INFILTRATOR® systems inc.

May 24, 2013

Mr. William Tillman
Wyoming Department of Environmental Quality
Water Quality Division
Hershler Building 4-W
122 West 25th Street
Cheyenne, WY 82002

Re: Comments on Proposed Revisions to the Water Quality Rules and Regulations Chapter 25, Small Wastewater Systems

Dear Mr. Tillman,

Infiltrator Systems Inc. (Infiltrator) appreciates the opportunity to make comment on the proposed revisions to the Water Quality Rules and Regulations, Chapter 25, Small Wastewater Systems.

We reference the most recent iteration of Chapter 25, which is labeled "Draft 4/19/13". Where applicable, we have also provided proposed text for the section under consideration. The comments are provided below by section number.

Section 7. Drain Field Sizing:

Section 7(b) addresses the issue of total infiltrative area provided by standard trenches (perforated pipe embedded in aggregate), chamber trenches, and bed systems. Subsection (i) of 7(b) details the calculation to be utilized to determine the infiltrative area for standard trenches (perforated pipe and aggregate) in part as follows:

> *"…the total infiltrative surface area shall be calculated by multiplying the total length of the trench (ft) by the sum of the bottom width (ft) and the height (ft) of each sidewall."*

Subsection (ii) of 7(b) details the calculation to be utilized to determine the infiltrative area for chamber trenches in part as follows:

> *"…the total infiltrative surface area shall be calculated by multiplying the total length of the trench (ft) by the sum of the bottom width (ft) of the chamber and the height (ft) of each sidewall."*

The calculations as proposed in Section 7(b)(i) and (ii) to determine infiltrative area for standard (pipe and aggregate) trenches and chamber trenches are virtually identical. There is no other language in the proposed regulations which relates to chamber system sizing. Therefore, the regulations as proposed eliminate DEQ's 25-year-old policy of sizing chamber systems with "equivalent area" (or reduced) sizing.

Without well-documented performance concerns, we strongly assert that DEQ's proposal to eliminate the "equivalent area" sizing of gravelless chamber systems is wholly unsupported and, as such, unjustified.

The following statements are <u>fact</u>:

- Chambers have an extensive history of use in Wyoming, spanning 25 years, at "equivalent area" (reduced) sizing. Please consider:
    - In a memorandum dated May 27, 1988, DEQ allowed the permitting of plastic chambers manufactured by Infiltrator using a 0.6 multiplier (see enclosed copy, labeled "Attachment 1"). This amounts to an approximate 40% reduction in system sizing as compared to standard (pipe and aggregate) system sizing;
    - In a memorandum dated November 21, 1994, DEQ established Policy #13.41.2 (copy enclosed, labeled "Attachment 2"). This policy allows the use of approved chamber products with "equivalent area" sizing, which translates to an approximate 50% reduction in system sizing as compared to standard pipe and stone system sizing. This policy remains in effect today;

- Policy #13.41.2 defines "equivalent area" sizing as follows:

    "...gravelless leachfield chambers get double infiltrative surface area credit for the bottom area of the chamber. This is allowed because research indicates that chambers provide an optimum infiltrative surface by eliminating the 50% stone masking associated with conventional systems utilizing stone in the leach field."

- A significant number of studies, based upon independent, third-party testing, prove that reduced-size gravelless chamber systems perform consistent with conventional pipe and stone systems while providing equivalent wastewater treatment; (See bibliography enclosed, labeled "Attachment 3");

- The only national standard relating to gravelless chambers – the International Association of Plumbing and Mechanical Officials (IAPMO) Uniform Plumbing Code (UPC) – allows a 30% reduction (or 0.70 multiplier) for chamber technology (Excerpt enclosed, labeled "Attachment 4");

- 48 of the 50 states and 10 Canadian provinces allow the use of plastic chambers at equivalent area (reduced) sizing;

- No other state has fully eliminated the use of chamber systems at previously issued reduced system sizing;

- There are more than 19,500 Infiltrator-brand chamber leachfields in the ground in Wyoming today; and

- Infiltrator has a total of 12 warranty claims on file at present, dating as far back as 1995. Of the 12 warranty claims:
    - 3 were found to be due to trench bottom installation too close to the groundwater table
    - 2 were due to incorrect soil characterization (resulting in undersizing)
    - 3 resulted from installation errors
    - 1 was damaged by gophers

  This leaves 3 systems as malfunctioning for unexplained reasons, and translates to a 99.98% rate of successful long-term chamber performance under the DEQ's historical sizing policies.

These facts make our case. "Equivalent area" sizing of chamber systems – that is, reduced system sizing for chamber leachfields as compared to standard (pipe and aggregate) leachfields – has been common practice in Wyoming for 25 years. Reduced system sizing for chamber leachfields as compared to standard (pipe and aggregate) leachfields is common practice throughout North America. The only national standard in place today with respect to chamber system sizing recommends "equivalent area" sizing. Both laboratory and full-scale field studies support the claim that reduced-size chamber systems perform as well as standard (pipe and aggregate) systems. Tens of thousands of chamber systems have been installed in Wyoming since 1988, and over 3 million Infiltrator chamber leachfields have been installed at "equivalent area" sizing across North America over the past quarter century.

We submit that without well-documented evidence of significant performance issues, there is no valid reason to modify chamber system sizing in any state, including Wyoming. We are aware of, and DEQ has produced, no such documentation.

Please consider the following, taken from the DEQ-produced document titled: "*RULE MAKING OUTREACH DOCUMENT, Responses to Stakeholder Comments For Comment Period Ending March 1, 2013, Wyoming Water Quality Rules and Regulations, Chapter 25, Small Wastewater Systems" (RULE MAKING OUTREACH DOCUMENT):*

> *Comment: "The sidewall height in the infiltrative area calculation is not being used typically anymore. I believe this should be removed from the calculation."*
>
> *DEQ Response: The WAD has used bottom and sidewall area for the absorption surface for many decades with one of the lowest failure rates in the country for small wastewater systems. With this success rate there is no reason to change just because other parts of the country are doing something different.*

With more than 19,500 chamber systems in the ground in the state, thousands of chamber systems would have had to have malfunctioned during the last 25 years for the failure rate to be considered problematical. DEQ's own comment (above) indicates that failure rates for small wastewater systems in Wyoming are amongst the lowest in the country. Infiltrator's own data supports this, in that we have formally followed-up on a total of 12 warranty claims in the state. (We pride ourselves on our commitment to working with any homeowner who is experiencing valid chamber system performance issues.) It is clear that the failure rate of chamber systems in the state of Wyoming is miniscule.

Furthermore, we agree with the DEQ in the first half of the final sentence in the above-referenced comment as well: "With this success rate there is no reason to change...".

We are aware of absolutely nothing that validates, and DEQ has offered no substantive support for, the modification of the sizing criteria of chambers systems in Wyoming as proposed in Chapter 25 as drafted. However, in the spirit of cooperation and collaboration we would recommend the following:

Colorado has allowed chamber systems for as long as Wyoming, with very similar sizing criteria. The Water Quality Control Division of the Colorado Department of Environmental Quality has allowed chamber trench systems to be sized at a 50% reduction, and chamber bed systems be sized at a 40% reduction, in infiltrative area as compared to the respective conventional pipe and aggregate systems. 5 CCR 1002-43 has just been completely rewritten, with significant changes having been made to many sections of the regulation. We find the process here in Wyoming of creating Chapter 25 from Chapter 11 as being very similar in many ways.

The new, revised regulations in Colorado have incorporated the IAPMO UPC standard for chamber systems – that is, a 0.70 multiplier (which amounts to a 30% infiltrative area reduction) when sizing chamber systems as compared to what is required for a conventional pipe and aggregate system. (We provide a copy of Table 10-3 from the new regulations, which is titled "Size Adjustment Factors for Types of Distribution Media in Soil Treatment Areas Accepting Treatment Level 1 Effluent", herein under "Attachment 5"). Infiltrator participated in the process in Colorado, and we are comfortable with the chamber system sizing criteria in these new regulations.

In an effort to work with the state, Infiltrator recommends that the same sizing criteria be adopted in Wyoming as well. This would honor the breadth of scientific support for reduced chamber system sizing, which is of the utmost importance to our company. At the same time it should offer critics of "equivalent area" sizing of chamber systems – regardless of their justification and whoever they may be – some solace. That stated, we cannot accept complete elimination of reduced chamber system sizing as presently proposed.

To accomplish this, Section 7 might be modified by inserting a new subsection between existing subsections (b) and (c) which reads:

(c) Chamber system sizing adjustment

(i) Chamber system sizing shall be determined by calculating the total infiltrative surface area in accordance with subsection (a) above, applying a 0.70 multiplier to this value, then applying the calculations as described in subsection (b).

Existing subsections (c) and (d) would be modified to (d) and (e) respectively.

Finally, we submit under "Attachment 6" a copy of an email (with attachments listed for reference) that was submitted on behalf of Infiltrator by Mr. David Lentz, P.E., the company's Director of Government Relations. Mr. Lentz sent this information to Mr. James Brough, P.E., of the Wyoming DEQ on August 8, 2012. It was submitted with the intent (as his email reads) of establishing Infiltrator's position early in the regulatory revision process. These comments were not presented in the *RULE MAKING OUTREACH DOCUMENT* and are critical to the scientific evaluation of chamber sizing in Wyoming. We submit this information again at this time both in support of the above comments and recommendation, as well as to be on record as having provided substantive technical input well before this final phase of review.

Section 9. Septic Tanks and Other Treatment Tanks:

Section 9(a)(i) – Septic tanks:

This section contemplates septic tanks manufactured using concrete and fiberglass or an approved material. Approximately 1 in 10 septic tanks installed in North America is fabricated using thermoplastic materials (polypropylene or polyethylene). The use of thermoplastic tanks is a growing national trend. As such, Infiltrator proposes the addition of this material to the Wyoming rules, as follows:

Septic tanks shall be fabricated or constructed of concrete, fiberglass, thermoplastic, or an approved material…

Section 9(a)(C)(iii) – Size:

Section 9(a)(C)(iii) allows the use of a 1,000-gallon tank for up to a 6-bedroom home. Using the daily flow values in Table 1 of the draft rule, the hydraulic residence times by number of bedrooms are as follows:

- 4 bedroom = 1,000 gallons / 470 gallons/day = 2.12 days
- 5 bedroom = 1,000 gallons / 550 gallons/day = 1.81 days
- 6 bedroom = 1,000 gallons / 630 gallons/day = 1.59 days

As a "rule of thumb", most states use a minimum hydraulic residence time of 2 days or 48 hours in the design of primary treatment units such as septic tanks. Shortening the residence time of effluent in the septic tank will reduce the time for settling of solids and flotation of solids, fats, oils, and grease. With reduced settling, the total suspended solids concentration in the septic tank effluent will have the potential to elevate, resulting in increased risk of the soil absorption system clogging with solids. Once the interstitial space of the soil absorption system clogs with solids, the drainfield's hydraulic capacity will be compromised, thereby reducing its life expectancy.

Infiltrator suggests leaving the 1,000-gallon minimum working volume in place for 4 bedrooms, increasing the 5-bedroom working capacity to 1,250 gallons (2.3 days residence time), and using a 1,500-gallon (2.4 days residence time) tank for 6 bedrooms. These size increments are consisting with tank sizing across the United States.

Section 9(a)(C)(iv)(B) – Configuration:
Infiltrator commends the DEQ for lowering the minimum liquid level from 4 feet to 3 feet in Section 9(a)(C)(iv)(B). This liquid level requirement is consistent with rule and policy in 48 states. We suggest separating the liquid level requirement from the requirements for 2-compartment tanks at the beginning of Section 9(a)(C)(iv)(B) to make the requirement applicable to single-compartment tanks. The liquid level requirement could become item Section 9(a)(C)(iv)(C), with other subsection lettering adjusted accordingly.

Section 9(a)(C)(iv)(D)(I) – Configuration:
Section 9(a)(C)(iv)(D)(I) limits the penetration depth of tees and baffles to no more than 1/3 the liquid depth. Assuming that the inlet and outlet tees and baffles are intended to direct sewage into the tank and allow effluent to exit the tank from within the clear zone that exists between the sludge and scum, the use of the middle 25% of the liquid height will establish a reasonable range for manufacturers to meet. This range is established in the IAPMO/ANSI Z1000-2013 ballot draft[1] (see excerpt under "Attachment 7"), which states:

4.7.3
The fitting inlets or the centroid of the openings shall be located between 50% and 75% of the liquid depth, measured from the inside floor of the tank.

The IAPMO/ANSI Z1000-2013 ballot draft document has successfully been balloted by the IAPMO Plumbing Standards Committee and is scheduled for publication in the fall of 2013. This will be the American National Standard for prefabricated septic tank manufacturing. Infiltrator suggests establishing a similar range of baffle and tee penetration in the Wyoming rules, as follows:

(I) *The tees or baffles shall*
  a. *extend a minimum of six (6) inches above the liquid level; and*
  b. *extend within 50% and 75% of the liquid depth below the liquid level, measured from the inside floor of the tank.*

Section 9(a)(C)(iv)(D)(II) – Configuration:
Section 9(a)(C)(iv)(D)(II) requires a minimum of 3 inches of clear space over the top of the baffles or tees. Many states use less than 3 inches of clear space above the top of baffle or tee. IAPMO/ANSI Z1000-2007, which is the version of the American National Standard for septic tank manufacturing that is being used at present, requires 2 inches of space, as follows (see excerpt labeled, "Attachment 8"):

3.5.2
Septic tanks shall have an air space equal to not less than 10 percent of the liquid volume, and total depth shall not be less than 9 in. (23 cm) above the liquid level. There shall be a minimum of 2 in. (5 cm) of separation between the top of the tank and the top of the sanitary tee vent opening.

The IAPMO/ANSI Z1000-2013 ballot draft reduced the 2-inch gap to a minimum of 1 inch, as follows (see excerpt under "Attachment 7"):

4.6.2
There shall be a separation of at least 25 mm (1 in) between the top of the tank and the top of the inlet and outlet device vent opening.

Infiltrator suggests the use of 1 or 2 inches as a minimum space above the top of baffle or tee. This gap will certainly meet the objective, which is to promote air flow and prevent a vapor lock from occurring. Adding space beyond 2 inches will provide no material benefit in air flow or tank performance, but will in fact increase the amount of material a septic tank manufacturer

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[1] Questions about the status or content of IAPMO/ANSI Z1000-2013 can be directed to Mr. Abraham Murra, P.E., Director of Standard at the International Association of Plumbing and Mechanical Officials. Mr. Murra can be reached at (909) 472-4106 or abraham.murra@iapmort.org.

needs to use for fabrication of a tank, which is a burdensome and unnecessary requirement in a time of difficult economic circumstances.

Section 9(a)(C)(iv)(D)(III) – Configuration:

Section 9(a)(C)(iv)(D)(III) requires the outlet elevation to provide a minimum distance of 9 inches or 20 percent of the liquid depth, whichever is greater, between the top of the liquid and the bottom of the septic tank cover for scum storage and the venting of gases. Nationally, only Wyoming, Montana, North Dakota, and South Dakota require 20% airspace (see analysis under "Attachment 9"). All other states either have a lower airspace requirement or stipulate a minimum distance from liquid to top of tank. The most common minimum airspace is 15%, with the minimum 9-inch space also being a common requirement in state rules. IAPMO has established a minimum of 10% *or* 9 inches. The Canadian Standards Association has established a minimum of 10% of the working capacity of the tank in standard CSA B66-10, which is the Canadian equivalent of IAPMO/ANSI Z1000.

Infiltrator proposes amending the minimum allowable airspace requirement to allow the manufacturer the option of using 20% *or* 9 inches. This would eliminate the "whichever is greater" clause from the rule. Under either scenario, adequate provisions will be in place within the tank for the retention of scum (floating solids). Note that Section 9(a)(C)(iv)(D)(I) already requires tees and baffles to extend a minimum of 6 inches above the liquid level to prevent scum from exiting the tank and entering the soil absorption system. Having an additional 6 inches of space above the outlet tee or baffle will be sufficient for air flow within the tank. The proposed amendment is as follows:

> *(III) The inlet pipe shall be at least two (2) inches higher than the outlet pipe. The outlet elevation shall be designed to provide a minimum distance of nine (9) inches or twenty (20) percent of the liquid depth~~, whichever is greater,~~ between the top of the liquid and the bottom of the septic tank cover for scum storage and the venting of gases.*

On a related note, we suggest adding a requirement for a minimum freeboard of 6 inches on the baffle for a 2-compartment tank to restrict scum from migrating from the first to second compartment.

Section 9(a)(C)(v)(B):

Section 9(a)(C)(v)(B) requires riser covers terminating above grade to have an approved "locking device". Methods for securing riser covers other than locks are commonplace in the onsite wastewater market and allowed across North America. Infiltrator suggests adjusting the language to expand the definition of "secure". The IAPMO/ANSI Z1000-2013 ballot draft includes the following language (excerpt provided under "Attachment 7"):

> ***4.10 Covers***
>
> *Openings shall be capable of accommodating covers (i.e., lids) that*
>
> *(a) are watertight;*
>
> *(b) are secure;*
>
> *Note: Acceptable measures for securing covers include padlock(s), covers that can be removed only with tools, or covers with a mass of at least 30 kg (66 lb).*

Infiltrator's suggested alternative language for the Wyoming rules is as follows:

> *(B) The riser shall terminate at a maximum of six (6) inches below the ground surface. Riser covers terminating above grade shall ~~have an approved locking device.~~ have a locking device, only be removable with tools, have a minimum weight of 66 pounds, or provide another approved method of being secured.*

Other tank comments – The Oklahoma rules (Section 252:641-7-2. Types of tanks) address the use of thermoplastic and fiberglass tanks, requiring certification by IAPMO or CSA. Note that Oklahoma, Utah, North Carolina, New Jersey, and Maine require CSA certification of thermoplastic tanks. Infiltrator suggests adopting the Oklahoma DEQ's rule language, as follows:

Fiberglass and plastic tanks shall meet either IAPMO or CSA standards for septic tanks and shall be installed according to the manufacturer's recommendations. If the tank does not bear the IAPMO or CSA mark, then the installer must submit documentation from IAPMO or CSA stating the tank meets the applicable standard.

We look forward to the public hearing to be held on June 14, 2013 in Casper. If you or others have any questions or concerns about these comments, or would like to be provided with any additional information in the meantime, please know that we will welcome your call.

Sincerely,

Dick Bachelder
Senior Regulatory Specialist
603-498-5306

cc: Mr. James Brough, P.E., WY Water Quality Division
Mr. David Lentz, P.E., Infiltrator Systems Inc.
Mr. Eric Berquist, Infiltrator Systems Inc.
Mr. Matt Gibbs, Infiltrator Systems Inc.

Attachment 1

1988 WQD Chamber Sizing Policy

THE STATE OF WYOMING

MIKE SULLIVAN
GOVERNOR

Department of Environmental Quality

Administration	Air Quality Division	Land Quality Division	Solid Waste Management Program	Water Quality Division
(307) 777-7937	(307) 777-7391	(307) 777-7756	(307) 777-7752	(307) 777-7781

MEMORANDUM

TO: Delegated Small Wastewater Permitting Agencies and Water Quality District Engineers

FROM: Larry Robinson, Engineering Supervisor, Water Quality Division

DATE: Leaching Chambers, Section 16.41, Policies and Procedures Manual

SUBJECT: May 27, 1988

Infiltrator System Inc. has submitted research literature, operating data and rules and regulations from other states concerning the use of leaching chambers. This system is intended to replace the standard trench and bed subsurface treatment system or leach field. The system involves the use of an inverted chamber used to protect the infiltration surface and does not require the use of stone. The system allows an adjustment to the required infiltrative surface area because the surface is protected from "stone masking" which reduces the effective infiltration area available in a standard gravel trench or bed.

After review of the submitted material this office is prepared t issue permits authorizing the use of Infiltrator and comparable leaching chamber systems in undelegated counties. In delegated counties, the use of these systems is dependent upon acceptance by the local agency. Each delegated agency has the authority, as outlined in the delegation agreement, to approve or reject the use of these systems.

The state will utilize the following criteria to evaluate applications for leaching chamber systems:

1. A leaching chamber system may be constructed in lieu of a standard trench or bed subsurface disposal system. The system must be proceeded by a septic tank that meets the requirements of Section 39, Chapter XI, Pretreatment.

2. The leaching chamber shall be constructed of durable material not subject to excessive corrosion and structurally capable of supporting the loads to which it shall be subjected. If the system is subject to vehicular traffic the chambers shall be designed to comply with AASHTO rating H-20 of 32,000 lbs/axle.

3. A minimum of twelve inches of soil cover shall be placed over the tops of the chambers.

4. When installed in a trench configuration the minimum distance between walls of adjacent trenches shall be 3 feet.

5. End plates are required at the inlet and downstream end of the chambers.

6. The bottom of the trench or bed shall be level and scarified.

7. For gravity systems the inlet pipe shall extend through the end plate and terminate on an adequate splash plate or block.

8. For pressure distribution systems perforated PVC pipe extending the length of the chamber is required.

9. Sizing of the required infiltration surface area shall be determined using the methods established in Chapter XI for trench systems. This area is adjusted by a multiplier of 0.6 in order to allow for the lack of "stone masking" under the leaching chamber. This multiplier is based upon 3 foot trench and assumes 50% masking. The area for bed systems utilizing leaching chambers shall be calculated assuming no bottom masking under the chamber and 50% masking for the chamber sidewall.

10. All other applicable requirements of Chapter XI shall remain unchanged.

/jt

cc: Jim Nichols, Infiltrator Systems Inc.

Attachment 2

1994 WQD Chamber Sizing Policy #13.41.2

THE STATE OF WYOMING

MIKE SULLIVAN
GOVERNOR

Department of Environmental Quality

1043 Coffeen Avenue, Suite D • Sheridan, Wyoming 82801

AIR QUALITY
(307) 672-[illegible]
Fax (307) 67[illegible]-6050

LAND QUALITY
(307) 672-6488
Fax (307) 672-2213

WATER QUALITY
(307) 672-6457
Fax (307) 674-6050

MEMORANDUM

TO: District Engineers
Delegated Small Wastewater Permitting Agencies

THROUGH: Larry Robinson LR

FROM: Brian Mark BM

DATE: November 21, 1994

SUBJECT: Sizing for Leachfield Chamber Systems. Revised Policy 13.41.2.

The following is intended to clarify and expand on the sizing criteria contained in the May 27, 1988 memo on the referenced subject.

Sizing of leachfields utilizing chamber systems is based on the following:

1. The total infiltrative surface of the soil absorption system is determined using the criteria in Section 38, Chapter XI of Wyoming Water Quality Rules and Regulations.

2. The total infiltrative surface determined from Section 38 is the sum of the bottom area and the sidewall area below the invert of the distribution pipe and is based on a system utilizing stone and not a chamber.

3. Documented research indicates that chambers provide an optimum infiltrative surface by eliminating the 50% stone masking associated with conventional systems utilizing stone in the leachfield.

4. Eliminating the stone masking by use of a chamber system is equivalent to doubling the infiltration effectiveness of the bottom area under the chamber.

5. The masking factor is only applicable to the bottom area under the chambers and should not be utilized to adjust the sidewall area used to meet the total infiltrative surface determined utilizing Section 38.

6. The effective infiltrative area can be determined by doubling the bottom area under the chamber and adding the unadjusted sidewall area. The effective infiltrative area is dependent upon the dimensions of the chamber and the system layout as a bed or a trench configuration.

7. The effective area should be compared directly to the total infiltrative surface as determined utilizing Section 38. This may be accomplished by one of the methods described below.

The manufacturers' recommended 50% masking factor, which is applicable to bottom area only, cannot be directly applied to the Section 38 total infiltrative surface which includes both bottom and sidewall area. The following illustrates calculating the correct size of a leachfield utilizing leaching chambers in a trench configuration for compliance with the state Section 38 standard for total infiltrative area.

The use of leaching chambers doubles the effective infiltration capability of the bottom area. As stated above, sidewall area is not affected. The effective infiltrative area per lineal foot of a trench system equals sidewall plus two times the bottom width plus sidewall times unit length, or

$$AREA_{chamber}/LF = [sidewall+(2 \times bottom\ width)+ sidewall] \times 1'/LF$$

For purposes of illustration assume a Section 38 total infiltrative surface of 1,000 square feet is required and a typical chamber will be used. This particular chamber has a width of 34", a sidewall of 6" and a length of 75" (for trench configurations a length of 72" will be used based on available sidewall reduced by the overlap connection). Using the above formula the effective infiltrative area per lineal foot of chamber is the following:

$$AREA_{chamber}/LF = [0.5' + (2 \times 34"/12) + 0.5'] \times 1'/LF = 6.\overline{6}\ SF/LF$$

The length of trench can now be determined by dividing the total required infiltrative surface area, determined in accordance with Section 38, by the effective infiltration area per unit foot.

$$TRENCH\ LENGTH = AREA_{required}(1,000\ SF) / 6.\overline{6}\ SF/LF = 150\ LF$$

The number of chamber units needed is obtained by dividing the length of trench required (150 LF) by the length of the chamber (6 LF), or

CHAMBER UNITS = 150 LF/ 6 LF/UNIT = 25 UNITS

The total effective infiltrative area of a chamber used for a trench system is

$$AREA_{CHAMBER} = 6.\overline{6} \text{ SF/LF} \times 6 \text{ LF/UNIT} = 40 \text{ SF/UNIT}$$

An alternative method of calculating the number of chamber units is to divide the Section 38 infiltrative surface area by 40 square feet/unit, or

CHAMBER UNITS = 1000 SF / 40 SF/UNIT = 25 UNITS

When determining the total effective infiltrative area of a chamber bed system the sidewall area can be ignored. This does not significantly increase the size of the bed. When the sidewall is ignored the total effective infiltrative area of a chamber is

$$AREA_{CHAMBER} = [(34/12)' \times 2] \times 6.25 \text{ LF/UNIT} = 35.4 \text{ SF/UNIT}$$

Using the same example of Section 38 infiltrative surface the number of chamber units required for a bed can be obtained by dividing the 1,000 square feet infiltrative surface by 35.4 square feet/unit, or

CHAMBER UNITS = 1000 SF / 35.4 SF/UNIT ≈ 28 UNITS

The actual layout of the bed could be any configuration totaling 28 units (i.e. 4x7, 14x2, etc.). This meets Section 38 requirements utilizing the minimum number of chamber units.

BDM/bm

Attachment 3

Chamber Treatment and Performance Study Bibliography

Research Summary on Infiltration Efficiency of Gravelless Chamber Drainfields Compared to Gravel Aggregate Drainfields

Research Study	Description of Study
Rock, et. al. 2009. Longevity of Convention Gravel and Reduced Area Chamber Distribution Systems Installed in the Town of Cumberland, Maine 1975 to 1988, Proceedings of NOWRA	Chamber longevity study on systems sized at 50% reduction; systems aged at least 20, and up to 30 years.
Lowe et al. 2008. Controlled Field Experiment for Performance Evaluation of Septic Tank Effluent Treatment during Soil Evaluation, Journal of Environmental Engineering	Two-year field study of 30 pilot-scale test cells.
Walsh, R. 2006. Infiltrative Capacity of Receiving Media as Affected by Effluent Quality, Infiltrative Surface Architecture, and Hydraulic Loading Rate, Master Thesis at Colorado School of Mines	One dimensional column study
Uebler et al. 2006. Performance of Chamber and EZ1203H Systems Compared to Conventional Gravel Septic Tank Systems in North Carolina, Proceedings of NOWRA	Field evaluation of failure rates of approximately 300 of each type system (gravel, chamber, EPS) 2-12 years old
Radcliffe et al. 2005. Gravel and Sidewall Flow Effects in On-Site System Trenches, Soil Science Society of America Journal	Two dimensional computer model (HYDRUS-2D)
Siegrist et al. 2004. Wastewater Infiltration into Soil and the Effects of Infiltrative Surface Architecture, Small Flows Quarterly	Two one dimensional column studies and pilot-scale field study
White and West. 2003. In-Ground Dispersal of Wastewater Effluent: The Science of Getting Water into the Ground. Small Flows Quarterly, 2003	Literature Review and One dimensional column study measuring the impact of gravel and fines (clean water)
King et al. 2002. Surface Failure Rates of Chamber and Traditional Aggregate-Laden Trenches in Oregon, Small Flows Quarterly	Field evaluation of failure rates of 198 chamber systems and 191 gravel systems 2-5 years old
Burcham, T. 2001. A Review of Literature and Computations for Chamber-Style Onsite Wastewater Distribution Systems, Report commissioned by the Mississippi Department of Health	Literature review and computer model
Joy, Douglas. 2001. Review of Chamber Systems and Their Sizing for Wastewater Treatment Systems, Ontario Rural Wastewater Centre Report, University of Guelph	Literature Review
Van Cuyk et al, 2001. Hydraulic and Purification Behaviors and their Interactions During Wastewater Treatment in Soil Infiltration Systems", Journal of Water Resources	Three-dimensional lysimeter study of treatment performance
Casper, Jay. 1997. Final Report: Infiltrator Side-by-Side Test Site, Killarney Elementary School, Winter Park, Florida. Report to State of Florida, Department of HRS.	Pilot-scale side-by-side study of 15 trenches (gravel and chamber).
Amerson, RS, Tyler, EJ, Converse, JC. 1991. Infiltration as Affected by Compaction, Fines and Contact Area of Gravel, *in* On-Site Wastewater Treatment: Proceedings of 6th National Symposium On Individual and Small Community Sewage Systems, American Society of Agricultural Engineers, St. Joseph, MI, December 1991	Evaluation of 30 soil cells to assess impact of gravel compaction, contact area and fines.
Siegrist, Robert. 2006. Evolving a Rational Design Approach for Sizing Soil Treatment Units, Small Flows Quarterly. Summer 2006	Proposed design methodology that takes into account BOD loading, soil type and infiltrative surface architecture.
2001. U.S. EPA Decentralized Systems Technology Fact Sheet – Septic Tank Leaching Chambers.	Literature Review and Recommended Usage

Attachment 4

IAPMO UPC Excerpt – Chamber Sizing

AN AMERICAN NATIONAL STANDARD
IAPMO/ANSI UPC 1 – 2012

2012 UNIFORM PLUMBING CODE®

IAPMO®

Approved American National Standard ANSI

SANITARY ENGINEERING ASSE

ACCREDITED Green Plumbers

Mechanical Contractors Association MCAA of America

PHCC PLUMBING-HEATING-COOLING CONTRACTORS ASSOCIATION

PLUMBERS • UNION • PIPEFITTERS • SERVICE TECHS • STEAMFITTERS • SPRINKLERFITTERS

WORLD PLUMBING COUNCIL

TABLE H 2.1(3)
LEACHING AREA SIZE BASED ON SEPTIC TANK CAPACITY

REQUIRED SQUARE FEET OF LEACHING AREA PER 100 GALLONS SEPTIC TANK CAPACITY (square feet per 100 gallons)	MAXIMUM SEPTIC TANK SIZE ALLOWABLE (gallons)
20–25	7500
40	5000
90	3500
120	3000

For SI units: 1 square foot per 100 gallons = 0.000245 m^2/L, 1 gallon = 3.785 L

the underground water stratum that is usable for domestic purposes.

Exception: In areas where the records or data indicate that the groundwaters are grossly degraded, the 5 foot (1524 mm) separation requirement shall be permitted to be reduced by the Authority Having Jurisdiction. The applicant shall supply evidence of groundwater depth to the satisfaction of the Authority Having Jurisdiction.

(4) The minimum effective absorption area in any seepage pit shall be calculated as the excavated sidewall area below the inlet exclusive of any hardpan, rock, clay, or other impervious formations. The minimum required area of porous formation shall be provided in one or more seepage pits. No excavation shall extend within 10 feet (3048 mm) of the water table nor to a depth where sewage is capable of contaminating underground water stratum that is usable for domestic purposes.

Exception: In areas where the records or data indicate that the groundwaters are grossly degraded, the 10 foot (3048 mm) separation requirement shall be permitted to be reduced by the Authority Having Jurisdiction.

The applicant shall supply evidence of groundwater depth to the satisfaction of the Authority Having Jurisdiction.

(5) Leaching chambers shall be sized on the bottom absorption area (nominal unit width) in square feet. The required area shall be calculated using Table H 2.1(2) with a 0.70 multiplier.

H 4.0 Percolation Test.

H 4.1 Pit Sizes. Where practicable, disposal field and seepage pit sizes shall be computed from Table H 2.1(2). Seepage pit sizes shall be computed by percolation tests, unless use of Table H 2.1(2) is approved by the Authority Having Jurisdiction.

H 4.2 Absorption Qualities. In order to determine the absorption qualities of seepage pits and of questionable soils other than those listed in Table H 2.1(2), the proposed site shall be subjected to percolation tests acceptable to the Authority Having Jurisdiction.

H 4.3 Absorption Rates. Where a percolation test is required, no private disposal system shall be permitted to serve a building where that test shows the absorption capacity of the soil is less than 0.83 gallons per square foot (gal/ft^2) (33.8 L/m^2) or more than 5.12 gal/ft^2 (208.6 L/m^2) of leaching area per 24 hours. Where the percolation test shows an absorption rate greater than 5.12 gal/ft^2 (208.6 L/m^2) per 24 hours, a private disposal system shall be permitted where the site does not overlie groundwaters protected for drinking water supplies, a minimum thickness of 2 feet (610 mm) of the native soil below the entire proposed system is replaced by loamy sand, and the system design is based on percolation tests made in the loamy sand.

H 5.0 Septic Tank Construction.

H 5.1 Plans. Plans for septic tanks shall be submitted to the Authority Having Jurisdiction for approval. Such plans shall show dimensions, reinforcing, structural calculations, and such other pertinent data as required.

H 5.2 Design. Septic tank design shall be such as to produce a clarified effluent consistent with accepted standards and shall provide adequate space for sludge and scum accumulations.

H 5.3 Construction. Septic tanks shall be constructed of solid durable materials not subject to excessive corrosion or decay and shall be watertight.

H 5.4 Compartments. Septic tanks shall have not less than two compartments unless otherwise approved by the Authority Jurisdiction. The inlet compartment of any septic tank shall be not less than two-thirds of the total capacity of the tank, nor less than 500 gallons (1892 L) liquid capacity, and shall be not less than 3 feet (914 mm) in width and 5 feet (1524 mm) in length. Liquid depth shall be not less than 2½ feet (762 mm) nor more than 6 feet (1829 mm). The secondary compartment of a septic tank shall have a capacity of not less than 250 gallons (946 L) and a capacity not exceeding one-third of the total capacity of such tank. In septic tanks having a 1500 gallon (5678 L) capacity, the secondary compartment shall be not less than 5 feet (1524 mm) in length.

H 5.5 Access. Access to each septic tank shall be provided by not less than two manholes 20 inches (508 mm) in minimum dimension or by an equivalent removable cover

Attachment 5

Colorado Regulations – Excerpt Sizing Table 10-3

WATER QUALITY CONTROL DIVISION PROPONENT'S PREHEARING VERSION INCLUDING REBUTTAL STATEMENT PROPOSALS AS PRESENTED IN STATE SUMMARY FOR THE MARCH 12, 2013 HEARING AND COMMISSIONER CHANGES AT THE MARCH 12, 2013 HEARING

REDLINES FOR COMMISSIONER FORMATTING AND EDITS

DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

Water Quality Control Commission

ON-SITE WASTEWATER TREATMENT SYSTEM REGULATION

5 CCR 1002-43

43.1 Authority

This regulation is promulgated pursuant to the On-site Wastewater Treatment System Act, 25-10-101, et seq. C.R.S.

43.2 Scope and Purpose

A. Declaration

1. In order to preserve the environment and protect the public health and water quality; to eliminate and control causes of disease, infection, and aerosol contamination; and to reduce and control the pollution of the air, land and water, it is declared to be in the public interest to establish minimum standards and regulations for On-site Wastewater Treatment Systems (OWTS) in the state of Colorado and to provide the authority for the administration and enforcement of such minimum standards and regulations.

2. This regulation shall apply to On-site Wastewater Treatment Systems as defined in section 25-10-103(12), C.R.S.

B. Purpose

1. The purpose of this regulation as authorized by the OWTS Act is to establish minimum standards for the location, design, construction, performance, installation, alteration and use of OWTS within the state of Colorado, and establish the minimum requirements for regulations adopted by local boards of health including but not limited to permit application requirements; requirements for issuing permits; the inspection, testing, and supervision of installed systems; the maintenance and cleaning of systems; the disposal of waste material and the issuance of cease and desist orders.

C. Effluent Discharged to Surfacestate Waters

Type of Soil Treatment Area	Method of Effluent Application from Treatment Unit Preceding Soil Treatment Area		
	Gravity	Dosed (Siphon or Pump)	Pressure Dosed
Trench	1.0	0.9	0.8
Bed	1.2	1.1	1.0

Table 10-3 Size Adjustment Factors for Types of Distribution Media in Soil Treatment Areas Accepting Treatment Level 1 Effluent

Type of Soil Treatment Area	Type of Storage/Distribution Media Used in Soil Treatment Area		
	Rock or Tire Chips	Manufactured Media Other Than Chambers	Chambers
Trench or Bed	1.0	0.9	0.7

E. Design of Distribution Systems

1. General

a. The infiltrative surface and distribution lines must be level.

b. The infiltrative surface must be no deeper than ~~4~~four feet unless adequate treatment at a deeper level can be demonstrated~~,~~ and is approved by the local public health agency. The depth will be measured on the downslope side of the trench or bed.

c. Trenches must follow the ground surface contours so variations in infiltrative surface depth are minimized. Beds must be oriented along contours to the degree possible.

d. Pipe for gravity distribution must be no less than ~~3~~three inches in diameter.

e. A final cover of soil suitable for vegetation at least ~~10~~ten inches deep must be placed from the top of the geotextile or similar pervious material in a rock and pipe system, chamber, or manufactured media up to the final surface grade of the soil treatment area.

f. Following construction, the ground surface must be graded to divert stormwater runoff~~deflect precipitation~~ or other outside water from the soil treatment area.

Attachment 6

Lentz Email August 8, 2012

Lentz, Dave

From: Lentz, Dave <dlentz@infiltratorsystems.net>
Sent: Wednesday, August 08, 2012 11:23 AM
To: James Brough
Cc: Rich Cripe; Berquist, Eric; Seth Tourney
Subject: RE: Drainfield Size Reductions for Chambered Systems
Attachments: WY chamber fact sheet_080712.pdf; NC Field Study_research paper version.pdf; OR King & Hoover Small Flows.pdf; ME Longevity of Conventional Gravel and Reduced Area Chambers - Rock et al.pdf; WY liquid level summary_080712.pdf

James,

Thank you for getting in touch in advance of your rulemaking process. I am especially pleased that we will have the opportunity to provide a comprehensive picture of the research and studies that have been undertaken with regard to chamber performance and sizing. In addition, I will be more than happy to provide you with any chamber regulatory approval information you are interested in obtaining (e.g., approval letters, regulations, etc.). For instance, I understand that Sara Heger indicated that chambers are not granted a sizing reduction in Minnesota. There are actually two manners of sizing chambers in Minnesota, and the method that was excluded from her communication allows a 40% reduction compared to the sizing of a stone and pipe trench. I can provide agency documents supporting any sizing you may be interested in, as I want to make sure you have a complete, rather than partial account of the regulatory framework for a particular jurisdiction.

I will call you to discuss chamber sizing and information needs you may have at this time, but before doing so, I thought it may be helpful to respond to some of your initial questions and provide information that you may not yet have on the performance of chamber technology. I have attached the following items for your review and possible future discussion:

- **Chamber technology fact sheet** – This summary document highlights key studies that have been undertaken to investigate chamber performance in the field, and also provides information on gravelless technology use in general.

- **North Carolina field performance study** – Conducted by the North Carolina Department of Environment and Natural Resources this is one of the largest onsite system studies in the world, examining the performance of 300 chamber systems compared to 300 gravel systems in the field. The study found that the there was no statistically significant difference in chamber system performance as compared to that of stone and pipe at a 95% upper confidence level.

- **Oregon field performance study at a 40% reduction** – This third-party study by Dr. Larry King and Dr. Michael Hoover at North Carolina State University was published in the Fall 2002 edition of Small Flows Quarterly. The study examined the performance of over 400 chamber and conventional stone and pipe systems and found that there was no statistical difference in surficial failure rates between these two system types.

- **Maine longevity study at a 50% reduction** – This study by the University of Maine's Dr. Chet Rock examines the longevity of gravelless drainfields sized at 50% the length of stone and pipe systems through the use of historical repair records. The study considers systems between 20 and 30 years old, with 63 chamber and 341 gravel system evaluated. The records show that, at a 95% upper confidence level, gravelless systems at a 50% sizing reduction outperformed stone and pipe. This study also provides an analysis of Sara Christopherson's (Heger's) University of Minnesota study, where manipulation of the dataset and distal measurement of effluent ponding in stone trenches skewed conclusions on the performance of chambers as compared to stone and pipe systems.

There is additional information responding to your concerns below (scroll down to your email to me), with Infiltrator's response appearing in dark red font. While Infiltrator is confident is the current sizing of chambers in Wyoming, we are willing to discuss a means of adjusting the state's chamber sizing to build additional safety factor into chamber system designs and lower the reduction from its current level of 50%.

In addition to our interest in working with you on the chamber portion of the rule, we are also interested in proposing revisions to the tank section that will allow for septic tanks with liquid levels of less than 48 inches. Infiltrator manufactures two lines of septic tanks that are on the state's "Type B" list. The use of a liquid level that is less than 48 inches is consistent with tank manufacturing policy in place in many other North American jurisdictions, demonstrating that there are a variety of acceptable liquid levels that yield a properly functioning septic tank (i.e., discharge of clarified effluent). Given the prevalence of tanks with less than 48 inches of liquid and the codification of this type of geometry across the United States, we think that adjusting the rule for this type of design is a reasonable change. I have attached a summary of minimum liquid level requirements for numerous states. If interested, I have a quantitative analysis comparing key operating parameters for tanks with 48- and 40-inch liquid levels.

I look forward to discussing your concerns and the attached information by telephone.

Sincerely,
Dave Lentz

INFILTRATOR®
systems inc.

David Lentz, P.E.
Regulatory Director
p. 860-577-7198
f. 860-577-7793
m. 860-575-8099
dlentz@infiltratorsystems.net
www.infiltratorsystems.com

From: James Brough [mailto:james.brough@wyo.gov]
Sent: Friday, July 27, 2012 11:41 AM
To: Lentz, Dave
Cc: Rich Cripe; Berquist, Eric; Seth Tourney
Subject: Drainfield Size Reductions for Chambered Systems

Mr. David Lentz:

Eric Berquist contacted me yesterday concerning chambers and associated drainfield size reductions. Wyoming DEQ has had some internal discussion regarding this issue. Below is some discussion that I have shared with coworkers. If you have additional papers or insight, I would appreciate hearing back from you. Thanks.

Wyoming has a policy that grants a 50% reduction to the bottom of chambers due to elimination of a "masking" effect. Some states allow no footprint reductions for chambers. Sarah Heger with the University of Minnesota shared a report of a field study that compared rock-filled and chamber trenches. Basically the study failed to demonstrate an advantage of using chamber systems over rock-filled systems.

Please see the sixth page of the attached paper by Dr. Chet Rock for an analysis of the University of Minnesota study. The full dataset was not used to reach the conclusions in the paper, and measurement of ponding levels in trenches only at the distal end is believed to have led to inaccurate conclusions as effluent was damned inside the trench, causing an accumulation at the proximal end while the distal end had no ponding. This phenomena has been documented in an unrelated study at the Massachusetts Alternative Septic System Test Center (MASSTC) in Buzzards Bay, MA.

Field Comparison of Rock-Filled and Chambered Trench Systems

http://septic.umn.edu/prod/groups/cfans/@pub/@cfans/@ostp/documents/asset/cfans_asset_125871.pdf

Another paper from Colorado School of Mines has the following discussion. This paper indicates that 33 to 50 percent reduction could be granted to chambers in sand and sandy loam soils.

This sizing is consistent with sizing in many jurisdictions and is supported by other research. Please see the multiplier summary (Table 2) in the attached chamber fact sheet. For reference, a 33% reduction is a 1.5 multiplier, and a 50% reduction is a 2.0 multiplier.

Wastewater Infiltration into Soil and the Effects of Infiltrative Surface Architecture

http://www.infiltratorsystems.com/pdfs/SFQ_w04_JURIED.pdf

Both of the States Idaho and Montana grant a 25% reduction for chambers in trenches. Utah grants 30% reductions for chambers in trenches. In short, I had one field study report that didn't support a reduction in drain field size when using chambers and another that supported a 33 to 50 percent reduction in sands. Per discussions with other state regulators, I came to the conclusion that Wyoming was giving the chambers too much credit for elimination of a "masking" effect.

The 50% reduction is not necessarily too much credit, as this sizing is consistent with research and has been proven to work over the long term (see attached University of Maine longevity study and consider Infiltrator's chamber performance track record in Wyoming). While Infiltrator is confident is the current sizing of chambers, we are willing to discuss a means of adjusting the state's chamber sizing to build additional safety factor into chamber systems and lower the reduction from its current level of 50%.

--

James S. Brough, P.E.
Northwest District Engineer
Water Quality Division

510 Meadowview Drive
Lander, WY 82520
307-335-6961 (office)
307-332-7726 (fax)
james.brough@wyo.gov

Attachment 7

IAPMO Z1000-2013 Excerpts

IAPMO Z1000-20yy

Prefabricated Septic Tanks

IAPMO

(b) extend below the liquid surface between 50% and 75% of the liquid depth, measured from the inside floor of the septic tank; and
(c) extend at least 120 mm (5 in) above the liquid surface.

4.5.3
The invert of the inlet pipe shall be at least 50 mm (2 in) above the invert of the outlet pipe.

4.6 Venting

4.6.1
Partitions, baffles, and inlet and outlet devices shall have a venting area not smaller than the cross-sectional area of the inlet or the outlet, whichever is greater.

4.6.2
There shall be a separation of at least 25 mm (1 in) between the top of the tank and the top of the inlet and outlet device vent opening.

4.7 Partitions and Baffles

4.7.1
Partitions and baffles separate compartments and shall extend at least 120 mm (5 in) above the liquid surface.

4.7.2
Flow between compartments shall be through a
(a) horizontal slot having a vertical dimension of at least 50 mm (2 in);
(b) inverted tee, 90º elbow, or similar fitting at least NPS-4 but in no case smaller than the tank inlet; or
(c) two or more equally spaced openings having a combined cross-sectional area of at least two times the area of the inlet device.

4.7.3
The fitting inlets or the centroid of the openings shall be located between 50% and 75% of the liquid depth, measured from the inside floor of the tank.

4.8 Air Space
Septic tanks shall have at least 230 mm (9 in) of air space above the liquid surface. The air space shall have a volume equivalent to at least 10% of the working liquid volume of the tank.

4.9 Risers
When applicable, septic tanks shall have a means of connecting with an access opening extension system (i.e., risers) that is watertight.

4.10 Covers
Openings shall be capable of accommodating covers (i.e., lids) that
(a) are watertight;
(b) are secure;

Note: *Acceptable measures for securing covers include padlock(s), covers that can be removed only with tools, or covers with a mass of at least 30 kg (66 lb).*

Attachment 8

IAPMO Z100-2007 Excerpts

IAPMO/ANSI Z1000-2007

Prefabricated Septic Tanks

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maintenance holes with a minimum 20 in. (50 cm) inside dimension. One access maintenance hole shall be located over the inlet, and one access maintenance hole shall be located over the outlet.

3.4 The inlet and outlet pipe or baffle shall extend a minimum of 5 in. (12 cm) above and a minimum of 8 in. (20 cm) below the water surface. The invert of the inlet pipe shall be at a level not less than a minimum of 3 in. (8 cm) above the invert of the outlet pipe.

3.4.1 The inlet sanitary tee shall not be smaller in size than the connecting sewer pipe nor less than 4 in. (10 cm). The outlet sanitary tee shall not be smaller in size than the connecting service pipe.

3.5 Compartment partitions and inlet and outlet fittings or baffles shall have a free-vent area greater than or equal to the cross-sectional area of the larger of a nominal pipe size 3 in. pipe or the inlet pipe. Free ventilation shall be provided above the water surface from the disposal field or seepage pit through the septic tank, building drain and vent stack to the outside air.

3.5.1 Partitions or baffles shall be constructed between compartments and shall extend at least 5 in. (12 cm) above the liquid level. Flow from inlet to outlet compartment shall be through a horizontal slot (having a minimum vertical dimension of 2 in.), a tee, ninety (90°) degree elbow or similar fitting (equivalent in size to the tank inlet but not less than 4 inches (10 cm) in diameter), inverted and extending down into the inlet compartment so that the entry to the fitting is located midway in the liquid depth of the tank.

3.5.2 Septic tanks shall have an air space equal to not less than 10 percent of the liquid volume, and total depth shall not be less than 9 in. (23 cm) above the liquid level. There shall be a minimum of 2 in. (5 cm) of separation between the top of the tank and the top of the sanitary tee vent opening.

3.6 Exterior walls shall be designed for a minimum inside hydrostatic water pressure equal to the head pressure based upon the height of the outlet. The exterior walls shall also be designed to withstand a minimum outside earth pressure equivalent to that exerted by a fluid with a density of 30 lbs/ft^3 (481 kg/m^3).

3.6.1 Internal baffles and fittings shall be designed to withstand the combined hydraulic and earth loads occurring when any compartment is empty of fluid and the remaining compartment(s) is full.

3.7 Septic tanks and covers shall be designed for a vertical earth load of not less than five hundred (500) lbs/ft^2 (24 kPa) when the maximum coverage does not exceed 3 ft. (0.9 m). Regardless of coverage, each tank and cover shall be structurally designed to withstand all anticipated earth or other loads.

3.7.1 Prefabricated septic tanks for installation in traffic areas shall be designed in accordance with ASTM C 890 for A-16 vehicle loading (AASHTO HS20-44). Wheel loading, dead load, horizontal pressures, and load surcharge shall be applied based on the requirements of ASTM C 890.

3.7.2 Septic tanks shall be designed to accept an access riser which can be brought to grade. Access riser(s) shall have a leak-resistant closure (i.e., lid) that cannot slide, rotate, or flip, thereby exposing the opening. The lid shall be designed to support the anticipated live load. The opening shall be designed to prevent the access of un-authorized individuals.

3.8 Connections between pipes and precast concrete tanks shall utilize flexible connectors which conform to ASTM C 1644. Connectors used between pipes and tanks made of materials other than precast concrete shall demonstrate conformance with the performance requirements of ASTM C 1644, paragraph 7.

3.9 Prefabricated Septic Tanks consisting of two or more sections shall have joints designed such that uniform pressure is exerted on joint sealants or gaskets along their entire length and shall provide a continuous watertight seal. The joint material shall be supplied by the manufacturer and shall be applied at the time of installation per manufacturer's requirements, unless otherwise approved by the Administrative Authority. Any tank with a horizontal joint below the liquid level shall be permanently bonded or mechanically fixed.

3.9.1 Gaskets, when required, used to seal horizontal seams in tanks shall be permanently fixed so they do not separate when subject to periodic servicing, seasonal shrink/swell pressures, or non-uniform differential settlement.

4. Material requirements

4.1 Concrete.

4.1.1 Concrete septic tanks shall comply with the "Materials and Manufacture" section of ASTM C 1227 and shall have a minimum compressive strength of 4000 psi (28 MPa) at 28 days of age and a maximum water to cementitious ratio (w/c) of 0.45.

4.1.2 Sealants. Flexible sealants employed in the manufacture or installation of tanks shall conform to ASTM C 990. Rigid (mortar) sealing or grout sealant of tank sections shall not be permitted.

4.1.3 Lifting. Lifting devices, embedded or otherwise attached to the tank, shall comply with the requirements of ASTM C 890.

4.1.4 Synthetic fiber-reinforced concrete tanks. Polypropylene or polyolefin fibers are only permitted as a

Attachment 9

Tank Airspace Volume Analysis by State

Infiltrator Systems Inc.
Summary of Septic Tank Air Space Volume to Working Volume Regulatory Requirements

State/Standard	Minimum Air Space as a Function of Working Volume (%)
IAPMO/ANSI Z1000	10
CSA B66-05	10
AL	No requirement
AR	12.5
AZ	No requirement
CA	Varies by county regulation
CO	No requirement
CT	No requirement
DE	No requirement
FL	15
GA	No requirement
IA	No requirement
ID	15
IL	No requirement
IN	No requirement
KS	No requirement
KY	No requirement
LA	No requirement
MA	No requirement
MD	No requirement
ME	No requirement
MI	No requirement
MN	15
MO	15
MT	20
NC	No requirement
NE	No requirement
NH	No requirement
NJ	No requirement
ND	20
NM	No requirement
NV	No requirement
NY	No requirement
OH	No requirement
OK	No requirement
OR	10
PA	No requirement
SC	No requirement
SD	20
TN	No requirement
TX	No requirement
VA	No requirement
WA	10
WI	No requirement
WV	No requirement
WY	20