Geotextile Sand Filter

British Columbia
Design & Installation Manual

For Systems Designed Using the BC Sewerage System Standard Practice Manual - Version 3

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CORPORATION
Innovative Onsite Products & Solutions Since 1970

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Introduction

This manual provides design and installation information for the Eljen GSF (Geotextile Sand Filter) System using the GSF A42 module within the design criteria as required in the BC Sewerage System Regulation and the BC Sewerage System Standard Practice Manual (SPM) - Version 3. All design suggestions contained herein are compliant with the BC SPM-V3.

More commonly known as an “In-Ground Treatment System”, the Eljen GSF in BC is referred to as a “CTDS” or Combined Treatment and Dispersal System as detailed in the SPM-V3. The Eljen GSF is the only CTDS that meets the requirements of the SPM-V3 demands for both gravity and Uniform (Pressure) Distribution.

The Eljen GSF system technology is derived from research conducted by nationally recognized engineering scientists from the University of Connecticut. Eljen Corporation has over 30 years of success in the onsite wastewater industry, with tens of thousands of systems currently in use worldwide. The GSF is recognized and approved by regulatory officials and experts in the industry as one of the most reliable secondary treatment technologies in the marketplace today. The system specifications in this manual are founded on this research and proven long-term performance history.

The GSF technology is based on scientific principles which state that improved effluent quality provides increased soil absorption rates. GSF’s proprietary two-stage Bio-Matt™ pre-filtration process improves effluent quality while increasing reliability and ease of operation.

The Eljen GSF has been tested and certified by NSF to NSF/ANSI Standard 40. Third-party independent testing data has shown that the Eljen GSF provides treatment of septic tank effluent to less than 10 mg/l BOD and less than 10 mg/l TSS.

The Eljen GSF Geotextile Sand Filter

GSF System Description

The Eljen GSF Geotextile Sand Filter system is a cost-effective improvement over other septic treatment technologies. Comprised of a proprietary two-stage Bio-Matt™ treatment process, the geotextile modules apply a better-than-secondary treated effluent to the soil, increasing the soil's absorption rate. The result is superior treatment in a smaller soil absorption area.

In British Columbia under the Sewerage System Regulation the Eljen GSF is a Type 2 Secondary Treatment System with the added benefit of reduced fecal coliform and reduced nitrogen. In the Standard Practice Manual – Version 3, the GSF is categorized as a Combined Treatment and Dispersal System.

How the GSF System Works

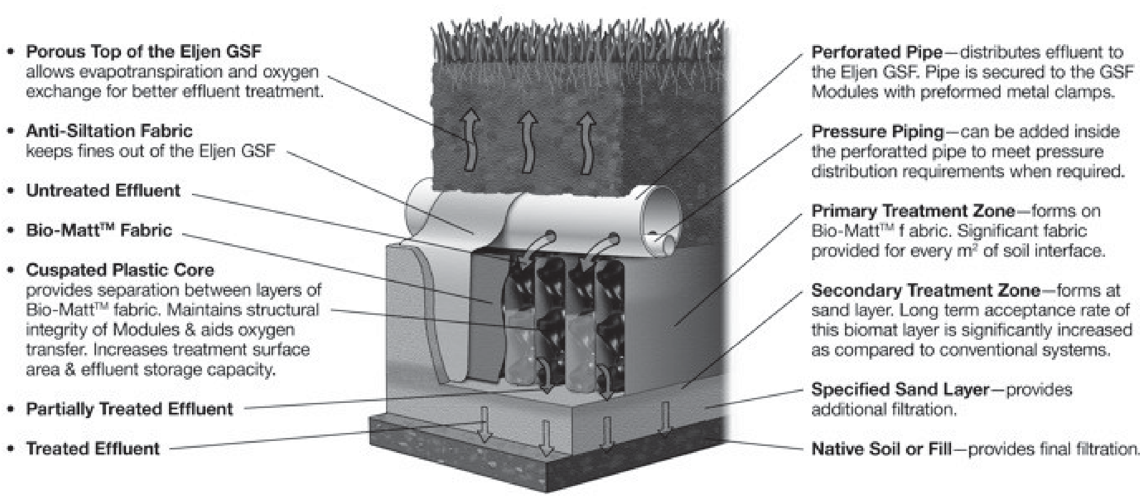
Primary Treatment Zone

- 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. For pressurized systems a pressure line is added inside the perforated pipe.
- 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.
- The native soil then provides final treatment and filtration prior to groundwater recharge.

Figure 1: GSF System Operation



Glossary of Terms

Note: The words and terms below, where used in this manual, have the following meanings:

A42 GSF Module	Dimensions – (L x W x H) - 120cm x 60cm x 18cm (48” x 24” x 7”) The individual module of a GSF system is comprised of a cuspated plastic core and corrugated geotextile biofabric.
Biofabric	Special filter fabric within the Geotextile Sand Filter Modules upon which the primary biomat layer forms.
Cover Fabric	The geotextile cover fabric (provided by manufacturer) that is placed over the GSF modules.
Cuspated Core	The rigid plastic core of the GSF module. It separates the geotextile Biofabric and creates downward infiltration channels and upward aeration channels where primary filtration and biological treatment of the septic effluent occurs. The curvilinear shape of the cuspations offers increased treatment surface area and greater effluent storage.
***CTDS**	Combined Treatment and Dispersal System
***Daily Design Flow**	(DDF) As defined in the SPM–V3, is the flow rate used for sizing a wastewater system taking into account mass loading and peak flows. The estimated peak flow per A42 unit that is used to size a GSF system using residential strength waste is 72 liters per day per module.
Distribution Box	(Or D-Box) A plastic or concrete box that receives effluent from a septic tank or pump tank and splits the flow to the dispersal pipes placed above the GSF modules.
Drop Box	(Spill-Over) A plastic or concrete box that receives effluent and delivers flow to the dispersal pipes placed above the GSF modules before spilling over to further down-slope Drop Boxes. See also Sequential Distribution.
Flow Equalizer	Also known as speed-levelers - Special insert placed in the inlet end of distribution pipes within the distribution box to adjust for effects of settling and out of level installation of the D-Box.
GAC Filter	Granular Activated Carbon (Charcoal) Filter used on vents to remove septic odors.
Geotextile Sand Filter	**GSF - I**ncludes the Eljen Geotextile Filter modules, a 15cm specified sand layer along the base and sides of the modules and the cover fabric. The GSF is a Type 2 Secondary CTDS as defined in the SPM–V3. (L x W x H) – 120cm x 90cm x 33cm (48” x 36” x 13”) for each module complete with specified sand.
LTAR	**Long Term Acceptance Rate** - LTAR is the average equilibrium absorption rate for effluent in a system, usually expressed in liters per day per square meter.
***Mound Sand**	A sand specification as detailed in the SPM-V3 along with Clean Coarse Sand and Sand Filter Coarse Sand.
NSF/ANSI Standard 40	National Sanitation Foundation standard protocol for testing residential wastewater treatment systems. Visit www.nsf.org for more information.
Pressure Distribution	Pressure Distribution is a method of achieving Uniform Distribution, both defined in the SPM-V3. The distribution method of pipe-in-pipe recommended by Eljen, is considered an Alternate Uniform Distribution System in BC. The requirements for pipe-in-pipe distribution as an alternate uniform distribution system have been met. For further information, contact Eljen Corp. or BWD Engineering Inc.

Glossary of Terms

***Point of Application** The Point of Application is the interface surface(s) where the secondary treated effluent passes from the Eljen GSF System to the native (or tertiary engineered media) receiving soils. See also: *Infiltrative Surface* as defined in the SPM-V3.

Sequential Distribution Are designs common to sloping sites where GSF lines that are laid on contour receive effluent from a series of "spill-over boxes" at different elevations. Effluent floods up-slope lines and then spills excess effluent to down-slope lines. See also Drop Box.

***SHWT** **Seasonal High-Water Table**

SPM-V3 The **Sewerage System "Standard Practice Manual" Version 3** as published by the Ministry of Health Services – BC dated September 2014. As referenced in the Sewerage System Regulation (SSR) Section 8 (3).

SSR **Sewerage System Regulation** – The BC Provincial Regulation that applies to the construction and maintenance of all septic systems under 22,700 L/d DDF. For more detail see actual BC Reg. 326/2004 including amendments to BC Reg.

Specified Sand The system sand specification required for GSF systems: ASTM C33 sand with less than 10% passing #100 sieve and less than 5% passing #200 sieve. Listed below is a chart outlining the sieve requirements for the Specified Sand. (Note: Mound Sand as specified in the SPM-V3 meets this requirement)

TABLE 1: Eljen GSF Specified Sand

Eljen GSF Specified Sand Requirements		
Sieve Size	Sieve Square Opening Size	Specification Percent Passing
0.375"	9.5 mm	100.0
#4	4.75 mm	95.0 – 100.0
#8	2.36 mm	80.0 – 100.0
#16	1.18 mm	50.0 – 85.0
#25	600 µm	25.0 – 60.0
#50	250 µm	5.0 – 25.0
#100	150 µm	0 – 10.0
#200	75 µm	0 – 5.0
Note: Request a sieve analysis from your material supplier to ensure that the system sand meets the specification requirements listed above.		

Width and Length The system width is the Specified Sand dimension perpendicular to the GSF module rows. The system length is measured parallel to the rows of GSF modules and also includes the system sand.

Wire Clamps Wire Clamps are used to secure perforated pipe above the GSF modules.

**See also SPM-V3, Volume I, Section 1.1 Glossary*

1.0 GSF System Sizing

TABLE 2: Standard GSF A42 Sizing Table - Residential Applications

Bedrooms					
1	**2**	**3**	**4**	**5**	**6**
Standard Daily Design Flow Liters/Day					
700	1000	1250	1600	1900	2200
Recommended Minimum Number of Modules					
10	14	18	24	30	36

Table 2 shows the minimum number of A42 modules required for residential systems up to 6 bedrooms. For other flow rates and number of bedrooms not shown in Table 2, divide the DDF by 72 L/d/module and round up to the next whole number. For residential homes a minimum of 6 modules per bedroom is required. If the DDF divided by 72 L/d/module equals less than 6 modules per bedroom, round up to the minimum number of A42 modules required per bedroom.

To cover the larger basal areas required by slower soils, in beds and mounds increase the edge to edge separation between runs to a maximum of 90 cm. For all systems, the Eljen GSF modules can be separated by up to 90 cm end-to-end to increased effective basal area without additional modules. All perforated holes not discharging at least 15 cm onto a GSF module must be sealed. See Figure 7 for a suggested method of sealing holes. For assistance with very large basal area requirements please contact the Eljen Technical Representative, BWD Engineering Inc.

In a single row, the GSF system width can be increased by 60 cm for a total width of 150 cm. Modules in a single row can also be separated end-to-end by up to 90 cm to further increase basal area coverage.

For non-residential applications, see Section 2.6 Commercial Systems.

2.0 Design Guidelines

2.1 Basic System Design

2.1.1 DISPOSAL FIELD SIZE: The total basal area required is site specific and determined by the Daily Design Flow (DDF) and soils analysis as specified in the SPM or by a professional.

The GSF system is a Type 2 - Combined Treatment and Dispersal System thus requiring about ½ the field size of a standard Type 1 stone and pipe system or chamber system.

- The number of GSF modules required (See 2.1.10) typically fits the required basal area and can be configured to properly cover any shape required and is the same for trench, bed or mound systems.
- In beds and mounds, a minimum of 30 cm separation is required between parallel rows of GSF modules to utilize sidewall infiltration area.
- Maximum edge-to-edge and end-to-end separation for Modules in all applications is 90 cm.

2.1.2 VERTICAL SEPARATION: As required by the BC Sewerage System SPM- V3 or as specified by a professional. (Note in Version 3 of the SPM, an additional 15 cm of Vertical Separation has been added, in some soil categories, for Type 2 systems that reduce or remove the Type 1 bio-mat. In the case of the Eljen GSF, the bio-mat is retained allowing for the required Vertical Separation to remain the same as Type 1 designs. ROWP Planners may require a professional letter to make this variance from the SPM-V3.)

2.1.3 SPECIFIED SAND SPECIFICATION FOR ALL SYSTEMS: The first 15 cm of Specified Sand immediately under, between rows and around the perimeter of the GSF system must be **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 page 6 for Specified Sand requirements.

2.1.4 FILL FOR RAISED SYSTEMS: Fill material below the Specified Sand (Section 2.1.3) for raised bed systems must be per the latest BC Regulations. Fill must be consolidated in lifts to prevent differential settling. Refer to SPM Version 3 for detailed fill specification.

2.1.5 PLACING GSF MODULES: Each row of modules are laid level and end to end on the above Specified Sand bed with a minimum spacing of 30 cm between parallel rows. No mechanical connection is required between units. Alternatively, in all applications modules may be spaced up to 90 cm end-to-end and edge-to-edge to increase effective basal area. See Figures 7 and 8.

2.1.6 DISTRIBUTION PIPE: Place the approved perforated pipe on top of GSF modules with holes at four and eight o'clock. Complete system piping with solid pipe and fittings. Refer to Sections 2.2 and 2.3 for level and sequential piping information respectively. Secure pipe to GSF modules with provided wire clamps, one clamp per Eljen module. In all applications, any pipe distribution holes not discharging onto the GSF module must be sealed. See Figure 7 for suggested method of sealing holes. See Figure 13 for a pressure distribution illustration.

2.1.7 DISTRIBUTION BOX: Set gravity system D-box outlet invert a minimum of 1 cm per meter (1/8" per foot) above invert of distribution pipe over modules (5 cm minimum for pumped D-Box systems). The fill below the D-Box and piping must be compacted to avoid settling. Flow Equalizers (speed levelers) are recommended for gravity systems.

2.1.8 COVER FABRIC: Geotextile fabric, provided with the system, is placed over the top, sides and ends of the module rows to prevent long-term siltation. ***Cover fabric substitution is not allowed.*** Fabric should drape vertically over the pipe and must neither block holes nor be stretched from the top of the pipe to the outside edge of the modules. "Tenting" will cause undue stress on fabric and pipe. *Note: If modules are spaced end-to-end, fabric must be cut and allowed to drape over and protect the ends of each spaced module. A continuous run of geotextile fabric is not allowed for these applications. Stipulate end-to-end spacing to receive adequate fabric when ordering.*

2.1 Basic System Design – Cont.

2.1.9 BACKFILL & FINISH GRADING: Carefully place backfill over the modules, followed by topsoil to complete a total minimum depth of 25 cm as measured from the top of the distribution pipe. Systems with total cover that exceeds 45 cm as measured from the top of the module shall be vented per section 2.1.15. Backfill material should be a well-graded sandy loam fill; clean, porous, and devoid of rocks larger than 5 cm. Divert surface runoff from the effluent disposal area. Finish grade to prevent surface ponding. Seed loam to protect from erosion.

2.1.10 NUMBER OF GSF MODULES REQUIRED: Each Eljen GSF A42 is designed to a standard loading for residential strength effluent of 72 liters per day per module for trenches and beds and mound systems.

Table 2 on page 7 indicates the minimum number of GSF A42 modules required for standard homes as listed in the SPM where trench, bed and mound systems are applicable. For all systems with unlisted Daily Design Flows (DDF) of residential effluent the number of GSF A42 modules is calculated by dividing the DDF in Liters/day by 72 L/day/module.

- For trench, bed and mound configuration drawings see pages 21-25 of this manual.
- For information on commercial systems see Section 2.6.

2.1.11 ADDITIONAL FACTORS EFFECTING RESIDENTIAL SYSTEM SIZE: Homes with an expected higher than normal water use should increase septic tank capacity and/or utilize multiple compartment tanks. Increasing the minimum effluent disposal area should also be considered.

Factors that may affect system size:

- Luxury homes, which may include Jacuzzi style tubs, or other high use fixtures.
- Homes with known higher than normal occupancy.
- Homes with water conditioner backwash and high efficiency furnace condensate. (Diversion from septic tank required).

Designers should use discretion when multiple additional factors are involved. Increase size in proportion to excess flow.

2.1.12 SYSTEM GEOMETRY: In general, design systems long and narrow along site contours to minimize groundwater mounding especially in poorly drained low permeability soils. If possible, design level systems with equal number of modules per row.

2.1.13 GARBAGE DISPOSALS: Garbage Disposal units (garburators) increase the organic loading to the system by 50%. If the owner wishes to use a garburator then the Daily Design Flow must be increased by 50% which subsequently increases the size of all components of the system including the number of Eljen GSF modules and the overall field size, see SPM-V3 section II-5.1.3.2. Design Drawings and Owners Operation & Maintenance manual must include a note that clearly indicates **"Garbage Disposals <u>ARE</u> (or <u>ARE NOT)</u> allowed to be used with this system."**

2.1.14 WATER CONDITIONERS: Water conditioners can adversely affect septic tank treatment and add to hydraulic load of the GSF system. **Conditioner backwash discharge from these devices shall be directed to a separate alternative disposal system.**

2.1.15 CONDENSATE FROM HIGH-EFFICIENCY FURNACE: Condensate from High-Efficiency Furnaces can adversely affect septic tank treatment and add to hydraulic load of the GSF system. **Condensate discharge from these devices shall be directed to a separate alternative disposal system.**

2.1.16 SYSTEM VENTING: All systems require sufficient oxygen supply to the effluent dispersal area to maintain proper long-term effluent treatment. Therefore, the following situations require venting <u>at the far end</u> of the system:

- Any system with more than 90 cm of total cover as measured from the top of the module.
- Areas subject to compaction.

2.1 Basic System Design – Cont.

2.1.17 VEHICULAR TRAFFIC: All vehicular traffic is prohibited over the GSF system. This is due to the compaction of material required to support traffic loading. This compaction greatly diminishes absorption below the GSF system and diminishes the void spaces that naturally exist in soils which provide oxygen transfer to the GSF system.

2.1.18 SEPTIC TANKS: The BC SPM-V3 recommends two septic tanks in series or dual compartment tanks for all systems. Eljen supports this practice as it helps to assure long system life by reducing suspended solids and BOD to the effluent disposal area.

2.1.19 SEPTIC TANK FILTERS AND RISERS: Wastewater filters are required as a means of preventing solids from leaving the septic tank. Access risers are recommended with septic tanks.

2.1.20 POINT OF APPLICATION: The Point of Application is the interface surface(s) where the secondary treated effluent passes from the Eljen GSF System to the native (or tertiary engineered media) receiving soils. See Figures 4 and 8.

2.1.21 SAMPLING: Contact Eljen Corporation and 800-444-1359 or BWD Engineering at 604-957-3611 for more information on sampling devices and techniques that can be used with the GSF system.

2.2 Level Site Systems

2.2.1 SYSTEM CONFIGURATIONS: Design level in-ground or raised systems with 30 cm minimum and a 90 cm maximum spacing between module rows and 0-90 cm spacing end to end. The system sand, GSF modules, and distribution pipes are installed level at their design elevations.

2.2.2 DISTRIBUTION PIPE LAYOUT: Approved perforated pipe runs along the center of the modules. Ends may be connected with approved solid pipe at the far end of the system. See Figure 9. Solid pipe is used to connect perforated lines to the distribution box.

2.3 Sloped Site Systems

2.3.1 SYSTEM CONFIGURATIONS: Sequential and serial dosed GSF systems may be used on sloped sites where applicable under the SPM-V3.

2.3.2 ROW SPACING: Systems with up to 15 cm elevation drop between adjacent module rows use 30 cm minimum spacing. If over 15 cm drop, use two times the elevation drop as minimum spacing between module rows.

2.4 Pumped Systems

2.4.1 PUMP TO DISTRIBUTION BOX: Specify an oversized distribution box for pumped systems. Provide velocity reduction in the D-box with a tee or baffle. Set D-box invert a minimum of 5 cm higher than invert of perforated pipe over GSF modules. Do not use flow equalizers or other restricting devices in the outlet lines of the D-box. Pump chamber shall be vented.

2.4.2 PRESSURE DISTRIBUTION: Pressure distribution piping is configured as shown in Figures 2 and 13. A smaller pressure pipe is inside the larger perforated pipe. One small diameter orifice is drilled for each GSF Module. The first and last holes in a single run are drilled at five o'clock and the remaining are drilled at twelve o'clock. Orifice size is determined by dividing the selected pump or floating outlet flow rate by the number of holes, then looking up the diameter required for that flow per hole at the desired squirt height.

2.4 Pumped Systems – Cont.

2.4.3 DOSING DESIGN CRITERIA: For all pump systems; use a maximum of 10 liters per dose per GSF Module in the system. Adjust pump flow and run time to achieve the above maximum dose or less. Longevity of currently available effluent pumps is not affected by shorter run times.

Note: When pumping to D-box do not exceed D-box manufacturer's maximum flow rate (see 2.4.1)

2.5 System Venting

2.5.1 VENTED SYSTEM: Air vents are only required in dispersal field systems when located under impervious surfaces or systems with more than 45 cm 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 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. The extension of the distribution pipe to the vent provides adequate delivery of air into the GSF system, as shown in Figure 2.

Home plumbing operates under negative pressure due to hot water heating the pipes and reducing the density of air in the house vent. As hot air rises and exits the home, it must be replaced by air from the GSF. To maintain this airflow and fully aerate the GSF system, it is important that air vents are located only on the distal end of the GSF pipe network. If a dosed (Pump to D-box) system is specified with greater than 90 cm of cover, an additional 5 cm (2 in.) diameter air-line must be extended from the GSF D-box back to the septic tank or the riser on the pump tank as shown in Figure 3. This maintains the continuity of airflow from the field into the house plumbing.

For the GSF system, the vent is a 10 cm (4 in.) diameter pipe extended to a convenient location behind shrubs, as shown in Figure 2. Corrugated pipe can be used with the placement and grade such that any condensation that may accumulate in the pipe does not fill and thus close off this line. If the vent is extended, the pipe must not drain effluent and must have an invert higher than the system. Elevated systems requiring venting must elevate the first meter of vent line above the top of the GSF with fittings to prevent effluent from migrating down the vent. The vent can then be pitched away from the system to a discrete area. A drain hole must be installed at the lowest point to drain any condensation.

2.5 System Venting – Cont.

Figure 2: Vent Details for Gravity / Demand Dosed and Pressure Distribution Systems (when required)

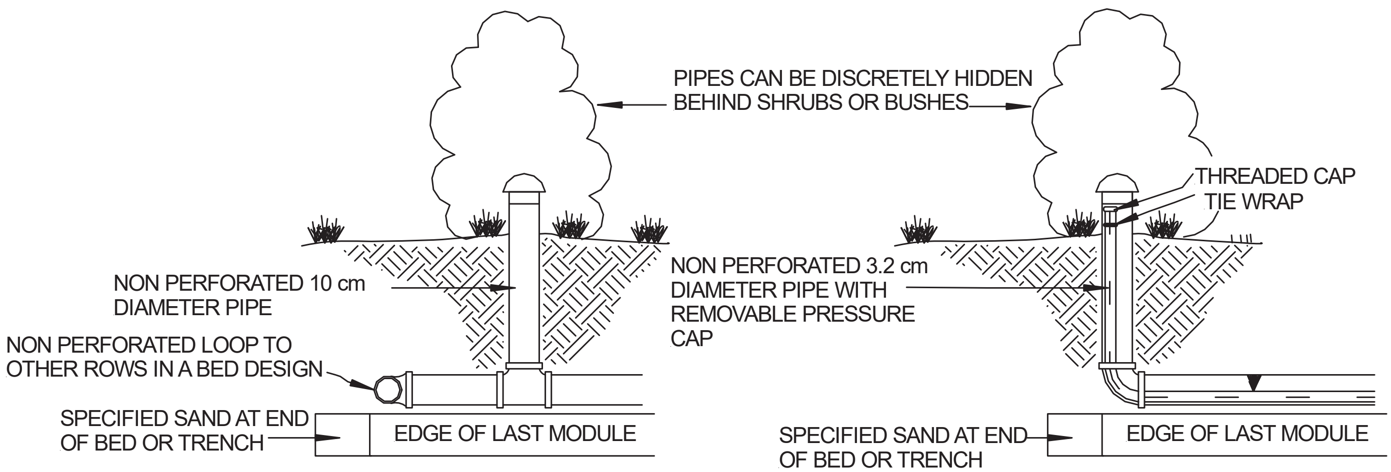
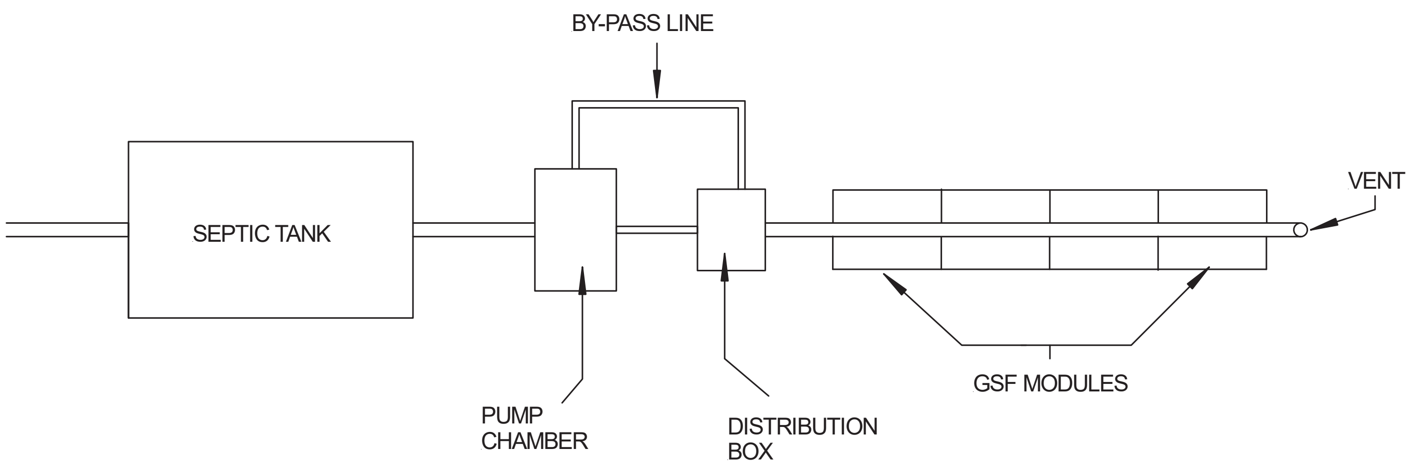


Figure 3: Air By-Pass Line Detail for Venting of Pumped Systems (when required)



2.6 Commercial Systems

2.6.1 DESIGN CONSIDERATIONS: Commercial systems differ from residential systems relative to wastewater characteristics, effluent distribution strategies, peak flows, system size and geometry. As these systems are normally larger, the designer must also consider the collection systems and their integrity, groundwater hydrology, drainage above and below the GSF system and design accordingly.

Designers should carefully review and document with their client effluent BOD_5 and TSS concentrations and water use numbers. The designer should document that the system installation meets the technology supplier's specifications to ensure long-term performance. In addition, designers must be attentive to special details of the system, conduct follow-through startup and document technical capabilities for personnel required for Operation and Maintenance of the system.

Owners can expect operational issues when occupants are not educated in the operation of the system, the discharge of excessive wastewater flows due to leaks, use of excessive water, installation of illegal items such as garbage grinders, and not performing routine maintenance on grease traps and septic tanks. Since the system owners and users may not know the costs associated with these types of problems, they will not be motivated to limit effluent problems and should be educated in these types of systems. Designers must provide oversight of system installation and associated system equipment.

2.6.2 DAILY DESIGN FLOW: To determine DDF for commercial systems, please refer to the entire Section III-5 of the SPM-V3. The systems in this section generally have organic loading that exceeds standard residential strength waste. Additional sizing factors are recommended. Please contact BWD Engineering, Inc. at 604-957-3611 or Eljen Corporation's Technical Services at 800-444-1359 for recommendations on sizing prior to design and submission of plans to local authority.

2.6.3 EFFLUENT APPLICATION: Distribution of effluent across a bed system or down a row of modules in a sequentially loaded system must be specifically addressed in the design plans. A variety of wastewater delivery options exist and include pressure distribution, pressure dosing, and gravity systems. Wastewater volume and strength, system size, and site conditions will dictate which type of system should be designed. Distribution requirements as laid out in the SPM-V3 are all suitable for use with the GSF system.

Designers must also consider how the distribution of the effluent onto the GSF modules may affect the linear loading rates and allow for the means to adjust the linear loading should the soils fail to move the effluent as predicted. Longer systems are naturally preferred as this geometry reduces the linear loading and the risk of hydraulic overload with surfacing of treated effluent down slope in sequential type systems.

Extremely large systems should be designed as several smaller systems allowing for independent management of the wastewater treatment system. Designs typically include valves to rotate zones into service with access to flow diversion boxes. Management plans are frequently implemented for monitoring the fluid levels and adjusting the effluent application onto the GSF modules.

2.6 Commercial Systems – Cont.

2.6.4 SITE DRAINAGE AND STORMWATER: Larger flow onsite absorption systems can be impacted by site drainage from above the systems area. The additional effluent can also increase the groundwater mound down slope. Recharge systems such as the GSF must be designed and located so that they can accept precipitation and the specified wastewater volume. Control and diversion of up-slope stormwater is normally included in the design. Understanding the storm water flows onto and out of the system is essential to successful management of these systems.

Landscape position and slope impact the drainage because the gradient frequently changes with the slope of the land, especially if placed above a restrictive layer. The depth and permeability of each soil layer above the restrictive horizon impacts the groundwater mound. For example, upper horizons may be fairly permeable and accept precipitation easily. If these layers are above a more restrictive horizon, a perched water table will develop whenever it rains. Movement of this perched groundwater can influence the disposal system and if not recognized will result in surfacing effluent. Interception and diversion of the groundwater is therefore necessary with larger systems especially over restrictive soils to insure acceptance of the treated effluent under wet conditions.

Down slope hydraulic capacity is also an important consideration with larger systems. For example, a system may be located on a free draining slope, but down slope conditions show a perched water table due to a reduced hydraulic gradient. Design limits and linear loading must be considered, and these limits should be based on the limitations of these down slope soils and gradient. Ideally, systems are located with diverging topography that reduces the linear loading and results in the effluent moving down slope.

2.6.5 MULTI-FAMILY DWELLINGS: Condominiums, apartments, trailer parks, RV campgrounds and other systems with domestic type wastewater, designers must have reference to 2.6.2 above and the maximum loading specified in Section 2.1.10. Make sure that garbage disposals are not being installed or specified. Appropriately sized septic tank effluent filters are required for all commercial systems.

2.6.6 RESTAURANTS: Restaurant system designers must have reference to 2.6.2 above for system sizing. Designs shall use one or more grease filter(s) appropriately sized at the outlet of the grease trap as required by BC Regulation. Specify grease traps whose outlets are compatible with the filter designed or allow for external filter between grease trap and septic tank. Combine kitchen flow with black water flow in 1 or more septic tanks. Multiple tanks are preferred. Install one or more septic tank effluent filter(s) appropriately sized at the outlet of the final septic tank.

2.6.7 LAUNDROMATS: Laundromat system designers must have reference to 2.6.2 above for system sizing. Designs shall use one or more filter(s) appropriately sized to help remove suspended lint.

2.6.8 OTHER COMMERCIAL SYSTEMS: Other non-residential systems, e.g. schools, butcher shops, milk or ice cream facilities, etc. may require more conservative sizing. The designer is advised to contact BWD Engineering Inc. (604-957-3611) for recommendations.

2.6.9 SYSTEM VENTING: It is recommended that all commercial systems be designed with vents. Systems with high waste strength and systems with more than 45 cm of cover material as measured from the top of the GSF modules to finished grade require venting. Designers that include vents in their designs often specify the use of Granular Activated Carbon or Charcoal (GAC) filters to ensure that septic odors do not become a nuisance. Designers should verify with the GAC filter manufacturer or supplier to ensure that the filter will allow airflow from both directions of the filter. Otherwise the filter will block airflow and the vent will not be effective in supplying enough oxygen that the system demands for long term performance.

2.6.10 COMMERICAL SYSTEM PLANS REVIEW: BWD Engineering Inc. (604-957-3611), Eljen Corporation's Canadian Technical Representative, is available for a no cost review of any commercial GSF plan prior to submission for approval from the local approving authority. Overall responsibility for system design remains with the licensed designer and/or professional.

2.7 GSF Design Considerations for Replacing Failed Systems

Before designing a GSF system to replace a failed system, ***IDENTIFY THE CAUSE OF FAILURE*** and adjust new system design accordingly. Listed below are some of the most common reasons why septic systems fail:

- Leaky plumbing fixtures.
- Pump settings incorrect or not working properly.
- More occupants or bedrooms than system was designed for.
- Unusually high-water usage.
- Garbage disposal.
- Water softener backwash.
- Detrimental chemicals being used.
- Excessive grease in system.
- Failed or missing septic tank outlet baffle.
- Infiltration of ground water into a leaky septic tank or pump chamber.
- Infiltration of surface water into the system.
- Specified Sand that does not meet the requirements as outlined in this manual.
- Poor quality fills material used below the system.
- Poor quality backfill over system (no oxygen flow to system).
- System too close to water table.
- Mounding due to poor drainage or soil permeability.
- Part or system not used because of blockage or excessive settling.
- System is undersized.
- Excessive backfill over system (more than 18” requires venting).
- Crushed distribution pipe(s).
- Distribution pipes not level.
- Loam not removed prior to construction.
- No vent installed or improper venting.
- Clogged septic tank effluent filter.
- No outlet baffle or tee in septic tank.
- Septic Tank needs to be pumped.
- Wiring or electrical problems with pump systems.
- Supply line to septic tank or D-box needs repair.

2.8 Required Notes on Design Plans

1. This system (IS/IS NOT) designed for the use of a garbage disposal.
2. This system is NOT designed for backwash from a water softener.
3. This system is NOT designed for condensate from a high-efficiency furnace.
4. This system IS design for __________ wastewater only.
5. Organic Loam Layer must be removed from bed and slope extension areas prior to fill placement. Scarify subsoil prior to fill placement.
6. All fill material shall meet SPM-V3 requirements. The 15 cm of Specified System Sand underneath and surrounding the GSF modules shall be concrete sand meeting the requirements of ASTM C33 with less than 10% passing a #100 sieve and less than 5% passing a #200 sieve.
7. Backfill material can be suitable soil with no stones larger than 5 cm in any dimension to a minimum depth of 25 cm over the top of the distribution pipe.
8. Any system that is more than 45 cm below finish grade as measured from the top of the module shall be vented.
9. This design complies with and must be installed in accordance with the February 2020 Eljen GSF Design and Installation Manual for British Columbia.
   With the following exceptions: (List any exceptions here)

3.0 System Installation Guidelines

3.1 General System Installation Guidelines

Note: An installation video is available for viewing at www.eljen.com

1. Place the 18 cm tall Geotextile Filter Modules on top of a 15 cm minimum level surface of ASTM C33 Specified Sand with less than 10% passing #100 sieve and less than 5% passing #200 sieve. You must use the Specified Sand as listed on page 6 of this manual to ensure proper system operation.

2. Use the provided clamps to secure the approved perforated 10 cm diameter distribution pipe to the top of each GSF module.

3. In applications where modules are spaced out end-to-end to increase effective basal area *all perforated holes not discharging at least 15 cm onto a GSF module must be sealed.* See Figure 7 for an example.

4. Cover the tops and sides of the modules along the entire length of each row with Eljen geotextile cover fabric. Drape the fabric vertically over the pipe and down the sides of the module. Do not tuck or tent the fabric from the pipe. Position and hold fabric in place with hand shovels of sand.

5. If modules are spaced end-to-end, fabric must be cut and allowed to drape over and protect the ends of each spaced module. A continuous run of geotextile fabric is not allowed for these applications.

6. Specified Sand placed along both sides of the GSF module. Additional sand placed above the module is recommended.

7. Where the percolation rate exceeds 25 minutes-per-inch or the soil texture is finer, the system should be built from one end to the other to avoid any compaction of the soil by the excavator.

8. When backfilling the installation with native soil, stones 5 cm or larger must be removed.

9. Finish by grading the area to divert storm water runoff away from the system.

10. Do not drive backhoe wheels over GSF modules. Light-weight track rigs may cross system area sparingly with a minimum of 25 cm of cover over the distribution pipe. System area should only be crossed perpendicularly.

11. Do not drive over mound or elevated systems.

12. It is also permissible to back-blade the soil to set final minimum cover. Perimeter landscape timbers are also recommended to locate the shallow beds, thereby keeping vehicles off the system.

13. Seeding and stabilizing the soil cover is required to protect the system from soil erosion.

14. Where the elevation of the surface exceeds the natural grade, a block or landscape timber frame or sloping soil toe at a 3:1 grade can be used to help eliminate soil erosion and support maintenance of the stabilizing grass cover adjacent to the GSF.

15. For pumped systems, provide a well-anchored D-box with a velocity reduction tee or baffle. Vent system at far end of the trench or bed when more than 45 cm of cover material as measured from the top of the GSF modules to finished grade is used.

3.2 Trench and In-Ground Bed System Installation Instructions

1. Carefully lay out the system components and boundaries. Define the location and elevation of the trench or bed and distribution box based on the septic tank outlet elevation and pipe grades required to maintain flow to each component.

2. Prepare the site according to BC regulations. Do not install a system on saturated ground or wet soils that are smeared during excavation. Keep heavy machinery off clay soils used for the GSF system as well as down-slope from the system where soil structure is critical for absorption and drainage of the treated effluent.

3. Plan all drainage requirements up-gradient of the system so as to not adversely affect the system's area. Set soil grades to ensure that storm water drainage and ground water is diverted away from the absorption area once the system is complete.

4. Excavate the trench or bed. Scarify the receiving layer to maximize the interface between the native soil and Specified Sand.

5. Minimize walking in the trench or bed prior to placement of the Specified Sand to avoid soil compaction.

6. Place 15 cm layer of Specified Sand to 2.5 cm above the sand fill grade. Gently hand compact, level and rake the Specified Sand on grade. A hand tamper is sufficient to stabilize the Specified Sand below the GSF modules. The finished height below the GSF module must be 15 cm minimum. Check the zero grades with a laser level before placing the GSF modules.

7. Place GSF modules with ***PAINTED STRIPE FACING UP***, end to end on top of the Specified Sand.

8. Provide D-box(es) installed in accordance with the current Standard Practice Manual.

9. Use approved 10 cm non-perforated pipe from the distribution box to the GSF modules.

10. Center approved 10 cm perforated distribution pipe lengthwise over modules with orifices at 4 o'clock and 8 o'clock.

11. In applications where modules are spaced end-to-end to increase effective basal area *all perforated holes not discharging at least 15 cm onto a GSF module must be sealed.* See Figure 9 for an example.

12. Secure pipe to GSF modules using one Eljen hoop per module. Push hoop ends straight down into up-facing core, through the fabric and into the underlying sand.

13. Spread Eljen cover fabric lengthwise over the pipe and drape over the sides of the GFS module rows. Secure in place with Specified Sand between and along the sides of the modules. Avoid blocking holes in perforated pipe by placing the cover fabric over the pipe prior to placing fill over the modules. Do not tuck or tent the fabric from the pipe. *Note: If modules are spaced end-to-end, fabric must be cut and allowed to drape over and protect the ends of each spaced module. A continuous run of geotextile fabric is not allowed for these applications.*

14. Place 15 cm minimum of Specified Sand along the sides of the modules and at the ends of each module row.

15. Complete backfill with Sandy Loam to 25 cm minimum over the GSF modules. Backfill exceeding 45cm above the top of the module requires venting at the far end of the trench. Fill should be clean, porous and devoid of large rocks. Use well graded sandy loam fill. Do not use wheeled equipment over the system. A light track machine may be used with caution, avoiding crushing or shifting of pipe assembly. Backfill in direction of perforated pipe.

16. Divert surface runoff. Finish grade to prevent surface ponding. Seed loam and protect from erosion.

3.3 Raised Bed or Mound System Installation Instructions

1. Carefully lay out the system components and boundaries. Define the location and elevation of the raised bed or mound system. *Note: Refer to figures 10 & 11 for Design Illustration.*

2. Prepare the site according to BC regulations. Do not install a system on saturated ground or wet soils that are smeared during excavation. Keep heavy machinery off clay soils used for the GSF system as well as down-slope from the system where soil structure is critical for absorption and drainage of the treated effluent.

3. Plan all drainage requirements up gradient of the system as to not adversely affect systems area. Set soil grades to ensure that storm water drainage and groundwater is diverted away from the absorption area once the system is complete.

4. Remove the Organic Layer. Scarify the receiving layer to maximize the interface between the native soil and Specified Sand.

5. Minimize walking in the basal area prior to placement of the specified fill material to avoid soil compaction.

6. Place fill material meeting SPM requirements onto the soil interface as you move down the excavated area. If this is done in two steps, bring in the fill material from the up-slope side of the excavation. Place 15 cm layer of Specified Sand to 2.5 cm above the sand fill grade. Gently hand compact, level and rake the sand on grade.

7. A hand tamper is sufficient to stabilize the Specified Sand below the GSF modules. Check the zero grade of the top of the Specified Sand using a 2 x 4 and carpenter's level or a laser before placing the modules.

8. Place GSF modules with PAINTED STRIPE FACING UP, end-to-end on top of the Specified Sand.

9. Use approved 10 cm non-perforated pipe from the distribution box to the GFS modules.

10. Center approved 10 cm perforated distribution pipe lengthwise over modules with orifices at 4 o'clock and 8 o'clock.

11. In applications where modules are spaced end-to-end to increase effective basal area *all perforated holes not discharging at least 15 cm onto a GSF module must be sealed.* See Figure 9 for an example.

12. Secure pipe to GSF modules using one Eljen hoop per module. Push hoop ends straight down into up-facing core, through the fabric and into the underlying sand layer.

13. Spread Eljen cover fabric lengthwise over the pipe and drape over the sides of the GFS module rows. Secure in place with Specified Sand between and along the sides of the modules. Avoid blocking holes in perforated pipe by placing the cover fabric over the pipe prior to placing fill over the modules. Do not tuck or tent the fabric from the pipe. *Note: If modules are spaced end-to-end, fabric must be cut and allowed to drape over and protect the ends of each spaced module. A continuous run of geotextile fabric is not allowed for these applications.*

14. Place 15 cm minimum of Specified Sand along the sides of the modules and at the ends of each module row.

15. Complete backfill with Sandy loam to 25 cm minimum over the GSF modules. Backfill exceeding 45cm above the top of the module requires venting at the far end of the trench. Fill should be clean, porous and devoid of large rocks. Use well graded sandy loam fill. Do not use wheeled equipment over the system. A light track machine may be used with caution, avoiding crushing or shifting of pipe assembly. Backfill in direction of perforated pipe.

16. Divert surface runoff. Finish grade to prevent surface ponding. Seed loam and protect from erosion.

3.4 Sequential Distribution on Sloped System Installation Instructions

1. Carefully lay out the system components and boundaries. Define the location and elevation of the sequential distribution system and distribution box based on the septic tank outlet elevation and pipe grades required to maintain flow to each component.

2. Prepare the site according to BC regulations. Do not install a system on saturated ground or wet soils that are smeared during excavation. Keep heavy machinery off clay soils used for the GSF system as well as down-slope from the system where soil structure is critical for absorption and drainage of the treated effluent.

3. Plan all drainage requirements up-gradient of the system as to not adversely affect systems area. Set soil grades to ensure that storm water drainage and groundwater is diverted away from the absorption area once the system is complete.

4. Excavate the Trenches. Scarify receiving layer by raking or contour plowing at a right angle to slope before placing the specified fill material or Specified Sand. Scarify the receiving layer to maximize the interface between the native soil and Specified Sand.

5. Minimize walking in the excavated area prior to placement of the specified fill material to avoid soil compaction.

6. Place fill material meeting SPM-V3 requirements onto the soil interface as you move down the excavated area. If this is done in two steps, bring in the fill material from the up-slope side of the excavation. Place 15 cm layer of Specified Sand to 2.5 cm above the sand fill grade. Gently hand compact, level and rake the sand on grade.

7. A hand tamper is sufficient to stabilize the Specified Sand below the GSF modules. Check the zero grade of the top of the Specified Sand using a 2 x 4 and carpenter's level or a laser before placing the modules.

8. Place GSF modules with PAINTED STRIPE FACING UP, end-to-end on top of the Specified Sand.

9. Drop Boxes are placed at the beginning of each row along the slope. Non-perforated pipe is plumbed to the next lower trench. Flow Equalizer fittings may be used to further manage wastewater flow if specified by the system designer.

10. Use approved 10 cm non-perforated pipe from the drop box to the GSF modules.

11. Install a line of approved 10 cm perforated distribution pipe lengthwise on the first row over the GSF modules with orifices at 4 o'clock and 8 o'clock. Cap at the far end.

12. In applications where modules are spaced end-to-end to increase effective basal area *all perforated holes not discharging at least 15 cm onto a GSF module must be sealed.* See Figure 9 for an example.

13. Secure pipe to GSF modules using one Eljen hoop per module. Push hoop ends straight down into up-facing core, through the fabric and into the underlying sand layer.

14. Spread Eljen cover fabric lengthwise over the pipe and drape over the sides of the GFS module rows. Secure in place with Specified Sand between and along the sides of the modules. Avoid blocking holes in perforated pipe by placing the cover fabric over the pipe prior to placing fill over the modules. Do not tuck or tent the fabric from the pipe. *Note: If modules are spaced end-to-end, fabric must be cut and allowed to drape over and protect the ends of each spaced module. A continuous run of geotextile fabric is not allowed for these applications.*

15. Place 15 cm minimum of Specified Sand along the sides of the modules and at the ends of each module.

16. Complete backfill with sandy loam to 25 cm minimum over the GSF modules. Backfill exceeding 45cm above the top of the module requires venting at the far end of the trench. Fill should be clean, porous and devoid of large rocks. Use well graded sandy loam fill. Do not use wheeled equipment over the system. A light track machine may be used with caution, avoiding crushing or shifting of pipe assembly. Backfill in direction of perforated pipe.

17. Divert surface runoff. Finish grade to prevent surface ponding. Seed loam and protect from erosion.

System Drawings

Figure 4: Vertical Separation to Limiting Conditions

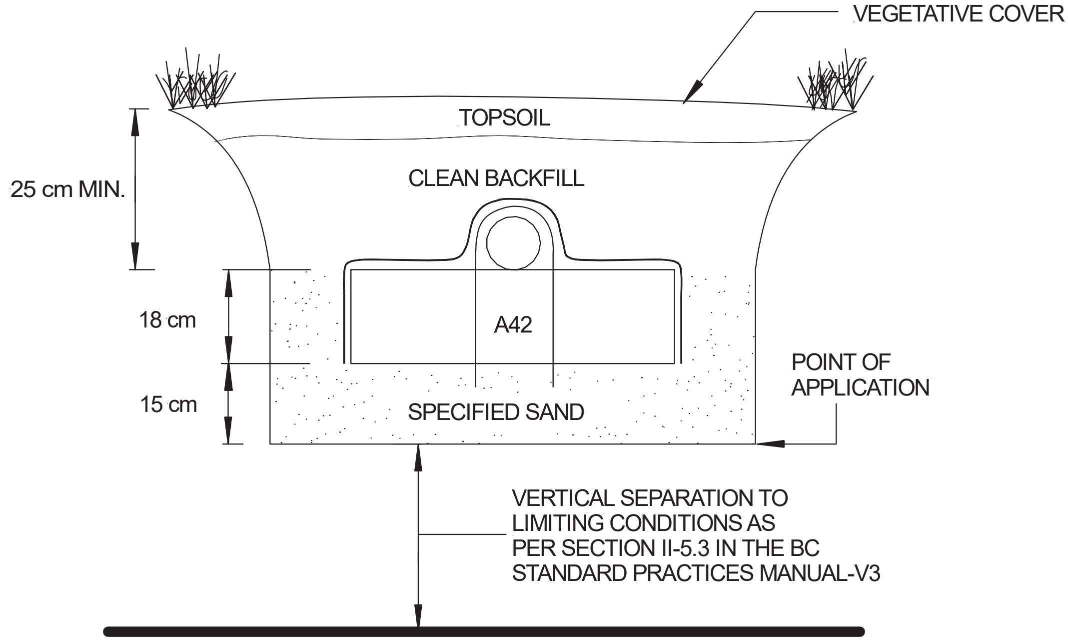
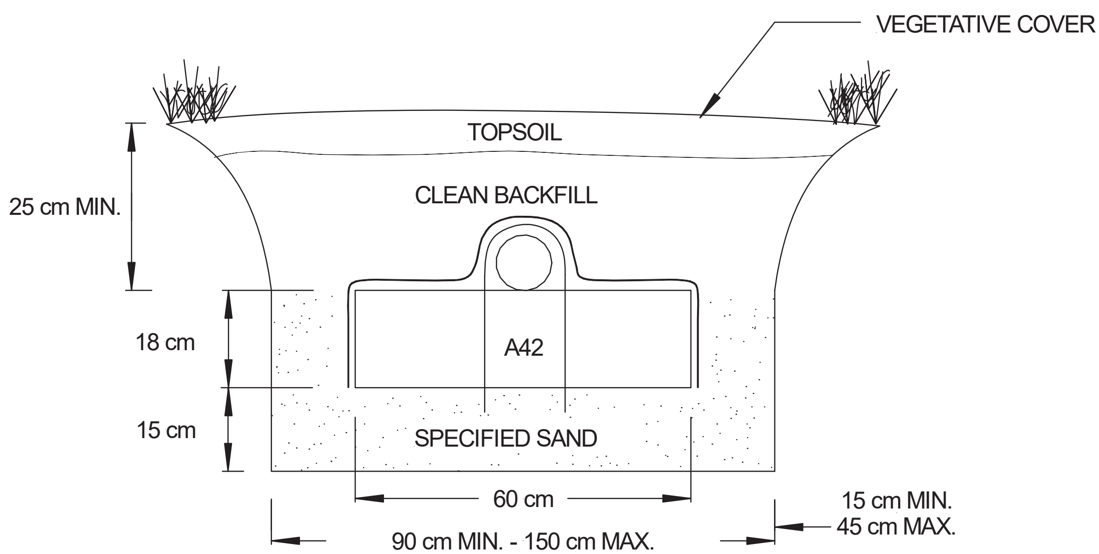


Figure 5: A42 Trench Cross Section



System Drawings – Cont.

Figure 6: A42 Butterfly Trench Configuration

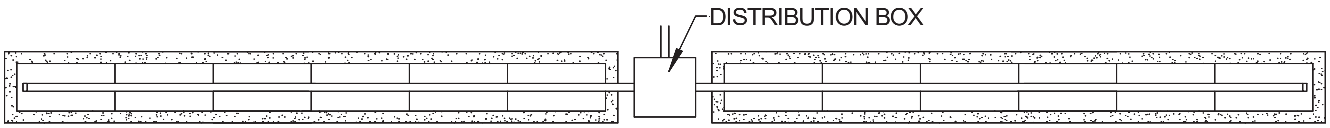
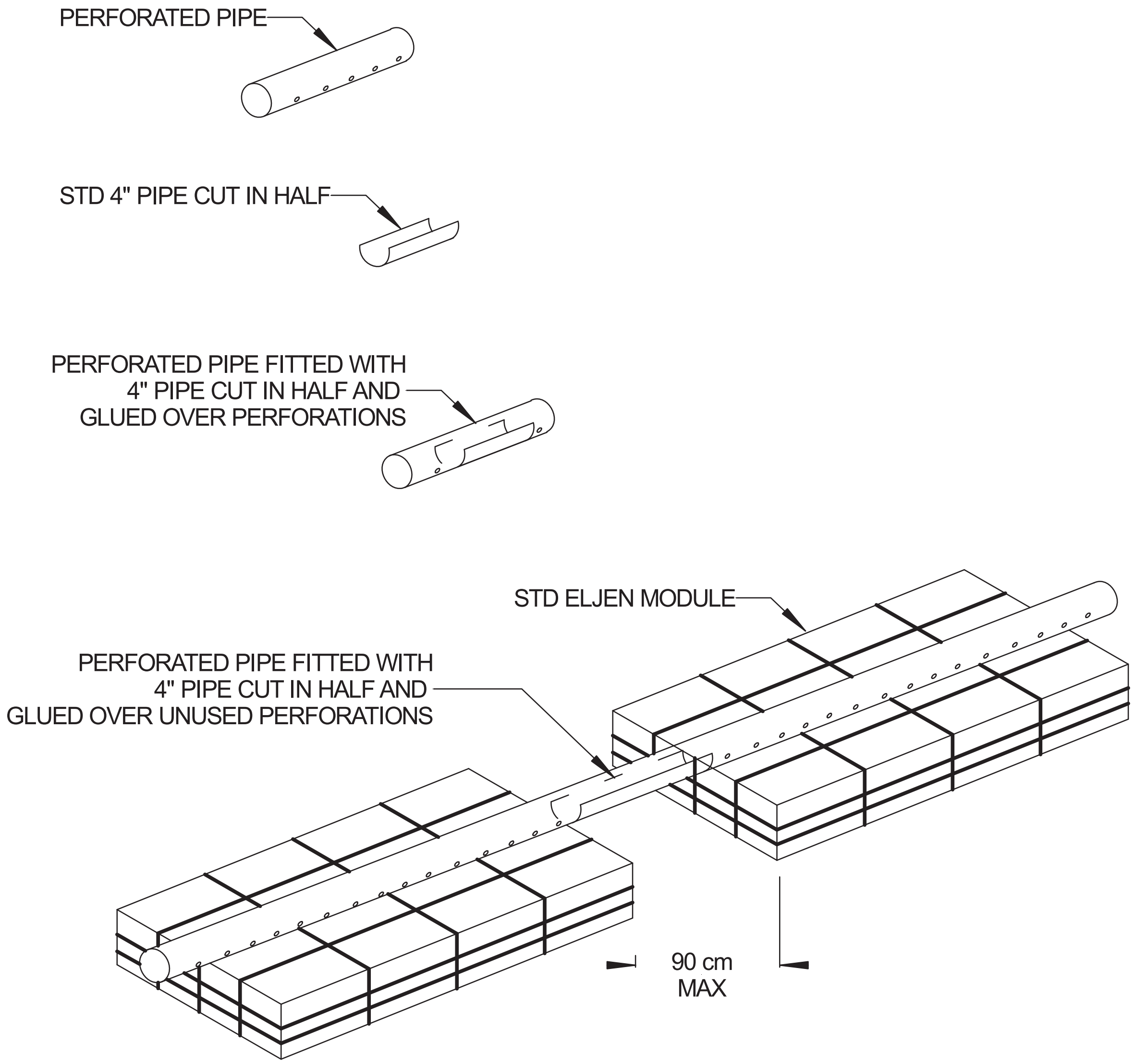


Figure 7: A42 Module End-to-End Separation for All Applications



NOTE: *Half-pipe must cover any hole above the A42 module that is within 15 cm of the edge. If modules are spaced end-to-end, fabric must be cut and allowed to drape over and protect the ends of each spaced module. A continuous run of geotextile fabric is not allowed for these applications.*

System Drawings – Cont.

Figure 8: A42 Bed Cross Section

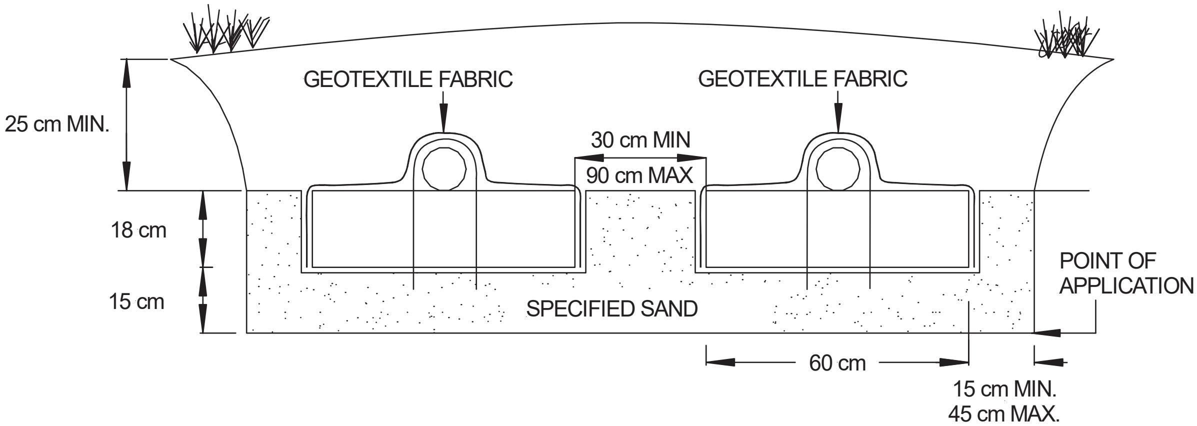
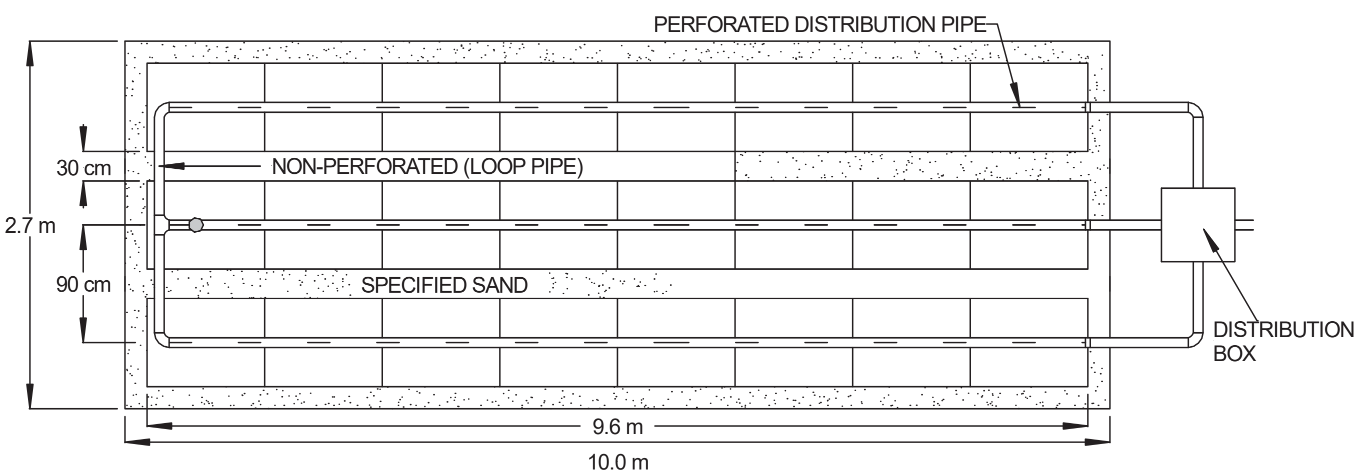


Figure 9: Level Bed Plan View

Note: Middle cross-over pipes (not shown) are recommended for systems over 15 m (50 ft) long. Contact Eljen for Cross-Over pipe details if needed. Cross-Over and end loop pipes are not required on Pressure or Serial Bed Systems.



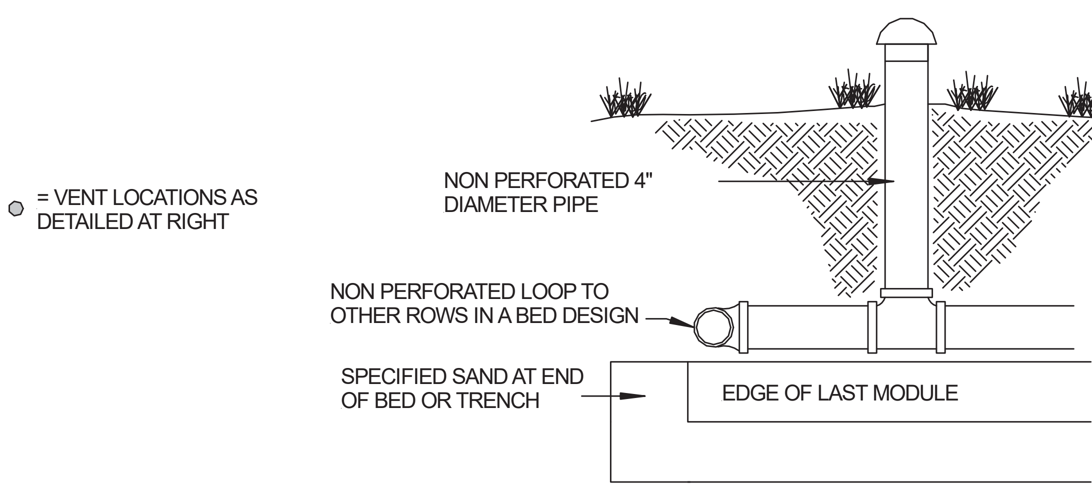


Figure 10: A42 Raised Bed (Sand Mound) Cross Section

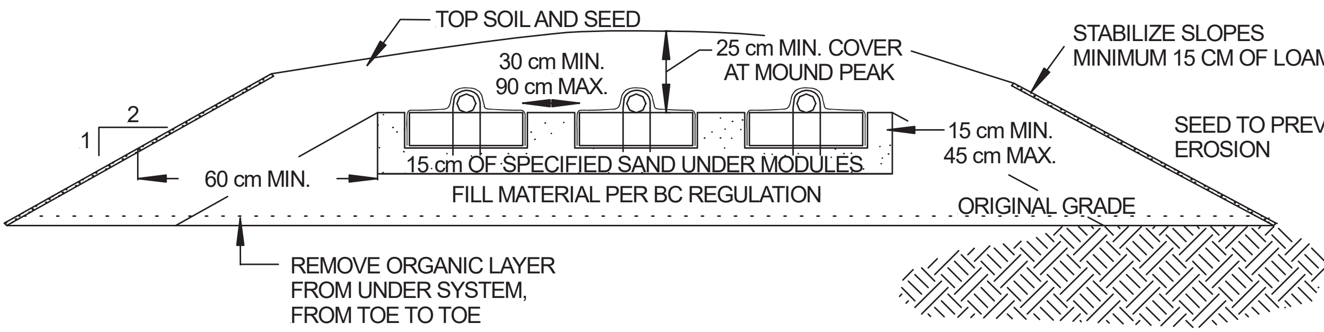
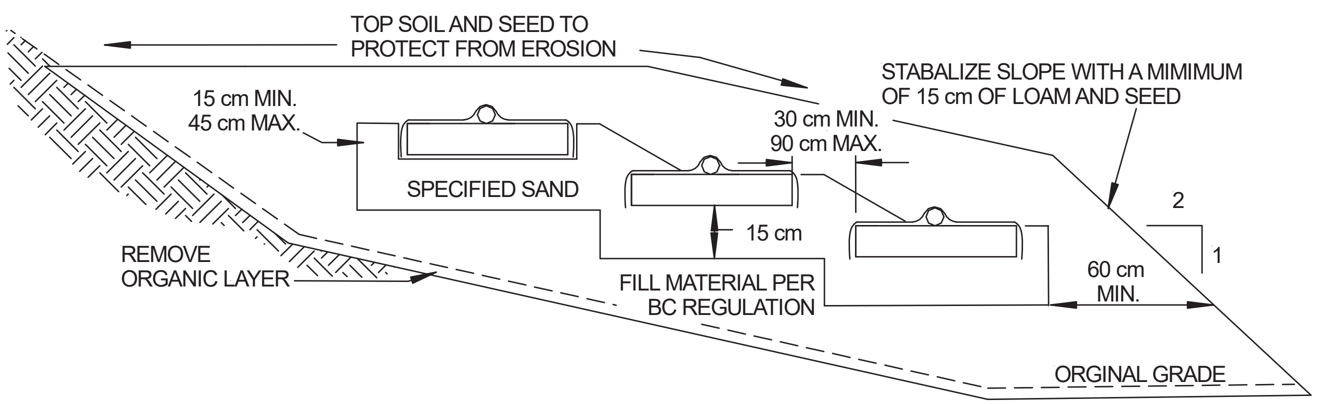


Figure 11: Raised Bed on Slope

Note: Do not end loop bed systems on slopes.



System Drawings – Cont.

Figure 12: Drop Box Detail – Serial Distribution System

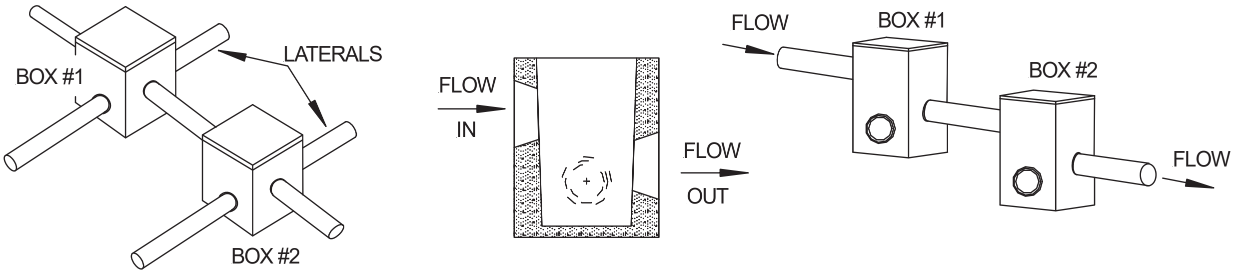
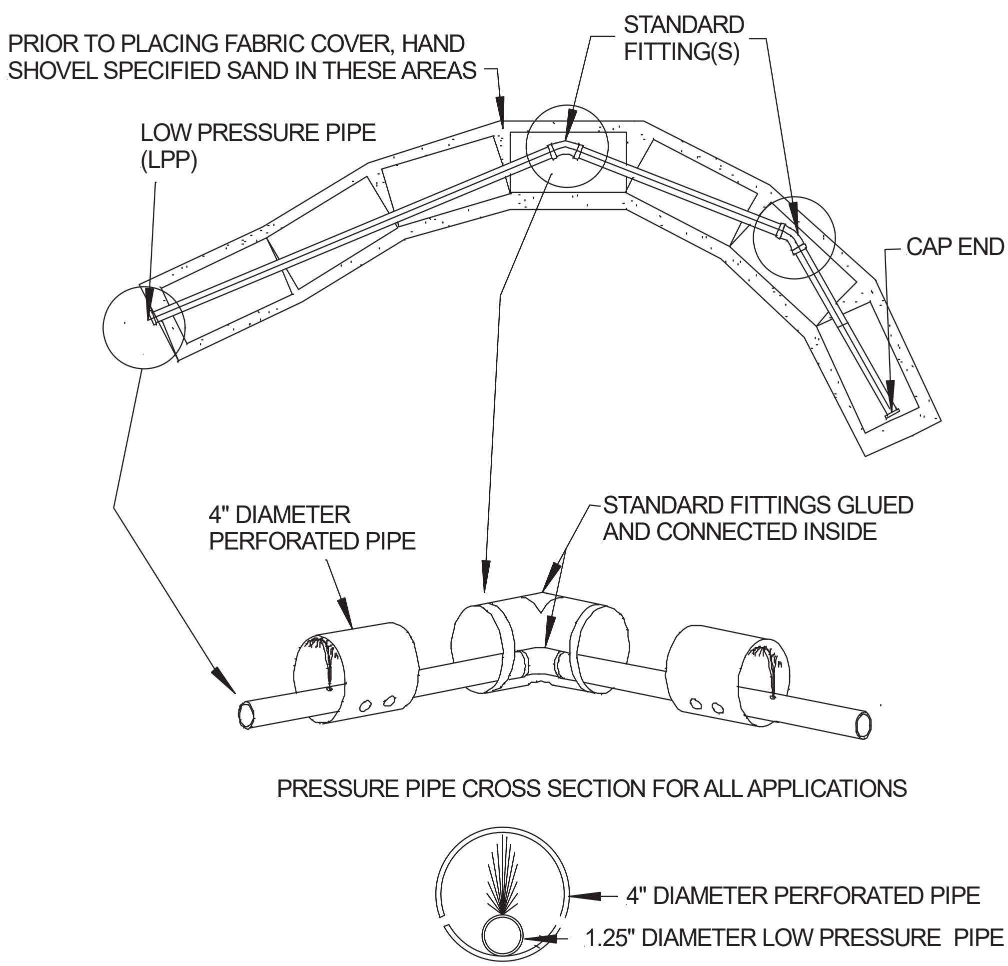


Figure 13: Pressure Distribution Lateral Layout- Pipe in Pipe Method



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.

eljen CORPORATION

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