TITLE 252. DEPARTMENT OF ENVIRONMENTAL QUALITY
CHAPTER 641. INDIVIDUAL AND SMALL PUBLIC ON-SITE SEWAGE TREATMENT SYSTEMS

SUMMARY OF COMMENTS AND RESPONSES
COMMENT PERIOD: November 15 through December 16, 2019

The following comments received by DEQ were made in an email dated December 3, 2019 from Kevin Ruark on behalf of the Oklahoma On-site Wastewater Association (OOWA). Please see the attached document for the full letter and corresponding documentation.

COMMENT: The proposed language requiring the installation of a manhole over the inlet cleanout is not clear. The confusion is related to the reference of the septic tank cleanout versus the sewer line cleanout.

RESPONSE: The use of the term cleanout is consistent with the terminology used in this subchapter when describing the required access to the inlet and outlet baffles of the septic tank. The proposed language effectively conveys the requirement for the installation of surface access to the inlet baffle cleanout and does not require any changes.

COMMENT: The proposed language of "to prevent tampering or unauthorized access" in OAC 252:641-9-1(b)(3) is unnecessary.

RESPONSE: DEQ agrees that the proposed language was unnecessary and removed the phrase from the draft rules and replaced it with "tamper-resistant".

COMMENT: The proposed installation depth for aerobic treatment units of thirty-six (36) inches is too much and a definition of serviceable parts should be included.

RESPONSE: The proposed maximum installation depth for aerobic treatment units of thirty-six (36) inches was a recommendation that OOWA made during the rule making process and was included in this revision. This increased installation depth will allow compliance for systems where building sewer does not allow for shallower installations and provides cost savings to the property owner by not having to install a pump to lift the sewage to the aerobic treatment unit. The inclusion of a definition for "serviceable parts" does not clarify the intent of OAC 252:641.

COMMENT: Leave the term mandatory in section OAC 252:641-10-3(c).

RESPONSE: The use of the term mandatory is redundant for the part (c) as the rule is referencing the owner responsibilities after the two year period ends. The use of the term mandatory does not clarify the intent of OAC 252:641-10-3(c).

COMMENT: The proposed language requiring the installation of flow meters on drip irrigation fields will be a significant cost addition to the system and is not necessary. It is simple to measure the amount of water dispersed in the field by measuring the water level in the pump tank.

RESPONSE: DEQ agrees that there are other methods available to achieve the same results in determining the volume of water applied to the dispersal field. This proposed language has been removed.

COMMENTS: We are finding no clear source for BOD ratings by industry or to determine the BOD capacity of aerobic systems.

RESPONSE: Biochemical Oxygen Demand (BOD) loading rates, in pounds per day, are based on the type of facility and the strength of the waste generated at the specific facility. DEQ used resources such as *Wastewater Engineering* by Metcalf and Eddy, research conducted by various higher learning institutes, and from testing completed by the DEQ and other regulatory agencies. The BOD loading rates, as found in Appendix F, represent sizing standards in the design of aerobic treatment units. The method used to assign daily treatment rating for aerobic treatment units is a function of the manufacturer not DEQ.

The following comment received by DEQ was made in an email dated December 9, 2019 from William Saupitty, Indian Health Service. Please see the attached document for the full letter and corresponding documentation.

COMMENT: The removal of the installation requirement language for solid pipe located between the house and the septic/trash tank is not a good idea. This change could cause problems with systems are completed and require a final construction inspection. The system could be approved without being connected to the home or business. There should be a location on the final inspection for the plumbing contractor to sign stating that the building sewer was completed properly.

RESPONSE: This is outside of DEQ's jurisdiction. The Construction Industries Board has exclusive jurisdiction over installation and approval of piping from the facility/structure to final disposal.

The following comment received by DEQ was made in an email dated December 9, 2019 from Irvin Haken, Certified Installer of On-site systems. Please see the attached document for the full letter and corresponding documentation.

COMMENT: I don't think that we should do away with the perk test. I think they have proven themselves over the years and they are more scientifically correct than soil profiles. I feel that doing away with the perk test would result in more aerobic systems being installed.

RESPONSE: The soil percolation test determines only the rate at which water moves through soil on a specific day. There can be significant variation in percolation rates depending on other factors such as rainfall, drought, proper test procedures, and soil conditions. Additional information is required for proper design of the system. The soil profile is a reproducible test method that allows the certified tester to determine the soils ability to receive wastewater and effectively identifies limiting features that will directly impact system function. Therefore, DEQ is proposing to phase out percolation tests.

The following comments received by DEQ were made in an email dated December 13, 2019 from David Lentz, P.E., Regulatory Director; Infiltrator Water Technologies. Please see the attached document for the full letter and corresponding documentation.

COMMENTS: With the end of use date set for the percolation test method, it is requested that the sizing reduction allowed for chambers be applied to the sizing requirements established for the soil profile method. It is suggested that rules be promulgated that provides for a sizing factor of 0.75 for chamber systems.

RESPONSE: DEQ is not proposing revisions to the sizing requirements established in Chapter 641. DEQ will consider this request in future rule revisions.

COMMENTS: Plastic and fiberglass septic tanks are required to bare a mark documenting either IAPMO or CSA standard compliance. Changes should be made to the language in OAC 252:641-7-2 that allows for the submission of documentation that the installed plastic or fiberglass septic tank meeting the appropriate standard.

RESPONSE: DEQ is not proposing revisions to OAC 252:641-7-2. DEQ will consider this request in future rule revisions.

COMMENTS: There is an offset distance of two inches that is required between the inlet and outlet baffles of the septic tank. We request that this distance be changed to either a minimum of two inches or a range of two to four inches.

RESPONSE: DEQ is not proposing a change to this item. DEQ will consider this request in future rule revisions.

COMMENTS: The proposed language found in OAC 252:641-7-3 addresses the securing of access lids installed on septic tanks. We propose amending the language to include "tamper-resistant" fasteners.

RESPONSE: Based on the received comment, DEQ agrees with the requested amendment and has amended the proposed language to include tamper-resistant fastener.

COMMENTS: Infiltrator proposed the allowance for chambers in low-pressure dosing fields as a replacement for conventional storage media.

RESPONSE: DEQ is not proposing changes to this section of Chapter 641. DEQ will consider this request in future rule revisions.

COMMENTS: Infiltrator proposed the allowance for chambers in Evapotranspiration/Absorption (ET/A) fields as a replacement for conventional storage media.

RESPONSE: DEQ is not proposing changes to the media type allowed for installation. DEQ will consider this request in our future rule revisions.

COMMENTS: Infiltrator proposes adding a new subchapter to the Rules to address combined treatment and dispersal systems, also referred to as sand-lined systems.

RESPONSE: DEQ is not proposing language for a new subchapter that provided for design criteria for combined treatment and dispersal systems. DEQ will consider this request in future rule revisions.

COMMENTS: Several of the standardization organizations (ASTM, CSA, and NSF) cited in the Rules have changed or updated their name. It is recommended that the proposed rules be amended to reflect these updated names as follows: ASTM is now ASTM International, CSA is now CSA Group, and NSF is now NSF International. It is noted that the reference to a standard should reflect the proper order and should read NSF/ANSI. It should also be noted that ASTM F405 no longer exists and should be removed from the table located in Appendix C. The final house-keeping item addresses the use of the arch shaped description in the definition of "chamber". This descriptive is no longer used in the industry.

RESPONSE: DEQ has considered the provided comments and changes to the proposed language have been made. The new names have been included with the associated definitions or reference in rule. The nomenclature for NSF/ANSI has been updated along with the definition of chamber. Appendix C has also been amended to reflect the no longer existing F405 standard.

CREATED: December 30, 2019

Nicholas Huber

From: Kevin Ruark <kevin@reddirtseptic.com>
Sent: Tuesday, December 3, 2019 12:27 PM
To: Richard McDaniel
Cc: Matt Pace; Nicholas Huber; 'Stu Young'; 'Julie Gates'; greeves; 'larryboyanton@yahoo.com'; 'Jason Birdsong'; 'Talan Weaver'
Subject: [External] 641 Revision - Final Requests

Gentlemen,

The OOWA Board met on 11/22/19 to discuss the 641 revisions as presented by Nicholas in Tulsa on 10/24 and Matt in OKC on 10/31. We appreciate your consideration of our input in this process. There is no question that our board and many of our associates feel that the DEQ has listened and been responsive to our input in this process.

That being said, there are a few items that we believe need some tweaking in the final draft.

1. **641-7-3 (c) (1) Inlet Manhole on Septic Tanks.** Good rule, but the language may need some work. "Tank inlet manhole" vs. "cleanout" to avoid confusion with the sewer line cleanout? Should the concrete plug remain intact? (Standard 20" lids will not fit through 24" risers.) If not, should the manhole include a safely catch? Observing what is happening in other states, it appears that manhole safety devices are an eventuality.

2. **641 – 9 – 1 (b) (3) – Unnecessary language?** "to prevent tampering or unauthorized access".

3. **641 – 10 – 2 (d) – Depth of Aerobic System Tank(s).** 30" is a good compromise, keeps manufacturers happy. Define "serviceable parts"?

4. **641 – 10 – 3 (c) – "Mandatory" Maintenance.** Leave in the "mandatory" language.

5. **641 – 12 – 6 (i) – Flow Meters.** According to industry experts that we have consulted, it is expensive and not necessary. It is very simple to measure the amount of water dispersed in the field by measuring the water level in the pump tank. Our experience with flow meters are that they have a very limited life. Of course, it is relative to the cost of the meters. Purchasing meters of decent quality would add approximately $1,000 to the initial installation.

6. **BOD.** We are finding no clear (accurate) source for BOD ratings by industry or to determine the BOD capacity of aerobic systems.

Thank you for your consideration.

RED DIRT SEPTIC

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PO Box 31501
Edmond, OK. 73003
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Nicholas Huber

From:	Saupitty, William (IHS/OKC/LAW) <william.saupitty@ihs.gov>
Sent:	Monday, December 9, 2019 8:50 AM
To:	Nicholas Huber
Cc:	Wiegmann, Melinda (IHS/OKC/LAW)
Subject:	[External] Sewer connections to home. (Subsurface & Aerobic)
Attachments:	GlobalCerts INSECURE.txt; GlobalCerts INSECURE.html

I went to the last meeting at DEQ in OKC and I believe Matt Pace was updating the contractors there. He asked me for an idea at that time to help resolve the problem that the installers were having, but I relented at that time. My thought at that time was about the DEQ On-Site Inspection Report. To me the installation would be incomplete without the proper sewer connection or connections to the home. I didn't like the idea of contractors leaving the new septic system installations in the ground without the proper sewer service connection to the home. I believe that to actually have a complete system the sewer connection or connections needs to be installed at that time of the subsurface septic tank or aerobic tank setting. For DEQ to have on record that the installation is valid they would need a plumbing contractor sign the DEQ Form 641-576A/S stating that a License Plumbing Contractor completed the sewer connection properly. That way in case anything should happened to the system, DEQ would have on record who would be responsible to correct the problem the Plumbing Contractor or the Installer. Personally I have no problem with having to have a license plumber sign a 641-576A/S form and if not their signature at least their CIB State License number entered on the form. This would make the DEQ On-Site Inspection Report complete in my view and the homeowner would have it for their records also.

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Nicholas Huber

From: Irvin Haken <hakendozer@gmail.com>
Sent: Monday, December 9, 2019 2:46 PM
To: Nicholas Huber
Subject: [External] Re: Chapter 641 Public Comment Period

I don't think we should do away with perk tests ever. I think they have proven themselves over the years. I think they are more scientifically correct than soil profiles. I feel the push to do away with them is to push for more aerobic systems to be installed. Thank you for letting me have input. Irvin Haken

Sent from my iPhone

On Dec 5, 2019, at 4:12 PM, Nicholas Huber <nicholas.huber@deq.ok.gov> wrote:

All,

I wanted to take this time to remind you that the public comment period for Chapter 641 is open. This period is provided for the submission of comments relating to the proposed changes to Chapter 641- Individual and Small Public Onsite Sewage Treatment Systems (see link below).

Written comments may be submitted to nicholas.huber@deq.ok.gov from November 15, 2019, through December 16, 2019. Oral comments may be made at the Water Quality Advisory Council meeting on January 7, 2020, and at the Environmental Quality Board meeting at the regularly scheduled meeting to be held in February 2020.

Proposed Rules
https://www.deq.ok.gov/wp-content/uploads/deqmainresources/252641_IndividualandSmallPublicOn-SiteSewageTreatmentSystems2019DRAFT.pdf

Sincerely,

Nicholas Huber
Program Manager/Onsite and TRL Section
OK Dept. of Environmental Quality/Environmental Complaints & Local Services
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INFILTRATOR®
water technologies

December 13, 2019

Nicholas Huber
Oklahoma Department of Environmental Quality
707 N Robinson Ave / PO Box 1677
Oklahoma City, OK 73101-1677

Re: Rulemaking comments - Title 252 Chapter 641

Dear Mr. Huber,

Infiltrator Water Technologies (Infiltrator) appreciates the opportunity to participate in the Oklahoma Department of Environmental Quality's rulemaking process for Title 252 Chapter 641 (the Rules). This letter and its attachments provide comments on the draft rules, along with supporting technical information, as applicable.

Each proposal is addressed under a section heading below. Attachment 1 includes an abridged version of the Rules with selected proposed amendments shown in track changes format.

252:641-3-2. Soil Percolation Test

In 252:641-3-2.(a)(3), the soil percolation test is phased out effective July 1, 2023. Prior to July 1, 2023, Infiltrator proposes promulgating rules with amended sizing of conventional chamber trenches using a 0.75 sizing factor compared to the conventional absorption trench sizing set forth in Appendix H Figure 3. The proposed sizing is provided in Attachment 2. The proposed sizing is conservative compared to chamber sizing in Texas, which has similar soils and a similar climate as compared to Oklahoma. As shown in Figure 1, proposed chamber sizing for Oklahoma is

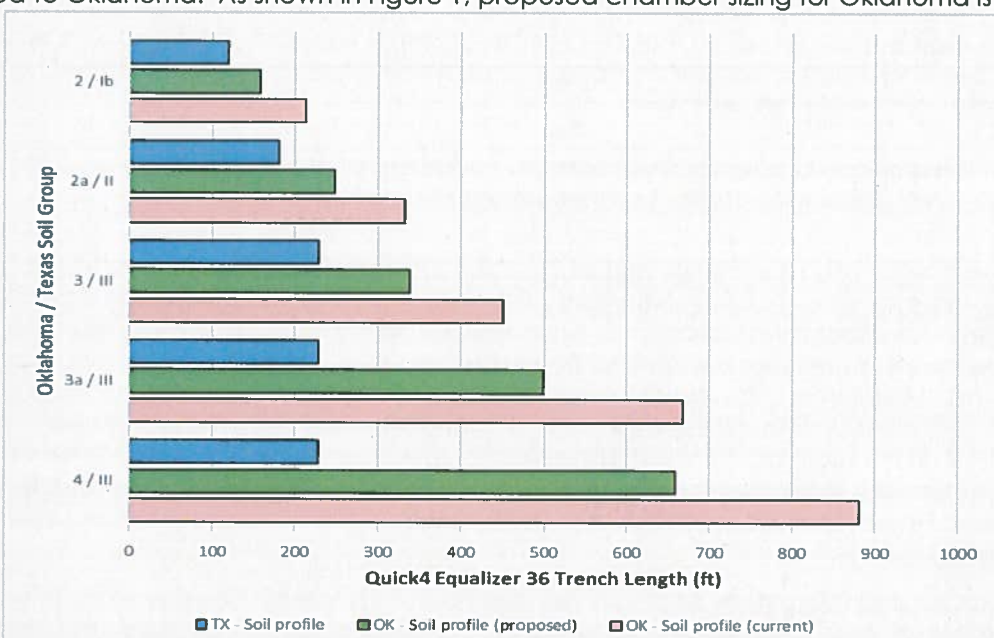


Figure 1 - Comparison of current and proposed Oklahoma sizing with Texas sizing

substantially greater than sizing prescribed in the Texas rules, which equates to a 40% reduction (0.60 sizing factor). Over the past 10 years, approximately 84,000 Quick4-brand chamber systems have been installed in Texas. The Texas sizing method has been effective, and when compared to

Infiltrator's proposed sizing shows conservatism for Oklahoma trench systems. Attachment 3 includes a table as well as the above figure comparing the current and proposed Oklahoma chamber sizing with the chamber sizing included in the Texas rules for over 20 years.

The proposed use of a 0.75 sizing factor for sizing chamber systems in Oklahoma is based on laboratory- and pilot-scale research, as well as empirical data gained from large-scale field performance assessments. The use of a 0.75 sizing factor for chamber technology is based upon a combination of two factors that differentiate chamber technology from conventional stone and pipe technology:

- Substantially more unobstructed, open infiltrative surface than conventional stone and pipe; and
- Absence of fine-grained stone dust present in conventional stone and pipe.

This combination of greater open area and lack of fines in chamber systems has been the basis for chamber sizing that is smaller in footprint than conventional stone and pipe in states across the country. The technical rational supporting each of these factors is explained below:

<u>Open Infiltrative Surface</u>
Chambers provide substantially more open infiltrative surface than conventional stone and pipe effluent dispersal technology. As a baseline, the open bottom and sidewall area for a stone-and-pipe infiltrative surface corresponds to the porosity of the stone media, which is approximately 35 percent (*Onsite Wastewater Treatment Systems Manual*, USEPA, 2002). This represents the fraction of the trench bottom and sidewalls that is not obstructed by embedded stones and will allow the passage of effluent to the native soil. In contrast, the open area of chamber systems exceeds 80 percent, allowing for higher efficiency effluent infiltration into the soil due to the greater availability of unobstructed flow area.

<u>Absence of fine-grained stone dust</u>
In addition to greater open area, fine-grained stone dust present in conventional stone and pipe leach lines is absent from chamber systems. Over time, stone dust migrates from the surfaces of stone to the trench bottom and sidewalls, reducing the infiltrative capacity of stone and pipe trenches compared to that of chamber systems. Because stone and pipe systems have reduced hydraulic capacity compared to chambers, they need comparatively more area to disperse the design daily flow.

In support of the proposed chamber sizing update, summaries of empirical data related to the performance of chamber field applications are provided below.

- <u>Oregon Third-Party Field Evaluations of Chambers (2001).</u> The Oregon Department of Environmental Quality (DEQ) required a third-party study in order to issue the state's current general-use approval for chambers. Over 400 chamber and conventional stone and pipe systems were installed at a 40% reduction (0.60 sizing factor) compared to stone and pipe systems. Malfunction rates for chamber systems and stone and pipe systems were less than 1.5%, with no statistical difference in surficial failure rates between these two system types. A juried article summarizing the study results was published in the Fall 2002 edition of Small Flows Quarterly (see article in Attachment 4). The Oregon DEQ issued an unrestricted product approval for chambers based on the results of the studies, with the approval in place today.
- <u>North Carolina 900-System Survey (2005).</u> This statistically valid 2005 study was performed by the State of North Carolina Department of Environment and Natural Resources (DENR) and evaluated the malfunction rate of the following systems ranging in age from 2 to 12 years: 1) 3'W x 1'H stone and pipe; 2) Infiltrator's 34-inch-wide Standard Chamber at a 25% length reduction; and 3) EZflow 1203H at a 25% length reduction (Attachment 5). The 900 systems surveyed in the study were distributed uniformly within the coastal, Piedmont, and mountain regions of North Carolina to examine performance in differing subsurface environments and climactic conditions. The study was managed solely by the state of

North Carolina. The results of the study show no statistical difference in malfunction rates between any of the three system types at a 95-percent confidence level. As a result of this study, DENR granted chambers and EZflow "accepted" status, which under North Carolina law can only be granted to products demonstrated to perform the same or better than a conventional stone and pipe system. Accepted status is the top tier of proprietary wastewater device approval in North Carolina, and the approvals are in place today.

- North Carolina 650-System Survey (2019). This statistically valid 2019 study was performed by North Carolina Department of Health and Human Services-approved independent third parties. and evaluated the malfunction rate of 290 Quick4 Equalizer 36 chamber systems compared to 376 conventional stone and pipe and accepted control systems. The Quick4 Equalizer 36 chamber systems where installed at a 33% reduction (0.67 sizing factor) compared to the conventional stone and pipe and accepted control systems in the study. The systems surveyed in the study were distributed within the coastal, Piedmont, and mountain regions of North Carolina to examine performance in differing subsurface environments and climactic conditions. The results of the study show no statistical difference in malfunction rates between any of the three system types at a 95-percent confidence level. As a result of this study, DHHS granted the Quick4 Equalizer 36 chamber "accepted" status, the top tier of proprietary wastewater device approval in North Carolina in August of 2019. The analysis from the North Carolina Center for Health Statistics is provided in Attachment 6.

In addition to the above field performance studies, the California Water Resources Control Board conducted a third-party evaluation of a proposed chamber sizing policy as part of its 2012 statewide Onsite Wastewater Treatment Systems (OWTS) Policy development process. The evaluation is based upon a sizing factor of 0.70, which was deemed appropriate. The evaluation by Dr. Jorg Drewes and Ronald W. Crites, P.E. are provided in Attachments 7 and 8, respectively (see highlighted text). California's OWTS Policy includes a 0.70 sizing factor.

Chamber technology is approved in all 50 states and all Canadian provinces. Example state and code sizing for chamber technology is provided in Table 1 below. In these sizing examples, sizing factors less than 0.75 represent comparatively smaller drainfield footprints than drainfields sized using the 0.75 sizing factor proposed in Oklahoma with a soil profile.

State or Published Code	Sizing Factor	Sizing Reduction
Oklahoma (proposed)	0.75	25%
Texas	0.60	40%
New Mexico	0.70	30%
Colorado	0.70	30%
Missouri	0.63	37%
Arkansas	0.63	37%
California	0.70	30%
Uniform Plumbing Code	0.70	30%
California Plumbing Code	0.70	30%

Table 1 – Regional chamber sizing summary

Over the past ten years, more than 2.2 million chamber drainfields have been installed nationwide at an average sizing factor of 0.69. Field performance studies and Infiltrator warranty claim records show that chamber technology has demonstrated a record of performance that is equal or superior to that of conventional stone and pipe systems.

252:641-7-2. Types of tanks

Section 252:641-7-2.(b) states that a fiberglass or plastic tank shall have an IAPMO or CSA mark. While IAPMO and CSA publish standards for prefabricated tank manufacture, any American National Standards Institute-accredited organization can certify to those standards, and this includes IAPMO and CSA. A similar example would be Gulf Coast Testing certifying an aerobic system to NSF/ANSI 40. We propose the minor clarification below that would eliminate the limitation to only two companies' marks on compliant tanks.

> (b) Fiberglass and plastic tanks. 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 a mark verifying IAPMO or CSA conformance, then DEQ will require the installer to submit documentation from IAPMO or CSA stating the tank meets the above standards.

252:641-7-3. Design

Under 252:641-7-3.(c), septic tanks must have a prescriptive 2-inch drop between inlet and outlet elevation. We propose making this a minimum or a range, such as:

> "The outlet of the septic tank shall be a minimum of two inches (2") lower than the inlet of the septic tank."
>
> or
>
> "The outlet of the septic tank shall be two to four inches (2" to 4") lower than the inlet of the septic tank."

252:641-7-3. Design

Requirements have been added to 252:641-7-3(c)(1) on the fastening of the lid to the tank. Many states use the term "tamper resistant" with regard to the fasteners, which we suggest adding, as shown below.

> The inlet cleanout shall have an opening of sufficient size to allow for maintenance that extends a minimum of two inches (2") above ground elevation. The cover for the opening shall have a lock, locking bolt or some type of tamper-resistant fastener, or require a tool for removal.

252:641-9-1. General provisions

Under 252:641-9-1.(b)(2), requirements are established for concrete septic tanks, but not fiberglass or plastic. This section should also reference 252:641-7-2.(b).

252:641-12-4. Low-pressure dosing fields

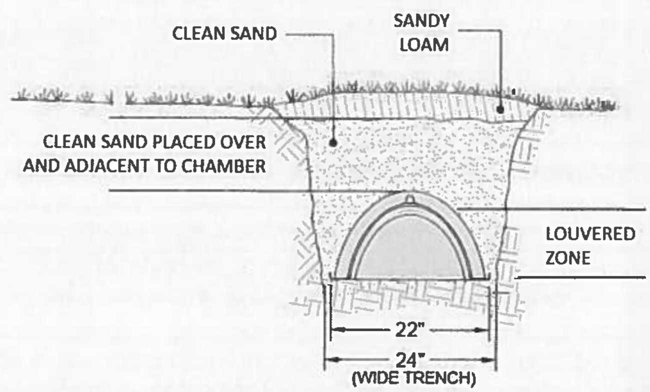
Infiltrator proposes the allowance for chambers in low-pressure dosing fields as a replacement for conventional storage media. Proposed amended language for 252:641-12-4. is provided in Attachment 1, where a new section for chambers has been added, modeled from the existing language in 252:641-12-2. A difference between the chamber language in 252:641-12-2 and that proposed in 252:641-12-4. is an added statement that low-pressure dosing pipe shall be installed in accordance with the manufacturer's recommendations. Generic low-pressure distribution installation instructions for Quick4 chambers are provided on the Infiltrator web site at: https://www.infiltratorwater.com/resource-center/manuals-guides-and-cad-details/?l=chamber&f=Q04.pdf. Sizing of chambers in low-pressure dosing applications would be 1:1 with conventional stone and pipe storage media.

In many states the use of low-pressure dosing is a regular occurrence. In some states, such as Washington, low-pressure dosing is employed on more than 50% of the chamber installations. In Wisconsin, where the iconic Wisconsin mound is used extensively, all chamber systems include low-pressure dosing. Infiltrator chambers are designed specifically to accommodate low-pressure dosing pipe, with molded holes in the inlet and outlet structure available to cinch the pressurized pipe to the underside of the chamber using a cable tie. A typical mound installation that includes low-pressure distribution pipe installation is provided on the Infiltrator YouTube page at: https://www.youtube.com/watch?v=2W4bu5mYa1I&t=612s.

252:641-12-5. Evapotranspiration/absorption (ET/A) fields

Infiltrator proposes the allowance for chambers in ET/A trench systems as a replacement for conventional storage media. Proposed amended language for 252:641-12-5. is provided in Attachment 1, where a new section for chambers has been added, modeled from the existing language in 252:641-12-2. Sizing of chambers in ET/A applications would be 1:1 with conventional stone and pipe storage media.

We are not aware of any jurisdiction that restricts the use of chambers for ET/A systems where these types of systems are in use. The use of chambers for ET/A systems in Texas and the Southwestern United States is commonplace. The proposed use includes the placement of clean sand as backfill around and above the chamber (illustration at right). The tapered sidewalls of the chamber allow ample space for sand placement between the louvered chamber sidewall and trench sidewall, where effluent can be drawn from within the chamber into the sand via capillary action and be available for evaporation in the overlying sand.



Addition of Combined Treatment and Dispersal Systems

Infiltrator proposes adding a new subchapter to the Rules to address combined treatment and dispersal systems, also referred to as sand-lined systems. The rationale for adding a new subchapter is that combined treatment and dispersal systems are unique in that they combine wastewater treatment (such as that detailed in Subchapter 10) and dispersal fields (such as that detailed in subchapter 12) as the name implies. As such, it does not "fit" within the framework of the existing Rules and would be regulated more efficiently as a separate technology. Draft text for a new subchapter to the Rules is provided in Attachment 1. In support of this proposal, we provide the following information:

Combined treatment and dispersal systems, as the term implies, combine sewage treatment and dispersal in the same footprint. These systems are comprised of a proprietary media encased in tightly specified medium sand, known as "system sand". The proprietary media serves to store and convey residential-strength septic tank effluent (sewage) to the surrounding system sand. Treatment occurs both as the sewage passes through the proprietary media as well as during time and travel within the system sand. Combined treatment and dispersal systems are engineered to produce effluent which meets NSF/ANSI 40 standards.

Combined treatment and dispersal systems are commonly designed and installed in bed configurations but may be installed in trench systems as well. They can be placed subsurface or in above-ground (mound) applications, and some of the proprietary systems can accommodate pressure distribution.

Combined treatment and dispersal systems were developed in New England, with initial approvals for use issuing in the early 2000s. There are a number of proprietary systems in use around the country as well as in Canada. Presently 25 states and one Canadian province allow the design and installation of combined treatment and dispersal systems. There are over 500,000 combined treatment and dispersal systems installed in North America.

Housekeeping Comments

In 252:641-1-2., some of the organizations cited have changed names over time.

- "ASTM" is now ASTM International (https://www.astm.org/ABOUT/overview.html)
- "CSA" is now CSA Group (https://www.csagroup.org/faq/)
- "NSF" is now NSF International (http://www.nsf.org/about-nsf/mission-values-history)

In 252:641-1-2., the definition of chamber includes "arch shaped", however, as successive generations of chamber design have entered the market, some chambers do not have a clearly defined arch shape, instead using a central support system, rather than an arch, to achieve the structural capacity required under IAPMO PS 63. To reflect the state-of-the-art design of chambers, we propose deleting "arch shaped", as shown below.

> "Chamber" means a molded rigid plastic, hollow structure with an open bottom area and sidewalls that are designed to allow effluent to flow into the surrounding soil while preventing soil from migrating into the chamber.

The reference to two NSF International standards in 252:641-10-2.(g) should conform with the title of the standards, as shown below (http://www.nsf.org/services/by-industry/water-wastewater/onsite-wastewater/residential-wastewater-treatment-systems). This nomenclature applies to all NSF International standards cited in the rules, which include NSF/ANSI, followed by the standard number. Some standard references include "ANSI" preceding "NSF".

> (g) Manufacturer's specification. All aerobic treatment systems shall be installed in accordance with the manufacturer's specifications and maintained as required by the most current version of NSF/ANSI 40 and NSF/ANSI 245.

Appendix C references ASTM F405, which was withdrawn by ASTM International and no longer exists (https://www.astm.org/Standards/F405.htm). ASTM F405 was replaced with ASTM F667, so the table should be updated accordingly.

Thank you very much for your review of these rulemaking comments. Please contact me at (860) 575–8099 if you have questions or additional information is required.

Sincerely,

David Lentz

David Lentz, P.E.
Regulatory Director
Professional licensure in CT, IL, NC, and NY

cc: Matt Pace, Oklahoma Department of Environmental Quality
Steve Murdock, Infiltrator Water Technologies
Dick Bachelder, Infiltrator Water Technologies

Attachment 1

Proposed Amendments to Title 252 Chapter 641

Codification through the 2012 Legislative session
Subchapters 1, 3, 9, 10 & 15; Appendix C
Board adoption - February 24, 2012
Gubernatorial approval - April 16, 2012
Legislative approval - May 2, 2012
Effective date - July 1, 2012

TITLE 252. DEPARTMENT OF ENVIRONMENTAL QUALITY
CHAPTER 641. INDIVIDUAL AND SMALL PUBLIC ON-SITE SEWAGE TREATMENT SYSTEMS

252:641-12-4. Low pressure dosing fields
(a) **Location.** All low pressure dosing fields shall be:
(1) located in the identified dispersal site;
(2) installed more than five feet (5') from the septic tank or aerobic treatment unit; and
(3) preceded by a low pressure dosing tank.
(b) **Header line.** The header pipe (i.e., the pipe between the pump tank and the manifold) shall:
(1) have a diameter the same as the diameter of the outlet of the low pressure dosing pump; and
(2) be no longer than thirty feet (30').
(c) **Total linear length.** All low pressure dosing fields shall meet the total linear length requirements set forth in Appendix H, Figures 8 and 9.
(d) **Trench length.** Each trench in a low pressure dosing field shall be forty feet (40') long.
(e) **Trench spacing.** The trenches in a low pressure dosing field shall be spaced six feet (6') apart, center to center.
(f) **Trench width.** All trenches in a low pressure dosing field shall be twenty-four inches (24") wide.
(g) **Trench depth.** Each trench in a low pressure dosing field shall have a uniform depth of at least fourteen inches (14") and no more than thirty inches (30"). The bottom of the trenches shall be level.
(h) **Dispersal and storage.** Each trench in a low pressure dosing field shall contain a zone for the dispersal and storage of effluent comprised of low pressuring dosing pipe and storage media.
(1) **Low pressure dosing pipe.** Low pressure dosing pipe shall:
(A) meet the minimum specifications listed in Appendix C;
(B) have one-fourth inch (1/4") diameter holes spaced five feet (5') apart the entire length of the pipe;
(C) extend the entire length of the trenches; and
(D) have all of the joints glued.
(2) **Storage media.** The storage media shall:
(A) be at least six inches (6") deep and at least twenty-four inches (24") wide the entire length of the trench;
(B) be installed with at least two inches (2") of the storage media above and two inches (2") of storage media below the low pressure dosing pipe; and
(C) be level:
(i) in each trench; and
(ii) across the low pressure dosing field.
(3) **Chambers.** When chambers are used, the chambers shall:
(A) have a minimum bottom width of twenty-two inches (22");
(B) have a minimum sidewall height of six inches (6") with the sidewalls having evenly distributed open space;
(C) meet the IAPMO PS 63-2019 standard;
(D) extend the entire length of the trenches;
(E) be level:
(i) in each trench;
(ii) across the low pressure field, unless installed in trenches of different elevations; and
(F) be installed according to the manufacturer's recommendations for low pressure dosing applications.

(i) **Retention structures prohibited.** Retention structures may not be used in low pressure dosing fields.
(j) **Backfill.** For low pressure dosing fields:
(1) the depth of the backfill shall be consistent and shall not vary more than four inches (4"); and
(2) the backfill shall consist of at least eight inches (8") of topsoil.
(k) **Layout examples.** There are layout examples located in Appendix K, Figure 3, and Appendix M, Figure 3.

252:641-12-5. Evapotranspiration/absorption (ET/A) fields
(a) **Location.** All ET/A fields shall be:
(1) located in the identified dispersal site; and
(2) installed more than five feet (5') from the septic tank or aerobic treatment unit.
(3) **Fall.** Unless a pump is utilized, there shall be a minimum fall of two inches (2") from the bottom of the outlet of the septic tank to the highest point of the storage media in the ET/A field.
(b) **Minimum linear length.** All ET/A fields must meet the minimum length requirements set forth in Appendix H, Figures 10 and 11. If perforated pipe is used between distribution structures and installed in accordance with the trench requirements of this Section, it may be counted as part of the overall required length of the ET/A field.
(c) **Trench length limitation.** ET/A fields shall be constructed so that no sewage flows through more than a total of one hundred fifty linear feet (150') of perforated pipe or chamber in any given path.
(d) **Trench spacing.** The trenches in an ET/A field shall be spaced at least eight feet (8') apart, center to center.
(e) **Trench width.** All trenches in an ET/A field shall be twenty-four inches (24") wide.
(f) **Trench depth.** Each trench in an ET/A field shall have a uniform depth not to exceed twenty-four inches (24"). The bottom of the trenches shall be level.
(g) **Dispersal and storage.** Each trench in an ET/A field shall contain a zone for the dispersal and storage of effluent comprised of perforated pipe and storage media or chambers.
(1) **Perforated pipe.** The perforated pipe shall:
(A) meet the minimum specifications listed in Appendix C; and
(B) extend the entire length of the trenches.
(2) **Storage media.** The storage media used shall:
(A) be at least ten inches (10") deep and at least twenty-four inches (24") wide the entire length of the trench;
(B) be installed with at least two inches (2") of the storage media above and two inches (2") of storage media below the perforated pipe;
(C) be level:
(i) in each trench; and
(ii) across the ET/A field, unless installed in trenches of different elevations.
(3) **Chambers.** When chambers are used, the chambers shall:
(A) have a minimum bottom width of twenty-two inches (22");
(B) have a minimum sidewall height of ten inches (10") with the sidewalls having evenly distributed open space;
(C) meet the IAPMO PS 63-2019 standard;
(D) extend the entire length of the trenches;
(E) be level:
(i) in each trench; and
(ii) across the ET/A field, unless installed in trenches of different elevations.
(h) **Retention structure.** Retention structures must be used between trenches of different elevations in ET/A fields. When a retention structure is used:
(1) the top of the outlet pipe of a retention structure shall be fourteen inches (14") above the trench bottom; and
(2) the line from the outlet of a retention structure to the next distribution point shall be constructed of solid pipe and shall be backfilled with compacted native soil.
(i) **Backfill.** For ET/A fields:

(1) the trenches shall be backfilled with clean sand to within two inches (2") of the ground level;
(2) the sand used to backfill the trenches shall be separated from the storage media by material that allows the flow of water but prevents the flow of sand; ~~and~~
(3) after a trench is backfilled with sand, two to four inches (2"-4") of sandy loam soil shall be mounded over the trench; ~~.~~ and
(4) when chambers are used, clean sand may be placed in contact with the chamber, without the need for a separation layer between the sand and chamber.

(j) **Layout examples.** There are layout examples located in Appendix K, Figures 1, 2, and 4, Appendix L, and Appendix M, Figure 2.

SUBCHAPTER XX. COMBINED TREATMENT AND DISPERSAL SYSTEMS

252:641-XX-1. Residential strength sewage treatment

Combined treatment and dispersal systems shall only be used for treatment and dispersal of residential strength sewage.

252:641-XX-2. General provisions

Combined treatment and dispersal systems shall be sized, designed, and installed in accordance with this subsection and an installation instructions document or design manual provided by the manufacturer that complies with this subsection.

(a) **Primary settling.** Prior to being conveyed to a combined treatment and dispersal system, all sewage must first pass through a septic tank for primary settling.
(b) **Delivery method.** All sewage shall be conveyed to the combined treatment and dispersal system through solid pipe, which shall meet the specifications listed in Appendix C.
(c) **Surface water.** Surface water shall be diverted around or away from the combined treatment and dispersal system.

252:641-XX-3. Combined treatment and dispersal system components. Combined treatment and dispersal systems shall be comprised of the following components:

(a) **Proprietary media.** A combined treatment and dispersal system includes a proprietary media manufactured from materials that are:
(1) nondecaying and nondeteriorating;
(2) a minimum of eight inches (8") in height; and
(3) capable of storing a minimum of two days of design flow.
(b) **System sand.** Medium sand shall conform to the gradation requirements described in the most current ASTM C-33 standard for fine aggregate, with a maximum of 2 percent passing the No. 100 sieve, unless a different gradation is supported by NSF/ANSI 40 Class I treatment testing or the manufacturer.
(c) **Testing and certification.** Combined treatment and dispersal systems shall be tested and certified by an American National Standards Institute-accredited third-party certifier as meeting the most current NSF/ANSI 40 standard.

252:641-XX-4. Design and installation.

(a) **Fluctuating flows.** If the daily flow fluctuates so that the flow on any given day during the week exceeds the combined treatment and dispersal systems' daily capacity, then a combined treatment and dispersal system may not be used unless a flow equalization tank, which meets the requirements of 252:641-9, is installed between the septic tank and the combined treatment and dispersal system.
(b) **Location.** All combined treatment and dispersal systems shall be located in the identified dispersal site.
(c) Combined treatment and dispersal systems may be designed and installed on sites with slopes up to 33% as detailed in Appendix XX, Figure XX. **Configuration**. Combined treatment and dispersal systems can be installed at-grade, below-grade, or above-grade in either a level or sloping configuration.
(d) **Layout.** Combined treatment and dispersal systems may be used in trench and bed configurations.
(1) **Trench spacing.** The trenches in a combined treatment and dispersal system shall be spaced at least eight feet (8') apart, center to center.

(2) **Trench width.** All trenches in a combined treatment and dispersal system shall be twenty-four inches (24") wide.

(3) **Trench depth.** Each trench in a combined treatment and dispersal system shall have a uniform depth of at least eighteen inches (18"), and no more than thirty inches (30"). The bottom of the trenches shall be level.

(4) **Bed layout.** A bed layout may be used if supported by the NSF/ANSI 40 Class I treatment testing. Proprietary device spacing shall be in accordance with spacing used in the NSF/ANSI 40 Class I treatment testing.

(e) **Horizontal and vertical separation distances**. Horizontal separation distances shall comply with OAC 252:641 and are measured from the edge of the system sand, inclusive of any sand extensions.

(f) **Minimum length.** The minimum total linear length of the proprietary media in a combined treatment and dispersal system must conform with the minimum specifications utilized in the NSF/ANSI 40 testing.

(g) **Maximum length**. The maximum length of a single row of proprietary distribution media is 100 feet.

(h) **Minimum basal area.** The minimum basal area of a combined treatment and dispersal system must meet the minimum basal area requirements set forth in Appendix XX, Figure XX.

(i) **Effluent distribution.** Combined treatment and dispersal systems may include parallel and series effluent distribution, unless restricted by the proprietary media manufacturer.

(j) **Fill material**. System sand may be used to raise the elevation of the combined treatment and dispersal to meet minimum vertical separation requirements. System sand or approved native soil shall be used to create side slopes in elevated applications.

(k) **Backfill.** For combined treatment and dispersal systems:

(1) the backfill shall consist of at least six inches (6") of topsoil;

(2) combined treatment and dispersal systems are not required to be covered with geotextile fabric, untreated building paper, or straw; and

(3) backfill shall be vegetated.

Appendix XX, Table XX – Combined Treatment and Dispersal System Minimum Basal Area

	NUMBER OF BEDROOMS IN RESIDENCE			
SOIL GROUP	**Two of Fewer**	**Three**	**Four**	**Each Additional Bedroom**
1	Prohibited			
2	200	266	332	66
2a	400	532	664	132
3	667	887	1,107	220
3a	667	887	1,107	220
4	667	887	1,107	220
5	Prohibited			

APPENDIX H. SIZE CHARTS FOR ON-SITE SEWAGE TREATMENT SYSTEMS

Figure 1. Individual Conventional Subsurface Absorption Fields Designed Using a Percolation Test

Minimum Trench Length in Feet

PERCOLATION RATE FOR DISPERSAL SITE	NUMBER OF BEDROOMS IN RESIDENCE†			
	Two or Fewer	Three	Four	Each Additional Bedroom
0-15 minutes per inch	200	270	340	70
16-30 minutes per inch	310	410	510	100
31-45 minutes per inch	420	560	700	140
46-60 minutes per inch	590	790	990	200
61-75 minutes per inch	770	1,030	1,290	260
>75 minutes per inch	Prohibited			

† These figures are based on an average flow of 6,000 gallons per month for a two-bedroom residence with an additional 2,000 gallons per month added for each additional bedroom. The size of the system should be increased if the actual or anticipated water usage exceeds this average.

~~**Figure 2. Individual Conventional Subsurface Absorption Fields Utilizing Chambers When Designed Using a Percolation Test**~~

~~Minimum Trench Length in Feet~~

~~PERCOLATION RATE FOR DISPERSAL SITE~~	~~NUMBER OF BEDROOMS IN RESIDENCE†~~			
	~~Two or Fewer~~	~~Three~~	~~Four~~	~~Each Additional Bedroom~~
~~0-15 minutes per inch~~	~~160~~	~~215~~	~~270~~	~~55~~
~~16-30 minutes per inch~~	~~250~~	~~330~~	~~410~~	~~80~~
~~31-45 minutes per inch~~	~~340~~	~~450~~	~~560~~	~~110~~
~~46-60 minutes per inch~~	~~470~~	~~630~~	~~790~~	~~160~~
~~61-75 minutes per inch~~	~~620~~	~~830~~	~~1040~~	~~210~~
~~>75 minutes per inch~~	~~Prohibited~~			

~~† These figures are based on an average flow of 6,000 gallons per month for a two-bedroom residence with an additional 2,000 gallons per month added for each additional bedroom. The size of the system should be increased if the actual or anticipated water usage exceeds this average.~~

Figure ~~3~~2. Individual Conventional Subsurface Absorption Fields Designed Using a Soil Profile Description

Minimum Trench Length in Feet

SOIL GROUP	NUMBER OF BEDROOMS IN RESIDENCE†			
	Two or Fewer	Three	Four	Each Additional Bedroom
1	Prohibited			
2	160	210	260	50
2a	250	330	410	80
3	340	450	550	100
3a	500	665	830	165
4	660	880	1,100	220
5	Prohibited			

† These figures are based on an average flow of 6,000 gallons per month for a two-bedroom residence with an additional 2,000 gallons per month added for each additional bedroom. The size of the system should be increased if the actual or anticipated water usage exceeds this average.

Figure 3. Individual Conventional Subsurface Absorption Fields Utilizing Chambers When Designed Using a Soil Profile Description

Minimum Trench Length in Feet

SOIL GROUP	NUMBER OF BEDROOMS IN RESIDENCE†			
	Two or Fewer	Three	Four	Each Additional Bedroom
1	Prohibited			
2	120	158	195	38
2a	188	248	308	60
3	255	338	413	75
3a	375	499	623	124
4	495	660	825	165
5	Prohibited			

† These figures are based on an average flow of 6,000 gallons per month for a two-bedroom residence with an additional 2,000 gallons per month added for each additional bedroom. The size of the system should be increased if the actual or anticipated water usage exceeds this average.

Attachment 2

Proposed New Title 252 Chapter 641 Appendix H Sizing Table for Chambers with Soil Profile

Attachment 2 - Proposed New Title 252 Chapter 641 Appendix H Sizing Table for Chambers with Soil Profile

PROPOSED CHAMBER SIZING: Based upon a 0.75 sizing factor compared to 252:641 Appendix H Figure 3 (below)

SOIL GROUP	NUMBER OF BEDROOMS IN RESIDENCE			
	Two of Fewer	Three	Four	Each Additional Bedroom
1	Prohibited			
2	120	158	195	38
2a	188	248	308	60
3	255	338	413	75
3a	375	499	623	124
4	495	660	825	165
5	Prohibited			

REFERENCE SIZING: Current 252:641 Appendix H Figure 3

SOIL GROUP	NUMBER OF BEDROOMS IN RESIDENCE			
	Two of Fewer	Three	Four	Each Additional Bedroom
1	Prohibited			
2	160	210	260	50
2a	250	330	410	80
3	340	450	550	100
3a	500	665	830	165
4	660	880	1,100	220
5	Prohibited			

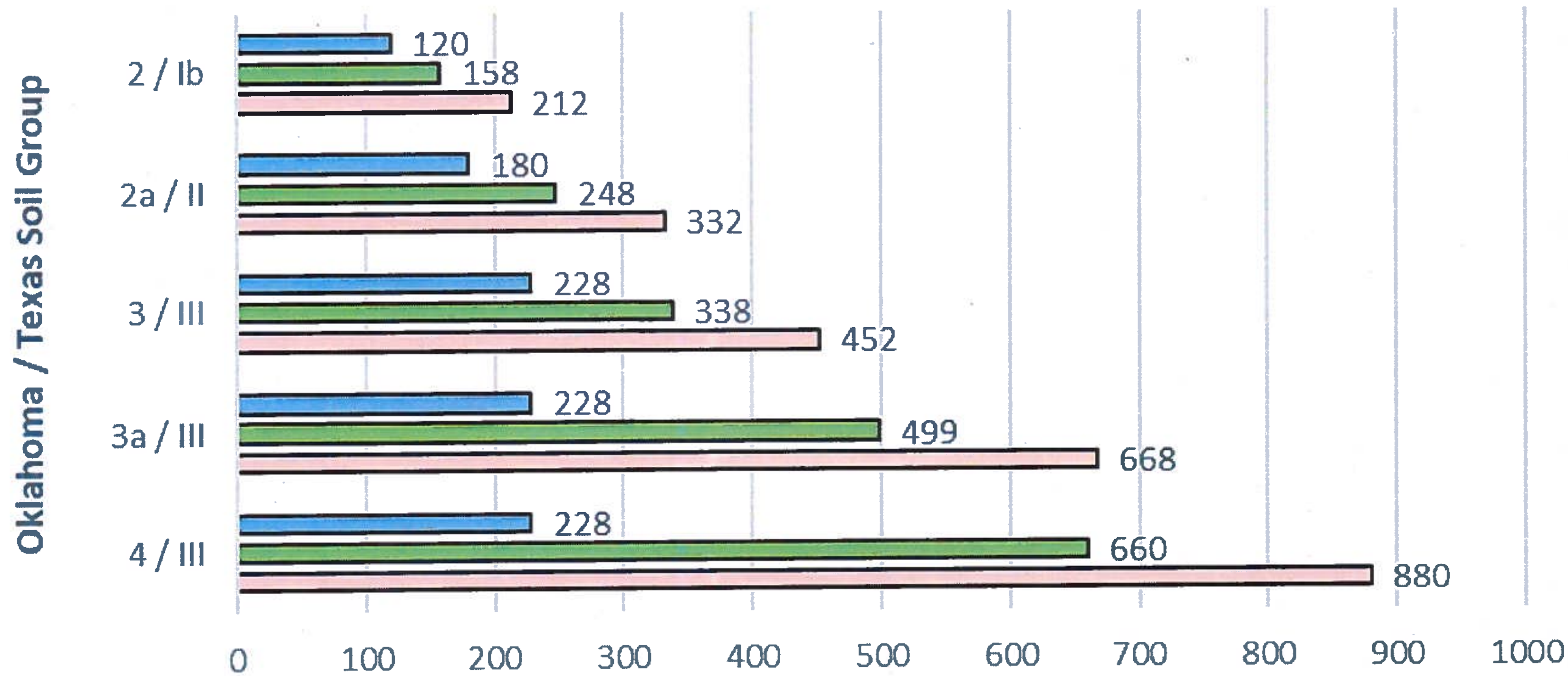
Attachment 3

Comparison of Proposed Oklahoma Chamber Sizing with Texas Chamber Sizing

Attachment 3 - Comparison of Proposed Oklahoma Chamber Sizing with Texas Chamber Sizing

			Oklahoma			Texas
OK Perc Rate (mpi)	OK Soil Group	TX Soil Class	Current Perc Test Minimum Length (ft)	Current Soil Profile Minimum Length (ft)	Proposed - 25% Reduction Soil Profile Minimum Length (ft)	Soil Profile Minimum Length (ft)
0-15	1	Ia	216	---	---	---
16-30	2	Ib	332	212	158	120
16-30	2a	II	332	332	248	180
31-45	3	III	452	452	338	228
46-60	3a	III	632	668	499	228
61-75	4	III	832	880	660	228
>75	5	IV	---	---	---	---

Attachment 3 - Comparison of Proposed Oklahoma Chamber Sizing with Texas Chamber Sizing



	4 / III	3a / III	3 / III	2a / II	2 / Ib
TX - Soil profile	228	228	228	180	120
OK - Soil profile (proposed)	660	499	338	248	158
OK - Soil profile (current)	880	668	452	332	212

Quick4 Equalizer 36 Trench Length (ft)

TX - Soil profile | OK - Soil profile (proposed) | OK - Soil profile (current)

Attachment 4

Performance Testing and Field Data – Oregon Chamber Study Report


SMALL FLOWS QUARTERLY
SF
Helping America's Small Communities Meet Their Wastewater Needs
JURIED ARTICLE
Surface Failure Rates of Chamber and Traditional Aggregate-Laden Trenches in Oregon
Flushing Out the Straight Pipes
NATIONAL SMALL FLOWS CLEARINGHOUSE

Surface Failure Rates of Chamber and Traditional Aggregate-Laden Trenches in Oregon

CONTRIBUTING WRITERS

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Abstract: A methodology for conducting failure rate studies of onsite systems was demonstrated by comparing the field performance of aggregate-free chamber systems (the treatment) with traditional aggregate-laden, rock-filled trench systems (the experimental control) in Oregon. System populations were studied in two counties stratified by physiographic province/climate (i.e., humid temperate climate and high desert climate) and soil permeability (low, moderate, and high permeability). A field assessment of a random, stratified sample of 389 treatment and control systems (average age approximately 4 years old; range from 2.9 to 5 years) was conducted during a two-week time frame to determine failure rates under the same weather conditions for both technologies. Failure was defined as surface discharge of sewage during the field survey. Surface failure rates were low—below five percent for both—and there were no statistically significant differences in failure rates between the technologies or within any of the strata.

Open-bottom concrete chambers have been used as substitutes for gravel aggregate in onsite wastewater trenches for nearly 30 years in New England (EPA, 1980). The state of Maine included chambers in their code at a 50 percent size reduction in 1974 (Dix and Hoxie, 2001). Over the past 15 years, most chambers have been arch-domed plastic chambers rather than the older concrete design. More than 700,000 chamber systems have been installed in the U.S., many with 25 percent to 50 percent reductions in the trench bottom infiltrative area (EPA, 2002).

In November 1995, the Oregon Department of Environmental Quality (ORDEQ) approved the EQ24 chamber technology as equivalent to the traditional stone aggregate trench. In Oregon, both the aggregate trench and chamber trench are 61 cm (24 inches) wide and of the same length. The traditional aggregate-laden trench in Oregon uses a 61-cm wide basal area (trench bottom) filled with 30 cm (12 inches) of aggregate. However, the EQ24 chamber has a 38-cm (15 inches) outside and 30-cm (12 inches) inside width. As a result, the exposed infiltrative basal area inside the EQ24 chamber is only 30 cm (12 inches) wide. Therefore, the exposed infiltrative basal area of the chamber system is only 50 percent of the aggregate system. While the infiltrative basal area for wastewater absorption is reduced by half, the trench length and width are the same size as in the aggregate system.

The design sewage flow rate for a new single family dwelling with between one and four bedrooms in Oregon is 450 gallons per day. This design flow rate was increased by 75 gallons per day for each additional bedroom above four bedrooms. The minimum required trench length in Oregon is determined using a sliding scale based on soil texture, thickness of effective soil depth, and depth to temporary groundwater (Table 1).

The design (bottom area) loading rates for standard systems shown in Table 1 have been calculated from the minimum trench lengths described in the Oregon Administrative Rules. As indicated earlier, the EQ24 chamber was approved as an equivalent to the 61-cm (24-inch) wide standard aggregate filled trench. Therefore, the design infiltrative basal area loading rates for the EQ24 chamber are 2.0 times the loading rates given for aggregate systems in Table 1.

While chambers have been used elsewhere for long periods of time, these systems have only been used in Oregon with the reduced infiltrative basal area since 1995. Hence, the state regulatory agency (ORDEQ) desired to determine functional performance of these systems in the state.

Field Side-by-Side Studies

Evaluation of performance of onsite technologies in the past has typically begun with rigorously controlled laboratory experiments and then moved to highly controlled side-by-side field assessments of scaled-down systems. However, for several reasons, side-by-side research assessments of pilot-scale trenches have not, by themselves, provided complete information when evaluating wastewater trench designs. Usually a side-by-side experiment is limited to one or two effluent qualities (wastewater strengths).

one soil, one design type, one or two flow rates, one contractor's method for installation, one set of operational parameters, and one climate. By controlling these factors, conclusions may be drawn, yet the results are not easy to extrapolate to other soils, wastewater strengths, installation styles, etc., unless the research is replicated at substantial cost in many different soils, a range of climates, etc.

Side-by-side tests also may be negatively influenced by soil variability within the test site. The limitations of side-by-side studies become more apparent when full-scale systems or full-scale trenches are tested, rather than just studying bench-scale units.

Soils, other than uniform sands, are so naturally variable in their characteristics that it is impossible to control random unexplained error and make direct side-by-side comparisons using side-by-side studies of full-scale trenches or systems. The trenches in such studies must be spaced far enough apart to prevent interactions with each other, thereby introducing significant soil variability.

Loudon et al. (1998) hypothesized that this soil variability introduced significant noise into the data set, such that differences within treatments were greater than differences between treatments. One method to potentially deal with such variability would be to use more replication. However, this approach would expand the research site to additional soil areas and would likely increase the amount of soil variability in the study, confounding the attempt to study treatments.

Since use of side-by-side studies is difficult, there was interest by regulators in Oregon regarding other methods to assess system function and performance. Field performance assessments of large samples of systems using rigorously controlled, random, stratified sampling is another method for assessing technology effectiveness. Such failure rate assessments provide the opportunity to test system function under the real-life range of different soils, climates, wastewater strengths, flow rates, design, installation, and operating conditions. However, such assessments must be designed to include large numbers of randomly selected systems and to utilize other sound research principles.

Purpose and Objectives

One important purpose of this paper is to demonstrate a sound methodology that others can adapt for the design and implementation of comprehensive onsite system failure rate assessments elsewhere. The primary goal of the research was to evaluate the performance of the Infiltrator Systems, Inc., Equalizer 24 (EQ24) chamber trench technology in Oregon using a failure rate assessment. Research objectives were to determine surface failure rates and to determine the factors that influenced the magnitude of failure rates.

The null hypothesis tested was whether the proportion of treatment systems (EQ24 chambers) functioning satisfactorily within the population of chamber trench systems in Oregon was equal to the proportion of control systems (traditional aggregate-laden systems) functioning satisfactorily within the population of gravel aggregate trench systems in Oregon. Satisfactory function was defined for the study as no surface discharge of sewage during the field performance assessment.

Literature Review

Onsite treatment and dispersal of domestic wastewater typically is achieved through primary treatment in a septic tank, followed by subsurface soil infiltration for final treatment and disposal of effluent. The effluent is delivered intermittently to the drainfield trenches by gravity or pressure dosing and moves through the soil into the groundwater (Crites and Tchobanoglous, 1998; EPA, 1978, 1980, and 2002; Kristiansen, 1982, Jenssen and Siegrist, 1990; and Anderson et al., 1985).

As sewage effluent infiltrates the soil at the soil/trench interface in an onsite system, soil pores may be blocked by several mechanisms, including microbiologically produced cells and slimes, chemical precipitates, solids overflow from the septic tank, and mineral fines originating from the aggregate used in rock-filled trenches. These processes collectively form a "biomat" at the soil interface and reduce the hydraulic capacity of the infiltrative surface. Biological, physical and chemical processes all influence biomat development.

In addition to contributing fines, aggregate that becomes embedded in the soil at the soil/trench interface may block soil pores, and thus reduce the area available for effluent infiltration once fines surround the aggregate or a biomat has formed (Tyler and Converse, 1985; Amerson et al., 1991; Siegrist et al., 1999; Jenssen and Siegrist, 1990; and Siegrist, 1986).

Highly controlled laboratory and bench-top scale studies and field assessments of chamber trenches and aggregate-laden trenches were conducted at the Colorado School of Mines from 1997 to 2001 (Siegrist et al., 1999; and Van Cuyk et al., 1999). The authors concluded that the hydraulic and purification performance between the two systems was comparable when a reduced-size infiltrative surface was present in the chamber technology. Theoretically, a distribution system without aggregate will have a larger infiltrative basal area and thus can accept a higher hydraulic loading rate. Joy (2001) and Burcham (2001) reviewed pertinent literature and used Darcy's Law to describe a theoretical basis for reduced infiltrative basal area with aggregate-free systems.

Failure rate studies of conventional and alternative technologies have been conducted over a 25-year period, but rarely have included chamber systems. Past assessments have measured failure rates ranging from less than 5 percent to almost 50 percent (Lindbo et al., 1998; Hoover et al., 1993; Hoover and Amoozegar, 1989; Hoover et al., 1981; and Hoover, 1979).

Failures during wet seasons typically exceeded those during dry seasons, but not always. For instance, dry-season failure rates were very high (even for young systems) when the infiltrative surface area was too small for the soil conditions (Hoover, 1979). Hoover measured failure rates of 30 to 39 percent for sand mound systems three years old and younger during a dry-season summer-time assessment in Pennsylvania.

Also, past failure rate studies have illustrated the impacts of incorporation of a proactive management program and improvement of the soil science expertise of the regulatory agency's field staff on reduction of failure rates. Lindbo et al. (1998) reported very low failure rates (≤ 5 percent) in a survey of sand-lined and traditional aggregate-laden trench systems that were very effectively sited, designed, installed, monitored, and maintained. These systems performed much better than the 12 to 20 percent failure rates measured five years earlier by Hoover et al. (1993) for systems less than five years old in the same four-county area. The major causes for the reduction in failure rates from 12 to 20 percent to ≤ 5 percent in the five-year time frame were the introduction of a public management program and improvement of the field staff's soil science expertise in the local health department.

Materials and Methods

The project was a large-scale, controlled survey of nearly 400 randomly selected onsite systems in Oregon stratified by system type, climate, and soil permeability. This research was conducted by an experienced team of onsite wastewater research scientists from The On-Site Corporation (TOC) and Cpec Environmental, Inc. (Cpec), working in conjunction with regulators from the ORDEQ and from local county onsite regulatory programs.

The first important attribute of the protocol for such a study is to conduct the evaluation independently of the product manufacturers. Therefore, the research was conducted by the third-party scientists and regulators listed above. Manufacturer's representatives were excluded from involvement in the sample selection process and did not participate on survey teams during the system performance evaluation.

Survey Areas and Research Protocol

The state of Oregon comprises three major physiographic regions: the Pacific border, the Pacific Mountain System, and the Columbia-Snake River Plateau. This study focused upon the Pacific border and the Columbia-Snake River Plateau regions, since they encompass much of the area where development has occurred and were of primary importance to the ORDEQ. These two physiographic regions have vastly different climates, ranging from a humid temperate climate with high rainfall in the Pacific border to a semi-arid, high-desert climate in the Columbia-Snake River Plateau, which is in the rain shadow of the Cascade range.

One county in each region was selected for the survey based upon criteria described by Hoover and Hinson (2002). Clackamas County, near Portland, was selected in the Pacific Border region and Deschutes County, near Bend, Oregon, was selected in the Columbia-Snake River Plateau. Hereafter, the survey areas will be referred to as West (Clackamas County, west of the Cascade range) and East (Deschutes County, east of the Cascade range).

Peer-review even of the research protocol is a second important element of properly designed failure rate studies. A peer-review process was used by Siegrist et al. (2000) to develop the Oregon research protocol. The study was designed to assess a broad range of soil conditions representing the range of soil texture groups included in the Oregon rules.

Although permeability within these texture groups can vary substantially with soil structure and other morphological characteristics, for the purposes of this study, the soils were combined into three assumed permeability groupings. Sandy soils were generally assumed to be highly permeable soils; loamy soils were generally assumed to be of intermediate permeability; and clayey, fine textured, soils were generally assumed to be low permeability soils when all other morphological factors were equal. Subsoil textures were therefore grouped into high (sand, loamy sand, and sandy loam), moderate, and low (clay, silty clay, and sandy clay) permeability categories by Hoover and Hinson (2002). This was similar to the three basic soil texture groupings used in the Oregon rules.

Population Database Construction and Sample Selection

Databases were compiled from U.S. Department of Agriculture/Natural Resources Conservation Service (NRCS) soil map databases, county-specific GIS databases, and county septic system permit files with cooperation and support from county staff and the ORDEQ (Hoover and Hinson, 2002).

Another important element in the design of field performance assessments is minimizing bias during the definition of the study population and selection of the sample from the study population. Electronic permit data for chamber systems and aggregate systems in the West and East areas were obtained from the counties and screened to eliminate systems inappropriate for the survey. These included commercial and industrial sites; sites where tanks, but not the drainfield, had been replaced; and systems with missing, incomplete, or contradictory records.

Only systems in use for three to five years were included in the population dataset. Since Oregon did not allow chamber systems until five years prior to the study, older aggregate-

Table 1 Design Loading Rates for Traditional Systems in Oregon.

	Effective Soil Depth or Depth to Temporary Groundwater = 48" or More (gpd/sf)	Effective Soil Depth = 36" – 48" (gpd/sf)	Effective Soil Depth of 24" – 36" or Depth to Temporary Groundwater = 24" – 48" (gpd/sf)	Effective Soil Depth = 18" – 24" (gpd/sf)
Soil Group A*	1.50	1.00	0.75	0.60
Soil Group B*	1.00	0.75	0.60	0.50
Soil Group C*	0.60	0.60	0.50	0.43

**Soil Group A – Sand, Loamy Sand, Sandy Loam.*
**Soil Group B – Sandy Clay Loam, Loam, Silt Loam, Silt, Clay Loam*
**Soil Group C – Silty Clay Loam, Sandy Clay, Silty Clay, Clay.*

laden systems were not included in the study population. Younger, less mature systems were also excluded from the study population.

Using geographic information system (GIS) technology, tax parcel identification numbers were used to match the county permit records with the parcel location and subsequently correlate permit records with the NRCS soils map data. Using the compiled GIS databases described above, the total population of aggregate systems and chamber systems three to five years old was established. The target size for the survey was 400 systems, with a goal of 100 of each type (chamber and aggregate) per climatic region.

The GIS overlay of systems on NRCS soils maps illustrated an uneven distribution of systems within soil permeability classes. Therefore, all sites in low permeability soils were selected from the West region, and all sites in high permeability soils were selected from the East region. Sites with medium permeability were evenly distributed between the two regions (Table 2).

Every system in each study population strata was assigned a numerically sequential number. Then, sets of random numbers were generated and used to select the study samples for each stratum from these populations. The actual number of sites selected was larger than the target sample size to account for site access problems such as an owner's refusal to participate, dogs, locked gates, "No Trespassing" signs, and uninhabited or incomplete buildings. These randomly selected sites were then assigned a unique identifier number that was used throughout the study to assure quality control during data collection, handling, and analysis.

Performance Survey Procedures

Reconnaissance of randomly selected sites was conducted in the weeks prior to the survey to improve the survey efficiency. Specifically, the reconnaissance

- located and confirmed the identification of the sites,
- determined site access from main roads,
- evaluated access to the site (e.g., uncontrolled dogs, locked gates, etc.), and
- eliminated uninhabited houses or sites where a system was installed but a house had not yet been built (a common occurrence in Oregon).

To avoid skewing data in the subsequent survey, no contact was made with homeowners. If homeowners had been contacted during the reconnaissance phase, they might have refused to allow access in the subsequent survey or in some way tried to hide a failure, thus biasing the sample.

A field survey evaluation instrument was developed with input from the ORDEQ (Hoover and Hinson, 2002). It was designed to serve as a site-specific data collection and compilation guide. Site identification information from the GIS database was electronically included, along with space for recording soils, system, and homeowner interview data. Also, system specifications and soils evaluations listed on the permit were transferred to the instrument prior to the survey. Information packets were also prepared to give to residents during the survey (Hoover and Hinson, 2002).

If the resident was home during the field performance assessment, then he/she was interviewed and the results recorded on the field survey evaluation instrument. On the other hand, if the resident was not at home, the team inserted a questionnaire and self-addressed, stamped envelope into the packet and left this material at the site.

An information packet was prepared and distributed to all the survey team members. It contained the following:

- the purpose and scope of the survey,
- criteria and definition of a failing system,
- drainfield distribution system descriptions,
- interview instructions to use when collecting data from the residents, and
- soil characterization guides (i.e., texture triangle, soil texture, and soil structure flow diagrams, and selected soil profiles from county soil surveys).

Each county was divided into six to eight districts containing approximately equal numbers of sample sites to evenly distribute the workload during the field assessment. Then a survey team was assigned to each district.

Using GIS databases and reconnaissance data, 1:24,000 maps were generated showing roads, the location of each site labeled with its unique identifier number, and routes to the sites. In addition to these hardcopy maps, handheld computers (Compaq Ipaq) linked to GPS units were used to provide real-time tracking of the team's location relative to the sites while driving. Files were organized in advance for each district with the appropriate maps, permits, and forms for the study sample included within that district.

Data Collection QA/QC Techniques

Another critical element of the study design was to utilize teams for the field performance assessment to minimize the potential for bias during data collection by any one individual. Each survey team consisted of two to three individuals who together provided substantial experience and expertise.

All teams included at least one person from a public regulatory agency (ORDEQ or local county agency) and one of the project scientists. The teams were constructed to assure that each team had experience in onsite wastewater treatment technologies as well as in subsurface investigation. Teams also were used for personal safety purposes and to facilitate quick transport from site to site.

QA/QC during data collection is an additional important element of the research design for field performance assessments. To assure consistency of data collection, the teams were trained together as a large group regarding the field data

Table 2 Distribution of 440 Randomly Selected Sites by Region, System Type, and Soil Permeability Class.

Permeability	West region Chamber	West region Aggregate	East region Chamber	East region Aggregate
High	0	0	74	77
Moderate	36	36	39	38
Low	70	70	0	0
Total	**106**	**106**	**113**	**115**

Table 3 **Distribution of 389 Viable Sites in the Study Sample.**

Region	EQ24	Gravel	Total
West	99	91	190
East	99	100	199
Total	198	191	389
Avg. Age (yrs.)	3.8	4.0	4.0
Age Range (yrs.)	2.9-4.8	2.9-5.0	2.9-5.0

collection protocol (including homeowner interview techniques) in a Monday morning meeting and subsequent field practicum evaluation of a mock site in the early afternoon. Then, teams dispersed and began data collection Monday mid-afternoon, continuing throughout the week until all sites had been properly assessed in their district.

The survey was conducted as a one-pass, single blind study; i.e., the survey teams did not know the type of system at the sites prior to the evaluations. Since a local or state regulatory agency representative was on every team, the one-pass approach (without prior contact of homeowners) was effective at facilitating site access.

If the homeowner was present when the survey team arrived at the site, then soil morphology was evaluated using a soil auger. Site suitability for an onsite system was evaluated and a determination was made as to whether the system had a surface failure. The definition of failure for this study was surface discharge of sewage on the ground surface or via a straight pipe during the field performance assessment.

If the homeowner was not present when the survey team arrived at a site, then only the most critical part of the assessment of hydraulic function (i.e., specifically the surface failure rate determination) was conducted. If the homeowner was not present during the field performance assessment, then the evaluation of the soil properties through soil augering was not conducted.

Substantial data was collected during the field performance survey including information from the following sources:

- county permit records,
- interview or questionnaire survey data from the homeowner, and
- field observations of soil and system conditions by the survey teams.

This data included the following:

- system type;
- water supply source;
- installation date;
- permit number;
- system design;
- system location;
- system inspection data from the final inspection prior to use of the system;
- as-built drawings;
- subsurface texture at the trench bottom depth (from both the permit site evaluation and from the survey team evaluation during the field assessment);
- number of bedrooms;
- number of occupants in the home;
- number of years the system has been in operation;
- problems with the system observed by homeowner;
- septic tank size;
- type of distribution/dispersal system;
- trench length, depth, and, number;
- use of pump system;
- the depth to any unsuitable soil characteristic (from both the permit site evaluation and the field performance assessment during the survey); and
- any observations of possible performance problems that were not surface discharges of sewage effluent.

A statistical approach was used to determine if the probability of observing an event for two binomial processes was the same or different (i.e., surface failure rates of chamber systems vs. surface failure rates of conventional systems). This probability was assessed by comparing the respective sample proportions (e.g., Berthouex and Brown, 1994).

The surveys were conducted in the West region during the week of February 27, 2001, and in the East region during the week of April 23, 2001. They were scheduled in advance to coincide with times of traditionally wet soil conditions and low evapotranspiration in each county, but also to avoid times when the snow pack would be expected to preclude field assessment of hydraulic function.

Results and Discussion

Study Efficiency and Sample Characteristics

Approximately one week had been allocated for each survey. Typically, five to six teams were in the field at the beginning of the week; fewer teams were operational at the end of the week.

The data collection for approximately 200 sites was completed in each region in less than a week. The site reconnaissance enhanced preparation, efficiency, clarity, and speed, which are important for logistical reasons and for quality control in data collection. The site reconnaissance facilitated efficient use of the limited time (one week per region) that the state and county regulatory staff could allocate to participate in the field performance aspect of the study.

Initially, 228 systems were chosen in the East region and 212 in the West region. About 88 percent of these systems (190 in the West area and 199 in the East area) were viable and used in the survey (Table 3).

Sites were nonviable if the residence was recently constructed or vacant and obviously not in use, if uncontrolled dogs were present, if the site was inaccessible during reconnaissance, if there was a locked gate at the driveway, or if the occupant refused to participate. Denial of site access to the survey teams was rare (10 aggregate-laden systems and 5 chamber systems) because the local regulatory authorities were present and involved in the study, and the homeowners were assured that this was a scientific study of system performance and not an enforcement survey.

There was only one site for each system type (of the 15 total sites where access was denied) where the survey teams observed (from afar) such conditions as lush vegetation or possible wet conditions over the drainfield area, indicating the possibility of surface

Table 4 Statistical Analysis of Hydraulic Function of EQ24 Chamber Systems (Treatment) Compared to Aggregate-Laden Systems (Control).

	Treatment (Chambers)			Control (Aggregate)			Total Sample		
	HF[1]	p_1	no.	HF	p_2	no.	HF	% failed	no.
Soil permeability									
High	1	0.97a[3]	39	0	1.00a	44	1	1.2	83
Moderate	0	1.00a	71	2	0.97a	74	2	1.4	145
Low	1	0.99a	88	1	0.99a	73	2	1.2	161
Region									
West	1	0.99a	99	2	0.98a	91	3	1.6	190
East	1	0.99a	99	1	0.99a	100	2	1.0	199
All systems	2	0.99a	198	3	0.98a	191	5	1.3	389

1. HF = number of hydraulically failing systems observed in a given class
2. p =sample mean of proportion of systems of a given stratum functioning satisfactorily.
3. Within a row, values followed by the same letter are not significantly different at the 95% level of confidence.

failure. Therefore, there were no indications that the sample was biased by homeowners with failing systems refusing to participate in the study.

The systems in the study sample were comparable in age (Table 3), averaging 4.0 years old.

Based upon the initial NRCS soils map data used for population stratification and sample selection, sites were fairly evenly distributed within permeability classes and system type, with a range of 60 to 70 samples per permeability/system. However, the soil permeability classifications of many sites changed after actual observation of soil texture in the field.

The NRCS soil map data was not as accurate as the field soils data collected during the survey. Therefore, field determination of soil texture (Hoover and Hinson, 2002) showed 36 percent fewer sites in the high permeability category and 30 percent more sites in the low permeability category (data for systems combined). Sites in the medium permeability category increased 7 percent.

Failure Rate Assessment

The null hypothesis tested was whether the proportion of treatment systems (EQ24 chamber systems) functioning satisfactorily (p_1) was equal to the proportion of control systems (aggregate laden) functioning satisfactorily (p_2). For this null hypothesis, the difference will have a mean of zero and be normally distributed for large sample numbers greater than 20 (e.g., Berthouex and Brown, 1994; Snedecor and Cochran, 1980). For this study "functioning satisfactorily" was defined as no hydraulic failure that resulted in sewage on the ground surface during the field performance survey or no straight pipe discharge of sewage. Hence, "failure" for this study was defined to be "surface failure" only and did not assess any potential "treatment failure" that could result in groundwater contamination.

Survey teams observed five surface failures or 1.3 percent of the total viable sites (Table 4). Three aggregate systems failed and two EQ24 systems failed. When grouped by soil permeability category, one failure occurred in the high category and two each in the moderate and low categories. When grouped by region, three failures occurred in the West region (humid temperate) and two occurred in the East region (semi-arid).

However, differences among failure rates between aggregate and chamber systems were not statistically significant when grouped by soil permeability category or region, nor was the difference significant for the entire sample (1.0 percent for EQ24 chamber and 1.6 percent for aggregate laden trenches). Therefore, the research results failed to reject the null hypothesis.

The definition of failure used was very specific; that is, surface discharge of sewage on the ground or via a straight pipe at the time of the survey. However, this definition may not have given a full picture of other problems or of system failures repaired prior to the survey. These problems included past repairs to distribution boxes, pump replacement, clogged tanks, crushed lines due to trucks driving over drainfields, homeowners (and dogs) digging into drainfields, backup of sewage into homes due to undefined causes, odor concerns, etc. Eleven to 12 systems in each region exhibited one of these problems, but did not meet the failure definition. These systems were evenly distributed between chamber (11 systems) and gravel aggregate (12 systems) designs.

Factors Influencing the Failure Rates

The extensive datasets collected from the field performance assessment, county permit files, and homeowner interviews/questionnaires by Hoover and Hinson (2002) regarding soils, site characteristics, system function, permitting, and usage indicated that the factors listed below contributed to the low failure rates observed. Our observations indicated

Table 5 Precipitation Prior to and During the Study Period Compared to Previous 38 Years Record.

West Region[1]	Sept-Feb	Dec-Feb	Jan	(survey) Feb	Mar	Apr	May
	mm						
38-yr mean	749	455	165	123	104	75	59
Study period	323	152	39	33	89	62	27
% below mean	57	67	76	74	14	18	55
East Region[2]	**Sept-Feb**	**Dec-Feb**	**Jan**	**Feb**	**Mar**	**(survey) Apr**	**May**
	mm						
38-year mean	187	122	49	25	22	17	21
Study period	103	66	4	37	12	17	0
% below mean	45	46	91	-47	44	1	100
East Region[3]	**Sept-Feb**	**Dec-Feb**	**Jan**	**Feb**	**Mar**	**(survey) Apr**	**May**
	mm						
38-year mean	369	239	94	59	47	31	27
Study period	177	122	39	33	89	62	27
% below mean	52	49	58	44	-89	-99	1

1. Data from North Willamette Experiment Station
2. Data from Bend Experiment Station
3. Data from Wickiup Dam Experiment Station

that each of these factors contributed to the low failure rates and none was singularly responsible for them.

- weather conditions,
- age of the systems,
- accuracy of soil determinations made by county staff at the initial permitting phase,
- effectiveness of regulatory enforcement programs during the system permitting and installation stages, and
- adequate wastewater absorption when the infiltrative basal area was reduced by half for chamber systems.

An important part of the study design was evaluation of both the treatment and control technology under the same weather conditions. The original intent was that the survey would occur under the most challenging weather conditions–the wet spring season.

While the survey was planned in advance and conducted during the spring, rainfall was below normal and this may have impacted the overall failure rates. However, since the comparison did provide an evaluation of the treatment and control technologies under the same weather conditions, weather was a constant, rather than variable, during the comparison of the two technologies.

Precipitation in the West region was 57 to 76 percent below normal prior to the survey (Table 5). However, soil temperature and evapotranspiration were still low in the winter/spring period compared to summer conditions. Significant rainfall did occur in the two-week period before the survey was conducted. Field observations indicated soils were moist, not dry.

Precipitation deficits prior to the survey in the East region were generally less than in the West region (Table 5). However, precipitation at the Bend Station was above normal in February and approximately normal in April prior to the survey, and above normal in March and April at the Wickiup Dam Station.

The young system age (three to five years old) may have also had an influence on the low failure rates observed. But, based upon other studies, the relatively young system age and dry weather conditions during the field assessment do not fully explain the low failure rates observed here.

Other studies of younger systems (one- to three-year-old mound systems) during the dry season in Pennsylvania showed much higher failure rates (e.g., 30 to 39 percent) than observed here when the drainfields in Pennsylvania were too small for the soil conditions (Hoover, 1979; Hoover, et al., 1981). Therefore, based upon past experience, if the chamber systems in the current study had been too small for the soil conditions in Oregon, one would expect to observe higher failure rates than the 1 to 2 percent rates observed here, regardless of the young system ages and dry conditions during the assessment. This is a pertinent issue because of the 50 percent reduction in infiltrative surface basal area sizing used for the chamber trenches in this field study.

The low failure rates observed were unusual but not unprecedented, as seen from earlier results by Lindbo et al. (1998), where failure rates were ≤ 5 percent. This is pertinent to the current study because implementing soil science expertise in the regulatory permitting staff was one primary factor causing the reduction of the 12 to 20 percent failure rates observed earlier by Hoover et al. (1993) to the ≤ 5 percent rates observed by Lindbo et al. (1998) in northeastern North Carolina.

In the current study, soil morphological characteristics and site suitability were observed at many of the study sites during the field performance assessment. These were compared to

Table 6 Minimum Length of EQ24 Chamber Trench Required for Four Bedroom Homes.

State	Length of Equalizer 24 Chambers Required for a 4 Bedroom System (feet)	State Soil Description	Equalizer 24 Approval Description
Oregon	300	Soil Group B	Equivalent to 24" Aggregate Trench
Maine	234	Medium	4.0 square feet/ linear foot
Idaho	333	B-2 (Loam, Silt Loam)	Equivalent to 24" Aggregate Trench
Kentucky	346	Soil Group 2 - Loam	Equivalent to 24" Aggregate Trench
New York	433	30 mpi	Equivalent to 24" Aggregate Trench
Illinois	464	30 mpi	2.5 square feet/ linear foot

the soil/site conditions determined by the county regulatory agency during permitting of the systems studied. Soil morphology and site suitability were evaluated during the field performance assessment at 164 sites–83 in the West region and 81 in the East region. The soil/site suitability decisions made by county regulators during the initial system permitting in Oregon were accurate and matched the survey teams soil assessments determined during the field performance assessment.

Observations indicated that soil/site assessments during permitting in Oregon were superior to soil/site assessments conducted during system permitting in Pennsylvania and North Carolina in earlier studies by Hoover (1979), Hoover and Amoozegar (1989) and Hoover et al. (1993). Therefore, the highly accurate soil/site assessments during system permitting likely also contributed to the low failure rates observed in Oregon.

One reason that may explain the highly accurate permit site assessments in Oregon was the training and expertise required for those conducting site evaluations for onsite systems. County and state personnel in Oregon who conduct site evaluations and issue permits are required to have 10 college credits in soil science, including a soil morphology and genesis course. Many of the county permitting staff in Clackamas and Deschutes Counties were even more highly trained than generally required in Oregon, being soil scientists, some with advanced degrees.

Electronic records and high-quality field procedures and permitting practices contributed to the low failure rates in Oregon. The survey showed that systems were invariably installed in the correct location on the lot; i.e., in the suitable soil that was initially permitted for use. Permitting records showing numerous construction corrections dictated during final inspection indicated that the county staff assured that installation was correct before the system was approved for use.

Also, "as-built" plans were attached to all permits. None of the failures were attributed to unsuitable soils or installation errors. Conducting the surveys in regions with excellent regulatory programs and well-trained site evaluators assured a truer evaluation of the technology by minimizing other sources of variation.

Actual wastewater flows were not measured for the nearly 400 systems that were evaluated for the following reasons. First, a large number of systems (e.g. 389) were randomly selected from the perspective of water use and wastewater loading. Therefore, the water use and wastewater loading tested in this study represented the realities of water use and wastewater loading (from low water use to high, excessive water use) by the suburban and rural population using onsite systems in Oregon. This assured that the study sample evaluated the real life potential for system failure at the same water use rates that would be expected to occur in the population of onsite systems in Oregon.

Second, because so few systems were failing and water for most houses was obtained from private wells that were unmetered, the collection of actual water use data was not worth the additional effort of installing water meters at all of the homes not already instrumented by the water utility. However, the occupancy of the homes served by both technologies was assessed in the interview/questionnaire process. This data revealed that there was no difference in occupancy or system age between the two technologies. Aggregate-laden systems averaged 2.9 occupants per home (s.d. 1.3), while chamber systems averaged 3 occupants per home (s.d. 1.5). Since occupancy was the same, it is reasonable to assume that water use was likely to be similar for both systems types that were studied.

Finally, it is important to recognize that the random selection process for choosing the sample assured that systems operating at design capacity had equal chance of being included in both the samples for the chamber and aggregate-laden trenches.

Each surface failing system was evaluated with the Failure Analysis Chart for Troubleshooting Septic Systems (FACTSS) method described by Adams et al. (1998) to determine the most likely causes of failure. This analysis determined that the failures observed were primarily due to poor operation and maintenance (O&M) at the sites of failing systems. Excessive water use in the home could not be ruled out as also possibly being a contributing factor to the failures since the systems were served by unmetered private wells.

However, the O&M problems observed were substantial enough to be identified as a primary cause of failure. For example, poor operation and site maintenance included landscaping of a sloping area exposing a trench, construction in a drainfield area disturbing the trenches, driving on a drainfield area causing ruts over and into the trenches, horses digging into a drainfield trench, and animals walking over a drainfield area repeatedly next to a fence in a pasture. Therefore, poor operation and site maintenance by the homeowner (i.e., not following typical O&M procedures, such as those described by Hoover, 1997 and Hoover and Hammer, 1994), even in the short-term for systems five years old and less, were determined to be the principal causes of the failures observed.

All of the failures were a result of poor operation and maintenance and none were related to reduction in infiltrative basal area or to inappropriately assigned loading rates or misevaluation of suitability of the soils by the regulatory authorities during the system siting, design, and permitting process. In Oregon, the EQ24 chamber (effective inside diameter of 30 cm not including the feet of the chamber) is sized with the same trench length as the 61-cm wide aggregate trench. Therefore, if a comparison is made of the infiltrative surface basal areas, the EQ24 chamber basal area is one-half that of aggregate trenches. There was no apparent increase in surface failure rate for the chamber systems in Oregon due to this 50 percent reduction of the infiltrative basal area.

Oregon rules adjusted design loading rates using a sliding scale based upon soil texture, effective soil depth, and depth to temporary groundwater. The deeper the soil and groundwater, the higher the loading rate used for soils of a given texture.

This approach accounted, in part, for differences in the lateral flow capability at the sites. That is, a loamy soil (Group B in Oregon rules) had an effective loading rate that ranged from 2 cm/d (0.50 gpd/ft^2) to 4 cm/d (1.0 gpd/ft^2) with an effective soil depth between 45 and 60 cm and greater than 120 cm, respectively. This sliding scale for system sizing could account for increased lateral flow capability through the soil downslope from the system at sites where limiting conditions are deeper in the soil. Thus, the Oregon rules address linear loading rate issues described earlier by Tyler and Converse (1985) and shown graphically by Hoover and Hinson (2002) and Hoover (2001).

The required EQ24 trench length for a four-bedroom system in various states is shown in Table 6. In each case, the system size in Table 6 was determined for a soil similar to an Oregon Group B soil (sandy clay loam, loam, silt loam, silt, or clay loam) with an effective soil depth of at least 36 inches. The total required trench lengths for EQ24 systems in Oregon was generally smaller than required for four bedroom homes in other states (Table 6). It follows that the results of this study could be extrapolated to other states where sizing of the chamber technology is at least as large as the trench lengths used in Oregon for similarly sized homes, assuming comparable soils are used and high-quality regulatory programs are in place.

Summary and Conclusions

The results of this study showed no significant difference in the surface failure rate of Infiltrator Systems, Inc. EQ24 aggregate-free chamber systems compared to conventional aggregate-laden systems. Failure rates were less than 2 percent for both systems. Of the failures that were observed, none appeared related to the reduction in the infiltrative basal area, but were primarily related to poor site maintenance. No relationship was detected between system failures and climate/physiographic region or soil permeability factors.

By evaluating such a large number of randomly selected systems, the study assured that the results were meaningful in the field and that the sample included a broad range of installation and operation characteristics. The systems were studied in two dramatically different climates, represented three large soil permeability groupings, and included almost 400 mature systems three to five years old. Using a large sample also increased the likelihood that a broad range of wastewater strengths, flow rates, family sizes, landscape positions, and designs were encountered during the field evaluation. Overall, failure rates for both technologies might be greater under wetter conditions, but there was no indication that wetter conditions would influence one technology more than the other.

This study provided an independent, third-party research assessment of whether Infiltrator Systems, Inc.'s EQ24 chamber system in Oregon performed equivalent to the traditional aggregate-laden technology after three to five years of operation. This study provides one building block in a foundation of knowledge regarding real-life performance of chamber technology outside the laboratory. These data should be placed within a foundation of scientific studies that includes other research such as laboratory studies and side-by-side field research, such as that conducted by Siegrist and others.

While the current study has provided important data, further research will be help determine long-term performance. Therefore, in the spirit of the scientific process, we recommend that this study be replicated at the same sample sites periodically over time (perhaps every three to five years) during the next 20 to 30 years and at other locations in the country using similar failure rate research designs. Such a research effort will determine if the data obtained here is reproducible elsewhere under other field conditions and whether failure rates remain low as the systems mature further and are evaluated under wetter weather conditions.

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We also appreciate the assistance of homeowners who allowed us to evaluate the performance of onsite wastewater systems at their homesites.

Finally, we acknowledge the project funding agencies, Environmental Studies Group and Infiltrator Systems, Inc., for funding such a broad-scale, independent, third-party research study of both chamber and traditional aggregate-laden septic systems across two divergent climatic zones.

Note that while we appreciate the assistance of these individuals, organizations, and funding agencies, the views expressed in this paper are those of the authors and are not those of the collaborators mentioned, their institutions or the funding agencies.

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Attachment 5

Performance Testing and Field Data: 2005 North Carolina Chamber Study Report

State of North Carolina
Department of Environment and Natural Resources
Division of Environmental Health

Michael F. Easley, Governor
William G. Ross, Secretary
Terry L. Pierce, Director

NCDENR

Performance of Chamber Systems Compared to Conventional Gravel Septic Tank Systems in North Carolina

INTRODUCTION

Recent legislation in North Carolina provides for the designation of approved Innovative on-site wastewater systems as accepted systems. The legislation was supported by Innovative product manufacturers because of a perceived stigma attached to Innovative designation of their product, and real permitting differences for Innovative products compared to conventional gravel systems, which were required by the state. Additional funds came from a grant awarded to the On-Site Section from the EPA 319 Non-Point Source Pollution Program. This effort demonstrated a partnership of private and public entities in the effort to evaluate these products and protect the public. The legislation requires that the manufacturer of a system must submit evidence that the system has been in general use in the state for 5 years. In addition, the manufacturer shall provide the Commission for Health Services with information sufficient to enable the Commission to fully evaluate the performance of the system in this State for at least the five-year period immediately preceding the petition. Rule was subsequently developed which established the requirements for what constituted "sufficient information" for the Commission to make their evaluation. For trench systems, the Rule requires "the field evaluation of at least 250 randomly selected innovative systems compared with 250 comparably-aged randomly selected conventional systems, with at least 100 of each type of surveyed system currently in use and in operation for at least five years. Systems surveyed shall be distributed throughout the three physiographic regions of the state in approximate proportion to their relative usage in the three regions. The survey shall determine comparative system failure rates, with field evaluations completed during a typical wet-weather season (February through early April), with matched innovative and conventional systems sampled during similar time periods in each region" (NCDEHNR. 2006).

Infiltrator, Inc., which manufactures a chamber system, and Ring, Inc., which manufactures a polystyrene aggregate system, subsequently applied for accepted system designation. A special provision within the law allowed either company to be granted accepted system status provided the comparative survey required in the Rule was completed within 2 years of accepted system designation. Results of the survey needed to show that there was no greater than a 5% difference in the failure rate of the innovative product compared to conventional gravel systems in order for the product to retain accepted system designation.

In addition to Infiltrator, three other chamber manufactures chose to participate in the survey, PSA, Inc., manufacturer of the Bio-diffuser chamber, Cultec, Inc., manufacturer of the Contractor Model chamber, and Hancor, Inc., manufacturer of the Envirochamber.

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Background

The chamber systems surveyed in this study were the standard design and had an average open bottom width (in) about 29 inches. The polystyrene aggregate systems surveyed were the EZ1203. The North Carolina approval for the both the standard chamber and the EZ1203, allows for a 25% reduction in trench length compared to a conventional gravel trench system. Other trench requirements for chambers are the same as for conventional systems. Trenches are dug with a 3-foot width, and placed on 9-foot centers, if multiple trenches are required.

Methods and Materials

The Rule required that a survey be conducted, which was to be able to detect if the failure rate, for the standard chamber or EZ1203 systems, was 5 or more percentage points higher than the failure rate for conventional systems. Further, if the comparison showed a difference of at least 5 percentage points (e.g. 9% failure rate for innovative system A and a 4% failure rate for conventional gravel systems), there should only be a 5% chance that the difference between the two samples would occur by chance. This is the "95% confidence level". If a statistically significant higher failure rate was not detected in the innovative group, than the conclusion would be that the innovative system performs the same as or better than conventional systems. This is a "one sided" test of the difference between proportions.

Preliminary analysis by Dr. Paul Beuscher with the State Center for Health Statistics revealed that, a sample size of 300 was needed for each type of system surveyed, in order to conclude with a 95% confidence that a measured failure rate for an innovative system that is 5 percentage points higher than the failure rate for conventional systems is not due to chance. The calculation of required sample size assumed that the samples have an 80% "power" to detect a **true** difference of 5 percentage points. This sample size estimate also assumed an overall septic tank failure rate (across all system types for 5-9 year old systems) in the range of 5%. It was determined that a sample size of 300 for each system would result in valid analysis, regardless of the total number of systems (population) from which the sample was chosen. It was recommended though that the sample selected might need to be slightly larger to allow for sites at which failure status could not be determined, such as inaccessible sites.

It was determined that systems from each of the three physiographic regions must be included in the survey in order for the results to be valid, since soils vary by region of the state. Two counties were chosen in each of North Carolina's physiographic regions (Mountains, Piedmont, and Coast Plain) for the purpose of conducting the required comparison of system performance. The six counties surveyed were selected on the basis of being representative of the region and the fact that they had a good system of record keeping for septic tank system permits. Further, counties were chosen that were known to have large numbers of each system type, so that it would be likely that a statistically valid sample could be drawn from the records for each system type. Since the total sample size for each system type was required to be at least 300 and there were 6 counties chosen, at least 50 systems were selected from each county for the survey. The

Counties chosen were Alamance (Piedmont), Buncombe (Mountain), Henderson (Mountain), Lincoln (Piedmont), Onslow (Coast) and Wilson (Coast).

A retired employee formerly with the NC Division of Environmental Health, whose primary responsibilities before retirement involved restaurants, was retained to draw a random sample of the required size from each county. This person was chosen because he was familiar with Health Department records, but had not been involved with the permitting of chamber or EZ1203 systems, in order to avoid a possible source of bias in the sample selection. The available records for each type of system were assigned a number. Records were than drawn on the basis of a random number generator until the required number of systems to be inspected was achieved.

A team of third party inspectors, *unaffiliated* with the NC On-Site Wastewater Section or the product manufacturers, was hired to visit each system for which a record was randomly drawn. The inspectors were Environmental Health students from Western Carolina University under the supervision of Dr. Burton Ogle from WCU. The students were trained to inspect septic tank systems by a former employee of the NC Wastewater Discharge Elimination program now with Western Carolina, whose primary responsibility had been the identification of failed septic tank systems in need of remediation. Systems were surveyed from March through April of 2005, in an effort to inspect systems during a time when the most failures are normally recorded and control seasonal effects on failure rate. Each system was inspected by two members of the survey team. Only houses, which were known to be occupied, were inspected.

The following questions were answered with a yes or no by the survey for each system inspected:

1.) Is sewage ponded on the surface?
2.) Does pressure to the soil surface with a shoe result in sewage coming to the surface?
3.) Is there straight pipe?
4.) Is there evidence of past failure
5.) Is there evidence of a repair?

In addition, an attempt was made to interview the occupants at each survey site in person or by phone. Answers to the following questions were obtained during the interview:

1.) Has your tank been pumped for other than routine maintenance?
2.) Are you having any of the following problems with your system today: surfacing on the ground; wet over system; odors; back up into the house; other?
3.) Have you had problems with the system in the past: surfacing on the ground; wet over system; odors; back up into the house; other?
4.) How was the problem solved?
5.) Has system been repaired or replaced?

A yes for one or more of the above questions answered by the survey or the occupant was considered to be a system failure. More information was collected, but was not used to determine system failure.

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Literature about septic system management and homeowner tips provided by the 319 grant was distributed to each household. Optical brightener tests were conducted to see if the "wetness" was sewage related. This turned out to be positive in most cases.

Results and Discussion

A total of 912 systems were inspected, 303 chamber systems, 306 EZ systems and 303 gravel systems. Interviews were completed with 370 of the occupants. The survey sample contained 290 sites from the Coastal Region, 317 sites from the Piedmont region and 305 sites from the Mountain region. The survey sample had the following age distribution: 307 systems were 2 to 4 years old, 377 systems were 5 to 7 years old, and 228 systems were 8 to 12 years old. No systems older than 12 years were included in the survey because neither the chamber nor EZ1203 were approved in the state at that time.

The following survey results were obtained.

Table 2. System failure rate for conventional gravel, chamber systems, and EZ1203 systems.

System Type	Systems OK	Systems Failed	Total	Percent Failure
Gravel	281	22	303	7.3
Chamber	277	26	303	8.5
EZ1203	277	29	306	9.5
Total	835	77	912	8.4

The statewide failure rate was 7.3 % for conventional gravel systems, 8.5% for chamber systems and 9.5% for the EZ1203 systems. The difference in failure rate between the conventional and chamber systems was 1.2%. The difference in failure rate between the conventional and EZ1203 systems was 2.2%. The purpose of this survey was to determine if there was a 5% difference in the failure rate of chamber systems compared to conventional gravel systems. Statistical analysis was performed controlling for both physiographic region and age of system. At a 95% confidence level, the null hypothesis of no difference in failure rate could not be rejected for the chamber or EZ1203 system compared to the gravel system, based on the data collected. In laymen's terms, we would say that the chamber and EZ1203 performed the same as gravel when compared on a statewide basis.

Dominant soil texture, upon which LTAR is assigned for system design, varies by physiographic region of the state. In the Coastal region, the two dominant soil groups are sands and fine loams. The most limiting factor to the performance of septic tank systems is often depth to the seasonal high water table. In the Piedmont region, the two most dominant soil groups are fine loams and clays. Soil depth and slowly permeable soils are often the most limiting factors to system performance. In the Mountain region, coarse loams and fine loams are the dominant texture groups. Shallow soil depth and steep slopes are often the most limiting factors to system performance. To see if there was a difference in performance by region given the identified dominant site differences, the data was further analyzed by physiographic region of the state (Coastal Plain, Piedmont or Mountains). An insufficient numbers of sites were surveyed to statistically compare the performance of each system type by region. The data was therefore grouped by region without regard for system type to make the regional comparison. The results are given in Table 3.

Table 3. System failure rate by physiographic region disregarding differences in system type.

Physiographic Region	Systems OK	Systems Failed	Total	Percent Failure

Coast	256	34	290	11.7
Piedmont	286	31	317	9.8
Mountain	293	12	305	3.9
All Regions	835	77	912	8.4

The failure rate for all systems combined was highest in the Coast at 11.7, and lowest in the Mountains 3.9%. In the Piedmont area the failure rate was similar to the Coast at 9.8%. The difference in failure rate when the mountains region is compared to both the Piedmont and Coast region was statistically significant at the 95% level. The significant effect of region might be explained in as follows. Most systems in the mountains are long and narrower. This factor in conjunction with slope ranging in excess of 25% promotes efficient movement of sewage away from the drain field, e.g. low linear loading rates, and better system performance.

The data was also analyzed to see if there was a difference in system failure rate as systems aged. System performance is summarized in the Table 4 below for three age groups: 1.) 2 to 4 years old, 2) 5 to 7 years old, and 3.) 8 years to 12 years old.

Table 4. System failure rate by age group disregarding differences in system type.

System Age	Systems OK	Systems Failed	Total	Percent Failure
2 to 4 years	283	24	307	11.8
5 to 7 years	351	26	377	7.4
8 to 12 years	201	27	228	13.4
All Ages	835	77	912	8.4

When data for all system types was aggregated within an age group and the aggregated data compared by system age,, the failure rate was higher for the 2 to 4 year old systems (11.8%) compared to the 5 to 7 year old systems (7.4%), and higher for the 8 to 12 year old systems (13.4%) compared to the 5 to 7 year systems (7.4%). The differences between the age groups, while controlling for system type and physiographic region, were statistically significant at the 95% level. It is relatively easy to understand why the oldest systems would have a failure rate higher than the middle-aged systems, because clogging of the trench can be expected to increase as more sewage is disposed in the trenches over time. It is harder to provide an explanation for why the youngest systems had a statistically higher failure rate than the middle-aged systems. One possibility may be the following. We have seen smaller lot sizes in recent years with larger houses, as developers try to maximize density and profit. Because of the increased housing density, there is often more site disturbance in the designated septic system area, due to contractors who deliver materials such as bricks and lumber to the site. Further, there is more impervious surface per lot, as the ratio of roof and driveway to open space on the lot gets smaller, which tends to make the remaining open space wetter. Both site disturbance and wetter site conditions would result in poorer system performance. We have no factual information from the survey to support this hypothetical explanation, though.

Finally, it is interesting to note that the average failure rate state-wide is 8.4% for systems with an age up to 12 years old. There is much speculation about the failure rate of ground absorption septic tank systems, with little or no substantive information to support the speculation. Perhaps a side benefit of this survey will be a defensible failure rate upon which to base future discussions.

Summary

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The purpose of this survey was to determine if there was a 5% difference in the failure rate of chamber and EZ1203 systems compared to gravel. Based on the data collected, the null hypothesis of no difference in failure rate could not be rejected for the chamber compared to gravel. In laymen's terms, we would say that the chamber and EZ1203 systems performed the same as gravel.

References

NCDENR. 1977. Laws and Rules for Sewage Treatment and Disposal Systems. Department of Environment and Natural Resources, Division of Environmental Health, On-Site Wastewater Section, 1642 Mail Service Center, Raleigh NC 27699-1642
http://www.deh.enr.state.nc.us/osww_new//index.htm

Attachment 6

Performance Testing and Field Data: 2019 North Carolina Chamber Study Report by the North Carolina Center for Health Statistics

Data Analysis Summary:

The Infiltrator Water Technologies, Inc. (IWT) filed a petition for Accepted System status, for their 22-inch chamber products (Equalizer 36 and Quick4 Equalizer 36 models). G.S. 130A-343(h) requires the manufacturer to provide enough information to evaluate the system performance in North Carolina for the five years preceding the petition. A statistically valid field survey was conducted following an accepted protocol to evaluate performance of the product.

It is required that on-site systems using products for which Accepted status is being sought be compared to conventional (gravel) systems or other accepted products of similar age. In this study, IWT's product was compared to available conventional systems, augmented by accepted systems to complete a statistically valid survey. A total of 657 randomly selected systems were surveyed to evaluate field performance of IWT's systems (Table 1). The survey sample contained 622 sites from the Mountain Region, 32 sites from the Piedmont Region and 3 sites from the Coastal Region. Age of the systems were categorized into three groups: 2 to 4 years old, 5 to 7 years old and 8 years or older. More than half (58.3%) of the survey samples were 8 years or older, 11.4% of the systems were 5 to 7 years older and 30.3% of the systems were 2 to 4 years older.

Table 1. Distribution of system type by region.

System Type	Insert			Total
	Coast	Piedmont	Mountain	
22" Chamber	1 (0.34%)	5 (1.72%)	284 (97.93%)	290
Accepted/Conventional	2 (0.54%)	27 (7.36%)	338 (92.10%)	367
Total	3	32	622	657

During the day of survey, a total of 9 (two IWT's product and seven conventional/accepted) systems were found to be Malfunctioning (Table 2). The overall statewide failure rate was 1.37%, 22-inch chamber product failure rate was 0.69% and conventional/accepted systems failure rate was 1.91%. The purpose of this survey was to determine if there was a difference in the failure rate of 22-inch chamber systems and accepted/conventional systems.

Table 2. System failure rate for 22" chamber systems and combined conventional and accepted systems.

System Type	Status of Systems		Total	Failure Rate (%)
	Working	Failing		
22" Chamber	288	2	290	0.69
Accepted/Conventional	360	7	367	1.91
Total	648	9	657	1.37

The Division of Public Health, State Center for Health Statistics performed a statistical analysis of the survey results. The null hypothesis is there is no association between system type and failure rate. Fisher's exact right-sided test was run to analyze whether the probability of failure rate of the 22-inch chamber system exceeds the probability of failure rate in the accepted/conventional system. Because the p-value (0.12) measured is greater than 0.05 we accept the null hypothesis. Fisher's is a better test when some of the expected values are small (<5) http://www.biostathandbook.com/fishers.html.

Based on the data collected, the statewide failure rate of the 22-inch chamber system of 0.69 (range 0 to 1.6%) compared to the accepted/conventional system failure rate of 1.91% (range 0.5 to 3.3%) was not statistically significant at a 95% confidence level.

Since nearly all systems sampled were in the mountain region, any differences in how the systems may perform based on where they are installed cannot be measured.

The conclusion of this field survey, pursuant to the 15A NCAC 18A .1969(h)(5)(B), is that IWT's 22-inch chamber product performs the same or better than accepted/conventional systems.

Attachment 7

California Onsite Wastewater Treatment System Policy Peer Review – Dr. Jorg Drewes

May 1, 2012

ATTACHMENT 2: SCIENTIFIC ASSUMPTIONS, FINDINGS AND CONCLUSIONS TO BE ADDRESSED BY PEER REVIEWERS

The statute mandate for external scientific peer review (Health and Safety Code Section 57004) states that the reviewer's responsibility is to determine whether the scientific portion of the proposed rule is based upon sound scientific knowledge, methods, and practices.

We request that you make this determination for each of the following assumptions, finding and conclusions that constitute the scientific portion of the proposed regulatory action. An explanatory statement is provided for each issue in order to focus the review.

An important caveat should be noted for the reviewers. The vast majority of existing OWTS are conventional systems (septic tank and dispersal system).

1. **It is reasonable to use expected waste strength as a trigger for submitting a report of waste discharge (State permit application) and for determining the necessary approach to direct State regulation and oversight through waste discharge requirements.**
   These regulations establish an upper limit for wastewater organic and solids strength due to concern for the performance and operating longevity of the dispersal field. Sections 2.4, 2.6.6, and 6.1.2 of the Policy allow commercial facilities that have an OWTS with biochemical oxygen demands (BOD) less than 900 mg/L provided that those facilities also have a grease interceptor. Other commercial OWTS with wastewater having a BOD greater than 900 mg/L and/or not having a grease interceptor would have to file for a separate waste discharge permit or waiver thereof.

<u>Reviewer Comment:</u>
The proposed trigger level for waste strength discharge is reasonable. The justification provided is sound.

2. **Use of the design flow as a trigger for submitting a report of waste discharge (State permit application) and for determining the necessary approach to direct State regulation and oversight through waste discharge requirements is reasonable.**

   Experience shows that larger OWTS (greater than 3,500 gallons-per-day) are more likely to fail than smaller ones and are best limited to design flows of less than 6,000 gallons-per-day (Plews et al. 1985). The Policy Section 2.6.2 would require that OWTS owners with new or replaced OWTS notify the regional water board if the flow rate is in excess of 3,500 gallons-per-day and if the system is not specifically allowed by a local permitting agency in the local agency management plan. The Policy Sections 2.6.3, 6.1.1 and 9.4.2

would require all existing OWTS owners not covered by an existing waiver or waste discharge requirements notify the regional water board if the flow rate is in excess of 10,000 gallons-per-day. The regional water board would then determine whether it would issue specific waste discharge requirements or a waiver that may be more stringent than required by the proposed regulations to guarantee protection of water quality.

Reviewer Comment:
The proposed design flows are reasonable and representative of commonly used OWTS systems.

3. **A site evaluation is required in Tier 1 (Section 7 of the proposed Policy) to determine that adequate soil depth is present in the dispersal area. Soil depth would be measured vertically to the point where bedrock, hardpan, impermeable soils, or saturated soils are encountered or an adequate depth has been determined.**

   Soil is the primary media that treats wastewater from OWTS. It also serves as the receiving environment and ultimate assimilation point for the wastewater volume that is passed from the structures through the OWTS. Bedrock, hardpan, impermeable soils, and saturated soils do not provide a porous media to provide adequate treatment to safely dispose wastewater with surety of proper treatment and disposal.

Reviewer Comment:
A site evaluation to determine the adequate soil depth is appropriate.

4. **A site evaluation for seasonal groundwater is required in Section 7.3 using one or a combination of the following methods: direct observation of the highest extent of soil mottling observed in the examination of soil profiles, direct observation of groundwater levels during the anticipated period of high groundwater, or other methods, such as historical records, acceptable to the local agency. Where a conflict in the above methods of examination exists, the direct observation method indicating the highest level shall govern.**

   All the prescribed methods are valid methods to determine seasonal high groundwater, with the most valid method being direct observation during the time that groundwater is most likely to be expected at its seasonal high level. This is because direct observation conclusively indicates actual groundwater levels.

Reviewer Comment:
All proposed methods are valid methods to determine or estimate groundwater levels.

5. **Section 7.4 requires that percolation test results in the effluent disposal area shall not be faster than one minute per inch (1 MPI) or slower than ninety minutes per inch (90 MPI) because of problems associated with allowing OWTS on soils that exhibit faster percolation rates than 1 MPI and slower than 90 MPI. All percolation rates shall be based on actual or simulated wet weather conditions by performing the test during the wet weather period as determined by the local agency or by presoaking of percolation test holes and shall be a stabilized rate.**

   In OWTS, soils provide both treatment and disposal of the wastewater. If soils percolate the wastewater too quickly, insufficient treatment of the wastewater can occur before entering groundwater. However, if the soil percolates too slowly, the soil may not be able to accept all of the wastewater and the wastewater may subsequently surface and pose a condition of nuisance or pollution. A commonly allowed acceptance rate is between 1 and 120 MPI. As such, the allowable interval proposed in the Policy is conservative towards protection from surfacing. Presoaking the percolation test hole helps to stabilize the rate at which soils absorbs the water and helps to estimate the long-term acceptance rate.

Reviewer Comment:
In section 7.4 and other sections of the draft policy, percolation rates are expressed in "minute per inch" (MPI). This is not correct, since an infiltration rate should be expressed as "volume per area and time" rather than "time over volume per area or distance". Thus, percolation rates in Table 1 should be expressed in inch/minute or cm/day.

Limiting the percolation rate in OWTS by defining a minimum and maximum percolation rate is very appropriate to avoid ponding and appropriate retention time in the porous media. The range of recommended infiltration rates are appropriate (1-120 MPI), but should be expressed in units of inch/minute or cm/day.

6. **Section 7.5 stipulates minimum horizontal setbacks as follows:**

   a. **5 feet from parcel property lines.**

      This setback is designed to protect the septic tank and dispersal system. Surcharges due to soil loads associated with structures can damage an OWTS. The default assumption for surcharges in building codes usually establishes a zero surcharge load when the structure on the soil is two times the distance of the depth of the cut. Setting OWTS away from the property lines helps assure that surcharges on an OWTS will be minimal, if not zero, since OWTS are usually not very deep and structures often have their own setback from property lines.

Reviewer Comment:
The suggested set-back is appropriate and the provided justification is sound.

b. 100 feet from water wells and monitoring wells, unless regulatory or legitimate data requirements necessitate that monitoring wells be located closer.

OWTS are identified as a possible contaminating activity (PCA) for groundwater (CA DHS 1999). OWTS contamination of water supplies is known to cause diseases such as infectious hepatitis, typhoid fever, dysentery, and various gastrointestinal illnesses (US EPA 1977). It is also known that dissolved contaminant plumes from conventional OWTS can travel hundreds of feet and exceed drinking water standards (USEPA 2002). Thus, discharges from OWTS are known to impair or threaten impairment of beneficial uses of groundwater in the immediate vicinity of the discharge.

This setback is established using a common standard of practice. Many references and technical documents prescribe 100 feet for OWTS setback from a well. While well pollution is documented to have occurred on occasion, the setback has been successful.

Reviewer Comment:
The suggested set-back is appropriate and the provided justification is sound. However, in lieu of justifications provided for 6f., 6g. and 6h. it seems appropriate to specify that wells listed under 6b. are not intended to provide drinking water supplies, to clearly distinguish them from public water wells specified under 6f. and 6 g.

c. 100 feet from any unstable land mass or any areas subject to earth slides identified by a registered engineer or registered geologist; other setback distance are allowed, if recommended by a geotechnical report prepared by a qualified professional.

Unstable land masses can be further destabilized by direct addition of water to the soil column. A setback of 100 feet or greater, if prescribed by a professional geologist, will assist in minimizing any further destabilization of unstable areas.

Reviewer Comment:
The suggested set-back from any unstable land mass is appropriate and the provided justification is sound.

d. **100 feet from springs and flowing surface water bodies where the edge of that water body is the natural or levied bank for creeks and rivers, or may be less where site conditions prevent migration of wastewater to the water body.**

For the same reasons described in Issue 6.b. above regarding concerns for pathogens, this setback is being established because springs and flowing surface water bodies are often areas of interflow, where groundwater exits the subsurface to become surface waters. Since the intent of subsurface disposal is to treat and dispose the wastewater in the subsurface, areas of interflow pose a design threat. A setback minimizes such design failure. The Policy prescribes 100 feet because it is a standard of practice often used in design manuals and local ordinances.

Reviewer Comment:
The suggested set-back from any spring and flowing surface water is appropriate and the provided justification is sound.

e. **200 feet from vernal pools, wetlands, lakes, ponds, or other surface water bodies where the edge of that water body is the high water mark for lakes and reservoirs, and the mean high tide line for tidally influenced water bodies.**

For the same reasons described in Issue 6.b. above regarding concerns for pathogens, this setback is being established because lakes, wetlands and other placid surface water bodies are often areas of interflow, where groundwater exits the subsurface to become surface waters. Since the intent of subsurface disposal is to treat and dispose the wastewater in the subsurface, areas of interflow pose a design threat. Unlike flowing waters, these water bodies with a relatively low level of mixing, due the lack of flow, will collect interflow and retain it, creating nuisance conditions. A setback minimizes such design failure. The Policy prescribes 200 feet because it is a standard of practice often used in design manuals and local ordinances.

Reviewer Comment:
The suggested set-back from any stagnant or low-flowing surface water bodies is appropriate and the provided justification is sound.

f. **150 feet from a public water well where the depth of the effluent dispersal system does not exceed 10 feet;**

For the same reasons described in Issue 6.b. above regarding concerns for pathogens, public water wells may have a have a greater zone of influence on the surrounding groundwater than monitoring wells, private domestic wells. Also, if the OWTS design fails, these public water wells also can affect more people and pose a risk to public health. For this reason, the Policy requires increased separation from the OWTS and public well, which is determined by multiplying the standard well separation by a factor of safety of 1.5.

Reviewer Comment:
The suggested set-back from any public water well is appropriate and the provided justification is sound providing that there is sufficient depth between the bottom of the system and groundwater. Under 6h., this depth is specified to be at least 5 feet. For consistency and to provide the same design standards throughout, the following statement should be added: "…the depth of the effluent dispersal system does not exceed 10 feet **and the separation from the bottom of the system and groundwater is more than five feet."** As an alternative, specify depth by making reference to Table 1.

g. **200 feet from a public water well where the depth of the effluent dispersal system exceeds 10 feet in depth.**

For the same reasons described in Issue 6.b. above regarding concerns for pathogens, deeper disposal systems have the potential to contaminate groundwater because there is potentially less unsaturated soil below the leachfield. For this reason, the Policy requires increased separation from the OWTS and the public well which is determined by multiplying the standard well separation by a factor of safety of 2.0.

Reviewer Comment:
The suggested set-back from any public water well is appropriate and the provided justification is sound providing that there is sufficient depth. Similar to the suggestion provided under 6f., the following statement should be added: "…the depth of the effluent dispersal system exceeds 10 feet **and the separation from the bottom of the system and groundwater is more than five feet."** As an alternative, specify depth by making reference to Table 1.

h. **Where the effluent dispersal system is within 600 feet of a public water well and exceeds 20 feet in depth and the separation from the bottom of the system and ground water is less than five feet, the horizontal setback required to achieve a two-year travel time for microbiological contaminants shall be evaluated. A qualified professional shall conduct this evaluation. However in no case shall the setback be less than 200 feet.**

For the same reasons described in Issue 6.b. above regarding concerns for pathogens, deeper disposal systems have the potential to contaminate groundwater because there is potentially less unsaturated soil below the leachfield. Where the OWTS exceeds 20 feet in depth and the separation from the bottom of the system and ground water is less than five feet, the OWTS begins to look more like a design for groundwater reinjection rather than an OWTS for wastewater treatment and dispersal. For this reason, simple factors of safety will not address the overall potential water quality problems and the Policy requires an evaluation by a qualified profession to ensure adequate destruction of pathogenic materials travelling in an aqueous environment.

Reviewer Comment:
The suggested site-specific evaluation is appropriate and the provided justification is sound.

i. **Where the effluent dispersal system is within 1,200 feet from a public water systems' surface water intake and within the catchment of the drainage, the dispersal system shall be no less than 400 feet from the high water mark of the reservoir, lake or flowing water body.**

For the same reasons described in Issue 6.b. above regarding concerns for pathogens, this requirement is directly related to the California Department of Public Health's Drinking Water Source Assessment Program (DWSAP). This requirement effectively requires that all OWTS must be outside the Protection Zones of surface waters used for consumption (CA DPH 1999).

Reviewer Comment:
The suggested set-back from any public water well is appropriate and the provided justification is sound.

j. **Where the effluent dispersal system is located more than 1,200 but less than 2,500 feet from a public water systems' surface water intake and within the catchment of the drainage, the dispersal system shall be no less than 200 feet from the high water mark of the reservoir, lake or flowing water body.**

For the same reasons described in Issue 6.b. above regarding concerns for pathogens, this requirement is directly related to the California Department of Public Health's Drinking Water Source Assessment Program (DWSAP). This requirement effectively requires that all OWTS must be outside the Protection Zones of surface waters used for consumption (CA DPH 1999).

Reviewer Comment:
The suggested set-back from any public water well is appropriate and the provided justification is sound.

7. **Natural ground slope in all areas used for effluent disposal shall not be greater than 25 percent for Tier 1 and 30 percent for Tier 2.**

Slopes can cause problems for the use of OWTS. If not constructed properly, dispersal systems constructed on sloping land can lead to surfacing of the water down gradient. Slopes in excess of 25% may limit the use of machinery (USEPA 1980; Crites 1998) in addition to problems related to surfacing wastewater. Tier 1 (Section 7.7) is subject to 25 percent due to less oversight in the OWTS management system. For Tier 2, where management is done under a local agency management plan, slopes are allowed (Section 9.4.4) up to 30 percent.

Reviewer Comment:
The suggested maximum slope factors are appropriate and the provided justification is sound.

8. **The average density for any subdivision of property occurring after the effective date of this Policy and implemented under Tier 1 shall not exceed one single-family dwelling unit, or its equivalent, per 2.5 acres for those units that rely on OWTS (Section 7.8).**

Accumulations of pollutants, particularly nitrogen compounds, in the groundwater are a major concern for the use of OWTS. It is OWTS density that leads to pollution due to the fact that the amount of wastewater exceeds the assimilative capacity of the groundwater (Canter and Knox 1986). Furthermore, Canter and Knox note: "Areas with more than 40 [OWTS] per square mile can be considered to have potential contamination problems." However, other researchers (Brown and Bicki 1997) have found that most of the studies that they reviewed "estimated that the minimum lot size necessary to ensure against contamination is roughly one-half to one acre." As such, an average density of one OWTS per 2.5 acres is a good step forward and between two estimations.

Reviewer Comment:
The proposed average density of one OWTS per 2.5 acres is not well justified. The reviewer notes that considering only the number of OWTS per area is a simplification that neglects subsurface conditions that are key to achieve nitrogen attenuation. The most important threat to contamination is likely downstream impact on any shallow wells

used for drinking water supply. Thus, it would be more appropriate to couple a maximum number of OWTS per area with a specification of subsurface conditions as described in 6f. and 6g. When conditions as specified in 6f. and 6g. are met, one OWTS per one acre (based on Brown and Bicki, 1997) seems an appropriate load.

9. All dispersal systems shall have at least twelve (12) inches of soil cover (Section 8.1.4).

Twelve inches of backfill over the dispersal system is common practice (U.S. Public Health Service 1967).

Reviewer Comment:
The suggested soil cover is appropriate and the provided justification is sound.

10. The minimum depth to the anticipated highest level of groundwater below the bottom of the leaching trench, and the native soil depth immediately below the leaching trench, shall not be less than prescribed in Table 1.

Reviewer Comment:
As mentioned above, the percolation rate should be expressed in units of "distance per time" or "volume per area and time" instead of "time per distance". It is understood that determining the percolation rate through observation in the field might be determined as monitoring the percolation of an inch of water over time, nevertheless rates listed in Table 1 should be computed as inch/min or cm/day. The same comments applies to section 7.4 of the draft policy.

Table 1: Tier 1 Minimum Depths to Groundwater and Minimum Soil Depth from the Bottom of the Dispersal System

Percolation Rate	Depth to groundwater
Percolation Rate ≤1 MPI	Only as authorized in a Tier 2 Local Management Program
1 MPI< Percolation Rate ≤ 5 MPI	Twenty (20) feet
5 MPI< Percolation Rate ≤ 30 MPI	Eight (8) feet
30 MPI< Percolation Rate ≤ 90 MPI	Five (5) feet
Percolation Rate > 90 MPI	Only as authorized in a Tier 2 Local Management Program

MPI = minutes per inch

The requirements for this portion of the Policy are established to ensure that wastewater discharged from OWTS has sufficient time to receive treatment prior to entering groundwater. The separation for groundwater requirements listed in Table 1 are taken from the Basin Plan from the Central Coast Regional Water Quality Control Board (Central Coast RWQCB

11. Dispersal systems shall be a leachfield, designed using not more than 4 square-feet of infiltrative area per linear foot of trench as the infiltrative surface, and with trench width no wider than 3 feet. Seepage pits and other dispersal systems may only be authorized for repairs where siting limitations require a variance. Maximum application rates shall be determined from stabilized percolation rate as provided in Table 2, or from soil texture and structure determination as provided in Table 3.

<u>Reviewer Comment:</u>
The specified rates in Table 2 and soil properties in Table 3 are appropriate. As mentioned earlier, percolation rates in Table 2 should be reported as inch/minute or cm/day. The justification provided for the values listed in sound.

ATTACHMENT 2

May 1, 2012

Table 2: Application rates as determined from stabilized percolation rate

Percolation Rate (minutes per Inch)	Application Rate (gallons per day per square foot)	Percolation Rate (minutes per Inch)	Application Rate (gallons per day per square foot)	Percolation Rate (minutes per Inch)	Application Rate (gallons per day per square foot)
<1	Requires Local Management Program	31	0.522	61	0.197
1	0.8	32	0.511	62	0.194
2	0.8	33	0.5	63	0.19
3	0.8	34	0.489	64	0.187
4	0.8	35	0.478	65	0.184
5	0.8	36	0.467	66	0.18
6	0.8	37	0.456	67	0.177
7	0.8	38	0.445	68	0.174
8	0.8	39	0.434	69	0.17
9	0.8	40	0.422	70	0.167
10	0.8	41	0.411	71	0.164
11	0.786	42	0.4	72	0.16
12	0.771	43	0.389	73	0.157
13	0.757	44	0.378	74	0.154
14	0.743	45	0.367	75	0.15
15	0.729	46	0.356	76	0.147
16	0.714	47	0.345	77	0.144
17	0.7	48	0.334	78	0.14
18	0.686	49	0.323	79	0.137
19	0.671	50	0.311	80	0.133
20	0.657	51	0.3	81	0.13
21	0.643	52	0.289	82	0.127
22	0.629	53	0.278	83	0.123
23	0.614	54	0.267	84	0.12
24	0.6	55	0.256	85	0.117
25	0.589	56	0.245	86	0.113
26	0.578	57	0.234	87	0.11
27	0.567	58	0.223	88	0.107
28	0.556	59	0.212	89	0.103
29	0.545	60	0.2	90	0.1
30	0.533			>90	Requires Local Management Program

Table 3: Design Soil Application Rates

(Source: USEPA Onsite Wastewater Treatment Systems Manual, February 2002)

Soil Texture (per the USDA soil classification system)	**Soil Structure Shape**	**Grade**	**Maximum Soil Application Rate(gallons per day per square foot)** [1]
Coarse Sand, Sand, Loamy Coarse Sand, Loamy Sand	Single grain	Structureless	0.8
Fine Sand, Very Fine Sand, Loamy Fine Sand, Loamy Very Fine Sand	Single grain	Structureless	0.4
Coarse Sandy Loam, Sandy Loam	Massive	Structureless	0.2
	Platy	Weak	0.2
		Moderate, Strong	Prohibited
	Prismatic, Blocky, Granular	Weak	0.4
		Moderate, Strong	0.6
Fine Sandy Loam, very fine Sandy Loam	Massive	Structureless	0.2
	Platy	Weak, Moderate, Strong	Prohibited
	Prismatic, Blocky, Granular	Weak	0.2
		Moderate, Strong	0.4
Loam	Massive	Structureless	0.2
	Platy	Weak, Moderate, Strong	Prohibited
	Prismatic, Blocky, Granular	Weak	0.4
		Moderate, Strong	0.6
Silt Loam	Massive	Structureless	Prohibited
	Platy	Weak, Moderate, Strong	Prohibited
	Prismatic, Blocky, Granular	Weak	0.4
		Moderate, Strong	0.6
Sandy Clay Loam, Clay Loam, Silty Clay Loam	Massive	Structureless	Prohibited
	Platy	Weak, Moderate, Strong	Prohibited
	Prismatic, Blocky, Granular	Weak	0.2
		Moderate, Strong	0.4
Sandy Clay, Clay, or Silty Clay	Massive	Structureless	Prohibited
	Platy	Weak, Moderate, Strong	Prohibited
	Prismatic, Blocky, Granular	Weak	Prohibited
		Moderate, Strong	0.2

Wastewater application rates are established for pathogen reduction, long-term unsaturated soil treatment of the wastewater, and to prevent surfacing of OWTS effluent in the dispersal system. The wastewater application rates contained in Tables 2 and 3 are developed from application rates specified in the Central Coast Regional Water Board's Water Quality Control Plan (Central Coast Regional Water Board 2011) and the 2002 USEPA Design Manual. The application rate associated with percolation testing has been broken down across the acceptable percolation rates by staff. However, these application rates are within the range of recommended/suggested values contained in both USEPA design manuals (USEPA 1980, USEPA 2002).

12. Dispersal systems shall not exceed a maximum depth of 10 feet as measured from the ground surface to the bottom of the trench.

This requirement is established to allow dispersal systems to target the preferential portion of the soil column, maximizing the amount of atmospheric oxygen for wastewater treatment.

Reviewer Comment:
The design feature is appropriate and well justified.

13. No dispersal systems or replacement areas shall be covered by an impermeable surface, such as paving, building foundation slabs, plastic sheeting, or any other material that prevents oxygen transfer to the soil.

This requirement is established to maximize the amount of atmospheric oxygen for wastewater treatment.

Reviewer Comment:
The design feature is appropriate and well justified.

14. Rock fragment content of native soil surrounding the dispersal system shall not exceed 50 percent by volume for rock fragments sized as cobbles or larger and shall be estimated using either the point-count or line-intercept methods.

Soils with a high fraction of coarse fragments (gravel, cobbles and rock) pose a problem for the treatment of the wastewater because the volume occupied by the coarse fragments is not available for providing the treatment of the wastewater (Woessner et. al. 1987, Ver Hey et. al. 1987).

Reviewer Comment:
The specified subsurface conditions are appropriate and well justified.

15. Septic Tank Construction and Installation: All new or replaced septic tanks and new or replaced grease interceptor tanks shall comply with the standards contained in Sections K5(b), K5(c), K5(d), K5(e), K5(k),

K5(m)(1), and K5(m)(3)(ii) of Appendix K, of Part 5, Title 24 of the 2007 California Code of Regulations.

These standards are industry standards found in the California Plumbing Code (CA Building Standards Commission 2011)

Reviewer Comment:
The specified design features are appropriate and well justified.

16. **New and replaced OWTS septic tanks shall be designed to prevent solids in excess of three-sixteenths (3/16) of an inch in diameter from passing to the dispersal system. Septic tanks that use a National Sanitation Foundation/American National Standard Institute (NSF/ANSI) Standard 46 certified septic tank filter at the final point of effluent discharge from the OWTS and prior to the dispersal system shall be deemed in compliance with this requirement.**

The draft regulations require all new septic tanks to restrict solids particles in excess of 3/16 inch in diameter from passing through to the dispersal field, thereby prolonging the life of the dispersal system. This value was selected from the body of knowledge surrounding septic tank effluent filters (1/8 effluent screens).

The specified design features are appropriate and well justified.

17.

The reviewer has a repeat number at this point. For easy of the reader we will provide the actual number next to each issue.

16. **The proposed regulations (Section 9.4.5) would allow design of gravel-less dispersal systems with a reduction (adjustment multiplier of 0.7) of the minimum required dispersal system area for effluent application.**

It has been shown in the laboratory and in the field that gravel-less chambers function as well as conventional dispersal systems even when the system sized is reduced by as much as fifty percent in size (King, et. al. 2002). When gravel-less chambers are sized equivalently to conventional OWTS, it has been shown that the long-term acceptance rate can be 1.5 to 2 times higher than that of conventional OWTS dispersal systems (Seigrist et. al. 2004). For this reason, SWRCB staff has included a multiplier allowing the reduction of the dispersal system when chambers are used.

Reviewer Comment:
The specified design features are appropriate and well justified.

Attachment 8

California Onsite Wastewater Treatment System Policy Peer Review – Ronald W. Crites, P.E.

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May 1, 2012

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Mr. Todd Thompson, P.E.
Program Manager
DoD & Site Cleanup Programs
Division of Water Quality
State Water Resources Control Board
1001 I Street
Sacramento, California 95814

1017-142613

Subject: Peer Review of State Board Onsite Wastewater Treatment Systems Policy

Dear Mr. Thompson:

As requested by Dr David Jenkins, I have prepared comments on the 22 questions posed to the peer reviewers of the new onsite wastewater treatment systems policy.

Background

The State Water Resources Control Board is issuing policy for Onsite Wastewater Treatment Systems (OWTS). The Final Draft of "Water Quality Control Policy for Siting. Design. Operation, and Maintenance of Onsite Wastewater Treatment Systems" dated March 20, 2012 was reviewed.

Focused Review Comments

The following are my review comments for each of the assumptions, findings and conclusions that constitute the scientific portion of the proposed regulatory action.

1. It is reasonable to use expected waste strength as a trigger for submitting a report of waste discharge (State permit application) and for determining the necessary approach to direct State regulation and oversight through waste discharge requirements.

   Comment: Yes. This is a reasonable assumption.

2. Use of the design flow as a trigger for submitting a report of waste discharge (State permit application) and for determining the necessary approach to direct State regulation and oversight through waste discharge requirements is reasonable.

   Comment: Yes it is.

3. A site evaluation is required in Tier 1 (Section 7 of the proposed Policy) to determine that adequate soil depth is present in the dispersal area. Soil depth would be measured vertically to the point where bedrock, hardpan, impermeable soils, or saturated soils are encountered or an adequate depth has been determined.

   Comment: A site evaluation of the depth of soil into which effluent is to be discharged is essential to the proper siting of soil treatment units.

4. A site evaluation for seasonal groundwater is required in Section 7.3 using one or a combination of the following methods: direct observation of the highest extent of soil mottling observed in the examination of soil profiles, direct observation of groundwater levels during the anticipated period of high groundwater, or other methods, such as historical records, acceptable to the local agency. Where a conflict in the above methods of examination exists, the direct observation method indicating the highest level shall govern.

   Comment: It is appropriate to require direct observation of the highest extent of groundwater rise to avoid direct contact between the applied effluent and the groundwater. The other methods are also appropriate where direct observation is not reasonably attained.

5. Section 7.4 requires that percolation test results in the effluent disposal area shall not be faster than one minute per inch (1 MPI) or slower than ninety minutes per inch (90 MPI) because of problems associated with allowing OWTS on soils that exhibit faster percolation rates than 1 MPI and slower than 90 MPI. All percolation rates shall be based on actual or simulated wet weather conditions by performing the test during the wet weather period as determined by the local agency or by presoaking of percolation test holes and shall be a stabilized rate.

   Comment: The performance of a soil treatment system depends on sufficient detention time of the wastewater within the soil matrix. At the 1 MPI (60 in/hr) end of the range, the fear is that too rapid of movement of wastewater through soil will result in insufficient treatment. At the 90 MPI (0.67 in/hr) end, the detention time is sufficient and there is adequate ability to move the water through the top layers of the soil matrix. In land treatment systems that rely on percolation, 0.2 in/hr (300 MPI) would be judged to be acceptable. In my opinion, the lower end of the range should be extended from 90 MPI to 120 MPI.

6. Setbacks

   Comment: All of the setbacks in this section of the policy appear reasonable.

7. Natural ground slope in all areas used for effluent disposal shall not be greater than 25 percent for Tier 1 and 30 percent for Tier 2.

   Comment: Steep slopes can be detrimental to the successful operation and performance of onsite systems. These restrictions are reasonable.

8. The average density for any subdivision of property occurring after the effective date of this Policy and implemented under Tier 1 shall not exceed one single-family dwelling unit, or its equivalent, per 2.5 acres for those units that rely on OWTS (Section 7.8).

   Comment: An average density of one equivalent single-family dwelling unit per 2.5 acres is too restrictive. Based on Assumption No. 1 that wastewater strength is important and that loading rates should be proportional to the ability of the soil treatment system to treat the applied effluent, a more scientific approach to determining the appropriate average density of individual home treatment units should be taken.

   One approach would be to use the average loading rate per acre of nitrogen from a conventional onsite system. For example, one County has set a loading rate of 45 grams/acre-day of nitrogen as the basis for a housing density. This loading rate would result in a housing density of one dwelling per 0.88 acres.

   Several other counties have a minimum size of 1 acre per dwelling unit, which seems to be an appropriate minimum size for this policy.

9. All dispersal systems shall have at least twelve (12) inches of soil cover (Section 8.1.4).

   Comment: This minimum cover should only be applied to conventional gravity distribution systems. Pressure dosed systems and drip emitters should be allowed as shallow as 6 inches.

10. The minimum depth to the anticipated highest level of groundwater below the bottom of the leaching trench, and the native soil depth immediately below the leaching trench, shall not be less than prescribed in Table 1.

    Comment: These minimum depths are appropriate.

11. Dispersal systems shall be a leachfield, designed using not more than 4 square-feet of infiltrative area per linear foot of trench as the infiltrative surface, and with trench width no wider than 3 feet. Seepage pits and other dispersal systems may only be authorized for repairs where siting limitations require a variance. Maximum application rates shall be determined from stabilized percolation rates as provided in Table 2, or from soil texture and structure determination as provided in Table 3.

    Comment: This is a reasonable approach.

12. Dispersal systems shall not exceed a maximum depth of 10 feet as measured from the ground surface to the bottom of the trench.

    Comment: This is a reasonable limit.

13. No dispersal systems or replacement areas shall be covered by an impermeable surface, such as paving, building foundation slabs, plastic sheeting, or any other material that prevents oxygen transfer to the soil.

    Comment: Under Tier 1 conditions, this is a reasonable restriction.

14. Rock fragment content of native soil surrounding the dispersal system shall not exceed 50 percent by volume for rock fragments sized as cobbles or larger and shall be estimated using either the point-count or line-intercept methods.

    Comment: This is a reasonable assumption.

15. Septic Tank Construction and Installation: All new or replaced septic tanks and new or replaced grease interceptor tanks shall comply with the standards contained in Sections K5(b), K5(c), K5(d), K5(e), K5(k), K5(m)(1), and K5(m)(3)(ii) of Appendix K, of Part 5, Title 24 of the 2007 California Code of Regulations.

    Comment: This is appropriate.

16. New and replaced OWTS septic tanks shall be designed to prevent solids in excess of three-sixteenths (3/16) of an inch in diameter from passing to the dispersal system. Septic tanks that use a National Sanitation Foundation/American National Standard Institute (NSF/ANSI) Standard 46 certified septic tank filter at the final point of effluent discharge from the OWTS and prior to the dispersal system shall be deemed in compliance with this requirement.

    Comment: Containment of suspended solids within the septic tank is an important step in the sustainable performance of OWTS. This is a reasonable assumption.

17. The proposed regulations (Section 9.4.5) would allow design of gravel-less dispersal systems with a reduction (adjustment multiplier of 0.7) of the minimum required dispersal system area for effluent application.

    Comment: This is appropriate.

18. The proposed Policy identifies OWTS within 600 lateral feet of an impaired water body listed for nitrogen or for pathogens pursuant to §303(d) of the Federal Clean Water Act as contributing to the impairment of the water body when further designated by the Regional Water Board. For purposes of this Section, impairment is limited to nitrate or bacterial contamination.

    Comment: This is appropriate.

19. Effluent from the supplemental treatment components designed to reduce nitrogen shall be certified by NSF, or other approved third party tester, to meet a 50 percent reduction in total nitrogen when comparing the 30-day average influent to the 30-day average effluent (Section 10.9).

    Comment: Fifty percent is a conservative value for nitrogen reduction treatment. I would favor a higher bar of 80 percent reduction. In actual practice many nitrogen reduction technologies can meet 50 percent under controlled conditions, but under actual conditions their performance will vary significantly.

20. Where a drip-line dispersal system is used to enhance vegetative nitrogen uptake, the dispersal system shall have at least six (6) inches of soil cover.

    Comment: Drip dispersal should be encouraged in this policy. This is an appropriate condition.

21. Supplemental treatment components designed to perform disinfection shall provide sufficient pretreatment of the wastewater so that effluent from the supplemental treatment components does not exceed a 30-day average TSS of 30 mg/L and shall further achieve an effluent fecal coliform bacteria concentration less than or equal to 200 Most Probable Number (MPN) per 100 milliliters (Section 10.10).

    Comment: This is appropriate.

22. The minimum soil depth and the minimum depth to the anticipated highest level of groundwater below the bottom of the dispersal system shall not be less than three (3) feet. All dispersal systems shall have at least twelve (12) inches of soil cover.

    Comment: This is appropriate.

23. BIG PICTURE

    Comment: The policy contains sufficient minimum standards for the range of conditions found in California. The use of tiers and risk categories is appropriate.

Please call Ron Crites at 530.204.5204 if you have questions.

Very truly yours,

Brown and Caldwell,

Ronald W. Crites

Ronald W. Crites, P.E.
Natural Systems Service Leader

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