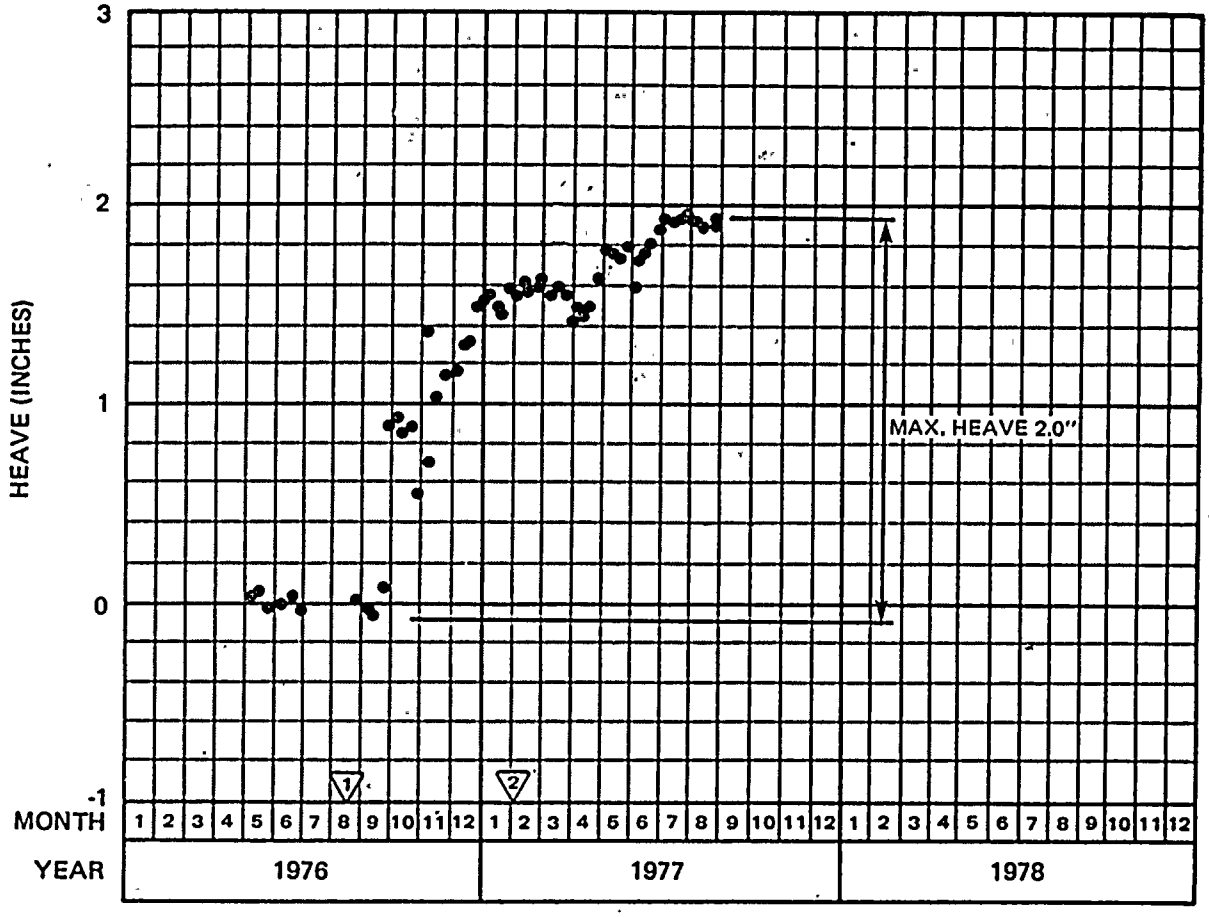
COORDINATES: N 870 277, E 211 099

TOP OF ANCHOR ELEVATION: 940 FT. MSL

TOP OF ANCHOR DEPTH: 17 FT. BELOW FINISH GRADE

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MRA-6
FIGURE 14



CONSTRUCTION MILESTONES

1 EXCAVATION STARTED 8-18-76

2 EXCAVATION COMPLETED 1-30-77

LOCATION: UNIT 2, NEAR CENTER OF CONTAINMENT BUILDING

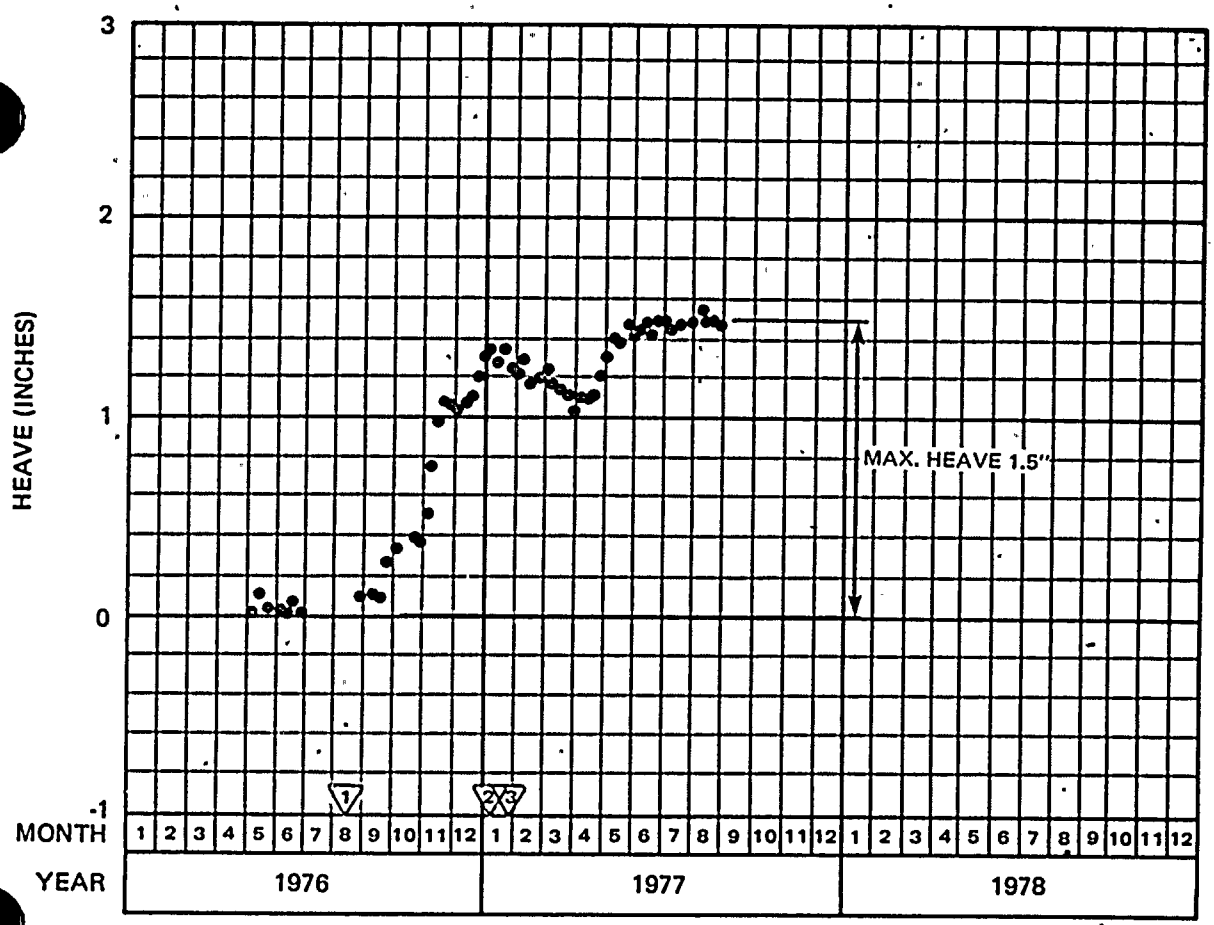
COORDINATES: N 869 707, E 210 654

TOP OF ANCHOR ELEVATION: 901 FT. MSL

TOP OF ANCHOR DEPTH: 53 FT. BELOW FINISH GRADE

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MRA-7
FIGURE 15



CONSTRUCTION MILESTONES

1. EXCAVATION STARTED 8-18-76
2. EXCAVATION COMPLETED 1-30-77
3. REINFORCED EARTH WALL COMPLETED 1-12-77

LOCATION: UNIT 2, BETWEEN CONTAINMENT AND TURBINE BUILDINGS

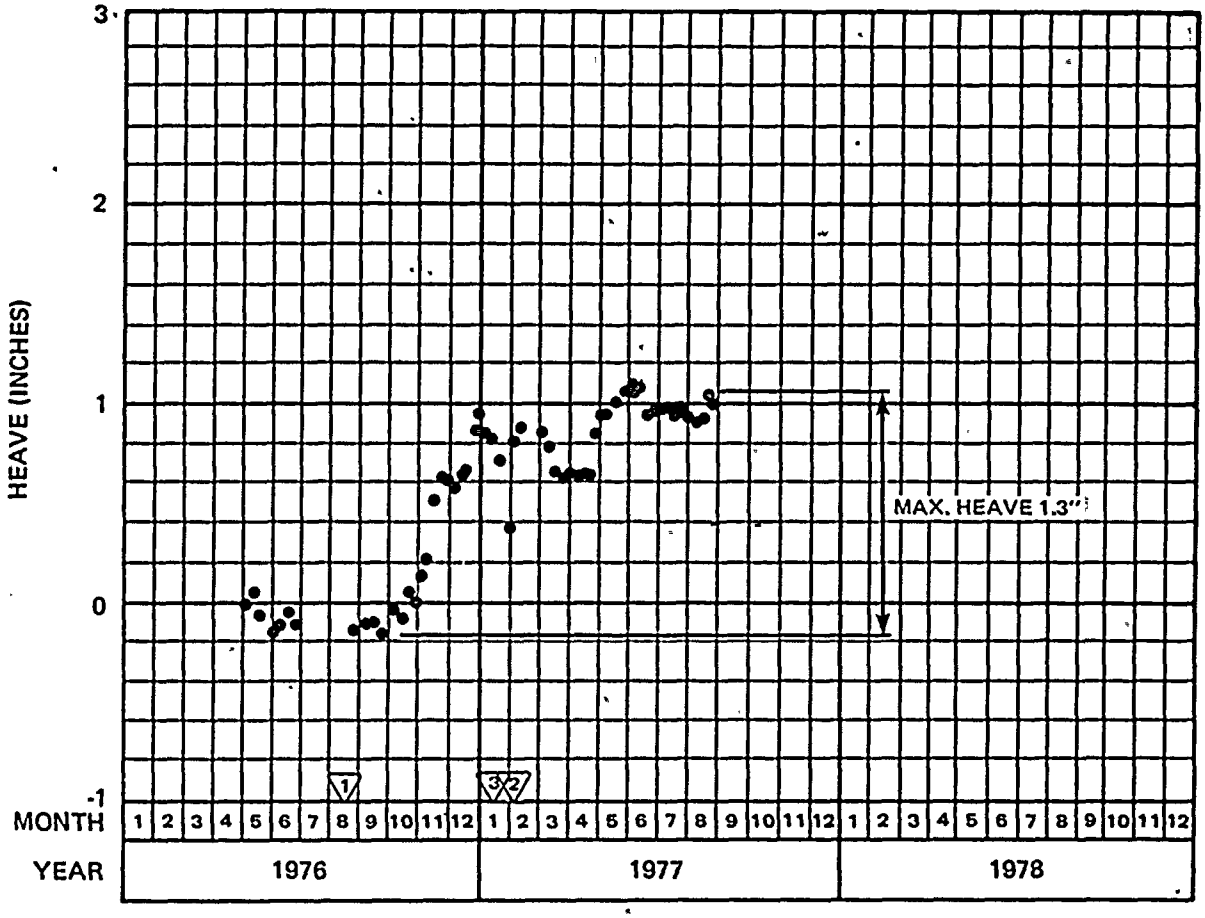
COORDINATES: N 869 802, E 210 709

TOP OF ANCHOR ELEVATION: 902 FT. MSL

TOP OF ANCHOR DEPTH: 52 FT. BELOW FINISH GRADE

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MRA-8
FIGURE 16



CONSTRUCTION MILESTONES

1. EXCAVATION STARTED 8-18-76
2. EXCAVATION COMPLETED 1-30-77
3. REINFORCED EARTH WALL COMPLETED 1-12-77

LOCATION: UNIT 2, EAST SIDE OF AUXILIARY BUILDING

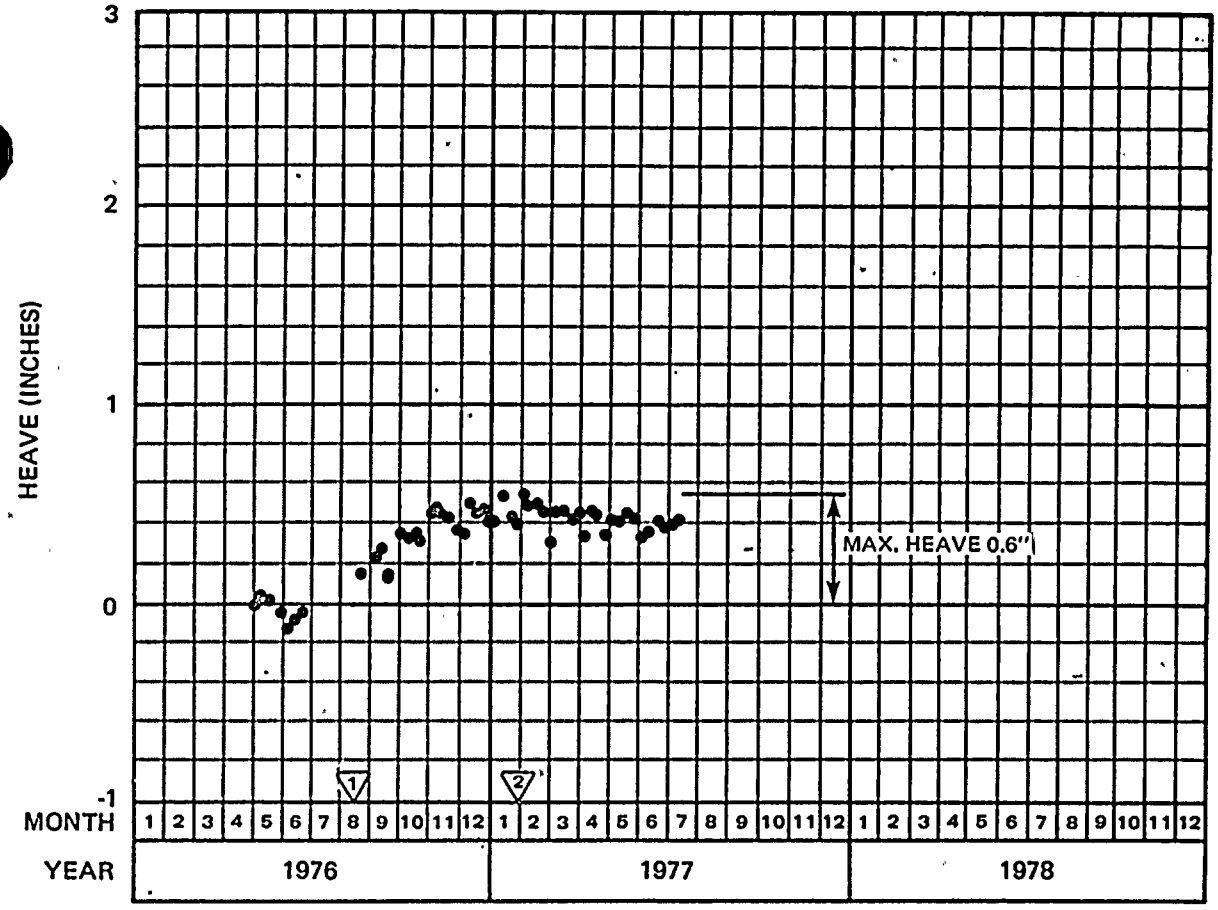
COORDINATES: N 869 729, E 210 817

TOP OF ANCHOR ELEVATION: 884 FT. MSL

TOP OF ANCHOR DEPTH: 70 FT. BELOW FINISH GRADE

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MRA-9
FIGURE 17



CONSTRUCTION MILESTONES

1 EXCAVATION STARTED 8-18-76

2 EXCAVATION COMPLETED 1-30-77

LOCATION: UNIT 2, NEAR CENTER OF TURBINE BUILDING

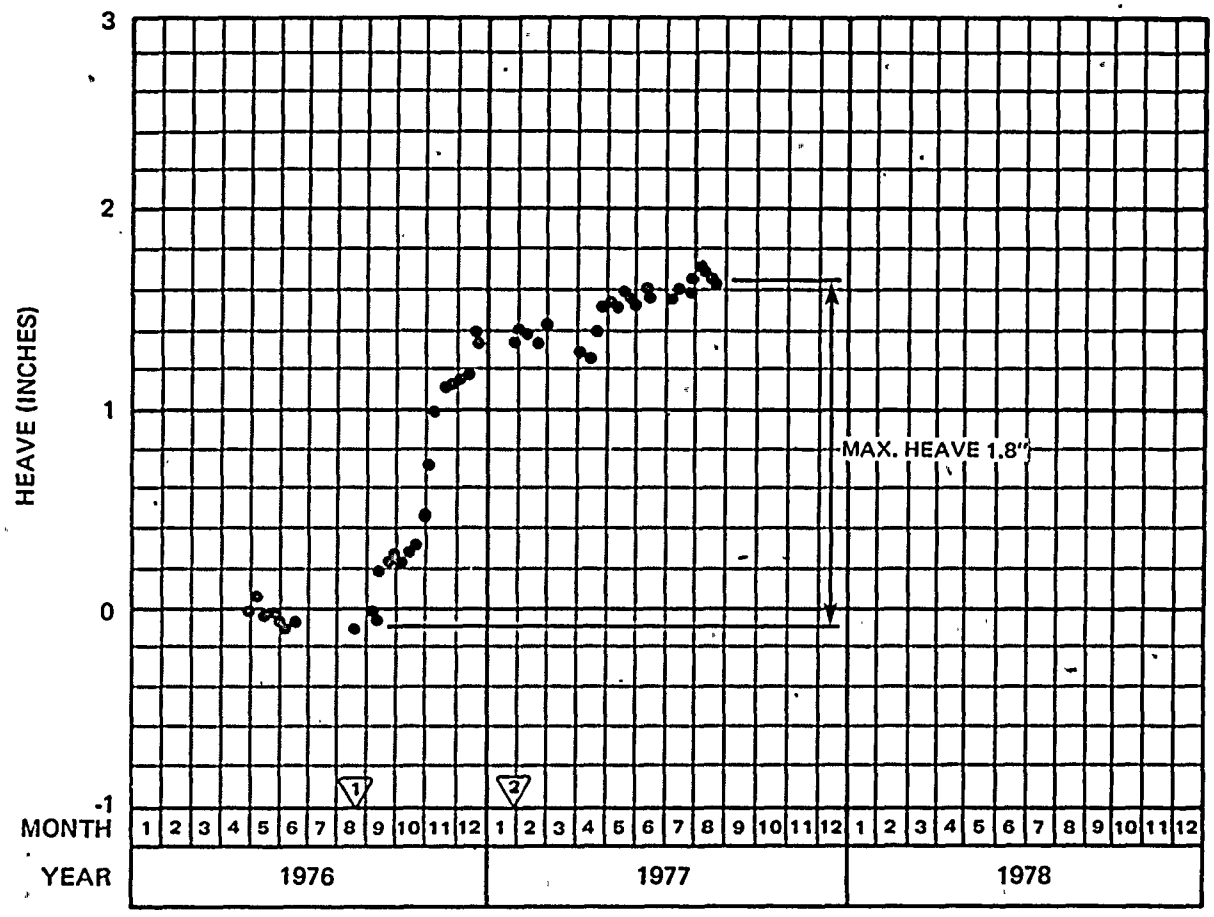
COORDINATES: N 869 996, E 210 833

TOP OF ANCHOR ELEVATION: 935 FT. MSL

TOP OF ANCHOR DEPTH: 19 FT. BELOW FINISH GRADE

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MRA-10
FIGURE 18



CONSTRUCTION MILESTONES

(1) EXCAVATION STARTED 8-18-76

(2) EXCAVATION COMPLETED 1-30-77

LOCATION: UNIT 2, BETWEEN FUEL AND RADWASTE BUILDINGS

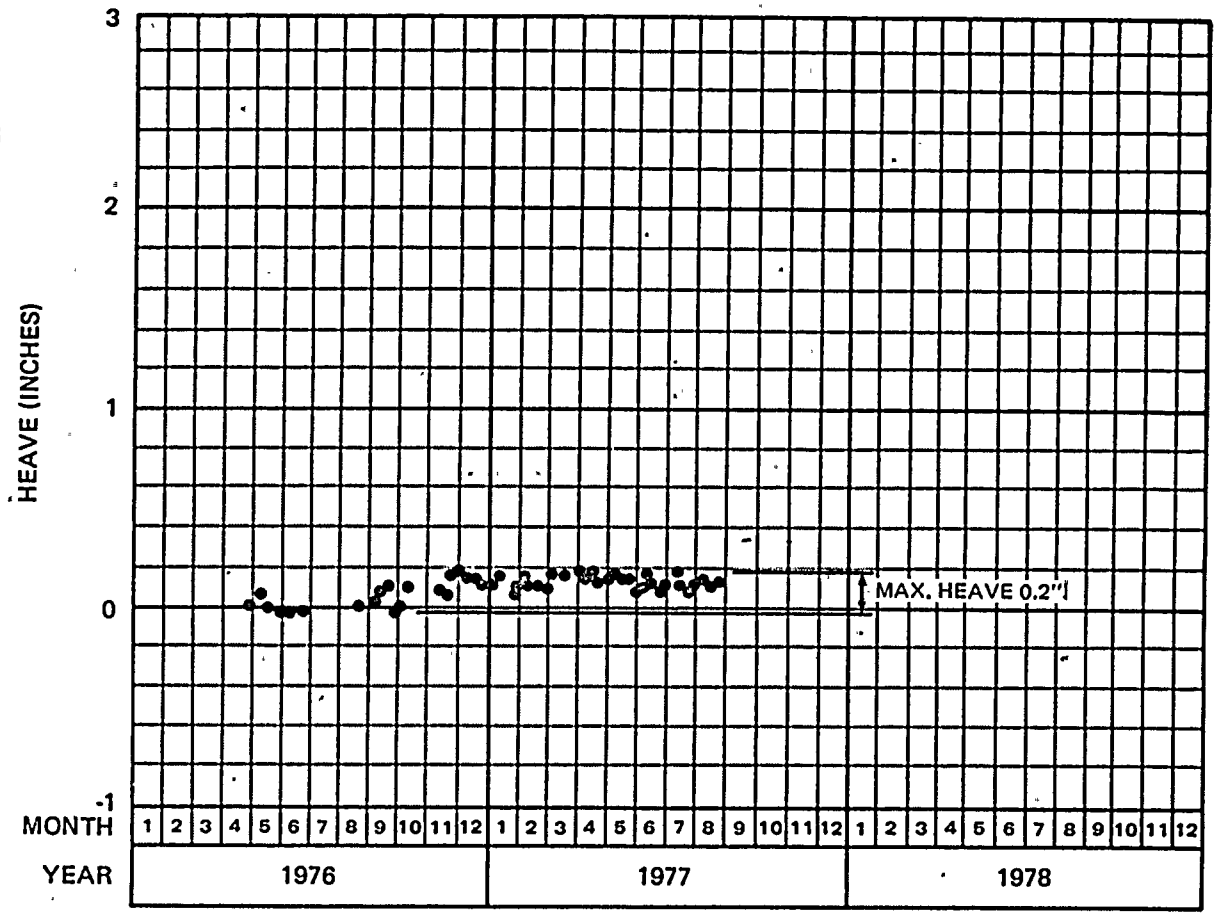
COORDINATES: N 869 523, E 210 652

TOP OF ANCHOR ELEVATION: 891 FT. MSL

TOP OF ANCHOR DEPTH: 63 FT. BELOW FINISH GRADE

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MRA-11A
FIGURE 19



CONSTRUCTION MILESTONES

(1) EXCAVATION STARTED 8-18-76

(2) EXCAVATION COMPLETED 1-30-77

LOCATION: UNIT 2, SPRAY PONDS

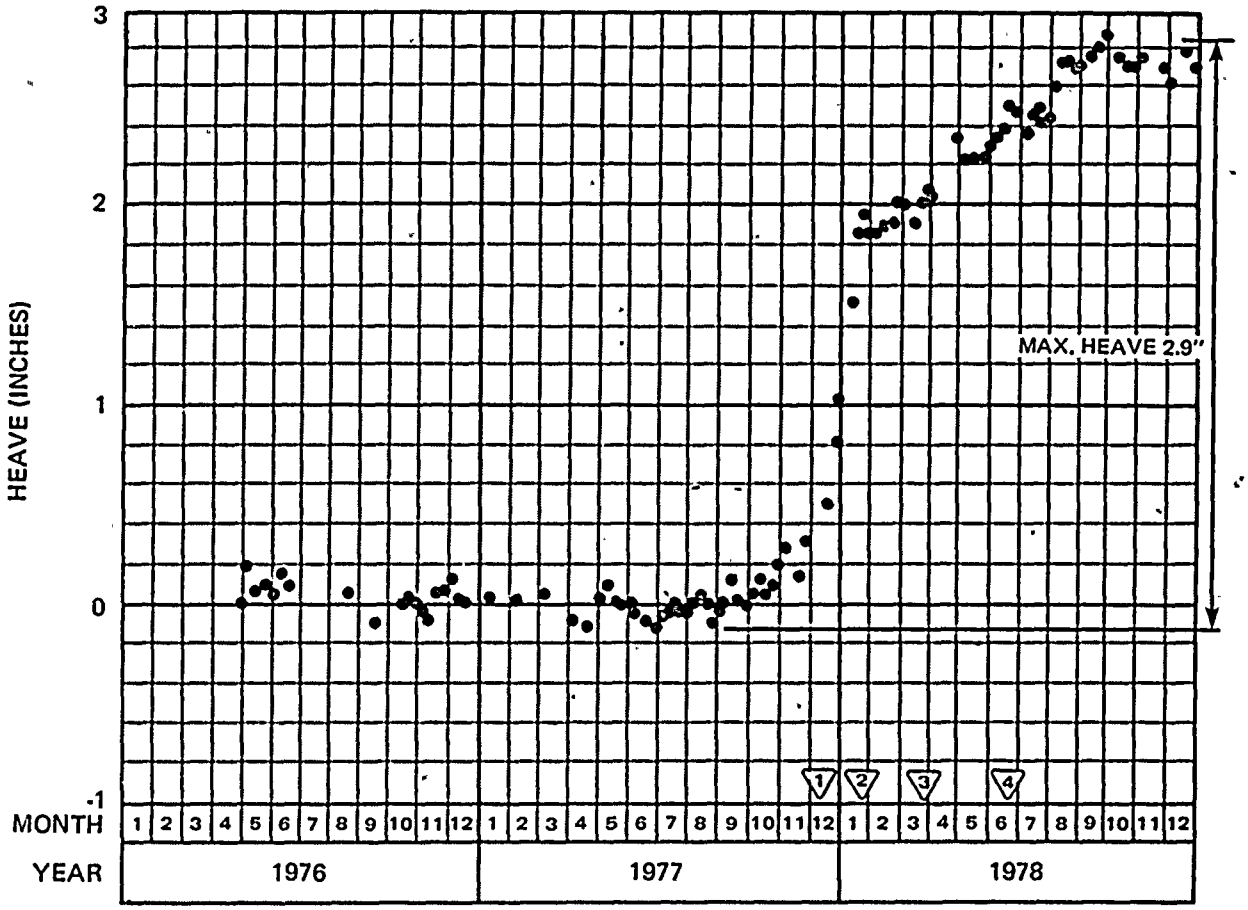
COORDINATES: N 869 267, E 210 475

TOP OF ANCHOR ELEVATION: 938 FT. MSL

TOP OF ANCHOR DEPTH: 16 FT. BELOW FINISH GRADE

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MRA-12
FIGURE 20



CONSTRUCTION MILESTONES

1. EXCAVATION STARTED 12-19-77
2. EXCAVATION STOPPED AT ELEV. 913' FOR DEWATERING 2-1-78
3. EXCAVATION DEEPENED TO ELEV. 904' 4-5-78
4. EXCAVATION COMPLETED 7-1-78

LOCATION: UNIT 3, NEAR CENTER OF CONTAINMENT BUILDING

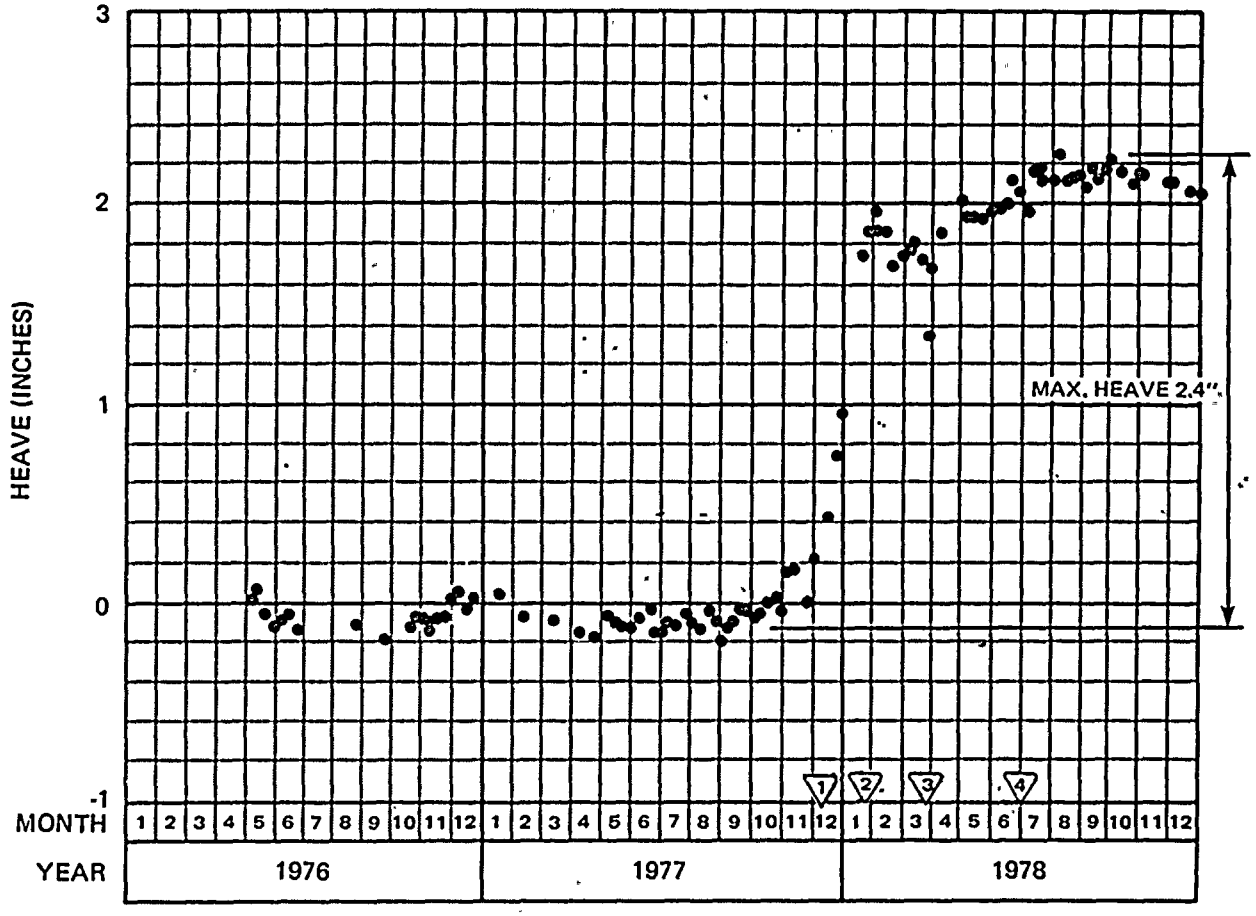
COORDINATES: N 868 579, E 210 251

TOP OF ANCHOR ELEVATION: 897 FT. MSL

TOP OF ANCHOR DEPTH: 54 FT. BELOW FINISH GRADE

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MRA-13
FIGURE 21



CONSTRUCTION MILESTONES

1. EXCAVATION STARTED 12-19-77
2. EXCAVATION STOPPED AT ELEV. 913' FOR DEWATERING 2-1-78
3. EXCAVATION DEEPENED TO ELEV. 904' 4-5-78
4. EXCAVATION COMPLETED 7-1-78

LOCATION: UNIT 3, BETWEEN CONTAINMENT AND TURBINE BUILDINGS

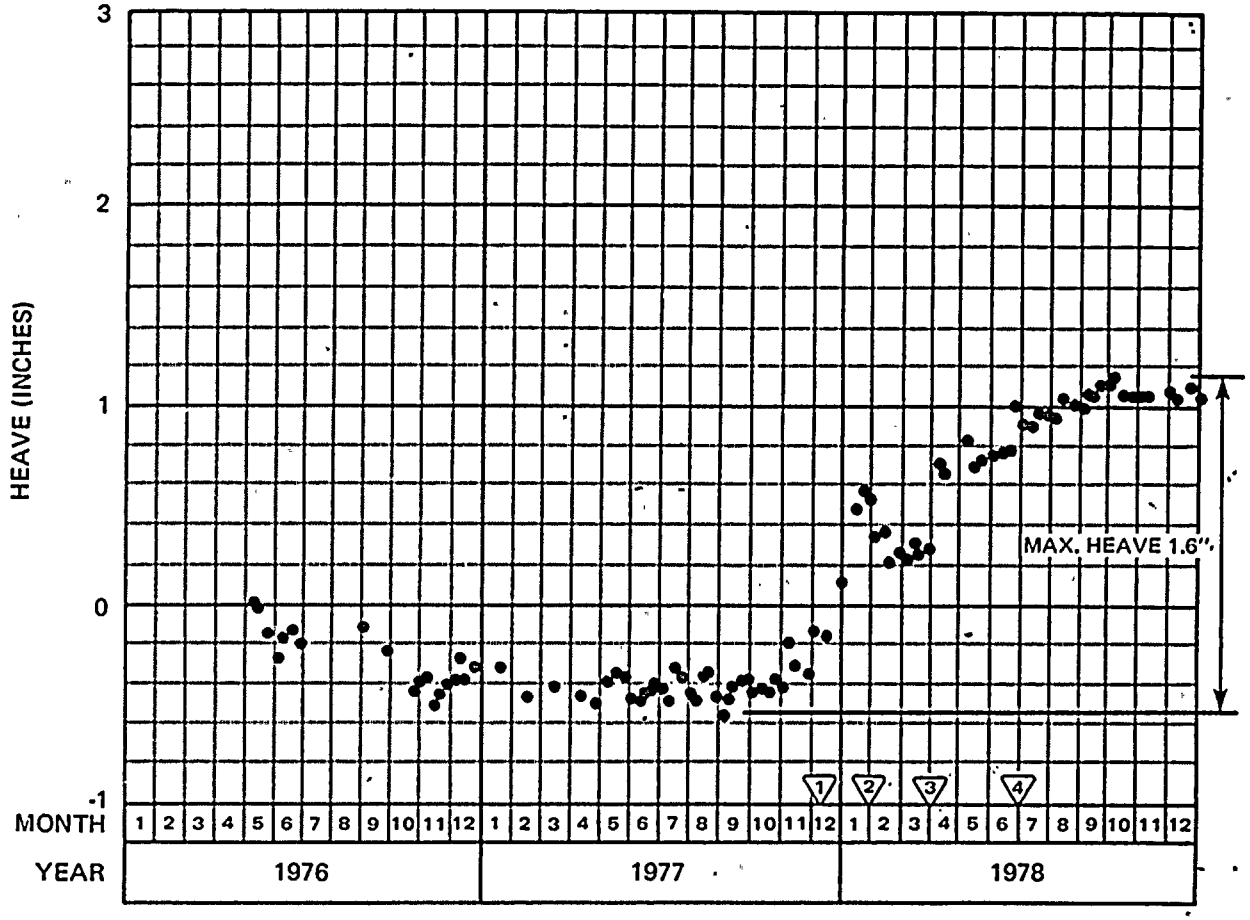
COORDINATES: N 868 687, E 210 270

TOP OF ANCHOR ELEVATION: 897 FT. MSL

TOP OF ANCHOR DEPTH: 54 FT. BELOW FINISH GRADE

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MRA-14
FIGURE 22



CONSTRUCTION MILESTONES

1. EXCAVATION STARTED 12-19-77
2. EXCAVATION STOPPED AT ELEV. 913' FOR DEWATERING 2-1-78
3. EXCAVATION DEEPENED TO ELEV. 904' 4-5-78
4. EXCAVATION COMPLETED 7-1-78

LOCATION: UNIT 3, NORTH SIDE OF AUXILIARY BUILDING

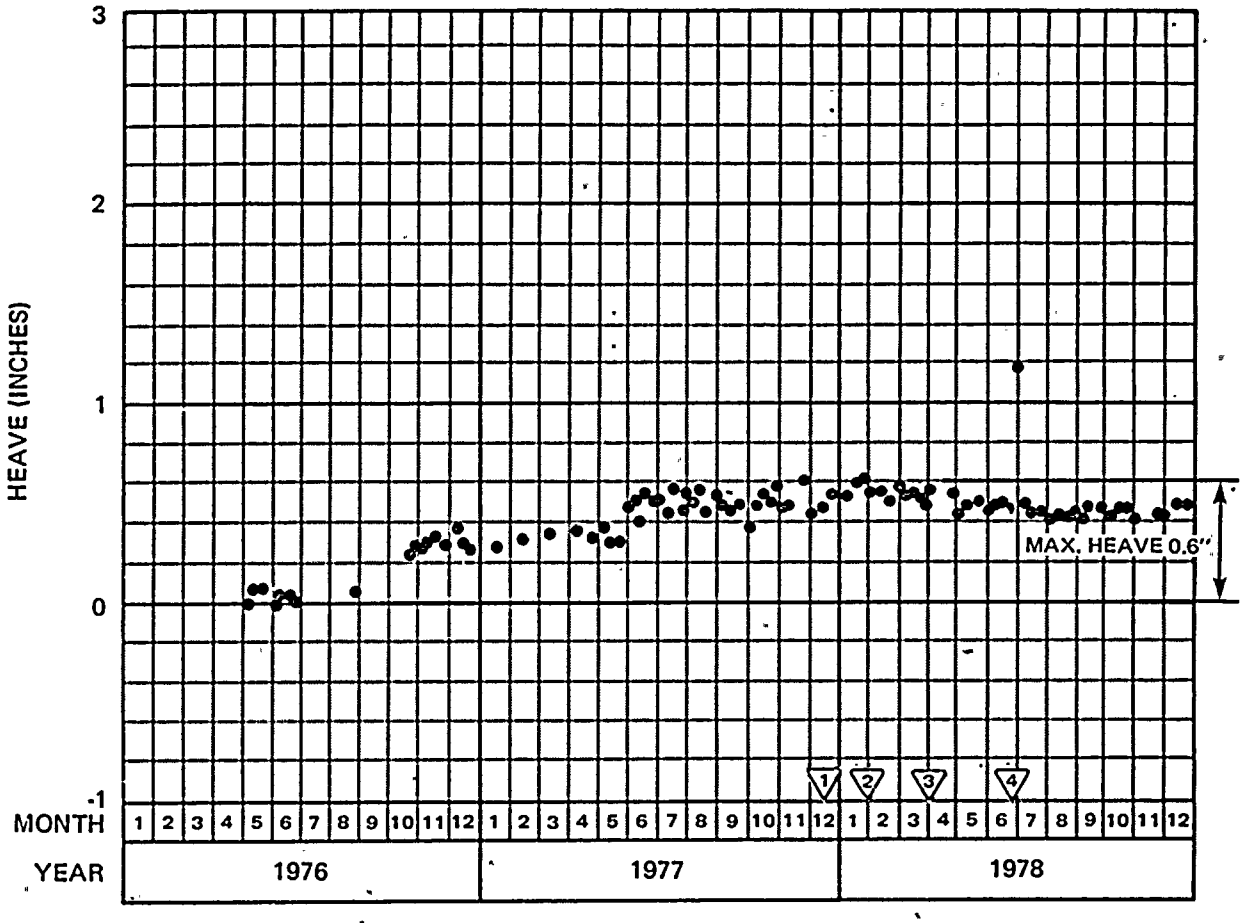
COORDINATES: N 868 655, E 210 397

TOP OF ANCHOR ELEVATION: 881 FT. MSL

TOP OF ANCHOR DEPTH: 70 FT. BELOW FINISH GRADE

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MRA-15
FIGURE 23



CONSTRUCTION MILESTONES

1. EXCAVATION STARTED 12-19-77
2. EXCAVATION STOPPED AT ELEV. 913' FOR DEWATERING 2-1-78
3. EXCAVATION DEEPENED TO ELEV. 904' 4-5-78
4. EXCAVATION COMPLETED 7-1-78

LOCATION: UNIT 3, TURBINE BUILDING

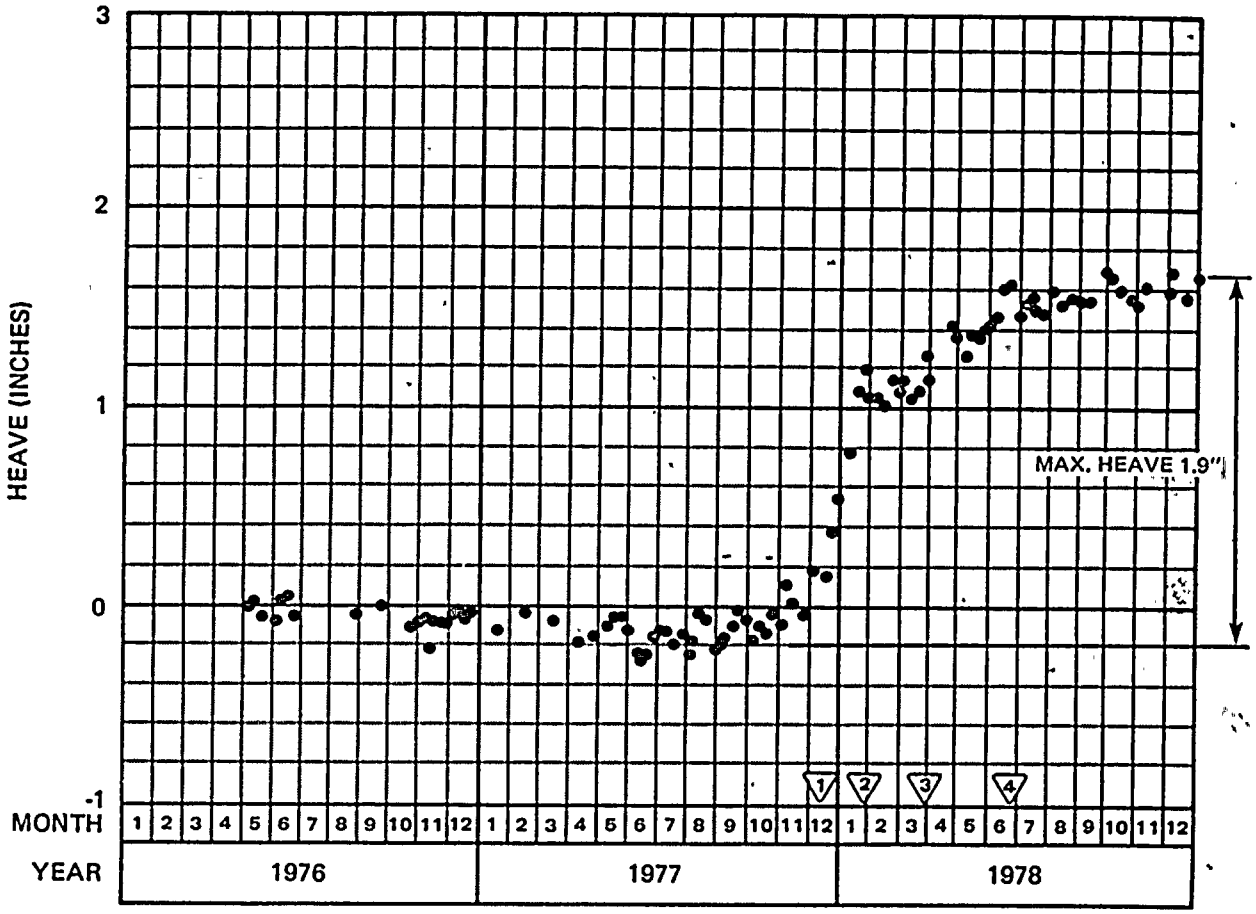
COORDINATES: N 868 912, E 210 320

TOP OF ANCHOR ELEVATION: 932 FT. MSL

TOP OF ANCHOR DEPTH: 19 FT. BELOW FINISH GRADE

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MRA-16A
FIGURE 24



CONSTRUCTION MILESTONES

1. EXCAVATION STARTED 12-19-77
2. EXCAVATION STOPPED AT ELEV. 913' FOR DEWATERING 2-1-78
3. EXCAVATION DEEPENED TO ELEV. 904' 4-5-78
4. EXCAVATION COMPLETED 7-1-78

LOCATION: UNIT 3, BETWEEN FUEL AND RADWASTE BUILDINGS

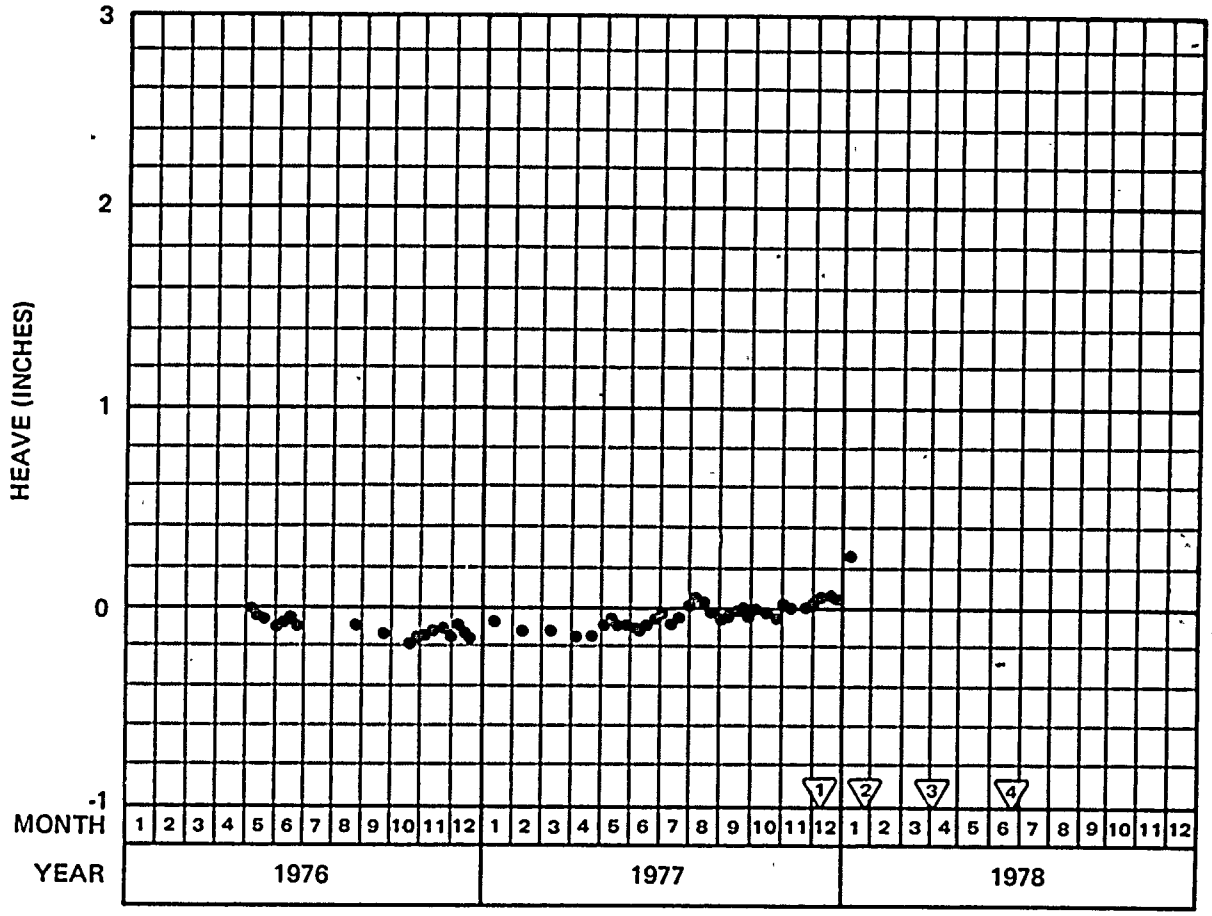
COORDINATES: N 868 406, E 210 312

TOP OF ANCHOR ELEVATION: . 886 FT. MSL

TOP OF ANCHOR DEPTH: 65 FT. BELOW FINISH GRADE

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MRA-17
FIGURE 25



CONSTRUCTION MILESTONES

1. EXCAVATION STARTED 12-19-77
2. EXCAVATION STOPPED AT ELEV. 913' FOR DEWATERING 2-1-78
3. EXCAVATION DEEPENED TO ELEV' 904' 4-5-78
4. EXCAVATION COMPLETED 7-1-78

LOCATION: UNIT 3, SPRAY POND

COORDINATES: N 868 105, E 210 234

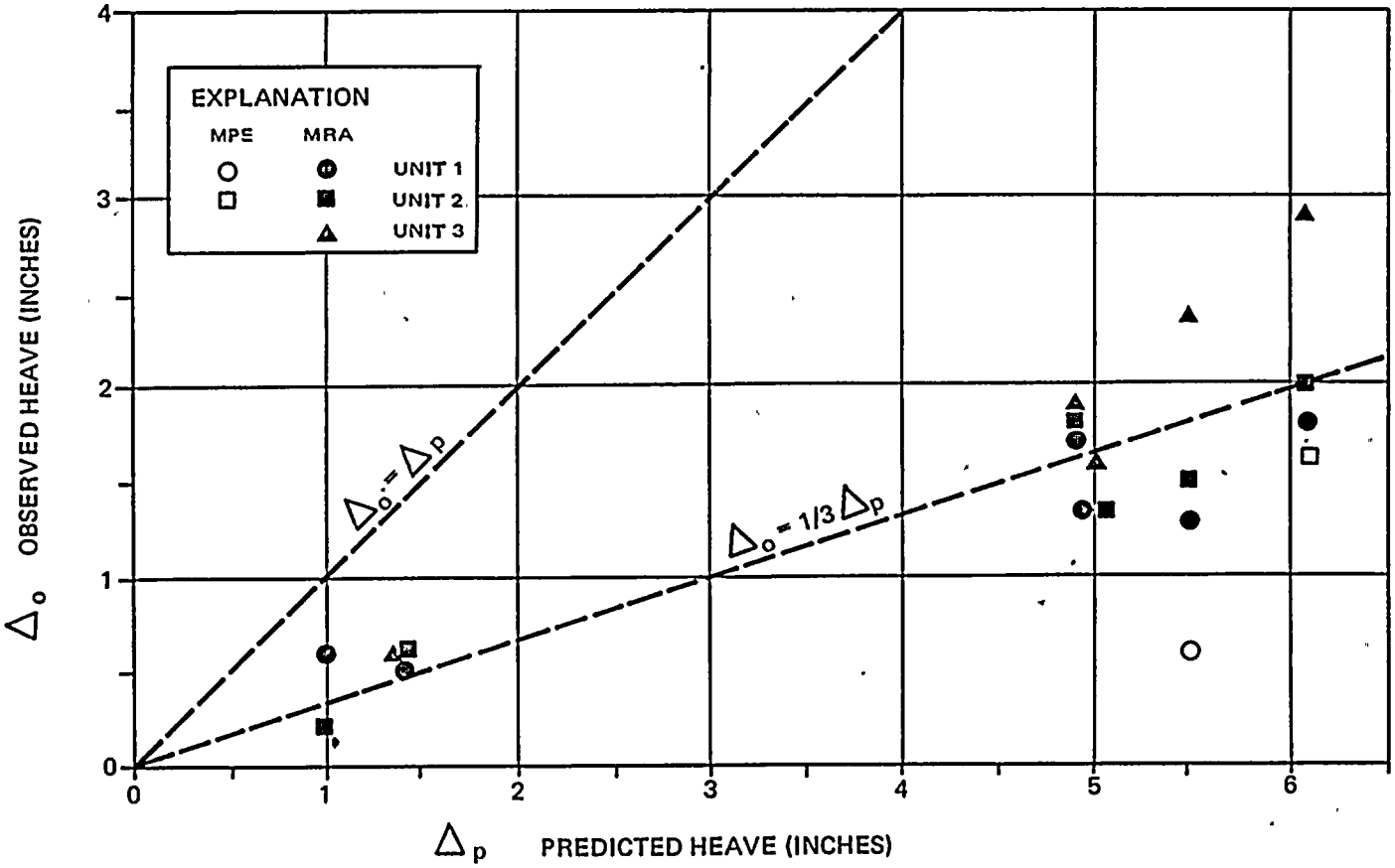
TOP OF ANCHOR ELEVATION: 935 FT. MSL

TOP OF ANCHOR DEPTH: 16 FT. BELOW FINISH GRADE

NOTE: THIS INSTRUMENT BECAME INOPERATIVE ON 1-19-78 THEREFORE, RELIABLE MEASUREMENT OF HEAVE IS NOT AVAILABLE.

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORD
MRA-18
FIGURE 26



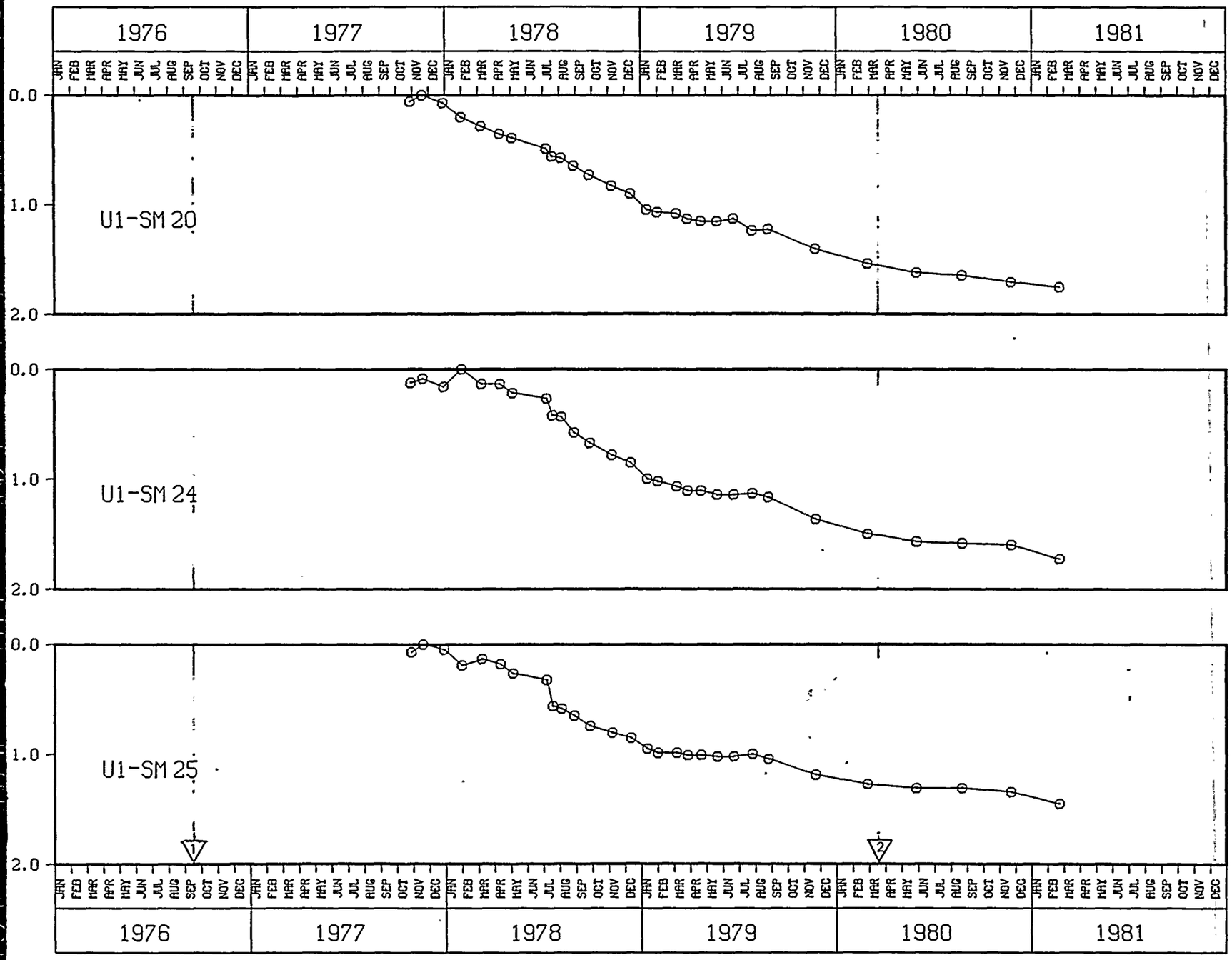
LOCATION	Δ_p	UNIT 1		UNIT 2		UNIT 3	
		STATION	Δ_o	STATION	Δ_o	STATION	Δ_o
CENTER OF CONTAINMENT BLDG.	6.1	MPE–1	•	MPE–4	1.6	MPE–5	•
		MRA–1	1.8	MRA–7	2.0	MRA–13	2.9
BETWEEN CONTAINMENT AND TURBINE BLDGS.	5.5	MPE–2	0.6				
		MRA–2	1.3	MRA–8	1.5	MRA–14	2.4
EDGE OF AUXILIARY BUILDING	5.0	MRA–3	1.3	MRA–9	1.3	MRA–15	1.6
TURBINE BUILDING	1.4	MRA–4	0.5	MRA–10	0.6	MRA–16	0.6
BETWEEN FUEL AND RADWASTE BLDGS	4.9	MRA–5	1.7	MRA–11	1.8	MRA–17	1.9
SPRAY POND	1.0	MRA–6	0.6	MRA–12	0.2	MRA–18	•

*RELIABLE MEASUREMENTS NOT AVAILABLE

Palo Verde Nuclear Generating Station
FSAR

OBSERVED VERSUS PREDICTED HEAVE

FIGURE 27



CONSTRUCTION MILESTONES

1 FORMING AND CONCRETE POURING BEGUN 9-76

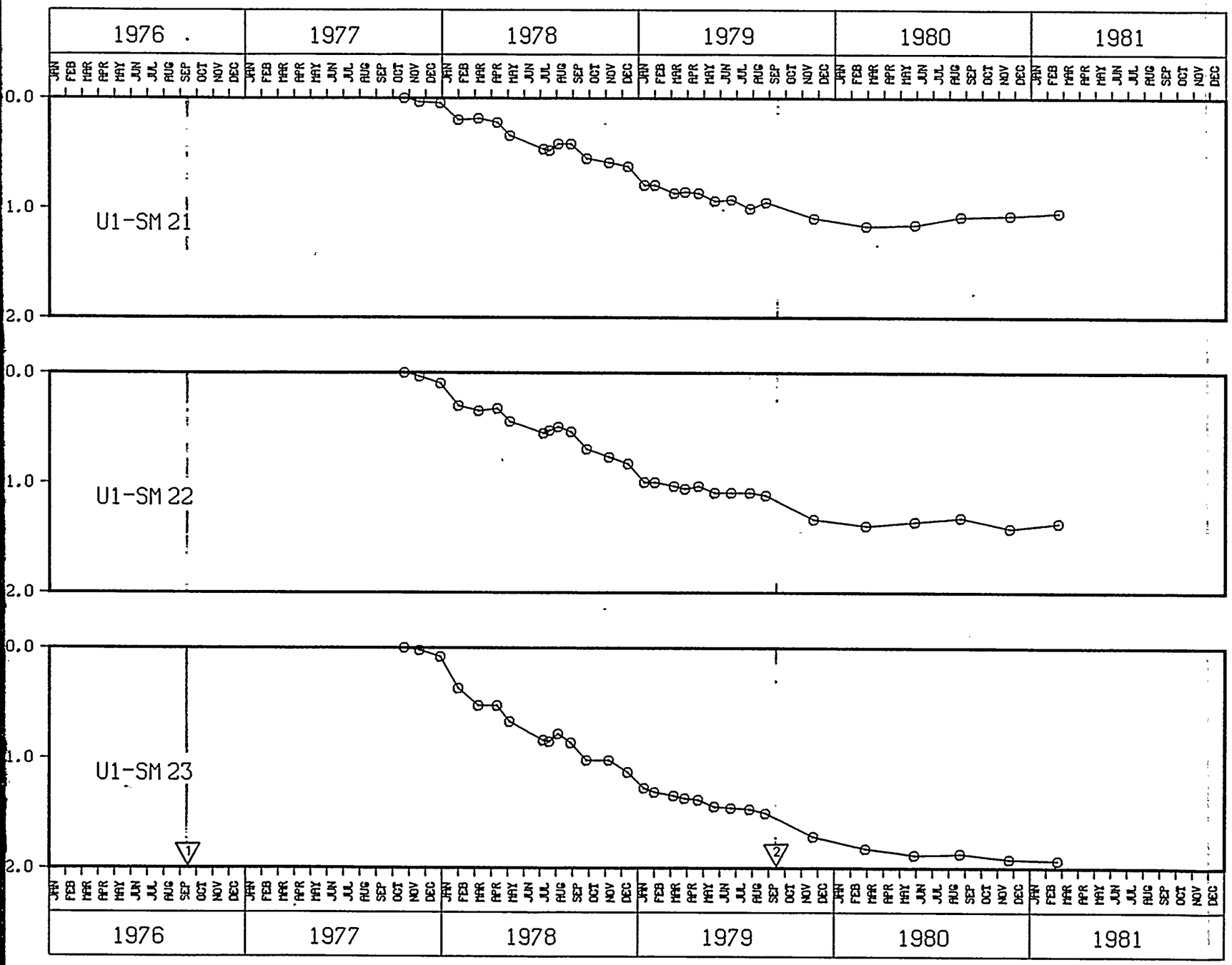
2 INTERIOR CONCRETE COMPLETE 3-80

MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE" BECHTEL DRAWING NO. SCH-20-3, STATUS AS OF 2-28-81

8109220505-08

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 1
CONTAINMENT BUILDING
Figure 28



CONSTRUCTION MILESTONES

1 FORMING AND CONCRETE POURING BEGUN 9-76

2 STRUCTURE COMPLETE 9-79

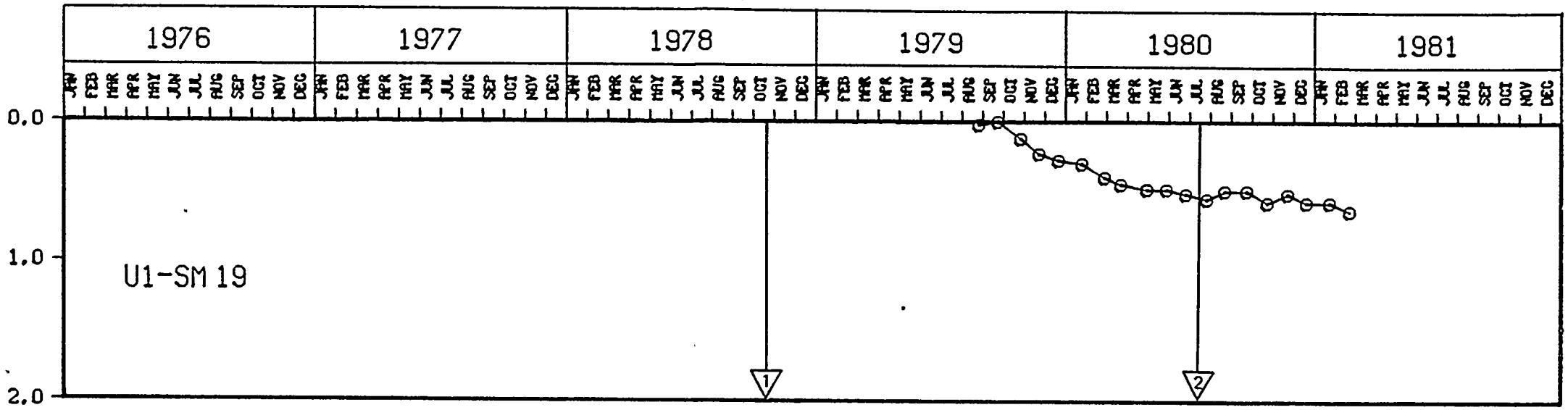
MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE"
BECHTEL DRAWING NO. SCH-20-3, STATUS AS OF 2-28-81

-09-

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 1
AUXILIARY BUILDING

Figure 29



CONSTRUCTION MILESTONES

1 FORMING AND CONCRETE POURING BEGUN 10-78

2 STRUCTURE COMPLETE APPROXIMATELY 7-80

MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE", BECHTEL DRAWING NO. SCH-20-3 , STATUS AS OF 2-28-81 , AND CONCRETE PLACEMENT SCHEDULES.

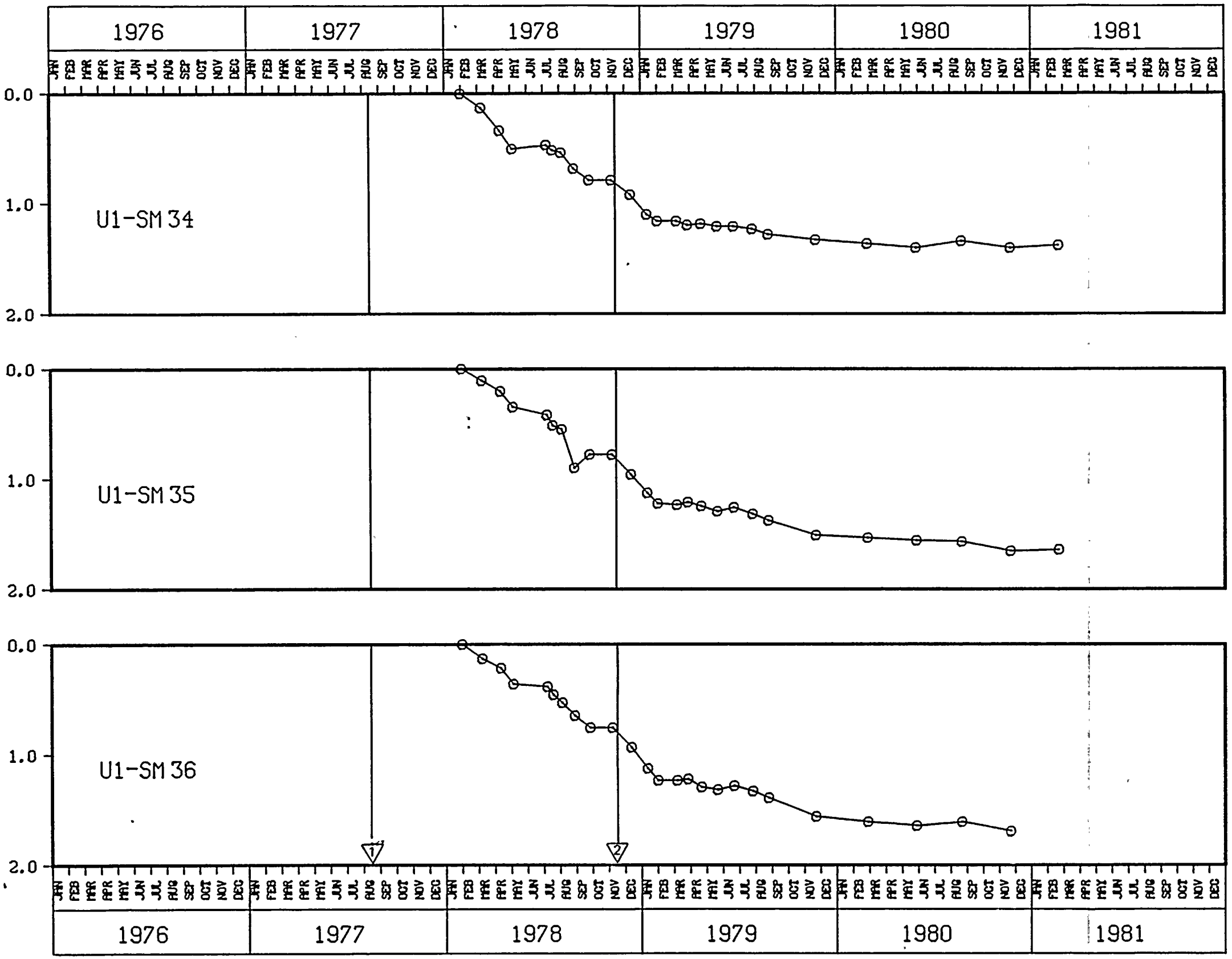
-10

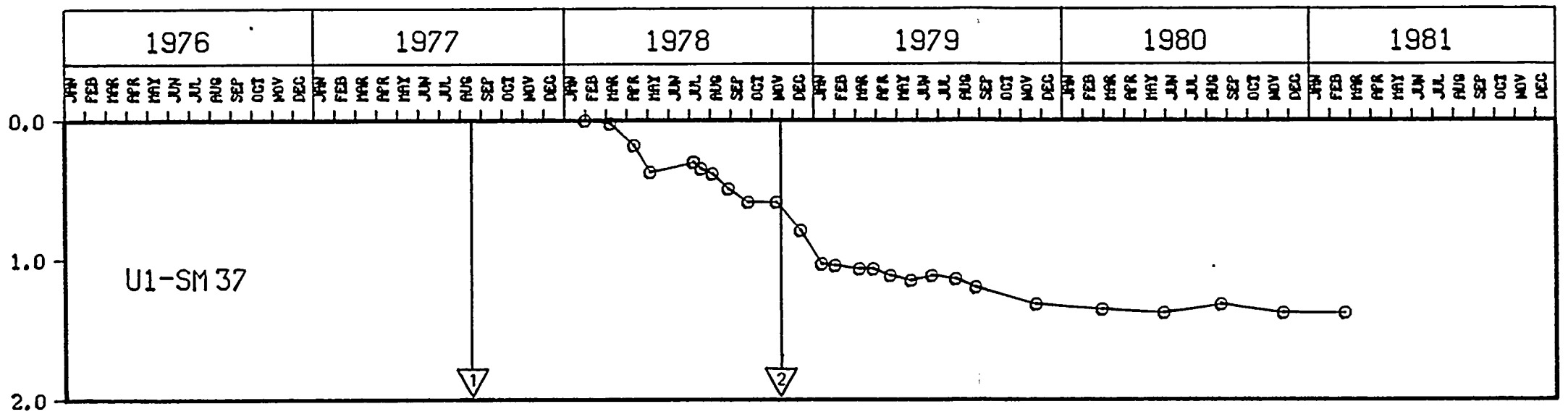
Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 1
-MAIN STEAM SUPPORT STRUCTURE
Figure 30

Project Number 76 056 10

SETTLEMENT (INCHES)





CONSTRUCTION MILESTONES

1 FORMING AND CONCRETE POURING BEGUN 8-77

2 STRUCTURE COMPLETE 11-78

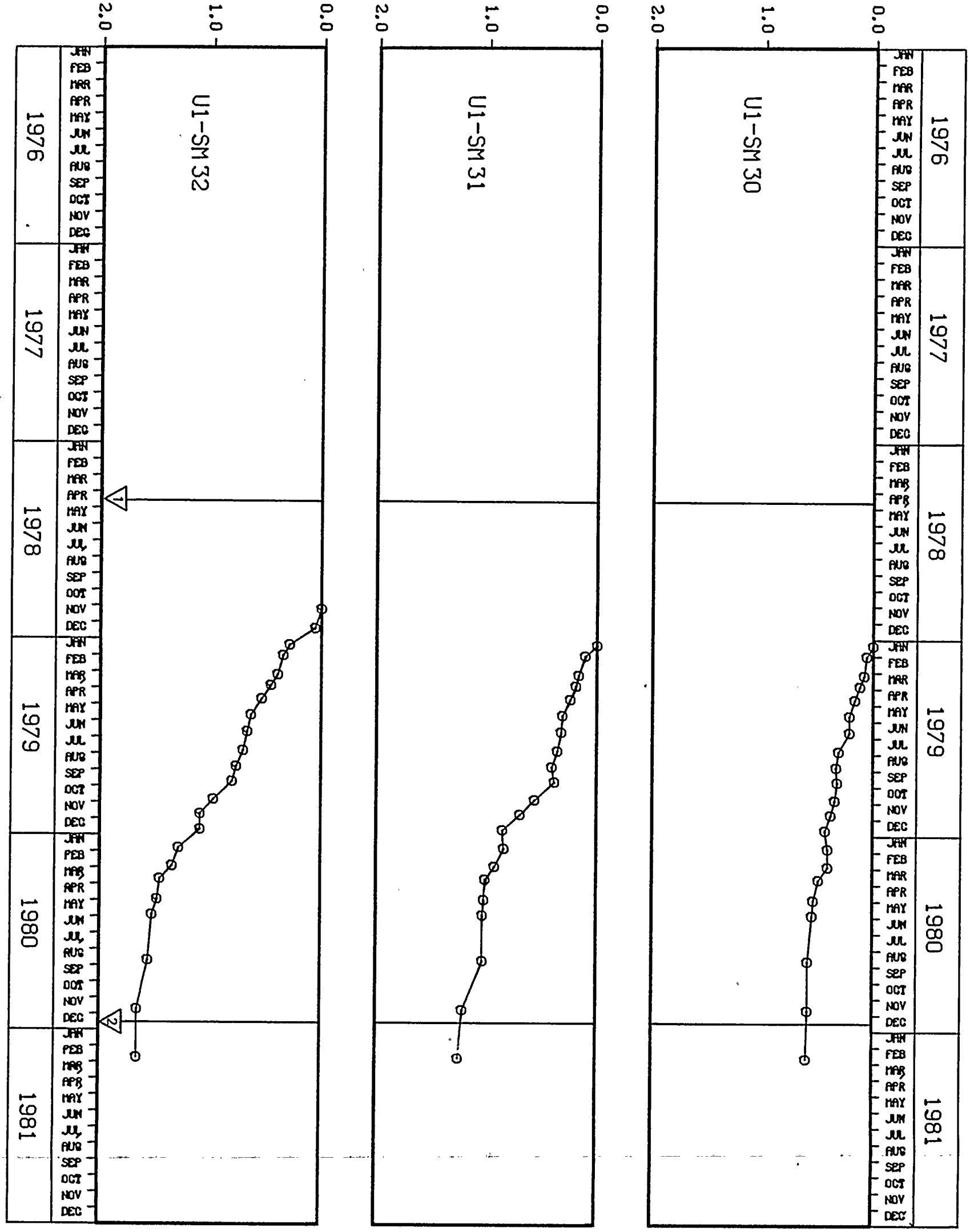
MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE"
BECHTEL DRAWING NO. SCH-20-3, STATUS AS OF 2-28-81

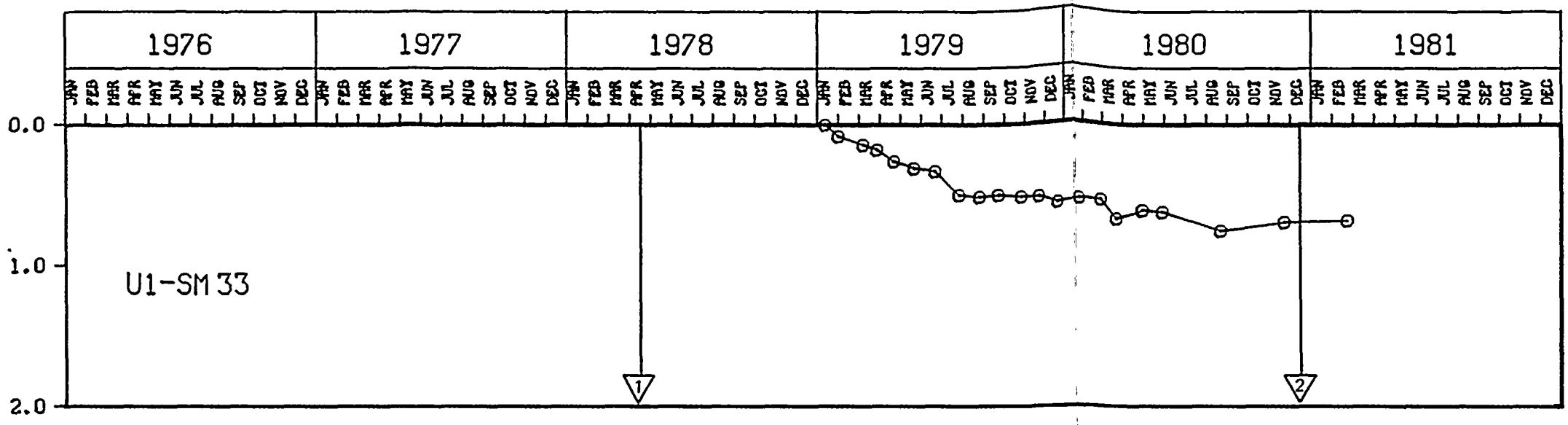
Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 1
CONTROL BUILDING
Figure 31

Project Number 76 056 10

SETTLEMENT (INCHES)





CONSTRUCTION MILESTONES

1 FORMING AND CONCRETE POURING BEGUN 4-78

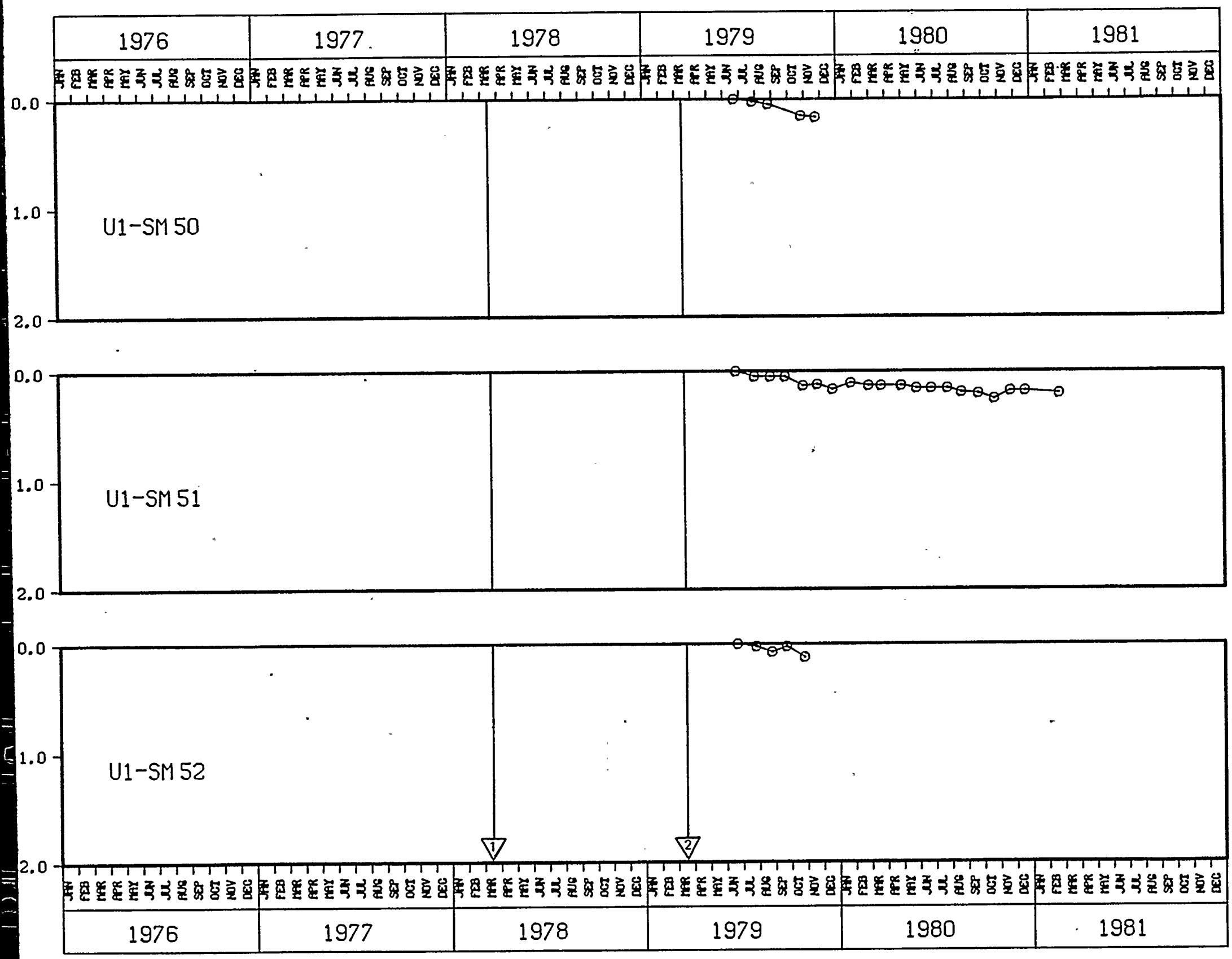
2 STRUCTURE COMPLETE 12-80

MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE"
BECHTEL DRAWING NO. SCH-20-3, STATUS AS OF 2-28-81

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 1
RADWASTE BUILDING
Figure 32

Project No. 76 056 10


1976
1977
1978
1979
1980
1981
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
0.0
1.0
2.0
U1-SM 50
U1-SM 51
U1-SM 52
1
2

CONSTRUCTION MILESTONES

1 FORMING AND CONCRETE POURING BEGUN 3-78

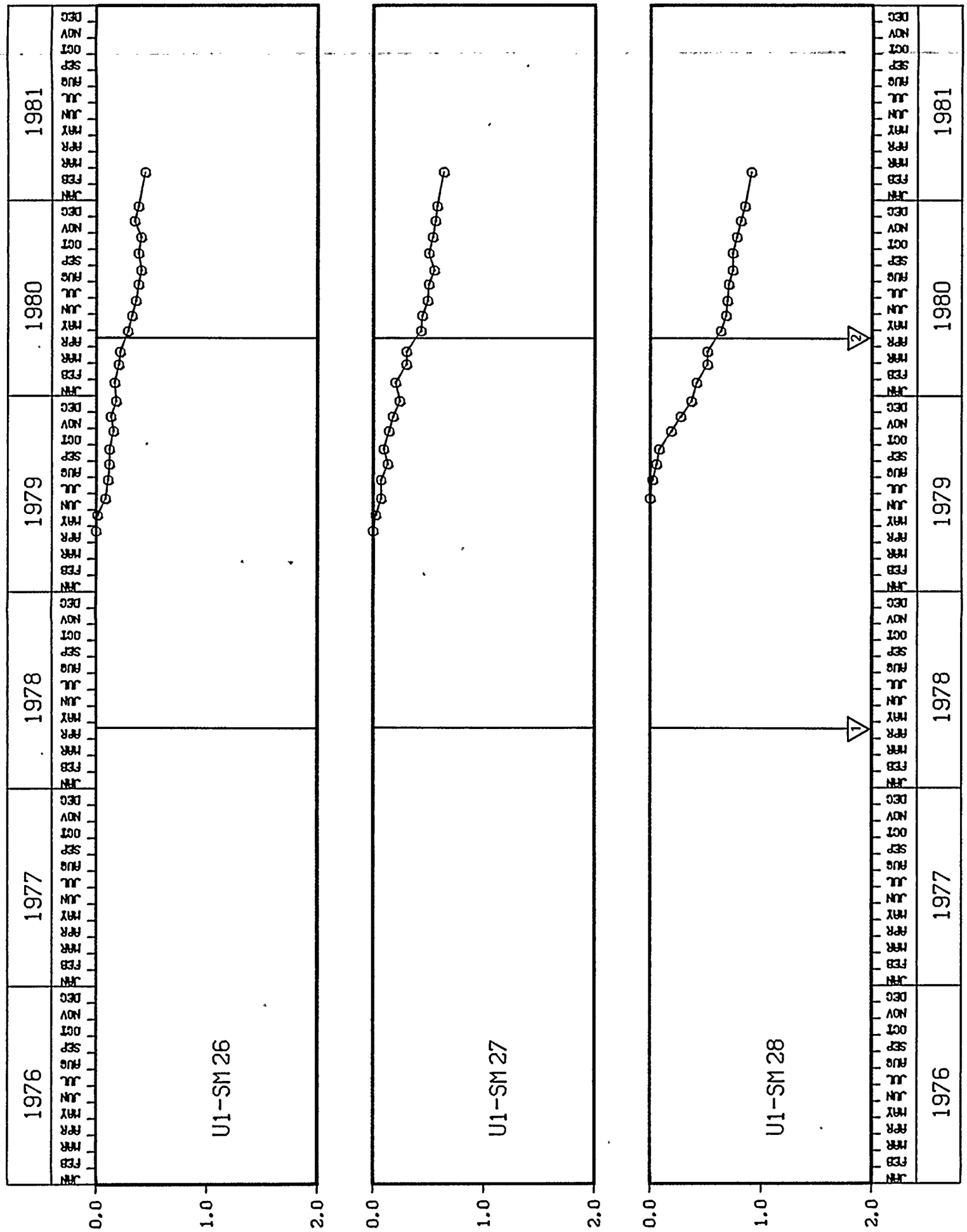
2 STRUCTURE COMPLETE 3-79

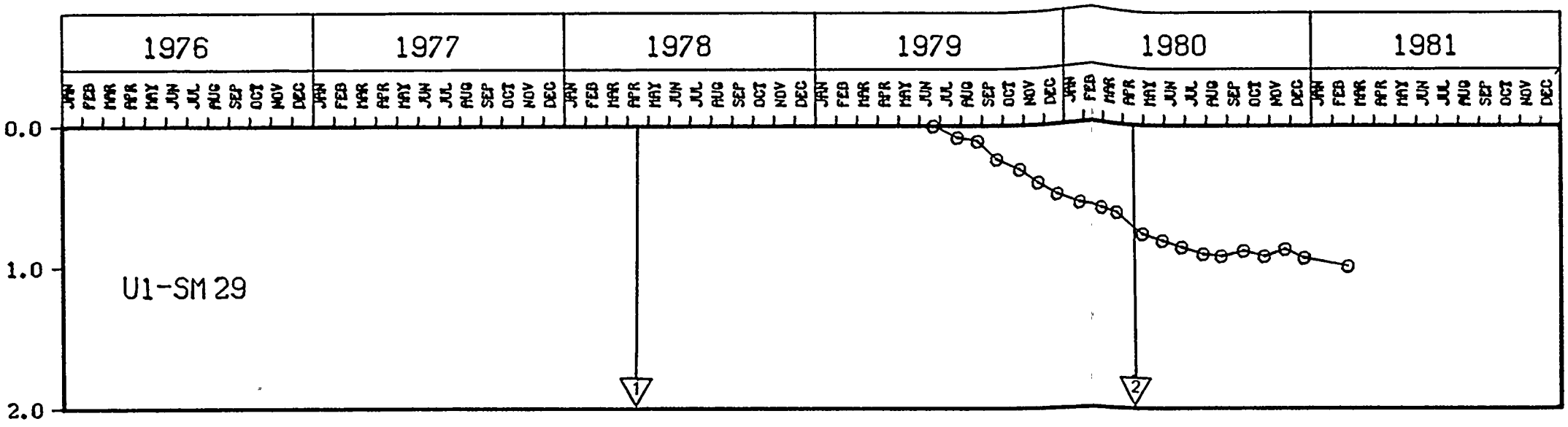
MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE"
BECHTEL DRAWING NO. SCH-20-3, STATUS AS OF 2-28-81

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 1
DIESEL GENERATOR BUILDING
Figure 33

Project Number 76 056 10


U1-SM 26
U1-SM 27
U1-SM 28
1976
1977
1978
1979
1980
1981
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
0.0
1.0
2.0
1
2
SETTLEMENT (INCHES)



CONSTRUCTION MILESTONES

1 FORMING AND CONCRETE POURING BEGUN 4-78

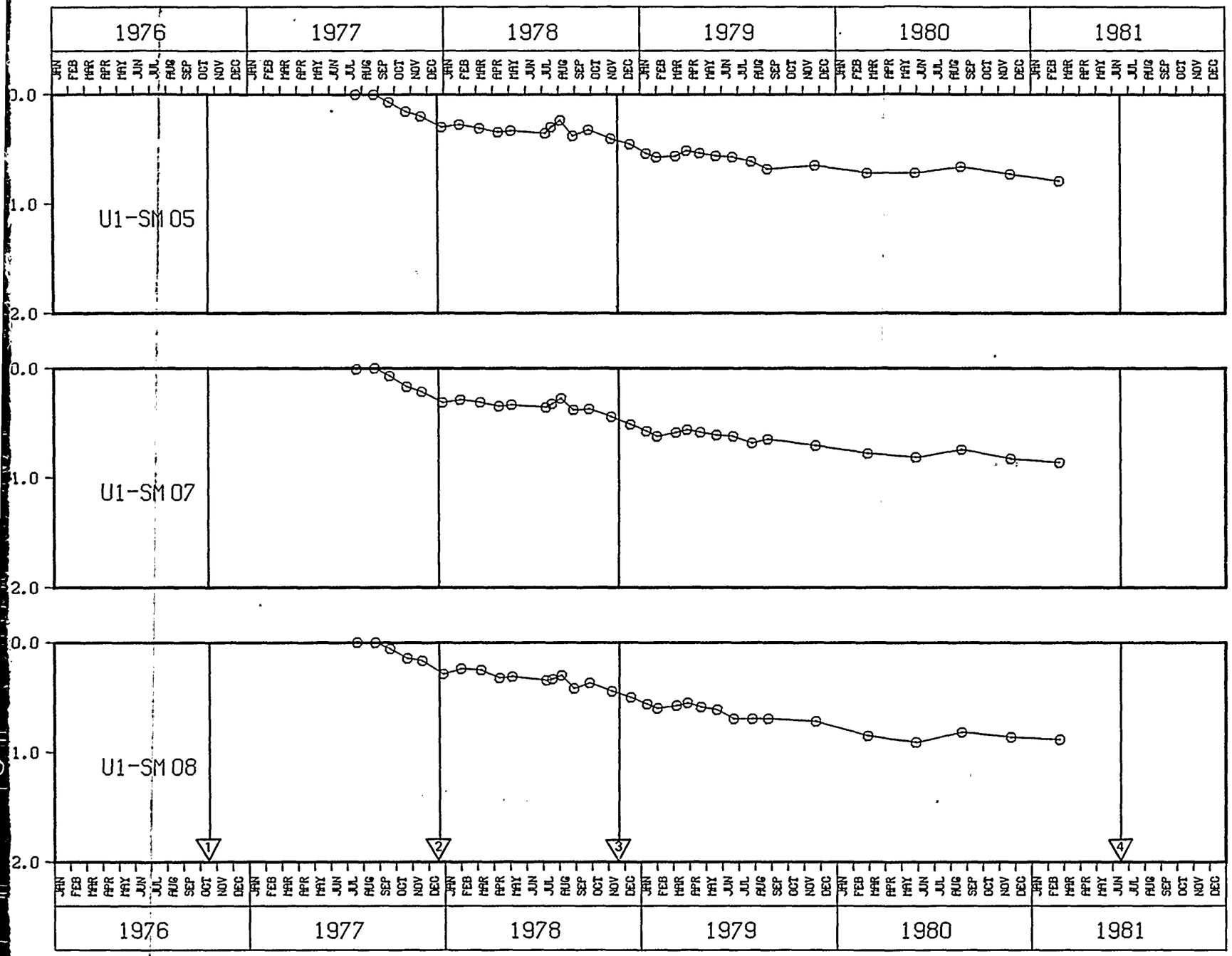
2 STRUCTURE COMPLETE 4-80

MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE"
BECHTEL DRAWING NO. SCH-20-3, STATUS AS OF 2-28-81

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 1
FUEL BUILDING
Figure 34

Project Number 76 056 10



CONSTRUCTION MILESTONES

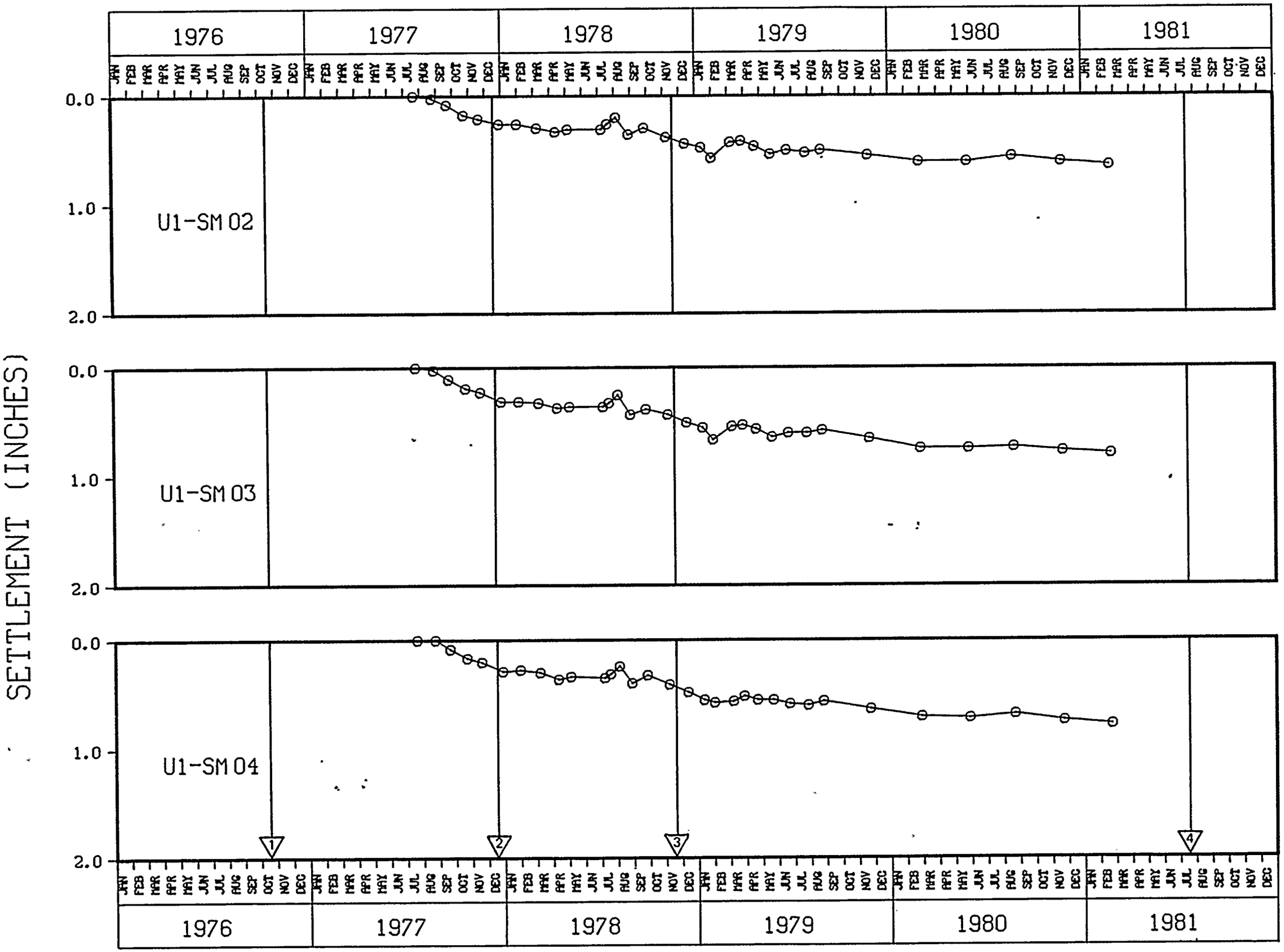
1. FORMING AND CONCRETE POURING BEGUN 10-76
2. PEDESTAL COMPLETE 12-77
3. TURBINE BUILDING COMPLETE 11-78
4. TURBINE GENERATOR ERECTION COMPLETE 6-81

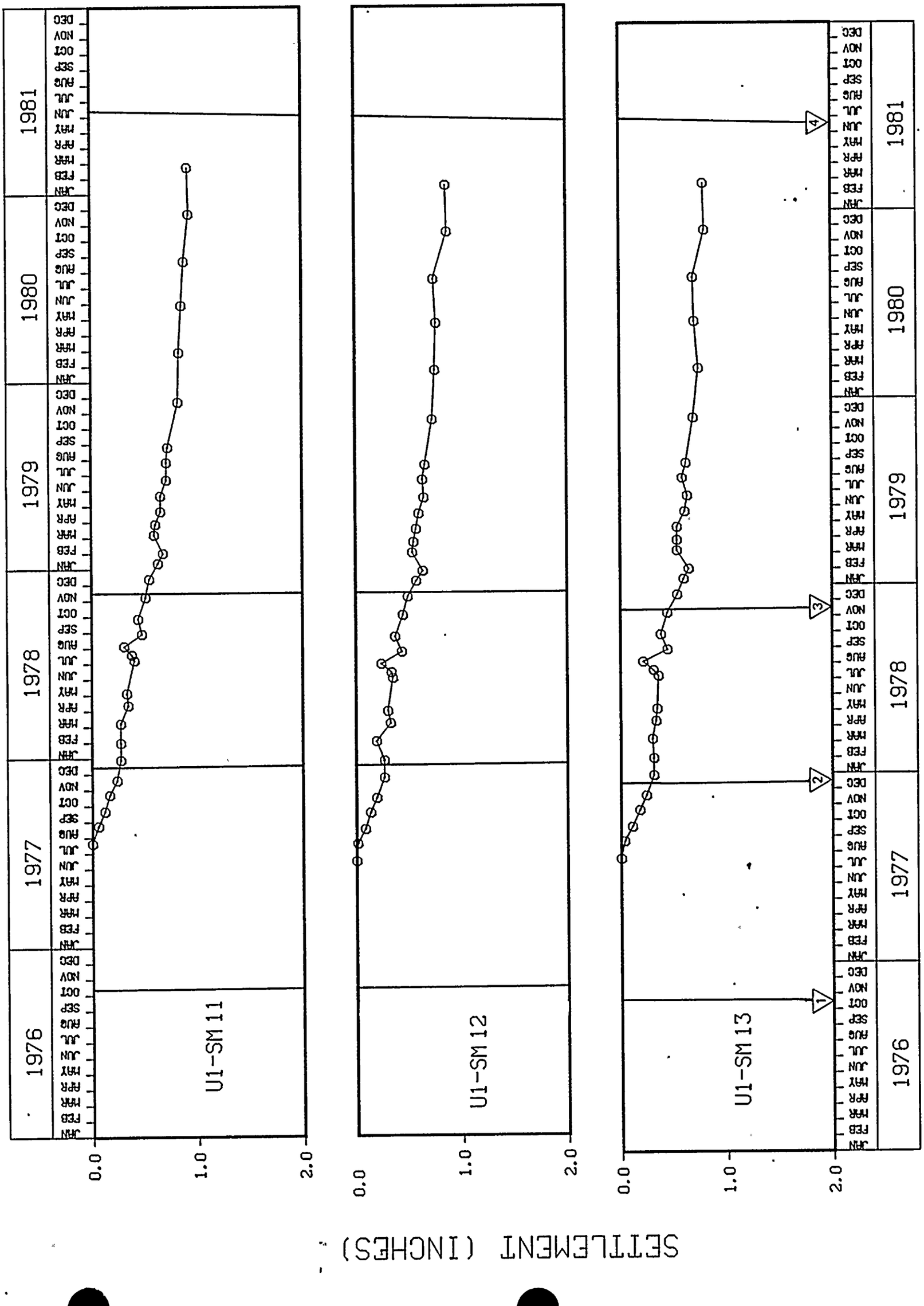
MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE"
BECHTEL DRAWING NO. SCH-20-3, STATUS AS OF 2-28-81

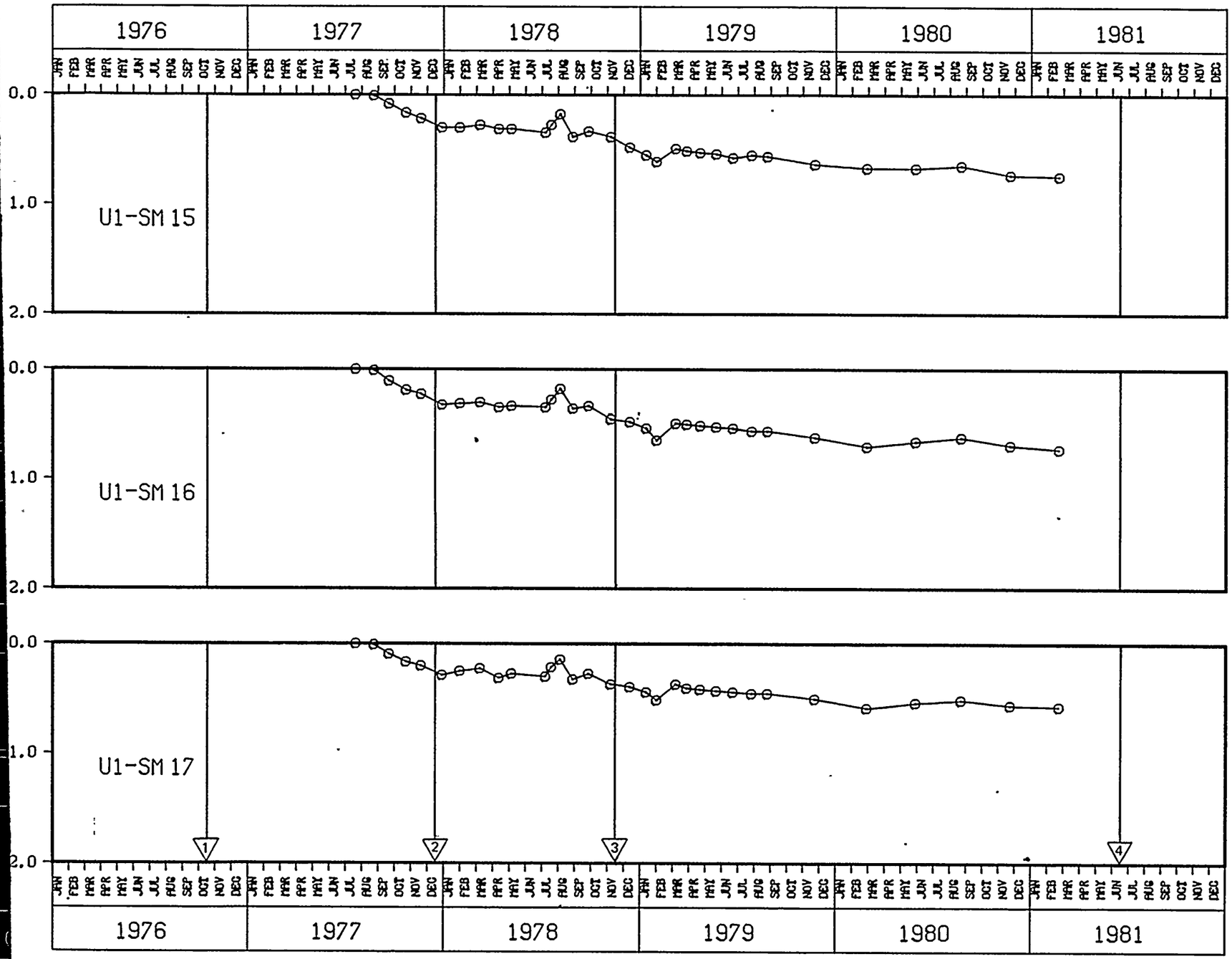
Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 1
TURBINE PEDESTAL
Figure 35
Sheet 1 of 2

Project Number 76 056 10


SETTLEMENT (INCHES)
1976
1977
1978
1979
1980
1981
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
0.0
1.0
2.0
U1-SM 02
U1-SM 03
U1-SM 04
1
2
3
4


1976
1977
1978
1979
1980
1981
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
U1-SM 11
U1-SM 12
U1-SM 13
1
2
3
4
0.0
1.0
2.0
SETTLEMENT (INCHES)



CONSTRUCTION MILESTONES

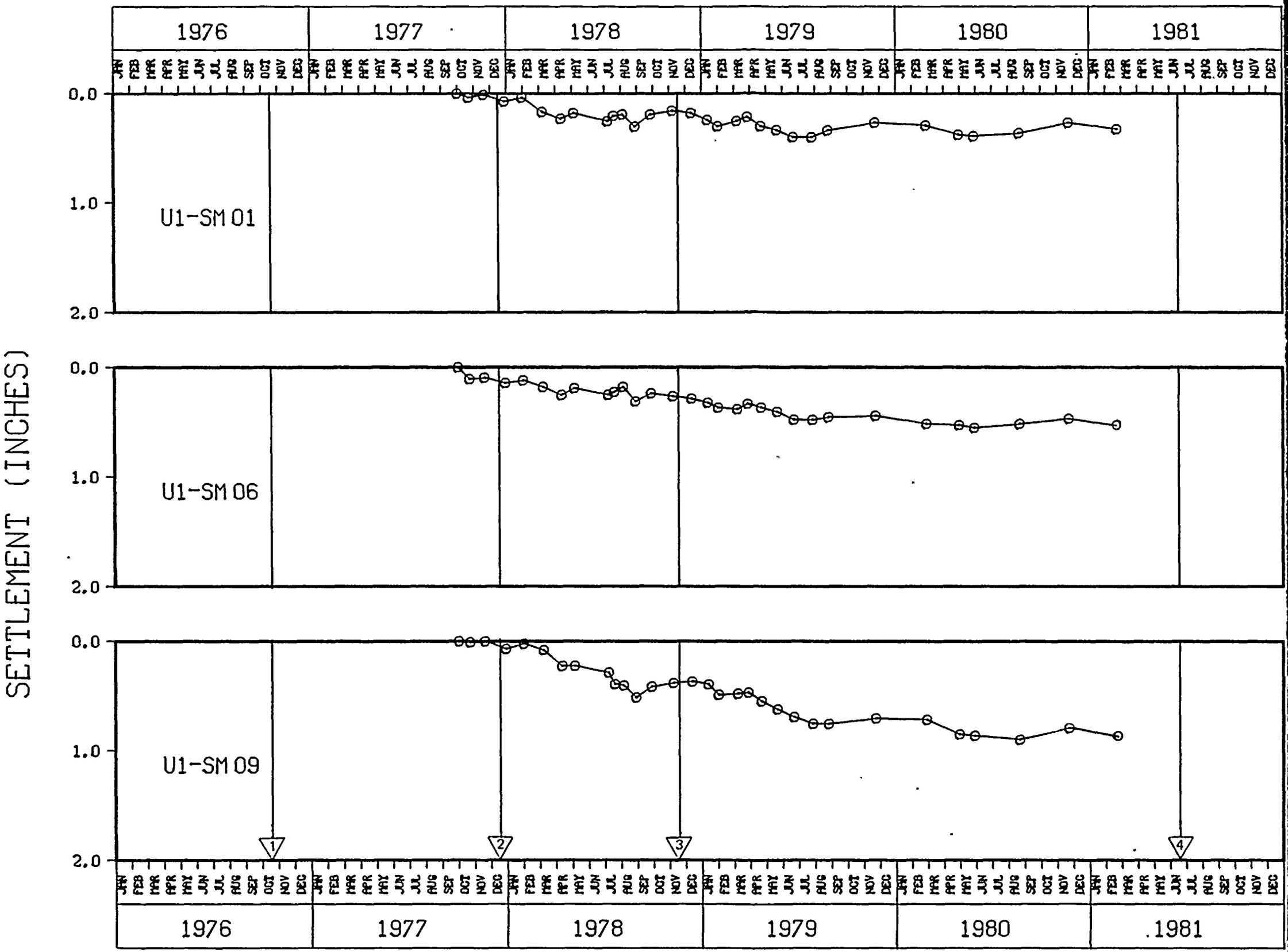
1. FORMING AND CONCRETE POURING BEGUN 10-76
2. PEDESTAL COMPLETE 12-77
3. TURBINE BUILDING COMPLETE 11-78
4. TURBINE GENERATOR ERECTION COMPLETE 6-81

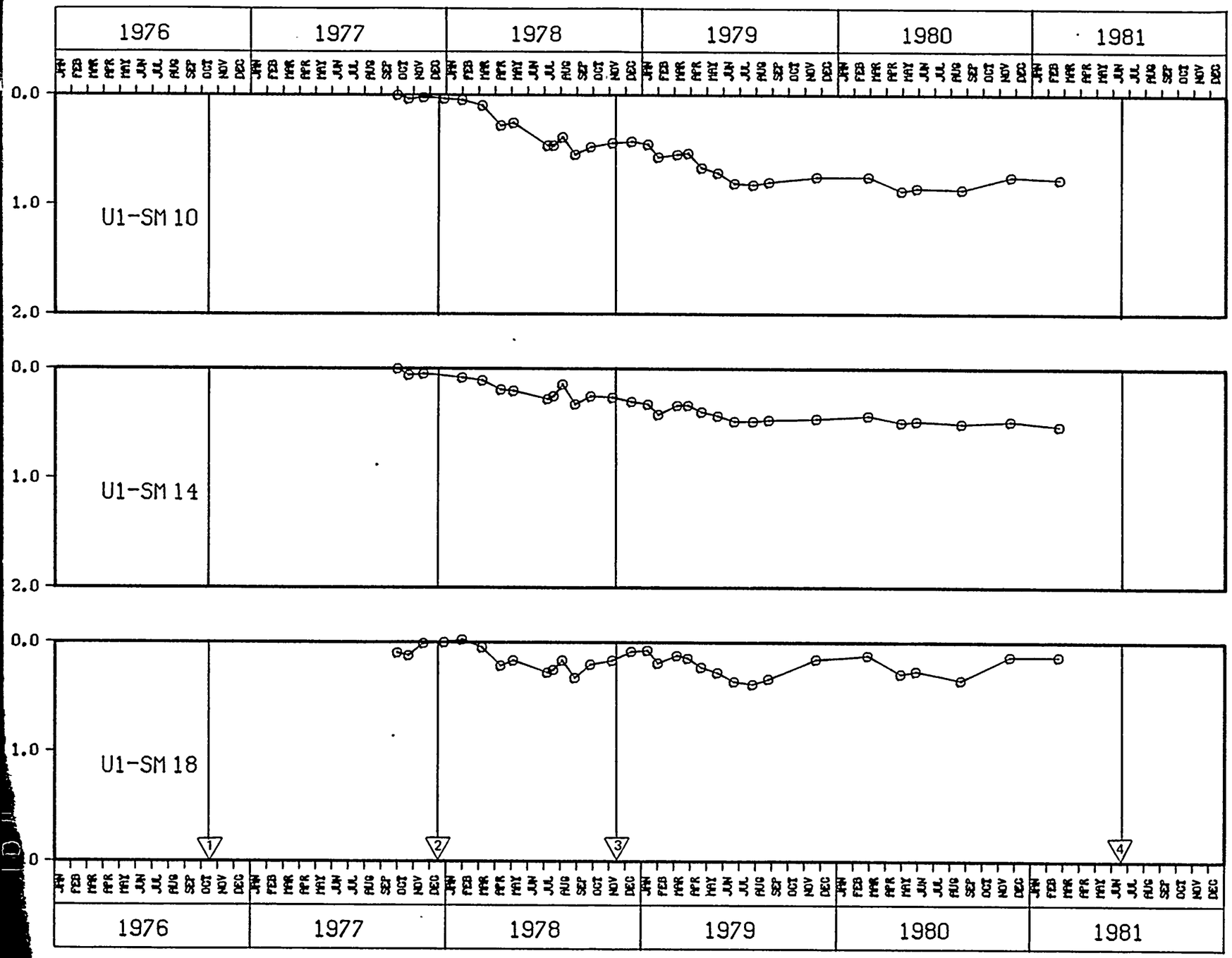
MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE"
BECHTEL DRAWING NO. SCH-20-3, STATUS AS OF 2 28-81

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 1
TURBINE PEDESTAL
Figure 35
Sheet 2 of 2

Project Number 76 056 10


1976
1977
1978
1979
1980
1981
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
0.0
1.0
2.0
U1-SM01
U1-SM06
U1-SM09
1
2
3
4
SETTLEMENT (INCHES)



CONSTRUCTION MILESTONES

1. FORMING AND CONCRETE POURING BEGUN 10-76
2. PEDESTAL COMPLETE 12-77
3. TURBINE BUILDING COMPLETE 11-78
4. TURBINE GENERATOR ERECTION COMPLETE 6-81

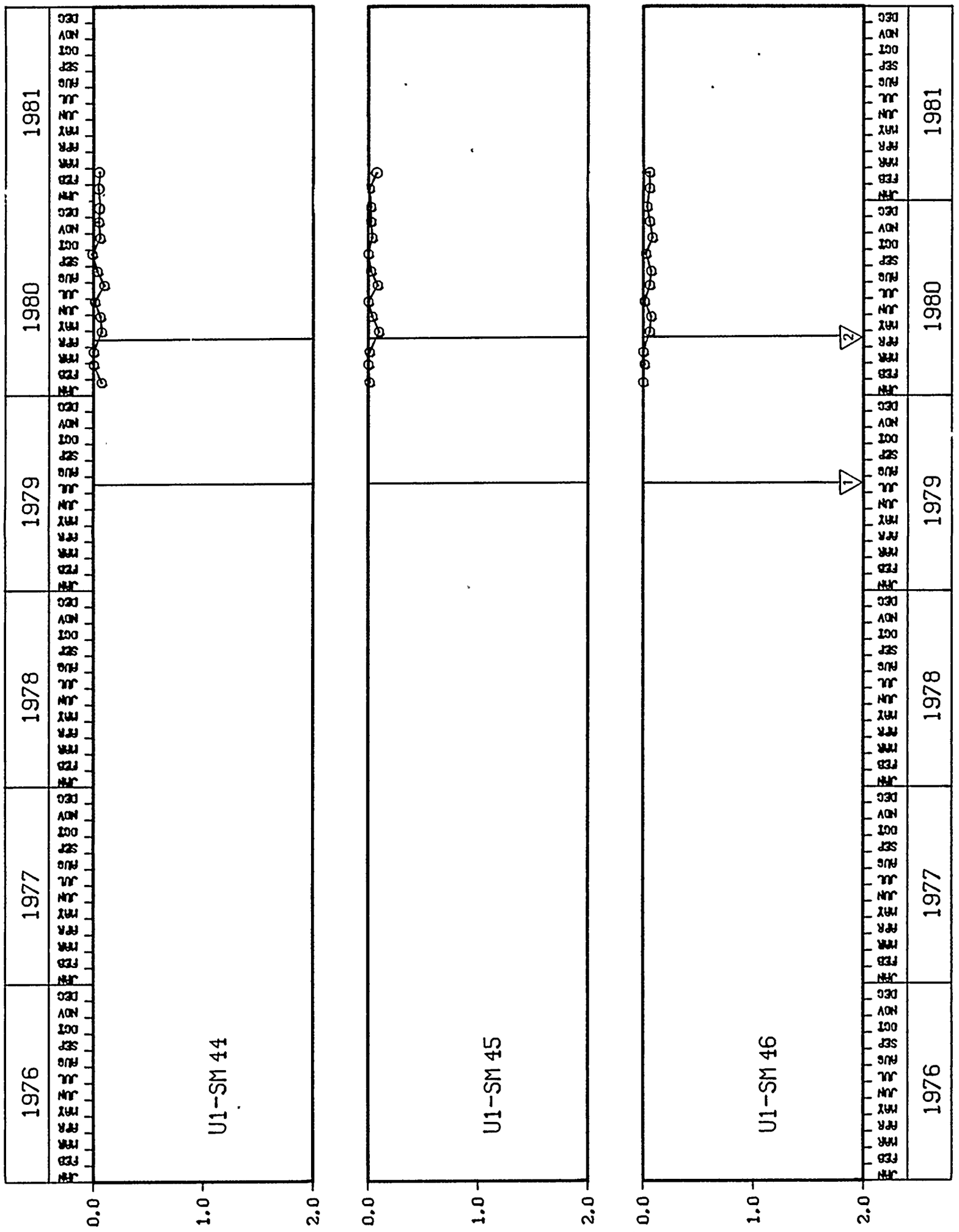
MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE" BECHTEL DRAWING NO. SCH-20-3, STATUS AS OF 28-2-81

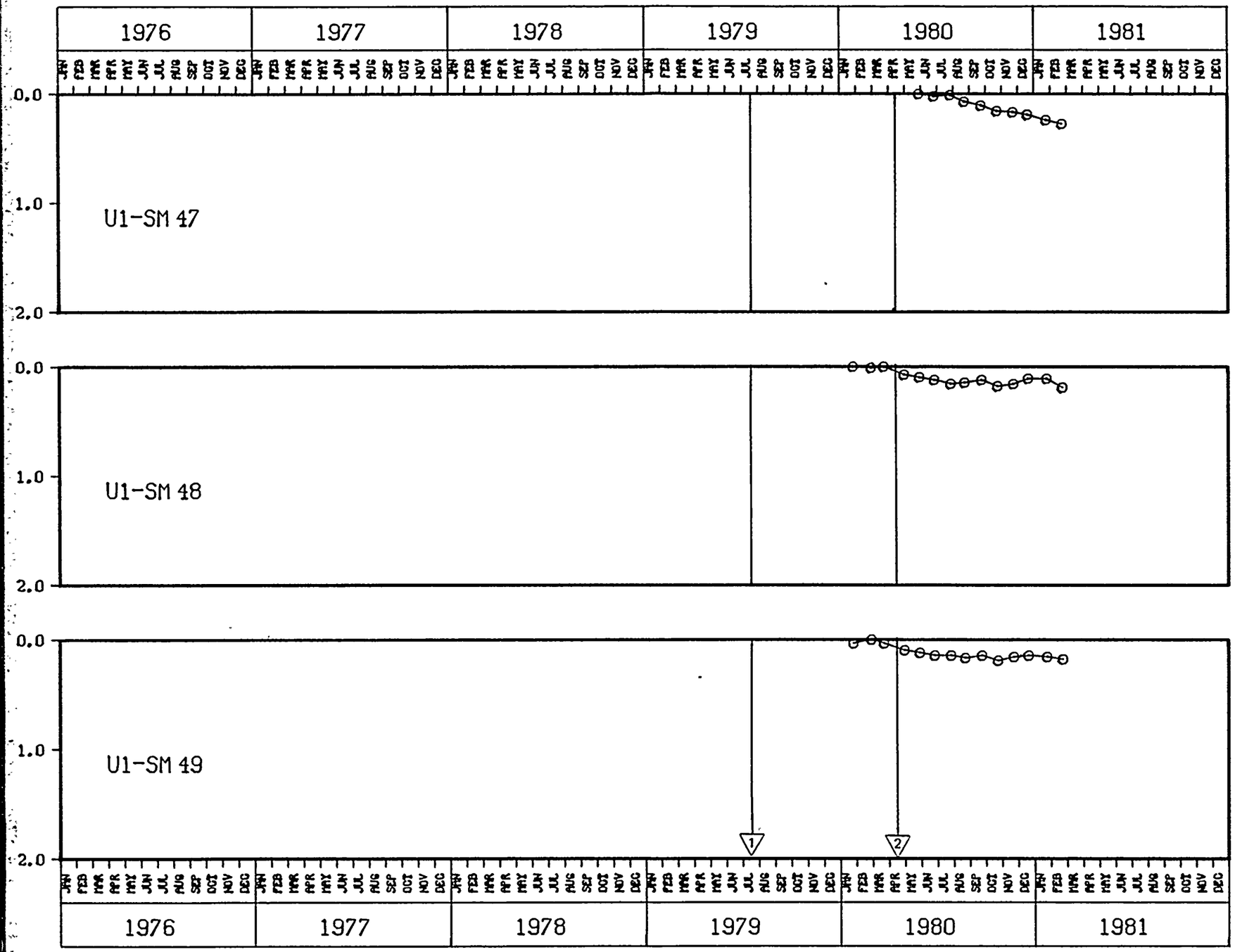
17

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 1
TURBINE BUILDING EXTERIOR COLUMNS
Figure 36

Project Number 76 056 10


1976
1977
1978
1979
1980
1981
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
U1-SM 44
U1-SM 45
U1-SM 46
1
2
0.0
1.0
2.0
SETTLEMENT (INCHES)



CONSTRUCTION MILESTONES

1 FORMING AND CONCRETE POURING BEGUN 7-79

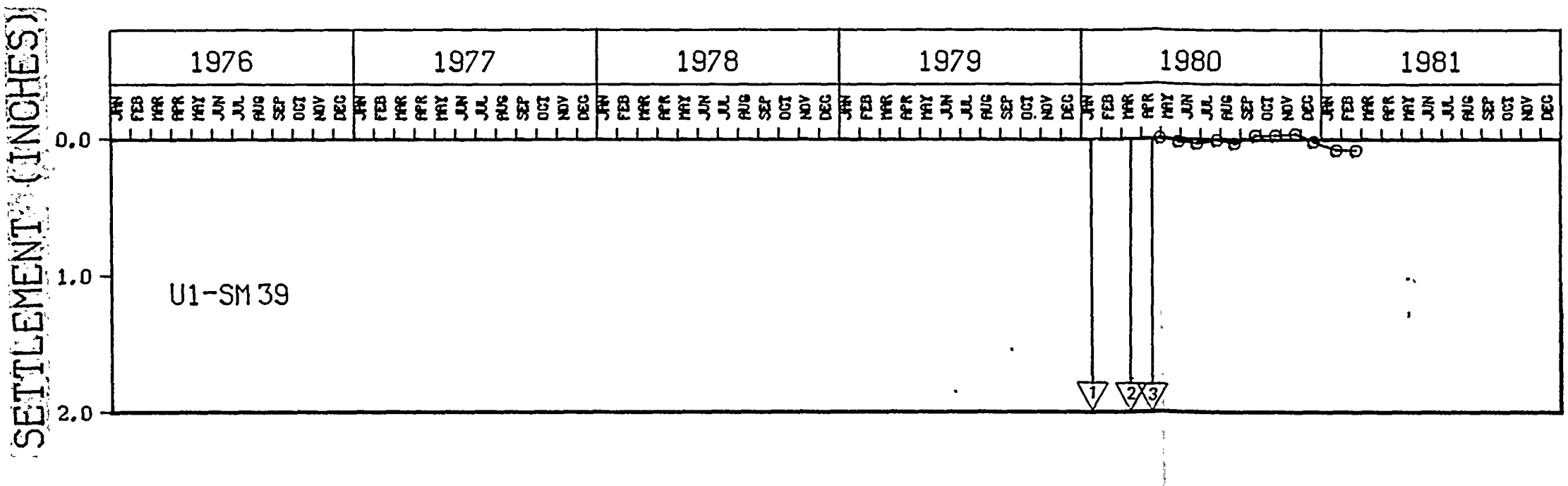
2 STRUCTURE COMPLETE 4-80

MILESTONE DATES PROVIDED BY BECHTEL PVNGS CIVIL ENGINEERING GROUP, APRIL, 1981.

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 1
ESSENTIAL SPRAY POND
Figure 37

Project Number 76 056 10



CONSTRUCTION MILESTONES

1 FORMING AND CONCRETE POURING BEGUN 1-80

2 START LINER 3-80

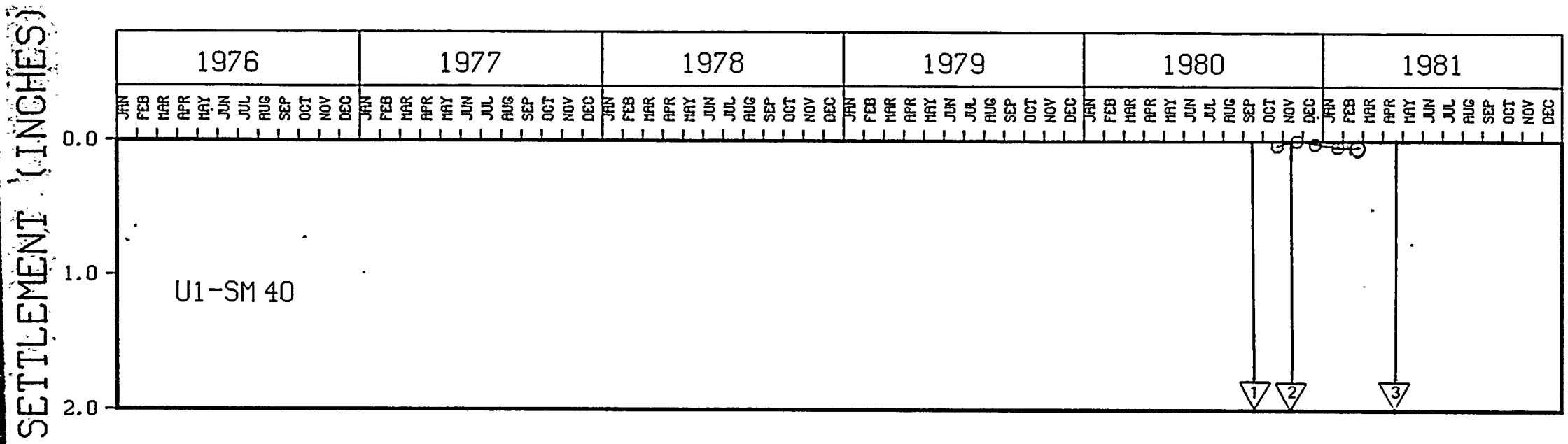
3 COMPLETE LINER 4-80

MILESTONE DATES PROVIDED BY BECHTEL PVNGS CIVIL ENGINEERING GROUP, APRIL, 1981.

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 1
REACTOR MAKE-UP TANK
Figure 38

Project Number 76 056-10



CONSTRUCTION MILESTONES

1 FORMING AND CONCRETE POURING BEGUN 9-80

2 START LINER 11-80

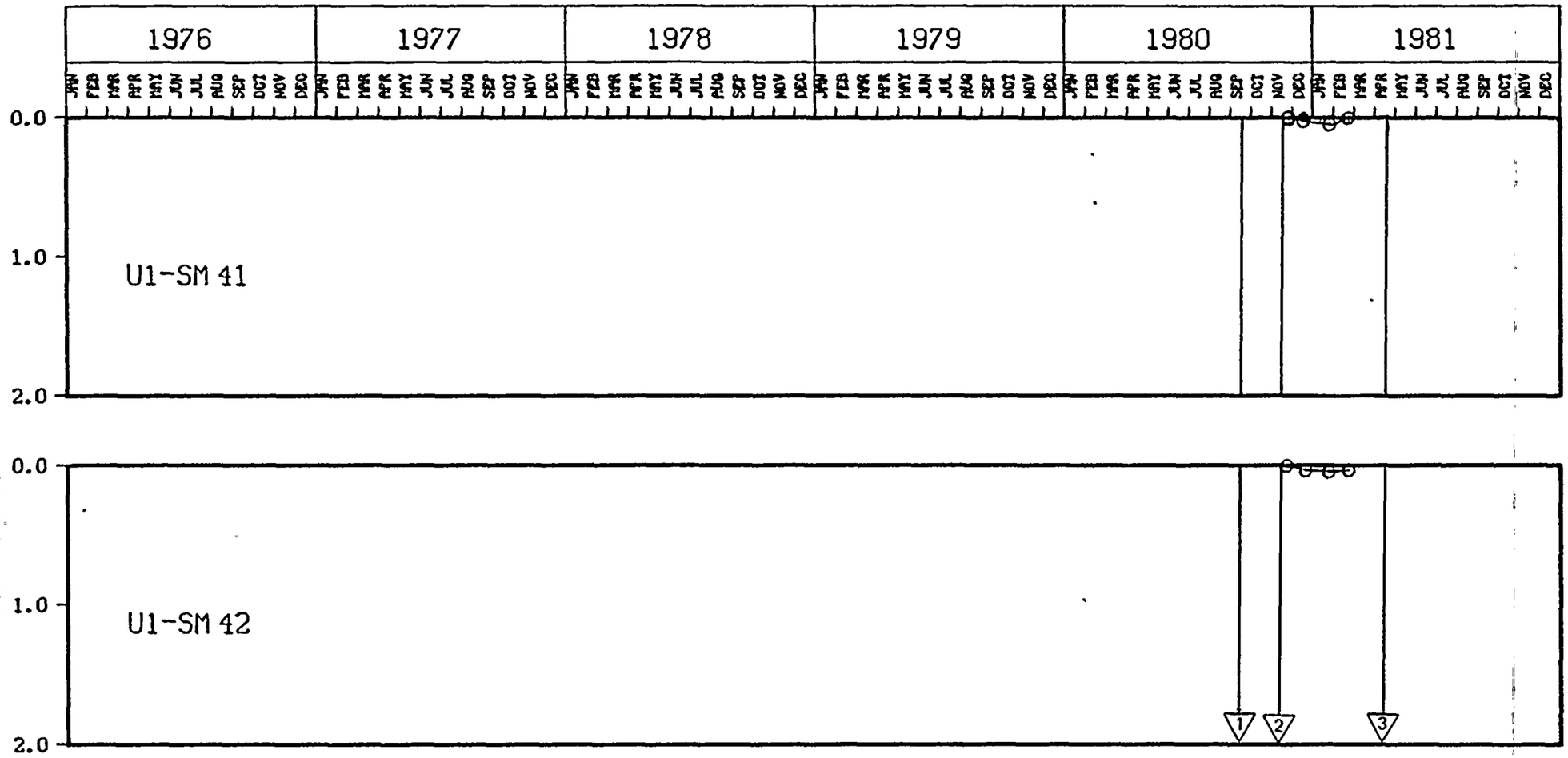
3 STRUCTURE COMPLETE 4-81

MILESTONE DATES PROVIDED BY BECHTEL PVNGS CIVIL ENGINEERING GROUP, APRIL, 1981.

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 1
HOLD-UP TANK
Figure 39

Project Number 76 056 10



CONSTRUCTION MILESTONES

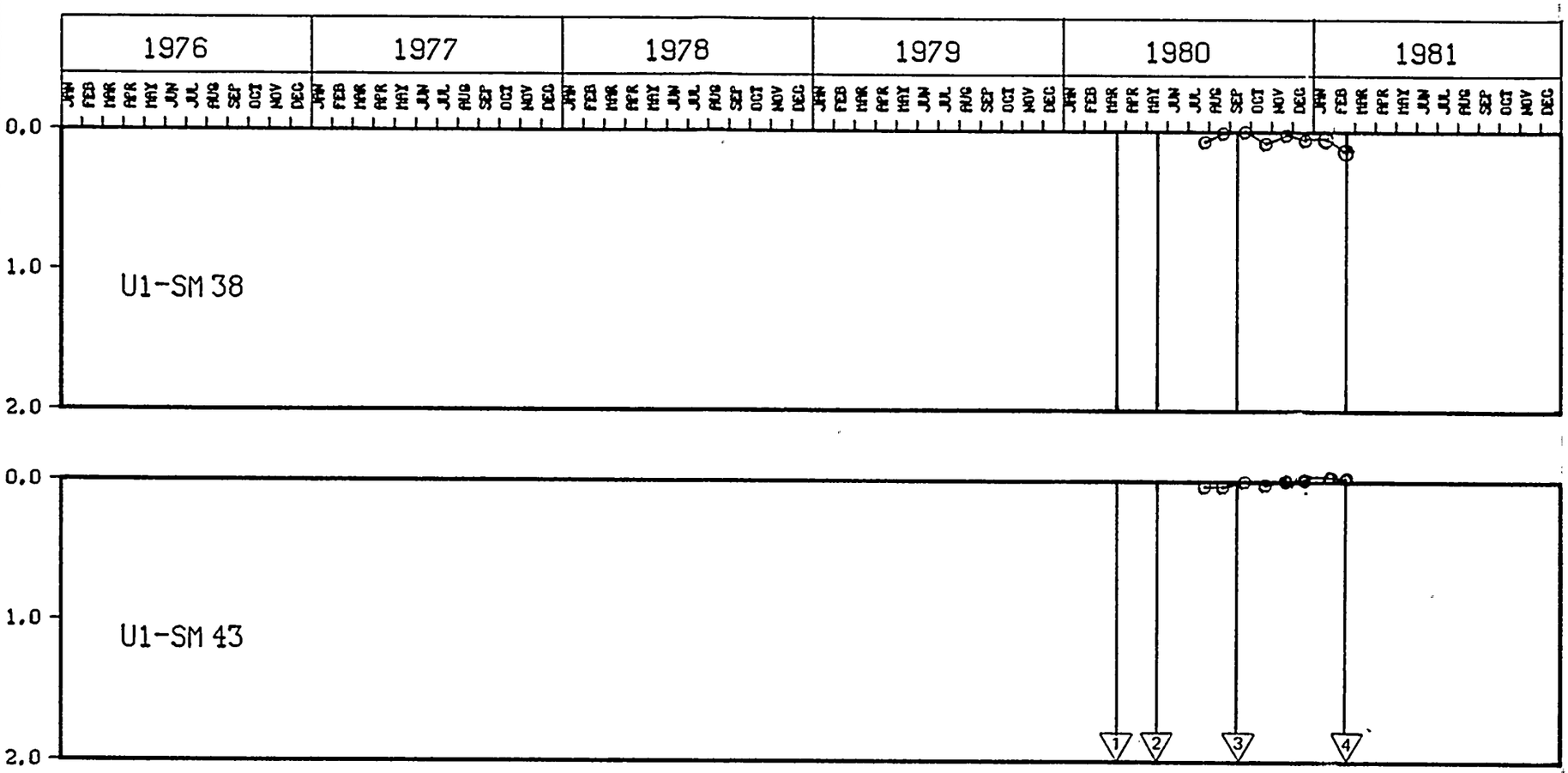
1. FORMING AND CONCRETE POURING BEGUN 9-80
2. START LINER 11-80
3. STRUCTURE COMPLETE 4-81

MILESTONE DATES PROVIDED BY BECHTEL PVNGS CIVIL ENGINEERING GROUP, APRIL, 1981.

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 1
REFUELING WATER TANK
Figure 40

Project Number 76 056 10



CONSTRUCTION MILESTONES

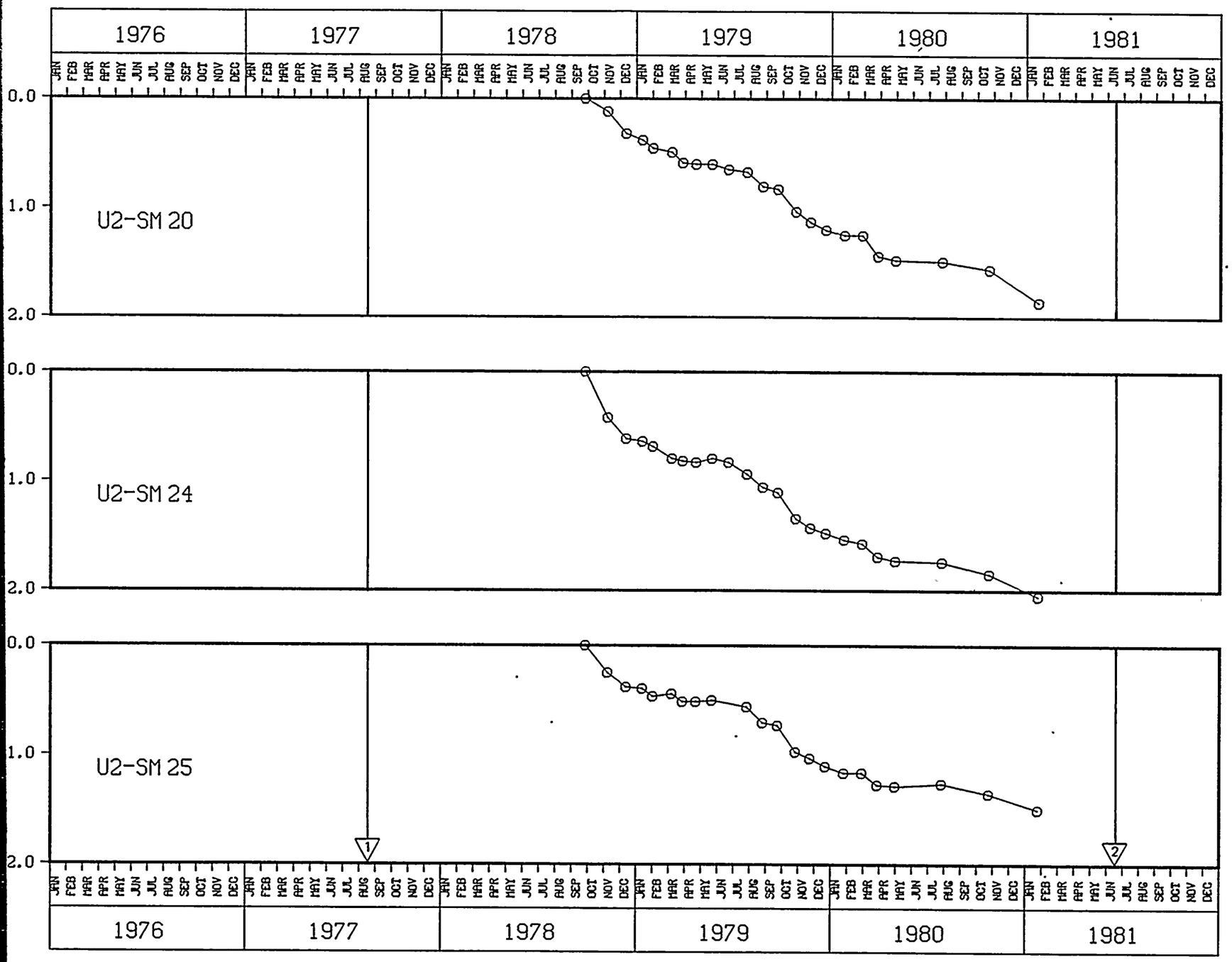
1. FORMING AND CONCRETE POURING BEGUN 3-80
2. START LINER 5-80
3. COMPLETE LINER 9-80
4. STRUCTURE COMPLETE 2-81

MILESTONE DATES PROVIDED BY BECHTEL PVNGS CIVIL ENGINEERING GROUP, APRIL, 1981.

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 1
CONDENSATE TANK
Figure 41

Project Number 76 056-10



CONSTRUCTION MILESTONES

1 FORMING AND CONCRETE POURING BEGUN 8-77

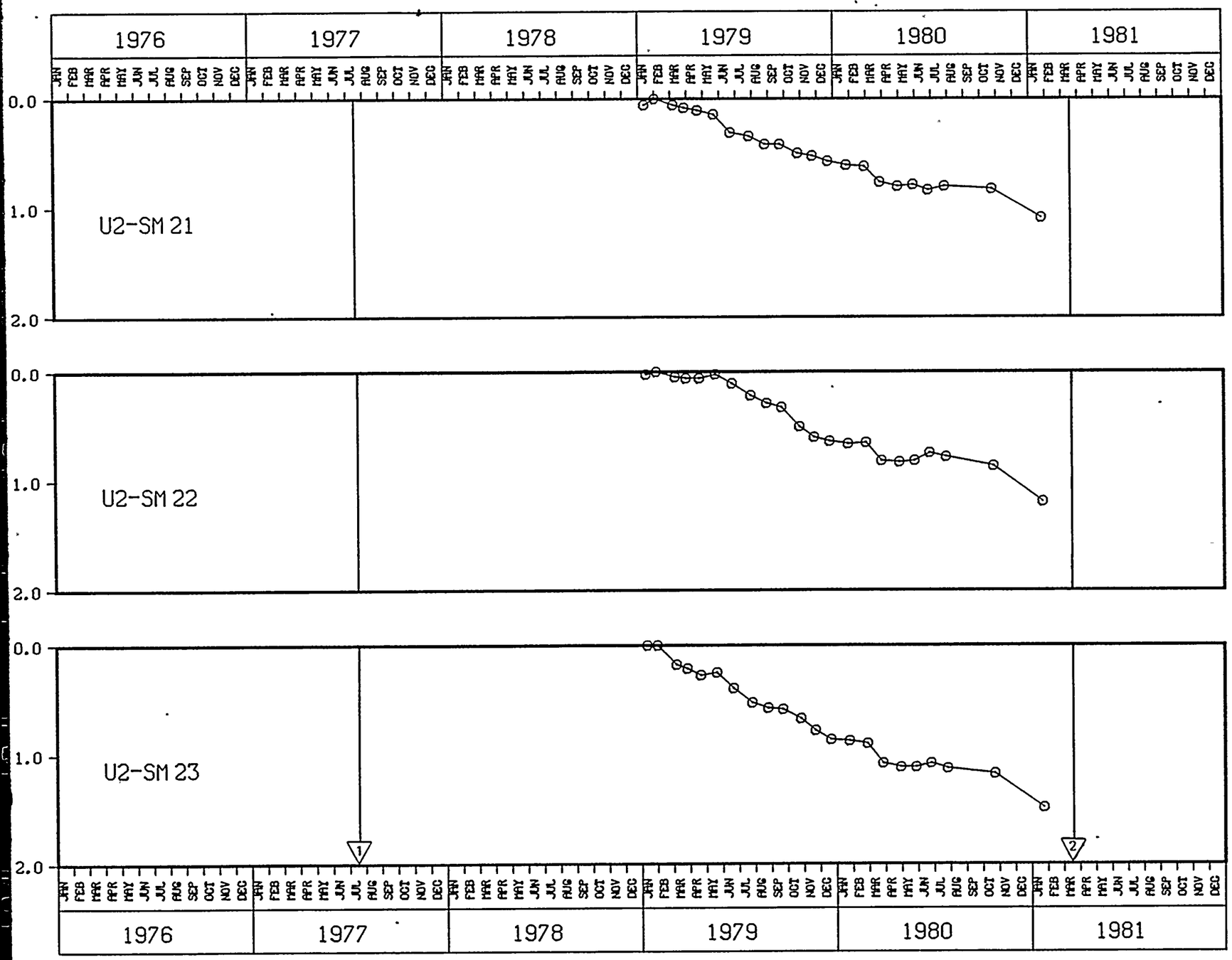
2 STRUCTURE COMPLETE 6-81

MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE"
BECHTEL DRAWING NO. SCH-20-3, STATUS AS OF 2-28-81

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 2
CONTAINMENT BUILDING
Figure 42

Project Number 76 056 10



CONSTRUCTION MILESTONES

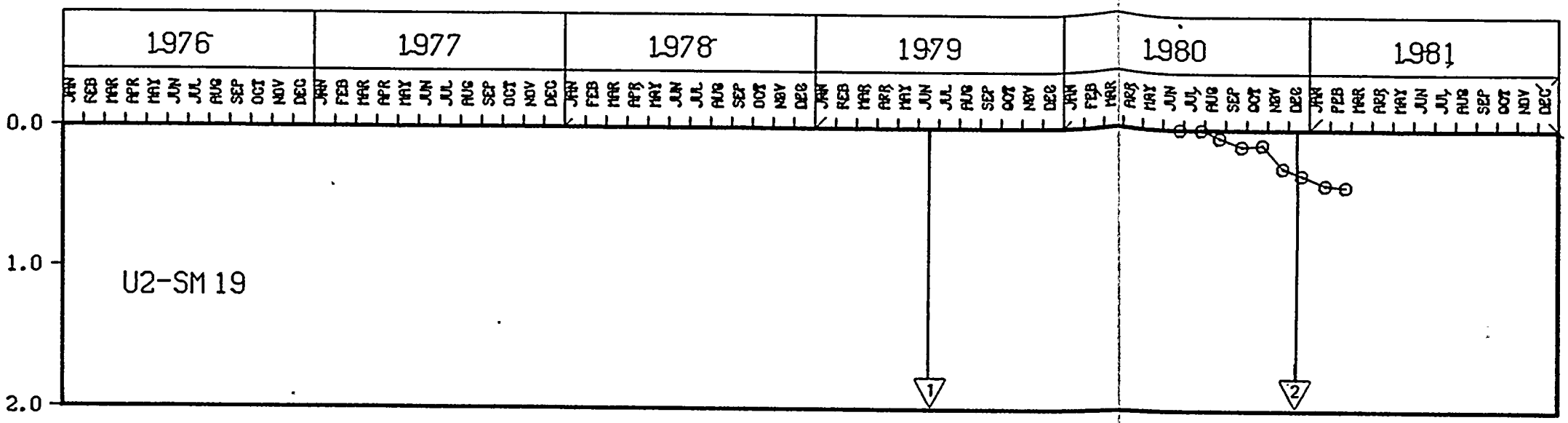
1 FORMING AND CONCRETE POURING BEGUN 7-77

2 STRUCTURE COMPLETE 3-81

MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE"
BECHTEL DRAWING NO. SCH-20-3, STATUS AS OF 2-28-81

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 2
AUXILIARY BUILDING
Figure 43



CONSTRUCTION MILESTONES

1 FORMING AND CONCRETE POURING BEGUN 6-79

2 STRUCTURE COMPLETE APPROXIMATELY 12-80

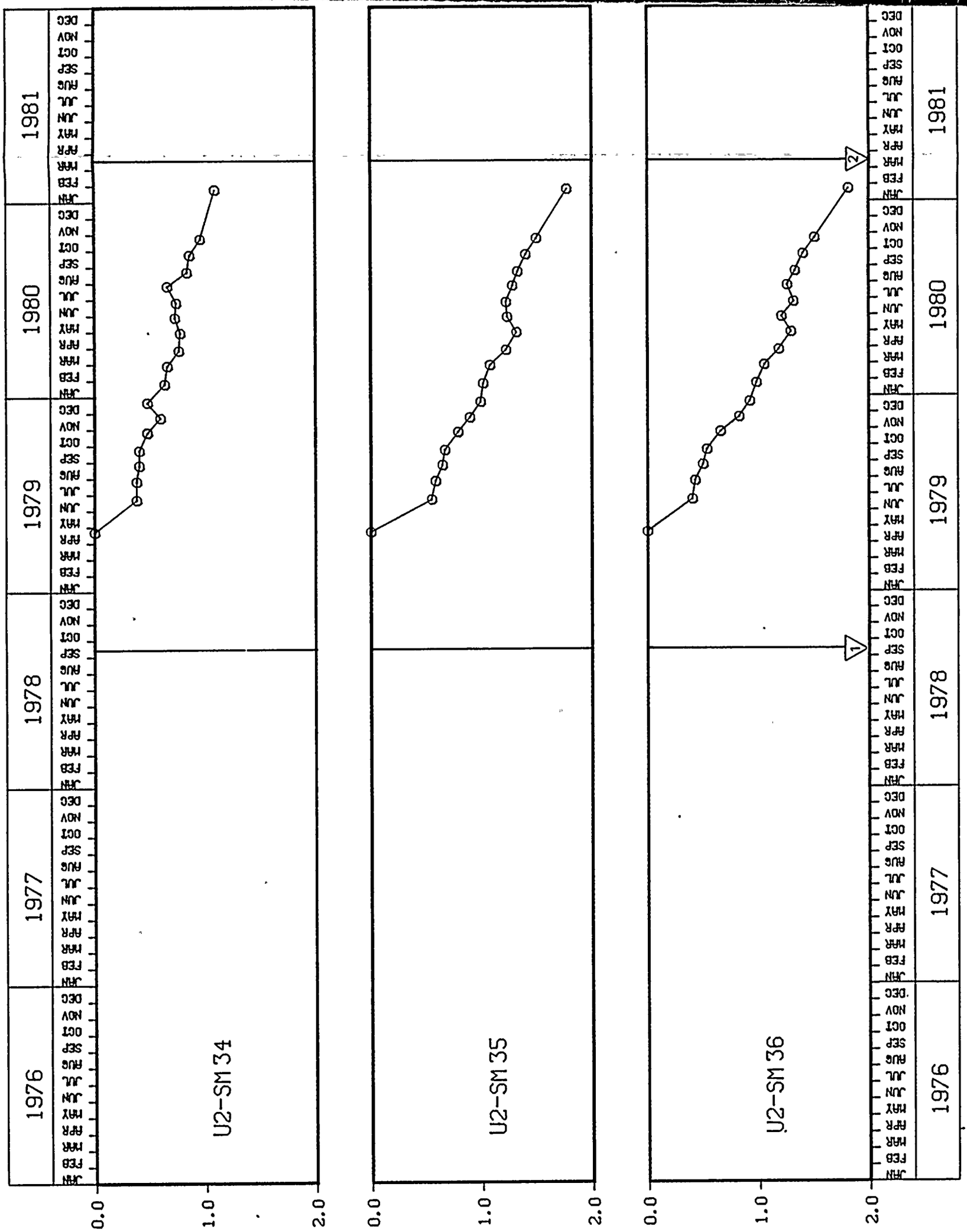
MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE" BECHTEL DRAWING NO. SCH-20-3 STATUS AS OF 2-28-81 , AND CONCRETE PLACEMENT SCHEDULES.

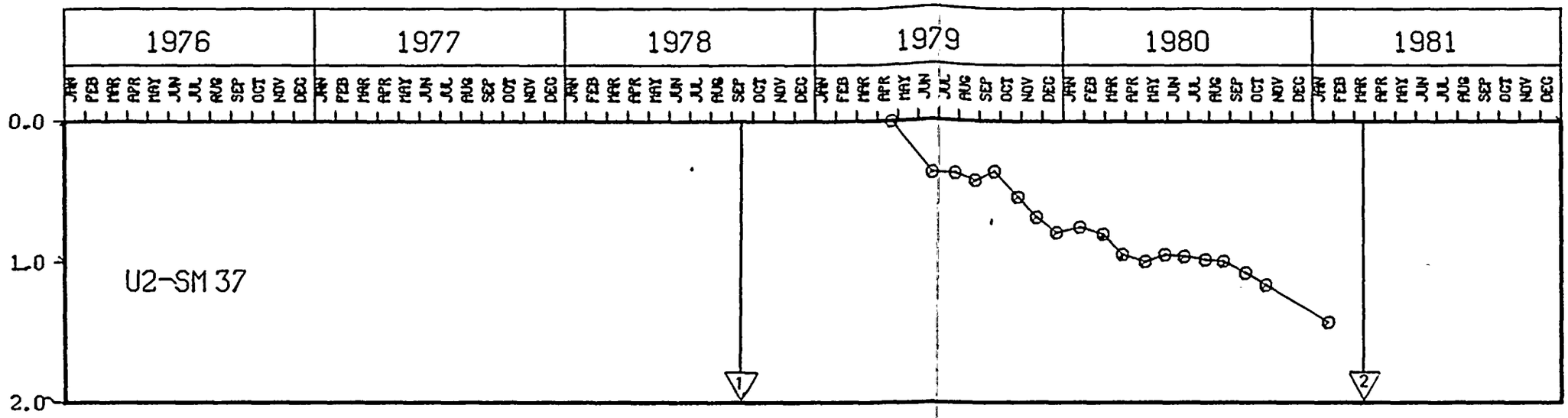
-25

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 2
MAIN STEAM SUPPORT STRUCTURE
Figure 44

Project Number 79-056-10


U2-SM 34
U2-SM 35
U2-SM 36
1976
1977
1978
1979
1980
1981
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
0.0
1.0
2.0
SETTLEMENT (INCHES)



CONSTRUCTION MILESTONES

1 FORMING AND CONCRETE POURING BEGUN 9-78

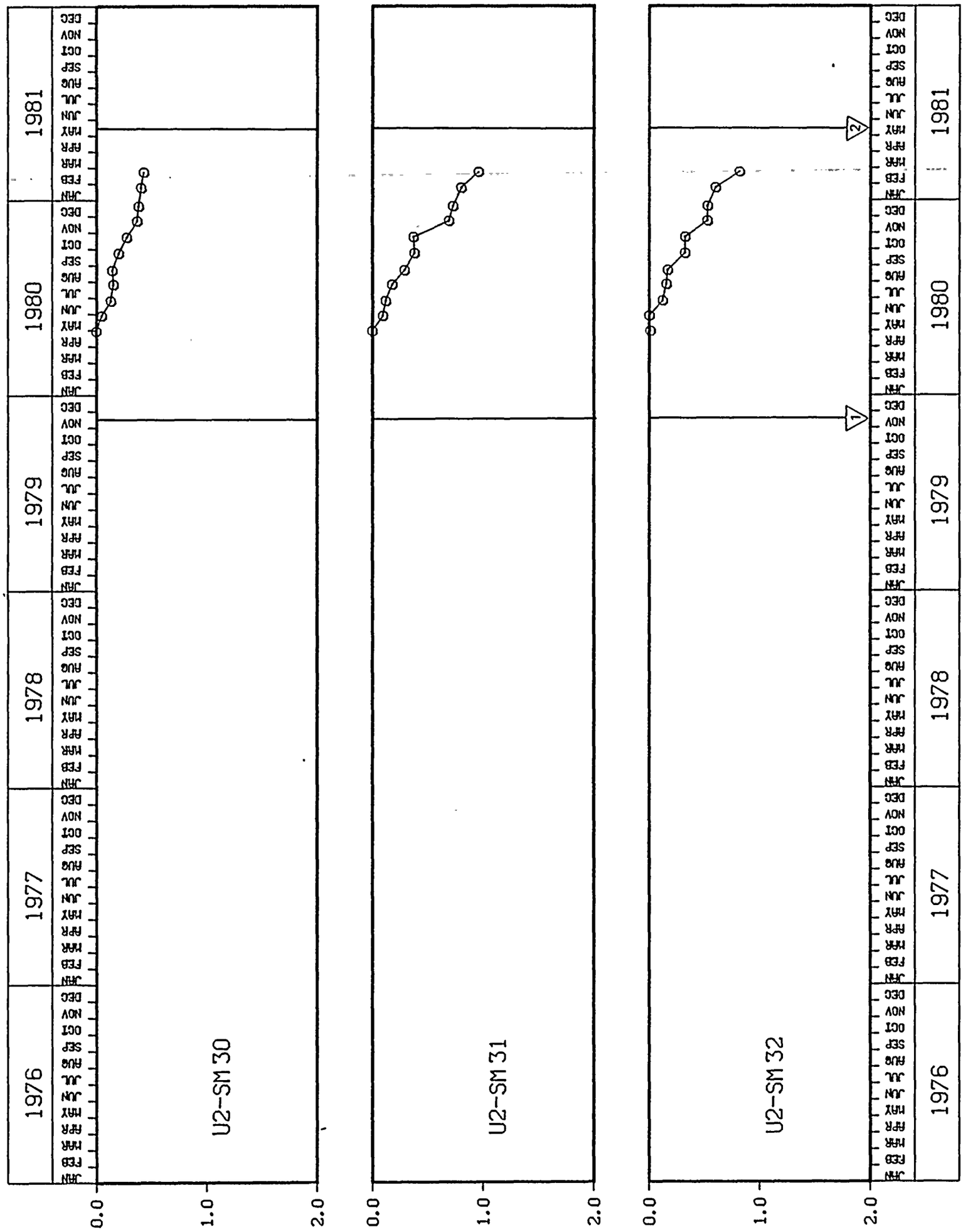
2 STRUCTURE COMPLETE APPROXIMATELY 3-81

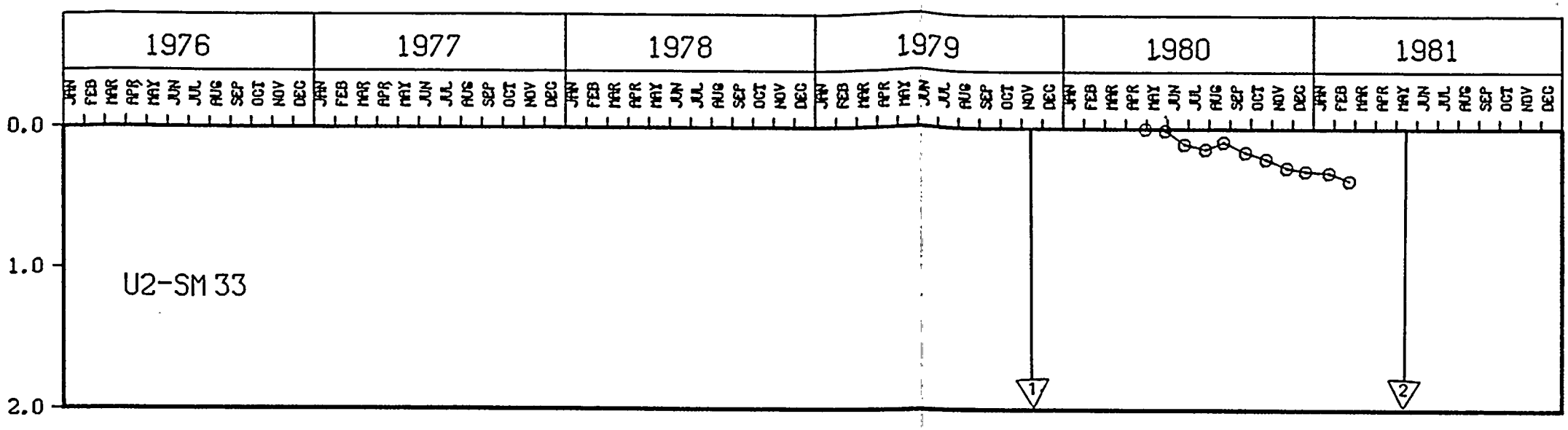
MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE" BECHTEL DRAWING NO. SCH-20-3 , STATUS AS OF 2-28-81 , AND CONCRETE PLACEMENT SCHEDULES.

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 2
CONTROL BUILDING
Figure 45

Project Number 76 056 10


1976
1977
1978
1979
1980
1981
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
U2-SM 30
U2-SM 31
U2-SM 32
1
2
0.0
1.0
2.0
SETTLEMENT (INCHES)



CONSTRUCTION MILESTONES

1 FORMING AND CONCRETE POURING BEGUN 11-79

2 STRUCTURE COMPLETE 5-81

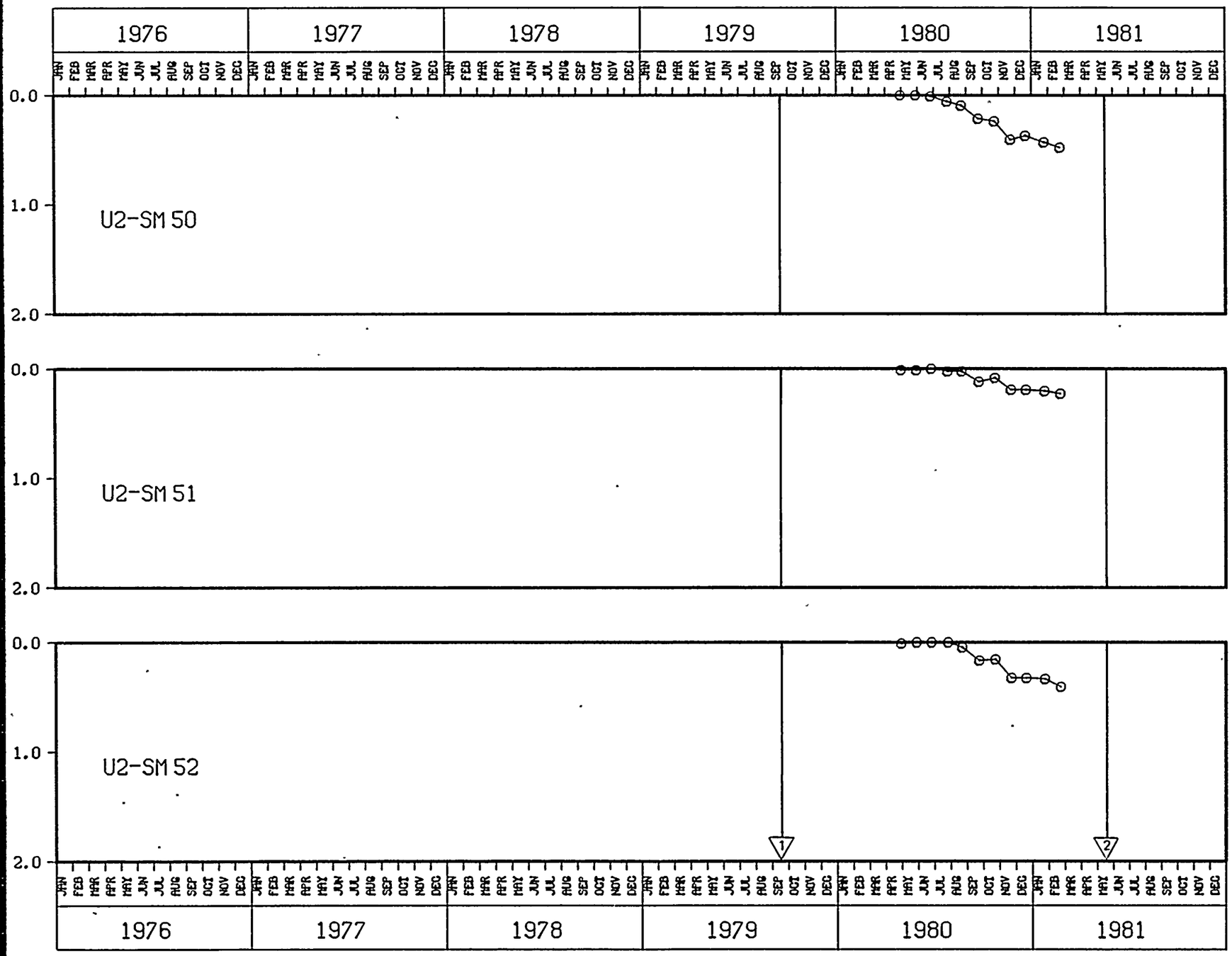
MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE"
BECHTEL DRAWING NO. SCH-20-3, STATUS AS OF 2-28-81

-37

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 2
RADWASTE BUILDING
Figure 46

Project Number 76 056 10



CONSTRUCTION MILESTONES

1 FORMING AND CONCRETE POURING BEGUN 9-79

2 STRUCTURE COMPLETE 5-81

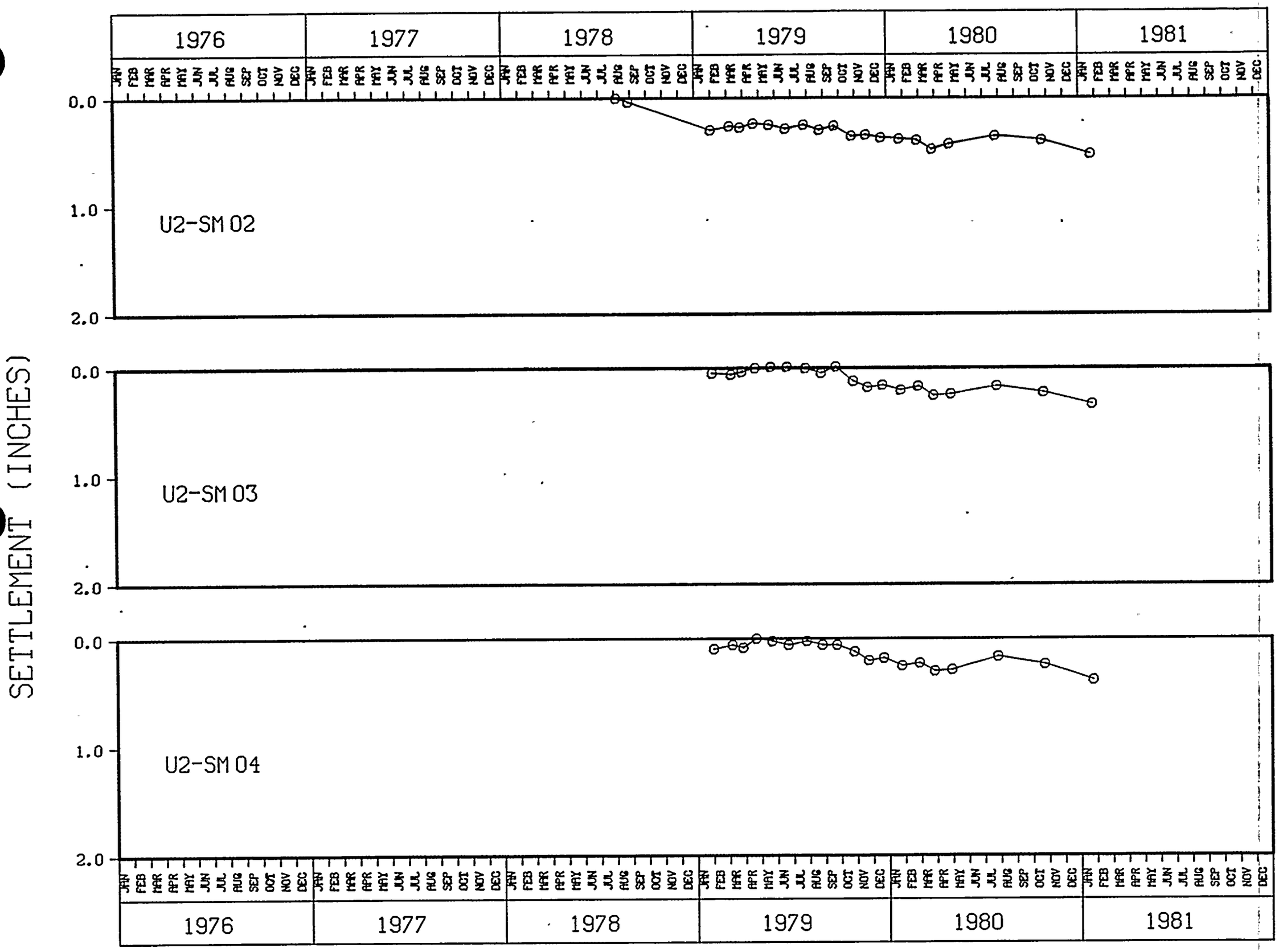
MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE"
BECHTEL DRAWING NO. SCH-20-3, STATUS AS OF 2-28-81

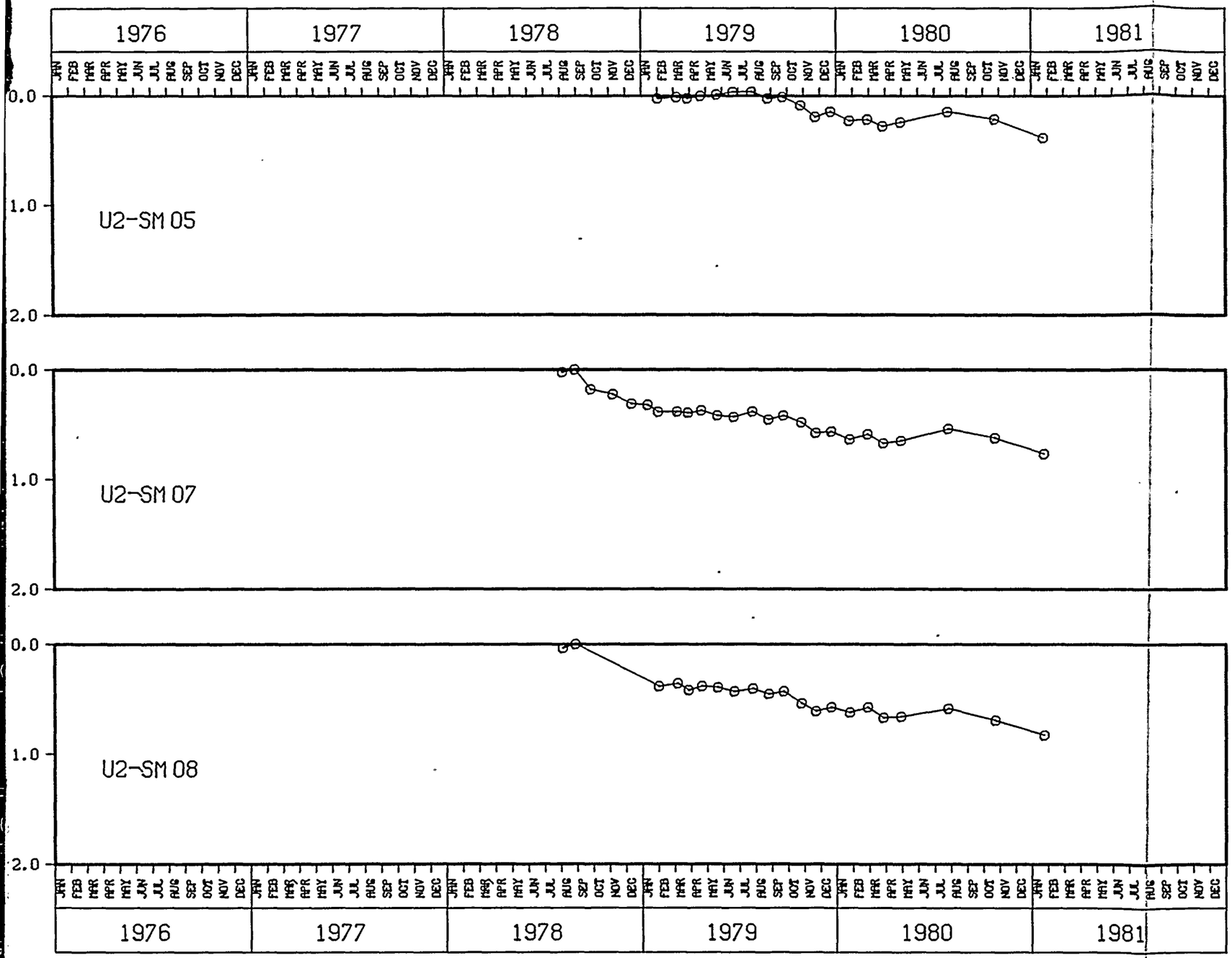
2d

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 2
DIESEL GENERATOR BUILDING
Figure 47

Project Number 76 056 10


SETTLEMENT (INCHES)
1976
1977
1978
1979
1980
1981
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
0.0
1.0
2.0
U2-SM 02
U2-SM 03
U2-SM 04



CONSTRUCTION MILESTONES

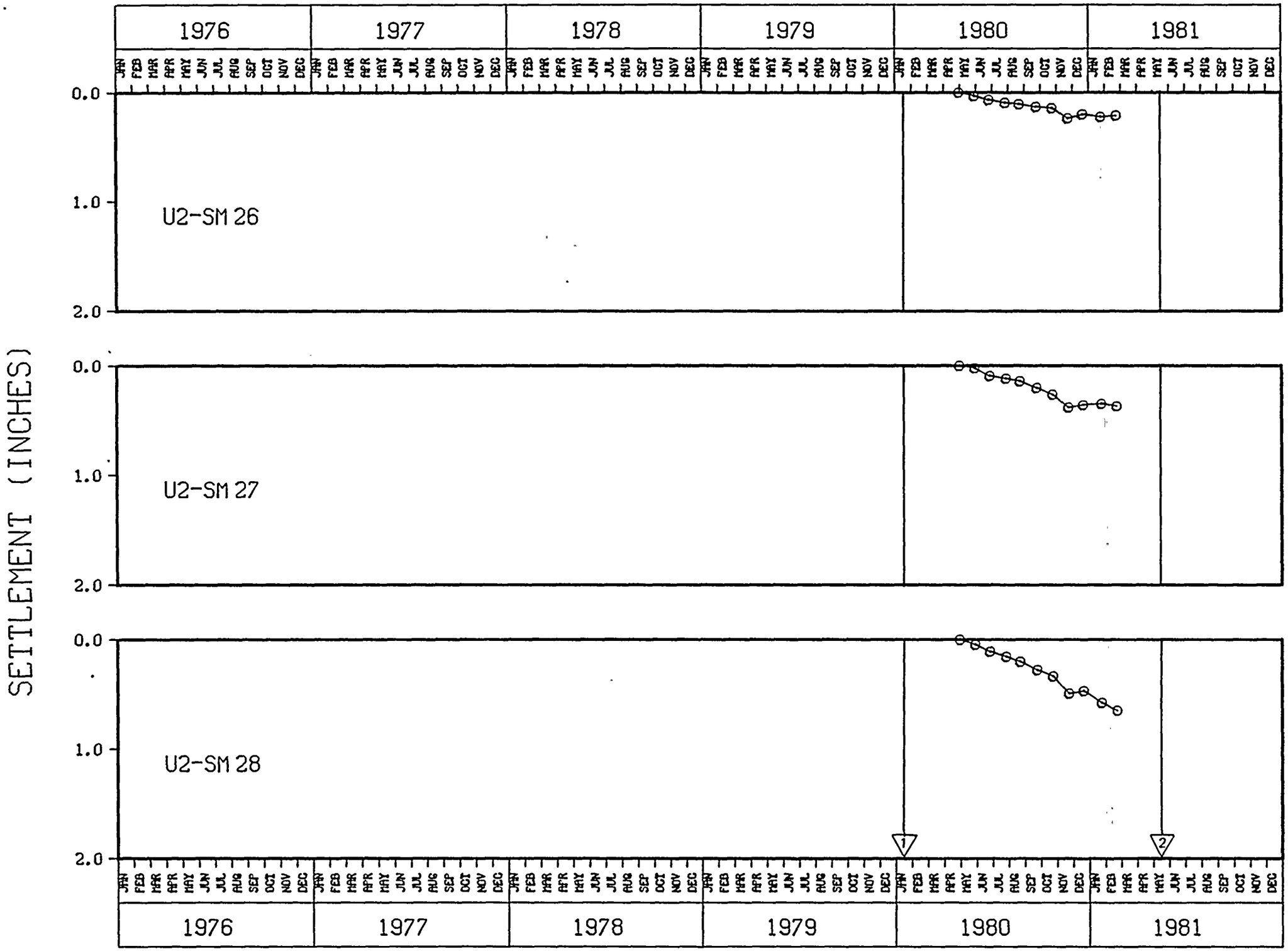
1. FORMING AND CONCRETE POURING BEGUN APPROXIMATELY 11-77
2. PEDESTAL COMPLETE 12-78
3. TURBINE BUILDING COMPLETE 7-79
4. TURBINE GENERATOR ERECTION COMPLETE 8-82

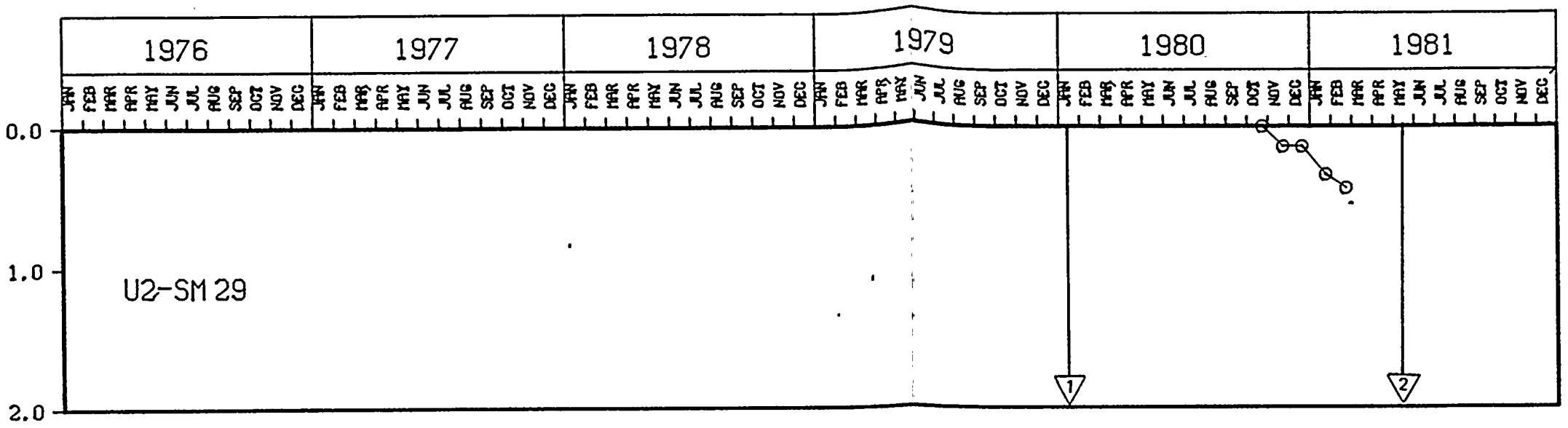
MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE" BECHTEL DRAWING NO. SCH-20-3, STATUS AS OF 2-28-81

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 2
TURBINE PEDESTAL
Figure 49
Sheet 1 of 2

Project Number 76 056 10


SETTLEMENT (INCHES)
1976
1977
1978
1979
1980
1981
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
0.0
1.0
2.0
U2-SM 26
U2-SM 27
U2-SM 28
1
2



CONSTRUCTION MILESTONES

1 FORMING AND CONCRETE POURING BEGUN 1-80

2 STRUCTURE COMPLETE 5-81

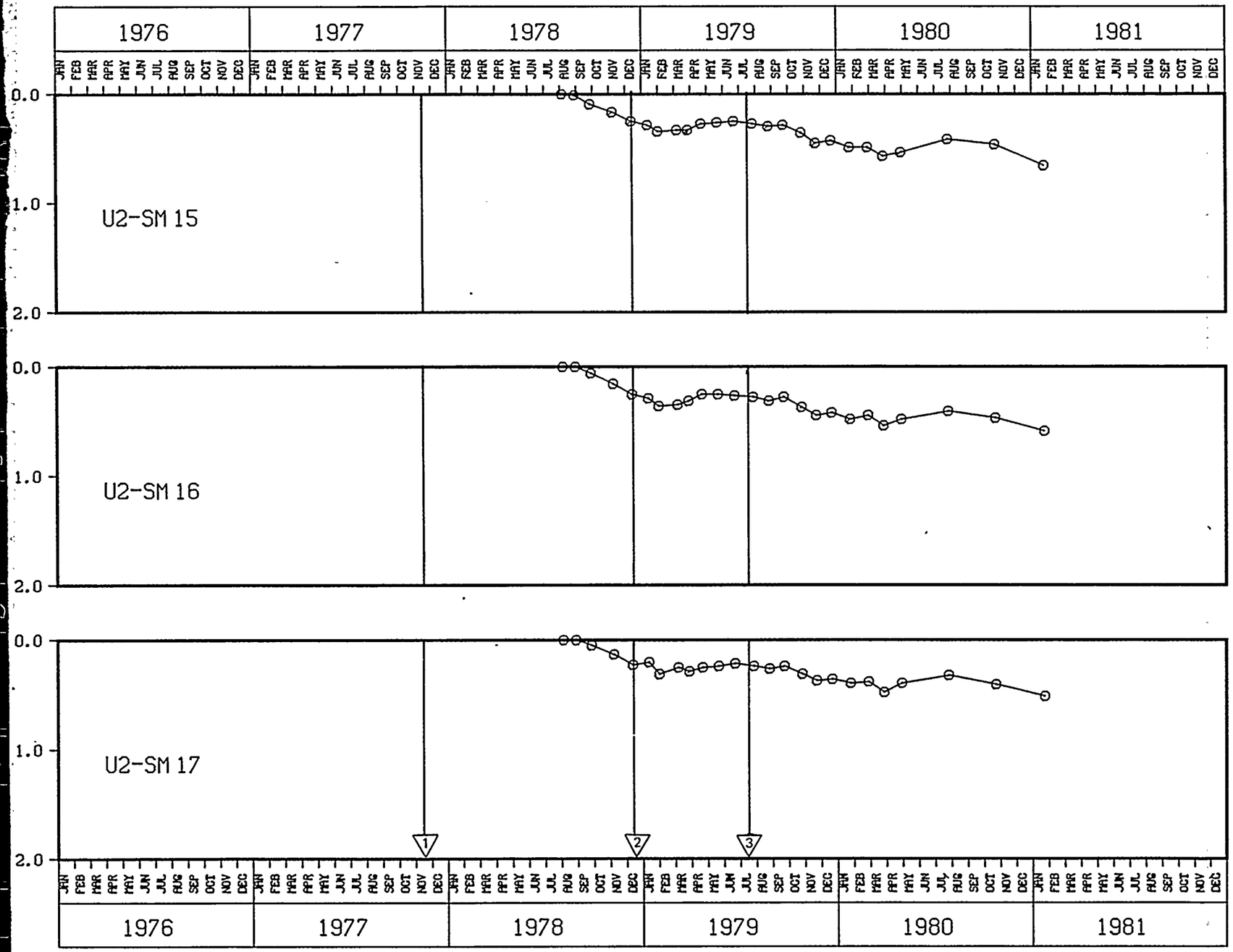
MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE"
BECHTEL DRAWING NO. SCH-20-3, STATUS AS OF 2-28-81

-29

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 2
FUEL BUILDING
Figure 48

Project Number 76-056-10



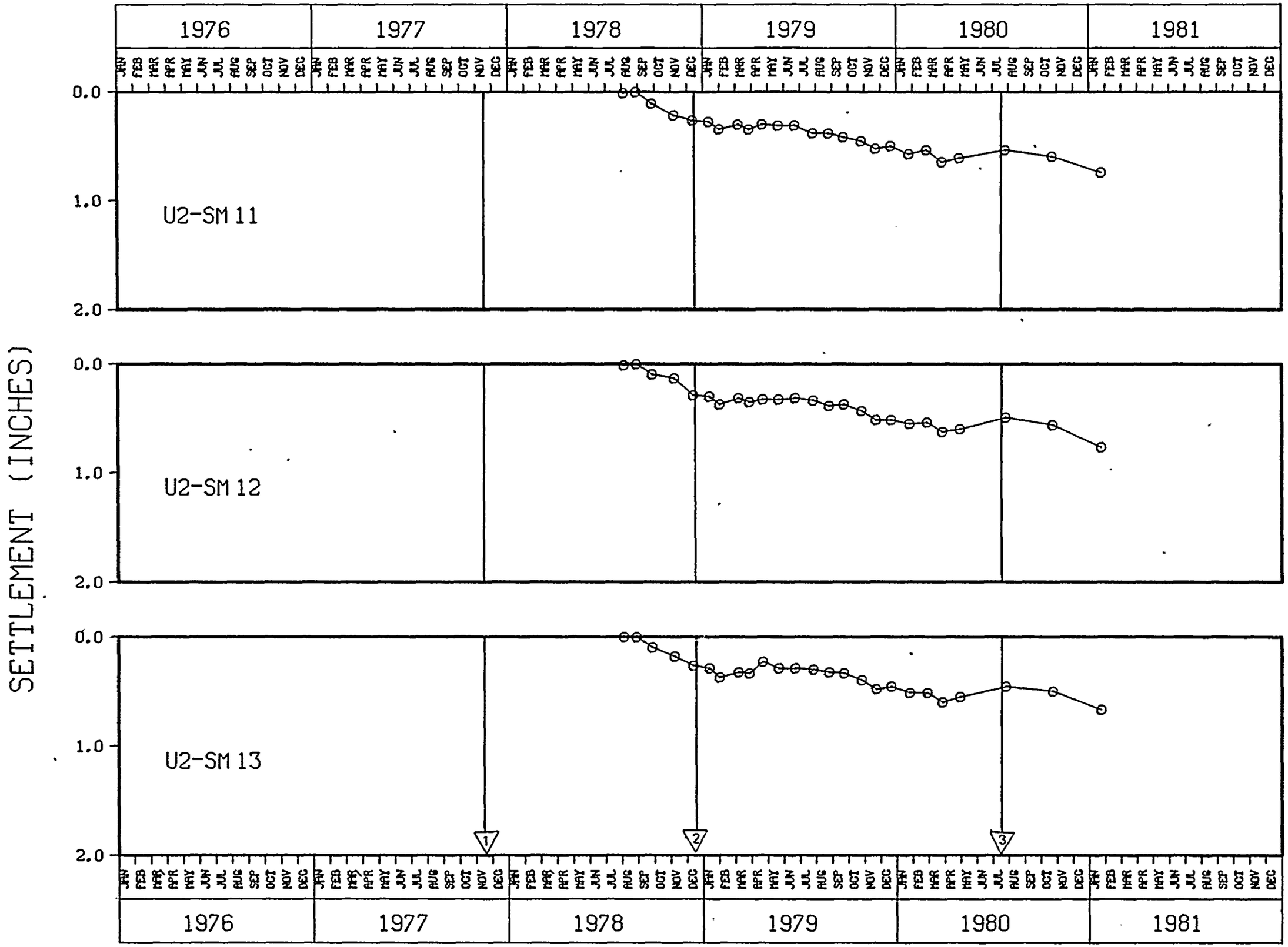
CONSTRUCTION MILESTONES

1. FORMING AND CONCRETE POURING BEGUN APPROXIMATELY 11-77
2. PEDESTAL COMPLETE 12-78
3. TURBINE BUILDING 7-79
4. GENERATOR ERECTION 8-82

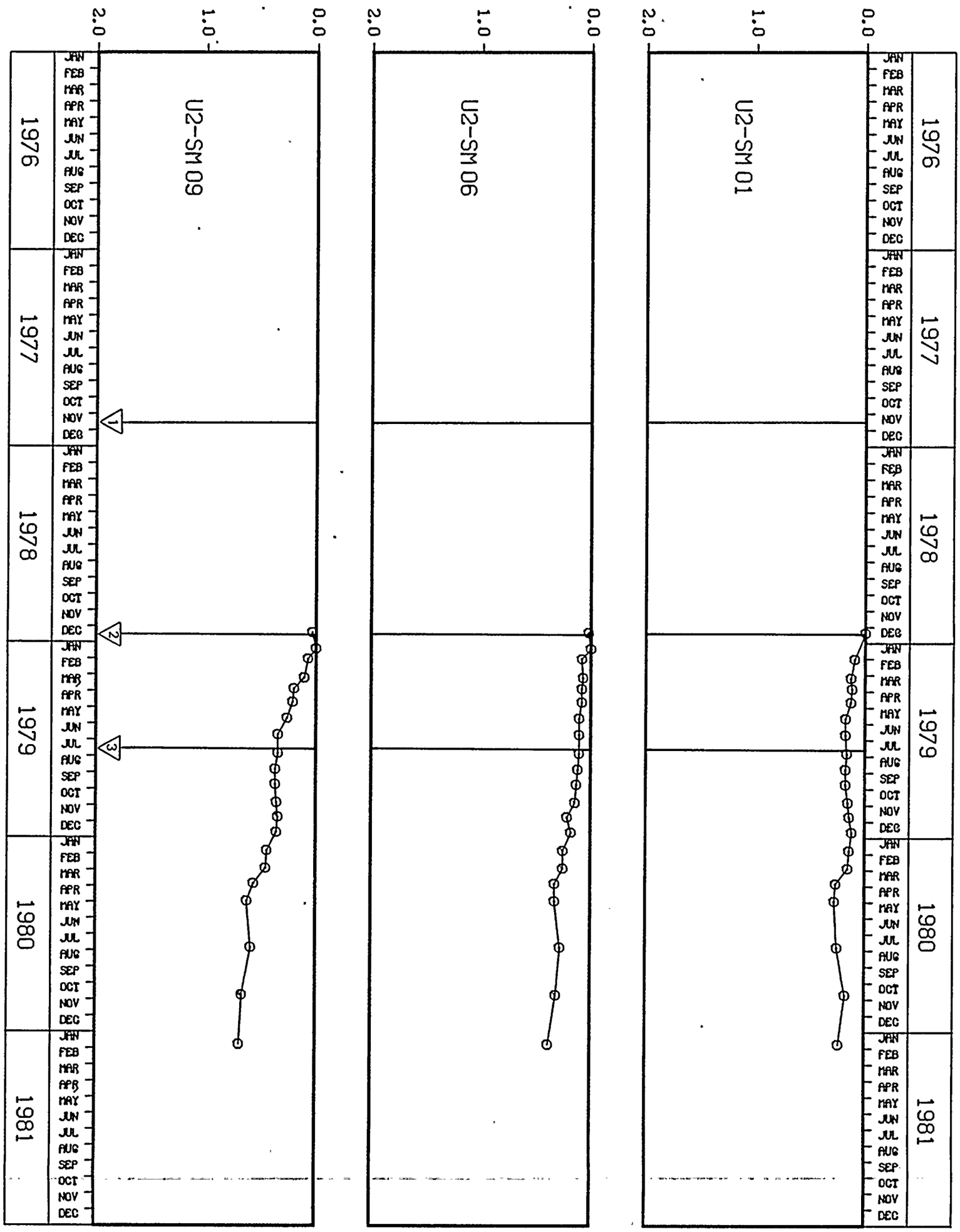
MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE" BECHTEL DRAWING NO. SCH-20-3 STATUS AS OF 2-28-81

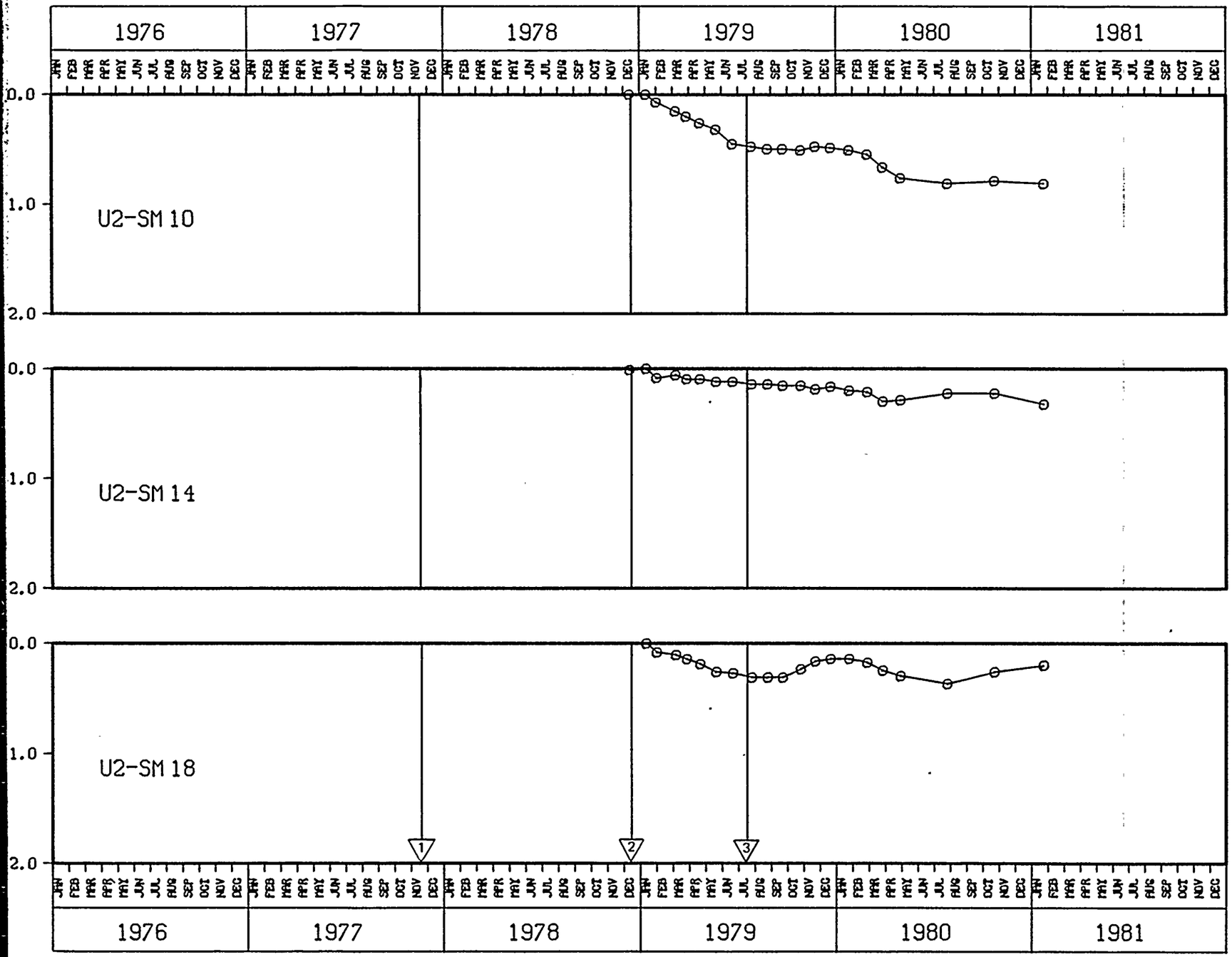
Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 2
TURBINE PEDESTAL
Figure 49
Project Number 76 056 10 Sheet 2 of 2


SETTLEMENT (INCHES)
1976
1977
1978
1979
1980
1981
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
0.0
1.0
2.0
U2-SM 11
U2-SM 12
U2-SM 13
1
2
3

SETTLEMENT (INCHES)





CONSTRUCTION MILESTONES

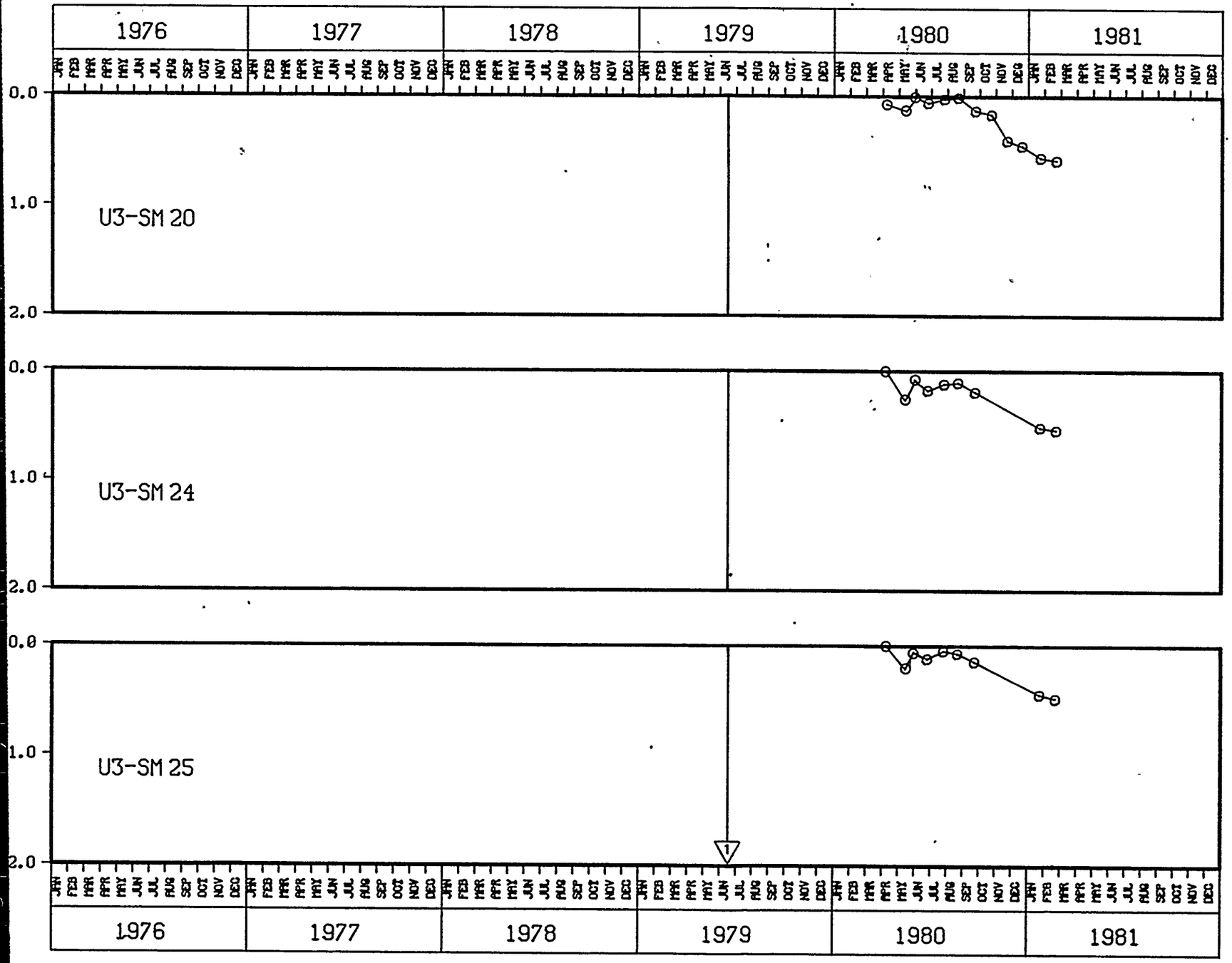
1. FORMING AND CONCRETE POURING BEGUN APPROXIMATELY 11-77
2. PEDESTAL COMPLETE 12-78
3. TURBINE BUILDING COMPLETE 7-79
4. TURBINE GENERATOR ERECTION COMPLETE 8-82

MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE BECHTEL DRAWING NO. SCH-20-3, STATUS AS OF 2-28-81

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 2
TURBINE BUILDING EXTERIOR COLUMNS
Figure 50

Project Number 76 056 10



CONSTRUCTION MILESTONES

1 FORMING AND CONCRETE POURING BEGUN 6-79

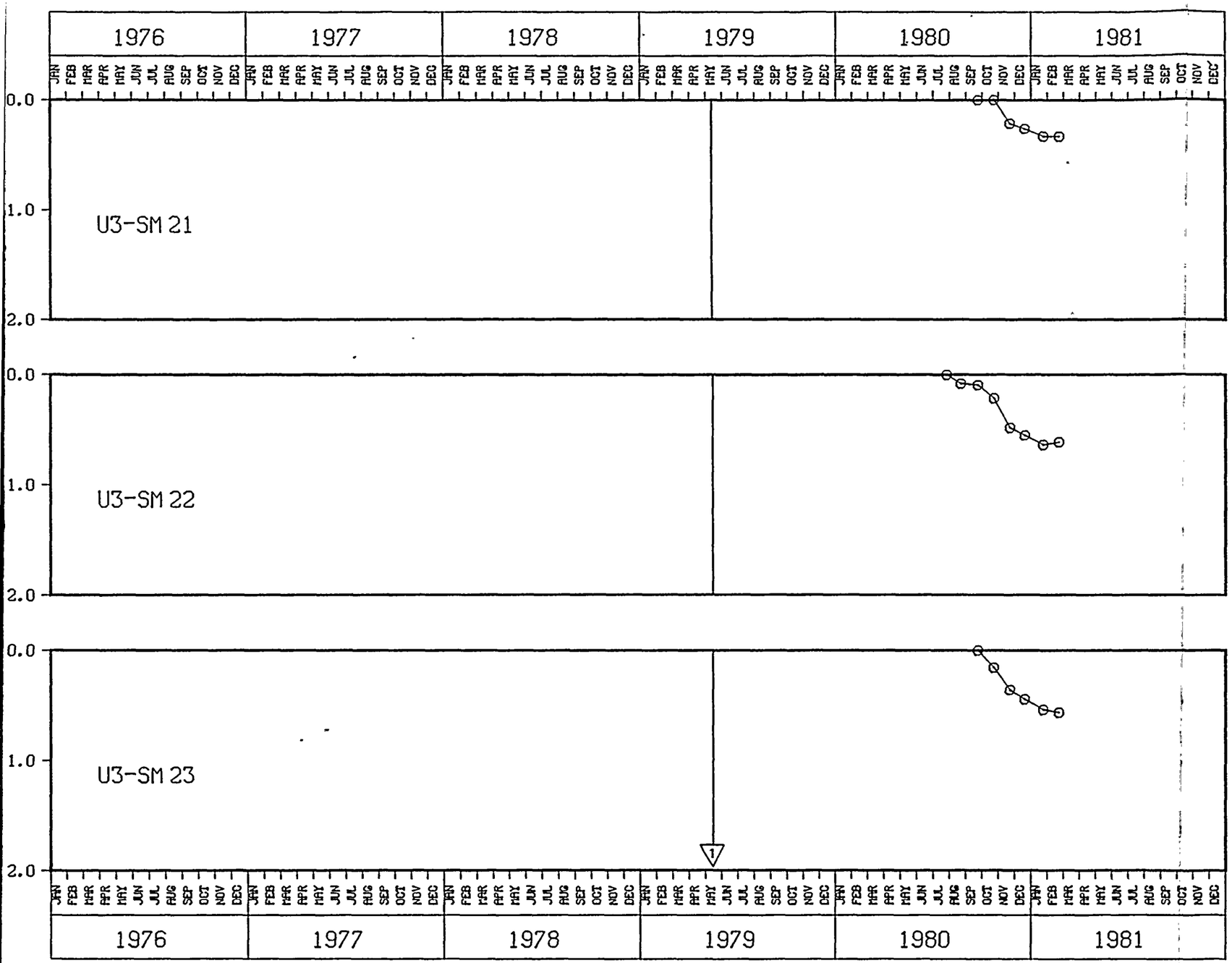
2 STRUCTURE COMPLETE 12-82

MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE" BECHTEL DRAWING NO. SCH-20-3, STATUS AS OF 2-28-81

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 3
CONTAINMENT BUILDING
Figure 51

Project Number 76-056-10



CONSTRUCTION MILESTONES

1 FORMING AND CONCRETE POURING BEGUN 5-79

2 STRUCTURE COMPLETE 1-83

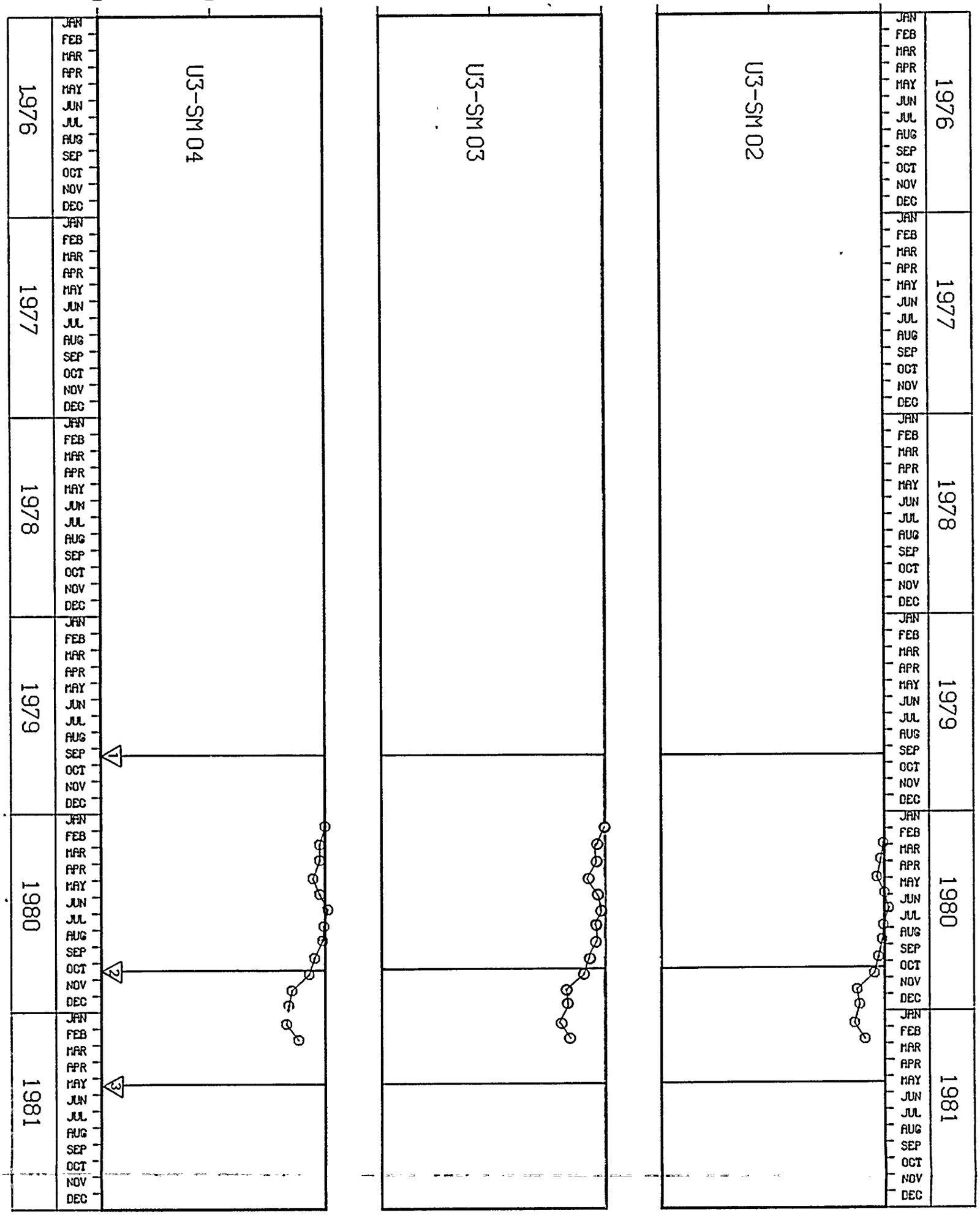
MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE" BECHTEL DRAWING NO. SCH-20-3, STATUS AS OF

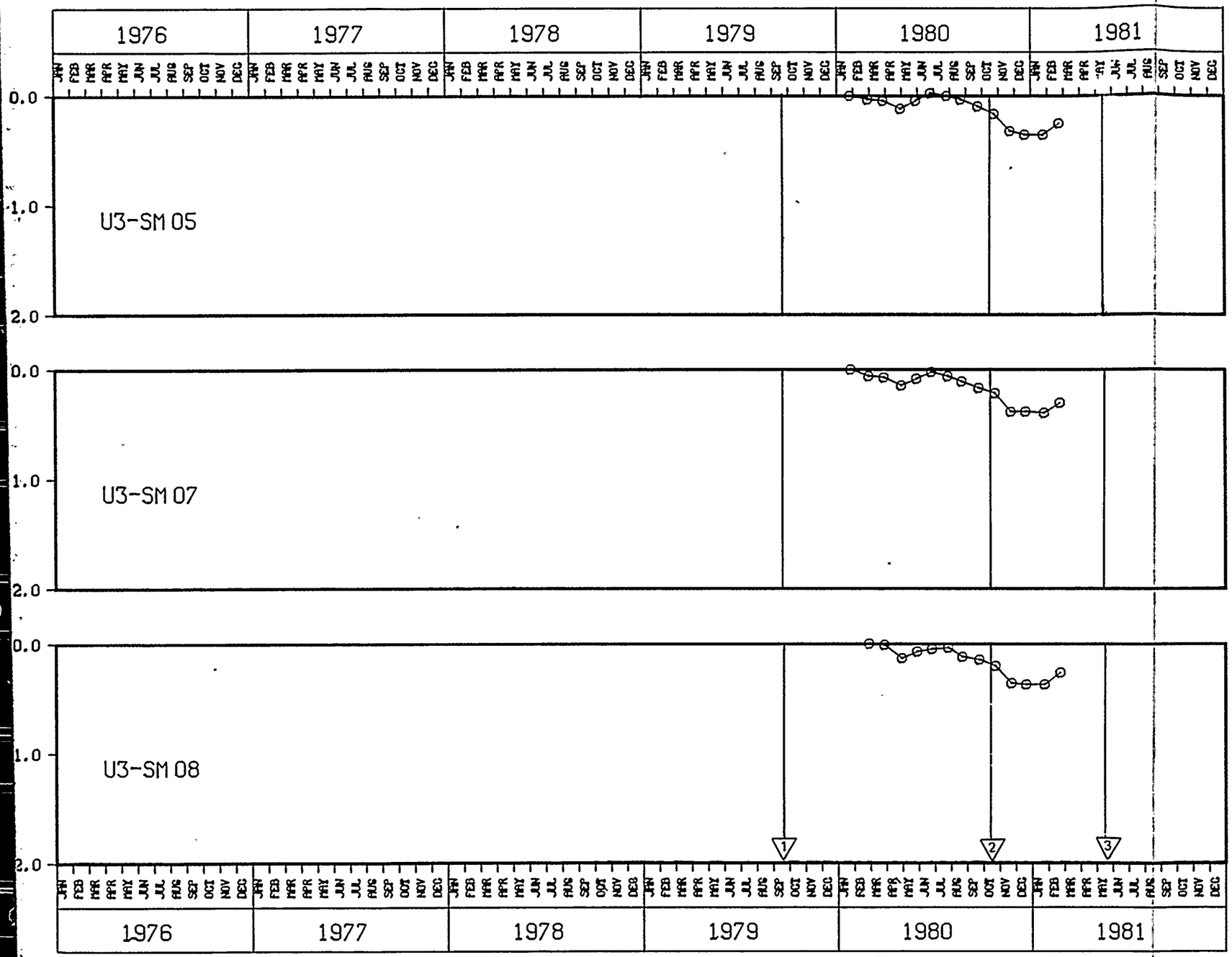
Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 3
AUXILIARY BUILDING
Figure 52

Project Number 76 056 10

SETTLEMENT (INCHES)





CONSTRUCTION MILESTONES

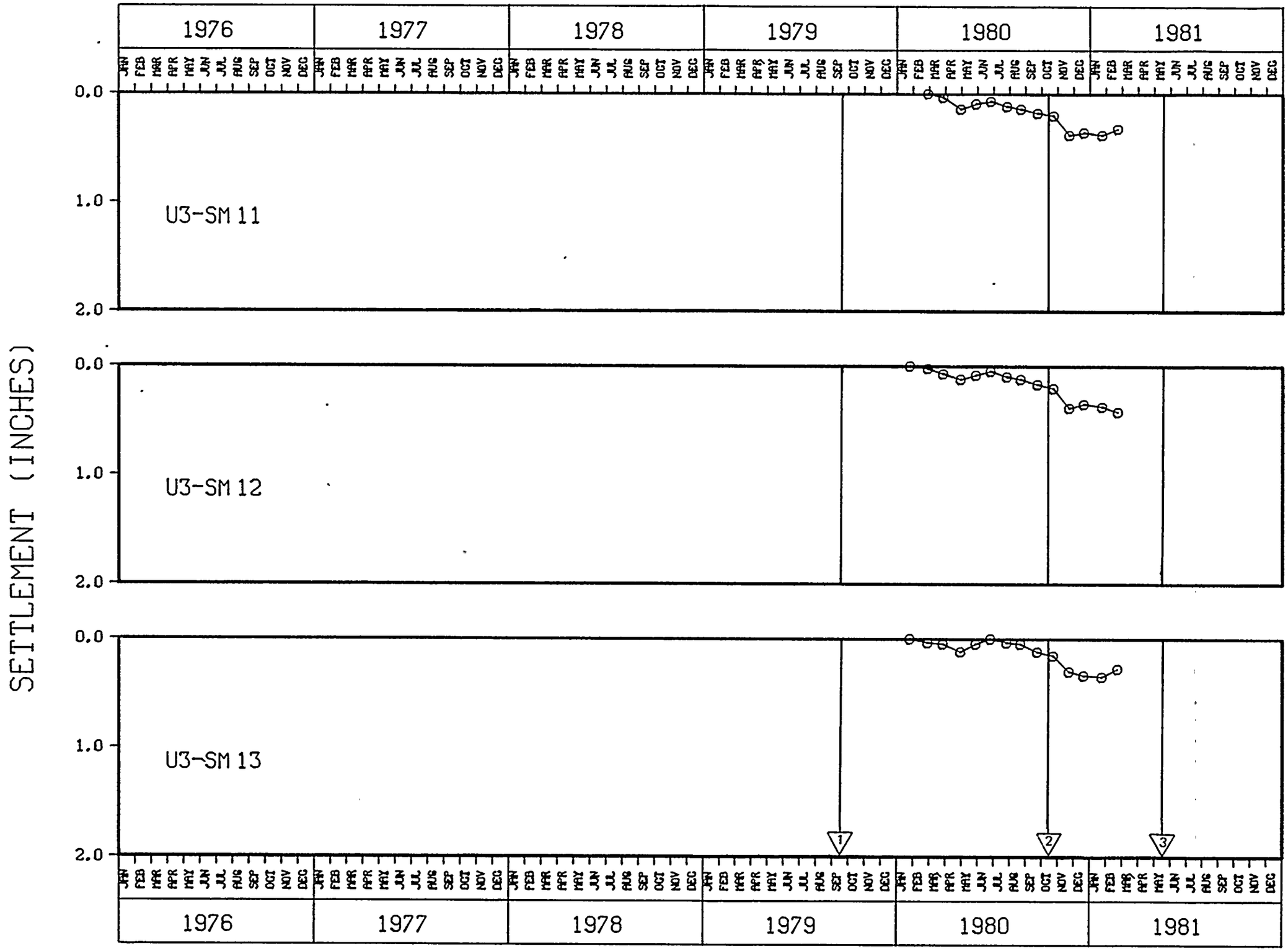
1. FORMING AND CONCRETE POURING BEGUN APPROXIMATELY 9-79
2. PEDESTAL COMPLETE 10-80
3. TURBINE BUILDING COMPLETE 5-81
4. TURBINE GENERATOR ERECTION COMPLETE 7-84

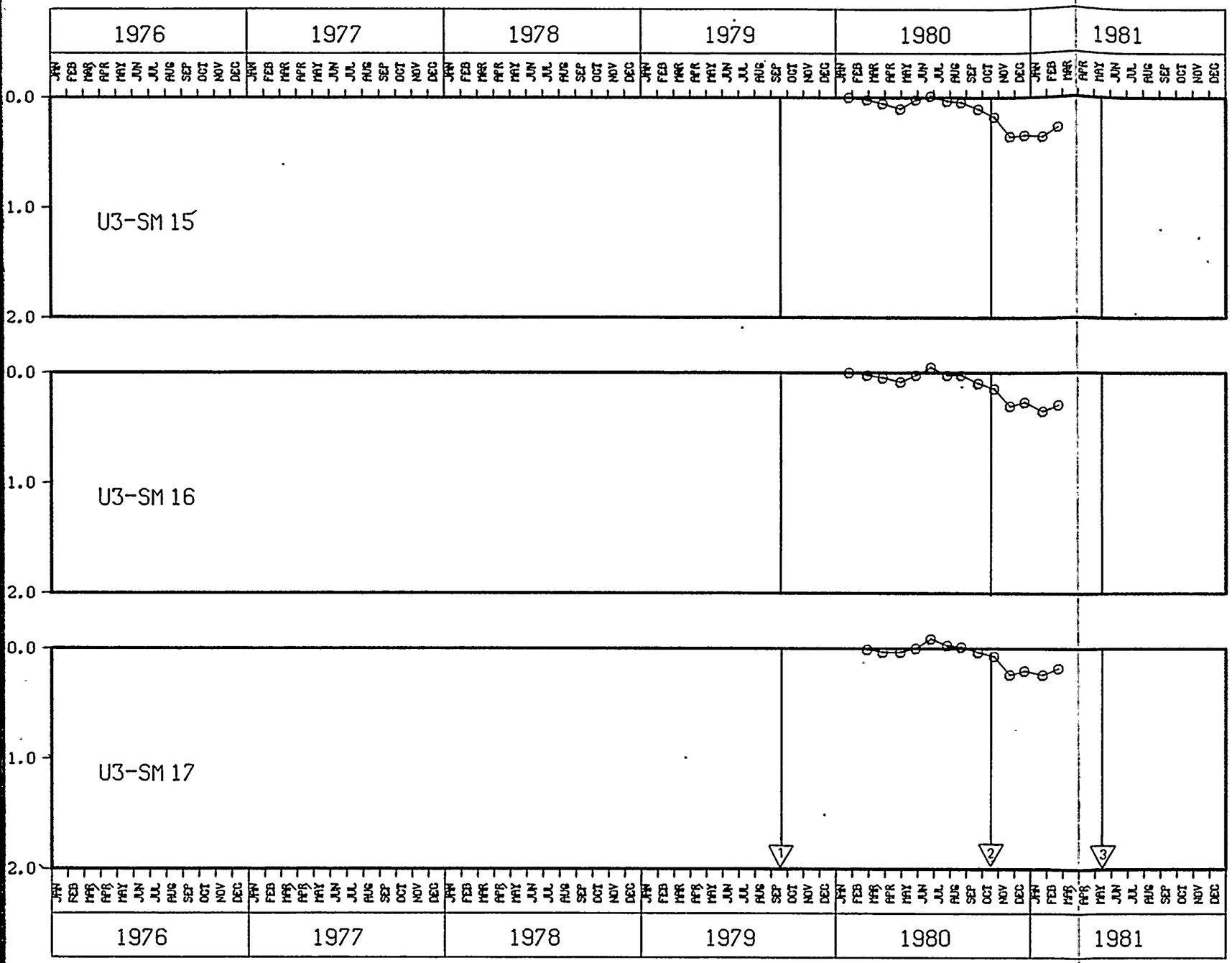
MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE BECHTEL DRAWING NO. SCH-20-3 STATUS AS OF 2-28-81

Palo Verde Nuclear Generating Station
ESAR

PARTIAL SETTLEMENT RECORD
UNIT 3
TURBINE PEDESTAL
Figure 53
Sheet 1 of 2

Project Number 76 056 10


SETTLEMENT (INCHES)
1976
1977
1978
1979
1980
1981
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
0.0
1.0
2.0
U3-SM 11
U3-SM 12
U3-SM 13
1
2
3



CONSTRUCTION MILESTONES

1. FORMING AND CONCRETE POURING BEGUN APPROXIMATELY 9-79
2. PEDESTAL COMPLETE 10-80
3. TURBINE BUILDING COMPLETE 5-81
4. TURBINE GENERATOR ERECTION COMPLETE 7-84

MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDULE"
BECHTEL DRAWING NO. SCH-20-3 STATUS AS OF 2-28-81

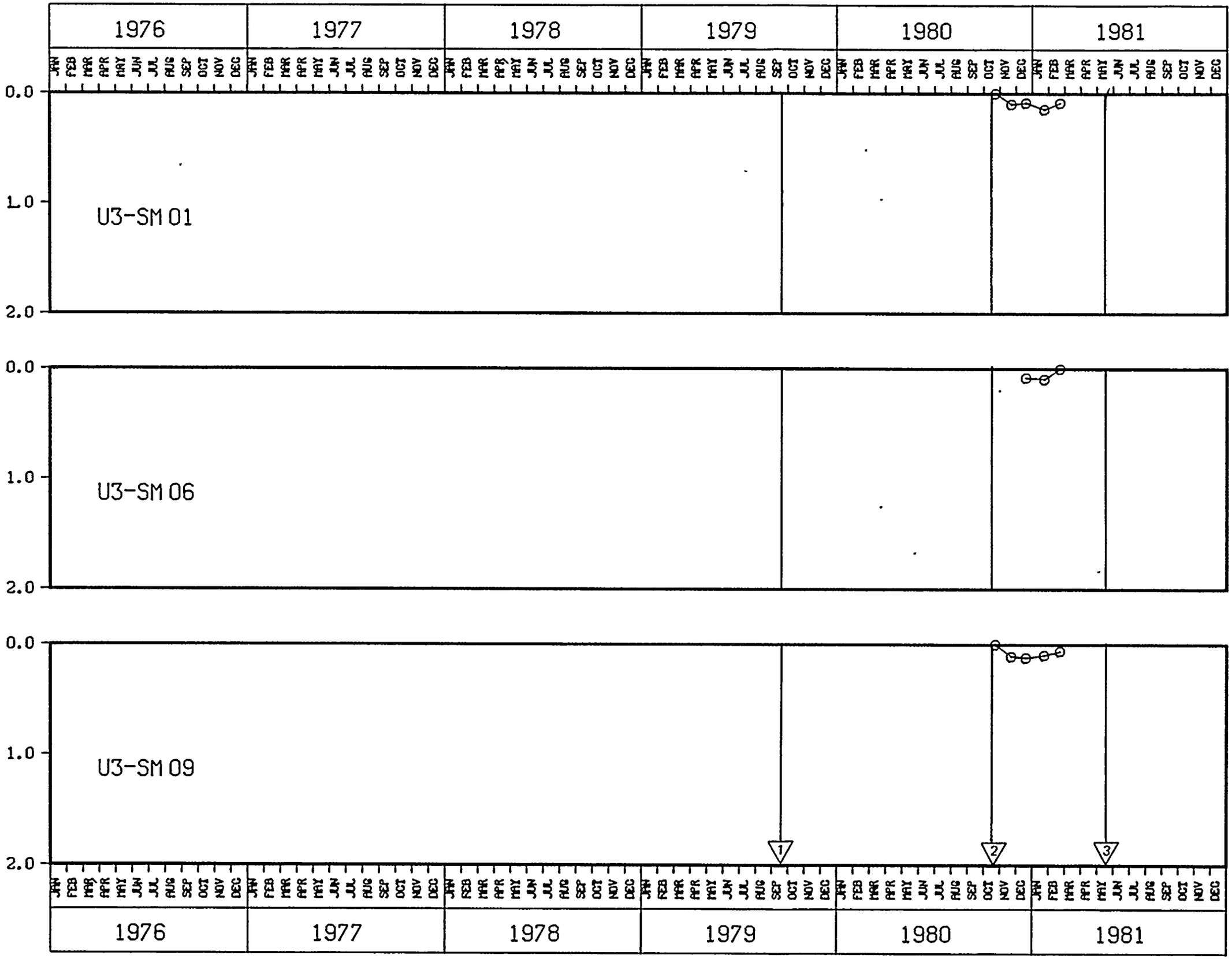
-B6

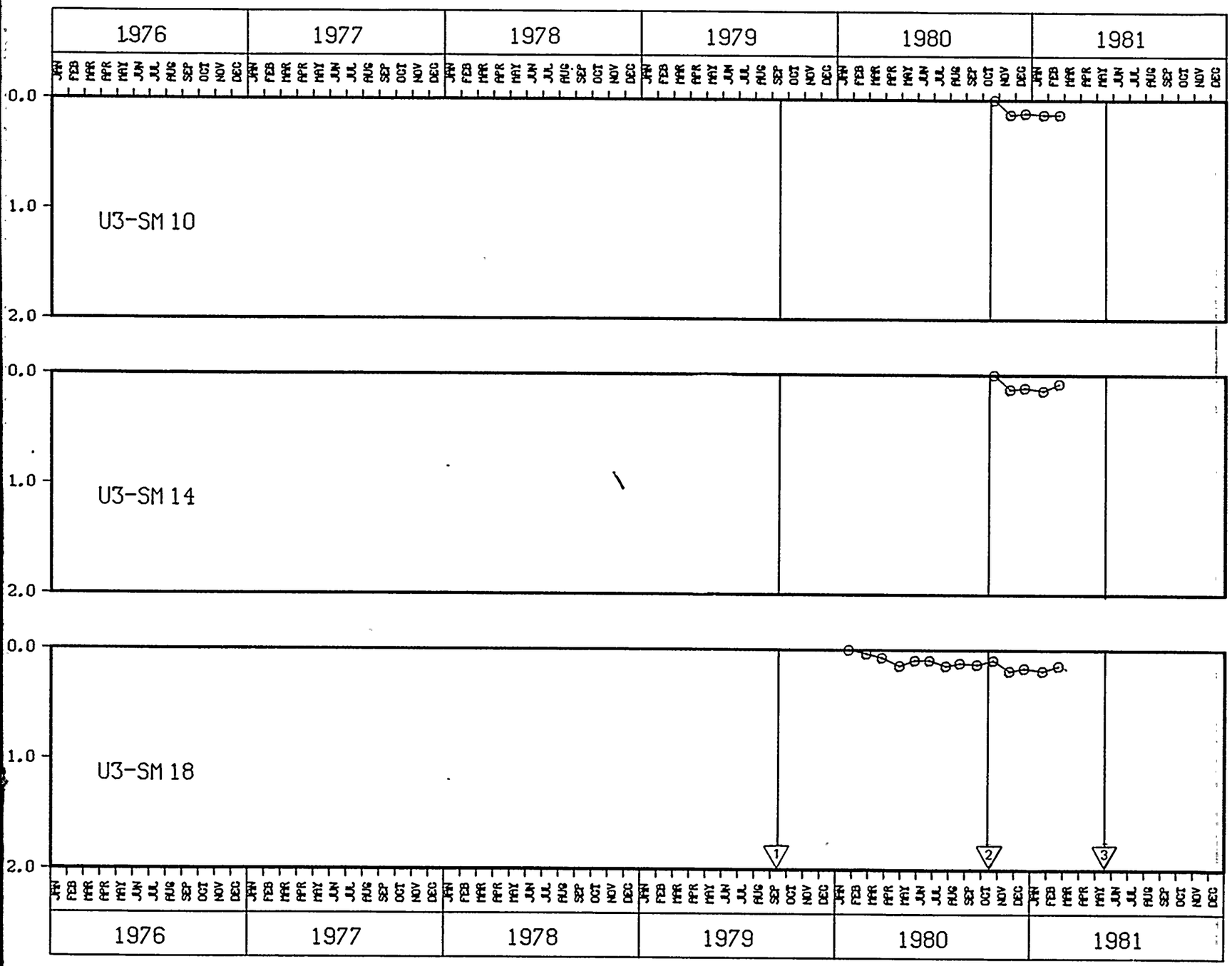
Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 3
TURBINE PEDESTAL
Figure 53
Sheet 2 of 2

Project Number 76 056 10

SETTLEMENT (INCHES)





CONSTRUCTION MILESTONES

1. FORMING AND CONCRETE POURING BEGUN APPROXIMATELY 9-79
2. PEDESTAL COMPLETE 10-80
3. TURBINE BUILDING COMPLETE 5-81
4. TURBINE GENERATOR ERECTION COMPLETE 7-84

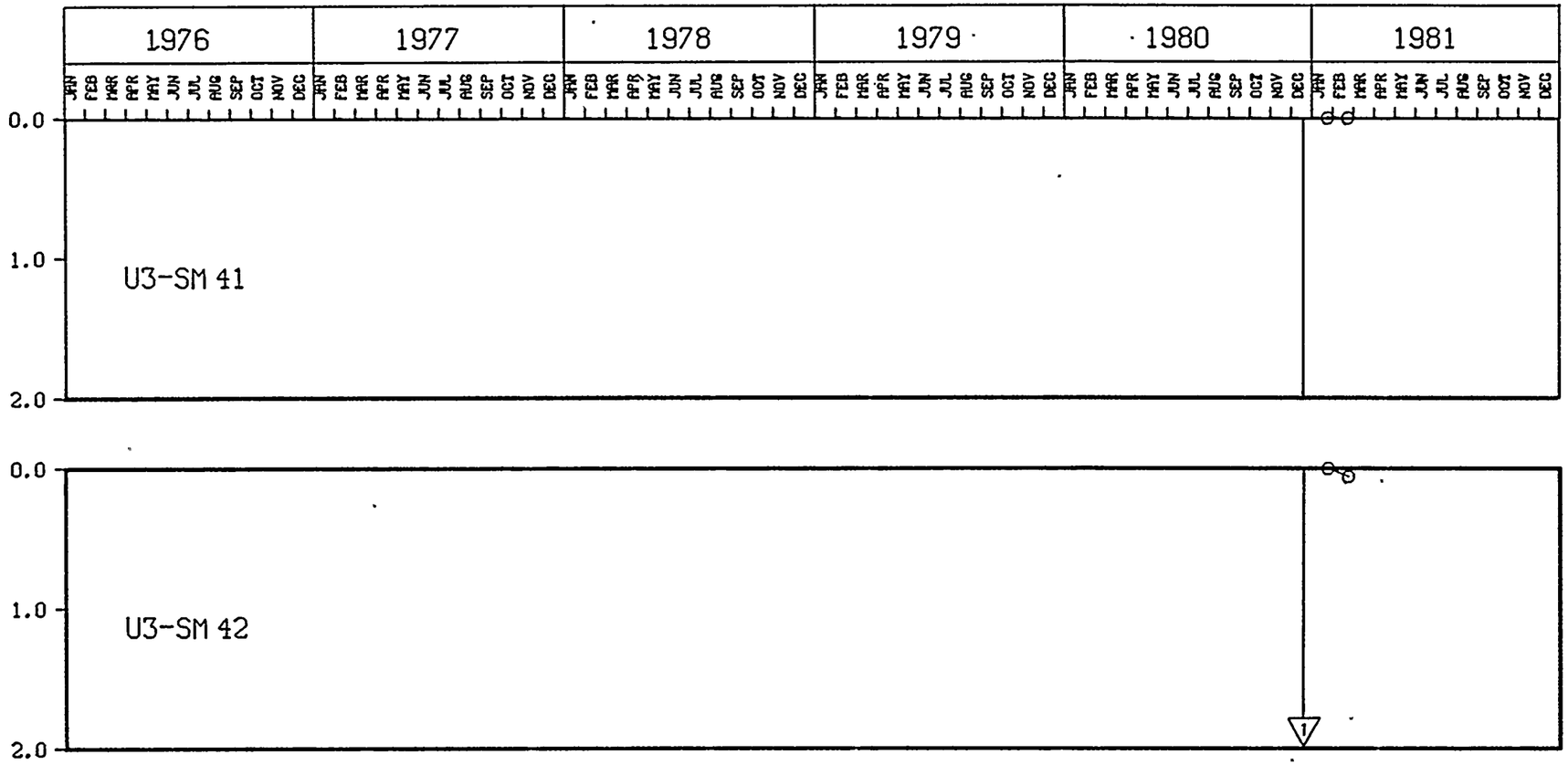
MILESTONE DATES BASED ON "PROJECT MILESTONE SCHEDUL
BECHTEL DRAWING NO. SCH-20-3, STATUS AS OF 2-28-81

87

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 3
TURBINE BUILDING EXTERIOR COLUMNS
Figure 54

Project Number 76-056-10



CONSTRUCTION MILESTONES

1 FORMING AND CONCRETE POURING BEGUN 12-80

2 START LINER 3-83

3 STRUCTURE COMPLETE 11-83

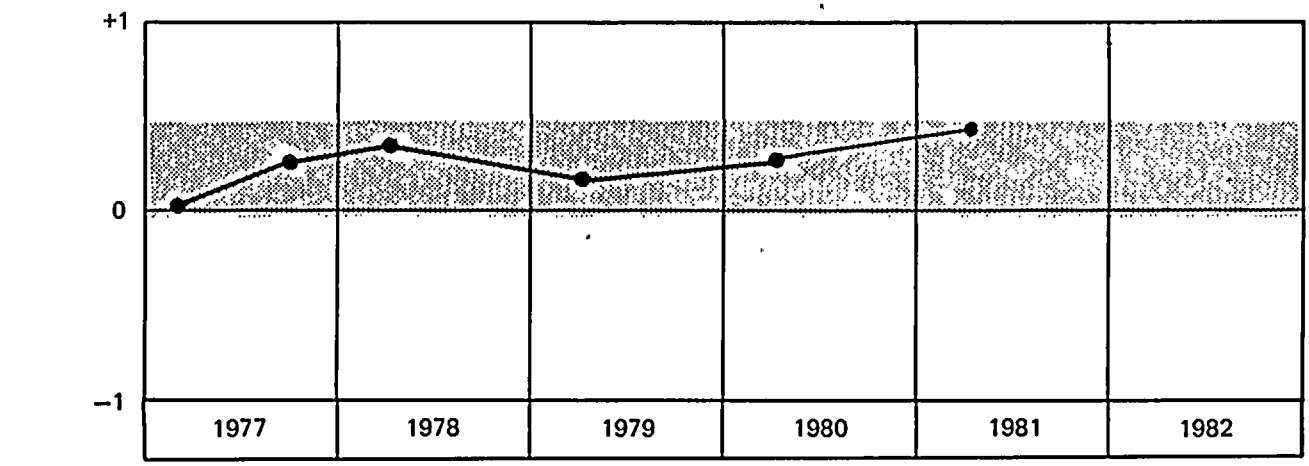
MILESTONE DATES PROVIDED BY BECHTEL PVNGS CIVIL ENGINEERING GROUP, APRIL, 1981

Palo Verde Nuclear Generating Station
FSAR

PARTIAL SETTLEMENT RECORD
UNIT 3
REFUELING WATER TANK

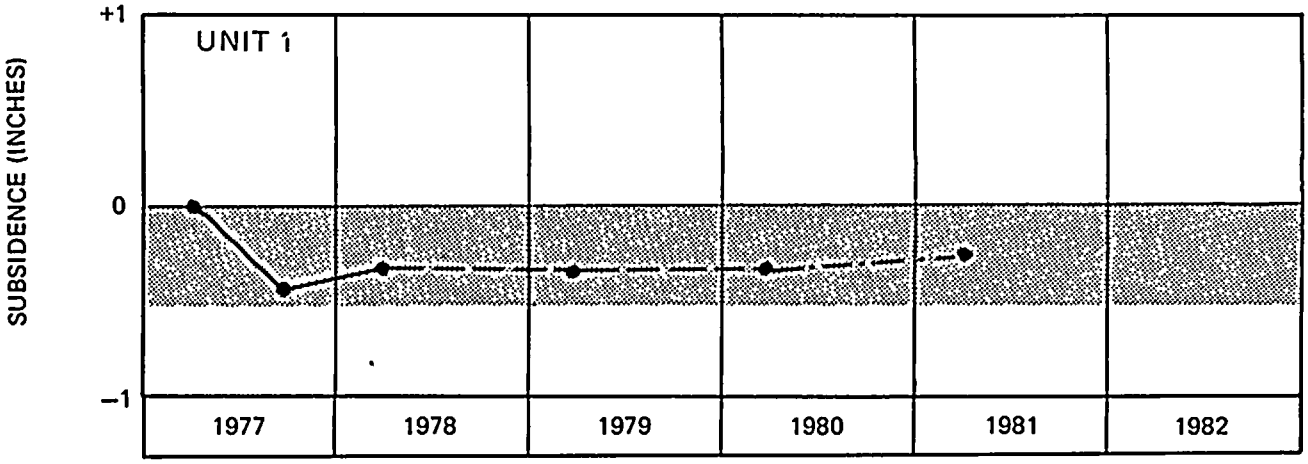
Figure 55

Project Number 76-056 10

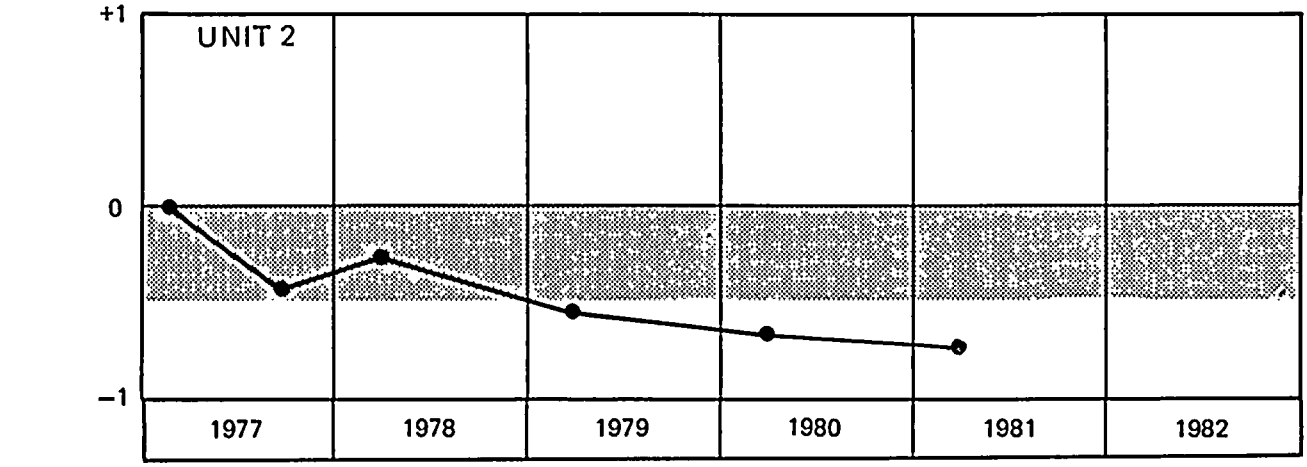


BM-RP

SUBSIDENCE (INCHES)

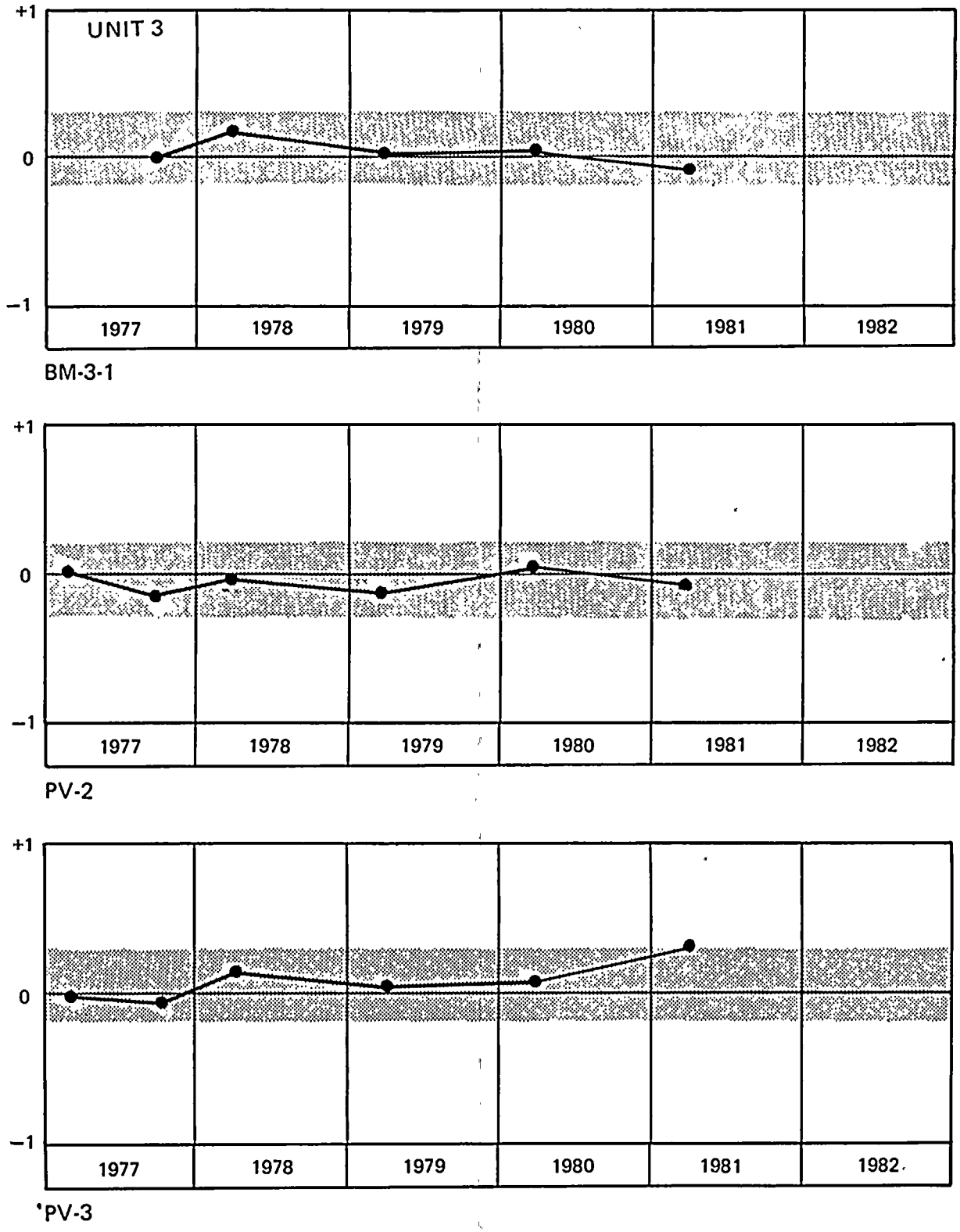


BM-1-1 ——— BM-1-4 — — — — BM-1-1B — • — •



BM-2-1

NO

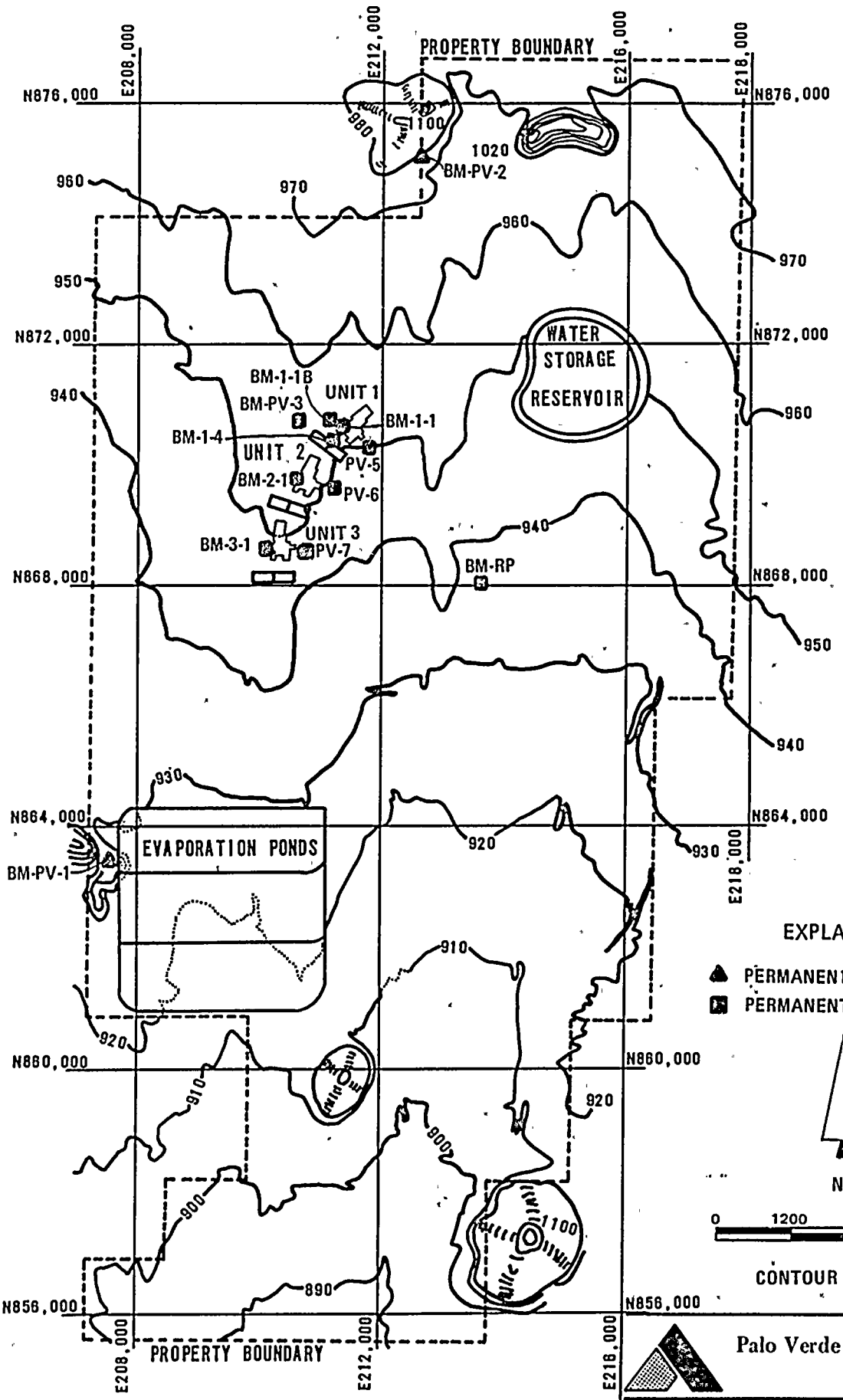


NOTES: Plots represent surveyed change in elevation with respect to BM-PV-1, located on a rock outcrop and assumed to be stable.

Shaded zone represents survey accuracy (+0.25").

Palo Verde Nuclear Generating Station
FSAR

GROUND DEFLECTION RECORDS
SUBSIDENCE MONITORING NETWORK
Figure 57



Palo Verde Nuclear Generating Statio
FSAR

SUBSIDENCE MONITORING
NETWORK BENCHMARK LOCATION
Figure 56

Project Number 76-056-10