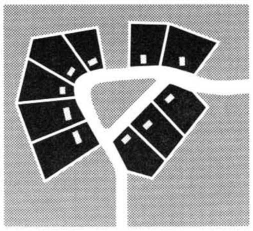
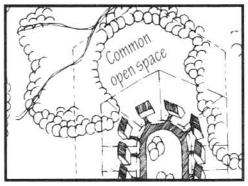
MI-7059-S
1998

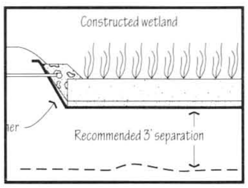


Residential Cluster Development: Fact Sheet Series



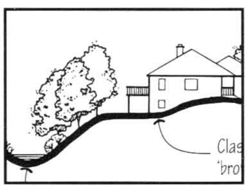
1. Overview of Key Issues

Definitions, goals and zoning implications, including important considerations of the long-term management of open space within a cluster development. By Mathew Mega et. al., University of Minnesota and SRF Consulting Group.



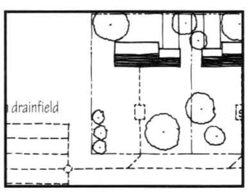
2. Alternative Wastewater Treatment Systems

Summarizes design, siting and permitting of alternatives to municipal wastewater treatment plants or individual septic tanks with drainfields. Includes design features for eight alternative systems. By J. L. Anderson, et. al., University of Minnesota.



3. Storm Water Management

Fundamentals of storm water management, highlighting a natural system of storm water management. Describes an existing subdivision that benefited from this type of design. By Robert D. Sykes, University of Minnesota.



4. Management Options

Basic management concepts used in new residential cluster developments and options available to municipalities and developers when establishing a management structure. By Mathew Mega et al., University of Minnesota and SRF Consulting Group.

Acknowledgments

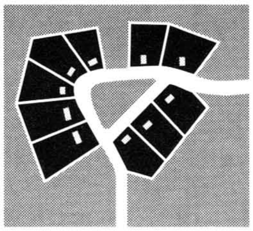
Produced by Communications, University of Minnesota Extension Service with funding provided by the Metropolitan Council and a University of Minnesota Extension Service Collegiate Program Leader Collaborative Grant.

Ordering Information

To order the full series of four fact sheets, contact the University of Minnesota Extension Service Distribution Center at (800) 876-8636 or in the Twin Cities at (612) 625-8173, or your local Extension office. This series is also available on the Internet at http://www.extension.umn.edu/, and alternative formats are available upon request.

University of Minnesota
Extension
SERVICE

MI-7059-S
1998



Residential Cluster Development: Overview of Key Issues

1

Mathew Mega, Barbara Lukermann and Robert Sykes

About This Series

Residential cluster development is a means of permanently protecting open space, rural character, and important environmental resources in new housing developments, while still providing homeowners with good housing and landowners with the opportunity to develop their property. This publication is the first in a series of four, all designed to help local officials, community leaders, developers and homeowners address the critical issues of residential cluster development.

These issues include the design, use, approval, and management of wastewater and storm water rural technologies. These technologies address people's legitimate concerns over the environmental degradation often associated with residential development in rural areas.

By combining the use of rural technologies with cluster development design, local officials have another option when developing their community. But to make rural technologies and cluster development possible, local officials need to incorporate new language into local ordinances and comprehensive land use plans. This series introduces the concepts for local officials considering revisions to their local comprehensive plan and zoning ordinance, as well as basic information to anyone curious about cluster development. It also provides background on how rural technologies can help preserve open space, protect environmental and cultural resources and enhance rural character.

This publication defines cluster development and gives an overview of the critical issues connected to it. The second and third publications in the series describe the engineering and design of community wastewater treatment and storm water management systems for use in cluster developments. They also provide a brief discussion of the current regulation and permitting requirements. Management issues that must be considered and management structures that can be used when establishing new cluster developments utilizing rural technologies are addressed in the final publication.

Goals of Cluster Development

- ▪▪▪ *preservation of open space*
- ▪▪▪ *protection of ecological resources*
- ▪▪▪ *preservation of agricultural land*

What Is Cluster Development ?

Cluster development is the grouping of a particular development's residential structures on a portion of the available land, reserving a significant amount of the site as protected open space. Many communities in Minnesota and across the United States are updating their comprehensive land use plans and establishing specific ordinances to guide the development and construction of residential clusters. New ordinances require design standards and identify minimum open space and density standards. These key changes have prompted some communities to opt for more descriptive terminology, including open space development or conservation subdivision design, for the more traditional cluster development. While the different terminology has created some confusion, each term still adheres to the three basic goals of cluster development: preserving open space, protecting critical ecological habitat and preserving agricultural land.

The usable open space created by a cluster development can meet a number of community goals. These goals sometimes conflict with one another. For example, the protection of wildlife habitat may be incompatible with the preservation of agricultural land. However, the key benefit is the ***availability*** of open space, space that has been preserved by clustering units on smaller lots. The landowner and the community make the ultimate decision on how the open space is used.

Current Zoning Practices

Current zoning practices establish ***minimum*** lot sizes, setbacks and widths that developers must follow when they design subdivisions. This leads to developments that maximize the number of lots based on the total acreage of a parcel. For instance, if the code requires a minimum lot size of 2.5 acres and the developer has a 40-acre parcel, the site will be developed with 16 residential units unless there are major site limitations (see

University of Minnesota
Extension
Service

Figure 1). The parcel is then said to have a gross density of 16 units.

Cluster development protects open space by establishing the number of units allowed for a parcel completely independent of any minimum lot size. While the gross density requirement in the example above allows a maximum of 16 units to be developed on the 40-acre site, if lot sizes can be less than 2 acres or of variable size, some clustering of units is possible. The developer is still limited to 16 total units, but has the flexibility to place them in a way that is more responsive to a site's physical characteristics. For example, Figure 1 shows a cluster development preserving 24 acres of commonly-owned land.

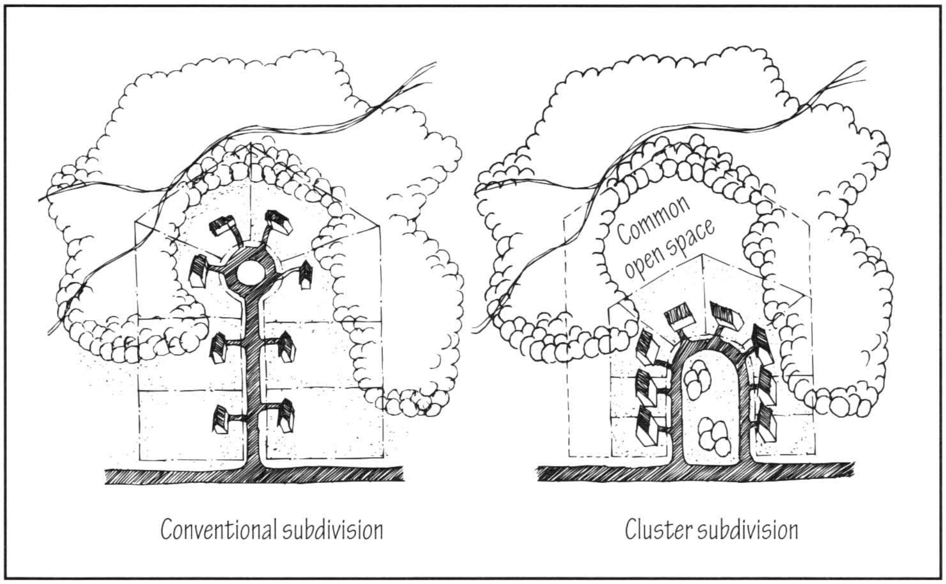


Figure 1. Two residential development scenarios

Options for Use of Open Space

The open space created by cluster developments can be used in three ways:

- *Exclusive use by residents (e.g., private trails, passive recreational areas)*
- *Preservation of agricultural land*
- *Protection of wildlife habitat*

While open space has traditionally been used exclusively by residents, a local government can encourage the other two options through its comprehensive land use plan and subdivision ordinances. Initially, the municipality needs to identify the areas that are important to the community and develop goals for these areas. These goals can then be realized by establishing physical design standards and density requirements, and by using transfer-of-development rights or other incentive programs.

Ensuring Full Potential of Development

The intent of cluster development ordinances is simple: develop less land area while allowing the same number of housing units that would be permitted under standard subdivision ordinances. By allowing the same number of units, landowners and developers aren't penalized financially for doing cluster development.

A yield plan or development plan is currently being used by a number of communities to determine the maximum number of units allowed in a cluster development. The yield plan provides a conceptual sketch of a conventional subdivision based on all standard criteria (setbacks, width, lot size, etc.). The result is the maximum number of units allowed on the parcel (its gross density). Some communities do not specifically require a yield plan, basing the maximum number of units instead on the net developable land as determined by performance standards.

Mandatory Versus Voluntary Cluster Development

Some communities mandate cluster development. In such instances, developers must meet the cluster ordinance criteria. However, many communities offer voluntary cluster ordinances, allowing the developer to choose between a standard subdivision or a cluster development.

In voluntary cluster development cases, communities usually provide developers with incentives to apply clustering. One common incentive, density bonuses, automatically provides developers with a number of additional units if they decide on a cluster development. These bonuses can also be discretionary, with the number of additional units based on the subdivision design. If the community chooses to have discretionary density bonuses, they need to be based on predetermined performance standards and incorporated into the community's comprehensive plan.

Protection of Water Resources

Cluster development may offer many other advantages to the municipality, developer and prospective homeowner. The use of rural technologies for storm water management, for example, can avoid expensive curbs, gutters and storm sewers. Instead, the development's storm water management system can be more responsive to the land's environmental constraints. And wastewater treatment systems can incorporate technologies that ensure that systems are sited appropriately and that centrally-located municipal systems or individual sewage treatment systems are avoided.

■ Storm Water Management

The design of storm water management systems in cluster developments seeks to maximize overland flow and combine the use of plants and landforms to slow, hold, and treat runoff from new development.

■ Wastewater Management

Many options are available to treat wastewater from a cluster of homes, including community drainfields, irrigation systems, and package plants. These options all have the potential to reduce infrastructure investment and allow systems to be located on sites that minimize adverse environmental impact. An example, community septic drainfields, is illustrated in Figure 2.

The specific engineering and design aspects of wastewater treatment and storm water management systems in cluster developments will be discussed in publications two and three of this series.

The Local Adoption and Approval Process

The local approval process for cluster development must be consistent with local comprehensive plans and ordinances and must satisfy the permit process for rural technologies.

Cluster developments generally follow the same review and approval process that traditional subdivisions do. This process is characterized by a preliminary and final plat review process that takes place at public hearings and planning and zoning board meetings. Typically, for a cluster development, the developer and the planning commission's staff hold a pre-application meeting. This informal meeting is used to review the proposed concept to identify any conflicts before the developer submits a formal application. The pre-application meeting incorporates much-needed flexibility into the approval process by allowing everyone to evaluate a development's impact while ensuring it stays consistent with a community's goals.

Many local permit processes have not been revised to give developers — who must undertake additional financial risk associated with new technologies — the flexibility they need. This lack of revisions has been the main difficulty in encouraging developers to use community wastewater treatment facilities and more complex storm water management technologies. Many developers, anticipating greater costs and disapproval of new methods, simply opt for more traditional systems.

Management of Common Resources

Clustering housing leaves the majority of a new development as open, shared space, mutually owned and managed. In a cluster development, that management involves controlling, directing, and handling all resources ***held in common*** by individual homeowners. These include, but are not limited to, open space, wastewater treatment systems, and storm water management facilities.

Many cluster development ordinances mandate the establishment of a homeowners association (HOA) to manage the common open space. Set up by the developer, who may remain a member until all or a specified number of units are sold, the HOA is then responsible for all management responsibilities and capital improvements.

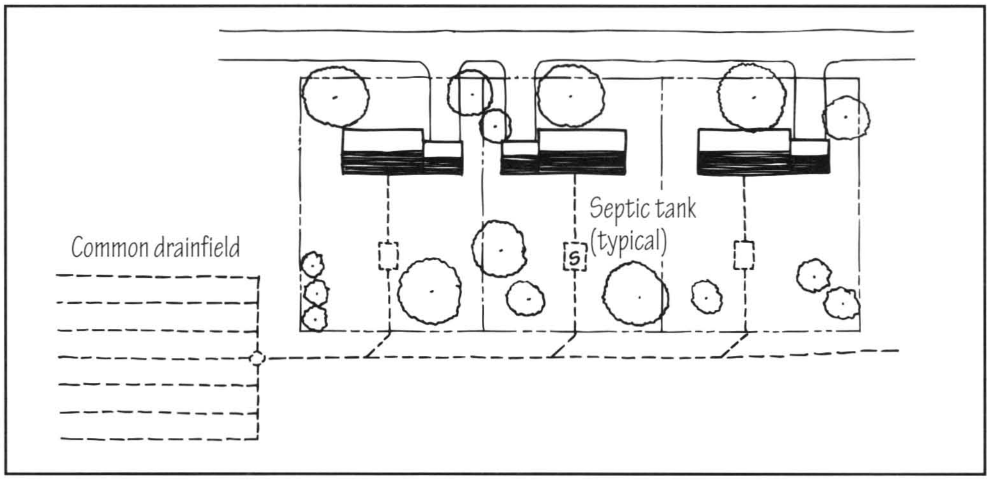


Figure 2. Typical on-site septic layout for a cluster.

In developments with many common resources, the developer may want to explore an alternative to an HOA. Several management options have emerged that replace or supplement HOA responsibilities.

There are six management options in all. Three, homeowners associations, privatized joint ventures and water quality cooperatives, are private. Three others, municipal utilities, sanitary sewer districts and subordinate service districts, involve public management. These will be discussed in greater detail in the fourth publication. Whatever management framework is created, however, it is very important that the developer and the municipality agree on a structure prior to construction or occupation of homes.

Authors

Mathew Mega
Graduate Student
Humphrey Institute of Public Affairs
University of Minnesota
and SRF Consulting Group
(612) 475-0010
mmega@srfconsulting.com

Barbara Lukermann
Senior Fellow
Humphrey Institute of Public Affairs
University of Minnesota
(612) 625-4310
blukermann@hhh.umn.edu

Robert Sykes
Associate Professor
Department of Landscape Architecture
University of Minnesota
(612) 625-6091
sykes002@maroon.tc.umn.edu

For More Information

Thomas Wegner
Extension Educator
University of Minnesota Extension Service
Hennepin County
(612) 374-8400
twegner@extension.umn.edu

Part of a Series

This is one in a series of four publications designed to assist local community leaders, city officials, developers and homeowners in creating viable residential cluster developments and management structures within their communities. The series includes:

1. Overview of Key Issues
2. Alternative Wastewater Treatment Systems
3. Storm Water Management
4. Management Options

Funding

Funding for these publications provided by the Metropolitan Council and a University of Minnesota Extension Service Collegiate Program Leader Collaborative Grant. For ordering information call (612) 625-8173.

Other Resources

These resources from the University of Minnesota Extension Service are available through your county Extension office or by calling the Distribution Center at:
Twin Cities local 624-4900 or Outstate 1-800-876-8636

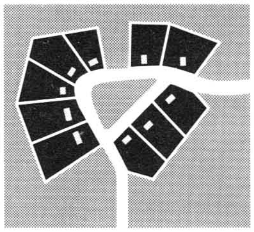
Septic System Owner's Guide EP-6769

Septic Systems Revealed video VH-6768

Printed with agribased inks on recycled paper with minimum 10% postconsumer waste.

Produced by Communications, University of Minnesota Extension Service. The information given in this publication is for educational purposes only.

MI-7059-S
1998



Residential Cluster Development: Alternative Wastewater Treatment Systems

2

J.L. Anderson and D.M. Gustafson

Introduction

Minnesota has a long history of providing wastewater treatment for clustered residential developments. In general, that has involved the installation of collector systems to solve existing problems. The best examples of these systems are found in lakeshore areas. Initially, most systems provided sewage treatment for resorts, where groups of cabins or lodges were hooked together by a sewer line delivering septic tank effluent to a soil-based treatment system. These systems have not been installed in new residential developments.

Some municipalities and small communities need to upgrade their wastewater treatment systems. Others are considering a cluster design for new residential developments. Local officials must decide what kind of wastewater treatment system to use. Until recently local officials had to choose from either a municipal wastewater treatment plant or a decentralized approach utilizing septic tanks and drainfields. There are now additional options available when using a decentralized approach. These alternatives include aerobic tanks, sand filters and constructed wetlands. Local officials need to review and evaluate their options carefully before selecting a specific system — including alternative systems — because the same approach won't work in every case.

Currently, these alternative systems typically provide pretreatment to septic tank effluent before being discharged to a drainfield. To use these alternatives, more than the usual amount of long-term monitoring will be necessary to ensure that these systems consistently meet the operating standards claimed by manufacturers and proponents. From both a surface and groundwater perspective, soil-based treatment systems — if properly sited, installed, and maintained — can offer a high degree of protection and reliability.

In general, alternative systems serving clustered developments require more monitoring than systems that use septic tanks for pretreatment. Usually, alternative systems require additional pumps and sewage tanks, which results in extra maintenance. That's why the organizations in charge of operating these systems need to be fiscally competent. While clustering has the potential to make operation and maintenance easier for an individual homeowner, a detailed plan for a development must be written and followed consistently. If that is not done, treatment will be less effective and there will be a greater negative impact on water resources.

Once the decision is made to use a cluster design, there are a number of factors to consider before choosing the appropriate wastewater treatment system.

Design and Siting Considerations

To be cost-effective and provide acceptable sewage treatment, the following factors must be addressed before choosing a system type and design:

1) where the wastewater will be discharged to the environment;
2) the type of collector sewer used;
3) the estimated volume of flow (a number used to design the final treatment system);
4) site characteristics (including the land footprint and projected future use);
5) system reliability and monitoring;
6) system maintenance and personnel requirements;
7) adaptability to changes in system operation.

Minnesota Pollution Control Agency Permits

When wastewater is discharged to the surface or ground waters of the state, a National Pollutant Discharge Elimination System (NPDES) or a State Disposal System (SDS) permit is required. These permits detail the wastewater source, types of requirements for discharge, the amount of monitoring necessary, and the minimum level of treatment required. The Minnesota Pollution Control Agency (MPCA) issues and administers both of these permits. Effluent limits are developed to protect water quality standards and the designated uses of waters. Both permits require monitoring to ensure the system is meeting the assigned effluent limitations.

When wastewater is discharged to the ground water via the ground's surface a State Disposal System (SDS) permit is required. Additionally, if the discharge to the ground water is via the subsurface and over 10,000 gallons per day (gpd) an SDS permits is required. Local permits are required if the volume of wastewater discharged to the subsurface is less than 10,000 gpd. Future rules regarding class V injection wells, defined as any system that serves over

University of Minnesota
Extension
Service

twenty people, may impact the permitting of systems used in residential clusters.

An SDS permit requires ground water monitoring to demonstrate that drinking water standards are being met at the property boundary. If the system includes a licensed facility, such as a resort, mobile home park, hospital, retirement facility, etc., the Minnesota Department of Health (MDH) must also review the plan. The permit's terms and conditions will vary depending on the ultimate disposal location of the treated wastewater.

If the discharge is to surface water, effluent limitations will be specified within an NPDES permit to protect water quality standards and the designated uses of the waters of the state. If the discharge is to ground water, the permit applicant will be required to meet drinking water standards at the property boundary. In both cases the permit will include monitoring of the effluent to ensure that standards are being met and to demonstrate that the system is operating efficiently.

To obtain an NPDES or an SDS permit, a permit application must be submitted to the MPCA at least 180 days prior to starting construction of the wastewater treatment facility.

Site Characteristics

There are several factors that should be considered when planning a wastewater treatment system that serves a cluster development and discharges to groundwater. The first is a general assessment of the suitability of a site's geology and soil. Existing water table elevations, shallow aquifers, land slope, soil texture, and permeability must all be evaluated. In sensitive areas, additional treatment of the sewage effluent will be required. Site soil type and landscape position also need to be identified.

Soil type and wastewater flow determine the size of the system. The size and location of the soil treatment unit is determined by the estimated daily sewage flow and a sizing factor based on soil texture and permeability. Although not required, it is good planning practice to make sure that there is a secondary treatment site of equal size available. In the case of larger systems, those over 10,000 gpd, it is wise to be able to accommodate 2.5 times the estimated volume of flow. Providing additional area allows maximum operational flexibility and leaves room for future expansion.

There are a number of siting factors that can have a long-term impact on the operation and use of the system. Road and sewer development need to be coordinated with system siting and construction, for example. The collector sewer needs to conform with appropriate design standards. Location of the sewage treatment site needs to fit with the overall physical plan of the development.

Figure 1. Siting of the proposed wastewater treatment system should fit in with the plan for the development.

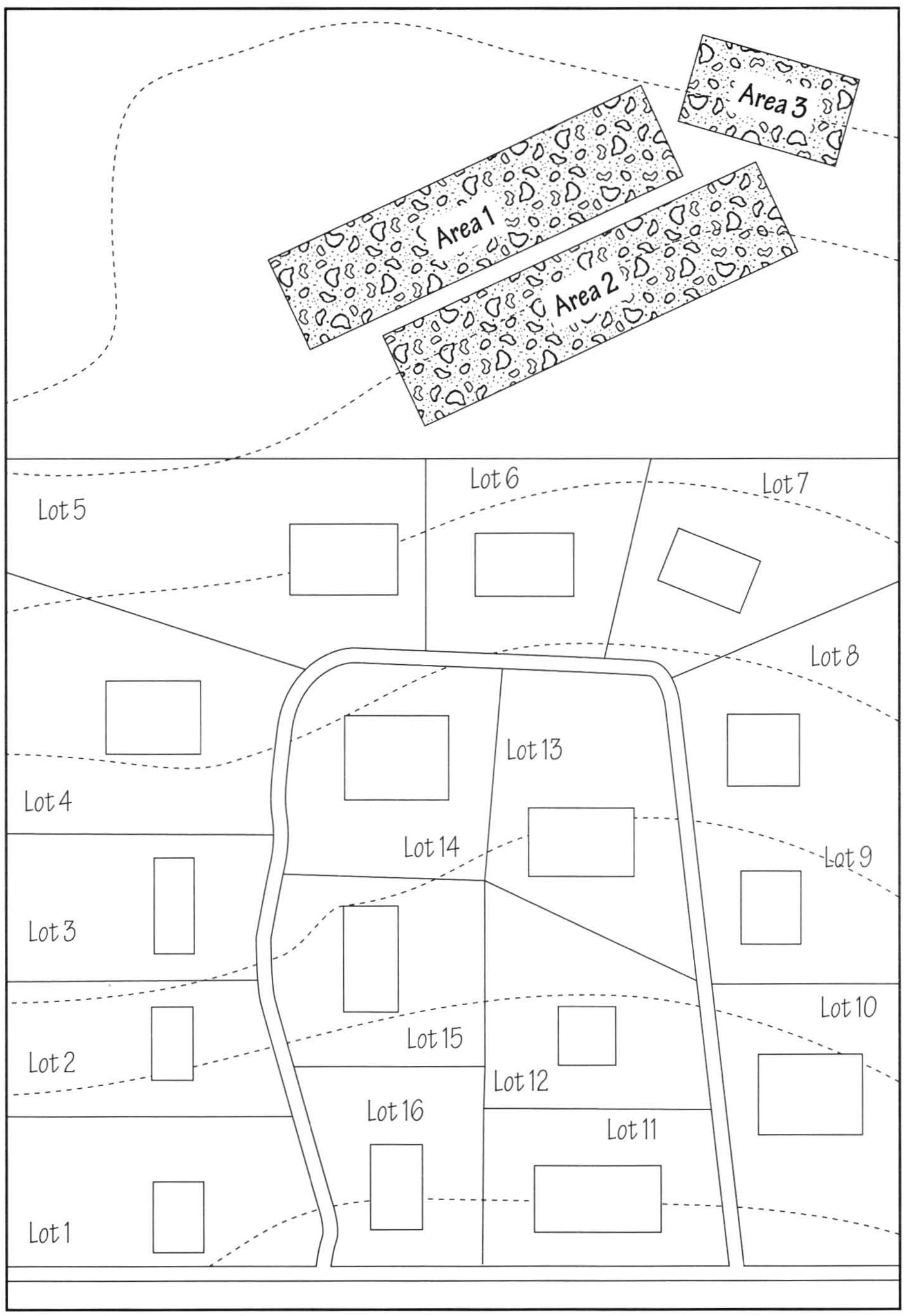


Table 1. Estimated sewage flows in gallons per day

Number of bedrooms	Type I	Type II	Type III	Type IV
2	300	225	180	
3	450	300	218	60% of
4	600	375	256	the values
5	750	450	294	in Type I, II,
6	900	525	332	or III
7	1050	600	370	columns
8	1200	675	408	

Type I: The total floor area of the residence divided by the number of bedrooms is more than 800 square feet, or more than two of the following water-use appliances are installed: automatic washer, dishwasher, water softener, garbage disposal, or self-cleaning furnace.

Type II: The total floor area of the residence divided by the number of bedrooms is more than 500 square feet, and no more than two water-use appliances are installed.

Type III: The total floor area of the residence divided by the number of bedrooms is less than 500 square feet, and no more than two water-use appliances are installed.

Type IV: Type I, II, or III homes but with no toilet wastes discharged into the sewage system.

Onsite Sewage Treatment Manual, University of Minnesota Extension Service, 1998, St. Paul.

Areas reserved for future development need to be clearly identified. And the proposed sewage site needs to fit with existing plans for open space and buffers around a development's residences (see Figure 1).

Estimated Daily Sewage Flow

Once site characteristics have been defined, an estimate can be made of the volume of sewage flow from a development. There is no simple recipe to follow when estimating such flows. It's as much an art as it is a science. However, because the estimates of flow volume will greatly influence the type of system selected and how well that system performs, it's important that system designers and community decision-makers be as accurate as possible.

The regulatory agencies, MPCA and MDH, play a major role in estimating flow volumes. If the agencies choose to continue with the current approach, considered to have a large safety factor built in, then minimal deviation from the current conservative estimates spelled out in Minnesota Rules Chapter 7080 should be used (Table 1). Currently, any reduction in flows from Chapter 7080 requires approval by the permitting authority.

Oversizing systems can have positive and negative results, depending on the final treatment system selected. For example, if a package plant (a non-soil-based treatment unit consisting of an aerobic tank followed by a chlorination process) provides wastewater treatment, oversizing leads to increased costs and lower operational efficiency.

On the other hand, some oversizing is desirable for soil-based treatment systems. Oversizing allows a treatment system's parts to be rested periodically, creating more flexible operation and extending system life. From a regulatory view, oversizing also reduces the need for monitoring and maintenance. Both of these are positives for individual systems, where it is hard to get individuals to perform such simple maintenance tasks as the regular cleaning of septic tanks.

Flow is a critical piece of the puzzle. Keep in mind that basic decisions made early in designing a wastewater system carry through the construction and operating phases, and can have a large impact on system performance.

When estimating flows, it is important to strike a balance among three considerations — the desired treatment, the level of monitoring, and costs.

System Monitoring

In cluster wastewater systems, there is more focus on flexible operation and a greater need to monitor how well a system is doing. Monitoring adds an additional burden, to the owner-operator as well as the regulatory agency, because of the need to track, evaluate and change (or add to) a system based on its operating record.

System Types

After identifying the site and flow characteristics, the type of system can be selected. There is a wide variety of choices and they all offer advantages and disadvantages. The key is understanding each system's requirements and having a plan in place that will ensure the system's long-term operation. In looking at the available treatment options, it is necessary to discuss how they fit into a development plan, and where they should be used. It is important to note that all the systems described below require pretreatment, either through septic tanks or some other kind of sewage tank.

■ Sub-surface Systems

■■■ *Community Drainfields*

For individual sewage treatment systems not limited by soil conditions, the most commonly used unit is trenches. A drainfield trench is constructed by making a level excavation 18-36 inches deep. Clean rock is placed in the bottom of the excavation to a depth of 12-24 inches; then, a four-inch diameter distribution pipe, using one pipe per trench, is placed on the rock and covered with soil (Figure 2). Pipe or chamber systems without gravel can be used as substitutes for the rock. Treatment occurs in the natural soil through interrelated physical, chemical, and biological processes. Special siting considerations for trench systems include:

— trenches need to be installed on a site's contour with the excavation depth limited by saturated soil or bedrock;
— a minimum of 10 feet on center must be maintained between trenches;
— the site must be large enough to accommodate a series of trenches laid along the natural slope.

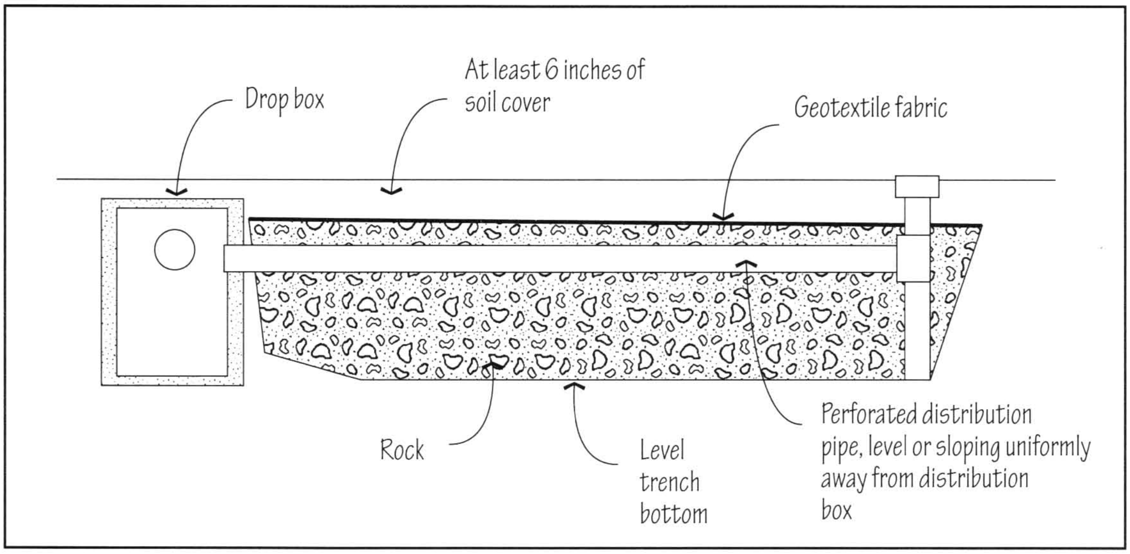


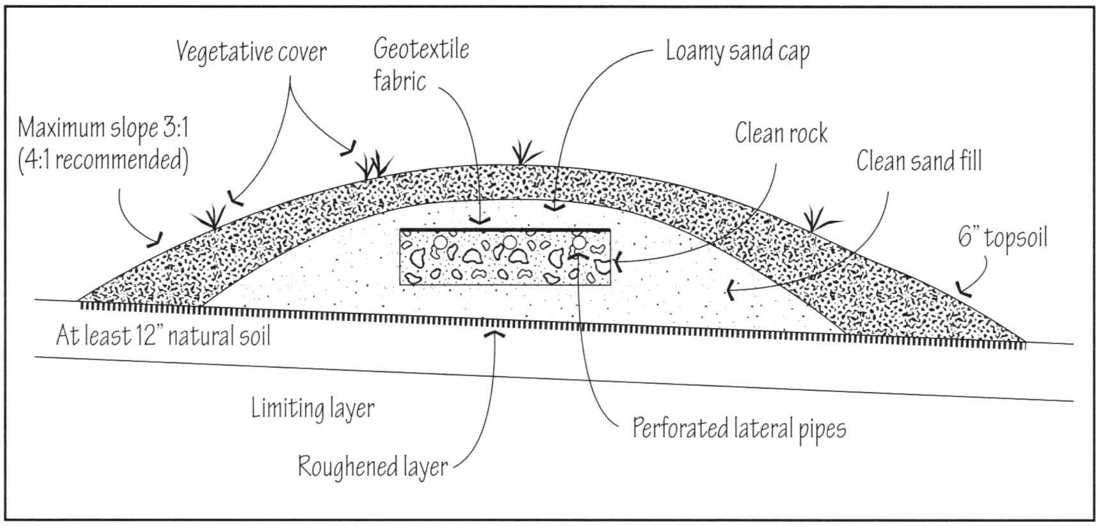
Figure 2. Left: a typical drainfield trench installation.

■■■

Figure 3. Right: a typical mound installation.

■■■

Figures 2 and 3 from *Onsite Sewage Treatment Manual,* University of Minnesota Extension Service, 1998, St. Paul.



■■■ *Soil Treatment Mounds*

In areas where limiting soil conditions do not allow the installation of sewage treatment trenches, mounds are an option. They are constructed with a layer of clean sand and leveled with a foot-deep rock layer before being covered by soil (see Figure 3). Special siting and construction considerations for cluster mound systems are:

— the configuration needs to be a long, narrow rectangle;

— mounds need to be installed on a site's contour with the special consideration that they don't act as dams for surface or subsurface flow across the site;

— if more than one mound is required (which is usually the case), there must be adequate distance between them to allow for construction and to assure they do not interfere with one another hydraulically.

■■■ *Constructed Wetland Systems*

Constructed wetlands treat wastewater by bacterial decomposition, settling, and filtering (see Figure 4). As in tank designs, bacteria break down organic matter in the wastewater, both aerobically and anaerobically. Oxygen for aerobic decomposition is supplied by the plants growing in the wetland. Solids are filtered and finally settle out of the wastewater within the wetland. After about two weeks in the wetland, effluent is usually discharged by gravity to an unlined wetland bed.

If these systems discharge effluent to surface ditches, they require a National Pollutant Discharge Elimination System (NPDES) permit. In theory, any wetland design could incorporate a soil treatment system for final effluent treatment, but since the wetland itself takes up a lot of space, communities are unlikely to construct a soil treatment system in addition to the wetland.

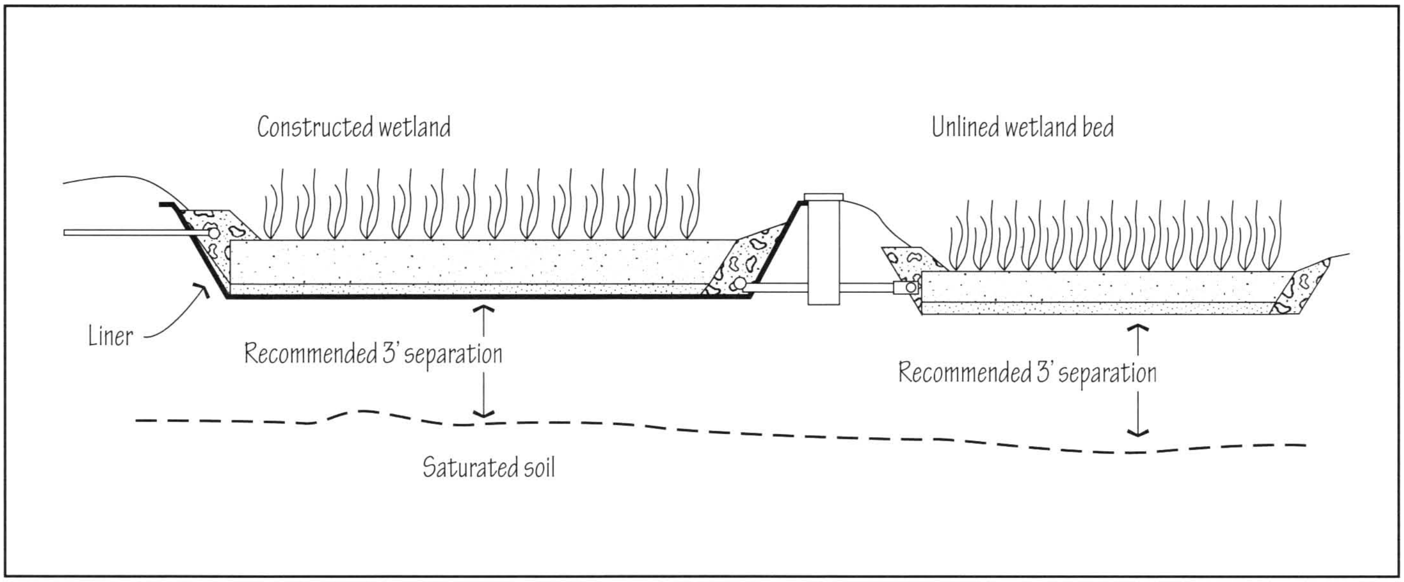


Figure 4. Above: a constructed wetland system.

■■■

■■■ *Sand Filters*

The sand filter uses sand, like a mound in a box, as a medium for treating wastewater. This system has been used with great success for over 100 years and there is a large amount of information available about design and applications (see Figure 5).

Wastewater should be introduced by pressure distribution. The goal is to load the system as evenly as possible over the filter surface. This is best accomplished by using a pump to put the wastewater under pressure inside the pipe. This allows the waste to move through the filter at a rate that maximizes treatment. This system's treatment mechanisms are physical filtering and ion exchange. A properly operating sand filter should produce high quality wastewater.

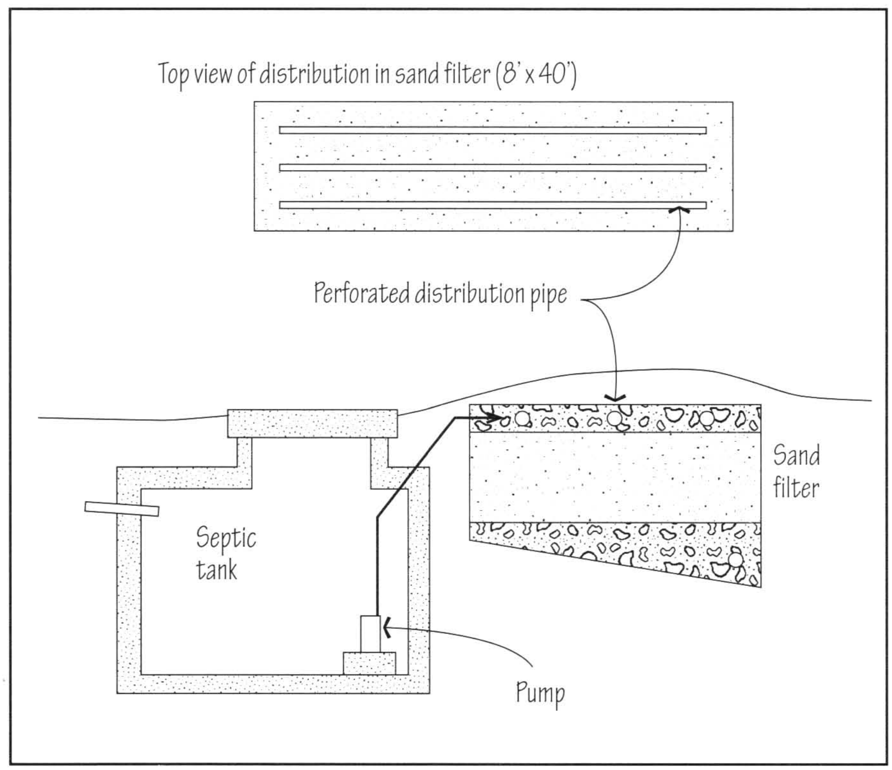


Figure 5. Above: a typical sand filter installation.

■■■

■■■ *Drip Irrigation*

This soil-based treatment system has been tested and used extensively in the southern United States. It uses small diameter tubing and a series of emitters to apply wastewater to the soil's upper layers (see Figure 6). By applying small amounts of effluent over a large area, evaporation is maximized, as is plants' ability to take up water and nutrients. The system is slightly larger than a conventional trench system. Although adding the effluent slowly over a large area increases treatment efficiency, lines freezing in winter can be a problem.

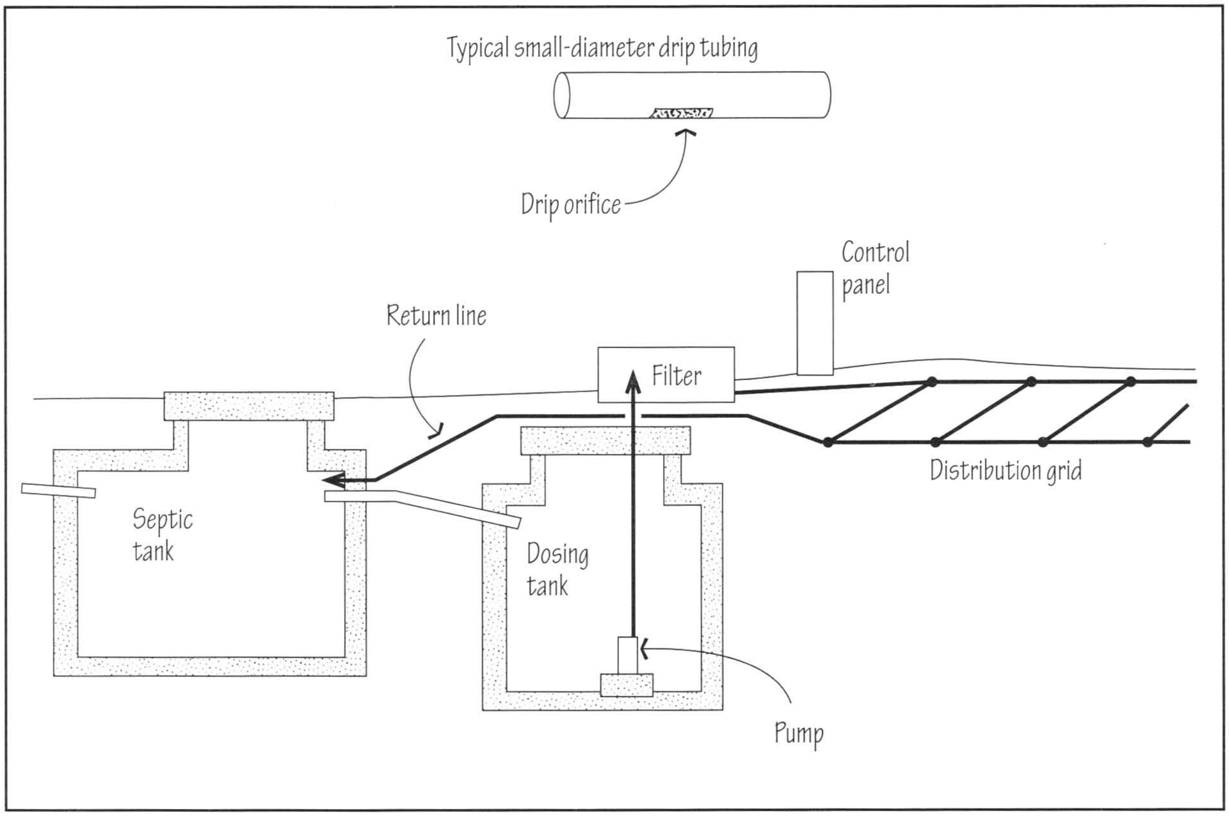


Figure 6 from *Onsite Sewage Treatment Manual,* University of Minnesota Extension Service, 1998, St. Paul.

Figure 6. A typical drip irrigation installation.

Above-surface Systems

Aerobic Tanks and Package Plants

Aerobic tanks treat wastewater far better than conventional septic tanks. This is due to the oxygen that is added to the liquid in the tank (see Figure 7). Aerobic tanks are, however, considerably more complicated to design, construct and maintain than septic tanks.

Aerobic tanks are available in residential or small-community sizes. In either case, these tanks require more maintenance than conventional septic tanks. If problems arise with the supply of air to the bacteria, an aerobic tank loses all its effectiveness. If there are problems with settling (more likely in these designs than with conventional tanks), there will be problems in the soil treatment system. It's critical that aerobic tanks be monitored regularly and repaired as needed.

For community aerobic tanks, there is a single location that needs checking and maintenance. Individual aerobic tanks provide multiple opportunities for problems and each one must be inspected as frequently as larger tanks. The aerobic tanks serving individual residences contain both the aeration and settling areas within the same tank. Since the discharge is to the soil there is no disinfection.

Package plants for small communities usually consist of an aeration tank followed by a settling tank and some type of disinfection or chlorination unit that treats the water before discharge.

Spray Irrigation

Spray irrigation uses both biological and chemical processes to treat wastewater. The pretreated and often disinfected wastewater is applied at low rates to agricultural or wooded areas.

A spray irrigation system often consists of a septic tank (that provides a highly pretreated effluent), a sand filter and a disinfection unit within a spray application site. The final product is applied to the spray field through a conventional sprinkler system (see Figure 8).

Site suitability is determined by soil permeability, the depth to saturated soil or bedrock, the availability of a buffer zone, and land slope. For proper treatment of wastewater, the soil must remain unsaturated, just as it does in subsurface systems.

Compared to other wastewater treatment alternatives, spray irrigation systems require more land. That's why they may be best suited for recreational areas (such as golf courses) and agricultural land.

System Costs

Estimates should be made of a system's capital costs and its operational costs over its expected lifetime. Capital costs include land, equipment (tanks, pumps, rock, etc.) and construction. Operational costs include electricity, pump replacement, repairs, and such routine

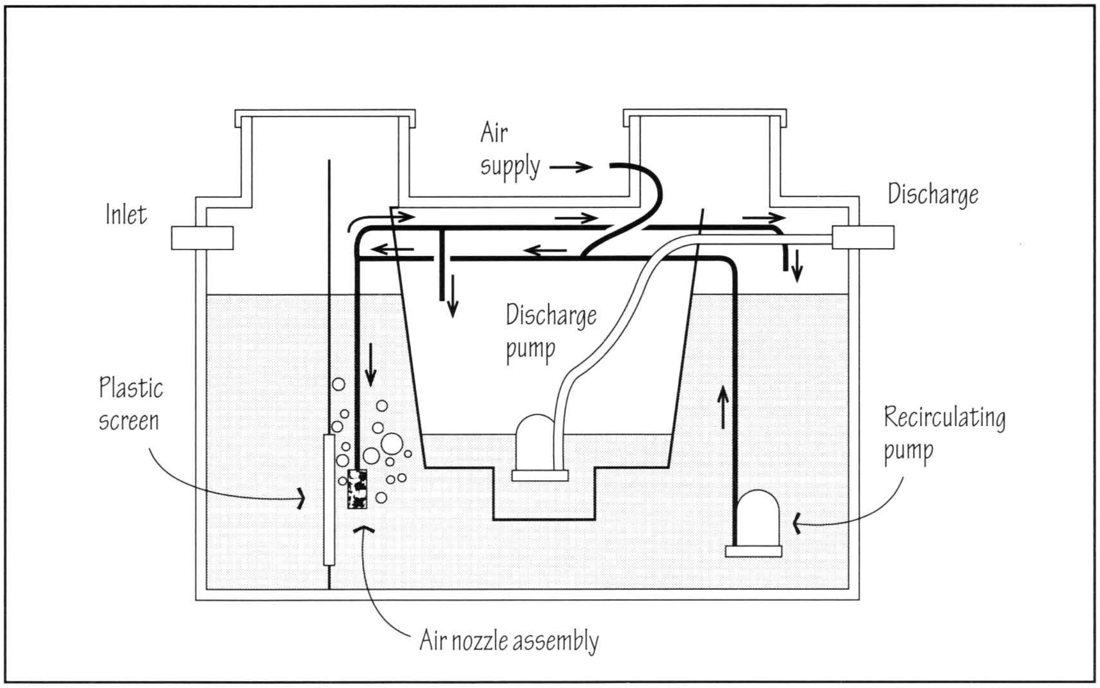
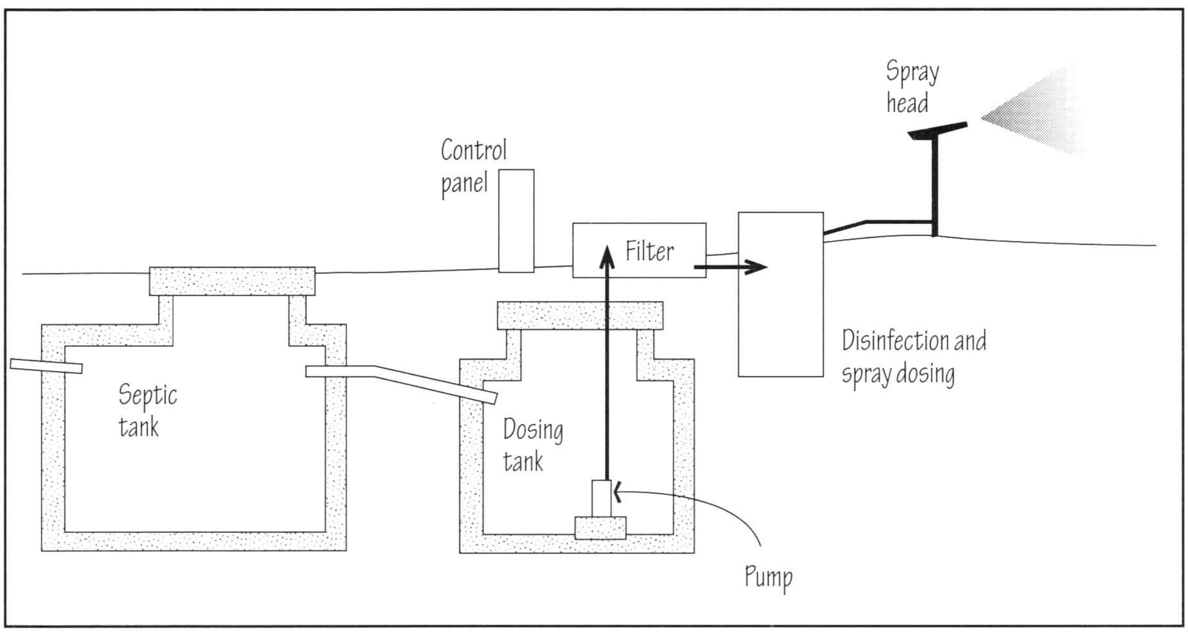


Figure 7. Left: schematic of an aerobic tank.

Figure 8. Right: a typical spray irrigation system.



maintenance as the periodic cleaning of septic tanks or the replacement of sand in sand filters.

It is difficult to know whether one system is better than another. That's because any comparison depends on numerous factors, including how flows are estimated and whether research will confirm that less soil treatment area is needed for effluent that is largely pretreated. Other important considerations affecting comparisons are the specific site conditions, a site's slope and the location of individual lots.

It currently appears that the standards for soil treatment units contained in Minnesota Rules Chapter 7080 are cost-effective at flows of 5,000 gpd and less. For flows between 5,000 and 15,000 gpd, the least costly system is a series of individual septic tanks (one for each residence) connected to a communal drainfield or mound system. Sand filters, aerobics tanks and package plants become more advantageous, especially if a 50 percent reduction in the size of the soil treatment area is allowed. If there is plenty of low-cost land available, spray irrigation becomes a viable, cost-effective system. For flows over 15,000 gpd municipal wastewater treatment systems such as waste stabilization ponds and mechanical treatment plants start becoming cost-effective depending on the individual situation.

Authors

J.L. Anderson
Professor and Extension Soil Scientist
Department of Soil, Water and Climate
University of Minnesota
(612) 625-8209
janderson@extension.umn.edu

David Gustafson
Assistant Extension Specialist
On-Site Sewage Treatment and Instruction
Department of Biosystems and Agricultural Engineering
University of Minnesota Extension Service
(612) 625-6711
dgustafson@extension.umn.edu

For More Information

Thomas Wegner
Extension Educator
University of Minnesota Extension Service
Hennepin County
(612) 374-8400
twegner@extension.umn.edu

Part of a Series

This is one in a series of four publications designed to assist local community leaders, city officials, developers and homeowners in creating viable residential cluster developments and management structures within their communities. The series includes:

1. Overview of Key Issues
2. Alternative Wastewater Management Systems
3. Storm Water Management
4. Management Options

Funding

Funding for these publications provided by the Metropolitan Council and a University of Minnesota Extension Service Collegiate Program Leader Collaborative Grant. For ordering information call (612) 625-8173.

Other Resources

These resources from the University of Minnesota Extension Service are available through your county Extension office or by calling the Distribution Center at:
Twin Cities local 624-4900 or Outstate 1-800-876-8636

Septic System Owner's Guide EP-6769

Septic Systems Revealed video VH-6768

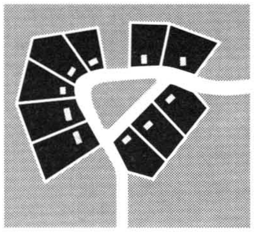
Printed with agribased inks on recycled paper with minimum 10% postconsumer waste.

Produced by Communications, University of Minnesota Extension Service. The information given in this publication is for educational purposes only.

In accordance with ADA, this material is available in alternative formats upon request. Please contact your Minnesota County extension office or, outside of Minnesota, contact the Distribution Center at (612) 625-8173.

Find more University of Minnesota Extension Service educational information at http://www.extension.umn.edu/ on the World Wide Web.

MI-7059-S
1998



Residential Cluster Development: Storm Water Management

3

Robert D. Sykes, ASLA

Summary

Residential cluster developments offer local governments an excellent opportunity to manage storm water more effectively than they can in conventional developments. This publication reviews the fundamentals of storm water management, highlighting the problems conventional developments have in this area, and identifying the benefits of cluster design in developing a natural system of storm water management. There is also a description of an existing subdivision that benefitted from this new design.

Fundamentals of Storm Water Management

In every location there are two storm water management systems, the major and the minor. Three considerations largely shape the design of these systems: flooding, convenience and water quality. Paths taken by runoff from very large storms are called major systems. Where these systems are specifically designed, flooding is usually avoided. But where the effects of large storms are not specifically considered or planned for, flood damage can be substantial.

Systems designed with convenience in mind quickly remove runoff water from areas such as streets and sidewalks because they're difficult to use when covered with water. Convenience facilities like storm sewers, technically referred to as minor systems, quickly remove the peak flow of a runoff resulting from typical small storms.

Apart from temporary measures to control sediment in construction areas, water quality concerns in residential areas focus on the polluting substances washed from paved surfaces and carried into streams or other bodies of water during storms. Pollutants carried in runoff include sediments, nutrients, chemicals, disease-carrying organisms and heavy metals. Sources of these pollutants include grass clippings, leaves, eroded soil, fertilizer particles, oil and gasoline drippings, animal droppings, and metal flecks from vehicles. Detention ponds remove most of these suspended substances from runoff by temporarily holding it until the particles settle out (see Figure 1). Regulations require such ponds.

Storm Water Management in Conventional Developments

Since World War II, conventional zoning has typically led to the development of residential subdivisions that completely blanket a parcel with evenly-spaced lots. This results from zoning provisions that require minimum lot sizes and widths, and from local governments requiring developers to construct streets that serve every lot. In most cases, these streets must have curbs, gutters and storm sewers (see Figure 2).

The adverse effects of storm water management in traditional developments mainly occurs because of changes made to the character of the land surface. Developments introduce roofs and large areas of pavement, referred to as impervious surfaces, which substantially reduce the amount of rainfall soaking into the soil and substantially increase the amount of runoff.

Because pavements and roofs have much less surface area to wet in a rainstorm compared to plant-covered lands, more water is also free to run off these simpler, impervious smooth surfaces. Because they are smoother, water also runs off them faster. Instead of flowing off slowly over a long period of time, a larger volume of water arrives downstream at the same time much like rush hour on highway networks. More water running more quickly causes "traffic jams" of water downstream that we commonly call flooding.

This addition of impervious surfaces associated with urbanization can significantly

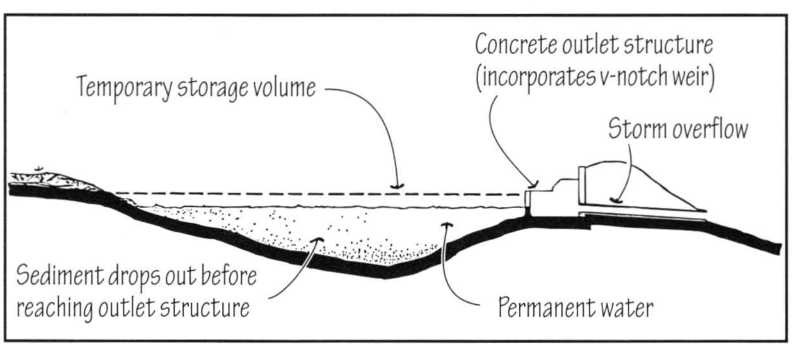


Figure 1. A wet detention pond is placed to capture runoff from residential land before it leaves the development. It settles out particles of pollution before overflowing off the site. It does not fully empty after a storm.

University of Minnesota Extension Service

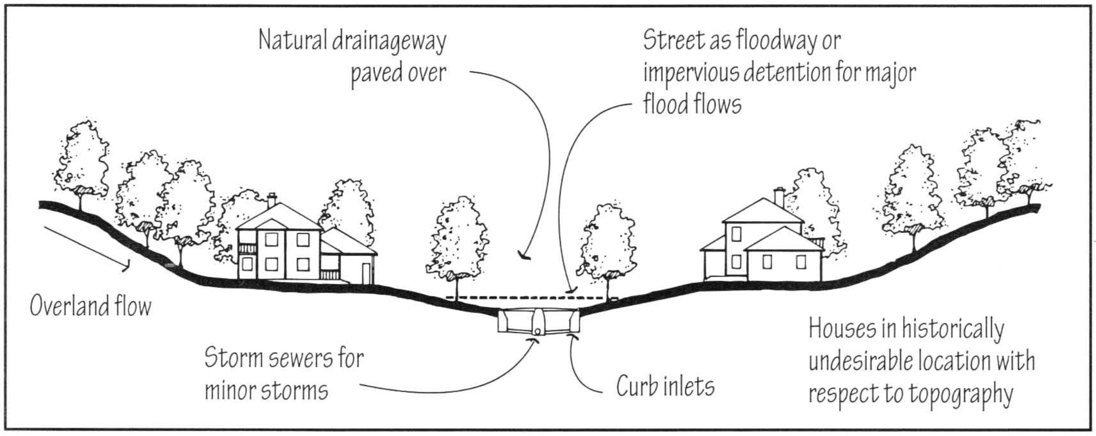


Figure 2. Traditional residential developments with storm sewers provide convenience drainage as the minor system, and overflow with major storms to augment the function of streets as flood or major system protection.

contribute to lowering the water table, both locally and regionally.* This can skew the balance of water over time into a feast-and-famine moisture pattern between storms and dry periods.

Development under conventional zoning does little to minimize, much less prevent, these ill effects. Curbs hold water in the roadway, requiring storm sewers to let it out. The round pipes used for storm sewers move masses of water very efficiently. But instead of moving runoff slowly over natural surfaces so it soaks in, runoff moves rapidly once it's inside storm sewers, with no opportunity to infiltrate the soil. The high speed of flow keeps pollutants suspended in the runoff. Constructed ponds are then required to remove pollutants and reduce peak flows. Since storm sewers are designed to flow without pumps, they tend to be put in the lowest portions of the landscape which are natural drainage-ways. Streets then follow this drainage pattern. Thus when storm sewers overflow, the street's smooth, uninterrupted, impervious surfaces become the paths flood flows follow.

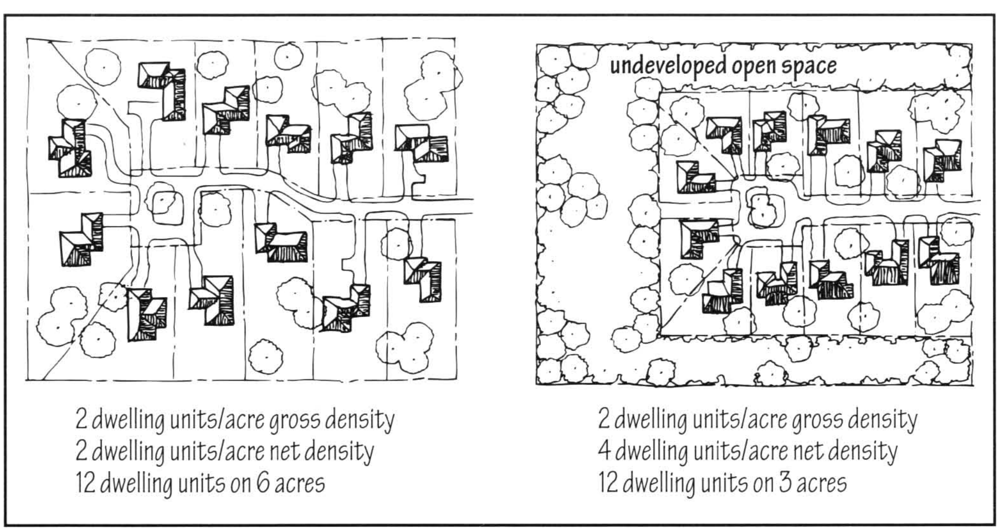
The proverbial "cookie cutter syndrome" that results from conventional zoning (houses spread evenly over an entire site) leads to a large amount of pavement so the streets connect to all the houses. In addition, large lots and front yard set-backs necessitate even more pavement to connect garages and front doors to streets. With all this pavement connected, there is much less opportunity for runoff to soak into the ground. In short, conventional development carries with it a subtle but powerful bias toward maximizing both the quantity and speed of runoff.

Storm Water Management in Cluster Developments

Cluster zoning allows the same number of houses on a site as conventional zoning (see Figure 3). However, it allows developers to put the houses on smaller lots and requires the preservation of large areas of a site as open space where houses can never be built. These two provisions give local governments and developers the flexibility needed for good design and modern storm water management.

The layout for a clustered housing development can be arranged so that the steep slopes, natural drainage-ways, and areas of prime vegetation fall where the open space is (see Figure 4). And by clustering lots closer together and facing them on open spaces, shorter roads (and less pavement) are necessary. Smaller, narrower lots also help reduce the need for pavement in driveways and walks, as in Figure 3.

Figure 3. Cluster development reduces the quantities of pavement and site grading compared to development under traditional zoning. It also permits the preservation of large blocks of open space from initial and future development.



* This is most readily observed by drops in the depth of stream base flows (flows between rainfalls). Base flow is fed by subsurface (groundwater) runoff. Subsurface runoff is supported by infiltration of rainfall from the surface. The water table is the top of the saturated zone of soil - the top of the subsurface runoff. In urban areas, imperviousness reduces replenishment of subsurface flows and is directly reflected by drops in the water table. See Schueler, Tom (1995) *Site Planning for Urban Stream Protection*, Silver Spring, MD: Center for Watershed Protection, Ch.1; Ferguson, Bruce K. (1994) *Stormwater Infiltration*. Boca Raton, FL: Lewis Publishers, Ch. 1; and Leopold, Luna B. (1974) *Water, A Primer*. San Francisco, CA: W. H. Freeman and Company.

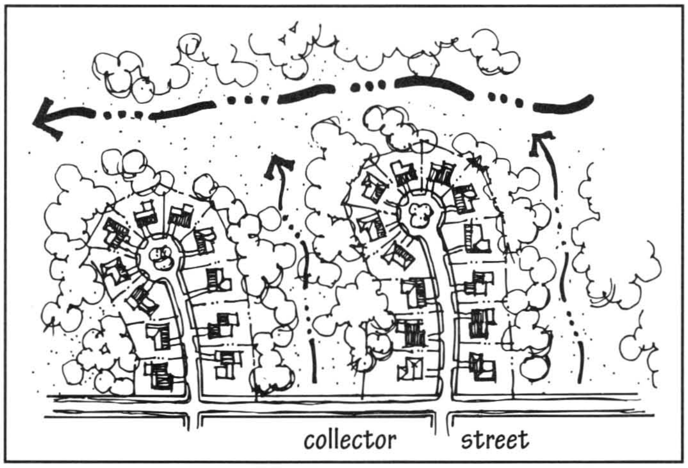


Figure 4. The layout plans for cluster housing development can be arranged so that the steep slopes, natural drainageways, and areas of prime vegetation fall into the open space areas.

Clustering enables a better relationship between impervious surfaces and natural drainageways, too. Roads can be placed along ridge lines, with houses just off the ridges on the ridge 'brow.' This means that most pavement and roofs are located as far from the preserved natural drainage system as possible (see Figure 5). Runoff from impervious surfaces now flows slowly over pervious, vegetation-covered areas, soaking into the soil, which filters out some of the pollutants before the storm water reaches lakes, rivers and streams. Greater use is made of drainage devices such as ditches and swales. (Similar to ditches, swales are typically short, shallow and wide depressions covered with vegetation.) Costs are lowered because curbs and storm sewers are no longer needed. More rainfall is directed toward the replenishment of ground water. The development generates a smaller volume of runoff moving more slowly toward the bodies of water receiving it.

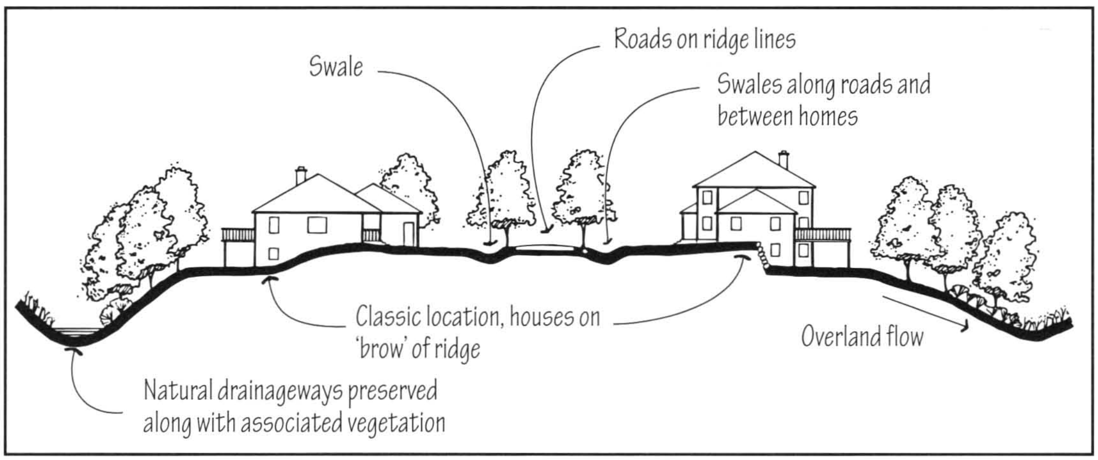


Figure 5. Clustering of houses permits roads to be placed along ridges as far as possible from preserved natural drainage-ways.

Management of Storm Water Facilities in Cluster Developments and Open Spaces

Preservation of natural drainage systems and the use of overland swales for storm water require a different approach to maintenance and repair than traditional storm sewer systems. Most of all, this type of storm water network requires maintenance of living plants and occasional removal of sediment. This in turn requires a management organization designed and funded for that purpose. Public works departments are one alternative for managing these natural drainage systems. There are three other management options: (1) homeowners associations, (2) storm water utilities, and (3) water quality cooperatives.

Homeowners Associations

A homeowners association is initially established by the land developer as a nonprofit organization. Through deed restrictions, all homeowners are members of the association and bound to the subdivision. This means the association can set rules and assess membership fees for the care of commonly owned property, including storm water systems and open spaces.

Storm Water Utilities

In Minnesota, a local government may establish a storm water utility for the maintenance of storm water infrastructure. Many cities have done so in the last fifteen years to take care of storm water detention ponds. A storm water utility can assess the costs of its services to property owners that benefit from the storm water facilities it owns or for which it is responsible. Two Minnesota examples are the cities of Lake Elmo and Marine-on-St. Croix.

Water Quality Cooperatives

Individuals can also form water quality cooperatives that own and care for the storm water infrastructure discussed above. Cooperatives are non-profit, member-owned organizations that provide services to their members and are financed through a membership fee structure. These organizations can also be used to join together several homeowners associations by using the Master Association feature of the Minnesota Common Interest Ownership Act. By joining, these groups effectively improve their bargaining position when securing technical management or other services for their residents.

The Woodlands Case Study

Figure 6. Typical residential street in The Woodlands, Texas. (Photo courtesy of Professor David G. Pitt, Department of Landscape Architecture, University of Minnesota)

Nationally, one of the best-known developments to use residential clustering for a natural system of storm water management is The Woodlands New Community outside Houston, Texas. This 20,000-acre town was planned and designed by Wallace, McHarg, Roberts and Todd, Landscape Architects and Planners, Philadelphia, Pennsylvania. The site is flat and heavily wooded, with extensive areas of poorly-drained soils. Clustering was included in the firm's comprehensive plan to preserve the site's natural drainage system, avoid environmentally-critical areas, work with existing topography, and maintain prevailing hydrological conditions.

The Woodlands' general plan used the existing natural drainage system to provide the town's major storm water system. Major roads and dense development were located along ridge lines, while preserving the natural flood plains as parks and open space. Rather than an underground storm sewer system, the minor storm water system is made up of open space and roadside and lot-line swales. The minor system focused on getting small rainstorms to soak into the soil.

In its original plan, engineers compared the capital cost of the natural drainage system to that of a conventional system and found that the natural approach saved over $14 million. In addition, a conventional storm water management approach would have cleared thousands of trees, increased runoff 180 percent, degraded downstream water quality, and caused a daily water table draw-down of 15 million gallons. The plan avoided or sharply reduced the impact of all these problems.**

The ultimate measure of The Woodlands' approach occurred one April day in 1979 when a record storm dropped nine inches of rainfall on the Houston area in less than five hours. No houses in The Woodlands experienced any flooding. But neighboring areas, with conventional storm water management systems, were hit hard by flood damage.

**For more information see Juneja, Narendra and James Beltman (1980) "Natural Drainage in The Woodlands" in *Stormwater Management Alternatives,* J. Toby Tourbier and Richards Westmacott, Newark, NJ: Water Resources Center, University of Delaware Development of the Woodlands.

Author

Robert Sykes
Associate Professor
Department of Landscape Architecture
University of Minnesota
(612) 625-6091
sykes002@maroon.tc.umn.edu

For More Information

Thomas Wegner
Extension Educator
University of Minnesota Extension Service
Hennepin County
(612) 374-8400
twegner@extension.umn.edu

Part of a Series

This is one in a series of four publications designed to assist local community leaders, city officials, developers and homeowners in creating viable residential cluster developments and management structures within their communities. The series includes:

1. Overview of Key Issues
2. Alternative Wastewater Treatment Systems
3. Storm Water Management
4. Management Options

Source for Figures 2, 3, 4, and 5: Protecting Water Quality in Urban Areas: Best Management Practices for Minnesota, Ch. 3, Minnesota Pollution Control Agency, Division of Water Quality, St. Paul, MN, Oct. 1989.

Funding

Funding for these publications provided by the Metropolitan Council and a University of Minnesota Extension Service Collegiate Program Leader Collaborative Grant. For ordering information call (612) 625-8173.

Printed with agribased inks on recycled paper with minimum 10% postconsumer waste.

Produced by Communications, University of Minnesota Extension Service. The information given in this publication is for educational purposes only.

MI-7059-S
1998

Residential Cluster Development: Management Options

4

Mathew Mega, Jon Erik Kingstad and Robert Sykes

Summary

This publication discusses basic management concepts used in new residential cluster developments, as well as the options available to municipalities and developers when establishing a management structure.

Management of Basic Functions

In a residential cluster development, the services residents are most concerned about include management of commonly-held open space, treatment of household wastewater and control of storm water runoff.

To manage these concerns, a management structure is necessary that identifies which services will be delivered, who will deliver them, and what resources will be used.

At the most basic level, management in a new cluster development means identifying individuals responsible for the construction, operation and maintenance of wastewater, storm water and open-space systems over the life of the cluster development.

■ Construction

This involves the basic design decisions about what services will be provided and defines construction standards. Construction is usually the developer's responsibility.

■ Operation

While there is operation and oversight of open space and storm water runoff, here the term operation usually refers to wastewater treatment facilities. If houses have individual on-site septic systems, the individual homeowner is responsible. As more complex wastewater treatment systems such as package plants are used, however, a professional operator will be required to oversee operations.

■ Maintenance

This is the most important function of the management structure, and its major components are the physical maintenance of wastewater and storm water systems. A good management structure should also provide a framework for future capital investment and system replacement. Management structures covering maintenance in most current developments usually do not have a future capital investment plan, which means that the developments tend to react to problems as they occur.

Current Management Situation

■ Open Space

Most residential cluster developments focus management activities on the protection of open space and the enforcement of community bylaws. This includes the maintenance of active and passive recreational areas, including ballfields, tennis courts, trails, and common areas. The majority of these issues can be addressed easily through a homeowners association (HOA). Residents automatically become members when they purchase a home and each household has an equal vote in such things as the setting of annual dues, physical design standards (e.g., house color), and the hiring of maintenance crews. Open space is protected through the use of deed restrictions, conservation easements or dedication of land to the municipality.

■ Storm Water Drainage Systems

Currently, two distinct forms of storm water management are simultaneously in place in residential cluster developments. Developers provide a basic storm water drainage system consisting of grassed swales and large detention ponds. The prevailing view is that these do not require extensive maintenance or replacement (for more information, see publication three of this series). The municipality, which controls the stormwater management structure in the majority of cluster developments, is responsible for the maintenance and upkeep of the second system, the curbs and gutters of public streets.

Many cluster developments lack a formal management structure. Once construction is complete, little attention is given to the storm water system's future needs beyond the mowing of swales, a task usually done by individual homeowners. When a problem does occur, such as the need to dredge a detention pond, the HOA must independently discover the procedure for correcting the problem. This leads to a reactionary management structure where problems are only addressed as they happen.

■ Wastewater Treatment

When there are individual septic tanks and drainfields, there is no

University of Minnesota
Extension
Service

formal management structure in place. Homeowners are responsible for the maintenance and upkeep of their own systems. In cluster developments, where individual drainfields may be placed in commonly-held open space, proper maintenance is still the ultimate responsibility of the individual homeowner. This fact sheet concludes with a more detailed look at wastewater management structures.

Technological Advances Lead to Increased Management Complexity

Unlike conventional subdivision developments, cluster developments explicitly incorporate greater housing density (on parts of a site), rural technologies, and innovative design to preserve more open space, to protect environmentally sensitive areas, and, sometimes, to preserve agricultural landscapes (see publication one). Technological advances in storm water drainage systems (publication three) and wastewater treatment systems (publication two) have greatly enhanced developers' ability to propose cluster designs.

Advances in wastewater treatment can ensure the protection of groundwater because systems can be located on a development's most suitable areas. Additionally, both the municipality and the developer can benefit from economies of scale by consolidating resources and minimizing duplication.

Better storm water management, including the use of vegetation and extensive overland flow systems, increases the opportunity to remove contaminants and keep sediment from discharging into local bodies of water.

However, many advances in rural technologies such as package plants, require professional maintenance and monitoring to ensure proper performance. This greater level of responsibility requires more complex management structures. Such a situation also makes it more desirable for municipalities, homeowners and developers to share this responsibility.

How to Select a Management Structure

As the complexity of residential cluster development increases, the local municipality needs to choose the management structure. This decision will be strongly influenced by the developer's design and layout proposals, however. Hopefully, the process creates a residential development that meets community goals, affords the developer appropriate financial gain, and provides homeowners with safe basic services that function properly.

■ Role of the Developer

The developer is the first and most critical stakeholder in establishing a management structure. The developer designs a cluster's layout, including the type and location of commonly-held resources and rural technologies. The physical design of the proposed cluster must conform to municipal zoning and subdivision codes. Typically, the developer is the initial petitioner for the development. The developer is also the key individual in the initial establishment and the future responsibility of the HOA. As the HOA's initial member, the developer acts on behalf of future homeowners.

■ Role of the Municipality

The municipality's primary role is to review and approve the formal design of the cluster development, ensuring its compatibility with local ordinances and codes. Usually this does not involve the establishment of a management structure except to require that developers create an HOA. But municipalities can establish formal management structures to aid local residents. An example is an environmental subordinate service district to correct a failing wastewater treatment system. As the need for alternative management structures arises, the municipality plays an expanded role in advising about and establishing new management structures.

Critical Components Influencing the Choice of Wastewater Management Structure

Three critical factors influence the choice of a wastewater management structure:

1. site characteristics,
2. design of the service system, and
3. size of the service area.

The first two are the developer's responsibility; in most cases, the municipality decides the third.

■ Site Characteristics

The physical characteristics of the site such as soil conditions, vegetative cover and areas of excessive slope determine what wastewater treatment facilities are most appropriate.

■ System Design

Once a specific system is chosen, its components determine the degree of monitoring and maintenance that is necessary, pointing almost inexorably to a specific management structure. For instance, a package plant has the capacity to service many units, but because it involves a number of mechanical components, it requires a professionally trained and licensed technician to ensure that the system runs smoothly. Community drainfields, on the other hand, with few mechanical components, require less strict monitoring (see Figure 1).

■ Service Area

The municipality should have some insight into the potential grouping of cluster developments in its community. If multiple cluster developments are close together, the municipality may choose to consolidate resources by incorporating all the clusters under a common management structure. If clusters are independent of each other, a simpler structure is usually more appropriate.

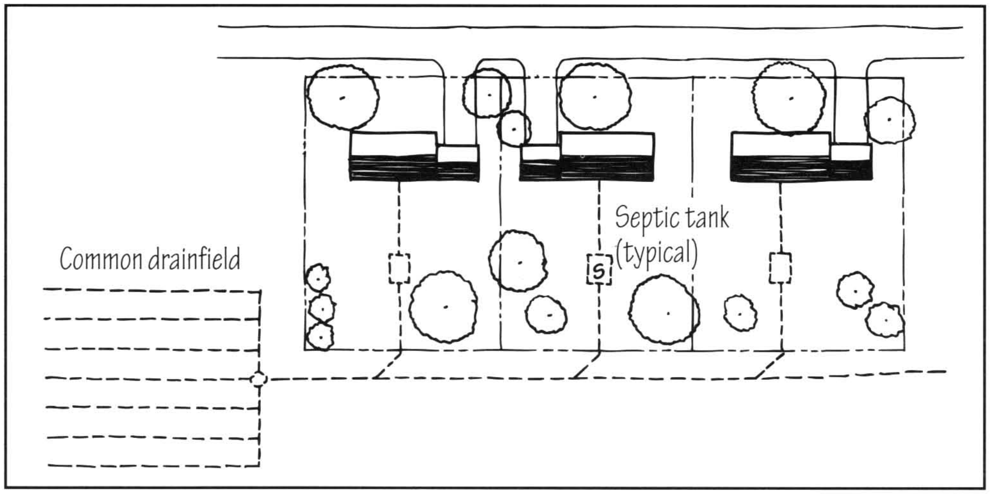


Figure 1. Typical on-site septic layout for a cluster.

Specific Management Options for Wastewater Treatment

Six management options exist to handle wastewater treatment, three public and three private.

■ Private Management Options

■■■ *Homeowners Association*

The most common management entity utilized today, the HOA's structure is determined by bylaws, which are usually typical of regulations for community property. Many municipalities require an HOA as a condition of plat approval for cluster developments and many codes state basic requirements HOAs must meet. After establishing an HOA, a developer remains a member until a set number of housing units are sold, usually around 50 percent. The primary disadvantage of the HOA is its lack of dedicated support staff and technical expertise when dealing with the additional monitoring and maintenance requirements associated with community wastewater treatment facilities.

■■■ *Privatized Joint Venture*

Private management of wastewater treatment is authorized under the Privatized Capital Intensive Services Act in Minnesota Statutes Chapter 471A. Under this statute, a local unit of government may contract for private wastewater treatment with a private vendor who provides service to residents for a user charge approved by the local unit of government. Creating the joint venture allows the HOA or the local unit of government to hire management with expertise beyond the capacities of the individual homeowners. As a permanent management structure, the joint venture also removes the burdens of monitoring and maintenance from the HOA or the local unit of government.

A privatized joint venture could be used to link a number of cluster developments' HOAs through a "master association" under the Minnesota Common Interest Ownership Act to provide wastewater treatment services beyond the capability of the individual HOA for a fee.

■■■ *Water Quality Cooperative*

Just as residents have organized rural electric cooperatives to obtain a lower-cost essential service, the cooperative framework enables individuals to obtain management expertise, monitoring, and maintenance beyond the capabilities of individual residents or even homeowners associations. The cooperative entity has the power to levy charges for its services, but the cost savings flow back to members as profits or capital credits. Legislation enacted in 1997 by the Minnesota legislature has authorized the creation of two pilot water quality cooperatives to own, operate, manage and control alternative sewage treatment systems and provide other water quality management and treatment services.

■ Public Management Options

■■■ *Municipal Utility*

The most familiar form of public management structure is a separate government entity providing basic services such as storm water, water supply or wastewater management. Municipal utilities can assess property owners who benefit from using the public service the utilities provide. Cities, counties and townships have the authority to plan, finance, construct and maintain sewer service systems within their boundaries.

■■■ *Sanitary Sewer District*

Sanitary sewer districts can be created in several ways. Townships, cities, counties or 20 percent of the voters residing and owning land in the affected area may petition the Minnesota Pollution Control Agency. Additionally, general purpose governments may enter into a joint powers agreement to create a sewer district. A county, district court and even the state legislature may create a district by passing a new law specific to the affected area.

■■■ *Subordinate Service District*

Townships use these to establish an area for improvement. An example would be upgrading a failing wastewater treatment system. Subordinate service districts are defined areas in a town in which one or more government services or additions to townwide services are provided by the town, with revenues financed from inside the area.

Authors

Mathew Mega
Graduate Student
Humphrey Institute of Public Affairs
University of Minnesota
and SRF Consulting Group
(612) 475-0010
mmega@srfconsulting.com

Jon Erik Kingstad
Research Fellow—Attorney at Law
Center for Rural Technology &
Cooperative Development (CRTCD)
Department of Landscape Architecture
University of Minnesota
(612) 626-9818
kings011@tc.umn.edu

Robert Sykes
Associate Professor
Department of Landscape Architecture
University of Minnesota
(612) 625-6091
sykes002@maroon.tc.umn.edu

For More Information

Thomas Wegner
Extension Educator
University of Minnesota Extension Service
Hennepin County
(612) 374-8400
twegner@extension.umn.edu

Paul R. Jacobs
Director, Center for Rural Technology and
Cooperative Development
Department of Landscape Architecture
University of Minnesota
(612) 626-9709

Part of a Series

This is one in a series of four publications designed to assist local community leaders, city officials, developers and homeowners in creating viable residential cluster developments and management structures within their communities. The series includes:

1. Overview of Key Issues
2. Alternative Wastewater Treatment Systems
3. Storm Water Management
4. Management Options

Funding

Funding for these publications provided by the Metropolitan Council and a University of Minnesota Extension Service Collegiate Program Leader Collaborative Grant. For ordering information call (612) 625-8173.

Other Resources

These resources from the University of Minnesota Extension Service are available through your county Extension office or by calling the Distribution Center at:
Twin Cities local 624-4900 or Outstate 1-800-876-8636

Septic System Owner's Guide EP-6769

Septic Systems Revealed video VH-6768

Printed with agribased inks on recycled paper with minimum 10% postconsumer waste.

Produced by Communications, University of Minnesota Extension Service. The information given in this publication is for educational purposes only.