APPENDIX C

Draft New Rule 4566 (Composting and Related Operations)
Costs and Cost Effectiveness Analysis

September 22, 2010

I. SUMMARY

District staff has received cost information from stakeholders and vendors during the rule development process. Stakeholders and vendors are encouraged to continue to submit their compliance cost estimates to aid District staff with the cost effectiveness analysis. District staff will refine the cost effectiveness analysis to reflect any new information provided during the rulemaking process and at the focus group. Based on the cost-effectiveness of the control measures, the new draft rule requirements may be revised, as appropriate, to mitigate significant impacts to the operators.

Cost effectiveness is the estimated using the annualized cost of a control divided by the estimated emission reductions. It is not the actual cost paid by the operator but is a metric used to compare the relative cost between various control techniques and rules.

Draft Rule 4566 (Composting and Related Operations) would require operators who manage these materials to reduce VOC emissions through mitigation measures which are a combination of best management practices, emission reduction methods, and engineered emission controls systems. In the case of composting operations, small facilities, which have fewer resources and lower total emissions, would only be required to implement management practices. Larger facilities, that have greater resources and higher total emissions, would be required to implement best management practices and emission reduction methods or install and operate and engineered control system that achieves VOC reductions equivalent to the control methods.

II. REQUIREMENTS OF COST EFFECTIVENESS ANALYSIS

The California Health and Safety Code 40920.6(a) requires the San Joaquin Valley Unified Air Pollution Control District to conduct a cost effectiveness analysis of available emission control options before adopting each Best Available Retrofit Control Technology (BARCT) rule. The purpose of conducting a cost effectiveness analysis is to evaluate the economic reasonableness of the pollution control measure or rule. The analysis also serves as a guideline in developing the control requirements listed in a rule. Absolute cost effectiveness of a control option is the added annual compliance cost in dollars per year divided by the emission reduction achieved in tons VOC reduced per year. This report presents the District staff's analysis of the absolute cost effectiveness of Draft Rule 4566.

Incremental cost effectiveness is intended to measure the change in costs, in dollars per year, and emissions reductions, in tons of VOC reduced per year, between two progressively more effective control options or technologies. Incremental cost effectiveness examines the additional costs and emission reductions that can be achieved by adding a second control to the primary control. Because the incremental reductions from the controlled source operation are typically low, incremental cost effectiveness produces a much higher cost-to-reduction ratio than the primary control and should not be compared to the absolute cost effectiveness value.

For composting operations, the additional annual costs will be developed as follows:

$$\text{Additional Cost} = \text{Cost to Implement Control (\$/wet-ton)} \times \text{Throughput (wet-ton/year)} = \text{\$/year}$$

$$\text{Absolute Cost Effectiveness} = \frac{\text{Incremental Cost (\$/year)}}{\text{Reductions (ton-VOC/year)}} = \text{\$/ton-VOC}$$

Draft Rule 4566 would provide compost facility operators with the flexibility to comply with the VOC control requirements by choosing the listed controls or developing mitigation measures of their own not specified in the rule, provided they could demonstrate that such measures could achieve specified VOC emission reductions. Since operators have the flexibility to develop other equivalent methods of achieving the required reductions, operators will choose the option with the best cost effectiveness for their particular operation.

III. SOURCES OF COST DATA

Costs for composting facilities were taken from two general categories of source: actual composting operators in the San Joaquin Valley and vendors of composting emission control systems. The vendors who provided data are Engineered Compost Systems (ECS), W.L. Gore & Associates (GORE), and Managed Organic Recycling (MOR). The Valley operators who provided data are from Tulare County Compost and Biomass (Tulare), HWY 59 (Merced), Mt Vernon Composting & Recycling (Bakersfield), and Community Recycling (Lamont), and the City of Modesto.

The cost information that District staff has considered in the revised cost analysis are as follow:

- The Modesto Composting facility is a 200,000 wet-ton/yr windrow composting operation with an overall operating budget of $1.34 million per year. Tipping fees are $18.35 per ton for organic material.
- Stanislaus Resource Recovery Facility is a Waste-to-Energy plant that charges a tipping fee of $28 per ton for organic material.
- Landfill tip fees within the region currently range from $25 per ton to $30 per ton for organic material.

Finished Compost Cover Control Method

The industry operators have participated in the rule development process and submitted cost information to the District, most recently in 2010. Their cost estimates were based on their site-specific requirements. Since the costs provided are based on site-specific requirements, there is a wide range of cost estimates to implement the control method. For the finished compost cover control method, operators provided costs including possible additional front-end loaders, dump trucks, and conveyors. While some facilities may need the additional heavy equipment, other facilities may be able to use existing equipment for the control measures. It is assumed that the finished compost cover control method does result increased labor, fuel, equipment, maintenance, and decreased amount of available finished compost for all applicable facilities.

To mitigate the impact of the rule and allow operators time to adjust to the practices, the rule allows a three year phase in period to full implementation.

- The first year of implementation, 33% or throughput or every third active-phase windrow would need to be covered with finished compost after formation and after each turning event, during the active composting phase. Curing-phase compost is not required to be covered with finished compost.
- The second year of implementation, an additional 33% of the active-phase piles shall be covered with finished compost after formation and after each turning event. During this year, a total of 66% of the active-phase piles would be covered.
- The third year, the remaining 34% of the facility's active-phase piles shall be covered with finished compost after formation and after each turning event.

The amount of finished compost needed to implement the control method is estimated to be approximately 12% of the facility's finished compost production for years 1 through 3, and an average of 3.6% over 10 years (see the compost cover volume determination spreadsheet for the detailed calculation). To summarize, the volume calculation is based on the following primary assumptions:

- Compost piles are triangular in shape,
- 6 turning events during active-phase,
- Finished compost cover is 6" at the peak and 2" at the base,
- Green waste volumetric shrink factor is 70%,
- Facilities process 4.5 compost cycles per year,
- Phase in schedule is 33%, 66%, and 100% of total throughput for years 1 - 3, respectively.

Based on the field study results, the footprint of the active-phase pile and the finished compost pile is not expected to be negatively affected. As the material composts, moisture and carbon are lost so that the normal compost pile is reduced by 70% in volume and 40% in mass. In addition the windrow machines, used t turn the piles, produce a consistent pile footprint. The finished compost cap adds mass, so there will be more volume initially on the curing-phase piles due to the finished compost covers added to them. The finished compost piles will be larger due to the material added for the covers and would potentially serve as the storage areas for the materials for next round of compost covers. As the process is implemented, more finished compost cover materials will be blended with the composting material until eventually 12% of the facility's production during the first three years is stored on the piles.

Since the draft rule requires cover upon creating a new active-phase pile, the facility must have enough finished compost stored separately to cover the new material. Upon day 1 implementation, a new windrow created and turned requires approximately 27% of a finished compost windrow for one covering. Therefore, the facility begins "storing" the cover material within the active-phase piles. Upon completing the active-phase, 6 coverings in 22 days, this controlled windrow will have required 161% or 1.61 normal finished compost windrows to cover it. Cover is now being stored in the curing phase.

For example, a facility creates 100 yd^3 active-phase windrows and produces 30 yd^3 finished compost windrows. To cover a new windrow for the entire active-phase will take 48 yd^3, which is 1.61 normal finished windrows. When the controlled windrow completes the curing phase (day 60), the facility will have more than enough cover within that one controlled compost windrow to cover the next new one that enters the active-phase. In this example, when the controlled windrow finishes the curing phase, it will be 78 yd^3, which is based on a normal finished windrow volume (30 yd^3) plus the cover volume (48 yd^3). Therefore at day 60, any new windrow created requires only 62% of a finished windrow by volume, since the finished windrows will now contain more volume.

This volume of the minimum cover material needed is then kept onsite on an ongoing basis. As new windrows are created, the same volume is utilized for cover, allowing the facility to sell compost except for the finished compost cap volume, which is 12% of their throughput for the first 3 years. The 12% value hinges on the concept that once enough cover material is created, that cover material volume does not need to be created again. At full implementation, sellable material can come and go at the pre-implementation rates, while the cap volume remains constant and is "stored" on the composting and curing piles.

Below is an example of how the compost cover volume was determined. Table 1 lists the basic windrow information and assumptions.

Table 1: Compost Cover Volume Determination (Site Process Information)

Pile length	**600**	ft			
Peak height	**8**	ft			
Base width	**20**	ft			
Number of windrows	**20**				
Number of compost cycles	**4.5**	per year			
Density of feedstocks	**0.25**	ton/yd3			
Density of finished compost	**0.5**	ton/yd3			
Shrink factor (volume basis)	**70%**	average			
Pile slant height of compost pile	12.8	ft			
One compost pile surface area (includes pile ends)	15,770	ft^2			
One compost pile volume (includes pile ends)	48,837	ft^3	equivalent to	1,809	yd^3
One compost pile production (1 cycle)	543	yd^3	equivalent to	271	ton
Incoming feedstocks (1 cycle)	36,176	yd^3	equivalent to	9,044	ton
Finished compost production (1 cycle)	10,853	yd^3	equivalent to	5,426	ton
Shrink factor, mass basis (for info only)				40%	
Incoming feedstocks (all cycles)	162,791	yd^3/yr	equivalent to	40,698	ton/yr
Finished compost production per year (all cycles)	**48,837**	**yd^3/yr**	equivalent to	24,419	ton/yr

Table 2 details the finished compost cover details and assumptions.

Table 2: Compost Cover Volume Determination (Compost Cover Information)

Compost cover thickness at peak	**6**	in	equivalent to	0.50	ft
Compost cover thickness at base	**2**	in	equivalent to	0.167	ft
Number of active-phase cover applications	**6**	per windrow			
Peak height	8.5	ft			
Base width	20.33	ft			
Slant height of covered pile	13.3	ft			
One pile surface area with cover	16,325	ft^2			
One pile volume with cover	52,770	ft^3	equivalent to	1,954	yd^3
One pile cover volume	146	yd^3	per cover		
One pile cover volume	874	yd^3	per active-phase		

Table 3 details the required finished compost amounts as the rule is implemented over a three-year phase-in period.

Table 3: Compost Cover Volume Determination
(Compost Cover Volume based on Draft Rule Requirements)

Day 1: Initial cover after formation	27%	of a finished windrow can cover a new windrow once after initial formation			
Day 22: After active-phase	161%	of an uncontrolled finished windrow can cover a new windrow six times after turning in the active-phase			
Day 60: After active and curing phases	62%	of a controlled finished windrow can cover a new windrow six times after turning in the active-phase, due to the additional mass of the cover material during the controlled active phase			
End of year 1, 33% of total throughput controlled	5,767	yd^3	equivalent to	2,884	ton
	12%	of facility's finished compost from 1st year			
End of year 2, 66% of total throughput controlled	5,767	yd^3	equivalent to	2,884	tons
	12%	of facility's finished compost from 2nd year			
End of year 3, 100% of total throughput controlled	5,942	yd^3	equivalent to	2,971	tons
	12%	of facility's finished compost from 3rd year			
Full rule implementation (Years 1 thru 3 total)	17,477	yd^3	equivalent to	8,738	tons
	12%	of facility's finished compost over 3 years			
	3.6%	of facility's finished compost over 10 years			

The loss of production revenue, 12% per year for 3 years, has been factored into the cost analysis as well, assuming product sales at $\$6/yd^3$ (\$12/ton) and lost interest revenue at 10% per year. The process should not require additional material storage or diversion after the third year, but District cost analysis policy annualizes capital expenses at 10% over 10 years so the 3.6% average over ten years figure is included.

Additional Irrigation

The industry operators have participated in the rule development process and submitted cost information to the District. Their cost estimates are based on their site-specific requirements. Operators provided costs of additional equipment and infrastructure necessary, such as sprinkler piping, water pumping equipment, power/fuel, and water. Since the costs reflect on site-specific conditions, there is a wide range of cost estimates to implement the control method. For example, one facility may have rights to water, while another would need to purchase the water needed for this control method. It is assumed that the additional irrigation would result increased labor, fuel, equipment, and maintenance.

Minimize Stockpile/Tipping Pile Storage Time

The District currently does not have an estimated cost to require the stockpile storage time does not exceed 3 days for larger facilities. As such, there are no costs factored into the VOC reductions claimed for this control method. This information will be updated later in the rule development process as cost data becomes available.

Engineered Control Vendors

ECS has participated in the rule development process and submitted cost information to the District, most recently in 2010. The cost estimates were for the AC Composter™ and CompDog™ (inflatable form) cover systems (negative ASPs vented to biofilter). The key assumptions are as follows:

- Capital costs of equipment, construction and start-up of control system (annualized over 10 years at 10%).
- Annual cost also includes operation and maintenance (O&M) of all equipment, labor, electrical power, and fuel.
- Paved surface for the AC Composter™ system to be built, unpaved for the CompDog™ cover system.
- Concrete pushwalls for both AC Composter™ and CompDog™ cover systems.
- Aeration vented to biofilter for both AC Composter™ and CompDog™ cover systems.
- Water management control system for separation of leachate and storm water to be built.
- Covered bunker or enclosed reception area to be built
- Water and Electricity in place

GORE has participated in the rule development process and submitted cost information to the District, most recently in 2010. The cost estimates were for a the GORE™ Cover System technology (positive ASPs with cover). The key assumptions are as follows:

- Annualized capital costs of equipment, construction and start-up of control system over 10 years at 10%,
- Annual cost also includes operation and maintenance (O&M) of all equipment, labor, electrical power, and fuel,
- Paved surface for the GORE™ Cover System to be built,
- Water management control system for separation of leachate and storm water to be built,
- Paved tipping area to be built,
- Water and Electricity in place

MOR has participated in the rule development process and submitted cost information to the District, most recently in 2010. The cost estimates were for a positive ASP with cover system. The key assumptions are as follows:

- Annualized capital costs of equipment, construction and start-up of control system over 10 years at 10%,
- Annual cost also includes operation and maintenance (O&M) of all equipment, labor, electrical power, and fuel,
- Paved surface for the covered system to be built,
- Water management control system for separation of leachate and storm water to be built,
- Paved tipping area to be built,
- Water and electricity in place

According to the vendors, the cost estimates are highly variable depending upon site specific requirements. For the purpose of this analysis, the cost estimates associated with the capture and control systems assume a flat and buildable site with all utilities in place. The District staff obtained as much data as available to establish the range of costs to implement an “engineered control system”. The collected cost estimations are for the purposes of the District’s cost effectiveness analysis during this rule project only.

The budgetary pricing from the mentioned vendors are the most current and best available information obtained at the time. Inclusion of these vendors in this report does not imply or serve as an endorsement of any vendor or product by the District.

IV. COSTS AND COST EFFECTIVENESS ESTIMATES

Proposed VOC control requirements would require operators to implement various mitigation measures, based on the operation type and facility size. All operators would be required to adopt management practices to reduce VOC emissions.

Management practices have been shown to promote efficient composting and still result in VOC reductions. No additional cost is associated with implementing these practices, since they are considered to be inherent in good composting practice at a well-managed facility.

Large facilities, defined as those with at least 25,000 wet tons per year throughput, would also be required to implement the finished compost cover control method, or an equally effective method at reducing VOC emissions. The finished compost cover method achieves VOC reductions of 53% over the active and curing phases. Therefore, if the finished compost method is not employed, another method or system shall meet a minimum of 53% overall VOC for the active and curing phases. Engineered controls, such as in-vessel systems, have demonstrated control efficiencies at or above 80% overall control. As such, these types of controls would be welcome to satisfy the rule.

The tables below summarize the District's cost findings, based on the information received from operators and vendors.

Finished Compost Cover Costs

Table 4 summarizes the cost information received from operators for site-specific costs to implement the requirement for a finished compost cover. These costs reflect the limited resources of the smaller facilities and a necessity to purchase additional equipment, resulting in a higher, per-ton implementation cost. Larger facilities may have greater equipment inventories and could possibly implement the rule requirements without additional equipment purchases.

Table 4: Finished Compost Cover Costs

Site	Feedstock Throughput (wet ton/yr)	Cost to Implement ($/wet ton)
1	25,000	5.65
2	100,000	3.48
3	150,000	0.59
4	200,000	0.60
5	1,300,000	1.93
	Average	**2.45**

If the resulting data was applied to a large facility, the total annualized costs for the finished compost cover method would range from $776,000/year to $7.43 million/year. Based on 1,789 tons per year of VOC emission reductions, the cost effectiveness for these largest compost facilities ranges from about $433 to $4,151/ton of VOC reduced.

Additional Irrigation Costs

Table 5 summarizes the cost information received from operators for site-specific costs to implement the requirement for additional irrigation before turning. These costs reflect the limited resources of the smaller facilities and a necessity to purchase equipment and water for the irrigation, resulting in a higher, per-ton implementation cost. One facility had access to water so costs included equipment and operating expenses but not water costs.

Table 5: Additional Irrigation Costs		
Site	**Feedstock Throughput (wet ton/yr)**	**Cost to Implement ($/wet ton)**
1	100,000	2.29
2	150,000	1.66
3	1,300,000	0.26
	Average	**1.4**

The rule would require medium facilities to implement the additional irrigation control. If the resulting cost data was applied to a medium facility, the total annualized costs for this control to medium sized facilities would range from $15 thousand per year to $132 thousand per year, depending on water availability. Based on 36 tons per year of VOC emission reductions, the cost effectiveness for these medium-sized compost facilities ranges from about $418 to $3,677 per ton VOC reduced.

Engineered Controls Costs

Table 6 summarizes the cost information received from vendors for hypothetical site-specific costs to install their specific control system. These costs reflect possible factors that could influence the installation and operation of the control system. In general, the cost per ton is lower for larger facilities since common equipment costs, like fans and ducting can be spread over a greater throughput.

It is important to note that the rule would not require any facility to install an engineered control system. An operator may consider installing such a system in lieu of using a finished compost cover, provided that it is demonstrated to achieve the same or better control efficiency as the finished compost cover. Because of the cost to install and run these systems, it is unlikely that even the largest facilities would find them to be cost-effective.

Table 6: Engineered Controls Costs			
Hypothetical Site	**Feedstock Throughput (wet ton/yr)**	**Cost to Implement ($/wet ton)**	**Cost Averages by Throughput ($/wet ton)**
1	25,000	6.79	7.44
2	25,000	6.79	
3	25,000	9.08	
4	25,000	9.91	
5	50,000	5.67	6.04
6	50,000	6.40	
7	100,000	3.24	4.33
8	100,000	3.48	
9	100,000	4.49	
10	100,000	5.20	
11	100,000	5.24	
12	200,000	2.57	3.48
13	200,000	3.10	
14	200,000	4.76	
15	500,000	2.78	3.78
16	500,000	3.80	
17	500,000	4.75	
18	1,000,000	3.09	3.80
19	1,000,000	3.21	
20	1,000,000	5.11	
	Average	**4.97**	

Staff only applied the cost data to large facilities given the lower cost of these controls relative to smaller facilities. For in-vessel engineered controls on these large facilities range, costs are estimated from $3.378 million per year to $13.026 million per year. Based on 3,001 tons per year of VOC emission reductions, the cost effectiveness for these largest compost facilities ranges from about $1,126 to $4,341 per ton VOC reduced.

Table 7 summarizes the Cost Effectiveness information based on draft rule requirements. The low - high range reflects the information received to date from stakeholders on possible implementation costs. Costs for covering the stockpiles after three days will be included in later staff reports and the cost data is available.

Table 7: Cost Effectiveness Summary (based on Rule Control Requirements)							
Facility Receiving Volume	**Actual Material Received (wet-ton/year)**	**Control Method**	**Emission Reductions (tons of VOC/year)**	**Cost ($/year) (Low - High Range)**		**Cost Effectiveness ($/ton-VOC Red) (Low - High Range)**	
Large Facilities (Receives ≥ 25,000 tons/year)	1,314,451	Active+Curing Windrow (Finished Compost Cover on Active - 53% overall control)	1,988	775,526	7,426,648	390	3,736
		Active+Curing Windrow (Engineered Controls - 80% overall control)	3,001	3,378,139	13,026,209	1,126	4,341
		Stockpile (3-Day Max)	1,471	TBD	TBD	TBD	TBD
Medium Facilities (Receives < 25,000 and ≥ 10,000 tons/year)	57,808	Active Phase Windrow (Irrigation)	36	15,030	132,380	418	3,677
		Curing Phase Windrow (No Control)	0	0	0	0	0
		Stockpile (3-Day Max)	86	TBD	TBD	TBD	TBD
Small Facilities (Receives < 10,000 tons/year)	21,318	Active Phase Windrow (No Control)	0	0	0	0	0
		Curing Phase Windrow (No Control)	0	0	0	0	0
		Stockpile (No Control)	0	0	0	0	0

V. REFERENCES

1. City of Modesto. Public Comment Letter dated January 4, 2008.
2. SJVAPCD Draft Rule 4566 and staff report.
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5. CIWMB. Public Comment Letter dated January 22, 2008.
6. Mt. Vernon Composting & Recycling (Bakersfield)
7. Tulare County Composting and Biomass
8. Community Recycling (Lamont)
9. HWY 59 (Merced)
10. Bouey, John, P.E. - President Managed Organic Recycling (MOR), e-mail correspondence and MOR website at http://www.odorfreecompost.com