Report for 2004UT44B: Alternative Decentralized Wastewater Treatment Systems for Utah Conditions

There are no reported publications resulting from this project.

Report Follows

Alternative Decentralized Wastewater Treatment Systems for Utah Conditions

Executive Summary

Increasing development of rural areas in Utah is resulting in demands for more options for treatment and disposal of wastewater, especially in areas not suitable for the use of the conventional septic tank – drain field system. Many of these alternative options are more complex treatment and disposal systems that require increased expertise in site evaluation, design, installation, management, operation, and maintenance. Also small communities that are facing growth pressures that impact water supply resources may be interested in decentralized wastewater treatment technologies that provide for beneficial reuse of the wastewater.

In this project, we are surveying, reviewing, and evaluating existing information on various wastewater technologies that would be protective of public health and the environment under Utah climatic, geological, and regulatory conditions, while at the same time addressing the pressures of population growth. Based on the information collected, we will develop guidance materials for state and local decision-makers on decentralized treatment technologies and appropriate management strategies for those technologies.

Specific tasks include:

1) Survey and collect existing information on alternative decentralized on-site and wastewater reuse treatment technologies.

2) Evaluate information with regards to applicability of technologies to Utah's climatic, geological, and regulatory conditions – consider life cycle costs, treatment efficiencies, management requirements, reliability and failure rates, and potential for beneficial reuse of wastewater.

3) Develop guidance materials for state and local decision-makers concerning wastewater treatment technologies and management programs that will be protective of public health and the environment.

Statement of Critical State Water Problem

Populations are increasing in many rural and small municipalities in Utah, with housing developments expanding into areas that can only be served by on-site wastewater systems. Freshwater supplies in Utah are limited and must be kept free from contamination from untreated or poorly treated wastewater discharges. The need for effective wastewater treatment in these areas is a major concern for public health and environmental quality managers.

In many of these areas, site conditions such as steep slopes, shallow ground water or bedrock and local soil characteristics such as clayey or sandy soils may preclude the use of the conventional septic tank/drain field system. To accommodate growth in these areas, the use of more complex systems that will provide equal or better treatment than that provided by the conventional system may be an option that will allow continued development. However, for these systems to be effective, they must be appropriate for Utah climatic and geological conditions, design, management and operating requirements must be known, and construction guidelines must be thorough.

Also as the drought in the western United States continues, the use of wastewater treatment technologies for individual homes or businesses or small communities that result in groundwater recharge or provide for beneficial reuse of treated wastewater is another goal of wastewater treatment.

In Utah at the present time, the opportunities to use more complex on-site wastewater treatment systems for individual homes and businesses and for small groups of homes and businesses is limited by prescriptive regulations. However, as population and growth demands increase, the options available need to also increase, but with adequate regulatory oversight and management programs. To ensure that Utah will make wise decisions in the use of complex on-site wastewater systems and systems in the future, in this project we are developing a rational scientific framework to evaluate potential technology options that will provide effective treatment and beneficial reuse while being protective of Utah's public health and environmental resources. The use of wastewater treatment technologies for small communities and individual households that provide adequate treatment are essential to maintain the quality of Utah's surface and groundwater supplies while adding to the sustainability of the water supply resources.

Statement of Benefits

The use of more complex on-site and small community wastewater treatment systems will allow continued development in Utah's more rural areas. By providing thorough and complete information on the range of technologies available, state and local decision-makers will be able to make wise decisions in the selection of technologies and will be able to ensure that appropriate siting, design, construction, installation, and operating and maintenance guidelines are implemented.

Nature, Scope, and Objectives

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Specific tasks include:

1) Survey and collect existing information on alternative decentralized on-site and wastewater reuse treatment technologies.

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Methods, Procedures, and Facilities

To accomplish the project tasks, during the first year of the project we surveyed literature sources concerning alternative decentralized systems. We extensively utilized the resources associated with the National Small Flows Clearinghouse at West Virginia University (NSFC, 2004). We also obtained information on various technologies from environmental and health state agencies, with a focus on those states with climatic and geological conditions similar to those in Utah. Equipment vendors of wastewater technologies were also surveyed.

To determine if technologies were appropriate for use in Utah, we defined those climatic and geological conditions that might affect the use of various technologies. We also developed a standardized format/matrix for evaluation of information, including:

- Treatment efficiencies anticipated in Utah's varying climatic and terrain conditions
    - Requirements to achieve predicted treatment efficiency (for example, residence time, loading rates, dose frequency, biomat effects, soil characteristics)
    - Dependence of technology on soil treatment
    - Dependence of technology on mechanical treatment

- Treatment efficiency expected through time

- Reliability of technology

- On-going monitoring, maintenance, and management requirements

- Projected life spans and failure rates of technologies

- Potential for:
    - Containment or removal of pathogens (disease-causing microorganisms)

    - Removal of nutrients (nitrogen and phosphorus)

- Life cycle costs
    - Site evaluation
    - Design
    - Installation and construction
    - Operation, monitoring and maintenance
    - Repair and replacement

- Beneficial reuse and groundwater recharge potential

Summaries of information on two technologies are presented in Tables 1 and 2. Additional information on these technologies, references for the information presented in Tables 1 and 2, and information on additional technologies can be found on the project web site: [http://www.engineering.usu.edu/uwrl/training/onsitesystems/].

Based on the information collected, evaluated, and assessed, during year 2 of the project we are preparing guidance materials that summarize the effectiveness and appropriateness of various decentralized technologies for use in Utah. This information will be used by state and local decision-makers as they develop programs to utilize alternative decentralized systems. A workshop on the use of packed bed filter technologies (sand, gravel, peat, and textile filters) in Utah will be given in the fall of 2005 to local health department and Utah Department of Environmental Quality staff.

Table 1. Peat Filters	
	Peat Filters
Residence time	36-48 hours (Bord Na Mona Products, 1999)
Loading rates	300 L/day/bedroom (Patterson, 2004); 1 gal/sq. ft./day (Gustafson et al., 2002); 360-480 gpd (Lindbo, 2001); Loading rates are designed for a four bedroom home with loading to 450 gpd per unit. You can twin two units together for more. (Festa, 2004); No more than 4 bedrooms served by 1 peat filter (Ecoflo, 2004)
Dose Frequency	60 L pumped at a time (Patterson, 2004); 30-40 L per dosing (Premier Tech, 2003)
Biomat effects	
Soil Characteristics	Works well in highly permeable soils over light sandy clays and in soils with low cation exchange capacity (Patterson, 2004); Areas with:Compacted, cut, or filled soil, Shoreline areas, Shallow bedrock areas, Aquifer recharge areas, Wellhead protection areas (Gustafson et al., 2002); Works with all soil types (Bord Na Mona Unlimited, 2004); If Group I or II soil, a level base percolation area is recommended (Bord Na Mona Products, 1999); If Group III or IV soil, piping the effluent to remote trenches is recommended (Bord Na Mona Products, 1999);The system will work in any soil that has a percolation rate and with drip irrigation it can work in moderate clay with proper sizing (Festa, 2004); Soil has to pass the perc test for a sand mound (Ecoflo, 2004)
Climate	Until 1993, confined to cool temperate climates with relatively long winters and mild summers (O'Driscoll, 1998); The effectiveness is not subject to significant seasonal variation with ambient air temperature fluctuations (Born Na Mona Products, 1999); All climates are acceptable. The system was tested from Maine to Florida with the same results (Festa, 2004); Approved for use in Alabama, Arizona, Georgia, Iowa, Massachusetts, Michigan, North Carolina, Ohio, Pennsylvania, South Carolina (Ecoflo, 2004)
Credit	30% reduction in adsorption area (Festa, 2004); 40% smaller adsorption area than for a sand mound (Ecoflo, 2004)
Dependence of technology on soil treatment	Soil can act as tertiary treatment or as a polishing, but is not required (Patterson, 2004); Since the peat filter is not 100% effective, soil is still needed as the final step (Lindbo, 2001)

Dependence of technology on mechanical treatment	Gravity flow: water may pond on top of the peat and compress it (Gustafson et al., 2002); Pressurized distributions system (Patterson, 2004): applied evenly over the peat surface (Gustafson et al., 2002)
Treatment efficiency expected through time	Performance after 10 years: Percent removal of BOD (96+), TSS (95+), NH_3-N (90+), Total Coliforms (99.9+) (Born Na Mona Products, 1999)
Reliability of technology	
On-going monitoring, maintenance, and management requirements	Add lime yearly to maintain P-sorbtion (Patterson, 2004); Low maintenance compared to other technologies (Patterson, 2004; O'Driscoll, 1998); Yearly to quarterly maintenance: Inspection of component, flow meter, and effluent (Gustafson et al., 2002), De-sludge when needed (Bord Na Mona Unlimited, 2004), Make sure the systems are water tight to avoid infiltration (Lindbo, 2001); Experience has shown that after five years it is good to add two extra bags of loose peat and after ten years replace all the peat in the unit (Festa, 2004)
Projected life spans and failure rates of technolgy	10 year life span (saturates with phosphorus in about 7 years) (Patterson, 2004); 10-15 years (Gustafson et al., 2002; Bord Na Mona Unlimited, 2004); Life span depends on homeowner use (Festa, 2004); 8 years (Ecoflo, 2004; Premier tech, 2003)
Removal of pathogens and nutrients	Containment or removal of pathogens (disease-causing microorganisms): 99.7% removal (Patterson, 2004), 93% removal (O'Driscoll, 1998), 99% removal (Bord Na Mona Unlimited, 2004; Lindbo, 2001; Premier Tech, 2003); Removal of Nitrogen: Ammmonia-N is oxidized to Nitrate-N in the aerobic zones of the peat: 275% increase in nitrate-N (Patterson, 2004), Ammonia nitrogen removal 96% (O'Driscoll, 1998), Nitrate-N is reduced in the anaerobic zones: 53.9% loss of nitrate-N (Patterson, 2004), Measured to be 4.5 mg/L (which is below the MCL of 10 mg/L) (Lindbo, 2001), 70-90% reduction of NH_3 levels (Bord Na Mona Product, 1999); Removal of Phosphorus: 74.6 % removal (Patterson, 2004), 58-96% reduction (Lindbo, 2001); Removal of BOD, 90% reduction (Lindbo, 2001), 95% reduction (Bord Na Mona Product, 1999; Premier Tech, 2003)

Life cycle costs	Site evaluation: Depends on contractor (Festa, 2004); Design: Depends on contractor (Festa, 2004); Installation and construction: Easier to install in small lots (Gustafson et al., 2002), Cost is higher where peat is not commonly found (USEPA, 2001), Standard ST-650 Biofilter: $3,895.00 (USEPA, Sept. 2004),Total materials and installation $11,808 (USEPA, Oct. 2004); Operation, monitoring and maintenance: Low energy inputs (Patterson, 2004); Yearly costs: $200-$500/year (included pumping, repairs, maintenance, and electricity) (Gustavson et al., 2002), A maintenance contract is recommended at of fee of $150 to $175 yearly (Festa, 2004), Costs to maintain or operate have not been standardized (USEPA, 2001), Present Value total O&M $12,604 (USEPA, Oct. 2004), Total over life of system $24,412 (USEPA, Oct. 2004), Monthly averaged over the life of the system $150 (USEPA, Oct. 2004); Repair and replacement: If the peat itself is replaced and added, the system as a whole should not ever need to be placed (Festa, 2004)
Beneficial reuse and groundwater recharge potential	
Disadvantages	Not consistent from batch to batch or from different suppliers (USEPA, 2001)

Table 2. Drip irrigation	
	Drip Irrigation
Residence time	Longer residence time enhances denitrification in the soil (Beggs et al., 2004)
Loading rates	Water application rate should not exceed the water absorption capacity of the soil (Geoflow, 2003): rate should be less than 10 percent of the saturated hydraulic conductivity (Geoflow, 2003), design for saturated events (rainfall) by including a safety factor of 10 or 12 (Geoflow, 2003); Design based on nitrogen loading rates: Lower for sandy soils, Higher for fine soils (Beggs et al., 2004)
Dose Frequency	Once-daily pulse application is better for nitrification/denitrification than smaller daily pulses (Beggs et al., 2004); Frequent, small doses are better than large doses once or twice a day (USEPA, 2002); Rule of Thumb: dose volume equals five times the network volume (USEPA, 2002)
Biomat effects	
Soil Characteristics	Should not be built in flood plain or bottom of a slope where excessive water may collect after rain (Geoflow, 2003); Must be classified as either well drained or moderately well drained (BF Environmental, 2005); Percolation test should be between 3 and 90 minutes per inch (BF Environmental, 2005); Slope 0-25% (BF Environmental, 2005)
Climate	1. No operational problems were found in cold temperatures (soil temperatures of -12°C) when properly designed aind installed (Bohrer and Converse, 2001); Less problems in cold weather if drip lines are buried 6" or more below the surface or a winter grass can be planted to provide insulation (Lesikar and Converse, 2005); In colder climates, the dripline should be buried deaper. Mulching the area the winter after construction (and the winter afterward) can help insulate the dripline (USEPA, 2002)
Credit	Must be 20 inches from the surface of the ground to a high water table or slower permeable soil conditions (BF Engineering, 2005); Must be 26-32 inches from a high permeable material or fractured rock (BF Engineering, 2005)
Dependence of technology on soil treatment	It is used as a polishing treatment and to get rid of the water
Dependence of technology on mechanical treatment	

Treatment efficiency expected through time	
Reliability of technology	
On-going monitoring, maintenance, and management requirements	Clean filter cartridges (Geoflow, 2003); Flush the field (Geoflow, 2003); Check the pressure in the drip field (Geoflow, 2003)
Projected life spans and failure rates of technolgy	10 year warranty for root intrusion, workmanship and materials (Geoflow, 2003); Durable with a long expected life (Geoflow, 2003)
Removal of pathogens and nutrients	Nitrogen removal by plant roots (Austin, 2001)
Life cycle costs	Installation and construction: Drip line $0.51-1.16 per foot (Geoflow, 2004), Controler $807.00-2,420.00 (Geoflow, 2004), Headworks $550.00-4,396.00 (Geoflow, 2004), Accessories $10.00-500.00 (Geoflow, 2004), System, installation (includes controls and alarm) $15,000 (Austin, 2001); Operation, monitoring and maintenance: Energy costs $0.47/month (Austin, 2001), O&M maintenance contract $45/month (Austin, 2001); Repair and replacement: 4.17/month (Austin, 2001)
Beneficial reuse and groundwater recharge potential	Irrigation of crops and Irrigation of landscapes
Disadvantages	Not consistent from batch to batch or from different suppliers (USEPA, 2001)