EPIC LEACH SYSTEMS

"A Matter Of Choice"

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PATENTED PROPRIETARY INFORMATION FOR REGULATORS AND INSTALLERS OF INDIVIDUAL HOME SEWAGE DISPOSAL SYSTEMS

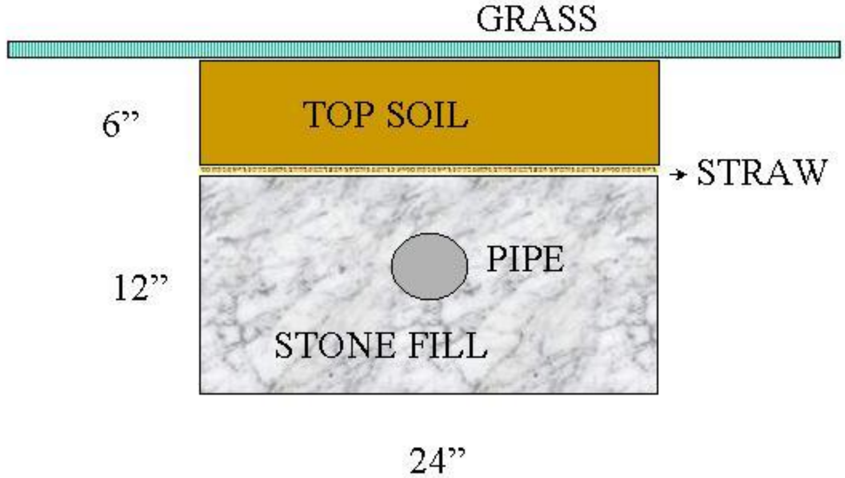
CONVENTIONAL LEACH LINE, PERSPECTIVE AND DYNAMICS

As a result of acceptable initial reliability, plus statutory “encouragement” through sanitation regulations, the design specifications for leach lines have changed very little over the past hundred years, apart from occasional variations in physical dimensions and structural components. A trench is dug, and then partly filled with stone. A perforated pipe is laid on top of the stone, which is then covered by additional stone. A semi-permeable membrane such as building paper or a layer of straw is placed over the stones, followed by a topping layer of soil.

A typical leach line is twenty-four inches in width and eighteen inches in depth. While seemingly quite shallow, at eighteen inches, sufficient oxygen is <u>expected</u> to be present in the native soil to support aerobic microorganism decomposition. Such organisms and processes are considerably more efficient in breaking down the semi-solid sewage materials than is the decomposition that occurs in a deeper, anaerobic (no oxygen) environment. In addition, most homogenous soils are also less permeable to water as the soil depth increases. The increasingly compressed soil structure at soil depths results in slower rates of water flow through the soil, and less efficient dispersal of the sewage effluent along the leach line.

In addition to providing support for the distribution pipe, the stone fill in the leaching trenches was expected to increase the effective decomposition surface area and create effluent storage volume within the trench. At three-quarter inch to one-and-a-half inches in diameter, the “Number 2” stone provided a sufficient number and size of void space to efficiently retain and distribute the sewage effluent throughout the leach line. One cubic foot of #2 stone provides a maximum of 3.25 gallons or 43% of the available storage volume for sewage effluent. For a typical twenty-four-inch wide by fifty-foot-long leach line, this results in approximately 6.5 gallons per foot, or 325 gallons of effluent storage volume. In addition to providing capacity for surges in liquid flow, this pore void volume is also <u>expected</u> to enhance the effective area for fluid dispersion at the soil-stone interface.

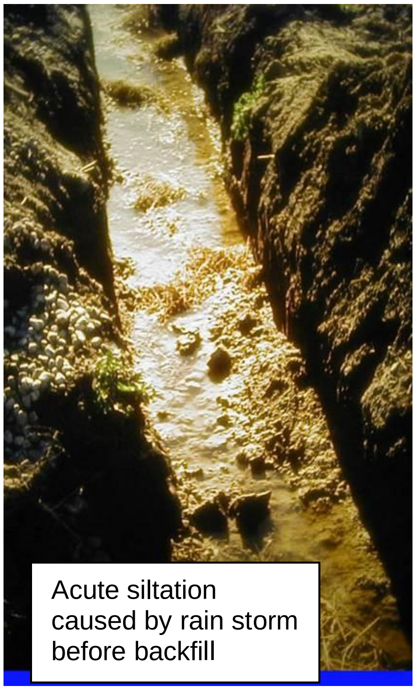
Conventional Leach Line Cross Section



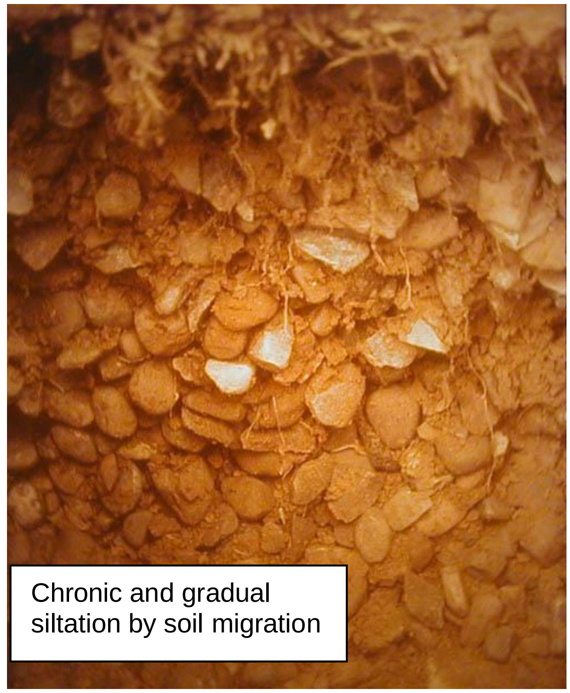
As initially installed, the effluent discharge surface area is considered to be the “wetted” area of the sides and bottom of the stone-soil interface. At a preferred width of twenty-four inches, the resultant stone-soil interface consists of the bottom, twenty-four-inch width, and that lower” wetted” portion of the two, twelve-inch side walls. Since the side walls provide equivalent absorbency to that of the bottom area, the 50:50 proportion of soil contact area, as between the twenty-four-inch bottom width and the two twelve-inch sidewalls, is expected to maximize the absorption efficiency between the leach line volume and the available soil contact area. Additionally, as the bottom layer becomes plugged (for reasons discussed below), an additional side wall surface area becomes available for liquid absorption as the liquid level rises in the leach line.

The final layer of the leach line consists of the topsoil cover. A six-inch depth of soil represents a satisfactory compromise between providing pathogen-to-atmosphere separation as well as providing an optimal soil matrix for grass development. While a deeper topsoil layer would beneficially increase the atmosphere-to-sewage separation distance, it would detrimentally decrease the evaporative loss rate from the leach line as well as result in the formation of an unstable layer of soil immediately above the semi-permeable membrane. Lying too deep to be stabilized by the grass roots, this layer of soil would tend to gradually silt into the stone-filled layer below, increasing an erosion problem that is inherent in stone layer leach lines.

In addition to its often being costly to obtain and labor-intensive to properly install, stone fill is not a stable component of subsurface soil structure. The voids within the stone fill, while beneficial for liquid storage, are subject to a slow siltation process, whereby the surrounding soil gradually invades and fills these interstices.

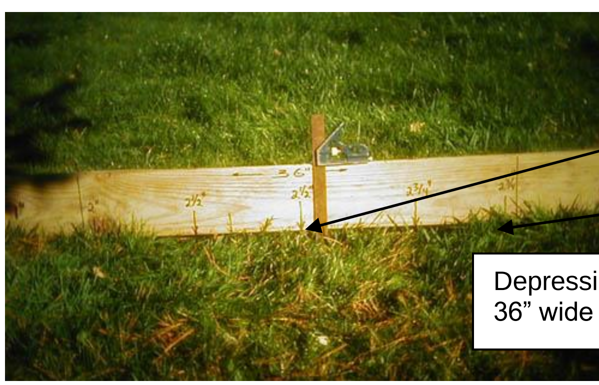


Acute siltation caused by rain storm before backfill



Chronic and gradual siltation by soil migration

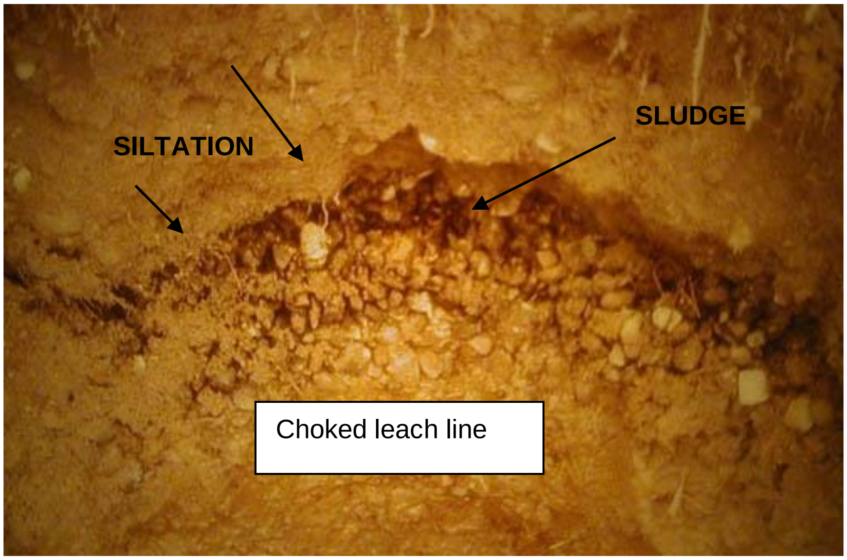
This slow collapse of the trench walls and ceiling into the stone voids reduces both the available pore space as well as the effective effluent discharge area. Further, this siltation process itself establishes subsurface liquid flow channels that tend to accelerate the siltation process. As one example, the gradual collapse of the trench walls and overlying soil of the original leach line creates a depression along the length of the leach line. Once formed, an increased volume and flow of surface rainwater is channeled into this depression, further accelerating the siltation of the surrounding soil into the stone bed.



Depression distances across a 36” wide leach line

In addition to siltation, the traditional stone-fill leach lines present other inherent steady-state operational problems. Typically, the perforated leach line pipe is a four-inch (diameter) PVC pipe that passively delivers sewage effluent to the stone fill. The void spaces permit liquid sewage to flow throughout the field, and with no capillary action within the stone fill, the liquid sewage settles over time to occupy the lowest portions of the leach line.

Additional sewage effluent flowing into the field will then accumulate on top of the initial fluid flows. The passive stone fill leach line provides no active mechanism to either evenly distribute this sewage (horizontally) throughout the field or to draw water upward (vertically), and thereby permit its interface with the upper portions of the trench. Over time, stagnation results and the lowest portions of the leach line become anaerobic. This further slows the decomposition of organic material in the lower sewage layer, as well as results in the production of incomplete decomposition by-products (sludge) that plug up additional soil interface areas. With the lower portions of the trench no longer able to absorb additional sewage flows, adding additional effluent only results in an increasingly deep anaerobic stagnant layer. The leach line slowly "dies".



Although ultimately susceptible to these unavoidable **siltation** and **stagnation** processes, the leach line design does offer effective pathogen containment and wastewater disposal by three separate mechanisms: (1) A reserve fluid storage capacity is provided by the stone voids; (2) the soil-stone interface establishes a mechanism for fluid absorption in the surrounding soil; and (3) Some evapotranspiration fluid loss is <u>expected</u> through the shallow construction and the grass root absorption.

ENVIRONMENTAL PASSIVE INTEGRATED CHAMBER (EPIC) DISTINGUISHED

The EPIC system provides an enhanced subsurface fluid distribution system in a manner **that avoids previous design deficiencies** in conventional leach line construction. The storage capacity of the EPIC design makes use of one or more interconnected chambers instead of the stone fill voids, with such chambers providing enhanced stability in terms of fluid capacity over the siltation-prone stone fill. With the sewage effluent distributed into the surrounding soil through such a chamber, the active soil interface area for absorption of the fluid is more than doubled.

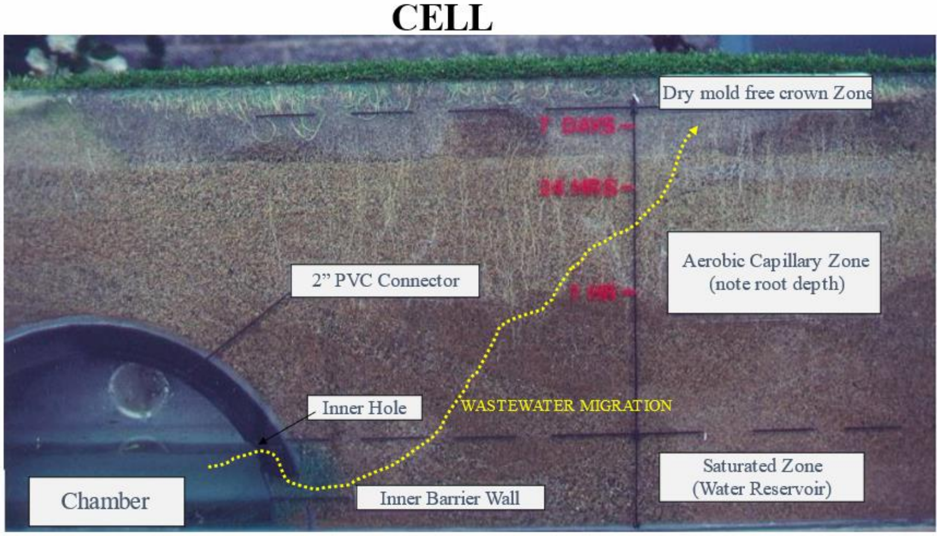
Additionally, these chambers are received within a sand bed, which itself provides an exceedingly active capillary action mechanism to withdraw water from the chambers. Moreover, this sand bed provides an excellent medium for supporting root growth, which in turn enables an increase in the evapotranspiration rate by a full order of magnitude. **Soluble nitrates, created by soil bacteria from septic effluent ammonia, now have the tendency to be directed upward for absorption as a nutrient for overlying plant growth instead of being forced unused into groundwater formations**.

Note Root growth in 15" Depth

Small and large EPIC Chambers in 15" width

Completed Line filled to surface with Sand

CROSS SECTION OF AN EPIC GROWTH CELL



Also, this sand envelope virtually eliminates siltation as a problem by preventing soil incursion into the sand bed, which otherwise comprises a stable underground soil formation. The capillary action provided by the surrounding sand bed not only distributes the sewage effluent evenly, both laterally and vertically but also enables the quick dewatering of the sewage effluent. Unlike the stagnant fluid found in the lower layer of stone-filled leach lines, the resulting dewatered leach line of the EPIC design enhances oxygen availability, and gas exchange, to the sewage solids - and therefore of aerobic microorganism activity. This greatly speeds the decomposition of the organic matter remaining after transport of the water from the chamber.

The shallow construction, the use of sand, the open design, and the elimination of all the problems associated with stone fill structures (see ***Problems Associated with the use of Gravel in Septic Tank Leachfield Systems***, Randy May, **Environmental Health,** September 1996), makes the EPIC design unique in soil absorption dynamics, efficiency and **nitrate removal**.

COMPARATIVE DATA

While the gravel fill leach line has been a long-time mainstay for sewage disposal, several alternative designs are now available including the patented EPIC design. As such to the installer and homeowner the issue of choice is no longer just a matter of cost, but also one of performance.

Cost factors will vary in terms of cost per unit length, installation manhours, delivery time, and productivity of the installer. Although these factors can vary, they can be individually calculated and estimated. On the other hand, the long-term performance characteristics and anticipated failure of any system depend on:

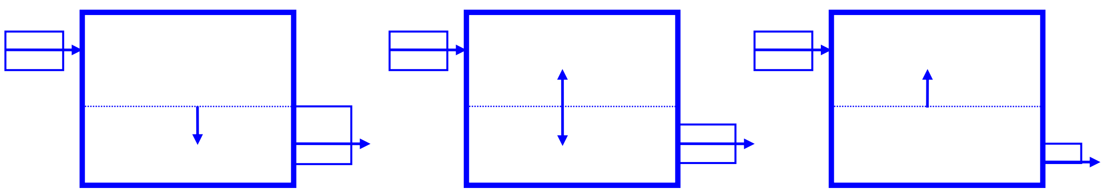
- **a. Soil percolation rates.**
- **b. Soil structure and its stability.**
- **c. Household flow, surge loading rates, and resting rates.**
- **d. Size of septic tank.**
- **e. Condition of septic tank and pumping frequency.**
- **f. Weather conditions, seasonal variations, temperature, rainfall.**
- **g. Sewage quality.**
- **h. Surface topography, and obstructions.**
- **i. Leach field size, and distribution network.**
- **j. Surface runoff influence.**
- **k. Construction damage, etc.**

It is obvious that due to the vast number of variables that can occur from installation to installation, the long-term performance prediction of any individual system is nearly impossible. Scientific **full-scale** research is unrealistic because the variables cannot be controlled from household to household, the biomechanics are difficult to observe once the system is backfilled, and few people have the patience to continue even minimal observations for 10 or more years (the minimum expected life expectancy of even a crude, conventional, properly installed leach line system).

As such, given that all variables remain equal, the logical progression is to choose designs that have the physical parameters and can demonstrate functional features that are known to be useful to leach line performance. Furthermore, these features must be based on **biological and physical realities.**

Regardless of design, an absorptive field has two physical characteristics: **A)** It provides a sewage storage cavity to receive septic tank effluent, and **B)** It provides an interface area with the surrounding soil where settleable and suspended solids are filtered at the interface allowing water and soluble compounds to pass through to the soil.

Absorption fields are essentially nothing more than underground filters. As such, the **effective filter area** is the most paramount feature that will determine a field's functional reliability. Storage volume capacity is secondary. This reality can be illustrated by the following figures:



A **B** **C**

In **Figure C**, regardless of the volumetric capacity, the liquid level will rise since the outflow rate (as determined by the available openings) is smaller than the incoming flow. In **Figure B** the liquid level is stable because the inflow rate matches the outflow rate, and in **Figure A**, the liquid level drops quickly because the outflow exceeds the inflow rate.

All leach field designs have the **Figure A** configuration in mind, however, due to the clogging effects at the filter interface (**the biological mat**) all leach field designs start to degenerate to **Figure B**, then to **Figure C** levels, and probable failure. This degeneration time is dependent on:

A. The available initial interface area, and
B. The ability to decompose (unclog) the biological mat.

The decomposition (unclogging) mechanism is a complex biological and chemical process where many **micro** (bacteria and fungi), and **macro** soil organisms (worms, insects and invertebrae) use the organic compounds present in the biological mat as nutrients and convert the insoluble products to simpler, soluble compounds and gases. However, for this process to occur, certain prerequisites are required:

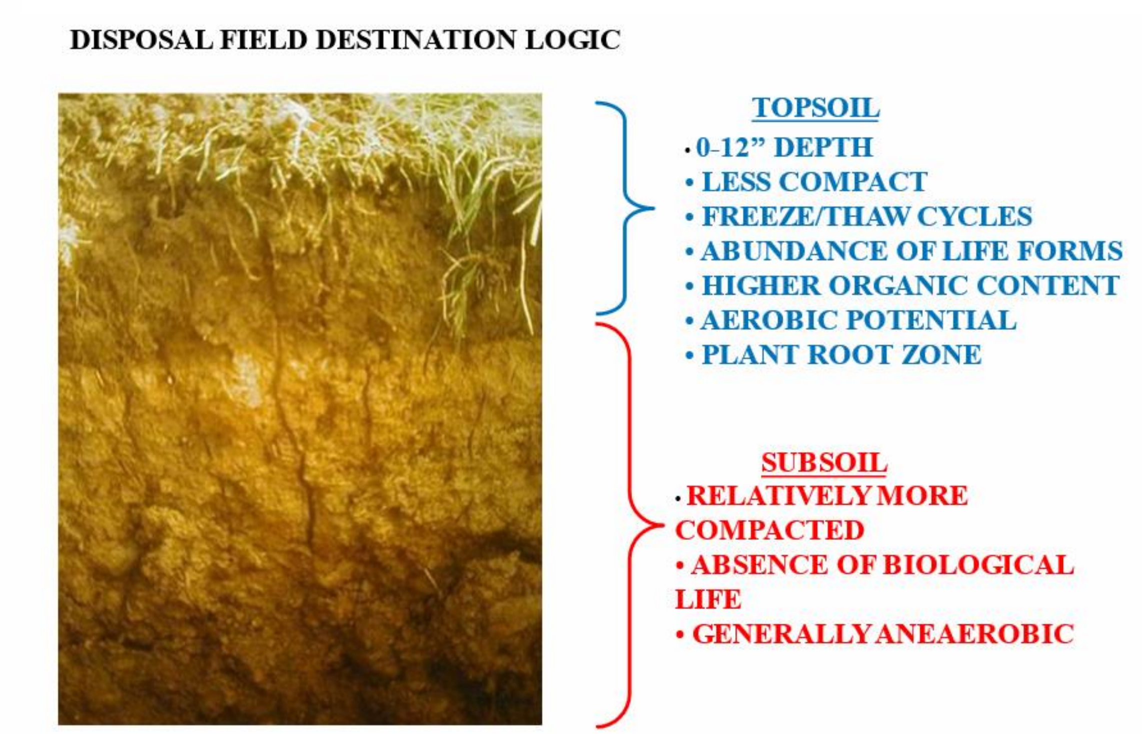
1. The biological mat must be in or near an aerobic state. Anaerobic states (absence of oxygen) do not support the activity of organisms which are effective in the decomposition process.

2. The biological mat must be easily accessible to the soil organisms.

3. Airflow around the biological mat must not be impeded such that decomposition gases can be removed and replaced with oxygen.

4. The biological mat must be dewatered quickly. Biological mats that are covered with liquid effluents remain in the anaerobic state because septic tank effluents lack dissolved oxygen.

The **EPIC** design offers one of the largest interface areas and is the only design that effectively addresses the prerequisites for biological mat decomposition.



1. **By design, the EPIC system allows the formation of the biological mat at the shallowest depth where soil absorption qualities are better and soil organisms more abundant. In soils, porosity and organism concentration can change drastically within a few inches.**

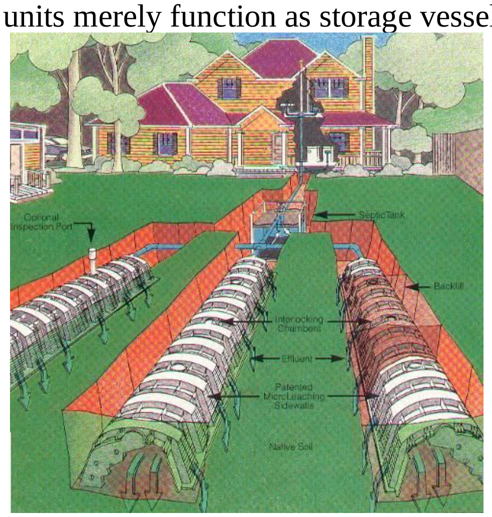
2. **A shallow depth, the open chamber design, and the porous sand envelope allow efficient oxygen transfer to the "biological mat".**

3. **The sand envelope through capillary action effectively moves water vertically to the roots of plants for transpiration, horizontally to other subsequent chambers, and to the unclogged side walls for lateral absorption. This dewatering action leaves the biological mat in an aerobic environment. The EPIC chambers ensure even and concentrated mat formation progressively from chamber to chamber.**

These demonstrable parameters are not found in any of the other alternatives and much less:

1. Besides the inherent problems of siltation and sludge entrapment, **stone-fill designs** restrict airflow and evaporation, do not provide capillary action, and increase the liquid depth of sewage per given volume due to space allocation taken up by the stone. The increased depth increases the time the biological mat remains in an anaerobic state.

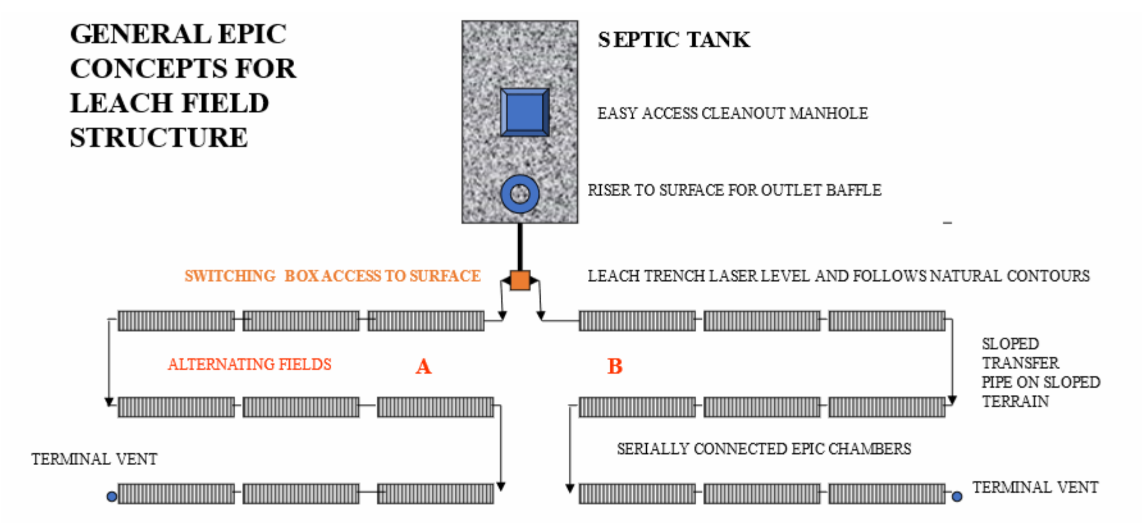
2. Over the past decades **concrete "flow diffusers", "igloo domes"** on some local scenes, and **"infiltration chambers"** on the national scene weaned away totally or partially from the procurement problems of stone by providing **large storage volumes** without the need of stone voids. However, the interface areas by design are deeper, and the structures limit evaporation loss and gas exchange due to the inherent impermeable cap. There is no mechanism for dewatering, the biological mat stays anaerobic and is not attractive to macroorganisms. Once the bottom interface becomes clogged, the units merely function as storage vessels.



Few systems are total failures "at the starting block", and most professional installers will warranty conventional systems for a year. **EPIC** systems are just better performers primarily because they interact with the physical and **biological processes** that take place in the soil environment. As such lifetime warranties for EPIC systems are feasible.

EPIC LEACH LINE INSTALLATION PRINCIPLES:

- **Total required leach line length is divided into two separate leaching areas.**
- **Leach line Fields are alternated yearly through appropriate switching inlet box or valve.**
- **Leach line structure follows contours of original ground topography with level construction of 13"-15" deep and 12"- 18" wide trenches. Use of transit to set leach line locations is mandatory. A level trench cannot be constructed by "eye".**
- **Minimum center-to-center leach line separation is 6', however, the separation pattern is dictated by the natural slope flow of land.**
- **Serially connected EPIC chambers have no minimum or maximum length per leach line segment as long as the level is maintained within segments.**
- **Transfer pipes between line segments are non-perforated sch40, 2" PVC or ABS pipe, and appropriate fittings.**
- **Grass, shrubs, or trees are allowed to develop in leach field areas.**
- **Minimum distance to well is 100'. The minimum distance to groundwater is 2' below the unprotected EPIC leach line bottom.**



FIELD SIZE DETERMINED BY COUNTY STANDARD APPLICATION RATES AND PERCOLATION DATA.
RECOMMENDED FIELD AREA DIVIDED BY TWO INTO TWO DISTINCT ALTERNATING FIELDS.
FIELDS ARE ALTERNATED ON A YEARLY BASIS THROUGH SWITCHING BOX OR VALVE.
SLUDGE DEPTH IN SEPTIC TANK MEASURED ANNUALY WHEN FIELD SWITCHING MADE.
LINE SEPARATION 6'-10'(+), BUT ACTUAL SEPARATION DETERMINED BY SLOPE OF LAND.

Expanded reading and more technical information are available in the following Appendixes.

Appendix A - The measurable and demonstrable parameters of the various alternatives
Appendix B – Epic product specifications
Appendix C - White paper discussion on Septic effluent use as irrigation water
Appendix D – Technical differences between Arched chambers (Infiltrator) and EPIC

Appendix A **Leach Line Comparative Data - Construction and Performance Aspects**

Parameter	Standard Leach Line	Stoneless Infiltrator system	EPIC System Large Chamber	EPIC System Small Chamber	Footnotes Comments reference
Depth x width	18”x 24”	24”x 36”	13”x18”	13”x12”	**(1)**
Soil Excavation/ft	3 cu.ft.	6 cu. ft.	1.6 cu. ft.	**1.08 cu. ft.**	**(2)**
Excavation volume/300 ft.	33.3 cu. yds.	66.6 cu. yds.	18 cu. yds.	**12 cu. yds.**	**(2)**
Excavation cost factor	100%	200%	54%	**36%**	**(2)**
Stone /300 ft.	22.2 cu. yds				**3**
Cost@$135	$2997				**3**
Sand /300 ft.			15.2 cu. yds.	**11.2 cu. yds.**	**4**
Cost@$60			$912	**$672**	**4**
Distribution Pipe/chambers	**30-10’x4” Perf. Pipes**	60-24”x12” Arc 24	60-13”x 6.25” EPIC	75-6.5”x 5.5” EPIC	**5**
Cost	**$600**	$3600	$3180	$3075	**5**
Cost mat + Labor ($1000)	**$3597 +** $1000	$3600 + $2000	$4092 + $540	$3747+ **$360**	**6**
Total	$4597	$5600	$4632	**$4107**	**6**
Soil Interface Area/SF	1.5 sq. ft.	1.9 sq. ft.	**3.6 sq. ft.**	3.1 sq. ft.	**7**
Interface over 300 ft.	450 sq. ft.	570 sq. ft.	**1080 sq. ft.**	930 sq. ft.	**7**
Saturated Void space/300’	(3.7 gal/ft) 1928 gal	(7.5 gal/ft) **2250 gal**	(6.65 gal/ft) 1994 gal	(4.07 gal/ft) 1222 gal	**8**
Sewage to Surface barrier	6”	12”	**13”**	**13”**	**9**
Siltation (void shrinkage)	YES	YES	**NO**	**NO**	**10**
Evapo Transpiration	Minimal	NO	**YES**	**YES**	**11**
ET/day/Ft	0.017 gal	0.00 gal	**0.34 gal**	0.31 gal	**11**
ET/300 ft.	5.1 gal	Minimal	**102 gal**	93 gal	**11**
Dewatering rate in clay	>382 days	Years	19 days	**13 days**	**12**
Aerobic environment	NO	NO	**YES**	**YES**	**13**
Clay soil Suitability	NO	NO	**YES**	**YES**	**11**
Macroorganism Habitat	NO	NO	**YES**	**YES**	**13**
Nitrate removal	NO	NO	**YES**	**YES**	**14**

Reference Comments

(1) Leach line depth excavations are generally shallow structures. The hundred (+) year standard depth was 18” to 24”. The EPIC leach line depths are shallower and between 13”-15” depths in order to take advantage of the aerobic biological activities and plant root depths that are more prolific in the top 12” of soil.

(2) The purpose of leach lines is to interface with the receiving native soil to absorb and treat the wastewater. Soils can be biological cleansing machines as they have evolved as complex ecosystems. The more they are disturbed the more affected is the porosity of the original soil status. Costs are also relative to excavation volume. The bigger the volume the bigger the labor and machinery requirements to accomplish the task. Note that EPIC excavation ratio is only 36% of a standard leach line.

(3) Note that #2 stone fill is now only used in a 100-year-old conventional design. Procurement and acquisition of this product is usually double the cost of sand.

(4) As EPIC chambers are the only chambers that can effectively interact with sand, EPIC advantages the provided physical properties that are only afforded by sand.

(5) While inside fluid distribution structures provided by specialized chambers are more expensive than the standard 4” perforated or holed pipe, the

(6) The completed installation costs of combining all material and labor makes EPIC the least expensive or generally competitive with the other approaches.

(7) The most important aspect of leach line performance function is the interface area provided between the fill and the native soil. EPIC designs provide more than twice the initial area amount, but this interface area is now stable as the interface area in the other designs starts to diminish over time.

(8) As discussed in the paper, although the calculated initial storage volume is greatest in an infiltrator arch, this factor is academic to performance. In a typical 4-person household this input volume can be reached in 10 days. The continued ability to continue the dewatering process with the native soil is the final factor in sewage disposal.

(9) Some regulators are concerned about the cover distance between liquid sewage and the surface atmosphere for public health reasons. EPIC, while being the shallowest in construction still provides the greatest distance of separation in this factor.

(10) By design the EPIC chamber is the only design that can be effective in a sand envelope without plugging and sand is fine enough to prevent soil creep into void spaces inherent in stone.

(11) Because sand actively draws water upward toward the surface, an active leach line water loss is initiated by the active mechanism of root absorption and evaporation.

(12) When installed in clay soils, water infiltration becomes minimal in the downward direction. If there is no mechanism to dewater the leach line by an upward mechanism, the system is not suitable in high clay-content soils with minimal percolation rates.

(13) Unless the leach line can become aerobic, the biological decomposition of waste products is minimal. Anaerobic environments support very few organisms, and the existing organisms in themselves have inherent coatings that further negatively affect soil porosity.

(14) Nitrates are negatively charged molecules. When present in negatively charged soil environments they move to wherever water goes. Leach lines that solely rely on downward percolation or soil absorption of water will also lend to nitrate addition to groundwater formations. EPIC directs nitrate absorption upward to plant roots.

APPEDIX B

EPIC Conveyance Chambers
Product Specifications

Environmentally **P**assive **I**ntegrated **C**onveyance (**EPIC™**) are single piece injection molded arched chambers. **EPIC™** is used individually or connected serially in preformed cells to provide non-plugging and bi-directional movement of fluids or gas in sand, gravel, grain or other imbedded porous matrixes. The chambers are used to provide non-plugging drainage systems, sub-irrigation and underground storage applications, **wastewater soil injection**, sand filtration, gas collection systems, pond bottom sludge air injection, oil/water separation, sand aeration, grain drying, paver heating/cooling systems, water decanting applications, etc.

US Patent #'s 5,921,711 and 7,517,172 large
US Patent # 10,472,813 B1 small

Product	Large Chamber	Small Chamber
Size	46" L x 13.25" W x 6.5" H	24"L x 6.5" W x 5.5" H
Color	Black	Black or custom
Weight	5.5 Pounds	1.7 Pounds
Polymer	Polypropylene	Polypropylene
Connection opening size	2.375" (nominal 2"Sch40 pipe)	2.375"(nominal 2"Sch40 pipe)
Side wall openings	46 - 0.75" x 1.30" (44.85 Sq.in.)	40 - 0.75"x 0.75" (22.5 Sq.in.)
Offset inner apertures	46 -0.875" circle (27.66 Sq.in.)	22–1"x1.5"ovals (25.92 Sq.in.)
Open Bottom area	45.5" x 10.25" (466 Sq. in.)	23.5" x 3.375" (79.31 Sq. in.)
Total internal volume	9.67 gallons (1.29 Cu. Ft.)	2.08 gallons (0.28 Cu. Ft)
Volume at Connection invert	6.02 gallons (0.80 Cu. ft.)	1.4 gallons (0.19 Cu. Ft.)
Connector stop distance	3.25" (to nub)	2" (to arch)
Base Pad support area	69.5 Sq. in.	30 Sq. in.
Packaging wt.	33/pallet (182 pounds)	16/box (28 pounds) (8 boxes/pallet)

APPENDIX C

EPIC strategies of incorporating sewage effluent As irrigation water

Treated effluent water as may be available from municipal sewage treatment plants or specialized small treatment plants designed for individual households can produce high-quality water with a very low suspended solid content (visibly clear). Although not of drinking water quality, the effluent is a beneficial nutrient water source for plant growth. Available dissolved solids of phosphates and nitrogen will move readily into the root zone of EPIC systems and be converted and consumed as nutrients for plant tissue. Bacteria will generally be filtered out in the sand matrix and be consumed by the dominant aerobic soil organisms ever present around the soil/biological mass of the root zone.

Where water conservation is **not** an issue, treated effluent water can readily be disposed of in an EPIC standard leach line structure without the use of a bottom pan or liner. Such a structure can provide irrigation water to trees or shrubs above the system. Application rates can be similar to leach line lengths calculated in the standard leach line tables. Irrigating lawn areas **without pan liners** will produce “green” stripes two to three feet wide above the 12”-18” wide trenches, and as such may not be desirable because even fertilization and irrigation would not occur in the space between trenches.

The use of **EPIC pan liners** provide even distribution of water (or effluent) over a wide area, and thus will produce a desirable grass surface for a lawn. These systems will also **prevent any nitrate migration** to ground water and protect ground water formations where the ground water table may be too high for standard leach line applications. The use of pan liners, however, will also prevent water loss to the ground and the only water loss will be through transpiration functions of the turf. During the **growing season** the lawn may require up to **0.15 gallons** per square foot per day, and as such the volume of effluent water may not even be enough to meet all of the demands of the lawn in a typical residential application. Supplementary water may be needed to augment the overall system. However in winter climate areas, cold temperatures will cause lawns to become dormant, and transpiration activities are greatly reduced. Water loss from EPIC systems in **frozen environments** is reduced to about **0.05 gallons** per square foot per day.

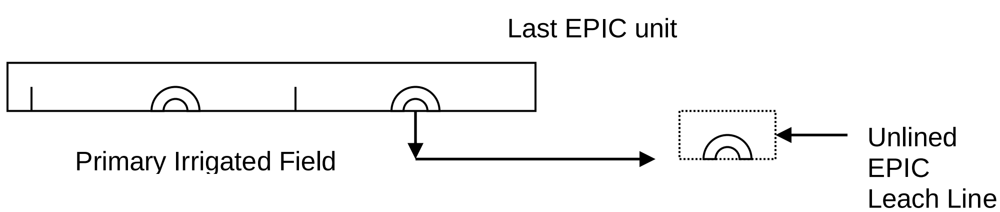
DAILY EXPECTED WATER LOSS FROM PANNED ECS SYSTEMS

LAWN AREA IN SQ. FT.	SUMMER	WINTER
3000	450 GAL	150 GAL
6000	900 GAL	300 GAL
9000	1350 GAL	450 GAL

Continued flows in excess of the capacity to evaporate water will mean that **excess water** (or treated effluent) will simply exit the terminal drain point. By design, panned EPIC systems are provided with a terminal overflow point at the end of the system to handle unexpected or seasonal precipitation beyond the system's ability to store water. If treated effluent is routinely used as irrigation water, the possibility of effluent water leaving the confines of EPIC beds is a reality when very wet periods occur. Although treated effluent may actually **improve** as it passes through the interconnected chambers in EPIC systems, many health departments may not approve potential unconditional discharges to the environment. Conditional requirements might be:

1. Discharge to an underground leach line.
2. Sand filtration prior to discharge.
3. Chlorination or other disinfection prior to discharge.
4. Discharge to captive evaporation ponds to initiate dilution and biotreatment.
5. Discharge to large diluting and already inherently polluted bodies of water. (i.e. Rivers that were the intended original recipients of the treated effluent before it was diverted to reuse as irrigation water.)

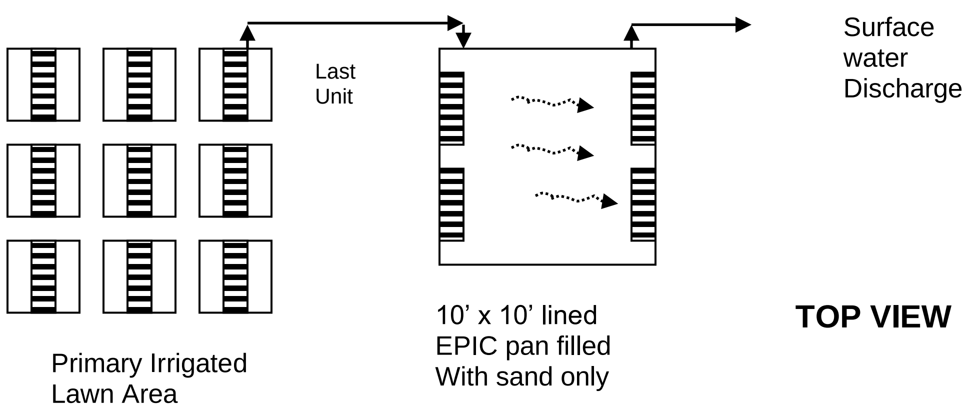
EPIC strategies prefer and are easily adaptable to **#1** and **#2**. In the first alternative, connection of a terminal overflow pipe to an **unlined**, EPIC leach line trench adjacent and below the irrigated area, provides a suitable reservoir that only fills if the primary field exceeds its storage capacity.



SIDE VIEW

A simple addition of **40’** of leach line will provide a storage capacity of over **260** gallons of overflow capacity, which is then absorbed in the surrounding soil.

In the second alternative, the primary field’s overflow can be passed through a horizontal 10’ sand filter, before the water blends with the adjacent surface water flows.



TOP VIEW

Flows from properly operating **septic tanks** may be referred to as **Untreated** Sewage flows. This wastewater has usable qualities for irrigation applications; however, septic tank discharges have a relatively high percentage of **suspended solids**. The water is visibly cloudy due to suspended particles of organic solids (primarily cellulose), which **will filter** out at the sand interface to form a "biological mat".

Essential nutrients for Plants	**Ideal water solution concentrations in ppm**	**Composition of Septic Tank Effluent**	**Concentration in ppm**
Calcium	200	Calcium Carbonate	300
		BOD	130
Iron	1-5	Suspended Solids	40
Magnesium	48	Sodium	100
Manganese	0.5	Chlorides	70
Nitrogen (nitrates)	210	Nitrate (NO^3)	0.003
		Nitrite (NO^2)	0.15
		Ammonia (NH^3)	25
Oxygen	5-6	Oxygen	0
Phosphorus (Phosphates)	31	Phosphates	20
Potassium	235	Potassium	10-15
Sulfur (Sulfates)	64	Sulfates	50
Water	99.9%	Water	99.9%
pH	7.0-7.5	pH	7.0-7.5
		Possible Pathogens	Yes

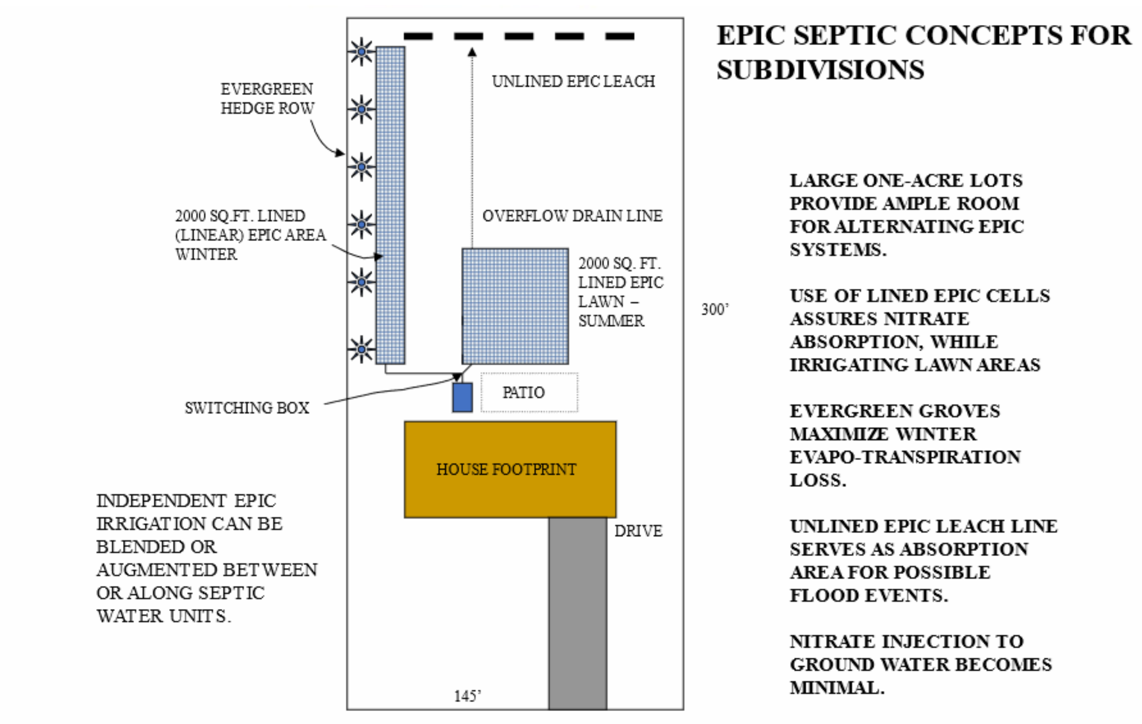
In the above table, the red items of concern are manageable. Salts (Sodium and Chloride) are absorbed and tolerated by most plants if levels are under 1000 ppm. Suspended solids consisting of primarily cellulose decompose aerobically back to Carbon dioxide and water. Potential pathogens are contained below ground, cannot compete with native soil organisms, and in an aerobic environment experience an accelerated die-off rate.

As such, just as in direct leach line disposal systems, areas that are irrigated by septic tank effluent have to be **dual fields** that are alternated on a yearly basis. This alternating principle allows the beds to become aerobic and initiates a biological decomposition of the biological mat.

When pan systems are used for lawn development consideration must be known that an EPIC system, **which uses septic tank effluent**, must be in a resting stage every other year or every six months. In arid climates, the developed grass over a resting system **may not** be green or as green as the field that is under irrigation.

EPIC **irrigation systems** provide two options for automatic flow control of auxiliary make up water. Where treated or untreated effluents are used, the electronic water level switch installed in the terminal EPIC unit is the preferred method. This design provides a dosing sequence in the system and a more aerobic environment during operation.

With proper planning and investment, residential structures in rural areas can be designed to manage all household wastewater, provide irrigation, manage drainage, and not only protect the environment and groundwater but also provide exceptional desirable plant growth around the development.



For questions or other design options, please write us or contact EPIC TOTAL WATER SOLUTIONS,LLC. via e-mail at info@epictws.com

APPENDIX D

Difference between **Subsurface Fluid Conveyance Chamber and Method**. **US Patent No. 10,472,813 B1** and **Leaching chamber with Perforated Web sidewall US Patent #5,511,903**

At first glance to the layman both the Sipaila patent and the Nichols patent appear to be mere arched chambers with an open bottom. That is true, however the claimed differences are a matter of function which then translates to the specifics in design. The Nichols patent **#5,511,903** is just another subtle variation of patents **#4,759,661**; #**5,017,041**; #**5,156,488;** #**5,336,017** and **#7,611,306B1** (assigned to Infiltrator Inc.) which provided subtle changes to the **basic single wall, arched chamber with open bottom and slotted slides** granted by the first **#4,759,661** patent. Its and the following designs purpose was to provide a leaching chamber <u>in soil</u> (specifically sewage effluent) replacing the conventional stone trench with perforated pipe.

The Sipaila patent **No. 10,472,813 B1** is an improvement on the Sipaila patents # **5,921,711** and **#7,517,172 B2** which provided a **double walled arched chamber with strategically placed holes designed to effectively work in a <u>quick sand</u> environment**. It is used as a sub-irrigation system, an injection system for fluids into porous aggregates, a passive water collection and filtration system into the chamber and as an alternative leach line design for sewage.

Differences explained.

<table>
<tr><th>Infiltrator patents</th><th>Sipaila Patents</th></tr>
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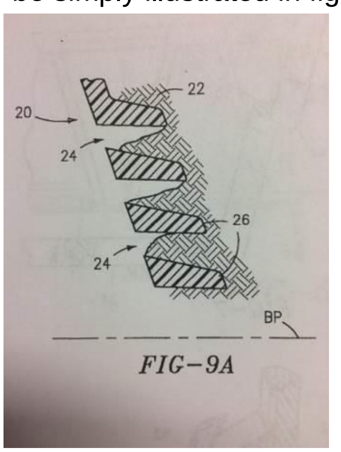
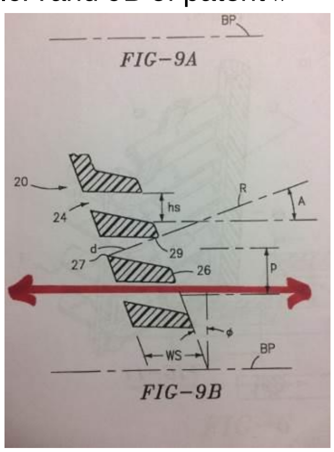
Slits in the **single wall outer wall**. The key functional ingredient in the Infiltrator patents can be simply illustrated in fig.9A and 9B of patent #





5,511,903. Fig.9A depicts the "assumed" angles of repose for soil which is discussed on p.8 of the patent body. Unfortunately the "angle of repose" in sand and especially quicksand is close to 0º (this is depicted by the red line) and sand and saturated sand will move laterally into the chamber compromising its function. The chamber cannot function in fluid sand environments.

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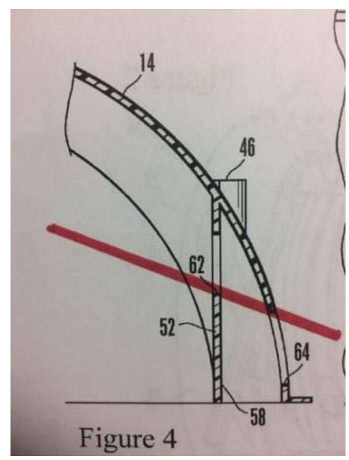
Large holes in **double wall** construction with **offset** holes to form "gravity traps" which are separated but integrated **small cavities** (space above 58) along the sidewall structure to prevent fluid sand entry into the primary conveyance chamber. This creates an angle of repose (depicted by red line) that is actually negative and way below 0º to effectively prevent sand entry into the chamber. All soils are a composite of different percentages of 3 particles – clay, silt and sand. All combinations have a different repose angle (but always above zero) which changes when soils are in saturation and become fluidized. The Sipaila patents and application are unique in addressing this issue.



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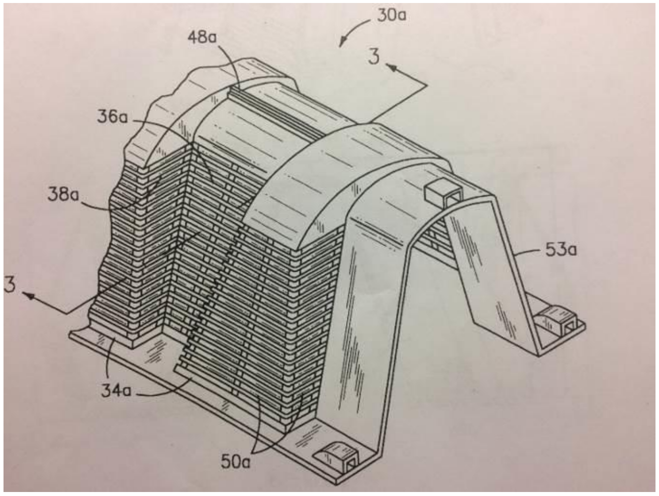
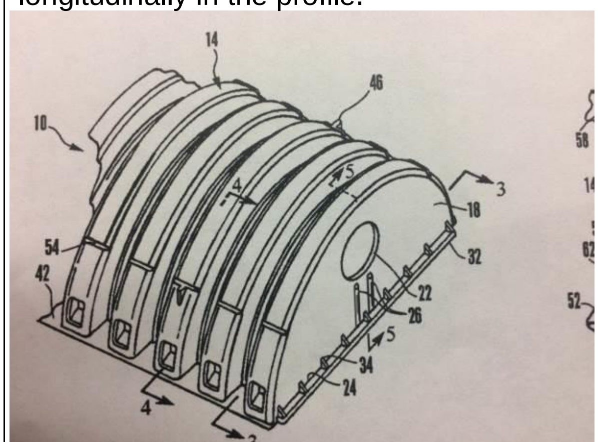
No built in end walls in chamber structure. The Infiltrator patents are open ended structures linked together by different overlap and connection techniques to form long (50’+) leach line structures. Although they terminate in end caps at the start and the end to transition to round  connecting pipe and to provide an obvious soil entry barrier, the created array cavity is single throughout its length. The patent language goes to great length in describing surface and contact ratios, and slot areas. However these surface areas do not come into play until the water (sewage) reaches the areas. As liquid rises more sidewall area comes in contact, but slots above the water line do not. Functionally however, a rising water line in the array also means that the soil interface at the bottom of the chamber has been blocked as have the sidewall slots that are now under water.	**Strategic end walls at both ends** of the chamber with a large 2” connection holes to connect the chambers. The end wall and the largest 2” connection hole are integral to the chamber in both structure and function. As the liquid rises within the 2’ - 4’ long chamber, the strategically placed 2” hole invert floods the chamber before the liquid moves on to the following connected chamber. Since the invert of the 2” connector is higher than the holes in the secondary inner wall, head pressure is created to push water through the inner hole, the sand interface and out the outside bottom holes to the sand fill. Capillary action then moves the injected water vertically, horizontally and longitudinally in the profile.  For further insight on the dynamics and function of the conveyance chamber, including the unique differences from other “arched chambers” read https://epictws.com/wp-content/uploads/2015/02/EPIC-ROAD-FILTER-DYNAMICS.pdf
The design cannot be an effective water collection device where water moves into the chamber. The slitted open slots are surrounded by soil. Soil has a slow permeability rate. If water actually moves through the soil, it will inherently dissolve, erode or loosen soil particle components when saturated and carry those particles with the water flow directly into the chamber as there is **no mechanism of separation**.	**The chamber simultaneously serves as an effective filter and water collection device** where flow can effectively occur into the chamber. The creation of the secondary small lateral cavities create the “gravity trap”. Since the chamber is intentionally surrounded by porous sand or fine gravel, water then moves **around** the sand particles, through the outer wall hole, then up and through the second inner hole (oval) into the primary chamber.