INTEGRATED WATER RESOURCES MANAGEMENT IN NORTH GEORGIA-IMPLICATIONS OF WASTEWATER MANAGEMENT POLICY

David J. Sample[1] and Robert A. Bocarro[2]

AUTHORS: [1]Senior Engineer, MACTEC Engineering and Consulting, Inc., 3200 Town Point Drive, NW, Ste. 100, Kennesaw, GA 30144 and [2]Senior Project Manager, MACTEC Engineering and Consulting, Inc., 3200 Town Point Drive, NW, Ste. 100, Kennesaw, GA 30144.
REFERENCE: *Proceedings of the 2005 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. Water management in the southeast, and particularly in Georgia, has become increasingly more complex due to rapid population growth, dwindling water supplies, water quality and instream flow concerns, and allocation disputes with neighboring states. The Georgia state legislature responded with two key initiatives: SB 130, passed in 2001, which formed the Metropolitan North Georgia Water Planning District (MNGWPD), and HB 237, passed in 2004, which requires the development of a Comprehensive Statewide Water Plan (CSWP). In 2003, the MNGWPD adopted wastewater management, watershed protection, and water supply and conservation plans that will guide water resources in metropolitan Atlanta for the next 30 years.

Implementation costs of the MNGWPD water and wastewater plans through 2030 has been estimated to total $60B. To conserve financial resources and encourage a sustainable development pattern, it is necessary to prioritize these investments, i.e., focus investments upon areas have the ability to increase population density due to the proximity of existing services. Currently, growth management policies in some jurisdictions encourage septic system development, increasing overall wastewater treatment costs and interfering with water management goals.

INTRODUCTION

The MNGWPD consists of 16 counties which are the bulk of the metropolitan Atlanta region, located in northern Georgia and straddle portions of five river basins: the Chattahoochee, Etowah-Coosa-Tallapoosa, Flint, Oconee, and Ocmulgee River basins. Two large federal dams have been constructed on the Chattahoochee and Etowah Rivers; these dams are Buford Dam which forms Lake Lanier, and Allatoona Dam, which forms Lake Allatoona, respectively. These dams are operated by the U.S. Army Corps of Engineers (USACE). Lake Lanier has a slightly smaller watershed than Lake Allatoona, but has a large volume of 2.554 million AF, almost 3 times the volume in Lake Allatoona (USACE 1991, 1993). In terms of flow, the Chattahoochee River is the smallest river to supply a major metropolitan area in the U.S (Georgia Rivers Network 2005). Despite this, water supply is not considered the primary purpose of either lake.

Rapid development has occurred in metropolitan Atlanta over the past several decades. Water supply withdrawals from Lakes Allatoona and Lanier have grown significantly. In order to reprioritize the two reservoirs for the benefit of water supply, Georgia entered into a reallocation process with the USACE; a process that was halted when the downstream states of Florida (part of the Apalachicola-Chattahoochee-Flint (ACF) system) and Alabama (part of both the ACF and Alabama-Coosa-Tallapoosa (ACT) systems) objected, resulting in a long, federally authorized compact negotiation with both states. A key component of these negotiations was return flows, i.e., those flows that are discharged to a basin subsequent to its withdrawal. Consumptive use within each basin thus has a direct, negative impact on downstream returns. Despite a tentative deal on both the ACT and ACF, both compacts failed to reach agreement of all parties by the required deadline. Two separate court actions are currently pending, however, it is recognized that due to the differences between the three parties, the ultimate decision may only by reached at the U.S. Supreme Court.

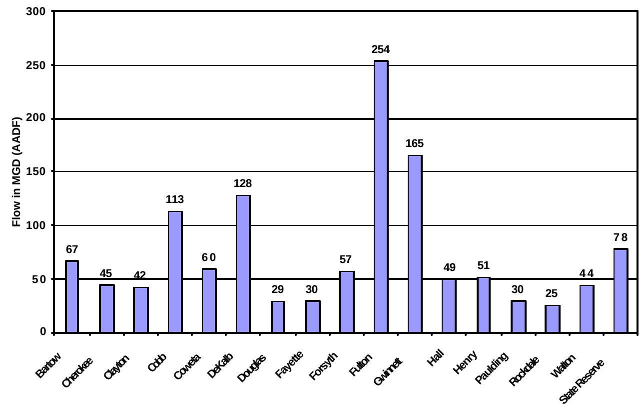
During the late 1990s, there was a growing awareness of both the decline in water supplies during the historic drought, and the decline in water quality as the direct result of development. This led to the formation of a task force known as the "Clean Water Initiative". A direct result of the initiative was SB 130 which created the MNGWPD, and charged it with developing regional plans for watershed management, wastewater treatment, water supply and conservation. The MNGWPD began the work of developing the three separate plans in 2001. Once the final plans were developed, a process was put in place for allocation of new supplies across the MNGWPD. During development of the MNGWPD plans, a need arose for a rational process for water allocation based upon choices made in land planning. MNGWPD, with Georgia

Environmental Facility Authority (GEFA), developed and adopted a Decision Support System (DSS) consisting of layers of interlocking spreadsheets that describe each governmental entity and watershed and integrate the effects of land management decisions upon available water supplies. The DSS, known as the Zero Based Budget Model (ZBBM), is based upon the principal "more for one means less for others"; rather than the traditional principal of "first come-first served" by which water supplies are allocated (Cowan et al. 2003). The ZBBM attempts to reward planning decisions that minimize consumptive use and encourage return flows. The final water allocation adopted by MNGWPD in 2003 is presented in Figure 1. The availability of future water supplies and estimation of future demand was one of the key tasks of the Water Supply and Conservation Plan. Estimation of future demand hinges on the implementation of an aggressive water conservation plan, estimated to save approximately 11% of baseline demand. Figure 2 illustrates the main demand reductions, existing supplies, and supply enhancements in the adopted plans.

The MNGWPD plans provide an outline for each county, by basin, of what facilities will be required to serve the expected population with wastewater capacity through the year 2030. The total estimated costs of approximately \$60B for both water supply and wastewater are spread over 30 years, however, the impact of this required investment is large and will require new financial management at the local, state, and federal level. Current Georgia Environmental Facility Authority (GEFA) provides low interest loans for water and wastewater projects; the aggregate bonding capacity for the entire state is currently limited to about \$2.5B. It will thus be important to prioritize the required investments to achieve the best returns in terms of meeting water and water quality goals.

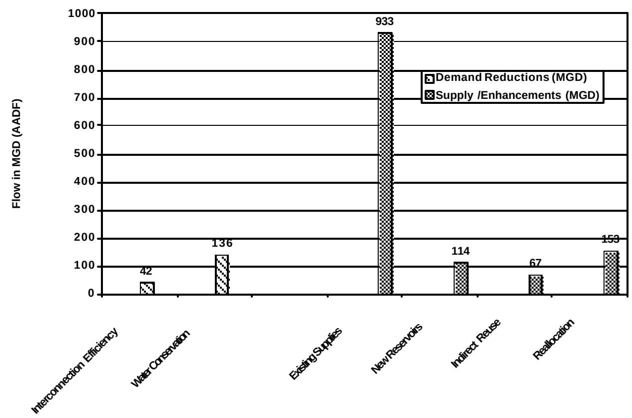
DECENTRALIZED SYSTEMS POLICIES AND IMPLICATIONS FOR THE MNGWPD

The MNGWPD was charged, as part of the long-term wastewater plan, to develop a set of recommendations regarding septic systems in critical areas of the district. Failing septic tanks are widely considered to be the main contributor to stream segments that are listed for nonattainment of their designated use (under section 303(d) of the Clean Water Act) for fecal coliform. However, an accurate spatial inventory of septic systems does not presently exist through all 16 counties. The U.S. Census included a count of septic systems in its 1990 Census; however, it was omitted in the 2000 census.
In order to develop an estimate for 2000 and beyond, a generalized relationship was needed and developed by



Source: MNGWPD Water Supply and Water Conservation Management Plan (JJG 2003)

Figure 1: MNGWPD Final Water Allocations for 2030



Source: MNGWPD Water Supply and Water Conservation Management Plan (JJG 2003)

Figure 2: MNGWPD Demand Reductions and Supply Enhancements

JJG, MMI, and MacGregor (2003). Based upon the detailed information available in the 1990 census, a relationship was developed between the dependent variable, septic use as a % of the population, or SU, and the independent variable, population density in persons/Acre. A curve fit was obtained using log transformation of the independent variable, and the resulting relationship was obtained:

$$SU = 87.425e^{-0.8256D} \quad \textbf{(1)}$$

where:

SU = Septic use, as percent of population
D = Population density in persons/acre

Estimates of population and density were developed as part of the development of the Water Supply and Water Conservation Management Plan (JJG, 2003). These estimates and the above relationship were then used to develop estimates of the wastewater flow to septic systems for the years 2000-2030 based upon the following three scenarios: Baseline, high septic use, and low septic use. The baseline scenario assumes that septic use will follow the curve established in Equation 1. The estimates developed by JJG, MMI and MacGregor (2003) for these three scenarios are provided in Table 1.

Table 1. Estimated Flow to Septic Systems, MNGWPD

Scenario	2030 Projected Flow to Septic Systems (MGD)	Portion of 2030 Wastewater Flow to Septic Systems
Baseline	51	7%
High Septic Use	127	18%
Low Septic Use	13	2%

Note: 2001 Estimated Flow to Septic Systems was estimated to be 87 MGD.

Return ratios have become an important performance measurement of the selected plans. A return ratio is calculated by dividing discharges to a basin by withdrawals from a basin; the ratio can thus assess the effect of interbasin transfers. By definition, consumptive uses are excluded and thus reduce returns. Return flows from septic systems will vary significantly by basin based upon local hydrogeology, soil characteristics, depth to groundwater, and distance to receiving waters. Little literature information is available regarding techniques to calculate or estimate septic return flows on a basinwide extent. Evapotranspiration would be expected to reduce returns significantly in a properly functioning septic system; thus returns may vary significantly with annual climate. Landon et al. (2000) used radioactive tracers to calculate transit times through the unsaturated zone by recharge water. The authors found that during periods of low groundwater conditions, transit times were on the order of 6 months or more. The EPD thus assumed, in the context of drought planning and compact negotiations that return flows from septic systems are negligible. Because the net returns were the substantive issue being negotiated during the compact negotiations, a tentative agreement was reached which established a minimum of 50-58% returns in the Chattahoochee Basin (JJG 2003a, JJG 2003b). Septic systems reduce the return ratio within a given basin because their return ratio is assumed to be negligible. Estimates of septic flows, withdrawals, and discharges from the MNGWPD plans for the years 2001 and 2030 are provided in Table 2.

Because of the potential effect of septic systems on consumptive use, and thus the return ratio and the regions' water supply, and for water quality concerns, the MNGWPD adopted a set of recommendations to improve septic system: siting, design, and construction; maintenance requirements; management systems (including development of a database); and development of improved policies for connecting systems to public sewers.

DISCUSSION OF THE CAUSAL FACTORS OF SEWERAGE STRATEGIES

Because of the inadequacy of the available database on septic locations, estimates of the current effects on return ratios can only be considered approximate. The MNGWPD has attempted to minimize the effect of this uncertainty in later years of the plan by providing for the evolution of policies regarding septic systems ranging from inventory to providing for areas where dry sewers will be installed for later hookup to sewerage systems. However, provision of sewerage services may vary widely in cost. These costs are not included in estimates of implementation costs of the Long Term Wastewater Plan.

The effect of population density on sewerage decisions should not be underestimated. Adams et al. (1972) and Clark (1997a, 1997b) both found significant diseconomies of scale as sewer systems became extended into suburban areas. Clark (1997b) developed a procedure that models a pipe network as a rectangular grid. Because of this generalization, the effect of spatial scale could be evaluated. Both Adams and Clark used their observations to support decentralized systems that reuse wastewater instead of regionalized wastewater treatment. These types of wastewater reuse systems have the advantage of reusing wastewater closer to the point of its origination, thus possibly saving significant transmission costs. However, in this model, population density is an extremely important factor. For example, Burchell (1998) estimated that connecting sparse suburban customers presently served by septic may cost an additional $7000 more than customers from more densely populated regions. This is consistent with the cost model developed in Heaney et al. (1999a) which found a very strong influence of population density. The authors estimated the costs of providing sewerage ranged from $1,100 per DU at 10 DU/acre to $7,000 per DU at 2 DU/acre.

Population density within the Atlanta metropolitan region has actually decreased during the past two decades. This is consistent with growth pattern of larger lot sizes and ever expanding suburbs. Current densities within the Atlanta metropolitan area from the 2000 Census are provided in Figure 4.

Because of the low density of some regions of the MNGWPD and the relatively high cost of providing sewerage services to low density areas, some areas may

Table 2. Projected Flows and Return Ratios, MNGWPD

	2001					2030 Adopted Plan			
Basin	**Existing Supplies (MGD)**	**Septic Consumptive Flows (MGD)**	**Withdrawals (MGD)**	**Discharges (MGD)**	**2001 Return Ratio**	**Septic Consumptive Flows (MGD)**	**Estimated Demand with Aggressive Conservation (MGD)**	**Discharges (MGD)**	**2030 Return Ratio**
Chattahoochee	641	30	414	262	0.63	15	533	498	0.75
Etowah	133	17	85	30	0.35	17	151	109	0.42
Flint	61	7	33	6	0.19	6	79	74	0.50
Ocmulgee	98	28	27	65	2.41	10	291	279	1.17
Oconee	0	4	5	2	0.42	4	27	18	0.25
Total	**933**	**86**	**564**	**365**		**52**	**1081**	**978**	

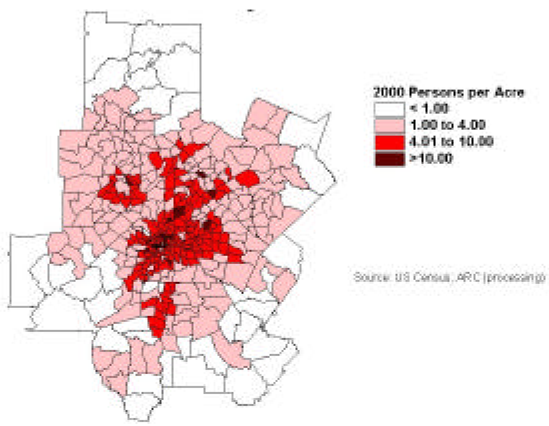
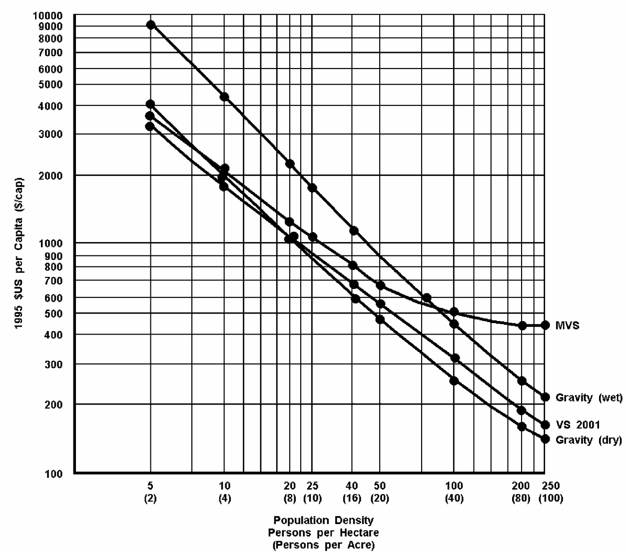


Figure 4: Atlanta Metropolitan Region, Population density in Persons/Acre

not be feasible to serve them by the year 2030. In these cases, alternative sewerage collection systems may be viable. These systems include vacuum sewers and septic tank effluent pumping, or STEP (Heaney et al. 1999b). Hassett reviewed these systems and developed cost as a function of population density for each two types of vacuum sewers, wet sewers (below water table), and dry sewers (above the water table); this relationship is provided in Figure 5. Note that at population densities lower than 8 persons per acre, the VS 2001 vacuum sewer was the most cost effective collection technology. Policies that encourage increases in population density and the provision of sewerage may also be influential in decreasing septic system installations and thus lower consumptive use. It has been suggested by (Metro Atlanta Chamber of Commerce 2004) that in cases where funds are limited, provisions should be to encourage expenditure in areas of greater population density, thus assisting in reduction of urban sprawl, another desirable outcome.

CONCLUSIONS AND RECOMMENDATIONS

The plans recently adopted by the MNGWPD anticipate a reduction in septic flows, based upon an increase in



Note: MVS and VS 2001 are brands, MVS stands for Modern Vacuum Sewer, and VS 2001 for Vacuum Sewer-21st Century.

Figure 5: Cost Curves for Different Sewer Collection System Technologies from Hassett (1995)

population density, thus improving the relative cost effectiveness of providing sewerage. However, it is the present policy of several MNGWPD members to encourage low population density growth that will be served by septic systems. Thus the future return ratios remain uncertain. As the MNGWPD plans evolve, the following considerations should be given:

- When the septic tank inventory is completed, the projected return flows should be updated which incorporates effects of uncertainty on future forecasts.
- A field assessment of several functioning septic systems should be performed during low and high groundwater conditions in order to confirm the assumption that these returns are negligible.

- A systematic model of the sewerage network could be developed for the metropolitan region, similar to that by Clark (1997b). Various forms of providing sewerage services can then be evaluated on a large scale in terms of a cost-effectiveness analysis.
- Alternative collection system strategies should be evaluated for consideration in low density areas.
- The current financing strategy whereby the homeowners are 100% responsible may not achieve the desired results in all areas.
- Alternative financing strategies may become necessary and need to be explored.

As the CSWP progresses; it should consider the methods and plans developed for the MNGWPD. Some of the early assumptions in developing the MNGWPD should be revisited in the CWP, particularly the assumption regarding septic tank return flows. With the varied hydrogeology and physiographic characteristics of the state of Georgia, it would be wise to quantify septic tank returns, if any, on a basin by basin basis, and assess performance, i.e., overall return flows on the same basis. Should the impact of septic tanks on return flow be similar to that shown in the MNGWPD plans, the above recommendations should be carefully considered for the CSWP.

LITERATURE CITED

Adams, B.J., J.S. Dajani, and R.S. Gemmell, 1972. On the centralization of wastewater treatment facilities. Water Resources Bulletin. 8(4), p. 669-678.

Burchell, R.W., (et al.), 1998. The Costs of Sprawl-Revisited, National Academy Press, Washington, D.C.

CH2MHill, 2003. District-Wide Watershed Management Plan. Prepared for the Metropolitan North Georgia Water Planning District, Atlanta, Georgia.

Clark, R., 1997a. An Exploration of the Concept, Unpublished Report #1 in the Water Sustainability in Urban Areas: An Adelaide and Regions Case Study. Department of Environment and Natural Resources. Adelaide, South Australia.

Clark, R., 1997b. Optimum Scale for Urban Water Systems, Unpublished Report #5 in the Water Sustainability in Urban Areas: An Adelaide and Regions Case Study. Department of Environment and Natural Resources. Adelaide, South Australia.

Cowan, J., Chou, A., Bocarro, R., and Sample, D., 2003. Managing the Interrelationships of Watersheds and Water supplies: The Zero Sum Water Allocation Model© 2002 GEFA, Proceedings of the World Water & Environmental Resources Congress 2003, ASCE, June 23-26, 2003, Philadelphia, PA, 2003.

Georgia Rivers Network, 2005. Chattahoochee River Basin-Quick Facts, obtained at http://garivers.org/PDF%20Files/Chattahoocheeshort.pdf.

Hassett, A., 1995. Vacuum Sewers-Ready for the 21st Century. In WEF. Sewers of the Future. WEF Specialty Conference Series Proceedings. September 10-15, 1995. Houston, TX. Water Environment Federation. Alexandria, VA

Heaney, J.P., D.J. Sample, and L. Wright, 1999a. Cost Analysis and Financing of Urban Water Infrastructure, Chapter 10 In Heaney, J.P., Pitt, R., and Field, R. (Eds), Innovative Urban Wet-Weather Flow Management Systems, U.S. EPA Report, EPA/600/R-99/029.

Heaney, J.P., L. Wright, D.J. Sample, 1999b. Collection Systems, Chapter 6 In Heaney, J.P., Pitt, R., and Field, R. (Eds), Innovative Urban Wet-Weather Flow Management Systems, U.S. EPA Report, EPA/600/R-99/029.

Jordan, Jones, & Goulding, Inc., 2003a. Long-Term Wastewater Management Plan. Prepared for the Metropolitan North Georgia Water Planning District. Atlanta, Georgia

Jordan, Jones, & Goulding, Inc., 2003b. Water Supply and Water Conservation Management Plan. Prepared for the Metropolitan North Georgia Water Planning District. Atlanta, Georgia.

Jordan, Jones, & Goulding, Inc., McKenzie MacGregor Inc., and L. MacGregor, 2003. Technical Memorandum 5-3: Impacts of Septic Systems, prepared for the Metropolitan North Georgia Water Planning District.

Landon, M.K., Delin, G.N., Komor, S.C., and Regan, C.P. (2000) Relation of Pathways and Transit Times of Recharge Water to Nitrate Concentrations Using Stable Isotopes, Ground Water, 38 (3): 381-395.

Metro Atlanta Chamber of Commerce, 2004. Trends, Implications & Strategies for Balanced Growth in the Atlanta Region, A Synthesis Report of the SMARTRAQ Outreach Program.

U.S. Army Corps of Engineers, 1991. Apalachicola Basin Reservoir Regulation Manual, Appendix B, Buford Dam (Lake Sidney Lanier), Chattahoochee River, Georgia.

U.S. Army Corps of Engineers, 1993. Water Control Manual, Appendix A, Allatoona Reservoir, Etowah River, Georgia, March 1952, revised December 1993.