FUNCTIONALITY OF MONITORING WELLS LOCATED IN ISLAND COUNTY, WASHINGTON

by Krystyna Kowalik

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Open-File Technical Report 86-02

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M E M O R A N D U M

September 16, 1986

TO: George Krill, Olympia

FROM: Herman Huggins, NWRO

SUBJECT: Report On The Test Wells In Island County

Included are two copies of a report concerning results of the cooperative project between WDOE and USGS for drilling ten test wells during 1983 in Island County.

The report has been prepared in the Northwest Regional Office (NWRO) Resource Management from data available to us from USGS and WDOE Water Resources Project Assistant and Investigation Section in Olympia.

The conclusions of the report indicate some problems with test wells and offer suggestions for improvement. In order for test wells to function as a network for monitoring ground water in Island County, cleaning of most of the piezometers might be required. However, an attempt to do so could be unsuccessful and costly. To avoid excessive expenditures, it would be advisable to plan remedial cleanup work in stages.

If cleanup of two wells would not produce desirable results, further attempts should be discontinued to avoid additional spending.

The difficulty anticipated in the cleanup effort are as follows:

1. Small dimension of piezometers (2") which could prevent usage of pumping equipment.

2. It could be impossible to rinse piezometers which are probably sealed by 'revert', an organic compound used in the past.

In addition, a major problem for the monitoring and sampling purposes is the placement of piezometers, e.g. piezometers tap the same aquifer in a single well. There are also other piezometers that are placed in almost impervious materials - silty clay, according to USGS lithology. These can not be improved in any case. We would appreciate your evaluation of report and guidance to the best solution.

HH:gm

FUNCTIONALITY OF

MONITORING WELLS LOCATED IN ISLAND COUNTY

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June 1986

BACKGROUND INFORMATION

This report summarizes and evaluates the results of a cooperative ground water project conducted by the United States Geological Survey (U.S.G.S.) and the Washington Department of Ecology (Ecology) in Island County.

Ten monitoring wells were drilled during 1983 on Camano and Whidbey Islands. Research focused on the subject of seawater intrusion into fresh water aquifers throughout Island County. The purposes of the 1000-foot deep drillings were:

1. Establish a zone of interface between sea and fresh ground water.

2. To reach the bedrock.

3. Serve as an observation and monitoring of wells.

For this reason, piezometers were installed in the wells to tap ground water from different aquifers. They would have provided opportunity to take samples from different aquifers in order to monitor seawater intrusion. Long duration measuring of ground water level fluctuations gives information about changes in the ground water level (lowering of ground water level indicates over-pumping of an aquifer).

In Island County, the network of monitoring wells is of great importance because of a threat or occurrence of seawater intrusion. Observation of changes of ground water levels and sampling for chlorides is the tool to check where and at what times seawater intrudes the fresh water aquifers. A better understanding of ground water flow, and a comprehensive description of lithology, and stratigraphy of aquifers, would contribute the necessary information for ground water management.

The drilling of monitoring wells was supposed to provide information relative to lithology, stratigraphy of aquifers, and better understanding of ground water flow. Results obtained from the drilling are partially incorporated in the USGS Water Investigation Report 85-4046 (1986), "Occurrence of Ground Water and Potential for Seawater Intrusion, Island County, Washington". Eight monitoring wells are located on Whidbey Island. Numbers 1, 2, 3, 10 in the northern part of the Island; 4 and 9 in the central part; and 5 and 6 in the south eastern tip of the Island (in the vicinity of Langley). Well number 7 is located in Camano Island and Well number 8, in the central part of Camano Island.

Between 1983 and 1986, ground water level measurements were not done on a regular basis. As of January 1986, NWRO, Resource Management, has taken measurements on a quarterly basis. The first two measurements

were completed and are used in this report in a table summarizing all the findings related to monitoring wells in Island County. Most of the monitoring wells need to be developed to allow water flow into piezometers, or need to be cleaned out (i.e., some oil from drilling equipment has been detected in the well). None of the wells are suitable for sampling, and in some wells, the piezometers are filled with silt. In others, inflow of ground water is obstructed by a gelafied organic compound "revert" which has been used initially to clean the wells . A detailed description of problems for the individual wells is listed below: (For a summary of information, see Table 1, and for further detail, geological sections of test wells are included.)

SUMMARY AND EVALUATION

The attached narrative describes specific technical problems encountered with some of the monitoring wells. In addition, most of the data integral to an accurate evaluation of the monitoring system (test wells) is three years old. The age of the data prohibits a qualified study of the original work. The purpose of this report is to clarify and describe operational problems with the monitoring wells.

Well Number 1 (Northeast Whidbey Island) T-33N/R2E-28k

Elevation: 400' Depth: 920' Number of Piezometers: 3

A. Piezometers #1 and #2 are functional, however it is difficult to conclude which aquifers are supplying water.

B. Placement of piezometers #2 and #3 does not correspond with occurrences of ground water as indicated in the well logs. (There is no ground water occurrence on the USGS well log from 254' - 800')

C. Piezometer #3 (after 2 DOE measurements) is dry at 350' or obstructed (possibly with silt).

Well Number 2 (Northwest Whidbey Island) T-33/R-1E-26D

Elevation: 130' Depth: 680' (Bedrock) Number of Piezometers: 4

A. The aquifer which is supposed to supply water to piezometer #2 (345') is a sand layer 1' thick; water stabilized at 103'. (It is difficult to explain 200' of piezometric pressure.) USGS hydrograph shows measurements of 103' for piezometer #2.)

B. Piezometer #3 taps 2 aquifers at 395' and 430'. Water analysis from a sample taken at 430' shows very high chloride content - 2200 mg/L. Mixing water from 2 different aquifers in one piezometer is not desirable.

C. Piezometer #4 ends at 585' at the beginning of a 60' sand layer (580' - 640'). Based on USGS logs, there are also two aquifers at 460' and 504' contributing water to this piezometer.

D. Ground water measurements in all piezometers are approximately the same 103'. Probable indication of improper sealing between piezometers.

E. All 4 piezometers need to be cleaned and developed, however, piezometers #2, #4, might not be useful for monitoring.

Well Number 3 (North Whidbey) T-32N/R1E -9M

Elevation: 180' Depth: 1005' Number of Piezometers: 4

A. Oily pollution in all 4 piezometers.

B. During two quarterly measurements by NWRO-RM, all measurements in 4 piezometers were almost the same - 162'.

C. Piezometers 1 and 2 ended in the middle of an aquifer: #1 (320'-390') end of piezometer 354' ; #2 (440'-525') piezometer ends 492'.

D. Piezometer #3 taps two aquifers (based on USGS well log) separated by clay: 535' - 650' which would create difficulty for sampling. The placement of this piezometer is approximately 225' of claystone, and siltstone is not justified although the formation is interbeded with clay and gravel layers.

E. Piezometer #4 does not penetrate aquifer (sand, gravel, which ends at 880'; piezometer ends at 834')

F. Well should be cleaned and developed (as it was advised in USGS hydrographs), however, piezometer might not respond to cleaning and should be removed.

Well Number 4 (Central part of Whidbey Island) T31N/R1E-11H

Elevation: 190' Depth: 1000' Number of Piezometers: 3

A. There is only one indication of ground water level in USGS well log - 122' from a neutron log.

B. Two quarterly measurements of ground water level are different than USGS hydrograph data. (NWRO measurements: 125, 125, 130, 150, 150, 124.)

C. It is impossible to conclude, based on USGS well log data, which aquifer provides water to which piezometers.

Well Number 5 (South Whidbey Island) T30/R3E-30M

Elevation: 320' Depth: 1005' Number of Piezometers: 3

A. Piezometer Number 1 ends in sand of considerable thickness. End of piezometer - 310'(sand from 50' to 575').

B. Placement of second piezometer is not fully justified. Piezometer Number 2 is placed in the same aquifer as Piezometer Number 1.

C. In Piezometer Number 3, at a depth of 319', there is mud or silt, and the piezometer is dry. The end of the piezometer is at 935'. It seems approximately 600' of silt has accumulated in this piezometer.

The piezometer should be cleaned; perhaps there is only a local obstruction which can be removed.

Well Number 6 (Southeast Whidbey Island) T29N/R3E-3J

Elevation: 179.83' Depth: 1005' Number of Piezometers: 4

A. Piezometers 1 and 2 end in a thick sand and gravel formation. Piezometer 1 ends at 214'; Piezometer Number 2 - ends at 448' (sand from 400' to 525')

B. Piezometer Number 3 - ends at 610', Piezometer Number 4 - ends 836', both piezometers are in clay formation (USGS well log lithology), which is deposited from 550' to 1005'.

C. It is difficult to distinguish which piezometer represents which aquifer. Ground water levels in Piezometers 1, 3, and 4 are very close in values - 161', 165', 167'. It is possible that seals between them allow some seepage. In Piezometer Number 3, which ends at a depth of 610' (in clay), the water level is 115'. There is no explanation why the water level is so high in that piezometer from the description of lithology in USGS well log.

D. Well should be cleaned and developed as suggested in USGS hydrographs.

Well Number 7 (North Camano Island) T32N/R2E-25K

Elevation: 430' Depth: 1002' Number of Piezometers: 3

A. Piezometers Number 2 - end 470', is penetrating claystone deposits (from 410'-630'). There was no ground water indication in that formation. It was indicated that water used for drilling was absorbed quickly.

B. Piezometer Number 3 is dry at the depth of 283'. It is not known if this is a local obstruction. Piezometer 3, 933' end, is drilled through thick clay formation as described by USGS well log (from 630' to 985'), which is underlain by sand and gravel producing water, that was not tapped by Piezometer Number 3.

C. Ground water measurement in USGS log is 80' below ground level. None of the present measurements confirm this. It could be an indication that all piezometers need to be cleaned to allow inflow of ground water.

D. Quarterly measurements by NWRO for Piezometers 1 and 2 are 203', 234', however, the source of water is not identifiable. USGS log indicates different water levels (see Table 1 for details).

Well Number 8 (Central part of Camano Island) T31N/R3E-30D

Elevation: 170' Depth: 1005' Number of Piezometers: 3

A. Piezometer number 1 ends at 135' in clay deposit (interceded with sand and gravel layers). Ground water level indicated by USGS well log was 15'--according to NWRO measurements, it is at 135'.

B. Piezometer Number 2, ends at 245', should have ended at 300' at the end of a sand layer which begins at 175' to 295'.

C. Piezometer Number 3, which ends at 584' is positioned at the top of a sand deposit (584'-625'). In the USGS well log, there are 4 ground water levels, all of which will contribute water to piezometer Number 3. Consequently, Piezometer Number 3 does not provide data for monitoring ground water level changes or sampling.

D. Ground water measurements from field data by NWRO are 80', 146', 108'. It is impossible to identify which aquifer provides water to which piezometer.

Well Number 9 (Previously #13 located in Central Whidbey) T31/R1E, Sec. 15

There is no well log for that well.

Elevation: Not known Depth: Not known Number of Piezometers: 4

Monitoring has no purpose without well log information.

Field measurements were taken by NWRO for this well and are as follows: Piezometer 1 - 2.5; 16.3; 14. Piezometer 2 is locked permanently.

Well Number 10 (Northwest Whidbey Island) T32N/R1E-Sec. 5

Elevation: Not known Depth: 1000' Number of Piezometers: 3

All piezometers are flooded, due to overflow of surface water or shallow ground water level.

The hydrographs compiled by U.S.G.S. for monitoring wells do not seem to be based on ground water level measurements. The data does not reflect present ground water level measured by DOE. In all 10 wells, information about ground water level in the deep piezometers is not available. The individual section for monitoring wells compiled by DOE include data for all piezometers deduced from U.S.G.S. hydrographs. The DOE hydrographs for three consecutive quarterly measurements for 1986 are attached to this report.

Chemical Analysis, Hydrographs

Separate attention should be given to chemical analysis of ground water samples. The relevance of water analysis and the results are directly related to the purpose of drilling monitoring wells. Seawater intrusion is detected by high chloride concentration in the analyzed sample. That, in turn, would provide information about the interface between fresh and sea ground water. The present state of piezometers in these monitoring wells prevents effective sampling. The results of chemical analysis that were performed by USGS should be confirmed because some of them could have computational errors. Ex. - Well Number 4 has, according to USGS lab results, 1600 mg/L Cl^- at depth 358'. Samples taken from a greater depth do not have a high chloride content. There were 30 samples taken from monitoring wells - 25 analyses have results, 8 should be critically viewed and be repeated.

Conclusions:

1. After reviewing in detail monitoring well logs (USGS and drillers), it is apparent that some assumption influenced the decision about placement of piezometers. The concept of four hydrogeological units (zones or aquifers), created need of positioning piezometers accordingly. (On all USGS well logs, those units are indicated and also on the hydrographs). In seven out of ten wells, piezometers are not placed optimally for inflow of ground water, based on a lithological description of aquifers in USGS well logs.

2. One of the aims during drilling of monitoring wells was to reach bedrock underlying unconsolidated deposits. In 10 wells, only one has accomplished that aim. Well Number 2 - bedrock at 645'.

3. The monitoring wells did not provide as yet conclusive information about the interface between seawater and fresh water. Extensive sampling would be necessary to obtain reliable evidence of the presence of high concentration chlorides.

4. Very crucial hydrogeological information is missing in all USGS well logs for monitoring wells.

   a. Occurrences of confined ground water.

   b. Aquifer information related to the first ground water measurements. (Ex. - Ground water level in first piezometer is 82' - not known which aquifer).

   c. Water observation not included in the log - data based on geophysical logging (Well #4). Consequently, there is no basis for suggestion on how to improve malfunctioning piezometer.

5. Due to the malfunction of the deepest piezometers and sometimes ambiguous description of lithology, there is no ground water information for the deeper aquifers.

6. Lack of information about perforation in the piezometers is perhaps most disadvantageous for improving the function of piezometers in the monitoring wells. Theoretically, according to specifications of observation wells, perforation should be extended through all thickness of a waterbearing deposit. In all 10 wells, however, perforation zones on the piezometers are not known (as of the time this report was finished).

7. The use of "revert" compound apparently caused clogging of piezometers, but it is not known in which well it has been used, nor how to remedy the situation.

8. The importance of monitoring wells in Island County is very significant and public opinion is focused on that subject. Monitoring ground water for seawater intrusion is a part of a ground water management plan and should provide accurate and appropriate information.

   Efforts should be made to improve monitoring wells to their original intended state. Assuming that all 10 wells could be fully functional, more wells are still needed to incorporate an effective network. With additional wells, a more accurate hydrogeological evaluation would emerge.

Presently NWRO Resource Management is establishing an initial, enlarged network of monitoring wells including, private production wells and public water system wells. Listed below are suggestions for some improvements of monitoring wells:

1. The most crucial factor will be to clarify construction details of individual wells.

2. Clean wells that can be pumped out and rinsed to allow ground water to enter piezometers. (This would require financing for NWRO Resource Management.)

3. Remove some of the piezometers which cannot be cleaned or which tap the same aquifer (after aquifer boundaries are established).

4. Limit piezometers to one if that would save a monitoring well from total loss (abandonment). In Table 1, all of the findings related to monitoring wells in the Island County are summarized in detail.

LOCATION OF TEST HOLES

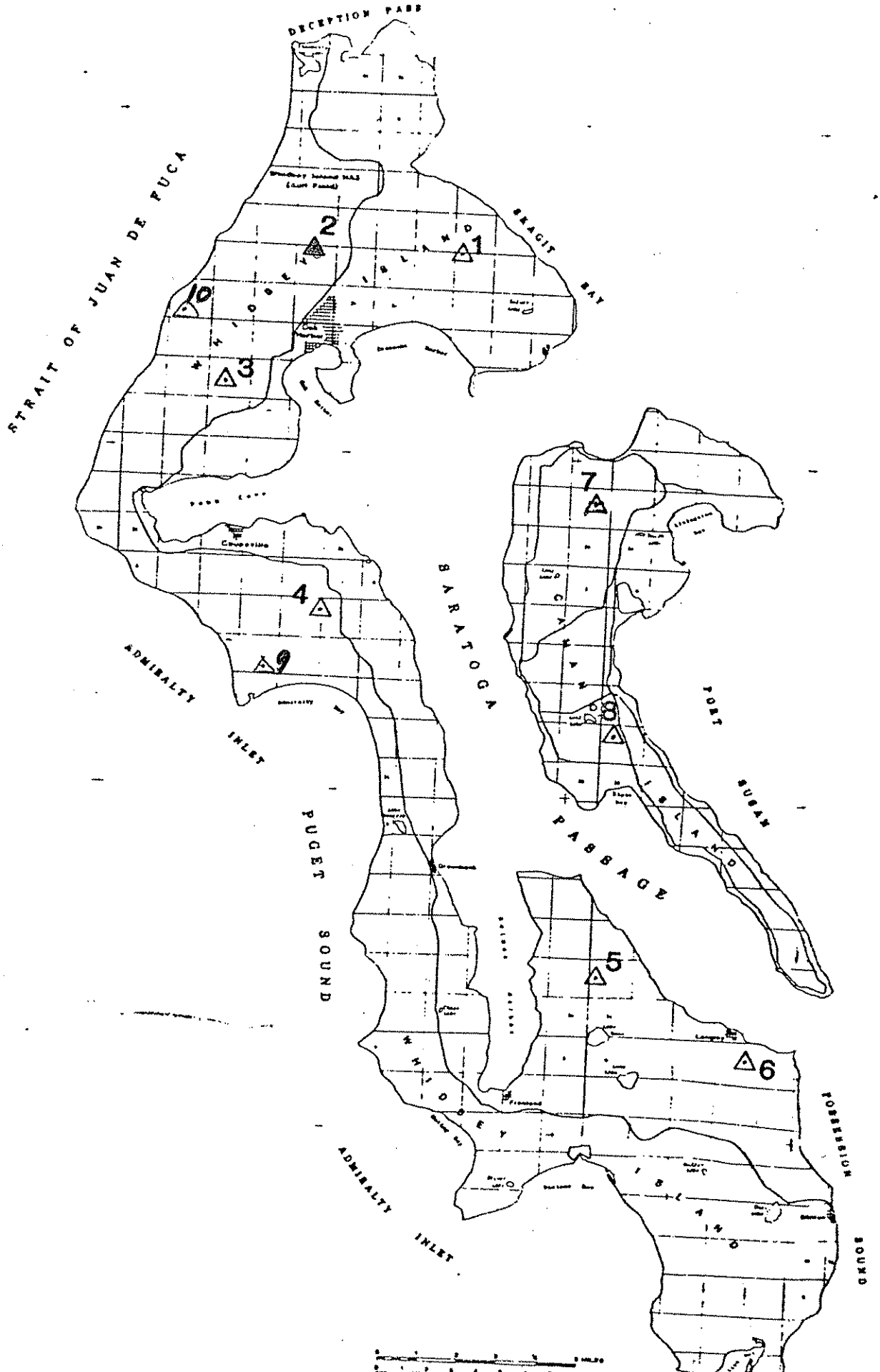


Figure 1

IDEALIZED DETAILS OF CONSTRUCTION

(NOT TO SCALE)

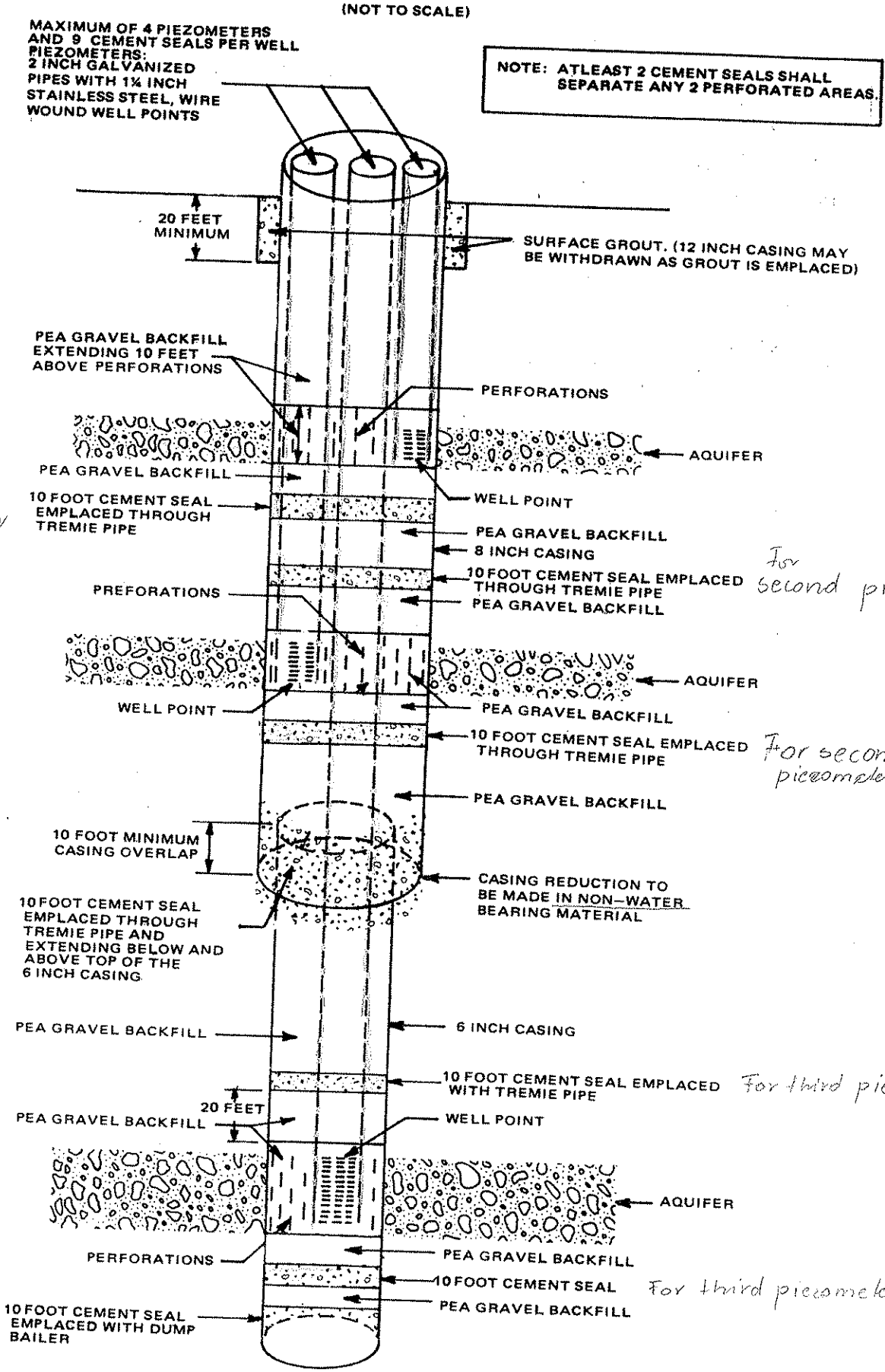


TABLE I

Well Number (Location) Elevation Depth	How Many Piezometers (Depth)	Ground Water Level In Piezometers DOE	Ground Water Level In Piezometers USGS	Ground Water Occurrences From USGS Well Logs - Water Samples (Depth)	Chloride Mg/L	Accomplishments	Problems Encountered	Suggestions For Improvement
1. 33N/2E - 28K E400' D.820	1 - 340' 2 - 429' 3 - 576'	*188.2 254.7 350. dry	182. 256. 406.	I. 183' first field data II. 190' III. 254' Water Samples A. 280' B. 800'	 8.9 1600	1. Piezometer #1, #2, active	1. Obstruction in piezometer 3 2. Perforation in all piezometers unknown 3. Sample B - source unknown (800 - aquatard) 4. No ground water information in the well log for Piezometers 2, 3	Remove Piezometer 3 if not possible to clean
2. 33N/1E - 26D El: 130 D: 682	1 - 162' 2 - 345' 3 - 441' 4 - 585'	103. 102.96 102.83 101.93	103.8 102.6 102.8 101.3	I. 105'(in Piez. 1) II. 430' III. 460' IV. 395' Water Samples A. 195' B. 348' C. 430' D. 504'	 56 66 2200 20	Bedrock at 695'	1. Measurements are all almost identical as a first ground water measurement in Piezometer 1. 2. Piezometer 1 ends in the sand, there is possible seepage or connection between piezometers. 3. For 2nd piezometer, aquifer unknown.	Perhaps piezometers 2 & 3 have to be removed.

* The measurements of ground water level are preformed by DOE quarterly: January, April, August, November. First 3 measurements were the same to: 0.2".

Ground Water Level in Piezometers		Ground Water Occurrences From USGS Well Logs - Water Samples (Depth)	Chloride Mg/L	Accomplishments	Problems Encountered	Suggestions For Improvement
DOE	USGS					
162.66 161.83 162.63 162.05	162.2 162.2 162.0 162.0	I. 167' II. 320' III. 425' IV. 440' V. 535' VI. 650' Water Samples A. 227' B. 297' C. 320' (658, 810) (425',445',558',617',640')	 16 16 30		1. Oily pollution in all 4 piezometers. 2. Water level in piezometers almost identical. Do not reflect ground water level. 3. Piezometer 1, 2 end in the middle of sand, gravel deposit.	Clean 4 piezometers
125. 125. 139.	150 140 124	122' - from neutron log Water Samples A. 350' B. 425' C. 443' D. 513' E. 745'	 1600 35 18 74 170	Probably reach the rock.	1. Piezometers 1,2,3 end in sand. 2. It is impossible to identify which piezometer taps which aquifer. 3. There could be a connection between Piezometer 1, 2. 4. There is no ground water observation other than neutron log.	Identification of piezometers in relation to aquifers. Check seal between Piezometer 1,2.

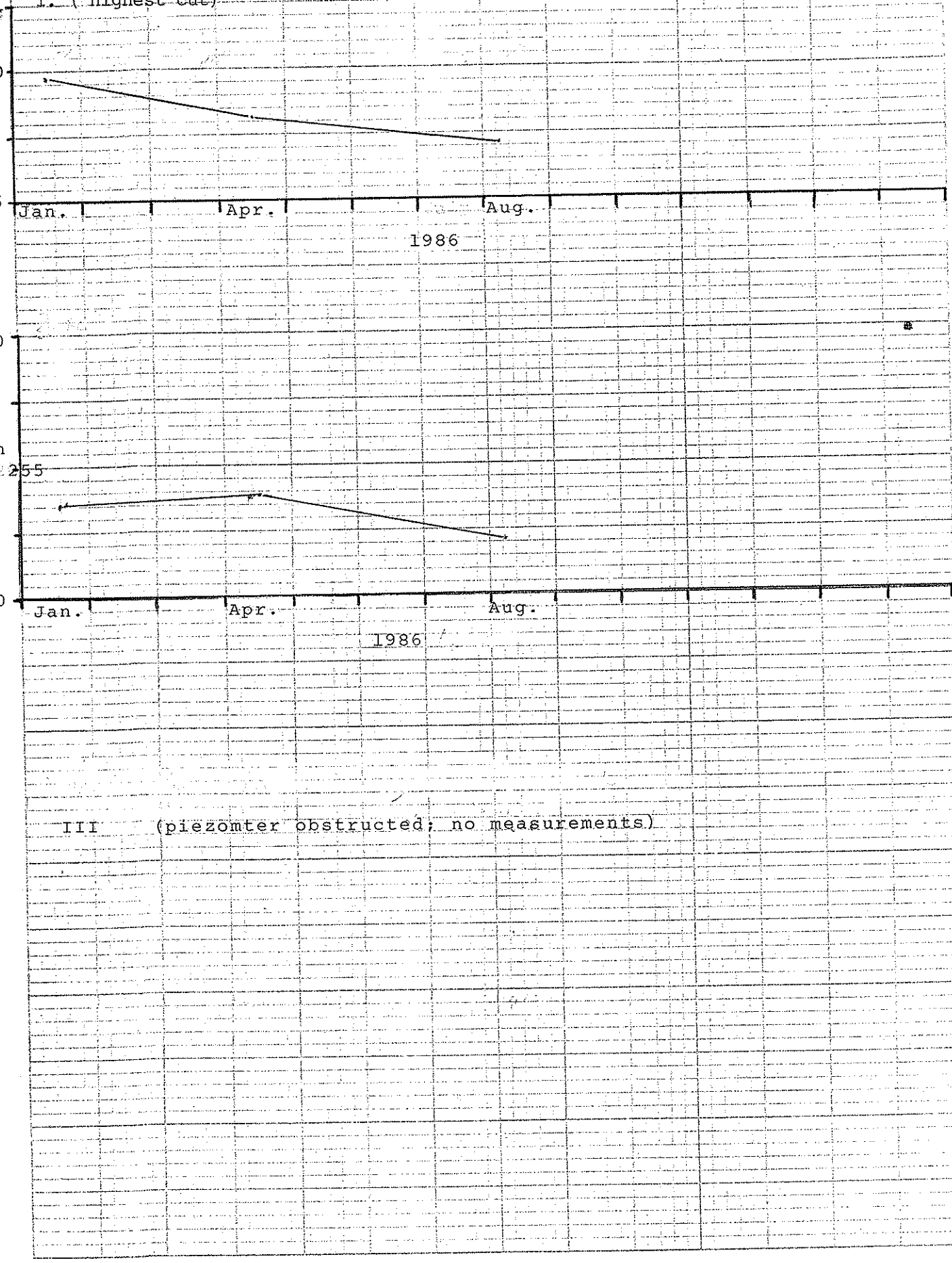
Ground Water Level in Piezometers		Ground Water Occurrences From USGS Well Logs - Water Samples (Depth)	Chloride Mg/L	Accomplishments	Problems Encountered	Suggestions For Improvement
DOE	USGS					
310	320	304			1. Piezometer 1 ends in sand.	Determine if Piezometer 3 has an obstruction.
320	320				2. Piezometer 3 is dry at 320' (perhaps filled with silt - 600' from the bottom of Piezometer 1.	Try to clean obstruction.
320 dry	303				3. Piezometers 1, 2, might be connected - not properly sealed.	Remove Piezometer 3 if not successful with cleaning.
		Water Samples				
		A. 464'	13			
		B. 540'	130			
		C. 940'	2900			
167		17'		Piezometers active	1. Difficult to assess which piezometer represents first aquifer.	For Piezometer 3, USGS recommendation, clean out and develop.
165					2. Piezometer 1,2, end in sand, perhaps tap the same aquifer or have poor sealing.	
115.3					3. Piezometer 3, 4, are penetrating thick clay deposits. There is no ground water observation.	
161.3		Water Samples				
		A. 384'	110			
		B. 505'	7200			

Ground Water Level in Piezometers		Ground Water Occurrences From USGS Well Logs - Water Samples (Depth)	Chloride Mg/L	Accomplishments	Problems Encountered	Suggestions For Improvement
DOE	USGS					
203.3 234.2 282 dry	185 229 383	80', 265', 362' Water Samples A. 278' B. 988 (fe dissolved 1700 mg/L)	 13 22		1. Piezometer 1 ends in sand. 2. Piezometer 2 is placed in 70' of clay - source of water not known. 3. Piezometer 3 ends after penetrating 65' of clay (drilled open hole). No groundwater information. 4. Piezometer 3 is dry at 282'.	Piezometer 3 should be cleaned.
79' 145' 107'	188'-150' 95' -180' 74' - 41'	82', 168', 340', 401-405', 505', 579' Water Samples A. 15' B. 236' C. 505' (fe dissolved 1100 mg/L) D. 599'	 15 19 230 210	All piezometers seem to be working.	1. It is impossible to identify which piezometer taps which aquifer. 2. Piezometer 2 ends in sand. 3. Piezometer 3 ends at the beginning of sand deposit which might be a confined aquifer. * No static water level observation.	USGS recommendation for Piezometers 1,3 - clean out, develop and refill.

Ground Water Level in Piezometers		Ground Water Occurrences From USGS Well Logs - Water Samples (Depth)	Chloride Mg/L	Accomplishments	Problems Encountered	Suggestions For Improvement
DOE	USGS					
2.40	4.0'				1. Well log not available.	Piezometer 4 should be open.
16.3	7 - 16'				2. Piezometer 4 shut tight.	All piezometers should be pumped out.
14.0	17'				3. Piezometer 1,2,3 on last measurement filled with water. (Perhaps not properly sealed)	Well log is essential for this well.
Locked	?					
				Well log exists	1. Well flooded measurements impossible.	Well should be pumped out.

TEST HOLE #1 Whidbey Island

Piezometer Water Level Measurements
DOE 1986

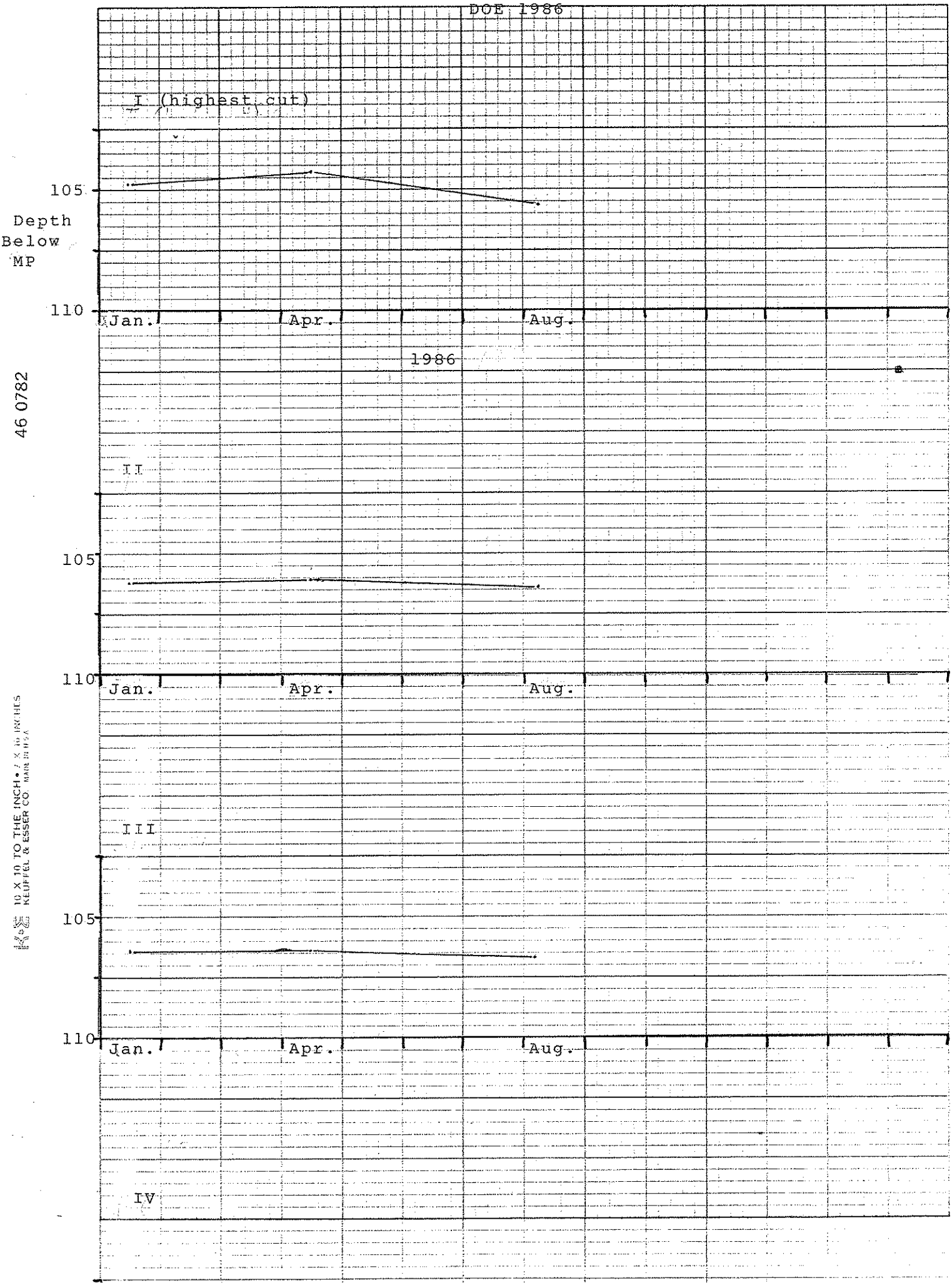


III (piezomter obstructed; no measurements)

TEST HOLE #2 Whidbey Island

Piezometer Water Level Measurements

DOE 1986



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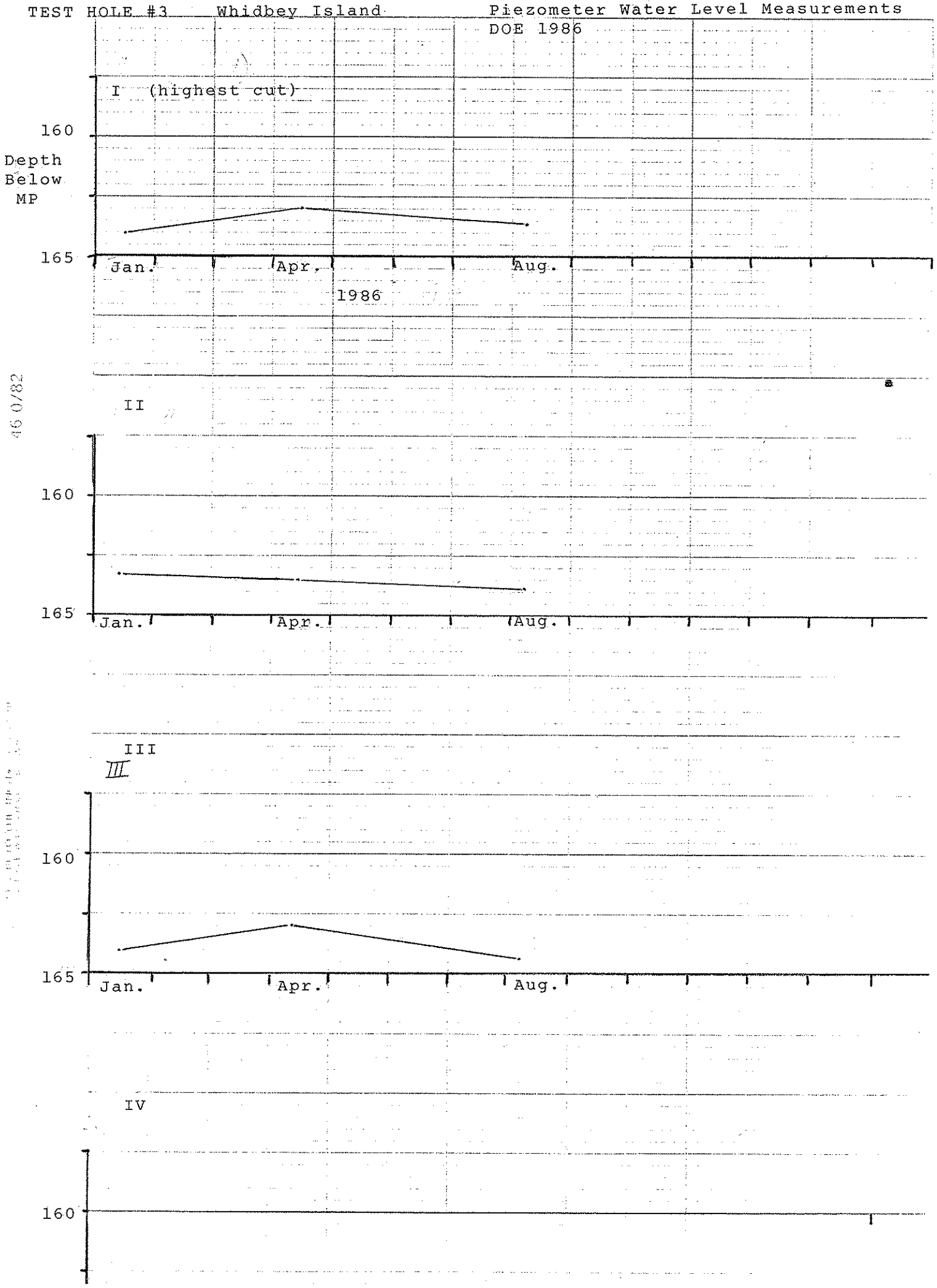
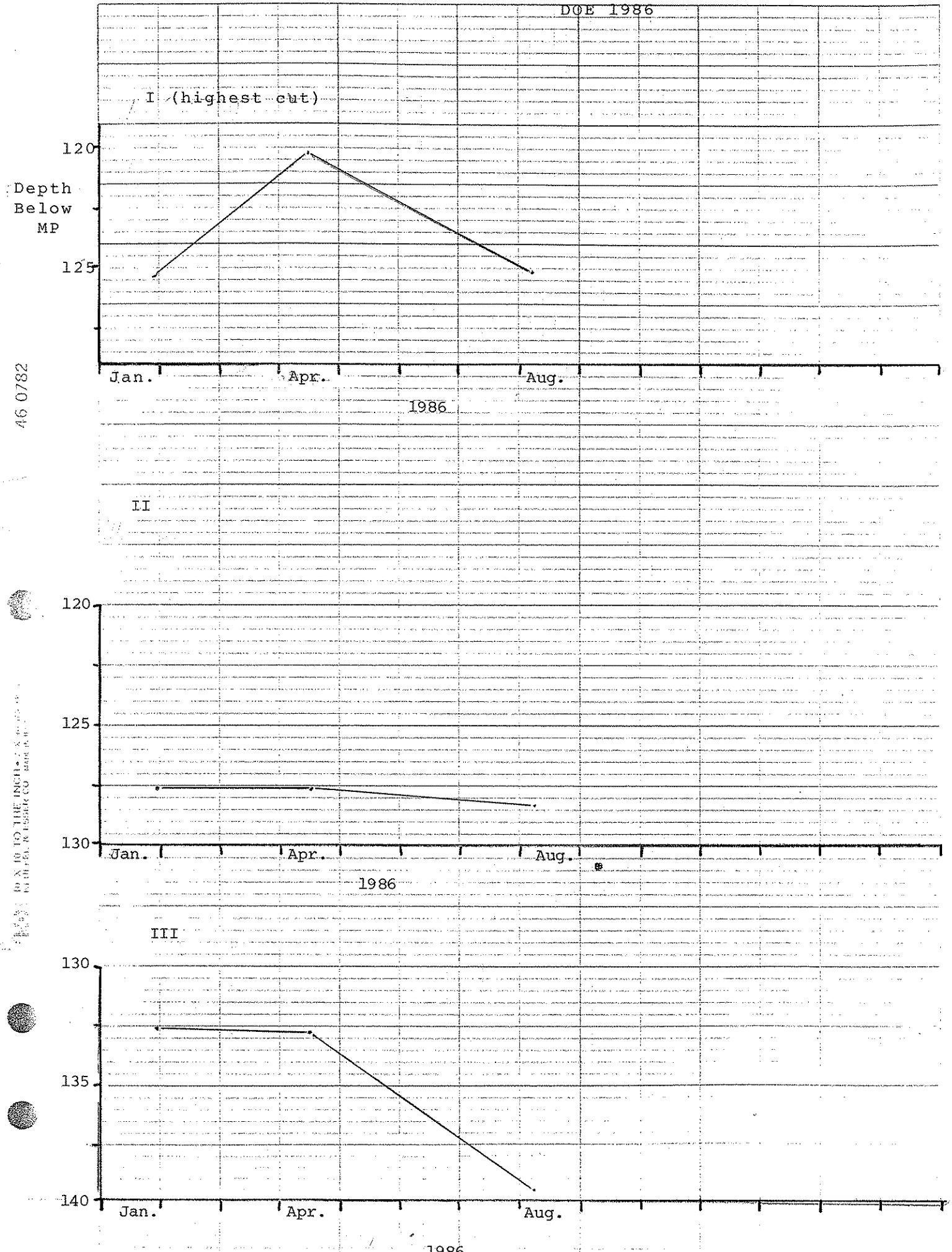
TEST HOLE #3 Whidbey Island Piezometer Water Level Measurements
DOE 1986



TEST HOLE #4 Whidbey Island Piezometer Water level Measurements

DOE 1986



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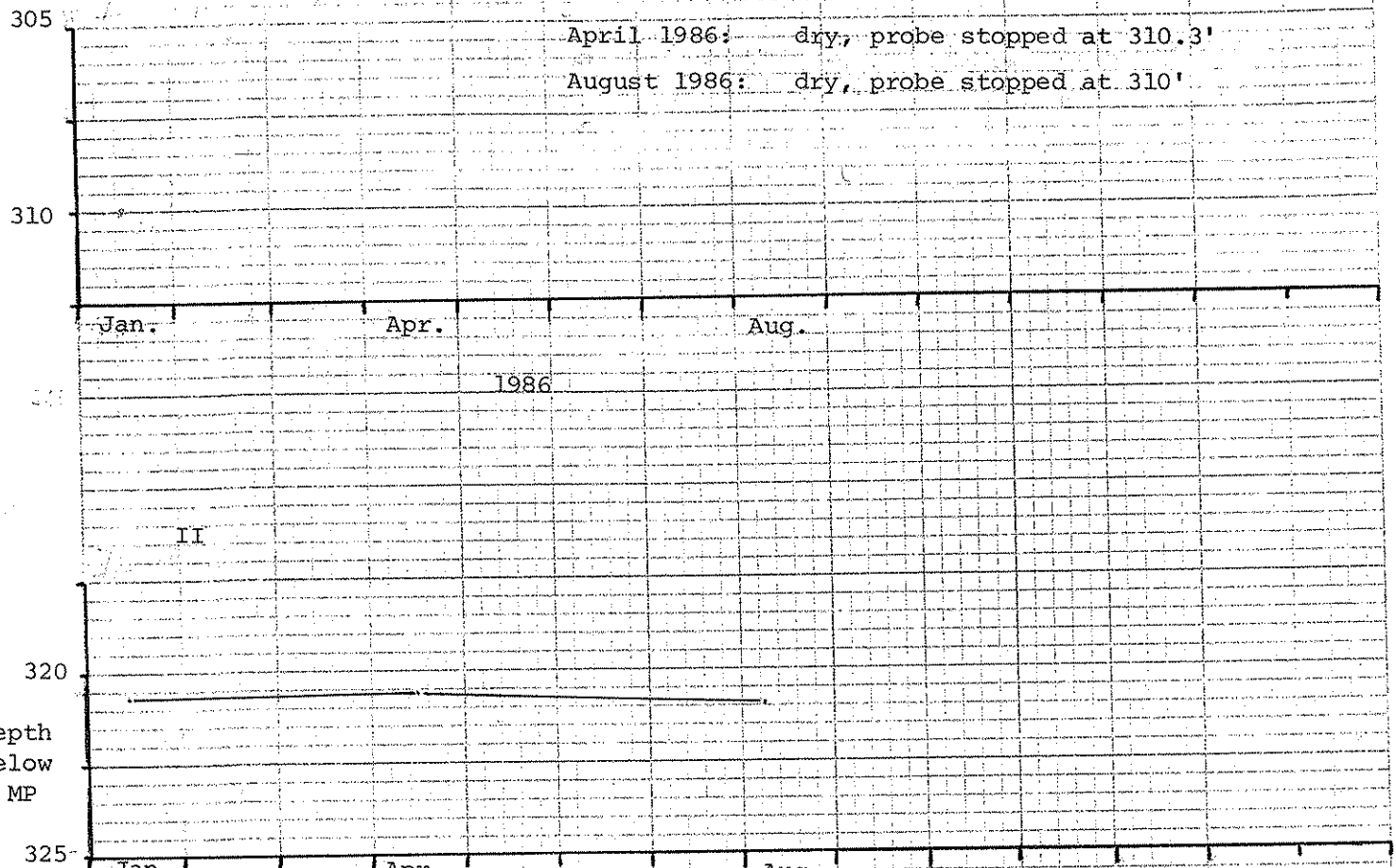
TEST HOLE #5 Whidbey Island Piezometer Water Level Measurements
DOE 1986

I (highest cut)

January 1986: mud at 310'

April 1986: dry, probe stopped at 310.3'

August 1986: dry, probe stopped at 310'



II

III January 1986: mud at 280' 8"

April 1986: dry, probe stopped at 319'

August 1986: dry, probe stopped at 280'

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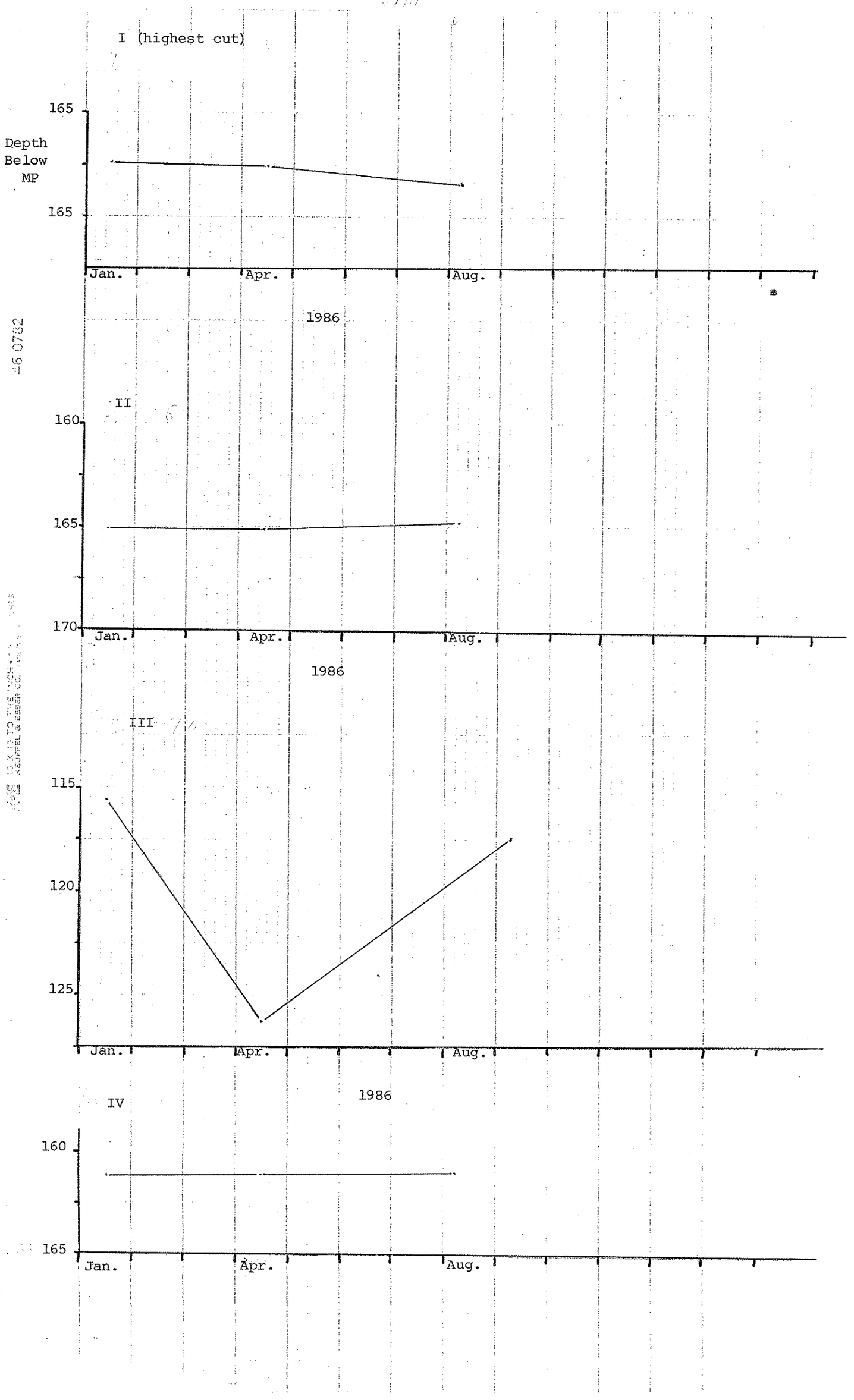
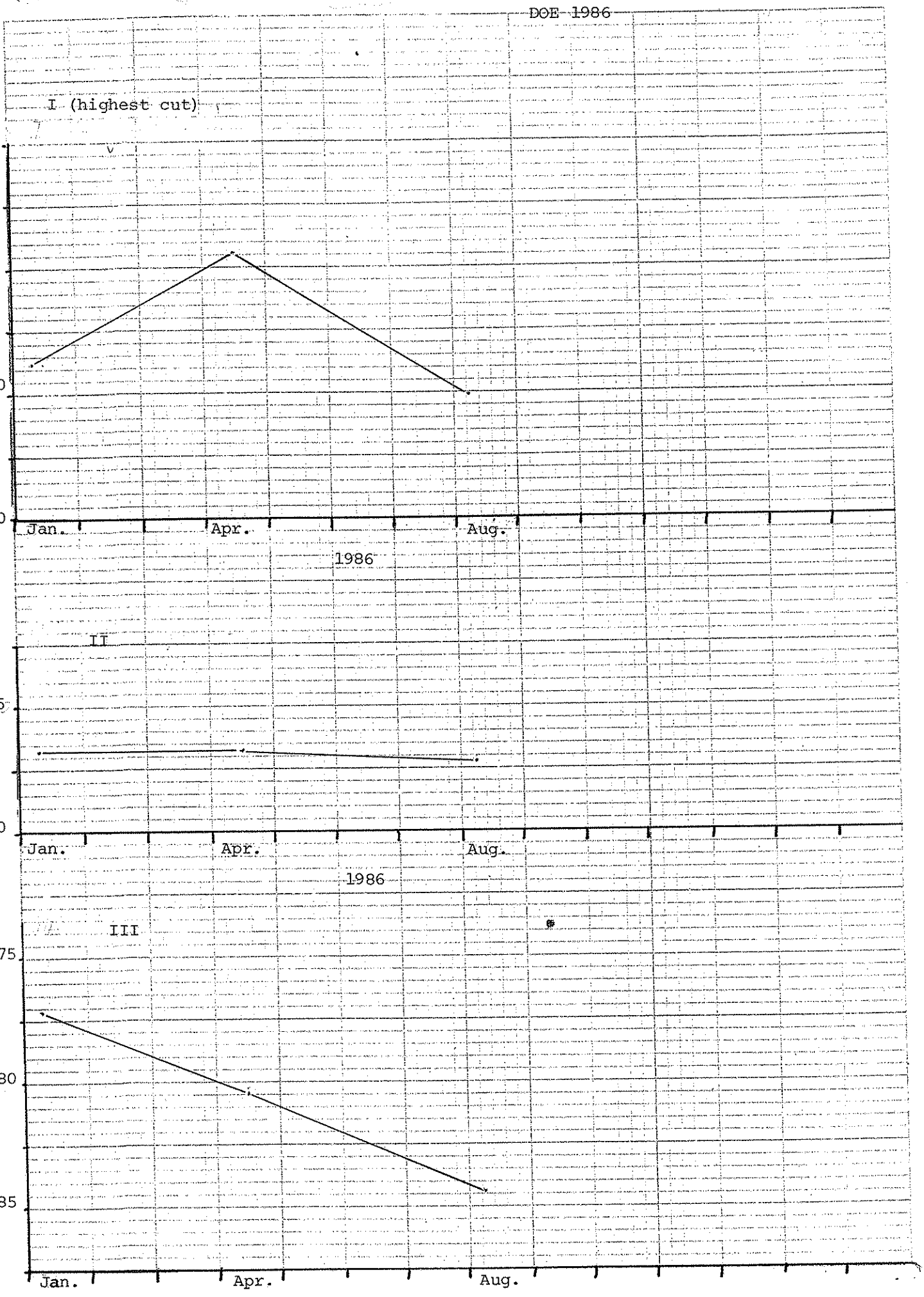
TEST HOLE #6 Whidbey Island

Piezometer Water Level Measurements
DOE 1986



TEST HOLE #8 Camano Island Piezometer Water Level Measurements
DOE 1986



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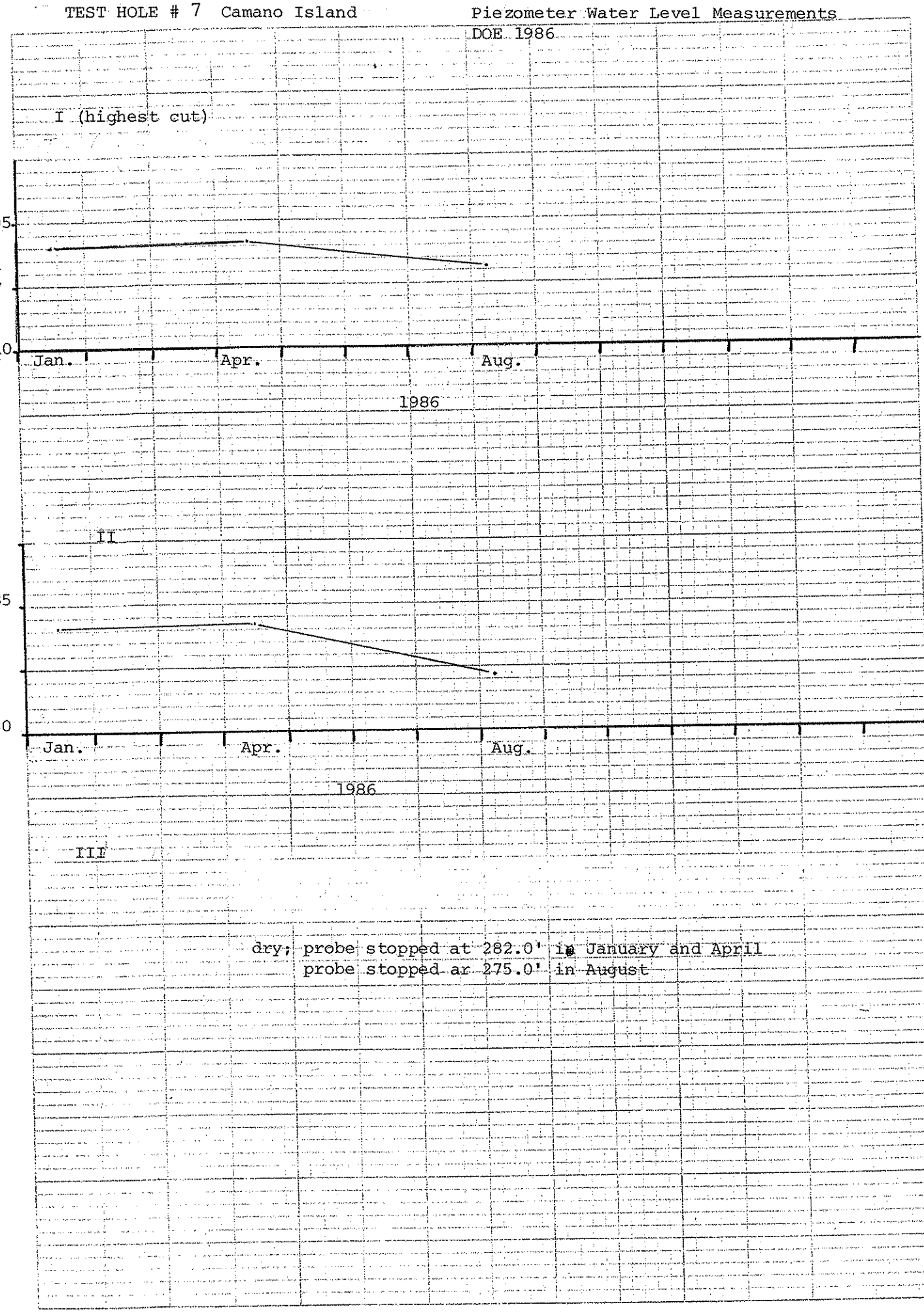
TEST HOLE # 7 Camano Island Piezometer Water Level Measurements

DOE 1986



dry; probe stopped at 282.0' in January and April
probe stopped ar 275.0' in August