Case 8224

O. C. D.

Exhibits

1 thru 12

Feb. 20, ~~[illegible]~~ 1985

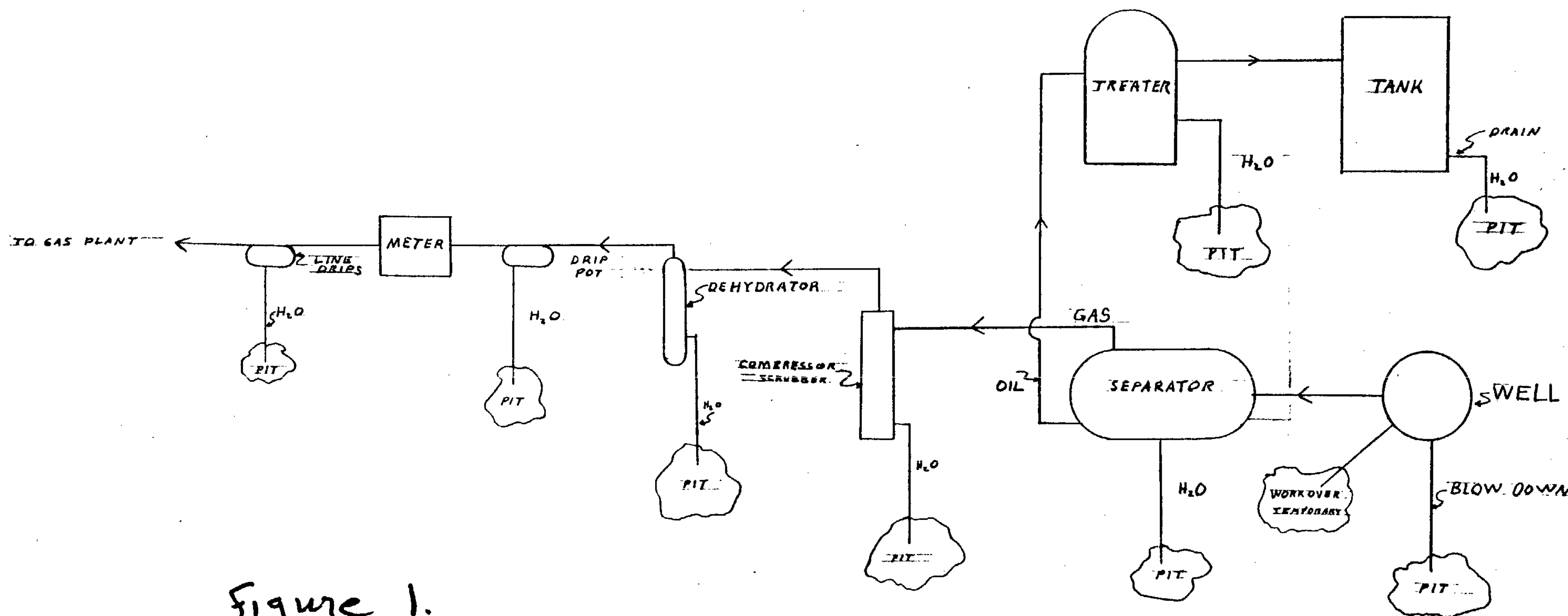
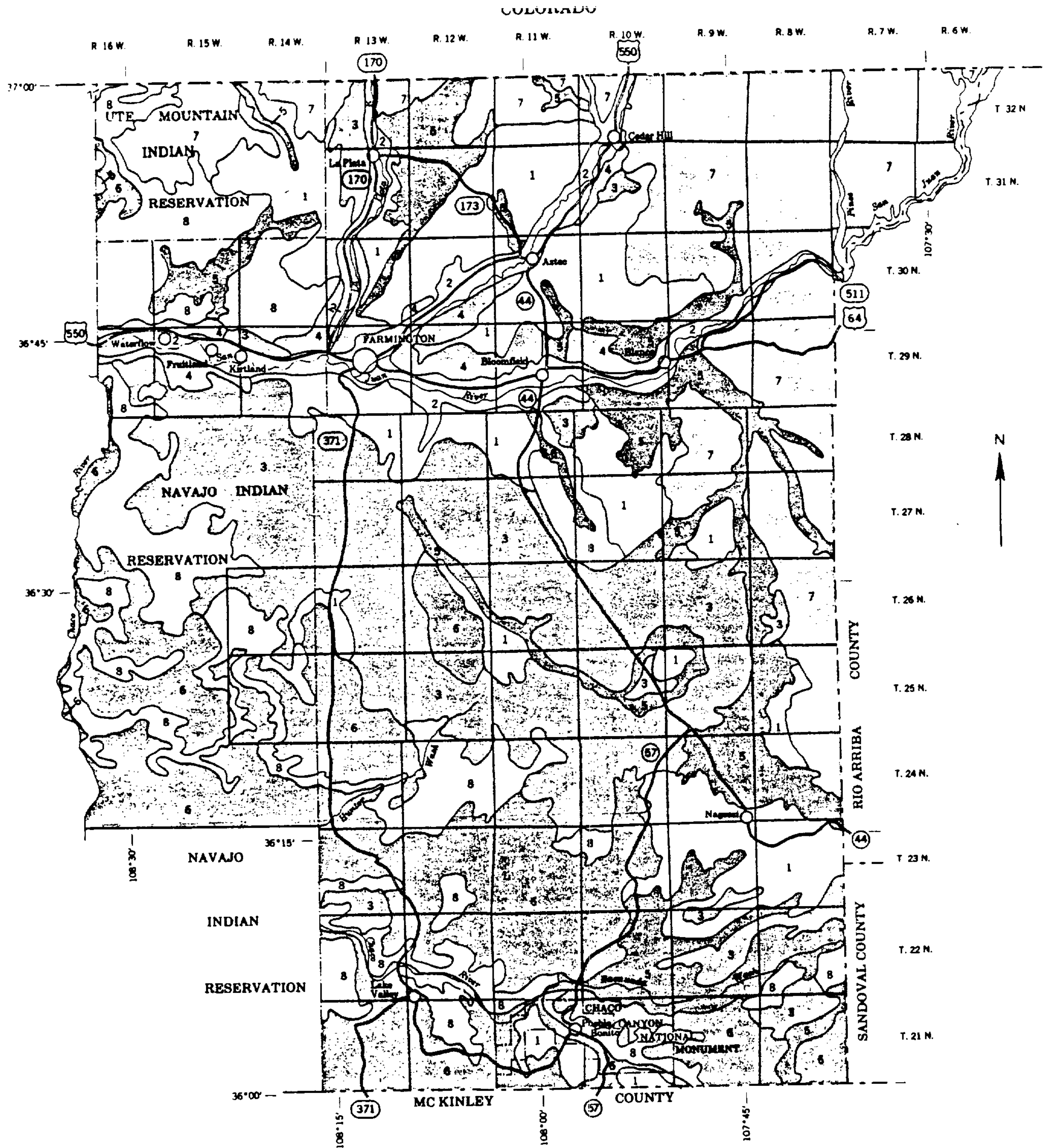


Figure 1.

POSSIBLE SOURCES OF PRODUCED WATER IN THE FIELD



MAP UNITS

1	Persayo-Fruitland-Sheppard: Very shallow to deep, nearly level to very steep, well drained to excessively drained soils that formed in alluvial, residual, and eolian material; on uplands and fans
2	Fruitland-Riverwash-Stumble: Deep, nearly level to moderately steep, well drained to somewhat excessively drained soils that formed in alluvium, and Riverwash; on fans and in valleys
3	Shiprock-Sheppard-Doak: Deep, nearly level to moderately steep, well drained to somewhat excessively drained soils that formed in alluvial and eolian material; on uplands
4	Haplargids-Blackston-Torriorthents: Very shallow to deep, nearly level to steep, well drained to excessively drained soils that formed in alluvium and residuum; on terraces, mesas, and plateaus
5	Blancot-Notal: Deep, nearly level to gently sloping, well drained to somewhat excessively drained soils that formed in alluvium; on valley sides, valley bottoms, and fans
6	Sheppard-Huerfano-Notal: Shallow to deep, nearly level to steep, well drained to somewhat excessively drained soils that formed in eolian material, alluvium, and residuum; on uplands, bottom lands, and fans
7	Travessilla-Rock outcrop-Weska: Very shallow to deep, nearly level to extremely steep, well drained soils that formed in alluvium, residuum, and eolian material, and Rock outcrop; on uplands
8	Badland-Rock outcrop-Monierco: Badland, Rock outcrop, and shallow, nearly level to gently sloping, well drained soils that formed in alluvial and eolian material; on uplands

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
BUREAU OF INDIAN AFFAIRS
NEW MEXICO AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

SAN JUAN COUNTY, NEW MEXICO, EASTERN PART

Scale 1:500,000
1 0 1 2 3 4 5 6 7 Miles

Figure 2

Each area outlined on this map ... more than one kind of soil. The ...

Compiled 1979

2. Fruitland-Riverwash-Stumble

Deep, nearly level to moderately steep, well drained to somewhat excessively drained soils that formed in alluvium, and Riverwash; on fans and in valleys

This map unit consists of elongated areas in the northern part of the survey area. It is on fans and in valleys. Slope is 0 to 20 percent. The vegetation is dominantly grasses, sedges, and hardwood trees along drainageways. Elevation is 4,800 to 6,400 feet. The average annual precipitation is 6 to 10 inches, and the average annual air temperature is 51 to 55 degrees F.

This unit makes up about 5 percent of the survey area. It is about 21 percent Fruitland soils, 20 percent Riverwash, 12 percent Stumble soils, and 8 percent Turley soils. The remaining 39 percent is Garland, Walrees, Werlog, Green River, and Youngston soils, Fluvaquents, and other soils of minor extent.

Fruitland soils are on fans and in valleys. These soils are deep and well drained. They formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is brown sandy loam. The underlying material is pale brown and light yellowish brown sandy loam.

Riverwash is in streambeds and arroyos and on flood plains. It consists of unstabilized sandy, silty, clayey, and gravelly sediment that is frequently flooded and reworked by water. It supports little or no vegetation.

Stumble soils are on fans and in valleys. These soils are deep and somewhat excessively drained. They formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is yellowish brown loamy sand. The upper part of the underlying material is pale brown and light yellowish brown sand and loamy sand. The lower part is brownish yellow gravelly sand, gravelly loamy sand, and sand.

Turley soils are on fans and in valleys. These soils are deep and well drained. They formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is grayish brown clay loam. The underlying material is grayish brown, light brownish gray, and light yellowish brown clay loam.

Areas of water, such as lakes, rivers, large storage ponds, and reservoirs, are in this unit.

This unit is used for irrigated crops, urban development, recreation, and wildlife habitat.

This unit provides habitat for wetland, woodland, and openland wildlife. The major limitation is urban encroachment. The wetland wildlife habitat consists of sedges and cattails and areas of shallow water. It provides food and cover for wildlife such as ducks, geese, heron, muskrat, and beaver. Suitable wildlife habitat improvement practices include the development of wetland areas.

The woodland wildlife habitat along the drainageways consists of Fremont cottonwood, Russian-olive, New Mexico forestiera, shrubs, and grasses. It provides food and cover for wildlife such as mule deer, gray fox, porcupine, squirrels, woodpeckers, and Gambel's quail. Suitable wildlife habitat improvement practices include retaining healthy trees and clearing spots or strips of old or dense stands.

The openland wildlife habitat consists of grain and seed crops, domestic grasses and legumes, and wild herbaceous plants. It provides food and cover for such wildlife as skunk, cottontail, pheasant, Gambel's quail, meadowlark, field sparrows, and killdeer. Suitable wildlife habitat improvement practices include stripcropping, planting windbreaks, and planting small grain for winter use.

Table 21a. NW N.M. Produced Waters. All units are mg/L unless otherwise. No entry indicates that the parameter was either not tested for or not reported. ND means the contaminant was not detected.

Sampling Station	Cornell A-1-E Kd	Gallegos Com. #94E Kd	Valdez A-1-E Kd	Valdez A-1-E Chacra	Florence #2 Kmv	Florence 37A Kmv
Sampling Date	9/6/84	9/7/84	9/6/84	9/6/84	9/6/84	9/6/84
Calcium	44.0/49.	760.0/690.	24./25.	196./180.	8.0/11.	1.6/1.3
Magnesium	11.3/5.8	170.8/120.	7.3/3.7	50.3/48.	4.9/0.40	0.7/0.34
Sodium	759.	11,270.	426.	8,901.	166.	0.0
Potassium	26.9	335.	5.07	83.9	9.75	0.00
Bicarbonate	291.8	502.8	59.1	766.4	212.0	17.3
Sulfate	23.6	ND	160.5	ND	12.6	6.3
Chloride	1,205.	21,969.	641.4	16,632	165.7	3.0
Fluoride	0.25	0.44	0.06	0.72	0.14	0.04
Nitrate-N	--	--	--	--	--	--
Ammonia-N	--	--	--	--	--	--
Aluminum	<0.10	0.31	<0.1	<0.1	<0.10	<0.10
Arsenic	<0.005	0.012	<0.005	0.13	<0.005	<0.005
Barium	0.65	0.33	<0.1	18.	0.35	<0.10
Beryllium	<0.10	<0.10	<0.1	<0.1	<0.10	<0.10
Boron	0.50	0.20	0.2	1.1	<0.10	<0.10
Cadmium	<0.10	<0.10	<0.1	<0.1	<0.10	<0.10
Chromium	<0.10	<0.10	<0.1	<0.1	<0.10	<0.10
Cobalt	<0.10	<0.10	<0.1	<0.1	<0.10	<0.10
Copper	0.15	0.11	<0.1	0.14	0.53	0.37
Iron	49.	150.	70.	16.	26.	45.
Lead	<0.10	0.17	<0.1	<0.1	<0.10	<0.10
Manganese	0.36	2.1	0.55	0.14	0.20	0.42
Mercury	--	--	--	--	--	--
Molybdenum	<0.10	<0.10	<0.1	<0.1	<0.10	<0.10
Nickel	<0.10	<0.10	<0.1	<0.1	<0.10	<0.10
Selenium	<0.005	0.029	0.006	0.038	<0.005	0.006
Silicon	10.	18.	3.1	7.5	2.9	0.66
Silver	<0.10	<0.10	<0.1	<0.1	<0.10	<0.10
Strontium	2.3	140.	1.2	22.	0.51	<0.0
Tin	<0.10	0.14	<0.1	<0.1	<0.10	<0.10
Vanadium	<0.10	<0.10	<0.1	<0.1	<0.10	<0.10
Yttrium	<0.10	<0.10	<0.1	<0.1	<0.10	<0.10
Zinc	<0.10	0.15	<0.1	0.23	<0.10	<0.10
TDS	2,200.	34,650.	1,238.	24,615.	488.	50.
pH (units)	8.02	7.34	7.70	7.76	8.03	7.16
COD	--	--	--	--	--	--
TOC	153.	229.	--	--	--	--
Benzene		21.8	21.9	5.4	29.5	15.8
Toluene		14.2	42.6	7.4	26.3	20.6
Ethylbenzene		<1.	0.96	0.49	0.55	0.67
p-Xylene		<1.	2.4	0.65	0.93	1.6
M-Xylene		2.2	9.7	2.4	3.2	7.6
o-Xylene		1.	2.0	0.99	1.1	2.0
Collector	OCD	OCD	OCD	OCD	OCD	OCD
Analyst	SLD	SLD	SLD	SLD	SLD	SLD

G. water standards .01

No entry indicates that the parameter was either not tested for or not reported. ND means that the contaminant was not detected.

Sampling Station	NW N.M. Produced Waters. 29N.13W.21 3-Phase Sep.	29N.13W.21 Pit	30N.12W.22 Pit	31N.13W.34 3-Phase Sep.	Condensate 30N.12W.29
Sampling Date	4/6/84	4/6/84	4/6/84	4/5/84	4/6/84
Calcium	670.	570.	190.	360.	
Magnesium	150.	120.	71.	72.	
Sodium					
Potassium					
Bicarbonate					
Sulfate				4,431.	
Chloride				11,322.9	
Nitrate-N					
Ammonia-N					
Aluminum	0.16	1.6	0.85	0.12	
Arsenic	0.033	0.27	0.057	0.068	
Barium	1.7	1.5	0.24	<0.10	
Beryllium	<0.10	<0.10	<0.10	<0.10	
Boron	4.1	3.3	4.6	6.2	
Cadmium	0.12	0.14	<0.10	<0.10	
Chromium	0.46	0.36	0.26	0.16	
Cobalt	<0.10	<0.10	<0.10	<0.10	
Copper	<0.10	0.20	0.22	<0.10	
Iron	14.	5.6	2.6	19.	
Lead	0.33	0.35	0.34	0.22	
Manganese	0.82	0.72	0.58	0.32	
Mercury	<0.0005	<0.0005	<0.0005	<0.0005	
Molybdenum	0.14	0.19	0.16	<0.10	
Nickel	0.17	0.11	<0.10	<0.10	
Selenium	0.139	0.072	0.24	0.31	
Silicon	26.	25.	38.	28.	
Silver	<0.10	<0.10	<0.10	<0.10	
Strontium	82.	52.	17.	18.	
Tin	0.33	0.30	0.28	0.24	
Vanadium	0.18	0.12	<0.10	0.10	
Yttrium	<0.10	<0.10	<0.10	<0.10	
Zinc	<0.10	0.16	0.13	<0.10	
TDS				15,294.	
pH					
COD					
TOC					
Benzene	8.86	4.5	3.2	14.4	12,400.
Toluene	10.2	0.76	0.73	12.2	80,400.
Ethylbenzene	0.77	0.068	0.08	0.28	1,910.
p-Xylene	0.74	0.06	0.13	1.3	3,530.
m-Xylene	2.1	0.7	3.3	4.6	61,600.
o-Xylene	0.23	0.23	0.43	1.66	7,760.
Collector	OCD	OCD	OCD	OCD	OCD
Analyst	SLD	SLD	SLD	SLD	SLD

Table 1. Properties of Soils in The San Juan River Valleys.

SOIL NAME	SYMBOL	ACREAGE	DEPTH (IN)	USDA TEXTURE	PERMEABILITY (FT/DAY)	HYDROLOGIC SOIL GROUP	SOIL LOCATION	SEVERITY & TYPE OF LIMITATION FOR UNLINED PIT
Apishapa Clayloam	Ap	576	0-51 5-81	Clayloam Clay	0.4-1.2 0.12-0.4	C	A	Severe: Wetness, Floods
Apishapa Clay	Ap	1,045	0-6 6-81	Clay Clay	0.12-0.4 0.12-0.4	C	A	Severe: Wetness, Floods
Beebe Loamy Sand	Be	2,484	0-6 6-61 61-81	loamy sand sand very gravelly sand	12-40 >40 >40	A	A	Severe: Floods, Seepage
Beebe Variant loamy sand	Bf	1,800	0-8 8-61 61-81	loamy sand sand, loamy sand very gravelly sand	12-40 12-40 12-40	C	A	Severe: Floods, Seepage
Blackston loam 0-3% slopes	Bk	1,888	0-11 11-27 27-81	loam very gravelly clay loam very gravelly sand	1.2-4 1.2-4 12-40	B	B	Severe: Seepage
Blackston gravelly loam, 3-8% slopes	Bm	1,225	0-9 9-25 25-60	gravelly loam very gravelly clay loam very gravelly sand	1.2-4 1.2-4 12-40	B	B	Severe: Seepage
Blancot Fruitland Assoc.	BR	17,614						
Blancot loam		(7,926)	0-6 6-60	loam sandy clay loam & loam	0.4-4 1.2-4	B	C	Moderate: Seepage
Fruitland sandy loam		(4,403)	0-8 8-60	sandy loam sandy loam	4-12 4-12	B	D	Severe: Seepage
OTheR		(5,285)	—	—	—	—	—	—

Fluvaquents Ponded	FP	1,607	0-4 4-30 30-60	organic material loam Strat. sand, loamy sand & gravel	- 0.4-4	-	E	—
Fruitland, sandy loam, 0-2 slopes	Fr	2,776	0-7 7-60	sandy loam sandy loam	4-12 4-12	B	D	Severe: Seepage
Fruitland sandy loam, 2-5% slopes	Fs	5,271	0-6 6-60	sandy loam sandy loam	4-12 4-12	B	D	Severe: Seepage
Fruitland sandy loam, wet 0.2% slopes	Ft	2,072	0-6 6-60	sandy loam sandy loam	4-12 4-12	B	D	Severe: Seepage, wetness
Fruitland loam 1-3% slopes	Fu	4,621	8-8 8-60	loam sandy loam	1.2-4 4-12	F	D	Severe: Seepage
Fruitland loam 5-8% slopes	Fw	2,096	0-3 3-60	loam sandy loam	1.2-4 4-12	B	D	Severe: Seepage
Fruitland slick spots complex:	Fy	4,848						
Fruitland, sandy loam		(3,636)	0-9 9-60	sandy loam sandy loam	4-12 4-12	B	D	Severe: Seepage
slick spots		(970)	-	Alkai-affected soil				
Other		(242)	-	-	-	—	—	—

Carland loam	Ga	4,017	0-4 4-24 24-60	loam clay loam very gravelly sand & loamy sand	1.2-4.0	B	H	Severe: Seepage
Green River find sandy loam	Gr	1,190	0-6 6-60	fine sandy loam stratified fine sandy loam and loam	4-12 1.2-4	B	A	Severe: Floods, Seepage, wetness
Riverwash	RA	29,514	-	sandy, silty, clay or gravelly sediment	-	-	E	
Stumble loamy sand, 0-3% slopes	St	4,299	0-5 5-29 29-81	loamy sand sand, loamy sand sand, gravelly sand, gravelly loamy sand	12-40 12-40	A	F	Severe: Seepage
Stumble loamy sand, 3-8% slopes	Su	3,086	0-5 5-49 49-81	loamy sand sand, loamy sand gravelly sand, sand	12-40 12-40 12-40	A	F	Severe: Seepage
Stumble sandy clay loam, gently sloping	Sv	969	0-7 7-60	sandy clay loam sand	1.2-4 12-40	A	F	Severe: Seepage
Stumble Fruitland Assoc., gently sloping:	Sw	22,073						
Stumble loamy sand		(8,829)	0-6 6-29 29-60	loamy sand sand, loamy sand gravelly sand	12-40 12-40 12-40	A	F	Severe: Seepage
Fruitland sandy loam		(6,622)	0-7 7-60	sandy loam sandy loam	4-12 4-12	B	F	Severe: Seepage
Other		(6,622)	-		-			

Stumble - NoTal complex, gentle sloping	Sx	11,088						
Stumble loam sand		(6,098)	0-31 loamy sand 3-60 sand, loamy sand	12-40 12-40	A	F	Severe:	Seepage
NoTal clay loam		(3,326)	0-24 clay loam 24-60 clay	0.4-1.2 <0.12	D	D	Slight	
Other		(2,772)	- -	-	-	-		
Stumble - slick spots complex, gently sloping:	Sz	3,603						
Stumble loamy sand		(2,252)	0-4 loamy sand 4-60 sand, loamy sand	12-40 12-40	A	F	Severe:	Seepage
Slick spots		(721)	- Alkali affected soil	-	-	-		
Other		(360)	- -	-	-	-		
Turley clay loam 0-1% slopes	Tp	1,544	0-3 clay loam 3-80 clay loam	0.4-1.2 0.4-1.2	B	F	Slight	
Turley clay loam, 1-3% slopes	Tr	4,637	0-9 clay loam 9-60 clay loam	0.4-1.2 0.4-1.2	B	F	Slight	
Turley, clay loam 3.5% slopes	Ts	485	0-4 clay loam 4-60 clay loam	0.4-1.2 0.4-1.2	B	F	Slight	
Turley, clay loam, wet 0.2% slopes	Tt	3,185	0-9 clay loam 9-60 clay loam	0.4-1.2 0.4-1.2	C	G	Severe:	Wetness

Turley, Slick Spots complex, 0-3% slopes:	Tv	1,566						
Turley clay loam		(1,096)	0-8 8-60	clay loam clay loam	0.4-1.2 0.4-1.2	B	G	Slight
Slick Spots		(313)	-	Alkali Affected soil	-	-	-	-
Other		(159)	-	-	-	-	-	-
Walrecs loam	Wa	4,112	0-6 6-30 30-81	loam loam stratified sand, gravel, cobbles	1.2-4 0.4-1.2 >40	C	A	Severe: Floods, Wetness
Werlog loam	Wr	4,515	0-6 6-60 6-81	loam loam, clay loam sand gravel, cobbles	1.2-4 0.4-1.2 >40	C	A	Severe: Wetness
Werlog loam, saline	Ws	1,984	0-5 5-60	loam silty clay loam	1.2-4 .4-1.2	C	A	Severe: Wetness
Youngston clay loam	Yo	918	0-10 10-66	clay loam loam, stilt loam	.4-1.2 .4-1.2	C	A	Severe: Floods

From: Soil Survey of San Juan County, NM, Eastern Part
USDA, SCS, 1980

2/20/8

Soil Locations

A. Floodplains and low river terraces

B. River terraces

C. Alluvial fans and upland valleys

D. Alluvial fans and valley bottoms

E. Floodplains

F. Alluvial fans and valley sides

G. Alluvial fans

H. Terraces and valley sides

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Table 2.
Application Rates For Pits of various Diameters and Variable Discharge Rates

$$\text{Application Rate} = \frac{\text{Volume Discharged/day}}{\text{Pit Area}}$$

$$AR = Vol(gpd) \times \left(\frac{1\,ft^3}{7.48\,gal}\right) \times \frac{1}{A(ft^2)} = (ft/day)$$

$$A = \pi \frac{d^2}{4}$$

d'	5 bbls/day	1 bbl/day	½ bbl/day	2.5 gpd
2	8.9 ft/d	1.79 ft/d	0.89 ft/d	0.11 ft/d
3	4.0 ft/d	0.79 ft/d	0.40 ft/d	0.05 ft/d
4	2.2 ft/d	0.45 ft/d	0.22 ft/d	0.03 ft/d

(At depths beneath 6 to 24 inches, Most Permeabilities [i.e. infiltration rates] exceed and in some cases greatly exceed application rates. Therefore, ponding will not occur under natural conditions)

Table 3.

Days to Complete Saturation of Material beneath pits (Assuming storage & no movement)

Volume = $(n)(A)(h)$

$n = 0.25$, $A = \pi \frac{d^2}{4}$

h = depth to groundwater = 10, 25, & 50'

Rate of Discharge (Q) .5, 1, & ½ bbls/day, 2.5gpd

Q = bbls/day

d	A	h	V	Q 5 bbl (Days)	Q 1 bbl (Days)	Q .5 bbl (Days)	Q 2.5 gall. (Days)
2	3.14 ft^2	10'	7.85 ft^3	0.3	1.4	2.8	23.5
2	3.14 ft^2	25	19.6	0.7	3.5	7.0	58.6
2	3.14 ft^2	50	39.3	1.4	7.0	14.0	117
3	7.07 ft^2	10	17.7	0.6	3.2	6.3	53.0
3	7.07 ft^2	25	44.2	1.6	7.9	15.7	132
3	7.07 ft^2	50	88.4	3.2	15.7	31.5	264
4	12.57 ft^2	10	31.4	1.1	5.6	11.2	93.9
4	12.57 ft^2	25	78.6	2.8	14.0	28.0	235
4	12.57 ft^2	50	157	5.6	28.0	55.9	470

$$\# days = \frac{1\ day}{\# gal} \times \frac{7.48\ gal}{ft^3} \times Volume(ft^3)$$

Table 4.

Ranges of K for alluvial material in River Valleys

K = Permeability in ft/day

Davis & DeWeist (1966):
25 to 250 ft/day, 1200 ft/day not rare
One gravel alluvium tested at 2750 ft/day

Bouwer (1978):
Sand & Gravel – 15-325 ft/day
Gravel – 3250 ft/day

Stone, et al (1983):
Pump (Aquifer) Test on McMahon #1
T30N, R12W, Section 32.2331
(Vicinity Farmington)

Avg. Transmissivity = 37900 ft²/day
b = Thickness of aquifer tested (opposite well) = 15'

$$K = \frac{T}{b} = \frac{37900\ ft^2/day}{15\ ft} = 2527\ ft/day$$

∴ Range of values chosen:
25 ft/day
250 ft/day
2500 ft/day

Ranges of Porosity (n) for sands & gravels:

Bouwer (1978): 10-30% ⎫ value chosen 25%
Fetter (1980): 20-35% ⎭

Table 5

Examples of River Gradients,
Farmington and vicinity

Quad	River	Location	Gradient
Bloomfield 15'	San Juan	W. Blanco to Bloomfield	0.0028
Aztec 15'	Animas	Cedar Hill to Aztec	0.0041
Horn Canyon 7½	San Juan	W. Bloomfield to Fairgrounds	0.0018
Farmington South 7½	San Juan	5300' line to Animas River	0.0022
Farmington South 7½	La Plata	Gauging Station (5260' to 5240')	0.0059
Kirtland 7½	San Juan	5200' line to Kirtland	0.0021
Fruitland 7½	San Juan	Fruitland to 5050' line	0.0023
Flora Vista 7½	Animas	W. Aztec to 5420'	0.0041
Flora Vista 7½	Animas	Flora Vista (5490' to 5470')	0.0040

Notes:

1. In absence of additional information, it is assumed that the ground water flow gradient is the same as the river gradient in the shallow groundwater areas near the river.
2. A gradient of 0.0022 is equivalent to 11.6 feet per mile.

Table 6.

Rates of Ground Water Movement (Average Linear Velocity) San Juan River Valleys

$$\bar{v} = \frac{K}{n}\left(\frac{dh}{dl}\right)$$ where K in ft/day

dh/dl = gradient

n = porosity

San Juan River

$\bar{v}$ = 0.24 ft/day, 2.4 ft/day, 24 ft/day

Animas River

$\bar{v}$ = 0.41 ft/day, 4.1 ft/day, 41 ft/day

La Plata (one measurement)

$\bar{v}$ = 0.59 ft/day, 5.9 ft/day, 59 ft/day

Table 7

Estimation of Ground Water Concentrations

$$C_F = \frac{C_i Q_i + C_E Q_E}{Q_i + Q_E}$$

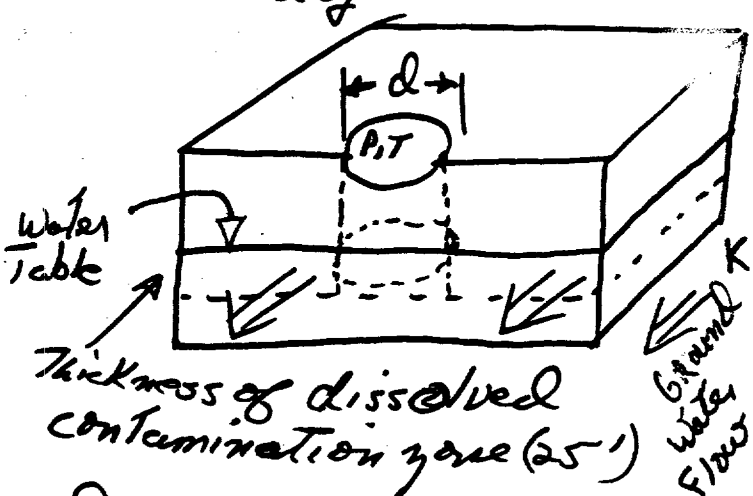
where:
C_F = Final Concentration
C_i = Initial Conc.
C_E = Effluent Conc.
Q_E = Effluent rate
Q_i = Ground water rate

For San Juan River: $\frac{dh}{dl} = 0.0024$

$Q_i = A \times K \frac{dh}{dl}$, A = diam × 25'
K = 25, 250, 2500 ft/day
d = diameter of pit = 2, 3, or 4 ft

$\therefore Q_i = (25' \times d)(K)(0.0024) \times \frac{7.48 \text{ gal}}{\text{day}}$

C_E = 14 mg/l benzene (average of 9 San Juan basin produced water samples)



C_E = 10,900 mg/l TDS (average of 7 San Juan basin produced water samples)

Q_E = 5 bbls/day (210 gpd), 1 bbl/day (42 gal/day), 1/2 bbl/day (21 gpd), 2.5 gallons/day

C_{iB} = 0 for Benzene
C_{iTDS} = 725 mg/l (average 13 Alluvial wells AZTEC Quad – Range 317 to 1104 mg/l)

For pit diameter = 2'

K	Q_i	Q_E	C_{FB}	C_{FTDS}
25	22.4	210	12.7	9920
25	22.4	42	9.1	7360
25	22.4	21	6.8	5650
25	22.4	2.5	1.4	1750
250	224.4	210	6.8	5640
250	224.4	42	2.2	2330
250	224.4	21	1.2	1600
250	224.4	2.5	0.15	840
2500	2244	210	1.2	1600
2500	2244	42	0.26	910
2500	2244	21	0.13	820
2500	2244	2.5	0.016	740
(ft/day)	(gpd)	(gpd)	(mg/l)	(mg/l)

Table 7A.

For Pit diameter = 3'

K	Q_i	Q_E	C_{FB}	C_{FTDS}
25	33.7	210	12.1	9490
25	33.7	42	7.8	6420
25	33.7	21	5.4	4630
25	33.7	2.5	0.97	1430
250	336.6	210	5.4	4630
250	336.6	42	1.5	1850
250	336.6	21	0.82	1320
250	336.6	2.5	0.10	800
2500	3366	210	0.82	1320
2500	3366	42	0.17	850
2500	3366	21	0.087	790
2500	3366	2.5	0.010	730

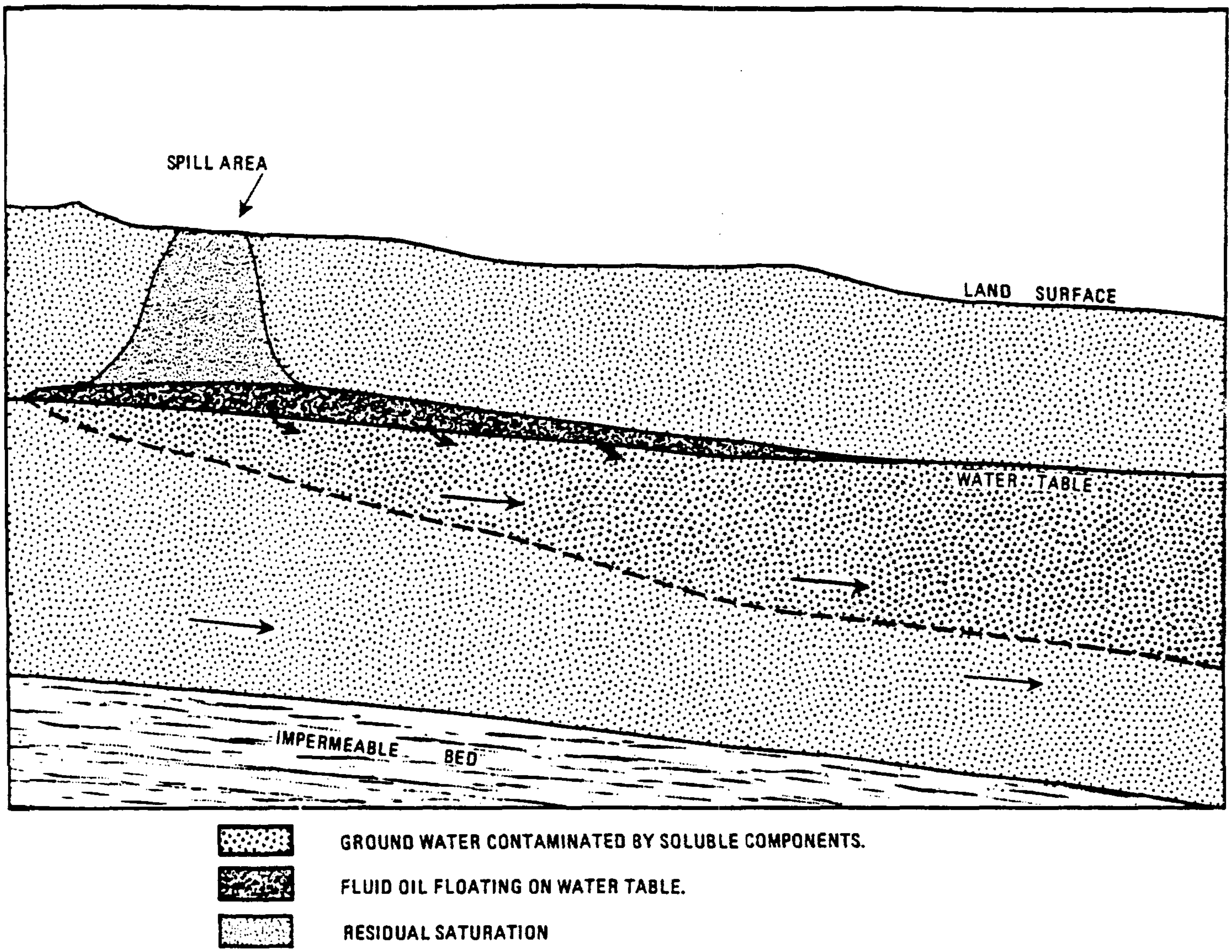
Table 7B.

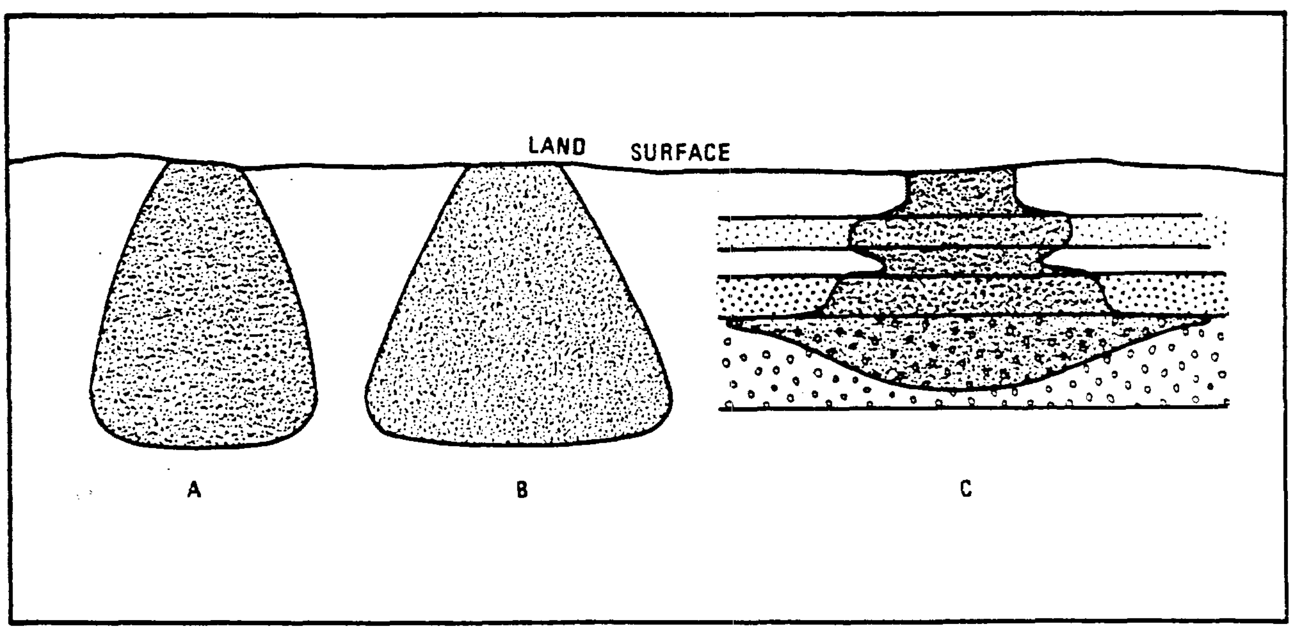
For pit diameter = 4'

K (ft/day)	Q_i (gpd)	Q_E (gpd)	C_{FB} (mg/l)	C_{FTDS} (mg/l)
25	44.9	210	11.5	9110
25	44.9	42	6.8	5640
25	44.9	21	4.5	3970
25	44.9	2.5	0.74	1260
250	448.8	210	4.5	3970
250	448.8	42	1.2	1600
250	448.8	21	0.63	1180
250	448.8	2.5	0.078	780
2500	4488	210	0.63	1180
2500	4488	42	0.13	820
2500	4488	21	0.065	770
2500	4488	2.5	0.008	730

Table 7c

Note: NM Standard in ground water for benzene is 0.01mg/l
The standard for TDS is 1000mg/l.





SPREADING CONES

A – HIGHLY PERMEABLE, HOMOGENEOUS SOIL
B – LESS PERMEABLE, HOMOGENEOUS SOIL
C – STRATIFIED SOIL WITH VARYING PERMEABILITY

figure 3

(source: API #4149)

USGS EVAPORATION DATA – FARMINGTON

	EVAP.	PPT.
J	.96	.52
F	1.56	.55
M	3.79	.61
A	6.34	.58
M	8.01	.46
J	8.83	.40
J	8.73	.91
A	7.33	1.01
S	5.71	.96
O	3.79	.99
N	2.03	.45
D	.99	.63

* BEFORE RUNNING PROGRAM, KEY IN SURFACE AREA AND STO IN 1. STO 0 in 6 to begin.

* PROGRAM (LABEL A)

001 f, LBL, A

002 ENTER "GALLONS DISCHARGED"

003-006 7.48

007 ÷

008 STO 2

009 R/S "STORE DISCHARGE, FT³, IN 2"

010 RCL 1

011 ÷

012 STO 3

013 R/S "STORE DISCHARGE DEPTH, FT, IN 3"

014 ENTER "EVAP. FOR MONTH"

015-017 0.7

018 X

019-020 12

021 ÷

ILLEGIBLE

022	STO 4	
023	R/S	"STORE EVAP. FOR MONTH, FT, IN 4"
024	ENTER	"PPT. FOR MONTH"
025-026	12	
027	÷	
028	STO 5	"STORE PPT FOR MONTH, FT, IN 5"
029	R/S	
030	RCL 3	
031	ENTER	
032	RCL 4	
033	−	
034	RCL 5	
035	+	
036	RCL 6	
037	+	
038	R/S	"RESIDUAL DEPTH AT END OF MONTH, FT"
039	ENTER	"DISPLAY OR ZERO"
040	STO 6	"STO RESIDUAL DEPTH"
041	R/S	
042	g RTN	

ILLEGIBLE

AREA = 100#   DISCHARGE = 20 gal/day

MONTH	DISCHARGE, ft^3	RESIDUAL DEPTH, ft
J 620	83	0.81
F 560	75	1.52
M 620	83	2.18
A 600	80	2.65
M 620	83	3.05
J 600	80	3.37
J 620	83	3.78
A 620	83	4.25
S 600	80	4.81
O [illegible]	83	5.50
N [illegible]	80	6.22
D 620	83	7.04

	AREA = 200#	YR1	YR2
J	83	0.40	2.56
F	75	0.73	2.89
M	83	0.98	3.13
A	80	1.05	3.21
M	83	1.04	3.20
J	80	0.96	3.12
J	83	0.94	3.10
A	83	1.01	3.17
S	80	1.16	3.31
O	83	1.43	3.59
N	80	1.75	3.91
D	83	2.16	4.32

AREA = 300 #　　　DISCHARGE = 20 gal/day

MONTH	DISCHARGE, ft^3	RESIDUAL DEPTH, ft (YR1)	(YR2)
J 620	83	YR1 → 0.26	YR2 → 0.87
F 560	75	0.47	1.07
M 620	83	0.57	1.18
A 600	80	0.52	1.13
M 620	83	0.37	0.98
J 600	80	0.15	0.76
J 620	83	0.0	0.61
A 620	83	0.0	0.54
S 600	80	0.014	0.55
O 620	83	0.15	0.69
N 600	80	0.34	0.87
D 620	83	0.61	1.15

MONTH	RESIDUAL DEPTH, ft (YR3)
J	YR3 → 1.41
F	1.61
M	1.72
A	1.66
M	1.51
J	1.30
J	1.14
A	1.07
S	1.08
O	1.22
N	1.41
D	1.68

AREA = 400 ft²   DISCHARGE = 20 gal/day

MONTH	DISCHARGE, ft³	RESIDUAL DEPTH, ft YR1	YR2
J 620	83	0.19	0.59
F 560	75	0.34	0.72
M 620	83	0.37	0.76
A 600	80	0.25	0.64
M 620	83	0.031	0.42
J 600	80	0.0	0.14
J 620	83	0.0	0.0
A 620	83	0.0	0.0
S 600	80	0.0	0.0
O 620	83	0.069	0.069
N 600	80	0.19	0.19
D 620	83	0.39	0.39

AREA = 350 ft²

		YR1	YR2	YR3
J	83	0.22	0.70	0.77
F	75	0.39	0.87	0.94
M	83	0.46	0.94	1.01
A	80	0.37	0.85	0.92
M	83	0.18	0.65	0.72
J	80	0.0	0.40	0.47
J	83	0.0	0.20	0.28
A	83	0.0	0.095	0.17
S	80	0.0	0.071	0.14
O	83	0.098	0.17	0.24
N	80	0.25	0.32	0.39
D	83	0.48	0.55	0.62

Minimum Net Evaporation Occurs in December:

NET EVAP. = EVAP − PPT = .99 − .63 = 0.36 in.

= 0.03 ft ≡ NE

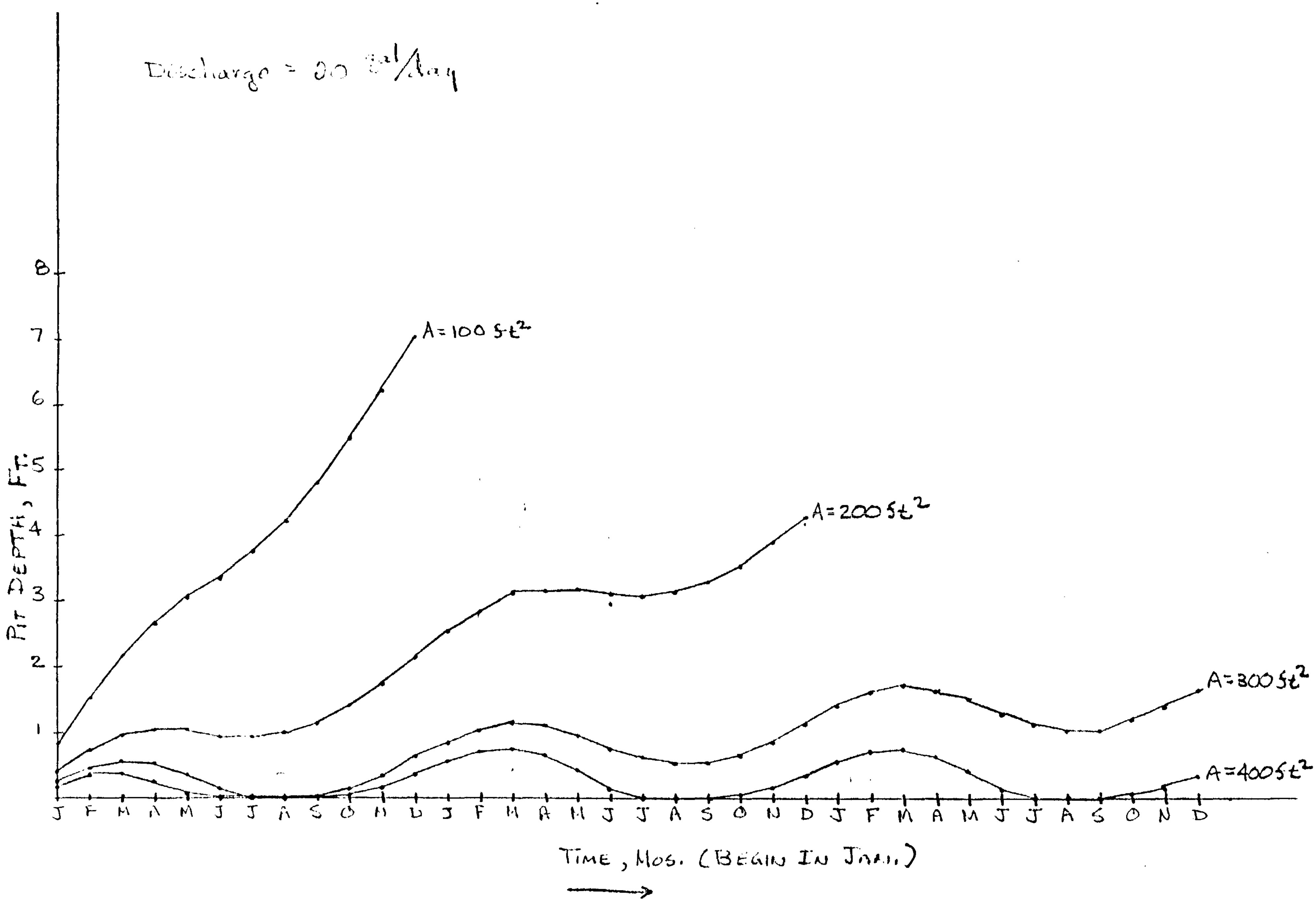
TO DESIGN FOR MINIMUM CONDITIONS:

DISCHARGE ≡ D

AREA OF PIT ≡ A

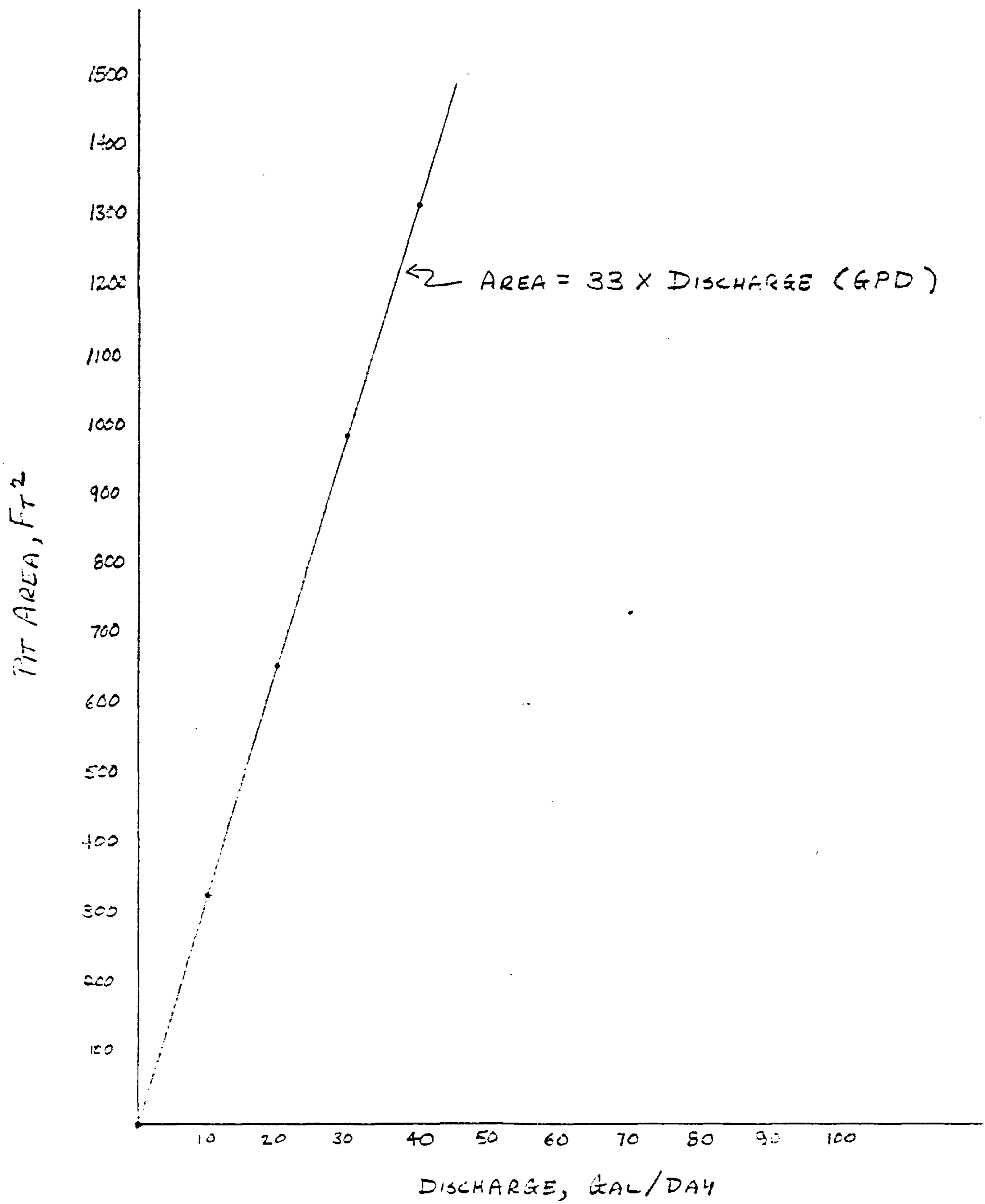
$$A = \frac{D}{NE} = \frac{D}{0.03} = 33\,D$$

D, gal	A, ft^2
10	330
20	660
30	990
40	1320
50	1650
60	1980
70	2310
80	2640
90	2970
100	3300



Discharge = 30 gal/day
A=100 ft²
A=200 ft²
A=300 ft²
A=400 ft²
PIT DEPTH, FT.
8
7
6
5
4
3
2
1
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
TIME, MOS. (BEGIN IN JAN.)

PIT DESIGN FOR MINIMUM NET EVAPORATION



Annual Net Evap = 2.71 ft

DISCHARGE (gpd)	AREA	END OF YR. HT
20	100	9.75
20	200	4.87
20	300	3.25
20	400	2.4

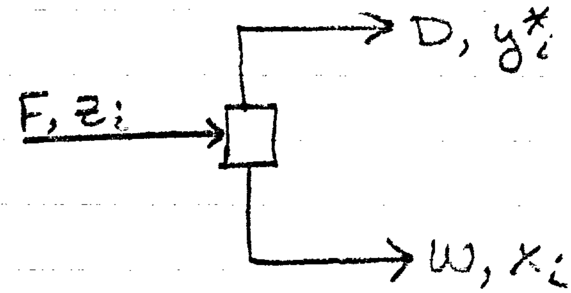
FLASH EVAPORATION

Assume we unload condensate from the dehydra[illegible] that contains 50 mole % Benzene, 25 mole % Toluene, and 25 mole % o-xylene. Flashes out at 100°C and 1atm. Find amount of liquid and vapor products.

Use Raoult's Law

$$y_i^* = \frac{\tilde{P}_i x_i}{P_T} \qquad \tilde{P} \equiv \text{Vapor Pressu[re]}$$

Define: Benzene ≡ A
Toluene ≡ B
O-xylene ≡ C



$P_T = 760$ mm Hg

Basis: 100 lb moles Feed ⟶ F = 100 lbmol

$$y_i^* = \frac{\tilde{P}_i}{P_T} x_i = M x_i$$

$$F = D + W$$

$$F z_i = D y_i^* + W x_i$$

$$(D+W) z_i = D y_i^* + W x_i$$

$$\left(\frac{D+W}{D}\right) z_i = y_i^* + \frac{W}{D} x_i$$

$$\left(1 + \frac{w}{D}\right) z_i - \frac{w}{D} x_i = y_i^*$$

$$z_i + \frac{w}{D}\left(z_i - x_i\right) = y_i^*$$

$$\frac{w}{D} = \frac{y_i^* - z_i}{z_i - x_i}$$

$$\frac{w}{D} = \frac{M x_i - z_i}{z_i - x_i} = \frac{y_i^* - z_i}{z_i - y_i^*/M}$$

Solve for y_i^*

$$\frac{w}{D}\left(z_i - \frac{y_i^*}{M}\right) = y_i^* - z_i$$

$$y_i^* + \frac{y_i^*}{M}\frac{w}{D} = \frac{w}{D} z_i + z_i$$

$$y_i^*\left(1 + \frac{w}{MD}\right) = z_i\left(\frac{w}{D} + 1\right)$$

$$y_i^* = \frac{z_i\left(w/D + 1\right)}{1 + \left(\frac{w}{D}\frac{1}{M}\right)} \qquad \text{Eq \#1}$$

From m.b.: $F z_i = D y_i^* + w x_i$

$$x_i = \frac{F z_i - D y_i^*}{w} \qquad \text{Eq \#2}$$

Now solve for y_i^* given the said conditions.

Assume $\frac{w}{D} = 2.08$ $\therefore$ $D = 32.5$ lb mol

$w = 67.5$ lb mol

SUBSTANCE	$\tilde{P}$, mmHg	$M = \frac{\tilde{P}}{760}$	z_i	y_i^*	x_i
A	1,370	1.803	0.5	0.715	0.397
B	550	0.724	0.25	0.198	0.275
C	200	0.263	0.25	0.0865	0.329
				$\Sigma = 0.9995$	
			$\Sigma = 1.00$		$\Sigma = 1.001$

Conclusion:

Given the above, our molar ratio of liquid to vapor is 2.08

To convert to a mass ratio, multiply by ratio of molecular weights:

$$\frac{w'}{D} = \frac{w}{D}\left(\frac{.397\left(\frac{78\text{ lb}}{\text{lb mol}}\right) + .275\left(\frac{92\text{ lb}}{\text{lb mol}}\right) + .329\left(\frac{106\text{ lb}}{\text{lb mol}}\right)}{.715\left(\frac{78\text{ lb}}{\text{lb mol}}\right) + .198\left(\frac{92\text{ lb}}{\text{lb mol}}\right) + .0865\left(\frac{106\text{ lb}}{\text{lb mol}}\right)}\right)$$

$\frac{w'}{D} \equiv$ weight ratio $= 1.096$

$\therefore$ Roughly, for every two lbs ejected 1 lb will stay liquid.