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COST EFFECTIVENESS ANALYSIS

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COST EFFECTIVENESS ANALYSIS

1. Cost Effectiveness Analysis: Definition and Calculation Procedure

1.1 Introduction

This section will present the general cost-effectiveness analysis procedures appropriate to small communal and onsite wastewater treatment systems design. The cost components of the analysis will first be defined and the general procedures for their determination will be outlined. Three examples of the application of the analysis will be presented for the Woodrock Community.

The process of selection of an appropriate technical option is influenced by three general factors:

* the technical feasibility of the option
* the presence of any over-riding, non-monetary objection to the option
* the cost effectiveness of the option

In order to be considered further, a particular option must be theoretically capable of providing the desired degree of treatment to the waste stream of concern. Technically feasible options must be examined for their acceptability to the community and incompatibility with local environmental conditions. Finally, those options which survive this preliminary sifting process are compared using the cost-effectiveness analysis (based upon the present worth method with an EPA specified discount rate and 20 year planning period). The appropriate technical option would be the most cost effective of these preselected alternatives.

The cost effectiveness analysis determines the total Present Worth of all wastewater treatment alternatives for the community. The Present Worth consists of:

- Construction and Development Costs (Capital Costs)
- Present Worth of Operations and Maintenance Costs
- Salvage Value of Structures, Equipment, and Land

This Present Worth must include <u>all</u> costs, both public and private.

The general cost effectiveness formula can be stated briefly as:

Capital Costs + Present Worth of Annual O & M Costs - Present Worth of Salvage Value = Total Present Worth

The determination of each of these components will be discussed in greater detail. An example of the general cost effectiveness procedure can be seen in the December 27, 1978 <u>Federal Register</u>.

1.1.1 Innovative/Alternative Preference. Under present EPA regulations, the Present Worth of Innovative/Alternative options may be 15% greater than the most cost effective conventional option and still be selected. This preferential procedure is designed to encourage the investigation and application of new technologies.

1.2 Definitions

1.2.1 Capital Costs. The capital costs of any technical option are the initial costs of providing a structural/process framework for the waste treatment. Capital costs include:

* costs of construction
* costs of land and easements
* contingencies
* engineering costs
* administrative, legal and financial costs (including interest during construction)

1.2.2 Operations and Maintenance Costs. The annual operation and maintenance costs are those costs associated with providing an acceptable level of wastewater management with the facilities provided. Annual operations and maintenance costs consist of:

* operator's salaries
* routine replacement of equipment and equipment parts (including septic system replacement)
* energy and chemical costs
* other required annual costs (management, water quality monitoring, etc.)
* deductions of revenues from energy recovery, crop production and other valued outputs (such as irrigation water)
* incremental costs which depend on quantity of flow treated

1.2.3 Salvage Value. Salvage value is the residual worth of components of the waste treatment facility at the end of the design period. If a component has a useful life longer than the design period, then a salvage value (based on a fraction of the component's initial value) can be determined. Such components include:

- land
- wastewater conveyance structures
- other structures (buildings, etc.)
- equipment, for which the useful life of the equipment is longer than the planning period.

1.3 Calculation Procedure For Cost Effectiveness Analysis

The calculation procedure was stated briefly in Section 1.1. In review the total Present Worth of an option is found by:

  Capital Costs
+ Present Worth of Annual Operations and Maintenance Costs
- Present Worth of Salvage Value

Total Present Worth

Determination of each category of costs will be examined in greater detail in the next sections.

1.3.1 Common Assumptions (1) In order to calculate the cost effectiveness of any particular alternative, the common factors must be defined. These are:

* a 20 year planning period
* land appreciation rate of 3% per year
* energy cost escalations based on EPA 40 CFR Part 35 (2)
* when this analysis was originally performed, the Water Resources Council mandated interest rate was 7 1/8%. It is noted that the present rate is 7 5/8%; however, the 7 1/8% rate will be retained in this study.

1.3.2 Capital Costs. These costs are a summation of the previously defined components in Section 1.2.1. The means of estimating each cost will be discussed briefly. Figure 1-1 presents the summation procedure in a graphical form.

1.3.2a Cost of Construction. These costs can be estimated from experience with similar facilities, industrial processes using similar technology, manufacturers' data, and EPA cost publications. Cost estimates should be updated, where necessary, using the appropriate index (ENR, Wholesale Price Index, EPA indices).

1.3.2b Cost of Land. Land costs are variable, and should be estimated either from experience or from local sources (real estate agencies, etc.).

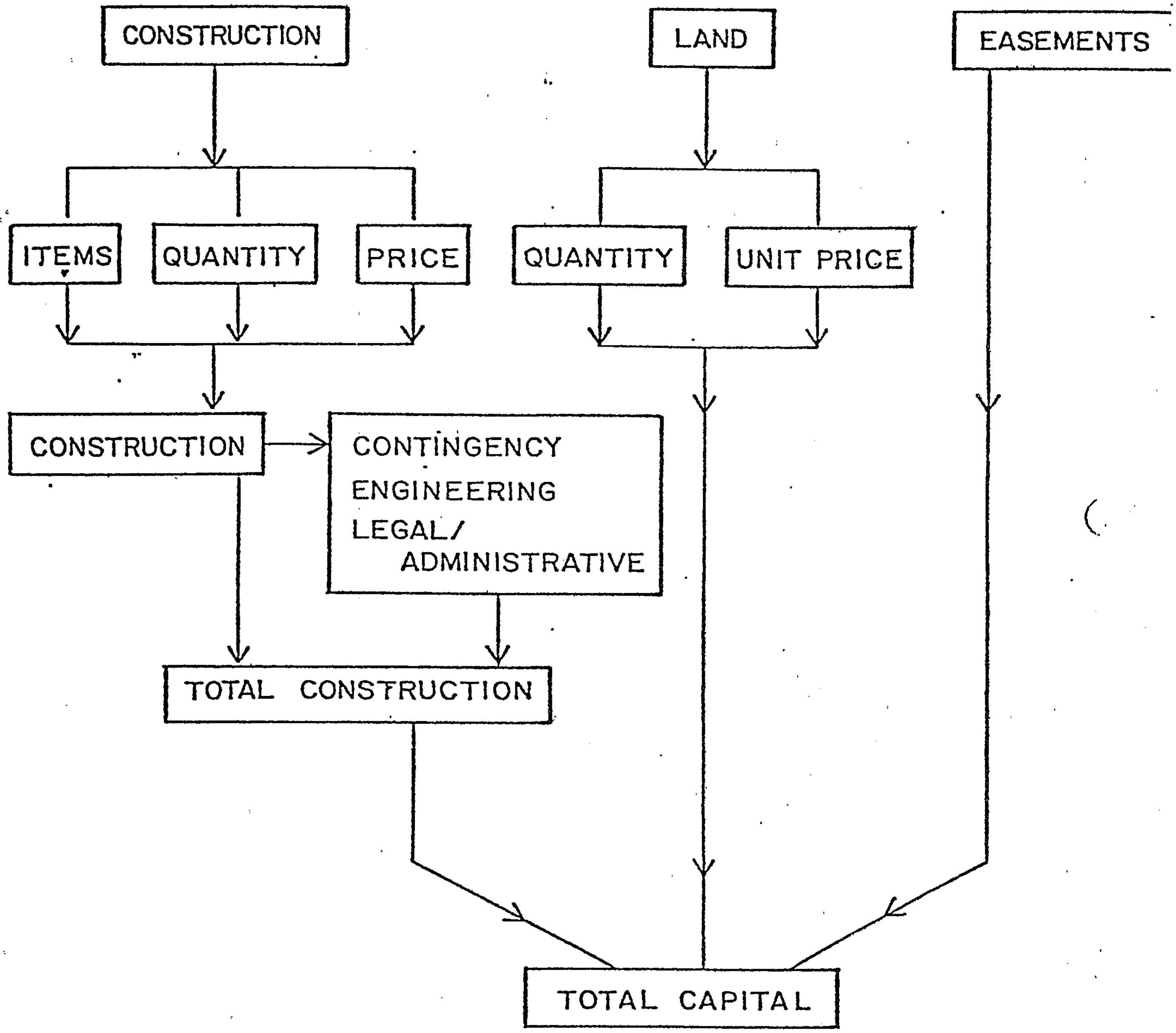
1.3.2c Interest During Construction (I) When capital expenditures can be expected to be fairly uniform during the construction period, interest during construciton may be calculated as:

$I = \frac{1}{2}(PCi)$; where

I = the interest accrued during the construction period
P = construction period in years
C = total capital expenditures
i = discount rate (7-1/8% per annum)

FIGURE 1-1

ELEMENTS OF TOTAL CAPITAL COST



If expenditures will not be uniform, or the construction period is longer than 4 years, interest during construction should be calculated on a year-by-year basis. This is usually included in the administrative/legal/financial portion of capital cost determination.

1.3.2d Contingencies. Contingencies are usually calculated as a fixed percentage of the total construction costs, reflecting the precision and detail of the construction cost calculations. For this analysis, a value of 20% is assumed.

1.3.2e Administrative, Legal, Financial and Engineering Design. The administrative, legal and financial costs are determined for each aspect of the project and are included in the Total Capital Costs. Interest during construction is normally included in this section.

Engineering design is based on estimations by the design firm. It is noted and emphasized that actual engineering and administrative costs cannot be based on a percentage of construction costs.

1.3.2f Summation of Capital Costs Computation. In summation, capital costs are calculated as follows:

Component	
Cost of Construction	A
Contingencies	0.20A
Engineering Design	ED
Financing, Administrative and Legal	FI
Land and Easements	L
Total Capital Expenditures	1.20A + ED + FI + L

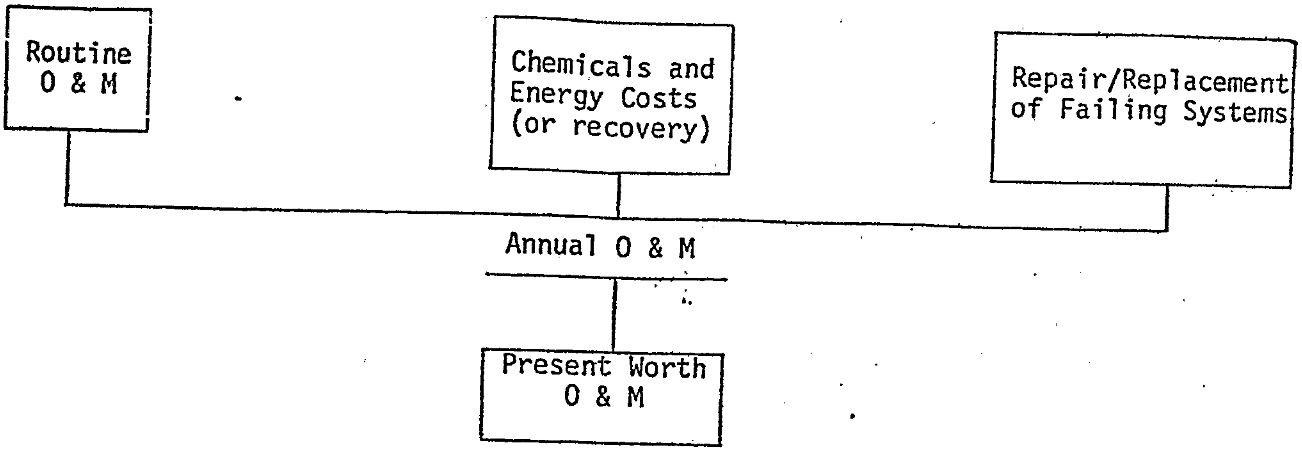
1.3.3 Annual Operations and Maintenance. These costs are a summation of the previously listed annual costs. The present worth of the annual O & M cost is found as shown below:

Component	Amount
O & M Costs	B
Revenues	(-C)
Total Annual O & M Costs	B-C

Figure 1-2 presents this procedure graphically.

Figure 1-2

Annual Operation and Maintenance



The Present Worth of annual O & M costs is found by multiplying the sum by the Present Worth Uniform Series Factor. A design period of 20 years and a discount of 7 1/8% are assumed. Thus:

$$\text{Present Worth} = 10.49186 \times (B-C)$$

1.3.3a Incremental (Growth - Related) Annual O & M Costs. There are annual costs which increase throughout the project primarily due to growth within the community.

The present worth of these increasing costs is found as shown:

Component	Amount in Last Year of Planning Period
Incremental O & M Costs......	D
Incremental Revenues.........	(-E)
	D-E (See Figure 1-3)

To obtain the present worth, the average incremental annual cost is multiplied by the gradient series factor:

$$\frac{(D-E)}{(\#\text{ of years in planning period})} \times PWF = PW$$

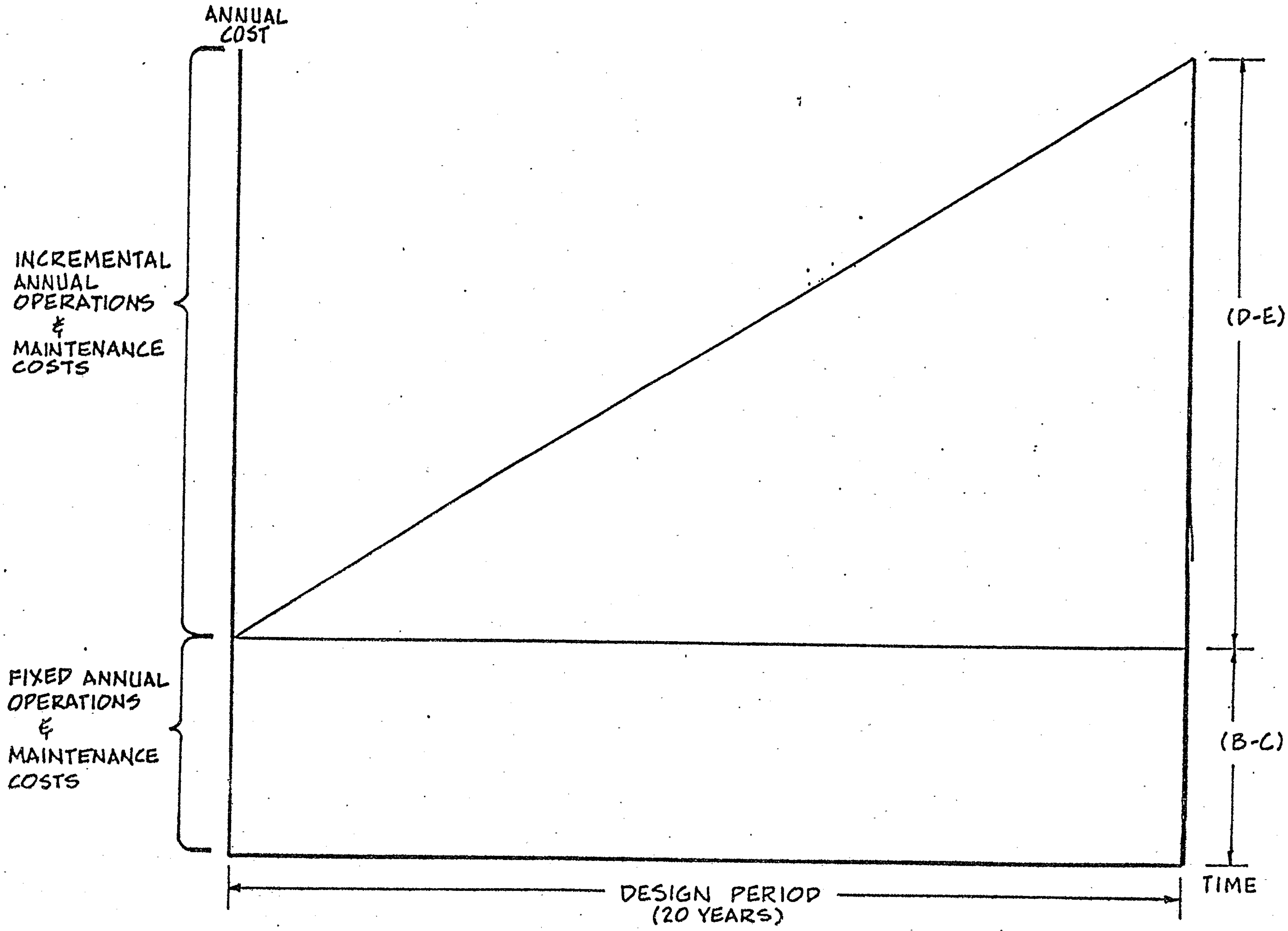
$$\frac{D-E}{20} \times (76.38969) = 3.8195 \times (D-E) = PW$$

The total annual O & M present worth is the sum of the fixed annual O & M present worth and the incremental annual O & M present worth:

$$\text{Total O \& M Present Worth} = (10.49186) \times (B-C) + (3.8195) \times (D-E)$$

Figure 1-3 presents a graphical representation of the two types of

FIGURE 1-3 FIXED & INCREMENTAL OPERATIONS & MAINTENANCE COSTS



1.3.3b Replacement of Onsite Systems. Septic systems which fail after the initial construction period must be replaced as part of the ongoing maintenance program. The total number of mounds emplaced during the Planning Period includes those which replace conventional septic systems (as they fail) and those which are repairs to the replacement mounds themselves.

Failure Rate of Present (conventional) Septic Systems

The rate of failure of present septic systems is central to this determination, and should be determined statistically for the community in question. In this case, a failure rate of 5% of the total number of initially unreplaced systems per year is assumed for demonstration purposes. To simplify the calculation procedure, the systems are assumed to fail linearly over the 20 year Planning Period and, thus, at the end of the Planning Period all present septic systems will have failed. This can be shown:

Total Number of Septic Systems Failures = Original Number of Septic Systems x .05 x 20 years =

Original Number of Septic Systems

Failure Rate of Replacement (mound) Systems

All mounds, including those emplaced at the beginning of the Planning Period and those which replace failing systems throughout the period, are themselves subject to failure. For the purpose of this analysis, a failure rate of 1% of all mounds per year is assumed. The number of failures of the originally built mounds can be determined by:

Number of Failures = Total Number of Originally Built Mounds x 20 Years x .01 =

Total Number of Original Mounds

Thus, at the end of the design period, 20% of the originally built mounds will have failed and been replaced.

The failure of mounds which have been built to replace conventional septic systems can be determined in a similar manner. With the assumption made above that the replacement of conventional systems is linear throughout the Planning Period, the average age of one of these replacement mounds is 10 years. The number of failures can therefore be calculated:

Number of Mound Failures = Original Number of Septic Systems x 10 Years x .01

Thus, it can be seen that 10% of the repairs to failing septic systems are estimated to fail during the Planning Period.

In summary, the total number of mounds built can be seen below:

Problem Source	Failure Rate (annual)	Number of Mounds Built During Planning Period
Initially Built Mounds	1%	0.2 x Number of Initially Built Mounds
Initially Conventional Septic Systems	5%	Number of Initially Conventional Septic Systems
Mound Repairs of Conventional Systems	1%	0.1 X Number of Initially Conventional Septic Systems

Summary of Onsite O & M Costs

Since all systems are assumed to fail linearly over the 20 year Planning Period the number of mounds replaced per year is equal to the total built divided by 20 years:

$$\text{Yearly Total} = [(0.2 \times \text{Number of Initially Built Mounds}) + (1.1 \times \text{Number of Initially Conventional Septic Systems})]/20 \text{ yrs}$$

This yearly total is multiplied by the mound unit cost to provide the annual O & M cost for mound replacement:

$$\text{Mound Replacement Cost (Present Worth)} = \text{Yearly Total} \times \text{Unit Cost} \times (\text{PWF})$$

1.3.3c Energy Cost Escalation

Because of the rising cost of energy and the regional factors involved in energy supply, the Present Worth Factor for energy sources is variable. Table 1-2 presents a summary of these Present Worth Factors for each Region and energy type.

1.3.3d Other Onsite Operating Costs

The other annual O & M costs for the onsite option include pump repair and replacement (for mound systems) and preiodic septage removal for all systems.

1.3.4 Salvage Value

Salvage value is determined by:

TABLE 1-1

UNIFORM PRESENT WORTH DISCOUNT FACTORS ADJUSTED FOR ENERGY COST ESCALATION *

(DISCOUNT RATE = 7 5/8%, PLANNING PERIOD = 20 YEARS AND NO INFLATION INCLUDED)

	REGION I	REGION II	REGION III	REGION IV	REGION V	REGION VI	REGION VII	REGION VIII	REGION IX	REGION X	NATIONAL AVERAGE
ELECTRICITY	11.23	10.99	11.64	12.25	11.84	12.15	11.00	10.10	11.46	14.91	11.84
DISTILLATE OIL	12.40	12.38	12.38	12.38	12.46	12.47	12.46	12.38	12.52	13.25	12.38
RESIDUAL OIL	12.30	12.30	12.30	12.42	12.38	12.43	12.43	12.37	12.49	12.61	12.37
NATURAL GAS (Liquid)	12.79	12.79	12.70	14.47	12.70	12.79	12.76	12.70	12.79	12.79	12.79
NATURAL GAS	12.11	12.19	13.82	14.87	14.17	14.20	16.97	13.78	12.39	12.39	14.05
COAL	11.78	11.84	11.82	11.93	11.89	11.80	11.93	11.32	11.78	10.10	11.87

SOURCES USED FOR COMPILATION OF THIS TABLE:

1. DOE: EIA " Short-Term Energy Outlook" May, 1980
2. DOE: EIA " Annual Report to Congress" DOE/EIA - 0173 (79-3), May 1979
3. DOE: EIA " Preliminary 1985, 1990 and 1995 Energy Forecast for the Annual Report to Congress, 1979" Service Report SR/IA/80-01 April 1980
4. Grant, E.L., W.G. Ireson adn R.S. Levenworth:" Principles of Engineering Economy" The Ronald Press Co., N.Y. 6th Edition, 1976

* From, U.S.E.P.A., Facilities Planning 1982, Municipal Wastewater Treatment Works Construction Grants Program, May 1981.

$$\text{Salvage Value (Present Worth)} = \text{Initial Cost of Item} \times \left(\frac{\text{\% of Useful Life Remaining}}{100\%}\right) \times \text{Discount Factor}$$

The discount factor for the 7-1/8% interest rate and 20 year planning period is 0.25245. The useful life of some capital items are presented below (1):

Item	Useful Life
Land	Permanent
Easements	Permanent
Wastewater Conveyance Structures	50 years
Tanks, Pump Chambers, Other Structures	30-50 years
Process Equipment	15-20 years
Auxiliary Equipment	10-15 years

1.3.4a Useful Life and Failure Rate of Mounds

Based on the excellent performance of properly designed and installed mounds in the last ten years, a useful life of 40 years will be assumed for the purposes of this analysis.

However, because: 1) the somewhat complicated and sensitive construction procedures required to properly install the systems are often not followed exactly; 2) the waste disposal systems are often subject to misuse (overloading, lack of preventive maintenance, etc.; and 3) the general sensitivity of the system to external environmental effects (accidents, floods, physical damage, etc.), the actual useful life is somewhat less than the assumed 40 year period. This difference in the design useful life and actual useful life of mound systems is taken into account by assuming a failure rate for the mounds. This methodology was chosen because it permits a more accurate estimation of salvage values than would be made using an arbitrary reduction in the assumed useful life. Because of the somewhat unpredictable nature of the factors responsible for mound problems, and the fact that each mound is an individual unit, the actual failures would tend to occur over an extended period rather than all at once. Shock loadings, misuse, or faulty construction would tend to affect systems on an individual rather than mass basis. Therefore, it is felt that the assumption of a failure rate provides a resonably accurate simulation of mound survival for the purposes of this Cost Effectiveness Analysis.

The failure rate is assumed to be 1% of all emplaced mound systems per year. In order to simplify analysis, it will be assumed that these mounds fail linearly over the 20 year Planning Period. Thus, there are two "types" of mounds that need to be examined: those which are emplaced at the beginning of the Planning Period and survive; and those which replace failed systems, either mounds or conventional (i.e., "future failures") systems.

Salvage Value of Initially Emplaced Mounds

For those mounds emplaced at the beginning of the Planning Period, the Salvage Value can be determined by:

$$\text{Salvage Value} = \text{Initial Value} \times \left(\frac{\%\ \text{Useful Life Remaining}}{100\%}\right)$$

$$\text{Salvage Value} = \text{Initial Value} \times \frac{(50\%)}{(100\%)} = 0.5 \times \text{Initial Value}$$

Theoretically, at the end of the 20 year Planning Period, the originally emplaced mounds still have 50% of their useful life remaining.

Salvage Value of Mounds Which Replace Failed Systems

For those mounds which replace failed systems, an average age must be determined. Because systems are assumed to fail linearly over the 20 year Planning Period, the average age of a system is 10 years. The salvage value of these systems can be determined by:

$$\text{Salvage Value} = \text{Initial Value} \times \frac{(75\%)}{(100\%)} = 0.75 \times \text{Initial Value}$$

Useful Life and Salvage Value of Septic Tanks

As described above, the useful life of a concrete septic tank is assumed to be 50 years. Thus, the salvage value of septic tanks can be determined by:

$$\text{Salvage Value} = \text{Initial Value} \times \frac{(60\%)}{(100\%)} = 0.6 \times \text{Initial Value}$$

This assumes that septic tanks will be emplaced only with those systems failing at the beginning of the Planning Period. Replacement systems will receive a mound only, with the assumption that non-failing systems have properly sized and installed tanks.

1.3.4b Summation of Salvage Value for Onsite Systems

Based on the number of mounds emplaced during the Planning Period as defined in Section 1.3.3b, a summation of the Salvage Value (Present Worth) for Onsite Systems is presented below:

Item	Number	Procedure Summary
Septic Tank	Number of Initial Problems	Number of Initial Systems X Unit Cost X 0.6 X Discount Factor
Initial Mounds	0.80 X Number of Initial Problems (1% failure rate)	Number of Initial Systems X 0.80 X Unit Cost X 0.5 X Discount Factor
Replacement Mounds	0.20 X Number of Initial Problems + Number of Initially Conventional Septic = Systems + 10% of Initially Conventional Septic Systems	Number of Replacement Mounds X 0.75 X Unit Cost X Discount Factor

1.3.4c Land & Easements

Land is assumed to appreciate at a 3% rate over the planning period. The resultant value (at the end of the 20 year planning period) is discounted to present worth using the discount factor. Easements are assumed to have their initial value at the end of the Planning Period. The Present Worth easements is found by using the initial value and the discount factor.

A summary of the Salvage Value determination procedure is presented on Figure 1-4.

2. Cost Effectiveness Analysis Methodology

2.1 Determination of Areas of Analysis

The analysis will be performed on three specific areas; Problem Area 4, Problems Area 14 (Town Center), and the Town as a whole. Sufficient information will be provided so that analysis can be performed on the other problem areas, if desired.

2.2 Methodology

The methodology for analysis will be performed as follows:

1) Define area into solution by

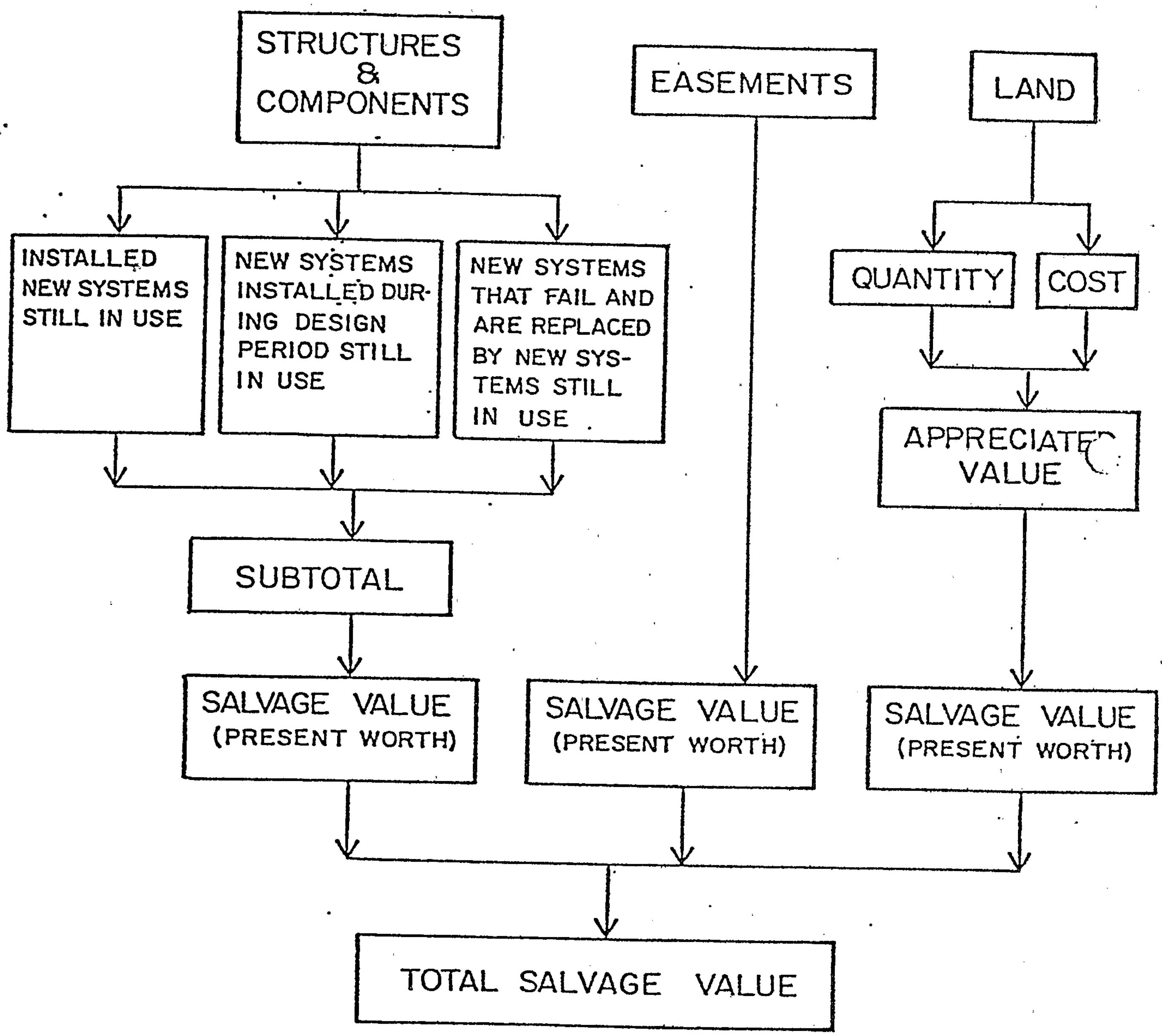
   a) onsite and
   b) communal (sewer)

2) Compute capital costs

   a) repairing onsite systems (present problems, not solved by b)
   b) communal

FIGURE 1-4

COMPONENTS OF SALVAGE VALUE AT END OF DESIGN PERIOD



3) Compute annual O & M of initially-repaired systems

   a) onsite
   b) communal

4) Compute annual repair costs of initially-repaired systems

5) Compute annual) & M of present non-problem systems

6) Compute annual repair costs of present non-problem systems

7) Compute salvage value of all equipment having a useful life greater than end of Planning Period

8) Compute management costs

9) Segregate land costs as a separate line item

10) New Construction: compute costs (capital, O & M and repair) of wastewater system for new construction.

Figure 2-1 summarizes this entire procedure.

2.3 Growth

The future growth of a community depends on many factors.

In order to simplify the analysis for the examples in the following sections, an assumption will be made for the growth rate of the Woodrock Community. This assumption assumes an annual growth of 50 homes/year. It is also assumed that this new construction does not occur in any of the previously defined problem areas, but is scattered throughout the undeveloped portions of the community.

3. Example Analysis

3.1 Background Information

3.1.1 Onsite Systems

The unit construction costs for mounded leachfields are presented in Tables 3-1 through 3-3. It should be noted that the costs presented in these Tables are for demonstration purposes only, and will not accurately reflect costs in all parts of the country. It should also be noted that the particular design code used for Woodrock results in a relatively larger mound size than would result from using other (e.g. Wisconsin) recommended designs. Table 2-1 in the Problem Area Description delineated the number and bedroom size of failing systems for all the problem areas. Annual operation and maintenance costs will be calculated with 5% per year present leachfield failure rate. The failure rate for all replacement (mound) will be assumed to be 1% per year. Present failing systems will receive a new septic tank, pump-chamber system, and mound. Future failing systems will receive only a new mound. The procedures necessary to perform the Cost Effectiveness Analysis are presented in three examples below.

FIGURE 2-1

COST EFFECTIVENESS PROCEDURES FOR SMALL COMMUNITY SYSTEMS

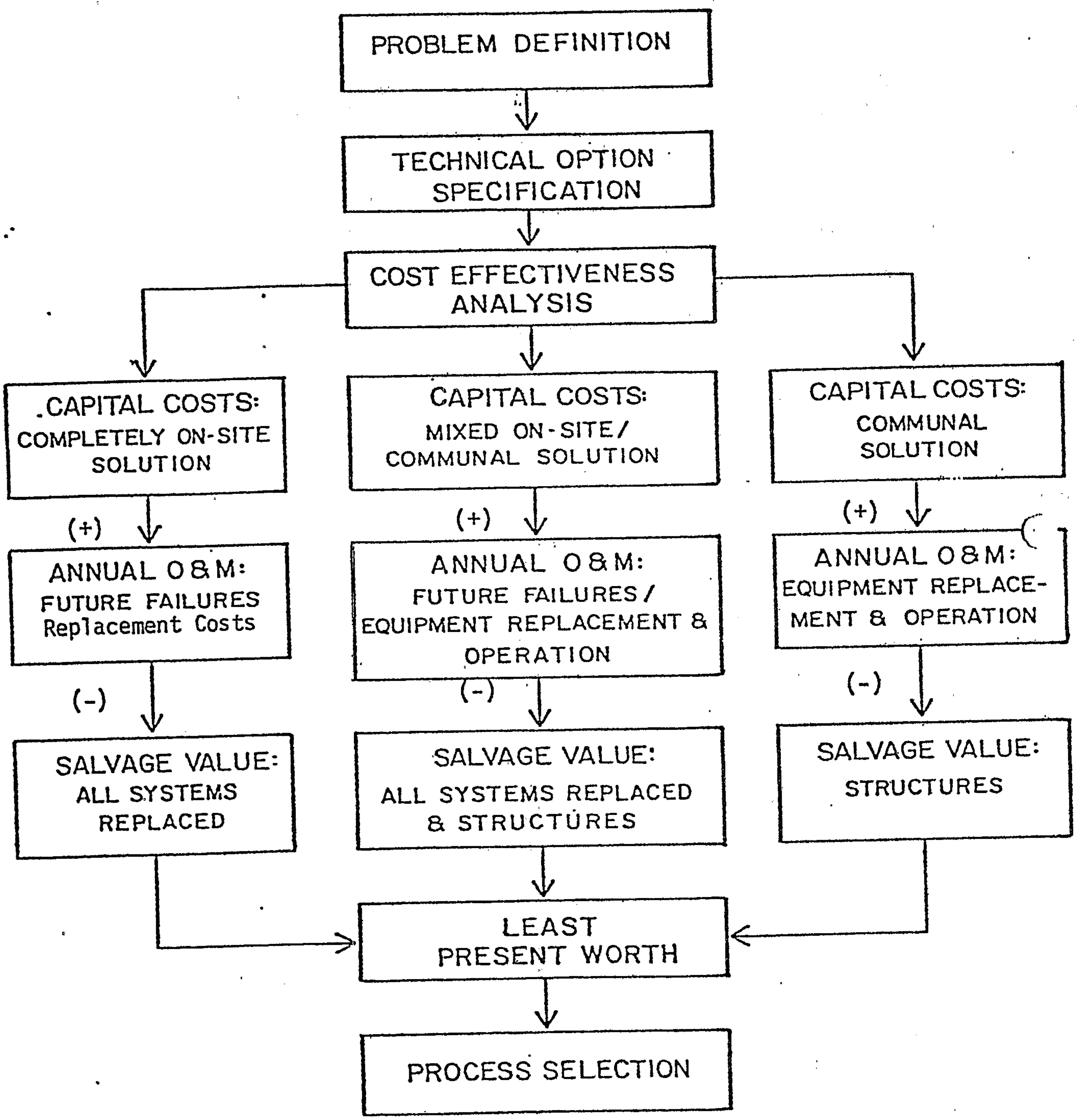


Table 3-1 Mounded Soil Absorption Bed for 10 minute per inch perc
Size Requirements and Associated Costs

Component	Unit Costs	2 Bedroom		3 Bedroom		4 Bedroom		6 Bedroom		7 Bedroom		11 Bedroom		13 Bedroom	
	Capital and Installation	Quantity	Costs	Quantity	Costs	Quantity	Costs	Quantity	Costs	Quantity	Costs	Quantity	Costs	Quantity	Costs
Excavation	2.50/yd^3	11.4yd^3	28.50	17.1yd^3	42.75	22.8yd^3	57.00	34.2yd^3	85.50	39.9yd^3	99.75	62.7yd^3	156.75	74.1yd^3	185.25
Gravel	10.00/yd^3	4.3yd^3	43.00	6.4yd^3	64.00	8.6yd^3	86.00	12.9yd^3	129.00	15.0yd^3	150.00	23.6	236.00	27.9yd^3	279.00
Peastone	9.00/yd^3	1.4yd^3	12.60	2.2yd^3	19.80	2.9yd^3	26.10	4.4yd^3	39.60	5.2yd^3	46.80	8.2yd^3	73.80	9.7yd^3	87.30
Fill Material	5.00/yd^3	242.6yd^3	1213.00	316.8yd^3	1584.00	365.4yd^3	1827.00	492.5yd^3	2462.50	553.9yd^3	2769.50	799.5yd^3	3997.50	992.3yd^3	4611.50
Distribution Pipe	2.50/LF	154LF	385.00	231LF	577.50	308LF	770.00	462LF	1155.00	539LF	1347.00	847LF	2117.50	100LF	2502.50
Backflow Preventer	175.00/ea	1	175.00	1	175.00	1	175.00	1	175.00	1	175.00	2	350.00	2	350.00
Header Pipe	3.00/LF	50LF	150.00	67LF	201.00	108LF	324.00	162LF	486.00	191LF	573.00	307LF	921.00	365LF	1045.00
Grading and Supervision	0.065/ft^2	3750ft^2	243.75	4550ft^2	295.75	5215ft^2	339.00	6700ft^2	435.50	7450ft^2	484.50	10350ft^2	672.75	11,850ft^2	770.25
Layout and Supervision	1.00/lf Trench	154LF	154.00	231LF	231.00	308LF	308.00	462LF	462.00	539:F	539.00	847LF	847.00	1001LF	1001.00
TOTAL			2404.85		3190.80		3912.10		5430.10		6184.80		9372.30		10,881.80

Table-3-2 Mounded Soil Absorption Bed for 20 minute per inch perc Rate

Size Requirements and Associated Costs

Component	Unit Costs	2 Bedroom		3 Bedroom		4 Bedroom		5 Bedroom		6 Bedroom		7 Bedroom		13 Bedroom	
	Capital and Installation	Quantity	Costs	Quantity	Costs	Quantity	Costs	Quantity	Costs	Quantity	Costs	Quantity	Costs	Quantity	Costs
Excavation	2.50/yd^3	19.5yd^3	48.75	29.3yd^3	73.25	39.1yd^3	97.75	48.9yd^3	122.25	58.7yd^3	146.75	68.4yd^3	171.00	126.yd^3	317.30
Gravel	10.00/yd^3	7.3yd^3	73.00	11.0yd^3	110.00	14.7yd^3	147.00	18.4yd^3	184.00	22.1yd^3	221.00	25.7yd^3	257.00	47.6yd^3	476.00
Peastone	9.00/yd^3	2.4yd^3	21.60	3.7yd^3	33.30	4.9yd^3	44.10	6.1yd^3	54.90	7.4yd^3	66.60	8.6yd^3	77.40	16.1yd^3	144.90
Fill Material	5.00/yd^3	331.4yd^3	1657.00	429.3yd^3	2146.50	559.2yd^3	2796.00	667.8yd^3	3339.00	781.yd^3	3908.50	895.6yd^3	4478.00	1579yd^3	7895.00
Distribution Pipe	2.50/LF	264LF	660.00	396LF	990.00	528LF	1320.00	660LF	1650.00	792LF	1980.00	924LF	2310.00	1716LF	4290.00
Distribution Boxes	175.00/ea	1	175.00	1	175.00	1	175.00	2	350.00	2	350.00	2	350.00	2	350.00
Header Pipe	3.00/LF	82LF	246.00	124LF	372.00	184LF	552.00	232LF	696.00	283LF	707.50	334LF	1002.00	640LF	1920.00
Grading and Supervision	0.065/ft^2	4820ft^2	313.30	6000ft^2	390.00	7140ft^2	464.10	8307ft^2	540.00	9467ft^2	615.35	10627ft^2	690.75	17587ft^2	1143.15
Layout and Supervision	1.00/LF	264LF	264.00	396LF	396.00	528LF	528.00	660LF	660.00	792LF	792.00	924LF	924.00	1716LF	1716.00
TOTAL			3458.35		4686.05		6123.95		7596.15		8787.70		10260.15		18,212.35

Table 3-3 Mounded Soil Absorption [illegible]l for 30 Minute Per Inch Percolation Rate

Size Requirements and Associated Costs

Component	Unit Costs	2 Bedroom		3 Bedroom		4 Bedroom		5 Bedroom	
	Capital and Installation	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
Excavation	2.50/yd^3	32.6yd^3	81.50	48.9yd^3	122.25	65.2yd^3	163.00	81.5yd^3	203.25
Gravel	10.00/yd^3	12.2yd^3	122.50	18.3yd^3	183.00	24.4yd^3	244.00	30.5yd^3	305.00
Peastone	9.00/yd^3	4.1yd^3	36.90	6.1yd^3	54.90	8.2yd^3	73.80	10.2yd^3	91.80
Fill Material	5.00/yd^3	465.3yd^3	2326.50	632.9yd^3	3164.50	798.3yd^3	3991.50	965.2yd^3	4826.00
Distribution Pipe	2.50/LF	440LF	1100.00	660LF	1650.00	880LF	2200.00	1100LF	2750.00
Distribution Boxes	175 each	1	175.00	2	350.00	2	350.00	2	350.00
Header Pipe	3.00/LF	165LF	495.00	220LF	660.00	230LF	690.00	270LF	810.00
Grading and Supervision	0.065/ft^2	6375ft^2	414.40	8280ft^2	538.20	10165ft^2	660.70	12065ft^2	784.25
Layout and Supervision	1.00/LF	440LF	440.00	660LF	600	880LF	880.00	1100LF	1100.00
TOTAL			5191.30		7382.85		9253.00		11,220.30

3.1.2 Communal Systems

The costs associated with Communal solution for the various Problem Areas are presented on Table 3-4. The communal solution involves the collection of septic tank effluent by a small diameter gravity sewer and transferal to a communal leachfield (mound). All present problem systems are hooked up to the sewer, as well as those presently non-failing systems which are along the sewer route.

3.2 PROBLEM AREA 4

Problem Area 4 was described in section 2.2.4 of Case Study. The cost effectiveness analyses for the onsite mounded option and communal (sewer) option are examined below.

3.2.1 Onsite Mounded Systems

3.2.1a Design Basis

Problem Area 4 contains a total of 34 septic systems, 13 of which are presently failing. In the onsite option, a septic tank, pump chamber and controls, and mound will be provided for each problem system during initial construction. Replacement of systems which fail during the Planning Period were addressed in detail in the Annual O & M Costs determination. It is assumed that mounds initially emplaced fail linearly over the 20 year period (1% of Total Number Constructed/year), while initial non-problem systems fail linearly at a higher rate (5% of Total Initial Non-Problems/year). Replacement systems receive only a mound, rather than septic tank/pump chamber/mound. There are 21 initial non-problem systems in Problem Area 4.

3.2.1b Capital Costs

Construction Costs:

Item	Number	Unit Costs	Total Cost	Present Worth
Septic Tank	13	1,833	$ 23,829	
Pump Chambers & Controls	13	975	12,675	
7-Bedroom Mounds (10 min/in)	13	6,184.80	80,402.40	
TOTAL CONSTRUCTION COSTS			$116,906.40	

Development Costs:

	Total Cost	Present Worth
Contingency	$ 23,381.30	
Engineering Design	23,381.30	
Financial, Legal, Administration	9,352.00	
Subtotal	$ 56,114.60	
Easements	1,300.00	
TOTAL CAPITAL COSTS	$ 174,321.00	$ 174,321.00

TABLE 3-4 Communal Solutions for Problem Areas"

COMPONENT	UNIT COST CAPITAL & INSTALLATION	PROBLEM AREA 1		PROBLEM AREA 2		PROBLEM AREA 3		PROBLEM AREA 4		PROBLEM AREA 5	
		QUANTITY	COST	QUANTITY	COST	QUANTITY	COST	QUANTITY	COST	QUANTITY	COST
1. SEPTIC TANK	$800/1000 gal. $1833/2000 gal in Problem Area 4	19	15,200	5	4000	24	19,200	13 (2000 GAL.)	23,829	7	5600
2. SEPTIC TANK HOOKUP	$450.00 each	58	26,100	8	3600	57	25,650	20	9,000	24	10,800
3 COLLECTION PIPE	$20.00/LF	4225 LF	84,500	1175/LF	23,500	4300 LF	86,000	2940LF	58,800	2865LF	57,300
4. CLEANOUTS	$1200 each	18	21,600	2	2400	13	15,600	6	7200	6	7,300
5. DOSING SYSTEM	$200 house siphon $400 house pump	58 house siphon	11,600	8 house siphon	1600	57 houses (pump)	22,800	20 houses (pump)	8000	24 houses (pump)	9,600
6. LEACH FIELD											
A. LAND PURCHASE	20,000/acre	4.64 acres	92,800	0.8 acres	16,000	1.425 acre	28,500	1.7 acres	34,000	1.68 acre	33,600
B. LAND CLEARING	2,000/acre	4.64 acre	9,280	0.8 acres	1,600	1.425 acre	2,850	1.7 acres	3,400	1.68 acre	3,360
C. EXCAVATION	2.50/yd^3	1157.9yd^3	2894.75	160yd^3	400	1138yd3	2,845	912yd^3	2,280	498yd^3	1,245
D. GRAVEL FOR TRENCHES	10.00/yd^3	435yd^3	4350	60yd^3	600	428yd^3	4,280	343yd^3	3,430	180yd^3	1,800
E. PEASTONE FOR TRENCHES	9.00yd^3	145yd^3	1305	20yd^3	180	143yd^3	1,287	114 yd^3	1,026	60yd^3	540
F. FILL MATERIAL	5.00yd^3	0yd^3	0.0	2810yd^3	14,050	0yd^3	0	0yd^3	0	3175yd^3	15,875
G. DISTRIB. PIPE	2.50/LF	15,631LF	39077.50	2156LF	5390	15,362LF	38,405	12320LF	30,800	6469LF	16,172.50
H. Backflow Preventers	175 each	35	6125	5	875	35	6,125	23	4,025	15	2,625
I. HEADER PIPE	3.00/LF	4143LF	12,429	600LF	1800	4071LF	12,213	2538LF	7,614	1477LF	4,431
J. GRADING & SUPERVISION	0.065/ft^2	138,330ft^2	8991.45	20,800ft^2	1352	135,945ft^2	8,836.45	70492ft^2	4,582	35058ft^2	2,278.75
K. LAYOUT & SUPERVISION	1.00/LF	15,631LF	15,631	2156LF	2156	15,362LF	15,362	12320	12,320	6469	22,907LF
7. SUBTOTAL		192,883,7			44,403		120,703.45		103,477		88,396.25
8. TOTAL			351,883.70		79,503		[illegible]				

TABLE 3-4 cont.

COMPONENT	UNIT COST CAPITAL & INSTALLATION	PROBLEM AREA 6		PROBLEM AREA 7		PROBLEM AREA 8		PROBLEM AREA 9		PROBLEM AREA 10	
		QUANTITY	COST	QUANTITY	COST	QUANTITY	COST	QUANTITY	COST	QUANTITY	COST
1. SEPTIC TANK	$800/1000 gal $1833/2000 gal in Problem Area 4	30	24,000	10	8,000	15	12,000	19	15,200	7	5600
2. SEPTIC TANK HOOKUP	$450.00 each	85	38,250	29	13,000	59	26,550	41	18,450	15	6750
3. COLLECTION PIPE	$20.00/LF	8135	162,700	2560	51,200	4200LF	84,000	3275LF	65,500	2100LF	42,000
4. CLEANOUTS	$1200 each	23	27,600	8	9,600	11	13,200	8	9,600	3	3600
5. DOSING SYSTEM	$200 house siphon $400 house pump	8.5 houses pumped	34,000	29 houses (pumped)	11,600	59 houses (siphon)	11,800	41 houses (pump)	16,400	15 houses (pump)	6000
6. LEACH FIELD A. LAND PURCHASE	20,000/acre	5.1 acres	102,000	3.77 acre	75,400	8.85 acre	177,000	2.05 acre	41,000	0.9acre	18,000
B. LAND CLEARING	2,000/acre	5.1 acre	10,200	3.77 acre	7,540	8.85 acre	17,700	2.05 acres	4,100	0.9 acre	1800
C. EXCAVATION	2.50/yd^3	1696yd^3	4,240	1483yd^3	3707.50	2308yd^3	5,770	818yd^3	2045	441 yd^3	1102.5
D. GRAVEL FOR TRENCHES	10.00/yd^3	636yd^3	6,360	558yd^3	5580	865yd^3	8650	307yd^3	3070	165yd^3	1650
E. PEASTONE FOR TRENCHES	9.00yd^3	212yd^3	1,908	187yd^3	1683	288yd^3	2592	102yd^3	918	54yd^3	486
F. FILL MATERIAL	5.00yd^3	0yd^3	0	0yd^3	0	22,026yd^3	110,130	0yd^3	0	0yd^3	0
G. DISTRIB. PIPE	2.50/LF	22,907LF	57,267.50	20,023LF	50,057.50	31,152LF	77,880	11,049LF	27622.50	5940LF	13,725
H. Backflow Preventers	175 each	42	7,350	31	5,425.	48	8,400	19	3325	13	2275
I. HEADER PIPE	3.00/LF	4,830LF	14,490	3580LF	10,740	5681LF	17043	2168LF	6504	1406LF	4218
J. GRADING & SUPERVISION	0.065/ft^2	143,264ft^2	9,312.15	118,855ft^2	7,725.60	218,929ft^2	14,230.40	64,023ft^2	4161.50	35121ft^2	2282.85
K. LAYOUT & SUPERVISION	1.00/LF	22,907	20,023	20,023	20023	31,152LF	31,152	11,049LF	11,049	5940LF	5990
7. SUBTOTAL			236,034.65		187,887.6		470,547.4		103,795		51,[illegible].35
8. TOTAL			522,584.65		[illegible] 331.60		618,097.40		223,945		115,429.35

TABLE 3-4 cont.

COMPONENT	UNIT COST CAPITAL & INSTALLATION	PROBLEM AREA 11		PROBLEM AREA 1		PROBLEM AREA 13	
		QUANTITY	COST	QUANTITY	COST	QUANTITY	COST
1. SEPTIC TANK	$800/1000 gal $1833/2000 gal in Problem Area 4	9	7200	11	8800	3	2400
2. SEPTIC TANK HOOKUP	$450.00 each	14	6300	28	12,600	17	7650
3 COLLECTION PIPE	$20.00/LF	1840LF	36,800	3265LF	65,300	1350LF	27,000
4 CLEANOUTS	$1200 each	3	3600	4	4800	2	2400
5. DOSING SYSTEM	$200 house siphon $400 house pump	14 houses (pump)	5600	28 houses (pump)	11,200	17 houses (pump)	6800
6. LEACH FIELD A. LAND PURCHASE	20,000/acre	0.56 acre	11,200	3.1acre	62,000	1.87 acre	37,400
B. LAND CLEARING	2,000/acre	0.56 acre	1120	3.1 acre	6,200	1.87 acre	3,740
C. EXCAVATION	2.50/yd^3	239yd^3	597.50	642 yd^3	1605	296 yd^3	740
D. GRAVEL FOR TRENCHES	10.00/yd^3	90yd^3	900	240 yd^3	2400	112yd^3	1120
E. PEASTONE FOR TRENCHES	9.00yd^3	31yd^3	279	80yd^3	720	36 yd^3	324
F. FILL MATERIAL	5.00yd^3	0	0	0	0	0	0
G. DISTRIB. PIPE	2.50/LF	3234LF	8085	8800	22000	4007LF	10017.50
H. Backflow Preventers	175 each	6	1050	20	3500	17	2975
I. HEADER PIPE	3.00/LF	764	2292	2800LF	8400	2137LF	6411
J. GRADING & SUPERVISION	0.065/ft^2	19,244	1250.85	51840 ft^2	3369.60	33,514 ft^2	2178.40
K. LAYOUT & SUPERVISION	1.00/LF	3234 LF	3234	8800 LF	8800	4007 LF	4007
7. SUBTOTAL			30008.35		118994.6		68,912.9
8 TOTAL			89,508.35		221,694.60		115,162.7

3.2.1c Annual O & M Costs

The annual O & M costs will be calculated for a 5% failure rate for septic systems. No new growth is assumed. The estimation of the number of mound replacements was outlined in Section 1.3.3b. For the initially constructed systems, the number of failures can be estimated by:

13 Initially Installed Systems X 0.01/year = 0.13 systems/year

For the initial nonproblem systems, the number of failures can be estimated by:

21 Initial Nonproblem Systems X 0.05/yr = 1.05 systems/year

Septage pumping is assumed to take place every 3 years for all systems as a cost of $75 per pump-out. The annual cost for pumping is, thus, $25.

ITEM	NUMBER	UNIT PRICE	ANNUAL COST	PRESENT WORTH
Initially Built Mounds	0.13/yr.	$6,185	$ 804	
Initially Conventional Septic Systems	1.05/yr.	$6,185	$6,494	
Mound Repairs	0.105/yr.	$6,185	$ 650	
Septage Pumping	34	$ 25	$ 850	
Pump Maintenance	13	$ 42.50	$ 618	
Total			$9,416	$98,791

3.2.1d Salvage Valve

The procedures for salvage value determination were outlined in Section 1.3.4. The value for each component is calculated below:

Septic Tanks

$$\text{Number} \times \frac{(\text{\% of Useful Life Remaining})}{100\%} \times \text{Unit Cost} = \text{Salvage Value}$$

13 x (0.60) x $1833 = $14,300

Initially Constructed Mounds

$$\text{Number} \times \left(\frac{\text{\% Useful Life Remaining}}{100\%}\right) \times \text{Unit Cost} = \text{Salvage Value}$$

(0.80 x 13) x (0.50) x \$6185 = \$32,160

Other Mounds

(21 + 0.2 x 13) x (.75) x \$6185 = \$109,475

Pump Chambers

13 x (0.6) x \$975 = \$7605

A summation of the salvage values is presented below:

Item	Salvage Value	Present Worth
Septic Tanks	\$ 14,300	
Pump Chambers	7,605	
Initial Mounds	32,160	
Replaced Mounds	109,475	
	\$163,540	\$41,286

3.2.1e Total Present Worth

Capital	\$174,321
O & M	98,791
Salvage	(41,286)
Total Present Worth	\$231,826

3.2.2 Communal System

3.2.2a Design Basis

In the communal option for problem area 4, all 13 of the present problem septic systems are hooked up to a septic tank effluent collection system. In addition, 7 presently non-failing systems are also hooked up to the small sewer because of its proximity. The collected septic tank effluent from the 20 houses is pumped to a communal leachfield some distance from the problem area. The remainder of the septic systems in problem area 4 will be repaired/replaced onsite. Figure 3-1 shows the collection system layout.

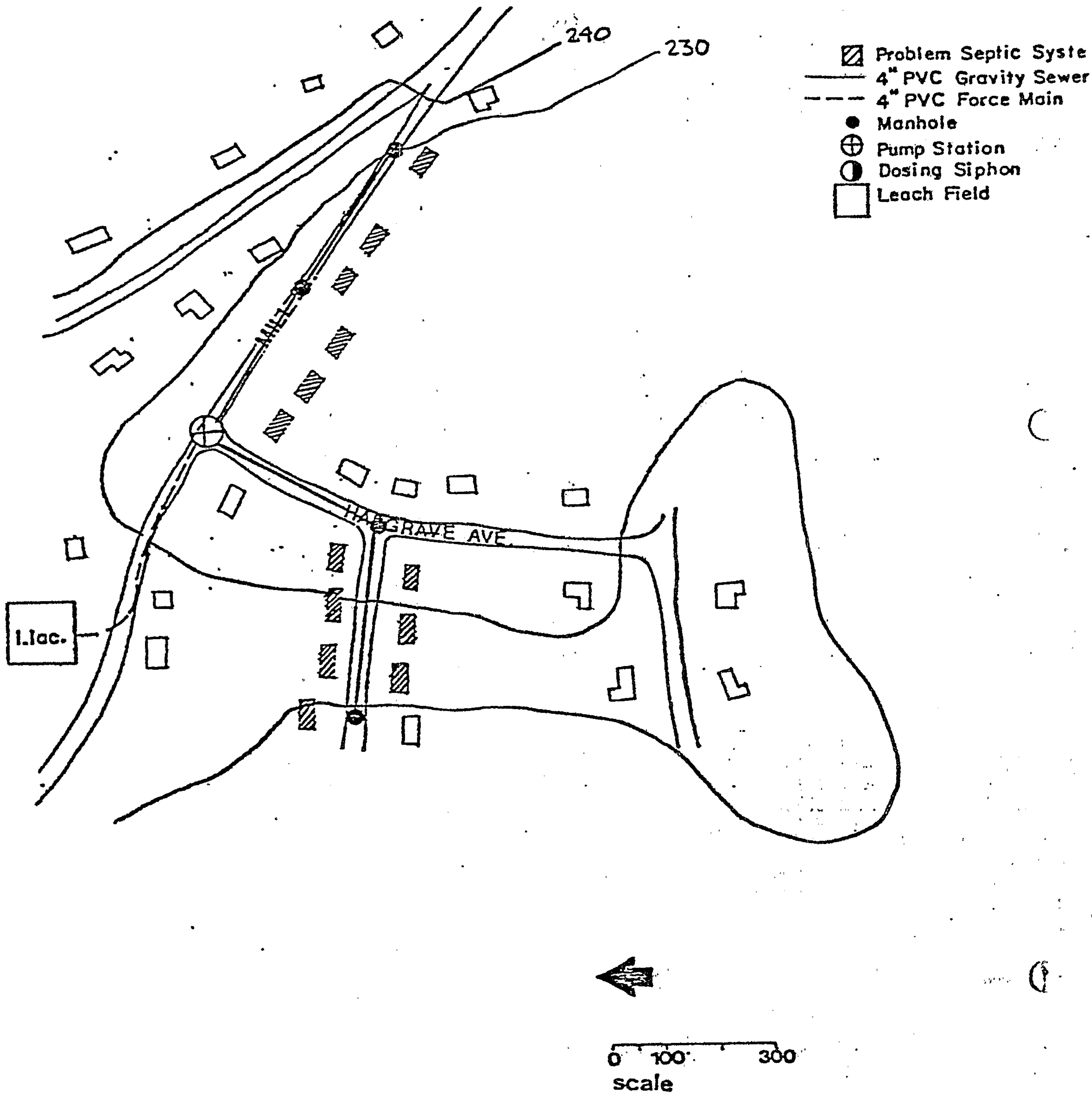
3.2.2b Capital Costs

Construction Costs from Table 3-4

Total Construction	\$176,310
Contingencies	\$ 35,260
Engineering Design	\$ 35,260
Financial/Legal Administration	\$ 14,100
Land	\$ 34,000
Easements	\$ 2,000
Total Capital Costs	\$296,930

PROBLEM AREA 4
201 WASTEWATER MANAGEMENT
STUDY

Figure 3-1



3.2.2c Annual Operations and Maintenance

The operations and maintenance costs include septage pumping, collection pipe and dosing system maintenance, communal system failure (1% per year, as with onsite mounds), and septic system failure (5% per year).

Collection Pipe

Quantity	Basis	Cost
2940 LF	$0.10/LF	$294

Septage Pumping

Quantity	Basis	Cost
34 Houses	$25/year/house	$850

Dosing System Repair - Pump Maintenance

Quantity	Basis	Cost
1 Pump	$363/Pump	$363

Communal Leachfield Repair

Quantity	Basis	Cost
1	1% of Total Cost (excluding land)	$1763

Onsite Replacement

Quantity	Basis	Cost
0.7 year	$6185/mound	$4330

The summary of annual O & M costs is presented below:

Annual Operations and Maintenance

Item	Amount	Present Worth
Septage Pumping	$850	
Collection Pipe	294	
Dosing System	363	
1% Communal Leachfield Failure Repair	1,763	
5% Onsite Failure Repair (.7/yr)	4,330	
TOTAL O & M (5% Failure)	7,600	$79,738

3.2.2d Salvage Value

The salvage value of the communal system is determined in a manner similar to that followed for the onsite system.

Septic Tank

Number	X	(% Useful Life Remaining) / 100%	X	Unit Cost	=	Salvage Value
13	X	0.60	X	1833		$14,300

Collection System

Quantity X (% Useful Life Remaining / 100%) X Unit Cost = Salvage Value

2940 LF X (0.60) x $20.00 = $35,280

Cleanouts

6 x (0.60 x $1200) = $4320

Communal System

Mound (excluding land)

1 x (0.5) x $69,477 = $34,739

Dosing System

1 x (0.60) x $8000 = $4800

Land

Land is appreciated at a rate of 3%/acre. Over twenty years, the land value increases by a factor of (1.03) 20 or 1.806.

Quantity	X	Appreciation Factor	X	Unit Cost	=	Salvage Value
1.7 acres	x	$(1.03)^{20}$	x	$20,000/acre	=	$61,408

Onsite Mounds

Quantity X (% Useful Life Remaining / 100%) X Unit Cost = Salvage Value

where:

% Useful Life Remaining = (Useful Life - Average Life of Mounds) / Useful Life x 100

$$= \frac{(40-10)}{40} \times 100 = 75\%$$

14 x (0.75) x $6185 = 64,943

Easements

The value of easements is assumed to be unchanged throughout the Planning Period

20 x 1 x $100 = $2000

The salvage values for the communal system are summed up below.

Item	Amount	Present Worth
Septic Tanks	$14,300	
Collection System	35,280	
Cleanouts	4,320	
Communal		
Mound	34,739	
Dosing	4,800	
Land	61,408	
Onsite Mounds (5% Failure)	64,943	
Easements	2,000	
TOTAL	$221,790	$55,991

Total Present Worth

5% Failure RAte

Capital....................	$ 296,930
O & M (PW)................	79,738
Salvage....................	(55,991)
	$ 320,677

3.2.3 Comparison of System by Cost

Onsite System (PW)	Communal System (PW)
$231,826	$320,677

The onsite solution is obviously the more cost effective for Problem Area 4.

3.3 Problem Area 14 (Downtown)

3.3.1 Design Basis

There are presently 36 problem systems in the downtown area of the case study community. In the onsite option, 29 will be repaired onsite, while the remaining 7 must be served by a communal system because of a lack of space onsite. The communal system also includes 6 presently non-failing systems which must connect to the sewer because of its proximity. The remaining 328 systems in the downtown region will be repaired onsite as they fail (5% of total/year). In the communal option, all 370 septic tanks in the downtown region are connected to a collection system and piped to an aerated lagoon/aquaculture treatment facility.

3.3.2 Onsite Solutions

Table 3-5 presents background cost estimate for onsite systems within the Woodrock town center.

Table 3-5 Cost Basis for Onsite Option

1)	Septic Tank/Conventional Soil Absorption System, based on a 3-bedroom home, percolation rate of 20 min/inch:	$2900
2)	Septic Tank/Mounded Soil Absorption System, based on a 3-bedroom home, 4 foot mound, and percolation rate of 10 min/inch:	$7325
3)	Septic Tank/Mounded Soil Absorption System, off-site	$9150

While most of the problems in the town center can be solved onsite, there are several which require the establishment of a communal leaching area in the town center.

3.3.2a CAPITAL COST

ONSITE SYSTEMS: (from Table 3-6)

by Method #1:	15@	$2900 each =	$43,500	
by Method #2:	8@	$7325 each =	$58,600	
by Method #3:	6@	$9150 each =	$54,900	
SUBTOTAL (ONSITE)			$157,000	$157,000

COMMUNAL LEACHING SYSTEMS:

Collection System Component

Septic Tanks	13 @ $800/ea	=	$10,400
Septic Tank Hook-up	13 @ $450/ea	=	$ 5,840
Collection Pipe 1410 LF	@ $20/LF	=	$28,200
Cleanouts	10 @ $1200/ea	=	$12,000
Pump Station	1 @ $15,000	=	$15,000
SUBTOTAL (COMMUNAL COLLECTION)			$81,440

Leachfield Component

Land Clearing	.62 Ac	@ $2000/Ac	=	$1,240
Excavation	144.4 yd^3	@ $2.5/$yd^3$	=	$ 360
Gravel	77.8 yd^3	@ $ 10/yd^3	=	780
Pea Stone	11.1 yd^3	@ $ 9 yd^3	=	100
Fill Material	1740 yd^3	@ $ 5 yd^3	=	$8,700
Trench Pipe	1200 LF	@ $2.5/LF	=	$3,000
Distribution Boxes	6	@ $175/ea.	=	$1,050
Pipe	50 LF	@ $3/LF	=	$ 150
Grading & Shaping	11,750 ft^2	@ $0.065/$ft.^2$	=	$765
Layout/Supervision	1200 LF	@ $1/LF	=	$1,200

SUBTOTAL (COMMUNAL DISPOSAL)	$17,345	
SUBTOTAL (COMMUNAL)	$98,785	$98,785
TOTAL CONSTRUCTION COSTS		$255,785

DEVELOPMENT COSTS

Contingencies	$ 51,150	
Engineering/Designs, etc.	38,375	
Legal, Administration, etc.	25,575	
Easements & Land Acquisition	36,000	
TOTAL DEVELOPMENT COSTS	$151,100	$151,000
TOTAL PROJECT COSTS		$406,885

3.3.2b ANNUAL OPERATION AND MAINTENANCE COSTS

	ANNUAL COST	PRESENT WORTH
I. Existing Problems:		
Septage Pumping (once every three yrs.) 36 @ $25/ea	$ 900	
Pumps 15 @ $46.50/ea.	700	
Replacement and repair	2375	
SUBTOTAL	$3975	
II. Non-Problem Systems		
Septage Pumping (once every three yrs.) 334 @ $25/ea	$8350	
III. Collection System (if required) Pipe Cleaning 1410 LF @ $0.60/LF	$ 845	
IV. 5% Failure/year of present onsite systems 328 x .05 = 16.4 @ $7325	$122,330	
Total Operations & Maintenance Per Year	$135,500	$1,421,650

3.3.2c Salvage Value

The salvage value of the onsite option is determined in the same manner as for the onsite and communal options described for Problem Area 4 above. A summation of the values is presented below:

Item	Amount	Present Value
Onsite Systems (Present Problems)	$ 78,500	
Communal System		
Septic Tanks	6,240	
Collection Pipe	16,920	
Cleanouts	7,200	
Pump Station	9,000	
Leachfield	8,675	
Future Onsite Systems (5% Failure)	91,750	
Easements	36,000	
Total Salvage	$254,285	$64,195

3.3.2d Total Present Worth

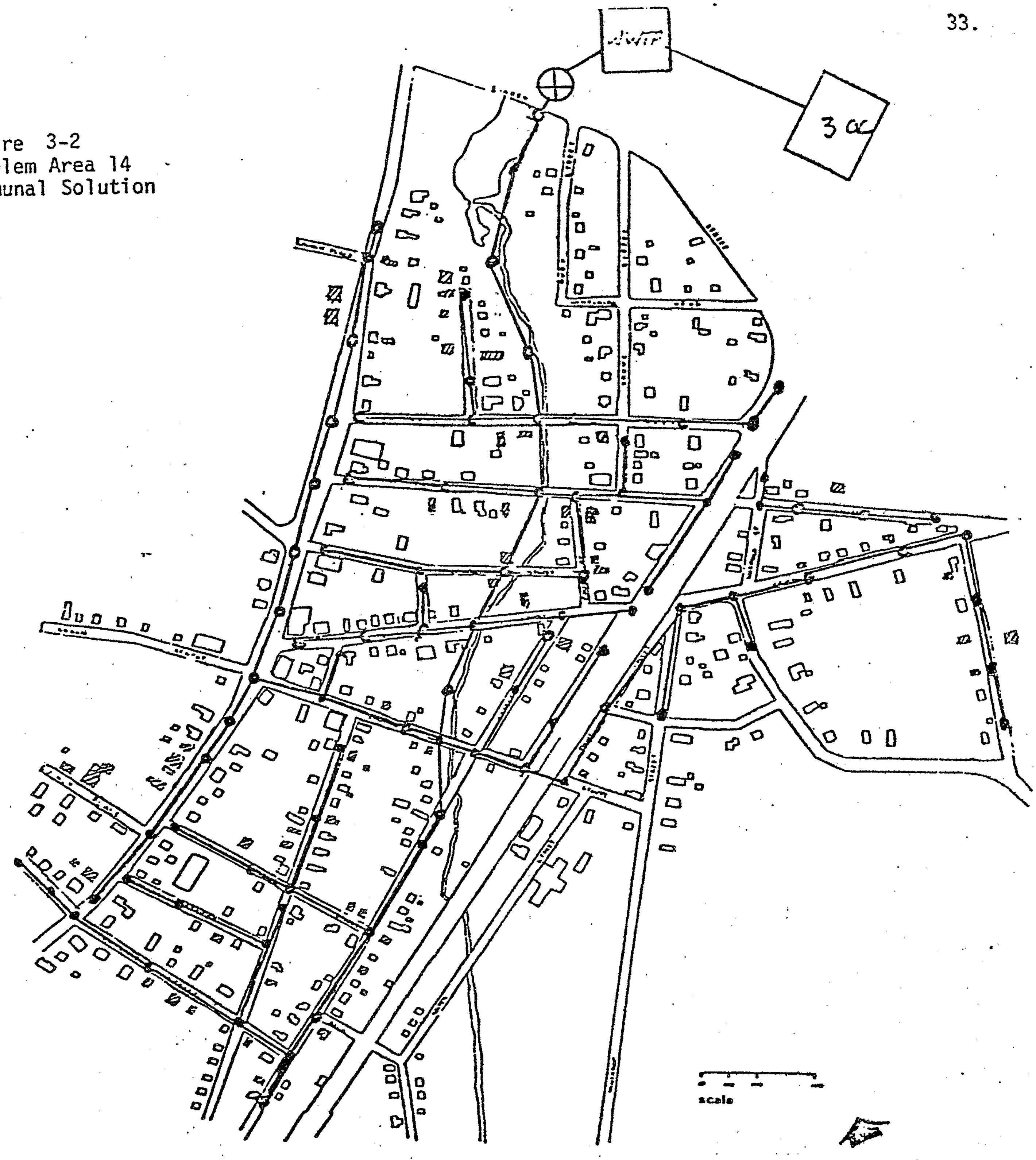
5% Per Year Failure of Present Non-Problem Systems

Capital..................	$ 406,885
Annual O & M (PW)........	1,421,650
Salvage (PW).............	(64,195)
Total Present Worth	$1,764,340

3.3.3 Communal System for Downtown Area

The communal system for downtown Woodrock involves the collection of septic tank effluent and treatment by an aerated lagoon/aquaculture system. The piping layout is presented in Figure 3-2, and the costs associated with collection and treatment are summarized in Tables 3-7 and 3-8.

Figure 3-2
Problem Area 14
Communal Solution



Problem Septic System
PVC Gravity Sewer
PVC Force Main
Manhole
Pump Station
Dosing Siphon
Leach Field

Table 3-6 Costs of Collection System

Capital Costs

Item	Basis		Cost
4" Collection Pipe	10,530 LF	@ $16/LF	$168,480
6" Collection Pipe	280 LF	@ $18/LF	5,040
8" Collection Pipe	9,620 LF	@ $20/LF	192,400
Cleanouts	110	@ 1200	132,000
Septic Tanks	370	@ 800	296,000
Pump Station	1	@ 42,000	42,000
Street Connection	370	@ 450	166,500
River Crossings	5	@ 16,500	82,500
Escavation	2270yd3	@ 35/yd^3	79,450
Total Construction Cost			$1,164,370

Contingencies....................	$232,875	
Engineering & Design.............	$232,875	
Financial/Legal/Administrative...	$ 93,150	
Total Capital Costs	$1,723,270	$1,723,270

Annual Operations & Maintenance

				Present Worth
Collection System	20,430 LF	@ $0.06/LF	$1,225	
Septage Pumping	370	@ $25	9,250	
			$10,475	$109,900

Salvage Value

	Value	Present Worth
Collection System	$219,550	
Cleanout	79,200	
Septic Tanks	177,600	
Pump Station	25,200	
River Crossings	49,500	
Total Salvage Value	$551,050	$139,115

Total Present Worth of Collection Systems

Capital Costs	$1,723,270	
Annual O & M (PW)	109,900	
Salvage Value	(139,115)	
Total Present Worth	$1,694,055	$1,694,0

TABLE 3-7

WASTEWATER TREATMENT FACILITY

PRESENT WORTH

CAPITAL COST:		
Site Preparation	$ 6,800	
Equalization Tank	19,900	
Acquaculture Treatment (aerated lagoon)	443,250	
Operations Building/Laboratory	35,000	
Exterior Piping	15,000	
Electrical, HVAC	20,000	
Effluent Disposal	62,500	
Total Construction Cost	$ 602,450	
Contingencies	$ 120,450	
Engineering, Design, etc.	90,400	
Legal, Administrative, etc.	30,100	
Operator Training	20,000	
Land	80,000	
Total Development Cost	$ 341,000	
TOTAL CAPITAL COST		$ 943,450
ANNUAL OPERATIONS AND MAINTENANCE:		Present Worth
Labor	$ 15,000	
Electricity	1,300	
Equipment Replacement	500	
Laboratory Analysis	1,000	
Resource Recovery	- 2,250	
TOTAL O & M COST	$ 15,550	$ 163,150
Salvage Value		Present Worth
Equalization Tank	$ 11,940	
Aquaculture Treatment	221,625	
Operations Building	21,000	
Exterior Piping	9,000	
Effluent Disposal	31,250	
Land	144,490	
	$ 439,305	$ 110,900

Table 3-7 cont.

Total Present Worth of Wastewater Treatment Facility

Capital Costs	$ 943,450
Present Worth of Annual O&M	163,150
Salvage Value (Present Worth)	(110,900)
Total Present Worth	$ 995,700

3.3.4 Comparison of Onsite vs. Communal Systems for Downtown Woodrock

Onsite Systems (5% Failure/yr)

Present Worth..................................$1,764,345

Communal System

Collection.....................................$1,694,055

Treatment Plant................................$ 995,700

Total Present Worth $2,689,755

The onsite option is more cost effective than the communal option.

3.3.5 Townwide Analysis

A townwide analysis can be made by summarizing the cost effectiveness analysis for problem areas 1-15 (Problem Area 15 is the dispersed problems). A 1% failure rate of onsite systems was assumed for the outlying regions, and a 5% failure rate in the downtown section. Downtown communal and onsite solutions are examined for their impact on the overall cost of the program. All outlying problem areas are solved by onsite solutions.

Included in the townwide assessment are:

* a septage treatment facility ($742,900 capital costs; $25,500/yr O & M costs)
* management option, including a computer and groundwater monitoring ($25,000 capital costs; $13,600/yr O & M costs)
* an assumption of 50 new septic systems added per year in non-problem areas.

The assumption that no new growth occurs in presently defined Problem Areas has been made because each of the Problem Areas is essentially a completely built-up housing development, with little room for further growth.

3.3.5a Repair of New Systems

The determination of the repair of new (growth-related) systems is similar to that for present systems. With an incremental annual increase of 50 systems per year and an assumed failure rate of 1%/year, there would be 115.5 failures in the 20 year design period. If these were assumed to fail in a linear fashion (a simplification) then the annual cost for repairs can be shown by:

Total Number of Failures/Planning Period X Unit Cost = Annual Cost

115.5 failures/20 years X $9253 = $53,435/year

The Present Worth of this annual cost is $530,632.

3.3.5b Salvage Value of New Systems

Based on the assumed growth and failure rates, a total of 115.5 systems will be estimated to fail in the design period. If these are assumed to fail linearly over the 20 year period then the salvage value can be calculated as:

Number of Replacements	X	(% Useful Life Remaining / 100%)	X Unit Cost	=	Salvage Value
115.5	X	(0.75)	X $9,253	=	$801,541
				=	$202,350 (Present Worth)

For the present case, the system cost is assumed to be $9,253 (4 Bedroom Mound with 30 minute/inch perc rate - from Table 3-3)

Tables 3-9 and 3-10 summarize the cost effectiveness analysis for the entire town ofWoodrock.

TABLE 3-8 ONSITE/SMALL COMMUNAL SYSTEM:

*Failure Rate of 5%/yr on the 334 present non-problem systems in downtown area
**Failure Rate of 1%/yr on all repaired and present non-problem systems

Cost Effectiveness Analysis

Problem Area: Entire Community

Cost Effectiveness Analysis Criteria: 20 year design period, 7-1/8 % interest rate

	PRESENT FAILURES		PRESENT NON-PROBLEM SYSTEMS		NEW CONSTRUCTION		COMMON COSTS		TOTAL PRESENT WORTH
NUMBER OF STRUCTURES	589		3514		50/yr	1000 total			5103
FAILURE RATES			*	**	1%/yr				
CAPITAL COSTS	$7,353,450	$7,353,450					$ 742,900	$ 742,900	$8,096,350
O&M COSTS — REPAIRS			$ 504,211/yr	$5,290,115	$53,435/yr	$560,630			$5,850,745
O&M COSTS — SEPTAGE PUMPING/ INSPECTION	$14,725/yr	$ 154,493	$ 87,850/yr	$ 921,710	$1250 incr/yr	$ 95,490			$1,171,693
O&M COSTS — ELECTRICITY, PARTS REPLACEMENT, CLEANING,...	$ 26,400/yr	$ 276,985	$1987 incr/yr	$ 151,789	$22/yr	$ 1680	$32,000/yr	$335,740	$ 766,194
MGM'T — COMPUTER, GROUNDWATER MONITORING WELLS							$25,000	$25,000	$ 25,000
MGM'T — INSPECTIONS, GROUND-WATER TESTING, ADMINISTRAT'N			$ 1400/yr	$ 14,689			$12,200/yr	$128,580	$143,269
LAND/EASEMENTS	$136,000	$136,000					$25,000	$25,000	$161,000
SALVAGE — CAPITAL EQUIPMENT	$3,145,986	($794,205)	$2,189,019	($552,616)			$123,000	(31,051)	($1,580,222)
SALVAGE — LAND AND EASEMENTS	$136,000	($ 34,333)					$ 45,156	($11,400)	($45,733)
TOTAL PRESENT WORTH		$7,092,390		$5,825,687				$1,214,769	$14,508,296

TABLE 3-9 ONSITE/LARGE COMMUNAL SYSTEM: Cost Effectiveness Analysis

Problem Area: Entire Community

Cost Effectiveness Analysis Criteria: 20 year design period; 7-1/8 % interest rate

*Includes 334 present non-problem systems in downtown communal system

		PRESENT FAILURES		PRESENT NON-PROBLEM SYSTEMS		NEW CONSTRUCTION		COMMON COSTS		TOTAL PRESENT WORTH
NUMBER OF STRUCTURES		923*		3180		50/yr	1000			5103
FAILURE RATES				----- 1% per year -----		1%/yr				
CAPITAL COSTS		$9,485,850	$9,485,850					$742,900	$742,900	$10,228,750
O&M COSTS	REPAIRS			$355,047/yr	$3,725,103	$53,435/yr	$560,630			$4,285,733
O&M COSTS	SEPTAGE PUMPING/ INSPECTION	$ 23,075/yr	$242,100	$79,500/yr	$834,103	$1250 incr/yr	$ 95,490			$1,171,693
O&M COSTS	ELECTRICITY, PARTS REPLACEMENT, CLEANING,...	$80,375/yr	$843,283	$760 incr/yr	$53,473	$22 incr/yr	$1680	$25,500/yr	$267,542	$1,165,978
MGM'T	COMPUTER, GROUNDWATER MONITORING WELLS							$25,000	$ 25,000	$ 25,000
MGM'T	INSPECTIONS, GROUND-WATER TESTING, ADMINISTRAT'N			$1400/yr	$14,689			$12,200/yr	$128,580	$143,269
LAND/EASEMENTS		$225,000	$225,000					$25,000	$25,000	$250,000
SALVAGE	CAPITAL EQUIPMENT	$1,064,250	($268,670)	$1,541,426	($389,132)	($801,541)	($202,350)	$123,000	($31,051)	($891,203)
SALVAGE	LAND AND EASEMENTS	$289,000	($72,958)					$45,156	($11,400)	($84,358)
TOTAL PRESENT WORTH			$10,454,605		$4,238,236		$455,450		$1,146,571	$16,294,862

4. User Costs

The determination of user costs in a situation where different users receive different types of services requires that the community make a number of decisions relative to the allocation of those costs. For the purposes of this example it is assumed that 370 structures will be serviced by the central collection treatment system; 589 will receive onsite repairs and 3144 will continue to use their existing onsite systems but will become part of the overall management district and will make avail of the septage treatment facilities. The costs used in this example are summarized below:

I. Capital Costs

A. Downtown Collection System

Total Capital Costs	=	$1,723,270
85% Federal Grant	-	1,464,780
10% State Grant	-	172,330
Total Local Share	=	$ 86,160
Debit Retirement (20 yrs @ 11%)*		$ 10,820/yr

B. Wastewater Treatment Facility

Total Capital Costs	=	$ 943,450
85% Federal Grant	-	801,930
10% State Grant	-	94,350
Total Local Share	=	$ 47,170
Debit Retirement (20 yrs @ 11%)*		$ 5,920/yr

C. Septage Treatment Facility

Total Capital Costs	=	$ 742,900
85% Federal Grant	-	631,470
10% State Grant	-	74,290
Total Local Share	=	$ 37,140
Debit Retirement (20 yrs @ 11%)*		$ 4,660/yr

D. Onsite System Repairs

Total Capital Costs	=	$7,353,450
85% Federal Grant	-	6,250,430
10% State Grant	-	735,350
Total Local Share	=	$ 367,670
Debit Retirement (20 yrs @ 11%)*		$ 46,170/yr

*Amortization Factor = 0.12558

II. Operation and Maintenance Costs

A. Downtown Collection System (excluding septage pumping) — $ 1,225/yr

B. Wastewater Treatment Facility — $15,550/yr

C. Septage Treatment Facility — $32,000/yr

D. Management Costs (onsite systems) — $37,200/yr

III. Septage Pumping/Hauling Costs

$75/household every three years = $25/household/yr

4.1. User Costs for Downtown Residents

The residents of the downtown district will be assessed the total cost of the collection and wastewater treatment systems and a proportionate share of the septage treatment and management costs. Since the downtown area will be served by a small diameter gravity sewer, each structure will be using a septic tank which will have to be pumped. A summary of the user cost calculation follows:

Collection system Capital Costs	=	$10,820
Wastewater Treatment Capital Costs	=	5,920
Septage Treatment Capital Costs (370 x 4660/4103)	=	420
Collection O & M	=	1,225
Wastewater Treatment O & M	=	15,550
Septage Treatment O & M (370 x 32,000/4103)	=	2,890
Mangement Costs (370 x 37,200/4103)	=	3,350
Total		$40,175

User Costs

Collection/Treatment	40,175/370	=	$109/yr
Septage Pumping		=	25/yr
Total User Cost		=	$134/yr

4.2 User Costs For System Being Initially Repaired

Residents who will be having their systems repaired will be assessed for the costs of those repairs plus a proportionate share of the other facilities they will use, these are summarized below.

Onsite System Repair Capital Costs	$46,170
Septage Treatment Capital Costs (589 x 4660/4103)	670
Septage Treatment O & M (589 x 32,000/4103)	4,590
Management Costs (589 x 37,200/4103)	5,340
Total	$56,770

User Costs

Treatment	56,770/589	=	$96/yr
Septage Pumping			25/yr
Total User Cost		=	$121/yr

4.3. User Costs For Residents Not Receiving System Repairs

For this example it is assumed that this group will pay for its share of all cost associated with utilizing the septage facilities.

A. Summary Follows:

Septage Treatment Capital Costs (3144 x 4660/4103)	=	$ 3,570
Septage Treatment O & M (3144 x 32,000/4103)	=	24,520
Management Costs (3144 x 37,200/4103)	=	28,510
Total		$56,600

User Costs

Treatment	56,600/3144	=	$18/yr
Septage Pumping			25/yr
Total User Cost		=	$43/yr

Questions

1. Is the most cost effective solution always the most favorable from a community's standpoint? Why or Why not?

2. A number of assumptions are made in conducting a cost effectiveness analysis, of the following which are mandated by EPA regulations and which are left to the discretion of the engineer:

   - length of planning period
   - discount rate
   - rate of failure of onsite systems
   - cost of repairing onsite treatment systems
   - useful life of capital items

   . Discuss, in general terms the implications of varying these assumptions as they relate to the selection of a particular alternative.

3. Different present worth factors are used for land costs and energy costs under existing EPA regulations. What is the basic assumption behind these differences?

APPENDIX A

COST-EFFECTIVENESS ANALYSIS GUIDELINES

1. *Purpose.* These guidelines represent Agency policies and procedures for determining the most cost-effective waste treatment management system or component part.

2. *Authority.* These guidelines are provided under sections 212(2)(C) and 217 of the Clean Water Act.

3. *Applicability.* These guidelines, except as otherwise noted, apply to all facilities planning under step 1 grant assistance awarded after September 30, 1978. The guidelines also apply to State or locally financed facilities planning on which subsequent step 2 or step 3 Federal grant assistance is based.

4. *Definitions.* Terms used in these guidelines are defined as follows:

a. *Waste treatment management system.* Used synonymously with "complete waste treatment system" as defined in § 35.905 of this subpart.

b. *Cost-effectiveness analysis.* An analysis performed to determine which waste treatment management system or component part will result in the minimum total resources costs over time to meet Federal, State, or local requirements.

c. *Planning period.* The period over which a waste treatment management system is evaluated for cost-effectiveness. The planning period begins with the system's initial operation.

d. *Useful life.* The estimated period of time during which a treatment works or a component of a waste treatment management system will be operated.

e. *Disaggregation.* The process or result of breaking down a sum total of population or economic activity for a State or other jurisdiction (i.e., designated 208 area or SMSA) into smaller areas or jurisdictions.

5. *Identification, selection, and screening of alternatives.* a. *Identification of alternatives.* All feasible alternative waste management systems shall be initially identified. These alternatives should include systems discharging to receiving waters, land application systems, on-site and other non-centralized systems, including revenue generating applications, and systems employing the reuse of wastewater and recycyling of pollutants. In identifying alternatives, the applicant shall consider the possibility of no action and staged development of the system.

b. *Screening of alternatives.* The identified alternatives shall be systematically screened to determine those capable of meeting the applicable Federal, State and local criteria.

c. *Selection of alternatives.* The identified alternatives shall be initially analyzed to determine which systems have cost-effective potential and which should be fully evaluated according to the cost-effectiveness analysis procedures established in the guidelines.

d. *Extent of effort.* The extent of effort and the level of sophistication used in the cost-effectiveness analysis should reflect the project's size and importance. Where processes or techniques are claimed to be innovative technology on the basis of the cost reduction criterion contained in paragraph 6e(1) of appendix E to this subpart, a sufficiently detailed cost analysis shall be included to substantiate the claim to the satisfaction of the Regional Administrator.

6. *Cost-effectiveness analysis procedures.* a. *Method of analysis.* The resources costs shall be determined by evaluating opportunity costs. For resources that can be expressed in monetary terms, the analysis will use the interest (discount) rate established in paragraph 6e. Monetary costs shall be calculated in terms of present worth values or equivalent annual values over the planning period defined in section 6b. The analysis shall descriptively present nonmonetary factors (e.g., social and environmental) in order to determine their significance and impact. Nonmonetary factors include primary and secondary environmental effects, implementation capability, operability, performance reliability and flexibility. Although such factors as use and recovery of energy and scarce resources and recycling of nutrients are to be included in the monetary cost analysis, the non-monetary evaluation shall also include them. The most cost-effective alternative shall be the waste treatment management system which the analysis determines to have the lowest present worth or equivalent annual value unless nonmonetary costs are overriding. The most cost-effective alternative must also meet the minimum requirements of applicable effluent limitations, groundwater protection, or other applicable standards established under the Act.

b. *Planning period.* The planning period for the cost-effectiveness analysis shall be 20 years.

c. *Elements of monetary costs.* The monetary costs to be considered shall include the total value of the resources which are attributable to the waste treatment management system or to one of its component parts. To determine these values, all monies necessary for capital construction costs and operation and maintenance costs shall be identified.

(1) Capital construction costs used in a cost-effective analysis shall include all contractors' costs of construction including overhead and profit, costs of land, relocation, and right-of-way and easement acquisition; costs of design engineering, field exploration and engineering services during construction; costs of administrative and legal services including costs of bond sales; startup costs such as operator training; and interest during construction. Capital construction costs shall also include contingency allowances consistent with the cost estimate's level of precision and detail.

(2) The cost-effectiveness analysis shall include annual costs for operation and maintanance (including routine replacement of equipment and equipment parts). These costs shall be adequate to ensure effective and dependable operation during the system's planning period. Annual costs shall be divided between fixed annual costs and costs which would depend on the annual quantity of waste water collected and treated. Annual revenues generated by the waste treatment management system through energy recovery, crop production, or other outputs shall be deducted from the annual costs for operation and maintenance in accordance with guidance issued by the Administrator.

d. *Prices.* The applicant shall calculate the various components of costs on the basis of market prices prevailing at the time of the cost-effectiveness analysis. The analysis shall not allow for inflation of wages and prices, except those for land, as described in paragraph 6h(1) and for natural gas. This stipulation is based on the implied assumption that prices, other than the exceptions, for resources involved in treatment works construction and operation, will tend to change over time by approximately the same percentage. Changes in the general level of prices will not affect the results of the cost-effectiveness analysis. Natural gas prices shall be escalated at a compound rate of 4 percent annually over the planning period, unless the Regional Administrator determines that the grantee has justified use of a greater or lesser percentage based upon regional differentials between historical natural gas price escalation and construction cost escalation. Land prices shall be appreciated as provided in paragraph 6h(1). Both historical data and future projections support the gas and land price escalations relative to those for other goods and services related to waste water treatment. Price escalation rates may be updated periodically in accordance with Agency guidelines.

e. *Interest (discount) rate.* The rate which the Water Resources Council establishes annually for evaluation of water resource projects shall be used.

f. *Interest during construction.* (1) Where capital expenditures can be expected to be fairly uniform during the construction period, interest during construction may be calculated at $I=1/2PCi$ where:

I = the interest accrued during the construction period,
P = the construction period in years,
C = the total capital expenditures,
i = the interest rate (discount rate in section 6e).

(2) Where expenditures will not be uniform, or when the construction period will be greater than 4 years, interest during construction shall be calculated on a year-by-year basis.

g. *Useful life.* (1) The treatment works' useful life for a cost-effectiveness analysis shall be as follows:

Land—permanent.
Waste water conveyance structures (includes collection systems, outfall pipes, interceptors, force mains, tunnels, etc.)—50 years.
Other structures (includes plant building, concrete process tankage, basins, lift stations structures, etc.)—30-50 years.
Process equipment—15-20 years.
Auxiliary equipment—10-15 years.

(2) Other useful life periods will be acceptable when sufficient justification can be provided. Where a system or a component is for interim service, the anticipated useful life shall be reduced to the period for interim service.

h. *Salvage value.* (1) Land purchased for treatment works, including land used as part of the treatment process or for ultimate disposal of residues, may be assumed to have a salvage value at the end of the planning period a least equal to its prevailing market value a the time of the analysis. In calculating the salvage value of land, the land value shall be appreciated at a compound rate of 3 percent annually over the planning period, unless the Regional Administrator determines that the grantee has justified the use of a greater or lesser percentage based upon historical differences between local land cost escalation and construction cost escalation. The land cost escalation rate may be updated periodically in accordance with Agency guidelines. Right-of-way easements shall be considered to have a salvage value not greater than the prevailing market value at the time of the analysis.

(2) Structures will be assumed to have a salvage value if there is a use for them at the end of the planning period. In this case, salvage value shall be estimated using straight line depreciation during the useful life of the treatment works.

(3) The method used in paragraph 6h(2) may be used to estimate salvage value at the end of the planning period for phased additions of process equipment and auxiliary equipment.

(4) When the anticipated useful life of a facility is less than 20 years (for analysis of interim facilities), salvage value can be claimed for equipment if it can be clearly demonstrated that a specific market or reuse opportunity will exist.

7. *Innovative and alternative wastewater treatment processes and techniques.*

a. Beginning October 1, 1978, the capital costs of publicly owned treatment works which use processes and techniques meeting the criteria of appendix E to this subpart and which have only a water pollution control function, may be eligible if the present worth cost of the treatment works is not more than 115 percent of the present worth cost of the most cost-effective pollution control system, exclusive of collection sewers and interceptors common to the two systems being compared, by 115 percent, except for the following situation.

b. Where innovative or alternative unit processes would serve in lieu of conventional unit processes in a conventional waste water treatment plant, and the present worth costs of the nonconventional unit processes are less than 50 percent of the present worth costs of the treatment plant, multiply the present worth costs of the replaced conventional processes by 115 percent, and add the cost of nonreplaced unit processes.

c. The eligibility of multipurpose projects which combine a water pollution control function with another function, and which use processes and techniques meeting the criteria of appendix E to this subpart, shall be determined in accordance with guidance issued by the Administrator.

d. The above provisions exclude individual systems under § 35.918. The regional Administrator may allow a grantee to apply the 15-percent preference authorized by this section to facility plans prepared under step 1 grant assistance awarded before October 1, 1978.

8. *Cost-effective staging and sizing of treatment works.*

a. *Population projections.* (1) The disaggregation of State projections of population shall be the basis for the population forecasts presented in individual facility plans, except as noted. These State projections shall be those developed in 1977 by the Bureau of Economic Analysis (BEA), Department of Commerce, unless, as of June 26, 1978, the State has already prepared projections. These State projections may be used instead of the BEA projections if the year 2000 State population does not exceed that of the BEA projection by more than 5 percent. If the difference exceeds this amount, the State must either justify or lower its projection. Justification must be based on the historical and current trends (e.g., energy and industrial development, military base openings) not taken into account in the BEA projections. The State must submit for approval to the Administrator the request and justification for use of State projections higher than the BEA projections. By that time, the State shall issue a public notice of the request. Before the Administrator's approval of the State projection, the Regional Administrator shall solicit public comments and hold a public hearing if important issues are raised about the State projection's validity. State projections and disaggregations may be updated periodically, in accordance with Agency guidelines.

(2) Each State, working with designated 208 planning agencies, organizations certified by the Governor under section 174(a) of the Clean Air Act, as amended, and other regional planning agencies in the State's nondesignated areas, shall disaggregate the State population projection among its designated 208 areas, other standard metropolitan statistical areas (SMSA's) not included in the 208 area, and non-SMSA counties or other appropriate jurisdictions. States that had enacted laws, as of June 26, 1978, mandating disaggregation of State population totals to each county for areawide 208 planning may retain this requirement. When disaggregating the State population total, the State shall take into account the projected population and economic activities identified in facility plans, areawide 208 plans and municipal master plans. The sum of the disaggregated projections shall not exceed the State projection. Where a designated 208 area has, as of June 26, 1978, already prepared a population projection, it may be used if the year 2000 population does not exceed that of the disaggregated projection by more than 10 percent. The State may then increase its population projection to include all such variances rather than lower the population projection totals for the other areas. If the 208 area population forecast exceeds the 10 percent allowance, the 208 agency must lower its projection within the allowance and submit the revised projection for approval to the State and the Regional Administrator.

(3) The State projection totals and the disaggregations will be submitted as an output of the statewide water quality management process. The submission shall include a list of designated 208 areas, all SMSA's, and counties or other units outside the 208 areas. For each unit the disaggregated population shall be shown for the years 1980, 1990, and 2000. Each State will submit its projection totals and disaggregations for the Regional Administrator's approval before October 1, 1979. Before this submission, the State shall hold a public meeting on the disaggregations and shall provide public notice of the meeting consistent with part 25 of this chapter. (See § 35.917(e).)

(4) When the State projection totals and disaggregations are approved they shall be used thereafter for areawide water quality management planning as well as for facility planning and the needs surveys under section 516(b) of the Act. Within areawide 208 planning areas, the designated agencies, in consultation with the States, shall disaggregate the 208 area projections among the SMSA and non-SMSA areas and then disaggregate these SMSA and non-SMSA projections among the facility planning areas and the remaining areas. For those SMSA's not included within designated 208 planning areas, each State, with assistance from appropriate regional planning agencies, shall disaggregate the SMSA projection among the facility planning areas and the remaining areas within the SMSA. The State shall check the facility planning area forecasts to ensure reasonableness and consistency with the SMSA projections.

(5) For non-SMSA facility planning areas not included in designated areawide 208 areas, the State may disaggregate population projections for non-SMSA counties among facility planning areas and remaining areas. Otherwise, the grantee is to forecast future population growth for the facility planning area by linear extrapolation of the recent past (1960 to present) population trends for the planning area, use of correlations of planning area growth with population growth for the township, county or other larger parent area population, or another appropriate method. A population forecast may be raised above that indicated by the extension of past trends where likely impacts (e.g., significant new energy developments, large new industries, Federal installations, or institutions) justify the difference. The facilities plan must document the justification. These population forecasts should be based on estimates of new employment to be generated. The State sh[illegible] check individual population forecasts to insure consistency with overall projections for non-SMSA counties and justification for any difference from past trends.

(6) Facilities plans prepared under step 1 grant assistance awarded later than 6 months after Agency approval of the State disaggregations shall follow population forecasts developed in accordance with these guidelines.

b. *Wastewater flow estimates.* (1) In determining total average daily flow for the design of treatment works, the flows to be considered include the average daily base flows (ADBF) expected from residential sources, commercial sources, institutional sources, and industries the works will serve plus allowances for future industries and nonexcessive infiltration/inflow. The amount of nonexcessive infiltration/inflow not included in the base flow estimates presented herein, is to be determined according to the Agency guidance for sewer system evaluation or Agency policy on treatment and control of combined sewer overflows (PRM 75-34).

(2) The estimation of existing and future ADBF, exclusive of flow reduction from combined residential, commercial and institutional sources, shall be based upon one of the following methods:

(a) *Preferred method.* Existing ADBF is estimated based upon a fully documented analysis of water use records adjusted for consumption and losses or on records of wastewater flows for extended dry periods less estimated dry weather infiltration. Future flows for the treatment works [illegible] should be estimated by determining t[illegible] isting per capita flows based on existing sewered resident population and multiplying this figure by the future projected population to be served. Seasonal population can be converted to equivalent full time residents using the following multipliers:

Day-use visitor	0.1 to 0.2
Seasonal visitor	0.5 to 0.8

The preferred method shall be used wherever water supply records or wastewater flow data exist. Allowances for future increases of per capita flow over time will not be approved.

(b) *Optional method.* Where water supply and wastewater flow data are lacking, existing and future ADBF shall be estimated by multiplying a gallon per capita per day (gpcd) allowance not exceeding those in the following table, except as noted below, by the estimated total of the existing and future resident populations to be served. The tabulated ADBF allowances, based upon several studies of municipal water use, include estimates for commercial and institutional sources as well as residential sources. The Regional Administrator may approve exceptions to the tabulated allowances where large (more than 25 percent of total estimated ADBF) commercial and institutional flows are documented.

Description	Gallons per capita per day
Non-SMSA cities and towns with projected total 10-year populations of 5,000 or less	60 to 70
Other cities and towns	65 to 80

c. *Flow reduction.* The cost-effectiveness analysis for each facility planning area shall include an evaluation of the costs, cost savings, and effects of flow reduction measures unless the existing ADBF from the area is less than 70 gpcd, or the current population of the applicant municipality is under 10,000, or the Regional Administrator exempts the area for having an effective existing flow reduction program. Flow reduction measures include public education, pricing and regulatory approaches or a combination of these. In preparing the facilities plan and included cost effectiveness analysis, the grantee shall, as a minimum:

(1) Estimate the flow reductions implementable and cost effective when the treatment works become operational and after 10 and 20 years of operation. The measures to be evaluated shall include a public information program; pricing and regulatory approaches; installation of water meters, and retrofit of toilet dams and low-flow showerheads for existing homes and other habitations; and specific changes in local ordinances, building codes or plumbing codes requiring installations of water saving devices such as water meters, water conserving toilets, showerheads, lavatory faucets, and appliances in new homes, motels, hotels, institutions, and other establishments.

(2) Estimate the costs of the proposed flow reduction measures over the 20-year planning period, including costs of public information, administration, retrofit of existing buildings and the incremental costs, if any, of installing water conserving devices in new homes and establishments.

(3) Estimate the energy reductions; total cost savings for wastewater treatment, water supply and energy use; and the net cost savings (total savings minus total costs) attributable to the proposed flow reduction measures over the planning period. The estimated cost savings shall reflect reduced sizes of proposed wastewater treatment works plus reduced costs of future water supply facility expansions.

(4) Develop and provide for implementing a recommended flow reduction program. This shall include a public information program highlighting effective flow reduction measures, their costs, and the savings of water and costs for a typical household and for the community. In addition, the recommended program shall comprise those flow reduction measures which are cost effective, supported by the public and within the implementation authority of the grantee or another entity willing to cooperate with the grantee.

(5) Take into account in the design of the treatment works the flow reduction estimated for the recommended program.

d. *Industrial flows.* (1) The treatment works' total design flow capacity may include allowances for industrial flows. The allowances may include capacity needed for industrial flows which the existing treatment works presently serves. However, these flows shall be carefully reviewed and means of reducing them shall be considered. Letters of intent to the grantee are required to document capacity needs for existing flows from significant industrial users and for future flows from all industries intending to increase their flows or relocate in the area. Requirements for letters of intent from significant industrial dischargers are set forth in § 35.925-11(c).

(2) While many uncertainties accompany forecasting future industrial flows, there is still a need to allow for some unplanned future industrial growth. Thus, the cost-effective (grant eligible) design capacity and flow of the treatment works may include (in addition to the existing industrial flows and future industrial flows documented by letters of intent) a nominal flow allowance for future nonidentifiable industries or for unplanned industrial expansions, provided that 208 plans, land use plans and zoning provide for such industrial growth. This additional allowance for future unplanned industrial flow shall not exceed 5 percent (or 10 percent for towns with less than 10,000 population) of the total design flow of the treatment works exclusive of the allowance or 25 percent of the total industrial flow (existing plus documented future), whichever is greater.

e. *Staging of treatment plants.* (1) The capacity of treatment plants (i.e., new plants, upgraded plants, or expanded plants) to be funded under the construction grants program shall not exceed that necessary for wastewater flows projected during an initial staging period determined by one of the following methods:

(a) *First method.* The grantee shall analyze at least three alternative staging periods (10 years, 15 years, and 20 years). He shall select the least costly (i.e., total present worth or average annual cost) staging period.

(b) *Second method.* The staging period shall not exceed the period which is appropriate according to the following table.

STAGING PERIODS FOR TREATMENT PLANTS

Flow growth factors (20 years)*	Staging period [1] (years)
Less than 1.3	20
1.3 to 1.8	15
Greater than 1.8	10

*Ratio of wastewater flow expected at end of 20 year planning period to initial flow at the time the plant is expected to become operational.

[1] Maximum initial staging period.

(2) A municipality may stage the construction of a treatment plant for a shorter period than the maximum allowed under this policy. A shorter staging period might be based upon environmental factors (secondary impacts, compliance with other environmental laws under § 35.925-14, energy conservation, water supply), an objective concerning planned modular construction, the utilization of temporary treatment plants, or attainment of consistency with locally adopted plans including comprehensive and capital improvement plans. However, the staging period in no case may be less than 10 years, because of associated cost penalties and the time necessary to plan, apply for and receive funding, and construct later stages.

(3) The facilities plan shall present the design parameters for the proposed treatment plant. Whenever the proposed treatment plant components' size or capacity would exceed the minimum reliability requirements suggested in the EPA technical bulletin, "Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability," a complete justification, including supporting data, shall be provided to the Regional Administrator for his approval.

f. *Staging of interceptors.* Since the location and length of interceptors will influence growth, interceptor routes and staging of construction shall be planned carefully. They shall be consistent with approved 208 plans, growth management plans and other environmental laws under § 35.925-14 and shall also be consistent with Executive orders for flood plains and wetlands.

(1) Interceptors may be allowable for construction grant funding if they eliminate existing point source discharges and accommodate flows from existing habitations that violate an enforceable requirement of the Act. Unless necessary to meet those objectives, interceptors should not be extended into environmentally sensitive areas, prime agricultural lands and other undeveloped areas (density less than one household per 2 acres). Where extension of an interceptor through such areas would be necessary to interconnect two or more communities, the grantee shall reassess the need for the interceptor by further consideration of alternative wastewater treatment systems. If the reassessment demonstrates a need for the interceptor, the grantee shall evaluate the interceptor's primary and secondary environmental impacts, and provide for appropriate mitigating measures such as rerouting the pipe to minimize adverse impacts or restricting future connections to the pipe. Appropriate and effective grant conditions (e.g., restricting sewer hookups) should be used where necessary to protect environmentally sensitive areas or prime agricultural lands from new development. NPDES permits shall include the conditions to insure implementation of the mitigating

measures when new permits are issued to the affected treatment facilities in those cases where the measures are required to protect the treatment facilities against overloading.

(2) Interceptor pipe sizes (diameters for cylindrical pipes) allowable for construction grant funding shall be based on a staging period of 20 years. A larger pipe size corresponding to a longer staging period not to exceed 40 years may be allowed if the grantee can demonstrate, wherever water quality management plans or other plans developed for compliance with laws under §35.925-14 have been approved, that the larger pipe would be consistent with projected land use patterns in such plans and that the larger pipe would reduce overall (primary plus secondary) environmental impacts. These environmental impacts include:

(a) *Primary impacts.* (i) Short-term disruption of traffic, business and other daily activities.

(ii) Destruction of flora and fauna, noise, erosion, and sedimentation.

(b) Secondary impacts. (i) Pressure, to rezone or otherwise facilitate unplanned development.

(ii) Pressure to accelerate growth for quicker recovery of the non-Federal share of the interceptor investments.

(iii) Effects on air quality and environmentally sensitive areas by cultural changes.

(3) The estimation of peak flows in interceptors shall be based upon the following considerations:

(a) Daily and seasonal variations of pipe flows, the timing of flows from the various parts of the tributary area, and pipe storage effects.

(b) The feasibility of off-pipe storage to reduce peak flows.

(c) The use of an appropriate peak flow factor that decreases as the average daily flow to be conveyed increases.

9. *State guidelines.* If a State has developed or chooses to develop comprehensive guidelines on cost-effective sizing and staging of treatment works, the Regional Administrator may approve all or portions of the State guidance for application to step 1 facility plans. Approved State guidance may be used instead of corresponding portions of these guidelines, if the following conditions are met:

a. The State guidance must be at least as stringent as the provisions of these guidelines.

b. The State must have held at least one public hearing on proposed State guidance, under regulations in part 25 of this chapter, before submitting the guidance for Agency approval.

10. *Additional capacity beyond the cost-effective capacity.* Treatment works which propose to include additional capacity beyond the cost-effective capacity determined in accordance with these guidelines may receive Federal grant assistance if the following requirements are met:

a. The facilities plan shall determine the most cost-effective treatment works and its associated capacity in accordance with these guidelines. The facilities plan shall also determine the actual characteristics and total capacity of the treatment works to be built.

b. Only a portion of the cost of the entire proposed treatment works including the additional capacity shall be eligible for Federal funding. The portion of the cost of construction which shall be eligible for Federal funding under sections 203(a) and 202(a) of the Act shall be equivalent to the estimated construction costs of the most cost-effective treatment works. For the eligibility determination, the costs of construction of the actual treatment works and the most cost-effective treatment works must be estimated on a consistent basis. Up-to-date cost curves published by EPA's Office of Water Program Operations or other cost estimating guidance shall be used to determine the cost ratios between cost-effective project components and those of the actual project. These cost ratios shall be multiplied by the step 2 cost and step 3 contract costs of actual components to determine the eligible step 2 and step 3 costs.

c. The actual treatment works to be built shall be assessed. It must be determined that the actual treatment works meets the requirements of the National Environmental Policy Act and all applicable laws, regulations, and guidance, as required of all treatment works by §§35.925-8 and 35.925-14. Particular attention should be given to assessing the project's potential secondary environmental effects and to ensuring that air quality standards will not be violated. The actual treatment works' discharge must not cause violations of water quality standards.

d. The Regional Administrator shall approve the plans, specifications, and estimates for the actual treatment works under section 203(a) of the Act, even though EPA will be funding only a portion of its designed capacity.

e. The grantee shall satisfactorily assure the Agency that the funds for the construction costs due to the addtional capacity beyond the cost-effective treatment works' capacity as determined by EPA (i.e., the ineligible portion of the treatment works), as well as the local share of the grant eligible portion of the construction costs will be available.

f. The grantee shall execute appropriate grant conditions or releases providing that the Federal Government is protected from any further claim by the grantee, the State, or any other party for any of the costs of construction due to the additional capacity.

g. Industrial cost recovery shall be based upon the portion of the Federal grant allocable to the treatment of industrial wastes.

h. The grantee must implement a user charge system which applies to the entire service area of the grantee, including any area served by the additional capacity.

Work Session: Cost Effectiveness Analysis

The cost effectiveness analysis presented for problem area 4 (pages 20-29 of Cost Effectiveness Analysis Module) illustrates the methodology of making the very basic decision of onsite versus a communal (or cluster) system. Under the assumptions used for the analysis the onsite systems were shown to be more cost effective. However it may be necessary to question some of the underlying assumptions. For purposes of conducting the necessary analysis, the group will be in smaller groups.

Work Tasks:

Problem Area Group: This group will act as a coordinating body for the work session assimilating the results of the other work groups. The other work groups will be addressing specific issues relative to cost effectiveness of onsite versus communal systems. This group will be responsible for combining the results of the other groups' work and assessing its overall implications as it relates to the selection of onsite versus cluster systems.

This group will also be responsible for identifying other issues which may impact this decision (i.e. onsite vs. communal) and assessing their implications.

Initial Failure Rate Group: A review of the problem area description provided in the Case Study (p.21) shows that all of the homes in the area were built around the same time and have relatively the same soil conditions. An argument might be made that the survey has in fact underestimated the number of systems that are now failing. Assess the implications of this possibility. Using the analysis presented on pages 20 and 24 of the cost effectiveness module conduct a similar analysis for 15, 20 and 25 failures. Assume that development costs will remain at about 48% of construction costs. What appears to be the cut-off point at which the number of existing failures would tend to sway the selection towards a community system. (Refer to the Comparison of Systems on page 29).

Future Failure Rate Group: Using a similar argument as that presented for the Initial Failure Rate Group one might argue that the 5% failure rate is too low. Using the analysis presented on p.24 conduct an analysis using a 10% and 20% failure rate. Since at a 10% failure rate all systems will fail by year 10 use a present worth factor of 6.98 (uniform series, 10 years @ 7 1/8%) for the present worth of initially conventional systems; similarly for 20%, a present worth factor of 4.09 should be used. Discuss how this effects the overall results by refering to the comparison of systems on p. 29.

Mound Design Group: As a contrary argument, one can argue that the mound design for the Woodrock system is very conservative. A mound design based on the EPA Design Manual for Onsite Systems for a 7-bedroom house and 10 min/in percolation rate has yielded the following results (these are comparable to the quantities presented in Table 3-1 of the Cost Effectiveness Module p. 17):

Excavation for Trenches	24.5	YD^3
Gravel for Trenches	24.5	YD^3
Peastone for Trenches	---	
Fill Material	190	YD^3
Distribution Pipe	292	LF
Backflow Preventer	1	EA

Header Pipe	55	LF
Grading and Supervision	2730	FT^2
Layout and Supervision	292	LF

Using this new design and the costs in Table 3-1 calculate the costs of such a mound. Using this cost show the effects of this mound cost on the cost effectiveness analysis presented on pages 20 and 24 of the Cost Effectiveness Module.