

## Powertech Dewey-Burdock Emissions Inventory

### Source Apportionment

For calculating the emissions inventory, sources of fugitive dust include mobile equipment and wind erosion on disturbed acreage. Sources of combustion emissions include stationary sources and mobile equipment. For modeling purposes, emissions from the project are characterized as either point, area (polygon) or line (multiple line segment) sources. The spatial orientation of each point, area and line source is expressed in UTM coordinates. Stationary sources correspond one-for-one with point sources. Emissions from mobile equipment and wind erosion, however, do not necessarily correspond one-for-one with area and line sources. The apportionment process therefore distributes these emissions over the appropriate area and line sources in proportion to the relative levels of activity associated with those sources. Table B-1 shows the apportionment of projected, year 7 fugitive dust emissions to the various area and line sources.

**Table B-1: Fugitive Emissions Apportionment**

<u>Fugitive Area/Line Source</u>	<u>Type</u>	<u>PM<sub>10</sub></u>	<u>PM<sub>2.5</sub></u>
Disturbed	Area	256.76	26.82
AccessRdSat	Line	17.41	1.74
AccessRdCPP	Line	34.92	3.49
NewWells	Area	112.06	11.21
FacilitiesCPP	Area	8.68	0.87
FacilitiesSat	Area	4.34	0.43
HaulRd	Line	10.07	1.01
OperWells	Area	32.21	3.22
DecomWells	Area	69.24	6.92
LandAPDewey	Area	5.35	0.80
LandAPBurdock	Area	4.57	0.68
AccessRdPublic	Line	181.31	18.13
<b>Year 7 Totals (tpy)</b>		<b>736.91</b>	<b>75.33</b>

Off-site fugitive emissions caused by the project were assigned at 100% to the line source, AccessRdPublic.

The equipment activity assignments leading to both fugitive and tailpipe emissions apportionment for year 7 are shown in Table B-2. Equipment with multiple entries in Table B-2 contributes emissions to multiple area and/or line sources (one entry per modeled source). Table B-3 combines the fugitive and tailpipe emissions by modeled source, with Year 7 totals shown at the bottom of the table.

**Table B-2: Tailpipe Emissions Apportionment**

<u>Equipment Type</u>	<u>Source Name</u>	<u>Portion</u>	<u>Pollutant</u>				
			<u>PM<sub>10</sub></u>	<u>PM<sub>2.5</sub></u>	<u>NO<sub>x</sub></u>	<u>SO<sub>2</sub></u>	<u>CO</u>
Scraper	DecomWells	100.00%	0.08	0.08	1.59	0.49	1.38
Bulldozer	DecomWells	100.00%	0.02	0.02	0.47	0.15	0.41
Compactor	DecomWells	100.00%	0.02	0.02	0.36	0.11	0.31
Motor Grader	DecomWells	42.38%	0.02	0.02	0.34	0.11	0.29
Motor Grader	NewWells	37.29%	0.01	0.01	0.30	0.09	0.26
Motor Grader	OperWells	20.33%	0.01	0.01	0.16	0.05	0.14
Water Truck (1,500 gal)	Disturbed	70.00%	0.23	0.22	4.64	1.44	4.02
Water Truck (1,500 gal)	AccessRdCPP	20.00%	0.07	0.06	1.33	0.41	1.15
Water Truck (1,500 gal)	AccessRdSat	10.00%	0.03	0.03	0.66	0.21	0.57
Fueling Truck	Disturbed	100.00%	0.01	0.01	0.22	0.07	0.19
Heavy Duty Diesel Truck	Disturbed	4.60%	0.00	0.00	0.05	0.01	0.04
Heavy Duty Diesel Truck	AccessRdSat	1.53%	0.00	0.00	0.02	0.00	0.01
Heavy Duty Diesel Truck	AccessRdCPP	3.07%	0.00	0.00	0.03	0.01	0.03
Heavy Duty Diesel Truck	AccessRdPublic	90.80%	0.05	0.05	0.95	0.29	0.82
Logging Truck	NewWells	100.00%	0.14	0.14	2.79	0.87	2.42
Electrical Pole Truck	NewWells	100.00%	0.05	0.05	0.93	0.29	0.81
Truck Mounted Drill Rig, Tier 1	NewWells	100.00%	2.65	2.57	45.22	6.13	56.03
Deep Well Drill Rig, Tier 1	FacilitiesCPP	100.00%	0.01	0.01	0.14	0.02	0.18
Trackhoe	NewWells	100.00%	0.08	0.08	1.57	0.49	1.36
Backhoe	NewWells	100.00%	0.04	0.04	0.80	0.25	0.69
Loader	FacilitiesCPP	66.67%	0.01	0.01	0.20	0.06	0.17
Loader	FacilitiesSat	33.33%	0.01	0.00	0.10	0.03	0.09
Tractor	DecomWells	100.00%	0.03	0.03	2.66	0.18	0.49
Resin-hauling Semi Truck	HaulRd	100.00%	0.03	0.03	0.59	0.18	0.51
Pump Pulling Truck	OperWells	50.00%	0.09	0.09	1.80	0.56	1.56
Pump Pulling Truck	DecomWells	50.00%	0.09	0.09	1.80	0.56	1.56
Product Transport Truck	AccessRdCPP	6.48%	0.00	0.00	0.01	0.00	0.01
Product Transport Truck	AccessRdPublic	93.52%	0.01	0.01	0.11	0.03	0.10
Crane	FacilitiesCPP	66.67%	0.07	0.06	0.92	0.06	0.20
Crane	FacilitiesSat	33.33%	0.03	0.03	0.46	0.03	0.10
Forklift	FacilitiesCPP	66.67%	0.21	0.20	2.97	0.20	0.64
Forklift	FacilitiesSat	33.33%	0.11	0.10	1.48	0.10	0.32
Manlift	FacilitiesCPP	66.67%	0.03	0.03	0.38	0.03	0.08
Manlift	FacilitiesSat	33.33%	0.01	0.01	0.19	0.01	0.04
Cementer	NewWells	75.00%	0.01	0.01	0.25	0.00	0.14
Cementer	DecomWells	25.00%	0.00	0.00	0.08	0.00	0.05
Welding Equipment	NoneYr7	0.00%	0.00	0.00	0.00	0.00	0.00
HDPE Fusion Equipment	NoneYr7	0.00%	0.00	0.00	0.00	0.00	0.00
Light Duty Pickup	Disturbed	100.00%	0.77	0.74	11.71	0.63	7.41
Light Duty Passenger Vehicle	AccessRdCPP	4.47%	0.01	0.01	0.08	0.00	0.05
Light Duty Passenger Vehicle	AccessRdSat	2.23%	0.00	0.00	0.04	0.00	0.03
Light Duty Passenger Vehicle	AccessRdPublic	93.30%	0.11	0.11	1.72	0.09	1.09
	<b>Year 7 Totals</b>		<b>5.14</b>	<b>4.99</b>	<b>90.13</b>	<b>14.25</b>	<b>85.75</b>

**Table B-3: Total Fugitive and Tailpipe Emissions Apportionment**

<u>Area/Line Source Totals</u>	<u>PM<sub>10</sub></u>	<u>PM<sub>2.5</sub></u>	<u>NO<sub>x</sub></u>	<u>SO<sub>2</sub></u>	<u>CO</u>
Disturbed	257.78	27.81	16.62	2.15	11.67
AccessRdSat	17.44	1.78	0.72	0.21	0.61
AccessRdCPP	34.99	3.56	1.45	0.43	1.24
NewWells	115.04	14.10	51.85	8.11	61.71
FacilitiesCPP	9.00	1.18	4.62	0.36	1.27
FacilitiesSat	4.50	0.59	2.24	0.17	0.55
HaulRd	10.10	1.04	0.59	0.18	0.51
OperWells	32.30	3.32	1.96	0.61	1.70
DecomWells	69.50	7.18	7.30	1.59	4.49
LandAPDewey	5.35	0.80			
LandAPBurdock	4.57	0.68			
AccessRdPublic	181.48	18.29	2.78	0.42	2.00
<b>Year 7 Totals (tpy)</b>	<b>742.05</b>	<b>80.32</b>	<b>90.13</b>	<b>14.25</b>	<b>85.75</b>

Source Timing

In order to match the modeled, short-term averaging periods, it is necessary to account for the variability in emission rates from combustion and fugitive emissions. For example, most of the activities planned for the Dewey-Burdock project will occur during the day shift, certain activities will only be carried out during early summer, commuter traffic to and from the site will occur predominantly in the two hours before 8:00 am and the two hours after 4:00 pm, and so forth. To convert equipment duty cycles to variable emission rates, each equipment item was assigned to specific months of the year, days of the week, and hours of the day. Some equipment items are projected to operate less than 10 hours per day, although the reduced hours are still distributed over the entire day. In cases such as this, where actual times during the day are either random or ambiguous, the variable emission rates are calculated on the basis of a 10-hour work day. Table B-4 presents the active months, days and hours expected for each equipment type and associated modeled source for year 7. This information formed the basis of the AERMOD variable rate emission factors for each modeled source. Table B-5 presents similar information, simplified in order to accommodate the variable rate factor feature in CALPUFF.

Each of the source types in Table B-3 contains one or more modeled area sources, where each modeled area source constitutes a single contiguous area (such as a well field). This requires a double allocation of equipment emissions. The first allocation is to the source type, based on the emissions apportionment shown in Table B-3. The second allocation is from source type to individual modeled sources, based strictly on area proportions.

The logic in Tables B-4 and B-5 was used to compute variable emission contributions from each equipment class to each source type, for each pollutant, month (or season), day-of-week, and hour-of-day. These contributions were then totaled for each source type and apportioned to the modeled sources according to relative areas. The apportioned emissions were summed for each modeled source and each time slice (month, day, hour). Each resulting total was converted to an emission rate applicable to its respective time slice, then divided by the annual average emission rate to get a variable rate factor for that time slice. These factors ranged from 0 (e.g., equipment not operating during the night) to 7 or

more (emissions concentrated in time, such as commuter traffic). The rate factors were applied to each modeled source and pollutant, then emissions were summed to verify that the totals matched the emissions inventory. Following is a mathematical description of the algorithm.

## Algorithm for Determining Variable Emission Rates: Dewey-Burdock Area Sources

### Given

$E_i$  = Annual emissions for emitter "i", where  $1 \leq i \leq$  total number of emitters

$\alpha_{ij}$  = Fraction of emissions from emitter "i" apportioned to source type "j", where  $1 \leq j \leq$  total number of source types

$A_j$  = Combined area (ft<sup>2</sup>) of source type "j"

$S_k$  = Area (ft<sup>2</sup>) of individual modeled area source "k", where  $1 \leq k \leq$  total number of modeled area sources

$R_k$  = Annual average emission rate (lb/hr/ft<sup>2</sup>) for modeled source "k"

$\rho_{ijuvw}$  = 1 if emitter "i" is active in source type "j" during the time block defined by month "u", hour of day "v", and day of week (DOW) type "w", where  $1 \leq u \leq 12$ ,  $1 \leq v \leq 24$ , and  $w = 1$  for weekdays and  $w = 2$  for weekends (Saturdays and Sundays);  $\rho_{ijuvw} = 0$  otherwise

$\tau_{uvw}$  = number of hours in time block u,v,w =  $365/12 \times 1 \times 5/7$  if  $w = 1$ , and  $365/12 \times 1 \times 2/7$  if  $w = 2$ , (i.e., average week days per month are 21.72619 and average weekend days per month are 8.690476)

### Find

$\sigma_{kuvw}$  = sum of all hourly emission rate contributions to modeled area "k" during the time block defined by month "u", hour of day "v", and day of week (DOW) type "w"

$f_{kuvw}$  = dimensionless factor applied to average emission rate  $R_k$  for modeled area "k" and time block u,v,w in order to yield actual emission rate for that same modeled area and time block (this becomes the input value for the AERMOD variable emission rate for each source, month, hour, and DOW type)

### Analysis

Total emission rate contributions to time block u,v,w from emitter "i" in source type "j" are calculated as the sum of the annual emissions from each emitter "i" and source type "j" divided by the product of the modeled source area  $S_k$  and the total hours that emitter "i" is active in modeled area "k". Note that since the modeled areas are merely spatial subdivisions of a given source type, the active hours of a given emitter in modeled area "k" are synonymous to the active hours of that emitter in source type "j". Multiplying the result of this sum by 2,000 this gives units of lbs/hr/ft<sup>2</sup>.

$$\sigma_{kuvw} = \sum_i \sum_j \left[ \frac{2000 E_i \alpha_{ij} \beta_{jk}}{S_k \sum_u \sum_v \sum_w \rho_{ijuvw} \tau_{uvw}} \right] \text{ and } f_{kuvw} = \frac{\sigma_{kuvw}}{R_k}$$

This process must be repeated for each pollutant, as the emission factors for individual emitters are generally not of uniform proportions. For example, PM<sub>2.5</sub> is 97% of PM<sub>10</sub> for tailpipe emissions, 10% of PM<sub>10</sub> for unpaved road emissions, and 15% of PM<sub>10</sub> for wind erosion emissions. Gaseous tailpipe emission factors also differ in proportion between Tier 1 diesel, Tier 3 diesel, and gasoline engines.

Table B-4: Timing of Equipment Activity and Modeled Source Emissions, AERMOD

Equipment Type	Source Name	Month												Hour																								Day of Week					
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	M-F	Sat	Sun			
Scraper	DecomWells					X	X	X	X											X	X	X	X	X	X	X	X	X	X										X				
Bulldozer	DecomWells					X	X	X	X											X	X	X	X	X	X	X	X	X	X										X				
Compactor	DecomWells					X	X	X	X											X	X	X	X	X	X	X	X	X	X										X				
Motor Grader	DecomWells					X	X	X	X											X	X	X	X	X	X	X	X	X	X										X				
Motor Grader	NewWells	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Motor Grader	OperWells	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Water Truck (1,500 gal)	Disturbed	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Water Truck (1,500 gal)	AccessRdCPP	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Water Truck (1,500 gal)	AccessRdSat	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Fueling Truck	Disturbed					X	X	X	X											X	X	X	X	X	X	X	X	X										X					
Heavy Duty Diesel Truck	Disturbed					X	X	X	X											X	X	X	X	X	X	X	X	X										X					
Heavy Duty Diesel Truck	AccessRdSat	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Heavy Duty Diesel Truck	AccessRdCPP	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Heavy Duty Diesel Truck	AccessRdPublic	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Logging Truck	NewWells	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Electrical Pole Truck	NewWells					X	X	X	X	X	X									X	X	X	X	X	X	X	X	X										X					
Truck Mounted Drill Rig, Tier 1	NewWells	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Deep Well Drill Rig, Tier 1	FacilitiesCPP	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Trackhoe	NewWells					X	X	X	X	X	X									X	X	X	X	X	X	X	X	X										X					
Backhoe	NewWells					X	X	X	X	X	X									X	X	X	X	X	X	X	X	X										X					
Loader	FacilitiesCPP					X	X	X	X											X	X	X	X	X	X	X	X	X										X					
Loader	FacilitiesSat					X	X	X	X											X	X	X	X	X	X	X	X	X										X					
Tractor	DecomWells					X	X	X	X											X	X	X	X	X	X	X	X	X										X					
Resin-hauling Semi Truck	HaulRd	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Pump Pulling Truck	OperWells	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Pump Pulling Truck	DecomWells	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Product Transport Truck	AccessRdCPP	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Product Transport Truck	AccessRdPublic	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Crane	FacilitiesCPP					X	X	X	X											X	X	X	X	X	X	X	X	X										X					
Crane	FacilitiesSat					X	X	X	X											X	X	X	X	X	X	X	X	X										X					
Forklift	FacilitiesCPP	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Forklift	FacilitiesSat	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Manlift	FacilitiesCPP	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Manlift	FacilitiesSat	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Cementer	NewWells	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Cementer	DecomWells	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X										X				
Welding Equipment	NoneYr7																																										
HDPE Fusion Equipment	NoneYr7																																										
Light Duty Pickup	Disturbed	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X											X				
Light Duty Passenger Vehicle	AccessRdCPP	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X											X			
Light Duty Passenger Vehicle	AccessRdSat	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X											X			
Satellite Plant Heater	SATHTR	X	X	X	X						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Satellite Plant Fire Pump	SATPUMP	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Central Plant Thermal Dryer	CPPDRY	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Central Plant Heaters	CPPHTR	X	X	X	X						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Central Plant Fire Pump	CPPPUMP	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Light Duty Passenger Vehicle	AccessRdPublic	X	X	X	X	X	X	X	X	X	X	X								X	X								X	X										X			

