An introduction to

COMMUNAL SEWAGE SYSTEMS

PIBS # 3326E

Ontario

Ministry of Environment and Energy

CONTENTS

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An introduction to

COMMUNAL SEWAGE SYSTEMS

The problem

In its concern for the protection of the environment, the Ministry of Environment and Energy (MOEE) is encouraging the installation of communal sewage systems in areas where municipal water and sewage facilities are not available.

In the ministry's experience, subdivision developments on communal sewage services are likely to result in a greater degree of environmental protection than those where each lot is serviced by an individual on-site (i.e. subsurface) sewage system: more sophisticated sewage treatment processes may be employed and more effective monitoring of the effluent is possible.

MOEE's document *Planning for Sewage and Water Services* contains a list of basic servicing alternatives, set out in the following order of preference:

(1) Development on full municipal services - the preferred mode of servicing;

(2) Communal sewage and water services in areas lacking full municipal services;

(3) Individual on-site sewage and water services where developments are limited, of small scale and low density.

What are communal sewage systems?

Communal sewage systems are shared facilities for the collection, treatment and disposal of sewage. In principle they are the same as full municipal services (on which 80 per cent of Ontario's population depend), in that all the lots in a development are connected by sewers to central sewage treatment and disposal facilities. They are generally of small to moderate size, and are often constructed by the developer as an integral part of the development. They are physically separate from and not connected to full municipal services, which have large centralized sewage treatment facilities and may serve entire municipalities.

Developments served by communal services are normally residential (for instance houses or cottages), but may also be institutional, commercial or industrial. The MOEE document *Planning for Sewage and Water Services* defines communal systems as those serving more than five units in a total development area.

Figs. 1-4 illustrate the general concept of communal services, compared to individual on-site systems and conventional full municipal servicing. Examples of alternative technologies available for communal sewage systems are illustrated later in this publication.

MOEE approvals

Communal sewage works and systems are subject to approval by MOEE (or its agents) under Part VIII of the *Environmental Protection Act* (*EPA*) where sewage disposal into the ground is concerned, or under Section 53 of the *Ontario Water Resources Act* (*OWRA*) where disposal of sewage, after treatment, is to surface water or on to the surface of the ground.

Certain communal sewage systems are also subject to the *Municipal Engineers Association Class Environmental Assessment for Water and Wastewater Projects*, under the *Environmental Assessment Act (EAA)*. Exact requirements are dependent on the technology involved, as well as who is the proponent of the project.

GENERAL CONCEPT OF COMMUNAL SERVICES

Figures 1 to 4 compare communal services with individual on-site systems and conventional full municipal servicing.

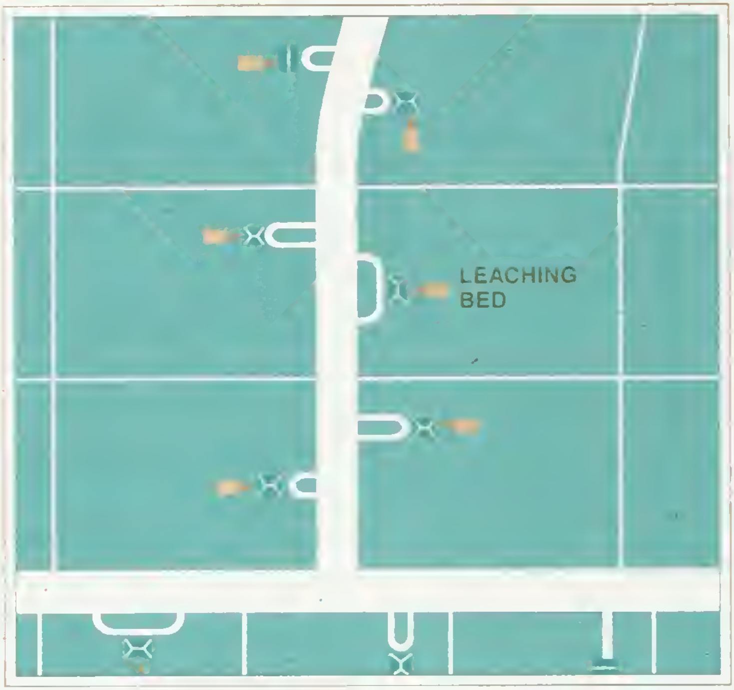


FIGURE 1

INDIVIDUAL ON-SITE SYSTEMS

Large lots, low density.

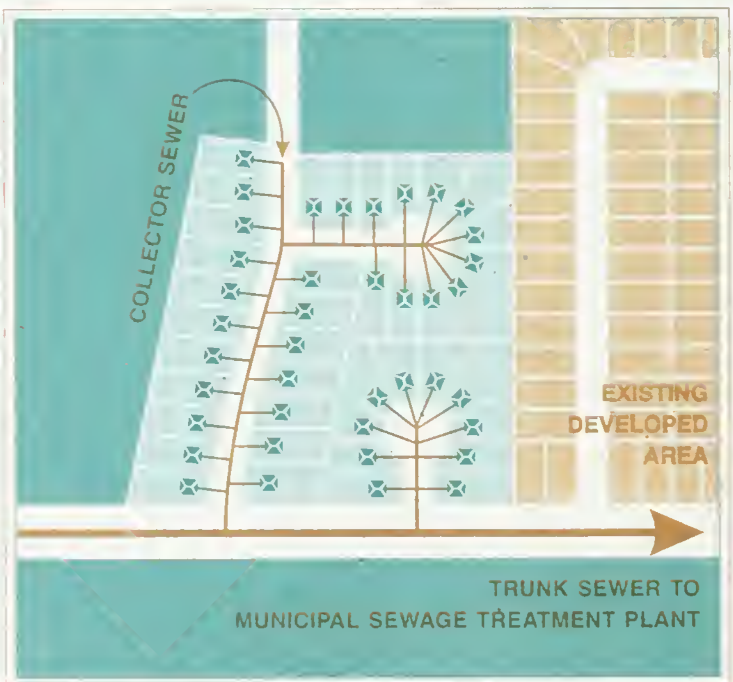


FIGURE 2

CONVENTIONAL MUNICIPAL SERVICING

Small lots, higher density.

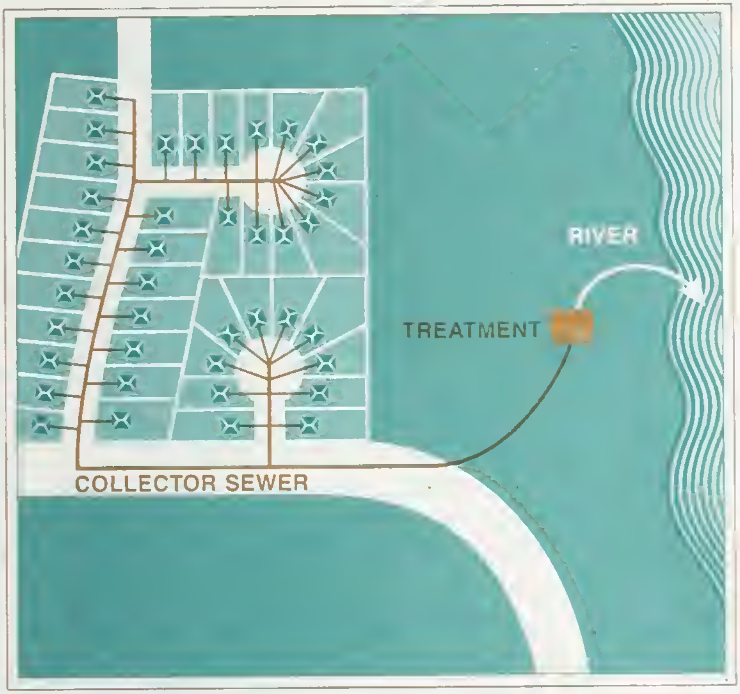


FIGURE 3

COMMUNAL (SURFACE DISPOSAL)

Small lots, higher density. Discharges to river after treatment in mechanical plant.

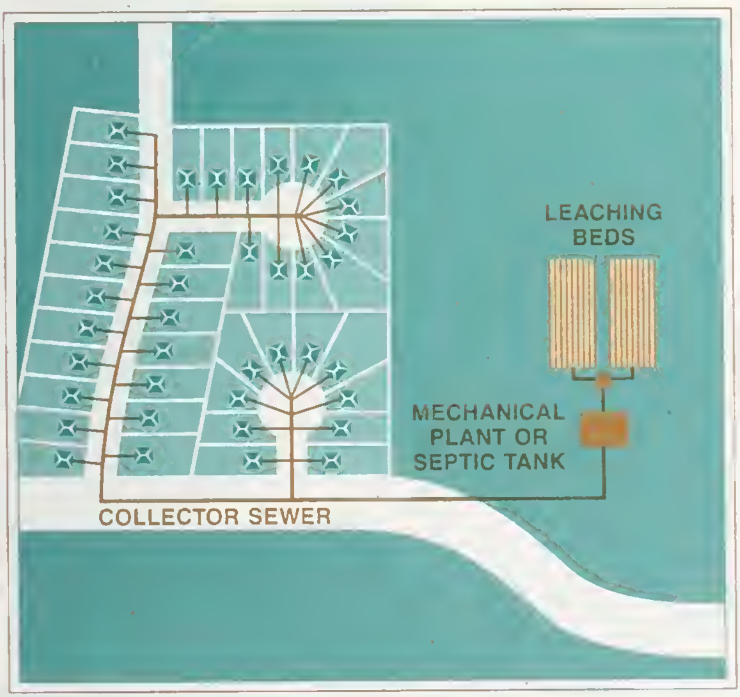


FIGURE 4

COMMUNAL (SUBSURFACE DISPOSAL)

Small lots, higher density. Discharges to mechanical plant or septic tank, then to leaching beds.

ADVANTAGES OF COMMUNAL SYSTEMS AS COMPARED WITH INDIVIDUAL ON-SITE SYSTEMS

- Lots serviced by communal systems can be smaller than those served by individual on-site systems (i.e. septic tanks and leaching beds).

The technical requirements for developments on individual on-site sewage systems are, in part, set out in *EPA* (Part VIII), and its accompanying Regulation 358, and in MOEE's *Manual of Policy, Procedures and Guidelines for On-site Sewage Disposal Systems*. On each lot an extra area should be set aside for a replacement leaching bed in case the original bed should fail. MOEE's *Technical Guideline for Individual On-site Sewage Systems: Water Quality Impact Risk Assessment* includes a procedure for determining the impact on ground water quality of individual on-site sewage systems. The results of this procedure may be the controlling factor in deciding on the density of development, which is likely to be lower than that for communal systems where lots of 300 to 400 square metres or smaller may be used.

- The use of communal sewage treatment and disposal systems allows for better protection of the environment and public health. Communal systems can employ more sophisticated sewage (and water) treatment processes than would be practical for small individual on-site sewage systems, taking into account the technical skills required for operation and maintenance (which are not usually available for individual on-site systems), as well as the costs.

Regularly and professionally maintained communal systems are likely to have fewer malfunctions and longer lives than individual on-site systems. The number of communal treatment plants needed for any one development would be far fewer than the number of individual on-site systems needed for the same development. The operation and maintenance would be easier to arrange. Also, once communal systems receive regular maintenance, it is easier to evaluate their performance, monitor their environmental impact and remedy any potential problems.

The more compact development possible with the use of communal services is consistent with provincial objectives for more concentrated land use[1]. Communal services provide a viable alternative to scattered, low density sprawl and thus help to preserve areas of natural environmental significance and agricultural lands.

Municipal services such as road maintenance, snow clearing, garbage collection, police and fire services, maintenance of water, electric and gas services, transit and school buses can be provided in a more efficient - and energy efficient - manner, when development is laid out compactly. Costs for these compact services are likely to be lower than for scattered developments.

In comparing developments on communal systems with those which have the same number of lots but are on individual on-site systems, there are potential savings on the length, and therefore the cost of other services such as water supply and electricity lines, as well as on land costs. This is because density of development can be higher for the former than for the latter.

Communal servicing allows for a multi-lot development to be easily connected to or incorporated into centralized municipal services, if this should become desirable or necessary.

(1) See also the Ministry of Municipal Affairs *Policy Guidelines for Growth and Settlement* and the Ministry of Agriculture, Food and Rural Affairs' *Food Land Guidelines*.

SEWAGE SYSTEMS

Introduction

The two main structural elements of a communal system (and also of a full-scale municipal system) are the treatment/disposal facility (where the sewage is treated and discharged) and the collector system (that is, the sewers which serve every unit of the development). Designers can choose from a number of collection and sewage treatment technologies, some of which are described below.

The effluent from sewage treatment facilities is discharged either to a receiving body of surface water such as a river or lake, on to the surface of the ground, or into the subsurface (i.e. below the surface, usually by means of a leaching bed).

Here are some examples of environmental constraints and how they may affect the choice of systems used. The type of soil: certain types of soil are likely to be very suitable for subsurface leaching beds, while others may not be suitable or may require special provisions such as expensive raised beds. The topography: this may influence the choice of collection system and location of the sewage treatment facility. Surface water: an adjacent river or other water body may have sufficient assimilative capacity for treated sewage to be discharged into it, which will influence the choice of options for sewage treatment. Location, existing quality and depth of groundwater: this will influence the choice and location of sewage treatment facilities (as well as, of course, the water supply). Availability of land: a sewage lagoon will normally require more land for both the lagoon itself and the separation distance from housing. Characteristics of sewage expected: variations (or lack of variations) in sewage strength and rates of flow may affect the choice of sewage treatment system.

It must be emphasized that, because of the number of variables, there is no one recommended system, no technical "black box", which can be applied to all projects. Each system must be designed and tailored to fit the particular situation. Therefore, competent professional advice should be obtained.

The best approach to designing communal sewage systems is first to identify the environmental constraints of the site or the receiving body of water (surface water or ground water), which will dictate both the type and degree of treatment, based on the quality of effluent which must be attained. Requirements for licensing, operating skill and maintenance may also affect the choice of technologies.

There is no "rule of thumb" for estimating the capital costs of communal services, which vary greatly, depending on the size and type of development, environmental constraints and the method of sewage collection, treatment and effluent discharge. The capital costs of servicing a lot (exclusive of land costs) are often comparable to, or less than, that for development based on individual on-site systems.

Sewage treatment facilities

Treatment systems may have one, two or three levels of treatment, known as primary, secondary and tertiary treatment. This depends on environmental requirements.

- Primary treatment usually provides screening and physical settling of the sewage to remove large solids, grit, grease, etc. from the sewage. This may be by means of screens, settling tanks and/or septic tanks.
- Secondary treatment generally involves the use of aerobic biological treatment, i.e. processes employing organisms which require oxygen in order to function.
- Tertiary treatment allows a greater degree of treatment. Typical tertiary treatment plants may include supplementary chemical addition and have effluent filters (following secondary treatment) and nitrification/denitrification (i.e. nitrate removal).

The following are some examples of sewage treatment facilities suitable for communal systems; this is not an exhaustive list. Such sewage treatment facilities may be combined in different ways; for example, mechanical systems may discharge into constructed wetlands.

Figs. 5 to 10 illustrate the general concepts of some of these sewage treatment facilities.

- **CONVENTIONAL COMMUNAL SEPTIC TANKS** discharging into (usually several) large leaching beds. Depending on the site constraints, supplementary treatment may improve the quality of the effluent.

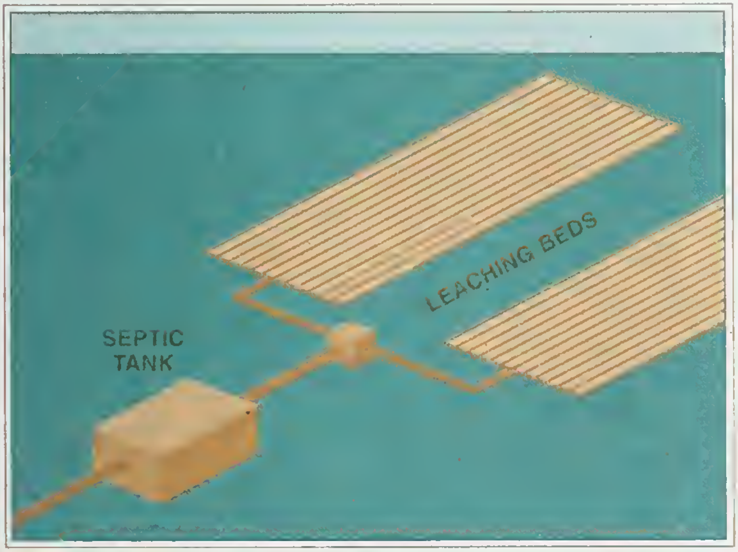


FIGURE 5

CONVENTIONAL SEPTIC TANK AND LEACHING BEDS

ACTIVATED SLUDGE PROCESSES: These are more sophisticated systems requiring frequent and skilled supervision.

Activated sludge including extended aeration systems feature separate tanks for the aeration and the settlement of solids from the sewage. Aeration means the introduction of oxygen in order to support the biological process of sewage treatment. Some of the sludge produced is recycled within the system, in order to maintain the treatment process. The treated sewage may be suitable for discharge either to a receiving stream (after filtration and disinfection) or to leaching beds. Excess waste sludge must also be disposed of.

Rotating biological contactors (RBCs) are mechanical systems which consist essentially of a series of discs, rotating within a partially filled tank, allowing the sewage to be aerated. The effluent is discharged either to surface water (in

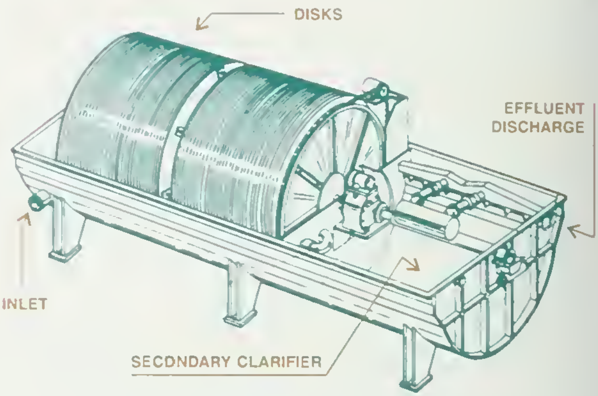


FIGURE 7a

ROTATING BIOLOGICAL CONTACTOR (RBC)

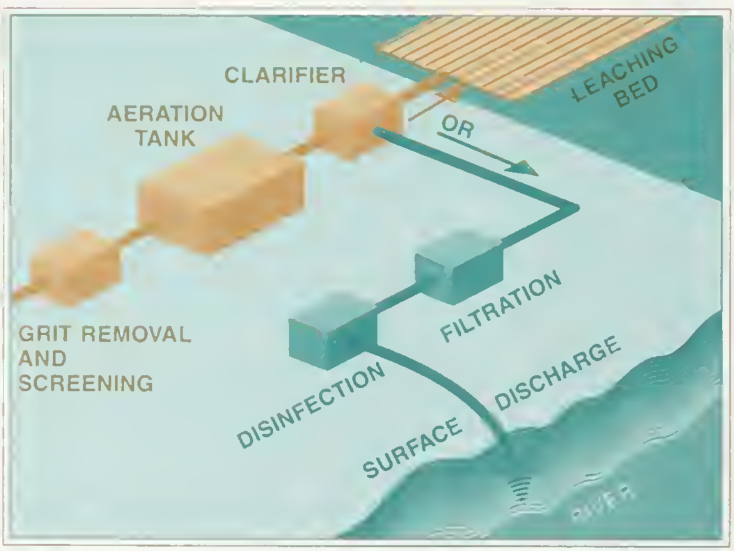


FIGURE 6

ACTIVATED SLUDGE SYSTEM: EXTENDED AERATION SYSTEM

Shows alternatives of subsurface and surface discharge to river.

which case disinfection, normally by chlorination, is required), or subsurface (i.e. to leaching beds). Such treatment units may be modified to achieve significant denitrification.

Sequencing batch reactors do not require separate tanks for aeration and clarification of the sewage: all phases of treatment occur sequentially in the same tank. There are usually two such tanks. The treated sewage may be suitable for discharge either to a receiving stream (after disinfection) or to leaching beds.

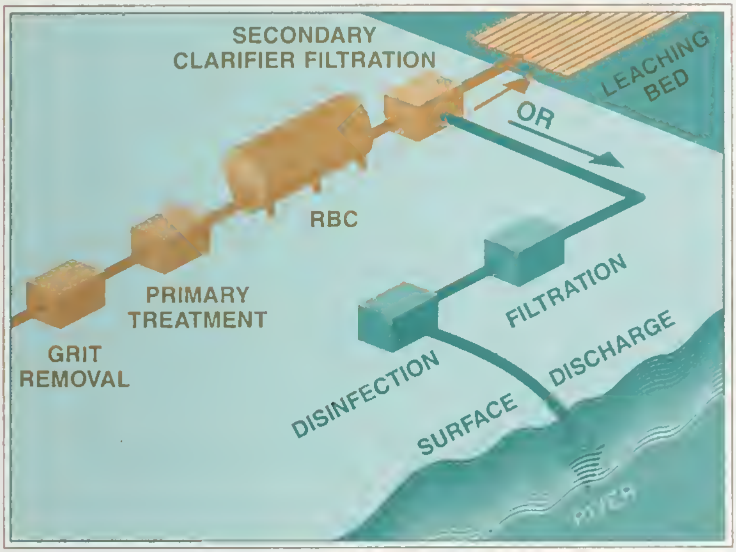


FIGURE 7b

ACTIVATED SLUDGE SYSTEM: ROTATING BIOLOGICAL CONTACTOR (RBC)

Shows alternatives of subsurface and surface discharge to river.

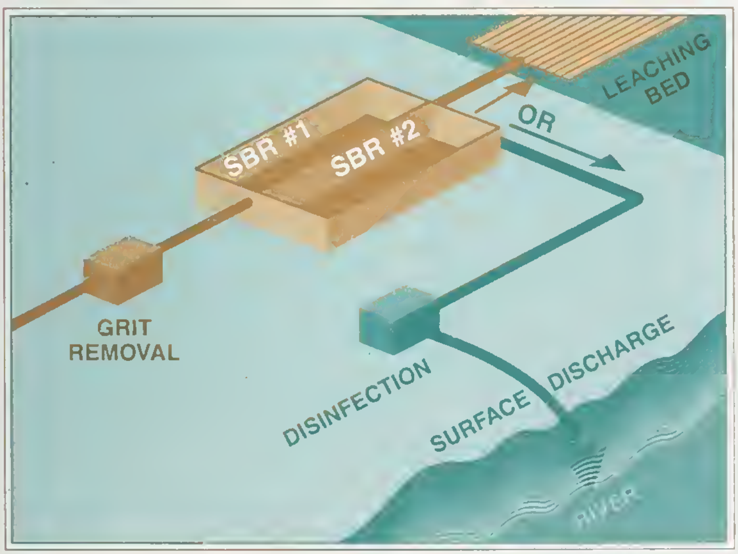


FIGURE 8

ACTIVATED SLUDGE SYSTEM: SEQUENCING BATCH REACTOR (SBR)

Shows alternatives of subsurface and surface discharge to river.

WASTE STABILIZATION PONDS, commonly known as lagoons, are large artificial ponds which rely on aeration, either by natural or mechanical means. They are watertight and the effluent is normally disposed of continuously or periodically throughout the year by pumping to adjacent surface water, such as a river or lake, or by spray irrigation (i.e. spraying it over the surface of adjacent land).

NATURAL OR CONSTRUCTED WETLANDS OR PONDS may be used for supplementary tertiary treatment for the final disposal of the effluent. There are a variety of such systems which rely on natural processes, including aquatic plant life, to help purify the sewage effluent.

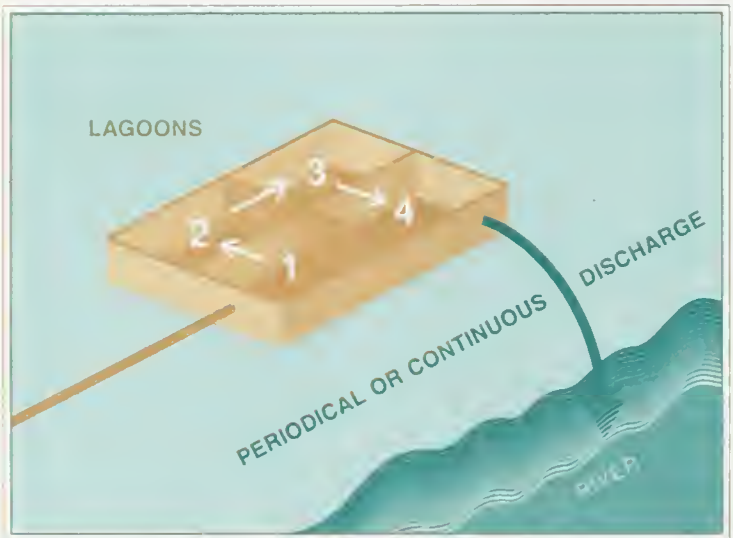


FIGURE 9

WASTE STABILIZATION PONDS (LAGOONS)

Shown discharging to river.

RECIRCULATING SAND FILTER SYSTEMS feature conventional septic tanks, sand filters and conventional leaching beds.

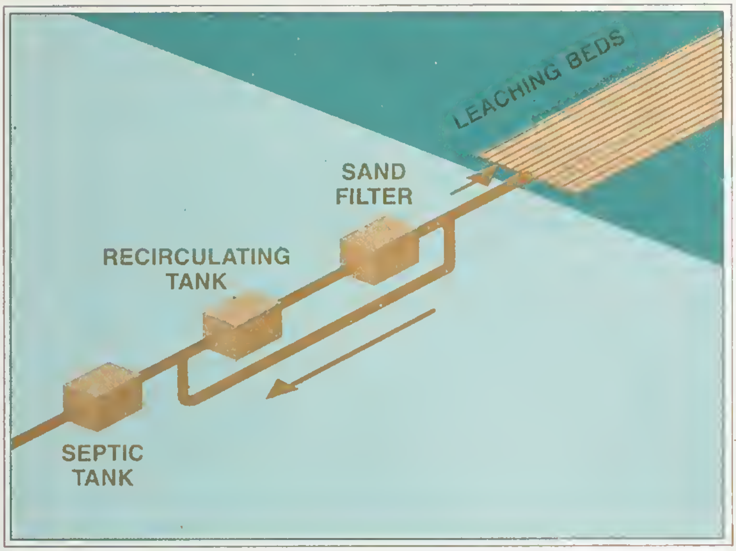


FIGURE 10

RECIRCULATING SAND FILTER

Collection Systems (Sewers)

Figs. 11 to 14 illustrate the general concepts of some of these collection systems.

The collector sewer system represents a significant percentage of the total cost of a communal sewage system (including treatment), ranging anywhere between 15 per cent and 50 per cent, depending on location, site conditions, type of layout, etc.

As with sewage treatment systems, the choice of technology will be entirely dependent on the particular conditions of the project and site, taking into account the environmental constraints and cost.

The following are some technologies for sewer collection systems.

CONVENTIONAL GRAVITY SEWERS, which require all pipes to be laid at a continuous downward gradient. In certain situations, this may result in trenches becoming progressively deeper, and thus more expensive to construct, unless pumping stations are constructed at intervals to lift the sewage up closer to ground level.

The use of "alternative" collector technologies, such as those listed below, rather than conventional technology, may result in savings, again depending on site conditions, layout, etc.

PRESSURE SEWER SYSTEMS, as their name implies, are under pressure. This allows pipes to be of smaller diameter, and trenches to be of uniform depth, since the sewers are not dependent on gravity and may follow the "lie of the land".

◗ **The grinder pumping (GP) system** usually has an individual sewage holding tank and pumping system on each lot. The sewage is ground up and pumped, via a communal pressure sewer, to the treatment plant.

◗ **The septic tank effluent pumping (STEP) system** has a two-compartment septic tank on each lot, which has the effect of settling out the solids in the sewage before it is pumped to the treatment facility.

FIGURE 11

GRINDER PUMP (GP) SYSTEM

Unit grinds sewage which is then pumped under pressure through small diameter sewers to treatment and disposal.

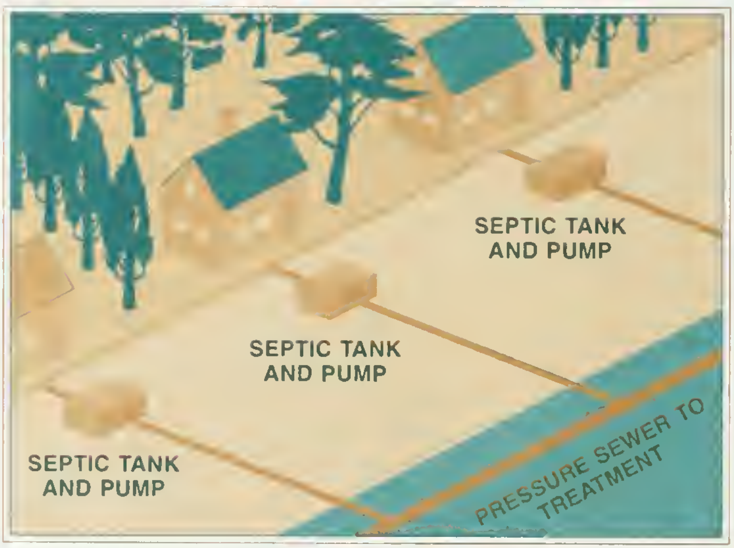


FIGURE 12

SEPTIC TANK EFFLUENT PUMP (STEP) SYSTEM

Sewage from individual septic tanks flows to pumping tank. Sewage is then pumped under pressure to treatment and disposal.

SMALL DIAMETER VARIABLE GRADE SEWERS are similar to the STEP system, except that they are not under pressure, and each lot has a two-compartment septic tank which removes some solids from the sewage. Therefore, they can be designed with small diameter pipes and reduced slopes (and may even go uphill over short sections).

VACUUM SEWER SYSTEMS have a vacuum-assisted flow. This again results in smaller pipes, and uniform depth of sewer trenches, thus saving on excavation costs.

FIGURE 13

SMALL DIAMETER VARIABLE GRADE SEWERS

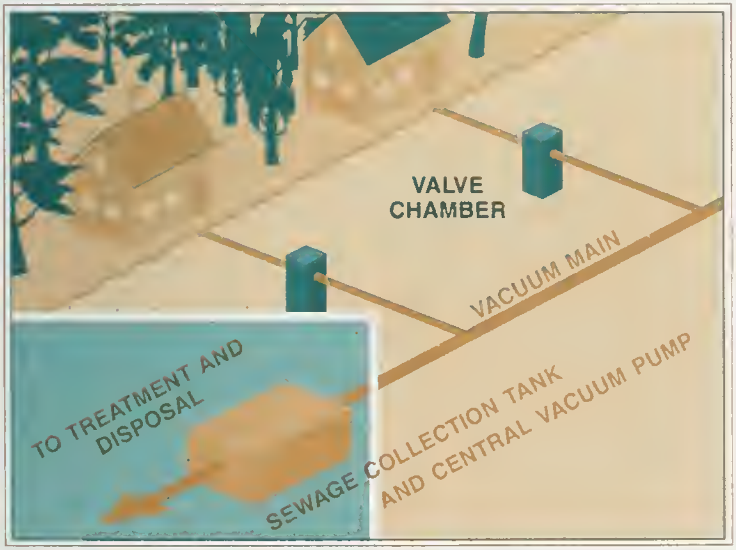


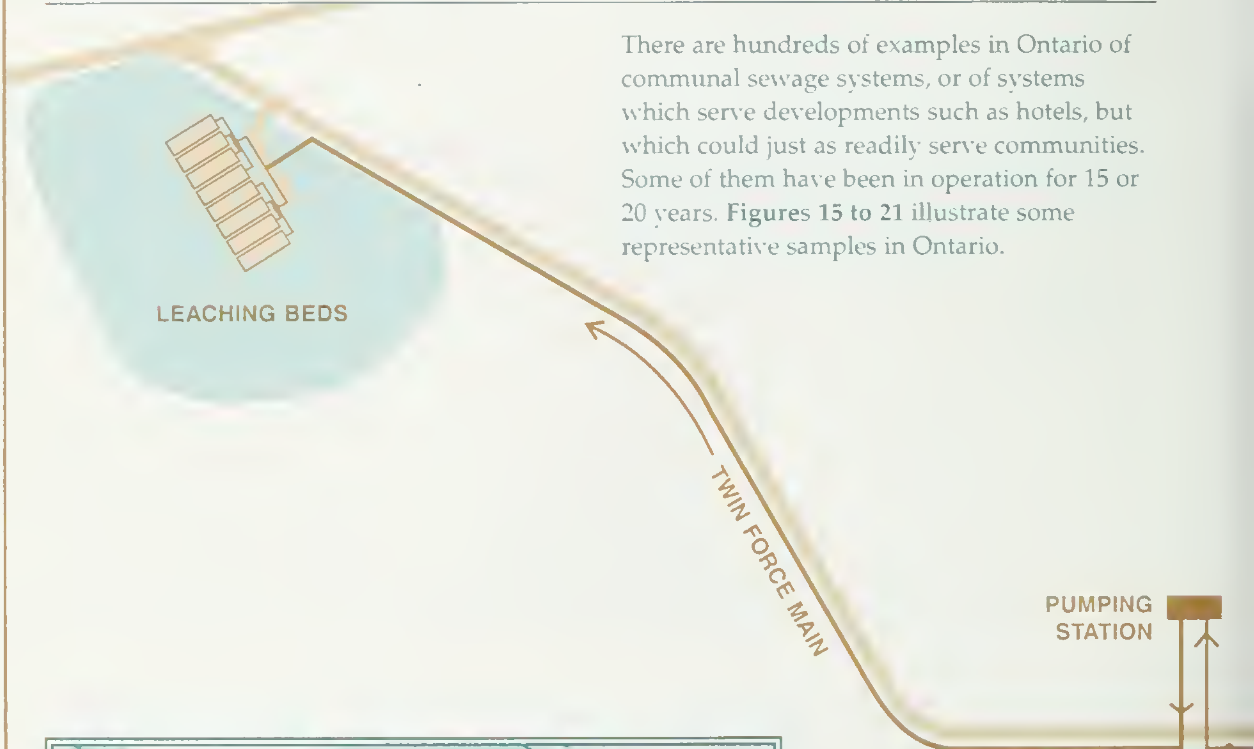
FIGURE 14

VACUUM SEWER SYSTEM

Vacuum forces sewage to collection tank; from there it goes to treatment and disposal.

EXAMPLES OF COMMUNAL SYSTEMS IN ONTARIO

There are hundreds of examples in Ontario of communal sewage systems, or of systems which serve developments such as hotels, but which could just as readily serve communities. Some of them have been in operation for 15 or 20 years. **Figures 15 to 21** illustrate some representative samples in Ontario.



COMMUNITY, I.D. GAUTHIER

STEP system:
storage tank / pump chamber
(see figure 16)

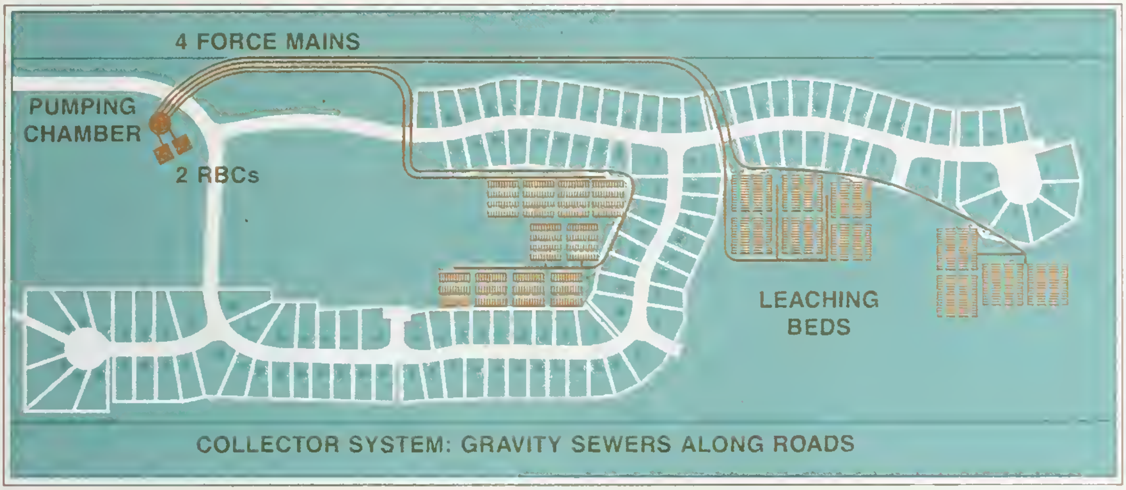


FIGURE 15

DEVELOPMENT, WILMOT TWP.

FIGURE 16

COMMUNITY, I.D. GAUTHIER

Existing community, originally on individual on-site systems, retrofitted to STEP system.

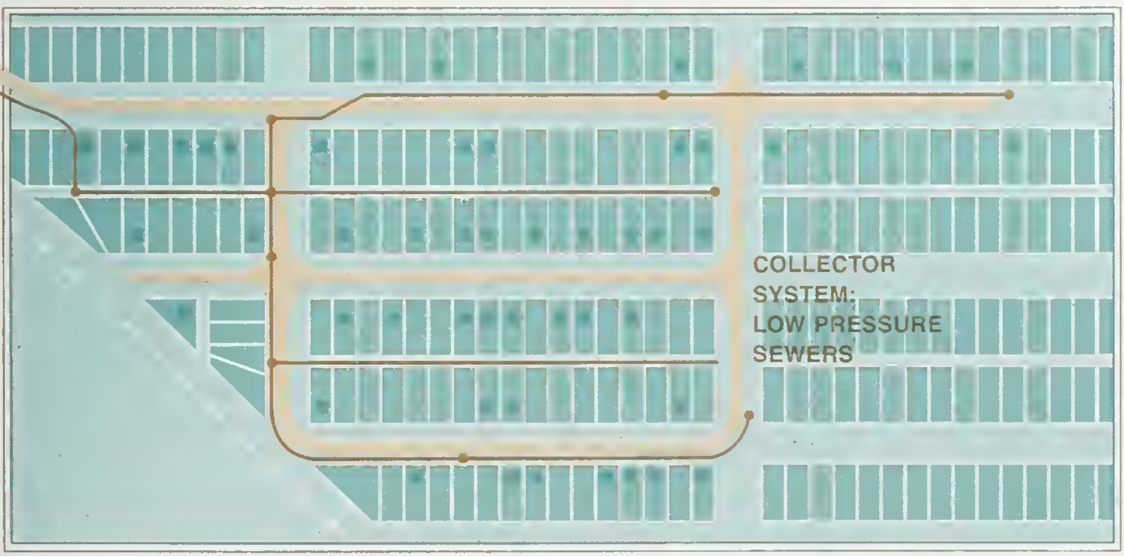
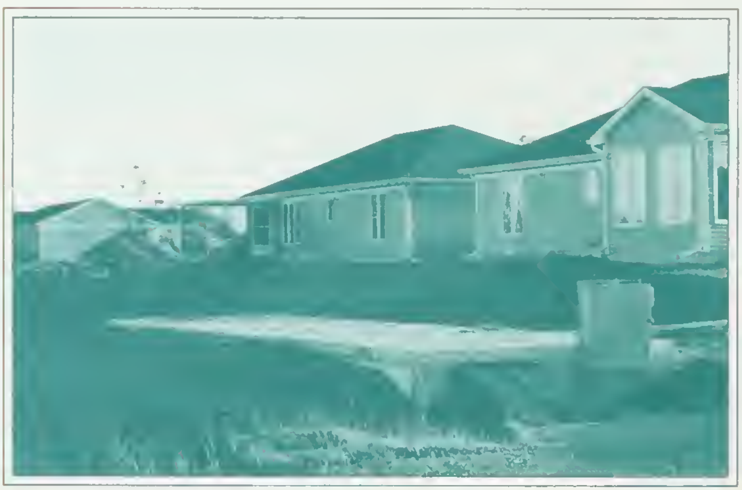


FIGURE 17

DEVELOPMENT, WEST GARAFRAXA TWP



DEVELOPMENT, WEST GARAFRAXA TWP

(see figure 17)

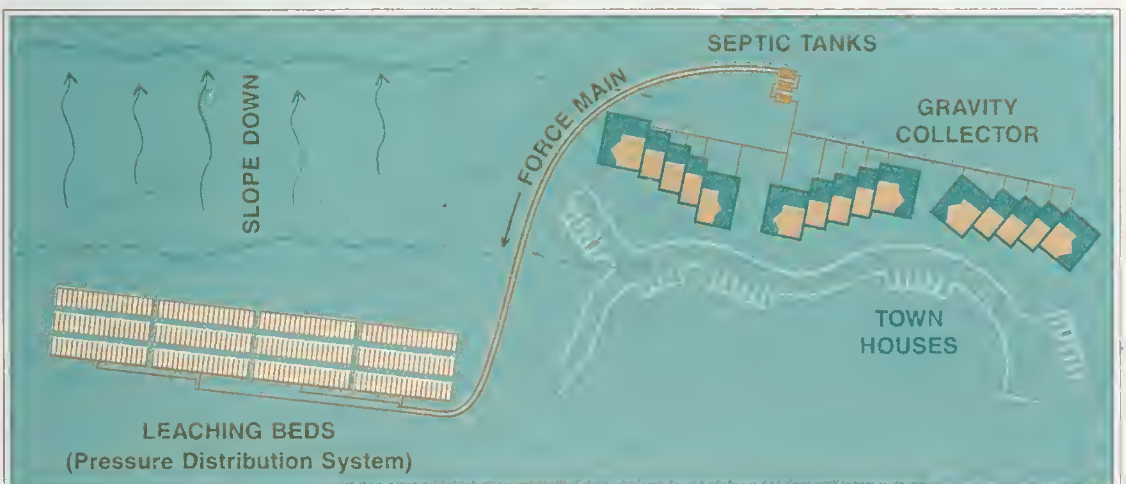
FIGURE 18

RESORT, MATCHEDASH TWP

FIGURE 19

COUNTRY CLUB, NOTTAWASAGA TWP

15 town houses



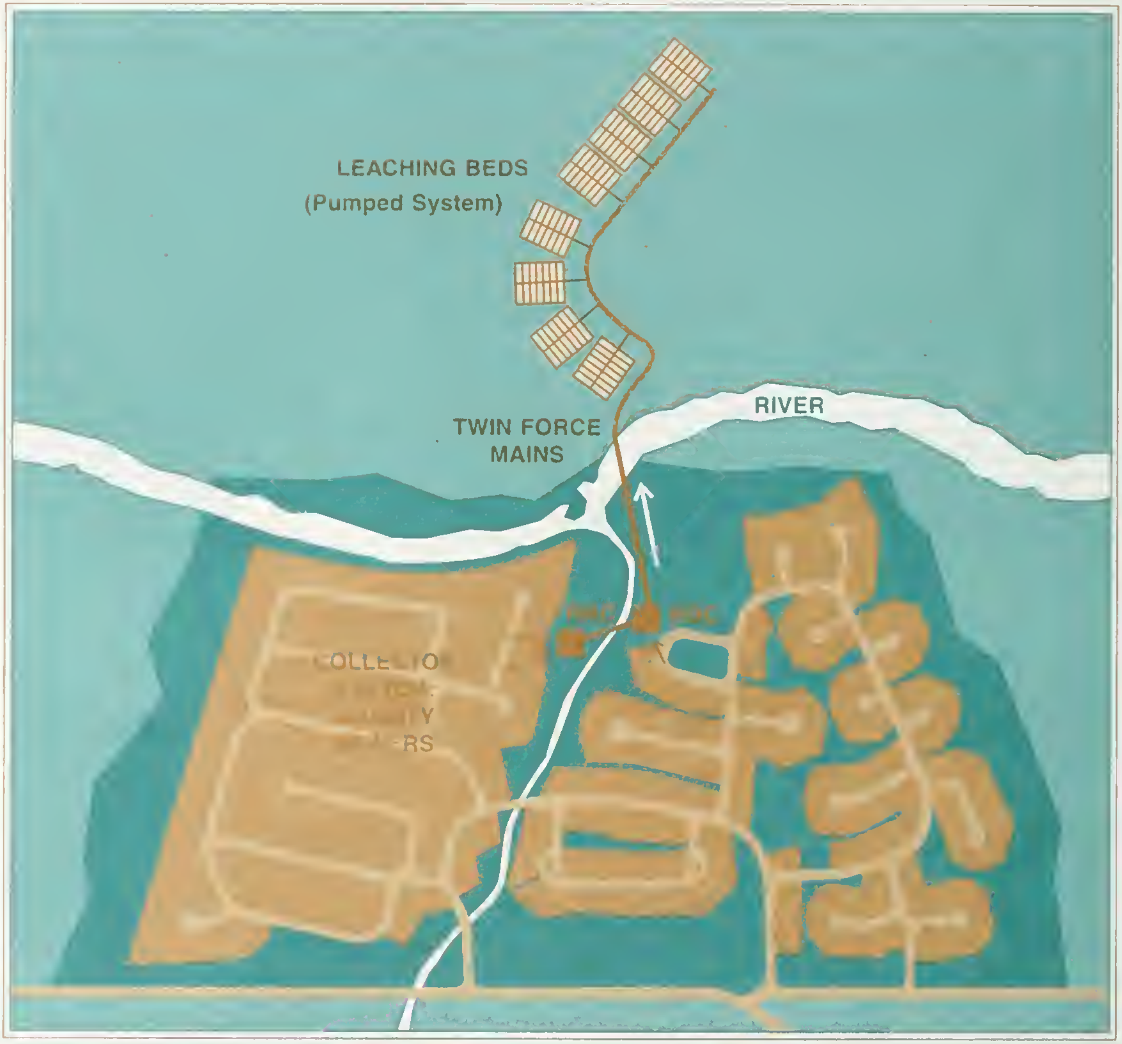


FIGURE 20

DEVELOPMENT, WILMOT TWP

Mechanical plant (RBC)

DEVELOPMENT, WILMOT TWP

(see figure 20)

General view

FIGURE 21

DEVELOPMENT,
TOWN OF NEW TECUMSETH

DEVELOPMENT, TOWN OF NEW TECUMSETH

Mechanical Plant.
Extended aeration system with lagoon (not shown).
(see figure 21)

Aerial view

OWNERSHIP, OPERATION AND MAINTENANCE

It is the ministry's position that the ownership, operation and maintenance of communal sewage and water services should be a municipal responsibility, preferably through ownership. If municipal ownership cannot be arranged, the ministry will request that the developer and the municipality enter into a Responsibility Agreement. Where the development is freehold (i.e. each unit is owned outright by the individual owner), the ministry will consider only municipal ownership, operation and maintenance.

A Responsibility Agreement is a legal agreement which defines the conditions under which communal services will be constructed, operated and maintained, as well as what the municipality will do in cases where the services are not being operated or maintained properly, and/or the operator is unable, or unwilling, to comply with ministry standards. The Responsibility Agreement includes provisions for financial assurance, so that if in the future the municipality has to take over the communal services, it will have access to finances previously set aside by the developer for this purpose.

MOEE policy on ownership, operation and maintenance is set out in the ministry's document *Planning for Sewage and Water Services, Appendix B: Application of Municipal Responsibility for Communal Water and Sewage Services*. Reg. 435/93, under *OWRA*, states that sewage works to which section 53 of that act applies (i.e. they discharge treated sewage to surface), require the services of a licenced operator. Where privately-owned sewage works are concerned, this will be the case when the sewage is primarily of domestic origin. Whether the licenced operator is full-time or not will depend on the particular circumstances.

CONCLUSIONS

- Experience has shown that developments on communal sewage services are likely to result in a greater degree of environmental protection than those where each lot is serviced by an individual on-site sewage system.

- Therefore, where development on full municipal services is not possible, MOEE encourages development on communal sewage systems, rather than on individual systems (unless lots are very large).

- Communal sewage systems have many advantages, including:

  - ✔ They allow for better protection of the environment and public health than individual systems.
  - ✔ Lots serviced by communal systems may be 300 to 400 square metres or less in area, and therefore likely to be substantially smaller than those for individual on-site systems.
  - ✔ They result in more compact development, which is consistent with provincial objectives for more concentrated land use in order to preserve resources.
  - ✔ There are potential savings for developers, owners and municipalities on first cost and/or maintenance/replacement as compared with developments on individual on-site systems.

- There is a variety of sewage treatment and collection systems. The choice of sewage treatment system depends on the quality and quantity of incoming sewage and on the quality of effluent which must be attained; hence the type and degree of treatment will be dictated by the environmental constraints of the location where it is to be discharged. **There is no one recommended type of sewage system - each project must be designed and tailored to fit the particular situation.**

FOR MORE INFORMATION

For systems which discharge effluent to leaching beds only: get in touch with the authority which administers approval under Part VIII of the *Environmental Protection Act*, normally the local Health Unit, or in some cases the Conservation Authority. MOEE regional offices listed below will be able to advise on addresses and telephone numbers. In a few areas, the MOEE district offices (which report to the regional offices) carry out the Part VIII *Environmental Protection Act* function.

For systems which discharge effluent to surface (either water or land), get in touch with MOEE regional offices (listed below) for preliminary discussions prior to submission for approval under Section 53 of *OWRA*. Formal applications for approval under *OWRA* are dealt with by:

- Approvals Branch
  250 Davisville Ave., 3rd Floor
  Toronto, Ontario M4S 1H2
  Telephone number: (416) 440-3713

Information on *EAA* is available from:

- Environmental Assessment Branch
  250 Davisville Ave., 5th Floor
  Toronto, Ontario M4S 1H2
  Telephone number: (416) 440-3450

MOEE Regional Offices

Northern Region
P.O. Box 5000
435 James St. S., 3rd Floor
Thunder Bay, Ontario P7C 5G6
(807) 475-1205

Mid Ontario Region
199 Larch St., 11th Floor
Sudbury, Ontario P3E 5P9
(705) 675-4501

Southwestern Region
985 Adelaide St., S.
London, Ontario N6E 1V3
(519) 661-2200

West Central Region
P.O. Box 2112
119 King St., W., 12th Floor
Hamilton, Ontario L8N 3Z9
(416) 521-7640

Central Region
7 Overlea Blvd., 4th Floor
Toronto, Ontario M4H 1A8
(416) 424-3000

Eastern Region
133 Dalton St.
Box 820 Kingston, Ontario K7L 4X6
(613) 549-4000

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- *Alternative Wastewater Collection Systems Manual*. 1991
- *Wastewater Treatment/Disposal for Small Communities Manual*. 1992
- *Alternative Systems for Small Communities and Rural Areas*. 1985

The Water Environment Federation (US), the National Small Flows Clearinghouse (US), the American Society of Agricultural Engineers and the Great Lakes - Upper Mississippi River Board of State Public Health and Environmental Managers, have all published design manuals, handbooks, operational experience reports, seminar proceedings, etc.

COMMUNAL SEWAGE SYSTEMS

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