PART VI - RECOMMENDED SYSTEM IMPROVEMENTS

PART VI

RECOMMENDED SYSTEM IMPROVEMENTS

A. ALTERNATIVE SYSTEM COMPONENTS

1. GENERAL

There are two basic types of drainage system components, "structural" and "nonstructural." Both types must be operated in a complementary way to avoid drainage "problems." Each element of the system has a cost associated with providing it. The goal of this plan is to recommend the best balanced combination of all system elements that will provide an acceptable level of service at the greatest economic benefit to the City as a whole.

2. NONSTRUCTURAL ELEMENTS

Nonstructural elements of a drainage system are generally those elements that don't involve significant capital construction but function as a part of the system of limiting runoff. Their "cost" is primarily measured by generally lowered tax revenue and economic activity, although some direct maintenance cost often applies to their continued performance. Once they become part of the "system" they can't readily be modified because such modifications will increase runoff to the entire downstream system reducing its level of service. Nonstructural elements include the following.

a. Zoning and Land Use

Zoning ordinances prescribe types of land use and density of development which determines, in part, relative runoff rates. Dense land use, such as commercial or industrial development, generates high runoff rates compared to residential or agricultural land use; areas of small lots will generate more runoff than areas developed in large lots. In real estate vernacular, the "highest and best use" of land produces the greatest tax revenue which corresponds with the densest types of development. Down-zoning to reduce runoff, and the associated cost of the downstream drainage system, reduces the potential revenue from properties. This loss of

revenues, then, can be viewed as the "cost" of zoning with respect to drainage.

b. Flowage Easements

Flowage easements involve the acquisition of the right to periodically use a natural channel and its overbank floodway or the overflow channel above an improved conveyance element to convey drainage. In some sense, these easements represent a form of limited conservation zoning in that they preclude any improvement of the land occupied by the easement. Flowage easements follow the natural channel or pipe alignment and vary in width to include all land below the elevation of the design hydraulic gradient plus a freeboard allowance. Representative easement widths are in the range of 50 to 100 feet for natural channels and 15 to 40 feet for improved system facilities. Natural channels and their overbank areas require little initial construction but must be maintained on a regular basis to remove obstructing debris and snags. Overflow channels above enclosed pipes or along improved channels must also be maintained to prevent obstructions to flow. Because these easements are typically located on private property, this responsibility generally falls to the individual property owners.

c. Regulatory Detention

Regulatory detention is the adoption of appropriate ordinances and implementation of regulations that, while permitting intense land uses, require the provision, operation, and maintenance of on-site detention facilities to limit the peak rate of discharge from the owner's, or developer's, site to the downstream system. They require no direct capital investment by the City but have the effect of either diminishing the net developable land by the area required for detention or requiring more costly structures as part of the development. They are most effective when physically located at the upper end of watersheds.

d. Removal of Improvements

The purchase, demolition, and removal of structures subject to damage from drainage is a viable method of providing drainage service to the City as a whole. Drainage "problems" are the damage and/or extreme nuisance resulting from the flow of storm water on private and public property. Removal of the affected improvements is a viable choice in cases where the cost of managing the water is disproportionately large compared with the value of the improvement.

3. STRUCTURAL ELEMENTS

Structural elements of a drainage system are those designed to collect and convey runoff. They include structures that require a significant capital investment to build, and will depreciate over a long period of time. Structural components of the system include conveyance facilities and public detention facilities.

a. Conveyance Facilities

Conveyance facilities are the conventional drainage structures such as:

- Pipes
- Inlets
- Culverts
- Bridges
- Lined open channels

b. Public Detention Facilities

Public detention facilities are ponds, dry ponds, and functionally similar structures constructed with controlled service and emergency spillways that are operated by the City to reduce the peak rate of flow in the drainage system. Land enclosed by some may be capable of other beneficial uses such as open parks and buffer zones between different land use areas. The construction cost of the facility is often moderate when compared with alternative structural conveyance facilities. Because they are functionally most effective when located near the upper reaches of watersheds, the land occupied is

valuable, and its acquisition forms a large part of the cost of their development. They require regular maintenance in the form of mowing and periodic removal of the sediment trapped by the facility.

4. COMPARISON OF ALTERNATIVES

Table VI-1 presents a qualitative comparison of the performance and cost impact typical of the alternative system components.

TABLE VI-1

COMPARISON OF ALTERNATIVES

System Component	Land Area Required	Land Value	Tax Base Effect	Regular Maint. Required	Capital Cost	Depr.
Nonstructural						
Downzoning	None	High	Negative	None	None	None
Flowage Easements	High	Low	None	High	None	None
Regulatory Detention	Moderate	High	Slight	None	None	None
Removal of Improvements	Moderate	High	Negative	None	None	None
Structural						
Enclosed Pipe/Culvert	Low	None	None	Moderate	High	High
Lined Open Channels	Moderate	None	None	Moderate	Moderate	High
Municipal Detention Basins	High	High	Slight	High	Moderate	Low

5. EVALUATION OF ALTERNATIVES

a. Zoning and Land Use

The majority of the undeveloped areas which are zoned for more intense future land uses are located within the Little Kitten Creek, North, Wildcat Southwest and Eureka Valley watersheds. Most are intended for residential development except for the Eureka Valley area which is planned for primarily industrial development. Some additional industrial/commercial development is planned in the Downtown East watershed in the industrial park east of Tuttle Creek Boulevard although that area is nearing full development.

The only area where a zoning change is recommended is in the Downtown East industrial area. In order to provide as much storage capacity as possible upstream from the Poyntz Avenue pump station,

portions of the area currently zoned for future industrial development should be left undeveloped. The area east of Tuttle Creek Boulevard, between McCall Road and the water treatment plant sludge ponds, should be left open and an additional ponding area constructed in this area. The area to the north of the sludge ponds extending to Casement and Hayes should also be left undeveloped for temporary ponding when water is diverted to the north by the Riverside Drain diversion structure. A more specific discussion of this area is contained in Part VII of this report dealing with the stormwater pumping stations.

b. Flowage Easements

It is recommended that the City require dedication of flowage easements for all new or reconstructed conveyance elements, including natural channels retained in the system in developing areas, where the 10-year peak discharge exceeds 100 CFS. These easements should cover the overflow area for the element, whether open channel or enclosed system, determined as the 100-year flood elevation plus one foot. Limitations on permanent obstructions within the easement should be included in the dedication. Specific requirements for flowage easements are included in the proposed "Stormwater Management Criteria" document which has been included as an appendix to this report.

c. Regulatory Detention

The use of regulatory detention was investigated in several undeveloped areas including the upper reaches of the Little Kitten Creek watershed, the Eureka Valley watershed, two locations within the North watershed and in the industrial park area of the Downtown East watershed. The use of regulatory detention is recommended for all of these areas except the two locations in the North watershed.

In the Downtown East and Eureka Valley industrial developments the specific drainage areas include those tributary to Lines 1160, 1177, 13115, 13120 and 13125 as indicated on the watershed maps. Adequate

detention volume should be provided as the currently open individual areas in the Downtown East watershed develop to prevent increases in the peak discharges to the box culverts under US 24. As the Eureka Valley area develops, private detention should be provided by developers in accordance with the requirements in the criteria document. Several culverts will still require improvement but the magnitude of the projects will be reduced by the use of detention.

In the Little Kitten Creek watershed, the existing bridges at Kimball and Anderson have sufficient capacity to handle the peak discharges from future residential development in the upper reaches and maintain at least a 10-year level of service. Because of the relatively steep slope along much of its length, the average velocity in the creek is already above 5 fps which is considered an erosive velocity in earthen channels. Therefore, reducing the future flows with detention will not prevent overloading the existing road culverts or reduce the velocity or erosive action along the channel. However, several homes along the lower reaches of the channel are already in jeopardy of being adversely impacted by a 5-10 year return period storm. Once the upper watershed is fully developed these downstream areas will be inundated during even more frequent events. Therefore, it is recommended that regulatory detention be required in the upper reaches of the Little Kitten Creek watershed north of Kimball along the main channel and its tributaries. Detention designed in accordance with the proposed criteria document will keep flows for the 2, 5 and 10 year return period storms at approximately existing levels. The greatest impact will be during the less frequent storm events when peak discharge to the downstream system will be reduced by as much as 50 percent. It is also recommended that the requirements for permanent flowage easements along the natural channel reaches retained in the drainage system of developed areas be rigorously enforced to avoid future problems with obstruction of the channel and erosion of private property along the channel.

In the North watershed, the use of detention was investigated in undeveloped drainage areas tributary to Line 11006 (zoned for future low-to-medium density residential use) and Line 11090 (zoned for office, high-density residential and institutional development). In the first area, detention reduces the future flow to Line 11006, two arch pipes under Browning Avenue, but does not totally eliminate the need for the improvement; however, the cost of construction and maintenance of the detention would be far greater than the additional cost of providing a culvert large enough for the entire future peak flow. In the second area, the future developed peak discharge does not exceed the capacity of the downstream system, specifically the triple 7'X 4' RCB across Browning (Line 11089), assuming the system is maintained. Therefore, detention in this location does not appear to have any real benefit.

The impact of two existing detention facilities and a planned detention facility on Ft. Riley property within the upper reaches of the Eureka Valley watershed, were also investigated as part of the existing system analysis. The two existing ponds have relatively little impact on the downstream drainage system across the municipal airport and on to the box culverts across K-18. However, the much larger, planned facility will dramatically reduce the discharge to the actual Eureka Valley Tributary channel once it is in place. This will eliminate a great deal of the flooding in the area along the existing channel to the south of Eureka Drive. It is therefore recommended that the City work with Ft. Riley to the greatest extent possible to expedite the construction of this facility.

d. Removal of Improvements

The removal of improvements was considered only in the vicinity of Tecumseh and Quivera where overflows from the inadequate storm drainage system flood the low area in the street and occasionally enter three to five houses along Tecumseh and College View. However, removing the structures would not eliminate the street flooding and associated traffic problems or the need for improving

the severely undersized downstream drainage system. Therefore, the removal of structures at this location is not recommended except as an interim solution to the structure flooding problems.

e. Conveyance Facilities

The recommended system improvements primarily involve enlarged or modified conveyance facilities, typically through replacement of existing facilities with larger pipes or box culverts. Open channels currently included in the system were generally retained with channel lining recommended in some instances.

f. Public Detention Facilities

A public detention facility was investigated in the CICO Park area during the conceptual design of improvement alternatives along CICO Tributary. The areas available for detention facilities were located within the park itself, along the east side. It was determined that the available storage volume was inadequate to substantially reduce peak flows downstream and did not eliminate the need for or reduce the magnitude of required improvements in the downstream system. Therefore, a detention facility at this location is not recommended.

In the 1974 stormwater management report, an option for a detention facility in the area north of Tecumseh and east of Wharton Manor Road was proposed to reduce the size of downstream system improvements. Since that time, construction of the Riley County Health Department building and a planned expansion of Wharton Manor has encroached upon the area to the point that it is no longer feasible. The limited amount of detention storage available would have essentially no impact on the magnitude of downstream improvements.

No other feasible locations for public detention facilities were identified in any of the other watersheds.

B. CAPITAL IMPROVEMENT PROJECTS

1. SCOPE

The location of capital improvement projects recommended by the study to correct deficiencies in the existing drainage system are indicated on Figure VI-1. Projects include one or more deficient modeled reaches of the drainage system that have been grouped to define a project that is logically constructable as an entity and, when complete, will eliminate an existing deficiency within the drainage system.

Although all existing major drainage system components were included in the analysis and problem identification process, not all elements that fail to meet the proposed recommended hydraulic criteria for new construction are included in the project recommendations. Locations where deficiencies are indicated by the analysis but where there are no apparent or reported adverse effects are not recommended for improvement. In addition, facilities such as state highway culverts and privately- owned drainage facilities have not been recommended for improvement since the City does not have jurisdiction over those system elements. In some cases, improvements have been proposed but have been included in a discretionary projects list when system deficiencies did not specifically fit the criteria outlined for improvements. (The discretionary project list is presented later in this report section.)

Generally, only those system elements which are currently public facilities and where the existing deficiency has one or more of the following recurring adverse effects are included in the identified projects:

- Building flooding at 25 year or more frequent intervals.
- Erosion on private property due to the direct discharge from public drainage facilities that, if permitted to continue, will eventually either endanger buildings or adversely affect the use of the property.
- Recurring nuisance and the lack of maintenance control created by the uncontrolled discharge of water collected in public right-of-way onto adjacent private property.

Improvements along natural channels that are located in developed areas are not included in the recommended projects list. While it is noted that problems have been reported at a number of locations, the City's policy continues to be not to perform maintenance or make repairs on existing, unimproved channels retained in the drainage system of developed areas. However, improvements to two channel reaches have been included for consideration in the discretionary projects list in the event that this policy is relaxed or changed at some point in the future.

2. RECOMMENDED PLAN SUMMARY

a. Scope

Eight improvement projects are recommended to upgrade the existing municipal storm drainage system. Included in the projects is construction of

- 2,550 lineal feet of pipe storm sewers
- 6,370 lineal feet of concrete box culverts
- Two energy dissipators at existing box culverts
- Enlarged pump station with additional ponding capacity.

b. Project Descriptions

Tables VI-2 and VI-2A summarize the projects and the costs included in the recommended improvements program. The first table includes Project No. 2, the recommended improvements for replacing inadequate drainage system components in the Tecumseh-Quivera area. The second table indicates the same information but substitutes Project No. 2A, which includes only removal of the affected buildings in the Tecumseh-Quivera area, for Project No. 2. Again, it is important to note that Project No. 2A is proposed only as an interim solution to specific aspects of the problem since it will not alleviate street flooding and overflows that occur throughout the area.

TABLE VI - 2

RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

Project Number	Project Name	Capital Cost	Annual Maint. Cost
1	Denison-Anderson System	2,625,100	2,490
2	Tecumseh-Quivera System	2,168,700	2,090
3	Hartford Road	658,100	800
4	Allen Road	689,600	750
5	Nevada Street	80,350	170
6	Claflin-CICO Culvert	250,000	350
7	Dickens Energy Dissipator	50,000	100
8	Poyntz Ave. Pump Station	679,000	2,500
	Totals	$ 7,200,850	$ 9,250

TABLE VI - 2A

ALTERNATIVE RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

Project Number	Project Name	Capital Cost	Annual Maint. Cost
1	Denison-Anderson System	2,625,100	2,490
2A	Tecumseh-Quivera Alternate	360,000	500
3	Hartford Road	658,100	800
4	Allen Road	689,600	750
5	Nevada Street	80,350	170
6	Claflin-CICO Culvert	250,000	350
7	Dickens Energy Dissipator	50,000	100
8	Poyntz Ave. Pump Station	679,000	2,500
	Totals	$ 5,392,150	$ 7,660

The following pages present the detailed information for each project. Information on cost estimating and priority rankings is outlined and discussed in more detail later in this section.

MANHATTAN, KANSAS
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

PROJECT NAME: Denison-Anderson System

PROJECT IDENTIFICATION NUMBER: 1

PERTINENT DATA SUMMARY:
Watershed: Downtown West
Priority No.: 2 (w/Proj. No. 2); 6 (w/Proj. No. 2A)
Design Capacity: 200-905 CFS
Cost Estimates: Capital $ 2,625,100 Annual $ 2,490
Model Reach Number(s): 2027, 2030, 2035, 2080, 2083 (new), 2087 (new)
Map Reference Sheets: 9
Return Period: 10 years

EXISTING PROBLEM DESCRIPTION:

The existing parallel systems of pipes and box culverts along Anderson from 14th St. to Denison and across the southwest corner of the K-State campus provide less than a 2-year level of service. Overflows into the streets cause traffic problems on heavily traveled thoroughfares into and around the university. Enlarging the separate parallel facilities along Anderson could be very difficult due to the relatively narrow street right-of-way and potential interference with other underground facilities. A portion of the system, a 7'X 4' RCB (Line 2085) from Denison and Hunting to Anderson, is located beneath the old K-State stadium making replacement or expansion essentially impossible.

RECOMMENDED IMPROVEMENTS:

At the intersection of Denison and Hunting, combine the two systems which cross the corner of the campus by constructing a flow splitter, or diversion structure, in the RCB along Hunting (Line 2090) which connects to the 7'X 4' box under the old stadium. Flow in excess of the existing box's capacity will be diverted south along Denison through a new 8.5'X 4' RCB (Line 2087). A junction structure at the end of Line 2037, north of Anderson, will combine flows from the west with the diverted flows. This flow will continue in the system in a double 8'X 4' RCB which replaces the existing 42-inch pipe along Anderson (Lines 2030 and 2035) and will be recombined with the flow from the 7'X 4' RCB at a junction structure at the campus access drive west of 16th St. From the junction, a double 8.5'X 4' RCB (Line 2083) will continue the system to a second diversion structure at 16th St. At this point a portion of the flow, equal to the existing system capacity, will be routed across Anderson through a 6'X 4' RCB extension of the facilities along 16th (Line 2027). The majority of the flow will continue along Anderson in a double 7'X 4' RCB (Line 2080) to 14th St. where it will connect to the upstream end of Line 2075. Construction will be within the existing easements and right-of-way. A small additional easement for Line 2030 will probably be necessary due to the increased width of the improved structure at this location.

MANHATTAN, KANSAS
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

PROJECT NAME: Tecumseh-Quivera System

PROJECT IDENTIFICATION NUMBER: 2

PERTINENT DATA SUMMARY:
Watershed: Downtown West
Priority No.: 3 (when included in list)
Design Capacity: 305-575 CFS
Cost Estimates: Capital $ 2,168,700 Annual $ 2,090
Model Reach Number(s): 2090, 2110, 2112, 2115, 2120, 2130
Map Reference Sheets: 5
Return Period: 10 years

EXISTING PROBLEM DESCRIPTION:

The existing pipe-arch and box culvert system from Tecumseh, near the southwest corner of Memorial Hospital's property, south and east along Quivera Dr. and Hunting Ave. is severely inadequate. The section from the upstream end to Sunset Ave. (Lines 2112, 2115, 2120 and 2130) provides less than a 2-year level of service and the section along Hunting (Lines 2090 and 2110) provide less than a 5-year level of service. Overflow from the system floods the sump area on Tecumseh to the west of Quivera, reportedly several feet deep at times, causing the street to be impassable and surface water to occasionally enter houses at 2005 Platt, and 2011 and 2015 Tecumseh. When the depth of water in the street exceeds approximately 2 feet, flow overtops a slight ridge between the houses and enters a shallow concrete-lined channel between 2006 and 2010 College View, behind the houses on Tecumseh, which carries it out to the street. However, the channel capacity is rather limited and it appears that overflow probably enters the basement windows of the houses on each side at times. Overflow from the system continues along the streets and in some yards in the area to the south of the hospital.

RECOMMENDED IMPROVEMENTS:

Replace the entire system with 1) a double 7'X 4' RCB along Hunting west of Denison (Line 2090); 2) a double 6.5'X 4' RCB along Hunting to approximately 500 feet west of Sunset then north along side lot lines to Quivera and College Heights Rd. (Lines 2110 and 2112); 3) a double 6'X 4' RCB north along Quivera to College View Rd. (Line 2115); and 4) a single 8.5'X 4' RCB from College View to the upstream end (Lines 2120 and 2130). All of the reaches will be constructed within existing easements or street R/W except for a portion of Line 2112. The section which runs north from Hunting to College Heights along lot lines will require additional drainage and flowage easements. This project could be split into several parts if necessary, beginning at the downstream end.

MANHATTAN, KANSAS
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

PROJECT NAME: Tecumseh-Quivera System Alternate

PROJECT IDENTIFICATION NUMBER: 2A

PERTINENT DATA SUMMARY:
Watershed: Downtown West
Priority No.: 1 (when substituted for Proj. No. 2)
Design Capacity: 305-575 CFS
Cost Estimates: Capital $ 360,000 Annual $ 500
Model Reach Number(s): 2090, 2110, 2112, 2115, 2120, 2130
Map Reference Sheets: 5
Return Period: 10 years

EXISTING PROBLEM DESCRIPTION:

The problems with the existing drainage system are the same as for Project No. 2, described previously.

RECOMMENDED IMPROVEMENTS:

As an interim solution to the flooding of houses in the area, it is proposed that the City purchase the houses at 2005 Platt, 2011 and 2015 Tecumseh, and 2006 and 2010 College View and demolish them to prevent further property damage. This is recommended only as a temporary solution since it will not eliminate existing problems or the need for improvements in the downstream system.

MANHATTAN, KANSAS
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

PROJECT NAME: Hartford Road

PROJECT IDENTIFICATION NUMBER: 3

PERTINENT DATA SUMMARY:
Watershed: Downtown West
Priority No.: 5 (w/Proj. No. 2); 4 (w/Proj. No. 2A)
Design Capacity: 295 CFS
Cost Estimates: Capital $ 658,100 Annual $ 800
Model Reach Number(s): 2135, 2136 (new), 2137 (new)
Map Reference Sheets: 5
Return Period: 10 years

EXISTING PROBLEM DESCRIPTION:

The existing 36-inch pipe along Hartford Rd., across and north of Claflin, has less than a 2-year capacity. In addition, there appear to be very few enclosed minor system facilities in some areas so that runoff from upstream areas is routed through the streets. Detention basins have been constructed as part of the development of the university athletic facilities and a multi-family residential area in the upper reaches of the drainage area which have kept downstream flows from increasing; however, existing flows through the residential streets are still a problem for area residents.

RECOMMENDED IMPROVEMENTS:

Replace the existing pipe (Line 2135) with a 6.5'X 4' RCB along Hartford to Todd Rd. From the intersection, extend a 36-inch pipe along Todd Rd. to University (Line 2136) and a 48-inch pipe north along Hartford to Jardine Dr. (Line 2137) within the existing street right-of-ways.

MANHATTAN, KANSAS
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

PROJECT NAME: Allen Road

PROJECT IDENTIFICATION NUMBER: 4

PERTINENT DATA SUMMARY:
Watershed: Northview
Priority No.: 6 (w/Proj. No. 2); 5 (w/Proj. No. 2A)
Design Capacity: 165-225 CFS
Cost Estimates: Capital $ 689,200 Annual $ 750
Model Reach Number(s): 3020, 3025
Map Reference Sheets: 6
Return Period: 10 years

EXISTING PROBLEM DESCRIPTION:

The upper end of the existing enclosed system along Allen Rd. (Lines 3020 and 3025) has less than a 2-year capacity. The downstream end, a 6'x 5' RCB extending to Casement Rd., has a 10-year in-system capacity but the lack of sufficient curb inlets does not allow runoff to enter the system along this reach. Overflow from the system runs in the street and in some yards adjacent to the street causing traffic and access problems in the area. Once the major system lines are full, the minor system cannot drain into it and runoff to those drainage facilities floods side streets when it can no longer enter the enclosed system. Water on some side streets has reportedly reached depths of 12 to 18 inches. In addition, the very flat slopes within the watershed reduce the rate at which the water recedes.

RECOMMENDED IMPROVEMENTS:

Replace the existing CMPAs at the upper end of the system along Allen Rd., from Hayes to Sloan, with a single 6'X 4' RCB and sufficient curb inlets within the existing street R/W. Add curb inlets along the existing downstream RCB section.

MANHATTAN, KANSAS
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

PROJECT NAME: Nevada Street

PROJECT IDENTIFICATION NUMBER: 5

PERTINENT DATA SUMMARY:
Watershed: Virginia-Nevada
Priority No.: 7 (with either Proj. No. 2 or 2A)
Design Capacity: 25-65 CFS
Cost Estimates: Capital $ 80,350 Annual $ 550
Model Reach Number(s): 5115, 5120
Map Reference Sheets: 5
Return Period: 10 years

EXISTING PROBLEM DESCRIPTION:

The existing pipe system along the back of the lots on the west side of Nevada, south of Kimball, generally provides a 5 to 10-year level of service. However, runoff unable to enter the system due to the lack of inlet capacity, runs south in a backyard swale which extends for approximately two blocks from Kimball to Montana Court. When added to gutter flows from Nevada and Montana, which collects at the single pair of curb inlets on Montana Ct., street flooding and traffic problems occur at times. A relatively new church at Kimball and Seth Child also has apparently increased localized runoff in the immediate area.

RECOMMENDED IMPROVEMENTS:

Add a 24-inch RCP from Line 5120 with an area inlet near the southeast corner of the church property, approximately in the natural drainage path, to pick up runoff from that property. Add a pair of curb inlets at the bend on Montana Ct. and a pair on Nevada just north of the intersection with Montana. Connect the new inlets to the existing system at the existing curb inlets on Montana Ct. with 24-inch RCP. The additional line near the church will require a new drainage easement. The existing swales appear to have sufficient overflow capacity but it is also recommended that flowage easements be obtained to prevent surface obstructions. There appears to be sufficient room to obtain flowage easements without unduly restricting the use of area residents' property. The new curb inlets and lines will be constructed within existing street right-of-way.

MANHATTAN, KANSAS
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

PROJECT NAME: Claflin-CICO Culvert

PROJECT IDENTIFICATION NUMBER: 6

PERTINENT DATA SUMMARY:
Watershed: CICO Park
Priority No.: 4 (w/Proj. No. 2); 3 (w/Proj. No. 2A)
Design Capacity: 1541 CFS (Line 6020); 62 CFS (Line 6030)
Cost Estimates: Capital $ 250,000 Annual $ 350
Model Reach Number(s): 6020, 6030
Map Reference Sheets: 5
Return Period: 50 years (6020); 10 years (6030)

EXISTING PROBLEM DESCRIPTION:

The existing 8'X 8' box culvert across Claflin on CICO Tributary has a 5-year capacity and the 21-inch pipe along Claflin, which drains to the box from the west, has less than a 2-year capacity. For storms of 5-year or greater return periods water overtops the street and the headwater elevation at the upstream end of the box culvert reaches or exceeds the ground elevation at the houses on the east side of the channel, just north of Claflin. Overflow from the pipe along Claflin runs in the street and adds to the overflow at the culvert.

RECOMMENDED IMPROVEMENTS:

Add two 6'X 8' cells to the existing box culvert and an energy dissipator at the downstream end. Replace the pipe along Claflin with a 51"X 31" RCPA. Construction will be within the existing street right-of-way.

MANHATTAN, KANSAS
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

PROJECT NAME: Dickens Energy Dissipator

PROJECT IDENTIFICATION NUMBER: 7

PERTINENT DATA SUMMARY:
Watershed: CICO Park
Priority No.: 1 (w/Proj. No. 2); 2 (w/Proj. No. 2A)
Design Capacity: 810 CFS
Cost Estimates: Capital $ 50,000 Annual $ 100
Model Reach Number(s): 6040
Map Reference Sheets: 5
Return Period: Approx. 10 years (to match existing RCB capacity)

EXISTING PROBLEM DESCRIPTION:

A large scour hole has developed at the downstream end of the 9'x 7' broken-back RCB across Dickens on CICO Tributary. Water ponds in this area to a depth of approximately 6 feet creating a safety hazard for children in the area and a nuisance for adjacent homeowners.

RECOMMENDED IMPROVEMENTS:

Construct a concrete energy dissipator at the downstream end of the culvert. An impact-type structure appears to be the most suitable for this situation. Drainage easements will be required from two tracts for the structure and an access easement from one tract.

MANHATTAN, KANSAS
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

PROJECT NAME: Poyntz Ave. Pump Station

PROJECT IDENTIFICATION NUMBER: 8

PERTINENT DATA SUMMARY:
Watershed: Downtown East
Priority No.: 8 (with either Proj. No. 2 or 2A)
Design Capacity: 70 CFS
Cost Estimates: Capital $ 679,000 Annual $ 2,500
Model Reach Number(s): N/A
Map Reference Sheets: 6, 10
Return Period: N/A

EXISTING PROBLEM DESCRIPTION:

The existing stormwater pumping capacity and temporary ponding capacity in the area to the east of Tuttle Creek Blvd. is inadequate to prevent flooding of the developed areas in the vicinity whenever gravity flow from the system is reduced by high river stages. (A more complete discussion of the situation is presented in Part VII of this report.)

RECOMMENDED IMPROVEMENTS:

Replace the original 10-cfs pump station with a 70-cfs pump station utilizing the existing gravity drain box culvert through the levee. Also add approximately 56 acre-feet to the upstream ponding capacity by excavating the area indicated on Figure 2 in Part VII.

Note: If the project scope is revised to eliminate the additional ponding capacity, the project cost is reduced to $265,000. The project becomes priority No. 5 when included with Project No. 2, and Priority No. 4 when included with Project No. 2A. All other projects remain in the same relative order in the priority rankings.

C. PROGRAM COST ESTIMATES

1. BASIS

Cost estimates for the recommended conveyance element improvements were prepared by the SYCOST computer model that generates planning grade estimates for both the capital and annual operating and maintenance cost of storm drainage system components. Although the program is capable of estimating land costs, the cost estimates for the recommended projects assume that all easements necessary for the construction and maintenance of improvements, including flowage easements, will be dedicated by property owners without charge to the City.

Estimates for the purchase of properties in the Tecumseh-Quivera area were based on appraised values obtained from Riley Co. records with a contingency of 10 percent and the estimated cost of demolition added. Costs for the pump station and pond excavation were based on experience with similar projects and typical costs encountered in the Manhattan area.

The time basis of cost estimates is June 1993 with a corresponding Engineering News Record Construction Cost Index for the Kansas City Metropolitan Area of 5124. Recent price trends indicate that an annual cost escalation factor of 5 percent compounded annually is appropriate for escalating base year estimates to future year implementation schedules.

2. PRICING

The cost items and their corresponding unit prices incorporated in the SYCOST model, as applied to prepare program estimates, are listed in the SYCOST User's Manual provided separately to the City staff. Planning grade quantities of the applicable key items are calculated internally by the model to generate summary cost estimates.

3. ESTIMATES

Table VI-3 presents the estimated cost for the reaches of the drainage system included in the recommended projects as calculated by the program. Costs presented are defined as follows:

- Const. - The direct construction cost
- Land - The cost of purchased easements, if required.
- F&C - Fees and contingencies as an allowance to include engineering and inspection.
- Capital - The "first cost" is the sum of Const. + Land + F&C.
- Annual - The average annual cost to maintain, repair, and manage the system over its useful life.

Annual costs are not expended at a uniform rate. They are paid intermittently as repair, cleaning, or other maintenance of the facility as needed.

TABLE VI-3

SYCOST COST SUMMARY FOR RECOMMENDED IMPROVEMENTS

Reach No.	Structure Type	Costs ($) Const.	F & C	Capital	Annual
2027	Single-cell 6 x 4 RCB	26,595	8,485	35,080	36
2030	Two-cell 8 x 4 RCB	753,146	199,418	952,564	890
2035	Two-cell 8 x 4 RCB	292,550	78,926	371,476	346
2080	Two-cell 7 x 4 RCB	536,682	142,337	679,020	645
2083	Two-cell 8.5 x 4 RCB	261,424	70,477	331,901	307
2087	Single-cell 8.5 x 4 RCB	200,326	54,686	255,012	262
2090	Two-cell 7 x 4 RCB	536,682	142,337	679,020	645
2110	Two-cell 6.5 x 4 RCB	292,550	79,126	371,676	355
2112	Two-cell 6.5 x 4 RCB	439,845	116,760	556,605	534
2115	Two-cell 6 x 4 RCB	209,547	56,730	266,278	257
2120	Single-cell 8.5 x 4 RCB	150,754	43,411	194,166	197
2130	Single-cell 8.5 x 4 RCB	76,397	23,519	99,916	100
2135	Single-cell 6.5 x 4 RCB	193,986	56,116	250,101	265
2136	48-inch RCP	126,326	37,771	164,097	222
2137	54-inch RCP	188,076	55,861	243,937	313
3020	Single-cell 6 x 4 RCB	374,448	100,956	475,405	517
3025	Single-cell 6 x 4 RCB	165,741	48,008	213,749	229
5120	24-inch RCP	59,962	20,389	80,351	163
6020	Two 6 x 8 RCB cells	50,360	15,348	65,709	55
6030	51-inch x 31-inch RCPA	103,047	31,053	134,101	192

D. IMPROVEMENT PRIORITIES

1. GENERAL

Since there are many elements of the existing city-wide drainage system that do not provide an acceptable level of service, and all cannot be corrected "first," it is necessary for the City to establish priorities

on an objective basis. The end objectives in setting these priorities should be to accomplish the following in order:

- Provide an equal minimum level of service to all citizens as soon as possible.

- Upgrade the drainage system as a whole to meet criteria standards for a higher level of service.

- Improve the system in order to yield the best practical benefit for the earliest investment.

- Accomplish the improvement in an order such that any isolated improvement does not add to an existing problem or create a new problem elsewhere.

- Directly benefit as many individual citizens as early as practical and reasonable to maintain continuing support for an orderly prioritized program of improving drainage service.

2. PRIORITY EVALUATION

Priority recommendations for capital improvement projects were formulated by the PRIOR computer model.

a. First Order

PRIOR uses the following factors and a calibrated scale of "priority points" to calculate a raw score of "priority points" for each project in the model:

(1) Frequency of Structure and Contents Damage.
(2) Relative Magnitude of Damage
    (a) Structural and contents
    (b) Erosion
    (c) Nuisance
(3) Frequency of Hydraulic Inadequacy
(4) Effect on City Development
(5) Structural Condition of Existing Facility

(6) Magnitude of 10-year Hydraulic Deficiency

(7) Capital Cost per Benefitted Property

Specific information on each category and the points assigned to each factor are outlined in the PRIOR Program User's Manual provided to City staff.

b. Second Order

After calculating the raw score, the model differentiates between projects having the same number of total points in the following order:

(1) Frequency of damaged is compared. Projects having the most frequent incidence of damage are assigned the highest priority. If there is no difference in this category then;

(2) Point scores in the structural and contents damage category are compared. Those projects having the higher score in this area are assigned the higher priorities. If there is no difference in this category then;

(3) Point scores in the category of capital cost per benefitted property are compared. Those projects having the lower cost per benefitted property are assigned the higher priority. If there is no difference in this category then;

(4) Point scores in the erosion damage category are compared. Those projects having the higher score in this area are assigned the higher priorities. If there is no difference in this category then;

(5) Point scores in the nuisance category are compared. Those projects having the higher score in this area are assigned the higher priority.

(6) Point scores in the category of absolute project cost are compared. Those projects having the lower cost are assigned the higher priority.

c. System Adjustments

After second order differentiation of priority without regard to the physical hydraulic relationship between projects, priorities are reevaluated on a "system" basis to insure that implementation of a high priority upstream project will not unreasonably worsen downstream conditions. Worsened conditions are defined as:

- Increasing discharge to an area already experiencing structure and contents damage at 10-year or more frequent return periods; or

- Increasing discharge to downstream areas having 2-year or less return period capacity, regardless of any associated damage; or

- Increasing discharge to a downstream area experiencing erosion damage at return periods more frequent than 5 years.

3. RECOMMENDED PLAN PRIORITIES

Tables VI-4 and VI-5 present the recommended priorities for the recommended improvement projects, the first with Project No. 2 included and the second with Project No. 2A. It is noted that the point scores are equal for several projects indicating second order differentiation was applied by the model to establish the priority order.

It is also important to note that the willingness of potentially benefitted property owners to dedicate easements for the construction of improvements is not a model factor. It is an important factor as the City implements an improvement plan; therefore the priorities should not be considered as absolute.

TABLE VI-4

RECOMMENDED IMPROVEMENT PROJECTS PRIORITY RANKING

Prior. No.	Proj. No.	Project Description	Points	Cost ($)	Priority Control
1	7	Dickens Energy Dissipator	18	50,000	Raw Pts.
2*	1	Denison-Anderson System	13	2,625,100	Freq. Damage
3	2	Tecumseh-Quivera System	15	2,168,700	Raw Pts.
4	6	Claflin Culvert @ CICO	14	250,000	Raw Pts.
5	3	Hartford Road System	13	658,100	$ per Prop.
6	4	Allen Road System	13	689,600	$ per Prop.
7	5	Nevada-Montana System	13	80,350	Raw Pts.
8	8	Poyntz Ave. Pump Station	12	679,000	Raw Pts.

* Projects ranked ahead of No. 2 which has higher points because downstream system has a 2-year capacity and must be corrected first to handle increased flows from upstream improvements.

When Alternative Project No. 2A is substituted for Project No. 2, the priority rankings are revised as indicated in Table VI-5.

TABLE VI-5

RECOMMENDED IMPROVEMENT PROJECTS ALTERNATIVE PRIORITY RANKING

Prior. No.	Proj. No.	Project Description	Points	Cost ($)	Priority Control
1	2A	Tecumseh-Quivera Alternate	19	360,000	Raw Pts.
2	7	Dickens Energy Dissipator	18	50,000	Raw Pts.
3	6	Claflin Culvert @ CICO	14	250,000	Raw Pts.
4	3	Hartford Road System	13	658,100	$ per Prop.
5	4	Allen Road System	13	689,600	$ per Prop.
6	1	Denison-Anderson System	13	2,625,100	Freq. Damage
7	5	Nevada-Montana System	13	80,350	Raw Pts.
8	8	Poyntz Ave. Pump Station	12	679,000	Raw Pts.

Another slight reordering of the projects also occurs if the scope of Project No. 8 - Poyntz Avenue Pump Station, is revised to eliminate the additional ponding capacity. The project cost is reduced to $265,000 for the pump station improvements only. With this revision, the project priority becomes No. 5 when included with Project No. 2 and the Hartford Road, Allen Road and Nevada-Montana system projects each drop one place to become priority Nos. 6, 7 and 8, respectively. When included with Project No. 2A, the pump station priority becomes No. 4 and, again, the Hartford Road, Allen Road, Denison-Anderson and Nevada-Monatana projects each drop one place in the priority ranking.

E. DISCRETIONARY PROJECTS

In addition to the recommended improvement projects, a separate list of 22 potential improvement projects was compiled which have been identified as discretionary projects. These projects include drainage system elements identified by the analysis as being deficient in capacity but which do not currently result in recurring or frequent adverse effects, or pose immediate problems for more than a few property owners due to remote locations or a relatively small magnitude of deficiency. They are intended to be undertaken at the discretion of the City as the need arises and as funds are available. Several of the projects will not really be necessary until redevelopment in the existing drainage areas occurs and others will be considered only after annexation of the area by the City.

The discretionary projects have been further divided into two groups. Group A includes those projects which are considered to have system-wide impacts. They generally involve improvements to large sections of the existing drainage system and are primarily along major city thoroughfares where access and traffic impacts affect a comparatively large number of people in addition to the residents in the immediate area. Because of wider impacts and the larger number of citizens benefitted, Group A projects are generally considered to be of higher priority than those in Group B which includes projects basically limited in scope to correcting localized problems that generally impact only the residents of adjacent properties. The projects have not been individually ranked by priority, however. The projects are listed by groups in Table VI-6 and indicated on Figures VI-2 and VI-3.

Brief summaries of the projects and their costs are presented on the following pages. Cost estimates were prepared using the SYCOST program. The total capital cost of all discretionary projects is $ 29,015,550.

TABLE VI- 6

DISCRETIONARY IMPROVEMENT PROJECTS

Proj. No.	Project Description	Group	Esmnt. Type(1)	Capital Cost
13	Bluemont Avenue System	A	1	$ 4,804,500
14	Bertrand Street System	A	1	7,002,900
18	South 14th Street System	A	1	3,616,700
19	South Manhattan Ave. System	A	1	8,553,500
20	Anderson-Grandview Culverts	A	1	48,200
23	Butterfield Channels	A	2,3	321,000
24	Browning-Dickens Culverts	A	1	138,900
28	Anderson-Woodland Culvert	A	1	29,600
31	College Avenue Culvert	A	1	287,200
	Group A Subtotal			$24,802,500
15	South 4th Street System	B	1	853,500
16	Ratone & 12th Street System	B	1	530,100
17	Hayes Drive Culvert	B	1	19,800
21	Casement-Griffith System	B	1	1,562,500
22	Lincoln Drive System	B	1,3	316,100
25	Shirley Lane System	B	1	68,200
26	CICO Channel-Dickens to Claflin	B	3	305,400
27	Plymouth-Everett Culvert & Channel	B	1,3	136,900
29	Rosencutter Road Culvert	B	1	129,700
30	College-Marion Culvert	B	4	114,000
32	Snowbird Dr. Culvert & Channel	B	1,2	81,550
33	Browning-Edwards Culvert	B	4	34,800
34	Eureka Dr.-Job Corps Cntr. Culvert	B	3	60,500
	Group B Subtotal			$4,213,050
	Total Capital Cost - All Projects			$ 29,015,550

(1) Easement Types
1 = Public Street Right-of-Way
2 = Private Property, Existing Drainage Easement
3 = Private Property, No Existing Easement
4 = County Road Right-of-Way

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PROJECT NAME: Bluemont Avenue

PROJECT IDENTIFICATION NUMBER: 13 GROUP: A

DATA SUMMARY:
Cost Estimates: Capital $ 4,804,500 Annual $ 4,690
Model Reach Number(s): 1050, 1055, 1060
Map Reference Sheet(s): 5, 9, 10

PROJECT DESCRIPTION: The existing pipe system along Bluemont Ave. from Tuttle Creek Blvd. west to Manhattan Ave. has less than a 2-year capacity and the pipe running north along Manhattan to Bertrand has a 5-year capacity. To eliminate system overflows in the streets creating potential traffic and access problems, replace the system with a double 7.5'x 5' RCB from Tuttle Creek Blvd. to Juliette, a 6.5'x 6' RCB from Juliette to Manhattan, and a 54-inch RCP along Manhattan. This project could also be logically split into two or three parts if necessary, beginning at the downstream end.

PROJECT NAME: Bertrand Street

PROJECT IDENTIFICATION NUMBER: 14 GROUP: A

DATA SUMMARY:
Cost Estimates: Capital $ 7,002,900 Annual $ 6,210
Model Reach Number(s): 1075, 1080, 1081
Map Reference Sheet(s): 5, 6

PROJECT DESCRIPTION: The existing box culvert along Bertrand has less than a 2-year capacity and the culvert across the water plant has less than a 5-year capacity. To prevent overflows in the streets creating potential traffic problems, and possible damage to water treatment plant structures, replace the system along Bertrand with a triple 9.5'x 4' RCB and add a third 7.5'x 5' cell to the RCB through the water plant. This project could also be logically split into two or three parts if necessary, beginning at the downstream end.

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PROJECT NAME: South 4th Street

PROJECT IDENTIFICATION NUMBER: 15 GROUP: B

DATA SUMMARY:
Cost Estimates: Capital $ 853,500 Annual $ 920
Model Reach Number(s): 1185, 1190
Map Reference Sheet(s): 10

PROJECT DESCRIPTION: The existing 36-inch pipe south of Ft. Riley Blvd. has less than a 2-year capacity and the 48-inch pipe along 4th St. has less than a 5-year capacity. Although few problems occur now, as redevelopment occurs in the area overflows from the system can potentially create traffic and access problems. The recommended improvements include replacing the pipe system with a 6.5'x 4' RCB along the entire length.

PROJECT NAME: Ratone & 12th Street

PROJECT IDENTIFICATION NUMBER: 16 GROUP: B

DATA SUMMARY:
Cost Estimates: Capital $ 530,100 Annual $ 620
Model Reach Number(s): 1100, 1105, 1110
Map Reference Sheets: 5

PROJECT DESCRIPTION: The existing pipe and box culvert system (Lines 1105 and 1110) from near the intersection of Legore Ln. and Claflin, south to Ratone provides less than a 2-year level of service, and the box culvert along 12th (Line 1100) provides less than a 5-year level of service. To eliminate system overflows into streets and onto private residential property, replace the existing system with a 5'X 4' RCB for Lines 1100 and 1105 and a 48-inch RCP for Line 1110.

PROJECT NAME: Hayes Drive

PROJECT IDENTIFICATION NUMBER: 17 GROUP: B

DATA SUMMARY:
Cost Estimates: Capital $ 19,800 Annual $ 25
Model Reach Number(s): 1150
Map Reference Sheet(s): 6

PROJECT DESCRIPTION: Replace the existing culvert across Hayes on the north side of McCall, which has a 2-year capacity, with a 48-inch RCP.

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PROJECT NAME: South 14th Street

PROJECT IDENTIFICATION NUMBER: 18 GROUP: A

DATA SUMMARY:
Cost Estimates: Capital $ 3,616,700 Annual $ 3,250
Model Reach Number(s): 2000, 2005, 2020
Map Reference Sheet(s): 9

PROJECT DESCRIPTION: The existing 84-inch pipe along S. 14th St., from Leavenworth to the levee, provides less than a 2-year level of service in the sections south of Humboldt and a 5-year level of service between Humboldt and Leavenworth. Overflow in the street tends to dissipate slowly due to the flat slopes in the area causing access problems along the relatively busy road. The overflow ponds located at the south end of this system provide minimal storage volume for runoff in excess of the system's capacity. To prevent system overflows, replace Lines 2000, 2005 and 2020 with a double 8.5'X 7' RCB, a double 7'X 7' RCB and a 9.5'X 6' RCB, respectively within the existing right-of-way. Because of the relatively narrow right-of-way through the rather densely developed area, parallel relief lines were not considered due to the potential for interference with other existing underground utilities. This project could also be logically split into two or three parts if necessary for funding, construction scheduling, etc., by constructing only one or two of the sections at a time beginning at the downstream end.

PROJECT NAME: South Manhattan Avenue

PROJECT IDENTIFICATION NUMBER: 19 GROUP: A

DATA SUMMARY:
Cost Estimates: Capital $ 8,553,500 Annual $ 7,410
Model Reach Number(s): 2060, 2065, 2075
Map Reference Sheet(s): 9

PROJECT DESCRIPTION: The existing 60, 66 and 72-inch pipes along S. Manhattan and 14th St. from Anderson to the levee have less than a 2-year capacity. Overflows run in the streets and the excess runoff that reaches the south end of the system ponds temporarily in the area inside the levee until the peak flows have subsided and the system can handle the additional water. To eliminate the access and nuisance problems, replace the existing system with a triple 9'X 5' RCB south of Poyntz (Lines 2060 and 2065) and a triple 8'X 5' RCB from Anderson to Poyntz (Line 2075) within the existing right-of-way. Due to the relatively narrow right-of-way from Anderson to Fremont and the width of the proposed improvements, parallel relief lines were not considered although detailed design may find this option possible primarily in the sections through the city park and in the wider street R/W south of Poyntz. This project could also be logically split into two parts if necessary for funding, construction schedules, etc., by dividing it at Poyntz, constructing the downstream half first.

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PROJECT NAME: Anderson-Grandview Culverts

PROJECT IDENTIFICATION NUMBER: 20 GROUP: A

DATA SUMMARY:
Cost Estimates: Capital $ 48,200 Annual $ 55
Model Reach Number(s): 2045, 2055
Map Reference Sheet(s): 9

PROJECT DESCRIPTION: The existing box culverts across Anderson and across Grandview Drive, just west of Sunset, have less than 2-year and 5-year capacities, respectively, causing excess flow to overtop the road and potentially create traffic problems. Replace the existing culverts with a 5'x 4' RCB and a 42-inch RCP, respectively.

PROJECT NAME: Casement-Griffith System

PROJECT IDENTIFICATION NUMBER: 21 GROUP: B

DATA SUMMARY:
Cost Estimates: Capital $ 1,562,500 Annual $ 1,730
Model Reach Number(s): 3035, 3040, 3045, 3055
Map Reference Sheet(s): 3, 5, 6

PROJECT DESCRIPTION: The existing system along Griffith and Casement, north of Allen Rd., generally has less than a 5-year capacity. Overflows run in the streets and in roadside ditches along Casement potentially creating traffic, access and erosion problems. To eliminate this situation, replace the major system components with a 6'x 3.5' RCB north from Allen Rd. to just west of Northview School (Lines 3035, 3040 and 3045) and with a 5.5'x 3' RCB along Frey east of Sloan (Line 3055). This project could also be logically split into two parts if necessary, beginning at the downstream end.

PROJECT NAME: Lincoln Drive

PROJECT IDENTIFICATION NUMBER: 22 GROUP: B

DATA SUMMARY:
Cost Estimates: Capital $ 316,100 Annual $ 375
Model Reach Number(s): 3059 (new)
Map Reference Sheet(s): 6

PROJECT DESCRIPTION: Drainage through the existing 4'x 4' RCB crossing Tuttle Creek Blvd. (Line 3060) currently flows into a series of 15 and 24-inch pipes along Lincoln, connecting to the existing major system on Allen Rd. The existing system is severely undersized, with overflows running in the street and in yards, and should be replaced by a new 4.5'x 3' RCB for the entire length.

PROJECT NAME: Butterfield Channels

PROJECT IDENTIFICATION NUMBER: 23 GROUP: A

DATA SUMMARY:
Cost Estimates: Capital $ 321,000 Annual $ 650
Model Reach Number(s): 4002, 4010, 4017
Map Reference Sheet(s): 3, 6

PROJECT DESCRIPTION: The graded open channel system between cross-road culverts is extremely flat creating problems with siltation and standing water which both affects the system capacity and becomes a nuisance to area residents. To eliminate these problems, construct a 12' wide x 3' deep concrete-lined channel for Lines 4002 and 4010, and an 8' wide x 3' deep section for Line 4017 which will handle the 10-year peak discharges. In addition, an improved outlet channel extended approximately 500 feet into the agricultural fields beyond the downstream end of Line 4002 is recommended to prevent erosion at the end of the improved system immediately behind several residences. (Ideally the outlet channel should be extended to Casement Rd. if funding and easements are available to insure proper drainage from the area.)

PROJECT NAME: Browning-Dickens Culverts

PROJECT IDENTIFICATION NUMBER: 24 GROUP: A

DATA SUMMARY:
Cost Estimates: Capital $ 138,900 Annual $ 130
Model Reach Number(s): 5065, 5070
Map Reference Sheet(s): 5

PROJECT DESCRIPTION: The existing double 7'x 2' RCB across Dickens, east of Browning, and the 6-ft. CMP across Browning, south of Dickens, have capacities of 2 years or less. Water overtops the streets when the capacity is exceeded creating traffic problems. Therefore, replace the culvert on Dickens with a triple 6'x 3' RCB and the culvert on Browning with either a 122"x 78" RCPA or comparable box culvert.

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PROJECT NAME: Shirley Lane

PROJECT IDENTIFICATION NUMBER: 25 GROUP: B

DATA SUMMARY:
Cost Estimates: Capital $ 68,200 Annual $ 135
Model Reach Number(s): 5135 (extended)
Map Reference Sheet(s): 5

PROJECT DESCRIPTION: Currently all runoff from along Shirley Lane and from an area to the east drains to a single pair of curb inlets located in the low point of the street. Although the pipe size is adequate, the curb inlets cannot handle the peak flow from even a 2-year storm without overtopping the curb. Erosion damage and structure flooding has occurred on various occasions. To eliminate this problem, extend the 24-inch line north along Shirley Lane, adding at least four 10-ft. inlets along the street.

PROJECT NAME: CICO Channel - Dickens to Claflin

PROJECT IDENTIFICATION NUMBER: 26 GROUP: B

DATA SUMMARY:
Cost Estimates: Capital $ 305,400 Annual $ 885
Model Reach Number(s): 6025
Map Reference Sheet(s): 5

PROJECT DESCRIPTION: The existing natural channel section of CICO Tributary between Dickens and Claflin is severely eroded in several areas, especially at bends in the channel. At several points the erosion has destroyed relatively large portions of backyards and is threatening decks and patios on several lots. A sanitary sewer line along the east side of the channel has been exposed in one area. A number of residents along the channel have built various types of retaining structures adjacent to the channel attempting to protect their properties.

A conceptual/preliminary study and design for channel improvements was completed as a separate part of the stormwater management plan project. Part of the study investigated the use of "bio-engineering" techniques (the use of plant materials) to stabilize the channel banks. Of the several alternative designs presented to area residents, the use of gabion walls to a height of approximately six feet and bottom channel lining is recommended to keep the appearance of the channel as natural as possible while providing the necessary erosion protection. The recommended improvements included filling and regrading the banks and utilizing vegetative ground cover above the gabions to stabilize those slopes.

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PROJECT NAME: Plymouth-Everett Culvert & Channel

PROJECT IDENTIFICATION NUMBER: 27 GROUP: B

DATA SUMMARY:
Cost Estimates: Capital $ 136,900 Annual $ 220
Model Reach Number(s): 7055, 7070
Map Reference Sheet(s): 4

PROJECT DESCRIPTION: The existing 36-inch pipe across Plymouth and Everett Streets north of Kimball has less than a 2-year capacity which can result in flooding at the upstream end and water overtopping the road, creating traffic problems. In addition, the downstream channel, south of Kimball, is eroding. To eliminate this problem, replace the pipe with a 4'x 3' RCB and line the existing channel with riprap to a depth of one foot.

PROJECT NAME: Anderson-Woodland Culvert

PROJECT IDENTIFICATION NUMBER: 28 GROUP: A

DATA SUMMARY:
Cost Estimates: Capital $ 29,600 Annual $ 30
Model Reach Number(s): 9070
Map Reference Sheet(s): 5

PROJECT DESCRIPTION: The existing culvert crossing Anderson near Woodland has less than a 5-year capacity. Overflows into the street potentially create traffic problems on a main thoroughfare. Therefore, replace the 36-inch pipe with a 4'x 4' RCB.

PROJECT NAME: Rosencutter Culvert

PROJECT IDENTIFICATION NUMBER: 29 GROUP: B

DATA SUMMARY:
Cost Estimates: Capital $ 129,700 Annual $ 130
Model Reach Number(s): 9090
Map Reference Sheet(s): 9

PROJECT DESCRIPTION: The existing 4'x 3' RCB across Rosencutter Rd. just south of Ft. Riley Blvd. has less than a 5-year capacity. Overflow across the road could potentially cut off access to the commercial and residential areas to the south. To eliminate this situation, replace the existing box with a double 3.5'x 2.5' RCB.

PROJECT NAME: College-Marion Culvert

PROJECT IDENTIFICATION NUMBER: 30 GROUP: B

DATA SUMMARY:
Cost Estimates: Capital $ 114,000 Annual $ 100
Model Reach Number(s): 11006
Map Reference Sheet(s): 2

PROJECT DESCRIPTION: The existing pipe-arches across College near Marion have less than a 2-year capacity resulting in frequent overflows across the road. Currently, there is little development in the area affected by the lack of culvert capacity. However, once development occurs the pipes will need to be replaced by a quadruple 8'x 3' RCB for adequate service.

PROJECT NAME: College Avenue Culvert

PROJECT IDENTIFICATION NUMBER: 31 GROUP: A

DATA SUMMARY:
Cost Estimates: Capital $ 287,200 Annual $ 235
Model Reach Number(s): 11055
Map Reference Sheet(s): 2

PROJECT DESCRIPTION: The existing 5'x 8' stone box culvert across College, approximately halfway between Marlatt and Kimball, has less than a 2-year capacity. Overflows overtopping the road may create traffic problems on a main city thoroughfare. Unplanned, temporary detention of runoff occurs at the upstream end of the culvert which currently does not cause serious problems since the area is essentially undeveloped; however, as the area develops in the future, the impact could become significant. To eliminate this problem, replace the culvert with a triple 8'x 8' RCB. (Note: This design project was already underway by a local consultant at the time of this report.)

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PROJECT NAME: Snowbird Drive

PROJECT IDENTIFICATION NUMBER: 32 GROUP: B

DATA SUMMARY:
Cost Estimates: Capital $ 81,600 Annual $ 420
Model Reach Number(s): 11065, 11070, 11071 (new), 11076 (new)
Map Reference Sheet(s): 5

PROJECT DESCRIPTION: The existing pipe-arch culverts across Snowbird Drive, just south of the intersection with Tamarron Terr., and the backyard swale behind the homes on Tamarron Terr. and Hillview Dr. provide less than a 2-year level of service. Flows exceeding the capacity of the culverts back up in the channel to the south of the inlet and overtop the street causing it to be impassable. The downstream channel, or swale, is extremely shallow and although it appears that sufficient capacity exists between houses to handle a 100-year storm without flooding homes, flows spread over a relatively wide area of yards and patios. Erosion in the swale is increasing. To eliminate the problems in this area, replace the pipe culverts with a single 8'X 4' RCB across Snowbird Dr. It is recommended that the street in the area of the culvert entrance be raised in elevation as much as possible to improve inlet conditions. The existing backyard swale should be a 12' wide x 2' deep channel lined with riprap. The improved channel and culvert can be constructed in the existing drainage easement and street right-of-way. The overflow channel will extend outside the drainage easement with a total width of approximately 70 feet and a depth of one foot above the channel banklines, coming close to several patios. Flowage easements for this area are not recommended, however, because the restrictions on usage would create problems in using backyards for many residents along the channel. In addition, the riprap lining should be continued in the channels upstream from Snowbird Dr. The section from the culvert to the end of Parkway (Line 11071) will be 5' wide x 3' deep, and the section from Parkway to the outlet of the culvert across Kimball near Browning (Line 11076) will be 3' wide x 3' deep.

PROJECT NAME: Browning-Edwards Culvert

PROJECT IDENTIFICATION NUMBER: 33 GROUP: B

DATA SUMMARY:
Cost Estimates: Capital $ 34,800 Annual $ 35
Model Reach Number(s): 11135
Map Reference Sheet(s): 2

PROJECT DESCRIPTION: The existing culvert across Browning near Edwards has a 2-year capacity. Overflows overtopping the road may create traffic problems on a major street. To eliminate this situation, add a second 7'x 3' cell to the existing RCB.

MANHATTAN, KANSAS
STORMWATER MANAGEMENT MASTER PLAN
DISCRETIONARY PROJECTS SUMMARIES

PROJECT NAME: Eureka Drive-Job Corps Drive Culvert

PROJECT IDENTIFICATION NUMBER: 34 GROUP: B

DATA SUMMARY:
Cost Estimates: Capital $ 60,500 Annual $ 55
Model Reach Number(s): 13115
Map Reference Sheet(s): 12

PROJECT DESCRIPTION: The existing 36-inch pipe across the entrance drive to the Jobs Corps Center on Eureka Drive has less than a 2-year capacity. Overflows which overtop the drive may create access problems into the center. Future development to the west of the center will compound the current problem. To eliminate this situation, replace the culvert with a double 7.5'x 3' RCB (sized for future anticipated flows).

* * * * *

LEGEND

① PROJECT NUMBER

PROPOSED PROJECT

PROPOSED PONDING AREA

KIMBALL

TUTTLE CREEK BLVD.

MANHATTAN AVE

SETH CHILD RD.

ANDERSON

POYNTZ

NORTH

2000 0 2000 4000

SCALE IN FEET

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Figure VI-1

RECOMENDED IMPROVEMENT PROJECTS

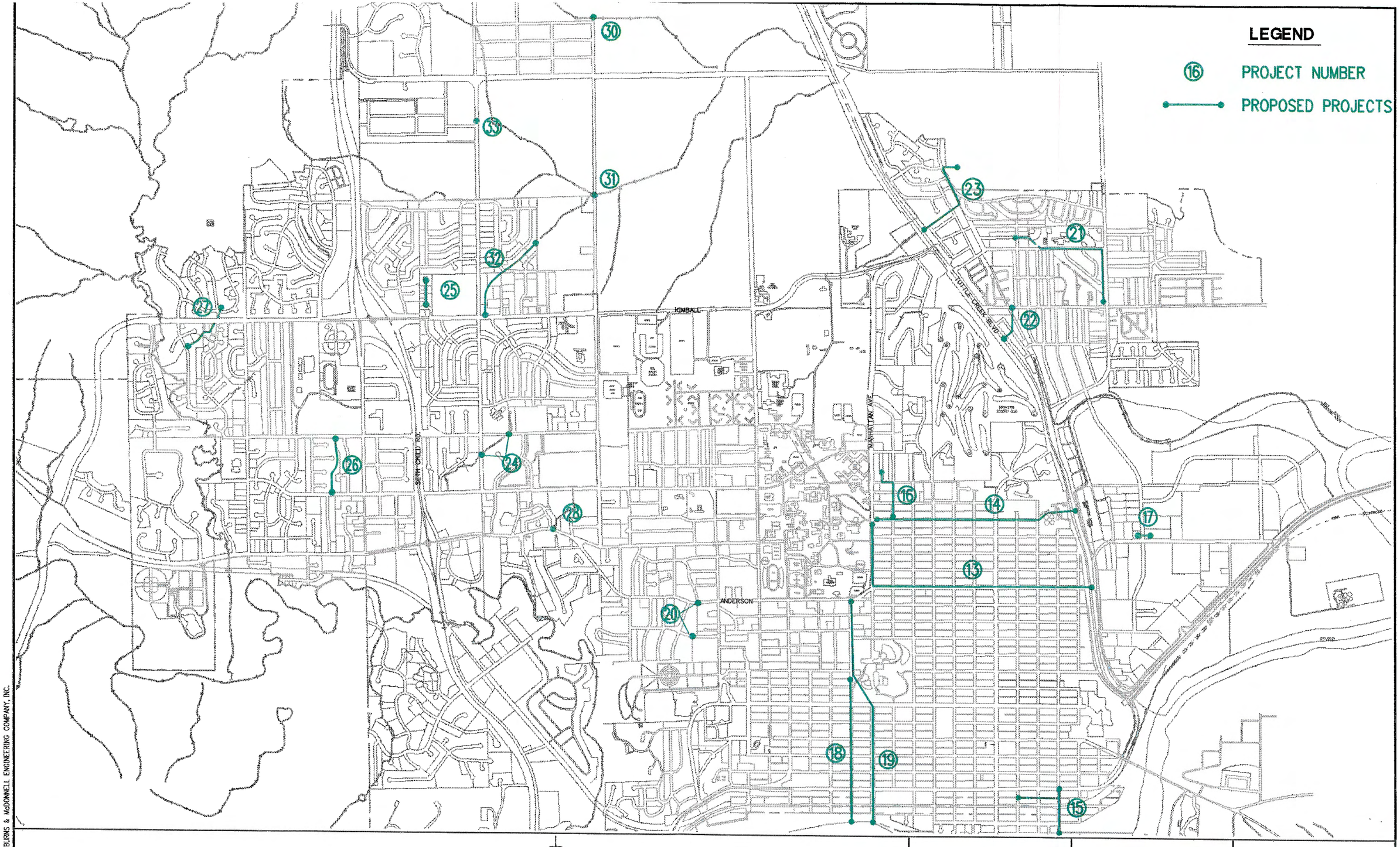

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Figure VI-2
DISCRETIONARY IMPROVEMENT PROJECTS

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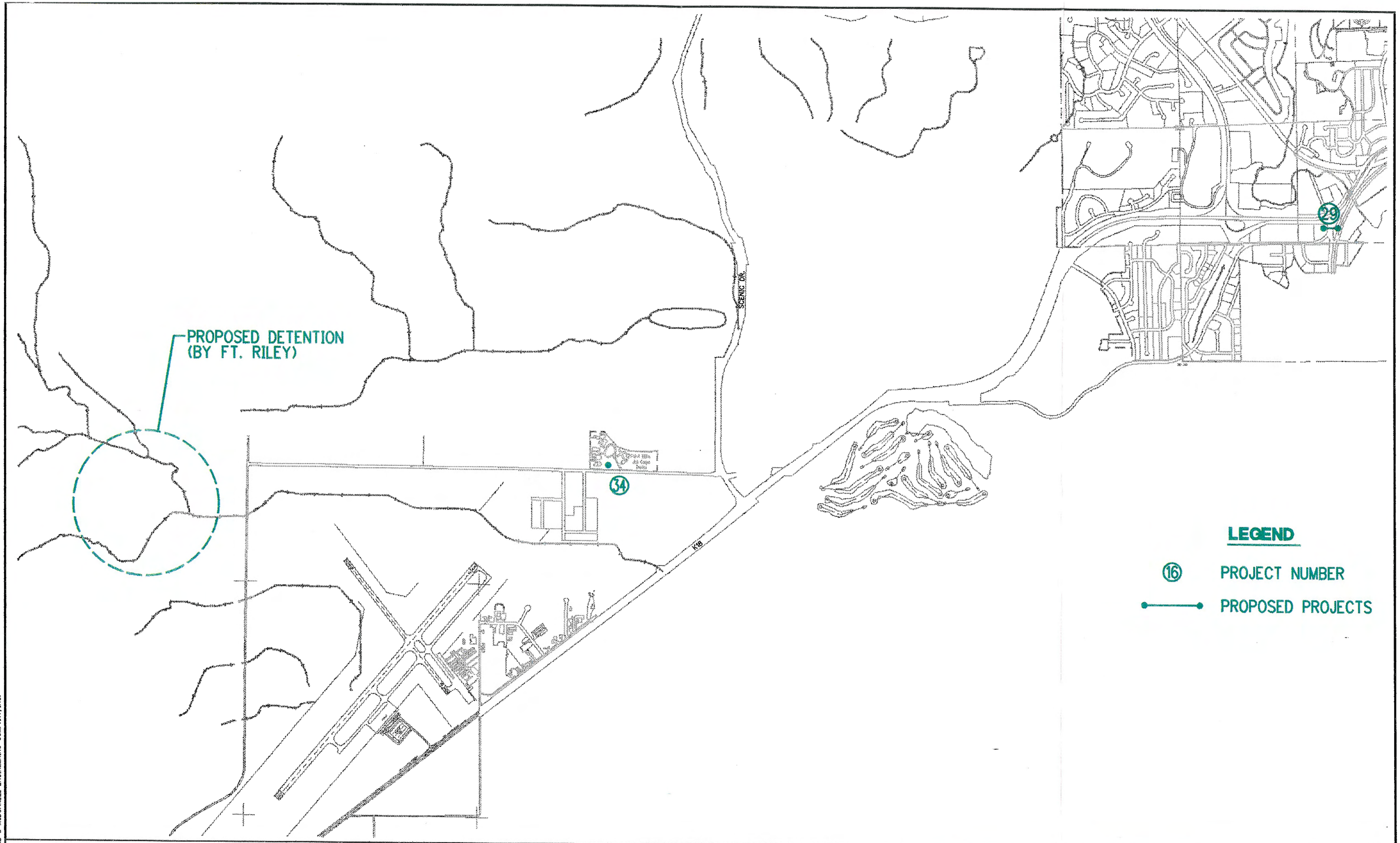

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Figure VI-3
DISCRETIONARY IMPROVEMENT PROJECTS

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