**COMMONWEALTH OF PENNSYLVANIA**
**DEPARTMENT OF ENVIRONMENTAL PROTECTION**
**Bureau of Clean Water**

**DOCUMENT NUMBER:** XXX-XXXX-XXX

**TITLE:** Pennsylvania At-grade Absorption Area: Siting, Design and Construction Manual (Classification Type: <Number>)

**EFFECTIVE DATE:** Upon publication of notice as final in the *Pennsylvania Bulletin*

**AUTHORITY:** The Pennsylvania Sewage Facilities Act, 35 P.S. §§ 750.1-750.20, 25 Pa. Code Chapter 73

**POLICY:** To inform land owners, designers, builders and Sewage Enforcement Officers about Department of Environmental Protection (DEP) approved alternate technology on-lot sewage treatment and disposal systems available for use during planning and permitting. To improve and preserve the purity of the waters of the Commonwealth for the protection of public health, animal and aquatic life, and for recreation.

**PURPOSE:** To provide guidance to DEP staff and the public for the siting, design, construction, and operation of an at-grade Absorption Area component as part of an on-lot sewage system. This guidance replaces in its entirety the previous documents titled At-grade Absorption Area Alternate Technology (A2014-0019-0003) and Shallow Limiting Zone At-grade Absorption Area Alternate Technology (A2014-0025-0003).

**APPLICABILITY:** This policy applies to persons seeking to site and design the At-grade Absorption Area component for the treatment of domestic sewage. This guidance provides the minimum requirements for planning, construction, and permitting the component.

**DISCLAIMER:** The policies and procedures outlined in this guidance are intended to supplement existing requirements. Nothing in the policies or procedures shall affect regulatory requirements.

The policies and procedures herein are not an adjudication or a regulation. DEP does not intend to give this guidance that weight or deference. This document establishes the framework, within which DEP will exercise its administrative discretion in the future. DEP reserves the discretion to deviate from this policy statement if circumstances warrant.

**PAGE LENGTH:** 59 pages

# PENNSYLVANIA AT-GRADE ABSORPTION AREA: SITING, DESIGN AND CONSTRUCTION MANUAL

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# I. DEFINITIONS AND ACRONYMS

## A. Definitions

*5-day Biochemical Oxygen Demand* – The dissolved oxygen used by microorganisms in the biochemical oxidation of organic matter in a period of 5 days expressed in mg/l.

*Absorption area* – A component of an individual or community sewage system where liquid from a treatment tank seeps into the soil; it consists of an aggregate-filled area containing piping for the distribution of liquid and the soil or sand/soil combination located beneath the aggregate.

*Advanced secondary on-lot sewage pretreatment* – Level of pretreatment of sewage that achieves a reduction in the five-day Carbonaceous Biochemical Oxygen Demand ($CBOD_5$) and Total Suspended Solids (TSS) to a level at or below 10 mg/l, respectively.

*At-grade* – Located at or on the ground surface in the landscape, whether level or sloping.

*Carbonaceous 5-day Biochemical Oxygen Demand* – The concentration of oxygen utilized by microorganisms in the non-nitrogenous oxidation of organic matter during a period of 5 days at a temperature of 20ºC expressed in mg/l.

*Distribution system* - A network of pumps, pump and flow controls, piping, and aggregate that transport and disperse effluent through a sewage system.

*Fecal Coliform* – A facultatively anaerobic, rod-shaped, gram-negative, non-sporulating bacterium. Coliform bacteria generally originate in the intestines of warm-blooded animals. Bacteria concentrations are measured in most probable number of total coliform bacteria per 100 ml (MPN/100 ml).

*Groundwater mounding* - occurs when the localized groundwater surface may temporarily rise below an area of concentrated recharge. Mounding can occur in areas where infiltrating water intersects a groundwater table and the rate of water entering the subsurface is greater than the rate at which water moves away from the infiltration system.

*Hydraulic Linear Loading Rate* – It is a conceptual estimate of the maximum flow of effluent that a soil surrounding an effluent infiltration system can transmit away from the infiltration surface such that it no longer influences the infiltration of additional wastewater, expressed in gallons per day per foot (gpd/ft).

*Infiltration Loading Rate* – The peak daily flow of effluent applied per unit area of undisturbed soil, expressed in gallons per day per square foot (gpd/$ft^2$). It may also be referred to as the basal loading rate or the soil infiltration loading rate.

*Limiting zone* – A soil horizon or condition in the soil profile or underlying strata which includes one of the following:

1. A seasonal high water table, whether perched or regional, determined by direct observation of the water table or indicated by soil mottling (redoximorphic features).
2. Rock with open joints, fractures or solution channels, or masses of loose rock fragments, including gravel, with insufficient fine soil to fill the voids between the fragments.
3. A rock formation, other stratum or soil condition which is so slowly permeable that it effectively limits downward passage of effluent.

*On-lot sewage system component* – Any subsection or component of an on-lot sewage system such as a building sewer (collection system), treatment tank(s), media filter(s), dosing tank, disinfection system, equalization tank(s), absorption area(s), or any component necessary for an on-lot sewage system to function properly.

*Original ground surface* – The natural, unaltered land surface; also referred to as existing grade.

*Seasonal high water table* –– The part of the soil profile closest to the soil surface that becomes saturated (usually in the spring) as observed in a monitoring well or determined by recognition of soil redoximorphic features.

*Domestic sewage* – (referred to as "sewage" in this document) The untreated wastes consisting of blackwater and graywater from toilets, baths, sinks, lavatories, laundries, and other plumbing fixtures in places of human habitation, employment, or recreation.

*Shallow limiting zone* – A soil horizon or condition in the soil profile or underlying strata which includes one of the following:

1. A seasonal high water table between 10 and 20 inches below the mineral soil surface, whether perched or regional, determined by direct observation of the water table or indicated by redoximorphic features.
2. Rock with open joints, fractures or solution channels, or masses of loose rock fragments, including gravel, with insufficient fine soil to fill the voids between the fragments between 16 and 20 inches below the mineral soil surface.
3. A rock formation, other stratum or soil condition which is so slowly permeable that it effectively limits downward passage of effluent between 16 and 20 inches below the mineral soil surface.

*Soil infiltrative surface* – the surface soil where it interfaces with the base of the aggregate.

*Soil profile* – A vertical section of the soil, typically described from a test pit, from the ground surface downwards to where the soil meets the underlying rock and includes the natural organic layers on the surface.

*Test pit* - An excavated trench exposing a soil profile for visual observation and physical evaluation of the soil horizons and overall soil conditions, both horizontally and vertically at a location. Soil test pit is often referred to as a *Soil Probe*.

*Total Suspended Solids* – A measure of all suspended solids in a liquid, typically expressed in mg/l; to measure, a well-mixed sample is filtered through a standard glass fiber filter and the residue retained on the filter is dried to a constant weight at 217 to 221 degrees F (103 to 105 degrees C); the increase in the weight of the filter represents the amount of total suspended solids.

*Undisturbed soil* — An area of soil or soil profile, unaltered by removal, compaction or other man-induced changes, except for normal agricultural tillage operations, and excavation or scarification activities necessary for the permitted installation of a system.

B. Acronyms

| | | |
|---|---|---|
| $BOD_5$ | = | 5-day Biochemical Oxygen Demand |
| $CBOD_5$ | = | Carbonaceous 5-day Biochemical Oxygen Demand |
| DEP | = | Pennsylvania Department of Environmental Protection |
| FC | = | Fecal Coliform |
| HLLR | = | Hydraulic Linear Loading Rate |
| ILR | = | Infiltration Loading Rate |
| LZ | = | Limiting Zone |
| OAT | = | On-lot Alternate Technology |
| O&M | = | Operation and Maintenance |
| SEO | = | Sewage Enforcement Officer |
| SHWT | = | Seasonal High Water Table |
| SLZ | = | Shallow Limiting Zone |
| TSS | = | Total Suspended Solids |

## II. INTRODUCTION

### A. At-grade On-lot Alternate Technology

This technical guidance document provides the general requirements for design, planning, construction, and permitting of the At-grade absorption area (component) On-lot Alternate Technology (OAT). This approval document prepared by the Department of Environmental Protection (DEP) is the basis for the Sewage Enforcement Officer's (SEO's) review and approval of the At-grade component in accordance with 25 Pa. Code § 72.43. Planning and permitting proposals that do not conform to the requirements in this DEP approval document will be denied.

The DEP-approved At-grade component, as described in this document, can be used for on-lot treatment and disposal of domestic sewage. The At-grade component is approved for use in planning for new land development and for repair of malfunctioning systems. It can be used with primary treated effluent on sites with a depth to limiting zone (LZ) of 48 inches or greater and on sites with a shallow limiting zone (SLZ) by including additional treatment components. A typical At-grade system consists of five major components: building sewer, primary treatment tank, secondary treatment unit, dosing tank, and an At-grade absorption area. All At-grade systems use low pressure distribution to disperse effluent into the absorption area; gravity feed distribution systems are not permitted.

With an At-grade system, the domestic sewage first travels from the house through the building sewer into the primary treatment tank, which is either a septic or aerobic digestion tank. Second, the effluent leaves the primary tank and receives filtration and/or advanced treatment in the secondary treatment unit(s). The type of secondary treatment required is dependent on the depth to the soil LZ. Next, the dosing tank receives the pretreated effluent and a set volume (dose) is pumped under low pressure to the absorption area. Finally, the At-grade absorption area component disperses the effluent across the soil infiltrative surface for final treatment and assimilation into the subsurface environment.

The At-grade component is an absorption area that is constructed to receive effluent at the advanced, secondary, or primary pretreatment levels depending on the depth of the mineral soil to a LZ. Figure 1 shows a typical cross-section of the At-grade component. The main difference between an At-grade sewage system and other on-lot systems is that the At-grade component (gravel aggregate and dispersal piping) is constructed directly on top of chisel plowed soil at the original ground surface, instead of placing it on a bed of sand or in the bottom of an excavation.

These DEP-approved generic At-grade OAT criteria are based on the studies conducted by researchers at the University of Wisconsin - Madison within the *Small Scale Waste Management Project*, (Converse et al. 1988 and 1990, Converse 1999). The WI researchers successfully tested the performance of the proposed At-grade bed technical design on several sites and published their results in Converse et al. 1991, Converse et al. 1998, and Converse et al. 1999. Many other states have published field studies and approved technology design manuals for the At-grade Absorption Area since the component was first developed in the early 1980s.

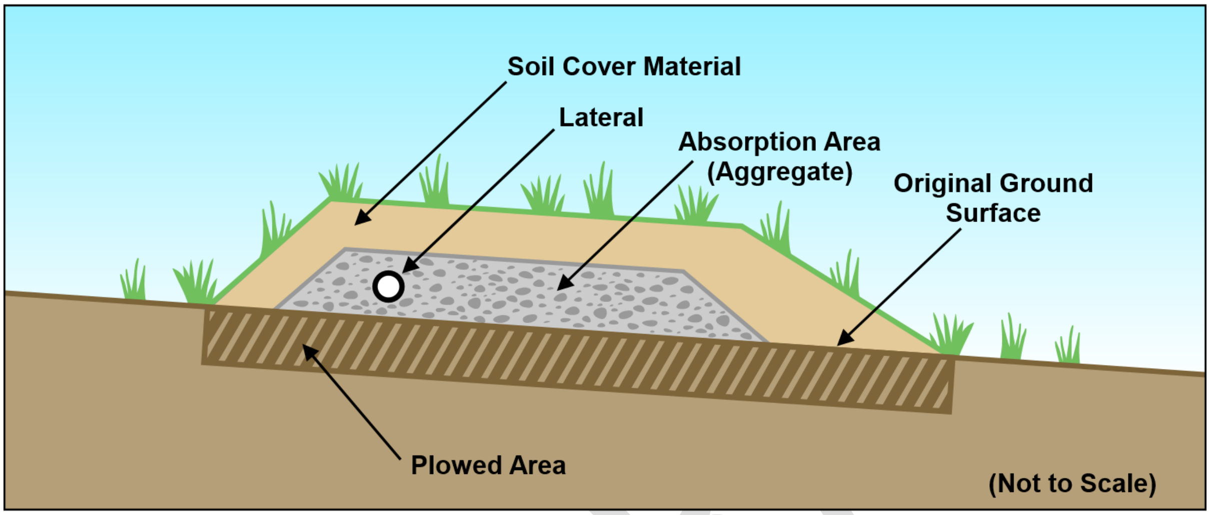
B. Regulatory Authority

Title 25, Chapters 71, 72, and 73 provide for the use of conventional sewage systems for the planning, siting, construction, and operation of on-lot sewage systems and components on sites with suitable soil. On sites where conventional on-lot sewage systems cannot be sited under the Act, such as those with SLZs, there were limited or no options for the SEO to permit conventional systems. This OAT provides a means for development of sites that are unable to support a conventional system. The Department may delegate the permit review and permit approval of OATs to SEOs who have been qualified by the Department in accordance with 25 Pa.§ Code 72.43(l).

DEP classifies a system as an OAT in accordance with 25 Pa. Code § 73.72. This classification is a state-wide approval stating that the specific technology meets the DEP’s requirements for classification as an alternate technology. For an alternate technology to be approved to disperse effluent onto soil with a SLZ, DEP will establish whether the level of pretreatment provided by the OAT is sufficient to allow for safe disposal on a site with shallow limiting zones.

Therefore, in accordance with Title 25, Chapter 73, Section 73.72, DEP classifies the At-grade absorption area for use as an OAT absorption area component that is capable of receiving sewage effluent at three different levels of pretreatment (advanced secondary, secondary, and primary).

**Figure 1. A cross-section of the At-grade component**




## III. GENERAL, SITE, AND SOIL REQUIREMENTS

### A. General Requirements

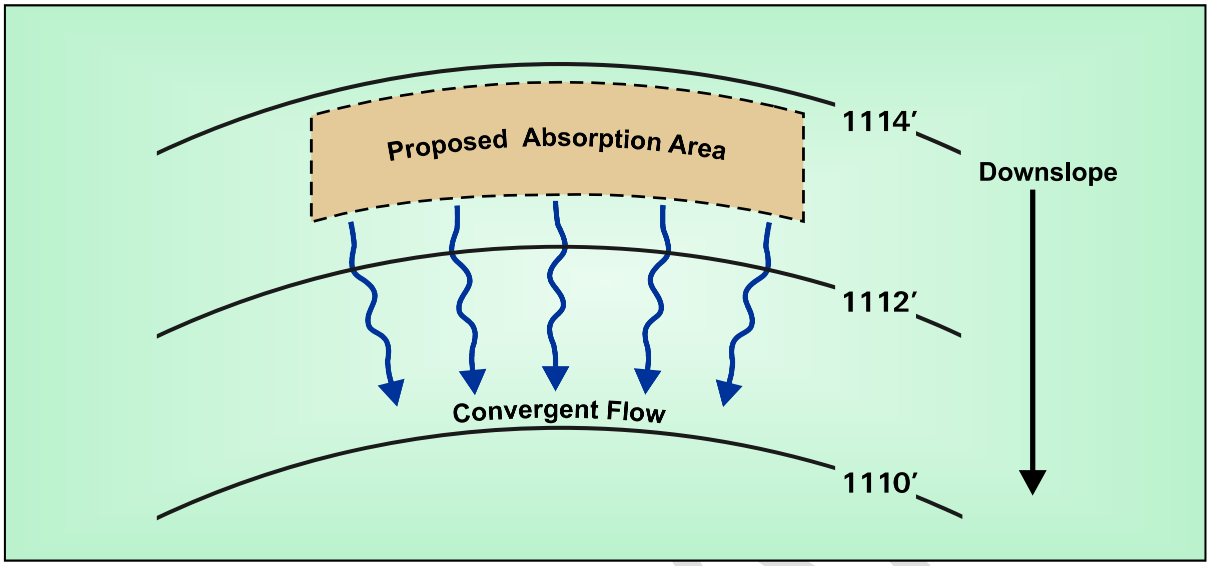
1. The At-grade absorption area component may be installed for the treatment of domestic strength sewage. Concentrations and mass loading rates of common constituents found in domestic wastewater are listed in Appendix C for reference.
2. Septic tank installation shall consist of a two-compartment rectangular tank, or two rectangular tanks in series, or otherwise conform to meet the requirements of 25 Pa. Code § 73.31. Vertically aligned circular (round) tanks are not permitted.
3. Aerobic treatment tank installation shall be in compliance with 25 Pa. Code § 73.32. A Department permit is required for peak design flows in excess of 1,500 gallons per day (gpd).

### B. Site Requirements

1. Sites shall meet the minimum horizontal isolation distances as per Title 25 Pa. Code § 73.13.
2. The maximum slope of the original ground surface across the absorption area including the berm should not exceed 15%. The slope should be measured at the steepest portion of the proposed absorption area. The slopes between 0 and 15% are subdivided in three ranges (0-4%, 5-9%, and 10-15%), each range will have a different hydraulic linear loading rate based on the criteria listed in the Infiltration and Hydraulic Linear Loading Rates table in Appendix A.

3. The length of absorption area shall be placed on contour. No other orientation is acceptable.
4. Location of the At-grade Absorption Area:
    a. To increase the effects of evaporation and transpiration on the assimilation of effluent, locations with sun exposure and little to no shade are preferable;
    b. Siting At-grade absorption areas on slopes greater than 4% and not exceeding 15% allows for both vertical and subsurface lateral movement of the effluent away from the soil infiltrative surface beneath the aggregate. The lateral flow component increases as the ratio of vertical hydraulic conductivity to the horizontal hydraulic conductivity decreases.
    c. On slopes not exceeding 4% the flow generally moves downward and outward in all directions instead of downward and downslope away from the component. Therefore, use caution when siting At-grade absorption areas on soils with a SLZ because it may cause groundwater mounding beneath the absorption area. Additional soil testing may be requested by the Department to determine if the site will be able to sufficiently renovate and hydraulically disperse the effluent.
    d. The At-grade on sites with at least 48 inches of suitable soil can receive primary treated effluent, sites with shallower depth to a limiting condition will require additional pretreatment, including disinfection on SLZ sites.
    e. The shape of the landform along the contour (perpendicular to slope) should not be concave if the slope is between 0-4% (see Figures 2). At-grade absorption areas are allowed on sites with slopes exceeding 4% with concave-shaped contours if the maximum deflection of the at-grade component does not exceed 10% (see Figure 5; Section IV.B for calculation of deflection);
    f. Placement in swales, depressions, sinkholes, floodways, or any topographic position that could concentrate subsurface flow or be inundated by overland flow is unacceptable;
    g. Placement of the absorption area or berms over bedrock outcrops is not allowed;
    h. Sites with more than 20% of the absorption area occupied by trees and/or large rocks should be avoided. Sites requiring minor tree or boulder removal can be cleared as follows:
        i. If trees need to be removed, cut the tree trunk off flush with the original ground surface, with the roots left in place, and remove the cut vegetation. If rocks can be easily removed from the surface without disturbing any of the soil in or around the absorption area, they should be removed.
        ii. Measure and total the square footage of the combined area of all tree stumps and remaining large rocks. This square footage will need to be added to the overall size of the absorption area. See Appendix F to perform the calculations.

**Figure 2. Concave contour site conditions**






C. Soil Requirements

1. At-grade absorption areas shall be sited on undisturbed soil.
2. A *qualified soil scientist* must perform all soil morphological testing. A *qualified soil scientist* is:
   a. A person certified as an SEO **<u>and</u>**;
   b. A person with documented 2 years' experience in the characterization, classification, mapping and interpretation of soils as they relate to the function of on-lot sewage systems **<u>and</u>**
   c. One of the following:
      1. A Bachelor of Science Degree in Soils Science from an accredited college or university;
      2. A current certification by the Soil Science Society of America;
      3. A current full professional member of the Pennsylvania Association of Professional Soil Scientists.
3. An area downgradient from the absorption area, as specified by the soil scientist, must be protected during testing, construction, and for the life of the system. Compaction or disruption of the soil in this area may alter the lateral flow of effluent and cause system failure.
4. The vertical isolation distance from the top of the undisturbed mineral soil surface to the top of the LZ shall be used to determine the type of At-grade system that can be sited.
5. There are five different limiting zone classifications suitable for At-grade systems, which require different levels of sewage pretreatment based on the depth to the LZ and the type of LZ.
6. SLZ At-grade components shall meet the vertical isolation distances listed below:
   a. a SHWT between 10 and 20 inches below the mineral soil surface, whether perched or regional, determined by direct observation of the water table, or indicated by redoximorphic features and, or;

b. rock with open joints, fractures or solution channels, or masses of loose rock fragments, including gravel, with insufficient fine soil to fill the voids between the fragments between 16 and 20 inches below the mineral soil surface or;

c. rock formation, other stratum or soil condition which is so slowly permeable that it effectively limits downward passage of effluent between 16 and 20 inches below the mineral soil surface.

7. Table 1 lists the level of effluent pretreatment required for two ranges of infiltration loading rates (ILR) based on the five LZ classifications.

8. Table 2 lists the standard maximum concentrations required for each level of pretreatment. The system components should be able to achieve the standards in Table 2 prior to discharging effluent to the absorption area.

9. Reductions in absorption area not allowed for any At-grade system.

10. When testing is being completed for new land development, primary and replacement absorption areas should be identified and preserved for all sites with LZs less than 20 inches, and as required by the local agency.

11. A soil morphological report prepared by a *qualified soil scientist* is required and should be thorough and concise. The primary function of the report is to evaluate site soil to determine the depth to a LZ, if one exists, and to identify the texture and structure of the restrictive soil horizon to be used for the design of the absorption area. The report should include, at a minimum, the following items:

   a. General Information such as project name, project location, date of investigation(s), narrative of relative site conditions and interpretive information collected during the desk-top site evaluation and the field investigation.

   b. Maps and plot plans with all site features listed in the regulations under § 73.13 (referring to horizontal isolation distances), the location of all utilities, all test pits (numbered) noting the slope at each pit, any wetlands, and soil survey data with all soil series labeled.

   c. The proposed absorption area should be drawn to scale and include the berm. The steepest slope of the undisturbed soil, to the extremities of the berm, of the proposed absorption area should be indicated in the report and on the plot plan and shall be used to design the at-grade component.

   d. All maps and plot plans should be to scale, provide a legend, graphic scale, north arrow and have contour lines covering the entire subdivision. Contour lines over the proposed absorption area should be at a two-foot interval or less.

   e. A minimum of four (4) soil test pits (see Figure 3) shall be excavated for each proposed absorption area. Each soil profile will be evaluated to verify the soil morphology independently:

      i. At least two soil profile evaluations on contour, on the upslope side of the proposed absorption area;

      ii. At least two soil profile evaluations on contour downslope of the proposed absorption area with the downslope distance determined by the soil scientist;

      iii. The test pits described in §III.C.11.e.i. (above) shall be dug outside the proposed absorption area, but within 10 ft from the end of the absorption area.

f. The soil profiles must be placed on-contour and the probes cannot be spaced more than 100 feet apart. In cases where soil conditions suggest an absorption area length will exceed 100 ft, additional test pits are required to verify the soil morphology of both the absorption area and the downslope area. The furthest pits should bracket the entire length of the proposed absorption area, or in other words, the absorption area needs to be enclosed within the upslope test pits.

g. Additional soil profiles may be required to verify the soil morphology of both the absorption area and the downslope area in finer textured soils or when higher flow rate projects result in longer length absorption beds.

h. Caution must be used to avoid placing soil test pits in the proposed absorption area. The Department may consider the site disturbed if test pits are placed inside the proposed absorption area. The use of hand augers or other method that minimizes disturbance of the soil before siting the proposed absorption area, and subsequent test pits is recommended.

i. All soil profile descriptions should be documented in detail on a soil test pit description log (see Appendix G). All depth measurements shall be made from the top of the mineral soil surface and recorded in inches staring with zero (0) as the reference point. Include the following in the description for each horizon:
   i. horizon designations (master, suffix);
   ii. horizon boundary depth;
   iii. boundary conditions (distinctness and topography);
   iv. color of the soil matrix and redoximorphic features (Munsell);
   v. texture (USDA);
   vi. rock fragment modifier;
   vii. redoximorphic features (type, abundance, size, and contrast);
   viii. structure (grade, size, and type) and;
   ix. moist consistence.

j. Observe the entire test pit and describe the most conservative soil profile (area with shallowest depths to master horizons with a LZ).

k. All measurements to the top of master horizons with an LZ must be taken from the shallowest point (i.e. top of a wavy boundary).

l. The soil report should explain why the At-grade Absorption Area component was selected for the site, the assigned HLLR, ILR and the sufficient area and dimensions (L and W) for an absorption area.

m. The soil report should identify and offer recommendations to address site conditions (i.e. stoniness, vegetation, surface drainage, site preparation, etc.) that could affect the design and/or the field investigation.

n. Signature of the *qualified soil scientist* (as defined above in this section) certifying the contents of the soils report.

**Figure 3. Soil test pit locations**

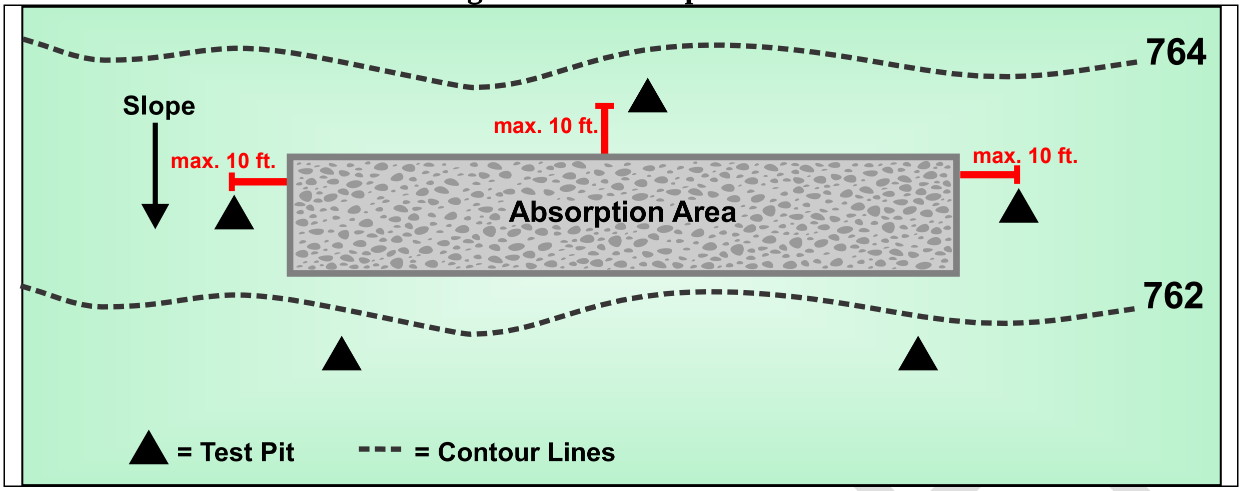



**Table 1. Effluent pretreatment levels based on the soil limiting zone classification**

| Depth to limiting zone below the mineral soil surface (in.) | Pretreatment Levels (ILR > 1.0 gpd/ft$^2$) | | Pretreatment Levels ($0.2 \leq$ ILR $\leq 1.0$ gpd/ft$^2$) | |
|---|---|---|---|---|
| | **$BOD_5$/TSS** | **FC** | **$BOD_5$/TSS** | **FC** |
| SLZ* with a SHWT ≥ 10 and <12 | AS | FC-4 | AS | FC-3 |
| SLZ*w or w/o SHWT ≥ 12 and < 20 | AS | FC-3 | AS | FC-2 |
| LZ ≥ 20 and < 48 | AS | FC-2 | AS | FC-1 |
| LZ ≥ 48 and < 60 | S | N/A | P | N/A |
| LZ ≥ 60 | P | N/A | P | N/A |
| SHWT = Seasonal High Water Table; FC = Fecal Coliform concentration; P = Primary; S = Secondary; AS = Advanced Secondary; * see definition for *shallow limiting zone.* | | | | |

**Table 2. Pennsylvania On-lot Sewage System Performance Standards**

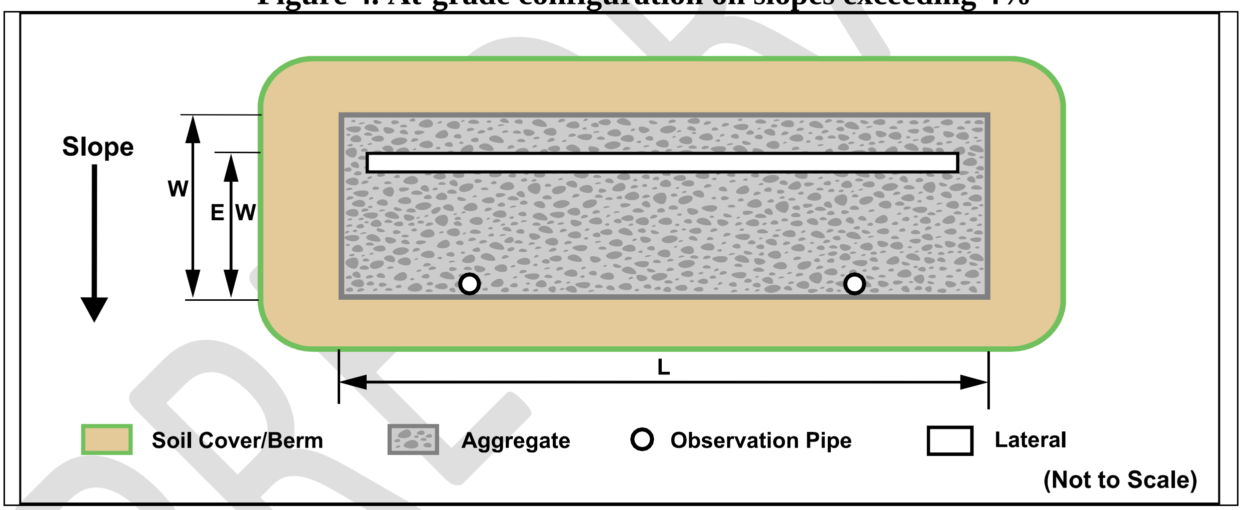
| **Level of Pretreatment** | **$CBOD_5$ Maximum Concentration** (mg/l) | **TSS Maximum Concentration** (mg/l) |
|---|---|---|
| Primary | ≤125 | ≤80 |
| Secondary | ≤25 | ≤30 |
| Advanced Secondary | ≤10 | ≤10 |
| **Level of Pretreatment** | **Fecal Coliform Maximum Concentration** (MPN/100ml) | |
| FC-1 | ≤50,000 | |
| FC-2 | ≤1000 | |
| FC-3 | ≤200 | |
| FC-4 | ≤1 | |

# IV. ABSORPTION AREA DESIGN

The design of an At-grade Absorption Area component is based on the peak daily flow and site soil characteristics. The size of the absorption area must be sufficiently large to absorb and treat the effluent without causing surface seepage or contamination of the groundwater. The At-grade component should receive the effluent by means of a low pressure distribution system. The distribution system components (dosing tank and piping network) should provide equal distribution of the effluent along the length of the absorption area. A professional engineer is required to design the system when multiple At-grade Absorption Areas (i.e. split absorption area) are necessary.

Once the qualified soil scientist has determined that the soil and site conditions are suitable for an At-grade system, one of the three design procedures listed below (A, B, or C) shall be implemented based on the slope and shape of the landform. Step-by-step calculations are presented below for the three design procedures: A) sites with slopes between 4% and 15%; B) sites with slopes between 4% and 15% with concave contours; and C) sites with slopes less than 4%.

**Figure 4. At-grade configuration on slopes exceeding 4%**



A. Design procedure for sites with slopes greater than 4% and not exceeding 15% without concave contours (see Figure 4):

1. Determine the *peak daily flow* (*PDF*) for the facility in gallons per day as per Title 25 Pa. Code § 73.17.
2. From the soil morphological report, identify the limiting soil characteristics (texture and structure), indicated by the *qualified soil scientist*. This determination should be made based on the test pit with the most restrictive LZ to design the At-grade Absorption Area.
3. Using Appendix A, locate the soil texture and structure of the limiting horizon in the left column and follow across the row to select the *infiltration loading rate* (*ILR*) based on the required level of treatment.
4. Calculate the *minimum aggregate area (Min. Area)* in square feet; this is where the aggregate will cover the soil infiltrative surface:

$$Min.\ Area = {}^{PDF}/_{ILR}$$

5. Using Appendix A , follow the row with the limiting soil texture and structure and select the *hydraulic linear loading rate (HLLR)* based on the slope of the site and depth to the LZ.
6. Determine the *effective width* (*EW)* of the aggregate area. This value should be calculated with the following equation and rounded up to the nearest whole number:

$$EW = {}^{HLLR}/_{ILR}$$

   *EW* equals the distance from the distribution pipe to the toe of the aggregate.

7. Determine the minimum *length (L)* of the absorption area. This value should be calculated with the following equation and rounded up to the nearest whole number:

$$L = {}^{PDF}/_{HLLR}$$

8. Determine the *effective absorption area EA*, in square feet, by multiplying *EW* and *L*.

$$EA = EW \times L$$

   The effective absorption area shall be at least equal to the minimum aggregate area.

$$EA \geq Min.\ Area$$

9. Design of the entire At-grade *aggregate area*:
   a. The *total width (W)* of the aggregate will be greater than *effective width of the aggregate area* and should not exceed 15 ft. Two additional feet of aggregate are required on the upslope edge of the effective absorption area:

$$W = EW + 2ft$$

   b. A 2:1 slope shall be maintained on all sides of the aggregate. Aggregate area is measured from the top of the aggregate bed inside of the sloping sides. Extra aggregate will be needed to create the 2:1 sloped sides. Therefore, the absorption area footprint will be larger than the actual *EA*.

10. The At-grade Absorption Area shall be surrounded by a berm consisting of mineral soil containing less than 20% coarse fragments with no coarse fragments greater than 4 inches in diameter and lightly compacted during construction to contain and protect the absorption area interior. The width of this berm shall be a minimum of 3 feet at the top of the aggregate, as specified in Section 73.55(b)(7).
11. Upon completion, the outside slope of the berm on slopes of 8% or less may be no greater than 2:1, on slopes of 8% to 12% the outside slope of the berm shall be no greater than 3:1. On sites with slopes ranging 12% to 15%, the outside slope of the berm may be no greater than 4:1 downslope and no greater than 3:1 upslope, with the downslope berm no greater than 4:1.
12. The cover over the aggregate shall be a minimum of 12 inches of soil suitable for the growth of vegetation and shall be seeded immediately following construction to assure the stability of the berm. Specifications for the soil cover material is discussed below in section IV. F.
13. Design requirements for the pressure distribution system shall conform to the requirements described in Appendix B. Pressure distribution systems dispersing primary treated effluent to the aggregate area shall have a minimum orifice size of ¼ inch.

B. Design procedure for sites with slopes greater than 4% and not exceeding 15% with concave contours (see Figure 5):

1. This procedure is to determine if a concave-shaped absorption area design can be built as a *percent deflection (%D)* not exceeding 10%. Designs resulting in %*D* greater than 10% are not allowed.

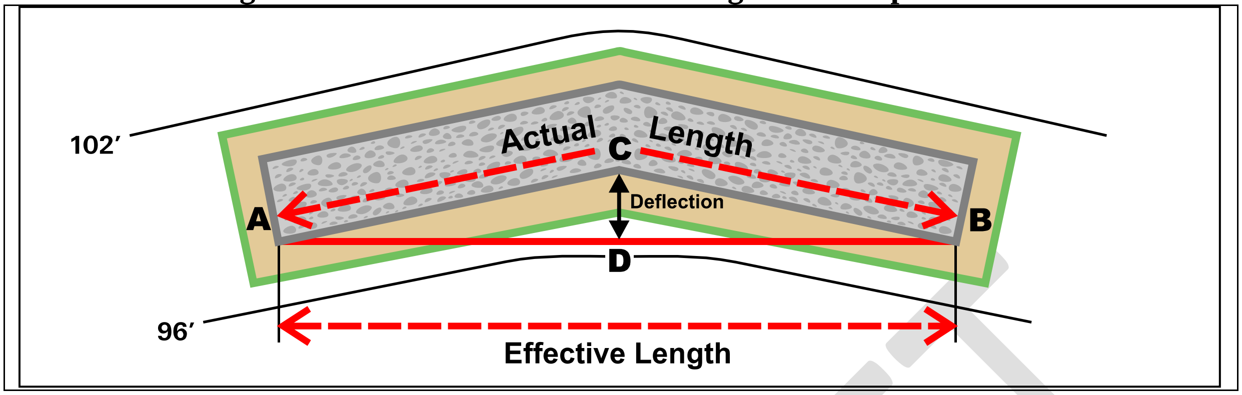
2. Follow steps A.1 through A.7 above to determine the *Min. Area* of the aggregate, the *EW* and the *L* of the absorption area. Then, follow the steps below to determine the percent deflection of the concave contour design:

   a. Measure the *effective length* (*EL*) of the absorption area. The *EL* of the absorption area is the distance between the points A and B in Figure 5. Points A and B represent the down slope corners of the concave aggregate area.
   b. Measure the distance between points C and D in Figure 5. This distance is called deflection and it is defined as maximum distance between the down slope edge of a concave absorption area to the length of a perpendicular line that intersects furthest points (A and B) of the contour line along the down slope edge of the absorption area.
   c. *%D* is calculated with the following equation:

$$\%D = 100 * \left[\frac{distance\ between\ C\ and\ D}{distance\ between\ A\ and\ B}\right]$$

   d. Verify that *%D* does not exceed 10%.

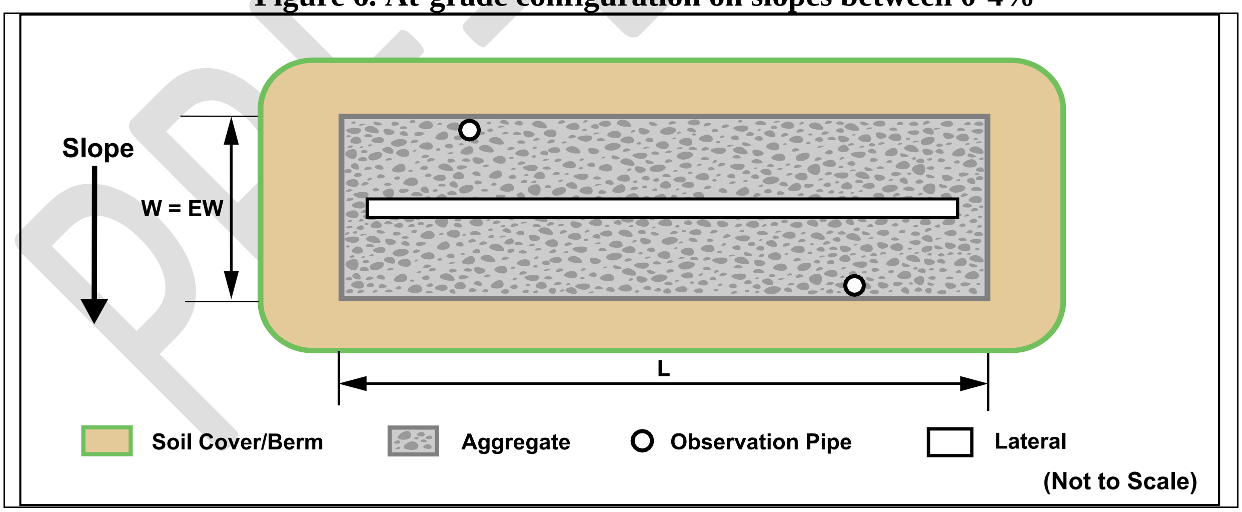
**Figure 5. Deflection of the concave at-grade absorption area**




C. Design procedure for sites with slopes between 0 and 4% (see Figure 6):

1. Concave sites are not allowed.
2. Follow steps A.1 through A.7 above to determine the *Min. Area* of the aggregate, the *EW* and the *L* of the absorption area.
3. On slopes between 0-4%, *EW* equals the *total width* (*W*) of the aggregate.
4. Determine the effective absorption area, in square feet, by multiplying *W* and *L*. This area shall be at least equal to the minimum aggregate area and represents the entire At-grade Absorption Area.
5. Follow steps A.10 through A.13 for design requirements of the pressure distribution system and of the sides slope of the aggregate, soil berm construction, and soil cover.

**Figure 6. At-grade configuration on slopes between 0-4%**




D. Laterals

Once the ILR is assigned, the minimum required absorption area can be determined. Converse et al. (1990) propose that the width of the absorption area should be based on the

HLLR. This rate is greater for deep permeable soils than for shallow zone of permeable soil over less permeable soil.

Based on the table in Appendix A, the HLLR is always less than 10 gpd/ft to avoid excessively wide absorption area even when the flow away from the system is primarily vertical. On the contrary, HLLR should not exceed 3-4 gpd/ft for shallow zone with permeable soil over a limiting zone with flow primarily horizontal, this will result in absorption areas narrow and long.

Therefore, the Wisconsin researchers do not recommend absorption areas wider than 10-15 ft for the following reasons:

1. Greater widths may cause compacting of the infiltrative surface during construction.
2. Narrow widths will increase the oxygen flux to the infiltration surface.

To increase the oxygen flux to the infiltration surface, the system design needs to be manipulated in a way that the infiltration unit is long and thin. Therefore, narrow widths and multiple infiltration areas can help maximize the oxygen supply (Erickson et al., 2000).
It is very important to have sufficient oxygen entering the system because the chemical reaction in the soil, that decompose organic matter, requires sufficient oxygen. A clogging mat will form between the gravel and the infiltration surface, if the system cannot meet the oxygen demand.

Table 3 shows the suggested number of laterals based on the width of absorption area.

**Table 3. Width and Number of Lateral Pairs**

| Width (ft) | # lateral pairs |
|---|---|
| < 7 | 1 |
| ≥7 and ≤ 15 | 2 |

E. Aggregate Specifications

1. All aggregate, including alternate aggregates, used in the distribution system shall meet the specifications described in Pennsylvania Department of Transportation, Publication 408, Section 703.2. The size and grading of the aggregate shall meet AASHTO No. 57 requirements from a Pennsylvania Department of Transportation (PADOT) certified stockpile and shall be Type A or Type B quality requirements.
2. All aggregate testing shall be conducted within 1 year prior to the delivery date.
3. The minimum amount of coarse aggregate should be 10 inches as follows:
   a. A minimum of 6-inch layer of aggregate beneath the lateral;
   b. A minimum of 2-inch layer of aggregate on each side of lateral;
   c. A minimum of 2-inch layer over the lateral.

4. The aggregate shall be placed beneath the laterals so that they are level. A 2:1 slope shall be maintained on all sides of the aggregate.
5. When placing the aggregate, work from the upslope edge of the system.

F. Cover material

The cover material should be fertile soil with less than 20% gravel by volume and no rock fragments greater than 4 inches diameter. The cover over the aggregate shall be a minimum of 12 inches of soil suitable for the growth of vegetation to prevent erosion, promote runoff, and promote gas exchange with the absorption area below the soil cover. Soil finer than silt loam is not recommended. It shall be seeded to assure the stability of the berm and maintain vegetative cover.

## V. CONSTRUCTION PROCEDURES

A. Prior to the construction of the system, a permit shall be obtained from the local agency SEO and posted in a visible location on the site.
B. An on-site conference attended by the SEO, designer, installer, and the property owner prior to construction is recommended.
C. Great care shall be used when constructing the At-grade component to avoid soil compaction, which could lead to future failure of the system. It is advisable to monitor the weather and plan construction to avoid possible precipitation events. Compaction of the soil shall be avoided. The soil shall be plowed when the moisture content is low, and the ground is not frozen. The area around the At-grade component should be roped off and all traffic prevented from entering the area, except lightweight equipment, preferably tracked, to mow and plow the area as described in the sections below.
D. Determine the moisture content of the soil at 8 inches or at the plow depth, whichever is greater. If the soil sample is too wet, stop the construction and wait until it dries. To check the soil field moisture:

1. Collect a representative handful of soil from the area to be plowed;
2. Squeeze the soil together and then open your hand;
3. Gently bounce the soil in your hand or tap it with your finger:
    a. If the soil clod crumbles in your hand or breaks up immediately when bounced or tapped with your finger, the soil moisture should be acceptable for working.
    b. If the sample sticks together, construction should be postponed.

E. Immediately after plowing, a uniform depth of 6 inches of aggregate shall be applied above the original grade. The aggregate shall be placed from the upslope side of the bed using only lightweight equipment. Under no circumstance may equipment travel on the plowed soil surface until the aggregate is in place.
F. Equipment that will not compact the At-grade area and the down slope area, such as track type tractors, are required:

1. All vehicular traffic is prohibited on the plowed area;
2. On slopes exceeding 4%, vehicle traffic is prohibited for 15 ft down slope;
3. On slopes between 0-4%, vehicle traffic is prohibited for 10 ft on both sides;
4. Stop construction if it rains on the plowed area and resume work only when the soil dries and contact the local agency SEO to inspect any damage that may have been caused by the rainfall, such as erosion;
5. Construction of this system must comply with Chapter 73, Section 73.51(b).

G. Lay out the entire At-grade component absorption area on the site so that it is level and on contour.

H. On a sloping site with concave contours, confirm that construction of the aggregate area will not exceed a percent deflection of 10% .

I. Determine where the force main from the dosing chamber will connect to the distribution system in the absorption area. If the force main is to be installed in the down slope area, the trench for the force main may not be wider than 12 inches. If installed after plowing, remember that no equipment may enter the plowed area.

J. Vegetation shall be cut close to the ground throughout the area to be utilized for the absorption area. Bushes and trees shall be cut flush with the ground surface; roots shall be left in place. Cut vegetation or organic litter shall be raked and removed from the absorption area and berm areas.

K. Large rocks or boulders on the surface that can be removed without the use of machinery should be removed from the absorption area and berm areas.

L. Plow (scarify) the surface soil perpendicular to the direction of the slope (along contour) for the full extent of the At-grade absorption area including the berm.

1. Scarifying with a chisel plow is the preferred plowing method, especially in fine textured soils, as described in Section 73.55(b)(2).
2. Rototilling or other means of plowing that pulverize the soil are not acceptable.
3. The results of plowing should be an uncompacted, rough, not smeared soil surface to place the aggregate on.
4. Plowing to a depth of approximately 6 inches will:
    a. Eliminate any organic surface mat that could impede the vertical flow of effluent into the in-situ soil.
    b. Allow the aggregate to intermingle with the soil clods, maintaining the infiltration rate.

M. No traffic is allowed on the plowed surface. Aggregate must be added from outside of the aggregate area and only from up slope on sloping sites.

N. Measurements for depths of aggregate should be made from the plowed ground elevation. For components on uneven terrain, measure the ground surface elevation from the highest point within the absorption area. Use this point as the reference benchmark. This is necessary to assure an adequate depth of aggregate above the soil infiltrative surface across the entire absorption area.

O. Install a minimum of two observation pipes near the ends of the absorption area, either on the down-slope side on sites with slopes 4 to 15%, or on opposite sides of a component on sites with less than 4% slope. The number and placement of the pipes will depend on size and type of absorption area. The observation pipes should be at least 4 inches in diameter and have vertical slots on the bottom 6 inches of the pipe. Observation pipes should be anchored by a suitable means and have a water tight cap (see Figure 7).

P. Spread a minimum of 6 inches of approved aggregate across the entire component aggregate area from outside the plowed perimeter. The aggregate should be level.

Q. Place the effluent distribution laterals on top the aggregate. Connect the laterals to the force main from the dosing chamber. Slope the piping from the laterals to the force main or install the effluent distribution laterals level, with the perforations down. All pipes shall freely drain after dosing.

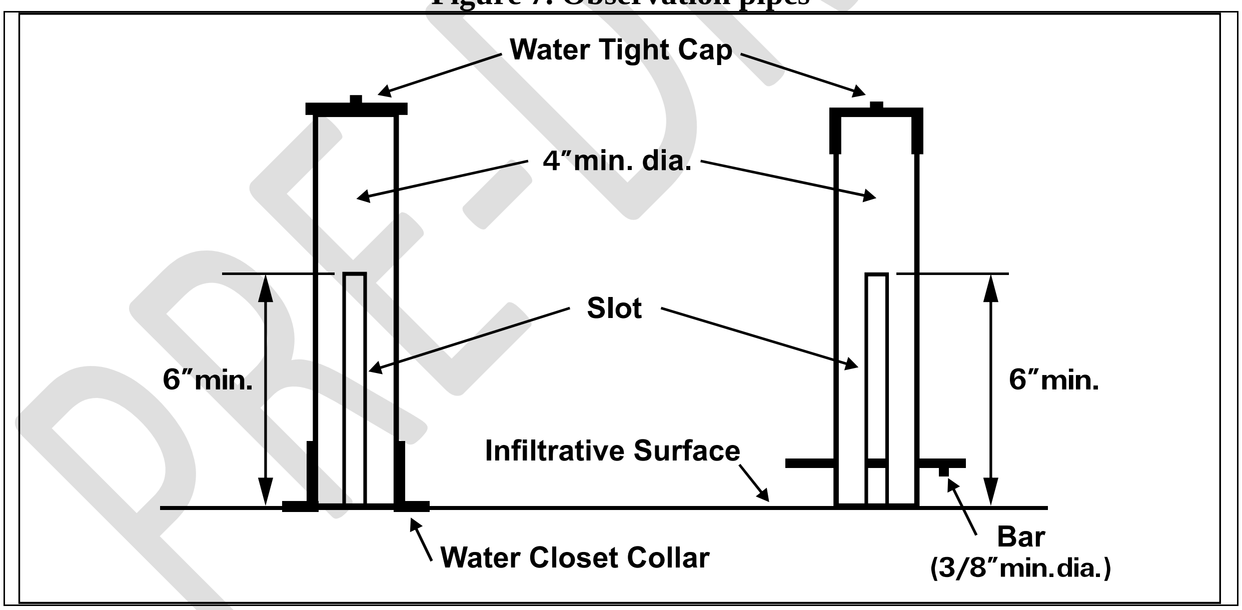
R. Place an additional 4-inch layer of aggregate surrounding and covering the laterals to achieve a minimum of a 10-inch thickness of aggregate in total. Add the additional aggregate to form the 2:1 slope on all sides.

S. The top of the aggregate shall be covered with geotextile material or similar barrier material to prevent backfill soil from settling into the aggregate.

T. Place soil cover material on top of the geotextile fabric and extend the soil cover to the boundaries of the overall component with a 3:1 slope on all sides.

U. Finally, divert surface water away from the At-grade component. Sod or seed and mulch the entire At-grade component. Remember to protect the down-gradient area from disturbance or compaction on all sloping sites.

**Figure 7. Observation pipes**



# VI. SEWAGE FACILITIES PLANNING

A. Planning is required for the use of alternate systems for all new land development.

B. Planning for new land development shall demonstrate that the alternate on-lot systems are permittable by an SEO or meets general site suitability as per the Title 25 Pa. Code § 71-72-73.

C. The following clarifies how the general site requirements apply to the At-grade Absorption Area sited on SLZ:

1. 25 Pa. Code §73.11 *General*: provides general requirements for the on-lot sewage system.
2. 25 Pa. Code §73.13 *Minimum horizontal isolation distances*: provides isolation distance requirements to be maintained between on-lot sewage system components and potential and existing site features. Soil water movement is predominantly horizontal for SLZ sites where infiltration is restricted by a slowly permeable or physically restrictive layer. When proposing the At-grade component adjacent to, and upgradient of, a horizontal isolation boundary, a hydrogeological study may be required to demonstrate there will not be effluent impacts beyond the boundary. Because of the potential for horizontal flow, the following horizontal isolation distances have been set in addition to those listed in Tile 25 Pa. Code §73.13:
    a. Down-gradient interceptor, curtain drain, foundation drain, or drainage ditch – 30 ft
    b. Up-gradient interceptor, curtain drain, foundation drain, or drainage ditch – 10 ft
    c. Down-gradient interceptor site features that may allow effluent to surface – 30 ft
    d. Down-gradient cut or bank, with a least 5 feet of original undisturbed soil above a restrictive layer - 30 ft
    e. Down-gradient cut or bank with a less than 5 feet of original undisturbed soil above a restrictive layer - 50 ft
    f. Other on-contour active on-lot systems or soil dispersal component or subsurface storm water infiltration system – 10 ft
    g. Down-gradient property line, easement, or right of way - 30 ft
    h. Stacking of active and proposed on-lot sewage systems, up-gradient or down-gradient, requires a hydrogeological study to demonstrate no impacts to downgradient systems, even if on an adjacent lot.
3. 25 Pa. Code §73.14 Site investigation, only applies to soils that can support a conventional absorption area or spray irrigation area. Section III of this document explains the requirements for site soil evaluation and testing for the At-grade system.
4. 25 Pa. Code §73.15 *Percolation tests*, only applies to soils that are suitable for a conventional absorption area. No percolation tests are required to be performed for At-grade siting requirements. Loading rates are determined from the Table in Appendix A based on the soil morphological descriptions from the test pits and the slope, as described in Section III.

5. 25 Pa. Code §73.16 *Absorption and spray field area requirements*, except for sections (c) and (d), the requirements apply to At-grade absorption area proposals.
6. 25 Pa. Code §73.17 *Sewage flow*, applies to all At-grade absorption area proposals.

D. Sufficient testing shall be conducted to ensure general site suitability to establish that a permit can be issued by an SEO on each lot in the planning area.

E. The specific Alternate On-lot System for use on each lot in the planning area will be selected as part of the alternatives evaluation.

F. The following applies to the shallow limiting zone At-grade absorption areas only: primary and replacement absorption areas will be sited for each lot to ensure long term sewage disposal needs are met. The siting and type of replacement area will be consistent with each the site evaluation and its findings. The primary and replacement absorption area for each lot should be protected by deed restriction. No reduction in sizing of the absorption area is allowed because the absorption area is designed based on hydraulic loading of the soil and not the nutrient loading.

## VII. PERMITTING REQUIREMENTS

A. Alternate system designs shall consider the design criteria listed in 25 Pa. Code § 73.72(c)(5-8).

B. Delegation of the review of the At-grade Absorption area design is contingent upon the adherence of the proposed design to this OAT approval document. Deviations from the planning requirements, design standards, and operation and maintenance standards listed in this document or referenced sections of 25 Pa. Code § 73 may render the approval null and void.

C. The permit shall include a written certification from the aggregate supplier to the SEO and permittee which includes: the name of the manufacturer of the aggregate; aggregate testing results; testing date; amount of material purchased; and the delivery date. The certification shall confirm that the aggregate meets the requirements in Section IV.E of this document.

D. The SEO shall include on both the Application for An On-lot Sewage Disposal Permit (Part III, Section 1) and the permit, the classification number(s) itemized in the Classification Type of this document.

## VIII. REQUIRED OPERATION AND MAINTENANCE

A. General: At-grade sewage systems designed and constructed with OAT pretreatment components require the manufacturers to provide an operation and maintenance (O&M) manual and individualized instruction to the homeowner for each individual unit. All At-grade systems will require O&M of the absorption area and protection of the down slope area to maintain proper long-term operation. Specific O&M requirements for each OAT component are included in the individual DEP approved TGD or listing. Systems with multiple treatment components may have a single O&M manual that includes information for all the units. Proper O&M of sewage facilities is essential to the provision of adequate sewage treatment and disposal over the functional life of an on-lot sewage treatment system and therefore, to the health and welfare of Pennsylvania's citizens and to the protection of the environment. Municipal-wide sewage management programs (SMPs) require periodic inspections and O&M of sewage facilities to assure the systems are providing adequate treatment and disposal within the municipality. Inspections should be made by a service provider every three years, at a minimum.

B. User's Manual: An At-grade component user's manual should be provided to the property owner as outlined in section C.2. below. At a minimum, the manual should contain the following:

1. Schematic diagrams of all system components, where they are in the system train, and a site plan with their locations, including the replacement absorption area if applicable. Include an as-built drawing if available.
2. Names and contact information of: local government (including local agency); component manufacturer; and service provider to be contacted in the case of component failure or malfunction.
3. A management plan that contains information on periodic inspection, maintenance or servicing of the components, including electrical/mechanical components.
4. Description of what type of activities are allowed on the replacement absorption area, if applicable.

C. Sewage Management Program Compliance: Ultimately, it is the municipality's responsibility to ensure that sewage facilities within its borders are properly sited, operated and maintained. The SMP is the tool used by the municipality to work with the property owner to meet their O&M responsibilities. If the municipality does not have an SMP in place, then until such time the municipality has developed, adopted and implemented an SMP, the municipality shall assure, for the life of the sewage facilities, the long-term proper O&M of the proposed sewage facilities through an evaluation and selection of one (1) or a combination of the administrative options listed below:

1. A maintenance agreement between the permit holder(s) or property owner(s) and the municipality or its designated local agency which establishes the permit holder's or property owner's responsibility for operating and maintaining the sewage facilities. Protection of this maintenance agreement must be by deed restriction.
2. A maintenance agreement between the permit holder or property owner, the municipality or its designated local agency, and an individual, firm or corporation demonstrated as experienced in the O&M of sewage facilities. The maintenance agreement must establish and designate the responsibilities between the permit holder or property owner and the individual, firm or corporation for operating and maintaining the sewage facilities. Protection of this maintenance agreement must be by deed restriction.
3. Establishment of a properly chartered association, trust or other private legal entity to assure long-term administration of an O&M program. The charter or other terms of establishment must establish the association, trust or other private legal entity as responsible for the proper performance of the sewage facilities and establish and designate responsibilities between the permit holder or property owner and the association, trust or other private legal entity for operating and maintaining the sewage facilities.
4. Municipal ownership of the sewage facilities upon completion.

D. A manufacturer representative and/or designer are(is) required to meet with the SEO, the installer (if different than the designer), and the property owner **before permit issuance**. The following should be covered:

1. During the meeting, the manufacturer's representative and/or designer will provide all pertinent information regarding the alternate technology to assure the SEO and the property owner understand the capabilities and limitations of the technology, and the long-term O&M requirements of the system.
2. In the event the resident of the property has not been established at the time of permitting, all information on the system should be included with materials disclosed during the future process of selling the property.
3. Documentation of the meeting should be provided to the Department with the preliminary design submission. The information should provide details on the date and time of the meeting, persons in attendance, and statements from both the SEO and the property owner stating that they understand the technology and the O&M requirements of the alternate technology.

E. Homeowner or service provider should inspect the area around the soil absorption area every 6 months to ensure that there is no ponding or seepage of effluent.

F. The service provider should inspect the system at least once every three years, or as recommended by the manufacturer, or as required by the OAT guidance document, or as directed by the SMP, whichever is shorter. A checklist of items to be inspected, including performance, is attached as Appendix H and includes the following:

1. Inspect septic tanks, dosing tanks, and lift pump tanks for structural integrity of the tanks, inlet and outlet baffles, solids retainer, pumps, siphons, and electrical connections.
2. Inspect aerobic tanks for structural integrity of the tank, inlets, and outlet baffles, buoyed solids retainer, pumps, siphons, and electrical connections.
3. Accesses to all tanks are secured.
4. Ensure that the pumping system is operational.
5. Ensure all alarms are operational.
6. Inspect the absorption area for leakage, soft spots, surface discharge, broken laterals, cleanouts, and observation pipes.
7. Flushing laterals annually at the minimum.

G. With the exception of lawn maintenance, no traffic is allowed on the At-grade component, or the protected area downslope (if the site has a slope greater than 4%), to avoid compaction.

H. To avoid hydraulic overloading of the absorption area, it is recommended that a water conservation plan be implemented within the residence (i.e. low flow sink, toilet, and shower fixtures, front loading clothes washer, and modifying your water use behaviors).

I. If the dose tank fills due to pump failure or power outages, the dose tank should be pumped by a certified service provider or manually operated to insure proper dosing before automated pump cycling resumes to avoid overloading the absorption area.

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| APPENDIX A: Infiltration and Hydraulic Linear Loading Rates Table (Adapted after Tyler et al., 2001) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Hydraulic Linear Loading Rate (gal/ft/d) | | | | | | | | |
| Soil Characteristics | | | Infiltration Loading Rate (gal/ft$^2$/d) | | Slope 0-4% | | | Slope 5-9% | | | Slope 10-15% | | |
| Texture (USDA) | Structure | | Primary | Secondary, Advance Secondary | Depth to LZ (in) | | | Depth to LZ (in) | | | Depth to LZ (in) | | |
| | Shape | Grade | | | 10-12 | 12-24 | >24 | 10-12 | 12-24 | >24 | 10-12 | 12-24 | >24 |
| | | | | | | | | | | | | | |
| COS, S, LCOS, LS | -- | 0 SG | 0.8 | 1.6 | 4.0 | 5.0 | 6.0 | 5.0 | 6.0 | 7.0 | 6.0 | 7.0 | 8.0 |
| FS, VFS, LFS, LVFS | -- | 0 SG | 0.4 | 1.0 | 3.5 | 4.5 | 5.5 | 4.0 | 5.0 | 6.0 | 5.0 | 6.0 | 7.0 |
| COSL, SL | -- | 0 M | 0.2 | 0.6 | 3.0 | 3.5 | 4.0 | 3.6 | 4.1 | 4.6 | 5.0 | 6.0 | 7.0 |
| | PL | 1 | 0.2 | 0.5 | 3.0 | 3.5 | 4.0 | 3.6 | 4.1 | 4.6 | 4.0 | 5.0 | 6.0 |
| | | 2, 3 | | | | | | | | | | | |
| | PR/BK/GR | 1 | 0.4 | 0.7 | 3.5 | 4.5 | 5.5 | 4.0 | 5.0 | 6.0 | 5.0 | 6.0 | 7.0 |
| | | 2, 3 | 0.6 | 1.0 | 3.5 | 4.5 | 5.5 | 4.0 | 5.0 | 6.0 | 5.0 | 6.0 | 7.0 |
| FSL, VFSL | -- | 0 M | 0.2 | 0.5 | 2.0 | 2.3 | 2.6 | 2.4 | 2.7 | 3.0 | 2.7 | 3.2 | 3.7 |
| | PL | 1, 2, 3 | | | | | | | | | | | |
| | PR/BK/GR | 1 | 0.2 | 0.6 | 3.0 | 3.5 | 4.0 | 3.3 | 3.8 | 4.3 | 3.6 | 4.1 | 4.6 |
| | | 2, 3 | 0.4 | 0.8 | 3.3 | 3.8 | 4.3 | 3.6 | 4.1 | 4.6 | 3.9 | 4.4 | 4.9 |
| L | -- | 0 M | 0.2 | 0.5 | 2.0 | 2.3 | 2.6 | 2.4 | 2.7 | 3.0 | 2.7 | 3.2 | 3.7 |
| | PL | 1, 2, 3 | | | | | | | | | | | |
| | PR/BK/GR | 1 | 0.4 | 0.6 | 3.0 | 3.5 | 4.0 | 3.3 | 3.8 | 4.3 | 3.6 | 4.1 | 4.6 |
| | | 2, 3 | 0.6 | 0.8 | 3.3 | 3.8 | 4.3 | 3.6 | 4.1 | 4.6 | 3.9 | 4.4 | 4.9 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SIL | -- | 0 M | 0.0 | 0.2 | 2.0 | 2.5 | 3.0 | 2.2 | 2.7 | 3.2 | 2.4 | 2.9 | 3.4 |
| | PL | 1, 2, 3 | | | | | | | | | | | |
| | PR/BK/ GR | 1 | 0.4 | 0.6 | 2.4 | 2.7 | 3.0 | 2.7 | 3.0 | 3.3 | 3.0 | 3.5 | 4.0 |
| | | 2, 3 | 0.6 | 0.8 | 2.7 | 3.0 | 3.0 | 3.0 | 3.5 | 4.0 | 3.3 | 3.8 | 4.3 |
| SCL, CL, SICL | -- | 0 M | | | | | | | | | | | |
| | PL | 1, 2, 3 | | | | | | | | | | | |
| | PR/BK/ GR | 1 | 0.2 | 0.3 | 2.0 | 2.5 | 3.0 | 2.2 | 2.7 | 3.2 | 2.4 | 2.9 | 3.4 |
| | | 2, 3 | 0.4 | 0.6 | 2.4 | 2.9 | 3.4 | 2.7 | 3.0 | 3.3 | 3.0 | 3.5 | 4.0 |
| SC, C, SIC | -- | 0 M | | | | | | | | | | | |
| | PL | 1, 2, 3 | | | | | | | | | | | |
| | PR/BK/ GR | 1 | | | | | | | | | | | |
| | | 2, 3 | 0.2 | 0.3 | 2.0 | 2.5 | 3.0 | 2.2 | 2.7 | 3.2 | 2.4 | 2.9 | 3.4 |

C = Clay; CL = Clay Loam; COS = Coarse Sand; COSL = Coarse Sandy Loam; FS = Fine Sand; FSL = Fine Sandy Loam; L = Loam; LS = Loamy Sand; LCOS = loamy Coarse Sand; LFS = Loamy Fine Sand; LVFS = Loamy Very Fine Sand; S = Sand; SC = Sandy Clay; SCL = Sandy Clay Loam; SIC = Silty Clay; SICL = Silty Clay Loam; SIL = Silt Loam; SL = Sandy Loam; VFS = Very Fine Sand; VFSL = Very Fine Sandy Loam. Note: No value given for Silt.

## APPENDIX B: PRESSURE DISTRIBUTION NETWORK DESIGN

This appendix provides guidance on how to size and design the pressure distribution network for the At-grade Absorption Area. The information provided here is based on: two research papers by Otis (1981, 1982); the orifice equation assuming a sharp-edge orifice coefficient of 0.6; and the Hazen-William friction relationship, assuming Hazen-William friction factor of 150 for plastic pipe. Orifice is referred to as "hole" in the 25 Pa. Code Chapter 73. For design requirements not otherwise specified in this appendix, Section 73.44 should be followed.

This appendix is divided in four main parts: A) Steps to design the distribution system; B) Steps to design the force main, pressurization unit, dose chamber and controls; C) Design Example; and D) Tables.

A. Steps to design the distribution system:

1. Establish the network configuration;
2. Calculate the lateral length;
3. Determine the orifice size and spacing;
4. Determine the diameter of the lateral;
5. Calculate the number of orifices per lateral;
6. Select the head to be maintained in the lateral and calculate the orifice and the lateral discharge rates;
7. Determine the number and spacing of the laterals;
8. Determine the manifold length and diameter;
9. Determine the network discharge rate;
10. Provide for flushing of the laterals.

An explanation of each step follows:

1. Establishing the network configuration: Select the configuration and the size of the absorption area based on the soil morphological report and design criteria in Section IV.
2. Calculate the lateral length: The lateral length is defined as the length from the manifold to the end of the pipe. Only a center feed manifold is allowed and therefore the length of each lateral is approximately one half the length of the absorption area, and laterals occur in pairs. The lateral should end about 6" to 12" from the end of the absorption area (Converse 2000).
3. Determine the orifice size and spacing: The orifices are the holes in the lateral through which the effluent is discharged into the aggregate. Select the diameter, spacing, and the number of the orifices required to match the flow rate of the network as follows:
    a. Size: A typical orifice size is ¼ inch diameter, smaller diameters can be used when effluent filters are installed to eliminate solids reaching the absorption area.
    b. Spacing: For small systems (typically less than 5000 gpd), spacing is 30 to 36 inches, while for larger systems it may vary from 5 to 7 feet. The spacing of the orifices is very important to uniformly distribute the effluent over the surface. The selection of orifice spacing may affect the spacing between

laterals, because the lateral spacing is generally set equal to the orifice spacing. It is recommended to place the orifice in an equilateral triangle among adjacent laterals (Converse et al., 1990).

c. Positioning: Converse (2000) recommends placing the orifices upward and using shields to protect the orifices or placing a 3 to 4 inch half-pipe over the entire length of the lateral. The lateral should be sloping back to the manifold; this is recommended to drain the laterals after each dose event to prevent freezing in cold climes. If orifice shields are not used, then the orifices are oriented downward.

4. Determine the diameter of the lateral: Based on the selected size and spacing of the orifices, use Table B-1 to select the lateral diameter.

5. Calculate the number of orifices (*n*) per lateral: *n* is a function of the lateral length and the orifice spacing (both in feet). The following formula applies to center manifold systems only:

$$\mathrm{n} = \left({}^{lateral\ length}/_{orifice\ spacing}\right) + 0.5$$

Round number off to the nearest whole number.

6. Select the head to be maintained in the lateral and calculate the orifice and the lateral discharge rates: based on the pressure head selected, Table B-2 gives the orifice discharge rates. Converse (2000) recommends minimum pressure head at the distal end of the lateral to be 2.5 ft for 1/4 inch orifices, 3.5 ft for 3/16 inch orifices, and 5 ft for 1/8 inch orifices. Multiply the number of orifices per lateral by the discharge rate to yield the lateral flow rate.

7. Determine the number of the laterals based on Table 3 in Section IV.D. Determine the lateral spacing as follows:

a. For sites on slopes between 0-4% with one lateral pair, the lateral is in the center of the absorption area.

b. For a site on slopes between 0-4% with more than one lateral pair, the laterals are equally spaced apart with the center two laterals the same distance from center of the aggregate area and the distance from outside laterals to the edge of the absorption area being half the distance between laterals.

c. For sites on slopes exceeding 4% with one lateral pair, the lateral is located 2 ft from upslope edge of the total absorption area.

d. For sites on slopes exceeding 4% with more than one lateral pair, one lateral is located 2 ft downslope from the upslope edge of the aggregate area and the other laterals are downslope of the upper lateral and upslope of the midpoint of the absorption area width.

8. Determine the manifold length and diameter using Table B-3 and Table B-4 for center manifolds.

a. The manifold length is the distance is the distance between the laterals. For a single distribution pipe with center feed, there is no manifold.

b. Use Tables B-3 and B-4 to select the manifold diameter. For small systems, the manifold diameter can be equal to the diameter of the force main, as if the manifold is an extension of the force main.

9. Determine the network discharge rate: this value is used to size the pump. Take the lateral discharge rate and multiply it by the number of laterals or take the orifice discharge rate and multiply it by the total number of orifices.
10. Provide for flushing of the laterals: The laterals should be flush periodically, or at least annually as suggested by Converse (2000). To achieve proper flushing of the pipes, install cleanouts at the end of each later and cover them with a valve or threaded cap (clean-out plug).

B. Steps to design of the force main, pressurization unit, dose chamber and controls:

1. Develop a system performance curve;
2. Determine the force main diameter;
3. Select the pressurization unit (pump);
4. Determine the required dose volume;
5. Size the dose chamber;
6. Select pump controls and alarms.

An explanation of each step follows:

1. Develop a system performance curve: the system performance curve predicts how the distribution system performs under various flow rates and heads. The flow rate is a function of the total head that the pump works against.
   The total dynamic head that the pump must work against is given by:
   a. System network head (1.3 x head, with a minimum head of 2.5 ft).
   b. Elevation difference between the off-float and the highest point in the network;
   c. Friction loss in the force main.

   Where:
   a. The system network head is the pressure maintained in the system during operation to assure relatively uniform flow through the orifices. The 1.3 multiplier relates to the friction loss in the manifold and laterals.
   b. The elevation difference is between the pump off switch and the distribution network in feet (the pump industry uses the bottom of the pump to the network).
   c. The friction loss in the force main between the dose chamber and the inlet to the network is determined by using Table B-5 and solving the following calculation:

$$f = L\left(\frac{Q}{K}\right)^{1.85}$$

   Where:
   f = friction loss through pipe (ft);
   L = length of pipe (ft);
   Q = flow (gpm);
   K = constant from Table B-5

The equation shown above is a simplified version of the Hazen-Williams formula. It is based on the assumptions that the pipe is PVC pipe conforming to the ASTM standard D-2241 (or D-1785 for schedule 40 and schedule 80 pipe) and a conservative Hazen-William flow coefficient of 150 (unitless).

The equivalent length for all fittings should be included in the calculation of the friction loss. The equivalent lengths are provided in Table B-6.

2. Determine the force main diameter. This is the value selected in step A.8 above.
3. Select the pressurization unit (pump): using a pump performance curve, select the pump that best matches the required flow rate at the operating head. Plot the pump performance curve on a system curve. Then determine if the pump will produce the flow rate at the required head. Do not undersize the pump. It can be oversized, but this will add to the expense of the system. Effluent pumps specifically designed for septic tank effluent should be used.
4. Determine the required dose volume: The lateral pipe volume is used in determining the minimum dose volume. The recommended dose volume is 5 to 10 times the pipe volume. From Table B-7 select the pipe void volume for the lateral diameter. Multiply the void volume by the total length of the laterals to determine the total pipe volume. Multiply the total pipe volume by 5 to 10 times to determine the dose volume. If time dosing is used then smaller doses could be applied, but sufficient volume needs to be applied to distribute the effluent uniformly across the network. Thus, net dose volume size is 5 times the lateral pipe volume with not over 20% of the design volume per dose. The floats are set based on the net dose volume plus the volume of the flow back.
5. The size of the dose chamber shall be large enough to meet the requirements in 25Pa. Code §73.45. If time dosing is selected, the pump chamber must have sufficient surge capacity.
6. Select pump controls and alarms: Select quality controls and alarms and follow the electrical code for electrical connections. Some electrical connections must be outside the dose chamber. If time dosing, select specific timed dose control panels.

## C. Design Example

Design a pressure distribution network for the following At-grade system: the absorption area length is 113 ft; the absorption area width is 4 ft; the force main length = 125 ft; and the elevation lift is 9 ft with three 90 º elbows.

1. This is a narrow absorption area component on a site with slope greater than 4%.
2. Lateral length $= \left({}^{L}/_{2}\right) - 0.5 = \frac{113}{2} - 0.5 = 56\ ft$

Where L is the absorption area length and the laterals terminate 0.5 foot from the edge of the absorption area. .

3. Select the orifice size and spacing;
   a. Orifice size selected for this exercise is 3/16 inch.
   b. Design one lateral pair with each orifice covering a maximum area of 6 $ft^2$, the orifice spacing is calculated as follows:

$$Spacing = {}^{\text{area per orifice}}/_{\text{width of the absorption area}}$$

$$Spacing = {}^{6\text{ ft}^2}/_{4\ ft} = 1.5\ ft$$

4. Use Table B-1 to select the lateral diameter for a Schedule 40 pipe. In Table B-1, among the four options with a 3/16 inch orifice size and 1.5 ft spacing, only one option meets the maximum lateral length for the assigned absorption area; therefore the selected lateral diameter is 2 inches;
5. Determine the number of orifices per lateral:

$$\text{n} = \left({}^{56}/_{1.5}\right) + 0.5 = 38$$

Since we have 2 laterals and 38 orifices per lateral, the total number of orifices for the absorption area is:

$$Total\ number\ of\ orifices = 2 * 38 = 76$$

The number of laterals is 2 when using a center feed manifold.
Verify that there is a maximum of 6 $ft^2$ of absorption area per orifice:

$$Total\ number\ of\ orifices = \frac{113ft * 4ft}{6ft^2} = 75$$

This means there must be at least 75 orifices within the application area. Our design example results in 76 orifices.

6. Determine lateral discharge rate. For this example, we will select a pressure head of 3.5 ft, Table B-2 gives the discharge rate of 0.78 gpm for the 3/16 inch orifice diameter. Therefore,

$$\text{Lateral discharge rate} = 38 \times 0.78 = 29.6\ {}^{gpm}/_{lateral}$$

7. Determine the number of laterals. Since the absorption area has a narrow width, only one lateral pair with center feed will be used.
8. Calculate the manifold size. This step can be skipped for this example because there is no manifold when using only one lateral pair for the absorption area. Assuming, instead, a different scenario with more than one lateral pair, then Table B-3 and Table B-4 provide the diameter of the manifold. The diameter of the manifold can be the same as the force main (this is acceptable for smaller systems).
9. Determine the network discharge rate:

$$\text{Network discharge rate} = 2 * 29.6 = 59.2\ round\ up\ to\ 60\ gpm$$

Next, select a pump that can discharge a minimum of 60 gpm against the total dynamic head that is determined in the next step.

10. Calculate the Total dynamic head:

*Total dynamic head = System head + Elevation head + Head loss*

Calculate each term in the previous equation:
*System head* = 1.3 x pressure head (ft)= 1.3 x 3.5 ft = 4.5 ft

*Elevation head* = 9.0 ft (pump shut off to network elevation)

Head Loss in the force main is calculated by using the 60 gpm and the values from Table B-5 and Table B-6 for a pipe length of 125 ft, and 3 x $90^{o}$ elbows.

Use Table B-6 to obtain the equivalent length of pipe for the fittings:

3" diameter force main = 3 x $90^{o}$ elbows @ 8.0 ft each = 24 ft

*Head Loss*: Table B-5 gives k= 803.9

$$f = (125+24) \times (60/803.9)^{1.85} = 1.23 \text{ ft}$$

*Total dynamic head = 4.5 + 9.0 + 1.23 = 14.73 ft*

11. Pump Summary

The previous steps showed how to calculate the flow and the head values. At a minimum, the system needs a pump capable of discharging 60 gpm against a head of 14.73 ft with a 3-inch force main. The actual flow and head will be recalculated based on the specific pump selected.

A system performance curve plotted against the pump performance curve will give a better estimate of the flow rate and total dynamic head the system will operate under.

D. Tables

The following tables are adapted after Washington (2012).

**Table B-1. Lateral Design Table**

| **Orifice** | **Lateral** | **Orifice Spacing** | **Maximum Lateral Length (ft)** Pipe Material |
|---|---|---|---|
| (inches) | (inches) | (feet) | **Schedule 40 PVC** |
| 1/8 | 1 | 1.5 | 42 |
| 1/8 | 1 | 2 | 50 |
| 1/8 | 1 | 2.5 | 57.5 |
| 1/8 | 1 | 3 | 66 |
| 1/8 | 1 | 4 | 80 |
| 1/8 | 1 | 5 | 90 |
| 1/8 | 1 | 6 | 102 |
| 1/8 | 1.25 | 1.5 | 66 |
| 1/8 | 1.25 | 2 | 80 |
| 1/8 | 1.25 | 2.5 | 92.5 |
| 1/8 | 1.25 | 3 | 105 |
| 1/8 | 1.25 | 4 | 124 |
| 1/8 | 1.25 | 5 | 145 |
| 1/8 | 1.25 | 6 | 162 |
| 1/8 | 1.5 | 1.5 | 85.5 |
| 1/8 | 1.5 | 2 | 104 |
| 1/8 | 1.5 | 2.5 | 120 |
| 1/8 | 1.5 | 3 | 135 |
| 1/8 | 1.5 | 4 | 164 |
| 1/8 | 1.5 | 5 | 190 |
| 1/8 | 1.5 | 6 | 210 |
| 1/8 | 2 | 1.5 | 132 |
| 1/8 | 2 | 2 | 160 |
| 1/8 | 2 | 2.5 | 185 |
| 1/8 | 2 | 3 | 207 |
| 1/8 | 2 | 4 | 248 |
| 1/8 | 2 | 5 | 290 |
| 1/8 | 2 | 6 | 324 |
| 5/32 | 1 | 1.5 | 31.5 |
| 5/32 | 1 | 2 | 36 |
| 5/32 | 1 | 2.5 | 42.5 |
| 5/32 | 1 | 3 | 48 |

**Table B-1. Lateral Design Table (continued)**

| | | | **Maximum Lateral Length (ft)** |
|---|---|---|---|
| **Orifice** | **Lateral** | **Orifice Spacing** | Pipe Material |
| (inches) | (inches) | (feet) | **Schedule 40 PVC** |
| 5/32 | 1 | 4 | 56 |
| 5/32 | 1 | 5 | 65 |
| 5/32 | 1 | 6 | 72 |
| 5/32 | 1 1/4 | 1.5 | 48 |
| 5/32 | 1 1/4 | 2 | 58 |
| 5/32 | 1 1/4 | 2.5 | 67.5 |
| 5/32 | 1 1/4 | 3 | 75 |
| 5/32 | 1 1/4 | 4 | 92 |
| 5/32 | 1 1/4 | 5 | 105 |
| 5/32 | 1 1/4 | 6 | 120 |
| 5/32 | 1 1/2 | 1.5 | 63 |
| 5/32 | 1 1/2 | 2 | 76 |
| 5/32 | 1 1/2 | 2.5 | 87.5 |
| 5/32 | 1 1/2 | 3 | 99 |
| 5/32 | 1 1/2 | 4 | 120 |
| 5/32 | 1 1/2 | 5 | 140 |
| 5/32 | 1 1/2 | 6 | 156 |
| 5/32 | 2 | 1.5 | 96 |
| 5/32 | 2 | 2 | 116 |
| 5/32 | 2 | 2.5 | 135 |
| 5/32 | 2 | 3 | 150 |
| 5/32 | 2 | 4 | 184 |
| 5/32 | 2 | 5 | 210 |
| 5/32 | 2 | 6 | 240 |
| 3/16 | 1 | 1.5 | 24 |
| 3/16 | 1 | 2 | 28 |
| 3/16 | 1 | 2.5 | 32.5 |
| 3/16 | 1 | 3 | 39 |
| 3/16 | 1 | 4 | 44 |
| 3/16 | 1 | 5 | 50 |
| 3/16 | 1 | 6 | 60 |
| 3/16 | 1.25 | 1.5 | 37.5 |

**Table B-1. Lateral Design Table (continued)**

| | | | **Maximum Lateral Length (ft)** |
|---|---|---|---|
| **Orifice** (inches) | **Lateral** (inches) | **Orifice Spacing** (feet) | Pipe Material **Schedule 40 PVC** |
| 3/16 | 1.25 | 2 | 46 |
| 3/16 | 1.25 | 2.5 | 52.5 |
| 3/16 | 1.25 | 3 | 60 |
| 3/16 | 1.25 | 4 | 72 |
| 3/16 | 1.25 | 5 | 85 |
| 3/16 | 1.25 | 6 | 96 |
| 3/16 | 1.5 | 1.5 | 49.5 |
| 3/16 | 1.5 | 2 | 60 |
| 3/16 | 1.5 | 2.5 | 70 |
| 3/16 | 1.5 | 3 | 78 |
| 3/16 | 1.5 | 4 | 92 |
| 3/16 | 1.5 | 5 | 110 |
| 3/16 | 1.5 | 6 | 120 |
| 3/16 | 2 | 1.5 | 76.5 |
| 3/16 | 2 | 2 | 92 |
| 3/16 | 2 | 2.5 | 105 |
| 3/16 | 2 | 3 | 120 |
| 3/16 | 2 | 4 | 144 |
| 3/16 | 2 | 5 | 165 |
| 3/16 | 2 | 6 | 186 |
| 7/32 | 1 | 1.5 | 19.5 |
| 7/32 | 1 | 2 | 24 |
| 7/32 | 1 | 2.5 | 27.5 |
| 7/32 | 1 | 3 | 30 |
| 7/32 | 1 | 4 | 36 |
| 7/32 | 1 | 5 | 45 |
| 7/32 | 1 | 6 | 48 |
| 7/32 | 1.25 | 1.5 | 31.5 |
| 7/32 | 1.25 | 2 | 38 |
| 7/32 | 1.25 | 2.5 | 42.5 |
| 7/32 | 1.25 | 3 | 48 |
| 7/32 | 1.25 | 4 | 60 |
| 7/32 | 1.25 | 5 | 70 |

**Table B-1. Lateral Design Table (continued)**

| | | | Maximum Lateral Length (ft) |
|---|---|---|---|
| **Orifice** | **Lateral** | **Orifice Spacing** | Pipe Material |
| (inches) | (inches) | (feet) | **Schedule 40 PVC** |
| 7/32 | 1.25 | 6 | 78 |
| 7/32 | 1.5 | 1.5 | 40.5 |
| 7/32 | 1.5 | 2 | 50 |
| 7/32 | 1.5 | 2.5 | 57.5 |
| 7/32 | 1.5 | 3 | 63 |
| 7/32 | 1.5 | 4 | 76 |
| 7/32 | 1.5 | 5 | 90 |
| 7/32 | 1.5 | 6 | 102 |
| 7/32 | 2 | 1.5 | 63 |
| 7/32 | 2 | 2 | 76 |
| 7/32 | 2 | 2.5 | 87.5 |
| 7/32 | 2 | 3 | 99 |
| 7/32 | 2 | 4 | 116 |
| 7/32 | 2 | 5 | 135 |
| 7/32 | 2 | 6 | 156 |
| 1/4 | 1 | 1.5 | 16.5 |
| 1/4 | 1 | 2 | 20 |
| 1/4 | 1 | 2.5 | 22.5 |
| 1/4 | 1 | 3 | 27 |
| 1/4 | 1 | 4 | 32 |
| 1/4 | 1 | 5 | 35 |
| 1/4 | 1 | 6 | 42 |
| 1/4 | 1.25 | 1.5 | 27 |
| 1/4 | 1.25 | 2 | 32 |
| 1/4 | 1.25 | 2.5 | 37.5 |
| 1/4 | 1.25 | 3 | 42 |
| 1/4 | 1.25 | 4 | 48 |
| 1/4 | 1.25 | 5 | 55 |
| 1/4 | 1.25 | 6 | 66 |
| 1/4 | 1.5 | 1.5 | 34.5 |
| 1/4 | 1.5 | 2 | 42 |
| 1/4 | 1.5 | 2.5 | 47.5 |

**Table B-1. Lateral Design Table (continued)**

| **Orifice** (inches) | **Lateral** (inches) | **Orifice Spacing** (feet) | **Maximum Lateral Length (ft)** **Schedule 40 PVC** |
|---|---|---|---|
| 1/4 | 1.5 | 3 | 54 |
| 1/4 | 1.5 | 4 | 64 |
| 1/4 | 1.5 | 5 | 75 |
| 1/4 | 1.5 | 6 | 84 |
| 1/4 | 2 | 1.5 | 52.5 |
| 1/4 | 2 | 2 | 64 |
| 1/4 | 2 | 2.5 | 72.5 |
| 1/4 | 2 | 3 | 81 |
| 1/4 | 2 | 4 | 100 |
| 1/4 | 2 | 5 | 115 |
| 1/4 | 2 | 6 | 126 |

**Table B-2. Discharge rates from orifices.**

| | Discharge Rates(gpm) | | | | |
|---|---|---|---|---|---|
| Orifice diameter (in.) / Head (ft) | 1/8 | 5/32 | 3/16 | 7/32 | 1/4 |
| 2.5 | - | - | 0.66 | 0.89 | 1.17 |
| 3.0 | - | - | 0.72 | 0.98 | 1.28 |
| 3.5 | - | 0.54 | 0.78 | 1.06 | 1.38 |
| 4.0 | - | 0.58 | 0.83 | 1.13 | 1.47 |
| 4.5 | - | 0.61 | 0.88 | 1.20 | 1.56 |
| 5.0 | 0.41 | 0.64 | 0.93 | 1.26 | 1.65 |
| 5.5 | 0.43 | 0.68 | 0.97 | 1.32 | 1.73 |
| 6.0 | 0.45 | 0.71 | 1.02 | 1.38 | 1.80 |
| 6.5 | 0.47 | 0.73 | 1.06 | 1.44 | 1.88 |
| 7.0 | 0.49 | 0.76 | 1.10 | 1.49 | 1.95 |
| 7.5 | 0.50 | 0.79 | 1.14 | 1.55 | 2.02 |
| 8.0 | 0.52 | 0.81 | 1.17 | 1.60 | 2.08 |
| 8.5 | 0.54 | 0.84 | 1.21 | 1.64 | 2.15 |
| 9.0 | 0.55 | 0.86 | 1.24 | 1.69 | 2.21 |
| 9.5 | 0.57 | 0.89 | 1.28 | 1.74 | 2.27 |
| 10.0 | 0.58 | 0.91 | 1.31 | 1.78 | 2.33 |
| | | | | | |
| Values were calculated as: gpm = 11.79 x $d^2$ x $h^{1/2}$ where d = orifice diameter in inches, h = head in feet. | | | | | |

**Table B-3: Maximum manifold length (ft) for various manifold diameters given the lateral discharge rate and the lateral spacing (Otis, 1981)**
(for orifice diameters of 3/16 in. and up with minimum 2 feet of residual head)

| Maximum Manifold Length (ft) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lateral Discharge Rate (gpm/lateral) | Manifold Diameter (inches) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1 1/4 | | | | | | 1 1/2 | | | | | | 2 | | | | | | 3 | | | | | | 4 | | | | | | 6 | | | | | |
| Central Manifold | Lateral Spacing (ft) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2 | 3 | 4 | 6 | 8 | 10 | 2 | 3 | 4 | 6 | 8 | 10 | 2 | 3 | 4 | 6 | 8 | 10 | 2 | 3 | 4 | 6 | 8 | 10 | 2 | 3 | 4 | 6 | 8 | 10 | 2 | 3 | 4 | 6 | 8 | 10 |
| 5 | 4 | 6 | 4 | 6 | 8 | 10 | 6 | 6 | 8 | 12 | 8 | 10 | 10 | 12 | 16 | 18 | 24 | 20 | 22 | 27 | 32 | 42 | 48 | 60 | 34 | 45 | 52 | 72 | 80 | 90 | 72 | 93 | 112 | 144 | 176 | 200 |
| 10 | 2 | 3 | 4 | | | | 2 | 3 | 4 | 6 | 8 | | 6 | 6 | 8 | 12 | 8 | 10 | 12 | 15 | 20 | 24 | 32 | 30 | 22 | 27 | 32 | 42 | 48 | 60 | 46 | 57 | 72 | 90 | 112 | 120 |
| 15 | 2 | | | | | | 2 | 3 | 4 | | | | 4 | 6 | 4 | 6 | 8 | 10 | 10 | 12 | 12 | 18 | 24 | 20 | 16 | 21 | 24 | 30 | 40 | 40 | 34 | 45 | 52 | 66 | 80 | 90 |
| 20 | | | | | | | 2 | | | | | | 2 | 3 | 4 | 6 | 8 | | 8 | 9 | 12 | 12 | 16 | 20 | 12 | 18 | 20 | 24 | 32 | 30 | 28 | 36 | 44 | 54 | 64 | 80 |
| 25 | | | | | | | | | | | | | 2 | 3 | 4 | | | | 6 | 9 | 8 | 12 | 16 | 10 | 10 | 15 | 16 | 18 | 24 | 30 | 24 | 30 | 36 | 48 | 56 | 60 |
| 30 | | | | | | | | | | | | | 2 | 3 | 4 | | | | 6 | 6 | 8 | 6 | 8 | 10 | 10 | 12 | 16 | 18 | 24 | 20 | 22 | 27 | 32 | 42 | 48 | 60 |
| 35 | | | | | | | | | | | | | 2 | 3 | | | | | 4 | 6 | 8 | 6 | 8 | 10 | 8 | 12 | 12 | 18 | 16 | 20 | 18 | 24 | 28 | 36 | 40 | 50 |
| 40 | | | | | | | | | | | | | 2 | | | | | | 4 | 6 | 4 | 6 | 8 | 10 | 8 | 9 | 12 | 12 | 16 | 20 | 18 | 21 | 28 | 36 | 40 | 40 |
| 45 | | | | | | | | | | | | | | | | | | | 4 | 3 | 4 | 6 | 8 | 10 | 6 | 9 | 8 | 12 | 16 | 20 | 16 | 21 | 24 | 30 | 32 | 40 |
| 50 | | | | | | | | | | | | | | | | | | | 4 | 3 | 4 | 6 | 8 | 10 | 6 | 9 | 8 | 12 | 16 | 10 | 14 | 18 | 24 | 30 | 32 | 40 |
| 55 | | | | | | | | | | | | | | | | | | | 2 | 3 | 4 | 6 | 8 | | 6 | 6 | 8 | 12 | 8 | 10 | 14 | 18 | 20 | 24 | 32 | 30 |
| 60 | | | | | | | | | | | | | | | | | | | 2 | 3 | 4 | 6 | | | 6 | 6 | 8 | 12 | 8 | 10 | 12 | 15 | 20 | 24 | 32 | 30 |
| 65 | | | | | | | | | | | | | | | | | | | 2 | 3 | 4 | 6 | | | 6 | 6 | 8 | 6 | 8 | 10 | 12 | 15 | 20 | 24 | 24 | 30 |
| 70 | | | | | | | | | | | | | | | | | | | 2 | 3 | 4 | | | | 4 | 6 | 8 | 6 | 8 | 10 | 12 | 15 | 16 | 24 | 24 | 30 |
| 75 | | | | | | | | | | | | | | | | | | | 2 | 3 | 4 | | | | 4 | 6 | 8 | 6 | 8 | 10 | 10 | 15 | 16 | 18 | 24 | 30 |
| 80 | | | | | | | | | | | | | | | | | | | 2 | 3 | 4 | | | | 4 | 6 | 4 | 6 | 8 | 10 | 10 | 12 | 16 | 18 | 24 | 30 |
| 85 | | | | | | | | | | | | | | | | | | | 2 | 3 | | | | | 4 | 6 | 4 | 6 | 8 | 10 | 10 | 12 | 16 | 18 | 24 | 20 |
| 90 | | | | | | | | | | | | | | | | | | | 2 | 3 | | | | | 4 | 3 | 4 | 6 | 8 | 10 | 10 | 12 | 12 | 18 | 24 | 20 |
| 95 | | | | | | | | | | | | | | | | | | | 2 | 3 | | | | | 4 | 3 | 4 | 6 | 8 | 10 | 8 | 12 | 12 | 18 | 16 | 20 |
| 100 | | | | | | | | | | | | | | | | | | | 2 | | | | | | 4 | 3 | 4 | 6 | 8 | 10 | 8 | 12 | 12 | 18 | 16 | 20 |

Instructions: This Table can be used to determine maximum length of a given diameter manifold *or* to determine required minimum diameter for a given manifold length.
Known values must include:

1) Manifold - lateral configuration (central)
2) Lateral discharge rate "Q" in gallons per minute
3) Lateral spacing in feet

Example A: Central manifold configuration, lateral discharge "Q" = 40 gpm, lateral spacing = 6 ft., manifold diameter = 4 inch; Maximum length = 12 ft.

**Table B-4: Maximum manifold length (ft) for various manifold diameters given the lateral discharge rate and the lateral spacing (Otis, 1981)**

(for orifice diameters of 1/8 in. and 5/32 in. with minimum 5 feet of residual head)

| Maximum Manifold Length (ft) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lateral Discharge Rate (gpm/lateral) | Manifold Diameter (inches) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1 1/4 | | | | | | 1 1/2 | | | | | | 2 | | | | | | | 3 | | | | | | | 4 | | | | | | 6 | | | | | |
| Central Manifold | Lateral Spacing (ft) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2 | 3 | 4 | 6 | 8 | 10 | 2 | 3 | 4 | 6 | 8 | 10 | 2 | 3 | 4 | 6 | | 8 | 10 | 2 | 3 | 4 | 6 | | 8 | 10 | 2 | 3 | 4 | 6 | 8 | 10 | 2 | 3 | 4 | 6 | 8 | 10 |
| 5 | 6 | 9 | 8 | 12 | 16 | 10 | 8 | | | 12 | 12 | 18 | 16 | 20 | 14 | 18 | 20 | 30 | 32 | 40 | 30 | 39 | 48 | 60 | 72 | 80 | 48 | 63 | 76 | 96 | 120 | 130 | 100 | 129 | 156 | 204 | 240 | 280 |
| 10 | 4 | 3 | 4 | 6 | 8 | 10 | 4 | 6 | 8 | 6 | 8 | 10 | 8 | | | 12 | 12 | 18 | 16 | 20 | 18 | 24 | 28 | 36 | 40 | 50 | 30 | 39 | 48 | 60 | 72 | 80 | 64 | 81 | 100 | 126 | 152 | 180 |
| 15 | 2 | 3 | 4 | | | | 4 | 3 | 4 | 6 | 8 | 10 | 6 | 6 | 8 | 12 | | 8 | | 10 | 14 | 18 | 20 | 24 | 32 | 30 | 22 | 30 | 36 | 42 | 56 | 60 | 48 | 63 | 76 | 96 | 112 | 130 |
| 20 | 2 | | | | | | 2 | 3 | 4 | 6 | | | 4 | 6 | 8 | 6 | | 8 | | 10 | 12 | 15 | 16 | 18 | 24 | 30 | 18 | 24 | 28 | 36 | 40 | 50 | 40 | 51 | 60 | 78 | 96 | 110 |
| 25 | | | | | | | 2 | 3 | 4 | | | | 4 | 6 | 4 | 6 | | 8 | | 10 | 10 | 12 | 12 | 18 | 16 | 20 | 16 | 21 | 24 | 30 | 40 | 40 | 34 | 45 | 52 | 66 | 80 | 90 |
| 30 | | | | | | | 2 | | | | | | 4 | 3 | 4 | 6 | | 8 | 10 | 8 | 9 | | 12 | 12 | 16 | 20 | 14 | 18 | 20 | 24 | 32 | 40 | 30 | 39 | 48 | 60 | 72 | 80 |
| 35 | | | | | | | 2 | | | | | | 2 | 3 | 4 | 6 | | | | 8 | 9 | | 12 | 12 | 16 | 20 | 12 | 15 | 20 | 24 | 24 | 30 | 26 | 36 | 40 | 54 | 64 | 70 |
| 40 | | | | | | | | | | | | | 2 | 3 | 4 | | | | | 6 | 9 | 8 | | 12 | 16 | 10 | 12 | 15 | 16 | 18 | 24 | 30 | 24 | 30 | 36 | 48 | 56 | 70 |
| 45 | | | | | | | | | | | | | 2 | 3 | 4 | | | | | 6 | 6 | 8 | 12 | | 8 | 10 | 10 | 12 | 16 | 18 | 24 | 20 | 22 | 30 | 36 | 42 | 56 | 60 |
| 50 | | | | | | | | | | | | | 2 | 3 | | | | | | 6 | 6 | 8 | 6 | | 8 | 10 | 10 | 12 | 12 | 18 | 24 | 20 | 20 | 27 | 32 | 42 | 48 | 60 |
| 55 | | | | | | | | | | | | | 2 | 3 | | | | | | 4 | 6 | 8 | 6 | | 8 | 10 | 8 | 12 | 12 | 18 | 16 | 20 | 20 | 24 | 28 | 36 | 48 | 50 |
| 60 | | | | | | | | | | | | | 2 | | | | | | | 4 | 6 | 8 | 6 | | 8 | 10 | 8 | 9 | 12 | 12 | 16 | 20 | 18 | 24 | 28 | 36 | 40 | 50 |
| 65 | | | | | | | | | | | | | 2 | | | | | | | 4 | 6 | 4 | 6 | | 8 | 10 | 8 | 9 | 12 | 12 | 16 | 20 | 18 | 21 | 28 | 36 | 40 | 50 |
| 70 | | | | | | | | | | | | | 2 | | | | | | | 4 | 6 | 4 | 6 | | 8 | 10 | 8 | 9 | 12 | 12 | 16 | 20 | 16 | 21 | 24 | 30 | 40 | 40 |
| 75 | | | | | | | | | | | | | | | | | | | | 4 | 3 | 4 | 6 | | 8 | 10 | 6 | 9 | 8 | 12 | 16 | 20 | 16 | 21 | 24 | 30 | 32 | 40 |
| 80 | | | | | | | | | | | | | | | | | | | | 4 | 3 | 4 | 6 | | 8 | 10 | 6 | 9 | 8 | 12 | 16 | 10 | 14 | 18 | 24 | 30 | 32 | 40 |
| 85 | | | | | | | | | | | | | | | | | | | | 4 | 3 | 4 | 6 | | 8 | | 6 | 9 | 8 | 12 | 16 | 10 | 14 | 18 | 20 | 30 | 32 | 40 |
| 90 | | | | | | | | | | | | | | | | | | | | 2 | 3 | 4 | 6 | | 8 | | 6 | 6 | 8 | 12 | 8 | 10 | 14 | 18 | 20 | 24 | 32 | 30 |
| 95 | | | | | | | | | | | | | | | | | | | | 2 | 3 | 4 | 6 | | 8 | | 6 | 6 | 8 | 12 | 8 | 10 | 14 | 18 | 20 | 24 | 32 | 30 |
| 100 | | | | | | | | | | | | | | | | | | | | 2 | 3 | 4 | 6 | | | | 6 | 6 | 8 | 12 | 8 | 10 | 12 | 15 | 20 | 24 | 32 | 30 |

Instructions: This Table can be used to determine maximum length of a given diameter manifold *or* to determine required minimum diameter for a given manifold length.
Known values must include:

1) Manifold - lateral configuration (central)
2) Lateral discharge rate "Q" in gallons per minute
3) Lateral spacing in feet

Example A: Central manifold configuration, lateral discharge "Q" = 40 gpm, lateral spacing = 6 ft., manifold diameter = 4 inch; Maximum length = 18 ft.

**Table B-5: Values for the Constant "K"**

| Nominal Pipe Diameter | Schedule 40 PVC |
|---|---|
| 1 | 47.8 |
| 1.25 | 98.3 |
| 1.5 | 147.5 |
| 2 | 284.5 |
| 2.5 | 454.1 |
| 3 | 803.9 |
| 4 | 1642.9 |
| 6 | 4826.6 |
| Additional coefficients can be determined by $K = 42.17 * D^{2.63}$ | |

**Table B-6: Friction Loss for PVC Fittings[1]**

Friction loss for some PVC pipe fittings, given in terms of equivalent length of pipe.

Equivalent length of pipe (feet)

PVC Pipe fittings

| Pipe Size (in) | 90° Elbow | 45° Elbow | Through Tee Run | Through Tee Branch |
|---|---|---|---|---|
| .5 | 1.5 | 0.8 | 1.0 | 4.0 |
| .75 | 2.0 | 1.0 | 1.4 | 5.0 |
| 1 | 2.25 | 1.4 | 1.7 | 6.0 |
| 1.25 | 4.0 | 1.8 | 2.3 | 7.0 |
| 1.5 | 4.0 | 2.0 | 2.7 | 8.0 |
| 2 | 6.0 | 2.5 | 4.3 | 12.0 |
| 2.5 | 8.0 | 3.0 | 5.1 | 15.0 |
| 3 | 8.0 | 4.0 | 6.3 | 16.0 |
| 4 | 12.0 | 5.0 | 8.3 | 22.0 |
| 6 | 18.0 | 8.0 | 12.5 | 32.0 |
| 8 | 22.0 | 10.0 | 16.5 | 38.0 |

[1] From SPEC-DATA, Sheet 15, Plastic Pipe and Fitting Association, November 1994

**Table B-7. Void volume for various diameter pipes**

| Nominal Pipe Size (in.) | Void Volume (gal./ft) |
|---|---|
| 3/4 | 0.023 |
| 1 | 0.041 |
| 1-1/4 | 0.064 |
| 1-1/2 | 0.092 |
| 2 | 0.163 |
| 3 | 0.367 |
| 4 | 0.650 |
| 6 | 1.469 |

Note:

The Hazen-William formula provides the friction losses in pipes:

$$f = \frac{10.46\ L\ Q^{1.85}}{C^{1.85}\ D^{4.87}}$$

where

Q = flow (gpm)

C = coefficient of roughness (Hazen-William flow coefficient, unitless)

D = actual inside pipe diameter (in)

L = length of pipe (ft)

Actual inside pipe diameter: 1.049, 1.61, 2.067, 3.068, 4.026, 6.065

## APPENDIX C: CONSTITUENT MASS LOADINGS AND CONCENTRATIONS IN TYPICAL RESIDENTIAL WASTEWATER TABLE

This table has been adapted after USEPA (2002); data are based on typical residential dwelling equipped with standard water-using fixtures and appliances.

| **Constituent** | **Mass loading (grams/person/day)** | **Concentration [A] (mg/l)** |
|---|---|---|
| Total solids (TS) | 115-200 | 500-880 |
| Volatile solids | 65-85 | 280-375 |
| Total suspended solids (TSS) | 35-75 | 155-330 |
| Volatile suspended solids | 25-60 | 110-265 |
| 5-day biochemical oxygen demand ($BOD_5$) | 35-65 | 155-286 |
| Chemical oxygen demands (COD) | 115-150 | 500-660 |
| Total nitrogen (TN) | 6-17 | 26-75 |
| Ammonium ($NH_4$) | 1-3 | 4-13 |
| Nitrites and nitrates ($NO_2$-N, $NO_3$-N) | <1 | <1 |
| Total phosphorous (TP)[C] | 1-2 | 6-12 |
| Fats, oils, and grease | 12-18 | 70-105 |
| Volatile organic compound (VOC) | 0.02-0.07 | 0.1-0.3 |
| Surfactants | 2-4 | 9-18 |
| Total coliforms (TC) in MPN/100 ml | - | $10^8$-$10^{10}$ |
| Fecal coliforms (FC) in MPN/100 ml | - | $10^6$-$10^8$ |

[A] Milligram per liter, assumed water use of 60 gal/person/day

## APPENDIX D: AT-GRADE DESIGN WORKSHEET

| Worksheet 1. Site Conditions | |
|---|---|
| Fill site | Y/N |
| Rock outcrops | Y/N |
| Sinkholes | Y/N |
| FFI mapping of floodway | Y/N |
| Absorption area on undisturbed soils | Y/N |
| Slope (%) | |
| All min. distances in Title 25 Pa. Code § 73.13 are met | Y/N |
| Soil morphological evaluation report included | Y/N |
| L.Z type SHWT | Y/N |
| L.Z. type rock with open joints | Y/N |
| L.Z. type rock formation slowly permeable | Y/N |
| Depth to redoximorphic features (in.) | |
| Depth to rocks (in.) | |

| Worksheet 2. Peak Design Flow | |
|---|---|
| Type of dwelling (Residential or Commercial) | |
| No. of bedrooms | |
| Flow in Title 25 Pa. Code § 73.17 | |
| Flow assigned by DEP policy | |
| Total design flow (**PDF**) | |

| Worksheet 3. Width and Length of the Absorption Area on site with slopes exceeding 4% | |
|---|---|
| **ILR** (gpd/ft$^2$), the infiltration loading rate is the soil application rate selected from Appendix A | |
| Min. Aggregate Area (ft$^2$) $Min. Area = {PDF}/{ILR} = \_\_/\_\_$ | |
| **HLLR** (gpd/ft), the horizontal linear loading rate is selected from Appendix A | |
| Determine the effective width of the aggregate area (**EW**) $EW = {HLLR}/{ILR} = \_\_/\_\_$ | |
| Determine the minimum length **L** (ft) of the absorption area $L = {PDF}/{HLLR} = \_\_/\_\_$ | |
| Determine the Effective Absorption Area **EA** (ft$^2$) $EA = EW * L = \_\_ * \_\_$ | |
| Verify EA ≥ Min. Area | Y/N |
| The total Width of the absorption area (**W**) is equal to or greater than the effective width (EW) of the aggregate plus 2 ft, W should not exceed 15 ft W ≥ EW +2= __ + 2 ft | |
| | |
| **Design for site with concave contour** | |

| | | |
|---|---|---|
| | Measure the Effective Length of the absorption area | |
| | Measure the Deflection (ft). Sec. IV.B.2.b. | |
| | Percentage of deflection **D%** $D\% = 100 \frac{Deflection}{Effective\ Absorption\ Area\ Length}$ | |
| | Check if $D\% \leq 10\%$ | |

| | | |
|---|---|---|
| **Worksheet 4. Width and Length of the Absorption Area on site with slopes between 0 and 4%** | | |
| | **ILR** (gpd/ft$^2$), the infiltration loading rate is the soil application rate selected from Appendix A | |
| | Min. Aggregate Area (ft$^2$) $Min. Area = {}^{PDF}/_{ILR} = \_\_/\_\_$ | |
| | **HLLR** (gpd/ft), the horizontal linear loading rate is selected from Appendix A | |
| | Determine the effective width of the aggregate area (**EW**), not exceeding 15 ft $EW = {}^{HLLR}/_{ILR} = \_\_/\_\_$ | |
| | The site is concave | Y/N |
| | Determine the minimum length **L** (ft) of the absorption area $L = {}^{PDF}/_{HLLR} = \_\_/\_\_$ | |
| | The total Width of the absorption area (W) is equal to or greater than the effective width of the aggregate area (EW). W ≥ EW<br>W (ft) = | |
| | Determine the Effective Absorption Area **EA** (ft$^2$) | |
| | | |

| | | |
|---|---|---|
| **Worksheet 5. Notes on laterals** | | |
| | **Horizontal Location of distribution lateral** | |
| | For sites on slopes between 0-4% with one lateral pair, the lateral is in the center of the absorption area. | |
| | For a site on slopes between 0-4% with more than one lateral pair, the laterals are equally spaced apart with the center two laterals the same distance from center of the aggregate area and the distance from outside laterals to the edge of the absorption area being half the distance between laterals. | |
| | For sites on slopes exceeding 4% with one lateral pair, the lateral is located 2 ft from up slope edge of the total absorption area. | |
| | For sites on slopes exceeding 4% with more than one lateral pair, one lateral is located 2 ft down slope from the up-slope edge of the aggregate area and the others are down slope of the upper lateral and up slope of the midpoint of the absorption area width. | |
| | **Vertical location of lateral in the absorption area** | |
| | Elevation of the lateral invert ≥ elevation of original contour directly under distribution lateral + 6 inches | |

| | | |
|---|---|---|
| | Elevation of lateral Invert ≥ ____ft + 0.5ft | |
| | Determine the location of the observation pipes along the length of the absorption area | |
| | | |

## APPENDIX E: AT-GRADE DESIGN WORKSHEET WITH EXAMPLE CALCULATIONS

| **Worksheet 1. Site Conditions** | |
|---|---|
| Fill site | N/A |
| Rock outcrops | N |
| Sinkholes | N |
| FFI mapping of floodway | N |
| Absorption area on undisturbed soils | N |
| Slope (%) | 5% |
| All min. distances in Title 25 Pa. Code § 73.13 are met | Y |
| Soil morphological evaluation report included | Y |
| L.Z type SHWT | Y |
| L.Z. type rock with open joints | N |
| L.Z. type rock formation slowly permeable | N |
| Depth to redoximorphic features (in.) | 14” |
| Depth to rock (in.) | 36” |

| **Worksheet 2. Peak Design Flow** | |
|---|---|
| Type of dwelling (Residential or Commercial) | Residential |
| No. of bedrooms | 5 |
| Flow in Title 25 Pa. Code § 73.17 (gpd) | 600 |
| Flow assigned by DEP policy | -- |
| Total design flow (**PDF**) (gpd) | 600 |

| **Worksheet 3. Width and Length of the Absorption Area on site with slopes exceeding 4%** | |
|---|---|
| **ILR** (gpd/ft$^2$), the infiltration loading rate is the soil application rate selected from Appendix A. | 0.6 |
| Min. Aggregate Area (ft$^2$) $Min. Area = PDF/ILR = 600/0.6$ | 1,000 |
| **HLLR** (gpd/ft), the horizontal linear loading rate is selected from Appendix A. | 3.0 |
| Determine the effective width of the aggregate area **EW** (ft) $EW = HLLR/ILR = 3.0/0.6$ | 5 |
| Determine the minimum length **L** (ft) of the absorption area $L = PDF/HLLR = 600/3.0$ | 200 |
| Determine the Effective Absorption Area **EA** (ft$^2$) $EA = EW * L = 5 * 200$ | 1,000 |
| Verify EA ≥ Min. Area | Y |
| The total Width of the absorption area (**W**) is equal to or greater than the effective width (EW) of the aggregate plus 2 ft, W should not exceed 15 ft W ≥ EW +2= 5+ 2 ft | 7 |
| | |
| **Design for site with concave contour** | N/A |

| | | |
|---|---|---|
| | Measure the Effective Length of the absorption area | |
| | Measure the Deflection (ft). Sec. IV.B.2.b | |
| | Percentage of deflection **D%** $D\% = 100 \frac{Deflection}{Effective\ Absorption\ Area\ Length}$ | |
| | Check if $D\% \leq 10\%$ | |

| | **Worksheet 4. Width and Length of the Absorption Area on site with slopes between 0 and 4%** | N/A |
|---|---|---|
| | **ILR** (gpd/ft$^2$), the infiltration loading rate is the soil application rate selected from Appendix A. | |
| | Min. Aggregate Area (ft$^2$) $Min. Area = {PDF}/{ILR} = \_\_\_/\_\_\_$ | |
| | **HLLR** (gpd/ft), the horizontal linear loading rate is selected from Appendix A. | |
| | Determine the effective width of the aggregate area (**EW**), not exceeding 15 ft $EW = {HLLR}/{ILR} = \_\_\_/\_\_\_$ | |
| | The site is concave | Y/N |
| | Determine the minimum length **L** (ft) of the absorption area $L = {PDF}/{HLLR} = \_\_\_/\_\_\_$ | |
| | The total Width of the absorption area (W) is equal to or greater than the effective width of the aggregate area (EW). W ≥ EW<br>W (ft) = | |
| | Determine the Effective Absorption Area **EA** (ft$^2$) | |
| | | |

| | **Worksheet 5. Notes on laterals** | |
|---|---|---|
| | **Horizontal Location of distribution lateral** | |
| | For sites on slopes between 0-4% with one lateral pair, the lateral is in the center of the absorption area. | N/A |
| | For a site on slopes between 0-4% with more than one lateral pair, the laterals are equally spaced apart with the center two laterals the same distance from center of the aggregate area and the distance from outside laterals to the edge of the absorption area being half the distance between laterals. | N/A |
| | For sites on slopes exceeding 4% with one lateral pair, the lateral is located 2 ft from up slope edge of the total absorption area. | Y |
| | For sites on slopes exceeding 4% with more than one lateral pair, one lateral is located 2 ft down slope from the up-slope edge of the aggregate area and the others are down slope of the upper lateral and up slope of the midpoint of the absorption area width. | |
| | **Vertical location of lateral in the absorption area** | |
| | Elevation of the lateral invert ≥ elevation of original contour directly under distribution lateral + 6 inches | 106 |

| | | |
|---|---|---|
| | Elevation of lateral Invert ≥ 105 ft + 0.5ft | |
| | Determine the location of the observation pipes along the length of the absorption area | |
| | | |

## APPENDIX F: CALCULATION OF TREES AND ROCKS IN PROPOSED ABSORPTION AREA

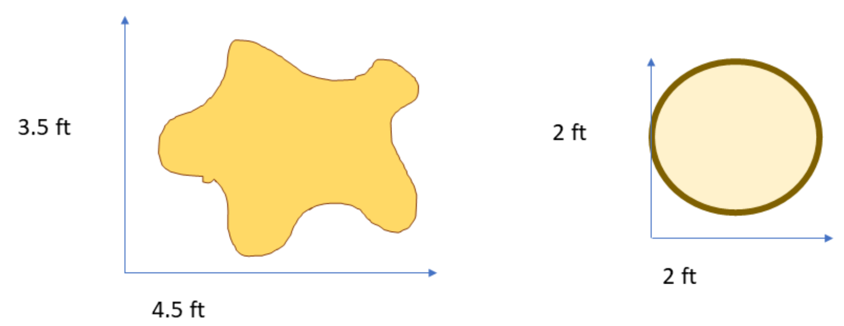
A. First measure all tree stump and boulder areas by squaring off the item as shown below. Then compute the total *additional area* (*AA*) by the summing all the areas of the tree stumps and boulders;

B. Then, divide the total additional area *(AA)* by the *effective width (EW)* of the absorption area to obtain the *additional length (AL)* of the absorption area;

C. The new *total length (TL)* of the absorption area is given by the previously calculated *length (L)* plus *AL*:

$$TL = L + AL$$

**Figure F-1. Cross section on the ground of tree stump and boulder**




Area of tree stump is 3.5 ft x 4.5 ft = 15.75 ft, round up to 16 $ft^2$.
Area of rock is 2 ft x 2 ft = 4 $ft^2$. For this absorption area *AA* = 20 $ft^2$.

**Figure F-2. Example of boulders on the ground**

**Figure F-3. Example of cross sections on the ground of tree stumps**

Photo credits: the web

# APPENDIX G: SOIL TEST PIT DESCRIPTION LOG



Project Name: ______________________
Mapped as Soil Series: ______________________
Test Pit ID: ______________

Site Address: ______________________
Soil matches the Series in the Soil Survey: Y / N
Date: ______________

Land Form: ______________________
Slope:

Land Use: ______________________

Limiting Zone Information

Municipality / County: ______________________
Temperature ( °F / °C ): ______________________
Depth: ______________

Described By:
Weather:
Type:

| Horizon | | | | | Moist Color (Hue, Value, Chroma) | | | | | | | Texture | | Structure | | | Consistence | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Master sub | Boundary (inches) | | | | Matrix | Concentrations | | | Depletions | | | CFM | USDA | Grade | Size | Type | Rupture Resistance | Roots, Seeps, Staining, Fill, Artifacts, etc. |
| | From | To | Dist | Topo | | Abn | Size | Cont | Abn | Size | Cont | | | | | | | |
| | 0 | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
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<table>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3"></td><td colspan="3"></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Bt1</td><td rowspan="2">18</td><td rowspan="2">26</td><td rowspan="2">A</td><td rowspan="2">S</td><td rowspan="2">10YR 4/6</td><td colspan="3">-------</td><td colspan="3">------</td><td rowspan="2">CH</td><td rowspan="2">SiL</td><td rowspan="2">3</td><td rowspan="2">M</td><td rowspan="2">ABK</td><td rowspan="2">fi</td><td rowspan="2">Common medium roots</td></tr>
<tr><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td></tr>
<tr><td rowspan="2">Bt2</td><td rowspan="2">26</td><td rowspan="2">38</td><td rowspan="2">C</td><td rowspan="2">W</td><td rowspan="2">10YR 4/6</td><td colspan="3">7.5YR 5/6</td><td colspan="3">10YR 6/2</td><td rowspan="2">VCH</td><td rowspan="2">SiCL</td><td rowspan="2">2</td><td rowspan="2">M</td><td rowspan="2">ABK</td><td rowspan="2">vfi</td><td rowspan="2">Few Large Roots, Mn staining</td></tr>
<tr><td>M</td><td>M</td><td>F</td><td>C</td><td>CO</td><td>D</td></tr>
</table>

| |
|---|
| Directions to the Site: |
| |
| GPS coordinates for the Site: GPS coordinates for the Test Pit: |

## APPENDIX H: SYSTEM CHECKLIST



| | |
|---|---|
| **Date Scheduled (Owner / Tenant):** | |
| **Inspector's Name:** | **Permit Number:** |
| **Inspector's Contact Information:** | **Permitted Sewage Flow:** |
| | **Date of Inspection:** |
| | **Date of Last Inspection:** |
| | **Follow-up Required:** |
| **Description of System:** | |
| | |
| | |
| **Types of Components (list):** | |
| | |
| **Complaints from Owner / Outside Source:** | |
| | |
| | |
| **Component Inspection and Performance Results** | |
| System or Component Installation Date / Age: | |
| Is there a mechanical problem with the component? | |

| | | | |
|---|---|---|---|
| | | | |
| Name of Inspector: | | Permit Number: | |
| Inspector's Contact Information: | | Permitted Sewage Flow: | |
| **Component Inspection and Performance Results** | | | |
| **Inspected** | **Results** | **Inspected** | **Results** |
| **Building Sewer** | | **Filter Tank** | |
| **Clean-out** | | **Pipe Connections** | |
| **Septic Tank** | | **Electrical Connections** | |
| **Inspection port** | | **Fluid level** | |
| **Tank cover(s)** | | **Solids Level** | |
| **Intact** | | **Scum level** | |
| **Depth** | | **Lift Pump** | |
| **Size** | | **Dosing Pump** | |
| **Baffles** | | **On switch** | |
| **Inlet** | | **Off switch** | |
| **Outlet** | | **High level switch** | |
| **Dividers** | | **Alarm** | |

| Question | Component | | Item | |
|---|---|---|---|---|
| Is there material fatigue, failure, corrosion, related to construction or structural design? | Solids retainer | | Light working | |
| Is there an installation problem: settling, shifting, improper alignment or orientation? | Grease trap | | Audible alarm working | |
| Is there improper pretreatment from one component to another? | **Aerobic Treatment** | | Distribution Box | |
| Does the septic tank need to be pumped? Excessive solids / excessive scum? | Inspection port | | Header Pipe | |
| Are floats working? | Tank cover(s) | | Manifold Pipe | |
| Are pumps working? | Intact | | Clean-outs | |
| Is the Process Control Panel secure and functioning? | Depth | | Distribution line | |
| Is the dose frequency correct? | Size | | End of laterals | |
| Is the dose volume correct? | **Dosing Tank** | | Vegetation Adequate | |
| Does Alarm function properly? Warning Light / Audible Alarm Checked. | Inspection port | | Sloped Correctly | |
| Is there evidence of groundwater intrusion? | Tank cover(s) | | Run-on Diverted | |
| Is there evidence of leakage? | Intact | | No compaction or Rutting | |
| Is there evidence of seepage or liquids at the surface? | Depth | | Downslope Protected | |
| Are there surface water issues on or around the system / absorption area? | Size | | Reserve Area Protected | |
| **Required Corrections / Comments:** | **Required Corrections / Comments:** | | | |