A Report Prepared for

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Crown Zellerbach Flexible Packaging Division
2101 Williams Street
San Leandro, California 94577

HYDROGEOLOGIC INVESTIGATION
FLEXIBLE PACKAGING DIVISION FACILITY
SAN LEANDRO, CALIFORNIA

HLA Job No. 1199,012.02

by

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I INTRODUCTION

This report presents the results of the hydrogeologic investigation performed by Harding Lawson Associates (HLA) at the Crown Zellerbach (CZ) Flexible Packaging Division facility (the facility) in San Leandro, California. The facility is located at 2101 Williams Street, San Leandro, at the corner of Doolittle Drive and Williams Street (Plate 1). On-site buildings include the manufacturing facility and offices. Most of the remaining grounds are covered with asphaltic pavement. Adjacent to the Crown Zellerbach property on the southeast is the AAAAA Rent-a-Space Self-Service Storage, and on the northeast is a railroad right-of-way.

The purpose of this hydrogeologic investigation was to evaluate the shallow hydrogeologic system beneath the facility and to evaluate the lateral and vertical extent of chemicals in ground water resulting from leaks in underground chemical storage tanks. The scope of the investigation included drilling and monitoring well installation, ground-water sampling, water-level measurement surveys, aquifer tests, chemical analyses, and preparation of this report.

A. Physical Setting

The CZ facility is located on the San Leandro cone of the East Bay Alluvial Plain. The East Bay Alluvial Plain is bounded on the east by the northwest-trending Hayward fault and East Bay hills, and on the west by the San Francisco Bay shoreline. The plain consists of alluvial gravels, sands, silts, and clays of Pliocene to late Pleistocene age, ranging in thickness from 500 to 1000 feet. These sediments are derived from the bedrock hills east of the historically active Hayward fault.

Within the San Leandro cone, two aquifer horizons are of immediate relevance to this investigation: 1) shallow, discontinuous, unconfined aquifers within 50 feet of the ground surface, and 2) interfingering layers of confined water-bearing units from 30 to 100 feet below ground surface, considered to be equivalent to the Newark Aquifer to the south. Regionally, ground water in the aquifers flows toward San Francisco Bay.*

B. Chronology of Events

Four underground solvent storage tanks are located at the facility in the area shown on Plates 1 and 2. Currently, one tank has not been in service since 1983; the other three tanks contain ethyl alcohol, n-propyl alcohol, and n-propyl acetate. The type, volume, and chronology of solvent storage for each of the tanks is as follows:

1. 6000-gallon coated steel tank
   Contents: Ethyl alcohol
   Chronology: The tank was installed in 1953 and was pressure-tested in 1983. No leaks were detected during the pressure test but, due to the age of the tank, it was pumped dry and taken out of service in 1983.

2. Originally, a 3000-gallon coated steel tank; currently, a 5000-gallon coated steel tank
   Contents: Butyl acetate, then isopropyl acetate, and currently ethyl alcohol
   Chronology: The tank was installed in 1967 for storing butyl acetate. The conversion date for removing the butyl acetate and storing isopropyl acetate is unknown. The tank was pressure tested on May 26, 1983, and no leaks were detected. The tank failed on June 6, 1983 with a loss of approximately 2000 gallons of isopropyl

*Maslonkowski, D. P., 1984, Ground Water in the San Leandro and San Lorenzo Alluvial Cones of the East Bay Plain of Alameda County acetate. The tank was removed and replaced in December 1983 with a 5000-gallon coated steel tank. The new tank has been used to store ethyl alcohol (until the present). Isopropyl acetate is no longer stored underground (now a low-inventory item).

3. 3000-gallon coated steel tank
   Contents: N-propyl alcohol, then ethyl alcohol, and currently n-propyl alcohol
   Chronology: The tank was installed in 1969 for storing n-propyl alcohol. In mid- to late-1983, the tank was used for interim storage of ethyl alcohol. From late 1983 until the present, the tank has been used for storing n-propyl alcohol.

4. Originally, a 2000-gallon coated steel tank; currently, a new 2000-gallon coated steel tank
   Contents: Ethyl acetate; currently, n-propyl acetate
   Chronology: The tank was installed in 1967 for storing ethyl acetate. The conversion date for removing the ethyl acetate and storing n-propyl acetate is unknown. On July 5, 1982, the tank failed with the loss of approximately 1500 gallons of n-propyl acetate. In July 1982, the tank was removed and replaced with a new 2000-gallon coated steel tank for continued storage of n-propyl acetate (until the present).

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II FIELD INVESTIGATION

Field activities for this investigation include subsurface utility location, borehole drilling, geophysical logging, A- and B-aquifer well installation, well development, ground-water sampling, aquifer tests, and water-level measurement surveys. The above tasks were conducted from January 15 to March 4, 1986.

A. Drilling Methods and Procedures

Three borings (W-7, W-8, and W-9) were drilled for the purpose of A-aquifer monitoring well installation using a hollow-stem auger drill rig; one pilot boring (PB-1) was drilled using a mud rotary drill rig for the purpose of designing a B-aquifer monitoring well; and a fifth boring (B-1) was drilled using a mud rotary drill rig for the purpose of B-aquifer monitoring well installation. All borings were lithologically logged using the Unified Soil Classification System. The logs were based on split-spoon samples and cuttings from the three A-aquifer borings and on continuous screen samples, drilling rate variations, and geophysical logs for the two B-aquifer borings. The locations of the borings are shown on Plate 2, and the lithologic logs are shown on Plates 3 through 7.

The A-aquifer borings were drilled to depths ranging from 35 to 40 feet on January 15, 16, and 17, 1986. The borings were drilled using a 12-inch-O.D., 6-inch-I.D., hollow-stem auger drill rig, and split-spoon samples were collected at 5-foot intervals for lithologic description. Upon completion of drilling for each boring, monitoring wells were installed as described in

Section II.B. Natural gamma geophysical logs were also run through the A-aquifer well casing to supplement the lithologic logs (Plates 3, 4, and 5).

The B-aquifer borings were drilled to depths of 80 and 54 feet on January 15, 16, 17, 28, and 31, 1986. The borings were drilled using a mud rotary drill rig, and cutting samples were continuously collected from each boring for lithologic description. A pilot boring (PB-1) was drilled to a depth of 80 feet with a 7-7/8-inch-diameter bit and, upon completion of drilling, natural gamma and electrical resistivity geophysical logs were run in the open, fluid-filled boring to supplement the lithologic log (Plate 6). PB-1 was then grouted to ground surface using a tremie and bentonite-cement grout.

Based on the stratigraphy encountered in PB-1, Boring B-1 was drilled and logged in two stages, first to a 40-foot depth using a 14-inch-diameter bit for the installation of a conductor casing, and then to a total boring depth of 54 feet using an 8-inch-diameter bit for well installation. The lithologic log for Well B-1 is shown on Plate 7.

Drilling equipment used during the investigation was steam cleaned prior to drilling each of the five borings, and soil sampling equipment was cleaned with an Alconox solution and rinsed with tap water following the collection of each sample. All borehole cuttings and drilling fluids were placed in plastic-lined 30- and 50-gallon drums provided by CZ, which were labeled and stored on-site for disposal by CZ.

B. Well Installation

Well construction materials for the three A-aquifer wells (W-7, W-8, and W-9) consisted of 4-inch-diameter, Schedule 40 PVC casing and screen (slot size of 0.02 inches). The casing and screen for each well were steam cleaned prior to installation. Screen intervals were placed from approximately 20 feet below ground surface to total boring depth, depending on the thickness of water-bearing sands. Each well's filter pack consisted of No. 3 Monterey sand emplaced from the total depth of the boring to approximately 2 feet above the screened interval. A 2-foot-thick bentonite pellet seal was placed on the filter pack in each of the wells, and the remaining annular space was grouted to approximately 1 foot below ground surface using a cement grout with 5 percent bentonite. Surface completion for Wells W-7, W-8, and W-9 consisted of a watertight PVC slip cap, locking steel well cover, lock, and Christy traffic box set in concrete to approximately 1/2 inch above grade. Well construction details for wells W-7, W-8, and W-9 are shown on Plates 3, 4, and 5.

Well B-1 is double-cased and was constructed in two phases on January 28 and 31, 1986. A 10-inch-diameter, 41-foot-long steel conductor casing was installed in the 14-inch-diameter, 40-foot-deep borehole and was pushed (utilizing drill rig hydraulics) 1 foot into the A-B aquitard. A cement grout with 5 percent bentonite was then tremied into the annular space. A 66-hour set time was allowed prior to drilling into the B-aquifer, and drilling fluids used during drilling for the conductor casing were removed and replaced with clean drilling fluid. The B-aquifer well was screened between 44 and 52 feet below ground surface using 4-inch-diameter, Schedule 40 PVC with 0.02-inch slots. Blank casing was extended from 44 feet to 0.5 feet below grade. The well's filter pack consisted of No. 3 Monterey sand which was placed from total boring depth to 2.5 feet above the screen interval. A 1-foot-thick bentonite pellet seal was placed above the filter pack, and a cement grout with 5 percent bentonite was tremied from a depth of 40.5 feet (top of the bentonite pellet seal) to 1 foot below grade. Surface well completion for Well B-1 consists of a watertight PVC slip cap, 8-inch-diameter locking steel casing, lock, and Christy traffic box set in concrete 1/2 inch above grade.

Upon completion of drilling, each well was surveyed for reference elevations using a Mean Sea Level datum. Each well was measured at three locations: top of PVC, south side; top of steel casing, south side; and ground surface, as shown in Table 1.

C. Well Development and Sampling

Following well installation, all four wells were developed by purging a minimum of five well volumes or by developing until ground water was not turbid. A centrifugal pump and drill rig bailer were both utilized in development of Wells W-7, W-8, and W-9. A submersible pump and drill rig bailer were utilized in development of Well B-1. During well development, each of the wells was monitored for pH and conductivity. Developed ground water was stored on site in 30- and 50-gallon drums provided by CZ.

Table 1. Reference Elevations

Well No.	Ground Surface Elevation	Top of Steel Casing Elevation	Top of PVC Elevation	Size of PVC (inches)
B-1	21.52	20.88	20.59	4
W-1	21.58	20.84	20.67	4
W-2	21.50	20.19	20.02	4
W-3	21.52	20.97	20.80	4
W-4	21.55	21.14	21.00	4
W-5	22.45	21.82	21.64	2
W-6	22.20	15.81	21.05	2
W-7	21.11	20.77	20.41	4
W-8	21.07	20.50	20.18	4
W-9	20.82	20.16	19.99	4

Notes:

1. Datum is Mean Sea Level.
2. Representative ground surface elevations are at top of Christy box.
3. Elevations at top of PVC casing are on south side of well with cap removed.
4. Elevations at top of protective steel casing are on south side with top removed.

On February 3 and 4, 1986, ground-water samples were collected from the nine A-aquifer wells and the single B-aquifer well for chemical analyses. Prior to sample collection, the water level was measured in each well and, using a centrifugal pump, three well volumes were purged. Field measurements of pH and conductivity were recorded periodically during purging. After purging, a stainless steel bailer was used to collect ground-water samples for chemical analyses. The samples were decanted from the bailer into laboratory-prepared 40 millimeter volatile organic analysis (VOA) bottles. The VOA bottles were filled completely, capped and sealed with no head space using teflon-lined lids, labeled, and stored on ice in an insulated container until delivery to the laboratory. Each sample was maintained under chain-of-custody during sampling and shipment. The samples were shipped daily via Federal Express for overnight delivery to the CZ chemical laboratory in Camas, Washington. Chemical analyses for the following compounds were requested for all samples:

N-propyl acetate
Isopropyl acetate
Ethyl acetate
N-propyl alcohol
Isopropyl alcohol
Methyl alcohol
Ethyl alcohol
Acetic acid
Propionic acid
Acetone

For purposes of quality assurance, the following samples were also submitted for chemical analyses:

- A split sample from Well W-4 was collected and delivered to Analytical Science Associates (ASA) laboratory in Emeryville, California, for analyses for isopropyl acetate, isopropyl alcohol, and acetone.

- Field blanks were included with each sample shipment.

- A duplicate sample from Well W-8 was collected and submitted blind to the CZ laboratory.

Prior to collecting each sample, all sampling and pumping equipment was decontaminated with an Alconox solution and rinsed with tap water. The steel water-level tape and water-quality meters were rinsed with deionized water before use in each well.

D. Aquifer Test Procedures

Two types of aquifer tests were performed during the field investigation at the facility. Both tests were performed in Well W-4. A short-term variable discharge rate aquifer test was performed on January 5, 1986 to evaluate the response of the shallow aquifer to various discharge rates and to determine the discharge rate for the second test. A constant discharge rate test was performed on January 6 and 7, 1986. This test was performed to collect data for evaluating and quantifying the aquifer's transmissivity and storage coefficient, the radius of influence of ground-water pumping at a known discharge rate, and the impact of ground-water pumping on water quality. The procedures for each test are presented below. The results of the aquifer tests are presented in Section III.

1. Variable Discharge Rate Aquifer Test

The procedures for performing the variable discharge rate aquifer test were as follows:

- Decontaminate all pumping and water-level monitoring equipment by washing with Alconox solultion and rinsing with tap water.
- Collect manual water-level measurements in Wells W-1, W-2, W-3, W-5, W-6, W-7, W-8, and B-1 using a steel tape.
- Install a submersible pump in Well W-4 with the intake at approximately 32 feet below ground surface, place a gate valve in the discharge line to regulate the discharge rate, and extend the discharge line to a 21,000-gallon Baker tank for temporary ground-water storage.
- Install pressure transducers in Wells W-1 and W-4 for remote monitoring and recording of water-level variations during the aquifer test.

- Start pump and monitor water levels in Wells W-1 and W-4 using the transducers, monitor water levels in the other wells using a steel tape, monitor the discharge rate using a calibrated container and stopwatch, and monitor the pH of the discharge water.

The variable discharge rate aquifer test was performed for approximately 3 hours. During the test, it was determined that the constant discharge rate aquifer test would be performed at a discharge rate of 2.5 gallons per minute (gpm). It was also determined that the submersible pump created excessive drawdown in the pumped well and that a centrifugal pump would be used for the constant rate test because of the smaller diameter of the pump intake.

2. Constant Discharge Rate Aquifer Test

The procedures for performing the constant discharge rate aquifer test were as follows:

- Decontaminate all pumping and water-level monitoring equipment by washing with Alconox solution and rinsing with tap water.

- Collect manual water-level measurements in Wells W-1, W-2, W-3, W-4, W-5, W-6, W-7, W-8, and B-1 using a steel tape.

- Install the suction line for a centrifugal pump in Well W-4 with the intake approximately 1 foot above the bottom of the well, place a gate valve in the discharge line to set the discharge rate at 2.5 gallons per minute, and extend the discharge line to a 21,000-gallon Baker tank for temporary ground-water storage.

- Install pressure transducers in Wells W-1, W-2, and W-3 and connect to a data logger for remote monitoring and recording of water-level variations during the aquifer test.

- Start pump and monitor water levels in Wells W-1, W-2, and W-3 using the transducers, monitor water levels in the other wells using a steel tape, monitor the discharge rate using a calibrated container and stopwatch, and monitor the pH of the discharge water from Well W-4 as well as in situ monitoring of ground water pH in Wells W-1, W-2, and W-3.

- Collect three ground-water samples for chemical analyses as described in Section II.C. The samples were collected at the start of the test, after 7 hours of pumping, and the end of the test.
- Shut off pump and monitor water-level recovery.

The constant discharge rate aquifer test was performed for 16 hours and 50 minutes out of the planned 24 hours. After 16 hours of pumping, the water level was drawn down to the intake level of the pump, suction was lost, and the test was halted by stopping the pump. Water-level recovery was monitored for over two hours.

Upon completion of the test, the drawdown data were evaluated for acceptibility and the Theis and Jacob methods* were used to calculate the transmissivity and storage coefficient for observation Wells W-1 and W-2. It was determined from the drawdown data from Well W-3 that no analyses could be performed because the data were inconclusive (insufficient draw down). Drawdown data from Wells W-1, W-2, W-5, W-7, and W-8 were used to prepare a distance-drawdown plot for evaluating the radius of influence for the aquifer test.

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*Lohman, S.W., 1979, Ground-Water Hydraulics, U. S. Geological Survey Professional Paper 708

III RESULTS OF FIELD INVESTIGATION

This section presents the results of the field investigation at the facility as they relate to site geology, hydrogeology, and water quality.

A. Geology

The subsurface geology encountered in each of the borings drilled during the field investigation is presented on Plates 3 through 7. In general, the geology beneath the site is as follows:

- From ground surface to a depth of approximately 22 to 25 feet, interbedded silts and clays were predominant. At some locations, silty sand layers are also encountered, but these layers do not appear to be continuous.

- The shallow aquifer (A-aquifer) was encountered from the base of the silts and clays to an approximate depth of 33 to 38 feet. The A-aquifer consists of coarse-grained materials ranging from clean, well sorted sand to sandy gravels. Average thickness of the aquifer is 14 feet. The aquifer appears to dip gently toward San Francisco Bay, but the data are insufficient to quantify the site-specific direction and degree of the dip.

- Beneath the A-aquifer, interbedded clays (aquitard material) and sands and gravels (aquifer materials) were encountered to the total exploration depth of 80 feet below ground surface. Clays were present from approximately 37 to 43 feet, 50 to 52 feet, 54 to 62 feet, and 74 to 80 feet. Sand was encountered from 43 to 50 feet, silty sand from 52 to 54 feet, and sandy gravel from 62 to 74 feet.

B. Hydrogeology

Site hydrogeological characteristics were determined from the results of the water-level measurement survey (ground-water movement) and the results of the aquifer tests (aquifer parameters).

1. Ground-Water Movement

The results of the water-level measurement survey performed on March 4, 1986 are shown on Plate 8 and included in Table 2. Based on the the water-level elevation data, the direction of ground-water flow is generally toward the bay and ranges from S30°W to S75°W. The average hydraulic gradient for the A-aquifer is approximately 0.002 foot per foot, and the range is from 0.001 to 0.003 foot per foot.

Table 2. Water-Level Elevations
(feet above Mean Sea Level)

Date	W-1	W-2	W-3	W-4	W-5	W-6	W-7	W-8	W-9	B-1
08/15/84	6.85	6.78	6.72	6.93	NA	NA	NA	NA	NA	NA
09/17/84	6.67	6.57	6.58	6.65	NA	NA	NA	NA	NA	NA
10/18/84	7.34	7.23	7.23	7.33	NA	NA	NA	NA	NA	NA
11/15/84	8.43	8.28	8.24	8.42	NA	NA	NA	NA	NA	NA
12/12/84	8.99	8.85	9.40	8.95	NA	NA	NA	NA	NA	NA
01/22/85	7.74	7.55	7.59	7.70	7.78	7.76	NA	NA	NA	NA
03/06/85	7.57	7.60	7.38	7.51	7.60	7.60	NA	NA	NA	NA
07/31/85	6.88	6.75	6.74	6.81	6.88	6.86	NA	NA	NA	NA
02/03/86	8.82	8.37	8.56	8.69	8.79	8.74	8.11	8.40	8.19	8.25
02/04/86	8.67	8.50	8.50	8.60	NA	NA	NA	8.35	NA	8.64
02/05/86	8.61	8.49	8.48	NA	8.64	8.61	8.07	8.33	NA	8.58
02/06/86	8.55	8.44	8.45	8.26	8.57	8.56	8.03	8.29	NA	9.62
03/04/86	9.65	9.50	9.48	9.55	9.67	9.67	9.03	9.33	9.11	9.62

NA = Not available because no measurement was performed.

Water-level variations also occur seasonally at the facility. Hydrographs for Wells W-1, W-2, and W-3 are shown on Plate 9. The lowest water-level elevations were recorded in July 1985; the highest, in March 1986. The variations in water-level elevations for the site coincide with the seasonal variations observed in other alluvial aquifers in the Bay Area: the highest elevations occur in the winter and spring because of precipitation and aquifer recharge, and the lowest elevations occur during the dry summer and fall seasons.

2. Aquifer Parameters

The results of the constant discharge rate aquifer test are summarized in Table 3. Aquifer parameters are presented for only Wells W-1 and W-2 because the drawdown in Well W-3 was insufficient to serve as input to any of the analytical methods. In general, the transmissivity of the A-Aquifer ranged from 460 to 2100 square feet per day (ft^2/d) with a mean of 1270 ft^2/d. Transmissivity in Well W-1 is apparently higher than in Well W-2. The storage coeffient for the A-aquifer ranged from 0.03 to 0.06 (dimensionless) with a mean of 0.04. The storage coefficient for Wells W-1 and W-2 is approximately equivalent.

When plotted on a distance-drawdown graph (Plate 11), drawdown data from the aquifer test are not adequate to calculate the radius of influence. However, qualitatively, the radius of influence from the aquifer test is estimated to be from 70 to 100 feet. There will also be some directional variations in the radius of influence related to the water-level gradient and the apparent anisotropy indicated from the calculated aquifer parameters, but these variations cannot be estimated from the existing data.

Table 3. Summary of Constant Discharge Rate Aquifer Test - Well W-4

Observation Well No.	Distance from Pumped Well (W-4) (feet)	Transmissivity ($feet^2$/day)	Storage Coefficient (dimensionless)	Type of Analysis
W-1	40	1419	0.03	Theis
		1630	0.03	Jacob
		2100	0.05	Recovery
W-2	33	460	0.06	Theis
		767	0.03	Jacob
		1258	0.05	Recovery
W-3	41	NA	NA	None

Discharge Rate = 2.5 gallons per minute (Plate 10)

Length of Test = 1010 minutes (16 hours, 50 minutes)

NA = None available because drawdown data from W-3 were inconclusive and not acceptable for performing aquifer parameter analyses.

C. Water Quality

This section presents the results of the field investigation related to water quality in the shallow aquifer. The results have been separated into data from field measurements and data from laboratory analyses.

1. Field Measurements

Field measurements for the water-quality indicators of pH and specific conductivity were obtained during ground-water sampling in all monitoring wells (Table 4). During the constant discharge rate aquifer test, pH was monitored in Wells W-1, W-2, W-3, and W-4 (Plate 12).

Table 4. Field Measurements During Sampling

Well No.	Gallons Purged	pH	Specific Conductivity (µmhos/cm)
W-1	15	6.47	1025
	85	5.39	2000
W-2	15	4.97	5000
	75	5.22	3100
W-3	15	5.26	3000
	75	5.78	1375
W-4	15	4.58	5800
	75	4.55	6500
W-5	10	6.84	810
	75	6.79	810
W-6	10	6.66	690
	75	6.82	560
W-7	15	6.84	820
	90	6.84	940
W-8	15	6.63	1020
	90	6.64	1016
W-9	15	7.27	720
	90	7.11	720
B-1	20	7.45	710
	120	7.24	650

During ground-water sampling, pH values ranged from a high of over 7.0 in Wells W-9 and B-1 to less than 5.0 in Well W-4. Specific conductivity data ranged from a less than 1000 micromhos per centimeter (µmhos/cm) in Wells W-5, W-6, W-7, W-9, and B-1 to over 5000 µmhos/cm in Wells W-2 and W-4. Using pH and specific conductivity as water-quality indicators during pumping, it is significant that water quality decreased in Wells W-1 and W-4 during pumping, water quality improved in Wells W-2 and

W-3 during pumping, and no substantial changes in water quality occurred in the other wells during pumping.

pH values in all four wells generally increased during the aquifer test. Two slight decreases in pH were recorded in Well W-4 and one slight decrease was recorded in Well W-3 (Plate 12).

2. Laboratory Data

The results of the chemical analyses performed on ground-water samples collected during the investigataion are presented in Table 5. The distribution of the chemicals in the A-aquifer is presented on Plates 13, 14, 15, and 16 for acetates, alcohols, acids, and acetone, respectively. Table 5 also includes the results of chemical analyses of three time-series ground-water samples during the aquifer test, as well as the results of chemical analyses of two Quality Control (QC) samples

Analyses were performed by the CZ laboratory on duplicate samples from Well W-8, for which the duplicate was submitted blind from the field. The second QC sample represented a duplicate sample from Well W-4: one sample was submitted to the CZ laboratory for a complete suite of analyses, and, in compliance wih the RWQCB request, the duplicate sample was submitted for analysis for only ispropyl acetate, isopropyl alcohol, and acetone. The results of both types of duplicate analyses indicate accpetable data quality.

The results of chemical analyses of the blank samples submitted to the CZ laboratory indicate that no chemicals were present in either blank sample submitted (one per day). The results of chemical analyses of blank

Table 5. Ground-Water Chemical Data
(milligrams per liter)

Well No.	Date	N-propyl Acetate	I-propyl Acetate	N-propyl Alcohol	I-propyl Alcohol	Acetone	Acetic*** Acid	Propionic*** Acid	Methyl Alcohol	Ethyl Alcohol	Ethyl Acetate	Toluene
W-1	2/05/86	ND	ND	ND	1800	1500	1600	1100	ND	ND	ND	ND
W-2	2/05/86	24	320	510	4800	400	4600	1300	30	1600	80	ND
W-3	2/05/86	ND	ND	41	2500	980	2400	4100	ND	TR	ND	ND
W-4	2/05/86	240	5070	1100	18,000	610	15,600	490	500	8900	1080	ND
W-4D*	2/05/86	NA	3600	NA	18,000	440	NA	NA	NA	NA	NA	NA
W-4**	2/06/86	NA	2100	NA	12,000	460	NA	NA	NA	NA	NA	NA
W-4**	2/06/86	NA	1700	NA	14,000	160	NA	NA	NA	NA	NA	NA
W-4**	2/07/86	NA	1500	NA	9,600	420	NA	NA	NA	NA	NA	NA
W-5	2/04/86	ND	TR	ND	TR	TR	80	ND	ND	10	ND	ND
W-6	2/04/86	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
W-7	2/04/86	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
W-8	2/05/86	ND	ND	ND	60	120	60	ND	ND	ND	ND	ND
W-8D	2/05/86	ND	ND	ND	40	140	80	ND	ND	ND	ND	ND
W-9	2/05/86	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
B-1	2/05/86	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

Ground-water samples analyzed by Crown Zellerbach Chemical Laboratory unless otherwise noted.

* Ground-water sample analyzed by Analytical Science Associates (ASA).

** Aquifer test sample analyzed by ASA.

*** ND, None detected, estimated detection limit less than 30 mg/l.

D = Duplicate sample.

ND = None detected, estimated detection limit less than 10 mg/l.

NA = Not analyzed.

TR = Trace detected, less than estimated detection limit, identity not confirmed.

samples submitted to ASA indicate that low levels (at or just above the detection limit) of acetone and isopropyl alcohol may have been present in both blank samples. No isopropyl acetate was detected in the blank samples. Because the detected chemical concentration levels in the field samples ranged from 3 to 5 orders of magnitude above ASA's analytical detection limits, the potential concentrations in the blank samples have no bearing on data interpretation because no low-concentration samples were analyzed by ASA.

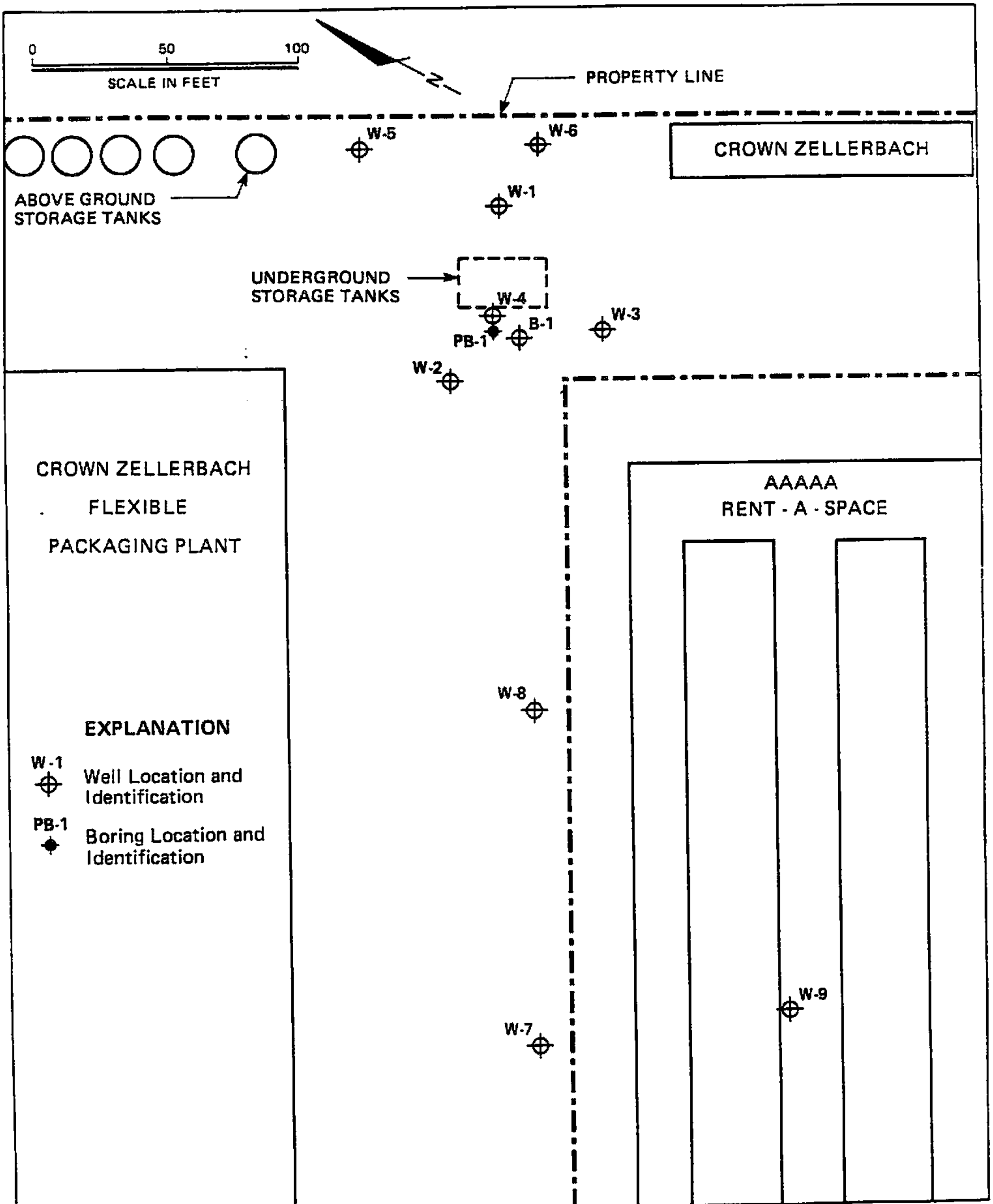
IV CONCLUSIONS

Having evaluated the results of the hydrogeological investigation, we conclude that adequate ground-water flow and water-quality data have been collected to assess contamination mitigation options for the CZ facility. Our conclusions regarding the extent of ground-water contamination and the hydrogeological characteristics that control ground-water movement are discussed below.

Based on the water-quality data shown on Plates 13 through 16 and in Table 5, the downgradient lateral extent of chemicals in ground water has been determined for the A-aquifer. Vertically, no chemicals are present beneath the A-aquifer (Well B-1). It appears that no chemicals have migrated beyond the current downgradient areal limits of ground-water monitoring. The distribution of the four classes of organic compounds are discussed below.

Acetates (Plate 13) appear to be limited to the immediate vicinity of the underground tanks and have not migrated downgradient to Well W-8. Most alcohols (Plate 14) are limited to the immediate vicinity of the tanks. The exception is isopropyl alcohol, which is present in low concentrations in Well W-8 but not in Well W-7 or W-9. The distribution of acids (Plate 15) is similar to the distribution of alcohols, in that the propionic acid is limited to the vicinity of the tanks and acetic acid has migrated to Well W-8, but no further. The distribution of acetone is somewhat unusual; it is found at a higher concentration upgradient from the tanks in Well W-1 than in Well W-2, W-3, or W-4. Acetone apparently has not migrated beyond Well W-8 in the downgradient direction. CZ chemical use records (Section I.B) do not indicate that acetone has ever been stored in the underground tanks or even used at the facility. Therefore, the reason for its presence and distribution is unknown. This question is under further investigation by CZ.

Based on the results of the water-level survey (Plate 8) and the aquifer test, ground water is moving toward the south-southwest in the A-aquifer under a low hydraulic gradient. Pumping the aquifer at a discharge rate of 2.5 gpm produces an apparent radius of influence of 70 to 100 feet. We note that the monitoring wells at the site were not designed for continuous ground-water production and, therefore, a properly designed and installed production well would probably produce greater discharge and a larger radius of influence. There is some anisotropy associated with the A-aquifer materials beneath the facility, and actual radius of influence from any pumping scheme would not be a true circle. However, the duration of the data from the aquifer test are sufficient to provide technical input to preliminary remedial alternative evaluations and cost estimates for potential ground-water removal schemes.



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Well and Boring Location Map
Crown Zellerbach
San Leandro, California

2

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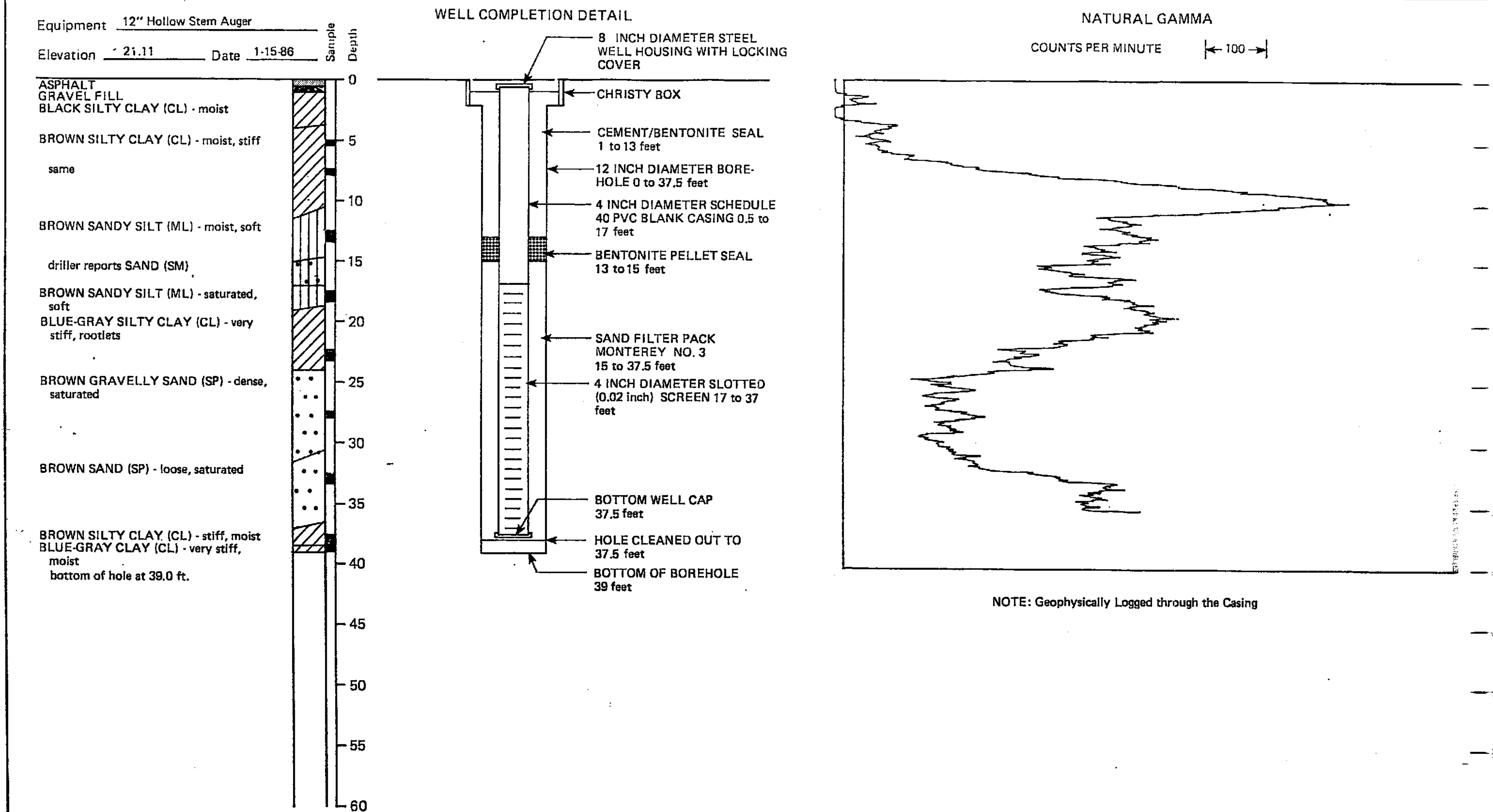

NOTE: Geophysically Logged through the Casing

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Log and Well Completion Detail for Well 7
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San Leandro, California

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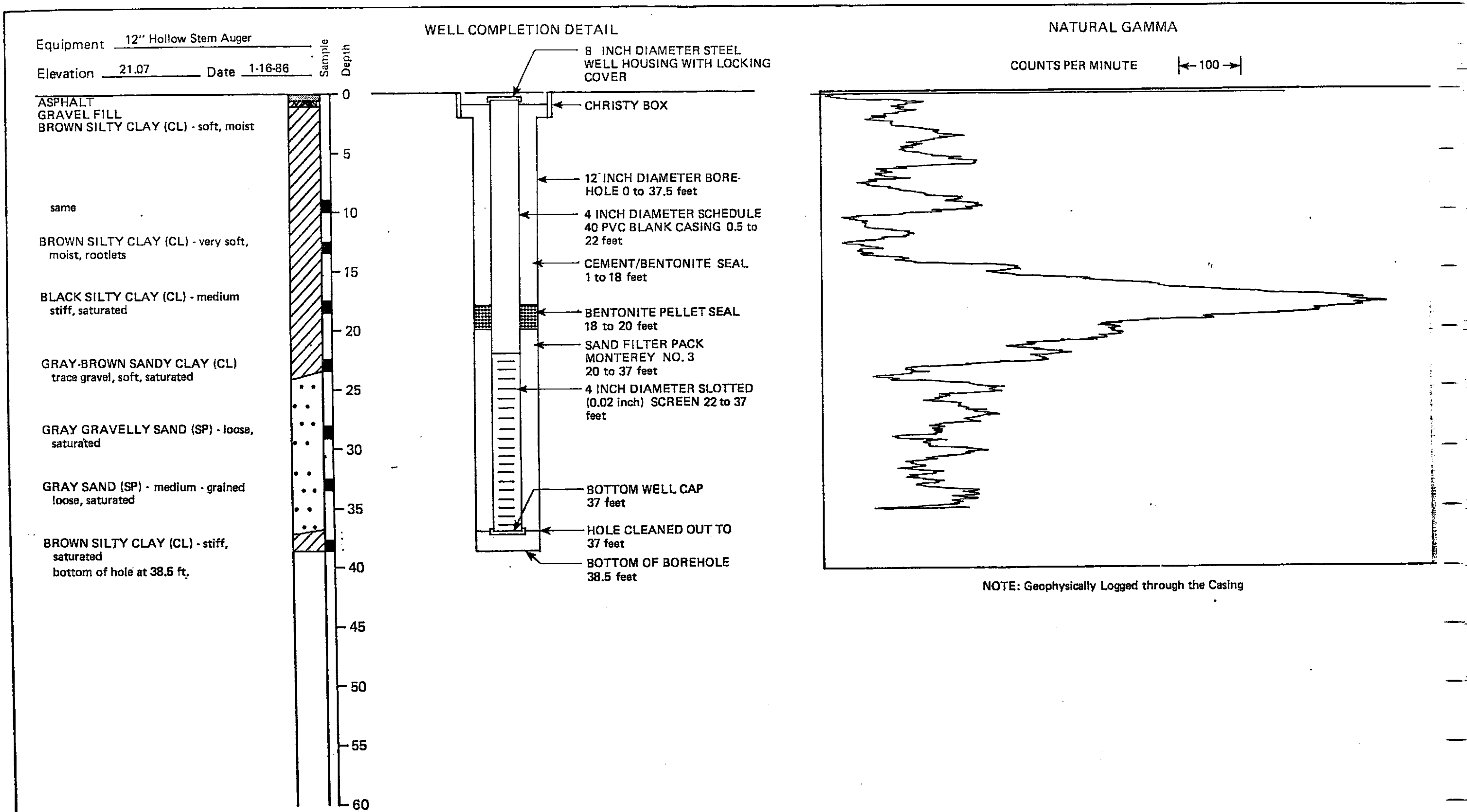

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Log and Well Completion Detail for Well 8
Crown Zellerbach
San Leandro, California

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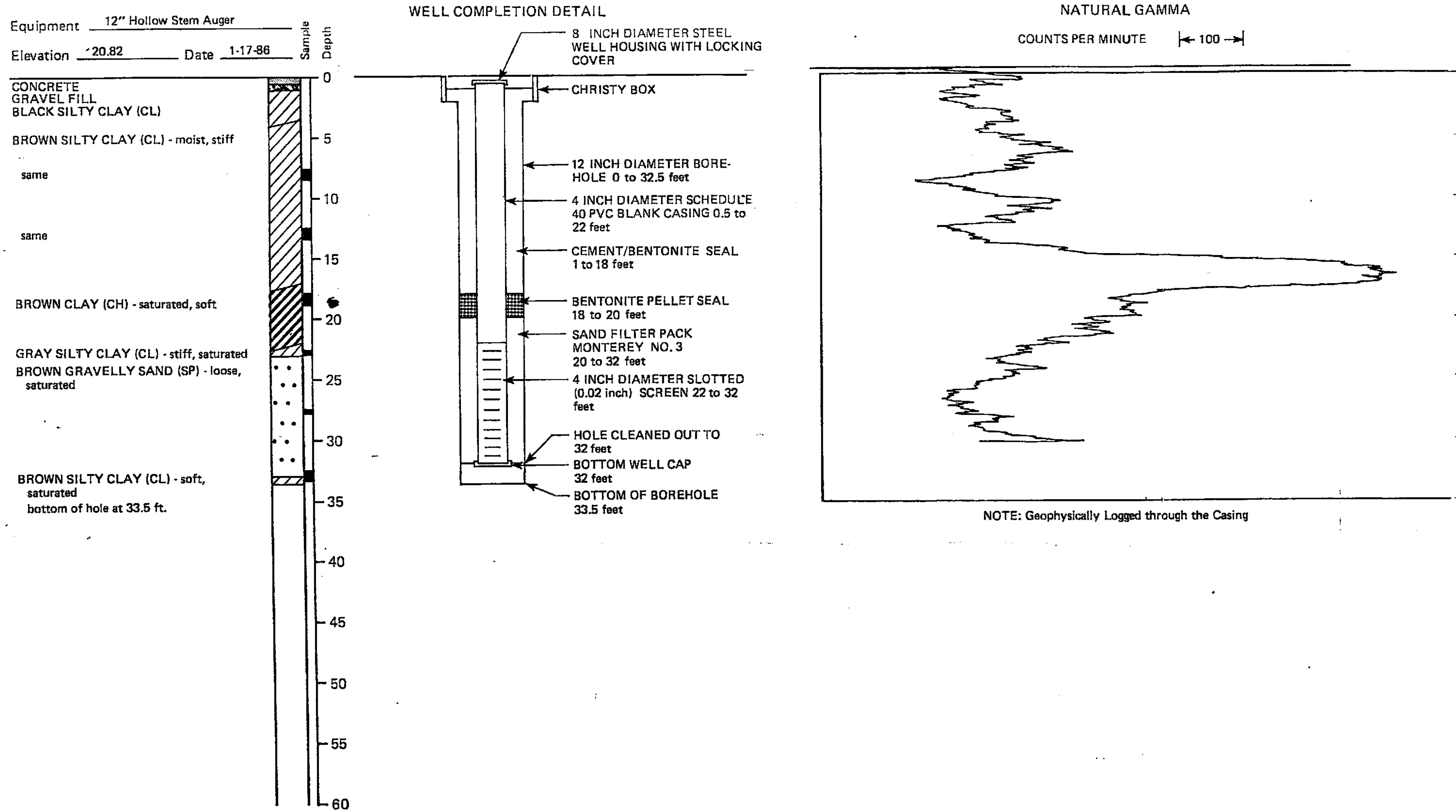

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Log and Well Completion Detail for Well 9
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San Leandro, California

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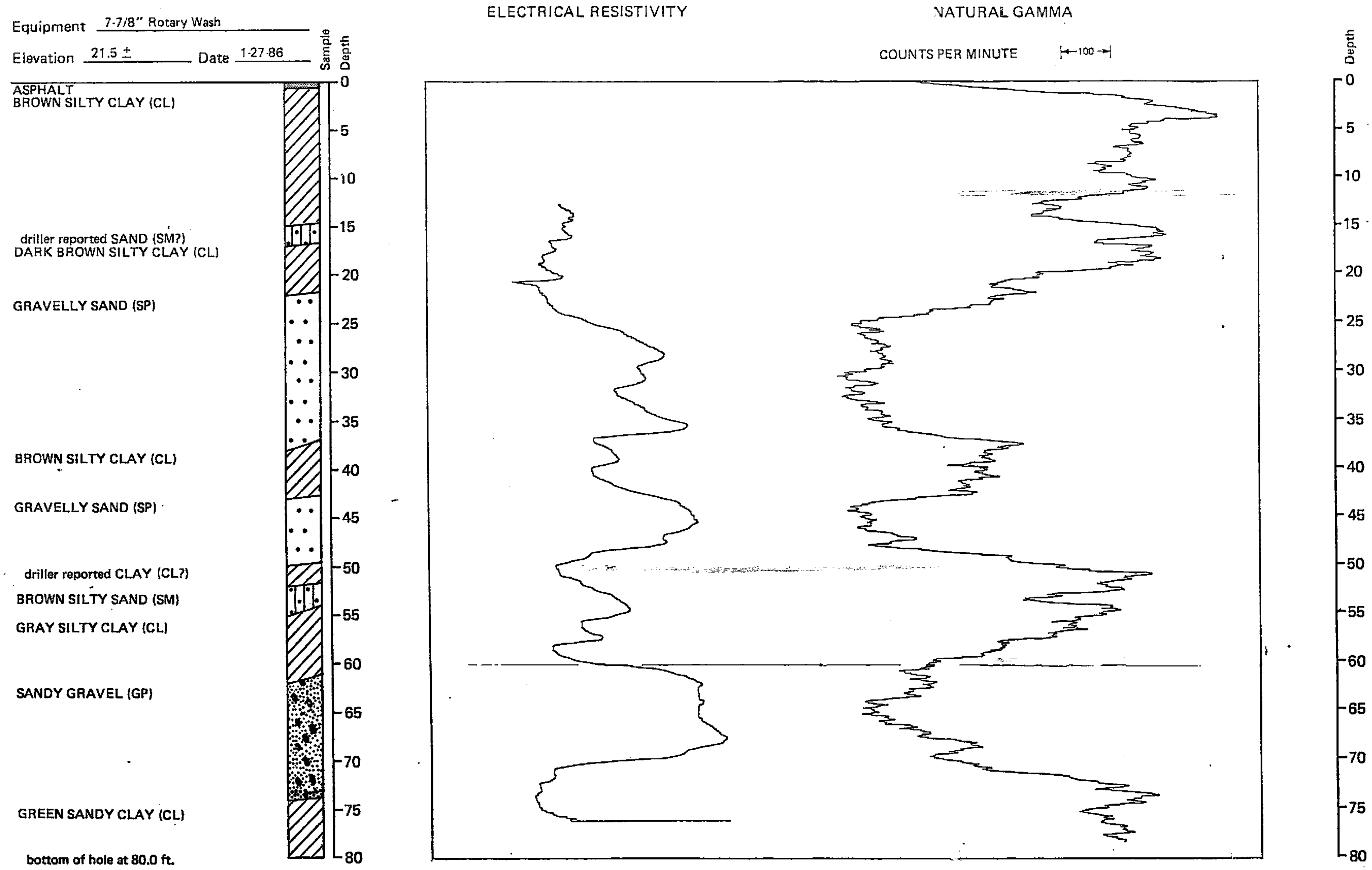

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Logs for Boring PB-1
Crown Zellerbach
San Leandro, California

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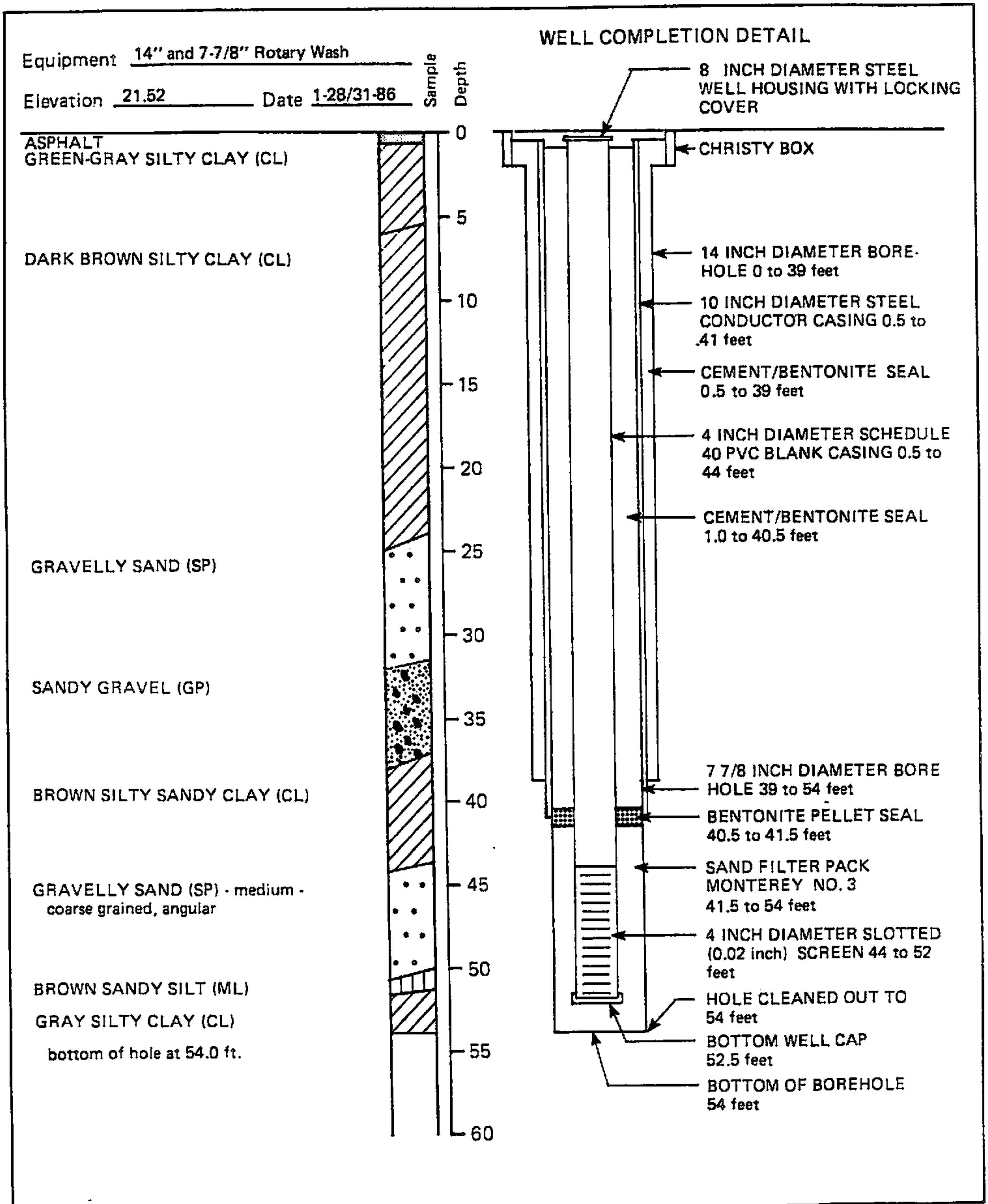

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Log and Well Completion Detail for Well B-1
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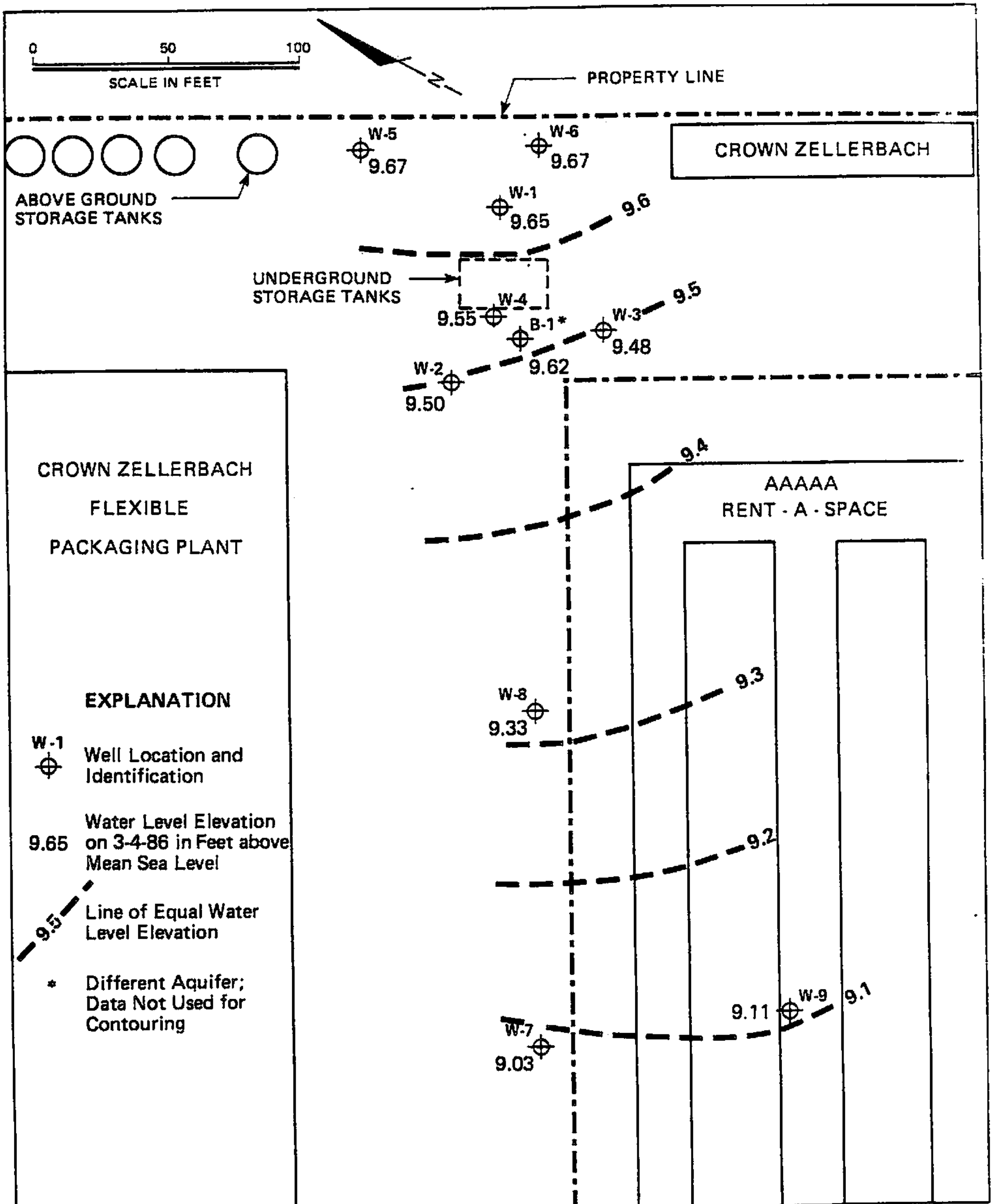

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Water-Level Elevation, March 1986
Crown Zellerbach
San Leandro, California

8

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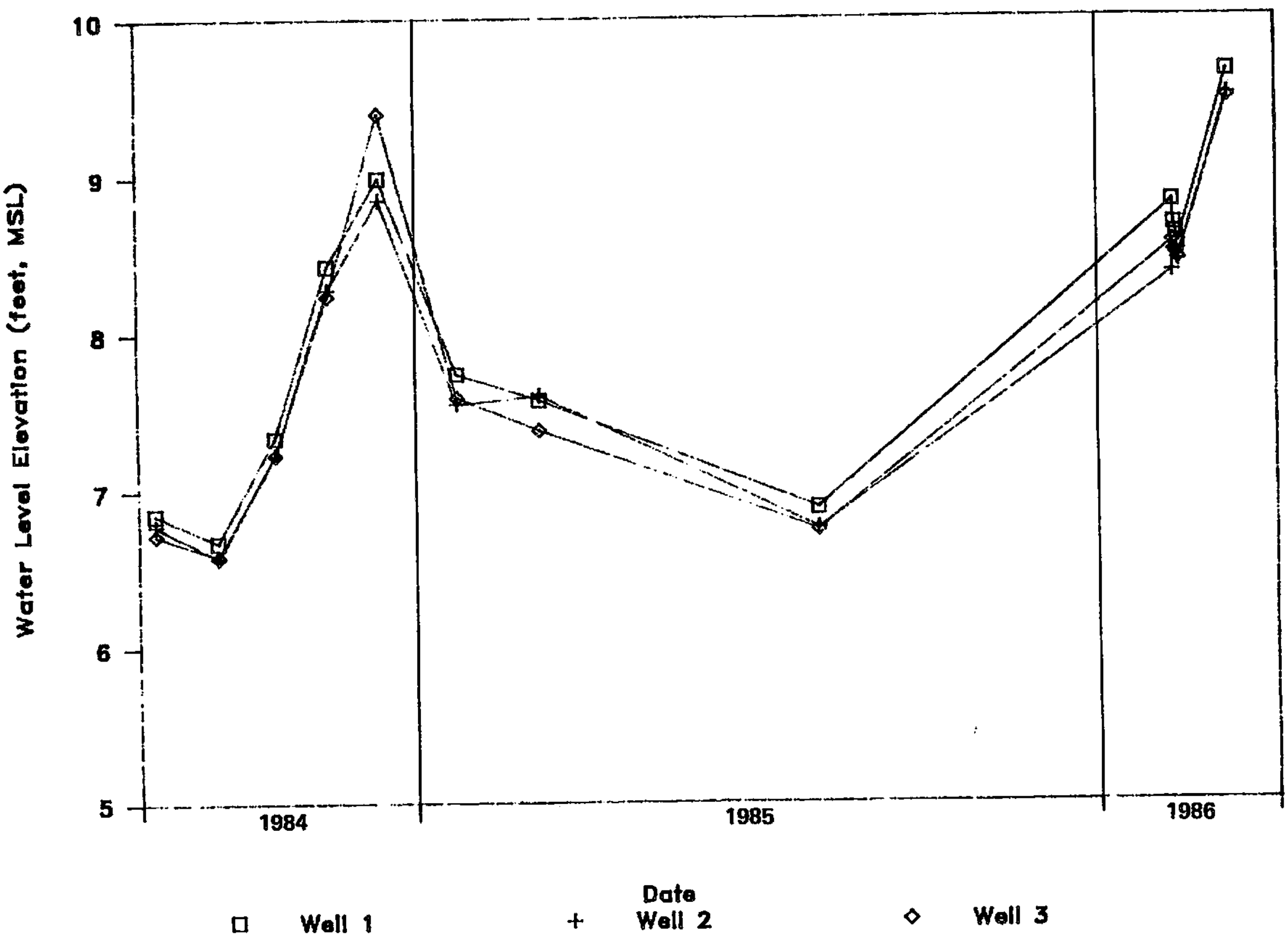
Water Level Elevation Hydrograph



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Hydrograph
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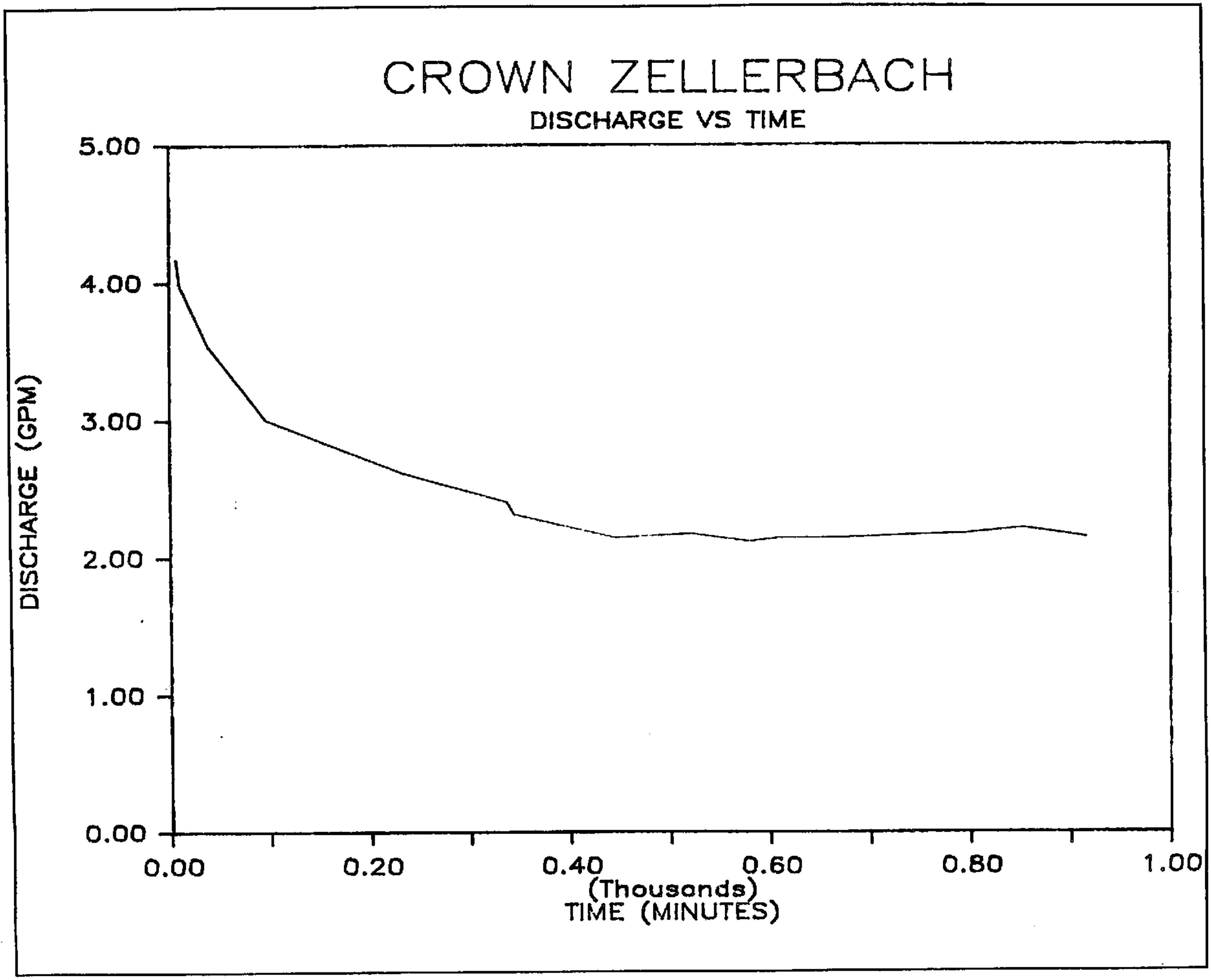

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Discharge Versus Time
Crown Zellerbach
San Leandro, California

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Distance - Drawdown Plot
Crown Zellerbach
San Leandro, California

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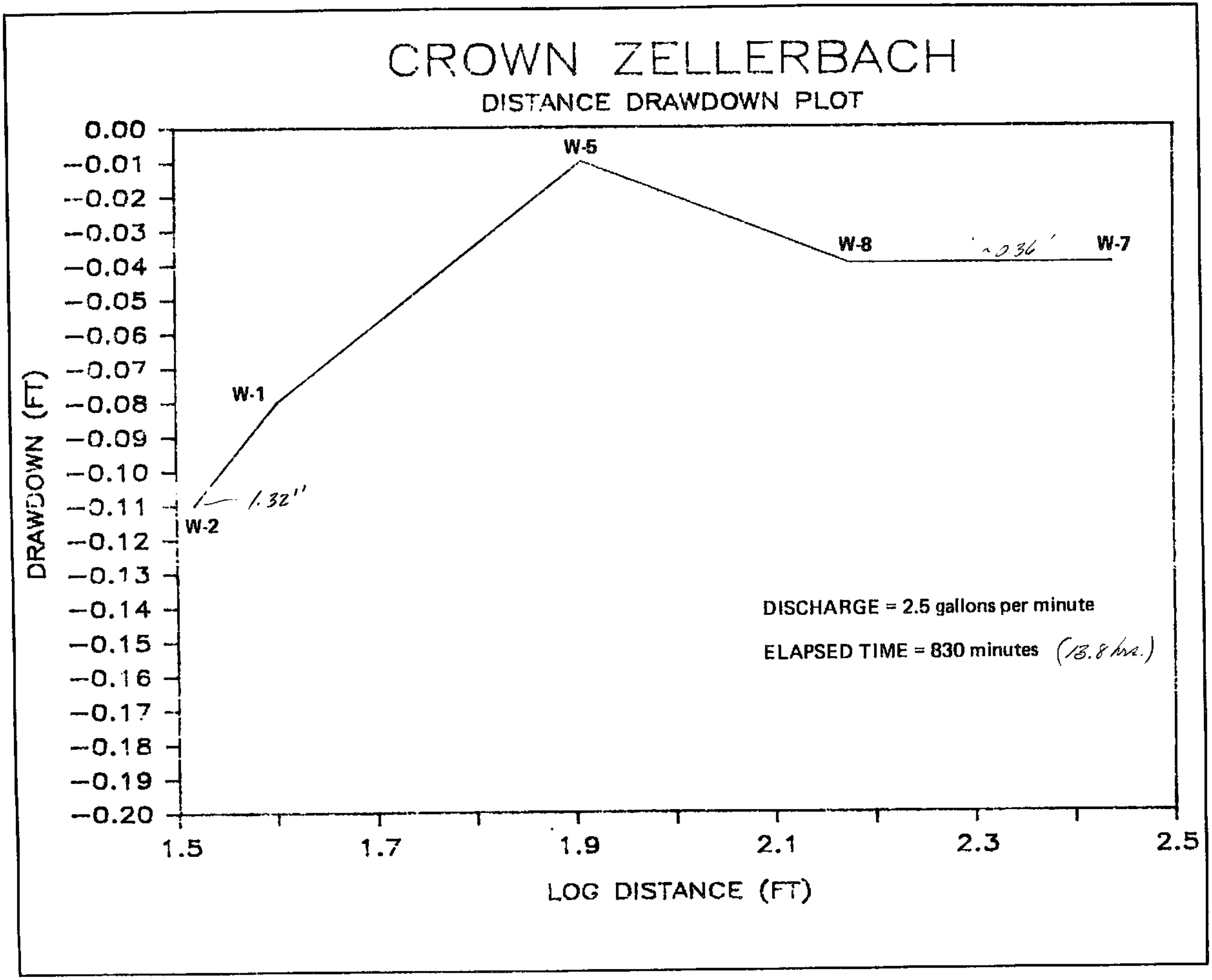

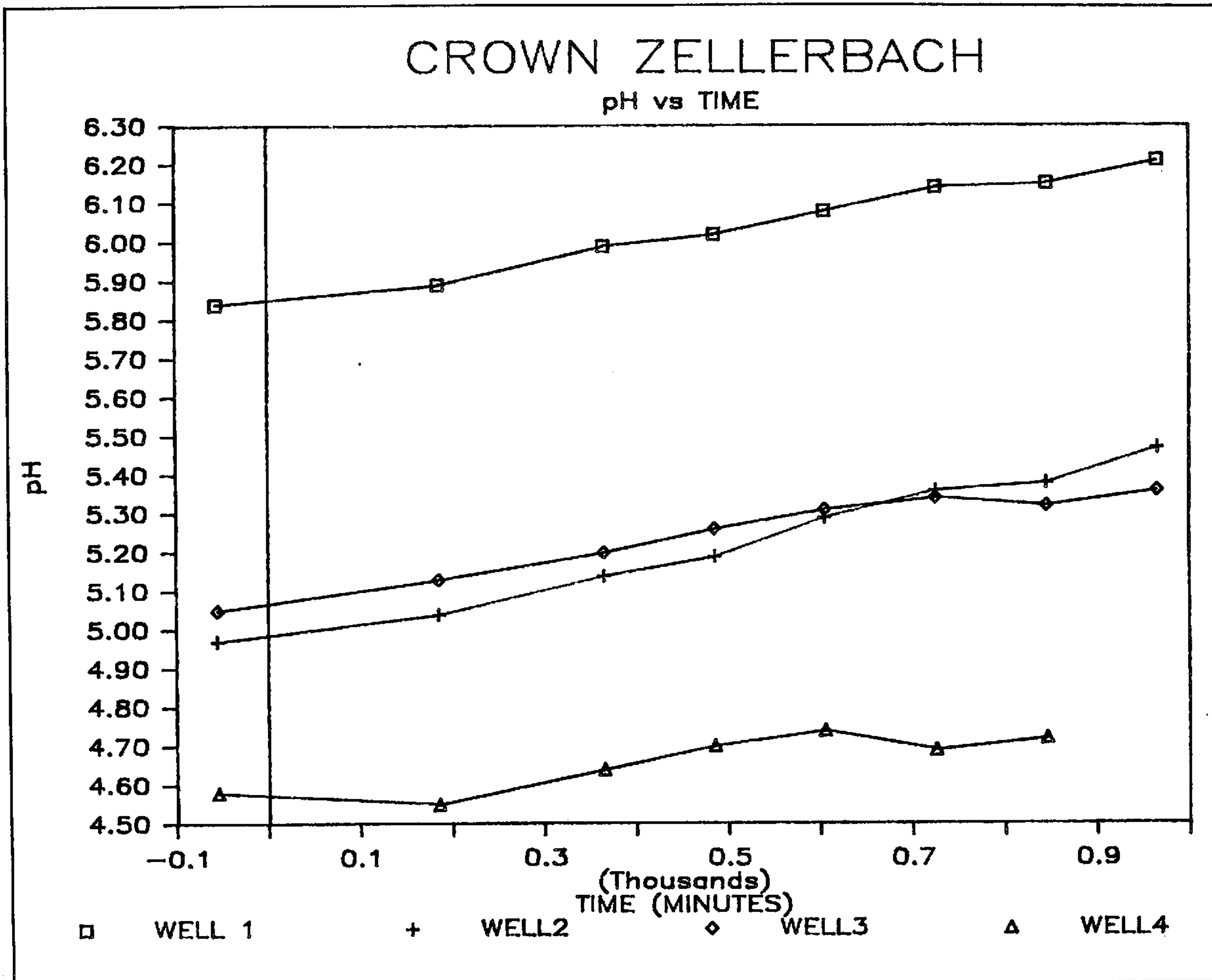

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pH Versus Time
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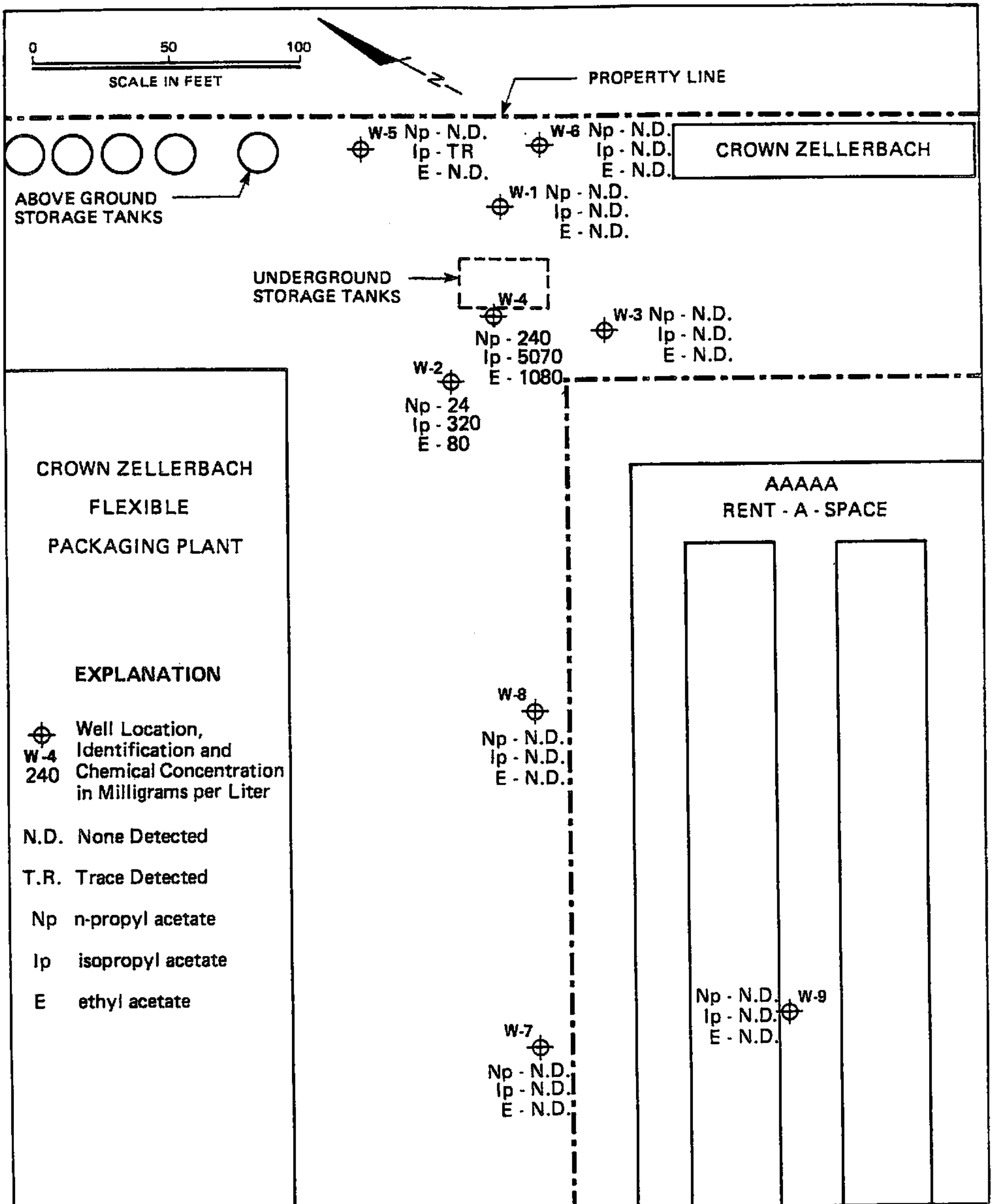

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Acetates in Ground Water February 1986
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San Leandro, California

PLATE
13

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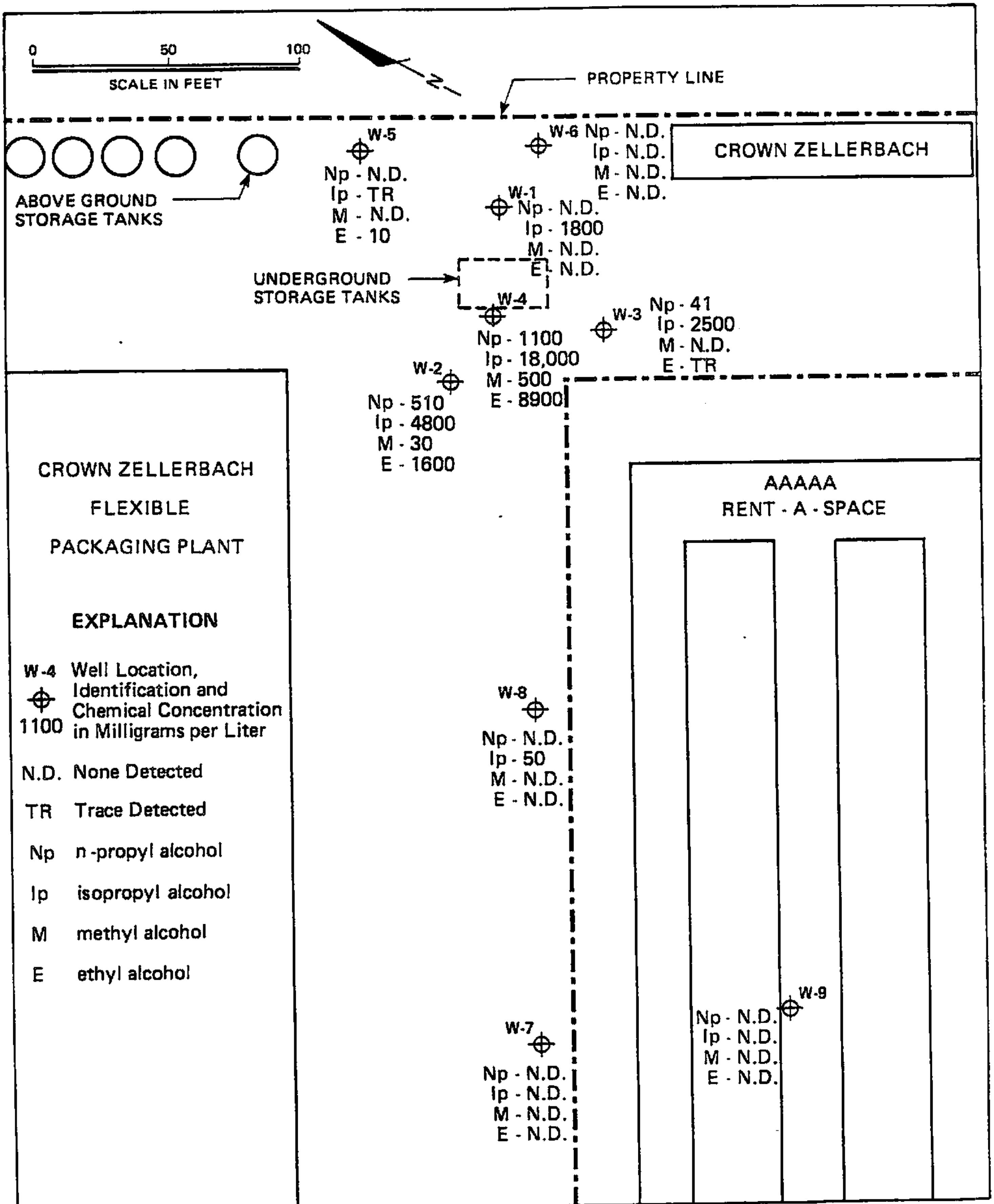

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Alcohols in Ground Water February 1986
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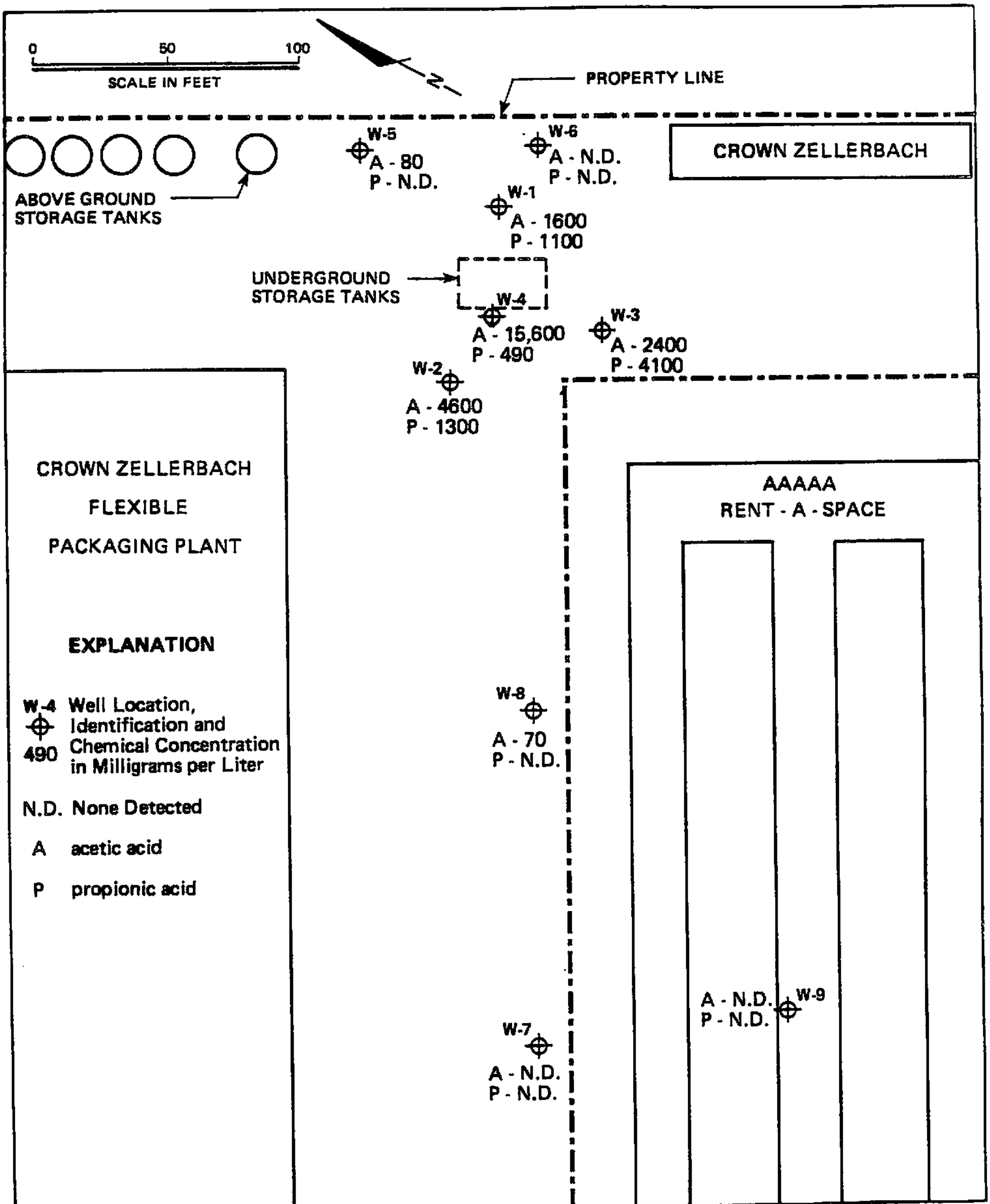

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Acids in Ground Water February 1986
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PLATE
15

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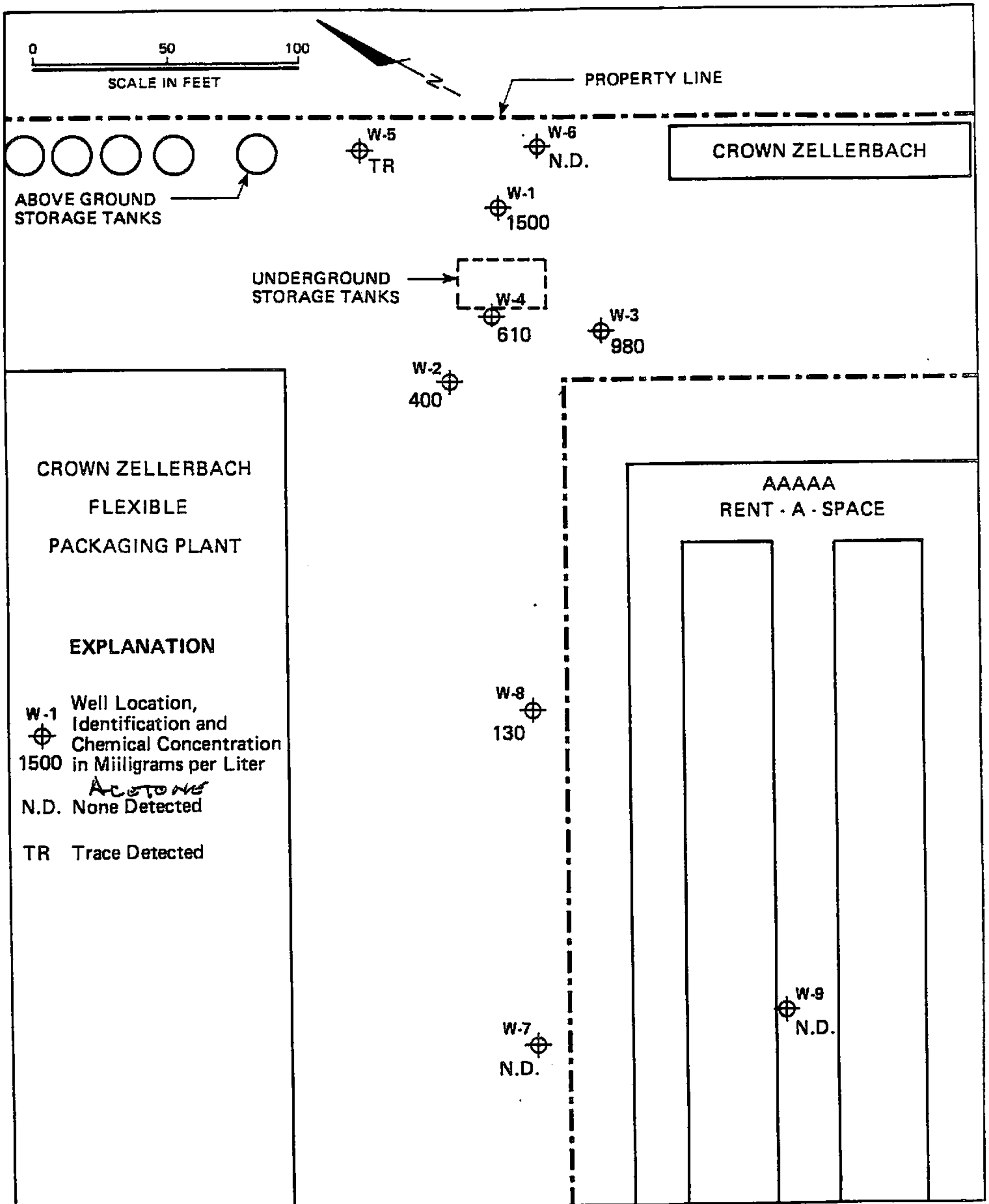

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Acetone in Ground Water February 1986
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PLATE
16

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