QUARTERL[redacted]
FOR AL[redacted]
PUNA GEO[redacted]

SEP[redacted] 1991

The following is a summary of the current status of the existing wells located on the Puna Geothermal Venture designated project area. The well locations are shown in Figure 1.

1. KS-1 (Figure 2)

Production well KS-1 was plugged with cement by Thermal Power on April 28, 1983. The plug was set from a depth of 1750 feet to a depth of 2153 feet. The well is completed with a single 2000# master gate valve which is maintained in the closed position and is locked. Wellhead pressure is stable at 6 psi in May, 1991. The gas observed when the pressure is bled through the side valve contains no H2S. The well cellar is currently filled with cinders due to mobilization and placement of equipment associated with the rework of KS-1A and proposed drilling of KS-11.

2. KS-2 (Figure 3)

Production well KS-2 was plugged with cement by Thermal Power on March 29, 1983. The plug was set from a depth of 2984 feet to a depth of 3175 feet. The well is completed with a single 2000# master gate valve which is maintained in the closed position and is locked. The following wellhead pressure readings have been observed:

Date	Pressure (psig)
5/20/91	0
6/16/91	1
7/12/91	0
9/15/91	3

3. KS-1A (Figure 4)

Production well KS-1A was plugged with cement by Puna Geothermal Venture on June 1, 1989. The plug was set from a depth of 3542 feet to a depth of 3692 feet. The well is currently being reworked. The 9-5/8" casing was inspected using a 60 arm caliper and magnetic casing inspection tool. The casing was found to be parted at 2908'. The 7" L-80 29# sleeve has been run and cemented from 3400' to the surface and a 9-5/8" wellhead installed. During the workover process it was determined that the 7" slotted liner was parted at 6113'. A fish consisting of 311' of drill collars and tapered mill was left in the hole with the top at 5745'.

The well was filled with fresh water and shut in. Drilling operations were suspended and the rig moved off the hole on 4/24/91. The following wellhead pressures have been observed:

Date	Pressure (psig)
5/30/91	0
6/1/91	3
8/1/91	87
8/15/91	280
8/30/91	429
9/15/91	558

4. KS-3 (Figure 5)

Production well KS-3 was completed by PGV on January 25, 1991. The well was drilled to a measured depth of 7406 feet. A 511' fish was left in the bottom of the hole. The well was flow tested from March 25 to March 31, 1991 and then shut in. The well built artesian wellhead pressure and a gas cap from 4/18/91 and reached 115 psi on 5/9/91. The well was killed using fresh water on 5/9/91 to eliminate the gas cap. From 5/12/91 the artesian pressure and gas cap began to build again. The following wellhead pressures were observed:

Date	Pressure (psig)
6/1/91	57
6/14/91	92
7/1/91	153
7/23/91	168
8/4/91	193
8/16/91	345
9/3/91	515
9/10/91	550
9/15/91	on vacuum

On 9/10-11/91 KS-3 was killed using fresh water in order to eliminate the gas cap. A permanent water line was hooked up to the 3" wellhead side valve so that the well can be maintained on a vacuum.

Since termination of the flow test on 3/31/91, temperature surveys were run in KS-3 on the following dates:

4/1/91	4/25/91
4/3/91	6/5/91
4/6/91	6/6/91
4/9/91	6/25/91
	9/10/91

(temp. data ?)

5. Well KS-7 (Figure 6)

KS-7 was spudded on January 30, 1991. 13-3/8" K-55 54# BT&C casing was set and cemented to 1020 feet. During the drilling of the 12-1/4" hole, an unanticipated high temperature, high pressure zone was encountered in the 1500 foot to 1678 foot interval. The hole bridged at a depth of 1277 feet. A cement plug was placed from 1277 feet to a depth of 740 feet. Drilling operations are currently suspended and the well is shut in with a 900 Series 10" valve. Pressure\water level and temperature in the KS-7 are being monitored daily. The data is reported to DLNR in a separate weekly report. No H2S gas has been detected from KS-7.

6. Monitoring\Water Supply Well MW-1 (Figure 7)

MW-1 was completed by PGV on December 30, 1990 to a depth of 731 feet. A 75 hp submersible pump was installed and the well was put in service to supply water for production drilling operations and fire protection. The well is also sampled quarterly as part of the Hydrologic Monitoring Program.

7. Monitoring Well MW-2 (Figure 8)

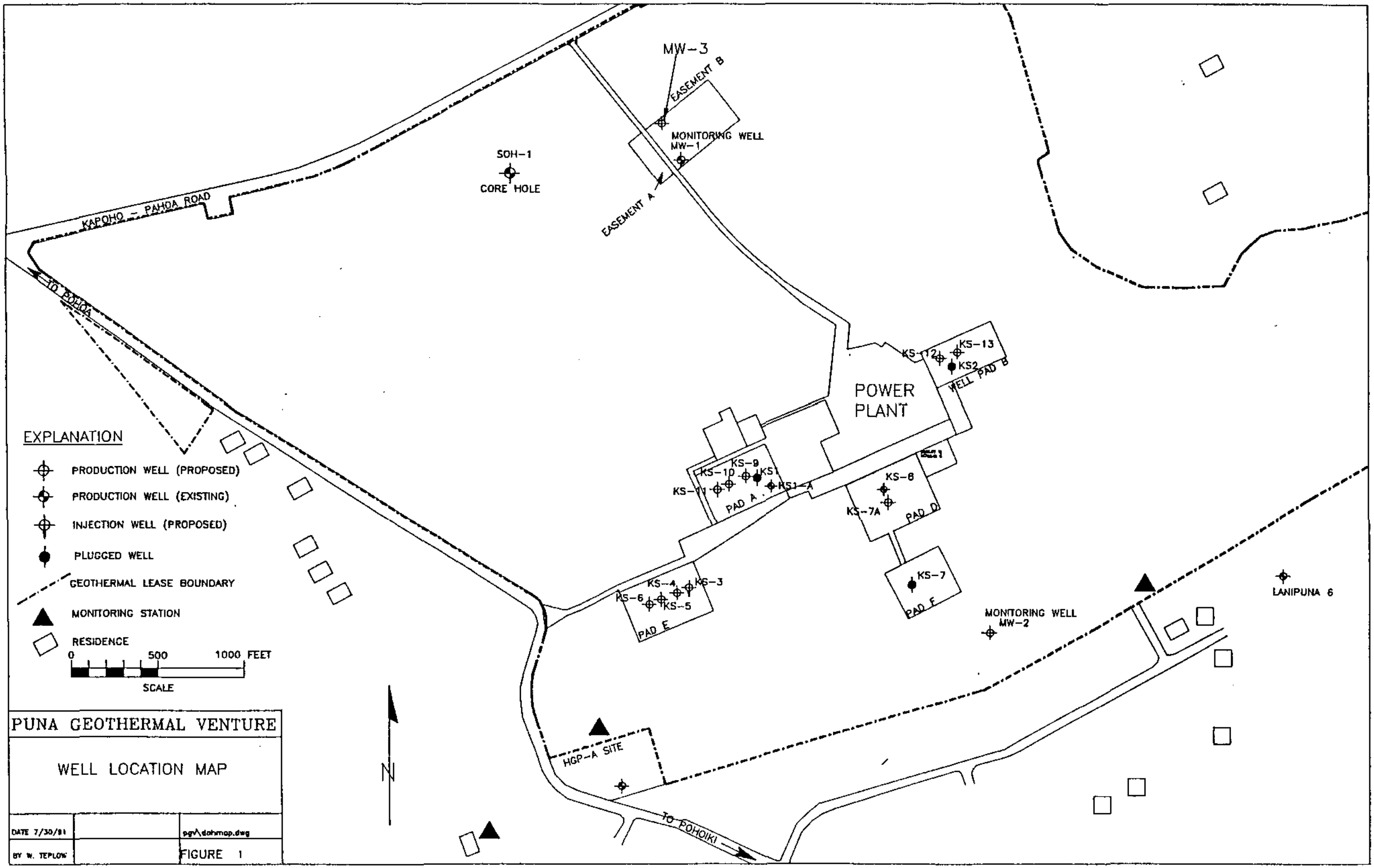
MW-2 was completed on January 21, 1991 to a depth of 646 feet. The well completed with 4" pipe which is perforated in the bottom 50 feet. The water level and temperature is monitored daily and is reported weekly to DLNR. Water chemistry is analyzed and reported weekly to DLNR. The well is also sampled and chemical analyses performed quarterly as part of the Hydrologic Monitoring Program.

8. Production Well KS-8 (Figure 9)

KS-8 is currently being completed with Parker Rig #231 on the well. 20" casing has been run to 1039', cemented and pressure tested. 13-3/8" casing has been cemented and pressure tested to 2128'. A 7" liner has be run from 2072' to 3379'. The 7" annulus has been cemented in the 2108'-2770' interval. An upgraded 1500 series wellhead has been installed on the 13-3/8" casing as a replacement for the 900 series wellhead. The well is currently plugged in the 7" liner with a mechanical and cement plug. No pressure is observed at the surface.

9. Drilling Water Supply Well MW-3 (Figure 10)

MW-3 was completed on 8/24/91 to a depth of 720' with 13-3/8" casing set to 680'. The well was immediately placed in service with a submersible pump. The well is currently producing 1200 gpm of water used for drilling operations. Water temperature ranges between 106 and 108 deg.F.



MW-3
EASEMENT B
MONITORING WELL
MW-1
SOH-1
CORE HOLE
EASEMENT A
KAPOHO - PAHOA ROAD
TO PAHOA
POWER
PLANT
KS-12
KS-13
KS2
WELL PAD B
KS-9
KS-10
KS1
KS-11
KS1-A
PAD A
KS-8
KS-7A
PAD D
KS-7
PAD F
KS-4
KS-3
KS-6
KS-5
PAD E
MONITORING WELL
MW-2
LANIPUNA 6
HGP-A SITE
TO POHOIKI
N
EXPLANATION
PRODUCTION WELL (PROPOSED)
PRODUCTION WELL (EXISTING)
INJECTION WELL (PROPOSED)
PLUGGED WELL
GEOTHERMAL LEASE BOUNDARY
MONITORING STATION
RESIDENCE
0
500
1000 FEET
SCALE
PUNA GEOTHERMAL VENTURE
WELL LOCATION MAP
DATE 7/30/91
pgv\dohmap.dwg
BY W. TEPLOW
FIGURE 1

PGV WELL KS-1

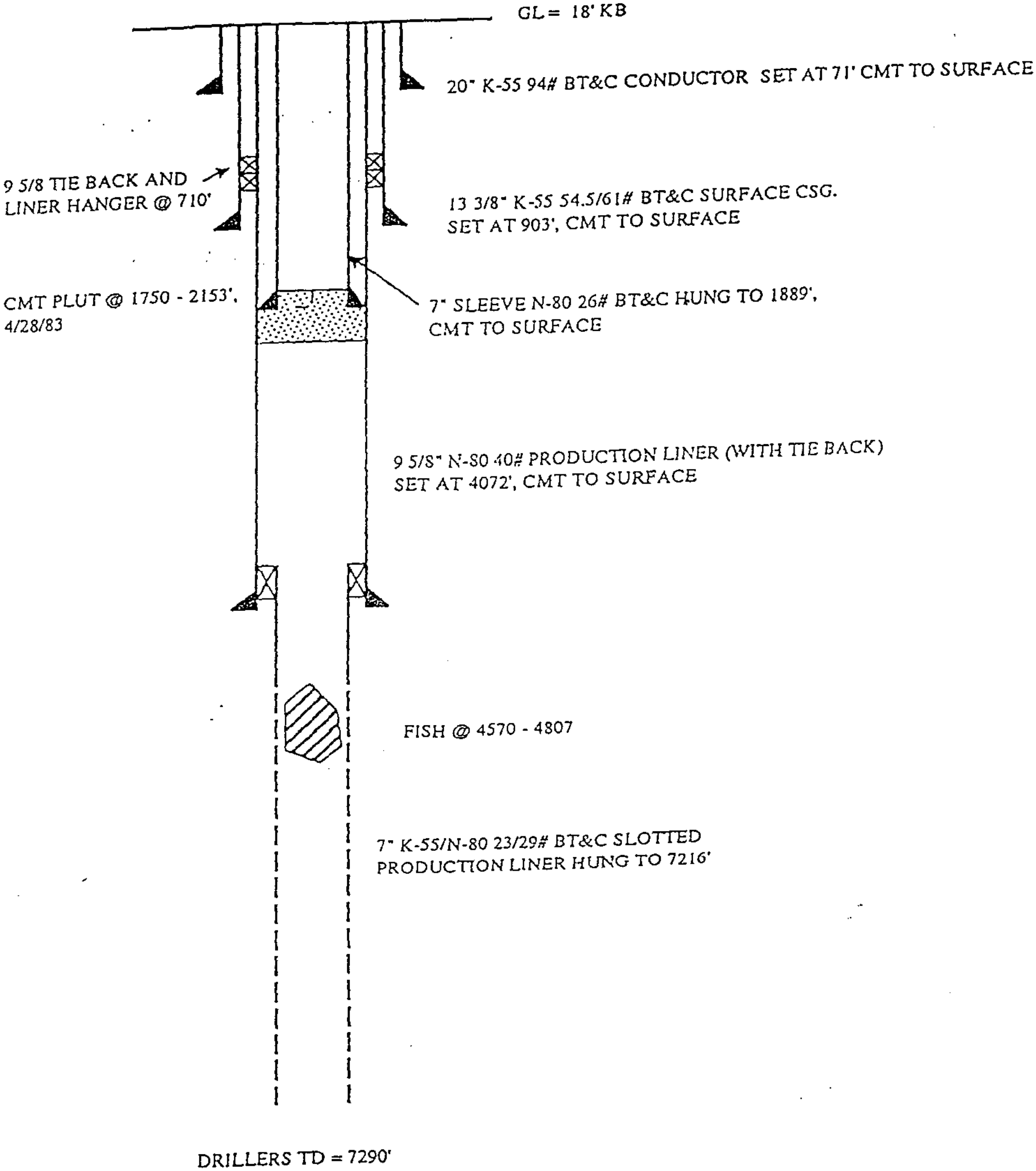


Figure 2

PGV WELL KS-2

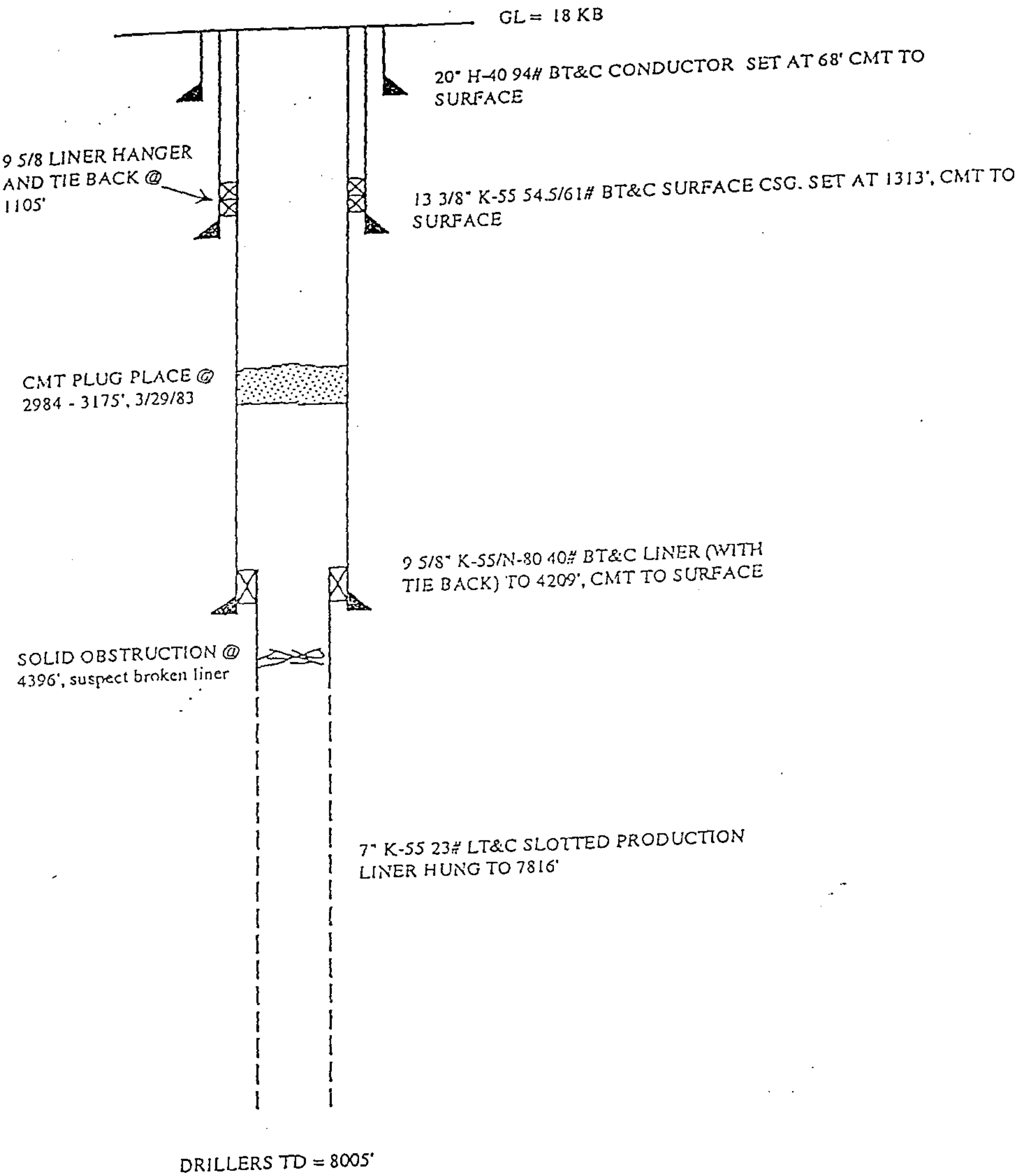
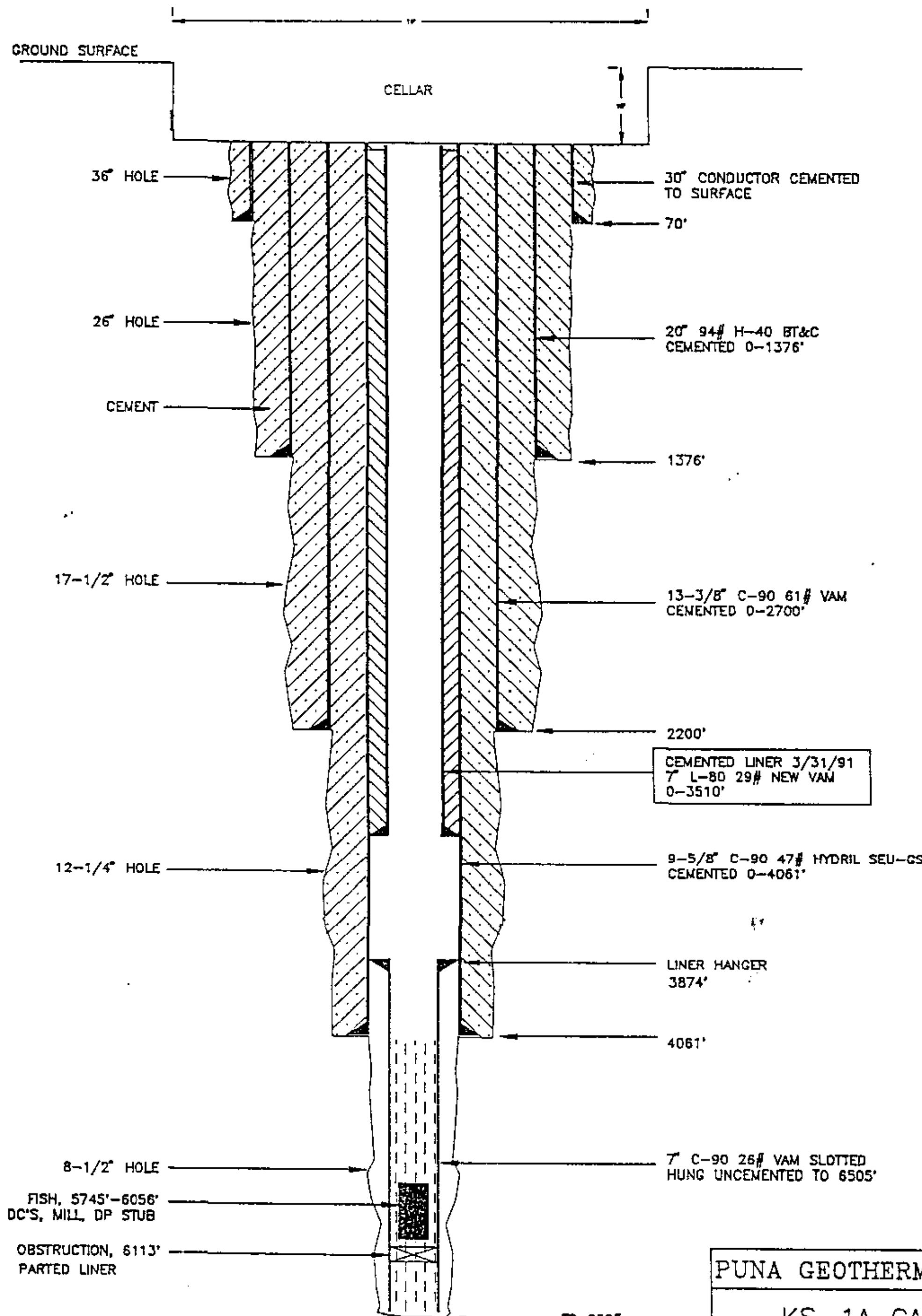


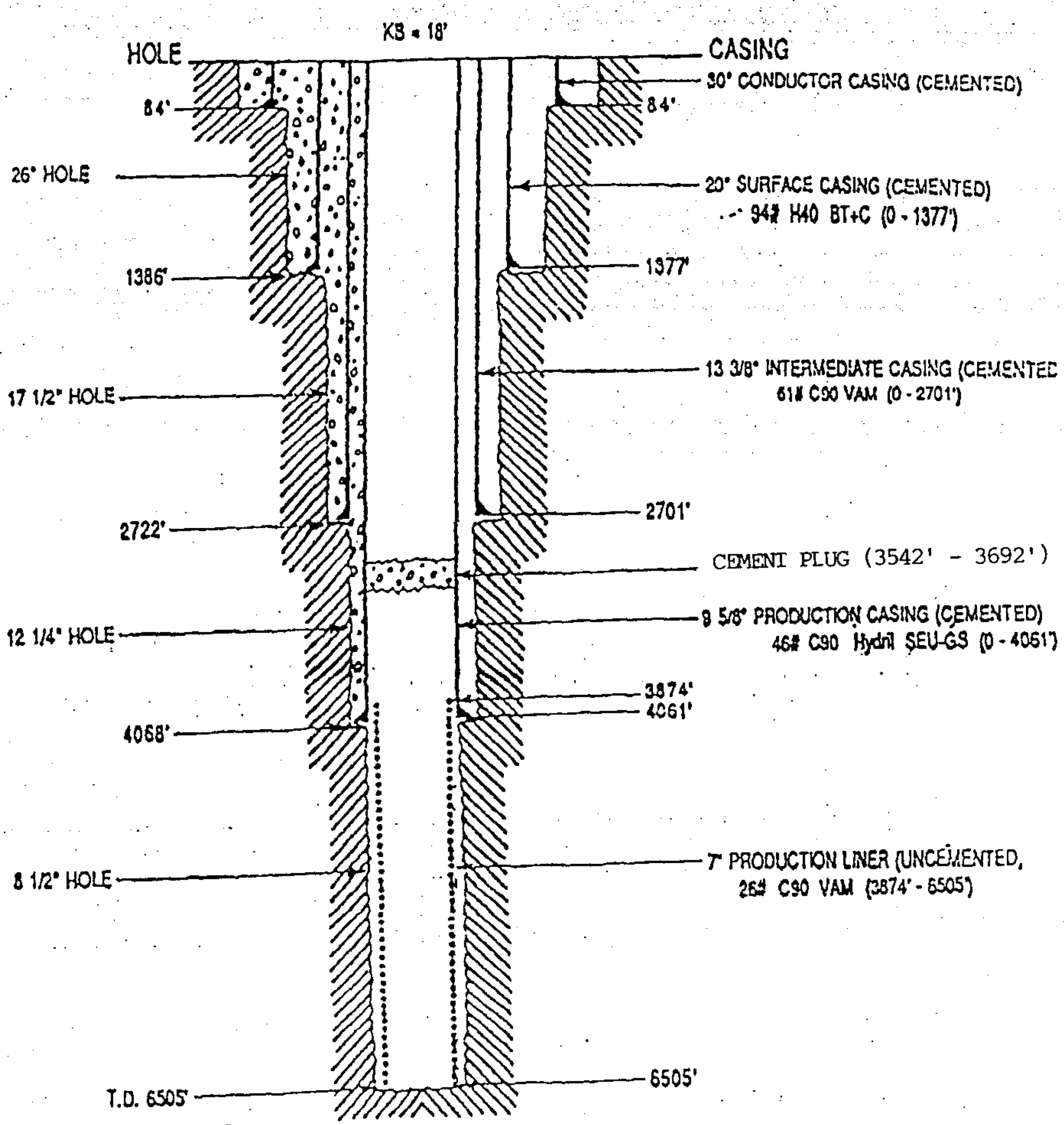
Figure 3



PUNA GEOTHERMAL VENTURE

KS-1A CASING SCHEMATIC AFTER REWORK

DATE 5/13/91		REV. 1
BY W. TEPLOW		FIGURE NO. 4

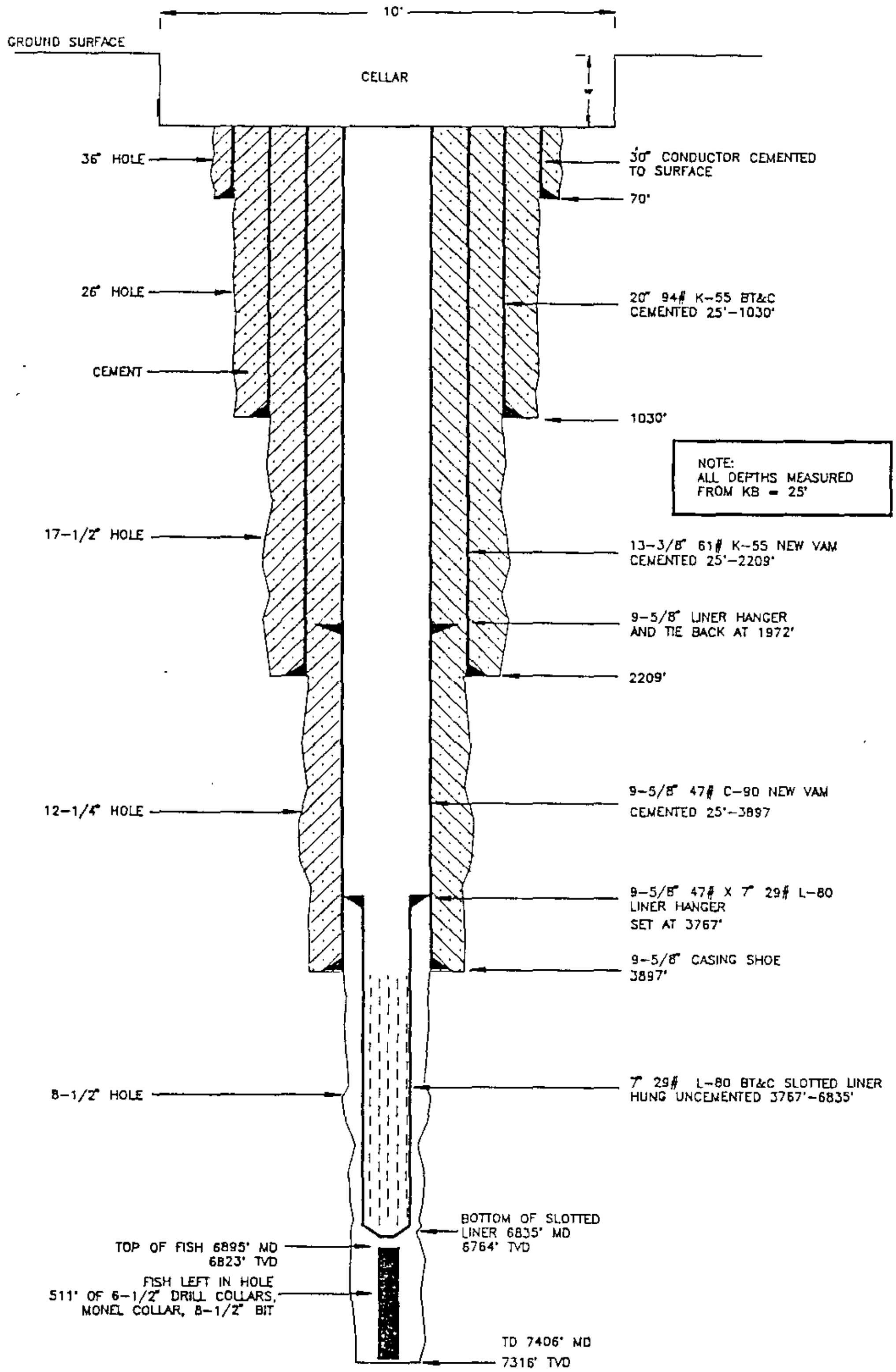


Status of Kapoho State - 1A After Placemnet of

Temporary Cement Plug

June 1, 1989

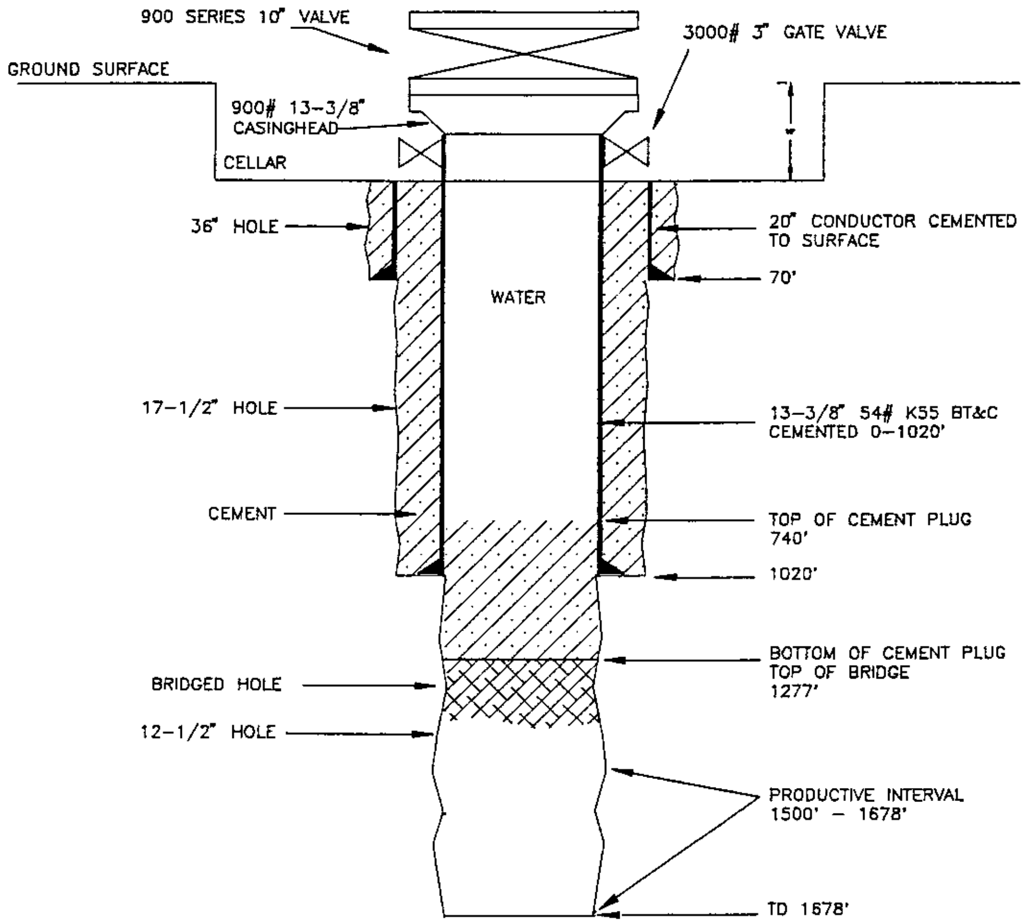
No Final As-built Drawing submitted for Well Modification (3/91)



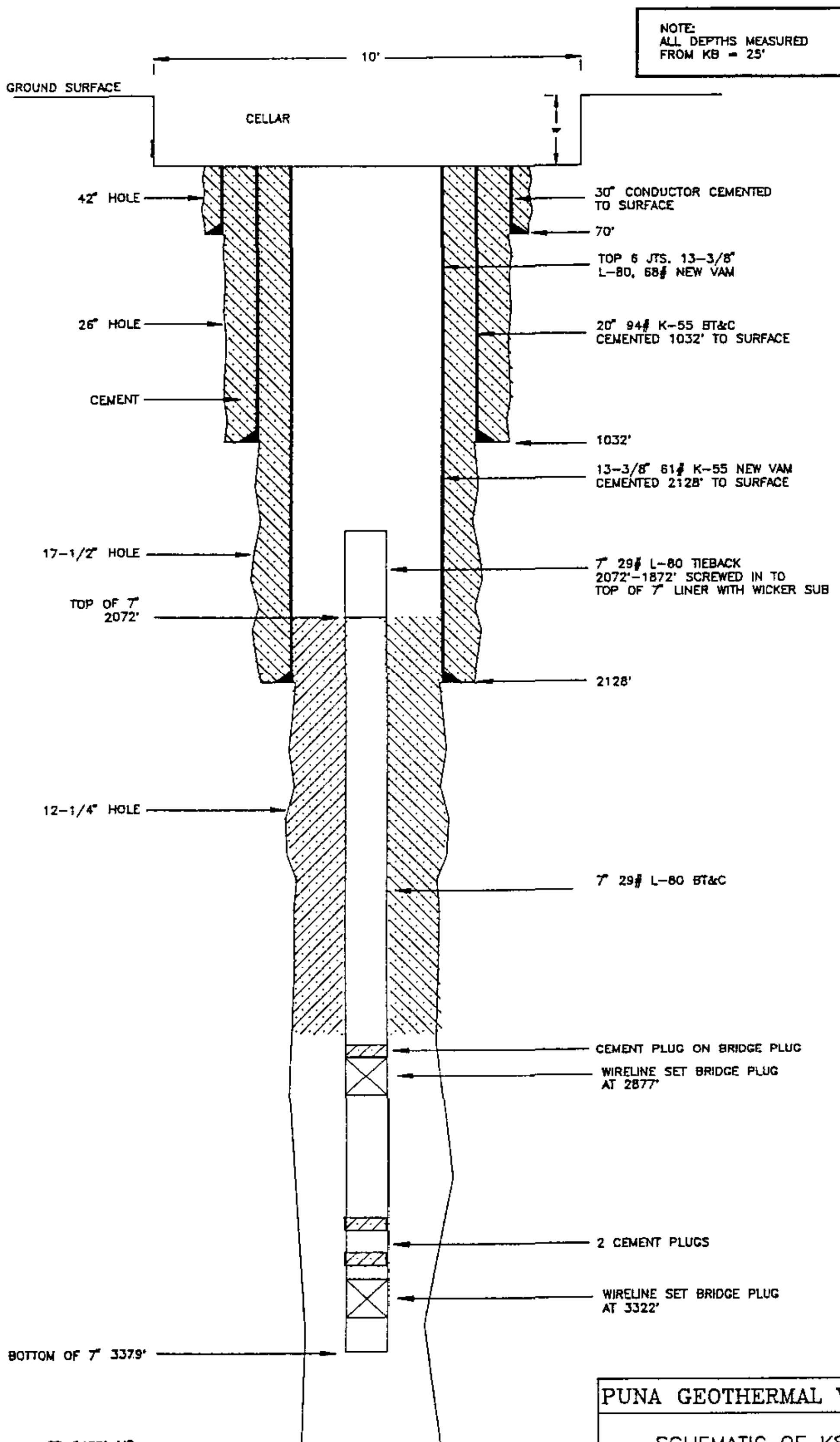
PUNA GEOTHERMAL VENTURE

KS-3 COMPLETION

DATE 4/7/91		REV. 1



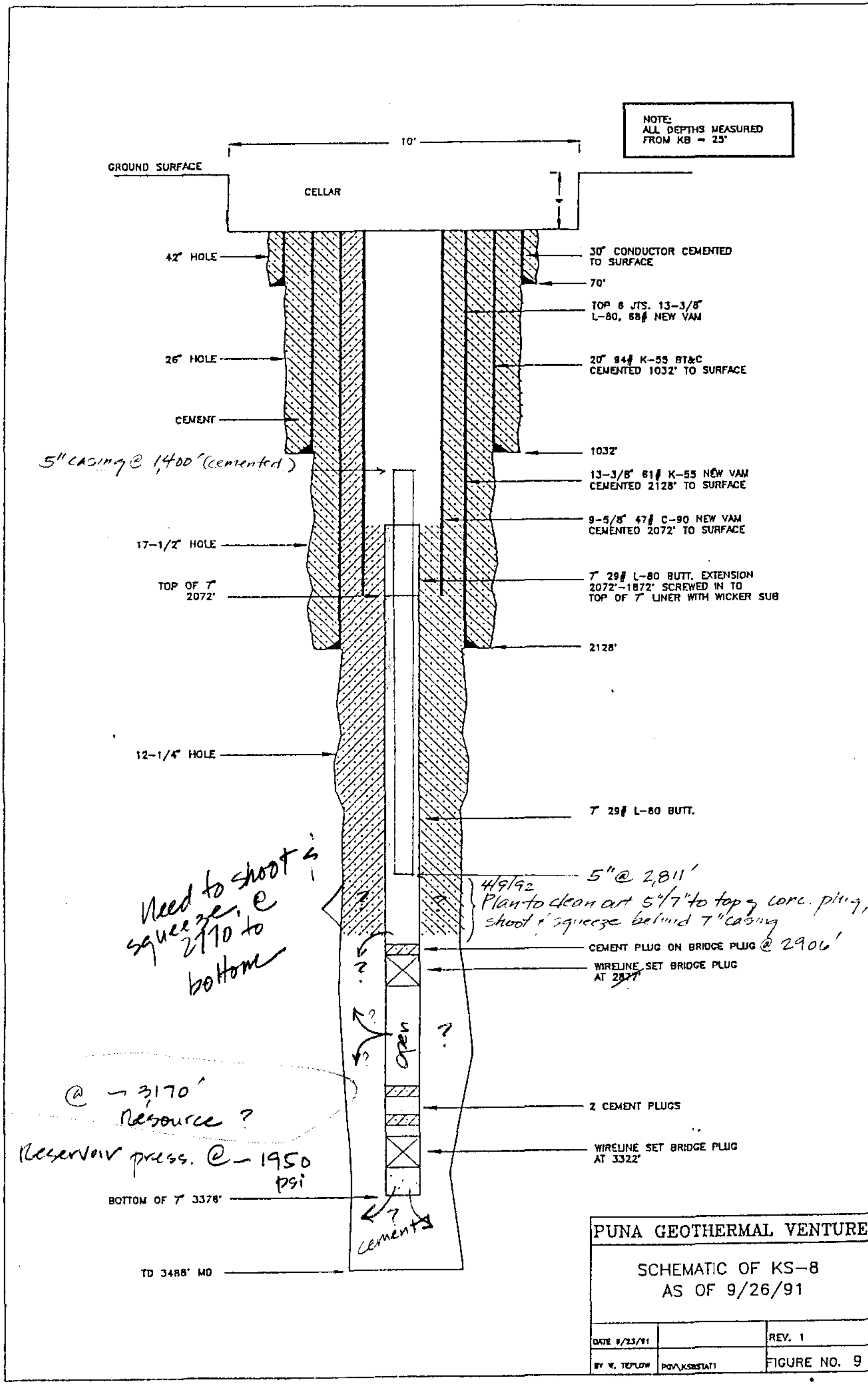
PUNA GEOTHERMAL VENTURE		
WELL KS-7 CEMENT PLUG AND WELLHEAD SCHEMATIC		
DATE 2/24/91	File pgv\ks7pando.dwg	REV. 1
BY W. TEPLOW		FIGURE NO. 5

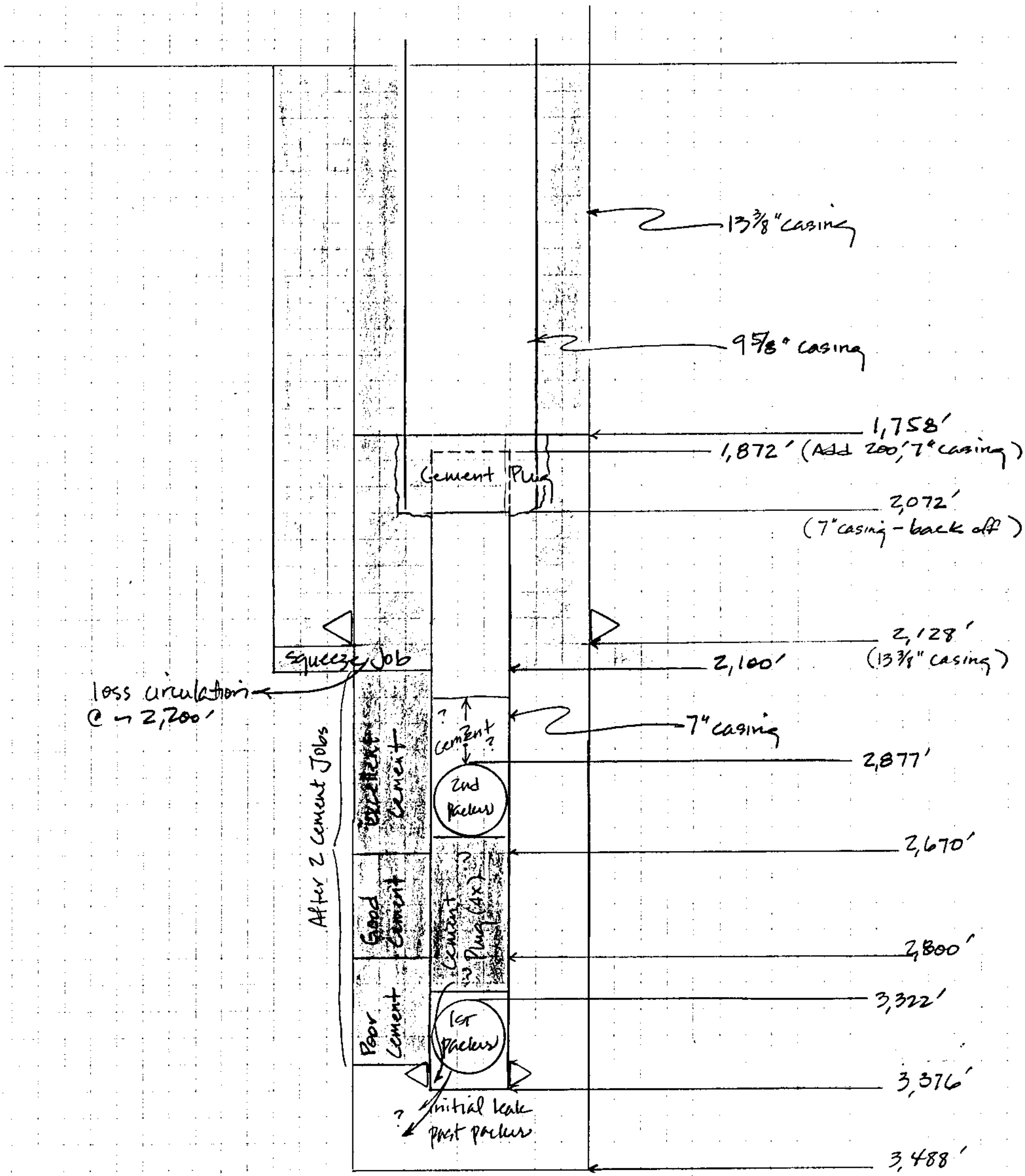


PUNA GEOTHERMAL VENTURE

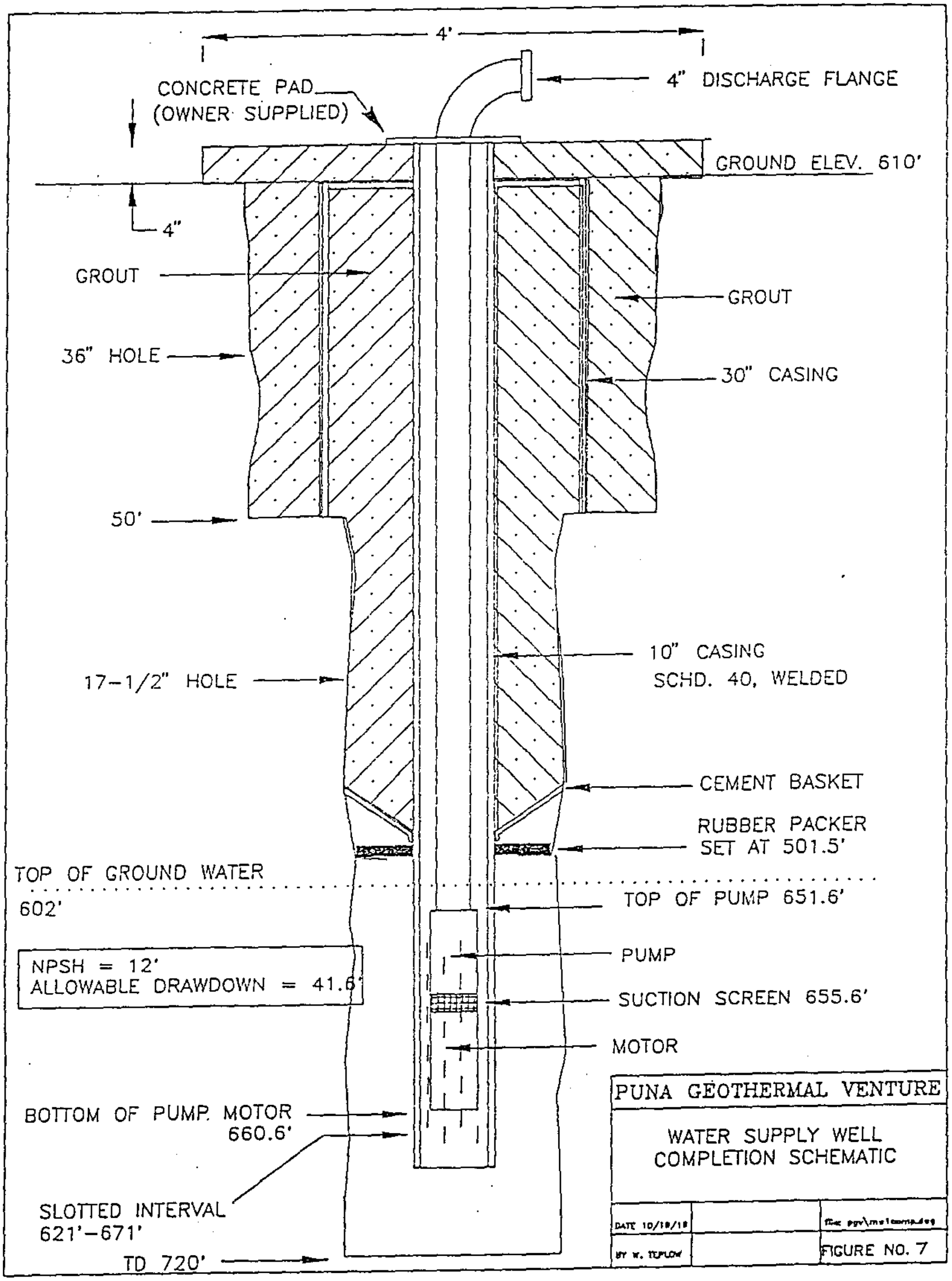
SCHEMATIC OF KS-8
AS OF 9/24/91

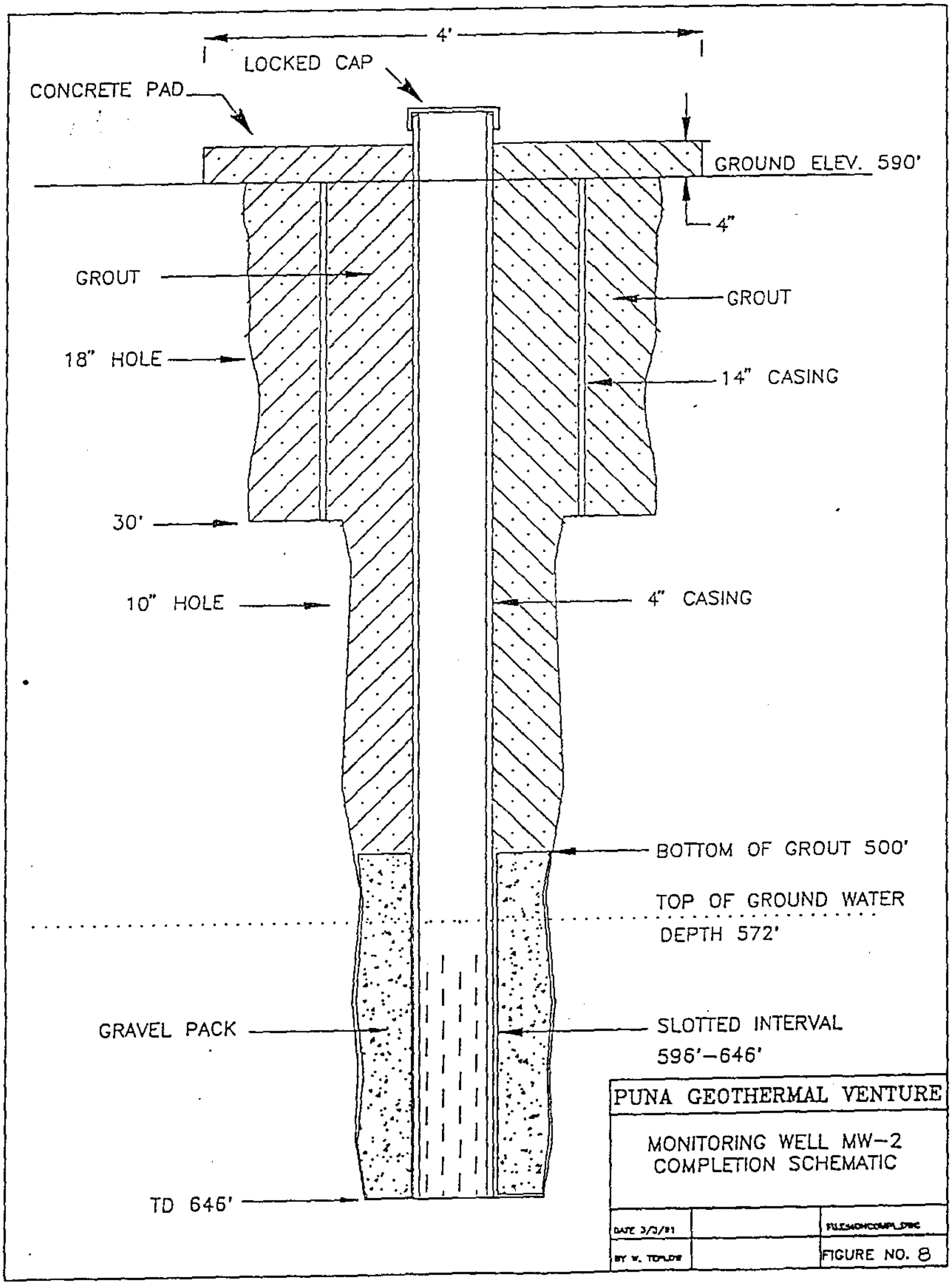
DATE 9/23/91		REV. 1
BY W. TEPLOW	PGV\KS8STAT1	FIGURE NO. 9

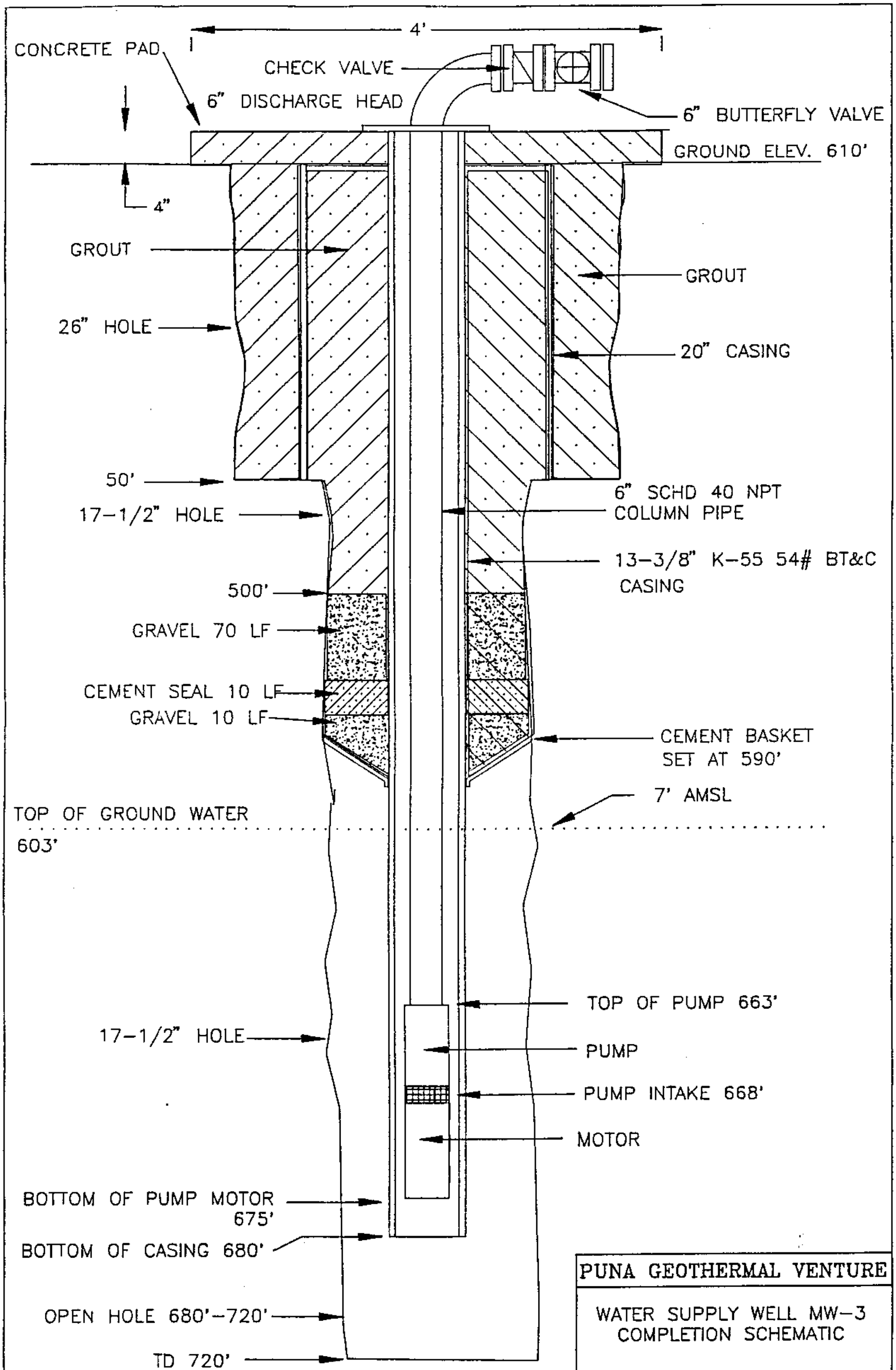

NOTE:
ALL DEPTHS MEASURED FROM KB – 25'
10'
GROUND SURFACE
CELLAR
42" HOLE
30" CONDUCTOR CEMENTED TO SURFACE
70'
TOP 6 JTS. 13-3/8" L-80, 68# NEW VAM
26" HOLE
20" 94# K-55 BT&C CEMENTED 1032' TO SURFACE
CEMENT
1032'
5" casing @ 1,400' (cemented)
13-3/8" 61# K-55 NEW VAM CEMENTED 2128' TO SURFACE
9-5/8" 47# C-90 NEW VAM CEMENTED 2072' TO SURFACE
17-1/2" HOLE
TOP OF 7" 2072'
7" 29# L-80 BUTT. EXTENSION 2072'–1872' SCREWED IN TO TOP OF 7" LINER WITH WICKER SUB
2128'
12-1/4" HOLE
7" 29# L-80 BUTT.
5" @ 2,811'
4/9/92 Plan to clean out 5"/7" to top of conc. plug, run logs shoot & squeeze behind 7" casing
Need to shoot & squeeze @ 2110' to bottom
CEMENT PLUG ON BRIDGE PLUG @ 2906'
WIRELINE SET BRIDGE PLUG AT 2877'
open
@ ~3170' Resource?
Reservoir press. @ ~1950 psi
2 CEMENT PLUGS
WIRELINE SET BRIDGE PLUG AT 3322'
BOTTOM OF 7" 3378'
cement
TD 3488' MD
PUNA GEOTHERMAL VENTURE
SCHEMATIC OF KS-8
AS OF 9/26/91
DATE 9/23/91
BY W. TEPLOW
PGV\KS8STAT1
REV. 1
FIGURE NO. 9



13 3/8" casing
9 5/8" casing
1,758'
1,872' (Add 200' 7" casing)
Cement Plug
2,072'
(7" casing - back off)
2,128'
(13 3/8" casing)
squeeze Job
2,100'
loss circulation @ ~ 2,200'
7" casing
cement
2,877'
2nd packer
After 2 Cement Jobs
Cement
2,670'
Good Cement
Cement Plug (4x)
2,800'
3,322'
Poor Cement
1st packer
3,376'
initial leak past packer
3,488'


4'
4" DISCHARGE FLANGE
CONCRETE PAD
(OWNER SUPPLIED)
GROUND ELEV. 610'
4"
GROUT
GROUT
36" HOLE
30" CASING
50'
10" CASING
SCHD. 40, WELDED
17-1/2" HOLE
CEMENT BASKET
RUBBER PACKER
SET AT 501.5'
TOP OF GROUND WATER
602'
TOP OF PUMP 651.6'
PUMP
NPSH = 12'
ALLOWABLE DRAWDOWN = 41.6'
SUCTION SCREEN 655.6'
MOTOR
BOTTOM OF PUMP MOTOR
660.6'
SLOTTED INTERVAL
621'-671'
TD 720'
PUNA GEOTHERMAL VENTURE
WATER SUPPLY WELL
COMPLETION SCHEMATIC
FIGURE NO. 7


4'
LOCKED CAP
CONCRETE PAD
GROUND ELEV. 590'
4"
GROUT
GROUT
18" HOLE
14" CASING
30'
10" HOLE
4" CASING
BOTTOM OF GROUT 500'
TOP OF GROUND WATER
DEPTH 572'
GRAVEL PACK
SLOTTED INTERVAL
596'–646'
TD 646'
PUNA GEOTHERMAL VENTURE
MONITORING WELL MW–2
COMPLETION SCHEMATIC
DATE 3/3/91
BY W. TEPLOW
FIGURE NO. 8



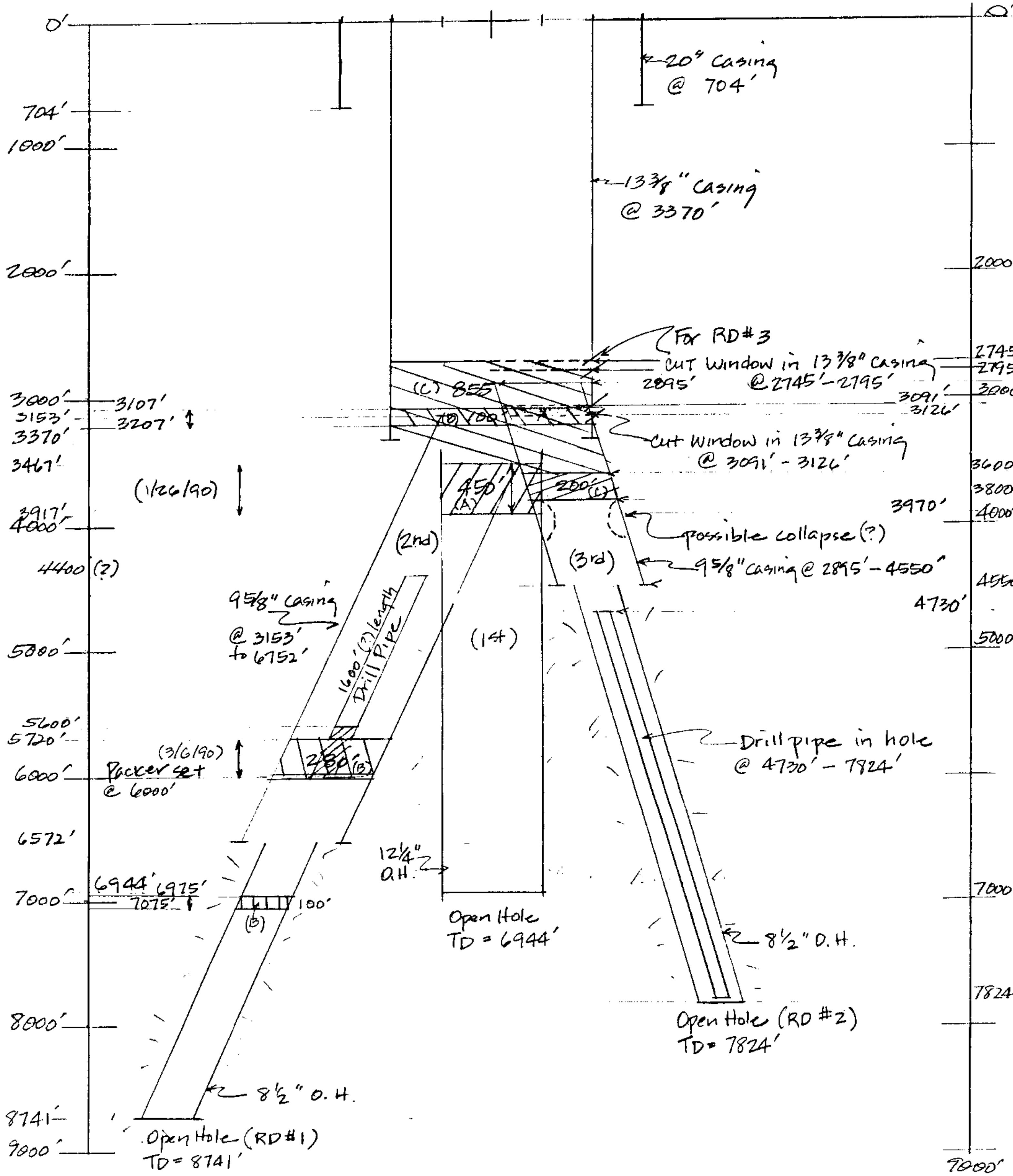
PUNA GEOTHERMAL VENTURE

WATER SUPPLY WELL MW-3
COMPLETION SCHEMATIC

DATE 7/30/91		FILE: PGV\MW3COMP.DWG
BY W. TEPLOW		FIGURE NO. 10

True/Mid-Pacific A1-

CONFIDENTIAL



(7/31/90 DN)

ATTACHMENT "B"
May 24 through May 30, 1992

Well No. KS-7

Starting Depth (ft)	1678'
Ending Depth (ft)	1678'
Net Footage Drilled (ft)	0'
Hole Size (inches)	17-1/2 T / 1050 (ft)
	12-3/4 T / 1678 (ft)
Casing set (inches)	13-3/8 to 1020 (ft)

Operations:
* Monitor well status
* Monitor down hole temp. at 730' (daily)
* Monitor MW-2 (daily)
* Monitor MW-2 H_2O chemistry (spot)

Well No. KS-3

Starting Depth (ft)	7406'
Ending Depth (ft)	7406'
Net Footage Drilled (ft)	0'
Hole Size (inches)	8-1/2"
Casing Set:	30" to 70'
	20" to 1030'
	13-3/8" to 2209'
	9-5/8" to 3897'
	7" (3767' to 6835')

Operations:
* Continued to maintain well on vacuum

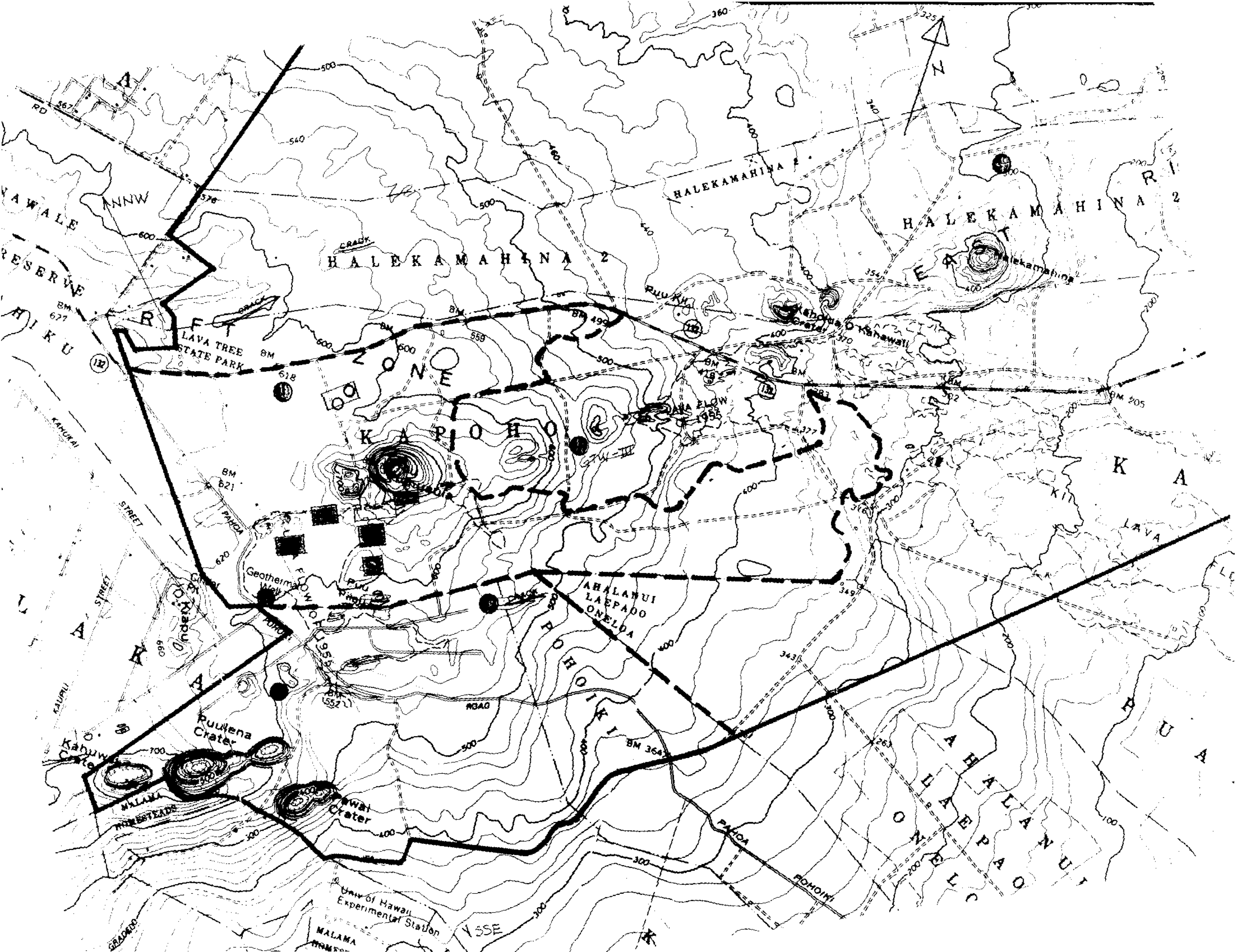
Well No. KS-8

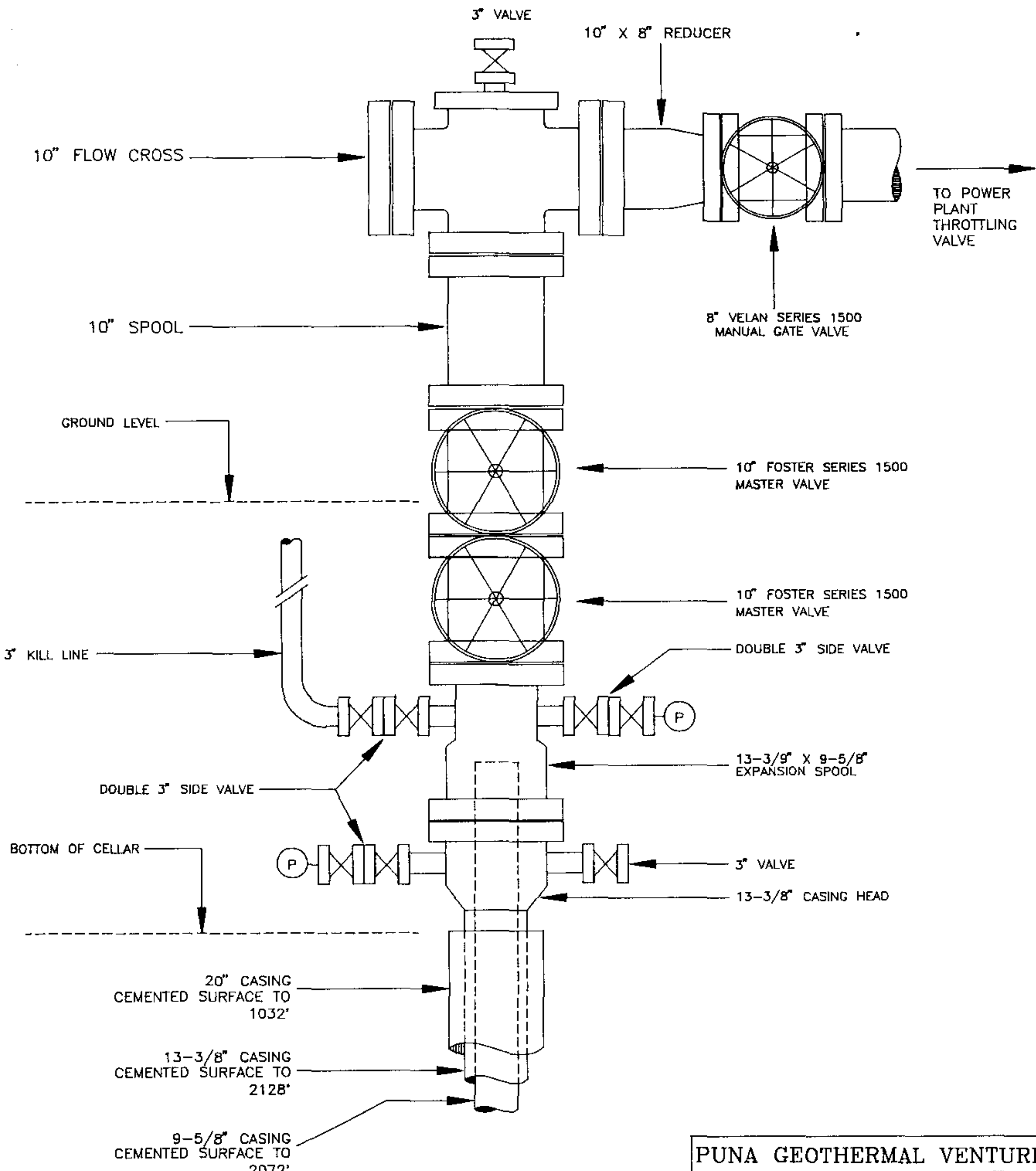
Starting Depth (ft)	3488'
Ending Depth (ft)	3488'
Net Footage Drilled (ft)	0'
Hole Size (inches)	12-1/4"
Casing set (inches)	30" to 74"
	13-3/8" to 2138"
	9 5/8" to 2072'
	7" (2062' to 3339')
	5" (1361' to 2808')

Operations:
* Standby and monitor wellhead pressure

Well No. KS-1A

Operations:
* Continued to maintain well on vacuum with injection of water
* Monitored well head pressure

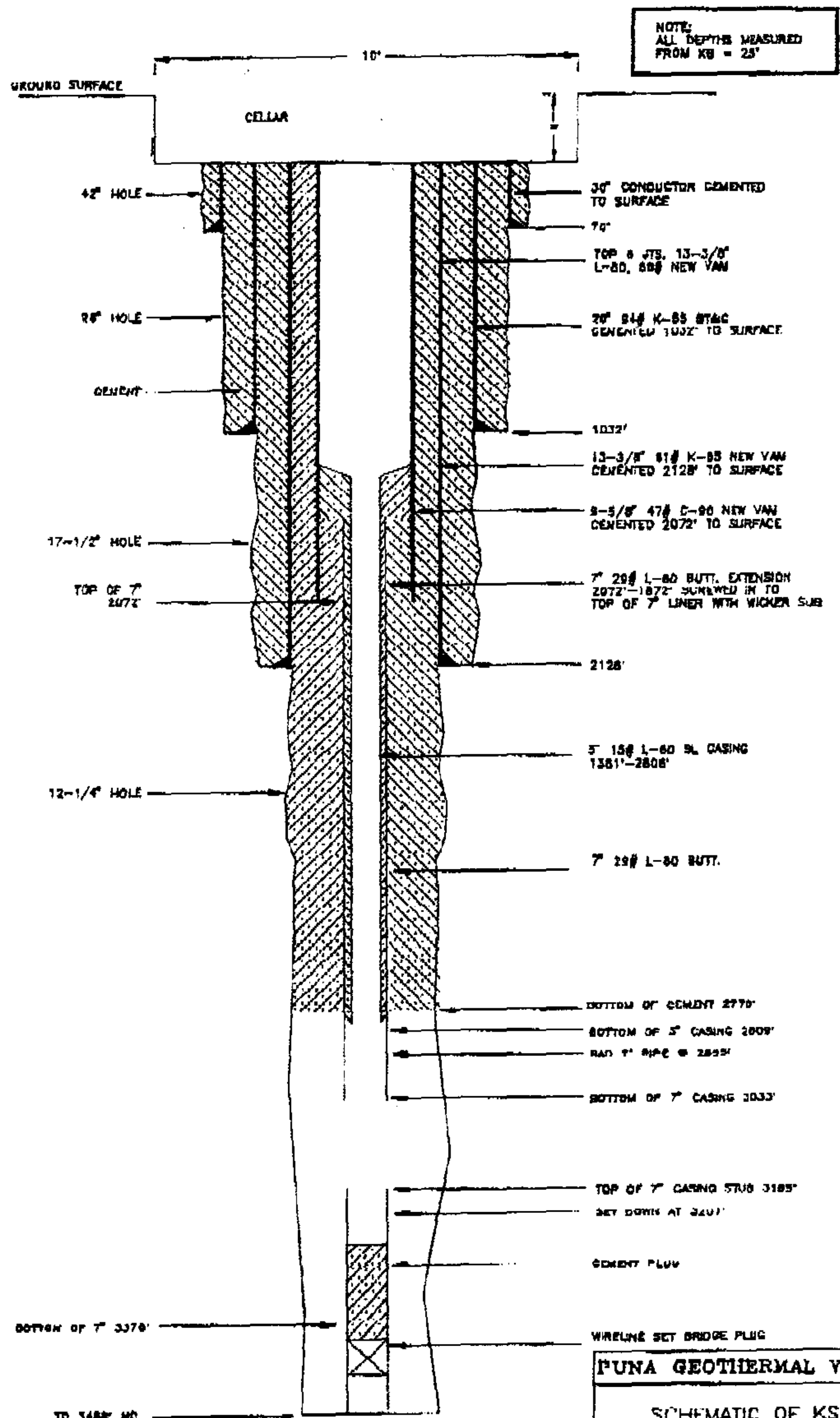

HALEKAMAHINA 2
LAVA TREE STATE PARK
RIFT ZONE
KAPOHO
AA FLOW 1955
GTW-III
AHALANUI LAEPAOO ONELOA
POHOIKI
Geothermal Well
Puulena Crater
Kahuwai Crater
Heiheiahulu
Kapoho
Halekamahina
Puu Kii
MALAMA HOMESTEADS
Univ of Hawaii Experimental Station
PAHOA
ROAD
PUA
LAVA
N
NNW
SSE



PUNA GEOTHERMAL VENTURE

PRODUCTION WELLHEAD CONFIGURATION FOR KS-8

DATE 10/22/92		REV. 1
BY TEPLOW	FILE:PGV\KS8WH	FIGURE NO.

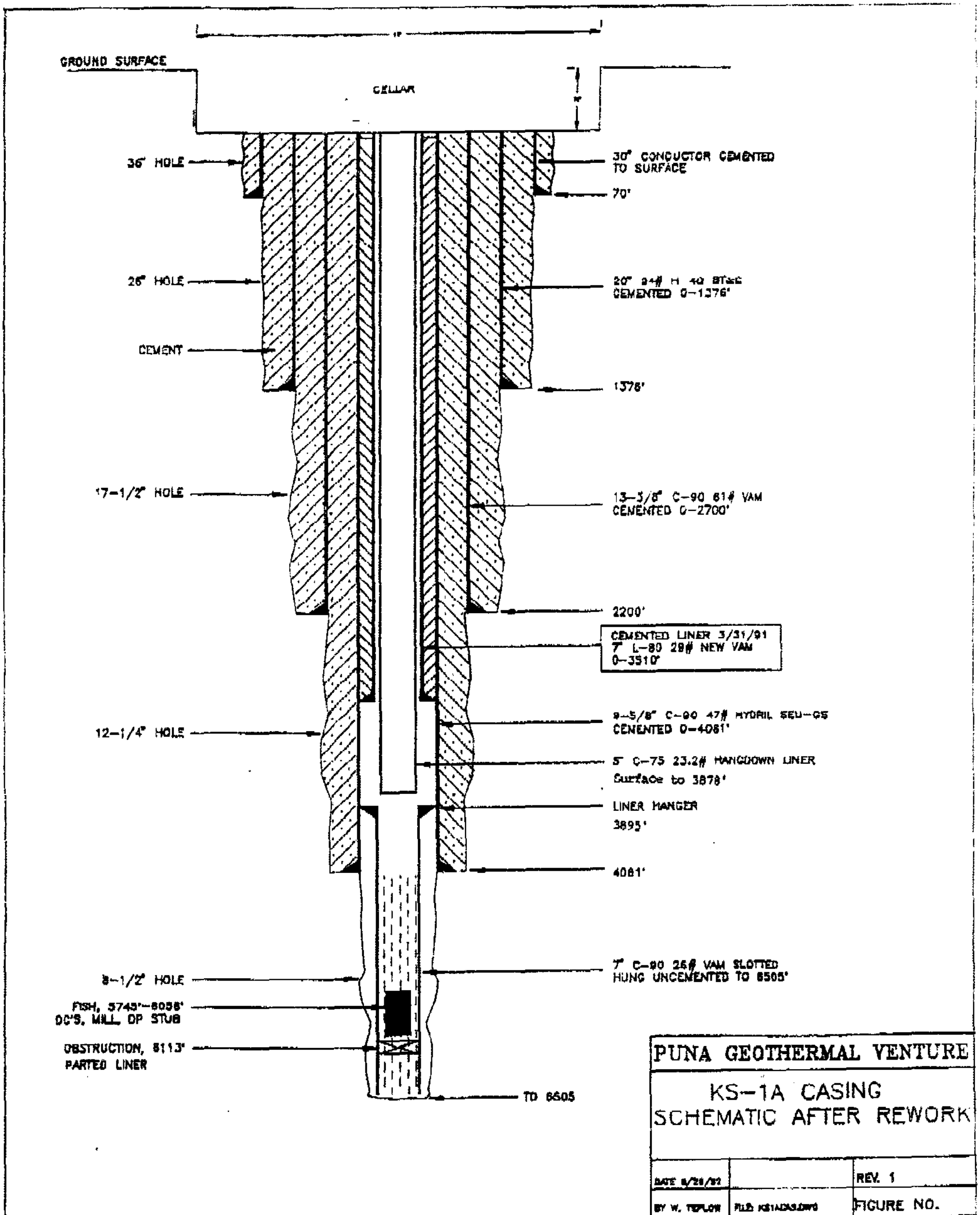


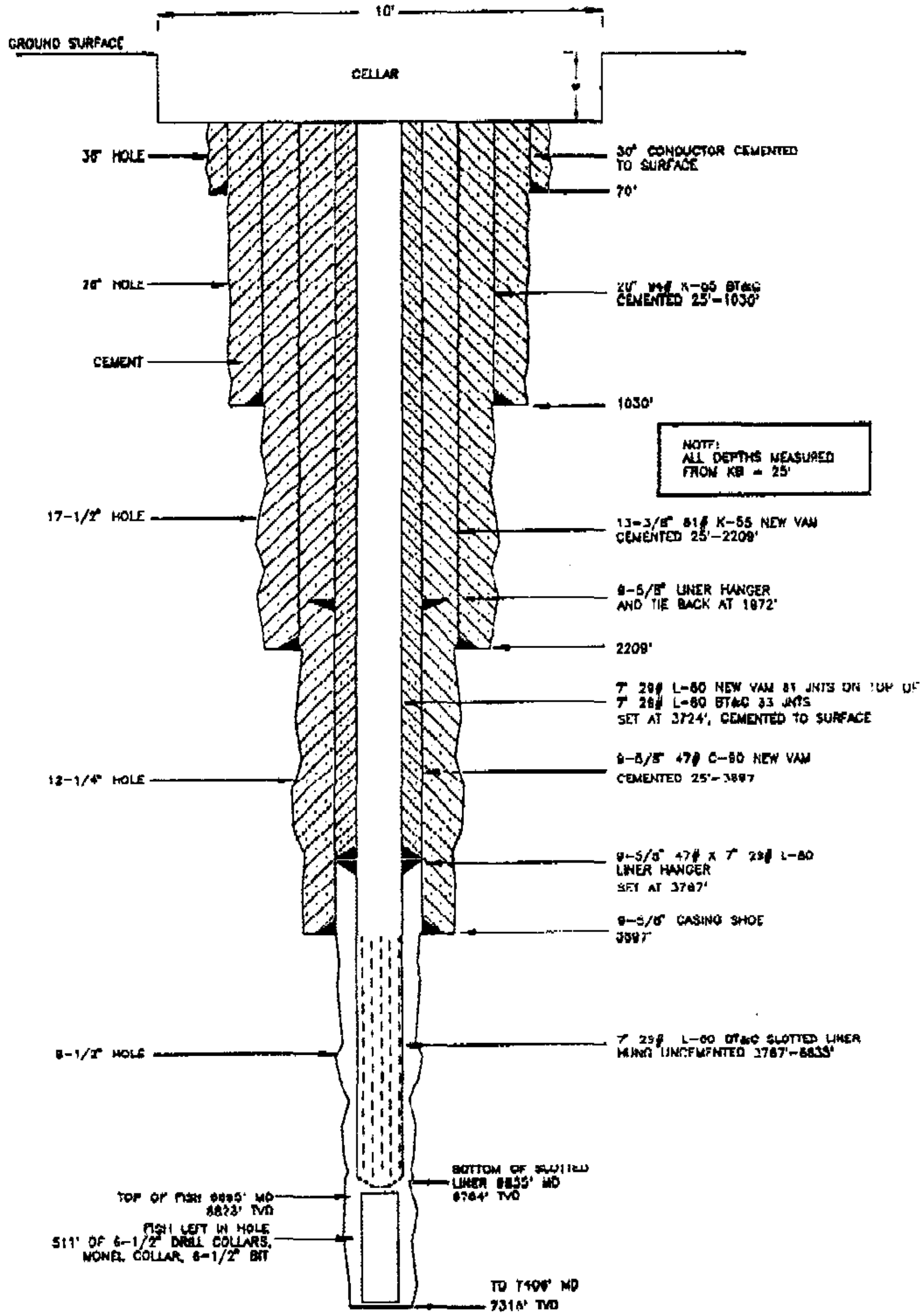
PUNA GEOTHERMAL VENTURE

SCHEMATIC OF KS-8
AS OF 8/3/92

REV. 1

FIGURE NO. 3


GROUND SURFACE
CELLAR
36" HOLE
30" CONDUCTOR CEMENTED TO SURFACE
70'
26" HOLE
20" 94# H 40 BT&C CEMENTED 0-1376'
CEMENT
1376'
17-1/2" HOLE
13-3/8" C-90 61# VAM CEMENTED 0-2700'
2200'
CEMENTED LINER 3/31/91 7" L-80 29# NEW VAM 0-3510'
12-1/4" HOLE
9-5/8" C-90 47# HYDRIL SEU-05 CEMENTED 0-4061'
5" C-75 23.2# HANGDOWN LINER Surface to 3878'
LINER HANGER 3895'
4061'
8-1/2" HOLE
7" C-90 26# VAM SLOTTED HUNG UNCEMENTED TO 6605'
FISH, 5745'-6056' DC'S, MILL, DP STUB
OBSTRUCTION, 6113' PARTED LINER
TD 6605
PUNA GEOTHERMAL VENTURE
KS-1A CASING SCHEMATIC AFTER REWORK
DATE 8/28/92
BY W. TEPLOW
REV. 1
FIGURE NO.



PUNA GEOTHERMAL VENTURE

KS-3 COMPLETION
AS OF 10/3/92

REV. 2

FIGURE NO. 1

PROGRESSIVO
PER LATE
DI ESECUZIONE
DEI POZZI

11-14-89
Need to:
- verify coordinates of geoth wells.
- copy of GRI map w/ well locations plotted

WELLS DRILLED KILAUEA EAST RIFT ZONE

Map #	Name	Location (N/W)	Mo/Yr.	Max Temp. C (°F)	Max Depth (M) (Ft)	Fluids	Operator	1989 Status	Quality of Avail. Data
HA-5	Geothermal 1 (2686-01)	19-26-34/154-56-46 ✓	'61	54 @ 54m	54	No	Hawaii Thermal Power Co.	Aband.	Poor
HA-6	Geothermal 2 (2686-02)	19-26-33/154-56-48 ✓	'61	102 @ 167m	170	No	Hawaii Thermal Power Co.	Aband.	Poor
HA-13	Geothermal 3 (2982-01)	19-29-13/154-~~54~~ (52')-55	'61?	93 18" csg.	210 (690')	No	Hawaii Thermal Power Co.	Aband.	Poor
HA-15	Geothermal 4 (3081-02)	19-30-39/154-51-19 ✓	'61	43	88	No	Hawaii Thermal Power Co.	Aband.	Poor
HA-1	NSF Kilauea (2317-01)	19-23-44/155-17-21 ✓	'73	139	1262	No	NSF	Aband.	Poor
HA-9	HGP-A (2883-01)	? 19-28-31/154-53-~~44~~ 43"	7/76	358 (676°)	1968 (645~~5~~7')	100,000#/hr. ⟨43% S 57% W⟩	University of Hawaii	~~Operating~~ Suspended	Excellent
HA-4	Ashida 1 (2685-01)	? 19-26-59/154-55-32 ✓	10/80	288 (550°)	2530 (8300')	?No.	GEDCO	~~Aband.~~ Suspended	Fair
HA-10	Lanipuna 1 (2883-02)	? 19-28-16/154-53-33 ✓	5/81	36~~8~~3 (685)	2557 (8389')	~~Yes~~ No.	GEDCO	~~Aband.~~ Suspended	Fair
HA-11	Kapoho ~~Site~~ State 1 (2883-03)	? 19-28-47/154-53-39 ✓ (50")	11/81	343 @ 1950 (64~~2~~9°)	2222 (7290')	~~73,000#/hr.~~ 71,500#/hr (100% S)	Puna Geothermal Venture (Thermal Power Company)	Plugged (Temp.)	Good
HA-12	Kapoho ~~Site~~ State 2 (2883-04)	? 19-28-~~47~~ (55")/154-53-~~49~~ (22") (25")	4/82	35~~5~~4 @ 2103 (669°)	2440 (8005')	~~41,000~~ 33,000#/hr. (100% S)	Puna Geothermal Venture (Thermal Power Company)	Plugged (Temp)	Good
-----	Lanipuna 1 ST	? 19-28-16/154-53-33 ✓	6/83	211 ~~292~~ ~~217~~ @ 1646 (~~429°~~ 411°F)	~~1911~~ 1910 (62~~71~~69')	~~Yes~~ No	GEDCO	~~Aband.~~ Suspended	Good
-----	Lanipuna 6 (2883-05)	? 19-28-~~40~~ (44")/154-53-~~22~~ 04"	6/84	168 @ 1290 (33~~8~~4°)	1510 (495~~4~~7')	No	GEDCO	~~Aband.~~ Suspended	Good
-----	Kapoho State 1A (2883-06)	? 19-28-~~47~~ 48" (51")/154-53-~~39~~ 37"	9/85	~~369~~ 346 (654°)	1983 (650~~8~~6')	~~78,000~~#/hr. 79,200 ⟨83% S 17% W⟩	Puna Geothermal Venture (Thermal Power Company)	~~Capped~~ Plugged Temp	Good

8/14/89 - 1106B

SCALA 1:24000 { LAT 1" = 1.28 mm; LONG 1" = 1.22 mm

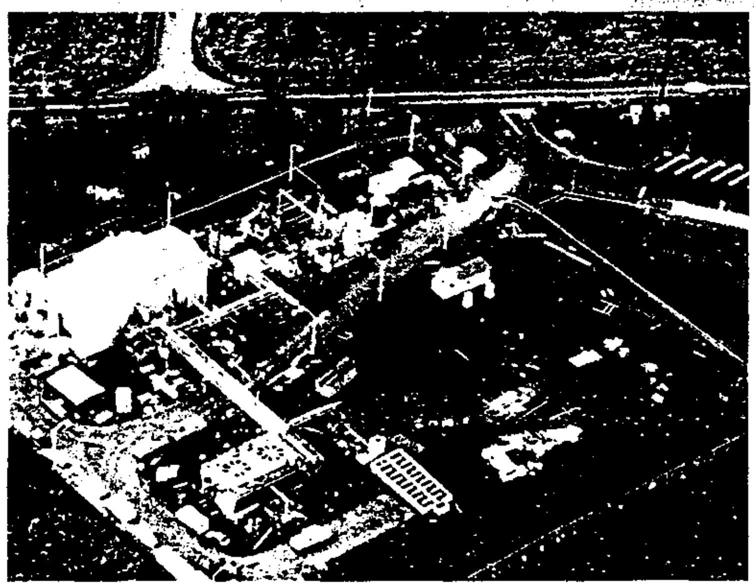
HGP-A: Hawaii's First Geothermal Well

The Hawaii Geothermal Project

Drilling for geothermal energy in Hawaii started in the early 1960's on the Island of Hawaii. The first four wells were drilled in the Puna District to relatively shallow depths and were unsuccessful in locating a producing geothermal resource. A fifth well was drilled in 1973 near the Halemaumau Crater to a depth of 4,140 feet (1,067 meters) where a temperature of 279° F (137° C) was reached.

With Federal, State, County and private funding, drilling of a well (named HGP-A) near Kapoho in Puna was started in December of 1975 and completed in April 1976 to a depth of 6,450 feet (1,966 meters). With a bottom hole temperature of 676° F (358° C) HGP-A was one of the hottest geothermal wells in the world.

The casing configuration for the well is a solid seven inch (17.8 cm) casing to a depth of 3,000 feet (915 meters) and a slotted seven inch liner from 3,000 feet to the bottom of the hole. The production of steam is believed to come primarily from aquifers located at 4,500 feet (1,372 meters), 5,800 feet (1,768 meters) and bottom hole. The well produces 110,000 lbs/hr (49,900 kg/hr) of a mixed phase fluid (57% liquid and 43% steam) at a wellhead pressure of 175 psia (12.3 kg/cm²) and 366° F (186° C).



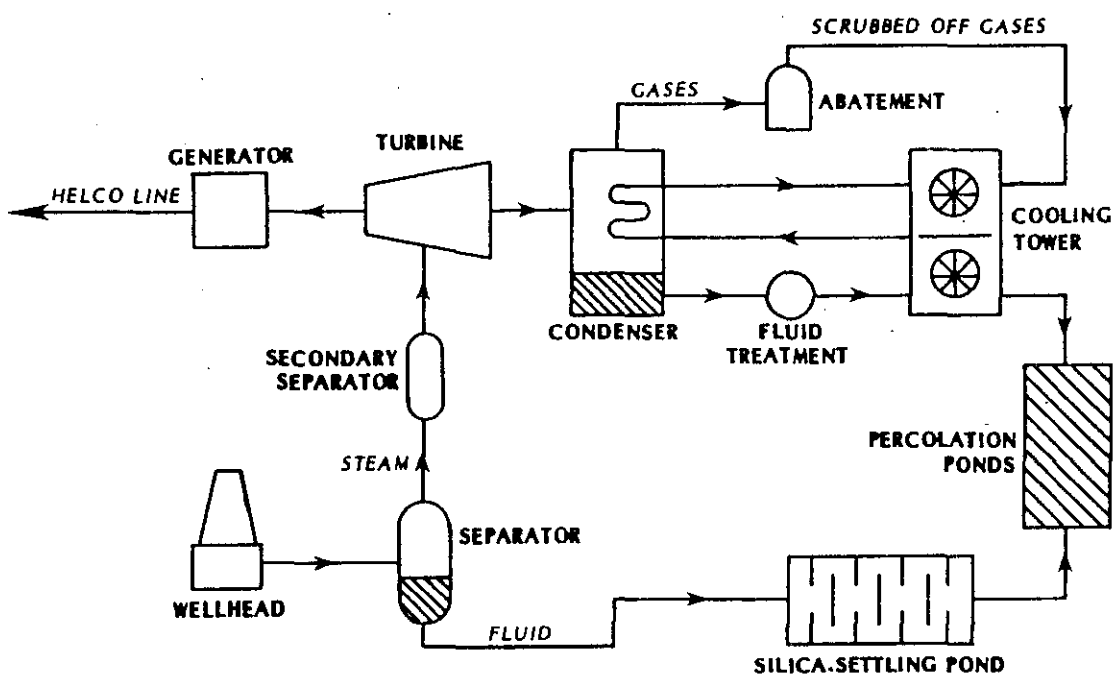
System Description

With major support from the U.S. Department of Energy, a Development Group consisting of the State of Hawaii Department of Planning and Economic Development, the County of Hawaii and the University of Hawaii's College of Engineering proceeded with the wellhead generator project. Rogers Engineering Company of San Francisco designed the power plant and provided construction management services. The plant was completed in mid-1981 at a cost of about $10 million. The plant design incorporates a single flash wellhead separator operated at a pressure of 175 psia, a three megawatt turbine generator set and a shell and tube surface condenser. Noncondensable gases are removed from the condenser shell with a dual stage steam ejector and are incinerated and scrubbed with a 10% caustic solution in a packed tower. Off gases from the scrubber are vented to the cooling tower intake. Separated brine is discharged to atmosphere in a muffler and is allowed to percolate into the ground. Steam stacking conditions are handled using a caustic injection system, to abate H_2S, and a rock muffler for noise control.

A number of mechanical problems were encountered with the major subsystems including the turbine control valves and turbine vibration which necessitated a suspension of operations approximately 90 days after start-up. After turbine repair and a subsystem recheck, start-up operations were resumed in December 1981 and commercial operation began in March 1982. Since commercial operation, the plant has had an availability factor exceeding 95%. Electrical output has been steadily increasing ..., 19.3×10^6 kWh in 1983, 20.6×10^6 kWh in 1984 and a projected 24.7×10^6 kWh in 1985. Actual production has averaged about 2.6 MW gross/2.4 MW net.

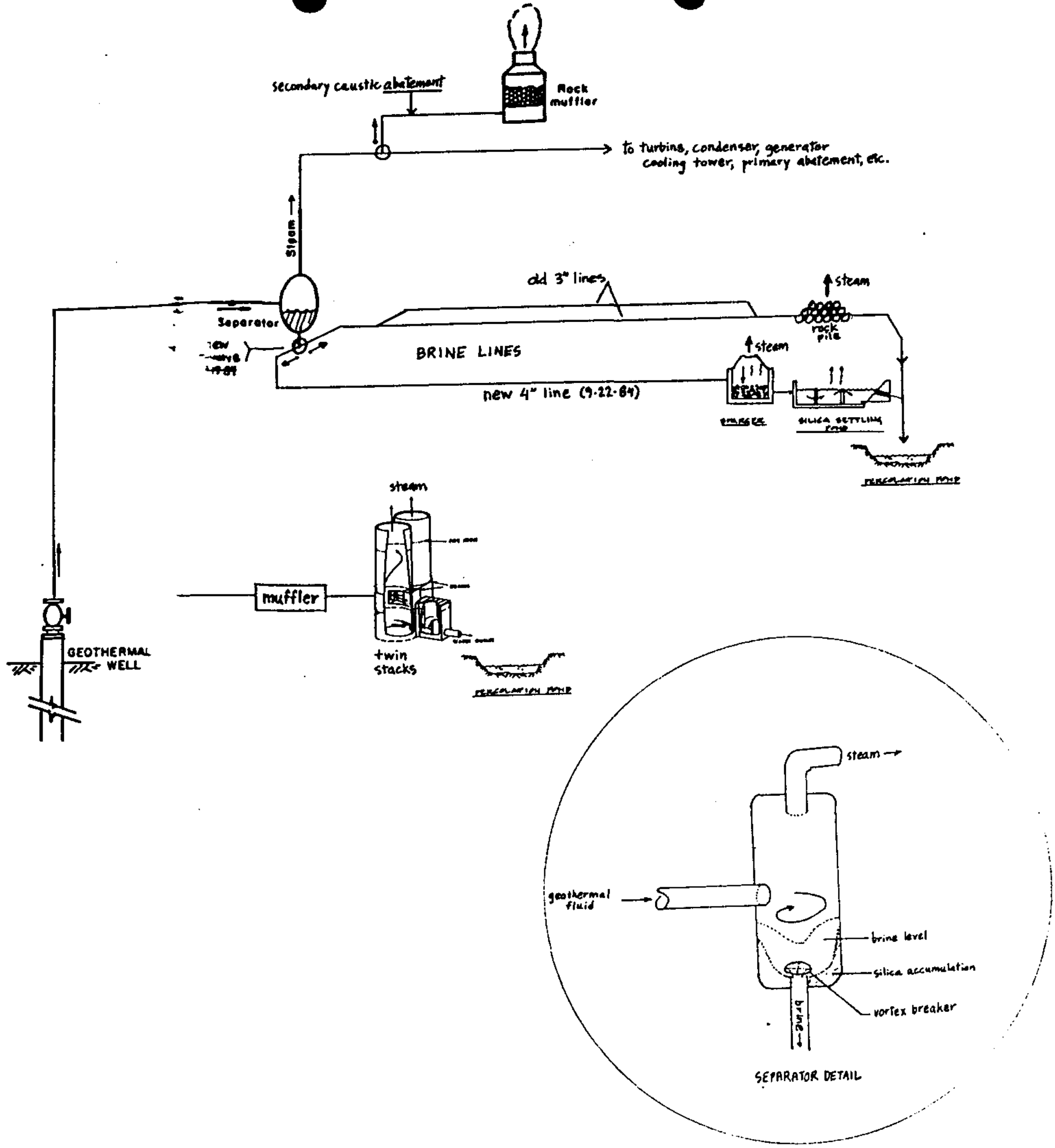
Several changes in the chemical composition of the fluids produced by HGP-A brine accrued during the nearly four years of continuous discharge from the well. Total dissolved solids concentrations have increased from 3,500 mg/Kg to nearly 20,000 mg/Kg, and total noncondensable gas concentrations have declined by about 10 percent. The chemistry of the brine phase indicates that seawater is infiltrating into the part of the geothermal reservoir penetrated by HGP-A, possibly induced by fluid withdrawal. Disparities between the brine and steam chemistry and their calculated geothermeters also suggest that two or more aquifers are supplying fluids to the well: one producing dry steam and the remainder a saturated brine-steam mixture.

The major maintenance problems encountered in the generator plant have resulted from deposition of silica from the geothermal brine phase. Initial silica deposition rates were relatively slow but, as salinities of the fluids increased, deposition rates in values and discharge lines also increased. Scale deposition in the steam supply system has been minimal and has consisted predominantly of iron sulfides and oxides. Exterior corrosion and maintenance of electrical equipment has also been aggravated by a combination of the very humid environment and the small amounts of H_2S discharged at the plant site.



HGP-A Production Record

The HGP-A plant has operated smoothly since early 1982, and has demonstrated that the production of electricity from the geothermal resource in the Kilauea East Rift Zone is technically, economically and environmentally viable.



HGP-A - Highlighting separator and brine-line repairs of Sept. 18-19, 1984.

(NO SCALE)

14. GEOLOGICAL SUMMARY

(This section was written by Dr G. A. Macdonald of the University of Hawaii)

Regional Geology

The drill hole is located on the east rift zone of Kilauea Volcano, approximately twenty-five miles east of the summit caldera of the volcano, at 600 feet altitude. The rift zone consists of innumerable more or less vertical fissures, many of which have led magma to the surface and fed eruptions. Historic eruptions in the general vicinity of the drill hole include those of 1790, 1840, 1955, 1960 and 1961. Around the eruptive vents ejecta piled up, forming spatter cones and ramparts. Below the surface the fissures remained filled with lava which consolidated as dikes. Between the cones on the surface, and between the dikes at depth, the rocks are mostly lava flows. At and near the surface the lava flows are of normal pahoehoe and aa type.

During the last decade lava flows advancing into the ocean along the south coast of Kilauea have formed pillow lavas, and submarine photographs and observations from submersibles show widespread pillow lavas on the slopes of the volcano below sea level. It is believed that the part of the volcano that was built below sea level consists mostly of pillow lavas. In other parts of the world the formation of pillow lavas, by contact of molten lava with water, has been accompanied by much granulation of the lava to form sandy-textured glassy material called hyaloclastite; and it is presumed that more or less hyaloclastite formed with the pillow lavas in the submarine part of Kilauea. However, waves and marine currents may have removed much of the sandy hyaloclastite from the upper submarine slopes of the volcano.

The lavas of Kilauea, so far as is known, are all basalt, and all tholeiitic. The principal difference among them is in the proportion of olivine phenocrysts. In some tholeiitic basalts the latter are absent, and in some oceanites their abundance reaches as much as 50 per cent. Most of the basalts of Kilauea contain scattered small olivine phenocrysts.

Above sea level the vesicularity of the lavas ranges from less than 2 per cent in the massive centre of some aa flows, to as much as 30 per cent averaging about 15 per cent. Below sea level samples dredged from the slopes decrease in both abundance and size of vesicles with increasing depth of water, and at a depth of approximately 6,000 feet the vesicles have essentially disappeared.

Even above sea level, permeability of the rocks depends very little on vesicularity. The vesicles are too poorly connected to allow free movement of water through them. The permeability is commonly high, but it results from fractures, spaces between the fragments in aa clinker, inter-flow spaces, and lava tubes.

In the Island of Hawaii, as in the other Hawaiian Islands, the main ground-water body is a Ghyben-Herzberg lens of fresh water floating on salt ocean water that saturates the basal part of the island.

Fresh water extends approximately forty times as far below sea level as it does above sea level. The water table rises inland, from sea level at the coast, at a rate of approximately two to eight feet per mile, depending on rock permeability and the amount of recharge in the area. Within the rift zones, dikes are less permeable than the intervening lava flows and retard the lateral movement of ground water, which may be confined between them far above the level at which the water table of the normal Ghyben-Herzberg lens would occur.

At the site of HGP-A the normal Ghyben-Herzberg water table would be expected to be approximately 8 feet above sea level, but dike confinement might result in a water table as much as 100 feet above sea level. However, other wells in the vicinity lack the normal Ghyben-Herzberg relationship, apparently because heating of the underlying salt water has decreased its density to the extent that it no longer can float the cooler fresh water. If this condition exists at HGP-A, the water table may be close to sea level and the shallow ground water be brackish.

Geology of the Drill Hole

The study of the rock samples from the HGP-A drill hole has begun. Microscopic thin sections are being made, and the physical properties of the rocks, including thermal and electrical conductivity, density, and porosity, are being determined. Later, samples will be selected for chemical analysis. The following descriptions are based wholly on examinations made in the field, with a hand magnifier.

Cores were taken through the following intervals:

A. 456 – 458 feet below rotary table
B. 1,057 – 1,068 " " " "
C. 1,412 – 1,423 " " " "
D. 2,230 – 2,240 " " " "
E. 2,876 – 2,886 " " " "
F. 3,666 – 3,676 " " " "
G. 4,447 – 4,457 " " " "
H. 5,396 – 5,406 " " " "
I. 6,029 – 6,039 " " " "
J. 6,446 – 6,456 " " " "

In addition, cutting samples were taken every ten feet through the part of the hole below 1,000 feet, and every five feet through part of the interval. In the upper part of the hole cutting samples were taken whenever return mud circulation was attained.

The rocks penetrated by HGP-A at and near the surface are normal olivine-bearing tholeiitic basalt of Kilauea, of both aa and pahoehoe types, with vesicularity ranging from about 5 to 25 per cent. The surficial lavas are highly jointed, with most of the joints dipping more than 70°. Ordinary appearing lavas, presumably of subaerial origin, continued well below sea level, as would be expected because of the sinking of the island since the lavas were formed. (The island is at present sinking at a rate of approximately 2 feet per century). Core B, between 1,057 and 1,068 feet below rotary table (eg 450 feet below sea level) consists of dark grey dense basalt with a few pahoehoe-type vesicles. The lava was probably formed subaerially. On the other hand, the lower part of Core C, from 1,412 to 1,423 feet below rotary table, is partly glassy and appears probably to be subaqueous pillow lava.

Core E, from 2,876 to 2,886 feet, consists at the top of 3 feet of fine grained olivine-bearing grey basalt with about 3 per cent of pahoehoe-type vesicles less than 0.5 mm across. It is probably tholeiitic. This grades downward through a thickness of about 4 inches into dense black tachylite (basalt obsidian), which constitutes the remaining 7 feet of the core. The tachylite is intensely fractured, and the fracture surfaces commonly are altered to a thin coating of serpentine, showing that the fracturing is old, and not the result of drilling. Some of the fracture surfaces are slickensided, and many of them bear many tiny cubes of pyrite. This very abnormal thickness of basaltic glass must be the result of very rapid chilling of the molten lava by water.

Between about 3,682 feet and 3,760 feet (BRT) the cuttings consist of sandy material with angular grains averaging about 1.5 mm in diameter. It appears to have been essentially loose at depth. The material appears to be hyaloclastite.

All the cores below 3,000 feet depth (BRT) show some degree of alteration, with a greenish colouring owing to the formation of secondary chlorite. Tiny cubes of pyrite also are present in all, and become more abundant with increasing depth. Below 1,200 feet (BRT) secondary zeolite and calcite appear in the cores, and remain moderately abundant to about 4,000 feet, but below that depth they decrease. The final core, taken from 6,446 to 6,456 feet, has at the top four inches of dense dark grey basalt bounded by a contact which runs across the core nearly at 90°. The contact is moderately lobate but shows very little effect of chilling. The rest of the core, below the contact is dense but greenish grey, with many spots of chlorite and much pyrite, it is intensely fractured, many of the fractures somewhat slickensided, and some covered with a white coating as much as 1 mm thick. The white material is partly calcite, but mostly zeolite (?).

The highly fractured character of most of the cores is noteworthy. Even cores that appear quite solid as they emerge from the core barrel may fall apart on handling. This characteristic was worrisome during drilling, because of the possibility that the fractured material might cave into the hole, and the caving possibility remains, particularly after the mud is removed from the hole. The hyaloclastite also has caving possibilities.

~~26)~~ Need [illegible] FY'93 Budget to [illegible] SOEST Contract.
(HTD to [illegible] by 4/24/92)

~~27)~~ Gov to draft SOEST contract

28) Don Thomas to initiate proposals thru SOEST to ORA to DBED.

per Tarry Stokes @ HVO - from Volcano

SO_2 800 tons/day.

H_2S 40 - 80 tons/day (5-10% of SO_2 produced)

<u>Note</u>: $H_2S \rightarrow SO_2 \rightarrow H_2SO_4$

H_2S conc. of HGP-A @ 850 ppm (850,000 ppb)
" " " KS-1A @ 1200 ppm (1,200,000 ppb)

Note: this does not take into consideration dispersion of the H_2S emissions from the source.

KS-3 (~60000 lbs/hr) steam

Brine is too acidic and would damage casing and pipeline if resource was used.

KS-8: H_2S conc. ? Acidity ?

29) Need Economic Analysis of [illegible] for 6/4/92 [illegible] mtg
(e.g. $ spent for HGP-A, SOH, Consultants, etc.)