LOWER MERAMEC RIVER WATERSHEDS:

BRUSH CREEK WATERSHED, FOX CREEK WATERSHED AND

HAMILTON CREEK WATERSHED

Issues Report

Prepared by:
The Trust for Public Land and The Open Space Council

SPRING 2009

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Lower Meramec Drinking Water Source Protection Project
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0 1.25 2.5 Miles

N

** The protected land on this map comes from a data set of open space provided by the East-West Gateway Council of Governments. Open space in this file is "community" open space, i.e. space that has been set-aside for public use. It does not include "ecological" open spaces, e.g. wetlands, forests or agricultural lands that have been set-aside.

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INTRODUCTION

The Lower Meramec River Watershed Issues Report, as a part of the Source Water Quality Demonstration Model Project, is designed to prepare the Strategy Exchange Team for their visit to the Brush Creek watershed, Hamilton Creek watershed and Fox Creek watershed ("the study area"). The purpose of this report is to summarize characteristics of the study area. The Issues Report will also become part of the overall Implementation Plan that will encompass the Lower Meramec River Greenprint, and the Lower Meramec River Strategy Exchange Report.

The following is a list of documents, data, and plans collected and used in this report:

- *LaBarque Creek Watershed Plan*. Missouri Department of Conservation, 2008.
- *The Meramec River Basin Almanac*. St. Louis: East-West Gateway Council of Governments, 2007.
- Criss, Robert E. and David A. Wilson. *At the Confluence: River, Floods, and Water Quality in the St. Louis Region.* St. Louis: Missouri Botanical Garden Press, 2003.
- *Lower Meramec Greenway Study, Water Quality Considerations.* St. Louis: East-West Gateway Council of Governments, 2005.
- *Water Quality Features: Watershed Planning for the Lower Meramec River*. St. Louis: East-West Gateway Council of Governments, 2005.
- *St. Louis County Meramec River Greenway Concept Plan.* St. Louis County Parks and Recreation, St. Louis County Department of Planning, 2003.
- Missouri Department of Conservation. Meramec River Watershed: Water Quality. http://mdc.mo.gov/fish/watershed/meramec/watqual/, 2007.
- Missouri Department of Conservation. Meramec River Watershed: Geology. http://mdc.mo.gov/fish/watershed/meramec/geology/, 2007.
- Missouri Department of Natural Resources. Source Water Assessment Plan - State of Missouri, Drinking Water Source Water Assessment Plan. http://drinkingwater.missouri.edu/swap/index.html, 2007.
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- Jefferson County, Missouri. Storm water Management Division. http://www.jeffcomo.org/stormwater.aspx, 2009.
- Franklin County, Missouri. Appendix I: Storm water Management Standards. http://www.franklinmo.org/, 2000.
- *2007 Annual Water Quality Report*. St. Louis: Missouri American Water, 2007.
- GIS data sources – various

BACKGROUND

I. THE STUDY AREA

Introduction to the Study Area Within the Lower Meramec River

The Lower Meramec River flows 108 miles from Sullivan, Missouri through the southern part of the St. Louis Metropolitan area and enters the Mississippi River at the city of Arnold. Covering 486 square miles, the watershed contains 33 sub-watersheds draining directly to the river. Twenty cities are located within the Meramec River watershed with a population of 174,000. Approximately 2.5 million people live within a half hour drive of the river. More than 10 watersheds drain into the Meramec River.

This report will focus on three of these sub watersheds that together comprise the study area for the Source Water Demonstration Project for the Lower Meramec River: Brush Creek watershed, Hamilton Creek watershed and Fox Creek watershed. The study area encompasses 135 square miles and crosses into three counties. The Franklin County area is lightly populated, with predominately forest and agricultural land cover, and the St. Louis and Jefferson County portions of the study area are more densely populated and urbanized. These three subwatersheds are upstream of drinking water intakes for Missouri-American Water, providing water to approximately 200,000 residents in the St. Louis metropolitan area.[1]

Subwatershed Descriptions

Brush Creek watershed includes 37 square miles and 3 tributaries to the Meramec River: Brush Creek, Clear Creek and Winch Creek located west of St. Louis along the I-44 corridor running through Franklin and St. Louis County near the city of Pacific. Approximately 7,000 people live in the watershed, and the majority reside in the city of Pacific, Missouri. The City of Pacific covers 5.4 square miles, most of which is in the Brush Creek watershed.

The Hamilton Creek watershed covers 55 square miles and includes 3 tributaries to the Meramec River: Hamilton Creek, Carr Creek, and Flat Creek. These creeks flow through western St. Louis County north of I-44 and the northern edge of Jefferson County. The watershed is home to an estimated population of 39,000, with 32,000 living in the city of Wildwood, Missouri.

Lying in southwestern St. Louis County and spanning west into Franklin County and south into Jefferson County, the Fox Creek watershed includes seven subwatersheds: LaBarque Creek, Fox Creek, Little Fox Creek, Antire Creek, Little Antire Creek, Flatrock Creek and McFall Creek. It covers 44 square miles. The lower watershed includes part of the city of Eureka, the largest city in the area (population of 7,700), and part of the city of Pacific. The Fox Creek watershed had an estimate 2,400 residents in

[1] Overall, Missouri-American Water supplies drinking water to 800,000 people in the St. Louis region, relying on these sources and others.

2000, with a density of approximately 120 people per square mile. Fox Creek has been identified as a priority stream by Missouri Department of Conservation (MDC). It is considered to be healthy, hosts a rich diversity of flora and fauna and registers low levels of pollutants in studies recently completed by various Missouri Stream Teams.[2] In terms of comparing aquatic biodiversity with Hamilton Creek and Brush Creek watersheds, the Fox Creek watershed is healthiest.

Regional Geology, Precipitation and Land Cover Characteristics Today

Lying in the Ozark Highlands physiographic region, the study area includes forests, woodlands, savannas, glades, caves, bluffs, springs, streams and sinkhole ponds. This portion of the Meramec River basin near the Mississippi River has rocks of the Mississippian Age, which is a mix of St. Louis Limestone, Salem Formation, Keukok Limestone, and Burlington Limestone.[3] Land cover in the watershed includes forest, prairie, cropland, pasture and urban development. Land elevations range from 1,400 to 400 feet. Major rock types include dolomite, limestone, chert and sandstone. Karsts topography comprises most of the watershed and includes features such as caves, sinkholes, filled sinkholes, losing streams[4] and many springs. There is a transition from dolomite to sandstone/ limestone bedrock in the Pacific area and limestone bedrock is present in the eastern part of the watershed. Limestone bluff outcroppings, dispersed glades and unique flora and fauna habitats create many scenic views in the watershed.

Average rainfall in the watersheds is close to 37.2 +/- 7.0 inches per year. [2] Runoff in the area is equivalent to 10 inches of rainfall per year and a small fraction of the precipitation recharges groundwater supplies. Major flooding in the area is common in the spring and summer. The entire Meramec watershed can experience flash flood conditions from severe thunderstorms where discharge can increase from less than 1,000 cfs to more than 30,000 cfs within a 24 to 48 hour period.[3] Recent increased flooding has led to many floodplain buyouts by the Federal Emergency Management Agency (FEMA) in cooperation with local cities and counties in the area. Cities affected in our study area include: Eureka, Wildwood and Pacific.

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[2] The Stream Team Program was created in 1989 by the Missouri Department of Conservation and is a volunteer based program allowing residents the opportunity to steward their area stream. The Fox Creek Stream Team monitors the creek on a regular basis to see that it retains its current healthy state.

[3] Missouri Department of Conservation. Meramec River Watershed: Geology. http://mdc.mo.gov/fish/watershed/meramec/geology/, 2007.

[4] A losing stream loses water as it flows downstream, which is caused by the water table lying below the bottom of the stream channel. This is contrast to a gaining stream which increases in water volume farther downstream as it gains water from the local aquifer. Little Antire, Antire, Keifer and Hamilton Creek are all losing streams.

[2] Criss, Robert E. and David A. Wilson. *At the Confluence: River, Floods, Water Quality in the St. Louis Region.* St. Louis: Missouri Botanical Garden Press, 2003.

[3] *Lower Meramec Greenway Study, Water Quality Considerations.* St. Louis: East-West Gateway Council of Governments, 2005.

Urban developments of higher density residential, commercial and light industrial land-uses are found in the eastern counties of St. Louis and Jefferson. Franklin County and parts of Jefferson County have experienced some urbanized growth only in recent years.

Current Water Quality

Water quality in the three subwatersheds has improved greatly since the 1970s although many issues threaten the current water quality. Declining fish species in the Meramec River tributaries in the last few years are likely caused by several problems associated with increasing urban development. Annual restoration efforts such as Operation Clean Stream and organized volunteers with Missouri Stream Teams work to keep the rivers and streams consistently healthy. Now in its 43rd year, Operation Clean Stream is held annually on the Meramec River and its tributaries and is one of the largest river restoration efforts in the country with over 2,000 volunteers. There are more than 3,700 Missouri Stream Teams across the state in which each team works to keep their selected stream clean and healthy throughout the year and perform regular water quality monitoring exercises.

Fish population studies by the Missouri Department of Conservation reveal declining conditions in the tributaries of the Meramec River. None of the small tributaries between the mouth of the Mississippi River and mile 41.9 near Eureka supports a broad diversity of fish species. LaBarque Creek (with 42 fish species) and Fox Creek (with 44 fish species) are considered healthy streams while none of the 15 comparably-sized tributaries to their east have more than 13 species and most have fewer than 10. From the most recent research it seems suburban development patterns and related practices in the Lower Meramec watershed have worsened water quality, which has lead to declining fish species. Non-point source pollution and stream sedimentation are also contributing factors threatening water quality. Livestock that graze and lounge in riparian corridors and stream water create conditions that lead to excessive sedimentation, nutrient loading, and poor riparian corridor and stream bank instability conditions in much of the Meramec basin. The Meramec River received the designation of one of the “10 Waters to Watch in 2009” by the National Fish Habitat Action Plan Board to increase awareness of the above problems.

LaBarque Creek, in the Fox Creek watershed, falls in one of the Missouri Department of Conservation’s (MDC) Conservation Opportunity Areas. These areas are priority places for all wildlife conservation. The area has a low level of disturbance producing a high quality aquatic system for 6 miles of flowing stream. High quality stream conditions and sandstone geology combine to create a habitat for a diversity of plants and animals in the watershed.

History of the Region

In pre-settlement times the main-stem riparian zones were up to two miles wide on either side of the Meramec River. Hardwood species were most common – such as scrub oak, white oak, post oak and red oak – in the uplands and black walnut, hickory, maple, ash,

birch and sycamore in the bottomlands.[5] Many changes came about in the 1800s when the Meramec watershed was affected by mining, timber cutting and grazing practices and subsequent erosion and sedimentation. During the Timber Boom, Missouri was a leading lumber producing state resulting in depleted forest cover in the area.[4] Large areas of the region were clear-cut such as the now present Rockwoods Reservation in western St. Louis County.

Wildlife was close to elimination by about 1860 due to market hunting, trapping and habitat loss. Streams were negatively impacted as soil erosion followed the loss of vegetation cover. In the Rockwoods Reservation area, which is in the Hamilton Creek watershed, streams that had once flowed year round became seasonal and many springs went dry. Huge quantities of coarse sediment aggraded in the streams changing them to shallow streams with gravel bottoms.[8] Gravel bars presently cover many of the stream banks in the watershed although this was not the case during settlement times according to written historical observations of early settlers and explorers.[9] In the late 1800s, movement of large quantities of gravel in streambanks and beds began, then leading to businesses springing up to process the abundant sand and gravel supplies in the Meramec tributaries. This resulted in the removal of these resources from quarry and instream locations.

Nevertheless, in the early 1900s the Meramec watershed became a major recreation destination for residents of the St. Louis region. There was an effort across Missouri in the 1930s to bring back forests with an emphasis on fire prevention. Legislation was passed to permit the federal government to purchase land for national forests. The Missouri Conservation Commission was created in 1936, and it established a Forestry Division. Acquisition began in 1934 and Mark Twain National Forest was established in 1939 by Presidential Proclamation.

However, by the end of World War II pollution reached intolerable levels. The water quality declined so much that people stopped swimming, fishing and using the river for other recreation purposes. A group of concerned citizens began a restoration effort in 1967 to bring attention to the degradation on the lower Meramec River. The group of citizens formed the organization the Open Space Council and the restoration effort became an annual event, Operation Clean Stream. Today the watershed has one of the best representations of biodiversity in the country. And as before, recreation represents a major land use within the watershed on public and private land. Kayaking, canoeing, hiking, fishing, swimming, camping and biking are just a few of the outdoor recreation activities available to the public. Also, the Meramec Greenway offers more than 30,000 acres of public and semi-public land for enjoyment of nature and outdoor recreation. This combination of easy access to public land and high water clarity in the streams attracts

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[5] Missouri Department of Conservation, 3.
[4] *The Meramec River Basin Almanac*. St. Louis: East-West Gateway Council of Governments, 2007, 6.
[8] Criss, 2003, 19.
[9] Missouri Department of Conservation, 2007, 1.

thousands of outdoor enthusiasts each year.[10] Forest logging and processing industry are still active today with management by the Missouri Department of Conservation and U.S. Forestry Service.[6] Today forest cover is dominated by oak species with stand size-classes on tracts of land are roughly 45% saw timber, 30% pole timber and 25% seedling and sampling timber.[7]

II. THREATS TO THE STUDY AREA

Over the past 200 years, the watersheds surrounding the St. Louis area have been impacted by a variety of activities including everything from farming, logging, mining and road building to urban development. These impacts have put considerable strains on ensuring good water quality in the watersheds.

Urban Development

Increasing urban development in the western regions of St. Louis County, northern Jefferson County and eastern Franklin County in recent years has caused numerous alterations in the rivers and streams. If development patterns continue to follow the current trend, large sections of the Brush Creek, Hamilton Creek and Fox Creek watersheds will be built-out with residential and commercial projects. The development will considerably reduce the size of contiguous forest tracts, according to the Missouri Department of Conservation.[11] Upstream development in St. Louis County and eastern Franklin and Jefferson counties has already fragmented forest habitats, contributed to a large loss of stream side vegetation and placed constraints on once free flowing creeks.

Heavy sediment became a problem in the Brush Creek watershed, in particular, due to land disturbance work connected to urban development. The city of Pacific has ordinances, which are not being fully enforced, where numerous businesses back up too closely to the creek banks. These poor development practices have led to similar problems also in the Hamilton Creek watershed and Fox Creek watershed.

Impaired Water Quality

Numerous pollutants have worked their way into the watershed such as emerging containments from pharmaceutical drugs, sediment, bacteria (human, pet, farm animals, wildlife sources) and salt from roads. Hazardous chemical spills from industrial and transportation related sources and corridor spills are also a threat. The close proximity of major interstates (I-44, I-55, I-270) and major railroads present the risk of a hazardous material spill along a transportation corridor entering the river. A serious spill could result in contaminating drinking water sources. Poorly designed creek crossings also allow for contamination. Also, volatile organic compounds (VOCs) from petroleum coming from sources such as oil in storm water run-off and spills from transportation

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[10] Missouri Department of Conservation, 2007, 4.
[6] East-West Gateway Council of Governments, 2007, 8.
[7] Missouri Department of Conservation, 2007, 4.
[11] Missouri Department of Conservation, 2007, 3.

sources may present additional drinking water treatment challenges and require powder activated carbon to be added to the treatment process, at additional labor and expense.

Algal blooms are a concern of the water treatment facility plant operators in the area. Algal blooms result from excessive nutrient loading and can cause taste and odor abnormalities in treated drinking water. These nutrients enter the river through stormwater run-off and wastewater treatment plant discharges. Powder activated carbon can help mitigate the problem, but add labor and other expenses to the treatment process.

Turbidity is a major challenge to water treatment facilities. The turbidity in the streams is normally very low. However, a large rain event can cause a rapid increase in turbidity, largely due to stormwater run-off from non-point sources and the resulting erosion due to increased velocity and quantity of rain water. Average turbidity is less than 10 NTU, however during rain events turbidity may exceed 300 NTU in the Meramec River.[12]

Harmful Landowner/Developer Practices

Common issues in the watersheds include animal grazing, illegal waste disposal, stream straightening, failing septic systems and improper use of motorized vehicles. Livestock that graze and lounge in riparian corridors and stream water create conditions that lead to excessive sedimentation, nutrient loading, poor riparian corridor and stream bank instability conditions in much of the Meramec basin. Actual animal waste in the streams also contributes to water contamination. MDC, specifically the Sullivan office, has developed a solution for this problem, which is the placing of tents on the land to shield animals from the sun. Tents help protect understory vegetation in wooded areas as well. Also in St. Louis County, MSD created a program to educate citizens on the proper disposal of pet waste. Land disturbance ordinances prohibit all illegal dumping including pet waste.

The use of ATVs and farming equipment driven in riparian areas and stream channels results in increased sedimentation. Ordinances by the counties and municipalities are in place to prevent this activity, but it is difficult to enforce. Illegal yard waste disposal and dumping of tires, chemicals, oil, appliances, etc are a reoccurring problem in the watershed. St. Louis County has two investigators that have observed this to be a big problem. This is also difficult to enforce as it occurs covertly and labor costs associated with properly disposing some items is a factor. Volunteer efforts and education by projects such as Operation Clean Stream and Stream Team have helped.

New development has altered stream channels and floodplains in recent years, which is becoming more frequent as population densities rise. MDC grants to fund the installation of fencing, shades and wells are a means to implement erosion reduction practices by keeping livestock out of the streams and riparian forest. Municipalities also have provisions for erosion fencing for developers to prevent future erosion. These and other flood damage prevention ordinances by the cities and counties help protect the watershed.

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[12] *2007 Annual Water Quality Report*. St. Louis: Missouri American Water, 2007.

Increased Flooding
Development is a major factor in increased flooding frequencies and intensities. This has been mitigated some since 1984. At this time FEMA in partnership with cities and counties, funded the buy-out of many floodplain properties in the watersheds. These areas are now reserved for greenways, parks and open space.

In 2000, Great Rivers Greenway District was formed to manage the development of parks and greenways in St. Louis City and County. This is funded by a one tenth of one cent sales tax. St. Louis County Parks and Recreation has included the concept of the Meramec River Greenway in their General Management Plan. This concept dates back over 40 years when several studies were done to advocate for the greenway concept after years of repeated flooding in the area. It is also important to mention the aesthetic, environmental, educational, recreational and economic values and benefits the greenway brings to the St. Louis area. The Meramec River Recreation Association (MRRA) was formed in 1975 to serve as the coordinating committee for the concept. Today, the plan is included in the Great Rivers Greenway District's River Ring concept. [13]

Underperforming Sewage Treatment Facilities
Under performing sewage treatment facilities and leaking septic systems are common in the watersheds. Septic systems are prevalent in the study area. For example, Hamilton Creek watershed has approximately one septic system per home for every 1,000 homes. Overall, the city of Wildwood, in the Hamilton Creek watershed, has 3,233 septic systems. Out of those, 869 fall within the Metropolitan Sewer District service area, leaving 2,364 outside the boundary. See **Appendix 1** for two maps – the first highlights the portions of Wildwood technically within the MSD's service area, but not receiving service and therefore relying upon septics. The second shows the portion of Wildwood outside of the MSD's service area, and the locations of septic systems there.

By January 2006 the city of Wildwood created a list of environmental policies for septic systems and other means of sewage treatment. These include: installation of individual septic systems to meet environmental standards; regular inspections; better cooperation between the city, the Missouri Department of Natural Resources, and the St. Louis County Department of Health in establishing an effective inspection system for package sewage treatment plants; and tertiary treatment of sewage effluent for any package treatment plant.[14]

Through the Jefferson County Storm Water Division, guidance and resources are provided to help prevent erosion and reduce the amount of sediment and other pollutants in storm water runoff through the Jefferson County Land Disturbance Ordinance and the

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[13] Great Rivers Greenway District. The River Ring. http://www.greatrivers.info/Projects/TheRiverRing.aspx, 2008.
[14] City of Wildwood, Missouri. Master Plan: Summary of Environmental Objectives & Policies. http://www.cityofwildwood.com/egov/docs/1137268012617.htm, 2006.

Jefferson County Erosion Sediment Control/Design Manual.[15] Franklin County also has set storm water management standards for control and criteria guidelines. Accordingly, every development is required to have storm water detention although in some cases immediate detention may not be required and the development must contribute to the Storm Water Management Improvements Fund.[16] In 2007, the Metropolitan Sewer District (MSD) adopted the Phase II Storm Water Management Plan creating regulations for St. Louis County. MSD is currently educating all St. Louis County municipalities so that they comply with the new regulations. Compliance and enforcement of these regulations and ordinances has been a challenge.

Challenges Related to Storm Water Management Coordination and Enforcement
There are several jurisdictions and three counties in the three-watershed area. Each county has their own storm water management division. St. Louis County's stormwater is managed by the Metropolitan Sewer District (MSD) and Jefferson and Franklin County's stormwater is managed by the respective counties. MSD recently adopted the Phase II Storm Water Management Plan for St. Louis. Storm water runoff quality regulations focus on sedimentation and erosion processes and other nonpoint pollution sources.

DNR issued a Non-Point Pollution Discharge Elimination System (NPDES) General Operating Permit for Jefferson County Small Municipal Separate Storm Sewer Systems (MS4s) and five co-permittees. Under this permit, implementation and enforcement of six minimum control measures is required. The Storm Water Task Force includes representatives from Jefferson County and its municipalities and interested communities and individuals. The regulations and standards for storm water control exist in St. Louis, Jefferson and Franklin County. There is a struggle over management to ensure optimal control.

III. CROSS-CUTTING CHALLENGES WITHIN THE STUDY AREA

Based on topics raised by the Meramec River Tributary Alliance, questions drawn by the Meramec River Tributary Alliance for the Strategy Exchange, and an analysis of research being conducted in the area, the following are the main priorities to protect, preserve and enhance the ecological integrity of the Brush Creek watershed, Hamilton Creek watershed and Fox Creek watershed while improving the quality of life in our communities. The Tributary Alliances asks that the Strategy Exchange Expert address each of these as they tackles specific issues outlined in the Strategy Exchange Questions attached.

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[15] Jefferson County, Missouri. Storm water Management Division. http://www.jeffcomo.org/stormwater.aspx, 2009.
[16] Franklin County, Missouri. Appendix I: Storm water Management Standards. http://www.franklinmo.org/, 2000.

Policy Implementation Hurdles
Dealing with three counties and several municipalities complicates policy implementation in the watersheds. Also, no method is currently in place to share information and best practices across jurisdictions. Although not an authority on enforcement, East-West Gateway Council of Governments is the planning agency for the St. Louis Region formed to provide a forum for cooperative problem-solving and the coordinated development of regional policy. Policy enforcement is in the hands of the cities and counties, leading to several issues. Different rules may confuse the public and developers and a standardization of rules does not presently exist. Different rules may also produce different results where staffing levels and inspections vary from county to county.

Landowner/ Developer Education and Outreach
The need for landowner and developer outreach and education is an on-going issue in every watershed. Landowners are threatened by the potential added cost to upgrade facilities and perceived threats to their private property rights. Better education and communication may help. Several efforts are in place by the Missouri Department of Conservation (MDC), MSD, cities and counties to convey a message that landowners and developers have responsibility for protecting the land and water downstream. Public meetings, workshops, training, brochures and other educational documents on watershed best management practices have been offered to landowners.

MDC, the Department of Natural Resources (DNR), local counties and municipalities have had a hand in creating watershed landowner groups and providing education to individuals across the state. The Friends of LaBarque Creek is one such organization. Several landowners in this watershed are very involved and they have held outreach events to encourage participation from other landowners. This is the type of "friends" organization needed to educate landowners on best land management practices.
Social marketing may be one way to promote best management practices and build off of MDC's already successful outreach program.

Agency/ Organization Collaboration
DNR, MDC, East-West Gateway Council of Governments, Missouri Department of Transportation (MODOT), St. Louis, Jefferson and Franklin Counties, and all municipalities in the watersheds may benefit from improving collaboration and funding that will enable plan implementation.

State and city agencies have specifically expressed challenges in working with the Missouri Department of Transportation in design of stream overpasses.
East-West Gateway works with MODOT in the development of a long-range transportation plan for the region. Recently there has been a stronger focus on preservation in highway planning at the regional level with plans to focus on repair rather than new development.

Funding Needs

There is a shortage of programmatic funding to enact and enforce water quality programs, and a need to identify national, state and local funding sources for meeting recommendations related to addressing the threats described above.

SUMMARY OF MAPPING ASSESSMENT

A Technical Advisory Team (TAT) of local, regional and state experts examined the Lower Meramec, Big River and Bourbeuse watersheds' ability to produce clean water, according to Geographic Information System (GIS) results of the unpublished study entitled: *Forest, Water and People: Drinking Water Supply and Forested Lands in the Northeastern United States*.[5] This analysis, together with other considerations raised by participants during an October 2009 meeting of the Meramec River Tributary Alliance, was used to select the subwatersheds that comprise the current study area. [6]

Then TPL, with guidance from the TAT, used the Watershed Management Priority Indices (WMPI) module from the UMASS Watershed Forest Management Information System to develop maps. The WMPI quantifies the relative influence of different land uses and site characteristics on overall water quality. For this approach, local land uses are categorized into three priority indices:

- The Conservation Priority Index identifies forests and wetlands critical for their role in supplying clean water;
- The Restoration Priority Index identifies agricultural and developed open space areas with a potential for adversely affecting water supplies; and
- The Stormwater Management Priority Index identifies where best management practices should be followed to prevent or decrease sources of nonpoint source pollution.

The WMPI methodology produces systematic patterns in each of the categories in relation to distance from water sources, slope, soil properties, and other watershed characteristics. (**See Appendix 2 for chart illustrating scoring approach for each WMPI index.**) These maps highlight the best areas for land conservation, stormwater best management practices, and restoration attention in the Hamilton, Brush Creek, and Fox subwatersheds. **These three maps are featured in Appendix 3**. Note that on each

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[5] This study was produced in cooperation between United States Forest Service Northeastern Area staff and University of Massachusetts at Amherst faculty through the Forest to Faucet partnership.

[6] Study area selection criteria included: subwatershed size, ability to produce clean water (UMASS Forest, Water and People study), development pressure 2000 – 2030 (SERGoM: Spatially Explicit Regional Growth Model), presence of habitat priorities (MO Comprehensive Wildlife Strategy), landcover diversity (2005), proximity of drinking water intakes, nature of existing water quality problems, overlap with Fish and Wildlife priority areas, recreational opportunities (as indicated by Great River Greenway District Boundaries), and specific subwatersheds nominated by meeting participants. The following criteria were also considered: high need for awareness/education, opportunity to work where FEMA buy-outs are occurring, diversity of threats/challenges, presence of receptive landowners, cultural groups are already working; areas targeted for receiving mitigation dollars, prior research exists, and including multiple jurisdictions.

page, the map shown in the middle is the result of the index model run based on the inputs shown in surrounding insets.

TPL also produced maps that show the conservation priority results with three different overlays: predicted development threat, wildlife habitat protection opportunity areas, and potential greenway and trail recreation areas, respectively. (**See Appendix 4**). For example, on the second map in this set, the Conservation Priority Index analysis (shown in bright and dark green) was combined with the already protected areas (shown in moss green) and Missouri Wildlife Conservation Opportunity Areas (shown in gray), to highlight areas of complementary conservation opportunity.

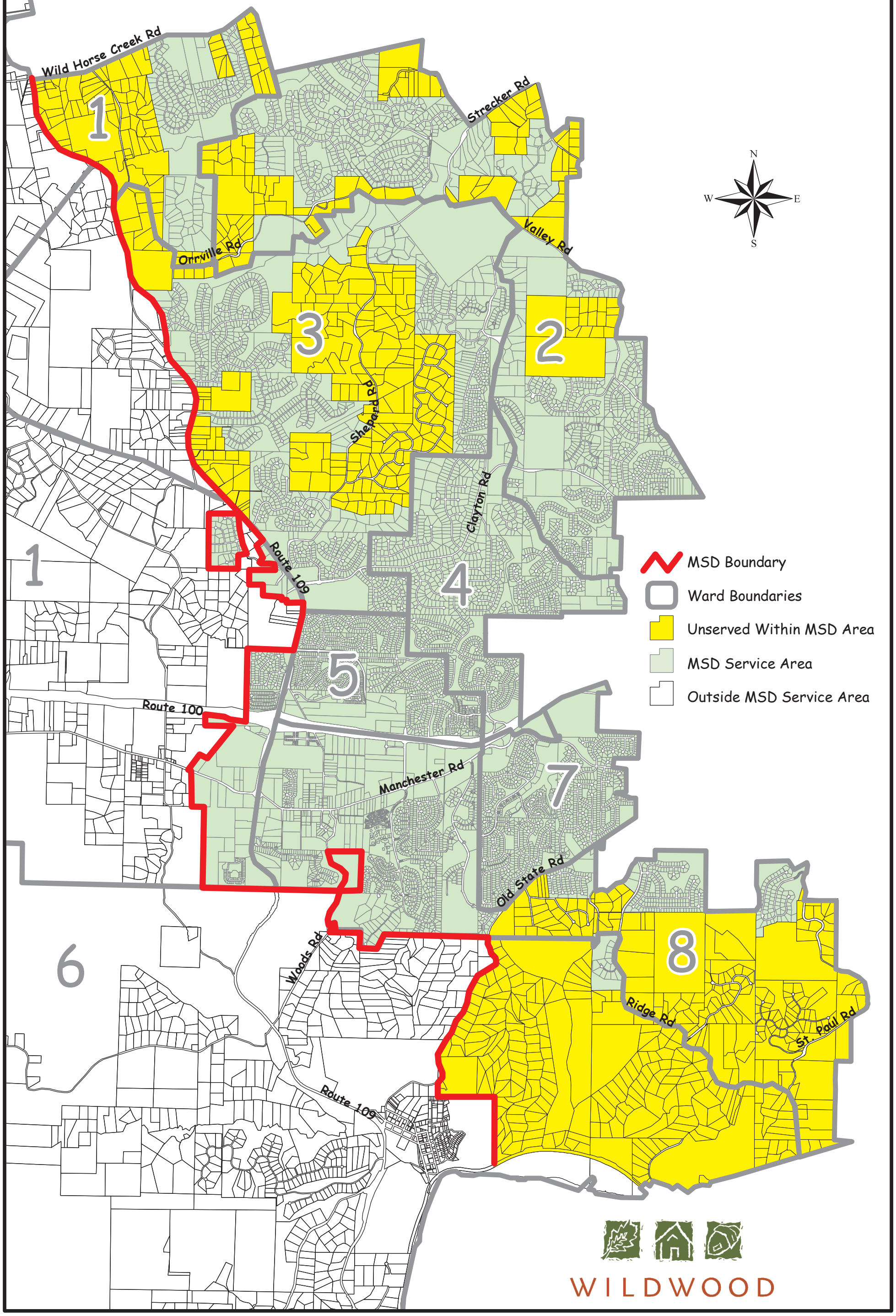
After overlaying property boundaries, these maps will identify which parcels may present the best opportunities for location-specific strategies for water quality protection and management. For example, **Appendix 5** contains the Stormwater Management Priority Map with parcel boundaries overlaid, and parcels containing red are those that should be investigated for potential follow-up. For the conservation and restoration maps, each of the parcels is scored relative to the other parcels so we can generate a list of most important to least important parcel with the property owner's name, address, size of parcel, etc. This information may be useful to Strategy Exchange experts and future implementers.

TPL plan to build an Internet Mapping Site that is password protected for use by local partners to facilitate identification of particular parcels that are promising for accomplishing protection, restoration and stormwater BMP objectives. The new technology will allow partners to select any parcel and see why it scored well, and digital data associated with the parcel will be available for ready follow-up with landowners.

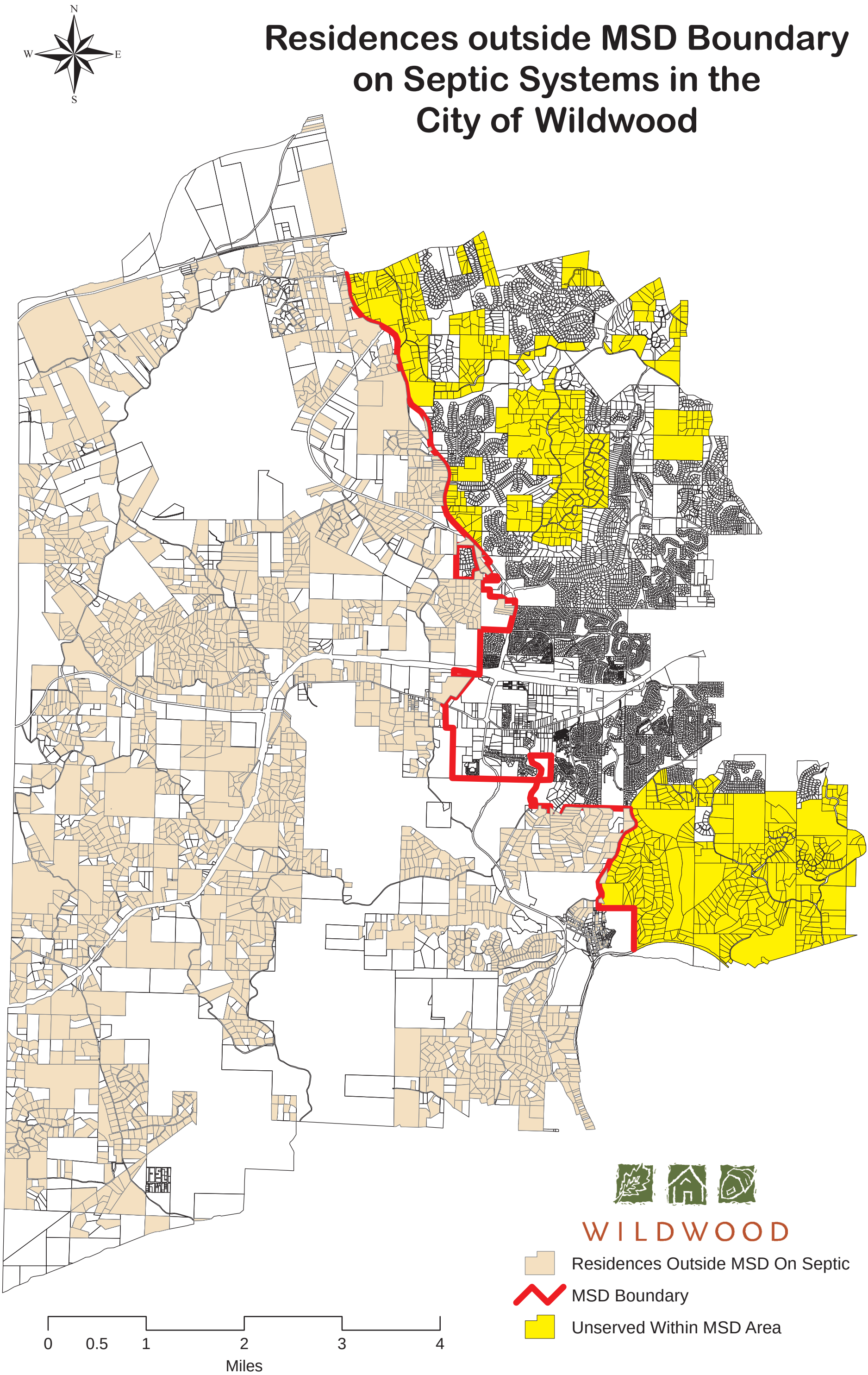
APPENDIX 1

Wildwood septic system locations (2 maps)

PRIMARY AREAS WITHIN MSD BOUNDARY WITHOUT SERVICE AVAILABLE IN EASTERN CITY OF WILDWOOD



Residences outside MSD Boundary on Septic Systems in the City of Wildwood



APPENDIX 2

Watershed Management Priority Indices
Parcel Scoring Chart

Scored on 0-3 scale	CPI Conservation Priority Index	RPI Restoration Priority Index	SWMPI Storm Water Management
Land Use	3 = Forested, Natural Land Cover	3 = Ag, Barren, Sparse Veg 2 = Grasslands	3 = High Intensity Urban 1 = Low Intensity Urban
Proximity to Streams	3 = 0-30 meters 2 = 30-60 meters 1 = 60-90 meters	3 = 0-30 meters 2 = 30-60 meters 1 = 60-90 meters	3 = 0-30 meters 2 = 30-60 meters 1 = 60-90 meters
Proximity to ponds/wetlands	3 = 0-30 meters 2 = 30-60 meters 1 = 60-90 meters	3 = 0-30 meters 2 = 30-60 meters 1 = 60-90 meters	3 = 0-30 meters 2 = 30-60 meters 1 = 60-90 meters
Soil Hydrologic Group	3 = C/D: Low Infiltration Rates 2 = B: Moderate Infiltration 1 = A: High Infiltration Rates	3 = C/D: Low Infiltration Rates 2 = B: Moderate Infiltration 1 = A: High Infiltration Rates	3 = C/D: Low Infiltration Rates 2 = B: Moderate Infiltration 1 = A: High Infiltration Rates
Soil Erodibility (Kfact)	3 = High 2 = Moderate 1 = Low	3 = High 2 = Moderate 1 = Low	3 = High 2 = Moderate 1 = Low
Slope	3 = greater than 18% 2 = 8% - 18% 1 = less than 8%	3 = greater than 18% 2 = 8% - 18% 1 = less than 8%	3 = greater than 18% 2 = 8% - 18% 1 = less than 8%
100 yr Floodplain	3 = In Floodplain	3 = In Floodplain	3 = In Floodplain

APPENDIX 3

Watershed Management Priority Indices maps:
Conservation Priority Areas
Restoration Priority Areas
Stormwater BMP Priority Areas

Lower Meramec Drinking Water Source Protection Project
Conservation Priority Index (CPI) Areas
December 16, 2008

Scored on 0-3 scale	CPI Conservation Priority Index
Land Use	3 = Deciduous Forest, Evergreen Forest, Deciduous Woody/Herbaceous, Wood-Dominated Wetland, Herbaceous-Dominated Wetland
Proximity to streams	3 = 0-30 meters 2 = 30-60 meters 1 = 60-90 meters
Proximity to ponds and wetlands	3 = 0-30 meters 2 = 30-60 meters 1 = 60-90 meters
Hydrologic Soil Group	3 = Hydro groups C&D 2 = Hydro group B 1 = Hydro group A
Erodibility (Kfact)	3 = >= .37 2 = >=.28 and <= .32 1 = < .28
Slope	3 = greater than 18% 2 = 8% - 18% 1 = less than 8%
100 yr Floodplain	3 = In Floodplain

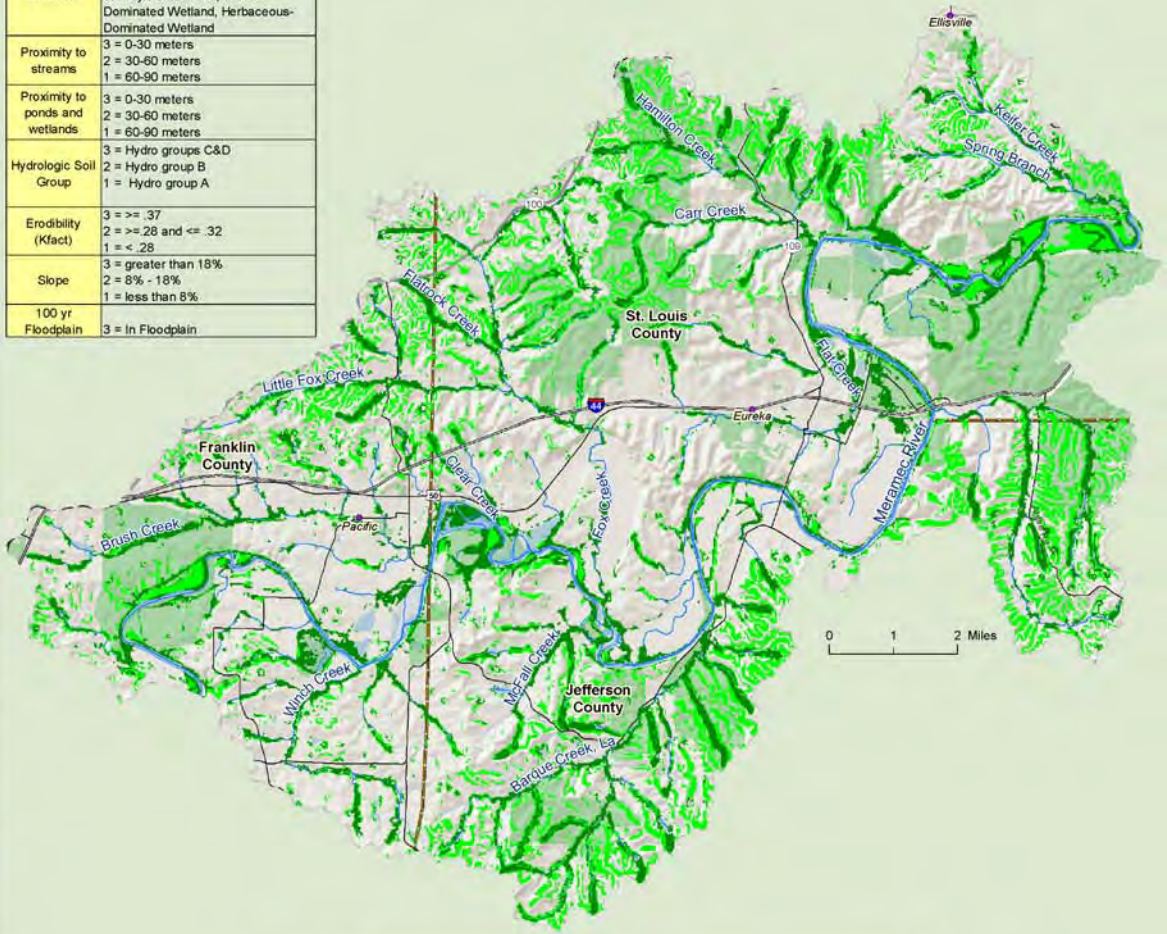
Proximity to Streams and Waterbodies

Soils Hydrologic Class

- Well Drained Soils, High Infiltration Rates
- Moderately Drained Soils
- Poorly Drained Soils, Low Infiltration Rates

Soil Erodibility - K Factor

- <= .28
- > .28 and <= .32
- > .32



Legend

CPI 90th percentile
13 - 21

CPI 70th percentile
12 - 21

Based on the Watershed Management Priority Indices (WMPI) Model developed by the Forest to Faucet Partnership in collaboration with UMASS, USFS, and TPL
http://www.wetpartnership.org/

Context
- Interstate
- Highway
- Local Road
- Protected Land
- Meramec River
- Wetlands
- Rivers and Streams
- County Boundary

Slope

- < 8
- 8-19
- > 19

FEMA 100 Year Flood Plain

Landuse - Natural

- Deciduous Forest
- Deciduous Wood/Herbaceous
- Evergreen Forest
- Herbaceous-Dominated Wetland
- Woody-Dominated Wetland

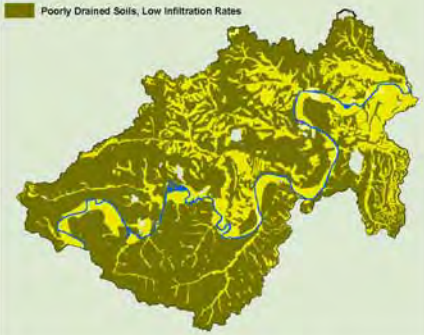
Lower Meramec Drinking Water Source Protection Project
Restoration Priority Index (RPI) Areas
December 16, 2008

Scored on 0-3 scale	RPI Restoration Priority Index
Land Use	3 = cropland, barren or sparsely vegetated 2 = Grassland
Proximity to streams	3 = 0-30 meters 2 = 30-60 meters 1 = 60-90 meters
Proximity to ponds and wetlands	3 = 0-30 meters 2 = 30-60 meters 1 = 60-90 meters
Hydrologic Soil Group	3 = Hydro groups C&D 2 = Hydro group B 1 = Hydro group A
Erodibility (Kfact)	3 = >= .37 2 = >=.28 and <= .32 1 = <= .28
Slope	3 = greater than 18% 2 = 8% - 18% 1 = less than 8%
100 yr Floodplain	3 = In Floodplain

Proximity to Streams and Waterbodies

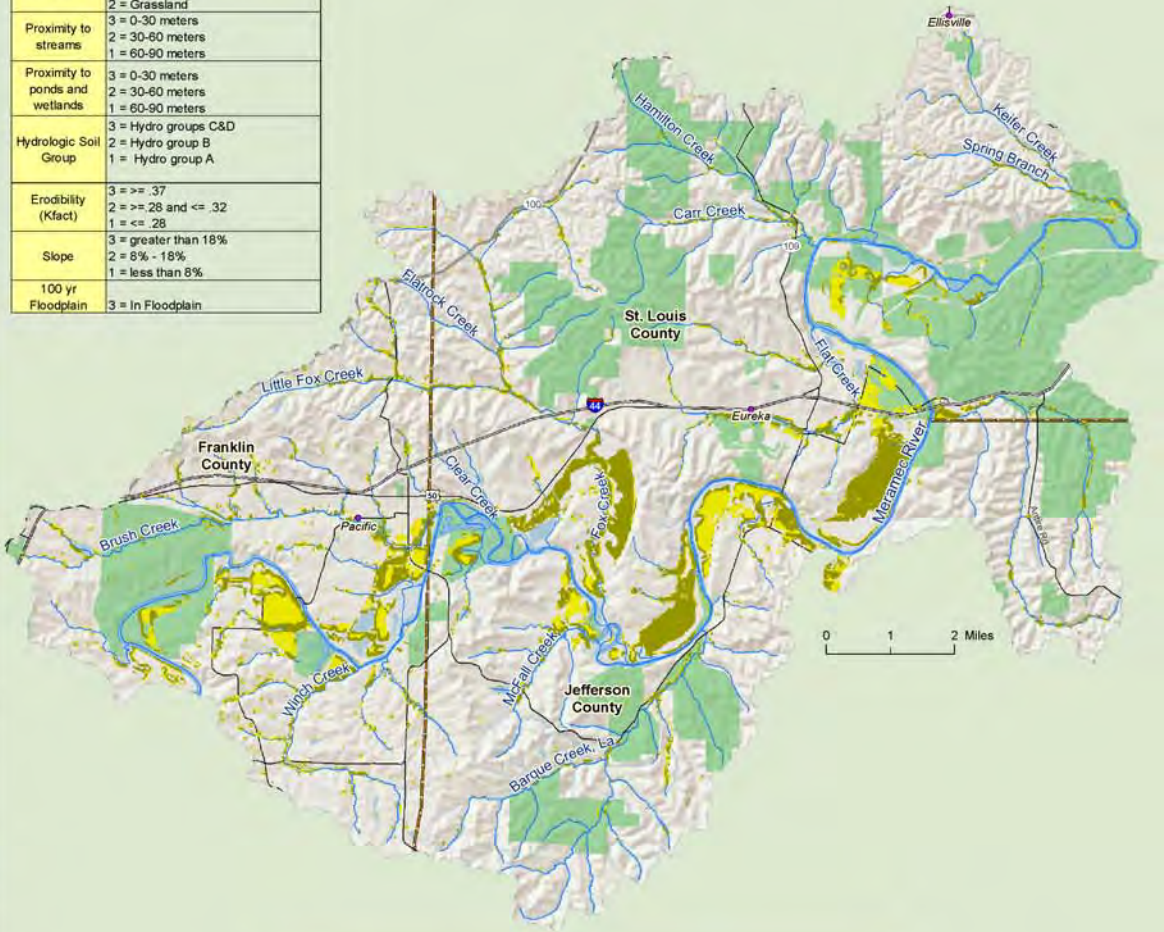
Soils Hydrologic Class

- Well Drained Soils, High Infiltration Rates
- Moderately Drained Soils
- Poorly Drained Soils, Low Infiltration Rates



Soil Erodibility - K Factor

- <= .28
- > .28 and <= .32
- > .32



Legend

RPI 90th percentile
- 13 - 20

RPI 70th percentile
- 12 - 20

Based on the Watershed Management Priority Indices (WMPI) Model developed by the Forest to Faucet Partnership in collaboration with UMASS, USFS, and TPL. http.//www.wetpartnership.org/

Context
- Interstate
- Highway
- Local Road
- Protected Land
- Meramec River
- Wetlands
- Rivers and Streams
- County Boundary

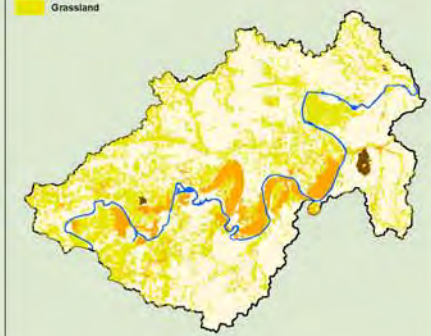
Slope

- < 8
- 8-19
- > 19

FEMA 100 Year Flood Plain

Landuse - Agriculture, Barren, Grassland

- Barren or Sparsely Vegetated
- Cropland
- Grassland



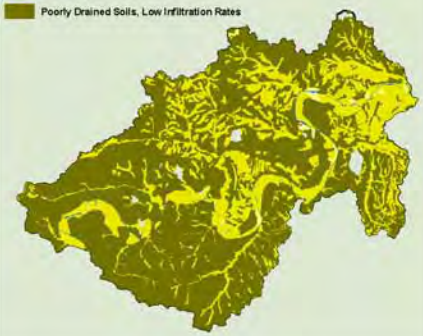
Lower Meramec Drinking Water Source Protection Project
Storm Water Management Priority Index (SMPI) Areas
December 16, 2008

Scored on 0-3 scale	SMPI Stormwater Management Priority Index
Land Use	3 = high intensity urban, impervious 1 = low intensity urban
Proximity to streams	3 = 0-30 meters 2 = 30-60 meters 1 = 60-90 meters
Proximity to ponds and wetlands	3 = 0-30 meters 2 = 30-60 meters 1 = 60-90 meters
Hydrologic Soil Group	3 = Hydro groups C&D 2 = Hydro group B 1 = Hydro group A
Erodibility (Kfact)	3 = >= .37 2 = >=.28 and <= .32 1 = < .28
Slope	3 = greater than 18% 2 = 8% - 18% 1 = less than 8%
100 yr Floodplain	3 = In Floodplain

Proximity to Streams and Waterbodies

Soils Hydrologic Class

- Well Drained Soils, High Infiltration Rates
- Moderately Drained Soils
- Poorly Drained Soils, Low Infiltration Rates



Soil Erodibility - K Factor

- <= .28
- > .28 and <= .32
- > .32

Legend

SMPI 90th percentile
12 - 20

SMPI 80th percentile
11 - 20

Based on the Watershed Management Priority Indices (WMPI) Model developed by the Forest to Faucet Partnership in collaboration with UMASS, USFS, and TPL
http://www.wetpartnership.org/

Context
- Interstate
- Highway
- Local Road
- Protected Land
- Meramec River
- Wetlands
- Rivers and Streams
- County Boundary

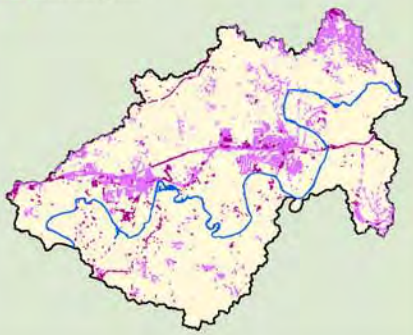
Slope

- < 8
- 8-19
- > 19

FEMA 100 Year Flood Plain

Landuse - Urban, Impervious

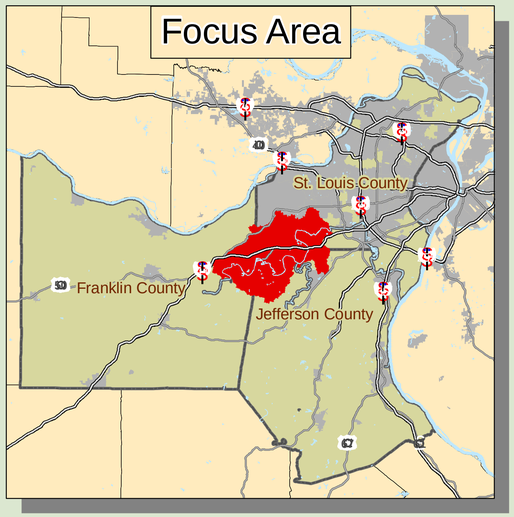
- High Intensity Urban; Impervious
- Low Intensity Urban

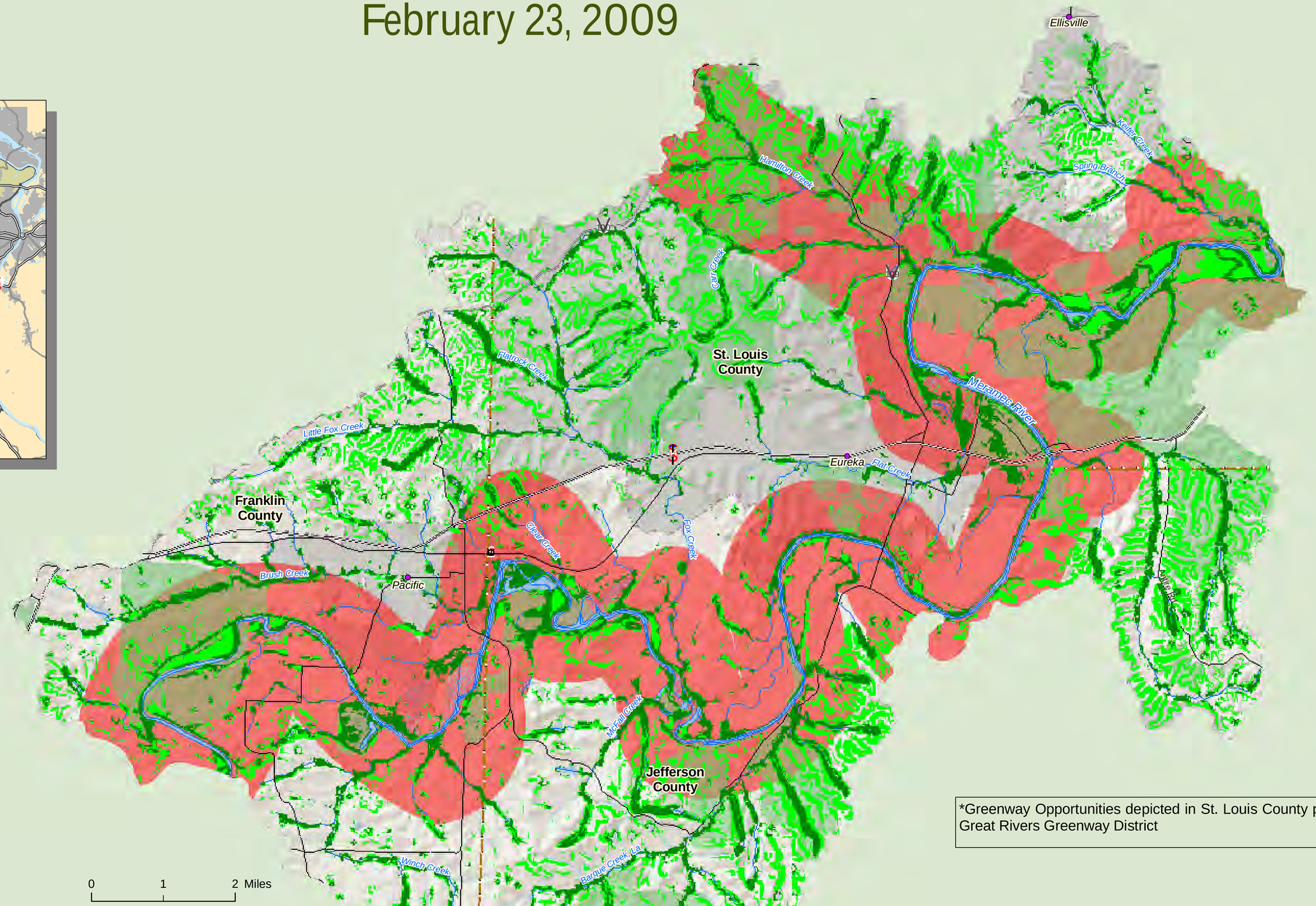


APPENDIX 4

Overlay Maps for Conservation Priority Area Results
(3 maps)

Lower Meramec Drinking Water Source Protection Project
Conservation Priority Index (CPI) Greenway and Trail Opportunities
February 23, 2009





*Greenway Opportunities depicted in St. Louis County provided by Great Rivers Greenway District

Legend

Meramec Greenway Plans/Opportunities*

CPI 90th percentile

13 - 21

CPI 70th percentile

12 - 21

Context

Interstate

Highway

Local Road

Protected Land

Meramec River

Wetlands

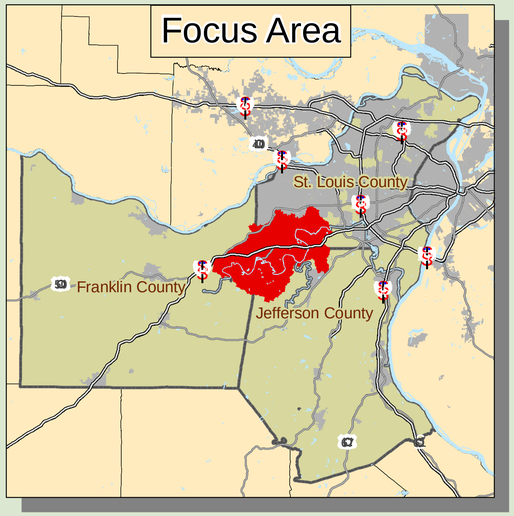
Rivers and Streams

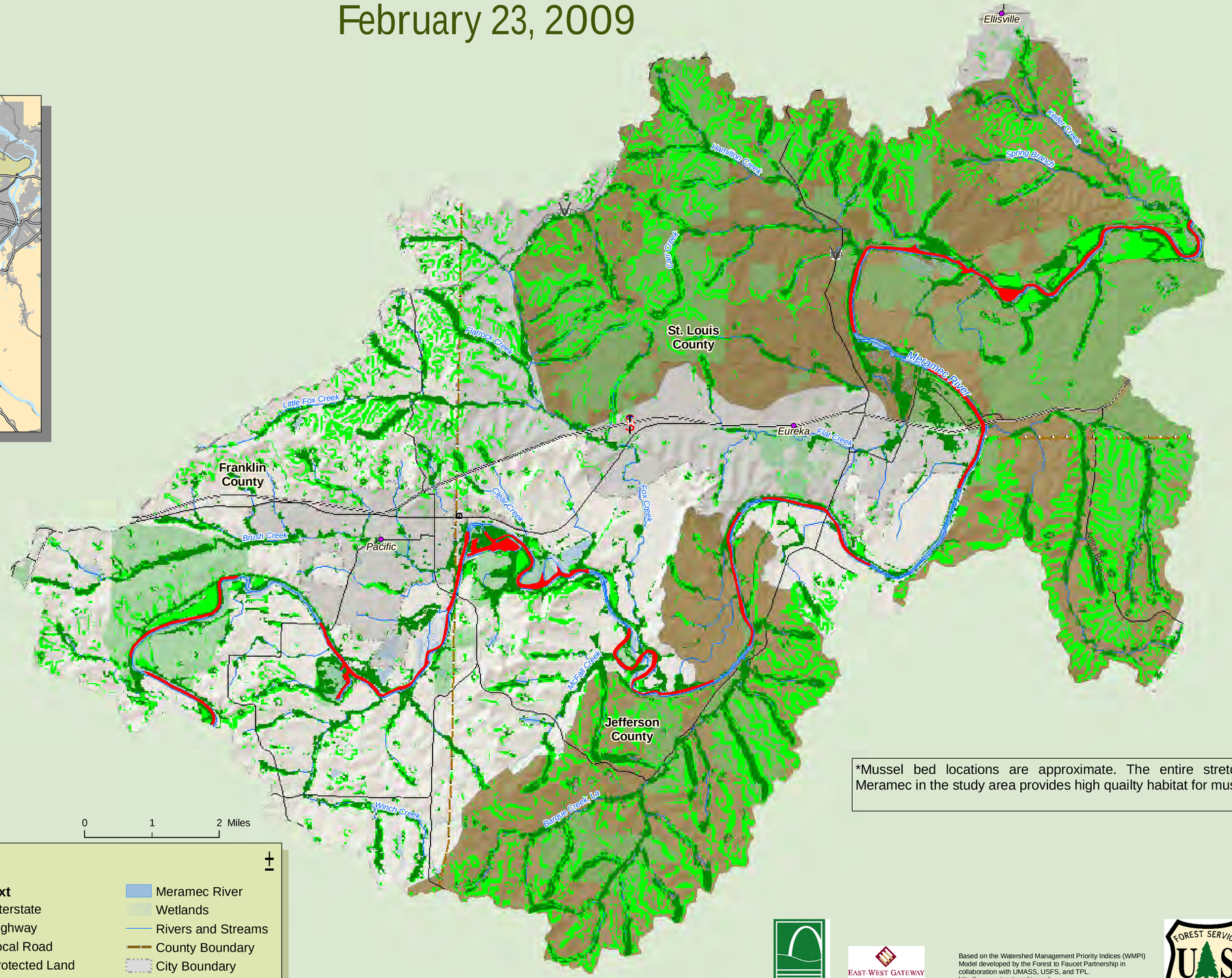
County Boundary

City Boundary

Based on the Watershed Management Priority Indices (WMPI) Model developed by the Forest to Faucet Partnership in collaboration with UMASS, USFS, and TPL. http://www.wetpartnership.org/

Lower Meramec Drinking Water Source Protection Project
Conservation Priority Index (CPI) Areas and Habitat Priority Overlays
February 23, 2009





*Mussel bed locations are approximate. The entire stretch of the Meramec in the study area provides high quailty habitat for mussels.

Legend

- Mussel Bed Locations*
- Wildlife Conservation Opportunity Areas

CPI 90th percentile

- 13 - 21

CPI 70th percentile

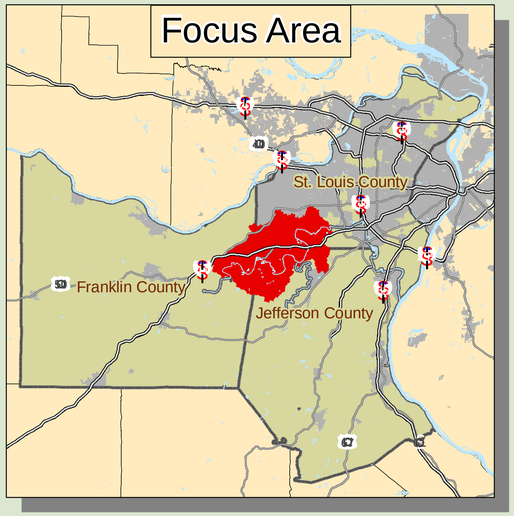
- 12 - 21

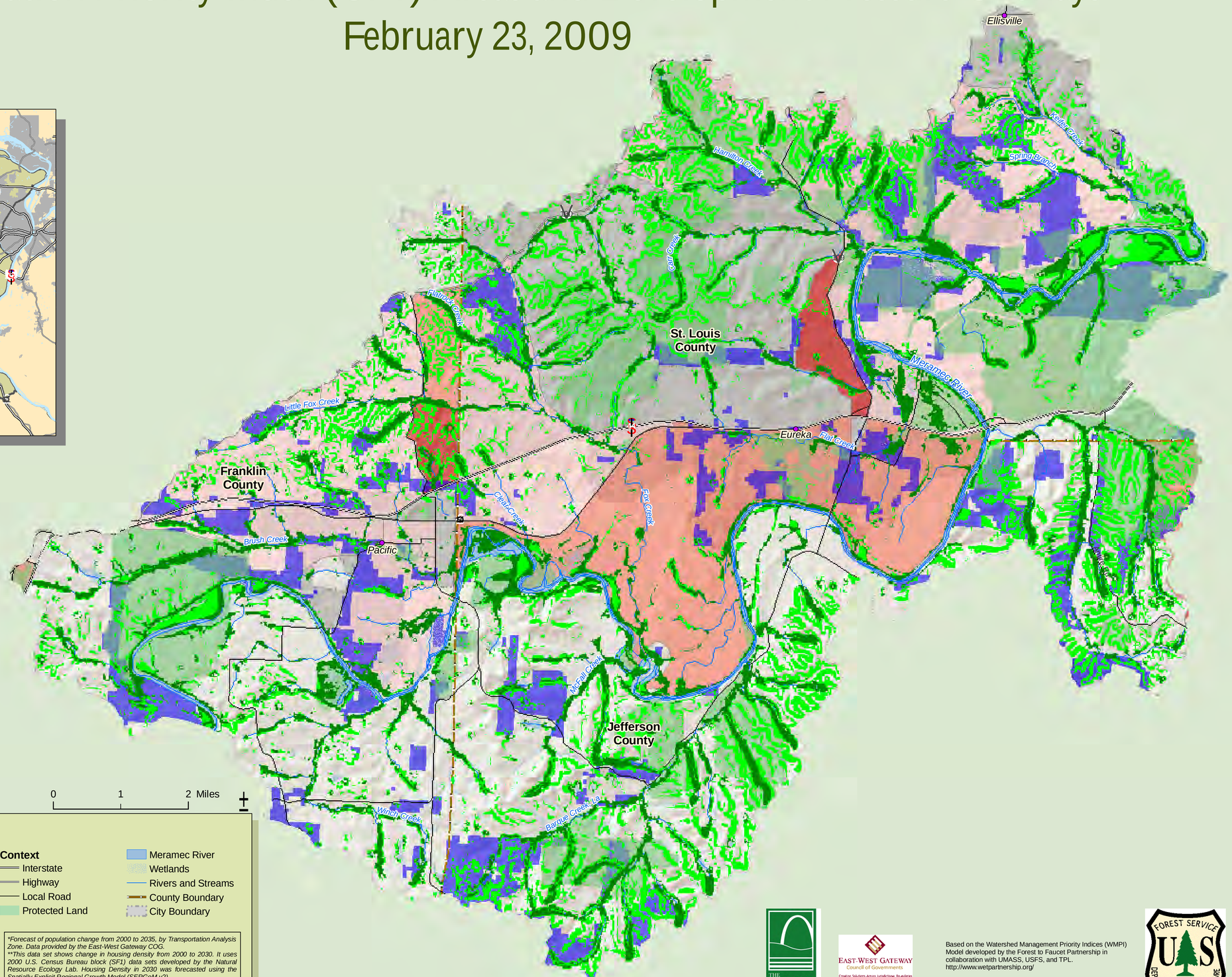
Context

- Interstate
- Highway
- Local Road
- Protected Land
- Meramec River
- Wetlands
- Rivers and Streams
- County Boundary
- City Boundary

Based on the Watershed Management Priority Indices (WMPI) Model developed by the Forest to Faucet Partnership in collaboration with UMASS, USFS, and TPL. http://www.wetpartnership.org/

Lower Meramec Drinking Water Source Protection Project
Conservation Priority Index (CPI) Areas and Development Pressure Overlays
February 23, 2009





Legend

2035 Forecasted Increase in Population Density*
- Moderate
- High
- Very High

2030 Forecasted Increase in Housing Density**

CPI 90th percentile
- 13 - 21

CPI 70th percentile
- 12 - 21

Context
- Interstate
- Highway
- Local Road
- Protected Land
- Meramec River
- Wetlands
- Rivers and Streams
- County Boundary
- City Boundary

*Forecast of population change from 2000 to 2035, by Transportation Analysis Zone. Data provided by the East-West Gateway COG.
**This data set shows change in housing density from 2000 to 2030. It uses 2000 U.S. Census Bureau block (SF1) data sets developed by the Natural Resource Ecology Lab. Housing Density in 2030 was forecasted using the Spatially Explicit Regional Growth Model (SERGoM v2).

THE OPEN SPACE COUNCIL for the St. Louis Region

EAST-WEST GATEWAY Council of Governments
Creating Solutions Across Jurisdictional Boundaries

Based on the Watershed Management Priority Indices (WMPI) Model developed by the Forest to Faucet Partnership in collaboration with UMASS, USFS, and TPL.
http://www.wetpartnership.org/

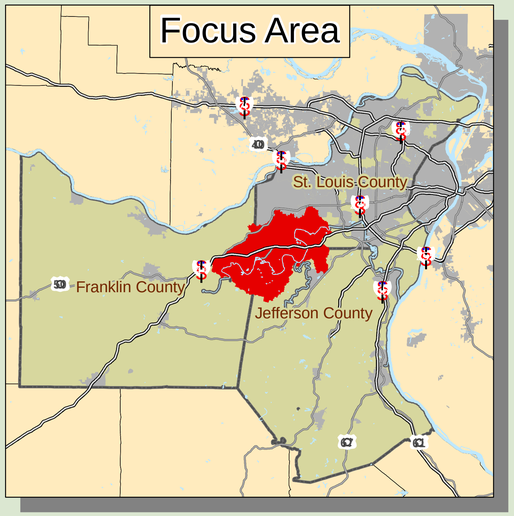
FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

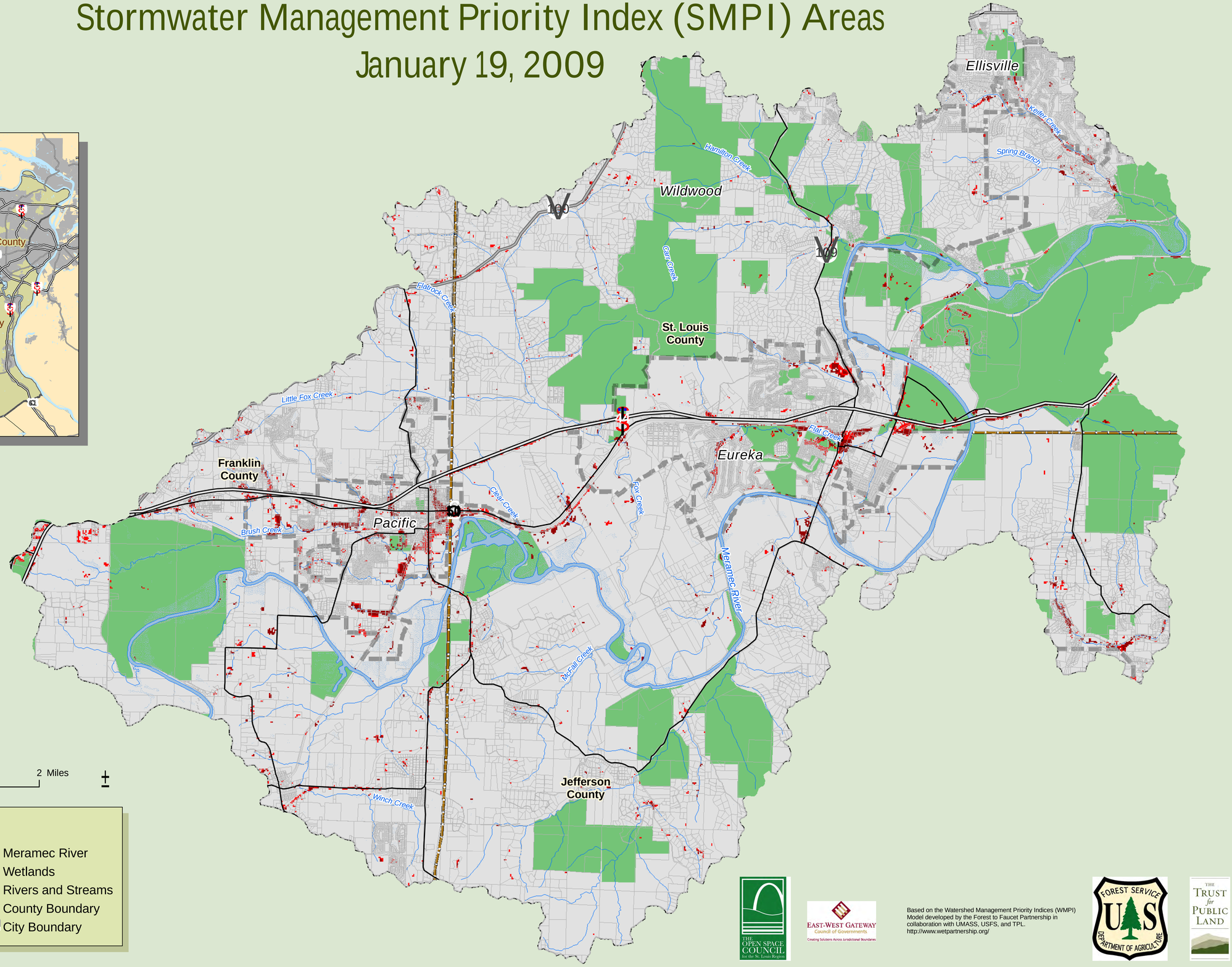
THE TRUST for PUBLIC LAND

APPENDIX 5

Stormwater Management Priority Map with Parcel Boundaries

Lower Meramec Drinking Water Source Protection Project
Stormwater Management Priority Index (SMPI) Areas
January 19, 2009





Legend

SMPI 90th percentile
- 12 - 20

SMPI 80th percentile
- 11 - 20
- Protected Land
- Meramec River
- Wetlands
- Rivers and Streams
- County Boundary
- City Boundary

Based on the Watershed Management Priority Indices (WMPI) Model developed by the Forest to Faucet Partnership in collaboration with UMASS, USFS, and TPL.
http://www.wetpartnership.org/