ADAMS COUNTY
HEALTH DEPARTMENT
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EVAPOTRANSPIRATION ON-SITE WASTEWATER TREATMENT SYSTEM (ET-OWTS) SAND MEDIA POLICY

Background

Evapotranspiration (ET) On-Site Wastewater Treatment Systems (OWTS) require the use of sand media in order to assist with the evapotranspiration of septic tank effluent (STE). STE enters the ET bed via “rock and pipe” distribution media or chambers. For unlined ET-OWTS, STE is then either absorbed into the soils below the infiltrative surface or “wicked” upward into the sand media, where it is then absorbed by the plant roots (transpiration), or evaporated.

Historical Tri-County Health Department (TCHD) Regulations

Table 1 below summarizes ET sand specifications from past TCHD Regulations.

Table 1: Historic TCHD ET Sand Specifications

<table>
<tr><th>Sieve/Regulation Year</th><th>1980</th><th>1985</th><th>1988</th><th>1996</th><th>2002</th><th>2011</th></tr>
<tr><td>4</td><td rowspan="3">Effective Size (D_{10}) Between 0.25 and 0.60 mm, Cu <=4</td><td rowspan="3">Size from 0.24 mm to 1mm, non-plastic</td><td>100</td><td>100</td><td>100</td><td>100</td></tr>
<tr><td>40</td><td>50</td><td>50-55</td><td>50-55</td><td>50-55</td></tr>
<tr><td>200</td><td><15</td><td><15</td><td><15</td><td><15</td></tr>
<tr><td></td><td></td><td></td><td colspan="4">Cc >1; Cu >6</td></tr>
</table>

Current Regulation O-14

Section 14.2 of Adams County Health Department (AHD) Regulation No. O-14 includes requirements for ET OWTS. Section 14.2 K. addresses requirements for Sand. Specifically, Section 14.2 K states:

Sand utilized in ET beds shall meet the gradation requirements shown in Table 13 in Appendix A. Sand shall be well graded as defined by ASTM D 2487, particularly between the #40 and #200 sieve sizes. Design Engineers shall approve systems contractor’s sand prior to delivery of material to the site and shall submit to the Department, prior to final approval, sand gradation results showing conformance with this Section.

Table #13 in Appendix A of O-14 has the following requirements:

TABLE #13: GRADATION OF WICKING SAND FOR EVAPOTRANSPIRATION BEDS	
Sieve Size	**Percent Passing**
4	100
40	50-70
200	<15

Rationale for Sand Specification

ET sand is specified in order be sufficiently fine to "wick" septic tank effluent while not clogging. Wicking refers to the capillary rise that occurs in soils whereby water moves upward. Capillary rise or "wicking" is dependent on fine soil pores within the soil matrix. Figure 1 below depicts capillary rise in glass tubes. Note that capillary rise is greater in the smaller diameter tube than the larger diameter tube. This same principle applies to soils-the finer the soil, the greater the capillary rise. Figure 2 below shows the relative capillary rise in four types of soil. As Figure 2 indicates, soils' with smaller pore sizes (higher percentage of silts and clay) produce a greater capillary rise.

While the degree of "wick" is an important performance measure in ET Sand, it is also important to prevent pore clogging in the ET sand. If the pore sizes are too small, the sand will become clogged. Pore sizes correspond to grain sizes; thus, finer grained soils will have smaller pore sizes than coarser grained soils. Consequently the sand specification has a maximum value of 15% passing the #200 sieve (silt and clay sized particles) smaller than 0.074 mm.

Figure 1: Capillary Rise in Glass Tubes

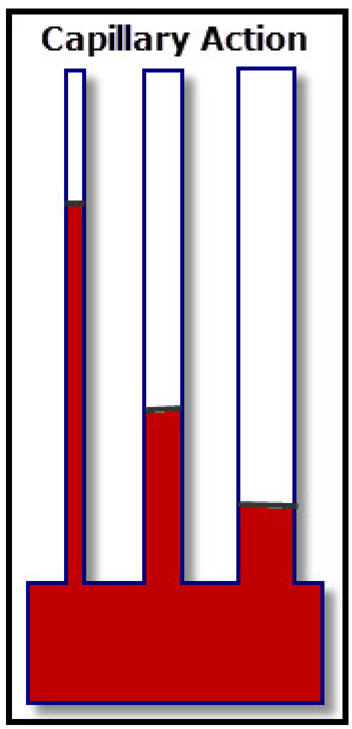
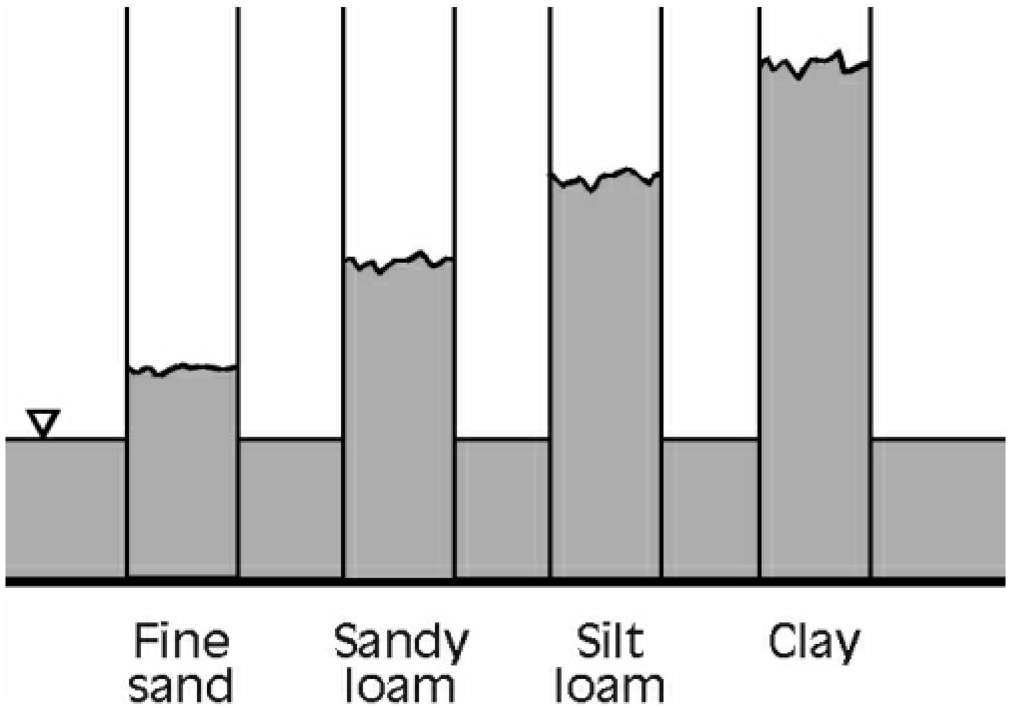


Figure 2: Capillary Rise or "Wick" in Four Soil Types



Locally Available ET Sand

Sand media is a substantial component of the overall cost of an ET-OWTS. Sand is obtained from a sand and gravel mine or pit, and then transported via truck to the site of the OWTS. The high cost is primarily due to transportation-the further the sand must be transported, the more the system costs. Consequently, it is desirable to obtain ET sand from a nearby pit.

Sand meeting the exact specifications of the Colorado Department of Public Health and Environment (CDPHE) Regulation #43 OWTS, and TCHD O-14, is often not available from pits near the locale of ET OWTS.

One of the local pits has provided a sieve analysis of their ET sand, with values relative to specifications as indicated below in Table 2:

Table 2: Locally Available Sand vs. O-14 Specification

Sieve No. or Indicated Value	Available Sand, Percent Passing or C_c & C_u	O-14 Specification Percent Passing, or C_c & C_u	Historic Spec Met? (I-80 & I-85)	Historic Spec Met? (I-88, I-96, I-02, I-11)	Current (O-14) Specification Met?
4	100	100	N/A	Yes	Yes
10	100	N/A	N/A		
20	99.66	N/A	N/A		
40	79.5	50-70	N/A	No	No
60	52.1	N/A	N/A		
100	10	N/A	N/A		
200	0	<15	N/A	Yes	Yes
Capillary Rise: 17"	N/A	N/A			N/A, but relevant to sand performance
0.25mm < D_{10} < 0.6mm (1980); 0.24 mm<D_{10}<1mm (1985)	0.149 mm (too fine)		I-80: No I-85: No		N/A
	C_c = 0.085	C_c >1			No
	C_u = 2	C_u >6			No

As the table indicates, the ET sand does not meet either the historic or the current specification. The ET sand is too fine, i.e. less than D_{10}, based on the 1980 and 1985 specifications, and also too fine (based on the % passing the #40 sieve) for the other historic TCHD regulations. Specifically, the sand material has 9.5% more passing the #40 sieve than the maximum allowable of 70%, indicating that the material is too fine on the #40 sieve by 9.5%.

The specification also states that the sand must be well graded between the #40 and #200 sieve sizes. The measures of a well graded soil are the Coefficient of Curvature (C_c) and the Coefficient of Uniformity (C_u). In order for a sand to be uniform, 1< C_c < 3 and C_u must be greater than 6.

The sample provided by the pit, labeled (ET Sand) has the following values:

Coefficient of Curvature (C_c): 0.085 <1;

Coefficient of Uniformity (C_u): 2 <6

Therefore, the sample is not well graded.

Grain Size Plot and Calculations

The grain size plot and related calculations for the locally available sand are shown in Figure #3 below. In order to compare, two hypothetical samples meeting the gradation specification (Sample A and Sample B), are plotted on the on a second grain size curve and the Coefficient of Curvature (C_c) and Coefficient of Uniformity (C_u) are calculated, as shown in Figure #4 below.

Figure 3: Locally Available Sand

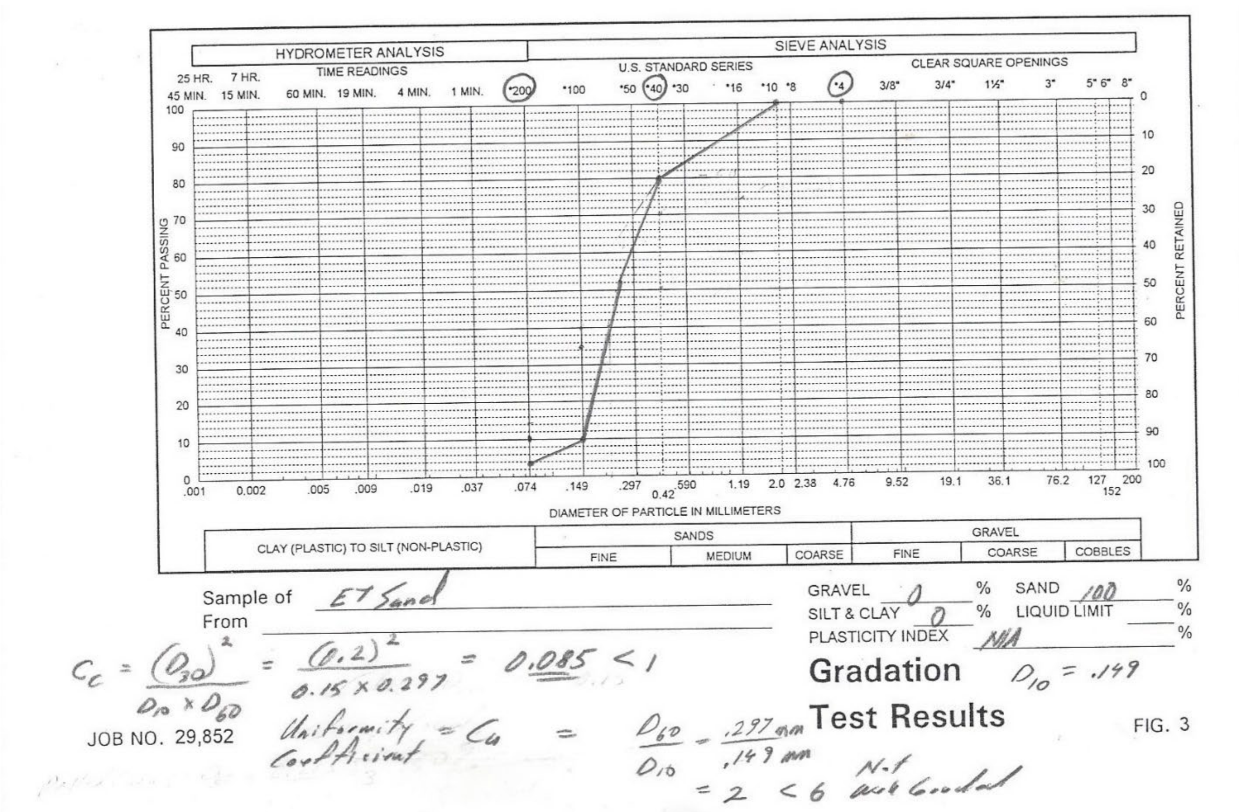
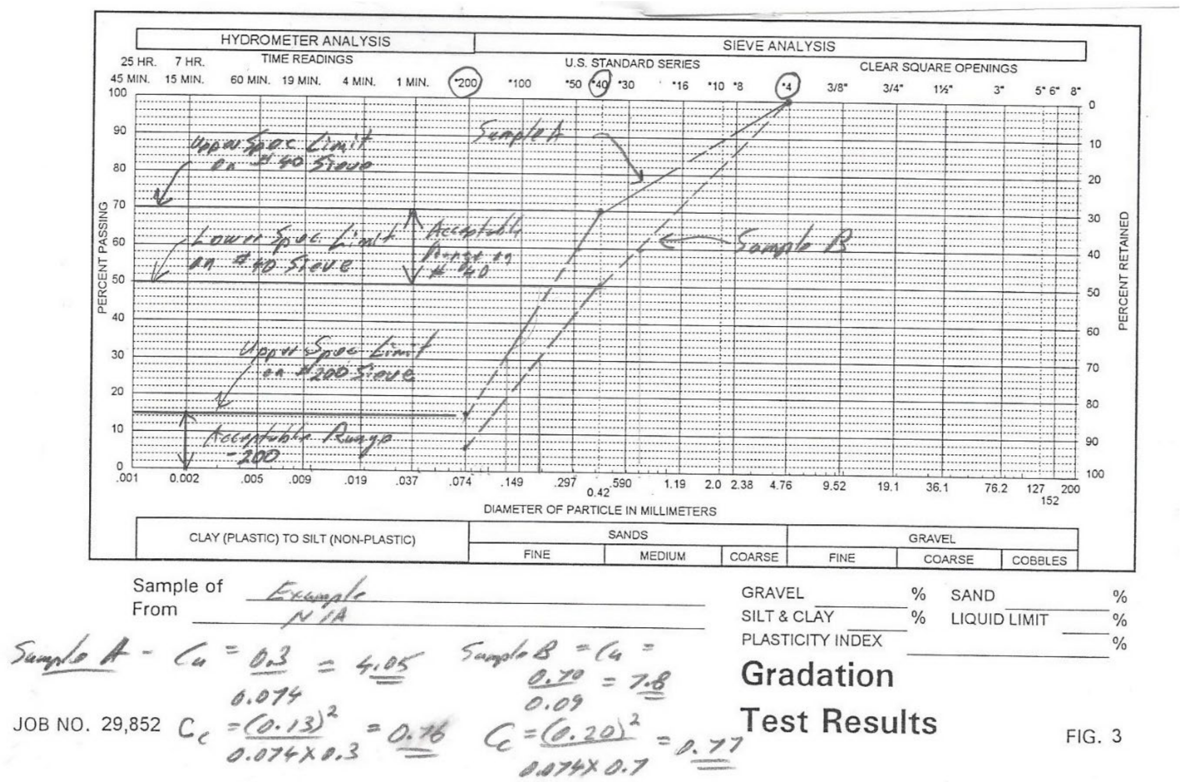


Figure 4: Hypothetical Samples A & B



Hypothetical Sample A:

Coefficient of Curvature (C_c): 0.76 < 1

Coefficient of Uniformity (C_u): 4.05 < 6

Therefore, Sample A is not well graded; however, it is significantly closer to being well graded than the "ET Sand" from the pit.

Hypothetical Sample B:

Coefficient of Curvature (C_c): 0.77 < 1

Coefficient of Uniformity (C_u): 7.8 > 6

Based on C_c, Sample B is not well graded; however, based on C_u alone, Sample B is well graded.

Therefore, all three samples do not meet the full definition of "well graded"; however, sample B is very close.

Table 3 below summarizes the results of the available sand from the pit, and the two hypothetical sand samples A and B:

Table 3: Comparison of Locally Available Sand and Hypothetical Samples

Sample	C_c	C_c (spec)	C_u	C_u Spec	Capillary Rise (in.)	Cap. Rise Spec	Available?
Pit	0.085	1-3	2	>6	17	N/A	yes
A	0.76	1-3	4.1	>6	Unknown	N/A	?
B	0.76	1-3	7.8	>6	Unknown	N/A	?

Capillary Rise Test

The capillary rise test involves placing a sample of sand in a clear glass tube, with the bottom of the tube in a bucket of water. The level of water in the sand is measured over a period of time, to determine the capillary rise. This simulates the amount of "wicking" of septic tank effluent that would occur in an ET bed. The owner of the pit did a capillary rise test on the sample sand and the water rose to a height of 17" in after 72 hours. Since the typical average depth of sand in an ET OWTS is 24", this would represent a rise of 71% of the depth of the bed. While the ET sand specification does not require this test, the test is useful in measuring that aspect of the performance of the sand.

Conclusions

The sample provided by the pit does not meet the specifications of O-14. It is probable that ET sand meeting the specifications would provide a higher capillary rise, resulting in a greater degree of evapotranspiration. However, the available material does produce a significant capillary rise or "wick" and is close to meeting the gradation standard. The deviation from the gradation standard is on the #40 sieve, which means the sand is finer than specification on the #40. However, the sand contains significantly less silt and clay sized particles or -200 sieve-size material than the maximum allowable (3.48% vs. 15%). Consequently, the potential for clogging of the sand is significantly less than sand containing higher amounts of silt and sand sized particles. The capillary rise should be sufficient to move the effluent upward into the rhizosphere (root zone) of the plants, facilitating transpiration of the effluent.

ACHD Policy

TCHD contacted the CDPHE OWTS coordinator, Chuck Cousino, regarding the acceptance of the locally available sand discussed in this document. It was agreed that the additional requirement for a capillary rise test and minimum capillary rise would be "more stringent than" what is required in Regulation #43, and thus acceptable for use in an ET installation.

ACHD will allow for the use of Evapotranspiration Sand which does not meet the prescriptive requirements in Regulation O-14, subject to the following:

1. **The sand gradation falls within the requirements for percent passing the #4 and #200 sieves, in Table #12 of O-14.**
2. **The sand gradation does not deviate more than 10% "finer than" the maximum allowable percent passing specification for the #40 sieve. That is, there may be as much as 80% passing the #40 sieve.**
3. **The sand gradation test must be dated no more than one month prior to the installation date.**
4. **The sand supplier conducts and maintains documentation of capillary rise testing, to indicate that the capillary rise of water within the sand is at least 15" or one-half the maximum depth**

of the sand media within the ET bed, whichever is greater. The capillary rise test shall be dated no more than one month prior to the installation date.

5. **The design engineer shall approve the sand material prior to delivery of material to the site and submit to the Department, prior to final approval, sand gradation and capillary rise test results showing conformance with this policy.**