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FINAL REPORT

TASK 4- FEASIBILITY ASSESSMENT OF EMISSION CONTROL EFFECTIVENESS FOR POTENTIAL WASTE MANAGEMENT PRACTICES REDUCING AMMONIA AND VOCs

LIVESTOCK WASTE MANAGEMENT PRACTICES SURVEY & CONTROL OPTION ASSESSMENT

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April 2004

CONTRACT #01226

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A SUMMARY

Summary- This report summarizes the feasibility assessment of potential control technologies and dairy waste handling practices that could reduce ammonia and VOC emissions from dairy waste in the South Coast Air Basin. Twenty-nine separate potential control measures were evaluated. For each of these control measures, an assessment was provided that included the ease of implementation, the time scale for implementation, regulatory program implementation, IEUA Organics Management Strategy status, control measure cost-effectiveness, and control measure implementability.

Conclusions- The conclusions from work completed in Task 4 include the following:

1. Five control measures should result in potentially significant reduction in ammonia and VOC emissions. These options include
    a. More frequent corral cleaning & manure removal
    b. Eliminating manure stockpiles/reducing duration of stockpiling
    c. Land Application with Best Management Practices Outside SoCal Air Basin
    d. Composting via ASP (enclosed or open)
    e. Regional anaerobic digestion systems
2. At the low end, these measures are capable of achieving at least 30% reductions while at the high end dairy relocation can achieve 100% reduction
3. The control measures appear to complement recently promulgated federal regulations governing the permitting, practices and record keeping of CAFOs
4. The time scale for implementation of these measures appears reasonable ranging from certain practices currently underway to several years to implement other practices
5. Closely working and linking these control measures with IEUA's Organics Management Strategy and the Santa Ana Regional Water Quality Control Board will significantly improve the overall control measure implementability. IEUA's Strategy is driven by water quality requirements that affords a substantial cross-media benefit.

B FEASIBILITY ASSESSMENT OF EMISSION CONTROL EFFECTIVENESS FOR POTENTIAL WASTE MANAGEMENT PRACTICES REDUCING AMMONIA & VOCS

Approach- The purpose of this report is to identify potentially feasible waste management practices to reduce ammonia and non-methane volatile organic compounds.

Background- Scope of Work- The scope of work for this report includes a feasibility assessment of potential control technologies and farm waste handling practices that could reduce ammonia and VOC emissions from dairy waste in the South Coast Air Basin (Basin). This task brings together information from the work conducted in Tasks 1, 2, and 3. Task 1 completed a field assessment of conditions and practices regarding animal livestock in the air basin. Task 2 reviewed the literature associated with emission control technologies and practices. Task 3 identified potential practices that reduce ammonia and VOC emissions from dairy waste in the Basin.

Sequence of Activities- The sequence of activities for this work included incorporation of the results from Tasks 1, 2, and 3 followed by assessment of the feasibility of implementation.

Description of Methodology & Techniques- The methodology and techniques associated with this task are described in the relevant sections of the report. The control measures considered in this task are summarized in Table 1.

TABLE 1- LIST OF POTENTIAL AMMONIA & VOC EMISSION CONTROL MEASURES

ON-DAIRY OPTIONS
House Keeping & Best Management Practices
1. More frequent corral cleaning & manure removal
2. Eliminating manure stockpiles/reducing duration of stockpiling
3. Stockpile covers
Production/Nutrition/Ration Management
1. Increase milking frequency
2. Use of somatotropin
3. Crude protein reduction
4. Rumen degradable protein reduction & utilization improvement
5. Multiple feed management strategies reducing manure pH
6. Wastewater covered anaerobic digester lagoons
Wastewater storage pond covers
1. Biofilter biomass blankets
2. Leca Rock
3. Plastic Covers
4. Concrete & Covered Tanks
5. Wastewater wetlands pond treatment
6. Biological/Microbial additives
7. Chemical additives

OFF-DAIRY OPTIONS
Land Application with Best Management Practices
1. Inside SoCal Air Basin
2. Outside SoCal Air Basin
Dairy Relocation
1. Young stock relocation outside SoCal Air Basin
2. Dairy relocation outside SoCal Air Basin
Composting Inside SoCal Air Basin
1. Enclosed ASP
2. Open ASP
3. Open Windrow
Composting Outside SoCal Air Basin
1. Enclosed ASP
2. Open ASP
3. Open Windrow
4. Regional anaerobic digestion systems
5. Regional high-tech manure processing
6. Drying-combustion-energy production

Emission Control Implementation Feasibility- The emission control implementation feasibility assessment was applied to the 29 potential control measures identified and detailed in Task 3. For each of these control measures, an assessment was provided that included the ease of implementation, the time scale for implementation, regulatory program implementation, IEUA Organics Management Strategy status, control measure cost-effectiveness, and control measure implementability.

1. Manure Harvesting / More Frequent Corral Cleaning

A. *Description including source size*- In this control measure, the dairy operator removes manure and urine more frequently than is currently practiced. The animal excretes the majority of its nitrogen in its urea. This nitrogen hydrolyzes rapidly into ammonia gas. To the extent that the manure and urine can be removed quickly for additional treatment, the ammonia and VOC emissions will be less. The source size for corral cleaning is the largest single source on the dairy. The open area of the corral is estimated to contribute an average of 61% of the overall ammonia emissions at the Inland Empire dairies. Estimates were completed indicating up to 50% of the ammonia and VOC emissions could be controlled yielding a net removal effectiveness for the dairy of about 30%.

B. *Ease of implementation*- The ease of implementation of this alternative is relatively good. There are no capital facilities required on the part of the dairy. Depending on the size of the dairy and the ultimate disposition of the manure solids, operators may need to acquire additional rolling stock that could include a tractor, collection machinery, hauling trailers, or land application equipment. Additionally, the operator may need to evaluate personnel requirements for implementation of this option. Alternatively, there exists a vibrant community of service contractors specializing in manure management services to the dairy industry that can immediately provide all of the needed services.

C. *Time scale for implementation*- The time scale for implementation for this alternative is immediate. There are no ramp up time requirements associated with this option.

D. *Regulatory program implementation*- Regulatory program implementation related to this alternative is insignificant. Current state and federal manure management requirements call for manure cleanup and removal at least once every six-months. No additional other regulatory requirements are imminent that would affect the dairy operator's manure management program.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy (OMS) is active. The OMS was implemented including continued operation of the manure composting facility and operation of two manure anaerobic digestion facilities handling a total of 285 tons per day (40 dry tons per day; 14,600 dry tons per year) or a capacity of about 1.6%[1] of the total manure production in the Inland Empire area. Additional manure digestion capacity adding an additional 285 tons per day of capacity is projected for 2005. Digestion requires fresh manure, expediting the removal of manure.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be reasonable. The practices required to achieve the option's goals are achievable with only minor adjustments and a small cost increase.

G. *Control measure implementability*- The implementability of this control measure is estimated to be high.

2. Stock Pile Elimination / Reduction

A. *Description including source size*- In this control measure, the dairy operator removes manure stockpiles more frequently than is currently practiced or prevents stockpiles altogether. Manure stockpiles on dairies have been a common practice. Data indicates that manure stockpiles are a significant ammonia source, on the average about 10% of the total ammonia emitted. Several data points indicate this value could be dramatically higher (up to 84%).

Recent experience on dairies in the Inland Empire has indicated significant reduction in manure stockpiles. The Santa Ana Regional Water Quality Board (SARWQCB) in 1999 adopted ordinances regulating manure management and stockpile removal. Since that time, dairies under compliance orders have removed manure stockpiles and cleaned their corrals of manure at least twice annually. These conditions are significantly improved over the base year conditions.

Estimates were completed indicating that 100% of the ammonia and VOC emissions would be controlled yielding a reliable net removal effectiveness for the dairy of about 10%.

B. *Ease of implementation*- The ease of implementation of this alternative is relatively high. There are no capital facilities required on the part of the dairy. There exists a vibrant community of service contractors specializing in manure management services to the dairy industry that are providing all of the needed services for this option.

C. *Time scale for implementation*- The time scale for implementation for this alternative is immediate.

D. *Regulatory program implementation*- Regulatory program implementation related to this alternative is significant. Current state, SARWQCB, manure management requirements require manure stockpile cleanup and removal by the end of 2003. In areas without

[1] Approximately 1.4 million tons per year corral dry manure at 65% solids equals 910,000 dry tons per year; 14,600 dry tons per year ÷ 910,000 dry tons per year = 1.6%

strong water quality requirements, air quality agencies may also implement similar regulations.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is active. A portion of the stockpiled manure has been placed into the IEUA composting facility.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be reasonable. The practices required to achieve the option's goals are achievable with only minor adjustments and a small cost increase.

G. *Control measure implementability*- The implementability of this control measure is estimated to be high.

3. Stockpile Covers

A. *Description including source size*- In this control measure, the dairy operator would cover manure stockpiles with a plastic or fabric material. Manure stockpiles on dairies have been a common practice although Inland Empire dairies are being required to remove stockpiles by the SARWQCB by the end of 2003. Data indicates that manure stockpiles are a significant ammonia source, on the average about 10% of the total ammonia emitted. Several data points indicate this value could be dramatically higher (up to 84%). No reliable estimates were found as to the effectiveness of this alternative.

B. *Ease of implementation*- The ease of implementation of this alternative is relatively poor. This alternative is not technically proven and requires significant capital expense.

C. *Time scale for implementation*- The time scale for implementation for this alternative is not relevant due to the regulatory requirements implementing the removal of stockpiles.

D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is significant. Current state, SARWQCB, manure management requirements require manure stockpile cleanup and removal by the end of 2003. This action eliminates the need for stockpile covers.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be unknown. Information from vendors offering these various covers was incomplete.

G. *Control measure implementability*- The implementability of this control measure is estimated to be poor.

4. Milking Frequency

A. *Description including source size*- In this control measure, the dairy operator increases the frequency of milking from 2 times per day to 3 times per day. Information was reported that increasing the frequency of milkings would reduce the amount of nitrogen excretion and consequently the amount of ammonia that can be volatilized. To the extent that the manure and urine is lessened through the process of maintaining steady feed rates, the ammonia and VOC emissions will be less. However, the risk is significant that if milk production is increased by milking more frequently the dairy operator will increase feed correspondingly, a situation that would tend to aggravate the emissions concerns rather than mitigate the emissions. The source size for increased milking frequency was estimated at an average of 70% of the overall ammonia emissions at the Inland Empire dairies. Estimates were completed indicating up to 7% of the ammonia

and VOC emissions could be controlled yielding a net removal effectiveness for the dairy of about 5%.

B. *Ease of implementation*- The ease of implementation of this alternative is relatively good. There are no capital facilities required on the part of the dairy.

C. *Time scale for implementation*- The time scale for implementation for this alternative is immediate. An operator could quickly move to a more frequent milking cycle.

D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is insignificant. There are no regulatory programs that currently or are forecast that will impact or affect milking frequency.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be reasonable. The practices required to achieve the option's goals are achievable with only minor adjustments and a small cost increase.

G. *Control measure implementability*- The implementability of this control measure is estimated to be poor.

5. Use of Somatotropin

A. *Description including source size*- In this control measure, the dairy operator would utilize a synthetic protein, bovine somatotropin, to increase milk production and decrease manure and urine. Somatotropin is a natural protein hormone that exerts a key control over nutrient utilization in dairy cattle. Research shows that Bovine somatotropin (BST), a synthetic protein, markedly improves productive efficiency and reduces manure and urine excretion in lactating cows. To the extent that the manure and urine is lessened through the BST, the ammonia and VOC emissions will be less. However, the risk is significant that if milk production is increased the dairy operator will increase feed correspondingly, a situation that would tend to aggravate the emissions concerns rather than mitigate the emissions. Lactating cows constitute about 70% of the herd. Research for over 30 years documents the safety and efficacy of BST. The value of a 12% increase in nutrient utilization and subsequent reduction in excretion has been extensively documented. The use of somatotropin would occur in the lactating portion of the herd, usually about 70% of the mature animals on the dairy. Twelve percent of 70% yields an 8.4% increase in nutrient utilization and a net removal effectiveness for the dairy.

B. *Ease of implementation*- The ease of implementation of this alternative is poor. Dairy industry representatives indicated that use of BST connotes use of genetically engineered products. This practice is strongly opposed by the dairy industry because users would likely suffer significant financial losses and taint the milk quality of the whole California milk industry, the largest in the world.

C. *Time scale for implementation*- The time scale for implementation for this alternative could occur relatively quickly if dairy industry acceptance, milk marketing and sales roadblocks were overcome.

D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is insignificant. There are no state or federal regulations that would hinder the use of BST or require its immediate or long-range implementation.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be unknown. Information from vendors offering these various additives was incomplete.

G. *Control measure implementability*- The implementability of this control measure is estimated to be extremely poor. It is estimated that use of this option could constitute a fatal flaw in that it could fatally impair the ability of the milk industry to market its products and put the industry out of business.

6. Reduction of Crude Protein

A. *Description including source size*- In this control measure, the dairy operator adjusts from current feeding practices to reduce the crude protein content of the cow's diet. Reduction of crude protein in the cows diet is another of several techniques considered that focus on dietary management. The overall goal of diet management is to utilize precision feeding techniques that will meet the animal's nutrient requirements while minimizing excretion of nitrogen. Crude protein adjustment usually takes the form of manipulating the total mix ration via changes to soybean meal, blood meal or feather meal. Several studies of the impact and effectiveness of this option were reported in the literature. Research work on this issue appears to have been undertaken over the past 10-years with some in Europe and some in North America. This is not an extensive database of research information. To the extent that the manure and urine is lessened through the process reducing crude protein feed rates, the ammonia and VOC emissions will be less. However, the risk is significant that if milk production is increased, the dairy operator will increase feed correspondingly, a situation that would tend to aggravate the emissions concerns rather than mitigate the emissions.

The source size for feed management is the whole dairy. Estimates were completed indicating up to 28% of the ammonia and VOC emissions could be controlled yielding a net removal effectiveness for the dairy of about 28%.

B. *Ease of implementation*- The ease of implementation of this alternative is poor. Dairy industry representatives indicate that reduction of crude protein in the cow's diet is an untested and unproven practice. This option would require operators to alter the feed ration that their herd is accustomed to, a practice that the dairy industry is strongly fearful of. This practice is strongly opposed by the dairy industry because operators would likely suffer significant financial losses.

C. *Time scale for implementation*- The time scale for implementation for this alternative is slow. Dairy operators would require significant research and demonstration trials to be conducted by academia prior to acceptance of the practice.

D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is insignificant. There are no state or federal regulations that would hinder the use of the option or require its immediate or long-range implementation.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be unknown. Information from vendors offering these various additives was incomplete.

G. *Control measure implementability*- The implementability of this control measure is estimated to be extremely poor.

7. Reduction of Rumen Degradable Protein & Utilization Improvement

A. *Description including source size*- In this control measure, the dairy operator adjusts from current feeding practices to reduce the degradable intake protein content of the cow's diet. Feed supplied to dairy cattle is categorized as degradable intake protein (DIP) or undegradable intake protein (UIP). Researchers have found that conditions related to the ratio between these criteria potentially affect the amount of nitrogen excreted by the cows. If the ratio between DIP and UIP is incorrect, it is highly likely that excess nitrogen will be excreted. Researchers have found that DIP may degrade too quickly to maintain proper balance within the animal thereby causing excess nitrogen excretion. Overall, these are extremely complex bio-chemical processes within the dairy rumen that makes it difficult to provide reliable predictive models. To the extent that the manure and urine is lessened through the process of reducing crude protein feed rates, the ammonia and VOC emissions will be less. However, the risk is significant that if milk production is increased, the dairy operator will increase feed correspondingly, a situation that would tend to aggravate the emissions concerns rather than mitigate the emissions.

The source size for feed management with less DIP is the lactating portion of the herd, usually about 70% of the mature animals on the dairy. Estimates were completed indicating up to 6% of the ammonia and VOC emissions could be controlled yielding a net removal effectiveness for the dairy of about 4%.

B. *Ease of implementation*- The ease of implementation of this alternative is poor. Dairy industry representatives indicate that reduction of DIP in the cow's diet is an untested and unproven practice. This option would require operators to alter the feed ration that their herd is accustomed to, a practice that the dairy industry is strongly fearful of. This practice is strongly opposed by the dairy industry because operators would likely suffer significant financial losses.

C. *Time scale for implementation*- The time scale for implementation for this alternative is slow. Dairy operators would require significant research and demonstration trials to be conducted by academia prior to acceptance of the practice.

D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is insignificant. There are no state or federal regulations that would hinder the use of the option or require its immediate or long-range implementation.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be unknown. Information from vendors offering these various additives was incomplete.

G. *Control measure implementability*- The implementability of this control measure is estimated to be extremely poor.

8. Multiple Feed Management Strategies Reducing Manure pH

A. *Description including source size*- In this control measure, the dairy operator adjusts from current feeding practices to a range of variations in the content of the cow's diet. Researchers have postulated that it is possible to optimize the dairy cow metabolism through various feed management strategies that yield a reduction in pH and a

consequent increased nutrient utilization within the cow and reduction in urea and manure excretion. To the extent that the manure and urine is lessened through the process of various feed management strategies, the ammonia and VOC emissions will be less. However, the risk is significant that if milk production is increased, the dairy operator will increase feed correspondingly, a situation that would tend to aggravate the emissions concerns rather than mitigate the emissions.

The source size for feed management is the whole dairy. Estimates were completed indicating up to 16% of the ammonia and VOC emissions could be controlled yielding a net removal effectiveness for the dairy of about 16%.

B. *Ease of implementation*- The ease of implementation of this alternative is poor. Dairy industry representatives indicate that reduction of DIP in the cow's diet is an untested and unproven practice. This option would require operators to alter the feed ration that their herd is accustomed to, a practice that the dairy industry is strongly fearful of. This practice is strongly opposed by the dairy industry because operators would likely suffer significant financial losses.

C. *Time scale for implementation*- The time scale for implementation for this alternative is slow. Dairy operators would require significant research and demonstration trials to be conducted by academia prior to acceptance of the practice.

D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is insignificant. There are no state or federal regulations that would hinder the use of the option or require its immediate or long-range implementation.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be unknown. Information from vendors offering these various additives was incomplete.

G. *Control measure implementability*- The implementability of this control measure is estimated to be extremely poor.

9. Covered Wastewater Lagoon

A. *Description including source size*- In this control measure, the dairy operator covers the wastewater lagoon using a floating cover system. Wastewater lagoons are a relatively rare component of dairy farming in the Southern California area. Dairy practices in this region are predominantly dry lot operation with lagoon systems in use only during rainfall events for control of potentially contaminated runoff. Within the dairy area, only six out of about 275 dairies were noted to have active flush systems that utilized wastewater lagoons.

The source size for covered lagoons was estimated at 11%. No reliable estimates were found as to the effectiveness of this alternative for the purposes of reductions in ammonia or non-methane VOCs.

B. *Ease of implementation*- The ease of implementation of this alternative is poor. Only six dairies in the Inland Empire area operate flush dairy systems that would be suitable for this alternative. Their overall contribution to potential emissions is about 2%.

C. *Time scale for implementation*- The time scale for implementation for this alternative is relatively quick. Covering lagoons requires up to a 6-month permitting and engineering process followed by about 3-months of construction.

D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is insignificant. There are no state or federal regulations that would hinder the use of the option or require its immediate or long-range implementation.
E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.
F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be relatively high. Based on work associated with the IEUA Organics Management Strategy, the cost of covered lagoon systems was estimated to equal at least $500,000 per dairy for the situation requiring only minor revisions to the dairy facility. In several cases, additional process facilities, such as solids separators, would be needed adding up to $500,000 in facility cost. A portion of these facilities could be eligible for USDA-NRCS grant funding associated with the 2002 Farm Bill- Title II Conservation: Environmental Quality Incentive Programs (EQIP). Operations and maintenance costs would be in a mid-range due to costs associated with solids separators.
G. *Control measure implementability*- The implementability of this control measure in the South Coast is estimated to be poor.

10. Storage Lagoon Covers: Biomass Blankets

A. *Description including source size*- In this control measure, the dairy operator covers the wastewater lagoon using a floating blanket of straw or other biomass. Wastewater lagoons are a relatively rare component of dairy farming in the Southern California area. Dairy practices in this region are predominantly dry lot operation with lagoon systems in use only during rainfall events for control of potentially contaminated runoff. Within the dairy area only six out over 275 dairies were noted to have active flush systems that utilized wastewater lagoons.

The source size for covered lagoons was estimated at 11%. The practice has been researched in Europe. No reliable estimates were found as to the effectiveness of this alternative.

B. *Ease of implementation*- The ease of implementation of this alternative is poor. Only six dairies in the Inland Empire area operate flush dairy systems that would be suitable for this alternative. Their overall contribution to potential emissions is about 2%. Additionally, the technical soundness of this option is not clear or proven.
C. *Time scale for implementation*- The time scale for implementation for this alternative is slow. Dairy operators would require significant research and demonstration trials to be conducted by academia prior to acceptance of the practice.
D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is insignificant. There are no state or federal regulations that would hinder the use of the option or require its immediate or long-range implementation.
E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.
F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be fair. R&D costs are not estimable at this time. Installation costs are estimated to be minimal. O&M costs to maintain a lagoon cover blanket are expected to be significant.

G. *Control measure implementability*- The implementability of this control measure in the South Coast is estimated to be poor. Substantial R&D is required before implementation could be considered.

11. Storage Lagoon Covers: Leca Pebbles

A. *Description including source size*- In this control measure, the dairy operator covers the wastewater lagoon using a floating blanket of Leca pebbles. Wastewater lagoons are a relatively rare component of dairy farming in the Southern California area. Dairy practices in this region are predominantly dry lot operation with lagoon systems in use only during rainfall events for control of potentially contaminated runoff. Within the dairy area only six out over 275 dairies were noted to have active flush systems that utilized wastewater lagoons.

The source size for covered lagoons was estimated at 11%. The practice has been researched in Europe. No reliable estimates were found as to the effectiveness of this alternative.

B. *Ease of implementation*- The ease of implementation of this alternative is relatively poor. Only six dairies in the Inland Empire area operate flush dairy systems that would be suitable for this alternative. Their overall contribution to potential emissions is about 2%.

C. *Time scale for implementation*- The time scale for implementation for this alternative is slow. Dairy operators would require significant research and demonstration trials to be conducted by academia prior to acceptance of the practice.

D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is insignificant. There are no state or federal regulations that would hinder the use of the option or require its immediate or long-range implementation.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be fair. R&D costs are not estimable at this time. Installation costs are estimated to be minimal. O&M costs to maintain a lagoon cover blanket with Leca pebbles are expected to be significant.

G. *Control measure implementability*- The implementability of this control measure in the South Coast is estimated to be poor. Substantial R&D is required before implementation could be considered.

12. Storage Lagoon Covers: Plastic Covers

A. *Description including source size*- In this control measure, the dairy operator covers the wastewater lagoon using a floating plastic or foam cover. Wastewater lagoons are a relatively rare component of dairy farming in the Southern California area. Dairy practices in this region are predominantly dry lot operation with lagoon systems in use only during rainfall events for control of potentially contaminated runoff. Within the dairy area only six out over 275 dairies were noted to have active flush systems that utilized wastewater lagoons.

The source size for covered lagoons was estimated at 11%. The practice has been researched in Europe. No reliable estimates were found as to the effectiveness of this alternative.

B. *Ease of implementation*- The ease of implementation of this alternative is relatively poor. Only six dairies in the Inland Empire area operate flush dairy systems that would be suitable for this alternative. Their overall contribution to potential emissions is about 2%.
C. *Time scale for implementation*- The time scale for implementation for this alternative is slow. Dairy operators would require significant research and demonstration trials to be conducted by academia prior to acceptance of the practice.
D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is insignificant. There are no state or federal regulations that would hinder the use of the option or require its immediate or long-range implementation.
E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.
F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be high. Based on work associated with the IEUA Organics Management Strategy, the cost of covered lagoon systems was estimated to equal at least $500,000 per dairy for the situation requiring only minor revisions to the dairy facility. In several cases, additional process facilities, such as solids separators, would be needed adding up to $500,000 in facility cost. A portion of these facilities could be eligible for USDA-NRCS grant funding associated with the 2002 Farm Bill- Title II Conservation: Environmental Quality Incentive Programs (EQIP). O&M costs to maintain a lagoon cover blanket are expected to be significant.
G. *Control measure implementability*- The implementability of this control measure in the South Coast is estimated to be poor. Substantial R&D is required before implementation could be considered.

13. Storage Lagoon Covers: Concrete & Covered Tanks

A. *Description including source size*- In this control measure, the dairy operator contains the manure wastewater covered tanks. Wastewater lagoons are a relatively rare component of dairy farming in the Southern California area. Dairy practices in this region are predominantly dry lot operation with lagoon systems in use only during rainfall events for control of potentially contaminated runoff. Within the dairy area only six out over 275 dairies were noted to have active flush systems that utilized wastewater lagoons.

The source size for covered lagoons was estimated at 11%. The practice has been researched in Europe. No reliable estimates were found as to the effectiveness of this alternative.

B. *Ease of implementation*- The ease of implementation of this alternative is relatively poor. Only six dairies in the Inland Empire area operate flush dairy systems that would be suitable for this alternative. Their overall contribution to potential emissions is about 2%.
C. *Time scale for implementation*- The time scale for implementation for this alternative is slow. Dairy operators would require significant research and demonstration trials to be conducted by academia prior to acceptance of the practice.
D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is insignificant. There are no state or federal regulations that

would hinder the use of the option or require its immediate or long-range implementation.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be high. Based on work associated with the IEUA Organics Management Strategy, the cost of concrete lagoon systems was estimated to equal at least $1,000,000 per dairy. In several cases, additional process facilities, such as solids separators, would be needed adding up to $500,000 in facility cost. A portion of these facilities could be eligible for USDA-NRCS grant funding associated with the 2002 Farm Bill- Title II Conservation: Environmental Quality Incentive Programs (EQIP).

G. *Control measure implementability*- The implementability of this control measure in the South Coast is estimated to be extremely poor. Substantial R&D is required before implementation could be considered.

14. Wastewater Constructed Wetlands Treatment

A. *Description including source size*- In this control measure, the dairy operator directs dairy wastewater to constructed wetlands for treatment. Constructed wetlands treatment of dairy wastes is applicable only to the wastewater portion of the residuals. Overall, wastewater lagoons and wastewater residuals are a relatively rare component of dairy farming in the Southern California area. Dairy practices in this region are predominantly dry lot operation with lagoon systems in use only during rainfall events for control of potentially contaminated runoff. Within the dairy area, only six out over 275 dairies were noted to have active flush systems that utilized wastewater lagoons.

The source size for wastewater wetlands treatment was estimated at 11%. No reliable estimates were found as to the effectiveness of this alternative.

B. *Ease of implementation*- The ease of implementation of this alternative is relatively poor. Only six dairies in the Inland Empire area operate flush dairy systems that would be suitable for this alternative. Their overall contribution to potential emissions is about 2%.

C. *Time scale for implementation*- The time scale for implementation for this alternative is slow. Dairy operators would require significant research and demonstration trials to be conducted by academia prior to acceptance of the practice.

D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is insignificant. There are no state or federal regulations that would hinder the use of the option or require its immediate or long-range implementation.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be high. Based on work associated with the IEUA Organics Management Strategy, the cost of wetlands lagoon treatment systems was estimated to equal at least $1,000,000 per dairy. In several cases, additional process facilities, such as solids separators, would be needed adding up to $500,000 in facility cost. A portion of these facilities could be eligible for USDA-NRCS grant funding associated with the 2002 Farm Bill- Title II Conservation: Environmental Quality Incentive Programs (EQIP).

G. *Control measure implementability*- The implementability of this control measure in the South Coast is estimated to be poor. Substantial R&D is required before implementation could be considered. The OCWD is currently conducting field tests on similar constructed wetlands.

15. Biological & Microbial Additives

A. *Description including source size*- In this control measure, the dairy operator applies biological or microbial additives to either the animal feed or the manure or wastewater. In general, additives fall into two categories of feed additives or post excreta additives that act on the manure and or wastewater. The supporting literature and data for this control measure is sparse. There does not appear to be any credible literature or research (excluding uncertified or validated vendor or manufacturer claims) that have directly measured the effectiveness of this control measure.

The source size for feed additives was estimated at 14%. The source size for manure additives was estimated at up to 100% depending on the area to be covered by the additive. The source size for the wastewater was estimated at 11%. No reliable estimates were found as to the effectiveness of this alternative.

B. *Ease of implementation*- The ease of implementation of this alternative is poor. Dairy operators would require significant research and demonstration trials to be conducted by academia prior to acceptance of the practice. Techniques for applying either the biological or the microbial additives are not standardized. Concerns exist about cross-contamination of various other media by whatever additives are used. The priority of cross-contamination concerns begins with milk, through the animal as beef, through the feed, and to water or land quality. Most vendors offering these various additives claim that formulations are proprietary and confidential. This technique hinders the acceptance and understanding of specific product formulations. Under separate work for AQMD, a potential product certification program is being developed.

C. *Time scale for implementation*- The time scale for implementation for this alternative is slow. Dairy operators would require significant research and demonstration trials to be conducted by academia prior to acceptance of the practice.

D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is significant. State and federal regulations pertaining to additives at dairy production facilities (food grade facilities) must be satisfied and could hinder the use of the option.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be unknown. Information from vendors offering these various additives was incomplete.

G. *Control measure implementability*- The implementability of this control measure is estimated to be poor. The cost-effectiveness of the control measure is unknown. Substantial R&D is required before implementation could be considered. Substantial state and federal regulatory requirements must be met prior to product utilization.

16. Chemical Additives

A. *Description including source size*- In this control measure, the dairy operator applies chemical additives to either the animal feed or the manure or wastewater. In general,

additives fall into two categories of feed additives or post excreta additives that act on the manure and or wastewater. The supporting literature and data for this control measure is sparse. There does not appear to be any credible literature or research (excluding uncertified or validated vendor or manufacturer claims) that have directly measured the effectiveness of this control measure.

The source size for feed additives was estimated at 14%. The source size for manure additives was estimated at up to 100% depending on the area to be covered by the additive. The source size for the wastewater was estimated at 11%. No reliable estimates were found as to the effectiveness of this alternative.

B. *Ease of implementation*- The ease of implementation of this alternative is poor. Dairy operators would require significant research and demonstration trials to be conducted by academia prior to acceptance of the practice. Techniques for applying either the biological or the microbial additives are not standardized. Concerns exist about cross-contamination of various other media by whatever additives are used. The priority of cross-contamination concerns begins with milk, through the animal as beef, through the feed, and to water or land quality. Most vendors offering these various additives claim that formulations are proprietary and confidential. This technique hinders the acceptance and understanding of specific product formulations. Under separate work for AQMD, a potential product certification program is being developed.

C. *Time scale for implementation*- The time scale for implementation for this alternative is slow. Dairy operators would require significant research and demonstration trials to be conducted by academia prior to acceptance of the practice.

D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is significant. State and federal regulations pertaining to additives at dairy production facilities (food grade facilities) must be satisfied and could hinder the use of the option.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be unknown. Information from vendors offering these various additives was incomplete.

G. *Control measure implementability*- The implementability of this control measure is estimated to be poor. The cost-effectiveness of the control measure is unknown. Substantial R&D is required before implementation could be considered. Substantial state and federal regulatory requirements must be met prior to product utilization.

17. Land Application With Best Management Practices Inside Southern California Air Basin

A. *Description including source size*- In this control measure, the dairy operator removes manure for land application to cropland as a fertilizer. Land application as a control measure can be effective. The practice should follow Natural Resources Conservation Service Conservation Practice Standard # 633- Waste Utilization. The size of the source in the case of Southern California dairies is approximately 45%. Estimates were completed indicating up to 50% of the ammonia and VOC emissions could be controlled yielding a net removal effectiveness for the dairy of about 22% when accomplished within the air basin.

As commercial fertilizer has reduced the need for manure, the economic benefit of manure has been increasingly viewed only in terms of the direct benefit associated with the essential nutrients for crop growth. This typically is measured in terms of the fertilizer replacement value. For example, an application of 10 tons of solid beef manure to an acre of land reduces fertilizer nitrogen requirements by about 40 lbs. during the next cropping year, which would save the farmer about $10 per acre at present fertilizer prices, disregarding the cost of manure application.

Utilization of manure applied to land is accomplished through microbial conversion of plant residues and wastes into usable crop nutrients. Breakdown of organic nutrient sources takes considerable time with only a fraction of the applied nitrogen being available the first year. Actual mineralization rates are difficult to determine given the fact that this is a biological process that is sensitive to temperature and moisture conditions found in the soil system. In manure, N is mostly organic and ammonium nitrogen. Organic N is a slow release N source. Ammonium N is equivalent to commercial fertilizer and, except for that lost to the air, can be used by plants in the application year. Organic nitrogen must be converted to inorganic form before plants can use it. Variable amounts of organic nitrogen are released to the soil in a plant-available form during the first cropping year after application. Organic N released during the second, third, and fourth cropping years after initial application is usually about 50%, 25%, and 12.5%, respectively of that mineralized during the first cropping season (MWPS, 1985).

Methods of application of manure are: broadcast (top dressed) with plow-down or disking, broadcast without plow-down or disking, knifed (wet manure injected under the soil surface), and irrigated (liquid manure).

The greatest nitrogen response follows land application and immediate incorporation into the soil. Best management practices recommend to plow down solid manure as soon as possible to minimize nitrogen loss and to begin release of nutrients for plant use. Most losses occur in the first 24 hours after application, so the most air quality benefit occurs when manure is incorporated into the soil as soon as possible. Injecting, chiseling, or knifing liquids into the soil minimizes odors and nutrient losses to the air and/or to runoff. Nitrogen loss as ammonia from land is greater during dry, warm, windy days than during humid or cold days. Ammonia loss is generally greater during the spring and summer months.

Use of manure should be based on at least one analysis of the material during the time it is to be used. In the case of daily spreading, the waste should be sampled and analyzed at least once each year. As a minimum, the manure analysis should identify nutrient and specific ion concentrations.

Where manures are to be spread on land not owned or controlled by the producer, the manure plan, as a minimum, should document the amount of manure to be transferred and who will be responsible for the environmentally acceptable use of the manure.

Additional description of the practice includes: All manure should be utilized in a manner that minimizes the opportunity for contamination of surface and ground water supplies. Where manures are utilized to provide fertility for crop, forage, fiber production, and forest products, the practice standard Nutrient Management (590) should be followed. Manures should be applied at rates not to exceed the crop nutrient requirements or salt concentrations as stated above, and should be applied at times the manures can be incorporated by appropriate means into the soil within 72 hours of

application. The effect of Waste Utilization on the water budget should be considered, particularly where a shallow ground water table is present or in areas prone to runoff. Limit manure to the volume of liquid that can be stored in the root zone. Minimize the impact of odors of land-applied manures by making application at times when temperatures are cool and when wind direction is away from neighbors. Priority areas for land application of manures should be on gentle slopes located as far as possible from waterways. When manures are applied on more sloping land or land adjacent to waterways, other conservation practices should be installed to reduce the potential for offsite transport of manure. It is preferable to apply manure on pastures and hayland soon after cutting or grazing before re-growth has occurred. Reduce nitrogen volatilization losses associated with the land application of manure by incorporation within 24 hours. Minimize environmental impact of land-applied manure by limiting the quantity of manure applied to the rates determined using the practice standard Nutrient Management (590) for all waste utilization. The manure management plan is to account for the utilization or other disposal of all animal wastes produced, and all manure application areas shall be clearly indicated on a plan map. The operation and maintenance plan should include the dates of periodic inspections and maintenance of equipment and facilities used in manure utilization. The plan should include what is to be inspected or maintained, and a general time frame for making necessary repairs.

B. *Ease of implementation*- The ease of implementation of this alternative is good. Land application of manure using best management practices is currently required by state and federal laws and regulations. Compliance enforcement measures are underway by the SARWQCB.
C. *Time scale for implementation*- The time scale for implementation for this alternative is immediate.
D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is significant. Current state and federal manure management requirements call for manure cleanup and removal at least once every six-months. Certain county ordinances regulate how manure is incorporated into cropland.
E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.
F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be reasonable. The practices required to achieve the management practices goals are achievable with only minor adjustments and small cost increased to the current land application practices.
G. *Control measure implementability*- The implementability of this control measure is estimated to be good. Current regulatory requirements call for implementation of these practices. These options will add only slight cost increases for manure management and are required under provisions of state and federal clean water laws and regulations.

18. Land Application With Best Management Practices Outside Southern California Air Basin

A. *Description including source size*- In this control measure, the dairy operator removes manure for land application to cropland as a fertilizer to land outside the Southern California air basin. As detailed in the previous section, land application as a control measure can be effective. The practice should follow Natural Resources Conservation Service Conservation Practice Standard # 633- Waste Utilization. The size of the source

in the case of Southern California dairies is approximately 45%. Estimates were completed indicating up to 100% of the ammonia and VOC emissions could be controlled yielding a net removal effectiveness for the dairy of about 45%.

B. *Ease of implementation*- The ease of implementation of this alternative is good. Land application of manure using best management practices is currently required by state and federal laws and regulations. Compliance enforcement measures are underway by the SA RWQCB.

C. *Time scale for implementation*- The time scale for implementation for this alternative is immediate.

D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is significant. Current state and federal manure management requirements call for manure cleanup and removal at least once every six-months. This requirement applies to the Chino and Ontario areas as well as the San Jacinto area.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be reasonable. The practices required to achieve the management practices goals are achievable with only minor adjustments and small cost increased to the current land application practices.

G. *Control measure implementability*- The implementability of this control measure is estimated to be good. Current regulatory requirements call for implementation of these practices. These options will add only slight cost increases for manure management and are required under provisions of state and federal clean water laws and regulations. Water quality or county regulations on how manure is land applied similar to regulations in the South Coast region could be adopted.

19. Young Stock Relocation Outside Southern California Air Basin

A. *Description including source size*- In this control measure, the dairy operator removes calves and heifers from the dairy operation in the Southern California Air Basin. Removal of young stock would remove the cattle and related emissions from the area. It would transfer the emissions to other locations that may or may not have assimilative capacity to absorb these emissions. Removal of all animals would result in 100% source size. Estimates were completed indicating up to 100% of the ammonia and VOC emissions could be controlled yielding a net removal effectiveness for the dairy of up to 100%.

B. *Ease of implementation*- The ease of implementation of this alternative is relatively good.

C. *Time scale for implementation*- The time scale for implementation for this alternative is immediate.

D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is insignificant. There are no state or federal regulations that would hinder the use of the option or require its immediate or long-range implementation.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be reasonable. Current dairy practices include regular relocation of young

stock to facilities outside the air basin. These are routine costs managed by the dairy operator.

G. *Control measure implementability*- The implementability of this control measure is estimated to be good. Current dairy practices include regular relocation of young stock to facilities outside the air basin. Although SCAQMD staff track relocation, SCAQMD currently does not have any relocation requirements.

20. Dairy Relocation Outside Southern California Air Basin

A. *Description including source size*- In this control measure, the dairy operator removes cattle from the South Coast Air Basin to facilities at other locations. Relocation of dairies outside of the Southern California air basin would remove the cattle and related emissions from the area. It would transfer the emissions to other locations that may or may not have assimilative capacity to absorb these emissions. No formal literature exists documenting the relocation of dairies outside the basin. Information available from the California Department of Food and Agriculture indicates that dairy relocation is occurring at up to several percent per year. Data from the RWQCB indicates that the number of dairies in the region are relocating or reducing by a similar amount. Industry sources including the Milk Producers Council and Western United Dairymen indicate that dairy relocation will continue as an industry trend. These sources believe that an overall reduction of 50% from today's levels will occur during the next 20-years. Removal of all animals would result in 100% source size. Estimates were completed indicating 100% of the ammonia and VOC emissions could be controlled yielding a net removal effectiveness for the dairy of 100%.

B. *Ease of implementation*- The ease of implementation of this alternative is relatively good. Although significant hurdles are often in the way of dairies desiring to relocate to places such as the Central Valley of California, opportunities to relocate still exist. As land values in the Chino and Ontario areas continue to rise due to development pressure, the overall economics of dairy location are likely to improve.

C. *Time scale for implementation*- The time scale for implementation for this alternative is immediate and sustained. Dairy relocation has been occurring over the past several years. Continued relocation is projected to occur over the next 20-years.

D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is insignificant. There are no state or federal regulations that would hinder the use of the option or require its immediate or long-range implementation.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be reasonable. Current dairy practices include relocation of dairies to locations outside the air basin. These are business costs managed by the dairy operator.

G. *Control measure implementability*- The implementability of this control measure is estimated to be good. Current dairy practices include regular relocation to facilities outside the air basin. Although SCAQMD staff track relocation, SCAQMD currently does not have any relocation requirements.

21. Composting Within Southern California Air Basin- Enclosed Aerated Static Pile

A. *Description including source size*- In this control measure, the dairy operator removes manure and urine to ASP composting facilities within the Southern California Air Basin. Composting is the controlled decomposition of organic material under aerobic conditions. Under certain conditions, such as composting via aerated static pile, emissions from composting operations can be greatly reduced. The size of the source relative to manure management is a function of the timing of manure removal from the dairy. The source size for relatively dry corral manure is about 60% while fresh or daily removal could approach 100%.

Three types of composting operations are available ranging from aerated windrows, aerated static piles (open or enclosed), to in-vessel. Aerated windrows are more suited to large volumes of organic material that are managed by power equipment used to turn the composting material periodically. Periodic turning re-aerates the windrows, promoting the composting process.

Organic material in aerated static piles is initially mixed to a homogeneous condition and not turned again throughout the composting process. Static pile material must have the proper moisture content and bulk density to facilitate air movement throughout the pile. Forced air is necessary to facilitate the composting process. ASP composting can economically occur either enclosed in a building or out of doors. In either case, where suction air is used, the air is typically captured and discharged through a biofilter for removal of odor, ammonia (routinely 75%), and volatile organic compounds (routinely 80%).

In-vessel composting in a totally enclosed structure is carried out on a blended organic material under conditions where temperature and air flow are strictly controlled. In-vessel composting also includes naturally aerated processes where organic materials are layered in the vessel in a specified sequence. Layered, in-vessel materials are usually turned once to facilitate the process. Vessel dimensions must be consistent with equipment to be used for management of compost.

Estimates were completed indicating up to 75% of the ammonia and 80% of the VOC emissions could be controlled yielding a net removal effectiveness for the dairy of 34% to 56% for ammonia and 36% to 60% for VOCs.

B. *Ease of implementation*- The ease of implementation of this alternative is good. Composting at windrow types of facilities is underway and has been practiced by the dairy industry for many years. Implementation of ASP or enclosed ASP facilities is underway in several locations in Southern California.

C. *Time scale for implementation*- The time scale for implementation for this alternative is immediate and sustained.

D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is significant. Rule 1133 regarding composting facilities was recently adopted by the AQMD. This rule moves the hierarchy of composting to ASP or enclosed ASP and away from windrow facilities.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is active. IEUA is completing the design of a new totally enclosed ASP composting facility in Rancho Cucamonga. This facility will replace the existing co-composting facility on Chino-Corona Road. Although it is unlikely that much manure will be processed in this facility, IEUA is in the early stages of planning new manure composting facilities to replace the existing

manure co-composting capacity of at least 200,000 tons per year. These facilities are projected to be operational by 2006.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be high. Enclosed ASP composting facilities are estimated to require tipping fees of $35 to $45 per ton of feedstock. This exceeds current tipping fee levels that are at $7.75 per ton by as much as 580%.

G. *Control measure implementability*- The implementability of this control measure is estimated to be fair. Enclosed composting facilities are high capital cost facilities. Initial cost estimates to implement such an option indicate that it could cost dairy operators up to 580% more than current costs for windrow composting. EQIP or other funding for the capital costs could improve the implementability of this option.

22. Composting Within Southern California Air Basin- Open Aerated Static Pile

A. *Description including source size*- In this control measure, the dairy operator removes manure and urine to ASP composting facilities within the Southern California Air Basin. As detailed in the previous section, composting via aerated static pile, emissions from composting operations can be greatly reduced. The size of the source relative to manure management is a function of the timing of manure removal from the dairy. The source size for relatively dry corral manure is about 60% while fresh or daily removal could approach 100%. ASP composting, where suction air is used, the air is typically captured and discharged through a biofilter for removal of odor, ammonia (routinely 75%), and volatile organic compounds (routinely 80%). Estimates were completed indicating up to 75% of the ammonia and 80% of the VOC emissions could be controlled yielding a net removal effectiveness for the dairy of 34% to 56% for ammonia and 36% to 60% for VOCs.

B. *Ease of implementation*- The ease of implementation of this alternative is good. Composting at windrow types of facilities is underway and has been practiced by the dairy industry for many years. Implementation of ASP or enclosed ASP facilities is underway in several locations in Southern California.

C. *Time scale for implementation*- The time scale for implementation for this alternative is immediate and sustained.

D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is significant. Rule 1133 regarding composting facilities was recently adopted by the AQMD. This rule moves the hierarchy of composting to ASP or enclosed ASP and away from windrow facilities.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is active. IEUA is completing the design of a new totally enclosed ASP composting facility in Rancho Cucamonga. This facility will replace the existing co-composting facility on Chino-Corona Road. Although it is unlikely that much manure will be processed in this facility, IEUA is in the early stages of planning new manure composting facilities to replace the existing manure co-composting capacity of at least 200,000 tons per year. These facilities are projected to be operational by 2006.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be high. Totally open ASP composting facilities are not practical in Southern California and the Chino Ontario area due to high winds from Santa Ana conditions that lead to excessive dust. Some type of enclosing and wind-protecting

facilities are needed and are estimated to require tipping fees of $30 to $40 per ton of feedstock. This exceeds current tipping fee levels that are at $7.75 per ton by as much as 515%.

G. *Control measure implementability*- The implementability of this control measure is estimated to be fair. Somewhat open composting facilities are high capital cost facilities. Initial cost estimates to implement such an option indicate that it could cost dairy operators up to 515% more than current costs for windrow composting. EQIP or other funding for the capital costs could improve the implementability of this option.

23. Composting Within Southern California Air Basin- Open Windrow

A. *Description including source size*- In this control measure, the dairy operator removes manure and urine to open windrow composting facilities within the Southern California Air Basin. As detailed in Section 21 windrow composting emissions do not result in any reduction of ammonia or VOC's. This method of composting may add ammonia and VOC burden to the air basin. The results of this feasibility assessment indicate that windrow composting does not favor air quality emissions reductions and may aggravate emissions issues.

B. *Ease of implementation*- The ease of implementation of this alternative is extremely poor.

C. *Time scale for implementation*- The time scale for implementation for this alternative is unlikely.

D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is significant. Rule 1133 regarding composting facilities was recently adopted by the AQMD. This rule moves the hierarchy of composting to ASP or enclosed ASP and away from windrow facilities.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is active. IEUA is completing the design of a new totally enclosed ASP composting facility in Rancho Cucamonga. This facility will replace the existing windrow co-composting facility on Chino-Corona Road. Although it is unlikely that much manure will be processed in this new facility, IEUA is in the early stages of planning new manure composting facilities to replace the existing manure co-composting capacity of at least 200,000 tons per year. These facilities are projected to be operational by 2006.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure was not estimated due to the regulatory restrictions on open windrow types of facilities.

G. *Control measure implementability*- The implementability of this control measure is estimated to be extremely poor due to the regulatory restrictions on open windrow types of facilities.

24. Composting Outside Southern California Air Basin- Enclosed Aerated Static Pile

A. *Description including source size*- In this control measure, the dairy operator transports manure and urine to enclosed ASP composting facilities outside the Southern California Air Basin. As described in Section 21, the source size for relatively dry corral manure is about 60% while fresh or daily removal could approach 100%. Estimates were completed indicating a range of 60% to 100% of the emissions could be controlled yielding a net removal effectiveness for the dairy of 60% to 100% of the emissions, driven by the amount of manure removed.

B. *Ease of implementation*- The ease of implementation of this alternative is relatively poor. Virtually no enclosed ASP composting facilities are contemplated outside the Southern California Air Basin.
C. *Time scale for implementation*- The time scale for implementation for this alternative is slow. Virtually no enclosed ASP composting facilities are contemplated outside the Southern California Air Basin.
D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is insignificant. There are no state or federal regulations that would hinder the use of the option or require its immediate or long-range implementation.
E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.
F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be high. Enclosed ASP composting facilities are estimated to require tipping fees of $35 to $45 per ton of feedstock. This exceeds current tipping fee levels that are at $7.75 per ton by as much as 580%.
G. *Control measure implementability*- The implementability of this control measure is estimated to be poor due to high capital costs. No enclosed ASP composting facilities of this nature currently exist in this region.

25. Composting Outside Southern California Air Basin- Open Aerated Static Pile

A. *Description including source size*- In this control measure, the dairy operator transports manure and urine to open ASP composting facilities outside the Southern California Air Basin. As described in Section 21, the source size for relatively dry corral manure is about 60% while fresh or daily removal could approach 100%. Estimates were completed indicating a range of 60% to 100% of the emissions could be controlled yielding a net removal effectiveness for the dairy of 60% to 100% of the emissions, driven by the amount of manure removed.
B. *Ease of implementation*- The ease of implementation of this alternative is poor. Virtually no enclosed ASP composting facilities are contemplated outside the Southern California Air Basin.
C. *Time scale for implementation*- The time scale for implementation for this alternative is slow. Virtually no open ASP composting facilities are contemplated outside the Southern California Air Basin.
D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is insignificant. There are no state or federal regulations that would hinder the use of the option or require its immediate or long-range implementation.
E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.
F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be high. Totally open ASP composting facilities are not practical in Southern California and the Chino Ontario area due to high winds from Santa Ana conditions that lead to excessive dust. Some type of enclosing and wind-protecting facilities are needed and are estimated to require tipping fees of $30 to $40 per ton of feedstock. This exceeds current tipping fee levels that are at $7.75 per ton by as much as 515%.

G. *Control measure implementability*- The implementability of this control measure is estimated to be poor due to the high capital cost. Virtually no open aerated ASP composting facilities of this nature currently exist in this region.

26. Composting Outside Southern California Air Basin- Open Windrow

A. *Description including source size*- In this control measure, the dairy operator transports manure and urine to open windrow composting facilities outside the Southern California Air Basin. As described in Section 21, the source size for relatively dry corral manure is about 60% while fresh or daily removal could approach 100%. Estimates were completed indicating a range of 60% to 100% of the emissions could be controlled yielding a net removal effectiveness for the dairy of 60% to 100% of the emissions, driven by the amount of manure removed.

B. *Ease of implementation*- The ease of implementation of this alternative is relatively good. Windrow composting facilities for manure and other feedstock are currently operating.

C. *Time scale for implementation*- The time scale for implementation for this alternative is immediate and active. Windrow composting facilities for manure and other feedstock are currently operating.

D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is insignificant. There are no state or federal regulations that would hinder the use of the option or require its immediate or long-range implementation.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be fair. The capital costs of new windrow composting facilities are expected to be somewhat higher than recently constructed facilities due to new facility requirements from the RWQCB's and the California Integrated Waste Management Board. The resulting cost-effectiveness is estimated to add up to 50% to the current cost of these types of facilities. New tipping fees would likely range from $10 to $12 per ton plus the cost of transportation. Transportation to locations outside the basin are likely to range from $8 to $12 per ton additional, bringing the overall cost to $18 to $24 per ton. These values are compared to current manure composting and transport costs of approximately $12 per ton.

G. *Control measure implementability*- The implementability of this control measure is estimated to be good. Windrow composting facilities for manure and other feedstock are currently operating. The economics of this alternative appear to be within reach of most dairy facilities.

27. Regional Or On-Site Anaerobic Digestion Systems

A. *Description including source size*- In this control measure, the dairy operator removes manure and urine more frequently than is currently practiced to an anaerobic digestion system. Anaerobic digestion is a natural process that converts biomass to energy. Manure for digestion would come from the feed aprons and various other parts of the dairy amounting to a source size up to 61%.

Biomass is any organic material that comes from plants, animals or their wastes. Anaerobic digestion has been used for over 100 years to stabilize municipal sewage and

a wide variety of agricultural and industrial wastes. The anaerobic process removes a majority of the odorous compounds. It also significantly reduces the pathogens present in the slurry. Over the past 25 years, anaerobic digestion processes have been developed and applied to a wide array of industrial and agricultural wastes including dairy manure. It is the preferred waste treatment process since it produces, rather than consumes energy and can be carried out in relatively small, enclosed tanks. The products of anaerobic digestion have value and can be sold to offset treatment costs.

Anaerobic digestion provides a variety of benefits including:

- ✓ Odors, ammonia, and VOCs are significantly reduced or eliminated.
- ✓ Flies are substantially reduced.
- ✓ A relatively clean liquid for flushing and irrigation can be produced.
- ✓ Pathogens are substantially reduced in the liquid and solid products
- ✓ Greenhouse gas emissions are reduced.
- ✓ Non-point source pollution is substantially reduced

The Inland Empire Utilities Agency as a part of its regional Organics Management Strategy is conducting demonstration projects of the effectiveness of anaerobic digestion systems to manage manure and related solids. IEUA commenced an Organics Management Study in August 2000 to address long-range plans for treating and utilizing biosolids as well as dealing with the problems of disposing of manure and green waste material generated within its service area. This resulted in the release of an Organics Management Strategy Business Plan dated May 31, 2001. The Business Plan summarized the technical facts and the process followed during the course of the Organics Management Study and proposed the evaluation of several sites and construction of digestion and composting facilities as necessary to meet the needs of the Agency.

Additionally, a report on the benefits of anaerobic digestion systems compared to non-digestion systems was completed for AgSTAR of the U. S. EPA. The results of the study are summarized in the table below, extracted from the report. The capital cost investment for the facility was estimated to require about 11-years of payback at the rate of about $34,000 per year. The cost of electricity ranged from $0.09 and $0.12 per kWh.

"Table 1-1. Impacts of anaerobic digestion on a semisolid dairy cattle manure management systems with solids separation and storage. (Source- A Comparison of Dairy Cattle Manure Management with and without Anaerobic Digestion and Biogas Utilization, AgSTAR Program, U.S. Environmental Protection Agency

Parameter	With anaerobic digestion (AA Dairy vs. Patterson Farms)
Odor	Substantial reduction
Greenhouse gas emissions	Methane—substantial reduction (8.16 tons per cow-yr)
	Nitrous oxide—No evidence of emissions with or without anaerobic digestion
	Ammonia emissions- No significant reduction
Potential water quality impacts	Oxygen demand—substantial reduction (8.4 lb per cow-day)
	Pathogens—substantial reduction (Fecal coliforms:

	~99.9%)
	(*M. avium paratuberculosis*: ~99%)
	Nutrient enrichment—no reduction
Economic impact	Significant increase in net farm income ($82 per cow-yr)"

Estimates were completed indicating up to 50% of the emissions could be controlled yielding a net removal effectiveness for the dairy of 30% of the emissions.

B. *Ease of implementation*- The ease of implementation of this alternative is relatively good. Full-scale demonstration facilities have been built and are operating in the Chino area. Additional facilities are contemplated as a part of the IEUA Organics Management Strategy. This option works in tandem with the activity by the dairy of more frequent manure cleaning of the dairy.

C. *Time scale for implementation*- The time scale for implementation for this alternative is immediate, active and sustained.

D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is insignificant. There are no state or federal regulations that would hinder the use of the option or require its immediate or long-range implementation.

E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is active. The OMS was implemented including continued operation of the manure composting facility and operation of two manure anaerobic digestion facilities handling a total of 285 tons per day (40 dry tons per day; 14,600 dry tons per year) or a capacity of about 1.6%[2] of the total manure production in the Inland Empire area. Additional manure digestion capacity adding an additional 285 tons per day of capacity is projected for 2005.

F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be high. The capital cost for installing about 225 tons per day of manure processing capacity was about $5,000,000. A portion of these facilities could be eligible for USDA-NRCS grant funding associated with the 2002 Farm Bill- Title II Conservation: Environmental Quality Incentive Programs (EQIP). Tipping fees for these facilities is estimated to be comparable to the cost of windrow composting outside of the Southern California Air Basin, from $10 to $12 per ton plus the cost of transportation, estimated at about $4 per ton. The total cost to the dairies is estimated at about $16 per ton according to analysis by IEUA. This cost does not include the amortization of capital facility costs which were funded by a grant from the Natural Resources Conservation Service. IEUA does not provide subsidies to the dairies for the purpose of manure management through anaerobic digestion systems.

G. *Control measure implementability*- The implementability of this control measure is estimated to be good. Anaerobic digestion facilities for manure and other feedstock are currently operating. The economics of this alternative appear to be within reach of most dairy facilities, if the capital costs for the facilities are not paid for by the dairies.

28. Regional High Technology Manure Processing Facilities

[2] Approximately 1.4 million tons per year corral dry manure at 65% solids equals 910,000 dry tons per year; 14,600 dry tons per year ÷ 910,000 dry tons per year = 1.6%

A. *Description including source size*- In this control measure, the dairy operator removes manure and urine more frequently than is currently practiced to a new high technology manure processing facility. Various private vendors have proposed a range of potential technologies including gasification and fuel creation. The supporting literature and data for this control measure is sparse. There does not appear to be any credible literature or research (excluding vendor or manufacturer claims) that has directly measured the effectiveness of this control measure. Due to a paucity of data, the net removal effectiveness cannot be calculated.
B. *Ease of implementation*- The ease of implementation of this alternative is relatively poor. High tech facilities are costly, require a relatively large footprint due to the desire for economies of scale pushing towards a large facility and therefore are likely to have difficult permit and community acceptance.
C. *Time scale for implementation*- The time scale for implementation for this alternative is slow. No high-tech facilities are currently proposed.
D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is insignificant. There are no state or federal regulations that would hinder the use of the option or require its immediate or long-range implementation.
E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.
F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be high. The capital cost for installing such facilities is estimated to exceed $5,000,000. A portion of these facilities could be eligible for USDA-NRCS grant funding associated with the 2002 Farm Bill- Title II Conservation: Environmental Quality Incentive Programs (EQIP). Tipping fees for these facilities is estimated to be comparable to the highest composting facility cost at tipping fees of $35 to $45 per ton of feedstock. This exceeds current tipping fee levels that are at $7.75 per ton by as much as 580%.
G. *Control measure implementability*- The implementability of this control measure is estimated to be poor. High-tech facilities have high capital costs. EQIP or other funding for the capital costs could improve the implementability of this option.

29. Manure Drying-Combustion-Energy Production Systems

A. *Description including source size*- In this control measure, the dairy operator removes manure and urine more frequently than is currently practiced to a new manure drying to combustion to energy production facility. Various private vendors have proposed a range of potential technologies including gasification and fuel creation. The supporting literature and data for this control measure is sparse. There does not appear to be any credible literature or research (excluding vendor or manufacturer claims) that has directly measured the effectiveness of this control measure. Due to a paucity of data, the net removal effectiveness cannot be calculated.
B. *Ease of implementation*- The ease of implementation of this alternative is relatively poor. High tech facilities are costly, require a relatively large footprint due to the desire for economies of scale pushing towards a large facility and therefore are likely to have difficult permit and community acceptance.
C. *Time scale for implementation*- The time scale for implementation for this alternative is slow. No drying-energy production facilities are currently proposed.

D. *Regulatory program implementation*- The status of regulatory program implementation related to this alternative is insignificant. There are no state or federal regulations that would hinder the use of the option or require its immediate or long-range implementation.
E. *IEUA Organics Management Strategy status*-The status of implementation of the manure portion of IEUA's Organics Management Strategy is not relevant to this option.
F. *Control Measure Cost-Effectiveness*- The cost-effectiveness of this control measure is estimated to be high. The capital cost for installing such facilities is estimated to exceed $5,000,000. A portion of these facilities could be eligible for USDA-NRCS grant funding associated with the 2002 Farm Bill- Title II Conservation: Environmental Quality Incentive Programs (EQIP). Tipping fees for these facilities is estimated to be comparable to the highest composting facility cost at tipping fees of $35 to $45 per ton of feedstock. This exceeds current tipping fee levels that are at $7.75 per ton by as much as 580%.
G. *Control measure implementability*- The implementability of this control measure is estimated to be poor. High-tech facilities have high capital costs. EQIP or other funding for the capital costs could improve the implementability of this option.

Cross-Media Impacts or Conflicts with Regulatory Programs- Implementation of various control measures has the potential to lead to impacts (positive or negative) on other environmental media or may not be consistent with other regulatory programs. This section briefly assesses the potential for either of these two situations.

Cross-Media Impacts- Potential cross-media impacts are summarized on Table 3 by potential control measure.

Table 3 – Potential Cross Media Impacts per Potential Control Measure

#	Potential Control Measures	Potential Cross-Media Impacts
1.	Manure Harvesting & More Frequent Corral Cleaning	1. Improve water quality 2. Reduce nuisance issues (odors, flies, vectors)
2.	Stockpile Elimination & Reduction	1. Improve water quality 2. Reduce nuisance issues (odors, flies, vectors)
3.	Land Application with BMPs Outside the Southern California Air Basin	1. Improve water quality 2. Reduce nuisance issues (odors, flies, vectors)
4.	Young Stock & Dairy Relocation	1. Improve water quality 2. Reduce nuisance issues (odors, flies, vectors)
5.	Composting Manure	1. Improve water quality 2. Reduce nuisance issues (odors, flies, vectors)
6.	Regional or On-Site Anaerobic Digestion Systems	1. Improve water quality 2. Reduce nuisance issues (odors, flies, vectors)

Regulatory Program Conflicts- The major concern with regulatory programs centers on the implementation by the US EPA and the SARWQCB of the recently promulgated regulations for Concentrated Animal Feeding Operations (CAFO) point sources. On December 15, 2002, EPA promulgated 40 CFR Parts 9, 122, and 412- National Pollutant Discharge Elimination System Permit Regulation and Effluent Limitation Guidelines and Standards for Concentrated Animal Feeding Operations. This rule clarifies the requirements under the federal Clean Water Act. The rule's highlights are as follows:

- ✓ Defines large and medium CAFOs as greater than 700 mature dairy cows or 200 to 699 mature dairy cows, respectively
- ✓ Requires all CAFOs to get an NPDES permit
- ✓ All CAFOs must implement
  - o No discharge unless exceeds 25-year, 24-hour rainfall event
  - o Nutrient management plan
  - o Proper storage of manure
  - o Proper management of mortalities
  - o Divert clean water
  - o Prevent direct contact of animals with water
  - o Handle chemicals properly
  - o Implement conservation practices
  - o Conduct appropriate testing of manure, litter, process wastewater, and soil
  - o Apply manure to land with BMPs also known as Best Practicable Control Technology
  - o Keep records for 5-years
  - o Submit an annual report
  - o Conduct a variety of inspections daily and weekly
  - o Implement no later than December 31, 2006

The activities contemplated by AQMD under this program do not appear to be in conflict with the requirements established by EPA for CAFOs. Most dairy operations in the Southern California Air Basin will qualify as large CAFOs and will be obtaining permits through programs designated to the SARWQCB. These permit programs do not directly affect air quality. To the extent that improved housekeeping results from these permit requirements, air quality may be somewhat improved through the more rapid removal or control of manure and wastewater.

Additional Research Needs Quantifying Cross-Media Impacts- A variety of additional research needs were identified during the completion of this work. Table 3 lists the research needs.

Table 3- List of Additional Research Needs

#	Emission Control Option	Research Need
1.	Stockpile Covers	✓ The technical effectiveness of covers on stockpiles must be measured ✓ The operations, maintenance, and cost must be determined
2.	Use of Somatotropin	✓ Evaluate the public and industry acceptance
3.	Reduction of Crude Protein, Rumen Degradable Protein, &	✓ Significant research into the efficacy of each of these options as applied to Southern California dairy practices

	Altered Feed Management Strategies	and situation
4.	Storage Lagoon Covers- Leca Pebbles, Plastic Covers, & Tanks	✓ Research into the efficacy of each of these options as applied to Southern California dairy practices and situation including technical performance, operations, maintenance, and cost
5.	Wastewater Constructed Wetlands	✓ Research into the efficacy of each of the option as applied to Southern California dairy practices and situation including technical performance, operations, maintenance, and cost
6.	Biological, Microbial, & Chemical Additives	✓ Research into the efficacy of each of the option as applied to Southern California dairy practices and situation including technical performance, operations, maintenance, and cost