INFILTRATOR®
systems inc.

Malfunction Analysis, Prevention, and Correction

Onsite Installer Article

2012 NOWRA Paper

ONSITE WASTEWATER TREATMENT SYSTEM MALFUNCTION:
INVESTIGATION, RESOLUTION, AND PREVENTION

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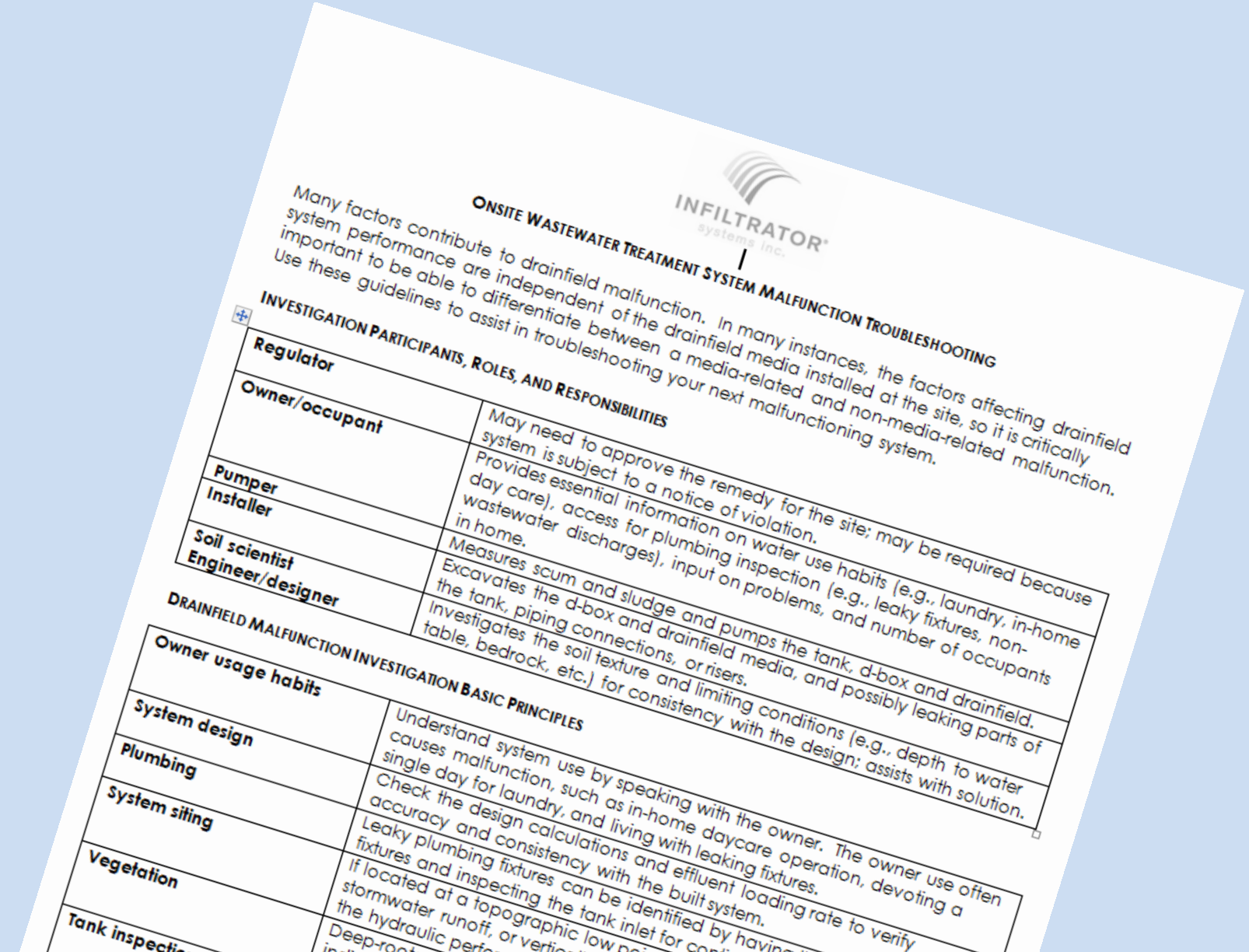
ABSTRACT

The lifespan of an onsite wastewater treatment system is influenced by a variety of factors, including, but not limited to, siting, vertical separation distance, maintenance, wastewater flow volume, septic tank volume, and homeowner behavior. The North Carolina Department of Health and Human Services (DHHS) conducted what is believed to be the largest field performance assessment of onsite wastewater system drainfields in the United States in 2005, evaluating over 900 total systems. The study was performed in support of product approval requests, and included the evaluation of approximately 300 gravel, chamber, and EZflow bundled expanded polystyrene drainfields, for a total of over 900 systems assessed. These systems ranged in age from 2 to 12 years, and the gravelless drainfields were installed at a 25-percent trench length reduction compared to the conventional gravel and pipe drainfields. The systems were distributed uniformly within the state's three physiographic provinces including the coast, piedmont, and mountains. At a 95-percent upper confidence level, no statistical difference in malfunction rates was identified between the gravel and two types of gravelless drainfields. A statistic of particular interest was the overall rate of system malfunction for all system types, which was elevated above DHHS-predicted values. The field performance assessment results show that multiple factors contribute to drainfield malfunction, including depth to groundwater, vertical separation, and topographic relief. During Infiltrator Systems Inc.'s warranty claims-related malfunctioning system investigations, considerations that were relevant in the North Carolina field performance assessment are contemplated, as well as a range of other considerations, including homeowner usage habits, siting on the parcel, vegetative growth, septic tank function, piping and distribution box function, and geochemistry. Case studies demonstrate the negative impacts on drainfield performance are independent of the instances, the factors affecting drainfield system performance for these conditions. In most media installed at the site, and it is important to be able to differentiate between and non-product-related malfunction. The root cause of the malfunction is determined with a properly conducted investigation, leading to proper operation and restores the malfunctioning system to

KEYWORDS

Onsite wast

Handout



INFILTRATOR systems inc.

ONSITE WASTEWATER TREATMENT SYSTEM MALFUNCTION TROUBLESHOOTING

Many factors contribute to drainfield malfunction. In many instances, the factors affecting drainfield system performance are independent of the drainfield media installed at the site, so it is critically important to be able to differentiate between a media-related and non-media-related malfunction. Use these guidelines to assist in troubleshooting your next malfunctioning system.

INVESTIGATION PARTICIPANTS, ROLES, AND RESPONSIBILITIES

Regulator	May need to approve the remedy for the site; may be required because system is subject to a notice of violation.
Owner/occupant	Provides essential information on water use habits (e.g., laundry, in-home day care), access for plumbing inspection (e.g., leaky fixtures, non-wastewater discharges), input on problems, and number of occupants in home.
Pumper	Measures scum and sludge and pumps the tank, d-box and drainfield.
Installer	Excavates the d-box and drainfield media, and possibly leaking parts of the tank, piping connections, or risers.
Soil scientist	Investigates the soil texture and limiting conditions (e.g., depth to water table, bedrock, etc.) for consistency with the design; assists with solution.
Engineer/designer	

DRAINFIELD MALFUNCTION INVESTIGATION BASIC PRINCIPLES

Owner usage habits	Understand system use by speaking with the owner. The owner use often causes malfunction, such as in-home daycare operation, devoting a single day for laundry, and living with leaking fixtures.
System design	Check the design calculations and effluent loading rate to verify accuracy and consistency with the built system.
Plumbing	Leaky plumbing fixtures can be identified by having fixtures and inspecting the tank inlet for
System siting	If located at a topographic low
Vegetation	stormwater runoff, or
Tank inspecti	the hydraulic
	Deep-root

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Soil scientist Engineer/designer	Investigates the soil texture and limiting conditions (e.g., depth to water table, bedrock, etc.) for consistency with the design; assists with solution.

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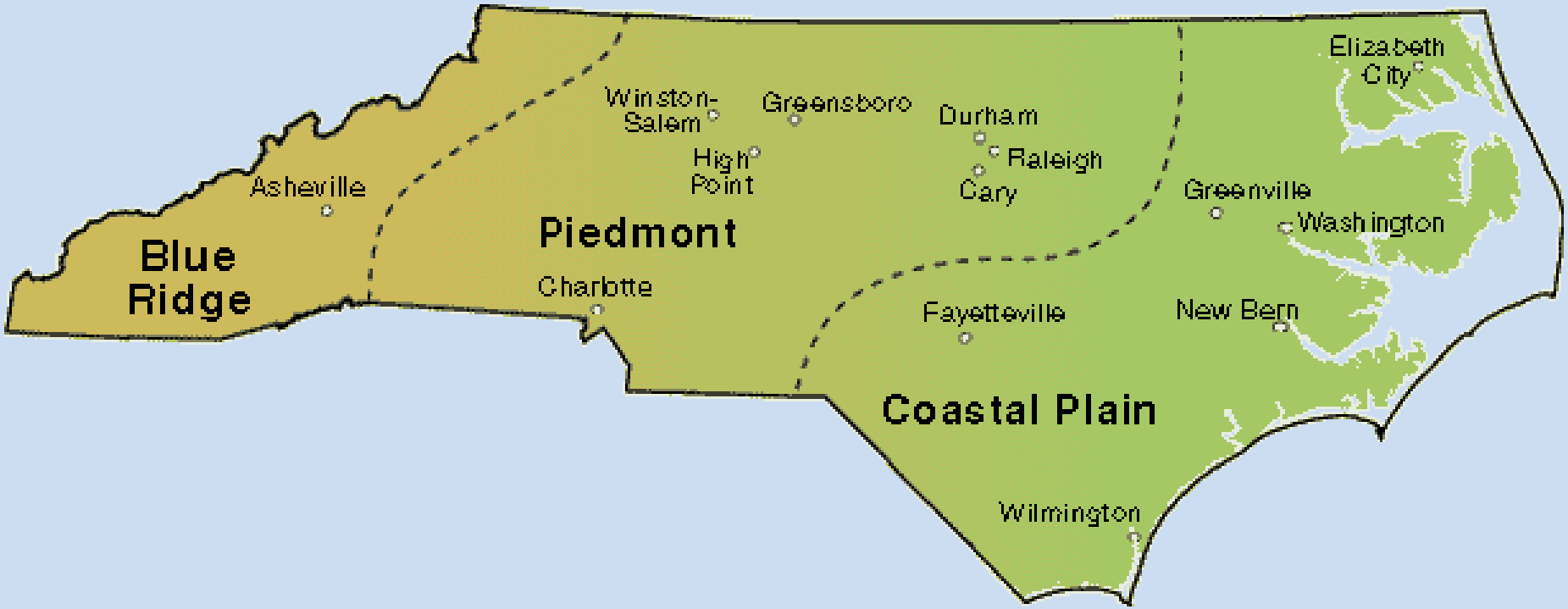
Owner usage habits	Understand system use by speaking with the owner. The owner use often causes malfunction, such as in-home daycare operation, devoting a single day for laundry, and living with leaking fixtures.
System design	Check the design calculations and effluent loading rate to verify accuracy and consistency with the built system.
Plumbing	Leaky plumbing fixtures can be identified by having the owner turn off all fixtures and inspecting the tank inlet for continued flow.
System siting	If located at a topographic low point, within a zone where roof stormwater runoff, or vertically coincident with seasonally standing water, the hydraulic performance of the drainfield may be compromised.
Vegetation	Deep-rooted vegetation or vegetation with an affinity for water may be indicators of root intrusion. Stressed vegetation at the ground surface may indicate saturated soil or shallow groundwater.
Tank inspection	Excessive scum and sludge decrease effluent storage volume, reducing hydraulic residence time. Sludge can block flow through inlet and outlet tees. A leaky tank can allow groundwater to flow into and overload the system.
Distribution box inspection	Excessive solids indicate the septic tank is not adequately separating solids and liquid, sending solids to drainfield. Mis-alignment can change outlet pipe invert elevations, under- or over-loading trenches.
Drainfield inspection	Solids in the drainfield media reduce hydraulic capacity by clogging the soil pore matrix. Excavate the biomat/soil interface and inspect the contact and underlying soil for staining and discoloration (grey to black). If not discolored, the soil pore matrix may be clogged. Check that the drainfield media has not collapsed due to excessive load. Compare the soil texture from the soil characterization with the texture determined in the field to verify proper system size.

DRAINFIELD MALFUNCTION REMEDIES

The best remedy for the site typically begins by considering some combination of site-specific conditions, type of drainfield media, homeowner usage habits, and other key factors. Note that remedies must adhere to any state and local regulatory requirements.

Improper siting	Relocate to a higher topographic position or elevate the system. Do not collocate the drainfield with surface water discharge and infiltration, such as roof drains, basement sump pump discharge, the lawn sprinkler system, and overland precipitation flow.
Clogged infiltrative surface	If clogging resulted from solids, grease, oil, or similar substances, affected areas may not be repairable and may require replacement or expansion. Avoid the discharge of deleterious substances, such as petrochemicals, harsh cleaners, poisons, and grease.
Incorrect soil characterization	Expanding the system to account for the actual site soil texture will allow for adequate capacity for effluent dispersal and treatment.
Malfunctioning septic tank	Pump the tank regularly, repair sources of leaking groundwater, and keep the effluent filter clean to allow for discharge to the drainfield. Verify that the piping and distribution box systems allow evenly distributed flow into the tank and drainfield.
Hydraulic overload	Repair leaky plumbing fixtures. Coach owners to alter water use habits, such that they spread wastewater discharges over time. Separate sump pump and water softener back wash discharges from the onsite wastewater treatment system. Repair or replace a leaky septic tank. Re-align d-boxes to balance flow to trenches.
Old system/excessive biomat	Remediate the drainfield through the installation of an aerobic bacterial generator to reduce biomat accumulation and allow the hydraulic capacity of the system to be restored.

North Carolina Study



North Carolina - Summary of Study

- Study by the NC Department of Health and Human Services
- 900 onsite systems
- Age from 2 to 12 years
- Largest field performance study in the world
- Distributed in 3 physiographic provinces
  - Coast – sands and fine loams
  - Piedmont – fine loams and clays
  - Mountains – coarse loams and fine loams
- Two counties per physiographic province

North Carolina – Systems Studied

- Field survey of over 900 systems
  - Stone and pipe: 303 systems at 100% sizing
  - Chamber: 303 systems at 25% length reduction
  - Expanded polystyrene: 306 systems at 25% length reduction

Stone and pipe

Chamber

Expanded polystyrene

North Carolina - Methods

- DHHS randomly selected sites
- Inspectors were W. Carolina University graduate students
- Inspectors trained to use a uniform evaluation system
- Systems numbered so inspectors did not know drainfield type
- Two inspectors per team to eliminate bias
- March – April 2005 to target wettest seasonal conditions
- Yes/no questions to identify a past/present malfunction

North Carolina – Analysis

- DHHS estimated 5% malfunction rate for stone and pipe
- Study to determine if reduced-length drainfield products had a difference of 5 percentage points or more higher than conventional stone and pipe:
  - *Example:* Product X malfunction rate = 9%, and 4% malfunction rate for stone and pipe system
- Statistical evaluation at the 95% confidence level:
  - Means there should only be a 5% chance the difference between samples would occur by chance
- Minimum sample size for 95% confidence was 300 systems

North Carolina – Findings by Province

- Coastal malfunction rate was the highest
  - Shallowest groundwater table
  - Vacation homes (city dwellers on septic system)
  - Little topographic relief

Table 1 - Malfunction rate by physiographic province

Physiographic Region	System OK	Malfunctioning	% Malfunctioning
Coast	256	34	11.7
Piedmont	286	31	9.8
Mountain	293	12	3.9
All Regions	835	77	8.4

North Carolina – Findings by Age

- Oldest systems had highest malfunction rates
  - Longer period of time for biomat formation
  - Longer period of time for solids to flow to drainfield
  - Longer period of time for system abuse to have an affect

Table 2 - Malfunction rate by age

Age	System OK	Malfunctioning	% Malfunctioning
2 to 4 years	283	24	7.8
5 to 7 years	351	26	6.9
8 to 12 years	201	27	11.8
All ages	835	77	8.4

North Carolina – Malfunction Rate by Type

- Difference between proprietary systems and stone and pipe was 2.2% or less
- Statistical analysis showed performance was the same between systems
- All system types malfunctioned greater than the expected 5%

Table 3 - Malfunction rate by system type

Type	System OK	Malfunctioning	% Malfunctioning
Stone and pipe	281	22	7.3
Chamber	277	26	8.5
Expanded polystyrene	277	29	9.5
Total	835	77	8.4


MALFUNCTION

Signs of Malfunction

Signs of Malfunction

Signs of Malfunction

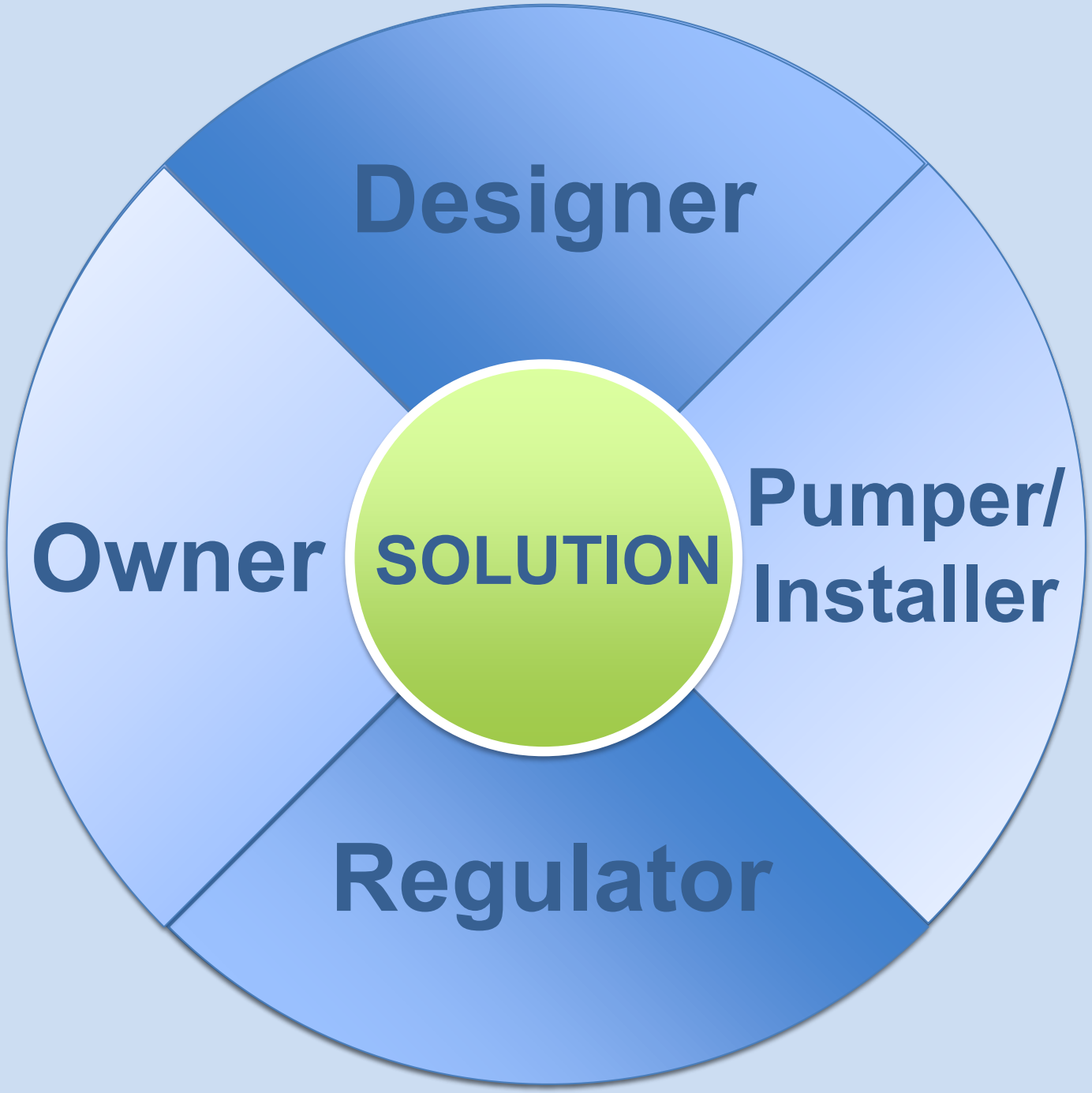
Signs of Malfunction

Signs of Malfunction

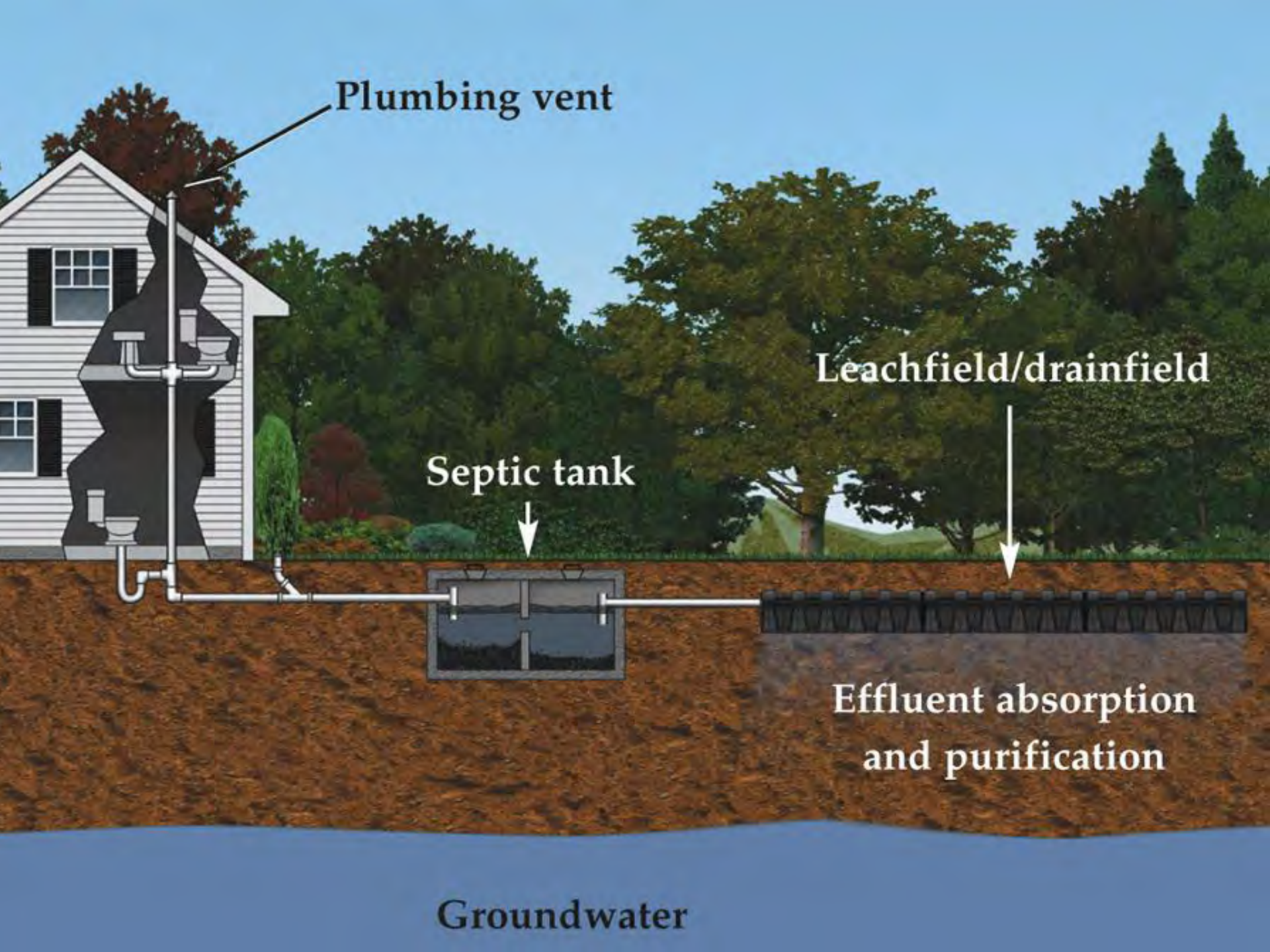
Staining

Investigation

The Right People


Designer
Owner
SOLUTION
Pumper/
Installer
Regulator

Investigation Scope


Plumbing vent
Leachfield/drainfield
Septic tank
Effluent absorption
and purification
Groundwater

Water Use

Loads per Week?

Water Use

Not a Trash Can!

Water Use

No Paint, Oils or Chemicals!

Water Use

Plumbing Check

Plumbing Check

Plumbing Check

SYSTEM STATISTICS and CALCULATIO

ROBINSON, LARRY

SITE CHARACTERISTICS:

Limiting zone: 20 inches
Perc. rate: 142.85 Min/inch
Number of bedrooms: 4
Sand required. 28 In.
Slope: 12.0%

SEPTIC TANK:

Minimum size required: 1250 gal. 2 - compartment
To be installed: 1000 gallon, 1 – compartment septic tank connected t
existing 1000 gallon septic tank.

ABSORPTION AREA DESIGN:

500 gal./day flow x 3.856 = 1928 sq. ft.(800sq.ft.Min.Req. by Town
To be installed: Infiltrator chambers, which yield up to a 40% reduction in disposa
will be used. Each infiltrator chamber is rated at 29.50 sq. ft. of
absorption are equivalent. Infiltrator chambers to be arranged in a
rectangular pattern consisting of an array of (7) rows of chambers
(10) col. total of (70) infiltrator chambers. Total disposal rating of t
infiltrator chambers is (2065) sq. ft.

Side A			Side B		
Lateral length:	32.65	Ft.	Lateral length	32.65	Ft.
Number required	7	Laterals	Number required	7	Laterals
Hole size:	1/4	In.	Hole size:	1/4	In.
Hole spacing:	6	Ft. on ctr	Hole spacing:	6	Ft. on cen
Lateral diameter:	11/2	In.	Lateral diameter	11/2	In.
		Manifold Diameter:	2	In.	
		Manifold length:	21.60	Ft.	

PUMP SIZING:

7 Laterals(Side A) x 5 holes + 7 laterals (Side B) x 5 holes = 70 Holes
1.28 gal/min/hole = 89.60 Gal./min.

HEAD LOSS:

Soil Check

Groundwater Check


Groundwater Check

Siting

Siting


Siting
bobcat
Wetland Plants


Siting
Stressed Vegetation

Siting


Construction
Future
Malfunctioning Drainfield
Location

Siting

Irrigation System

Septic Tank


Septic Tank
Is it Watertight?

Effect of Tank Hydraulic Residence Time

Residence time is dependent upon both tank capacity and daily effluent flow rate:

Example 1 – Typical flow

- Tank effective capacity = 1,500 gallons
- Daily flow = 330 gallons/day
- Residence time = 1,500 gal / 330 gal/day = 4.5 days

Example 2 – Low flow

- Tank effective capacity = 1,500 gallons
- Daily flow = 330 gallons/day x 0.5 (low usage) = 165 gallons/day
- Residence time = 1,500 gal / 165 gal/day = 9.1 days

Example 3 – High flow

- Tank effective capacity = 1,500 gallons
- Daily flow = 330 gallons/day x 2.5 (high usage) = 825 gallons/day
- Residence time = 1,500 gal / 825 gal/day = 1.8 days


Septic Tank
Solids Above Outlet?


Septic Tank
Filter Tossed Aside?

D-Box Inspection

Clogged Pipes

Root Intrusion

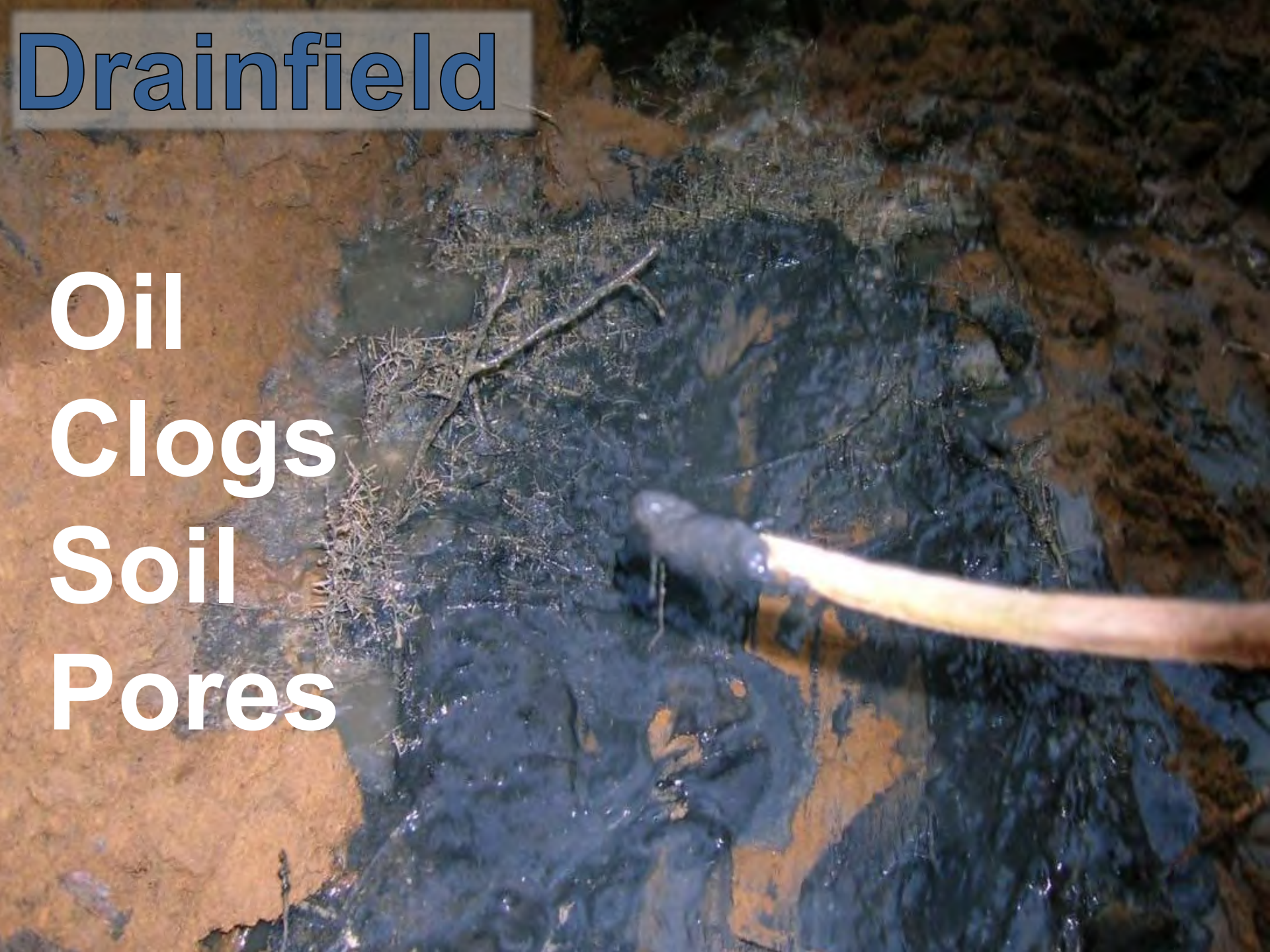

Drainfield
Inspect the Biomat


Drainfield
Evidence
of Flow?

Drainfield


Drainfield
Inspect
the Biomat


Drainfield
Inspect the Biomat


Drainfield
Oil
Clogs
Soil
Pores

Drainfield

Adirondack Environmental Services, Inc

Date: *24-Nov-08*

CLIENT: Infiltrator
Work Order: 081112006
Reference: /
PO#:

Client Sample ID: B10 Mat Sludge
Collection Date: 11/11/2008
Lab Sample ID: 081112006-001
Matrix: SLUDGE

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
GASOLINE AND DIESEL RANGE ORGANICS SW8015M						Analyst: **MG**
(Prep: SW8015B - 11/12/2008)						
TPH (Diesel)	735	100		µg/g	1	11/12/2008 8:31:18 PM
TPH (Gasoline)	< 100	100		µg/g	1	11/12/2008 8:31:18 PM
OIL AND GREASE E1664						Analyst: **VZ**
Oil & Grease	1070	10		µg/g	1	11/24/2008

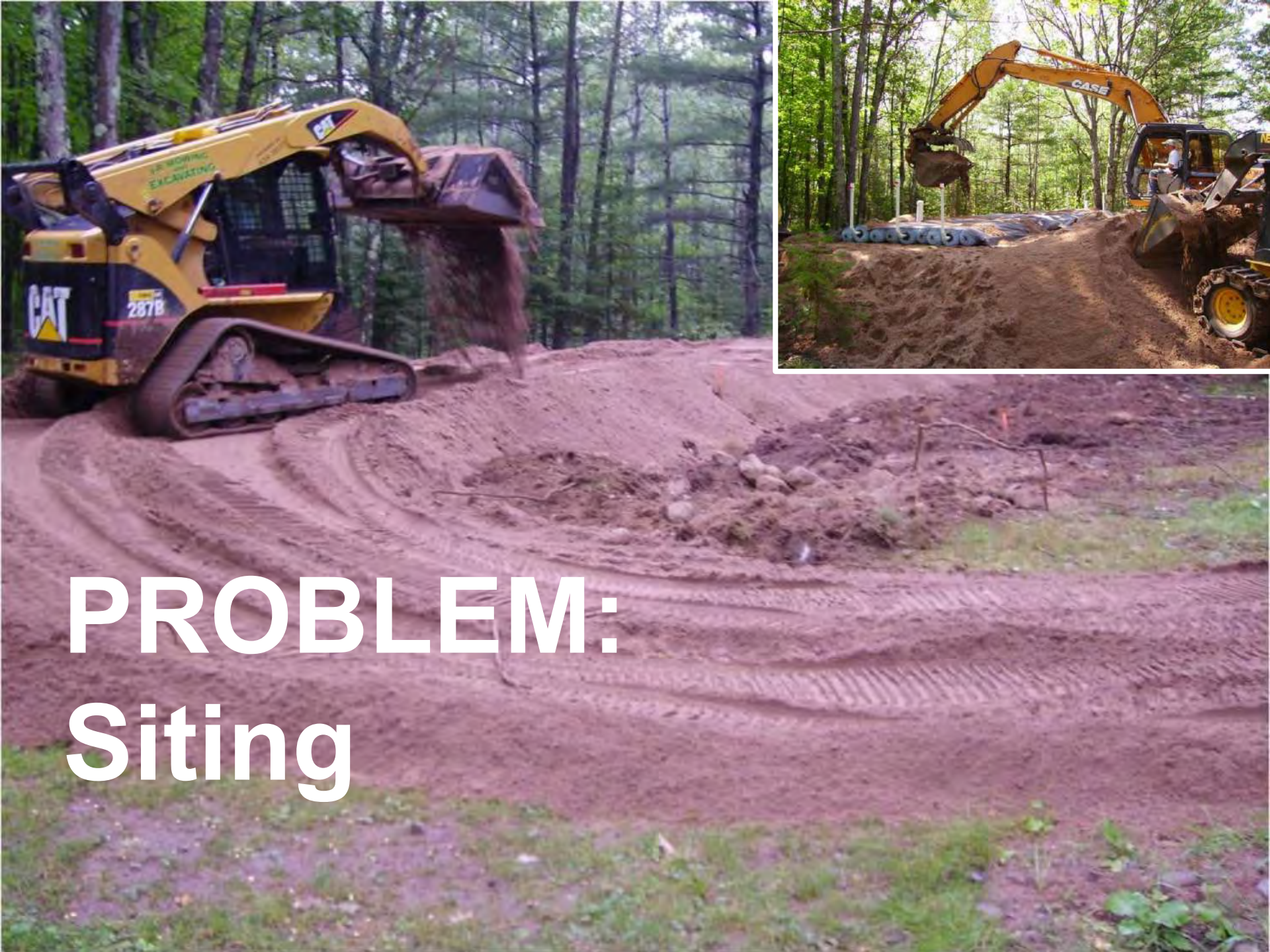
Drainfield

Natural Conditions


Drainfield
Is This Sewage?


Drainfield
Or This?


PROBLEM
SOLUTION



PROBLEM:
Siting

SOLUTION:
Relocate
Elevate


PROBLEM:
Clogged
Infiltrative
Surface


SOLUTION:
Replace
Expand

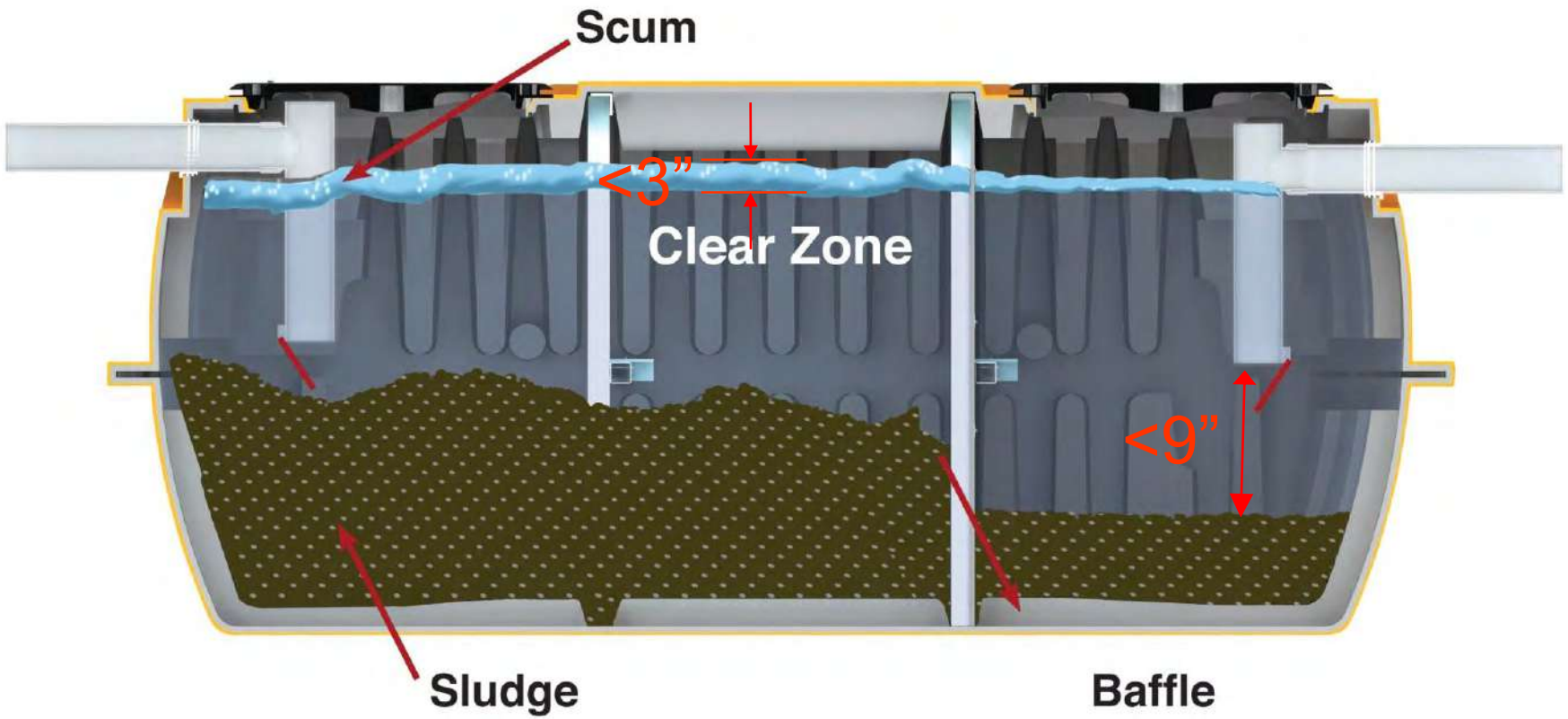

PROBLEM:
Incorrect
Soil Texture


SOLUTION:
Expand


PROBLEM:
Malfunctioning
Tank


SOLUTION:
Pump Regularly

Pump Every 2 to 5 Years




PROBLEM:
Leaking
Tank


SOLUTION:
Repair or
Replace

PROBLEM:
Excessive Water Use

SOLUTION:
Repair Fixtures
Reduce Water Use

INFILTRATOR®
systems inc.

Presented by
David Lentz, P.E.

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