United States
Environmental Protection
Agency

Office of Water
Program Operations (WH-595)
Washington DC 20460

October 1979

FRD-9

EPA

Determining Wastewater Treatment Costs for Your Community

430979507

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Determining Wastewater
Treatment Costs for
Your Community

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INTRODUCTION

Public Law 95-217, The Clean Water Act of 1977, has mandated the nation's waters must be protected from pollution and existing pollution levels must be reduced. One of the provisions of the Act is to assist municipalities and other public dischargers of waste with the financial burden of necessary construction of the pollution control facilities. In most cases, the Federal government will contribute 75 percent of the construction costs while the local share will be 25 percent.

In addition, EPA encourages small treatment systems and innovative and alternative treatment systems; because they often are less costly than traditional treatment methods, resulting in cost savings to both the community and EPA. Innovative and alternative treatment systems can receive up to 85 percent Federal funding.

In order to choose the most viable approach for wastewater treatment, it is important that communities have a general idea of the potential costs as they begin the planning process. The U.S. Environmental Protection Agency (EPA) is providing this brochure to assist you and your community in determining the approximate cost of building and operating a municipal wastewater collection and treatment system. The brochure has been developed for facilities serving less than 50,000 people.

We have developed the cost to your community, which is "average" for the population served. The data from which these estimates were derived are from national averages. Costs in your locality will probably vary from these averages due to regional economic differences, climate, terrain, and other factors. Before outlining this general cost information, it is necessary to present background information on wastewater collection and treatment, as well as some of the assumptions used to arrive at these national averages.

WHY TREAT WASTEWATER

Water has long been used to transport unwanted materials away from our homes, businesses, and industries. About 26 billion gallons of wastewater are generated in the U.S. daily. The wastewater is composed of organic compounds from plants, animals, and humans; and inorganic compounds from household activities, industrial proceses, and commercial practices. These wastes take the form of particles suspended in the water, commonly called Suspended Solids (SS) or wastes that are dissolved in the water. Suspended solids can harbor harmful microorganisms (typhus, polio, etc.) and toxic chemicals.

Organic matter in wastewater serves as food for bacteria and other small organisms. The amount of oxygen needed by the organisms to oxidize the organics for food and energy is called Biochemical Oxygen Demand (BOD). BOD is an important measurement, as aquatic life is dependent upon the amount of oxygen in the water. A depletion of available oxygen can decrease the desirable aquatic populations in our waterways, causing fish kills for example.

Inorganic materials present problems also. Phosphorus and nitrogen act as nutrients for algae and other growths which can deplete streams of oxygen, can cause odor problems, and are generally unsightly. High levels of certain chemicals such as mercury, lead, cadmium, and zinc are suspected of causing certain sicknesses in humans.

Untreated wastewater can, therefore, deplete our streams of fish and wildlife, transmit diseases, reduce property values, and generally prove a public nuisance and health hazard.

HOW WASTES ARE COLLECTED

Our sewer systems are composed of piping, pump stations, manholes, and associated items. The sewer pipes are separated into four categories: house connections, collectors, interceptors, and force mains. These different types of sewers may be compared to our city street system: house connections are similar to driveways, collectors are similar to suburban streets, interceptors are similar to major highways.

House connections carry wastewater from the house into the collection system. The cost of house connections must be borne completely by the homeowner. The wastewater flows from house connections into collector sewers. Collector sewers are eligible for Federal funding in communities existing before October 1972, where there are no sewers now. New communities, or newly developed areas of existing communities must bear the entire cost of the collectors. In many States, however, collector sewers do not receive a sufficiently high priority to receive any funds. The main conveyance pipe which gathers flows from the collectors and transports the wastewater to the treatment plant is called an interceptor. Depending on the terrain, a force main may be necessary to carry water, under pressure, from a pump station to the treatment plant. Interceptors, force mains, and pump stations are all fundable by the Federal government. The Federal government will pay 75 percent of the cost on all eligible items. The community is responsible for finding funds to cover the remaining costs.

COSTS FOR WASTEWATER COLLECTION

The costs of a sewer system vary widely among different localities. These variances are influenced by climate, terrain, population density, soil condition, and cost of living to name but a few. Reasonable costs for the grant eligible portion of a sewer system range from $500 to $1,500 per person served, the average being approximately $1,000 per person. This average is for those communities with eligible collector and interceptor sewers. Of these totals, the Federal government pays $750 per person and the community pays $250 per person, on the average. The homeowner must pay any additional costs for the house connection and any hookup charges.

If your community is not eligible for Federal grants for the collector systems, and none are presently existent, the total costs will remain approximately the same, but the community will be responsible for a greater share. The cost of the collection system must be added to the treatment costs mentioned later in the brochure to give an estimate of total costs.

HOW WASTES ARE TREATED

Wastewater treatment is designed to

accomplish in a controlled and managed environment what occurs in nature under a much slower process. The contaminants are removed from the wastewater by various physical, chemical, and biological processes.

There are three basic levels of wastewater treatment: primary, secondary, and advanced treatment. The objective of primary treatment is to remove readily settleable and flotable material, thus reducing the amount of suspended solids (SS). Secondary treatment is designed to remove dissolved pollutants and provide greater efficiencies in suspended solids removal. Advanced treatment is used for phosphorous and nitrogen removal or for greater reduction of BOD and SS.

The effluent (treated wastewater) of a sewage treatment plant must meet certain Federal or State water quality criteria. Secondary treatment is now the minimum requirement. Advanced treatment may be required if the receiving body of water is particularly sensitive to certain pollutants, or to protect the health and welfare of people and wildlife.

Since secondary treatment is the minimum level of treatment required by law and is usually used in conjunction with primary treatment, emphasis will be placed on it. Most new treatment plants in this country will be some form of secondary. Secondary treatment utilizes the natural process of microorganisms feeding on organics in the water which reduces the BOD. The process creates an ideal, confined habitat, providing proper light, temperature, oxygen, and food for the microorganisms. A secondary treatment plant generally consists of screening devices, a settling tank (primary treatment, SS removal), a biological treatment unit (secondary process, BOD removal), a secondary settling tank, and chlorination (disinfection). The material settled out in sedimentation tanks, called sludge, is further reduced or densified by digestion, thickening, drying, or incineration processes for safe and easy final disposal.

A variety of biological processes can be used for secondary treatment. Some of the most common are lagoons, activated sludge, and trickling filters. Lagoons are large shallow ponds where wastewater is held for a period of time while a biological community feeds on the organics in the wastewater. Some lagoon designs provide for addition of oxygen to the ponds by using aerators, thus increasing the biological activity and treatment efficiency. Activated sludge processes consist of a tank in which sufficient air is supplied to support a biological community. With trickling filters, the biological communities are grown on a fixed media rather than in the water. Trickling filter plants spray the wastewater onto rocks or plastic media to which microorganisms attach themselves and use the wastewater as a food source.

Plant size, strength of incoming wastes, effluent requirements, climate, energy requirements, and operating manpower requirements are some of the factors which bear upon the selection of secondary treatment processes.

Advanced treatment can usually be achieved by adding processes to a secondary plant. Some advanced treatment processes add chemicals which enhance the settling properties of the suspended materials. Some are processes which use a form of filtration to refine the secondary effluent. Land treatment of wastewater may achieve advanced treatment standards by applying partially treated wastewater to land.

ENLARGEMENTS AND UPGRADES OF EXISTING WASTEWATER TREATMENT PLANTS

Existing treatment plants that cannot meet present effluent requirements must be upgraded. This includes all primary plants, since secondary treatment in now the required minimum level of treatment, and plants in areas where discharges are restricted and advanced treatment is required. An upgrade can range from the modification of present processes to the addition of totally new processes. A treatment plant may also need to be enlarged to relieve overloaded conditions. The type and extent of the needed additional construction is dependent upon the individual community and the existing plant (present capabilities, adaptability to modification, etc.). In enlarging and upgrading, a complete evaluation of the existing system is essential along with a detailed study of alternatives. Costs associated with enlarging and upgrading plants are so plant specific that reasonable cost estimates cannot be presented within the scope of this brochure.

COSTS FOR WASTEWATER TREATMENT

The choice of treatment alternatives is dependent upon variables such as climate, land availability, waste constituents, effluent restrictions, general community goals, process reliability, and costs. There is no single best method of treatment. The deciding factor when considering alternatives often is system costs, not only the initial capital outlay, but also the yearly charges that the community must meet.

The Federal government will fund 75 percent (85 percent in some cases) of the costs for treatment plant construction. This includes new construction, enlarging or upgrading a plant. The only nonfundable portion is the cost of the land on which the plant is built. Land is fundable only if it is used for land application of wastewater. The annual operation and maintenance costs of the treatment facility are completely the responsibility of the community. These costs are shared by the homeowners through hookup and user charges. Industries which discharge into the treatment system pay a portion of yearly operating expenses in proportion to their use.

Costs are presented for lagoons, other secondary plants, and advanced treatment plants. Costs presented include total cost for new construction, yearly treatment plant operation, maintenance, and routine replacement cost, and the annual operating expenses of the plant. These costs may vary due to regional labor rates, chemical costs, utility costs, and construction material costs. All costs are in January, 1979 dollars. Estimates for inflation between that time and now should be used to determine the present cost.

NEW PLANT CONSTRUCTION COSTS

Figure 1 provides average costs (in millions of dollars) derived from historical data for construction of new plants. A general assumption made when determining plant size is that 100 gallons of wastewater per person per day is generated. The graph covers a population of zero to 50,000. The actual flow for a community can vary widely depending upon locale, climate, size of community, and the degree of industrialization.

EXAMPLE

The example presented below provides new plant construction costs; annual operation, maintenance, and routine replacement costs; and annual treatment plant operating expenses for constructing and operating a new secondary treatment plant for a community of 25,000 people.

POPULATION: 25,000

NEW PLANT CONSTRUCTION COSTS: From the graph in Figure 1, follow the line up from the population (25,000) until it cuts across the secondary treatment curve. Follow the line across the vertical cost scale. Read the cost from the scale in millions of dollars = 4.8 million dollars.

CAPITAL OUTLAY = 4.8 x 1,000,000 = $4,800,000

SAMPLE FORM (For your community)

POPULATION SERVED: ____________________

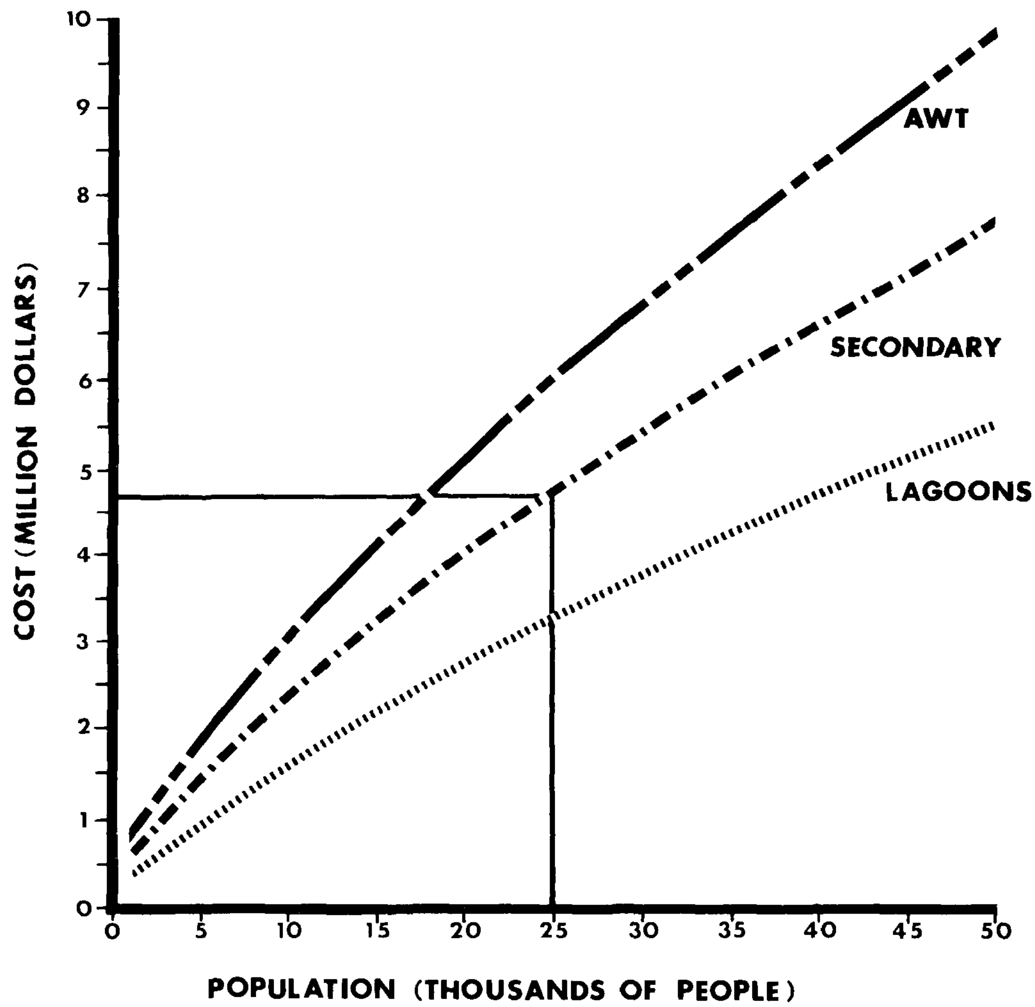
TREATMENT
LEVEL: ______________________________

CAPITAL OUTLAY: From the graph in Figure 1, trace a line up from the population ____________ to the treatment level curve, across the cost scale. Enter the cost in the blank and multiply by 1,000 dollars. ___________ x 1,000 dollars = _________. Enter this figure in the blank below for new plant construction costs.

CAPITAL OUTLAY = $____________

FIG. 1

NEW PLANT CONSTRUCTION COST



ASSUMING 100 GAL. PER CAPITA PER DAY

OPERATION, MAINTENANCE, AND ROUTINE REPLACEMENT COSTS

Figure 2 presents annual costs (in thousand dollars per year) to operate and maintain treatment plants. Costs for lagoons, secondary, and advanced treatment plants are given.

EXAMPLE

ANNUAL OPERATION, MAINTENANCE, AND ROUTINE REPLACEMENT COSTS: From the graph in Figure 2, follow the line up from the population (25,000) until it cuts across the secondary treatment curve. Follow the line across to the vertical cost scale. Read the cost from the scale in thousands of dollars per year = 200 thousand dollars

O&M COSTS: 200 x 1,000 = $200,000 per year

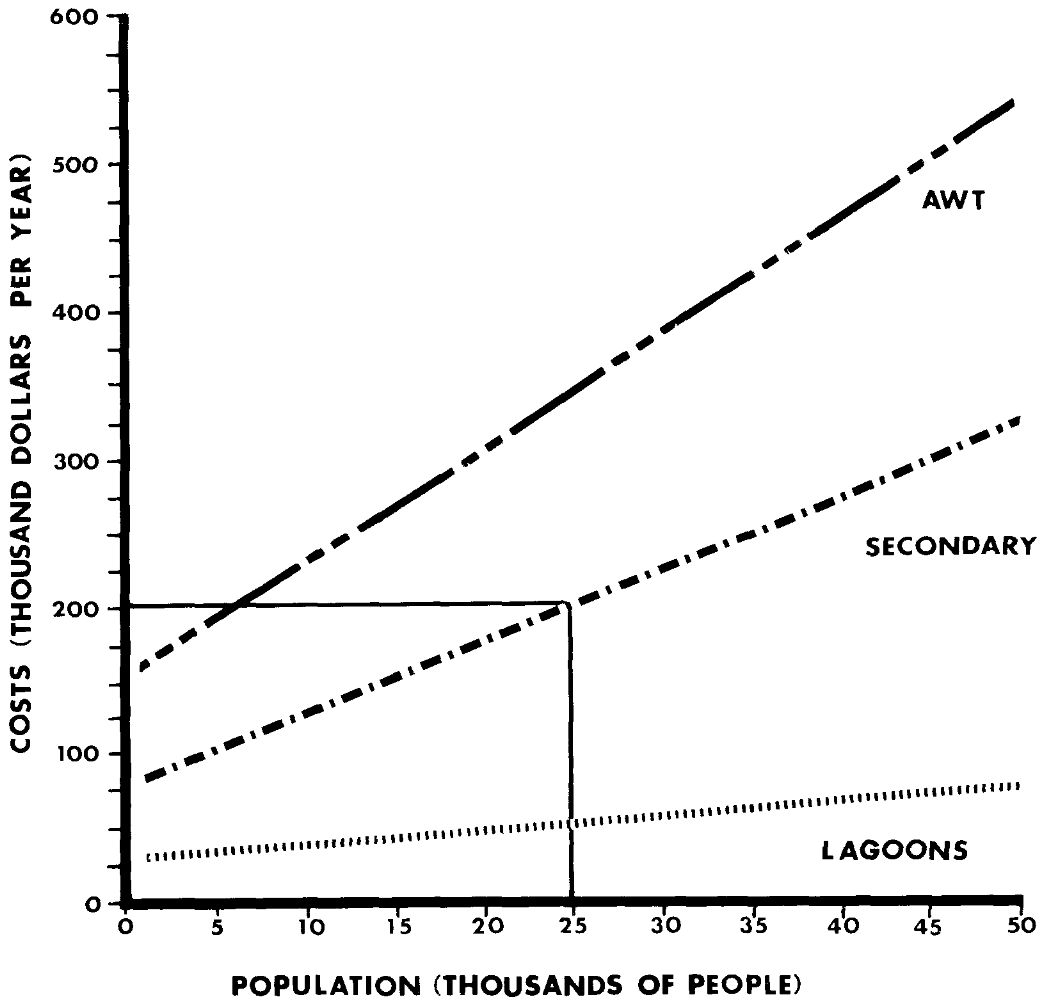
SAMPLE FORM (For your community)

ANNUAL OPERATION, MAINTENANCE, AND ROUTINE REPLACEMENT COSTS: From the graph in Figure 2, trace a line up from the population ______ to the treatment level curve, across to the cost scale. Enter the cost in the blank and multiply by 1,000 dollars. ________ x 1,000 dollars = __________ . Enter this figure in the blank below for total annual operation, maintenance, and routine replacement cost, in dollars per year.

O&M COST = $____________ PER YEAR

FIG. 2

ANNUAL O & M COSTS



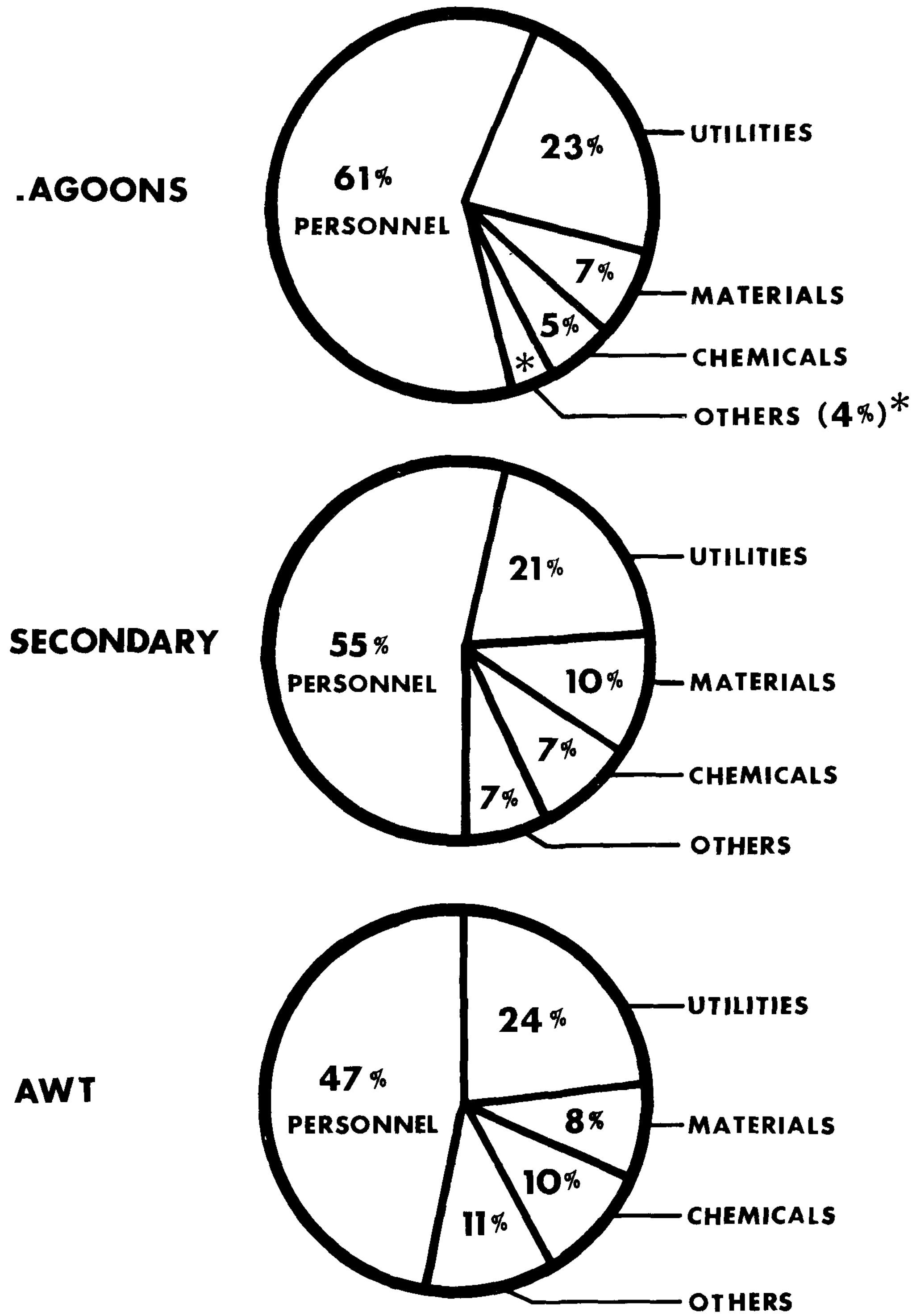
ASSUMING 100 GAL. PER CAPITA PER DAY

COMPONENT PARTS OF ANNUAL OPERATING AND MAINTENANCE COSTS

The pie diagram (Figure 3) below demonstrates the relative proportions of components which make up the annual cost of operating and maintaining a plant. This can aid a community in determining what impacts future increases in utility rates, chemical costs, labor rates, or routine replacement costs will have on operating costs.

IG. 3

PROPORTIONATE O & M COSTS



ANNUAL TREATMENT PLANT OPERATING EXPENSES

Annual operating expenses are those costs, calculated on a yearly basis, required to own and operate a facility. They include principal and interest payments for retirement of any debt acquired for the construction, yearly salaries for manpower (including overhead and fringe benefits), chemical and power costs for operation, and all costs associated with routine replacement and maintenance of the facilities.

Annual operating expenses for municipalities were developed assuming 75 percent Federal funding and 25 percent municipal funding of construction costs, general obligation bonding at six percent compounded semiannually for 20 years, and 100 percent municipal funding for annual operation and maintenance costs. The municipality's share in terms of annual operating expenses (in thousands of dollars per year) is presented in Figure 4 for a population range of zero to 50,000.

EXAMPLE

ANNUAL TREATMENT PLANT OPERATING EXPENSES: From the graph in Figure 4, follow the line up from the population (25,000) until it cuts across the secondary treatment curve. Follow the line across from the intersection to the vertical cost scale. Read the cost from the scale in thousands of dollars per year = 325 thousand dollars.

ANNUAL TREATMENT PLANT OPERATING EXPENSES = 325 x 1,000 = $325,000 per year

SAMPLE FORM (For your community)

ANNUAL TREATMENT PLANT OPERATING EXPENSES: From the graph in Figure 4, trace a line up from the population __________ to the treatment level curve, across to the cost scale. Enter the cost in the blank and multiply by 1,000 dollars. ______ x 1,000 dollars = ______________. Enter this figure in the blank below for the annual treatment plant operating cost in dollars per year which includes the municipality's 25 percent share of the capital outlay and the bond debt retirement plus the annual operation, maintenance, and routine replacement costs.

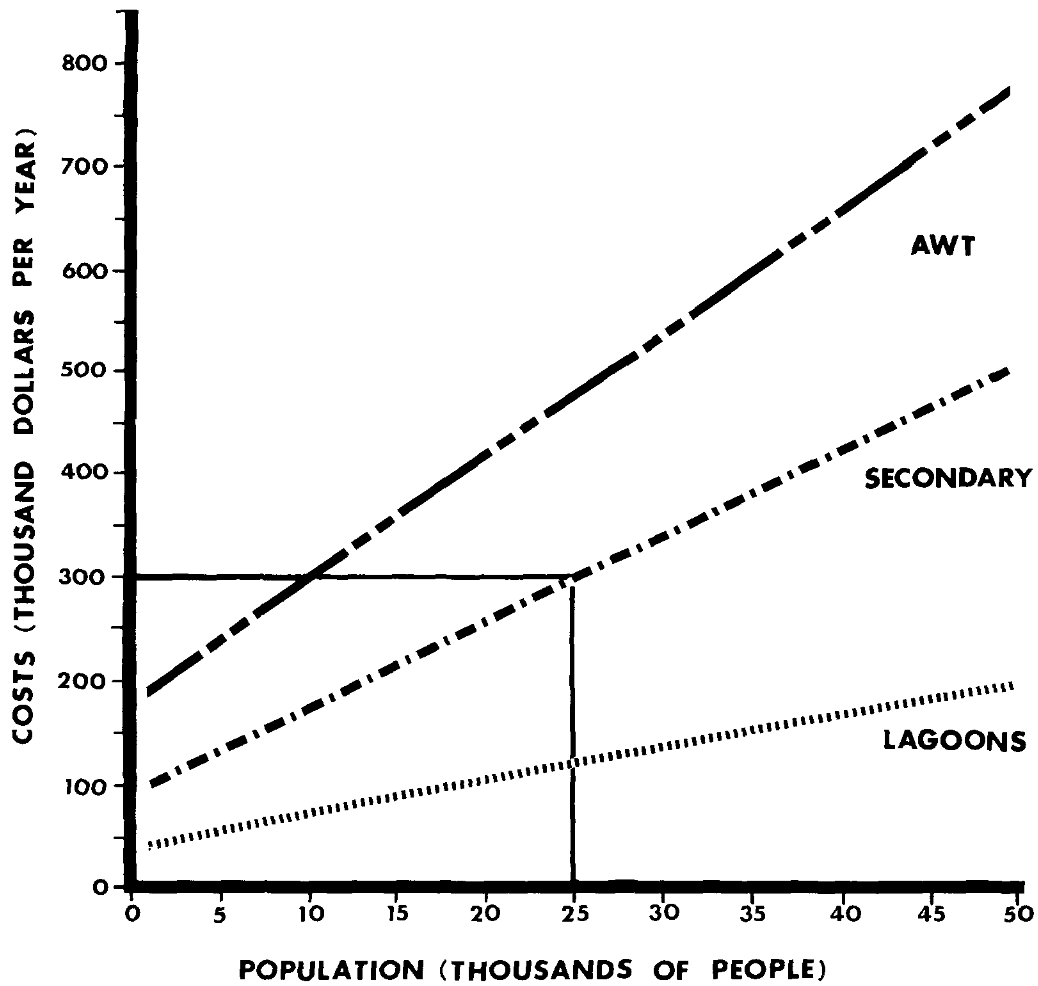
ANNUAL TREATMENT PLANT OPERATING EXPENSES = $__________ per year.

The annual treatment plant operating expenses are a rough planning level estimate of what the new treatment plant will cost the community.

Remember that the actual costs in your community may be very different; because we have used national average costs for treatment plants, and we have not included any costs for the sewage collection system.

FIG. 4

ANNUAL TREATMENT PLANT OPERATING EXPENSES



ASSUMING 100 GAL. PER CAPITA PER DAY

REFERENCES AND ADDITIONAL SOURCES OF INFORMATION

1. Environmental Pollution Control Alternatives: Municipal Wastewater (EPA-625/5-76-012).

2. A Primer on Wastewater Treatment (Office of Public Affairs, A-107, July 1976).

3. Construction Costs for Municipal Wastewater Treatment Plants: 1973-1977 (EPA-430/9-77-013, MCD-37).

4. Analysis of Operation and Maintenance Costs for Municipal Wastewater Treatment Systems (EPA-430/9-77-015, MCD-39).

5. Construction Costs for Municipal Wastewater Conveyance Systems: 1973-1977 (EPA-430/9-77-014, MCD-38).

6. Cost Effective Comparison of Land Application and Advanced Waste Treatment (EPA-430/9-75-015, MCD-17).

7. All You Need to Know About Sewage Treatment Construction Grants (Office of Public Affairs, A-107, August 1976).

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