Kansas City Stream Asset Inventory Phase I

CITY OF FOUNTAINS
HEART OF THE NATION

KANSAS CITY
MISSOURI

City Planning and Development Department

Tools and Strategies for Protecting Natural Resources

Kansas City, Missouri
December 9, 2003

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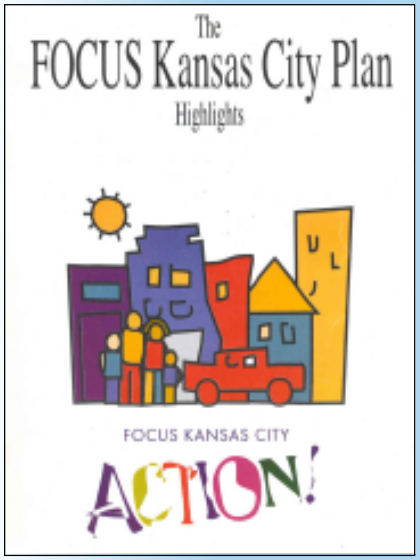
Chapter 1

Executive Summary

The City of Kansas City, Missouri is stepping up to the challenge of understanding, protecting, and incorporating its natural resources into development and stormwater management. By including natural resources within the development process with the same weight as infrastructure planning, the City will be better able to reach a balance between the economic, social, and environmental aspects of growth management. The City's ability to incorporate natural resource inventories such as this one into the planning process will be critical to the success of managing stormwater, preventing flooding, and providing healthy communities in the future. Used in conjunction with other projects throughout the region (KC One, MARC Natural Resources Inventory, MARC Green Infrastructure) these types of inventories will provide planners with the tools and strategies necessary to incorporate protection, enhancement, and management of natural resources into the City's planning process.

Long range plans like the ***FOCUS Kansas City Plan*** have set goals for growth and development using a natural resource inventory as the foundation for these goals. Citizens are becoming more aware of the negative impacts growth generally has on water quality and the importance of protecting and enhancing their natural resources, including improving water quality. This stream asset inventory is only the beginning of the City's goal of meeting the natural resource inventory objective in the ***FOCUS Kansas City Plan***.

Stream Asset Inventories can provide tools and strategies for future resource protection.



This plan provides the foundation for integrating natural resources into communitities.

executive summary

An integrative approach has been developed for conducting asset inventories and deriving planning tools and strategies. The goals of this approach are:

- Improving stormwater management and water quality while preventing flooding
- Integrating and prioritizing economic, environmental, and social resources
- Increasing base knowledge of existing resources
- Making ecologically sound land use decisions
- Decreasing infrastructure costs and maintenance

In-stream wetland area.

Inventory, prioritization, and protection are the foundations to the approach for conducting a stream (natural resources) asset inventory. At each step one begins to acquire the pieces and understanding necessary to develop the recommendations, tools, and strategies needed by City staff from a variety of departments, to successfully plan for and implement future growth within the city.

Recommendations based on information gathered in the inventory are based upon three categories:

- Land use planning and regulation
- Site development regulation
- Design standards for public infrastructure

Type 4 stream, highly disturbed by roadway and development.

These general categories form the basis from which tools and strategies have been developed to help guide staff when making future land use decisions. This framework includes definitions, policies, and planning and development checklists.

Streams within the Line Creek Watershed and Stadium/Park East Planning Area are the focus of this initial stream asset inventory. The goals of the study are to determine water quality and adjacent riparian (stream) corridor conditions. This inventory will be used to establish a baseline reference of the streams and their related natural resources and to provide recommendations related to the City's goals for improving natural resource protection and stormwater management.

Location of the two study areas in relation to the city and region.

Major conclusions drawn from field data collection and analysis are two-fold. First, some of the streams appear to be stabilizing, while others remain in a state of fluctuation or dynamic change. Second, the level of water quality within the streams appear to be directly linked to the amount of impacts within the adjacent riparian corridors. Thus, most of the streams having average to poor water quality have moderate to highly impacted adjacent riparian corridors. Among the major factors contributing to the instability of the streams are increasing pollutant concentrations, water volumes and velocities entering from overland runoff, trash and debris buildup, and storm sewer outfalls. Variations in stream conditions between the two study areas are most likely due to differences in age and development patterns. Development within the Stadium/Park East Planning Area is older than that found within most of the Line Creek Watershed. Also, development patterns within the Stadium/Park East Planning Area conform to the steep topography, whereas current development patterns within Line Creek appear to disregard its physical aspects.

The study analysis shows an absence of highest (Type 1) and lowest (Type 5) quality streams within both study areas. In the Line Creek Watershed, results indicate a number of stream segments rank as high quality (Type 2), especially within the main channel of Line Creek. The majority of the remaining stream segments rank as restorable (Type 3) with the exception of a few low quality (Type 4) stream reaches. The low quality reaches occur where development pressures are the greatest.

In Stadium/Park East high quality and restorable (Type 2 - 3) stream reaches are generally found in areas with little disturbance/development and with intact vegetated corridors, while Type 4 (highly disturbed) streams are generally located adjacent to major roadways or newly disturbed/developed areas.

High quality Type 2 stream.

Type 4 stream, highly disturbed due to chemical exposure.

Direct encroahment on stream by development within Stadium/ Park East Planning Area.

executive summary

The Stadium/Park East Planning Area is mostly developed, providing minimal opportunity for new development but at the same time providing opportunities for improvement at the time of redevelopment. Recommendations for this study area place the greatest emphasis on protecting the buffer areas along Round Grove Creek and reducing the amount of impervious surfaces (roads, parking lots, roof tops) as appropriate during redevelopment. The parking lots at the Truman Sports Complex (the Stadiums) and Blue Ridge Mall are two prime areas for implementing Best Management Practices (BMPs) to demonstrate the value of these practices in reducing stormwater runoff from the site while providing additional functional value in the form of shade and aesthetics.

Recommendations for the two study areas reflect major differences in existing resources, development age, structure and type, and the potential for implementation of "greener" solutions in future developments. Line Creek Watershed is only partially developed. Pressure to develop the remaining open space is placing a considerable burden on City staff to make quick decisions without enough base information regarding resources present to assist them with these decisions. Recommendations for this watershed focus on protecting the high quality stream reaches within Line Creek through vegetated buffers, parkways and open space, cluster development, relocating the proposed Community Mixed Use Center, and realigning a few proposed streets and intersections.

Phase II of the Kansas City Stream Asset Inventory which is currently underway, will evaluate 5 watersheds in the Northland area (Platte and Clay counties) of Kansas City, Missouri. The results of this inventory will provide City staff with an even clearer picture of the natural resources within the northland and the best methods for protecting those resources as this area rapidly develops. Recommendations will also be made as to how to integrate natural resource tools and strategies into the City's infrastructure management program.

Limestone falls within a high quality stream reach of Line Creek.

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Chapter 2

Introduction

"To be successful in the next century, we must think of our expenditures for public safety, preservation of the natural environment and maintenance of public infrastructure as long-term investments." (FOCUS Kansas City Plan)

Functional natural system with native vegetation.

Development patterns within the Kansas City metropolitan area are greatly impacting the existence and function of natural systems. Destruction of these important and valuable systems can pose risks to life and property and greatly increase the cost of development.

Healthy, functional natural systems are an integration of:

- Topography
- Soils
- Water Resources
- Floodplains
- Native Vegetation
- Wildlife Habitats

Wildlife habitats.

New federal regulations (Non-Point Discharge Elimination Phase II), will require major changes to traditional perspectives and methods of dealing with stormwater runoff, and protecting and improving water quality. Cities, counties, and states must learn to deal with stormwater in a manner which is healthier, safer, and more in balance with the natural environment. Most municipal, county, and state agencies are only beginning to understand the interrelationship of urbanization, and natural, economic and cultural resources.

Past management strategies for stormwater have concentrated on getting runoff away from the site as quickly as possible. This is accomplished by using methods which place streams within straight, narrow, concrete or rock riprap channels, or pipe the water underground to the nearest stormwater sewer or open stream. Many cities, however, are beginning to realize that this is no longer an acceptable solution as it is costly and inefficient. A major reason cities often become responsible for riparian systems within urban areas is that they are generally undevelopable (thus of little value to developers) and they can be used to accommodate public utilities for sewer easements and stormwater runoff.

Concrete channel represents a once commonly used stormwater management practice.

A three-tiered approach **(Inventory, Prioritization, and Protection)** has been developed to provide city staff with some tools necessary to achieve successful long-term growth and stability within the community.

Achieving these GOALS will:

- Increase base knowledge of existing resource types and locations
- Prioritize and integrate environmental, social, and economic resources
- Improve stormwater management to prevent flooding and improve water quality
- Decrease infrastructure cost and maintenance
- Make land use decisions that are ecologically sound

An integrated approach to stormwater management that equates water quality to quantity (Q2).

By using this type of approach, the City of Kansas City, Missouri is stepping up to the challenge of understanding, protecting and incorporating its natural resources into development and stormwater management practices. Staff throughout various City departments will be able to coordinate and facilitate a new approach to development within the city and region that make cultural, environmental, and economic sense.

The **DEPARTMENTS** include:

- City Planning and Development
- Environmental Management
- Neighborhood and Community Services
- Parks and Recreation
- Public Works
- Water Services

Downtown Kansas City, Missouri.

Inventory

In order to make ecologically sound land use decisions, it is critical to have a base knowledge of existing natural resources; their condition, and relationship to current and planned land uses. Soil surveys, topographic maps, aerial photography, and historic documentation can be useful in providing a picture of changes in resource condition over time.

INFORMATION consists of:

- Current Geographical Information System (GIS) mapping
  - Surface water resources - streams, rivers, lakes, and wetlands
  - Land use
  - Current and future development plans
  - Natural areas and parks
  - Recent aerial photographs and topographic maps
  - Major street and utility plans
- Site specific field data collection (see chapter 3 - The Assessment Process)

Aerial photography used to provide a larger picture of current land use.

By using the above resource documents in conjunction with field work, assumptions can be made as to where resources potentially exist and in what condition. Site-specific ground-truthing (randomized sampling) is necessary to verify the accuracy of these assumptions.

Prioritization

Citizen surveys have been conducted throughout the region regarding numerous issues affecting developed and developing areas. These surveys have been conducted by agencies such as the Mid America Regional Council (MARC), municipalities, counties and the state. Results of these surveys show the number one concern of citizens within the Kansas City region is to protect water quality. Other high ranking concerns include: protecting natural resources, providing open space and conservation areas, and the desire for walking trails. Many municipal, county, state and federal agencies are working together to address these issues. However, given the rapid pace of development and limited resources within urban areas, it is necessary to prioritize resources.

Determining resource conditions prior to field work.

PRIORITIZATION will help the City:

- Conserve existing, high quality, natural resources
- Identify resource potentials and amenities for development and recreation
- Identify and categorize resources suitable for restoration
- Assess infrastructure problems and potential solutions

Protection

Collecting data and setting priorities are only the initial steps to protecting natural resources and allowing for healthy, productive growth within the region. Besides environmental benefits there are many social and economic benefits to protecting and restoring natural resources.

PROTECTION Strategies include:

- Integrating watershed management across department and city boundaries
- Implementing stormwater Best Management Practices (BMPs)
- Implementing stream buffers and setbacks
- Setting the standard for watershed stewardship through public education and involvement
- Balancing regulations, incentives, and partnerships

Existing high quality natural resources.

By using these strategies throughout the development process, the city and region can coordinate funding from multiple sources, reduce duplication of effort, decrease costs for infrastructure maintenance, and improve the overall quality of communities throughout the region.

Site analysis of stormwater runoff.

For these strategies and tools to be USEFUL to city staff, they must be:

- **User friendly**
- **Easy to understand**
- **Easy to implement**
- **Reasonable to enforce**

All of the steps within this three-tiered system are critical to providing planners and other decision makers with the necessary strategies and tools to integrate the natural environment and the human environment in a healthy and balanced manner. By implementing short-term and long-term guidelines for resource protection, the biological health and function of streams, rivers and other natural resources will be maintained and improved throughout the region.

Providing water quality and resource protection is vital for our future.

Chapter 3

The Assessment Process

Site Selection

The Line Creek Watershed north of the Missouri River and Stadium/Park East Planning Area south of the river, were the two areas selected for this study. Initial selection was based upon location, past, present, and proposed development patterns, and stormwater issues. As part of the Inventory process, the project team verified and expanded in-house information provided by City staff. Current aerial photographs were used to determine the optimal number and location of field sample sites. Each sample site encompassed 3 sample points: left bank, streambed, and right bank. Sample sites were chosen based on a variety of positive and negative land use conditions. They represent locations adjacent to developments, upstream of developments, adjacent to relatively undisturbed areas, and at the confluence (junction) of two streams.

Selected study area locations.

CRITERIA used in selecting sample sites:

- Geography - physical location
- Geology and topography - soils, steepness, length, and shape of slopes
- Hydrology - water sources and drainage patterns
- Land cover - vegetation
- Land use - rural/urban, undeveloped/developed, older/newer development
- Project budget


Site selection criteria including topography and hydrology.

Descriptions of soil types and locations provide critical information on the suitability, limitations, and management of soils for specified uses and assist in planning future land use patterns. Suitability for use as building sites is generally dependent upon slope, shrink-swell potential, permeability and frost action.

Line Creek Watershed has a range of development types from established residential areas to those with no development, but that will soon be developed, while the Stadium/Park East Planning Area includes mostly older commercial and residential developments. Land use within Line Creek appears to show little regard for topography whereas within the Stadium/Park East Planning Area land use patterns are typically constrained by the slopes and streams within the area.

COMPARISONS of streams within and between areas will increase staff understanding of:

- **How quickly natural resources are impacted by changes in land use**
- **The importance of early protection of existing resources**
- **How implementation of protection strategies will provide environmental, economic, and social benefits throughout the region.**

Line Creek Watershed Site Selection

The Line Creek Watershed is an approximately 20 square mile area in southwest Clay and south-east Platte counties. The study area boundary is the watershed boundary indicated in Figure 3.1, which lies slightly north of Hwy 152 on the north, Hwy 9 on the south, MO 71 on the west and the Kansas City limits east of Hwy 169. This watershed includes Line Creek and three of its major tributaries, East Fork, Old Maids, and East Creek.

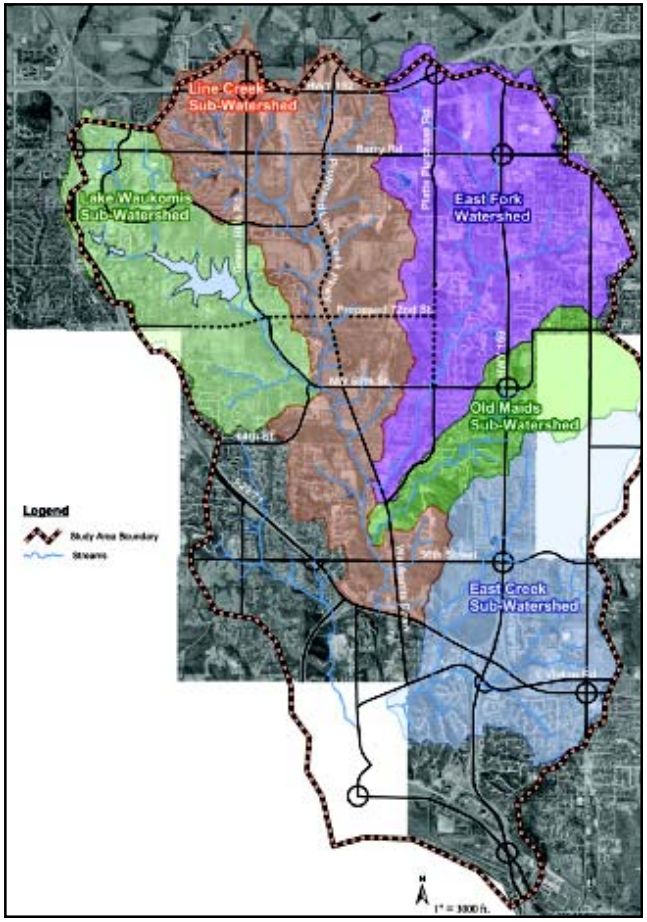


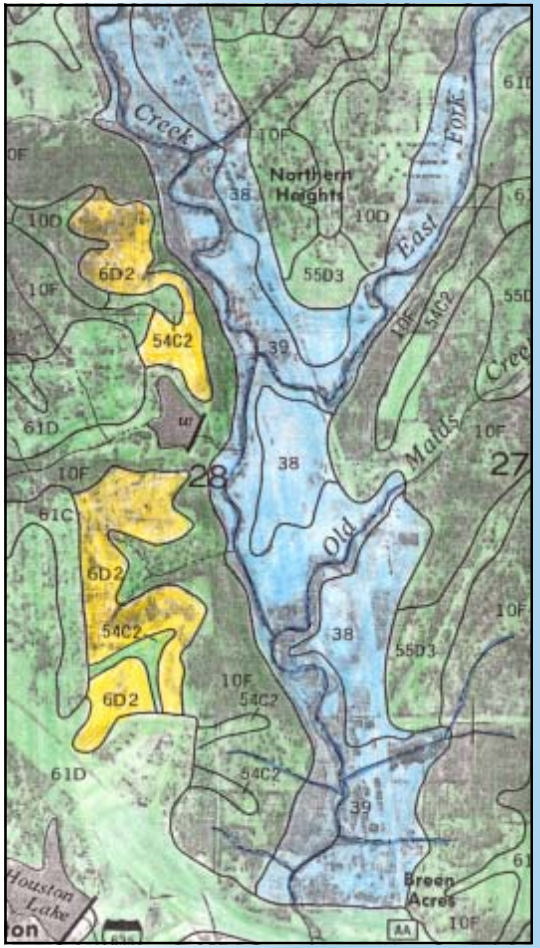
Figure 3.1 Tributaries and their subwatersheds within Line Creek Watershed study.

Soils present are representative of three main soil associations (represented on soils map):

Nodaway-Colo-Wiota - (blue, 39, 31, 38) deep, nearly level, moderately well drained and poorly drained soils formed in alluvium (deposits by running water) on floodplains and terraces. Soils are generally unsuitable for building.

Sharpsburg-Higginsville-Sibley - (yellow, 6D2) deep, gently sloping to strongly sloping, somewhat poorly drained to well-drained soils formed in loess or residuum from shale and limestone; on uplands. Soils are generally suited for building.

Knox-Snead – (green, 54, 55, 61, 10) deep and moderately deep, gently sloping to steep, well drained and moderately well drained soils formed in loess or residuum from shale and limestone; on uplands. Soils are well suited for building. The moderately steep and steep soils are not suited to urban development.



Map of soil associations within the watershed.

The **topography** is generally steeply sloping hills with relatively flat areas within the floodplains of Line Creek. Bluffs, ravines, tree cover (native oaks, hickories, black walnut), views and connectivity by major roads, provide distinct character to this watershed.

Line Creek receives water from Lake Waukomis and several small, unnamed lakes. The area east of Line Creek above its confluence with East Fork Creek is relatively undeveloped. The north area adjacent to Line creek is extensively developed primarily with single family and multifamily residential uses. Stormwater enters Line Creek as overland runoff from fields, gullies, and cross-streets. Line Creek flows south for another half-mile before the confluence with Old Maids Creek. The topography in this area is relatively flat. This area is developed and undergoing more residential development. Most of the water in this area enters the stream as runoff from roads, parking lots, roofs, and neighborhood yards.

East Fork Creek extends about 2 miles to the northeast from its confluence with Line Creek to a small, unnamed lake near Highway 169. The topography of the watershed is flat to gently rolling. Land use on the eastern side of East Fork is residential development from the unnamed lake to its confluence with Line Creek. The western side of East Fork Creek contains wooded areas interspersed with residential development closer to the confluence with Line Creek. Most of the water entering the stream in this area comes from stormwater runoff flowing into storm sewers and then into the stream or flowing over paved areas and residential yards directly into the stream.

Old Maids Creek is about 2 miles long and is located approximately one-quarter mile south of, and relatively parallel to, East Fork Creek. The topography of the watershed is flat to gently rolling. Old Maids Creek originates in several housing subdivisions located east of Highway 169, between 64th and 66th Streets. The area around Old Maids is primarily residential, with new housing subdivisions being built adjacent to the stream. Much of the water that enters Old Maids is surface runoff from residential yards, roads, or storm sewers.

Three box culvert on East Fork.

View of Line Creek north of confluence with Old Maids Creek.

Bank sloughing along East Creek due to nearby development.

East Creek is a tributary to Line Creek located almost a mile south of, and relatively parallel to, Old Maids Creek. East Creek originates in the housing subdivisions located east of Highway 169, between 58th and 61st Streets. The topography of the watershed is flat to gently rolling. Land use within the portion of the watershed east of Highway 169 is predominantly residential. In general, backyards provide the only buffer for the stream from overland runoff. The portion of the watershed west of Highway 169 is also being developed into a single family residential area. Overland runoff is the primary contributor of water and sediment to the stream in this area.

While there is a significant amount of development within the Line Creek watershed, there is still a considerable amount of open space scattered throughout. Development within this watershed is, however, occurring rapidly and has strong potential for negatively impacting water quality and riparian corridor conditions long after build out is complete.

A total of 4 **streams** including the main channel of Line Creek were chosen for this study area. (See figure 3.2)

- East Creek – 5 sample sites (15 sample points)
- East Fork Creek – 9 sample sites (27 sample points)
- Old Maids Creek – 6 sample sites (18 sample points)
- Line Creek – 9 sample sites (27 sample points)

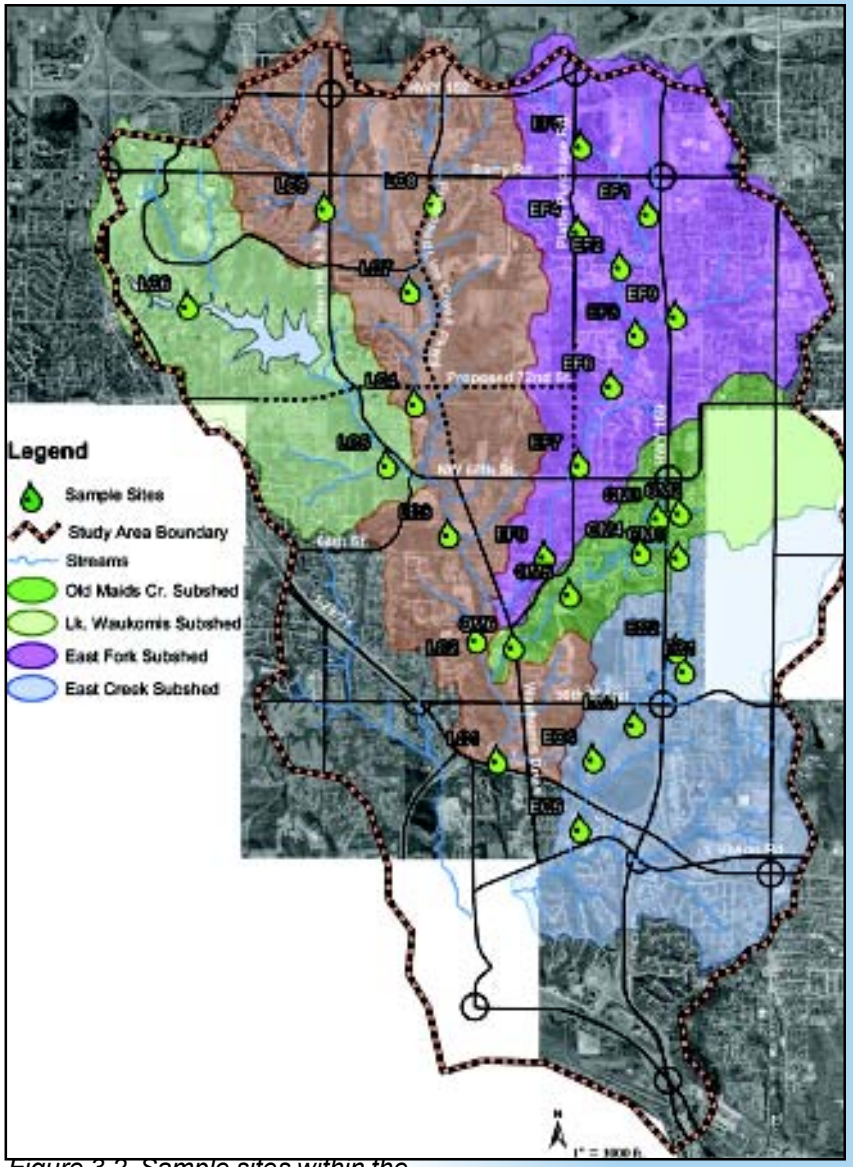


Figure 3.2 Sample sites within the Line Creek Watershed study area.

Stadium/Park East Planning Area

The Stadium/Park East Planning Area is an approximately 20 square mile area located in western Jackson County, bordered by the Blue River on the west, Kansas City city limits on the east, 23rd Street on the north and 87th Street on the south. Round Grove Creek is the only named tributary of the Blue River within this planning area.

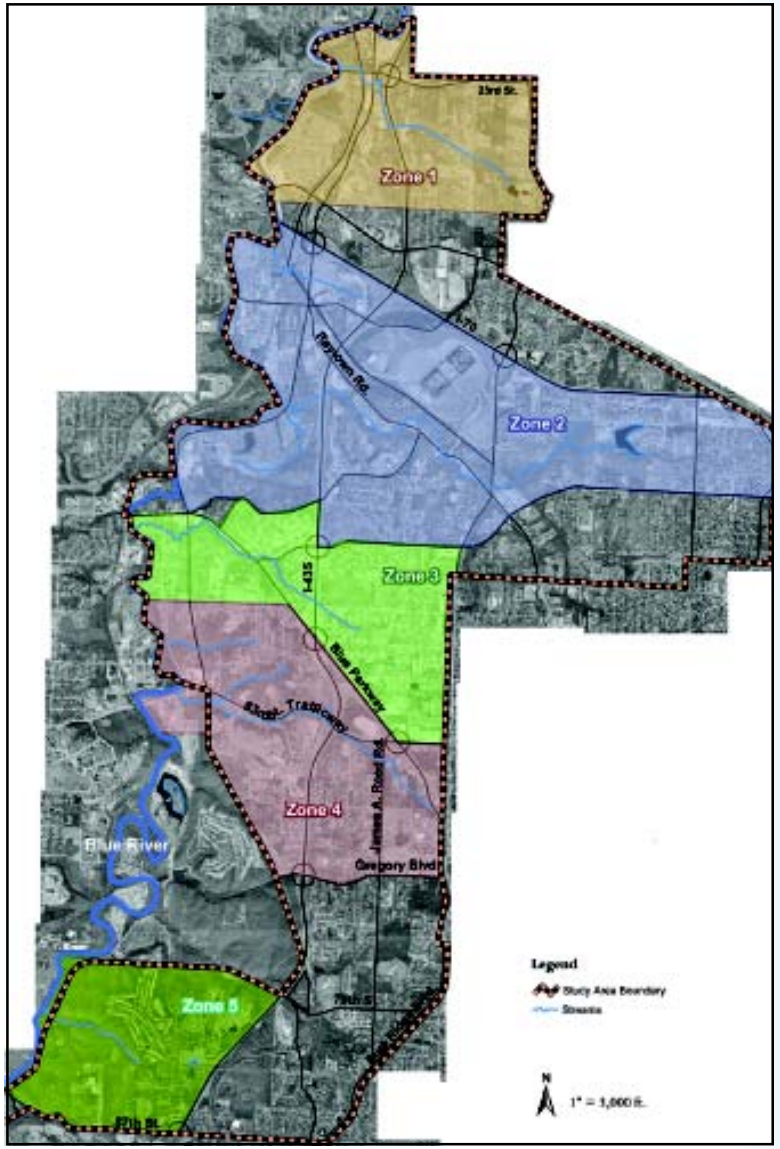


Figure 3.3 Tributaries within the Stadium/Park East Planning Area.

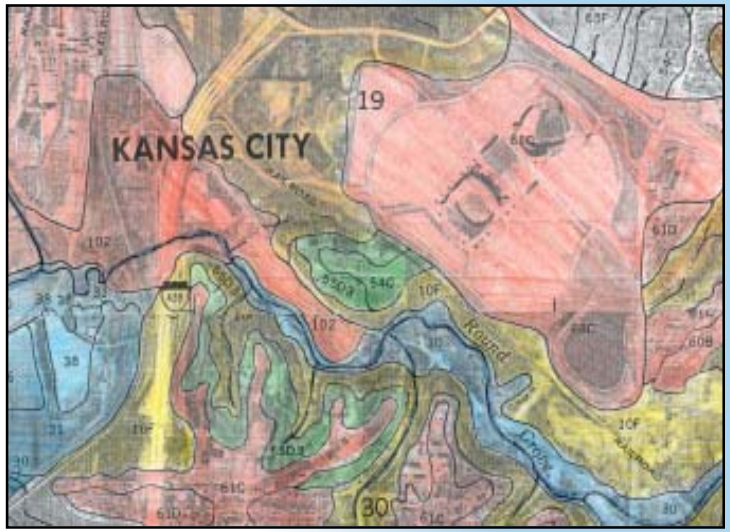
Round Grove Creek.

Soils present within the planning area are representative of three main soil associations (represented on soils map to right):

Kennebec-Colo-Bremer - (blue, 30, 31, 36, 38) deep, nearly level, moderately well drained and poorly drained soils formed in alluvium (deposits by running water) on flood-plains and terraces. These soils are generally not suitable for building.

Snead-Menfro-Oska – (yellow, 10) moderately deep and deep, gently sloping to steep, well-drained and moderately well drained soils formed in loess or residuum from shale and limestone on uplands. Snead, Menfro and Oska soils are generally suitable for building site development.

Knox-Sibley-Urban Land – (Green/Red/Orange, 54, 55, 61, 60, 102) Urban land and deep, gently sloping to steep, well drained soils formed in loess on uplands. These soils are suitable for building.



Map of soil associations present within the Planning Area.

Features of the planning area that contribute to its character include bluffs, ravines, tree cover, highly visible sites, views of the downtown skyline, and strong linkages to other areas of the city by major roads. The area's topography is characterized by ridge lines with moderate slopes that lay between two major river valleys, the Little Blue River to the east and the Blue River to the west. Drainage tends to flow away from the area toward the Blue River, creating a low potential for flooding.


Topography characteristic of area.

The northern and eastern areas are highly developed in residential and commercial uses. Due to the amount of development (i.e., pavement) present, very little water seeps into the ground. Water in this area primarily flows into storm sewers and ditches, which then discharge into Round Grove Creek, the unnamed tributaries, or directly into the Blue River.

A total of 5 **streams** located throughout the planning area and a representative number of sample sites were chosen for this study. Unlike the Line Creek Watershed which has named tributaries and defined sub-watersheds, the Stadium/Park East Planning Area does not have these as reference points. Therefore, the study area has been divided into zones for the sake of discussing study results (See figure 3.4).

- Zone 1 (RGC1) - Underground Mines – 3 sample sites (9 sample points)
- Zone 2 (RGC TRN) - Round Grove Creek (Stadiums System) - 8 sample sites (24 sample points)
- Zone 3 (RGC2) - Septic Systems – 5 sample sites (15 sample points)
- Zone 4 (RGC3) - Girl Scout Headquarter Bldg. – 8 sample sites (24 sample points)
- Zone 5 (RGC4) - Future Development Site – 3 sample sites (9 sample points)

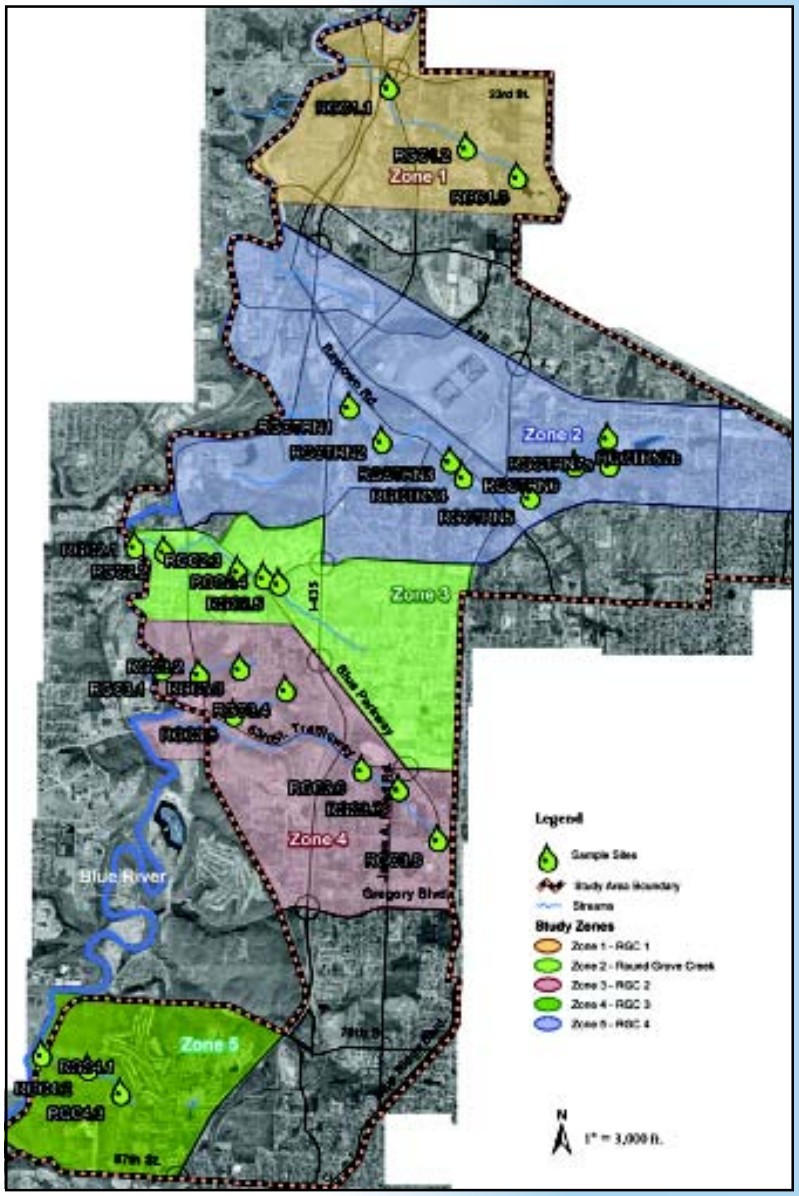


Figure 3.4 Sample sites within Stadium/ Park East Planning Area.

Stream Assessment Methodology

Field Assessment

The methodology used for this project has progressed through a development and testing process initiated with the City of Lenexa's Stream Assessment and Natural Resource Inventory Project (Project Report December 2001).

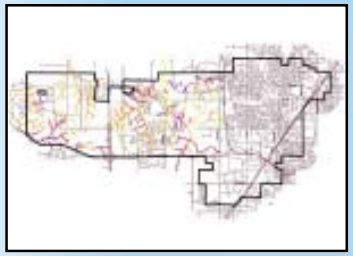
The PROCESS begins with a field assessment that includes:

- Characterization of Streambanks and Streambeds
- Characterization of Erosion and Sedimentation
- Stream Flow Rate
- Identification of Overstory and Understory Vegetation
- Identification and Classification of Aquatic Invertebrates (small water animals)

The project team downloads the field data collected from each sample site into a spreadsheet for analysis. They give each of the above factors a numeric value that is used to determine stream type (Type 1 - highest quality to Type 5 - lowest quality) for each segment assessed.

The preliminary field investigation consists of field reconnaissance, streambank and streambed characterization, erosion characterization, measurement of flow rate, vegetation identification, aquatic identification and classification, site photographs, and general observations of stream conditions. These factors were combined to determine the general health of the stream and future restoration opportunities for the watershed. Field data sheets and photographs are located in the Report Supplement (separate document).

Field assessment team collecting data.



Base map of stream types derived from data analysis.

Potential stream buffers based on stream conditions.

Streambank and Streambed Characterization

Streambank and streambed characterization is used to determine the physical stability of the stream channel. Stability is based upon material composition and erosion potential characterized below:

Composition	Erosion Potential	Stability
Sands and gravel	High	Low
Silts and clays	High	Low
Bedrock	Low	High
Riprap (large rocks)	Low	Moderate to high
Mix of the above	Moderate to high	Moderate to high

The physical form of the stream channel is shaped by the forces of water (direction and velocity of stormwater and surface runoff) acting on these base materials. Channel downcutting (vertical deepening of channel) occurs when channel stability is low. Bank incision or cutting (horizontal widening of channel) occurs when bank stability is low and bed stability is high. Erosion can also lead to stability problems for structures located too close to the stream channel, cause water quality problems downstream, and be unhealthy to aquatic organisms. Channels lined with riprap have variable characteristics, typically eroding only during major storm events and/or after several years of exposure. However, while used for streambank stabilization, these large rocks can increase runoff velocities and volumes resulting in an increase in erosion and sedimentation downstream, upstream, or even at the location of the riprap.

Mixed channel, silts and clays with gravel.

Bedrock lined channel.

Streambank lined with rip rap.

Erosion and Sedimentation Characterization

Several factors are used to evaluate rates of erosion and sedimentation:

- Overland runoff
- Water turbulence
- Tree fall disturbance
- Natural debris (tree limbs)
- Stream channel constriction
- Toe (base of bank where it meets the stream bed) erosion
- Streambank slippage
- Agricultural use

Streambank slippage with agricultural field in background.

Each of these factors serves as a useful indicator of the cause(s) and extent of erosion, and the amount of sediment entering the streams. These factors also assist in identifying restoration opportunities available to each sample site location.

Flow Rate

Flow rate was calculated using a conservative average of 11 gallons per minute per cubic inch of water (U.S. Department of Agriculture [USDA] 1935). The flow rate was calculated by multiplying the width of the stream (in inches) by the average depth (in inches). This value was multiplied by 11 to determine the flow rate of the stream (in gallons per minute).

Determining rate of flow of water present within streams.

Vegetation Identification

The types, diversity, and condition of vegetation present are important factors in determining the condition of the riparian corridor and its ability to protect the stream. The "canopy or overstory layer" consists of a variety of tree species, while the "understory layer" consists of shrubs, vines, and/or herbaceous plants, and occasionally small trees. The top three dominant overstory and understory vegetative species are identified for both right and left bank at each sample site.

Stream shading resulting from overhead tree canopy.

This information is important to:

- Determine percentage of shading of stream provided by overhead vegetation.
- Assess the amount of erosion prevention from vegetation type present.
- Determine vegetative restoration opportunities.

Identification of dominant vegetative species present including trees, shrubs, and ground cover.

A combination of professional knowledge of the field assessor and a variety of plant identification guides and keys were instrumental in identifying vegetation. These included the Textbook of Dendrology (Harlow and Others 1996); Missouri Trees (Missouri Department of Conservation, 1980); Trees, Shrubs, and Woody Vines in Kansas (Stephens, 1969); Weeds of Nebraska and the Great Plains (Stubbendieck, Frisoe, and Bolick, 1995); and Flora of Missouri (Styermark, 1996).

Aquatic Identification and Classification

Prominent aquatic invertebrates (damsel fly larvae, dragonfly larvae, snails, crayfish, etc.) are sampled using a method practiced by the Missouri Stream Team. Randomly selected sites are sampled using a 3 foot square, fine mesh, cloth net called a kick net (Murdoch and Cheo, 2001). The base of the net is anchored to the bottom of the stream and held in place at an angle while a 1-square-meter area of substrate upstream is stirred up causing any aquatic invertebrates present to float into the net. The invertebrates are identified to the family level, using field identification sheets. Each family of invertebrates is grouped into a general quality category from Group 1 being the best, least pollution tolerant to Group 3 being the worst, most pollution tolerant. The presence of fish and mollusks is another indicator of moderate to good water quality.

Adult dragonfly.

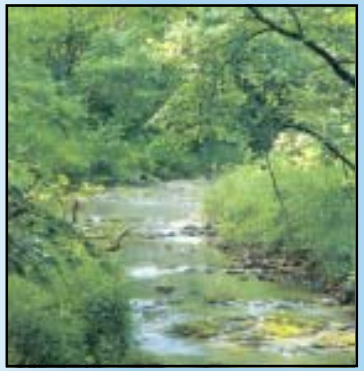
Caddisfly larvae.

Stream Scoring

Field data collected is downloaded into an Excel spreadsheet for scoring and analysis. The stream evaluation factors described above are given numeric scores based on USDA scoring methods. The score values are then weighted using the professional knowledge and judgement of field biologists involved in this project **(**see Appendix C for the complete scoring sheet**)**. Scores for each data point are totalled, averaged, and then compared to the range for all values within the study area. Determining the range for each stream segment is possible by calculating the mean value for the study area + 1 Standard Deviation (SD).

Type 1 - Highest Quality

Generally described as the highest quality naturally occurring stream with little negative impact. Erosion and sedimentation is low, water quality indicators are positive and the surrounding riparian zone is a healthy, mature, succession woodland or other high-quality environment.



Type 1 high quality stream.

Type 2 - High Quality

This type of stream may have some down or side-cutting however, bank and bed composition (bedrock) assist in keeping the impact low. Water quality is generally good and the riparian zone is largely intact, although vegetation may be altered from that of a typical native plant association.

Type 2 Quality stream.

Type 3 - Restorable

Deterioration of the riparian corridor is more noticeable. While some remnant plant associations may be present, overall vegetative canopy cover is comprised of immature tree species. The potential for restoration exists although erosion and sedimentation can be greater than desirable.

Type 3 restorable stream.

Type 4 - Low Quality

Impacts are greater on this stream type with significant indicators of bank erosion and sedimentation present. The adjoining riparian corridor may be intact but vegetation is not representative of a native plant association.

Type 4 highly impacted stream.

Type 5 - Lowest Quality

The channel in this type is the most changed. The riparian corridor is becoming impaired to the point of providing little protection or benefit, and erosion and sedimentation indicators are significant. Water quality is questionable with noticeable phosphate and nitrate loading (large algae blooms).

Type 5 extremely impacted stream.

Chapter 4

Stream Assessment Inventory Results

Although many of the conditions and impacts noted during the field survey were common to both study areas, the streams within these two study areas are in distinctly different phases of their evolutionary cycle. One note of particular interest is that neither study area contains any stream reaches of highest (Type 1) or lowest (Type 5) quality. Streams within the Line Creek Watershed exhibit a greater diversity of conditions within adjoining stream reaches, however, many are showing evidence of damaging influences from increasing development within the watershed. The majority of streams within the Stadium/Park East Planning Area are in moderate to good condition, appearing to be reaching a level of stability associated with the absence of new development. Development within this area reached its peak many years ago, and left undisturbed, the streams return to relative equilibrium.

It is critical to minimize development impacts upon streams and water quality.

Studies show that a disproportionate amount of damage is done to stream quality during the relatively short period of active site development. Field observations indicate the existence of turbidity and sediment plumes attributable to development within the watershed. Cumulative downstream impacts of sediments and other pollutants are a significant contributor to water quality degradation in the study area. Unless proper erosion and sediment control practices are enforced as the watershed develops, these cumulative impacts will increase the negative impacts on water quality and aquatic systems.

Line Creek Watershed Results

In general, the condition of Line Creek and its three major tributaries (see map page 33) is good to moderate with the higher quality stream reaches (Type 2) generally found within the main channel of Line Creek, which has, until recently, remained relatively undeveloped. East Fork Creek has the broadest range of stream conditions (Type 2-4), where the better quality reaches remain only in those areas containing a well-vegetated riparian corridor. Of all of the streams within both study areas, Old Maids and East Creek are in the worst condition (predominantly Type 4) throughout the full length of the tributaries. Both of these streams are influenced by high density residential developments and Highway 169 within their headwaters.

Deteriorating section of Line Creek.

Streams within the Line Creek watershed are in a greater state of flux and degradation due to impacts from increasing development. Existing agricultural land uses within the floodplain are rapidly giving way to residential and commercial developments resulting in a higher percentage of impervious surfaces within the watershed, and consequently, an increase in stormwater runoff entering the main channel of Line Creek. The impacts of these new development types are evident at many locations along Line Creek and its tributaries. Where roads extend right up to streambanks in several locations, hydraulic constrictions from road crossings and undersized stormwater infrastructure are evident. As a result, many streambanks have been regraded from their natural meandering state with native plant species, to straighter and more channelized with non-native, exotic species as the dominant vegetation, both by intent and neglect. Erosion resulting from increasing overland runoff is also prevalent throughout the watershed, especially downstream of newly developed or developing areas.

Agricultural lands are quickly converted to housing and commercial developments.

Thus, many of the streams are exhibiting the following conditions:

- Downcutting and incising of streambanks is increasing, although some reaches have streambeds composed of bedrock that are helping to stabilize these cuts.
- Removal of riparian corridor vegetation along most sample sites throughout the watershed where residential development has occurred up to the edge of the stream-banks.
- Toe erosion and treefall disturbance are leading to further bank instability problems.
- Bridges and sanitary sewer lines are acting as constriction points collecting natural and man-made debris which then inhibits stream flow through the structure, resulting in increased flooding, bank destabilization upstream and downstream and damage to the bridge infrastructure.

Toe erosion exposing tree roots.

Downcutting of stream channel resulting in exposed sewer lines.

Specific positive and negative impacts to water quality noted in field observations include:

- Presence of intact quality riparian corridor vegetation along Type 2 stream reaches (LC1, LC3-5, and EF8).
- Low water crossings in need of repair and/or retrofit at the end of northwest 60th St.(sample site LC2), NW 64th St. (south of sample site LC3), and the end of NW 78th St. (sample site LC7).
- Streambank and road stabilization (sample site LC3). Mayview Avenue currently comes directly up to the top edge of the streambank resulting in high quantities of unfiltered runoff flowing directly into the main channel of Line Creek, increasing bank instability, and deterioration of the road bed.
- Treefall debris on north side of box culvert on NW 68th St. (south of LC5).
- Lack of proper sediment and erosion control measures on construction sites adjacent to stream reaches (sample sites LC8, LC3, and EF7).
- Increasing pollutants, sediment, and nutrients are entering the streams as evidenced by man-made debris, sediment plumes, turbidity, algae blooms, and foam at several locations (LC9 and EF 3).

Vegetated corridor along main channel of Line Creek.

Bank stabilization using grouted riprap.

Chemical pollutants from overland runoff.

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Stadium/Park East Planning Area Results

Stream segments of Round Grove Creek in Zone 2 (see map page 37) are in moderate to good (Type 3, 2) condition with the exception of the segment south of the Stadium Complex which is in poor condition (Type 4). This segment exhibited severely eroded banks, septic odors and trash, and a stream channel constriction formed by the bridge on Eastern Rd. The stream segments within Zone 5, in the southern most part of the plan area are in moderately good condition (Types 2 and 3). Stream reaches within Zones 1 and 3 are in moderate to poor condition (Types 3 and 4). The tributary exhibiting the widest range of stream types and land use conditions is in Zone 4 (Types 2-4).

Although signs of historic degradation are present, it appears that streams within the Stadium/Park East Planning Area are well into the process of stabilization. The age and nature of development throughout this area has resulted in places where disturbances (construction), a lack of management, and intentional introduction (roadside plantings) of exotic species have negatively altered the function of the landscape and the streams. Although the vegetation present is a mix of native and non-native exotic (crown vetch, amur honeysuckle, and musk thistle) plants, it is helping to stabilize many of the streambanks. Another factor influencing these streams is their downcutting to bedrock which often results in stabilization of the stream's profile.

Encroachment by non-native, exotic vegetation .

Land use within the planning area is generally low to medium density residential, with some commercial and industrial development interspersed along major road and railroad corridors. Mixed throughout these developments are large expanses of pavement in places like the Truman Sports Complex, Blue Ridge Mall and Bannister Mall. There are existing pockets of open space located between I-435, I-70 and the Blue River. There is potential for infill residential and commercial development to occur in the southwestern portion of the planning area using the numerous vacant lots. Industrial and commercial redevelopment have the greatest potential to change characteristics of existing streams by increasing surface runoff thereby increasing flow rates, volumes and erosion.

Many of the streams within the Planning Area are exhibiting the following conditions:

- Trash and other man-made waste, including oil and grease.
- Localized algae growth due to nutrient rich overland runoff entering the stream unfiltered.
- Constriction points created by combined sewer outflows (CSO) and box culverts which impede flow, increase flooding and bank erosion, and decrease infrastructure stability.
- Riparian corridors dominated by non-native, exotic vegetation.

Encroachment of development with subsequent removal of stream buffer vegetation.

Several positive and negative impacts to water quality of specific notation include:

- Zone 1 generally has a severely impacted riparian corridor and poor water quality due to the proximity of residential development and the absence of a buffer to filter overland runoff, sediments, and pollutants.
- Zone 2 is in moderately good condition with the exception of site 1 where there is a deeply scoured north bank, septic odors, man-made trash, and a constriction due to the bridge at Eastern. Sites 3 and 4 need removal of non-native, exotic vegetation. There is an abandoned rail line on the west side of site 5.
- Zone 3 has a deeply incised stream channel and the vegetation is sparse and immature.
- Zone 4 shows the greatest impacts within the collection zone (headwaters) where there is the greatest amount of development. The low quality of the stream reach at the confluence with the Blue River is likely a result of changes occurring within the Blue River Watershed.
- Zone 5 has the largest intact “patch” of woodland and the steepest slopes present within the study area. The Hillcrest Country Club and the Blue River are likely the contributing factors to the poor condition of the stream reaches at each end.

Healthy segment of Round Grove Creek.

Bridge on Eastern constricting stream flow during high flow events.

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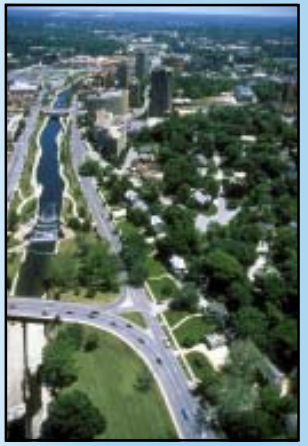
Chapter 5

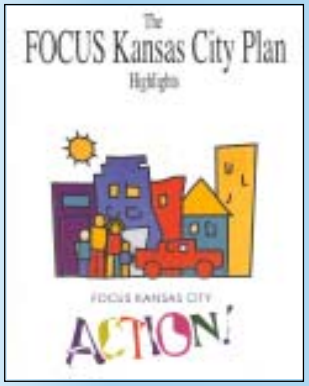
Kansas City Stream Assessment Phase I Recommendations

The undesirable effects of stormwater runoff continue to surface in the wake of site development despite best efforts to predict and mitigate consequences of each project. Citizen requests in the PIAC process often center on trying to solve stormwater problems after the fact; City watershed studies recommend millions of dollars in capital improvements to try to "manage" stormwater. At the same time there is serious concern that the natural environment is disappearing, that stream corridors are at risk daily from current development practices and that structural solutions are simply too costly and tie the City to an unfunded maintenance liability as the infrastructure ages.



Stormwater management practices along Brush Creek.

Particularly in the Northland, citizens realize the value of their natural setting and through the ***FOCUS Kansas City Plan - Northland volume,*** emphasized the importance of preserving the hills, valleys and streams of the City's natural environment while accommodating growth and development. Completion of a natural resources inventory was a primary objective of the plan in hopes that the most significant resources could be protected.



The FOCUS Plan provided the foundation for integrating natural resources.

City Planning staff plays a pivotal role in protecting the city's natural resources in that they are the "first line of defense" in making land use recommendations and then reviewing development proposals on a site by site basis. The information contained here will guide the preservation thought process so that the most effort is spent to protect the most valuable assets. This information should be shared with the development community as early as possible in the design process so the private sector becomes a partner in preservation with the City.

City decisions impact stream stability and water quality in many ways. Three areas, however, are most significant:

- **Land use planning/regulation**
- **Site development regulations**
- **Design standards for public infrastructure**

High quality stream with intact, vegetated buffer.

The recommended resource protection strategies relate to each of these three areas. The primary goal of the recommendations is to allow development while retaining the existing, working, natural stormwater systems.

Primary OBJECTIVES are to:

- **Protect and retain high quality natural resources**
- **Use natural systems such as vegetation to return stormwater to the soil rather than continuing to rely on structural storm drainage solutions.**
- **To manage precipitation as close to where it falls as is physically and economically possible.**

Tree roots provide excellent bank and soil stability and absorption of stormwater runoff.

General Land Use Planning Recommendations

Improving stormwater management is often seen as a site issue rather than a larger scale planning issue. When the objective is to protect and retain high quality natural resources, however, the process begins with conservation–sensitive land use planning. There is a direct relationship between land use intensity and resource degradation.

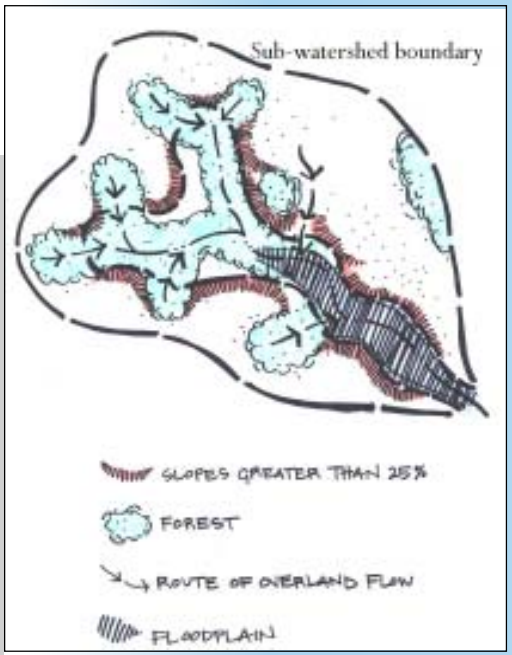
Make conservation of existing natural areas a high priority

Stream-ways, forested lands, and grasslands have an important role to play in stormwater management. Much attention is paid to stream channels, the need for setbacks and the role streamside buffers can play in improving water quality. It is equally important to understand that upland forests contribute significantly to the system as well. Forested lands serve to slow the flow of stormwater allowing for greater infiltration; they also treat stormwater by using it. Removal of large tracts of upland forest contributes to resource and stream degradation, flooding and a decrease in water quality. Larger forested areas, or "patches", at least 5 acres in size are particularly important. Strips or patches of native grassland vegetation can also provide filtration of runoff and greater soil and bank stabilization. Native grasses and wildflowers have an extensively deep root system that functions to increase soil permeability while providing greater soil stabilization than lawn or turf grasses can (as much as 15' compared to the 3-6" root system of Kentucky bluegrass, a common turf grass).

High quality natural resources are defined for the purpose of this plan as the buffer zones and upland forests and grasslands relating to Type 1, Type 2, and Type 3-Quality Streams.

Policies:

- Planners and landowners shall identify upland forest and/or grasslands of at least 5 acres in size on all land use plans and site plans prior to adoption or approval and shall indicate uses compatible with the preservation of such forests and grasslands.
- Residential and commercial uses that cover more than 25% of the land area with any type of impermeable surface, including structures, are not appropriate in high quality natural areas (the upland forests and grasslands relating to Type 1, Type 2, and Type 3-Quality Streams) and should be avoided unless there is an overriding public purpose involved. Industrial uses are not appropriate in these areas.



Anatomy of a high quality natural

- High quality natural areas (the buffer zones and upland forests relating to Type 1, Type 2, and Type 3-Quality Streams) shall be connected together wherever possible to form continuous corridors, instead of isolated segments. The City shall encourage the development and preservation of such corridors by such means as a property tax credit for the conservation of land, allowing set backs and buffer areas from high quality natural areas to count against required parkland dedication, and allowing stormwater credits.

High quality prairie/grassland includes a variety of native grasses and wildflowers.

Planning and Development Review Checklist:

- ☐ Does the development contain "patches" of upland forest of 5 acres in size or greater? Figures 5.1 and 5.2 show the location of upland forests in the Line Creek and Stadium/Park East planning areas. Outside those areas planners should consult current, regional aerial photography, which shows the generalized location of upland forests throughout the city, and verify them with a smaller scale aerial photograph and preferably a field check.
- ☐ Can the patches be connected by at least a 100-foot wide permanent open space, homeowner easement, or section of parkland?
- ☐ Does the land use plan propose high intensity land uses in Type 1, Type 2, and Type 3 Stream buffers or upland forested or grassland areas?
- ☐ Can the high intensity land uses be shifted to preserve the patches and connections?

High quality woodland contains large areas with variety of native trees and shrubs.

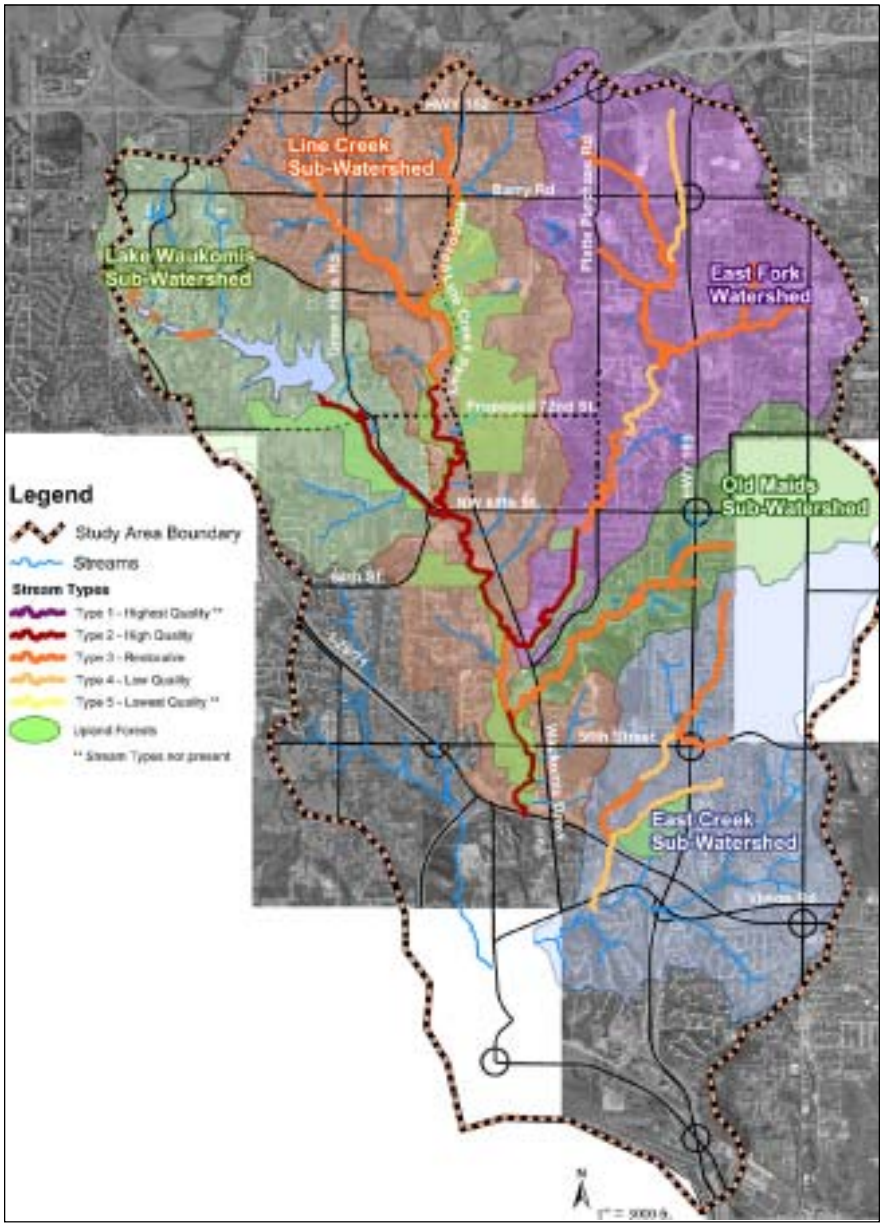


Figure 5.1 Upland forest areas adjacent to streams within the watershed.

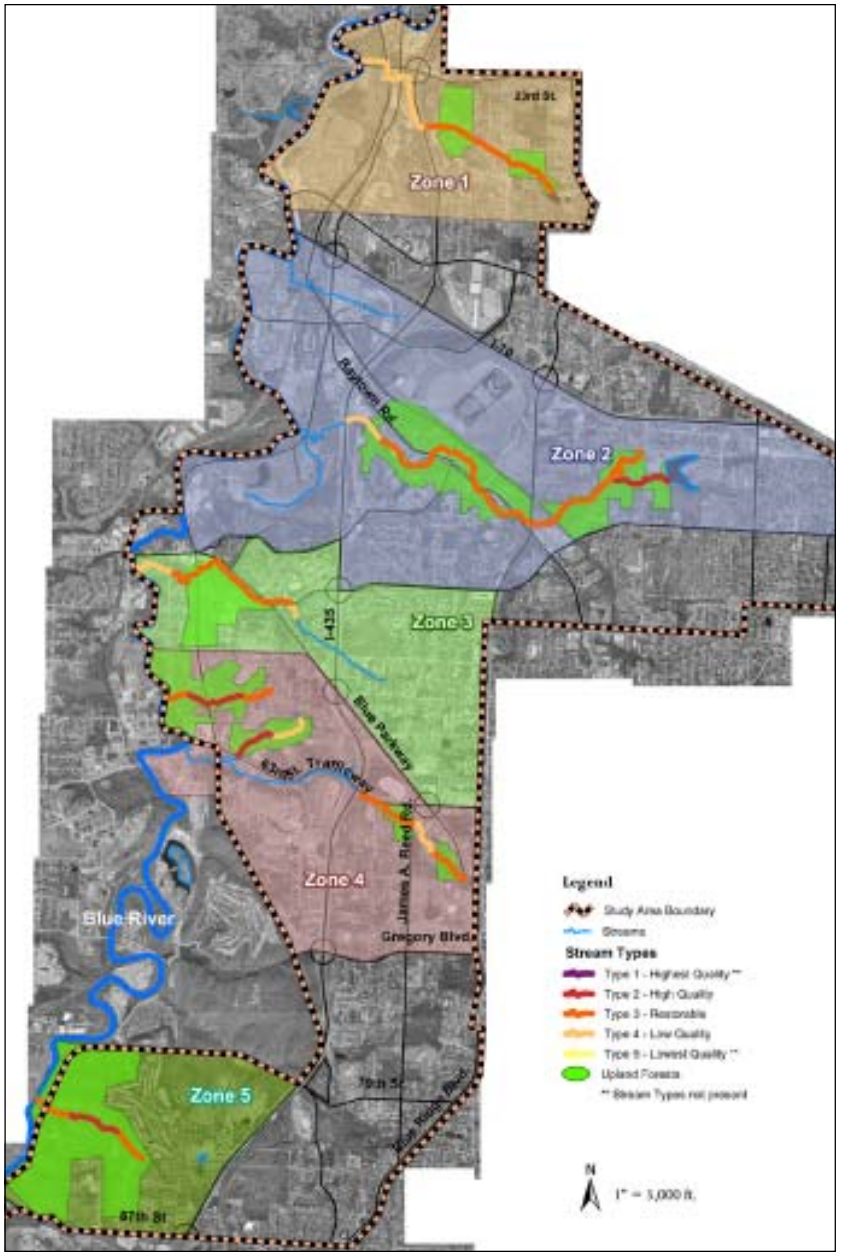


Figure 5.2 Upland forest areas adjacent to streams within the Stadium/ Park East Planning Area.

Direct growth to areas that can best accommodate it

Certain portions of a watershed are more conducive to development than others. Many land use decisions are made on the basis of transportation facilities. High intensity land uses are proposed at major street intersections, for example. Unfortunately roadway alignments are not necessarily determined with a watershed's natural resources in mind. In some cases it may be possible to impact an alignment decision and preserve a resource. Generally, the buffer zones, upland forests and grasslands relating to Type 1, Type 2, and Type 3-Quality Streams are high quality areas to avoid.

Policies:

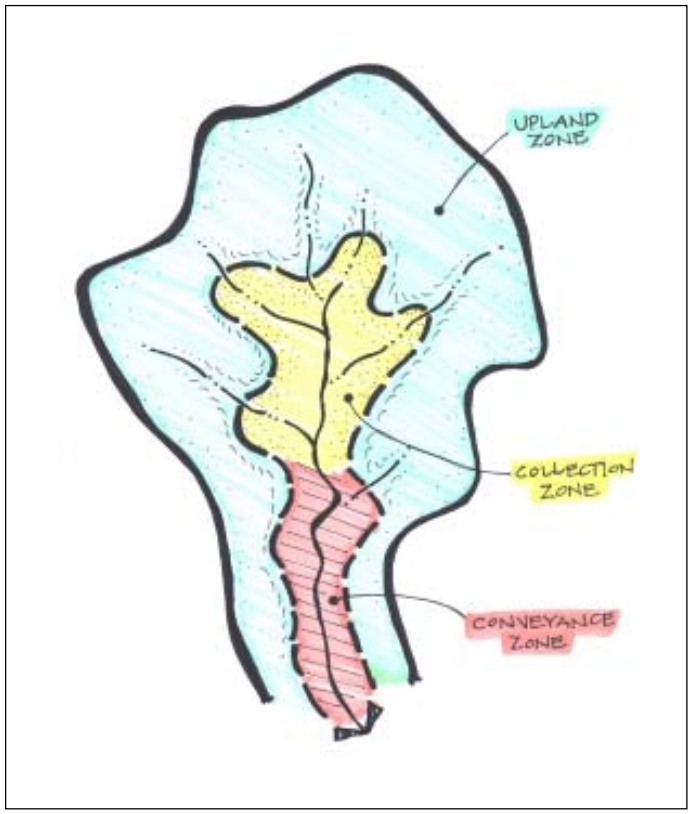
- Where known high quality natural areas exist in locations designated for streets on the City's ***Major Street Plan*** but are as yet unbuilt, the City in land use plans, and developers in site plans shall propose mechanisms to avoid the impact.
- From the time of adoption of this plan forward, all land use plans shall contain guidelines to help prevent development from impacting streams, such as stream buffers, cluster development where appropriate, and preservation of open space and linkages.

Planning and Development Review Checklist:

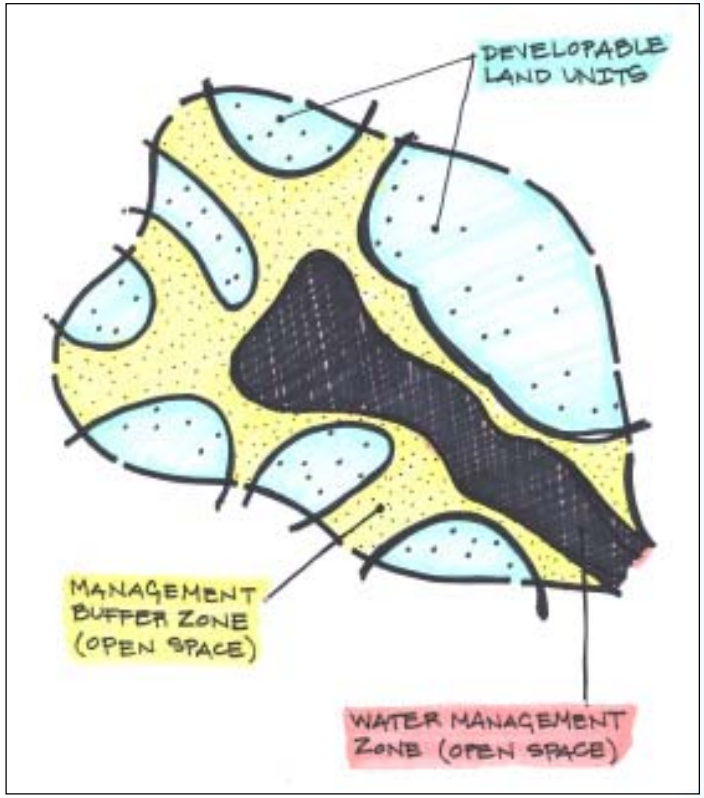
- ☐ Define priority development zones on the basis of protecting high quality natural areas, not just on the availability of infrastructure and utilities. This is especially important in the "collection zone" at the headwaters of a stream.
- ☐ Is there an opportunity to realign transportation corridors to encourage development in areas best suited for it?
- ☐ Where can development occur without impacting streams?

Action Item:

City Planning and Development staff should review unbuilt portions of the ***Major Street Plan*** to determine whether the proposed street locations impact known or potential high quality natural areas. Proposed streets that impact known high quality natural areas should be studied to determine if the street could be moved to avoid the stream buffer. This should be followed with an amendment to the ***Major Street Plan*** reflecting the change.



Collection and conveyance zones within a watershed.



Land Management zones for guiding development.

Protecting the collection zone (headwaters) within a watershed provides the greatest opportunity to protect the stream's integrity and water quality.

The amount and type of development that doesn't impact adjacent streams can be determined by outlining "management zones" within the watershed.

The maximum allowable percent of impervious cover for development within the contributing watershed is:

- <10% for Type1
- 10-25% for Type 2
- 10-25% for Type 3
- 26+% for Type 4-5

Implement stream buffers

Providing a buffer zone along streams, especially in the collection zone (head waters) is an important resource protection tool. The buffer serves a number of purposes: filtering runoff, slowing stormwater flows, protecting stream banks from disturbance, allowing the stream to shift and move, increasing property values, providing corridors for trails and wildlife, and protecting steep slopes from disturbance to name a few. There are many methods for calculating buffer widths but generally, the wider the better. At a minimum, the buffer should include the floodplain, adjacent steep slopes, wetlands and significant habitat areas. Keeping development 100' from top of bank results in significant protection.

Quality stream buffers provide a variety of benefits including improved water quality.

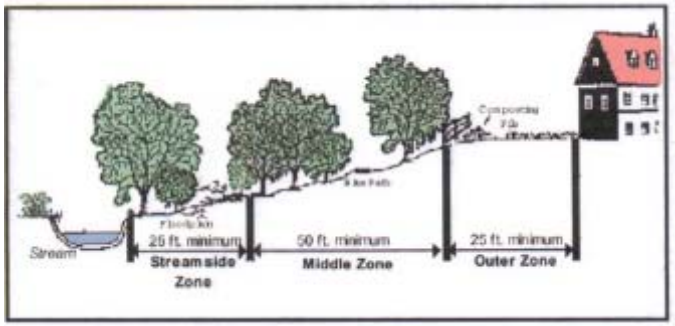
Policies:

- Unless the developer provides the Director of City Development specific information justifying reduction of the width of the stream buffer, development shall not be allowed in the following areas:
  - Within 100 year flood plain
  - Within 100 feet of centerline of stream, if sides of stream do not slope more than 15%
  - Within 100 feet of the top of the slope, if sides of stream slope more than 15%
- Appropriate land uses within the stream buffer are limited to open space, low intensity recreational uses excluding impermeable surfaces and structures, and trails.

Planning and Development Review Checklist:

- ☐ Define stream buffer areas on all stream corridors in undeveloped areas.
- ☐ Limit uses within the buffer to open space, low intensity recreation uses and trails. Impermeable surfaces and structures are not allowed.
  - ☐ Streamside Zone - functions to protect stream integrity. Uses are highly restricted and generally limited to flood control structures, utility easements, foot paths, and road crossings. Goal is to maintain undisturbed, native vegetation.
  - ☐ Middle Zone - functions to provide a buffer between development and streamside zone. Uses are restricted to hiking/biking trails, stormwater facilities, recreational uses with limited clearing of trees. Goal is to maintain mature, native vegetation.
  - ☐ Outer Zone - functions to filter runoff and prevent encroachment into the middle zone. Uses are moderately restricted and often include backyard areas. However, they do not allow for septic systems or permanent structures.

Trails should be encouraged as allowable uses within the streamside and middle zones.



Example of 3 zone stream buffer system used by the City of Lenexa, Kansas.

Implement a greenway program

As mentioned in the stream buffer section, buffers and greenways work together to protect natural assets. The greenways provide public and private open space, and are excellent locations for parkways when the parkway is adjacent to, but not located in, the stream buffer. When development fronts a greenway, experience shows that initial property values increase and stay higher over time. Whenever possible the greenways should connect.

Policies:

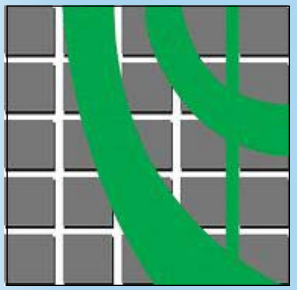
- Developments that include parkways or boulevards adjacent to or greenways in a high quality natural area shall be considered for development incentives.
- Development proposals for funding or implementation that include parkways or boulevards adjacent to or greenways in a high quality natural area shall receive a higher priority than those that do not, other factors being equal.
- The types of streets to be located on the side of the greenway adjacent to a stream buffer should be limited to local, collector, or secondary arterial streets. Primary arterial streets can also be appropriate if uses within the stream buffer are limited to open space, low intensity recreational uses without impermeable areas and structures, and the design makes adequate provision for frequent and safe pedestrian crossings.
- The City and developers should avoid locating intersections of collectors or larger streets immediately adjacent to stream buffers because they would tend to draw higher intensity uses into the stream buffer.

Trail through a high quality natural area.

Vegetated riparian corridors provide important greenway linkages within a community.

Planning and Development Review Checklist:

- ☐ Does the planning or development area include areas designated in any greenway, parkway or trails plan (MetroGreen, Northland Trails Vision Plan, Park and Boulevard Plan, etc.)?
- ☐ Are high quality stream corridors candidates for parkway and boulevards designated by the Kansas City Board of Park and Recreation Commissioners?
- ☐ What classifications of streets are proposed in or adjacent to high quality natural areas (Type 1, Type 2, and Type 3 Stream buffers or upland forested or grassland areas)?
- ☐ Can local, collector or arterial streets in or adjacent to the high quality natural areas be realigned away from these areas or redesigned to provide additional protection and public access to the stream? [Note: Freeways and Trafficways are not appropriate in these areas unless there is an overriding public purpose.]



Metro Green Regional trail system.

Kansas City Parks and Recreation Dept. manages parks, boulevards and natural open space within the City.

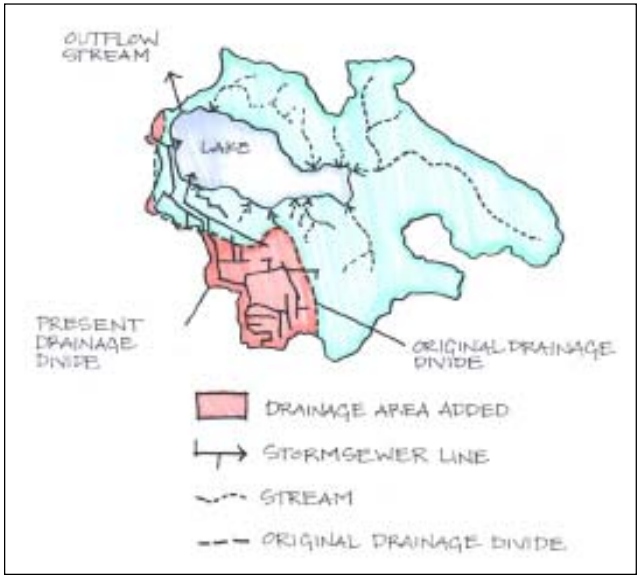
Establish impervious cover goals for each stream type

Impervious cover significantly impacts stormwater runoff. Impervious surfaces allow surface pollutants such as spilled oil, pesticides, and fertilizers to be swept into the storm sewers in a rain. Limitations on impervious cover by stream type can dramatically reduce stormwater flows and thereby stream degradation. By minimizing the amount of impervious surface in residential and commercial developments, the quantity of runoff is reduced and the quality of water entering the stream is improved. The goals set for minimizing impervious cover are ambitious. With extremely few high quality streams left in Kansas City, however, an ambitious program is required to protect them. The payoff in minimizing storm drainage problems and protecting natural resources can be great.

Policies:

- The maximum amount of area that is allowed to be covered by impervious surface (impervious cover) within the contributing subwatershed of the stream shall be limited depending on the quality of the stream, as determined by a stream assessment.
- The following goals for impervious cover shall be included in all future land use plans and shall be used to review development plans:
  - Type I – Highest Quality Stream, goal for maximum impervious cover to be allowed within contributing subwatershed of the stream: less than 10%.
  - Type 2 – High Quality Stream, goal for maximum impervious cover to be allowed within contributing subwatershed of the stream is 10%-25%.
  - Type 3 – Restorable Stream, goal for maximum impervious cover to be allowed within contributing subwatershed of the stream is 10%-25%.
  - Type 4 & 5 – Lower Quality Streams, goal for maximum impervious cover to be allowed within contributing subwatershed of the stream is 26%-100%.

Minimizing percentage of impervious surface within watershed reduces runoff impact on streams.



Drainage pattern from contibuting sub-watershed.

Planning and Development Review Checklist:

- ☐ For land use plans: include map showing type of stream, the contributing subwatershed of the stream, and impervious surface goal for each type.
- ☐ For developer site plans, check land use plan for type of stream by area, calculate amount of impervious surface within the contributing subwatershed and determine whether impervious surface goals are met. If not, include appropriate condition in staff recommendation.

Encourage cluster development as an alternative to large lot development

Kansas City allows cluster development. Consideration of a land use category that requires cluster development in certain sensitive areas, however, would go a long way toward preservation of the highest quality resources.

Policies:

- Cluster development, which within overall density guidelines allows higher density residential development in certain areas of a site in exchange for a larger amount of open space, shall be required in the contributing sub-watersheds of Type 1, 2, and 3-Quality streams.

Planning and Development Review Checklist:

- ☐ Identify undeveloped parcels
- ☐ Compare to the stream assessment map
- ☐ Designate areas as "Conservation Districts" which are in the contributing sub-watersheds of Type 1, 2, and 3-Quality streams.
- ☐ When development proposals are presented in Conservation Districts, use the adopted regulations to review the proposals.

Action Item:

City Planning and Development staff should develop and secure adoption of regulations related to "Conservation Districts" that require clustering of residential development, and provide criteria for designation, along with design and development guidelines related to maximum impervious surface, minimum required open space, preservation of natural vegetation, etc.

General Site Development Recommendations

This section relates to the review of site plans and issues to consider as Kansas City begins the zoning ordinance and subdivision regulation review process. In many cases, implementing more water sensitive and environmentally sensitive site design means changing the City's design standards. The stream inventory can help prioritize the areas where the most aggressive approaches will retain the most valuable resources. Overall there is a need in the site plan review process to require far more site analysis information than is currently provided. City staff needs pre-development site information in more detail to provide appropriate feedback on site designs.

Lower Density Residential Development Near High Quality Stream Corridors

These Policies and Checklist items apply specifically to new and significantly redeveloped residential areas that contain up to 8 units per acre that are located in the contributing subwatershed of Type 1, 2, and 3-Quality streams, although the plan encourages their use throughout the city. Standard, low-density residential housing can be extremely detrimental to the health and existence of sensitive natural areas. This type of development tends to require more infrastructure (streets, sewer, water, utilities) to provide services to homes that are "scattered" over the landscape. These homes tend to be on larger lots (1+ acre) that are regularly maintained in a manner similar to that of a city lot (regular mowing, application of fertilizer and water). This often results in the removal of native vegetation along stream corridors and an increase in overland runoff, including pollutants, entering the streams.

Low-density development promotes major changes in land cover resulting in greater im-

Encourage open space design, require in some locations

- Consistent with the land use discussion above, open space or conservation subdivision design should be employed in areas located in the contributing subwatershed of Type 1, 2, and 3-Quality streams.

Require the preservation of natural vegetation

- Vegetation considered indigenous or native to the area (prairies, wetlands, riparian systems, and woodlands) shall be preserved to maintain a diversely balanced and functional system.
- Non-native, invasive exotic vegetation shall be removed especially in accordance with any state/federal noxious weed laws, and be replaced with native species appropriate to the functional habitat required.

Reduce impervious area whenever possible

- Encourage shared driveways for adjoining homes to reduce the amount of impervious drives created within a standard subdivision.

Reduce setbacks and lot sizes

- Consider narrower frontages and smaller lots in the contributing subwatershed of Type 1, 2, and 3-Quality streams, with the corresponding requirement that the area gained be placed in common open space. This increases open space and decreases street length.

Relax requirements for curb and gutter

- Not every street needs curb and gutter. In lower density development allow open swales to handle stormwater. These should be designed in such a way as to allow infiltration as well as transport of stormwater.

Vegetated riparian buffer protecting stream from impacts of development

Policy:

- Sites for new lower density residential development (up to 8 dwelling units per acre) located in the contributing subwatershed of Type 1, 2, and 3-Quality Streams, shall be designed in such a way as to protect the stream corridors by:
    - Maximizing the amount of open space (50 percent open space preferred).
    - Preserving native vegetation wherever it is found.
    - Reducing impervious area by reducing street and driveway widths and by the design and reduced number of cul-de-sacs.
    - Reducing setbacks and lot sizes and adding the savings to common open space.
    - Relaxing requirements for curbs and gutters in certain cases.
- Consider establishing a requirement to maintain 50% open space on sites located in the contributing subwatershed of Type 1, 2, and 3-Quality Streams.
- Accompany the open space requirement with smaller lot size requirements or consider eliminating the lot size requirement altogether. Base considerations on overall density rather than lot size.
- Require the developer to identify on their site plans all existing native grasslands, upland forests, and wetlands.
- Require the developer to show how the proposed plan will preserve existing native vegetation to the maximum extent possible.

Native vegetation maintained during site development.

Conservation Subdivision Designs incorporate green space and natural resources into the design.

Planning and Development Review Checklist:

- Street widths: allow residential streets to be as narrow as 18-22 ft. Parking can still be accommodated on one side, however two-way traffic must yield. This has the added benefit of slowing cars down, a desirable condition in residential areas.
- Cul-de-sacs: reduce the number of cul-de-sacs wherever possible. Where they are used, consider allowing a "green" center island. Change the minimum radius to 35'. Allow loop streets as an alternative.
- Driveways: Specify a maximum driveway width and decrease the minimum allowed to 9' for one lane and 18' for two lanes. Encourage the more traditional "two track design".
- Encourage planting of trees along streets. Tree lined streets tend to reduce traffic speeds while also reducing heat island effect of pavement.
- Determine the maximum appropriate dwelling units per acre for a given plot of land.
- Reduce the overall coverage of land by:
  - Reducing side yard setbacks to 5 ft. and front setbacks to 15-20 ft.
  - Reducing minimum lot sizes to 5000-5500 sq. ft.
  - Designating the remaining area for common open space.
- Organize a joint City Planning and Development, Public Works, and Water Services Task Force to determine under what circumstances in low density residential development that swales may be substituted for curbs and gutters.
- Approve swales on a case by case basis following the Task Force guidelines.

Loop street design in place of cul-de-sacs.

Cul-de-sac with "green" center island.

Higher Density Residential and Commercial Development

- The most significant positive impact on water quality and protection of natural resources in higher intensity/density development is through regulation of land disturbance during construction, reduction of impervious surface and in requiring stormwater storage and treatment as an integral part of the site design.

Parking ratios and codes

- Parking ratios and codes often dictate creation of larger impervious areas than necessary to support the use. It is important to note however, that the market also helps set parking requirements.

Parking lot dimensions

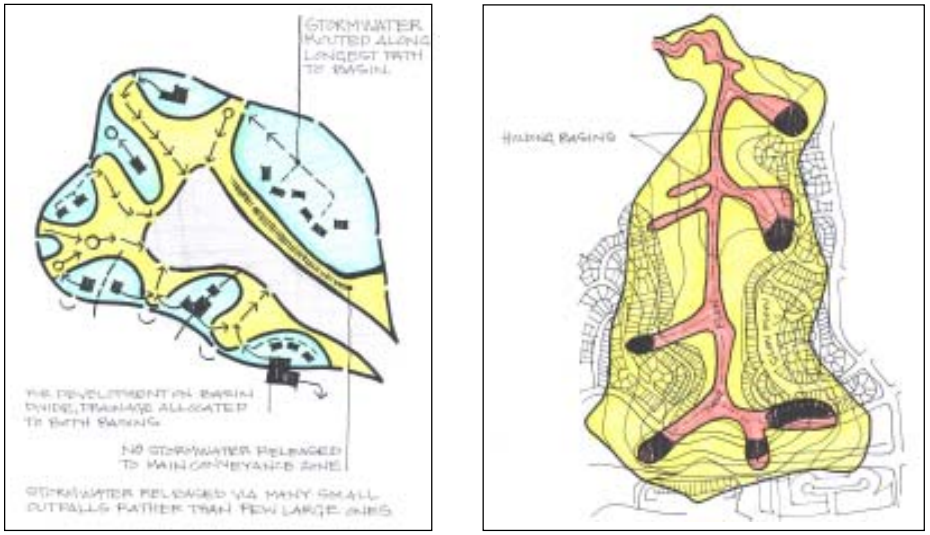
- Parking lot dimensions are often more generous than necessary to safely serve their purpose. Rather than allowing compact car spaces, require 30% of the spaces be compact car spaces.

Use natural systems to convey and treat parking lot stormwater

- The use of bioretention islands and other Best Management Practices (BMPs) to store and treat stormwater before it enters into natural streams should be a required use of the landscape areas and islands in and adjacent to the parking lots.

Curbless street with native vegetation along drainage ditch.

Parking lot bioretention swale for stormwater management.



Directing stormwater flows to maximize on-site management.

Policies:

- Sites for new higher density residential development (over 8 dwelling units per acre) and for commercial or mixed-use development in the contributing subwatershed of Type 1, 2, and 3-Quality Streams, shall be designed in such a way as to protect the stream corridors by:
  - Reducing impervious surface by decreasing size of parking lots.
  - Using natural systems to convey and treat parking lot stormwater.
  - Limiting site clearing, staging site clearance and retaining natural cover.
  - Insuring that post development stormwater flows stay within the pre-development basin.

Planning and Development Review Checklist:

- ☐ Reduce office parking ratios to a maximum 3.0 spaces per 1000 sq. ft.
- ☐ Reduce retail parking ratios to 4.5 spaces per 1000 sq. ft.
- ☐ Establish parking ratios as maximums rather than minimums.
- ☐ If owners desire parking in excess of the maximum, require it to be constructed in porous disturbance pavement.
- ☐ Encourage and incent shared parking arrangements.

Other Site Planning Issues

Advocate for public streets adjacent to Type 1, 2, and Type 3

- Quality Stream Corridors where development is restricted to the side away from the stream

  - Public streets adjacent to the outside edge of a stream buffer zone adds to the buffer system by insuring that stormwater outfalls are handled in an environmentally sensitive way and that the amenity derived from the buffer is available to the public.

Limit site clearing and retain natural cover

- Require phasing of construction that limits site grading to one portion of the site at a time. Require vegetative cover be reestablished on disturbed sites within 30 days. City code currently requires revegetation within 14 days. However, monitoring and enforcement of this code is unequivalent. The City needs to determine more effective methods of monitoring and enforcing the existing regulation.

Phase development to minimize site disturbance, sediment and erosion.

Insure post development stormwater flow stays in the pre-development basin

- Sometimes developments are designed to send stormwater from one subwatershed to another. This is similar to the situation experienced in the sanitary sewer system years ago. Development plans should maintain stormwater in the basin or sub-basin that it originally contributed to.

General Design Standards for Public Infrastructure Projects

Current standards for design of public infrastructure often work against preservation of natural systems and valuable resources. The public sector can play a role in demonstrating "green" solutions and more environmentally friendly construction techniques by employing them in public projects.

Native vegetation along stream channel.

Utilize "green" solutions whenever possible

- Use riparian, wetland, or other natural systems when designing stormwater management solutions. Natural systems can even be integrated into more structured or engineered solutions to improve function and aesthetics.
- Reference the Kansas City Chapter of the American Public Works Association (APWA) 5600 Stormwater Guidelines and BMP Manual.

Retain existing vegetative cover

- This is especially important for mature, native woodlands and grasslands adjacent to streams and wetlands.

Site constraints imposed by topography.

Match improvements to existing site character whenever possible

- Work within the constraints of the site such as topography, soils, etc.

Make reduction of impervious surface a high priority

- Reduce street widths, minimize parking lot size and incorporate porous pavements.

Employ standards that increase infiltration of stormwater

- City staff should strive to minimize impervious surfaces present within development that contribute runoff to nearby streams. Follow the maximum allowable by stream type listed in the Land Use Planning/Regulation section.
- Reference APWA 5600 Guidelines and BMP Manual.

Employ standards that reduce erosion and improve water quality at discharge points

- Install and maintain proper sediment and erosion control measures on all construction sites.
- Phase construction to minimize soil exposure.
- Reference APWA 5100 (Sediment and Erosion Control) and 5600 Guidelines and BMP Manual.

Swale at road edge with native vegetation.

Sample Applications

Two sample applications, provided within this section, are to illustrate to City staff, developers, and others within the community some of the previously discussed policies and review checklists used in practice.

Example #1

The stream within this development area is part of a previously conducted stream asset inventory. Analysis of the inventory results show this particular area to predominantly consist of lower quality (Type 4-5) streams.

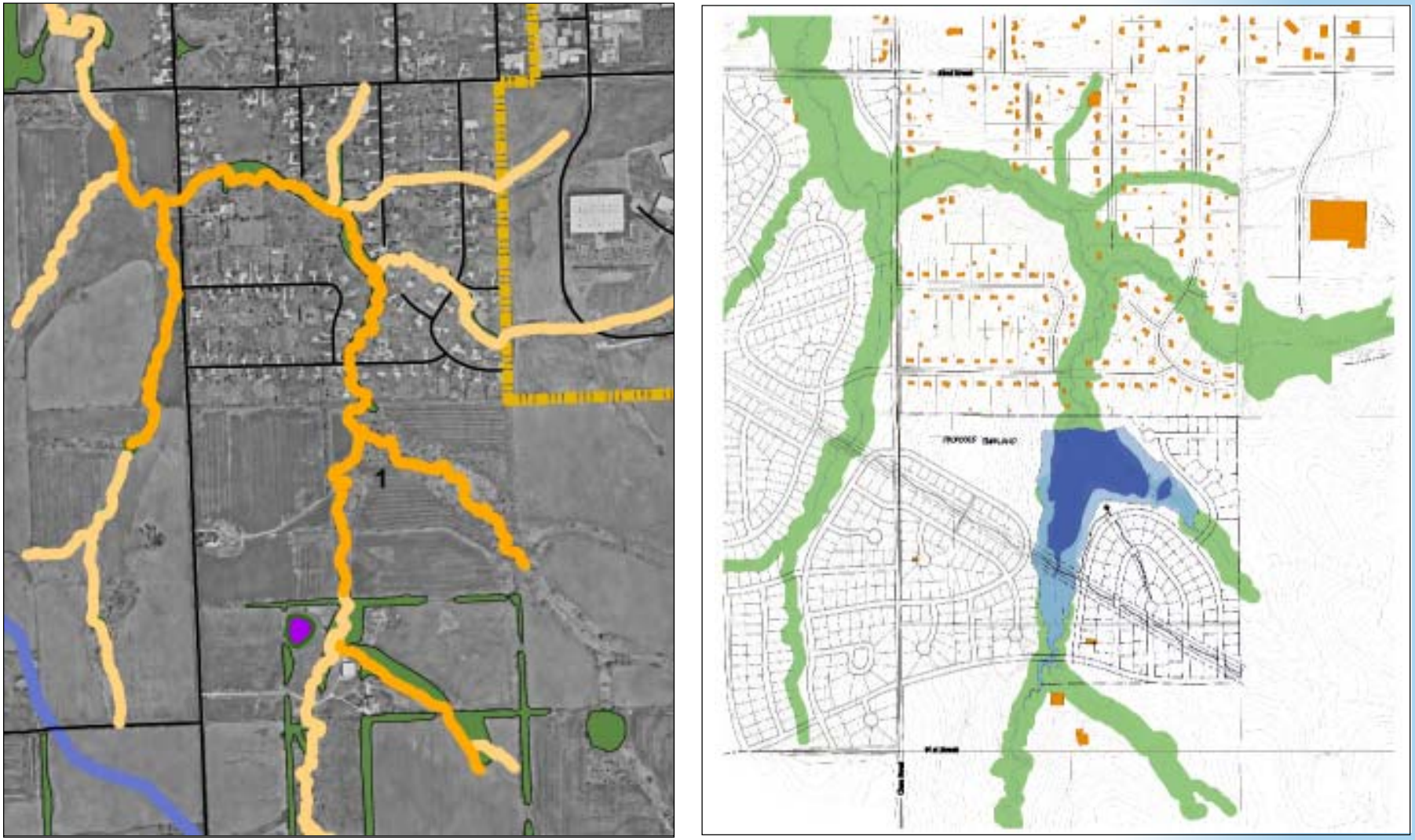
The following are recommendations that have been implemented into the development plan for this site:

Land Use

- Stream Asset Inventory used to determine stream types and quality natural areas. The inventory also helped determine appropriate location of parkland.
- All stream reaches provided with a minimum width buffer to protect from impacts of development.
- Stream buffers provide neighborhood with linkages to surrounding community.
- Uses within buffers limited to light recreation including trails.

Site Development and Public Infrastructure

- Wherever possible, streets have been designed to be single-loaded, providing public access and open space to the greenways and lake.
- Loop streets used in place of cul-de-sacs to reduce pavement quantities.
- Parkland and a lake located and designed to assist in preserving existing vegetation.



Example 1: Higher density residential development with stream buffers and a lake for stormwater management and community recreation.

Example #2

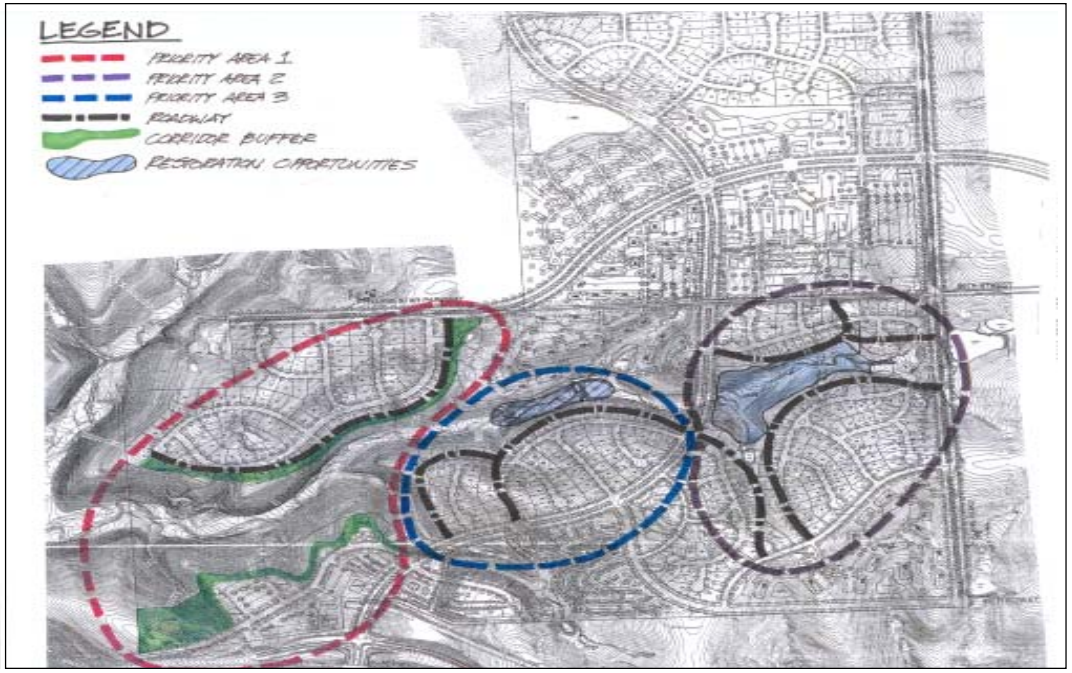
This application provides a much more environmentally sensitive approach to development within a watershed:

Land Use

- Results of stream asset inventory show highest quality stream reach along with quality upland present within development site.
- This information provides planners with the knowledge of where to provide the greatest protection and where to let development occur. Both ends of the highest quality stream reach are prioritized for protection.
- A stream buffer is designated along the western end to protect the stream from development.
- Restoration opportunities are also designated on the map.

Site Development and Public Infrastructure

- Streets are realigned from dual-loaded to single loaded when possible to provide public open space.
- Collector streets are designed as boulevards to assist with stormwater management and calm traffic.
- Development is pushed to a higher density level in order to minimize infrastructure needs and maximize open space and natural resource protection.



Example 2: Stream Asset Inventories provide natural resource preservation priorities which are in turn used to guide development priorities.

Line Creek Watershed Recommendations

Land Use

Make conservation of existing natural areas a high priority

- Implement Line Creek Parkway immediately and design as a prototype measure for stream corridor protection.
- Begin acquiring the property; don't wait for development.

Direct growth to areas that can best accommodate it

- Move Location of Community Mixed Use Center: Relocate to pasture land and retain high quality forested upland for low intensity use to filter and use water.
- Realign particular proposed streets to minimize impact on existing buffers.

Implement Stream Buffers

- Preserve wooded corridor along east side of Line Creek.
- Retain buffer along southern section of East Fork (Type 2) down to its confluence with Line Creek.

Implement greenway program

- Line Creek Parkway will provide a major north-south greenway corridor.

Establish impervious cover goals for each stream type

- Type 2 - a goal of 10-25% for maximum impervious cover within Line Creek and the southern reach of East Fork sub-watersheds.
- Type 3 - a goal of 10-25% for maximum impervious cover for a majority of the sub-watersheds.

Encourage Cluster Development

- In areas where there are large tracts of developable land with quality woodland or grass-land habitat present, cluster development should be used to preserve the quality habitat.

Wooded riparian corridor provides protection from development, recreational opportunities, and wildlife habitat.

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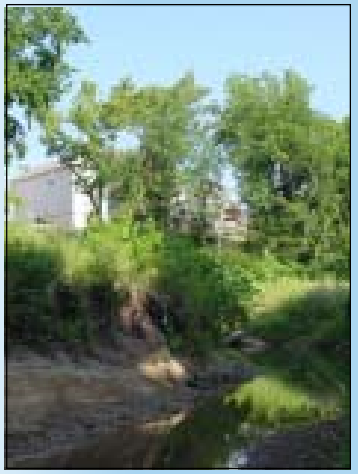
Site Development and Public Infrastructure

- Site developments along Type 1-3 streams shall take additional measures to provide open space, minimize impervious surfaces, and protect streams with quality, vegetated buffers.
- Quality native vegetation present shall be protected throughout the development process with fencing and/or monetary fines for disturbances to these areas.
- Arterial residential streets should be constructed with swales along roadsides and no curbs or gutters.
- Employ alternative stormwater BMPs along Line Creek and southern reach of East Fork.



Development too close to stream impacts stream integrity and long-term stability of the development.

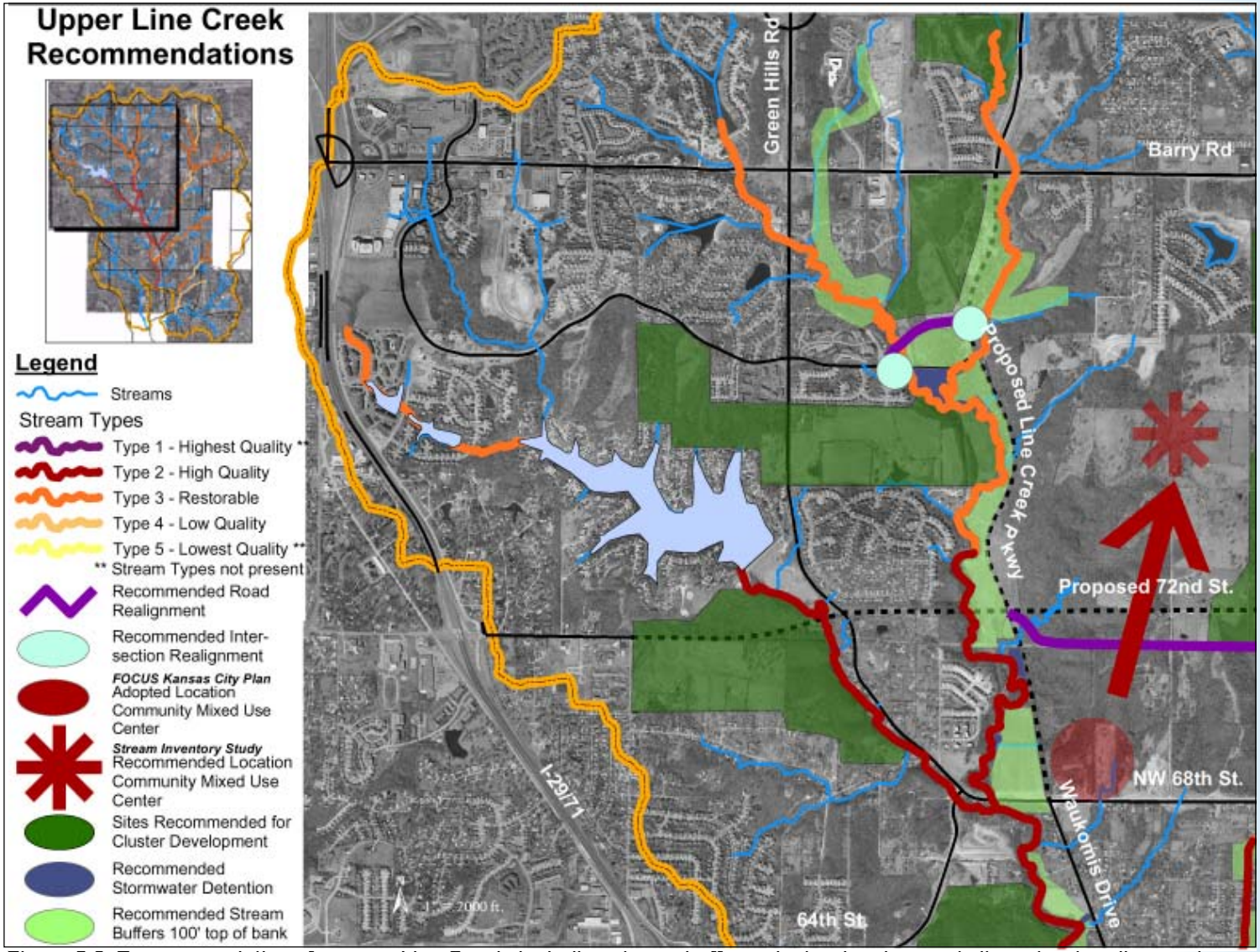


Figure 5.3 Recommendations for upper Line Creek, including stream buffers, cluster development sites, street realignments.

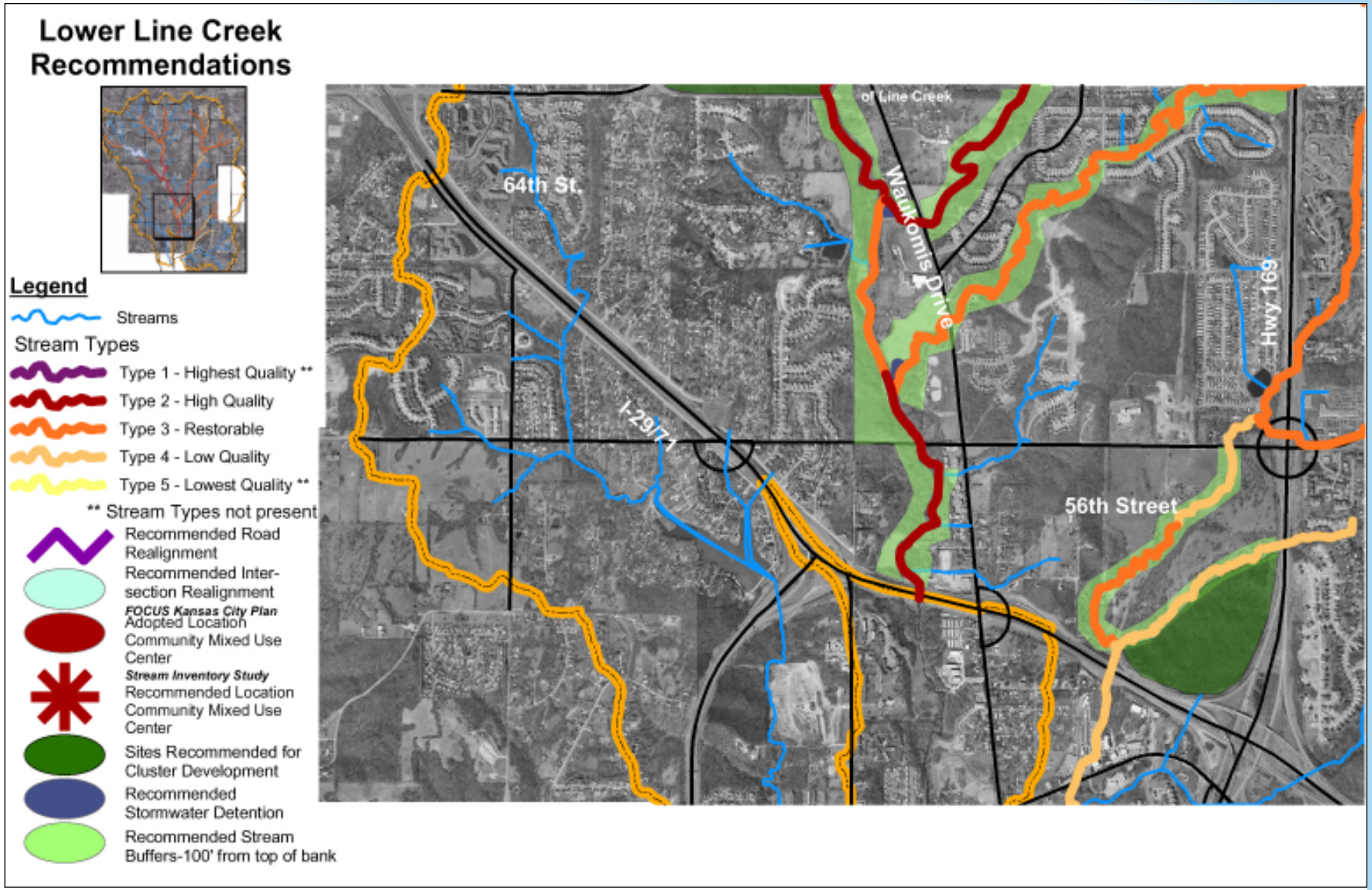


Figure 5.4 Recommendations for lower Line Creek, including stream buffers, cluster development sites, street realignments.

Stadium/Park East Planning Area Recommendations

Land Use

Make conservation of existing natural areas a high priority

- Preserve existing open space:
  - 100 acres along the east end of Round Grove Creek. It contains a mix of woodland and grassland that could provide a quality buffer with minimal management efforts.
  - Wooded area in Zone 5 adjacent to the west side of Hillcrest Country Club.
  - Steep, wooded area in Zone 3 west of I-435.

Direct growth to areas that can best accommodate it

- Maintain topographic constraints (steep slopes) when redeveloping parcels.
- Provide incentives to landowners with old, dysfunctional septic systems to repair or replace these systems.

Implement Stream Buffers

- Enhance and protect existing riparian buffers, especially along Round Grove Creek.
- Remove nonnative exotic vegetation and establish native trees, shrubs, or grasses.

High quality, vegetated buffer along Round Grove Creek.

Tree fall debris and non-native exotic vegetation in stream channel.

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Implement greenway program

- Convert abandoned rail line on the south side of the Stadiums, that runs parallel to Raytown Rd for greenway connection for bicycles and pedestrians (Rails to Trails program).
- Encourage use of vacant lots (commercial and residential) to create connectivity between parks and to create additional open space in the form of neighborhood parks (Brownfields program).

Establish impervious cover goals for each stream type

- Reduce the amount of pavement within parking lots for the Stadiums and Blue Ridge Mall.

Encourage cluster development as an alternative to large lot development

- Given the limited availability of sizable tracts of land within the Planning Area, there is minimal opportunity for recommending places to locate cluster development.

Implement stormwater management plans

- Areas like the Stadiums and Blue Ridge Mall are ideal locations to implement and demonstrate the functionality of stormwater BMPs that would not only manage all stormwater runoff on site but, would also provide shade (which helps reduce the heat produced by the pavement) for recreational and aesthetic enhancements.

In the absence of vegetated buffers, runoff from roads and parking lots directly enters streams.

Site Development and Public Infrastructure

Land use regulations related to site designs have been well established within the Planning Area through past developments. Redevelopment will likely need to conform with current uses but can still implement improved design techniques that will serve to do no further harm to existing resources. The potential does exist in several places for site designs to improve upon the quality and quantity of existing natural resources and water quality. These improvements generally provide benefits to the greater community area as well as the site.

Vacant lots can be designed during redevelopment to contain less pavement and even provide additional parkland within a neighborhood.

- Encourage use of vacant lots to create connectivity between parks and to provide initial and/or additional buffers for streams.
- Reduce the amount of pavement within vacant lots and areas of redevelopment.
- Protect and enhance native vegetation along stream corridors and potential greenway corridors.
- Remove exotic invasive vegetation and replace with native vegetation to enhance the diversity and stability of stream corridors.

Conclusions

The results of this study indicate a variety of conditions present within the two study areas. Line Creek is experiencing the pressures of new development that is not constrained by topography (steep slopes) or other site issues and therefore is being greatly impacted by development occurring very close to streams within this watershed. However, there are still opportunities to change this pattern and protect the high quality stream reaches within the watershed. This area would be an ideal location to implement a variety of stormwater BMPs to illustrate the value and function of these practices for short and long-term protection of resources and infrastructure.

An example of the resources worth protecting in the Line Creek Watershed.

Opportunities to change development patterns and implement new stormwater BMPs within the Stadium/Park East Planning Area are limited given the age of development in this area. However, efforts to redevelop vacant lots and retrofit facilities like the Stadium parking lots, can be opportunities to implement change and improve infrastructure designs. While streams within this area appear to be stabilizing, redevelopment or new developments in areas like the eastern end of Round Grove Creek should be planned with maximization of effort to protect and enhance the stream resources present.

An example of the resources worth protecting in the Stadium/ Park East Planning Area.

City staff should find reports such as this one to be essential elements within the planning process. In the future, the region will have an ecological database (MARC Natural Resource Inventory) that cities and developers throughout the region will be able to reference for conditions presents wherever development is proposed within the region. The Natural Resource Inventory used in conjunction with site assessments, will provide planners with tools necessary to incorporate protection, enhancement, and management of natural resources into the infrastructure planning process.

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Appendices

Appendix A - Terms and Definitions

Aquatic Invertebrates - Small animals without backbones that require an aquatic environment (pond, stream) for at least part of their life span.

Hydraulic Constriction - any structure or object that at the entrance or within a pipe, culvert or bridge interfers with the normal conveyance of water through the structure.

Loess Soils - material transported and deposited by wind and consisting predominantly of silt-sized particles.

Riparian Corridor - any stream, river, pond, lake, or wetland together with adjacent upland areas comprised of plant and wildlife species normally found near fresh water.

Stream Buffer - a vegetated area including trees, shrubs, and herbaceous vegetation, that exists or is established to protect a stream or river system, pond, lake, or wetland.

Sub-watershed - smaller watersheds contained within a larger watershed. Large watersheds, like the Mississippi River basin contain thousands of smaller watersheds

Setback Ordinance - restrictions through zoning or other mechanisms on development activities within a specified distance of a stream or other water resource.

Succession - the natural progression of ecological systems from one type to another (i.e., prairie to woodland).

Toe Erosion - erosion of materials within stream channels that are located at the base of the stre-ambanks.

Watershed - the land area that drains water to a particular stream, river, or lake. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge. A land area, also known as a drainage area, which collects precipitation and contributes runoff to a receiving body of water or point along a water course.

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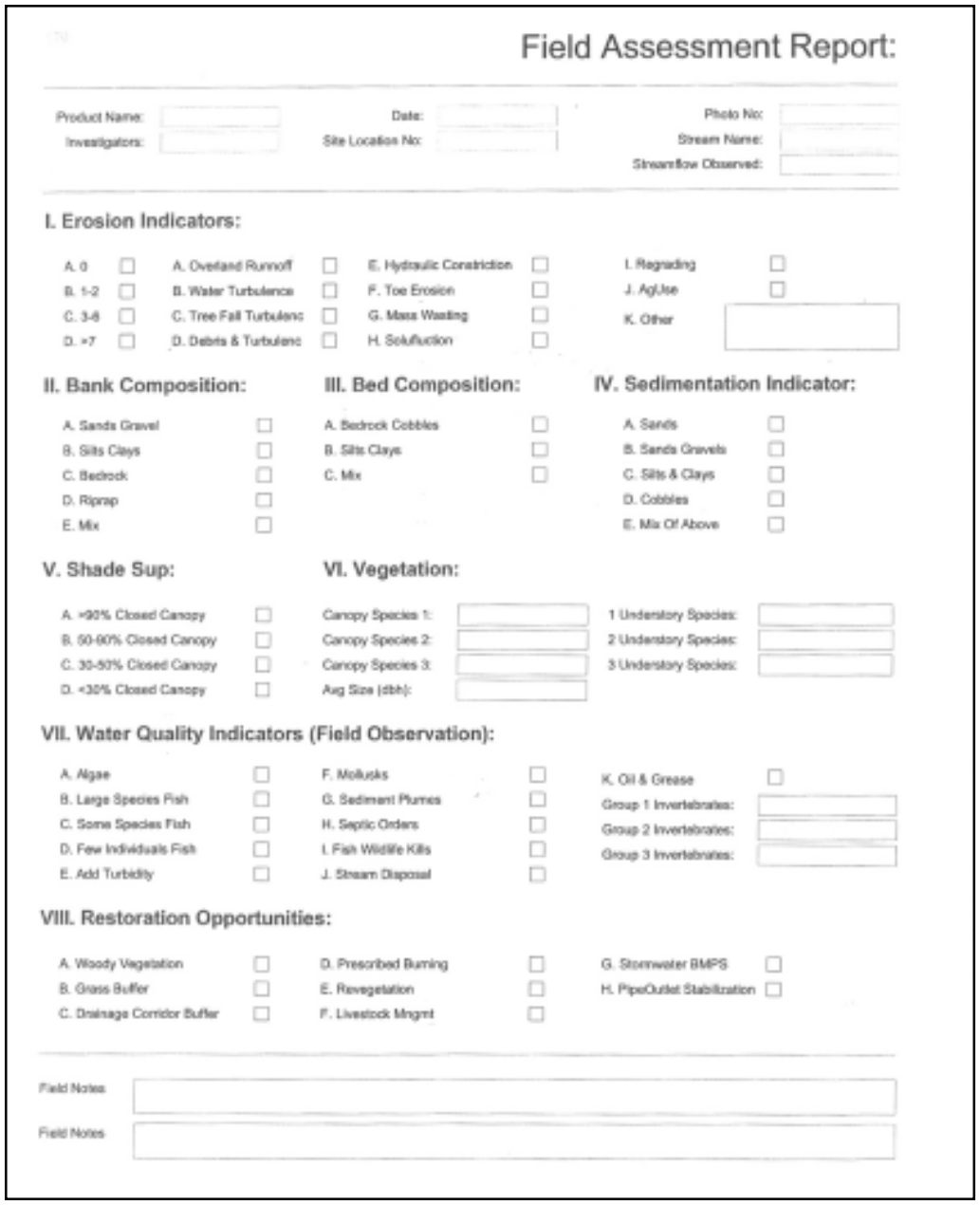
Appendix C - Field Data Collection Form



Field Assessment Report:

Product Name: | Date: | Photo No:
Investigators: | Site Location No: | Stream Name:
Streamflow Observed:

I. Erosion Indicators:

A. 0 ☐ | A. Overland Runnoff ☐ | E. Hydraulic Constriction ☐ | I. Regrading ☐
B. 1-2 ☐ | B. Water Turbulence ☐ | F. Toe Erosion ☐ | J. Ag Use ☐
C. 3-6 ☐ | C. Tree Fall Turbulenc ☐ | G. Mass Wasting ☐ | K. Other
D. >7 ☐ | D. Debris & Turbulenc ☐ | H. Solufluction ☐

II. Bank Composition:

A. Sands Gravel ☐
B. Silts Clays ☐
C. Bedrock ☐
D. Riprap ☐
E. Mix ☐

III. Bed Composition:

A. Bedrock Cobbles ☐
B. Silts Clays ☐
C. Mix ☐

IV. Sedimentation Indicator:

A. Sands ☐
B. Sands Gravels ☐
C. Silts & Clays ☐
D. Cobbles ☐
E. Mix Of Above ☐

V. Shade Sup:

A. >90% Closed Canopy ☐
B. 60-90% Closed Canopy ☐
C. 30-60% Closed Canopy ☐
D. <30% Closed Canopy ☐

VI. Vegetation:

Canopy Species 1:
Canopy Species 2:
Canopy Species 3:
Avg Size (dbh):

1 Understory Species:
2 Understory Species:
3 Understory Species:

VII. Water Quality Indicators (Field Observation):

A. Algae ☐ | F. Mollusks ☐ | K. Oil & Grease ☐
B. Large Species Fish ☐ | G. Sediment Plumes ☐ | Group 1 Invertebrates:
C. Some Species Fish ☐ | H. Septic Orders ☐ | Group 2 Invertebrates:
D. Few Individuals Fish ☐ | I. Fish Wildlife Kills ☐ | Group 3 Invertebrates:
E. Add Turbidity ☐ | J. Stream Disposal ☐

VIII. Restoration Opportunities:

A. Woody Vegetation ☐ | D. Prescribed Burning ☐ | G. Stormwater BMPS ☐
B. Grass Buffer ☐ | E. Revegetation ☐ | H. Pipe Outlet Stabilization ☐
C. Drainage Corridor Buffer ☐ | F. Livestock Mngmt ☐

Field Notes
Field Notes

field data collection form

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Appendix D - Field Assessment Stream Scoring

I. Erosion Indicators **Cut Dimension** **(Bank Stability)** 0 = 10 1-2 = 7 3-6 = 3 >7 = 1 **Type of Erosion** **(# of indicators)** 0 = 10 1-2 = 7 3-5 = 3 >5 = 1	**II. Bank/Bed Composition** **Bank Composition** Bedrock = 10 Mix = 7 Sands & Gravels = 5 Silts/Clays = 3 Riprap = 1	**II. Bank/Bed Composition** **Bed Composition** Bedrocks/Cobbles = 5 Mix = 3 Silts/Clays = 1 **Sedimentation** None=10 Cobbles=7 Sands/Gravel=5 Mix=3 Silts/Clays=1
III. Water Quality Indicators **Benthic** Fish = 5 Mollusks = 3 None = 0	**Invertebrates** Group I = 5 Group II = 3 Group III = 1 None = 0	**Other Indicators** Algae = -1 Additional Turbidity = -1 Sediment Plumes = -2 Septic Odor = -1 Fish and Wildlife Kills = -4 Stream Disposal = -1 Oil and Grease = -2
IV. Riparian Zone Vegetation **Canopy Cover** >90% Shaded = 10 50-90% Shaded = 7 30-50% Shaded = 3 <30% Shaded = 1	**Woodland Quality** High diversity - mix of mature native trees and understory species = 10 Medium diversity - some non-native, undesirable species = 5 Low diversity - dominated by non-native, undesirable species = 1	**Grassland Quality** High diversity - mix of native grass and herbaceous species = 10 Medium diversity - some non-native, undesirable species = 5 Low diversity - dominated by non-native, undesirable species = 1

Stream Type Characteristics and Scoring Range

Type 1 - Highest Quality (41 - 50 points)

Generally described as the highest quality naturally occurring stream with little negative impact. Erosion and sedimentation is low, water quality indicators are positive and the surrounding riparian zone is a healthy, mature, succession woodland or other high-quality environment.

Type 2 - High Quality (31 - 40 points)

This type of stream may have some down or side-cutting however, bank and bed composition (bedrock) assist in keeping the impact low. Water quality is generally good and the riparian zone is largely intact, although vegetation may be altered from that of a typical native plant association.

Type 3 - Restorable (21 - 30 points)

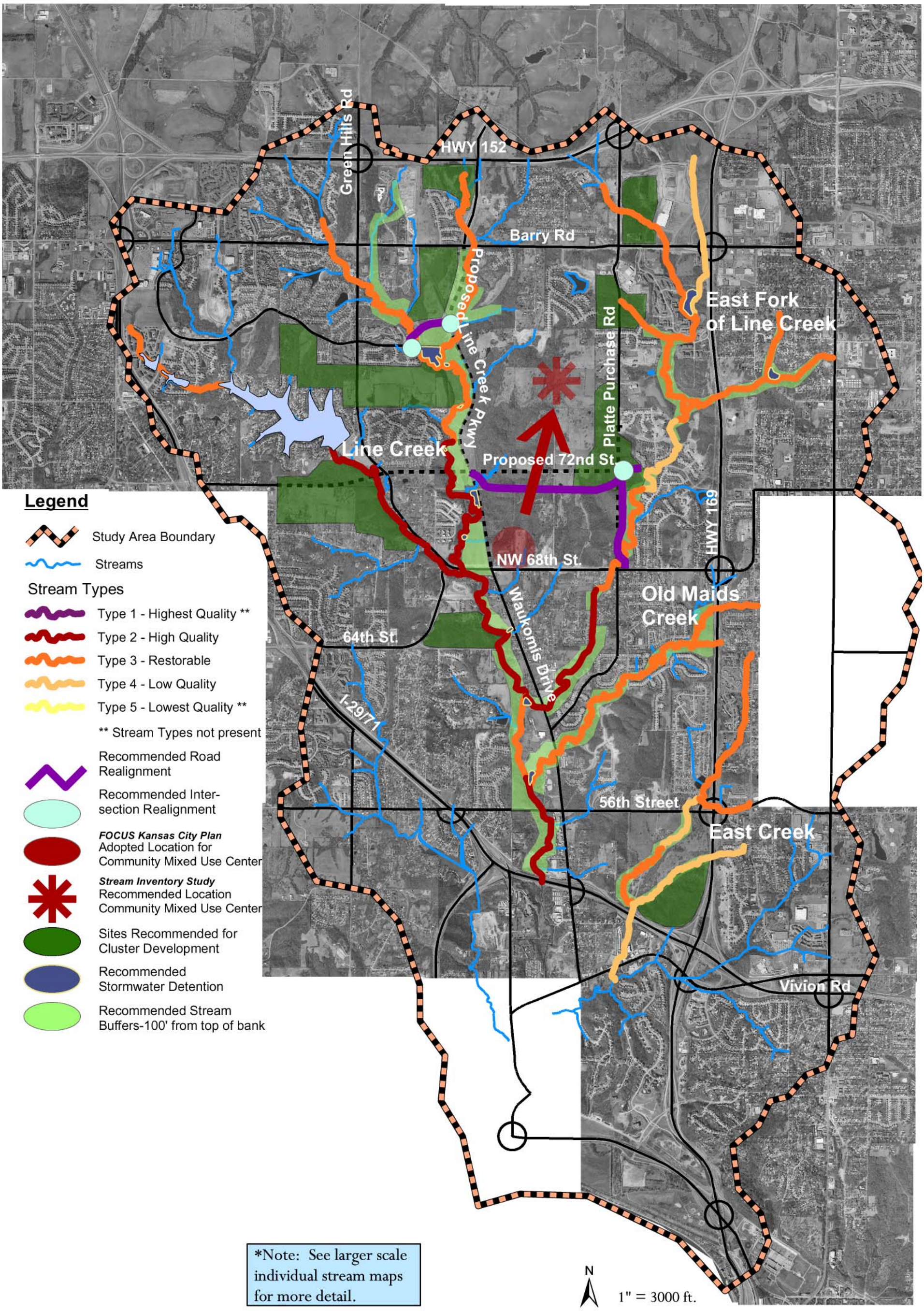
Deterioration of the riparian corridor is more noticeable. While some remnant plant associations may be present, overall vegetative canopy cover is comprised of immature tree species. The potential for restoration exists although erosion and sedimentation can be greater than desirable.

Type 4 - Low Quality (11 - 20 points)

Impacts are greater on this stream type with significant indicators of bank erosion and sedimentation present. The adjoining riparian corridor may be intact but vegetation is not representative of a native plant association.

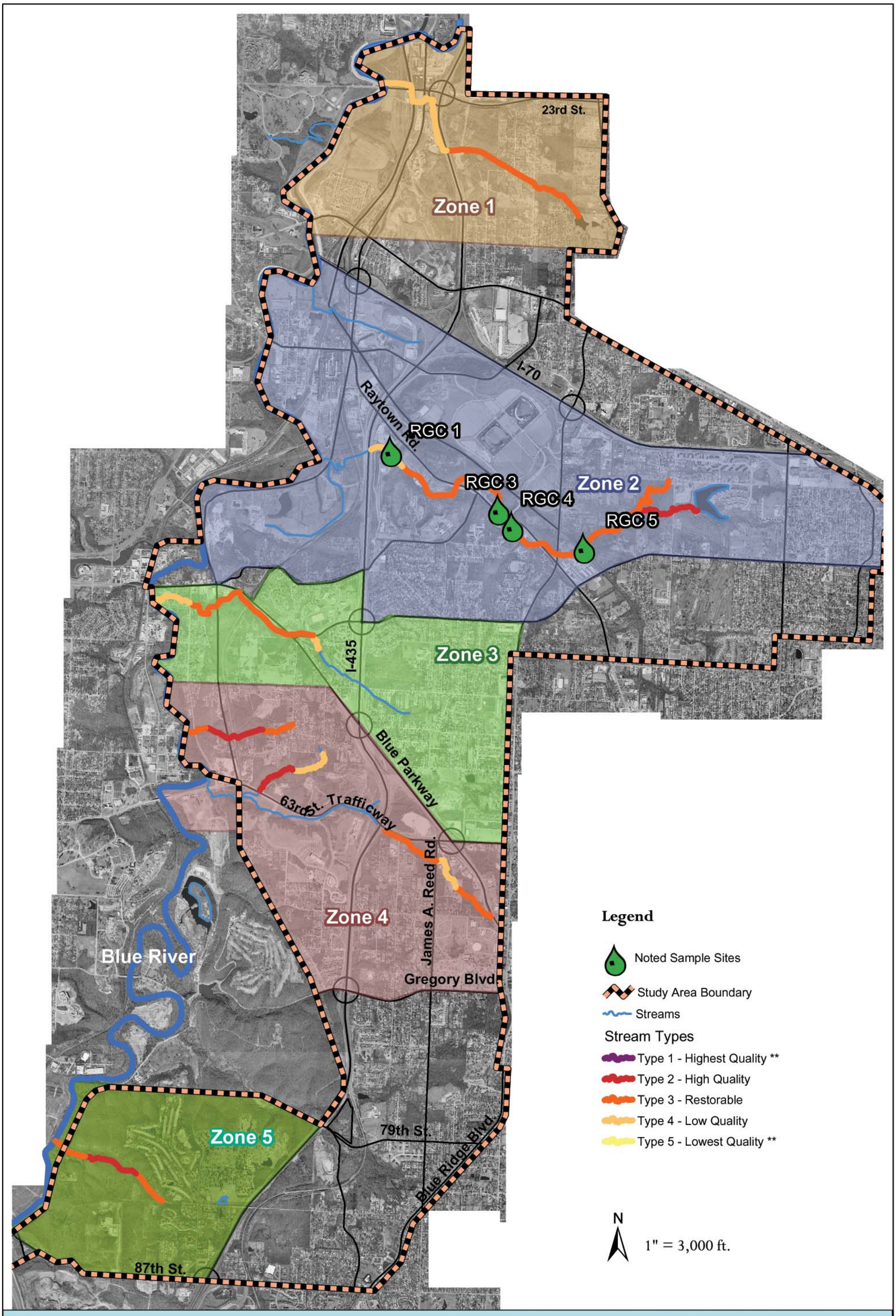
Type 5 - Lowest Quality (< 11 points)

The channel in this type is the most changed. The riparian corridor is becoming impaired to the point of providing little protection or benefit, and erosion and sedimentation indicators are significant. Water quality is questionable with noticeable phosphate and nitrate loading (large algae blooms).



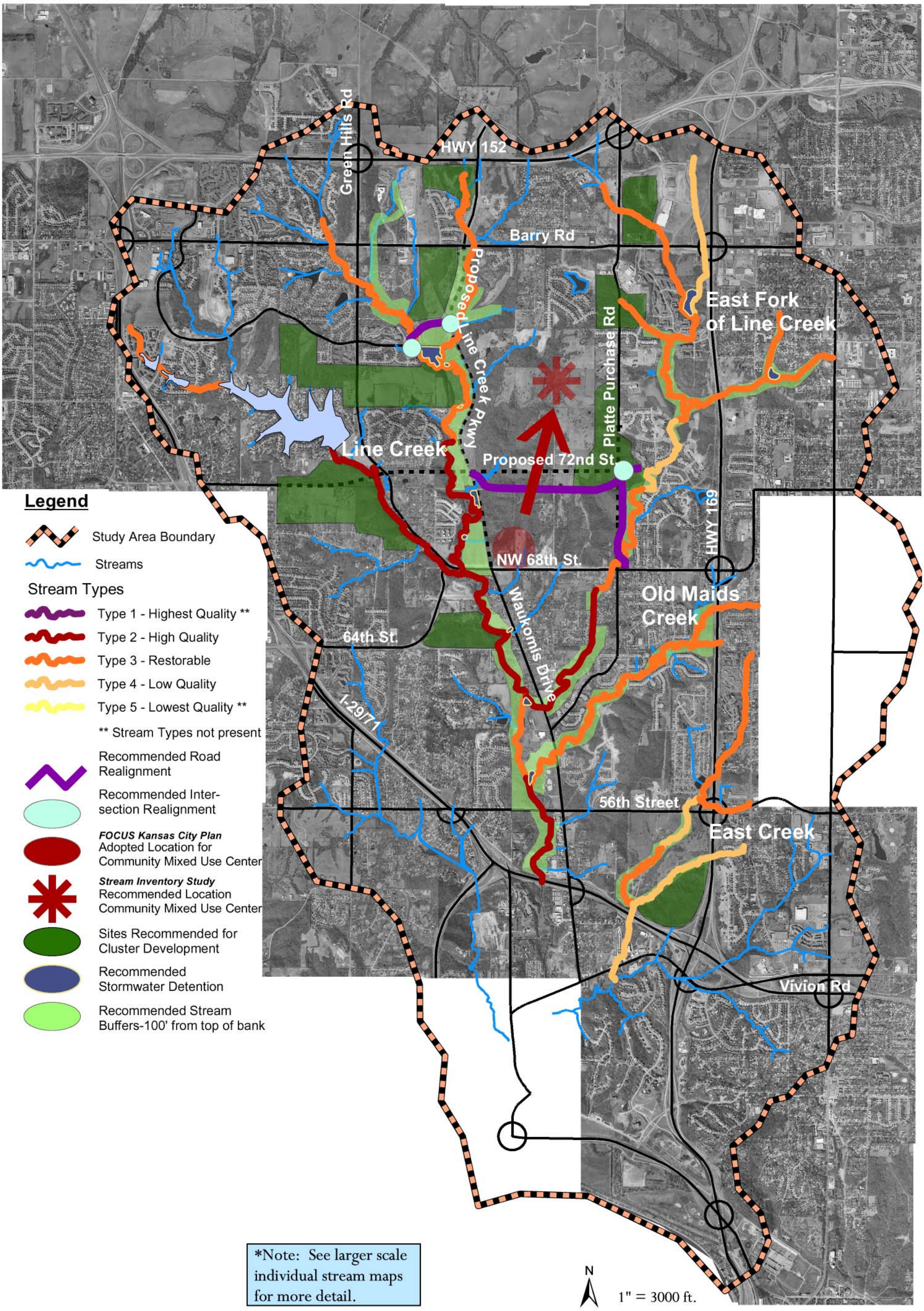
Kansas City Stream Assessment Phase I

Line Creek Watershed Recommendations



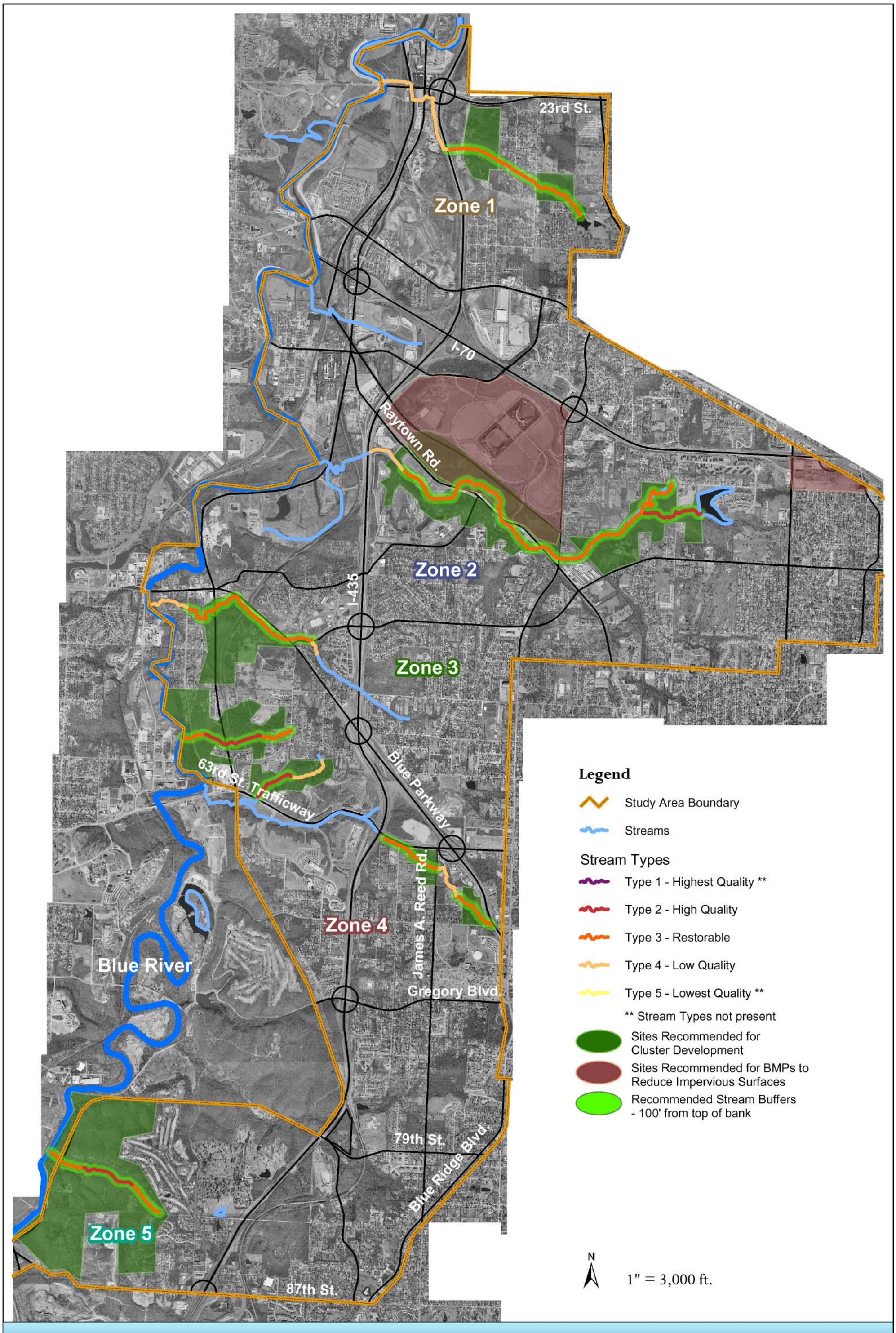
Kansas City Stream Assessment Phase I

Stadium/Park East Planning Area
Streams by Type



Kansas City Stream Assessment Phase I

Line Creek Watershed Recommendations



Kansas City Stream Assessment Phase I

Stadium/Park East Planning Area Recommendations