



Geotextile Sand Filter

Arizona
Design & Installation Manual



eljen
CORPORATION

Innovative Onsite Products & Solutions Since 1970

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Glossary of Terms

A42 Module	48" x 24" x 7" (L x W x H)
B43 Module	48" x 36" x 7" (L x W x H)
Cover Fabric	The geotextile cover fabric (provided by manufacturer) that is placed over the GSF modules.
Design Flow	The estimated peak flow that is used to size a GSF system, and is in accordance to Arizona State Regulation R18-9-A314(4).
Distribution Box	A plastic or concrete box that receives effluent from a septic tank and splits the flow to pipes placed above the GSF modules. For equal distribution, the outlet pipe orifices are typically set at the same elevation to equalize the flow to each line.
Flow Dial/Equalizer	Special insert placed in the end of distribution pipes within the distribution box to compensate for possible unlevel installation and promote favorable flow to the distribution pipes.
GSF	The Eljen Geotextile Sand Filter Modules and the 12-inch sand layer at the base and along the sides of the modules.
GSF Module	The individual module of a GSF system. The module is comprised of a cusped plastic core and geotextile fabric.
Serial or Sequential Distribution	Designs common to sloping sites where GSF lines are laid on the contour, receiving effluent from a series of Drop-Boxes starting at upper Modified Trench / Line and overflows effluent when required to down-slope Modified Trenches / Lines.
Specified Sand	To ensure proper system operation, the system MUST be installed ASTM C33 SAND. Sand must be used in accordance with R18-9-E308(D)(2) with not more than 10% passing the #100 Sieve and not more than 5% passing the # 200 sieve. Ask your material supplier for a sieve analysis to verify that your material meets the required specifications.

TABLE 1: SPECIFIED SAND SIEVE REQUIREMENTS

ASTM C33 SAND SPECIFICATION		
Sieve Size	Sieve Square Opening Size	Specification Percent Passing (Wet Sieve)
3/8 inch	9.52 mm	100
No. 4	4.76 mm	95 - 100
No. 8	2.38 mm	80 - 100
No. 16	1.19 mm	50 - 85
No. 30	590 µm	25 - 60
No. 50	297 µm	10 - 30
No. 100	149 µm	< 10
No. 200	75 µm	< 5

GSF System Description

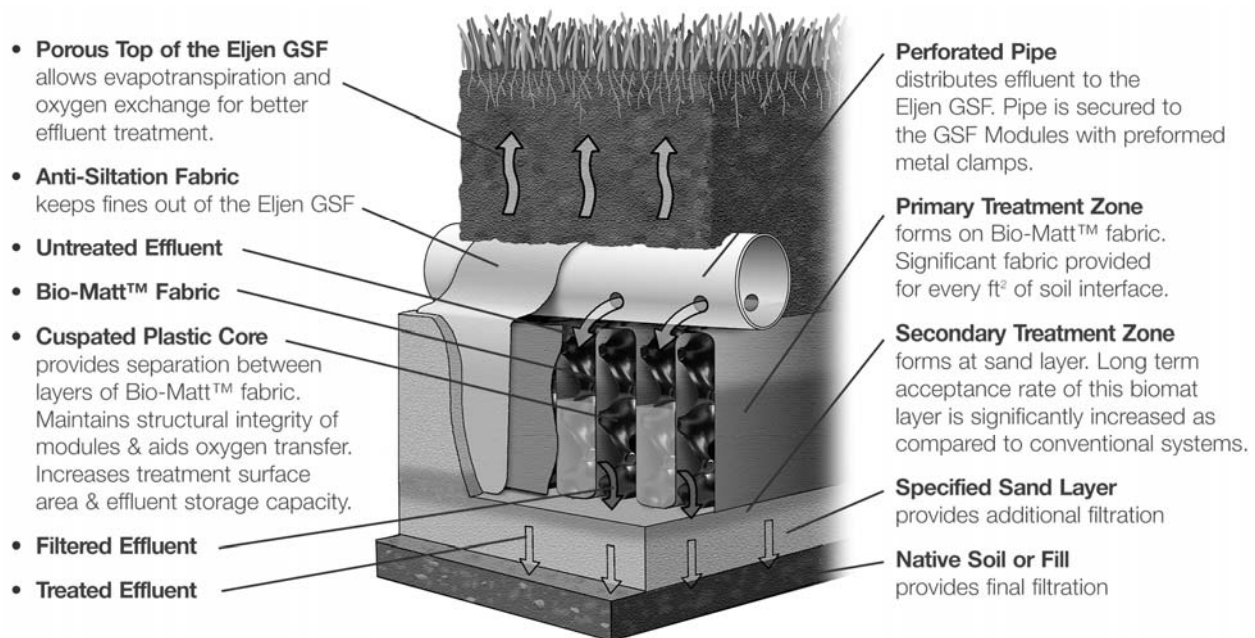
Primary Treatment Zone

- Perforated pipe is centered above the GSF module to distribute septic effluent over and into corrugations created by the cusped core of the geotextile module.
- Septic effluent is filtered through the Bio-Matt fabric. The module's unique design provides increased surface area for biological treatment that greatly exceeds the module's footprint.
- Open air channels within the module support aerobic bacterial growth on the modules geotextile fabric interface, surpassing the surface area required for traditional absorption systems.
- An anti-siltation geotextile fabric covers the top and sides of the GSF module and protects the Specified Sand and soil from clogging, while maintaining effluent storage within the module.

Secondary Treatment Zone

- Effluent drips into the Specified Sand layer and supports unsaturated flow into the native soil. This Specified Sand/soil interface maintains soil structure, thereby maximizing the available absorption interface in the native soil. The Specified Sand supports nitrification of the effluent, which reduces oxygen demand in the soil, thus minimizing soil clogging from anaerobic bacteria.
- The Specified Sand layer also protects the soil from compaction and helps maintain cracks and crevices in the soil. This preserves the soil's natural infiltration capacity, which is especially important in finer textured soils, where these large channels are critical for long-term performance.
- Native soil provides final filtration and allows for groundwater recharge.

FIGURE 1: GSF SYSTEM OPERATION



1.0 System Preconditions

1.1 REQUIREMENTS: GSF subsurface treatment must meet Arizona Administrative Code, Title 18, Chapter 9, except as outlined in this manual.

The sizing information in Sections 2.21 – 2.23 of this manual applies to residential systems only. Please contact *Eljen's Technical Resource Department at 1-800-444-1359* for design information on commercial systems.

1.2 WATER SOFTENER BACKWASH: At no time should water softener backwash be disposed of in the septic system. Water softener backwash should be discharged to a separate soil absorption field.

1.3 GARBAGE DISPOSALS: Eljen discourages the use of garbage disposals with septic systems. If a GSF system is to be designed and installed with garbage disposals the following measures must be taken to prevent solids from leaving the tank and entering the GSF system:

- Increasing the septic tank capacity by a minimum of 30%, or
- Installation of a second septic tank installed in series, or
- Installation of an appropriately sized septic tank outlet effluent filter.

Eljen requires the use of septic tank outlet effluent filters on all systems especially on those systems that have single compartment tanks, even if up-sized, and when the dwelling has a garbage disposal installed.

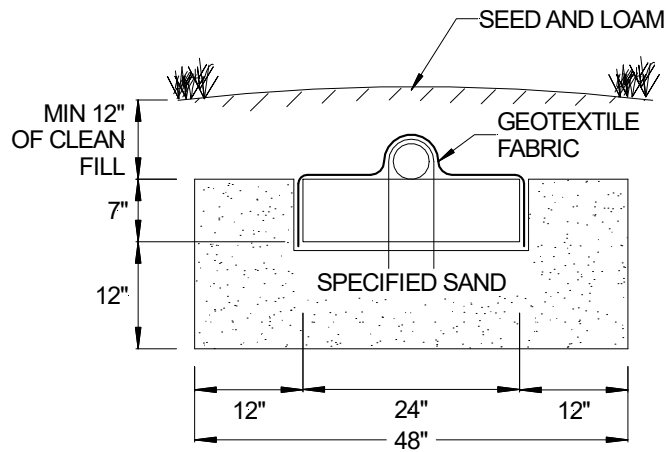
1.4 ADDITIONAL FACTORS AFFECTING RESIDENTIAL SYSTEM SIZE: Homes with expected higher than normal water usage may consider increasing the septic tank volume as well as incorporating a multiple compartment septic tank. Consideration for disposal area may be up-sized for expected higher than normal water use.

For example:

- Luxury homes, homes with a Jacuzzi style tubs, and other high use fixtures.
- Homes with known higher than normal occupancy.

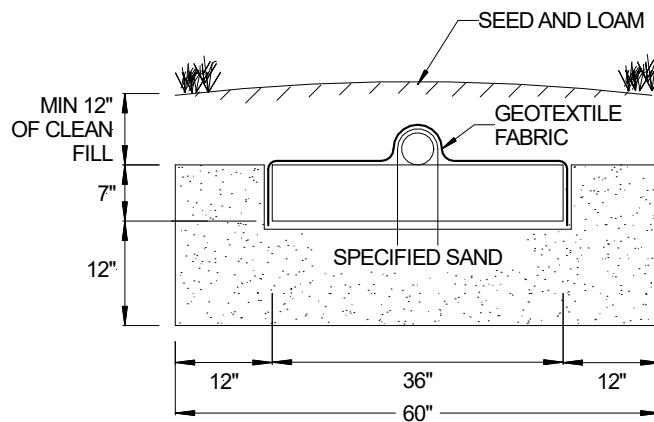
1.5 SYSTEM PROHIBITED AREAS: All vehicular traffic is prohibited over the GSF system. GSF systems shall not be installed under paved or concreted areas. If the system is to be installed in livestock areas, the system must be fenced off around the perimeter to prevent compaction of the cover material and damage to the system.

FIGURE 2: TYPICAL A42 CROSS SECTION



A42 MODULE (L x W x H) 48" x 24" x 7"

FIGURE 3: TYPICAL B43 CROSS SECTION



B43 MODULE (L x W x H) 48" x 36" x 7"

All systems are required to have a minimum of:

- 12 inches of Specified Sand is at the edges of the GSF module.
- 12 inches of Specified Sand is at the beginning and end of each GSF Row.
- 12 inches of Specified Sand is directly below the GSF module.
- Minimum 12 inches of cover above the module.

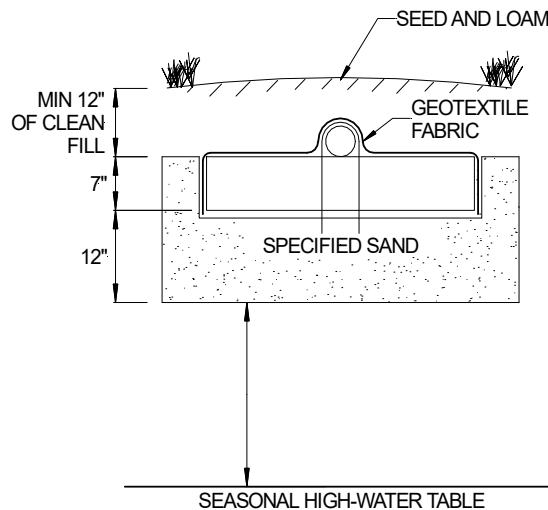
2.0 Design and Installation

2.1 SEPTIC TANK: Septic tanks should be fitted with an effluent filter and sized according to state regulations. Refer to R18-9-A314 for further guidelines.

2.2 SEPTIC TANK FILTERS: Septic tank effluent filters are **REQUIRED** on the outlet end of septic tank. Filter manufactures require that filters be cleaned from time to time. Ask your installer or designer for specific cleaning requirements based on the type or make of the filter installed. Eljen requires the septic tank to be pumped every three years or as needed which would be a good time to check and conduct filter maintenance.

2.3 SEASONAL HIGH-WATER TABLE: Use section R18-9-A312(E)(2) when a seasonal high-water table is identified at the site. This may include conducting a hydraulic analysis showing that soil is sufficiently permeable to conduct wastewater downward and laterally without surfacing for the site conditions.

FIGURE 4: VERTICAL SEPARATION DISTANCE

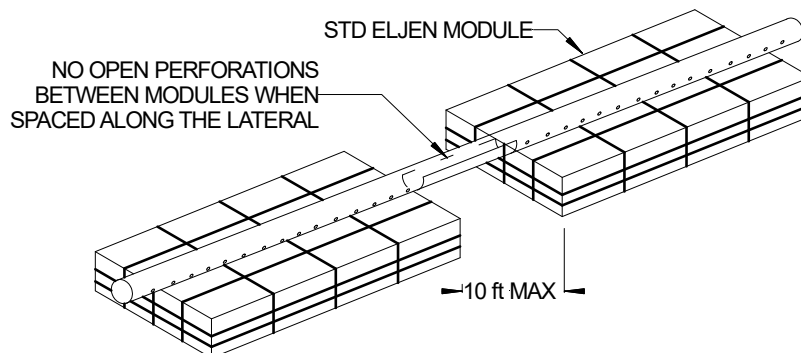


2.4 SPECIFIED SAND SPECIFICATION FOR GSF SYSTEMS: The first 12 inches of Specified Sand immediately under, between rows and around the perimeter of the GSF system must be an **ASTM C33 WASHED CONCRETE SAND WITH LESS THAN 10% PASSING A #100 SIEVE AND LESS THAN 5% PASSING A #200 SIEVE**. Please place a prominent note to this effect on each design drawing. See Table 1 for more information on the ASTM C33 sand and sieve specifications or refer to R18-9-E308(D)(2).

2.5 PLACING GSF MODULES: The "painted stripe" on the GSF modules indicates the top of the module and is not intended to indicate the location of the distribution pipe. With the painted stripe facing up, all rows of GSF modules are set level, end to end on the Specified Sand layer.

Units may not be placed greater than 10 feet end to end along the lateral. Use SDR-35 solid pipe to create the separation between the units.

FIGURE 5: ALONG LATERAL SEPARATION DISTANCE



2.0 Design and Installation

2.6 DISTRIBUTION: Gravity, pump to gravity or pressure distribution are acceptable when using the GSF System. Piping shall meet the requirements guidelines; however, Eljen strongly recommends the use of SDR 35 pipe and fittings as to prevent crushing during backfill. All distribution piping must meet a minimum 2,500-pound crush test specification for polyvinyl chloride (PVC) drain, waste and vent pipe. For more information, refer to R18-9-A312(F)(2)(c).

All systems require a perforated 4" diameter pipe centered on top of the GSF modules unless the system is curving. The distribution pipe continues along the entire length of all modules in a trench or row. Holes are set at the 4 and 8 o'clock position and secured by the Eljen provided wire clamps.

When using pressure distribution, a pressure manifold is placed inside the 4-inch distribution pipe. Section 7 of this manual goes into details of how to construct the distribution network. All piping must meet state and local regulations.

Gravity flow for effluent to contiguous (units touching end to end) units only, no spacing along the lateral is allowed.

Pump or siphon to gravity and **pump to pressure distribution** are acceptable for units that are spaced along the lateral.

2.7 CONNECTIONS AND FITTINGS: Connections of lines to tanks and distribution boxes must be made using watertight seals. Use of any grouting material is not permitted. Refer to R18-9-A312(F)(2)(B) for more details.

2.8 DISTRIBUTION BOX: Set the gravity system D-box outlet invert a minimum of 1/8 inch drop in elevation per linear foot to the top first module in the row. Set a 2-inch minimum drop for dosed systems from the D-box to the modules. Ensure that the distribution box and pipes feeding the system are placed on compacted soil. Flow Dials may be used in either Gravity or Dosed installations.

D-boxes are acceptable in gravity, pump to gravity and siphon to gravity designs.

D-boxes may be used to split the effluent to treatment pads that are non-contiguous and are acceptable in contiguous unit designs as well.

It is important to correctly size the D-box for the design.

- For every open 4" outlet of the D-box, assume a flow of 15 gallons per minute out.
- The box should have the capacity to hold the one-minute dose volume minus the number of open outlets times 15 gallons per minute.
- D-boxes may be used in series to increase volume.

2.9 INSTALLING ON SLOPING TERRAIN: For trench systems, edge-to-edge spacing will be a minimum of 5 feet. For bed systems, edge-to-edge spacing will be 2 feet.

Provide a D-box at the beginning of the first row of modules for effluent distribution and velocity reduction and as a system inspection port. Lower rows may also be loaded from one or more D-boxes with Flow Dials to insure effluent is distributed per design requirements. Serial or equal distribution is permitted.

Equal Distribution: Set Flow Dials to insure effluent is distributed equally to all rows in the system.

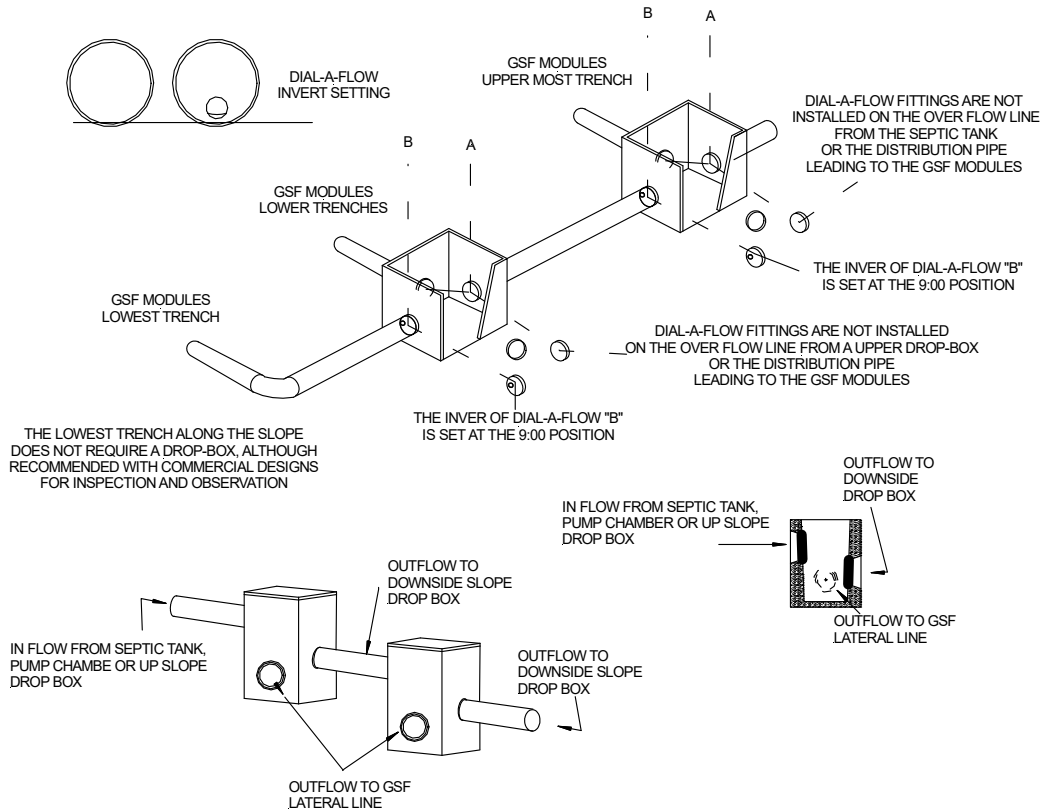
Serial Distribution: Set Flow Dials to insure effluent is loaded to the upslope trench first before continuing to lower trenches within the system.

2.10 EQUAL DISTRIBUTION: Parallel distribution is the preferred method of dosing to a gravity or pump to gravity system. It encourages equal flows to each of the lines in the system. It is recommended for most trench systems.

2.0 Design and Installation

2.11 SEQUENTIAL DISTRIBUTION: Sequential Distribution using a distribution box will fully utilize the uppermost section of the system prior to spilling effluent into a lower row of modules. This is for use on any site with greater than 0.5% slope when not using parallel distribution.

FIGURE 6: SEQUENTIAL DISTRIBUTION DROP-BOX DETAIL



2.12 COVER FABRIC: Geotextile cover fabric is provided by Eljen Corporation for all GSF systems. It is placed over the top and sides of the module rows to prevent long term siltation and failure. **Cover fabric substitution is not allowed.** Fabric should drape vertically over the pipe and must *not* block holes in the distribution pipe or be stretched from the top of the pipe to the outside edge of the modules. "Tenting" will cause undue stress on fabric and pipe.

2.13 SYSTEM VENTING: It is required to vent all systems that are over 18" below finished grade and systems beneath any surface condition that would not allow for surface air exchange with the system such as patios. See Section 10.0 for a more detailed explanation of venting GSF products.

2.14 BACKFILL & FINISH GRADING: Complete backfill with a minimum of 12 inches of clean porous fill measured from the top of modules. Use well graded sandy fill that is clean, porous and devoid of large rocks. Do not use wheeled equipment over the system. A light track machine may be used with caution, avoiding crushing or shifting of pipe assembly. Divert surface runoff from the system absorption area. Finish grade to prevent surface ponding. Seed and loam system area to protect from erosion.

2.15 SYSTEM GEOMETRY: Design systems as long and narrow as practical along site contours to minimize ground water mounding especially in poorly drained low permeability soils. If possible, design level systems with equal number of modules per row.

There is a minimum 5-foot separation between trenches, measured from sidewall to sidewall as per R18-9-E302(C)(2)(c).

In bed and trench systems, it is acceptable to space the units to maximize points of application to the basal area.

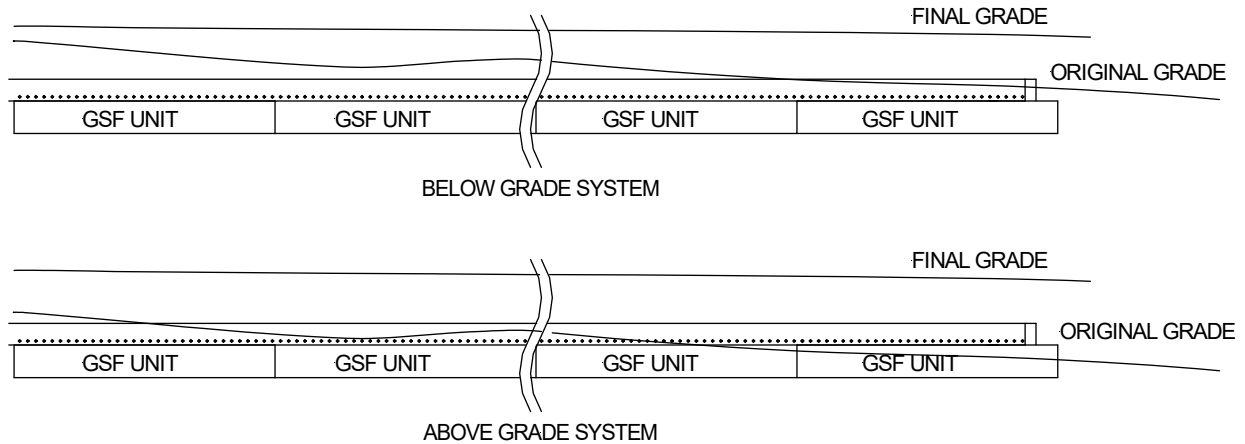
2.0 Design and Installation

2.16 TRENCH SYSTEMS: Trench systems may not exceed 8 feet in width. Once the design exceeds 8 ft, the system is considered a bed and will use the bed loading rates.

2.17 BED SYSTEMS: Bed systems typically have a minimum of 2 rows and Eljen recommends a maximum lateral to lateral spacing of 12 feet. Care should be taken and additional units should be added to ensure there are sand does not go over 10 feet from a unit. See Bed Example 1 for an example of this.

2.18 ABOVE GRADE SYSTEMS: Above grade systems are any system where 50% of the length of the Eljen GSF distribution pipe is above original grade.

FIGURE 7: ABOVE GRADE SYSTEM



2.19 NUMBER OF GSF MODULES REQUIRED: Calculations on how to determine the number of GSF module for residential systems use are based on the following information:

- a maximum loading rate of 30 gallons per day per module for B43 modules;
- a maximum loading rate of 25 gallons per day per module for A42 modules;
- a minimum of 5 B43 Modules per bedroom; or
- a minimum of 6 A42 Modules per bedroom.

2.20 SIZING GSF SYSTEM FOR TRENCHES & BEDS: When determining the correct sizing for your GSF system, it is important to follow your local codes and regulations for proper surface and subsurface classifications as specified under R18-9-A310. The adjusted SAR is from the code R18-9-A312(D)(3). Design flow is developed from R18-9-A314(4).

EQUATIONS AND FORMULAS

The following equation is used to determine the proper Adjusted Soil Absorption Rate (SAR_a):

$$SAR_a = \left[\left(\frac{11.39}{\sqrt[3]{TSS + BOD_5}} - 1.87 \right) SAR^{1.13} + 1 \right] SAR$$

2.0 Design and Installation

2.21 SIZING CHARTS:

TABLE 2: NUMBER OF MODULES REQUIRED PER DESIGN FLOW

GPD FLOW	150	300	450	600	750	900	1050
Number of Modules Required for A42	6	12	18	24	30	36	42
Number of Modules Required for B43	5	10	15	20	25	30	35

TABLE 3: SARa FOR TRENCH AND BED DESIGNS

SARa FOR TRENCH DESIGN			SARa FOR BED DESIGN		
Perc Rate Min/Inch	SAR Trench GPD/FT ²	Adjusted SAR Trench GPD/FT ²	Perc Rate Min/Inch	SAR Bed GPD/FT ²	Adjusted SAR Bed GPD/FT ²
7	0.75	2.6	7	0.5	1.28
10	0.63	1.91	10	0.42	0.96
15	0.5	1.28	15	0.33	0.65
20	0.44	1.03	20	0.29	0.53
25	0.4	0.885	25	0.27	0.48
30	0.36	0.75	30	0.24	0.4
35	0.33	0.65	35	0.22	0.36
40	0.31	0.59	40	0.21	0.33
45	0.29	0.53	45	0.2	0.31
50	0.28	0.51	50	0.19	0.29
55	0.27	0.48	55	0.18	0.27
55 - 60	0.25	0.43	55 - 60	0.17	0.25
61 - 120	0.2	0.31	61 - 120	0.13	0.17

2.22 SYSTEM DESIGN WIDTH: The minimum trench width for a A42 module is 4 ft wide and a B43 is 5 ft wide.

If the required square footage of the disposal works is greater than the area required under the treatment works, then extend the width of the trench to a point where the product of the length will equal the square footage requirement.

If a bed is to be used, extend the width and length of the bed to a point where the product will equal the square footage requirement.

In all cases, the edge of any treatment module will be at least 12 inches from the sidewall of the trench or bed.

2.0 Design and Installation

TABLE 4: SARa FOR SOIL EVALUATION METHOD OF SOIL CHARACTERISTICS

Sequence of Soil Characteristics Questions	SAR, Trench, Chamber, and Pit gal/day/ft ²	SARa	SAR Bed gal/day/ft ²	SARa
A. Is the horizon gravelly coarse sand or coarser?	A site-specific SAR is required		A site-specific SAR is required	
B. Is the structure of the horizon moderate or strongly platy?	A site-specific SAR is required		A site-specific SAR is required	
C. Is the texture of the horizon sandy clay loam, clay loam, silty clay loam, or finer and the soil structure weak platy?	A site-specific SAR is required		A site-specific SAR is required	
D. Is the moist consistency stronger than firm or any cemented class?	A site-specific SAR is required		A site-specific SAR is required	
E. Is the texture sandy clay, clay, or silty clay of high clay content and the structure massive or weak?	A site-specific SAR is required		A site-specific SAR is required	
F. Is the texture sandy clay loam, clay loam, silty clay loam, or silty loam and the structure massive?	A site-specific SAR is required		A site-specific SAR is required	
G. Is the texture of the horizon loam or sandy loam and the structure massive?	0.2	0.31	0.13	0.17
H. Is the texture sandy clay, clay, or silty clay of low clay content and the structure moderate or strong?	0.2	0.31	0.13	0.17
I. Is the texture sandy clay loam, clay loam, or silty clay loam and the structure weak?	0.2	0.31	0.13	0.17
J. Is the texture sandy clay loam, clay loam, or silty clay loam and the structure moderate or strong?	0.4	0.885	0.27	0.48
K. Is the texture sandy loam, loam, or silty loam and the structure weak?	0.4	0.885	0.27	0.48
L. Is the texture sandy loam, loam, or silt loam and the structure moderate or strong?	0.6	1.75	0.4	0.88
M. Is the texture fine sand, very fine sand, loamy fine sand, or loamy very fine sand?	0.4	0.885	0.27	0.48
N. Is the texture loamy sand or sand?	0.8	2.92	0.53	1.41
O. Is the texture coarse sand?	1.2	6.24	A site-specific SAR is required	

2.23 DESIGN NOTE: All systems must meet the requirements of 2.20, 2.21 or 2.22. The system must have the minimum number of units and it must have the minimum footprint required. Some designs will require additional modules or bottom area to meet these requirements.

3.0 Trench Installation Sizing and Guidelines

Trench Example: 1

House size:

4 Bedrooms

Daily Design Flow: Bedrooms x 150 gpd =

600 gpd

Percolation Rate:

7 min/in

Minimum Number of Units

Lookup the information required from Table 2:

GPD FLOW	150	300	450	600	750	900	1050
Number of Modules Required for A42	6	12	18	24	30	36	42
Number of Modules Required for B43	5	10	15	20	25	30	35

A42: 24 Units

B43: 20 Units

SARa

Lookup the information required from Table 3:

SARa FOR TRENCH DESIGN		
Perc Rate Min/Inch	SAR Trench GPD/FT ²	Adjusted SAR Trench GPD/FT ²
7	0.75	2.6

Minimum Trench Bottom required

$GPD \div SARa = \text{Minimum Trench Bottom Area}$

$600 \text{ gpd} \div 2.6 \text{ gpd/ft}^2 = 230.8 \text{ ft}^2$, round to 231 ft²

Calculate Minimum Trench Length

A42: 24 units x 4 + 2 ft = 98 ft Units x 4 + 2 ft B43: 20 units x 4 + 2 ft = 82 ft

Trench Width

A42: 4 ft B43: 5 ft

Final Dimension Layout

(Note: System layout and number of rows will vary based on site constraints)

A42

B43

Min. Trench Length (note: additional rows will change the min trench length)	98 ft.
Trench Width	4 ft.
Minimum Number of Units	24 A42s
System Area	392 ft ²

Min. Trench Length (note: additional rows will change the min trench length)	82 ft.
Trench Width	5 ft.
Minimum Number of Units	20 B43s
System Area	410 ft ²

3.0 Trench Installation Sizing and Guidelines

FIGURE 8: PLAN VIEW – A42 TRENCH SYSTEM EXAMPLE

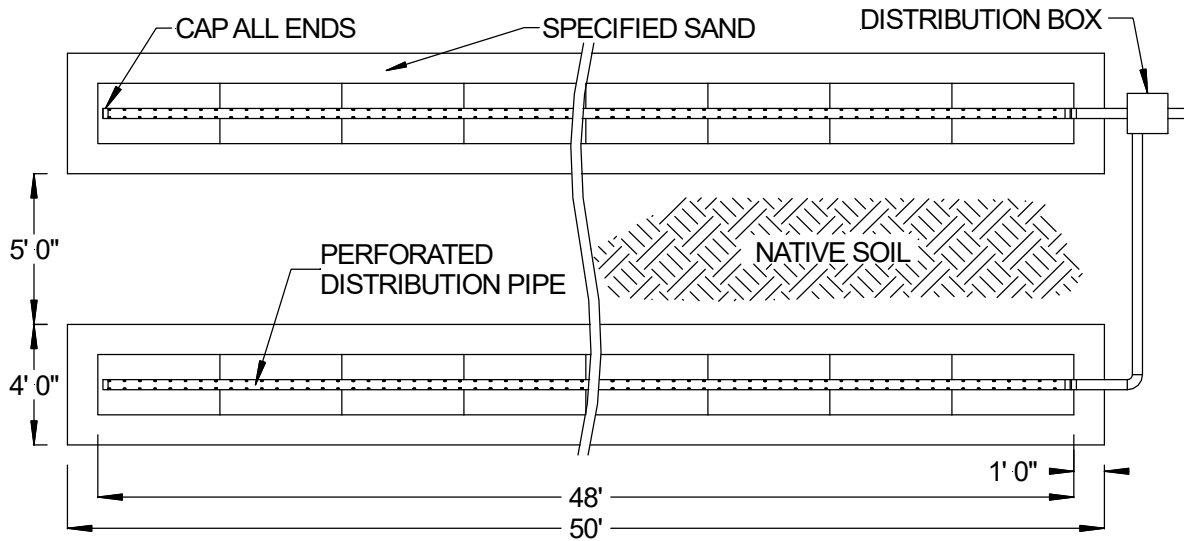


FIGURE 9: SECTION VIEW – A42 TRENCH SYSTEM EXAMPLE – LEVEL SITE

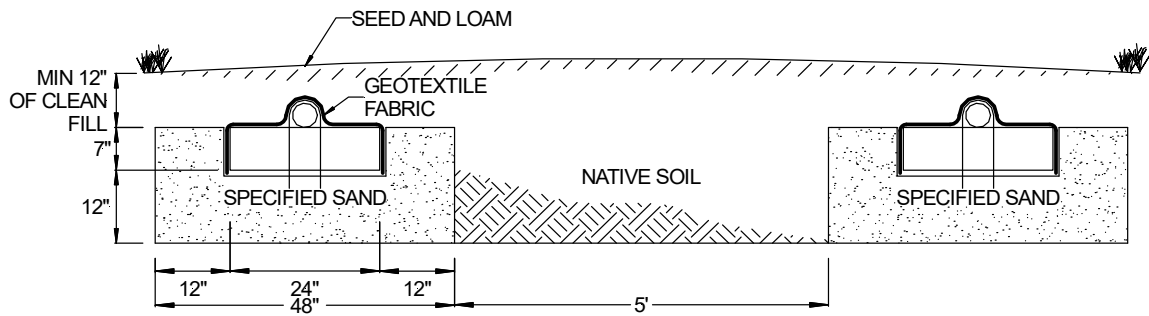
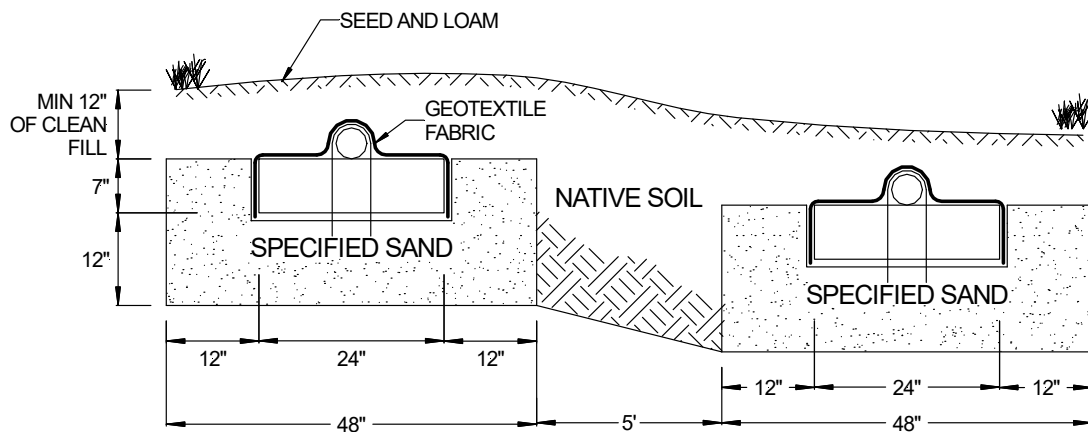


FIGURE 10: SECTION VIEW – A42 TRENCH SYSTEM – SLOPING SITE



3.0 Trench Installation Sizing and Guidelines

Trench Example: 2

House size: 3 Bedrooms
 Daily Design Flow: Bedrooms x 150 gpd = 450 gpd
 Soil Characteristic: 0.4 gpd/ft²
 Linear Loading Rate from Hydraulic Analysis: 5 gal/day/ft

Minimum Number of Units

Lookup the information required from Table 2:

GPD FLOW	150	300	450	600	750	900	1050
Number of Modules Required for A42	6	12	18	24	30	36	42
Number of Modules Required for B43	5	10	15	20	25	30	35

A42: 18 Units B43: 15 Units

SARa

Lookup the information required from Table 4:

Sequence of Soil Characteristics Questions	SAR, Trench, Chamber, and Pit gal/day/ft ²	SARa	SAR Bed gal/day/ft ²	SARa
J. Is the texture sandy clay loam, clay loam, or silty clay loam and the structure moderate or strong?	0.4	0.885	0.27	0.48

Minimum Trench Bottom required

$$\text{GPD} \div \text{SARa} = \text{Minimum Trench Bottom Area}$$

$$450 \text{ gpd} \div 0.885 \text{ gpd/ft}^2 = 508.5 \text{ ft}^2, \text{ round to } 509 \text{ ft}^2$$

Minimum Trench Length required

$$\text{GPD} \div \text{Linear Loading Rate} = \text{Minimum Trench Length}$$

$$450 \text{ gpd} \div 5 \text{ gal/day/ft} = 90 \text{ ft}$$

Trench Width

$$\text{Minimum Trench Bottom} \div \text{Minimum Trench Length} = \text{Trench Width}$$

$$509 \text{ ft}^2 \div 90 \text{ ft} = 5.65 \text{ ft}, \text{ round to } 6 \text{ ft}.$$

Calculate Unit Spacing

$$((\text{Minimum Trench Length} - 6 \text{ ft}) \div (\text{Number of Units per Row} - 1)) - 4 \text{ ft} = \text{Edge to Edge Module Spacing}$$

A42: ((90 ft - 6 ft) ÷ (18 - 1)) - 4 ft =	B43: ((90 ft - 6 ft) ÷ (15 - 1)) - 4 ft =
A42: (84 ft ÷ 17) - 4 ft =	B43: (84 ft ÷ 14) - 4 ft =
A42: 4.94 ft - 4 ft = 0.94 ft, round to 1 ft	B43: 6 ft - 4 ft = 2 ft

Final Dimension Layout

(Note: System layout and number of rows will vary based on site constraints)

A42

Min. Trench Length	90 ft.
Trench Width	6 ft.
Minimum Number of Units	18 A42s
Edge to Edge Module Spacing	1 ft
System Area	540 ft ²

B43

Min. Trench Length	90 ft.
Trench Width	6 ft.
Minimum Number of Units	15 B43s
Edge to Edge Module Spacing	2 ft
System Area	540 ft ²

3.0 Trench Installation Sizing and Guidelines

FIGURE 11: PLAN VIEW – B43 TRENCH SYSTEM EXAMPLE

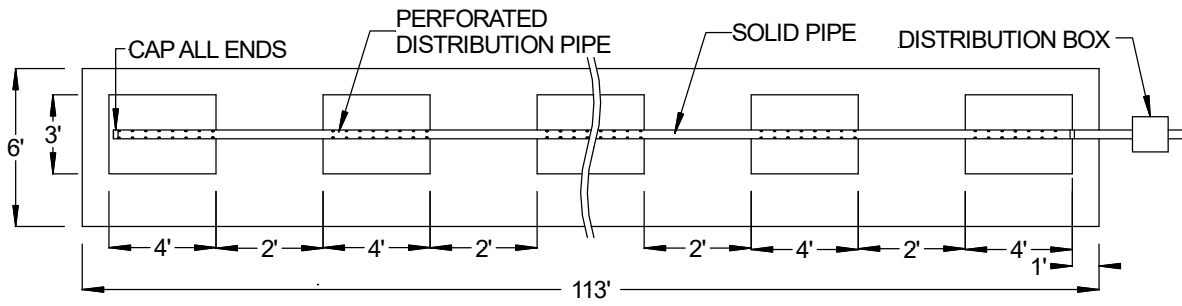
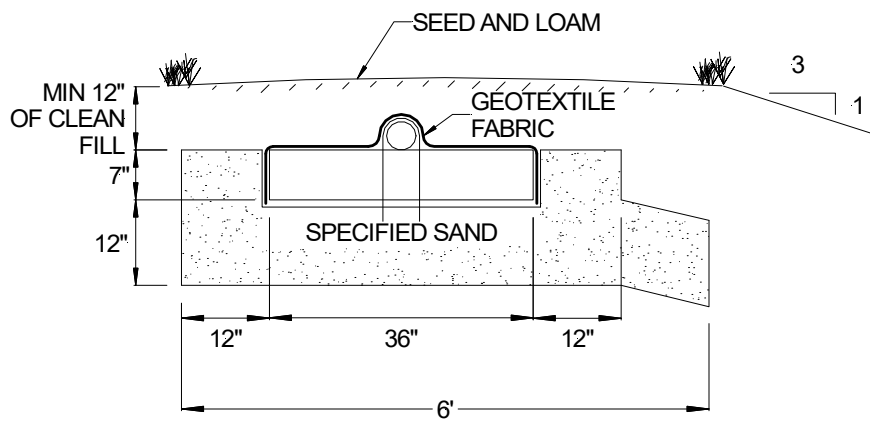


FIGURE 12: SECTION VIEW – B43 TRENCH SYSTEM EXAMPLE



3.0 Trench Installation Sizing and Guidelines

1. Ensure all components leading to the GSF system are installed properly. Septic tank effluent filters are required with the GSF system.
2. Determine the number of GSF Modules required using the trench sizing example.
3. Prepare the site. Do not install a system on saturated ground or wet soils that are smeared during excavation. Keep machinery off infiltrative areas.
4. Plan all drainage requirements above (up-slope) of the system. Set soil grades to ensure that storm water drainage and ground water is diverted away from the absorption area once the system is complete.
5. Excavate the trench; prepare the receiving layer to maximize the interface between the native soil and specified sand.
6. Minimize walking in the trench prior to placement of the specified sand to avoid soil compaction.
7. Place specified sand in a 6" lift and stabilize by foot, a hand held tamping tool or a portable vibrating compactor. The minimum stabilized height below the GSF module must be level at 12".
8. Place GSF modules with **PAINTED STRIPE FACING UP**, end to end on top of the specified sand along their 4-foot length.
9. A standard 4-inch perforated pipe, SDR 35 or equivalent, is centered along the modules 4-foot length. Orifices are set at the 4 & 8 o'clock position.
10. All 4-inch pipes are secured with manufacturers supplied wire clamps, one per module.
11. (Pressure Distribution Systems) Insert a pressure pipe (size per design and code) into the standard 4-inch perforated pipe. The pressure pipe orifices are set at the 12 o'clock position as shown in Figure 19. Each pressure lateral will have a drain hole at the 6 o'clock position. Each pressure lateral shall include sweeping cleanouts at the terminal ends and be accessible from grade.
12. **Cover fabric substitution is not allowed.** The installer should lay the Eljen provided geotextile cover fabric lengthwise down the trench, with the fabric fitted to the perforated pipe on top of the GSF modules. Fabric should be neither too loose, nor too tight. The correct tension of the cover fabric is set by:
 - a. Spreading the cover fabric over the top of the module and down both sides of the module with the cover fabric tented over the top of the perforated distribution pipe.
 - b. Place shovelfuls of Specified Sand directly over the pipe area allowing the cover fabric to form a mostly vertical orientation along the sides of the pipe. Repeat this step moving down the pipe.
13. Place the sand extensions along both sides of the modules edge. A minimum of 12 inches of Specified Sand is placed at the beginning and end of each trench.
14. Complete backfill with a minimum of 12 inches of clean porous fill measured from the top of the module. Backfill exceeding 18 inches requires venting at the far end of the trench. Use well graded native soil fill that is clean, porous and devoid of large rocks. Do not use wheeled equipment over the system. A light track machine may be used with caution, avoiding crushing or shifting of pipe assembly.
15. Divert surface runoff from the system. Finish grade to prevent surface ponding. Topsoil and seed system area to protect from erosion.

4.0 Bed Installation Sizing and Guidelines

Bed Example: 1

House size:

3 Bedrooms

Daily Design Flow: Bedrooms x 150 gpd =

450 gpd

Percolation Rate:

45 min/in

Minimum Number of Units

Lookup the information required from Table 2:

GPD FLOW	150	300	450	600	750	900	1050
Number of Modules Required for A42	6	12	18	24	30	36	42
Number of Modules Required for B43	5	10	15	20	25	30	35

A42: 18 Units

B43: 15 Units

SARa

Lookup the information required from Table 3:

SARa FOR BED DESIGN		
Perc Rate Min/Inch	SAR Bed GPD/FT ²	Adjusted SAR Bed GPD/FT ²
45	0.2	0.31

Minimum Absorption Area required

$$\text{GPD} \div \text{SARa} = \text{Minimum Trench Bottom Area}$$

$$450 \text{ gpd} \div 0.31 \text{ gpd/ft}^2 = 1,451.6 \text{ ft}^2, \text{ round to } 1,452 \text{ ft}^2$$

Bed Width

Number of Rows x Desired Row Width (Recommend Max of 12 feet)

A42: 2 Rows x 10 feet

20 ft

B43: 2 Rows x 12 ft

24 ft

Calculate Bed Length – Minimum 2 Rows

Minimum Absorption Area Required \div Bed Width

A42: 1,452 ft \div 20 ft

72.6 ft

B43: 1,452 ft \div 24 ft

60.5 ft

A42: Round to

73 ft

B43: Round to

61 ft

Calculate Unit Length

A42: 18 A42s \div 2 Rows

9 A42s per Row

B43: 15 B43s \div 2 Rows

7.5

A42: 9 A42s x 4 ft per A42

36 ft

B43: Round to

8 B43s per Row

B43: 8 B43s x 4 ft per B43

32 ft

Determine Lateral Spacing

Lateral to Lateral Spacing = Bed Width \div Number of Rows

A42: 20 ft \div 2 Rows

10 ft

B43: 24 ft \div 2 Rows

12 ft

Lateral to Edge Spacing = Lateral to Lateral Spacing \div 2

A42: 10 ft \div 2

5 ft

B43: 12 ft \div 2

6 ft

Determine Module Spacing in Bed

(Bed Length – Unit Length) \div 2

A42: (73 ft – 36 ft) \div 2

18.5 ft

B43: (61 ft – 32 ft) \div 2

14.5 ft

A42: Round to

18.5 ft

B43: Round to

14.5 ft

4.0 Bed Installation Sizing and Guidelines

Final Dimension Layout

(Note: System layout and number of rows will vary based on site constraints)

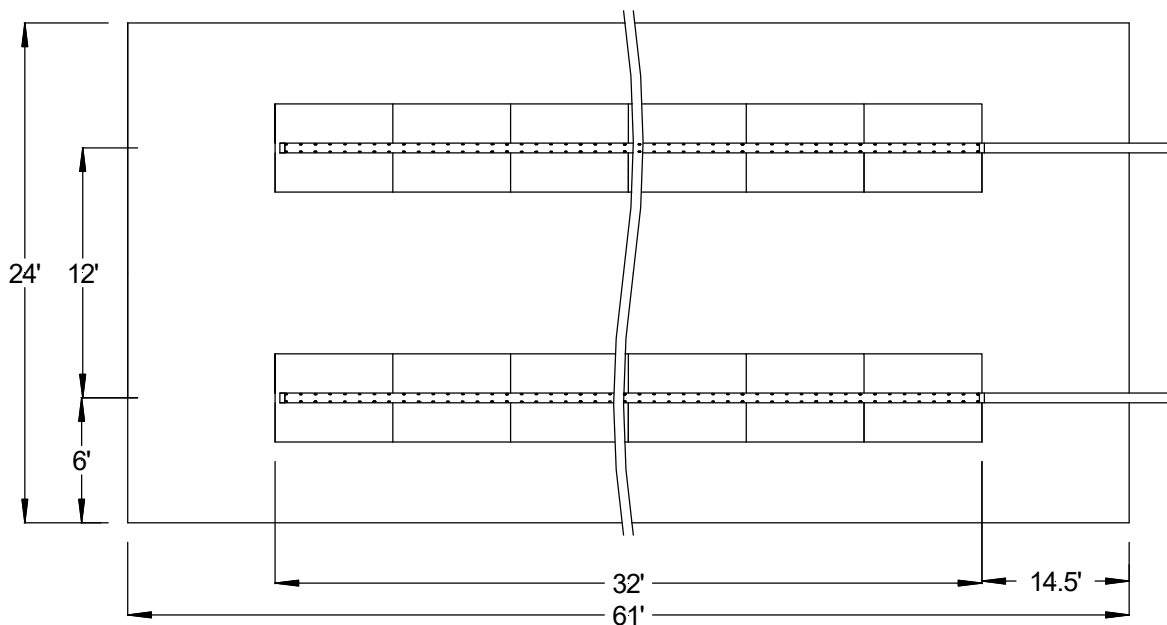
A42

Bed Length	73 ft.
Bed Width	20 ft.
Minimum Number of Units	18 Units
Units per Row	9 units per row
Lateral to Lateral Spacing	10 ft.
Lateral to Edge Spacing	5 ft.
Edge of System to Module	18.5 ft
System Area	1,460 ft ²

B43

Bed Length	61 ft.
Bed Width	24 ft.
Minimum Number of Units	16 Units
Units per Row	8 units per row
Lateral to Lateral Spacing	12 ft.
Lateral to Edge Spacing	6 ft.
Edge of System to Module	14.5 ft
System Area	1,464 ft ²

FIGURE 13: PLAN VIEW – B43 BED SYSTEM EXAMPLE – LEVEL SITE



Note: The system in figure 13 requires adjustment. For the B43 example, add 3 additional units to each row (total 6 additional units) to lessen the amount of empty sand from the beginning and end of the bed. For the A42 example, add 5 additional units to each row (total 10 additional units) to lessen the amount of empty sand from the beginning and end of the bed. The other option for either the A42 or B43 system is to space the units out along the lateral, however the system would require pump or siphon dose to gravity or pressure distribution. The next example shows how this is done.

4.0 Bed Installation Sizing and Guidelines

Final Dimension Layout

(Note: System layout and number of rows will vary based on site constraints)

A42

Bed Length	73 ft.
Bed Width	20 ft.
Number of Units used	28 Units
Units per Row	14 units per row
Lateral to Lateral Spacing	10 ft.
Lateral to Edge Spacing	5 ft.
Edge of System to Module	8.5 ft
System Area	1,460 ft ²

B43

Bed Length	61 ft.
Bed Width	24 ft.
Minimum Number of Units	22 Units
Units per Row	11 units per row
Lateral to Lateral Spacing	12 ft.
Lateral to Edge Spacing	6 ft.
Edge of System to Module	8.5 ft
System Area	1,464 ft ²

FIGURE 13: ADJUSTED PLAN VIEW – B43 BED SYSTEM EXAMPLE – LEVEL SITE

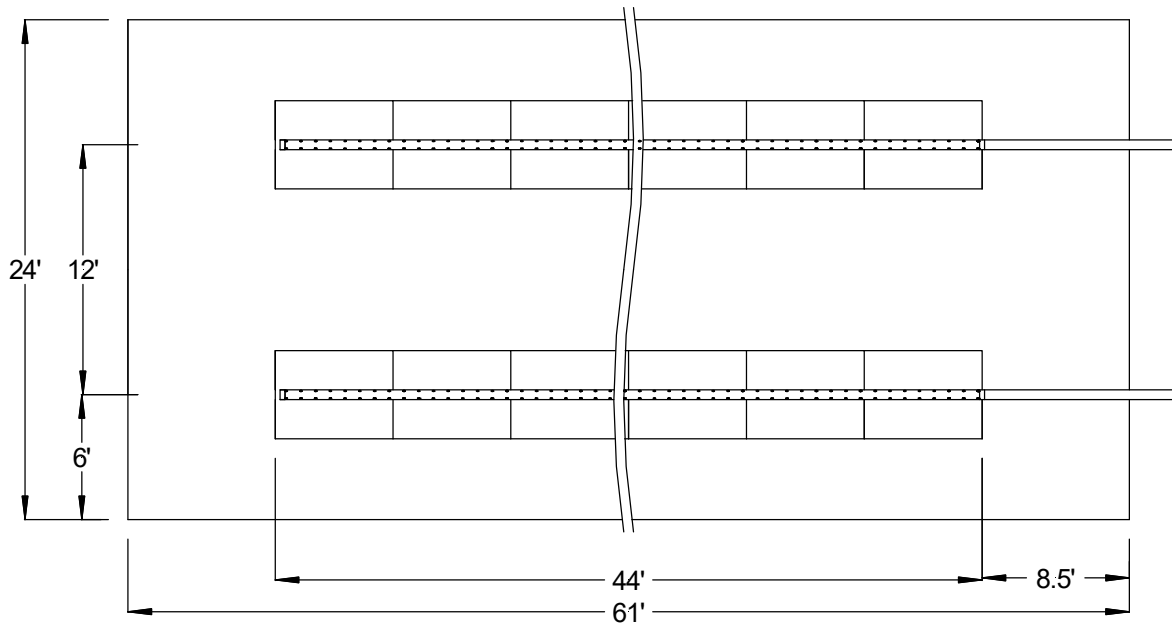
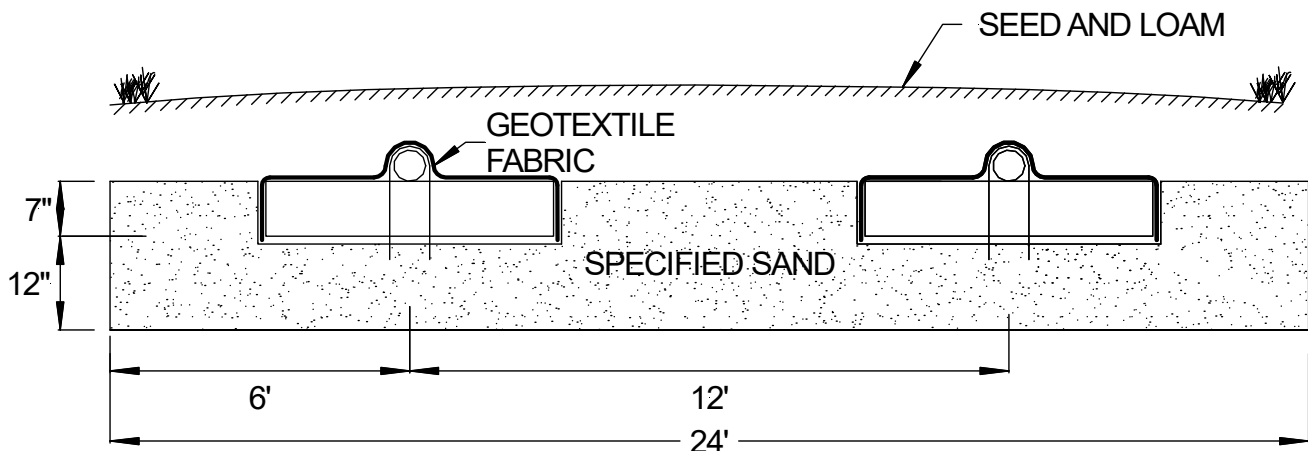


FIGURE 14: SECTION VIEW – BED SYSTEM EXAMPLE



4.0 Bed Installation Sizing and Guidelines

Bed Example: 2

House size: 3 Bedrooms
 Daily Design Flow: Bedrooms x 150 gpd = 450 gpd
 Soil Characteristic: 0.27 gpd/ft²
 Linear Loading Rate from Hydraulic Analysis: 4 gal/day/ft

Minimum Number of Units

Lookup the information required from Table 2:

GPD FLOW	150	300	450	600	750	900	1050
Number of Modules Required for A42	6	12	18	24	30	36	42
Number of Modules Required for B43	5	10	15	20	25	30	35

A42: 18 Units

B43: 15 Units

SARa

Lookup the information required from Table 4:

Sequence of Soil Characteristics Questions	SAR, Trench, Chamber, and Pit gal/day/ft ²	SARa	SAR Bed gal/day/ft ²	SARa
J. Is the texture sandy clay loam, clay loam, or silty clay loam and the structure moderate or strong?	0.4	0.885	0.27	0.48

Minimum Absorption Area required

$$\text{GPD} \div \text{SARa} = \text{Minimum Trench Bottom Area}$$

$$450 \text{ gpd} \div 0.48 \text{ gpd/ft}^2 = 937.5 \text{ ft}^2, \text{ round to } 938 \text{ ft}^2$$

Minimum Bed Length required

$$\text{GPD} \div \text{Linear Loading Rate} = \text{Minimum Trench Length}$$

$$450 \text{ gpd} \div 4 \text{ gpd/day/ft} = 112.5 \text{ linear ft, round to } 113 \text{ ft}$$

Bed Width

$$\text{Minimum Absorption Area} \div \text{Minimum Bed Length} = \text{Bed Width}$$

$$938 \text{ ft}^2 \div 113 \text{ ft} = 8.3 \text{ ft, round to } 8.5 \text{ ft.}$$

Determine Lateral Spacing

$$\text{Lateral to Lateral Spacing} = \text{Bed Width} \div \text{Number of Rows}$$

$$8.5 \text{ ft} \div 2 \text{ Rows} = 4.25 \text{ ft}$$

$$\text{Lateral to Edge Spacing} = \text{Lateral to Lateral Spacing} \div 2$$

$$4.25 \text{ ft} \div 2 \text{ Rows} = 2.125 \text{ ft}$$

Determine Module Spacing in Bed

$$((\text{Minimum Bed Length} - 6 \text{ ft}) \div (\text{Number of Units per Row} - 1)) - 4 \text{ ft} = \text{Edge to Edge Module Spacing}$$

$$\text{A42: } ((113 \text{ ft} - 6 \text{ ft}) \div (9 - 1)) - 4 \text{ ft} =$$

$$\text{A42: } (107 \text{ ft} \div 8) - 4 \text{ ft} =$$

$$\text{A42: } 13.4 \text{ ft} - 4 \text{ ft} =$$

9.4 ft

$$\text{B43: } ((113 \text{ ft} - 6 \text{ ft}) \div (8 - 1)) - 4 \text{ ft} =$$

$$\text{B43: } (107 \text{ ft} \div 7) - 4 \text{ ft} =$$

$$\text{B43: } 15.3 \text{ ft} - 4 \text{ ft} =$$

$$\text{B43:}$$

11.3 ft*
10.0 ft

*The maximum spacing is 10 ft (per Sections 2.5, 2.17 of this manual)

4.0 Bed Installation Sizing and Guidelines

Final Dimension Layout

(Note: System layout and number of rows will vary based on site constraints)

A42

Bed Length	113 ft.
Bed Width	8.5 ft.
Minimum Number of Units	18 Units
Units per Row	9 units per row
Lateral to Lateral Spacing	4.25 ft.
Lateral to Edge Spacing	2.125 ft.
Edge to Edge Module Spacing	9.4 ft
System Area	960.5 ft ²

B43

Bed Length	113 ft.
Bed Width	8.5 ft.
Minimum Number of Units	16 Units
Units per Row	8 units per row
Lateral to Lateral Spacing	4.25 ft.
Lateral to Edge Spacing	2.125 ft.
Edge to Edge Module Spacing	10.0 ft
System Area	960.5 ft ²

FIGURE 15: PLAN VIEW – A42 BED SYSTEM EXAMPLE

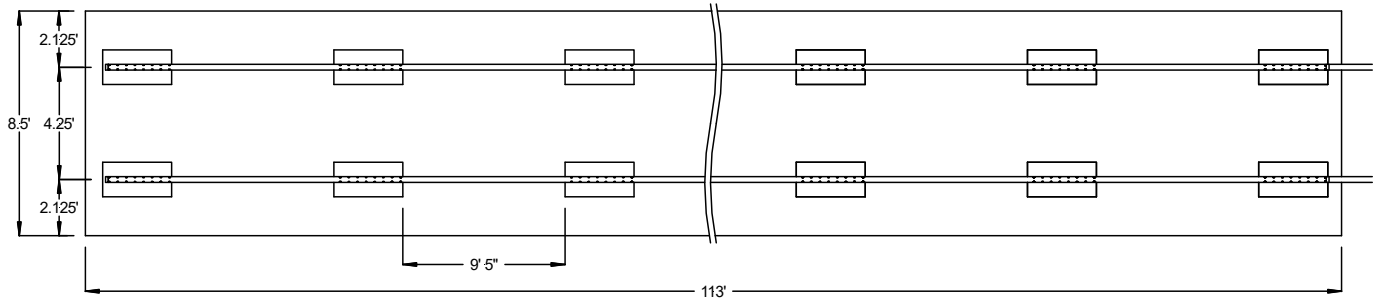
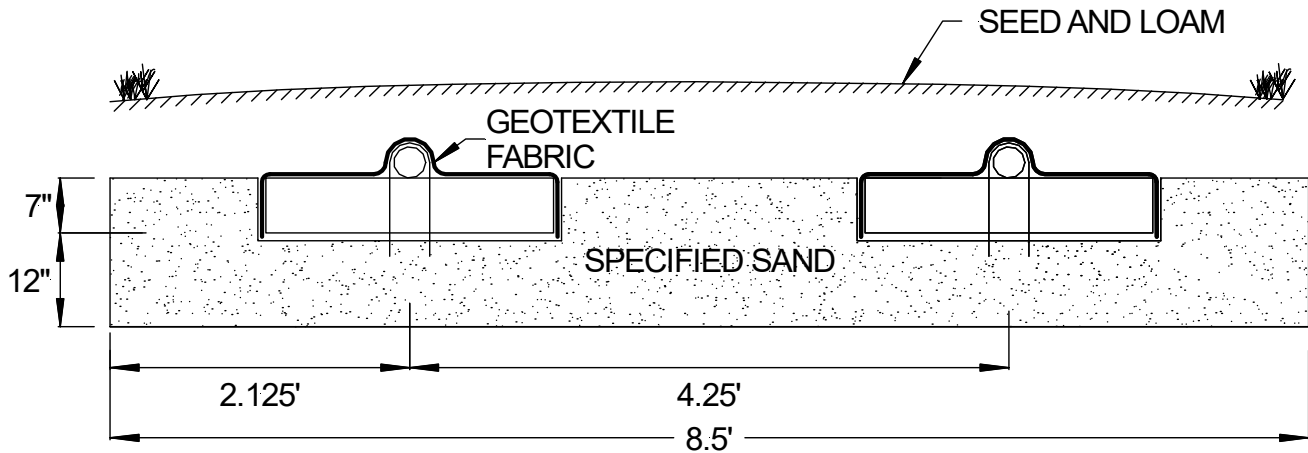


FIGURE 16: SECTION VIEW – BED SYSTEM EXAMPLE



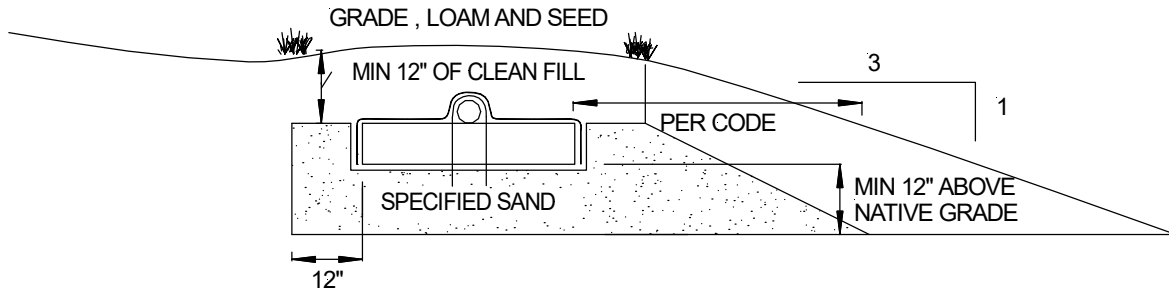
4.0 Bed Installation Sizing and Guidelines

1. Ensure all components leading to the GSF system are installed properly. Septic tank effluent filters are required with the GSF system.
2. Determine the number of GSF Modules required using the bed sizing example.
3. Prepare the site. Do not install a system on saturated ground or wet soils that are smeared during excavation. Keep machinery off infiltrative areas.
4. Plan all drainage requirements above (up-slope) of the system. Set soil grades to ensure that storm water drainage and ground water is diverted away from the absorption area once the system is complete.
5. Excavate the bed absorption area; prepare the receiving layer to maximize the interface between the native soil and specified sand.
6. Minimize walking in the absorption area prior to placement of the specified sand to avoid soil compaction.
7. Place specified sand in 6" lifts, stabilize by foot, a hand held tamping tool or a portable vibrating compactor. The minimum stabilized height below the GSF module must be level at 12".
8. Place GSF modules with **PAINTED STRIPE FACING UP**, end to end on top of the specified sand along their 4-foot length.
9. A standard 4-inch perforated pipe, SDR 35 or equivalent, is centered along the modules 4-foot length. Orifices are set at the 4 & 8 o'clock position.
10. All 4-inch pipes are secured with manufacturers supplied wire clamps, one per module.
11. (Pressure Distribution Systems) Insert a pressure pipe (size per design and code) into the standard 4-inch perforated pipe. The pressure pipe orifices are set at the 12 o'clock position as shown in Figure 19. Each pressure lateral will have a drain hole at the 6 o'clock position. Each pressure lateral shall include sweeping cleanouts at the terminal ends and be accessible from grade.
12. **Cover fabric substitution is not allowed.** The installer should lay the Eljen provided geotextile cover fabric lengthwise down the row, with the fabric fitted to the perforated pipe on top of the GSF modules. Fabric should be neither too loose, nor too tight. The correct tension of the cover fabric is set by:
 - a. Spreading the cover fabric over the top of the module and down both sides of the module with the cover fabric tented over the top of the perforated distribution pipe.
 - b. Place shovelfuls of Specified Sand directly over the pipe area allowing the cover fabric to form a mostly vertical orientation along the sides of the pipe. Repeat this step moving down the pipe.
13. Place 12 inches of Specified Sand along both sides of the modules edge. A minimum of 12 inches of Specified Sand is placed at the beginning and end of each module row. Beds on level sites require a minimum spacing of 12" of Specified Sand between parallel module rows.
14. Complete backfill with a minimum of 12 inches of clean porous fill measured from the top of the pipe. Backfill exceeding 18 inches requires venting at the far end of the bed. Use well graded native soil fill that is clean, porous and devoid of large rocks. Do not use wheeled equipment over the system. A light track machine may be used with caution, avoiding crushing or shifting of pipe assembly.
15. Divert surface runoff from the system. Finish grade to prevent surface ponding. Topsoil and seed system area to protect from erosion.

5.0 Above Grade Installation Guidelines

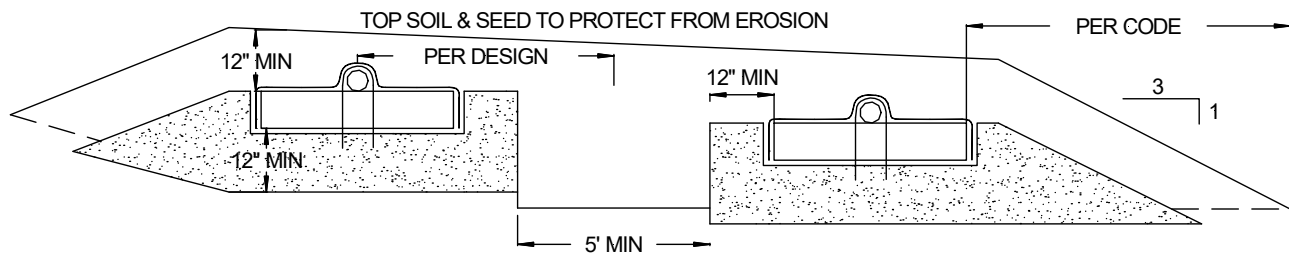
5.1 INSTALLING ABOVE NATURAL SOIL GRADE: If the portions of the installation that is to be installed above natural soil grade (as specified in R18-9-E309.D.4.b), the following guidelines provide an overview for a above grade design and construction. Above grade distribution can be either gravity feed, pumped dosed, siphon dosed or pressure dosed. If pressure distribution is used, then the design should include the requirements of R18-9-E304.

FIGURE 17: INSTALLING ABOVE NATURAL SOIL GRADE



*Note: Design Can Utilize Either B43 or A42 Modules

FIGURE 18: CROSS SECTION – SLOPED ABOVE GRADE SYSTEM



REMOVE TOP SOIL & SET SYSTEM BASE BELOW ORIGINAL GRADE

*Note: Design Can Utilize Either B43 or A42 Modules

5.0 Above Grade Installation Guidelines

1. Ensure all components leading to the GSF system are installed properly. Septic tank effluent filters are required with the GSF system.
2. Determine the number of GSF Modules required using the sizing formula.
3. Prepare the site. Do not install a system on saturated ground or wet soils that are smeared during preparation. Keep machinery off infiltrative areas.
4. Plan all drainage requirements above (up-slope) of the system. Set soil grades to ensure that storm water drainage and ground water is diverted away from the absorption area once the system is complete.
5. Remove the organic soil layer. Prepare the receiving layer to maximize the interface between the native soil and Specified Sand. Minimize walking in the absorption area prior to placement of the Specified Sand to avoid soil compaction.
6. Place fill material meeting local requirements (or Specified Sand requirements) onto the soil interface as you move down the excavated area. Place specified sand in a 6" lift, stabilize by foot, a hand held tamping tool or a portable vibrating compactor. The stabilized height below the GSF module must shall meet the above grade design requirements.
7. Place GSF modules with **PAINTED STRIPE FACING UP**, end to end on top of the specified sand along their 4-foot length.
8. A standard perforated 4-inch distribution pipe is centered along the modules 4-inch length. Orifices are set at the 4 & 8 o'clock position.
9. All distribution pipes are secured with manufacturers supplied wire clamps, one per module.
10. (Pressure Distribution Systems) Insert a PVC Sch. 40 pressure pipe (size per design and code) into the standard perforated distribution pipe. The pressure pipe orifices are set at the 12 o'clock position as shown in Figure 19. Each pressure lateral will have a drain hole at the 6 o'clock position. Each pressure lateral shall include sweeping cleanouts at the terminal ends and be accessible from grade.
11. **Cover fabric substitution is not allowed.** The installer should lay the Eljen provided geotextile cover fabric lengthwise down the row, with the fabric fitted to the perforated pipe on top of the GSF modules. Fabric should be neither too loose, nor too tight. The correct tension of the cover fabric is set by:
 - a. Spreading the cover fabric over the top of the module and down both sides of the module with the cover fabric tented over the top of the perforated distribution pipe.
 - b. Place shovelfuls of Specified Sand directly over the pipe area allowing the cover fabric to form a mostly vertical orientation along the sides of the pipe. Repeat this step moving down the pipe.
12. Ensure there is 12 inches of specified sand surrounding the GSF modules in the above grade. Slope the sand away from the system as described on the plan.
13. Complete backfill with a minimum of 12 inches of cover material measured from the top of the module. Use well graded native soil fill that is clean, porous and devoid of large rocks. Do not use wheeled equipment over the system. A light track machine may be used with caution, avoiding crushing or shifting of pipe assembly. Divert surface runoff from the system. Finish grade to prevent surface ponding. Topsoil and seed system area to protect from erosion.
14. Divert surface runoff from the system. Finish grade to prevent surface ponding. Topsoil and seed system area to protect from erosion.

6.0 Dosing Distribution Guidance

6.1 PUMP TO DISTRIBUTION BOX: Specify an oversized distribution box for pumped dosed systems. Provide velocity reduction in the d-box with a tee or baffle. Set d-box outlets at the same elevation to equalize flow to each line or use drop boxes at the head of each line for serial distribution. If the absorption area is installed deeper than 18 inches, the system must be vented. See section 10.0 of this manual for detailed information on venting of systems.

6.2 DOSING DESIGN AND FLOW RATE: Dosing volume must be set to deliver a maximum of 4 gallons per B43 Module and 3 gallons per A42 Module per dosing cycle. Higher flow rates and short dose cycle push the effluent down the line and thus disperse the effluent over a larger area. A valve on the force main is recommended to set the flow rate so that the outlet pipes are submerged but prevents the d-box from over flowing.

For residential strength wastewater, the maximum B43 Module design flow shall not exceed 30 gallons per day per module; the maximum A42 Module design flow shall not exceed 25 gallons per day per module.

6.3 SIPHON DOSING DESIGN: Siphon dosing is available for the GSF system. Set the siphon to deliver a maximum of 4 gallons per B43 Module and 3 gallons per A42 Module per dosing cycle. Ensure the siphon is free of any obstructions in the dose tank.

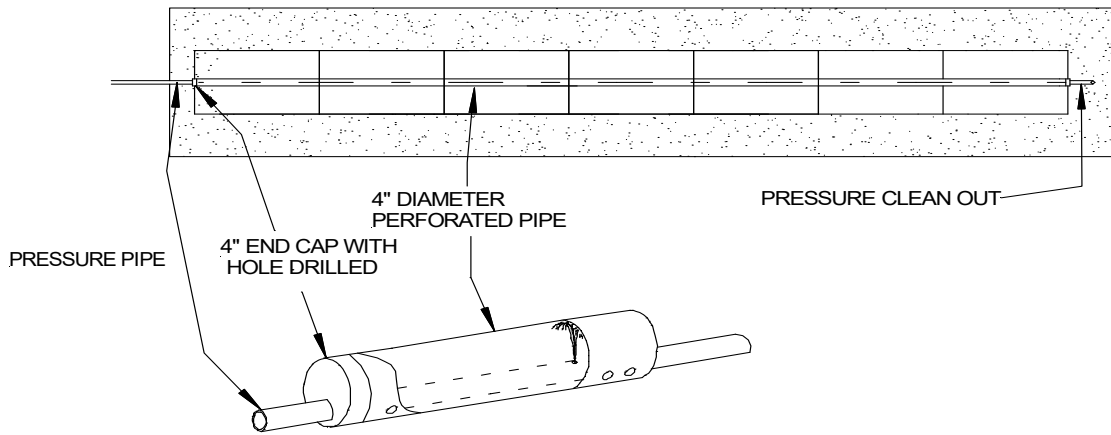
7.0 Pressure Distribution Guidance

7.1 PRESSURE DISTRIBUTION: Dosing with small diameter pressurized laterals is acceptable for GSF systems. The pipe networks must be engineered and follow principles established for pressure distribution. Flushing ports are required to maintain the free flow of effluent from orifices at the distal ends of each lateral. Contact Eljen's Technical Resource Department at 1-800-444-1359 for more information on pressure distribution systems

The pressure distribution requirements contained in section R18-9-E304 provide guidance on the performance, design requirements, maintenance procedures of the pressure distribution system. Adjust pump gallons per minute and run time to achieve the above maximum dose and maintain 4 – 24 doses a day per R18-9-E309(D)(1)(B).

Standard procedures for design of pressure distribution networks apply to the GSF filter. Minimum orifice and lateral pipe size are based on design. A ¼ inch diameter drain hole is required at the beginning of each row at the 6 o'clock position of each pressure lateral for drainage purposes. The lateral pipe network is placed within a standard 4-inch perforated pipe. The perforation in the 4-inch outer pipe are set at the 5 and 7 o'clock position, the drilled orifices on the pressure pipe are set to spray at the 12 o'clock position directly to the top of the 4-inch perforated pipe as shown below.

FIGURE 19: PRESSURE PIPE PLACEMENT



PRESSURE PIPE CROSS SECTION FOR ALL APPLICATIONS

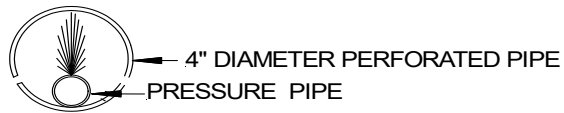
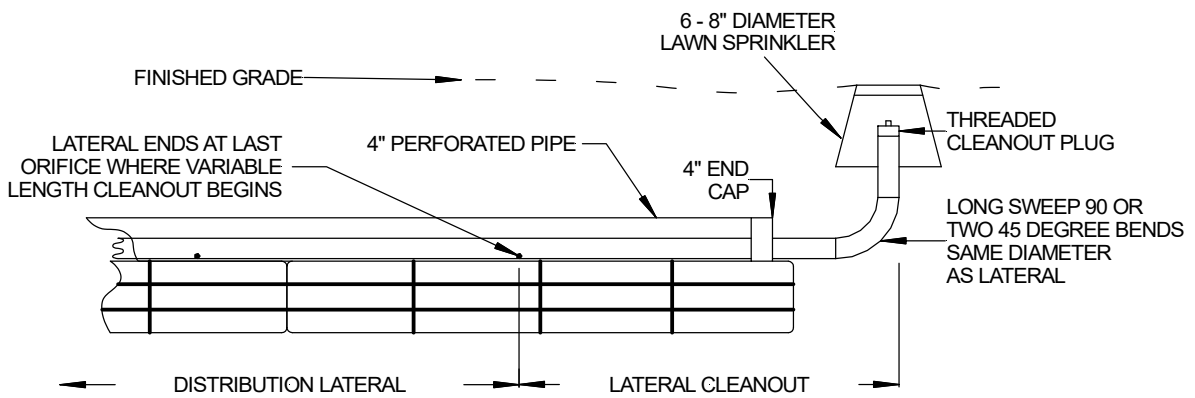
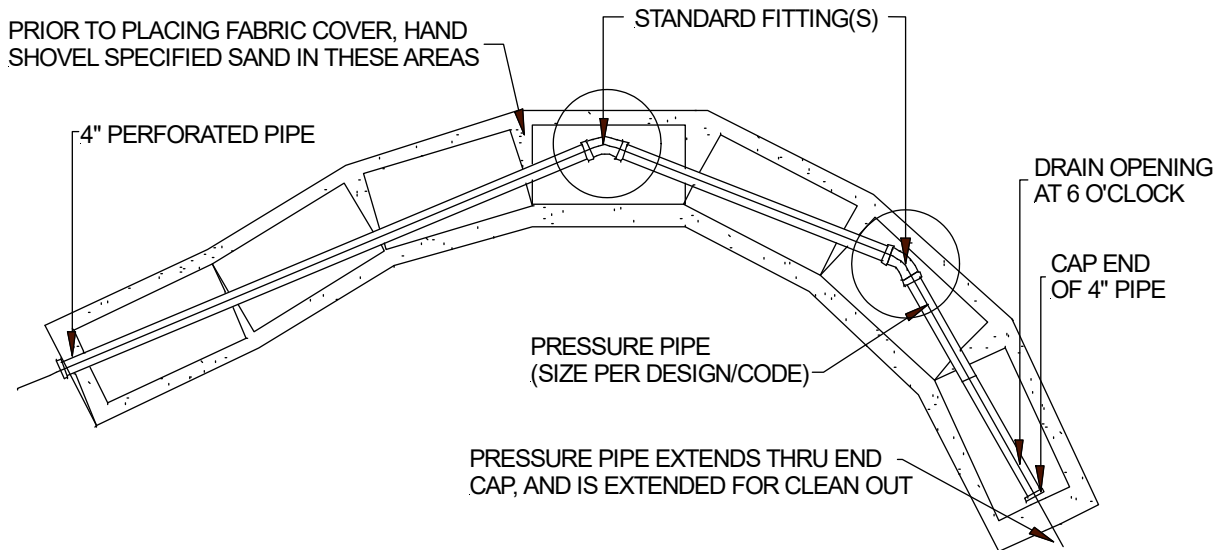


FIGURE 20: PRESSURE CLEAN OUT



7.0 Pressure Distribution Guidance

FIGURE 21: CONTOURED TRENCH PRESSURE DISTRIBUTION



GSF Pressure Distribution trench placed on a contour or winding trenches to maintain horizontal separation distances may also be used in Dosed or Gravity system by removing the pressure pipe and using the 4-inch diameter perforated distribution pipe.

8.0 Pump Controls

ELECTRICAL CONTROLS: Demand and Pressure Dosed controlled systems will include an electrical control system that has the alarm circuit independent of the pump circuit, controls, and components that are listed by UL or equivalent, is located outside, within line of sight of the pump chamber and is secure from tampering and resistant to weather (minimum of NEMA 4). The control panel shall be equipped with cycle counters and elapsed time meters. Where a water supply water meter is available it may be possible to eliminate the counters or timers.

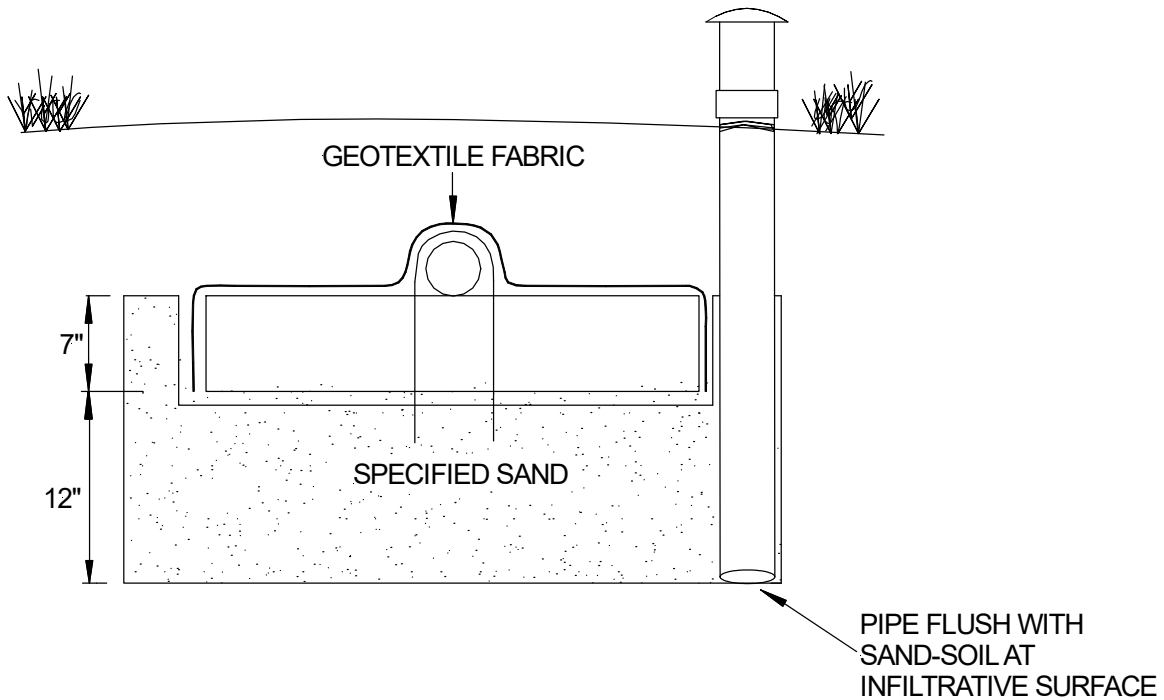
The control panel shall be equipped with both audible and visual high liquid level alarms installed in a conspicuous location. Float switches shall be mounted independent of the pump and transport line so that they can be easily replaced and/or adjusted without removing the pump.

9.0 Inspection/Monitoring Port

9.1 MONITORING REQUIREMENTS: The system shall include an Inspection/Monitoring Port designed and installed with access from the ground surface. It shall be open at the bottom, and be void of sand or gravel to the infiltrative surface to allow visual monitoring of standing liquid in the field. The figures below depict construction and placement of the Inspection/Monitoring Port. Positioning of the port in reference to the length of the trench is in accordance to your local regulations and specifications. Refer to R18-9-A312(F)(2)(A) for more information regarding the State of Arizona's code on Monitoring Wells.

9.2 INSPECTION / MONITORING WELL CONSTRUCTION: Place a solid piece of pipe at the ends of the row of modules and extend it to 6" above the finish grade elevation. Place a removable cap on the solid section of the pipe. The figures below depict placement of the Inspection/Monitoring Port. Positioning of the port in reference to the length of the row of modules is in accordance to your local regulations and specifications. Refer to R18-9A312(F)(2)(A) for more information regarding the State of Arizona's code on Monitoring Wells.

FIGURE 22: MONITORING WELL FOR SAND-SOIL INTERFACE

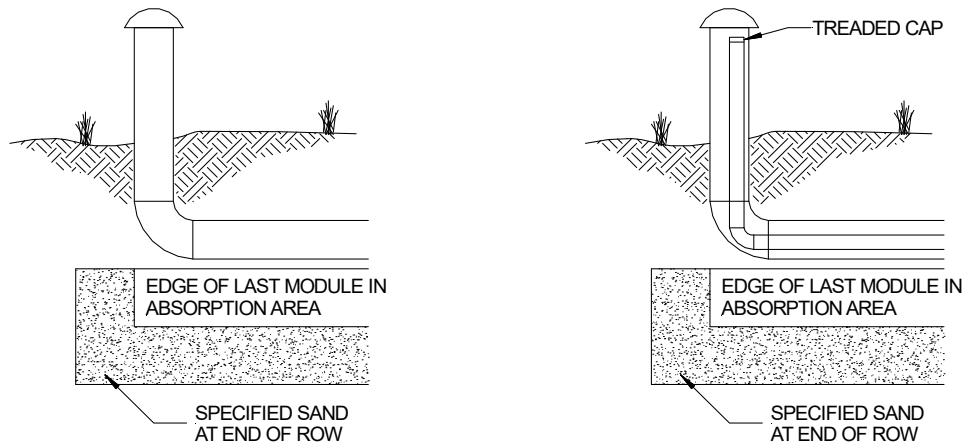


10.0 System Ventilation

10.1 SYSTEM VENTILATION: Air vents are required on all absorption systems located under impervious surfaces or systems **with more than 18 inches of cover material** as measured from the top of the GSF module to finished grade. This will ensure proper aeration of the modules and sand filter. The GSF has aeration channels between the rows of GSF modules connecting to cuspatations within the GSF modules. Under normal operating conditions, only a fraction of the filter is in use. The unused channels remain open for intermittent peak flows and the transfer of air.

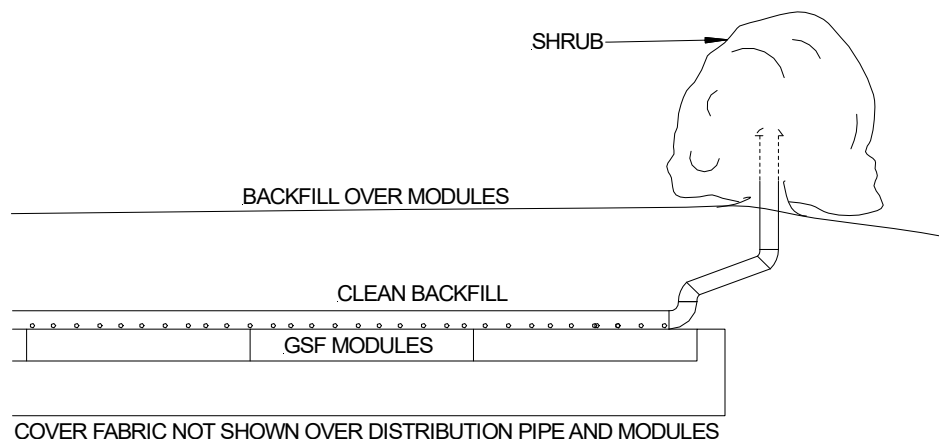
10.2 VENT PIPE FOR GRAVITY AND LOW-PRESSURE SYSTEMS: Systems with over 18" of cover over the top of the modules require a vent. If the system is a low-pressure distribution system, ensure that the LPP clean outs are located in the vent for easy access.

FIGURE 23: VENT LAYOUTS FOR GRAVITY AND LOW-PRESSURE SYSTEMS



10.3 VENTILATION PLACEMENT: In a GSF system, the vent is usually a 4-inch diameter pipe extended to a convenient location behind shrubs, as shown in the figure below. Corrugated pipe may be used. If using corrugated pipe, ensure that the pipe does not have any bends that will allow condensation to pond in the pipe. This may close off the vent line. The pipe must have an invert higher than the system so that it does not drain effluent.

FIGURE 24: GSF WITH 4" VENT EXTENDED TO CONVENIENT LOCATION



COMPANY HISTORY

Established in 1970, Eljen Corporation created the world's first prefabricated drainage system for foundation drainage and erosion control applications. In the mid-1980s, we introduced our Geotextile Sand Filter products for the passive advanced treatment of onsite wastewater in both residential and commercial applications. Today, Eljen is a global leader in providing innovative products and solutions for protecting our environment and public health.

COMPANY PHILOSOPHY

Eljen Corporation is committed to advancing the onsite industry through continuous development of innovative new products, delivering high quality products and services to our customers at the best price, and building lasting partnerships with our employees, suppliers, and customers.



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