

PART I - EXECUTIVE SUMMARY

## PART I

### EXECUTIVE SUMMARY

#### A. GENERAL INFORMATION

This Executive Summary presents a condensed discussion of the Manhattan Stormwater Management Master Plan authorized by the City of Manhattan on March 9, 1993. The following sections of this report, together with accompanying watershed maps, computer models, and exhibits, present the detailed report and supporting information resulting from the study of the City's major drainage system which is the focus of this project. The major system is considered to begin at the point where approximately 40 acres become tributary to the system.

Services performed by BG Consultants, Inc., of Manhattan and Burns & McDonnell Engineers of Kansas City, Missouri to complete the study included:

- Field investigation of the City's major drainage system.
- Preparation of a set of watershed maps covering the study area.
- Evaluation of the existing system's performance capability.
- Development of an optimized capital improvements plan for the City to correct system deficiencies.
- Preparation of capital and operating cost estimates for the system.
- Recommendation of implementation priorities for improvements.
- Development of a recommended program and annual budget for continuing maintenance of the system.

The 13 principal watersheds included in this study cover 28.3 square miles tributary to three major waterways: Wildcat Creek, the Kansas River, and the Blue River. Figure I-1, following this page, indicates the study area and the 13 watersheds.

Average annual precipitation is 32.9 inches. Rainfall events that create peak demands on the system occur as convective thunderstorms an average of 55 times each year. Land slopes vary from nearly flat to approximately 30 percent in limited areas.

Land use within the corporate limits is substantially developed with single family residential development being the largest use class. Currently developing areas are located primarily within the North and Little Kitten Creek watersheds, at the edge of or just outside of the municipal boundaries. A relatively large portion of the land included in the study area is occupied by the main campus of Kansas State University and its associated facilities and property.

Data for modeling the existing system's performance were acquired from field investigations and a comprehensive review of City records and related studies. Two computer models developed by the Corps of Engineers were the primary tools used for the analyses. In addition, three programs developed by Burns & McDonnell were utilized for various aspects of the project. Specific models are:

- HEC-1 - Flood Hydrograph Package: Corps hydrology program for generating runoff or streamflow hydrographs for peak flows.
- HEC-2 - Water Surface Profiles: Corps program for determining flood elevations and evaluating open channels, bridges and culverts.
- URBMOD - B&McD comprehensive hydraulic and integrated hydrologic model used in this study for determining individual line capacities of some system reaches.
- SYCOST - B&McD program for estimating drainage system capital and annual maintenance costs.
- PRIOR - B&McD program for ranking improvement priorities on basis of benefit, cost and performance.

Operating copies of the models, users manuals, data files and hands-on training are being furnished to the City for their use in continuing management of the stormwater system.

## B. EXISTING SYSTEM PERFORMANCE

### 1. SYSTEM COMPONENTS

The existing major drainage system within the study area consists of 55.1 miles of conveyance elements including enclosed pipe storm sewers, improved and natural open channels, and cross-road culverts in addition

to several detention basins. Computer models defined the drainage system in terms of 365 individual sections, or reaches, for analysis. The existing drainage system is comprised of the following components as illustrated by Figure I-2.

<u>Type of Component</u>	<u>Lineal Feet of System Length</u>	<u>Percent of System</u>
Open Channels	210,245	72
Pipe System	59,820	21
Box Culverts	20,370	7
Detention Basins	5 each	-

2. HYDRAULIC PERFORMANCE

Figure I-3 graphically depicts the hydraulic capacity of the improved drainage system, if open and maintained, in terms of its return period capacity, or level of service. Current design criteria require varying system capacities although the basic requirements are for a 5-year peak flow capacity in most residential areas and a 10-year capacity in commercial and industrial areas. Proposed design criteria for new construction require that the system be designed for a 10-year return period in all areas with provisions for overflow channels to handle the 100-year peak flow when combined with the conveyance element capacity. By these proposed standards, 62 percent of the existing improved system, based on system length, is hydraulically deficient.

However, identifying an existing system element as failing to meet either current or proposed criteria, according to the model, does not indicate deficiencies in design or construction at the time the element was originally constructed. The principal determinants of hydraulic demand on the drainage system are land use and rainfall, neither of which has remained static during the period of time over which Manhattan's system has developed. Additionally, the development of more sophisticated computer modeling techniques and other analytical methods, which permit a much more refined analysis of the systems' performance than was previously practical, has had a major impact on the results of studies and design calculations.

The mere absence of "criteria" capacity also is not necessarily indicative of a problem requiring corrective action. Corrective action is warranted only when the deficiency results in damage from flooding, an unacceptable level of nuisance or a public safety issue. Conversely, adequate hydraulic capacity does not mean that a system component is performing satisfactorily. Significant erosion, difficult maintenance, and structural deterioration are examples of problems that may warrant the replacement of a storm drainage system component having adequate total hydraulic capacity.

Of the 117 individual pipes, culverts or improved channel sections included in the model that are rated at less than a 10-year capacity, only 24 cause problems of sufficient magnitude to warrant corrective action as outlined in the recommended improvement projects.

The portions of the system length comprised of natural, or unimproved, open channels generally have adequate hydraulic capacity if maintained clear of major obstructions. Likewise, those storm drains owned and maintained by the Kansas Department of Transportation on highways throughout the area are generally free from hydraulic deficiencies.

## C. DRAINAGE POLICY

### 1. TECHNICAL STANDARDS

Adoption of the "Stormwater Management Criteria" manual, which outlines specific technical standards and criteria for storm drainage system design, is recommended. A copy of this document, prepared as a part of this study, is contained in Appendix I.

### 2. REPLACEMENT AND UPGRADING OF EXISTING FACILITIES

#### a. Improved System

For the purposes of identifying and developing recommended improvement projects for this study, only those system elements where the existing deficiency has one or more of the recurring adverse effects listed below were considered.

- 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.

Although this study focuses on the major drainage system, the criteria for replacement can also be applied to the improved minor system.

Facilities recommended for improvement were also limited to those currently maintained by the City. No improvements are recommended along natural channels located in developed areas since the City does not maintain those segments of the system.

b. Private System Facilities

Recent and current city policies have required developers to construct adequate storm sewers as part of the land development process. Those policies are reflected in a corresponding value and cost of the privately-owned property in those developments. Other principally older developed areas, many of which were annexed after development, do not have a commensurate private investment in storm sewers.

Because there is an inherently inequitable level of private investment, the City should limit its correction of drainage problems on private property to the following circumstances.

- When water collected and discharged from public rights-of-way contributes significantly to, or causes, the problem.
- An improved system is present but either lacks capacity or is in deteriorated structural condition.

3. STORMWATER DETENTION

A drainage system responds to rainfall in an interdependent and complex

manner. Stormwater detention may either reduce or increase the peak rate of discharge to other drainage elements depending on the specific location of the basin within the system; therefore, requiring detention for all new development may not always accomplish the desired goal.

We recommend that the City establish a policy of requiring stormwater detention in connection with new development only when such detention is recommended by the Stormwater Management Master Plan in areas where it provides a clear benefit to the drainage system. We further suggest that the City consider establishing an impact fee applicable to all development for use in managing the major drainage system. Waiver of such a fee when a developer is required to provide on-site detention provides a method of eliminating inequities between different development tracts.

D. RECOMMENDED SYSTEM IMPROVEMENTS

1. ALTERNATIVES

System capital improvement project recommendations were developed after consideration of the benefits, performance and cost of a broad range of options including:

- Land Use/Zoning Changes
- Flowage Easements
- Removal of Damageable Improvements
- Detention
- Open Channels
- Enclosed Pipe/Box Culvert Storm Drains

The resulting recommended and discretionary improvement projects are generally structural improvements to the system combined in most cases with flowage easements to maximize the system's performance. Zoning changes, regulatory detention and removal of damageable property are also proposed for limited areas and specific situations.

2. RECOMMENDED CAPITAL IMPROVEMENTS

Recommended improvements to the existing major drainage system include

- 8,920 lineal feet of pipes and box culverts

- Construction of two energy dissipators at existing box culverts
- One larger stormwater pump station with additional detention storage capacity on the City's east side.

Figure I-4 indicates the relative length of each type of linear system improvement.

The recommended improvements are consolidated into eight defined projects with one project having an alternative, interim solution outlined for consideration. Tables I-1 and I-1A identify the specific projects and their estimated capital and annual maintenance costs. A detailed description of each project is presented in Part VI of this report.

TABLE I - 1  
RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

<u>Project Number</u>	<u>Project Name</u>	<u>Capital Cost</u>	<u>Annual Maint. Cost</u>
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	<u>679,000</u>	<u>2,500</u>
	Totals	\$ 7,200,850	\$ 9,250

TABLE I - 1A  
ALTERNATIVE RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

<u>Project Number</u>	<u>Project Name</u>	<u>Capital Cost</u>	<u>Annual Maint. Cost</u>
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	<u>679,000</u>	<u>2,500</u>
	Totals	\$ 5,392,150	\$ 7,660

3. PROJECT PRIORITIES

Table I-2 presents the eight projects in the recommended order of priority for implementation. Recommendations are as developed by the PRIOR computer program. The priorities are established objectively to optimize the mitigation of property damage, benefit to the system, and cost. Table I-3 indicates the revisions to the priority rankings when alternative Project No. 2A is substituted for Project No. 2.

TABLE I-2

RECOMMENDED IMPROVEMENT PROJECTS PRIORITY RANKING

<u>Prior. No.</u>	<u>Proj. No.</u>	<u>Project Description</u>	<u>Points</u>	<u>Cost (\$)</u>
1	7	Dickens Energy Dissipator	18	50,000
2*	1	Denison-Anderson System	13	2,625,100
3	2	Tecumseh-Quivera System	15	2,168,700
4	6	Claflin Culvert @ CICO	14	250,000
5	3	Hartford Road System	13	658,100
6	4	Allen Road System	13	689,600
7	5	Nevada-Montana System	13	80,350
8	8	Poyntz Ave. Pump Station	12	<u>679,000</u>
Total Project Costs				\$ 7,200,850

\* Project ranked ahead of Project 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.

TABLE I-3

RECOMMENDED IMPROVEMENT PROJECTS ALTERNATIVE PRIORITY RANKING

<u>Prior. No.</u>	<u>Proj. No.</u>	<u>Project Description</u>	<u>Points</u>	<u>Cost (\$)</u>
1	2A	Tecumseh-Quivera Alternate	19	360,000
2	7	Dickens Energy Dissipator	18	50,000
3	6	Claflin Culvert @ CICO	14	250,000
4	3	Hartford Road System	13	658,100
5	4	Allen Road System	13	689,600
6	1	Denison-Anderson System	13	2,625,100
7	5	Nevada-Montana System	13	80,350
8	8	Poyntz Ave. Pump Station	12	<u>679,000</u>
Total Project Costs				\$ 5,392,150

4. DISCRETIONARY PROJECTS

In addition to the recommended improvement projects, 22 potential projects were identified to be undertaken at the City's discretion as the need arises and funds become available and, therefore, are not prioritized. Several of these projects involve private or county system components which the City is not currently responsible for maintaining. In the case of those facilities outside of the City limits, action will not be necessary at least until such time as the areas are annexed and under the City's jurisdiction.

The projects are also separated into two groups. Group A includes the larger projects that are considered to have system-wide impacts or which will affect a relatively large number of people such as system improvements along major streets where traffic disruptions could be substantial. Group B projects are those that are more limited in scope and generally have a localized effect on specific areas and residents.

Table I-4 identifies the projects and total costs. More detailed descriptions of the projects are presented in Part VI of this report.

TABLE I- 4  
DISCRETIONARY IMPROVEMENT PROJECTS

<u>Proj. No.</u>	<u>Project Description</u>	<u>Group</u>	<u>Esmnt. Type<sup>(1)</sup></u>	<u>Capital Cost</u>
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	<u>287,200</u>
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			<u>\$4,213,050</u>
	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

E. SYSTEM MAINTENANCE

1. CURRENT NEEDS

The City's major drainage system includes 55.1 miles of pipes, culverts and open channels plus an extensive minor system. Past maintenance of the system has been done on a complaint/emergency response basis. As a result, "normal" maintenance needs for many of the drainage facilities exist. Immediate major system high-priority maintenance needs to open obstructed facilities and to repair structural deficiencies have been identified at 12 locations. This work is estimated to cost \$ 30,200.

2. PROGRAM AND BUDGET

It is recommended that a planned program of regular inspection and maintenance of the storm drainage system, with a corresponding budget, be established. The estimated average annual cost of maintaining the present improved major system is \$ 43,000 per year and it is anticipated that at least that much more will be needed to maintain the minor system so that a total maintenance budget of approximately \$ 100,000 annually will be required. The recommended maintenance program is within the

current technical capability of the City's public works department. Some maintenance activities included in the recommended program have previously been classified as street maintenance and so are in effect already included in the City's budget. Figure I-5 indicates the allocation of maintenance funds to the major system.

Although storm drainage facilities owned by the highway department, railroads and private interests are an integral part of the functional system, the cost of their maintenance is not included in the recommended budget. The costs of hiring additional personnel that may be required to perform this work are also not directly included in the budget although labor costs are a factor in determining average maintenance costs for the system.

F. FINANCIAL PLAN

An increase in the current level of funding for storm drainage is essential to construct the recommended capital improvements to correct present major drainage problems, to undertake operation and maintenance of the City's drainage system at a level that can avoid the development of new drainage problems, and to provide funds for future capital improvement projects. The financial plan presents alternative funding mechanisms and revenue sources necessary to implement the improvements program. It is not expected that all of the options presented will ever be used but a basic understanding of all the possibilities is necessary to make decisions in the best interest of the community.

The two alternatives for financing the recommended improvement projects are cash-basis and debt financing. Of the debt financing methods available to the City, general obligation bonds are recommended as the most appropriate for the capital improvements program when compared with revenue or special assessment bonds. The overall and annual costs of various financing plans were investigated assuming specific durations for the capital improvements program and the number of bond issues. Tables I-5 and I-6 summarize the costs for cash-basis and bond financing. Each plan is outlined in more detail in Part IX of this report.

TABLE I-5

## ANNUAL COSTS FOR CASH-BASIS FUNDING

<u>Program Duration</u>	<u>Total Cost of Construction</u>	<u>Total O&amp;M Costs</u>	<u>Average Annual Program Costs</u>
5 years	\$ 7,575,000	\$ 520,400	\$ 1,619,080
10 years	8,067,400	1,095,000	916,240

TABLE I-6

## NET BOND FINANCING COST

<u>Program Duration</u>	<u>Issue Amount</u>	<u>Annual Debt Service</u>	<u>Total Cost of Bond Issue</u>
5 years	\$ 7,180,000	\$ 677,740	\$ 13,554,800
10 years - 1 issue	6,925,000	653,670	13,073,400
10 years - 2 issues	7,650,000	339,810/722,100	14,442,000

Potential revenue sources include the stormwater utility fees, property taxes and a capital improvements sales tax. It is recommended that funding for the improvement program be derived from the stormwater utility fees since the utility was created primarily for this purpose and the fees fairly apportion the cost of drainage service to runoff generators. Since the City's sales tax rate is currently at the legal maximum, an increase is not feasible at this time and this option is not included in any detailed analysis. The increase in the mill levy rate for funding the program entirely from property taxes was determined; however, this option is also not recommended since it is based only on value and has no relation to actual contributions to runoff into the drainage system for each property.

Currently the utility generates approximately \$111,000 annually. To fund any capital improvements program from this source the utility rates must be increased substantially, either all at once or in phases. Although the recommended program totaling approximately \$ 7,200,000 should be considered the minimum required at this time, other options have been investigated in the event only a limited amount of money will be available and the scope of the improvement program must be reduced. Table I-7 summarizes the options considered and the associated increases in the stormwater utility rate schedule required to fund each one.

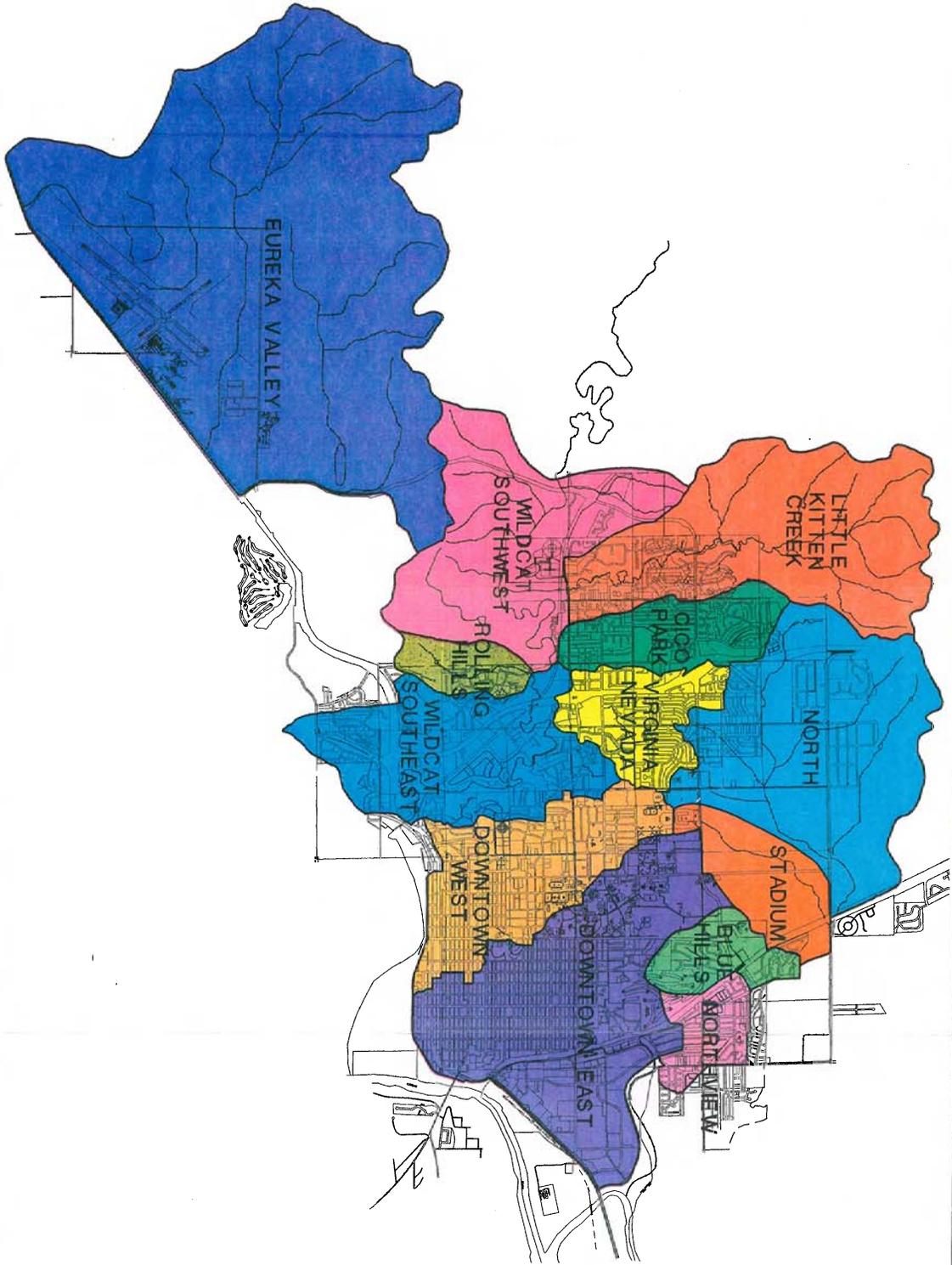
TABLE I-7

FINANCING COSTS FOR VARIOUS LEVELS OF CAPITAL IMPROVEMENTS PROGRAM

<u>Bond Issue Amount</u>	<u>Bond Term (Years)</u>	<u>Annual Debt Service</u>	<u>Total Cost of Bonds</u>	<u>Approx. Increase in Utility Rates</u>
\$1,000,000	20	\$ 94,390	\$ 1,887,800	170%
2,000,000	20	188,790	3,775,800	260%
3,000,000	20	283,180	5,663,600	340%
4,000,000	20	377,570	7,551,400	425%
5,000,000	20	471,960	9,439,200	500%
7,200,000	20	679,630	13,592,600	680%
\$1,000,000	10	\$ 142,380	\$ 1,423,800	215%
2,000,000	10	284,760	2,847,600	340%
3,000,000	10	427,130	4,271,300	470%
4,000,000	10	569,510	5,695,100	590%
5,000,000	10	711,890	7,118,900	715%
7,200,000	10	1,025,120	10,251,200	1000%

While the financial plan presents options, the actual choice of funding mechanisms, levels and revenue sources is the prerogative of the City Commission. It is the City's responsibility to balance the community's needs with available revenues which are acceptable to the citizens.

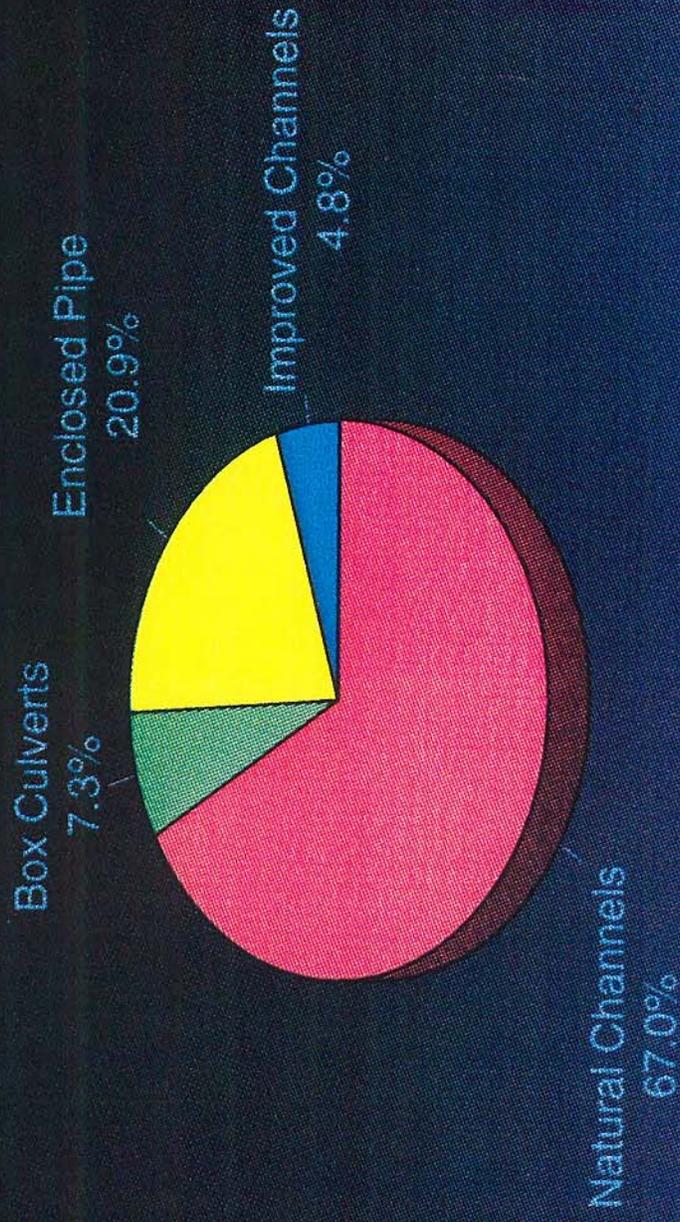
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CITY OF  
**MANHATTAN KANSAS**  
Figure 1-1  
WATERSHED MAP

# Existing Major Drainage System

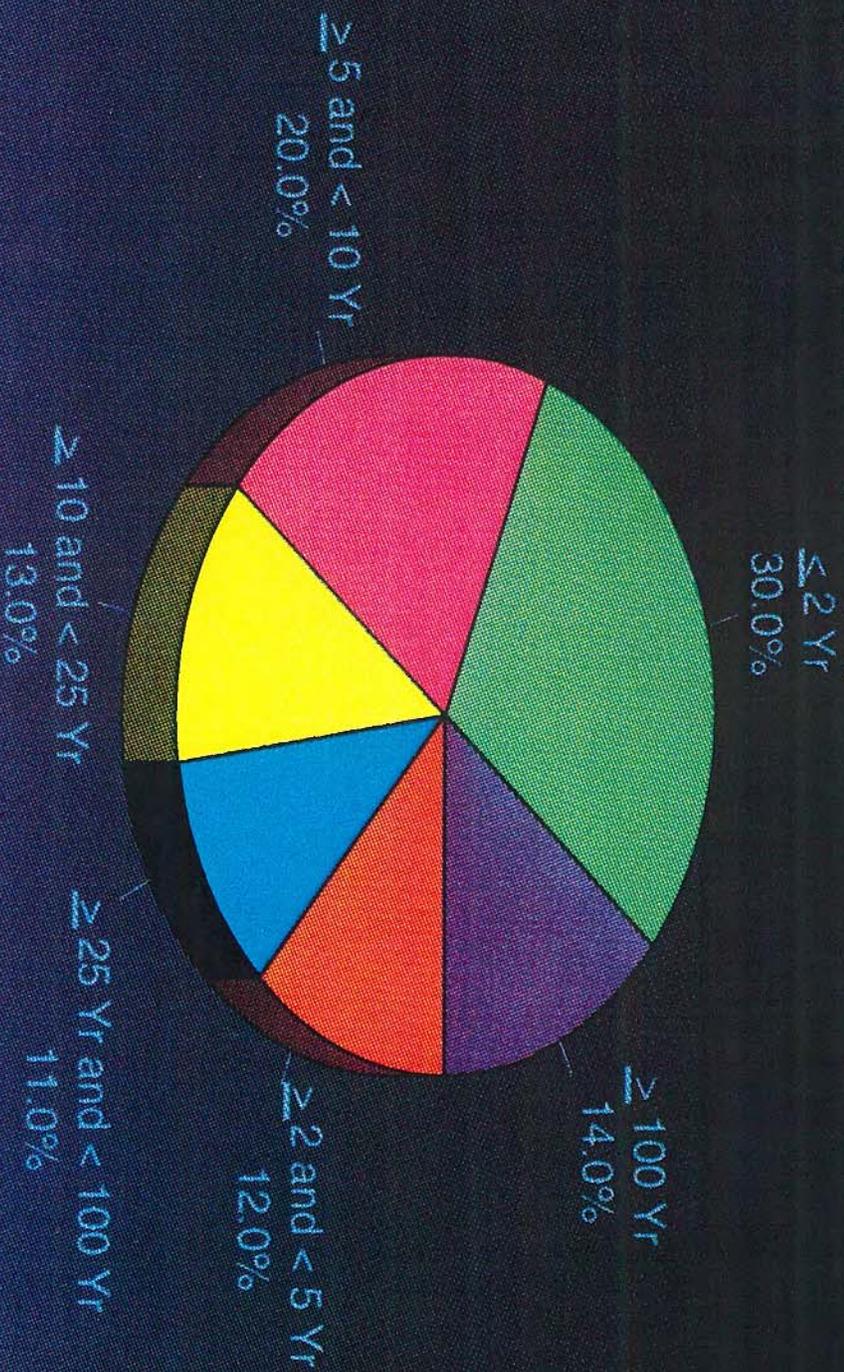
Component Length



City of Manhattan, Kansas  
Stormwater Management Plan

Figure 1-2

# Existing Improved System Return Period Performance (By Length of System)



City of Manhattan, Kansas  
Stormwater Management Plan  
Figure 1-3

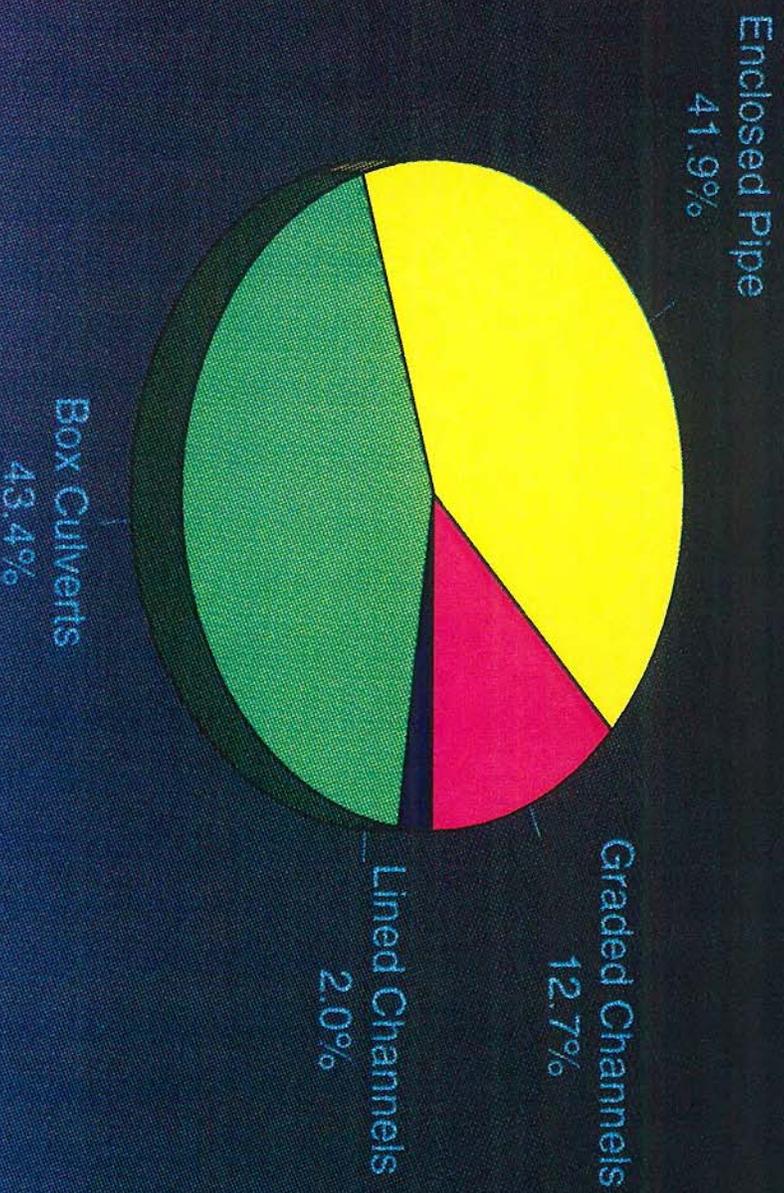
# Summary of Capital Improvements



City of Manhattan, Kansas  
Stormwater Management Plan  
Figure 1-4

# Annual Maintenance Cost Distribution

## Improved Major System



City of Manhattan, Kansas  
Stormwater Management Plan  
Figure 1-5