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Technical Bulletins: Sand for Wastewater Drying Beds

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MTAS Municipal Technical Advisory Service

*In cooperation with the
Tennessee Municipal League*



May 8, 2007

SAND FOR WASTEWATER DRYING BEDS

Brett Ward, Utility Operations Consultant

Drying beds for wastewater sludge or biosolids require a specific type of sand in order to dewater the sludge quickly. Sand from the local building supply or concrete retailer, though low cost, is a very poor choice for drying beds. Masonry sand is very fine and will not drain the water away from the sludge. For faster drying, choose a coarse sand that will hold the solids but allow the water to drain.

DESIGN CRITERIA

Sand is classified according to two criteria. The first, called the effective size, is the size or diameter of the sand particles. The second, called the coefficient of uniformity, is the uniformity of the particles.

The coefficient of uniformity tells the purchaser if the sand particles are uniform. A coefficient of uniformity of 1.0 means that all the sand particles are exactly the same size. This is never the case; particles will always have some variation in size.

The effective size tells the purchaser that 90 percent of the particles are larger than the effective size and 10 percent of the particles are smaller than the effective size. This smallest 10 percent determines the speed of draining from a drying bed. The more small

particles and dust in the sand, the longer it takes for the solids to dry.

The state design criteria specify that:

- the top course (in the drying bed) shall consist of at least nine inches of sand with a uniformity coefficient of less than 3.5; and
- for trickling filter sludge, the effective size of the sand shall be between 0.8 and 3.0 mm; and
- for waste activated sludge, the effective size of the sand shall be between 0.5 and 0.8 mm.

Sands of these sizes will provide excellent dewatering. However, they are expensive and hard to find. Because of this, many facilities use whatever is easily available, which in most cases is construction sand that is too fine to dewater biosolids quickly.

GENERAL SIZE CLASSIFICATIONS

Sand sizes are determined by the amounts that will pass through each of a series of sieves. Coarse sand will pass through a No. 4 sieve with an opening size of 4.76 mm, but it will not pass through a No. 10 sieve with openings of 2.0 mm. Medium sand will pass through a No. 10 sieve but not through a No. 40 with openings of 0.42 mm.

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Fine sand will pass through a No. 40 sieve but not a No. 200 sieve with openings of 0.074 mm. Course sand is used for trickling filter plants, whereas medium sand works best for activated sludge plants. NEVER use fine sand on the drying bed. Fine sand is used for mixing mortar and concrete and also in golf course sand traps. If you use this type of sand in a drying bed, expect the sludge dewatering to be very slow. In addition, after a fine sand has contaminated the coarse sand and gravel media of the bed, water movement through the media will be slowed from that point on or until the entire media bed is replaced. The reason is that the fine particles and dust in the fine sand move down into the coarser media clogging the media and slowing water movement.

River sand is available in many parts of Tennessee. Natural sands often do not meet state specifications for drying beds; however, they are far superior to construction sand and are economical to purchase. There are also some manufactured sands and other similar products that will function in the drying bed. Using these “junk sands” is more economical than using sand that meets the state’s exact specifications. And with careful selection, they can dewater sludge just as well.

SIEVE TEST RESULTS		
Table No. 1		
Sieve Size	No. 1	No. 2
	Percentage Passing	Percentage Passing
4		99.9
8		97.8
10	100	96.4
14	85.7	
46	58.9	80.5
20	10.7	
30	3	28.2
40	1.0	
50	0.6	5.5
100		0.8

EXAMPLES

Table 1 shows the results of sieve tests done on two types of sand. Sand No. 1 is an AWWA (America Water Works Association) approved filter sand that has been washed and graded to specifications of 0.75-0.85 mm. This is excellent for drying beds, but it is also expensive. The cost is more than \$20 per ton in Junction City, Georgia. The No. 2 sand is from the Nolichucky River and costs less than \$5 per ton in Greeneville, Tennessee.

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The results of these analyses are plotted on semi-logarithmic graph paper and show a gradation curve for each product. (See Figure 1 on the following page.) The No. 1 sand has an effective size of 0.82 mm. This is the point where the graphed line crosses the 10 percent horizontal line. This tells an operator that 10 percent of the sand will be smaller than 0.82 mm. The smaller the effective size, the finer the sand, which means that dewatering will be slower.

The other important requirement for sand is the coefficient of uniformity. This is found by dividing the size at the 60 percent line by the effective size at the 10 percent line. Sand No. 1 is $1.18 \text{ mm}/0.82 \text{ mm} = 1.44$, proving that this a very uniform sand. Sand No. 2 has a coefficient of $0.95 \text{ mm}/0.35 \text{ mm} = 2.7$. Both of these sands meet the state specification that sand must have a uniformity coefficient of less than 3.5.

The most important aspect of choosing sand for a wastewater sludge drying bed is to use a coarse sand. When purchasing sand, request that the supplier provide you with the effective size and coefficient of uniformity. If they cannot, request a sieve analysis and use the graph on page 8 to construct your own gradation curve, which you can use to calculate the needed specifications. Choose the sand for your drying beds by comparing the effective size and coefficient of uniformity of the available sands with the state specifications for your type of plant.

The closer you can get to this ideal effective size and coefficient of uniformity, the quicker your sludge will dewater. If you have a sand available that is very close to state specifications and is economical to purchase, use it. If your available sands are not close to state specifications, continue to search for a better source of sand. The effort you put into finding a coarse, uniform sand will be rewarded many times over through faster dewatering of biosolids and more efficient use of your plant facilities.

SAND BED MANAGEMENT TIPS

- Clean biosolids thoroughly from the sand. Rake sand to remove the small biosolids.
- Prepare the surface by using a garden tiller to loosen the sand. Or, loosen by stabbing the sand with a fork and rocking it side to side.
- Leave the surface rough to allow the sand to dry.
- Level sand immediately before applying an application of biosolids.
- To accelerate drying, consider covering partially dried biosolids with a plastic sheet during wet weather. When the sun returns, remove the plastic to allow drying to continue.

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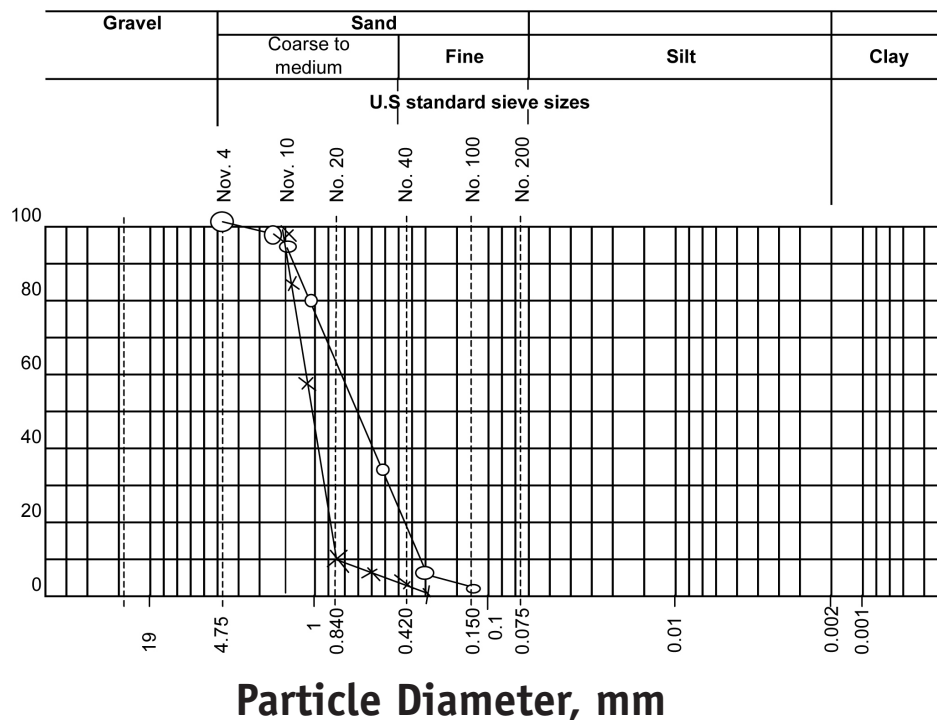
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To assist utilities in locating the appropriate sand for their facility, Appendix 1 includes an MTAS survey of sand suppliers across the state. The first

suppliers listed have stated that they have products available that meet the exact criteria for drying beds. The second group of suppliers indicated that they do not have the exact sand but can either make the exact sand or have one that is close. Sand meeting the exact specifications should always be the first choice, but one that is close to the specifications may prove almost as good and far more economical. Some of the surveyed suppliers sent sieve analysis data, which is not included in this publication. It is recommended that if a utility is considering a sand that does not exactly meet the design criteria specifications, an up-to-date sieve analysis should be used in making that purchasing decision.

FIGURE NO. 1 PLOTTING GRADUATION CURVES



X-Porter Warner .75 - .85 mm
effective size = .82 mm
Cu = 1.46

O-Nolichucky River Sand
effective size = .35
Cu = 2.7

APPENDIX I: FILTER SAND FOR MUNICIPAL WASTEWATER PLANTS

A survey conducted for Brett Ward, June 2006

CONTACT	Can you provide sand with an effective size 0.8 - 3.0 mm & a uniformity coefficient of <3.5?	Can you provide sand with an effective size 0.5 - 0.8 mm & a uniformity coefficient of <3.5?	If your company cannot provide these products, can you provide anything close?	If so, could you please provide sieve test results?	Approximate price per ton
Church Brothers Sand & Gravel 917 West Watauga Avenue Johnson City, TN 37604 Phone: (423) 926-1241	Yes	Yes			\$21/ton
Culligan of the Tri-Cities 2004 Highway 75 P.O. Box 1037 TCAS Blountville, TN 37617 Phone: (423) 323-4195 Fax: (423) 323-4195	Yes	Yes			\$505 + freight
Rinker Materials 736 Centenary Road Blountville, TN 37617 Phone: (423) 323-5111	Yes	Yes			\$11.25/ton, pickup
Tennessee Asphalt Company P.O. Box 1327 Paris, TN 38242 Phone: (731) 642-5791 Fax: (731) 642-2646 E-mail: dpryor@tnasphalt.com	Yes	Yes	Yes, concrete sand	Yes	\$6.50 concrete sand, pickup \$12.50 filter media, pickup
Porter Warner Industries Chattanooga, TN Phone: (423) 266-4735	Yes	Yes			Graded sand is expensive.
Tinker & Watkins Sand & Gravel 1299 Perryville Road Parsons, TN 38363 Phone: (731) 847-7718	Yes	Yes		Yes	\$10, pickup
U.S. Silica Co. 105 Burkett Switch Road Jackson, TN Phone: (800) 345-6170	Yes	Yes			\$70/ton, pre-packaged 3,000 lb. bulk bag

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CONTACT—THE FOLLOWING SUPPLIERS DID NOT HAVE THE CORRECT SIZES IN SUPPLY BUT MANY INDICATED THEY COULD PROVIDE THEM.	Can you provide sand with an effective size 0.8 - 3.0 mm & a uniformity coefficient of <3.5?	Can you provide sand with an effective size 0.5 - 0.8 mm & a uniformity coefficient of <3.5?	If your company cannot provide these products, can you provide anything close?	If so, could you please provide sieve test results?	Approximate price per ton
Cumberland Mtn. Sand Co. P.O. Box 99 Hillsboro, TN 37342 Phone: (931) 596-2841	No	No	Request sieve analysis	Yes	Masonry \$10.50 + tax Concrete \$9.50 + tax
Dement Construction Co. P.O. Box 1812 Jackson, TN 38302 Phone: (731) 424-6283 Fax: (731) 784-3054	No	No	Request sieve analysis		\$8 at plant
Dunlap Sand & Stone P.O. Box 1595 Dunlap, TN 37327 Phone: (423) 949-6588	No	No	Yes	Yes	\$9/ton, pickup
Greystone (sub of Vulcan Materials, formerly Nolichucky Sand & Gravel) 75 Rambo Road Greeneville, TN 37743 Phone: (423) 638-8564	No	No	Yes	Yes	Could not give approximate price
Hunter Marina (Supplier) 6615 Robertson Road Nashville, TN 37209 Phone: (615) 352-6935	No	No	Maybe—can manufacture large volumes of any size.	Yes	\$7.90, pickup for concrete sand
Ingram Materials, Clarksville 610 Riverside Drive Clarksville, TN 37040 Phone: (931) 648-0231	No	No	Yes—same sand as Nashville location	Yes	\$8.15/ton, pickup
Ingram Materials Co. 1030 Visco Drive Nashville, TN 37210 Phone: (800) 421-6998	No	No	Yes—effective size 0.3 mm and a uniformity coefficient of <2.1	Yes	\$8.15/ton, pickup in Nashville

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CONTACT—THE FOLLOWING SUPPLIERS DID NOT HAVE THE CORRECT SIZES IN SUPPLY BUT MANY INDICATED THEY COULD PROVIDE THEM. (cont'd)	Can you provide sand with an effective size 0.8 - 3.0 mm & a uniformity coefficient of <3.5?	Can you provide sand with an effective size 0.5 - 0.8 mm & a uniformity coefficient of <3.5?	If your company cannot provide these products, can you provide anything close?	If so, could you please provide sieve test results?	Approximate price per ton
Martin Marietta Materials 1455 Bud Cleary Road Statonville, TN 38379 Phone: (731) 632-9510 Fax: (731) 632-1651	No	No	Yes—concrete sand	Yes	\$5.50/ton, F.O.B.
Memphis Stone 10236 Millington Arlington Road Arlington, TN 38002 Phone: (901) 947-5700 Fax: (901) 774-4028 E-mail: gray.oakley@msgravel.com	No	No	Yes—concrete sand, #4-100 sieve	Yes	\$6.50/ton, F.O.B.
Sand Supply Co. P.O. Box 97 Jamestown, TN 38556 Phone: (931) 863-3752	No	No	Yes—masonry sand	Yes	\$8, price depends on quantity purchased.
Sandswitch 15878 Sewanee Hwy. Sewanee, TN 38375 Phone: (931) 598-0091	No	No	Not in stock, but could produce special order if large enough quantity is desired		
Short Mountain Silica 170 Silica Road Mooresburg, TN 37811 Phone: (423) 272-5700 www.shortmtsilica.com	No	No	Yes—30/70 filter sand. Effective size 0.35 and a uniformity coefficient of 1.54	Yes	\$27/ton + freight
Teague Brothers Sand & Gravel 3107 Cypress Creek Road Linden, TN 37096 Phone: (731) 847-0848	No	No	Yes—concrete sand, 2.95-4.75 mm	Yes	\$4.80/ton, pickup

SIEVE ANALYSIS

U.S. STANDARD SIEVE OPENING
in Inches

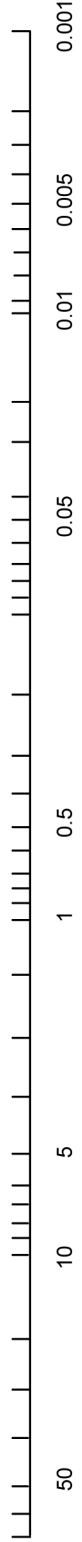
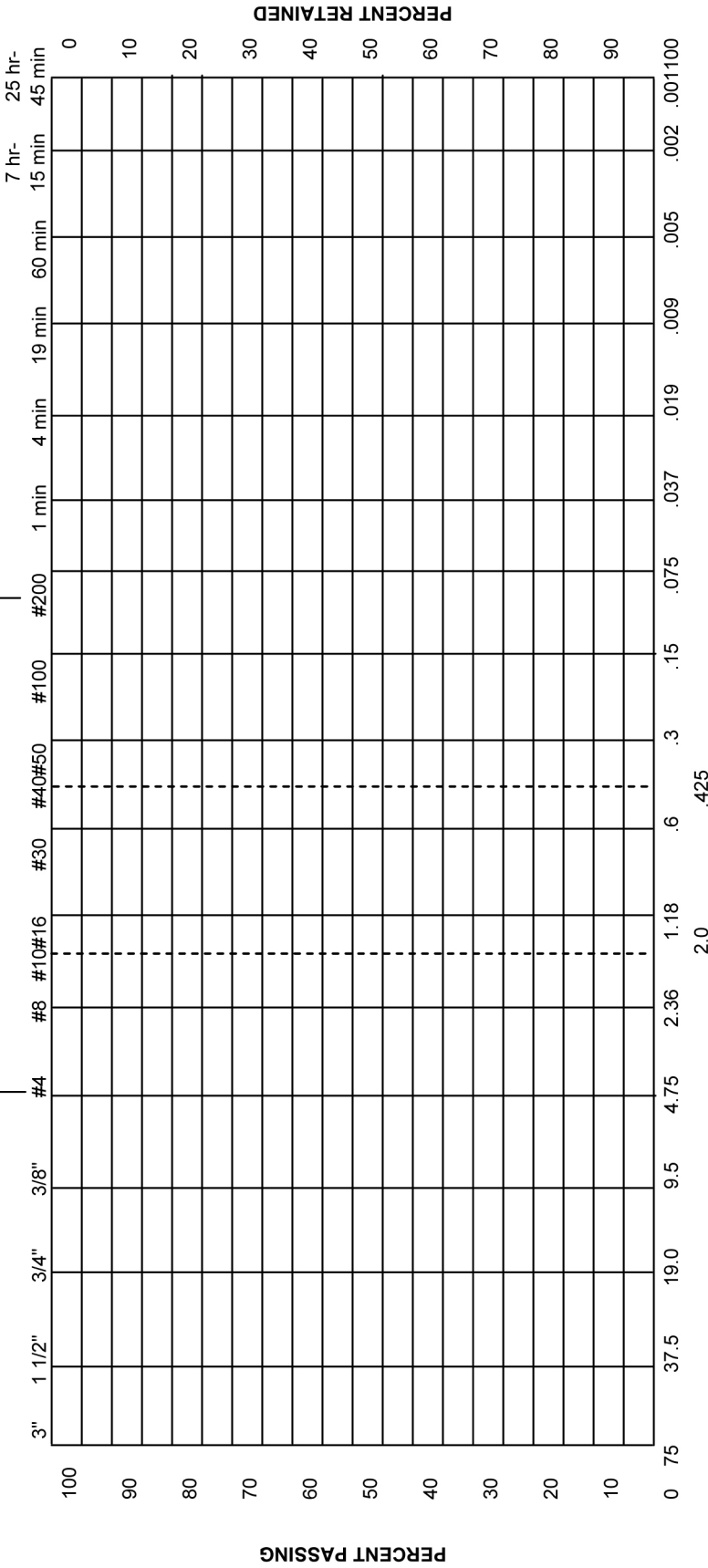
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HYDROMETER ANALYSIS

U.S. STANDARD SIEVE NUMBERS

TIME READINGS

GRADUATION TEST



DIAMETER OF PARTICLE IN MILLIMETERS

GRAVEL	SAND		FINES	
COARSE	FINE	COARSE	MEDIUM	FINE

PREPARED BY _____ CHECKED BY _____ FIGURE _____

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MTAS OFFICES

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