Nutrient Trading in Missouri

Critical Policy Factors and Program Recommendations

A Work Product of:
Missouri Innovative Nutrient Trading (MINT) Project
Evaluating and Practicing Innovative Conservation (EPIC) Project

Geosyntec consultants

Environmental Resources Coalition

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EXECUTIVE SUMMARY

In November 2011, the Missouri Department of Natural Resources (MDNR) announced a new state clean water initiative called *Our Missouri Waters*. With this initiative, the Department is hoping to develop and apply a coordinated, systematic approach to managing water resources across the state. As part of the initiative, MDNR will begin implementing a watershed-based permitting approach for point source dischargers in the state. By using a watershed-based permitting approach, MDNR hopes to better integrate important point and nonpoint source water quality management programs to more effectively protect water quality in Missouri.

Water quality trading (WQT) is one tool that MDNR can use to help facilitate the development of a watershed-based permitting program. WQT is a market-based pollution reduction approach that allows point sources to meet regulatory requirements by purchasing pollution reduction credits from other sources with lower pollution control costs. Because the data needs and implementation activities (identify existing sources, quantify pollutant loads and reductions, and achieve water quality goals in a defined geographic area) used in WQT closely match those that would be needed to implement a watershed-based permitting program, WQT can serve as a central vehicle for implementing this permitting approach. To help identify the specific challenges that Missouri may face in implementing a statewide WQT program, the Environmental Resources Coalition and Geosyntec Consultants conducted a simulated nutrient trading exercise in two Missouri watersheds and qualitatively evaluated opportunities for trading within the larger Missouri and Mississippi River Basins (Big Rivers).

The purpose of this report is to provide information that will assist with the development of a workable, statewide, nutrient WQT program in Missouri. In doing so, this report evaluates economic and regulatory barriers that could significantly limit the environmental and economic benefits associated with trading in Missouri. The primary focus of this evaluation is to assess how programmatic decisions related to three important trading factors (trading margin, trading area, and trading ratios) will affect the feasibility of WQT in Missouri. Other programmatic trading issues, such as “hot spots”, baseline requirements, monitoring and enforcement, and market structure, are also considered.

Because regulatory drivers are not currently in place, specific trading outcomes for individual dischargers are difficult to forecast. However, results from the simulated trading evaluation presented in this report will be helpful for informing development of a WQT program framework going forward. Most importantly, the simulations illustrate the potential efficiencies and environmental benefits gained through trading and the importance of including flexibilities when implementing nutrient criteria. General conclusions from the evaluation include the following:

1) Trading areas should be as large as possible.
2) Trading ratios impact the feasibility of a WQT program.
3) Point-to-point trading is the most cost-effective trading option in some situations.
4) Drivers for Big River trading may be different than for other waters in the state.
5) WWTPs should be free to set the top of the trading margin.
6) Administrative burdens and transaction costs may prohibit direct trading for most dischargers.
7) Liability, monitoring, and enforcement require special considerations in the context of trading.
8) Agricultural baselines effectively behave like a trading ratio and can limit trading activity.

Specific recommendations resulting from this analysis are included in Geosyntec’s (2012) *Proposed Framework for a Missouri Water Quality Trading Program* document.

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1.0 INTRODUCTION

In 2009, the U.S. Department of Agriculture-Natural Resources Conservation Service awarded two Conservation Innovation Grants (CIG) to the Environmental Resources Coalition (ERC) and MEC Water Resources, Inc., (now Geosyntec Consultants, Inc.). The grants were awarded with the purpose of introducing water quality trading (WQT) in Missouri. The potential for WQT to provide flexible, low-cost alternatives for achieving state numeric nutrient criteria, if and when established, has generated considerable interest in Missouri. However, as demonstrated by the relatively small number of active trading programs across the country, the challenges of successfully implementing a WQT program are complex. To help identify the specific challenges that Missouri may face in implementing a statewide WQT program, ERC and Geosyntec conducted a simulated nutrient trading exercise in two watersheds in the state. Trading opportunities for dischargers to the Missouri and Mississippi Rivers were also evaluated on a more qualitative basis. This report presents the results of the trading simulations and discusses the implications for developing a WQT program in Missouri.

1.1. WHAT IS WATER QUALITY TRADING?

WQT is a market-based approach to pollution reduction that allows point sources to meet regulatory requirements by purchasing pollution reduction credits generated from agriculture or other sources that have lower pollution control costs (EPA 2003). In such a transaction, the pollution reduction credits are purchased in lieu of funding traditional abatement technologies, including point source treatment that may not be practical or improve overall water quality in the watershed. WQT not only provides the potential for substantial economic savings but also for ancillary environmental benefits. For example, in addition to reducing nutrient loadings, nonpoint source offsets create biodiversity, increase habitat, and improve flood control. In doing so, WQT functions as a holistic management approach that serves to draw public awareness to other important features in the watershed.

Traditionally, WQT occurs between a point source buyer and a nonpoint source seller (point-to-nonpoint) or between two point sources (point-to-point) (**Figure 1-1**). In either case, the seller must generate pollution reduction credits by reducing their pollutant discharge level below the baseline level, or the pollutant level that is required in the absence of trading. The number of credits a buyer needs to purchase is determined by how far they are above the baseline; sellers may sell credits generated below the baseline (**Figure 1-2**).

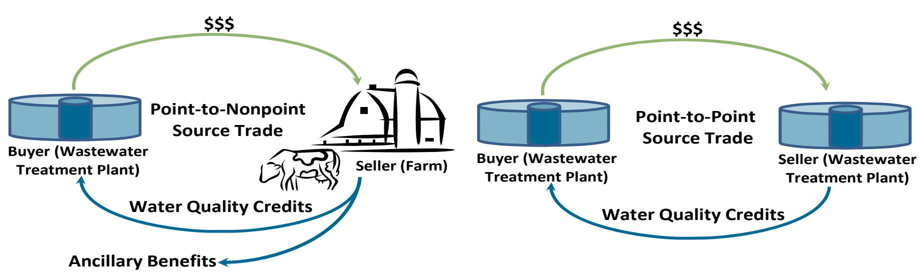


FIGURE 1-1. Conceptual Diagram of Point-to-Nonpoint and Point-to-Point Water Quality Trading.

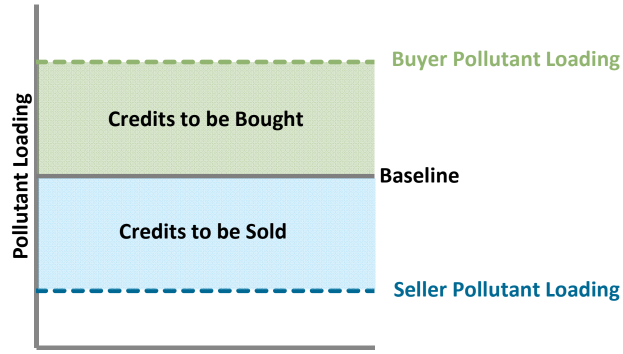


FIGURE 1-2. Pollutant Reduction Credits to be Bought and Sold (Adapted from EPA 2007).

1.2. WATER QUALITY TRADING DRIVERS IN MISSOURI

The leading drivers of WQT are typically wasteload allocations (WLA) under a total maximum daily load (TMDL), water quality criteria, or other kinds of caps which limit nutrient discharges (EPA 2007). At this time, TMDLs account for the bulk of nutrient trading around the country. A recent report sponsored by the U.S. Environmental Protection Agency (EPA) found that more than 80% of all documented trades have occurred in the Long Island Sound trading program, which is structured around a nitrogen TMDL (EPA 2008). Most other high-profile trading programs are also based on single nutrient TMDLs (e.g., Neuse River, Great Miami River, and Chesapeake Bay).

Missouri does not currently have statewide, numeric water quality criteria for nutrients. As a result, there are few regulatory drivers which require point source nutrient reductions. The Missouri Department of Natural Resources (MDNR or Department) has completed two, large-scale nutrient TMDLs in the James and Elk River Basins in southwest Missouri. These TMDLs set low instream targets for TN (<1.5 mg/L) and TP (<0.08 mg/L) in both basins. However, most recent nutrient TMDLs that have been developed in Missouri are focused on correcting either low dissolved oxygen or nuisance algae conditions in small waters. MDNR is currently in the process of developing numeric criteria for streams, river, and lakes in the stateSuccessfully implementing a WQT program to accommodate multiple drivers throughout the entire state will require careful consideration and a flexible nutrient implementation policy.

1.3. THE ROLE OF WATER QUALITY TRADING IN MISSOURI

In addition to numeric nutrient criteria, the Department expects that several other new state and federal regulations (e.g., stream classification changes, revised ammonia and dissolved oxygen criteria, updated stormwater rules) will go into effect in the near future. Effectively implementing and enforcing existing and new requirements without causing undue financial or regulatory hardships for affected entities will be difficult. The Department understands that addressing these complex issues requires innovative approaches that are aligned with core environmental programs already being implemented in the state.

In November 2011, MDNR announced a new state clean water initiative called *Our Missouri Waters*. With this initiative, the Department is hoping to develop and apply a coordinated, systematic approach to managing water resources across the state. This new initiative will help to integrate important point and nonpoint source water quality management programs to more effectively protect water quality in Missouri.

Watershed-based permitting is one approach MDNR will be evaluating in the *Our Missouri Waters* initiative as a tool for improving water quality management. Watershed-based permitting is supported by EPA (2007) as a method for issuing National Pollutant Discharge Elimination System (NPDES) permits for multiple point sources while considering the overall water quality conditions and goal in the watershed. Currently, individual NPDES permitting activities are conducted on a site-specific basis. Under a watershed-based permitting framework however, the impact of multiple pollutant sources and stressors, including point and nonpoint sources, can be addressed (EPA 2007). Because a wide variety of local, state, environmental regulations, plans and programs drive management activities in a given watershed, EPA suggests that states attempt to integrate watershed-based frameworks with these other programs. According to EPA (2007), "a truly comprehensive watershed management approach should bring together key programs under the Clean Water Act, such as the NPDES Program, the TMDL Program, the Section 319 Nonpoint Source Program, and Section 404 Wetlands Permitting, as well as the Source Water Assessment Program under the Safe Drinking Water Act."

In the near future, MDNR is planning to synchronize NPDES permits on a watershed basis to provide opportunities for addressing watershed-specific issues. WQT can be used to help facilitate both development of a watershed-based permitting approach and integration with other Clean Water Act programs. Because the data needs and implementation activities (identify existing sources, quantify pollutant loads and reductions, and achieve water quality goals in a defined geographic area) used in WQT closely match those that would be needed to implement other CWA programs, WQT can serve as a central vehicle for implementing watershed-based permitting approaches.

1.4. DEFINING A SUCCESSFUL WATER QUALITY TRADING PROGRAM

Three widely accepted standard principles of any public policy or program are efficiency, effectiveness, and equity (Patton and Sawicki 1993). Consideration must be given to each of these principles if a WQT program is to be successful. Issues of efficiency, effectiveness, and equity frequently compete with each other and must be balanced with careful policy planning. Ultimately, the success of a WQT program must be judged by all three of these factors.

Efficiency

Efficiency refers to the economics of a trading program and is potentially the most important criterion. If a WQT market is not efficient, trading will likely not be cost-effective and trading activity will be limited. An efficient WQT market requires that prices are broadly known and that transaction costs are low (NRCS 2011). Transaction costs can occur at every stage of the trading process and can include time spent on permit negotiation, searching for trading partners, administrative expenditures, communications between the permittee and the enforcement agency, credit verification, post-project site inspection, and routine project management. By one estimate, transaction costs increase total trading costs by at least 35 percent (Fang et al. 2005).

Efficiency can also be compromised in trading programs where regulators compel NPDES permittees to maximize technical feasible controls before they are allowed to trade. For example, in some permitting situations water quality standards cannot ultimately be achieved because of pollutant contributions from unregulated nonpoint sources. Rather than denying a permit, regulators may issue the point source permit on the condition that the point source pay for nonpoint source pollutant reductions, but only after the point source has implemented all feasible technological controls. In these situations, WQT maximizes, not minimizes, control costs for point sources (Stephenson and Shabman 2011).

Effectiveness

Effectiveness refers to whether or not the water quality benefits of a trading program are occurring as intended and is directly related to issues of equivalency, accountability, and additionality. Equivalency refers to the exchangeability of water quality credits (Fang et al. 2005). For example, 100 pounds of phosphorus continuously discharged directly from a point source to a lake has a different environmental impact than a 100 pound load of phosphorus periodically discharged to the same lake from several nonpoint sources 50 miles upstream. Equivalency issues can be compensated for through timing limitations (e.g., purchased reductions should be produced during the same time period that a buyer was required to purchase them), zoning limitations (e.g., limited trading area), and trading ratios (e.g., 2 pounds of phosphorus must be purchased for every pound needed). Accountability refers to measures necessary to ensure environmental benefits are in fact taking place as intended. These measures include monitoring, credit reduction certifications, and enforcement. Additionality refers to credits only applying to those nonpoint source practices that would not have occurred otherwise in the absence of the trade.

Equity

Equity refers to issues of fairness and can be at odds with the goals of a WQT program. If the goal of a WQT program is to provide cost-effective alternatives for offsetting point source nutrient loadings, there should be no expectation that loads will be reduced beyond levels required to meet regulatory obligations. However, a goal of some programs is for point sources to reduce nutrients in the watershed beyond what would be required in the absence of a trading program. Stephenson and Shabman (2011) have expressed concern over this view noting that “[i]f trading programs are designed for trades to produce net nonpoint source-pollutant reductions, then trading begins to take the form of a tax, raising fairness and political issues.”

Equity concerns are also raised where trading is used as a tool to bridge the gap between the limits of technology and water quality criteria. Under such a scenario the permittee is required to go above and beyond what would be required in the absence of trading and participation is effectively mandated. Not only does this approach raise issues of fairness, but it also violates a central tenet of EPA’s current WQT policy that participation is voluntary (EPA 2003).

1.5. SIMULATION APPROACH AND OBJECTIVES

The WQT evaluation presented in this report is based on simulated trading scenarios in two 8-digit hydrologic unit codes (HUC) located in Missouri – the South Fork Salt River Basin (07110206) and the Spring River Basin (11070207). The South Fork Salt River Basin is located in the Mark Twain Lake watershed in northern Missouri and the Spring River Basin is located in southwest Missouri in the Ozarks (**Figure 1-3**). Both basins are heavily agricultural; however, cropland is proportionately greater in the South Fork Salt River Basin and pastureland is proportionately greater in the Spring River Basin. The two basins were selected as they represent two distinctly different geographic areas in Missouri and have significant water resources. Additionally, the Spring River Basin is one of the watersheds MDNR is evaluating as part of the *Our Missouri Waters* initiative. This report also qualitatively evaluates opportunities for developing a sustainable WQT program for the Missouri and Mississippi River Basins, both within the state of Missouri and across the entire basin.

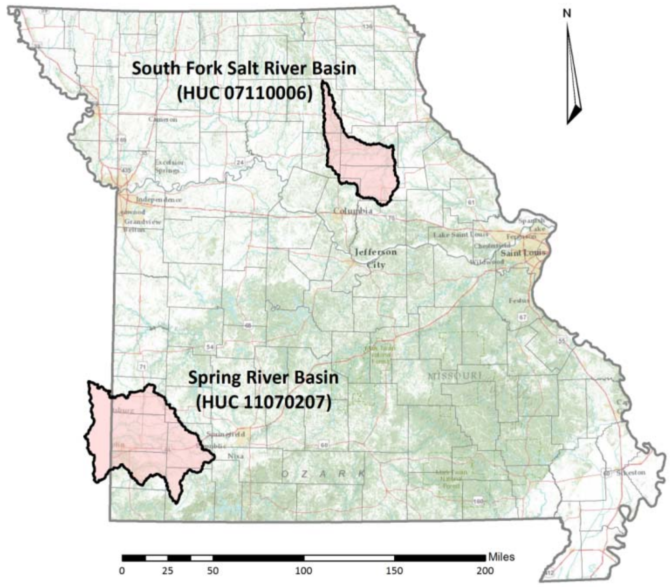


FIGURE 1-3. Study Basins Used for Water Quality Trading Simulations.

The purpose of this report is to provide information that will assist with the development of a workable, statewide, nutrient WQT program in Missouri. In doing so, this report evaluates economic and regulatory barriers that could significantly limit the environmental and economic benefits associated with trading in Missouri. The primary focus of this evaluation was to assess how programmatic decisions regarding three important trading factors will affect feasibility of WQT in the South Fork Salt, Spring River, Missouri and Mississippi River Basins. These three factors are:

- *Trading margin* – Requirements that dictate how many credits a point source needs to meet NPDES permit limits.
- *Trading area* – The geographic limitations placed on nutrient trading.
- *Trading ratio* – A multiplying factor applied to the number of credits needed to meet NPDES permit limits.

In addition to these basin-specific assessments, several other programmatic decisions were qualitatively evaluated. These decisions relate to the issues of “hot spots”, baseline requirements, monitoring and enforcement, and market structure.

2.0 WATER QUALITY TRADING BASICS

The basic programmatic decisions of any trading program must address what can be traded (i.e., baseline and trading margin), where can trading occur (i.e., trading area and "hot spots"), how will issues of credit equivalency be addressed (i.e., trading ratios), how trading will occur (i.e., market structure), and what measures will be taken to ensure efficacy (i.e., monitoring and enforcement). How these issues are addressed has a significant influence on the feasibility and success of a WQT program.

2.1. BASELINE

The baseline in WQT determines how many credits are either available for sale or how many need to be purchased. Credits are generated when discharges are reduced to below the baseline. Conversely, a deficiency in credits occurs if a discharge exceeds the baseline (**Figure 1-2**). EPA (2007) defines the baseline for WQT as the NPDES permit limits (for point sources) or BMPs (for nonpoint sources) that would apply in the absence of trading.

The point source baseline is further defined by EPA (2007) as the more stringent of water quality-based effluent limitations (WQBEL) or technology-based effluent limitations (TBEL). EPA (2007) prohibits trading to meet TBELs, but it is important to distinguish between federally-mandated TBELs and non-federally mandated TBELs. EPA (2007) is referring to federally-mandated TBELs, which are those limits included in Section 301(b) of the Clean Water Act. Currently, Section 301(b) only includes secondary treatment standards for WWTPs and effluent guidelines. As there are no federally-mandated nutrient TBEL requirements, trading can be used to meet nutrient TBELs defined by industry standards (such as the BNR, ENR, and RO levels used in this report).

For nonpoint sources, EPA (2007) distinguishes between baselines for sellers located in watersheds with and without a TMDL. Where TMDLs exist, EPA guidance indicates the baseline should be derived from the nonpoint source's load allocation (LA) in the TMDL. However, establishing the nonpoint source baseline as the LA could have the unintended consequence of discouraging trading and reducing the likelihood of the LA ever being achieved. Not only would this significantly raise the cost for entering a WQT program, it potentially leaves little room for additional credit generation. Under this scenario trading may not be feasible or cost-effective. Without other forms of financial incentives, the LA may never be achieved.

In the absence of a TMDL, EPA's Trading Policy (2003) states that state and local requirements and/or existing practices should determine a nonpoint source's baseline. Agricultural operations would be expected to meet minimum "baseline" nutrient management requirements to be considered eligible to sell credits in a nutrient trading program. Baseline requirements help assure that producers participating in a trading program are already managing nutrient runoff to an extent that is common for reputable farming practices.

An appropriate nonpoint source baseline for a Missouri WQT program could be the basic nutrient management plan or "Basic Option" of NRCS Practice 590 (NRCS 2007). The Basic Option of practice code 590 consists of developing a nutrient management plan as well as conducting soil testing. With this baseline, all agricultural operations would be required to establish a nutrient management plan and collecting soil data to better understand existing nutrient levels before being permitted to sell nutrient credits. Water quality credits could only be generated for those activities considered above and beyond the "Basic Option" including all practice code 590 enhanced nutrient management options.

2.2. TRADING MARGIN

For purposes of this report, trading margin represents the number of credits a point source buyer must purchase to be in compliance without consideration of a trading ratio. As discussed above, credits to be purchased are a function of the baseline - referred to here as the *bottom of the trading margin*. The *top of the trading margin* represents the desired or maximum allowed discharge level. Because regulatory drivers for nutrients are not fully in place in Missouri, neither the top nor bottom of the trading margin is defined at this time. However, trading margins will likely be represented by one of the following three general scenarios:

- *No requirement to technology-based*[1] – The discharger is free to set the top of the trading margin at any effluent concentration. The bottom of the trading margin is represented by some minimum level of technology. There is no minimum level of nutrient removal required.

- *No requirement to water quality-based* – The discharger is free to set the top of the trading margin at any effluent concentration. The bottom of the trading margin is represented by some minimum level of technology. There is no minimum level of nutrient removal required.

- *Technology-based to water quality-based* – The top of the trading margin is defined by some minimum level of technology. The bottom of the trading margin is based on numeric nutrient water quality criteria or a TMDL.

2.3. WATER QUALITY TRADING AREA

Trading area is the geographic boundary which defines where trading can occur. In general, trading areas are represented as either upstream of a discharge point, or encompass an entire watershed. With upstream limitations, point sources can only purchase water quality credits if they are generated upstream. With watershed scale trading, the only restriction is that water quality credits must be generated somewhere within the watershed. Upstream only trading areas are typically enforced to limit unacceptable localized impacts or "hot spots" (see Section 2.4). Watershed scale trading is typically applied in a TMDL situation where there is a watershed pollutant loading cap.

[1] The term "technology-based" refers to the various categorical levels of treatment that a WWTP may implement to meet a minimum or baseline nutrient reduction requirement. It does not refer to a federally-mandated minimum control technology. In their December 2012 response to a petition from the Natural Resource Defense Council (NRDC), EPA indicated that national nutrient technology-based limits were not warranted at this time. However, EPA does not support WQT as a means for achieving federally-mandated technology-based limits, should they be developed in the future.

Both watershed scale and upstream only trading are evaluated as part of this report. For purposes of this report, watershed scale trading is defined by the 8-digic Hydrologic Unit Code (HUC). However, the scale of a watershed trading area is a function of the regulatory driver and can be much larger. For example, if the Gulf of Mexico represents the regulatory driver, the trading area could encompass the entire Mississippi River Basin.

2.4. HOT SPOTS

The potential for WQT to cause hot spots is a concern addressed in most WQT programs and guidance documents. There is no clear definition of what constitutes a hot spot, but is generally considered to be an unacceptably high level of pollutant. A variety of approaches exist for avoiding hotspots, the most common of which is to limit trading to upstream. In principle, limiting the purchase of credits to upstream will generate sufficient assimilative capacity to compensate for the excess loading at the point of discharge. However, this assumes there is sufficient upstream flow, which effectively limits trading to those WWTPs located on waterbodies with relatively large drainage areas. As demonstrated in this report, most WWTPs in the South Fork Salt and Spring River Basins are located on streams with smaller drainage areas. Additionally, as nutrients are non-toxic and impacts generally occur far downstream of their source, it may not be necessary to limit trading to upstream.

2.5. TRADING RATIO

Trading ratios greater than 1:1 are applied where there are issues of credit equivalency. Equivalency issues arise where credits from different sources have different environmental impacts depending on location, form of pollutant, and uncertainties in credit quantification. For example, it may be necessary to purchase credits at a 2:1 ratio to account for instream attenuation. The different types of trading ratios are described below.

- *Delivery Ratio* - Delivery ratios are used to account for the situations in which a pound of pollutant discharged at an upstream location will not necessarily arrive as a pound of pollutant at a given point downstream. For example, a 100 pound TN reduction four miles upstream from a lake may only equate to a 70 pound reduction at the lake due to attenuation processes. Delivery ratios would adjust for these processes.

- *Equivalency Ratio* - These ratios can be used to adjust for trading different forms of the same pollutant – particularly for phosphorus. Phosphorus from wastewater treatment plants (WWTPs) is generally in a soluble form more readily available for biological uptake. Whereas phosphorus from agricultural runoff is generally in insoluble form and is not readily available for biological uptake. From a water quality perspective, the soluble form of phosphorus potentially has the greater impact and is more of a concern. Therefore, an equivalency ratio may be applied to account for differences in environmental effects.

- *Uncertainty Ratio* - Challenges will always exist in accurately estimating nonpoint source credit generation because of complexities and costs associated with modeling and assessing pollutant load reductions from BMPs. Greater certainty can be achieved through more costly and complicated modeling and monitoring efforts. However, such measures may not be practical, nor can they produce the same level of certainty associated with estimating a point source credits. To address uncertainties associated with implementing BMPs, some trading programs apply a trading ratio greater than one.

- *Retirement Ratio* - Retirement ratios are applied in trading programs where the goal is to accelerate achievement of water quality standards. These ratios 'retire' a percentage of all credits generated, and these credits cannot be sold. Therefore, the overall loading to the watershed is reduced with each trade that yields net water quality improvement.

Both a 1:1 and a 2:1 trading ratio are evaluated as part of the trading simulation presented in **Section 5**.

2.6. MARKET STRUCTURE

Market structure defines how trading will occur and the infrastructure for reducing transaction costs (Ribaudo and Gottlieb 2011). Consideration of market structure must be made at the outset of a WQT program as it has direct implications on market efficiency, liability, and trading area. Market efficiency is described by the ability to complete transactions without imposing transaction costs (Woodward et al. 2002). Liability refers to who is responsible should a nonpoint source project fail to produce as many credits as expected (Ribaudo and Gottlieb 2011). As previously discussed, trading area refers to geographic restrictions of a trading program. The four market structures and their impacts on these factors are discussed below.

Four Main Market Structures

The four main market structures are bilateral negotiation, exchanges, clearinghouses, and sole source offsets.

- *Bilateral negotiation* – Bilateral trades are characterized by one-on-one negotiations where the buyer independently locates the seller and directly negotiates the terms of the trade. Buyers and sellers make agreements on their own, with a public authority participating to approve the trade (EPA 2008).

- *Exchanges* – An exchange market is characterized by its open information structure and fluid transactions between buyers and sellers. Information regarding prices being asked and offered is publicly available. Strictly defined, exchanges can develop only when a unit of pollutant is viewed as equivalent to a unit from any other source (Woodard et al. 2002 and EPA 2008). Establishing equivalency between nonpoint offsets and point source discharges takes into account the location of nonpoint sources relative to the point source and the body of water being protected (Ribaudo and Gottlieb 2011). Because nonpoint source credits are inherently nonhomogenous, developing an exchange can be very difficult (Woodward et al. 2002). Less strictly defined, an exchange is simply a public forum where buyers and sellers meet (e.g., online) without expectations of equivalency.

- *Clearinghouses* – Clearinghouses are frequently defined as a form of an exchange, but are different because in a clearinghouse the link between the buyer and seller is completely broken by an intermediary. The intermediary acts as an aggregator of credits, converting products of variable price and quality into a uniform product (Woodward et al. 2002).

- *Sole-Source Offsets* – Sole-source offsets do not represent traditional market-based trading, but occur when trading sources are allowed to increase nutrient discharge at one point if they reduce their nutrient discharge elsewhere. For example, a WWTP receives credits equivalent to the total amount of nutrients retired through decommissioning septic systems (Selman et al. 2009).

Implications of Market Structure on Efficiency, Liability, and Trading Area

Exchanges and clearinghouses are considered the most efficient market structures for WQT (Woodward 2002). Although initial set up costs are higher, transaction costs are generally much lower for exchanges and clearinghouses because the price is fully visible, information regarding buyers' and sellers' interests is easily transmitted, and transactions are made easily. Conversely, transaction costs for bilateral negotiation are typically greatest because buyers must identify sellers on their own and are responsible for ongoing administrative burdens such as tracking trades, monitoring and verifying discharge reductions, and reporting.

Under the CWA, legal liability cannot be transferred during a water quality trade (Selman et al. 2009). However, in practice, liability is reduced with some market structures. In a clearinghouse market structure, where credits are aggregated and the contractual link between the buyer and seller is completely broken, no one buyer can be held accountable should a seller fail to meet their required reductions. One method clearinghouses can use to address this liability issue is to create a reserve pool of excess credits. Liability issues are more easily addressed under the bilateral negotiation market structure, as there is a direct link between the buyer and seller.

Some market structures are less accommodating of trading area restrictions than others. In general, exchanges work against the concept of trading area restrictions as there are expectations of credit equivalency, regardless of location. For example, under a clearinghouse, upstream trading area restrictions are infeasible as credits are pooled and dispersed over a large area. Bilateral negotiation represents the most accommodating market structure with respect to trading area restrictions as the buyer selectively chooses the seller. **Table 2-1** presents a summary of market structure impacts on market efficiency, buyer liability, and trading area.

TABLE 2-1. Implications of Market Efficiency, Buyer Liability, and Trading Area by Market Structure.

Market Component	Bilateral Negotiation	Exchange	Clearinghouse	Sole-Source Offset
Market Efficiency				
Transaction Costs Per Trade	High	Low	Low	NA
Initial Set Up Costs	Low	High	High	Low
Buyer Liability	Yes	Limited	Limited	NA
Accommodates Trading Area Restrictions	Yes	Potentially	No	NA

2.7. MONITORING AND ENFORCEMENT

Monitoring and reporting requirements are fundamental to establishing compliance with the CWA. However, the substantial discharge monitoring and reporting requirements applied to point sources (see 33 U.S.C. 1318(a)(4)(A)) present significant challenges if applied to nonpoint sources. Nonpoint sources are fundamentally different than point sources due to their diffuse and intermittent nature. These differences make accurate monitoring of nonpoint sources prohibitively expensive (Ribaudo and Gottlieb 2011).

As accurate monitoring of nonpoint sources is both technically challenging and expensive, enforcement of BMPs used in a trading program may more effectively be based on measures other than water quality monitoring. A more feasible and cost-effective solution is to employ field inspections by qualified soil and water conservation professionals. Field inspections of BMPs can be used to ensure correct installation and proper function, as well as to determine failure. However, it is important to recognize that requiring land access to inspectors can act as an impediment to farmer participation in a WQT program. A producer survey conducted by ERC in the South Fork Salt River watershed indicates approximately half of all farmers have concerns with allowing access to confirm BMP installation and operation. Farmers are generally more comfortable with inspections performed by a known, trusted organization (EPA 2008).

Although water quality monitoring may be infeasible for purposes of enforcement, it can still serve a critical role in a WQT program. Limited edge-of-field monitoring could be used to refine and better characterize assumptions regarding BMP pollutant control effectiveness. Additionally, instream monitoring could be used to help prioritize placement of BMPs and for assessing long-term impacts of trading on water quality.

3.0 EXISTING BASIN CONDITIONS

Baseline nutrient loading conditions in the South Fork Salt and Spring River Basins were estimated from existing land use and domestic WWTP NPDES permits. Methods used to derive existing loads are described in the following sections.

3.1. LAND USES

The South Fork Salt River (Hydrologic Unit Code (HUC) 8 watershed 07110006) is located in north central Missouri and encompasses portions of Audrain, Boone, Callaway, Monroe, Macon, Randolph, and Shelby Counties. The watershed drains approximately 1,200 square miles of land tributary to the Mark Twain Lake with approximately 81% (976 square miles) of the watershed located within Audrain, Monroe, and Randolph County. In addition to the main stem of the South Fork Salt River, the Salt River system is comprised of several significant tributaries including the Middle South Fork Salt River, Elk Fork Salt River, Long Branch, Youngs Creek, and Littleby Creek. Collectively, there are approximately 1,850 miles of stream within the South Fork Salt watershed. The South Fork Salt River watershed is predominantly agricultural, mostly being a mixture of cropland (39%) and pastureland (33%). The remainder of the watershed is primarily a mix of forest (16%) and urban (6%) areas. Land use in the watershed is summarized in **Table 3-1** and shown in **Figure 3-1**.

TABLE 3-1. Land Use in the South Fork Salt River Basin.

Land Use Type	Acres	Percentage
Water	10,100	1%
Urban	43,100	6%
Barren	731	<1%
Forest	122,000	16%
Grassland	15,600	2%
Pastureland	258,000	33%
Cropland	306,000	39%
Wetland	20,800	3%
Total	**776,000**	**---**

Source: National Land Cover Database, 2006

The Spring River (HUC 8 watershed 11070207) Basin is located in southwest Missouri and encompasses portions of Barry, Barton, Christian, Dade, Jasper, Lawrence, Newton, and Stone Counties. The watershed drains approximately 2,600 square miles of land. The headwaters begin in southeastern Lawrence County and flow for 100 miles before reaching its confluence with the Lower Neosho River and Grand Lake o' The Cherokees in northeast Oklahoma. Major tributaries include Center, Cow, and Shoal Creeks. Approximately 77% (2,000 square miles) of the Spring River Basin is located in Missouri.[2] Land use statistics within the Missouri portion of the Spring River watershed are generally consistent with watershed-wide statistics (**Table 3-2**).

TABLE 3-2. Land Use in the Spring River Basin.

Land Use	Entire Watershed		Missouri Only	
	Acres	Percentage	Acres	Percentage
Water	9,200	1%	4,460	<1%
Urban	138,000	8%	106,000	8%
Barren	4,950	<1%	3,770	<1%
Forest	299,000	18%	248,000	19%
Grassland/Shrubland	19,400	1%	14,400	1%
Pastureland	827,00	50%	692,000	53%
Cropland	326,000	20%	220,000	17%
Wetland	32,500	2%	19,500	2%
Total	**1,660,000**	**---**	**1,310,000**	**---**

[2] The Spring River Basin includes portions of Missouri, Kansas, and Oklahoma. For this analysis, potential trading areas in the Spring River were limited to the watershed located in Missouri.

The Spring River watershed is predominantly characterized by pastureland (50%) and cropland (20%). The remainder of the watershed is primarily a mix of forest (18%) and urban (8%) areas. The high percentage of pastureland is consistent with U.S. Department of Agriculture (USDA) statistics which show the greatest numbers of beef cows within Missouri existing in or near the Spring River Basin (approximately 25,000 head of beef cattle per county). Land use in the watershed is summarized in **Table 3-2** and shown in **Figure 3-2**.

3.2. AGRICULTURAL NUTRIENT LOADING

Existing incremental nutrient yields from agricultural sources (e.g., rowcrop [attributed as fertilizer] and pastureland [attributed as manure from livestock]) were derived for subbasins within the South Fork Salt and Spring River Basins based on model simulations obtained from the U.S. Geological Survey (USGS) SPARROW decision support system (DSS)[3]. The incremental yield reflects the quantity of nutrients transported from the incremental land area to an individual reach outlet after accounting for the effects of instream attenuation processes (e.g., long-term storage and denitrification) associated with one-half the reach time of travel and any reservoirs in that particular reach (Booth et al. 2011). Although SPARROW is suitable for demonstrating large scale implications of trading policies as part of this report, it is not necessarily recommended for use as part of a formal trading program. Additional nutrient loading models exist, which warrant consideration when and if Missouri adopts a formal trading program.

For purposes of the trading simulation, the SPARROW-based nutrient yields were 1) converted into area weighted averages for the South Fork Salt and Spring River Basins, and 2) normalized to respective land use types (**Tables 3-3 and 3-4**). It was necessary to normalize nutrient yields to land use types, as the SPARROW model results represented average yields over the entire basin. Values presented in **Tables 3-3** and 3**-4** were calculated assuming that 100% of fertilizer and unconfined livestock manure runoff attributed in the model originate from cropland and pastureland, respectively. Normalizing the nutrient yields enabled greater spatial characterization of nutrient loading. Based on results of the USGS SPARROW model and land use data, TN and TP yields from agricultural sources were calculated for the 12-digit HUCs in the South Fork Salt and Spring River Basins (**Figures 3-2 and 3-2**).

TABLE 3-3. Agricultural Nutrient Yields and Loads in the South Fork Salt River Basin.

Land Use	Total Nitrogen		Total Phophorus	
	Yield (lbs/acre/year)	Load (lbs/acre)	Yield (lbs/acre/year)	Load (lbs/acre)
Cropland	11.8	3,620,000	1.4	428,000
Pastureland	3	781,000	0.7	193,000
Total	**---**	**4,400,000**	**---**	**621,000**

TABLE 3-4. Agricultural Nutrient Yields and Loads in the Spring River Basin.

Land Use	Total Nitrogen		Total Phophorus	
	Yield (lbs/acre/year)	Load (lbs/acre)	Yield (lbs/acre/year)	Load (lbs/acre)
Cropland	11.1	2,430,000	2.6	575,000
Pastureland	2.3	1,590,000	0.2	137,000
Total	--	4,020,000	--	712,000

Note: Loading values represent the Missouri portion of the Spring River Basin.

[3] Results for the South Fork Salt Basin are based on the MRB3 model (Robertson and Saad, 2011). Results for the Spring River Basin are based on the MRB5 model (Rebich et al., 2011). http//water.usgs.gov/nawqa/sparrow/dss/.

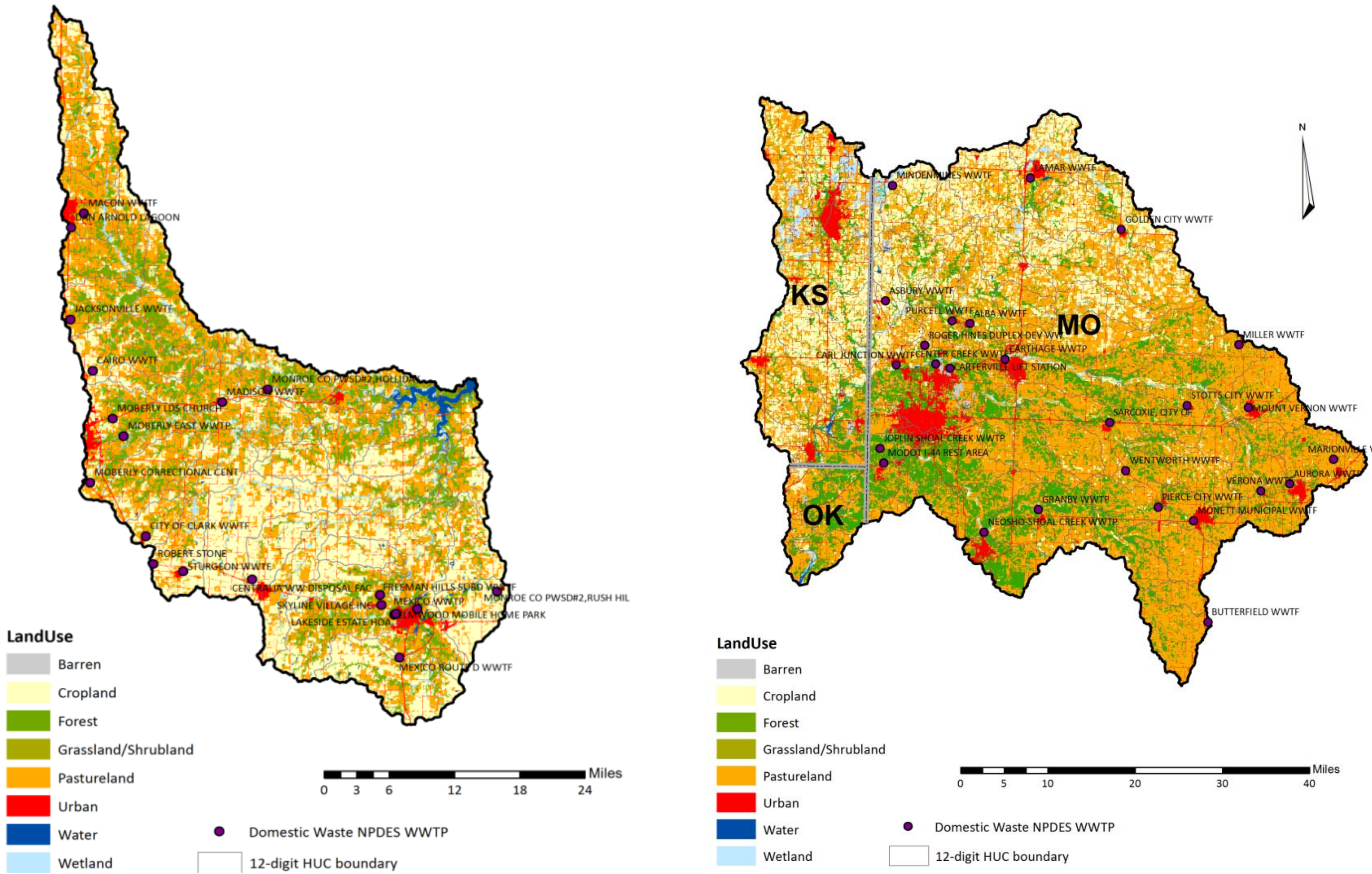


FIGURE 3-1. Land Use in the South Fork Salt (Left) and Spring River (Right) Basins.

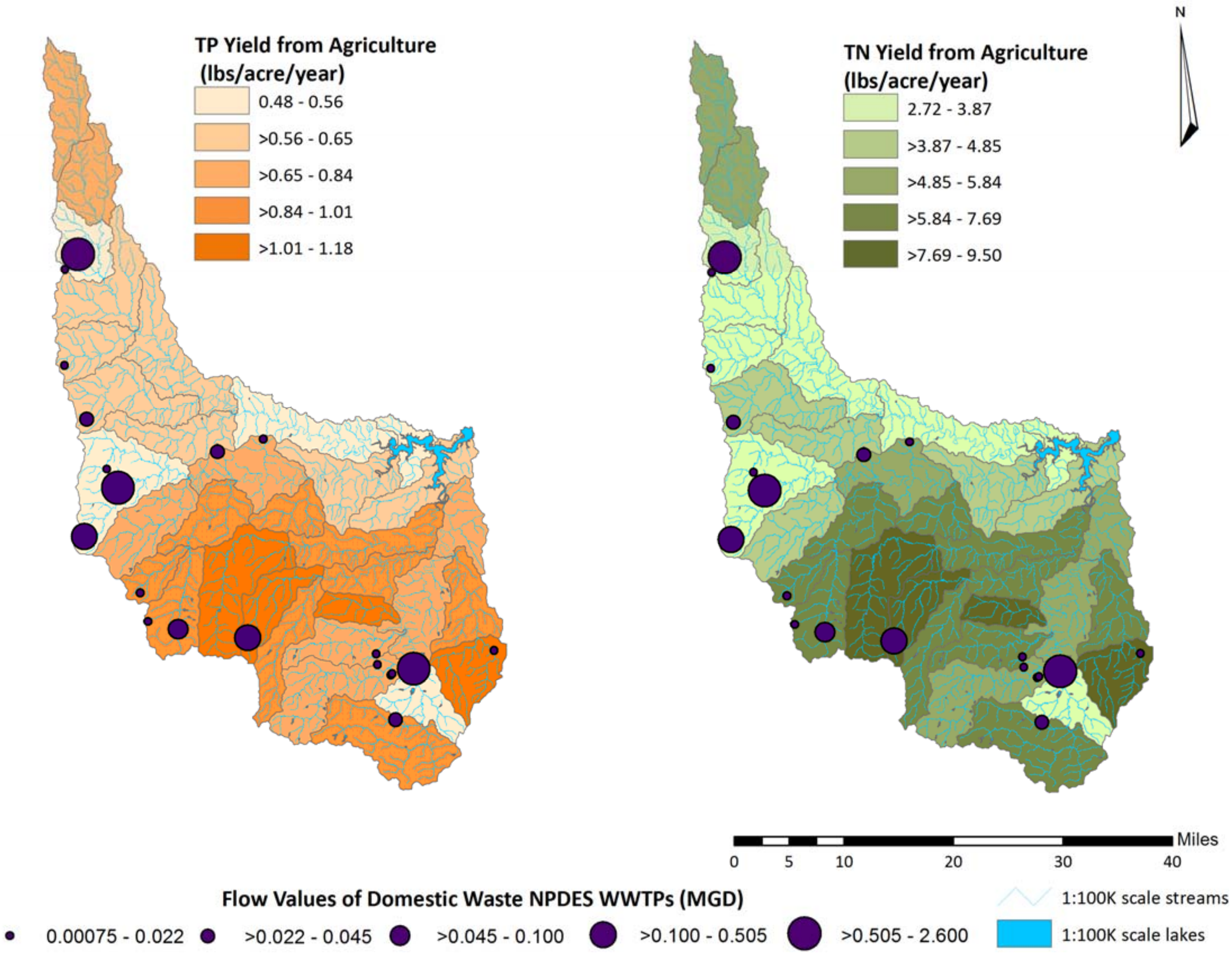


FIGURE 3-2. Agricultural Yields of Nitrogen and Phosphorus by 12-Digit HUC in the South Fork Salt River Basin.

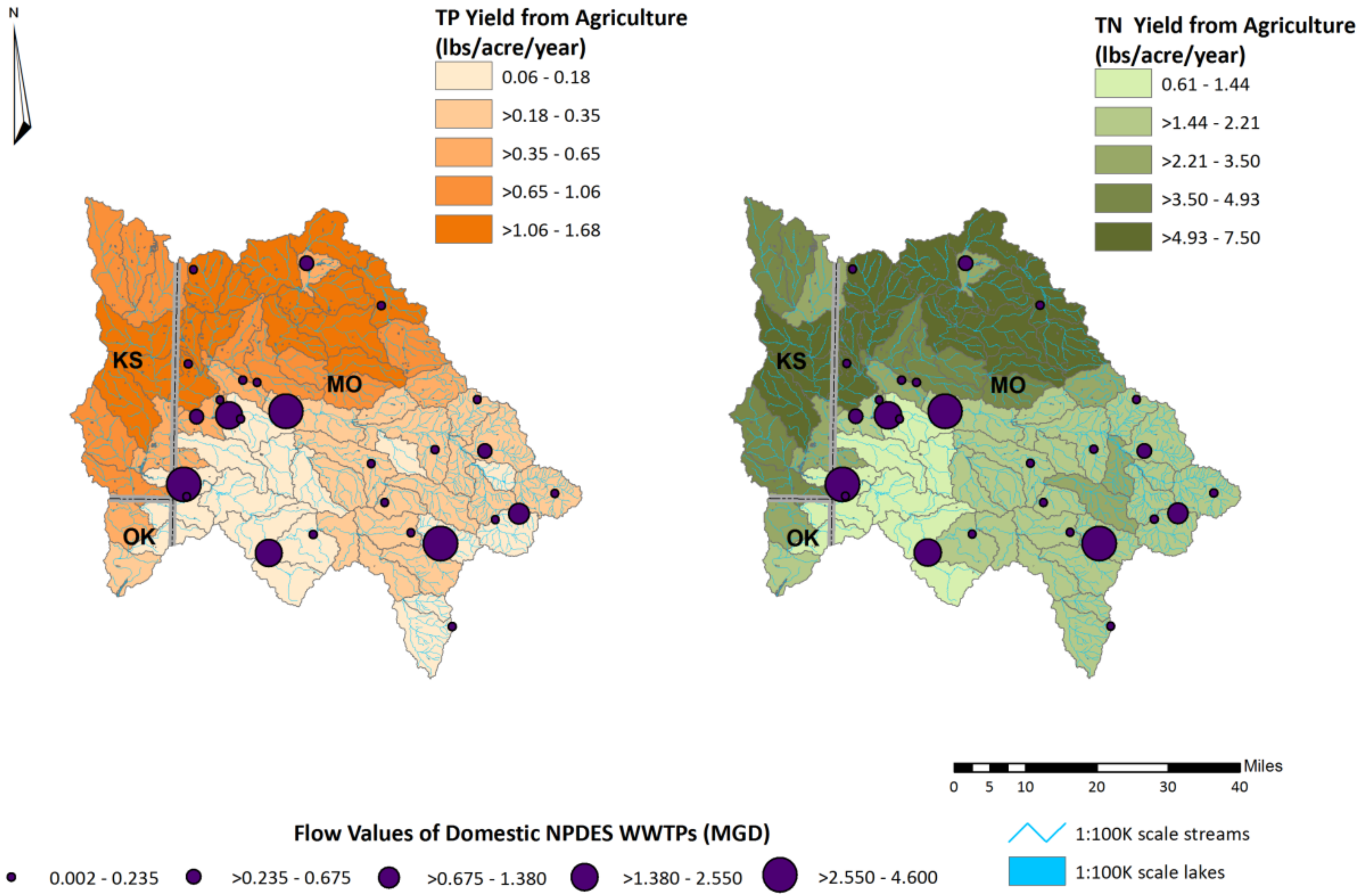


FIGURE 3-3. Agricultural Yields of Nitrogen and Phosphorus by 12-Digit HUC in the Spring River Basin.

3.3. NPDES POINT SOURCE NUTRIENT LOADING

Existing point source nutrient loadings were estimated from National Pollutant Discharge Elimination System (NPDES) discharges of domestic waste within the South Fork Salt River and Spring River Basins. For purposes of this report, domestic WWTPs were assumed to have an existing effluent concentration equal to a TN and TP concentration of 20 mg/L and 4 mg/L, respectively. Individual facility existing nutrient loads were calculated from reported actual flow values as opposed to the design average flow (DAF).

There are 20 domestic wastewater NPDES discharges in the South Fork Salt River Basin. The facilities have a combined annual TN and TP loading of approximately 446,000 lbs/year and 89,000 lbs/year, respectively (**Table 3-5**). Ninety-one percent of the total point source loading in the watershed originates from the Cities of Centralia, Macon, Mexico, and Moberly.

TABLE 3-5. Domestic Waste NPDES Discharges and Nutrient Loads in the South Fork Salt River Basin.

Facility ID	Facility Name	Design Flow (MGD)	Actual Flow (MGD)	Watershed Area at Outfall (acres)	TN Load (lbs/yr)	TP Load (lbs/yr)
MO0103390	Cairo WWTF	0.061	0.045	447	2,740	548
MO0028789	Centralia WW Disposal Fac.	1.47	0.505	1,840	30,700	6,150
MO0054585	City of Clark WWTF	0.035	0.022	199	1,340	268
MO0057088	Dan Arnold Lagoon	0.004	0.002*	35	122	24
MO0054038	Elmwood Mobile Home Park	0.005	0.004	163	244	49
MO0033901	Freeman Hills Subd WWTF	0.0077	0.00385*	27	234	47
MO0097527	Jacksonville WWTF	0.02	0.017	297	1,040	207
MO0113948	Lakeside Estate HOA	0.0107	0.00864	330	526	105
MO0023221	Macon WWTF	2.5	1.5	2,100	91,300	18,300
MO0096920	Madison WWTF	0.08	0.04	328	2,440	487
MO0117668	Mexico Route D WWTF	0.052	0.033	57	2,010	402
MO0036242	Mexico WWTP	3	2.6	57,300	158,000	31,700
MO0053937	Moberly Correctional Cent.	0.47	0.307	470	18,700	3,740
MO0117960	Moberly East WWTP	3.5	2.1	3,190	128,000	25,600
MO0106551	Moberly LDS Church	0.0015	0.00075*	501	46	9
MO0126951	Monroe Co PWSD#2, Holliday	0.02	0.0143	42	871	174
MO0126888	Monroe Co PWSD#2, Rush Hill	0.015	0.0121	550	737	147
MO0045675	Robert Stone	0.003	0.0015*	147	91	18
MO0081850	Skyline Village Inc.	0.016	0.01	9	609	122
MO0052027	Sturgeon WWTF	0.254	0.1	6,470	6,090	1,220
				Totals	**446,000**	**89,300**

*Actual flow assumed half of design average flow.

There are 26 domestic wastewater NPDES discharges in the Spring River Basin. The facilities have a combined annual TN and TP loading of approximately 1.3 millon lbs/year and 259,000 lbs/year, respectively (**Table 3-6**). Ninety percent of the total point source loading originates from the following 7 facilities: Carthage WWTP, Joplin Shoal Creek WWTP, Monett Municipal WWTF, Center Creek WWTF, Neosho Shoal Creek WWTP, Aurora WWTP, and the Mount Vernon WWTF.

TABLE 3-6. Domestic Waste NPDES Discharges and Nutrient Loads in the Spring Basin.

Facility ID	Facility Name	Design Flow (MGD)	Actual Flow (MGD)	Watershed Area at Outfall (acres)	TN Load (lbs/yr)	TN Load (lbs/yr)
MO0089036	Alba WWTF	0.1	0.05*	14,800	3,040	609
MO0114740	Asbury WWTF	0.017	0.018	1,670	1,100	219
MO0036757	Aurora WWTP	2	1.38	4,540	84,000	16,800
MO0126292	Butterfield WWTF	0.0604	0.0302*	165	1,840	368
MO0025186	Carl Junction WWTF	0.84	0.54	184,000	32,900	6,580
MO0040193	Carterville Lift Station	0.04	0.02*	3,470	1,220	244
MO0039136	Carthage WWTP	7	4.3	288,000	262,000	52,400
MO0040185	Center Creek WWTF	4.8	2.4	3,730	146,000	29,200
MO0031658	Golden City WWTF	0.125	0.0625*	2,900	3,810	761
MO0107581	Granby WWTP	0.22	0.11*	5,840	6,700	1,300
MO0023256	Joplin Shoal Creek WWTP	6.5	4.6	290,000	280,000	56,000
MO0044172	Lamar WWTF	0.9	0.45*	1,390	27,400	5,480
MO0023159	Marionville WWTF	0.5	0.235	6,340	14,300	2,860
MO0041149	Miller WWTF	0.075	0.0375*	977	2,280	457
MO0116581	Mindenmines WWTF	0.04	0.02*	2,820	1,220	244
MO0035548	MoDOT I-44 Rest Area	0.008	0.002	218	122	24
MO0021440	Monett Municipal WWTF	6	3.5	11,900	213,000	42,600
MO0022381	Mount Vernon WWTF	1.35	0.675*	12,800	41,100	8,220
MO0104906	Neosho-Shoal Creek WWTP	3	2.55	214,000	155,000	31,100
MO0099155	Pierce City WWTF	0.2	0.1*	26,000	6,090	1,220
MO0129755	Purcell WWTF	0.043	0.0215*	301,000	1,310	262
MO0117978	Roger Hines Duplex WW	0.004	0.002*	1,160	122	24
MO0028657	Sarcoxie, City of	0.15	0.125	50,100	7,610	1,520
MO0115321	Stotts City WWTF	0.025	0.0125*	6,620	761	152
MO0092525	Verona WWTF	0.106	0.053*	17,200	3,230	645
MO0120634	Wentworth WWTF	0.016	0.008*	2,970	487	97
				Total	1,300,000	259,000

*Actual flow assumed half of design average flow .

3.4. POINT AND NONPOINT SOURCE LOADING COMPARISONS

The existing nutrient loading from agricultural nonpoint sources exceeds NPDES point source loadings in the South Fork Salt River and Spring River Basins for both TN and TP (**Figure 3-4**). The greatest differentials are in the South Fork Salt River Basin where agricultural loadings exceed point source loading by a factor of 9.9 and 7.0 for TN and TP, respectively. In the Spring River Basin, agricultural loadings are approximately 3 times higher than point source loadings for both TN and TP, respectively.

It is important to note that agricultural loadings presented in **Figure 3-4** represent the total potential nonpoint source supply of nutrient credits (100% of agricultural loading) in each watershed. However, in a real WQT scenario, less than 100% of existing agricultural loading would be available for trading because 1) not all nonpoint sources will participate in trading, and 2) BMPs nutrient removal rates are less than 100%. The effects of producer participation and BMP removal rates on WQT will be evaluated in subsequent sections.

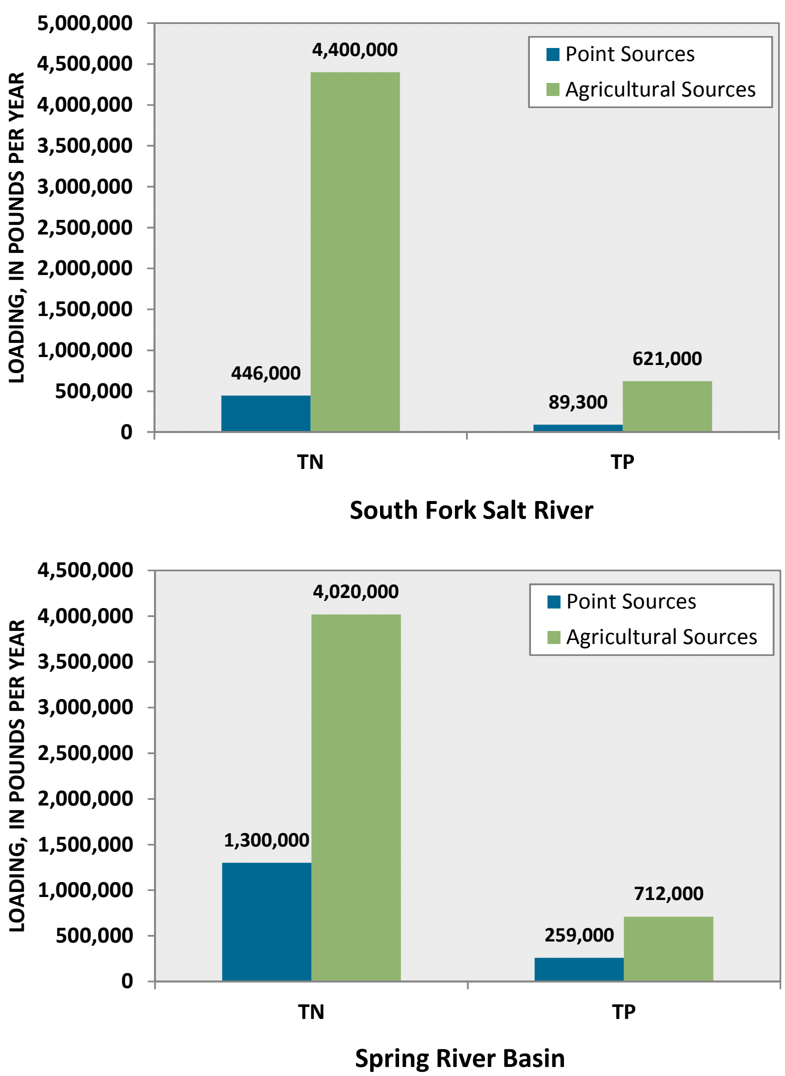


FIGURE 3-4. Agricultural and Point Source Nutrient Loading in the South Fork Salt and Spring River Basins.

4.0 CREDIT SUPPLY AND DEMAND ESTIMATES

To evaluate the potential impacts of the three programmatic decisions (trading margins, areas, and ratios) on trading efficiency and effectiveness, it is necessary to predict the supply, demand, and costs of nutrient credits associated with any particular simulated trading scenario. For this analysis, it is assumed that all credits supplied for trading are produced by reducing nonpoint source nutrient loading from agricultural areas through implementation of best management practices (BMPs); credit demand is assumed to result only from domestic WWTPs discharging above baseline nutrient levels. Methods used to estimate these parameters are outlined below.

Although every effort was made to accurately estimate the trading parameters, the factors affecting credit supply, demand, and cost are highly variable and site-specific in nature. To simplify the analysis, it was necessary to generalize many of the parameters to be applicable in both the South Fork Salt and Spring River Basins. **Therefore, credit supply, demand, and costs presented in the following sections are intended to serve only as order of magnitude estimates useful for evaluating the relative impacts of programmatic decisions on trading. More detailed BMP and WWTP-specific studies would be needed to accurately determine values in a real trading program.**

4.1. NONPOINT SOURCE SUPPLY CREDIT ESTIMATES

As mentioned above, this analysis assumes all credits available for the simulated trades are produced by reducing nonpoint source nutrient loading from agricultural areas through implementation of BMPs. Several BMP components must be identified before they can be used to evaluate trading efficiency and effectiveness in a simulated trading exercise. These components include the types of BMP that will be used, nutrient treatment efficiency of the BMP, establishment and maintenance costs, BMP implementation rates, and the producer participation rate. Information needed to estimate each of these components was compiled from both a literature review and a producer survey conducted by ERC in the South Fork Salt River watershed.

Five agricultural BMPs were selected for the simulated trading exercise. For row-crop operations, filter strips, cover crops, conservation tillage, and constructed wetlands were considered. Offstream watering with stream fencing was considered for pasture areas. Obviously, these BMPs represent only a limited selection of the alternatives available to control nonpoint source runoff. These BMPs were selected because information about them is readily available, they are commonly used in Missouri, they represent a range of nutrient removal efficiencies, and they were identified in the producer survey as BMPs which farmers would be interested in implementing. A brief description of each BMP is given below.

- Filter Strips – Filter strips are areas of vegetation that remove suspended solids and dissolved contaminants from overland flow (NRCS 2009). In addition to reducing pollutants in runoff, filter strips can be useful in managing erosion, streambank protection and improving wildlife habitat (Los et al. 2001). Filter strip effectiveness depends on soil characteristics, land size, slope and shape, quality of vegetative cover within the filter, land use and climate (Leeds et al. 1994). The minimum recommended flow width for a filter strip varies depending on constituent targeted for removal; NRCS (2009) recommends a minimum width of 20 feet and 30 feet to remove suspended solids and dissolved contaminants, respectively.

- Cover Crops – Cover crops are grasses, legumes, or forbs planted annually to provide seasonal cover on row-crop areas (NRCS 2012). Cover crops have many uses, including reducing field erosion, increasing organic matter in the soil, increasing infiltration, and promoting nitrogen fixation. Cover crops are generally planted during the non-crop period but can be seeded into an existing crop using appropriate methods and cover crop types (SAN 2007). Cover crops can be grown either as temporary cover or as a commodity crop, however publicly subsidized cover crop practices generally cannot be harvested for sale (NRCS 2012).

- Conservation Tillage – Conservation tillage refers to any method of cultivation that leaves crop residue in place after harvest. Conservation tillage methods have both environmental and practical benefits, including reducing erosion, conserving water by reducing evaporation, providing food and cover for wildlife, and reducing fuel and labor costs (MDA 2012). Tillage methods include no-till, strip-till, ridge-till, and mulch till operations. In no and strip-till practices, crops are planted directly into the previous season's residue. Ridge-till practices involve planting crops in ridges elevated 6 inches above the surrounding ground. In ridge-till systems, residue is cleared from ridges before planting. Mulch-till systems are any other tillage practice where between 30% and 100% of residue is left on the soil surface (MDA 2012).

- Constructed Wetlands – Constructed wetlands practices may include the creation of new wetlands or the re-establishment and modification of existing wetlands (NRCS 2006a, 2006b, 2006c). Wetlands improve water quality through natural chemical, biological, and physical processes. In wetlands, nitrogen removal occurs primarily via denitrification processes under anaerobic conditions; phosphorus is primarily removed through sedimentation processes (UMRSHNC 2008). Like the other BMPs discussed, wetlands also provide many other environmental benefits such as enhancing habitat for wildlife and reducing flooding potential in low-lying areas (Hey et al. 2005b).

- Offstream Watering with Fencing – Fences are used to exclude livestock from having direct access to streams. Fencing improves water quality primarily by preventing the direct deposit of nutrients into waterways from livestock excretions. Livestock exclusion practices also help to prevent instream habitat degradation caused by streambank erosion. This BMP requires alternative water sources to be provided for livestock.

- BMP treatment efficiency is another critical element that must be estimated. As discussed by Strecker et al. (2001), reported removal efficiencies, or "percent removals," are not the most accurate measures of BMP effectiveness. Some BMPs may have low percent removal values because they have high quality influent or vice versa. Instead, BMP effectiveness should be measured by evaluating whether or not effluent from the BMP had a statistically significant effect on water quality (Strecker et al. 2001). Further, Strecker et al. (2001) point out that efficiencies may not be directly transferable between studies because measurement methods and statistical procedures used to calculate them vary. However, to simplify the simulated trading scenarios for both basins, it was necessary to estimate effectiveness via reported percent removals. Before a real WQT program is implemented, additional efforts would be needed to better quantify BMP effectiveness.

Data from similar WQT and agricultural evaluations were reviewed to estimate BMP nutrient treatment efficiencies for the simulated trading exercise (CH2M Hill 2008, Devlin et al. 2003, Devlin and Barnes 2009, CTIC 2011, Green and Haney 2012, Hey et al. 2005a, Leeds et al. 2004, and Van Houten et al. 2012). For cropland BMPs, results of this review demonstrate that reported treatment effectiveness is highly variable both across BMP types and within a single BMP category (**Figure 4-1**). For TN, reported efficiencies range from 0% removal for tillage practices to approximately 60% for filter strips. Percent removals for TP were similarly variable, ranging from 10% for tillage and cover crops up to 80% for filter strips.

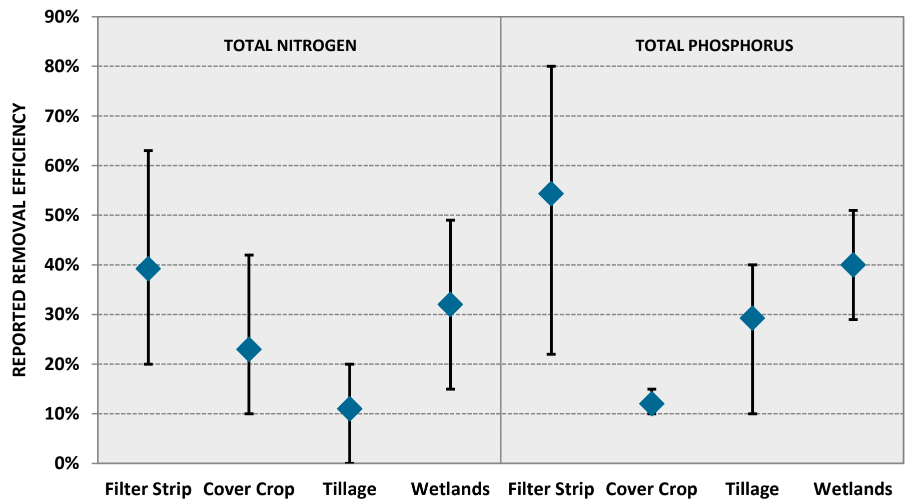


FIGURE 4-1. Potential Range of Nutrient Treatment Efficiencies for the Cropland BMPs Evaluated.

Variability across BMP types is expected, as some BMPs are more efficient than others but the variability of results reported for any single BMP category may be related to 1) the different measurement and estimation methods used in a given study; 2) differences in climate, precipitation, and geography; 3) site-specific or field-level factors; or, 4) actual treatment variability that exists within a BMP category. These results highlight the inherent uncertainty associated with controlling nonpoint source pollution and support the concerns raised by Strecker et al. (2001) regarding the limitations of percent removal data. Further, they reinforce the notion that additional efforts may be needed to quantify BMP effectiveness in a real WQT program. For purposes of conducting the simulated trades for this study however, the average treatment efficiency reported in **Figure 4-1** for each BMP was applied for the cropland practices (**Table 4-1**).

Nutrient reduction efficiencies for offstream watering with fencing were obtained from a review conducted by the Mid-Atlantic Water Program (MAWP) in support of the Chesapeake Bay Program's watershed model. MAWP contracted an expert to review applicable literature and propose an efficiency for model calibration. Based on this review, MAWP recommended a 25 and 30% removal efficiency for TN and TP, respectively (Simpson and Weammert 2007).

BMP Type	TN Removal Efficiency	TP Removal Efficiency
Filter Strips	39%	54%
Cover Crops	23%	12%
Conservation Tillage	11%	29%
Constructed Wetlands	32%	40%
Offstream Watering with Fencing	25%	30%

TABLE 4-1. BMP Treatment Efficiencies Used in the Simulated Trading Exercises.

The total cost of implementing agricultural BMPs requires the estimation of four cost components: practice establishment costs, annual maintenance costs, opportunity costs, and useful life. Practice establishment costs are the one-time costs related to the time, labor, capital, and materials used in establishing or replacing the BMP. Annual maintenance costs reflect the ongoing costs associated with repairing and maintaining a given BMP. Opportunity costs are the ongoing costs of taking land out of production and apply only to those BMPs which permanently reduce tillable acreage or reduce crop yield. Finally, useful life refers to the expected lifespan of a given BMP before it must be replaced.

Annual costs for each BMP were calculated from 20-year present values (5% discount, 3% inflation). Present values were estimated from establishment costs, annual maintenance, and opportunity costs associated with each BMP. Adjustments were made for replacement costs if the useful life was less than 20 years. Establishment and maintenance cost estimates were primarily derived from applicable Missouri NRCS payment schedules (http://efotg.sc.egov.usda.gov) for the 2012 Environmental Quality Incentives Program (EQIP). The EQIP program reimburses producers for a percentage of costs associated with implementing a given practice. Therefore, costs derived from EQIP schedules were adjusted to more closely reflect the true practice cost. If EQIP schedules were insufficient for deriving costs, practice costs were estimated from similar WQT or agricultural evaluations.

Opportunity costs were assumed equal to the net income that a farmer might expect from an acre of a typical corn-bean rotation farming operation. Estimated net incomes were obtained by averaging the net income from predicted crop cost and return data for 2009 through 2011 published by the MU Food and Agricultural Policy Research Institute (FAPRI). MO NRCS also relies on these FAPRI data for estimating conservation practice payments for foregone income. Opportunity costs are primarily driven by expected crop yields and associated crop prices. The FAPRI estimates assume an average yield of 155 and 50 bushels of dryland corn and soybeans, respectively. Estimates also assumed an average cost of $4.08 and $9.68 per bushel of corn and beans, respectively. As yields and crop prices change over time, it is expected that opportunity costs will change accordingly. However, the assumed FAPRI yields and prices are comparable to recent statewide average values (USDA 2010). Therefore, they were considered adequate for estimating opportunity costs in the simulated trading scenarios (**Table 4-2**). The final average expected opportunity cost calculated for the simulated trades was $150 per acre.

TABLE 4-2. Comparison of FAPRI Estimates and Statewide Crop Production Measures from 2009 and 2010.

Statistic	Statewide 2009 Production	Statewide 2010 Production	2009 – 2011 Average FAPRI Estimate
Corn Yield, in bushels/acre	153	123	155
Soybean Yield, in bushels/acre	44	42	50
Average Corn Price, in $/bushel	$3.58	$5.45	$4.08
Average Soybean Price, in $/bushel	$9.61	$12.10	$9.68

Individual BMP cost assumptions are described below. It is important to note that final BMP cost estimates roughly reflect the "break-even", or minimum, price a farmer would accept for adopting a given BMP. In a real WQT program, minimum BMP costs would vary according to individual farmer costs and goals, as well as credit supply and demand pressures. Final costs (in 2011 dollars, rounded to the nearest dollar) used in the simulated trades are presented in **Table 4-3.**

- Filter Strips – EQIP payment schedules were not adequate for developing filter strip cost estimates. The average establishment costs reported in similar (CH2M Hill 2008, Devlin et al. 2003, CTIC 2011, Van Houten et al. 2012, Nakao and Sohngen 1999) studies was $312 per acre of filter strip. Annual maintenance costs were assumed to be 2% of the establishment costs (CTIC 2011). One acre of filter strip has an opportunity cost of $150 per year, treats 40 acres of cropland, and has a useful life of 10 years.

- Cover Crops – EQIP 2012 payment schedules include five cover crop options. The options include legumes, cereal grains, winter kill species, grasses, and mixed species crops. The average cover crop establishment costs were estimated to be $50 per acre. Annual maintenance is 1% of the establishment costs (CTIC 2011). Although some studies have reported changes in yield (increases and decreases) following the implementation of cover crops, these changes are generally associated with the specific type of cover crop used (Mannering et al. 2007). Because cost estimates presented here include a range of cover crops, opportunity costs were assumed to be $0. One acre of cover crops treats one acre of cropland and has a useful life of one year.

- Conservation Tillage – EQIP 2012 schedules include payments for continuous no-till or strip-till practices. Establishment costs were estimated to be $43 per acre. Annual maintenance costs were assumed to be $0. The EQIP payment schedule assumes a 5% reduction in crop yield ($8 per acre opportunity cost) for conservation tillage. One acre of conservation tillage treats one acre of cropland and has a useful life of one year.

- Constructed Wetlands – Wetlands costs were estimated from a 0.5 acre demonstration wetland project installed in the South Fork Salt River Watershed. Establishment costs were $32,000 per acre, although these costs could be reduced significantly for large, regional wetland systems. EQIP estimates annual operation costs at 3% of establishment costs. One acre of wetland has an opportunity cost of $150 per year, treats 50 acres of cropland, and has a useful life of 20 years.

- Offstream Watering with Fencing – Establishment costs for this practice were estimated from EQIP payment schedules and include costs for fencing, a standard watering tank without storage, 100 feet of well drilling, and installation of a pump and pressure tank for a deep well. Fencing materials were estimated to cost $2 per linear foot. On average, there are 25 and 18 linear feet of stream intersecting each acre of pasture in the South Fork Salt and Spring Rivers, respectively. It was assumed that fencing would be needed on both sides of the stream in each acre of pasture. Establishment costs for the watering facility were estimated to be $5,550 with a pump replacement cost of $3,940 every 10 years. According to the EQIP schedule, one standard watering tank is typically installed for every 30 animal units. Adjusting for cattle density in each watershed indicated that one watering facility would serve 143 and 120 acres in the South Fork Salt and Spring River watersheds, respectively. Annual maintenance costs were estimated to be 2% of establishment costs for fencing and the watering facility. Except for the pump replacement, this BMP has a useful life of 20 years. There are no opportunity costs.

TABLE 4-3. Final Individual BMP Cost Estimates. Values rounded to the nearest whole dollar.

Applicable Land Use	BMP	Annual Cost per Acre Treated	Annual Cost per Pound TN Removed (Salt/Spring)	Annual Cost per Pound TP Removed (Salt/Spring)
Cropland	Filter Strips	$6	$2/$2	$2/$4
	Cover Crops	$65	$50/$53	$158/$85
	Conservation Tillage	$65	$24/$26	$389/$209
	Constructed Wetlands	$80	$21/$23	$143/$77
Pasture	Offstream Watering (S. Fk. Salt River)	$11	$15	$181
	Offstream Watering (Spring River)	$11	$19	$181

In a simple trading scenario between one buyer and seller, it may be appropriate to assume that a single BMP would be used to generate credits. However, in a watershed-scale scenario, it is unlikely that all participating farmers would or could implement a single BMP. To better illustrate the average trading results that may realistically be expected when trading occurs between many buyers and sellers in a watershed, it is more appropriate to assume that BMPs will not be implemented uniformly. Therefore, it was necessary to define the rate at which each individual BMP would be implemented across the watershed. Final BMP implementation rates (**Table 4-4**) were estimated based on responses to the producer survey and best professional judgment and assume that the most cost-effective BMPs are implemented at a higher rate than least cost-effective BMPs. Additional efforts would be needed to more accurately identify individual BMP costs and removal efficiencies as part of a Missouri WQT program going forward.

TABLE 4-4. Assumed BMP Implementation Rates.

Applicable Land Use	BMP	Implementation Rate
Cropland	Filter Strips	40%
	Cover Crops	25%
	Conservation Tillage	25%
	Constructed Wetlands	10%
Pasture	Offstream Watering	100%

The implementation rates were used to calculate single BMP credit costs and removals for TN and TP for each land use type in the basins (**Table 4-5**). As presented, the final weighted values represent the average credit costs and removals if credit demand equals credit supply in the watershed (i.e, if all available credits are purchased). In other words, values in **Table 4-5** represent the highest average costs and lowest average removals that may be expected in the trading simulations. These values were used solely for purposes of simplifying the trading simulations. In practice, the average values would change with decreasing demand; as the percentage of available credits purchased decreases, average cost would decrease and average removal would increase because relatively more cost-effective credits would be purchased.

The producer participation rate, or the percentage of producers expected to take part in the trading program, was also estimated from the producer survey. In the survey, 60% of respondents stated that they would be interested in participating in a trading program. However, the survey was conducted in a watershed with a group of producers who historically have been interested and active in conservation-related activities. Therefore, the 60% estimate is likely biased high and not representative of potential producer participation in a statewide program. A 20% rate was assumed to be more reasonable and, unless noted otherwise, was applied in the simulated trades. To simplify the trading scenarios, this participation rate was interpreted as the percentage of available acres of cropland and pasture available for credit production.

Final Implementation-Weighted BMP Assumptions	South Fork Salt River Cropland	South Fork Salt River Livestock	Spring River Basin Cropland	Spring River Basin Livestock
Total Nitrogen Removed, in lbs/acre/year & (% removal)	3.23 (27%)	0.75 (25%)	3.04 (27%)	0.58 (25%)
Total Phosphorus Removed, in lbs/acre/year & (% removal)	0.5 (36%)	0.21 (30%)	0.94 (36%)	0.06 (30%)
Total Nitrogen Credit Cost, in $/lb/year	$21	$15	$23	$19
Total Phosphorus Credit Cost, in $/lb/year	$154	$53	$83	$180

TABLE 4-5. Final Weighted BMP Cost and Removal Estimates Used in the Trading Simulations. Cost values rounded to nearest whole dollar.

4.2. POINT SOURCE CREDIT DEMAND ESTIMATES

Credit demand is driven by domestic WWTPs being required to offset their nutrient loads to meet more stringent TN and TP effluent limits. If it is more cost-effective to WWTPs to offset their loads by trading with agricultural producers or other point sources rather than upgrading their treatment facilities, they will have an incentive to participate in trading. If instead it is more cost-effective for WWTPs to upgrade their facilities, they likely will not purchase BMP credits. As discussed in **Section 1**, nutrient effluent limits are not enforced on a statewide basis in Missouri so there is currently no demand for nutrient credits in either watershed.

Because there are currently no statewide nutrient effluent limits, potential credit demand and facility upgrade costs were estimated for several effluent limit scenarios that may be considered by MDNR in the future. Three levels of nutrient treatment were evaluated: biological nutrient removal (BNR), enhanced nutrient removal (ENR), and reverse osmosis (RO, **Table 4-6**). BNR removes nutrients using microorganisms under different environmental conditions in the treatment process. Attainable effluent quality for BNR systems is approximately 8 and 1 mg/L for TN and TP, respectively (Falk et al. 2011). ENR is accomplished with a combination of BNR, chemical additions, and effluent filtration and can achieve approximately 5.0 and 0.5 mg/L TN and TP, respectively (Falk et al. 2011). RO treatment processes are membrane systems that remove solids and some large dissolved constituents. RO systems can generally achieve less than 2.0 and 0.02 mg/L TN and TP, respectively (Falk et al. 2011).

BNR and ENR were considered because these technologies represent potential technology-based effluent limit targets in the absence of stream or lake water quality criteria (**Table 4-6**). RO treatment was evaluated because it was considered the technology that would be needed for WWTPs to meet nutrient water quality criteria "end of pipe," should they be developed. It is important to note that although RO produces a high quality effluent, it is possible that future nutrient criteria will be set at levels lower than what even an RO system can achieve. However, for purposes of this analysis, RO effluent limits are considered equivalent to potential, future nutrient criteria.

TABLE 4-6. Treatment Scenarios and Assumed Effluent Quality.

Treatment Level	Effluent TN (mg/L)	Effluent TP (mg/L)	Basis
Existing Treatment	20	4	Assumed Existing Effluent Quality
Biological Nutrient Removal (BNR)	8	1	Potential Technology-Based Limit
Enhanced Nutrient Removal (ENR)	5	0.5	Potential Technology-Based Limit
Reverse Osmosis (RO)	< 2 (1)	< 0.02 (0.01)	Surrogate for Potential Criteria

To more efficiently estimate costs for individual WWTPs to upgrade to any one of the three treatment scenarios in **Table 4-6**, it was necessary to first generally categorize the existing, individual treatment technologies present in the study area. A review of NPDES permits for the 46 WWTPs in both watersheds indicated that existing treatment technologies fell into one of three categories: activated sludge, lagoons, and trickling or small recirculating sand filters. In the Spring River watershed, activated sludge and lagoon facilities are the dominant treatment technologies; in the South Fork Salt River watershed, lagoons are used more often (**Table 4-7**). Existing WWTP design flows range from 0.002 to 7.0 MGD, with the majority of facilities (76%) having flows less than 1.0 MGD.

TABLE 4-7. General Treatment Categories for Domestic WWTPs in the Study Watersheds.

Current Treatment Level	South Fork Salt River		Spring River	
	# WWTPs	Design Flow (MGD)	# WWTPs	Design Flow (MGD)
Activated Sludge	3	0.08 – 3.5	12	0.1 – 7.0
Lagoon	15	0.003 – 1.47	9	0.004 – 0.9
Trickling or Recirculating Sand Filters	2	0.002 – 2.5	5	0.02 – 6.5

The costs of upgrading existing WWTPs technologies to each of the three potential effluent limit scenarios were estimated from cost data reported in similar studies. Average annual BNR and ENR upgrade costs were developed from the Conservation Technology Information Center's (CTIC, 2011) comprehensive review of upgrade costs for comparable facilities[4]. RO cost estimates were based on capital and annual operations costs for a new, 10 MGD RO facility (Falk et al. 2011). Capital and annual costs reported by Falk et al. (2011) were scaled down (using $/MGD) to incorporate WWTP design flows observed in the South Fork Salt and Spring River watersheds. Because the Falk et al. (2001) estimates did not include labor or maintenance, an annual maintenance cost of $24,000/year/MGD was added to account for membrane replacement (Blend and Suplee 2011). Final 20-year present value estimates were annualized using a 6% interest rate to maintain consistency with costs reported by CTIC.

Average annual costs were used to develop equations for estimating individual WWTP upgrade costs for each advanced nutrient treatment scenario. Costs derived using this method were compared to a limited number of WWTP upgrade projects in Missouri and were found to generally be accurate to within 30% of actual costs for most facilities. However, estimates for small WWTPs (<0.05 MGD) are likely less accurate due to the limited and variable upgrade cost data available for these facilities. This is particularly true for small recirculating sand filter upgrades, which were roughly estimated using the trickling filter cost curves. Final annual costs for each scenario were divided by the number of pounds removed annually to determine the marginal cost, or the cost of removing the next (or last) pound of a nutrient, for each upgrade scenario (**Figure 4-2**). It is important to note that in both **Figure 4-2** and the simulations presented in **Section 5**, costs for upgrading or trading nutrients were calculated independently for TN and TP. In other words, estimates reflect the costs for upgrading or trading to meet only a TN target or only a TP target. A method that could be used to estimate costs for simultaneously purchasing both TN and TP credits is discussed in **Attachment 1**.

[4] In their evaluation, CTIC (2011) presented annual upgrade costs for "low ENR" and "high ENR" technologies. Although the "low ENR" upgrade were slightly more technologically advanced than the BNR option assumed in this report, the expected effluent quality was comparable. Therefore, the average of "low ENR" upgrade costs was assumed to be a suitable estimate for the BNR technology. The average reported "high ENR" costs for each category in the CTIC report were used to estimate ENR upgrade costs for this study. Because the range of design flows evaluated for each technology by CTIC did not include all design flows present in the South Fork Salt and Spring River watersheds, some costs were adjusted for flow using the original studies cited by CTIC.

The cost curves are useful for evaluating the potential economic efficiencies WWTPs may gain through trading. According to the curves, facilities less than approximately 2.0 MGD tend to have upgrade costs that are higher than the estimated BMP credit costs for both TN and TP (**Figure 4-2**). Therefore, these facilities have an economic incentive to purchase the less expensive BMP credits. Larger facilities, on the other hand, tend to have low upgrade costs relative to BMP credit costs and therefore, do not have an economic incentive to purchase BMP credits. Because their marginal costs are low, larger facilities may have an economic incentive to generate credits to sell to smaller facilities (see **Section 5.2**). Additional discussions regarding the application of marginal cost comparisons for evaluating trading activity in the simulations are included in the following section.

It is important to reiterate that BMP estimates used in the simulations (**Table 4-5**) represent the highest average costs and lowest average removals that may be expected in a trading program. In practice, individual facilities may be able to purchase BMP credits for a lower cost than reflected in the simulations, depending on the scenario being evaluated. As a result, large facilities may have an economic incentive to trade if sufficient low-cost BMPs (such as filter strips) are available.

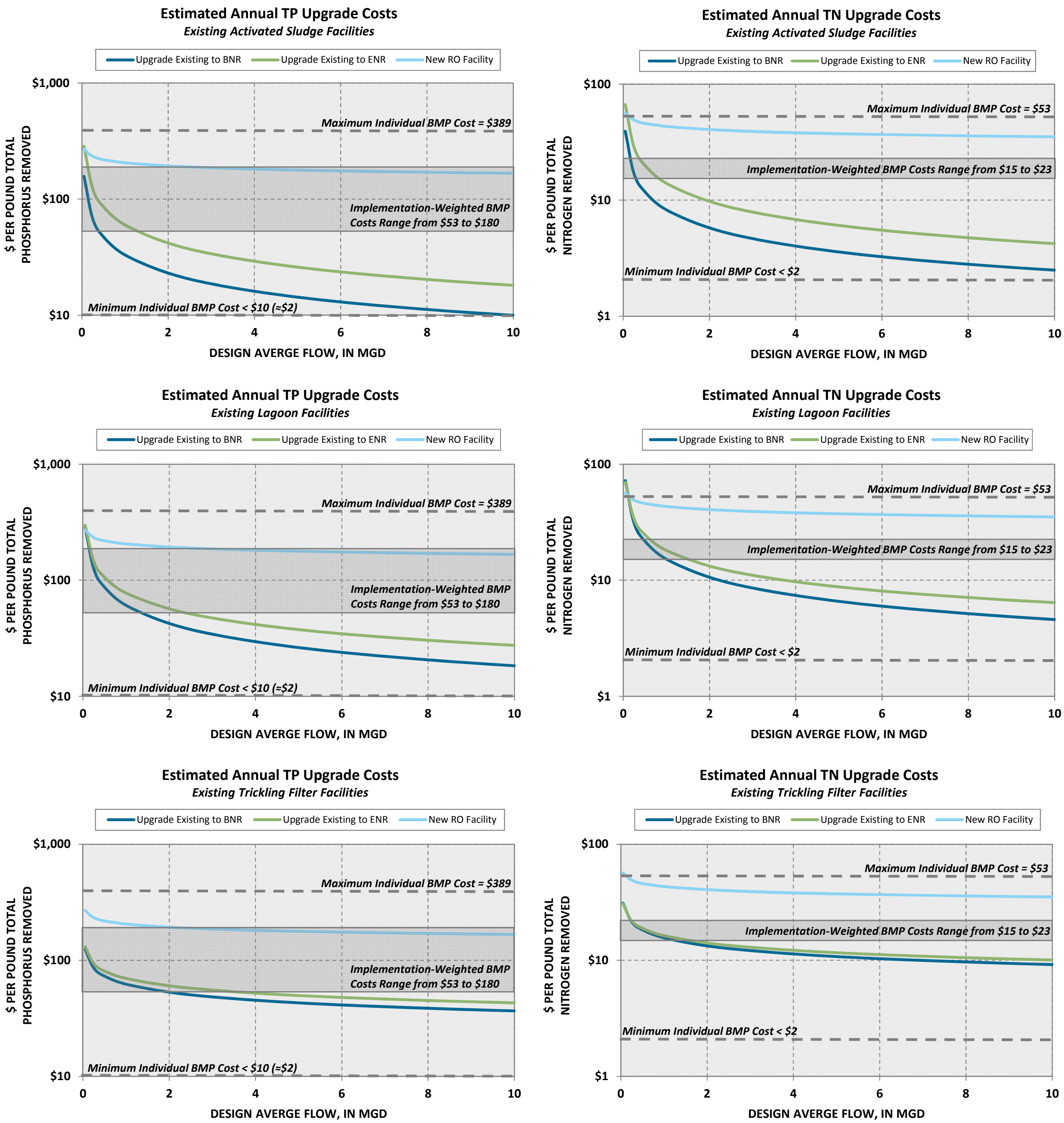


FIGURE 4-2. Estimated Annual WWTP Costs for Existing Treatment Technologies in the South Fork Salt and Spring River Basins. Estimates assume existing TN and TP concentrations for all facilities are 20 and 4 mg/L, respectively. The gray rectangles represent the range of implementation-weighted BMP costs (from **Table 4-5**) used in the simulations; dashed lines represent the range of individual BMP costs. More accurate point and nonpoint source control cost estimates are needed to pursue a Missouri WQT program going forward.

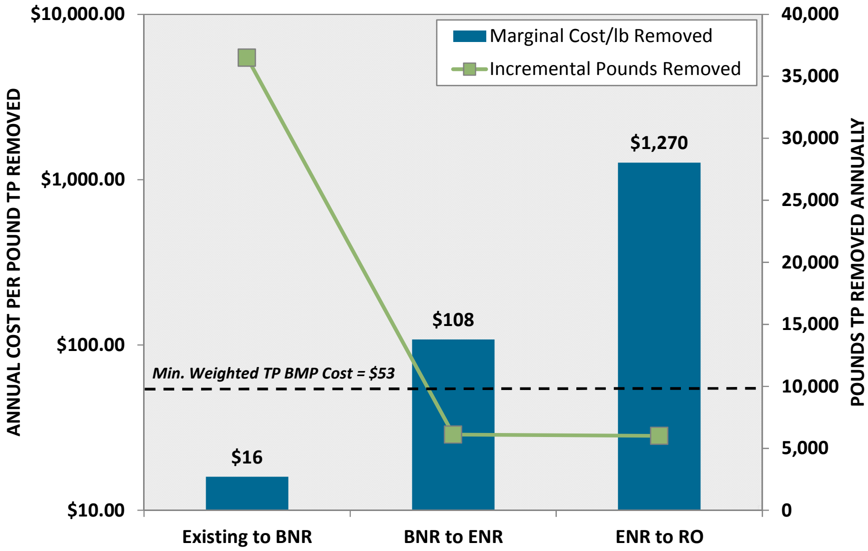


FIGURE 4-3. Comparison of Marginal Costs Associated with Upgrading between Advanced Nutrient Treatment Levels for TP Removal. Data reflect the costs and nutrient removals for an existing 4.0 MGD activated sludge facility.

Potential cost-inefficiencies for individual WWTPs would ultimately depend on a comparison of their marginal upgrade cost relative to the BMP cost. If BMP costs are lower than the marginal costs, it would be inefficient to upgrade to reduce the incremental loading. In the above example, the upgrade is inefficient relative to trading because the 4.0 MGD facility would spend $54 ($107 minus $53) more per incremental pound to install ENR. Conversely, if BMP costs are higher than marginal upgrade costs, it would be more efficient to upgrade. For example, if the BMP cost in the previous scenario was $180/lb (maximum TP BMP cost from **Table 4-5**), the facility would save $72/lb ($180 minus $108) by upgrading to ENR.

This example demonstrates the importance allowing WWTPs the freedom to choose how they meet required nutrient reductions. Programs that require minimum levels of treatment before, or in lieu of, trading will create cost-inefficiencies for some facilities. However, if allowed to meet nutrient reduction requirements through an undefined combination of upgrading and/or trading, WWTPs will always choose the most cost-efficient option. Because both regulatory approaches (minimum upgrade requirement versus freedom to choose) achieve the same level of water quality, programs should support the approach which minimizes costs.

4.3. EVALUATING POTENTIAL COST-EFFICIENCIES GAINED THROUGH TRADING

In the trading simulations presented in **Section 5**, potential cost efficiencies gained through trading were estimated by comparing the marginal cost of removing nutrients through facility upgrades (credit demand) with the marginal cost of offsetting nutrient loads with BMP credits (credit supply). In the simulations, it was assumed that individual WWTPs with upgrade costs that exceed BMP costs would always be willing to buy BMP credits; WWTPs with low upgrade costs would always rather upgrade their facilities to a higher treatment technology. With the exception of the partial loading offset example in **Section 5.3**, all nonpoint source trading simulations were conducted assuming WWTPs would offset either all or none of their individual credit demand. With this approach, trading scenarios could be evaluated to predict the number of WWTPs that would be willing to trade, the number of BMP credits that WWTPs would purchase, and potential costs savings for both the basin and individual WWTPs.

An example application of the analysis used in the trading simulations is illustrated in **Figure 4-4**. Comparing BMP supply and individual demand in the scenario indicates that trading would be cost-effective for the 18 WWTPs that fall above the BMP supply line (**Figure 4-4**). These 18 WWTPs would offset their loading demand by purchasing BMP credits; the remaining 8 WWTPs would offset their loading demand through facility upgrades. In the example, trading would provide substantial cost savings in the watershed. If no trading occurred, the total cost for all 26 WWTPs to upgrade would be $8.5 million per year. However, when 18 WWTPs participate in trading, total nutrient abatement costs in the watershed decrease by $1.4 million annually ($1 million for trading, $6.1 million for upgrade, **Figure 4-4**).

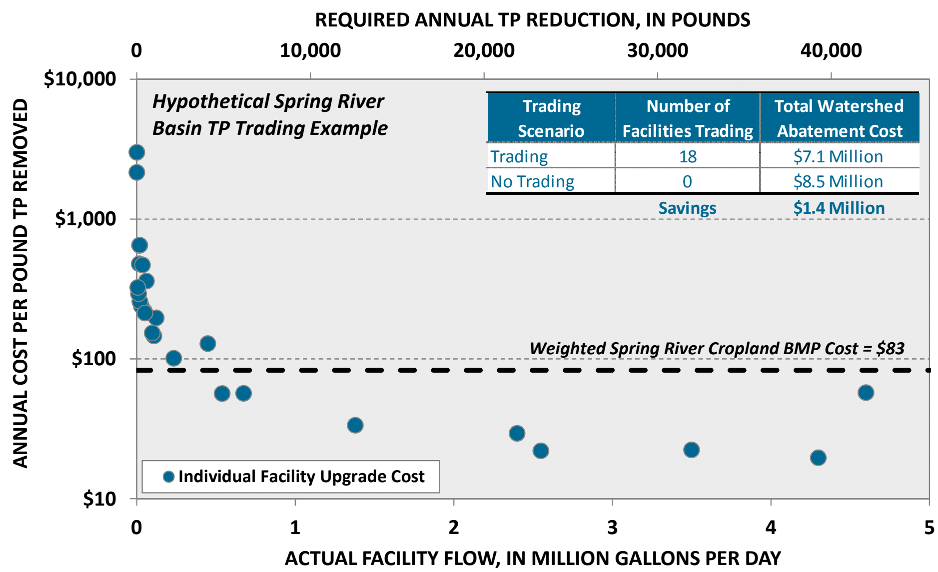


FIGURE 4-4. Example Demonstrating the Use of Credit Supply and Demand Curves to Evaluate Potential Cost-Efficiencies Gained through Trading to Meet Hypothetical TP Removal Requirements in the Spring River Basin. Individual WWTP upgrade costs were calculated from cost curves in Figure 4-2 and represent the cost for each facility in the basin to upgrade from existing treatment to BNR treatment. The evaluation assumes an unlimited supply of cropland BMP credits is available for purchase (1:1 trading ratio) at the weighted BMP cost from Table 4-5.

It is apparent that trading activity and associated cost savings will vary with changes in BMP pricing. In a real trading program, individual and aggregate BMP prices would be determined by market forces and would vary in response to 1) changes in BMP treatment efficacy or input costs, 2) changes in number and type of BMP credits supplied, or 3) trading ratio requirements. The potential impact of these BMP changes are briefly outline below.

- Changes in treatment efficacy or input costs. As discussed in Section 4.1., reported removal rates for BMP options are highly variable. All other inputs held constant, adjusting removal efficiencies to a higher or lower value within the reported range for any given BMP would change prices and affect trading activity. Input cost assumptions affect BMP pricing similarly. For example, increases in equipment costs or opportunity costs associated with changes in crop prices would increase overall BMP pricing and impact the feasibility and cost-effectiveness of trading.

- Changes in the number and type of BMP credits supplied. The supply curve is simply a graphical relationship between the number of credits supplied and the price at which those credits would be sold. In this report, the price of individual (**Table 4-3**) and aggregate (**Table 4-5**) BMP credits is assumed to be perfectly elastic. That is, the price at which a farmer would sell BMP credits is constant regardless of the number of credits supplied. In other words, the slope of the BMP supply curve is 0. However, in a real trading scenario the BMP supply curve may have a positive slope, indicating that producers are willing to supply more credits at higher prices and fewer credits at lower prices. All other inputs held constant, changing the slope of the supply curve would likely change the price at which it is more cost-effective for facilities to trade than to upgrade.

  BMP credit supply would also change depending on the type of BMPs being supplied. As discussed previously, BMP cost estimates used in this report (**Table 4-5**) represent the highest average costs that may be expected and were used solely to simplify the trading simulations. In practice, WWTPs would prefer to purchase the most cost-effective BMP credits available (such as filter strips). In response to increasing demand for low-cost credits, farmers would implement more cost-effective BMPs, thus shifting the BMP supply curve downward.

- Trading ratios requirements. Trading ratios are sometimes applied in WQT programs to account for issues related to credit exchangeability (see **Section 2**). For example, a program could require participating WWTPs to purchase two BMP credits for every pound of nutrient they need to reduce. In this instance, the 2:1 trading ratio doubles credit demand or alternatively, halves credit supply, and effectively doubles the total cost of BMP credits. In the example above where the price of a BMP credit is perfectly elastic, a 2:1 ratio would increase the cost of a cropland BMP credit from $83 to $166/lb TP. Increasing the credit cost to $166 would reduce the number of WWTPs trading from 18 to 14, and would reduce cost savings from $1.4 million to $0.7 million annually.

It is important to note that the trading efficiency evaluation approach and BMP pricing considerations presented above are only useful for determining whether or not a WWTP *would be willing* to trade from a cost perspective. The efficiency analysis must be coupled with a feasibility evaluation to determine whether or not a sufficient BMP credits are available such that a WWTP *could* trade. In practice, a limited number of BMP credits may be available to due to trading area restrictions or lack of supply. In the trading simulations discussed in the following sections, trading efficiency and feasibility were evaluated to determine potential trading activity under a variety of trading restrictions.

5.0 SOUTH FORK SALT AND SPRING RIVER BASIN TRADING SIMULATIONS

As discussed in **Section 1**, there are several potential nutrient regulations that may be enforced in Missouri in the near future. MDNR is considering WQT as one approach for addressing these new requirements. When developing the WQT program, the Department will have to make several programmatic decisions that prescribe the conditions under which trading will be allowed. Three important factors that MDNR will have to consider are the required trading margin, trading area, and trading ratios.The potential individual and cumulative implications of these factors are explored through simulated trading exercises in the South Fork Salt and Spring River Basins. The simulations are based on effluent limitations and criteria assumed for purposes of this study and are not intended to project future regulatory conditions.

The point source trading margin can significantly influence trading feasibility because it changes individual WWTP credit demand and potential cost-efficiencies that could be gained through trading. For example, in the study watersheds, the difference in TN and TP credit demand between the largest margin (i.e., existing to criteria) and the margin defined by BNR treatment to criteria is 58% and 33%, respectively (**Table 5-1**). The overall impact of margin on cost-efficiency is more difficult to quantify because it is facility-specific and must fully consider other trading program factors such as trading area or ratios. In general however, the marginal costs for upgrading to advanced levels of treatment are lower for large facilities than for smaller facilities (see **Figure 4-2**).

TABLE 5-1. Potential Cumulative Demand for Nutrient Credits in the South Fork Salt and Spring River Basins for all POTWs Based on Different Trading Margins. Margin calculations are based on assumed effluent concentrations.

Basin	Trading Margin					
	TN, lbs/year			TP, lbs/year		
	Existing Treatment to BNR	Existing Treatment to Criteria	Difference	Existing Treatment to BNR	Existing Treatment to Criteria	Difference
South Fork Salt River	420,865	666,370	245,505 (58%)	105,216	139,938	34,722 (33%)
Spring River	1,246,358	1,973,400	727,042 (58%)	311,590	414,414	102,824 (33%)

The potential impact of trading area restrictions is illustrated below for dischargers in the Salt Fork Salt River Basin (**Figure 5-1**). If trading is permitted anywhere within the basin (left in **Figure 5-1**), the supply of BMP credits is potentially sufficient to meet the cumulative demand for nutrient credits from all WWTPs. If trading area is limited to upstream (right in **Figure 5-1**), there are not enough BMP credits for each individual WWTP to trade. In the upstream-only scenario, sufficient BMP credits are only available for four facilities; the remaining 16 would be required to upgrade their treatment processes.

Finally, ratios impact trading activity because they increase the credit demand to levels which cannot be satisfied by the available supply (see **Section 4.3**.). Ratios also may decrease trading activity because at some level of trading ratio, it will be less cost-effective for a WWTP to buy BMP credits than to upgrade the facility.

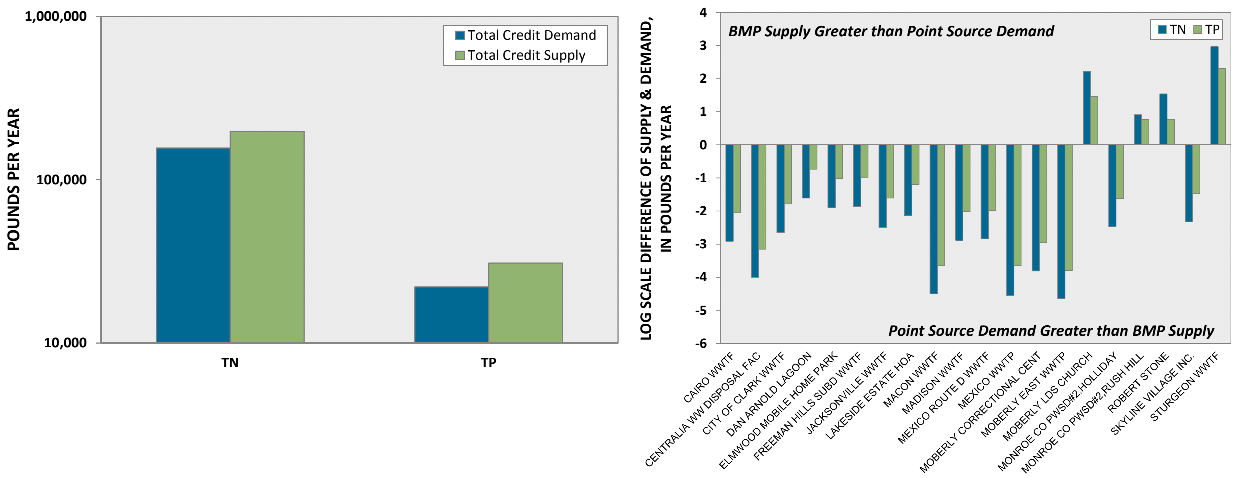


FIGURE 5-1. Example of the Impacts that Watershed-Wide (Left) and Upstream-Only (Right) Trading Scenarios Can Have on Credit Supply and Demand. Both scenarios are for the South Fork Salt River Basin and assume the WWTP trading margin is from BNR to RO/Criteria and the trading ratio is 1:1.

5.1. POINT-TO-NONPOINT SOURCE TRADING

In practice, some combination of the three trading factors described in the preceding sections would be enforced in a trading program. The additive impacts of these factors on credit supply, demand, and cost-effectiveness determine whether or not trading would occur. To evaluate the impacts of these additive impacts, 16 trading scenarios were simulated (**Figures 5-2 and 5-3**). In the simulations, trading area and trading ratios were varied for two different trading margins in the South Fork Salt and Spring River Basins. The first margin assumes existing WWTPs must meet BNR-equivalent nutrient levels through trading or facility upgrades. The second margin assumes WWTPs are upgrading or trading from BNR levels to meet water quality criteria.

Not surprisingly, the simulations show that for any given margin, large trading areas and lower ratios allow the highest number of number of facilities to trade, and result in the lowest overall nutrient abatement costs[5]. Of the three trading factors evaluated, trading area restrictions had the largest impact on the number of facilities that would trade (**Figures 5-2 and 5-3**); in the South Fork Salt River Basin, a majority of facilities (≥ 85%) would trade with nonpoint sources if trading was permitted watershed-wide regardless of the ratio or margin. The same is true in the Spring River, although the relative number of facilities trading is less (≥ 54%). Because trading area impacts the number of facilities that would trade, it also has a large impact on overall nutrient abatement costs. In general, total abatement costs substantially increased between watershed-wide and upstream-only scenarios in each simulation (**Figures 5-2 and 5-3**).

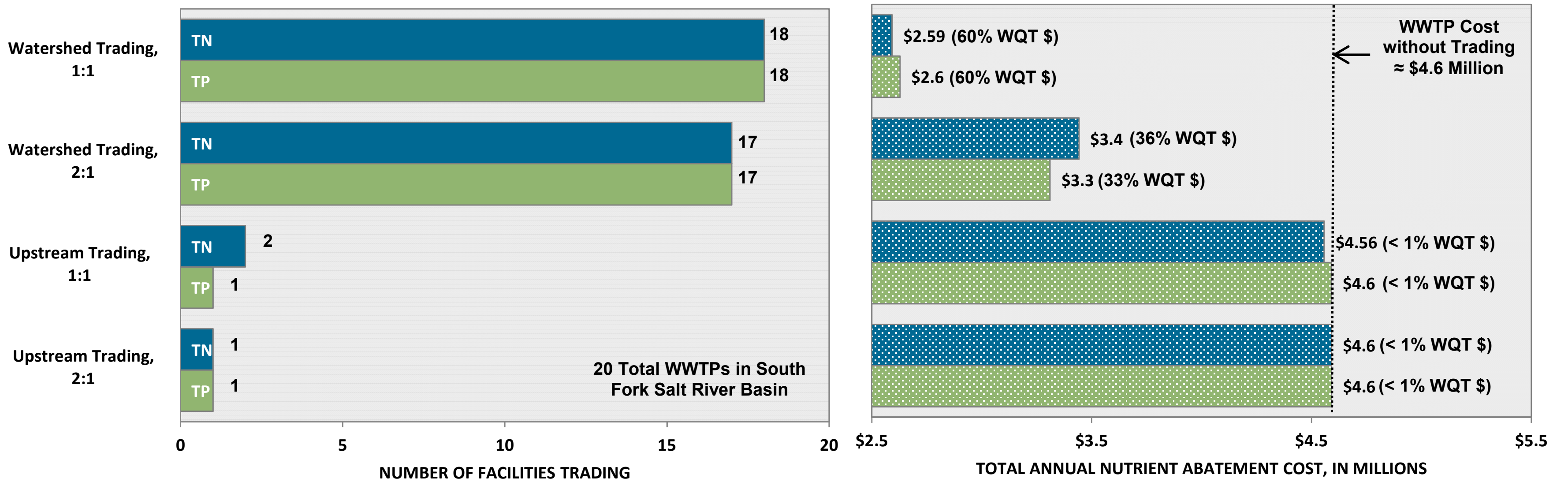
Simulation results for upstream-only trading situations are important because these scenarios represent common requirements associated with traditional trading programs. As discussed above, many traditional point-to-nonpoint source trading programs require nutrient credits to be purchased from upstream

[5] Total nutrient abatement costs for each scenario were calculated as the sum of total trading costs (for facilities that would trade) and total upgrade costs (for facilities that would or could not trade).

sources to increase assimilative capacity and avoid “hot spots” below the WWTP. The simulation results show that in both the South Fork Salt and Spring River Basins, an upstream only trading requirement significantly limits the number of facilities that would be able to trade. Further, total nutrient abatement costs indicate that there would be very little cost savings for these scenarios.

In general, the limited trading activity in the upstream-only simulations was due to limited credit supply, not cost-efficiency. Credit supply was insufficient for many WWTPs because they have small watershed areas from which credits could be generated (**Tables 3-5 and 3-6**). This situation will likely be true for most WWTPs discharging to small, headwater streams or facilities located on hill or ridge tops.

Simulation 1 - South Fork Salt River Basin, Upgrading from Existing Treatment (20 mg/L TN, 4 mg/L TP) to BNR (8 mg/L TN, 1 mg/L TP)



Simulation 2 - South Fork Salt River Basin, Upgrading from BNR (8 mg/L TN, 1 mg/L TP) to RO/Criteria (1 mg/L TN, 0.01 mg/L TP)

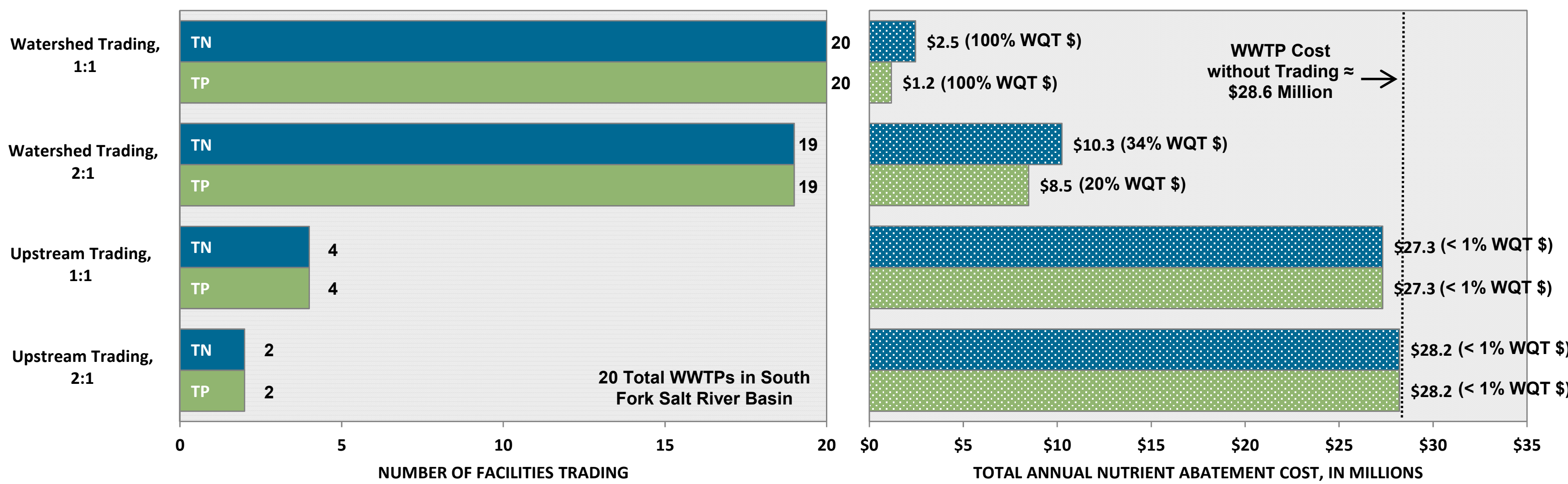
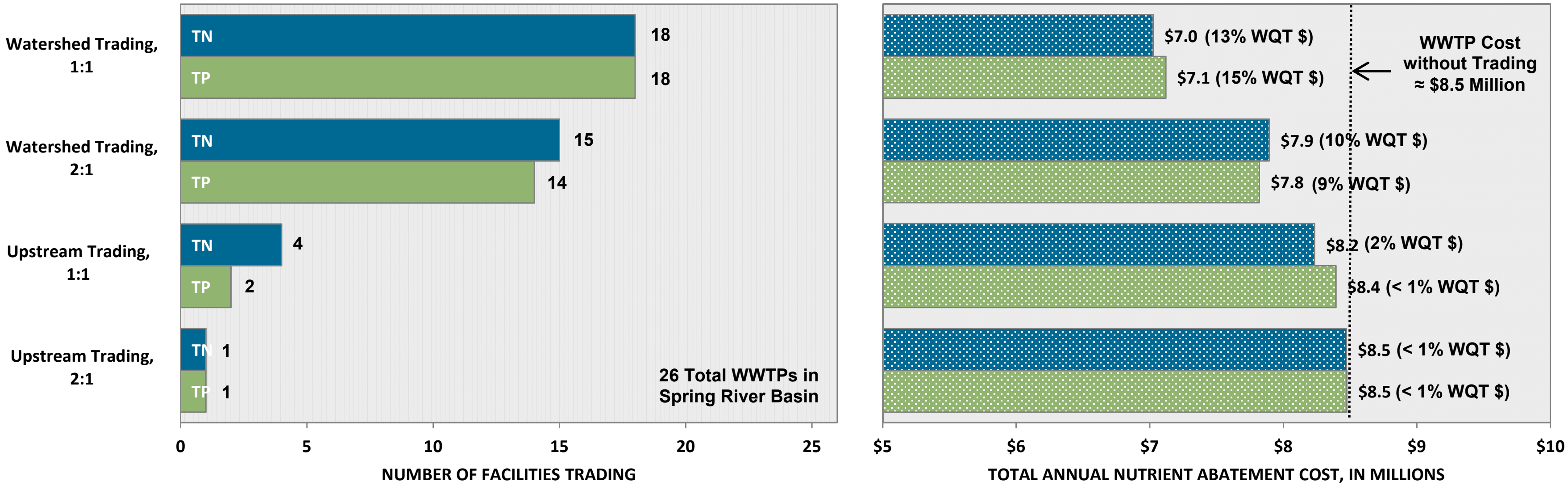


FIGURE 5-2. Additive Impacts of Trading Margin, Area, and Ratio Restrictions on WQT Activity and Cost-Efficiency in the South Fork Salt River Basin. Simulations were conducted independently for TN and TP. Therefore, cost estimates reflect the costs to meet only TN or only TP requirements.

Simulation 3 – Spring River Basin, Upgrading from Existing Treatment (20 mg/L TN, 4 mg/L TP) to BNR (8 mg/L TN, 1 mg/L TP)



Simulation 4 - Spring River Basin, Upgrading from BNR (8 mg/L TN, 1 mg/L TP) to RO/Criteria (1 mg/L TN, 0.01 mg/L TP)

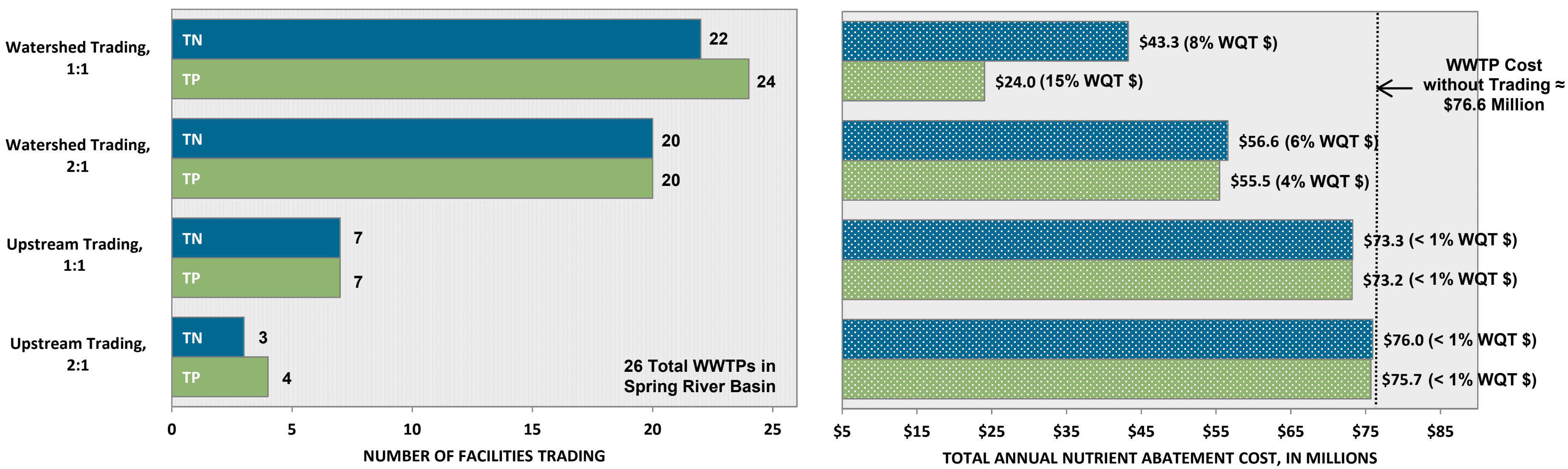


FIGURE 5-3. Additive Impacts of Trading Margin, Area, and Ratio Restrictions on WQT Activity and Cost-Efficiency in the Spring River Basin. Simulations were conducted independently for TN and TP. Therefore, cost estimates reflect the costs to meet only TN or only TP requirements.

5.2. POINT-TO-POINT SOURCE TRADING

Although the primary focus of this report is on point-to-nonpoint source trading, point-to-point source trading may offer a more cost-effective option in some instances. As demonstrated previously, it is more cost-effective for larger wastewater treatment facilities to upgrade from existing treatment levels than it is for smaller facilities. Additionally, larger wastewater treatment facilities generally represent the majority of point source nutrient loading within a watershed. For example, by size, the top 20% of facilities represent 92% and 81% of the total point source nutrient loading in the South Fork Salt River and Spring River Basins, respectively. Differences in costs and loadings between larger and smaller facilities create potential trading opportunities. To illustrate this point, examples of point-to-point source trading are presented below for both the South Fork Salt River and Spring River Basins.

The examples presented below assume the following trading scenario:

Point-to-Nonpoint Source Trading Ratio = 2:1
Point-to-Point Source Trading Ratio = 1:1
Trading Area = Watershed-Wide
Trading Margin = Existing Treatment to BNR

Nitrogen Point-to-Point Source Trading in the South Fork Salt River Basin

The three largest WWTPs in the South Fork Salt River Basin can comply with nitrogen removal requirements for less cost through treatment than through nonpoint source trading. For the Mexico WWTP, which is the largest of these facilities, nonpoint source trading costs are $39.71/lb, compared to upgrade costs of $5/lb (**Table 5-2**). Conversely, for the 17 smaller facilities, nonpoint source trading is more cost-effective than upgrading; treatment costs range from $36 to $623/lb, compared to $30/lb for nonpoint source trading (**Table 5-2**).

TABLE 5-2. Comparison of Nonpoint Source Trading and Treatment Costs for Total Nitrogen Removal Requirements in the South Fork Salt River Basin.

Treatment Facility	Actual Flow (MGD)	Required TN Reduction (lbs/year)	Annual Nonpoint Source Trading Costs		Annual Treatment Costs	
			(Total Cost)	(Cost/lb)	(Total Cost)	(Cost/lb)
Mexico WWTP	2.6	94,976	$3,771,889	$40	$511,778	$5
Moberly East WWTP	2.1	76,711	$3,000,279	$39	$551,081	$7
Macon WWTF	1.5	54,794	$2,074,346	$38	$1,153,854	$21
Centralia WW Disposal Facility	0.505	18,447	$549,974	$30	$666,844	$36
Moberly Correction Center	0.307	11,214	$334,341	$30	$386,266	$34
Sturgeon WWTF	0.1	3,653	$108,906	$30	$287,692	$79
Cairo WWTF	0.045	1,644	$49,008	$30	$144,957	$88
Madison WWTF	0.04	1,461	$43,562	$30	$89,856	$61
Mexico Route D WWTF	0.033	1,205	$35,939	$30	$134,265	$111
City of Clark WWTF	0.022	804	$23,959	$30	$111,028	$138
Jacksonville WWTF	0.017	621	$18,514	$30	$84,874	$137
Monroe Co. PWSD#2, Holliday	0.0143	522	$15,574	$30	$84,874	$162
Monroe Co. PWSD#2, Rush Hill	0.0121	442	$13,178	$30	$73,927	$167
Skyline Village Inc.	0.01	365	$10,891	$30	$76,253	$209
Lakeside Estate HOA	0.00864	316	$9,409	$30	$62,946	$199
Elmwood Mobile Home Park	0.004	146	$4,356	$30	$43,630	$299
Freeman Hills Subd WWTF	0.00385	141	$4,193	$30	$53,678	$382
Dan Arnold Lagoon	0.002	73	$2,178	$30	$39,198	$537
Robert Stone	0.0015	55	$1,634	$30	$34,143	$623
Moberly LSD Church	0.00075	27	$817	$30	$3,814	$139

Because treatment costs for the Mexico WWTP ($5/lb) are less than the nonpoint source trading costs of the 17 smallest facilities ($30/lb), point-to-point source trading may be a more cost-effective option. However, in order to generate additional TN credits to sell, the Mexico WWTP needs a higher level of treatment than BNR. Assuming the Mexico WWTP upgrades to ENR, an additional 23,744 TN credits will be generated at a marginal cost of $24 per pound (**Table 5-3**). At $24 per pound of nitrogen, it is still more cost-effective for the smaller facilities to trade with the Mexico WWTP than for nonpoint source trading. Although the supply of credits from the Mexico WWTP is insufficient to address all other point source facilities in the basin, it is sufficient to address the smallest 16 facilities in the basin.

TABLE 5-3. Cost to Generate Saleable Credits for the Mexico WWTP.

Treatment Upgrade Parameter	Value
BNR Treatment Cost, in $/year	$511,778
ENR Treatment Cost, in $/year	$1,082,637
Marginal ENR Cost, in $/year	$570,859
BNR TN Reduction, in lbs/year	94,976
ENR TN Reduction, in lbs/year	118,720
Incremental ENR Reduction, in lbs/year	23,744
Marginal Cost for Incremental Credits, in $/lb	$24

Phosphorus Point-to-Point Source Trading in the Spring River Basin

The ten largest WWTPs in the Spring River Basin can comply with phosphorus removal requirements for less cost through treatment than through nonpoint source trading. For the Joplin Shoal Creek WWTP, which is the largest of these facilities, nonpoint source trading costs are $117/lb, compared to upgrade costs of $57/lb (**Table 5-4**). Conversely, for the 16 smaller facilities, nonpoint source trading is more cost-effective than upgrading; upgrade costs range from $196 to $2,146/lb, compared to $166/lb for nonpoint source trading (**Table 5-4**).

Treatment Facility	Actual Flow (MGD)	Required TP Reduction	Annual Nonpoint (Total Cost)	Annual Nonpoint (Cost/lb)	Annual Treatment (Total Cost)	Annual Treatment (Cost/lb)
Joplin Shoal Creek WWTP	4.6	42,009	$4,924,473	$117	$2,408,132	$57
Carthage WWTP	4.3	39,269	$4,924,473	$125	$768,617	$20
Monett Municipal WWTF	3.5	31,963	$4,924,473	$154	$713,804	$22
Neosho-Shoal Creek WWTP	2.55	23,287	$4,387,890	$188	$511,778	$22
Center Creek WWTF	2.4	21,918	$3,892,919	$178	$641,296	$29
Aurora WWTP	1.38	12,603	$2,092,793	$166	$421,267	$33
Mount Vernon WWTF	0.675	6,164	$1,023,649	$166	$348,838	$57
Carl Junction WWTF	0.54	4,931	$818,919	$166	$277,790	$56
Lamar WWTF	0.45	4,110	$682,432	$166	$527,614	$128
Marionville WWTF	0.235	2,146	$356,381	$166	$216,555	$101
City of Sarcoxie	0.125	1,142	$189,565	$166	$223,256	$196
Granby WWTP	0.11	1,005	$166,817	$166	$146,025	$145
Pierce City WWTF	0.1	913	$151,652	$166	$139,495	$153
Golden City WWTF	0.0625	571	$94,782	$166	$204,549	$358
Verona WWTF	0.053	484	$80,375	$166	$102,851	$212
Alba WWTF	0.05	457	$75,826	$166	$100,015	$219
Miller WWTF	0.0375	342	$56,869	$166	$160,070	$467
Butterfield WWTF	0.0302	276	$45,799	$166	$65,635	$238
Purcell WWTF	0.0215	196	$32,605	$166	$50,525	$257
Carterville Lift STATION	0.02	183	$30,330	$166	$118,377	$648
Mindenmines WWTF	0.02	183	$30,330	$166	$118,377	$648
Asbury WWTF	0.018	164	$27,297	$166	$78,505	$478
Stotts City WWTF	0.0125	114	$18,956	$166	$33,278	$292
Wentworth WWTF	0.008	73	$12,132	$166	$23,600	$323
MODot I-44 Rest Area	0.002	18	$3,033	$166	$54,672	$2,993
Roger Hines Dupleix WW	0.002	18	$3,033	$166	$39,198	$2,146

TABLE 5-4. Comparison of Nonpoint Source Trading and Treatment Costs for Total Phosphorus Removal Requirements in the Spring River Basin.

As marginal treatment costs for the Joplin Shoal Creek WWTP ($57/lb) are less than the nonpoint source trading costs of the 16 smallest facilities ($166/lb), point-to-point source trading may be a more cost-effective option. However, in order to generate additional TP credits to sell, the Joplin Shoal Creek WWTP needs a higher level of treatment than BNR. Assuming the Joplin Shoal Creek WWTP upgrades to ENR, an additional 7,001 TP credits will be generated at a cost of $123 per pound (**Table 5-5**). At $123 per pound of phosphorus, it is still more cost-effective for the smaller facilities to trade with the Joplin Shoal Creek WWTP than for nonpoint source trading. Although the supply of credits from the Joplin Shoal Creek WWTP is insufficient to address all other point source facilities in the basin, it is sufficient to address the smallest 10 facilities in the basin.

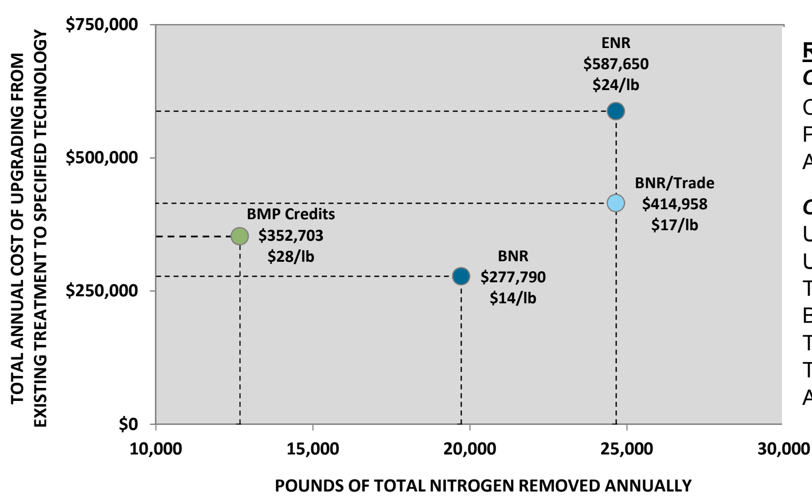
TABLE 5-5. Cost to Generate Saleable Credits for the Joplin Shoal Creek WWTP.

Treatment Upgrade Parameter	Value
BNR Treatment Cost, in $/year	$2,408,132
ENR Treatment Cost, in $/year	$3,266,521
Marginal ENR Cost, in $/year	$858,389
BNR TP Reduction, in lbs/year	42,009
ENR TP Reduction, in lbs/year	49,010
Incremental ENR Reduction, in lbs/year	7,001
Marginal Cost for Incremental Credits, in $/lb	$123

5.3. PARTIAL LOADING OFFSETS

The previous point-to-nonpoint source simulations assumed that WWTPs would trade only if it was cost-effective to offset their entire load. However, in some specific cases it may be more cost-effective for a WWTP to upgrade to a less-expensive treatment technology and offset the remaining load through trading. These partial trades may be the more cost-effective load reduction approach when 1) BMP credits are in short supply, and/or 2) the WWTP's average credit cost for partial trading is lower than its marginal upgrade cost.

The potential benefits realized from partial trading are illustrated in **Figure 5-4** below. In the scenario, the Carl Junction WWTP must meet ENR-equivalent TN levels (24,657 lbs) and there are insufficient BMP credits (12,679 lbs) to offset the entire nutrient load. Rather than simply upgrade to ENR treatment, it would be more cost-effective for the WWTP to first upgrade to BNR treatment and trade for the remaining credits needed. This load reduction approach is more cost-effective because the average credit cost for the partial trade is $17/lb, compared to $24/lb for upgrading to ENR treatment. In this example, partial trading would be the more efficient option as long as BMP costs were less than the marginal cost of upgrading from BNR to ENR, or $63/lb.



Required Reduction = 24,657

Option 1 - Upgrade to ENR
Compliance Cost: $587,650
Pounds Removed: 24,657
Average Cost/lb: $24

Option 2 - Upgrade to BNR, Then Trade
Upgrade Cost: $277,790
Upgrade Pounds Removed: 19,726
Trading Cost: $137,168
BMP Credits: 4,931
Total Compliance Cost: $414,958
Total Pounds Removed: 24,657
Average Cost/lb: $17

FIGURE 5-4. Example of Trading to Partially Offset Total Nitrogen Reduction Requirements for the Carl Junction WWTP. The scenario assumes the facility must reduce from Existing TN levels to RO/Criteria levels, is limited to upstream-only trading, and trades at a 1:1 ratio.

6.0 BIG RIVER WATER QUALITY TRADING APPROACHES

Although smaller rivers and streams like those in the South Fork Salt and Spring River Basins make up the majority of stream miles, the Missouri and Mississippi Rivers (Big Rivers) are significant waterways in Missouri; about 550 and 500 miles of the Missouri and Mississippi Rivers respectively, flow through the state (**Figure 6-1**). As with small streams, there are currently no nutrient drivers in place for Big Rivers. Unlike small streams however, future nutrient reduction requirements for Big Rivers may not be based on meeting numeric criteria designed to protect against localized impacts. Instead, Big River nutrient targets may be focused on addressing the hypoxic zone in the Gulf of Mexico.

FIGURE 6-1. Mississippi River Basin.

The hypoxic zone is a 22,000 square kilometer area that exhibits seasonal low dissolved oxygen concentrations (< 2 mg/L). The low dissolved oxygen is caused by decomposition from large algal blooms that occur in the Gulf as a result of Mississippi River nutrient supplies (Rabalais et al. 2002). In 2008, the U.S. Geological Survey (Alexander et al. 2008) completed a national level analysis of nutrient sources contributing to gulf hypoxia. Alexander et al. (2008) estimated that the majority of nitrogen (71%) and phosphorus (80%) loads to the Gulf of Mexico from the Mississippi River originate from agricultural nonpoint sources. Many speculate that increased water column nitrate is attributable to widespread uses of commercial fertilizers (Goolsby 1999).

In 2008, the Natural Resources Defense Council (NRDC) requested that EPA move forward with developing a nutrient TMDL to address the Gulf issues[6]. Specifically, the NRDC petition requested that

[6] In a separate petition, NRDC asked EPA to 1) publish information regarding the degree of nutrient reductions attainable through secondary treatment, and 2) amend its secondary treatment regulations to include nutrients. In December 2012, EPA published an updated secondary treatment report. EPA also denied NRDC's second request.

EPA develop nitrogen and phosphorus TMDLs for the mainstem and all tributaries of the Mississippi River. EPA denied the 2008 petition (NRDC filed a follow-up complaint) and, although they effectively agreed with the environmental concerns raised, EPA stated that they prefer to work cooperatively with states to develop their nutrient management programs.

Given the national focus on Gulf Hypoxia, it is clear that any WQT program developed in Missouri will have to be flexible enough to accommodate Big River trading that addresses downstream impacts. In particular, MDNR will have to consider how the three programmatic factors (trading margin, area, and ratio) discussed previously may have to be enforced differently to support point-to-nonpoint and point-to-point trading opportunities for the 83 point sources in the Big River region of Missouri (**Figure 6-2**). These issues are discussed in the following sections.

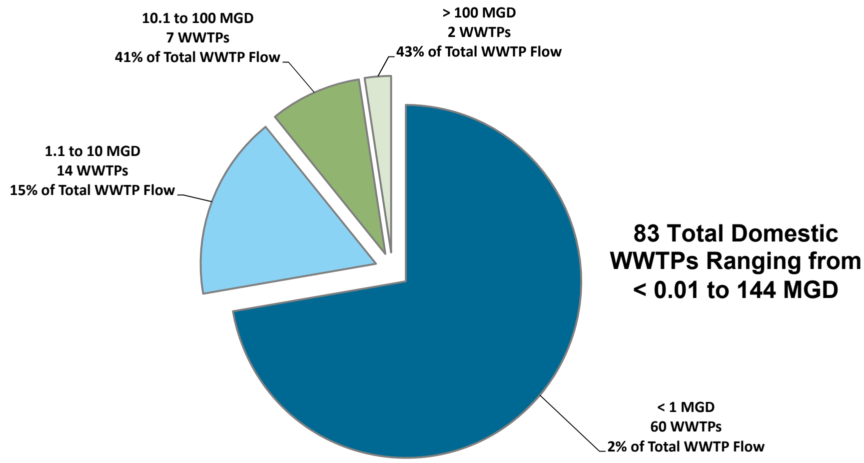


FIGURE 6-2. Distribution of Domestic WWTPs Discharging Directly to the Mississippi or Missouri Rivers. For this evaluation, "direct" dischargers were defined as those domestic WWTPs whose NPDES permits list the Mississippi or Missouri Rivers as the first classified receiving stream. Flows depicted are actual flows.

6.1. BIG RIVER POINT-TO-NONPOINT SOURCE TRADING

As discussed in **Section 5**, the point source trading margin affects trading feasibility because it impacts individual WWTP credit demand and potential cost-efficiencies that may be gained through trading. Regardless of the trading margin needed to meet future nutrient reduction requirements, the potential demand for nutrient credits in the Big Rivers is substantial. With respect to the two technology-based treatment requirements considered in this report, there are up to 5.3 million and 22.9 million pounds of TN and TP demand per year in the Big Rivers, respectively (**Table 6-2**). The overall impact of the margin on cost-efficiency in the Big River region is more difficult to quantify given the size of some of the WWTPs (>10 MGD costs not evaluated in this report). In general however, the marginal costs for upgrading to advanced levels of treatment are lower for large facilities than for smaller facilities (see **Figure 4-2**).

TABLE 6-2. Potential Cumulative Demand for Nonpoint Source Nutrient Credits on the Big Rivers Based on Technology-Based Trading Margins.

Nutrient	Existing Treatment to BNR	Existing Treatment to ENR
Total Nitrogen, in lbs/year	4.6 Million	5.3 Million
Total Phosphorus, in lbs/year	18.2 Milion	22.9 Million

In the Big River region, the nine largest facilities contribute more than 80% of the total WWTP flow (**Figure 6-2**). Because the large facilities represent the majority of nonpoint source credit demand and (presumably) have relatively low marginal upgrade costs, a significant pool of low-cost agricultural credits will be needed if point-to-nonpoint source trading is going to effectively and efficiently address Gulf Hypoxia. Unlike the small streams which may require upstream-only trading for some drivers, the Gulf Hypoxia driver in Big Rivers allows for watershed-wide trading. Given the size of the potential trading area for Big Rivers (**Figure 6-1**), a large number of nonpoint source trading opportunities will be available. In Missouri alone, for example, there are significant opportunities to harvest agricultural BMP credits from cropland present along the length of the Missouri and Mississippi Rivers. In particular, the Bootheel region (southeast) of the state is dominated by cropland (**Figure 6-3**) and could be targeted for BMP credits.

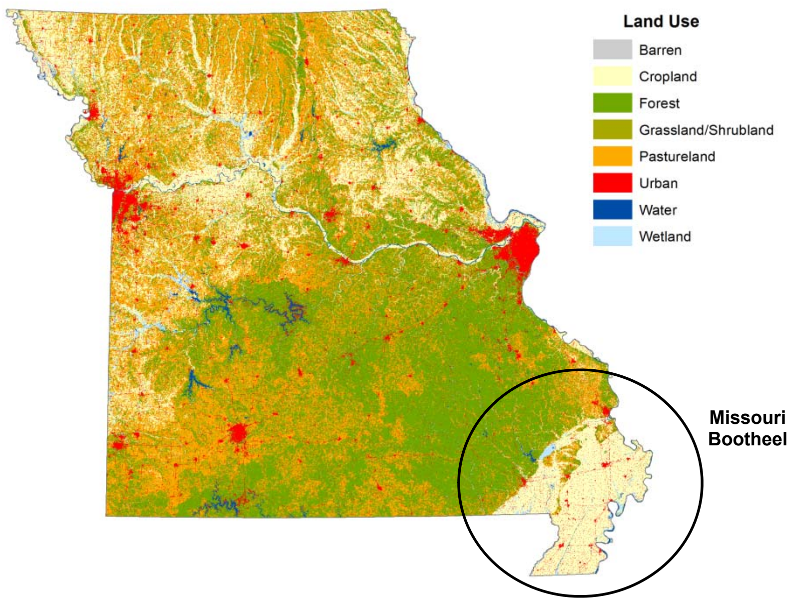


FIGURE 6-3. Land Uses in Missouri. The Bootheel Region's dense cropland and close proximity to the Mississippi River create the potential for significant nonpoint source trading opportunities with Big River point sources.

As demonstrated in previous sections, low-cost BMP options are available (filter strips = $2/ lb N or P), but opportunities for implementing them are typically limited in small watersheds such as the 8-digit HUCs evaluated in this report. Because the supply of nonpoint source credits increases with a larger trading area, the opportunity for purchasing low-cost BMP credits should increase, thereby decreasing the overall cost of Big River trading. Furthermore, the cost-effectiveness of some BMPs which are expensive at small scales can be improved if the BMPs are implemented on larger scales. For example, when implemented on a small scale, wetlands were estimated to cost over $20/lb and $77/lb for TN and TP credits, respectively (**Table 3-3**). However, regional treatment wetlands designed to offset nutrient loads from larger point sources have been estimated to cost less than $2 each for TN and TP credits (Hey et al. 2005b). When implemented on large scales and in priority areas such as the Bootheel, these low-cost regional BMPs would generate considerable nonpoint source credits for Big River WQT.

In general, the greater the distance between the seller and buyer, the less likely pollutant impacts from the two sources are equivalent. For example, slow, shallow waters contribute to increased nutrient attenuation. Additionally, lakes or reservoirs located between credit sources act as nutrient sinks. In the Mississippi River Basin, Alexander et al. (2008) demonstrated that only 25% to 75% of nutrients located in small to mid-size streams upstream of the Big Rivers ever reach the Gulf. Because attenuation and loss affect credit equivalency, nonpoint source trading over large areas like the Mississippi River Basin will require that appropriate trading ratios be developed on a site-specific basis after all relevant factors (see **Section 2**) are evaluated.

In Big River nonpoint source trading situations where numerous uncertainties must be considered, ratios may necessarily be high and significantly increase the cost of credits. For this reason, it is most cost-effective to target nonpoint credit sources located adjacent to or near the Big Rivers. With this consideration, the close proximity to the Mississippi River further contributes to the Bootheel region's potential to serve as a significant source of nonpoint source credits (**Figure 6-3**).

6.2. BIG RIVER POINT-TO-POINT SOURCE TRADING

There are significant point-to-point trading opportunities for the 83 domestic WWTPs that discharge directly to the Missouri or Mississippi Rivers (**Figure 6-4**). Further, there is more certainty associated with trading in the Big Rivers than there is in smaller waterbodies for two reasons. First, nutrient impacts are minimal in large turbid waters with rapid velocities such as the Mississippi River. Antweiler et al. (1996) reports "[t]he major response of plants to nutrients in the Mississippi River is delayed until the water reaches the estuarine regions along the coast of the Gulf of Mexico, where velocities decrease and sediment settles out of the water, allowing light to penetrate and algae to bloom." Second, within Big Rivers there is relatively little nutrient attenuation, as the percent delivery to the Gulf generally increases with stream size (Alexander et al. 2008). For these reasons, trading ratios for direct Big River nutrients loadings will be a negligible part of a WQT program.

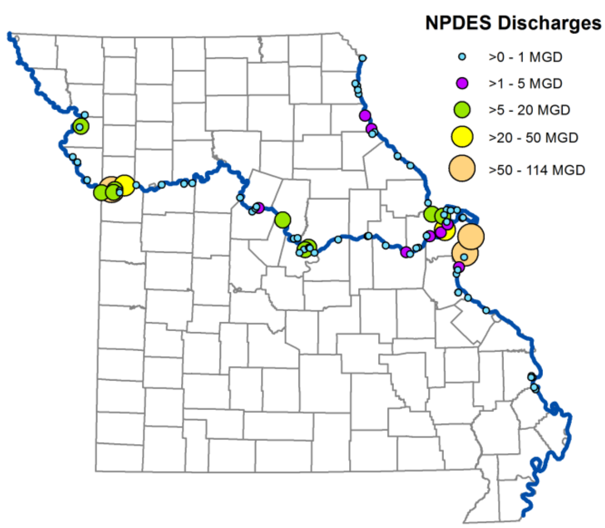


FIGURE 6-4. Direct Discharges to the Missouri and Mississippi River. The map depicts actual flow values.

Approximately three quarters of WWTPs that discharge directly to the Missouri or Mississippi River in Missouri have average actual flows of less than 1 MGD, whereas the top 10 percent have average actual flows ranging from approximately 10 to 114 MGD. Given these discrepancies and considerations for economies of scale, larger WWTPs could cost-effectively address nutrient removal requirements for the majority of Big River dischargers. For example, assuming there is a regulatory requirement to meet TP limits equivalent to BNR, the largest Big River facility in Missouri could generate approximately 174,000 credits by upgrading their facility to ENR. This would be sufficient for addressing the TP removal needs of the smallest 80% of WWTPs.

Trading partners for direct dischargers to the Big Rivers are not necessarily limited to other dischargers in Missouri. Because the regulatory driver may be based on Gulf hypoxia issues, potential trading partners exist throughout the entire Mississippi River Basin. However, delivery ratios would be required for trading partners located several miles upstream of the Missouri or Mississippi Rivers. For trading partners located on either the Big Rivers or relatively large tributaries to the Big Rivers, delivery ratios would be small because there is little in-stream nutrient attenuation. When trading partners are far apart or located a significant distance away from the Big Rivers however, ratios may be so large that trading becomes prohibitively expensive.

Direct dischargers to the Missouri and Mississippi River also have a potential opportunity to operate under a single “bubble permit.” Bubble permits assign a single pollutant loading cap for multiple facilities. Under such a scenario, WWTPs may exceed their individual wasteload allocations provided the aggregate pollutant loading is maintained. The terms and conditions of point-to-point trading can be flexible under bubble permit and do not necessarily require regulatory oversight. For example, trading and internal enforcement measures are all handled internally within the Neuse River Association in North Carolina, which effectively operates under a bubble permit. A similar organization could be created in Missouri for all WWTPs with direct discharges to the Missouri or Mississippi River.

7.0 TRADING SIMULATION CONCLUSIONS AND RECOMMENDATIONS

Nutrient WQT is an important tool that MDNR can use to facilitate watershed-based management in Missouri. Because regulatory drivers are not currently in place, it is difficult to forecast and quantify the specific outcomes that trading may provide. However, results from the simulated trading evaluation presented in this report will be helpful for informing development of a WQT program framework going forward. Most importantly, the simulations illustrate the potential structures of a Missouri trading program, the importance of including flexibilities when implementing nutrient criteria, and the general program elements required to successfully implement a trading program in Missouri. These conclusions are briefly discussed below.

7.1. WATER QUALITY TRADING IMPLEMENTATION PATHWAYS

Successfully implementing WQT in Missouri will require careful consideration of the policy decisions which dictate the program's structure. The most appropriate WQT program implementation approach will ultimately depend on the nutrient driver being addressed. In general, there are two basic types of drivers, and thus two basic program implementation approaches (**Table 7-1**). If numeric stream and river criteria are enforced "end of pipe," trading will likely occur according to the first pathway outlined in **Table 7-1**. In this approach, trading activity will generally be limited to upstream bilateral trading. As demonstrated in the simulations, trading partners and opportunities will likely be too limited to support significant trading activity or more efficient market structures (e.g., exchange and clearinghouse) with upstream-only trading.

TABLE 7-1. Potential Trading Implementation Pathways for a Missouri WQT Program.

Trading Implementation Pathway	Pathway 1	Pathway 2
Driver	"End of Pipe" Criteria	Watershed Loading Cap, Lake Criteria, or Total Maximum Daily Load
Trading Area	Upstream-Only	Watershed-Wide
Trading Ratios	Variable	Variable
Trading Margin	Set by Policy	Set by Policy
BMP Supply Assuming Sufficient Removal Efficiency and Cost-Effectiveness	Potential Shortage of Credits for Individual WWTPs Depending on Position in Watershed	Likely Sufficient Credits for Majority of WWTPs in Watershed
Market Structure	Bilateral or Sole-Source Offsets	Bilateral, Exchange, Clearinghouse, Sole-Source Offsets
Relative Market Efficiency	Low to Moderate	Moderate to High
Potential Point-to-Nonpoint Trading Activity	Low	Moderate to High
Potential Point-to-Point Trading Activity	Low, Depends on Number of WWTP Located Upstream	Moderate to High

The second potential trading implementation pathway will occur if nutrient discharges are restricted by an overall collective loading cap or a downstream point of compliance, such as a lake or river confluence (**Table 7-1**). If implemented according to this pathway, WWTPs will be free to trade suppliers in the larger watershed, thereby increasing trading opportunity and activity. This pathway is accommodating of more efficient market structures (e.g., exchange and clearlinghouse), which are characterized by lower transaction costs.

7.2. NUMERIC CRITERIA IMPLEMENTATION CONSIDERATIONS

As demonstrated in **Table 7-1**, numeric stream nutrient criteria will significantly affect how and if trading will work in Missouri. Of course, MDNR must ultimately develop and enforce nutrient criteria that protect designated beneficial uses. However, for WQT to remain a viable WWTP nutrient reduction alternative, "hot spots" cannot be strictly defined as an exceedance of numeric criteria. As most WWTPs in Missouri discharge to small ephemeral and intermittent streams without upstream dilution, WQT will inevitably lead to high nutrient levels downstream - otherwise, trading would not be necessary. Because nutrients are non-toxic and impacts generally occur far downstream of their source, an exceedance of numeric criteria will not necessarily result in unacceptable localized impacts. Therefore, MDNR can implement numeric nutrient criteria with flexibilities that encourage WQT while still protecting designated beneficial uses.

For example, MDNR could use a hierarchical approach where high nutrient levels alone do not constitute an exceedance of water quality standards. Instead, high nutrient levels would be coupled with biological data that demonstrate impacts to the designated beneficial use. Another flexibility would be to use an adaptive management approach, such as in Kansas or Wisconsin, where progress towards the attainment of instream nutrient targets is reviewed periodically, with adjustments made over time when necessary.

7.3. GENERAL WATER QUALITY TRADING PROGRAM CONCLUSIONS

General WQT recommendations based on trends observed in the simulations, as well as their implications for the Missouri program, are presented below. Specific recommendations for several program elements are included in the *Proposed Framework for a Missouri Water Quality Trading* document, which is included in **Attachment 2**.

1) Trading areas should be as large as possible

Trading area is important because it defines geographical trading boundaries and allows participating point sources to identify potential credit suppliers. As demonstrated in the simulated trading scenarios, trading area is an important factor influencing trading activity and cost-efficiency. The prescribed trading area for any given WQT program ultimately depends on the nutrient driver being addressed. If point source nutrient compliance is measured as an overall loading cap that must be met at some downstream lake or major river confluence, watershed-scale trading would be an appropriate trading area. If instead, the driver is a nutrient criterion which point sources must meet "end of pipe," an upstream-only trading requirement may be necessary to limit unacceptable hot spots downstream. However, WWTPs may have limited upstream area from which to purchase credits.

Implications for WQT in Missouri: If the trading area is limited to upstream only, trading activity will be very limited. Opportunities for trading will significantly increase if trading is conducted on a watershed-wide basis.

2) Trading ratios impact the feasibility of a WQT program

Trading ratios are important for ensuring the effectiveness of a WQT program, but should be kept as low as possible to not compromise efficiency or equity. Although trading ratios increase the certainty that environmental improvements are occurring as intended, they can make trading infeasible by limiting the relative supply of credits. Even where trading is permitted watershed-wide, the trading simulations show that at a trading ratio of 2:1 the potential for widespread trading is unlikely. Trading ratios also increase the cost of trading, thereby limiting potential cost savings for many facilities. Where the cost benefits are small, even low trading ratios can undermine economic incentives for trading.

Equity issues are also important to consider when applying ratios for purposes of generating nutrient loading reductions beyond what is required by regulation for point sources. Using high ratios that require WWTPs to more than offset their loadings essentially taxes them for participating in the program and will likely limit the number of facilities willing to purchase BMP credits.

Implications for WQT in Missouri: Trading ratios must be carefully applied as to not compromise efficiency and equity. Only scientifically-justified ratios needed to meet regulatory requirements should be implemented.

3) Point-to-point trading is the most cost-effective option in some situations

In general, advanced levels of nutrient treatment are more cost-effective for larger WWTPs than for smaller facilities. Additionally, in some situations advanced treatment is more cost-effective than trading with nonpoint sources. For example, assuming a 2:1 trading ratio in the South Fork Salt River Basin, the three largest WWTPs can treat TN at a lower cost than through nonpoint source trading. In this situation, it is more cost-effective for the smaller WWTPs to trade with the larger WWTPs than with nonpoint sources. While this may not always be the case, point-to-point source trading will likely present the most cost-effective option in some circumstances.

Implications for WQT in Missouri: Both point-to-nonpoint and point-to-point source trading are necessary in a WQT program to maximize efficiency.

4) Drivers for Big River trading are different than for other waters in the state

Future Big River nutrient targets may be focused on addressing the hypoxic zone in the Gulf of Mexico rather than protecting against localized impacts. If the Gulf of Mexico is the primary WQT driver, watershed-wide trading will be an important mechanism forharvesting agricultural BMP credits inintensely-cropped areas along the Big Rivers. Point-to-point source trading is also very feasible in the Big Rivers, as there are a large number (83 evaluated in this report) of WWTPs which discharge directly to the rivers. Because upgrade costs will generally decrease with facility size, larger (>10 MGD) Big River WWTPs could cost-effectively address nutrient removal requirements for the majority of smaller Big River dischargers.

Implications for WQT in Missouri: Given the national focus on Gulf Hypoxia, it is clear that any WQT program developed in Missouri will have to be flexible enough to accommodate Big River trading. As a result, the Big River trading approaches may differ from those used in smaller waters.

5) WWTPs should be free to set the top of the trading margin

Stephenson and Shabman (2011) note that "[p]roponents of market-like trading programs believe that given the freedom and incentive to explore waste-reducing activities, people will produce creative solutions." This freedom to explore creative and cost-effective solutions under a WQT program is compromised where WWTPs must first adopt some minimum level of control technology or level of treatment. The simulated trading scenarios presented in this report demonstrate this fact, as the most cost-effective combination of control technology and WQT is not the same for every facility. Additionally, although it could not be simulated with the trading exercises presented here, efficiencies are likely gained where treatment plant operators are free to explore creative solutions for optimizing plant operations.

Capping the top of a trading margin through minimum control technologies also raises issues of equity. If WWTPs are required to first maximize nutrient reductions through control technologies, then trading represents an additional expense that would never have been incurred in the absence of a WQT program.

Implications for WQT in Missouri: Capping the top of a trading margin through minimum control technologies or level of treatment will result in less cost-effective solutions for WWTPs. The most efficient and equitable approach to WQT is to allow WWTPs to set the top of the trading margin.

6) Administrative burdens and transaction costs may prohibit direct trading for the majority of WWTPs

As with most types of markets, there are economies of scale with WQT. Larger WWTPs have a significant advantage when it comes to negotiating a trade, particularly with respect to minimizing transaction and administrative costs because costs can be spread over a larger number of credits. Conversely, smaller WWTPs have relatively higher transaction costs and administrative burdens because they are purchasing fewer credits. As the majority of WWTPs in Missouri are relatively small facilities (<1 MGD), direct trading may not be a feasible option for most WWTPs.

Implications for WQT in Missouri: Transaction costs and administrative burdens may be prohibitively high for the majority of WWTPs with a bilateral negotiation market structure. An exchange or clearinghouse market structure may be necessary to facilitate trading for the majority of WWTPs in Missouri.

7) Liability, monitoring and enforcement require special consideration in the context of trading

Liability, monitoring and enforcement are necessary for ensuring water quality goals are achieved, but require special considerations in the context of a WQT program. The CWA does not allow point sources to transfer legal liability for meeting NPDES permit limits to a nonpoint source. This raises several issues, particularly in the context of a clearinghouse where credits are pooled and the contractual link between the buyer and seller is completely broken. Traditional methods of addressing liability (e.g., monitoring and enforcement) must also be reconsidered in a WQT program. Directly measuring water quality improvements resulting from the implementation of all BMPs in a trading program would be complicated and prohibitively expensive. Therefore, it would be impracticable to base enforcement measures on water quality monitoring data in a point-to-nonpoint trade.

Implications for WQT in Missouri: A WQT program should explicitly state how issues of liability, monitoring and enforcement would be addressed. Answers to these issues may depend on the program's market structure. In a bilateral negotiation market structure, liability would reside with the buyer and necessitate greater oversight and reporting requirements on their part. In a clearinghouse market structure, liability could be addressed through use of credit reserves or insurance pools. BMP compliance should be based on site-inspections by qualified specialists. Water quality monitoring should be used for non-enforcement purposes such as refining BMP assumptions.

8) Agricultural baselines effectively behave like a trading ratio

Any baseline set above and beyond current nutrient management practices would result in additional trading costs. These costs would be passed on to WWTPs purchasing credits and, in effect, would act as a trading ratio because credit supplies would become more limited and trading would be less cost-effective. Baselines also raise issues of equity as WWTPs are effectively paying for nutrient removal activities beyond that required by regulation. Additionally, as demonstrated in the South Fork Salt and Spring River Basins, WWTPs may be challenged to identify a sufficient supply of nonpoint source credits – applying a high agricultural baseline will only exacerbate the situation.

Implications for WQT in Missouri: If the agricultural baseline is set higher than current nutrient management practices, WQT will be less cost-effective, fewer WWTPs will be able to trade, and issues of equity will be raised. Implementation of the "Basic Options" of the Missouri NRCS Nutrient Management Conservation Practice (Practice Code Number 590) is the suggested baseline requirement for participation in a Missouri water quality trading program. Nutrient management practices that are in place prior to participation in a water quality trading program should not be considered eligible for nutrient trading credits.

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ATTACHMENT 1

Optimizing Nutrient Credit Costs

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ATTACHMENT 1 – OPTIMIZING NUTRIENT CREDIT COSTS

Although TN and TP trading costs are addressed independently in this report, the costs are not mutually exclusive. The true trading cost of simultaneously purchasing TN and TP BMP credits is typically less than the combined cost of the credits purchased separately because removal rates and costs vary by BMP. In other words, the total cost for nutrient reductions decreases since BMPs remove both TN and TP. The true cost associated with simultaneously purchasing TN and TP credits is illustrated in the following, hypothetical example.

Example of Optimizing Credit Costs

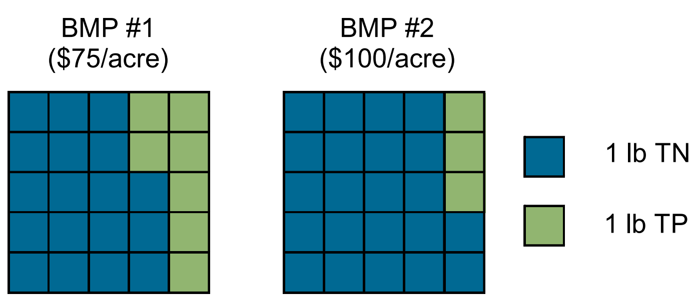
A WWTP needs to purchase 110 lbs of TN and 21 lbs of TP. TN can most cost-effectively be purchased from BMP #1 at $3.41/lb, whereas TP can most cost-effectively be purchased from BMP #2 at $14.29/lb. Purchased separately, the WWTP would pay $375 for TN credits and $300 for TP credits, resulting in a total cost of $675 (**Table 3-8**). However, the true cost for purchasing both TN and TP credits is less than $675. Using standard linear calculation techniques, the minimal cost can be calculated with the constraints and cost equation given below.

Constraints: $22BMP_1 + 18\ BMP_2 \geq 110$ (lbs TN/year)
$3BMP_1 + 7\ BMP_2 \geq 21$ (lbs TP/year)
$BMP_1 \geq 0$
$BMP_2 \geq 0$

Cost Equation: Cost = $75\ BMP_1 + 100\ BMP_2$

where BMP_1 = number of acres in BMP #1
BMP_2 = number of acres in BMP #2

The optimal solution is that 3.9 acres of BMP #1 and 1.3 acres of BMP #2 yields 110 lbs TN and 21 lbs TP, for a total cost of $426.



BMP	Cost ($/acre)	Removal Rate (lbs/acre/year)		Credit Cost ($/lb)		Required Credits (lbs)		Total Cost		BMP Acres
		TN	TP	TN	TP	TN	TP	TN	TP	
1	$75	22	3	**$3.41**	$25.00	110	--	$375	--	5
2	$100	18	7	$5.56	**$14.29**	--	21	--	$300	3

Bolded cost represents the most cost-effective option for each nutrient.

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ATTACHMENT 2

Proposed Framework for a Missouri Water Quality Trading Program

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Proposed Framework for a
Missouri Water Quality Trading Program

December 2012

Prepared by

Geosyntec consultants

engineers | scientists | innovators

Geosyntec Consultants, Inc.
1123 Wilkes Blvd., Suite 400
Columbia, Missouri 65201

&

Environmental Resources Coalition

3118 Emerald Lane
Jefferson City, Missouri 65109

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1.0 PURPOSE AND OBJECTIVE

The purpose of this document is to propose a framework for a water quality trading (WQT) program to be implemented through the National Pollutant Discharge Elimination System (NPDES) permit program in Missouri. WQT is a market-based approach to pollution reduction that allows point sources to meet regulatory requirements by purchasing pollution reduction credits generated from agriculture or other sources that have lower pollution control costs. The proposed framework is intended to facilitate development of a successful WQT program in Missouri. Recommendations and suggestions included within this framework are based on findings of the Missouri Innovative Nutrient Trading (MINT) Project.

The objectives of any public policy or program, including WQT, should include efficiency, effectiveness, and equity. Efficiency addresses the overall economics of the WQT program. The less efficient the program, the less likely it will result in cost-effective solutions. Effectiveness refers to whether or not the water quality benefits of the WQT program are occurring as intended and deals with such issues as credit equivalency and accountability. Equity refers to issues of fairness. Fairness issues are raised where WQT is no longer voluntary or where the goals of the trading are to generate net pollutant load reductions (i.e., above and beyond what would be required in the absence of a trading program). As these objectives are frequently at odds, they must be balanced with one another. The intent of the proposed framework is to achieve this balance without undermining the potential for WQT to provide flexible, low-cost alternatives for achieving nutrient reduction goals.

2.0 WATER QUALITY TRADING GUIDELINES

Water quality trades and trading programs must be consistent with the Clean Water Act (CWA), Code of Federal Regulations (CFR), Missouri State Code of Regulations (CSR), and all other applicable regulations. Following is a list of guidelines to which any water quality trading program must adhere:

- An NPDES-regulated entity cannot trade to meet technology-based effluent limits as defined by: 1) the federally-mandated treatment technology requirements specified in 40 CFR 133 and 2) the national guidelines and performance standards as specified in 40 CFR 405 through 499.
- Any water quality trading activities in impaired waters where there is not an approved total maximum daily load (TMDL) shall achieve progress towards meeting water quality standards.
- WQT activities in impaired waters with an approved TMDL shall be consistent with the assumptions and requirements upon which the TMDL is established and shall not delay implementation of an approved TMDL.

Best management practices (BMPs) may generate water quality credits as long as they are fully maintained and continue to function as designed and shall be inspected on an annual basis by a qualified soil and water conservation professional.

3.0 MARKET STRUCTURE

Market structure defines how trading will occur and the infrastructure for reducing transaction costs. The four main market structures under which WQT occur include bilateral negotiation, exchanges, clearinghouses, and sole source offsets. Bilateral negotiations are characterized by one-on-one negotiations and typically have the greatest administrative burden and transaction costs. An exchange is characterized by its open information structure and fluidity of transactions; thereby, minimizing transaction costs. A clearinghouse is frequently defined as a form of an exchange, but is distinguished as the buyer and seller link is completely broken. Sole source offsets do not represent traditional market-based trading, but occurs within a single entity (e.g., sewage treatment plant receives credits equivalent to the total amount of nutrients retired through decommissioning septic systems).

The two main WQT market structures recommended here for Missouri are the clearinghouse and bilateral negotiation. The basic framework for a clearinghouse – here named the water quality improvement fund (WQIF) – and bilateral negotiation are presented below in Sections 3.1 and 3.2.

3.1 WATER QUALITY IMPROVEMENT FUND (WQIF)

The WQIF will likely be the most attractive option for the majority of NPDES facilities purchasing nonpoint source credits. As a clearinghouse, the WQIF has the least administrative burden and lowest transaction costs of any market structure. Additionally, by pooling credits, liability issues are effectively shared in the WQIF. If a best management practice (BMP) fails, liability costs can be spread among all the buyers through the purchase of credit reserves. Additionally, as the intermediary for multiple buyers, the WQIF can more effectively target BMP placement and monitoring activities. Basic attributes of the proposed WQIF are outlined below.

- Statewide program with a broad role in trading activities.
- WQIF works as a clearinghouse that pools credits from multiple sellers.
- Simplest option for permittee and state.
- Third party manages administrative duties.
- Soil and Water Conservation District or qualified professional quantifies credits and verifies BMPs.
- Limited to point-to-nonpoint trades.
- Limited to nutrients.
- Central administration of funds promotes a coordinated nutrient control strategy.
- Most effective when a large number of regulated entities participate and economies of scale can be achieved.

3.2 BILATERAL NEGOTIATION

Bilateral negotiation represents the highest administrative burdens and transaction costs, but offers the greatest flexibility. For nonpoint source trades, bilateral negotiation may offer the more attractive market structure for a limited number of scenarios. Point-to-point source trading will likely be exclusively conducted through bilateral negotiation. Basic attributes of a bilateral negotiation are outlined below.

- Trades are negotiated between two or more parties.
- Allows for point-to-point or point-to-nonpoint negotiations.
- Administrative burden is the responsibility of permittee purchasing credits.
- Requires Missouri Department of Natural Resources (MDNR) approved water quality trading management plan.
- Provides greater flexibility in terms of types of trades and pollutant.

4.0 POLLUTANTS

WQT is not limited to any one pollutant or class of pollutants. Guidelines concerning which pollutants may or may not be included in a water quality trading program are outlined below.

- Water quality trading is primarily intended to address nutrients (e.g., nitrogen and phosphorus).
- Pollutants including, but not limited to, sediment, temperature, and oxygen demanding substances may be traded on a case-by-case basis with MDNR approval.
- Cross-pollutant trading (e.g., trading sediment for nutrients) may be allowed with MDNR approval.
- Persistent bioaccumulative toxic pollutants may not be traded.

5.0 TYPES OF TRADES

“Types of trades” refers to the participants in a water quality trading program. In general, water quality trading occurs between point and nonpoint sources (i.e., point-to-nonpoint) and between point sources (i.e., point-to-point). However, additional types of trading scenarios potentially exist. Allowable types of trades are outlined below.

- **Point-to-point** – Water quality trading between two NPDES-permitted facilities. Generally easiest to implement, measure, and enforce.
- **Point-to-nonpoint** – Water quality trading between NPDES-permitted buyers (point sources) and non-NPDES permitted sellers (nonpoint sources). May provide avenue for cost-effective pollutant removal through BMP implementation rather than wastewater treatment technology upgrades.
- **Intraplant and Intramunicipal** – Water quality trading between multiple outfalls within the same wastewater treatment facility or municipality.
- **Stormwater** – Water quality trading involving NPDES-permitted, wet-weather sources. Similar to point-to-point or point-to-nonpoint trading. An example could include a trade between a municipal separate storm sewer (MS4) and a wastewater treatment plant (WWTP).
- **Pretreatment** – Water quality trading which gives a municipality flexibility to allow trading among industrial users rather than allocating the load among users directly. Established and administered by the POTW responsible for administering the pretreatment program.

6.0 BASELINE

The baseline for water quality trading is the NPDES permit limits (for point sources) or BMPs (for nonpoint sources and municipal separate storm sewer systems) that would apply in the absence of trading. Credits are generated when discharges are reduced to below the baseline. Conversely, a credit shortfall is defined by a deficiency in meeting one's baseline. The point source baseline is currently undefined as regulatory drivers for nutrients are lacking in Missouri. For nonpoint sources, implementation of the "Basic Options"[1] of the Missouri NRCS Nutrient Management Conservation Practice (Practice Code Number 590)[2] is the suggested baseline requirement for participation in a Missouri water quality trading program. Additionally, nutrient management practices that are in place prior to participation in a water quality trading program should not be considered eligible for nutrient trading credits.

7.0 TRADING AREA

Trading area defines the geographic limitations placed on trading and is determined by the regulatory driver. For example, if the Gulf of Mexico represents the regulatory driver, then the trading area could encompass the entire Mississippi River Basin. Similarly, if lake criteria represent the regulatory driver, then the trading area could encompass the entire lake watershed. If stream criteria represent the regulatory driver, the trading area is generally limited to upstream of the discharge for toxic parameters. However, as nutrients are non-toxic and impacts generally occur far downstream of their source, nutrient trading can be enlarged to the entire watershed. Including the entire watershed as the trading area is critical as nonpoint source credits may be insufficient if limited to upstream.

Proposed trading areas based on different nutrient regulatory drivers are presented below.

- **Lake criteria** - the entire lake watershed
- **Stream criteria** – trading area is the 8 – digit hydrologic unit code (HUC) and any other area that contributes surface flow to the 8-digit HUC
- **Missouri or Mississippi River criteria** – the entire Mississippi River Basin.
- **TMDL** – trading area is defined by the TMDL document
- **Case-by-case** – In some instances (e.g., due to a combination of regulatory drivers or unforeseen regulatory drivers) the trading area may be defined on a case-by-case basis

[1] FY11 Missouri NRCS MRBI EQIP Policies, http://www.mo.nrcs.usda.gov/programs/eqip/out/2011/03252011/B%20FY11%20EQIP%20High%20Tunnel%20Policy1-19-11.pdf
http://www.mo.nrcs.usda.gov/programs/eqip/Excel%20Payment%20Schedules/Excel%20Files/590NutrientManagement_FY11.xlsx

[2] Natural Resources Conservation Service Conservation Practice Standard Nutrient Management Code 590, Missouri NRCS, September 2007, http://nmplanner.missouri.edu/resources/MO-590_std_907.pdf

8.0 TRADING MARGIN

The trading margin represents the number of credits a point source buyer must purchase to be in compliance without consideration of a trading ratio. The trading margin is the difference between baseline (i.e., amount of pollutant loading allowed in the absence of trading) and the permitted discharge level after trading. To maximize market efficiency, there should be no restrictions on the permitted discharge level, provided sufficient credits are purchased to achieve baseline.

9.0 TRADING RATIO

Trading ratios are used to ensure the amount of reduction resulting from the trade has the same effect as the reduction that would be required without the trade. Recommended trading ratios for nutrients are described below. Howerver, in all instances, lower trading ratios may be appropriate if ancillary benefits such as habitat development, carbon sequestration, or flow reductions are provided.

- **Delivery Ratio** – Delivery ratios should be applied on a case-by-case basis, but in general should only apply where the regulatory driver represents a downstream point (e.g., lake located downstream of the point source or BMP). As the recommended trading area for streams is the entire 8-digit HUC and not some downstream point, delivery ratios should not be applied to small stream criteria. Similarly, delivery ratios should not be applied to direct discharges to the Missouri or Mississippi River.
- **Equivalency Ratio** – 'Equivalency' broadly refers to the comparability of credits, whereas 'equivalency ratios' specifically addresses issues related to different forms of the same pollutant – particularly phosphorus. Depending on the level of treatment, point source phosphorus is typically more soluble than nonpoint source phosphorus. The more soluble forms of phosphorus are typically of greater environmental concern owing to its bioavailability. If used, it is recommended that the effective trading ratio when combined with the uncertainty ratio does not exceed 1.5:1 for nonpoint source trades. For point-to-point source trading, it is recommended that the equivalency ratio does not exceed 1:1.
- **Uncertainty Ratio** – Uncertainty ratios are applied to address issues in estimating nonpoint source loadings. It is recommended that the effective trading ratio when combined with an equivalency ratio does not exceed 1.5:1. For point-to-point source trading, it is recommended that the uncertainty ratio does not exceed 1:1.
- **Retirement Ratio** – Retirement ratios are applied in trading programs where the goal is to accelerate achievement of water quality standards. As the overriding goal of a WQT program is to provide a cost-effective alternative to strict command and control regulations on point sources, there should be no retirement ratio. In addition to reducing the cost-effectiveness of trading, imposing retirement ratios raises equity issues as the burden of reducing nonpoint sources is transferred to point sources.

10.0 CREDIT QUANTIFICATION AND VERIFICATION

General guidance for quantifying and verifying water quality credits is suggested below.

10.1 QUANTIFYING CREDITS

- **Point sources** – The number of credits required for purchased or available for sale is defined by the difference between baseline loading and actual discharge loading. Baseline loading is based on the design average flow of the facility and the effluent concentration required by regulation in absence of trading. The actual discharge loading is based on the actual flow and the effluent concentration as determined with discharge monitoring report (DMR) data.
- **Nonpoint sources** – EPA's 2008 *Water Quality Trading Evaluation Report* recommends the use of simple "rule of thumb" approaches for quantifying nonpoint source pollutant reductions. Therefore, simple mathematical or computer models should be used for estimating pollutant loadings – e.g., Nutrient Tracking Tool (NTT), Region 5 model, or MDNR-approved model. Additionally, BMP removal efficiencies could be based on default assumptions.
- **Timing** – Timing refers to when credits are purchased and when they apply. In general, EPA recommends credits should be generated during the same time period when they are used to comply with effluent limits or other requirements specified in an NPDES permit. As it can be impracticable to purchase credits ahead of production, the WQT program should include flexibilities to prevent the purchase of too few or too many credits. For example, a trading program could allow for "squaring up" at the end of the year.
- **Units** – Water quality credits are typically quantified in pounds.

10.2 CREDIT VERIFICATION

- **Point sources** – Point source credits required for purchased or available for sale will be verified based on DMR data.
- **Non-point sources** – Non-point source credits will be verified with field inspections by a soil and water conservation professional.

11.0 MONITORING REQUIREMENTS

General guidance regarding the role of water quality monitoring in a WQT program is suggested below.

- Water quality monitoring is expected to be a component of any point to non-point water quality trading program.
- The objectives of water quality monitoring should be to track long term trends in receiving streams and guide decisions regarding the implementation of non-point source reduction activities.
- Due to the complexity of monitoring BMP's, monitoring should not used for BMP compliance purposes.
- Limited edge-of-field monitoring may be used for verifying model assumptions.
- The design of the water quality network will largely depend on the type of trading program, but should not represent a significant cost to the overall trading program.

12.0 COMPLIANCE AND ENFORCEMENT

WQT activities will be enforced by MDNR through the NPDES permitting process. Water quality trading program guidelines related to compliance and enforcement are outlined below.

- Permits authorizing trading must contain monitoring and reporting requirements documenting trading activities and results of trading activities.
- Enforcement of noncompliance with permit conditions will be conducted in accordance with MDNR enforcement guidelines.
- The permittee is responsible for complying with its permit conditions. If the permittee's anticipated credits, either self-generated or purchased, are not available to comply with permit conditions the permittee will need to respond appropriately. This response may include acquiring other available credits, taking appropriate operational actions to maintain compliance, or other action (e.g., permit modification).

13.0 ADAPTIVE MANAGEMENT

Given the uncertainties inherent in the water quality trading process, adaptive management guidance should be included in any statewide water quality trading program. Following are general adaptive management guidelines that should be considered.

- Corrective actions are required where monitoring indicates water quality trading program is causing or contributing to an exceedance of water quality standards.
- Corrective action plans are required in all water quality trading management plans, which are developed as part of any bilateral negotiation.
- Corrective action plans should allow for cost-effective solutions through the continued use of trading and innovative and alternative treatments and BMPs.

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CONTACT INFORMATION

Tom Wallace
1123 Wilkes Blvd. Suite 400
Columbia, Missouri 65202
Phone (573) 443-4100
twallace@geosyntec.com

Mark White
3118 Emerald Lane
Jefferson City, MO 65109
Phone (573) 634-7078
mark@erc-env.org

David Carani
1123 Wilkes Blvd. Suite 400
Columbia, Missouri 65202
Phone (573) 443-4100
dcarani@geosyntec.com

John Christiansen
1123 Wilkes Blvd. Suite 400
Columbia, Missouri 65202
Phone (573) 443-4100
jchristiansen@geosyntec.com

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