Whether to use septic tank systems to provide needed sewage disposal facilities is an increasingly critical question facing the ever-expanding suburbs.

The Septic Tank System in Suburbia

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THE WIDESPREAD use of the septic tank has come as a result of an unprecedented demand for housing in suburban areas. Before attempting an evaluation of the septic tank as a means of sewage disposal, it is well to review the factors promoting its use. Since the septic tank is intimately connected with the house-building industry, the review must consider that industry and the forces governing its activities.

After a long freeze during the war, construction got under way in the late 1940's with a mass movement of people to the suburbs of population centers. It seemed reasonable at that time to believe that this shift in population resulted from the wartime backlog of housing demand, that eventually construction would catch up with demand leaving relatively stable communities with new outer boundaries, and that permanent facilities could then be installed to replace the temporary devices used during the expansion period.

It now appears that this reasoning was in error. The tremendous increase in the birth rate following the war was contrary to all predictions. In 1940, the consensus was that the population of the United States had become relatively stationary and perhaps would even begin to decline. Even as late as 1946 a population of 153 million was forecast for 1960, and an ultimate peak of 164.5 million was predicted for 1990. The great increases in marriages and births following the war made these predictions appear ridiculous. The present population is more than 171 million, and an estimate of 180 million now seems logical for 1960. In fact, during the past 10 years population increase has consistently exceeded the estimates.

The number of immediate housing starts is more nearly associated with new family formation than with population increase. The formation of new families is sagging at present. One reason may be that people of marriageable age are now being drawn from the low birth rate years of the depression, but the high birth rate after the war should bring a population wave in the marriageable age commencing in the late 1960's. Even now we are watching a wave of children pass through grade school. In a few years they will be in high school, later in college, and then they will marry and become prospective home owners.

Family income is another factor that greatly influences house building and home ownership. In spite of increases in the cost of housing, rising family income has brought home ownership within the reach of a large portion of the Nation. The percentage of owner-occupied dwellings rose from 43.6 percent in 1940 to 55 percent in 1950, and a further increase to 60 percent is predicted for 1960 (*1*). There is also

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good reason to believe that a rising family income, coupled with modern financing, will lower the age at which first homes are bought.

Suburban Expansion

Considering these facts, housing starts are expected to continue at the present rate of approximately 1 million a year for the next 4 years. Subsequently, the number of starts should steadily increase to a possible 2 million or more a year in the 1970's.

The location of new housing in relation to the central city is extremely important to any consideration of the septic tank's place in fringe area sanitation. Since 1950, practically all of the population increase has been registered in the 172 standard metropolitan areas, but the largest gains have been made on the fringes of the parent cities. This trend is expected to continue (*2*). To be realistic, we must conclude that the limits of the parent cities are virtually fixed by a number of factors, including the will of the people. Building sites within the corporate limits served by a sewerage system are already scarce and are priced out of the speculative house-building market. Therefore, the vast majority of new houses will be built in the suburbs at an ever-increasing distance from the parent city.

Because of these circumstances, the highway-building program may have more impact on housing location than any other factor in history. Approximately $40 billion of the estimated $100 billion to be spent on modern roads in the next decade will be spent in metropolitan areas. As a result, expressways of limited access will lead from the countryside into the heart of all major cities. Since time and not distance is the major consideration of commuters, the expressways will make land, considerably distant from the city, available and attractive for housing. Clearing rights of way during the construction of the highways will generate more pressure for the suburban movement. One noted economist estimated that from 300,000 to 400,000 houses a year demolished in the highway and urban renewal programs will have to be replaced and relocated. Although the estimate appears high, the demolition of houses is undeniably another factor in forcing people to the suburbs.

With the highways will come restaurants, motels, shopping centers, and other service installations. Industries will also locate along the highways, creating still further pressure for fringe area housing. All of these buildings, requiring sewerage and other community facilities, will intensify sanitation needs.

An appraisal of these facts and trends leads to a sobering conclusion. The expansion of standard metropolitan areas is not a passing phase. Rather, we have seen the start of a trend that may continue into the 1980's.

We are entirely unprepared to provide adequate sanitary facilities of all types in a dispersed community of the proportions visualized. The problem of sewage disposal is already acute. In fact, to dispose of sewage properly in an expanding suburban area from the time the first house is occupied until the area is fully developed is perhaps the most complex problem ever faced by the sanitary engineering profession.

Other disciplines are also concerned, but the basic responsibility for supplying essential sanitary facilities is vested in the sanitary engineer. Unless he seizes the initiative and becomes a strong leader, the situation will continue to deteriorate and confusion will increase.

Uses and Drawbacks of the Septic Tank

The problem of sewerage facilities for the rapidly developing, dispersed urban complex springing up around the population centers has no universally acceptable solution. The usefulness and the limitations of each method must be reviewed according to specific circumstances, and the method that can be financed and that shows the greatest promise as a permanent solution should be selected. There is danger in advocating one solution to the exclusion of all others. Conversely no usable solution should be discarded on the basis of experience arising from abuse or improper use of that solution.

The septic tank system, a term I am using to mean the method of on-lot disposal by soil absorption, can be satisfactory for individual homes in a developing suburban area. However, its use must be governed by a number of stringent conditions to avoid extremely unsatisfactory results. When properly used, the system has these advantages:

1. Sewage treatment is complete; the effluent is disposed of on each lot, and each home owner is responsible for his own system.

2. The method is compatible with both the pattern of construction in the United States and the requirements of health authorities.

3. Sufficient capacity to serve each home in a development is added as the house is built.

In general, the usefulness of the septic tank system decreases as the volume of sewage from the individual establishment to be served increases. This limitation is serious when schools, shopping centers, industries, and other larger installations are contemplated for the same general area as the housing. Even though septic tanks may be satisfactory for the individual houses, their use may thwart the construction of a unified sewerage system capable of serving the larger establishments.

The septic tank should never be used where conditions are improper for successful operation. Although frequently used as a temporary measure, the septic tank is actually a poor interim device. Septic tanks have often been permitted in soil where there was little, if any, chance for successful operation, on the assumption that adequate sewerage service would be provided as soon as the population density reached the point where it was practical. Theoretically the temporary use of septic tanks may appear attractive, but practical considerations work against the plan. Some of these considerations are:

1. Immediate failures create nuisances and public health hazards.

2. Many home owners, fearing the effect on property values, refuse to admit that failures are occurring, and do not support remedial action by a community.

3. Not all systems fail at the same time, and home owners who are not having trouble, or who have recently spent sizable sums to repair their systems, are reluctant to agree to community action.

4. There will always be resistance to bond issues and higher taxes. The expense and inconvenience of tearing up streets and lawns to install a community system stymies action until the need is critical.

5. The expense of installing a collection system in an established neighborhood is several times the cost of the same system in raw land.

Other methods of interim treatment to protect public health should be devised so that the collection system is installed when the houses are constructed, thus eliminating the inconvenience and double expense.

Conditions for Satisfactory Use

A septic tank can be used satisfactorily under certain conditions. These conditions have been reported in a number of technical publications and described in detail in the Manual of Septic Tank Practice (*3*). If recommendations for sewage systems were based on these conditions, the septic tank system would be rejected where it will not work, and complaints stemming from malfunctioning systems would be tremendously reduced. Almost equally important, a system installed under proper conditions which later fails due to misuse, lack of maintenance, or old age can be corrected at the home owner's expense.

Control by a strong, well-organized health department and a sound ordinance are essential to prevent abuses of this system. A good ordinance defines the soil conditions suitable for septic tanks, requires enough usable area on each lot for two complete disposal fields, empowers the proper authority to establish minimum requirements for both septic tank and disposal field, and requires an approved permit before construction starts, individual design and construction by competent, responsible, authorized parties, and a final inspection of the system before it is covered.

The regulation should set forth the soil prerequisites for use of a septic tank system. A reliable percolation test is time consuming and requires great attention to detail. Some health departments feel that the evaluation of land is not a government function but part of the engineering services to be borne by the developer. For this reason, a number of county departments require that every application for a septic tank permit be accompanied by a log of the subsoil and results of percolation tests performed under the direction of a licensed professional engineer or another equally responsible person.

The regulation should also specify the mini-

mum available area that must be provided on each lot for the disposal field. Generally, this is a better practice than specifying lot size; the shape of the lot, the location of the house and driveways, and undesirable terrain features often make it difficult, even on large lots, to find a suitable location for the absorption field. The areas reserved for the system should be large enough to replace the disposal field completely, if necessary.

At the county level, authority to issue septic tank permits is vested in the health department or the building department, but invariably complaints are handled by the health department. Where dual authority and responsibility exist, cooperation between the two departments is essential so that no permit is issued unless the soil conditions are satisfactory and the system is designed in accordance with the regulation.

Inspection is necessary to see that the system was constructed in accordance with the permit and that good construction practice was used. A builder has sometimes been required to remove tile and rock and rework trenches to remove smeared and sealed surfaces. It is necessary also to check the provisions for storm water runoff, the house sewer for stoppages, the tank inlet for clearance, and the distribution box for level, as well as the capacity and construction details of tank and disposal field. Most counties prefer to have their own man make the inspection. The system should be covered as soon as the inspection is completed to protect it from rain and accidental damage.

Important Factors

Soil is the most important natural factor, and the only uncontrollable one, governing the successful use of the septic tank system. To be useful for subsurface disposal of sewage from a large number of homes, an area must have at least 4 feet of cover between the bottom of the disposal field and rock or other restraining formation; the ground water table must be at least 4 feet below the surface of the ground; and the soil must have an acceptable, sustained percolation rate.

For isolated dwellings it may be possible to shade some of these requirements, but for subdivisions all of them must be met. Unfortunately, more than half of the soil in the United States is unsuitable. Furthermore, unsuitable soil is likely to be found on high ground desirable for house building, while suitable soil is likely to be in the bottom land desirable for agriculture. Because no practical method of improving soil for this purpose has been found, the wise builder has learned to make a preliminary investigation before purchasing a tract of land for housing development.

Design starts with the capacity of the system. As water consumption and modern appliances have increased, the concept of increased tank capacity has been readily accepted. Surprisingly, there is resistance, or at least apathy, to enlarging the absorption area even though it is the absorption field that ultimately disposes of the daily volume of liquid.

The relationship between soil area and life of the system is difficult to convey, but it exists nevertheless. Each year an increment of the available absorption area is exhausted and becomes useless for leaching. When the remaining area no longer absorbs the daily volume of liquid the system fails. A 3-bedroom modern house requires approximately 1,000 square feet of design area in a 60-minute soil. Few existing recommendations of local health departments meet that standard. Location, layout, grade, and details of construction are also essential to good design, and for the most part are adequately covered in present recommendations.

Careful construction is as important as good soil. Good construction cannot improve the soil, but good soil can be ruined by poor construction. Within my experience, most early failures of well-designed systems in good soil can be traced to improper construction. Perhaps the worst offense is working the soil when it is too wet. Surfaces are smeared and effectively sealed before any sewage is applied to the system. Walking or working on the absorption surface will compact and seal it prematurely. Raking the sides and bottom of the trench after the soil is relatively dry, and removing all loose rakings before the gravel is laid in the trench is strongly recommended.

Another common fault is to set the distribution box so that most of the liquid goes to one trench. This practice is especially serious and

always leads to failure on sloping ground where the overloaded trench can be relieved only through surface seepage. Occasionally, the box is set correctly and later disturbed by a truck or other piece of heavy equipment running over it.

Open trenches are seldom protected from rainstorms, and surface water loaded with silt is permitted to run into them. Another fault is to permit roof drainage to run over the ground above the disposal field. Wet weather failures can often be traced to this cause. An assortment of articles including tools, rags, lunches, and gloves have been left in house sewers. A frequent mistake is to set the septic tank backwards. The inlet baffle is sometimes broken off, or only a narrow crack is left for sewage to pass through when the house sewer is pushed too far into the tank. The list of construction deficiencies can run into a full scale treatise, but fortunately, installation techniques have improved tremendously in the past few years and are continuing to improve.

Proper use of the system is essential to long and trouble-free operation. Even with good soil, correct design, and proper construction, the home owner can misuse his system and cause it to fail. Using water wastefully or adding appliances can overload the system. Maintenance is simple but essential for a long period of efficient performance. The tank should be inspected annually and cleaned before sludge reaches the level where it is carried to the disposal field and damages the soil. On a lot of sufficient size with the septic tank located properly, failures due to abuse of the system can be corrected by installing a new disposal field. This is of course expensive, and when the home owner is informed of the dangers of abuse and the expense of installing a new disposal field, he is usually very cooperative about proper maintenance of the system.

Summary

The population of the United States is increasing at a rate far in excess of that predicted as late as 1946. Substantially all of the increase is being absorbed in the fringes of the standard metropolitan areas. The growth and decentralization of metropolitan areas is not a passing phase, but rather a major population trend that will continue for many years. The construction of new housing in undeveloped areas creates a problem of sewage disposal of a complexity and magnitude never before faced by the sanitary engineering profession.

The change in community development from the tightly knit parent city of 20 years ago to the sprawling urban complex of today calls for reorientation of plans, philosophy, and techniques if costly errors are to be avoided. The usefulness and limitations of each method of sewage disposal should be reviewed in the light of specific circumstances, and the method that can be financed and that shows the greatest promise as a permanent solution should be selected.

The septic tank system can be a satisfactory means for disposal of sewage from individual houses in a developing suburban area, but its use is subject to a number of stringent conditions if extremely unsatisfactory results are to be avoided. The septic tank is a poor temporary measure, and it should never be used when conditions prohibit its successful operation. In general, the usefulness of the septic tank system decreases as the size of the individual establishment it is to serve increases.

The essential conditions for the satisfactory use of the septic tank system are effective regulation and control, suitable soil, and proper design, construction, and use. Sufficient area should be provided on each lot for replacing the absorption system in case of failure.

REFERENCES

(1) U. S. Housing and Home Finance Agency: Housing in the United States. Washington, D. C., U. S. Government Printing Office, 1956.

(2) Bollens, John C.: The States and the metropolitan problem, a report to the governors' conference. Chicago, Council of State Governments, 1956.

(3) U. S. Public Health Service: Manual of septic tank practice. Public Health Service Pub. No. 526. Washington, D. C., U. S. Government Printing Office, 1957.