Developing Offset Banking Systems In Georgia[*]

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Abstract

Offset banking involves a public or private entity investing in a project that has the effect of substantially reducing a targeted pollutant(s), such as sediment runoff, phosphorus, heavy metals, etc. This project is referred to as "the bank." The entity creating the bank receives "credits" for the associated reduction in pollutants, which it can then sell to publically-owned treatment works (POTWs) or other point source polluters facing high costs of meeting discharge standards. Trades can be allowed on a 1-to-1 basis: the buyer obtains one credit for each credit-equivalent increase in pollution associated with his/her activities; or *higher* trading ratios can be required, e.g., 3:1, where the buyer must acquire (in this example) *three* credits for each credit-equivalent increase in pollution associated with his/her activities. In this latter case trades result in actual environmental improvements.

This paper addresses two major issues. The first refers to the steps required to establish a pilot project for one or more offset banking projects in Georgia. These steps are: identifying entities with incentives to purchase offset credits; identifying one or more entities that might establish a bank, and potential bank sites; establishing trading rules with appropriate local water quality management authorities; and obtaining approval of the proposed trading program from the U.S. EPA.

The second major issue addressed in the paper is means by which an offset bank might be created. For this purpose, a brief survey is offered of existing water quality trading projects in the U.S.. Buyers of offset credits are virtually always point-source polluters (POTWs or industries). Point and non-point projects have been used as "banks" -- as a source for offset banking credits. Attention in this paper is focused on non-point sources that might serve as banks for pilot offset banking projects in Georgia. Both low- and high-technology alternatives that might be used for such projects are discussed.

Notwithstanding incentive-related limitations on the number of point source polluters that might constitute the "demand" for offset credits discussed in section II, the authors have identified one entity (Fulton County) that may represent significant demand for credits, and they expect to identify others. Moreover, the authors argue that continued growth in Georgia, particularly in the Atlanta and Coastal areas of the State, will give rise to sufficient numbers of point source entities seeking new discharge permits to warrant interest in offset banking as a means of meeting increasingly stringent discharge restrictions at minimum cost. If or when enforcement of TMDLs gains strength in the State, needs for systems like offset banking will increase accordingly. These considerations, and the associated benefits to Georgians that might attend the establishment of offset banking programs in the State, serve as the rationale for the author's continued interest in exploring means by which pilot offset banking projects can be established in Georgia.

Developing Offset Banking Systems In Georgia

I. Introduction

As pointed out by Morrison,[1] offset banking programs potentially offer the State a means for promoting growth in Georgia's urban and rural areas with no increases in pollution — indeed, *with reductions* in pollution. Basically, offset banking involves a public or private entity investing in a project (typically on a fairly large scale[2]) that has the effect of substantially reducing a targeted pollutant(s), such as sediment runoff, phosphorus, heavy metals, etc. This project is referred to as "the bank." The entity creating the bank receives "credits" for the associated reduction in pollutants, which it can then sell to publically-owned treatment works (POTWs) or other point source polluters facing high costs of meeting discharge standards. Trades can be allowed on a 1-to-1 basis: the buyer obtains one credit for each credit-equivalent increase in pollution associated with his/her activities; or *higher* trading ratios can be required, e.g., 3:1, where the buyer must acquire (in this example) *three* credits for each credit-equivalent increase in pollution associated with his/her activities. In this latter case trades result in actual environmental improvements. Examples of trading ratios used in selected effluent trading and offset projects in the U.S. are given in Table 1. As seen in Table 1, 16 of 20 projects make use of trading ratios greater than 1:1 (note the 4:1 ratio for farmers not using BMPs in the Kalamazoo Project).

The potential benefits for Georgia from offset banking programs derive from the many

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[1] Morrison, Mark D., "Offset Banking — A Way Ahead For Controlling Nonpoint Source Pollution In Urban Areas In Georgia," Water Policy Working Paper #2002-004, Georgia Water Planning and Policy Center (North Georgia unit), Andrew Young School of Policy Studies, Georgia State University (Atlanta: June 2002).

[2] Examples include: stabilizing streambanks with riprap, vegetation, other land cover; construction of terracing, kudzu in gullies, brush dams, and/or storm channels; POTW's implementation of biological nutrient reduction, enhanced treatment of effluents, putting users of sewer systems on sewage lines, etc..

Table 1
Trading Ratios For Selected Offset Programs in the U.S.

Project	Controlled Pollutants	Trading Ratio
San Luis & Delta Mednota Water Authority	Selenium	1:1
S.F. Bay Mercury Offset	Mercury	3:1 (5:1 under discussion)
Cherry Creek Basin	Phosphorus	1.3:1 to 3:1
Blue Plains WWTP	Nitrogen	1:1
Cargill & Ajinomoto Plants	Ammonia, CBOD	1:1
Specialty Minerals, Inc.	Temperature	2:1
Acton Municipal Plant	Phosphorus	3:1
Wayland Business Center	Phosphorus	3:1
Maryland Nutrient Trading	Phosphorus & nitrogen	2:1
Kalamazoo River Trading Demo	Phosphorus	2:1; 4:1 for farmers with *less* than BMP
Michigan Trading Rule Develop	Nutrients	1.1:1 (point); 1.5:1 (non-point)
Minnesota River Trading Study	Phosphorus	3:1
Rahr Malting	Phosphorus	2:1
So. Minnesota Beet Sugar Coop	Phosphorus	2.6:1
Neuse River	Nitrogen	2:1
Tar-Pamlico Program	Nitrogen, phosphorus	2:1 + 10% admin. fee
Passaic Valley Project	Heavy metals	5:4
NY City Watershed Program	Phosphorus	3:1
Delaware River Basin	Various	1.1:1
Henry County Public Service	TDS	1:1

Source: Environomics, "A Summary of U.S. Effluent Trading and Offset Programs," 37 pp. plus appendices (Bethesda MD: November 1999)

stretches of Georgia's rivers that are out of compliance with water quality standards (see Table 2 below) and the fact that offset banking can reduce the costs of bringing water quality into compliance with standards. In terms of out-of-compliance river reaches given in Table 2, note particularly the 92 miles of streams that are in a non-attainment status as a result of point source polluters (municipal and industrial).

The purpose of this paper is to set out the feasibility of creating one or more pilot offset banking projects in Georgia. Such projects would involve point source "buyers" of offset

Table 2: Potential Sources of non-attainment of Designated Uses -- Georgia River and Streams

Pollution Source	Miles of rivers/stream in non-attainment
Industrial point	18
Municipal point	74
Hydropower/habitat (dam releases)	17
Natural sources	433
Urban runoff/stormwater	1,537
Industrial nonpoint	169
Nonpoint source	3,518

Source: Morrison, 2002, p. 4.

banking credits, with "banks" created primarily from nonpoint sources.[3] The paper is organized in the following manner. Section II details the steps that must be taken to assess the feasibility of one or more pilot offset banking projects in Georgia. Section III provides a brief review of water quality trading programs that are in operation (or plans exist for their operation) in various states in the U.S.. Section IV describes low- and high-technology alternatives that might be used for creating one or more offset "banks" in Georgia. Closing remarks are offered in section V.

[3] At some future time in may be desirable to explore the possibility of having nonpoint source buyers, such as home developers, etc.. Problems associated with this alternative are beyond the intended scope of this paper, however.

II. Assessing The Feasibility Of Offset Banking Programs

An assessment of the feasibility of an offset bank involves *four* distinct lines of inquiry:

- What "rules" will guide the establishment of banks (e.g., what are the pollutants that can be traded and what are their trading ratios)?
- What entities in the State would be reasonable candidates as banks (generators of credits) and what are the costs of creating credits for these banks?
- What entities in the State would be reasonable candidates as buyers of an offset bank's credits and what are the costs of pollution control technologies that would be implemented by these purchasers in the absence of a trading program?
- Would a program that meets the ecological and economic needs of the State be approved by the U.S. Environmental Protection Agency?

While the issues that must be addressed in each bullet above are not mutually exclusive, they can be broadly categorized as follows. The first bullet involves assessing the ecological and regulatory feasibility of an offset banking system. In other words, the ecological goals for a trading area, and the ecological constraints that might require specific attention in the development of trading rules must be identified. For instance, the relationship between possible trades with a bank and the achievement of water quality goals must be understood so that, for example, trades do not result in "hot spots" occurring. This primarily relates to limits on the bank's geographic location relative to buyers of credits. The second two bullets involve understanding the technical and economic feasibility of establishing an offset program. Technical feasibility involves understanding the physical works that could be undertaken to generate credits. To be economically feasible, the costs of generating credits must be less than the costs of own-source control for potential buyers of credits, and there must exist point source polluters with incentives to implement own-source control. The last bullet refers to the legal feasibility of such a program, and this primarily involves assessing the prospects for EPA approval of an offset system designed to fit the ecological and economic needs of the region.

Below, we further elucidate the issues surrounding each of the above bullets. In doing so, we hope to provide a framework upon which further efforts to develop an offset banking system might build.

A. Establishing "Rules" for a Banking System.

To assess technical and economic feasibility of an offset system, we must first identify the likely "rules" that would be established by the regulatory authority that would guide the establishment and operation of an offset bank. There are at least seven major issues that must be considered in this regard.

> A1) What pollutant is to be controlled (e.g., phosphorus, nitrates, BOD) and how are standards to be set? Are standards to be based on average conditions, or flows (e.g., pollutant loadings arising from, say, transient storm runoff events)? When regulatory interest is in the control of multiple pollutants, it may be desirable to have more than one bank: a bank for each target pollutant (or recognition that a bank's activities may affect more than one pollutant in which case the bank receives credits for each affected pollutant).
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> A2) What method(s) are to be used to estimate pollution loads at the bank site, pre- and post-construction of the bank?[4]
>
> A3) What will be the monitoring/reporting requirements pre- and post-bank to verify bank credits?
>
> A4) Related to (A3), what percent of initial, estimated credits can be sold by the bank in the first and succeeding years? The importance of this issue derives from the uncertainties surrounding pre-construction *estimates* for reduced pollution loads attributable to the bank. It is usually the case that only a fraction of the estimated credits are tradeable until post-construction monitoring clearly establishes the effects of the bank in reducing the target pollutant.
>
> A5) What will be the trading ratio — a decision that determines net effects on pollution loads associated with trading (see Table 2 above)?
>
> A6) How will site restrictions related to the "hot spot" issue be identified? Given

[4] Given our maintained assumption that the buyer will be a point source polluter, end-of-pipe measures of pollutant loads should be readily available for the buyer.

a stretch of the river that is in non-attainment, the construction of a bank *below* this stretch may not allow increased discharges of the target pollutant within the non-attainment stretch without worsening conditions (an exception *might* exist in the case of phosphorus[5]). Thus, it may be the case that the bank would have to be within or up-stream of the non-attainment, "hot" stretch of the river.

A7) What method(s) will be used to ensure perpetual maintenance of the bank? This issue relates to a second element of risk associated with offset banks. If credits are traded, the presumption is that the reduced pollution loads associated with the credits will be maintained into perpetuity (or certainly over the operating life of the point source buyer). Thus, if the bank is developed by a private company, bonding may be required to insure the availability of funds for the continued operation and maintenance of the bank. If the bank is developed by a public entity, the State and/or local government may or may not wish to require some kind of guarantee for the operation/maintenance of the bank.

B. Locating Bank Sites and Operators.

Our second line of inquiry is that of identifying potential bank sites and the entity (or entities) that will construct and maintain the bank(s). Our discussion of this aspect of developing an offset banking system is necessarily limited until specific pollutants and locations are identified as feasible to trade in an offset system. However, we offer a few comments on basic issues that must be addressed before it can be determined if an adequate "supply" of credits may be developed.

Conceptually, private firms could develop a bank, but usually offset banks are developed by governmental organizations or natural resource conservation commissions and organizations. Potential bank sites must be identified, appropriate pollution-reduction technologies (for the selected site) must be determined. Site selection may be a difficult task. In some cases it may be necessary for the bank site to be located within the impaired stretch of a river (or possibly

[5] The exception would arise if phosphorous concentrations in moving water did not "matter." What "matters" is downstream concentrations behind reservoirs where water is not moving. If, and we emphasize "if," this is the case, a phosphorous-reducing bank could be located downstream of the discharger.

upstream) if pollution reductions at the site are to reduce pollution loads in the impaired stretch.

Two critically important and interrelated tasks are involved in the assessment of potential bank sites: determining the required scale of bank operations, and the costs of developing the bank (which then implies required prices for offset credits required for the bank to be economically feasible). Identifying the required scale of bank operations is inextricably tied to the topic discussed in the upcoming subsection: the identification of buyers of credits. At issue here is the simple fact that unit costs for credits will depend on the number of units created *and sold.* Thus, suppose that there is only a single buyer, and the buyer will want (say) 100 credits (adjusted for any trading ratio greater than 1:1). The bank would then incur unnecessary costs, and would require higher credit prices, if it created more than 100 credits. Since, in the immediate future, it is unlikely to be the case that there will be "many" buyers and sellers of credits in Georgia, in which case competitive forces that would determine optimal levels of credit production will not exist, it may be necessary to shape the scale of the bank according to the limited needs of the one (or few) known buyers of credits.

Given reasonable estimates for the desired scale of operation of the bank, estimates of costs will be based on three major considerations. At sites determined to be technically feasible for bank operations, what are the number and costs of BMPs required to produce the desired number of credits? Examples of BMP costs for controlling stormwater runoff -- a nonpoint source of pollution -- are given below in Tables 3 and 4. Second, what will be the costs associated with the operation and maintenance of the bank? Third, and finally, what will be the costs of monitoring required to establish the precise number of credits "earned" by the bank?

Table 3

Typical Base Capital Construction Costs For Selected BMPs

BMP Type	Typical Cost Per Cubic Foot
Retention/detention Basins	$0.50 to $1.00
Wetland construction	$0.60 to $1.25
Infiltration trench	$4.00
Infiltration basin	$1.30
Sand filter	$3.00 to $6.00
Bioretention	$5.30
Grass swale	$0.50
Filter strip	$0.00 to $1.30

Source: U.S. EPA, "Preliminary Data Summary of Urban Storm Water Best Management Practices," EPA-821-R-99-012 (Washington, DC: August, 1999), sections 5 and 6.

Table 4

Base Costs Of Selected BMP Applications

BMP type	Typical cost	**Application** (IC = Impervious Cover)
Retention basin	$100,000	50-acre residential site, IC = 35%
Constructed wetland	$125,000	50-acre residential site, IC = 35%
Infiltration trench	$ 45,000	5-acre residential, IC = 65%
Infiltration basin	$ 15,000	5-acre residential, IC = 65%
Sand Filter	$35,000-$75,000	5-acre residential, IC = 65%
Bioretention	$ 60,000	5-acre residential, IC = 65%
Grass swale	$ 3,500	5-acre residential, IC = 35%
Filter strip	$0.00 - $9,000	5-acre residential, IC = 35%

Source: U.S. EPA, "Preliminary Data Summary of Urban Storm Water Best Management Practices," EPA-821-R-99-012 (Washington, DC: August, 1999), sections 5 and 6.

Adequate monitoring may be quite expensive. Reasonably accurate baseline (pre-bank development) measures for water quality upstream *and* downstream of the bank site may require constant, real-time monitoring for a year or more in order to capture the range of storm events that characterize "average" conditions. The same applies to monitoring requirements after the bank is developed.

C. Locating Potential Purchasers of Credits: The Incentive Question.

Potential buyers of offset credits must be identified to assess the feasibility of such a system for improving water quality. The task here is to identify point source polluters located along impaired reaches of a stream or river *with incentives* to purchase offset credits. Such incentives arise when an entity is facing *enforced* limitations on discharges of the targeted pollutant which it is or expects to be exceeding, and where the costs of complying with these limitations are "high" relative to the costs of credits. These conditions create the "demand" for offset credits.

Potential incentives to buy offset credits on the part of *new* point source polluters do exist[6]. Such incentives derive from discharge limits that will be a part of the new EPD-issued discharge permit which they must obtain, and the costs of complying with these limits. Reflecting the present regulatory framework in Georgia, however, there is *little or no incentive* for holders of existing point source discharge permits to be a purchaser of credits. This is due to the fact that there currently exists no sanctions that the EPD can place on pollution from point source polluters in compliance with limits set on discharge permits issued in the past. Furthermore, there is little or no incentive for existing sources of nonpoint pollution (as

[6] New nonpoint polluters, such as land/home/commercial developers also face pollution control criteria that can be quite expensive and *might* give rise to a demand for offset credits. However, there is a wide range of special circumstances associated with nonpoint polluters that we are unprepared to address at this point in time.

examples: stormwater runoff in developed areas, agriculture, and forest lands) to be a purchaser of credits. In the case of nonpoint pollution arising from existing patterns of land, given that Georgia is a "home rule" state" (issues such as land use are controlled by local, not state, government), the EPD has little to no regulatory options that can change existing local patterns of land use or that can control ongoing discharges from such land uses.

The EPD does establish "total maximum daily load" (TMDL) standards for Georgia's rivers and streams, and *via* sampling identifies stretches of rivers/streams wherein TMDLs are not being met.[7] When TMDLs are not being met, EPD in conjunction with the basin's Regional Development Council prepares an "Implementation Plan" that spells our how this stretch of the river/stream is to be brought into compliance with the TMDL. The process for preparing the Implementation Plan involves, to as great an extent possible, stakeholders in the area. Required pollution reductions are "assigned" to the various sources of polluted discharges, e.g., urban areas (stormwater runoff), agriculture and forested areas (a source of "natural" pollution).

Unfortunately, compliance with the "assigned" pollution reductions is *voluntary*. If compliance is voluntary, there is no obvious incentive for entities affected by the Implementation Plan to purchase offset banking credits because there are no obvious effective incentives for them to incur the costs that would be required to meet their assigned pollution reduction. Even for new nonpoint pollution associated with construction activities, beyond requiring BMPs for controlling runoff and erosion *during* construction (i.e., during *new* land-disturbing activities), the EPD has little to no regulatory options for assuring that facilities designed to control runoff and erosion after construction is completed are maintained, and therefore that such runoff and

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[7] See "Summary of Comments and Responses on the Georgia 2002 §305(b)/303(d) List of Waters," Georgia EPD, February 6, 2002.

erosion is in fact controlled.

All of this is to suggest that even when credits might offer a means for reducing point and/or nonpoint pollution discharges at existing sites at a lower cost than those means directly available to those responsible for such pollution, there are no incentives to purchase them if there is no enforced requirement to undertake such reductions.

As suggested above, all of this means that it may well be the case that our efforts to identify potential point source buyers of credits will be limited to sources seeking new discharge permits. At this point we know of at least one instance where this is the case. The Fulton County Public Works Department (FCPWD) has plans to expand (double) capacity at five of its treatment plants that discharge into impaired reaches of the Chattahoochee River. Such expansions will require that they obtain new discharge permits. While the FCPWD has yet to obtain such permits for these five plants (construction of which is scheduled over the next four to five years), they have obtained a permit for the expansion of a sixth plant. At this sixth, small plant, capacity is being doubled from 2.5 mgd to 5 mgd. However, the new EPD discharge permit requires no increase in the plant's overall discharge *load* of phosphorus, which implies, given the doubling of capacity, that phosphorus discharges per unit volume discharged will have to be reduced *by one half*. Achieving this reduction at the plant is expected to be very costly.

While there is considerable uncertainty as to precisely what discharge limits will be placed on new permits for the other five plant expansions, FCPWD planners are proceeding under the assumption that they will face conditions similar to those with their most recently obtained discharge permit, in which case they have strong incentives to seek alternative, lower cost means for meeting expected discharge limitations. An offset banking program for phosphorus might achieve a least-cost reduction in the total phosphorus discharged into the impaired river — and if trading ratios are set correctly, could lead to substantial improvements in the quality of the river.

D. Obtaining EPA Approval.

Given that a well-researched plan for a pilot offset banking system has been developed which is expected to both improve water quality and be technically and economically feasible, the U.S. EPA must ultimately approve the program. In principle, the EPA supports and encourages water quality trading programs. In their most recent statement of Water Quality Trading Policy[8] the EPA states that:

> "Finding solutions to ... complex water quality problems requires innovative approaches that are aligned with core water programs. Water quality trading is an approach that offers greater efficiency in achieving water quality goals on a watershed basis. It allows one source to meet its regulatory obligations by using pollutant reductions created by another source that has lower pollution control costs...The United States Environmental Protection Agency (EPA) believes that market-based approaches such as water quality trading provide greater flexibility and have potential to achieve water quality and environmental benefits greater than would otherwise be achieved under more traditional regulatory approaches."[9]

The EPA approval process has not always gone smoothly, however. For example, EPA approval of a proposed trading program depends in large part on the district EPA office's interpretation of the Clean Water Act. Generally, the EPA has taken the position that offsets must be "additional" in the sense that the credit-establishing activity would *not* have happened in the absence of a trading program. Establishing just what constitutes "additional" has been a point of some contention. Moreover, in some instances the EPA has gone beyond the

[8] "Water Quality Trading Policy," Office of Water, U.S. Environmental Protection Agency, 11 pp., (Washington D.C.: January 13, 2003). Available on the U.S. EPA web site.

[9] *Ibid* at p. 1.

"additional" consideration in considering a proposed trading program. As one example, the town of Acton, MA, terminated household use of septic systems, connecting them to sewers for treatment at a POTW. The town sought credit for this activity to allow the operation of a new POTW that would discharge to a river in which new discharges were prohibited. In this case, credit was denied by the EPA, not on the "additional" principle, but seemingly on their interpretation of the Clean Water Act as requiring that offsets *must derive from entirely unrelated sources* (in this case, reducing one source of sewage discharge could not earn credits to be used for the discharge of sewage at a different location).[10]

The new EPA policy statement appears to suggest that the EPA will be more encouraging in terms of the establishment of new trading programs for water quality. There are exceptions, however. For example, the EPA will not support trading of persistent bioaccumlative toxics (PBTs) except under special circumstances. Nor will it support trading to allow compliance with existing technology-based effluent limitations except as expressly authorized by federal regulations.[11]

E. Summary.

As the above discussion indicates, many factors need to be carefully considered to determine the environmental, economic, and legal feasibility of an offset banking program to improve water quality in north Georgia. However, the authors remain optimistic that an offset banking program can be developed that will offer a means for a substantive move forward in Georgia's efforts to improve water quality in its rivers and streams at minimum cost.

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[10] Marshall, Chuck, "Results of Water-based Trading Simulations," Phillip Services (Fort Washington, PA), Final report to the U.S. EPA 68-C7-0011.

[11] U.S. Environmental Protection Agency, *Op. Cit.* January, 2003, at pp. 4 and 6.

III. Examples Of Water Quality Trading Programs In The U.S.

In 1999, thirty-seven effluent trading and offset activities in the U.S. were reviewed for the EPA by Environomics, a consulting group in Bethesda, MD.[12] Some of the programs reviewed are in place and approved by the EPA, while others are still in the planning process. All of the existing trading programs involve "buyers" that are point source polluters, primarily POTWs; banks (the sellers of credits) are often point sources of pollution, although there are a number of examples where banks involve nonpoint sources of pollution. In what follows we provide the reader with a sampling of existing programs, with particular attention given to bank sources, innovative approaches to the design of programs, and issues that needed to be addressed during the EPA approval process.

An interesting example of trading programs in the U.S. is seen in the proposed Blue Plains Credit Creation Program which involves POTWs as buyer *and* seller. In Virginia, several of its POTWs were behind schedule in upgrading facilities to meet nutrient standards for their discharges in to Chesapeake Bay. To meet standards (7.5 mg/L), Virginia's POTWs would need to invest in facilities for biological nutrient reduction (BNR) — facilities that are very costly. Washington D.C.'s Blue Plains POTW already had in place BNR for about half of its discharges and was meeting its discharge standard. With BNR in place, it was then much cheaper for the Blue Plains plant to implement BNR to all of its flow, thereby meeting a 4.5 mg/L standard, than for Virginia to expand BNR in its plants. Thus, a proposed trading arrangement was developed wherein Blue Plains would reduce its nutrient discharges and sell the credits to Virginia. The terms of the agreement, however, called for a trade that would continue until Virginia no longer

[12] Environomics, "A Summary of U.S. Effluent Trading and Offset Projects," 37 pages plus appendices, [Bethesda, MD: November, 1999].

needed the credits, after which the Blue Plains plant would revert to meeting the 7.5 mg/L standard. The potential weakness of the proposed trading program was that it would violate the EPA's "anti-backsliding" requirements that would prohibit the bank, in this case the Blue Plains POTW, from increasing its discharges at any post-program date.

A few trading programs in the U.S. involve industrial plants. An example of a relatively simple trading program between two industrial plants in seen in a trading program established in Iowa during the early 1990s.[13] In this instance a Cargill plant's discharge of ammonia and CBOD exhausted the assimilative capacity of the Des Moines River; new discharges were then prohibited. A new plant, New Ajinomoto Food Preparations, wanted to open a plant in a nearby area, a development that would benefit the economy of the region. A trading arrangement was established whereby the Cargill plant agreed to accept and treat Ajinomoto's effluent stream to levels that met discharge standards, which actually helped Cargill with its control of nutrient discharges.

There exist programs with point source buyers (usually POTWs) and nonpoint source banks. The first point-nonpoint trading program in the U.S. was developed at the Lake Dillon Reservoir in Colorado. The lake provides drinking water for Denver, and had become an increasingly popular recreation facility. Several POTWs discharge into the lake, and phosphorus levels exceeded standards developed by a group of government and stakeholder organizations. Banks were developed by connecting septic sewer systems to POTW systems, and reductions in *nonpoint sources* of phosphorus discharges from surface and subsurface stormwater. While the

[13] See, also, the Speciality Minerals, Inc. program in Adams, MA, and for project involving POTWs *and* industrial dischargers see the Lower Boise River Effluent project and the Illinois Pretreatment trading program, in Environomics, *Op. Cit.* (1999).

trading project was established in 1984, very little trading has taken place due to improved operations of the POTWs (the first sale occurred in the early 1990s; a 2:1 trading ratio was used) and somewhat strict interpretation of the EPA's "additional" rule discussed above. Population growth or other activities that place stress on the lake's water quality could lead to increased trading, however.

Other trading programs exist where a point source polluter (a POTW) is both the buyer *and* seller of credits -- credits created by a non-point source bank. This point-nonpoint, and *cross-pollutant* trading program is seen in a Boulder Colorado project. The City of Boulder, CO, was faced with the necessity of very costly upgrades to it's POTW to address ammonia toxicity problems in Boulder Creek.[14] The City was allowed to trade nonpoint source pollution reductions -- derived from stream restoration improvements -- for point source pollutant load reductions of ammonia at the POTW. Stream restoration improvements on Boulder Creek included streambank stabilization, riparian restoration, the development of pool habitat, narrowing/deepening the channel, returning natural sinuosity, restoring wetlands habitat, rerouting irrigation return flows through developed wetland, and fencing off livestock from the riparian zone, creating a 120-foot wide buffer between grazing land and Boulder Creek. These stream restoration projects involved costs of $1.4 million (as of December, 1996), and saved between $3 million and $7 million in capital costs that would have been required to upgrade its POTW to full nitrification.

A final example of a trading arrangement involving point source buyers and nonpoint

[14] The following is taken from "Draft Trading Update — December 1996: Boulder Creek Colorado," U.S. EPA, at web site address www.epa.gov/owow/watershed/trading/bould.htm.

source banks is North Carolina's Tar-Pamlico Basin project.[15] What distinguishes this particular program is the involvement of a relatively large number of POTWs dispersed across entire river basins.[16] As a result of severe water quality problems in this Basin, North Carolina's Division of Environmental Management (NCDEM) was prepared to impose strict nitrogen and phosphorus effluent standards for discharges at POTWs, standards that were expected to involve high capital costs. A coalition was formed involving dischargers, the Environmental Defense Fund, the Pamlico-Tar River Foundation, and NCDEM to develop a nutrient trading framework through which dischargers could pay for the development and implementation *of agricultural* BMPs to achieve all or part of the state's nutrient-reduction goals.

Hopefully, the discussions given above provide the reader with an appreciation of the range of applications of offset trading arrangements. Experiences with water quality trading programs in other states may be important for our considerations of pilot offset banking projects in Georgia. This being the case, we wish to consider in greater depth the methods and technologies by which non-point source discharges might be reduced for the purpose of creating offset banking credits.

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[15] See U.S. EPA, "Case #10: TMDL Case Study: Tar-Pamlico Basin, North Carolina," (no date), available at www.epa.gov/owow/watershed/trading/cs10.htm. For other examples, see the Illinois Pretreatment Trading Program and the Long Island Sound Trading Program described in Environomics, *Op. Cit.* (1999).

[16] For a description of a multi-state project, see the description of the Chesapeake Bay Watershed Nutrient Trading Program in Environomics, *Op. Cit.* (1999) at p. 24.

IV. Creating Non-point Source Offset Banks: A Selected Review Of Technologies

There are a number of methods and technologies that have been applied to reduce the discharge of pollutants at non-point sources -- some are not capital-intensive and are relatively low cost in nature, others are more capital-intensive and more costly. Examples of costs associated with capital-intensive technologies were given above in Tables 3 and 4. Costs for lower technology, less capital-intensive methods are much lower, particularly when the agriculture is used as the venue for the bank. For example, it has been shown that nitrate emissions to a watershed can be reduced by as much as 50% (from 4.6 lbs/acre to 2.1 lbs/acre) with the relatively simple BMPs of changing the timing of nitrate applications and reducing such applications by 40%, at costs ranging from $0.20/acre to $4.76/acre.[17]

Less capital-intensive programs to reduce pollution at non-point sources include streambank stabilization, riparian corridor improvements, the rerouting of irrigation return flow through wetlands, road sanding, and landscaping.[18] Such programs are found in both urban and rural areas. Examples of the effective use of these programs are seen in projects sponsored by the Natural Resources Conservation Service (NRCS; a part of the U.S. Department of Agriculture) that are designed to reduce sedimentation and soil erosion. The bulk of these projects,[19] which have been ongoing for decades, are generally *not* a part of an offset program, but provide interesting suggestions for methods that might be used in such programs. As

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[17] Ipe, Viju C., Eric A. DeVuyst, John B. Braden, and David C. White, "Simulation of a Group Incentive Program for Farmer Adoption of Best Management Practices," *Agri and Resource Economics Rev*, 30(2), 139-150, October 2001 (assuming applications to row crops, 306,000 acres), at Tables 3 and 4. See, also, Cooper, Joseph C and Russ W. Keim, "Incentive Payments to Encourage Farmer Adoption of Water Quality Protection Practices," *Am. J. Agri. Econ.*, 78(1), 54-64, February 1996.

[18] See Marshall, Chuck, *Op. Cit.*, no date.

[19] See an overview of NRCS projects at their web site: www.nrcs.usda.gov/programs/watershed/wr_success/ws_success.html.

examples of successful NRCS programs, 59 miles of streambanks along New York's Buffalo Creek were stabilized, thereby reducing sedimentation, by the relatively simple means of applying riprap, and planting vegetation trees, grass, and legumes along the streambank. Along Iowa's Little Sioux River, in addition to activities such as those described above, farmers were persuaded to adopt crop rotation practices that reduced erosion and sedimentation, as well as to terrace their lands, and kudzu was planted in gullies. At other sites, NRCS programs have constructed brush dams and storm channels (e.g., along Mississippi's Little Tallahatchie River), as well as debris basins (California's Los Angeles River basin).[20]

In looking to more capital-intensive methods/technologies that might be used to reduce discharges of pollutants at non-point sources, thereby serving as a bank, most of these methods are used to reduce stormwater runoff in urban areas. These methods fall into two categories. Projects intended to collect, detain, and/or filter surface and subsurface stormwater, thereby reducing sediment and associated nutrient loads, typically make use of either "detention systems" or "retention systems." A second system, is an "infiltration system."

Detention systems, usually involving underground vaults, pipes, and tanks, intercept a volume of stormwater runoff and temporarily impounds the water for gradual release to streams or rivers. The detention system typically empties out between runoff events and is often used primarily to control water quality, not quantity. A retention system is designed to capture a volume of runoff during a runoff event, retaining it until its storage volume is displaced, in whole or in part, by the next runoff event. Retention systems make use of retention ponds, tanks, tunnels, vaults, and/or pipes.

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[20] *Ibid.*

Infiltration systems[21] are intended to capture a portion of runoff during runoff events and infiltrate the runoff into the ground. In theory, the use of infiltration technologies would appear to be ideal in that reliance on natural soil infiltration allows "...the hydrological cycle to continue in pre-disturbance condition, so that aquifers are recharged and increased surface runoff pollutant loadings are prevented."[22] Unfortunately, infiltration systems present confounding challenges in terms of design and implementation.

The two most common infiltration systems in use today are porous pavement systems and systems making use of infiltration basins, trenches and wells.[23] The use of porous pavement is appropriate for a limited number of applications: parking lots in commercial areas and, perhaps, driveways and streets in residential areas. Such systems use coarse aggregate and filter material to create a recharge bed on top of which porous concrete is established. Cahill Associates in California have installed such systems for parking facilities serving commercial areas ranging from 3,000 to as much as 147,000 square feet.[24]

However, stormwater managers have become reluctant to rely on porous pavement systems because of large failure rates that have been experienced.

> "Experience has shown that most porous pavement failures occur because of a lack of erosion/sediment control during construction. In many instances, contractors, unfamiliar with what they were doing and why they were doing it, allowed substantial quantities of sediment to erode onto the pavement surface after installation. Construction traffic also tracks heavy loads of clay particles onto the surface. Void spaces in the porous asphalt

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[21] See also Ferguson B K 1994, "*Stormwater Infiltration*", Lewis, Boca Raton.

[22] Cahill, Thomas, "A Second Look At Porous Pavement/Underground Recharge," Technical Note #21, *Watershed Protection Techniques*, 1(2), 76-78.

[23] A third system, rarely used primarily because its use requires that the control site must be in an area of shallow groundwater, is the constructed wetland system, which simply involves the creation of a wetland area that absorbs some part of the volume of runoff during a runoff event, and the "stored" water infiltrates into the underlying aquifer.

[24] *Ibid.*

> become permanently clogged, preventing stormwater from even entering the recharge bed below...The fine silts that ...pass through the porous pavement and through the underlying rock-filled recharge beds then settled out on the recharge bed bottom, reducing the recharge bed's ability to infiltrate over time."[25]

Cahill argues, however, that "...porous pavement/underground recharge bed stormwater practice applications *can* be developed successfully."[26] Specifications/guidelines suggested by Cahill for a successful porous pavement system include the following. First, permeability of a soil layer must be verified, with a soil layer of four feet or more and percolation rates of .5 inches per hour or more. Second, sediment-laden runoff from pervious zones being landscaped after construction should be redirected away from the system's recharge bed to eliminate sedimentation and resultant clogging. Third, contractors and workers involved in a project must understand what is being done and why compliance with specifications is essential. Finally, Cahill recommends that completed porous pavement be vacuum-cleaned twice per year using commercially available pavement vacuuming equipment.

Thus, the porous pavement system, properly designed and implemented, would appear to have promise as an effective tool for stormwater management that might play an important role in an offset banking system. To date, however, we must note that this view does not appear to be widely accepted.

The use of infiltration basins, trenches, and/or wells (or tanks) are much more prevalent than the use of porous pavement as an infiltration system. In the case of trenches, some portion of stormwater runoff is diverted to a trench in which a recharge bed has been established. Infiltration trenches are typically used to serve relatively small projects — up to around 10 acres

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[25] *Ibid.*

[26] *Ibid.*

— and are limited to depths of around three feet for public safety. Site conditions required for the successful use of infiltration trenches include: infiltration rates of no less than .5 inches/hour; clay content of soils no greater than 30%; silt-clay content of soils no greater than 40%, depth to bedrock and high water table of around 3 feet; and a maximum ponding time of 24 hours.

Infiltration basins are used for more extensive drainage areas, up to some 50 acres. Infiltration basins are typically off-main line areas with enhanced vegetation and other infiltration enhancements to which some part of runoff is diverted. Infiltration basins have been shown to substantially reduce peak discharges during runoff events, even if they do not fully restore pre-development hydrological conditions.[27] Infiltration basins established in Annandale and Powells Creek, Australia, have been used to successfully collect and treat runoff from a catchment area of five streets and to reduce the discharge of suspended solids, heavy metals, and nutrients.[28]

Experience in the U.S. with infiltration trenches and basins has been mixed. Galli[29] inspected over sixty infiltration trenches and basins in Prince Georges County, Maryland, which is noted for its leadership in infiltration design standards. The inspected projects ranged in age from six months to six years. Galli found less than half of the infiltration trenches working as designed, and that the longevity of trenches declined over time — less than one-third still functioned after five years. Failures noted by Galli were attributable to a number of factors,

[27] Holman-Dodds, Jennifer and Allen Bradley, "Evaluation the Potential for Infiltration-Based Storm Water Management in Urban Areas," IIHR - Hydroscience & Engineering, College of Engineering, University of Iowa, 3 pp., November 18, 2002, at www.iihr.uiowa.edu/projects/infiltration/.

[28] See "Storm Water Infiltration Basin," and "Storm Water Filtration & Re-Use System," Atlantis Water Management, at www.atlantiscorp.com.au/case_studies/storm_water_(infiltration_basin; and filtration_&_reuse_system).

[29] Galli, J., "Analysis of Urban BMP Performance and Longevity in Prince George's County, Maryland," unpublished manuscript, 202 pp., Metropolitan Washington Council of Governments, 1993.

many of which are avoidable. Such factors include impacted soil during construction (*a la* the problem noted by Cahill regarding porous pavement), further compaction by the mass of ponded water after construction, absence of pretreatment facilities to trap coarse sediments before they enter the infiltration basin, poor vegetative cover on basin floor, and sealing of the basin floor by algal mats.[30] It should be noted, however, that most of the projects surveyed by Galli were constructed prior to the development of contemporary guidelines for infiltration basins.[31]

Similarly, Hilding, *et al.* surveyed twenty three filtration basins in the Puget Sound Basin of the Pacific Northwest.[32] Like the Galli study, most of the basins surveyed by Hilding, et al., were constructed prior to emergence of contemporary guidelines for infiltration basins. Thus, few of the basins surveyed had effective pretreatment features, such as biofilters, forebays, or filter berms that are now required on new infiltration basins. In contrast to Galli's study, Hilding *et al.* found that a majority of basins were working properly after 10 years. Many had encountered problems, however, including standing water in between storms (usually attributable to locally high water tables), noticeable sediment deposits (attributable in large part of poor maintenance), and scarification (sediment scraping). Frequent maintenance problems identified by Hilding, *et al.*, were associated with the difficulty in sustaining grass on the basin floor due, among other things, to frequent inundation. Hilding, *et al.* conclude that even under ideal conditions, extensive maintenance is required to keep infiltration basins operative over the

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[30] *Ibid.*

[31] For a discussion of relatively recent BMPs for infiltration systems, see Taylor, Scott, and G. Fred Lee, "Development of Appropriate Stormwater Infiltration BMPs: Part II Design of Infiltration BMPs," available at www.gfredless.com/stmwt_infil2.html (no date).

[32] Hilding, Karin, Hammond, Collier, Wade, and Livingston Associates, "Longevity of Infiltration Basins Assessed in Puget Sound," Technical Note #33 from *Watershed Protection Techniques*, 1(3), pp. 124-125. See, also, Hilding, K., "A Study of Infiltration Basins in the Puget Sound Region, ME thesis, Department of Biological and Agricultural Engineering, Univ. Of California, Davis, 1993; and Gaus, J., "Soils of Infiltration Basins in the Puget Sound Region: Trace Metals and Concentrations," ME thesis, University of Washington, 1993.

long run.

In summary, both low and high technology alternatives exist as a potential source for creating credits in a nonpoint source offset banking program. Low technology alternatives include such things as streambank stabilization, riparian corridor improvements, the rerouting of irrigation return flow through wetlands, road sanding, and landscaping, and are used in rural as well as urban areas. More technology and capital intensive alternatives, used primarily in urban areas to reduce sediment loads from stormwater runoff, include the construction of detention/retention systems and infiltration systems.

Infiltration systems are superior to detention and retention systems, at least conceptually. Their "superiority" derives from the quasi-natural hydrological cycle that they attempt to protect by putting stormwater runoff into the ground, as would be the case in the absence of land-disturbing activities. The advantages of infiltration systems include: reductions in the volume of water discharged to receiving streams, and associated reductions in some impacts caused by excess flows; increases in time-to-peak, and some peak reductions, in water discharged to receiving streams, and therefore the duration of sediment transporting discharges; increases in aquifer discharge; and *in some instances* improvements in water quality.

In terms of the disadvantages of infiltration systems, typically, such systems capture but a small part of stormwater runoff, especially in high runoff events. Since such systems are not designed to retain a permanent pool volume, the timing and size of peaks in stormwater discharges may not be significantly affected in some cases. Finally, there is a risk that pollutants in urban stormwater may contaminate groundwater as a result of infiltration.[33]

VI. Concluding Remarks

We have described the complexities associated with assessing the feasibility of pilot offset banking programs in Georgia, and have reviewed types of programs that might be used to create an offset bank. In our review of considerations related to the feasibility of offset banking programs, we noted limitations on the "demand" side of a water quality trading program imposed by the lack of incentives to purchase credits on the part of many point and nonpoint source polluters.

We conclude by suggesting that, notwithstanding the incentive-related issues, we know of at least one instance where an offset banking program might serve to benefit residents of Fulton County, and we expect that we will be able to identify others. Moreover, continued growth in Georgia, particularly in the Atlanta and Coastal areas of the State, will give rise to increasing numbers of point source entities seeking new discharge permits, and offset banking programs may offer attractive least cost alternatives for meeting what will likely be increasingly stringent limits on discharges of pollutants. Of course, if or when enforcement of TMDLs gains strength in the State, needs for systems like offset banking will increase accordingly. These considerations, and the associated benefits to Georgians that might attend the establishment of offset banking programs in the State, serve as the rationale for the author's continued interest in exploring means by which pilot offset banking projects can be established.

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[33] See, e.g., Pitt, R., K. Parmer, S. Clark, and R. Field, "Potential Groundwater Contamination from Intentional and Nonintentional Stormwater Infiltration-1993 Research Project," Report to the U.S. EPA CR819573EPA/600/SR-94/051, 1994.