Minimum Required Information to Accept Disposal in Engineered Fill

Biographical Sketches of Respondents:

Robert A. Rubin, Ed.D.
Professor/Retired
North Carolina State University
Department of Biological and Agricultural Engineering
210-A Weaver Labs
Box 7625, NCSU
Raleigh, NC 27695-7625

Voice: (919) 515-6791
Fax: (919) 515-6772
E-mail: rubin@eos.ncsu.edu

Dr. Bob Rubin retired June 30th 2004 after serving the department since 1978. He was first appointed as an extension specialist and progressed through the ranks to become professor in 1996. Rubin has conducted one of the most dynamic and far reaching programs in wastewater management and biosolids recovery/disposal in the United States. His innovative technology transfer efforts, aimed at training operational personnel, regulators, and government officials, were second to none and were extremely well attended. Rubin provided national leadership in the critically important areas of rural water quality and wastewater management, as evidenced by his invitation to address Congressional committees that deal with those problems.

June of 2003, Dr. Rubin was presented the "Bronze Medal for Commendable Service" by the United States Environmental Protection Agency. This was a very deserved and fitting honor for an individual who has devoted his professional career to enhancing the performance and reliability of wastewater treatment systems. Rubin plans to continue some consulting work and to continue working with the USEPA as a visiting scientist. As an emeritus faculty member, Bob will continue to contribute to the mission of the BAE department.

James Converse, Ph.D.
University of Wisconsin-Madison
College of Agricultural and Life Sciences
Department of Soil Science
263 Soils Bldg
1525 Observatory Drive
Madison, WI 53706

608-262-1106
608-262-1228
jcconver@facstaff.wisc.edu

Dr. James C. Converse is currently emeritus professor after having been a professor in the Biological Systems Engineering Department at the University of Wisconsin Madison for 35 yrs. He has been involved in teaching, research and extension in the environmental area specializing in onsite domestic wastewater treatment and in animal waste management. He has served as chair of a number of onsite wastewater treatment symposiums and animal waste symposiums sponsored by ASAE over the past number of years.

He served as Department Chair from 1988 - 1996. He has received numerous awards including the Gunlogson Country Side Engineering Award from the American Society of Agricultural and Biologic Engineers (ASAE). He is a Fellow in ASAE. He has numerous publications animal waste management and on-site wastewater treatment.

He received a BS and MS degree in Agricultural Engineering in 1964 and 1966 from North Dakota State University and a PhD in Agricultural Engineering in 1970 from the University of Illinois.

Randall J. Miles, Ph.D.
Associate Professor
Director, Sanborn Field and Duley-Miller Research Plots
Director, Missouri Wastewater Small Flow Research and Training Center
University Of Missouri
School of Natural Resources
301 Anheuser-Busch Natural Resources Bldg.
Columbia, MO 65211
(573) 882-6607

Dr. Randall J. Miles is an Associate Professor of Soil Science at the University of Missouri in the Soil, Environmental, and Atmospheric Sciences Department. Randy coordinates the department's undergraduate program, teaches introductory soils courses, coordinates the Introductory Soil Science Laboratory, and serves as coach of the MU Soil Judging Team. Randy’s research efforts have focused on soils and onsite wastewater systems, soil acidity, aluminum activity, liming, and soils and archaeology. He also serves as the Director of Sanborn Field (the third oldest continuous research field in the world) and as the Director of the Missouri Small Flows Wastewater Research/Education Training Center.

Rodney Ruskin
Founder & CEO
Geoflow Inc
506 Tamal Plaza
Corte Madera, CA 94925

Tel: (415) 927-6000
Fax: (415) 927-0120
rr@geoflow.com

Rodney Ruskin, Karen Ferguson and Alvaro Sanjines founded Geoflow in August 1990, when the use of ROOTGUARD® technology was granted in the United States. They have a combination of skills and experience gained over forty years in drip irrigation product design, manufacturing and marketing. We develop and deliver cutting–edge technology and train you, the user, about the advantages and opportunities of subsurface drip. Geoflow is recognized in the drip community for delivering extremely reliable high quality products and service.

Our team consists of qualified, knowledgeable experts, including professional engineers and certified irrigation designers who will take care of your subsurface drip needs. We are here to work with you every step of the way from design through distribution, installation and maintenance.

We are dedicated to protecting the environment. Geoflow's mission is to provide products, technology and know–how that will enable the agriculture, landscape and wastewater industries to use sound irrigation and dispersal practices that preserve the quality and quantity of valuable water resources.

David Venhuizen, P.E.
Principal
Venhuizen Engineering
5803 Gateshead Dr
Austin TX 78745
512-442-4047
512-442-4057
waterguy@ix.netcom.com

B.S. Aeronautical & Astronautical Engineering
B.S. Liberal Arts & Sciences--Biology Major
University of Illinois at Urbana-Champaign, 1970
M.S. Civil Engineering from University of Texas at Austin, 1975

Registered Professional Engineer:
State of Texas, 1980
State of Wisconsin, 1987
Licensed Irrigator, State of Texas, 1987

In the course of pursuing his efforts in this field, Venhuizen has conducted extensive investigations and literature studies to determine appropriate design and performance capabilities of the septic tank, the anaerobic upflow filter, biofiltration concepts, various constructed wetland concepts, and other technologies which appear well suited to small-scale deployment. Having built over the years relationships with many of the foremost authorities in this field-university researchers, regulatory officials, and those in private practice-Venhuizen is often just a phone call away from the latest information on cutting edge practices in this field. His ability to quickly translate such information into practical wastewater management methods is a key to the success of his projects.

Venhuizen has served on the Texas Department of Health's On-Site Surface Application Advisory Committee and its Greywater Standards Advisory Committee, on the Texas Water Commission's Constructed Wetlands Standards Advisory Committee and its Clean Water Task Force's Alternative Treatment Committee. He has served on the City of Austin Water and Wastewater Commission and was one of six nationally recognized experts to serve on the Technical Advisory Committee for the first phase of EPA's National Onsite Demonstration Project. He has also conducted seminars on innovative/alternative small-scale wastewater management in Colorado, Massachusetts, Texas, Oklahoma, Wisconsin, and El Salvador.

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(Drip or other method of application)

Information from professionals that have designed and installed at least three systems each, and have observed them for at least five years who can answer the following questions (the experience need not be identical, but there should be no information that is contradictory):

1. What textures and structures of soil are allowed to be used for fill? Describe with USDA soil triangle, percolation rate, or permeability.

Dr. Bob Rubin	I suggest that any soil texture listed can be used, however, loamy soils and coarser will be the best to "work" with heavy equipment. If you were to specify a finer textured soil, there will probably be limitations encountered during the fill operations. Permeability should be above 10 minutes per inch and below 60 minutes per inch. Depending on the permeability of the permeability of the native soil - I would suggest trying to match permeability as close as possible in the range suggested.

Dr. Jim Converse	I would limit the texture to a sandy loam, loamy sand or coarse sand as placement will be much easier than using finer textured soils with structure as you will destroy the structure when placing the soil. That is the main reason we use coarse sand in mounds. My following comments are based on using the coarse soils as placement of the fine textured soils will alter the soil structure.

Dr. Randy Miles	From an overall standpoint I would insist on sandy loams, silt loams, loams, and loamy sands with 20% clay or less. This should be performed under dry conditions and with little organic debris (roots, twigs, etc) in the material. Under the proper conditions other textures can be used but the prescriptive aspects of the material placement becomes more narrow with respect to moisture etc.

Rodney Ruskin	It depends to some degree as to why you are adding the fill and the end use of drainfield. In many cases the final use is for landscaping, parks or playing fields. In those cases a good garden soil is useful. If the application is only dispersal, then I agree with the comments above.

David Venhuizen, P.E.	Depends on how much the soil has to be "worked". If it can be placed (at "proper" moisture) without any more compaction than walking over it, allowed to "consolidate" from sprinkling or rainfall, then I'd expect any soil type could be used. But I spec loam or "better". As Rodney noted, prepared "garden" soils, a mix of soil and compost would also be an excellent choice. As he noted, what you use will depend somewhat on how "finished" you want the final surface to be -- e.g., you'd want an "improved" soil if the area would be a high quality landscaped area.

2. How is the soil to be used for fill to be harvested? Describe allowed moisture content of harvested soil, how the soil is transported, and any requirements for storage at the site to be filled.

Dr. Bob Rubin	Harvest should be with backhoe or scraper blade. Moisture content should be dry - field capacity to wilt point. Manufactured soils are appropriate also. Those are soils i would define as designed or specified mixes of compost and soil materials specified for the fill. Those soil materials could be harvested from river sediments or construction projects where soil was removed, hauled to a site and mixed or blended with specified proportions of compost to add organic matter, sand or other soil materials to adjust texture to desired range. Soil should not be stored on site for a long period of time. Don't really know the limit for storage.

Dr. Jim Converse	Soil should be relatively dry but not as critical when using a coarse textured soil as recommended above.

Dr. Randy Miles	The vegetation must be removed from the surface of placement and harvest. All of this must be performed under dry conditions. I prefer that the soil is harvested transported, then immediately placed where it is intended to be placed. Stockpilin requires more handling and possible compaction. also if the material is stockpiled there will be differential moisture content when transported again (outer cone is dry while interior is moist to wet) thus smearing and poor mixing attributes.

Rodney Ruskin	I agree with the comments above.

David Venhuizen, P.E.	Agreed.

3. How is the site to receive the soil to be prepared? Is any equipment allowed on the site, and if so what kind?

Dr. Bob Rubin	I suggest the host soil must be scarified to a depth of say 4 to 6 inches, the fill soil must be added in lifts of say 6 inches per lift and each lift should be blended with the previous lift until the desired height is achieved. Placing piles of soil adjacent to one another does create some discontinuity in the area and that is why i suggest lifts. This placement can be done with backhoe placing fill from the side, not over the area specified to host the system. Light farm equipment can be used to mix the lifts.

Dr. Jim Converse	The native vegetation should be removed but not the sod with the resulting surface tilled with a chisel plow to a depth of about 4/5 inches with the moisture level in the native soil being below the plastic limit (won't form a wire when rolled between the palms.

Dr. Randy Miles	The imported soil must be placed in lifts of 6 to 8 inches under dry soil conditions (both receiving soil site as well as the imported soil). The native vegetation of both the receiving site and the area of harvest for the imported soil must be removed. Use of a chisel plow for scarification is fine.

Rodney Ruskin	Any time fill material is to be used, the area to receive the fill should have all surface grasses and other organic material removed or it must be incorporated into the natural soil to prevent an organic layer from forming and restricting downward water movement. The fill material should be applied in shallow layers with the first 4 to 6 inches incorporated into the natural soil to prevent an abrupt textural interface. Continue this process until all fill has been incorporated

David Venhuizen, P.E.	Scarify and blend with thin layer of fill. Can leave existing plant cover as long as it is "chopped up" and blended in.

4. How is the soil to be used for fill applied? Please address the following points:

Dr. Bob Rubin	See above

Dr. Jim Converse	Place in 6-8" layers with each layer being sightly mixed into the other layer to avoid boundary layers. Use backhoe to place. Minimize driving on the layers. If coarse textured soils such as sand are used, it can be compacted slightly to minimize settling later. Small track type tractor with blade can be used to smooth the surface.

Dr. Randy Miles	

Rodney Ruskin	Rodney Ruskin: 4” – 6” is commonly used. I think that the critical point is to use at least two layers. E.g. Even if one is adding only 6” use two layers of 3” each.

David Venhuizen, P.E.	David Venhuizen: 4-6"

a. What is the maximum imported soil lift depth?

Dr. Bob Rubin	I suggest 6 inches per lift
Dr. Jim Converse	6-8" lifts
Dr. Randy Miles	6 to 8 inch lifts
Rodney Ruskin	I do not know of any reason why there should be a limit. However, I also do not know of any reason why more than 3 ft. should be useful.
David Venhuizen, P.E.	With high quality pretreatment, as little as 6" of "suitable" soil is all you need between drip emitters and a limiting condition to provide protection of public health and environmental values. Typically specified minimum burial depth of the drip lines is 6". So I wouldn't see much point in any more than 18" total fill depth. But as far as whether you can "engineer" a greater depth, sure.

b. Is there a maximum total depth of engineered fill allowed?

Dr. Bob Rubin	I would suggest 2 to 3 feet as a reasonable maximum

Dr. Jim Converse	2-3 ft

Dr. Randy Miles	I would use no more than 3 feet max. I prefer 2 feet.

Rodney Ruskin	I do not know of any reason why there should be a limit. However, I also do not know of any reason why more than 3 ft. should be useful.

David Venhuizen, P.E.	With high quality pretreatment, as little as 6" of "suitable" soil is all you need between drip emitters and a limiting condition to provide protection of public health and environmental values. Typically specified minimum burial depth of the drip lines is 6". So I wouldn't see much point in any more than 18" total fill depth. But as far as whether you can "engineer" a greater depth, sure.

c. Is there a minimum depth of engineered fill required?

Dr. Bob Rubin	Whatever the site evaluation suggests, again, i would suggest 6 inch lifts, so a minimum might be 6 inches.

Dr. Jim Converse	I suggest a minimum of 6" with the native soil providing the remaining separation distance to limiting conditions of seasonal saturation or bedrock.

Dr. Randy Miles	With the lifts being a range of 6-8 inches I recommend that a minimum of 6 " of imported soil.

Rodney Ruskin	No

David Venhuizen, P.E.	That depends on the purpose of adding the fill. If it is to attain a minimum standoff to a limiting condition, then that sets the minimum.

d. Is there a maximum moisture content allowed in the imported soil when it is placed?

Dr. Bob Rubin	Field capacity to wilt point
Dr. Jim Converse	field capacity to wilt point
Dr. Randy Miles	I prefer wilting point as idea for harvesting and placement. However, with time and weathering playing a role the more under field capacity the better. If one is to err go on the dry side.
Rodney Ruskin	Agreed
David Venhuizen, P.E.	Agreed, it needs to be "not wet".

5. How is the imported soil conditioned after it is placed (compacted, allowed to settle naturally, watered, other?). Please provide specifics of the process (e.g. what type of compaction equipment). Are there specific methods of consolidation that are prohibited?

Dr. Bob Rubin	Allow soil to rest in place for a few days. Place from the up-slope side with backhoe or excavator bucked, use light farm equipment to mix and blend

Dr. Jim Converse	Some settling may result when placed in deeper depths. Placement in layers should minimize settling. A light watering of the sand/ sandy loam will assist in settling but not to heavy watering as it may cause size separating. If moistened in layers make sure to provide some mixing of the top of the layer to avoid the silts from being exposed on the surface.

Dr. Randy Miles	Do NOT compact. One of the secrets is the 6-8" lifts under dry conditions. If equipment is used be sure it is tracked equipment. Many times we place the fill in, then place the drip tubing, set with U-hold-downs to keep in place then the 6-8" lifts on top. Again if equipment is used it must be tracked. No wheeled equipment.

Rodney Ruskin	The fill area should be left crowned to shed surface water and may need diversion ditches or some other devices to prevent surface water from infiltrating. The entire fill area should have a vegetative cover to prevent erosion. If possible allow the fill to set at least seven to ten days before installing

David Venhuizen, P.E.	If it is a granular soil -- e.g., loamy sand or coarser, or a "garden" soil -- it wouldn't make much difference. I prefer to require it to be placed so that no machine traffic goes over it, or if it must, only a lightweight "skidsteer" type of vehicle. Tamp with a hand roller or by walking over it. Sprinkle or allow rainfall to "compact" to "finished" density. Or -- as otherwise specified by the landscaping profession responsible for installing the plants. They will typically warrantee the plants, so they will dictate the planting conditions. And those conditions will not entail "over" compaction.

6. What type of wastewater pretreatment is required prior to discharge to the fill? Please provide effluent limitations for BOD, TSS, and total or fecal coliform.

Dr. Bob Rubin	Again, my suggestion is 30/30 to 15/15 unless conditions allow different limits. i have used septic tank effluent in fill soils in mounds and drip systems, the issue is not necessarily associated with a pre-treatment level, rather with a site assimilative capacity issue. What is required to meet a standard at the design boundary of the system???

Dr. Jim Converse	Septic or aerobically treated effluent can be used. Septic drip usually requires more area than aerobically treated effluent.

Dr. Randy Miles	We go with NSF class I treatment (ATU, media filter, etc). In other words less than 30/30 the lower the better.

Rodney Ruskin	If septic tank effluent is permitted with drip then there is no reason why it may not be used in fill. In California 30/30, or better, is exclusively used.

David Venhuizen, P.E.	Pretreatment to at least secondary quality is ALWAYS required prior to drip dispersal. Dispersal of septic tank effluent after physical filtration is a long-term O&M nightmare -- unless of course you are good with replacing the drip hose every few years. A "good" pretreatment process -- e.g., recirculating biofilter such as gravel filter, AdVanTex, E-Z Treat -- will result in at least a 3 log reduction in fecal coliform. Any standards beyond what is "naturally" produced by these sorts of processes would be as dictated by the circumstances at hand. Is the watershed nitrogen sensitive? Then provide nitrogen reduction in the pretreatment system? Is there a critical concern about bacteriological/viral pollution? UV disinfect prior to discharge and/or provide greater depth to a limiting condition. And so on.

7. How are the wastewater loading rates to fill determined (by texture, permeability, etc.) and what are they?

Dr. Bob Rubin	Texture works well. And remember, match loadings as closely as possible. Loamy soils may be loaded as high as 0.4 to 0.5 gallons per square foot per day. Maybe higher if advanced pretreatment (15/15 or lower) is achieved

Dr. Jim Converse	Our code assigns a loading rate for the various textures and structures. For septic tank effluent, the loading rate is lower than for aerobically treated effluent (BOD, TSS <30 mg/L. Mounds with a specific coarse sand are allowed to be loaded at 2 gpd/ft2 for aerobically treated effluent and 1 gpd/ft2 for septic tank effluent < 220 mg/L BOD

Dr. Randy Miles	Because one is likely to destroy or degrade structure we assign by texture. The loading rate for the imported material is less than what in would be in the native state. Usually 1/2 to 2/3 of the native.

Rodney Ruskin	Dispersal however still occurs in the natural soil and the field size must be based on the hydraulic capability of the natural soil to prevent hydraulic overload.

David Venhuizen, P.E.	All my designs are reuse designs, not "disposal" designs, so the nominal loading rate is 0.1 gal/sq.ft./day, which is below the saturated hydraulic conductivity for all but the finest/"tightest" soils. So the fill does not impact on this. But if you are "designing" just to make the water "go away", then you need to know the hydraulic conductivities of all the soil layers the water would have to pass through in order to set the upper limit of application rate.

8. Is drip disposal in the imported soil allowed? If so, what emitter flow and spacing is allowed and how does it vary by soil texture or permeability.

Dr. Bob Rubin	We have used drip in the added soil successfully. 2x2 spacing works well.

Dr. Jim Converse	Drip dispersal is probably the best way to distribute the effluent. Usually 2 by 2 spacing is used but other spacings can be used as long as the loading rate is the same.

Dr. Randy Miles	Go with drip. We have only used the 2 x 2 spacing with great success. The loading rate and time dosing are the keys.

Rodney Ruskin	Agreed. Usually 2’ x 2’ and 0.5 gph emitters.

David Venhuizen, P.E.	What does this mean, is it allowed? Isn't that what this is all about? Spacing and emitter flow is determined just like it is for any application, on the basis of the soil type and the needs of the plants. 2X2 spacing is "typical" for most plantings except turf, which needs closer spacings if "stripping" is to be minimized and a high quality turf cover is to be maintained.

9. What is the maximum slope allowed for engineered fill?

Dr. Bob Rubin	Fill is typically level to as much as 4 to 5 %. If steeper slope is encountered, divide the system into small sub-systems to accommodate slope.

Dr. Jim Converse	Slope of the native soil is not an issue. but steeper sites will require a lot of fill depth at the downslope edge of the absorption area. The linear loading rate of the native soil must be considered with laying out the width of the the absorption area so that the native soil will be able to allow the effluent to move away from the system either vertically, horizontally or a combination of both. Long narrow absorption areas are the best if the flow away from the system is primarily horizontal. Infiltration distance (native soil surface to limiting condition), slope and soil texture/structure of the native soil all influence the contour linear loading rate.

Dr. Randy Miles	We have put drip in fill on 25-30% slopes which are fairly shallow to bedrock. One of the important aspects is to control surface water (surface diversion) to slow surface runoff as well as erosion. As the slope increases I also evolve to a more loamy and less sand texture (Question 1). Sands and loamy sands are more susceptible to erosion on steeper slopes. Long narrow systems are preferred. However, we have had short, stacked systems work also. If there is vertical stacking I like to get zones with space in between each zone if possible.

Rodney Ruskin	It is generally agreed that fill should not be used on slopes greater than 20% unless means for controlling erosion, such as netting are used. On steep slopes consult a soils engineer on a case by case basis.

David Venhuizen, P.E.	Agree with the above.

There should be a record of at least semi-annual inspections (twice per year, once during a dry period, and once during a wet period) that include:

1. Observation of the fill area for breakouts.
2. Observation of the fill surface for breakouts.
3. 3. Verification that the drip system pressure [BOB RUBIN](AND FLOW RATE TO THE SYSTEM) has not changed substantially from its initial values (to help verify the absence of plugged or broken lines or emitters or lowered permeability conditions around the emitters).
4. For systems with shallow groundwater, groundwater data for total and fecal coliform from shallow monitoring wells upgradient and downgradient of the system should be available (taken during the wet season, if applicable).

Dr. Bob Rubin	5. Observation of the downslope area for breakouts. Tests to confirm the pretreatment system is performing properly.

Dr. Jim Converse	System evaluation should be done every 6 months to make certain that the system is performing properly. This includes the total system as per manufacturer's recommendations and specifications.

Dr. Randy Miles	I recommend evaluation within the first 3 months, then 6 months, then one year for the first cycle. If treatment and dispersal is of the level expected then every 6 months. There may need to be some "walk over' evaluation during times of unusual rainfall periods. The drip pressure and flow rate (especially) are critical with initiation. We would likely have a conventional drip dispersal system evaluated every 6 months or per manufacturers specs. A minimum of checking proper pre-treatment is most helpful

Rodney Ruskin	Agreed with the above – particularly that the entire system must be inspected because dispersal failure often is caused by failure of the treatment plant.

David Venhuizen, P.E.	As required by the conditions, but generally agree with the above.