The Case for Narrow Trenches

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Disclaimer

The opinions and statements made in this presentation are those of the speaker and not NOWRA or sponsors of the 2023 Mega-Conference

History - Personal

- 1940 – First public wastewater treatment plant in Michigan came on line – City of Detroit
- 1945 – I was born
- 1950's – My hometown built its own POTW
  - Postage stamps were 3 cents
  - Engineers were paid ~ $500 per month
- 1963 – Graduated from high school
- 1963 – Freshman at Michigan State - Tuition was $327/ year
- 1967 – Graduated from Michigan State
- 1968 – Started work at MDPH
- 1969 – First man visits the moon
- 1971 – Became a licensed PE
- 1980 – Resigned from MDPH and started Stephens Consulting

History – Wastewater Treatment

- 1960's and early 1970's – Most of county sanitary codes in Michigan were developed and established
- POTW's being built were lagoons, activated sludge plants, and trickling filters
- Goal of POTW's was "secondary" treatment
- 1972 – Federal Clean Water Act was passed
- Lots of public money available to pay 80% to 90% of the cost of treatment works
- Today – Tertiary treatment, nutrient removal and ultra-filtration are the norm

History - Technology

- Elementary school – First TV, used long hand for math, phones were party-lines
- High school (early 1960's) – learned to use slide rule for math calculations
- College – slide rule and log calculations
- 1968 – First calculator – Sears –

  add, subtract, multiply and divide

  ($100)

History - Technology

- 1985 – Acquired first computer and started producing electronic drawings with CAD
- 1990's – Internet and Email
- Now – "Dick Tracy" watches, face time,

  Zoom meetings with people all over the world
- Next - AI (artificial intelligence) to do our thinking for us, and even create things that aren't real

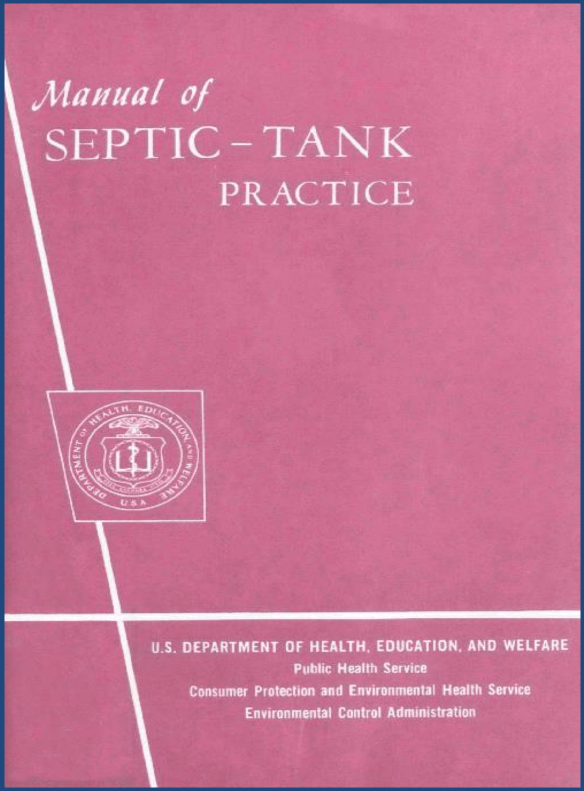
SO, WHY DO I OPEN WITH THESE EXAMPLES OF PROGRESS IN THE WORLD AROUND US?

TAKE A LOOK AT THE CHANGES, OR LACK THEREOF, IN OUR ONSITE WASTEWATER WORLD DURING

THOSE 50+ YEARS!

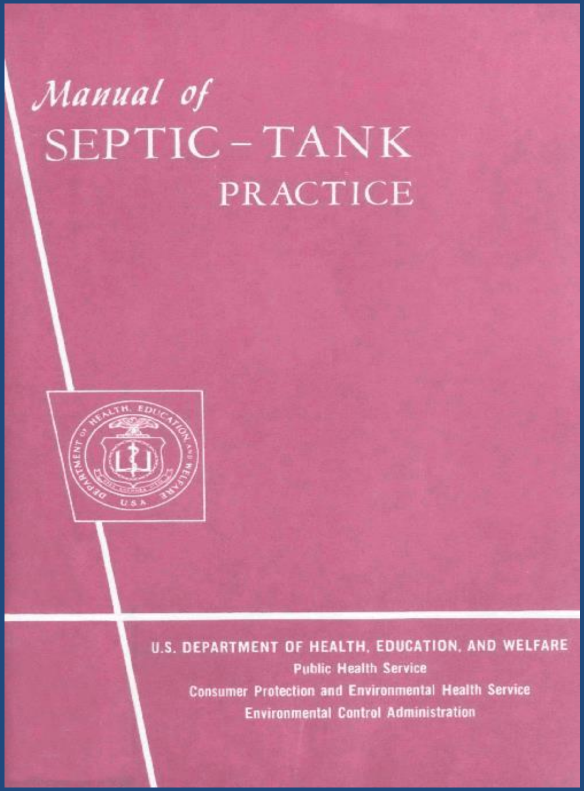
History – Onsite WW Treatment

- 1960's – U.S. Public Health Service created and published the "Manual of Septic Tank Practice" as the first comprehensive guideline for the design and installation of onsite septic systems.
  - First printed in 1957
  - Last revised in 1967



History – Onsite WW Treatment

- 1960's – Along with this in the same time frame came extensive research by many on "leach fields" or "drain fields"
- Significant leaders in this research were P.H. McGauhey and John H. Winneberger at the University of California Berkeley.
- Their research cited 45 other references to significant works of the that time … the research by McGauhey and Winneberger is cited as a reference 3 times in the Manual of Septic Tank Practice

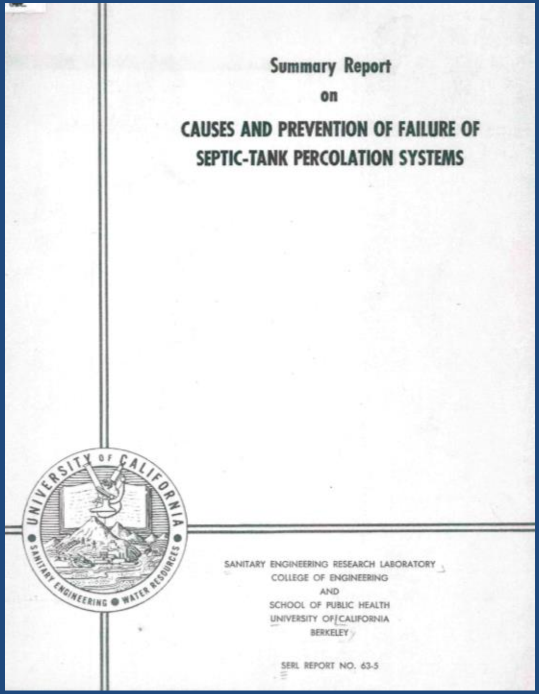


History – Onsite WW Treatment

- 1963 – McGauhey and Winneberger

published a “Summary Report” of what I would consider one of the most significant research subjects of that time entitled:

“CAUSES AND PREVENTION OF FAILURE OF SEPTIC-TANK PERCOLATION SYSTEMS”


Summary Report
on
CAUSES AND PREVENTION OF FAILURE OF SEPTIC-TANK PERCOLATION SYSTEMS

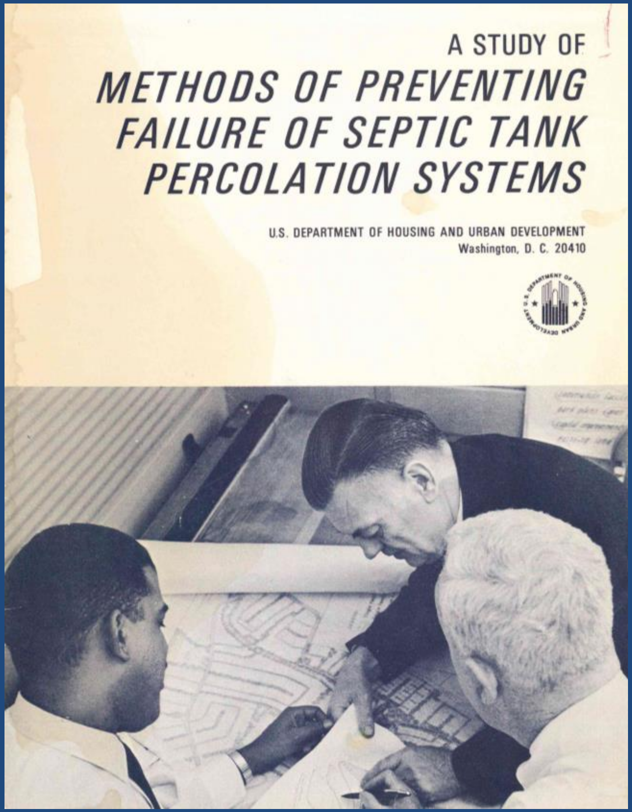
UNIVERSITY OF CALIFORNIA
SANITARY ENGINEERING • WATER RESOURCES

SANITARY ENGINEERING RESEARCH LABORATORY
COLLEGE OF ENGINEERING
AND
SCHOOL OF PUBLIC HEALTH
UNIVERSITY OF CALIFORNIA
BERKELEY

SERL REPORT NO. 63-5

History – Onsite WW Treatment

- 1967 – U.S. Department of Housing and Urban Development published a document based upon the work of McGauhey and Winneberger and others entitled:
- “A Study of METHODS OF PREVENTING FAILURE OF SEPTIC-TANK PERCOLATION SYSTEMS”



Why is History Important?

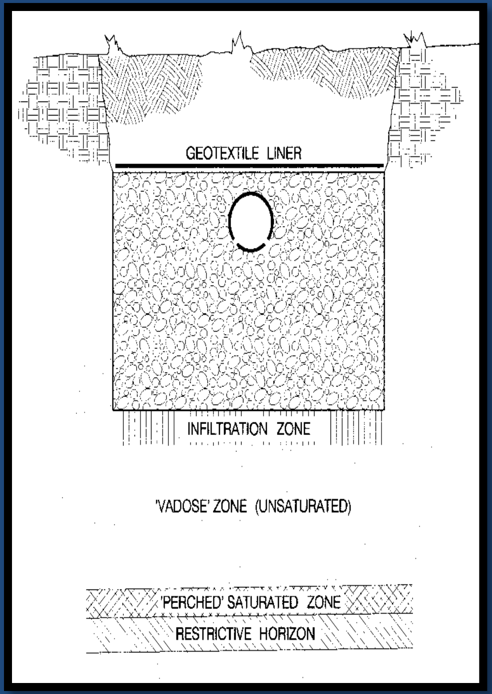
- For a number of reasons this research has long since been forgotten
- Many of the findings of this research are valid today, but have gone unrecognized
- We did not have the products or tools available then to use the findings of this research
- We now have new tools developed over time that could help implement these findings that were not practical with the tools of that day

Could we now utilize the findings of this work?

Findings Revisited

Importance of maintaining aerobic conditions in the soil in and around the infiltrative surface

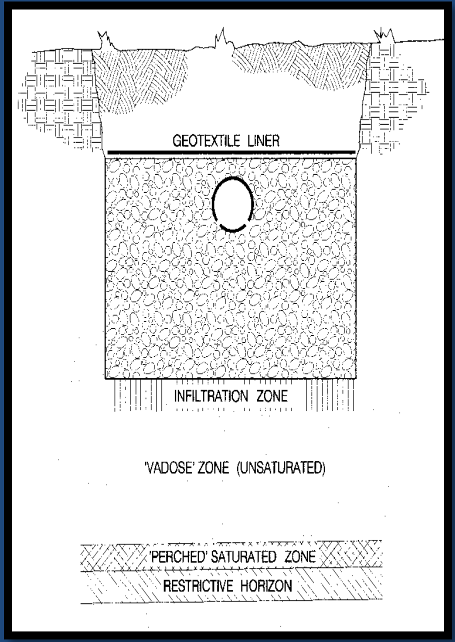
It is well documented that aerobic biological activity in the dispersal system is much more efficient than anaerobic biological activity, resulting in a greater longevity of the system



Findings Revisited

Continuous inundation of the infiltrative surface should be avoided

If the infiltration interface with the native soil is continuously inundated anaerobic conditions develop. Anaerobic conditions fed by organic matter in the wastewater effluent result in a buildup of ferric sulfide resulting in a black slime biomass that seals the soil pores and inhibit wastewater infiltration.



Findings Revisited

Water movement in soil is complex with conflicting forces at work

Water movement is a result of:

- Gravity
- Capillary attraction (stronger than gravity)
- Degree of saturation
- Soil permeability
- Soil structure
- Soil drainage

Findings Revisited

Nature of clogging of percolation fields

McGauhey & Winneberger found that the clogging of the soil is a physical phenomenon resulting from the interaction of chemical, physical and microbiological processes. So even this is complex.

Research at the time found that soil clogging is a "**surface phenomenon confined to the top half centimeter**" except in soils with larger grain sizes.

Findings Revisited

Weekness of bottom area as a primary infiltrative surface

McGauhey & Winneberger stated after research that:

". . . The bottom area of the percolation trench is essentially *useless* as an infiltration surface in the long-term infiltration of sewage into soil."

Findings Revisited

Weekness of bottom area as a primary infiltrative surface per McGauhey & Winneberger

1. Construction practices using excavation equipment can cause smearing and compaction
2. Silting of the bottom of excavations with fines when rainfall event occurs during construction

Findings Revisited

Weekness of bottom area as a primary infiltrative surface per McGauhey & Winneberger

3. The weight of stone used as a distribution media can blind portions of the infiltrative surface.

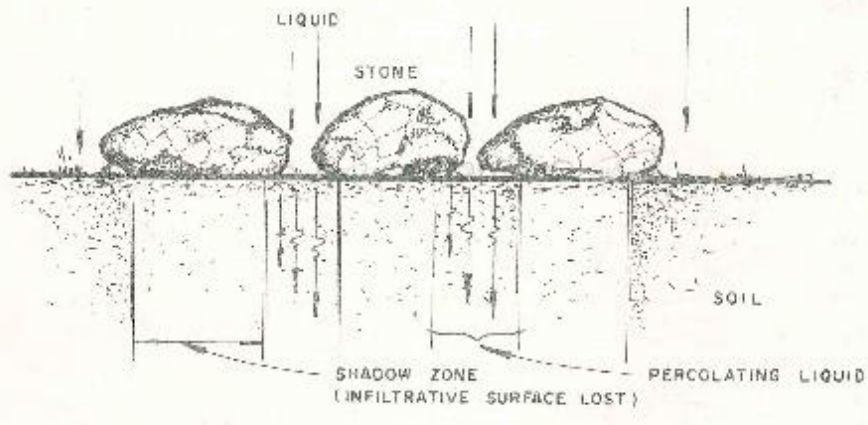


FIGURE 7. LOSS OF INFILTRATIVE CAPACITY BY ABRUPT CHANGE IN PARTICLE SIZE

Findings Revisited

Weekness of bottom area as a primary infiltrative surface per McGauhey & Winneberger

4. Organic matter in the wastewater will feed biomass on the stone and sidewalls, which will eventually slough off to accumulate on the bottom and clog the infiltrative surface.
5. Fine silt and sand from backfill above or from dirty stone will migrate downward and accumulate on the bottom area contributing to the clogging of the infiltrative surface.

Findings Revisited

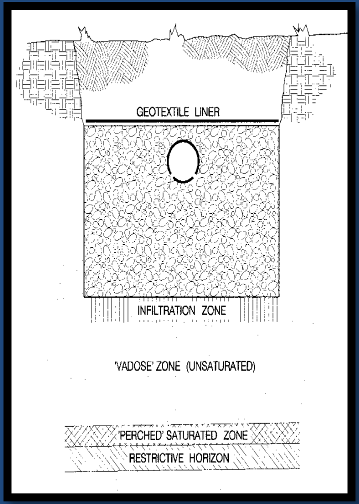
Weekness of bottom area as a primary infiltrative surface per McGauhey & Winneberger

6. Soil pores at the stone/soil interface where silt and biomass accumulate will stay saturated for long periods of time and become anaerobic unless the system is rested for long periods of time. Once anaerobic ferric sulfide develops and a sealing mat forms that slows or stops the movement of water into the soil.

Findings Revisited

Weekness of bottom area as a primary infiltrative surface per McGauhey & Winneberger

7. Soil absorption systems in the form of **beds** will perform much like buried pond bottoms, rather than infiltration systems.
8. "Continuous inundation of the soil is to be avoided if biological clogging is to be minimized."



Findings Revisited

Weekness of bottom area as a primary infiltrative surface per McGauhey & Winneberger

9. "… clogged bottom surfaces showed little tendency to recover infiltrative capacity after resting a few hours, whereas the sidewalls regained their original infiltrative capacity in the same period of rest."
10. "… sidewall clogging rate is independent of the sewage loading rate in G/SF/day, being far more dependent upon the dosing and resting cycle."

Findings Revisited

Weekness of bottom area as a primary infiltrative surface per McGauhey & Winneberger

11. And: “Contrary to common assumption, clogging experiments show **the trench bottom to be of minor importance as an infiltrative surface** …”
12. The infiltrative capacity of systems that are left open to precipitation events during construction can be severely lost by the washing of fines from spoils piles into the system, clogging the infiltrative surface.

Findings Revisited

Weekness of bottom area as a primary infiltrative surface

In comparing the bottom of the excavation to the sidewall area available McGauhey & Winneberger state:

"... the **bottom** of the excavation is of **secondary importance** as an infiltrative surface."

Regarding Sidewalls

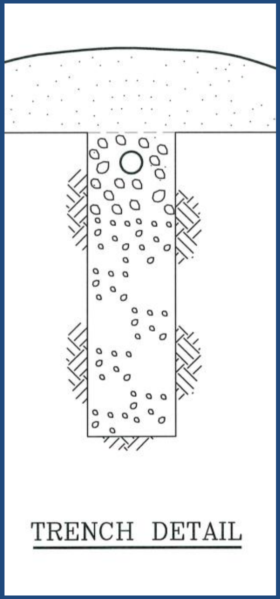
The advantages of the sidewall area as a primary infiltrative surface

1. "The important principal underlying the design of trench systems is that trench **widths** should be kept at the practical **minimum**."
2. Side by side comparisons indicated that narrow trenches operated continuously without ponding while the "wide trench" exhibited continuous ponding in similar soils.

Regarding Sidewalls

The <u>advantages</u> of the sidewall area as a primary infiltrative surface

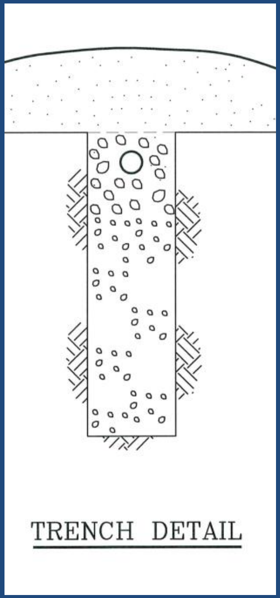
3. Sidewall areas are less vulnerable to smearing and compaction during construction
4. Sidewalls are less prone to clogging from fines washed into the excavation if precipitation occurs during construction



Regarding Sidewalls

The <u>advantages</u> of the sidewall area as a primary infiltrative surface

5. Any bio-growth that occurs within the system will tend to wash from the sidewalls and accumulate in the bottom of the system, leaving sidewalls free

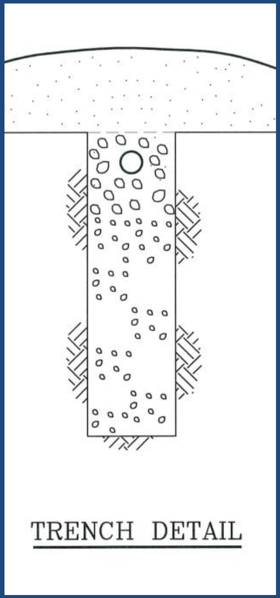


Regarding Sidewalls

The <u>advantages</u> of the sidewall area as a primary infiltrative surface

6. The fluctuating water levels in the trench tend to keep the sidewall areas aerobic

7. Intermittent resting of the system will encourage aerobic conditions and prevent the precipitation of ferrous sulfide, anaerobic conditions and eventual clogging of the soil



Other Recommendations

McGauhey & Winneberger recommend these other design features for soil "percolation systems" ---

1. Ideally the entire infiltrative surface should be loaded uniformly to prevent "creeping failure" (for instance – pressure distribution)
2. Periodic resting will maintain aerobic conditions and extend the life of the system (for instance – timed dosing)

Other Recommendations

McGauhey & Winneberger recommend these other design features for soil "percolation systems" ---

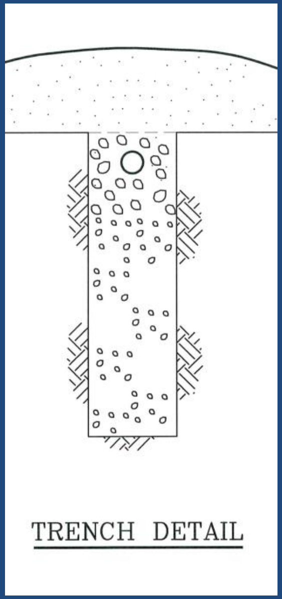
3. The use of a distribution box is "**essentially useless**" per U.S. Public Health Service sponsored research in 1958
4. The infiltrative capacity of the native soil interface is enhanced by minimizing the particle size differential between the distribution media (stone, etc.) and the native soil

Other Recommendations

Regarding the spacing of narrow trenches . . .
McGauhey & Winneberger :

5. "Theoretically there is no reason why trench spacing . . . should be greater than twice the sidewall depth . . ."

Solution for small spaces???



Other Recommendations

Also recommended by McGauhey & Winneberger was this construction advisory:

Open excavations that would allow precipitation events to wash silt into open excavations must be avoided.

Trench Design

McGauhey & Winneberger recommended these two types of trench configuration . . .

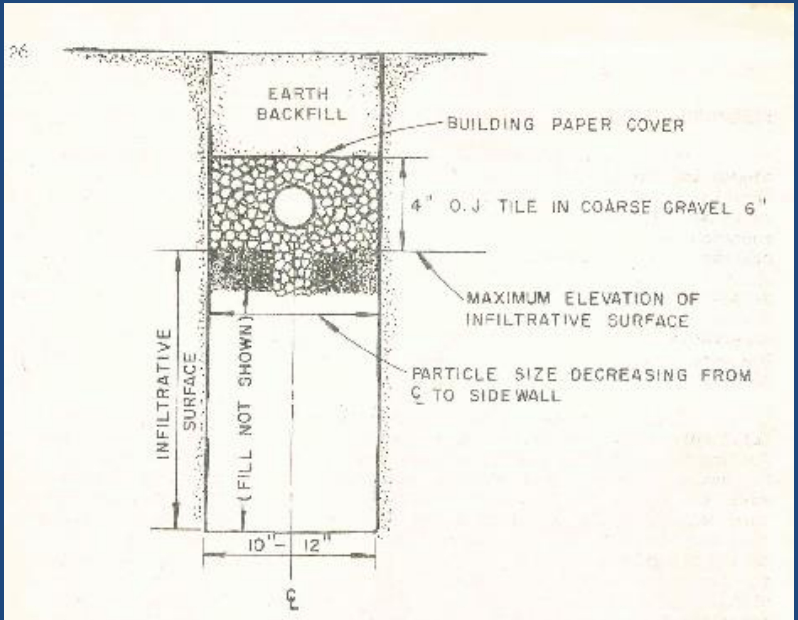


FIGURE 11a. IDEAL TYPE TRENCH FILL (CONTINUOUS GRADING)

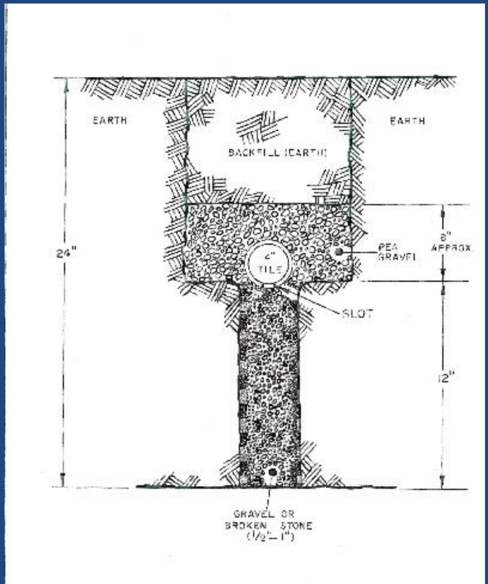


FIGURE 18. DETAIL OF SUGGESTED NARROW-TRENCH SYSTEM

Trench Design

But McGauhey & Winneberger also recognized the difficulty constructing such trench designs with the tools available at that time

But today . . .

Assortment of Small Trenching Machines

Mini - Excavators

Two Personal Experiences

Country Manor Mobile Home Park – 1992

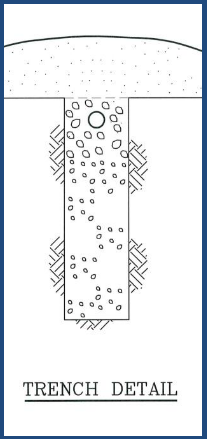
Onondaga, MI

- Old on-site drain field had failed
- Limited area
- Sandy soil – saturated conditions at 3-4 feet
- Designed new pressure-dosed drainfield with shallow narrow trenches using stone
- Installed in the winter of 1992/1993

Two Personal Experiences

Country Manor Mobile Home Park – 2015
Onondaga, MI

- Began having some surfacing over orifices
- Trouble-shooting of system found stone was clogged around orifices and could not flow along trenches
- Likely cause was two-fold
    - ✓ Poor maintenance of tanks and distribution laterals, and
    - ✓ Voids in stone trenches were partially filled with sand and biomass

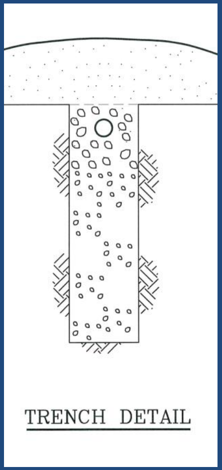


Two Personal Experiences

Residential Home – 1995

Meridian Township, MI

- Old existing system had failed
- Tanks and old system in front yard, replacement area in backyard
- Installed new dosing tank and pumped to backyard where new drain field was located
- Clay loam/sandy clay loam soils
- Used narrow trenches (6”) with stone
- and pressure distribution
- System still working



And today . . .

New stoneless drainfield products are being developed for use in narrow trenches in today's drain field designs

Conclusions - The Future

1. We can learn from this past research by McGauhey and Winneberger over 50 years ago, and their other colleagues of the time
2. In my opinion their research is timeless, and my experience over these same 50 years or so empirically validates their conclusions of the day
3. The tools of today make it possible to implement the recommendations of this research, especially if manufacturers develop products that are tailored for use in narrow trenches that maximize sidewall infiltration

Conclusions - The Future

4. Of course, this research will continue to be forgotten and ignored if the industry, including the regulatory community , does not buy into the results of this research.

From slide rules to A.I. and from trickling filters to membrane filtration, the world has changed a lot in the last 50 years, ***will onsite dispersal continue to be stuck in the middle of the 20th century!***

Contact Information

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