



ELJEN GSF SYSTEM

Ontario

Design and Installation Manual

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Eljen GSF Performance Testing

The GSF technology is based on scientific principles which show that improving the effluent quality before infiltration in the native soil increases soil absorption rates and reduces risks of clogging. To ensure onsite system designers can confidently specify Eljen's GSF model A42 product, rigorous and official third-party independent testing was conducted in accordance with the NSF/ANSI Standard 40 Protocol.

Fecal Coliform, although not part of Standard 40 protocol, was also tested by the approved testing facility.

The testing was also extended to cover a full 12 consecutive month period instead of the minimal 6 months required by Standard 40. This to verify the stability of the performances and the capacity to handle colder weather conditions.

It is relevant to mention that the Eljen GSF product has been used extensively throughout the United States for decades and is also approved in two Canadian provinces (BC and Saskatchewan) with hundreds of installations in Canada.

The intrinsic characteristics of the Eljen GSF system, combining simplicity, robustness and optimized natural biological processes make it one of the best options for onsite wastewater treatment.

For more information on our product testing, design standards, installation procedures or how the Eljen GSF meets high effluent quality, please contact Enviro-STEP Technologies at 1-877-925-7496 or the Eljen Technical Support Department at 1-800-444-1359.

A summary of the test results from independent third-party testing using the NSF/ANSI Standard 40 Protocol are listed below:

Eljen GSF A42 Modules Treatment Performance during official 12 months testing (including 12 consecutive weeks with influent temperature below 10°C)			
	CBOD ₅ (mg/L)	TSS (mg/L)	Fecal Coliform (MPN/100ml)
Average	1.2	2.4	66*
Median	1.0	1.0	71*
Min Value	1.0	1.0	2*
Max Value	8.3	11.0	10 965*

*Geometric average

**The Eljen GSF system is described as an
Combined Advanced Treatment and Dispersal System.**

Glossary of Terms

A42 GSF Module	Dimensions – (L x W x H) – 1220 mm x 610 mm x 180 mm (48" x 24" x 7") The individual module of a GSF system. The module is comprised of a cuspated plastic core and corrugated geotextile fabric.
Biofabric	Special filter fabric within the Geotextile Sand Filter Modules upon which the primary biomat layer forms.
Cover Fabric	The geotextile cover fabric 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 cuspatations offers increased treatment surface area and greater effluent storage.
Daily Design Flow	The Daily Design Sewage Flow rate used for sizing a wastewater system taking into account mass loading and peak flows. The flow rate per A42 GSF module that is used to size a GSF System using residential strength waste is 95 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 pipes placed above the GSF modules.
Flow Equalizer	Special insert placed in the end of distribution pipes at the distribution box to minimize effects of settling and out of level installation of the D-Box. Also known as speed-levelers.
GAC Filter	Granular Activated Carbon (Charcoal) Filter used on vents to remove any septic odors.
GSF	Geotextile Sand Filter - Includes the Eljen Geotextile Filter modules and the 150 mm sand layer along the base and sides of the modules and the cover fabric.
Level-IV	Level IV Effluent Quality – Level IV refers to the effluent quality from the Eljen GSF System and correspond to CBOD and TSS concentrations not exceeding 10 mg/L.
LPDS	Low Pressure Distribution System – LPDS is a mean of effluent distribution using low pressure and calibrated orifices to evenly distribute effluent over a large area.
LTAR	Long Term Acceptance Rate - LTAR is the average equilibrium absorption rate for effluent in a system, typically expressed in liters per day per square meter.
OBC-B8	Ontario Building Code Division B, Part 8.
SHWT	Seasonal High Water Table.
STE	Septic Tank Effluent (STE) is anaerobically digested effluent that is discharged to a Eljen GSF System for final treatment.

Specified Sand

To ensure proper system operation, the system must be installed using ASTM C33 sand with a maximum of 5% of particles with a diameter of 75 µm or less, a maximum of 10% of particles with a diameter of 150 µm or less and a maximum of 20% of particles with a diameter of 2,36 mm or greater.

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
#30	600 µm	25.0 – 60.0
#50	300 µm	5.0 – 30.0
#100	150 µm	0 – 10.0
#200	75 µm	0 – 5.0
<i>Note: Request a sieve analysis from your material supplier to ensure that the system sand meets the specification requirements listed above.</i>		

Width & 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.

Wire Clamps

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

Introduction

This manual provides design and installation information for the Eljen GSF System using the A42 GSF modules. Design layouts and installation instructions for gravity, bed, trench, raised, pumped systems are included. GSF systems must be designed and constructed according to the most current edition of this manual.

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 advanced treatment technologies in the marketplace today. The Eljen GSF 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 show that improving the effluent quality before infiltration in the native soil increases soil absorption rates and reduces risks of clogging. GSF's proprietary two-stage Bio-Matt™ pre-filtration process improves effluent quality while increasing reliability and ease of operation. The Eljen GSF System is a combined treatment and dispersal system.

Third-party independent testing data modeled on NSF/ANSI Standard 40 Protocol has shown that the Eljen GSF System provides Level IV Quality effluent that exceeds the treatment parameter listed in OBC Table 8.6.2.2.



Eljen GSF System Description

The Eljen GSF Geotextile Sand Filter system is an efficient, combined treatment and dispersion system, that produces a consistent high quality treated effluent. Comprised of a proprietary two-stage Bio-Matt™ treatment process, the geotextile modules apply a high quality pretreated effluent to the soil, increasing the soil's absorption rate, delaying/avoiding bed clogging thus extending the life of the bed. The result is an effective wastewater treatment system that protects our drinking water and the environment.

How the Eljen GSF System Works

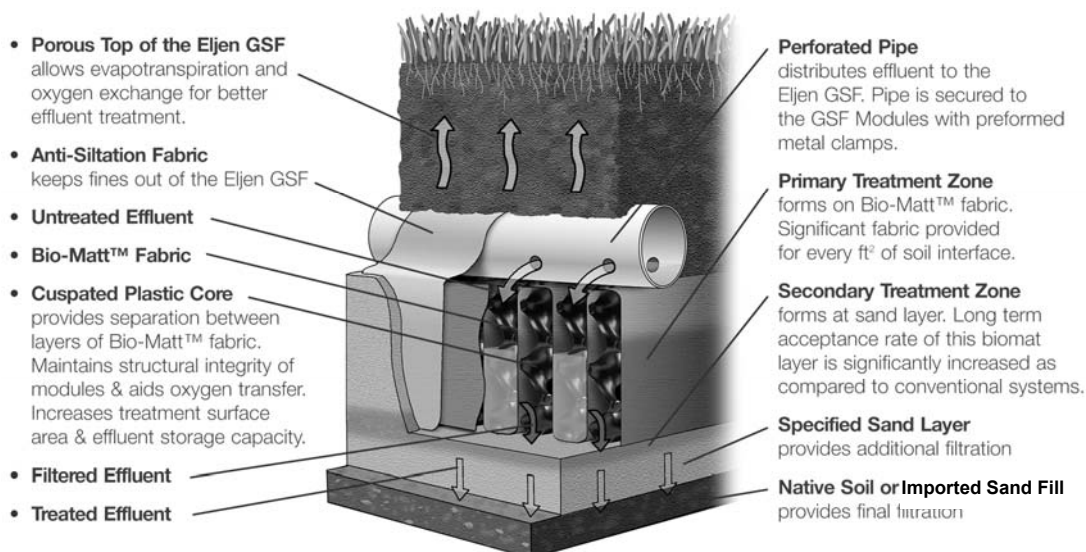
Primary Aerobic Filtration Treatment Zone

- Imitating a conventional leach bed, perforated pipe are centered over the GSF modules to distribute primary effluent over and into corrugations created by the cusped core of the geotextile modules.
- Septic effluent is filtered through the Bio-Matt fabric. The module's unique accordion shaped 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.
- High void space within the modules offers storage during peak flows and maintain close to constant hydraulic loading to the native soil. These alternating wetter and dryer sequences favors a controlled biomass thickness on the fabric and bacteria starvation periods assuring optimal biological sludge digestion;
- 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 Granular Filtration Treatment Zone

- Effluent drips from the modules 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 highly permeable Specified Sand complete aerobic degradation and plays an important role in effluent disinfection.
- The Specified Sand layer also protects the soil from compaction and helps maintain natural soil fissures 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 polishing and filtration prior to groundwater recharge.

Figure 1: Eljen GSF System Operation



1.0 Basic System Design

1.1 ABSORPTION BED SIZE: The total basal area required is site specific and determined by the Daily Design Flow (DDF) and percolation time from the soils analysis as specified in the OBC and determined by an approved Designer.

Eljen GSF System is a Combined Treatment and Dispersal System that allows for a reduced field area in comparison to conventional beds.

- The number of GSF modules required (See 1.10) fits within the required basal area and can be configured to properly cover any shape required and is the same for trench, bed or raised systems.
- In beds and raised systems, a minimum of 300 mm separation is required between parallel rows of GSF modules to utilize sidewall infiltration areas.
- Modules within a same row can be spaced to increase the length of this row and cover a larger infiltration surface.
- Minimum perimeter separation between naturel soil and Eljen GSF modules is 150 mm.

1.2 VERTICAL SEPARATION: The percolation time (T) of the natural soil shall determine the minimum vertical distance from the bottom of the Eljen System Sand to the high ground water table, bedrock or soil with a percolation time (T) greater than 50 min/cm:

- .1 if T is less than or equal to 6 min/cm, or greater than 50 min/cm, then the vertical separation distance shall be at least 600 mm, or
- .2 if T is greater than 6 min/cm, or less than or equal to 50 min/cm, then the vertical separation shall be at least 450 mm.

1.3 SPECIFIED SAND SPECIFICATION FOR ALL SYSTEMS: The 150 mm of Specified Sand immediately under, between rows and around the perimeter of the GSF system shall be **ASTM C33 SAND**. Please place a prominent note to this effect on each design drawing. See page 5 of this manual for details on the ASTM C33 sand specification.

1.4 FILL FOR RAISED SYSTEMS: If the absorption bed requires to be raised such that more than 150 mm of Specified Sand is required to extend any limiting factor, the fill material below the Specified Sand in Section 1.3 shall be ASTM C-33. Sand or imported sand with a percolation time of at least 6 and not more than 10 min/cm, with not more than 5% fines passing the “200 sieve”.

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 300 mm between parallel rows. No mechanical connection is required between units. Alternatively, in all applications modules may be spaced end-to-end and edge-to-edge to increase effective basal area. See Figure 7 and 8 for details.

1.6 DISTRIBUTION PIPE: Place the approved perforated pipe (75 or 100 mm \varnothing) on top of GSF modules with holes at 5 and 7 o'clock. Complete system piping with solid pipe and fittings. Refer to Sections 2 and 3 for level and sloped site piping information respectively. Secure pipe to GSF modules with provided wire clamps, one clamp per Eljen GSF 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 perforated holes. See Figure 12 for pressure distribution.

1.7 DISTRIBUTION BOX: Set gravity system D-box outlet invert a minimum of 10 mm per meter (1/8” per foot) above invert of distribution pipe over modules (50 mm 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.

1.0 Basic System Design

1.8 COVER FABRIC: Geotextile fabric, provided with the system, is placed over the top and sides 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 in trench applications, 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.*

1.9 BACKFILL & FINISH GRADING: Carefully place backfill over the modules, followed by a minimum of 150 mm of top soil to complete a total minimum depth of 300 mm as measured from the top of the module. Systems with total cover that exceeds 450 mm as measured from the top of the module shall be vented at the far end of the system. Backfill material should be a well-graded sandy loam fill; clean, porous, and devoid of rocks larger than 50 mm. Divert surface runoff from the effluent disposal area. Finish grade to prevent surface ponding. Seed loam to protect from erosion.

1.10 NUMBER OF GSF MODULES REQUIRED: Each Eljen GSF A42 modules is designed to a standard loading for residential strength effluent of 95 liters per day per module.

For all systems with Daily Design Flows (DDF) of residential effluent the number of A42 GSF modules is calculated by dividing the DDF in Liters/day by 95 L/day/module.

- For trench, bed and raised configuration drawings see pages 23-28 of this manual.
- For information on commercial or high strength systems see Section 6.

1.11 ADDITIONAL FACTORS EFFECTING RESIDENTIAL SYSTEM SIZE: Homes with an expected higher than normal water use should increase septic tank capacity. Increasing the minimum effluent dispersal area should also be considered.

Factors that may affect system size:

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

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

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

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. Design Drawings and Owners O&M manual must include a note that clearly indicates “**Garbage Disposals ARE (or ARE NOT) allowed to be used with this system.**”

1.14 DOMESTIC WATER TREATMENT DEVICES: Backwash from domestic water treatment devices may adversely affect septic tank treatment and Eljen GSF system.

As a general design consideration, discharge from residential water treatment device **shall be diverted into a separate alternative disposal system.**

1.0 Basic System Design

1.15 SAMPLING DEVICE: The sampling device refers to the assembly required on every Eljen GSF System (1 per system) and allowing for taking a sample of the treated effluent. The sampling pipe is a slotted 100mm diameter pipe wrapped in permeable geotextile fabric and installed below the Specified Sand and covering the length of the first two Eljen GSF modules of the center row. This pipe is extended using solid 100mm pipe to the surface where a threaded cap allow access for sampling. To take a sample, insert a 9mm flexible pipe down to the horizontal slotted section and pour a sample using a hand pump or peristaltic pump. See picture 13.

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 at the far end of the system:

- Any system with more than 450 mm of total cover as measured from the top of the module.
- Areas subject to compaction.
- Any system fed with a pressurized pipe therefore preventing the adequate operation of the building vent.

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

1.18 SEPTIC TANKS: Use a septic tank in compliance with the OBC.

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

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 Specified Sand to the native receiving soils. See Figures 4 & 8.

2.0 Level or Raised Site Systems

2.1 SYSTEM CONFIGURATIONS: Design level in-ground or raised systems with 150 mm minimum spacing between Specified Sand outside perimeter and modules. Provide 300 mm minimum spacing between rows. The modules forming a row can be evenly spaced end-to-end to increase the area covered. The specified Sand, GSF modules, and distribution pipes are installed level at their design elevations.

2.2 DISTRIBUTION PIPE LAYOUT: Approved perforated pipe (75 or 100 mm Ø) runs along the center of the modules. Ends of rows are connected together with approved (75 or 100 mm Ø) solid pipe. If rows are longer than 15 meters, intermediate connections have to be made at mid-point, see Figure 9. Solid pipe is used to connect perforated lines to the distribution box.

3.0 Sloped Site Systems

3.1 SYSTEM CONFIGURATIONS: Gravity or dosed GSF systems may be used on sloped sites where applicable.

3.2 ROW SPACING: Systems with up to 150 mm elevation drop between adjacent module rows use 300 mm minimum spacing. If over 150 mm drop, use 2 times the elevation drop as minimum spacing between module rows.

3.3 DISTRIBUTION BOX: Provide a distribution box at the beginning of the first row of modules for effluent velocity reduction and a system inspection port. For each run, provide an individual solid pipe from the distribution box.

4.0 Pumped Systems

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 50 mm 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.

4.2 PRESSURE DISTRIBUTION: Pressure distribution piping is configured as shown in Figures 2 & 12. A smaller pressure pipe is inserted inside the larger perforated pipe. Distribution is assure through small diameter pressurized orifices. Drainage of the line after each pump cycle is assure through drainage orifices. One distribution orifice is drilled at 12 o'clock for each Eljen GSF A42 module . One draining orifice is drilled at 5 o'clock at the beginning of the first module of each row and at the end of the last module of each row. Orifices size is determined using low pressure distribution calculations assuring that the flow is equally divided to every orifices and the residual pressure result in a minimum of 600mm squirt height.

4.3 DOSING DESIGN CRITERIA: For all pump systems; use a maximum of 10 liters per dose per GSF A42 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. Choose force main diameter to minimize percentage of dose drain back.

Effluent velocity in force main should not exceed 3 m/sec. In all cases design for a minimum of 7 doses per day. For Commercial systems refer to section 6.0.

Note: When pumping to D-box do not exceed D-box manufactures maximum flow rate

5.0 System Venting

5.1 VENTED SYSTEM: Air vents are only required on absorption systems with more than 450 mm of cover material as measured from the top of the GSF module to finished grade. This will ensure proper aeration of the GSF modules and Specified Sand. The GSF has aeration channels between the rows of GSF modules connecting to cuspatations within the GSF modules. Under normal operating conditions, only a small portion of the GSF module 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 Eljen GSF System. To maintain this airflow and fully aerate the Eljen 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 450 mm of cover, an additional 50 mm (2 in.) diameter air-line must be extended from the Eljen 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.

In the gravity fed Eljen GSF system, the vent is typically a 100 mm (4 in.) diameter pipe extended to a convenient and esthetical location (behind shrubs for example), 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 modules 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.

5.0 System Venting

Figure 2: Vent Details for Gravity / Dosed and Pressure Distribution Systems (where specified)

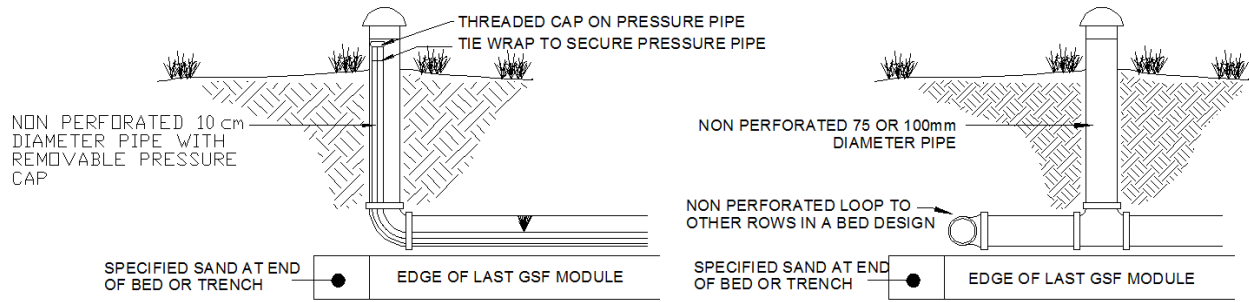
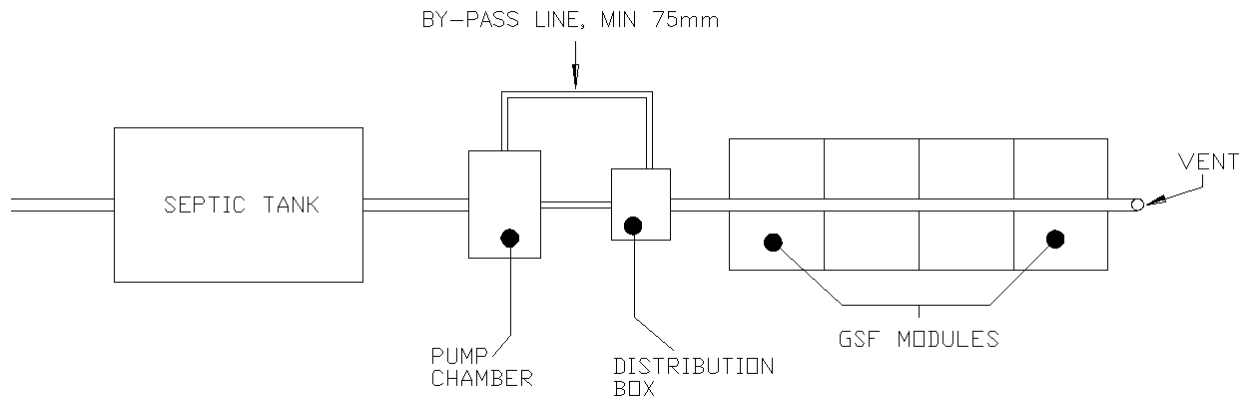


Figure 3: Air By-Pass Line Detail for Venting of Pumped Systems (where specified)



6.0 Commercial Systems

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 dispersal systems and their integrity, groundwater hydrology, drainage above and below the Eljen GSF System and design accordingly.

Designers should carefully review and document with their client effluent BOD₅ 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.

We strongly recommend to the designer to validate each commercial design with Enviro-STEP Technologies Engineering staff.

6.2 MAXIMUM UNIT LOADING: For commercial applications the design must be verified to assure that not only the hydraulic loading rate per GSF module is respected but also the organic loading rate, taking the more stringent of the two criteria. See section 6.10.

6.3 DESIGN FLOW: To determine design flow for commercial systems, please refer to OBC Tables 8.2.1.3.A and 8.2.1.3.B. When using water meter readings, Eljen recommends an adequate safety factor to account for expansion, unusual events and reflects full occupancy of the facility. We strongly recommend to the designer to validate each commercial design with Enviro-STEP Technologies Engineering staff.

6.4 EFFLUENT APPLICATION: Dispersion of effluent across a bed system or down a row of GSF modules must be specifically addressed in the design plans. A variety of wastewater delivery options exists and includes pressure distribution, pressure dosing, and gravity dispersed type systems. Wastewater volume and strength, systems size, and site conditions often dictate which type of system is designed.

Designers must also consider that longer systems are naturally preferred as this geometry reduces the linear loading rate. Water table mounding must be considered to assure that an adequate layer of unsaturated soils is maintained at all times.

Extremely large Eljen GSF systems should be designed as several smaller systems allowing for independent management of the wastewater treatment system. Designs typically include indexing valves to rotate zones into service.

6.0 Commercial Systems

6.5 SITE DRAINAGE AND STORMWATER: Very large onsite absorption beds can be impacted by site drainage from up-slope to the bed area. Larger effluent flows can also increase the groundwater mound down slope. Large recharge systems must be designed and located so that they can accept precipitation and the specified wastewater volume. Control and diversion of up-slope storm water 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 Eljen GSF 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.

6.6 MULTI-FAMILY DWELLINGS: Condominiums, apartments, vacation resorts, trailer parks, RV campgrounds and other systems with domestic type wastewater may use the design formula in Section 6.10 with the maximum loading specified in Section 1.10. Ensure that garbage disposals are not being installed or specified. Appropriate sized septic tank and effluent filters are required for all commercial systems. If the design formula in Section 6.10 is not used, a 1.5 safety factor should be added to the DDF.

6.7 RESTAURANTS: Restaurant or food preparation systems shall use the design formula in Section 6.10. Designs shall in all cases include an appropriately sized grease interceptor. Wastewater from the kitchen shall be piped separately from the rest of the sewage and discharged to the grease interceptor. The remainder of the sewage is discharged to the septic tank where the effluent from the grease interceptor will also be connected on the kitchen plumbing.

Designers may strongly consider the use of a pretreatment unit to reduce the organic loading to conventional domestic sewage strength. These designs must consider the additional sludge produced and assure an adequate settling and storage capacity between pumpouts.

6.8 LAUNDROMATS: Laundromat systems shall use the design formula in Section 6.10. Designs shall use an effluent filter in the septic tank with filtration openings no larger than 0.8 mm.

6.9 OTHER COMMERCIAL SYSTEMS: Other non-residential systems, e.g. schools, butcher shops, milk or ice cream facilities etc. will require more detailed design. The designer is advised to contact Enviro-STEP Technologies Inc. for recommendations on sizing prior to design and submission of plans for permitting.

6.0 Commercial Systems

6.10 FORMULA FOR DESIGN FLOW ADJUSTMENT: Any application where the raw sewage is stronger than conventional domestic wastewater (ex: raw sewage with CBOD > 250 mg/L, TSS > 350 mg/L) **must be designed taking into consideration both hydraulic and organic loading rates of the GSF A42 modules. The most stringent number of modules as to be considered.**

Since the Eljen GSF system receives primary effluent, the primary effluent BOD concentration is to be considered in the calculation. Approximately 30% of the raw sewage BOD is considered being removed by the septic tank.

Eljen GSF daily average hydraulic loading rate: 95 litres/modules.d (daily average)

Eljen GSF maximum hourly peak loading rate: 300 litres/modules.d (hourly peak)

Eljen GSF daily average organic loading rate: 22 g CBOD litres/modules.d (daily average)

6.11 SYSTEM VENTING: It is recommended that all commercial systems be designed with vents. Systems with high waste strength and systems with more than 450 mm 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.

6.12 COMMERCIAL SYSTEM PLANS REVIEW: Enviro-STEP Technologies Engineering staff, will review at no cost all commercial Eljen GSF System plans prior to submission for approval from the local approving authority. Overall responsibility for system design remains with the licensed designer and / or professional.

7.0 GSF Design Considerations for Replacing Failed Systems

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

- Leaking plumbing fixtures.
- Pump settings incorrect or not working properly.
- More occupants or bedrooms than the system was designed for.
- Excessive water usage.
- Garbage disposal device.
- 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 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 45" 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.
- Septic Tank needs to be pumped.
- Wiring or electrical problems with pump systems.
- Supply line to septic tank or d-box needs repair.

8.0 Required Notes on Design Plans

Enviro-STEP Technologies strongly recommends that the following notes appears on Eljen GSF System design plans:

1. This system (is/is not) designed for the use of a garbage disposal.
2. This system is not designed to receive backwash from a domestic water treatment device.
3. Organic Loam Layer must be removed from bed and slope extension areas prior to fill placement. Scarify subsoil prior to fill placement.
4. All fill material shall be clean and permeable and meet Eljen design manual requirements. The 150 mm of Specified Sand underneath and surrounding the GSF modules shall comply with ASTM C33 sand.
5. Backfill material can be native soil with no stones larger than 50 mm in any dimension to a maximum depth of 30 cm over the GSF modules and covered with a minimum 150 mm of clean loam.
6. Any Eljen GSF System that is more than 450 mm below finish grade as measured from the top of the module shall be vented.
7. This design complies with and must be installed in accordance with the December 2014 Eljen GSF System Design and Installation Manual for Ontario.
8. Installation shall be performed by an authorized ELJEN Installer detaining a valid BCIN.
9. Eljen GSF product shall be supplied by an Ontario authorized Eljen GSF Distributor.

9.0 Eljen GSF System Installation Guidelines

- The design plans should present the system layout and details. The Installers must detail the system layout with respect to surface covered, spacing, number of modules, type of material, elevations, wastewater distribution, primary treatment, etc.
- Place a 150 mm minimum level surface of Specified Sand (ASTM C33 sand). You must use the Specified Sand as listed on page 5 of this manual to ensure proper system operation.
- Place GSF modules with **PAINTED STRIPE FACING UP**, on top of the Specified Sand following the design plans in regards to number of rows, spacing between rows, spacing around the Specified Sand perimeter, end-to-end modules spacing and number of GSF modules per rows
- Specified Sand placed along both sides and between rows of GSF module ensures aeration of the modules.
- Use the provided clamps to secure the approved perforated pipe to the top of each GSF module.
- In applications where modules are spaced out end-to-end to increase effective basal area *all perforated holes not discharging at least 150 mm onto a GSF module must be sealed*. See Figure 7 for details.
- Cover the tops and sides of the modules along the entire length of each row with Eljen geotextile cover fabric.
- 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.
- When backfilling the installation with native soil, clay, debris and stones 50 mm or larger must be removed.
- Finish by grading the area to divert storm water runoff away from the system.
- Do not drive backhoe wheels over GSF modules or any portion of the Specified Sand area. Light-weight track rigs may cross system area sparingly with a minimum of 300 mm of cover over the distribution pipe. System area should only be crossed perpendicularly.
- Do not drive over raised systems.
- 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.
- Seeding and stabilizing the soil cover is required to protect the system from soil erosion.
- Where the elevation of the surface exceeds the natural grade, a block or landscape timber frame or sloping soil toe at a maximum 4:1 grade can be used to help eliminate soil erosion and support maintenance of the stabilizing grass cover adjacent to the GSF modules.
- 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 450 mm of cover material as measured from the top of the GSF modules to finished grade is used.
- Eljen GSF product shall be supplied by an Ontario authorized Eljen GSF Distributor.
- Installation shall be performed by an authorized ELJEN Installer detaining a valid BCIN.
- Installer and/or designer shall notify the end user of the requirements pertaining to servicing and maintaining the ELJEN and refer the end user to the authorized ELJEN distributor or Ontario Home owner's manual for details.

10.0 In-Ground Bed System Installation Instructions

1. The design plans should present the system layout and details. The Installers must reproduce the system layout with respect to surface covered, spacing, number of modules, type of material, elevations, wastewater distribution, primary treatment, etc.
2. Carefully lay out the system components and boundaries. Define the location and elevation of the bed and distribution box based on the septic tank outlet elevation and pipe grades required to maintain flow to each component.
3. Prepare the site according to OBC regulations. Do not install a system on saturated ground or wet soils that are smeared during excavation. Keep heavy machinery off clay-type soils used for the Eljen GSF System as well as down-slope from the system where soil structure is critical for absorption and drainage of the treated effluent.
4. Plan all drainage requirements above (up-slope) of the system as to not adversely affect systems 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.
5. Excavate the trench or bed. Scarify the receiving layer to around 150 mm depth to maximize the interface between the native soil and Specified Sand.
6. Place a minimum of 150 mm layer of Specified Sand above the native soil 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 150 mm minimum. Check the zero grades with a laser level before placing the GSF modules.
7. Place GSF modules with **PAINTED STRIPE FACING UP**, on top of the Specified Sand following the design plans in regards to number of rows, spacing between rows, spacing around the Specified Sand perimeter, end-to-end modules spacing and number of GSF modules per rows.
8. If using a D-box(s), installation must follow the manufacturer's recommendations and any applicable regulation. The D-box receiving soil must be compacted to avoid differential movement..
9. Use approved 75 or 100 mm \varnothing non-perforated pipe from the distribution box to the GFS modules.
10. Center approved 75 or 100 mm \varnothing perforated distribution pipe lengthwise over modules with orifices at 5:00 and 7:00. For Gravity Systems, connect mid points on level bed systems on rows over 15 meters long. See Figure 9.
11. In applications where modules are spaced end-to-end to increase effective basal area *all perforated holes not discharging at least 150 mm onto a GSF module must be sealed*. See Figure 7 for details.
12. Secure pipe to GSF modules using one Eljen clamp per module. Push clamp 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. *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 Specified Sand along the sides of the modules and at the ends of each module row up the height of the GSF modules (180 mm).
15. Complete backfill with permeable soil (ex: Sandy Loam) to a minimum of 150 mm over the GSF modules. Place a minimum of 150 mm of top-soil on top of the fill. Total backfill exceeding 450 mm requires venting at the far end of the trench. Fill should be clean, porous and devoid of debris, large rocks and organic matter. 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 surface of fill material and protect from erosion.

11.0 Raised System Installation Instructions

Note: Refer to Figure 10 for design illustration.

1. The design plans should present the system layout and details. The Installers must reproduce the system layout with respect to surface covered, spacing, number of modules, type of material, elevations, wastewater distribution, primary treatment, etc.
2. Carefully lay out the system components and boundaries. Define the location and elevation of the raised bed and distribution box based on the septic tank outlet elevation and pipe grades required to maintain flow to each component.
3. Prepare the site according to OBC 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.
4. Plan all drainage requirements above (up-slope) of the system as to not adversely affect systems 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.
5. Remove the Organic Layer. Scarify the receiving layer to around 150 mm depth to maximize the interface between the native soil and Specified Sand.
6. Place fill material meeting regulatory 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 150 mm layer of Specified Sand to 25 mm 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**, on top of the Specified Sand following the design plans in regards to number of rows, spacing between rows, spacing around the Specified Sand perimeter, end-to-end modules spacing and number of GSF modules per rows.
9. Use approved 75 or 100 mm \varnothing non-perforated pipe from the distribution box to the GFS modules.
10. Center approved perforated distribution pipe lengthwise over modules with orifices at 5:00 and 7:00.
11. 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.
12. 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. *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.*
13. Place Specified Sand along the sides of the modules and at the ends of each module row up the height of the GSF modules (180 mm).
14. Complete backfill with permeable soil (ex: Sandy Loam) to a minimum of 150 mm over the GSF modules. Place a minimum of 150 mm of top-soil on top of the fill. Total backfill exceeding 450 mm requires venting at the far end of the trench. Fill should be clean, porous and devoid of debris, large rocks and organic matter. 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.
15. Divert surface runoff. Finish grade to prevent surface ponding. Seed surface of fill material and protect from erosion.

12.0 Absorption Bed System Sizing and Details

Design Parameters Summary

Vertical Separation:

The percolation time (T) of the natural soil shall determine the minimum vertical distance from the bottom of the Eljen GSF System Specified Sand to the high ground water table, bedrock or soil with a percolation time (T) greater than 50 min/cm:

- if T is less than or equal to 6 min/cm, or greater than 50 min/cm, then the vertical separation distance shall be at least 600 mm, or
- if T is greater than 6 min/cm, or less than or equal to 50 min/cm, then the vertical separation shall be at least 450 mm.

Number of Eljen GSF A-42 modules Required :

Each Eljen GSF A-42 module has the capacity to treat 95 L of wastewater per day. Thus, the number of Eljen GSF modules required:

- The formula to determine the number of Eljen GSF modules required is $Q/95$.
- The number of Eljen GSF modules obtained must be rounded up at all times.

Modules Spacing Requirements :

The Eljen GSF modules shall be spaced using the following criteria:

- Each modules of a given row are placed end-to-end or can be evenly spaced to increase to total area covered.
- Each rows are spaced at a minimum of 300 mm calculated side to side of modules.
- Each row start and stop at a minimum of 150 mm inside the perimeter defined by the Specified Sand.
- Modules can be placed in angle to follow site topographic contours.

Dispersal Area (A) – In-ground, partially raised, or above ground

The area (m^2) to be covered by the Specified Sand in the Eljen GSF System shall be equal or larger than the area (A) determined by the formula $A = QT/400$, in which the T is the percolation time (T) in min/cm of the native soil - to a maximum of 50 min/cm - and Q is the total daily design sewage flow in (L).

- In all Eljen GSF System designs the minimum spacing requirement shall be met.
- Where the area determined using $QT/400$ is larger than that required by the minimum spacing required above, the Eljen GSF modules may be evenly spaced over the entire area of the Eljen GSF Specified Sand.
- The dispersal surface shall have the long dimension perpendicular to the direction in which effluent entering the soil will move horizontally.
- When the native soil has a T of 50 min/cm or greater, the Eljen GSF System must be fully raised.

Other

The Eljen GSF System shall be designed, installed, operated, and maintained using these criteria:

- No System shall be installed in an area in which the original ground has a slope in excess of 4 horizontal to 1 vertical.
- All pumped systems shall use differential venting and a vent shall be located at the far end of one of the Eljen GSF modules rows.
- Except when used with a "Low Pressure Distribution System", all Eljen GSF Systems that have a pump must use a velocity reducer located in the distribution box.

- The Eljen GSF System shall have a sampling device, for the purpose of sampling the effluent and it shall be installed as described in the Eljen / Enviro-Step Technologies Inc. "Eljen GSF System: Design and Installation Manual – Ontario", dated December 2014.
- The site shall be protected from erosion by proper grading, mulching, seeding, and runoff control.
- The Eljen GSF peripheral modules in the bed, measured from the centre of the perforated distribution pipe, shall meet the setback requirements outlined in Article 8.2.1.4. of Division B, of the Building Code.
- No reduction in size of the Eljen GSF System is permitted with the use of treatment device beyond that of a septic tank.

13.0 Eljen GSF System Drawings

Figure 4: Vertical Separation to Limiting Conditions

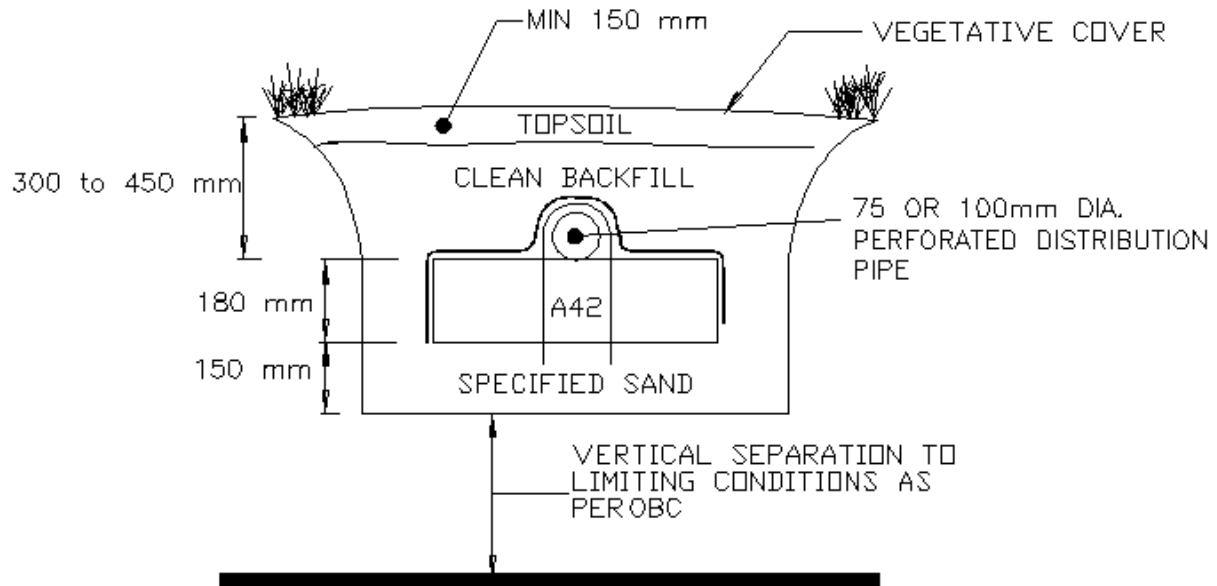
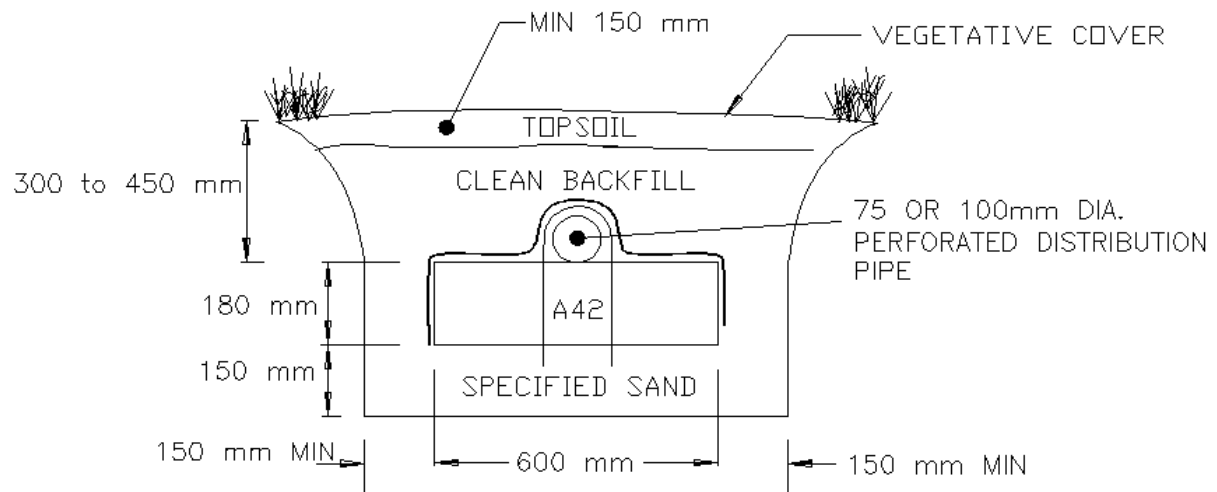


Figure 5: A42 Single Trench Cross Section



13.0 Eljen GSF System Drawings

Figure 6: A42 Butterfly Trench (or bed) Configuration

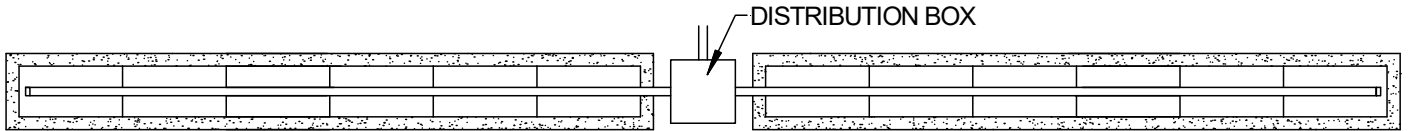
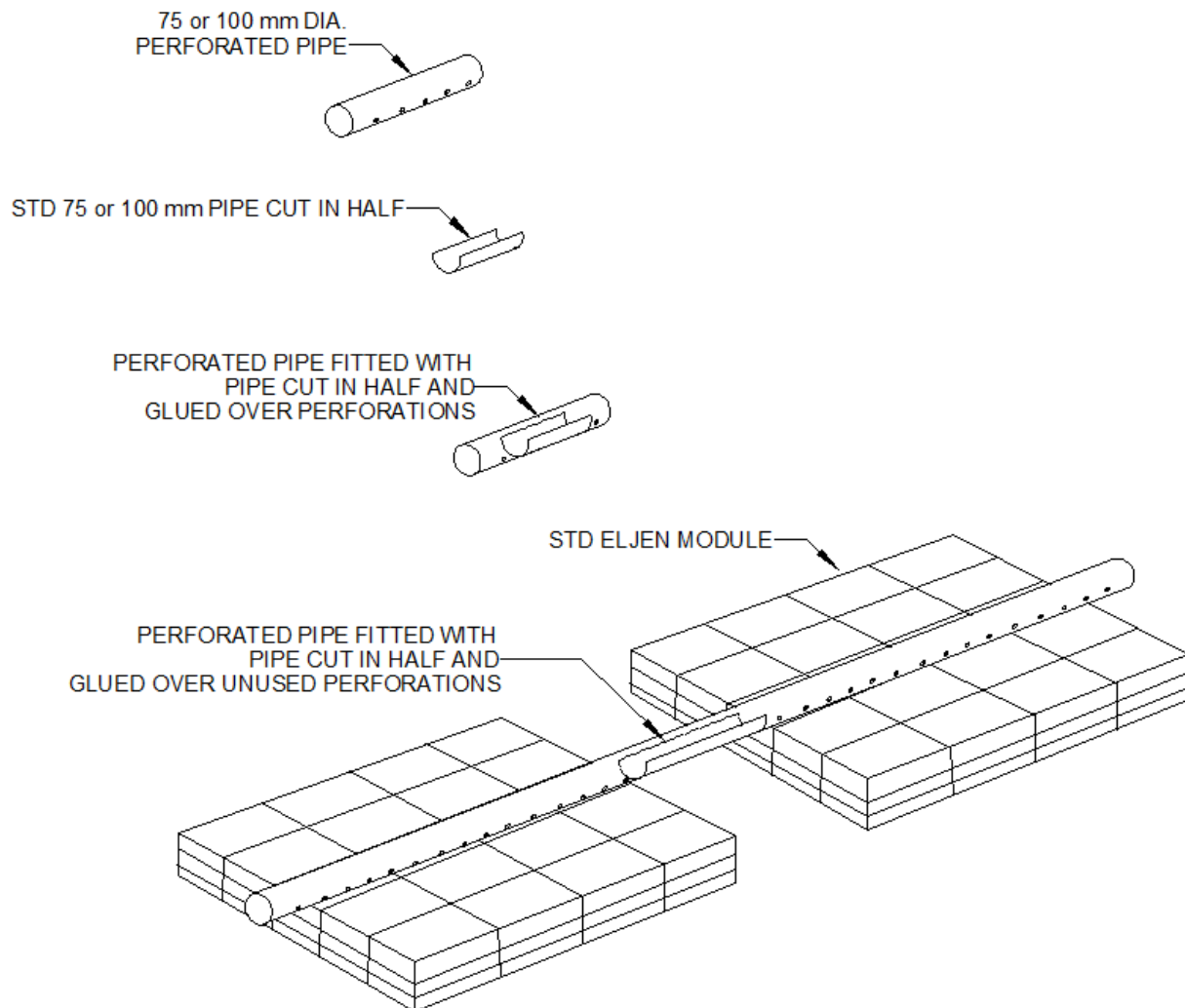


Figure 7: A42 Module End-to-End Separation for All Applications



NOTE: Half-pipe must cover any hole above the A42 module that is within 150 mm 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.

13.0 Eljen GSF System Drawings

Figure 8: A42 Bed Cross Section

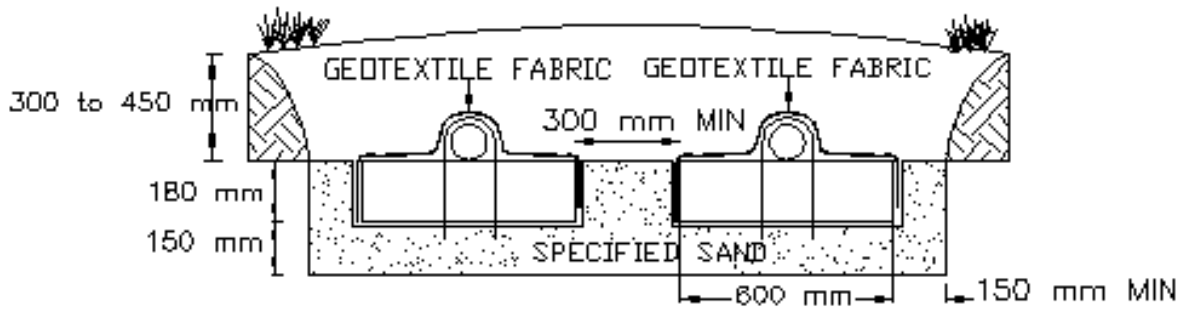
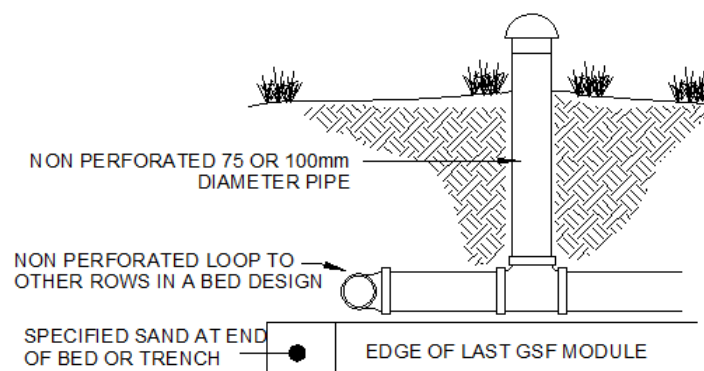
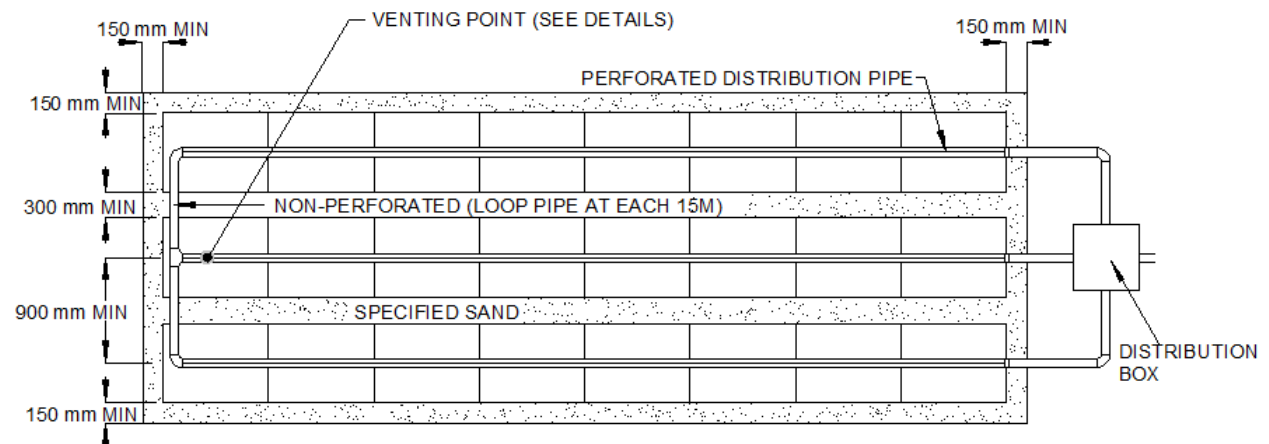


Figure 9: Level Bed Plan View

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



13.0 Eljen GSF System Drawings

Figure 10: A42 Raised Bed Cross Section

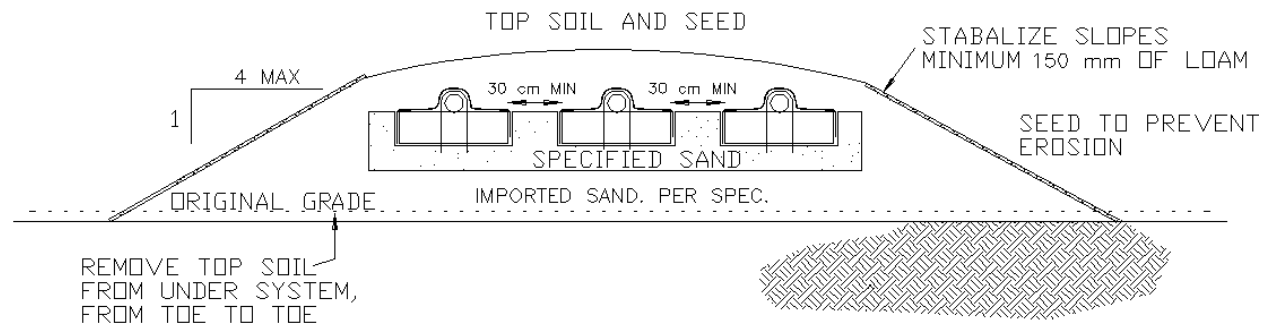
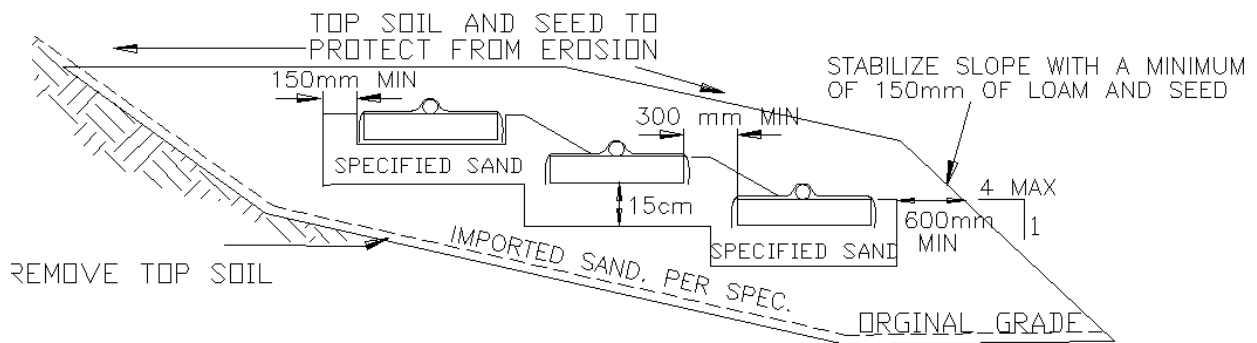


Figure 11: Raised Bed on Slope

Note: Do not end loop bed systems on slopes.



14.0 System Drawings

Figure 12: Pressure Distribution Lateral Layout

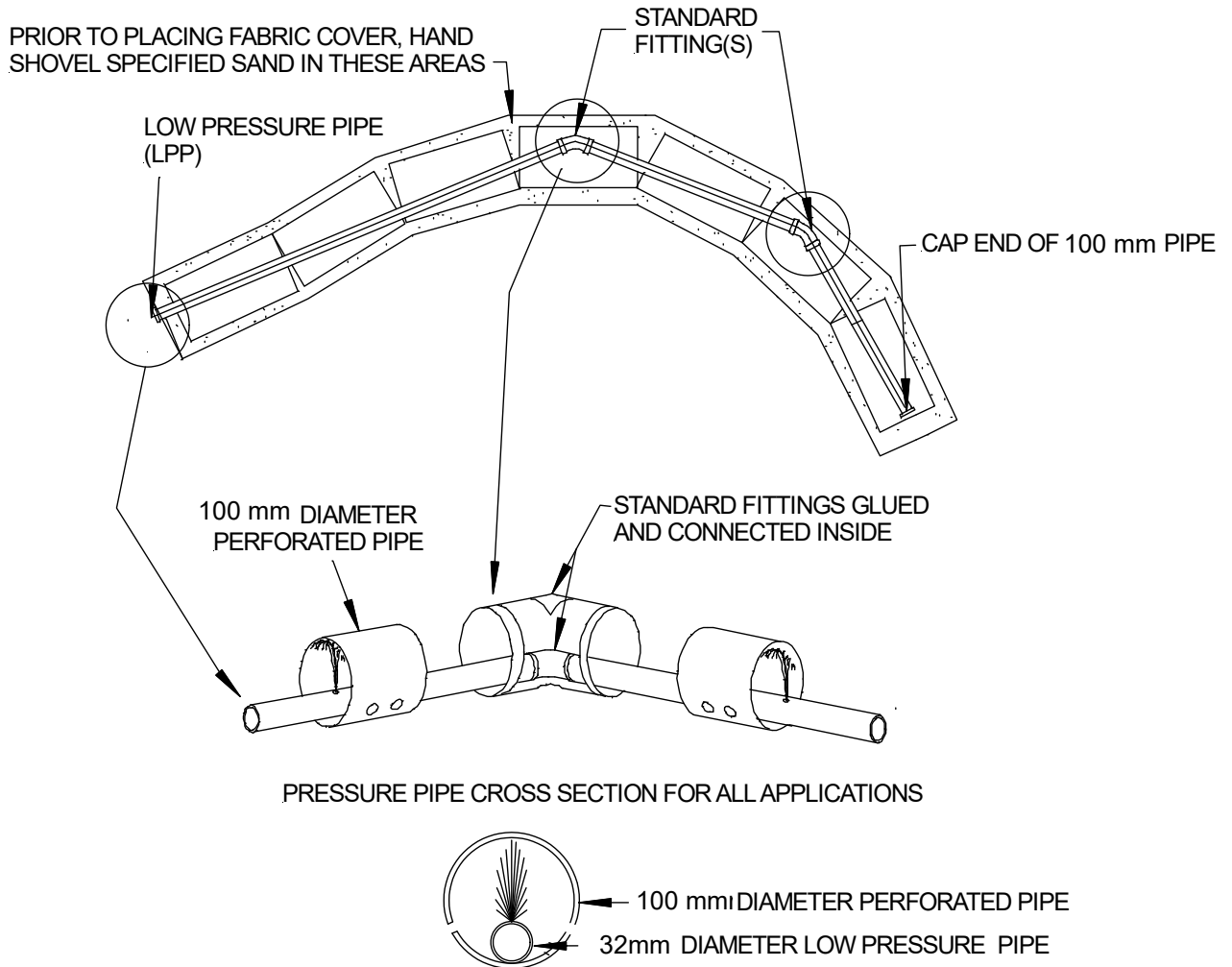
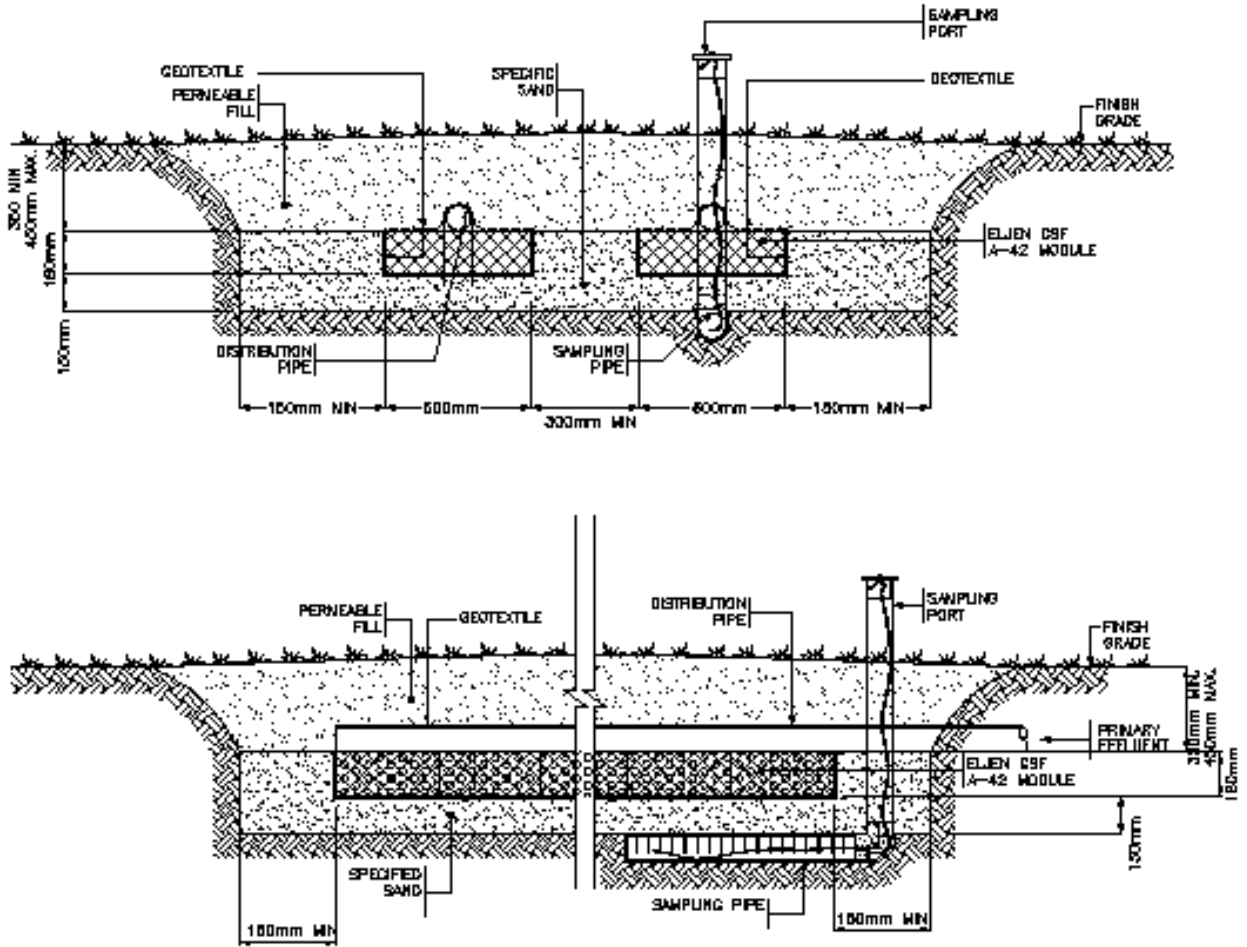


Figure 13: Sampling Pipe



THE SAMPLING PIPE CONSIST IN A 100mm PVC PIPE SLOTTED ON ITS UPPER PORTION TO MID-DIAMETER AND WRAPPED IN GEOTEXTILE FABRIC. SLOTS ARE 3.2mm (1/8"), SLOTTED PIPE LENGTH IS 2.4m AND TERMINATED WITH A CAP. PIPE IS EXTEND TO SURFACE USING A SOLID PIPE TERMINATED WITH A SCREWED CAP.

PIPE IS PLACED BELOW THE SPECIFIED SAND 100mm IN THE NATIVE SOIL AND POSITIONED PARALLEL TO THE CENTER OF THE FIRST TWO MODULES OF A ROW

