WATER REUSE – A WATER SUPPLY OPTION IN THE METROPOLITAN ATLANTA AREA?

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REFERENCE: *Proceedings of the 2003 Georgia Water Resources Conference*, held April 25-27, 2005, at the University of Georgia. Kathryn J. Hatcher, editor, Institute Ecology, The University of Georgia, Athens, Georgia.

Abstract. This paper summarizes information presented in the Metropolitan North Georgia Water Planning District (District) Water Supply and Water Conservation Plan (Plan) developed by Jordan, Jones & Goulding, Inc. and completed in 2003, in which the feasibility of using highly treated wastewater effluent (reclaimed water) as a water supply option was investigated. Three types of water reuse were considered, including direct potable reuse, indirect potable reuse, and non-potable reuse. The estimated amount of potable water that could be augmented with indirect potable reuse applications ranges from 40 to 120 MGD, or between 4 and 12 percent of the projected 2030 annual average day (AAD) demand. Due to stringent nutrient limits, the cost-effectiveness of indirect potable reuse decreases significantly as the discharge quantity of reclaimed water exceeds 120 MGD into a lake or reservoir. The final Plan recommends including 67 MGD-AAD of indirect potable reuse through reclamation in Lake Lanier as a water supply resource.

INTRODUCTION

Securing adequate water supplies for future growth and treating wastewater to preserve water quality in receiving water bodies present major challenges as well as opportunities for the District. One possible way to address both of these issues is through water reuse.

Over the next 30 years the application of water reclamation technology is expected to expand the reuse of water. Currently, there are a few instances of reuse in the District, but other parts of the country rely heavily on reclaimed water to meet their water needs.

The three types of water reuse that will be discussed in this paper are defined below:

Direct potable reuse. Direct potable reuse is reclaimed water that is directly introduced into a potable water distribution system without intermediate storage or mixing in the environment. Direct potable reuse is not currently practiced in the United States, due to a lack of regulatory acceptance and public confidence with its safety. However, this type of reuse continues to be researched with demonstration facilities to evaluate the effectiveness of systems and necessary requirements for implementation.

Indirect potable reuse. Indirect potable reuse is reclaimed water that is returned to the natural environment (groundwater reservoir, storage reservoir, or stream) and mixes with the receiving waters for an extended period of time. Unplanned indirect potable reuse is occurring in virtually every major river system that receives discharges of treated wastewater. In areas with limited water resources, indirect potable reuse is a viable option to help maximize the use of water resources. With planned indirect potable reuse, wastewater is treated to a much higher quality than is typical for unplanned indirect potable reuse water, when the effluent is discharged to surface water that is used downstream as a potable water source. Planned indirect potable reuse has been in practice for more than 30 years in the United States.

Non-potable reuse. Non-potable reuse is reclaimed water that is used for non-potable purposes such as agricultural irrigation, industrial process water, or urban water reuse. Urban water reuse includes irrigation of public areas such as parks, golf courses, residential and commercial landscapes, athletic fields, etc. To facilitate development of non-potable reuse systems and to protect public health, the Georgia Environmental Protection Division (EPD) established the Guidelines for Water Reclamation and Urban Water Reuse in February 2002.

Each type of reuse calls for a different level of treatment. The most common treatment parameters imposed for water reclamation are biochemical oxygen demand (BOD_5), total organic carbon (TOC), turbidity, total suspended solids (TSS), fecal coliform, nitrogen, and chlorine residual. The leaders in reuse water regulations are California and Florida, which stipulate the type of reuse and the increasingly stringent levels of treatment required from non-potable use where human access is restricted to indirect potable reuse.

Although the protection of public health directs reuse water regulations, meeting the needs of the end use should also be considered. For example, treated wastewater contains plant nutrients and organic matter, which improve the soil fertility and encourages growth of plants. Therefore, removing nutrients in reclaimed water for landscape and golf course irrigation is not desired.

POTENTIAL REUSE DEMAND ESTIMATES FOR THE DISTRICT

As part of the Plan, water demand estimates were projected for the District. Based on the moderate growth scenario, the projected annual average day (AAD) water supply need in 2030 is 1,042 MGD for the District. Water demand were also projected by customer categories and water usage types such as residential single family (RSF), residential multi-family, industrial, commercial, indoor water usage, irrigation, as well as other outdoor water usages such as car washing and recreation.

Non-Potable Reuse Estimate. In order to estimate non-potable reuse demands, the irrigation and industrial demand components for the entire District were obtained from the projections. These two components are anticipated to be the most likely type of non-potable resue over the next 30 years. Although in the future, a dual distribution system could supply both potable and reclaimed water to RSF and mulit-family homes as well as commercial buildings for irrigation and other non-potable indoor uses, the expense associated with this option is not likely to occur on a large scale over the next 30 years. The maximum portion of the irrigation demand that could be more readily offset with reclaimed water is the projected 78-MGD AAD urban irrigation demand. However, the urban irrigation demand would not be entirely met through non-potable reuse because of a number of factors, including proximity to a reuse corridor, the use of private irrigation facilities (such as small lakes or groundwater wells), or the small size of some parks or open spaces that can make the cost of infrastructure prohibitive. Therefore, it was estimated that 75 percent of the urban irrigation demand would be met through non-potable reuse, or 58 MGD AAD.

Most parks and golf courses are only irrigated in the spring and summer months, and the irrigation demand is usually very low during winter months. Replacing potable water with reclaimed water for urban irrigation would have a small, but positive impact on demand reduction, especially during peak demand months. Because of the abundant rainfall in the region, demand reduction through urban irrigation is best treated as a way to lower potable water use during peak demand months, therefore conserving potable water for other types of consumption.

The industrial water demand projection is estimated to be 42 MGD AAD by 2030. This demand includes industrial potable water use as well as process water use. The total industrial water demand that could be met through reclaimed water was estimated using industrial survey data from the 1999 *ARC Water Supply Source Evaluation*. The average reclaimed water demand for the surveyed industries, which represented a wide range of process types, was calculated to be approximately 32 percent of the total industrial demand This percentage was applied to the 2030 projected industrial demand; the industrial reclaimed water demand was estimated to be 13 MGD AAD.

The total AAD potable water demand that could potentially be offset through non-potable reuse is 71 MGD, which represents less than 7 percent of the total 2030 AAD District demand.

Indirect Potable Reuse Estimate. Indirect potable reuse quantities were developed by considering the amount of wastewater discharged, minimum in-stream flow requirements, and downstream water withdrawals. However, in practice each WWTP would need to be evaluated individually to determine the potential downstream impacts. Based on preliminary calculations, the amount of reclaimed water available for potable use could range from 40 MGD to 125 MGD, or 4 to 12 percent of the projected 2030 AAD demand for the District. The EPD has imposed limits on the amount of indirect potable reuse that Lake Lanier can accept. The current limit is 92 MGD with a phosphorus level of 0.13 milligrams per liter (mg/L). A larger quantity of reclaimed water could be accepted if more stringent phosphorus limits could be met.

SCREENING ANALYSIS

A screening analysis of the three major types of reuse - non-potable, indirect potable, and direct potable - was performed to determine the best reuse option for the District. Economic and non-economic factors were considered to rank the reuse options.

Economics of Water Reuse

Several cost elements are associated with the development of water reuse systems. These elements include treatment facilities, distribution systems, and operation and maintenance (O&M). The capital and O&M costs for a reuse project vary depending on the type of reuse application, treatment processes applied, and effluent quality standards. Typical capital and O&M costs were collected and compared.

Treatment Facility Cost. Public perception and effluent quality standards in reuse projects demand advanced water reclamation facility (AWRF) and back-up systems to provide additional reliability.

Distribution System Cost. The cost components of a reclaimed water distribution system are similar to that of a potable water supply system. The cost of a reclaimed water distribution system is project-specific, depending on the type of reuse.

O&M Costs. Annual operation and maintenance (O&M) costs for a treatment facility and distribution system include power, chemicals, labor, etc. to maintain continuous operation of the systems.

Cost Summary. The unit cost (based on 2002 dollars) associated with each type of reuse is as follows:

- Non-potable:
  - Treatment capital costs: $2 to $7 per gallon of treatment capacity
  - Irrigation system (drip): $2 to $5 per gallon
  - O &M: $0.50 to $2 per 1000 gallons
- Indirect Potable Reuse:
  - Treatment capital costs: $5 to $10 per gallon of treatment capacity
  - O&M: $1 to $2 per 1000 gallons
- Direct Potable Reuse
  - Treatment capital costs: $22 per gallon of treatment capacity
  - O&M: $2 to $4 per 1000 gallons

In general, indirect potable reuse is less expensive than the direct potable reuse applications due to additional system redundancies and treatment processes required for direct potable reuse. Non-potable reuse can be more expensive than indirect potable reuse because it requires a separate distribution system to convey the reclaimed water to the end users and may also require the installation of irrigation systems and seasonal storage reservoirs.

Ranking of Water Reuse Options. A ranking system was developed by combining the estimated costs with the non-economic criteria that included the following: health risks, reliability, minimizing consumptive use, regulatory, intergovernmental/District and public acceptance, and reduction of potable demand. Using this ranking system, the indirect potable reuse option scored the highest. Direct potable reuse is considered least applicable in the District. Non-potable reuse scored in the middle because this type of usage is expensive to implement and tends to encourages consumptive use while offsetting less of the potable demand.

INDIRECT POTABLE REUSE – DISTRICT IMPLEMENTATION AND COSTS

Indirect potable reuse provides the most flexibility in meeting future potable demands without encouraging consumptive uses such as irrigation. Regulatory acceptability of this option is good, because such systems have already been approved in the State. District/intergovernmental acceptance is also high, although public/stakeholder acceptance may not be as good, as recent court cases have shown.

Discharge Options. Discharge of reclaimed water to a lake or reservoir is preferable to the discharge of water to a river or stream. The water withdrawal credit is 100 percent when the reclaimed water is discharged to a lake or reservoir assuming that these water bodies are capable of storing the discharge. However, when reclaimed water is discharged to a river or stream, the water withdrawal credit is expected to be some fraction of the reclaimed discharge. This is because flow in excess of demand cannot be stored, other downstream users withdraw and discharge fractional amounts of water, and that minimum in-stream flows must be maintained.

Lake Lanier and Lake Allatoona are two likely choices for the discharge of reclaimed water. However, in the Etowah River Basin the available water supply exceeds demand over the next thirty years. The Chattahoochee River Basin does have a water supply shortfall and could greatly benefit from the additional water supply from water reclamation systems.

Conveyance. The cost per gallon of indirect potable reuse accomplished by discharging to a water supply reservoir will increase as more reuse is undertaken. Two factors contribute to this cost escalation: (1) Reclaimed water will need to be pumped from farther away as indirect potable reuse is increased; and (2) Treatment standards will be more stringent to maintain water quality in the reservoir as discharges to the reservoir are increased. An analysis of the cost escalation from pumping and conveyance is presented in Figure 1. To analyze the pumping and conveyance costs associated with indirect potable reuse, planning level cost estimates

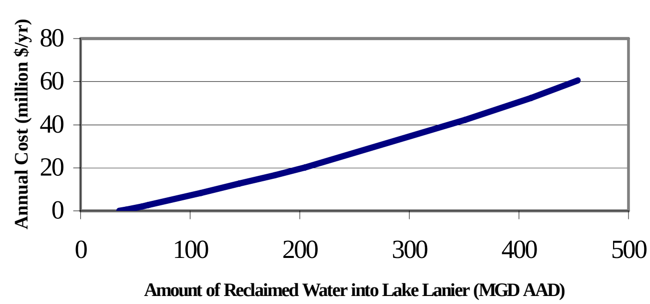

Figure 1: Escalation of pumping and conveyance costs with increased indirect potable reuse.

Table 1. Treatment costs of indirect potable reuse

Amount of Reclaimed Water (MGD)	Required Phosphorus Limit to Maintain Current Loading (mg/L)	Total Annualized Additional Cost (million $/yr)
60 AAD 75 MMF	0.16	0
125 AAD 155 MMF	0.08	26
450 AAD 560 MMF	0.02	285
Greater than 450 AAD	< 0.02	Beyond Capability of Current Practical Technology

MMF = maximum month average daily flow

were developed for several options using Lake Lanier as the ultimate discharge destination for reclaimed water.

Treatment. As indirect potable reuse increases, estimated treatment costs show an even more pronounced escalating trend than pumping and conveyance costs. This is due to the fact that as discharges to a reservoir are increased, all discharges to the reservoir must meet a higher average treatment standard.

Table 1 illustrates the four levels of indirect potable reuse. They are presented with anticipated treatment standards to accompany each level and estimated costs over typical current treatment. Discharges above 125 MGD AAD will result in a sharp increase in the required treatment cost. This is because microfiltration will be required above this discharge amount to meet EPD's phosphorus loading limit for the lake. At a discharge level of 450 MGD AAD, a phosphorus level of 0.02 mg/L would need to be achieved by all the facilities contributing reclaimed water. This is the practical limit of current technology. It was also assumed that at the 450-MGD level of discharge, all facilities contributing reclaimed water would include ozonation and carbon filtration in their process train in order to reduce the level of trace organic contaminants such as endocrine disrupting compounds (EDCs) and pharmaceuticals/personal care products (PPCPs).

SUMMARY

By 2030, the District will be utilizing almost all of its water resources. A small amount of indirect potable reuse is included in the Plan. It is expected that indirect potable reuse will increase beyond 2030 to meet increasing demands. Therefore, building public acceptance through public education and demonstrated success will be important between now and 2030. A total of 67 MGD-AAD of indirect potable reuse to Lake Lanier is one of the strategies identified to extend the water resources of the District.

LITERATURE CITED

Water Supply and Water Conservation Plan, Metropolitan North Georgia Water Planning District, 2003.

Water Supply Source Evaluation, Atlanta Regional Commission, 1999.