

DRAINAGE PLAN
AND
SUPPORTING CALCULATIONS

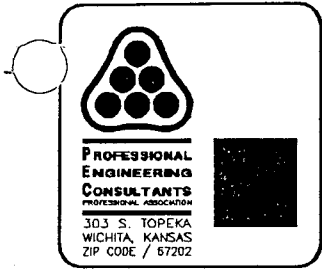
FOR
BAREFOOT BAY ADDITION
TO WICHITA, SEDGWICK COUNTY, KANSAS

PREPARED BY
PROFESSIONAL ENGINEERING CONSULTANTS, P.A.
ENGINEERS

WICHITA, KANSAS

NOVEMBER 22, 1993

MEMO



TO: Michael E. Lindebak, P.E. PROJECT NO. 36-93444-2051
455 N. Main - 7th Floor PROJECT: Barefoot Bay
Wichita, KS 67220 Drainage Plan

COPIES TO: ATTN: Ms. Vicky Huang, P.E. DATE: November 22, 1993

Jack Ritchie

FROM: Darwin R. Cronk, E.I.T.

REFERENCE: Drainage Plan Computations

PLEASE ADVISE IMMEDIATELY OF ANY MISCONCEPTIONS OR OMISSIONS YOU BELIEVE TO BE CONTAINED HEREIN.

Attached hereto are the computation s for the referenced project.

The publication Interim Drainage and Storm Sewer policy for Design Criteria and Documentation, City of Wichita, as revised 7/1/87, was used as the guideline for the hydrologic and hydraulic computations. This publication is hereinafter referred to as the "Design Manual".

Manual #1 refers to Drainage of Highway Pavements, Hydraulic Engineering Circular #12, by Tye Engineering, Inc., March 1984.

The analysis made herein is based on the available site data which includes a February 25, 1986, aerial photogrammetry map, and the Drainage Plan for Barefoot Bay Addition.

HYDROLOGIC ANALYSIS FOR STORM WATER SEWERS

For storm sewer design, the Rational Method was used for hydrologic analysis in accordance with the Design Manual. Runoff coefficients were based on the table provided in Attachment D of the Design Manual. The Rational Method assumes uniformly distributed rainfall, both temporally and spatially.

For this development, a uniform assumption of the minimum time of concentration value of 15 minutes was appropriate.

HYDRAULIC ANALYSIS FOR STORM WATER SEWERS

For each inlet, street flooding and inlet capacity was checked for the design storm. Conveyance in the street was based on the modified Manning Equation:

$$Q = 0.56 (S_x)^{5/3} (T)^{8/3} S / n \text{ (Eq. 4, Manual \#1)}$$

It was assumed that t_c for street flow was equal to t_c for pipe flow. This is a conservative assumption, as pipe velocities generally exceed gutter velocities.

For local streets, walk-grade-deep flow is tolerable for the design storm.

Inlet capacities were determined by the methods presented in Manual #1, using Chart No. 12.

In this analysis, City of Wichita Type 1A inlets and 3/8 in./ft. street cross-slope were assumed to be utilized. Minimum walk grade was assumed as 0.3 feet above the top of curb. Local streets are assumed to have standard curb and gutter.

All storm water sewers drain to the adjacent lake either between or next to residential lots. Therefore, in order to avoid frequently flooding lots, the design storm has a recurrence interval of one hundred years. All systems are designed to carry the design storm with street flows contained within the street rights-of-way.

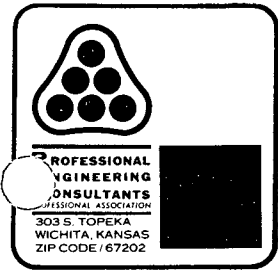
To simplify analysis, the following assumption was made:

1. The street conveyance was analyzed using only the street with. Depths above the curb up to the walk grade were used, but the conveyance of the parking was neglected. In general, the parking area conveyance is quite small, due to the relatively higher "n" factor. Again, Eq. 4 of Manual #1 was used.

Pipe sizes for the systems were chosen using Fig. 5 of the Concrete Pipe Design Manual, by the American Concrete Pipe Association, June 1980. From the Figure, a friction slope corresponding to the chosen pipe size is used to approximate the hydraulic grade line elevation at inlets. Minor losses have been ignored and are considered insignificant as the hydraulic grade line elevation is greater than 0.5' below the top of curb elevation at all inlets for the design storm. It is desirable to keep the hydraulic grade line at or below the top of curb for a one hundred year storm. All pipes are assumed to be reinforced concrete with a Manning's "n" factor of 0.013.

DRAINAGE MAP

A 1" = 100' scale drainage map is included in a map packet at the back of the report.



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Project BAREFOOT BAY

Item DRAINAGE PLAN

I. HYDROLOGY

A. Determine "C" factor

<u>Basin</u>	<u>Hyd. Group</u>	<u>Land Use</u>	<u>C₁₀₀</u>
1A	B	Res. (3/4 Ac)	0.52
1B	B	"	0.52
2A	B	"	0.52
2B	B	"	0.52
3A	B	"	0.52
3B	B	"	0.52
3C	B	"	0.52
4A	B	"	0.52
4B	B	"	0.52

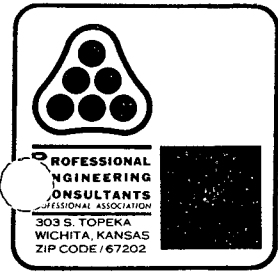
B. Determine "I"

Assume $T_c = 15$ min.

$I_{100} = 7.37$ in/hr for all basins

C. Basin Areas

1A	-	3.18 Ac
1B	-	2.11 Ac
2A	-	3.09 Ac
2B	-	3.23 Ac
3A	-	3.00 Ac
3B	-	1.24 Ac
3C	-	3.95 Ac
4A	-	1.97 Ac
4B	-	2.70 Ac



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Project BAREFOOT BAY

Item DRAINAGE PLAN

D. SUBBASIN RUNOFF FLOWS

1A

$$\begin{aligned} Q_{100} &= CIA \\ &= (0.52)(7.37 \text{ in/hr})(3.18 \text{ Ac}) \\ &= \underline{12.2 \text{ cfs}} \end{aligned}$$

1B

$$\begin{aligned} Q_{100} &= (0.52)(7.37)(2.11) \\ &= \underline{8.10 \text{ cfs}} \end{aligned}$$

2A

$$\begin{aligned} Q_{100} &= (0.52)(7.37)(3.09) \\ &= \underline{11.8 \text{ cfs}} \end{aligned}$$

2B

$$\begin{aligned} Q_{100} &= (0.52)(7.37)(3.23) \\ &= \underline{12.4 \text{ cfs}} \end{aligned}$$

3A

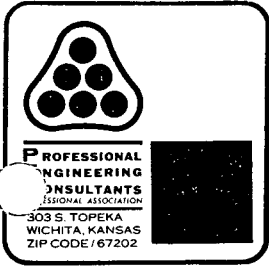
$$\begin{aligned} Q_{100} &= (0.52)(7.37)(3.00) \\ &= \underline{11.5 \text{ cfs}} \end{aligned}$$

3B

$$\begin{aligned} Q_{100} &= (0.52)(7.37)(1.24) \\ &= \underline{4.8 \text{ cfs}} \end{aligned}$$

3C

$$\begin{aligned} Q_{100} &= (0.52)(7.37)(3.95) \\ &= \underline{15.1 \text{ cfs}} \end{aligned}$$



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Project BAREFOOT BAY

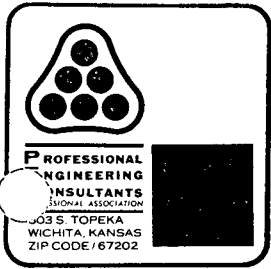
Item DRAINAGE PLAN

4A

$$Q_{100} = (0.52)(7.37)(1.97) \\ = 7.54 \text{ cfs}$$

4B

$$Q_{100} = (0.52)(7.37)(2.70) \\ = 10.3 \text{ cfs}$$



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Project BAREFOOT BAY

Item DRAINAGE PLAN

II. Pipe Sizing for 100-year Storm

A. System 1

$$\text{Starting HGL} = 1322.0$$

$$\text{Inlet Elev.} = 1326.0$$

$$\begin{aligned} \text{Total Q at inlet} &= 12.2 + 8.1 \\ &= 20.3 \text{ cfs} \end{aligned}$$

Use 24" Pipe or larger

$$\text{Fric. slope} = 0.80\%$$

$$\text{HGL @ inlet} = 1322 + 220(0.008) = \underline{1323.76} \text{ OK}$$

$$\text{Diff.} = 2.24'$$

B. System 2

$$\text{Starting HGL} = 1322.0$$

$$\text{Inlet Elev.} = 1326.0$$

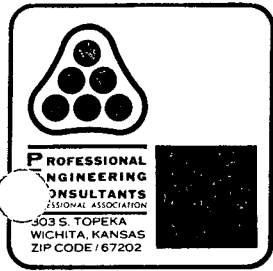
$$\begin{aligned} \text{Total Q at inlet} &= 11.8 + 12.4 \\ &= 24.2 \text{ cfs} \end{aligned}$$

Use 24" Pipe or larger

$$\text{Fric. Slope} = 1.1\%$$

$$\text{HGL @ inlet} = 1322 + .011(240) = \underline{1324.64} \text{ OK}$$

$$\text{Diff.} = 1.36'$$



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Project BAREFOOT BAY

Item DRAINAGE PLAN

C. System 3

Node 301 to 300

$$\text{Starting HGL} = 1322.0$$

$$\text{Inlet Elev} = 1326.5 \text{ @ Node 301}$$

$$\begin{aligned} \text{Total Q @ inlet} &= 11.5 + 4.8 + 15.1 \\ &= 31.4 \text{ cfs} \end{aligned}$$

Use 27" Pipe or Larger

$$\text{Fric slope} = 1.0\%$$

$$\text{HGL @ inlet node \#301} = 1322 + (0.010)(230) = \underline{1324.30 \text{ OK}}$$

D.H. = 2.00'

Node 302 to 301

$$\text{Starting HGL} = 1324.30 \text{ @ Node 301}$$

$$\text{Inlet Elev} = 1326.50 \text{ @ Node 302}$$

$$\begin{aligned} \text{Total Q @ inlet node \#302} &= 11.5 + 4.8 \\ &= 16.3 \text{ cfs} \end{aligned}$$

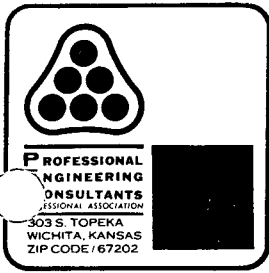
Use 18" pipe or Larger

$$\text{Fric. Slope} = 2.4\%$$

$$\text{HGL @ Inlet node \#302} = 1324.30 + (0.024)(70) = \underline{1325.98}$$

D.H. = 0.52'

OK



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D. System 4

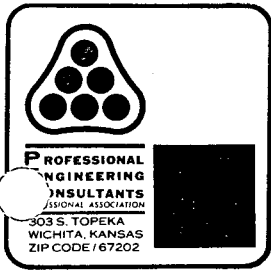
Starting HGL = 1322.0
Inlet Elev. = 1326.0

Total @ @ inlet = 7.5 + 10.3
= 17.8 cfs

Use 24" Pipe or larger

Frict. Slope = 0.0065
HGL @ Inlet = 1322.0 + (0.0065)(280')
= 1323.82 OK

Diff. = 2.18'



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III. Street Flow - 100 YR

Basin 1A

$$S = 0.57\%$$
$$Q_{100} = 12.2 \text{ cfs}$$
$$z = 32 \quad n = 0.016 \quad z/n = 2000$$

$$d_{100} = 0.46' \quad d_{max} = 0.55' \quad \text{OK}$$

BASIN 1B

$$S = 0.57\%$$
$$Q_{100} = 8.10 \text{ cfs}$$
$$z = 32 \quad n = 0.016 \quad z/n = 2000$$

By inspection $d_{100} < d_{max}$ OK
(See BASIN 1A)

BASIN 2A

$$S = 0.5\%$$
$$Q_{100} = 11.8 \text{ cfs}$$
$$z = 32 \quad n = 0.016 \quad z/n = 2000$$

$$d_{100} = 0.48' \quad d_{max} = 0.55' \quad \text{OK}$$

BASIN 2B

$$S = 0.5\%$$
$$Q_{100} = 12.4 \text{ cfs}$$
$$z = 32 \quad n = 0.016 \quad z/n = 2000$$

$$d_{100} = 0.49' \quad d_{max} = 0.55' \quad \text{OK}$$



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Item DRAINAGE PLAN

BASIN 3A

$$S = 0.4\%$$

$$Q_{100} = 11.5 \text{ cfs}$$

$$z = 32 \quad n = 0.016 \quad \frac{z}{n} = 2000$$

$$d_{100} = 0.49'$$

$$d_{max} = 0.55'$$

OK

BASIN 3B

$$S = 0.4\%$$

$$Q_{100} = 4.8 \text{ cfs}$$

$$z = 32 \quad n = 0.016 \quad \frac{z}{n} = 2000$$

By inspection $d_{100} < d_{max}$ ∴
(See Basin 3A)

OK

BASIN 3C

$$S = 0.4\%$$

$$Q_{100} = 15.1$$

$$z = 32 \quad n = 0.016 \quad \frac{z}{n} = 2000$$

$$d_{100} = 0.55'$$

$$d_{max} = 0.55'$$

OK

BASIN 4A

$$S = 0.8\%$$

$$Q_{100} = 7.5 \text{ cfs}$$

$$z = 32 \quad n = 0.016 \quad \frac{z}{n} = 2000$$

$$d_{100} = 0.38'$$

$$d_{max} = 0.55'$$

OK

BASIN 4B

$$S = 0.8\%$$

$$Q_{100} = 10.3 \text{ cfs}$$

$$z = 32 \quad n = 0.016 \quad \frac{z}{n} = 2000$$

$$d_{100} = 0.42'$$

$$d_{max} = 0.55'$$

OK



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Project BAREFOOT BAY

Item DRAINAGE PLAN

IV. Inlet Sizing (100-yr)

<u>NODE</u>	<u>SIZE & TYPE</u>	<u>Q, CFS</u>	<u>PONDING DEPTH, Ft.</u>	<u>Remarks</u>
101	10', 1A	20.3	0.63'	OK
201	10', 1A	24.2	0.85'	OK
301	10', 1A	15.1	0.46'	OK
302	10', 1A	16.3	0.48'	OK
401	10', 1A	17.8	0.53	OK

EXHIBIT NO. 1

SOIL LEGEND

<u>SYMBOL</u>	<u>HYDROLOGIC GROUP</u>	<u>NAME</u>
Aa	B	Albion-Shellabarger sandy loams, 1 to 4 percent slopes
Ab	B	Albion and Shellabarger sandy loams, 7 to 15 percent slopes
Ba	C	Blanket silt loam, 0 to 1 percent slopes
Bb	C	Blanket silt loam, 1 to 3 percent slopes
Ca	B	Canadian fine sandy loam
Cb	B	Canadian-Waldeck fine sandy loams
Cc	D	Carwile fine sandy loam
Cd	B	Clark-Ost clay loams, 1 to 4 percent slopes
Ce	C	Cline silty clay, 3 to 6 percent slopes
Ea	B	Elandco silt loam
Eb	B	Elandco silt loam, occasionally flooded
Ec	B	Elandco silt loam, frequently flooded
Fa	B	Farnum loam, 0 to 1 percent slopes
Fb	B	Farnum loam, 1 to 3 percent slopes
Fc	B	Farnum loam, sandy substratum, 0 to 1 percent slopes
Ga	D	Goessel silty clay, 0 to 1 percent slopes
Gb	D	Goessel silty clay, 1 to 2 percent slopes
Ia	D	Irwin silty clay loam, 1 to 3 percent slopes
Ib	D	Irwin silty clay loam, 3 to 6 percent slopes
Ic	D	Irwin silty clay loam, 2 to 6 percent slopes, eroded
La	C	Lesho loam
Lb	A	Lincoln soils
Ma	B	Milan loam, 1 to 3 percent slopes
Mb	B	Milan form, 3 to 6 percent slopes
Mc	B	Milan clay loam, 2 to 6 percent slopes, eroded
Na	B	Naron fine sandy loam
Oc	D	Owens clay loam, 1 to 3 percent slopes
Od	D	Owens-Rock outcrop complex, 3 to 10 percent slopes
Pa		Pits
Pb	D	Plevna fine sandy loam
Pc	A	Pratt loamy fine sand, undulating
Pd	A	Pratt-Tivoli complex, rolling
Ra	D	Renfrow silty clay loam, 1 to 3 percent slopes
Rb	D	Renfrow silty clay loam, 3 to 6 percent slopes
Rc	D	Renfrow-Owens clay loams, 1 to 4 percent slopes
Rd	D	Rosehill silty clay, 1 to 3 percent slopes
Sa	B	Shellabarger sandy loam, 1 to 3 percent slopes
Sb	B	Shellabarger sandy loam, 3 to 6 percent slopes
Sc	B	Shellabarger sandy loam, 3 to 6 percent slopes, eroded
Ta	D	Tabler silty clay loam
Tb	D	Tabler-Drummond complex
Ua	B	Urban land-Canadian complex
Ub	B	Urban land-Elandco complex
Uc	B	Urban land-Farnum complex, 0 to 3 percent slopes
Ud	D	Urban land-Irwin complex, 1 to 3 percent slopes
Ue	D	Urban land-Tabler complex
Va	B	Vanoss silt loam, 0 to 1 percent slopes
Vb	B	Vanoss silt loam, 1 to 3 percent slopes
Vc	B	Vanoss silt loam, 3 to 6 percent slopes
Vd	B	Vanoss silt loam, 3 to 6 percent slopes, eroded
Ve	D	Vernon sandy loam, 1 to 3 percent slopes
Vf	D	Vernon sandy loam, 3 to 6 percent slopes
Wa	C	Waldeck sandy loam
Wb	D	Waurika silt loam

ATTACHMENT D

DRAINAGE CRITERIA

CITY OF WICHITA, KANSAS

RECOMMENDED RUNOFF COEFFICIENTS FOR RATIONAL METHOD
AND PERCENT IMPERVIOUS FOR UNIT HYDROGRAPH METHOD

Land Use or Surface Characteristics	Percent Impervious	Frequency			
		<u>2</u>	<u>5</u>	<u>10</u>	<u>100</u>
1. Business:					
Downtown Areas	95	0.84	0.85	0.87	0.91
Neighborhood Areas	70	0.68	0.69	0.73	0.80
2. Residential:					
<u>Single Family (Soil Group D)</u>					
1/8 Acre	50	0.57	0.61	0.66	0.79
1/4 Acre	38	0.50	0.54	0.62	0.76
1/3 Acre	30	0.46	0.50	0.59	0.73
1/2 Acre	25	0.42	0.48	0.56	0.72
3/4 Acre	22	0.42	0.46	0.55	0.71
1 Acre	20	0.41	0.45	0.54	0.71
<u>Multi-Family (Soil Group D)</u>					
Multi-Unit (detached)	60	0.62	0.66	0.72	0.82
Multi-Unit (attached)	65	0.64	0.68	0.73	0.83
Apartments	75	0.70	0.73	0.79	0.86
<u>Single Family (Soil Group C)</u>					
1/8 Acre	50	0.55	0.58	0.64	0.73
1/4 Acre	38	0.48	0.51	0.57	0.68
1/3 Acre	30	0.43	0.46	0.53	0.65
1/2 Acre	25	0.40	0.43	0.50	0.63
3/4 Acre	22	0.39	0.42	0.49	0.62
1 Acre	20	0.37	0.40	0.48	0.61
<u>Multi-Family (Soil Group C)</u>					
Multi-Unit (detached)	60	0.60	0.63	0.69	0.77
Multi-Unit (attached)	65	0.63	0.66	0.71	0.79
Apartments	75	0.68	0.72	0.77	0.83
<u>Single-Family (Soil Group B)</u>					
1/8 Acre	50	0.52	0.54	0.59	0.67
1/4 Acre	38	0.44	0.46	0.52	0.61
1/3 Acre	30	0.39	0.41	0.47	0.57
1/2 Acre	25	0.36	0.38	0.44	0.54
3/4 Acre	22	0.34	0.36	0.42	0.52
1 Acre	20	0.33	0.35	0.40	0.51
<u>Multi-Family (Soil Group B)</u>					
Multi-Unit (detached)	60	0.58	0.60	0.65	0.72
Multi-Unit (attached)	65	0.61	0.64	0.68	0.75
Apartments	75	0.67	0.70	0.74	0.80

Land Use or face Characteristics	Percent Impervious	Frequency			
		<u>2</u>	<u>5</u>	<u>10</u>	<u>100</u>
<u>Single Family (Soil Group A)</u>					
1/8 Acre	50	0.47	0.50	0.54	0.60
1/4 Acre	38	0.39	0.41	0.45	0.52
1/3 Acre	30	0.33	0.35	0.39	0.47
1/2 Acre	25	0.30	0.31	0.35	0.44
3/4 Acre	22	0.28	0.29	0.33	0.42
1 Acre	20	0.26	0.28	0.32	0.40
<u>Multi-Family (Soil Group A)</u>					
Multi-Unit (detached)	60	0.55	0.57	0.61	0.67
Multi-Unit (attached)	65	0.58	0.60	0.64	0.70
Apartments	75	0.65	0.68	0.72	0.77
3. Industrial:					
Light Areas	70	0.68	0.69	0.73	0.80
Heavy Areas	80	0.74	0.76	0.79	0.84
4. Playgrounds:	15	0.33	0.35	0.42	0.55
5. Schools:	40	0.49	0.51	0.56	0.66
6. Railroad Yard Areas:	30	0.43	0.45	0.50	0.62
Undeveloped Urban Areas:					
Offsite Flow Analysis (when land use not defined)	45	0.52	0.54	0.59	0.68
8. Streets:					
Paved	99	0.87	0.88	0.90	0.93
Gravel	00	0.24	0.26	0.33	0.48
9. Drive, Parking Lots and Walks:	96	0.87	0.87	0.88	0.89
10. Roofs:	90	0.80	0.85	0.90	0.93
11. Urban Lawn Areas (See Note No. 1 below):					
<u>Soil Group A</u>					
Slope less than 1%	00	0.08	0.09	0.13	0.23
Slope 1% to 4%	00	0.12	0.13	0.17	0.27
Slope more than 4%	00	0.16	0.17	0.21	0.31
<u>Soil Group B</u>					
Slope less than 1%	00	0.16	0.18	0.24	0.37
Slope 1% to 4%	00	0.20	0.22	0.28	0.41
Slope more than 4%	00	0.24	0.26	0.32	0.45
<u>Soil Group C</u>					
Slope less than 1%	00	0.24	0.27	0.35	0.51
Slope 1% to 4%	00	0.26	0.29	0.37	0.53
Slope more than 4%	00	0.28	0.31	0.39	0.55

<u>Land Use or Surface Characteristics</u>	<u>Percent Impervious</u>	<u>Frequency</u>			
		<u>2</u>	<u>5</u>	<u>10</u>	<u>100</u>
<u>Soil Group D</u>					
Slope less than 1%	00	0.28	0.33	0.43	0.63
Slope 1% to 4%	00	0.30	0.35	0.45	0.65
Slope more than 4%	00	0.32	0.37	0.47	0.67

Note No. 1: Coefficients shown in the above table are for pervious open space areas with thick turf which includes pervious areas in parks and cemeteries. Coefficients shown above must be increased 0.02 for use with agricultural pasture areas. Coefficients shown above must be reduced by 0.04 for use with agricultural cultivated areas. Group A soils are well-drained, coarse textured sands with high infiltration rates. Group B soils are moderately well-drained, moderately coarse textured soils with moderate infiltration rates. Group C soils are moderately poor-drained, moderately fine textured soils with slow infiltration rates. Group D soils are poor-drained, fine textured soils with very slow infiltration rates.

GENERAL NOTE: These Rational Formula Coefficients may not be valid for basins 320 acres or larger.

April 15, 1986

ATTACHMENT A
DRAINAGE CRITERIA MANUAL

CITY OF WICHITA, KANSAS

RAINFALL INTENSITY TABLE FOR SEDGWICK COUNTY, KANSAS

The following tabulation contains rainfall intensity in inches per hour as derived from ESSA Weather Bureau Technical Paper 40 Modified to NWS Hydro-35, 1977 During First Hour

JDF

DURATION IN MINUTES	RETURN PERIODS OF						
	1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
5	4.18	5.57	6.53	7.41	8.52	9.48	10.32
6	3.99	5.32	6.25	7.09	8.16	9.09	9.89
7	3.81	5.09	5.99	6.81	7.84	8.74	9.50
8	3.66	4.89	5.75	6.55	7.55	8.42	9.15
9	3.52	4.70	5.54	6.31	7.28	8.13	8.83
10	3.39	4.52	5.34	6.09	7.04	7.86	8.54
11	3.27	4.36	5.16	5.89	6.81	7.61	8.27
12	3.18	4.21	4.99	5.71	6.60	7.38	8.02
13	3.05	4.08	4.84	5.53	6.41	7.17	7.79
14	2.96	3.95	4.69	5.37	6.23	6.97	7.57
15	2.87	3.83	4.56	5.22	6.06	6.78	7.37
16	2.78	3.72	4.43	5.08	5.90	6.60	7.18
17	2.71	3.61	4.31	4.95	5.75	6.44	7.00
18	2.63	3.51	4.20	4.83	5.61	6.29	6.84
19	2.56	3.42	4.10	4.71	5.47	6.14	6.68
20	2.50	3.33	4.00	4.60	5.35	6.00	6.53
21	2.44	3.25	3.90	4.50	5.23	5.87	6.39
22	2.38	3.17	3.81	4.40	5.12	5.75	6.26
23	2.32	3.10	3.73	4.31	5.01	5.63	6.13
24	2.27	3.03	3.65	4.22	4.91	5.52	6.01
25	2.22	2.96	3.57	4.13	4.81	5.41	5.90
26	2.20	2.90	3.50	4.05	4.72	5.31	5.79
27	2.16	2.84	3.43	3.98	4.63	5.21	5.69
28	2.14	2.78	3.37	3.90	4.55	5.12	5.59
29	2.11	2.72	3.30	3.83	4.47	5.03	5.49
30	2.08	2.67	3.24	3.76	4.39	4.94	5.40
31	2.05	2.62	3.19	3.70	4.32	4.86	5.32
32	2.02	2.57	3.10	3.63	4.25	4.79	5.22
33	1.99	2.52	3.05	3.57	4.18	4.71	5.14
34	1.96	2.48	3.01	3.51	4.11	4.63	5.07
35	1.93	2.44	2.98	3.46	4.05	4.56	5.00
36	1.91	2.39	2.93	3.41	3.99	4.50	4.93
37	1.89	2.35	2.88	3.36	3.93	4.43	4.86
38	1.87	2.32	2.84	3.31	3.87	4.37	4.79
39	1.85	2.28	2.80	3.26	3.82	4.31	4.73
40	1.83	2.24	2.76	3.22	3.76	4.25	4.66
41	1.81	2.21	2.72	3.17	3.71	4.19	4.60
42	1.79	2.18	2.68	3.13	3.66	4.13	4.54
43	1.77	2.14	2.64	3.09	3.61	4.08	4.49
44	1.75	2.11	2.61	3.05	3.57	4.03	4.43
45	1.73	2.08	2.57	3.01	3.52	3.98	4.38

ATTACHMENT A CONTINUED
Page 2

<u>DURATION IN MINUTES</u>	<u>RETURN PERIODS OF</u>						
	<u>1-YR</u>	<u>2-YR</u>	<u>5-YR</u>	<u>10-YR</u>	<u>25-YR</u>	<u>50-YR</u>	<u>100-YR</u>
46	1.70	2.05	2.54	2.97	3.48	3.93	4.33
47	1.67	2.02	2.50	2.93	3.44	3.88	4.28
48	1.66	2.00	2.47	2.90	3.39	3.84	4.23
49	1.64	1.97	2.44	2.86	3.35	3.79	4.18
50	1.61	1.95	2.41	2.83	3.32	3.75	4.13
51	1.59	1.92	2.38	2.79	3.28	3.71	4.09
52	1.56	1.89	2.35	2.76	3.24	3.67	4.05
53	1.54	1.86	2.33	2.73	3.20	3.63	4.00
54	1.52	1.84	2.30	2.70	3.17	3.59	3.96
55	1.50	1.81	2.27	2.67	3.14	3.55	3.92
56	1.47	1.79	2.25	2.64	3.10	3.51	3.88
57	1.45	1.76	2.22	2.61	3.07	3.48	3.84
58	1.43	1.74	2.20	2.59	3.04	3.44	3.81
59	1.42	1.72	2.18	2.56	3.01	3.41	3.77
60	1.40	1.69	2.15	2.53	2.98	3.37	3.73
61	1.38	1.67	2.13	2.51	2.95	3.34	3.70
62	1.36	1.65	2.11	2.48	2.92	3.31	3.67
63	1.34	1.63	2.09	2.46	2.89	3.28	3.63
64	1.33	1.61	2.07	2.44	2.86	3.25	3.60
65	1.31	1.59	2.05	2.41	2.84	3.22	3.57
66	1.30	1.57	2.03	2.39	2.81	3.19	3.54
67	1.28	1.56	2.01	2.37	2.79	3.16	3.51
68	1.26	1.54	1.99	2.35	2.76	3.13	3.48
69	1.25	1.52	1.97	2.33	2.74	3.10	3.45
70	1.24	1.50	1.95	2.31	2.71	3.08	3.42
71	1.22	1.49	1.93	2.28	2.69	3.05	3.39
72	1.21	1.47	1.92	2.26	2.67	3.02	3.36
73	1.20	1.46	1.90	2.25	2.64	3.00	3.34
74	1.18	1.44	1.88	2.23	2.63	2.98	3.31
75	1.17	1.43	1.86	2.21	2.61	2.95	3.29
76	1.16	1.41	1.85	2.19	2.58	2.93	3.26
77	1.15	1.40	1.83	2.17	2.55	2.90	3.24
78	1.13	1.38	1.82	2.15	2.53	2.88	3.22
79	1.12	1.37	1.80	2.14	2.50	2.86	3.19
80	1.11	1.36	1.79	2.12	2.48	2.84	3.16
81	1.10	1.34	1.77	2.10	2.46	2.82	3.13
82	1.09	1.33	1.76	2.08	2.43	2.79	3.10
83	1.08	1.32	1.74	2.06	2.41	2.76	3.07
84	1.07	1.31	1.73	2.04	2.39	2.74	3.04
85	1.06	1.30	1.72	2.02	2.37	2.71	3.01
86	1.05	1.28	1.70	2.00	2.34	2.69	2.99
87	1.04	1.27	1.69	1.99	2.32	2.66	2.96
88	1.03	1.26	1.68	1.97	2.30	2.64	2.93
89	1.02	1.25	1.68	1.95	2.28	2.62	2.91
90	1.01	1.24	1.66	1.93	2.26	2.59	2.88

<u>DURATION IN MINUTES</u>	<u>RETURN PERIODS OF</u>						
	<u>1-YR</u>	<u>2-YR</u>	<u>5-YR</u>	<u>10-YR</u>	<u>25-YR</u>	<u>50-YR</u>	<u>100-YR</u>
91	1.00	1.23	1.65	1.92	2.24	2.57	2.86
92	1.00	1.22	1.63	1.90	2.22	2.55	2.83
93	0.99	1.21	1.62	1.89	2.20	2.53	2.81
94	0.98	1.20	1.61	1.87	2.19	2.51	2.79
95	0.97	1.19	1.59	1.85	2.17	2.49	2.76
96	0.96	1.18	1.58	1.84	2.15	2.46	2.74
97	0.96	1.17	1.57	1.82	2.13	2.44	2.72
98	0.95	1.16	1.56	1.81	2.12	2.42	2.70
99	0.94	1.15	1.54	1.80	2.10	2.41	2.67
100	0.93	1.14	1.53	1.78	2.08	2.39	2.65
101	0.93	1.13	1.52	1.77	2.07	2.39	2.65
102	0.92	1.13	1.51	1.75	2.05	2.35	2.61
103	0.91	1.12	1.50	1.74	2.04	2.33	2.59
104	0.90	1.11	1.49	1.73	2.02	2.31	2.57
105	0.90	1.10	1.47	1.72	2.01	2.30	2.55
106	0.89	1.09	1.46	1.70	1.99	2.28	2.54
107	0.88	1.09	1.45	1.69	1.98	2.26	2.52
108	0.88	1.08	1.44	1.68	1.96	2.25	2.50
109	0.87	1.07	1.43	1.67	1.95	2.23	2.48
110	0.87	1.06	1.42	1.65	1.93	2.21	2.46
111	0.86	1.06	1.41	1.64	1.92	2.20	2.45
112	0.85	1.05	1.40	1.63	1.91	2.18	2.43
113	0.85	1.04	1.39	1.62	1.89	2.17	2.41
114	0.84	1.03	1.38	1.61	1.88	2.15	2.40
115	0.84	1.03	1.37	1.60	1.87	2.14	2.38
116	0.83	1.02	1.36	1.59	1.86	2.12	2.36
117	0.82	1.01	1.36	1.58	1.84	2.11	2.35
118	0.82	1.01	1.35	1.57	1.83	2.09	2.33
119	0.81	1.00	1.34	1.56	1.82	2.08	2.32
120	0.81	0.99	1.33	1.55	1.81	2.07	2.30

<u>DURATION IN HOURS</u>	<u>RETURN PERIODS OF</u>						
	<u>1-YR</u>	<u>2-YR</u>	<u>5-YR</u>	<u>10-YR</u>	<u>25-YR</u>	<u>50-YR</u>	<u>100-YR</u>
2	0.81	0.99	1.33	1.55	1.81	2.07	2.30
3	0.59	0.72	0.97	1.13	1.32	1.51	1.68
4	0.47	0.58	0.78	0.91	1.06	1.21	1.35
5	0.40	0.49	0.66	0.77	0.89	1.02	1.14
6	0.35	0.42	0.57	0.67	0.78	0.89	0.99
8	0.28	0.34	0.46	0.53	0.62	0.71	0.79
10	0.23	0.29	0.39	0.45	0.52	0.60	0.67
12	0.20	0.25	0.33	0.39	0.45	0.52	0.58
18	0.15	0.18	0.24	0.28	0.33	0.38	0.42
24	0.12	0.15	0.20	0.23	0.27	0.31	0.34

FIGURE 3

FLOW FOR CIRCULAR PIPE FLOWING FULL
 BASED ON MANNING'S EQUATION $n=0.011$

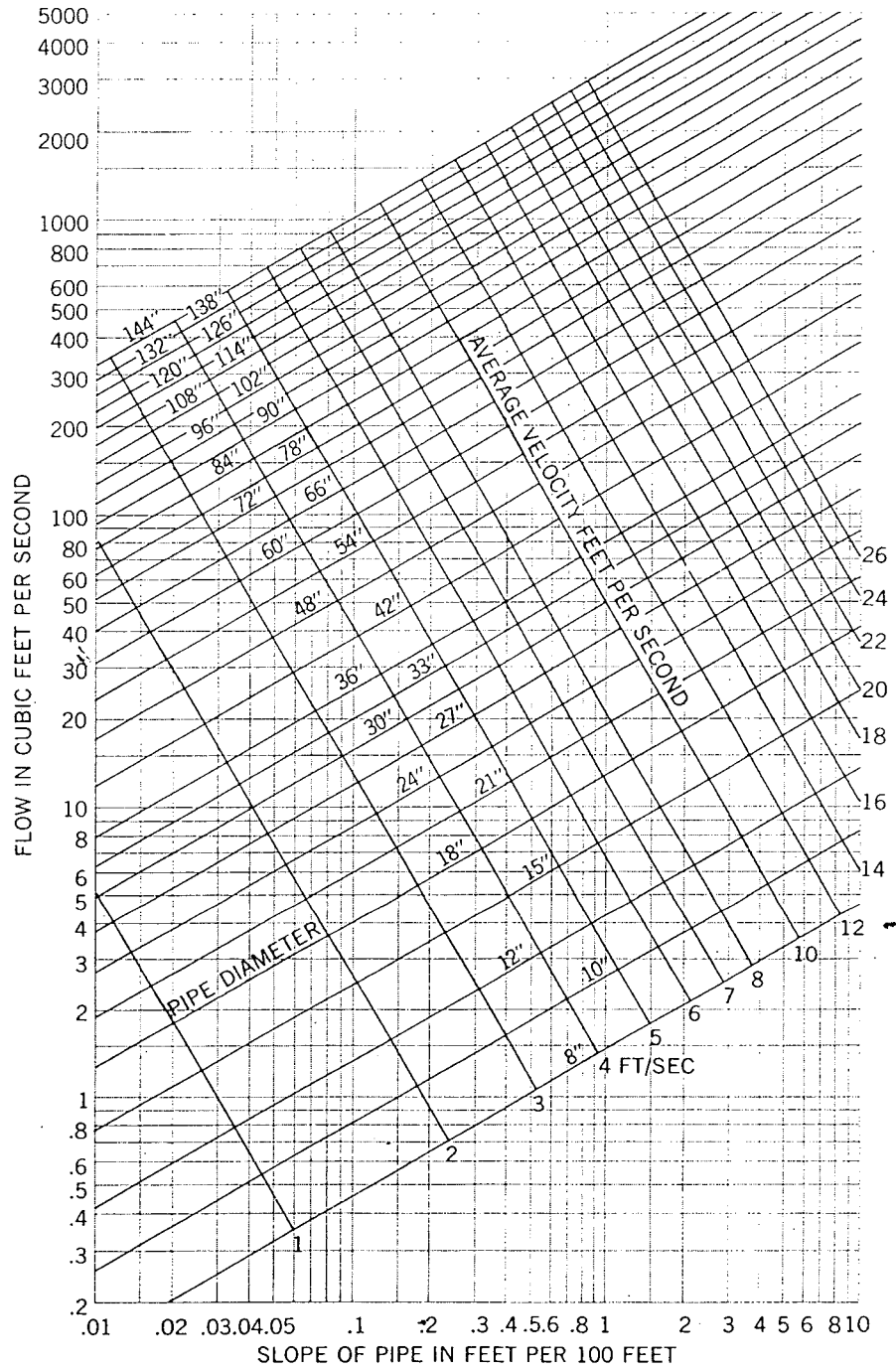
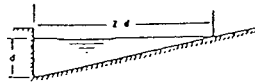


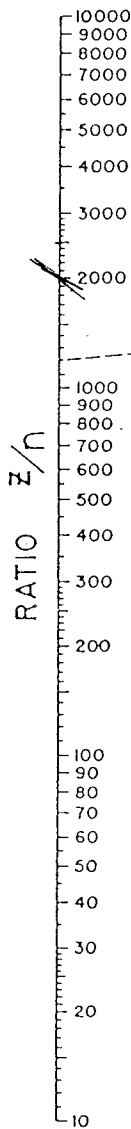
Chart 1



EQUATION: $Q = 0.56 \left(\frac{z}{n}\right)^{2/3} d^{5/3}$
 n IS ROUGHNESS COEFFICIENT IN MANNING
 FORMULA APPROPRIATE TO MATERIAL IN
 BOTTOM OF CHANNEL
 z IS RECIPROCAL OF CROSS SLOPE
 REFERENCE: H. R. B. PROCEEDINGS 1948,
 PAGE 150, EQUATION (14)

EXAMPLE (SEE INSTRUCTION 1)

GIVEN: $z = 0.03$
 $z = 24$
 $n = .02$ $z/n = 1200$
 $Q = 200$ CFS
 FIND: $d = 0.22$ BY FOLLOWING
 DASHED LINES



TURNING LINE

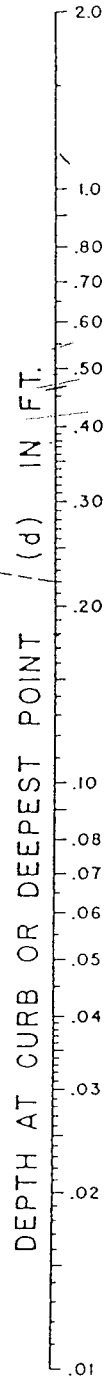
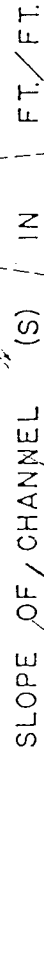
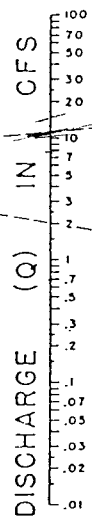
INSTRUCTIONS

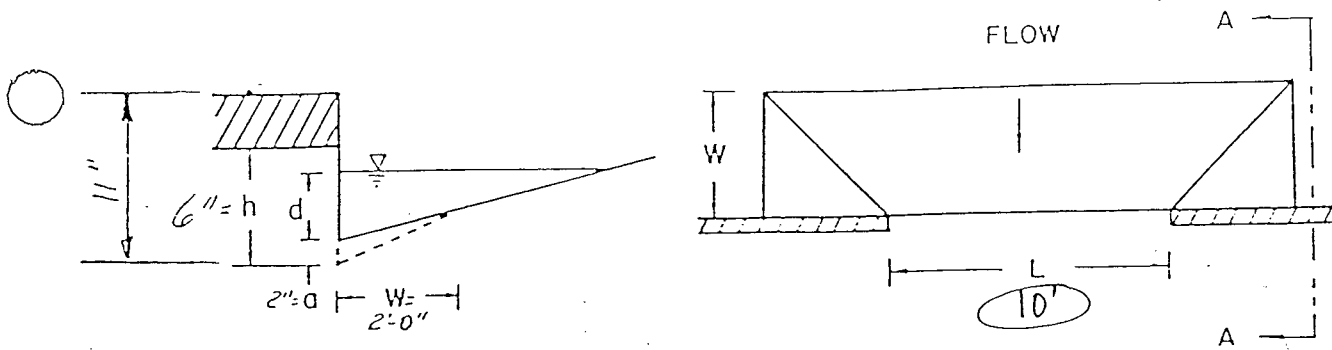
1. CONNECT z/n RATIO WITH SLOPE (S) AND CONNECT DISCHARGE (Q) WITH POINT WHERE LINE CROSSES TURNING LINE. READ DEPTH AT CURB (d) CAN BE FOUND FROM d BY CONNECTING d WITH CROSSING OF TURNING LINE.

2. FOR SHALLOW V-SHAPED CHANNEL AS SHOWN USE NOMOGRAPH AS EXPLAINED IN INSTRUCTION 1 BUT WITH $z = \frac{1}{d}$.

3. TO DETERMINE DISCHARGE Q_1 IN PORTION OF CHANNEL HAVING WIDTH x : DETERMINE DEPTH d FOR TOTAL DISCHARGE IN ENTIRE SECTION AS EXPLAINED IN 1. THEN USE NOMOGRAPH TO DETERMINE Q_2 IN SECTION OF WIDTH b FOR DEPTH $d' = d - \left(\frac{x}{z}\right)$. THEN $Q_1 = Q_2$.

4. TO DETERMINE DISCHARGE (Q) IN COMPOSITE SECTION: FOLLOW INSTRUCTION 3. TO OBTAIN DISCHARGE (Q) IN SECTION d AT ASSUMED DEPTH d BASED ON AN EXTENSION OF SLOPE RATIO z_1 TO INTERSECT WATER SURFACE; OBTAIN Q_1 FOR SLOPE RATIO z_1 AND DEPTH d' ; $d' = d - \frac{x}{z_1}$. THEN $Q = Q_1 + Q_2$.





DEF. SKETCH, C.D.W. TYPE 1A INLET

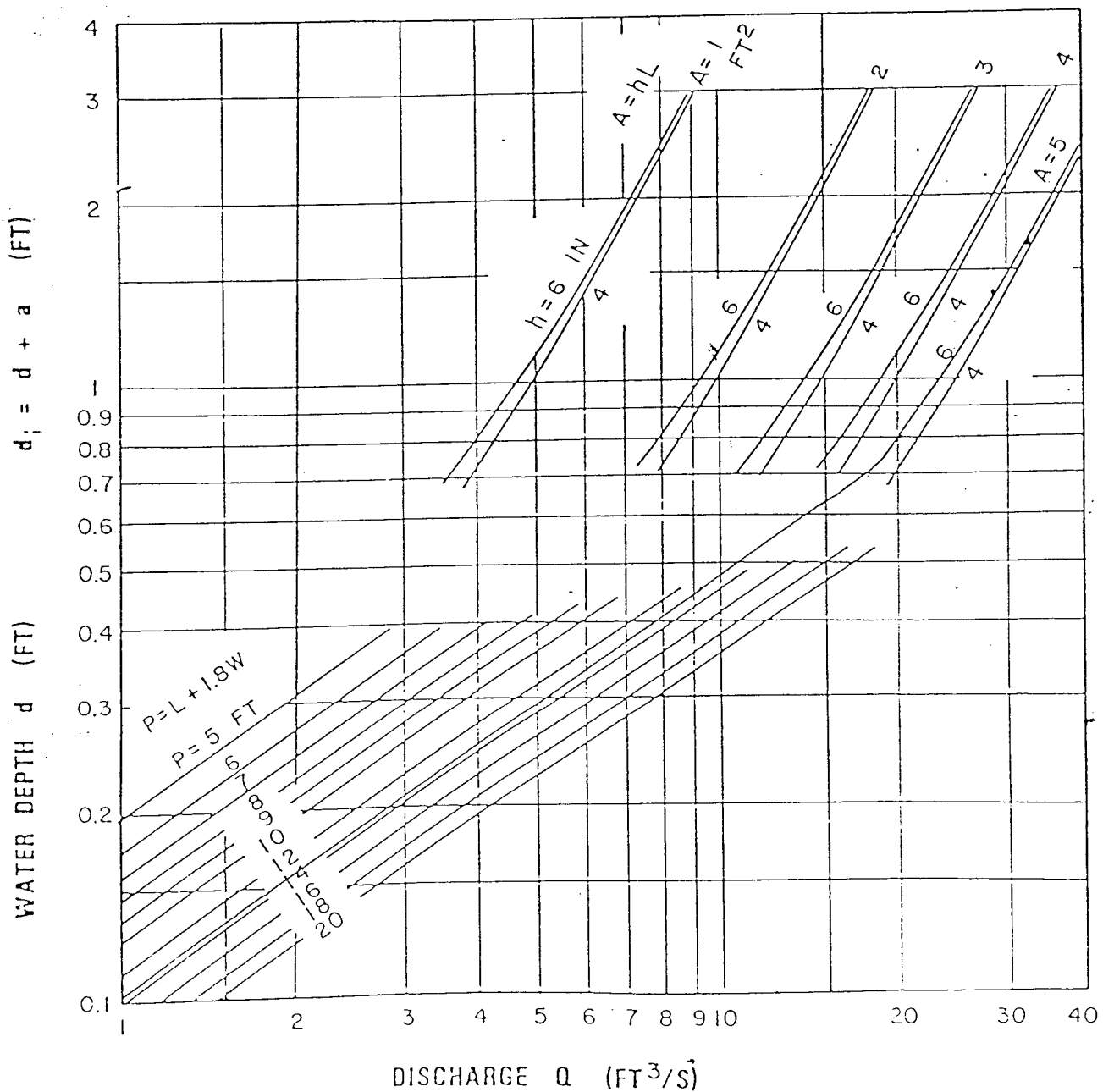


CHART 12. Depressed curb-opening inlet capacity in sump locations.

FROM: HEC-12, DRAINAGE OF HIGHWAY PAVEMENTS, FHWA, MAR, 1974

GROUNDWATER OBSERVATIONS

LAKE RIDGE 2ND ADDITION

STORMWATER DRAIN NO. 101

WICHITA, KANSAS

PREPARED BY

PROFESSIONAL ENGINEERING CONSULTANTS, P.A.

WICHITA, KANSAS

MARCH 11, 1994

I. Introduction

This report describes observations of groundwater levels made during and after construction of a detention/retention reservoir constructed into the groundwater table. The site lies near 21st and Ridge Road in Wichita, Sedgwick County, Kansas, in the S 1/2 of the SW 1/4 of Sec. 3, T 27 S, R 1 W (see Figure 1).

The reader is advised that this report states the findings made at this site under a specific set of conditions. Use of the data presented in this report is the sole responsibility of the reader. Evaluation of the applicability of this data to other sites or to this site in other circumstances is beyond the scope of this report.

II. Project Description

Under contract to the City of Wichita, Bergkamp Construction Co., Inc., constructed a drainage project for the Lake Ridge 2nd Addition known as Storm Water Drain No. 101. The project consisted of construction of an earthen detention/retention pond by means of excavation below the groundwater table to a depth of approximately six feet. The undeveloped site consisted of a fine sandy loam underlain by fine sands. The water-bearing stratum is sand and gravel alluvium of the Arkansas River Valley.

During the course of the construction, the Contractor maintained a pumping system to locally lower the groundwater elevation to permit excavation of the basin by means of conventional scraper earthmoving equipment. The purpose of the investigation was to make a determination of the zone of influence that the pumping exerts on the surrounding groundwater table.

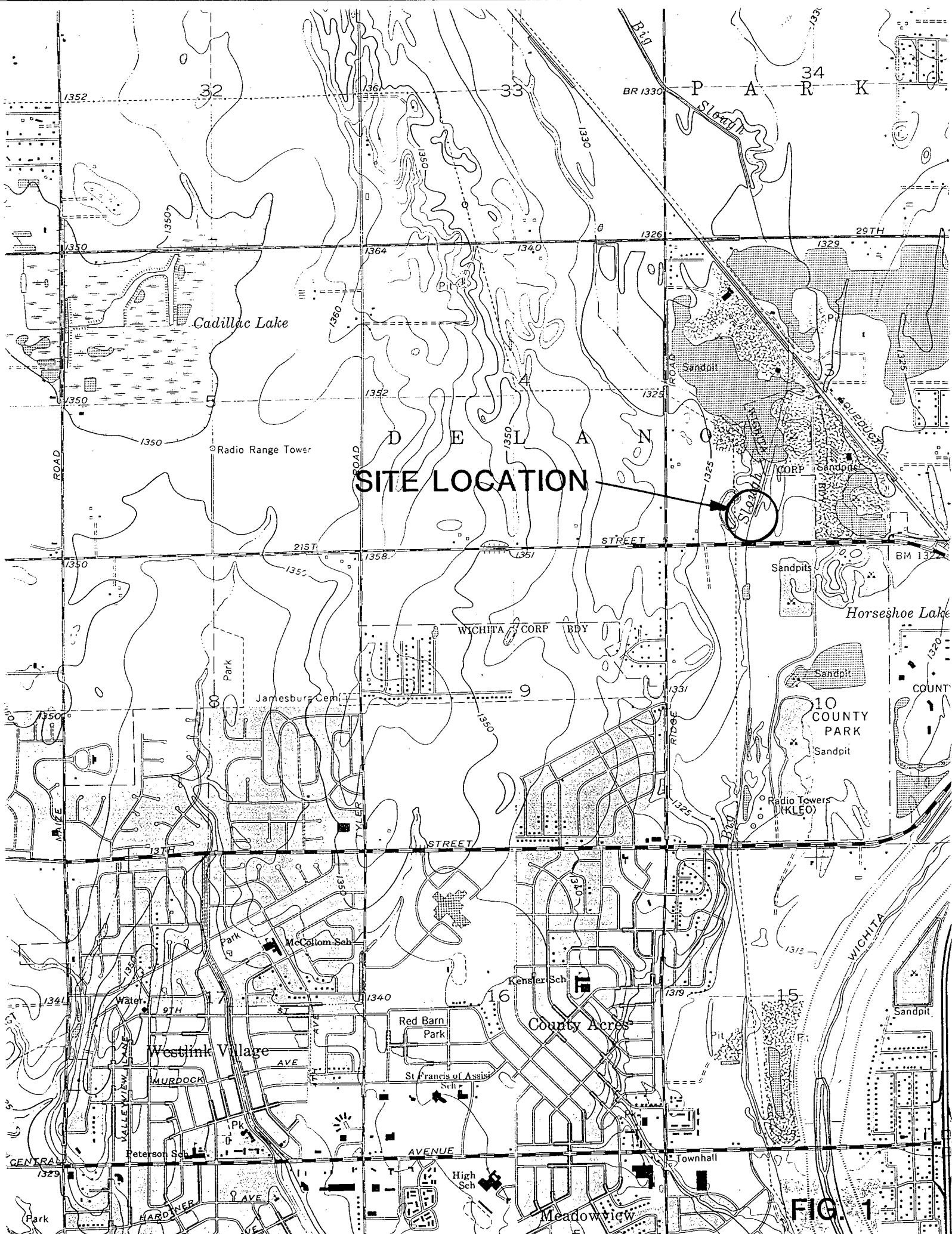
III. Investigation Description

After the pumping operation had been in place for approximately three weeks, and the aquifer had presumably reached equilibrium, five temporary well points were set (see Figure 2). These were placed close to the pond outlet at approximately right angles to the natural groundwater gradient direction. Groundwater level observations were made at all five locations during the assumed equilibrium stage. After the pumping operation system ceased, observations were made to evaluate the rate of rise of the groundwater table as it rose back to a normal elevation. Table 1 lists the data collected.

Figure 3 illustrates the drawdown effect as a function of distance from the pond, and the rise of the groundwater over time as well.

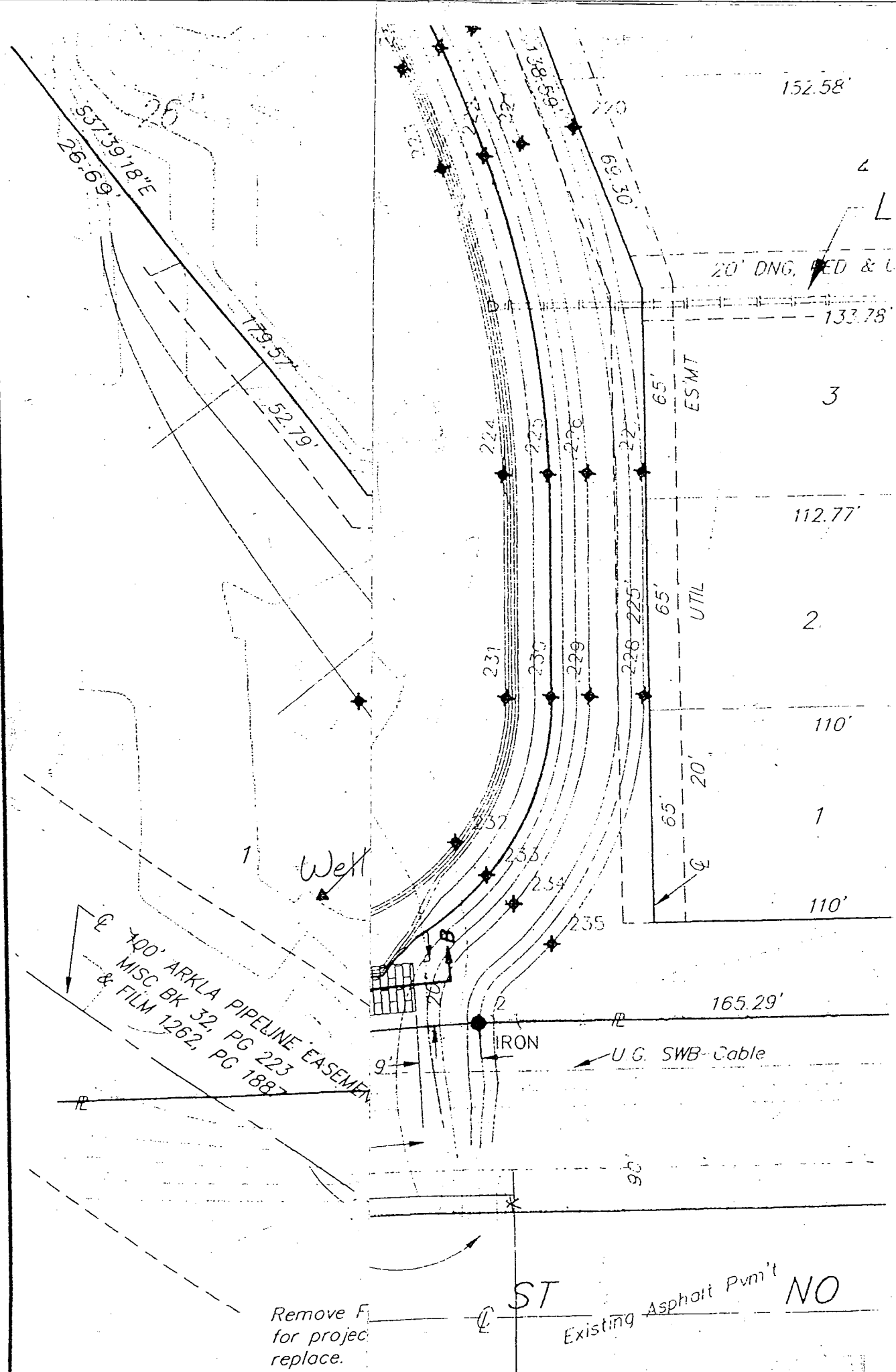
IV. Summary

Five observation wells were established adjacent to a pond excavated into the groundwater. During and after pumping operations to locally drawdown the groundwater table, observations of the groundwater elevations were made. The greatest zone of drawdown influence is closest to the lake, as can be expected. At a distance of 200 feet from the lake, the rate of groundwater elevation change was less than one foot per week.

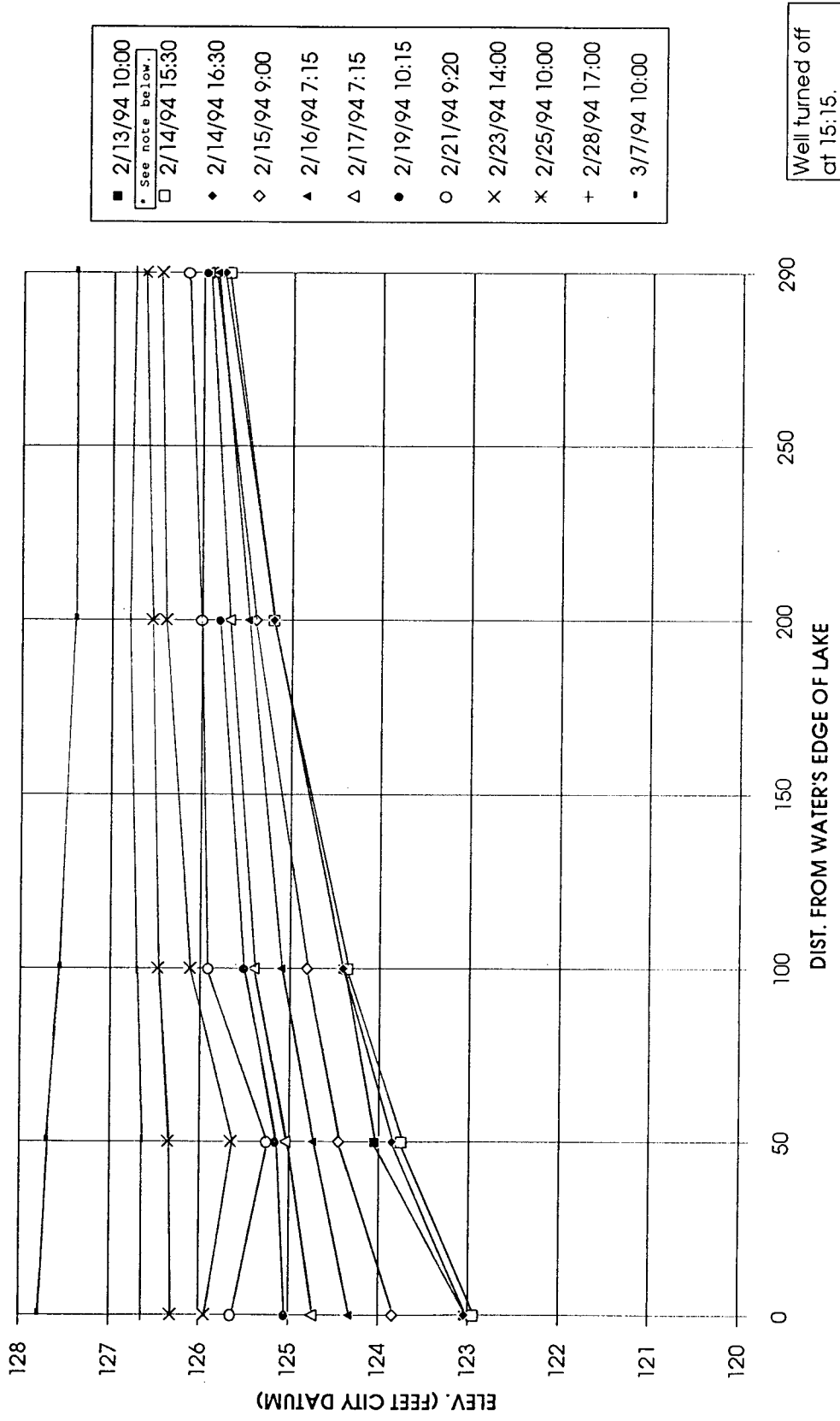


SITE LOCATION

FIG. 1



WELL READING DATA



WELL READING DATA

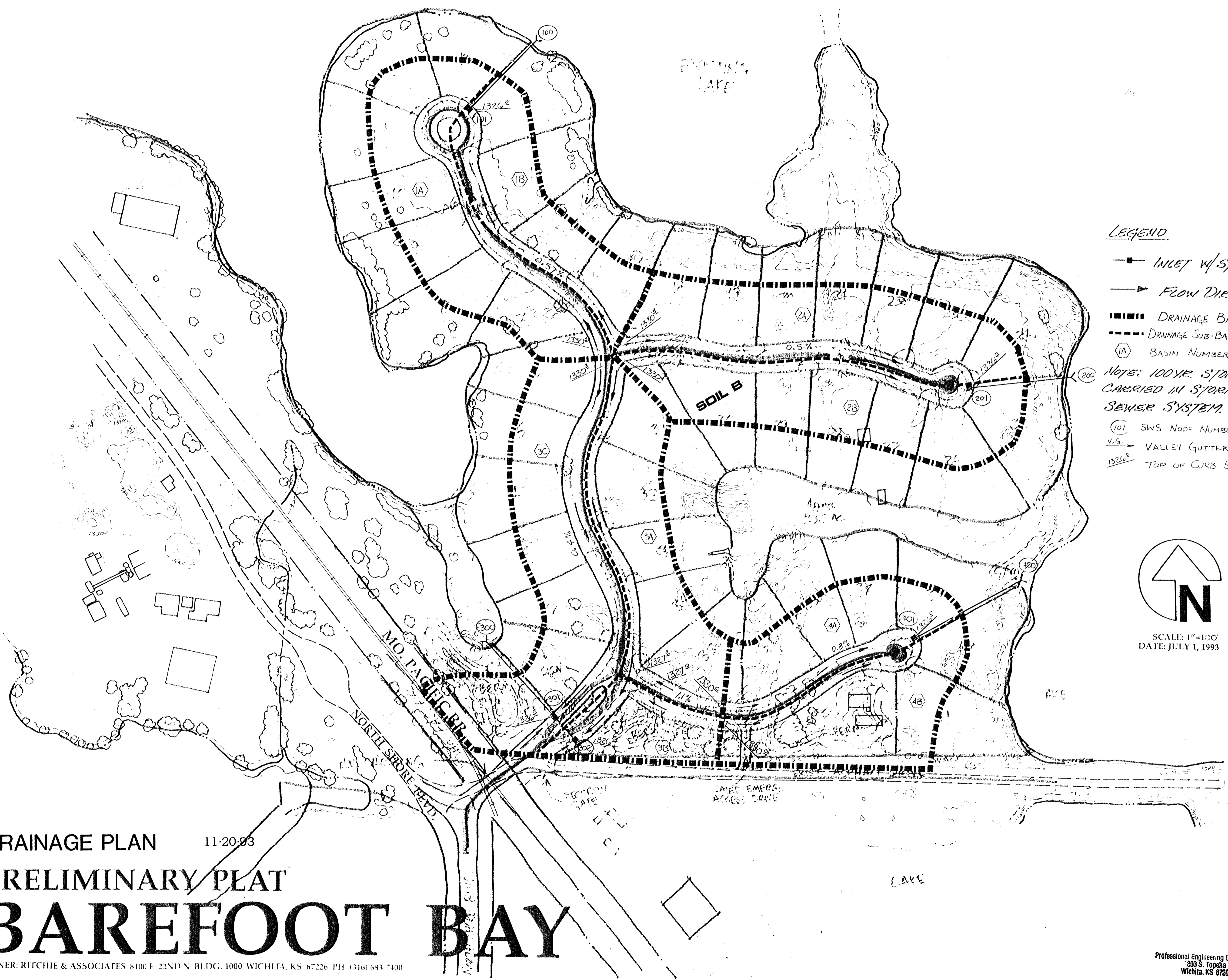
Boring #	Elevation Top of PVC	2/13/94 10:00		2/14/94 15:30		2/14/94 16:30		2/15/94 9:00		2/16/94 7:15		2/17/94 7:15	
		Depth	Elev.	Depth	Elev.	Depth	Elev.	Depth	Elev.	Depth	Elev.	Depth	Elev.
1	130.94	7.90	123.04	8.00	122.94	7.90	123.04	7.10	123.84	6.60	124.34	6.20	124.74
2	132.75	8.70	124.05	9.00	123.75	8.90	123.85	8.30	124.45	8.00	124.75	7.70	125.05
3	131.71	7.30	124.41	7.35	124.36	7.30	124.41	6.90	124.81	6.60	125.11	6.30	125.41
4	131.9	6.70	125.20	6.70	125.20	6.70	125.20	6.50	125.40	6.40	125.50	6.20	125.70
5	132.56	6.80	125.76	6.83	125.73	6.80	125.76	6.70	125.86	6.70	125.86	6.60	125.96

Boring #	Elevation Top of PVC	2/19/94 10:15		2/21/94 9:20		2/23/94 14:00		2/25/94 10:00		2/28/94 17:00		3/7/94 10:00	
		Depth	Elev.	Depth	Elev.	Depth	Elev.	Depth	Elev.	Depth	Elev.	Depth	Elev.
1	130.94	5.90	125.04	5.30	125.64	5.00	125.94	4.63	126.31	4.30	126.64	3.15	127.79
2	132.75	7.60	125.15	7.50	125.25	7.10	125.65	6.40	126.35	6.10	126.65	5.05	127.70
3	131.71	6.20	125.51	5.80	125.91	5.60	126.11	5.24	126.47	5.00	126.71	4.15	127.56
4	131.90	6.10	125.80	5.90	126.00	5.50	126.40	5.35	126.55	5.10	126.80	4.50	127.40
5	132.56	6.60	125.96	6.40	126.16	6.10	126.46	5.92	126.64	5.80	126.76	5.15	127.41

DRAINAGE PLAN 11-20-93
 PRELIMINARY PLAT

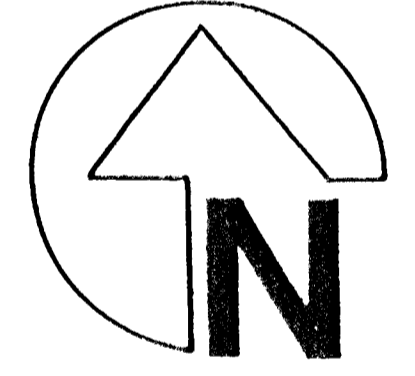
BAREFOOT BAY

OWNER: RITCHIE & ASSOCIATES 8100 E. 22ND N. BLDG. 1000 WICHITA, KS. 67226 PH. (316) 683-7100

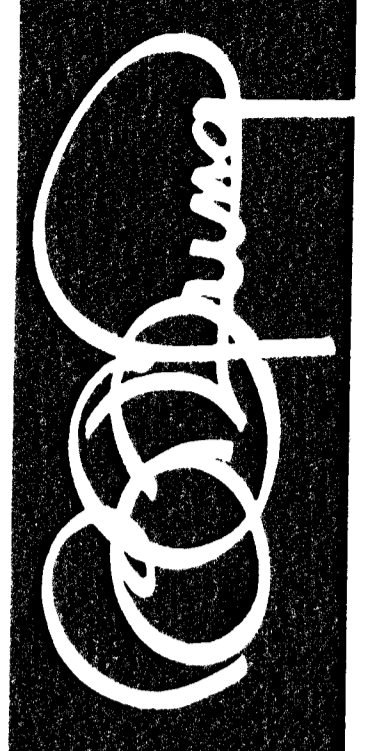


LEGEND

- INLET w/ STORM SEWER
- ▶— FLOW DIRECTION
- DRAINAGE BASIN BOUNDARY
- - - DRAINAGE SUB-BASIN BOUNDARY
- (IA) BASIN NUMBER
- NOTE: 100 YR. STORM TO BE CARRIED IN STORM WATER SEWER SYSTEM.
- (101) SWS NODE NUMBER
- V.G. VALLEY GUTTER
- 1320' TOP OF CURB ELEV.



SCALE: 1"=100'
 DATE: JULY 1, 1993



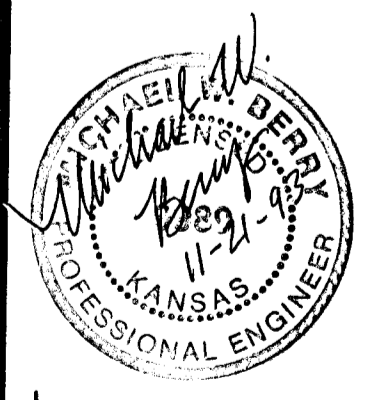
BILL G. YUNG DESIGN
 4819 E. 28TH STREET NORTH
 WICHITA, KS. 67220
 316-683-6567 FAX 316-683-9596

DATE
 REV.

SHEET TITLE

PROJECT

SHEET
 OF



233

Professional Engineering Consultants
 303 S. Topeka
 Wichita, KS 67202