5030 60000299

PRELIMINARY HYDROGEOLOGIC INVESTIGATION

ASHDOWN MINE

Project No. 90-521

July 25, 1990

Prepared for:

BILLITON MINERALS U.S.A. INC.
1175 W. Moana Lane, Suite 200
Reno, Nevada 89509

Prepared by:
WILLIAM E. NORK, INC.

William E. Nork

William E. Nork, President

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1.0 SUMMARY AND CONCLUSIONS

1. A total of five test borings were completed at the Ashdown Mine site. Of these only one encountered ground water.

2. On the basis of water level data obtained from boreholes and wells in the vicinity of the Ashdown Mine, the depth to ground water beneath the proposed leach pads and process fluid ponds ranges from approximately 100 to 200 feet below land surface.

3. Alluvial fan deposits overlay volcanic rocks of dacitic and andesitic composition at the site. Beneath the proposed process facilities, the fan deposits range in thickness from 82 to 142 feet and are, for the most part, unsaturated.

4. Preliminary values of horizontal hydraulic conductivity of the unsaturated alluvial-fan deposits at the site were obtained by performing slug injection tests. Values range from 0.0014 to 0.000014 cm/sec. The hydraulic conductivity of the underlying volcanic rocks is as low as 10^{-6} cm/sec.

5. Ground water movement beneath the project is from east to west under a gradient of 0.1 ft./ft. West of the project it decreases one to two orders of magnitude.

6. The volcanic rocks do not appear to be capable of yielding ground water to wells in amounts sufficient to meet the projected water supply requirement to the project of 300 gallons per minute.

7. The most promising target for drilling a water supply well is the alluvial deposits west of the project site. High yield irrigation wells and a flat hydraulic gradient in that area indicate relatively high transmissivity.

8. The chemical quality of the ground water at the Mine site does not meet State and Federal Drinking Water Standards due to elevated levels of arsenic and selenium.

2.0 INTRODUCTION

WILLIAM E. NORK, INC. (WEN, INC.) was retained by BILLITON MINERALS U.S.A. INC. (BILLITON) to conduct a preliminary hydrogeologic investigation at its Ashdown Mine Project. The Ashdown Mine is located in northern Humboldt County, Nevada approximately nine miles south-southwest of Denio Junction, Nevada (Figure 1). It is situated in Bog Hot Valley on the western flank of the Pine Forest Range. BILLITON's plans include an open pit mine in the mountains with the process facilities (cyanidization/heap leach) on the alluvial fan west of the range front. The purpose of this initial work effort was to determine the depth to ground water, plus a preliminary evaluation of the permeability of the geologic materials immediately beneath the proposed pads and ponds, and the collection of background water chemistry data.

The field effort included drilling a total of five test borings. Three were drilled in an attempt to delimit the piezometric surface and two were drilled to determine the permeability of the geologic materials in the uppermost 50 feet below land surface. Field work was accomplished the week of July 2, 1990. This report summarizes that field effort, the data collected, and the conclusions deduced from the information.

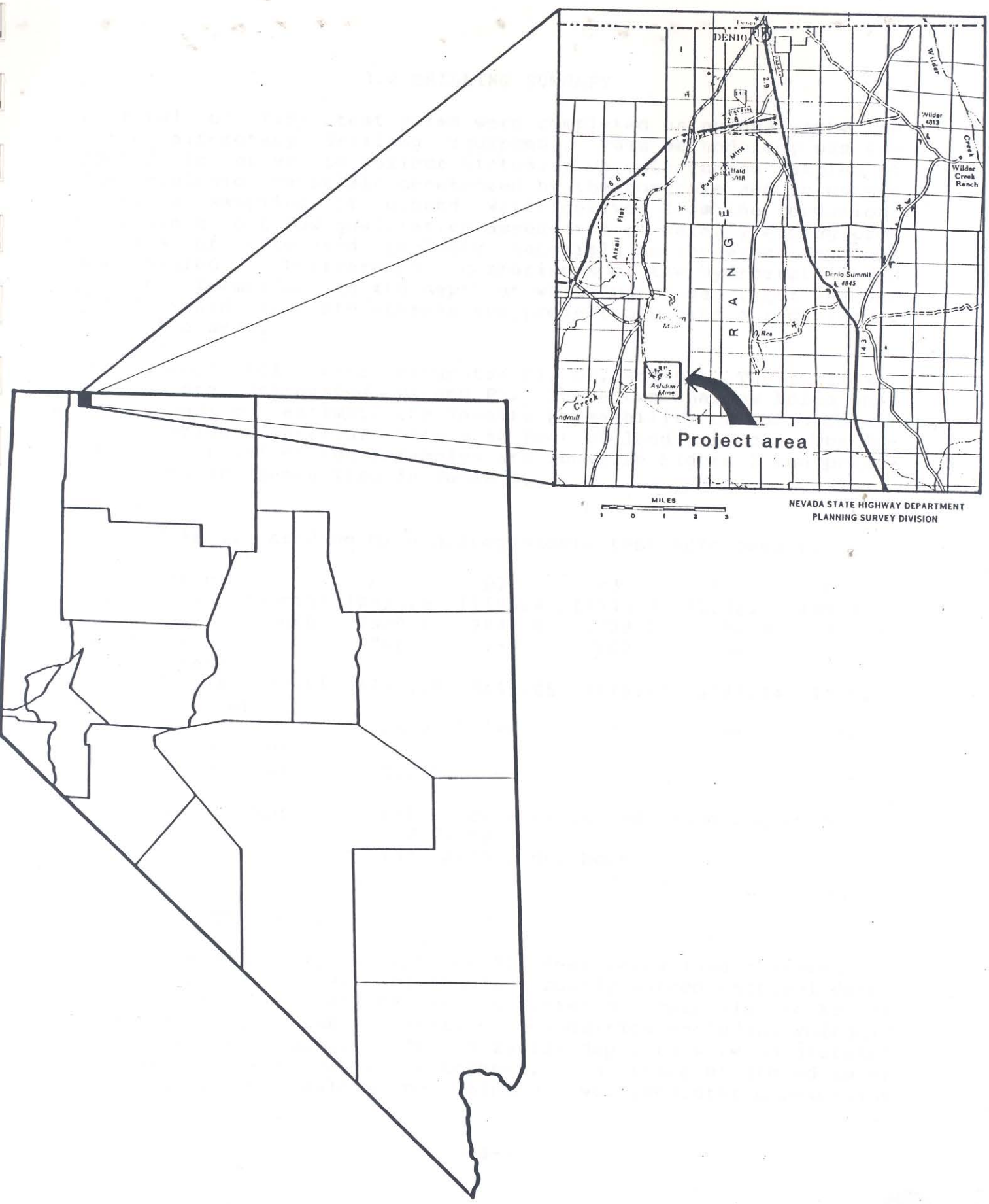


Figure 1. Ashdown Mine project reference map.

3.0 DRILLING SUMMARY

A total of five test holes were completed using dual-tube reverse air-rotary drilling equipment. This methodology was employed in order to collect virtually uncontaminated samples of the geologic materials penetrated by the borehole and to enable air-lift sampling of ground water derived from the formation. It would also allow qualitative assessment of water yielding properties of saturated geologic materials in the event any were encountered. Furthermore, comparisons of the hydrostatic head in the formation to the depth at which water was first encountered would indicate whether the project occupies a recharge or discharge area.

The deeper holes were designated D1, D2, and D3. The shallower holes were designated P1 and P2. These two shallow holes were also used to estimate the in-situ permeability of the unsaturated geologic materials within 50 feet of land surface. The locations of all of the boreholes are shown in Figure 2 and pertinent data are summarized in Table 1.

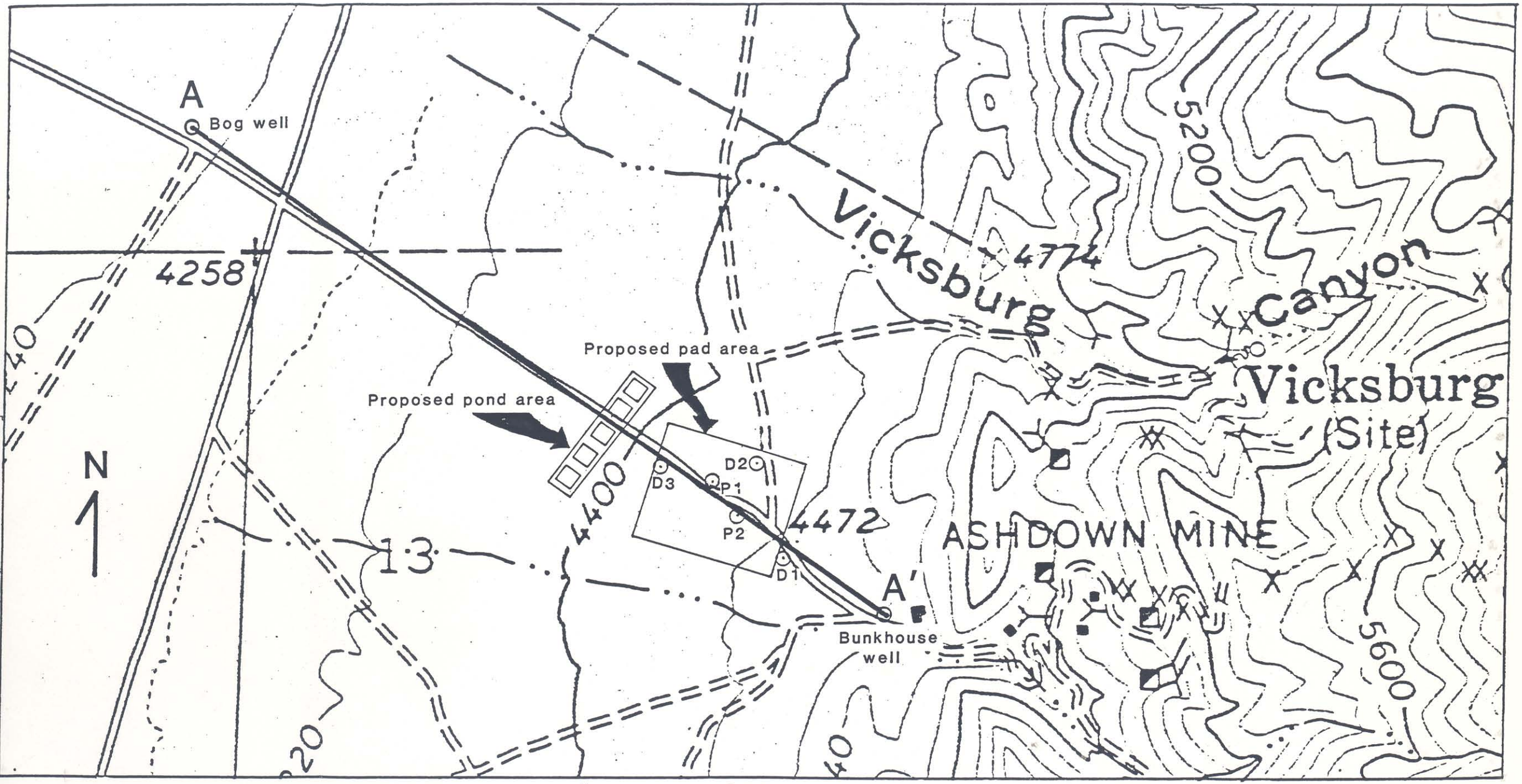
Table 1. Ashdown Mine hydrogeologic test hole summary.

Designation		D1	D2	D3	P1	P2
Coordinates*	(North)	10596.6	11408.4	11378.2	11238.1	10984.6
	(South)	7329.1	7048.5	6289.1	6616.0	6946.0
Total depth		200	150	180	50	50
Land surface elevation*	(feet)	4492.15	4445.45	4419.67	4437.14	4456.0
Depth to water	(feet)	108.2	**	**	**	**
Static water level elevation	(feet)	4383.95	--	--	--	--

Notes * reference - Basin and Range Surveying, 7/24/90
** indicates a dry hole

3.1 DEEP TEST HOLES

D1 was drilled to a depth of 200 feet below land surface. It penetrated 102.5 feet of angular, poorly sorted unconsolidated alluvial-fan deposits before encountering volcanic rocks of apparent dacitic and andesitic composition including volcanic ash beds and tuffs. The alluvial deposits were unsaturated throughout their entire thickness. A trace of ground water (less than one gallon per minute) was encountered below the



ref. U.S.G.S. 15 min. Denio Quadrangle

⊙ Location of test hole.

Figure 2. Ashdown Mine test hole location map.

contact with the overlying alluvial deposits. The air-lift discharge did not measurably increase at the ultimate depth of 200 feet. The water level in the borehole equilibrated at a depth of 108.2 feet below land surface after a period of two days.

D2 was drilled to a depth of 150 feet below land surface. It penetrated 82 feet of dry unconsolidated alluvial deposits similar to those observed in D1. The underlying volcanic rocks were also unsaturated.

D3 was drilled to a depth of 180 feet below land surface. The contact between the alluvial-fan deposits and the underlying volcanic rocks was encountered at a depth of 142 feet. Neither formation gave any indication of the presence of ground water.

Both D2 and D3 were sounded more than 24 hours after drilling was completed and were found to be dry.

3.2 SHALLOW TEST HOLES

Both P1 and P2 were drilled to a depth of 50 feet below land surface. Each encountered dry alluvial-fan deposits similar to those penetrated in the upper 82 to 142 feet of the deeper boreholes. Upon completion of drilling, each was equipped with a total of 50 linear feet of two-inch diameter PVC casing, the bottom 10 feet of which was perforated with factory mill-slot perforations. The hole was then filled with water to allow soils to swell in preparation of testing the following day.

4.0 TESTING SUMMARY

The airlift discharge of D1 was estimated at less than one gallon per minute. At that rate the borehole was essentially dewatered in the time it took to drill. The transmissivity of these volcanic rocks can be estimated from the discharge and drawdown data obtained during drilling operations. Assuming a static water level of 108 feet (measured 7/4/90), the drawdown,

$$s = 200 \text{ ft} - 108 \text{ ft} = 92 \text{ ft}$$

The specific capacity,

$$Cs = Q / s = 1 \text{ gpm} / 92 \text{ ft} = 0.011 \text{ gpm/ft}$$

From the relationship where Transmissivity,

$$T = 2{,}000 \times Cs = 2{,}000 \times 0.011 \text{ gpm/ft} = 2.0 \text{ gal/day/ft}$$

Assuming further that the contributing aquifer thickness (b) is 92 feet, the hydraulic conductivity,

$$K \cong T / b = 2.0 \text{ GPD/ft} / 92 \text{ ft} = 0.022 \text{ GPD/ft}^2$$

$$(1.0 \times 10^{-6} \text{ cm/sec})$$

From the foregoing analysis, it is apparent that the volcanic rocks in the immediate vicinity of the proposed leach pad and ponds are relatively impermeable.

The shallow boreholes were tested to examine the permeability of the near-surface alluvial-fan deposits. This was accomplished via slug injection tests within intervals of the formation ranging from 5.7 to 16 feet in length. In each test, a measured volume of water (slug) was introduced into the borehole and the decline in water level over time was monitored. The casing was then withdrawn and the borehole below the casing was plugged to seal the previous test interval. A total of two tests were completed for P1 and three for P2.

The permeability of the soils were evaluated using the method of Cooper, Bredehoeft, and Papadopulos (1967) and the computer Program WHIP (Well Hydraulics Interpretation Package; HYDRO-GEO CHEM, 1988). Field data sheets and data plots are provided in Appendices B and C, respectively. Analyses results are summarized in Table 2, below.

Table 2. In-situ permeability of alluvial deposits at the Ashdown mine.

Piezometer	Test Interval (ft)	Permeability (cm/sec) 1.	2.
P1	35 - 48	5.4 e-5	1.9 e-5
P1	4.7 - 10.4	3.1 e-5	2.5 e-5
P2	34 - 50	1.0 e-3	4.4 e-5
P2	25 - 30	3.1 e-4	1.4 e-3
P2	3.5 - 9.7	3.4 e-5	1.7 e-5

Notes - 1. Analyzed by Cooper, Bredehoeft, & Papadopolus method
2. Analyzed by WHIP

Results in column 1 above reflect analysis of early time data only. This interval was selected because these data are affected the least by changes in the wetted thickness of the test interval. Such changes cause the observed data to depart from the type curves. The WHIP program (analyses results in column 2) compensates for the change in thickness. As a result there is better overall agreement between observed and calculated data.

Although neither analytical method was developed specifically for application to unsaturated material, they lend themselves to the type of testing which was conducted. The results, however, should be viewed as approximations of true field values. Other methods, such as a ring infiltrometer or "shallow well pump in" test, would yield more representative values, but these methods are not suited to reconnaissance studies such as this because of the time required to conduct each test. Nor is the ring infiltrometer amenable to testing at depth.

The values in Table 2 are consistent with published values of hydraulic conductivity for mixtures of silt and clay (Freeze and Cherry, 1979).

The permeability of the alluvial-fan deposits in the uppermost 20 feet of each borehole was also examined through relationships between grain size and permeability. Mechanical (sieve) analyses of splits of composite samples for the zero to 10 and 10 to 20 foot depth intervals were run to determine the grain size distribution. There was little agreement between this method and values determined via the slug tests. Calculated values ranged from 0.005 to 0.1 cm/sec. The discrepancy between these values and those derived from the slug tests may be due to

loss of the finer portion of the sample as a result of the drilling/sampling process. In addition, the empirical equation may not be suitable for use with angular, poorly sorted materials such as those encountered in the boreholes.

5.0 WATER CHEMISTRY

A secondary objective of this initial investigative effort was the collection of baseline water chemistry data from the deeper boreholes (if they encountered ground water) plus the Morris irrigation well (two miles southwest of the project). This goal was not met for the following reasons.

1. Permission to sample the Morris well was denied.
2. D2 and D3 did not penetrate saturated geologic materials.
3. Although D1 encountered saturated geologic materials, the yield was so small as to render collection of a water sample by air-lift pumping difficult. Developing the borehole sufficiently to collect a representative water sample would have tied up the drilling rig for several days at considerable expense or would have required the completion of a formal monitoring well. Both were beyond the scope of the work effort.

A water sample, however, was collected from the "bunkhouse well" and the results are provided below in Table 3.

The water derived from this well may be classified as a calcium-sulfate type. It is extremely hard and does not meet the applicable Drinking Water Standards. Both arsenic and selenium exceed their respective limits.

The general chemistry of the water suggests that it may have originated as infiltration of precipitation in carbonate rock units within Mesozoic metamorphic rocks in the Pine Tree Range east of the project. Evolution of the water to its present state has likely resulted from reacting with sulfide minerals and igneous rocks along the flow path.

Table 3. Water Chemistry Data for the Bunkhouse Well, Ashdown Mine.

Collection date	7/4/90	Drinking Water Standard
time	1900	
Temperature	18.0	
pH (standard units) - field	7.05	
- lab	7.33	6.5 - 8.5[2]
Electrical Conductivity (umho/cm) - field	1400	
Total Dissolved Solids	955	1000[2]
Hardness, as Ca CO_3	503	
Turbidity (NTU)	0 - 5	1 - 5[1]
Calcium	155	
Magnesium	28	150[2]
Sodium	62	
Potassium	13	
Bicarbonate	267	
Sulfate	397	500[2]
Chloride	61	400[2]
Nitrate, as NO_3^-	24	45[1]
Fluoride	0.51	1.4 - 2.4[1]
Arsenic	0.18	0.05[1]
Barium	<0.1	1.0[1]
Cadmium	<0.01	0.01[1]
Chromium	<0.025	0.05[1]
Copper	<0.025	1.0[2]
Iron	0.054	0.6[2]
Lead	<0.05	0.05[1]
Manganese	<0.03	0.1[2]
Mercury	<0.001	0.002[1]
Selenium	0.34	0.01[1]
Silver	<0.05	0.05[1]
Zinc	0.051	5.0[2]
Cyanide (Total)	<0.01	-
Cyanide (WAD)	<0.01	0.2

1. USEPA Primary Drinking Water Standards
2. State of Nevada Secondary Drinking Water Standards
3. Values reported in mg/l unless noted otherwise

6.0 INTERPRETATION OF RESULTS

The data collected as a result of the field investigation are summarized in a hydrogeologic cross section oriented northwest southeast through the project (Figure 3). The site of the process facilities is underlain by alluvial-fan deposits and volcanic rocks. This area may constitute a bajada or pediment. The volcanics were encountered at depths ranging from 82 to 142 feet. The presence of a pediment or bajada was hypothesized prior to the onset of field work and has implications relative to the location of a production water supply.

The depth to ground water beneath the fan ranges from approximately 36 feet at the range front to more than 180 feet in mid-fan on the basis of water levels measured in the bunkhouse well and the lack of water in D3 to a depth of 180 feet, respectively. Immediately beneath the proposed leach pad and process fluid ponds the depth to ground water ranges from 100 to 200 feet below land surface.

The horizontal permeability of the alluvial fan deposits ranges from 10 e-5 to 10 e-3 cm/sec. The low value is a consequence of the silt and clay fraction of the poorly sorted angular alluvium. The vertical permeability of sedimentary deposits is typically one to two orders of magnitude lower than the horizontal permeability. However, additional testing is recommended to confirm this relationship at the project on site.

Similar low values of permeability (hydraulic conductivity) characterize the volcanic rocks which underlie the alluvial fan. These low values preclude either unit from constituting a significant water resource in this area.

The hydraulic gradient beneath the fan is steep, approximately 0.1 ft./ft. toward the west. A steep gradient is consistent with the low permeability of the geologic materials. West of the project, toward the valley floor, the gradient flattens abruptly. The suggestion is that the transmissivity of the geologic materials increases in this direction. The most likely cause is an increase in the transmissivity of the alluvial deposits beneath the valley floor. This hypothesis is supported by the high yield of wells completed in the alluvial deposits southwest of the project.

Consistent with typical Basin and Range hydrogeology, the alluvial fan at the project is located in a recharge area. Evidence in support of this conclusion was obtained during the drilling of D1. A comparison of the static water level in the borehole versus the depth at which water was first encountered indicates a measurable downward gradient (approximately 0.06 ft/ft). A

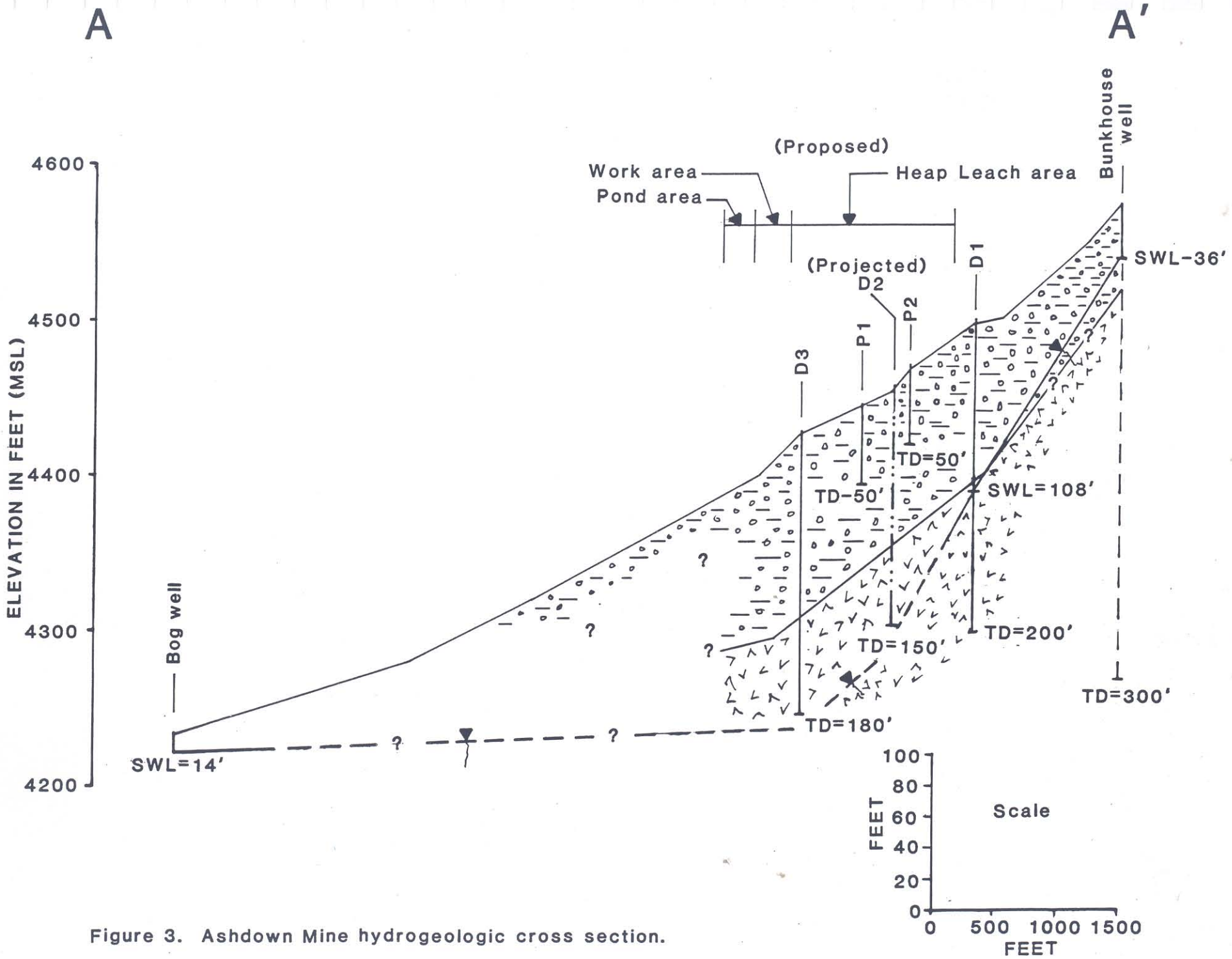


Figure 3. Ashdown Mine hydrogeologic cross section.

downward potential such as this is indicative of recharge areas. However, considering the very low permeability of the geologic materials, recharge to the ground water system originating on the fan is essentially nil.

The low permeability of the alluvial-fan deposits and the thickness of unsaturated materials beneath the proposed process facilities suggests that the site is ideally suited for locating a project of the type proposed by BILLITON. The low-permeability geologic materials, depth to ground water, and lack of a significant water resource beneath the site indicate that contamination of a ground water resource from fugitive process fluids is highly unlikely. Moreover, the native soils appear to be suitable for use as a secondary liner. However, more investigation by BILLITON's design engineer is recommended to confirm that the data from the initial test holes holds true for the entire site.

The volcanic rocks in the mountain block do not appear to constitute a probable source of the production water supply. While the Ashdown Mine decline historically yielded a few tens of gallons of water per minute and ground water in quantities approximating this quanitity has been encountered in a number of mineral exploration holes it is unlikely that wells capable of sustained discharge of 300 gallons per minute can be developed. Localized zones with well-developed secondary permeability may exist at the mine site, but alteration and fault gouge will tend to compartmentalize the aquifer materials in that area thus limiting recharge.

For the reasons discussed above, the alluvial fan in the vicinity of the process facilities is not a likely candidate either.

The alluvial deposits west of the project near the "bog" well offer definite promise. Considering the high yields of irrigation wells in the area southwest of the project, a 300 gallon per minute well is a virtual certainty. Testing the "bog" well is not germane to this effort. It is less than 50 feet deep. State law requires that wells be sealed through this interval. Therefore, testing an interval which is unavailable to you from a construction standpoint is pointless. A more direct and cost effective approach may include drilling a pilot hole, running a series of electric logs, and designing a production well on the basis of the drill cuttings and E-logs. A 10-inch diameter cased, gravel packed well in a nominal 12-inch diameter borehole will be adequate to provide the 300 gpm water supply.

7.0 SOURCES OF INFORMATION

Cohan, W.T., 1989. Ashdown Project General Site Plan. Map prepared for WIN-ELDRICH MINES, LTD.

Cooper, H.H., Jr., J.D. Bredehoeft, and I.S. Papadopulos, 1967. Response of a finite-diameter well to an instantaneous charge of water: Water Resources Research, v.3, no.1, pp. 263-269.

HYDRO-GEO CHEM. INC., 1988. Well Hydraulics Interpretation Package (WHIP) computer code.

Wenzel, L.K., 1942. Methods for determining permeability of water-bearing materials: U.S.G.S. Water supply Paper 887. p. 192.

Other Sources

Survey data provided Basin and Range Surveying

Denio, NV 15-minute USGS topographic quadrangle

APPENDIX A

BOREHOLE LOGS

LOG OF BOREHOLE

BOREHOLE D1

LOC. or COORDS.

GROUND ELEV. 4500 +/-

TOTAL DEPTH 300

BOREHOLE DIAM. 5 1/4"

DRILLER STRETCH'S EXPLORATION
ELY NV

RIG MODIFIED SCHRAMM

BIT(S) TRICONE

FLUID AIR (w/ EZ MUD)

	START	FINISH
DATE	7/2/90	7/2/90
TIME	0958	1570

GEOPHYS LOG ___ YES X NO

HOW LEFT PLUGGED

LOCATION BOGHOT V., 2MI SSW OF DENIO TCT

LOGGED BY Dep

PROJECT 90-521 ASHDOWN MINE

DEPTH	PENETRATE	CIRC. PET	CIRC. LOSS	AIR-LIFT (gpm)	MATERIAL	SYMBOL	DESCRIPTION AND COMMENTS
0		1/50		0	Alluvial fan deposit		20' STB Poorly sorted silt thru Pebbles (s 1") sub angular lt brown - tan
							fines ~ 20-50% - silty clay / clayey silt
							color @ 20-25 from lt. brown to lt. tan.
							fines
50							DAMP @ 50'
							HOLE INSTABILITY @ 55'. INJECTING EZ MUD mist below 55'
							incr. clay content - fine portion is silty clay.
	1120 1122						trace @ 85' (possibly), blow hole, throw shut off to check for water - no water
100	1142						shut off inj. to check tbr
					W.L. 1840 7/3/90 =108.15'		color to grey @ 102.5' contact w/ bed rock black to dk green metamorphic rx same etc.
							red brown color again
							back to brown @ 115'
	1205 1212			Trace	Dacite		lt brown gravelly, sandy, clayey silt, fines ~ 20%
							color @ 125' GW for certain!
							fresh is dk gray-green mottled brown inc.
							brown color due to altered portion perhaps hematite staining
	1242 1248						
150							

LOG OF BOREHOLE

BOREHOLE D1

LOC. or COORDS. _____

GROUND ELEV. _____

TOTAL DEPTH 300 FT

BOREHOLE DIAM. _____

DRILLER _____

RIG SCHRAM

BIT(S) _____

FLUID _____

	START	FINISH
DATE	7/2/90	7/2/90
TIME	0958	1510

GEOPHYS LOG ___ YES X NO

HOW LEFT _____

LOCATION Bighorn Valley Pull Site of Denio Jct

LOGGED BY D.B.

PROJECT 90-521 Ashdown Mine

DEPTH	PENETRATE	CIRC. LOSS	AIR-LIFT (gpm)	MATERIAL	SYMBOL	DESCRIPTION AND COMMENTS
			Trace	Dacite?		air lift < 1 gpm green-black, altered red-brown
160	1305 1310			Andesite		more altered, clayey @ 158' to red brown igneous (?) rx either more clay or more weathered. greenish but soft, some pyrite some well rounded coarse sand grains w/few lithic chips
				" "		
	1325					same
						same
						same
200	1341 1343					adding more water to wash out clayey portions which plugs cyclone
						same
	1354 1358					same
				Tuff/Ash		@ 220' ~ green gray silt/sandstone then back to brown
	1406					@ 238' color Δ to gray-green
			1 gpm			water in water @ 245' then back to brown
250						
	1424 1436		2 gpm	TUFF/Ash DACITE		soft spot @ 255' Δ color to gray-green again, soft else similar to above
						dito
						dito
	1456					
						dito
						dito
300						Target depth @ 1510 Hole dropped [illegible]

LOG OF BOREHOLE

BOREHOLE D2

PAGE 1 of 1

LOC. or COORDS.

GROUND ELEV. 4440

TOTAL DEPTH

BOREHOLE DIAM. 5¼"

DRILLER STRETCHES EXPLORATION
ELY, NV

RIG MODIFIED SCHRAMM

BIT(S) TRIGONE

FLUID AIR & AIR-EZMUD MIST

	START	FINISH
DATE	7/3/90	7/3/90
TIME	1110	1420

GEOPHYS LOG ___ YES X NO

HOW LEFT

LOCATION BOG HOT VALLEY, 8MI SSW OF DENIO JCT.

LOGGED BY DCW

PROJECT 90-521 ASHDOWN MINE

DEPTH	PENETRATE FT/MIN	CIRC. PET	CIRC. LOSS	A-LIFT Q (gpm)	MATERIAL	SYMBOL	DESCRIPTION AND COMMENTS
				0	Alluvial fan deposits		DRILL DRY TO START POORLY SORTED MIXTURE OF GRAVEL, SAND, & CLAYEY SILT FINES 10% gravel ≤ 3/8", angular to subangular
							sample @15' large but dry again @ 20' (mist injection) mineral gravel portion 1"-
	2						
							@ 25 FT INCREASE IN FINES FINES CLAYEY SILT ~ 40% COARSE FRACTION coated w/ clay.
							gravel fraction decreasing gravelly, silty sand gravel ~10% ≤ 3/4", mostly 3/8"-
50	2						
							increased gravel @ 55', drilled rougher.
							silty, sandy gravel gravel 1"-
							@65-70' clay content increased gravel, sand in silty clay silty clay ~15%-20%
	2						
	1.5						
	1				Andesite		Hole instability, start injecting EZ Mud mist @ 82' red-brown volcanic, fine grained & amygdular
					Dacite		rough @ 89' colr ∆ to dk brown Black fine gr. volcanic w/ red-brown some alteration to clay, hematite staining
	1						
100							
	0.9						
							less altered @ 105'. large (0.5") amygdules w/ xtalline qtz
	0.8						
							same, minor tiny pyrite
	0.9						
							Similar to above, but w/ some brown altered rx Apparently fractured w/ some qtz veins.
							more mineralized/stained @ 145'
							@147', a back to less mineralized rx
150							@1420 stop @ 150' TO CHECK FOR WATER

LOG OF BOREHOLE

BOREHOLE D3

PAGE 1 of ___

LOC. or COORDS. ___

GROUND ELEV. 4430

TOTAL DEPTH 180 FT

BOREHOLE DIAM. 5¾"

DRILLER STRETCH'S EXPLORATION

RIG MODIFIED SCHRAMM

BIT(S) TRICONE

FLUID AIR & EZ MUD

	START	FINISH
DATE	7/2/90	
TIME	1810	

GEOPHYS LOG ___ YES X NO

HOW LEFT ___

LOCATION

LOGGED BY

PROJECT 90-521 ARMBRUSTER MINE

DEPTH	PENETRATE FT/MIN	CIRC. PET	CIRC. LOSS	A-LIFT (gpm)	MATERIAL	SYMBOL	DESCRIPTION AND COMMENTS
					Alluvial Fan deposits		Poorly sorted mixture of pebbles, gravel, sand, silt & clay. coarse fraction is angular to subangular. fines 20-30% clayey silt. coarse fraction - up to 3/4" volcanics, qtz & granitic
							30-35' angular gravel, minor fines. Below 35, fines ret.
50							DRILL DRY TO 50' ADD EZ MUD TO STABILIZE HOLE. less fines than above (~10%), also similar mixture of sand thru pebbles
							fine to v coarse sand & granules
100							END 7/2/90 DRY WHEN SOUNDED A.M. 7/3. pebbles than sand. fines < 5%
	2.5						sand-gravel, fines 20%
							poorly sorted sand-pebbles fines < 10% granules + 60%
	4				silty clayey sand		@ 130' mixture of sand, silt & clay - no pebbles. fines ~ 40%
					tuff		color ↓ to lt. brown / tan. @ 142' lt brown, soft, gritty, v fine grained. rough @ 1
150							

LOG OF BOREHOLE

BOREHOLE D3

LOC. or COORDS.

GROUND ELEV.

TOTAL DEPTH 180 FT

BOREHOLE DIAM. 5 1/4"

DRILLER STRETCH'S EXPLORATION
ELY, NV

RIG MOD. SCHRAMM

BIT(S) Tricone

FLUID Air EZ MUD MIST

	START	FINISH
DATE	7/2/90	7/3/90
TIME	1810	0957

GEOPHYS LOG ___ YES X NO

HOW LEFT

LOCATION EAST SIDE ROCK HOT VALLEY

LOGGED BY D.J.

PROJECT 90-521 ASHDOWN MINE

DEPTH	PENE-TRATE	CIRC. PET	CIRC. LOSS	A-LIFT Q (gpm)	MATERIAL	SYMBOL	DESCRIPTION AND COMMENTS
				0 1 trace	tuff		brown,
					dacite		@ 154, black volcanic, dacite rough 154- red volcanic, v. fine grained med-dark brown volcanic amygdular
160					tuff		@ 158'
					andesite		@ 161
							T.D. = 180 FT shut in 2" & blow after allowing to recover ~10 minutes
							still dry @ 1848 hrs
200							

let hole stand then blow. possible trace

LOG OF BOREHOLE

BOREHOLE P1

PAGE 1 of ___

LOC. or COORDS. ___

GROUND ELEV. ___

TOTAL DEPTH 49'

BOREHOLE DIAM. 5¼

DRILLER STREICH'S EXPLORATION
ELY, NV

RIG MODIFIED SCHRAMM

BIT(S) TRICONE

FLUID Air

	START	FINISH
DATE	7/2/90	7/2/90
TIME	1728	1756

GEOPHYS LOG ___ YES X NO

HOW LEFT ___

LOCATION B23 HOT 1/4 2nd STAND OF DENIO FIT

LOGGED BY DCB

PROJECT 90-521 ASHDOWN MINE

DEPTH	PENE-TRATE	CIRC. DET	CIRC. LOSS	AIR-LIFT Q (gpm)	MATERIAL	SYMBOL	DESCRIPTION AND COMMENTS
					Alluvial fan deposits		DRILL DRY silty, clayey, sand & gravel fines 10-20% rough @ 5'
10	3						
20							clayey, silty, coarse sand & gravel fines 10%
	3						as above, w/ slightly more clay
30							clayey, silty sand fines 5-10%
	3						
40							@ 35' gravelly clay (¼" minus, subrounded) clay ~ 80%
	3						
50							TD @ 1756

Set 10 L.F 2"ϕ PVC SCREEN
40 L.F 2" PVC BLANK
FILL W/ WATER 1810-1813
Refill 1815-1816
W.L. @ 1818-1.3'
W.L. @ 1820 2.65'
1824 3.7'
1827 4.4'
1830 5.0'
1845 8.0'

LOG OF BOREHOLE

BOREHOLE P2

PAGE 1 of 1

LOC. or COORDS.

GROUND ELEV.

TOTAL DEPTH

BOREHOLE DIAM. 5¼"

DRILLER STRETCH'S EXPLORATION
ELY, NV

RIG MODIFIED SCHRAMM

BIT(S) TRICONE

FLUID AIR

	START	FINISH
DATE	7/3/90	7/3/90
TIME	1546	1630

GEOPHYS LOG ___ YES x NO

HOW LEFT

LOCATION Rog Hot K. 8 mi SW of Denio Jct

LOGGED BY DCB

PROJECT 90-521 Abandoned Mine

DEPTH	PENETRATE	CIRC. LOSS	AIR-LIFT (gpm)	MATERIAL	SYMBOL	DESCRIPTION AND COMMENTS
			0	Alluvial fan deposit		DRILL DRY
	3.5					Poorly sorted clayey, silty, ~~sandy gravel~~ gravelly sand fines: clayey silt - 20-30% gravel to 3/8" - sub angular
						gravel increases silty, clayey sandy gravel fines - 10-20%
						below 20' color as from H tan to lt brown
	1*					gravelly, sandy, clayey silt 25-30 fines - 30%-40% gravel 1/8"-
						30-35 same as above
						35-40 similar to above but w/ gravel to 1"
						similar to 30-35', less gravel than above
50						T.D @ 1630

* drilling rate reflects time spent going up/down multiple times

Set 10 FT of 2" PVC screen plus 40' 2" PVC BLANK

filled w/ water to LSD @ 1655 1700 (56.25 EAL)

fell initially to 3.3', translucent

5.0 ft @ 1704
9.3 ft @ 1720
15.78 ft @ 1835 } 0.37 FT/min 11 cm/60 sec

APPENDIX B

FIELD DATA SHEETS

AQUIFER TEST DATA

Pumping Well P1 **Observation Wells** NA

Owner BILLITON MINERALS USA Address _____ County _____ State _____

Date 7/4/90 Company performing test WILLIAM E. NORK, INC. Measured by DCB

Well No. P1 Distance from pumping well — Type of test SLUG INJECTION Test No. 1

Measuring equipment Olympia Sounder (float probe)

Time Data
Pump on: Date _____ Time _____ (t)
Pump off: Date _____ Time _____ (t')
Duration of aquifer test:
Pumping _____ Recovery _____

Water Level Data
Static water level 47.68'
Measuring point T.O.C.
Elevation of measuring point +2.20'

Discharge Data
How Q measured Bucket/watch
Depth of pump/air line —
Previous pumping? Yes ____ No X
Duration _____ End _____

Comments on factors affecting test data: 97.8-47.8 point interval

Date	Clock time	Time since pump started t	Time since pump stopped t'	t/t'		H_0 = 12.78' Water level measurement	H Correction or Conversion	H Water level	Water level change s or s'	H/H_0	Discharge measurement	Rate		
7/4	1028	0												10 gal/45 sec
		1.25	0.5			34.90		12.78		1				
		1.75	1			34.91		12.77		0.999				
		2.25	1.5			35.07		12.61		0.987				
		2.75	2.0			35.16		12.52		0.980				
		3.25	2.5			35.26		12.42		0.972				
		3.75	3.0			35.34		12.34		0.966				
		4.25	3.5			35.45		12.23		0.957				
		4.75	4.0			35.51		12.17		0.952				
		5.25	4.5			35.57		12.11		0.948				
		5.75	5			35.66		12.02		0.941				
		6.75	6			35.78		11.9		0.931				
		7.75	7			35.94		11.74		0.919				
		8.75	8			36.09		11.59		0.907				
		9.75	9			36.19		11.49		0.899				
		10.75	10			36.40		11.28		0.883				
		12.75	12			36.58		11.1		0.869				
		14.75	14			36.74		10.94		0.856				
		16.75	16			36.90		10.78		0.845				
		18.75	18			37.09		10.59		0.829				
		20.75	20			37.22		10.46		0.819				
		23.75	23			37.40		10.28		0.804				
		26.75	26			37.53		10.15		0.794				
	1058	30.75	30			37.71		9.97		0.780				
		35.75	35			~~37~~								
	1108	40.75	40			38.24		9.44		0.739				
	1113	45.75	45			38.51		9.17		0.718				
	1118	50.75	50			38.82		8.80		0.695				

WILLIAM E. NORK, INC.

AQUIFER TEST DATA

Pumping Well P1 **Observation Wells** NA

Owner BILLITON MINERALS USA Address _____ County _____ State _____

Date 7/4/90 Company performing test WILLIAM E. NORK, INC Measured by DCB

Well No. P1 Distance from pumping well — Type of test SLUG INJECTION Test No. 1

Measuring equipment Olympic Sounder (float probe)

Time Data
Pump on: Date _____ Time _____ (t₀)
Pump off: Date _____ Time _____ (t'₀)
Duration of aquifer test:
Pumping _____ Recovery _____

Water Level Data
Static water level 47.68'
Measuring point T.O.C
Elevation of measuring point 2.20'

Discharge Data
How Q measured _____
Depth of pump/air line _____
Previous pumping? Yes ____ No ____
Duration _____ End _____

Comments on factors affecting test data: 37.8-47.8 FT PERF INTERVAL

Date	Clock time	Time since pump started t	Time since pump stopped t'	t/t'		H_0 = 12.78 Water level measurement	Correction or Conversion	H Water level	Water level change s or s'	H/H_0	Discharge measurement	Rate	
7/4	1128	60.75	60			39.86		8.42		0.66			
	1138	70.75	70			39.59		8.09		0.63			
	1148	80.75	80			39.80		7.88		0.62			
	1158	90.75	90			40.00		7.68		0.601			
	1355	205.75	205			46.15		1.53		0.12			

AQUIFER TEST DATA

Pumping Well P1 **Observation Wells** —

Owner BILLITON MINERALS USA Address _____ County _____ State _____

Date 7/4/90 Company performing test WILLIAM E. NORK, INC Measured by DCB

Well No. P1 Distance from pumping well — Type of test SLUG INJECTION Test No. 2 ✓

Measuring equipment Olympic Sounder (float switch)

Time Data
Pump on: Date _____ Time _____ (ℓ.)
Pump off: Date _____ Time _____ (ℓ.)
Duration of aquifer test:
Pumping _____ Recovery _____

Water Level Data
Static water level 10.4
Measuring point T.O.C.
Elevation of measuring point -0.4

Discharge Data
How Q measured _____
Depth of pump/air line _____
Previous pumping? Yes ____ No ____
Duration _____ End _____

Comments on factors affecting test data: 0.4-10.4 perforated interval

Bucket -1.7'
9.5 gal / 45 sec

Date	Clock time	Time since pump started t	Time since pump stopped t'	t/t'		Water level measurement (H_o = 5.68)	Correction or Conversion	H Water level	Water level change s or s'	H/H_o	Discharge measurement	Rate	
7/4	1509	0.75											
		1.25	0.5			4.72		5.68		1			
	1510	1.75	1.0			4.76		5.64					
		2.25	1.5			4.72		5.68		1			
	1511	2.75	2.0			4.72		5.68		1			
		3.25	2.5			4.73		5.67		1			
	1512	3.75	3.0			4.74		5.66		0.998			
		4.25	3.5			4.75		5.67		1			
	1513	4.75	4.0			4.76		5.64		0.995			
		5.25	4.5			4.7							
	1514	5.75	5.0			4.76		5.64		0.995			
	1515	6.75	6			4.79		5.61		0.989			
	1516	7.75	7			4.82		5.58		0.984			
	1517	8.75	8			4.85		5.55		0.979			
	1518	9.75	9			4.87		5.53		0.975			
	1519	10.75	10			4.90		5.50		0.970			
	1521	12.75	12			4.96		5.44		0.959			
	1523	14.75	14			5.0		5.40		0.952			
	1525	16.75	16			5.06		5.34		0.942			
	1527	18.75	18			5.06		5.4		0.952			
	1529	20.75	20			5.09		5.31		0.937			
	1532	23.75	23			5.13		5.17		0.912			
	1535	26.75	26			5.14		5.16		0.908			
	1539	30.75	30			5.15		5.25		0.926			
	1544	35.75	35			5.22		5.18		0.914			
	1549	40.75	40			5.22		5.18		0.914			
	1554	45.75	45			5.29		5.11		0.90			
	1559	50.75	50			5.31		5.09		0.896			

AQUIFER TEST DATA

Pumping Well P1 **Observation Wells** —

Owner RILLITON MINERALS USA Address _____ County _____ State _____

Date 7/4/90 Company performing test WILLIAM E. NORK, INC Measured by DCB

Well No. P1 Distance from pumping well — Type of test SLUG INJECTION Test No. 2 ✓

Measuring equipment Olympic Sounder (float switch)

Time Data
Pump on: Date _____ Time _____ (t,)
Pump off: Date _____ Time _____ (t')
Duration of aquifer test:
Pumping _____ Recovery _____

Water Level Data
Static water level 10.4
Measuring point TOC
Elevation of measuring point -0.4'

Discharge Data
How Q measured _____
Depth of pump/air line _____
Previous pumping? Yes ____ No ____
Duration _____ End _____

Comments on factors affecting test data: 0.4-104' perforated interval

H_0 = 5.68

Date	Clock time	Time since pump started t	Time since pump stopped t'	t/t'		Water level measurement	Correction or Conversion	H Water level	Water level change s or s'	H/H_0	Discharge measurement	Rate	
7/4	1609		~~60~~										
	1624	75.75	75			5.48		4.92		0.867			
			80										
	1639	90.75	90			5.57		4.38		0.850			
	1654	105.75	105 162			5.64		4.76		838			
	1757		167			5.96		4.40		0.732			
	1920					6.30		4.1		0.722			

AQUIFER TEST DATA

Pumping Well P2 **Observation Wells** NA

Owner BILLITON MINERALS USA Address _____ County WASHOE State NV

Date 7/4/90 Company performing test WILLIAM E. NORK, INC. Measured by DCR

Well No. P2 Distance from pumping well _____ Type of test SLUG INJECTION Test No. 1

Measuring equipment Olympic Sounder (float probe)

Time Data
Pump on: Date _____ Time _____ (AM)
Pump off: Date _____ Time _____ (AM)
Duration of aquifer test:
Pumping _____ Recovery _____

Water Level Data
Static water level 47.22
Measuring point T.P.C.
Elevation of measuring point _____

Discharge Data
How Q measured _____
Depth of pump/air line —
Previous pumping? Yes ____ No X
Duration _____ End _____

Comments on factors affecting test data: 40-50 ft perf. INTERVAL

Date	Clock time	Time since pump started t	Time since pump stopped t'	t/t'		H_o 13.28 Water level measurement	Correction or Conversion	H Water level	Water level change s or s'	H/H_o	Discharge measurement	Rate		
7/4/90	0845	1.08												9 gal / 65 sec
		1.41	0.33			33.94		13.28		1				7 gal / 1.053 min = 8.31 gpm
		2.08	1.0			34.17		13.05		.983				
		2.83	1.75			34.45		12.77		.962				
		3.58	2.5			34.63		12.58		.948				
		4.08	3.0			34.83		12.39		.933				
		4.58	3.5			34.98		12.24		.922				
		5.08	4.0			35.09		12.13		.913				
		5.58	4.5			35.29		11.93		.898				
		6.08	5.0			35.41		11.81		.889				
		7.08	6			35.68		11.54		.869				
		8.08	7			35.85		11.37		.857				
		9.08	8			36.2		11.02		.823				
		10.08	9			36.45		10.77		.811				
		11.08	10			36.60		10.62		.800				
		13.08	12			36.98		10.24		.771				
		15.08	14			36.84		10.38		.786				
		17.08	16			36.54		10.68		.805				
		19.08	18			36.48		10.74		.809				
		21.08	20			36.72		10.50		.791				
		24.08	23			37.0		10.22		.770				
		27.08	26			37.03		10.19		.767				
	0915	31.08	30			37.06		10.16		.765				
		36.08	35			37.25		9.97		.751				
		41.08	40			37.50		9.72		.732				
		46.08	45			37.7		9.5		.715				
		51.08	50			37.93		9.29		.700				
	0945	61.08	60			38.32		8.9		.670				

AQUIFER TEST DATA

Pumping Well P2 **Observation Wells** —

Owner BILLITON MINERALS Address _____ County _____ State _____

Date 7/4/90 Company performing test WILLIAM E. NORK, INC Measured by DCB

Well No. P2 Distance from pumping well — Type of test SLUG INJECTION Test No. 1

Measuring equipment _____

Time Data
Pump on: Date _____ Time _____ (t_0)
Pump off: Date _____ Time _____ (t'_0)
Duration of aquifer test:
Pumping _____ Recovery _____

Water Level Data
Static water level 47.22
Measuring point T.OC.
Elevation of measuring point L.S.D.

Discharge Data
How Q measured _____
Depth of pump/air line _____
Previous pumping? Yes ____ No ____
Duration _____ End _____

Comments on factors affecting test data: 40-50 FT PERF INTERVAL

Date	Clock time	Time since pump started t	Time since pump stopped t'	t/t'		Water level measurement	Correction or Conversion	H Water level	Water level change s or s'		Discharge measurement	Rate	
7/4	0955	71.03	70			38.67		8.55		.644			
	1005	81.03	80			38.99		8.23		.62			
	1015	91.03	90			39.26		7.96		.60			
	1230		225			46.60		0.62		0.05			

AQUIFER TEST DATA

Pumping Well P2 **Observation Wells** —

Owner BILLITON MINERALS USA Address County State

Date 7/14/90 Company performing test WILLIAM E. NORK, INC Measured by DCB

Well No. P2 Distance from pumping well — Type of test SLUG INJECTION Test No. 2 ✓

Measuring equipment Olympic Sounder (float switch)

Time Data
Pump on: Date — Time — (t₀)
Pump off: Date — Time — (t'₀)
Duration of aquifer test:
Pumping 45 sec Recovery 1 hr

Water Level Data
Static water level 30
Measuring point T.O.C.
Elevation of measuring point 0'

Discharge Data
How Q measured bucket/watch
Depth of pump/air line
Previous pumping? Yes — No X
Duration — End —

Comments on factors affecting test data: 20-30 FT INTERVAL

Date	Clock time	Time since pump started t	Time since pump stopped t'	t/t'		Water level measurement (H_0: 5.32)	Correction or Conversion	H Water level	Water level change s or s'	H/H_0	Discharge measurement	Rate		Comments
7/4	1355													8.5 gal/45 sec
		0.	0.5			24.68		5.32		1				
			1.0			24.80		5.2		0.977				
			1.5			24.83		5.17		0.972				
			2.0			24.91		5.09		0.957				
			2.5			24.99		5.01		0.942				
			3.0			25.02		4.98		0.936				
			3.5			25.05		4.95		0.931				
			4.0			25.17		4.83		0.908				
			4.5			25.27		4.73		0.889				
			5			25.36		4.64		0.872				
			6			25.46		4.54		0.853				
			7			25.67		4.33		0.814				
			8			25.81		4.19		0.787				
			9			25.94		4.06		0.763				
			10			26.09		3.91		0.735				
			12			26.28		3.72		0.699				
			14			26.40		3.6		0.677				
			16			26.55		3.45		0.646				
			18			26.61		3.39		0.637				
			20			26.76		3.24		0.609				
			23			26.80		3.2		0.602				
			26			26.87		3.13		0.570				
	1425		30			27.02		2.98		0.560				
			35			27.02		2.98		0.56				
			40			27.16		2.84		0.538				
			45			27.20		2.80		0.528				
	1445		50			27.31		2.69		0.504				
	1455		60											

WILLIAM E. NORK, INC.

AQUIFER TEST DATA

Pumping Well P2 **Observation Wells** —

Owner BILLITON MINERALS USA Address ____ County ____ State ____

Date 7/4/90 Company performing test WILLIAM E. NORK, INC Measured by DCB

Well No. P2 Distance from pumping well — Type of test SLUG INJECTION Test No. 3

Measuring equipment Olympic Sounder (float switch)

Time Data
Pump on: Date ____ Time ____ (t,)
Pump off: Date ____ Time ____ (t')
Duration of aquifer test:
Pumping ____ Recovery ____

Water Level Data
Static water level 9.7 FT
Measuring point TOC
Elevation of measuring point 0.1

Discharge Data
How Q measured Bucket/watch
Depth of pump/air line ____
Previous pumping? Yes ____ No X
Duration ____ End ____

Comments on factors affecting test data: 0-10 FT PERFORATED INTERVAL

H_0 = 6.21

Date	Clock time	Time since pump started t	Time since pump stopped t'	t/t'		Water level measurement	Correction or Conversion	H Water level	Water level change s or s'	H/H_0	Discharge measurement	Rate		
7/4	1702													10 gal / 45 sec
			0.5			3.49		6.21		1				
	1703		1			3.48		6.22		1				
			1.5			3.49		6.21		1				
	1704		2			3.51		6.19		0.997				
			2.5			3.52		6.18		0.995				
	1705		3			3.52		6.18		0.995				
			3.5			3.54		6.16		0.992				
	1706		4			3.55		6.15		0.990				
			4.5			3.57		6.13		0.987				
	1707		5			3.6		6.1		0.983				
	1708		6			3.61		6.09		0.981				
	1709		7			3.63		6.07		0.978				
	1710		8			3.65		6.05		0.974				
	1711		9			3.67		6.03		0.971				
	1712		10			3.69		6.01		0.967				
	1714		12			3.71		5.99		0.965				
			14.5			3.76		5.92		0.953				
	1718		16			3.77		5.93		0.955				
	1720		18			3.80		5.9		0.950				
	1722		20			3.84		5.86		0.944				
	1723		23			3.86		5.84		0.940				
	1724		26			3.89		5.81		0.936				
	1732		30			3.93		5.7		0.929				
	1737		35			3.98		5.7		0.921				
	1742		40			4.04		5.66		0.911				
	1747		45			4.08		5.6		0.905				
	1752		50			4.11		5.5		0.900				

AQUIFER TEST DATA

Pumping Well P2 **Observation Wells** —

Owner Billiton Minerals USA Address _____ County _____ State _____

Date 7 Company performing test [illegible] Measured by _____

Well No. P2 Distance from pumping well — Type of test Slug Injection Test No. 3

Measuring equipment _____

Time Data

Pump on: Date _____ Time _____ (t.)
Pump off: Date _____ Time _____ (t'.)
Duration of aquifer test:
Pumping _____ Recovery _____

Water Level Data

Static water level 9.7 FT
Measuring point TOC
Elevation of measuring point 0.1 FT

Discharge Data

How Q measured _____
Depth of pump/air line _____
Previous pumping? Yes ____ No ____
Duration _____ End _____

Comments on factors affecting test data: 10-0 perforated interval

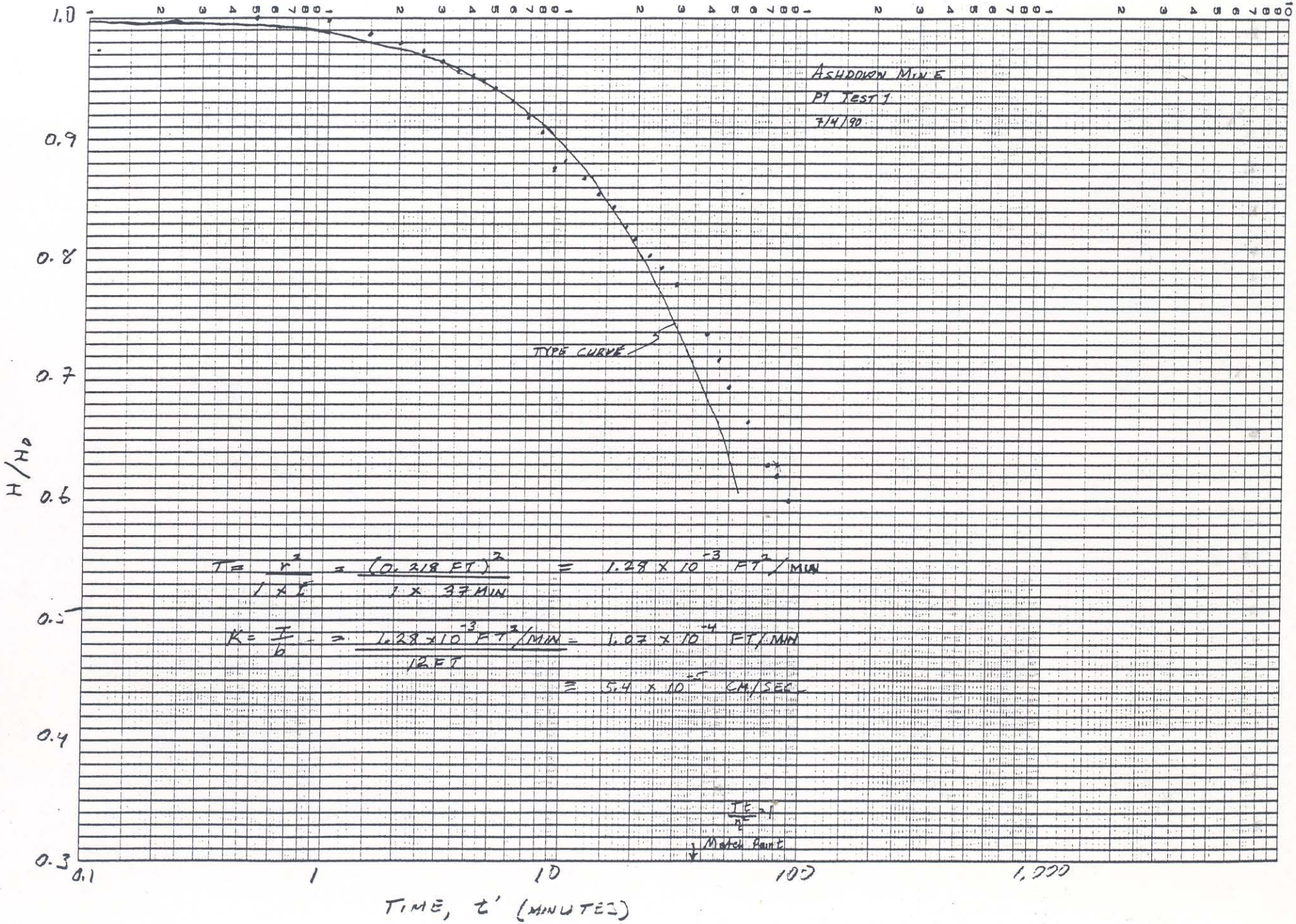
Date	Clock time	Time since pump started t	Time since pump stopped t'	t/t'		Water level measurement (Ho = 6.21)	Correction or Conversion	H Water level	Water level change s or s'	H/Ho	Discharge measurement	Rate	
7/4	1802		60			4.18		5.52		0.739			
	1817		75			4.28		5.42		0.873			
	1919		90			4.37							

APPENDIX C

DATA PLOTS

NO. 340-L510 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
5 CYCLES X 10 DIVISIONS PER INCH

DIETZGEN CORPORATION
MADE IN U.S.A.



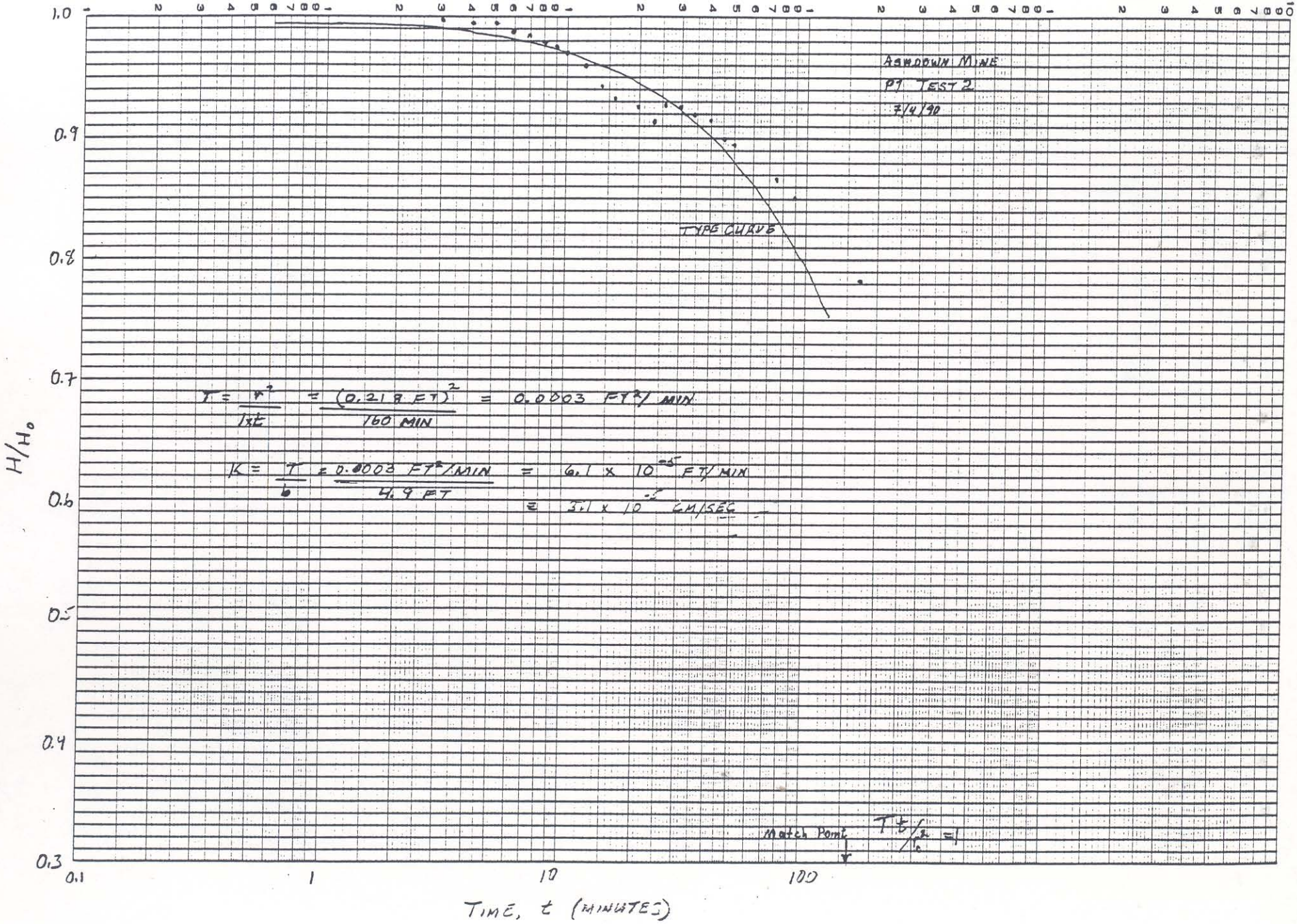
$$T = \frac{r^2}{1 \times E} = \frac{(0.318\ FT)^2}{1 \times 37\ MIN} = 1.28 \times 10^{-3}\ FT^2/MIN$$

$$K = \frac{T}{b} = \frac{1.28 \times 10^{-3}\ FT^2/MIN}{12\ FT} = 1.07 \times 10^{-4}\ FT/MIN$$

$$\cong 5.4 \times 10^{-5}\ CM/SEC$$

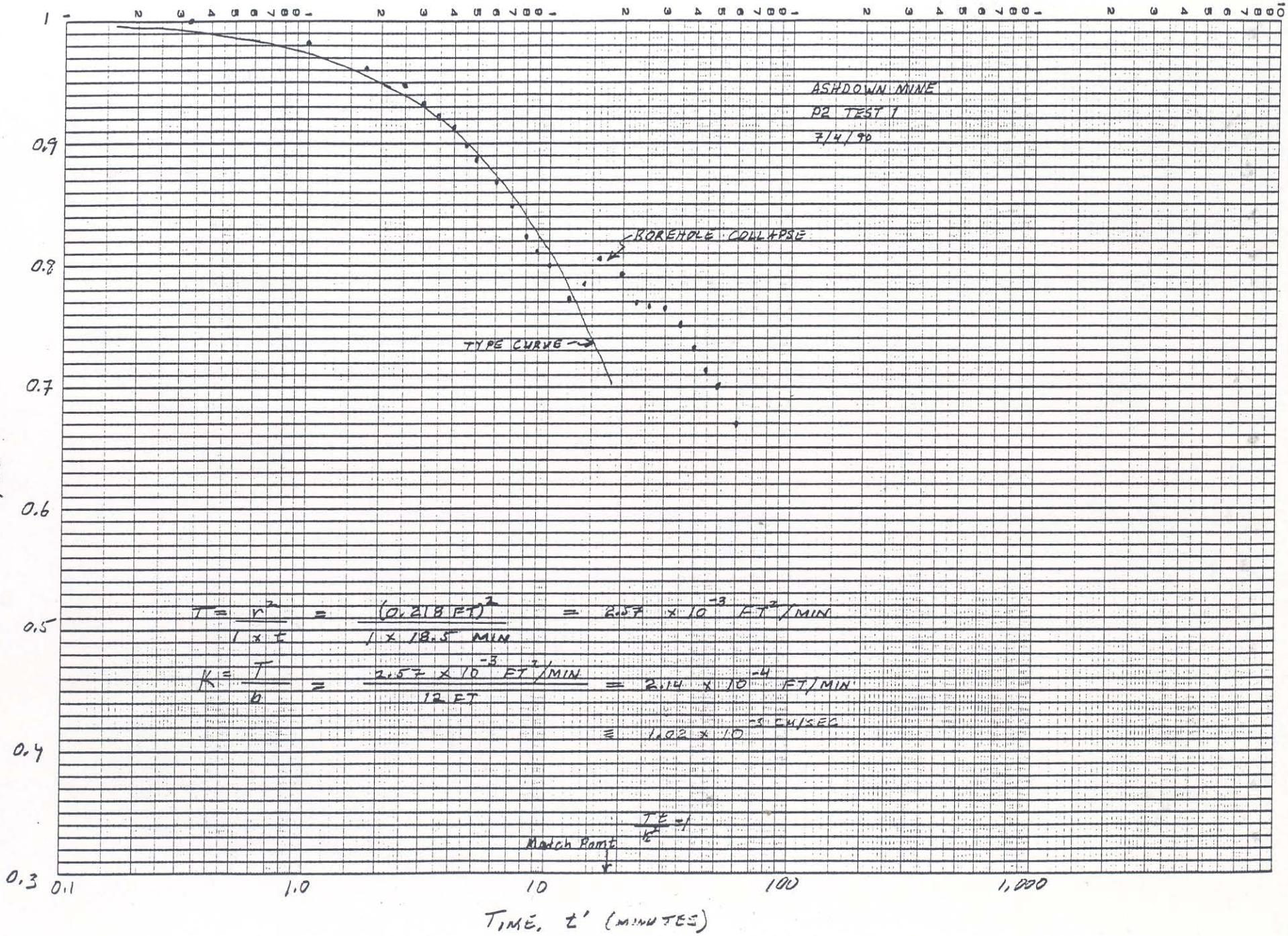
NO. 340-LS10 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
5 CYCLES X 10 DIVISIONS PER INCH

DIETZGEN CORPORATION
MADE IN U.S.A.



NO. 340-LS10 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
5 CYCLES X 10 DIVISIONS PER INCH

DIETZGEN CORPORATION
MADE IN U.S.A.



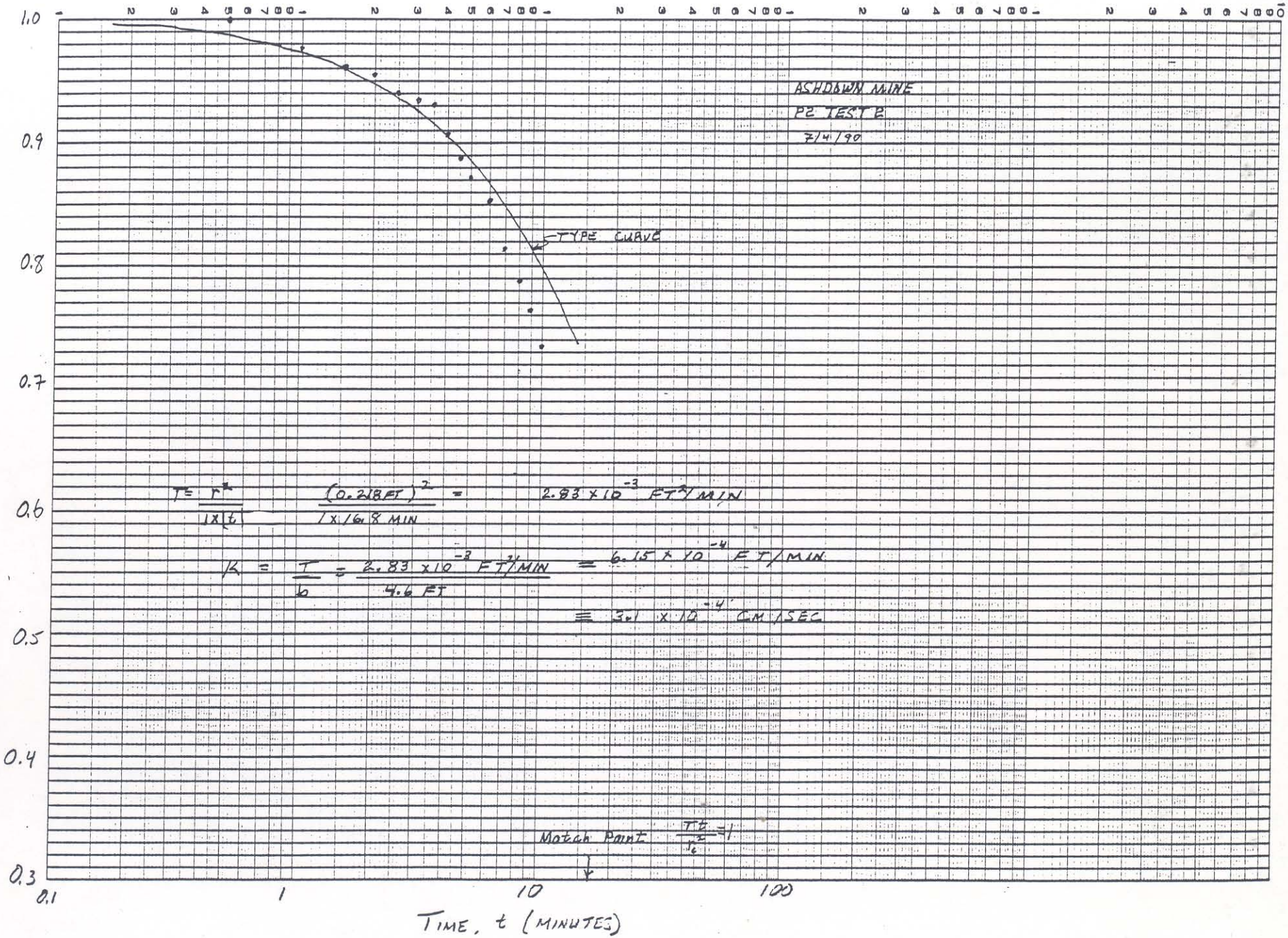
$$T = \frac{r^2}{1 \times t} = \frac{(0.218\ FT)^2}{1 \times 18.5\ MIN} = 2.57 \times 10^{-3}\ FT^2/MIN$$

$$K = \frac{T}{b} = \frac{2.57 \times 10^{-3}\ FT^2/MIN}{12\ FT} = 2.14 \times 10^{-4}\ FT/MIN$$

$$\equiv 1.02 \times 10^{-3}\ CM/SEC$$

NO. 340-L510 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
5 CYCLES X 10 DIVISIONS PER INCH

DIETZGEN CORPORATION
MADE IN U.S.A.



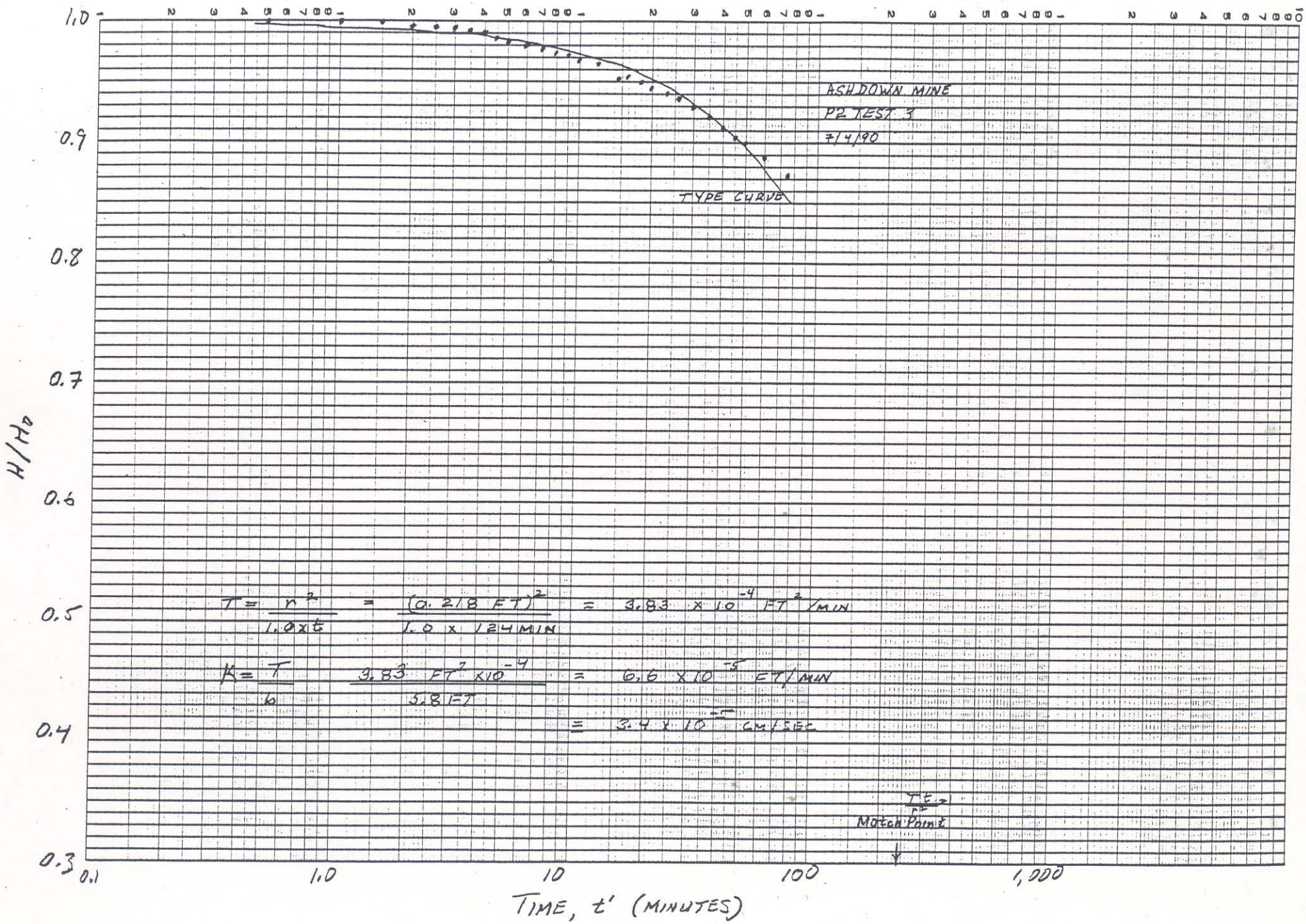
$$T = \frac{r^2}{1 \times t} \qquad \frac{(0.218\,FT)^2}{1 \times 16.8\,MIN} = 2.83 \times 10^{-3}\ FT^2/MIN$$

$$K = \frac{T}{b} = \frac{2.83 \times 10^{-3}\ FT^2/MIN}{4.6\ FT} = 6.15 \times 10^{-4}\ FT/MIN$$

$$\equiv 3.1 \times 10^{-4}\ CM/SEC$$

NO. 340-LS10 DIETZGEN GRAPH PAPER
SEMI-LOGARITHMIC
5 CYCLES X 10 DIVISIONS PER INCH

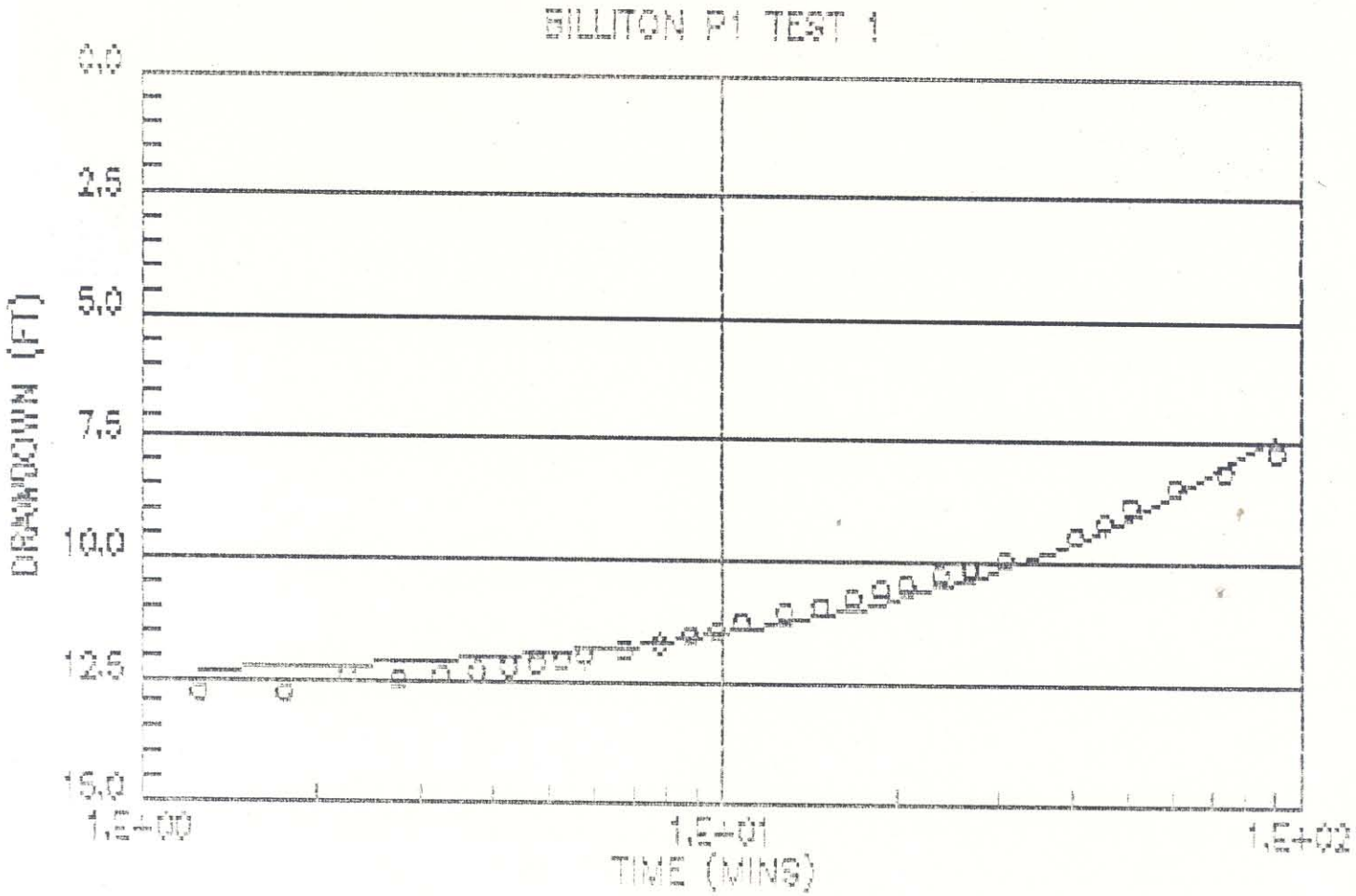
DIETZGEN CORPORATION
MADE IN U.S.A.



$$T = \frac{r^2}{1.0 \times t} = \frac{(0.218\ FT)^2}{1.0 \times 124\ MIN} = 3.83 \times 10^{-4}\ FT^2/MIN$$

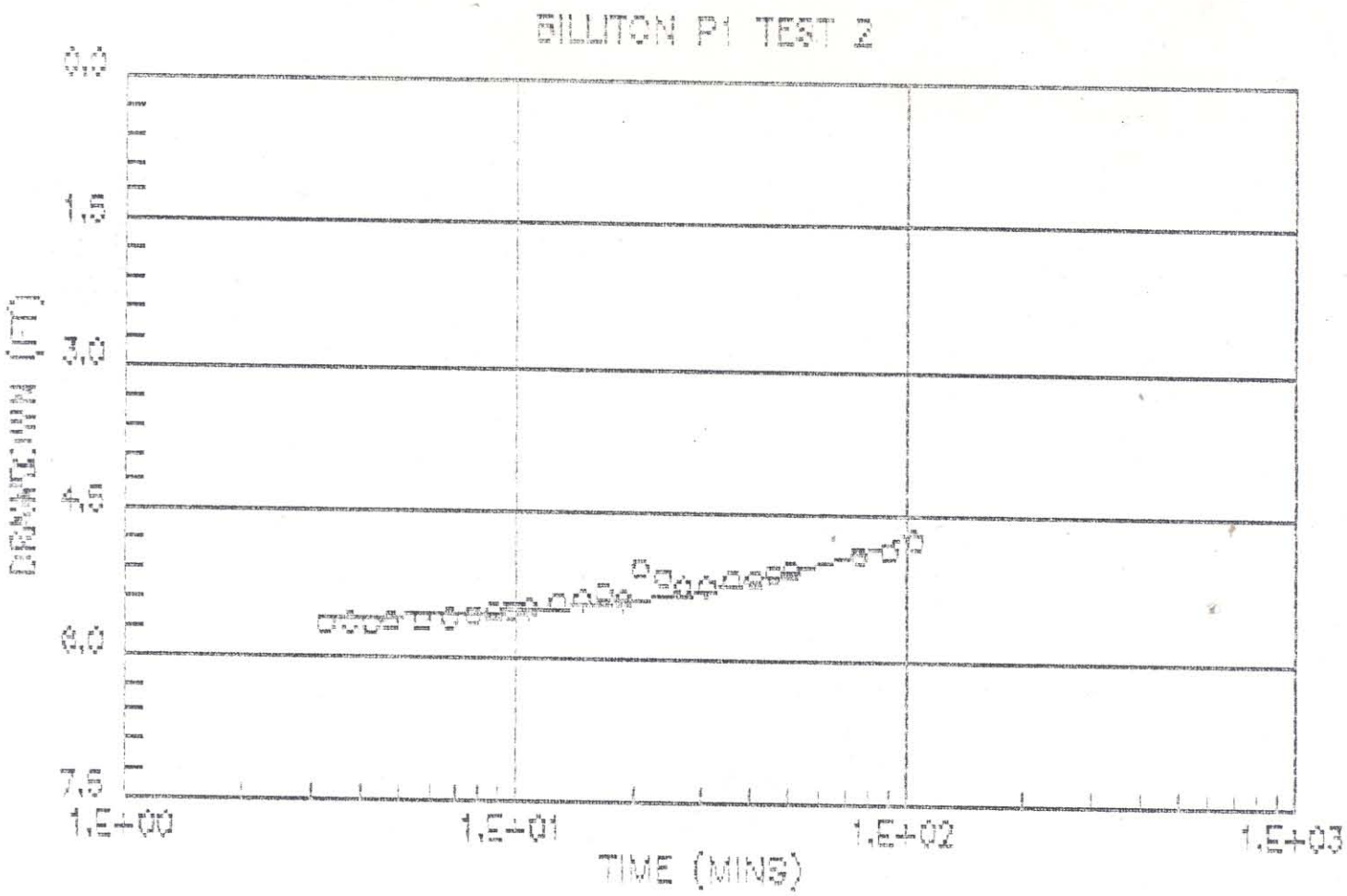
$$K = \frac{T}{b} \quad \frac{3.83\ FT^2 \times 10^{-4}}{3.81\ FT} = 6.6 \times 10^{-5}\ FT/MIN$$

$$= 3.4 \times 10^{-7}\ CM/SEC$$



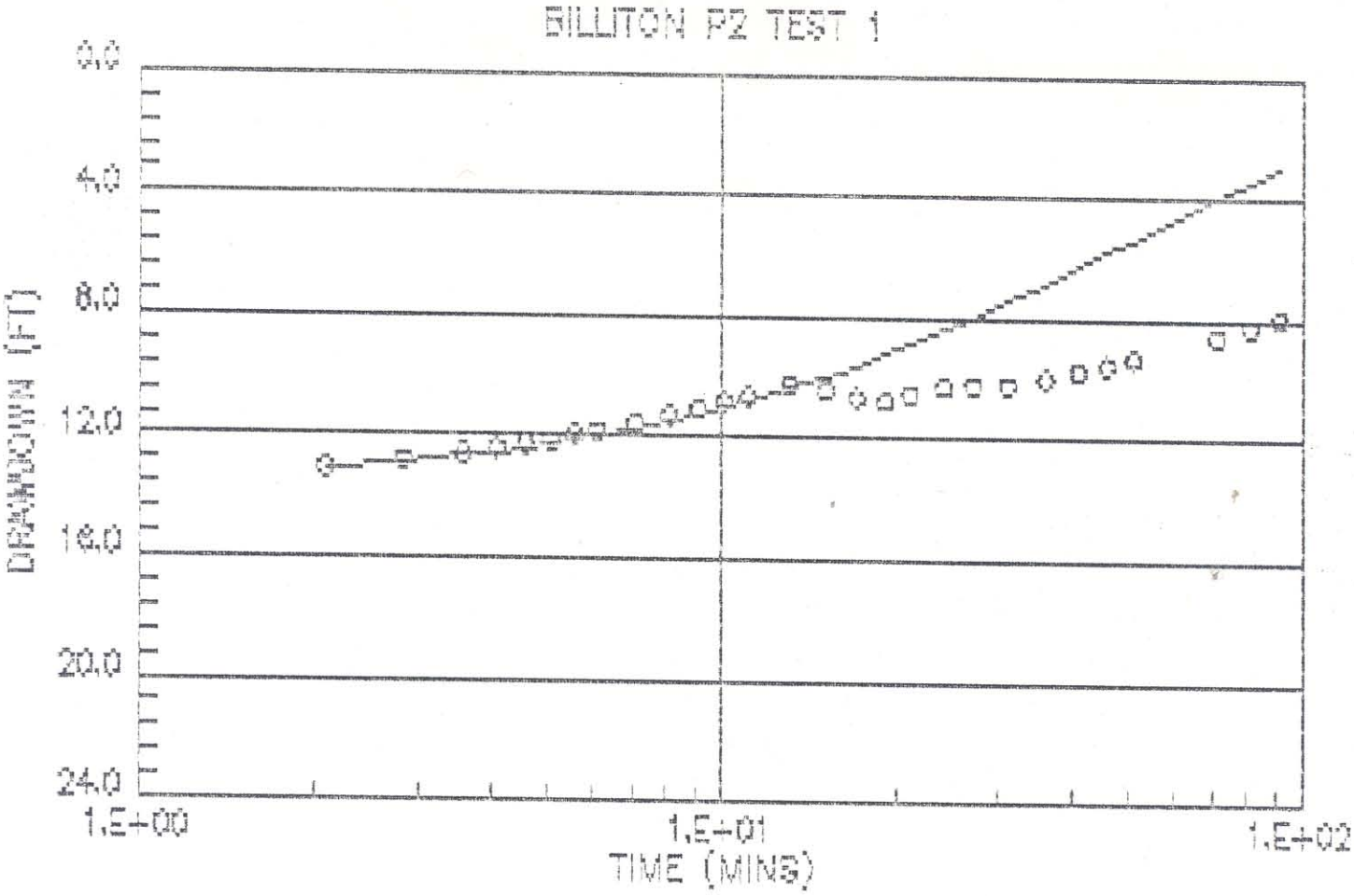
WILLIAM E. NORK, Inc.

Reno, Nevada 89503

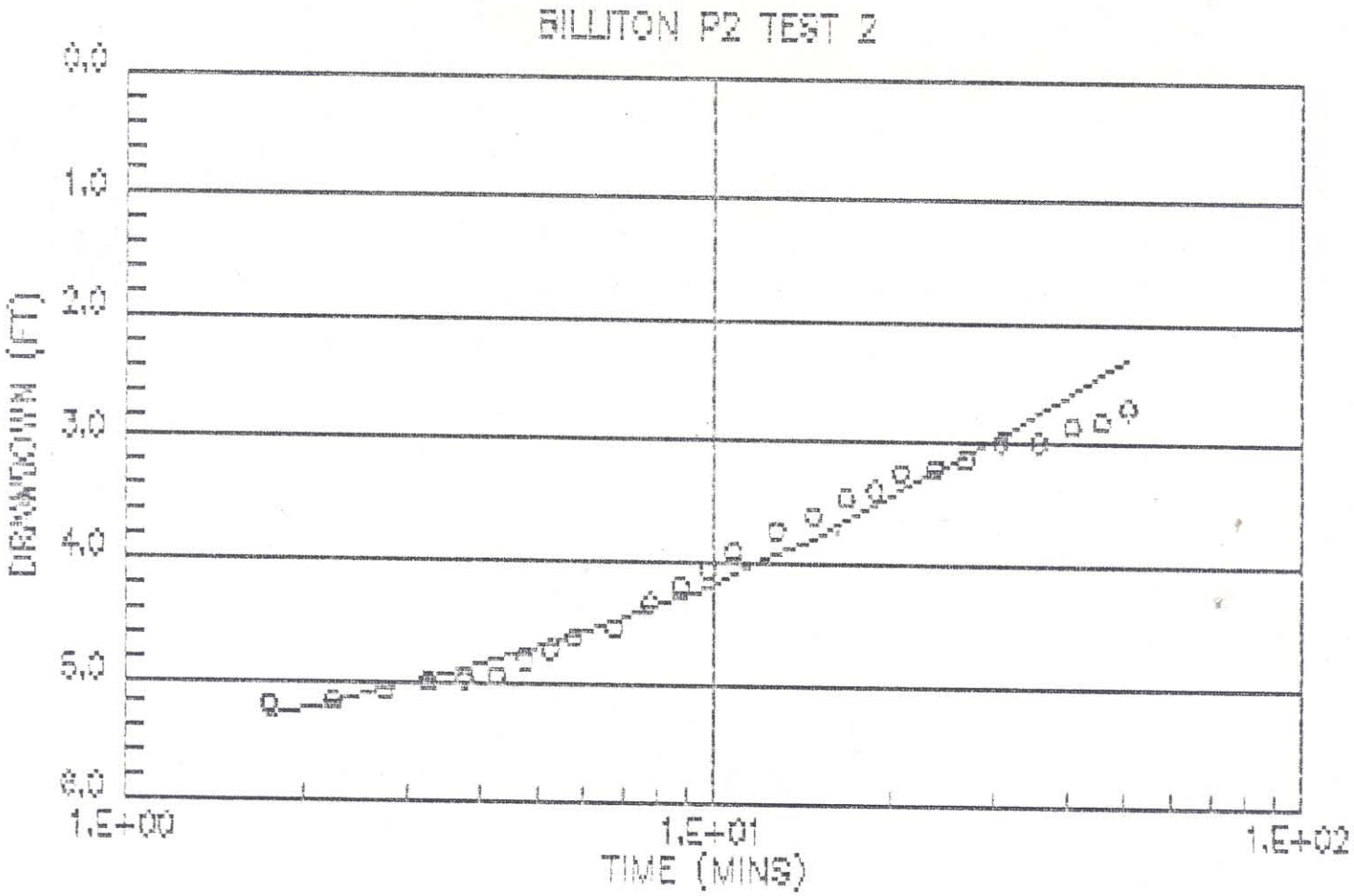


WILLIAM E. NORK, Inc.

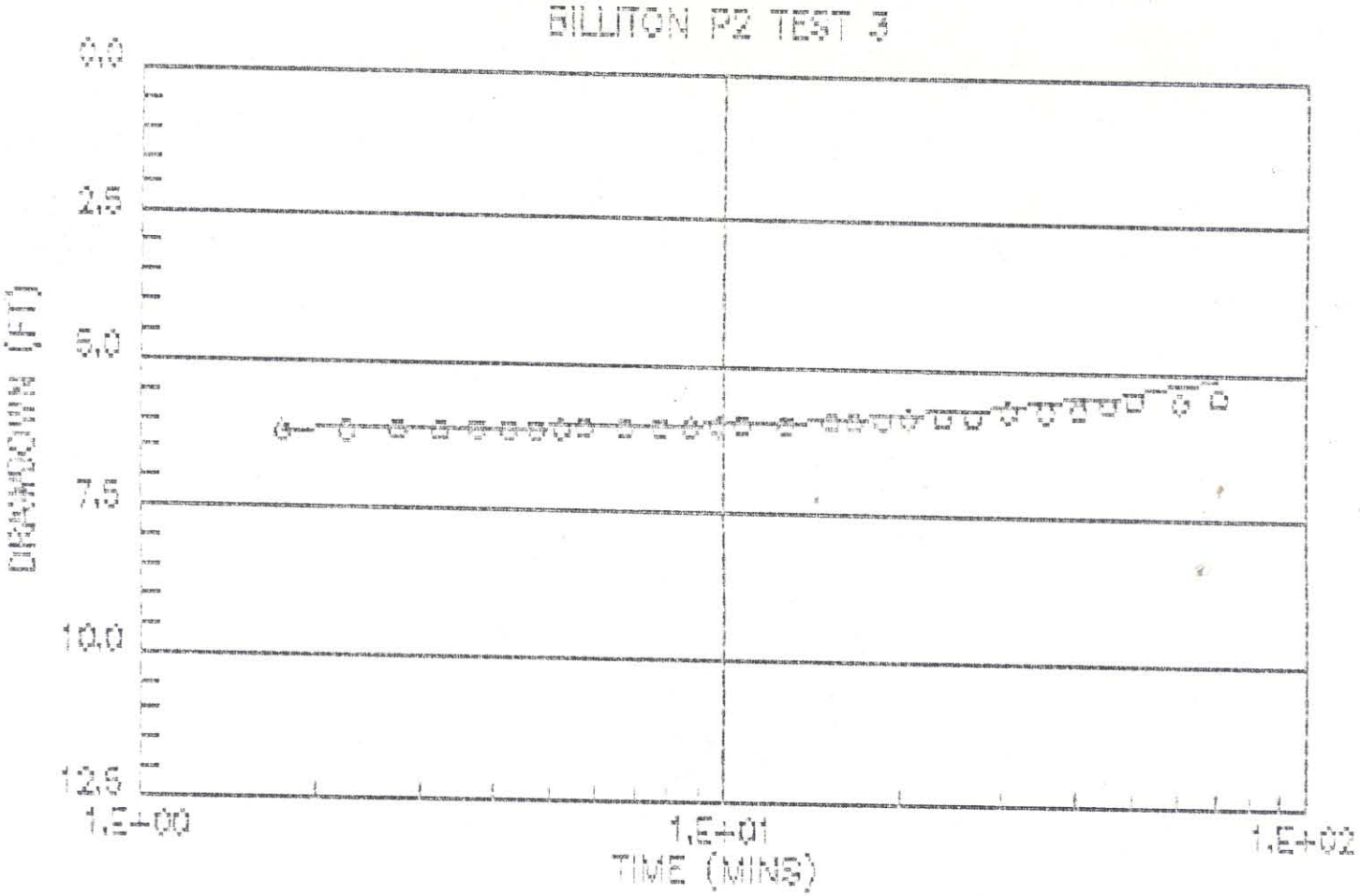
Reno, Nevada 89503



WILLIAM E. NORK, Inc.
Reno, Nevada 89503



WILLIAM E. NORK, Inc.
Reno, Nevada 89503



WILLIAM E. NORK, Inc.

Reno, Nevada 89503

APPENDIX D

GRAIN SIZE DISTRIBUTIONS

Johnson Division
P.O. Box 3118 • St. Paul, Minnesota 55165
Telephone 612-636-3900 • Telex 29-7451
uop Inc.

SAND ANALYSIS
(FINE)

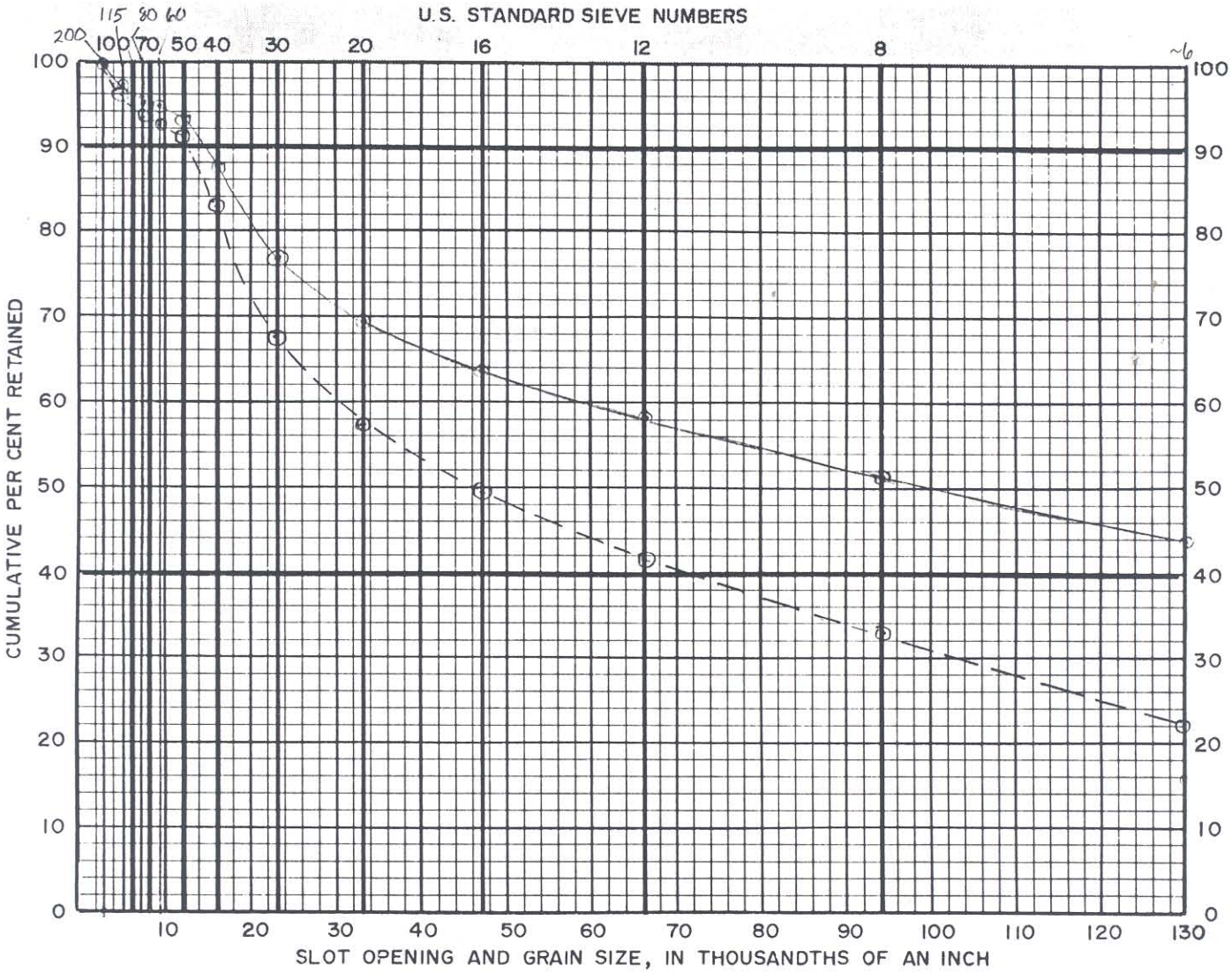
MAILING ADDRESS: P.O. BOX 3118
ST. PAUL, MINNESOTA ▪ 55165

Sample sent in by _____

Town DENIO 90-521 State NV Zip _____ Date 7/9/90

From well of D-1-1 AND 2 (0-10 ft)

Remarks: _____



U.S. SIEVE NO	SIEVE OPENING INCHES	SIEVE OPENING MM.	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
12	.066	1.68			
16	.047	1.19			
20	.033	0.84			
30	.023	0.60			
40	.016	0.42			
50	.012	0.30			
70	.008	0.21			
100	.006	0.15			

Notes: _____

Recommended Slot Opening: _____

Recommended Screen: Dia. _____ in. Length _____ Ft.

_____ By: _____

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS.

Johnson Division
P.O. Box 3118 • St. Paul, Minnesota 55165
Telephone 612-636-3900 • Telex 29-7451
uop Inc.

SAND ANALYSIS
(FINE)

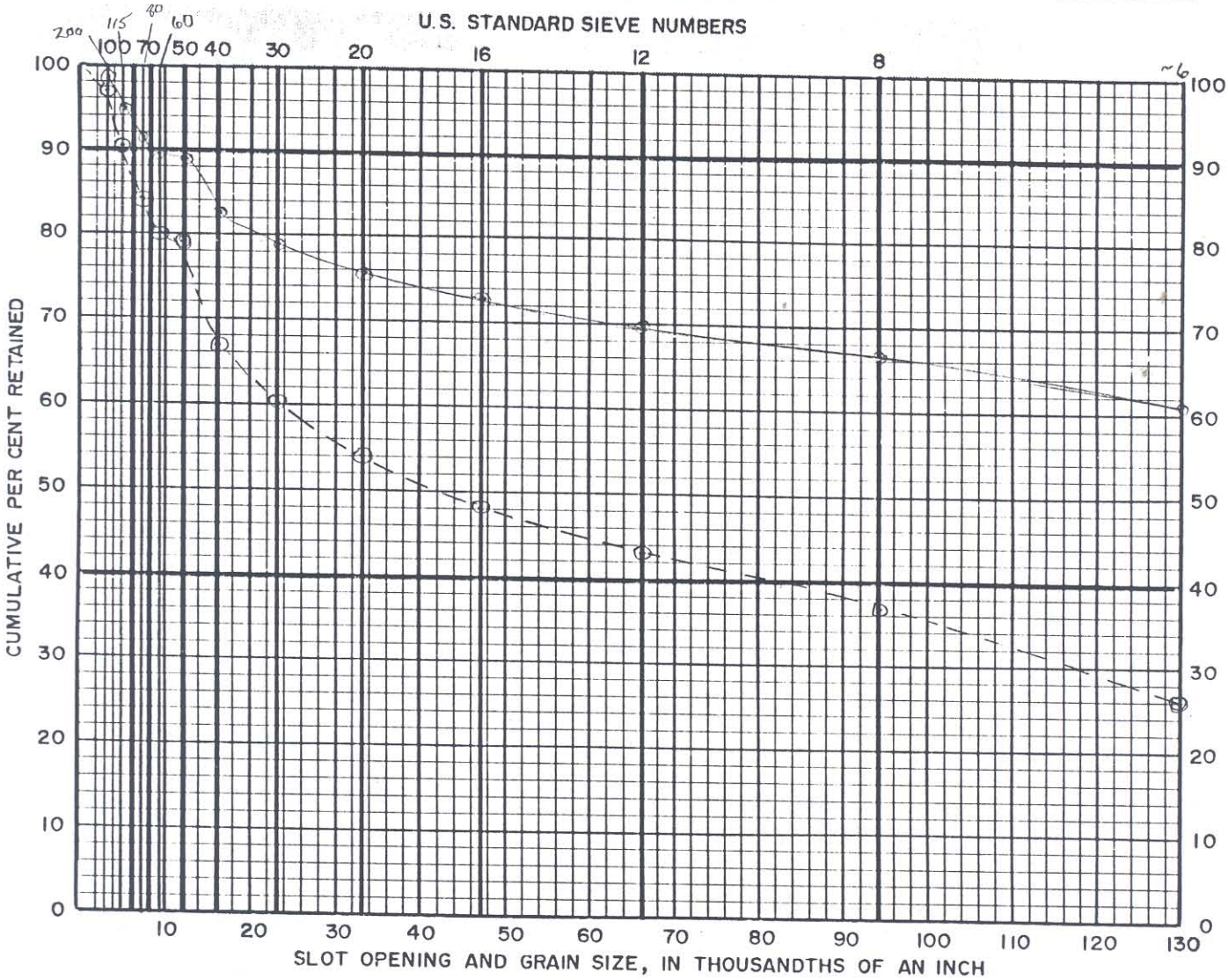
MAILING ADDRESS: P.O. BOX 3118
ST. PAUL, MINNESOTA ▪ 55165

Sample sent in by _____

Town DENIO 90-521 State NV Zip _____ Date 7/9/90

From well of D-1-3 AND 4 (10-20 ft)

Remarks: _____



U.S. SIEVE NO	SIEVE OPENING INCHES	SIEVE OPENING MM.	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
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Notes: _____

Recommended Slot Opening: _____

Recommended Screen: Dia. _____ in. Length _____ Ft.

_____ By: _____

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SAND ANALYSIS
(FINE)

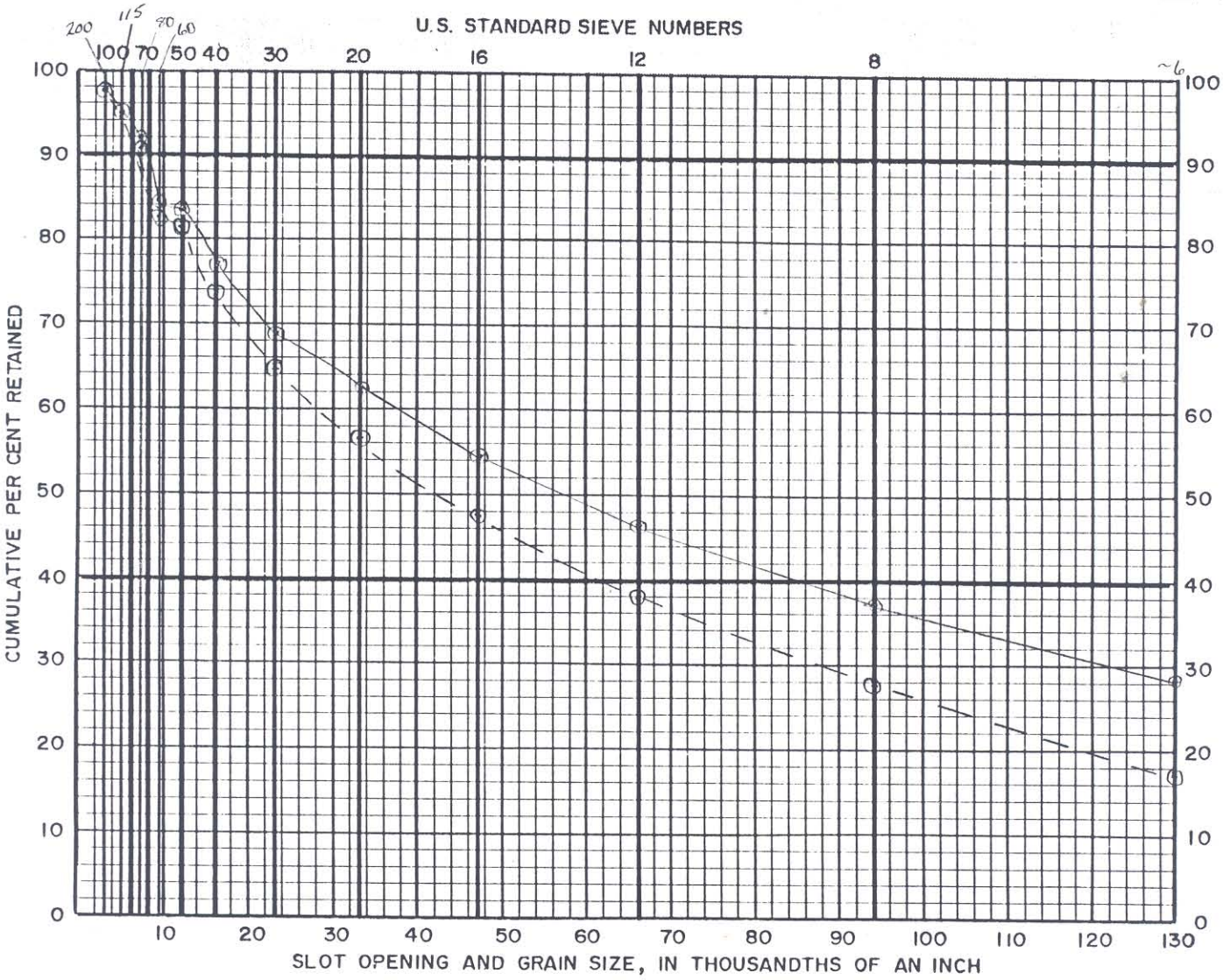
MAILING ADDRESS: P.O. BOX 3118
ST. PAUL, MINNESOTA ▪ 55165

Sample sent in by _____

Town DEMIO 90-521 State NV. Zip _____ Date 7/9/90

From well of D-2-1 AND 2 (0-10 ft)

Remarks: _____



U.S. SIEVE NO	SIEVE OPENING INCHES	SIEVE OPENING MM.	CUMULATIVE % RETAINED		
6	.132	3.36			
8	.094	2.38			
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Notes: _____

Recommended Slot Opening: _____

Recommended Screen: Dia. _____ in. Length _____ Ft.

By: _____

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uop Inc.

SAND ANALYSIS
(FINE)

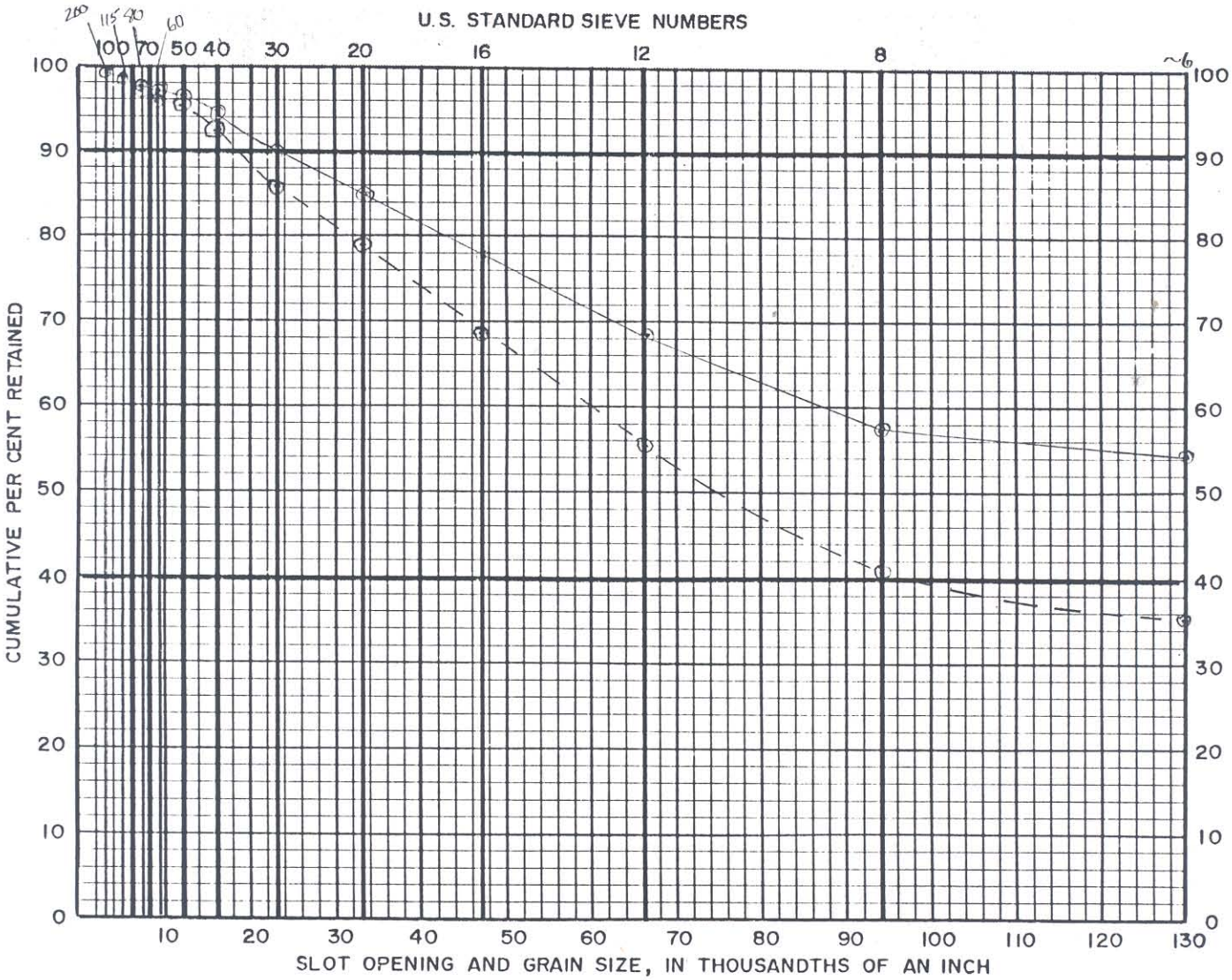
MAILING ADDRESS: P.O. BOX 3118
ST. PAUL, MINNESOTA ▪ 55165

Sample sent in by _____

Town DENIO 90-521 State N.V. Zip _____ Date _____

From well of D - 2 - 3 AND 4 (10 - 20 ft)

Remarks: _____



U.S. SIEVE NO	SIEVE OPENING INCHES	SIEVE OPENING MM.	CUMULATIVE % RETAINED		
6	.132	3.36			
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Notes: _____

Recommended Slot Opening: _____

Recommended Screen: Dia. _____ in. Length _____ Ft.

By: _____

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Johnson Division
P.O. Box 3118 • St. Paul, Minnesota 55165
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uop Inc.

SAND ANALYSIS
(FINE)

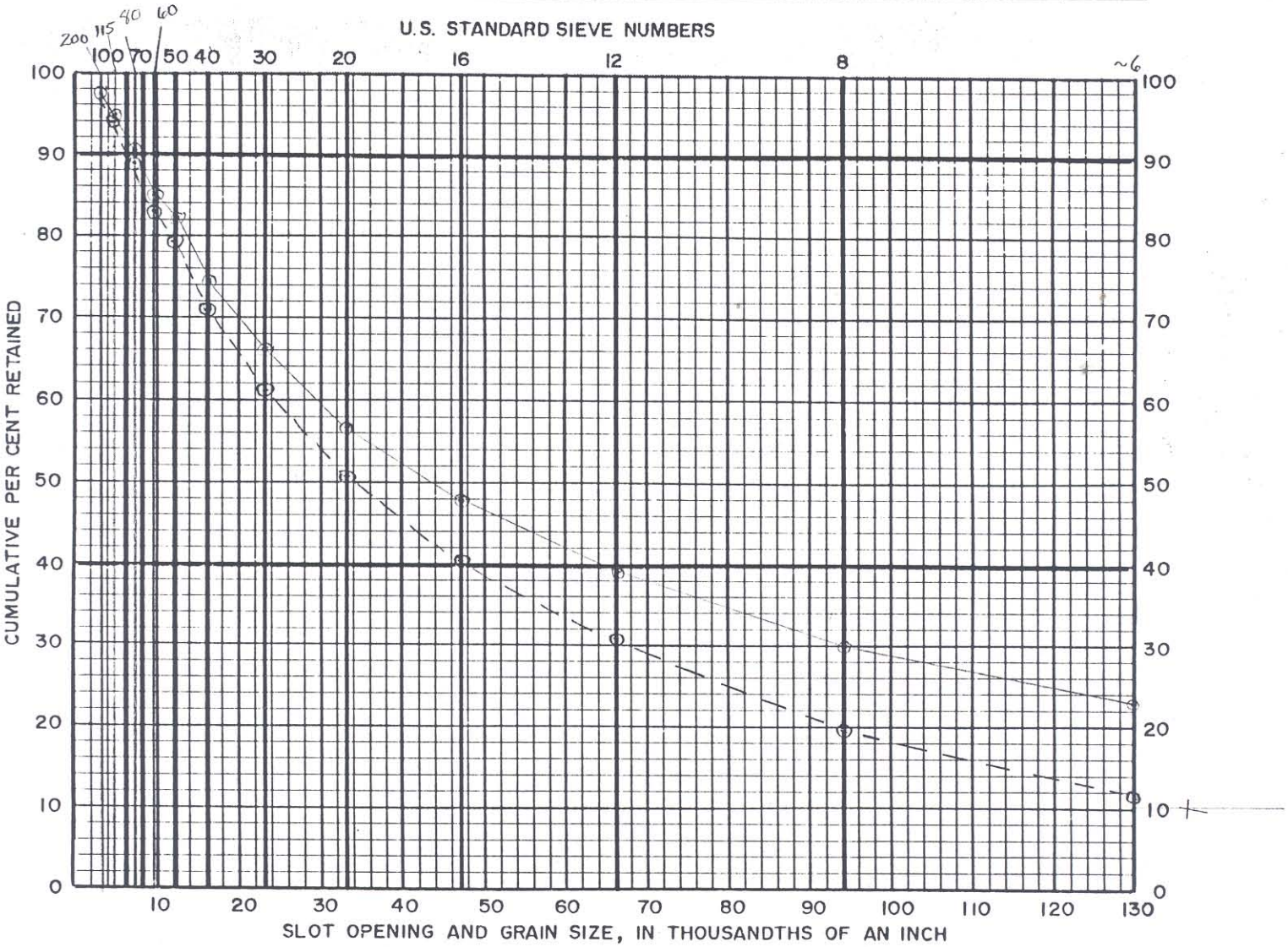
MAILING ADDRESS: P.O. BOX 3118
ST. PAUL, MINNESOTA ▪ 55165

Sample sent in by _____

Town DENIO 90-521 State NV. Zip _____ Date 7/10/90

From well of D-3-1 and 2 (0-10 ft)

Remarks: _____



U.S. SIEVE NO	SIEVE OPENING INCHES	SIEVE OPENING MM	CUMULATIVE % RETAINED		
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Recommended Slot Opening: _____

Recommended Screen: Dia. _____ in. Length _____ Ft.

By: _____

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uop Inc.

SAND ANALYSIS
(FINE)

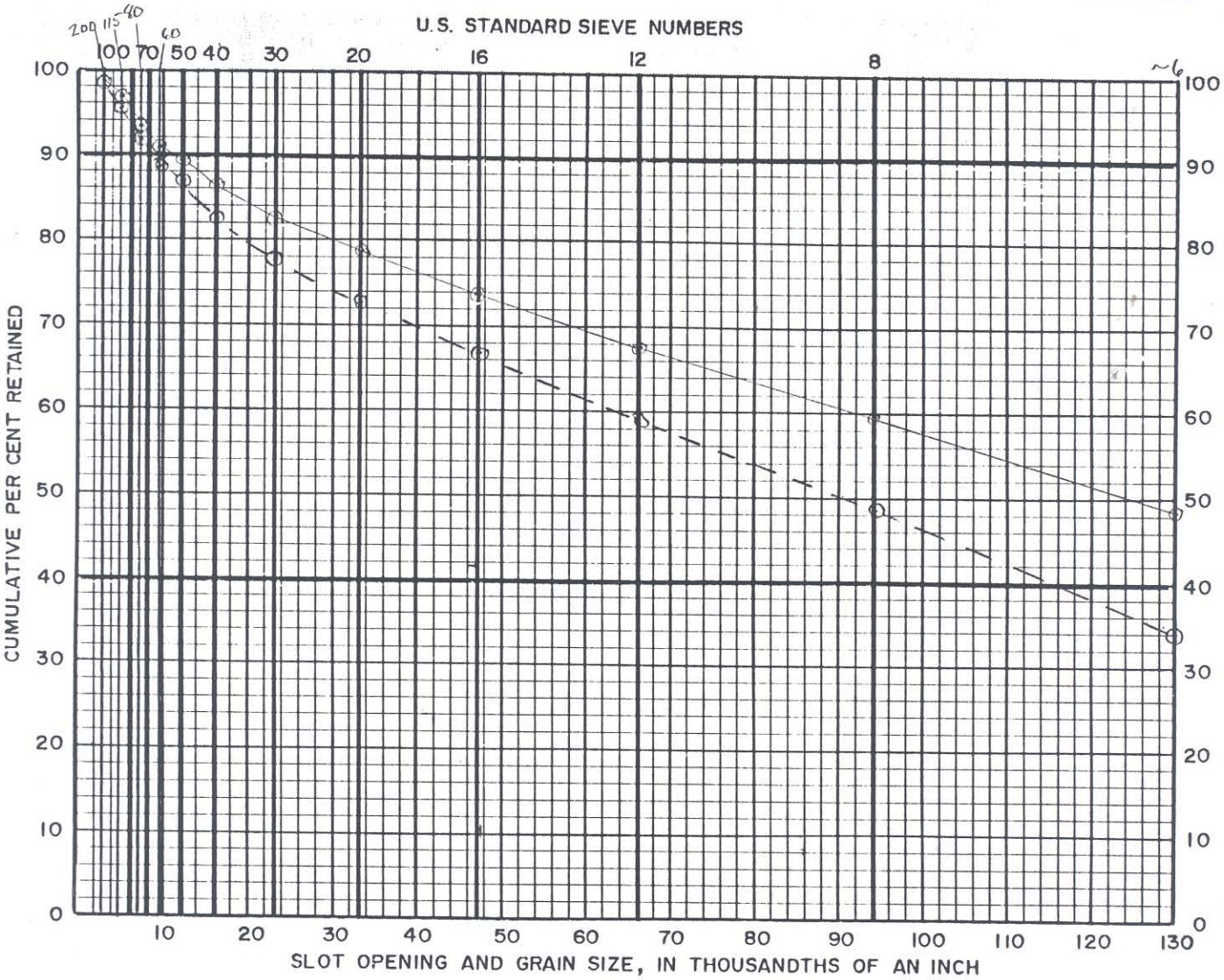
MAILING ADDRESS: P.O. BOX 3118
ST. PAUL, MINNESOTA ▪ 55165

Sample sent in by _____

Town DGN10 90-521 State NV Zip _____ Date 7/10/90

From well of D-3-3 AND 4 (10-20 ft)

Remarks: _____



U.S. SIEVE NO	SIEVE OPENING INCHES	SIEVE OPENING MM.	CUMULATIVE % RETAINED		
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uop Inc.

SAND ANALYSIS
(FINE)

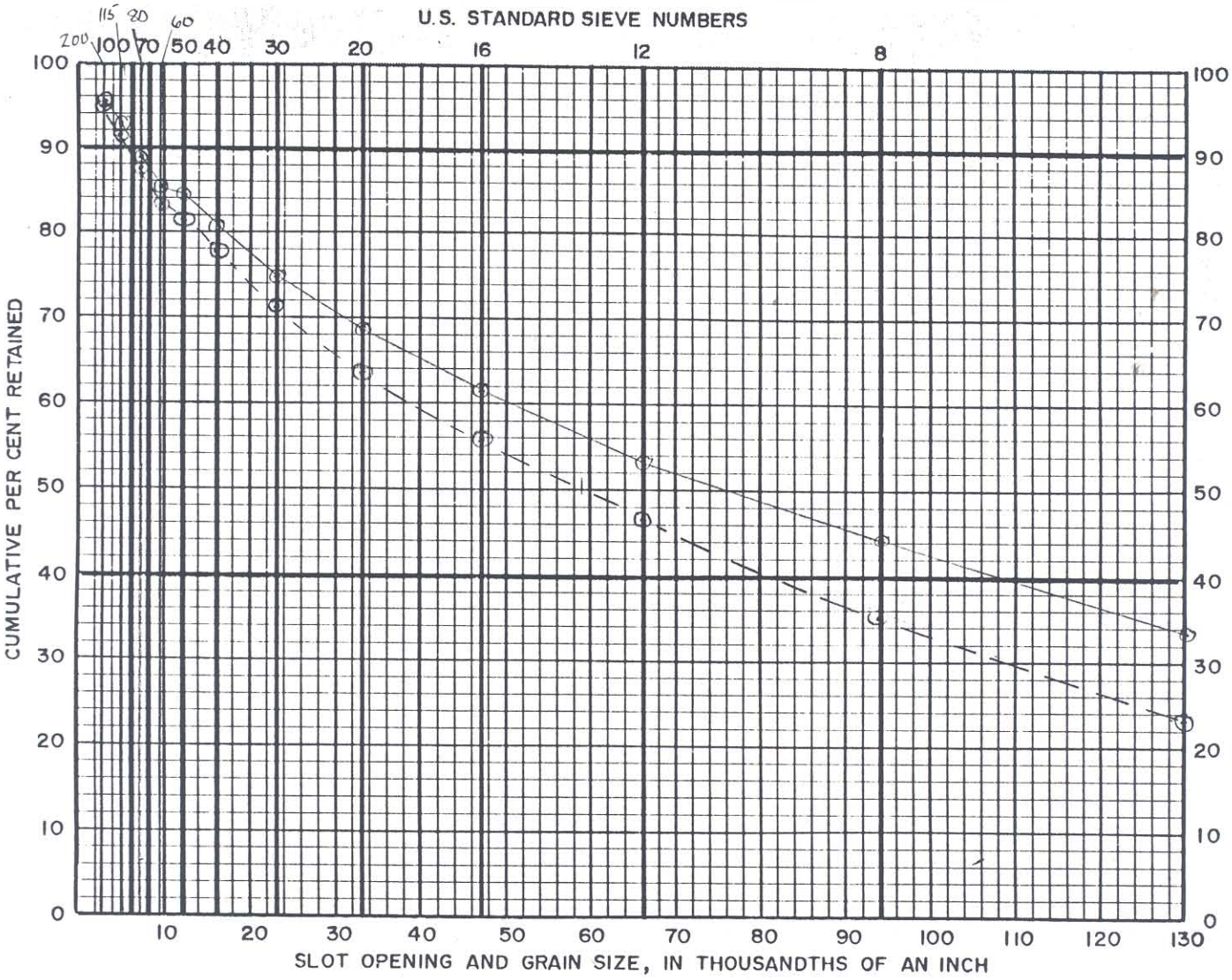
MAILING ADDRESS: P.O. BOX 3118
ST. PAUL, MINNESOTA ▪ 55165

Sample sent in by _____

Town DENIO 90-521 State NV Zip _____ Date 7/10/90

From well of P-1-1 AND 2 (0-10ft)

Remarks: _____



U.S. SIEVE NO	SIEVE OPENING INCHES	SIEVE OPENING MM.	CUMULATIVE % RETAINED		
6	.132	3.36			
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Recommended Slot Opening: _____

Recommended Screen: Dia. _____ in. Length _____ Ft.

By: _____

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SAND ANALYSIS
(FINE)

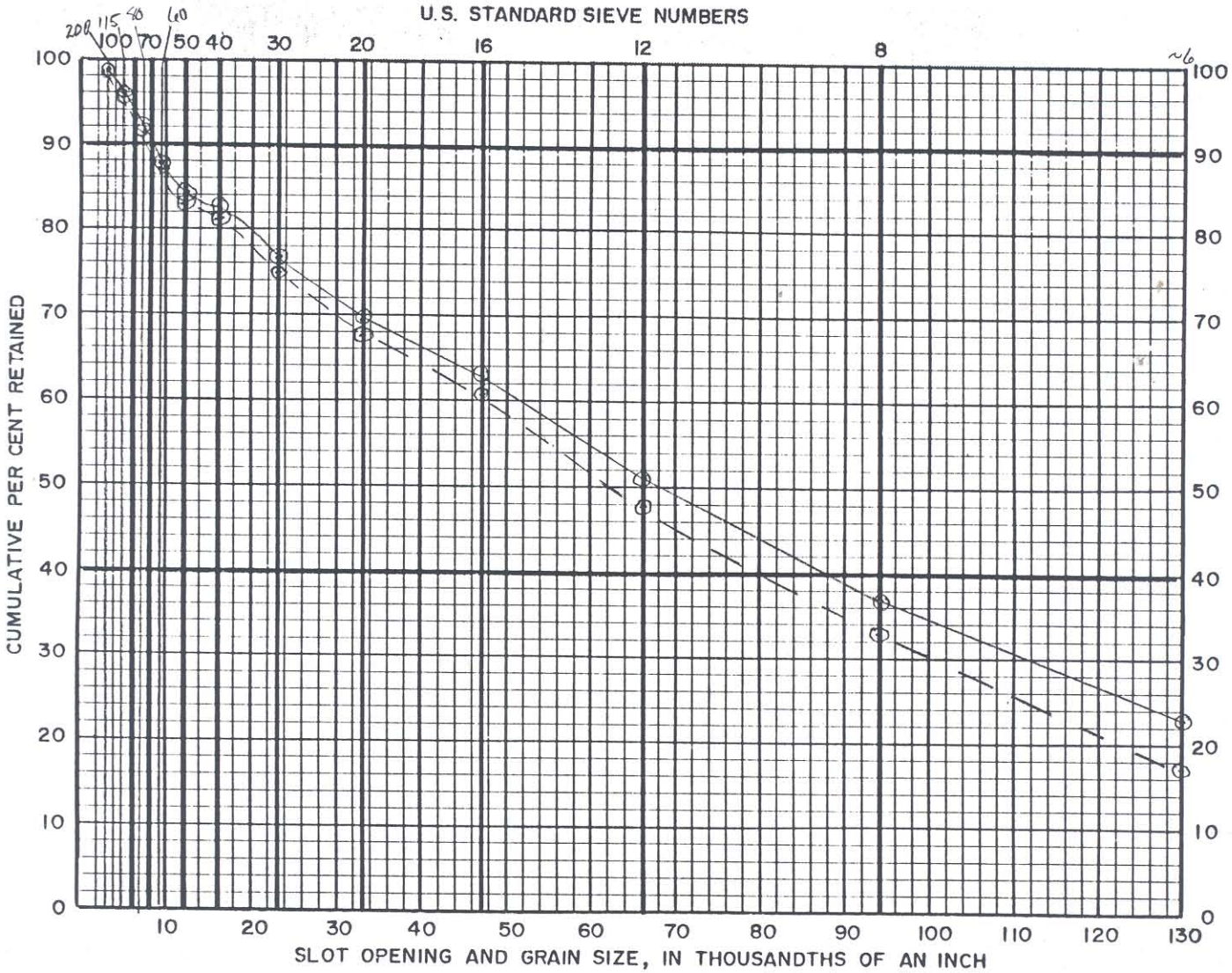
MAILING ADDRESS: P.O. BOX 3118
ST. PAUL, MINNESOTA ▪ 55165

Sample sent in by _____

Town DENIO 90-521 State NV Zip _____ Date 7/10/90

From well of P-1-4 (15-20 ft)

Remarks: NOTE P-1-3 (10-15 ft) SAMPLE WAS NOT AVALABLE.



U.S. SIEVE NO	SIEVE OPENING INCHES	SIEVE OPENING MM.	CUMULATIVE % RETAINED		
6	.132	3.36			
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Notes: _____

Recommended Slot Opening: _____

Recommended Screen: Dia. _____ in. Length _____ Ft.

_____ By: _____

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uop Inc.

SAND ANALYSIS
(FINE)

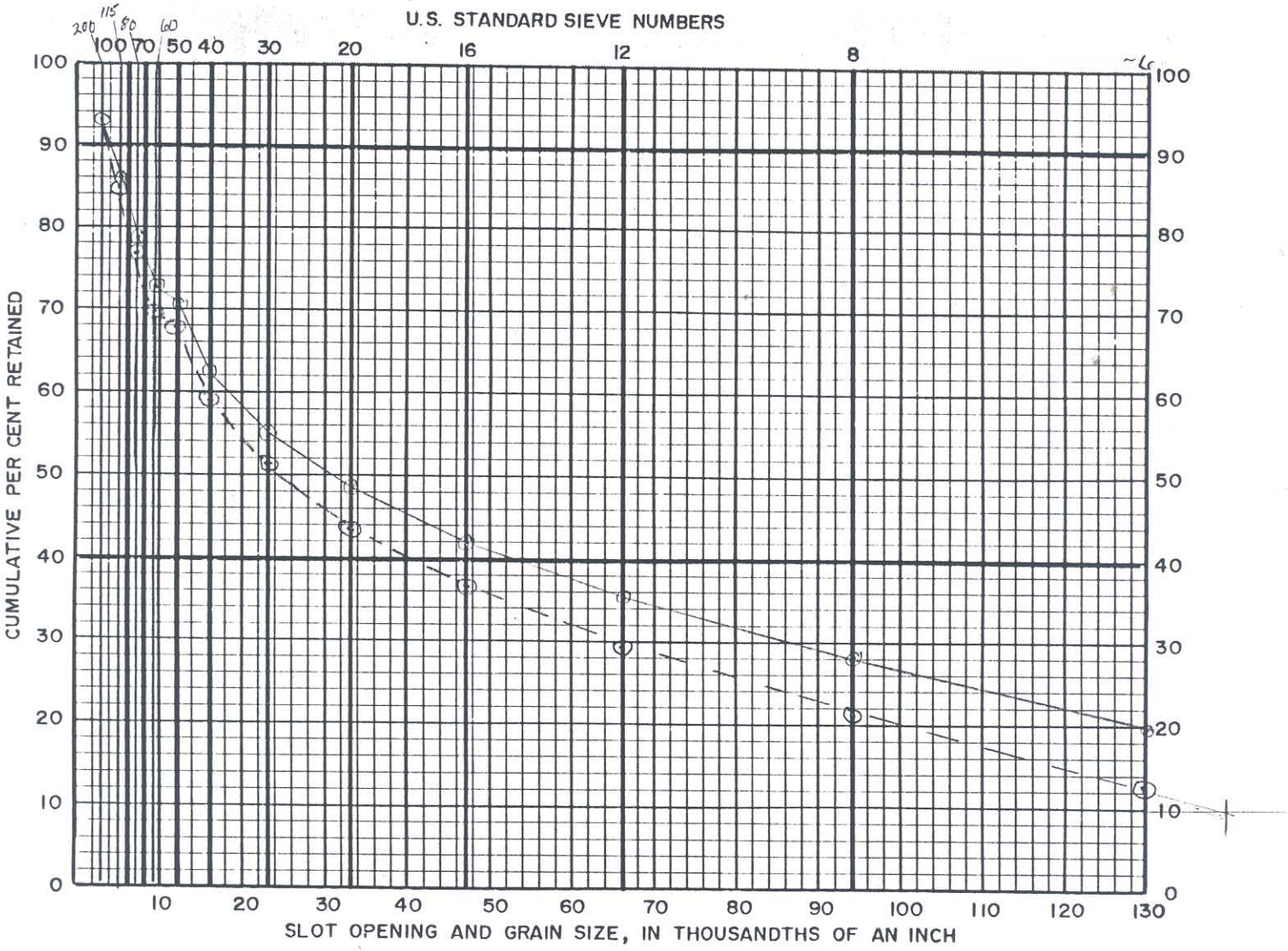
MAILING ADDRESS: P.O. BOX 3118
ST. PAUL, MINNESOTA ■ 55165

Sample sent in by _____

Town DENIO 90-521 State NV Zip _____ Date 7/10/90

From well of P-2-1 AND 2 (0-10 ft)

Remarks: _____



U.S. SIEVE NO	SIEVE OPENING INCHES	SIEVE OPENING MM.	CUMULATIVE % RETAINED		
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Notes: _____

Recommended Slot Opening: _____

Recommended Screen: Dia. _____ in. Length _____ Ft.

By: _____

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SAND ANALYSIS
(FINE)

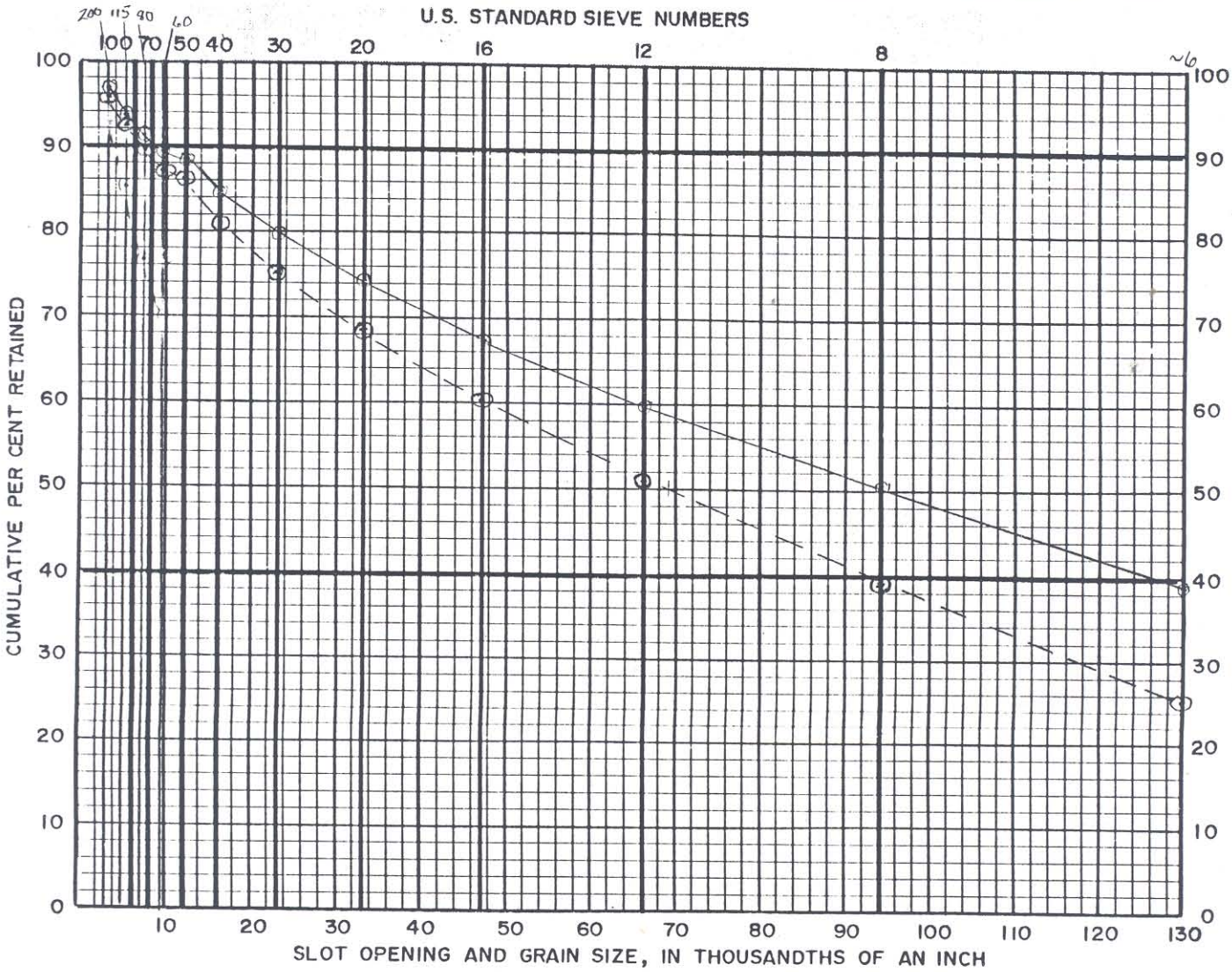
MAILING ADDRESS: P.O. BOX 3118
ST. PAUL, MINNESOTA ▪ 55165

Sample sent in by _____

Town DENIO 90-521 State NV Zip _____ Date 7/10/90

From well of P-2 - 3 AND 4 (10 - 20 ft)

Remarks: _____



U.S. SIEVE NO	SIEVE OPENING INCHES	SIEVE OPENING MM.	CUMULATIVE % RETAINED		
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WILLIAM E. NORK, INC.
1026 West First Street
RENO, NEVADA 89503
(702) 322-2604

JOB 90-521
SHEET NO. ____ OF ____
CALCULATED BY CW DATE 7/6/90
CHECKED BY ____ DATE ____
SCALE ____

SIEVE #	D1 (0-10) Grams of Sample	Grams Cum.	% Cum	D1 (10-20) Grams of Samp	Grams Cum	%	D-2-(0-10) Grams Sample	Grams Cum.	%	D-2-(10-20) Grams Sample	Grams Cum.	%
1/4"	306	306	27.9	623	623	47.2	229	229	13.2	327	327	29.3
6	174	480	43.8	181	804	60.9	264	493	28.5	280	607	54.3
8	82	562	51.2	72	876	66.4	154	647	37.4	40	647	57.9
12	74	636	58.0	45	921	69.8	152	799	46.2	119	766	68.6
16	63	699	63.7	37	958	72.6	142	941	54.4	102	868	77.7
20	62	761	69.4	41	999	75.7	137	1078	62.3	83	951	85.1
30	81	842	76.8	42	1041	78.9	118	1196	69.1	55	1006	90.1
40	120	962	87.7	47	1088	82.5	137	1333	77.0	49	1055	94.4
50	63	1025	93.4	87	1175	89.1	120	1453	83.9	24	1079	96.6
60	10	1035	94.3	5	1180	89.5	10	1463	84.5	5	1084	97.0
80	8	1043	95.1	28	1208	91.6	135	1598	92.3	10	1094	97.9
115	22	1065	97.1	43	1251	94.9	46	1644	95.0	9	1103	98.7
200	26	1091	99.5	48	1299	98.5	47	1691	97.7	9	1112	99.6
PAN	6	1097	100	20	1319	100	40	1731	100	5	1117	100
TOTAL	1097	1097	1	1319	1319	1	1731	1731	100.3	1117	1117	

SIEVE #	D-3-(0-10) Grams of Sample	Grams Cum.	%	D-3-(10-20) Grams of Sample	Grams Cum.	%
1/4"	206	206	12.8	334	334	21.9
6	162	368	22.9	405	739	48.5
8	117	485	30.1	172	911	59.7
12	152	637	39.6	123	1034	67.8
16	133	770	47.9	93	1127	73.9
20	143	913	56.7	68	1195	78.4
30	149	1062	66.0	63	1258	82.5
40	139	1201	74.6	55	1313	86.1
50	119	1320	82.0	55	1368	89.7
60	47	1367	85.0	17	1385	90.8
80	86	1453	90.3	43	1428	93.6
115	73	1526	94.8	45	1473	96.6
200	48	1574	97.8	30	1502	98.5
PAN	35	1609	100	22	1525	100
TOTAL	1609	1609	100	1525	1525	

PRODUCT 204-1 NEBS Inc., Groton, Mass. 01471.

WILLIAM E. NORK, INC.
1026 West First Street
RENO, NEVADA 89503
(702) 322-2604

JOB 90 - 521
SHEET NO. _____ OF _____
CALCULATED BY CW. DATE 7/9/90
CHECKED BY _____ DATE _____
SCALE _____

SIEVE	P-1-(0-10)			P-1-(15-20)			P-2-(0-10)			P-2-(10-15)		
NO.	GRAMS OF SAMPLE	GRAMS CUM.	%	GRAMS OF SAMPLE	GRAMS CUM	%	GRAMS OF SAMPLE	GRAMS CUM.	%	GRAMS OF SAMPLE	GRAMS CUM.	%
1/4"	205	205	13.3	49	49	6.1	81	81	8.7	261	261	18.5
6	310	515	33.5	131	180	22.5	104	185	19.9	294	555	39.4
8	166	681	44.3	117	297	37.1	75	260	28.0	154	709	50.4
12	141	822	53.5	112	409	51.1	70	330	35.6	134	843	59.9
16	126	948	61.7	94	503	62.9	59	389	41.9	107	950	67.5
20	102	1050	68.3	55	558	69.8	61	450	48.5	94	1044	74.1
30	102	1152	74.9	55	613	76.6	64	514	55.4	81	1125	79.9
40	90	1242	80.8	49	662	82.8	65	579	62.4	66	1191	84.6
50	53	1295	84.2	10	672	84.0	75	654	70.5	58	1249	88.7
60	24	1319	85.8	31	703	87.9	18	672	72.4	11	1260	89.5
80	57	1376	89.5	35	738	92.3	58	730	78.7	30	1290	91.6
115	48	1424	92.6	30	768	96.0	68	798	86.0	32	1322	93.9
200	50	1474	95.9	22	790	98.8	66	864	93.1	39	1361	96.7
PAN	63	1537	100	10	800	100	64	928	100	47	1408	100
TOTAL	1537	1537	100	800	800	100	928	928	100	1408	1408	100

PRODUCT 204-1 NEBS Inc., Groton, Mass. 01471.

APPENDIX E

CALCULATIONS

$$P = Cd_e^2 \text{ @ } 50^\circ F$$

$$d_e = d_{10}$$

	d_{10} (inch)	d_{10} (mm)	$(d_{10})^2$ (mm^2)	$C(d_{10})^2$ m/day		cm/sec
P1	0.006	0.1524	0.0232	(9.28)	23.2	0.027 (0.011)
P1	.008	0.2032	0.0413	(16.52)	41.3	0.048 (0.02)
P2	.004	0.1016	0.0103	(4.12)	10.3	0.012 (0.0049)
P2	.008	0.2032	0.0413	(16.52)	41.3	0.048 (0.020)
D1	.010	0.2540	0.0645	(25.8)	64.5	0.747 (0.031)
D1	.005	0.1270	0.0161	(6.44)	16.1	0.186 (0.0077)
D2	.007	0.1778	0.0316	(12.64)	31.6	0.366 (0.015)
D2	.019	0.4826	0.2329	(93.6)	232.9	0.270 (0.11)
D3	.006	0.1524	0.0232	(9.28)	23.2	0.027 (0.011)
D3	.009	0.2286	0.0523	(20.9)	52.3	0.061 (0.025)