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## EMISSIONS SUMMARY

*Maximum Drilling Phase Emissions*

| | Emissions | |
|---|---|---|
| **Pollutant** | *lb/day* | *tpy* |
| $NO_X$ | 2,861.8 | 500.8 |
| VOC | 404.4 | 70.8 |
| CO | 3,546.1 | 620.6 |
| $PM_{10}$ | 230.1 | 40.3 |
| $PM_{2.5}$ | 177.4 | 31.0 |
| $SO_2$ | 68.1 | 11.9 |

*Maximum Construction Phase Emissions*

| | Emissions | |
|---|---|---|
| **Pollutant** | *lb/day* | *tpy* |
| $NO_X$ | 175.4 | 23.7 |
| VOC | 24.8 | 3.3 |
| CO | 217.4 | 29.3 |
| $PM_{10}$ | 69.0 | 9.3 |
| $PM_{2.5}$ | 33.0 | 4.5 |
| $SO_2$ | 4.2 | 0.6 |

*Maximum Solution Mining Process Phase Emissions*

| | Emissions | | | | |
|---|---|---|---|---|---|
| | Boiler | | Separator Tank Vent | | Facility Total |
| **Pollutant** | *lb/day* | *tpy* | *lb/day* | *tpy* | *tpy* |
| $NO_X$ | 70.6 | 12.9 | -- | -- | 12.9 |
| VOC | 9.4 | 1.7 | 48.0 | 8.8 | 10.5 |
| CO | 118.6 | 21.6 | -- | -- | 21.6 |
| $PM_{10}$ | 2.0 | 0.4 | -- | -- | 0.4 |
| $PM_{2.5}$ | 2.0 | 0.4 | -- | -- | 0.4 |
| $SO_2$ | 2.3 | 0.4 | -- | -- | 0.4 |

*Maximum ICP Process Phase Emissions*

| | Emissions | | | | | |
|---|---|---|---|---|---|---|
| | Boilers (both) | | Incinerator | | Fugitive | Facility Total |
| **Pollutant** | *lb/day* | *tpy* | Max *lb/day* | *tpy* | *tpy* | *tpy* |
| $NO_X$ | 50.1 | 8.8 | 1,580.3 | 61.2 | - | 70.0 |
| VOC | - | 1.1 | - | 21.7 | 72.2 | 95.0 |
| CO | 50.1 | 8.8 | 178.5 | 31.2 | - | 40.0 |
| $PM_{10}$ | 8.7 | 1.5 | 25.7 | 4.5 | - | 6.0 |
| $PM_{2.5}$ | 8.7 | 1.5 | 25.7 | 4.5 | - | 6.0 |
| $SO_2$ | 82.0 | 14.3 | 2,121.0 | 80.7 | - | 95.0 |
| $H_2S$ | - | 0.008 | - | 1.3 | 8.3 | 9.5 |

Note: Input values are in blue, calculated values are in black

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## DRILLING OPERATION CHARACTERISTICS

| | | | Reference |
|---|---|---|---|
| Drill Rig Horsepower (avg operating) | 750 | *hp/rig* | *OST Drilling Fuel Consumption Estimate.xls* |
| Rig Operation | 20 | *hrs/day* | *OST Drilling Fuel Consumption Estimate.xls* |
| | 350 | *days/yr* | |
| Number of Operating Rigs | 4 | *rigs* | *OST Drilling Fuel Consumption Estimate.xls* |
| Diesel Consumption | 36.0 | *gal/hr/rig* | *OST Drilling Fuel Consumption Estimate.xls* |
| Heat Content of Diesel | 137,000 | Btu/gal | *EPA AP-42 Appendix A* |
| Sulfur Content of Diesel | 0.05% | | *40 CFR part 80.29* |
| Density of Diesel | 7.05 | *lbs/gal* | *EPA AP-42 Appendix A* |
| Internal Combustion Engine Efficiency | 7,000 | *Btu/hp-hr* | *AP-42 Table 3.3-1* |

| | Annual | Maximum Daily |
|---|---|---|
| **Diesel Consumption** | 1,008,000 *gal/yr* | 2,880 *gal/day* |

## EMISSIONS FACTORS - DRILLS

| Pollutant | *g/kW-hr* | *g/hp-hr* | *g/MMBtu* | *Reference* |
|---|---|---|---|---|
| $NO_X$ | 9.2 | 6.9 | *980.1* | *40 CFR part 89.112, 450≤kW≤560 (Tier I)* |
| VOC | 1.3 | 1.0 | *138.5* | *40 CFR part 89.112, 450≤kW≤560 (Tier I)* |
| CO | 11.4 | 8.5 | *1,214.4* | *40 CFR part 89.112, 450≤kW≤560 (Tier I)* |
| $PM_{10}$* | 0.54 | 0.40 | *57.53* | *40 CFR part 89.112, 450≤kW≤560 (Tier I)* |
| $PM_{2.5}$* | 0.54 | 0.40 | *57.53* | *40 CFR part 89.112, 450≤kW≤560 (Tier I)* |
| $SO_2$ | -- | -- | *11.67* | |

*All particulate assumed to be ≤1μm in diameter (AP-42 Table 3.3-1)

## EMISSIONS - DRILLS

| | Emissions | |
|---|---|---|
| **Pollutant** | **tons/yr** | **lbs/day** |
| $NO_X$ | 149.2 | 852.5 |
| VOC | 21.1 | 120.5 |
| CO | 184.9 | 1,056.4 |
| $PM_{10}$ | 8.8 | 50.0 |
| $PM_{2.5}$ | 8.8 | 50.0 |
| $SO_2$ | 3.5 | 20.3 |

| Conversion Factors | |
|---|---|
| 453.5924 | g/lb |
| 2,000 | lb/ton |
| 1.341 | hp/kW |
| **Molecular weights** | |
| 32.06 | S |
| 64.06 | $SO_2$ |

## SOURCE CHARACTERISTICS (4 Stacks at corners of drilling area)

| Parameter | *English Units* | *Metric Units* |
|---|---|---|
| Exhaust Temp. | 750 *°F* | 672 *°K* |
| Stack Height | 12 *ft* | 3.66 *m* |
| Stack Diameter | 8.00 *in* | 0.20 *m* |
| Exhaust Velocity | 131 *ft/s* | 40.00 *m/s* |

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## OTHER NON-ROAD SOURCE CHARACTERISTICS

| Engine Operation | *hp/unit* | *hrs/day* | *days/yr* | *unit* | *gal/hr/unit* | *gal/day* | *gal/yr* | *Reference* |
|---|---|---|---|---|---|---|---|---|
| Compressor | 503 | 20 | 350 | 8 | 24.1 | 3,863 | 1,352,064 | *OST Drilling Fuel Consumption Estimate.xls* |
| Booster Compressor | 500 | 20 | 350 | 2 | 24.0 | 960 | 336,000 | *OST Drilling Fuel Consumption Estimate.xls* |
| Light Plants | 25 | 12 | 350 | 6 | 1.2 | 86 | 30,240 | *OST Drilling Fuel Consumption Estimate.xls* |
| Mud Treatment System | 190 | 20 | 350 | 4 | 9.1 | 728 | 254,800 | *OST Drilling Fuel Consumption Estimate.xls* |
| **Total** | | | | | | **5,637** | **1,973,104** | |

| | | | |
|---|---|---|---|
| Heat Content of Diesel | 137,000 | Btu/gal | *EPA AP-42 Appendix A* |
| Sulfur Content of Diesel | 0.05% | | *40 CFR part 80.29* |
| Density of Diesel | 7.05 | *lbs/gal* | *EPA AP-42 Appendix A* |
| Internal Combustion Engine Efficiency | 7,000 | *Btu/hp-hr* | *AP-42 Table 3.3-1* |

## EMISSION FACTORS - OTHER NON-ROAD

### Tier I Emission Factors (Criteria Pollutants)

| Pollutant | *g/kW-hr* | *g/hp-hr* | *g/MMBtu* | *Reference* |
|---|---|---|---|---|
| $NO_X$ | 9.2 | 6.9 | *980.063* | *40 CFR part 89.112, 130≤kW≤450 (Tier I)* |
| VOC | 1.3 | 1.0 | *138.487* | *40 CFR part 89.112, 130≤kW≤450 (Tier I)* |
| CO | 11.4 | 8.5 | *1214.43* | *40 CFR part 89.112, 130≤kW≤450 (Tier I)* |
| $PM_{10}$* | 0.54 | 0.40 | *57.5254* | *40 CFR part 89.112, 130≤kW≤450 (Tier I)* |
| $PM_{2.5}$* | 0.54 | 0.40 | *57.5254* | *40 CFR part 89.112, 130≤kW≤450 (Tier I)* |
| $SO_2$ | -- | -- | *11.67* | |

*All particulate assumed to be ≤1µm in diameter (AP-42 Table 3.3-1)

## EMISSION - OTHER NON-ROAD

| | Emissions | |
|---|---|---|
| **Pollutant** | **tons/yr** | **lbs/day** |
| $NO_X$ | 292.0 | 1,668.7 |
| VOC | 41.3 | 235.8 |
| CO | 361.9 | 2,067.8 |
| $PM_{10}$ | 17.1 | 97.9 |
| $PM_{2.5}$ | 17.1 | 97.9 |
| $SO_2$ | 6.9 | 39.7 |

| Conversion Factors | |
|---|---|
| 453.592 | g/lb |
| 2,000 | lb/ton |
| 1.341 | hp/kW |
| **Molecular weights** | |
| 32.06 | S |
| 64.06 | $SO_2$ |

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**MOBILE SOURCE CHARACTERISTICS**

| Vehicle Operation | *hp/unit* | *hrs/day* | *days/yr* | *unit* | *gal/hr/unit* | *gal/day* | *gal/yr* | *Reference* |
|---|---|---|---|---|---|---|---|---|
| Service Truck | 300 | 12 | 350 | 4 | 14.4 | 691 | 241,920 | *OST Drilling Fuel Consumption Estimate.xls* |
| Front-End Loader | 150 | 20 | 350 | 1 | 7.2 | 144 | 50,400 | *OST Drilling Fuel Consumption Estimate.xls* |
| Crane Truck | 300 | 20 | 350 | 4 | 14.4 | 1,152 | 403,200 | *OST Drilling Fuel Consumption Estimate.xls* |
| Backhoe | 75 | 20 | 350 | 2 | 3.6 | 144 | 50,400 | *OST Drilling Fuel Consumption Estimate.xls* |
| Forklift | 150 | 18 | 350 | 1 | 7.2 | 130 | 45,360 | *OST Drilling Fuel Consumption Estimate.xls* |
| Supervisory Trucks | 150 | 12 | 350 | 4 | 0.8 | 40 | 14,000 | |
| **Total** | | | | | | **2,301** | **805,280** | |

| | | | |
|---|---|---|---|
| Heat Content of Diesel | 137,000 | *Btu/gal* | *EPA AP-42 Appendix A* |
| Sulfur Content of Diesel | 0.05% | | *40 CFR part 80.29* |
| Density of Diesel | 7.05 | *lbs/gal* | *EPA AP-42 Appendix A* |
| Internal Combustion Engine Efficiency | 7,000 | *Btu/hp-hr* | *AP-42 Table 3.3-1* |
| Utilization Factor | 50% | | *E-mail from Mike Long 04/27/2006* |

**EMISSION FACTORS - MOBILE**

| Pollutant | *g/kW-hr* | *g/hp-hr* | *g/MMBtu* | *Reference* |
|---|---|---|---|---|
| $NO_X$ | 9.2 | 6.9 | *980.063* | *40 CFR part 89.112, 75 ≤kW≤225 (Tier I)* |
| VOC | 1.3 | 1.0 | *138.487* | *40 CFR part 89.112, 75 ≤kW≤225 (Tier I)* |
| CO | 11.4 | 8.5 | *1214.43* | *40 CFR part 89.112, 75 ≤kW≤225 (Tier I)* |
| $PM_{10}$* | 0.54 | 0.40 | *57.5254* | *40 CFR part 89.112, 75 ≤kW≤225 (Tier I)* |
| $PM_{2.5}$* | 0.54 | 0.40 | *57.5254* | *40 CFR part 89.112, 75 ≤kW≤225 (Tier I)* |
| SO2 | -- | -- | *11.67* | |

*All particulate assumed to be ≤1µm in diameter (AP-42 Table 3.3-1)

**EMISSIONS - MOBILE**

| | Emissions | |
|---|---|---|
| **Pollutant** | **tons/yr** | **lbs/day** |
| $NO_X$ | 59.6 | 340.5 |
| VOC | 8.4 | 48.1 |
| CO | 73.8 | 422.0 |
| $PM_{10}$ | 3.5 | 20.0 |
| $PM_{2.5}$ | 3.5 | 20.0 |
| $SO_2$ | 1.4 | 8.1 |

| Conversion Factors | |
|---|---|
| 453.592 | g/lb |
| 2,000 | lb/ton |
| 1.341 | hp/kW |
| **Molecular weights** | |
| 32.06 | S |
| 64.06 | $SO_2$ |

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## FUGITIVE DUST CHARACTERISTICS

| | | | | | |
|---|---|---|---|---|---|
| Length of trip across site | 0.4 | miles | Number of holes drilled | 565 | holes |
| Length of access road to site | 4.0 | miles | | 1.61 | holes/day |
| Trips across site | 80.0 | trips/day | | 565 | holes/yr |
| Trips on access road | 24.0 | trips/day | | | |
| Vehicle Miles Traveled | 128 | VMT/day | | Conversion Factors | |
| | 44,800 | VMT/yr | | 453.592 | g/lb |
| Vehicle Operation | 350 | days/yr | | 2,000 | lb/ton |

## EMISSION FACTOR - UNPAVED ROADS

*Reference*

$E = k\,(s/12)^a \times (W/3)^b$ — AP-42 Chapter 13.2.2.2

where: E= Emission Factor (lb/VMT)

k= constant (lb/VMT)

s= surface material silt content (%)

W= mean vehicle weight (tons)

| | | $PM_{10}$ | $PM_{2.5}$ | |
|---|---|---|---|---|
| k= | | 1.5 | 0.23 | AP-42 Table 13.2.2-2; Industrial Roads |
| s= | 2.6 % | | | AP-42 Section 13.2.2, Related Info. r13s0202_dec03.xls |
| a= | | 0.9 | 0.9 | AP-42 Table 13.2.2-2; Industrial Roads |
| W= | 5.0 *tons* | | | |
| b= | | 0.45 | 0.45 | AP-42 Table 13.2.2-2; Industrial Roads |

$PM_{10}$ E= $1.5(2.60/12)^{0.9} \times (5/3)^{0.45}$

$PM_{2.5}$ E= $0.23(2.60/12)^{0.9} \times (5/3)^{0.45}$

E= 0.48 *lb* $PM_{10}$*/VMT*

E= 0.07 *lb* $PM_{2.5}$*/VMT*

## EMISSION FACTOR - DRILLING FUGITIVES

E= 1.3 *lb/hole TSP* — *EPA AP-42 Table 11.9-4 (Overburden Drilling)*

Scaling Factors $PM_{10}$ 0.52 $PM_{2.5}$ 0.03 — *EPA AP-42 Table 11.9-1 (Overburden Blasting)*

E= 0.676 *lb/hole* $PM_{10}$ 0.039 *lb/hole* $PM_{2.5}$

## EMISSIONS - FUGITIVE

| | Un-Paved Road Emissions | | Drilling Emissions | |
|---|---|---|---|---|
| **Pollutant** | **tons/yr** | **lbs/day** | **tons/yr** | **lbs/day** |
| $PM_{10}$ | 10.7 | 61.0 | 0.2 | 1.1 |
| $PM_{2.5}$ | 1.6 | 9.4 | 0.01 | 0.1 |

* Watering and chemical suppressant - 0.05 gal/yd$^2$, 4 times/year. AP-42 Figure 13.2.2-5.

## SOURCE CHARACTERISTICS

| | | |
|---|---|---|
| Area | 2,121,611 *ft*$^2$ | 646,675 m$^2$ |
| Height | 15 *ft* | 4.57 *m* |

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## SITE PREPARATION

| | | | *Reference* |
|---|---|---|---|
| Days of Operation | 270 | *days/yr* | *9 months of construction* |
| Hours of Operation for Bulldozer | 10 | *hrs/day* | *E-mail from Fran Amendola 04/27/2006* |
| Area Disturbed | 160 | *acres* | *Experimental tract size* |
| Total Area Exposed at a time | 40 | *acres* | *One quarter of total area disturbed* |
| Duration of Exposure | 3 | *months* | *One quarter of a year* |
| Topsoil Removed | 200,000 | *$yd^3$* | *E-mail from Rene Orillac 04/19/2006* |
| | 220,000 | *tons* | |
| Area of Topsoil Stock Piles | 10 | *acres* | *SEPCo Correspondence 02/22/2006* |
| Material Excavated and Reused | 485,000 | *$yd^3$* | *E-mail from Rene Orillac 04/19/2006* |
| | 533,500 | *tons* | |
| Material silt content | 16.4 | *%* | *AP-42 Table 11.9-3 mean silt content for scrappers* |
| Material moisture content overburden | 7.9 | *%* | *AP-42 Table 11.9-3 mean moisture content for bulldozed overburden* |
| Material moisture content topsoil | 4.8 | *%* | *AP-42 Table 11.9-3 max moisture content for aggregate handling* |
| Material density (undisturbed) | 1.1 | $ton/yd^3$ | *NRCS Soil Data Mart; moist bulk density for soils 70, 73, 75* |
| Mean wind speed at site | 3.6 | *m/s* | *Meteorological Data Report Mahogany Project, March 2006* |
| | 8.1 | *mph* | |
| Diesel Consumption (Scrappers/bulldozers) | 160,000 | *gal/yr* | *E-mail from Fran Amendola 04/27/2006* |
| Heat Content of Diesel | 137,000 | Btu/gal | *EPA AP-42 Appendix A* |
| Sulfur Content of Diesel | 0.05% | | *40 CFR part 80.29* |
| Density of Diesel | 7.05 | *lbs/gal* | *EPA AP-42 Appendix A* |

## EMISSION FACTORS - MATERIAL DISTURBANCE

| Activity | Emission Factor | Particle Size Multiplier | *Reference* |
|---|---|---|---|
| Topsoil removed by scraper | 0.058 *lb TSP/ ton* | 0.35 *$PM_{10}/TSP$*<br>0.110 *$PM_{2.5}/TSP$* | *EPA AP-42 Table 11.9.4* |
| Topsoil unloading | $E = k(0.0032) \times \frac{(u/5)^{1.3}}{(M/2)^{1.4}}$ *lb $PM_{10}$/ ton*<br>u= mean wind speed (mph)<br>M= material moisture content | Included in equation<br>k= 0.35 for $PM_{10}$<br>k= 0.110 for $PM_{2.5}$ | *EPA AP-42 Chapter 13.2.4.3* |
| Overburden bulldozing | $E = \frac{1.0(s)^{1.5}}{(M)^{1.4}}$ *lb $PM_{15}$* /hr | 0.75 *$PM_{10}/PM_{15}$* | *EPA AP-42 Table 11.9.1* |
| | $E = \frac{5.7(s)^{1.2}}{(M)^{1.3}}$ *lb TSP/hr*<br>s= material silt content<br>M= material moisture content | 0.105 *$PM_{2.5}/TSP$* | *EPA AP-42 Table 11.9.1* |
| Wind Erosion of exposed areas | 0.38 *ton TSP/acre/yr* | 0.5 *$PM_{10}/TSP$*<br>0.2 *$PM_{2.5}/TSP$* | *EPA AP-42 Table 11.9.4* |

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**EMISSIONS - MATERIAL DISTURBANCE**

**Emissions from Material Disturbance**

| | $PM_{10}$ Emissions | | $PM_{2.5}$ Emissions | |
|---|---|---|---|---|
| **Activity** | **tons/yr** | **lbs/day** | **tons/yr** | **lbs/day** |
| Topsoil removed by scraper | 2.2 | 16.5 | 0.7 | 5.2 |
| Topsoil unloading | 0.1 | 0.5 | 0.0 | 0.2 |
| Overburden bulldozing | 3.7 | 27.6 | 1.6 | 11.7 |
| Wind Erosion of exposed areas | 1.9 | 14.1 | 0.8 | 5.6 |
| Total Emissions | 7.9 | 58.7 | 3.1 | 22.7 |

Weight Conversion 2,000 lb/ton

Topsoil unloading

$$E = 0.35 \times (0.0032) \frac{(8.05297/5)^{1.3}}{(4.8/2)^{1.4}}$$

$$E = 0.0006 \text{ lb } PM_{10}/\text{ton}$$

$$E = 0.110 \times (0.0032) \frac{(8.053/5)^{1.3}}{(4.8/2)^{1.4}}$$

$$E = 0.0002 \text{ lb } PM_{2.5}/\text{ton}$$

Overburden bulldozing

$$E = \frac{1 (16.4)^{1.5}}{(7.9)^{1.4}}$$

$$E = 3.678 \; lb\ PM_{15}/\text{hr}$$

$$E = \frac{5.7 (16.4)^{1.2}}{(7.9)^{1.3}}$$

$$E = 11.137 \; lb\ TSP/\text{hr}$$

**SOURCE CHARACTERISTICS**

| | | |
|---|---|---|
| Area | 2,121,611 ft2 | 646,675 *m2* |
| Height | 15 ft | 4.572 *m* |

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## EMISSION FACTORS - NON-ROAD MACHINERY

**Construction Machinery Tier I Emission Factors (Criteria Pollutants)**

| Pollutant | *g/kW-hr* | *g/hp-hr* | *g/MMBtu* | *Reference* |
|---|---|---|---|---|
| $NO_X$ | 9.2 | 6.9 | *980.1* | *40 CFR part 89.112, 130 ≤kW≤450 (Tier I)* |
| VOC | 1.3 | 1.0 | *138.5* | *40 CFR part 89.112, 130 ≤kW≤450 (Tier I)* |
| CO | 11.4 | 8.5 | *1,214.4* | *40 CFR part 89.112, 130 ≤kW≤450 (Tier I)* |
| $PM_{10}$ | 0.54 | 0.40 | *57.53* | *40 CFR part 89.112, 130 ≤kW≤450 (Tier I)* |
| $PM_{2.5}$* | 0.54 | 0.40 | *57.53* | *40 CFR part 89.112, 130 ≤kW≤450 (Tier I)* |
| SO2 | -- | -- | *11.67* | |

*All particulate assumed to be ≤1µm in diameter (AP-42 Table 3.3-1)

## EMISSIONS - NON-ROAD MACHINERY

| | Emissions | |
|---|---|---|
| **Pollutant** | **tons/yr** | **lbs/day** |
| $NO_X$ | 23.7 | 175.4 |
| VOC | 3.3 | 24.8 |
| CO | 29.3 | 217.4 |
| $PM_{10}$ | 1.4 | 10.3 |
| $PM_{2.5}$ | 1.4 | 10.3 |
| $SO_2$ | 0.6 | 4.2 |

| Conversion Factors | |
|---|---|
| 453.5924 | g/lb |
| 2,000 | lb/ton |
| **Molecular weights** | |
| 32.06 | S |
| 64.06 | $SO_2$ |

**SOURCE CHARACTERISTICS (8 stacks 100 m from perimeter of property)**

| Parameter | *English Units* | *Metric Units* |
|---|---|---|
| Exhaust Temp. | 750 *°F* | 672 *°K* |
| Stack Height | 12 *ft* | 3.66 *m* |
| Stack Diameter | 4.00 *in* | 0.10 *m* |
| Exhaust Velocity | 131 *ft/s* | 40.00 *m/s* |

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## SOLUTION MINING PROCESSES[1]

| | | | *Reference* |
|---|---|---|---|
| Production Capacity | 50,000 *ton/yr* | *Nacholite* | *AmerAlia Rock School Lease EA, 12/03/1999* |
| Boiler Capacity | 60 *MMBtu/hr* | | *AmerAlia Rock School Permit Application, 1999* |

## EMISSIONS - POINT SOURCES

| | Emissions* | | | | |
|---|---|---|---|---|---|
| | Boiler | | Separation Tank Vent | | |
| **Pollutant** | *lb/day* | *tpy* | *lb/day* | *tpy* | *Reference* |
| $NO_X$ | 70.59 | 12.88 | -- | -- | *AmerAlia Rock School Permit Application, 1999* |
| VOC | 9.36 | 1.71 | 48.00 | 8.76 | *AmerAlia Rock School Permit Application, 1999* |
| CO | 118.59 | 21.64 | -- | -- | *AmerAlia Rock School Permit Application, 1999* |
| $PM_{10}$ | 2.04 | 0.37 | -- | -- | *AmerAlia Rock School Permit Application, 1999* |
| $PM_{2.5}$** | 2.04 | 0.37 | -- | -- | *AmerAlia Rock School Permit Application, 1999* |
| $SO_2$ | 2.29 | 0.42 | -- | -- | *AmerAlia Rock School Permit Application, 1999* |

*The SEPCo Solution Mining Test Project is assumed to have the same processes (without a dryer) and production capacity as the AmerAlia Rock School Project and therefore emissions are taken from the AmerAlia Construction Permit Application, 1999.

**All particulate assumed to be ≤1µm in diameter (AP-42 Table 1.4-2)

## SOURCE CHARACTERISTICS

### Boiler Stack

| Parameter | *English Units* | *Metric Units* |
|---|---|---|
| Exhaust Temp. | 550 *°F* | 561 *°K* |
| Stack Height | 75 *ft* | 22.86 *m* |
| Stack Diameter | 4.55 *ft* | 1.39 *m* |
| Exhaust Velocity | 33 *ft/s* | 10.06 *m/s* |

| Conversion Factors | |
|---|---|
| 2000 | lb/ton |
| 24 | hrs/day |
| 365 | day/yr |
| 7,000 | gr/lb |

### Separator Tank Vent

| Parameter | *English Units* | *Metric Units* |
|---|---|---|
| Exhaust Temp. | 300 *°F* | 422 *°K* |
| Stack Height | 20 *ft* | 6.10 *m* |
| Stack Diameter | 0.30 *ft* | 0.09 *m* |
| Exhaust Velocity | 33 *ft/s* | 10.06 *m/s* |

[1] Associated fugitive dust is negligible

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## SOLUTION MINING PROCESSES

| | | | | *Reference* |
|---|---|---|---|---|
| Fuel Gas Quality | LHV | 900 | *Btu/scf* | *AmerAlia Rock School Project Fuel Tests* |
| | Sulfur | 0.5 | *gr/100scf* | *AP-42* |
| Boiler Capacity | | 60 | *MMBtu/hr* | *AmerAlia Rock School Permit Application, 1999* |
| Fuel Consumption Rate | | 66,667 | *scf/hr* | |

### EMISSIONS - BOILER

| | Emision Factors | | Emissions | |
|---|---|---|---|---|
| **Pollutant** | Original | Scaled** | *(lb/hr)* | *Reference* |
| $NO_X$ | 50 *lb/MMscf* | 44 *lb/MMscf* | 2.94 | *AP-42 Table 1.4-1* |
| VOC | 0.39 *lb/hr* | - | 0.39 | *Manufacturer's Data (AmerAlia)* |
| CO | 84 *lb/MMscf* | 74 *lb/MMscf* | 4.94 | *AP-42 Table 1.4-1* |
| $PM_{10}$* | 0.085 *lb/hr* | - | 0.09 | *Manufacturer's Data (AmerAlia)* |
| $PM_{2.5}$* | 0.085 *lb/hr* | - | 0.09 | *Manufacturer's Data (AmerAlia)* |
| SO2 | - | - | 0.10 | |

*All particulate assumed to be ≤1μm in diameter (AP-42 Table 1.4-1)

**$NO_X$ and CO factors must be scaled due to fuel value in AP42 of 1020 BTU/scf. Ratio of 900/1020 = 0.882 applied

### EMISSIONS - SEPARATION TANK VENT

| **Pollutant** | **Emission Factor** | **Emissions** *(lb/hr)* |
|---|---|---|
| VOC | Non-methane and Non-ethane emissions will be < 10 tpy, Estimate* | 2.00 |

*Estimate from AmerAlia Rock School Permit Application, 1999

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## ICP PROCESSES[1]

### EMISSIONS - LONG-TERM

| | Emissions (tpy) | | | |
|---|---|---|---|---|
| **Pollutant** | **Boilers (both)** | **Incinerator** | **Fugitives** | **Facility Total** |
| $NO_X$ | 8.76 | 61.24 | - | 70.00 |
| VOC | 1.10 | 21.67 | 72.23 | 95.00 |
| CO | 8.76 | 31.24 | - | 40.00 |
| $PM_{10}$ | 1.51 | 4.49 | - | 6.00 |
| $PM_{2.5}$* | 1.51 | 4.49 | - | 6.00 |
| $SO_2$ | 14.35 | 80.66 | - | 95.00 |
| $H_2S$ | 0.008 | 1.25 | 8.27 | 9.52 |

*All particulate assumed to be ≤1µm in diameter (AP-42 Table 1.4-2)

### EMISSIONS - SHORT-TERM

**Boilers:**

Days of Operation 350 *days/yr*

**Incinerator:**

Days of Operation 350 *days/yr*

| Conversion Factors | |
|---|---|
| 2000 | lb/ton |
| 24 | hrs/day |
| 365 | day/yr |
| 8,760 | hrs/yr |
| 42 | gal/bbl |
| 2.2 | lb/kg |

| | Emissions (lb/day) | | |
|---|---|---|---|
| | | **Incinerator** | |
| | | Operational Conditions | |
| **Pollutant** | **Boilers (both)** | Normal | Maximum |
| $NO_X$ | 50.1 | 106.9 | 1,580.3 |
| CO | 50.1 | 106.9 | 178.5 |
| $PM_{10}$ | 8.7 | 16.4 | 25.7 |
| $PM_{2.5}$ | 8.7 | 16.4 | 25.7 |
| $SO_2$ | 82.0 | 154.7 | 2,121.0 |

### SOURCE CHARACTERISTICS

**Boiler Stacks**

| Parameter | *English Units* | *Metric Units* |
|---|---|---|
| Exhaust Temp. | 450 *°F* | 505 *°K* |
| Stack Height | 35 *ft* | 10.67 *m* |
| Stack Diameter | 2 *ft* | 0.61 *m* |
| Exhaust Velocity | 52.1 *ft/s* | 15.88 *m/s* |

**Incinerator Stack (with SRU)**

| Parameter | *English Units* | *Metric Units* |
|---|---|---|
| Stack Temp. | 1,500 *°F* | 1,089 *°K* |
| Stack Height | 115 *ft* | 35.05 *m* |
| Stack Diameter | 5.5 *ft* | 1.68 *m* |
| Stack Velocity | 79.8 *ft/s,* | 24.32 *m/s* |

[1] Associated fugitive dust is negligible

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## EMISSIONS - BOILERS

**Operating Information**

| | | |
|---|---|---|
| Capacity | 25 | MMBtu/hr, HHV (each) |
| Number of Boilers | 2 | units |
| Operating Hours | 8,760 | hr/yr |

**Fuel Gas Properties***

| | SRU Tail Gas as Fuel | |
|---|---|---|
| Heat Content | 1,099 | Btu/dscf, HHV |
| SO2 Factor | 72.00 | lb/MMdscf |
| H2S Factor | 0.038 | lb/MMdscf |

*Estimated from Fuel Tests

**Per-Boiler Emissions Expected (using SRU tail gas) at Peak Production**

| Pollutant | Emission Factor | | Emissions | | *Reference* |
|---|---|---|---|---|---|
| $NO_X$ | 43.96 | lb/MMdscf | 4.38 | tpy | EnviroPro estimate |
| VOC | 5.50 | lb/MMdscf | 0.55 | tpy | AP-42 Tables 1.4-1 and -2, Small, Controlled - Low NOX burners. |
| CO | 43.96 | lb/MMdscf | 4.38 | tpy | EnviroPro estimate |
| $PM_{10}$ | 7.60 | lb/MMdscf | 0.76 | tpy | AP-42 Tables 1.4-1 and -2, Small, Controlled - Low NOX burners. |
| $PM_{2.5}$* | 7.60 | lb/MMdscf | 0.76 | tpy | AP-42 Tables 1.4-1 and -2, Small, Controlled - Low NOX burners. |
| $SO_2$ | 72.00 | lb/MMdscf | 7.17 | tpy | Estimated from Fuel Tests |
| $H_2S$ | 0.04 | lb/MMdscf | 0.0038 | tpy | Estimated from Fuel Tests |

[1] Estimated from Fuel Tests

[2] Based on AP-42 Tables 1.4-1 and -2, Small, Controlled - Low $NO_X$ burners.

[3] EnviroPro estimate

**Sample Calculations**

$SO_2$ emission calculation for one boiler:

$$\frac{25\ \cancel{MMBtu}}{1\ hr} \cdot \frac{1\ scf}{1{,}099\ \cancel{Btu}} \cdot \frac{1{,}000{,}000\ \cancel{scf}}{1\ \cancel{MMdscf}} = \frac{22{,}748\ scf\ fuel}{hr}$$

$$\frac{22{,}748\ \cancel{scf\ fuel}}{1\ hr} \cdot \frac{72.00\ lb\ SO_2}{1\ \cancel{MMdscf}} \cdot \frac{1\ \cancel{MMdscf}}{1{,}000{,}000\ \cancel{dscf}} = \frac{1.638\ lb\ SO_2}{hr}$$

$NO_X$ and CO emission factors: *

$$\frac{0.04\ lb}{1\ MM\cancel{Btu}} \cdot \frac{1{,}099\ \cancel{Btu}\ (HHV)}{1\ dscf} = \frac{43.960\ lb}{MMdscf}$$

* EnviroPro estimate

**EMISSIONS - FUGITIVE EMISSIONS FROM USC LOADING ARMS**

Maximum USC hauled off site

404 bbl/day, 365-day average — Shell Engineering Process Model

16,968 gal/day

**Loading Loss Emissions Calculation**

L = 12.46 × (SPM / T) — Eq. Reference: AP-42 Page 5.2-4.

L = Loading Loss (lb/103 gal)
S = Saturation Factor
P = Vapor Pressure (psia)
M = Molecular Weight of Vapors (lb/lb-mol)
T = Temperature of Liquid Loaded °R (°F + 460)

| Variable | USC | Reference |
|---|---|---|
| S | 0.6 | AP-42 Table 5.2-1 (submerged loading: dedicated normal service) |
| P | 5.7 psia (@100 °F) | AP-42 Table 7.1-2 (crude oil) |
| M | 50 lb/lb-mol | AP-42 Table 7.1-2 (crude oil) |
| T | 560 °R | 100°F + 460 |
| L | 3.80475 lb/1,000 gal | |

**VOC Emissions: 11.78 tpy** Based on 365-day average production rate.

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## EMISSION FACTORS - FUGITIVE EMISSIONS FROM EQUIPMENT LEAKS

**Emission Factors***

| Equipment Type | Service | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Gas | | Light Oil | | Heavy Oil | | Water/Oil | |
| | kg/hr | lb/hr | kg/hr | lb/hr | kg/hr | lb/hr | kg/hr | lb/hr |
| Valves | 4.50E-03 | 9.92E-03 | 2.50E-03 | 5.51E-03 | 8.40E-06 | 1.85E-05 | 9.80E-05 | 2.16E-04 |
| Pump Seals | 2.40E-03 | 5.29E-03 | 1.30E-02 | 2.87E-02 | NA | NA | 2.40E-05 | 5.29E-05 |
| Connectors | 2.00E-04 | 4.41E-04 | 2.10E-04 | 4.63E-04 | 7.50E-06 | 1.65E-05 | 1.10E-04 | 2.43E-04 |
| Flanges | 3.90E-04 | 8.60E-04 | 1.10E-04 | 2.43E-04 | 3.90E-07 | 8.60E-07 | 2.90E-06 | 6.39E-06 |
| Open-Ended Lines | 2.00E-03 | 4.41E-03 | 1.40E-03 | 3.09E-03 | 1.40E-04 | 3.09E-04 | 2.50E-04 | 5.51E-04 |
| Others | 8.80E-03 | 1.94E-02 | 7.50E-03 | 1.65E-02 | 3.20E-05 | 7.05E-05 | 1.40E-02 | 3.09E-02 |

*EPA. Nov. 1995. Protocol for Equipment Leak Emission Estimates, Table 2-4. (EPA-453/R-95-017).

**Equipment Count***

| Stream | Service | Equipment Type | | | | | |
|---|---|---|---|---|---|---|---|
| | | Valves | Pump Seals | Connector | Flanges | Open-Ended Lines | Others |
| Aq. Ammonia | Water/Oil | 143 | 2 | 92 | 341 | 1 | 0 |
| Well Vapor | Gas | 221 | 0 | 118 | 426 | 0 | 0 |
| USC Condensate | Heavy Oil | 946 | 23 | 333 | 966 | 4 | 0 |
| Cold Sep Vapor | Gas | 52 | 0 | 22 | 86 | 0 | 2 |
| Glycol Water/MDEA | Light Oil | 465 | 8 | 240 | 576 | 4 | 0 |
| 3-Stage Comp. | Gas | 162 | 0 | 79 | 213 | 0 | 4 |
| Sour Water | Water/Oil | 857 | 23 | 501 | 715 | 0 | 0 |
| Knock-out Liquids | Light Oil | 438 | 13 | 235 | 305 | 2 | 0 |
| Absorber Overhead | Gas | 176 | 2 | 111 | 198 | 0 | 0 |
| Absorber Bottoms | Light Oil | 209 | 9 | 101 | 208 | 0 | 0 |
| Acid Gas | Gas | 314 | 0 | 208 | 444 | 0 | 0 |
| Lean Sulfinol | Light Oil | 331 | 6 | 180 | 282 | 2 | 0 |
| Sulfur | Heavy Oil | 87 | 0 | 20 | 72 | 0 | 0 |
| Stabilizer Overhead | Gas | 78 | 0 | 39 | 94 | 0 | 2 |
| SCOT Regenerator | Gas | 78 | 0 | 50 | 109 | 0 | 1 |

*Estimate

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**EMISSIONS - FUGITIVE EMISSIONS FROM EQUIPMENT LEAKS**

| | Stream Composition (Weight Fraction) | | Emissions (tpy) | |
|---|---|---|---|---|
| **Stream*** | **VOC** | **H2S** | **VOC** | **H2S** |
| Aq. Ammonia | 0 | 0 | 0.00 | 0.00 |
| Well Vapor | 0.248 | 0.0311 | 2.84 | 0.36 |
| USC Condensate | 0.971 | 0.00021 | 0.10 | 0.00 |
| Cold Sep Vapor | 0.762 | 0.02707 | 2.13 | 0.08 |
| Glycol Water/MDEA | 0.65 | 0 | 8.66 | 0.00 |
| 3-Stage Comp. | 0.552 | 0.04799 | 4.60 | 0.40 |
| Sour Water | 0.00003 | 0.01156 | 0.00 | 0.02 |
| Knock-out Liquids | 0.905 | 0.0178 | 11.77 | 0.23 |
| Absorber Overhead | 0.994 | 0.000001 | 8.60 | 0.00 |
| Absorber Bottoms | 0.7367 | 0.0159 | 4.86 | 0.10 |
| Acid Gas | 0.3945 | 0.376 | 6.20 | 5.91 |
| Lean Sulfinol | 0.75 | 0.00007 | 7.06 | 0.00 |
| Sulfur | 0 | 0.083 | 0.00 | 0.00 |
| Stabilizer Overhead | 0.909 | 0.00623 | 3.63 | 0.02 |
| SCOT Regenerator | 0 | 0.288 | 0.00 | 1.15 |
| **TOTAL** | | | **60.45** | **8.266** |

*Estimate