SUBSURFACE WASTEWATER DISPOSAL SYSTEMS DESIGNED IN MAINE BY THE SITE EVALUATION METHOD: SYSTEM DESIGN, LAND USE TRENDS, AND FAILURE RATES

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ABSTRACT

Since 1974, the Subsurface Wastewater Disposal Rules in Maine have utilized site evaluations as a means of siting and designing disposal systems. Over sixty-four thousand (64,000) systems have been installed since 1974. The purpose of this study was to determine the effectiveness of Maine's Disposal Rules and site evaluation requirement by determining, for the 7,677 systems installed between May 1983 and July 1984: (1) types of permits issued, (2) types of disposal systems installed, (3) types of soils utilized for on-site disposal, and (4) disposal system failure rates.

Types of Permits Issued

Review of the types of permits issued indicates: 69% were for new systems, 27% were for replacement of existing systems, and 4% included expansion, experimental and others. Three percent (3%) of the permits for new systems required a variance to Maine's Rules while 60% of the replacement systems required a variance. The large percentage of variances for replacements systems was attributed to earlier development done prior to passage of land use laws and adoption of Maine's more stringent Subsurface Wastewater Disposal Rules.

Types of Disposal Systems Installed

Of the total absorption areas being installed, 84% are disposal beds, 10% are chamber systems, 1% are disposal trenches and 5% unknown.

Types of Soils Utilized for On-Site Disposal

Eighty-one percent (81%) of Maine's mapped land acreage is rated poor or very poorly suited for subsurface wastewater disposal due to high ground water tables, slow permeabilities and impervious substrata.

Sixty-one percent (61%) of the systems were sited on glacial till soils, 23% on stratified drift soils, 9% on ma ' rine and lacustrine soils, and 6% on .soils of mixed origin. Based on drainage, 24% had a seasonal high ground water table at a depth greater than 1.2 meters [48 inches], 57% had a seasonal high ground water table between .38 and 1.2 meters [15 to 48 inches], 7% had a seasonal high ground water table between 15 and 38 centimeters [6 to 15 inches], a trace percentage had a seasonal high ground water table less than 15 centimeters [O to 6 inches], and 11% were shallow to bedrock (i.e. bedrock less than 1.2 meters from the soil surface [48 inches].

Disposal System Failure Rates

Based on data on age of malfunctioning systems replaced between May 1983 and July 1984, projected system failure rates are: 0.12, 1.0 and 5.0 percent within 1, 5, and 10 years, respectively.

Chamber absorption areas did not have a higher incidence of failure than bed systems, based on limited data, although 50% smaller than bed systems for any given soil type.

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SUBSURFACE WASTEWATER DISPOSAL SYSTEMS DESIGNED IN MAINE

BY THE SITE EVALUATION METHOD:

LIFE EXPECTANCY, SYSTEM DESIGN AND LAND USE TRENDS

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Population increases have intensified the problems associated with on-site disposal systems. Sewer extensions and new municipal treatment plants have become financially prohibitive in many localities. Consequently, federal, state and local governments have now focused their attention on individual subsurface wastewater disposal systems which are recognized as a viable wastewater management alternative which can provide reliable service and treatment - at a reasonable cost, while preserving environmental quality (U.S. Environmental Protection Agency, 1980).

In the past, Maine, like many other states, utilized the Manual of Septic-Tank Practice (U.S. Public Health Service, 1967) to site and design disposal systems. In the early 1970's, Maine's Department of Human Services, Division of Health Engineering reviewed its siting and design criteria because areas with unsuitable soils were being developed and the use of percolation tests were unreliable (Toppan, 1976), (White, Davis, 1979). Maine decided to discontinue using the percolation test because of concerns about the increasing potential for escalation of health hazards, nuisances and environmental degradation. Many studies to date cite problems with the use of percolation tests for disposal system design (U.S. Environmental Protection Agency, 1978).

In 1974, Maine's Subsurface Wastewater Disposal Rules were modified to incorporate a site evaluation concept to replace the percolation test, and new design criteria to overcome Maine's severe soil limitations (Maine's Department of Human Services, 1974). The site evaluation concept is based on soil morphology to appraise the expected hydraulic loading rates without the requirement for conducting percolation tests. The absorption area design, size, and vertical separation distance to the limiting factor (e.g. bedrock, impervious layer, ground water table) is also determined by the soil evaluation (Frick et al. 1983), (Black and Struchtemeyer, 1982).

This study examines the effectiveness of Maine's site evaluation program and Subsurface Wastewater Disposal Rules after ten years of implementation and refinement, by investigating the:

1. types of disposal systems installed,
2. soil types utilized for on-site disposal, and
3. disposal system failure rate

METHOD

Maine law requires that a disposal system installation permit be obtained prior to a system's installation (Maine's Department of Human Services, 1983). Site evaluations conducted by licensed site evaluators are part of this permitting process. Site Evaluators are required to classify the soil in accordance with Table 1 and complete an application for the permit (Figure 1) . The application details the system type, size, location, as well as provides soil information, lot size, etc (Frick, et al, 1983). Before installation " the system is staked out by the site evaluator and the finished elevation is referenced to an established bench mark. Maine's Department of Human Services receives a copy of all permits issued and has recorded limited information for over 64,000 permits received since 1974.

More extensive information has been recorded from the first page (Figure 1) of 7,677 applications which were received between May 1983 and July 1984 and analyzed by computer.

RESULTS & DISCUSSION

Types of Permits Issued

A summary of the permits issued between May 1983 and July 1984 is shown in Table 2. New system installations composed 69% of all permits issued, replacement systems 27%, expansions to existing systems 2% and 2% are unknown.

Variances Issued

Table 2 shows that 3.1% of the new systems required a variance to Maine's Rules for either setback distances or minimum soil limitations, while 60% of the replacement systems required a variance for the same reasons. The Rules have relatively stringent criteria for New System Variance approval (Maine's Depa'rtment of Human Services, 1983) and consequently restrict the number of systems that are allowed. Replacement system variance approval criteria are less stringent, recognizing that the majority of the failed systems were installed prior to 1974 when land use laws were non-existent and the subsurface wastewater disposal regulations were based on the percolation test method.

Table 2. Types of Permits and Variances Issued from May 1983 to July 1984

	Number permits issued	Percent of total issued	Permits issued with variance	Percent of type with variance
New system installation	5,263	69	164	3.1
Replacement system	2,096	27	1,272	60.0
Expansion of existing system	118	2	0	-
Seasonal Conversion	40	-	0	-
Unknown	160	2	-	-
Total	7,677	100	1,436	

Types of Disposal Areas Utilized.

Table 3 indicates that beds, chambers and trenches compose 84%, 10% and 1% respectively of the disposal fields being installed. Bed and chamber systems are commonly used in Maine because they utilize less total area and are easier to design in compliance with setback distance criteria, site modifications and hydraulic loading rates.

Table 3. Types of Disposal Areas Installed from May 1983 to July 1984

Type	Number installed	Percent of total
Bed	6,441	84
Chamber	779	10
Trench	71	1
Other	29	-
Unknown	357	5
Total	7,677	100

Types of Soils Utilized

Table 4 is a record of the percentage of disposal systems sited on the various soil types. The data indicate that 61% of the systems were sited on glacial till soil, 23% on stratified drift, 9% on marine or lacustrine sediments, and 6% on mixed origin soils. Concurrently, the data show that 24% were sited on well drained soils, with a seasonal high ground water table at a depth greater than 1.2 meters [48 inches], 57% on moderately well drained soils, with a seasonal high ground water table between .38 and 1.2 meters [15 to 48 inches], 7% on poorly drained soils with a seasonal high ground water table between 15 and 38 centimeters [6 to 15 inches], and a trace percentage was on very poorly drained soils with a seasonal high ground water table less than 15 centimeters [6 inches]. Shallow to bedrock soils, with bedrock less than 1.2 meters (48 inches] from the soil surface accounted for 11% of the sites.

Table 5 tabulates the soil series, mapped in Maine by the National Cooperative Soil Survey, and. including the percentage of land mapped for each soil series, and to the Maine Rule's soil classification **system. A** tabulation of the mapped land percentage with respect to soil suitabilities for subsurface wastewater disposal (Ferwerda, et al 1975) is reported in Table 6 which shows that 81% of Maine's mapped land acreage is poor or very poorly suited for subsurface wastewater disposal due primarily to high groundwater tables, slow permeabilities and impervious substrata. Maine's Subsurface Wastewater Disposal Rules attempt to guide disposal systems **onto** those soils with the greater soil potentials and requires special designs to overcome the inherent soil limitations (Mitchell et al, 1977).

Life Expectancy of Systems Designed by Maine's Site Evaluation Method

Table 7 tabulates the number and types of failed systems replaced between May 1983 and July 1984. Cesspools were not permitted to be installed after the early 1950s. Disposal trenches were essentially the only systems installed between 1950 to 1974. Disposal beds and chamber systems were not routinely installed until after 1974. The usage patterns tend to explain the higher trench and cesspool failure rates. The ratio of beds to chambers failure rate is 10:1 and the ratio of beds to chambers installed is 8:1. This suggests that chambers do not have a higher incidence of failure than bed systems, although 50% smaller than bed systems for a given soil type.

During the study period from May 1983 to July 1984, 1,995 replacement absorption areas and 101 replacement septic tanks [total 2,096) were installed in Maine. There is a significant correlation [r = 0.83 (.01 significance)] between the age of the system and the number of failures. These data suggest that 2.1% [not including unreported systems] to 5.0% [adjusting for unreported systems] of these systems replaced during 1984 had failed within 10 years. Table 8 tabulates the number of disposal systems Installed In each year from 1974 to 1.983 and the number of reported failed

Systems that were replaced during the study period. Conservatively, 0.12, 1.0 and 5.0 percent of the systems fail within 1, 5 and 10 years respectively. There was no detectable difference on failure rates with regard to system and soil types. The reasons for failure were not investigated.

Table 4. Soil Classification and Percentage of Subsurface Wastewater Disposal Systems Sited on from may 1983 to July 1984.

Table 6. Soil Suitability for Waste Disposal and Percent of Mapped Land Area

Soil Suitability Rating	Percentage of Mapped Land Area
Very Poor	52.20
Poor	29.11
Fair	3.17
Good	6.59
Waterbodies, etc.	8.93

Table 7. Failed Systems Replaced from May 1983 to July 1984

	Installed after 1974 by site evaluation	Installed prior to 1974 by percolation test	Total systems replaced
Bed	68	48	116
Chamber	7	1	8
Trench	43	659	702
other	24	326	350
Unknown	11	808	819
Total	153	1,842	1,995

Table 8. Replacement Disposal Systems Installed in Maine from May 1983 to July 1984

Year	Total systems installed in year	Systems replaced in study period that were originally installed that year*	Percentage of systems replaced to total systems installed*	Years of usage	Accumulative percentage failure rate*
1984	incomplete	-		1 Yr.-	
1983	5,990	(3- 7)	(.05- .12)	1 Yr.	(.05- .12)
1982	5,901	(3- 7)	(.05- .12)	2 Yr.	(.10- .24)
1981	3,787	(4- 9)	(.11- .24)	3 Yr.	(.21- .48)
1980	3,182	(6- 14)	(.19- .44)	4 Yr.	(.40- .92)
1979	6,581	(2- 5)	(.03- .08)	5 Yr.	(.43-1.0)
1978	7,955	(19- 45)	(.24- .57)	6 Yr.	(.67-1.6)
1977	4,958	(13- 31)	(.26- .63)	7 Yr.	(.93-2.2)
1976	8,230	(14- 33)	(.17- .40)	8 Yr.	(1.1-2.6)
1975	10,288	(33- 78)	(.32- .76)	9 Yr.	(1.4-3.4)
1974	7,494	53- 126)	(.71-1.68)	10 Yr.	(2.1-5.0)
Pre 1974	-	(733-1740)			
No Date Reported	1213				

*The lower limit of range excludes data of systems with no date reported. The higher limit of range represents the failures and failure rates if the 1,213 undated replacement systems are redistributed in proportion to the reported failure rates.

CONCLUSIONS

1. New and replacement systems were 69% and 27% of the total (7,677) disposal system sampled, respectively.

2 . Approximately 3% of the new systems required a variance to Maine's Subsurface Wastewater Disposal Rules whereas 60% of the replacement

systems required a variance. The larger percentage of variances for replacement systems was attributed to the fact that many of the older systems being replaced were installed 'prior to land use laws and adoption of the more stringent current regulations.

3. Of the total absorption areas installed, 84% were beds, 10% chambers and 1% trenches with 5% unknown. Bed and chamber systems are commonly used in Maine to satisfy the criteria for setback distances, site modification and hydraulic loading rates.

4. Maine's soils are inherently poorly suited for sewage disposal systems with 81% of the mapped land area having a poor or very poor soil suitability rating for sewage disposal; however, Maine's Subsurface Wastewater Disposal Rules direct disposal systems onto soils with greater potential since 81% of the total systems are on well to moderately well drained sites and are designed to overcome site limitations.

5. Chamber systems do not have a higher incidence of failure than bed systems**,** based on limited data, although 50% smaller than bed systems for any given soil type.

6. The projected failure rates of disposal systems in Maine, based on a review of 1,995 replacement systems, are 0.12, 1.0 and 5.0 percent failures within 1, 5 and 10 years respectively.

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