

Appendix A
Air Quality and Greenhouse Gas Emissions Calculations

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Palermo-East Nicolaus Transmission Line Reconstruction Project
Site Preparation Assumptions

Tower	Construction duration (days)	Pad ^a (feet)	Pad total volume (yds ³) ^b	Road (feet) ^a	Road total volume (yds ³) ^{b,c}	Total volume (yds ³)	Total truck trips ^d	Total truck VMT	Special equipment	Typical construction emissions	Typical construction emissions (mitigated)	Dozer emissions (lbs/day)	Dozer emissions (lbs/day) (mitigated)	Truck Emissions ^e (lbs/day)	Daily Emissions (lbs/day)	Daily Emissions (lbs/day) (mitigated)	
306 H	1	25 x 100	31	n/a		31	3	77		16.47	9.88			2.2	18.63	12.04	2/2011, 1-2
305	1	25 x 100	31	225	33	64	6	160		16.47	9.88			4.5	20.97	14.38	7/2011, 1; 11/2011, 4
283	2	49,126	606	0	0	606	61	1,516		16.47	9.88			42.5	58.97	52.38	6/2011, 3-4; 11/2011, 4
		25 x 100	31	0	0	31	3	77		16.47	9.88			2.2	18.63	12.04	
276	1	25 x 100	31	100	15	46	5	114	Dozer	16.47	9.88	11.06	6.64	3.2	30.73	19.72	
		100 x 100	123	0	0	123	12	309		16.47	9.88			8.7	25.12	18.53	3/2011, 2;
247	1	25 x 100	31	100	15	46	5	114		16.47	9.88			3.2	19.67	13.08	6/2011, 2-3;
	2	25 x 100	31	50	7	38	4	96		16.47	9.88			2.7	19.15	12.56	11/2011, 3-4
224		25x100	31	50	7	38	0	0		16.47	9.88			0.0	16.47	9.88	
		100 x 100	123	0	0	123	12	309		16.47	9.88			8.7	25.12	18.53	
212	1	25 x 100	31	100	0	31	3	77		16.47	9.88			2.2	18.63	12.04	10/2011, 3-4
189	1	25 x 50	15	280	41	57	6	142		16.47	9.88			4.0	20.46	13.87	
188	1	25 x 50	15	656	97	113	11	282		16.47	9.88			7.9	24.36	17.77	
187	1	25 x 50	15	0	0	15	2	39		16.47	9.88			1.1	17.55	10.96	
186	1	25 x 50	15	0	0	15	2	39		16.47	9.88			1.1	17.55	10.96	
185	2	25 x 100	31	600	89	120	12	299		16.47	9.88			8.4	24.86	18.27	
		25 x 50	15	0	0	15	2	39		16.47	9.88			1.1	17.55	10.96	
182	1	25 x 50	15	50	7	23	2	57		16.47	9.88			1.6	18.07	11.48	9/2011,3-4;
181	1	25 x 50	15	125	19	34	3	85		16.47	9.88			2.4	18.85	12.26	2/2012, 4
180	1	25 x 50	15	200	30	45	5	113		16.47	9.88			3.2	19.63	13.04	
178	1	25 x 50	15	127	19	34	3	86		16.47	9.88			2.4	18.87	12.28	
177	1	25 x 50	15	0	0	15	2	39		16.47	9.88			1.1	17.55	10.96	
173	2	25 x 50	15	500	74	90	9	224	Dozer	16.47	9.88	11.06	6.64	6.3	33.80	22.79	
171	1	25 x 50	15	400	59	75	7	187		16.47	9.88			5.2	21.70	15.12	
170	1	25 x 50	15	75	11	27	3	66		16.47	9.88			1.9	18.33	11.74	
169	2	25 x 50	15	700	104	119	12	298		16.47	9.88			8.3	24.82	18.23	
164	1	25 x 200	62	0	0	62	6	154		16.47	9.88			4.3	20.80	14.21	
141	1	100 x 100	123	0	0	123	12	309		16.47	9.88			8.7	25.12	18.53	8/2011, 1-4,
140	1	100 x 125	154	0	0	154	15	386		16.47	9.88			10.8	27.28	20.70	1/2012, 3
87	1	25 x 100	31	50	7	38	4	96		16.47	9.88			2.7	19.15	12.56	
		100 x 100	123	0	0	123	12	309		16.47	9.88			8.7	25.12	18.53	5/2011,1-3;
72	1	25 x 100	31	0	0	31	3	77		16.47	9.88			2.2	18.63	12.04	3/2012, 4
		100 x 100	123	0	0	123	12	309		16.47	9.88			8.7	25.12	18.53	
39 - 10	4	n/a				0	0	0		16.47	9.88			0.0	16.47	9.88	
39 & 34	4 days for 39-34	25 x 50	15	607	90	105	11	263		16.47	9.88			7.4	23.85	17.26	
38	4 days for 39-34	25 x 50	15	607	90	105	11	263		16.47	9.88			7.4	23.85	17.26	
37	4 days for 39-34	25 x 50	15	607	90	105	11	263		16.47	9.88			7.4	23.85	17.26	
36	4 days for 39-34	25 x 50	15	607	90	105	11	263		16.47	9.88			7.4	23.85	17.26	
35	4 days for 39-34	25 x 50	15	607	90	105	11	263		16.47	9.88			7.4	23.85	17.26	
34	4 days for 39-34	25 x 50	15	607	90	105	11	263		16.47	9.88			7.4	23.85	17.26	
33 & 32	1	25 x 50	15	700	104	119	12	298		16.47	9.88			8.3	24.82	18.23	
30	1	25 x 50	15	0	0	15	2	39		16.47	9.88			1.1	17.55	10.96	4/2011, 3-4;
29	1	25 x 50	15	225	33	49	5	122		16.47	9.88			3.4	19.89	13.30	3/2012, 4
31	1	25 x 50	15	50	7	23	2	57		16.47	9.88			1.6	18.07	11.48	
28	1	25 x 50	15	75	11	27	3	66		16.47	9.88			1.9	18.33	11.74	
27	1	25 x 50	15	150	22	38	4	94		16.47	9.88			2.6	19.11	12.52	
22	1	0	0	0	0	0	0	0	Dozer	16.47	9.88	11.06	6.64	0.0	27.53	16.52	
21	2	0	0	497	74	74	7	184	Dozer	16.47	9.88	11.06	6.64	5.2	32.69	21.68	
20	2	0	0	501	74	74	7	186	Dozer	16.47	9.88	11.06	6.64	5.2	32.73	21.72	
19	1	25 x 50	15	50	7	23	2	57	Dozer	16.47	9.88	11.06	6.64	1.6	29.13	18.12	
10	3	25 x 100	31	627	93	124	12	309		16.47	9.88			8.7	25.14	18.55	
		25 x 100	31	0	0	31	3	77		16.47	9.88			2.2	18.63	12.04	4/2011, 1-2
1	2	25 x 100	31	400	59	90	9	225		16.47	9.88			6.3	22.79	16.20	

FRAQMD

BCAQMD

^a Pad and road assumes skid steer loader to move gravel
^b Pad and road gravel depth assumption (inches) 4
^c Road width assumption (feet) 12
^d Truck capacity assumption (yds³) 10
^e Truck haul distance assumption (miles) 25
^f Truck emission factor (lbs/mile) 0.028029
Typical construction emissions (lbs/day) 16.47
Dozer construction emissions (lbs/day) 11.06

Construction Phase	2011				2011				2012				2012				2012				2012				2012				2012				2012											
	November				December				January				February				March				April				May				June				July				August				September			
	Non-Ozone Season																Ozone Season																											
	1st Week	2nd Week	3rd Week	4th Week	1st Week	2nd Week	3rd Week	4th Week	1st Week	2nd Week	3rd Week	4th Week	1st Week	2nd Week	3rd Week	4th Week	1st Week	2nd Week	3rd Week	4th Week	1st Week	2nd Week	3rd Week	4th Week	1st Week	2nd Week	3rd Week	4th Week	1st Week	2nd Week	3rd Week	4th Week	1st Week	2nd Week	3rd Week	4th Week								
Site Prep Activities																																												
Weekly Operation			1	3							2								2																									
Weekly Emissions (unmitigated)			31	111							27								34																									
Weekly Emissions (mitigated)			20	87							21								23																									
Tower Work Activities																																												
Weekly Operation	1	1																																										
Line Stringing Activities																																												
Weekly Operation			1	1	2	2	3	1	1	1		2	2	3	1	1	1	1	2	1																								
Unmitigated NOx Emission	Non-Ozone Season																Ozone Season																											
<i>Construction Alternative 1 with Helicopters to String Lines and Construct Towers</i>																																												
Daily Emission (lbs)	125	125	87	167	112	112	168	56	56	56	55	112	112	168	56	124	56	56	112	56																								
<i>Construction Alternative 2 with Ground Equipment to String Lines in Ozone Season</i>																																												
Daily Emission (lbs)	125	125	52	132	42	42	64	21	21	21	55	42	42	64	21	89	21	21	42	21																								
Mitigated NOx Emission	Non-Ozone Season																Ozone Season																											
<i>Construction Alternative 1 with Helicopters to String Lines and Construct Towers</i>																																												
Daily Emission (lbs)	85	85	76	142	112	112	168	56	56	56	41	112	112	168	56	102	56	56	112	56																								
<i>Construction Alternative 2 with Ground Equipment to String Lines in Ozone Season</i>																																												
Daily Emission (lbs)	85	85	33	100	27	27	41	14	14	14	41	27	27	41	14	59	14	14	27	14																								

Palermo-East Nicolaus Transmission Line Reconstruction Project

Daily Construction NOx Emission

Construction Phase	Unmitigated Daily (lbs/day)	Mitigated Daily (lbs/day)
Tower Work Activities		
Ground Equipment	108.36	68.74
Helicopters	16.32	16.32
Total	124.68	85.06
Line Stringing Activities		
Helicopters	55.96	55.96
Ground Equipment when helicopters are not used in ozone season	21.19	13.68

6 days/week

Original Mitigated (8-2009)	Revised Mitigated (9-2009)
75.34	58.83
91.66	75.16
Original Mitigated (8-2009)	
14.94	11.68

Construction Schedule within Butte County AQMD

Construction Phase	2011 January				2011 February				2011 March				2011 April				2011 May				2011 June				2011 July				2011 August				2011 September				2011 October						
	Non-Ozone Season																Ozone Season																										
	1st Week	2nd Week	3rd Week	4th Week	1st Week	2nd Week	3rd Week	4th Week	1st Week	2nd Week	3rd Week	4th Week	1st Week	2nd Week	3rd Week	4th Week	1st Week	2nd Week	3rd Week	4th Week	1st Week	2nd Week	3rd Week	4th Week	1st Week	2nd Week	3rd Week	4th Week	1st Week	2nd Week	3rd Week	4th Week	1st Week	2nd Week	3rd Week	4th Week							
Site Prep Activities																																											
Weekly Operation													1	1	1	1	1	1	1																								
Weekly Emissions (unmitigated)														25	25	33	33	25	25	25																							
Weekly Emissions (mitigated)													19	19	22	22	19	19	19																								
Tower Work Activities																																											
Weekly Operation																				1	1	1	1	1																			
Line Stringing Activities																																											
Weekly Operation																				1	1																						
Unmitigated NOx Emission																																											
Construction Alternative 1 with Helicopters to String Lines and Construct Towers																																											
Daily Emission (lbs)																25	25	89	213	150	150	150	125	125	249	125																	
Construction Alternative 2 with Ground Equipment to String Lines in Ozone Season																																											
Daily Emission (lbs)																25	25	54	179	150	150	150	125	125	249	125																	
Mitigated NOx Emission																																											
Construction Alternative 1 with Helicopters to String Lines and Construct Towers																																											
Daily Emission (lbs)																19	19	78	163	104	104	104	85	85	170	85																	
Construction Alternative 2 with Ground Equipment to String Lines in Ozone Season																																											
Daily Emission (lbs)																19	19	35	120	104	104	104	85	85	170	85																	

Palermo-East Nicolaus Transmission Line Reconstruction Project
Daily Construction Emissions

Tower Work Activities

Construction Source	Unmitigated Construction Emissions (pounds per day)						Mitigated Construction Emissions (pounds per day)					
	ROG	NOx	CO	SO2	PM10 Fugitive Dust	DPM Exhaust	ROG	Nox	CO	SO2	PM10 Fugitive Dust	DPM Exhaust
Off-Road Diesel	11.13	99.05	43.42	0	0	4.35	11.13	59.43	43.42	0	0	2.39
On-Road Diesel	0.5	8.41	2.58	0.01	0.04	0.3	0.5	8.41	2.58	0.01	0.04	0.3
Worker Trips	0.57	0.9	15	0.01	0.05	0.03	0.57	0.9	15	0.01	0.05	0.03
Helicopter Operation	0.36	16.32	7.76	1.10	0.00	1.07	0.36	16.32	7.76	1.10	0.00	1.07
Total Daily Emissions	12.56	124.68	68.76	1.12	0.09	5.75	12.56	85.06	68.76	1.12	0.09	3.79
Total Daily Ground Equipment Emissions	12.20	108.36	61.00	0.02	0.09	4.68	12.20	68.74	61.00	0.02	0.09	2.72

Line Stringing Activities with Helicopters

Construction Source	Unmitigated Construction Emissions (pounds per day)					
	ROG	NOx	CO	SO2	PM10 Fugitive Dust	DPM Exhaust
Helicopter Operation	1.23	55.96	26.62	3.76	0	3.66

Line Stringing Activities with Ground Equipment to Replace Helicopter Operation in Ozone Season

Construction Source	Unmitigated Construction Emissions (pounds per day)						Mitigated Construction Emissions (pounds per day)					
	ROG	NOx	CO	SO2	PM10 Fugitive Dust	DPM Exhaust	ROG	NOx	CO	SO2	PM10 Fugitive Dust	DPM Exhaust
Off-Road Diesel	1.93	18.77	6.18	0	0	0.68	1.93	11.26	6.18	0	0	0.37
On-Road Diesel	0.13	2.24	0.69	0	0.01	0.08	0.13	2.24	0.69	0	0.01	0.08
Worker Trips	0.11	0.18	3	0	0.01	0.01	0.11	0.18	3	0	0.01	0.01
Total Daily Ground Equipment Emissions	2.17	21.19	9.87	0.00	0.02	0.77	2.17	13.68	9.87	0.00	0.02	0.46

FAQMD Required Construction Mitigations

As required by FRAQMD, off-road construction equipment must achieve a project wide fleet-average 20% NOx reduction and 45% DPM reduction compared to the most recent CARB fleet average at the time of construction.

Palermo-East Nicolaus Transmission Line Reconstruction Project
 Assumptions for Ground Construction Equipment Operation

Tower Work Activities

On-Site Construction Equipment	Assumed Equipment Horsepower	Number of Equipment	Equipment Operation Hours/Day per Piece	Equipment Operation Days/Week
Bulldozer	357	1	12	6
Grader	174	1	12	6
Scraper	313	1	12	6
Backhoe	108	1	12	6
Crane	399	1	12	6
Line truck	189	1	12	6
Water truck	189	1	12	6
On-site Dump truck	189	1	12	6
Other Equipment	0	32	12	6

Average Daily On-road Trucks 15 Table 3-2, 3-3, and 3-4 of PEA
 [(3000 cy / 20 cy-per-truck) + (500 trucks + 1500 trucks)] / 18 weeks / 6 days-per-week

Emissions from worker commute trips are calculated for 50 workers per day, based on Table 3-7 of PEA.
 In Urbemis, the number of workers is estimated as 125% of the total number of construction equipment (vehicles and machines) selected.
 In order to account for commute trips from 50 workers, a total of 40 pieces of equipment should be selected in Urbemis.
 Therefore, the other 32 pieces of equipment are assigned, but with 0 horsepower, so they will not contribute any on-site emissions.

Line Stringing Activities to Replace Helicopter Operation in Ozone Season

On-Site Construction Equipment	Assumed Equipment Horsepower	Number of Equipment	Equipment Operation Hours/Day per Piece	Equipment Operation Days/Week
Crane	399	1	12	6
Line truck	189	1	12	6
Other Equipment	0	6	12	6

Average Daily On-road Trucks 4 Table 3-4 of PEA 500 trucks / 21 weeks / 6 days-per-week

Emissions from worker commute trips are calculated for 12 workers per day.
 In Urbemis, the number of workers is estimated as 125% of the total number of construction equipment (vehicles and machines) selected.
 In order to account for commute trips from 10 workers, a total of 8 pieces of equipment should be selected in Urbemis.
 Therefore, the other 6 pieces of equipment are assigned, but with 0 horsepower, so they will not contribute any on-site emissions.

Palermo-East Nicolaus Transmission Line Reconstruction Project
Daily Helicopter Emission Calculation

Helicopter Type and Usage

Type	Engine	Power (hp)	Fuel Consumption (gallon/hr)
Bell 214ST (Heavy Duty)	GECT7-2A	3250	133
MD 500D/E (Light Duty)	Alison 250-C20B	420	28

Source: Fuel Consumption is obtained from the U.S. Department of Interior National Business Center (2006).

Helicopter Emission Factor

Type	HC (lbs/hr)	NOx (lbs/hr)	CO (lbs/hr)	SOx (lbs/hr)	PM10 (lbs/hr)	CO2 (lbs/gallon)
Bell 214ST (Heavy Duty)	0.13	10.49	2.02	0.65	0.72	18.355
MD 500D/E (Light Duty)	0.08	1.75	2.07	0.14	0.1	18.355

Source: Emission factors for HC, NOx, CO, and SOx were obtained from the California Public Utilities Commission (2007); PM10 emission factors were obtained from the CPUC (2006); and CO2 emission factor for aviation gasoline was obtained from the U.S. Department of Energy (2008).

Note: Emission factors for Bell 214ST were derived from the emission factors for H-53 Super Stallion (T64-GE-416 Turboshaft 4,380 hp engine). Emission factors for take-off and climb-out modes were used.

Emission factors for MD 500D/E were derived from the emission factors for Bell 206 Jet Ranger (Alison 250-C20 Turboshaft 420 hp engine).

Emission factors for take-off mode were used.

Helicopter Usage

Type	Project-wide	Tower Work (20%)			Line Stringing (80%)		
	Total Operation Hours	Schedule (weeks)	Total Operation Hours	Daily Operation Hours	Schedule (weeks)	Total Operation Hours	Daily Operation Hours
Bell 214ST (Heavy Duty)	600	18	120	1.11	21	480	3.81
MD 500D/E (Light Duty)	1440	18	288	2.67	21	1152	9.14

Note: Total project-wide operation hours are based on Table 3-11 in PEA.

Helicopter Emissions

Type	HC (lbs/day)	NOx (lbs/day)	CO (lbs/day)	SOx (lbs/day)	PM10 (lbs/day)	CO2 (total tons)
Tower Work Activities						
Bell 214ST (Heavy Duty)	0.14	11.66	2.24	0.72	0.80	146.47
MD 500D/E (Light Duty)	0.21	4.67	5.52	0.37	0.27	74.01
Total Emissions	0.36	16.32	7.76	1.10	1.07	220.48
Line Stringing Activities						
Bell 214ST (Heavy Duty)	0.50	39.96	7.70	2.48	2.74	585.89
MD 500D/E (Light Duty)	0.73	16.00	18.93	1.28	0.91	296.03
Total Emissions	1.23	55.96	26.62	3.76	3.66	881.92

References

California Public Utilities Commission (CPUC). 2006. Southern California Edison. Antelope-Pardee 500-kV Transmission Line Project. Environmental Impact Report. <http://www.cpuc.ca.gov/Environment/info/asp/antelopepardee/antelopepardee.htm>. Accessed September 2008.

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Palermo-East Nicolaus Transmission Line Reconstruction Project

CO2 Construction Emissions

Construction Phase	CO2 Emissions (total tons per phase)	CO2 Emissions with Mitigation APM AIR-1 (total tons per phase)	CO2 Reduction Factor w/ Mitigation APM AIR-3	CO2 Emissions with APM AIR-1 and APM AIR-3 (total tons per phase)
1 Staging area preparation	419	351		315
Off-Road Diesel ^{1,3}	406	338	10%	304
On-Road Diesel	2	2		2
Worker Trips ⁴	11	11	20%	9
2 Existing tower removal	835	686		659
Off-Road Diesel ^{1,2,3}	396	247	10%	222
On-Road Diesel	20	20		20
Worker Trips	11	11	20%	9
Helicopter Operation	408	408		408
3 New pole construction	1411	1264		1186
Off-Road Diesel ^{1,3}	879	732	10%	659
On-Road Diesel	55	55		55
Worker Trips ⁴	27	27	20%	22
(Helicopter Operation)	450	450		450
4 Transmission line installation	313	265		239
Off-Road Diesel ^{1,3}	285	237	10%	213
On-Road Diesel	20	20		20
Worker Trips ⁴	8	8	20%	6
5 Staging area recovery	337	282		253
Off-Road Diesel ^{1,3}	327	272	10%	245
On-Road Diesel	1	1		1
Worker Trips ⁴	9	9	20%	7
Total CO2 (tons for project)	3315	2848		2652

Mitigation APM AIR-1

¹ Operation of off-road construction equipment is assumed to reduce to 10 hours per day by minimizing idling time to 5 minutes.

² Operation of off-road construction equipment is limited to five 5 hours per day when helicopters are used on the same day.

Mitigation APM AIR-3

³ Construction contractors are assumed to use B10 biodiesel (10% biodiesel and 90% diesel) for all off-road construction equipment.

⁴ 20% of workers are assumed to carpool.