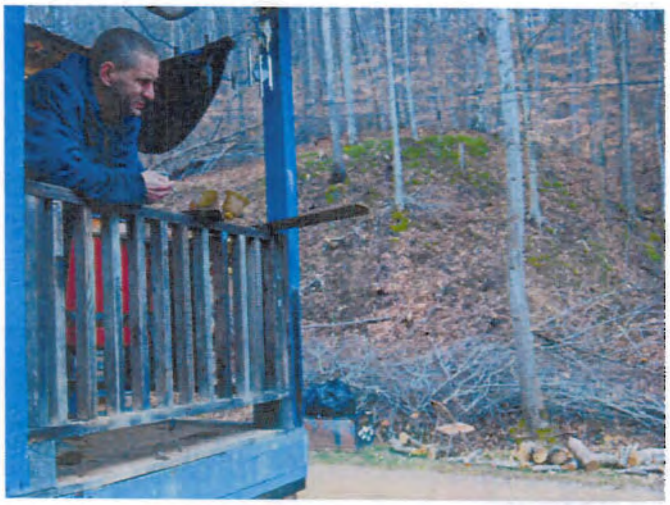
Alternative Wastewater Demonstration Project

Left Fork Watershed of the Mud River

<u>Lincoln County Commission ~ US EPA Cooperative Project</u>

Final Report ~ Key Lessons Learned ~



- This project's watershed sampling analysis demonstrates that installing alternative wastewater systems in contiguous homes decreases bacterial levels in tributaries.

- When local citizens are equal decision making partners in wastewater projects, the projects themselves are more successful, and local communities gain important leadership and decision making skills.

- Trainings and conversations among county sanitarians and local wastewater installers help raise awareness, comfort levels, and success in installing new wastewater technologies.

- Involving state regulatory agencies and personnel, and working with them to address challenges and concerns, helps increase multi-agency collaboration and project success.

Support from local county government and willingness by them to treat local communities as equal decision makers increases short and long term project accomplishments.

Universities and funding agencies need to understand that engaged, local communities have the ability to wrestle with complicated issues and make difficult decisions including fair allocation of scarce financial resources.

When national wastewater system and component manufacturers are willing to come into communities and provide hands on training for sanitarians, installers, and homeowners, problems with wastewater systems decrease and effective maintenance increases.

Engaging university research partners in community based projects is often complicated and difficult, especially when there are major physical distances between the university and community, and when discussions about roles, paradigms, and responsibilities are not adequately addressed before projects start.

Several key research questions about alternative wastewater technology still need to be addressed and resolved:

- **How does mineral content of rural well water impact effectiveness of alternative systems?**
- **How can homeowners insure their wastewater systems work properly when household members are taking strong prescription drugs, antibiotics, or undergoing chemotherapy?**
- **What are affordable methods to monitor bacterial content from direct discharge systems in order to protect tributaries?**
- **What strategies will best insure that septic and pump tanks are watertight when they are installed on site?**

Wastewater projects are more successful when their directors are actively involved in system installation and are willing to engage manufacturers and regulatory agencies about problems and community concerns.

West Virginia has no laws requiring wastewater system installers to receive continuing education in order to keep their licenses. Requiring such training would help decrease installation problems as well as create installers who are more comfortable, skilled, and successful with new technologies.

Site inspection during snow squall with DHHR State Onsite Sewage Program Manager

In the final analysis, the alternative wastewater systems installed in this project really may not be the best choices for rural, low income communities. The systems' high price tags, temperamental natures, and high maintenance requirements, present very real short and long term barriers to success. The need grows for research and development of systems which are more affordable, have less technology, and are more appropriate and forgiving.

~ Project Impact ~

The project officially began on December 2, 2004, and ended on February 28, 2010.

40 homes in the Left Fork Watershed of the Mud River have new alternative wastewater systems

12 homes are in ground systems: 4 are LPP; 2 are drip; 3 are bottomless peat
28 homes are direct discharge systems with ultraviolet light final disinfection

19 homes are Bord na Mona Puraflo Peat Systems
6 homes are Premier Tech Ecoflo Peat Systems
3 homes are Quanics Synthetic Media Systems
1 home is Microfast Synthetic Media System
1 home is an Eljen Geotextile System
6 homes are sand filter systems

6 different installers put in wastewater systems; 1 from the local community became a certified installer during the project

78% of the homeowners who received a system were low income

74 different community meetings were held during the project attended by **169** different people

3555 hours of community members' time were donated to project

8 representatives of national systems manufacturers and components came into the watershed to help with training and trouble shooting

2 universities contributed expertise and faculty time to the project

29 West Virginia sanitarians and wastewater installers attended trainings sponsored by the project.

21 different project reports, updates, and research papers were distributed to interested stake holders.

11 presentations about the project were made at state, regional and national meetings

Based on the success of the project, the Lincoln County Commission applied for and received **$719,000** in ARRA Stimulus funding to install an additional **19** systems in the Left Fork Watershed

$355,000 contributed at local level toward project match

Final Report

Lincoln County Commission, West Virginia
Left Fork of the Mud River
Decentralized Wastewater Demonstration Project
Assistance ID # X-83212101-4

Submitted by Ric MacDowell, Principal Investigator
ric.macdowell@mail.wvu.edu. (304-824-7911).

Dates Covered: December 2004 through February 2010

Introduction and Background.

For several decades, Lincoln County citizens talked of building a residence camp in the county. In the mid-1980's, the county finalized plans to create an artificial lake by making a dam where the Mud River and the Left Fork of the Mud join together. Land in both of these watersheds was condemned and purchased by the county. Advocates for a residence camp began to work with the Lincoln County Commission. Eventually a tract of 44 acres was set aside on the Left Fork to develop a camp. Work on this has been sporadic, depending on available funds. In the 1990's, a swimming area with a floating dock was installed at the edge of the lake. Canoes and kayaks were purchased, and a variety of youth and civic groups began to use the camp for swimming, kayaking, canoeing, and day events.

Mud River Lake at the Camp Lake View beachfront

Then, in October 1998, the lake water by the camp's floating dock turned a bright red. Eventually the discoloration disappeared, but people involved in the camp worried that if the problem recurred it might doom the development of the facility.

Also in 1999, WVU received funding to begin a Kellogg Community Partnership project. The purpose of the project was to link communities with the University so that ***together***, they might solve local problems. Lincoln County Extension faculty member, Ric MacDowell, worked with Morgantown faculty Jim Kotcon and Alan Collins, designing a proposal to investigate reasons for the red coloration. In April 1999, and then again in April 2000, WVU students and faculty came down to Lincoln County. Partnering with Hamlin and Duval High School teachers and students, they did a series of water samplings and analyses in the Left Fork Watershed. No exact cause for the red discoloration was ever found. However, tributary water sample results showed levels of E. coli much higher than what was acceptable by either state or federal standards. At the same time, water testing in the main fork of the Mud showed high enough levels of E. coli that the public swimming area on that side of the lake was closed for health concerns on many occasions. This awareness led to discussions in the county about how to deal with the E. coli problem.

Dr. Patricia Miller was working for Extension in 2000 and was interested in issues of wastewater treatment. She came to Lincoln County, toured the watershed, went back to Morgantown, and began to look for possible funds to address the E. coli problem. Working with WV Department of Agriculture, the Lincoln County Commission, and the local Extension office, Dr. Miller submitted a proposal in 2001 for a National Capacity Development Project grant to investigate sewage issues in both the Mud River and Shavers Fork in Randolph County. That proposal was not funded. In 2002, Dr. Miller submitted a new proposal focusing only on the Mud River, this time as an EPA National Decentralized Wastewater Demonstration Project. The proposal was one of six national projects chosen and funded in the 2003 Federal Appropriations Bill. Just under $1 million was allocated for a three-year project.

This was not a traditional competitive grant stemming from an RFP (request for proposal). The funding, instead, was based on a few paragraphs. Once funding was allocated, however, a formal proposal was written and submitted to EPA in June 2004. In late November, the final EPA contract was sent to the Lincoln County Commission where it was signed and returned to Washington.

By the time the Lincoln County Commission formally signed the contract with EPA, Dr. Miller had left Extension, and Ric MacDowell, the WVU Lincoln County Extension Agent, had moved into the role of the grant's Principal Investigator. Living and working in Lincoln County since the late 1960's, including teaching at an elementary school in the Left Fork Watershed, had given him critical experiences, relationships, and knowledge valuable to the project. However, he lacked formal training and experience in issues of water analysis and wastewater treatment.

It seemed appropriate for the county to partner within WVU to find expertise to complement what MacDowell lacked. Eventually, the Lincoln County Commission, WVU Extension, and West Virginia University collaborated to find skills needed for the project to succeed. Key players at the University included personnel from Extension, NRCCE's (National Research Center for Coal and Energy) Water Research Institute, NRCCE's National Environmental Services Center, and the WVU Research Corporation. Two WVU researchers from NRCCE were brought on to work as Co-Investigators. Clement Solomon, Projects Director for the National Environmental Services Center, had a background in sewage system engineering and Tamara Vandivort, Program Coordinator for the West Virginia Water Research Institute, had a background in water quality analysis. Clement left the project for a new job in April 2008. Tammy's work with the project ended in March 2009. MacDowell continued with the project through its end.

Typical ridges and valleys in the Left Fork Watershed

Outputs and Outcomes

In May 2009, the County successfully negotiated with EPA for return of $29,800 that was set aside from the original Congressional allocation and retained by the federal agency in 2003. As part of the requirements to access this additional money, the County developed additional outputs and outcomes for the project. They are listed here, and each is evaluated and reported against.

Output 1. Prepare and Disseminate at Least 10 Reports *A variety of electronic and paper reports will be shared with project stakeholders, state agencies, legislators, and others. These will highlight project activities and findings, and make suggestions about improvements in alternative wastewater development and policies.* These reports were disseminated:

☑ **January 2009 Yearly Update**
☑ **Extension's Advocacy Role in Wastewater Projects in Low Income Communities (2009)**
☑ **Creating Affordable Wastewater Technologies; Protecting Drinking Water; Engaging Higher Education (2009 White Paper)**
☑ **Direct Discharge Sampling ~ Report and Analysis Update (2009)**
☑ **Recommendations to WV Legislative Interim Committees (2008)**
☑ **Developing Effective Wastewater Management in Rural Low Income West Virginia Communities (2008)**
☑ **Explanation of Installed Systems for Watershed Tour (2008)**
☑ **Direct Discharge Sampling ~ Report and Analysis (2008)**

☑ **2007 Project Highlights and Findings**
☑ **Local Communities: Equal Partners or Ignored Bystanders? (2007)**
☑ **Bacterial Source Tracking Analysis (2007)**
☑ **Promoting Social Justice through Community Engagement (2006)**
☑ **2006 Year End Report**

In addition, as the project has drawn to a close, two additional white papers were prepared and disseminated. These white papers are included in Appendix G (p. 31): **White Papers**.

❖ Tributary Water Quality Findings and Analysis
❖ Outstanding Technical Issues: *Leaking Tanks, Direct Discharge Issues, NSF 40 Testing, Implications of Mineral Content of Well Water, Impact of Antibiotics & Other Pharmaceuticals on Septic Tanks' Viability*

Common challenge in low income, rural communities ~ finding enough room for systems where homes are close to roads and tributaries

Output 2. Present at Least 4 Workshops at National and State Venues

Workshops will highlight findings from the project, lessons learned, areas needing improvement, engagement issues between academia and the community. Presentations about the project were made at:

☑ **USDA-CSREES National Water Conference (2009)**

☑ WVCEOS State Conference (2009)
☑ WVU Local Government Leadership Academy (2009)
☑ USDA-CSREES National Water Conference (2007)
☑ National Outreach Scholarship Conference (2006)

Output 3. Prepare and Distribute at Least 4 Educational Flyers. *These will focus on information which will help citizens better understand and maintain their wastewater systems.* Flyers produced included:

☑ Solving Wastewater Challenges in West Virginia (2009)
☑ Effective Wastewater Management Strategies (2009)
☑ Effective Wastewater Lessons for Rural, Low Income WV (2009)
☑ How to Take Care of Your Septic System (2008)
☑ The Lincoln County Commission's Federal EPA Alternative Wastewater Demonstration Project (2008)

Output 4. Install at Least 30 New Wastewater Systems in the Left Fork Watershed of the Mud River. In October 2009, the Lincoln County Commission awarded the final system installation bid for the project. This brought to **40** the number of homes in the Left Fork Watershed which now have new alternative wastewater systems through the project. (See **Appendix A Household Installation History** for complete list, p. 22.)

Installing new septic tank

The following **Outcomes** are long term and harder to measure or quantify in the short run:

Outcome 1. Citizens in West Virginia, especially in Lincoln County, will have a better understanding of wastewater technology and the importance of maintaining proper wastewater systems.

Part of the project's dissemination has included programs for groups around the state including the State CEOS Conference, the state Leadership Academy, the McDowell County Wastewater

Coalition, and Legislative Interim Committees. All of these sessions have provided information about new wastewater technology and suggestions for maintaining systems properly. In addition, this topic has been a constant in the Left Fork Community meetings which the project has sponsored. The Community has been kept abreast about sampling findings and recommendations at trainings by system manufacturers. Without a doubt, Left Fork citizens have increased their understanding of both system technology and maintenance. The Commission believes this will transfer into homeowner actions to properly maintain systems.

Outcome 2. Water quality in the Left Fork Watershed of the Mud River will be improved.

Sections in the Left Fork Watershed with contiguous new systems have shown consistent improvement in water quality.

(See **Appendix C** for Table of ***Post Installation Tributary Sampling Results*** p.27) One of the tributary sampling sites is located where 7 new, contiguous systems have been installed. Six of these were funded by this project. The last four sampling events show significantly lower levels of E. coli at this site, supporting the contention that installing alternative wastewater systems will improve water quality.

Outcome 3. West Virginia state universities will increase their engagement efforts in rural, low income communities in many areas including wastewater technology.

This continues to be one of the more elusive goals of the project. In 1999, the Kellogg Commission on the Future of State and Land-Grant Universities called for universities to return to their roots of engagement. Numerous papers, speeches, and studies have continued this theme. Yet experts from academia often provide solutions based on what *they* see as the community's needs. Real engagement is based on mutual collaboration, respect, and the understanding that local communities have knowledge and expertise apart from academia. Local knowledge and understanding are often as valid as academic knowledge, and often essential for grounding decision making. Long term commitments by academic deans, professors, administrators, and researchers to strengthen the value a university puts on engagement with local communities as well as how this impacts promotion and tenure will be the test of this outcome's effectiveness.

Outcome 4. Improvements in wastewater will be valued by citizens and elected officials as much as improvements in drinking water.

One of the recommendations from the Lincoln County sponsored 2008 Flex-E Conference on *Developing Effective Wastewater Management for Rural, Low Income West Virginia Communities* was to work with local PSDs to insure that consideration for developing sewage capacity proceeds in tandem with expansion of water. This key point has been stressed in meetings with agencies, in WV state legislative hearings, and in the WV Leadership Academy training for elected officials. Yet the challenge of raising wastewater awareness to the same level as drinking water awareness continues.

Outcome 5. Regulators and rule makers will better understand the impacts of wastewater requirements and regulations on low income citizens.

There are a variety of special issues faced by low income, rural communities as they try to follow county and state wastewater regulations. Too often, certain regulations are ignored, because they are nearly impossible for some people to meet. Systems are then installed which are not up to code often in prohibited places. Sometimes the only options people have for siting homes are on unsuitable pieces of land. The project has raised these concerns with regulators and state agencies, but currently there are few accommodations which take the reality of low income, rural people into account. Helping regulators and rule makers better appreciate the reality faced by low income people continues to be a critical need.

The project continues to advocate for low income, rural families.

Outcome 6. Sanitarians and installers will better understand the intricacies of new, innovative wastewater technologies.

Early on as the project talked to installers and sanitarians, it became clear that few had much experience with newer alternative wastewater systems. That spurred the project to hold workshops for both groups in an effort to increase knowledge about and willingness to consider NSF-40 alternative systems.

Workshops and training have been held in the watershed about general NSF-40 technology, evaluating soil conditions using observation holes, installation of Puraflo peat, Ecoflo peat, and Quanics technologies, and Salcor UV disinfection systems. National representatives from alternative system manufacturers have come twice into the watershed to do *pro bono* trainings.

Project sponsored training for installers and sanitarians on evaluating soil conditions

Work Plan Objectives

The project's work plan was divided into a number of objectives. These have been used as benchmarks to evaluate what has happened.

Objective 1. Support leadership development, critical thinking, and project sustainability in the Left Fork community

Action 1.1. Establish calendar and educational programs for ongoing community meetings.

Even before the project was finalized and money was available, county project staff began to meet with members of the local community. This was based on the belief that without local participation and buy-in, the project would not succeed. The first community meeting was held March 24, 2004. Though meetings at first were held in different locations throughout the watershed in an attempt to reach more people, early on a central place the Mud River Volunteer Fire Department, became the normal meeting site.

The February 2010, final community meeting brought the total number of project meetings to 74. Though not every person attended every meeting, 169 different people attended at least once. A core group of 20 people provided leadership at nearly every meeting. Community members contributed 3555 hours of their time at these meetings.

Focus of the meetings included bid specifications and processes, roles of individuals and groups involved, ways to move forward with installations, and budgets. Specific technologies and systems were discussed as were critical long term maintenance issues. Periodically there were discussions about proper care of systems, especially what ***not*** to put into septic tanks. For each installation bid series, a committee of community members reviewed system bids and made recommendations to the County Commission on which installers to hire. Leaking tanks and problems with effluent samples from direct discharge systems were concerns that the community took to the Commission and state agencies.

Septic waste from failing tank comes up in yard where the project later installed a new system

Action 1.2. Develop criteria for installation.

The local community spent several months in 2005 working to develop criteria for ranking homes for systems. Since there was not enough money in the project for every home to get a new system, the Commission felt it was critical for the community, itself, to develop a way to decide who would get and who would not get a system. The process was not easy, but people discussed many ideas and options, and created what they felt was a fair procedure. Early in 2006, the community approved the criteria and sent it on to the Commission which also approved it. (See **Appendix D** for Criteria and Point Sheet, p. 28.) Using the criteria, a priority ranking was done for the 36 homes whose owners had completed the criteria questionnaire. Some of the homeowners in this initial group opted out of the project; a few others failed to complete necessary paperwork. The remainder became the initial homes in the first round of installations.

A second round of installation rankings began with discussions at community meetings in late 2007 and early 2008. As more people in the community began to see that the project was actually installing systems and was more than just talk, interest in the project grew. The number of people who expressed interest in getting on a list grew, and the community began to discuss what changes in criteria were needed in the second round of rankings. Eventually, the community modified the original criteria slightly, increasing the number of possible points for meeting attendance, and clarifying issues of home ownership among relatives, renters, and heirship property. This new criteria was approved by the community in April 2008, and then approved by the County Commission the following May. Thirty homeowners submitted the required forms. These were evaluated, given points and ranked. In the end a total of 40 homes received new systems. An additional 19 will be part of a new project funded with ARRA (Stimulus) Green Wastewater funds and completed in 2010.

Action 1.3. Develop local leadership to sustain the project.

Community committee meeting at Mud River Volunteer Fire Department

The periodic community meetings reinforced leadership development as did community members' work on various bid committees. Finding ways to resolve contentious issues, though difficult, helped to strengthen the community's civic society and leadership. The Lincoln County Commission made a decision in 2009 to apply for federal ARRA (Stimulus) funding available through the WV Department of Environmental Protection. The Commission wanted to build on the work of the Left Fork Community and the successes of this EPA alternative wastewater project. At the end of January 2010, the Commission and the WVDEP signed agreements for ARRA funding. The ARRA project will add 19 more new home systems in the watershed. That project will conclude in 2011. Currently the community is looking into models for creating long term maintenance plans. These focus on developing a community based organization with responsibility for over site maintenance led by local residents. Homeowners would pay a monthly fee and would co-pay on services like required maintenance inspections, yearly septic tank inspection, and UV disinfection bulb replacements. Costs would be matched using funds generated by the community. It is anticipated that final plans, incorporation and tax-exempt status would be finished by the summer of 2010.

Action 1.4. Evaluate community attitudes.

This component was handled by WVU Extension and was not funded by this project. An initial pre-assessment of people involved in the project was done during 2004. Then in October 2009, WVU Extension re-surveyed community members and compared attitudes at that point with attitudes from the beginning of the project. Not all the same people participated in both the pre- and post assessment. (See Appendix E for Pre-Post Comparison, p. 29.)

One of the more interesting results comes in statement # 3. ***In communities like mine people can trust the county government***. Local citizens, especially those in the more rural, low income areas of Lincoln County, often have little faith that local government will look out for their interests. In fact as this project began to unfold, people often raised a fear at community meetings that the Commission might abscond with all the project's funds. This was not possible, both because the funds could only be drawn down as spent, and because the Commission had set up a separate checking account and hired a bookkeeper dedicated solely to the project. Yet, there was a concern at the community level about fiscal accountability. Besides the safeguards the Commission set up to assure funds would be properly handled, the project also shared information continually with the community. Every meeting included a current financial statement. Questions about finance were encouraged and answered openly and honestly. All salaries for the project were known by the community. In addition, the Commission continually gave the community responsibilities for working through difficult decisions, put community members on bid committees, and made sure that project recommendations came first from the community before the Commission made decisions. These actions, coupled with fiscal transparency helped both to develop stronger community leadership and to convince the community that indeed, they could trust their county government. Post project responses to that third statement reinforce this. In the pre-assessment **34%** of those survived chose yes or maybe that people could trust the county government. As the project ended that percentage had risen to **59%**.

Also see *Action 5.1* for additional assessments.

Objective 2. <u>Sample and analyze streams and tributaries in the Left Fork Watershed</u>

Dye placed in drains, washers, and toilets colors streams and demonstrates that the home's septic system is failing

Action 2.1. Collect existing data, develop baseline.

Baseline water quality data was established from November 2005 through September 2006. Samples were taken on 9 separate dates under a variety of conditions and during all seasons. A total of 195 different water samples were taken at 37 different sites. Of these, 119 or 61% were over the acceptable E. coli limit of 200 colonies per 100 mL

Action 2.2. Design sampling regimen, follow through with sampling and analysis.

Prior to initial sampling in 2005, protocols were established, approved by EPA, and local samplers were trained.

Ongoing sampling of tributary water

Action 2.3. Sample potential locations and analyze data. See *Action 2.1*
Action 2.4. Sample hot spots more intensively and analyze data.

Of the 37 baseline sites, 18 were sampled on each date. Seven of these sites were identified for Bacterial Source Tracking analysis.

The Commission worked with Marshall University's biotechnology department and used their bacterial source tracking technology to look for human contamination at some of the sites in the watershed. In September 2006 and March 2007, the same seven sites were sampled and spent filters from the lab which did the project's E. coli analysis were shared with Marshall. The biotechnology department compared DNA fingerprints from these filters with DNA fingerprints in their library. Marshall's BST results showed that five of the seven sites (71%) had a human E. coli isolate in one of the two analyses. Three of the seven sites showed a human e. coli isolate in both samplings. This information helped confirm the project's contention that human contamination of the watershed accounted for part of the high E. coli readings. (See Appendix F for more information on Bacterial Source Tracking, p.30.)

Objective 3. Install appropriate wastewater systems and monitor their effectiveness

Action 3.1. Complete NEPA / FONSI.

Our Categorical Exclusion application was submitted to EPA on May 17, 2006. In June, the application was sent from the NEPA office to the Water Office for approval. On August 22, 2006, the Lincoln County Commission received official notification that the request was approved by EPA.

Action 3.2. Develop criteria for installation (See Action 1.2).

Action 3.3. Identify potential site locations.

Locations were identified through the criteria ranking.


Peat module installation

Action 3.4. Install systems. Monitor system installation.

Forty homes now have new systems because of this project. The majority of technologies use peat as a disinfection medium. Recirculating sand and synthetic media systems were also used. Inground discharge included low pressure pipe and drip systems. Because of soil and lot size limitations the majority of systems were direct discharge. All of these have ultraviolet light as the final disinfection.


Beginning installation at home on Flat Creek

As systems were being installed, the project PI spent time on site helping installers and monitoring the installation. The local county sanitarian, staff from the state DEP and DHHR offices also visited sites during installation to help with trouble shooting and monitoring. Direct discharge sites had a final inspection by the District Sanitarian. All other systems had a final inspection by the county sanitarian.

Action 3.5. Sample wastewater, tributaries and analyze system effectiveness.

Each system bid included a two year maintenance requirement by the installer. In addition to this, the project and homeowners also inspected systems. Direct discharge systems received extra scrutiny, and most had their final effluent sampled. When there were higher than acceptable levels of E. coli in these samples, additional samples were taken and discussions were held with installers and manufacturers to find solutions to reduce the high levels.

Tributary sampling ended in early February 2010. Co-PIs Tammy Vandivort and Jen Fulton submitted their *Water Quality Report* to the Commission in June 2009 though it was revised and resubmitted that July. That report focused on tributary sampling at eight sites during six sampling events, the last of which was in July 2008. The report was distributed as part of the Third Quarter 2009 report.

Tributary sampling continued, however. From May 2009 through February 2010 there were six more sampling events. As discussed in Outcome 2 and in Appendix C, page 27, interesting trends have developed. Site *Collins DS* is a sampling point above which there are 7 adjacent homes. Six of these have new systems installed by the project. The 7th is a relatively new aerator system, privately installed. Results from this sampling site show consistently lower levels of E. coli than anywhere else in the watershed and suggest that **the installation of alternative wastewater systems by this project has improved the bacterial health of local tributaries**. Though the EPA project has ended the county's ARRA Stimulus project will continue tributary sampling and analysis through 2011. It is expected that future results will reinforce current findings

Objective 4. Incorporating the project into Lincoln County schools

Action 4.1 Design and present programs at High School Environmental Science Classes.

Presentations and discussions of the project and its implications for the community took place in several classrooms over the length of the project. There were also field trips by high school ecology classes into the watershed. Students had hands on experiences doing tributary sampling and benthic life analysis.

High school environmental science classes learn stream monitoring techniques

Action 4.2 Facilitate and advise annual HSTA project with Hamlin High School Club

The HSTA (Health, Science, Technology Academy) program focused their group project on watershed ecology during 2005-2006. After that, they switched to a new project.

Objective 5. <u>Create reports based on project research</u>

Action 5.1. Community Case Study

A qualitative evaluation of challenges and successes that project staff (Vandivort, Solomon, Conley, MacDowell) identified was completed during the last quarter of 2006. The report by Elizabeth Campbell was ***<u>NOT</u>*** funded with project money. Copies of that report were distributed to a variety of stake holders.

Action 5.2. Community Attitude Evaluation

See Action 1.4 and Appendix E, p. 32.

Action 5.3. Water Sampling Findings (See *Action 3.5*)

Congressman Nick Rahall (on right) helps with tributary sampling

Action 5.4. Systems Monitoring, Wastewater Sampling and Analysis.

Historically, systems seem to take a few months after installation before they begin to have optimal discharge readings. There were, though, systems which even after an appropriate time period, did not have acceptable readings. In these cases high readings often triggered a closer look at the system, its components, and homeowner habits. The project uncovered situations where homeowners were letting too much grease get into their systems, situations where installations had not been done correctly, and situations where UV lights were broken or not working right. All of this reinforced how important looking critically at the installation process is, as well as how important careful long term maintenance is. In most instances, corrections by installers and/or homeowners did improve the system bacterial counts. However, one system serving the Ferrell-Pauley homes continues to be problematic. (See <u>Appendix B</u>, p. 23.) The project has not been successful in pinpointing reasons for the system's unacceptable E. coli levels. Both manufacturer and installer offered a number of hypotheses about what was causing the problems. None of these seemed to be the answer. In the end the project decided to separate the two homes. One will keep the current system, and the other will have a new system installed through the ARRA project.

Objective 6. Disseminate project findings

Action 6.1. Various websites, electronic journals, print journals.

The county's weekly paper was very supportive of the project and ran many featured articles. These focused on system installations and reports to the County Commission.

Action 6.2. Conferences and presentations.

PI MacDowell presented findings about the project at a number of state and national conferences including USDA-CSREES National Water Conference (2009), WVCEOS State Conference (2009), WVU Local Government Leadership Academy (2009), USDA-CSREES National Water Conference (2007), National Outreach Scholarship Conference (2006). In addition there were a number of smaller meetings of coalitions and citizens groups where presentations were made.

Objective 7. Comply with various project reporting requirements

This work is ongoing and continuous.

Action 7.1. Report and meet with Lincoln County Commission (monthly), other stakeholders and collaborators

MacDowell met at least monthly with the Lincoln County Commission and provided them with written updates and findings from the project. There were also monthly community meetings where data was disseminated. Finally, reports and findings were shared with a variety of state-wide stakeholders.

Action 7.2. File quarterly and other specified reports to EPA

Quarterly reports and other reports were filed as required by EPA.

Preparation for low pressure pipe system

~ Final Financial Report ~

Mud River Watershed Decentralized Wastewater Demonstration Project
Sponsor: USEPA
Duration: March 1, 2004 - February 28, 2010

	Total Project Budget Revised Sep-09	Paid-to-Date Feb. 28, 2010	Recipient Cash Contribution	Amount Remaining In Budget
Salaries	$ 287,801.40	$ 266,947.49		$ 20,853.91
Benefits	$ 67,992.08	$ 64,045.29		$ 3,946.79
Supplies (General Expenses)	$ 6,000.00	$ 6,893.04		$ (893.04)
Equipment	$ 2,000.00	$ 459.19		$ 1,540.81
Sub Contractors	$ 516,692.00	$ 576,380.75	$ 30,059.13	$ (59,688.75)
Travel	$ 24,000.00	$ 22,992.92		$ 1,007.08
Other Direct Costs (Sample Analysis)	$ 20,000.00	$ 16,046.85		$ 3,953.15
WVU Indirect Costs (F&A)	$ 69,014.52	$ 69,793.60		$ (779.08)
Total	$ 993,500.00	$ 1,023,559.13	$ 30,059.13	$ (30,059.13)

Watershed Homeowner Cash Contributions	$2,200.00
Watershed Community Volunteer Hours	$35,580.00
Additional In-Kind Matches	$202,601.73
WVU Salary Contribution	$86,957.64
Hobet Cash Contribution	$27,859.13
Total-to-date of Recipient Contribution	$ 355,198.50
vs. expected contribution of $ 331,167.00	

March 23, 2010

All federal funds were expended in the project and the Commission exceeded its required project match.

Appendix A Household Installation History

Family	Location	Done	System	Cost
Beecher, Judy Adkins	Flat Creek	2007	*Ecoflo / Direct Discharge / Salcor UV*	$9,964.89
Marie, Kenneth Collins	Left Fork	2007	Puraflo / Drip	$16,150.00
Kenneth, Linda Adkins	Flat Creek	2007	Microfast / LPP	$11,859.40*
Garry White	Stinson	2007	LPP	$7,340.67*
Delmar, Icylene White	Flat Creek	2007	Quanics / LPP	$23,630.00 *
Kevin, Melissa Ferrell	Flat Creek	2007	*Ecoflo / Direct Discharge / Ashco UV*	$15,715.43
Kenneth Bailey	Sycamore	2007	*Recirculating Sand / Direct Discharge / Ashco UV*	$18,786.21
Tina Warner	Sycamore	2007	*Recirculating Sand / Direct Discharge / Ashco UV*	included w/ Bailey
Diane Adkins	Wolf Branch	2007	Puraflo / Bottomless peat	$19,650.00
Michelle Cooper	Wolf Branch	2007	Puraflo / Bottomless peat	included w/ D. Adkins
Ronald Pauley	Flat Creek	2008	*Ecoflo / Direct Discharge / Ashco UV*	$3,411.54
Eric, Patty Woodrum	Bulger Road	2008	*Quanics / Direct Discharge / Salcor UV*	$22,855.00
Eric & Amy Woodrum	Bulger Road	2008	*Quanics / Direct Discharge / Salcor UV*	included w/ Woodrum
Dorothy Mary Adkins	Stinson	2008	*Puraflo / Direct Discharge / Salcor UV*	$12,750.00
Dannie Clark	Bark Camp	2008	*Puraflo / Direct Discharge / Salcor UV*	$13,540.00
Dallas, Lillian Clay	Bulger Road	2008	*Puraflo / Direct Discharge / Salcor UV*	$14,500.00
Willie Clay, Jr	Bulger Road	2008	*Puraflo / Direct Discharge / Salcor UV*	$14,540.00
Lyle, Norma Clark	Bark Camp	2008	*Sand Filter / Direct Discharge / Salcor UV*	$14,980.00
Danny Collins Home A	Bark Camp	2008	*Puraflo / Direct Discharge / Salcor UV*	$15,500.00
Danny Collins Home B	Bark Camp	2008	*Puraflo / Direct Discharge / Salcor UV*	included w/ Collins A
Vicki Watkins	Dog Bone	2008	*Puraflo / Direct Discharge / Salcor UV*	$9,000.00
Emma J. Miller	Bulger Road	2008	Sand Filter / Inground	$19,885.00
Carl Campbell	Bulger Road	2008	Septic to LPP Inground	$19,900.00
Roger Lovejoy	Flat Creek	2008	HAU to LPP Inground	$13,999.90*
Jimmy Walls	Bark Camp	2009	*Sand Filter / Direct Discharge / Salcor UV*	$16,485.00
Janet Clark	Bark Camp	2009	*Puraflo / Direct Discharge / Salcor UV*	$12,268.00
Victor Clark	Bulger Road	2009	*Sand Filter / Direct Discharge / Salcor UV*	$17,017.45
Tammy & Gene Pauley	Flat Creek	2009	Eljen Geotextile Sand / Inground	$12,625.00
Tracy, Gail Adkins	Flat Creek	2009	*Puraflo / Direct Discharge / Salcor UV*	$15,300.00
Bonnie Hager	House Road	2009	*Ecoflo / Direct Discharge / Salcor UV*	$15,600.00
Janet & Eugene Adkins	Dog Bone	2009	*Ecoflo / Direct Discharge / Salcor UV*	$18,300.00 *
Stacie & Benjamin McClure	Dog Bone	2009	*Ecoflo / Direct Discharge / Salcor UV*	$15,400.00
Franklin Terry	Flat Creek	2009	Puraflo / Stone Bed / Inground	$15,120.00
Chris Campbell	Bulger Road	2009	*Puraflo / Direct Discharge / Norewco UV*	$16,100.00
Mickie & Tina Elkins	Gritter Fork	2009	*DF-50 HAU In ground*	$16,400.00
Lawrence Tudor, Jr.	Dog Bone	2009	*Puraflo / Direct Discharge / Norewco UV*	$16,800.00
Birdia & Gary Cooper	House Road	2009	*Puraflo / Direct Discharge / Norewco UV*	$17,950.00 *
Gary Cooper, Jr.	House Road	2009	*Puraflo / Direct Discharge / Norewco UV*	$18,250.00 *
Pearl Adkins	House Road	2010	*Puraflo / Direct Discharge / Salcor UV*	$26,550.00
Dottie Terry	House Road	2010	*Puraflo / Direct Discharge / Salcor UV*	included with P. Adkins
			TOTAL	**$439,693.52**
			Average for 40 homes	***$10,992.34***

Direct Discharge Systems

* Includes cost of electric upgrade (average: $1520.00)

Appendix B Sampling Results Homes with Direct Discharge Final

Sampled at Point Where Effluent Enters Creek

All sample analysis by Bio-Chem Testing in Teays, WV, unless noted

For the project we are using DEP average monthly limitations, their highest standard

Homeowner	Date	BOD5 Mg/L *Limitation 30* *(75 for single grab)*	Fecal – 6 hr Col/100mL *Limitation 200* *(500 for single grab)*	Total Suspended Solids Mg/L *Limitation 30* *(75 for single grab)*	E. Coli Col/100mL *No DEP Standard*	notes
A. Kenneth Bailey **Installation 11-07** ***ASHCO*** ***Recirculating Sand*** **2 homes on system**	3-6-08 4 mos	7	1364	7	Not measured	Sampling done by NRCCE
A. Kenneth Bailey	4-30-08 5 mos	6	9		9	Ric sampled, grate on, algae present
A. Kenneth Bailey	5-14-08 6 mos	6	240		27	Ric sampled, grate on, algae present
A. Kenneth Bailey	6-5-08 7 mos	15	500		207 207	Ric sampled, grate on, algae present
A. Kenneth Bailey	7-25-08 8 mos.	4	<10	<5	<10	Ric sampled, grate on, algae present
A. Kenneth Bailey	7-30-08 8 mos.	Not measured	<10	Not measured	Not measured	DEP Sampling
Stopped sampling at this site. Feeling that system is working properly.						
B. Ferrell-Pauley **Installation 10-07** ***ASHCO*** ***Ecoflo Peat*** **2 homes on system**	3-6-08 5 mos	39	3300	11	Not measured	Sampling done by NRCCE
B. Ferrell-Pauley	4-30-08 6 mos	43	>60,000		>200,000 >200,000	Ric sampled Bio-Chem
B. Ferrell-Pauley	5-14-08 7 mos	2	54		153	Ric sampled Bio-Chem
B. Ferrell-Pauley	6-5-08 8 mos	4	280		300 300	Ric sampled Bio-Chem
B. Ferrell-Pauley	7-17-08 9 mos	12	>60,000	10	>200,000 >200,000	Ric sampled Bio-Chem
B. Ferrell-Pauley	9-3-08 11 mos	48	>60,000	10	>60,000 >60,000	Ric sampled Bio-Chem
B. Ferrell-Pauley	9-3-08 11 mos	11	5,800	11	Not measured	Ric sampled REIC

		BOD5	Fecal	TSS	E. coli	
B. Ferrell-Pauley	9-9-08 11 mos	Not measured	20,000	Not measured	78,000 78,000	Ric sampled Bio-Chem **UV sleeve cleaned 9-5-08**
B. Ferrell-Pauley	10-16-08 12 mos	113	>60,000	12	>200,000 >200,000	Ric sampled Bio-Chem
B. Ferrell-Pauley	*10-16-08* *12 mos*	413	>60,000	38	>200,000 >200,000	Ric sampled **After Septic tank**
B. Ferrell-Pauley	*10-16-08* *12 mos*	153	>60,000	495	>200,000 >200,000	Ric sampled **Bottom of Peat tank**
B. Ferrell-Pauley	11-13-08 13 mos	32	>60,000	<5	>200,000 >200,000	Ric sampled **Iron 1.53**
B. Ferrell-Pauley	12-09-08 14 mos	10	260	<5	909 est 909 est	Ric sampled Bio-Chem
B. Ferrell-Pauley	2-24-09 16 mos	64	>60,000	<5	41,000 41,000	Ric sampled Bio-Chem
B. Ferrell-Pauley	2-25-09 16 mos	55	>60,000	<21	Not sampled	DEP Sampled
B. Ferrell-Pauley	5-12-09 19 mos	29	Not sampled	11	80,000 80,000	Ric sampled Bio-Chem
B. Ferrell-Pauley	6-22-09 20 mos	18	Not sampled	25	3,000 3,000	Ric sampled Bio-Chem
B. Ferrell-Pauley	6-22-09 20 mos	523	Not sampled	66	75,000 75,000	Ric Sampled **After Septic Tank**
B. Ferrell-Pauley	7-21-09 21 mos	32	Not Sampled	12	2,220 2,220	Ric sampled Bio-Chem
B. Ferrell-Pauley	7-21-09 21 mos	926	Not Sampled	57	130,000 130,000	Ric Sampled **After Septic Tank**
B. Ferrell-Pauley	9-1-09 23 mos	49	Not Sampled	15	>200,000 >200,000	Ric sampled Bio-Chem
B. Ferrell-Pauley	9-1-09 23 mos	744	Not Sampled	66	>200,000 >200,000	Ric Sampled **After Septic Tank**
B. Ferrell-Pauley	10-20-09 24 mos	37	Not Sampled	12	>200,000 >200,000	Ric sampled Bio-Chem
C. Mary Adkins **Installation 5-30-08** ***B. Clark*** ***Puraflo Peat***	6-5-08	7	35,000		55,000 55,000	Ric sampled Bio-Chem

		BOD5	Fecal	TSS	E. coli	
C. Mary Adkins	9-3-08 3 mos	54	18	127	<10	Ric sampled Bio-Chem
C. Mary Adkins	9-3-08 3 mos	9	26	115	Not measured	Ric sampled REIC
C. Mary Adkins	10-16-08 4 mos	63	36	146	9	Ric sampled
C. Mary Adkins	11-12-08 5 mos	71.7	12,200	<12.0	>/= 1,600 1,600	Analabs Sampled **Iron 0.13** (effluent)
C. Mary Adkins	11-13-08 5 mos	13	23,000	5	40,000 40,000	Ric sampled
C. Mary Adkins	2-24-09 8 mos	5	<10	<5	<10	Ric Sampled
D. Dannie Clark **Installation 5-30-08** ***L. Clark*** ***Puraflo Peat***	6-5-08	5	<10		<10	Ric sampled
D. Dannie Clark	7-17-08	Not enough volume to sample	<10	Not enough volume to sample	<10	1 drop every 3 sec. Ric sampled
D. Dannie Clark	7-30-08 2 mos.	8	91	9	Not measured	DEP Sampled
D. Dannie Clark	11-12-08 6 mos	9.66	600	16.0		Analabs **0.2010 Iron**
Stopped sampling at this site. Normally only one person stays at this home and is there infrequently.						
E. Eric Woodrum **Installation 5-30-08** ***T.R. Davis*** ***Quanics Synthetic***	6-5-08	169	9		10,000 10,000	Ric sampled
E. Eric Woodrum	7-17-08	20	500	<5	9	Ric sampled
E. Eric Woodrum	7-30-08 2 mos	83	545	440	Not measured	DEP Sampled
E. Eric Woodrum	9-3-08 3 mos	33	545	100	818 818	Ric sampled Bio-Chem
E. Eric Woodrum	9-3-08 3 mos	10	3,700	81	Not measured	Ric sampled REIC
E. Eric Woodrum	10-16-08 4 mos	6	36	<5	9	Ric sampled TR Davis had cleaned the UV sleeve week before sampling
E. Eric Woodrum	11-13-08 5 mos	7	<10	<5	<10	Ric sampled
E. Eric Woodrum	2-24-09 8 mos	16	5,500	<5	25,000 25,000	Ric sampled

		BOD5	Fecal	TSS	E. coli	
E. Eric Woodrum	2-25-09 8 mos	29	1,180	14	Not sampled	DEP sampled
E. Eric Woodrum	5-12-09 11 mos	16	Not sampled	17	260 260	Ric sampled
E. Eric Woodrum	6-22-09 12mos	12	Not sampled	3	36 est	Ric sampled
F. Beecher Adkins **Installed 5-07** ***ASHCO*** ***Ecoflo Peat*** Changed to direct discharge 8-08	9-03-08 16 mos	185	27,000	21	14,000 est. 14,000	Ric sampled
F. Beecher Adkins	10-16-08 17 mos	13	<10	5	<10	Ric sampled
F. Beecher Adkins	11-13-08 18 mos	5	<10	<5	36	Ric sampled
F. Beecher Adkins	2-24-09 21mos	6	9	<5	<10	Ric Sampled
F. Beecher Adkins	2-25-09 21mos	<2	<10	5	Not sampled	DEP Sampled
G. Dallas Clay Installed 6-08 ***B. Clark*** ***Puraflo Peat***	10-16-08 4 mos	5	6,000	7	<10	Ric sampled
G. Dallas Clay Installed 6-08	11-13-08 5 mos	4	<10	9	<10	Ric sampled
G. Dallas Clay	2-24-09 8 mos	11	<10	39	<10	Ric Sampled forced
G. Dallas Clay	2-25-09 8 mos	9	<10	126	Not sampled	DEP Sampled
H. Danny Collins Installed 8-08 ***B. Clark*** ***Puraflo Peat*** **2 homes on system**	11-13-08 3 mos	3	<10	<5	<10	Ric sampled No grate from here on
H. Danny Collins	11-12-08 3 mos	<3.60	<18.0	14.0	23.0	Analabs Sampled **Iron 0.0821** (effluent)
H. Danny Collins	2-24-09 6 mos	<3	<10	<5	<10	Ric Sampled
H. Danny Collins	2-25-09 6 mos	<2	<10	<2	Not sampled	DEP Sampled

		BOD5	Fecal	TSS	E. coli	
H. Danny Collins	2-3-10 18 mos	<2		2	<10	Ric Sampled Bio-Chem
I. Lyle Clark Installed 7-08 *Ashco* *Sand Filter*	11-13-08 4 mos	<2	<10	<5	<10	Ric sampled
I. Lyle Clark	2-24-09 7 mos	<3	<10	<5	<10	Ric Sampled
I. Lyle Clark	2-25-09 7 mos	<2	<10	<2	Not sampled	DEP Sampled
J. Vicki Watkins Installed 10-2-08 ***B. Clark*** ***Puraflo Peat***	2-24-09 4 mos	<3	<10	<5	<10	Ric Sampled
J. Vicki Watkins	2-25-09 4 mos	123	>60,000	131	Not sampled	DEP Sampled
J. Vicki Watkins	5-12-09 7 mos	<2	Not sampled	<2	<10	Ric Sampled
K. Gary Cooper Sr **Installation 12-09** ***Lyle Clark*** ***Puraflo Peat***	2-3-10 2 mos	24		5	>200,000 >200,000	Ric sampled Bio-Chem

Over acceptable limits **No DEP standards, but too high based on 200 limit**

Appendix C Post Installation Tributary Sampling E. Coli Analysis

Site ID, Installation Date, Tributary	Historic	3/6/2008 WVWRI	5/29/2008 WVWRI	6/26/2008 WVWRI	7/24/2008 WVWRI	12/9/2008 Ric	5/12/2009 Ric	6/22/2009 Ric	7/21/2009 Ric	9/1/2009 Ric	10/20/2009 Ric	2/3/2010 Ric
DA-DS, 12/07, *Wolf Br* *Diane Adkins*	***4 of 9 over***			210	2000	9 Est.	360	450	2000	220	300	350
House Road Culvert											108 Est.	9 Est.
DW-DS, 8/07, *Flat Ck* *Delmar White*	***2 of 2 over***	18	54	162	630	220	280	310	500	350	126 Est.	135 Est.
BA-DS, 5/07, *Flat Ck* **DW and BA sites on Flat Creek are adjacent.** *Beecher Adkins*						350	260	360	117 Est.	189 Est.	220	230
KF-DS 9/07, 1/08, *Flat Ck* *Kevin Ferrell*	***1 of 1 over***	430	330	1091	760	800	450	630	216 Est.	4700	700	90 Est.
#12, *Flat Ck* Immediately upstream of KF	***5 of 9 over***							640	700	250	200	54 Est.
KB-DS, 11/07, *Sycamore* *Kenneth Bailey*		45	72	2500	310	27 Est.	1340	640	250	99 Est.	144 Est.	63 Est.
Owl Creek Upstream of KB, no people or farm animals								240	45 Est.	560	81 Est.	<10
Collins-DS, 8/08, *Bark Camp* **Of 7 adjacent homes above this site, 6 have new systems installed by project.** *Danny Collins*	Results from this sampling site show consistently lower levels of E. coli than anywhere else in the watershed and suggest that **the installation of alternative wastewater systems by this project has improved the bacterial health of local tributaries**.						380	220	126 Est.	135 Est.	153 Est.	126 Est.
DC-DS, 6/08, *Flat Ck, Bulger* *Dallas Clay*			480	330	600	135 Est.	>800	280	4500	370	2200	210
WC-DS, 7/08, *Flat Ck, Bulger* **DC and WC sites on Bulger are adjacent.** *Willie Clay*				300	530	189 Est.	>800[1]	500	1000	630	1000	171 Est.

Shaded numbers are over acceptable limits of 200 colonies per 100 mL

[1] UV Disinfection at WC damaged in flooding. Not working 5-12-09 or 6-22-09 or 7-21-09. Back working starting with 9-1-09 sampling.

Appendix D

Left Fork Community Criteria for Getting Alternative Sewage Treatment Unit

Item	*Possible Points*	*Homeowner Points*
low income status	25	
high e. coli level in creek over acceptable limits some of the time 10 points over acceptable limits at least 30% of time 15 points over acceptable limits at least 50% of time 20 points over acceptable limits at least 70% of time 25 points	25	
number of people the new system would serve 3 points for every person living in the house up to 21 points	21	
participation in community meetings attended at least 10% of meetings 5 points attended at least 30% of meetings 10 points attended at least 50% of meetings 12 points attended at least 60% of meetings 15 points	15	
early sign up to agree to put in a system	9	
willing to contribute financially to installation costs contribute at least $50 1 point contribute at least $100 2 points contribute at least $250 3 points contribute at least $500 5 points	5	
Total Points	100	

Other things would also play into deciding who gets a system including recommendations from our engineering and sewage partners, additional water quality information, government agency rules (historic preservation, archeological sites, clean water act).

Appendix E Left Fork Community Attitude **PRE /POST Assessment Comparison**

(*Yes & Maybe* Combined) **28** people filled out the PRE at several meetings prior to 9-2005. **27** people filled out the POST at one meeting on 9-14-09. In both assessments, not all answered every question.

Question		*YES & MAYBE*	*NO*
1. In communities like mine… **people care about each other.**	PRE	*100%*	*0%*
	POST	89%	11%
2. In communities like mine… **people believe they have control over what happens to them.**	PRE	*50%*	*50%*
	POST	52%	48%
3. In communities like mine… **people can trust the county government.**	PRE	*34%*	*59%*
	POST	59%	41%
4. In communities like mine… **people know how to work together.**	PRE	*89%*	*11%*
	POST	78%	22%
5. In communities like mine… **there are good community leaders.**	PRE	*89%*	*11%*
	POST	89%	11%
6. In communities like mine… **the government tries to help us.**	PRE	*55%*	*44%*
	POST	52%	48%
7. In communities like mine… **people work together to make things change for the better.**	PRE	*82%*	*19%*
	POST	61%	38%
8. In communities like mine… **our children have a good chance to succeed.**	PRE	*82%*	*18%*
	POST	69%	31%
9. In communities like mine… **people respect each other.**	PRE	*85%*	*15%*
	POST	67%	33%
10. In communities like mine… **people know how to make good decisions.**	PRE	*96%*	*4%*
	POST	74%	26%
11. In communities like mine… **most people are able to live good lives.**	PRE	*93%*	*7%*
	POST	85%	15%
12. In communities like mine… **my opinion is important.**	PRE	*89%*	*11%*
	POST	81%	19%

Appendix F

Bacterial Source Tracking

BACKGROUND. Bacterial Source Tracking is a relatively new technique which compares DNA E. coli "fingerprints" to evaluate the presence of E. coli from certain species.

This project has collaborated with Marshall University's Forensic Science Center's Bacterial Source Tracking Laboratory to determine the presence of human E. coli in tributaries in the Left Fork of the Mud River Watershed. The project has a record of multiple watershed tributary samplings dating from the late 1990's. However, until the work with Marshall there had been no attempt to separate out and identify human and non-human E. coli.

Clearly there is serious contamination in the watershed. Between November 2005 and July 2006, twenty-three sites in the watershed were sampled between seven and ten times. At seventeen of these sites, samples were over the acceptable limits for E. coli (200 parts per 100 milliliter) 50% or more of the times they were sampled. Viewed another way, of the 195 different water samples taken, 119 or 61% were over the acceptable E. coli limit.

PROCEDURE. Marshall has been willing to donate lab analysis for 50 water samples to the project. Bio-Chem Testing analyzes the project's water samples for E. coli. They save the spent filters from these tests. Marshall, then, uses the E. coli colonies grown on these filters for their analysis. For each site analyzed, the spent filter which had the greatest dilution is used. Ten different pure isolates (clones of 10 separate bacteria colonies) from each site's water sample are analyzed. The Left Fork isolates' "fingerprint" is compared to Marshall's library of 14,000 isolates to attempt both a 3-way match (wildlife, domestic animal, and human) and a 2-way match (nonhuman and human).

PROJECT SAMPLING AND RESULTS. To date, the project has asked Marshall to analyze E. coli from seven different sites throughout the watershed from two different sampling dates (September 2006 and March 2007). With only seven sites and two samplings, results cannot be assumed to be definitive, but they do confirm what can be assessed from visual observation and from home dye tests: current septic systems are failing. **Marshall's BST results show that five of the seven sites (71%) have a human E. coli isolate in one of the two analyses**. **Three of the seven sites show a human E. coli isolate in both samplings.**

APPLICABILITY. The project hoped to do at least one bacterial source tracking sampling during the 2007 summer, but to drought conditions made it impossible to gather appropriate samples. The project will continue tributary sampling as new systems are put in. However, it looks as if systems will be installed broadly throughout the watershed, rather than concentrating on one tributary section. This will make it difficult to determine using BST technique whether without question these new systems have reduced human E. coli in the watershed. The BST results will only give a limited snapshot of a moment in the health of a tributary. BST, therefore, will be used as part of a broader investigation of tributary health including e. coli results, field analysis, and analysis of effluent from new septic systems.

<u>Appendix G: White Papers</u>

White Paper for Final Project Report:

Tributary Water Quality Findings and Analysis

This Alternative Wastewater Demonstration Project has its roots in work done cooperatively among West Virginia University, the WVU Lincoln County Extension Office, and two Lincoln County high schools. Together these groups did a series of water samplings and analyses in the Left Fork of the Mud River, in the southeastern corner of the county. These happened in 1999 and 2000. Funds for this came from a Kellogg Community Partnership grant to the University with the goal of linking WVU with local communities in attempts to solve local problems. The tributary water sample results showed levels of E. coli much higher than what was acceptable in either state or federal standards. This established a preliminary water quality baseline for the Left Fork watershed. The watershed is approximately 6.5 miles long and drains into a 307 acres artificial lake.

As the EPA project began in 2005 potential tributary sampling points were identified in the watershed. Eventually the number of sampling points was narrowed down from 37 to 18 locations. From November 2005 through September 2006, samples were taken at these 18 sites on 9 separate dates under a variety of conditions and during all seasons. <u>**Of the 162 different samples, 73 or 64% were over the acceptable E. coli limit of 200 colonies per 100 mL.**</u>

Results from this baseline sampling helped determine what homes in the watershed would receive new alternative wastewater systems. The local community developed a point system for selection based on 6 criteria. The percentage of sampling times that E. coli results were over the acceptable limits was one of two criteria weighted most heavily. (The other most heavily weighted criterion was low income status.) Since installations were based on points, new systems ended up being installed randomly throughout the watershed. In hindsight, trying to concentrate installations in selected geographic areas would probably have helped create more definitive results. However, the project director, the County Commission, and the community felt a point system was a more equitable approach.

As new systems were installed, sampling locations were changed so that they were closer to these systems. Post installation sampling began in March 2008 and finished in February 2010. By the final sampling event, 11 different sites were being sampled. Not all were sampled as often because new sampling sites were added as more systems were installed. Again, hindsight would suggest the value of establishing the same pre-installation and post-installation sampling sites. Again, however, the commitment to create a more equitable community driven method for installing systems, overrode other considerations.

At the 11 tributary sampling sites there were 11 different sampling events resulting in 83 individual samples. The most interesting trend developed at Site *Collins DS*. This is a sampling point above which there are 7 adjacent homes. Six of these have new systems installed by the project. The 7^{th} is a relatively new aerator system, privately installed. Results from this sampling site show consistently lower levels of E. coli than anywhere else in the watershed. This suggests that <u>**the installation of alternative wastewater systems by this**</u>

project has improved the bacterial health of local tributaries. Though the EPA project ended in February 2010, the county received ARRA Stimulus funding in January 2010. This new project will install another 19 wastewater systems in the same watershed. Tributary sampling and analysis will continue through 2011. It is expected that future results will reinforce current findings.

Because E. coli is present in not only humans, but other warm blooded animals, the project wanted to determine the presence of human E. coli in tributaries in the Left Fork. The Lincoln County Commission collaborated with Marshall University's Forensic Science Center's Bacterial Source Tracking Laboratory, in order to differentiate between human and non human E. coli. Marshall donated lab analysis of project water samples. The project delivered to Marshall the spent filters used by the lab which analyzed the watershed's E. coli samples. Marshall, then, used the E. coli colonies grown on these filters for their analysis. For each site, the spent filter which had the greatest dilution was used. Ten different pure isolates (clones of 10 separate bacteria colonies) from each site's water sample were analyzed. The Left Fork isolate's "fingerprint" was compared to Marshall's library of 14,000 isolates to attempt both a 3-way match (wildlife, domestic animal, and human) and a 2-way match (nonhuman and human).

Marshall analyzed E. coli from seven different watershed sites from two different sampling dates (September 2006 and March 2007). With only seven sites and two samplings, results cannot be assumed to be definitive, but they do confirm what visual observation and home dye tests suggested: current septic systems are failing and contributing bacteria to the tributaries. **Marshall's BST results showed that five of the seven sites (71%) had a human e. coli isolate in one of the two analyses**. **Three of the seven sites showed a human e. coli isolate in both samplings. This supports the contention that inadequate human wastewater systems are polluting tributaries in the Left Fork.**

In addition to sampling tributaries, the project also sampled direct discharge effluent from the new wastewater systems. Because of poor soil conditions, high water tables, and limited lot size, 28 of the 40 homes (70%) were direct discharge systems. Though the state Division of Environmental Protection requires semi-annual maintenance inspections of direct discharge systems, these do ***not*** include bacterial analysis of final effluent. Also, even though the secondary treatment systems have NSF 40 certification, this is only based on BOD and TSS, and does not how well systems eliminate bacteria. The project felt it was prudent to sample some of these direct discharges to make sure the final effluent was as pure as expected. During the project, 12 different direct discharge systems were sampled at the point where effluent entered the tributary. At times BOD5, Total Suspended Solids, Fecal, and E. coli were all monitored. However, because E. coli was the key element in tributary samples, it was also the driver for the final effluent samples. (One of the 12 homes (Ferrell-Pauley) was problematic throughout the project. Of the 15 times E. coli was analyzed in the final effluent, 67% of the time results had over 40,000 colonies per 100 mL. Work continues on this system.) Other systems had much better results. When these other systems had higher than acceptable readings, installers, sanitarians, and the project director worked together to problem solve what might be causing the high numbers, and in all cases found solutions which led to acceptable E. coli levels.

Conclusions

- **The most important conclusion from this project is the finding that alternative wastewater systems, when installed correctly and in contiguous homes, decrease bacterial levels in tributaries.**
- **Direct discharge systems need to have their final effluent monitored to insure systems are properly decreasing bacteria. Doing this, however, is expensive and will increase long term financial costs. This burden could greatly impact in lower income communities where it may cause people to avoid using alternative wastewater technologies. State agencies need to look critically at ways to protect the environment while making sure it is affordable.**

White Paper for Final Project Report:

Outstanding Technical Issues:

Leaking Tanks, Direct Discharge and NSF 40 Testing,
Implications of Mineral Content of Well Water,
Antibiotics & Other Pharmaceuticals on Septic Tanks' Viability

As this EPA Demonstration Project unfolded, a number of technical issues challenged the Commission. Some of these were solved; others still loom as challenges. Solutions are administrative and regulatory as well as research driven. Those discussed here are more applicable to rural, low income communities like the Left Fork Watershed. All need additional research and are especially appropriate for land grant universities with commitments to rural community outreach.

LEAKING TANKS. The WV state code specifies that septic tank should be water tight, and one would expect that brand new concrete septic and pump tanks would not leak. In order to make sure tanks are securely in the ground and that the process of breaking down raw sewage begins properly, once tanks are set in the ground on location, they are normally filled with water. When the project noticed that some new concrete tanks after being filled were leaking, the Commission decided to inspect tanks before they were brought on site. Local tank fabricators were asked to fill tanks with water a day in advance, and these were inspected the following morning. During the original inspection 5 out of 9 tanks (55%) were leaking the morning of the inspection. Non-leakers were spray painted with EPA to insure that only those passing inspection would be brought to sites.

Yet, even tanks which did not leak at the manufacturer's, sometimes end up leaking by the time they were filled with water on site. Lifting tanks on to flat bed trucks, transporting them over rough roads, and then lifting them off and positioning them in the ground can aggravate potential flaws and create leaks. Tanks which leaked on site were drained and painted or coated on the outside or the inside in an effort to re-seal.

Most of the leaking concrete tanks were mid-seam construction. Yet, most of the leaks were within the body of the tank, not at the seam. This led the project to feel that construction materials and poor workmanship were the real issues, rather than tank seam placement.

The project raised the issue of newly manufactured leaking tanks at the state level. The WV State Sewage Advisory Board voted to require annual inspection of state concrete tank fabricators. In addition to this impact on state regulations, the project reinforced the expectation that tanks would be water tight at pre-bid site visits and linked installation payments to tank inspections. In the end the Commission barred from the project tanks fabricated by a certain manufacturer because of repeated leaking problems.

This project's history of leaking tanks led the Commission to require heavy duty plastic tanks rather than concrete for all installations in its new ARRA Green Stimulus project.

One of the project's lessons-learned was the importance of continually raising the issue of leaking tanks before regulators and installers as a way to keep attention on this problem. It is vital that a project director, county sanitarian, or other homeowner advocate be on site during installation to make sure tanks do not leak before they are "hidden" underground.

DIRECT DISCHARGE and NSF 40 TESTING. Ideally, every home wastewater system would have its final effluent go into the ground. But for this to happen a home needs 1) enough land area for a discharge field, 2) soils which allow effluent to effectively percolate through them for final decontamination, and 3) a deep enough water table to ensure wastewater effluent doesn't pollute drinking or tributary water.

Homes in the Left Fork Watershed often can't meet these requirements. In-ground effluent dispersal then, though desirable, is not always possible. The alternative is direct discharge into the creek or stream. Because the state of West Virginia wants to insure that bacteria and other wastewater contaminants do not pollute tributaries, there are two critical system requirements that must be met before direct discharge can be permitted. New wastewater systems must be NSF-40 approved (an international accreditation process), and for the life of the systems, they must be monitored (usually twice a year) to make sure components work correctly.

The final stage in the discharge process before the effluent enters the creek is bacterial decontamination. The West Virginia Department of Environmental Protection recommended that this project use ultraviolet light decontamination rather than a chlorine / de-chlorination process because of problems encountered with the latter. (*There are a growing number of states; however, which do not allow direct discharge under any circumstances. West Virginia is not at that point, though this project's experience raises concerns about short and long term viability of direct discharge.*)

West Virginia's required direct discharge monitoring does **NOT** include analyzing the quality of the final effluent which goes into the creek. The required monitoring in WV focuses on the mechanical components of the system. The Commission, however, felt it was prudent to test at least some of these systems. After all, the federal funding was about demonstrating that alternative systems can clean up bacterial content in creeks and streams.

Eleven of the project's 28 direct discharge system homes had their final effluent sampled. Sampling began in March 2008 and ended in February 2010. Originally, BOD, Fecal, TSS, and E. coli were all sampled. Eventually, the sample focus became E. coli because that was also the key parameter for tributary sampling. In the end there were 57 individual sampling events measuring E. coli. The project used 200 colonies per 100mL as the cutoff acceptable limit. 29 or 51% of these sampling events were over the acceptable limit. 20 or 35% had readings of over 25,000 colonies per 100 mL. While most of the direct discharge systems in the project worked properly as far as meeting acceptable discharge limits, some systems were problematic.

The project tried to figure out what might be causing these high bacteria counts. The Commission engaged state agencies, NFS International, water quality labs, system and component manufacturers in discussions and even sponsored meetings and workshops in the county with national system representatives, state agency officials, and local installers.

One potential cause for high bacteria counts relates to fouling of the sleeve around the UV light. UV rays kill E. coli as the effluent flows around this sleeve. However, if the sleeve isn't clean, the UV rays don't reach the bacteria which then pass out into the creek. In examining the UV lights in some of the project's systems, sleeve fouling was found. However, no conclusive cause for the fouling has been accepted. As with so many issues in the project, organizations tended to defend their turf. Agencies, manufacturers, installers, labs, all suggest that the cause for the problem rested with another entity. Establishing good research in this area is critical to long term viability of alternative systems.

MINERAL CONTENT OF WELL WATER. The majority of the homes in the Left Fork Watershed get their water from individual drilled wells. Those not relying on wells use springs or hand dug wells. Early sampling of home well water showed very few wells contaminated by E. coli. The project did not sample for mineral content. As the project tried to unravel causes for unacceptably high levels of E. coli in the new systems' direct discharge samples, well water mineral content became a potential concern.

There is a perception that minerals in the home water supply (especially iron and calcium) might contribute to UV sleeve fouling. Some of the labs the project consulted shared experiences in which it seemed that bacteria secreted minerals which fouled systems.

High mineral content in household water, may, in fact, be a barrier to proper decontamination of wastewater effluent. If so, it is especially discouraging that none of the project's advisors, system manufacturers, or collaborators, raised that concern as the project moved forward. In part, this may be because alternative wastewater systems are very uncommon and untested in rural, low income areas, where homeowners do not have the luxury of installing costly filtration systems to remove minerals in their water. This topic like others needs committed research.

IMPACT OF ANTIBIOTICS & OTHER PHARMACEUTICALS ON SEPTIC TANK VIABILITY. The final area where the projected wished there was more concrete research was the impact of various pharmaceuticals on home septic tanks. Again, there seems to be a dearth of research related to rural communities. In areas served by larger septic package plants, pharmaceuticals entering one home system are diluted by the multiple homes served by the plant. In rural communities with individual home septic tanks, when all people in a home are sick and taking antibiotics, the septic tank can be rendered useless as those antibiotics pass through the humans, enter the tank, and kill off the beneficial tank bacteria. Besides potential negative impact to the tank, what is the impact on the secondary system? As more and more people use more and more medicines, the issue of pharmaceuticals' negative impact on home septic systems only grows.

Conclusions

Clearly there are a number of critical, wastewater related, research issues which are endemic to rural, low income communities. All are especially appropriate topics for land grant universities with commitments to rural community outreach and ought to be encouraged by federal and state agencies.