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Decentralized Systems Technology Fact Sheet
Mound Systems

DESCRIPTION

The mound system was originally developed in North Dakota in the late 1940s and called the NODAK disposal system. Some soil types are unsuitable for conventional septic tank soil absorption systems. As a result, alternative systems such as the mound system can be used to overcome certain soil and site conditions.

The mound design in predominate use today was modified from the NODAK design by the University of Wisconsin-Madison in the early 1970s. Although there are now many different mound designs in use, this fact sheet will focus on the Wisconsin design. The Wisconsin mound has been widely accepted and incorporated into many state regulations.

The three principle components of a mound system are a pretreatment unit(s), dosing chamber and the elevated mound. Figure 1 illustrates a Wisconsin mound system.

APPLICABILITY

Mounds are pressure-dosed sand filters that discharge directly to natural soil. They lie above the soil surface and are designed to overcome site restrictions such as:

- Slow or fast permeability soils.
- Shallow soil cover over creviced or porous bedrock.
- A high water table.

The main purpose of a mound system is to provide sufficient treatment to the natural environment to produce an effluent equivalent to, or better than, a conventional onsite disposal system.

ADVANTAGES AND DISADVANTAGES

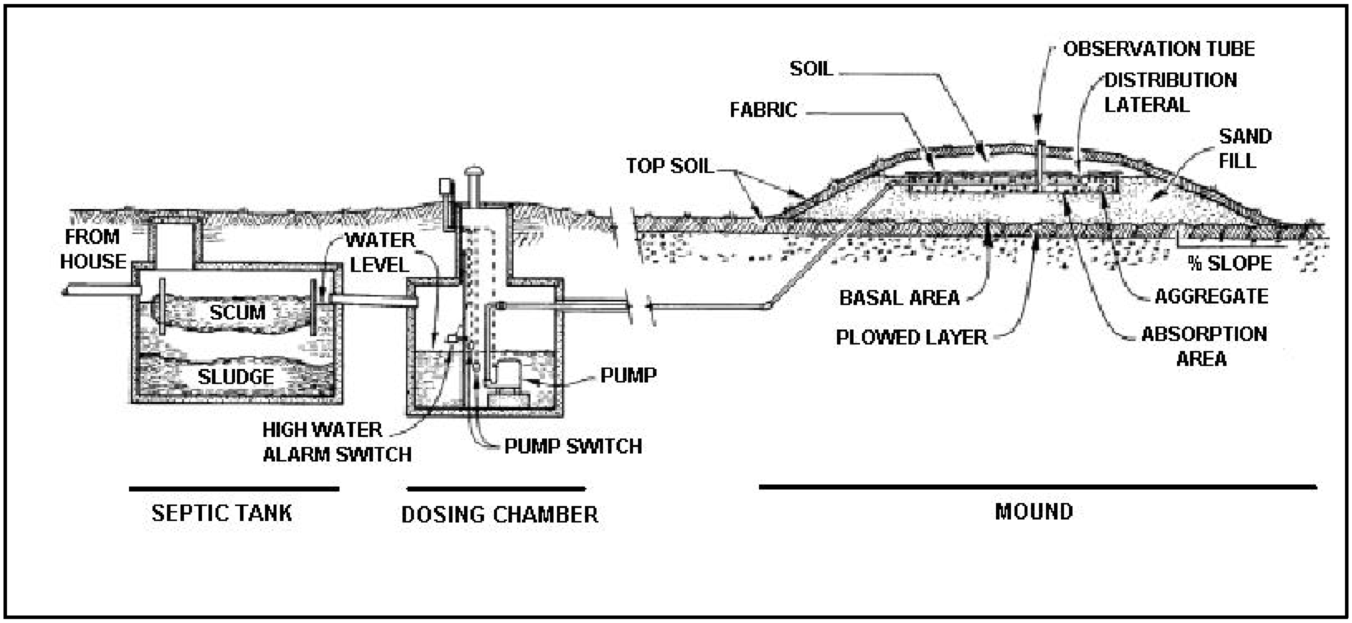
Listed below are some advantages and disadvantages of mound systems when compared to other alternative onsite systems.

Advantages

- The mound system enables use of some sites that would otherwise be unsuitable for in-ground or at-grade onsite systems.
- The natural soil utilized in a mound system is the upper most horizon, which is typically the most permeable.
- A mound system does not have a direct discharge to a ditch, stream, or other body of water.
- Construction damage is minimized since there is little excavation required in the mound area.
- Mounds can be utilized in most climates.

Disadvantages

- Construction costs are typically much higher than conventional systems.



Source: Converse and Tyler, Copyright © by the American Society of Agricultural Engineers, reprinted with permission, 1987.

FIGURE 1 SCHEMATIC OF A WISCONSIN MOUND SYSTEM

- Since there is usually limited permeable topsoil available at mound system sites. Extreme care must be taken not to damage this layer with construction equipment.
- The location of the mound may affect drainage patterns and limit land use options.
- The mound may have to be partially rebuilt if seepage or leakage occurs.
- All systems require pumps or siphons.
- Mounds may not be aesthetically pleasing in unless properly landscaped.

DESIGN CRITERIA

Two factors that determine the size and configuration of a mound are; how the effluent moves away and the rate at which it moves away from the system. The prediction of the movement and rate of movement is done from studies of the soil and site information obtained. To ensure proper performance of the mound system, the following concepts must be included in the design and construction process:

- 1) Leaving the topsoil in place but plowing it before placement of the fill.
- 2) Using a coarse sand fill meeting grain size distribution specifications.
- 3) Using pressure to uniformly distribute the effluent over the seepage area.

Soil Depth

A suitable depth of soil is required to treat the effluent before it reaches the limiting condition, such as bedrock, a high water table, or a slowly permeable soil layer. Although the separation distance varies, it is usually between 1 and 4 feet.

Site and Design

To date, siting and design experience at sites suitable for mound systems indicates that absorption systems should be long and narrow and should follow the contour (i.e., level). The more restrictive the site, the narrower and longer the system. Table 1 gives the soil criteria for a Wisconsin mound based on research and field experience.

TABLE 1 RECOMMENDED SOIL AND SITE CRITERIA FOR THE WISCONSIN MOUND SYSTEM BASED ON RESEARCH AND FIELD EXPERIENCE

Parameter	Value
Depth of high water table (permanent or seasonal)	10 in.
Depth to crevice bedrock	2 ft.
Depth to non-crevice bedrock	1 ft.
Permeability of top 10 in.	Moderately low
Site slope	25%
Filled site	Yes[a]
Over old system	Yes[b]
Flood plains	No

a Suitable according to soil criteria (texture, structure, consistence).
b The area and backfill must be treated as fill because it is a disturbed site.

Source: Converse and Tyler, 1990.

High Water

The high water table is determined by direct observation (soil boring), interpretation of soil mottling, or other criteria. The bedrock should be classified as crevice, non-crevice semi-permeable, or non-crevice impermeable. This will determine the depth of sand media required.

Percolation and Loading

Percolation tests are used in some jurisdictions to estimate the soil permeability because they are empirically related to the loading rate. Loading rates should be based on the soil texture, structure, and consistence, using the percolation test only to confirm morphological interpretations.

Mounds

Mounds can be constructed on sites with slopes up to 25%. The slope limitation is primarily for construction safety, because it is difficult to operate equipment on steep slopes, and they pose a construction hazard. From a hydraulic perspective, mounds can be positioned on steep slopes.

Sites

In the case of filled sites, fill material is placed on top of the natural soil and may consist of soil textures ranging from sand to clay. Sufficient time must be allowed for the soil structure to stabilize before constructing a system. Many more observations are required for filled areas.

When evaluating the soil loading rate for a mound over an old or failing in-ground system, the soil over the system must be considered to be disturbed, and thus, treated as a filled site. If a mound is to be placed over a large in-ground system, a detailed evaluation of the effluent movement should be done.

Mounds should not be installed in flood plains, drainage ways, or depressions unless flood protection is provided. Another siting consideration is maintaining the horizontal separation distances from water supply wells, surface waters, springs, escarpments, cuts, the boundary of the property, and the building foundation. Sites with trees and large boulders can make it difficult in preparing the site. Trees should be cut to the ground surface with tilling around stumps. The size of the mound should be increased to provide sufficient soil to accept the effluent when trees and boulders occupy a significant amount of the surface area.

The actual size of a mound system is determined by estimating the sand fill loading rate, soil (basal) loading rate, and the linear loading rate. Once these values are established, the mound can be sized for the site. The final step is to design the effluent distribution network and the pumping system.

PERFORMANCE

One factor that determines good performance is the type of sand fill material. A suitable sand is one that can adequately treat the wastewater. Suitable sand should contain 20% or less material greater than 2.0 mm and 5% or less finer than 0.053 mm. It should also have a size distribution that meets certain sieve analysis specifications, ASTMC-33 specifications, or meets limits for effective diameter and coefficient of uniformity.

For design of residential mounds, the daily wastewater volume is determined by the number of bedrooms in a house. Typical design flow requirements for individual homes are up to 150 gallons per day (gpd) per bedroom. Design specifications for mound systems are usually the same for both large and small flows for typical domestic septic tank effluent. Higher strength wastes must be pretreated to the levels of domestic septic tank effluent, or lower hydraulic loading rates may be applied.

IMPLEMENTATION

In Wisconsin, the success rate of the mound system is over 95%, which is due to their emphasis on siting, design, construction and maintenance.

Years of monitoring the performance of mound systems have shown that mounds can consistently and effectively treat and dispose of wastewater. Studies have shown evidence that some nitrogen removal does occur in mound systems when approximately 2 feet of natural unsaturated soil is below the fill material.

Mound Systems in Wisconsin (State-Wide)

Using relatively conservative soil criteria, many states have accepted the Wisconsin mound system as an alternative when conventional in-ground trenches and beds are not suitable. The Wisconsin mound system has evolved into a viable onsite system for the treatment of wastewater from individual, commercial, and community systems by overcoming some of the site limitations and meeting code requirements and guidelines.

In 1978, an experimental study was initiated to evaluate soil/site limitations for the Wisconsin mound (see Converse and Tyler, 1987a). The objectives of this research study were to determine whether the existing soil/site limitations on mounds were too restrictive and to determine the minimum soil/site limitations under which the mounds would perform without affecting public health and the environment. The experimental approach was to design, construct, and evaluate sites with mound systems that currently did not meet code requirements due to failing systems.

The sites selected for this study had to fit the objectives of the research and generate a reasonable amount of wastewater to be mound treated. The sites selected had to have:

1. Fill soil placed over natural soil.

2. A high water table where the seasonal high water table level was less than 60 cm below the ground surface.

3. Slowly permeable soils that were rated slower than moderately permeable soils.

4. Steep slopes greater than 12%.

5. Mounds over existing failing systems.

6. A combination of the above.

Over 40 experimental mounds were constructed between 1979 and 1983 on sites that did not meet the code requirements; 11 of these mounds are described in detail in this study. Site evaluations were done by certified soil scientists, plans prepared by designers were reviewed and approved by the state, and licensed contractors installed the systems with inspections by county sanitarians during construction.

The study concluded that the overall performance of the mounds was very good. The systems functioned satisfactory on filled sites, on sites with a high water table (seasonal water table 25 to 30 cm from the ground surface), on steep slope sites (up to 20 to 25%), on sites with slowly permeable soil, and on top of failing systems. Leakage occurred at the base of the mound on some sites during extremely wet conditions, but the effluent quality was good, with fecal counts generally less than 10 colonies per 100 ml in saturated toe effluent. It was found that Wisconsin mound systems can be constructed on difficult sites if the system is designed using linear loading rates, which are established based on the horizontal and vertical acceptance rates of the soil for each system.

Failure of Mound System in Wisconsin

Expansion of a Wisconsin firm's mound system in 1978, resulted in a clogging and seepage problem. The system was originally built to handle 65 employees at 750 gpd and was now serving a staff of 165. This expansion created a failure of the mound system due to hydraulic overload. To solve this problem, the mound system was expanded and a water conservation program was initiated. The expansion of the mound increased the hydraulic capacity to 2,600 gpd (Otis, 1981.)

In November 1979, the mound system failed again—this time due to a biological clogging mat. The clogging mat was removed by using 450 gallons of a 10% solution of hydrogen peroxide. The mound system was operating successfully within 2 days. However, further research indicates that for structured natural soils other than sand, hydrogen peroxide may reduce the soil infiltration rate, and thus, may not be an effective procedure to eliminate soil clogging.

A third failure occurred in January 1980, again due to hydraulic overload. The firm had expanded its employee base to 215 employees, with an average daily flow of 3,000 gpd. There was no room available to expand the mound system itself, so the firm redesigned the pumping chamber to avoid large peak flows, allowing the mound system to receive optimum dosing without failure.

OPERATION AND MAINTENANCE

The septic tank and dosing chamber should be checked for sludge and scum buildup and pumped as needed to avoid carryover of solids into the mound. Screens or filters can be used to prevent large solids from escaping the septic tank. The dosing chamber, pump, and floats should be checked annually and replaced or repaired as necessary. It is critical that the septic tank and dosing chamber be watertight. In addition, electrical parts and conduits must be checked for corrosion. Flushing of the laterals annually is recommended.

When a mound system is properly installed and maintained, it should last for a long period of time. In general, the maintenance required for mounds is minimal. However, as with any system, poor maintenance could lead to early system failure. Possible problems that can occur in an improperly designed or constructed mound system include:

- Ponding in the absorption area of the mound.
- Seepage out of the side or toe of the mound.
- Spongy areas developing on the side, top, or toe of the mound
- Clogging of the distribution system.

Practices that can be used to reduce the possibility of failure in a mound system include:

- Installing water-saving devices to reduce the hydraulic overload to the system.
- Calibrating pumps and utilizing event counters and running time meters.
- Timed dosing to dose equally sized doses on regular intervals throughout the day.
- Diverting surface water and roof drainage away from the mound.
- Preventing traffic on the mound area.
- Installing inspection tubes in the mound to check for ponding.
- Keeping deep-rooted plants (shrubs and trees) off the mound.
- Planting and maintaining grass or other vegetative cover on the mound surface to prevent erosion and to maximize water uptake.
- Stand-by power for the pump.

Follow all instructions recommended by the manufacturer. All equipment must be tested and calibrated as recommended by the equipment manufacturer. A routine operation and maintenance (O&M) schedule should be developed and followed for any mound system in addition to checking local codes.

COSTS

The cost of a mound system is dependent on design costs, energy costs, the contractor used, the manufacturers, land, and the characteristics of the wastewater. Table 2 lists some typical capital and O&M costs for a mound system serving a three-bedroom single home at a flow rate of 450 gpd (150 gallons per bedroom). Septic tank costs were estimated at $1 per treated gallon. It should be noted however, that costs will vary from site to site. To keep construction costs to a minimum, use good quality and local materials, when available.

TABLE 2 TYPICAL COST ESTIMATE FOR A MOUND SYSTEM (SINGLE HOME)

Item	Cost ($)
Capital Costs	
Construction Costs	
Septic tank (1000 gallon concrete tank)	1,000
Dosing chamber (includes pump and controls)	2,000
Mound structure	6,000
Total Construction Costs	**9.000**
Non-Component Costs	
Site evaluation	500
Permits	250
Total Costs	**9,750**
Annual O&M Costs	
Labor @$20/hr.	20 per year
Power @8 cents/kWh	35 per year
Septic tank pumping	75 to 150 every 3 years

Source: Ayres Associates, Inc., 1997.

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ADDITIONAL INFORMATION

Mr. Richard J. Otis, Ph.D., P.E., DEE
Ayres Associates
2445 Darwin Road
Madison, WI 53704-3186

National Small Flows Clearing House at
West Virginia University
P.O. Box 6064
Morgantown, WV 26506

For more information contact:

Municipal Technology Branch
U.S. EPA
Mail Code 4204
401 M St., S.W.
Washington, D.C., 20460

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