Geotextile Sand Filter

Wisconsin

Design and Installation Manual

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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. Barrier material cannot be substituted.

Daily Wastewater Flow or Design Flow One- and two-family dwellings are typically designed at 150 gal/day/bedroom. Other structures or calculations for blackwater are found in Table 4 or s. 383.43(6), Wis. Adm. Code.

GSF Unit The Eljen Geotextile Sand Filter Modules and the 12-inch sand layer at the base and 6 – 18 inches along the sides of the modules.

GSF Module The individual module of a GSF system. The module is comprised of a cuspated plastic core and geotextile fabric.

Specified Sand To ensure proper system operation, the system MUST be installed using ASTM C33 Sand. Mound sand in Wisconsin typically meets these requirements.

ASTM C33 sand will have less than 10% passing the #100 Sieve and less 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	5 - 30
No. 100	149 µm	0 - 10
No. 200	75 µm	0 - 5

GSF System Description

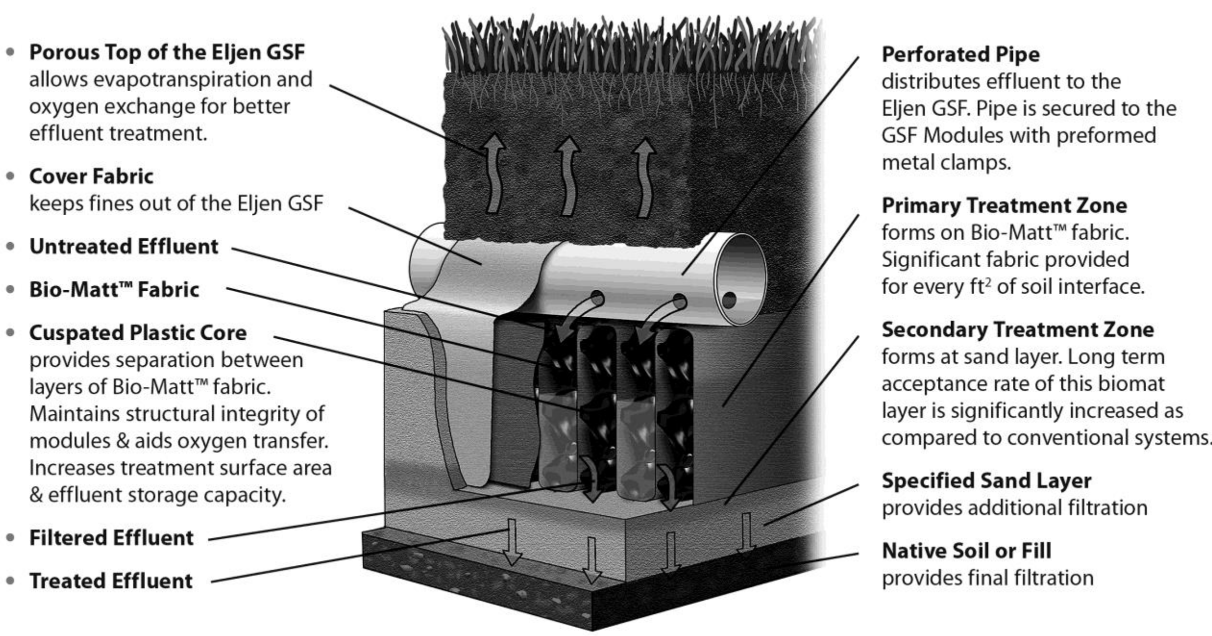
Primary Treatment Zone

- Perforated pipe is centered above the GSF module to distribute septic effluent over and into corrugations created by the cuspated core of the geotextile module.
- Septic effluent is filtered through the Bio-Matt (geotextile) 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.
- A cover 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 Conditions for Use

1.0.1 ALTERATION OF MODULES: GSF modules shall not be altered by cutting or any other type of physical modification.

1.0.2 WATER SOFTENER BACKWASH: Water softener backwash shall be discharged to a separate soil absorption field meeting all required state codes and local regulations.

1.0.3 SEPTIC TANK OUTLET FILTERS: Eljen requires the use of outlet filters on all tanks including single compartment tanks, up-sized tanks or when the dwelling has a garbage disposal installed.

1.0.4 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:

- Increase the septic tank capacity by a minimum of 30% *or*
- Installation of a second septic tank installed in series if a multi-compartment tank isn't used

1.0.5 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.

1.0.6 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.

1.0.7 ELJEN INSTALLER CERTIFICATION: All installers are required to be trained and certified by an authorized Eljen representative. Contact your local distributor for training information.

1.1 System Design

1.1.1 REQUIREMENTS: GSF systems must meet the local rules and regulations except as outlined in this manual. This manual is not a substitute for the Wisconsin Component manuals governing the use of Eljen GSF in Wisconsin, however this is a reference guide. The Wisconsin State regulations and applicable component manuals will be referred to as the *guidelines*.

The sizing charts apply to residential systems only and are found in section 1.1.4. Please contact Eljen's Technical Resource Department at 1-800-444-1359 for design information on commercial systems.

1.1.2 NUMBER OF GSF MODULES REQUIRED: Calculations in this manual will show how to arrive at the minimum number of modules required for the system. Systems can always be designed beyond the minimum required number of modules. The minimum design requirements per 150 gpd are 6 A42 modules or 5 B43 modules.

1.1.3 SUITABLE SITE AND SOIL CONDITIONS: The Eljen Modules may be designed for all sites that meet the criteria of the local approving authority.

1.1.4 SIZING GSF SYSTEMS:

TABLE 2: MINIMUM BASAL AREA AND APPLICATION RATES

Maximum Soil Application Rates Based Upon Morphological Soil Evaluation (in gals./sq. ft./day)						
Soil Characteristics			Maximum Monthly Average			
Texture[d]	Structure[e]		BOD_5 > 30 ≤ 220 mg/L		BOD_5 ≤ 30 mg/L	
	Shape	Grade	TSS > 30 mg/L ≤ 150 mg/L		TSS ≤ 30 mg/L	
COS, S, LCOS, LS	-	0	0.7[a]	0.5[b,c]	1.6[a]	0.5[b]
FS, LFS	-	0	0.5		1.0	
VFS, LVFS	-	0	0.4		0.6	
COSL, SL	-	0M	0.2		0.6	
	PL	1	0.4		0.6	
		2, 3	0.0		0.2	
	PR, BK, GR	1	0.4		0.7	
		2, 3	0.6		1.0	
FSL, VFSL	-	0M	0.2		0.5	
	PL	2, 3	0.0		0.2	
	PL, PR, BK, GR	1	0.2		0.6	
	PR, BK, GR	2, 3	0.4		0.8	
L	-	0M	0.2		0.5	
	PL	2, 3	0.0		0.2	
	PL, PR, BK, GR	1	0.4		0.6	
	PR, BK, GR	2, 3	0.6		0.8	
SIL	-	0M	0.0		0.2	
	PL	2, 3	0.0		0.2	
	PL, PR, BK, GR	1	0.4[c]		0.6	
	PR, BK, GR	2, 3	0.6		0.8	
SI	-	-	0.0		0.0	
SCL, CL, SICL	-	0M	0.0		0.0	
	PL	1, 2, 3	0.0		0.2	
	PR, BK, GR	1	0.2		0.3	
		2, 3	0.4		0.6	
SC, C, SIC	-	0M	0.0		0.0	
	PL	1, 2, 3	0.0		0.0	
	PR, BK, GR	1	0.0		0.0	
		2, 3	0.2		0.3	

Note a: With ≤ 60% rock fragments
Note b: With > 60 to < 90% rock fragments
Note c: Requires pressure distribution

Note d:	COS - Coarse S	LVFS – Loamy Very Fine Sand	SI – Silt
	S–Sand	COSL – Coarse Sandy Loam	SCL – Sandy Clay Loam
	LCOS – Loamy (	SL – Sandy Loam	CL – Clay Loam
	LS – Loamy San	FSL – Fine Sandy Loam	SICL – Silty Clay Loam
	FS – Fine Sand	VFSL – Very Fine Sandy Loam	SC – Sandy Clay
	LFS – Loamy Fi	L – Loam	C – Clay
	VFS – Very Fine	SIL – Silt Loam	SIC – Silty Clay
Note e:	PL – Platy	0 – Structureless	
	PR – Prismatic	1 – Weak	
	BK – Blocky	2 – Moderate	
	GR – Granular	3 – Strong	
	M – Massive		

2.0 Trench Design and Installation

2.0.1 ACCEPTABLE METHODS OF DISTRIBUTION: Gravity, dosed and pressure distribution are acceptable.

2.0.2 DEPTH FROM ORIGINAL GRADE: There is no maximum bury depth, however venting is required once the unit has 18 inches of cover place on top of it. The minimum depth is 13 inches measured from grade.

2.0.3 GENERAL CROSS SECTIONS

FIGURE 2: A42 TRENCH CROSS SECTION

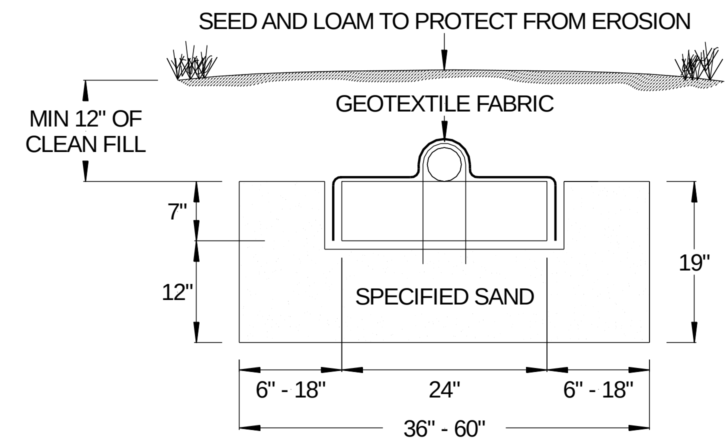
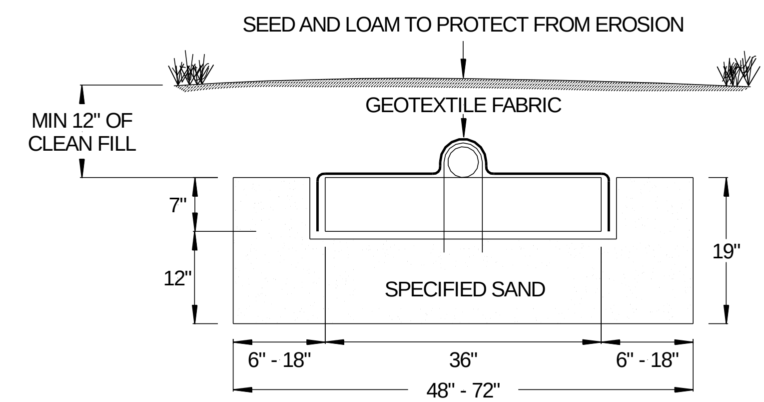


FIGURE 3: B43 TRENCH CROSS SECTION

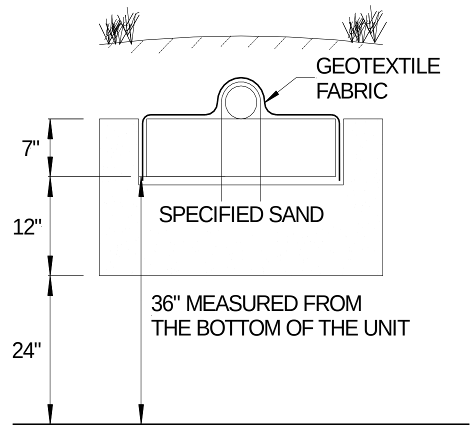


<u>All trenches are required to have a minimum of:</u>

- 6 - 18 inches of Specified Sand at the edges of the GSF module.
- 6 inches of Specified Sand at the beginning and end of each GSF Row.
- 12 inches of Specified Sand directly below the GSF module.
- 12 inches of cover soil material above the unit.

2.0.4 VERTICAL SEPARATION TO SEASONAL HIGH-WATER TABLE OR LIMITING LAYER: The guidelines allow for the Vertical Separation from bottom of the 12 inches of sand under the GSF units to the restrictive layer.

FIGURE 4: VERTICAL SEPARATION DISTANCE



2.0.5 DISTRIBUTION BOX: Parallel distribution is preferred.

2.0.6 PARALLEL DISTRIBUTION: Parallel distribution is the preferred method of application 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.

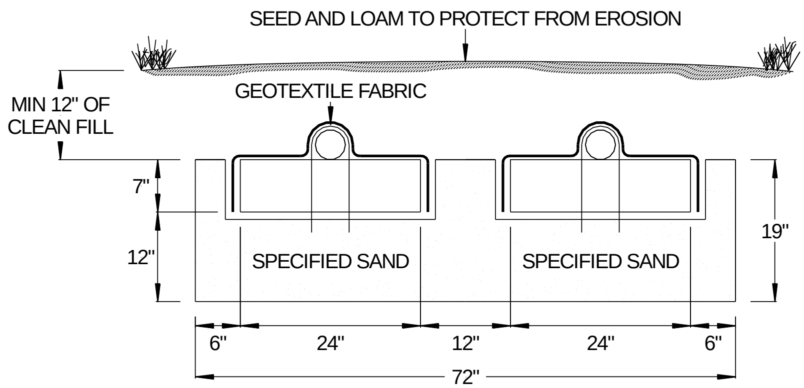
2.0.7 TRENCH WIDTH: The maximum trench width is 6 feet, but there are multiple allowed configurations.

TABLE 3: TRENCH CONFIGURATIONS

Unit	Sand at the Edge of the Unit	Trench Width
A42	6"	3'
A42	12"	4'
B43	6"	4'
A42	18"	5'
B43	12"	5'
2 rows of A42	6"	6'
B43	18"	6'

Figures 2 & 3 show the single unit configuration. The 6' A42 configuration is depicted below.

FIGURE 5: A42 DUAL LATERAL IN-GROUND CROSS SECTION



2.0.8 TRENCH LENGTH: Eljen recommends that the maximum gravity lateral run not exceed 100 feet. If a lateral is supplied from the center, the total length should not exceed 200 feet (100 feet to each side).

2.0.9 EQUAL LENGTH: Eljen recommends trenches are of equal length in order to provide equal distribution.

2.0.10 SPACING GUIDANCE BETWEEN TRENCHES: Adjacent trenches should be separated by at least 3 feet of undisturbed soil.

2.0.11 DISPERSAL AREA: Dispersal area requirements are met by total length and width of each trench added together. Example: 3 trenches x 3 feet wide x 60 feet = 540 square feet of dispersal area.

2.1 Trench Design Example

Trench Example:

House size:	3 Bedrooms
Design Flow:	450 gpd
Soil Description:	Loamy Fine Sand (Eff#1: 0.5 g/d/ft^2)
Absorption Field Type:	Trench

Determine the Application Rate

Lookup the application rate (Eff#2) from Table 2:

Soil Characteristics			Maximum Monthly Average	
Texture[d]	Structure[e]		$BOD_5 > 30 \le 220$ mg/L	$BOD_5 \le 30$ mg/L
	Shape	Grade	TSS > 30 mg/L ≤ 150 mg/L	TSS ≤ 30 mg/L
FS, LFS	-	0	0.5	1.0

Basal Area = Design Flow ÷ Application Rate

450 gpd ÷ 1.0 g/d/ft^2 = 450 ft^2

Trench Width

Choose configuration that fits your site constraints from Table 3:

Unit	Sand at the Edge of the Unit	Trench Width
A42	6"	3'
A42	12"	4'
B43	6"	4'
A42	18"	5'
B43	12"	5'
2 rows of A42	6"	6'
B43	18"	6'

Calculate Minimum Trench Length

Basal Area ÷ Trench Width = Trench Length

450 ft^2 ÷ 5 ft = 90 ft

Calculate Minimum Units Required

(Minimum Trench Length -1) ÷ 4 = Units Required

(90 ft – 1) ÷ 4 = 22.25 units, round up to 23 A42 units

Calculate Trench Length

Units x 4 + 1 ft system sand at end of trench = Trench Length

23 units x 4 + 1 = 93 ft

Final Dimension Layout

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

Min. Trench Length	93 ft
Trench Width	5 ft
Number of Units	23 A42 Units
Min. System Area	465 ft^2

2.1 Trench Design Example

FIGURE 6: PLAN VIEW –TRENCH SYSTEM

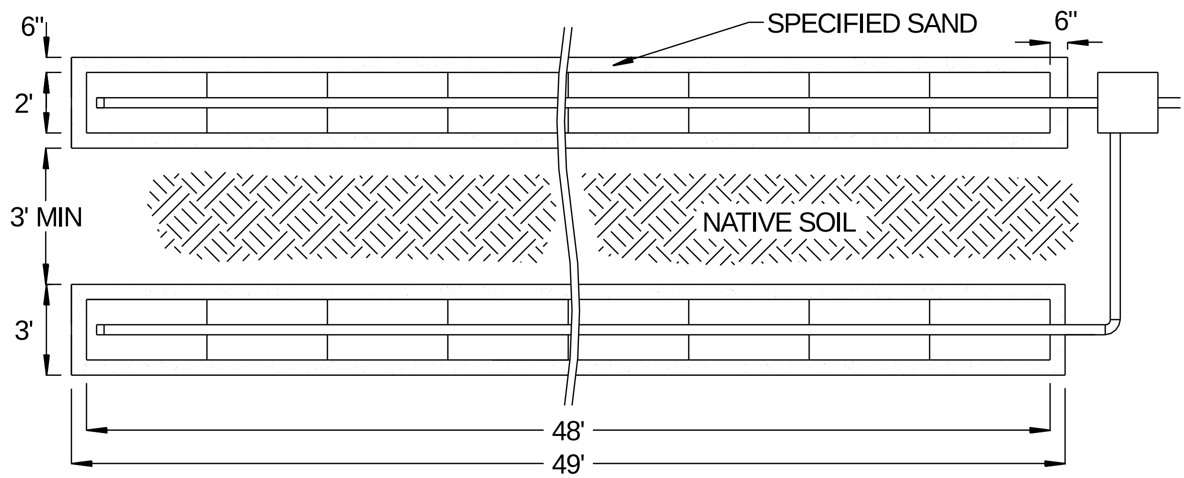


FIGURE 7: SECTION VIEW – TRENCH SYSTEM – LEVEL SITE

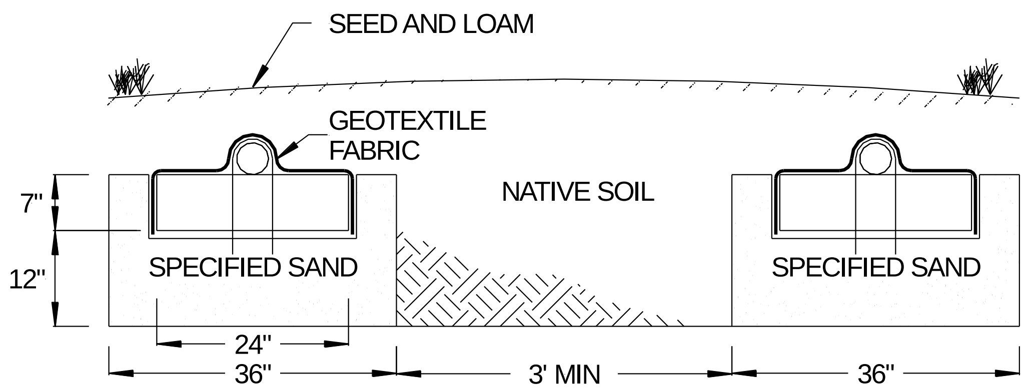
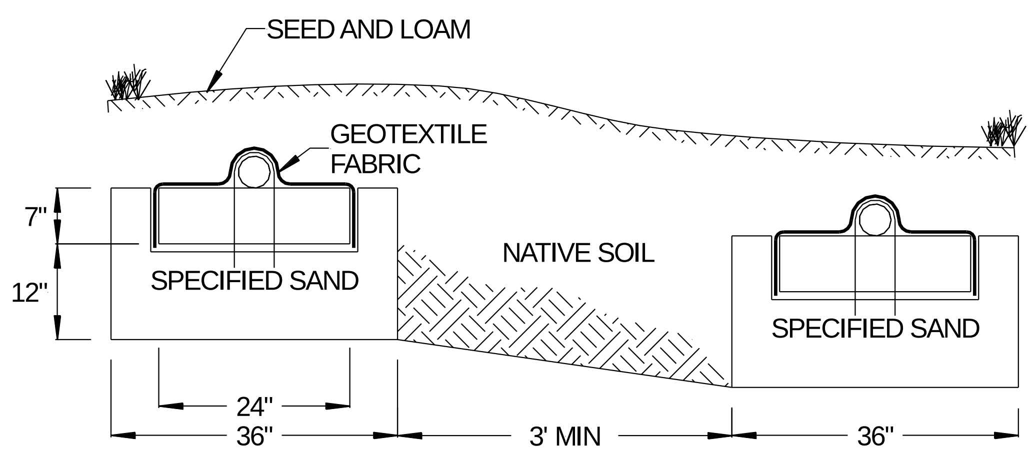


FIGURE 8: SECTION VIEW – TRENCH SYSTEM – SLOPING SITE



2.2 Trench Design Installation Steps

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 in 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; scarify 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 observations ports as required in the excavation. See Section 10 for more info.

8. 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 be level at 12".

9. Place GSF modules with **PAINTED STRIPE FACING UP**, end to end on top of the specified sand along their 4-foot length.

10. 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.

11. All 4-inch pipes are secured with manufacturers supplied wire clamps, one per module.

12. (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 21. 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.

13. ***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.

14. Place 6 inches of Specified Sand along both sides of the modules edge. A minimum of 6 inches of Specified Sand is placed at the beginning and end of each trench.

15. Complete backfill with a minimum of 12 inches of approved cover material measured from the top of the module. Backfill exceeding 18 inches over the top of the unit 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.

16. Divert surface runoff from the system. Finish grade to prevent surface ponding. Topsoil and seed system area to protect from erosion.

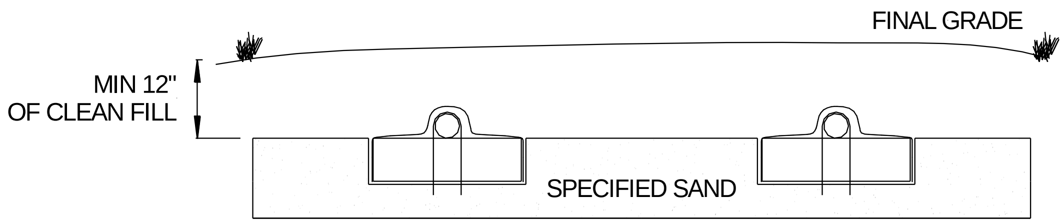
3.0 Bed Design and Installation

3.0.1 ACCEPTABLE METHODS OF DISTRIBUTION: Gravity, dosed and pressure distribution are acceptable.

3.0.2 MINIMUM DEPTH FROM ORIGINAL GRADE: There is no maximum bury depth, however venting is required once the unit has 18 inches of cover place on top of it. The minimum depth is 13 inches measured from grade.

3.0.3 GENERAL CROSS SECTION

FIGURE 9: BED CROSS SECTION

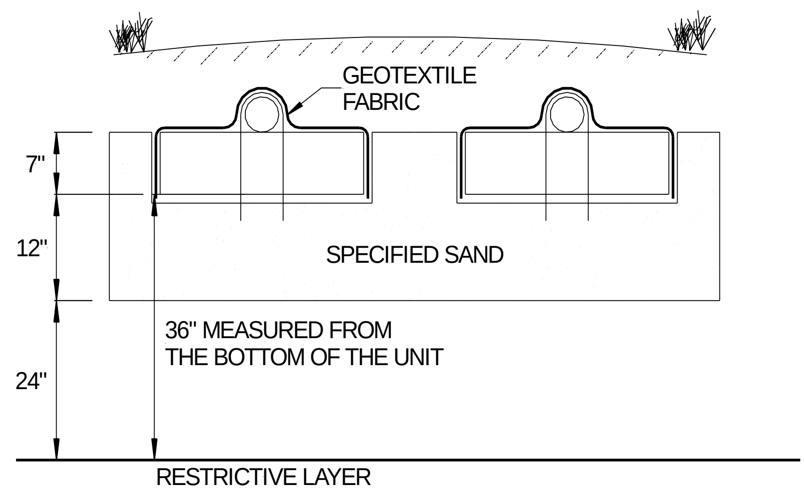


<u>All bed systems are required to have a minimum of:</u>

- 6 - 18 inches of Specified Sand at the edges of the GSF module.
- 6 inches of Specified Sand at the beginning and end of each GSF Row.
- 12 inches of Specified Sand directly below the GSF module.
- 12 inches of cover soil material above the unit

3.0.4 VERTICAL SEPARATION TO SEASONAL HIGH-WATER TABLE OR LIMITING LAYER: The guidelines allow for the Vertical Separation from bottom of the 12 inches of sand under the GSF units to the restrictive layer.

FIGURE 10: BED VERTICAL SEPARATION DISTANCE



3.0.5 DISTRIBUTION BOX: Parallel distribution is preferred. Sequential distribution may be utilized for sloping sites.

3.0.6 PARALLEL DISTRIBUTION: Parallel distribution is the preferred method of application 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 bed systems.

3.0.7 ROWS REQUIRED: All bed systems shall meet one of the configurations below listed in Table 4.

TABLE 4: BED CONFIGURATIONS

Unit	Sand at the Edge of the Unit	Bed Width
2 rows of A42	12"	8'
2 rows of B43	6"	8'
3 rows of A42	6"	9'
2 rows of A42	18"	10'
2 rows of B43	12"	10'

3.0.8 ROW LENGTH: Eljen recommends that the maximum gravity lateral run not exceed 100 feet. If a lateral is supplied from the center, the total length should not exceed 200 feet (100 feet to each side).

3.0.9 EQUAL LENGTH: Eljen recommends rows are of equal length in order to provide equal distribution.

3.0.10 DISPERSAL AREA: Dispersal area requirements are met by total length and width of the bed. Example: 10 feet wide x 60 feet = 600 square feet of dispersal area.

3.0.11 BED DESIGN: Evenly distribute the bed laterals in the basal area for level bed installations. A minimum separation distance between laterals for A42's is 3 feet.

3.1 Level Bed Design Example

Bed Example:

House size:	3 Bedrooms
Design Flow:	450 gpd
Soil Description:	Loamy Fine Sand (Eff#1: 0.5 g/d/ft^2)
Absorption Field Type:	Trench

Determine the Application Rate

Lookup the application rate (Eff#2) from Table 2:

Soil Characteristics			Maximum Monthly Average	
Texture[d]	Structure[e]		$BOD_5 > 30 \leq 220$ mg/L	$BOD_5 \leq 30$ mg/L
	Shape	Grade	TSS > 30 mg/L ≤ 150 mg/L	TSS ≤ 30 mg/L
FS, LFS	-	0	0.5	1.0

Basal Area = Design Flow ÷ Application Rate

450 gpd ÷ 1.0 g/d/ft^2 = 450 ft^2

Bed Width

Choose configuration that fits your site constraints from Table 4:

Unit	Sand at the Edge of the Unit	Bed Width
2 rows of A42	12"	8'
2 rows of B43	6"	8'
3 rows of A42	6"	9'
2 rows of A42	18"	10'
2 rows of B43	12"	10'

Calculate Minimum Bed Length

Basal Area ÷ Bed Width = Bed Length

450 ft^2 ÷ 10 ft = 45 ft

Calculate Units Required

(Minimum Bed Length -1) ÷ 4 = Units per Row

(45 ft – 1) ÷ 4 = 11 A42 units per Row

Calculate Row Length

Units x 4 + 1 ft system sand at end of row = Bed (Row) Length

11 units x 4 + 1 = 45 ft

Final Dimension Layout

Bed Length	45 ft
Bed Width	10 ft
Number of per Row	11 A42 Units
Number of Rows	2 Rows
Min. System Area	450 ft^2

3.1 Level Bed Design Example

FIGURE 11: PLAN VIEW – BED SYSTEM

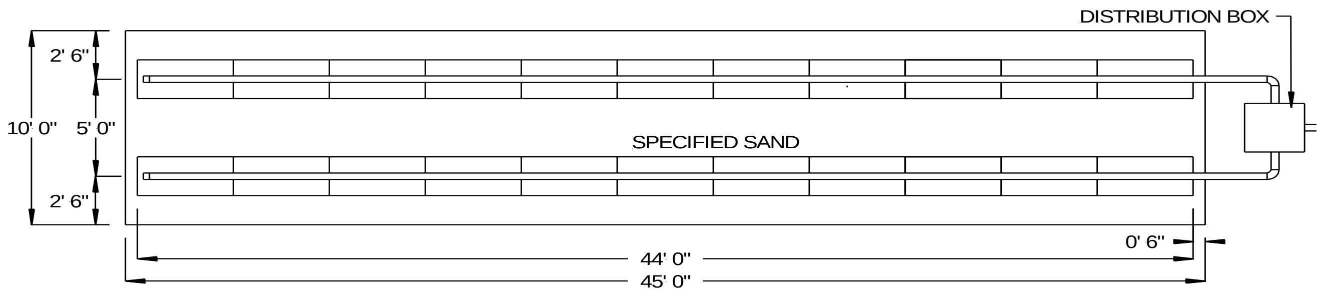
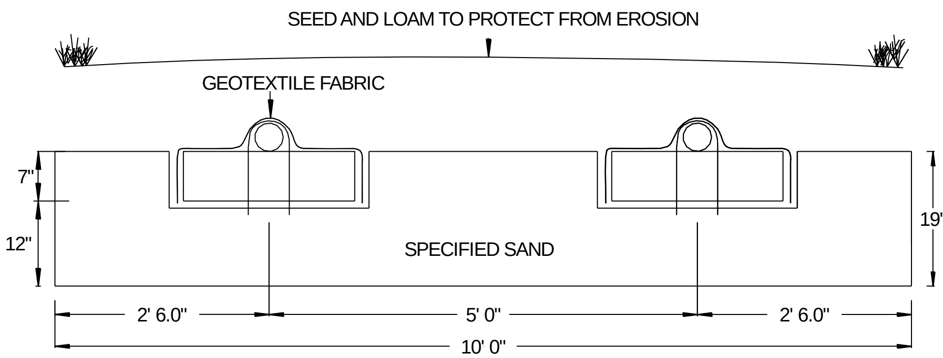


FIGURE 12: SECTION VIEW – 2 LATERAL BED SYSTEM



3.2 Bed Design Installation Steps

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 in 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; scarify 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 observations ports as required in the excavation. See Section 10 for more info.

8. 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 be level at 12".

9. Place GSF modules with **PAINTED STRIPE FACING UP**, end to end on top of the specified sand along their 4-foot length.

10. 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.

11. All 4-inch pipes are secured with manufacturers supplied wire clamps, one per module.

12. (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 21. 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.

13. ***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.

14. Place 6 inches of Specified Sand along both sides of the modules edge. A minimum of 6 inches of Specified Sand is placed at the beginning and end of each module row. A minimum of 12 inches of Specified Sand is placed in between module rows.

15. Complete backfill with a minimum of 12 inches of approved cover material measured from the top of the unit. Backfill exceeding 18 inches over the top of the unit 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.

16. Divert surface runoff from the system. Finish grade to prevent surface ponding. Topsoil and seed system area to protect from erosion.

4.0 Mound Installation Sizing and Guidelines

4.0.1 MOUND REFERENCE: The following sizing and guidelines provide the dimensions of the dispersal bed for your mound. Consult the local regulations for more information on the construction of the mound system.

4.0.2 MOUND EXAMPLE:

House size:	3 bedrooms
Slope of site:	6%
Horizontal Gradient of Side Slope	3:1
Depth to Limiting Factor:	25 inches
Soil Description:	Loamy Fine Sand (Eff#1: 0.5 g/d/ft^2)
Absorption Field Type:	Mound

FIGURE 13: CROSS SECTION – MOUND SYSTEM

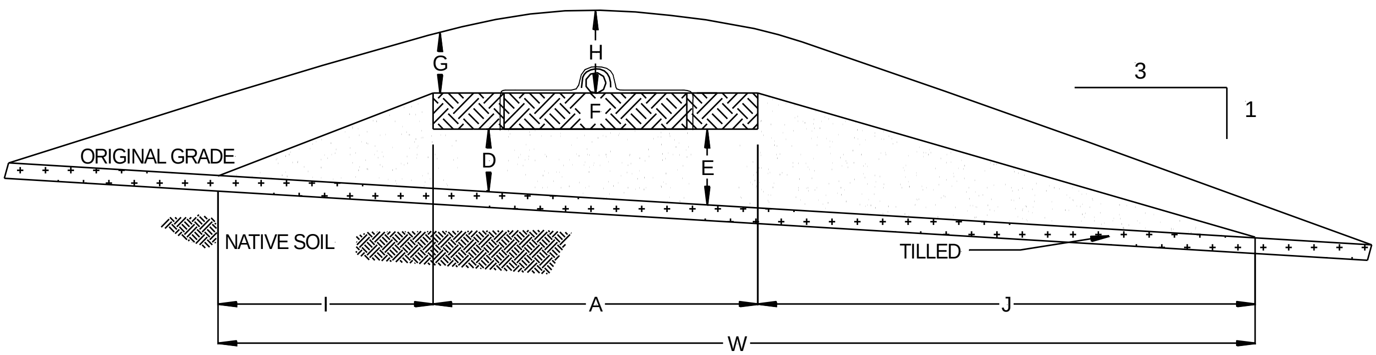
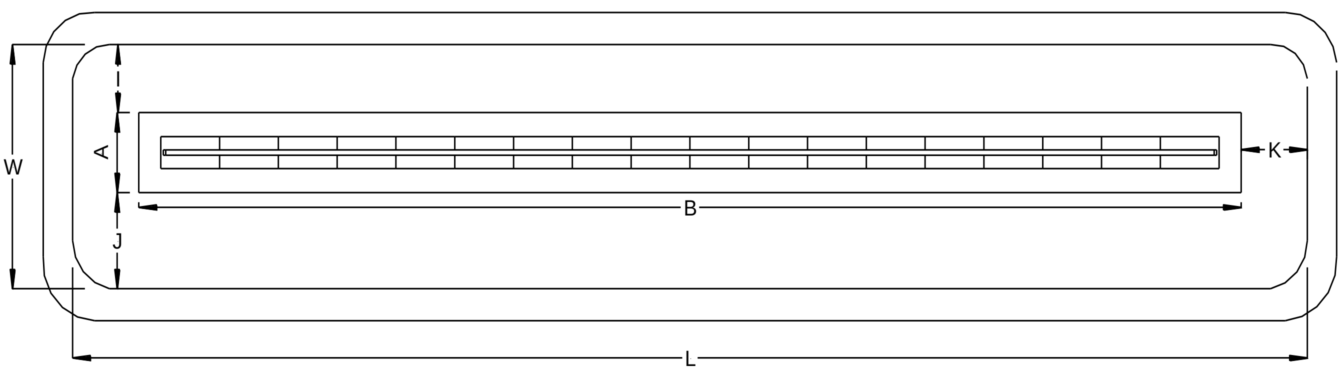


FIGURE 14: PLAN VIEW – MOUND SYSTEM



A – Dispersal bed width (accounts for sand) – **Minimum 3 ft; Maximum 10 ft**
B – Dispersal bed length (accounts for sand)
D – Up slope mound fill depth – **Minimum 1 ft**
E – Down slope mound fill depth – **Minimum 1 ft**
F – Cell Height – **Constant 0.583 ft**
G – Height of cover over edge of cell
H – Height of cover over center of cell
I – Up slope measurement from distribution cell
J – Down slope measurement from distribution cell
K – End slope length
L – Length
W – Width

4.0.3 CALCULATE VARIABLES:

Step 1: Determine Daily Design Flow (DDF) 450 gpd

Step 2: Fill Material Loading Rate (FMLR) 2.0 gpd/ft^2 (constant)

Step 3: Distribution Cell Width (A)

Unit	Sand at the Edge of the Unit	Distribution Cell Width	Product Square Footage per 4 ft Increment
A42	6"	3'	12
A42	12"	4'	16
B43	6"	4'	16
A42	18"	5'	20
B43	12"	5'	20
2 rows of A42	6"	6'	24
B43	18"	6'	24
2 rows of A42	12"	8'	32
2 rows of B43	6"	8'	32
3 rows of A42	6"	9'	36
2 rows of A42	18"	10'	40
2 rows of B43	12"	10'	40

(A) Distribution Cell Width = 3 ft

Step 3: Distribution Cell Square Footage

DDF ÷ FMLR = Distribution Cell Square Footage

450 gpd ÷ 2.0 gpd/ft^2 = 225 ft^2

Step 4: Required # of 4 ft product increments

(Distribution Cell Square Footage – Sand Header and Footer Square Footage) ÷ Product Square Footage

SAND HEADER AND FOOTER SQUARE FOOTAGE	
Distribution Cell Width	Square Footage
3 feet	3 square feet
4 feet	4 square feet
5 feet	5 square feet
6 feet	6 square feet
8 feet	8 square feet
9 feet	9 square feet

(225 ft^2 – 3 ft^2) ÷ 12 ft^2 per increment = 18.5 increments of 1 Row of A42s, round up to 19 A42s

Note: Ensure the units meet the minimum requirements of 5 B43s per bedroom or 6 A42s per bedroom.

4.0 Mound Installation Sizing and Guidelines

Step 5: Distribution Cell Length (B)

B = Unit Increments x 4 + 1
= 19 increments x 4 ft per increment + 1 ft
= 77 ft

Note: If the soil application rate is less than 0.3 gal/ft^2/day within 12 inches of fill, the linear loading rate must be less than 4.5 gal/ft/day.

To determine the linear loading rate:

DDF ÷ Distribution Cell Length (B)

Since the loading rate of the basal area is 1 gal/ft^2/day (determined from Table 2) this calculation is not needed in this example.

Step 6: Fill Depth Under Distribution Cell (D) and (E)

D = 36 inches – Depth to Restrictive Layer at upper edge of Distribution Cell
= 36 in – 25 in
= 13 in (*Note: Minimum is 12 inches)*
= 13 in ÷ 12 in/ft = 1.08 ft

E = (D) + (% natural slope expressed as a decimal x (A; converted to inches))
= 13 in + (.06 x 36 in)
= 13 in + 2.16 in
= 15.16 in
= 15.16 in ÷ 12 in/ft = 1.26 ft

Step 7: Determine Mound Depths (F), (G) and (H)

F = 0.583 ft (constant)

G = 0.5 ft (typical)

H = 1 ft (typical)

Step 8: Determine the end-slope length (K)

K = Horizontal Gradient of Side Slope x ((D + E) ÷ 2) + F + H)
= 3 x ((1.08 ft + 1.26 ft) ÷ 2) + 0.583 ft + 1 ft)
= 3 x ((2.34 ft) ÷ 2) + 0.583 ft + 1 ft)
= 3 x ((1.17 ft) + 0.583 ft + 1 ft)
= 3 x (2.753 ft)
= 8.26 ft

Step 9: Determine the up-slope width (I)

I = Horizontal Gradient of Side Slope x (D + F +G) x (Up Slope Correction Factor)

Up Slope Correction Factors																										
Slope %	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%
Correction Factor	1.00	0.97	0.94	0.92	0.89	0.88	0.85	0.83	0.80	0.79	0.77	0.75	0.73	0.72	0.71	0.69	0.68	0.66	0.65	0.64	0.62	0.61	0.60	0.59	0.58	0.57

= 3 x (1.08 ft + 0.583 ft + 0.5 ft) x 0.85
= 3 x (2.163 ft) x 0.85
= 5.52 ft

4.0 Mound Installation Sizing and Guidelines

Step 10: Determine the down-slope width (J)

J = Horizontal Gradient of Side Slope x (E + F +G) x (Down Slope Correction Factor)

Down Slope Correction Factors																										
Slope %	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%
Correction Factor	1.00	1.03	1.06	1.10	1.14	1.18	1.22	1.27	1.32	1.38	1.44	1.51	1.57	1.64	1.72	1.82	1.92	2.04	2.17	2.33	2.50	2.70	2.94	3.23	3.57	4.00

= 3 x (1.26 ft + 0.583 ft + 0.5 ft) x 1.22
= 3 x (2.343 ft) x 1.22
= 8.58 ft

Step 11: Determine the end slope length (L + W)

L = B + 2K
= 77 ft + 2 x 8.26 ft
= 77 ft + 16.52 ft
= 93.52 ft

W = I + A + J
= 8.58 ft + 3 ft + 5.52 ft
= 17.1 ft

Step 12: Basal Area Check

Basal Area Required
= DDF ÷ soil application Rate (Eff#2)
= 450 gpd ÷ 1.0 gpd/ft^2
= 450 ft^2

Basal Area Available (level site)
= B x W

Basal Area Available (sloped site)
= B x (A + J)
= 77 ft x (3 ft + 8.58 ft)
= 77 ft x 11.58 ft
= 891.66 ft

If Basal Area Available is greater than Basal Area Required, system is ok. If not, extend (J) so that Basal Area Provided equals or exceeds Basal Area Required.

4.0.4 ACCEPTABLE METHODS OF DISTRIBUTION: Gravity, dosed and pressure distribution are acceptable.

4.0.5 MOUND CONSTRUCTION–
Overall Width (with slopes) – 17.1 ft
Overall Length (with slopes) – 93.52 ft

FIGURE 15: SECTION VIEW – MOUND SYSTEM

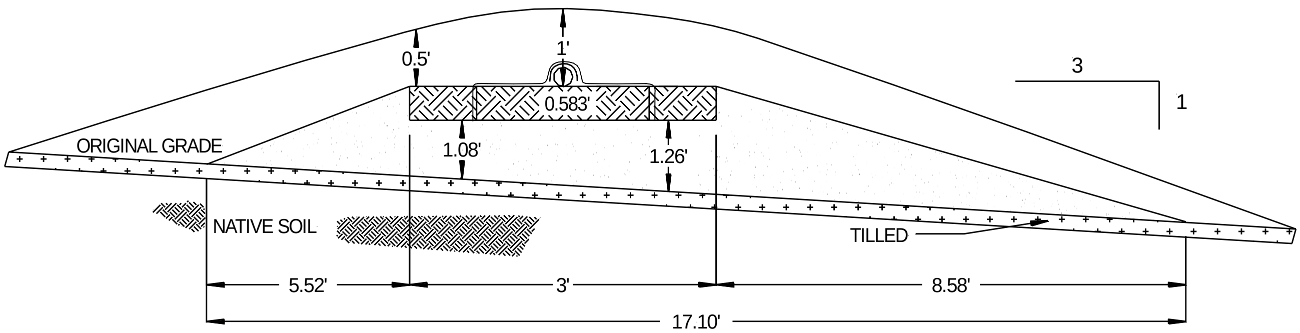
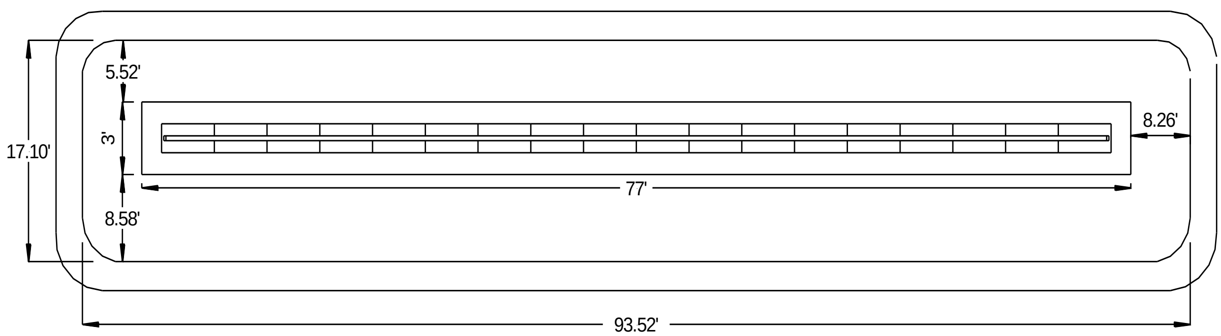


FIGURE 16: PLAN VIEW – MOUND SYSTEM



4.1 Mound Design Installation

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. Scarify 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 6" lifts, stabilize by foot, a hand held tamping tool or a portable vibrating compactor. The stabilized height below the GSF module must meet the mound design requirements.
7. Place observations ports as required in the excavation. See Section 10 for more info.
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 perforated 4-inch distribution pipe is centered along the modules 4-inch length. Orifices are set at the 4 & 8 o'clock position.
10. All distribution pipes are secured with manufacturers supplied wire clamps, one per module.
11. (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 21. 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.

    It is strongly recommended to install a 4-inch vent onto the distribution pipe. Distribution pipes can be connected to one vent or use one vent per distribution line.
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. Ensure there is 6 inches of specified sand surrounding the GSF modules in the mound. Slope the sand away from the mound as described on the plan.
14. 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.
15. Divert surface runoff from the system. Finish grade to prevent surface ponding. Topsoil and seed system area to protect from erosion.

5.0 Mound in a Box Installation Sizing and Guidelines

5.0.1 MOUND REFERENCE: The following sizing and guidelines provide the dimensions of the dispersal bed for your mound in a box. Consult the local regulations for more information on the construction of the mound system.

5.0.2 MOUND EXAMPLE:

House size:	3 bedrooms
Slope of site:	6%
Horizontal Gradient of Side Slope	3:1
Depth to Limiting Factor:	25 inches
Soil Description:	Loamy Fine Sand (Eff#1: 0.5 g/d/ft^2)
Absorption Field Type:	Mound in a Box

FIGURE 17: CROSS SECTION – MOUND IN BOX SYSTEM

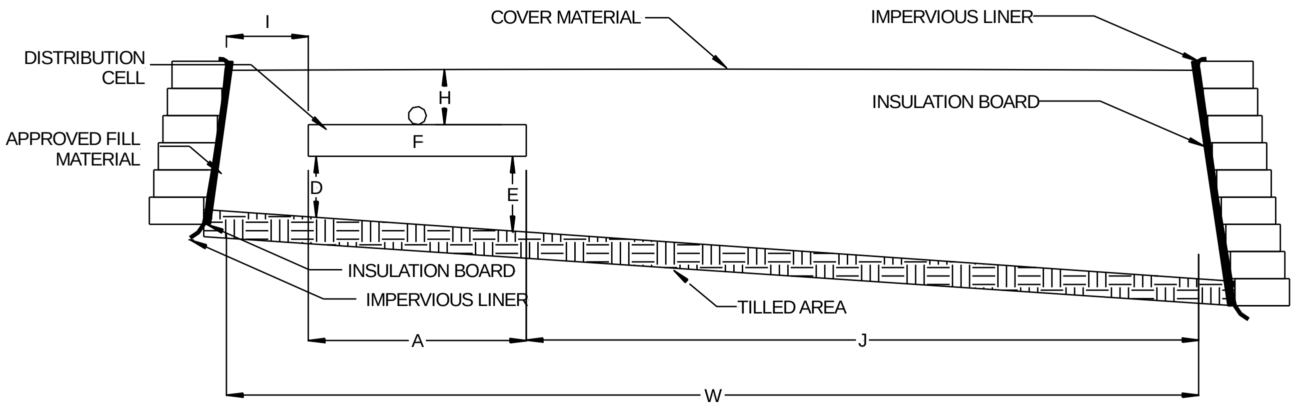
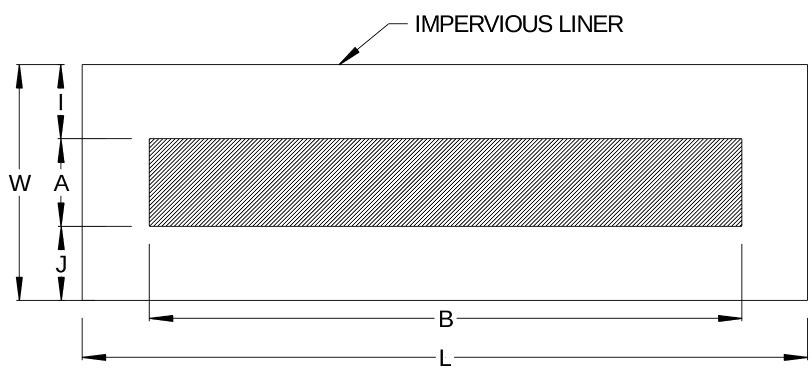


FIGURE 18: PLAN VIEW – MOUND IN BOX SYSTEM



A – Dispersal bed width (accounts for sand) – **Minimum 3 ft; Maximum 10 ft**
B – Dispersal bed length (accounts for sand)
D – Up slope mound fill depth – **Minimum 1 ft**
E – Down slope mound fill depth – **Minimum 1 ft**
F – Cell Height – **Constant 0.583 ft**
H – Height of cover over center of cell
I – Up slope measurement from distribution cell ‘
J – Down slope measurement from distribution cell
K – End slope length
L – Length
W – Width

5.0.3 CALCULATE VARIABLES:

Step 1: Determine Daily Design Flow (DDF) 450 gpd

Step 2: Fill Material Loading Rate (FMLR) 2.0 gpd/ft^2 (constant)

Step 3: Distribution Cell Width (A)

Unit	Sand at the Edge of the Unit	Distribution Cell Width	Product Square Footage per 4 ft Increment
A42	6"	3'	12
A42	12"	4'	16
B43	6"	4'	16
A42	18"	5'	20
B43	12"	5'	20
2 rows of A42	6"	6'	24
B43	18"	6'	24
2 rows of A42	12"	8'	32
2 rows of B43	6"	8'	32
3 rows of A42	6"	9'	36
2 rows of A42	18"	10'	40
2 rows of B43	12"	10'	40

(A) Distribution Cell Width = 4 ft

Step 3: Distribution Cell Square Footage

DDF ÷ FMLR = Distribution Cell Square Footage

450 gpd ÷ 2.0 gpd/ft^2 = 225 ft^2

Step 4: Required # of 4 ft product increments

(Distribution Cell Square Footage – Sand Header and Footer Square Footage) ÷ Product Square Footage

SAND HEADER AND FOOTER SQUARE FOOTAGE	
Distribution Cell Width	Square Footage
3 feet	3 square feet
4 feet	4 square feet
5 feet	5 square feet
6 feet	6 square feet
8 feet	8 square feet
9 feet	9 square feet

(225 ft^2 – 4 ft^2) ÷ 16 ft^2 per increment = 13.8 increments of 1 Row of B43s, round up to 14 B43s

Note: Ensure the units meet the minimum requirements of 5 B43s per bedroom or 6 A42s per bedroom. ***Increase this system by one unit for a total of 15 B43s/Increments.***

Step 5: Distribution Cell Length (B)

B = Unit Increments x 4 + 1
= 15 increments x 4 ft per increment + 1 ft
= 61 ft

Note: If the soil application rate is less than 0.3 gal/ft^2/day within 12 inches of fill, the linear loading rate must be less than 4.5 gal/ft/day.

To determine the linear loading rate:

DDF ÷ Distribution Cell Length (B)

Since the loading rate of the basal area is 1 gal/ft^2/day (determined from Table 2) this calculation is not needed in this example.

Step 6: Fill Depth Under Distribution Cell (D) and (E)

D = 36 inches – Depth to Restrictive Layer at upper edge of Distribution Cell
= 36 in – 25 in
= 13 in (*Note: Minimum is 12 inches)*
= 13 in ÷ 12 in/ft = 1.08 ft

E = (D) + (% natural slope expressed as a decimal x (A; converted to inches))
= 13 in + (.06 x 48 in)
= 13 in + 2.88 in
= 15.88 in
= 15.88 in ÷ 12 in/ft = 1.32 ft

Step 7: Determine Mound Depths (F), (G) and (H)

F = 0.583 ft (constant)

G = 0.5 ft (typical)

H = 1 ft (typical)

Step 8: Determine the end-slope length (K)

K = 0.5 ft (or greater)

Step 9: Determine the up-slope width (I)

I = if system has greater than 1% slope, 1.5 ft

Else

= I

5.0 Mound in a Box Installation Sizing and Guidelines

Step 10: Determine the down-slope width (J)

J = Horizontal Gradient of Side Slope x (E + F +G) x (Down Slope Correction Factor)

Down Slope Correction Factors																										
Slope %	0%	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	21%	22%	23%	24%	25%
Correction Factor	1.00	1.03	1.06	1.10	1.14	1.18	1.22	1.27	1.32	1.38	1.44	1.51	1.57	1.64	1.72	1.82	1.92	2.04	2.17	2.33	2.50	2.70	2.94	3.23	3.57	4.00

= 3 x (1.32 ft + 0.583 ft + 0.5 ft) x 1.22
= 3 x (2.403 ft) x 1.22
= 8.79 ft

Step 11: Determine the end slope length (L + W)

L = B + 2K
= 61 ft + 2 x 0.5 ft
= 61 ft + 1 ft
= 62 ft

W = I + A + J
= 1.5 ft + 4 ft + 8.79 ft
= 14.29 ft

Step 12: Basal Area Check

Basal Area Required
= DDF ÷ soil application Rate (Eff#2)
= 450 gpd ÷ 1.0 gpd/ft^2
= 450 ft^2

Basal Area Available (level site)
= B x W

Basal Area Available (sloped site)
= B x (A + I)
= 61 ft x (4 ft + 8.79 ft)
= 61 ft x 12.79 ft
= 780.19 ft

If Basal Area Available is greater than Basal Area Required, system is ok. If not, extend (J) so that Basal Area Provided equals or exceeds Basal Area Required.

5.0.4 ACCEPTABLE METHODS OF DISTRIBUTION: Gravity, dosed and pressure distribution are acceptable.

5.0.5 ACCEPTABLE LINER MATERIAL: Box construction shall be made out of an impervious layer (20 mil liner or equivalent) with a structurally sound retaining wall surrounding it.

5.0.6 ACCEPTABLE INSULATION BOARD: A minimum insulation with an R value of 5 is required around the perimeter of the system.

5.0 Mound in a Box Installation Sizing and Guidelines

5.0.7 MOUND CONSTRUCTION–
Overall Width (with slopes) – 14.29 ft
Overall Length (with slopes) – 62 ft

FIGURE 19: SECTION VIEW – MOUND IN BOX SYSTEM

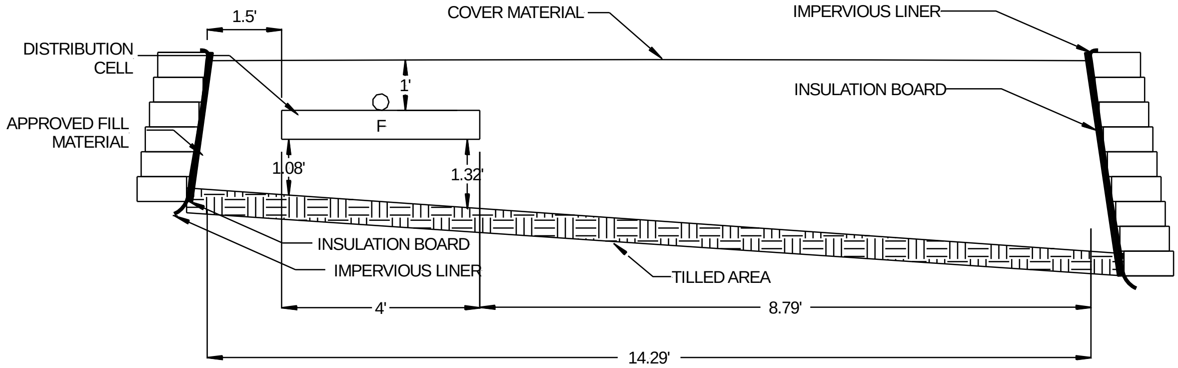
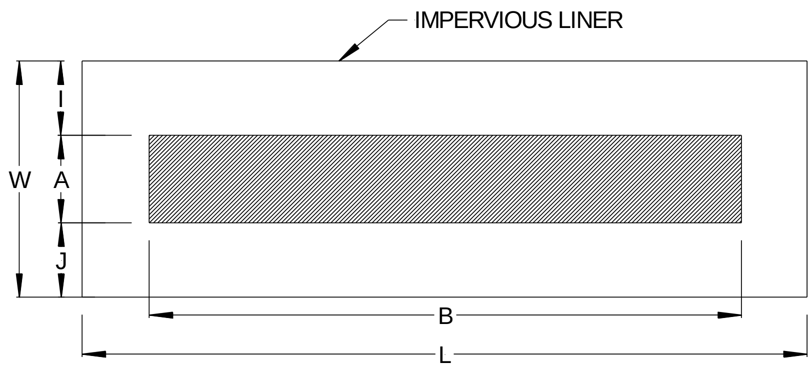


FIGURE 20: PLAN VIEW – MOUND IN BOX SYSTEM



5.1 Mound in a Box Design Installation

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. Check the moisture content of the soil to a depth of 8 inches. Proper soil moisture content can be determined by rolling a soil sample between the hands. If it rolls into a 1/4- inch wire, the site is too wet to prepare. If it crumbles, site preparation can proceed. If the site is too wet to prepare, do not proceed until it dries.

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. Scarify 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. Build the outside support structure and line with an impervious barrier and insulation board. Ensure that the bottom of the cell is left open to the receiving soil.

7. Immediate application of at least 6 inches of fill material is required after tilling. All vehicular traffic is prohibited on the tilled area. For sites with restrictive soils, vehicle traffic is also prohibited for 15 ft. down slope and 10 ft. on both sides of level sites. If it rains after the tilling is completed, wait until the soil dries out before continuing construction, and contact the local inspector for a determination on the damage done by rainfall.

8. 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 6" lifts, stabilize by foot, a hand held tamping tool or a portable vibrating compactor. The stabilized height below the GSF module must meet the mound design requirements.

9. Move the fill material into place using a small track type tractor with a blade or a large backhoe that has sufficient reach to prevent compaction of the tilled area. Do not use a tractor/backhoe having tires. Always keep a minimum of 6 inches of fill material beneath tracks to prevent compaction of the in situ soil.

10. Place the fill material to the required depth

11. Place GSF modules with **PAINTED STRIPE FACING UP**, end to end on top of the specified sand along their 4-foot length.

12. 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.

13. All distribution pipes are secured with manufacturers supplied wire clamps, one per module.

14. (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 21. 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.

    It is strongly recommended to install a 4-inch vent onto the distribution pipe. Distribution pipes can be connected to one vent or use one vent per distribution line.

5.1 Mound in a Box Design Installation

15. ***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.

16. Ensure there is 6 inches of specified sand surrounding the GSF modules in the mound. Slope the sand away from the mound as described on the plan.

17. 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.

18. 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 Requirements

6.0.1 DOSING DESIGN CRITERIA: Dosing volume must be set to deliver a maximum of 4 gallons per B43 Module and 3 gallons per A42 Module per dosing cycle. Head loss and drain back volume must be considered in choosing the pump size and force main diameter.

7.0 Pressure Distribution Requirements

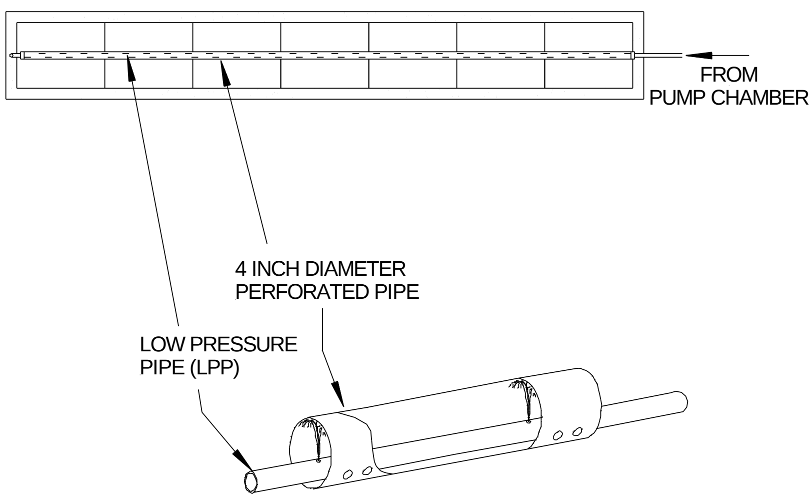
7.0.1 PRESSURE DISTRIBUTION: Dosing with small diameter pressurized laterals is acceptable for GSF systems. The pipe networks must be engineered and follow principles established for pressure distribution. Flushing ports are required to maintain the free flow of effluent from orifices at the distal ends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

Standard procedures for design of pressure distribution networks apply to the GSF filter. Minimum orifice and lateral pipe size are based on design. A drain hole is required at the end 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 4 and 8 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.

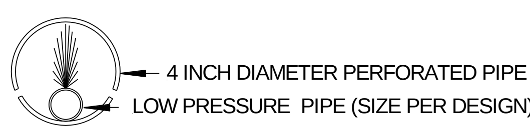
Orifice shields are an acceptable replacement for the 4" pipe.

7.0.2 DOSING DESIGN CRITERIA: For all pump systems; use a maximum of 4 gallons per B43 Module and 3 gallons per A42 Module per dosing cycle. Adjust pump flow and run time to achieve the above maximum dose. Use a minimum pump run time of one minute. Longevity of currently available effluent pumps are not affected by shorter run times. Choose force main diameter to minimize percentage of dose drain back.

FIGURE 21: PRESSURE PIPE PLACEMENT



PRESSURE PIPE CROSS SECTION FOR ALL APPLICATIONS



7.0 Pressure Distribution Requirements

FIGURE 22: PRESSURE CLEAN OUT

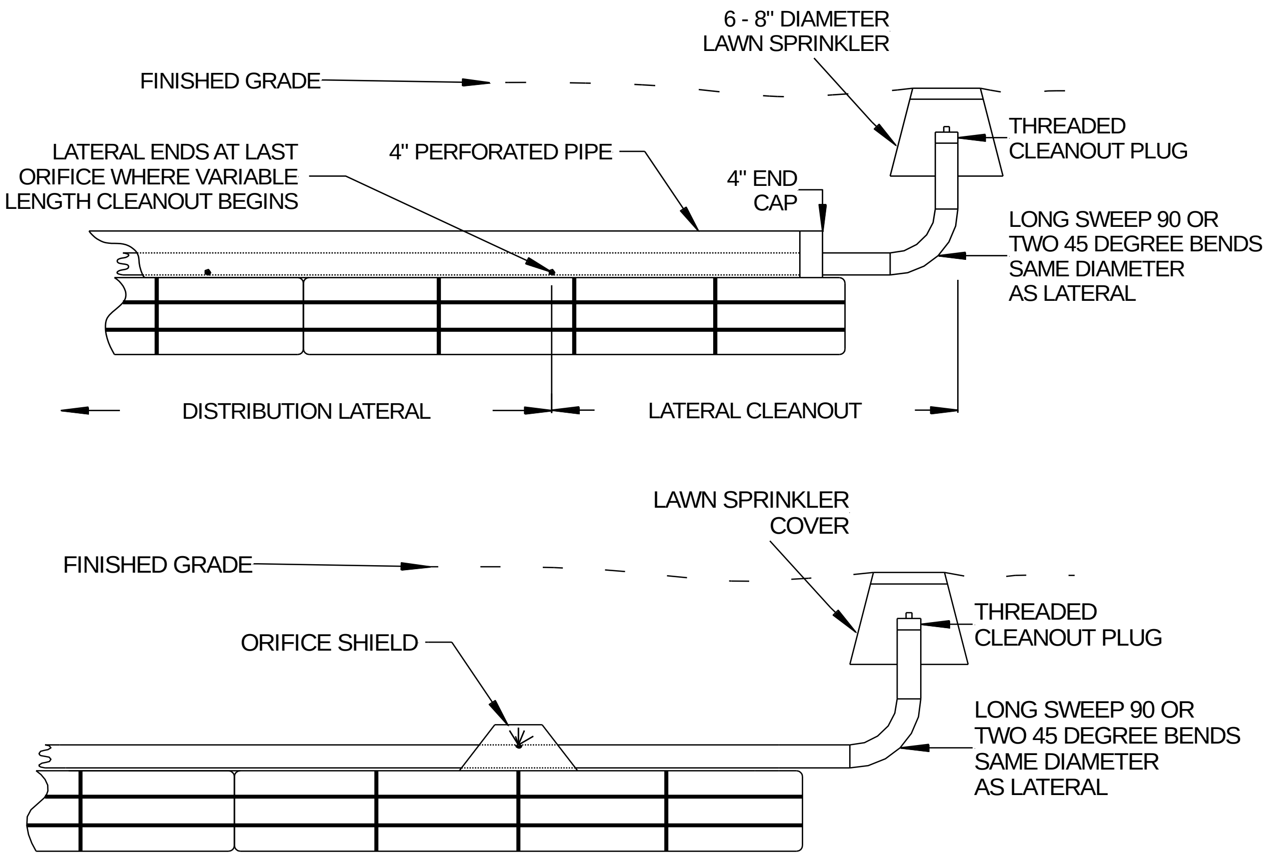
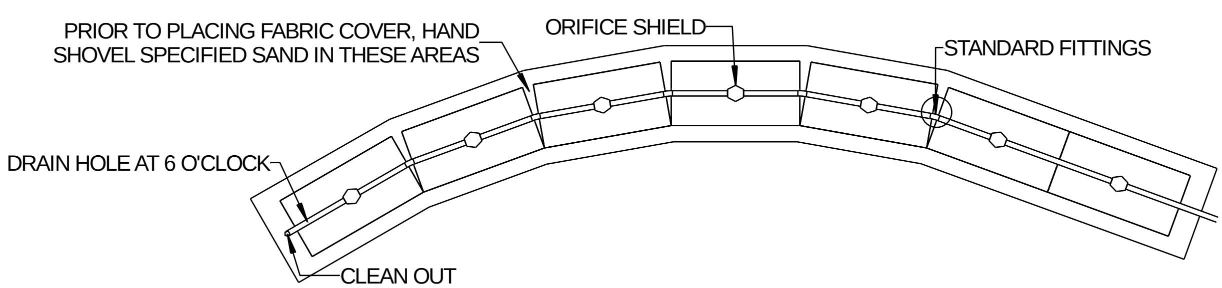


FIGURE 23: CONTOURED TRENCH PRESSURE DISTRIBUTION USING ORIFICE SHIELDS



GSF Pressure Distribution trench placed on a contour or winding trenches to maintain horizontal separation distances.

8.0 Pump Controls

Pump 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 dosing tank and is secure from tampering and resistant to weather (minimum of NEMA4X).

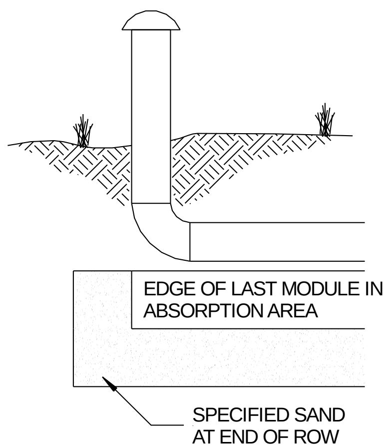
The control panel shall be equipped with both audible and visual high liquid level alarms installed in a conspicuous location. Float switches shall be mounted independent of the pump and force main so that they can be easily replaced and/or adjusted without removing the pump.

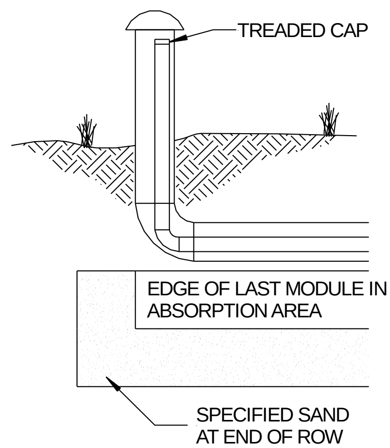
9.0 System Ventilation

9.0.1 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 cuspations 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.

9.0.2 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.

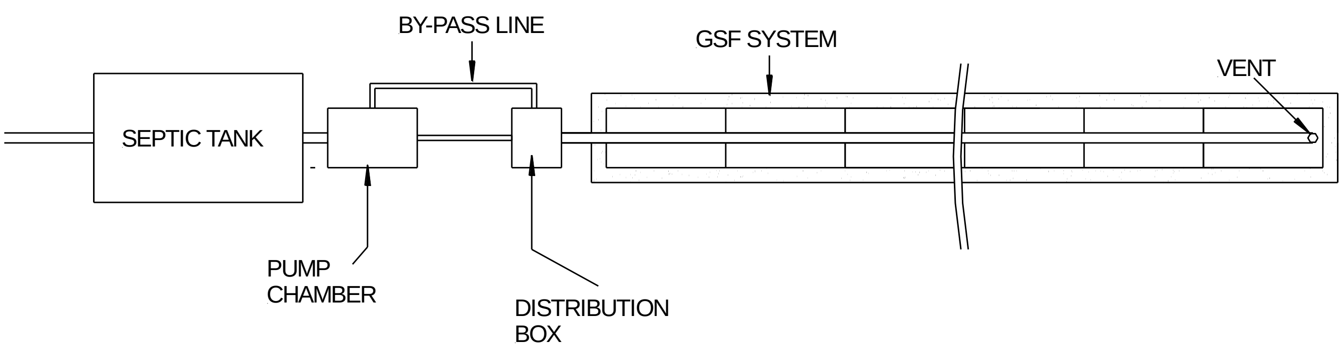
FIGURE 24: VENT LAYOUTS FOR GRAVITY AND LOW-PRESSURE SYSTEMS





9.0.3 AIR BY-PASS LINE: Systems with over 18" of cover that are pumped or pressure dosed require an air by-pass line to continue flow from the low vent on the system to the high vent of the house. Simply plumb an airline from the distribution system back to the pump chamber or septic tank to provide unobstructed flow.

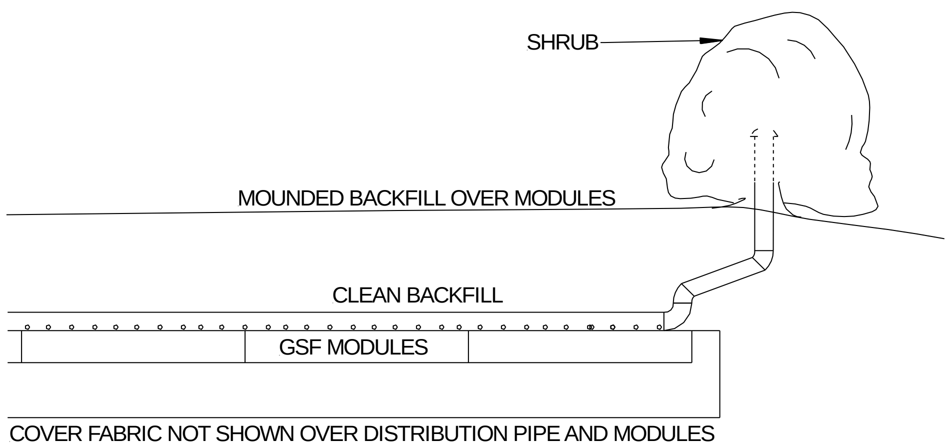
FIGURE 25: AIR BY-PASS LINE PLAN VIEW FOR VENTING OF PUMPED SYSTEMS



9.0 System Ventilation

9.0.4 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.

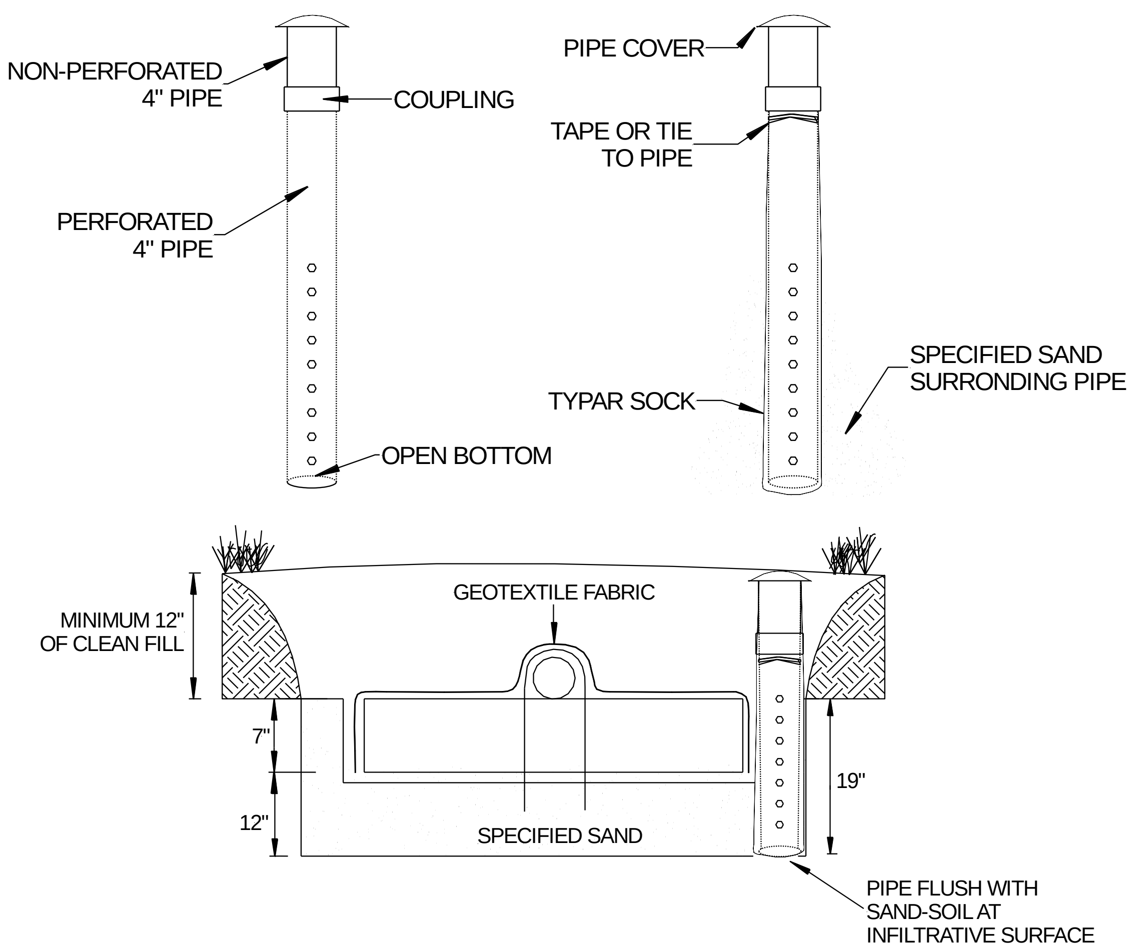
FIGURE 26: GSF WITH 4” VENT EXTENDED TO CONVENIENT LOCATION



10.0 Inspection/Monitoring Port

The system shall include an Inspection/Monitoring Port designed and installed with access from the ground surface. It shall be open and slotted at the bottom and be void of sand or gravel to the infiltrative surface to allow visual monitoring of standing liquid in the absorption field. The figures below depict construction and placement of the Inspection/Monitoring Port. For beds and elevated systems, place two ports per lateral. At least one inspection port should be placed at the midpoint of a row. At the distal ends, use 90-degree elbows and extend to the surface as an additional inspection port, capped and sealed to be watertight. One inspection port should be located downslope in the OSS basal area as well.

FIGURE 27: MONITORING WELL FOR SAND-SOIL INTERFACE



10.0 Inspection/Monitoring Port

FIGURE 28: MONITORING WELL FOR SAND-SOIL INTERFACE

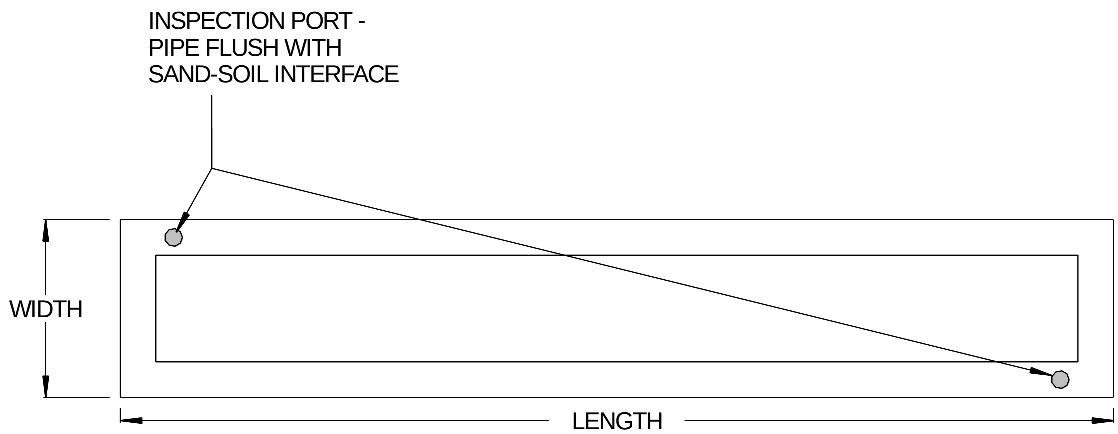


FIGURE 29: COMBINATION VENT/MONITORING WELL FOR SAND-SOIL INTERFACE