# engineering bulletin no. 12

## Minimum Requirements for the Design and Installation of Septic Tank Systems and Alternative On-site Disposal Systems

June 1989

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

# ENGINEERING BULLETIN NO. 12

MINIMUM REQUIREMENTS FOR THE DESIGN AND INSTALLATION

OF SEPTIC TANK SYSTEMS

AND ALTERNATIVE ON-SITE DISPOSAL SYSTEMS



ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

JUNE 1989

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# PART I - INTRODUCTION

## A. PURPOSE OF GUIDELINES

The information and recommendations contained in this Engineering Bulletin are intended:

1. to provide guidance and minimum design criteria for the construction of septic-tank systems and alternative on-site disposal systems;

2. to assist in compliance with Arizona Department of Environmental Quality (ADEQ) rules, Title 18, specifically Chapter 9, Article 8, Sewage Systems, Chapter 9, Article 1, Aquifer Protection Permits, Chapter 9, Article 7, Regulations for the Reuse of Wastewater, and Chapter 11, Article 4, Aquifer Water Quality Standards.

3. to improve understanding and operation of septic tank systems and alternative on-site disposal systems; and,

4. to assist in compliance with provisions of A.R.S. § 49-101 et. sec., the Environmental Quality Act, which includes Aquifer Protection Permits, and Underground Injection Control requirements.

## B. DEFINITIONS

1. **Alternative on-site disposal system** - any on-site disposal system other than a conventional septic tank system.

2. **Aggregate** - graded hard rock or gravel that has been washed with water under pressure over a screen during or after grading to remove fine material and with a hardness value of 3 or greater on Moh's Scale of Hardness. Aggregate that can scratch a copper penny without leaving any residual rock material on the coin would have a hardness of 3 or more on Moh's Scale of Hardness. Volcanic rock that meets the above criteria may be substituted for hard rock or gravel.

3. **Bedrock** - solid rock, which may have fractures, that lies beneath soils and other unconsolidated material. Bedrock may be exposed at the surface or have an overburden up to several hundred feet thick.

4. **Bedroom** - a habitable room, providing privacy and year around occupancy, intended primarily for sleeping and consisting of the following:

   a. a floor space of no less than 70 sq. ft.;

   b. a ceiling height of no less than 7'6" high (trailer mobile home bedrooms may have ceiling heights less than 7'6" high);

   c. at least one closet;

   d. electrical service and ventilation; and

e. an exit window not over 44 inches off the floor at least 20 inches wide, consisting of at least 5.7 sq. ft. of clear opening when fully opened, intended for egress and emergency rescue.

5. **Department** - the ADEQ or any appropriately delegated agency.

6. **Disposal bed** - a type of bottom area absorption system which uses an area at least ten feet wide, partially filled with gravel or crushed stone. Piping distributes the treated sewage evenly throughout the entire bed so that it may seep into the earth.

7. **Disposal pit** - a type of sidewall absorption system which uses a vertical, cylindrical underground receptacle so constructed as to permit disposal of effluent or clear wastes by soil absorption through its walls.

8. **Disposal trench** - a type of sidewall absorption system which uses an area excavated 1 to 3 feet in width and which contains a bedding of aggregate and a single disposal trench.

9. **Distribution box** - a watertight structure which receives sewage effluent from a septic tank or home aerobic treatment system and distributes such effluent in equal portions to two or more distribution pipes leading to the disposal pipes.

10. **Disposal pipe** - perforated pipe that is placed in disposal trenches, beds or pits to disperse septic tank effluent to the soil absorption surfaces.

11. **Distribution pipe** - the network of non-perforated pipe used for distributing septic tank and alternative treatment plant effluent to the disposal system.

12. **Dosing tank** - a watertight structure that receives and stores sewage effluent from a septic tank for periodic discharge to subsequent treatment units or disposal areas. Pumps or siphons with appropriate switches and alarms are mounted in the tank to discharge the accumulated liquids.

13. **Dry wash** - a natural watercourse channel that only flows in response to rainfall and a related surface - water run-off event. The wash does not intercept the groundwater table. The dry wash is not man made although it may be mechanically channelized and it is bordered by definite channel boundaries.

14. **Dry well** - a bored, drilled or driven shaft pit or hole whose depth is greater than its largest surface dimension used exclusively for on-site disposal of storm water runoff.

15. **Effective absorption area** - the sidewall area below the bottom of the distribution pipe of a disposal trench or pit and the bottom area of a disposal bed acceptable for effluent Areas of rock or poor soil permeability are not included. (For calculation of effective absorption area see Part III.E.)

16. **Failure** (of the disposal system) - the exceedance of the soil capacity to absorb the effluent from the wastewater treatment system.

17. **Floodplain** - the areas adjoining the channel of a watercourse including area where drainage is or may be restricted by man-made structures which have been or may be covered partially or wholly by floodwater from the one hundred-year flood.

18. **Floodway** - the channel of a river or other water course and the adjacent land areas necessary in order to discharge the one hundred-year flood without cumulatively increasing the water surface elevation more than one foot.

19. **Fractured rock** - a consolidated formation (sedimentary, igneous, metamorphic) that exhibits breaks, fractures, interconnecting cracks and openings.

20. **Graywater** - wastewater that originates from clothes washers, bath tubs, showers, and sinks, except kitchen sinks, dishwashers and toilets.

21. **Groundwater** - water which is in the zone of saturation and under pressure equal to or greater than atmospheric pressure.

22. **Seasonal groundwater level** - the highest level to which the upper surface of groundwater may be expected to rise within a one year period. The anticipated highest level of groundwater shall be estimated:

    a. As the highest extent of soil mottling observed in the examination of soil profiles; or

    b. as observed as a free water surface in an unlined test hole or properly installed monitoring pipe during the time of the year when the groundwater is the highest; or

    c. from site-specific well data, if available and indicative conditions at the site.

    Where a conflict in the above methods of examination exists, the direct observation shall govern.

    In those areas where, because of soils composition, soils lack the necessary iron compounds to exhibit mottling, direct observation during wet weather conditions may be required. Guidance in defining such areas shall be provided by the Department.

23. **Impervious strata** - a soil zone with a percolation rate numerically greater than 120 minutes per inch.

24. **Individual disposal system** - a device or system for the treatment and disposal of sewage from a single housing, manufacturing or commercial unit.

25. **Intermittent stream** - an open water channel which flows about 10 to 80 percent of the time as a direct result of a discontinuous supply from springs or groundwater seepage, or from surface water sources, or both.

26. **Live stream** - an open water channel which is either perennial or intermittent.

27. **On-site disposal system** - any septic tank system or alternative disposal system installed at a site to treat and dispose of domestic wastewater generated at that site.

28. **Perennial stream** - an open water channel which flows throughout the year. It receives water not only from the rain but also from underground sources at springs and seeps, and owes its permanency to the fact that the level at which groundwater stands in the regions adjoining the streams is higher than the stream bed.

29. **Porosity** - the percentage of the total volume of soil or rock material that is occupied by pores or interstices.

30. **Seepage bed** - same as disposal bed.

31. **Seepage pit** - same as disposal pit.

32. **Seepage trench** - same as disposal trench.

33. **Septage** - domestic strength liquid and semisolid wastes, oils and greases pumped from septic tanks, interceptors, grease traps, package treatment plant sludge, and other domestic liquid waste holding tanks.

34. **Septic tank** - a watertight container which receives the raw sewage and discharges a settled, slightly treated effluent.

35. **Septic tank system** - a method used for treatment and disposal sewage. It usually consists of a septic tank and subsurface disposal trench, bed or pit.

36. **Soils** - sediment or other unconsolidated accumulations of mineral particles which may or may not contain organic material and which have filtering properties.

37. **Static groundwater** - the water level in an aquifer or well before pumping begins.

38. **Standard percolation test** - the test used to determine the rate water is absorbed by the soil. From this data the design size for a subsurface disposal system is determined. Procedures are given in Part III.C.

39. **Subsurface disposal system** - a rock or gravel-filled underground bed or trench into which septic tank and alternative plant effluent is discharged for final treatment and disposal.

40. **Water supply watershed** - a drainage basin which has within its boundaries one or more surface water segments with the designated protected use of domestic water source.

# PART II - GENERAL STANDARDS, REQUIREMENTS AND PROCEDURES

## A. AVAILABILITY OF SEWER HOOK-UP

1. Construction of new on-site disposal systems are prohibited where connection to a public sewer system is determined by the Department to be practical. Connection to the public sewer system shall be made:

   a. At the minimum for residential and commercial properties when there is an adequate public sewer within 200 feet of the nearest property line as measured along the usual or most feasible route of access; or

   b. when the total cost of connecting to an adequate public sewer is less than two times the cost of installing an on-site disposal system, when the distance is measured as in part a.

2. Natural barriers such as outcrops and streams between the disposal site and the public sewer may make the sewer connection impractical.

## B. APPROVAL TO CONSTRUCT AND AQUIFER PROTECTION PERMIT

1. No person shall begin construction of any on-site disposal system or make any change or repair of a failed system which may affect capacity, quality, flow or operational performance of an on-site disposal system prior to receiving a Certificate of Approval to Construct from the Department . This approval may be required before any building permit is issued for any structure which requires an on-site disposal system.

2. An application to construct a new septic tank system or repair a failed septic tank disposal system to serve a private residence, a hotel, motel, restaurant, trailer park, service station, picnic ground, recreational area, camp or other similar place shall be submitted to the local county health department for approval prior to construction.

3. An application to construct a new alternative on-site disposal system or repair a failed alternative on-site disposal system must first be submitted to the local county health department. County health departments that do not have delegated authority to approve alternative on-site disposal systems will forward these applications to ADEQ along with their concept approval on form ADEQ/OWQ-113 for approval prior to construction.

4. Where a septic tank system equals or exceeds a capacity of 20,000 gallons per day or does not meet criteria for a general permit under Aquifer Protection Permit rules, the application to construct along with an application for an Aquifer Protection Permit shall be submitted to ADEQ. Individual disposal systems with less than 2,000 gallons per day capacity meet the general permit criteria if they are in compliance with these guidelines. The general permits criteria for sewage disposal systems with capacities from 2,000 to 20,000 gallons per day also includes disposal density limits and minimum vertical separation requirements. Facilities that discharge any materials that are not considered to be typical

of domestic sewage are excluded from general permit. New subdivisions will be reviewed for disposal density and vertical separation requirement at the time they receive approval for sanitary facilities from the department. However, lots in existing subdivisions that have received approval from the department for sanitary facilities are not subject to these requirements.

## C. APPROVAL TO CONSTRUCT APPLICATION CONTENT

All applications to construct an on-site disposal system shall include:

1. Signed and completed application forms (ADEQ/OWQ-113 and 114) or appropriate county forms.

2. Legal description and county assessor's parcel number of the property on which construction, alteration or extension is proposed.

3. Two copies of a plot plan drawn to scale which shows the following items (a sample plot plan is given in Figure 1):

   a. A site location map providing sufficient details to locate the property. These details may include road or street names, distances from road crossings, mile posts or other identifiable landmarks.

   b. Direction of North clearly indicated.

   c. Location and distances to other sewage systems, sewer lines, water lines and political boundaries. If none, make a statement to indicate same.

   d. Location of driveways, public water and sewer utilities, houses, swimming pools, tennis courts, car ports, water features, and retention ponds within 5 ft. of the property lines.

   e. The distance(s) within 500 feet of the proposed on-site disposal system to any live streams, dry washes, road-cuts and wells indicated. If none, make a statement to indicate same.

   f. The location of the percolation test hole(s) and boring test hole(s).

   g. All individual disposal system components including reserve area properly marked and located at specified distances.

   h. Distances of well and individual disposal system components to property line.

   i. Location of proposed structures on the property.

   j. A floor plan of the residence identifying the number of bedrooms.

   k. A topographic map of the proposed site. The contour interval shall clearly identify any wash, watercourse, rock outcropping, road cuts, or other significant topographical features. The maximum contour interval shall be:

| GRADE (%) | CONTOUR INTERVAL (feet) |
|---|---|
| 0 - 5 | 2 |
| 5 - 10 | 5 |
| Greater than 10 | 10 |

1. Design specifications for the on-site disposal system.

4. Soil boring logs, depth to high seasonal groundwater table and bedrock and percolation test results in accordance with Chapter III of this bulletin.

5. If a public sewer is available within one mile of the nearest property line, an engineer's construction cost estimates of the installed on-site system and of the installed connection to the public sewer.

## D. ON-SITE DISPOSAL SYSTEM DESIGN

System design must meet following requirements:

### 1. Design Responsibility

Alternative on-site disposal system plans shall be sealed and signed by a Professional Engineer registered in the State of Arizona unless otherwise exempted by the Code of the State Board of Technical Registration.

### 2. Hydraulic Loading

Septic tank systems and alternative on-site disposal systems shall be designed to accommodate hydraulic loading provided in Table 1. A lower hydraulic loading for individual residences may be used if water saving toilets are used as provided in Table 2. The hydraulic loading for home aerobic units shall be 150 gal/bedroom/day. Flow reduction for use of low flow toilets shall be limited to a maximum of 16% for calculation of capacity of home aerobic units.

For facilities other than individual residences the flow reduction should be calculated using the following formula:

Design Flow in gallons/day = $(I-y) \times h + (f/5) \times h \times y$ where:

y = fraction of flow from toilets.

h = hydraulic loading calculated from Table 1 in gallons per day.

f = amount of water used in toilet per flush in gallons.

# TABLE 1
# AVERAGE DAILY SEWAGE FLOW

| TYPE OF ESTABLISHMENT (unit basis) | | SEWAGE FLOW (gallons per unit per day) |
|---|---|---|
| Airport (passenger) | | 4 |
| Apartments, multiple family (resident) | | 100 |
| | 1 bedroom assume 2 residents, 2 bedrooms assume 3 residents, etc. | |
| Bar (patron) | | 25 |
| Barber shop (50 per chair over 8) | | 100 |
| Beauty parlor (100 per chair over 5) | | 1000 |
| Camp: | Campground, overnight with flush toilets (camper space) | 25 |
| | Campground, overnight with flush toilets and shower (camper space) | 50 |
| | Construction (bed) | 50 |
| | Day with no meal served (camper space) | 15 |
| | Luxury (camper) | 100-150 |
| | Resorts, Day and night, with limited plumbing (camper space) | 50 |
| | Tourists with central bath and toilet facilities (person) | 35 |
| Churches: | Without kitchens (person) | 7 |
| | With kitchens (person) | 10 |
| Clubs: | Country (resident member) | 100 |
| Country (nonresident member) | | 25 |
| Cottages with seasonal occupancy (resident) | | 100 |
| Dental office (chair) | | 500 |
| Dog Kennel (per animal) | | 15 |
| Dwellings: | Boarding of rooming houses (resident) | 100 |
| | Additional kitchen requirements for nonresidents (boarder) | 10 |
| Dwellings: | Residential (resident) (2 residents per bedroom) | 100 |
| Factory: | no showers (person) | 25 |
| | with showers (person) | 35 |
| Highway Rest Area (contact State Department of Transportation) | | |
| Hospital (bed) | | 250-400 |
| Hotel | without kitchen (room) | 125 |
| | with kitchen (room) | 150 |
| Institutions other than hospitals (person) | | 75-125 |
| Laundries, self service (machine) | | 400 |
| Mobile Home Community System for family (space) | | 250 |
| | for adults only community (space) | 150 |
| Motel: | without kitchen (room) | 125 |
| | with kitchen (room) | 150 |
| Office (person) | | 25 |
| Picnic: | With bathhouses, showers & flush toilets (picnicker) | 20 |
| | With toilet facilities only (picnicker) | 10 |
| Public Restrooms (toilet) | | 200 |
| Recreation Vehicle Park: | without water or sewer hook-up (vehicle) | 75 |
| | with water and sewer hook-up (vehicle) | 100 |
| Restaurant (seat) | | 30 |
| per meal served | | 7 |
| Schools: | Boarding (pupil) | 100 |
| | Day with cafeteria, gymnasiums & showers (pupil) | 25 |
| | Day with cafeteria, but no gymnasiums or showers (pupil) | 20 |
| | Day without cafeteria, gymnasiums or showers (pupil) | 15 |
| Service Station (bay) | | 1000 |
| Shopping Center, (sq. ft. of store area) (no food/laundry) | | 0.1 |
| Stores | | 500 |
| Swimming Pool (swimmer) | | 10 |
| Theaters: | Drive-In (car space) | 5 |
| | Movie (seat) (vehicle) | 5 |

For structures and facilities not specifically mentioned in the above table, flow rates available from other standard books and literature are acceptable.

TABLE 2
FLOW REDUCTION CHART FOR LOW FLOW TOILETS
USED IN INDIVIDUAL HOMES

| Gallons per Flush | Liters per Flush | Toilet Flow Reduction (%) | Total Flow Reduction (%) |
|---|---|---|---|
| 5.0 | 18.9 | 0 | 0.0 |
| 4.5 | 17.0 | 10 | 4.0 |
| 4.0 | 15.1 | 20 | 8.0 |
| 3.5 | 13.2 | 30 | 12.0 |
| 3.4 | 12.9 | 32 | 12.8 |
| 3.3 | 12.5 | 34 | 13.6 |
| 3.2 | 12.1 | 36 | 14.4 |
| 3.1 | 11.7 | 38 | 15.2 |
| 3.0 | 11.4 | 40 | 16.0 |
| 2.9 | 11.0 | 42 | 16.8 |
| 2.8 | 10.6 | 44 | 17.6 |
| 2.7 | 10.2 | 46 | 18.4 |
| 2.6 | 9.8 | 48 | 19.2 |
| 2.5 | 9.5 | 50 | 20.0 |
| 2.4 | 9.1 | 52 | 20.8 |
| 2.3 | 8.7 | 54 | 21.6 |
| 2.2 | 8.3 | 56 | 22.4 |
| 2.1 | 7.9 | 58 | 23.2 |
| 2.0 | 7.6 | 60 | 24.0 |
| 1.9 | 7.2 | 62 | 24.8 |
| 1.8 | 6.8 | 64 | 25.6 |
| 1.7 | 6.4 | 66 | 26.4 |
| 1.6 | 6.1 | 68 | 27.2 |
| 1.5 | 5.7 | 70 | 28.0 |
| 1.4 | 5.3 | 72 | 28.8 |
| 1.3 | 4.9 | 74 | 29.6 |
| 1.2 | 4.5 | 76 | 30.4 |
| 1.1 | 4.2 | 78 | 31.2 |
| 1.0 | 3.8 | 80 | 32.0 |
| 0.9 | 3.4 | 82 | 32.8 |
| 0.8 | 3.0 | 84 | 33.6 |
| 0.7 | 2.6 | 86 | 34.4 |
| 0.6 | 2.3 | 88 | 35.2 |
| 0.5 | 1.9 | 90 | 36.0 |
| 0.4 | 1.5 | 92 | 36.8 |
| 0.3 | 1.1 | 94 | 37.6 |
| 0.2 | 0.8 | 96 | 38.4 |
| 0.1 | 0.4 | 98 | 39.2 |
| 0.0 | 0.0 | 100 | 40.0 |

ASSUMPTIONS:

1. Capacity of normal flow toilet equals 5.0 gal/flush.
2. Toilet flow from a home equals 40% of total flow.

SOLUTION:

X = Capacity of low flow toilet (gal/flush)
Y = X/5
Z = I-Y
Z x 100 = % Toilet Flow Reduction
100 - (Z x 0.4) x 100 = % Total Flow

3. **Effluent Limit**

Facilities that dispose treated wastewater on the surface or in shallow trenches less than 2 feet in total depth must include chlorination and meet the following effluent standards:

| | Parameter | Allowable Limits |
|---|---|---|
| a. | Fecal Coliform (CFU/100 ml) | |
| | Geometric mean of 5 samples | 25 |
| | Single Sample not to exceed | 75 |
| b. | Chlorine residual, mg/l | 2.0 |

4. **Waivers**

a. **Reserve Area**

All on-site disposal systems except evapotranspiration beds and surface irrigation systems must provide replacement area equivalent to 100% of the initial area for replacement of the disposal system. No permanent structure or pavement shall be built upon this reserve replacement. The reserve area must be easily accessible for future construction.

Individual disposal systems installed on lots in subdivisions that existed prior to 1974 may be exempted from reserve area requirements by the Department.

b. **Setback from Wells**

For unaltered lots approved prior to October 1, 1986, the recommended setback from private wells is 100 feet. At the discretion of the Department, where the recommended setback cannot be met due to lot size, a minimum setback of 50 feet shall apply. However, disposal fields and wells must be located to approach the recommended setback as closely as possible.

c. **Minimum Vertical Separation**

For unaltered lots approved prior to the effective date of this bulletin, subsurface disposal systems must meet the requirements in Table 3 for the minimum vertical separation from water table. At the discretion of the Department, where these minimum distances cannot be met, a minimum separation distance of four feet shall apply. However, disposal systems must be designed to approach the Table 3 vertical separation as closely as possible.

## E. DEVIATION FROM GUIDELINES AND NEW PROCESSES AND EQUIPMENT

The policy of the Department is to encourage, rather than obstruct, new methods and equipment for on-site disposal systems. For this reason, guidance documentation is included in the engineering bulletin to furnish the basis for the criteria. If it is proposed to deviate from the criteria, the exact nature of the proposed differences shall be noted in a Design Report. The scientific basis for the proposed change, including computations, and documented practical experience similar

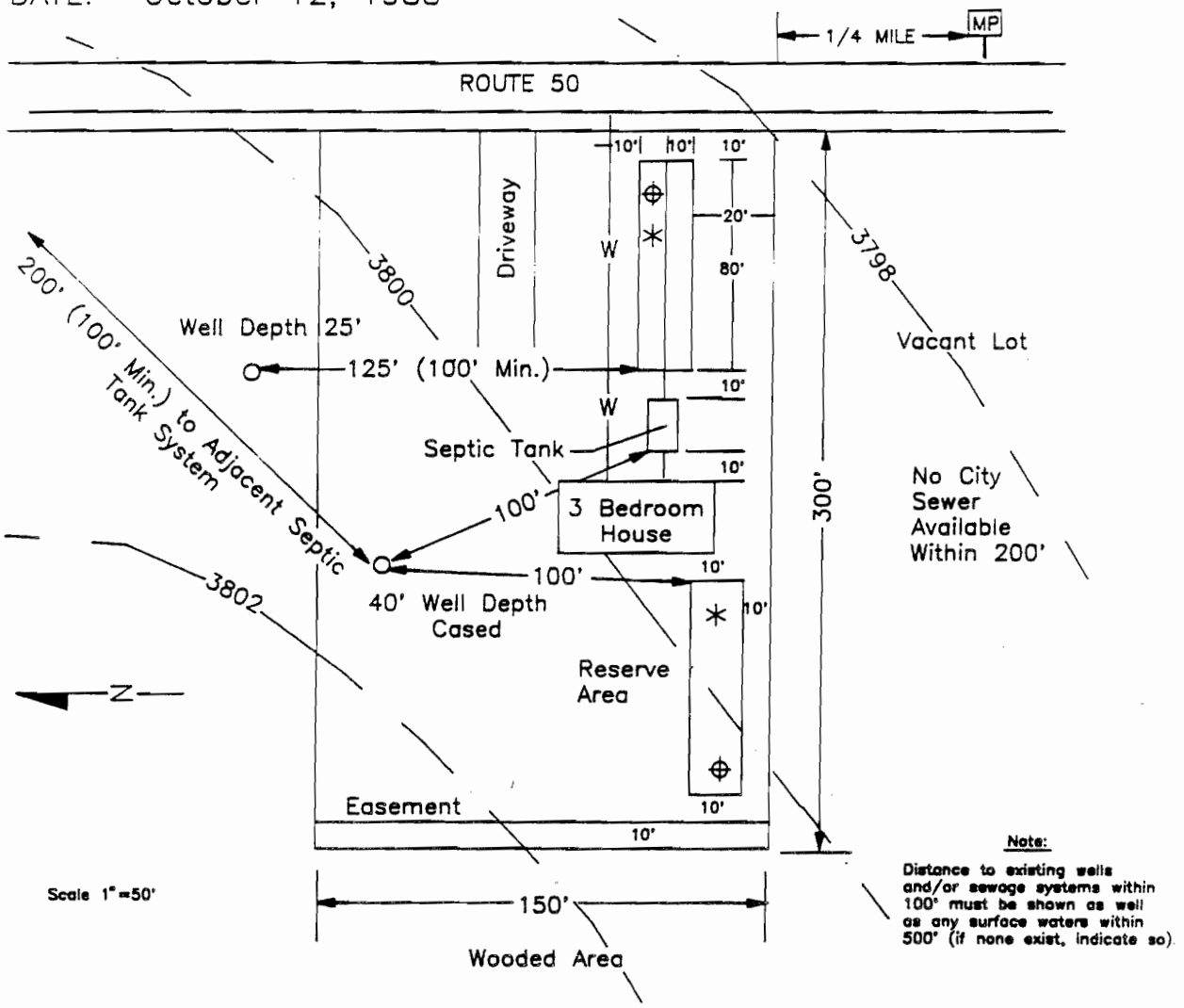
installations, shall be included. The justification and burden of proof for deviations from standards shall be the responsibility of the applicant.

Any new development should have been thoroughly tested in full scale comparable installation, under competent supervision, before approval of plans can be issued for an on-site disposal system utilizing a new process or equipment. Testing requirement may be reduced if the person owning the on-site disposal system in question is amply protected by a performance bond or other acceptable arrangement, so that any expenditure of money will be refunded in case of failure of any new process or equipment. The owner of the on-site disposal system shall agree in writing to revisions or rebuilding of disposal system structures necessary to accommodate other treatment or equipment, after the original installation has been rejected. The performance bond should include provisions to cover the cost of such alterations.

# FIGURE 1. SAMPLE PLOT

TITLE: Sewage Disposal System for John Doe

DATE: October 12, 1988




⊕ Soil Boring

✳ Percolation Test

# PART III - SITE SUITABILITY

## A. INTRODUCTION

The site evaluation shall include consideration of related geological, hydrological, topographic, climatic and soil analysis factors to effectively determine site suitability of all on-site disposal systems. If the whole evaluation focuses on percolation tests alone, the evaluation may be faulty and lead to unnecessarily greater pollution potential.

### 1. Site Suitability

Before considering the percolation test, the site should be considered from a broad and comprehensive perspective.

a. Developments must be within acceptable density limits of on-site systems and within the capacity of the soil and aquifer to accept wastewater discharges. This includes meeting minimum vertical separation requirements, and maximizing distances to wells both on and off the property.

b. Subsurface disposal systems must not be installed near deep support structures, banks, or retaining walls.

c. High seasonal groundwater levels shall be determined to assure minimum separation requirements are met.

d. Surface drainage must be studied to assure systems are not subject to physical damages by the maximum expected one hundred year flood.

e. Soil borings should be logged as necessary to locate impervious barriers, solution channels, or other factors which may affect design.

f. The operation of existing systems at similar sites within the area should be evaluated.

g. Where site evaluations indicate conventional systems are not likely to be acceptable, alternative on site disposal systems and connection to a sanitary sewer if available, may be considered.

h. The number of percolation tests and soil borings required will be determined by the uniformity or dissimilarity of various parts of the site.

The percolation test program should be conducted only after the above factors have been considered. Then the number and location of such tests is based, in part, on the results of the complete site evaluation. Thus, enough tests are made to confirm data from soil evaluation site studies and an unnecessarily large number of tests is avoided.

### 2. Soil Suitability

The next step in the design of subsurface sewage disposal systems is to determine by a

more accurate measure the suitability of the soil to absorb and treat sewage effluent. This is accomplished following a standard prescribed method to measure the time it takes for water to disappear in a standard test hole under prescribed conditions, the percolation test.

The soil must have an acceptable percolation rate without interference from groundwater or impervious strata below the level of the absorption system. In addition, the pollution potential of the septic tank or alternative on-site disposal system to groundwater must be minimized.

a. **Percolation Rate**

The first condition that must be met for suitable soil is a percolation rate which lies within the range of those specified in Table 3. Although percolation rates over 60 minutes per inch (MPI) are considered unsuitable for conventional subsurface disposal, rates up to 120 MPI may be approved for mound system design and subsurface trenches dosed with a low pressure distribution system and constructed such as to avoid sidewall compaction and smearing. Also, soil with percolation rates under 10 MPI may be unsuitable if groundwater table elevations are high.

b. **Minimum Vertical Separation**

The minimum vertical separation (MVS) from the bottom of the disposal trench, bed, or pit to the high seasonal groundwater level should be great enough to filter out microbiological contaminants. Based on studies of the movement of bacteria and virus through various types of soils, the following MVS criteria must be met for the design of subsurface systems.

**Table 3**
**Minimum Vertical Separations**
**and Test Hole Depths**

| Soil Percolation Rate (minutes per inch) | Vertical Separation from the Water Table | Depth of Test* Hole, (feet) |
|---|---|---|
| 1 to less than 2 | 40 | 50 |
| 2 to less than 10 | 10 | 20 |
| 10 or longer | 5 | 15 |

* This could be reduced upon approval of the Department. Minimum depth of the test hole shall be sum of the minimum vertical separation and the depth of the disposal field.

Unless these conditions can be satisfied, the site is unsuitable for a conventional subsurface disposal system.

## B. LOCATING A SUITABLE AREA

### 1. Subsurface Formations

#### a. Minimum Separation

Rock formations or other impervious strata shall be greater than 4 feet below the bottom of the septic tank system trench, bed, or pit.

#### b. Blasting

Soil conditions which necessitate blasting in order to facilitate construction of a septic tank disposal system are not normally acceptable. However, where acceptable soil conditions exist beneath an impermeable confining layer near the surface as shown by soil borings, blasting and removal of the impermeable overburden may be allowed to provide construction access to the proper permeable soils below for installation of a conventional subsurface disposal system. Only that surface area which is below the impermeable layer may be used in calculating the size of the disposal area, and the system should be designed and constructed to preclude the movement of any effluent above the impermeable layer. Such special conditions and actions must be fully described in the engineer's or geologist's sealed and signed report.

### 2. Soil Borings

#### a. Purpose

The purpose of soil borings is to determine subsurface formations and locate likely soil profiles for a soil absorption and disposal system. A backhoe hole is adequate for determining subsurface formations for disposal trenches. Augers should be used for determining formations for disposal pits. These borings must be at least 3 inches in diameter and 5 feet deeper than the proposed disposal system unless water table evidence or bedrock is encountered sooner. The holes should be numbered and identified on a scale map of the site.

#### b. Soil Description

To complete the soil boring logs, describe and record the soil texture (sand, sandy loam, silt loam, clay or other) where changes in texture occur. A description of soil textural classes, composition and their relation to soil permeability is given in Table 4. If the soil percolation rate is 10 minutes per inch or greater and the water table or an impervious layer is encountered at less than 8 or 7 feet, respectively, the area is not suitable for a conventional disposal system.

Mottled soils indicate a high groundwater table during wet seasons and may be unsuitable for a soil treatment system. Mottled soil closer than 5 feet to the bottom of the percolation trench, pit, or bed indicates the formation of maximum seasonal water table elevation. The system will fail in clay soil and inadequately treat sewage in exceptionally coarse, sandy soil.

c. **Minimum Requirements**

(1) There shall be a minimum of three suitable borings per soil absorption site in shallow and non-uniform depth soils. More soil borings may be necessary for accurate evaluation of a site. If the reserve area is contiguous with the initial system area, the requirement of six borings may be reduced to five. In this case, one boring is made on each outer corner of the contiguous area and the fifth boring is made between the system areas.

(2) If the soil is shown to be uniform, less than five soil borings but no less than 2 may be approved by the Department. General soils data for a specific area may be used in lieu of individual test data when the Department has such documented evidence on file.

TABLE 4

Soil Texture Classes, Composition and Corresponding Percolation Rates

| | | COMPOSITION[β] | | | PERCOLATION RATE[Γ] |
|---|---|---|---|---|---|
| | | SAND | SILT | CLAY | |
| GENERAL TEXTURE[α] | SOIL TEXTURAL CLASS | % | % | % | min/in |
| Coarse | gravel, course sand | | | | <1 |
| | medium sand | >85 | <15 | <10 | 1-5 |
| | loamy sand | 70-90 | <30 | <15 | 6-15 |
| Moderately course | sandy loam | 43-85 | <50 | <20 | 16-30 |
| Medium | loam | 23-52 | 28-50 | 7-27 | 31-60 |
| | silt loam | 20-50 | 50-80 | 12-27 | 31-60 |
| | silt | <20 | >80 | <12 | 45-60 |
| Moderately fine | sandy clay loam | 45-80 | <28 | 20-35 | 31-60 |
| | silty clay loam | <20 | 40-73 | 27-40 | 45-60 |
| | clay loam | 20-45 | 15-53 | 27-40 | 61-120 |
| Fine | sandy clay | 45-65 | <20 | 35-55 | 61-120 |
| | silty clay | <20 | 40-60 | 40-60 | 61-120 |
| | clay | <45 | <40 | >40 | >120 |

α. Texture vs Permeability: Aeration and drainage are closely related to texture because of the texture's influence on pore size and continuity. Clay soils are not very permeable because their pores are very small and not continuous. Sands, on the other hand, are more permeable (though less porous), because the pores are large and continuous.

β. Structure vs Permeability: The type of soil structure, the aggregation of soil particles into clusters, determines the dominant direction of the pores and, hence, the direction of water movement. Platy structures restrict vertical percolation, prismatic and columnar structures enhance vertical percolation and blocky and glandular structures enhance percolation both horizontally and vertically. Structural units that can withstand at least moderate handling without disintegrating will provide better hydraulic properties.

Γ. Estimates Only

3. **Test Holes**

In those areas where soils have a rapid percolation rate, numerically lower than 10 minutes per inch, and where it is known that the groundwater level has been within ten feet of the surface, one or more test holes should be excavated to determine the current groundwater level in the area of the proposed leach field. Seasonal variations in the groundwater elevation should be taken into account when determining the need for and in the evaluation of the results of test holes. A separate test hole should be required for the reserve area if its location is significantly different from that of the primary use leach field.

The excavation should be made at a representative location for the proposed leach field to a depth as shown in Table 3 providing that the existing soils allow conventional excavation methods. A deeper excavation is desirable if percolation rates or soil types are uncertain or undesirable. However, a deeper excavation is not necessary if conditions for such an excavation are unjustified or unreasonable. The exposed soil profile can be used to confirm soil conditions and percolation rates used in the system design. If the percolation rate is 1 to 2 minutes per inch, a conventional tank system should not be constructed on the site unless a minimum vertical separation to the high seasonal groundwater of 40 feet exists.

4. **Other Useful Information**

An auger with extension handles is usually adequate for making soil investigations. In some cases, an examination of road cuts, stream embankments, or building excavations will provide useful information. Wells and well driller's logs can also be used to obtain information on groundwater and subsurface conditions. If depth to water information is to be obtained from a well, the well location should be in the general vicinity of the disposal site in order to obtain water levels representative of the point of disposal.

## C. PERCOLATION TESTS

The permeability of the soil in the proposed soil absorption system shall be determined by percolation tests. These help to determine the acceptability of the site and establish the design size of the subsurface disposal system.

1. **Minimum Requirement**

At least three percolation tests shall be conducted in each system area. The holes shall be uniformly located over the proposed absorption field site or in different soil conditions. Less than three percolation tests may be approved by the Department if shown that the soil is uniform.

Where soils are shallow, place percolation test holes at the depth of the proposed disposal trenches or beds. In deeper soils where deep trenches or disposal pits will be used, percolation test holes should be placed at more than one level. Where very deep disposal pits are contemplated, percolation tests should be made in each stratum penetrated. A backhoe may be used to dig holes to expose soil profiles and dig down to suitable strata. Percolation tests should be witnessed by a representative of the Department. If this is not possible, then temporarily leave test holes open until they can be subsequently verified and inspected.

2. Standard Percolation Test Procedures

a. Disposal Trenches and Beds

(1) Digging the Hole

With hand tools dig a 12" square or 15" round hole. If the soil collapses, place a perforated pipe vertically into the hole and carefully pack gravel or some other supporting material between the pipe and the hole wall. Perform the test within the pipe and adjust calculations to account for water displacement by the supporting gravel pack.

(2) Preparing the Hole

Remove any smeared soil surfaces from the sides of the hole to provide as natural a soil interface as practical, to infiltrating waters. Remove loose materials from the bottom of the hole. To protect the bottom from scouring, add two inches of fine gravel.

(3) Presoaking the Hole

Presoak the hole by filling it with clear water to a depth of 12 inches above the bottom of the hole. Determine the time for this amount of water to seep away. If the water seeps away in 60 minutes or less, this procedure shall be repeated. If a third test repeats the above result and the soil has a low clay content, 15% or less, and a low shrink-swell potential, the percolation rate test may proceed immediately. If not, maintain a minimum water depth of 12 inches above the bottom of the hole for a 4 hour period by refilling as necessary or by use of an automatic siphon. Water remaining in the hole after 4 hours shall not be removed. Thereafter, the soil shall be allowed to swell not less than 16 nor more than 30 hours. Following the soil swelling period, remove any soil which has sloughed into the hole.

(4) Percolation Rate

Fill the hole with clean water to exactly six inches above the soil bottom of the hole. With a tape measure or float gauge and a timepiece, determine the time for the water to recede exactly 1 inch. Refill immediately and repeat the process until successive time intervals needed for a one inch drop indicate that a stabilized rate has been obtained. This is generally indicated when three consecutive percolation rate measurements vary by no more than 10%. Report the stabilized percolation in minutes per inch.

b. Disposal Pits

(1) Digging the Hole

With an auger, drill holes 18 inches in diameter, or larger, to the depths of soil strata extending to the bottom of the proposed disposal pit.

The minimum acceptable depth is 30 feet. Holes should be dug to each vertical soil strata to be utilized for absorption area.

(2) **Preparing the Hole**

Follow the procedure in Part C.2.a.2. to the extent possible.

(3) **Presoaking the Hole**

Follow the procedure in Part C.2.a.3. to the extent possible. If not, then presoak the hole by filling the hole with water up to 3 feet below grade. Maintain this level for a 4 hour period by refilling as necessary by use of an automatic siphon. Water remaining the hole after 4 hours shall not be removed. The soil shall be allowed to swell not less than 16 nor more than 30 hours.

(4) **Percolation Rate**

Fill the hole with clean water to approximately 12 inches above the soil bottom of the hole. With a tape measure, or other measuring device, determine the time for the water to recede exactly one inch. Refill immediately and repeat the process until successive time intervals needed for a one inch drop indicate that an approximately stabilized rate has been obtained. Report the rate in minutes per inch. If it is not practical or feasible to follow this procedure, the following alternative may be used.

i. Refill the hole with water up to 3 ft. below grade.

ii. Place a plank or similar board across the top of the hole and place a mark on it as a reference point from which all measurements will be made.

iii. Measure the rate of fall by dropping the measuring tape from the mark on the plank to the top of the water.

iv. Measure the rate of fall every 10 minutes for 1 hour, or longer if needed, to obtain a stabilized rate of fall.

v. Report the stabilized percolation rate in minutes per inch.

If the percolation rate is altered because of sidewall materials caving into the hole during the test, the site evaluator should make any necessary adjustments in water level in the stabilized rate to give a more accurate measurement.

## D. CALCULATION OF THE PERCOLATION RATE

1. **Disposal Trenches**

Determine the stabilized percolation rate for each test hole. In most cases repetitively measuring the infiltration until 3 subsequent values are within 10% is adequate to approximate the stabilized percolation rate. However, if subsequent values are not

approaching a steady rate or if that rate is close to a regulatory limit, 60 minutes or 120 minutes per inch, an alternative method based on a graphical solution of a theoretically derived formula is recommended. This graphical method is described in Attachment 4. Use the numerically highest percolation rate of all test holes for design of the soil treatment unit.

2. **Disposal Pits**

Perform percolation tests at the depth of each layer of different soil texture along the sidewall of the proposed pit. Compute a weighted average of the suitable percolation rates. Do not include the depth of any soil layers where the percolation rate is slower than 30 MPI.

As an example, calculate the weighted average percolation from the following data:

0 - 1 foot loam top soil

1 - 3 feet sandy loam, percolation rate = 8 MPI

3 - 6 feet loam, percolation rate = 25 MPI

6 - 8 feet silty clay, percolation rate = 55 MPI

8 - 10 feet loam, percolation rate = 28 MPI

Compute the weighted average percolation rate:

| Depth of Soil below Ground Surface, in ft. | Thickness of Soil Layer in ft. | Percolation Rate | Weighted Value |
|---|---|---|---|
| 0 to 1 | Not included | | |
| 2 to 3 | 1 x | 8 MPI | = 8 |
| 3 to 6 | 3 x | 25 MPI | = 75 |
| 6 to 8 | 0 | | |
| (Do not include because percolation rate is slower than 30 MPI) | | | |
| 8 to 10 | 2 x | 28 MPI | = 56 |
| Totals | 6 feet | | = 139 |

Weighted average = 139/6 = 23 MPI

The value of 23 MPI should be used for design purposes, and the sidewall depth is 6 feet. Note that this soil is suitable for trenches and that they are the preferable soil treatment unit.

## E. DETERMINATION OF ABSORPTION AREA REQUIREMENTS

1. Effective absorption area requirements and allowable rates of application based on percolation tests are given in Table 5.

2. The sidewall areas below the bottom of the distribution pipe in disposal trenches and pits are the effective absorption surfaces. Only consider sidewall areas in permeable substrata. Discount all bottom surfaces for trenches and pits.

3. Sufficient area shall be provided for at least two bedrooms. Design is based on the total number of bedrooms. Dens, garages, family rooms and similar areas that may be converted bedrooms may be included at the discretion of the local county health department.

4. As noted in Table 5, soil in which the percolation rate is numerically greater than 30 MPI is unsuitable for disposal pits and seepage beds. Soil with a percolation rate numerically greater than 60 MPI is generally unsuitable for any type of soil absorption system. These soils can be easily smeared and compacted during construction further reducing the soil infiltration rate. Although not recommended, trench systems may be approved in soils with percolation rates as slow as 120 MPI at the discretion of the Department under conditions specified in Table 5 and in Part V.

5. Effective absorption areas of round seepage pits are given in Table 6.

6. Effective absorption area for leach beds is figured as bottom area only.

TABLE 5

## EFFECTIVE ABSORPTION AREA REQUIREMENTS AND ALLOWABLE RATE OF APPLICATION FOR SUBSURFACE DISPOSAL SYSTEMS BASED ON PERCOLATION TESTS

| PERCOLATION RATE (Time in minutes required for water to fall 1 inch) | REQUIRED EFFECTIVE ABSORPTION AREA IN SQ. FT. PER BEDROOM (See α, ß & Γ below) | MAXIMUM RATE OF APPLICATION GALLONS PER SQ. FT. PER DAY (See ß and Γ below) |
|---|---|---|
| <1 | Not permitted | |
| 1 to 2 | 145 | 1.40 |
| 3 | 185 | 1.10 |
| 4 | 200 | 1.00 |
| 5 | 225 | 0.90 |
| 7 | 270 | 0.75 |
| 10 | 320 | 0.63 |
| 15 | 400 | 0.50 |
| 20 | 455 | 0.44 |
| 25 | 500 | 0.40 |
| 30(π below) | 560 | 0.36 |
| 35 | 610 | 0.33 |
| 40 | 645 | 0.31 |
| 45 | 690 | 0.29 |
| 50 | 715 | 0.28 |
| 55 | 745 | 0.27 |
| 60 (Σ below) | 800 | 0.25 |
| >60 to 120 | 1000 | 0.20 |

α - Sufficient area shall be provided for at least 2 bedrooms.

ß - Effective absorption surfaces are sidewalls of disposal trenches and pits and bottom area for disposal beds.

Γ- Sidewall areas in permeable substrata only are considered, bottom surfaces are ignored.

π - Over 30 minutes unsuitable for disposal pits and disposal beds.

Σ - Over 60 minutes unsuitable for subsurface disposal systems. At the discretion of the Department subsurface trenches may be allowed in soils with percolation rates of over 60 to 120 MPI if the following conditions are met:

(1) A low pressure distribution system is used to maintain a uniform application rate throughout the leach field;

(2) Special construction procedures are undertaken to assure that absorption surfaces are not compacted or smeared during construction.

TABLE 6

## EFFECTIVE ABSORPTION AREAS OF ROUND SEEPAGE PITS

**(In Square Feet)**

| DIAMETER OF SEEPAGE PIT (feet) | EFFECTIVE STRATA DEPTH BELOW FLOW LINE (BELOW INLET) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 ft. | 2 ft. | 3 ft. | 4 ft. | 5 ft. | 6 ft. | 7 ft. | 8 ft. | 9 ft. | 10 ft. |
| 3 | 9.4 | 19 | 28 | 38 | 47 | 57 | 66 | 75 | 85 | 94 |
| 4 | 12.6 | 25 | 38 | 50 | 63 | 75 | 88 | 101 | 113 | 126 |
| 5 | 15.7 | 31 | 47 | 63 | 79 | 94 | 110 | 126 | 141 | 157 |
| 6 | 18.8 | 38 | 57 | 75 | 94 | 113 | 132 | 151 | 170 | 188 |
| 7 | 22.0 | 44 | 66 | 88 | 110 | 132 | 154 | 176 | 198 | 220 |
| 8 | 25.1 | 50 | 75 | 101 | 126 | 151 | 176 | 201 | 226 | 251 |
| 9 | 28.3 | 57 | 85 | 113 | 141 | 170 | 198 | 226 | 254 | 283 |
| 10 | 31.4 | 63 | 94 | 126 | 157 | 188 | 220 | 251 | 283 | 314 |
| 11 | 34.6 | 69 | 101 | 138 | 173 | 207 | 212 | 276 | 311 | 346 |
| 12 | 37.7 | 75 | 113 | 151 | 188 | 226 | 264 | 302 | 339 | 377 |

Example: A pit of 5 foot diameter and 6 foot depth below the inlet has an effective area of 94 sq. ft. A pit of 5 foot diameter and 16 foot depth has an area of 94 + 157, or 251 sq. ft.

# PART IV - CONVENTIONAL SEPTIC TANK SYSTEM DESIGN AND CONSTRUCTION

## A. SEPTIC TANK

### 1. Design

a. After December 31, 1989, all new septic tanks must have a minimum of two compartments. The inlet compartment of any septic tank shall be at least two-thirds (2/3) of the total capacity of the tank.

b. The minimum liquid capacity of the septic tank shall be 960 gallons or 1.6 times the daily design flow (see Table 1), whichever is greater. Minimum septic tank capacities for single family dwellings shall be:

| Bedroom served | Minimum tank liquid capacity (gallons) |
|---|---|
| 1 - 3 | 960 |
| 4 | 1,200 |
| 5 | 1,500 |
| 6 | 1,800 |

Dens, garages, family rooms and similar areas that can be converted to bedrooms may be included at the discretion of the county health department. For more than 6 bedrooms use 1.6 x 200 x number of bedrooms for minimum tank capacity in gallons.

c. The maximum size for a septic tank is 20,000 gallons. Systems in excess of this design capacity should be designed using secondary treatment technology (See Engineering Bulletin 11).

### 2. Construction

a. Septic tanks shall be of approved shape (Figure 2), structurally sound, watertight and constructed of materials resistant to corrosion or decay, such as concrete, fiberglass, polyurethane, polyethylene, medium or heavyweight concrete block or burned hard brick. Cinder block is not acceptable.

b. The walls, base and partitions of all tanks shall be securely bonded together or shall be of monolithic or keyed construction. Walls, base and partitions of poured-in-place tanks shall have a minimum thickness of four inches throughout. A minimum thickness of three inches will be allowed in precast tanks which have been properly reinforced unless calculations are provided by a Professional Engineer registered in the State of Arizona that show a narrower thickness will provide a compressive strength of at least 2500 psi.

c. A septic tank installed under a driveway or parking area shall have adequate reinforcement to support any anticipated static and/or dynamic load, and gas-tight access plugs brought up to grade.

d. Rectangular, elliptical and semi-elliptical septic tanks shall have a length of at least twice but not more than three times the width. The liquid depth of such tanks generally shall not be less than four feet nor more than six feet. Tanks of other shapes and dimensions will be considered for approval when accompanied by data supporting their effectiveness.

e. Inlet and outlet connections of each compartment of a septic tank shall be designed and installed to retain sewage solids, scum and sludge effectively.

f. At least a 12-inch freeboard or void is required between the sewage level and the underside of the tank cover. The second compartment shall be vented to the first compartment.

g. The invert, or flow line, of the outlet pipe shall be set a minimum of 12 inches below the bottom of the tank cover. The inlet pipe shall be two inches higher than the outlet pipe.

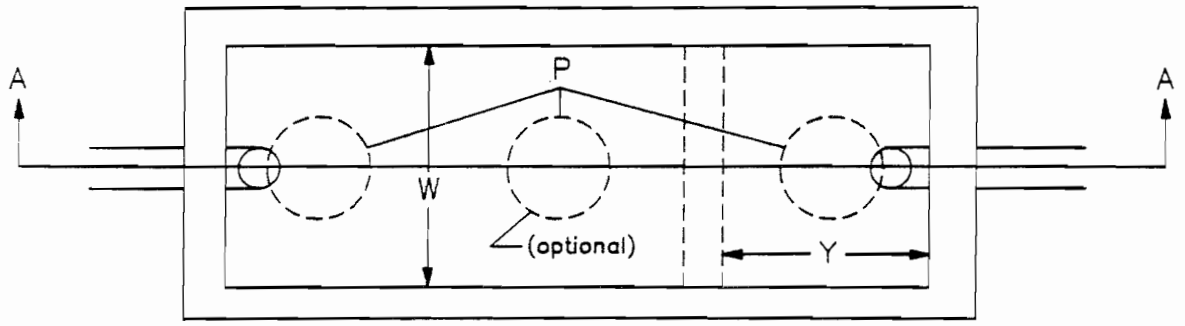
h. Outlet control devices are required for all septic tanks. These shall consist of pipe tees not less than four inches in diameter. The bottom of the tee shall extend at least 18 inches below the surface of the liquid and the top shall be at least eight inches above the invert of the outlet and not less than two inches below the bottom of the cover. The two compartments may be connected by a six inch diameter ell or a slot in the compartment wall as shown in Figure 2.

i. Either an inlet pipe tee or an inlet baffle shall be used to spread the influent as evenly as possible across the septic tank. To avoid compaction and plugging in the vertical leg of the tee, non-plugging inlets with more sweeping elbows or with regular baffles are recommended.

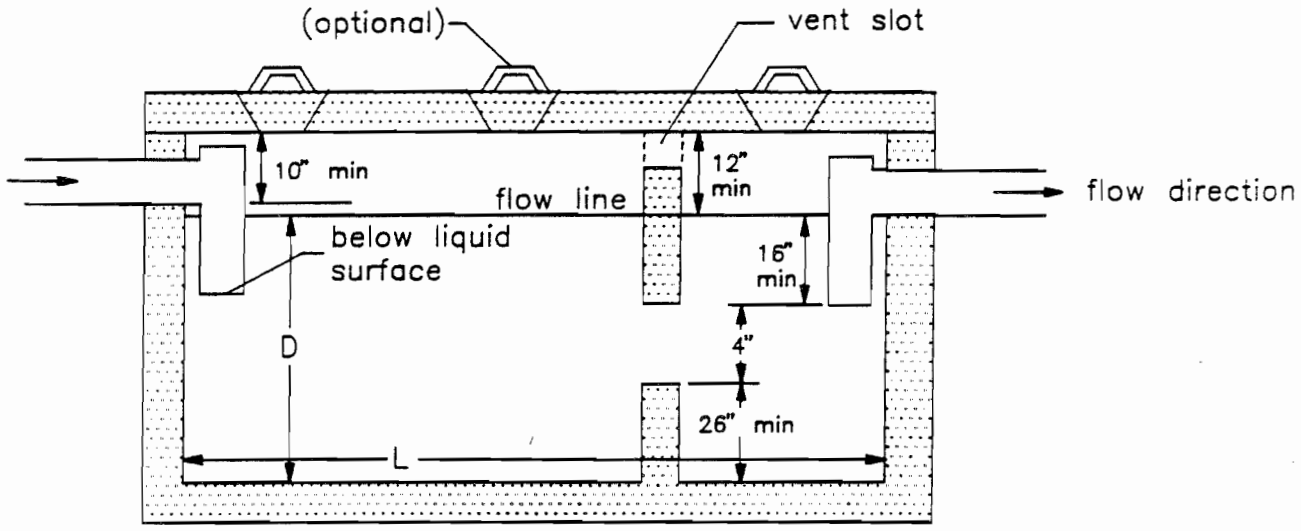
j. Septic tank covers shall be sufficiently strong to support whatever static and/or dynamic loads may reasonably be expected to be imposed upon it and tight enough to prevent the entrance of dirt or other foreign matter and the escape of the odorous gases of digestion.

k. Each tank shall be provided with two or more access openings at least 16 inches in diameter or square (Figure 2). The access openings shall be located over each inlet and outlet.

# FIGURE 2. SEPTIC TANK DETAILS




PLAN (Cover Removed)




SECTION A – A

D – Liquid Depth, generally not less than 4 feet or greater than 6 feet.
L – Tank Length, at least 2 times but not more than 3 times the width.
P – Position of inspection holes, minimum of 2 inspection holes, 12 inches in diameter or square.
W – Tank Width, at least 1/3 but not more than 1/2 the length.
Y – Position of baffles, 1/3 of tank length (L).

3. Materials

a. Concrete Septic Tanks

All concrete septic tanks shall be coated with an approved bituminous coating or protected from corrosion by other acceptable means. The coating shall extend to at least four (4) inches below the water line, and shall cover all of the internal area above that point. A concrete mix incorporating 15% to 18% fly ash may be substituted for specific tank coatings if adequate documentation is submitted by the manufacturer to demonstrate satisfactory tank sealing.

b. Alternate Materials

(1) Septic tanks constructed of alternate materials may be approved by the Department when complying with approved standards set forth in this Engineering Bulletin.

(2) Wooden septic tanks are prohibited.

c. Prefabricated Septic Tanks

(1) Manufactured or prefabricated septic tanks shall comply with all approved applicable standards set forth herein and must be approved by the ADEQ for installation in the State of Arizona.

(2) Independent laboratory tests and engineering calculations certifying the tank capacity and structural stability shall be provided by a registered structural engineer licensed by any State Board of Technical Registration.

d. Precast Septic Tanks

(1) All forms used in placing concrete must be smooth, sufficiently designed and braced to maintain their alignment under pressure of the concrete during placing.

(2) Precast sections must be set evenly in a full bed of sealant. Excessively mortared joints must be trimmed flush. Sealants used between the joints are at the manufacturer's discretion, unless otherwise specified. If grout is used, it must consist of two parts plaster sand to one part cement with sufficient water added to make the grout flow under its own weight. The grout must be poured into a water-soaked groove, and filled to the top of the groove in the previously set section. If mastic joint compound is used, it must be placed along the walls of the groove unless a double amount is to be used as a further precaution against leakage. In this case, the mastic sealant must be placed on the two shoulders of the groove. If polyurethane or approved equal is used it must be mixed as directed on the label and placed in the groove. The next section must be placed while the foaming reaction is still in process.

4. Location

a. The septic tank shall be located in compliance with Tables 7 and 8, but not in excess of 100 feet from the facility being served. Distances from trees, swimming pools, sidewalks, and driveways shall be sufficient to prevent cave-in during construction.

b. The septic tank or an approved access manhole to the tank shall not be buried more than six inches below the ground surface finish grade. A marker shall be brought up to grade. The tank access cover shall be adequately reinforced to support the load imposed. If the pitch of the house sewer from the structure stub-out to the tank is more than 1/4 inch per foot, a method acceptable to the Department must be employed to assure a moderate entrance velocity of the raw sewage into the tank.

c. The septic tank shall be installed such that the bottom of the tank is at least 2 feet above the high seasonal groundwater level to prevent tank flotation or the septic tank design shall incorporate anti- floatation devices approved by ADEQ.

d. A two-way cleanout shall be installed between the facility being served and the septic tank.

## B. DISPOSAL TRENCHES

1. **Absorption Area** - see Part III.E.

2. **Construction**

a. A disposal trench replacement area equivalent to 100% of the initial area shall be available for replacement disposal trenches. This space shall not be used for permanent structures.

b. The disposal trenches shall be constructed in either of the following ways:

(1) The trenches may be laid out as a parallel distribution system preceded by a manifold or distribution box (see Figure 3); or,

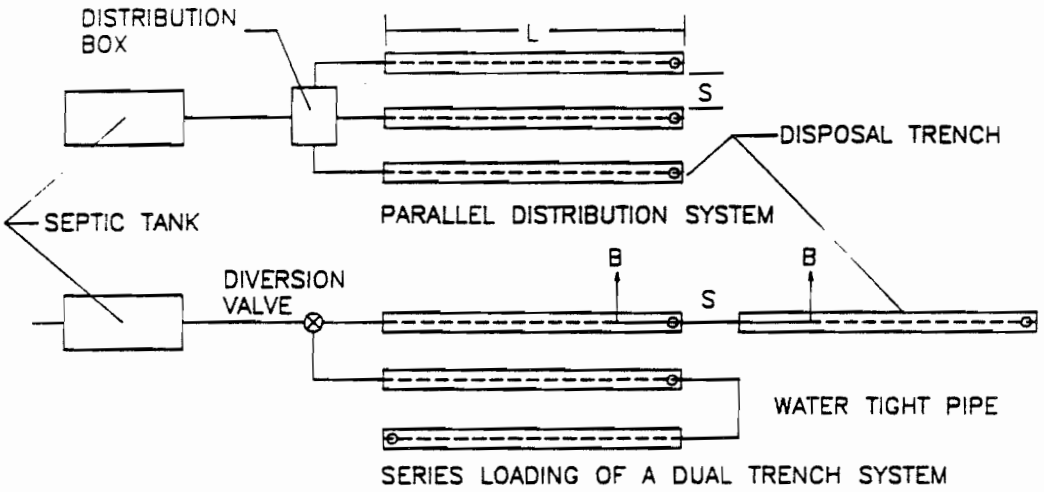
(2) The trenches may be constructed in two systems preceded by a dosing chamber with an alternating siphon. Each system of trenches shall contain one-half the required area and may be serially loaded (see Figure 3). A diversion valve for this type of system may be installed if the applicant can justify its use to the Department as being an effective means of alternating use of each half of the disposal system. If approved, the diversion valve shall be installed near the septic tank and the housing of the valve shall be clearly and easily accessible at the ground surface.

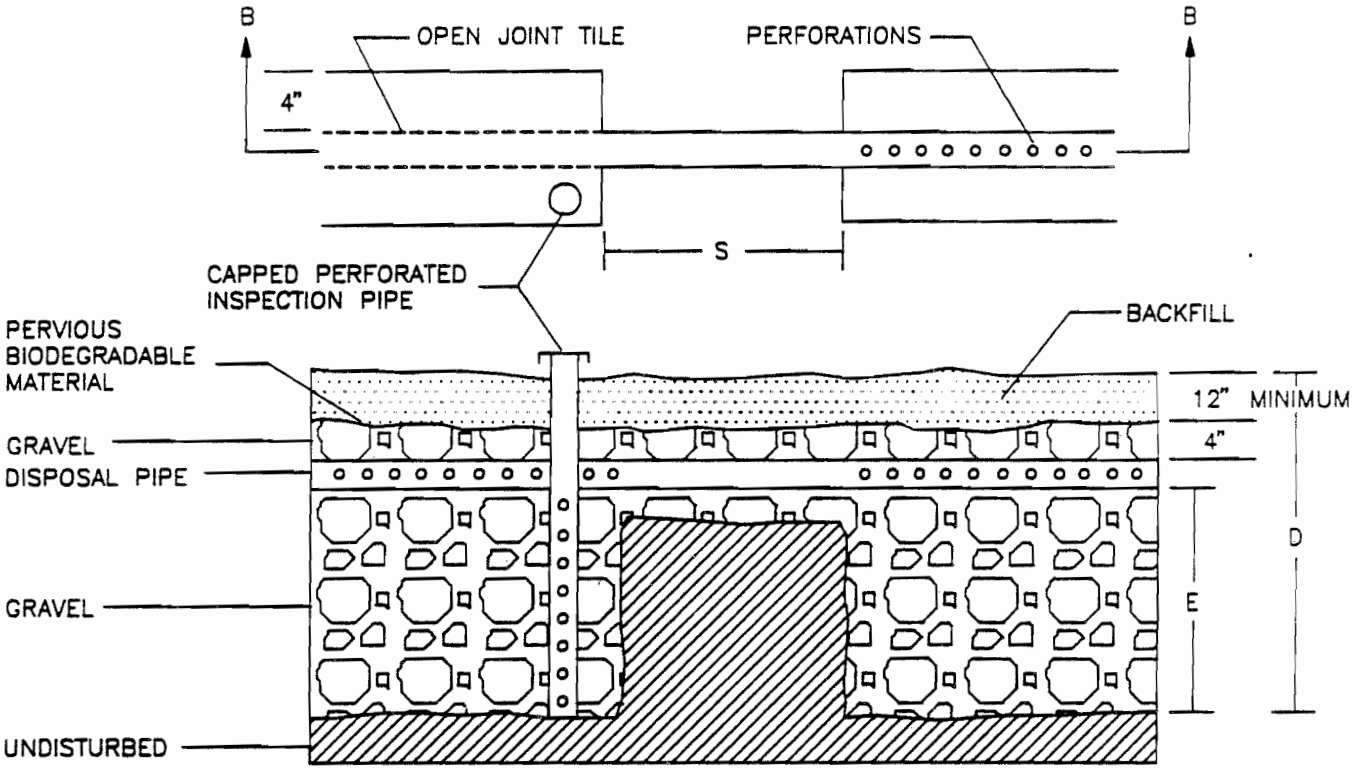
c. Both disposal pipe and trench bottom shall be level.

d. Disposal trenches shall be a minimum of 12 inches wide.

e. Bottom of the trench shall be a minimum of 5 feet above the seasonal high groundwater level.

# FIGURE 3. TRENCH DETAILS




SECTION B–B, TOP AND SIDE VIEW

D – Total Trench Depth
E – Effective sidewall for absorption. Absorption area per trench = 2xExL
L – Trench length, 100 feet maximum
S – Trench spacing, minimum 2 times total effective trench depth (2xE), but not less than 10'
W – Trench width, 12 inch minimum

f. Aggregate fill shall extend from the bottom of the trench to four inches above the distribution pipe. Aggregate fill shall be clean and of uniform size, preferably 3/4 inch to two inches in diameter, and shall offer 30% or more void space.

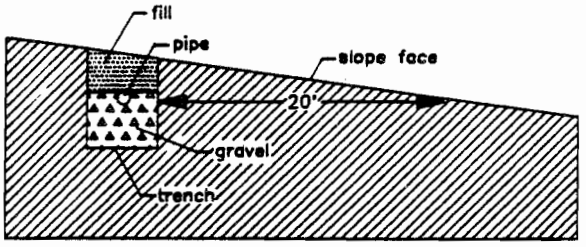
g. Backfill shall be at least 12 inches of native soil over a protective layer of untreated building paper, filter fabric or other pervious biodegradable material. Soil placed over trenches shall be slightly mounded to control settlement.

h. Each trench shall not exceed 100 feet in length. For serial loaded trenches leave a minimum of 2 times the effective trench depth, but in no case less than 10 ft. of undisturbed material between trenches.

i. On sloped sites disposal trenches shall be constructed in series. Each trench shall parallel contour lines. Minimum spacing between trenches on the same contour shall be two times the effective trench depth. Trenches not on the same contour shall be spaced as follows:

| SLOPE OF GROUND BETWEEN TRENCHES | MINIMUM SPACING BETWEEN TRENCHES |
|---|---|
| 0% to 5% | 2.0 times the effective trench depth |
| 5% to 10% | 2.5 times the effective trench depth |
| 10% to 20% | 3.0 times the effective trench depth |
| Over 20% | 4.0 times the effective trench depth |

j. For lots with slopes in excess of 20 percent, soil absorption must be a minimum of 20 feet horizontally from the face of the slope or ground surface as in the following diagram:




k. A watertight line shall connect the septic tank, distribution box, and disposal pipes.

l. The outlet invert of the septic tank shall be a minimum of four inches above the distribution pipe invert.

m. Disposal trenches shall be constructed and scarified in a manner which will prevent or correct any smearing of the sidewall surface areas.

n. Breathers may be placed at all terminal ends of absorption trenches. The breather shall consist of perforated pipe at least four inches diameter, placed vertically within the backfill of the trench and penetrating into the trench aggregate.

o. Inspection pipes shall be installed in the subsurface absorption trenches to observe the depth of ponding to measure system performance and to serve as a means of locating the disposal field. The pipes should extend from the bottom infiltrative surface up to or above final grade. The bottom should be open and the top capped. The pipe within the gravel should be perforated.

p. Disposal pipe shall run the length of each trench and distribution pipe shall connect each trench in series or parallel. Except for low pressure distribution systems the minimum diameter of the distribution and disposal pipe shall be four inches. Distribution and disposal pipe shall be a minimum of four inches from any soil surface (sidewall or soil cover). Disposal pipe shall have a minimum crushing strength of 2000 psi.

q. The end of each drainfield trench in parallel and the end of the disposal pipe in the last trench in serially loaded drainfield systems shall be capped.

r. The use of dynamite or jack-hammer is prohibited in the construction of disposal trenches except as allowed under Section III.B.1.b.

s. The use of V-shaped trenches is prohibited, except where soil conditions make construction of vertical impossible.

t. All types of piping materials used in construction shall have established ASTM, ANSI or NSF standards if manufacture or seals of approval and shall be designated for use as sewer pipe.

3. Location

a. Setback requirements for disposal trenches are given in Tables 7 and 8.

b. Construction or paving over the disposal trenches is prohibited, unless:

(1) The 100% replacement disposal system is constructed initially; and,

(2) All distribution and disposal piping shall be schedule 40 at a minimum.

c. Vehicular traffic is prohibited in the disposal trench area at any time after its construction unless structural protection or 3 feet of soil cover is provided.

TABLE 7

MINIMUM SETBACK REQUIREMENTS

FOR ON-SITE DISPOSAL SYSTEMS[cc], feet

| | SEPTIC TANK | DISPOSAL TRENCH, BED, PIT | ET BED LINED | ET BED UNLINED | HOME AEROBIC UNITS | SURFACE IRRIGATION | COMBINATION ET/ABS TRENCH | MOUND SYSTEM |
|---|---|---|---|---|---|---|---|---|
| Buildings | 10 | 10[bb] | 10 | 10 | 10 | 0 | 10[bb] | 10 |
| Property lines[aa], easements | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Wells (Public Water Supplies) | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Wells (Private) | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Live streams[dd] | 100 | 100 | 25 | 100 | 100 | 100 | 100 | 100 |
| Lake or reservoir[ee] | 100 | 100 | 25 | 100 | 100 | 100 | 100 | 100 |
| Water Supply watershed | 200 | 200 | 50 | 200 | 200 | 200 | 200 | 200 |
| Dry wash[ff] | 50 | 50 | 25 | 50 | 50 | 50 | 50 | 50 |
| Water lines | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Cuts on sloping terrain | 25 | 50 | 25 | 25 | 25 | 50 | 50 | 50 |
| Driveway | 0 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Swimming pool | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |

aa. Lots with individual wells require setbacks of 50 feet.
bb. Or minimum spacing between trenches, pits, or beds, whichever is greater.
cc. Distances are from edge to edge.
dd. As measured from the line which defines the limit of the 10-year frequency flood.
ee. As measured from the high-water line.
ff. As measured from the edge of the water course or drainage easement.
gg. As measured from the edge of the bed.
hh. As measured from the edge of the berm surrounding the disposal area.
ii. As measured from the basal area perimeter.

TABLE 8

MINIMUM SETBACK REQUIREMENTS

FOR ON-SITE DISPOSAL SYSTEMS FROM CANALS, feet

| CANAL TYPE | SEPTIC TANK | DISPOSAL TRENCH, BED, PIT | ET BED LINED | ET BED UNLINED | HOME AEROBIC UNITS | SURFACE IRRIGATION | COMBINATION ET/ABS TRENCH | MOUND SYSTEM |
|---|---|---|---|---|---|---|---|---|
| Lined | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Unlined[aa] | 100 | 100 | 100 | 25 | 100 | 100 | 100 | 100 |
| Elevated (at or above ground level) | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Intermittent | 100 | 100 | 100 | 25 | 100 | 100 | 100 | 100 |
| Abandoned | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |

aa. 200 feet on water supply watersheds.

## C. DISPOSAL PITS

1. **Absorption Area** - see Part III.E., and Table 4.

2. **Construction**

a. A disposal pit replacement area equivalent to 100% of the initial area shall be available for a replacement disposal pit. This space shall not be used for permanent structures.

b. The design and construction of a hollow lined disposal pit shall conform to the following (See Figure 4):

(1) Each disposal pit shall be circular in shape and shall have an excavated diameter of not less than 3 feet. Each such pit shall be lined with an approved type whole new hard burned clay brick, concrete block, concrete circular manhole type rings or other approved materials. Approval shall be obtained prior to commencement construction of any seepage pit.

(2) The lining in every disposal pit shall be laid on a firm foundation. Lining materials shall be placed tight together and laid with joints staggered. Except in the case of approved type pre-cast concrete circular sections, no brick or block shall be greater in height than its width and shall be laid flat to form at least a 4 inch wall. Brick or block greater than 12 inches in length shall have chamfered matching ends and be scored to provide for seepage. Excavation voids behind the brick, block or concrete liner shall have a minimum of 6 inches of clean 3/4 inch gravel or rock.

(3) All brick or block used in disposal pit construction shall have a minimum compressive strength of 2500 pounds per square inch.

(4) Each disposal pit shall have a minimum sidewall (not including the dome) of 10 feet below the inlet.

(5) The cover of any disposal pit shall be constructed with a reinforced concrete slab of 2500 pounds per square inch minimum compressive strength, not less than 5 inches thick and designed to support an earth load of not less than 400 pounds per square foot. Each such cover shall be provided with a 9 inch minimum inspection hole with a plug or cover, shall be coated on the underside with an approved bituminous or other nonpermeable compound, and shall extend to final grade.

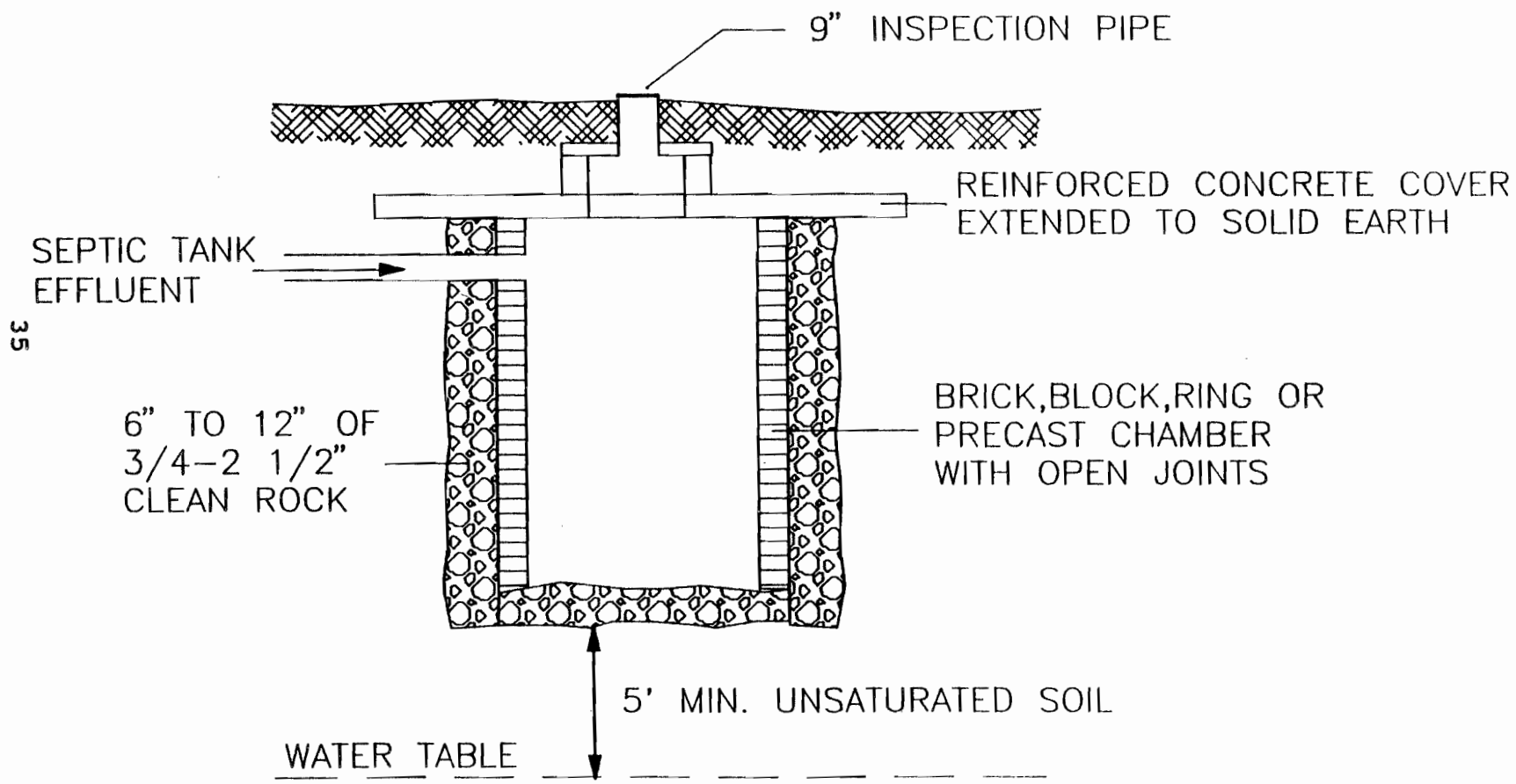
(6) The top of the dome or cover must be at least 12 inches, but not more than 4 feet below the surface of the ground.

(7) An approved vented inlet fitting shall be provided in every seepage pit so arranged as to prevent the inflow from damaging the sidewall.

(8) At the discretion of the local County Health Department, gravel filled disposal pits without block or brick lining may be approved.

c. Disposal pits shall terminate at least five feet above the seasonal high static

FIGURE 4. DISPOSAL PIT CROSS-SECTION



groundwater level and four feet above impermeable strata.

d. For hollow lined pits the disposal pit bottom shall be backfilled 6 to 12 inches in depth and the annular space left between the wall of the chamber and the excavation shall be filled to the top of the chamber with durable aggregate. Aggregate shall be clean and of uniform size, preferably 3/4 inch to two inches in diameter. Material used for backfill shall offer 30% or more void space.

e. For gravel filled pits the entire pit shall be backfilled with durable aggregate. Aggregate shall be clean and of uniform size, 3/4 inch to two inches in diameter. Material used for backfill shall offer 30% or more void space.

f. A watertight line shall connect the septic tank, distribution box and disposal pits.

g. The outlet of the septic tank shall be a minimum of four inches above the bottom of the distribution pipe.

h. Multiple disposal pit installations shall be constructed in either series or parallel arrangements and served through an approved distribution box, dosing chamber or diversion valve with watertight lines to each pit. Minimum diameter of the distribution pipe shall be four inches.

i. Disposal pits shall be excavated in a manner which will minimize, prevent or correct any smearing of the sidewall surface areas.

j. Breathers or inspection pipes shall be placed in all disposal pits. The breather shall consist of perforated pipe at least four inches in diameter, placed vertically within the backfill of the pit. The pipe shall extend from the bottom of the pit to several inches above the ground level.

k. Minimum spacing between pits on the same contour shall be three times the pit diameter (12 foot minimum spacing measured edge to edge). Pits not on the same contour shall be spaced as follows (12 foot minimum spacing):

| % SLOPE OF GROUND BETWEEN PITS | MINIMUM SPACING BETWEEN PITS (times the pit diameter) |
|---|---|
| 0 to 5 | 3 |
| 5 to 10 | 4 |
| 10 to 20 | 5 |
| Over 20 | 6 |

l. The use of dynamite or jack-hammer in construction of disposal pits is prohibited except as allowed under Section III.B.1.b..

3. **Location**

Setback requirements are given in Tables 7 and 8.

## D. DISPOSAL BEDS

1. **Absorption Area** - see Part III.E.

2. **Construction**

   a. A disposal bed replacement area equivalent to 100% of the initial area shall be available for replacement beds. This space shall not be used for permanent structures.

   b. The disposal pipe should drop 2" per 100 ft. of pipe. The bottom of the bed shall be level.

   c. Disposal pipes for distributing effluent shall be spaced 4 to 6 feet apart and 3 feet from the bed sidewall (See Figure 5).

   d. The bottom of the bed shall be a minimum of five feet above the seasonal high groundwater table. The bed shall have a minimum depth of 36 inches below the natural ground level to provide minimum earth backfill of 12 inches.

   e. Aggregate fill shall extend from the bottom of the bed to depth of 24 inches. Aggregate fill shall be clean and of uniform size, preferably 3/4 inch to two inches in diameter. Soft volcanic cinders are prohibited.

   f. Backfill shall be at least 12 inches of native soil over a protective layer of untreated building paper or other approved biodegradable material. Soil placed over the bed shall be slightly mounded to control settlement.

   g. Each bed shall be not more than 100 feet in length.

   h. A watertight line shall connect the septic tank, distribution header and disposal lines. The ends of the disposal lines shall be looped or capped.

   i. The outlet of the septic tank shall be a minimum of four inches above the bottom of the distribution pipes.

   j. Disposal beds shall be constructed in a manner which will prevent or correct any smearing of the sidewall or bottom surface areas.

   k. Disposal pipes shall run the length of the bed parallel to each other. Minimum diameter of the distribution pipe shall be four inches.

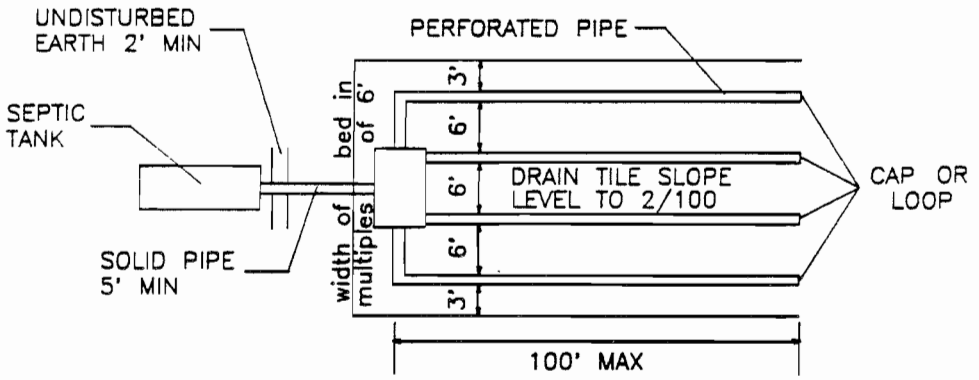
   l. Use of dynamite or jack-hammer is prohibited in construction of a disposal bed except as allowed under Section III.B.1.b.

   m. Breathers or inspection pipes shall be installed in all disposal beds. The breather shall consist of perforated pipe at least 4 inches in diameter, placed vertically within backfill of the bed. The pipe shall extend from the bottom of the bed to finish grade or above and be capped.

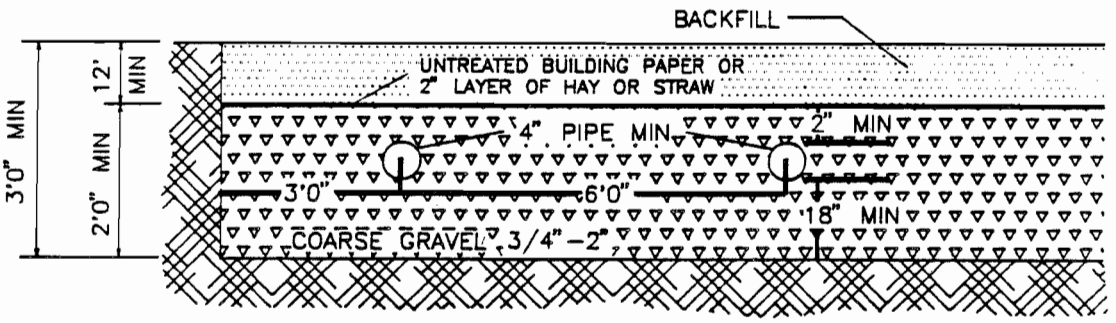
3. **Location**

   a. Setback requirements for a disposal bed are given in Tables 7 and 8.

FIGURE 5. TYPICAL DISPOSAL BED SYSTEM




PLAN




SECTION

b. Construction or paving over the disposal beds shall not be permitted.

c. Vehicular traffic on the disposal bed area at any time after its construction is prohibited.

d. Disposal beds are acceptable where:

(1) The site is relatively level, no more than 5% slope, and

(2) percolation rates are 30 minutes/inch or faster.

## E. OTHER COMPONENTS

### 1. Distribution Boxes

#### a. General

A distribution box shall be used to distribute tank effluent in equal portions to two or more distribution pipes, unless otherwise approved by the Department. Alternatives that may be approved by the Department are:

(1) A manifold system that is leveled by transit or sitelevel for single family residences only, or

(2) A diversion valve that will allow for alternate use of each half of a split system of disposal trenches, provided that a maintenance schedule is designed into the system.

#### b. Design

(1) The distribution box must be of sufficient size to accommodate the required number of distribution lines. The box must be of watertight construction (See Figure 6).

(2) The outlet lines must be set at the same level and 4 to 6 inches above the bottom of the box.

(3) The inlet must be at least 1 inch above the outlets. A masonry baffle at least 6 inches high and 12 inches long must be placed transversely to the distribution box inlet and 6 inches in front of it.

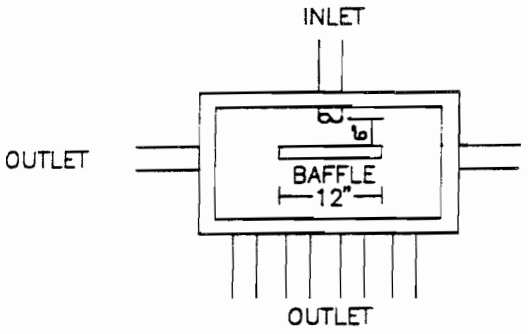
(4) The box must be provided with a satisfactory concrete, plastic or steel cover.

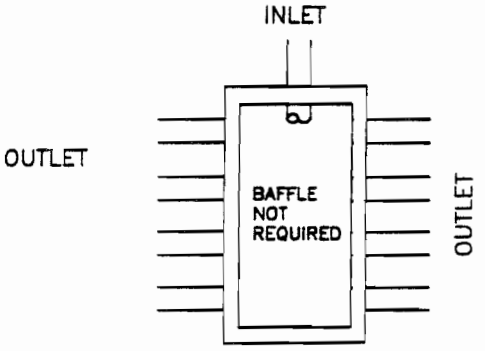
#### c. Construction

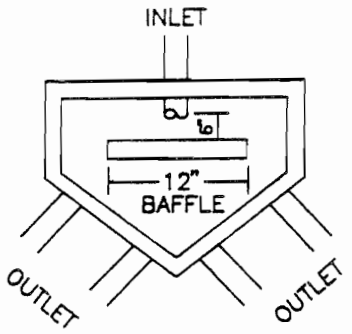
(1) Distribution boxes shall be of approved shape, structurally watertight and constructed of materials resistant to corrosion or decay, such as concrete, fiberglass, polyurethane, polyethylene, heavyweight concrete block or burned hard brick.

(2) The walls, base and baffle of all boxes shall be securely bonded together or shall be of monolithic or keyed construction. Walls, base and baffle

FIGURE 6. DISTRIBUTION BOX DETAILS



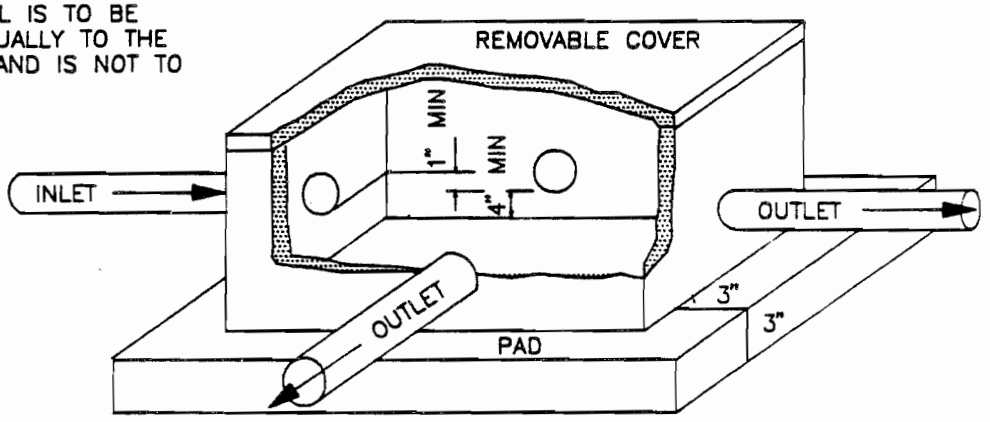

THE DISTRIBUTION BOX IS TO BE CONSTRUCTED OF SOUND, DURABLE MATERIAL (CONCRETE, COATED METAL, CMU, HARD BURNED BRICKS,ETC.) SUCH AS TO ASSURE WATERTIGHTNESS.

A MASONARY BAFFLE 6" HIGH, 12" LONG AND PLACED TRANSVERSELY TO THE INLET ● 6" DISTANCE.

ALL OUTLET INVERTS ARE TO BE LEVEL AND FROM 4" TO 6" ABOVE FLOOR OF THE BOX.

INLET INVERT HEIGHT 1" MIN. ABOVE OUTLET INVERTS.

EACH FIELD LATERAL IS TO BE CONNECTED INDIVIDUALLY TO THE DISTRIBUTION BOX AND IS NOT TO BE SUBDIVIDED.



of poured-in-place boxes shall have a minimum thickness of four inches throughout. A minimum thickness of three inches will be allowed in precast boxes which have been properly reinforced.

(3) Distribution box covers shall be sufficiently strong to support whatever static and/or dynamic loads may reasonably be expected to be imposed upon it and tight enough to prevent the entrance of dirt or other foreign matter and the escape of the odorous gases of digestion.

**d. Materials**

(1) Distribution boxes constructed of alternate materials may be approved by the Department when complying with approved standards.

(2) Wooden distribution boxes are prohibited.

(3) Prefabricated distribution boxes.

i. Manufactured or prefabricated distribution boxes shall comply with all approved applicable standards and must be approved by the ADEQ for installation in the State of Arizona.

ii. Independent laboratory tests and engineering calculations certifying the box structural stability shall be provided by a registered engineer licensed or registered any State Board of Technical Registration.

**e. Location**

(1) The distribution box shall be located as near as is practical to the disposal bed, pit or trench system, but not closer than 2 ft..

(2) The distribution box shall be installed at such depth that the top, or an approved access manhole to the box, will be not more than 18 inches below the ground surface. If a diversion valve is located in the box, the cover to the access manhole should be installed at grade-level. The tank cover shall be adequately reinforced to support the load imposed.

(3) A distribution box shall be installed on a level concrete installation pad or undisturbed base unless the box is built in place. In any event, the bottom of the box must be level.

(4) If constructed of fiberglass or plastic the distribution box shall be anchored in concrete.

**2. Grease, Sand, and Lint Interceptors**

**a. Applicability**

(1) All commercial and industrial users of private sewage disposal systems, that have liquid wastes containing grease, garbage, flammable wastes, sand, hair, lint or other ingredients in quantities greater than a domestic source which may adversely affect the operation of such systems, shall install and

maintain an appropriate approved interceptor to ensure satisfactory operation of their respective sewage disposal system.

(2) Sampling boxes shall be installed when required by the Department.

(3) Interceptors shall be located prior to treatment and as close as possible to the source and be accessible for servicing. All necessary manholes for servicing shall be at grade level and be gas tight.

b. **Design**

(1) Interceptors shall be of approved design and have at least 2 compartments. Structural requirements shall be equal to the applicable portions for septic tanks (See Figure 7).

(2) The following design formulae shall be applied, unless the design engineer can demonstrate to the satisfaction of the Department that other criteria are more appropriate in a given circumstance:

i. Grease and garbage - commercial kitchens
$S = NM \times R \times T \times 4\ F$

ii. Sand, silt and oil - auto washers
$S = NV \times R \times T \times F$

iii. Silt, lint and grease - laundries, laundromats
$S = NW \times 2 \times R \times T \times F$

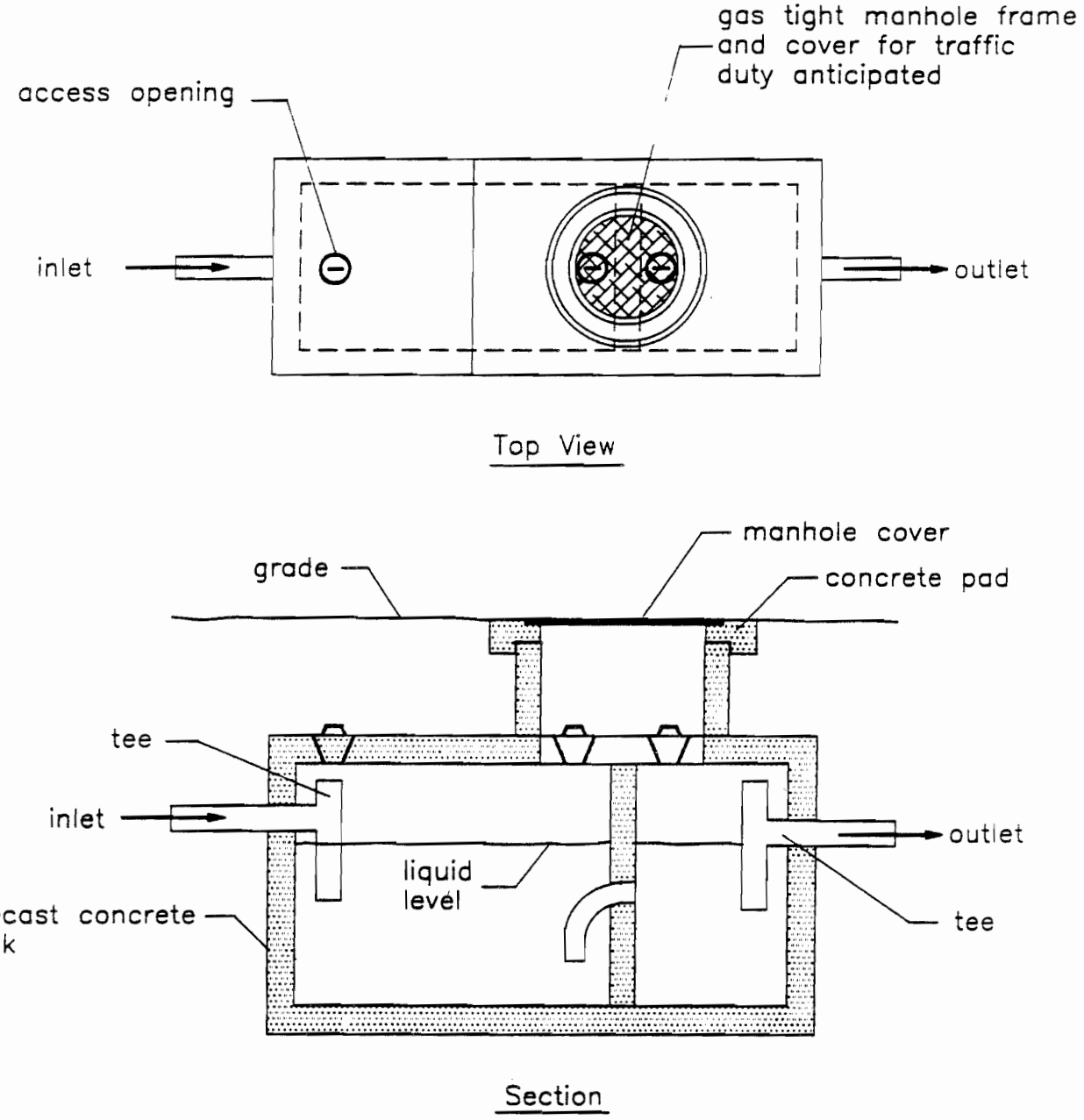
iv. Where:

S = the liquid capacity (size) of the interceptor
R = the waste flow rate
T = required retention time
F = the storage factor, in terms of 8 hours units of operation
NM = number of meals per peak hour
NV = number of vehicles per hour
NW = number of washing machines per laundry

v. Normal retention times:

| | |
|---|---|
| Commercial kitchen waste with dishwasher and or disposal | 2.5 hours |
| Single service kitchen waste with disposal | 1.5 hours |
| Auto washer | 2.0 hours |
| Laundry | 2.0 hours |

# FIGURE 7. DOUBLE-COMPARTMENT INTERCEPTER




A vertical extension of 12 inches separates the inlet, outlet and baffle fittings from the tank floor. The tops of the fittings should be well above the liquid layer.

vi. Normal storage factors:

Fully equipped commercial kitchen
- 8 hr. operation . . . . . 1
- 16 hr. operation . . . . . 2
- 24 hr. operation . . . . . 3

Single service kitchen . . . . . 1.5

Auto washers
- self-serve . . . . . 1.5
- employee operated . . . . . 2

Laundries, laundromats . . . . . 1.5

vii. Waste flow rates:

Commercial kitchen
- with dishwashing machine . . . . . 6 gal/meal
- without dishwashing machine . . . . . 5 gal/meal

Single service kitchen . . . . . 2 gal/meal

Food waste disposer . . . . . 1 gal/meal

# PART V - ALTERNATIVE ON-SITE DISPOSAL SYSTEMS

## A. GENERAL REQUIREMENTS

### 1. Treatment

a. Alternative on-site disposal systems are intended and will be approved for individual lots only where conventional septic tank systems are not suitable and cannot be approved.

b. Alternative on-site disposal systems shall not be approved for wastewater disposal as the basis for subdivision approval if the lot size is less then one acre. Such subdivisions not meeting the minimum lot size may still be approved providing a public management agency exists at the time of subdivision approval to operate and maintain the proposed alternative on-site systems.

c. Alternative on-site disposal systems will be approved only if the homeowner is aware of his responsibility for operation and maintenance, of health hazards, and of his potential personal liability. The owner must agree to maintain the system as required. (See attachment 1.)

d. Wherever possible, aerobic treatment units shall be maintained by a management agency or by contract with an operator certified by the Department, minimum Grade WW2.

### 2. Effluent Disposal

a. Subsurface disposal in the form of percolation, evapotranspiration or irrigation is preferred. A comparison of various on-site treatment and disposal systems and conditions for their use is given in Table 9.

b. All surface disposal and uses must comply with applicable treatment and reuse rules.

c. All surface disposal must be contained on-site. This does not apply to wastewater that is percolated, transpired or trucked from the site, or sludge from such treatment systems that must be removed to an approved disposal site.

d. Lining of evapotranspiration (E-T) or similar disposal areas and special sealing of treatment units may be required where there is a high water table, underlying broken or fractured rock strata, excessive percolation rates with nearby surface and/or subsurface bodies of water, a close proximity to slopes or retaining walls, if blasting required to form the disposal field, if located in fill, or if located above the natural grade.

## TABLE 9

## COMPARISON OF ON-SITE TREATMENT AND DISPOSAL METHODS AND CONDITIONS OF USE

| TYPE OF ON-SITE DISPOSAL SYSTEM | SOIL CONDITIONS | | TYPE OF ON-SITE TREATMENT SYSTEM | | |
|---|---|---|---|---|---|
| | Percolation Rate MPI | Minimum Total Depth to Groundwater/Impermeable Layer | Septic Tank | Class I Rated Home Aerobic Unit | Class I Rated Home Aerobic Plus Disinfection |
| 1. Conventional Sub-surface Disposal System: Trench | 1-60* | 8/7 | X | | |
| Bed | 1-30 | 8/7 | X | | |
| Pit | 1-30 | 15/14 | X | | |
| 2. Evapotranspiration Bed: | | | | | |
| Lined with plastic | N/A | 3/3 | X | | |
| Unlined | N/A | 8/7 | X | | |
| 3 Mound System | 1-120 | 2/2 | X | | |
| 4. Sub-surface Irrigation may be used if: | | | | | |
| a. The minimum vertical separation** (MVS) to an impermeable layer is at least 12 inches less than 48 inches; and | | | | | |
| b. The MVS to the high seasonal groundwater level and/or fractured rock is at least 5 feet. | | | | | |
| Case I. .The disposal trenches are greater than 2 feet in total depth; and .The total cover of natural soil is at least 12 inches. | 1-60 | >7/>3 | | X | |
| Case II. .The disposal trenches are 2 feet in total depth or less; or .The total cover of natural or imported soil is less than 12 inches but at least 6 inches. | 1-60 | 6.5/2.5 | | | X |
| 5. Surface irrigation may be used if the total depth of natural soil in the disposal area is at least 24 inches. | N/A | 2/2 | | | X |

* May be approved for percolation rates of 60-120 MPI providing a pressure distribution system is installed and special construction measures are followed.

** Minimum vertical separation extends from the bottom of the trench, pit, or bed, to rock, other impermeable layers, or the high seasonal groundwater level.

3. **Application Requirements For Construction Approval**

a. In addition to items required by Part II. C. the following items are required prior to construction of any new alternative on-site disposal system, or before modifications are made to an existing alternative on site disposal system.

(1) Plans and Specifications sealed and signed by a Professional Engineer registered in the state of Arizona unless otherwise exempted by the Code of the State Board of Technical Registration.

(2) An Operation and Maintenance manual for individual home aerobic systems must be submitted with the application for approval. The Operation and Maintenance Manual must conform to Engineering Bulletin No. 11, Chapter 11, and must contain:

i. A schedule of daily, weekly, monthly, and yearly operation and maintenance requirements together with instructions for completing each operation and maintenance item.

ii. Testing requirements, methods, frequencies, and reporting responsibilities (see Part V.A.4.c.).

iii. Pumping requirements.

iv. Power requirements.

v. Spare parts list with current prices.

vi. Any other information necessary for proper operation of the facility.

(3) An affidavit signed by the owner that he has read and understands the operation and maintenance requirements, that he has an Operation and Maintenance Manual, and that he will do the required maintenance, testing, and reporting (see Attachment 1). The affidavit shall be recorded requiring maintenance by the owner and future owners.

(4) A report from the county health department with their findings of the required site inspection together with any recommendations. The report should be included on form ADEQ/OWQ-113 containing any conditions required for approval and indicate that a conventional septic tank system is not feasible.

(5) For those projects that require an Aquifer Protection or Reuse Permit, a completed permit application.

b. If construction has not started within one year after the date of issue, the "Certificate of Approval to Construct" will be void, unless an extension of time has been requested and granted in writing.

4. **Approval to Operate**

a. Before operation begins on any alternative on-site disposal system, a Certificate of

Approval of Construction must be obtained.

b. Before a Certificate of Approval of Construction can be issued, the facility must be constructed in accordance with approved plans and specifications or approved modifications. The Department shall verify by on-site inspection conformance with the approved construction plans.

c. For those projects, requiring an Aquifer Protection or Reuse Permit, a signed permit must be issued by the ADEQ before a Certificate of Approval of Construction can be issued.

d. When issued, the Certificate of Approval of Construction may contain, but not be limited to, any or all of the following:

(1) That all wastewater be contained for disposal within the property boundaries.

(2) That disposal area requirements including provisions for future expansion if required must be followed.

(3) That operation and maintenance must be in accordance with the approved Operation and Maintenance manual.

(4) That monitoring requirements, including testing, sampling, and reporting be performed.

i. All facilities practicing disinfection by chlorination will be required to keep a log of effluent chlorine residuals. A minimum of one sample per month shall be tested.

ii. Compliance with the fecal coliform effluent quality requirements listed in Part V.C.5., except for chlorine residual, will require that the owner verify such compliance on an annual basis. Samples must be collected on different days and times. Collection, shipment and analysis of all samples are the responsibility of the owner and shall be in accordance with procedures approved by the Department.

In general this shall require that samples be collected in clean containers and shipped to an approved laboratory. A list of approved laboratories may be obtained from the Arizona Department of Health Services or the Department. The selected laboratory should be contacted before collecting samples. Samples should be received by the laboratory within six hours of time of collection. Samples received after being too long in transit must be resampled until samples are received within the specified time limits. Analytical results should be submitted to the Department within 30 days of receipt of all analytical results from the laboratory.

(5) That the Department will reserve the right of entry for State or local officials to inspect the facility and collect any samples needed to determine compliance with any standards.

(6) That whenever the property is sold, the seller must inform the buyer of these requirements and the new owner must submit all required affidavits.

e. Failure to comply with any conditions or provisions of the Certificate of Approval of Construction may subject the owner of the facility to revocation of the certificate or legal action by the Department. Another acceptable means of wastewater treatment and disposal may be required.

## B. EVAPOTRANSPIRATION BEDS

### 1. General

In areas of shallow soils, high groundwater tables, elevated ambient groundwater nitrate levels, tight soils, steep slopes or fractured rock which will not permit adequate filtration, E-T beds can be used to dispose of wastewater to the atmosphere so that no discharge to surface or groundwater occurs. A typical cross section of an E-T bed is shown in Fig. 8.

### 2. Design

#### a. Single Family Residence

Evapotranspiration bed design areas should be calculated by using the application rates shown on Figure 11. Design flows shall be 200 gallons per day per bedroom. Allowances will be made for low flow toilets as specified in Table 2.

#### b. Multi-family Subdivisions, Apartments, Office Buildings and Other Commercial Projects.

Design areas should be calculated based on a water mass balance for the winter months and evapotranspiration application rates shown in Figure 11. Design flows shall be based on Table 1.

#### c. Effluent Quality

Pretreatment to remove settleable and floatable solids is necessary to prevent physical clogging of the disposal system. Additional treatment to improve E-T rates is unnecessary. Septic tank pretreatment is adequate and E-T bed design shall be based solely on hydraulic loading rates.

#### d. Micro Environments

Care should be taken in the design process to evaluate possible on-site micro-environment impacts on E-T rates such as north facing slopes, crown closure, abnormally high relative humidity and wind stagnation factors.

#### e. Macro Environments

E-T bed disposal of effluent is not as effective in areas of the state that average a January minimum temperature of 20°F or less and is generally not recommended. Projects in these areas shown on Figure 11 by the 20°F lines must include provisions for long term storage of effluent and precipitation based on a water mass balance for the period of negative net evaporation.

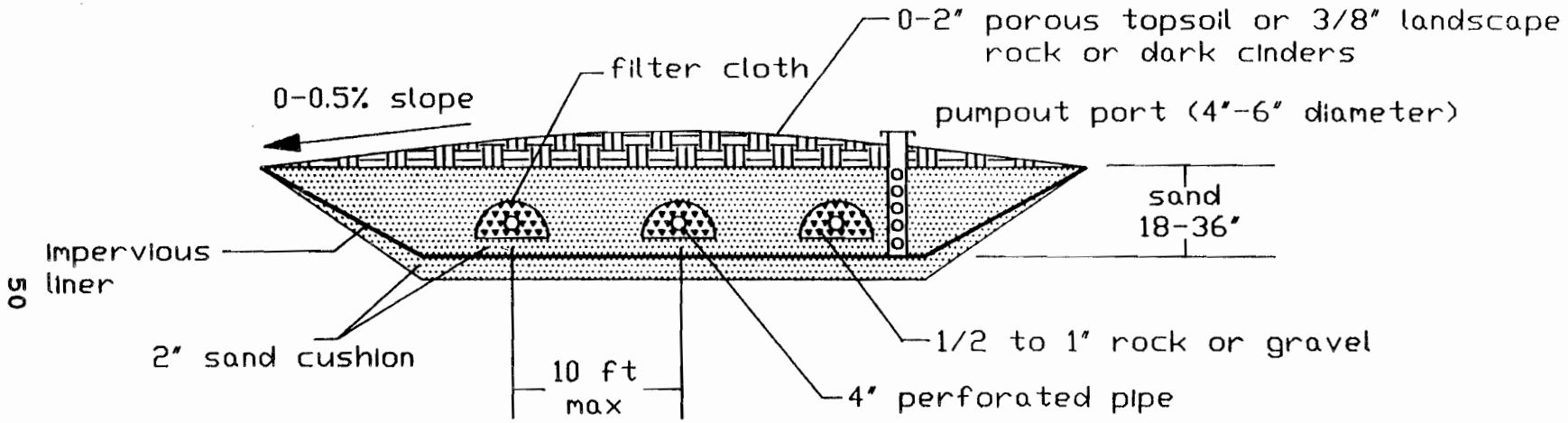



FIGURE 8. TYPICAL EVAPOTRANSPIRATION BED CONSTRUCTION
(no scale)

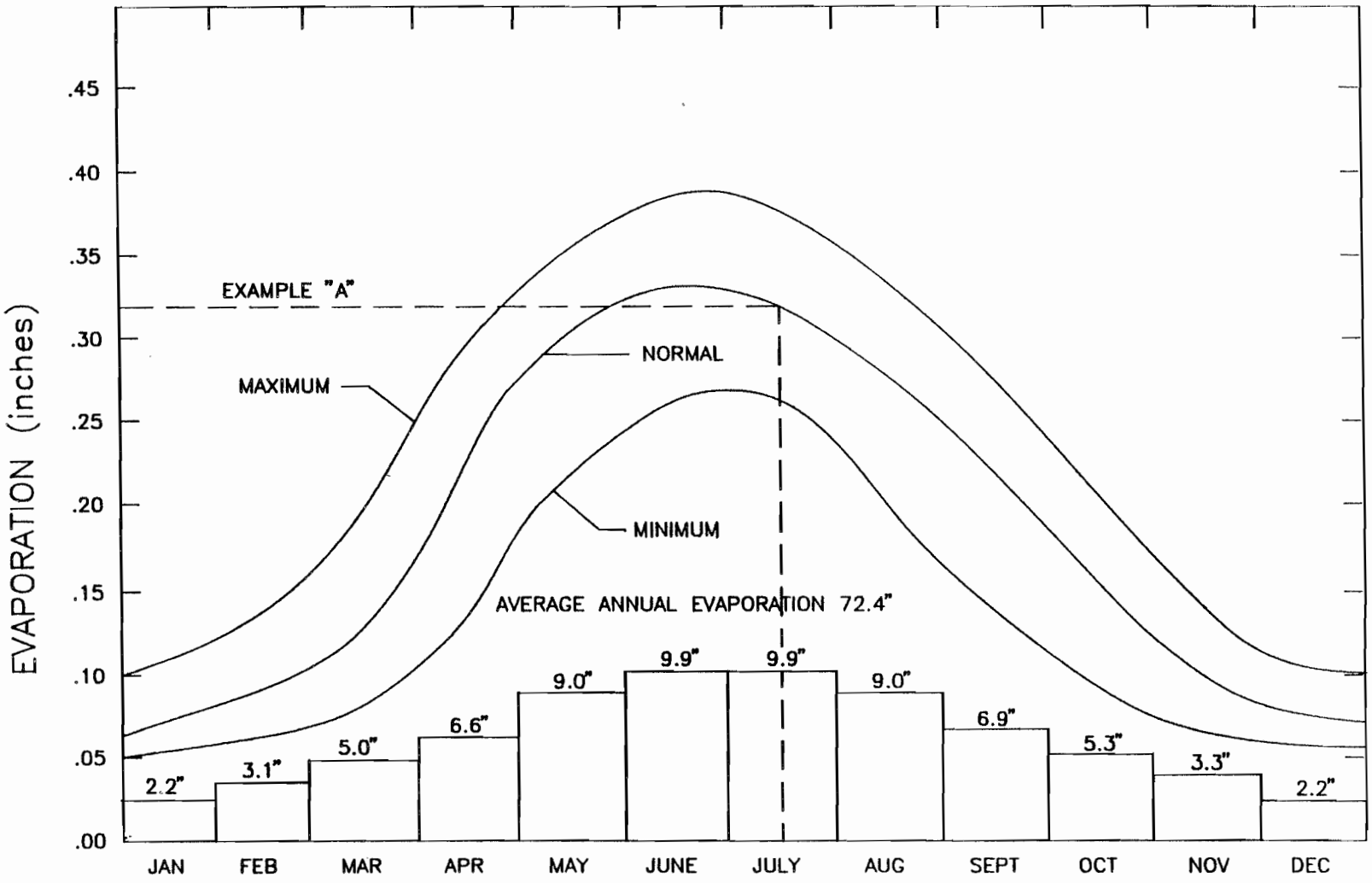
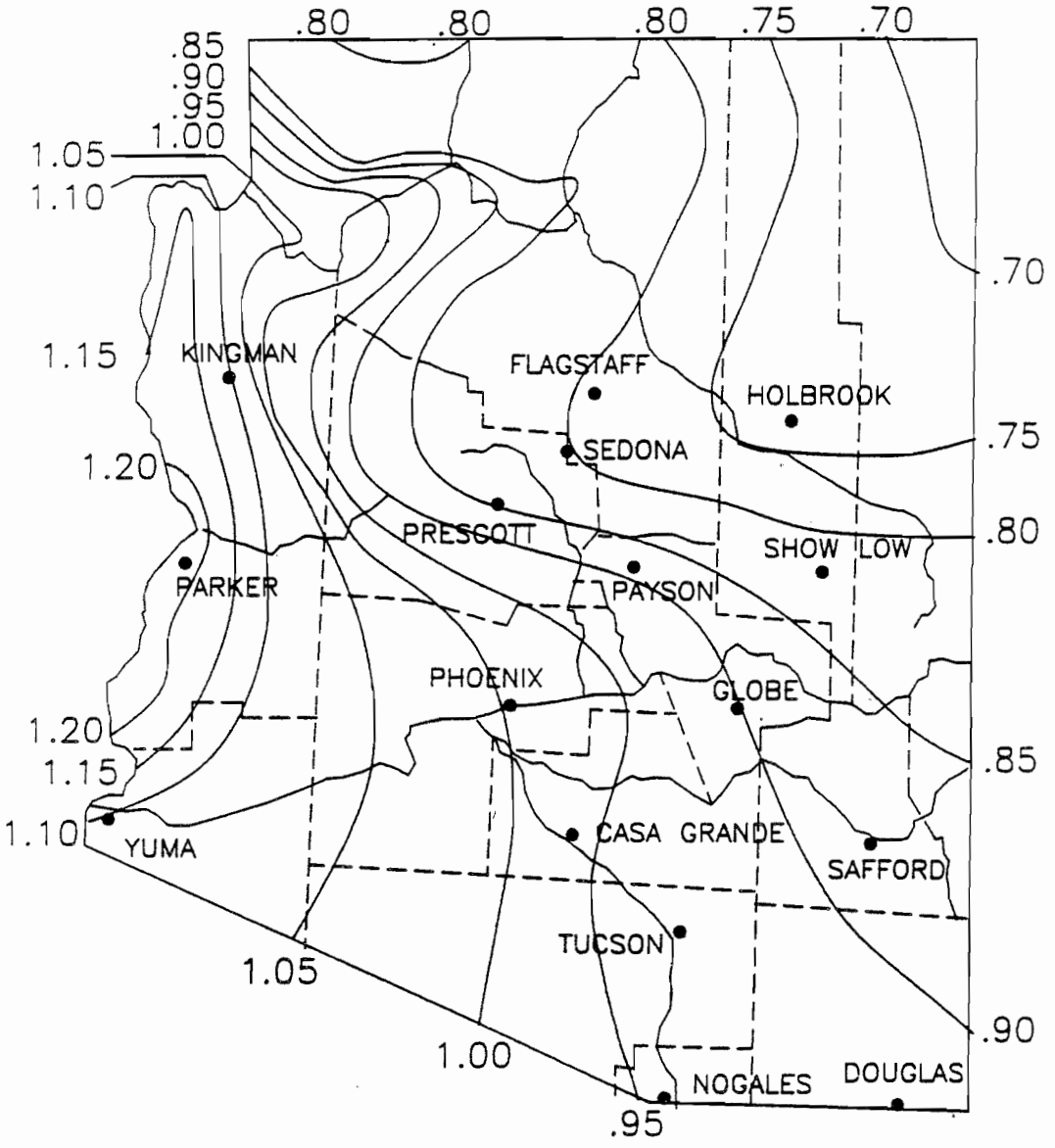
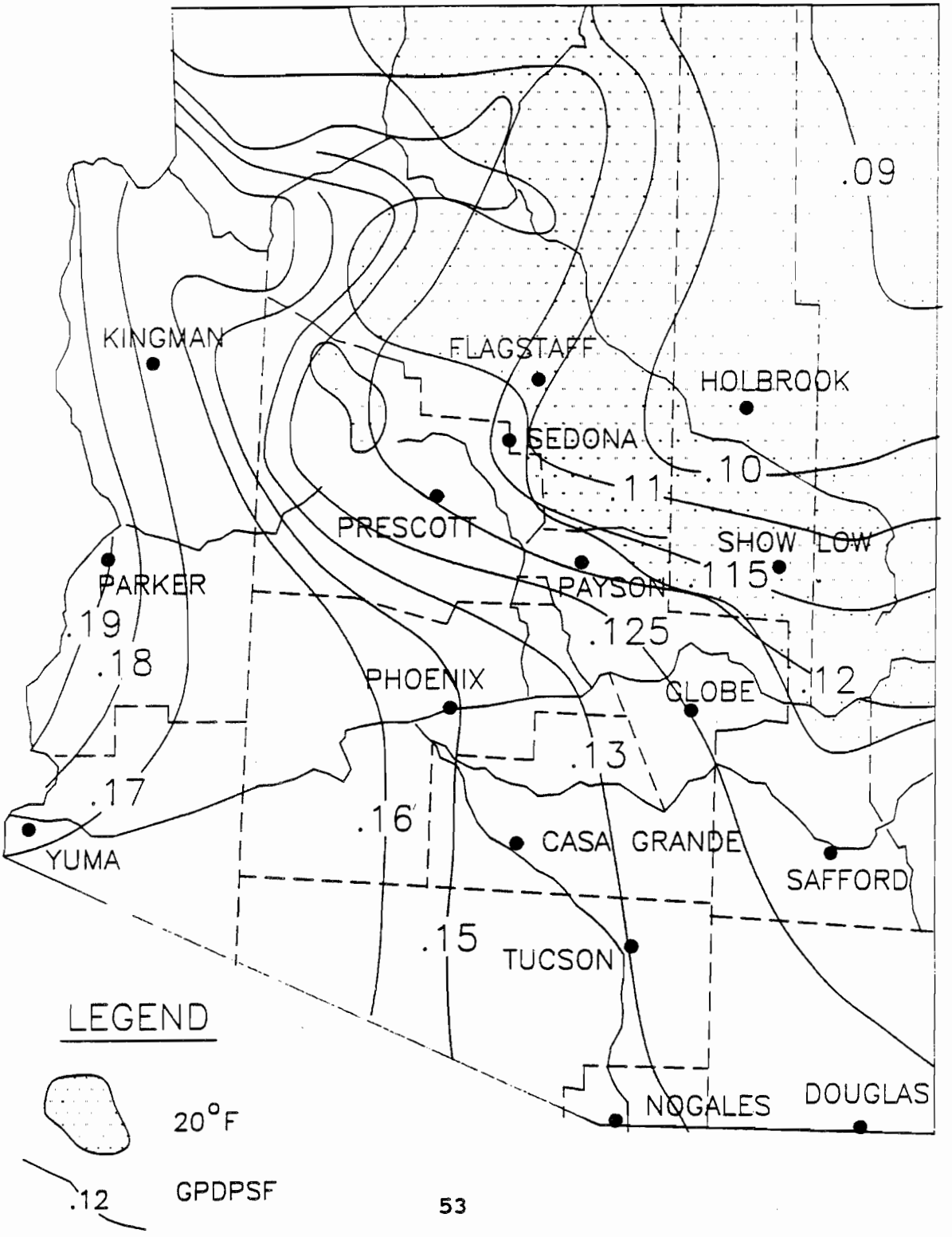



FIGURE 9. MAXIMUM, NORMAL AND MINIMUM DAILY EVAPORATION AND AVERAGE MONTHLY EVAPORATION FROM OPEN WATER SURFACES (Adjustment Factor = 1.00)

FIGURE 10. EVAPORATION ADJUSTMENT FACTORS FOR ARIZONA



# FIGURE 11. EVAPOTRANSPIRATION BED APPLICATION CRITERIA



3. **Construction Features of the E-T Bed**

a. The construction of an E-T bed shall be in accordance with Figure 8.

b. To maximize capillary rise and bed storage the E-T bed should be filled completely with sand meeting $D_{50}$ of 0.1 mm. (50 percent by weight smaller or equal to 0.1 mm.). This size sand is capable of raising water about 3 feet by capillary action. If this material is not commercially available the designer may specify an ASTM C-33 Concrete Sand, D-422 Mortar Sand or D-1663 asphalt fine sand. Capillary rise potential test results shall be submitted for review before source/gradation can be used. Capillary rise shall not be less than 18 inches.

c. E-T bed depth shall have a minimum depth of 18" and a maximum depth of 36". The design depth shall be a function of E-T sands capillary rise as per ASTM D-2325 and the anticipated maximum frost depth.

d. Synthetic liners should consist of a single sheet of plastic with a 20 mil minimum thickness. The plastic shall be Hypalon, PVC or approved equal. All plastic seams shall be factory fabricated or field welded according to manufacturers recommendations and cover all sides and bottom of the bed.

(1) Synthetic liners shall be cushioned on both sides with layers of sand at least 2" thick to prevent puncturing during construction.

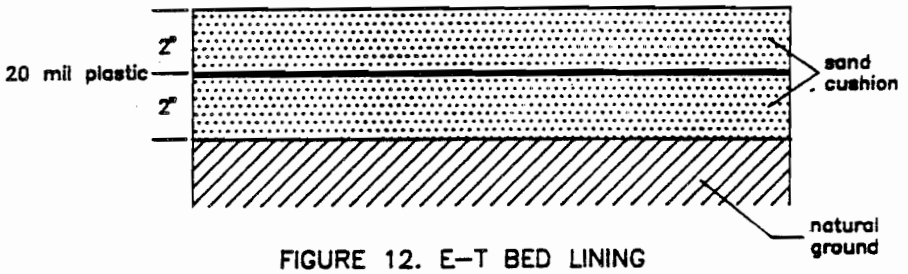



FIGURE 12. E–T BED LINING

(2) Where it is not possible to bring the inlet pipe in over the top edge of the liner, the joint where the pipe passes through the liner must be tightly sealed. Slack in the liner around the inlet pipe should be provided to prevent the pipe from pulling away from the liner if settling occurs.

e. A six inch thick layer of natural soil or an imported clay (Bentonite) in which the bed is being placed may be used as a liner if the soil has the following characteristics:

(1) The percolation rate of either the soil or clay liner (1 percolation test/1000 sq. ft. of surface area) is numerically greater than 60 min/inch, such as 70 min/inch. The tests shall be performed at the bottom of the excavation for the bed. The test location and results shall be determined by the design engineer.

(2) There shall be no fissures or crevices in the ET bed excavation through which the effluent may pass.

(3) There is a minimum of five feet of soil below the bottom of the bed to the high seasonal groundwater level or 4 feet to an impervious layer.

f. Surface run-off from upslope areas and roof drainage shall be diverted around the system by berms or drainage swales.

g. A two to four inch layer of 1/2" to 1" diameter crushed stone or gravel shall be placed around the distribution pipes. Filter cloth shall be placed on top of the rock to prevent sand from settling into the aggregate and reducing the void capacity.

h. A topsoil meeting Maricopa Association of Governments (MAG) Uniform Standard Specification for Public Works Construction 795.2, dark cinders, decomposed granite or similar landscaping material may be used. Maximum surfacing depth shall be 2".

i. Irrigation of E-T bed area is not allowed.

j. To minimize potential future problems associated with salt accumulation and allow for periodic inspection of the efficiency of the E-T bed, a 4" - 6" pumpout port shall be installed to permit flushing of the bed. The port shall be perforated pipe, capped on top, extending vertically to within 4 inches of the ET bed liner.

k. All E-T beds must be protected against flooding such that the bed remains operable during a 25-year flood and is not damaged during a 100-year flood.

4. **Leak Testing of Evaporation Bed Liners**

The liners for E-T beds should be tested in the following manner:

a. **Plastic Liners**

The bed liner shall not be tested until after the E-T bed sand is at final grade.

The following steps shall be taken in the test:

(1) The bed shall be filled with water through the pumpout ports and the disposal system to 3" - 6" below the finish grade of the sand without disturbing ET bed sand and liner.

(2) The water shall be allowed to stand for 24 hours to allow water level to reach equilibrium.

(3) At the end of the above 24 hours, the level of the water in the bed should be measured by measuring the depth of water in the pumpout port.

(4) After 48 hours from the preceding measurement, the water level in the bed should again be noted.

(5) The amount of precipitation which falls on the bed (onsite rain gauge) during the 48 hours between measurements should be noted.

(6) If after correcting for precipitation, the measured drop in the water level (difference between (3) and (4) above) times 0.30 (Porosity factor) is greater than 1.5 times the allowable average evaporation as calculated from Figures 9 and 10, the liner shall be repaired or replaced and retested.

(7) When the test is finished, slowly pump out the bed through the pumpout port to minimize disturbance of the bed.

The above test shall be conducted under the supervision of a Professional Engineer registered in the State of Arizona. The engineer shall submit the results of this test to the Department in a report with his signature and seal.

b. **Natural Soil Liners**

In the case of natural liners, they need not be tested if the percolation rate has been determined to be numerically greater than 60 MPI or if the minimum depth of soil below the bottom of the bed to the seasonal high groundwater level is 5 feet or more.

5. **Setbacks for Evapotranspiration Beds**

The setbacks for E-T beds both unlined and those beds using 20 mil one-piece liners are as shown in Tables 7 and 8. Because of the testing protocol required for the one-piece plastic liners, these ET beds may be allowed to be placed a minimum of:

a. Twenty-five feet from the edge of a dry wash.

b. Twenty-five feet from the edge of a live stream.

c. Fifty feet from the edge of a live stream in a water supply watershed.

d. Twenty-five feet from the edge of a lake or reservoir.

e. Twenty-five feet from cuts on sloping terrain.

In all cases provision of Part V.B.3.k. regarding flood protection must be met. Edges are defined in the Tables 7 and 8.

6. **Vegetation**

Generally vegetation plantings are not recommended. Because of the variability in water levels and salt accumulation in properly operating E-T beds, most types of vegetation are adversely affected after long periods of use. To minimize potential problems small salt tolerant low lying pfitzer type evergreens are recommended if vegetation is used. The evergreens provide some transpiration in the winter which aids disposal rates to a small extent and appear to tolerate the dry soil conditions present in the summer period. Contact your local nursery or county agricultural extension office for other appropriate plantings in your area.

## C. INDIVIDUAL AEROBIC TREATMENT SYSTEMS

### 1. General

a. Individual aerobic treatment systems shall be approved only when conditions are unsuitable for the use of septic systems.

Such conditions exist when any one of the following conditions exist:

(1) The percolation rate of the soil is greater than 60 minutes per inch; or,

(2) The distance between the bottom of the disposal trench and any impervious strata is less than 4 feet; or,

(3) The distance from the bottom of the disposal trench and the maximum elevation of the high seasonal groundwater table is less than 5 feet.

b. Individual aerobic treatment plants shall not be approved, regardless of the disposal method, if:

(1) Intended intermittent use of the plant (weekends or short holiday periods only) is likely to affect its proper functioning, unless National Sanitation Foundation (NSF) testing has shown that it is expected to work under its intended use and operational procedures are provided.

(2) Electrical service is unreliable.

(3) Intended use is not according to NSF testing to meet Standard Number 40

### 2. Effluent Disposal

a. Effluent from an individual, aerobic treatment plant shall be disposed of by one of the following methods:

(1) Evapotranspiration bed

(2) Mound

(3) Surface irrigation

(4) Subsurface irrigation

b. Individual, aerobic treatment plants shall not be approved for surface or subsurface irrigation if any of the following conditions exist:

(1) The total depth of the soil in the disposal area is less than 24".

(2) The distance between the bottom of the subsurface disposal trench and the impervious layer is less than 12".

(3) The distance between the bottom of the subsurface disposal trench and the

high groundwater level is less than 5 feet.

(4) The distance between the bottom of the subsurface disposal trench and fractured rock is less than 5 feet.

(5) Sufficient disposal area is not available because of the presence of large numbers of rocks or boulders.

3. **Treatment Plant Approval**

a. All new, individual aerobic treatment plants shall possess a current NSF Class I rating. A listing of plants currently rated NSF Class I can be obtained from the Department.

b. All existing individual aerobic treatment plants shall meet standards for effluent quality given in Part V.C.5.

c. All new, individual aerobic treatment plants that require backwash to meet NSF testing requirements shall include an automatic filter backwashing system.

4. **Operation and Maintenance Manual**

a. The manufacturer, distributor, or owner of an individual, treatment plant shall provide the purchaser with an Operations and Maintenance Manual approved by the Department.

b. The Operations and Maintenance (O&M) Manual shall provide complete, detailed instructions for installation, start-up and proper operation and maintenance procedures including safety, replacement parts, public health considerations, and treatment limitations.

c. If final effluent disposal requires disinfection, then the O&M Manual shall include a section on the disinfection unit. Disinfection methods and units not approved as part of the O & M Manual shall be reviewed on an individual basis.

5. **Design Requirements**

a. **Effluent Quality Requirements**

(1) Surface disposal effluent shall meet requirements in the Reuse Rules, A.A.C. R18-9-703.C.5.a.

(2) Subsurface disposal for disposal trenches not meeting all the requirements for conventional leach systems and greater than 2 feet in total depth, effluent quality shall meet NSF Standard 40 performance requirements for Class I effluent. Monitoring and sampling shall be performed in accordance with ADEQ policies. An individual aerobic treatment plant with current NSF class I rating must be used.

(3) For disposal trenches not meeting all requirements for conventional disposal trenches and less than or equal to 2 feet in total depth or with less than 12" of cover, effluent quality shall meet all requirements for surface disposal.

b. Treatment Units

(1) Hydraulic Capacity

i. For single family dwellings with not more than three bedrooms, the minimum rated hydraulic capacity shall be 450 gallons per day.

ii. For each additional bedroom the capacity shall be increased by 150 gallons per day.

iii. The use of low-flush toilets shall reduce the design flow rate by the value of the Total Flow Reduction factor listed in Table 2 up to a maximum total flow reduction of 16% for calculation of capacity of home aerobic units.

(2) Installation

i. The treatment plant site shall be overexcavated to contain emergency overflow equal to one day's design flow. Include an emergency overflow pipe from the pumping chamber and a pump out port.

ii. The excavation shall be completely lined with a minimum 20 mil plastic liner cushioned on each side by 2" of fine sand similar to that required for ET bed construction.

iii. The excavation shall be backfilled with 3/4" to 2" gravel. For fiberglass tanks use 1/4" to 3/8" gravel.

iv. The treatment plant shall be located away from drainage or discharge from downspouts, and shall be accessible for septage pumping.

v. Setback requirements shall be identical to those for septic tanks.

(3) Appurtenances

i. Pretreatment tanks are recommended to remove grease, floating solids, and large debris.

The capacity of the pretreatment tank shall be equal to at least one day's design flow rate (150 gpd/bedroom).

ii. All appurtenances required for NSF Class I rated plants must be provided with the plant.

iii. Disinfection shall be required for all surface and subsurface irrigation with shallow disposal trenches (see Part V.C.5.a.(3)).

iv. Pumps

(a) Submersible pumps shall be timer controlled or water level controlled as required for the disposal method.

(b) Pumps shall be equipped with audio and visual high level alarms.

c. **Effluent Disposal**

**(1) Disposal Field Location**

i. Setbacks shall be the same for surface irrigation as those listed in Tables 7 and 8 for disposal trenches. The only exception to the setback requirements is that surface irrigation shall be allowed as close to buildings on the owner's property as desired.

ii. The disposal field shall not be located in the floodway.

iii. The disposal field should be protected from the 100 - year flood event.

**(2) Effluent Containment**

i. All wastewater effluent shall be contained within the property boundaries. The effluent may be held on the lot by tree wells, berms, or ditches or any combination of methods. Berm compaction shall be 85% according to MAG specification 211.4. Berm construction materials should not contain any rock greater than 2 inch in size.

ii. The disposal area shall be designed to contain a 10 year, 24 hour rainfall event for that locale.

iii. If the lot in question cannot hold the effluent plus the rainfall from a 10 year, 24 hour event, a federal discharge permit may be required as called for in the "Federal Water Pollution Control Act", as amended (33 USC 466 et seq.).

**(3) Diversion of Off-Site Surface Water Runoff**

All surface water run-off, including run-off from roofs of nearby buildings, shall be diverted around and away from the disposal field.

**(4) Reserve Area**

Disposal fields used for subsurface irrigation shall have unused space available for a reserve area equal to 100% of the area required for disposal. The reserve area shall be suitable for use as a disposal area and shall not contain any permanent structures or construction over the reserve area.

(5) **Specifications**

Construction and plumbing specifications must conform to MAG, UPC, or equivalent.

(6) **Surface Irrigation**

i. The required disposal area shall be determined using the appropriate evapotranspiration design factor shown in Figure 11 and the irrigation system manufacturer's specifications.

ii. Examples

4 bedroom house with 5 gal/flush toilets (Yavapai County)

$$\frac{4 \times 150 \text{ gpd/bedroom}}{0.115 \text{ gpdpsf}} = 5217 \text{ sq.ft.}$$

4 bedroom house with 3 gal/flush toilets

$$\frac{4 \times 150 \text{ gpd/bedroom} \times 0.84}{0.115 \text{ gpdpsf}} = 4383 \text{ sq.ft.}$$

iii. Distribution system

(a) The irrigation system shall be automatic.

(b) Effluent shall be spread throughout the entire disposal area.

(c) Use of either bubblers or sprinklers is acceptable.

(d) Piping shall be color coded or labeled to differentiate between potable water and effluent.

iv. Spray irrigation

(a) The distribution system shall be valved to allow rotation of irrigation.

(b) The effluent shall not be allowed to pond.

(c) The spray nozzles shall be spaced so that the spray pattern is overlapping.

(d) Buffer zones shall be provided to prevent wind transport of the effluent aerosols across property boundaries or into occupied areas.

(e) Nozzles for spray irrigation should be designed to minimize clogging and to allow easy maintenance.

(f) Signs saying, "Contaminated Water - Do Not Drink", shall be posted in the irrigation area.

(g) No external hose bibs shall be installed on the spray irrigation lines.

**d. Combination E-T/Absorption Trenches**

(1) Subsurface irrigation by combination E-T/absorption trenches is the disposal of effluent below ground level. The disposal method is an alternative to construction of a conventional septic tank disposal trench or an evapotranspiration bed. It combines elements of each.

(2) No testing or monitoring is required for subsurface irrigation.

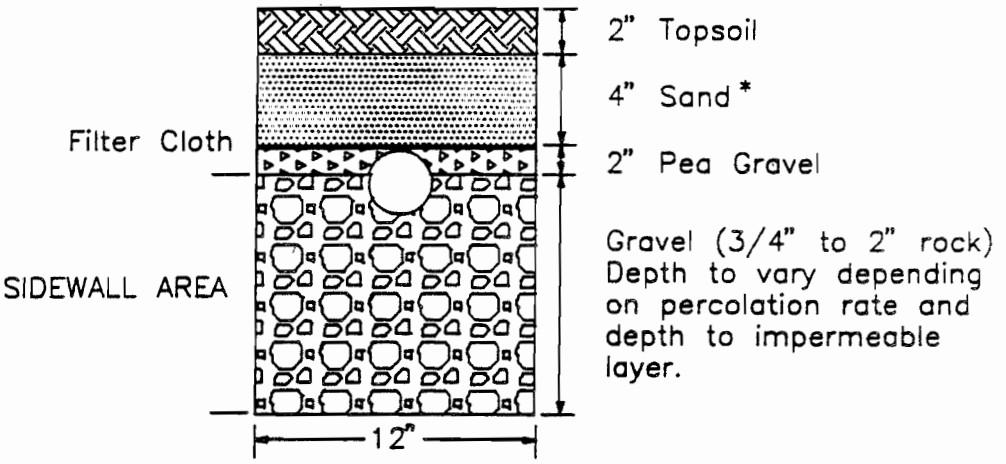
(3) Minimum Requirements for Subsurface Irrigation.

i. The suitability for subsurface disposal and the permeability of the soil shall be determined using the same procedures and methods described for disposal trenches in Part III.

ii. Setback requirements shall be equal to those given in Tables 7 and 8 for conventional septic tank systems.

iii. The total trench depth must be at least 24" and the bottom of the trench must be at least 12" above bedrock or other impermeable layers and 5 feet above the high seasonal groundwater.

iv. Minimum dimensions




* If sand is not used, evapotranspiration may not be considered, and topsoil cover must be a minimum of 6".

v. Spacing requirements between trenches shall be the same as for leach trenches given in Part IV.

vi. Each trench shall not be more than 100 feet in length.

vii. Use of dynamite or jack-hammer is prohibited in construction of trenches except as allowed under Section III.B.1.b.

viii. Trenches shall be constructed along contour lines.

ix. Design Example

Given:

(a) The County Health Department rejects the use of a conventional septic tank and leach field system due to inadequate soil depth.

(b) depth of soil above impermeable strata is 5 feet.

(c) percolation rate is 30 minutes per inch. (Application rate from Table 5 is 0.36 gpdpsf.)

(d) evapotranspiration rate is 0.11 gpdpsf.

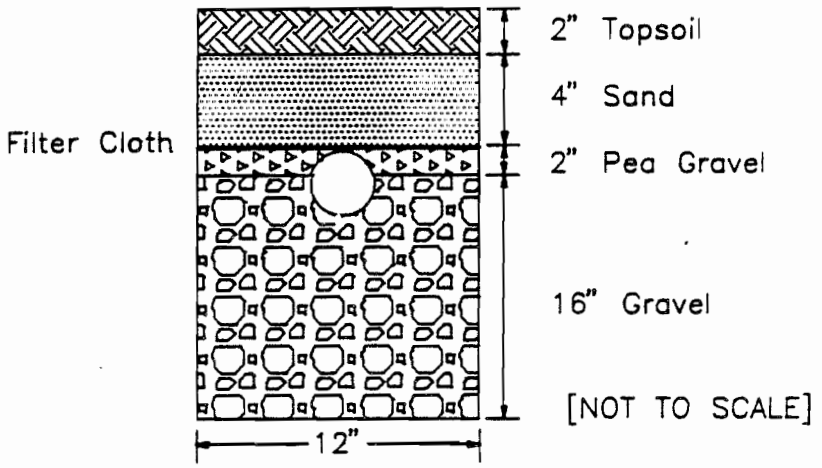
(e) three bedroom home is to be built.

(f) Wastewater treatment will be by individual home aerobic plant with disinfection.

Solution:

Total flow = 3 x (150 gpd/bedroom) = 450 gpd

Construct a trench with the following cross-section.



The trench has 2.67 sq. ft. of sidewall area per foot of trench and one sq. ft. of surface.

Effluent disposal per foot of trench is equal to the following:

(g) By percolation
(0.36 gpdpsf) x (2.67 sq. ft.) = 0.96 gpd

(h) By evapotranspiration
(0.11 gpdpsf) x (1.0 sq. ft.) = 0.11 gpd

(i) Total = 0.96 + 0.11 = 1.07 gpd/ft

(j) Trench length = 450 gpd/1.07 gpd/ft = 420 feet

## D. GRAYWATER AND BLACKWATER SYSTEMS

### 1. General

a. When graywater wastewater is separated from blackwater waste (toilet wastewater and kitchen sink wastes) a total blackwater waste flow reduction of up to 40% can be anticipated.

b. For graywater systems using septic tank soil absorption systems the basic guidelines set forth in this bulletin for soil absorption systems will still apply toward the construction of graywater disposal systems. The only difference is a potential reduction in the septic tank and disposal capacity for graywater systems.

c. The graywater system receives wastewater generated from showers, baths, wash basins, clothes washers and miscellaneous cleaning operations.

d. Segregation of the blackwater/graywater waste streams yields several benefits including; (1) conservation of water resources, (2) potential for recycling valuable nutrients to the soil, (3) reuse potential of recycled graywater, and (4) prolonged life of the septic tank soil absorption system.

### 2. Design and Construction

a. Although residential graywater does contain pollutants and must be properly managed, graywater is easier to manage due to reduced flow volumes. While diverse strategies have been proposed for graywater management, rigorous field evaluations have not been conducted in most cases. Until further field data becomes available and is evaluated, graywater treatment and disposal systems shall be designed similarly for typical residential wastewater septic tank soil absorption systems, Part IV of this bulletin.

b. Design allowances can be made only for reductions in flow volumes, as compared to typical residential septic tank absorptive systems. A minimum septic tank capacity table is presented below for a typical graywater system, Table 10.

TABLE 10

SEPTIC TANK CAPACITIES (Gallons)

| Bedrooms | Conventional Septic Tank/ Soil Absorptive System | Graywater Systems |
|---|---|---|
| 1 - 3 | 960 | 650 |
| 4 | 1,200 | 800 |
| 5 | 1,500 | 1,000 |
| 6 | 1,800 | 1,200 |

3. Reuse of Graywater

Graywater from single and multi-family residences may be used for surface irrigation under the following conditions:

a. The design and construction of the system are approved by the Department in accordance with A.A.C. Title 18, Chapter 9, Article 7.

b. Such irrigation sites shall be designed to contain a 10-year, 24-hour rainfall event.

c. The graywater must meet the allowable limits for surface irrigation Part V.C.5.a.

4. Blackwater Treatment Alternatives

In the treatment of graywater systems, it may be necessary to find alternative methods of disposal for blackwater wastes. According to A.A.C. 18-8-607, the storage and disposal of human excreta shall be accomplished by one of the methods listed below which are arranged in the order or priority in which they will be considered by the Department.

a. A water closet connected to a public sewer.

b. A water closet connected to an individual septic tank disposal system.

c. Earth-pit privy (only where there is no piped water).

d. Other-such as chemical toilets, vault privies, etc., when approved by the Department.

Where conditions are such as to make it impossible or impractical to construct either a septic tank disposal or an earth-pit privy, other excreta disposal facilities may be approved by the Department such as composting toilets, incinerator toilets, chemical toilets or vault privies, provided they can be maintained and operated without endangering the public health

or creating a nuisance. The design and construction of such facilities shall conform in general to the requirements set forth in Engineering Bulletin No. 2, entitled "The Earth Pit Privy and Other Methods of Excreta Disposal".

## E. LOW PRESSURE DISTRIBUTION SYSTEM

### 1. General

a. A pressure distribution system is a low pressure system comprised of:

(1) a dosing chamber;

(2) a pump or siphon;

(3) a pressure transport line;

(4) a manifold; and,

(5) a small diameter perforated plastic pipe laterals.

b. A pressure distribution system must be used when the following alternative treatment systems are employed:

(1) Sand filtration;

(2) Mound systems; and,

(3) Any subsurface soil absorption system where the soil percolation rates are in excess of 60 MPI.

c. In addition, a pressure distribution system may be used whenever it is desirable to:

(1) Maintain a uniform application rate throughout leach field;

(2) Treat and dispose of effluent in the uppermost of the subsurface soil profile;

(3) Aid in mitigating the potential of contaminating groundwater in areas of excessive permeability low areas with unfavorable disposal characteristics; or,

(4) Improve the performance and increase the life span of a leach field.

### 2. Conditions for Approval

a. This guidance should not be used where laterals are at different elevations (elevational differences greater than 6") or for systems with daily flows over 2500 gallons. Plans for systems with designs different than those provided herein shall be reviewed on a case by case basis by the Department.

b. A minimum of 4 feet shall be required between the bottom of the absorptive field trenches any underlying restrictive layer, such as bedrock, or 5 feet to the high seasonal groundwater table.

c. The following guidelines are recommended for pressure distribution system design outside of these guidelines:

(1) Design of Pressure Distribution Networks for Septic-Tank Absorption Systems, Small Scale Waste Management Project Publication #9.6, University of Wisconsin, Madison, WI, 1981.

(2) Onsite Wastewater Treatment and Disposal Systems, Design Manual, EPA, 1980.

3. **Design**

a. **Laterals**

(1) The lateral length should be at least 6 inches shorter than the trench length but not more than one-half the orifice spacing.

(2) Laterals in trenches should be placed equidistant from each side.

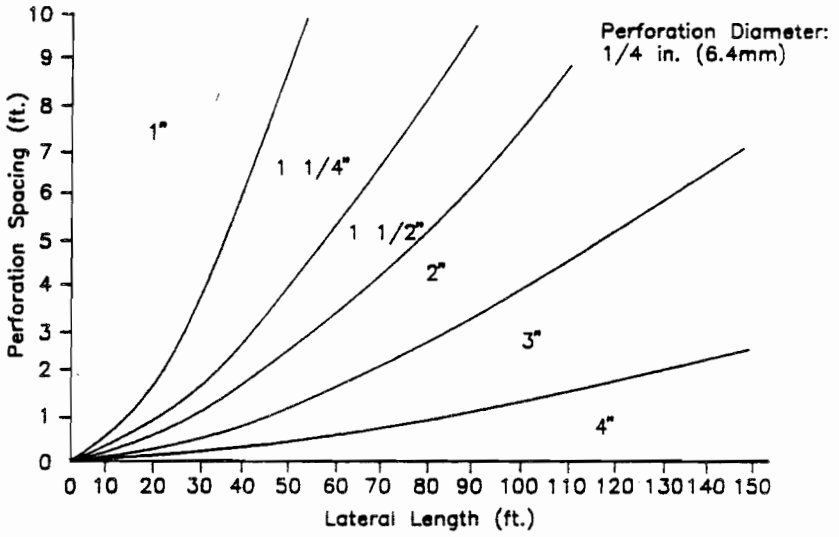
(3) The lateral spacing in beds is typically 3 to 6 feet. The outside laterals should be placed at one-half the selected lateral spacing from the bed's edge.

(4) A preliminary estimate of orifice spacing should be made. Normally, the first estimate will be one-half the lateral spacing. For most installations spacing will be between 18 and 36 inches.

(5) The orifice diameter will be 1/4 (0.25) inches. A residual head of 2.5 feet is used for calculating flows and pump size. The flow through each orifice at that head will be 1.17 gallons per minute.

(6) Determine the lateral diameter from the following figure:

FIGURE 13. LATERAL DIAMETER



(7) The laterals should not exceed the lengths below for the pipe anticipated be used.

**TABLE 11**

**MAXIMUM LATERAL LENGTHS (Ft)**

| Lateral Diameter Inches | Orifice Spacing Feet | Schedule 40 | Class 200 | Class 160 | Class 125 |
|---|---|---|---|---|---|
| 1.00 | 1.5 | 16.5 | 21.0 | 21.0 | ---- |
| 1.00 | 2.0 | 20.0 | 24.0 | 24.0 | ---- |
| 1.00 | 2.5 | 22.5 | 27.5 | 27.5 | ---- |
| 1.00 | 3.0 | 27.0 | 33.0 | 33.0 | ---- |
| 1.25 | 1.5 | 27.0 | 30.0 | 30.0 | 31.5 |
| 1.25 | 2.0 | 32.0 | 36.0 | 38.0 | 38.0 |
| 1.25 | 2.5 | 37.5 | 42.5 | 45.0 | 45.0 |
| 1.25 | 3.0 | 42.0 | 48.0 | 48.0 | 51.0 |
| 1.50 | 1.5 | 34.5 | 39.0 | 39.0 | 40.5 |
| 1.50 | 2.0 | 42.0 | 46.0 | 48.0 | 50.0 |
| 1.50 | 2.5 | 48.5 | 52.5 | 56.0 | 59.0 |
| 1.50 | 3.0 | 55.0 | 59.0 | 64.0 | 68.0 |
| 2.00 | 1.5 | 52.5 | 55.5 | 58.5 | 60.0 |
| 2.00 | 2.0 | 64.0 | 68.0 | 70.0 | 72.0 |
| 2.00 | 2.5 | 72.5 | 77.5 | 80.0 | 82.5 |
| 2.00 | 3.0 | 81.0 | 87.0 | 90.0 | 93.0 |

(8) Calculate the lateral and total discharge rates:

Lateral Discharge Rate, gpm = 1.17 x number of orifices

Total Discharge Rate, gpm = Lateral Rate x number of laterals

b. Determine the manifold size from Table 12.

## TABLE 12

## MANIFOLD SIZE

| Lateral Discharge Rate (gpm) | | Manifold Diameter 1¼" | | | | | Manifold Diameter 1½" | | | | | Manifold Diameter 2" | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lateral Spacing (ft) | | | | | Lateral Spacing (ft) | | | | | Lateral Spacing (ft) | | | | |
| Terminal | Central | 2 | 4 | 6 | 8 | 10 | 2 | 4 | 6 | 8 | 10 | 2 | 4 | 6 | 8 | 10 |
| 10 | 5 | 4 | 8 | 6 | 8 | 10 | 10 | 5 | 12 | 16 | 20 | 12 | 16 | 24 | 24 | 30 |
| 20 | 10 | 4 | 4 | 6 | | | 4 | 4 | 6 | 8 | 10 | 6 | 8 | 12 | 16 | 20 |
| 30 | 15 | 2 | | | | | 2 | 4 | 6 | | | 4 | 8 | 6 | 8 | 10 |
| 40 | 20 | | | | | | | | | | | 4 | 4 | 6 | 8 | 10 |
| 50 | 25 | | | | | | | | | | | 2 | 4 | 6 | 8 | |
| 60 | 30 | | | | | | | | | | | 2 | 4 | | | |
| 70 | 35 | | | | | | | | | | | 2 | 4 | | | |
| 80 | 40 | | | | | | | | | | | 2 | | | | |
| 90 | 45 | | | | | | | | | | | 2 | | | | |
| 100 | 50 | | | | | | | | | | | 2 | | | | |
| 110 | 55 | | | | | | | | | | | | | | | |
| 120 | 60 | | | | | | | | | | | | | | | |
| 130 | 65 | | | | | | | | | | | | | | | |
| 140 | 70 | | | | | | | | | | | | | | | |
| 150 | 75 | | | | | | | | | | | | | | | |
| 160 | 80 | | | | | | | | | | | | | | | |
| 170 | 85 | | | | | | | | | | | | | | | |
| 180 | 90 | | | | | | | | | | | | | | | |
| 190 | 95 | | | | | | | | | | | | | | | |
| 200 | 100 | | | | | | | | | | | | | | | |

TABLE 12 (Continued)

## MANIFOLD SIZE

| Lateral Discharge Rate (gpm) | | Manifold Diameter 3" | | | | | Manifold Diameter 4" | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Lateral Spacing (ft) | | | | | Lateral Spacing (ft) | | | | |
| Terminal | Central | 2 | 4 | 6 | 8 | 10 | 2 | 4 | 6 | 8 | 10 |
| 10 | 5 | 26 | 40 | 48 | 56 | 70 | 42 | 64 | 84 | 96 | 110 |
| 20 | 10 | 16 | 24 | 30 | 32 | 40 | 26 | 40 | 54 | 64 | 70 |
| 30 | 15 | 12 | 16 | 24 | 24 | 30 | 20 | 28 | 36 | 48 | 50 |
| 40 | 20 | 10 | 12 | 18 | 16 | 20 | 16 | 24 | 30 | 32 | 40 |
| 50 | 25 | 8 | 12 | 12 | 16 | 20 | 14 | 20 | 24 | 32 | 40 |
| 60 | 30 | 6 | 8 | 12 | 16 | 20 | 12 | 16 | 24 | 24 | 30 |
| 70 | 35 | 6 | 8 | 12 | 8 | 10 | 10 | 16 | 18 | 24 | 30 |
| 80 | 40 | 6 | 8 | 6 | 8 | 10 | 10 | 12 | 18 | 16 | 20 |
| 90 | 45 | 4 | 8 | 6 | 8 | 10 | 8 | 12 | 18 | 16 | 20 |
| 100 | 50 | 4 | 4 | 6 | 8 | 10 | 8 | 12 | 12 | 16 | 20 |
| 110 | 55 | 4 | 4 | 6 | 8 | 10 | 8 | 12 | 12 | 16 | 20 |
| 120 | 60 | 4 | 4 | 6 | 8 | 10 | 6 | 8 | 12 | 16 | 10 |
| 130 | 65 | 4 | 4 | 6 | 8 | 10 | 6 | 8 | 12 | 16 | 10 |
| 140 | 70 | 2 | 4 | 6 | 8 | | 6 | 8 | 12 | 8 | 10 |
| 150 | 75 | 2 | 4 | 6 | | | 6 | 8 | 6 | 8 | 10 |
| 160 | 80 | 2 | 4 | 6 | | | 6 | 8 | 6 | 8 | 10 |
| 170 | 85 | 2 | 4 | 6 | | | 4 | 8 | 6 | 8 | 10 |
| 180 | 90 | 2 | 4 | | | | 4 | 8 | 6 | 8 | 10 |
| 190 | 95 | 2 | 4 | | | | 4 | 8 | 6 | 8 | 10 |
| 200 | 100 | 2 | 4 | | | | 4 | 4 | 6 | 8 | 10 |

**Example A:**

Central Manifold
Lateral Q = 40 gpm
Lateral Spacing = 6'
Manifold Length = 18'
Manifold Diameter = 4"

**Example B:**

Terminal Manifold
Lateral Q = 30 gpm
Lateral Spacing = 6'
Manifold Length = 24'
Manifold Diameter = 3"

c. Transport (Pressure) Line.

Determine the diameter of the transport line from the following table. (The table is specifically for ABS Schedule 40 pipe with a Hazen-Williams Coefficient of 150)

**TABLE 13**

**FRICTION LOSS PER 100 FEET OF PVC PIPE**

Friction Loss in feet per one hundred feet
Pipe Diameter, in inches

| Flow GPM | 1" | 1¼" | 1½" | 2" | 3" | 4" |
|---|---|---|---|---|---|---|
| 5 | 1.52 | 0.39 | 0.18 | | | |
| 6 | 2.14 | 0.55 | 0.25 | 0.07 | | |
| 7 | 2.89 | 0.76 | 0.36 | 0.10 | | |
| 8 | 3.63 | 0.97 | 0.46 | 0.14 | | |
| 9 | 4.57 | 1.21 | 0.58 | 0.17 | | |
| 10 | 5.50 | 1.46 | 0.70 | 0.21 | | |
| 11 | | 1.77 | 0.84 | 0.25 | | |
| 12 | | 2.09 | 1.01 | 0.30 | | |
| 13 | | 2.42 | 1.17 | 0.35 | | |
| 14 | | 2.74 | 1.33 | 0.39 | | |
| 15 | | 3.06 | 1.45 | 0.44 | 0.07 | |
| 16 | | 3.49 | 1.65 | 0.50 | 0.08 | |
| 17 | | 3.93 | 1.86 | 0.56 | 0.09 | |
| 18 | | 4.37 | 2.07 | 0.62 | 0.10 | |
| 19 | | 4.81 | 2.28 | 0.68 | 0.11 | |
| 20 | | 5.23 | 2.46 | 0.74 | 0.12 | |
| 25 | | | 3.75 | 1.10 | 0.16 | |
| 30 | | | 5.22 | 1.54 | 0.23 | |
| 35 | | | | 2.05 | 0.30 | 0.07 |
| 40 | | | | 2.62 | 0.39 | 0.09 |
| 45 | | | | 3.27 | 0.48 | 0.12 |
| 50 | | | | 3.98 | 0.58 | 0.16 |
| 60 | | | | | 0.81 | 0.21 |
| 70 | | | | | 1.08 | 0.28 |
| 80 | | | | | 1.38 | 0.37 |
| 90 | | | | | 1.73 | 0.46 |
| 100 | | | | | 2.09 | 0.55 |
| 150 | | | | | | 1.17 |

Example: The transport line will be 50 ft. long and the flow is calculated at 20 gpm. The headloss for 100 ft. of 1½" diameter pipe is 2.46. For 50 ft. it would be 1.23.

d. Calculate the total head:

Total Head = E + T + R

Where E = elevation difference between the pump and the manifold

T = transport pressure line head

R = residual head (2.5 feet)

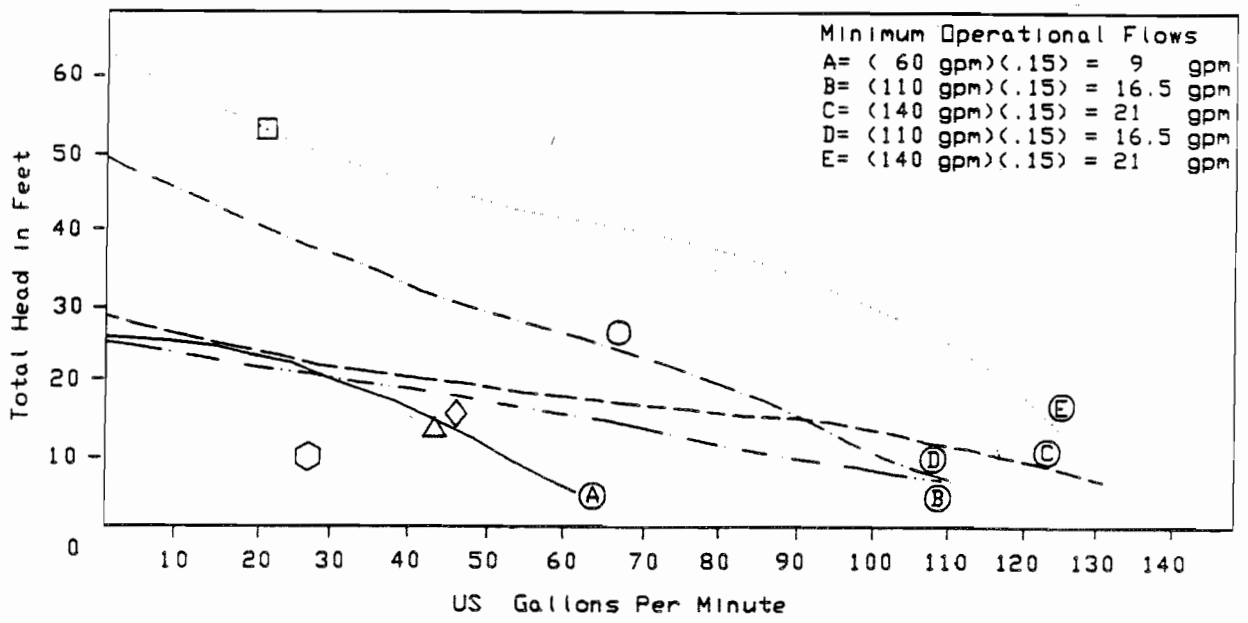
e. Pump Selection

(1) Pump selection is a critical part of the system design package. It is based on the discharge rate and pumping head required for the system. Using the pump head-discharge rate curves supplied by the manufacturer, select a pump at the required head.

(2) To help maximize pump efficiency, pump selection should also address maximum usable head. Select pumps where the operating point will be greater than 15 percent of the maximum pump rate (maximum gpm rating). For example, a pump with a maximum capacity of 80 gpm should only be used if the operational requirement is greater than (80 gpm) x (0.15) or 12 gpm.

(3) The preceding will help illustrate proper pump selection. Five pump curves are shown in the following example. In the upper right corner of the graph are the calculations showing the minimum operational flows based on the 15% pump curve efficiency requirement. In the table several system requirements are shown with the pumps ultimately selected.

FIGURE 14. PUMP PERFORMANCE CURVES



| SYSTEM | REQUIREMENTS | | PUMP | COMMENTS |
|---|---|---|---|---|
| | GPM | TDH | SELECTED | |
| 1 | 26 | 9 | A, B, or C | All pumps will work, but because of price and serviceability pump A, B or C were selected. |
| 2 | 43 | 13 | A, B, or C | Price and serviceability. |
| 3 | 45 | 15 | B or C | Pump A not adequate. |
| 4 | 67 | 26 | E | Pump D might be adequate, check the operation point. |
| 5 | 20 | 53 | N/A | 20 gpm is less than 15 percent of the maximum flow for Pump E. |

(4) Other pump considerations:

i. Pump should be specified for effluent.

ii. Pump should transfer solids as large as orifice diameter.

iii. Pump should be serviceable from ground level without the need to enter the pump chamber. PVC compression couplings are available which assist in the easy removal of pumps.

iv. Pumps must be kept submerged and all connections made outside the chamber in an explosion-proof box.

v. Impellers shall be cast iron, bronze, or other corrosion-resistant material. Regardless of the material, the impeller may freeze if the pump remains inactive for several months.

vi. If for any reason a check valve is used, a bleeder hole should be installed so the volute is kept filled with effluent. Some pumps may run backwards if the impeller is in air.

f. Dosage

Determine the dose volume by the following sets of design criteria:

(1) Soil Type:

Determine the dose volume by dividing the average daily flow, in gpm, by the following recommended dosing frequency:

| Soil Texture at Drainrock Interface | Doses per Day |
|---|---|
| Medium and fine sand | 4 |
| Loamy sand, sandy loam | 1 - 2 |
| Loam and finer soils | 1 |

(2) Doses/Volume Ratio:

(a) The daily dose volume ratio should be at least 7 times the volume of the manifold and lateral piping which drains between doses plus one time the interior volume of the transport line. If the dose is too small, then the pipe network will not become fully pressurized or may not be pressurized for a significant portion of the total dosing cycle.

(b) It may be necessary to modify the piping network configuration to reduce the pipe volume or space which drains between doses.

(c) Use the following table to calculate distribution line, manifold, and transport volumes. Calculate only pipe volumes that drain between doses.

**TABLE 14**

**Transport Line Volumes**

| Diameter (inches) | Volume (gal/ft of length) Sch 40 | Class 200 | Class 160 | Class 125 |
|---|---|---|---|---|
| 1 | .045 | .058 | .058 | ---- |
| 1¼ | .078 | .092 | .096 | .098 |
| 1½ | .105 | .120 | .125 | .130 |
| 2 | .175 | .189 | .196 | .204 |
| 3 | .385 | .417 | .417 | .435 |
| 4 | .667 | .667 | .714 | .714 |
| 6 | 1.429 | 1.429 | 1.429 | 1.667 |

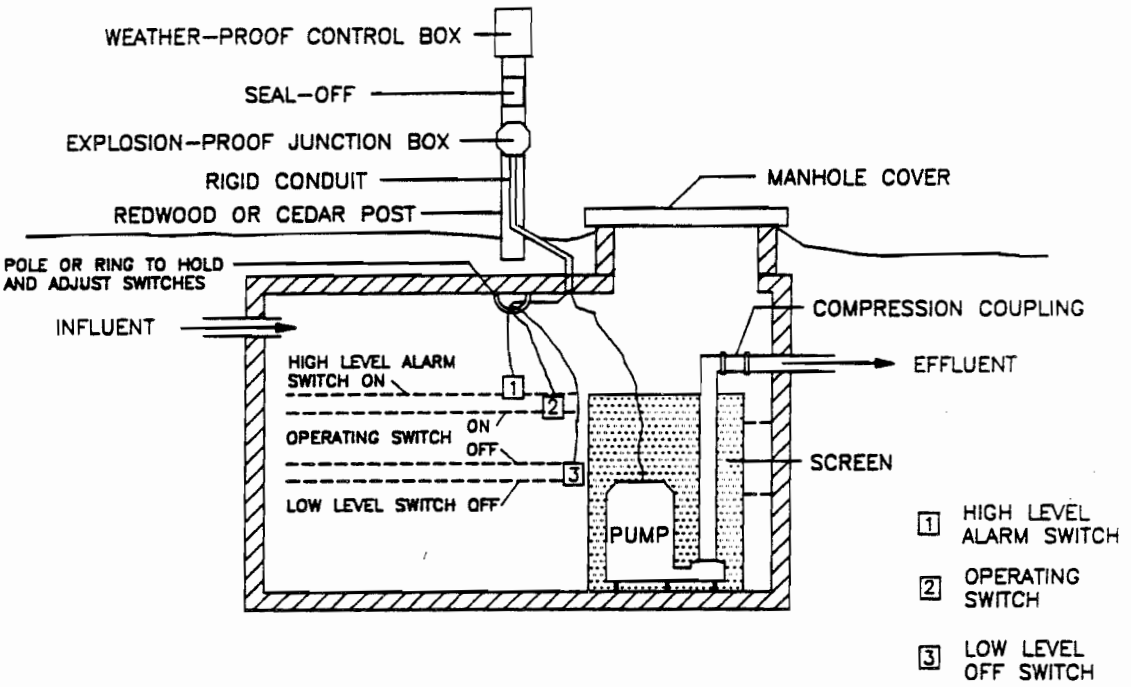
g. Dosing chamber

(1) The dosing chamber must be watertight, with all joints sealed. Precautions must be made in high groundwater areas to prevent the tank from floating.

(2) A screen is recommended around the pump. It should have 1/8" holes or slits, be of non-corrosive material and have a minimum area of 12 square feet. Its placement must not interfere with the floats and it should be easily removable for cleaning.

(3) The volume of the dosing chamber should be equal to at least two days' flow. A 750 gallon tank will provide sufficient volume to keep the pump covered with effluent, provide an 80 to 120 gallon dose and store one day's flow for most single dwelling installations. See Figure 15 for a typical dosing chamber installation. See Figure 15 for a typical dosing chamber.

FIGURE 15. DOSING CHAMBER



## F. INTERMITTENT SAND FILTERS

### 1. General

a. An intermittent sand filter consists of a bed of medium sand in a container which filters and biologically treats septic tank effluent. The filtered effluent is then distributed to a disposal trench. Sand filters characteristically produce a high quality effluent which will prolong the life of any soil absorption system.

b. Alternatives to the standard septic tank soil absorption system may be necessary for a number of reasons:

(1) Soil absorptive characteristics are not suitable for septic tank effluent because infiltration rates are slower than 60 min/inch or faster than 1 min/inch for adequate soil treatment of effluent.

(2) Groundwater levels are characteristically too high for proper treatment of septic tank effluent by soil.

(3) Depth to bedrock or impermeable layers preclude adequate depth for treatment of septic tank effluent.

(4) Topographic features, such as slope of the land, are too steep to permit adequate treatment.

(5) Land area is too limited to allow construction of a proper soil absorption system.

### 2. Conditions for Approval

a. Slope must be no greater than 20 percent.

b. The bottom of the filter shall be a minimum of 5 feet above the high seasonal groundwater level or, 1 foot above the impermeable strata.

### 3. Filter Design

a. Application rate of septic tank effluent to the filter must not be greater than 1.2 gallons per square foot per day.

b. The filter sand must conform to the gradation of medium sand.

The following definitions may be used to determine if a soil texture is a medium sand:

(1) Conforms to the gradation requirements of ASTM-C-33.

| SIEVE SIZE | % PASSING |
|---|---|
| 4 | 95-100 |
| 8 | 80-100 |
| 16 | 50-85 |
| 30 | 25-60 |
| 50 | 10-30 |
| 100 | 2-10 |

(2) Conforms to the USDA definition of a medium sand:

| SIEVE SIZE | MILLIMETER SIZE | % PASSING |
|---|---|---|
| 4 | 2.0-10 | 100 |
| 10 | 1.0-2.0 | 75 |
| 16 | 0.6-1.2 | 50 |
| 140 | 0.05-0.10 | 0-15 |

c. The filter sand must be washed sand, have no more than 1% fines, and be sharp edged or angular in shape.

d. The Uniformity Coefficient must be less than or equal to 2.0.

e. The filter must be dosed more than 4 times per day.

f. Sand filter container, piping, gravel, gravel cover, and soil crown material should meet the minimum requirements shown in figure 16.

g. The filter container may be constructed of concrete or with materials other than concrete where equivalent function, workmanship, watertightness and at least a twenty year service life can be documented. The following requirements must be met for flexible membrane liners:

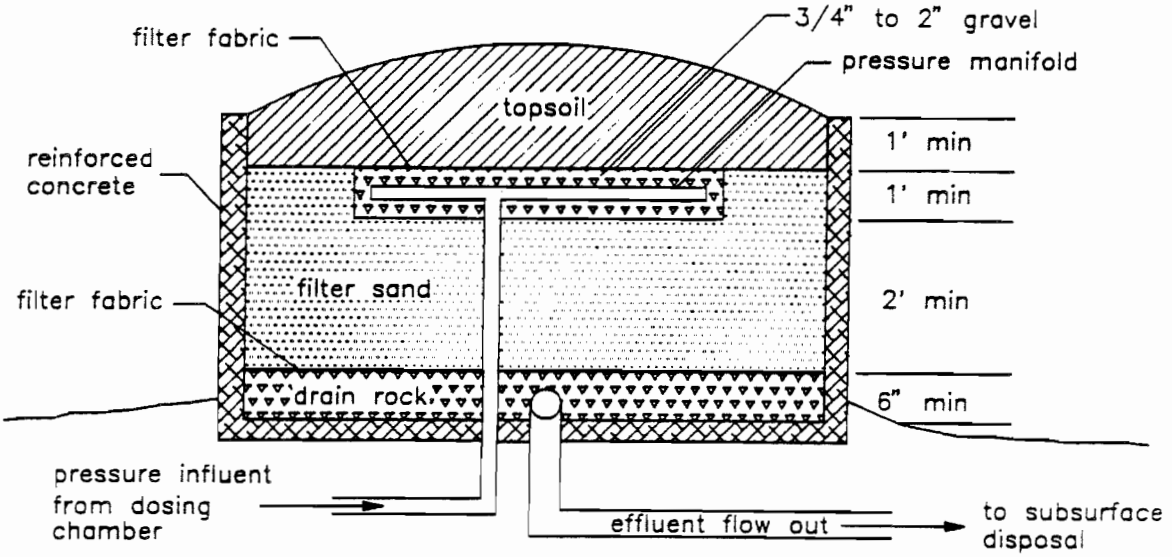
(1) Have properties equivalent to or greater than thirty mil unreinforced polyvinyl chloride.

(2) Have field repair instructions and materials provided to the purchaser of the liner.

(3) Have factory fabricated "boots" for waterproof field bonding of piping to and through the liner.

(4) Have placement against smooth, regular surfaces free of sharp edges, nails, wire, splinters, or other objects that may puncture the liner. A four inch layer of clean medium sand should provide liner protection.

FIGURE 16. TYPICAL INTERMITTANT SAND FILTER




4. **Filter Construction**

   a. All materials must be structurally sound, durable and capable of withstanding normal installation and operation stresses. Components that may be subject to excessive wear must be readily accessible for repair or replacement.

   b. All filter containers must be placed over a stable level base.

   c. The pressure system must be designed and installed according to the guidance given for Pressure Distribution Systems.

5. **Gravity Disposal Trenches**

   The disposal trenches must meet the requirements of standard trench system.

## G. MOUND SYSTEMS

1. **General**

   a. Many rural areas in the United States are not suited for on-site disposal of home sewage using the conventional septic tank system because of site limitations such as slowly permeable soils, shallow soils, and high water table soils. The septic tank-mound system is one system which overcomes some of these soil limitations but allows subsurface disposal of the effluent (Figure 17).

   b. The septic tank-mound system consists of the septic tank, a pumping chamber, and the mound. The septic tank is sized the same as for the conventional septic tank-soil absorption system. The pump elevates the effluent to the mound and pressurizes the distribution within the mound. A siphon can be used in place of the

pump if the mound is located down slope. The mound consists of a fill material, an absorption area, a distribution system, a cap and top soil.

The effluent is pumped into the absorption area through the distribution system. It flows through the fill material where it is purified and then it passes into the natural soil. The cap, usually consisting of a topsoil or subsoil, provides frost protection, a barrier to infiltration, retains moisture for vegetation and promotes runoff of precipitation. The topsoil aids in establishing and maintaining a good vegetative cover.

2. **Conditions for Approval**

a. For all soil textural classifications with percolation rates from 1 to 120 minutes per inch, the minimum depth of natural soil to the limiting layer shall be 2 feet.

b. The maximum slope of natural ground for soils with percolation rates of 1 to 60 MPI and 61 to 120 MPI shall be 12% and 6% respectively.

c. The mound must not be installed in flood ways, areas with large trees and boulders, concave slopes, slope bases or depressions.

d. The minimum pretreatment of sewage prior to disposal to the mound must be a septic tank designed according to guidelines in this bulletin.

e. The cap area of the mound must remain open above with no structures placed above or upon it. The mound must remain accessible for repairs if failure occurs.

3. **Design and Construction**

a. Please refer to the *Design and Construction Manual for Wisconsin Mounds* for design and construction criteria. This manual and a list of required modifications is available from ADEQ.

b. A pressure distribution system shall be used in the mound system design.

c. A 100% reserve area is required for all mound systems.

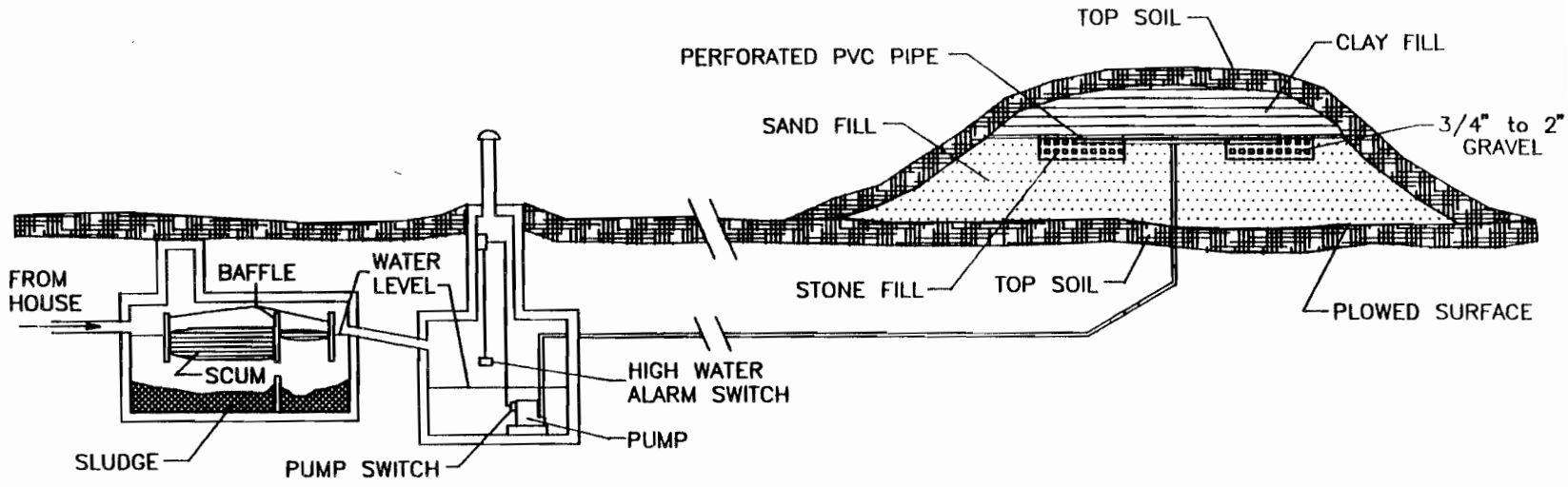
d. Either the mound shall be sodded with grass sod or lawn grasses or other appropriate low profile vegetation shall be established before the system is put into operation.

e. A standpipe shall be installed within the bed down to the fill sand, so that ponding water can be measured periodically and pumped if necessary.

4. **Setbacks**

Setback requirements shall be equal to those given in Tables 7 and 8 for conventional septic tank systems.

FIGURE 17. TYPICAL MOUND SYSTEM, INCLUDING SEPTIC TANK, PUMP STATION, AND MOUND.



# H. DISINFECTION FOR INDIVIDUAL DISPOSAL SYSTEMS

## 1. General

### a. When Required

Disinfection of domestic wastewater refers to the selective destruction of pathogenic organisms in the effluent wastewater stream. The application of disinfectants is required for:

(1) Surface disposal of effluent from aerobic treatment facilities;

(2) Surface disposal of effluent from graywater treatment systems; and,

(3) Disposal of effluent from aerobic treatment facilities in shallow trenches less than or equal to 2 feet deep or with less than 12 inches of cover.

### b. Disinfectants

A listing of potential disinfectants available for on-site application is shown in Table 15.

Chlorine and chlorine compounds such as calcium hypochlorite and sodium hypochlorite are the most common forms of disinfectants used today. When properly operated the chlorination process is a safe, practical, and effective way to destroy disease-causing organisms.

Chlorine is a powerful oxidizing agents capable of oxidizing organic matter, including organisms, at a rapid rate in relatively low concentrations.

**TABLE 15**

**SELECTED POTENTIAL DISINFECTANTS FOR ON-SITE APPLICATION**

| DISINFECTANT | FORMULA | FORM USED | AVAILABLE CHLORINE % | EQUIPMENT |
|---|---|---|---|---|
| Sodium Hypochlorite | NaOCl | Liquid | 5-15 | Metering Pump |
| Calcium Hypochlorite | $Ca(OCl)_2$ | Tablet | 35-70 | Tablet Contactor |

### c. Efficiency of Disinfection

The destruction of organisms is directly related to two factors, concentration and contact time. This means that if the chlorine concentration is decreased, the contact time, the length of time the chlorine and the organisms are in physical contact, must be increased to ensure that the kill rate remains the same. Similarly, as the chlorine concentration increases, the contact time needed for a given kill decreases. The chlorine demand (concentration) of selected domestic wastewaters is given in Table 16.

TABLE 16
CHLORINE DEMAND OF SELECTED DOMESTIC WASTEWATERS[a]

| WASTEWATER | CHLORINE DEMAND,MG/L |
|---|---|
| Septic tank effluent | 30 - 45 |
| Home aerobic treatment plant effluent | 10 - 25 |
| Sand-filtered effluent | 1 - 6 |

a. Estimated concentration of chlorine consumed in nonspecific side reactions with 15-minute contact time.

For chlorination to be successful:

(1) Chlorine must be thoroughly mixed with all the effluent water to be treated.

(2) Mixing must be continuous.

(3) Enough chlorine must be added to accomplish the degree of treatment desired.

2. **Location of Equipment**

The disinfection equipment, including feed systems and contact chamber, must be located immediately after the aerobic treatment facilities or graywater treatment system or, if included, the filtration system, and before the final discharge point. The equipment should be located below grade, be readily accessible, and be designed for proper operation during all seasons of the year.

3. **Design Criteria**

a. **Dosage**

The design of disinfection processes depends on the wastewater characteristics, wastewater temperature, pathogen to be destroyed, and disinfectant to be employed. From this information, the required residual-relationship may be developed and disinfectant dose may be calculated.

Design of on-site wastewater disinfection systems must result in conservative dose-contact time values, since careful control of the process is not feasible. Guidelines for chlorine disinfection for on-site applications are presented in Table 17.

TABLE 17
CHLORINE DOSAGE DESIGN GUIDELINES

| Effluent pH | Chlorine Dose[a],mg/l Septic Tank Effluent | Package Biological Process Effluent | Sand Filter Effluent |
|---|---|---|---|
| 6 | 35 - 50 | 15 - 30 | 6 - 10 |
| 7 | 40 - 55 | 20 - 35 | 10 - 20 |
| 8 | 50 - 65 | 30 - 45 | 20 - 35 |

a. Contact time = 15 minutes at peak flow and 20°C; increase contact time to 30 minutes at 10°C and 1 hour at 5°C for similar efficiency.

b. **Sample Calculations**

The sizing of chlorine feed systems is dependent upon the form of the chlorine used and the method of distribution. Sample calculations are presented Also refer to Appendix A of Engineering Bulletin 8, *Disinfection*, provided as Attachment 7.

Estimate of sodium hypochlorite dose - liquid feed

Chlorine: NaOCl - trade strength 15% (150 g/l)
Dose required: 20 mg/l available chlorine
Wastewater flow: 200 gpd average

(1) Available chlorine =

(150 g/l) x (3.785 l/gal) x (1.0 lb/453.6 g) = 1.25 lb/gal

(2) Dose required =

(20 mg/l) x (3.785 l/gal) x (1 lb/453.6 g) x ($10^{-3}$ g/mg)
= 1.67 x $10^{-4}$ lb/gal

(3) Dose required =

(1.67 x $10^{-4}$ lb/gal) x (200 gal/d) = 3.34 x $10^{-2}$ lb/d

(4) NaOCl dose =

(3.34 x $10^{-2}$ lb/d) / (1.25 lb/gal) /128 oz/gal = 3.5 oz/day

Estimate of chlorine design - tablet feed

Chlorine: $(Ca(OCl)_2$ tablet - 115 g; commercial strength 70%
Dose Required : 20 mg/l available chlorine

Wastewater Flow: 200 gpd (750 l/d)

(1) Available chlorine in tablet = 0.7 x 115(g) = 80.5 g/tablet

(2) Dose required = 20 (mg/l) x 750 (l/d) x 1 gm/1000 mg = 15 g/d

(3) Tablet consumption = $\frac{15\ (g/d)}{80.5\ (g/tablet)}$

= 0.19 tablets/day
or: 5.4 days/tablet

4. **Construction Features**

a. **Feed Systems**

(1) **Stack or Tablet Feed Systems:**

These are used for feeding $Ca(OCl)_2$ tablets (see Figure 18). They are constructed of durable corrosion-free plastic or fiberglass and designed for in-line installation. Tablets dissolve in proportion to the wastewater flow. Restocking of tablets is done manually as needed. Protection from freezing weather conditions should be provided as necessary.

(2) **Liquid Feed Systems:**

i. An aspirator feeder employs the use of a vacuum to draw disinfection solution from a container into the unit. The water-disinfectant solution is then injected into the main wastewater stream.

ii. Suction feeders operate by pulling the disinfection solution from a reservoir by suction into the disinfection unit. The suction is created by a pump or a siphon.

iii. The storage reservoir should be large enough according to the manufacturer's recommendations to provide ample volume of disinfection solution for several weeks of operation.

vi. Construction materials for the tanks, piping, pumps, and appurtenances must be corrosion resistant.

a. **Contact Basins**

(1) For low flows, less than 1,000 gallons per day, contact basins may be plastic, fiberglass or a length of concrete pipe placed vertically and outfitted with a concrete base.

(2) Contact basins should be baffled in order to prevent serious shortcircuiting within the basin. One sample baffling arrangement is shown in Figure 19.

FIGURE 18. STACK FEED CHLORINATOR

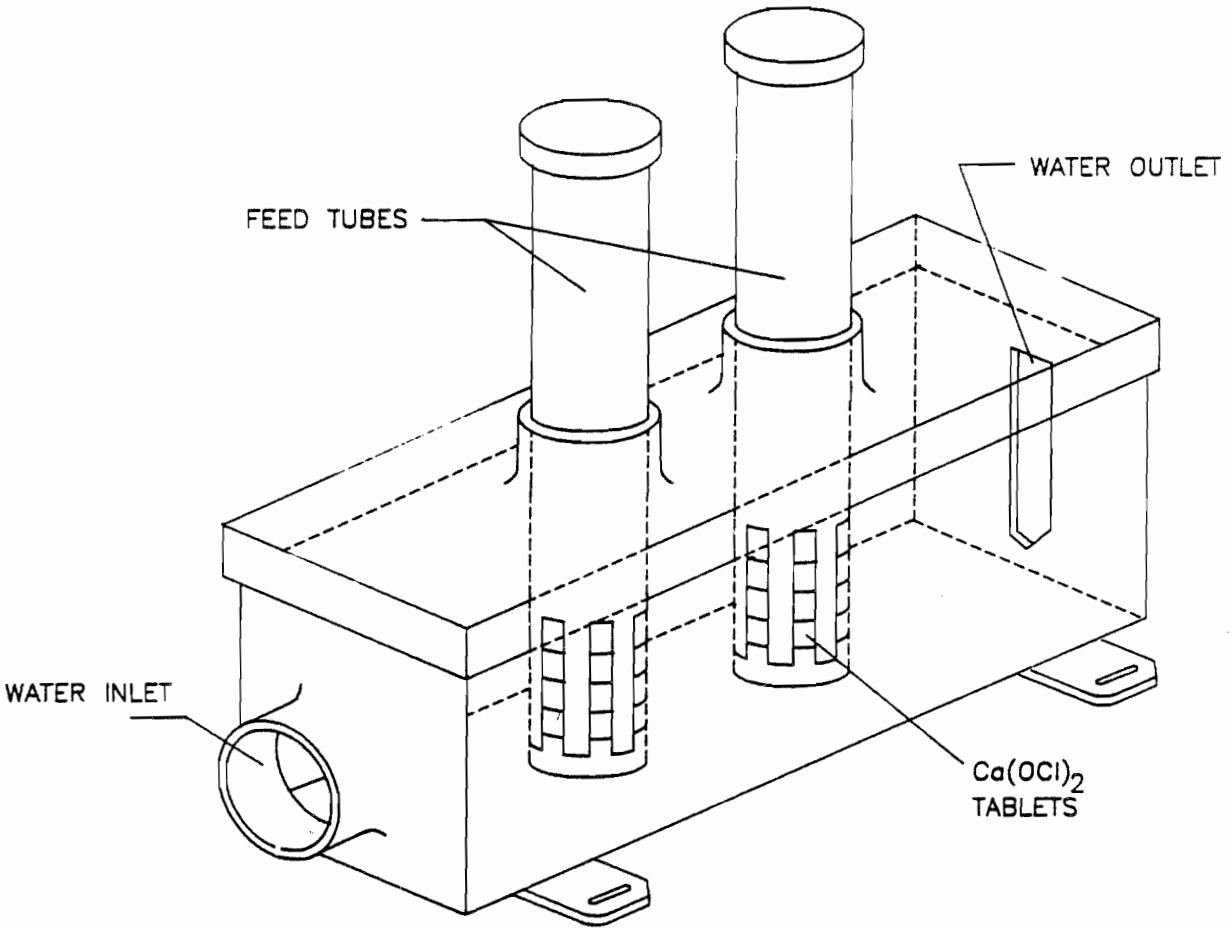
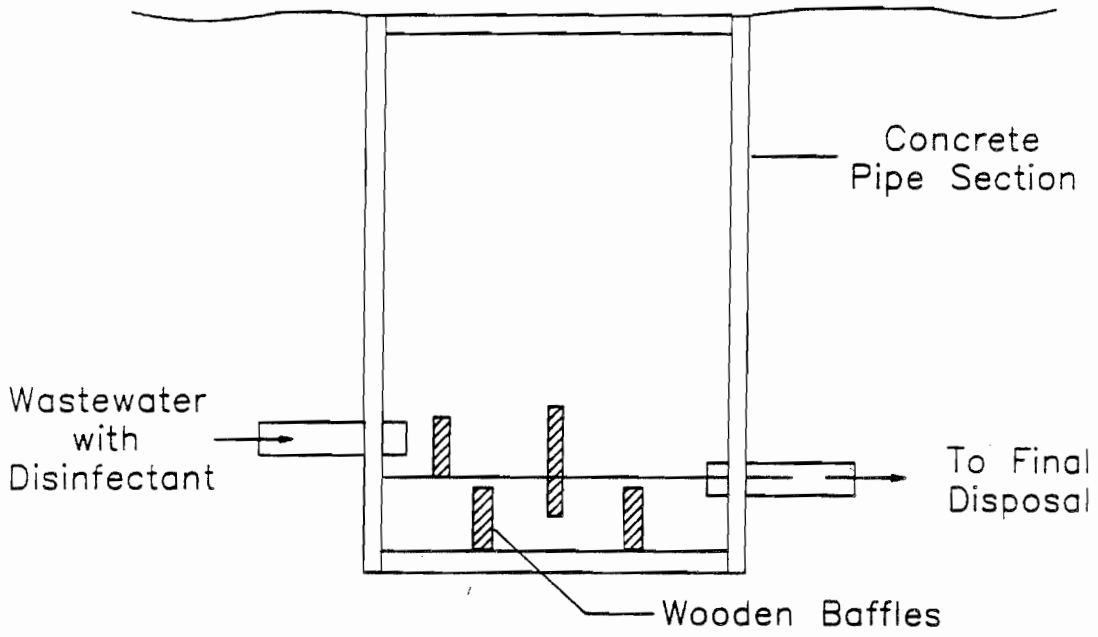


FIGURE 19. SAMPLE CONTACT CHAMBER



# I. GRAVEL-LESS TRENCH SYSTEM

## 1. General

A gravel-less trench system shall meet all the requirements of a standard trench system except that the aggregate fill is replaced by a large diameter, nylon fabric-wrapped, plastic pipe approved by the Department.

## 2. Conditions for Approval

a. Gravel-less trenches shall not be used if a source of clean aggregate fill rock is readily available.

b. Unless otherwise noted herein, the system must be installed according to the pipe manufacturer's recommendations.

## 3. Design

a. Length of pipe needed should be calculated on the following basis:

8" diameter pipe = 2 sq. ft. effective area/ft.
10" diameter pipe = 3 sq. ft. effective area/ft.

b. Effective area is equivalent to one lineal foot of trench absorption area.

Example:

A three bedroom home on a site with soil with a percolation rate of 15 MPI would require 600 linear feet of 8" pipe ((600 gal/day/0.50 gal/sq. ft./day)/2) of 8" pipe or 400 linear feet of 10" pipe ((600/0.50)/3).

a. Individual lines should be as long as possible, but not exceeding the 100 ft. maximum.

b. An inspection port (sludge sump) should be installed at the terminal end of each line.

## 4. Construction

a. The trench should follow the contour of the land and the pipe should be installed between 18" and 36" below the surface.

b. Trench excavations should not be less than 18" wide and no more than 36" wide.

c. Pipe must be installed level with an allowable variation of not more than 1/2" per 100 feet. A transit, engineer's level or surveying station is required.

# PART VI - OPERATION AND MAINTENANCE

## A. OPERATION AND MAINTENANCE (O&M) OF THE SEPTIC TANK

One of the major advantages of the septic tank is that it has no moving parts and, therefore, needs very little routine maintenance. A well designed and maintained concrete, or plastic tank should last for 50 years. Because of corrosion problems, steel tanks can be expected to last no more than 10 years. One cause of septic tank problems involves a failure to pump out the sludge solids and scum when required. As the sludge depth increases, the effective liquid volume and detention time decrease. As this occurs, sludge scouring increases, treatment efficiency falls off, and more solids escape through the outlet. Scum may also begin to flow into the disposal system. The most common cause of disposal area failure is the accumulation of scum or sludge which escapes from the septic tank. The only way to prevent this is by periodic inspection and pumping of the tank.

1. Tanks should be inspected at intervals of no more than every year to determine the rates of scum and sludge accumulation. If inspection programs are not carried out, a pump-out frequency of once every 3 to 5 years is reasonable. Once the characteristic sludge accumulation is known, inspection frequency can be adjusted accordingly. The inlet and outlet structures and key joints should be inspected for damage after each tank pump-out.

   Actual inspection of sludge and scum accumulations is the only way to determine definitely when a given tank needs to be pumped. When a tank is inspected, the depth of sludge and scum should be measured in the vicinity of the outlet baffle of both chamber.

   a. To determine the scum level, gently break the scum until a clear space can be seen. This should reveal the thickness of the scum.

   b. To determine the sludge level, use a clear plastic tube. Remove scum with a shovel if it is too thick to penetrate. If the sludge is too thick to penetrate, churn the tank with the shovel. Otherwise, just insert a tube down through the scum and water into the sludge to check the cross section of the tank.

2. The septic tank should be pumped whenever:

   a. The bottom of the scum layer is within 3 inches of the bottom of the outlet device; or,

   b. The sludge level is within 8 inches of the bottom of the outlet device. The efficiency of suspended solids removal may start to decrease when these conditions are reached.

3. The septic tank should be pumped at the time of sale of the residence or it should be certified by the homeowner that the tank was inspected and pumping is not necessary based on the conditions of items 2a or b. Pumping receipt records or inspection records should be kept by the homeowner for verification.

4. Following is a list of other considerations pertaining to septic tank operation and maintenance.

   a. Do not hydraulically overload the septic tank. This will result in inadequate detention time and treatment of solids, carry-over into the absorption system, and clogging of the soils.

   b. Dispose only domestic wastes in the septic tank system. Disposal of large amounts of any chemicals pesticides, solvents, and paints will destroy the septic tank ecosystem.

   c. When pumped, leaving solids in the septic tank to aid in starting the system is not necessary. However, the septic tank must not be disinfected, washed, or scrubbed.

   d. Garbage grinders to dispose of kitchen waste should not be used unless an additional 25% capacity is built into the tank and leach field. This uses excessive amounts of water and the ground garbage heavily burdens the septic tank.

   e. Special biological or chemical additives are not needed to improve or assist tank operation. No chemical additives are needed to "clean" septic tanks. Such compounds may cause sludge bulking and decreased sludge digestion. However, small amounts of bleaches, lyes, caustics, soaps, detergents, and drain cleaners do not harm the system. Other preparations, some of which claim to eliminate the need for septic tank pumping, are not necessary for proper operation and are of questionable value.

   f. Materials not readily decomposed such as sanitary napkins, prophylactics, coffee grounds, cooking fats, bones, wet-strength towels, disposable diapers, facial tissues, and cigarette butts should never be flushed into a septic tank. They will not degrade in the tank, and can clog inlets, outlets, and the disposal systems.

## B. OPERATION AND MAINTENANCE OF THE GREASE TRAP

1. In order to be effective, grease traps must be operated properly and cleaned regularly to prevent the escape of appreciable quantities of grease. The frequency of cleaning at any given installation can best be determined experience based on observation. Generally, cleaning should be done when 50% of the grease-retention has been reached. At restaurants, pumping frequencies range from once a week to once every 2 or 3 months.

2. Use of degreasers, emulsifiers or other additives do not keep the system free of grease. By creating an emulsion grease may be passed through the trap and septic tank and end up clogging the leach field.

## C. OPERATION AND MAINTENANCE OF THE LEACH FIELD

Once installed, a subsurface soil absorption system requires little or no attention as long as the wastewater discharged into it is nearly free of settleable solids, greases, fats, and oils. This requires that the septic tank be maintained. To assure that the system will have a long, useful life, the following actions are suggested:

1. Alternating use of two separate leach fields to rest the system by taking it out of service for a period of time is an effective method of restoring the optimum infiltration rate.

Resting allows the absorption to gradually drain, exposing the infiltrative surfaces to air. After several months, the clogging is degraded through biochemical and physical processes. This requires that a second absorption system exist to allow continued disposal, while the first is in the resting phase. The systems can be alternated on a yearly basis by means of a diversion valve (see Figure 3).

2. The plumbing fixtures in the home should be checked regularly to repair any leaks which can add substantial amounts of water to the system.

3. The use of special additives such as yeast, bacteria, chemicals, and enzyme preparations is not necessary and is of little value for the proper function of the soil absorption system.

4. Surface water drainage should be checked to assure that grading does not allow water to run onto the absorption system. All gutters should direct water away from the absorption system. All roofs should have gutters to prevent drainage toward the absorption system. Patios and driveways should be located far from the drainfield or be ditched so that water from their surfaces will flow in another direction.

5. Lack of proper maintenance of the septic tank may result in excessive clogging of the leach field due to poor solids removal by the tank. This can be determined checking the maintenance record and the condition of the tank. If this appears to be the problem, the tank should be pumped and repaired, or replaced if necessary. The infiltrative surface of the absorption field should also be checked. If siting, design, or maintenance do not appear to be the cause of failure, excessive clogging is probably the problem. In such cases, the infiltrative surface can sometimes be rejuvenated by oxidizing the clogging mat. This can be done by allowing the system to drain and rest for several months.

## D. OPERATION AND MAINTENANCE OF THE AEROBIC TREATMENT PLANT

### 1. Responsibility

The Department may require that responsibility for operation and maintenance of individual, aerobic treatment systems shall be vested in a public management agency such as a city, county, sanitary district or other public entity which the Department determines as having proper statutory authority and adequate resources carry out such responsibility. If no such entity exists, the Department may require the home owner to contract with a certified operator for system operation and maintenance.

### 2. Minimum Requirements

a. Each approved installation shall be inspected by the responsible entity at least every month and checked for necessary corrective maintenance.

b. Records, both of maintenance and performance shall be kept and submitted annually to ADEQ or the county health department.

c. Operation and maintenance tasks must follow those recommended by the manufacturer as specified in the approved operation and maintenance manual.

## E. OPERATION AND MAINTENANCE OF THE DISINFECTION SYSTEM

1. The disinfection system should be designed to minimize operation and maintenance requirements, yet ensure reliable treatment.

   a. Routine operation and maintenance of premixed liquid chlorine solution feed equipment consists of replacing chemicals, adjusting feed rates, and maintaining the mechanical components.

   b. Tablet feed chlorination devices should require less frequent attention, although recent experience indicates that caking of hypochlorite tablets occurs due to the moisture in the chamber. Caking may result in insufficient dosing of chlorine, but may also produce excessive dosage due to cake deterioration and subsequent spillage into the wastewater stream. Dissolution of chlorine may also be erratic, requiring routine adjustment of tablet and liquid elevation (experience with some units indicates that dissolution rates actually increase with decreased flow rates).

2. Process control is best achieved by periodic analysis at least monthly, of chlorine residuals in the contact chamber. The chlorine residuals can be measured using a color comparator. Periodic bacteriological analyses of treated effluents provide actual proof of efficiency. Anyone can be trained in the proper techniques of sample collection for bacterial analyses. The critical part will be to preserve and transmit the sample to the lab within 6 hours from the time of collection to lab set-up.

## F. OPERATION AND MAINTENANCE OF THE PRESSURE DISTRIBUTION SYSTEM

A properly designed and installed pressure distribution system requires little ongoing maintenance. However, several routine items should be checked periodically, including:

1. Systems employing pumps for dosing should be inspected monthly for proper switch and pump operation.

2. If the alarm panel has a "PUSH TO TEST" button, it should be checked monthly and repaired or replaced as necessary.

3. Pump maintenance should follow the manufacturer's recommendations.

4. When inspecting be sure to turn off the power supply and disconnect all cords before removing or replacing the pump or control assembly.

5. Before replacing any components be sure that the level controls have not simply become entangled. Check the pump operation independently from the controls.

6. Siphons should be observed semi-annually for proper operation. The bell and any bell vents should be flushed each year.

7. Periodically the pump discharge rate should be checked by timing the period it takes the pump to empty the chamber. If the time has increased significantly the pump should be removed and inspected for wear, clogging or impeller damage.

# PART VII - HYDROGEOLOGIC CONSIDERATIONS AND PERMITS

## A. INTRODUCTION

The Department is authorized by A.R.S. § 49-101 et seq., to establish water quality standards and to protect and preserve the quality of water in all aquifers in the State. In addition, the statutes authorize the Department to require that anyone who owns or operates an on-site wastewater disposal system or any other discharging facility obtain an Aquifer Protection Permit prior to operation. The water quality of all aquifers is to be preserved for drinking water use. Based on the drinking water quality standards the Department has established numeric values which are the maximum pollutant concentrations allowable. These numeric standards are called Aquifer Water Quality Standards.

Uncontrolled releases of pollutants could potentially contaminate aquifers anywhere in the state. While much of the nitrate contamination of groundwater is the result of fertilizer application on croplands, nitrate contamination which is attributable to septic tank systems has been detected in several areas statewide. Further nitrate accumulation can be controlled by the regulation of on-site wastewater disposal systems. Individual septic tank systems may qualify to operate under a General Permit if they meet the following conditions:

1. The system has a design capacity of less than 20,000 gallons per day; and

2. The system is in compliance with these guidelines; and

3. The system does not receive wastes from industrial or commercial processes with non-domestic strength wastes.

Septic tank systems not meeting these conditions are required to obtain an individual permit.

## B. AQUIFER PROTECTION PERMITS

In order to prevent contamination of aquifers, the Department has developed a system of rules which regulate sources of pollution. Any person who proposes to discharge pollutants is subject to these rules and must obtain a permit before operating his facility. These permits are called Aquifer Protection Permits.

The Aquifer Protection Permits Program replaces the Groundwater Protection Permits Program which was instituted in July of 1984. Under the Groundwater Quality Protection Permits Program applicants may have been required to file a Notice of Disposal (N.O.D.) and they may have received a groundwater protection permit. If they are operating in compliance with a valid Groundwater Quality Protection Permit or they have filed a complete and current N.O.D., they are considered to be in compliance with the requirements of the Aquifer Protection Program. If they have recently filed an N.O.D. for a new wastewater disposal system or for the expansion of an existing one, then their N.O.D. is being processed. Their N.O.D. may enter the permits processing system at a future date. When it does, the Department may require additional information in order to prepare a permit for the operation of their facility.

## C. PERMITS AND PLAN APPROVAL

Many county health departments have accepted delegated authority to review and approve plans for wastewater disposal. The process of obtaining plan approval starts at the county health department. They can also advise applicants of the need for an individual permit or whether the project may qualify to operate under the statewide general permit.

## D. GENERAL PERMITS

Your planned system may qualify for operation under a General Permit. Your county health department's approval and compliance with the minimum criteria for operation under a general permit automatically qualifies your system for a General Permit. Designing your system so that it meets the requirements for the General Permit will avoid the expense and delays which may be associated with obtaining an Individual Permit. A General Permit for individual wastewater disposal systems with design capacities up to 20,000 gallons per day has been established on a statewide basis in the rules for Aquifer Protection Permits. The systems with capacities greater than 2,000 gallons per day must also meet the disposal density requirement which is dependent on ambient groundwater nitrate concentrations (R18-11-403).

## E. DISPOSAL DENSITY AND SETBACKS

### 1. Nitrate Contamination

Where individual on-site wastewater disposal systems are used in conjunction with high density development the potential for groundwater contamination is high. The contaminant of greatest concern is nitrate. Nitrate is very water soluble, highly mobile, and not readily adsorbed by soils. Even in areas where there is a great depth to groundwater, eventually the nitrate is likely to reach the water table. Whether the source is agricultural fertilizers or domestic wastewater, nitrate is a pollutant of great concern. The drinking water maximum contaminant level (MCL) and the corresponding water quality standard for nitrate nitrogen is 10 mg/l.

Septic systems and most aerobic treatment systems discharge significant amounts of ammonia or nitrate. Ammonia is usually converted to nitrate under aerobic conditions and eventually reaches groundwater. Therefore systems are only appropriate in lower population density areas. Areas which already have nitrate contamination from septic systems or agricultural practices will not be approved for additional septic system use. The law requires that an aquifer that is already polluted shall not be further degraded in quality as a result of a facility's discharge. This concept has been incorporated into the disposal density criteria of the requirements for general permits in R18-9-126.

### 2. Disposal Density

The disposal density is calculated by dividing the average daily flow by the total acreage used for the dispersal of the wastewater. The total acreage used in the density calculation is called the "effective acreage". The effective acreage generally includes all of the area within the property boundaries which is hydrologically downgradient (as determined by the local groundwater flow direction) from the disposal point or area. Allowances are made for wastewater dispersal within the aquifer as groundwater moves downgradient, and in cases where a large depth-to-water exists beneath a facility, additional effective acreage may be given due to the lateral migration of wastewater over fine-grained sediment layers which

are commonly found in alluvial vadose zones. Unless otherwise justified in the individual permit application or in other administrative actions initiated by the Department of Environmental Quality, the following disposal densities will apply. Where ambient groundwater nitrate (as nitrogen) concentration is:

a. From 0 up to 3.0 mg/l the maximum disposal density may be 1200 gallons per acre per day;

b. From 3.1 up to 5.0 mg/l the maximum disposal density may be 800 gallons per acre per day;

c. From 5.1 up to 7.0 mg/l the maximum disposal density may be 400 gallons per acre per day; and

d. In areas where ambient groundwater nitrate concentration exceeds 7.0 mg/l the statewide general permit is not valid. No new septic tank installations be allowed unless justified in an individual permit application or in other administrative actions from the Department of Environmental Quality.

3. Alternatives

a. Use of individual on-site wastewater disposal systems which remove nitrate by a microbial process of denitrification can also prevent the contamination of groundwater by nitrate. Only those treatment systems which would not further degrade aquifer water quality would be issued a permit. Approval to construct such systems must be issued by the Department.

b. Aquifers which are created solely as a result of discharges from a facility may qualify for aquifer reclassification.

## F. ACCEPTABLE AMBIENT AQUIFER WATER QUALITY DATA CRITERIA

1. Historical data used in the determination of ambient aquifer water quality (nitrates) should be no older than one year prior to the application submittal date. If there is no data available within a year but there is a sampling well available, the well should be resampled to obtain the water quality data.

2. If the facility decides not to submit aquifer water quality data or there are no monitor wells in the vicinity, and there is no agricultural activity in the area, a disposal limit of 800 gpd/acre will be automatically set. If there is agricultural activity in the area a disposal limit of 400 gpd/acre will be set.

3. Distances to the groundwater sampling point from the proposed disposal site will be determined by the disposal volume from the facility. If the disposal volume is less than 10,000 gpd then the groundwater sampling point must be within a one mile radius of the disposal area. If the volume of disposal exceeds 10,000 gpd the sampling point must be within a one-half mile radius from the site.

4. The following list is a priority ranking, from best to worst, of the types of wells that can be sampled to obtain representative ambient water quality data.

Monitor Well
Domestic Well
Public Supply Well
Irrigation Well

The criteria used in this ranking reflects the depth from which samples would be taken from the aquifer.

## G. MICROBIOLOGICAL CONTAMINANTS AND VERTICAL SEPARATION

### 1. General

Individual on-site wastewater disposal systems also discharge bacteria, viruses, and other organisms which cause disease. Soils and fine sands can filter out these organisms. However, where the effluent is discharged to coarser materials, the bacteria can travel longer distances and remain viable and able to cause disease. Viruses are smaller and can be carried even farther distances. Some viruses can also survive longer exposure to environmental conditions than other disease causing organisms. Live viruses have been carried over a mile by groundwater flowing through fractured rock.

The subsurface characteristics for a proposed site of an individual on-site wastewater disposal system should be examined to ensure that adequate filtration of microbial organisms will occur. Soil acts as a filter in removing many bacteria and large microorganisms from the effluent. The effectiveness of filtration depends upon the thickness of the soil above the water table and the ability of the soil to conduct water. These two parameters are described by (1) separation from the water table and (2) percolation rate..

Soil which does not easily allow fluid to pass will also prevent microorganisms from entering the pore spaces and traveling with the effluent. Eventually, the bacteria left behind will die. Viruses which are too small to be physically filtered by soil particles, become positively charged under conditions of low pH. In this situation, they are adsorbed by negatively charged clay particles in the soil. After a period of time these immobilized viruses will also die. Low flow rate of the downward moving water increases the removal of both bacteria and viruses. Therefore a minimum separation from the bottom of the leach trench or leach pit will help to ensure that microorganisms will not reach groundwater.

### 2. Minimum Vertical Separation

To control the amount of bacteria and virus through various types of soils, minimum vertical separation criteria has been established. This is presented in Table 3.

## H. INDIVIDUAL AQUIFER PROTECTION PERMITS

If the system which you propose to install does not meet the criteria listed in the rules for a General Permit, you must apply for an Individual Aquifer Protection Permit. The individual permit application may require you to submit additional information including the design of your system, site-specific characteristics and evidence that your plans will apply the Best Available Demonstrated Control Technology. In some cases groundwater quality monitoring may be required. A fully complete application will expedite the permitting process. Changes in design after submittal of a

permit application may cause substantial delays. Individual permits generally take several months and include a public comment period in which a public hearing may be required. For individual permits, there is a $100 permit application fee which is to be paid to the State of Arizona. You are encouraged to contact the staff of the ADEQ early in your planning. Early communication the ADEQ will help to ensure that your project is feasible, that your permit application will be complete and that your facility will discharge in compliance with law.

# PART VIII - COMPLIANCE AND ENFORCEMENT

## A. INSPECTIONS

### 1. Site inspections

Inspections shall be performed by a registered professional engineer, registered sanitarian or state or county representative who shall keep detailed records of the construction design and siting of the facility, before construction begins. Inspector shall make these records available to the Department.

### 2. Construction Inspections

Inspections shall be performed on the facility during the construction period to ensure compliance with design and construction standards.

### 3. Final Inspection

Final inspection of the construction of the facility by the Department or the Department's designee before the facility is put into operation shall include inspection of all records kept by the engineer as well as inspection of the facility itself. The facility shall not be operated until the final inspection has been completed and the facility meets the established standards.

### 4. Operation and Maintenance Inspections

If a routine operation and maintenance inspection of an alternative onsite disposal system reveals that the facility is not being operated in compliance with established standards, the Department may provide the owner of the facility up to ninety days to bring the facility into compliance and reinspect the facility at the end of that period.

Additional inspections may be required at anytime if the Department receives information indicating that the facility is being operated in violation of established standards.

### 5. Pre-sale Inspections

All individual on-site wastewater treatment facilities should be inspected to indicate that the facility is being operated in compliance with all established standards at the time of any resale.

The inspection must be performed by a registered professional engineer, registered sanitarian, county health official or a licensed septic tank cleaner.

The inspection must include but not be limited to:

a. Signs that the leachfield is not failing such as surface sewage puddles or lush green grass growing over a leachfield.

b. Sludge level in the septic tank is not over 1/4 the total liquid depth.

c. Scum level in the septic tank is not over 1/8 the total liquid depth.

d. Signs of sluggish flow from the drains in the house.

e. Sampling and testing of effluent from aerobic units or sand filters which must meet Department standards and permit conditions for reuse of wastewater.

## B. LICENSING

### 1. Site Evaluators

a. A site evaluation is required prior to siting and designing a facility to determine the specific soil suitability.

b. The site evaluation and percolation tests shall be done by or under the supervision of a registered professional engineer, or geologist with the State of Arizona, a registered sanitarian, a representative of a county health department, a qualified person approved by the county health department or a representative of the Department of Environmental Quality. Individuals approved by the county health department must demonstrate competence and knowledge in performing this service.

### 2. Installation Contractors

a. Any contractor who undertakes or offers to undertake or purports to have the capacity to undertake construction, alteration, repair, addition to, improvement, or to provide mechanical or structural service for any such improvement to install or repair any sewage system, septic tank, leach field or alternative treatment system must be a duly registered contractor in good standing with the State of Arizona Registrar of Contractors.

b. It is unlawful for a person, firm, corporation, or other organization engage in the business, act or offer to act in the capacity, or purport to have the capacity of contractor without having his own license in good standing in his own name as prescribed in A.R.S. Title 32, Chapter 10.

### 3. System Designers

a. All plans, specifications, and design reports submitted for an alternative on-site disposal system must be prepared by or under the supervision a registered professional engineer who shall affix his signature and seal of registration in the State of Arizona to such documents.

b. A non-registrant may design a conventional septic tank system if the total value of such construction does not exceed twelve thousand five hundred dollars as verified by a cost estimate for material, equipment, and labor submitted with plan documents. Septic tank systems for individual residences need not verify cost if designed by a non-registrant.

c. A non-registrant may design a federal facility if that person is an officer or employee of the United States Government, pursuant to A.R.S. Title 32, Chapter 10.

4. **Septic Tank Cleaners**

An approved septic tank cleaner means a person having approved equipment and vehicles for the collection, transportation and disposal of human excreta and who holds an unrevoked license from the Arizona Department of Environmental Quality for each vehicle used to perform such operations and such other licenses or permits as may be required by other agencies, pursuant to the A.A.C. Title 9, Chapter 8, Article 12.

## C. MONITORING, RECORDKEEPING AND REPORTING

The following conditions apply only to the general permit requirements regarding the reuse of wastewater.

1. **Permit Compliance**

a. To assure compliance with permit terms and conditions, permittee shall monitor:

(1) The amount, concentration, or other measurement in the permit.

(2) The volume of wastewater released for reuse.

(3) Other parameters and quantities specifically required in the permit.

2. **Recording of Monitoring Results**

a. Any permittee required to monitor shall maintain records of all monitoring information and monitoring activities including:

(1) The date, exact place and time of sampling or measurements.

(2) The persons who performed the sampling or measurements.

(3) The dates the analyses were performed.

(4) The persons who performed the analysis.

(5) The analytical techniques or methods used.

(6) The results of such analysis.

b. All records of monitoring activities and results shall be retained by the permittee for a minimum of three years. The three year period may be extended;

(1) Automatically during the course of any unresolved litigation regarding the discharge of contaminants by the permittee.

(2) or, as requested in writing by the Department.

3. **Access to Records**

The owner/operator of the facility shall allow any and all of the reusers to have access to the records of physical, chemical, and biological quality of the reclaimed wastewater.

4. **Availability of Records**

Water quality records of the facility will be available for public inspection at the Department.

## D. PENALTIES AND FINES

1. It is unlawful to:

   a. discharge wastewater without a permit or appropriate authority.

   b. fail to monitor, sample or report discharges as required by a valid permit.

   c. violate a discharge limitation specified in a permit.

   d. cause a violation of a water quality standard.

2. If the Department determines that any alternative on-site wastewater treatment facility:

   a. has been installed or is being operated without an Approval to Construct;

   b. does not conform to the originally approved construction or,

   c. is being operated in violation of the established standards.,

   The Department may:

   (1) issue an order to the owner to modify the facility to conform to the approved plans;

   (2) issue an order requiring compliance within a reasonable time, to cease and desist from operating facility in violation of those standards; or,

   (3) issue an order to cease and desist from all operation of the facility within a reasonable time.

3. A compliance order becomes final thirty days after the order is served unless within thirty days of service the person named on the order requests a hearing.

4. The Department may impose on the owner a civil penalty of twenty dollars ($20) for each day the violation continues (ARS §49-362.E). Fines may be accumulated from the date the responsible party was first informed of the violation to the date the fine is paid.

## ATTACHMENT 1

# DRAFT OF AFFIDAVIT

I, _____, hereby certify that I have in my possession a copy of the Operation and Maintenance manual, which has been approved by the Arizona Department of Environmental Quality, for the

_____.

(Name and model number of treatment plant)

I have read and completely understand the contents of this manual, including all operational requirements, all maintenance requirements, all monitoring requirements, all reporting requirements, and all costs which may be incurred because of these requirements. I will comply fully with all aspects of this manual.

In the event that I sell, lease, or otherwise convey ownership of the treatment plant, I will notify the new owner of these responsibilities and the Arizona Department of Environmental Quality in writing within one week so that my responsibility can be released.

_____

(Owner's Signature)

This instrument was acknowledged before me this _____

(Date, month, year)

_____

(Notary's Signature and Seal)

## ATTACHMENT 2

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY, OFFICE OF WATER QUALITY
2005 N. Central Avenue, Phoenix, Arizona 85004

# COUNTY APPROVAL OF WATER AND/OR WASTEWATER PROJECT

__ New sewage disposal system
__ Individual sewage disposal systems
__ Extension or addition to existing sewage disposal system
__ New public water supply
__ Extension or addition to existing public water supply

To be filled out, signed and submitted with all Applications for Approval to Construct Water and/or Wastewater Facilities and/or Applications for Approval of Sanitary Facilities for Subdivisions.

_____

NAME OF PROJECT

Plans and supporting data for the above project have been reviewed by the

_____

NAME OF COUNTY HEALTH DEPARTMENT

and county approval is hereby given for the project, except as noted below. For individual sewage disposal systems, this is an approval of method only and approval of plans and inspection of individual systems by the county health department will be required later. FINAL PLAN APPROVAL BY THE ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY MUST BE OBTAINED BEFORE CONSTRUCTION OF THE PROJECT CAN BEGIN.

Date _____

Name (type of print) _____

Signature _____

Title _____

Address _____

City _____ Zip Code _____

ADEQ/OWQ-113 (4-89)

ADEQ/DWQ-114 (Rev. 5/89)

# ATTACHMENT 3

**ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY**
Office of Water Quality ■ 2005 North Central ■ Phoenix, Arizona 85004

## APPLICATION FOR APPROVAL TO CONSTRUCT WATER AND/OR WASTEWATER FACILITY

*(Submit in duplicate)*

☐ New sewage disposal system
☐ Extension or addition to existing sewage disposal system
☐ New public water supply
☐ Extension or addition to existing public water supply

### SYSTEM INFORMATION:

1. NAME OF: A. Water system _____ SYSTEM NUMBER ☐☐ ☐☐☐
   B. Sewer system _____ SYSTEM NUMBER ☐☐ ☐☐☐
2. LOCATION _____ COUNTY _____
3. OWNER: A. Water System _____
   NAME MAILING ADDRESS ZIP CODE
   B. Sewer System _____
   NAME MAILING ADDRESS ZIP CODE
4. OWNER: A. Water system _____ _____ _____
   NAME GRADE CERTIFICATION NUMBER
   B. Sewer system _____ _____ _____
   NAME GRADE CERTIFICATION NUMBER

### PROJECT INFORMATION:

1. DESCRIBE PROJECT _____
2. ENGINEER OF PROJECT _____ ADDRESS _____ PHONE _____
3. PERSON AUTHORIZING ENGINEER TO DESIGN PROJECT _____ _____
   TYPE OR PRINT SIGNATURE
   ADDRESS _____ PHONE _____

### PLAN DOCUMENTS *(required by regulations to be submitted)*:

☐ Engineer "Design Report"
☐ Four copies of construction plans and specifications
☐ Project MASTER PLAN (*for new systems only*)
☐ Water Source information:
Well - Driller's log, pumping test, water chemical report
Surface - Water chemical report, source name & location

Estimated date of start of construction _____ Estimated date of construction completion _____

### CONSTRUCTION AGREEMENT:

The undersigned hereby agrees to construct the water and/or wastewater facilities according to the approved plan documents

| TYPE OR PRINT NAME | AFFILIATION | SIGNATURE | DATE |
|---|---|---|---|
| | | | |
| TYPE OR PRINT NAME | AFFILIATION | SIGNATURE | DATE |
| | | | |

**ATTACHMENT 4**
**SAMPLE**

# PERCOLATION TEST DATA SHEET

Test hole location _____ Hole number _____
Date test hole was prepared _____ Depth of hole bottom, _____ inches.
Diameter of hole,_____ inches.
Soil data from test hole:

| Depth, inches | Soil texture |
|---|---|
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |
| _____ | _____ |

Method of scratching sidewall _____
Depth of pea-size gravel in bottom of hole, _____inches
Date and hour of initial water filling _____
Depth of initial water filling, _____inches above hole bottom
Method used to maintain at least 12 inches of water depth in hole for at least four hours:_____
_____
Percolation test readings made by _____

on_____starting at _____a.m./p.m.
(date)
Maximum water depth above hole bottom during test, _____inches

| Run # i (1) | Start time (2) | End time (3) | Time Intervals, $t_i$ Minutes (4) | Drop in water level, inches (5) | Percolation rate, minutes per inch (6) | $\frac{t_i+t_{i+1}}{2}$, $\Delta t$ (7) | $P_{i+1}-P_i$, $\Delta P$ (8) | $\frac{\Delta P}{\Delta t}$ (8) / (7) |
|---|---|---|---|---|---|---|---|---|
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Stabilized Percolation Rate (from graph) _____min/in.
Engineer's seal if applicable:_____
Name of person responsible for test results: _____
Address: _____
Phone Number:_____.

## STABILIZED PERCOLATION RATE DETERMINATION BY GRAPHICAL METHOD

Fill in the percolation test data sheet information and measurements. The columns (7) and (8) require no new measurements but simply require the addition and subtraction of data found in previous columns. For all percolation test runs beyond the first approximate value of $\triangle/p\ \triangle t$ can be obtained by dividing the change in percolation time for two sequential runs by the average percolation time for the same two sequential runs. This is shown in the far right column (8)/(7). The first of the two plots is a plot of measured percolation rates (6) versus time interval (4). This provides a visual check in the field to determine whether the test is stabilizing. If the curve begins to flatten out, the test is proceeding as expectd. if it does not, the field engineer will know immediately that something is wrong.

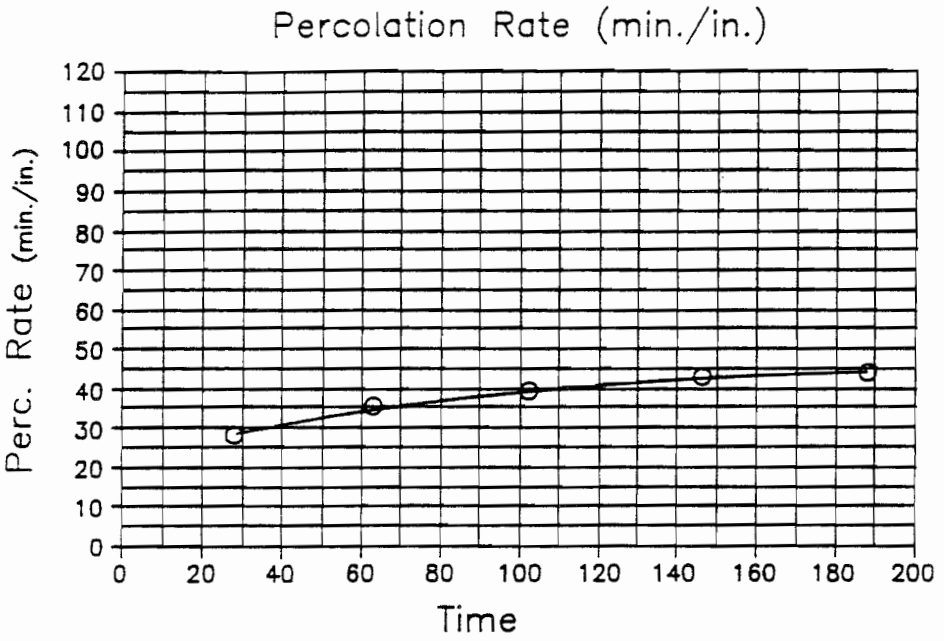
The second plot can be completed in the field or later at the office. The sequential values of $\triangle/p\ \triangle t$ (8)/(7), plotted against percolation rate (6) should define a linear relationship. This straight line plot when extrapolated to the horizontal axis will reveal a best estimate of the "stabilized" percolation rate

An example of this technique follows.

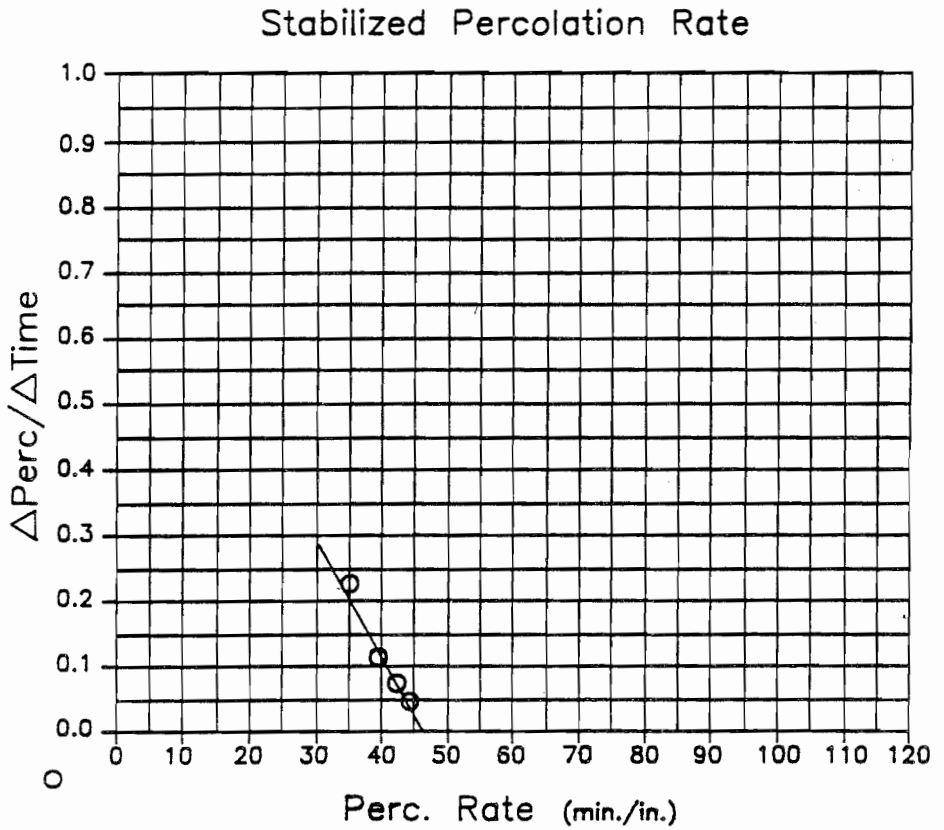
| Run # i (1) | Start time (2) | End time (3) | Elapsed Time $T_i$ (4) | Distance (in.) (5) | Perc. Rate (min./in.) (6) | $\frac{(T_i+T_{i+1})}{2}$, $\triangle$ T (min.) (7) | $P_{i+1}-P_i$, $\triangle$ P (8) | $\frac{\triangle P}{\triangle t}$ (8) / (7) |
|---|---|---|---|---|---|---|---|---|
| 1 | 8:00 | 8:28 | 28 | 1" | 28 | N.A. | N.A. | N.A. |
| 2 | 8:28 | 9:03 | 35 | 1" | 35 | 31.5 | 7 | .222 |
| 3 | 9:03 | 9:42 | 39 | 1" | 39 | 37.0 | 4 | .108 |
| 4 | 9:42 | 10:24 | 42 | 1" | 42 | 40.5 | 3 | .074 |
| 5 | 10:24 | 11:08 | 44 | 1" | 44 | 43.0 | 2 | .047 |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | |
| 10 | | | | | | | | |

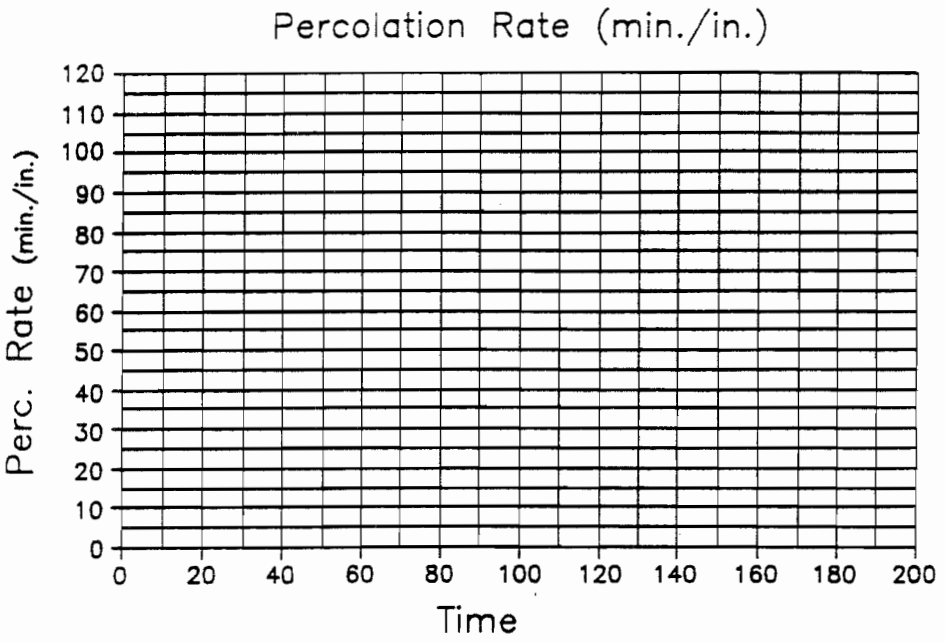
Stabilized Percolation Rate 46 (SEE GRAPH) min/inch.

**Example**

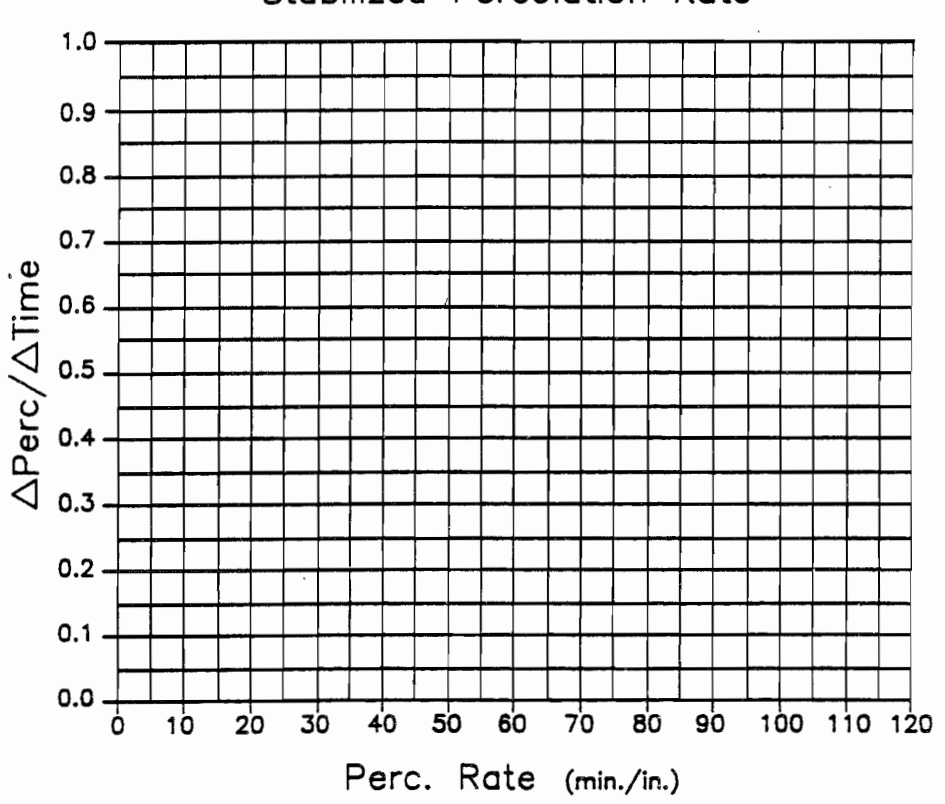



**Provide an appropriate time scale to display data.**






**Provide an appropriate time scale to display data.**



ATTACHMENT 5
MAG SPECIFICATIONS
SECTION 795

# LANDSCAPE MATERIAL

## 795.1 GENERAL:

Material used for landscaping purposes shall be in conformance with this section.

The common and scientific names of plants shall conform to the approved names in Standard Plants Names (SPN) or its successor, American Association of Nurserymen (ASN). For identification and inspection, durable, legible labels, bearing the plant's name in water-resistant ink, shall be attached to all nursery stock or containers of stock delivered to the project site.

## 795.2 TOPSOIL:

Topsoil shall be a fertile, friable soil, obtained from well-drained arable land, and shall be free from nut grass, refuse, roots, heavy clay, clods, noxious weeds or any other material toxic to plant growth. At least 10 days prior to delivery of topsoil to the site, the Contractor shall furnish the Engineer, at no additional cost, with a soil sample from each source for analysis and tests.

To be acceptable the pH factor shall not exceed 8.0 or be lower than 5.5, soluble salts shall not exceed 1,500 PPM, the plasticity index shall be in the range of 3 and 15 inclusive, and it shall contain approximately 1 1/2 %, by dry weight, of organic matter either natural or added. Gradation shall be in accordance with the table shown below:

| Sieve Size | Percent Passing |
|---|---|
| 1" | 100 |
| 1/2" | 95 - 100 |
| No. 4 | 90 - 100 |
| No. 10 | 70 - 100 |
| No. 200 | 15 - 70 |

### 210.3 PLACING AND COMPACTING:

Local borrow and imported borrow shall be placed and compacted as specified in Section 211.

The Contractor shall satisfy himself that there is sufficient space available in fill locations for placing any excavated material, before placing borrow. Any excess excavation which develops as a result of placing borrow in advance of completing excavations shall be disposed of by the Contractor at no additional cost to the Contracting Agency in accordance with the provisions in Section 205 and a corresponding reduction in the quantity of borrow to be paid for will be made, for which the Contractor will have no claim for compensation.

### 210.4 MEASUREMENT:

Quantities of borrow will be measured as specified for roadway excavation in Section 205.

Material excavated at the borrow site and not used on the work will be deducted from the computed quantities and will not be paid for.

### 210.5 PAYMENT:

Quantities of borrow excavation will be paid for at the contract unit price per cubic yard. Such price shall include excavating, sloping and cleaning of borrow area, hauling, depositing, spreading and compacting the material compete in place, and disposal of surplus material, unless an alternate basis of payment is stipulated in the proposal.

# SECTION 211
# FILL CONSTRUCTION

### 211.1 DESCRIPTION:

Fill construction shall consist of constructing embankments except as may otherwise be specified, including the preparation of the areas upon which they are to be placed; the construction of dikes; the placing and compacting of approved material within areas where unsuitable material has been removed, and the placing and compacting of material in holes, pits, and other depressions.

### 211.2 PLACING:

Rocks, broken concrete, or other solid materials, which are larger than 4 inches in greatest dimension shall not be placed in fill areas where piles are to be placed or driven.

When fill is to be made and compacted on hillsides or where new fill is to be compacted against existing fill or where embankment is built 1/2 width at a time, the slopes of original hillsides and old or new fills shall be benched a minimum of 4 feet horizontally as the fill is placed. A new bench shall be started wherever the vertical cut of the next lower bench intersects the existing ground. Material this cut out shall be recompacted along with the new embankment material by the Contractor at no additional cost to the Contracting Agency, unless the width of the bench required exceeds 4 feet, in which case the excavated material in excess of 4 feet will be measured and paid for as excavation.

Clods or hard lumps of earth of 6 inches in greatest dimension shall be broken up before compacting the

material in embankment, except as provided in the following paragraph:

When the fill material includes large rock material, or hard lumps, such as hardpan or cemented gravel which cannot be broken readily, such material shall be well distributed throughout the fill. Sufficient earth or other fine material shall be placed around the larger material as it is deposited so as to fill the interstices and produce a dense, compact fill. However, such material shall not be placed within 2 feet of the finished grade of the fill.

**211.3 COMPACTING:**

Fill shall be constructed in compacted layers of uniform thickness and each layer shall be compacted in accordance with the requirements herein specified with the following exception.

Where fills are to be constructed across low, swampy ground which will not support the weight of hauling equipment, the lower part of the embankment may be constructed by dumping successive loads of suitable material in a uniformly distributed layer of a thickness not greater than that necessary to support the equipment while placing subsequent layers, after which the remainder of the embankment shall be constructed in layers and compacted as specified.

Unless specified herein, or in the special provisions, the construction of dikes, the placing and compacting of approved material within the right-of-way where unsuitable material has been removed, and the filling of holes, pits and other depressions within the right-of-way, shall conform to all of the requirements herein specified for compacting fills. Trenches, holes, depressions and pits outside of areas where fills are to be constructed shall be graded to provide a presentable and well-drained area.

Areas over which fills are to be placed shall be cleared and scarified to a depth of 6 inches to provide a bond between the existing ground and the material to be deposited thereon. Unless otherwise specified, the original ground area upon which fills are to be constructed shall be compacted to a uniform density of not less than 95 percent.

The loose thickness of each layer of fill material before compacting shall not exceed 8 inches, except as provided in the following paragraph for rocky material. Each layer shall be compacted in accordance with the following requirements to a uniform density of not less than 90 percent, except that where a new or widened roadway and appurtenances are required, density of the upper 2 feet and when the fill is within 2 feet of the above, shall not be less than 95 percent.

When fill material contains by volume over 25 percent of rock larger than 6 inches in greatest dimension, the fill below a place 3 feet below finished grade may be constructed in layers of a loose thickness before compaction not exceeding the maximum size of rock in the material but not exceeding 3 feet in thickness.

The interstices around the rock in each layer shall be filled with earth or other fine material and compacted. Broken portland cement concrete and bituminous type pavement obtained from the project excavations will be permitted in the fill with the following limitation:

(A) The maximum dimension of any piece used shall be 6 inches

(B) Pieces larger than 4 inches shall not be placed within 12 inches of any structure.

(C) Pieces larger than 2 1/2 inches shall not be placed with 12 inches of the subgrade for paving.

(D) Nesting of pieces will not be permitted.

At the time of compaction, the moisture content of fill material shall be such that the specified relative compaction will be obtained and the fill be firm and unyielding. Fill material which contains excessive moisture shall not be compacted until the material is dry enough to obtain the required relative compaction. Full compensation to any additional work involved in drying fill material to the required moisture content shall be considered as included in the contract price paid and no additional compensation will be allowed therefore.

Embankments shall be constructed so that each layer shall have a cross fall of at least 2 percent but no more than 5 percent.

**211.4 TESTS:**

Unless otherwise provided in the plans or special provisions, the fill shall be thoroughly compacted to not less than the stated densities when tested and determined by AASHTO T-99, Method A, and T-191 or ASTM D-2922 and D-3017 with the percent of density adjusted in accordance with the rock correction procedure for maximum density determination, standard detail, to compensate for the rock content larger than that which will pass a No. 4 sieve.

**211.5 MEASUREMENT:**

The quantities of fill construction used to construct embankments or dikes will be those of the completed bid item, in place, within the limits of dimensions shown on the plans.

The Engineer will compute the quantities of fill by a method which in his opinion is best suited to obtain an accurate determination.

**211.6 PAYMENT:**

Quantities of fill construction will be paid for at the contract unit price per cubic yard of fill as stipulated in the proposal. Such price shall include placing and compaction and all related work as specified above, unless an alternate basis of payment is stipulated in the proposal.

Unless otherwise provided in the special provisions, no payment will be made for fill construction to replace unsuitable material or for fill for holes, puts, and other depressions. The cost thereof shall be included in the price bid for the construction of the items to which such fill is incidental or appurtenant.

# ATTACHMENT 7

## Chlorine Dosage Calculator *

**Instruction for use:** Select desired parts per million. Determine strength of solution to be used. Compute number of gallons to be chlorinated. Read across to where lines intersect to obtain quantity of material to be used.

| Desired PPM | 1 | 1 | 1 | 1 | 5 | 5 | 5 | 5 | 25 | 25 | 25 | 25 | 50 | 50 | 50 | 50 | 100 | 100 | 100 | 100 | 200 | 200 | 200 | 200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strength of chlorine solution | 5% | 25% | 70% | 100% | 5% | 25% | 70% | 100% | 5% | 25% | 70% | 100% | 5% | 25% | 70% | 100% | 5% | 25% | 70% | 100% | 5% | 25% | 70% | 100% |
| Gallons of water chlorinated 50,000 | 1 Gal | 1 lb 11 oz | 10 oz | 6.7 oz | 5 Gal | 8 lb 6 oz | 3 lb | 2 lb 2oz | 25 Gal | 41 lb 12 oz | 14 lb 15 oz | 10b 7 oz | 50 Gal | 83 lb 7 oz | 30 lb | 20 lb 14 oz | 100 Gal | 166 lb 13 oz | 59 lb 10 oz | 41 lb 12 oz | 200 Gal | 333 lb 10 oz | 119 lb 14 oz | 83 lb 7 oz |
| 25,000 | 2 Qt | 13.4 oz | 5 oz | 3.34 oz | 2.5 Gal | 4 lb 3 oz | 1 lb 8 oz | 1 lb 1 oz | 12.5 Gal | 20 lb 14 oz | 7 lb 7 oz | 5 lb 4 oz | 25 Gal | 41 lb 12 oz | 15 lb | 10lb 7 oz | 50 Gal | 83 lb 7 oz | 29 lb 13 oz | 20 lb 14 oz | 100 Gal | 166 lb 13 oz | 59 lb 10 oz | 41 lb 12 oz |
| 10,000 | 25.6 oz | 5.5 oz | 2 oz | 1.34 oz | 1 Gal | 1 lb 11 oz | 9.6 oz | 6.72 oz | 5 Gal | 8 lb 6 oz | 3 lb | 2 lb 2 oz | 10 Gal | 16 lb 11 oz | 6 lb | 4 lb 3 oz | 20 Gal | 33 lb 6 oz | 12 lb | 8 lb 6 oz | 40 Gal | 66 lb 12 oz | 23 lb 14 oz | 16 lb 11 oz |
| 5,000 | 12.8 oz | 2.8 oz | 1 oz | .61 oz | 2 Qt | 14 oz | 4.8 oz | 3.36 oz | 2.5 Gal | 4 lb 3 oz | 1 lb 8 oz | 1lb 1 oz | 5 Gal | 8 lb 6 oz | 3 lb | 2 lb 2 oz | 10 Gal | 16 lb 11 oz | 6 lb | 4 lb 3 oz | 20 Gal | 33 lb 6 oz | 11 lb 12.4 oz | 8 lb 6 oz |
| 2,000 | 5.12 oz | 1.1 oz | .4 oz | .26 oz | 25.6 oz | 6 oz | 1.92 oz | 1.35 oz | 1 Gal | 1 lb 11 oz | 9.6 oz | 6.68 oz | 2 Gal | 3 lb 6 oz | 1 lb 4 oz | 13.5 oz | 4 Gal | 6 lb 11 oz | 2 lb 62 oz | 1 lb 11 oz | 8 Gal | 13 lb 6 oz | 4 lb 12.4 oz | 3 lb 6 oz |
| 1,000 | 2.56 oz | .55 oz | .2 oz | .14 oz | 12.8 oz | 3 oz | .96 oz | .68 oz | 2 Qt | 13.6 oz | 4.8 oz | 3.34 oz | 1 Gal | 1 lb 11 oz | 9.6 oz | 6.72 oz | 2 Gal | 3 lb 6 oz | 1 lb 3.1 oz | 13.5 oz | 4 Gal | 6 lb 11 oz | 2 lb 6.2 oz | 1 lb 11 oz |
| 500 | 1.28 oz | .28 oz | .1 oz | | 6.4 oz | 1.4 oz | .48 oz | .34 oz | 1 Qt | 6.72 oz | 2.4 oz | 1.67 oz | 2 Qt | 13.5 oz | 4.8 oz | 3.36 oz | 1 Gal | 1 lb 11 oz | 9.54 oz | 6.72 oz | 2 Gal | 3 lb 6 oz | 1 lb 3.1 oz | 13.4 oz |
| 200 | .512 oz | .11 oz | | | 2.56 oz | .56 oz | .2 oz | .14 oz | 12.8 oz | 2.68 oz | .96 oz | .68 oz | 25.6 oz | 5.4 oz | 1.92 oz | 1.35 oz | 51.2 oz | 10.7 oz | 3.82 oz | 2.67 oz | 102.4 oz | 1 lb 6 oz | 7.64 oz | 5.34 oz |
| 100 | .256 oz | | | | 1.28 oz | .28 oz | .1 oz | .07 oz | 6.4 oz | 1.35 oz | .48 oz | .34 oz | 12.8 oz | 2.7 oz | .96 oz | .68 oz | 25.6 oz | 5.3 oz | 1.91 oz | 1.35 oz | 51.2 oz | 10.7 oz | 3.82 oz | 2.67 oz |
| 50 | .13 oz | | | | .64 oz | .14 oz | | | 3.2 oz | .68 oz | .24 oz | .17 oz | 6.4 oz | 1.4 oz | .48 oz | .34 oz | 12.8 oz | 2.72 oz | .96 oz | .68 oz | 25.5 oz | 5.4 oz | 1.91 oz | 1.34 oz |
| 25 | .064 oz | | | | .32 oz | | | | 1.6 oz | .34 oz | .12 oz | | 3.2 oz | .68 oz | .24 oz | .17 oz | 6.4 oz | 1.36 oz | .48 oz | .34 oz | 12.8 oz | 2.72 oz | .96 oz | .67 oz |
| 10 | .026 oz | | | | .128 oz | | | | .64 oz | .14 oz | | | 1.28 oz | .3 oz | .1 oz | | 2.56 oz | .56 oz | .192 oz | .14 oz | 5.12 oz | 1.12 oz | .384 oz | .27 oz |
| 5 | .013 oz | | | | .064 oz | | | | .32 oz | | | | .64 oz | .14 oz | | | 1.28 oz | .28 oz | .1 oz | | 2.56 oz | .56 oz | .192 oz | .14 oz |

* Materials used are as follows: 5%-sodium hyprochlorite (liquid) 25%-chlorinated lime (solid) 70%-calcium bypochlorite (solid) 100%-gaseous chlorine