Development of Public Outreach Approaches and Decision Making Tools for Local Government

by Kim N. Irvine, Mary Perrelli, Natalie Brown and Mary C. Rossi

The Buffalo River, located in western New York State, frequently is used for swimming and secondary contact purposes despite the lack of designated bathing areas and the potential for high levels of fecal coliform. The 33 combined sewer outfalls (CSOs) that potentially discharge to the Buffalo River during larger storm events were thought to be a principal source of bacteria. However, more recent studies including work on the Buffalo CSO Long Term Control Plan, showed that by far the greatest loadings entered the river from the upper watershed (upstream of the CSOs). There are several potential bacteria sources in the upper watershed, including agricultural activity, wildlife, suburban runoff, and failing septic systems.

A 2001 Buffalo News article (8/19/01, www.buffalonews.com) reported that 44 percent of 983 wells tested for homes sold in rural parts of Erie County (communities of Akron, Alden, Aurora, Boston, Clarence, Colden, Eden, and Newstead) between 1996 and 2001 were positive for coliform. This percentage was higher than the 11 percent reported by neighboring Chautauqua County for 2001 and the 32 percent reported for three rural counties in upstate New York (Schwartz et al., 1998). The Buffalo News article identified failing septic systems as a source of coliform to the wells.

Recognizing the potential importance of failing septic systems as a contributing factor to high bacteria levels both in local waterways and in wells, this study had two broad objectives. The first objective was to develop and deliver a county-level outreach program related to appropriate septic system construction and maintenance. The second objective was to develop a modeling and data visualization approach to help Erie County personnel identify problem source areas and evaluate the potential impact of septic remediation on receiving water quality.

Methods

Septic System Workshops and Website

Four septic system workshops were offered in the towns of Clarence, Grand Island, Sardinia, and Eden, through the collaborative efforts of the Erie County Water Quality Committee. A package of septic system information developed by the Cornell Cooperative Extension was reproduced and provided to each participating family as they signed in at the beginning of the workshop. The workshop included four specific presentations:

- Soil characteristics (presentation provided by USDA NRCS-US Department of Agriculture-Natural Resources Conservation Service personnel)
- Environmental impacts of failing septic systems (presentation provided by Erie County Health Department personnel)
- Septic system design considerations (presentation provided by Erie County Health Department personnel)
- Septic system maintenance issues (presentation provided by a private septic system maintenance operator)

A questionnaire was handed out upon sign in at the Sardinia and Eden workshops to obtain information about current septic system practices. The questionnaire was mailed to the Clarence and Grand Island participants because these workshops were held prior to the development of the questionnaire. The Erie County Department of Environment and Planning also designed and hosted a web page describing the project, as well as key aspects of septic system operation and maintenance (www.erie.gov/environment/compliance/pollution_prevention.asp#SepticSystem).

Water Quality Assessment Tools

Figure 1 outlines the general approach used to develop water quality assessment tools for the Buffalo River watershed. The Automatic Delineation Tool within the US Environmental Protection Agency's (EPA) BASINS (Better Assessment Science Integrating point and Nonpoint Sources) was used to divide the 1,155 km² watershed into 101 sub-basins. Digital building footprint data and parcel data (1993) for the watershed were obtained from the Erie County Water Authority and imported into the ArcView 3.2 Geographic Information System (GIS) software. The parcel data file included information on the structure (footprint) classification and for most residential structures it included the number of bedrooms. A small portion of the upper Buffalo River watershed is located outside of Erie County, therefore, the Erie County Water Authority data did not cover this area. The one (1) meter statewide digital ortho-imagery, or digital airphotos, from 1994 to 1999 was used to identify and digitize structures outside of Erie County and to update the Water Authority coverage within the county.

![Figure 1: Methodology used to develop water quality assessment tools.](image)

Studies have shown that properly functioning septic systems can remove essentially all bacteria over a distance of 50 to 300 feet. To be conservative, a 300-foot buffer was placed around all waterways within the watershed using ArcView 3.2. It was assumed that any structure within the 300-foot buffer (and not including sewered areas) potentially contributed fecal coliform to the waterway (Figure 2). Fecal coliform loading from each structure within the 300-foot buffer is a product of discharge rate to the septic system and coliform concentration. Discharge rates for most structures were determined from the USEPA's Onsite Wastewater Treatment System Manuals (USEPA,1980; 2002). For major dischargers, such as large institutions, industries, etc., discharge rates were adjusted according to the USEPA's Onsite Wastewater Treatment System Manuals (USEPA,1980; 2002).
and commercial facilities, the SPDES (State Pollutant Discharge Elimination System) permitted discharge rates were used. To calculate the total volume of flow from each structure on a daily basis, the number of people per structure must be determined. The USEPA (2002) noted that residential occupancy typically is 1.0 to 1.5 persons per bedroom, with a maximum of 2.0 persons per bedroom. For those residences that were included in the Erie County Water Authority database, the multiplier was taken as 1.5 persons per bedroom. For those residences that were not included in the Water Authority database, the multiplier was taken as the average number of people per household in that town, as determined from the 2000 US census.

For each of the 101 sub-basins, the total daily septic system discharge volume was calculated by summing the discharge from each structure within the 300-foot buffer. The bacteria load was then calculated by summing the product of the daily septic system discharge volume for each structure within the 300-foot buffer and a representative fecal coliform concentration, here taken as $1 \times 10^5$ cfu/L (fecal coliform per liter) (USEPA, 2002). Septic systems have different treatment efficiencies, so the calculated bacteria load that potentially would reach the waterway was reduced by varying factors, zero (0) percent (i.e., no bacteria treatment), and 50, 90, 95, 99.5, and 99.9 percent. This range enabled evaluation of the average level of efficiency needed to ensure good water quality.

For all headwater sub-basins, the bacteria concentration at the channel outlet was calculated using the bacteria load divided by the total daily flow volume from the sub-basin (Figure 1). The sub-basin flow volume was modeled using a calibrated version of BASINS winHSP-F (Hydrologic Simulation Program-Fortran, release 3). To determine bacteria concentrations for downstream sub-basins, the winHSP-F model was used to add and route the flow and bacteria from the upper sub-basins.

Results and Discussion

Workshop Outreach and Questionnaire

Approximately 350 people attended the four workshops and a total of 120 questionnaires were analyzed (if more than one member of a family attended the workshop, they were asked to complete only one questionnaire). There was a 55 percent return rate for the question-
naire mailings. Questionnaire results were tabulated separately for the Sardinia, Eden, and Grand Island/Clarence (mailings) workshops. A list of all questions is available from the authors, but the most significant findings are summarized in Figures 3, 4 and Table 1.

The questionnaire revealed some positive aspects of public understanding, as well as some areas of concern regarding proper septic system practices. For example, while most people practiced at least some BMPs (Best Management Practices), and the majority of respondents pumped their septic system every three to five years, approximately one-third of the homes had a septic system that was more than 30 years old. The average lifespan of a properly designed, installed, and maintained septic system is 20-30 years (Cornell Cooperative Extension, Fact Sheet SS-4), so the relatively large proportion of older systems in rural Erie County represents a higher risk for failure. There also was a relatively high percentage of septic systems in the one to nine-year age category, in part reflecting the current trend of out-migration from the city of Buffalo. Our questionnaire showed that the percentage of respondents pumping their septic system every three to five years ranged from 54 to 85 percent for the different workshop locations, with an average of 62 percent. By comparison, Schwartz et al. (1998) reported 35-73 percent (average of 53 percent) of respondents pumped their systems every three to five years in three upstate New York counties.

![Figure 3: Age of septic systems.](image)

![Figure 4: Best Management Practices employed by workshop attendees.](image)

Notes:
A – Safe disposal of substances (e.g. don’t put grease, oil, antifreeze or other non-biodegradable substances down the sink or toilet)
B – Protection of the absorption field
C – Conservation of water
D – Not placing additives in the septic tank to accelerate settling or decomposition
E – Not using chemical solvents to clean plumbing or septic system

Based on the responses shown in Table 1, it can be concluded, with some caution, that the frequency of septic system failure ranged between 10 and 42 percent, with an average of 27 percent. The USEPA (2002) found that comprehensive data to measure the true extent of septic system failure are not currently collected. Although failure rate estimates were made for 28 different states, no state directly measured its own failure rate and the conditions used to define a failure varied from state to state. The failure rates, as reported by the USEPA (2002), ranged from low values of 0.4 - 0.5 percent (Arizona, Utah, Wyoming) to high values of 50 - 75 percent (Louisiana, Minnesota, Missouri). The failure rate for New York was listed as four (4) percent, which clearly is less than the rate calculated for this study. Part of the reason for the lower rate as reported by the USEPA (2002) may be related to the fact that failure in New York is only reported when a home sale occurs, or when a local health department is called. The response for those people who noticed signs of septic system failure matched well with the response of those not planning to replace their septic system (Table 1). The lowest rate of reported problems with system failure was recorded for the mailings (10 percent), which also had the highest percentage of people indicating that they did not have plans to replace their septic system (85 percent). The Eden survey had the highest rate of reported problems with system failure (42 percent) and the lowest percentage of people indicating that they did not have plans to replace their septic system (54 percent).

The cost of replacing a septic system clearly was a consideration for workshop attendees, as 46-59 percent (average of 51 percent) indicated cost was at least in part a deciding factor in replacement. For those who responded to an additional question, it seems that a subsidy in the range of 75 percent of the cost (or $2,700 for those who responded in a dollar value) would be needed to encourage people to replace their system.

**Model Results**

The hydrologic and sediment transport components of the winHSP-F model were calibrated in a previous study using daily mean flow from US Geological Survey (USGS) gauge stations on Cazenovia, Buffalo, and Cayuga Creeks for the years 1990, 1992, 1995, and 2000 and suspended sediment data collected in 2000 (Perrelli et al., 2005). Fecal coliform loading estimates were made for the 101 sub-basins using the assumption that each septic system had a uniform treatment efficiency of 0, 50, 90, 95, 99, 99.5, and 99.9 percent. An example of the loading estimates on a daily basis and the geometric mean fecal coliform level for these estimated inputs only represent estimated inputs from septic systems and no other bacteria sources within the continued on page 55
Fecal Coliform Levels at 99.5% Efficiency

Figure 5: Daily fecal coliform loading (total number of coliform) from septic systems, by sub-basin, assuming 99.5 percent removal efficiency.

watershed. Table 2 also shows the geometric mean of dry weather samples collected in 1991-93, 1996, 2000, and 2002 from sites within the identified sub-basins.

Based on the results in Table 2, it seems that septic systems may provide between 20 and 50 percent of the fecal coliform concentrations in the downstream sub-basins of the Buffalo River watershed during dry weather.

Study Conclusion

The septic system workshops were well attended and seemed an effective method of community outreach. The questionnaires generated useful information about current septic system conditions and practices in Erie County. Cost was an important consideration in the homeowner decision to replace a septic system. A subsidy in the range of 75 percent of the cost, or $2,700, would be needed to encourage many respondents to replace their system.

The visualization of potential fecal coliform loads using GIS, on a sub-basin scale, provides a good outreach tool. Development of these loading estimates is not complicated and most county agencies would have personnel skilled enough in GIS to conduct such analyses. However, time and funding considerations may be such that this type of evaluation would not be possible. The spatial pattern of loading estimates matched well with historical fecal coliform data. Results of the BASINS winHSP-F modeling indicated that septic systems may be the source of 20-50 percent of the fecal coliform concentration in downstream sub-basins during dry weather. The BASINS winHSP-F model provides the capability of exploring “what if” scenarios to examine the impacts of different levels of septic system treatment efficiency and also can be used in TMDL (total maximum daily loads) development. Although BASINS version 3.0 is easier to work with than its predecessors, the model still requires considerable time and experience in both GIS and water quality modeling.

Kim N. Irvine (irvinekn@buffalostate.edu) is a professor and chair in the Department of Geography and Planning and an affiliate member of the Great Lakes Center at Buffalo State - State University of New York. Mary Perrelli is the GIS lab manager also in the Department of Geography and Planning at Buffalo State. Natalie Brown was an undergraduate research assistant in the same department. Mary C. Rossi is with the Erie County Department of Environment and Planning.

References


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