An Alternative To Standard Engineered Water Quality Protection Measures At Composting Facilities

December 1, 2012

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Appropriate Technology: Science or technology considered reasonable for a particular purpose that conforms to existing cultural, economic, environmental and social conditions. It is suitable for the place in which it will be used, involving skills or materials that are easily available in the local area.

If all you have is a hammer, everything looks like a nail.

Traditional water quality preservation measures (WQPM) have relied on engineered solutions. Engineered solutions are defined here as a constructed part of a facility that has been designed and constructed as protection against an event that has some likelihood of occurring. Examples would be containment domes over nuclear power plants, flood basins, and silt fences on construction sites.

Examples of engineered solutions on composting facilities would consist of ponds, berms, concrete pavement, roof structures, etc. All of these are built with the idea that if rain should fall, perceived contaminated water would be held on site, above ground. For the engineer, he / she can sleep at night knowing that the facility can withstand certain events. For an engineer, the best solutions are rigid, static, and passive.

The following proposal argues that neither the operator nor society in general benefits from traditional engineered solutions at a compost facility. That with proper pile management techniques, the operator can make a better use of the land and capital, and yet at the same time, society's water protection goals remain in place. Assumed here is that society is better off when production efficiencies can be achieved without sacrificing environmental goals. By reducing the amount of land and capital devoted to inefficient protection measures at a composting facility without countervailing environmental losses, this is a net gain. Contrasting with an engineered containment pond, there is an alternative based on the following assumptions:

- If built for a 100-year storm event, that means that each day that structure has a probability of .0000274 of being used. Unlike roads, tractors, and grinders that are used every day, the containment pond is used once every 100 years. This represents a significant insurance cost.

•During the dry months of the year, the pond represents capital and land that is lost.

•There are certain social / environmental costs to protect the environment. Lost land, heavy equipment doing excavation, concrete making, and other costs adversely affects the environment. Thus, the net gain from such a structure should be reduced.

•The "pond" mentality accepts that clean water and contaminated water will be mixed, resulting in a larger quantity of contaminated water. Once capital costs for the pond are sunk, operational options to reducing contaminated water are disregarded. "Hey we spent all that money for the pond, we might as well use it."

In a perfect world with perfect foresight, the containment would be only in place when needed, and would cease to exist when it was not. If we knew that the 100-year storm event was going to happen in December of 2075, then the capital and land could be used for more appropriately until that event occurred. After the event, the land would be then reclaimed for production. Because we lack perfect knowledge, as insurance, such structures are built today for a future event. Built into the "pond" mentality is the assumption that clean rain water will mix with rain water that has flowed through a compost pile.

Once clean and contaminated waters mixed, then the entire amount is considered contaminated. Rainwater from the entire facility is treated on an aggregate level. In theory, an intermediate approach would be to prevent the mixing. The contaminated water would be captured, and the clean could flow off the facility. This would reduce the size of the pond considerably. This diversion is significant challenge in the real world of compost facilities.

Optimally would be to have no contaminated water, then all other rainfall (which is clean) could flow off the property. If all the rainfall were contained within the pile, then all other rainfall would be considered clean. Compost piles have unique properties that make this possible:

1) Compost material is highly absorbent.

2) Compost piles are an environment composted of trillions of bacteria and fungi. These organisms metabolize the feedstock producing heat. As the heat raises, the relative humidity within the pile drops. As the heated air leaves the pile, it carriers with it considerable amounts of water vapor. The area surrounding a pile may be saturated, but the pile itself is quickly drying. See attached video.

3) While not perfect, the National Weather Service can provide the operator with detailed forecasts that can be used to alter the pile management to adopt a "wet" operation. During dry times, the operator can manage as a "dry operation.

4) Storm intensity and probability is predictable. The rainfall for a northern coastal area is predictably different than a southern desert.

Essentially the containment of rainfall is built into the management of the piles. Simple procedures that make use of onsite machinery (capital), labor, and materials, plus forecast from the NWS allow the operator to manage the facility for maximum efficiency, and yet protect the environment.

Many manufacturing processes are exposed to outdoor elements. In many of these, rainfall that lands on the materials has the potential to carry wastes/ toxins/ nutrients / etc., into water bodies that have beneficial use. Water bodies may be above or below ground. The nomenclature for these wastes is "constituents of concern". Some manufacturing materials have low / no absorptive capabilities. Thus, some or all of the rainfall that lands on the materials will runoff. If any component from the exposed materials is transported with the runoff, then this water / component mix is defined as leachate. If the materials include constituents of concern, then it is assumed that any runoff will contain leachate..

Other exposed materials may possess very high absorption capabilities. Therefore, a high percentage, or all, of rainfall will not create leachate. If there is no runoff, then the discussion of constituents of concern is moot. For all the constituents of concern remain contained in the exposed material. Compost is an example of the latter. It can absorb copious amounts of water before any leachate is created. Even with large rain events, only specific parts of the pile will create leachate. While the discussion of the risk of "constituents of concern" of compost is unresolved for some, my comments will explore various methods preventing rainfall from exiting compost piles.

The following statements are assumed true:

#1: Compost in all stages of decomposition has a high water holding capacity. It is a material that is routinely specified for its water retention capabilities. Several companies have developed products that employ compost as an agent to retain / filter storm water.

#2: Compost dissipates the kinetic energy of raindrops because of its sponginess. Thus the erosive / scouring of falling rain is eliminated and the rain is more likely to remain in place.

#3: There exists significant rainfall data that allows a specific region to determine the expected rainfall amounts and probabilities. These events are expressed as the probability of a rainfall amount for a given year. Table #1 gives specific rain levels for our location in Lake Forest, CA.

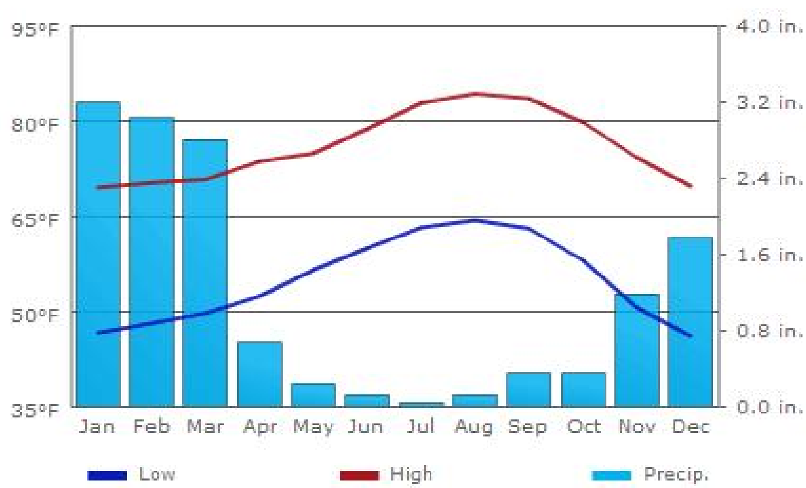
#4: Any rainfall that is prevented from coming in contact with , or from exiting a compost pile, is considered to be free of "constituents of concern", and thus can be discharged / allowed to percolate. These waters would not affect ground water quality and not be subject to ponding / berming / etc.

The higher the compost pile the more rainfall it can absorb. Typically, center of the pile will retain all storm rainfall. In our location, the most recent storm event (November 19, 2011) was measured by our onsite Davis Vantage Pro 2 weather station. The recorded rainfall was .55". A finished pile was then opened up and the depth of rainfall percolation was measured at 5".

Table #1

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.134 (0.113-0.161)	0.183 (0.153-0.220)	0.247 (0.207-0.299)	0.301 (0.250-0.367)	0.376 (0.300-0.474)	0.434 (0.340-0.561)	0.495 (0.377-0.656)	0.559 (0.413-0.763)	0.648 (0.458-0.925)	0.718 (0.490-1.06)
10-min	0.192 (0.161-0.231)	0.262 (0.220-0.315)	0.354 (0.296-0.428)	0.431 (0.358-0.526)	0.538 (0.431-0.680)	0.622 (0.487-0.804)	0.709 (0.540-0.940)	0.801 (0.592-1.09)	0.928 (0.656-1.33)	1.03 (0.702-1.52)
15-min	0.232 (0.195-0.279)	0.316 (0.265-0.381)	0.429 (0.359-0.518)	0.522 (0.433-0.636)	0.651 (0.521-0.822)	0.753 (0.589-0.972)	0.858 (0.654-1.14)	0.969 (0.716-1.32)	1.12 (0.794-1.60)	1.25 (0.849-1.84)
30-min	0.330 (0.277-0.397)	0.449 (0.377-0.541)	0.609 (0.509-0.735)	0.741 (0.614-0.903)	0.924 (0.739-1.17)	1.07 (0.836-1.38)	1.22 (0.928-1.61)	1.38 (1.02-1.88)	1.59 (1.13-2.28)	1.77 (1.21-2.62)
60-min	0.442 (0.371-0.531)	0.602 (0.505-0.724)	0.815 (0.682-0.984)	0.992 (0.823-1.21)	1.24 (0.990-1.56)	1.43 (1.12-1.85)	1.63 (1.24-2.16)	1.84 (1.36-2.52)	2.13 (1.51-3.05)	2.37 (1.61-3.51)
2-hr	0.633 (0.531-0.761)	0.852 (0.715-1.03)	1.15 (0.962-1.39)	1.40 (1.16-1.71)	1.75 (1.40-2.21)	2.03 (1.59-2.63)	2.33 (1.77-3.08)	2.64 (1.95-3.61)	3.08 (2.18-4.41)	3.44 (2.35-5.10)
3-hr	0.775 (0.651-0.932)	1.04 (0.872-1.25)	1.40 (1.17-1.69)	1.70 (1.41-2.07)	2.13 (1.70-2.69)	2.47 (1.94-3.19)	2.84 (2.16-3.76)	3.23 (2.38-4.41)	3.78 (2.67-5.39)	4.23 (2.88-6.26)
6-hr	1.08 (0.906-1.30)	1.44 (1.21-1.73)	1.93 (1.61-2.33)	2.34 (1.94-2.85)	2.93 (2.34-3.69)	3.40 (2.66-4.39)	3.89 (2.97-5.16)	4.43 (3.27-6.05)	5.18 (3.67-7.40)	5.80 (3.96-8.60)
12-hr	1.42 (1.19-1.70)	1.89 (1.58-2.27)	2.53 (2.12-3.05)	3.07 (2.54-3.74)	3.82 (3.06-4.83)	4.42 (3.46-5.71)	5.05 (3.85-6.70)	5.72 (4.23-7.81)	6.66 (4.71-9.51)	7.41 (5.05-11.0)
24-hr	1.85 (1.63-2.13)	2.48 (2.19-2.87)	3.33 (2.93-3.86)	4.04 (3.53-4.72)	5.04 (4.26-6.08)	5.82 (4.83-7.17)	6.64 (5.38-8.37)	7.50 (5.92-9.72)	8.71 (6.60-11.7)	9.68 (7.09-13.5)
2-day	2.27 (2.01-2.63)	3.06 (2.70-3.54)	4.13 (3.63-4.79)	5.03 (4.39-5.87)	6.29 (5.32-7.59)	7.30 (6.06-8.99)	8.37 (6.78-10.5)	9.49 (7.49-12.3)	11.1 (8.39-14.9)	12.4 (9.06-17.2)
3-day	2.48 (2.19-2.87)	3.35 (2.96-3.87)	4.54 (3.99-5.26)	5.54 (4.84-6.47)	6.96 (5.89-8.40)	8.11 (6.72-9.98)	9.32 (7.55-11.7)	10.6 (8.37-13.7)	12.4 (9.43-16.8)	13.9 (10.2-19.4)
4-day	2.67 (2.36-3.09)	3.61 (3.19-4.18)	4.91 (4.32-5.69)	6.01 (5.25-7.02)	7.57 (6.41-9.14)	8.84 (7.33-10.9)	10.2 (8.24-12.8)	11.6 (9.16-15.0)	13.7 (10.3-18.4)	15.3 (11.2-21.4)
7-day	3.05 (2.70-3.53)	4.14 (3.66-4.79)	5.65 (4.97-6.55)	6.93 (6.05-8.10)	8.78 (7.42-10.6)	10.3 (8.52-12.6)	11.9 (9.61-15.0)	13.6 (10.7-17.6)	16.0 (12.2-21.6)	18.1 (13.2-25.2)
10-day	3.30 (2.92-3.82)	4.50 (3.97-5.20)	6.15 (5.41-7.13)	7.57 (6.61-8.85)	9.61 (8.13-11.6)	11.3 (9.34-13.9)	13.0 (10.6-16.4)	14.9 (11.8-19.4)	17.7 (13.4-23.9)	20.0 (14.6-27.8)
20-day	3.96 (3.49-4.57)	5.44 (4.80-6.29)	7.50 (6.61-8.70)	9.28 (8.10-10.8)	11.8 (10.0-14.3)	13.9 (11.6-17.2)	16.2 (13.1-20.4)	18.6 (14.7-24.1)	22.1 (16.7-29.8)	25.0 (18.3-34.8)
30-day	4.68 (4.14-5.41)	6.46 (5.70-7.47)	8.93 (7.86-10.4)	11.1 (9.66-12.9)	14.1 (12.0-17.1)	16.7 (13.8-20.5)	19.3 (15.7-24.4)	22.3 (17.6-28.8)	26.5 (20.1-35.7)	30.0 (22.0-41.8)
45-day	5.57 (4.92-6.43)	7.66 (6.76-8.86)	10.6 (9.30-12.3)	13.1 (11.4-15.3)	16.7 (14.1-20.2)	19.7 (16.3-24.2)	22.9 (18.5-28.8)	26.3 (20.7-34.1)	31.3 (23.7-42.2)	35.5 (26.0-49.4)
60-day	6.47 (5.71-7.47)	8.82 (7.79-10.2)	12.1 (10.7-14.0)	14.9 (13.1-17.5)	19.1 (16.1-23.0)	22.4 (18.6-27.6)	26.0 (21.1-32.8)	29.9 (23.6-38.8)	35.6 (27.0-48.0)	40.3 (29.5-56.1)

http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ca



http://www.usclimatedata.com/climate.php?location=USCA1016

From this, It can be extrapolated from above that for every 1” of rain, a minimum of 9.1” of compost will fully capture the precipitation rain. If the pile is higher than the required minimum, then no rain will percolate through the pile into the ground below. Since the ground remains dry, there is no probability of water carrying constituents of concern into the ground water. Those sections of the compost pile that are less than the minimum height to fully capture a rain event can create leachate. This would typically be the toes of sloped edge piles. See Figure #1

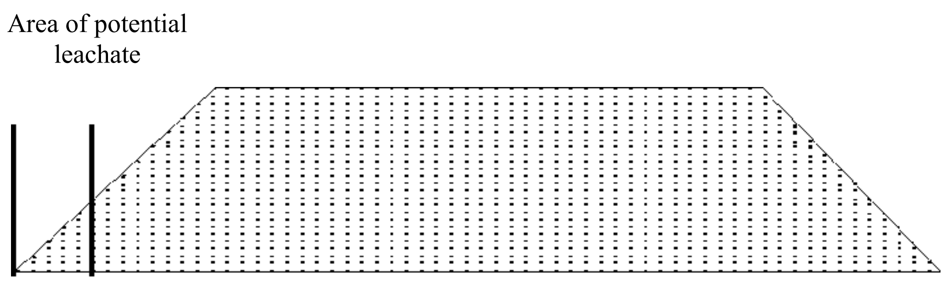


Figure #1

From Figure #1, a discharge graph (figure#2) can be drawn which is the inverse of the pile shape.

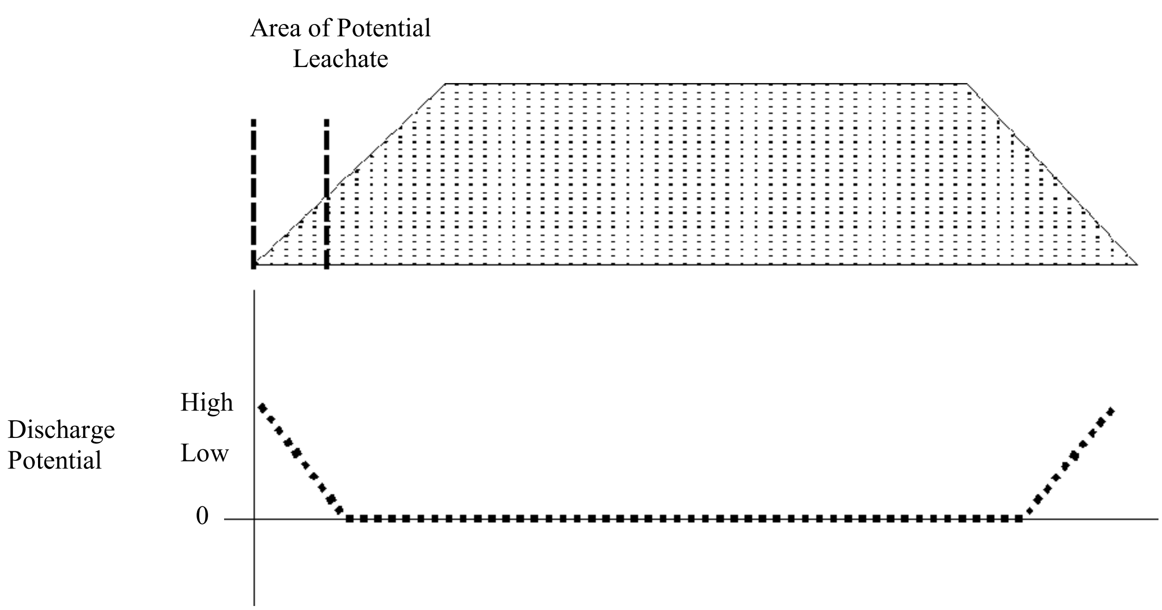


Figure #2

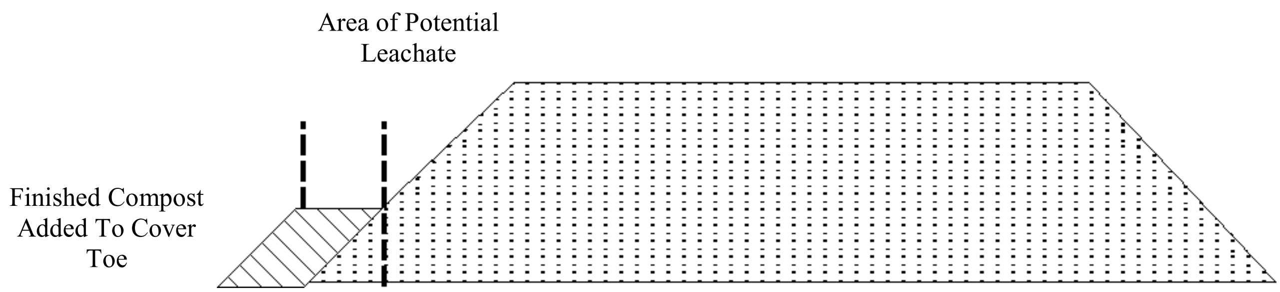
The operator has several options to eliminate leachate from those portions of the pile.

#1 Cover the toe of the pile with finished (stabilized) compost to raise the level to the minimum required height, as determined by rainfall requirement.

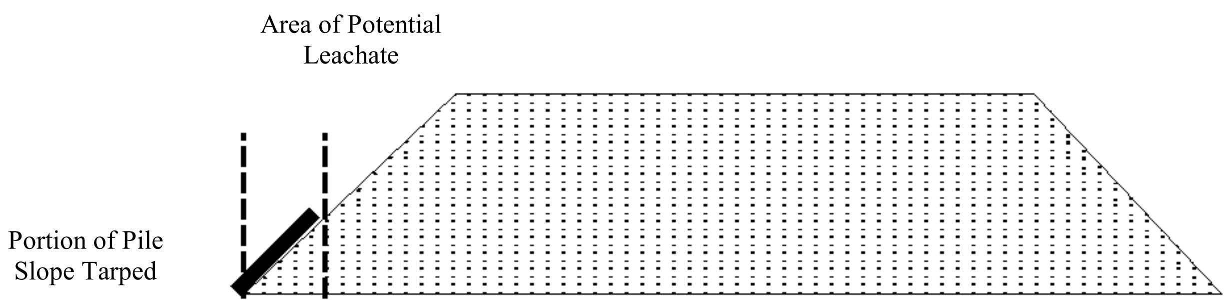
#2 Tarp that portion of the pile that is less than the minimum depth.

#3 Install a vertical structure to maintain the required minimum depth.

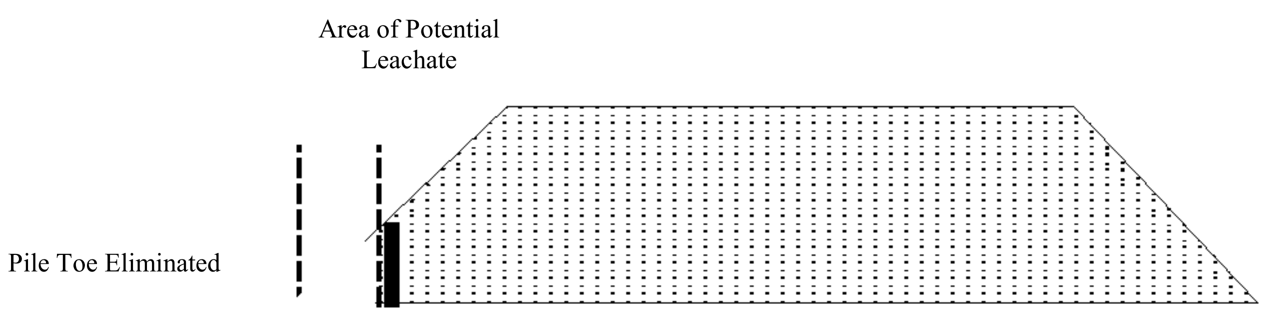
Options #1, 2, & 3 are graphic demonstrations of these three solutions.



Option #1



Option #2



Option #3

The height of that portion of the pile's edge that needs to be protected is determined by the attached spreadsheet.   All measurements are in inches.

The user inputs (all green fields) are:

- Pile slope. Choose a ratio of height / run
- Pile height. Expressed in inches
- Specific storm level. A chart of various regions and storm levels is included for assistance (pg. 4)
- Pile absorption rate. Expressed in inches of compost to absorb 1" of rainfall

The spread sheet will then calculate (all red fields):

- Is the overall pile high enough to capture all the rainfall
- The height and depth of additional finished compost as detailed in example #1
- The width of tarping if option #2 is selected
- The height of a wall if option #3 is selected.

With these alternative WQPM's and associated calculations, the operator can make operationally efficient

decisions based on the time of the year (probability of rainfall), as well as near term (forecasted rainfallamount). For example in August there is very low chance of measurable rainfall, so the WQPM's would not be employed. Conversely, January has a high probability of rain. The operator should be ready to quickly employ the WQPM's based on a predicted rainfall amount. Or as an alternative, employ them as standard operating procedure using a predetermined storm frequency level (2,10, 25 100 storm event).