Appendix J

Air Quality Emissions Tables

Helicopter Emissions - Preferred Alternative and Proposed Action

Assumptions:

MD 600 (Hughes 500) Helicopter for stringing wire

Bell 412 Helicopter for wood pole construction and transporting concrete for structure foundation

Sikorsky Skycrane for constructing steel lattice towers

One Hughes 500 helicopter would operate for 4 hours per day for 160 days to string the wires

One Bell helicopter would operate 4 hrs per day for 120 days over the course of construction

One Sikorsky Skycrane helicopter would operate 4 hrs per day for 120 days over the course of construction

Hydrocarbons assumed to equal VOCs for estimating purposes

Emission Factors:

Helicopter emission factors derived from FAA Aircraft Emission Database as reported in California Public Utilities Commission Antelope-Pardee 500-kV Transmission Line Project Final EIR/EIS.
http://www.cpuc.ca.gov/environment/info/aspen/antelopepardee/EIR/Appendices/App%203.pdf

CO2 Emission factor for aviation gasoline from US Department of Energy. 2008. Energy Information Administration. Voluntary Reporting of Greenhouse Gases Program - Fuel and Energy Source Codes and Emission Coefficients.
http://www.eia.doe.gov/oiaf/1605/coefficients.html. Accessed November 12, 2012

Fuel rates from US Department of Interior National Business Center. 2006. Aviation Management Directorate. Aircraft Rental Agreement.
http://amd.nbc.gov/akro/akflight/pdf/ex2.pdf

Helicopter Emissions from Construction

			Fuel Rate	Working	# of	Emission Factor (lb/hr)					Emissions (lb/day)					Emissions (tons)				
	HP	# Engines	gal/hr	Hrs/day	Days	HC	CO	NOx	SOx	PM10	HC	CO	NOx	SOx	PM10	HC	CO	NOx	SOx	PM10
Hughes 500	420	1	28	4	160	0.08	2.07	1.74	0.14	0.1	0.32	8.28	6.96	0.56	0.40	0.03	0.66	0.56	0.04	0.03
Bell 214ST	1625	2	133	4	120	0.13	2.02	10.49	0.65	0.72	0.52	8.08	41.96	2.60	2.88	0.03	0.48	2.52	0.16	0.17
Sikorsky	4500	2	160	4	120	4.2	29.76	38.37	0.32	2.13	16.80	119.04	153.48	1.28	8.52	1.01	7.14	9.21	0.08	0.51
										Total Emissions	***17.64***	***135.40***	***202.40***	***4.44***	***11.80***	***1.06***	***8.29***	***12.28***	***0.28***	***0.72***

Helicopter CO2 Emissions from Construction

	HP	# Engines	Fuel Rate gal/hr	Working Hrs/day	# of Days	Emission Factor (lb/gal)	Total Emissions (tons)
Hughes 500	420	1	28	4	160	18.36	164.46
Bell 214ST	1625	2	133	4	120	18.36	585.89
Sikorsky	4500	2	160	4	120	18.36	705.02
						Total	***750.35***

Vehicle Exhaust Emissions - Preferred Alternative and Proposed Action

Assumptions:

Vehicle trips and mileage derived from applicant-provided estimates, with traffic estimates for ramp up and ramp down (the first two months and last two months of construction) and peak (the 20 months of construction in between ramp up and ramp down)

Analysis assumes 300 working days per year, or 600 days for the two-year construction period

For ramp up and down, 10 vehicles would travel 50 miles per day, with 70 percent on unpaved roads

For peak, 20 light duty vehicles/pickup trucks would travel 100 miles per day to and from the staging areas on the project site, with 70 percent of the miles driven on unpaved roads

70 construction workers would commute to the staging areas from their homes daily. Each worker would travel 30 miles round-trip per day on paved roads

5 tractor-trailer delivery trucks would travel 50 miles per day to deliver supplies and equipment to the staging areas or to remove waste and debris. Travel would be on paved road

Concrete truck deliveries would occur an average of two trips per day 50 miles roundtrip for 400 days, with 35 miles being on paved roads and 15 on unpaved roads

10 mid-size trucks would drive 100 miles per day from the staging areas to various locations along the route, with 70 percent of the miles would be on unpaved roads

Emission Factors:

Emission Factors obtained from SCAQMD (http://www.aqmd.gov/ceqa/handbook/onroad/onroad.html)

Scenario Year: **2015**

All model years in the range 1971 to 2015

Passenger Vehicles (pounds/mile)	
CO	**0.00614108**
NOx	**0.00060188**
ROG	**0.00066355**
SOx	**0.00001070**
PM10	**0.00009259**
PM2.5	**0.00006015**
CO2	**1.10192837**
CH4	**0.00005923**

Delivery Trucks (pounds/mile)	
CO	**0.01169445**
NOx	**0.01285026**
ROG	**0.00173890**
SOx	**0.00002741**
PM10	**0.00050307**
PM2.5	**0.00041268**
CO2	**2.81247685**
CH4	**0.00008076**

Scenario Year: **2015**

All model years in the range 1971 to 2015

HHDT-DSL (pounds/mile)	
CO	**0.00766891**
NOx	**0.02122678**
ROG	**0.00178608**
SOx	**0.00004082**
PM10	**0.00104715**
PM2.5	**0.00087977**
CO2	**4.20902225**
CH4	**0.00008369**

HHDT-DSL, Exh (pounds/mile)	
PM10	**0.00090631**
PM2.5	**0.00083282**

	Trips/day		Miles per roundtrip		Total VMT/day			Emissions (lb/day)								
	Paved	*Unpaved*	*Paved*	*Unpaved*	*Paved*	*Unpaved*	*Total*	CO	NOx	ROG	SOx	PM10	PM2.5	CO2	PM10-EX	PM2.5-EX
Passenger Vehicles																
Worker Commute Trips	70	0	30	0	2100	0	2100	12.90	1.26	1.39	0.02	0.19	0.13	2314.05	0.00	0.00
On-site traffic (ramp up)	10	10	15	30	150	300	450	2.76	0.27	0.30	0.00	0.04	0.03	495.87	0.00	0.00
On-site traffic (peak)	20	20	30	70	600	1400	2000	12.28	1.20	1.33	0.02	0.19	0.12	2203.86	0.00	0.00
Mid-Sized Vehicles																
Concrete trucks	2	2	35	15	70	30	100	1.17	1.29	0.17	0.00	0.05	0.04	281.25	0.00	0.00
Construction trucks	10	10	30	70	300	700	1000	11.69	12.85	1.74	0.03	0.50	0.41	2812.48	0.00	0.00
Heavy-Heavy Duty																
Materials Delivery	5	0	50	0	250	0	250	1.92	5.31	0.45	0.01	0.26	0.22	1052.26	0.23	0.21
							TOTAL	***42.72***	***22.18***	***5.38***	***0.09***	***1.24***	***0.95***	***9159.75***	***0.23***	***0.21***

	Days/Yr	Emissions (tons)								
		CO	NOx	ROG	SOx	PM10	PM2.5	CO2	PM10-EX	PM2.5-EX
Passenger Vehicles										
Worker Commute Trips	500	3.22	0.32	0.35	0.01	0.05	0.03	578.51	0.00	0.00
On-site traffic (ramp up)	100	0.64	0.06	0.07	0.00	0.01	0.01	115.70	0.00	0.00
On-site traffic (peak)	500	0.69	0.07	0.07	0.00	0.01	0.01	123.97	0.00	0.00
Mid-Sized Vehicles										
Concrete trucks	400	0.23	0.26	0.03	0.00	0.01	0.01	56.25	0.00	0.00
Construction trucks	500	2.92	3.21	0.43	0.01	0.13	0.10	703.12	0.00	0.00
Heavy-Heavy Duty										
Materials Delivery	500	0.48	1.33	0.11	0.00	0.07	0.05	263.06	0.06	0.05
	TOTAL	***8.20***	***5.24***	***1.07***	***0.02***	***0.27***	***0.21***	***1840.61***	***0.05***	***0.00***

Paved Road Dust Emissions - Preferred Alternative and Proposed Action

PM10 Emission Factor Equation (lb/VMT)	E = [(k*(sL/2)^0.65 * (W/3)^1.5-C)]*(1-P/1460)

Emission Factor Parameters		
sL--silt loading (g/m^2)	0.32	Average based on daily traffic counts of local public roads (from WRAP Speadsheet Calculator)
W--average vehicle weight (tons)	4.74	See table to the right for average weight per vehicle class
C for PM10 (lb/VMT)	0.00047	Constant
C for PM2.5 (lb/VMT)	0.00036	Constant
P--wet days per year	60	Ave # of days of precipitation for different cities along the route as reported in www.bestplaces.net
k	0.016 PM_{10} 0.0024 $PM_{2.5}$	Constant

Average Vehicle Weight	Trips/day	Miles/trip	Total VMT/day	Days / Project	Total VMT
	Paved	*Paved*	*Paved*		
Passenger Vehicles					
Worker Commute Trips	70	30	2100	500	1050000
On-site traffic (ramp up)	10	15	150	100	15000
On-site traffic (peak)	20	30	600	500	300000
Mid-Sized Vehicles					
Concrete trucks	2	35	70	400	28000
Construction trucks	10	30	300	500	150000
Heavy-Heavy Duty					
Materials Delivery	5	50	250	500	125000
					1668000

Ave. Weight [(1,365,000 VMT *2 tons) + (178,000 VMT * 8 tons) + (125,000 * 30 tons)] / 1,668,000 4.7 tons

	k	sL	W	C	P	E (uncontrolled)
E_{PM10}	0.016	0.32	4.74	0.00047	60	0.008808202
$E_{PM2.5}$	0.0024	0.32	4.74	0.00036	60	0.001043628

Paved Road Dust Emissions

	Total VMT	Emission Factor		Emissions (tons) (Uncontrolled)	
	Unpaved	*PM10*	*PM2.5*	*PM10*	*PM2.5*
Paved Road Dust Emissions	1668000	0.0088082	0.001043628	7.35	0.87

Unpaved Road Dust Emissions - Preferred Alternative and Proposed Action

PM10 Emission Factor Equation (lb/VMT)	$E = 1.5\ (s/12)^{0.9}\ (W/3)^{0.45} * (365-P/365)$
Reference for PM10 EF Equation	AP-42
PM2.5/PM10 ratio	0.1
Reference for PM2.5/PM10 Ratio	MRI, 2006

Emission Factor Parameters	
s--silt content (%)	8.5
Average W--vehicle weight (tons)	4
umber of Days with Precipitation above 0.1 inch	60

	Trips/day	**VMT/trip**	**Total VMT/day**	**Days / Project**	**Total VMT for Project**
	Unpaved	***Unpaved***	***Unpaved***		
Passenger Vehicles					
On-site traffic (ramp up)	10	30	300	100	30000
On-site traffic (peak)	20	70	1400	500	700000
Mid-Sized Vehicles					
Concrete trucks	2	15	30	400	12000
Construction trucks	10	70	700	500	350000
					1092000

Ave. Total Weight = [(730,000 VMT *2 tons) + (362,000 VMT * 8 tons)] / 1,092,000 4

	Total VMT	**Emission Factor**		**Emissions (tons) (Uncontrolled)**		**Emissions (tons) Controlled with Watering**		**Emissions (tons) Controlled with Watering and Speed Limits**	
	Unpaved	***PM10***	***PM2.5***	***PM10***	***PM2.5***	***PM10***	***PM2.5***	***PM10***	***PM2.5***
Unpaved Road Dust Emissions	1092000	1.04600697	0.1046007	1142239.61	114223.96	257.00	25.70	143.92	14.39

Assumes 4 months ramp up and down, 20 months peak activity

Assumes 70 percent of travel occurs on unpaved roads

Assumes 240 of the 300 work days annually are without rain

Assumes 55 percent control efficiency from twice daily watering and 44 percent control efficiency from speed limit reduction

Average weight calculated from vehicle miles traveled by each weight class divided by total vehicle miles travellec

E = (k*(s/12)^a * (W/3)^b)) * (365-P/365)							
	k	s	a	W	b	P	E (Uncontrolled)
E_{PM10}	1.5	8.5	0.9	4	0.45	60	1.046006967
$E_{PM2.5}$	0.15	8.5	0.9	4	0.45	60	0.104600697

Fugitive Dust Emissions

Emission Factors:

An emission factor of 0.11 ton/acre-month was used based on the Western Regional Air Partnership Fugitive Dust Handbook, Chapter 3, Table 3-2. http://www.wrapair.org/forums/dejf/fdh/content/Ch3-Construction_and_Demolition_Rev06.pdf

PM2.5 to PM10 ratio is 0.1 (WRAP Fugitive Dust Handbook)

Emission factor includes 50 percent dust control for watering

PM10 = 0.11 ton/acre-month

PM2.5 = 0.011 ton/acre-month

Preferred Alternative

Activity Assumptions:

Activity	No.	Acres Per Unit	Total Acres	Average Daily Disturbance (acres)	Duration (months)	Emission Factor (ton/acre-month)		Emissions (tons)	
						PM10	PM2.5	PM10	PM2.5
Structure Sites	366	0.7	256.2	1.4	14	0.11	0.011	2.156	0.2156
Wire Pull Sites	51	2.1	107.1	2.1	2	0.11	0.011	0.462	0.0462
Staging Areas	5	20	100	2	2	0.11	0.011	0.44	0.044
Helicopter Yard	1.0	20	20	2.5	0.26	0.11	0.011	0.0715	0.00715
Helicopter Landing Sites	25	1	25	1	5.33	0.11	0.011	0.5863	0.05863
Guard Structures	80	0.01	0.8	0.5	0.37	0.11	0.011	0.02035	0.002035
Three Rivers Substation	1	20	20	2.5	3	0.11	0.011	0.825	0.0825
Kiffen Canyon Substation	1.00	23	23	2.5	3	0.11	0.011	0.825	0.0825
Iron Horse Substation Exp.	1	3.5	3.5	1.5	1	0.11	0.011	0.165	0.0165
Access Roads	1	244.372	244.372	5	9	0.11	0.011	4.95	0.495
TOTAL			***799.972***					***10.50115***	***1.050115***

Daily Disturbance and Duration based on engineering judgment and study of other transmission line projects

Proposed Action

Activity Assumptions:

Activity	No.	Acres Per Unit	Total Acres	Average Daily Disturbance (acres)	Duration (months)	Emission Factor (ton/acre-month)		Emissions (tons)	
						PM10	PM2.5	PM10	PM2.5
Structure Sites	411	0.7	287.7	1.4	15	0.11	0.011	2.31	0.231
Wire Pull Sites	51	2.1	107.1	2.1	2	0.11	0.011	0.462	0.0462
Staging Areas	5	20	100	2	2	0.11	0.011	0.44	0.044
Helicopter Yard	1.0	20	20	2.5	0.26	0.11	0.011	0.0715	0.00715
Helicopter Landing Sites	25	1	25	1	5.33	0.11	0.011	0.5863	0.05863
Guard Structures	56	0.01	0.56	0.5	0.37	0.11	0.011	0.02035	0.002035
Three Rivers Substation	1	20	20	2.5	3	0.11	0.011	0.825	0.0825
Kiffen Canyon Substation	1.00	23	23	2.5	3	0.11	0.011	0.825	0.0825
Iron Horse Substation Exp.	1	3.5	3.5	1.5	1	0.11	0.011	0.165	0.0165
Access Roads	1	240.4	240.4	5	9	0.11	0.011	4.95	0.495
TOTAL			***827.26***					***10.65515***	***1.065515***

Daily Disturbance and Duration based on engineering judgment and study of other transmission line projects

Non-Road Emissions

Assumptions:

Emission factors in pounds per hour obtained from the South Coast Air Quality Management District Off-road Mobile Source Emission Factors, Scenario Year 2015 (http://www.aqmd.gov/ceqa/handbook/offroad/offroad.html). Composite emission factors were used since specific equipment hp is unknown

Equipment types obtained from applicant (Exhibit 2-19 and 2-20). Truck (e.g., concrete trucks and water trucks) emissions accounted for in onroad exhaust category

Equipment hours based on engineering judgment

Construction would last 2 years, or 600 workdays

	No.	hrs/ day	Total Days	(lb/hr) ROG	(lb/hr) CO	(lb/hr) NOX	(lb/hr) SOX	(lb/hr) PM	(lb/hr) CO2	(lb/day) ROG	(lb/day) CO	(lb/day) NOX	(lb/day) SOX	(lb/day) PM	(lb/day) CO2	(tons) ROG	(tons) CO	(tons) NOX	(tons) SOX	(tons) PM	(tons) CO2
Geotechnical Investigations																					
Generator Set	1	8	205	0.0640	0.2913	0.4717	0.0007	0.0268	61.0	0.51	2.33	3.77	0.01	0.21	487.94	0.05	0.03	0.05	0.00	0.00	6.25
Drill Rig	1	8	205	0.0234	0.2235	0.2240	0.0004	0.0075	31.0	0.19	1.79	1.79	0.00	0.06	248.29	0.02	0.02	0.02	0.00	0.00	3.18
Vegetation Clearing - Preferred Alternative and Proposed Action																					
Chipper	2	8	300	0.0159	0.0544	0.1008	0.0002	0.0039	13.2	0.26	0.87	1.61	0.00	0.06	211.48	0.04	0.01	0.02	0.00	0.00	1.98
Staging Areas																					
Forklift	5	8	550	0.0459	0.2200	0.3163	0.0006	0.0156	54.4	1.83	8.80	12.65	0.02	0.62	2175.83	0.50	0.06	0.09	0.00	0.00	14.96
Bulldozer	1	10	66	0.2300	0.8352	1.8987	0.0025	0.0732	259	2.30	8.35	18.99	0.03	0.73	2592.29	0.08	0.03	0.06	0.00	0.00	8.55
Grader	1	10	66	0.1666	0.5739	1.3760	0.0023	0.0496	229	1.67	5.74	13.76	0.02	0.50	2294.84	0.05	0.02	0.05	0.00	0.00	7.57
Helicopter Yard and Landing Sites																					
D-6 Bulldozer	1	10	36	0.1415	0.5650	1.0059	0.0013	0.0594	114	1.41	5.65	10.06	0.01	0.59	1140.19	0.03	0.01	0.02	0.00	0.00	2.05
Grader	1	10	36	0.0159	0.0544	0.1008	0.0002	0.0039	13.2	0.16	0.54	1.01	0.00	0.04	132.17	0.00	0.00	0.00	0.00	0.00	0.24
Access Road Construction																					
Bulldozer	2	10	217	0.2300	0.8352	1.8987	0.0025	0.0732	259	4.60	16.70	37.97	0.05	1.46	5184.59	0.50	0.09	0.21	0.00	0.01	28.13
Roller	2	10	217	0.1107	0.3575	1.0948	0.0017	0.0368	153	2.21	7.15	21.90	0.03	0.74	3061.80	0.24	0.04	0.12	0.00	0.00	16.61
Grader	2	10	217	0.1666	0.5739	1.3760	0.0023	0.0496	229	3.33	11.48	27.52	0.05	0.99	4589.69	0.36	0.06	0.15	0.00	0.01	24.90
Foundation Installation																					
Generator Set	4	8	400	0.0640	0.2913	0.4717	0.0007	0.0268	61.0	2.05	9.32	15.09	0.02	0.86	1951.77	0.41	0.06	0.09	0.00	0.01	12.20
Digger derrick	4	8	400	0.1118	0.5511	0.7692	0.0031	0.0236	311	3.58	17.63	24.61	0.10	0.75	9961.88	0.72	0.11	0.15	0.00	0.00	62.26
Anchor Installation																					
Bobcat	2	8	250	0.0850	0.4577	0.5588	0.0008	0.0423	70.3	1.36	7.32	8.94	0.01	0.68	1124.49	0.17	0.06	0.07	0.00	0.01	8.79
Structure Assembly																					
Crane	2	6	425	0.2358	0.7835	2.0490	0.0030	0.0729	303	2.83	9.40	24.59	0.04	0.88	3636.54	0.60	0.17	0.44	0.00	0.02	64.40
Wire Installation																					
Tensioner	1	8	60	0.1905	0.7051	1.1159	0.0011	0.0952	93.7	1.52	5.64	8.93	0.01	0.76	749.90	0.05	0.02	0.03	0.00	0.00	2.81
Post Construction Cleanup																					
Grader	2	8	60	0.1666	0.5739	1.3760	0.0023	0.0496	229	2.67	9.18	22.02	0.04	0.79	3671.75	0.08	0.02	0.04	0.00	0.00	6.88
SUBSTATIONS																					
Site Development																					
Bulldozer	1	10	45	0.2300	0.8352	1.8987	0.0025	0.0732	259	2.30	8.35	18.99	0.03	0.73	2592.29	0.05	0.02	0.04	0.00	0.00	5.83
Grader	1	10	45	0.1666	0.5739	1.3760	0.0023	0.0496	229	1.67	5.74	13.76	0.02	0.50	2294.84	0.04	0.01	0.03	0.00	0.00	5.16
Fence Installation																					
Bobcat	1	8	60	0.0850	0.4577	0.5588	0.0008	0.0423	70.3	0.68	3.66	4.47	0.01	0.34	562.25	0.02	0.01	0.02	0.00	0.00	2.11
Equipment Footings																					
Generator Set	1	8	60	0.0640	0.2913	0.4717	0.0007	0.0268	61.0	0.51	2.33	3.77	0.01	0.21	487.94	0.02	0.01	0.01	0.00	0.00	1.83
Digger Derrick	1	8	60	0.1118	0.5511	0.7692	0.0031	0.0236	311	0.89	4.41	6.15	0.02	0.19	2490.47	0.03	0.02	0.02	0.00	0.00	9.34
Cable trench and Conduits																					
Bobcat	1	8	60	0.0850	0.4577	0.5588	0.0008	0.0423	70.3	0.68	3.66	4.47	0.01	0.34	562.25	0.02	0.01	0.02	0.00	0.00	2.11
Steel Structure Installation																					
Crane	1	8	60	0.2358	0.7835	2.0490	0.0030	0.0729	303	1.89	6.27	16.39	0.02	0.58	2424.36	0.06	0.02	0.06	0.00	0.00	9.09
Power Equipment Assembly																					
Tensioner	1	8	45	0.1905	0.7051	1.1159	0.0011	0.0952	93.7	1.52	5.64	8.93	0.01	0.76	749.90	0.03	0.02	0.03	0.00	0.00	2.11
Bobcat	1	8	45	0.0850	0.4577	0.5588	0.0008	0.0423	70.3	0.68	3.66	4.47	0.01	0.34	562.25	0.02	0.01	0.01	0.00	0.00	1.58
Crane	1	8	45	0.2358	0.7835	2.0490	0.0030	0.0729	303	1.89	6.27	16.39	0.02	0.58	2424.36	0.04	0.02	0.05	0.00	0.00	6.82
									TOTAL	***44.67***	***175.57***	***349.24***	***0.59***	***15.09***	***57878.39***	***4.16***	***0.92***	***1.85***	***0.00***	***0.08***	***311.50***

Access Roads: Assume 1 bulldozer, 1 grader, and 1 roller for 10 hrs/day for 4 days per mile of road.

Staging areas, helicopter yard, landing areas: Assume 1 grader and 1 bulldozer operate 10 hrs/day preparing 1.5 acre/day.

Drill foundations: Assume 1 drill rig, 8 hrs/day for 2 days per foundation hole