Jordan Lake Watershed Nutrient Credit Trading: Trading Areas and Ratios

PREPARED FOR: Mid-Carolina Council of Governments
Cape Fear River Assembly

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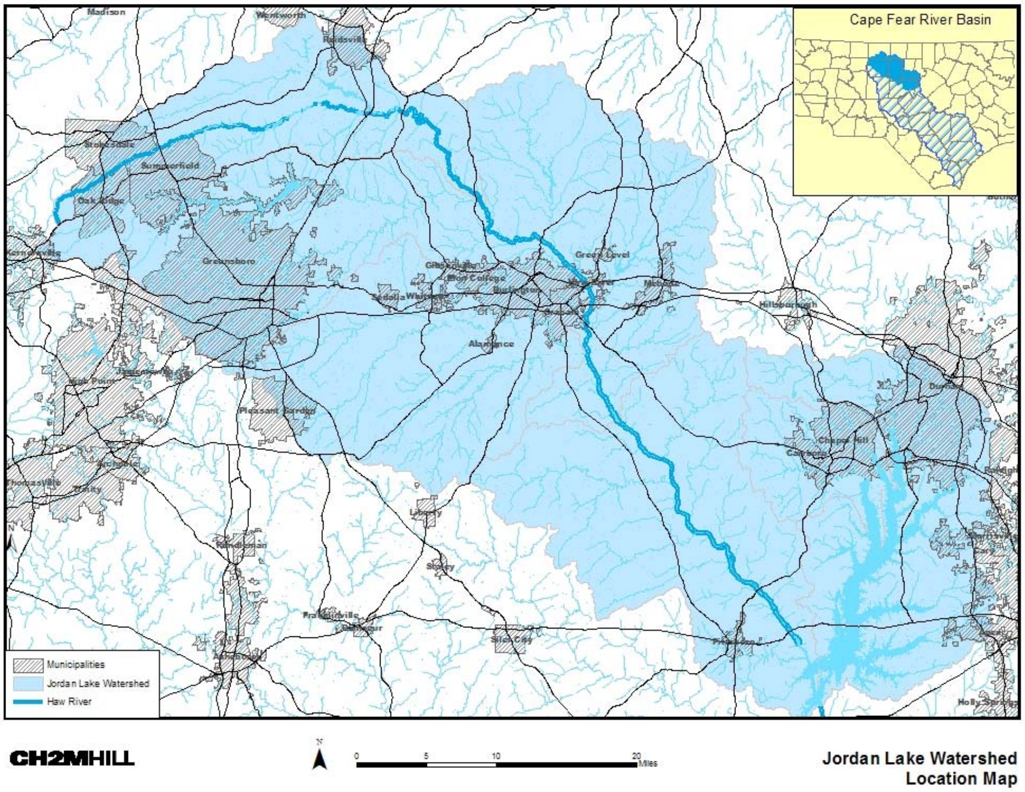
1.0 Introduction

Continued economic growth in the Cape Fear River Basin (the Basin) is essential for North Carolina’s economy and quality of life. The Basin includes many of the state's largest urban areas —Greensboro, High Point, Burlington, Durham, Cary, Fayetteville, and Wilmington, as seen in Exhibit 1. As the largest watershed in the state, it represents 23 percent of the state’s land area (CFRA, 2002). The Basin is currently home to 26 percent of the state’s population and supports jobs in a variety of industries, including manufacturing, high-tech, and agriculture (CFRA, 2002). Growth rates currently exceed the state-wide average—water usage, one key growth indicator, is projected to increase nearly 95 percent by 2030 (NC DWR, 2002).

Jordan Lake is an important resource within the Cape Fear River Basin. Jordan Lake was created by the US Army Corps of Engineers (USACE) and provides the following services: downstream flood protection; downstream water quality protection; water supply; and recreation.

Two main tributaries form Jordan Lake: the Haw River which accounts for the majority of the lake’s drainage area and New Hope Creek. The North Carolina Division of Water Quality considers Jordan Lake impaired due to chlorophyll *a* violations.

EXHIBIT 1*Cape Fear River Basin and Jordan Lake Watershed Detail*



Water quality problems such as the chlorophyll a impairment in Jordan Lake can limit---and even stop—economic growth opportunities. In the early 1980s, North Carolina's Water Quality Assessment Report (305(b)) included many waters in the Cape Fear River Basin as impaired by specific toxic chemicals. Efforts over the last 20 years have been successful in improving water quality—see for example Exhibit 2. As a result, very few waters remain on the impaired waters list because of toxic pollutants.

EXHIBIT 2
Successful Cape Fear River Basin Partnerships

Partnerships formed in the Basin have resulted in water quality improvements. Examples of successful efforts include:

- Addressed toxic substances and color problems in the Haw and Deep Rivers through a combination of grassroots groups, state regulatory efforts, and pretreatment.
- Improved the water quality of Jordan Lake through policies developed by NC DWQ in concert with the watershed stakeholders that addressed nutrient loads from upstream communities. This effort began with a voluntary water supply watershed program in the mid-1980s, followed by mandatory rules in the early 1990s.
- USGS Monitored water supply watersheds on a regional scale to ensure long term data to evaluate quality and protect public health through local funding.
- Developed a nutrient response model for Jordan Lake through local funding.

Although these improvements benefit all in the Basin, there is still considerable work to accomplish. Twenty percent of the Basin's waters remain on the 303(d) list including Jordan Lake for nutrient enrichment. Nutrients are also a concern downstream in the Cape Fear River and may contribute to the low dissolved oxygen in the estuarine portion of the river, a 303(d) listed water.

Accordingly, watershed management strategies must be formulated and implemented in a manner to balance the competing goals of growth and the environment. The Mid-Carolina Council of Governments (MCCOG) and the Cape Fear River Assembly (CFRA) are proposing to establish a framework for water quality credit trading as a potentially important component of a strategy that will build upon past successes and integrate powerful incentive-based options with existing regulatory and voluntary approaches.

The MCCOG and the CFRA were awarded a targeted watershed grant from EPA to evaluate water quality credit trading within the Jordan Lake Watershed. The goal of this grant project is to develop, demonstrate, and evaluate a water quality credit trading program for the Jordan Lake Watershed that will build on work conducted to date and provide an innovative, incentive-based framework to support implementation of the regulatory requirements based on the final TMDL embodied in the Jordan Water Supply Nutrient Strategy Rules (the 'Rules' located in 15A NCAC 02B .0262-.0272) and support cost-effective water quality management strategies.

This study is organized into the following tasks:

Task 1. Visioning and Project Chartering;

Task 2. Designing the Trading Program;

Task 3. Developing an Implementation Framework;

Task 4. Evaluating the Monitoring Program;

Task 5. Demonstrating the Trading, Implementation, and Monitoring Frameworks in a Pilot Subwatershed; and

Task 6. Expanding Innovative Approaches throughout the Basin.

This Technical Memorandum (TM) is submitted in partial fulfillment of the deliverable requirements for Task 2. Specifically, this TM addresses elements of subtask 2.5, Credit Trading Protocol, including trading areas, credit units, and trading ratios.

The remainder of this TM is organized as follows:

Section 2. **Establishing Trading Areas**;

Section 3. **Defining Credit Units**;

Section 4. **Calculating Credits Using Delivery Factors and Location Ratios;**

Section 5. **Possible Use of Uncertainty and Retirement Ratios;** and

Section 6. **Conclusions and Next Steps**.

2.0 Establishing Trading Areas

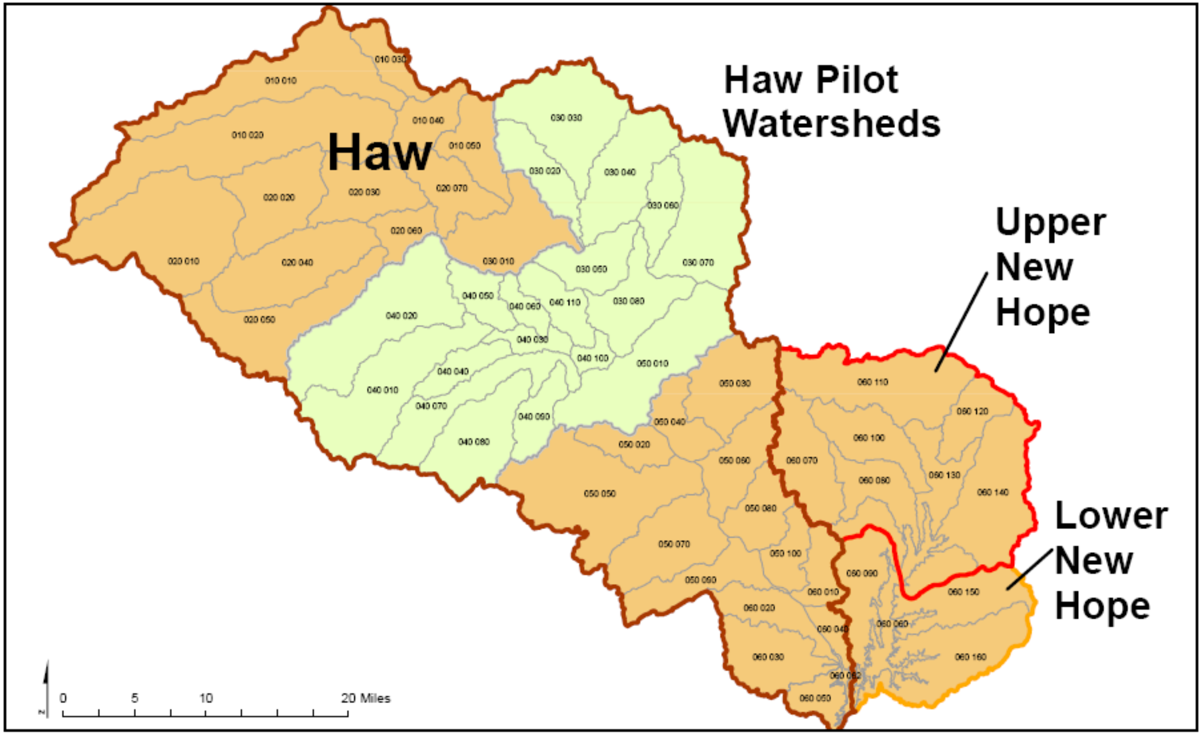
With respect to establishing eligible and ineligible trades on the basis of location in the watershed, Section 15A NCAC 2B .0262 of the Rules allows credit trades only within the same subwatershed of the Jordan watershed. Exhibit 3 delineates the resulting three trading areas where trades may occur between sources within:

- The Haw River Arm (outlined in brown);
- The Upper New Hope Arm (outlined in orange); or
- The Lower New Hope Arm (outlined in yellow).

Thus, trading is precluded between sources in different subwatersheds—i.e., sources may not trade across the brown, orange, or yellow lines. Additionally, other restrictions on certain trades, either directionally (e.g., upstream/downstream) or by specific location (e.g., regarding a downstream impoundment) may need to be established to protect local water quality. Such considerations can be examined at a later date when more information becomes available about the types of trades anticipated and appropriate rules and policies are being considered for adoption.

This provision is intended to ensure that credit use in lieu of on-site loading reductions does not produce localized adverse water quality impacts that contribute to impairment of classified uses of the affected waters. The implication of this delineation of trading areas on the application of trading ratios is discussed in the next section.

EXHIBIT 3
Trading Areas for Jordan Lake Watersheds



3.0 Defining Credit Units

“Credits”, as defined for this analysis, are those units of pollutant load reduction, or other environmental benefit that can be banked or exchanged in a water quality credit trading program. Depending on how a program is structured, one mass-based unit of pollutant load reduction (or one unit of environmental benefit) may or may not equal one credit. It sometimes takes more than one unit of reduction (or benefit) to equal one credit—occasionally it can take less, depending on the net effect of applying any trading ratios.

Credits are most successfully delineated in units of exchange that are directly relevant to those entities that will be banking or trading credits for compliance purposes. This means that credit units should be identical to or consistent with the applicable baselines for the demand side of the market. **In this case, the relevant metric appears to be: pounds per year of pollutant load reduction of nitrogen/phosphorus**. This is consistent with the TMDL mass-based and temporal approach, and its primary implementing mechanism the Jordan Water Supply Nutrient Strategy Rules as adopted by the Environmental Management Commission in May 2008 and located in 15A NCAC 02B .0262-.0272 (the Rules).

Credit units can also have a locational aspect. For example, load reductions could be measured at the edge of a nonpoint source or at the outfall of a point source, or somewhere farther downstream. Notably, the applicable TMDL allocations are expressed as loads delivered to Jordan Lake. **To be consistent with the TMDL, credit units could be measured at the stream edge or outfall and/or also defined as “Lake Credits,”** which would be pounds per year of pollutant load reduction as measured in/at the Lake.

The next section describes how delivery factors taken from the TMDL modeling can be used to calculate location ratios that will support trades between sources in “local” credit currency as well as “Lake Credits.”

4.0 Calculating Credits: Delivery Factors & Location Ratios

4.1 Methodology Overview

A variety of analytical methods are used to translate units of reduction (or benefit) into credits. The most common purposes of these translators are to: (1) convert reductions (or benefits) at different locations in the watershed into a common, normalized unit; and/or (2) account for uncertainty in the estimated load reduction (or benefit) generated from specific practices, independent of location. These translators are collectively referred to as "trading ratios" in this TM. Such ratios may be referred to by a variety of different names depending on how they are calculated and local preferences, including but not limited to: delivery factors; location ratios; equivalency ratios; uncertainty ratios; and retirement ratios.

Based on a review of existing trading programs and EPA guidance, the Project Team identified four types of trading ratios that may be applicable for a Cape Fear River Basin trading program. This section addresses the most definitively applicable: delivery factors and location ratios. Section 5 addresses two others, uncertainty and retirement ratios, that may be applicable based on types of trades that are anticipated and available data.

Under this approach, location ratios can be used to convert loads reduced at a specific location into equivalent loads reduced at the Lake. If there is a desire to support direct trades between sources without first converting reductions into "Lake Credits," delivery factors also could be used to calculate equivalency between two reductions achieved in different segments of the same subwatershed. The presumed differences between delivery factors and location ratios are discussed in more detail below. As the delivery factors, location ratios, and uncertainty ratios are unitless, the recommended credit unit of pounds per year will be preserved, irrespective of the credit currency as Lake Credits or otherwise.

Delivery factors and **location ratios** account for the attenuation of a pollutant (or other environmental benefit) as it moves through the watershed. Some pollutants may travel between two points in the watershed relatively unchanged, or undiminished in their ability to impact water quality. The effects of others may diminish substantially as each distance unit traveled increases the chances that the pollutant is taken up by aquatic plants, settles into/onto the bottom of the waterbody, or is otherwise diminished or removed (e.g., adsorption/sedimentation, water supply intake, irrigation diversion channel).

Delivery factors and location ratios are both derived from transport factors. As defined for this analysis, they differ in mathematical application and purpose for which they are used:

- **Delivery factors** reflect the relative difference between the water quality impact and the value of a loading reduction at one source versus another and are **used to establish direct equivalency between two trading partners**; and
- **Location ratios** reflect the relative difference between a pollutant source and a specific location in the watershed, such as a terminal waterbody for which a TMDL or other management objective has been developed (where potential trading partners may or may not be present), **and are used to establish a common credit currency into which sources' credit values can be converted** (location ratios also can be used to establish direct equivalency between two sources).

In practice, programs that technically employ both delivery factors and location ratios often simply trade credit units calculated to reflect a normalized value at the terminal waterbody. For tracking and management purposes, local load reduction values are often also calculated and reported.

In the case of the Jordan Lake watersheds, prospective trading partners may want to use both delivery factors and location ratios. For example, for a bilateral trade conducted without using a bank or facilitator,[1] the two parties could simply use delivery factors to establish equivalency and would not necessarily need to convert their credits and debits into 'Lake' currency. However, if more than two parties are involved in a trade, or if a seller/buyer registers his credits/debits with a bank or facilitator, it may be most convenient for everyone to convert their credits/debits into a common trading currency such as 'Lake pounds'.

Effectively, using only delivery factors accounts for differences in **generated** loads—the nutrient load (reduction) as it leaves the point source effluent pipe[2] or edge of lot for a nonpoint source BMP site, while using location ratios accounts for differences in **delivered** loads—the nutrient load (reduction) as it reaches the Lake (or some other defined third location).

Transport factors for the Jordan Lake demonstration subwatersheds' individual Hydrologic Unit Codes (HUC codes) derived from the TMDL Watershed Model (Tetra Tech, 2003) can be used to calculate delivered load from generated load. These transport factors—referred to as delivery factors in this TM—account for attenuation between two segments as well as the percent loss between the source and the Lake.

4.2 Proposed Delivery Factors and Location Ratios

Exhibit 4 on the following page presents the proposed delivery (transport) factors by HUC code, shows how location ratios can be derived from delivery factors, and specifies the number of Lake Credits provided by defined reductions by subwatershed. These transport factors were derived from the TMDL Watershed Model (Tetra Tech, 2003 and model spreadsheet provided by DWQ on August 25, 2006).

These delivery factors establish how many Lake Credits one pound of nutrient reduction in a given watershed will generate, while the location ratios (which is 1 divided by the delivery factor) establish how many pounds of nutrient reduction are needed for a source in a given watershed to generate one Lake Credit. Where the delivery factor is 1, the location ratio also will be 1. To conduct trades in Lake Credits, the delivery factors and location ratios would be used to convert all generated (i.e., local) reductions into the common currency of Lake Credits.

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[1] See the TM *Jordan Lake Watersheds Trading Project: Draft Nutrient Credit Trading Framework for the Haw and Upper New Hope Watersheds* (CH2M HILL, July 20, 2008) for more detail on the proposed trading framework, including banking and facilitator services.

[2] Note that the wasteload allocation and the allocations for individual NPDES facilities are expressed as delivered loads; however, permit limits are measured at the point of discharge, so nutrient limits are given in terms of generated loads (DWQ, 2007a).

EXHIBIT 4

Delivery (Transport) Factors and Location Ratios for the HUCs in the Pilot Areas of the Jordan Lake Subwatersheds[3]

The pilot areas for this project includes 20 of the 47 14-digit HUCs in the Haw and all of the 14-digit HUCs in the Upper New Hope subwatershed. The prefix for the 7 digits shown in the table is 0303000.

HUC	Delivery Factor (1) for TN	Location Ratio (2) for TN	Delivery Factor (1) for TP	Location Ratio (2) for TP
Haw Subwatershed				
2030020	0.44	2.26	0.31	3.26
2030030	0.25	3.93	0.08	13.06
2030040	0.42	2.36	0.30	3.35
2030050	0.64	1.55	0.62	1.62
2030060	0.39	2.57	0.19	5.16
2030070	0.36	2.79	0.18	5.46
2030080	0.73	1.37	0.64	1.56
2040010	0.30	3.35	0.14	6.99
2040020	0.28	3.51	0.14	7.24
2040030	0.71	1.41	0.63	1.59
2040040	0.32	3.11	0.15	6.65
2040050	0.52	1.91	0.50	2.02
2040060	0.54	1.86	0.51	1.97
Haw Subwatershed				
2040070	0.67	1.49	0.60	1.65
2040080	0.53	1.89	0.51	1.97
2040090	0.54	1.84	0.51	1.98
2040100	0.75	1.33	0.65	1.53
2040110	0.66	1.52	0.60	1.66
2050010	0.74	1.35	0.68	1.48
Upper New Hope Subwatershed				
2060070	0.40	2.48	0.19	5.36
2060080	0.59	1.70	0.45	2.24
2060100	0.69	1.45	0.63	1.59
2060110	0.61	1.63	0.58	1.73
2060120	0.69	1.44	0.63	1.58
2060130	0.69	1.45	0.63	1.59
2060140	0.85	1.18	0.89	1.12

(1) Number of Lake Credits from 1 lb reduction at source location

(2) Number of pounds reduction at Source Location to = 1 Lake Credit (= 1 ÷ DF)

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[3] These are proposed delivery factors for illustrative purposes only based on Tetra Tech (2003) watershed modeling: DWQ may modify the transport factors to be used in tools developed to implement the Rules. Changes to the delivery factors would result in changes to the calculated location ratios.

4.3 Direct Exchange Ratios Derived from Delivery Factors/Location Ratios

It also would be possible to conduct trades directly between two sources just using the delivery factors. For example, if a source in Upper New Hope HUC# 2060070 was selling credits to a source in HUC# 2060140, Source 2060070 would need to generate 0.85/0.40 or 2.10 pounds of reduction for every pound Source 2060140 needed because the seller's delivery factor is less than the buyer's. If Source 2060140 was selling credits to Source 2060070, it would only need to generate 0.40/0.85 or 0.48 pounds of reduction for every pound Source 2060070 needed because the seller's delivery factor is greater than the buyer's. This conversion can become confusing, so most trading programs with more than several delivery factors conduct trades in a common currency.

Exhibit 5 provides matrices with the direct buyer-seller/seller-buyer conversions for nitrogen and phosphorus for the Upper New Hope subwatershed. Exhibit 6 on the following page provides the same matrices for the Haw segments in the project's pilot area.

EXHIBIT 5

Example Upper New Hope HUC to HUC Location Trading Ratios

This presumes upstream:downstream and downstream:upstream trades are allowed under the rationale that the ratios achieve equivalency of benefits at the terminal Lake irrespective of source locations. All conversions given are number of pounds Seller must reduce to provide 1 credit pound to Buyer.

NITROGEN

			BUYER							
	HUC		**2060070**	**2060080**	**2060100**	**2060110**	**2060120**	**2060130**	**2060140**	
		N DF	*0.40*	*0.59*	*0.69*	*0.61*	*0.69*	*0.69*	*0.85*	
SELLER	**2060070**	*0.40*		**1.46**	**1.71**	**1.53**	**1.72**	**1.71**	**2.10**	**SELLER**
	2060080	*0.59*	**0.69**		**1.17**	**1.05**	**1.18**	**1.17**	**1.44**	
	2060100	*0.69*	**0.59**	**0.86**		**0.89**	**1.01**	**1.00**	**1.23**	
	2060110	*0.61*	**0.66**	**0.96**	**1.12**		**1.13**	**1.12**	**1.38**	
	2060120	*0.69*	**0.58**	**0.85**	**0.99**	**0.89**		**0.99**	**1.22**	
	2060130	*0.69*	**0.58**	**0.85**	**1.00**	**0.89**	**1.01**		**1.23**	
	2060140	*0.85*	**0.48**	**0.69**	**0.81**	**0.73**	**0.82**	**0.81**		
			BUYER							

PHOSPHORUS

			BUYER							
	HUC		**2060070**	**2060080**	**2060100**	**2060110**	**2060120**	**2060130**	**2060140**	
		P DF	*0.19*	*0.45*	*0.63*	*0.58*	*0.63*	*0.63*	*0.89*	
SELLER	**2060070**	*0.19*		**2.40**	**3.37**	**3.10**	**3.40**	**3.38**	**4.77**	**SELLER**
	2060080	*0.45*	**0.42**		**1.41**	**1.29**	**1.42**	**1.41**	**1.99**	
	2060100	*0.63*	**0.30**	**0.71**		**0.92**	**1.01**	**1.00**	**1.42**	
	2060110	*0.58*	**0.32**	**0.77**	**1.09**		**1.10**	**1.09**	**1.54**	
	2060120	*0.63*	**0.29**	**0.71**	**0.99**	**0.91**		**0.99**	**1.40**	
	2060130	*0.63*	**0.30**	**0.71**	**1.00**	**0.92**	**1.01**		**1.41**	
	2060140	*0.89*	**0.21**	**0.50**	**0.71**	**0.65**	**0.71**	**0.71**		
			BUYER							

EXHIBIT 6

Example Haw HUC to HUC Location Trading Ratios

This presumes upstream:downstream and downstream:upstream trades are allowed under the rationale that the ratios achieve equivalency of benefits at the terminal Lake irrespective of source locations. All conversions given are number of pounds Seller must reduce to provide 1 credit pound to Buyer.

NITROGEN MATRIX

BUYER

SELLER

HUC		2030020	2030030	2030040	2030050	2030060	2030070	2030080	2040010	2040020	2040030	2040040	2040050	2040060	2040070	2040080	2040090	2040100	2040110	2050010
	N DF	*0.44*	*0.25*	*0.42*	*0.64*	*0.39*	*0.36*	*0.73*	*0.30*	*0.28*	*0.71*	*0.32*	*0.52*	*0.54*	*0.67*	*0.53*	*0.54*	*0.75*	*0.66*	*0.74*
2030020	*0.44*		0.58	0.96	1.46	0.88	0.81	1.64	0.67	0.64	1.61	0.73	1.19	1.22	1.52	1.19	1.23	1.70	1.49	1.67
2030030	*0.25*	1.74		1.67	2.53	1.53	1.41	2.86	1.17	1.12	2.79	1.27	2.06	2.12	2.64	2.08	2.14	2.95	2.59	2.91
2030040	*0.42*	1.04	0.60		1.52	0.91	0.84	1.71	0.70	0.67	1.67	0.76	1.23	1.27	1.58	1.24	1.28	1.77	1.55	1.74
2030050	*0.64*	0.69	0.39	0.66		0.60	0.56	1.13	0.46	0.44	1.10	0.50	0.81	0.83	1.04	0.82	0.84	1.17	1.02	1.15
2030060	*0.39*	1.14	0.66	1.09	1.66		0.92	1.87	0.77	0.73	1.83	0.83	1.35	1.39	1.73	1.36	1.40	1.93	1.69	1.91
2030070	*0.36*	1.24	0.71	1.19	1.80	1.09		2.03	0.83	0.80	1.99	0.90	1.46	1.50	1.87	1.48	1.52	2.10	1.84	2.07
2030080	*0.73*	0.61	0.35	0.58	0.89	0.53	0.49		0.41	0.39	0.98	0.44	0.72	0.74	0.92	0.73	0.75	1.03	0.90	1.02
2040010	*0.30*	1.48	0.85	1.42	2.16	1.30	1.20	2.44		0.95	2.38	1.08	1.76	1.80	2.25	1.77	1.82	2.52	2.21	2.48
2040020	*0.28*	1.55	0.89	1.49	2.26	1.36	1.26	2.55	1.05		2.49	1.13	1.84	1.89	2.36	1.85	1.91	2.64	2.31	2.60
2040030	*0.71*	0.62	0.36	0.60	0.91	0.55	0.50	1.02	0.42	0.40		0.45	0.74	0.76	0.94	0.74	0.76	1.06	0.93	1.04
2040040	*0.32*	1.37	0.79	1.32	2.00	1.21	1.11	2.26	0.93	0.88	2.21		1.63	1.67	2.08	1.64	1.69	2.33	2.04	2.30
2040050	*0.52*	0.84	0.49	0.81	1.23	0.74	0.68	1.39	0.57	0.54	1.36	0.61		1.03	1.28	1.01	1.04	1.43	1.26	1.41
2040060	*0.54*	0.82	0.47	0.79	1.20	0.72	0.66	1.35	0.55	0.53	1.32	0.60	0.97		1.25	0.98	1.01	1.40	1.22	1.37
2040070	*0.67*	0.66	0.38	0.63	0.96	0.58	0.53	1.08	0.44	0.42	1.06	0.48	0.78	0.80		0.79	0.81	1.12	0.98	1.10
2040080	*0.53*	0.84	0.48	0.80	1.22	0.74	0.68	1.38	0.56	0.54	1.35	0.61	0.99	1.02	1.27		1.03	1.42	1.25	1.40
2040090	*0.54*	0.81	0.47	0.78	1.19	0.71	0.66	1.34	0.55	0.52	1.31	0.59	0.96	0.99	1.23	0.97		1.38	1.21	1.36
2040100	*0.75*	0.59	0.34	0.57	0.86	0.52	0.48	0.97	0.40	0.38	0.95	0.43	0.70	0.72	0.89	0.70	0.72		0.88	0.99
2040110	*0.66*	0.67	0.39	0.65	0.98	0.59	0.54	1.11	0.45	0.43	1.08	0.49	0.80	0.82	1.02	0.80	0.83	1.14		1.12
2050010	*0.74*	0.60	0.34	0.57	0.87	0.52	0.48	0.98	0.40	0.38	0.96	0.43	0.71	0.73	0.91	0.71	0.73	1.01	0.89	

SELLER

BUYER

PHOSPHORUS MATRIX

BUYER

SELLER

HUC		2030020	2030030	2030040	2030050	2030060	2030070	2030080	2040010	2040020	2040030	2040040	2040050	2040060	2040070	2040080	2040090	2040100	2040110	2050010
	P DF	*0.31*	*0.08*	*0.30*	*0.62*	*0.19*	*0.18*	*0.64*	*0.14*	*0.14*	*0.63*	*0.15*	*0.50*	*0.51*	*0.60*	*0.51*	*0.51*	*0.65*	*0.60*	*0.68*
2030020	*0.31*		0.25	0.97	2.01	0.63	0.60	2.08	0.47	0.45	2.05	0.49	1.61	1.66	1.97	1.65	1.65	2.13	1.96	2.21
2030030	*0.08*	4.01		3.90	8.05	2.53	2.39	8.36	1.87	1.80	8.23	1.96	6.47	6.64	7.89	6.63	6.60	8.54	7.85	8.85
2030040	*0.30*	1.03	0.26		2.06	0.65	0.61	2.14	0.48	0.46	2.11	0.50	1.66	1.70	2.02	1.70	1.69	2.19	2.01	2.27
2030050	*0.62*	0.50	0.12	0.48		0.31	0.30	1.04	0.23	0.22	1.02	0.24	0.80	0.82	0.98	0.82	0.82	1.06	0.98	1.10
2030060	*0.19*	1.58	0.39	1.54	3.18		0.94	3.30	0.74	0.71	3.25	0.78	2.56	2.62	3.12	2.62	2.61	3.37	3.10	3.49
2030070	*0.18*	1.68	0.42	1.63	3.37	1.06		3.49	0.78	0.75	3.44	0.82	2.70	2.78	3.30	2.77	2.76	3.57	3.28	3.70
2030080	*0.64*	0.48	0.12	0.47	0.96	0.30	0.29		0.22	0.22	0.98	0.23	0.77	0.79	0.94	0.79	0.79	1.02	0.94	1.06
2040010	*0.14*	2.15	0.54	2.09	4.31	1.35	1.28	4.47		0.97	4.40	1.05	3.46	3.55	4.22	3.55	3.53	4.57	4.20	4.73
2040020	*0.14*	2.22	0.55	2.16	4.46	1.40	1.33	4.63	1.04		4.56	1.09	3.59	3.68	4.37	3.67	3.66	4.73	4.35	4.90
2040030	*0.63*	0.49	0.12	0.47	0.98	0.31	0.29	1.02	0.23	0.22		0.24	0.79	0.81	0.96	0.81	0.80	1.04	0.95	1.08
2040040	*0.15*	2.04	0.51	1.99	4.10	1.29	1.22	4.26	0.95	0.92	4.19		3.30	3.38	4.02	3.38	3.36	4.35	4.00	4.51
2040050	*0.50*	0.62	0.15	0.60	1.24	0.39	0.37	1.29	0.29	0.28	1.27	0.30		1.03	1.22	1.02	1.02	1.32	1.21	1.37
2040060	*0.51*	0.60	0.15	0.59	1.21	0.38	0.36	1.26	0.28	0.27	1.24	0.30	0.97		1.19	1.00	0.99	1.29	1.18	1.33
2040070	*0.60*	0.51	0.13	0.49	1.02	0.32	0.30	1.06	0.24	0.23	1.04	0.25	0.82	0.84		0.84	0.84	1.08	0.99	1.12
2040080	*0.51*	0.60	0.15	0.59	1.21	0.38	0.36	1.26	0.28	0.27	1.24	0.30	0.98	1.00	1.19		1.00	1.29	1.18	1.33
2040090	*0.51*	0.61	0.15	0.59	1.22	0.38	0.36	1.27	0.28	0.27	1.25	0.30	0.98	1.01	1.20	1.00		1.29	1.19	1.34
2040100	*0.65*	0.47	0.12	0.46	0.94	0.30	0.28	0.98	0.22	0.21	0.96	0.23	0.76	0.78	0.92	0.78	0.77		0.92	1.04
2040110	*0.60*	0.51	0.13	0.50	1.03	0.32	0.30	1.06	0.24	0.23	1.05	0.25	0.82	0.85	1.01	0.84	0.84	1.09		1.13
2050010	*0.68*	0.45	0.11	0.44	0.91	0.29	0.27	0.94	0.21	0.20	0.93	0.22	0.73	0.75	0.89	0.75	0.75	0.97	0.89	

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5.0 Possible Use of Uncertainty and Retirement Ratios

Two other types of trading ratios that might be considered, in addition to using delivery factors to develop locational ratios to establish equivalency between offsetting loads at one location using credits generated at another location, are: uncertainty ratios; and retirement ratios. As discussed below, it appears that uncertainty ratios may only be applicable in a few situations, and any decision regarding retirement ratios may best be left until after the Rules have been through the entire Rules Review Commission process and local governments' implementation plans are clearer.

5.1 Uncertainty Ratios

Uncertainty ratios are usually developed and applied to account for mathematical variance in assumptions used to develop underlying models, construct margins of safety, or in the estimated performance of best management practices and other actions that will be relied upon to generate water quality credits. For example, if a particular BMP has an expected effectiveness of 50%, but an estimated performance range of 25% to 75%, establishing an uncertainty ratio of 2:1 would ensure that in those instances where actual performance was at the low end of the range the expected number of credits associated with the 50% estimate would be delivered (50% ÷ 25% = 2; 2 x 25% = 50%). When considering whether uncertainty ratios are necessary, program designers and stakeholders need to fully understand what other conservative assumptions may have been made and if margins of safety are already included so as to not result in overly conservative uncertainty ratios.

5.1.1 Uncertainty Ratios for Urban BMP Credits Sold to Urban Sources

In the case of urban BMPs in the pilot watersheds, it appears that sufficient conservatism may have already been factored in for nitrogen and phosphorus and uncertainty ratios might not be necessary at the present time. Exhibit 6 presents the BMP removal efficiencies assumed for this study, as published in the Division of Water Quality's (DWQ) Stormwater Best Management Practices Manual (2007). Performance ranges specific to these values were sought, but not identified, either in the guidance or its supporting documentation. The ranges in EPA's Preliminary Data Summary of Urban Storm Water Best Management Practices (1999) publication, which was used as a source for screening level cost estimates for this study (the cost estimates will be published in a forthcoming TM), were examined to see if those ranges would allow for calculation of uncertainty ratios. However, the assumed removal efficiencies are **less than the low end of the range** for all but two of the BMPs with respect to nitrogen, and for five of nine BMPs with respect to phosphorus. As such, it is not possible to calculate an uncertainty ratio with these values using the method that divides the assumed removal efficiency by the low end of the range to arrive at an uncertainty ratio for most of the BMPs under consideration (see description of method in previous subsection), as indicated by the "NA" in the possible uncertainty ratio columns of Exhibit 6.

If it is later determined that a sufficient amount of conservatism exists in the nitrogen removal efficiencies for urban BMPs, uncertainty ratios would not be necessary for nitrogen credit trades between urban sources involving the BMPs in DWQ's manual. However, if it is determined that the existing conservatism is insufficient, or if trades were proposed involving other BMPs or between urban sources and another source, uncertainty ratios might be needed and would have to be negotiated on a case by case basis with the entity approving the trade.

Somewhat less conservatism is present for four of nine BMPs with respect to phosphorus. If a proposed trade involves implementing one of these BMPs instead of one of the other five, then it might be appropriate to use an uncertainty ratio such as that presented in Exhibit 6. However, if a proposed trade involves credits generated off-site from the same BMP that might have been used on-site then an uncertainty ratio should not be needed if the uncertainty—i.e., the assumed performance range—is the same for both sites.

Making such a determination may not always be easy, especially where credits are bought and sold from pools, rather than in bilateral deals. So it is hard to estimate the need for TP uncertainty ratios and easy to see why calculating appropriate ones might be difficult. Moreover, it is anticipated that most urban sources will not need to trade phosphorus credits because BMPs that meet non-tradable TSS requirements will usually also meet TP requirements. Therefore, no uncertainty ratios for phosphorus trades between urban sources are proposed at this time.

EXHIBIT 7
Assumed Removal Efficiencies, EPA Ranges, and Possible Uncertainty Ratio

Structural Urban Stormwater BMPs	% TN Removal Efficiency[1]	% TN Range	Possible TN Uncertainty Ratio	% TP Removal Efficiency[1]	% TP Range	Possible TP Uncertainty Ratio
Bioretention	40%	50-80%[2]	NA	45%	50-80%[2]	NA
Stormwater wetlands	40%	50-80%[2]	NA	35%	15-45%[2]	2.33:1
Wet detention basin	25%	30-65%[2]	NA	40%	30-65%[2]	1.33:1
Sand filter	35%	<30%[2]	1.17:1	45%	50-80%[2]	NA
Restored riparian buffer	30%	54-73%[3]	NA	35%	50-79%[3]	NA
Grassed swale	20%	15-45%[2]	1.33:1	20%	15-45%[2]	1.33:1
Infiltration devices	30%	50-80%[2]	NA	35%	15-45%[2]	2.33:1
Filter strip	20%	50-80%[2]	NA	35%	50-80%[2]	NA
Dry extended detention basin	10%	15-45%[2]	NA	10%	15-45%[2]	NA

[1] DWQ Stormwater Best Management Practices Manual (2007c).
[2] Preliminary Data Summary of Urban Storm Water Best Management Practices from the USEPA (1999).
[3] Osborne (1993).

5.1.2 Uncertainty Ratios for Agricultural BMP Credits Sold to Urban Sources

With respect to whether uncertainty ratios are needed for trades between urban and agricultural sources, no uncertainty ratios are recommended at this time. With respect to nitrogen, it is possible that urban sources might be interested in buying credits from agricultural sources. As will be documented in a forthcoming TM, several agricultural

BMPs appear more cost-effective than most urban BMPs.[4] However, under the Rules, agricultural sources must first meet a collective loading reduction for their sector category before they can trade credits with urban sources (they are permitted to trade credits with other agricultural sources but there is currently no incentive to do so).

The single exception is for credits generated by fencing cattle out of streams when a buffer of at least 30 feet is included in the practice. In this case, nitrogen removal was assumed at 66%. This removal assumes 50 percent removal for a 50 foot riparian buffer with the additional 16 percent from the cattle exclusion. This riparian buffer removal is at the low end of the range shown in Exhibit 7. As such, it may not be possible or necessary to construct an uncertainty ratio using the method described above, if the expected performance range for the agricultural buffer is similar to that of the urban buffer (i.e., the 50% assumption is lower than the low end of the range—to use the described method, the low end would need to be lower than the assumed point estimate). A determination will need to be made as to whether agricultural sources may sell fencing-buffer credits to urban sources with no uncertainty ratio as soon as demand exists, or if an uncertainty ratio is necessary, and if so a basis for establishing it will need to be developed.

With respect to later possible credit availability from other practices once agricultural sector targets have been met, it is premature to develop TN uncertainty ratios at this time because it is not yet clear that a significant supply of agricultural credits will be available compared to possible urban demand. Existing levels of BMP implementation are already high in the agricultural sector, and additional BMPs will be needed to meet the sector cap, therefore leaving relatively little capacity for additional BMP implementation, especially in areas where the agricultural sector is shrinking.[5] The potential need for uncertainty ratios for agriculture-urban nutrient credit trades can be revisited once DWQ and DSWC have a better estimate of the capacity for additional credit generation from the agricultural sector. At that time, the analysis of uncertainty ratios can be tailored to the types of BMPs that may be most feasible for the remaining areas without BMPs or where more BMPs could be installed.

5.1.3 Uncertainty Ratios for Urban and Agricultural BMP Credits Sold to Point Sources

For most of the same reasons outlined above, uncertainty ratios for TN and TP credits generated by nonpoint sources traded to point sources are either not necessary or not calculable at this time.

From the analysis to be presented in a forthcoming TM, it appears that most point sources will not need phosphorus credits and the few that do can likely get them from other point sources in their watershed. Moreover, TP credits from urban sources are likely to be more expensive than those from point sources, and as noted above, agricultural TP credits will not be available.

The analysis is similar with respect to estimated point source demand for nitrogen: from a demand-supply perspective it appears point sources in most watersheds can meet their targets on their own, or through point-point trading. Again, point source credits are likely to

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[4] See also the PowerPoint presentation given at the stakeholder meeting on May 22, 2008.

[5] Personal communication with Julie Henshaw, DSWC, May 20, 2008.

be less expensive than urban credits; and while agricultural credits may be cost-effective, as noted above, there may not be a sufficient supply.

Under these circumstances, no uncertainty ratios for TN or TP credits generated by nonpoint sources sold to point sources are recommended at this time. In the event point sources become interested in nonpoint source credits—a situation this assessment does not intend to rule out[6]—it is recommended that additional analysis be conducted to develop more rigorous performance ranges for the eligible BMPs from which uncertainty ratios can be calculated using the method outlined at the beginning of this section.

5.1.4 Uncertainty Ratios for Point Source Generated Credits

No uncertainty ratio for point-point trades is proposed, consistent with EPA guidance and other programs' precedent given that point source loads relative to trading baselines (wasteload allocations for point sources) are typically sufficiently monitored under NPDES permit requirements. In the event point source-generated credits are sold or otherwise transferred to a nonpoint source, no uncertainty ratio is expected to be needed since Discharge Monitoring Reports will document creditable reductions. It is assumed that delivery factors/location ratios would be applied as applicable, per the discussion in Section 4.

5.1.5 The Role of Monitoring in Setting Efficiency Assumptions and Uncertainty Ratios

Historical monitoring data, modeling, and future sampling results could be used to provide a more detailed basis for setting assumptions about removal efficiency ranges from which uncertainty ratios could be derived, as discussed in the beginning of Section 5.1. For example, at least one trading pilot—the Lower Boise River—uses a tiered approach to granting credits—"calculated" credits and "measured" credits":[7]

- Calculated credits are those for which adequate data exists and for which removal efficiencies and uncertainty discounts (from which uncertainty ratios can be derived) have been published in the trading guidance; and
- Measured credits are those for which nutrient removal is quantified through grab samples taken during the BMP's operation.

This approach could be tailored for the Jordan Lake watersheds to establish BMP efficiency assumptions for BMPs not listed in DWQ's manual or published in DSWC guidance and to help establish a basis for uncertainty ratios where they later are determined to be needed. With respect to uncertainty ratios, to the extent a credit generator thought he could do better than the performance range underlying the applicable trading ratio, he could be given the option to accept the published uncertainty ratio, or subject his BMP(s) to a measured approach which would establish site-specific uncertainty ratios based on a statistical

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[6] As noted in the May and June stakeholder meetings, the trading framework TM (CH2M HILL July 20, 2008) and in the forthcoming point source analysis TM, there is a possibility that local governments could be interested in transferring (or selling) surplus urban-sector credits to their POTW counterparts. This analysis is not intended to rule that possibility out, but merely acknowledge that such exchanges may not occur frequently enough, or in such volumes, that it is necessary to develop uncertainty ratios at this time.

[7] Idaho Department of Environmental Quality (2003).

analysis of a monitoring program designed to evaluate the effectiveness of the BMP over certain storm events using automatic samplers.

A program that set provisional uncertainty ratios to be finalized based on monitoring data could operate as follows. For example, if guidance assumes the expected performance of a BMP generating credits is 50% removal, and the assumed performance range is 25% to 75%, then the provisional uncertainty ratio would be 2:1 using the method outlined in this section. If monitoring data indicate expected performance in the range of 40% to 70%, the uncertainty ratio would be adjusted to 1.25:1 (50/40 = 1.25). However, if monitoring data indicate expected performance worse than assumed in the guidance, for example, 16% to 70%, then the ratio would be adjusted to 3.125:1 (50/16 = 3.125).

Provisional credits could be granted based on estimates of expected performance then reconciled after monitored performance is recorded and evaluated. Since this might involve ultimately granting a fewer number of credits, such a situation could be managed through posting performance bonds or through limits on percent of credits that may be sold pending certification, for example. Alternatively, the program could stipulate that no credits may be sold before a certain amount of sampling data are available, for example a year's worth. For programs that reconcile credits on an annual basis, this might be feasible—e.g., data from January to December of Year 1 would document the credits available for a March Year 2 sales and reconciliation of Year 1. The program rules would also need to address how situations would be handled where monitoring indicated more credits than provisionally granted were documented.

5.2 Retirement Ratios

Retirement ratios are typically established as a policy choice and/or to achieve a net loading reduction beyond what would be accomplished with other applicable trading ratios or program provisions. EPA's 2007 "Toolkit" observes that these ratios may be used to help "accelerate achievement of water quality standards." Retirement ratios effectively take a certain percentage of credits created out of the trading pool so that they cannot be applied to offset others' loadings above their caps. Exactly how the retirement ratio is specified can determine whether this tithing responsibility falls on the seller, the buyer, or both.

No retirement ratio is recommended at this time under the following rationale:

- It is expected that much of any credit trading volume in the Jordan Lake watersheds will be connected to urban sources' compliance with the Rules (as they may be amended prior to adoption);
- No retirement ratio is currently imposed on sources that pay an in-lieu fee to satisfy nutrient control requirements beyond the buy-down threshold;
- Credit trading in the Jordan Lake watersheds is primarily likely to be an extension of this buy-down program; and

- Stakeholders have agreed that any credit trading involving urban sources should generally be consistent with provisions of the buy-down program.[8]

At a later date, stakeholders may revisit the issue of a retirement ratio, including whether one may be appropriate for some or all types of trades, and if so, what the basis for establishing it should be.

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[8] Stakeholder meeting discussion, June 19. 2008.

6.0 Summary Conclusions and Related Project Activities

The Rules clearly establish the three trading areas and the delivery factors which must be used to account for locational differences between the site of credit generation and credit use. These delivery factors can be converted into delivery ratios that establish exchange rates between the buyer and seller, either directly between their two locations, or by normalizing their credit generation and credit use values to a third common location—Jordan Lake. By and large, these trading area specifications and use of delivery ratios are sufficient to support trading in the Jordan Lake watersheds without other types of trading ratios.

It is concluded that uncertainty ratios are generally not needed at the present time under the following rationale:

a) Nitrogen credits from urban BMPs—performance ranges assumed in DWQ’s manual (2007) appear to be sufficiently conservative;

b) Phosphorus credits from urban BMPs—uncertainty ratios may not be needed for urban-urban trades and may be derived case-by-case should point-urban trades materialize;

c) Nitrogen credits from agricultural BMPs—the removal efficiency assumption is sufficiently conservative for the single BMP likely to be traded early in the Rule implementation period and uncertainty ratios for other BMPs can only reasonably be suggested with more detail about future potential supply from this sector;

d) Phosphorus credits from agricultural BMPs—not eligible for trading, according to DWQ;

e) Nonpoint source credits traded to point sources—subject to (a) through (d) above, with the understanding that point source demand for nonpoint source credits is likely to be limited, nonpoint source supply is likely to be limited, and situation-specific ratios can be developed for TP as needed;

f) Point source credits traded to point or nonpoint sources—no uncertainty ratio needed.

Requiring or offering the option to credit generators to measure their BMP performance through periodic grab samples would provide a way to document reductions from BMPs not listed in DWQ or DSWC guidance and to reward documented performance better than assumptions based on average conditions.

With respect to retirement ratios, none are recommended at the present time, consistent with the general provisions of the buy-down program for urban nonpoint sources with which it is assumed most of the credit trading in the Jordan Lake watersheds will be associated. Stakeholders may revisit this issue at a later date.

The findings and recommendations associated with trading areas and ratios will be presented to stakeholders for their consideration and reflected in the proposed trading framework that will be described in a separate TM.

7.0 References

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