VIII. Flooding Locations, Improvements, and Preliminary Costs

A. Scope

The facilities assessment was performed to characterize the existing stormwater conveyance system and to identify means to decrease or eliminate present and future flooding. The facilities can be divided into three groups: the main channel system, the tributary subsystem, and the non-modeled system. The main channel system includes the large open channels, culverts, and bridges in Three Mile Creek, Three Mile Creek South Branch, and Five Mile Creek; the tributary subsystems consist of smaller open channels and underground conduits leading to the main channel system or to receiving waters outside of the Three Mile and Five Mile Creek watersheds; and the non-modeled conveyance systems consist of smaller than 18-24 inch diameter equivalent facilities. The scope of this study covers the main channel and tributary conveyance systems and portions of the non-modeled systems only. Problem identification is discussed in separate sections for each group.

Although only the main channel system and tributary subsystems were modeled, the local system is crucial to the operation of the entire conveyance system. Some of the more noticeable flooding is the result of inadequate local drainage facilities, such as clogged or collapsed driveway tubes. Therefore, general discussion has been included, where appropriate, to help understand and identify problems associated with the local systems as well as basin-wide problems. The discussion is based on responses to questionnaires mailed to area residents at the beginning of the study, and on past experience. Sufficient information is available on all aspects of the drainage systems to permit a proper assessment.

Structural improvement alternatives are described for the main channel and tributary subsystems in the Three Mile and Five Mile Creek and outlying, or external (EMC), watersheds. Recommended improvements not evaluated by computer modeling are discussed separately.

The detention/retention alternative is described in Section F.

Unit costs and preliminary cost estimates complete this chapter.

B. Assumptions

The following assumptions can be made regarding improvements to the stormwater conveyance system components:

- Wherever possible, non-structural improvements, such as flood-proofing, will be used.
- If flood plain improvements are not practical for developed areas, paralleling existing pipes, culverts, and bridges will most likely be used as a remedy for inadequate structures, and lining for inadequate channels. Where these measures are not appropriate, replacement with additional or larger structures, followed by retention or detention, where cost-effective, will be used.
- All low water crossings should be eliminated.
- Detention facilities may be required to prevent peak flows from exceeding existing flows.
- The most effective location for detention facilities for peak flow reduction in a watershed or subwatershed is the middle third of the area; the lower one-third is the next most effective location.
- Since detention facilities may be required, providing additional storage to reduce the peaks to a rate that downstream facilities can convey, may be the most cost-effective solution.
- Inadequate system components in undeveloped areas will not be improved unless they have a detrimental impact on the upstream system, or if they cause high water or flooding that is a significant threat to life.
- Detention facilities in a subwatershed may be designed to reduce peak flow in the subwatershed, in the entire watershed, or both.
- The main channels in the Three Mile and Five Mile Creek watershed models were evaluated for the 100-year design storm. To simulate the worst case 100-year flood over the entire watershed, each tributary subsystem was assumed capable of passing all the runoff to the main channel with minimal attenuation. Where bridges or culverts caused flooding or were overtopped under these conditions, improvements were made to keep the water surface below the road surface. After the main channel bridges and culverts were evaluated and resized, or remedied with non-structural improvements, they were modeled for the 50-year and 10-year design storms to set the 50-year and 10-year tailwater elevations at the confluence of all tributary subsystems with the main channel. Individual models of each tributary subsystem were then extracted from the main model. With main channel backwater boundary conditions, the subsystem networks were evaluated for the 10-year design

storm. Similarly, structures under major arterials and collector streets were analyzed for the 50-year design storm.

C. Problem Identification

The stormwater conveyance systems modeled in the Three Mile and Five Mile Creek watersheds and the external watersheds are described separately, as are the non-modeled systems. The intent is to present the existing stormwater conveyance system and the drainage system in general, followed by discussions of system inadequacies and deficiencies, and locations of flooding. Where appropriate, information on the local drainage system is presented.

1. Three Mile Creek Watershed

The majority of the Three Mile Creek watershed within the Leavenworth city limits has been fully developed, and most of the major conveyance elements are unimproved or not regularly maintained. Some of the arch culverts are about 100 years old. Previous studies and reports have documented historical accounts of flooding from newspapers and eyewitnesses. Recurrent problems have plagued the downtown central business district, especially at Cherokee and Broadway; Shawnee Street; and 6th, 7th, and 10th Streets. Many of the improvements recommended by Black & Veatch in the 1967 study have been implemented, which has alleviated some of the historical problems. Flooding is also occurring in new developments, however, as a result of the lack of a comprehensive drainage policy and regulations for developers.

Computer modeling for present conditions indicates that at least 18 percent of the pipes and culverts are inadequate to convey a 10-year event. The Stormwater Committee agreed that the 10-year storm is the minimum standard. Table VIII-1, located at the end of this section beginning on page VIII-29, presents a system summary for the Three Mile Creek watershed and Table VIII-2, on page VIII-31, presents specific information for the inadequate structures. "Existing Capacity" is the Manning's full flow for a conduit based on its cross-sectional area, slope, and material roughness. "Maximum Flow" is the sum of the pressure flow through the conduit and any street overflow from flooding at the upstream junction as a result of the design storm. Where maximum flow is less than existing capacity, flooding may be occurring at the junction because of backwater effects, rather than due to the conduit. Figure VI-11 in Chapter VI shows these elements in relation to the locations identified in responses to the Stormwater Questionnaire.

2. Five Mile Creek Watershed

The Five Mile Creek watershed is less densely developed than the Three Mile Creek watershed, but is experiencing new growth in the south and west. Some of the flooding is due to inadequate inlet capacity; other problems are caused by conduits with adverse slopes and poorly maintained channels. Previous studies and reports have described flooding problems along Five Mile Creek, especially at the wastewater treatment plant, the 4th Street bridge, Limit Street, and Shrine Park Road. Recurrent problems have also affected 16th and 17th and Vilas Streets, 4th Street, and in the area of the proposed West Leavenworth Trafficway. Some improvements have been implemented, including channelization of Five Mile Creek from the wastewater treatment plant to the Missouri River and pipe replacement at Limit Street west of 10th Street. New growth and inadequate storm conveyance facilities are causing new flooding problems.

Computer modeling for present conditions indicates that at least 6 percent of the pipes and culverts are undersized for the 10-year event. Table VIII-3, beginning on page VIII-42, presents a system summary for the Five Mile Creek watershed and Table VIII-4, on page VIII-43, presents specific information for the inadequate structures. "Existing Capacity" is the Manning's full flow for a conduit based on its cross-sectional area, slope, and material roughness. "Maximum Flow" is the sum of the pressure flow through the conduit and any street overflow from flooding at the upstream junction as a result of the design storm. Where maximum flow is less than existing capacity, flooding may be occurring at the junction because of backwater effects, rather than due to the conduit. Figure VI-12 in Chapter VI shows these elements in relation to the locations identified in responses to the Stormwater Questionnaire.

3. External Watersheds and Problems Not Predicted by Model

Watersheds that are within the city limits, but outside the Three Mile and Five Mile Creek basin boundaries, are known as "external watersheds." These watersheds drain to 14 different subsystems which range in size from one culvert to 50 or more conveyance elements, and discharge to one of three destinations: Ft. Leavenworth, the Missouri River, or the City of Lansing.

The single conduit subsystems were evaluated for a selected design storm using the Rational Method. The runoff from the contributing watershed, calculated by the Rational Method formula, was compared to the full flow capacity of the existing conduit. If the capacity was less than about 80 percent of the runoff, the conduit was considered inadequate. It was assumed that a conduit could convey up to 25 percent more than its full flow capacity under pressure flow conditions without flooding. For more complex subsystems, the computer program XP-SWMM was used to identify the flooding problems and to size needed improvements. A list of the external watershed subsystems is provided in Table VIII-5, on page VIII-57.

Five of the nine subsystems modeled had some inadequate conduits, as indicated in Table VIII-6, on page VIII-58. "Existing Capacity" is the Manning's full flow for a conduit based on its cross-sectional area, slope, and material roughness. "Maximum Flow" is the sum of the pressure flow through the conduit and any street overflow from flooding at the upstream junction as a result of the design storm. Where maximum flow is less than existing capacity, flooding may be occurring at the junction because of backwater effects, rather than due to the conduit. Of the single-conduit systems evaluated using the Rational Method, one was identified as inadequate because its capacity was only 50 percent of the calculated peak flow.

Because not every stormwater conveyance element in the city was modeled, other sources were used to determine drainage problem areas within the city limits. Communications with the Stormwater Committee, the Questionnaire, and the Hotline; complaint calls; past reports and studies; and City staff provided historic flooding locations and other drainage problem areas. In general, the responses to the Stormwater Questionnaire indicated prevalence of the following problems: (1) missing, non-maintained, or inadequate driveway tubes/ditches; and/or (2) unauthorized regrading of property by residents to divert runoff to the street, creek, or adjacent property. These two problems were common throughout the City and the number of these types of problem areas is much greater than the number of problems on the modeled system. The Questionnaire responses are included in Chapters III and VI and are omitted from Table VIII-7. The locations and descriptions of the other reported drainage problems are listed in Table VIII-7, beginning on page VIII-61.

The Watershed ID segregates the problems by watershed as "3MC, "5MC," or "EMC" for Three Mile Creek, Five Mile Creek, or external, respectively. The Map Sheet No. refers to the respective M.J. Harden map sheet. The Problem Identification Number simply signifies the order in which the problems were recorded in the office.

D. General Corrective Measures

Proper development of a stormwater conveyance system from the master planning level to design, construction, operation, and maintenance includes identification of corrective measures to be implemented. Historically, corrective measures have focused principally on structural improvements such as channel lining and enclosing open channels. Although effective, these solutions are not necessarily consistent with the present views of City officials and residents, nor do they have a positive impact on water quality or reducing present and future peak flows. Figure VIII-1 presents the corrective measures discussed below.

1. Introduction

The corrective measures will be only as good as the methods used to identify the problems, their locations, and the most appropriate combination of measures to provide practical solutions. The corrective measures available for a comprehensive Stormwater Master Plan can be divided into two basic categories--storm drainage system improvements and flood plain improvements. The main difference between them is in the location. Storm drainage system improvements are aimed at lowering flood water elevations or eliminating the flooding altogether. Flood plain improvement measures, on the other hand, are directed at reducing the damage caused by flooding. The flooding, however, will still occur and the flood water elevations will usually remain the same.

Storm drainage system improvements can be divided into maintenance, construction of system components, and system initialization. System initialization consists of restoring the components of the system to their initial, or appropriate, hydraulic capacities. The level of effort involved falls between remedial maintenance and construction of system components. It is a one-time task, and is carried out before the implementation of a regular maintenance plan. The difference is in the timing. System initialization is a one-time effort, whereas remedial maintenance may be required after each major storm. The corrective measures used for remedial maintenance usually apply to system initialization as well.

The solution to storm drainage problems in a watershed typically consists of a combination of drainage system improvements and flood plain management improvements. Both are of equal importance, and usually neither is adequate by itself when considering not only alleviation of flooding, but also project life expectancy; cost-benefit; future maintenance and upkeep; initial cost; effects on water quality; and regulatory compliance. The water quality issue is becoming increasingly important. The NPDES regulations require some communities to monitor stormwater quality and to evaluate measures such as erosion repair, infiltration swales, or detention/retention basins to improve the water quality. At present, only cities with populations of 100,000 or

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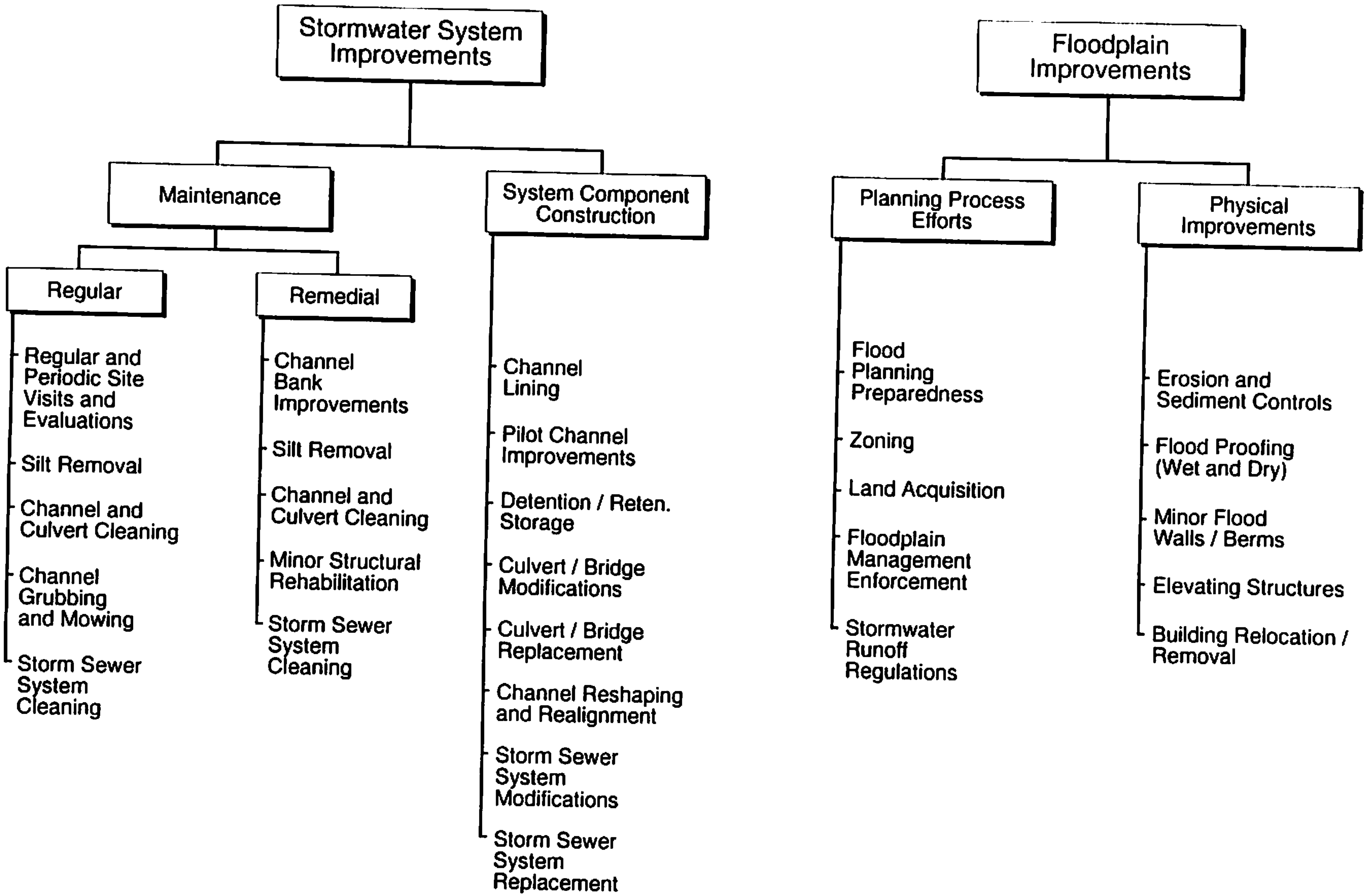


BLACK & VEATCH

General Corrective Measures

Figure VIII-1

greater are required to comply, but the requirement may be extended to smaller communities in the future.

The general corrective measures available and applicable to Leavenworth's watersheds are indicated on Figure VIII-1 and discussed below.

2. Storm Drainage System Improvements

A key element in improving an existing storm drainage system is to provide practical improvements; however, a more vital element is to assure that the improvements are provided at the necessary level and at the appropriate time. For example, although a section of channel may be inadequate, timely cleaning or reshaping may be a more appropriate solution than lining it with concrete later. The intent is to provide an early improvement to the storm drainage system without the expense associated with capital improvements. Such upgrading measures are practical and cost-effective, and are categorized as system initialization. It should be noted that aggressive implementation of these measures would require significant upgrade of personnel, budget, and ordinances.

a. Maintenance. Maintenance is the upkeep necessary for efficient operation of the system. The theory is that it is better to maintain a facility now than to rebuild it later. In general, maintenance can be categorized as regular maintenance and remedial maintenance.

Regular maintenance differs from remedial maintenance in the scope, level of effort, and timing. If the regular maintenance program cannot keep pace with deterioration, the program should be adjusted or supplemented before remedial maintenance or structural improvements become necessary. Regular maintenance is repetitive, whether it be several times each year as for channel mowing, or once every five years as in the case of channel and culvert cleaning. Remedial maintenance, on the other hand, is the effort necessary to return a system component to proper condition after it has been damaged.

The criterion for differentiating between remedial maintenance and the need for replacing a component is whether the component will function properly when returned to its intended use after remedial maintenance.

(1) Regular maintenance. Regular maintenance of storm drainage facilities is defined as the necessary repetitive attention to all components of the system to assure that it continues to operate as designed. Improving regular maintenance of existing facilities could alleviate flooding without the construction of additional system components. For future facilities, proper planning, design, and construction, supplemented with a well-planned regular maintenance program, is vital. Examples of regular maintenance tasks are listed below. Regular maintenance is repetitive; however, requirements can vary from year to year depending on the frequency and intensity of storms and the general conditions in the watershed. This is further discussed for each type of regular maintenance.

- Regular and periodic site visits and evaluations.
- Silt removal.
- Channel and culvert cleaning.
- Channel grubbing and mowing.
- Storm sewer system cleaning.

*(a) **Regular and periodic site visits and evaluation.*** The site evaluation is usually done early in the spring and after major rainfall events. The purpose is to inspect the condition of major channels and structures, and to identify maintenance requirements, both regular and remedial, as well as the need for constructing or replacement of system components. Site investigations should also be made after major rainfall events to check for damage and to identify possible preventive measures against future damage.

*(b) **Silt removal.*** Silt removal is part of regular maintenance to keep the channels and culverts clean from solids deposits. Siltation is the result of the erosion from upstream construction sites; channel erosion caused by high flow velocities and inadequate channel protection; and runoff from impervious areas, particularly in highly urbanized districts. The amount and frequency of silt removal will vary depending on the location and the frequency and intensity of rainfall events.

*(c) **Channel and culvert cleaning.*** Channel and culvert cleaning consists of removing large debris such as tree limbs, abandoned shopping carts, household items, and tires, to name a few. Locations and amounts of debris are identified during site investigations. Cleaning is typically performed once each year, usually in the spring.

*(d) **Channel grubbing and mowing.*** Channel grubbing and mowing consist of removing unwanted vegetation within the limits of the channel section and maintaining the wanted vegetation to improve the capacity of the channel. Typically, grubbing at the

regular maintenance level is done with light equipment only. Primary locations for grubbing are channel sections where the overgrowth of trees and brush has progressed beyond the scope of mowing. Channel grubbing should be performed once each year at locations where needed.

Although channel mowing is one of the more obvious maintenance procedures, it is sometimes forgotten or considered an unnecessary task. Often, steep slopes or the overgrowth of trees and brush make mowing channel banks difficult or impossible; however, mowing is crucial to maintaining the channel capacity. The required frequency of mowing depends primarily on the amount of rainfall. Typically, it should be scheduled three times a year.

*(e) **Storm sewer system cleaning.*** Storm sewer system cleaning consists of removing debris and silt from inlets, manholes, and the underground conveyance system so that the system can operate as intended. Locations and amounts of debris and silt are typically identified during site investigations. Cleaning is typically performed once each year, usually in the spring.

*(2) **Remedial maintenance.*** Remedial maintenance involves upgrading the storm drainage system to a degree beyond regular maintenance, but to a lesser extent than construction of system components. Where a regular maintenance program has been implemented, remedial maintenance should be necessary only after major storm events. Typical remedial maintenance tasks to correct system deficiencies are as follows:

- Channel bank improvements.
- Silt removal.
- Channel and culvert cleaning.
- Minor structural rehabilitation.
- Storm sewer system cleaning.

*(a) **Channel bank improvements.*** Channel bank improvements consist of reconfiguring the channel to stabilize its cross-section, make it easier to maintain, reduce the erosion potential, and increase the channel capacity. Typical improvements include minor reshaping to increase channel capacity or to improve maintainability of its cross-section, and providing erosion control by installing riprap, gabion baskets, or concrete or fabric liners. At the remedial maintenance level, channel bank improvements are most

likely to be needed near existing structures (both upstream and downstream) and at locations where the original cross-section has become inadequate, such as at bends in the channel, or where the existing channel bank material is not suitable or is generally saturated and difficult to maintain. A secondary benefit of channel bank improvements is the potential for reducing siltation downstream, since upstream erosion is being reduced.

(b) Silt removal. Silt removal at the remedial maintenance level consists of the same type of work as regular maintenance. The difference is in the timing. Silt removal at remedial maintenance level should be necessary only after major storm events, and therefore, the frequency and level of effort will vary.

(c) Channel and culvert cleaning. Channel and culvert cleaning at the remedial maintenance level consists of the same type of work as regular maintenance. The difference is in the timing. Channel and culvert cleaning at remedial maintenance level should be required only after major storm events, and therefore, the frequency and level of effort will vary.

(d) Minor structural rehabilitation. Minor structural rehabilitation consists of improvements to the structural components of the system. These improvements are often necessary after major storm events where the stormwater or the debris it carries has damaged the system's integrity to the point of creating potentially dangerous conditions.

(e) Storm sewer system cleaning. Storm sewer system cleaning at the remedial maintenance level consists of the same type of work as regular maintenance. The difference is in the timing. Cleaning at remedial maintenance level should be required only after major storm events; therefore, the frequency and level of effort will vary.

b. System Component Construction. System component construction involves improvements to the conveyance system to reduce or alleviate present flooding, to eliminate the potential for future flooding, and to replace deteriorating or structurally deficient components. System component construction is the most obvious and most labor- and cost-intensive corrective measure, and is not always the most practical or cost-effective. Detailed assessments should be performed to assure that construction is necessary, and that maintenance, either regular or remedial, is not more appropriate. If it is determined that system component construction is the most practical and cost-effective corrective measure to be used, care must be taken to thoroughly analyze the conditions to minimize costs. The more practical system component construction measures to alleviate flooding, for both present and future conditions, are listed below:

- Channel lining.
- Pilot-channel improvements.
- Channel reshaping and realignment.
- Culvert and bridge modifications.
- Culvert and bridge replacement.
- Storm sewer system modifications.
- Storm sewer system replacement.
- Detention/retention storage.

(1) Channel lining. As a form of bank stabilization and erosion protection, channel lining is also used to increase the capacity of a channel section by decreasing its roughness. When used to increase flows, care must be used to assure that the greater flows do not have an adverse impact on the downstream system. A second potential drawback to channel lining is the detrimental effect on the natural setting. Although natural-looking linings are available, some scenic value may still be lost. Therefore, lining improvements must be carefully selected. Examples of channel lining materials include concrete, riprap, and gabion baskets. Regardless of the material used, lining can be provided for the entire channel cross-section or just part-way up the bank, and for considerable distances or only at critical locations such as bends and constrictions.

(2) Pilot-channel improvements. Pilot-channel improvements, in addition to protecting against erosion, also improve the low-flow capabilities of the channels and eliminate meandering of the pilot section. Pilot-channel improvements differ from channel lining by the extent of lining provided. Pilot-channel lining is limited to the immediate area of the flow-line, and is generally provided along extended lengths of channel. A drawback to pilot-channel lining is its vulnerability to undercutting by flow at the interface between the lining and the natural channel. This condition can be caused by siltation in the pilot channel forcing the low flows to coincide with the interface, and can be prevented by maintaining the pilot channel free from silt. Typical materials for lining the pilot channel include concrete, riprap, and gabions.

(3) Channel reshaping and realignment. Channel reshaping and realignment are means of increasing channel capacity, improving its maintainability, and decreasing erosion potential. This reshaping is similar to the remedial maintenance; however, it is more extensive and also includes realignment of the channel. The channel realignment is particularly important in developing areas where it can increase channel capacity while making more area available for development.

(4) Culvert and bridge modifications. Culvert and bridge modifications are made to supplement the capacity of existing structures. Generally, the structures are upgraded by lining the barrels to decrease their roughness, adding wingwalls to increase efficiency, installing new barrels or enlarging the opening to increase capacity, or by improving the structural integrity.

(5) Culvert and bridge replacement. If the construction measures described above are not applicable or are not sufficient to correct system deficiencies, culvert and bridge replacement may be necessary. It is generally the most obvious and common solution; however, its drawbacks include high costs and loss of value of the existing structure. In certain instances, such as in highly developed areas or where structurally unsafe components are involved, replacement may be the only viable and cost-effective solution.

(6) Storm sewer system modifications. Storm sewer system modifications are made to supplement the capacity of the existing capture and conveyance system. Generally, the system components are upgraded by adding more inlets; lining the underground conveyance system to decrease its roughness; installing new, parallel conduits to supplement the capacity of the existing conduits; or by improving the structural integrity of the system components.

(7) Storm sewer system replacement. If the construction measures described above are not applicable or are not sufficient to correct system deficiencies, storm sewer system replacement may be necessary. It is generally the most obvious and common solution; however, its drawbacks include high costs and loss of value of the existing system. In certain instances, such as in highly developed areas or where structurally unsafe components are involved, replacement may be the only viable and cost-effective solution.

(8) Detention/retention storage. Detention storage ranges from on-site detention of excess stormwater to the use of large basins, either at remote locations or directly upstream from the flood-prone areas. Detention storage makes it possible to store the water temporarily and to release it at a rate that will not cause flooding downstream. Detention storage also makes it possible to comply with local ordinances that restrict the peak flow rates from developing areas. Two types of detention storage can be considered--below-ground and above-ground. An alternative form of the above-ground basis is the retention basin in which a portion of the water is restrained for aesthetic and recreation amenities. Drawbacks of detention facilities include large construction costs for the below-ground facilities; land acquisition costs for regional-type facilities; increased maintenance requirements if site-specific basins are used since there will be a large number of basins; and liability concerns, especially in the case of the above-ground multiple use facilities. Potential benefits include reduced flows downstream; improved water quality since the basins can function as settling basins; and multiple uses, as the ponds and the surrounding sites can be used as parks and recreation areas during dry weather. Detention storage is ideal for undeveloped and developing areas; it is difficult to implement in highly urbanized areas.

3. Flood Plain Improvements

Flood plain improvements differ from system improvements in that the flood plain improvements do not affect the conveyance system components, nor do they reduce the floodwater elevations. The primary benefits from flood plain improvements include reduction of the effects of damage caused by flooding and decreasing the potential for the floodwaters to cause damage in the future. Costs incurred for flood plain improvements can equal or exceed those of structural improvements. Depending on the present land use and availability and value of the land, flood plain improvements can be extremely cost-effective.

Flood plain improvements can be categorized as planning process efforts or physical improvements. Listed below are the more general types of flood plain improvements. The concept behind the flood plain improvements is to provide feasible and cost-effective relief to property owners, and to minimize or eliminate the hazards of major damage and loss of life.

a. Planning Process Efforts. There are certain measures that the City can employ to prevent flooding problems before they develop. These measures should be viewed as "preventive medicine" in the control of flood plain problems, as opposed to "corrective measures" after flooding has occurred. These measures, identified as Planning Process Efforts, must be initiated prior to development, and generally require action by the City legislature. Planning Process Efforts for improvements to the flood plain generally represent the least expensive remediation to flooding problems, but require diligence and foresight on the part of planners, lawmakers, and other City officials. A definite distinction can be made between Planning Process Efforts and Physical Improvements to the flood plain: Physical Improvements can be readily seen as modifications to the flood plain, whereas Planning Process Efforts will be less apparent. Because of the absence of any tangible evidence in the community, promoting and recommending Planning Process Efforts to the public is probably the most difficult barrier to their effective use. The public must be aware of how such improvements would have prevented loss of life or expenditure of public money if Planning Process Efforts had been employed prior to past flooding events, as well as of the cost of current "structural" improvements to remedy the effects of past flooding. If this is successfully accomplished, public acceptance and backing of Planning Process Efforts will increase substantially, ultimately saving considerable tax monies. Recommended Planning Process Efforts are described in detail below:

- Flood preparedness planning.
- Zoning changes.
- Land acquisition.
- Flood plain management enforcement.
- Stormwater runoff regulations.

(1) Flood preparedness planning. The most serious consequence of stormwater flooding problems is loss of life. Therefore, prevention of this outcome is the most important consideration of Planning Process Efforts.

There are several elements to Flood Preparedness Planning. The first of these is an early warning system for flood-prone areas. Such a system can consist of electronic sirens, mechanical alarms that alert authorities to proceed with evacuation or warning plans, or similar means.

The next step in Flood Preparedness Planning is to make the public aware of the early warning systems and to provide proper training for dealing with impending flooding. Public meetings and mailings should be utilized to spread general information of Flood

Preparedness Planning. These measures can then be reinforced by establishing local or neighborhood liaisons, or associations that can act as leaders and organizers in the event of actual flooding. In this way, the public can learn the basic requirements for meeting an emergency, with advanced training and preparedness of volunteers or selected key personnel. For this type of planning to be effective, it is essential to inform the public of the systems or plans that are to be implemented during an emergency.

(2) ***Zoning changes.*** Zoning changes are a means of restricting or prohibiting development in flood-prone areas. Depending on the value, availability, location, and ownership of land, zoning changes can be difficult and time-consuming.

(3) ***Land acquisition.*** As an alternative to zoning restrictions, the City or other government entity can purchase the flood-prone land. Although this can be expensive, using the land for amenities such as parks, playgrounds, or athletic fields can make this option viable. These amenities, combined with detention storage if applicable, can serve as multipurpose facilities.

(4) ***Flood plain management enforcement.*** Most communities participate in the Federal Emergency Management Agency's (FEMA, formerly the Federal Insurance Administration, FIA) Flood Insurance Program (FIP). Under this plan, communities are required to administer and enforce proper flood plain management in order to receive federal flood insurance benefits. Although FEMA provides flood insurance coverage for participating communities, the overall enforcement of the program is the communities' responsibility. Under the City's Zoning Ordinance, Section 21.212 (FP) Flood Plain, the City provides for continued participation in the National Flood Insurance program. The resolution provides flood plain regulations to reduce hazards to persons, property damage, and public expenditures, and to qualify for flood insurance and federal funds or loans. With proper implementation, flood plain management enforcement by the City will accomplish the following:

- Ensure that all new developments in the flood plain fringe areas are so planned and constructed that future flooding potential for these areas is essentially removed.

- Ensure that the City will continue to comply with FEMA regulations, thus removing the potential for future violations and possible termination of flood insurance benefits.
- Ensure that any new legislation and other flood plain improvements are carried out properly and implemented as intended.

(5) Stormwater runoff regulations. Probably the most effective way to correct flooding by stormwater is prevention. Although Planning Process Efforts such as flood plain management and flood preparedness planning can significantly reduce flooding problems and damage, nothing reduces the potential for flooding, with respect to effort and cost, more efficiently than proper stormwater runoff regulations. Implementation of such regulations allows communities to attack the flooding problems before they occur. The expense burden of compliance with the regulations would be shouldered by developers and property owners. Although the ultimate outcome of stringent stormwater runoff regulations is physical improvements such as detention or retention facilities, their implementation involves a Planning Process Effort by the City.

The City currently has no stormwater runoff regulations in place. As part of this project, a new Storm Drainage Design Criteria manual (Appendix A, bound separately) and a new Subdivision Planning manual (Appendix B, bound separately) were developed. These manuals provide regulations for the control of stormwater runoff and design requirements for retention basins, among other facilities.

b. Physical Improvements. Similar to the Planning Process Efforts for flood plain improvements, physical improvements are another vitally important, less expensive remedy to flooding problems. The Physical Improvements are described in detail below:

- Erosion and sediment control.
- Floodproofing (wet and dry).
- Minor flood walls and berms.
- Elevating buildings.
- Relocating/removing buildings.

(1) Erosion and sediment control. Erosion and sediment control involves controlling the degradation of channels and reducing the amount of suspended matter carried in the stormwater. A key element is sufficient control facilities to retain sediment

within a particular site, especially during construction. Factors that affect erosion and sedimentation include soil types, surface cover, topography, climate, channel cross-sections and linings, and flow velocity. Methods of erosion and sediment control include vegetative cover, control of flow velocities, buffer strips between the channel and the source of runoff, sediment traps or barriers (especially at construction sites), retention facilities, and stream bank stabilization.

(2) Floodproofing. Floodproofing consists of reducing and preventing flood damage. Two types of floodproofing techniques are available--wet and dry. Wet floodproofing techniques consist of altering existing buildings to minimize damage when floodwaters rise and enter the building. Elements of wet floodproofing include uses for below-ground and ground-level space that will not be adversely affected by floodwaters. This technique is geared mainly towards commercial buildings.

Dry floodproofing techniques involve making the building walls watertight and sealing the openings so floodwaters cannot enter. This method of protecting existing structures can be incorporated into the design of new buildings. Elements of dry floodproofing include installation of watertight seals at doors and windows, and at other above-ground locations below the flood level; applying sealing compounds to foundations and subsurface walls; sealing off or eliminating below-ground openings; and installing check valves on the sewer mains to prevent backups.

(3) Minor flood walls and berms. Flood walls are constructed of concrete, and berms are built of earth, to provide a physical barrier against the floodwaters. The applicability of this option depends on the degree of flooding and the height of the floodwaters.

(4) Elevating buildings. Floodproofing by elevation involves physically raising a building to allow floodwaters to pass beneath it. This technique is ideal for structures such as storage buildings and sheds, but less practical for homes and larger buildings.

(5) Relocating/removing buildings. In the event that the measures discussed above do not provide sufficient protection from floodwaters, relocation of the building may be an option. Whether on the same property, to higher ground that is not affected by the floodwaters, or to an entirely new site, building relocation can eliminate the flooding

potential. This measure is generally limited to smaller structures and can be quite expensive.

E. Stormwater Facilities Improvements

The system improvement alternatives consist of the corrective measures presented in Section D of this chapter. Within the overall focus of this study, a variety of the solutions presented in Section D of this chapter for each watershed are discussed. Stormwater analyses have been completed for each watershed at a subsystem level; thus, the recommendations are presented as improvements to the entire subsystem, rather than to individual structures. In some instances, the opportunity may exist for development and completion of individual improvements; however, the impacts of the improvement must be analyzed for the entire watershed and not only for the specific site.

Conditions vary throughout Leavenworth. The fully-developed Three Mile Creek watershed presents one extreme, with a severely inadequate system near the central business district and a history of flooding. For some of the subsystems, few improvement alternatives, other than construction of replacement and parallel conveyance systems, are likely to meet present design standards, and the cost of such improvements is likely to make them impractical. The Five Mile Creek watershed, on the other hand, has a generally adequate conveyance system. Opportunities are available for a variety of improvements, including detention, conveyance system modification and replacement, and both planning process efforts and physical flood plain improvements.

The recommended improvements have been sized for future land use, to assure that they meet the future needs. The improvements are based on planning level analyses consistent with the intent and goals of this plan. More detailed analyses will be required to identify the design configurations and construction-level costs.

Leavenworth has taken a significant step to address the needs of the stormwater system, and with proper guidance, can assure that the inadequacies of the older subsystems do not occur in new developments.

In general, the types of improvements evaluated can be categorized as follows:

(1) Structural improvements to the conveyance system.
(2) Structural improvements to the flooded properties.
(3) Policy/standards development and enforcement.

Categories (1) and (3) improvements are ideal for addressing future flooding, while Category (2) improvements are developed in response to flooding problems that already exist. Category (1) improvements are recommended to provide a consistent level of improvement throughout the City and a common basis for cost projections. However, Categories (2) and (3) improvements should be considered on a subsystem-by-subsystem basis. Significant cost savings can be realized by these improvements; however, their development will require significant involvement and commitment from various public officials, since these types of improvements, particularly development and enforcement of new policies, involve not only official support, but also the support of developers and the public. Although not quantified, the Categories (2) and (3) improvements are presented to encourage the City to seriously consider and implement these types of improvements.

In many subsystems, the potential for flooding is related to future development that may occur, and therefore, the recommended improvements are future action items. The recommendations and cost projections have been developed to provide a basis for the extent and magnitude of the improvements necessary to bring the system into compliance with present City standards for the design storm events. Although a variety of options are available for several subsystems, the recommendations and cost opinions are based on providing technically feasible and practical solutions.

As a basis for providing consistent cost opinions throughout the city, the recommended improvements have been developed to comply with the present City standards to convey the 10-year design storm everywhere except for structures under major arterial and collector streets, which must pass the 50-year storm, and in the Three Mile Creek main channel and South Branch, and the Five Mile Creek main channel, which must be designed for the 100-year event.

1. Three Mile Creek Watershed

The Three Mile Creek watershed, which contains the older and more developed portions of Leavenworth, has a history of flooding problems. Portions of the system are severely undersized and improvements to adequately convey the design storm are extensive. Alternatives for conveying/controlling the stormwater flows include the following:

(1) Modifying/replacing the stormwater conveyance system.
(2) Detention storage.

(3) Acquisition of flood-prone properties.
(4) Floodproofing of flood-prone properties.
(5) Developing improvements to accommodate a lesser storm event.

Alternatives (1) and (2) would comply with City standards for adequately conveying design stormwater flows. However, both options are costly; and although Alternative (2) is technically feasible, it may not be practical due to the amount of land that would be required to adequately detain the flows. Since very little vacant/open land is available in the middle and lower portions of the watershed, developed land would have to be purchased and buildings demolished--which would result in loss of revenue from the property taxes associated with the demolished buildings.

Alternatives (3) and (5) would not result in compliance with present City standards, and would not eliminate flooding from the specific design storm. However, they would provide cost-effective solutions to reducing the extent of flooding and the flood damage. Certain aspects of Alternative (4), such as wet floodproofing, also would not comply with present City standards; however, Alternative (4), specifically the proper placement of berms and floodwalls, would provide a higher level of protection than presently available, and it can greatly reduce the costs of the improvements.

To comply with present City standards, a combination of Alternative (1) modify/replace the existing stormwater conveyance system; and Alternative (4), flood barriers, is recommended. Although this combination will not provide enhancements to water quality as would Alternative (2), it does comply with present City standards. Alternative (2) is technically feasible; however, the acquisition of property, particularly if occupied by homes and/or businesses, is a long and slow process, and is nearly always viewed negatively by the public. The use of detention storage upstream, however, can reduce the extent of conveyance system improvements required downstream, as discussed in Section F of this chapter.

The improvements for the Three Mile Creek watershed have been divided into the main channel and subsystem improvements as summarized in Sections E.1.a. and E.1.b. Detailed cost tables are presented in Appendix D.

a. Main Channel and South Branch. The main channel and South Branch conveyance system consists of a series of large open channels and bridges, represented in the model as culverts, which discharge to the Missouri River. The South Branch joins the main channel at approximately the midpoint of Three Mile Creek. Modeling the effects of future development identified several bridges and culverts that are inadequate to convey the 100-year storm. To assure that this conveyance system complies with design standards for future land use conditions, the following alternatives for conveying/controlling the stormwater flows were identified:

(1) Upgrade the existing stormwater conveyance system.
(2) Install floodproofing measures.
(3) Provide detention storage.
(4) Provide combination of upgrading, floodproofing, and detention storage.

These alternatives would result in a conveyance system that meets present City standards to adequately convey the future 100-year stormwater flows. Since the Three Mile Creek watershed is not fully developed, particularly in the upper reaches, open land may be available for the development of a detention facility capable of reducing flows and the extent of improvements in portions of the conveyance system.

Improvements for Alternative (1), upgrade the existing conveyance system, are presented in Table VIII-8, beginning on page VIII-73, and on Figures VIII-2A, 2B, and 2C in Appendix J. Alternative (2) improvements are also indicated. Alternative (4), a combination of system upgrading, floodproofing, and detention storage, should be evaluated further, since the upper reaches of this watershed have not yet been fully developed. Detention facilities could reduce peak flows and minimize structural improvements, while enhancing water quality, aesthetic appearance, and the potential for multi-use facilities. However, the viability of constructing one or more detention basins in the Three Mile Creek watershed will need to be further investigated, as discussed in Section F of this chapter.

In general, recommended improvements consist of replacing a system or constructing a relief system parallel to the existing system. Constructing a parallel system may be a cost-effective alternative to complete replacement and should be further evaluated during detailed design.

b. Subsystems. The Three Mile Creek watershed consists of 30 individual subsystems shown on Figure II-1 that are drained by systems of underground conduits, open channels, box culverts, and arches. Twelve of the subsystems, S1R through S8R, drain to the South Branch and the remaining 18 of the subsystems, 1L through 10L, are tributary to the main channel. The subsystem name provides an indication of its relative location. The number indicates relative position from the mouth of the creek; and the letter indicates whether it is a left bank (L) or right bank (R) tributary. The letter "S" indicates a South Branch subsystem. Presently, some of the underground conduits are flooded by a 10-year storm, and some arterial or collector streets by a 50-year storm. To comply with design standards for future land use conditions, the following alternatives are available for conveying/controlling the stormwater flows:

(1) Modify/replace the existing stormwater conveyance system.
(2) Provide detention storage.
(3) Use a combination of modifying/replacing the system and detention storage.

These alternatives would provide a conveyance system that meets present City standards to adequately convey the future 10-year and 50-year stormwater flows. Improvements under Alternative (1) are presented in Table VIII-9, beginning on page VIII-75, and on Figures VIII-3 through VIII-32 in Appendix J. The feasibility of detention storage was investigated for the largest of the subsystems, 2R, as discussed in Section F of this chapter.

The culvert improvements are designed for continued natural detention, but not to the present extent. Some channel widening may also be required. The expansion of flood plains could effectively decrease the extent of improvements needed by increasing the natural storage available. Therefore, in addition to the improvements listed in Table VIII-9, it is recommended that flood plain limits be confirmed and expanded, where feasible, to reduce the extent of structural improvements required.

2. Five Mile Creek Watershed

The Five Mile Creek watershed, which includes subdivisions of various ages as well as some less-developed portions of Leavenworth, has a history of flooding problems. Portions of the conveyance system are severely undersized, and need extensive improvements to adequately convey the design storm. Alternatives for conveying/controlling stormwater flows include the following:

(1) Modifying/replacing the existing stormwater conveyance system.
(2) Detention storage.
(3) Acquisition of flood-prone properties.
(4) Floodproofing of flood-prone properties.

(5) Developing improvements to accommodate a lesser storm event.

Alternatives (1) and (2) would comply with City standards to adequately convey design stormwater flows. However, both options are costly; and although Alternative (2) is technically feasible, it may not be practical due to the amount of land that would be required to adequately detain the flows. Since very little vacant/open land is available in the lower portions of the watershed, developed land would have to purchased and buildings demolished--which would result in loss of revenue from the property taxes associated with the demolished buildings. Undeveloped land in the middle and upstream portions, however, may be available for construction of detention basins.

Alternatives (3) and (5) would not result in compliance with present City standards, and would not eliminate flooding from the specific design storm. However, they would provide cost-effective solutions to reducing the extent of flooding and the flood damage. Certain aspects of Alternative (4), such as wet floodproofing, also would not comply with present City standards; however, Alternative (4), specifically the proper placement of berms and floodwalls, would provide a higher level of protection than presently available, and it can greatly reduce the costs of the improvements.

To comply with present City standards, a combination of Alternative (1) modify/replace the existing stormwater conveyance system; and Alternative (4), flood barriers, is recommended. Although this combination will not provide enhancements to water quality as would Alternative (2), it does comply with present City standards. Alternative (2) is technically feasible; however, the acquisition of property, particularly if occupied by homes and/or businesses, is a long and slow process, and is nearly always viewed negatively by the public. The use of detention storage upstream, however, can reduce the extent of conveyance system improvements required downstream, as discussed in Section F of this chapter.

The improvements for the Five Mile Creek watershed have been divided into the main channel and subsystem improvements as summarized in Sections E.2.a. and E.2.b. Detailed cost tables are presented in Appendix D.

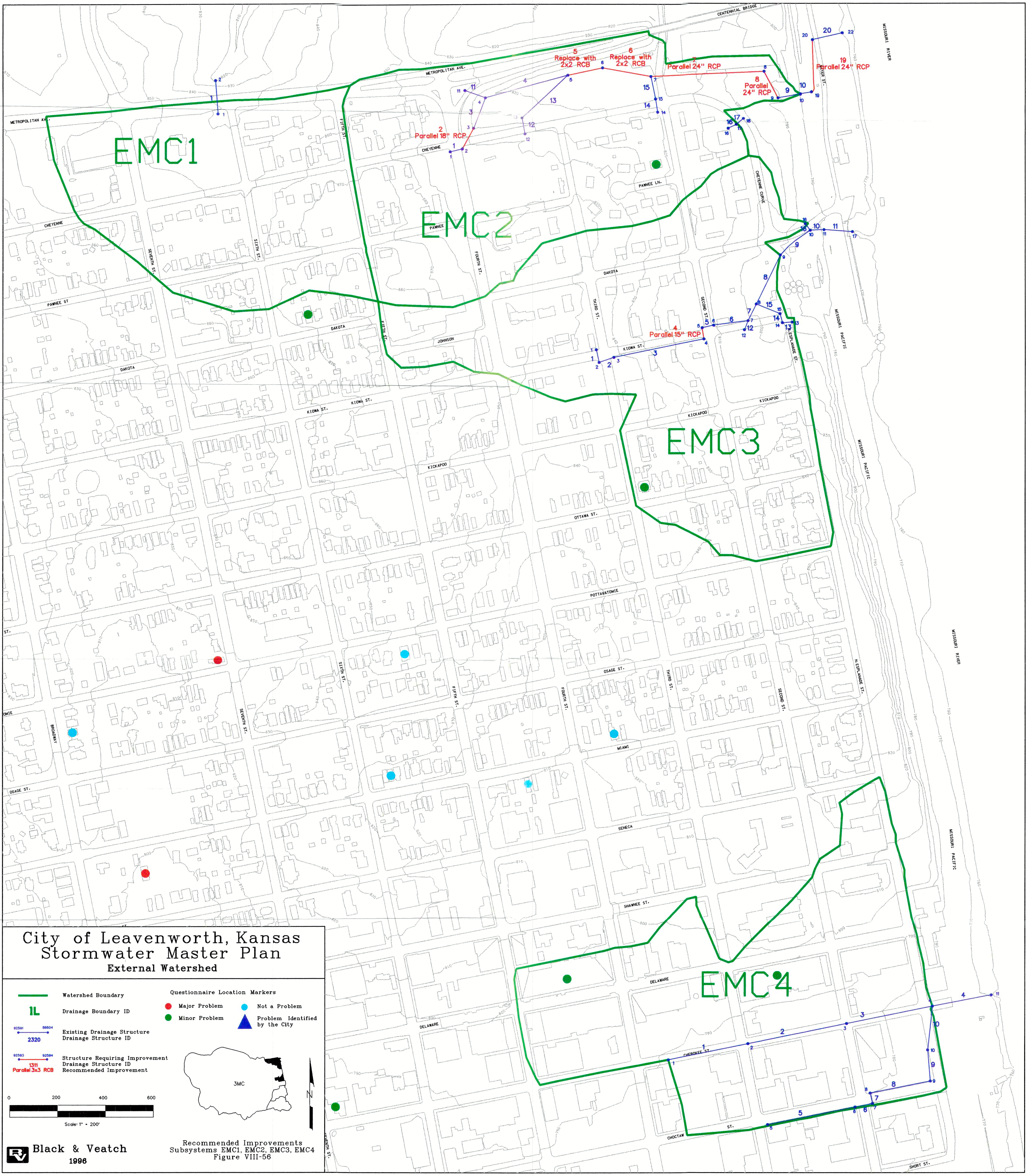
a. Main Channel. The main channel conveyance system consists of a series of large open channels and bridges, represented in the model as culverts, which discharge to the Missouri River. Modeling the effects of future development identified several bridges and culverts that are inadequate to convey the 100-year storm. In addition, portions of the wastewater treatment plant are subject to flooding due to this event. To assure that this conveyance system complies with design standards for future land use conditions, the following alternatives for conveying/controlling the stormwater flows were identified:

(1) Upgrade the existing stormwater conveyance system.
(2) Install floodproofing measures.
(3) Provide detention storage.
(4) Provide a combination of upgrading, floodproofing, and detention storage.

These alternatives would result in a conveyance system that meets present City standards to adequately convey the future 100-year stormwater flows. Since the Five Mile Creek watershed is not fully developed, particularly in the upper reaches, open land may be available for the development of a detention facility capable of reducing flows and the extent of improvements in portions of the conveyance system.

Improvements for Alternative (1), upgrade the existing conveyance system, are presented in Table VIII-10, on page VIII-98, and on Figures VIII-33A, 33B, and 33C in Appendix K. Alternative (2) improvements are also indicated. Alternative (4), a combination of system upgrading, floodproofing, and detention storage, should be evaluated further, since the upper reaches of this watershed have not yet been fully developed. Detention facilities could reduce peak flows and minimize structural improvements, while enhancing water quality, aesthetic appearance, and the potential for multi-use facilities. However, the viability of constructing one or more detention basins in the Five Mile Creek watershed will need to be further investigated, as discussed in Section F of this chapter. It is doubtful that detention storage in the upstream reaches would significantly reduce flooding potential.

b. Subsystems. The Five Mile Creek watershed consists of 22 individual subsystems shown on Figure II-1 that are drained by systems of underground conduits, open channels, box culverts, and arches. The subsystem name provides an indication to its relative location. The number indicates relative position from the mouth of the creek; and the letter indicates whether it is a left bank (L) or right bank (R) tributary. Presently, some of the underground conduits are flooded by a 10-year storm, and some arterial or collector streets by a 50-year storm. To comply with design standards for future land use



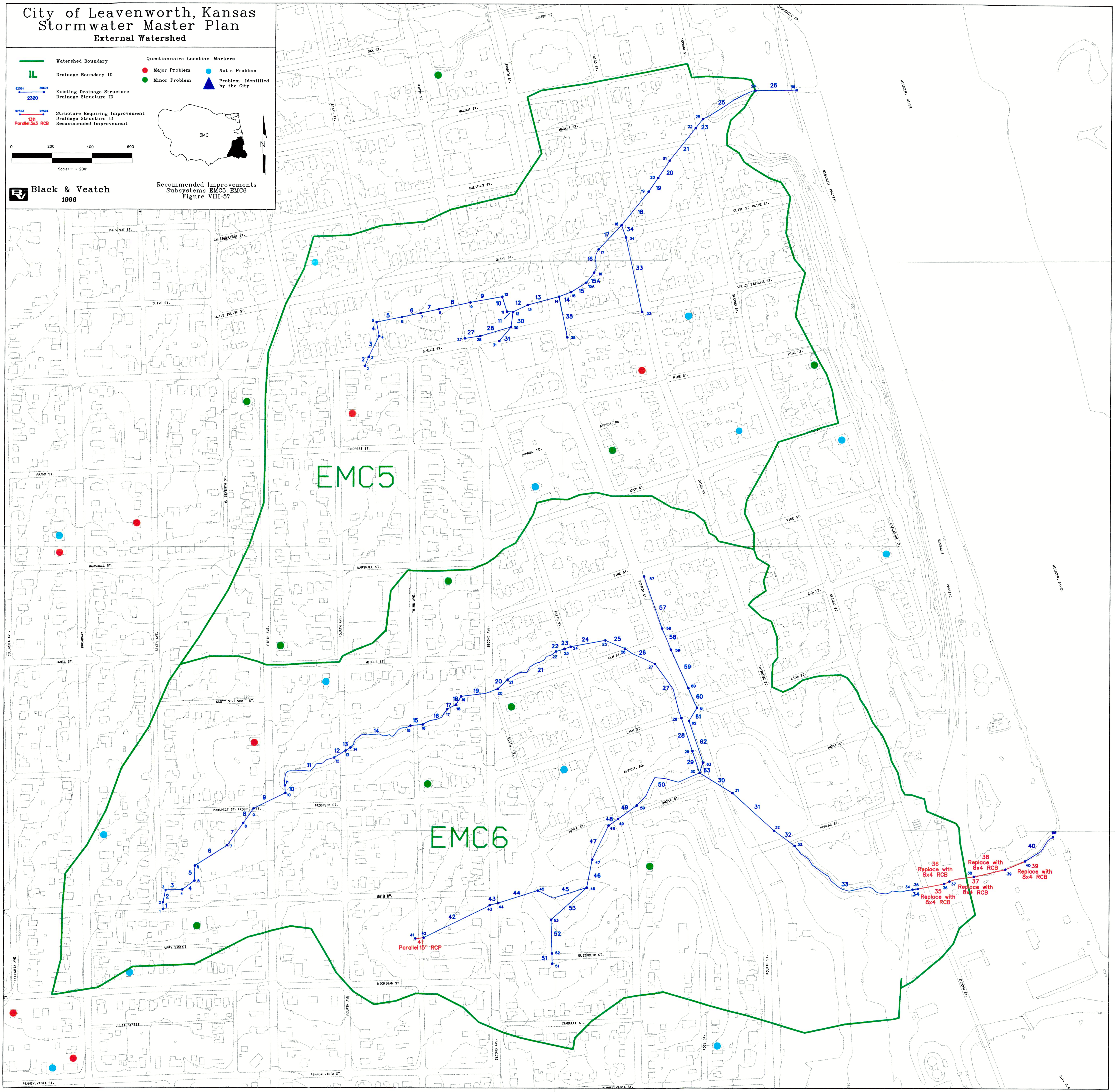
City of Leavenworth, Kansas Stormwater Master Plan

External Watershed

Black & Veatch

1996

Recommended Improvements
Subsystems EMC1, EMC2, EMC3, EMC4
Figure VIII-56


City of Leavenworth, Kansas
Stormwater Master Plan
External Watershed
Watershed Boundary
Drainage Boundary ID
Existing Drainage Structure
Drainage Structure ID
Structure Requiring Improvement
Drainage Structure ID
Recommended Improvement
Parallel 3x3 RCB
Questionnaire Location Markers
Major Problem
Minor Problem
Not a Problem
Problem Identified by the City
Scale: 1" = 200'
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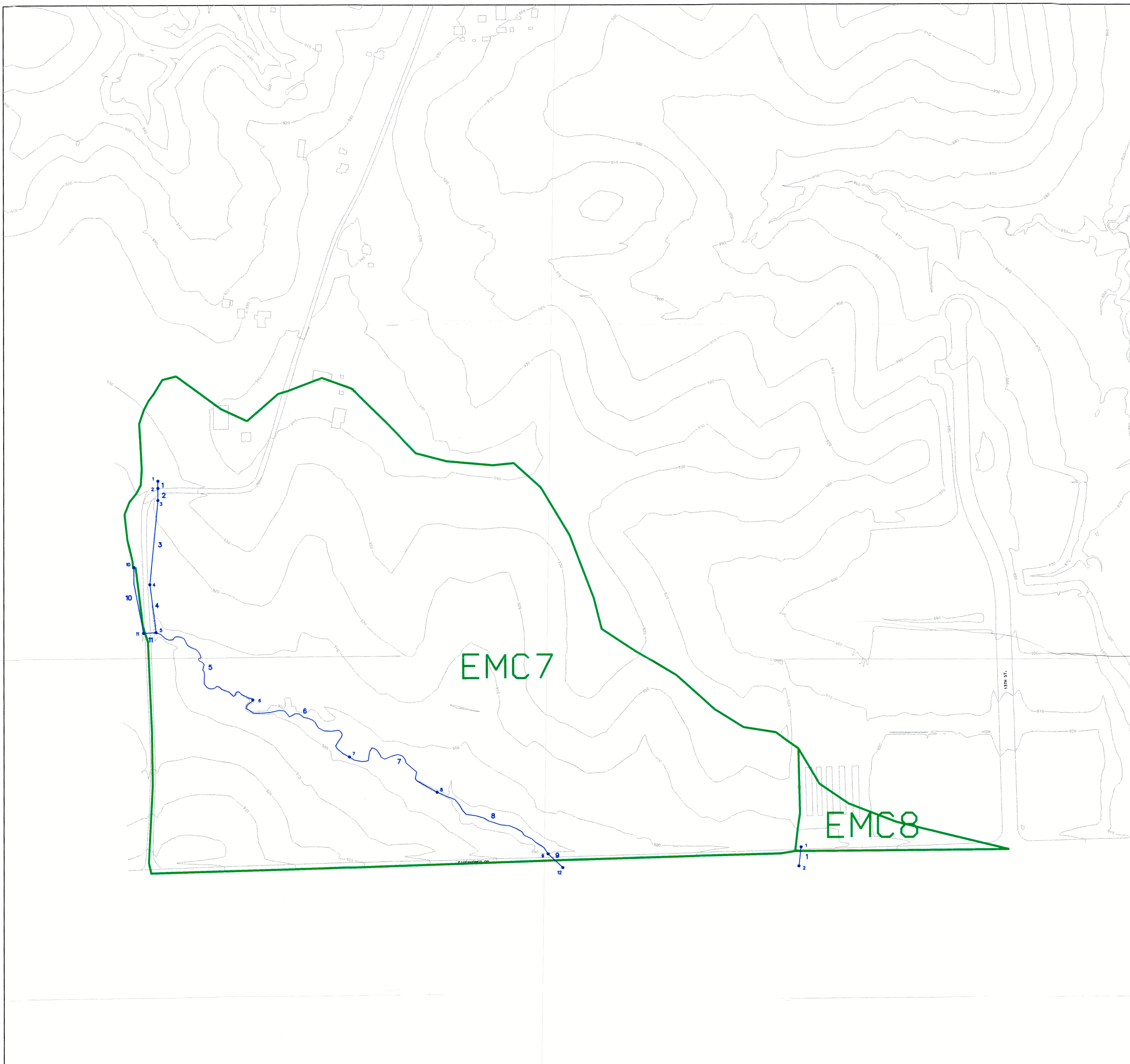
1996
Recommended Improvements
Subsystems EMC5, EMC6
Figure VIII-57
EMC5
EMC6
Parallel 15" RCP
Replace with 8x4 RCB
Missouri River
Missouri Pacific



City of Leavenworth, Kansas
Stormwater Master Plan
External Watershed

Watershed Boundary

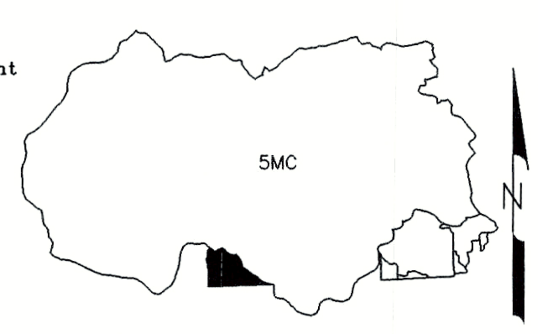
1L Drainage Boundary ID

92591 86604 2320 Existing Drainage Structure Drainage Structure ID

92593 92594 1311 Parallel 3x3 RCB Structure Requiring Improvement Drainage Structure ID Recommended Improvement

Questionnaire Location Markers

- Major Problem
- Minor Problem
- Not a Problem
- Problem Identified by the City



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Scale: 1" = 200'

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Recommended Improvements
Subsystems EMC7, EMC8
Figure VIII-58

City of Leavenworth, Kansas
Stormwater Master Plan
External Watershed

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1996

Recommended Improvements
Subsystems EMC9, EMC10, EMC11, EMC12, EMC13, EMC14
Figure VIII-59

conditions, the following alternatives are available for conveying/controlling the stormwater flows:

(1) Modify/replace the existing stormwater conveyance system.
(2) Provide detention storage.
(3) Use a combination of modifying/replacing the system and detention storage.

These alternatives would provide a conveyance system that meets present City standards to adequately convey the future 10-year and 50-year stormwater flows. Improvements under Alternative (1) are presented in Table VIII-11, beginning on page VIII-99, and on Figures VIII-34 through VIII-55 in Appendix K. The use of detention storage within existing ponds was investigated for two of the subsystems, 6R and 8R, as discussed in Section F of this chapter.

The culvert improvements are designed for continued natural detention, but not to the present extent. Some channel widening may also be required. The expansion of flood plains could effectively decrease the extent of improvements needed by increasing the natural storage available. Therefore, in addition to the improvements listed in Table VIII-11, it is recommended that flood plain limits be confirmed and expanded, where feasible, to reduce the extent of structural improvements required.

3. External Watersheds and Other Improvements Not Evaluated By Modeling

The external watersheds drain to 14 subsystems composed of underground conduits, open channels, box culverts, and arches. Some of the underground conduits are flooded by a 10-year storm, and arterial or collector streets by a 50-year storm. To assure that the subsystems comply with design standards for future land use conditions, the inadequate elements should be modified or replaced as recommended. Because of the relatively small size of these subsystems or because of their location in fully developed areas, detention storage was not evaluated as an alternative.

The recommended improvements, as indicated in Table VIII-12, on page VIII-121, and on Figures VIII-56 through VIII-59, would provide conveyance systems that meet present City standards to adequately convey future flows from 10-year and 50-year storms.

Although many of the drainage problems listed in Table VIII-5 were located within the Three Mile or Five Mile Creek watershed, several were external to the two main basins and were so indicated by the identifier "EMC." About half the reported problems were storm sewer systems that were evaluated by the computer models. Other evaluations were made using maps and other data, and supplemented by field visits.

The majority of the recommended improvements involve upgrading the maintenance of existing facilities; paralleling or replacing conduits; and installation of new curbs and gutters or drainage ditches. Reference is also made to future City projects already planned or designed. Recommended improvements for the reported drainage problems are listed in Table VIII-13, beginning on page VIII-124.

The watershed ID segregates the problems by watershed as "3MC," "5MC," or "EMC" for Three Mile Creek, Five Mile Creek, or External, respectively. The Map Sheet No. refers to the M.J. Harden map.

F. Detention/Retention Basin Alternatives

As undeveloped areas become urbanized or suburbanized, the ratio of impervious surfaces, such as roofs and parking lots, to pervious surfaces, such as farm fields, increases. Consequently, the rate and amount of stormwater runoff increases, and this can adversely affect downstream flood plains and developed areas. One way to control the impacts of development on the watershed is to limit the amount of post-development discharges from a site to the pre-development runoff for a certain storm frequency. Detention and retention facilities are a means of managing peak discharges by storing runoff and releasing it at a slow rate. Detention basins store floodwaters temporarily while continuously discharging a reduced flow through a pipe or some other control device, until they are emptied. Retention basins store floodwaters for longer periods to promote coagulation and settling of pollutants. Retention basins often include one or more forebays and a permanent pool.

The U.S. Soil Conservation Service Technical Release 55, "Urban Hydrology for Small Watersheds," includes a method for estimating the effects of temporary detention on peak discharges. According to TR-55, this method is based on average storage and routing effects for many structures, and its principal use is to assess adequacy of storage. The relationships in the nomograph were determined on the basis of single-stage outflow devices--such as pipes or weirs.

Several sites within the City limits were evaluated for the potential to reduce peak flows and minimize structural improvements downstream. It was assumed that the improvements upstream from the pond, recommended in Section E of this chapter, would be installed. The impacts on water quality were not evaluated in this study.

Topographic maps with preliminary sketches of seven ponds in the Three Mile Creek watershed were provided by the City. In addition, the City identified the area north of Metropolitan as a potential detention site to reduce or eliminate the need for structural improvements to the bridges at 14th and Cheyenne and 13th and Kiowa Streets. All eight ponds were evaluated using the method outlined in TR-55. The most promising sites were further evaluated using XP-SWMM to determine the effects downstream.

Three potential sites in the Five Mile Creek watershed were identified in relatively open areas upstream from bridges and culverts in need of capital improvements. The City has other plans for two of these sites. The third site, however, was evaluated. In addition, the City requested that Subsystems 6R and 8R, which include lakes midstream and in the upper reaches, be reevaluated with XP-SWMM, this time taking into account the full storage effects of the existing lakes.

The results of the detention alternatives evaluation follow in Tables VIII-14 through VIII-24, beginning on page VIII-136, and shown on Figure VIII-60.

Five Mile Creek Subsystems 6R and 8R were re-evaluated to determine whether the need for capital improvements would be reduced or eliminated if detention was used. The XP-SWMM models for Subsystems 6R and 8R were adjusted to allow for the storage effects of the on-line lakes. In the initial run, each lake was assumed empty and was filled to a level determined by the inflow and its storage characteristics. This level became the starting water surface elevation for the final run.

Because the M.J. Harden storm sewer maps lack bathymetric lines that would show the shape of the basins below the water surface, the submerged characteristics of the lakes were estimated. The lower two points of the depth-area storage curve for each lake were determined by estimating areas at mid-depth and at the bottom. The bottom elevation was assumed the same as the apparent bottom contour elevation of the downstream dam face. The top two points of the depth-area storage curves were generated by digitizing the area enclosed by the topographic contour elevation at the top of the dam and at the water surface elevation indicated on the maps. The highest point along the dam face was assumed the overtopping elevation.

Because no information was provided regarding discharge piping, it was assumed that the primary outlet from the lakes was a spillway weir. The length of this broad-crested weir was measured at the lowest elevation along the dam face, and a discharge coefficient of 3 was used.

There are five on-line lakes in Subsystem 6R, and four smaller ponds within the subwatershed, but only five of these are located along the modeled conveyance system.

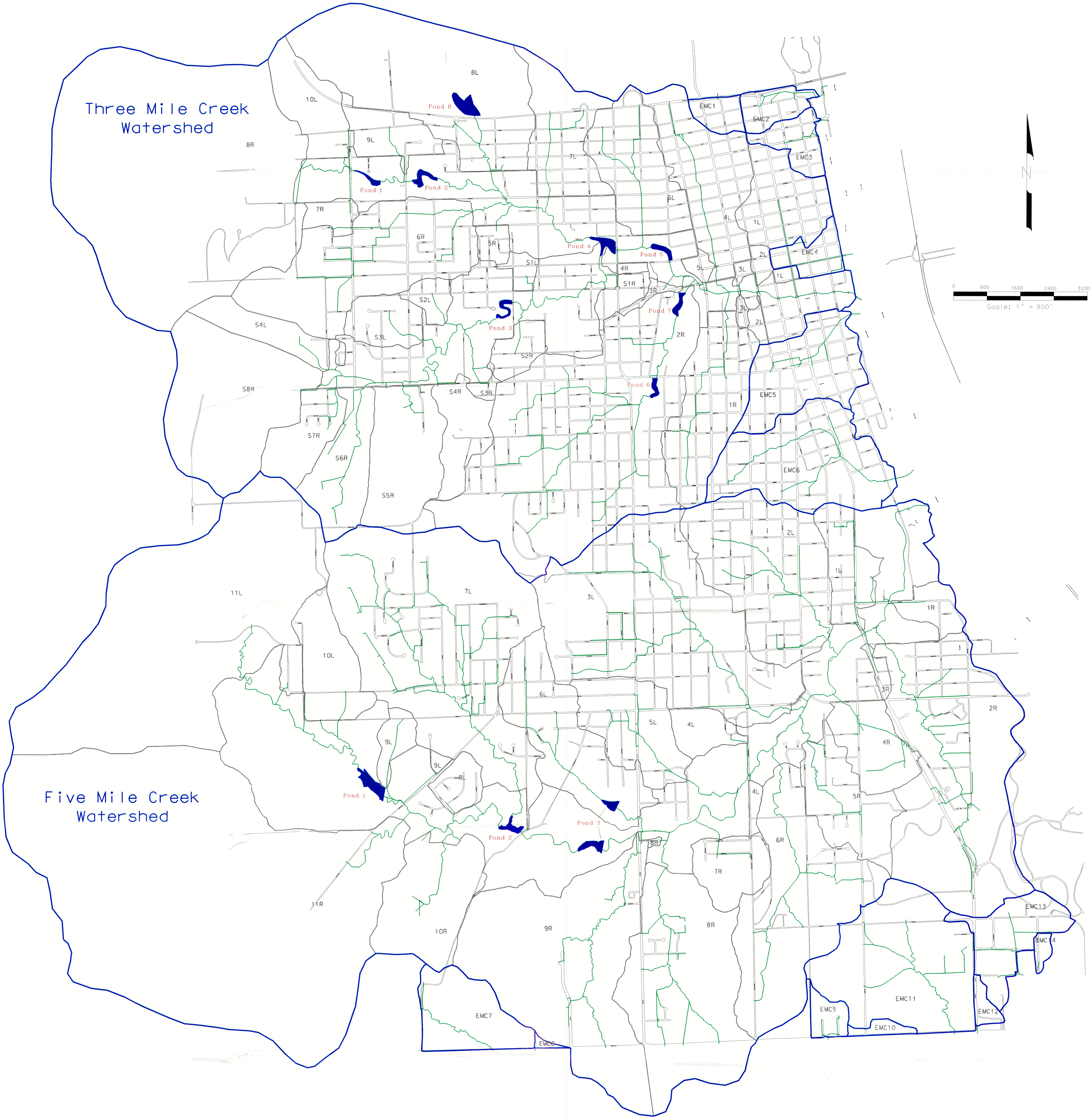

Figure VIII-60: Detention Basins

City of Leavenworth, Kansas
Stormwater Master Plan

(blue line)	Watershed Boundary
(gray line)	Subwatershed Boundary
1L	Subwatershed ID
(green line)	Stormwater Conveyance System

Black & Veatch
1996

In Subsystem 8R, three on-line lakes were modeled. Storage characteristics and weir parameters for these eight lakes were determined as described above. The locations are in Table VIII-25, on page VIII-148.

The storage in the lakes appears to have a significant effect on the stormwater conveyance network in Subsystem 6R. For the 10-year design event, there is virtually 100 percent detention in four of the five lakes. In other words, there is no discharge over the spillways of Lake 1, Lake 2, or Lake 3, and less than 10 cfs from Lake 5. All of the underground conduits downstream of these lakes are adequately sized.

Lake 4, which is significantly smaller than the other four and does not appear to be as highly effective a detention device, receives 59 cfs through upstream piping and 52 cfs of overland runoff. Only 27 percent of the total 111 cfs is detained in Lake 4, as approximately 81 cfs is discharged over the weir. Two underground conduits downstream from Lake 4, near Lakeview Drive and Pleasant Avenue, will need parallel pipes to increase flow capacity.

For the 50-year design event, Lakes 1 and 2 will provide 100 percent detention; Lakes 3, 4, and 5 will provide some detention, discharging 33 cfs, 123 cfs, and 114 cfs, respectively. The conduits under Shrine Park Road, Muncie Road (one of which is downstream from Lake 2), and along Hughes Road are adequately sized. There are no culverts under arterials or collector streets downstream of Lake 3, 4, or 5.

In Subsystem 8R, all three lakes are effective detention devices, and two of them are located so that they reduce the need for some downstream capital improvements. Lake 1 provides 100 percent detention for both the 10- and 50-year design events, and Lakes 2 and 3 for the 10-year event. Lake 2 detains approximately 261 cfs, or 73 percent of its 357 cfs 50-year inflows, and discharges 96 cfs over the weir. Lake 3 discharges 107 cfs while attenuating 651 cfs, or 86 percent, of its 758 cfs 50-year inflows.

The benefits of detention in Lake 3 are not realized in Subsystem 8R because the lake, which discharges to a natural channel tributary to Five Mile Creek, is located downstream from all closed conduits in the conveyance network.

Most of the recommended capital improvements are in parts of the storm sewer network that are not affected by storage in the lakes. Most of the culverts under arterials or collectors in Subsystem 8R are inadequate, as are all of the underground conduits in the Hometown Village Subdivision. However, the detention of peak flows in Lakes 1 and 2 does reduce the need for some of the improvements that otherwise would be recommended between the lakes and Hometown Village. As a result of the previous analysis which assumed no detention, the improvements had involved paralleling approximately 700 feet of 12, 54, and 60 inch pipe. After reevaluating the system using the existing lake storage, it was determined that only 320 feet of 27 inch parallel pipe would be needed.

G. Preliminary Opinions of Costs

A complete list of the unit costs used for this study is included in Appendix D. Preliminary cost opinions are provided for the main channels and storm sewer subsystems in the Three Mile and Five Mile Creek watersheds. An element-by-element ledger is preceded by a concise summary sheet arranged by facility unit description. The costs are presented in numerical order, beginning with the Three Mile Creek subsystems.

Table VIII-1
Three Mile Creek Watershed
Modeled Conveyance System Summary

Subwatershed	Length of Open Channel (feet)	Length of Closed Conduit (feet)	Number of Junctions, Manhole Structures, and Nodes
Main Channel & South Branch	27,188	3,281	94
1L	0	3,272	17
2L	0	621	10
3L	0	329	5
4L	541	4,758	51
1R	451	6,587	46
5L	0	364	6
2R	12,482	12,679	138
3R	0	704	9
6L	2,420	2,728	43
4R	0	287	4
7L	1,753	1,863	31

Table VIII-1
Three Mile Creek Watershed
Modeled Conveyance System Summary

Subwatershed	Length of Open Channel (feet)	Length of Closed Conduit (feet)	Number of Junctions, Manhole Structures, and Nodes
5R	455	355	6
6R	5,752	6,424	53
8L	2,839	697	19
9L	713	846	9
10L	273	959	8
7R	0	1,129	7
8R	1,064	69	5
S1R	175	731	16
S1L	0	703	7
S2R	1,068	43	5
S3R	1,410	627	9
S2L	1,024	56	4
S3L	1,359	345	9
S4R	292	541	7
S5R	1,488	794	16
S6R	3,459	3,423	24
S4L	2,037	434	11
S7R	1,121	1,243	16
S8R	51	593	6
Total	69,415	57,485	691

Table VIII-2
Three Mile Creek Modeled Problem Identification

							Structures With Flooding At Upstream Node	
Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Existing Capacity (cfs)	Maximum Flow (cfs)
Main Channel	N/A	N/A	N/A	Unprotected Structures	10th Street	100	N/A	N/A
Main Channel	N/A	N/A	N/A	Unprotected Structures	Osage Street	100	N/A	N/A
Main Channel	3215	86197	92197	29' x 16' RCB	3MC & 6th St.	100	1360	3440
Main Channel	3003	92614	92064	2 - 14' x 10' RCB	3MC & 13th St.	100	772	244
Main Channel	2578	92301	92302	29.5' x 10' RCB	3MC & Ottawa	100	898	1100
South Branch	1248	92083	92084	12' x 12.7' ARCH	3MC SB & Cherokee	100	1010	808
South Branch	940	92023	92024	9' x 12.6' ARCH	3MC SB & 18th St.	100	873	1150
South Branch	942	92646	92013	10' x 7.5' RCB	3MC SB & 19th St.	100	2420	1380
South Branch	2300	86524	92646	10' x 7.5' RCB	19th & Spruce	100	532	1550
South Branch	1289	92643	86524	10' x 7.5' RCB	19th & Spruce	100	2310	1450
1L	1311	92593	92594	5' x 3.3' ARCH	4th & Seneca	50	78	129
1L	1316	92594	86605	5' x 3.3' ARCH	4th & Shawnee	50	79	164
1L	1317	86591	86592	2' Dia. VCP	3rd & Shawnee	10	12	52
1L	1322	92595	86601	5' x 3.3' ARCH	4th & Delaware	50	103	231

Table VIII-2
Three Mile Creek Modeled Problem Identification

							Structures With Flooding At Upstream Node	
Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Existing Capacity (cfs)	Maximum Flow (cfs)
2L					No Flooding			
3L					No Flooding			
4L	1331	86624	86625	2' Dia. VCP	Broadway & Dakota	10	17	55
4L	1336	86633	92622	6.2' x 5.5' ARCH	Broadway & Kiowa	10	7	88
4L	1340	86640	86639	32" Dia. CMP	Broadway & Kickapoo	10	80	56
4L	1343	86644	92623	3' Dia. CMP	Broadway & Ottawa	10	34	68
4L	1344	92778	86647	3' Dia. CMP	Broadway & Pottawatomie	10	54	95
4L	1345	92625	86648	5' x 3.5' ARCH	Broadway & Osage	10	110	87
4L	1346	92624	86645	3' Dia. CMP	Broadway & Pottawatomie	10	37	68
4L	1529	86910	86624	2' Dia. VCP	Broadway & Dakota	10	23	40

Table VIII-2
Three Mile Creek Modeled Problem Identification

							Structures With Flooding At Upstream Node	
Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Existing Capacity (cfs)	Maximum Flow (cfs)
4L	3032	86637	86640	Natural Channel	Broadway & Kickapoo	10	544	162
1R	993	86017	86018	2' Dia. RCP	6th Ave. & Spruce	10	59	64
1R	996	86021	92740	1.75' Dia. VCP	9th Ave. & Kansas	10	21	23
1R	1001	86030	86042	3.5' Dia. RCP	9th Ave. & James St.	10	76	84
1R	1005	86054	86055	4' Dia. RCP	Spruce & Columbia	10	65	70
1R	1006	86055	92717	4' x 4' ARCH	Spruce & Columbia	50	74	77
1R	1173	86020	86325	3' Dia. CMP	6th Ave. & Spruce	10	39	49
1R	2091	86034	92741	1.5' Dia. RCP	9th Ave. & Quincy	10	17	19
1R	2116	86015	86017	2' Dia. RCP	6th Ave. & Spruce	10	30	38
5L	1194	86364	86365	1.5' Dia. RCP	Broadway & Cherokee	10	6	18

Table VIII-2
Three Mile Creek Modeled Problem Identification

Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Structures With Flooding At Upstream Node: Existing Capacity (cfs)	Structures With Flooding At Upstream Node: Maximum Flow (cfs)
5L	1256	86366	86367	1.5' Dia. RCP	Broadway & Cherokee	10	19	15
2R	723	85488	85489	2' Dia. RCP	Klemp St. & Pennsylvania	10	19	36
2R	726	85494	85495	2' Dia. CMP	Klemp St. & Ohio	10	20	14
2R	728	85496	85497	2.5' Dia. CMP	Grand Ave. & Michigan	10	11	25
2R	1487	85498	92345	2.5' Dia. RCP	11th St. & Ohio	10	1	44
2R	1114	92345	92346	3' Dia. RCP	11th St. & Ohio	50	61	61
2R	1115	92346	92736	3' Dia. RCP	Kingman St. & Ohio	50	84	71
2R	2231	92736	86228	3' Dia. RCP	Kingman St. & Ohio	10	94	74
2R	1116	86228	85982	3' Dia. CMP	Kingman St. & Ohio	10	43	74
2R	980	85976	85978	2' Dia. CMP	10th Ave. & Ohio	10	7	9

Table VIII-2
Three Mile Creek Modeled Problem Identification

Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Structures With Flooding At Upstream Node: Existing Capacity (cfs)	Structures With Flooding At Upstream Node: Maximum Flow (cfs)
2R	702	85456	85455	2' Dia. RCP	Forest Lane & Westwood Dr.	10	42	34
2R	715	85479	85480	2' Dia. RCP	Michigan St. & Jackson Ct.	10	37	31
2R	718	85482	85484	1.5' Dia. RCP	Ohio St. & Franklin St.	50	11	13
2R	720	85484	85485	1.5' Dia. RCP	Ohio St. & Jackson Ct.	50	6	10
2R	2689	92363	92364	3' Dia. RCP	Ohio St. & Westwood Dr.	50	98	117
2R	3200	92732	92733	3" Dia. RCP	Ohio St. & Stonleigh Ct.	50	26	100
2R	3202	92734	92735	3' Dia. RCP	Ohio St. & Stonleigh Ct.	50	36	117
2R	946	85920	85922	2.5' Dia. RCP	15th St. & Kansas St.	10	8	31
2R	1440	85923	92682	2' Dia. RCP	Kansas St. & Patterson	10	1	24
2R	1166	92075	86318	3.5' Dia. CMP	Franklin & Quincy	10	134	76

Table VIII-2
Three Mile Creek Modeled Problem Identification

							Structures With Flooding At Upstream Node	
Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Existing Capacity (cfs)	Maximum Flow (cfs)
2R	1167	86318	86319	6' Dia. CMP	Franklin & Quincy	10	61	113
2R	1156	86303	86304	1.5' Dia. RCP	Madison St. & Quincy	10	1	7
2R	1158	86307	92723	1.5' Dia. CMP	Jackson & Randolph	10	5	6
2R	1219	92688	86285	2' Dia. VCP	Spruce & Franklin	10	37	25
2R	1147	86285	86289	2' Dia. VCP	Spruce & Franklin	50	53	60
2R	1149	86289	92724	3' Dia. RCP	Franklin & Kenton St.	10	88	91
2R	2251	92724	86291	3' Dia. RCP	Klemp St. & Kenton	10	90	72
2R	1150	86291	86292	3' Dia. CMP	Klemp St. & Kenton	10	93	97
2R	2247	86278	86272	2' Dia. RCP	Grand Ave. & Kenton	10	47	47
2R	1137	85996	92725	3' Dia. RCP	10th Ave. & Randolph	10	140	92

Table VIII-2
Three Mile Creek Modeled Problem Identification

Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Structures With Flooding At Upstream Node: Existing Capacity (cfs)	Structures With Flooding At Upstream Node: Maximum Flow (cfs)
2R	3178	92721	92722	8' x 8.5' Arch	Spruce & Olive	10	52	357
2R	1181	92689	92690	2.5' Dia. CMP	Chestnut & 9th St.	10	98	78
2R	1178	86334	86335	2' Dia. RCP	Lawrence Ave. & Chestnut	10	21	35
2R	2688	92362	92363	3' Dia. RCP	15th St. & Ohio	50	113	114
2R	1121	86240	86242	1.5' Dia. CMP	Quincy St. & Washington	50	12	8
3R					No Flooding			
6L	1363	86664	86665	4.5' Dia. CMP	9th & Pottawatomie	10	94	119
6L	1365	92148	92147	4.5' Dia. CMP	9th & Osage	10	3.4	154
6L	1541	92601	92602	2' Dia. VCP	9th & Cheyenne	10	32	35
6L	1542	92602	92603	2' Dia. VCP	9th & Pawnee	10	14	24
6L	2499	92604	86944	2' Dia. RCP	9th & Dakota	10	21	47
4R					No Flooding			
7L	1559	86971	86972	2' Dia. CMP	11th & Cheyenne	10	18	21

Table VIII-2
Three Mile Creek Modeled Problem Identification

							Structures With Flooding At Upstream Node	
Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Existing Capacity (cfs)	Maximum Flow (cfs)
7L	1565	86973	86975	2' Dia. CMP	12th & Cheyenne	10	19	23
5R	2581	92304	92056	1.5' Dia. RCP	14th & Osage	10	4	9
6R	2446	86795	86803	2' Dia. RCP	20th St. & Seneca	50	30	44
6R	2448	86806	86809	4.5' Dia. RCP	20th St. & Seneca	10	273	214
6R	1458	86810	86811	4.5' Dia. RCP	18th St. & Miami	10	314	203
6R	2449	86811	86814	4.5' Dia. RCP	18th St. & Miami	10	172	224
6R	1477	86842	86841	1.5' Dia. RCP	20th Terr. & Osage	10	12	12
6R	1423	86759	86760	6' Dia. CMP	17th & Osage	10	264	318
6R	1431	86770	86776	2' Dia. RCP	17th St. & Terry	10	32	38
6R	2425	86776	86777	2' Dia. RCP	17th St. & Terry	10	22	34
6R	1432	86777	86778	2' Dia. RCP	16th St. & Michael	10	29	32

Table VIII-2
Three Mile Creek Modeled Problem Identification

Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Structures With Flooding At Upstream Node: Existing Capacity (cfs)	Structures With Flooding At Upstream Node: Maximum Flow (cfs)
6R	2427	86779	86780	2' Dia. RCP	16th St. & Michael	10	37	35
6R	2428	86781	86782	2' Dia. RCP	16th St. & Osage	10	26	36
6R	2314	86559	92307	2.5' Dia. RCP	20th St. & Shawnee	50	141	121
6R	1304	92307	86556	3' Dia. RCP	20th St. & Shawnee	50	112	121
9L	1587	87021	87022	2' Dia. CMP	18th & Metropolitan	50	13	37
8L	1581	92047	92049	4' x 4' RCB	14th & Cheyenne	10	280	142
8L	1583	87013	87014	2' Dia. CMP	16th & Metropolitan	50	13	16
8L	1584	87016	87015	2' Dia. CMP	16th & Metropolitan	50	14	25
10L					No Flooding			
7R	1472	86834	86835	1.5' Dia. RCP	20th & Pottawatomie	50	12	16

Table VIII-2
Three Mile Creek Modeled Problem Identification

Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Structures With Flooding At Upstream Node: Existing Capacity (cfs)	Structures With Flooding At Upstream Node: Maximum Flow (cfs)
7R	2461	92008	86840	1.5' Dia. RCP	20th & Ottawa	50	34	12
7R	1476	86840	86830	2.5' Dia. RCP	20th & Ottawa	50	38	34
8R	1478	86844	86845	2' Dia. CMP	22nd & Ottawa	50	25	16
8R	1597	87035	87036	2' Dia. CMP	22nd & Dakota	10	55	32
S1R	1241	86444	86441	2' Dia. RCP	10th & Delaware	50	1	26
S1L	1252	86462	86463	1.5' Dia. RCP	13th & Delaware	10	19	18
S1L	2280	86466	86467	1.5' Dia. RCP	13th & Cherokee	10	13	23
S2R					No Flooding			
S3R					No Flooding			
S2L					No Flooding			
S3L	1282	86512	86513	1.5' Dia. RCP	18th & Sherman St.	50	1	11
S4R					No Flooding			
S5R	938	92014	85913	2' Dia. CMP	19th & Spruce	50	28	17

Table VIII-2

Three Mile Creek Modeled Problem Identification

Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Structures With Flooding At Upstream Node: Existing Capacity (cfs)	Structures With Flooding At Upstream Node: Maximum Flow (cfs)
S6R	2743	92414	92415	2' Dia. RCP	WL Tfwy. & Ohio	50	73	33
S4L	3055	92639	92641	4' Dia. RCP	22nd & High St.	10	100	94
S7R	921	85894	85895	2' Dia. RCP	21st Ct. & Randolph	10	18	6
S7R	2066	85895	85896	2' Dia. RCP	21st Ct. & Randolph	10	21	27
S7R	2067	85896	85897	3.5' Dia. RCP	21st Ct. & Randolph	10	145	75
S7R	935	85909	85910	2' Dia. CMP	21st & Spruce	50	1	6
S8R	931	85904	85903	2' Dia. RCP	22nd & Spruce	50	35	40
S8R	929	85903	85906	2' Dia. RCP	22nd & Spruce	50	20	25
S8R	932	85906	85907	2' Dia. RCP	22nd & Spruce	50	7	13

Table VIII-3 Five Mile Creek Watershed Modeled Conveyance System Summary			
Subwatershed	Length of Open Channel (feet)	Length of Closed Conduit (feet)	Number of Junctions, Manhole Structures, and Nodes
Main Channel	27,311	1,258	59
1L	0	5,049	39
1R	0	886	5
2R	11,253	5,689	81
3R	0	1,019	7
2L	5,672	4,632	49
4R	0	4,947	33
3L	10,226	11,333	102
5R	3,543	2,159	26
6R	10,054	1,195	37
4L	899	668	14
5L	3,420	3,367	34
7R	760	1,584	12
8R	9,285	3,571	51
6L	3,453	3,830	38
9R	8,520	2,168	37
7L	13,665	15,579	162
8L	0	885	8
10R	2,846	1,391	13
11R	2,617	378	9
9L	1,032	2,098	13
10L	2,977	267	13
11L	2,615	884	9
Total	120,148	74,837	851

Table VIII-4
Five Mile Creek Modeled Problem Identification

Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Structures With Flooding At Upstream Node: Existing Capacity (cfs)	Structures With Flooding At Upstream Node: Maximum Flow (cfs)
Main Channel	N/A	N/A	N/A	Unprotected Structures	Wastewater Treatment Plant	100	N/A	N/A
Main Channel	2617	92320	92321	3 - 40' x 11' RCB	Union Pacific RR	100	2,430	7,488
Main Channel	2615	92318	92319	14' x 33' - 44' - 33' Bridge	2nd Street	100	4,590	7,484
Main Channel	2626	92326	92327	15' x 23' - 38' - 23' Bridge	Limit St./2nd Ave.	100	3,436	6,846
Main Channel	203	92136	92153	2 - 16' x 12' RCB	10th Avenue	100	8,600	5,302
Main Channel	245	92061	92062	24' x 14' MAC	New Lawrence Road	100	337	5,045
1L	780	85610	85611	2' Dia. RCP	3rd & Marion	10	0.6	8
1L	1441	85768	85769	2' Dia. CMP	4th & Evergreen	10	23	22
1L	1937	85569	85570	2' Dia. RCP	Rose & Pennsylvania	10	15	29
1L	2016	85770	85771	2.5' Dia. RCP	4th & Evergreen	10	68	20
1L	765	85565	85568	2' Dia. CMAP	Rose & Pennsylvania	10	29	33
1L	1961	85602	85607	5' Dia. RCP	4th & Marion	50	86	136

Table VIII-4
Five Mile Creek Modeled Problem Identification

Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Structures With Flooding At Upstream Node: Existing Capacity (cfs)	Structures With Flooding At Upstream Node: Maximum Flow (cfs)
1L	862	85771	85774	4.5' Dia. CMP	4th & Evergreen	50	183	53
1L	2043	85774	85855	4.5' Dia. CMP	4th & Evergreen	50	170	56
1L	918	85890	92251	3.5' Dia. CMP	3rd & Marion	50	208	87
1R	903	85870	85873	2' Dia. RCP	2nd & Marion	50	28	45
1R	908	85876	85878	3' Dia. RCP	2nd & Marion	50	114	116
1R	909	85878	92250	3' Dia. RCP	2nd & Marion	50	265	132
2R	3240	92278	84666	2' Dia. VCP	4th St. & VA entr.	10	39	25
2R	148	84666	92276	2' Dia. VCP	4th St. & VA entr.	10	10	7
2R	304	84791	84897	2' Dia. RCP	Limit St. & Wilson Ave.	50	24	27
2R	249	84793	84802	2' Dia. CMP	Wilson Ave. & Idaho St.	10	30	29
2R	250	84795	84794	2' Dia. CMP	Wilson Ave. & Ash St.	10	27	22
2R	258	84804	84803	4' x 3' RCB	Wilson Ave. & St. Mary St.	10	9	112

Table VIII-4

Five Mile Creek Modeled Problem Identification

Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Structures With Flooding At Upstream Node: Existing Capacity (cfs)	Structures With Flooding At Upstream Node: Maximum Flow (cfs)
2R	260	84808	84807	2' Dia. RCP	Frontage Rd. & St. Mary St.	10	40	20
2R	263	84815	84816	2' Dia. CMP	Frontage Rd. & St. Mary St.	10	1	8
2R	886	85825	85826	3' Dia. CMP	Limit St. & 2nd St.	10	17	42
2R	1658	92269	84679	3' x 2' RCB	4th St. & VA entr.	50	113	86
2R	154	92273	84683	2' Dia. VCP	4th St. & VA entr.	10	24	28
2R	252	92426	84796	2' Dia. RCP	Wilson Ave. & St. Mary St.	10	49	32
2R	150	84672	84673	30" x 48" MAC	4th St. & VA entr.	50	52	58
2R	308	84899	84902	2' Dia. RCP	Limit St. & 1st St.	50	53	53
2R	1442	84902	84903	2' Dia. RCP	Limit St. & 1st St.	50	47	52
3R	893	85845	85847	2' Dia. CMP	4th St. & Vilas	50	24	27

Table VIII-4
Five Mile Creek Modeled Problem Identification

							Structures With Flooding At Upstream Node	
Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Existing Capacity (cfs)	Maximum Flow (cfs)
3R	894	85848	85850	2.5' Dia. CMP	4th St. & Sheridan	50	27	29
3R	2038	85850	85853	2.5' Dia. RCP	4th St. & Santa Fe St.	50	58	23
3R	895	85853	85855	2.5' Dia. CMP	4th St. & Santa Fe St.	50	50	26
2L	2004	85792	85793	2' Dia. RCP	3rd Ave. & Sherman St.	10	12	27
2L	870	85793	85794	2' Dia. RCP	3rd Ave. & Sherman St.	10	21	21
2L	872	85798	85802	2' Dia. RCP	Santa Fe & 3rd Ave.	10	39	40
2L	874	85802	85804	2.5' Dia. RCP	Santa Fe & 2nd Ave.	10	55	44
2L	743	85541	85543	2' Dia. VCP	2nd Ave. & Reaser St.	10	34	34
2L	1926	85543	92310	2' Dia. VCP	2nd Ave. & Doniphan	10	35	46
2L	746	92310	85547	2' Dia. VCP	2nd Ave. & Buettinger Pl.	10	32	35

Table VIII-4
Five Mile Creek Modeled Problem Identification

Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Structures With Flooding At Upstream Node: Existing Capacity (cfs)	Structures With Flooding At Upstream Node: Maximum Flow (cfs)
2L	747	85547	85550	2' Dia. VCP	2nd Ave. & Buettinger Pl.	10	32	35
2L	755	85554	85507	8' x 4' RCB	2nd Ave. & Thornton	50	17	335
2L	796	85642	85643	2' Dia. CMP	Garfield St. & Cleveland Terr.	10	1	17
2L	1968	85695	85694	2.5' Dia. RCP	Broadway & Arthur St.	10	62	60
2L	819	85697	92339	3' Dia. RCP	Cleveland Terr. & Arthur St.	10	82	52
4R	286	84872	84874	2' Dia. RCP	Hughes Rd. & Limit St.	50	57	23
4R	1749	84874	84876	2.5' Dia. RCP	Hughes Rd. & Limit St.	50	34	29
4R	1748	84873	84876	6' Dia. RCP	Hughes Rd. & Limit St.	50	155	125
4R	324	84869	84870	2' Dia. RCP	Hughes Rd. & Utah St.	50	18	39
4R	2901	92537	92536	2' Dia. RCP	Hughes Rd. & Limit St.	50	29	29

Table VIII-4
Five Mile Creek Modeled Problem Identification

							Structures With Flooding At Upstream Node	
Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Existing Capacity (cfs)	Maximum Flow (cfs)
4R	847	85739	85740	4' Dia. CMP	Limit St. & State St.	50	167	153
3L	494	85162	85163	6' Dia. CMP	Garland Ave. & Marion St.	10	131	171
3L	1850	85230	92347	2' Dia. RCP	Grand Ave. & Sherman St.	10	25	25
3L	543	92347	85247	2.5' Dia. RCP	Sherman St. & Grand Ave.	10	73	89
3L	554	85251	85253	2' Dia. RCP	Grand Ave. & Marion St.	10	32	31
3L	556	85257	85261	2' Dia. RCP	Kingman St. & Marion St.	10	41	37
3L	558	85261	85247	2' Dia. RCP	Kingman St. & Sherman St.	10	21	36
3L	708	85463	92343	2' Dia. RCP	Halderman St. & Grand Ave.	10	36	38
3L	1904	92343	92344	2' Dia. RCP	10th Ave. & Halderman	50	13	28
3L	731	92344	85466	2' Dia. RCP	10th Ave. & Halderman	50	9	34

Table VIII-4
Five Mile Creek Modeled Problem Identification

Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Structures With Flooding At Upstream Node: Existing Capacity (cfs)	Structures With Flooding At Upstream Node: Maximum Flow (cfs)
3L	807	85466	85669	3' Dia. CMP	10th Ave. & Halderman	50	82	80
3L	711	85470	85471	2' Dia. RCP	10th Ave. & South St.	50	53	36
3L	712	85471	85473	2' Dia. RCP	10th Ave. & South St.	50	32	32
3L	1909	85473	85475	2' Dia. RCP	10th Ave. & South St.	50	22	27
3L	1915	85475	92342	2' Dia. RCP	10th Ave. & South St.	50	66	50
3L	804	85659	85660	2' Dia. CMP	Lawrence Ave. & AT&SF RR	10	24	23
3L	808	85668	85669	1.5' Dia. RCP	Halderman & Lawrence	10	2	24
3L	1977	85669	92155	3' Dia. RCP	Halderman & Lawrence	50	77	91
3L	811	85672	85671	1.5' Dia. RCP	Lawrence & South St.	10	14	9
3L	849	85746	85747	2' Dia. RCP	Limit St. & AT&SF RR	50	24	15

Table VIII-4
Five Mile Creek Modeled Problem Identification

Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Structures With Flooding At Upstream Node: Existing Capacity (cfs)	Structures With Flooding At Upstream Node: Maximum Flow (cfs)
3L	1999	85743	85745	2' Dia. RCP	Limit St. & AT&SF RR	50	1	27
3L	476	92334	85138	2' Dia. CMP	Garland & Santa Fe St.	10	23	31
3L	1783	84959	84957	2' Dia. RCP	Limit St. & Broadway Terr.	50	26	38
3L	473	85124	85125	2' Dia. RCP	Limit St. & Maple Ave.	50	53	56
5R	1481	92517	92516	3' Dia. RCP	Hughes & McDonald	10	50	84
5R	1665	92516	84713	3' Dia. RCP	Hughes & McDonald	10	107	97
5R	822	85701	85700	1.25' Dia. RCP	Iowa & Oregon	10	9	15
5R	170	84703	84706	3.5' Dia. CMP	Hughes & McDonald	50	64	66
6R	196	84741	84740	30" CMP	Lakeview Dr. & Pleasant Ave.	10	54	98
6R	197	84740	92524	36" RCP	Lakeview Dr. & Pleasant Ave.	10	36	108

Table VIII-4

Five Mile Creek Modeled Problem Identification

							Structures With Flooding At Upstream Node	
Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Existing Capacity (cfs)	Maximum Flow (cfs)
4L	331	84946	92503	1.5' Dia. CMP	Virginia Circle & Goddard Cr.	10	1	5
4L	330	84944	84945	2' Dia. CMP	Shrine Pk. Rd. & Goddard Cr.	50	1	15
4L	327	84937	92504	3' Dia. RCP	Shrine Pk. Rd. & Five Mi. Ck.	50	78	70
4L	328	84941	84940	5' x 2.5' RCB	Shrine Pk. Rd. & golf course entr.	50	9	21
5L	375	85011	92482	2' Dia. RCP	Tanglewood & Grand Ave.	10	18	19
5L	377	92482	85015	24" x 36" MAC	Tanglewood & Grand Ave.	10	16	28
5L	378	85015	85014	24" x 36" MAC	Meadow Rd. & Limit St.	10	25	23
5L	349	84976	84977	1.5' Dia. RCP	Limit St. & 10th Ave.	50	12	7
5L	1778	84977	84979	2.5' Dia. RCP	Limit St. & 10th Ave.	50	27	28

Table VIII-4
Five Mile Creek Modeled Problem Identification

Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Structures With Flooding At Upstream Node: Existing Capacity (cfs)	Structures With Flooding At Upstream Node: Maximum Flow (cfs)
5L	352	84982	84983	1.5' Dia. RCP	Meadow Ln. & 10th Ave.	50	11	8
5L	353	84983	84981	2' Dia. RCP	Meadow Ln. & 10th Ave.	50	22	23
5L	351	84981	84979	2' Dia. RCP	Meadow Ln. & 10th Ave.	50	18	12
5L	1786	84989	84990	2' Dia. RCP	Brookside & Pin Oak St.	10	44	27
5L	1776	84973	84975	2.5' Dia. RCP	Limit St. & 10th Ave.	50	37	74
5L	506	85183	85184	2' Dia. RCP	Holman St. & 10th Ave.	50	11	21
5L	507	85184	85185	2' Dia. RCP	Holman St. & 10th Ave.	50	28	41
7R	222	84772	84773	18" RCP	Fawncreek & Garland	10	11	12
7R	201	92497	84749	24" CMP	Deerfield & Shrine Pk.	50	19	28
8R	87	84591	84590	33" x 49" MAC	Eisenhower Rd. & 10th Ave.	50	55	105

Table VIII-4
Five Mile Creek Modeled Problem Identification

Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Structures With Flooding At Upstream Node: Existing Capacity (cfs)	Structures With Flooding At Upstream Node: Maximum Flow (cfs)
8R	88	84593	84592	36" CMP	Eisenhower Rd. & 10th Ave.	50	56	52
8R	89	84595	84594	36" CMP	Eisenhower Rd. & 10th Ave.	50	73	77
8R	104	84621	84622	24" CMP	Parkway Dr. & Park Ave.	10	8	90
8R	97	84609	84608	30" RCP	10th Ave. & Park Ave.	50	28	85
8R	109	84625	84628	66" CMP	Parkway Dr. & Park Ave.	10	163	251
8R	3316	92859	92857	30" RCP	Muncie Rd. & Parkway Dr.	50	53	84
8R	3319	92855	92854	30" RCP	Muncie Rd. & Parkway Dr.	50	33	38
8R	3321	92860	92861	24" CMP	Hometown Village	10	12	60
8R	2946	92565	92566	24" RCP	10th Ave. & Muncie Rd.	50	33	36
6L	518	85199	85200	2' Dia. RCP	14th St. & Vilas St.	50	34	14

Table VIII-4
Five Mile Creek Modeled Problem Identification

							Structures With Flooding At Upstream Node	
Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Existing Capacity (cfs)	Maximum Flow (cfs)
6L	519	85202	85206	2' Dia. RCP	14th St. & Vilas St.	10	43	45
6L	1830	85206	85208	2' Dia. RCP	14th St. & Holman St.	10	16	53
6L	1800	85045	85046	4' Dia. RCP	Militia Ct. & Revolutionary Ct.	10	39	121
6L	407	85047	85048	4' Dia. CMP	14th St. & Independence	10	86	107
6L	388	85028	85029	2.5' Dia. RCP	Tanglewood & N. Lawrence Rd.	10	74	43
9R	212	84757	84758	2' Dia. RCP	10th Ave. & Josela Ct.	50	25	12
9R	1684	84758	92494	2' Dia. RCP	10th Ave. & Josela Ct.	50	29	17
9R	112	84633	84632	3' Dia. CMP	13th & Eisenhower	50	37	65
7L	227	84778	84777	2' Dia. CMP	14th St. & New Lawrence Rd.	10	16	12

Table VIII-4
Five Mile Creek Modeled Problem Identification

Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Structures With Flooding At Upstream Node: Existing Capacity (cfs)	Structures With Flooding At Upstream Node: Maximum Flow (cfs)
7L	1861	85292	85293	1.5' Dia. RCP	16th St. & Holman St.	10	10	9
7L	585	85293	92356	1.5' Dia. RCP	16th St. & Holman St.	10	22	15
7L	2799	85311	92464	4' Dia. RCP	16th St. & Santa Fe	10	146	98
7L	614	85326	85328	4.5' Dia. CMP	16th St. Terr. & Thornton	10	35	88
7L	617	85336	85337	1.5' Dia. RCP	Marion St. & Francis Ct.	10	31	31
7L	1870	85337	85338	1.5' Dia. RCP	Marion St. & Francis Ct.	10	20	28
7L	658	85407	85405	4' Dia. RCP	Thornton & 19th St. Terr.	50	198	132
7L	647	85386	85388	1.5' Dia. RCP	Evergreen St.& Cambridge St.	10	17	18
7L	649	85388	92016	1.75' Dia. RCP	Evergreen St. & Cambridge St.	10	18	27
7L	631	85362	85365	2' Dia. RCP	17th St. Terr. & Evergreen	10	10	30

Table VIII-4
Five Mile Creek Modeled Problem Identification

							Structures With Flooding At Upstream Node	
Subsystem ID	XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Structure Size and Type	Nearest Streets	Design Storm Frequency	Existing Capacity (cfs)	Maximum Flow (cfs)
7L	669	85370	85371	2' Dia. RCP	18th St. & Thornton St.	50	1	23
8L	2786	85061	92451	2' Dia. RCP	Candlewood & Winchester	10	30	30
8L	427	92451	85066	2' Dia. CMP	Candlewood & Tudor	10	21	19
10R	2806	92470	92469	3' Dia. RCP	West Leavenworth Tfwy. & Limit	50	85	43
11R					No Flooding			
9L	2769	92438	92439	2' Dia. RCP	West Leavenworth Tfwy. & Limit	50	20	32
10L	639	85376	85377	3' Dia. CMP	Limit St. & 22nd St.	10	93	73
10L	638	85375	85374	2' Dia. RCP	Vilas St. & 22nd St.	10	42	25
11L	1113	86214	86215	2-3' Dia. CMPs	Hebbelin Dr. & 23rd St.	10	74	120

Table VIII-5
External Watersheds - Subsystems Not Within 3mc or 5mc Basin Boundaries

Subsystem ID	Evaluation Method	Adjacent to Basin	Map Sheet Nos.	Upstream GIS Node	Nearest Streets at Upstream End	Flow Destination
emc1	Rational	3mc	26NE	86899	6th & Metropolitan	North
emc2	xp-swmm	3mc	25NW	86886	4th & Cheyenne	East
emc3	xp-swmm	3mc	25NW	86851	2nd & Kiowa	East
emc4	xp-swmm	3mc	25SW, 36NW	92314	4th & Cherokee	East
emc5	xp-swmm	3mc	36NW	86115	6th & Spruce	Northeast
emc6	xp-swmm	5mc	36SW, 35SE, 1NE & 1NW	85691	6th Ave. & Ohio	East
emc7	xp-swmm	5mc	15NE	92576	N. Lawrence & Eisenhower	Southeast
emc8	Rational	5mc	14NW	84635	Eisenhower, west of 13th	South
emc9	xp-swmm	5mc	13NW	84568	Eisenhower & Lakeview	South
emc10	Rational	5mc	13NE	92271	Hughes & Eisenhower	South
emc11	xp-swmm	5mc	13NE	84538	Hughes & Muncie	South
emc12	Rational	5mc	18NW	85128	4th St. & Eisenhower	South
emc13	xp-swmm	5mc	18NW	92550	4th St. & Muncie	South
emc14	Rational	5mc	18NW	84481	Brewer Pl. & Commercial St.	South

Table VIII-6
External Watersheds Problem Identification

Subsystem ID	GIS Up Node	XPSWMM Up Node	XPSWMM Conduit No.	Structure Size and Type	Nearest Streets	Design Storm Frequency	Structures With Flooding At Upstream Node: Existing Capacity (cfs)	Structures With Flooding At Upstream Node: Maximum Flow (cfs)
emc1					No Flooding			
emc2	86886	Node 2	Link 2	24" Dia. RCP	4th St. & Cheyenne	10	23	35
emc2	86872	Node 5	Link 5	18" Dia. CMP	3rd St. & Cheyenne	10	10	86
emc2	92586	Node 6	Link 6	18" Dia. CMP	2nd St. & Cheyenne	10	8	100
emc2	92587	Node 7	Link 7	24" Dia. VCP	2nd St. & Cheyenne	10	39	119
emc2	92588	Node 8	Link 8	24" Dia. VCP	Cheyenne Curve	10	39	133
emc2	92589	Node 9	Link 9	36" Dia. CMP	Cheyenne Curve	10	91	115
emc2	86880	Node 20	Link 20	24" Dia. RCP	Water St.	10	36	113
emc3	86851	Node 4	Link 4	19" x 30" HERCP	2nd St. & Kiowa	10	31	64
emc4					No Flooding			
emc5					No Flooding			
emc6	85622	Node 35	Link 35	6' x 5' ARCH	2nd St. & Poplar	50	117	555

Table VIII-6
External Watersheds Problem Identification

							Structures With Flooding At Upstream Node	
Subsystem ID	GIS Up Node	XPSWMM Up Node	XPSWMM Conduit No.	Structure Size and Type	Nearest Streets	Design Storm Frequency	Existing Capacity (cfs)	Maximum Flow (cfs)
emc6	92312	Node 34	Link 34	8' x 3' RCP	2nd St. & Poplar	10	198	447
emc6	85628	Node 36	Link 36	48" Dia. RCP	2nd St. & Mo Pac RR	10	8	166
emc6	85631	Node 39	Link 39	48" Dia. CMP	2nd St. & Missouri River	10	52	113
emc6	85523	Node 41	Link 41	24" Dia. CMP	3rd Ave. & Michigan St.	10	22	21
emc7					No Flooding			
emc8					No Flooding			
emc9					No Flooding			
emc10					No Flooding			
emc11	84547	Node 14	Link 14	24" Dia. CMP	Hughes Rd. & Muncie Rd.	50	25	47
emc11	84539	Node 33	Link 33	24" Dia. RCP	4th St. & Commercial St.	10	23	21
emc11	84527	Node 36	Link 36	30" Dia. RCP	4th St. & Retail Parking Lot	10	15	46

Table VIII-6
External Watersheds Problem Identification

Subsystem ID	GIS Up Node	XPSWMM Up Node	XPSWMM Conduit No.	Structure Size and Type	Nearest Streets	Design Storm Frequency	Structures With Flooding At Upstream Node: Existing Capacity (cfs)	Structures With Flooding At Upstream Node: Maximum Flow (cfs)
emc12	85128	N/A	N/A	24" Dia. RCP	4th St. & Eisenhower	50	37	75
emc13	92550	Node 1	Link 1	24" Dia. CMP	4th St. & Muncie Terr.	50	17	21
emc13	92551	Node 2	Link 2	24" Dia. CMP	4th St. & Commercial St.	50	9	21
emc13	84496	Node 5	Link 5	30" Dia. RCP	Commercial St. & Commercial Pl.	10	49	60
emc13	84497	Node 10	Link 10	24" Dia. RCP	Commercial St. & Commercial Pl.	10	12	31
emc13	92580	Node 19	Link 19	48" Dia. RCP	4th St. & unnamed street	10	98	76
emc13	92579	Node 20	Link 20	50" Dia. CMP	4th St. & unnamed street	10	30	81
emc13	84486	Node 16	Link 16	36" Dia. RCP	Highway Terr. & Brewer Pl.	10	27	55
emc14					No Flooding			

Table VIII-7
Reported Drainage Problems

Watershed ID & Map Sheet No.	Problem Identification Number	Location	Description
3MC 35 NW	1	13th and Delaware and Cherokee	No roadside ditches along Delaware and Cherokee, east of 13th, or along 13th. Area becomes a lake during hard rains.
3MC 27 SW	2	18th and Osage, 1815 and 1819 Osage; Subsystem 6R	Large drainage area; houses built on fill; storm sewer and sanitary sewer backups; 54" storm RCP flowing 20% full on 1/26/96, but no precipitation on that day or on preceding days.
3MC 27 SE	3	1418 Osage; Subsystem 5R	Water runs across street and in yard between 1420 and 1418 Osage.
5MC 12 SW	4	4200-4400 block of Valley View Road, northeast of intersection of Shrine Park and Muncie	Lack of roadside ditches for drainage.
5MC 11 SW	5	Wellington Drive, west of 10th	Obstructed storm sewers; flooding causes debris to accumulate on street.
3MC 35 SE	6	Hanson residence, 1011 9th Avenue	Dwelling at 1015 9th Avenue, has downspout on north side of house which diverts rainwater to Hanson's property.
3MC 34 NW	7	Bennett residence, 407 S. 20th Street; between Choctaw and High Streets	Trash and debris accumulation at 18" storm sewer outlet and along street; erosion of drainage ditch and banks.
3MC 35 NW	8	Mensch residence, 1204 Spruce Street; Subsystem 2R	Basement and yard flooding; stormwater can't get into inlets, overflows curb into yard.

Table VIII-7
Reported Drainage Problems

Watershed ID & Map Sheet No.	Problem Identification Number	Location	Description
EMC 36 SW	9	Shelley residence, 1424 S. 5th Street; near Maple Street	Stormwater washes gravel and mud down Maple Street into homeowner's driveway and yard where it pools. There are no drainage ditches or tubes on north side of street.
EMC 25 SW	10	Cherokee Street and Missouri River	New outlet of 3' x 4' arch under Cherokee recommended in 1967 B&V report.
EMC 25 SW	11	Adams residence, 229 Osage Street	An approximately 3 ft dia., 1 ft deep sinkhole in the backyard; resident thinks there may be an old cistern at the rear of property.
3MC 35 NE	12	Cherokee and Broadway; 760 and 777 Cherokee	Failing arch culvert.
3MC 26 SE	13	Shawnee and Broadway, 720 Shawnee	Alley runoff problem.
3MC 26 SW	14	10th and Miami Streets	Flash flooding; sanitary sewer backups; threat to loss of life.
3MC 35 NW	15	Davidson residence, 1137 Delaware	Street lacks curbs and gutters; ill-defined drainage ditches; no drainage culverts on adjoining properties north and south.
3MC 27 SE	16	Bockman residence, 1600 Osage Street; Subsystem 6R	Curbed and guttered street; runoff from 16th and Osage Streets is tubed to drainage ditch on north side where it causes erosion along property lines.

Table VIII-7
Reported Drainage Problems

Watershed ID & Map Sheet No.	Problem Identification Number	Location	Description
3MC 27 SW	17	Seneca and 20th Street Terrace; Subsystem 6R	Sediment and erosion problems.
3MC 27 SW	18	Shawnee and 22nd Streets; Subsystem 6R	Failed CMP; need detention/retention to reduce peak flows?
EMC 36 NW	19	6th and Olive Streets	Low spot receives drainage from west and east; yard totally flooded during rains.
3MC 35 NE	20	739 Olive Street; Subsystem 1R	Basement at flowline of creek.
3MC 35 SE	21	1424 Lawrence Ave.; Subsystem 2R	(No description available).
3MC 35 SW	22	10th Avenue and Randolph; Subsystem 2R	Arch culvert, smaller than upstream conduits.
3MC 35 SW	23	Jones residence, 1116 Quincy Street	No curb or gutter; no drainage ditches on north side of Quincy; residence is below slope of off-street parking.
3MC 2 NW	24	1210 Ohio; Subsystem 2R	Standing water on Ohio, between Newman and west of Jackson, due to high flows in ditch leading to Ohio crossroad pipe.
3MC 34 NE	25	Wagler residence, 1620 Spruce	West of this residence (last one on north side of Spruce), erosion is undercutting along property line as well as the slope on the north side; just north of westbound sidewalk.

Table VIII-7 Reported Drainage Problems			
Watershed ID & Map Sheet No.	Problem Identification Number	Location	Description
5MC 1 SE	26	Santa Fe and 3rd Streets; Subsystem 2R	Flash flooding requires traffic control barricades; bad crossroad pipes.
5MC 1 SE	27	5 Mile Creek and 4th Street	Old arch under 4th Street needs replacement.
5MC 2 SE and 11 NE	28	Shrine Park Road and Limit Street; Subsystem 3L	Culvert okay for now, but ongoing development upstream may increase runoff beyond current capacity.
5MC 2 SE	29	760 Santa Fe Street; Santa Fe Street, Garland to Old Creek Court; Subsystem 3L	Lack of drainage tubes on south side of Santa Fe, artificial berm not keeping water from rerouted tributary out of back yards; flooding at confluence of creeks.
5MC 2 SE	30	2400 Spring Garden Avenue, between Santa Fe and Marion Streets; Ferguson residence, 2304 Garland; Subsystem 3L	Channel bottom is eroding; exposed sanitary service line; water overtopped Garland in 1993 flood; failed arch, west side; sinkhole in vicinity of sanitary sewer.
5MC 2 SE	31	2311 Girard Avenue; Subsystem 3L	Replace arch with culvert at Girard, north of Santa Fe.
5MC 2 NE	32	Szychowski residence, 2015 Lawrence Avenue	Natural spring developed along driveway; basement flooding in past.

Table VIII-7
Reported Drainage Problems

Watershed ID & Map Sheet No.	Problem Identification Number	Location	Description
5MC 3 SE	33	2413 16th Street Terrace, north of Vilas to Thornton Streets; 1609 Holman Street, 16th Street, south of Vilas, including Holman; Subsystem 7L	Up to 3 ft standing water in street; poor access to conveyance system, filled w/railroad ties; obstructed and damaged drainage tubes.
5MC 3 NW and 3 SW	34	Thornton and 19th Street Terrace	Obstructed and damaged culvert.
5MC 4 SE	35	22nd St. Terrace and Hebbelin Drive; Subsystem 11L	Failed outfall of CMP; poor channel maintenance.
5MC 12 NE	36	4th Street and Idaho Street; Subsystem 4R	Flash flooding west of Frontage Road requires traffic barricades.
5MC 12 SE	37	4101 Fourth Street, 4th Street Trafficway and V.A. entrance; Subsystem 2R	Flash flooding around driveway requires traffic barricades.
5MC 12 NW	38	3412 and 3413 Iowa Street, near Oregon Street; Needham and Fassett residences; Subsystem 5R	Curbed and guttered street; eroding drainage ditch continues to deteriorate; crossroad culvert at Oregon Street curve drains west toward homes rather than south away from homes.
5MC 11 NE	39	Five Mile Creek and Shrine Park Road	Low water crossing; impassable with high water; inadequate inlet capacity.

Table VIII-7
Reported Drainage Problems

Watershed ID & Map Sheet No.	Problem Identification Number	Location	Description
5MC 11 NE	40	3130 Shrine Park Road, north of Five Mile Creek, south of Goddard Circle, west side of Shrine Park Road; Subsystem 4L	Insufficient culverts; local flooding and flooding due to Five Mile Creek backwater.
5MC 11 NW	41	3523 10th Avenue; 10th Avenue culvert north of Wellington Drive; Subsystem 6L	Erosion around wingwalls and in channel downstream of culvert.
5MC 11 SW	42	3911 Tenth Avenue; Wellington Drive culvert at 10th Avenue; Subsystem 9R	Inlet submerged and water in street upstream, but outlet only partially full during flooding; incoming flow can't make sharp left turn and floods the street.
5MC 11 SW	43	Wallis Lane and 10th Avenue; Subsystem 9R	Erosion of channel banks; exposed PVC service lines; eroded toe downstream , debris and sharp turn in creek upstream of culvert.
5MC 11 SE	44	905 Park Avenue; Subsystem 8R	Creek diverts to tube adjacent to house, ground level of house is below creek invert; inadequate drainage.
EMC 36 NW	45	Short Street and Railway	Culvert needs replacement as recommended in 1967 study.
EMC 25 NW	46	Cheyenne and 2nd Street	Culvert at Cheyenne west of 2nd Street to railway is inadequate.

Table VIII-7
Reported Drainage Problems

Watershed ID & Map Sheet No.	Problem Identification Number	Location	Description
5MC 1 SW and 1 SE	47	4th St. and Evergreen; Subsystem 1L	Low-lying area with chronic flooding.
3MC 26 SW	48	10th and Shawnee	Three Mile Creek flooding.
3MC 35 SW and 35 SE	49	10th Avenue, south of Spruce Street; between Kansas and Ohio; Subsystem 2R	Partially collapsed arch with existing dimensions 4' x 4' or 4' x 5'.
EMC 36 SW	50	919 4th Ave., Matteo residence; between Spruce and Congress on 4th	Street and storm drain flooding along 4th Ave. between Spruce and Congress; water washes onto lawn, deposits trash/debris every hard rain; floods driveway.
3MC 35 NW	51	1137 Delaware, Forgy residence; between 11th and 12th	Building flooded; no drainage ditches.
5MC 2 SE	52	2200 Garland, Boone residence; Garland and Marion; Subsystem 3L	Yard becomes lake when it rains; no drainage inlet at end of street; water carries debris across yard to 5MC trib.
3MC 27 SW	53	324 20th Street Terr., Curran residence; between Osage and Miami, 20th and 21st Streets	One storm sewer serves block. Runoff includes rocks and dirt from upstream development; street flooding, yard flooding; no designated drainage ditch.

Table VIII-7
Reported Drainage Problems

Watershed ID & Map Sheet No.	Problem Identification Number	Location	Description
5MC 3 NE and 3 SE	54	Thornton and S. 16th Street, Klingely residence	Street and yard flooding and erosion several times a year; 25 ft wall of water w/mud and debris from field to north; road closed 5 months due to 18" deep mud.
3MC 26 NW	55	1321 Metropolitan, Lober residence; 13th and Metropolitan	Torrential rains wash into basement; sidewalk work needed.
3MC 35 SE	56	776 Ohio St., Benson residence; between Columbia and 9th Ave.; Subsystem 1R	Storm drain clogs every time it rains; backs up in the street, water depth to ankles.
5MC 3 NE	57	1600 Ridge Road, Smith residence; north of Thornton, east of 18th Street	Street and yard flooding, trash/debris, erosion every rain; new development--no storm sewers or ditches; hill upstream seems to drain water continuously; drainage paths cutting through property.
3MC 35 NE	58	718 Lawrence Ave., Hodge residence; between Chestnut and Olive, 9th and Broadway	Basement and yard flooding during every rain; floodwaters come in through walls and floors on north side; new retaining wall for fire station forcing water to yard.
5MC 3 SW	59	2120 S. 19th St., Kimball residence; 19th and Thornton; Subsystem 7L	Yard flooding, trash/debris in ditches, soil erosion seasonally; drainage ditch behind houses is collector for trash and debris, causing erosion of property.

Table VIII-7
Reported Drainage Problems

Watershed ID & Map Sheet No.	Problem Identification Number	Location	Description
3MC 35 SW	60	906 Madison, Jacobs residence; near 14th and Spruce	Street and yard flooding, several inches deep; development to west appears to make worse; yard eroding into floodway.
3MC 26 SE	61	737 Miami, Lippman residence; between 7th and Broadway, south side of Miami; Subsystem 4L	Drainage problem getting worse; floodwaters from 7th and Broadway funnel to property; washed out driveways, gravel, and is affecting foundation.
5MC 3 SE	62	2115 S. 16th St.; 16th and Thornton, Rodgers residence	No clearly defined drainage path. Backyard floods and accumulates debris every hard rain.
5MC 14 NE	63	Sepulvedo residence, 4501 Parkway Drive; Muncie and Parkway	15' flood path flows from large farm across yard to drainage system.
3MC 26 SE	64	Lanze residence, 621 Kiowa; Kiowa, between 6th and 7th	No drainage ditches or storm sewers and low curbs on this block. Water from street jumps sidewalk, floods houses, erodes dirt.
3MC 27 SE	65	1615 Michael; east of 17th St., near Miami; Arnold residence; Subsystem 6R	Area drain not big enough to let water in from 17th, between Terry and Miami; backs up during hard rains.
3MC 35 SW	66	Ettinger residence, 1019 Ohio St.; 11th and Ohio, near Kingman; Subsystem 2R	11th and Ohio intersection is low spot, collects rocks and floodwater, storm sewer manhole cover floats due to surging floodwaters; floodwaters wash onto front yard.

Table VIII-7 Reported Drainage Problems			
Watershed ID & Map Sheet No.	Problem Identification Number	Location	Description
3MC 35 SW	67	Shockey residence, 1011 Madison St; near 14th and Randolph and Spruce; Subsystem 2R	Standing water in vacant lot on corner; water runs across street; hard rains flood utility shed in backyard.
3MC 27 NE	68	1420 and 1409 Cheyenne St.; 14th and Cheyenne; Subsystem 8L	Small bridge at end of Cheyenne constricts flow, causing floodwaters to jump creek bank and flood houses. New problem since large culvert upstream under Metropolitan was installed.
3MC 27 SE	69	1351 and 1420 Kiowa St.; 14th and Kiowa; Subsystem 8L	Flooding due to entrance condition of box culvert; capacity of creek upstream is ok; flooding worse since new culvert at Metropolitan installed.
3MC 27 SW	70	Rice residence, 1921 Miami; 19th and Miami; Subsystem 6R	Water flows in sheets across backyard from 20th and Shawnee. Ditch on east side can't handle all flow, water up to foundation, drains slow.
5MC 4 SE	71	Meyer residence, 2510 22nd Terrace; near 22nd and Vilas; Subsystem 11L	Backyard and basement flooding and ponding about 6 times per year.
5MC 11 SE	72	Gray residence, 725 Fawn Creek; between Garland and Shrine Park Road; Subsystem 7R	Bottom floor of house has flooded 6 times in past 3-4 years. Regraded yard to divert flow away from pool.

Table VIII-7 Reported Drainage Problems			
Watershed ID & Map Sheet No.	Problem Identification Number	Location	Description
3MC 26 SW, 27 SE, and 27 SW	73	Shawnee, both sides, from 10th to 13th and from 16th to 20th	Drainage problems having to do with inadequate ditches and driveway tubes (City Drainage Hot Spot List).
5MC 2 NE	74	706 Garfield, Busey residence; Subsystem 2L	Water drainage from street to basement, walls cracked (City Drainage Hot Spot List).
3MC 34 SE	75	S. 16th St. from Ohio to Western, Finch residence	Drainage problem from construction upstream (City Drainage Hot Spot List).
3MC 26 SW	76	13th St. from Osage to Shawnee	Ditch has inadequate drainage (City Drainage Hot Spot List).
5MC 2 NE and 2 SE	77	Thornton at RR tracks; between Garland and Montezuma	Inadequate drainage (City Drainage Hot Spot List).
3MC ?	78	7th Street Church	Inadequate drainage (City Drainage Hot Spot List).
5MC 1 NW	79	5th Ave. and Rees	City Drainage Hot Spot List.
3MC 34 SE	80	1323 S. 15th St., Carey residence; Subsystem 2R	Water running into garage (City Drainage Hot Spot List).
3MC 2 NW	81	1509 Klemp, Thorne residence; Subsystem 2R	S. of Hawthorne Park. Any time it rains, water runs into basement (City Drainage Hot Spot List).
5MC 3 SE	82	Thornton from 15th to 16th	Drainage ditch problem (City Drainage Hot Spot List).

Table VIII-7
Reported Drainage Problems

Watershed ID & Map Sheet No.	Problem Identification Number	Location	Description
3MC 27 NW	83	2000 block of Dakota; Subsystem 10L	Water from county lot runs over onto city street (City Drainage Hot Spot List).
3MC 26 SE	84	On Ottawa, from Broadway 200' east; Subsystem 4L	Failed storm sewer (City Drainage Hot Spot List).
3MC 26 SW	85	In alley between 12th and 13th, from Kickapoo to Ottawa; Subsystem 7L	Drainage archway has collapsed (City Drainage Hot Spot List).
5MC ?	86	1204 & 1208 Ridge Road	Un-maintained drainage ditch (City Drainage Hot Spot List).
5MC 11 NW	87	2925 Meadow Road; Subsystem 5L	N. side of creek which is north of Josela Ct. washed out under sidewalk on 10th Avenue (City Drainage Hot Spot List).
3MC 35 NW	88	109 S. 11th St., Harper residence	Easement is eroding behind property, inadequate drainage (City Drainage Hot Spot List).

Table VIII-8
Three Mile Creek Watershed
Main Channel and South Branch Improvements

XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Street Location	Original Size and Type	Improved Size and Type	Design Storm Frequency	Improved Capacity (cfs)	Maximum Flow (cfs)
3149, 3152, 3155, 3156, 3159, 3161, 3165, 3216, 3217, 3219, 3221, 3223, 3225, 3227, 3229	92617	92764	Shawnee to mouth of Missouri River	Natural Channel	Smooth finish concrete trapezoid channel w/2:1 side slopes, 25' bottom width, 12'-16' depth	100	38,200	5,900 -7770
N/A	N/A	N/A	10th Street	Unprotected Structures	Flood levees on north and south banks	N/A	N/A	N/.A
N/A	N/A	N/A	Osage Street	Unprotected Structures	Flood levee on north bank	N/A	N/A	N/A
3215	86197	92197	6th Street	29' x 16' RCB	Replace w/4 - 16' x 16' RCB	100	3,840	6,960
3003	92614	92064	13th Street	2 - 14' x 10' RCB	Replace w/3 - 12' x 12' RCB	100	1,353	3,980
2578	92301	92302	Ottawa St.	29.5' x 10' RCB	Replace w/4 - 11' x 11' RCB	100	3,010	3,520

Table VIII-8
Three Mile Creek Watershed
Main Channel and South Branch Improvements

XPSWMM Conduit Number	XPSWMM Up Node	XPSWMM Down Node	Street Location	Original Size and Type	Improved Size and Type	Design Storm Frequency	Improved Capacity (cfs)	Maximum Flow (cfs)
1248	92083	92084	South Branch, Cherokee	12' x 12.7' ARCH	Replace w/20' x 10' RCB	100	3,510	2,020
940	92023	92024	South Branch, 18th Street	9' x 12.6' ARCH	Replace w/10' x 10' RCB	100	1,740	1,660
942	92646	92013	South Branch, 19th Street	10' x 7.5' RCB	Parallel 6' x 6' RCB	100	3,337	1,660
2300	86524	92646	19th and Spruce	10' x 7.5' RCB	Parallel 5' x 5' RCB	100	656	1,508
1289	92643	86524	19th and Spruce	10' x 7.5' RCB	Parallel 2' x 2" RCB	100	2,357	1,375

Table VIII-9
Three Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
1L	1089	86607	92754	4th and Choctaw	50	6' x 4.5' ARCH	Parallel 6' x 3' RCB	351	457
1L	1311	92593	92594	4th and Seneca	50	5' x 3.3' ARCH	Parallel 3' x 3' RCB	177	176
1L	1316	92594	86605	4th and Shawnee	50	5' x 3.3' ARCH	Parallel 5' x 3' RCB	270	372
1L	1317	86591	86592	3rd and Shawnee	10	2' Dia. VCP	Parallel 2.5' Dia. RCP	31	105
1L	1319	86592	86606	3rd and Shawnee	10	3.2' x 2.3' ARCH	Parallel 2.5' Dia. RCP	113	105
1L	1322	92595	86601	4th and Delaware	50	5' x 3.3' ARCH	Parallel 6' x 3' RCB	417	449
1L	1323	86601	86603	4th and Delaware	50	6' x 3.3' ARCH	Parallel 6' x 3' RCB	250	449
1L	1324	86603	86607	4th and Cherokee	50	6' x 4.5' ARCH	Parallel 6' x 3' RCB	330	457
1L	2323	86605	92595	4th and Shawnee	50	5' x 3.3' ARCH	Parallel 5' x 3' RCB	611	327

Table VIII-9
Three Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
1L	2355	86594	92595	4th and Delaware	10	3.2' x 2.3' ARCH	Parallel 2.5' Dia. RCP	6	105
1L	2373	86606	86594	4th and Delaware	10	3.2' x 2.3' ARCH	Parallel 2.5' Dia. RCP	100	105
4L	1197	86370	86371	Broadway and Delaware	10	5' Dia. RCP	Parallel 5' Dia. RCP	382	405
4L	1198	86372	92705	Broadway and Delaware	10	5' Dia. RCP	Parallel 5' Dia. RCP	162	428
4L	1201	92706	86373	Broadway and Cherokee	10	6' Dia. CMP	Parallel 4.5' Dia. RCP	374	428
4L	1331	86624	86625	Broadway and Dakota	10	2' Dia. VCP	Parallel 2.5' Dia. RCP	44	128
4L	1333	86625	86626	Broadway and Dakota	10	3' Dia. VCP	Parallel 2.5' Dia. RCP	63	128
4L	1335	86629	86633	Broadway and Kiowa	10	3' Dia. CMP	Parallel 3' Dia. RCP	314	214
4L	1337	92622	86634	Broadway and Kickapoo	10	3' Dia. CMP	Parallel 4' Dia. RCP	242	214

Table VIII-9
Three Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
4L	1340	86640	86639	Broadway and Kickapoo	10	32" Dia. CMP	Parallel 4' Dia. RCP	195	243
4L	1343	86644	92623	Broadway and Ottawa	10	3' Dia. CMP	Parallel 4' Dia. RCP	150	290
4L	1344	92778	86647	Broadway and Pottawatomie	10	3' Dia. CMP	Parallel 4.5' Dia. RCP	310	309
4L	1345	92625	86648	Broadway and Osage	10	5' x 3.5' ARCH	Parallel 4.5' Dia. RCP	324	309
4L	1346	92624	86645	Broadway and Pottawatomie	10	3' Dia. CMP	Parallel 4.5' Dia. RCP	210	290
4L	1347	86649	92626	Broadway and Osage	10	4.5' x 3' ARCH	Parallel 4.5' Dia. RCP	198	338
4L	1349	86653	86654	Broadway and Miami	10	5' x 3' ARCH	Parallel 4.5' Dia. RCP	15	357
4L	1350	86654	86655	Broadway and Seneca	10	4' Dia. CMP	Parallel 4.5' Dia. RCP	304	357
4L	1351	86655	86656	Broadway and Seneca	10	5.5' x 4.5' ARCH	Parallel 5' Dia. RCP	23	376

Table VIII-9
Three Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
4L	1352	86656	86657	Broadway and Seneca	10	5' x 4.5' ARCH	Parallel 5' Dia. RCP	244	378
4L	1353	86657	86658	Broadway and Shawnee	10	5' x 4.5' ARCH	Parallel 5' Dia. RCP	173	380
4L	1354	86659	86370	Broadway and Shawnee	10	4.5' Dia. RCP	Parallel 5' Dia. RCP	291	405
4L	1529	86910	86624	Broadway and Dakota	10	2' Dia. VCP	Parallel 2.5' Dia. RCP	59	89
4L	1607	92627	86652	Broadway and Miami	10	6' x 5' ARCH	Parallel 4.5' Dia. RCP	160	338
4L	2375	86626	86628	Broadway and Kiowa	10	3' Dia. RCP	Parallel 3' Dia. RCP	106	128
4L	2383	86639	86641	Broadway and Ottawa	10	32" Dia. RCP	Parallel 4' Dia. RCP	273	241
4L	2384	86643	86644	Broadway and Ottawa	50	3' Dia. RCP	Parallel 4' Dia. RCP	524	392
4L	2385	92623	92624	Broadway and Ottawa	10	5.5' x 3.5' ARCH	Parallel 4' Dia. RCP	19	290

Table VIII-9
Three Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
4L	2387	86646	92778	Broadway and Pottawatomie	10	3' Dia. RCP	Parallel 4.5' Dia. RCP	592	309
4L	2388	86647	92625	Broadway and Pottawatomie	10	5' x 3.5' ARCH	Parallel 4.5' Dia. RCP	399	309
4L	2389	86648	86649	Broadway and Osage	10	4.5' x 3' ARCH	Parallel 4.5' Dia. RCP	13	338
4L	2392	86652	86653	Broadway and Miami	10	5' x 3' ARCH	Parallel 4.5' Dia. RCP	215	356
4L	2393	86658	86659	Broadway and Shawnee	50	6' x 4' ARCH	Parallel 5' Dia. RCP	19	566
4L	3032	86637	86640	Broadway and Kickapoo	10	Natural Channel	Replace w/5.5' Dia. RCP	380	248
1R	993	86017	86018	6th Ave. and Spruce	10	2' Dia. RCP	Parallel 1.25' Dia. RCP	76.	72
1R	996	86021	92740	9th Ave. and Kansas	10	1.75' Dia. VCP	Parallel 1.5' Dia. RCP	33	32
1R	999	92740	86027	9th Ave. and Kansas	10	2.5' Dia. RCP	Parallel 1' Dia. RCP	81	80

Table VIII-9 Three Mile Creek Watershed Subsystem Improvements									
	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
1R	1001	86030	86042	9th Ave. and James St.	10	3.5' Dia. RCP	Parallel 1.5' Dia. RCP	84	157
1R	1002	86042	86043	Columbia Ave. and Charles St.	10	3.5' Dia. RCP	Parallel 1.5' Dia. RCP	98	157
1R	1003	86043	86049	Columbia Ave. and Marshall St.	10	3.5' Dia. RCP	Parallel 3.5' Dia. RCP	136	196
1R	1004	86049	86054	Columbia Ave. and Frank St.	10	4' Dia. RCP	Parallel 3' Dia. RCP	224	224
1R	1005	86054	86055	Spruce and Columbia	10	4' Dia. RCP	Parallel 3' Dia. RCP	189	224
1R	1006	86055	92717	Spruce and Columbia	50	4' x 4' ARCH	Parallel 3.25' Dia. RCP	280	300
1R	1007	92717	92718	Spruce and Broadway	10	4' x 3' ARCH	Parallel 3.25' Dia. RCP	151	244
1R	1169	86324	92716	Spruce and Broadway	10	4' x 3' ARCH	Parallel 3.25' Dia. RCP	350	262
1R	1170	92716	92777	Spruce and Broadway	10	4' x 3' ARCH	Parallel 3.25' Dia. RCP	155	262

Table VIII-9
Three Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
1R	1171	92777	92715	Spruce and Broadway	10	4' Dia. RCP	Parallel 3.25' Dia. RCP	252	273
1R	1173	86020	86325	6th Ave. and Spruce	10	3' Dia. RCP	Parallel 1.5' Dia. RCP	49	72
1R	1174	86325	92713	6th Ave. and Olive	10	6' Dia. CMP	Parallel 3.25' Dia. RCP	332	361
1R	1175	92713	92714	6th Ave. and Olive	10	6' Dia. CMP	Parallel 3.25' Dia. RCP	273	365
1R	1176	86330	86331	6th Ave. and Chestnut	10	5.5' x 5' ARCH	Replace w/6' Dia. RCP	348	413
1R	1172	92715	86325	Spruce and Broadway	10	4.25' Dia. CMAP	Parallel 3.25' RCP	421	274
1R	2091	86034	92741	9th Ave. and Quincy	10	1.5' Dia. RCP	Parallel 1' Dia. RCP	23	25
1R	2116	86015	86017	6th Ave. and Spruce	10	2' Dia. RCP	Parallel 1.25' Dia. RCP	39	49
1R	2118	92718	86323	Spruce and Broadway	10	4' x 3' ARCH	Parallel 3.25' Dia. RCP	222	244

Table VIII-9
Three Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
1R	2254	86323	86324	Spruce and Broadway	10	4' x 3' ARCH	Parallel 3.25' Dia. RCP	245	262
1R	2255	92714	86329	6th Ave. and Olive	10	6' Dia. RCP	Parallel 3.25' Dia. RCP	460	365
1R	3167	86378	92185	6th Ave. and Walnut	10	Natural Channel	Replace w/6' Dia. RCP	486	458
1R	3168	86332	92184	6th Ave. and Walnut	10	Natural Channel	Replace w/6' Dia. RCP	303	413
1R	3169	86331	86333	6th Ave. and Chestnut	10	Natural Channel	Replace w/6' Dia. RCP	279	413
1R	3170	86329	86330	6th Ave. and Chestnut	10	Natural Channel	Replace w/6' Dia. RCP	630	365
5L	1194	86364	86365	Broadway and Cherokee	10	1.5' Dia. RCP	Parallel 1' Dia. RCP	8	20
5L	1195	86365	86368	Broadway and Cherokee	10	1.5' Dia. RCP	Parallel 1.5' Dia. RCP	50	20
5L	1196	86367	86369	Broadway and Cherokee	10	1.5' Dia. RCP	Parallel 1.5' Dia. RCP	34	20

Table VIII-9
Three Mile Creek Watershed
Subsystem Improvements

Subsystem ID	XPSWMM			Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
	Conduit #	Up Node	Down Node						
5L	1256	86366	86367	Broadway and Cherokee	10	1.5' Dia. RCP	Parallel 1' Dia. RCP	25	20
2R	723	85488	85489	Klemp St. and Pennsylvania St.	10	2' Dia. RCP	Parallel 2' Dia. RCP	47	63
2R	724	85489	85493	Klemp St. and Pennsylvania St.	10	2.5' Dia. CMP	Parallel 2' Dia. RCP	81	63
2R	726	85494	85495	Klemp St. and Ohio St.	10	2' Dia. CMP	Parallel 15" Dia. RCP	29	21
2R	728	85496	85497	Grand Ave. and Michigan St.	10	2.5' Dia. CMP	Parallel 3' Dia. RCP	39	63
2R	702	85456	85455	Forest Ln. and Westwood Dr.	10	2' Dia. RCP	Parallel 21" Dia. RCP	71	72
2R	1901	85455	85457	Forest Ln. and Westwood Dr.	10	2' Dia. RCP	Parallel 21" Dia. RCP	146	72
2R	715	85479	85480	Michigan St. and Jackson Ct.	10	2' Dia. RCP	Parallel 2' Dia. RCP	74	83
2R	1487	85498	92345	11th St. and Ohio St.	10	2.5' Dia. RCP	Parallel 3' Dia. RCP	3	88

	XPSWMM								
Table VIII-9 Three Mile Creek Watershed Subsystem Improvements									
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
2R	1114	92345	92346	11th St. and Ohio St.	50	3' Dia. RCP	Parallel 3' Dia. RCP	122	134
2R	1115	92346	92736	Kingman St. and Ohio St.	10	3' Dia. RCP	Parallel 3' Dia. RCP	168	139
2R	2231	92736	86228	Kingman St. and Ohio St.	10	3' Dia. RCP	Parallel 3' Dia. RCP	188	166
2R	1116	86228	85982	10th Ave. and Ohio St.	10	3' Dia. CMP	Parallel 3' Dia. RCP	112	168
2R	980	85976	85978	Lawrence Ave. and Ohio St.	10	2' Dia. CMP	Parallel 21" Dia. RCP	15	19
2R	2688	92362	92363	Ohio St. and Westwood Dr.	50	3' Dia. RCP	Parallel 27" Dia. RCP	165	162
2R	2689	92363	92364	Ohio St. and Westwood Dr.	50	3' Dia. RCP	Parallel 33" Dia. RCP	176	193
2R	694	92364	92732	Ohio St. and Westwood Dr.	50	3' Dia. RCP	Parallel 33" Dia. RCP	242	193
2R	3200	92732	92733	Ohio St. and Westwood Dr.	50	3' Dia. RCP	Parallel 39" Dia. RCP	100	235

Table VIII-9
Three Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
2R	3201	92733	92734	Ohio St. and Stonleigh Ct.	50	3' Dia. RCP	Parallel 39" Dia. RCP	239	235
2R	3202	92734	92735	Ohio St. and Stonleigh Ct.	50	3' Dia. RCP	Parallel 3.5' Dia. RCP	90	259
2R	3203	92735	85487	Ohio St. and Washington	50	3' Dia. RCP	Parallel 3.5' Dia. RCP	206	259
2R	716	85487	85485	Ohio St. and Washington	50	4' Dia. RCP	Parallel 3' Dia. RCP	376	277
2R	718	85482	85484	Ohio St. and Franklin St.	50	1.5' Dia. RCP	Parallel 2' Dia. RCP	35	17
2R	720	85484	85485	Ohio St. and Washington	50	1.5' Dia. RCP	Parallel 2.5' Dia. RCP	29	26
2R	721	85485	86233	Ohio St. and Washington	50	2.5' Dia. RCP	Parallel 3.5' Dia. RCP	465	291
2R	946	85920	85922	Kansas St. and 15th St.	10	2.5' Dia. RCP	Parallel 2' Dia. RCP	75	61
2R	1119	86237	86238	Quincy St. and Washington	10	3' Dia. CMP	Parallel 15" Dia. RCP	88	81

Table VIII-9
Three Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
2R	1156	86303	86304	Madison St. and Randolph St.	10	1.5' Dia. RCP	Replace w/2' x 2' RCB	37	46
2R	1157	86305	86306	Washington and Randolph St.	10	2' Dia. RCP	Parallel 1.5' Dia. RCP	54	59
2R	1158	86307	92723	Jackson St. and Randolph St.	10	1.5' Dia. CMP	Parallel 33" Dia. RCP	48	63
2R	1149	86289	92724	Franklin St. and Kenton St.	10	3' Dia. RCP	Parallel 2' Dia. RCP	118	130
2R	2251	92724	86291	Klemp St. and Kenton St.	10	3' Dia. RCP	Parallel 2' Dia. RCP	120	130
2R	1150	86291	86292	Klemp St. and Kenton St.	10	3' Dia. CMP	Parallel 2' Dia. RCP	143	141
2R	1147	86285	86289	Spruce St. and Franklin St.	50	2' Dia. VCP	Parallel 2' Dia. RCP	99	68
2R	1164	86317	92731	Franklin St. and Kansas St.	10	4' Dia. CMP	Parallel 3.5' Dia. RCP	269	291
2R	1166	92075	86318	Franklin St. and Quincy St.	10	3.5' Dia. CMP	Parallel 1.5' Dia. RCP	156	128

Table VIII-9
Three Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
2R	1167	86318	86319	Franklin St. and Quincy St.	10	6' Dia. CMP	Parallel 2' Dia. RCP	211	382
2R	2236	86258	86259	Newman St. and Quincy St.	10	5.5' Dia. RCP	Parallel 4' Dia. RCP	384	430
2R	1128	86259	92729	Quincy St. and Newman St.	10	78" x 52" MAC	Parallel 4' Dia. RCP	197	447
2R	1137	85996	92725	10th Ave. and Randolph St.	10	3' Dia. RCP	Parallel 3' Dia. RCP	280	163
2R	2111	92725	92726	10th Ave. and Randolph St.	10	3' Dia. RCP	Parallel 3' Dia. RCP	106	163
2R	1138	92726	85997	10th Ave. and Randolph St.	10	3' x 4' ARCH	Parallel 3' Dia. RCP	60	174
2R	1135	92098	92728	Grand Ave. and Iron Moulders	10	6' x 6' ARCH	Replace w/5' Dia. RCP and 4' Dia. RCP	430	449
2R	1136	92728	92727	Grand Ave. and Iron Moulders	10	5' Dia. CMP	Parallel 4' Dia. RCP	382	449

Table VIII-9 Three Mile Creek Watershed Subsystem Improvements									
	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
2R	3178	92721	92722	Lawrence Ave. and Olive St.	10	8.5' x 8' ARCH	Remove culvert and restore open channel	12,400	1,040
2R	1178	86334	86335	Lawrence Ave. and Chestnut	10	2' Dia. RCP	Parallel 3' x 2' RCB	84	134
2R	3176	86335	92720	Lawrence Ave. and Chestnut	10	2' Dia. RCP	Parallel 3' x 2' RCB	260	134
2R	3154	92701	86357	Cherokee St. and Broadway	10	Natural Channel	See 3157		
2R	1192	86357	86359	Cherokee St. and Broadway	10	8' Dia. CMP	See 3157		
2R	1193	86359	86360	Cherokee St. and Broadway	10	9' x 9.5' ARCH	See 3157		

Table VIII-9
Three Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
2R	3157	86360	92702	Cherokee St. and Broadway	10	Natural Channel	Salvage, abandon, or fill in existing elements and install new bypass channel to Broadway bridge per Larkin design	10,500	1,090
6L	1363	86664	86665	9th and Pottawatomie	10	4.5' Dia. CMP	Parallel 2' Dia. RCP	163	155
6L	1364	92145	92146	9th and Osage	10	5' x 5' ARCH	Parallel 2' Dia. RCP	225	166
6L	1365	92148	92147	9th and Osage	10	4.5' Dia. CMP	Parallel 4' Dia. RCP	258	167
6L	1541	92601	92602	9th and Cheyenne	10	2' Dia. VCP	Parallel 1.75' Dia. RCP	51	54
6L	1542	92602	92603	9th and Pawnee	10	2' Dia. VCP	Parallel 2.25' Dia. RCP	30	55

Table VIII-9
Three Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
6L	1543	92603	92604	9th and Pawnee	10	2' Dia. VCP	Parallel 2.25' Dia. RCP	91	85
6L	2499	92604	86944	9th and Dakota	10	2' Dia. RCP	Parallel 4' x 3' RCB	176	107
7L	1559	86971	86972	11th and Cheyenne	10	2' Dia. CMP	Parallel 1' Dia. RCP	22	22
7L	1561	86975	92070	12th and Cheyenne	10	2' Dia. RCP	Parallel 1.5' Dia. RCP	34	44
7L	1565	86973	86975	12th and Cheyenne	10	2' Dia. CMP	Parallel 1.5' Dia. RCP	33	36
5R	2581	92304	92056	14th and Osage	10	1.5' Dia. RCP	Replace w/2.5' Dia. RCP	64	49
6R	1477	86842	86841	20th Terr. & Osage St.	10	18" RCP	Parallel 15" RCP	19	31
6R	2458	86841	86843	20th Terr. & Osage St.	10	18" RCP	Parallel 15" RCP	33	31
6R	1-3033	86843	1-86843	20th St. & Osage St.	10	Natural Channel	Replace w/21" RCP	36	54

Table VIII-9
Three Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
6R	2-3033	1-86843	2-86843	20th St. & Osage St.	10	Natural Channel	Replace w/24" RCP	52	54
6R	3-3033	2-86843	86819	19th St. & Osage St.	10	Natural Channel	Replace w/24" RCP	46	54
6R	1463	86819	86820	19th St. & Osage St.	10	15" RCP	Parallel 27" RCP	22	54
6R	2456	86820	86821	19th St. & Osage St.	10	18" RCP	Parallel 27" RCP	27	54
6R	1464	86821	86817	19th St. & Osage St.	10	18" RCP	Parallel 27" RCP	63	54
6R	2446	86795	86803	20th St. & Seneca St.	50	24" RCP	Parallel 15" RCP	39	73
6R	2314	86559	92307	20th St. & Shawnee St.	10	30" RCP	Parallel 30" RCP	334	171
6R	1304	92307	86556	20th St. & Shawnee St.	50	36" RCP	Parallel 30" RCP	232	242
6R	1303	86556	86558	20th St. & Shawnee St.	50	36" RCP	Parallel 36" RCP	185	248

Table VIII-9
Three Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
6R	1455	86558	86804	20th St. & Shawnee St.	50	42" RCP	Parallel 42" RCP	284	286
6R	1454	86804	86806	20th St. & Seneca St.	10	54" RCP	Parallel 42" RCP	266	293
6R	2448	86806	86809	20th St. & Seneca St.	10	54" RCP	Parallel 42" RCP	372	321
6R	1457	86809	86810	19th St. & Miami St.	10	54" RCP	Parallel 42" RCP	300	321
6R	1458	86810	86811	19th St. & Miami St.	10	54" RCP	Parallel 42" RCP	486	321
6R	2449	86811	86814	19th St. & Miami St.	10	54" RCP	Parallel 42" RCP	266	349
6R	1460	86814	86815	19th St. & Osage St.	10	54" RCP	Parallel 48" RCP	262	349
6R	2451	86815	86816	19th St. & Osage St.	10	54" RCP	Parallel 54" RCP	268	349
6R	1461	86816	86817	19th St. & Osage St.	10	54" RCP	Parallel 54" RCP	458	349

Table VIII-9
Three Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
6R	1467	86817	86825	18th St. & Osage St.	10	60" RCP	Parallel 54" RCP	403	427
6R	1468	86825	86757	18th St. & Pottawatomie	10	60" RCP	Parallel 54" RCP	417	429
6R	1420	86757	86758	18th St. & Pottawatomie	50	60" RCP	Parallel 54" RCP	380	681
6R	1421	86758	86759	18th St. & Pottawatomie	10	60" CMP	Parallel 54" RCP	612	460
6R	1431	86770	86776	17th St. & Terry St.	10	24" RCP	Parallel 21" RCP	56	59
6R	2425	86776	86777	17th St. & Terry St.	10	24" RCP	Parallel 27" RCP	53	71
6R	1432	86777	86778	16th St. & Michael St.	10	24" RCP	Parallel 27" RCP	69	71
6R	2426	86778	86779	16th St. & Michael St.	10	24" RCP	Parallel 27" RCP	69	71
6R	2427	86779	86780	16th St. & Michael St.	10	24" RCP	Parallel 27" RCP	87	81

Table VIII-9
Three Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
6R	1433	86780	86781	16th St. & Michael St.	10	24" RCP	Parallel 27" RCP	80	81
6R	2428	86781	86782	16th St. & Osage St.	10	24" RCP	Parallel 30" RCP	74	93
6R	1434	86782	86783	16th St. & Osage St.	10	36" CMP	Parallel 30" RCP	105	107
6R	2585	86783	86766	16th St. & Osage St.	10	36" CMP	Parallel 30" RCP	173	107
9L	1587	87021	87022	18th and Metropolitan	50	2' Dia. CMP	Parallel 2' Dia. RCP	33	73
8L	N/A	N/A	92038	North of Metropolitan	10 & 50	N/A	Earthfill dam and detention basin. Supersedes 1581, 2566, & 2544 improvements	111	661
8L	1581	92047	92049	14th and Cheyenne	10	4' x 4' RCB	Parallel 4' x 4' RCB	560	574

Table VIII-9
Three Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
8L	1584	87016	87015	16th and Metropolitan	50	2' Dia. CMP	Parallel 1.25' Dia. RCP	20	41
8L	2544	92052	92053	14th and Kiowa	10	5' x 6.5' RCB	Parallel 4' x 4' RCB	947	661
8L	2566	92049	92044	14th and Cheyenne	10	Natural Channel	Replace w/8' Wide Conc. Channel	725	577
8L	7777	87013	87018	16th and Metropolitan	50	N/A	New 1.75' Dia. RCP	21	24
7R	1474	86838	92008	20th and Ottawa	50	2.5' Dia. RCP	Parallel 1.25' RCP	35	10
7R	2461	92008	86840	20th and Ottawa	50	1.5' Dia. RCP	Parallel 5' x 2' RCB	34	32
7R	1476	86840	86830	20th and Ottawa	50	2.5' Dia. RCP	Parallel 3' Dia. RCP	104	30
7R	1472	86834	86835	20th and Pottawatomie	50	1.5' Dia. RCP	Parallel 1.25' Dia. RCP	20	34
8R	1478	86844	86845	22nd and Ottawa	50	2' Dia. CMP	Parallel 1.5' Dia. RCP	45	16

Table VIII-9 Three Mile Creek Watershed Subsystem Improvements									
	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
S1R	1241	86444	86441	10th and Delaware	50	2' Dia. RCP	Parallel 1.25' Dia. RCP	2	40
S1R	2287	86441	86442	10th and Delaware	50	2' Dia. RCP	Parallel 1.75' Dia. RCP	105	80
S1L	1252	86462	86463	13th and Delaware	10	1.5' Dia. RCP	Parallel 1.25' Dia. RCP	31	29
S1L	1253	86463	86464	13th and Delaware	10	1.5' Dia. RCP	Parallel 1.25' Dia. RCP	31	29
S1L	2279	86464	86465	13th and Delaware	10	1.5' Dia. RCP	Parallel 1.25' Dia. RCP	25	29
S1L	1254	86465	86466	13th and Cherokee	10	1.5' Dia. RCP	Parallel 1.25' Dia. RCP	32	29
S1L	2280	86466	86467	13th and Cherokee	10	1.5' Dia. RCP	Parallel 1.5' Dia. RCP	27	42
S1L	1255	86467	86468	13th and Cherokee	10	2' Dia. RCP	Parallel 1.5' Dia. RCP	46	42
S3L	1282	86512	86513	18th and Sherman St.	50	1.5' Dia. RCP	Parallel 4' x 2' RCB	4	120

Table VIII-9
Three Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
S5R	938	92014	85913	19th and Spruce	50	2' Dia. CMP	Parallel 2.25' RCP	93	56
S6R	2743	92414	92415	W. Leavenworth Tfwy. and Ohio	50	2' Dia. RCP	Parallel 1.25' RCP	95	43
S4L	3055	92639	92641	22nd and High St.	10	4' Dia. RCP	Parallel 2' Dia. RCP	117	116
S7R	935	85909	85910	21st and Spruce	50	2' Dia. CMP	Parallel 1.75' Dia. RCP	1	16
S7R	2067	85896	85897	21st Ct. and Randolph	10	3.5' Dia. RCP	Parallel 2' Dia. RCP	180	111
S7R	923	85897	85899	21st Ct. and Randolph	10	3.5' Dia. RCP	Parallel 2' Dia. RCP	115	124
S8R	931	85904	85903	22nd and Spruce	50	2' Dia. RCP	Parallel 1.5' Dia. RCP	52	55
S8R	929	85903	85906	22nd and Spruce	50	2' Dia. RCP	Parallel 2.25' Dia. RCP	49	55
S8R	932	85906	85907	21st and Spruce	50	2' Dia. RCP	Parallel 3' x 3' RCB	41	55

Table VIII-10
Five Mile Creek Watershed
Main Channel Improvements

	XPSWMM							
Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
N/A	N/A	N/A	Wastewater Treatment Plant	100	Unprotected Structures	Floodwall	N/A	N/A
2615	92318	92319	2nd Street	100	14' x 33' - 44' - 33' Bridge	Same size, elevate road	1,943	8,840
2626	92326	92327	Limit St. and 2nd Avenue	100	15' x 23' - 38' - 23' Bridge	Same size, elevate road, add berm	1,555	8,010
203	92136	92153	10th Avenue	100	2 - 16' x 12' RCB	Parallel 8' x 7' RCB	10,270	6,209
245	92061	92062	New Lawrence Rd.	100	24' x 14' CM Box	Parallel 8' x 8' RCB	220	5,980

Table VIII-11
Five Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
1L	780	85610	85611	3rd and Marion	10	2' Dia. RCP	Parallel 1.5' Dia. RCP	2	12
1L	1441	85768	85769	4th and Evergreen	10	2' Dia. CMP	Parallel 2' Dia. RCP	46	44
1L	861	85769	85770	4th and Evergreen	10	2.5' Dia. CMP	Parallel 2.25' Dia. RCP	78	44
1L	2016	85770	85771	4th and Evergreen	10	2.5' Dia. RCP	Parallel 2.5' Dia. RCP	136	138
1L	765	85565	85568	Rose and Pennsylvania	10	2' Dia. CMAP	Parallel 1.5' Dia. RCP	58	66
1L	766	85568	85569	Rose and Pennsylvania	10	2' Dia. RCP	Parallel 2' Dia. RCP	76	66
1L	1937	85569	85570	Rose and Pennsylvania	10	2' Dia. RCP	Parallel 2' Dia. RCP	30	66
1L	768	85570	85571	4th and Pennsylvania	50	2' Dia. RCP	Parallel 2' Dia. RCP	48	66
1L	1938	85571	92311	4th and Pennsylvania	50	2.5' Dia. RCP	Parallel 2.5' Dia. RCP	108	66

Table VIII-11
Five Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
1L	918	85890	92251	3rd and Marion	50	3.5' Dia. RCP	Parallel 3.5' Dia. RCP	416	138
1L	1961	85602	85607	4th and Marion	50	5' Dia. RCP	Parallel 5' Dia. RCP	172	155
1L	779	85607	85609	4th and Marion	50	5' Dia. CMP	Parallel 5' Dia. RCP	160	181
1L	1964	85609	85778	4th and Marion	50	5' Dia. RCP	Parallel 5' Dia. RCP	674	181
1L	2019	85778	85782	4th and Marion	50	5' Dia. RCP	Parallel 5' Dia. RCP	334	181
1L	862	85771	85774	4th and Evergreen	50	4.5' Dia. CMP	Parallel 4' Dia. RCP	366	92
1L	2043	85774	85855	4th and Evergreen	50	4.5' Dia. CMP	Parallel 4' Dia. RCP	340	92
1R	903	85870	85873	2nd and Marion	50	2' Dia. RCP	Replace w/3' Dia. RCP	81	87
1R	905	85873	85876	2nd and Marion	50	3' Dia. RCP	Replace w/3.5' Dia. RCP	178	153

Table VIII-11 Five Mile Creek Watershed Subsystem Improvements									
	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
1R	908	85876	85878	2nd and Marion	50	3' Dia. RCP	Replace w/3.5' Dia. RCP	172	167
1R	909	85878	92250	2nd and Marion	50	3' Dia. RCP	Replace w/3.5' Dia. RCP	399	183
2R	3240	92278	84666	4th St. & VA entr.	10	2' Dia. VCP	Replace w/4' x 3' RCB	204	123
2R	148	84666	92276	4th St. & VA entr.	10	2' Dia. VCP	Replace w/4' x 3' RCB	80	123
2R	2883	92276	84673	4th St. & VA entr.	10	Natural Channel	Replace w/4' x 3' RCB	5	123
2R	2885	84674	92273	4th St. & VA entr.	10	Natural Channel	Replace w/4' x 3' RCB	116	158
2R	154	92273	84683	4th St. & VA entr.	10	2' Dia. VCP	Replace w/4' x 3' RCB	153	158
2R	155	84683	84684	4th St. & VA entr.	10	3' Dia. CMP	Replace w/4' x 3' RCB	478	387

Table VIII-11
Five Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
2R	258	84804	84803	Wilson Ave. & St. Mary St.	10	4' x 3' RCB	Remove & restore open channel	5810	556
2R	156	84685	84689	St. Mary St. & Wilson Ave.	10	5' Dia. RCP	Parallel 48" Dia. RCP	314	516
2R	266	84823	84824	Ash St. & Wilson Ave.	10	5' Dia. RCP	Parallel 48" Dia. RCP	498	715
2R	263	84815	84816	Frontage Rd. & St. Mary St.	10	2' Dia. CMP	Replace w/3' x 2' RCB	50	47
2R	2891	84816	84806	Frontage Rd. & St. Mary St.	10	Natural Channel	Replace w/3' x 2' RCB	39	47
2R	259	84806	84808	Frontage Rd. & St. Mary St.	10	1.5' Dia. CMP	Replace w/3' x 2' RCB	152	110
2R	260	84808	84807	Frontage Rd. & St. Mary St.	10	2' Dia. RCP	Replace w/3' x 2' RCB	118	110
2R	250	84795	84794	Wilson Ave. & Ash St.	10	2' Dia. CMP	Parallel 2' x 2' RCB	101	90

Table VIII-11
Five Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
2R	249	84793	84802	Wilson Ave. & Idaho St.	10	2' Dia. CMP	Parallel 21" Dia. RCP	64	74
2R	886	85825	85826	Limit St. & 2nd St.	10	3' Dia. CMP	Parallel 24" Dia. RCP	26	89
2R	304	84791	84897	Limit St. & Wilson Ave.	50	2' Dia. RCP	Parallel 2' x 2' RCB	66	71
2R	1756	84897	84899	Limit St. & Wilson Ave.	50	2' Dia. RCP	Parallel 24" Dia. RCP	88	71
2R	308	84899	84902	Limit St. & 1st St.	50	2' Dia. RCP	Parallel 24" Dia. RCP	106	95
2R	1442	84902	84903	Limit St. & 1st St.	50	2' Dia. RCP	Parallel 24" Dia. RCP	94	95
2R	309	84903	84904	Limit St. & 2nd St.	50	2.5' Dia. RCP	Parallel 24" Dia. RCP	82	106
3R	893	85845	85847	4th St. & Vilas	50	2' Dia. CMP	1.25' Dia. RCP	36	28
3R	2037	85847	85848	4th St. & Sheridan	50	2.5' Dia. RCP	1.25' Dia. RCP	70	31
3R	894	85848	85850	4th St. & Sheridan	50	2.5' Dia. CMP	2' Dia. RCP	52	48

Table VIII-11 Five Mile Creek Watershed Subsystem Improvements									
	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
3R	2038	85850	85853	4th St. & Santa Fe	50	2.5' Dia. RCP	2.25' Dia. RCP	105	48
3R	895	85853	85855	4th St. & Santa Fe	50	2.5' Dia. CMP	2.25' Dia. RCP	114	57
2L	796	85642	85643	Cleveland Terr. & Garfield St.	10	24" CMP	Parallel 15" RCP	1	22
2L	752	85510	85554	4th Ave. & Thornton St.	50	24" RCP	Parallel 15" RCP	59	52
2L	820	92339	85698	Cleveland Terr. & Arthur St.	10	2' x 2' RCB	Parallel 21" RCP	93	105
2L	2649	85698	85515	5th Ave. & South St.	10	Natural Channel	Replace w/48" RCP	180	110
2L	743	85541	85543	2nd Ave. & Reaser St.	10	24" VCP	Parallel 18" RCP	48	49
2L	1926	85543	92310	2nd Ave. & Doniphan	10	24" VCP	Parallel 24" RCP	67	76
2L	746	92310	85547	2nd Ave. & Doniphan	10	24" VCP	Parallel 27" RCP	73	76

Table VIII-11
Five Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
2L	747	85547	85550	2nd Ave. & Buettinger Pl.	10	24" VCP	Parallel 36" RCP	118	76
2L	749	85550	85507	2nd Ave. & Thornton St.	50	24" VCP	Parallel 36" RCP	302	132
2L	2004	85792	85793	Sherman St. & 3rd Ave.	10	24" RCP	Parallel 24" RCP	44	62
2L	870	85793	85794	Sherman St. & 3rd Ave.	10	24" RCP	Parallel 27" RCP	52	62
2L	2005	85794	85798	Santa Fe St. & 3rd Ave.	10	24" RCP	Parallel 36" RCP	49	62
2L	872	85798	85802	Santa Fe St. & 3rd Ave.	10	24" RCP	Parallel 36" RCP	163	127
2L	874	85802	85804	Santa Fe St. & 2nd Ave.	10	30" RCP	Parallel 36" RCP	210	132
2L	2013	85804	85805	Santa Fe St. & 2nd Ave.	10	30" RCP	Parallel 36" RCP	109	132
2L	2014	85805	92325	Santa Fe St. & 2nd Ave.	10	30" RCP	Parallel 36" RCP	82	181

Table VIII-11
Five Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
2L	876	92325	85808	Santa Fe St. & 2nd Ave.	10	36" RCP	Parallel 3.5' x 3' RCB	219	181
4R	845	84876	85738	Hughes Rd. and Limit St.	50	4' Dia. VCP	Parallel 5' Dia. RCP	317	391
4R	1479	85738	85739	Hughes Rd. and Limit St.	50	4' Dia. VCP	Parallel 5' Dia. RCP	786	391
4R	847	85739	85740	Hughes Rd. and Limit St.	50	4' Dia. VCP	Parallel 5' Dia. RCP	829	459
4R	853	85740	92328	Hughes Rd. and Limit St.	50	4' Dia. CMP	Replace w/6' Dia. RCP	959	459
3L	708	85463	92343	Halderman St. & Grand Ave.	10	2' Dia. RCP	Parallel 15" Dia. RCP	46	47
3L	1904	92343	92344	10th Ave. & Halderman St.	50	2' Dia. RCP	Parallel 36" Dia. RCP	52	70
3L	731	92344	85466	10th Ave. & Halderman St.	50	2' Dia. RCP	Parallel 36" Dia. RCP	34	89
3L	807	85466	85669	10th Ave. & Halderman St.	50	3' Dia. CMP	Parallel 36" Dia. RCP	164	170

Table VIII-11
Five Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
3L	1977	85669	92155	Lawrence Ave. & Halderman St.	10	3' Dia. RCP	Parallel 42" Dia. RCP	193	238
3L	711	85470	85471	10th Ave. & South St.	50	2' Dia. RCP	Parallel 18" Dia. RCP	80	63
3L	712	85471	85473	10th Ave. & South St.	50	2' Dia. RCP	Parallel 24" Dia. RCP	67	63
3L	1909	85473	85475	10th Ave. & South St.	50	2' Dia. RCP	Parallel 27" Dia. RCP	55	63
3L	1915	85475	92342	10th Ave. & Halderman St.	50	2' Dia. RCP	Parallel 27" Dia. RCP	162	104
3L	809	92342	85670	10th Ave. & Halderman St.	10	2.5' Dia. CMP	Parallel 30" Dia. RCP	100	77
3L	808	85668	85669	Lawrence Ave. & Halderman St.	10	1.5' Dia. RCP	Replace w/2 - 36" Dia. RCPs	28	115
3L	494	85162	85163	Garland Ave. & Marion St.	10	6' Dia. CMP	Parallel 6' Dia. RCP	262	340
3L	811	85672	85671	Lawrence Ave. & South St.	10	1.5' Dia. RCP	Parallel 18" Dia. RCP	28	26

Table VIII-11
Five Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
3L	810	85671	85673	Lawrence Ave. & South St.	10	1.5' Dia. RCP	Parallel 21" Dia. RCP	30	26
3L	804	85659	85660	Lawrence Ave. & AT&SF RR	10	2' Dia. CMP	Parallel 18" Dia. RCP	43	30
3L	1989	85664	92165	Lawrence Ave. & Halderman St.	10	3' Dia. RCP	Parallel 27" Dia. RCP	63	63
3L	476	92334	85138	Santa Fe St. & Garland Ave.	10	2' Dia. CMP	Parallel 24" Dia. RCP	62	49
3L	468	92331	92332	Maple Ave. & Limit St.	50	7' Dia. RCP	Parallel 7' x 6' RCB	969	1,050
3L	1485	92332	92191	Maple Ave. & Limit St.	50	10' x 10' RCB	Parallel 7' x 6' RCB	6790	1,087
3L	1999	85743	85745	Limit St. & AT&SF RR	50	2' Dia. RCP	Parallel 3.5' x 2' RCB	3	34
3L	848	85745	92329	Limit St. & AT&SF RR	50	2' Dia. RCP	Parallel 3.5' x 2' RCB	204	34
3L	849	85746	85747	Limit St. & AT&SF RR	50	2' Dia. RCP	Parallel 4' x 2' RCB	125	96

Table VIII-11
Five Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
3L	2002	85747	92220	Limit St. & AT&SF RR	50	2' Dia. RCP	Parallel 4' x 2' RCB	241	96
3L	1783	84959	84957	Limit St. & Broadway Terr.	50	2' Dia. RCP	Parallel 15" Dia. RCP	34	48
3L	337	84957	84956	Limit St. & Broadway Terr.	50	2' Dia. RCP	Parallel 15" Dia. RCP	55	48
3L	471	84956	84954	Limit St. & Broadway Terr.	50	2' Dia. RCP	Parallel 15" Dia. RCP	50	68
3L	472	84954	85124	Limit St. & Maple Ave.	50	2.25' Dia. RCP	Parallel 15" Dia. RCP	81	68
3L	473	85124	85125	Limit St. & Maple Ave.	50	2' Dia. RCP	Parallel 15" Dia. RCP	69	68
3L	1816	85125	85126	Limit St. & Maple Ave.	50	2' Dia. RCP	Parallel 15" Dia. RCP	53	68
3L	493	85160	85161	Garland Ave. & Santa Fe St.	10	5' Dia. CMP	Parallel 60" Dia. RCP	310	421
3L	554	85251	85253	Grand Ave. & Marion St.	10	2' Dia. RCP	Parallel 3' x 2' RCB	127	123

Table VIII-11
Five Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
3L	555	85253	85257	Grand Ave. & Marion St.	10	2' Dia. RCP	Parallel 3' x 2.5' RCB	129	123
3L	556	85257	85261	Kingman St. & Marion St.	10	2' Dia. RCP	Parallel 3' x 2.5' RCB	206	147
3L	558	85261	85247	Kingman St. & Sherman St.	10	2' Dia. RCP	Parallel 4' x 2.5' RCB	144	167
3L	1850	85230	92347	Grand Ave. & Santa Fe St.	10	2' Dia. RCP	Parallel 18" Dia. RCP	37	46
3L	543	92347	85247	Sherman St. & Grand Ave.	10	2.5' Dia. RCP	Parallel 30" Dia. RCP	146	146
3L	553	85247	85248	Sherman St. & Kingman St.	10	4' Dia. RCP	Parallel 48" Dia. RCP	386	324
3L	552	85248	85249	Sherman St. & Kingman St.	10	4' Dia. RCP	Parallel 48" Dia. RCP	384	324
3L	1602	85249	85154	Sherman St. & 10th Ave.	10	4' Dia. RCP	Parallel 48" Dia. RCP	232	324
3L	488	85154	85155	10th Ave. & Sherman St.	50	4' Dia. RCP	Parallel 5' x 3' RCB	169	471

Table VIII-11
Five Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
5R	170	84703	84706	Hughes and McDonald	50	3.5' Dia. CMP	Parallel 2.25' Dia. RCP	98	120
5R	1665	92516	84713	Hughes and McDonald	10	3' Dia. RCP	Parallel 3' Dia. RCP	214	186
5R	1481	92517	92516	Hughes and McDonald	10	3' Dia. RCP	Parallel 2.5' Dia. RCP	83	173
5R	822	85701	85700	Iowa and Oregon	10	1.25' Dia. RCP	Parallel 1.25' Dia. RCP	18	16
6R	196	84741	84740	Lakeview Dr. & Pleasant Ave.	10	30" Dia. CMP	Parallel 30" RCP	140	99
6R	197	84740	92524	Lakeview Dr. & Pleasant Ave.	10	36" Dia. RCP	Parallel 30" RCP	58	108
4L	331	84946	92503	Virginia Cir. & Goddard Cir.	10	18" CMP	Parallel 15" RCP	13	7
4L	332	92503	84947	Virginia Cir. & Goddard Cir.	10	18" CMP	Parallel 15" RCP	16	7
4L	330	84944	84945	Shrine Park Rd. & Goddard Cir.	50	24" CMP	Replace w/2 - 5' x 2.5' RCB	10	122

Table VIII-11
Five Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
4L	2843	84945	84942	Shrine Park Rd. & Goddard Cir.	50	Natural Channel	Replace w/2 - 5' x 2.5' RCB	286	122
4L	329	84942	84943	Shrine Park Rd. & golf course entr.	50	5' x 2.5' RCB	Parallel 5' x 2.5' RCB	394	122
4L	2844	84943	84941	Shrine Park Rd. & golf course entr.	50	Natural Channel	Replace w/2 - 5' x 2.5' RCB	236	122
4L	328	84941	84940	Shrine Park Rd. & golf course entr.	50	5' x 2.5' RCB	Parallel 5' x 2.5' RCB	10	122
4L	2845	84940	84937	Shrine Park Rd. & Five Mile Creek	50	Natural Channel	Replace w/2 - 5' x 2.5' RCB	410	122
4L	327	84937	92504	Shrine Park Rd. & Five Mile Creek	50	36" RCP	Replace w/2 - 5' x 2.5' RCB	455	122
5L	506	85183	85184	Holman St. & 10th Ave.	50	24" RCP	Parallel 15" RCP	14	28
5L	507	85184	85185	Holman St. & 10th Ave.	50	24" RCP	Parallel 18" RCP	42	56
5L	508	85185	85186	Holman St. & 10th Ave.	50	30" RCP	Parallel 18" RCP	66	58

Table VIII-11
Five Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
5L	509	85186	84973	Limit St. & 10th Ave.	50	30" RCP	Parallel 18" RCP	52	58
5L	1776	84973	84975	Limit St. & 10th Ave.	50	30" RCP	Parallel 24" RCP	59	100
5L	350	84975	84977	Limit St. & 10th Ave.	50	30" RCP	Parallel 24" RCP	130	100
5L	1778	84977	84979	Limit St. & 10th Ave.	50	30" RCP	Parallel 42" RCP	99	100
5L	377	92482	85015	Tanglewood & Grand Ave.	10	24" x 36" MAC	Parallel 18" RCP	23	42
5L	378	85015	85014	Meadow Rd. & Limit St.	10	24" x 36" MAC	Parallel 18" RCP	37	60
5L	379	85014	92481	Meadow Rd. & Limit St.	10	36" ARCH	Parallel 30" RCP	72	60
5L	352	84982	84983	Meadow Ln. & 10th Ave.	50	18" RCP	Parallel 18" RCP	22	23
5L	353	84983	84981	Meadow Ln. & 10th Ave.	50	24" RCP	Parallel 3' x 2' RCB	64	63

Table VIII-11
Five Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
5L	351	84981	84979	Meadow Ln. & 10th Ave.	50	24" RCP	Parallel 4' x 2' RCB	28	63
5L	1786	84989	84990	Brookside St. & Pin Oak St.	10	24" RCP	Parallel 15" RCP	57	29
5L	356	84990	84988	Brookside St. & Pin Oak St.	10	24" RCP	Parallel 21" RCP	26	29
7R	201	92497	84749	Shrine Park Rd. and Deerfield	50	2' Dia. CMP	Parallel 1.5' Dia. RCP	34	44
7R	222	84772	84773	Shrine Park and Fawn Creek	10	1.5' Dia. RCP	Parallel 4.5' Dia. RCP	229	18
7R	223	84773	92501	Shrine Park and Fawn Creek	10	1.67' Dia. CMP	Parallel 1.5' Dia. RCP	28	18
8R	87	84591	84590	Eisenhower Rd. & 10th Ave.	50	33" x 49" MAC	Parallel 36" RCP	120	105
8R	88	84593	84592	Eisenhower Rd. & 10th Ave.	50	36" CMP	Parallel 15" RCP	65	131
8R	89	84595	84594	Eisenhower Rd. & 10th Ave.	50	36" CMP	Parallel 24" RCP	115	77

Table VIII-11 Five Mile Creek Watershed Subsystem Improvements									
	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
8R	104	84621	84622	Parkway Dr. & Park Ave.	10	24" CMP	Parallel 3.5' x 2' RCB	53	90
8R	1647	84622	84623	Parkway Dr. & Park Ave.	10	24" RCP	Parallel 3.5' x 2' RCB	169	96
8R	105	84623	84624	Parkway Dr. & Park Ave.	10	36" CMP	Parallel 24" RCP	100	96
8R	97	84609	84608	10th Ave. & Park Ave.	50	30" RCP	Parallel 27" RCP	50	85
8R	1643	84608	84612	10th Ave. & Park Ave.	50	30" RCP	Parallel 27" RCP	186	85
8R	109	84625	84628	Parkway Dr. & Park Ave.	10	66" CMP	Parallel 27" RCP	187	500
8R	3316	92859	92857	Muncie Rd. & Parkway Dr.	50	30" RCP	Parallel 27" RCP	82	84
8R	3317	92857	92856	Muncie Rd. & Parkway Dr.	50	30" RCP	Parallel 27" RCP	65	84
8R	3318	92856	92854	Muncie Rd. & Parkway Dr.	50	30" RCP	Parallel 27" RCP	121	84

Table VIII-11
Five Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
8R	3320	92854	92563	Muncie Rd. & Parkway Dr.	50	30" RCP	Parallel 27" RCP	149	122
8R	3319	92855	92854	Muncie Rd. & Parkway Dr.	50	30" RCP	Parallel 30" RCP	130	40
8R	3321	92860	92861	Hometown Village	10	24" CMP	Parallel 30" RCP	48	60
8R	3322	92861	92862	Hometown Village	10	24" CMP	Parallel 30" RCP	47	60
8R	3323	92862	92863	Hometown Village	10	24" RCP	Parallel 30" RCP	56	60
8R	3324	92863	92864	Hometown Village	10	24" RCP	Parallel 30" RCP	56	60
8R	3325	92864	92865	Hometown Village	10	24" CMP	Parallel 30" RCP	67	60
8R	3326	92865	92564	Hometown Village	10	24" CMP	Parallel 30" RCP	83	60
8R	2946	92565	92566	10th Ave. & Muncie Rd.	50	24" RCP	Parallel 12" RCP	38	37

Table VIII-11
Five Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
6L	519	85202	85206	14th St. & Vilas St.	10	24" RCP	Parallel 24" RCP	83	93
6L	1830	85206	85208	14th St. & Holman St.	10	24" RCP	Parallel 30" RCP	46	107
6L	525	85208	85035	14th St. & Limit St.	10	30" RCP	Parallel 30" RCP	128	107
6L	1795	85035	85038	14th St. & Limit St.	50	36" RCP	Parallel 3' x 3' RCB	307	224
6L	397	85038	85041	14th St. & Limit St.	50	42" RCP	Parallel 4' x 3' RCB	173	224
6L	405	85043	85045	Revolutionary Ct. & Militia Ct.	10	48" RCP	Parallel 48" RCP	278	166
6L	1800	85045	85046	Revolutionary Ct. & Militia Ct.	10	48" RCP	Parallel 48" RCP	78	180
6L	407	85047	85048	14th St. & Independence Ct.	10	48" CMP	Parallel 48" RCP	233	188
6L	387	85027	85028	Tanglewood & New Lawrence Rd.	10	24" CMP	Parallel 15" RCP	18	23

Table VIII-11
Five Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
6L	389	85029	85031	Tanglewood & New Lawrence Rd.	10	30" CMP	Parallel 15" RCP	48	50
9R	244	84782	84783	10th Ave. & Josela Ct.	50	59" x 81" Ultra Flow	Replace w/2 - 8' x 6' RCB	1814	1,060
9R	112	84633	84632	13th & Eisenhower	50	36" Dia. CMP	Parallel 42" RCP	127	179
7L	669	85370	85371	18th St. & Thornton	50	24" RCP	Parallel 15" RCP	1	24
7L	647	85386	85388	Evergreen St. & Cambridge St.	10	18" RCP	Parallel 15" RCP	28	25
7L	649	85388	92016	Evergreen St. & Cambridge St.	10	21" RCP	Parallel 24" RCP	46	38
7L	658	85407	85405	Thornton & 19th St. Terr.	50	48" RCP	Parallel 15" RCP	207	256
7L	661	85406	85408	Cambridge & Thornton	10	54" RCP	Parallel 36" RCP	301	224
7L	631	85362	85365	17th St. Terr. & Evergreen	10	24" RCP	Parallel 15" RCP	34	35

Table VIII-11
Five Mile Creek Watershed
Subsystem Improvements

	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
7L	634	85365	85366	17th St. Terr. & Evergreen	10	24" RCP	Parallel 15" RCP	31	35
7L	611	85328	85327	16th St. Terr. & Evergreen	10	54" CMP	Parallel 24" RCP	115	149
7L	589	92356	85294	16th St. & Holman St.	10	60" CMP	Parallel 36" RCP	243	346
7L	617	85336	85337	Marion St. & Francis Ct.	10	18" RCP	Parallel 15" RCP	52	34
7L	1870	85337	85338	Marion St. & Francis Ct.	10	18" RCP	Parallel 15" RCP	33	34
7L	1871	85338	85339	Marion St. & Francis Ct.	10	18" RCP	Parallel 15" RCP	57	34
7L	618	85339	85342	Marion St. & Francis Ct.	10	18" RCP	Parallel 15" RCP	41	34
7L	2799	85311	92464	16th St. & Santa Fe St.	10	48" RCP	Parallel 48" RCP	303	183
7L	601	92464	85307	16th St. & Santa Fe St.	10	48" CMP	Parallel 48" RCP	46	192

Table VIII-11 Five Mile Creek Watershed Subsystem Improvements									
	XPSWMM								
Subsystem ID	Conduit #	Up Node	Down Node	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
7L	1805	85086	85262	16th St. & Limit St.	50	36" RCP	Parallel 15" RCP	125	111
7L	227	84778	84777	14th St. & New Lawrence Rd.	10	24" CMP	Parallel 15" RCP	24	15
8L	427	92451	85066	Candlewood and Tudor	10	2' Dia. CMP	Parallel 1.25' Dia. RCP	31	33
10R	2806	92470	92469	W. Leavenworth Tfwy. and Muncie	50	3' Dia. RCP	Parallel 2.5' Dia. RCP	141	64
9L	2769	92438	92439	W. Leavenworth Tfwy. and Limit	50	2' Dia. RCP	Parallel 1' Dia. RCP	23	37
10L	458	85111	85112	22nd and Limit	50	4' Dia. CMP	Parallel 2.5' Dia. RCP	234	195
10L	638	85375	85374	20th and Vilas	10	2' Dia. RCP	Parallel 1.75' Dia. RCP	73	39
10L	639	85376	85377	22nd and Vilas	10	3' Dia. CMP	Parallel 3' Dia. RCP	219	130
11L	1113	86214	86215	Hebbelin and 24th	10	3' Dia. CMP	Parallel 4' Dia. RCP	172	300

Table VIII-12 External Watersheds Subsystem Improvements									
		XPSWMM							
Subsystem ID	GIS Up Node	Up Node	Conduit Number	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
emc2	86886	Node 2	Link 2	4th St. & Cheyenne	10	24" Dia. RCP	Parallel 18" RCP	34	48
emc2	86872	Node 5	Link 5	3rd St. & Cheyenne	10	18" Dia. CMP	Replace w/2' x 2' RCB	80	66
emc2	92586	Node 6	Link 6	2nd St. & Cheyenne	10	18" Dia. CMP	Replace w/2' x 2' RCB	46	66
emc2	92587	Node 7	Link 7	2nd St. & Cheyenne	10	24" Dia. VCP	Parallel 24" RCP	73	87
emc2	92588	Node 8	Link 8	Cheyenne Curve	10	24" Dia. VCP	Parallel 24" RCP	73	87
emc2	86880	Node 20	Link 20	Water St.	10	24" Dia. RCP	Parallel 24" RCP	72	95
emc3	86851	Node 4	Link 4	2nd St. & Kiowa	10	19" x 30" HERCP	Parallel 15" RCP	40	64
emc6	85622	Node 35	Link 35	2nd St. & Poplar	50	6' x 5' ARCH	Replace w/8' x 4' RCB	325	528
emc6	85628	Node 36	Link 36	2nd St. & Mo Pac RR	10	48" Dia. RCP	Replace w/8' x 4' RCB	32	453

Table VIII-12
External Watersheds
Subsystem Improvements

		XPSWMM							
Subsystem ID	GIS Up Node	Up Node	Conduit Number	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
emc6	85627	Node 37	Link 37	2nd St. & Mo Pac RR	10	8' x 3' RCB	Replace w/8' x 4' RCB	400	453
emc6	85629	Node 38	Link 38	2nd St. & Mo Pac RR	10	Natural Channel	Replace w/8' x 4' RCB	227	453
emc6	85631	Node 39	Link 39	2nd St. & Missouri River	10	48" Dia. CMP	Replace w/8' x 4' RCB	353	453
emc6	85523	Node 41	Link 41	3rd Ave. & Michigan St.	10	24" Dia. CMP	Parallel 15" RCP	32	20
emc11	84547	Node 14	Link 14	Hughes Rd. & Muncie Rd.	50	24" Dia. CMP	Replace w/2' x 2' RCB	68	46
emc11	84527	Node 36	Link 36	4th St. & retail parking lot	10	30" Dia. RCP	Replace w/3' x 3' RCB	43	49
emc12	85128	N/A	N/A	4th St. & Eisenhower	50	24" Dia. RCP	Parallel 21" RCP	63	75
emc13	92551	Node 2	Link 2	4th St. & Commercial St.	50	24" Dia. CMP	Parallel 18" RCP	15	21
emc13	84496	Node 5	Link 5	Commercial St. & Commercial Pl.	10	30" Dia. RCP	Parallel 15" RCP	57	62

Table VIII-12
External Watersheds
Subsystem Improvements

		XPSWMM							
Subsystem ID	GIS Up Node	Up Node	Conduit Number	Nearest Streets	Design Storm Frequency	Original Size and Type	Improved Size and Type	Improved Capacity (cfs)	Maximum Flow (cfs)
emc13	92580	Node 19	Link 19	4th St. & unnamed st.	10	48" Dia. RCP	New Slope	176	63
emc13	92579	Node 20	Link 20	4th St. & unnamed st.	10	50" Dia. CMP	New Slope	78	84
emc13	84477	Node 21	Link 21	4th St. & unnamed st.	10	50" Dia. RCP	New Slope	120	94
emc13	84486	Node 16	Link 16	Highway Terr. & Brewer Pl.	10	36" Dia. RCP	Replace w/4' x 2' RCB	38	57

Table VIII-13
Recommended Improvements for Reported Drainage Problems

Watershed ID & Map Sheet No.	Problem Identification Number	Location	Recommendation
3MC 35 NW	1	13th and Delaware and Cherokee	Install roadside ditches along Delaware and Cherokee, east of 13th, and along 13th to drain to creek.
3MC 27 SW	2	18th and Osage, 1815 and 1819 Osage; Subsystem 6R	Potential infiltration/inflow problem should be investigated. Model results indicate parallel pipe needed along line between houses.
3MC 27 SE	3	1418 Osage; Subsystem 5R	Model results indicate 18" dia. conduit 2581 to be replaced with 30" RCP.
5MC 12 SW	4	4200-4400 block of Valley View Road, northeast of intersection of Shrine Park and Muncie	Install roadside ditches along Valley View Road and then drain to east to lakes.
5MC 11 SW	5	Wellington Drive, west of 10th	Improve maintenance. Keep storm sewers free of debris.
3MC 35 SE	6	Hanson residence, 1011 9th Avenue; between Frank Street and Randolph	Inspect to determine whether nuisance problem.
3MC 34 NW	7	Bennett residence, 407 S. 20th Street; between Choctaw and High Streets	Regular maintenance needed. Recommend line drainage ditch w/riprap.
3MC 35 NW	8	Mensch residence, 1204 Spruce Street; Subsystem 2R	Model results indicate parallel pipe needed along Franklin St. from Spruce south to alley.

Table VIII-13

Recommended Improvements for Reported Drainage Problems

Watershed ID & Map Sheet No.	Problem Identification Number	Location	Recommendation
EMC 36 SW	9	Shelley residence, 1424 S. 5th Street, near Maple Street	Regrade yard to improve drainage to existing drainage culvert under Maple Street.
EMC 25 SW	10	Cherokee Street and Missouri River	New outlet of 3' x 4' arch under Cherokee needed per 1967 B&V report.
EMC 25 SW	11	Adams residence, 229 Osage Street	Recompact and regrade yard to improve drainage northwest to 3rd and Osage.
3MC 35 NE	12	Cherokee and Broadway; 760 and 777 Cherokee	Reroute tributary south of property east to Three Mile Creek at Broadway bridge per Larkin design. Abandon arch.
3MC 26 SE	13	Shawnee and Broadway; 720 Shawnee	Improve ditches along Broadway.
3MC 26 SW	14	10th and Miami Streets	Improve ditches along 10th Street; potential infiltration/inflow problem should be investigated.
3MC 35NW	15	Davidson residence, 1137 Delaware	Install drainage ditches along Delaware to drain east to creek.
3MC 27 SE	16	Bockman residence, 1600 Osage Street; Subsystem 6R	Enclose drainage ditch, starting from outlet of 3 ft. dia. pipe for approximately 100 ft. downstream w/same pipe type.
3MC 27 SW	17	Seneca and 20th Street Terrace; Subsystem 6R	Model results indicate parallel pipes needed along 20th St. north to Seneca, and along Seneca east of 20th St.

Table VIII-13
Recommended Improvements for Reported Drainage Problems

Watershed ID & Map Sheet No.	Problem Identification Number	Location	Recommendation
3MC 27 SW	18	Shawnee and 22nd Streets; Subsystem 6R	Repair failed CMP. Model results indicate no other improvements necessary.
EMC 36 NW	19	6th and Olive Streets	Install roadside ditches along 6th Street and along Olive to direct flow to subsystem south of intersection.
3MC 35 NE	20	739 Olive Street; Subsystem 1R	Residence is in low point, sump of drainage way. Some flooding may be alleviated by improvements recommended for adjacent storm sewer system.
3MC 35 SE	21	1424 Lawrence Avenue; Subsystem 2R	Model results indicate parallel pipe needed under railroad tracks.
3MC 35 SW	22	10th Avenue and Randolph; Subsystem 2R	Model results indicate conduit capacity ok.
3MC 35 SW	23	Jones residence, 1116 Quincy Street	Improve drainage ditch on north side of Quincy.
3MC 2 NW	24	1210 Ohio; Subsystem 2R	Model results indicate parallel pipes needed along Ohio from Franklin to Washington.
3MC 34 NE	25	Wagler residence, 1620 Spruce	Residence is on side of steep hill that drains directly to a South Branch tributary stream. Suggest owner install terraces. No recommendation for City.

Table VIII-13 Recommended Improvements for Reported Drainage Problems			
Watershed ID & Map Sheet No.	Problem Identification Number	Location	Recommendation
5MC 1 SE	26	Santa Fe and 3rd Streets; Subsystem 2R	Model results indicate conduit capacity ok. Improve maintenance.
5MC 1 SE	27	5 Mile Creek and 4th Street	Model results indicate no improvements necessary.
5MC 2 SE and 11 NE	28	Shrine Park Road and Limit Street; Subsystem 3L	Model results indicate parallel conduits needed along Limit St. and along Maple Ave.
5MC 2 SE	29	760 Santa Fe Street; Santa Fe Street, Garland to Old Creek Court; Subsystem 3L	Improve drainage ditch on south side of Santa Fe, and install tubes to continue drainage under Garland Ave. and under Broadway Terr. Model results indicate parallel pipe needed at Santa Fe & Garland.
5MC 2 SE	30	2400 Spring Garden Avenue; between Santa Fe and Marion Streets; Ferguson residence, 2304 Garland; Subsystem 3L	Model results indicate culvert capacity adequate.
5MC 2 SE	31	2311 Grand Ave.; Subsystem 3L	Model results indicate parallel conduits needed at Grand & Marion and Grand & Sherman.
5MC 2 NE	32	Szychowski residence, 2015 Lawrence Avenue	Site visit required.

Table VIII-13
Recommended Improvements for Reported Drainage Problems

Watershed ID & Map Sheet No.	Problem Identification Number	Location	Recommendation
5MC 3 SE	33	2413 16th Street Terrace, north of Vilas to Thornton Streets; 1609 Holman Street, 16th Street, south of Vilas, including Holman; Subsystem 7L	Install drainage ditches or extend storm sewer along 16th St. Terrace north from Vilas St. Model results indicate parallel existing 60" CMP south of Holman St. w/36" RCP; and parallel existing 36" RCP along Limit St. at 16th St. w/15" RCP.
5MC 3 NW and 3 SW	34	Thornton and 19th Street Terrace	Future West Leavenworth Trafficway project.
5MC 4 SE	35	22nd St. Terrace and Hebbelin Drive; Subsystem 11L	Repair outfall of CMP; improve channel maintenance.
5MC 12 NE	36	4th Street and Idaho Street; Subsystem 4R	Improve roadside ditches. Model results indicate no other improvements necessary.
5MC 12 SE	37	4101 Fourth Street, 4th Street Trafficway and V.A. entrance; Subsystem 2R	Model results indicate conduits from VA entrance to berm crossing need to be removed and replaced with RCBs and improved slopes.
5MC 12 NW	38	3412 and 3413 Iowa Street, near Oregon Street; Needham and Fassett residences; Subsystem 5R	Relocate 18" CMP cross-road culvert at Oregon St. curve from west to southwest to drain to creek. Fill and regrade ditch from Oregon to Iowa. Model results indicate parallel Iowa St. cross-road pipe.

Table VIII-13
Recommended Improvements for Reported Drainage Problems

Watershed ID & Map Sheet No.	Problem Identification Number	Location	Recommendation
5MC 11 NE	39	Five Mile Creek and Shrine Park Road	Shrine Park Road bridge capacity OK; Shrine Park Road between 5MC and Goddard Circle should be elevated to 794 ft.
5MC 11 NE	40	3130 Shrine Park Road, north of Five Mile Creek, south of Goddard Circle, west side of Shrine Park Road; Subsystem 4L	Model results indicate natural channels along Shrine Park to be replaced w/2 - 5' x 2.5' RCBs, and existing culverts to be paralleled w/5' x 2.5' RCBs. Conduits at Goddard Cir. to be paralleled w/15" RCPs.
5MC 11 NW	41	3523 10th Avenue; 10th Avenue culvert north of Wellington Drive; Subsystem 6L	Regular maintenance needed to prevent erosion. Model results indicate culvert capacity ok.
5MC 11 SW	42	3911 Tenth Avenue; Wellington Drive culvert at 10th Avenue; Subsystem 9R	Model results indicate replace 59" x 81" ultra flow pipe with 2 - 8' x 6' RCBs. Alternatively, consider new outlet to 5 mc from point where tributary turns east to 3911 10th St.
5MC 11 SW	43	Wallis Lane and 10th Avenue; Subsystem 9R	Model results indicate conduits ok as is. Regular maintenance needed to clear debris and check erosion.
5MC 11 SE	44	905 Park Avenue; Subsystem 8R	Model results indicate 66" CMP upstream to be paralleled by new 27" RCP, and existing 30" RCPs adjacent to residence to be paralleled by new RCP.
EMC 36 NW	45	Short Street and Railway	Culvert appears to have been abandoned.

Table VIII-13
Recommended Improvements for Reported Drainage Problems

Watershed ID & Map Sheet No.	Problem Identification Number	Location	Recommendation
EMC 25 NW	46	Cheyenne and 2nd Streets	Future Metropolitan project.
5MC 1 SW and 1 SE	47	4th St. and Evergreen; Subsystem 1L	Model results indicate parallel pipes from 4th St. and Evergreen downstream to 5MC.
3MC 26 SW	48	10th and Shawnee	Flooding due to 3MC should be alleviated by improvements downstream of 10th St.
3MC 35 SW and 35 SE	49	10th Avenue, south of Spruce Street; between Kansas and Ohio; Subsystem 2R	Model results indicate cross-section area 4' x 4' ok. Repair stone arch or replace with new RCB.
EMC 36 SW	50	919 4th Ave., Matteo residence; between Spruce and Congress on 4th	Extend storm sewer system from 4th Ave. and Spruce St. to 4th Ave. and Marshall St.
3MC 35 NW	51	1137 Delaware, Forey residence; between 11th and 12th	Install drainage ditches along both sides of Delaware, and cross-road pipe at 11th St.
5MC 2 SE	52	2200 Garland, Boone residence; Garland and Marion; Subsystem 3L	House sits in drainage way. Site visit.
3MC 27 SW	53	324 20th Street Terr., Curran residence; between Osage and Miami, 20th and 21st Streets	Install drainage ditches on both sides of Osage and west side of 20th Terr. to direct flow to existing inlets.

Table VIII-13
Recommended Improvements for Reported Drainage Problems

Watershed ID & Map Sheet No.	Problem Identification Number	Location	Recommendation
5MC 3 NE and 3 SE	54	Thornton and S. 16th Street, Klingely residence	Extend storm sewer pipe and inlets north along 16th St. from Evergreen St. to Thornton St.
3MC 26 NW	55	1321 Metropolitan, Lober residence; 13th and Metropolitan	Install curb and gutters or drainage ditch from 13th St. to divert flows to west.
3MC 35 SE	56	776 Ohio St., Benson residence; between Columbia and 9th Ave.; Subsystem 1R	Model results indicate storm sewer pipes between Ohio and James Streets to be paralleled with new pipes.
5MC 3 NE	57	1600 Ridge Road, Smith residence; north of Thornton, east of 18th Street	Residence is in drainage way. Site visit.
3MC 35 NE	58	718 Lawrence Ave., Hodge residence; between Chestnut and Olive, 9th and Broadway	Residence is in drainage way. Site visit.
5MC 3 SW	59	2120 S. 19th St., Kimball residence; 19th and Thornton; Subsystem 7L	Improve maintenance of drainage ditch. Model results indicate conduit capacity adequate in this vicinity.
3MC 35 SW	60	906 Madison, Jacobs residence; near 14th and Spruce	Property is in drainage way, adjacent to low point. Site visit.

Table VIII-13 Recommended Improvements for Reported Drainage Problems			
Watershed ID & Map Sheet No.	Problem Identification Number	Location	Recommendation
3MC 26 SE	61	737 Miami, Lippman residence; between 7th and Broadway, south side of Miami; Subsystem 4L	Model indicates adjacent storm sewer system to be paralleled with new pipes. Residence is in drainage way for runoff from Broadway and Miami.
5MC 3 SE	62	2115 S. 16th St.; 16th and Thornton, Rodgers residence	Improve channel from outlet of 18" CMP at Thornton St. to existing open channel along east side 2203 S. 16th St.
5MC 14 NE	63	Sepulvedo residence, 4501 Parkway Drive; Muncie and Parkway	Install a berm on east side of property and ditch to divert flow to 30" RCP inlet on Muncie, and a berm and ditch on the south side to divert flow to Parkway Drive.
3MC 26 SE	64	Lanze residence, 621 Kiowa; Kiowa, between 6th and 7th	Install higher curbs along south side of Kiowa to keep water in street.
3MC 27 SE	65	1615 Michael; east of 17th St., near Miami; Arnold residence; Subsystem 6R	Model results indicate parallel pipes needed along entire line from 17th & Terry to northeast of 16th & Osage.
3MC 35 SW	66	Ettinger residence, 1019 Ohio St.; 11th and Ohio, near Kingman; Subsystem 2R	Model results indicate parallel pipes needed along line from Grand Ave. and Michigan St. to 10th Ave., between Kansas St. and Ohio St.

Table VIII-13 Recommended Improvements for Reported Drainage Problems			
Watershed ID & Map Sheet No.	Problem Identification Number	Location	Recommendation
3MC 35 SW	67	Shockey residence, 1011 Madison St.; near 14th and Randolph and Spruce; Subsystem 2R	Model results indicate 18" RCP under Madison St. needs to be replaced with new RCB at improved slope; and parallel pipe needed at Washington St. 24" RCP; and improve maintenance in channel between.
3MC 27 NE	68	1420 and 1409 Cheyenne St.; 14th and Cheyenne; Subsystem 8L	Model results indicate parallel Cheyenne St. bridge with new culvert, and line downstream channel to Pawnee with concrete bottom and concrete vertical side flume.
3MC 27 SE	69	1351 and 1420 Kiowa St.; 14th and Kiowa; Subsystem 8L	Model results indicate parallel Kiowa St. bridge with new culvert.
3MC 27 SW	70	Rice residence, 1921 Miami; 19th and Miami; Subsystem 6R	Model results indicate parallel pipes needed from Seneca to Miami, along Miami to 19th St., and northeast to Osage St.
5MC 4 SE	71	Meyer residence, 2510 22nd Terrace; near 22nd and Vilas; Subsystem 11L	Improve channels behind 22nd Terr. houses to divert hill runoff to inlets on Vilas.

Table VIII-13
Recommended Improvements for Reported Drainage Problems

Watershed ID & Map Sheet No.	Problem Identification Number	Location	Recommendation
5MC 11 SE	72	Gray residence, 725 Fawn Creek; between Garland and Shrine Park Road; Subsystem 7R	Model results indicate 18" RCP under, and 20" CMP along side, Fawn Creek to be replaced with single, larger dia. pipe. Improve grading in vicinity to divert runoff to curb/gutter and inlet.
3MC 26 SW, 27 SE, and 27 SW	73	Shawnee, both sides, from 10th to 13th and from 16th to 20th	Ditch work, clean, repair, and replace driveway tubes.
5MC 2 NE	74	706 Garfield, Busey residence; Subsystem 2L	Residence is in drainage way. Install curbs to keep water in street. Model results indicate conduit capacity ok from Cleveland Terr. to 5th Ave.
3MC 34 SE	75	S. 16th St. from Ohio to Western, Finch residence	North shoulder Ohio hill, western to lot entrance, clear brush and ditch.
3MC 26 SW	76	13th St. from Osage to Shawnee	Clear debris downstream, line ditch.
5MC 2 NE and 2 SE	77	Thornton at RR tracks; between Garland and Montezuma	Improve maintenance.
3MC ?	78	7th Street Church	Pave at end of church.
5MC 1 NW	79	5th Ave. and Rees	SKW Plans exist for improvements at 5th Ave. between South and Rees.

Table VIII-13
Recommended Improvements for Reported Drainage Problems

Watershed ID & Map Sheet No.	Problem Identification Number	Location	Recommendation
3MC 34 SE	80	1323 S. 15th St., Carey residence; Subsystem 2R	Model results indicate parallel pipe needed along 30" RCP at 15th and Kansas.
3MC 2 NW	81	1509 Klemp, Thorne residence; Subsystem 2R	House is in drainage way. Improve drainage.
5MC 3 SE	82	Thornton from 15th to 16th	Improve and maintain drainage ditches along Thornton.
3MC 27 NW	83	2000 block of Dakota; Subsystem 10L	Improve drainage ditches along north sides of Metropolitan and Dakota.
3MC 26 SE	84	On Ottawa, from Broadway 200' east; Subsystem 4L	Repair failed storm sewer. Model results indicate parallel most of this line.
3MC 26 SW	85	In alley between 12th and 13th, from Kickapoo to Ottawa; Subsystem 7L	Repair collapsed archway. Model results indicate no other improvements required in alley.
5MC ?	86	1204 and 1208 Ridge Road	Clean drainage ditch.
5MC 11 NW	87	2925 Meadow Road; Subsystem 5L	Model results indicate 36" MAC to be paralleled by 18" RCP from Grand Ave. to Meadow Rd., and by 30" RCP from Meadow Rd. east to ditch between Meadow Rd. & 10th Ave.
3MC 35 NW	88	109 S. 11th St., Harper residence	Backyard is in South Branch flood plain. Install terraces.

Table VIII-14 Detention Basin Site Evaluation Three Mile Creek Watershed Pond 1	
Location	Between 18th, 20th, Ottawa, and Dakota Streets
Map Sheet No.	27 SW
Subsystem ID	Main Channel
High Water Surface Elevation	836 ft
Bottom Elevation	820 ft
Nearest XP-SWMM Node to Outlet	92786
Sum of Runoff Volume to XP-SWMM Node (Vr)	229.5 ac-ft
Estimated Storage Volume from Digitized Areas (Vs)	25.8 ac-ft
Ratio of Storage to Runoff Volumes (Vs/Vr)	0.11
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi) (From TR-55, Figure 6-1, for Type II Rainfall)	~ 1.0
XP-SWMM Conduit Adjacent to Outlet	3248
Peak Inflow, Existing System (qi exist)	2,674 cfs
Peak Inflow, System with Capital Improvements (qi impr)	2,676 cfs
Peak Outflow, (qo/qi) x qi impr	2,676 cfs
Result	Pond 1 has negligible effect
Sum of Ponds	N/A
Sum of Storage Volumes/Runoff Volumes (EVs/Vr)	N/A
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi) (From TR-55, Figure 6-1, for Type II Rainfall)	N/A
Peak Outflow, (qo/qi) x qi impr	N/A cfs
Result	N/A
Further Evaluation	See Pond 2

Table VIII-15
Detention Basin Site Evaluation
Three Mile Creek Watershed
Pond 2

Location	Between 16th Terrace, 18th, Ottawa, and Dakota Streets
Map Sheet No.	27 SE
Subsystem ID	Main Channel
High Water Surface Elevation	826 ft
Bottom Elevation	808 ft
Nearest XP-SWMM Node to Outlet	92300
Sum of Runoff Volume to XP-SWMM Node (Vr)	254.1 ac-ft
Estimated Storage Volume from Digitized Areas (Vs)	32.9 ac-ft
Ratio of Storage to Runoff Volumes (Vs/Vr)	0.13
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi) (From TR-55, Figure 6-1, for Type II Rainfall)	~ 1.0
XP-SWMM Conduit Adjacent to Outlet	3246
Peak Inflow, Existing System (qi exist)	2,845 cfs
Peak Inflow, System with Capital Improvements (qi impr)	2,846 cfs
Peak Outflow, (qo/qi) x qi impr	2,846 cfs
Result	Pond 2 has negligible effect
Sum of Ponds	1 and 2
Sum of Storage Volumes/Runoff Volumes (EVs/Vr)	0.23
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi) (From TR-55, Figure 6-1, for Type II Rainfall)	0.63
Peak Outflow, (qo/qi) x qi impr	1,793 cfs
Result	Ponds 1 and 2 reduce peak flows by 37%

Further Evaluation...XP-SWMM was used to determine the effects on the downstream system due to using detention ponds 1 and 2. The ponds did alleviate flooding at Ottawa Street and 13th Street, thereby eliminating the need for improvements to these two bridges. Also, the water surface elevation was lowered enough to eliminate the need for two of the three floodwalls around structures near Osage Street.

Table VIII-16
Detention Basin Site Evaluation
Three Mile Creek Watershed
Pond 3

Location	Between 14th, 17th, Cherokee, and High Streets
Map Sheet No.	34 NE
Subsystem ID	South Branch
High Water Surface Elevation	820 ft
Bottom Elevation	804 ft
Nearest XP-SWMM Node to Outlet	92650
Sum of Runoff Volume to XP-SWMM Node (Vr)	255.6 ac-ft
Estimated Storage Volume from Digitized Areas (Vs)	44.7 ac-ft
Ratio of Storage to Runoff Volumes (Vs/Vr)	0.18
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi) (From TR-55, Figure 6-1, for Type II Rainfall)	0.79
XP-SWMM Conduit Adjacent to Outlet	3068
Peak Inflow, Existing System (qi exist)	1,618 cfs
Peak Inflow, System with Capital Improvements (qi impr)	2,077 cfs
Peak Outflow, (qo/qi) x qi impr	1,641 cfs
Result	Pond 3 has negligible effect
Sum of Ponds	N/A
Sum of Storage Volumes/Runoff Volumes (EVs/Vr)	N/A
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi) (From TR-55, Figure 6-1, for Type II Rainfall)	N/A
Peak Outflow, (qo/qi) x qi impr	N/A cfs
Result	N/A
Further Evaluation	None

Table VIII-17 Detention Basin Site Evaluation Three Mile Creek Watershed Pond 4	
Location	Between 10th, 13th, Shawnee, & Ottawa Streets
Map Sheet No.	26 SW
Subsystem ID:	Main Channel & South Branch
High Water Surface Elevation	792 ft
Bottom Elevation	782 ft
Nearest XP-SWMM Node to Outlet	92607
Sum of Runoff Volume to XP-SWMM Node (Vr)	308.6 ac-ft
Estimated Storage Volume from Digitized Areas (Vs)	19.5 ac-ft
Ratio of Storage to Runoff Volumes (Vs/Vr)	0.02
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi) (From TR-55, Figure 6-1, for Type II Rainfall)	~ 1.0
XP-SWMM Conduit Adjacent to Outlet	2993
Peak Inflow, Existing System (qi exist)	4,358 cfs
Peak Inflow, System with Capital Improvements (qi impr)	5,843 cfs
Peak Outflow, (qo/qi) x qi impr	5,843 cfs
Result	Pond 4 has negligible effect
Sum of Ponds	1, 2, 3, and 4
Sum of Storage Volumes/Runoff Volumes (EVs/Vr)	0.15
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi) (From TR-55, Figure 6-1, for Type II Rainfall)	0.90
Peak Outflow, (qo/qi) x qi impr	5,259 cfs
Result	Sum of ponds together have negligible effect
Further Evaluation	None

Table VIII-18 Detention Basin Site Evaluation Three Mile Creek Watershed Pond 5	
Location	Between Broadway, 10th, Shawnee, and Miami Streets
Map Sheet No.	26 SE
Subsystem ID	Main Channel
High Water Surface Elevation	788 ft
Bottom Elevation	778 ft
Nearest XP-SWMM Node to Outlet	92617
Sum of Runoff Volume to XP-SWMM Node (Vr)	887.3 ac-ft
Estimated Storage Volume from Digitized Areas (Vs)	19.9 ac-ft
Ratio of Storage to Runoff Volumes (Vs/Vr)	0.02
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi) (From TR-55, Figure 6-1, for Type II Rainfall)	~ 1.0
XP-SWMM Conduit Adjacent to Outlet	3017
Peak Inflow, Existing System (qi exist)	4,457 cfs
Peak Inflow, System with Capital Improvements (qi impr)	5,909 cfs
Peak Outflow, (qo/qi) x qi impr	5,909 cfs
Result	Pond 5 has negligible effect
Sum of Ponds	1, 2, 3, 4, and 5
Sum of Storage Volumes/Runoff Volumes (EVs/Vr)	0.16
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi) (From TR-55, Figure 6-1, for Type II Rainfall)	0.86
Peak Outflow, (qo/qi) x qi impr	5,082 cfs
Result	Sum of ponds together have negligible effect
Further Evaluation	None

Table VIII-19 Detention Basin Site Evaluation Three Mile Creek Watershed Pond 6	
Location	Between Central, 10th Avenue, Spruce, and Quincy Streets
Map Sheet No.	35 SE
Subsystem ID	2R
High Water Surface Elevation	820 ft
Bottom Elevation	804 ft
Nearest XP-SWMM Node to Outlet	86011
Sum of Runoff Volume to XP-SWMM Node (Vr)	177.1 ac-ft
Estimated Storage Volume from Digitized Areas (Vs)	29.5 ac-ft
Ratio of Storage to Runoff Volumes (Vs/Vr)	0.17
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi) (From TR-55, Figure 6-1, for Type II Rainfall)	0.83
XP-SWMM Conduit Adjacent to Outlet	3212
Peak Inflow, Existing System (qi exist)	477 cfs
Peak Inflow, System with Capital Improvements (qi impr)	978 cfs
Peak Outflow, (qo/qi) x qi impr	812 cfs
Result	Pond 6 has negligible effect
Sum of Ponds	N/A
Sum of Storage Volumes/Runoff Volumes (EVs/Vr)	N/A
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi) (From TR-55, Figure 6-1, for Type II Rainfall)	N/A
Peak Outflow, (qo/qi) x qi impr	N/A cfs
Result	N/A
Further Evaluation	None

Table VIII-20 Detention Basin Site Evaluation Three Mile Creek Watershed Pond 7	
Location	Between Broadway, Lawrence Avenue, Cherokee, and Spruce Streets
Map Sheet No.	35 NE
Subsystem ID	2R
High Water Surface Elevation	800 ft
Bottom Elevation	780 ft
Nearest XP-SWMM Node to Outlet	92700
Sum of Runoff Volume to XP-SWMM Node (Vr)	210 ac-ft
Estimated Storage Volume from Digitized Areas (Vs)	68 ac-ft
Ratio of Storage to Runoff Volumes (Vs/Vr)	0.32
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi) (From TR-55, Figure 6-1, for Type II Rainfall)	0.40
XP-SWMM Conduit Adjacent to Outlet	3180
Peak Inflow, Existing System (qi exist)	312 cfs
Peak Inflow, System with Capital Improvements (qi impr)	1131 cfs
Peak Outflow, (qo/qi) x qi impr	452 cfs
Result	Pond 7 has negligible effect
Sum of Ponds	6 and 7
Sum of Storage Volumes/Runoff Volumes (EVs/Vr)	0.46
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi)	0.195
Peak Outflow, (qo/qi) x qi impr	221 cfs
Result	Ponds 6 and 7 reduce peak flows by 29%
Further Evaluation	None

Table VIII-21 Detention Basin Site Evaluation Three Mile Creek Watershed Pond 8	
Location	North of Metropolitan Avenue, between 14th and 16th Streets
Map Sheet No.	27 NE
Subsystem ID	8L
High Water Surface Elevation	838 ft
Bottom Elevation	820 ft
Nearest XP-SWMM Node to Outlet	92038
Sum of Runoff Volume to XP-SWMM Node (Vr)	30.83 ac-ft
Estimated Storage Volume from Digitized Areas (Vs)	18.96 ac-ft
Ratio of Storage to Runoff Volumes (Vs/Vr)	0.62
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi) (From TR-55, Figure 6-1, for Type II Rainfall)	~ 0.10
XP-SWMM Conduit Adjacent to Outlet	1582
Peak Inflow, Existing System (qi exist)	603 cfs
Peak Inflow, System with Capital Improvements (qi impr)	603 cfs
Peak Outflow, (qo/qi) x qi impr	60 cfs
Result	See Below
Sum of Ponds	N/A
Sum of Storage Volumes/Runoff Volumes (EVs/Vr)	N/A
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi)	N/A
Peak Outflow, (qo/qi) x qi impr	N/A cfs
Result	N/A

Table VIII-21 Detention Basin Site Evaluation Three Mile Creek Watershed Pond 8
Further Evaluation...A detention pond could be installed on the north side of Metropolitan to eliminate the need for improvements at 14th and Cheyenne Streets and 14th and Kiowa Streets, for the 10-year event, with proper outlet control. An earthen embankment dam, 500 ft long and 16 ft high, with a 5-ft wide surface on top along the major axis, can be constructed upstream of the 8' x 8' RCB culvert under Metropolitan Avenue. A concrete-lined emergency spillway and 36" RCP outlet pipe direct flows to the entrance of the existing 8' x 8' RCB. The top and bottom elevations of the dam are 840 ft and 824 ft, respectively; and the spillway and outlet pipe elevations are 836 ft and 827 ft, respectively. The maximum water surface elevation for the 10-year event is 835.95 ft, and for the 50-year event it is 838.12 ft. The upstream and downstream dam face slopes are three horizontal to one vertical. 33.7 ac-ft of storage is provided when the water surface is 838 ft. Without this proposed dam and detention basin, the following improvements would be needed: a parallel 4' x 4' RCB at 14th & Cheyenne, an 8-ft wide concrete channel lining from Cheyenne to Pawnee, and a parallel 4' x 4' RCB at 14th & Kiowa.

Table VIII-22 Detention Basin Site Evaluation Five Mile Creek Watershed Pond 1	
Location	Between Limit Street, West Leavenworth Tfwy, County Hwy. 5, and 22nd Street
Map Sheet No.	10 NW
Subsystem ID	Main Channel
High Water Surface Elevation	870 ft
Bottom Elevation	850 ft
Nearest XP-SWMM Node to Outlet	92432
Sum of Runoff Volume to XP-SWMM Node (Vr)	251.5 ac-ft
Estimated Storage Volume from Digitized Areas (Vs)	92.7 ac-ft
Ratio of Storage to Runoff Volumes (Vs/Vr)	0.37
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi) (From TR-55, Figure 6-1, for Type II Rainfall)	0.315
XP-SWMM Conduit Adjacent to Outlet	3286
Peak Inflow, Existing System (qi exist)	2,122 cfs
Peak Inflow, System with Capital Improvements (qi impr)	2,125 cfs
Peak Outflow, (qo/qi) x qi impr	669 cfs
Result	Pond 1 reduces peak flows by 68%
Sum of Ponds	N/A
Sum of Storage Volumes/Runoff Volumes (EVs/Vr)	N/A
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi) (From TR-55, Figure 6-1, for Type II Rainfall)	N/A
Peak Outflow, (qo/qi) x qi impr	N/A cfs
Result	N/A
Further Evaluation...Pond 1 eliminated by City. Considered too far upstream and too close to proposed West Leavenworth Trafficway.	

Table VIII-23 Detention Basin Site Evaluation Five Mile Creek Watershed Pond 2	
Location	Between 14th Street, New Lawrence Road, County Hwy. 5, and Limit Street
Map Sheet No.	10 NE and 10 SE
Subsystem ID	Main Channel
High Water Surface Elevation	840 ft
Bottom Elevation	820 ft
Nearest XP-SWMM Node to Outlet	92061
Sum of Runoff Volume to XP-SWMM Node (Vr)	840 ac-ft
Estimated Storage Volume from Digitized Areas (Vs)	166 ac-ft
Ratio of Storage to Runoff Volumes (Vs/Vr)	0.198
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi) (From TR-55, Figure 6-1, for Type II Rainfall)	0.73
XP-SWMM Conduit Adjacent to Outlet	2795
Peak Inflow, Existing System (qi exist)	4,296 cfs
Peak Inflow, System with Capital Improvements (qi impr)	4,966 cfs
Peak Outflow, (qo/qi) x qi impr	3,625 cfs
Result	Pond 2 reduces peak flows by 16%
Sum of Ponds	N/A
Sum of Storage Volumes/Runoff Volumes (EVs/Vr)	N/A
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi) (From TR-55, Figure 6-1, for Type II Rainfall)	N/.A
Peak Outflow, (qo/qi) x qi impr	N/A cfs
Result	N/A
Further Evaluation	None

Table VIII-24 Detention Basin Site Evaluation Five Mile Creek Watershed Pond 3	
Location	Between 10th Avenue, New Lawrence Road, and Wallis Lane
Map Sheet No.	11 NW and 11 SW
Subsystem ID	6L and Main Channel
High Water Surface Elevation	830 ft
Bottom Elevation	810 ft
Nearest XP-SWMM Node to Outlet	92480 and 92829
Sum of Runoff Volume to XP-SWMM Node (Vr)	ac-ft
Estimated Storage Volume from Digitized Areas (Vs)	ac-ft
Ratio of Storage to Runoff Volumes (Vs/Vr)	
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi) (From TR-55, Figure 6-1, for Type II Rainfall)	
XP-SWMM Conduit Adjacent to Outlet	2827
Peak Inflow, Existing System (qi exist)	cfs
Peak Inflow, System with Capital Improvements (qi impr)	cfs
Peak Outflow, (qo/qi) x qi impr	cfs
Result	See Below
Sum of Ponds	N/A
Sum of Storage Volumes/Runoff Volumes (EVs/Vr)	N/A
Ratio of Peak Outflow to Peak Inflow Discharges (qo/qi) (From TR-55, Figure 6-1, for Type II Rainfall)	N/A
Peak Outflow, (qo/qi) x qi impr	N/A cfs
Result	N/A
Further Evaluation...Pond 3 was eliminated from consideration by the City because it would inundate an existing park and the site for a proposed new school. Therefore, analysis was not completed for Pond 3.	

Table VIII-25
Existing Lake Locations

Subsystem	Map Sheet	Lake Number	Location Between Streets
6R	13 NW	1	Shrine Park Rd., Eisenhower Rd., Lakeview Dr.
6R	13 NW	2	Shrine Park Rd., Muncie Rd., Lakeview Dr.
6R	12 SW	3	Valley View, Muncie Rd., Lakeview Dr.
6R	12 SW	4	Iowa St., Pleasant Ave., Hughes Rd.
6R	12 SW	5	Valley View, McDonald Rd., Lakeview Dr.
8R	14 NE	1	10th Ave., ? (unnamed cul-de-sac)
8R	14 NE	2	?, Eisenhower Rd., Shrine Park Rd.
8R	11 SE	3	Muncie Rd., 10th Ave., Josela Ct.