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The Kentucky Institute for Watershed Management Support

Abstract

This paper will demonstrate the effectiveness of the university-housed watershed capacity development approach of the Kentucky Institute for Watershed Management Support (KIWMS). KIWMS engages students in developing and implementing model holistic processes for rehabilitation/regionalization and management for communities with aging on-site wastewater management systems. This approach exposes students to the broader aspects of watershed management beyond the mere technical components.

KIWMS provides regional planning support to communities throughout the Commonwealth in order to maintain the natural and economic resources of their watersheds. The Center for Water Resource Studies (CWRS), which houses KIWMS, uses undergraduate students from Western Kentucky University (WKU) to conduct field work, develop surveys and analyze data under the direction of a Professional Engineer. The CWRS expertise in water and wastewater, combined with its mission as a utility and municipal technical assistance provider, empowers communities to realize the fundamental goal of holistic watershed management. KIWMS leverages synergy between local, state and other resource agencies at a watershed level by providing infrastructure and support for accountability and the technical basis to ensure measurable results.

Background

Kentucky Institute for Watershed Management Support. Regulatory instruments exist for improving water quality on a watershed basis for redress and rehabilitation in the case of pathogen impaired streams. For streams impacted by runoff from agricultural operations, Kentucky's Agricultural Water Quality Act provides operational standards and a means for enforcement to ensure the protection of the Commonwealth's waters. Water quality impacts from failed septic systems can be mitigated by enforcement of performance standards by local public health departments. Kentucky's Watershed Management Framework favors local engagement and implementation over regulatory enforcement for meeting water quality goals. Success of this approach is dependent on access and engagement of technical, financial and managerial capacity development programs in a similar fashion as those existing for drinking water and wastewater infrastructure. KIWMS engages stakeholders at the local and regional level in a collaborative problem solving process to develop sustainable and technically sound solutions for pervasive failures in onsite wastewater systems that potentially contribute to the pathogen impairment of local streams and limit economic growth.

KIWMS engages local communities with regional planning entities to achieve local change that positively impacts watershed health. A key strategy in the community-specific implementation of the KIWMS is a public education campaign. KIWMS promotes strategies for wastewater minimization for both residential and commercial establishments. KIWMS also provides Technical, Financial and Managerial assistance to develop and implement functional and extensible wastewater management alternatives for communities throughout Kentucky to improve watershed health and promote economic development. This assistance is provided through detailed situation assessments, technology demonstrations, public education, and

technical, managerial and financial alternatives that include hands-on student engagement. The techniques developed and resources accessed to further wastewater minimization strategies are transferable to other project areas.

As an impartial entity, KIWMS acts at the interface between federal, state and local government, private sector organizations, funding agencies and local stakeholder groups with the ability to expend effort and resources on critical activities that do not fit neatly within the other organizations' missions. KIWMS provides scientific expertise to local Area Development Districts and local stakeholder groups using CWRS resources and through coordination with universities and community/technical colleges serving the region. This model builds on the established Technical, Financial, and Managerial (TFM) capacity development precepts employed by the CWRS in the drinking water and wastewater infrastructure sectors. This approach is modeled on the Initiative for Watershed Excellence[1] promoted by the United States Environmental Protection Agency (USEPA).

Center for Water Resource Studies. The CWRS is a unit of the Applied Research and Technology Program (ARTP) at WKU focused on capacity development for small and rural water resource management entities. The ARTP, a student engagement and entrepreneurship stimulation initiative of the University, serves as a catalyst for regional economic development by developing a creative workforce and providing technological and environmental services. KIWMS is a relatively new initiative of CWRS, designed to provide local community and Non-Governmental Organization (NGO) support by leveraging university technical capacity in much the same way university-based technical assistance centers provide support to small drinking water systems under the Safe Drinking Water Act[2].

Student Engagement Philosophy. Engaging undergraduate students in practitioner-outcome driven projects is inherently more costly than reliance on a team of technical professionals. The primary factors driving the additional cost are the lack of technical knowledge and practical experience typically associated with undergraduate students. Projects involving graduate students tend to be less cost negative, although traditional graduate students may still lack practical experience requiring additional effort to remediate. Teaming graduate and undergraduate students leverages the technical knowledge of the graduate student while maximizing the value of the enthusiasm of the undergraduate student.

In order for a university housed service center (i.e., one that provides a fee-based suite of services to the community) to be effective while engaging undergraduate and graduate students, a core set of technical professionals have to be in place to offset the additional effort expended on student learning without negatively impacting project performance.

The Community of Glendale, Kentucky. Glendale is a small unincorporated community approximately 10 miles south of Elizabethtown, Kentucky, with approximately 75 residential dwellings (See Figure 1). Its economic base is primarily from antique retail establishments located within a community Historic District. The surrounding area has seen some growth with subdivisions being developed to support the Elizabethtown urban area. No centralized wastewater services exist, and the proliferation of on-site residential units, along with the existing base of older installations has limited the expansion of the retail establishments due to

reluctance by the Health Department to permit new septic units in the "downtown" area. The Glendale community lies within…miles of Valley Creek, which is one of the 39 segments listed in Kentucky's 2006 Integrated Report to Congress for pathogens. The causes of the pathogen impairments are typically either runoff from animal feeding operations, or failed septic systems.

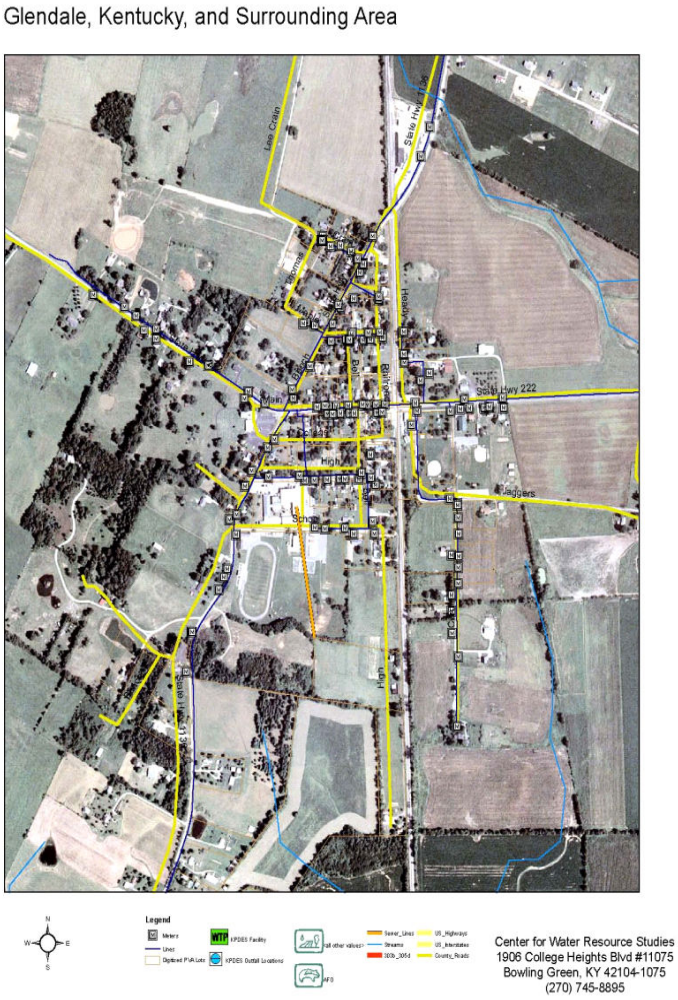

Figure 1. Locational Map of Glendale, Kentucky

Objectives

KIWMS is in the process of implementing a place-based approach, focusing on the community of Glendale as a demonstration of the stewardship approach in which stakeholders at the local and regional level are engaged in a collaborative problem solving process to develop sustainable and technically sound solutions for pervasive failures in onsite wastewater systems that potentially contribute to the pathogen impairment of the neighboring Valley Creek segment and limit the community's economic growth.

Approach

1. Engage students in project execution
2. Identify "hot spots" or trouble areas in community

3. Situation assessment
4. Evaluate and present alternatives
5. Educate the public

Student Engagement Logistics. The CWRS field operations team for this project consists of three students, two of which are full time employees and at the graduate studies level in their education, and one undergraduate student. The Field Operations Manager has a bachelor's degree in Geography/Chemistry, is working on a graduate degree, and has earned numerous certifications since being employed by CWRS. The Field Operations Supervisor on staff for this project has a bachelor's degree in Geology, and is in the process of working on a graduate degree in Geology. The undergraduate student who worked on this project has since received an Agronomy degree with a focus on soil science, and is now a full time employee working on a graduate degree.

Initial Activities. In order to determine where it would be the most beneficial to begin surveying the current state of wastewater management structures in the community, and to determine the best route for addressing the local public, KIWMS met with the several organizations in the Glendale area. Organizations that had a key role in the planning process included the Hardin County Alternatives to Onsite Septic Systems workgroup (which is managed by the Hardin County Planning and Development Commission); the Glendale Merchants Association (which represents approximately 10 Glendale businesses); Hardin County Water District #2; Hardin County Health Department; Lincoln Trail District Health Department; and the Hardin County School System. The first meeting took place in May, 2008, and others have followed regularly throughout the duration of the project.

Situation Assessment. A situation assessment was among the first activities that were started in the project area which involved conducting a detailed survey of the current state of wastewater management structures currently in place in the community of Glendale. This included the location, operational state and capacity of all existing septic systems, package plants and other treatment systems.

Evaluation of Alternatives/Options. Technical assistance is provided by KIWMS by leveraging the scientific and technical resources of the CWRS to support and guide the local stakeholder group in achieving the desired goals. A comprehensive suite of technical alternatives have been developed ranging from case-by-case tank/tile field rehabilitation, through clustered/decentralized treatment/disposal, to regional sewer infrastructure. Each alternative will be subjected to conceptual design development and preliminary cost estimation for feasibility assessment, funding potential and management infrastructure alternatives determination. The most feasible solution is the creation of a "decentralized" wastewater disposal system to replace the on-site septic systems, in which package plants could be phased into operation for the Glendale community and vicinity.

Public Education. Utilizing available resources such as the Center for Watershed Protection[3] and the National Small Flows Clearinghouse[4], KIWMS will develop and implement a comprehensive public education campaign to promote proper operational practices, elucidate the

impacts of septic system failures, and prepare the community for the potential of a cost-based community wastewater management infrastructure.

Anticipated Outcomes/Results

Initial Activities. It was decided after much discussion that the appropriate starting point would be the Whistle Stop Café, which is essentially the hub of the community, and this decision was made mainly due to the fact that the facility's leach field seemed to be dangerously near failure. The septic waste disposal system for The Whistle Stop Restaurant is located on the opposite side of the railroad track in a field owned by the previous owners of the restaurant. This system is in need of repair or replacement. The restaurant underwent a major review of operational practices starting in June, 2008, during which KIWMS assessed and mapped every possible outlet of flow from the restaurant to the septic system. Using graduate and undergraduate students, detailed assessments were completed in regards to what chemicals/cleaning supplies were used and Material Safety Data Sheets were obtained for each of these products, which could possibly be used in determining what was causing failure in the leach field. In August, 2008, CWRS field staff and students used a GPS to map the entirety of the septic system, including the distribution boxes, valves and septic tanks. The leach field is broken up into three separate sections and there were areas in the leach field that were saturated and had sewage standing above ground, which led to the troubleshooting phase of the project and was done throughout the fall months of 2008. A lysimeter was constructed by students and staff (See Figure 2), and was placed in the leach field to extract water samples from below the leach field, and a Guelph Permeameter (See Figure 3) was utilized to measure the water infiltration into the soil. In the end, it was determined that the leach field failure at the Whistle Stop was primarily due to improper operation. Once all of the distribution boxes were located and dug up, it was obvious that the entirety of the field was not being utilized since sewage was not reaching two of the three sections. The two unused sections of the field were opened up to allow flow and, with time, the saturated areas of the field have dried up completely.

In general, the students participating in field work learned about onsite wastewater processes, soil sampling, soil analysis, and wastewater sampling. Septic System Management Surveys were developed by field staff, which were later utilized to collect anonymous information during the first public meeting regarding the overall health of the septic systems in the community. A Model 2800K1 Guelph Permeameter was purchased specifically for this project. A lysimeter was constructed by the field crew for the collection of soil leachate, which was modeled after the instrument described in detail in the Journal of Environmental Quality 22:207-212 (1993) entitled "A Zero-Tension Sampler for the Collection of Soil Water in Macropore Systems" by Simmons & Baker. Upon obtaining the permeameter and construction of the lysimeter, the field team was charged with determining how to operate and deploy the equipment. The typical scenario was such that the full time employee/graduate student would supervise and aid the undergraduate student worker as field equipment was deployed and operated. This team was also responsible for site evaluation with regard to topography, general soil appearance, intended application, and the selection of the number and location of the areas that are to be representative of the soils under study. The field crew chose and collected soil sampling sites based on the previously mentioned criteria, at which time samples were delivered to the Scott Center at Western Kentucky University for soil classification. The Scott Center works in partnership with

local construction and engineering firms to give students hands on engineering experiences, and is also a part of the ARTP at WKU which shares the same basic philosophy as CWRS.

Figure 2. Students installing a Lysimeter below a leach field

Situation Assessment. A preliminary assessment determined that the Glendale Village and community utilize approximately 100 septic systems with many additional systems installed in the Glendale community. Two restaurants are in operation in Glendale - the Whistle Stop and The Depot. Both of these facilities must utilize septic systems for wastewater disposal. East Hardin Middle School operates a wastewater package plant located south of the school along KY 1136. The wastewater from the plant is piped for approximately one mile along KY 1136 and discharges into the Nolin River at the highway bridge downstream from Taylor Bend Park. Three package plants are located at the I-65 Interchange at KY 222 and include Pilot Truck Stop on the east side of I-65, the Petro Truck Stop on the northwest side of I-65 plus the Glendale Inn and Truck Stop on the west and south side of the interstate share a package plant. Activities at the Glendale Children's Home have been greatly reduced, and the associated lagoon system may not be in operation at this time but could be activated and upgraded to address the needs of the Glendale Community.

Hardin County owns a 1,500 acre property east of Glendale between I-65 and the railroad, south of KY 222. This property is to be used for a major manufacturing facility with an estimated employment base of 2,000 individuals. Planning for a previous potential tenant included a forced line for wastewater from the industrial property to the Elizabethtown Wastewater Treatment Plant located approximately three miles north of Glendale. The proposal was for a

forced wastewater line located on the property owned by CSX and installed along the railroad tracks which are adjacent to the Elizabethtown Wastewater Treatment Plant on Gaither Station Road.

Figure 3. Students operating a permeameter

The Hardin County School District has proposed a fourth high school for the district. A location for the school has not been determined. The school facility in Glendale was East Hardin High

School but was converted to East Hardin Middle School following the construction of Central Hardin High School. An option for the District would be to convert the middle school to a high school or the construction of a new high school in the Glendale vicinity. The need for wastewater treatment would be increased with the establishment of a fourth high school.

The area between Elizabethtown and Glendale is a residential growth area. Nine major subdivisions involving the construction of new streets have been approved since the year 2000 creating approximately 400 lots in the Rose Run, East Rhodes Creek and Valley Creek drainage areas that go to the Nolin River watershed. The subdivisions include Beckley Woods (88 lots), Whistling Oaks (14 lots), Settlers Crest (45 lots), Monterey (67 lots), Serene Oaks (82 lots), Brentwood (25 lots), Oxmoor (28 lots), Four Seasons (19 lots), Andover Pointe (30 lots). A similar level of growth is anticipated or an increase in the number of new subdivision lots is anticipated with the potential of the Glendale Industrial Property being developed.

Evaluation of Alternatives/Options. A short-term option currently being considered for implementation involves the creation of a clustered system using a sub-set of the community. Specifically, a clustered system will be attempted between the two restaurants, considered to be the greatest water consumers and wastewater producers in the area. Both facilities utilize traditional septic tanks and leach fields, and both leach fields appear to be dangerously near failure. A combination of rehabilitation of the existing leach fields using hydrogen peroxide, implementing optimal operating practices (water efficiency, grease removal, etc) and load-leveling will be used. Upon completion of the situation assessment, technology vendors will be recruited to demonstrate technologies such as drip-irrigation and mound systems to achieve sustainable operational performance. This technological base will be used within the public education phase of the project.

Many options could be incorporated into a decentralized wastewater treatment facility as a solution to the Glendale existing and future wastewater treatment needs: re-activation and upgrade to the existing lagoon system installed at the Glendale Children's Home; the existing septic tanks in the Glendale Historic District, if in good condition, could be maintained with the wastewater going to a decentralized system to be treated instead of utilizing the lateral fields; the East Hardin Middle School wastewater treatment package plant could be eliminated and the lagoon system utilized; the three wastewater treatment package plants located at the I-65 Interchange could be eliminated and the lagoon system utilized; Gilead Baptist Church, located adjacent to the Glendale Children's Home, is planning the construction of a new facility. The new facility could utilize a decentralized wastewater treatment facility instead of the installation of an on-site septic system; a fourth high school facility is needed by the Hardin County School District. An option would be the conversion of the East Hardin Middle School to a High School or the construction of a new high school in the Glendale Community which would need a wastewater treatment facility; the anticipated new residential subdivisions in the Glendale community could be developed with decentralized wastewater treatment facility that could allow for higher density subdivisions creating more lots with less land being developed. It is anticipated that the drainage area that could contain the proposed decentralize treatment facility could maintain the growth rate of the last five years and create an additional 400 lots in the next five years; The Glendale Industrial Property will be developed for a major manufacturing facility with an anticipated workforce of 2,000 employees and will need wastewater treatment facility.

With a major manufacturing facility, the decentralized lagoon treatment facility could be replaced with a centralized wastewater treatment facility located on the Nolin River to serve the Glendale Community and southern Hardin County.

KIWMS also coordinates with local and regional governmental agencies to develop a management infrastructure that minimizes overhead and maximizes performance and accountability. KIWMS will provide the local stakeholder group a detailed assessment of management infrastructure alternatives feasible for each of the technical alternatives reviewed. Management alternatives can range from existing individual ownership and accountability; establishment of a local sanitation district under the authority of the Hardin County Fiscal Court; and absorption of the community by Hardin County Water District Number 2 (HCWD2) who currently provide water to the community. The operational impacts of each management model will be evaluated along with the statutory establishment authority and resulting access to financing options.

Financial capacity will be achieved by leveraging local, state and federal resources to maximize the economic viability and minimize the financial liability of wastewater management alternatives implemented. A detailed evaluation of the financial and economic potential and liability of the community with respect to wastewater management will be performed. The results of this study will be incorporated into the public education campaign.

Public Education. An initial Glendale Public Meeting to discuss wastewater alternatives was held, at which a total of thirty-four (34) people were in attendance. A presentation was given explaining the progress of work in the community up to that point in time, and brochures were handed out detailing homeowner maintenance of septic systems. A Septic System Management Survey was developed by students and handed out to meeting attendees, in which they were asked questions regarding basic operations of a septic system. A more detailed survey of local septic systems will be completed by students during a door-to-door campaign in which the state of each system will be physically observed and more operational questions will be asked of each home/business owner.

Summary and Conclusions

Overall project technical performance will be evaluated in terms of achievement of the primary goals - Demonstration of the KIWMS Approach and Glendale Wastewater Load Reduction. Specific measures include: Pre- and post- public education surveys to assess attitudinal and behavioral changes in the community members and business owners; Quantitative assessment of community-wide waste load reduction via surrogate water consumption data; Monitoring of influent and effluent characteristics for technology demonstration sub-project and any component infrastructure implementation projects that arise in support of the overall project goals; Number, amount and potential for success of financing opportunities pursued and recruited. Financing opportunities include both grant and loan funds; Number and amount of leveraging opportunities secured. Leveraging opportunities include community member/business owner in-kind or cash contributions to overall infrastructure implementation, and recruitment of technology vendors; Financial sustainability of final solution - full-cost pricing, persistence & capacity of management infrastructure. Environmental results expected

from the project include mitigation of the contribution of failed septic systems from the Glendale area to the nearby pathogen-impaired Valley Creek waterbody. Benefits include an increased community awareness of the wastewater treatment process, and stewardship of the surrounding area based on the increase in knowledge. In addition to the service learning benefit to the students engaged in the process, an unintended outcome of using students in the publicly visible aspects of the project has been increased receptivity to the stewardship concepts promoted during public meetings. It is expected that once this demonstration project has been proven successful, the support system can be expanded and extended to other communities in the Commonwealth and surrounding states.

References

1. Initiative for Watershed Excellence William L. Cox; Mark Nuhfer , 2005 Georgia Water Resources Conference, Athens, Georgia, (2005)
2. Safe Drinking Water Act of 1974, Pub. L. no. 93-523, 88 Stat. 1660 (1974)
3. Center for Watershed Protection CWP.org , (1992)
4. National Small Flows Clearinghouse nesc.wvu.edu , (1979)