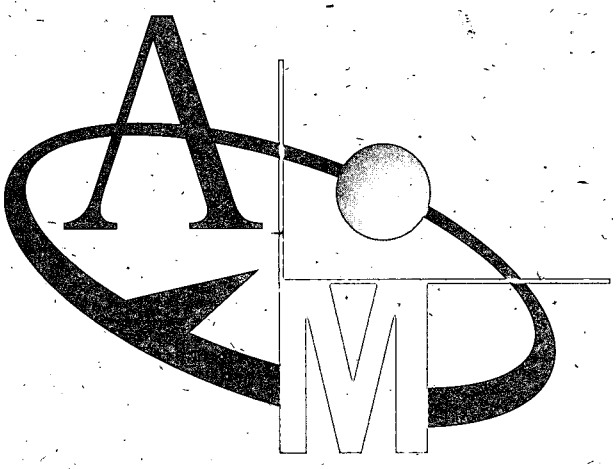
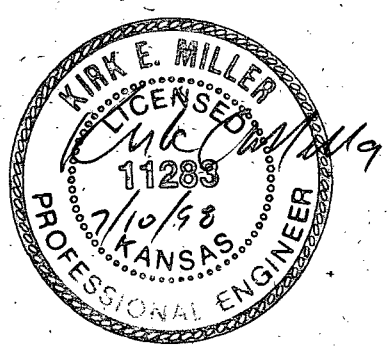
AUSTIN MILLER P.A.

ENGINEERING SERVICES





City of Park City Drainage Report Area Bound by Broadway, 53rd, Hydraulic, & I-235

July, 1998

City of Park City

6110 N. Hydraulic • Park City, KS 67219-2499 • (316) 744-2026

August 5, 1998

Ms. Terry Kollmai
Development Assistance Director
City of Wichita
455 N. Main-13th Floor
Wichita, Kansas 67202

Dear Terry:

Find enclosed a copy of a drainage report completed by Austin/Miller Engineers for your use. The drainage report covers an area of interest to the City lying south of 45th Street North, east of Broadway and west of I-135. I thought this report would be of value to the City, since there are two developments looking at locating in this area.

If you have any questions, please let me know.

Yours truly,

PARK CITY, KANSAS

Jack Whitson
Director of Economic Development & Planning

INTEROFFICE MEMORANDUM

Sensitivity: COMPANY CONFIDENTIAL
07:59am

Date: 10-Aug-1998

From: Marvin Krout
Dept: Planning
Tel No: 268-4425

Walk down to Engineering (7)

To: Vicky Huang
To: Mike Lindebak
CC: Steve Lackey
CC: Terry Kollmai

Subject: sending down drainage study

I am sending down to Vickie a drainage study done by Austin-Miller for Park City, which Jack Whitson sent it Terry for the City's information and Terry sent to me. It covers the area east of Broadway to I135 and from 53rd Street North south to I235. This includes the area south of 45th Street North, for which we have two significant pending plats. The plats are currently in the county, so the platting engineers are probably working with the County Engineer, but with the expected annexation step in September of the land west of Broadway in this area, these two tracts will be eligible for annexation. So I wanted to be sure City Engineering reviewed this study and offered any comments on the plats to the County Engineer and the Subdivision Committee, and then pass the study on to County Engineering.

AUSTIN MILLER P.A.
ENGINEERING SERVICES

July 10, 1998

Mr. Jack Whitson
City of Park City
6110 N. Hydraulic
Park City, KS 67219

RE: Drainage Report

Dear Mr. Whitson:

Accompanying this letter is a final draft of the drainage report for the property bound by Broadway, 53rd Street, Hydraulic, and I-235. I will be prepared to present this report to the Council on July 14, 1998.

If you have any questions or need additional information, please call.

Respectfully,
Austin Miller, P. A.

Kirk Miller, P. E.

254 S. Laura, Suite 210
Wichita, Kansas 67211
Tel 316-262-1281
Fax 316-262-6773
E-mail: foram@feist.com • http://www.feist.com/~foram

INTRODUCTION

An area bound by Broadway, I-235, Hydraulic, and 53rd Street North in Park City, Kansas, experiences drainage problems including poor drainage and localized flooding. This report will identify some of these problems and offer possible solutions.

EXISTING CONDITIONS

The streams that drain the subject property are Chisholm Creek and the Middle Fork of Chisholm Creek. Portions of these streams have been channelized. Chisholm Creek bounds the west side of the property, the Middle Fork of Chisholm Creek bounds the south, and a tributary to the Middle Fork bounds east. These streams have man-made dikes which prevent drainage from sheet flowing into the streams. The overall drainage area is shown in Figure 2.

The portion of the drainage area north of 49th Street, east of Chisholm Creek, and west of I-135 is developed with mostly single family residential, with areas of commercial development along 53rd Street North. The remainder of the property within the drainage area is mainly agricultural.

The USGS map for this area (Valley Center Quadrangle) indicates the area north of 49th Street and the area east of I-135 have natural ground slopes of about 2%. This slope should be adequate for proper drainage. The area south of 49th Street and west of I-135

has a slope which varies from about 0.3% to 0.1%. When areas are this flat, they are difficult to drain.

The Sedgwick County soil survey indicates the majority of the soil in this drainage basin is Tabler silty clay loam. This soil is a poor percolating soil with available water capacity ranging from 0.12 - 0.24 in/in. The Tabler soil is in hydrological group "D", which is a high runoff factor group. Perched water tables are often found with this soil type, at a depth of 2.5 to 3.5 feet.

ANALYSIS

The majority of the runoff in this drainage basin collects in a drainage ditch that discharges into Chisholm Creek. Figure 1 shows flows at various locations that were calculated for use in the drainage analysis. The first major area of constriction is at Larry's Trailers on Broadway. The channel discharges into two pipe culverts running under the pavement. The pipes are 24 " and 18", and have restricted flow due to pipe openings being covered with trash and concrete. These pipes have a limited capacity much less than actual flow. The affects on the upstream flooding at 45th Street are minimal because large flows will probably overtop the pipe culverts and sheets flow across the parking lot and the Schaefer property will act as a large flood plain and provide storm water detention. Improvements in this area will improve a localized flooding situation at Broadway and upstream to about 45th Street.

Storm water runoff calculations shown in Figure 1 show a flow in undeveloped and developed conditions less than the flows 4000 feet upstream because of the great increase in time of concentration. The ditch from 45th Street to Broadway is so flat that the time of concentration increases in orders of magnitude. This means that the flow is at a slow velocity from 45th Street to Broadway and will require a larger cross-sectional area to convey flow, which increases the chances of localized flooding in this area.

A 20' x 2.5' concrete box culvert carries the ditch run-off under Old Lawrence Road. The capacity of the culvert is 230 cfs with no headwater and 460 cfs with 2.5 feet of headwater. The 5 year runoff at this box culvert is 36 cfs and the 100 year runoff is 61 cfs in the undeveloped condition. In developed conditions, the 5 year flow is 238 cfs and the 100 year flow is 335 cfs. The box culvert does not have the capacity to carry the 5 year or 100 year storm in the developed condition without backwater at the bridge.

The ditch upstream from the box culvert has about a 15 foot wide bottom with side slopes of 1:1. The ditch is overgrown with trees, shrubs, and tall weeds. The City of Park City subdivision regulations indicate an overgrown channel has a roughness coefficient of 0.10, and a clean grass lined channel has a roughness coefficient of 0.03. Table 1 shows flows for various depths of the existing channel in the current condition and in a maintained condition.

The flow in the ditch for a five year storm is 65 cfs in an undeveloped state. If the property upstream of the ditch develops, the 5 year runoff will be 224 cfs and the 100 year runoff will be 388 cfs. The unmaintained channel in its current configuration has a capacity of 72 cfs at a depth of 4 feet. If the channels are cleaned and shaped with a 15 foot bottom and 3:1 side slopes, the capacity of the channel is 388 cfs (100 year storm runoff) at a depth of 4.35 feet.

The main channels passes through a 4-10'x5' box culvert at 45th Street North. The 5 year storm runoff at the box is 66 cfs and the 100 year runoff is 115 cfs undeveloped, and 224 cfs and 388 cfs respectively in a developed condition. The box will have tailwater control and flow at the depth of the downstream channel flow. At the north end of the box, the main channel is a roadside ditch along 45th street to the east. The ditch is not well defined. The 5 year flow in the ditch at the railroad is 65 cfs and the 100 year flow is 95 cfs undeveloped, with the developed flows being 216 cfs for the 5 year and 375 cfs for the 100 year storm. A ditch with a 6 foot bottom and 3:1 side slopes can carry the 5 year storm at a depth of about 3.6 feet at the railroad tracks under developed conditions. The ditch will be about 4.55 feet deep when carrying the 100 year storm. This ditch size is based upon the downstream channel being cleaned and maintained.

The main drainage continues to the east from the railroad tracks under I-135 to a channelized section about 1/4 mile west of Hydraulic. A large drainage area north of 45th Street is also drained by a ditch along the railroad, and ditches on the east and west sides

of I-135. There are multiple drainage culverts under I-135 from the north side of 45th Street to the north side of 53rd Street. These structures, with proper development of the property, should carry the drainage from the east side of I-135 to the west side of I-135.

POSSIBLE SOLUTIONS

The major drainage bottlenecks for the subject drainage area are south of 45th Street along the major drainage channel. The transition from a box culvert to much smaller pipes at Larry's Trailers is the first channel constriction. The land which the pipes run through is used for trailer storage. A culvert can be extended through the property for about $500,000. An open channel can be used instead of a culvert, but this would probably require purchase of the property. The property is not in Park City, so it may be difficult to construct any improvements at this site.

The ditch from Larry's Trailers to 45th Street is a major cause of poor drainage north of 45th Street. For proper upstream drainage, the channel should be cleaned and shaped. The 0.7 mile channel should have a minimum 15 foot bottom with 3:1 side slopes. If no improvements are made at Larry's Trailers, the channel should be wider to function as a detention pond and keep the water surface elevation lower. Because the channel is overgrown with large trees, the cost of this improvement will probably be about $325,000. As with Larry's Trailers, this property is not located in Park City.

By altering the drainage pattern along 45th street, the drainage can be forced to the railroad tracks, then south along the railroad to the Middle Fork of Chisholm Creek. A new structure would need to be installed under 45th Street, probably a 4-10'x4' RCB at a cost of about $75,000. The railroad ditch would need to be cleaned and widened to a 15 foot bottom with 3:1 side slopes. This total cost for this option will be about $380,000. The existing drainage along the south side of 45th street does not dump into the railroad ditch, but bypasses and continues to the west. The railroad ditch has a ditch plug which prevents drainage from 45th Street from entering the ditch. Because this would alter the natural drainage, permission would be required from the local governing bodies to do this. This property is also not in Park City.

If the drainage patterns are not altered to drain to the railroad, then the drainage could possibly be taken to the KDOT lake on the south side of 45th. To do this, a box culvert, probably 4-10'x4' RCB would need to be constructed from the north side of 45th to the KDOT lake. This box would cost about $400,000. KDOT and Sedgwick County would need to grant permits to do this. There is a possibility that the box may not need to be extended to the lake, but just across the road, with a ditch draining the box to the lake. This option would cost about $210,000.

One more option is to require storm water detention on the developing sites in the drainage basin. Typically, when a drainage basin has detention requirements, the detention will be in the upper 1/3 of the watershed. This watershed is nearly fully developed in the

upper 1/3 and detention cannot be required for existing developments. If drainage improvements are not made in this watershed, then a stringent detention policy may be necessary to insure the development does not adversely affect the downstream properties. In addition to limiting the peak runoff to no more than the undeveloped peak, a requirement to delay the peak may also be necessary. Because the flooding from mostly undeveloped ground exists, an even stricter policy may be necessary, such as dictating the peak runoff and peak delays in new developments, based on a designated peak discharge per acre. Any significant changes in the drainage areas or patterns may require alterations in a detention policy.

Another alternative that may help alleviate flooding is to alter the drainage patterns on the portion of the watershed east of I-135 so that the runoff goes to the Middle Fork of Chisholm Creek. If the water is diverted, approvals will need to be obtained from the City of Wichita and Sedgwick County, as the property is not in Park City. Diverting this runoff will decrease the watershed area and runoff and reduce flooding in the downstream channel.

A combination of alternatives may be used to solve the drainage problems. If all drainage north of 45th drains to the KDOT lake, and stormwater detention is required, then the size of the structure to the lake can be reduced. By keeping the peak runoff at its undeveloped peak, 4-36" pipes will drain the watershed. This will dramatically reduce the cost of construction versus carrying the developed flow.

CONCLUSION

Many of the drainage problems and solutions occur in properties outside of Park City. Cooperation from the City of Wichita would be helpful but should not be expected. If the properties adjacent to the ditch from 45th Street to Broadway develop, Wichita may require detention to avoid increasing drainage problems in Park City, but would probably not require improving the channel section from 45th Street to Broadway. Because of the anticipated lack of cooperation from downstream property owners, options for improving drainage are somewhat limited. The preferred option is probably to divert the 100 year storm, fully developed, to the KDOT Lake. The problem with this option is the cost. If funding is not available, the City of Park City may need to initiate a storm water detention policy for this watershed. This may reduce the acreage of developable land, but detention ponds may be necessary to provide dirt for required fill during the development of the sites. By combining detention and drainage to the KDOT Lake, a much more economical solution is available. The present drainage system cannot handle the undeveloped flows. If a system is installed to convey the undeveloped storm, and detention is required with all new upstream developments, then a properly designed and built system will work satisfactory and eliminate flooding on a 100 year storm.

APPENDIX

Flows at various locations in the Drainage Basin

Q = (c) x (i) x (A)
where Q is the flow
c is the roughness coefficient of the channel — c=0.3 for undeveloped, 0.6 for industrial uses
i is the rainfall intensity — measured in inches per hour
A is the drainage area — measured in acres

45th Street North and the railroad tracks

Undeveloped

Time of concentration Tc = 4500 ft/0.24fps + 2900 ft/0.58 fps = 23750 sec = 396 min = 6.6 hrs

i(5yr) = 0.64 in/hr A = 340 acres Q(5) = (.3)(.64)(340 ac) = 65 cfs

i(100yr)=0.93 in/hr Q(100) = (.3)(0.93)(340) = 95 cfs

Developed

Time of concentration Tc = 4500 ft/1.7fps + 2900 ft/0.40 fps = 9897 sec = 165 min = 2.75 hrs

i(5yr) = 1.06 in/hr A = 340 acres Q(5) = (.6)(1.06)(340 ac) = 216 cfs

i(100yr)=1.84 in/hr Q(100) = (.6)(1.84)(340) = 375 cfs

Figure 1

45th Street North at 4-10'x 5' RCB

Undeveloped

Time of concentration Tc = 4500 ft/0.24fps + 4200 ft/0.58 fps = 25991 sec = 433 min = 7.2 hrs

i(5yr) = 0.50 in/hr A = 440 acres Q(5) = (.3)(.50)(440 ac) = 66 cfs

i(100yr)=0.87 in/hr Q(100) = (.3)(0.87)(440) = 115 cfs

Developed

Time of concentration Tc = 4500 ft/1.7fps + 4200 ft/0.40 fps = 13147 sec = 219 min = 3.65 hrs

i(5yr) = 0.85 in/hr A = 440 acres Q(5) = (.6)(0.85)(440 ac) = 224 cfs

i(100yr)=1.47 in/hr Q(100) = (.6)(1.47)(440) = 388 cfs

At Broadway

Undeveloped

Time of concentration Tc = 4500 ft/0.24fps + 4200 ft/0.58 fps + 3700 ft/.06 = 87658 sec = 1460 min = 24.3 hrs

i(5yr) = 0.20 in/hr A = 600 acres Q(5) = (.3)(.20)(600 ac) = 36 cfs

i(100yr)=0.87 in/hr Q(100) = (.3)(0.34)(600) = 61 cfs

Figure 1 (cont.)

Developed

Time of concentration Tc = 4500 ft/1.7fps + 4200 ft/0.40 fps + 3700 ft/0.35 =23718 sec = 395 min = 6.6 hrs

i(5yr) = 0.66 in/hr A = 600 acres Q(5) = (.6)(.66)(600 ac) = 238 cfs

i(100yr)=0.93 in/hr Q(100) = (.6)(0.93)(600) = 335 cfs

45th Street North and the railroad tracks, everything draining to KDOT lake

Undeveloped

Time of concentration Tc = 4500 ft/0.24fps + 2900 ft/0.58 fps = 23750 sec = 396 min = 6.6 hrs

i(5yr) = 0.64 in/hr A = 440 acres Q(5) = (.3)(.64)(440 ac) = 85 cfs

i(100yr)=0.93 in/hr Q(100) = (.3)(0.93)(440) = 123 cfs

Developed

Time of concentration Tc = 4500 ft/1.7fps + 2900 ft/0.40 fps = 9897 sec = 165 min = 2.75 hrs

i(5yr) = 1.06 in/hr A = 340 acres Q(5) = (.6)(1.06)(440 ac) = 280 cfs

i(100yr)=1.84 in/hr Q(100) = (.6)(1.84)(440) = 486 cfs

Figure 1 (cont.)

OPEN CHANNEL FLOW

Channel Depth	4	Area	76	Existing Channel
Channel Bottom	15	Wetted Perimeter	26.314	South of 45th
Side Slope	1	Hydraulic Radius	2.8882	
Channel Roughness	0.1			
Channel Slope	0.001	Channel Flow	72.43	
Channel Depth	2.6	Area	45.76	Cleared Channel
Channel Bottom	15	Wetted Perimeter	22.354	South of 45th
Side Slope	1	Hydraulic Radius	2.0471	100 yr Storm
Channel Roughness	0.03			Undeveloped
Channel Slope	0.001	Channel Flow	115.56	
Channel Depth	1.85	Area	31.173	Cleared Channel
Channel Bottom	15	Wetted Perimeter	20.233	South of 45th
Side Slope	1	Hydraulic Radius	1.5407	5 yr Storm
Channel Roughness	0.03			Undeveloped
Channel Slope	0.001	Channel Flow	65.135	
Channel Depth	5.2	Area	105.04	Cleared Channel
Channel Bottom	15	Wetted Perimeter	29.708	South of 45th
Side Slope	1	Hydraulic Radius	3.5358	100 yr Storm
Channel Roughness	0.03			Developed
Channel Slope	0.001	Channel Flow	381.86	
Channel Depth	3.85	Area	72.573	Cleared Channel
Channel Bottom	15	Wetted Perimeter	25.889	South of 45th
Side Slope	1	Hydraulic Radius	2.8032	5 yr Storm
Channel Roughness	0.03			Developed
Channel Slope	0.001	Channel Flow	226	

Channel Depth	2.35	Area	51.818	Improved Channel
Channel Bottom	15	Wetted Perimeter	29.863	South of 45th
Side Slope	3	Hydraulic Radius	1.7352	100 yr Storm
Channel Roughness	0.03			Undeveloped
Channel Slope	0.001	Channel Flow	117.2	

Channel Depth	1.75	Area	35.438	Improved Channel
Channel Bottom	15	Wetted Perimeter	26.068	South of 45th
Side Slope	3	Hydraulic Radius	1.3594	5 yr Storm
Channel Roughness	0.03			Undeveloped
Channel Slope	0.001	Channel Flow	68.118	

Channel Depth	4.35	Area	122.02	Improved Channel
Channel Bottom	15	Wetted Perimeter	42.512	South of 45th
Side Slope	3	Hydraulic Radius	2.8702	100 yr Storm
Channel Roughness	0.03			Developed
Channel Slope	0.001	Channel Flow	386.01	

Channel Depth	3.3	Area	82.17	Improved Channel
Channel Bottom	15	Wetted Perimeter	35.871	South of 45th
Side Slope	3	Hydraulic Radius	2.2907	5 yr Storm
Channel Roughness	0.03			Developed
Channel Slope	0.001	Channel Flow	223.66	

Channel Depth	3.6	Area	60.48	45th St. Ditch
Channel Bottom	6	Wetted Perimeter	28.768	5 yr Storm
Side Slope	3	Hydraulic Radius	2.1023	Developed
Channel Roughness	0.03			
Channel Slope	0.002	Channel Flow	219.86	

Channel Depth	4.55	Area	89.408	45th St. Ditch
Channel Bottom	6	Wetted Perimeter	34.777	100 yr Storm
Side Slope	3	Hydraulic Radius	2.5709	Developed
Channel Roughness	0.03			
Channel Slope	0.002	Channel Flow	371.69	

Table 1

Construction Cost Projections
Drainage Improvements
Park City, Kansas

Larry's Trailers drainage improvements

Item	Quantity	Unit Price	Unit	Cost
4-10'x4' RCB	400	$1,000.00	LF	$400,000
Wing Walls	2	$15,000.00	Each	$30,000
Rem. of Ex. Str.	1	$10,000.00	LS	$10,000
	Subtotal			$440,000
	Engg., Insp., Admin.			$88,000
	Project Cost			$528,000

Drainage Ditch from Broadway to 45th Street

Item	Quantity	Unit Price	Unit	Cost
Clearing and Grubbing	3800	$50.00	LF	$190,000
Grading	3800	$20.00	LF	$76,000
Erosion Protection	100	$50.00	SY	$5,000
	Subtotal			$271,000
	Engg., Insp., Admin.			$54,200
	Project Cost			$325,200

Drainage along the railroad

Item	Quantity	Unit Price	Unit	Cost
4-10'x4' RCB	45	$1,000.00	LF	$45,000
Wing Walls	2	$15,000.00	Each	$30,000
Grading	2400	$100.00	LF	$240,000
	Subtotal			$315,000
	Engg., Insp., Admin.			$63,000
	Project Cost			$378,000

Drainage Structure to KDOT Lake (Total Enclosure, No Detenetion)

Item	Quantity	Unit Price	Unit	Cost
4-10'x4' RCB	300	$1,000.00	LF	$300,000
Wing Walls	2	$15,000.00	Each	$30,000
Pavmt Rem&Replace	300	$25.00	SY	$7,500
	Subtotal			$337,500
	Engg., Insp., Admin.			$67,500
	Project Cost			$405,000

Drainage Structure to KDOT Lake (Partial Enclosure, No Detention)

Item	Quantity	Unit Price	Unit	Cost
4-10'x4' RCB	120	$1,000.00	LF	$120,000
Wing Walls	2	$15,000.00	Each	$30,000
Ditch Grading	180	$100.00	LF	$18,000
Pavmt Rem&Replace	300	$25.00	SY	$7,500
	Subtotal			$175,500
	Engg., Insp., Admin.			$35,100
	Project Cost			$210,600

Drainage Structure to KDOT Lake (Partial Enclosure, With Detention)

Item	Quantity	Unit Price	Unit	Cost
4-36" RCP	120	$300.00	LF	$36,000
Wing Walls	2	$15,000.00	Each	$30,000
Ditch Grading	180	$100.00	LF	$18,000
Pavmt Rem&Replace	300	$25.00	SY	$7,500
	Subtotal			$91,500
	Engg., Insp., Admin.			$18,300
	Project Cost			$109,800

Table 2

ATTACHMENT E

DRAINAGE CRITERIA

CITY OF WICHITA, KANSAS

AVERAGE OVERLAND FLOW VELOCITY FOR USE WITH URBANIZED AREAS

Surface Type	VELOCITY IN FEET/SECOND FOR SLOPES IN PERCENT SHOWN																			
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	20.0
Forest with Heavy Ground Litter or Meadow	0.03	0.04	0.06	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.16	0.21	0.28	0.33	0.39	0.46	0.53	0.60	0.72	1.10
Fallow or Minimum Tillage Cultivation	0.06	0.08	0.10	0.12	0.13	0.14	0.16	0.17	0.18	0.19	0.29	0.40	0.51	0.66	0.78	0.91	1.05	1.20	1.44	2.10
Short Grass Pasture or Lawns	0.09	0.13	0.15	0.18	0.20	0.21	0.23	0.25	0.26	0.28	0.45	0.60	0.77	0.96	1.17	1.33	1.50	1.68	1.98	3.20
Almost Bare Ground	0.16	0.22	0.28	0.31	0.35	0.38	0.41	0.44	0.46	0.49	0.70	0.85	1.05	1.26	1.50	1.75	2.03	2.32	2.79	4.40
Grassed Waterway	0.35	0.48	0.58	0.67	0.77	0.84	0.91	0.98	1.05	1.12	1.54	1.82	2.10	2.38	2.78	3.20	3.66	4.14	4.56	7.00
Paved Areas (Sheet Flow) or Shallow Gutter Flow	0.44	0.62	0.77	0.91	1.05	1.12	1.19	1.26	1.33	1.40	2.00	2.55	3.20	3.83	4.41	5.04	5.70	6.00	6.20	9.00

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

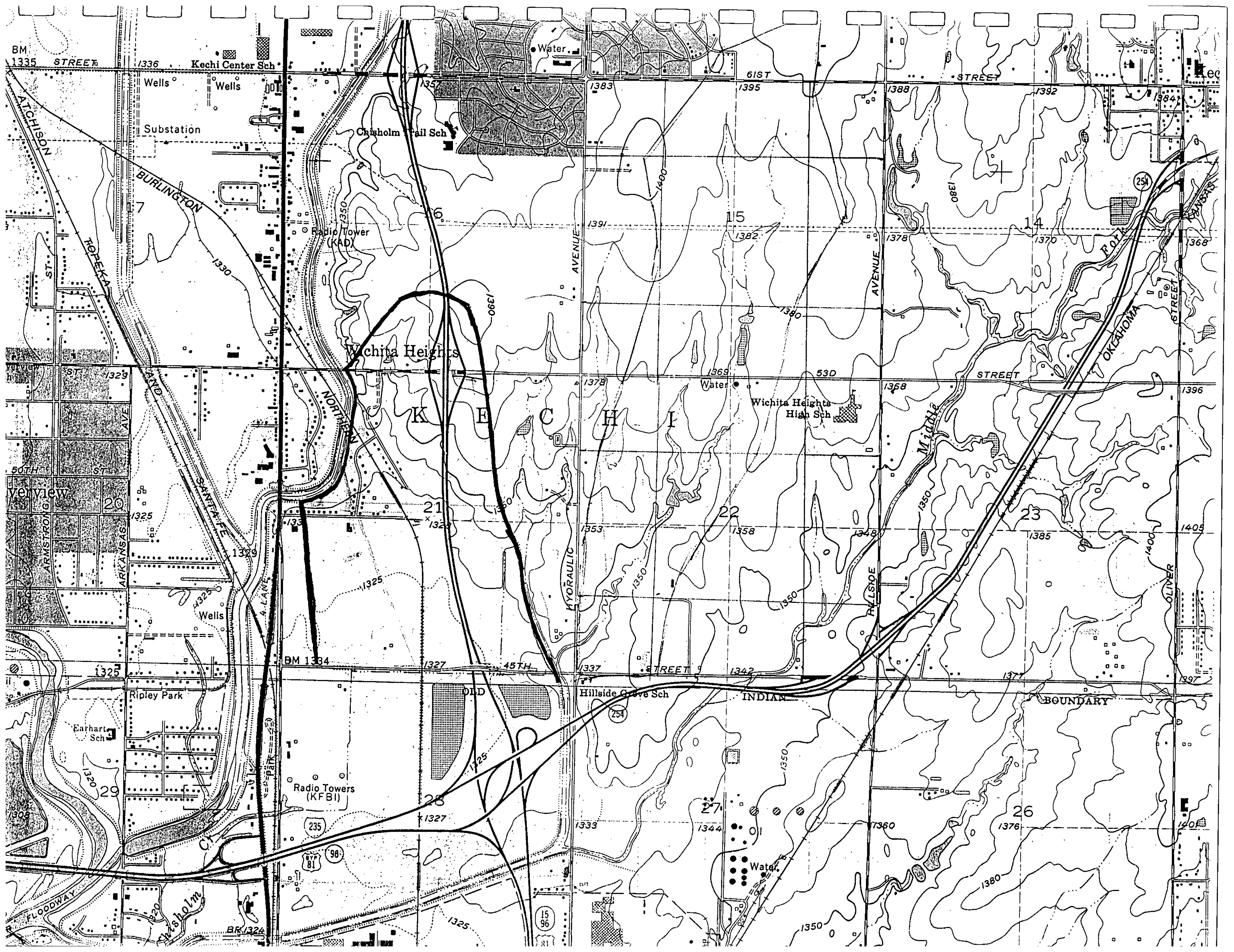
DURATION IN MINUTES	RETURN PERIODS OF 1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
5	4.18	5.57	6.53	7.41	8.52	9.48	10.32
6	3.99	5.32	6.25	7.09	8.16	9.09	9.89
7	3.81	5.09	5.99	6.81	7.84	8.74	9.50
8	3.66	4.89	5.75	6.55	7.55	8.42	9.15
9	3.52	4.70	5.54	6.31	7.28	8.13	8.83
10	3.39	4.52	5.34	6.09	7.04	7.86	8.54
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

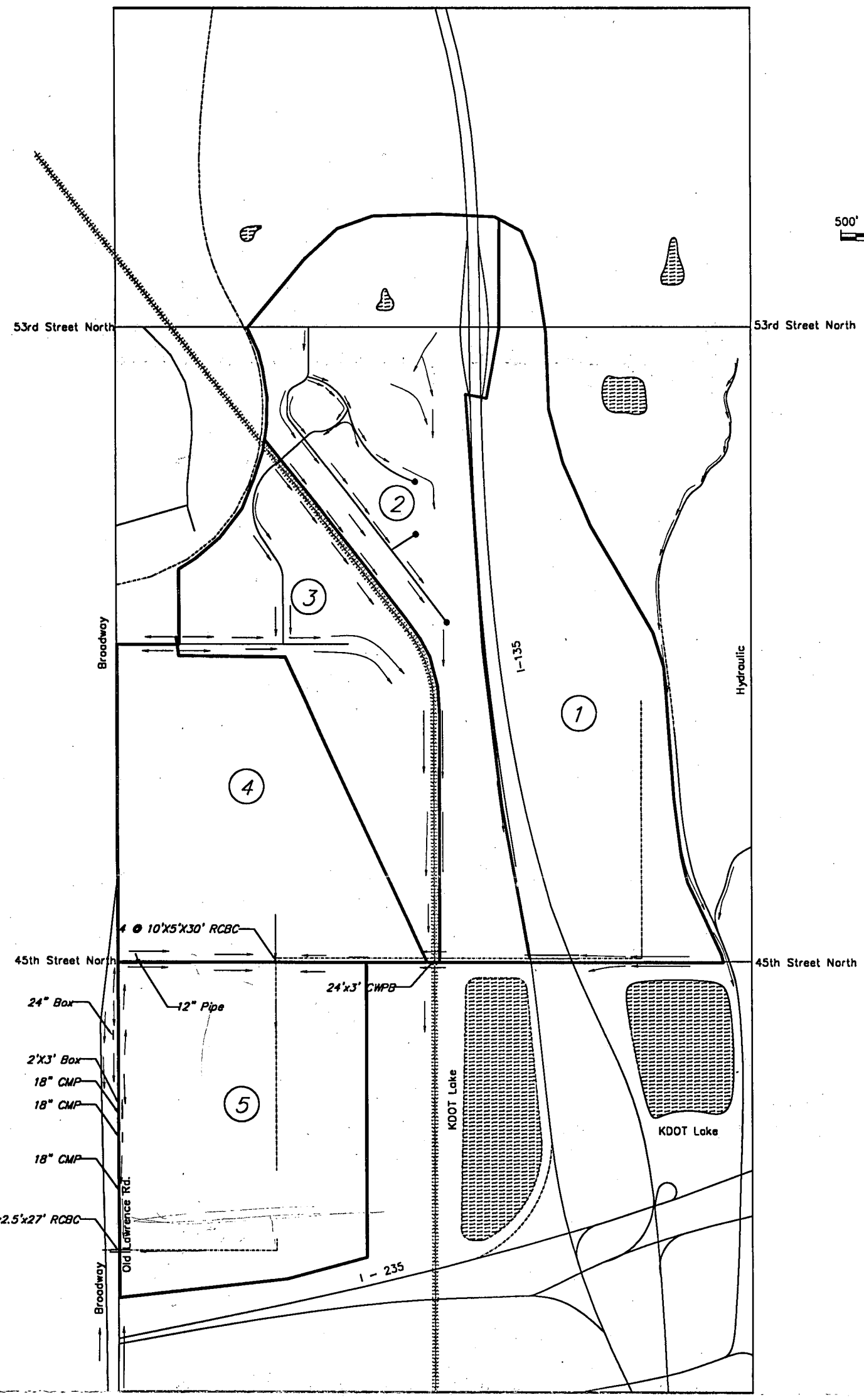
DURATION IN MINUTES	RETURN PERIODS OF 1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
46	1.70	2.05	2.54	2.97	3.48	3.93	4.33
47	1.67	2.02	2.50	2.93	3.44	3.88	4.28
48	1.66	2.00	2.47	2.90	3.39	3.84	4.23
49	1.64	1.97	2.44	2.86	3.35	3.79	4.18
50	1.61	1.95	2.41	2.83	3.32	3.75	4.13
51	1.59	1.92	2.38	2.79	3.28	3.71	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

DURATION IN MINUTES	RETURN PERIODS OF 1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
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

DURATION IN HOURS	RETURN PERIODS OF 1-YR	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
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



BM 1335
61ST STREET
Kechi Center Sch
Wells
Substation
Chisholm Trail Sch
Water
Radio Tower (KAD)
ATCHISON
TOPEKA
AND
SANTA FE
BURLINGTON
NORTHERN
Wichita Heights
KECHI
53D STREET
Wichita Heights High Sch
AVENUE
HYDRAULIC
HILLSIDE
OLIVER
OKLAHOMA
KANSAS
Middle Fork
45TH STREET
OLD INDIAN BOUNDARY
Hillside Grove Sch
BM 1334
Ripley Park
Earhart Sch
Radio Towers (KFBI)
ARKANSAS
ARMSTRONG
50TH ST
4-LANE
Park
Chisholm Cr
FLOODWAY
BR 1324
Riverview

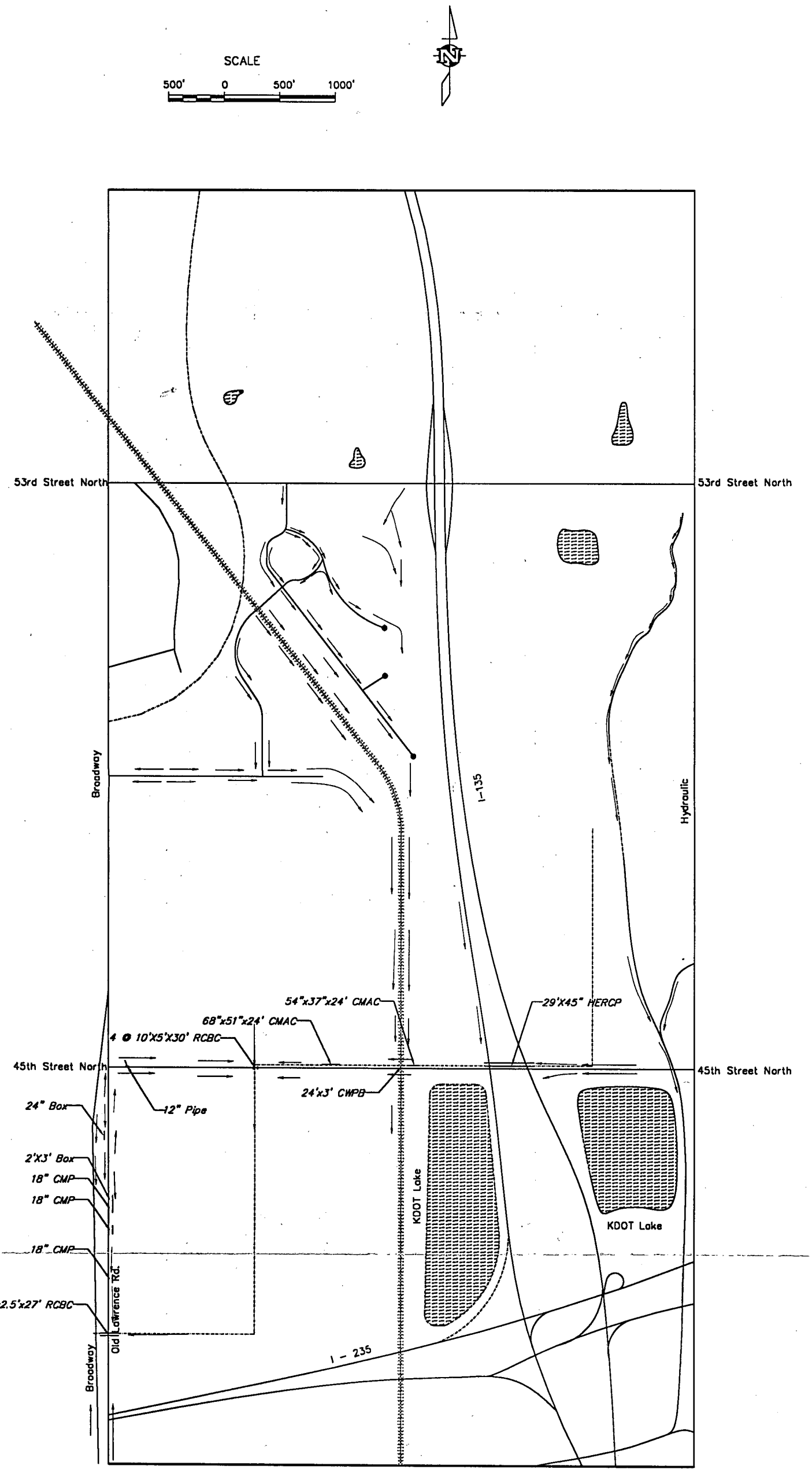


Area #	Area	Q_5 (und.)	Q_5 (dev.)	Q_{100} (und.)	Q_{100} (dev.)	
1	160	30	102	45	175	Flow for this area
	160	30	102	45	175	Entire flow to downstream end
2	105	20	67	30	116	Flow for this area
	265	51	169	74	293	Entire flow to downstream end
3	75	30	60	52	104	Flow for this area
	340	65	216	95	375	Entire flow to downstream end
4	100	8	58	24	100	Flow for this area
	440	66	224	115	388	Entire flow to downstream end
5	160	12	93	20	161	Flow for this area
	660	36	238	61	335	Entire flow to downstream end

Drainage Areas

Figure 2

AUSTIN MILLER P.A.
ENGINEERING SERVICES
254 S. Laura; Suite 210 Wichita, KS 67211
316/262-1281 fax: 316/262-6773



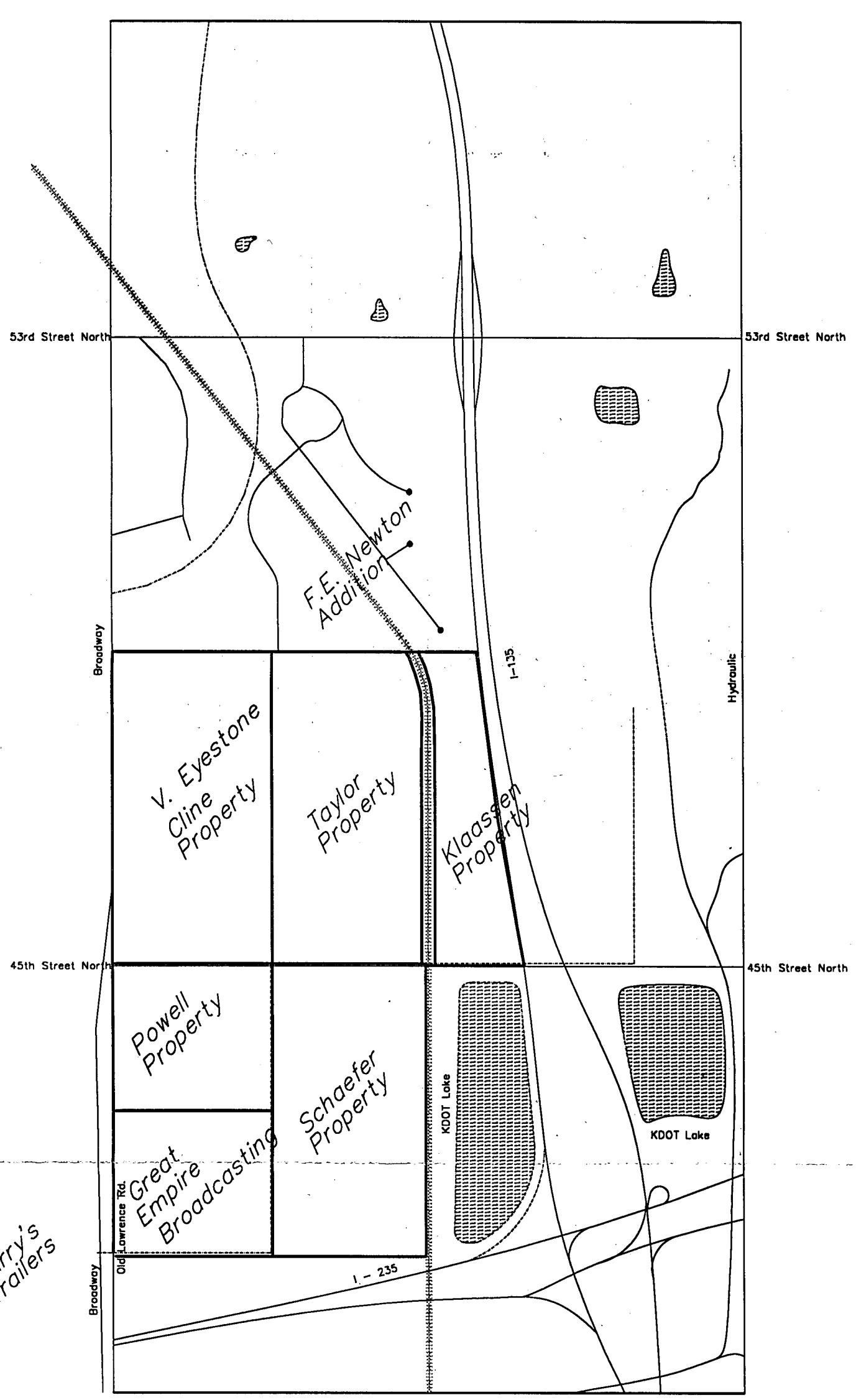
Drainage Patterns

Figure 3

AUSTIN MILLER P.A.
ENGINEERING SERVICES
254 S. Laura; Suite 210 Wichita, KS 67211
316/262-1281 fax: 316/262-6773

SCALE

500' 0 500' 1000'



Property Owners

Figure 4

AUSTIN MILLER P.A.
ENGINEERING SERVICES
254 S. Laura; Suite 210 Wichita, KS 67211
316/262-1281 fax: 316/262-6773