APPENDIX D: AIR QUALITY

This Appendix includes additional information on the methodology used to calculate both criteria pollutant and Greenhouse Gas (GHG) emissions for the sources at the proposed test locations analyzed in greater detail for this PEIS for Modernization of Training Infrastructure and Construction and Operation of an Infantry Platoon Battle Area at Pōhakuloa Training Area, Hawai‘i. Summary tables for each major category of emission source for these proposed test locations are also included in this Appendix.

All references used in the air quality analysis are listed in this Appendix. Major areas of emission estimates include:

- Ordnance and munitions from troops conducting live-fire training at designed locations in the range area
- Emissions from personal commuter vehicles

Emissions from Live-fire Training Exercises at IPBA facilities

Live-fire training occurs at the IPBA facilities and primarily consists of small arms ammunition and rocket fired ammunition from helicopters which emit a minute amount of emissions per round from combustion of the propellant charge. A smaller percentage of ordnance with explosive or pyrotechnic components such as flares, smoke devices, and demolition charges is also used for some training exercises.

The primary criteria pollutant emissions from small arms firing include carbon monoxide (CO) and lead. CO is emitted as a combustion by-product from the detonation of the energetic material inside the ammunition. The energetic material in most small arms ammunition usually includes a small amount of a lead ingredient, which may be emitted into the atmosphere when the ammunition is fired. The projectile (slug) which is fired at the target also usually contains lead.

The amount of emissions generated from small arms firing is dependent on the type and quantity of ammunition rounds fired. Emissions from small arms ammunition fired at the IPBA, MOUT and Live-fire Shoothouse were calculated for each facility individually.

The primary weapons and ammunition authorized for use on the IPBC range are listed in Table D.1 Emissions calculated from ordnance use at the IPBC are provided in Table D.2.

Table D.1 Total IBCT Annual Ammunition Expenditures at the IPBC

Weapon Type	Ammunition Type	Ammo per weapon/ event	Weapons per platoon	Weapons per company	Weapons per battalion	Weapons per BCT	Annual expenditures (2 events/yr)
Rifle Squads							
M16 / M4 Rifle	5.56 BALL	40	15	45	135	405	32400
	5.56 BLANK	40	15	45	135	405	32400

M249 SAW	5.56 BALL	100	6	18	54	162	32400
	5.56 BLANK	100	6	18	54	162	32400
M203 40mm Grenade Launcher	40 MM TPT	4	6	9	54	162	1296
Weapons Squad							
M16/M4 Rifle	5.56 BALL	20	6	18	48	144	5760
	5.56 BLANK	20	6	18	48	144	5760
M240B	7.62 BALL	100	2	6	18	54	10800
	7.62 BLANK	100	2	6	18	54	10800
M2 Machine Gun	.50 CAL BALL	75	1	3	9	27	4050
MK19	40 MM TPT	5	1	3	9	27	270
Engineer Platoon							
M16/M4	5.56 BALL	75	12			36	5400
M249	5.56 BALL	150	2			6	1800
M240	7.62 BALL	150	1			3	900
M2	.50 CAL BALL	50	1			3	300

Table D.2. Total SBCT Annual Ammunition Expenditures at the IPBC

Weapon Type	Ammunition Type	Ammo per weapon/ event	Weapons per platoon	Weapons per company	Weapons per battalion	Weapons per BCT	Annual expenditures (2 events/yr)
Rifle Squads							
M16 / M4 Rifle	5.56 BALL	40	15	45	135	405	32400
	5.56 BLANK	40	15	45	135	405	32400
M249 SAW	5.56 BALL	100	6	18	54	162	32400
	5.56 BLANK	100	6	18	54	162	32400
M203 40mm Grenade Launcher	40 MM TPT	4	6	9	54	162	1296
Weapons Squad							
M16/M4 Rifle	5.56 BALL	20	6	18	48	144	5760
	5.56 BLANK	20	6	18	48	144	5760
M240B	7.62 BALL	100	2	6	18	54	10800
	7.62 BLANK	100	2	6	18	54	10800
M2 Machine Gun	.50 CAL BALL	75	1	3	9	27	4050
MK 19	40 MM TPT	5	1	3	9	27	270
Engineer Platoon							
M16/M4	5.56 BALL	75	12			36	5400
M249	5.56 BALL	150	2			6	1800
M240	7.62 BALL	150	1			3	900
M2	.50 CAL BALL	50	1			3	300

Table D.3. Total CAB Annual Ammunition Expenditures at the IPBC

Weapon Type	Ammunition Type	Ammo per weapon/ event	Weapons per platoon	Weapons per company	Weapons per battalion	Weapons per CAB	Annual expenditures (2 events/yr)
Aviation Battalion							
M16/M4	5.56 BALL	75	12			36	2700
M249	5.56 BALL	150	2			6	900
M240	7.62 BALL	150	1			3	450
M2	.50 CAL BALL	50	1			3	150
Attack Helicopter (1) Squadron (Heavy)							
HA 13 M274	2.75 inch Rocket (Practice)						245
HA 13 M267	2.75 inch Rocket (Practice)						59
Attack Helicopter Squadron (Light)							
HA 13 M274	2.75 inch Rocket (Practice)						248
HA 13 M267	2.75 inch Rocket (Practice)						73
Assault Helicopter Squadron							
A143	7.62 Ball						4282
A131	7.62 Mix						1665

Table D.4. Ammunition/Ordnance Emissions at the IPBC facility

	SO_2 (tpy)	CO (tpy)	NOx (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	CH_4 (tpy)	TSP (tpy)	CO_2 (tpy)	TNMHC (tpy)	Lead (tpy)
Light Infantry IBCT	<0.01	0.12	<0.01	<0.01	<0.01	<0.01	<0.01	0.07	<0.01	<0.01
Light Infantry SBCT	<0.01	0.12	<0.01	<0.01	<0.01	<0.01	<0.01	0.07	<0.01	<0.01
Engineer Platoon IBCT	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01
Engineer Platoon SBCT	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
Aviation Battalion	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Attack Helicopter Squadron (Heavy)	-	0.08	--	0.02	0.03	<0.01	0.02	0.73	<0.01	0.01
Attack Helicopter Squadron (Light)	-	0.09	--	0.03	0.03	<0.01	0.02	0.77	<0.01	0.01
Assault Helicopter Squadron	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total (tpy)	0.00	0.47	0.01	0.32	0.16	<0.01	0.25	1.72	<0.01	0.02

The primary weapons and ammunition authorized for use at the Live-fire Shoothouse are listed in Table D.5. Practice fragmentation hand grenades are also authorized for use in the Shoothouse. Emissions calculated from ordnance use at the IPBC are provided in Table D.6.

Table D.5 Total Estimated 25th ID Ammunition Expenditures at the Live-Fire Shoothouse

Weapon Type	Ammunition Type	Ammo per weapon/ event	Weapons per platoon	Weapons per company	Weapons per battalion	Weapons per BCT	Annual expenditures (2 events/yr)
Rifle Squads - IBCT							
M16 / M4 Rifle	5.56 BLANK	20	15	45	135	405	16200
	Short Range Training Ammunition (SRTA)	20	15	45	135	405	16200
M249 SAW	5.56 BLANK	20	6	18	54	162	6480
	SRTA	40	6	18	54	162	12960
Rifle Squads - SBCT							
M16 / M4 Rifle	5.56 BLANK	20	15	45	135	405	16200
	SRTA	20	15	45	135	405	16200
M249 SAW	5.56 BLANK	20	6	18	54	162	6480
	SRTA	40	6	18	54	162	12960

Table D-6. Ammunition/Ordnance Emissions at the Live-fire Shoothouse facility

	SO2 (tpy)	CO (tpy)	NOx (tpy)	PM10 (tpy)	PM2.5 (tpy)	CH4 (tpy)	TSP (tpy)	CO2 (tpy)	TNMHC (tpy)	Lead (tpy)
Light Infantry IBCT	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	0
Light Infantry SBCT	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	0
Total	**<0.01**	**0.05**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**0.03**	**<0.01**	**0**

The primary weapons and ammunition authorized for use at the MOUT are listed in Table D.7. Smoke grenades, smoke pots, and artillery/hand grenade simulators are also used in the MOUT. Emissions calculated from ordnance use at the MOUT are provided in Table D.8. Ammunition expenditures are

expected to be fully contained within the structure, however, the emissions shown assume all be released to the surrounding atmosphere.

Table D.7 Total Estimated 25th ID Ammunition Expenditures at the MOUT

Weapon Type	Ammunition Type	Ammo per weapon/ event	Weapons per platoon	Weapons per company	Weapons per battalion	Weapons per BCT	Annual expenditures (2 events/yr)
Rifle Squads - IBCT							
M16 / M4 Rifle	5.56 BLANK	20	15	45	135	405	16200
	SESAMS (Paint Ball)	60	15	45	135	405	48600
M249 SAW	SESAMS	100	6	18	54	162	1944
Weapons Squads - IBCT							
M16 / M4 Rifle	5.56 BLANK	20	6	18	48	144	5760
M240B	7.62 BLANK	100	2	6	18	54	10800
Rifle Squads - SBCT							
M16 / M4 Rifle	5.56 BLANK	20	15	45	135	405	16200
	SESAMS	60	15	45	135	405	48600
M249 SAW	SESAMS	100	6	18	54	162	1944
Weapons Squads - IBCT							
M16 / M4 Rifle	5.56 BLANK	20	6	18	48	144	5760
M240B	7.62 BLANK	100	2	6	18	54	10800

Table D.8. Ammunition/Ordnance Emissions at the MOUT facility

	SO2 (tpy)	CO (tpy)	NOx (tpy)	PM10 (tpy)	PM2.5 (tpy)	CH4 (tpy)	TSP (tpy)	CO2 (tpy)
Light Infantry IBCT	<0.01	0.01	<0.01	0.26	0.10	<0.01	0.19	0.05
Light Infantry SBCT	<0.01	0.01	<0.01	0.27	0.20	<0.01	0.20	0.14
Total	**<0.01**	**0.02**	**0.01**	**0.53**	**0.21**	**<0.01**	**0.39**	**0.19**
Note: The TSP emissions have assumed to be equal to the PM10 emissions given the emission factor in EPA AP-42 for TSP from smoke pots (Table 15.7.6-1) appears to be incorrect. The TSP emission factor listed in the table is 21 lb/item while the PM10 emission factor is listed as 32 lb/item.								

Based on the commander's risk assessment (for safety) and evaluation of his unit's training status infantry attalions are also potentially resourced additional munitions that may be used in the Shoothouse and at the MOUT Site on a yearly basis. These include;

- up to 18 live hand grenades,
- 30 inert training grenades,
- 150 5.56m fuses for training grenades,
- 78 stun grenade bodies,
- and up to 780 stun grenade fuses

Use of these items were included in the analysis for a conservative estimate on impacts to air quality, but may, in reality, be used throughout the year by a battalion during a number of different training exercises to simulate more realistic combat scenarios.

Emissions associated with each ammunition type used at the MOUT, IPBC, and Live-fire Shoothouse are calculated according the following equation:

$$\mathbf{Epoll = NR * EF_{poll}}$$

Where,

E_{poll} = Emissions pollutant (lb/yr)

NR = Number of rounds of a particular type of ammunition fired during the year (rounds or item/yr)

EF_{poll} = Pollutant emission factor (lb/item) [Emission factors used are from AP-42 Section 15 as shown in Table D.8]

Table D.9. AP-42 Emissions Factors for Ordnance Use at IPBA Ranges

Weapon	Ammunition Type	SO_2 (lbs/item)	CO (lbs/item)	NOx (lbs/item)	PM_{10} (lbs/item)	$PM_{2.5}$ (lbs/item)	CH_4 (lbs/item)	TSP (lbs/item)	CO_2 (lbs/item)	TNMHC (lbs/item)	Lead (lbs/item)	AP-42 Source
M16/M4	5.56 BALL	0	1.6E-03	8.5E-05	3.9E-05	2.8E-05	9.7E-06	3.8E-05	8.7E-04	0	0.0E+00	Ch. 15.1.4.1
	5.56 BLANK	9.80E-08	2.80E-04	2.00E-05	6.00E-06	6.00E-06	1.60E-06	7.50E-06	2.00E-04	0	0.0E+00	Ch. 15.1.9.1
	SRTA	0	1.6E-03	8.5E-05	3.9E-05	2.8E-05	9.7E-06	3.0E-05	8.7E-04	0	0.0E+00	
M249	5.56 BALL	0	1.6E-03	8.5E-05	3.9E-05	2.8E-05	9.7E-06	3.8E-05	8.7E-04	0	0.0E+00	Ch. 15.1.4.1
	5.56 BLANK	9.80E-08	2.80E-04	2.00E-05	6.90E-06	6.00E-06	1.60E-06	7.50E-06	2.30E-04	0	0.0E+00	Ch. 15.1.9.1
M203	40 MM TPT	0	3.50E-04	3.60E-05	2.60E-05	2.30E-05	3.70E-06	2.30E-05	2.60E-04	0	0.0E+00	15.2.2.1
M240B	7.62 BALL	0	2.30E-03	9.70E-05	5.10E-05	3.80E-05	1.00E-05	5.10E-05	1.20E-03	0	0.0E+00	Ch. 15.1.15.1
	7.62 BLANK	3.50E-07	6.80E-04	4.40E-05	1.70E-05	1.50E-05	2.90E-06	1.70E-05	9.50E-04	0	0.0E+00	Ch. 15.1.12.1
M2	.50 CAL BALL	0	1.60E-02	3.30E-05	9.70E-04	4.40E-04	5.30E-05	1.00E-03	9.20E-03	0	0.0E+00	15.1.27.1
MK 19	40 MM TPT	0	2.60E-03	9.70E-05	1.40E-04	1.20E-04	5.40E-06	1.40E-04	2.70E-03	0	0.0E+00	15.2.7.1
HA 13 M274	2.75 inch Rocket (Practice)	0	5.30E-01	0	1.60E-01	1.70E-01	6.20E-03	1.50E-01	4.80E+00	0	7.00E-02	15.6.7
HA 13 M267	2.75 inch Rocket (Practice)	0	5.30E-01	0	1.60E-01	1.70E-01	6.20E-03	1.50E-01	4.80E+00	0	7.00E-02	15.6.7
A143	7.62 Ball	0	2.30E-03	9.70E-05	5.10E-05	3.80E-05	1.00E-05	5.10E-05	1.20E-03	0	0.0E+00	15.1.15.1
A131	7.62 Mix	0	2.30E-03	9.70E-05	5.10E-05	3.80E-05	1.00E-05	5.10E-05	1.20E-03	0	0.0E+00	15.1.15.1
Fragmentat	Live hand	0	1.70E-02	1.10E-03	3.10E-02	1.70E-02	2.80E-04	3.80E-02	2.40E-01	0	5.00E-04	15.5.2.1

Weapon	Ammunition Type	SO_2 (lbs/item)	CO (lbs/item)	NOx (lbs/item)	PM_{10} (lbs/item)	$PM_{2.5}$ (lbs/item)	CH_4 (lbs/item)	TSP (lbs/item)	CO_2 (lbs/item)	TNMHC (lbs/item)	Lead (lbs/item)	AP-42 Source
ion Hand grenade	grenades											
M228 Practice Hand grenade Fuse	5.56 fuses for training grenades	1.10E-05	1.10E-05	4.00E-05	1.10E-04	9.40E-05	0	1.20E-04	1.70E-04	3.20E-07	0	15.5.1.1
M84 Non-lethal Stun Hand grenade	780 Stun grenade fuses	0	1.50E-05	4.10E-04	4.60E-03	3.30E-03	0	4.70E-03	1.70E-03	0	0	15.5.13.1
ABC-M5 30-Pound HC Smoke Pot	Smoke Pots	4.40E-03	7.90E-01	2.60E-03	32	17	0	21	4.60E-01	1.70E-02	2.40E-02	15.7.6.1
M18 Green Smoke Hand grenade	Smoke grenades (various colors)	1.60E-04	1.20E-02	1.20E-04	1.30E-01	1.00E-01	0	1.30E-01	8.40E-02	2.10E-03	0	15.5.6.1
M7A3 CS Riot Control Agent Hand grenade	CS grenades (tear gas)	5.10E-05	3.40E-02	1.40E-03	4.20E-02	3.70E-02	0	1.80E-02	9.10E-02	5.60E-03	0	15.5.10.1
	HC grenades (white smoke)	1.20E-04	4.60E-02	1.00E-03	6.80E-01	1.00E-01	0	4.70E-01	3.30E-02	6.30E-04	4.70E-04	15.5.5.1
ABC-M5 30-Pound HC Smoke	Smoke Pots	4.40E-03	7.90E-01	2.60E-03	32	17	0	21	4.60E-01	1.70E-02	2.40E-02	15.7.6.1

Weapon	Ammunition Type	SO_2 (lbs/item)	CO (lbs/item)	NOx (lbs/item)	PM_{10} (lbs/item)	$PM_{2.5}$ (lbs/item)	CH_4 (lbs/item)	TSP (lbs/item)	CO_2 (lbs/item)	TNMHC (lbs/item)	Lead (lbs/item)	AP-42 Source
Pot												
M158 Red Star Cluster Sig0l Flare	Star Clusters	1.50E-04	8.80E-03	3.30E-03	8.90E-02	0	0	9.00E-02	1.80E-01	2.80E-04	1.70E-06	15.8.2.1
M49A1 Surface Trip Flare	Trip Flares	1.20E-04	5.30E-04	2.90E-03	1.30E-01	0	0	1.70E-01	5.20E-02	1.00E-05	9.90E-06	15.8.9.1
M115A2 Ground Burst Simulator	Ground Burst Simulators	1.50E-04	2.10E-03	5.50E-03	1.90E-01	0	0	1.60E-01	3.40E-03	1.30E-04	4.10E-06	15.8.10.1
Booby trap Simulators	Booby trap Simulators	4.40E-04	5.30E-05	5.00E-05	2.50E-03	0	0	3.20E-03	0	3.80E-06	2.30E-06	15.8.12.1
M116A1 Hand grenade Simulator	Hand Grenade Simulators	4.70E-04	3.70E-04	5.60E-03	1.20E-01	0	0	1.10E-01	4.10E-03	4.20E-05	1.40E-06	15.8.15.1

Fugitive Dust Emissions from Construction Activities

Another source of emissions identified as part of the Proposed Action includes disturbance of the area from construction activities and heavy equipment use. Short-term impacts throughout the construction period would result in emissions of fugitive dust from disturbance of the site and equipment emplacement as well as exhaust and fugitive dust emissions from the operation of heavy construction vehicles and equipment. The methods used to calculate fugitive dust emissions are discussed below. Exhaust emissions from equipment and vehicle use were not estimated because of a lack of information about what equipment and vehicles would be used during construction activities.

Construction activities for the IPBA would occupy an estimated 200 acres, with new buildings and structures occupying 0.18 acre[4] Construction of the IPBA was estimated to span 270 days per year for a two year period. Emissions from construction activity are assumed to be generated during simple site grading, with no major cut-and-fill or excavation activity. Construction activities include demolition and debris removal (bulldozing, truck loading and unloading of debris, truck travel), site preparation (bulldozing, scrapers, truck loading and unloading), and general construction (vehicular traffic). An emission factor for construction activity operations of 0.22 tons of PM-10 per acre per month (20.95 lbs/acre/day) was used to estimate PM-10 emissions. This is based on a recommended PM-10 emission factor of 0.11 ton/acre/month adjusted for a worst case where no control are used assuming that standard dust control practices provide a 50% reduction in PM-10 emissions (WRAP Fugitive Dust Handbook, 2004).

Fugitive Dust Emissions from Heavy Construction Operations

$$\mathbf{E_{PM\text{-}10} = EF * D * A}$$

$$\mathbf{E_{TSP} = E_{PM\text{-}10} * 1.56}$$

$E_{PM\text{-}10}$ = Emissions of PM-10 (lbs/yr)

D = Number of Days of Heavy Construction Activity

A = Area Disturbed (Acres)

PM-10 Emission Factor = 20.95 lbs/acre/day of activity) [Emission factors used are from WRAP Fugitive Dust Handbook, 2004]

Conversion factor for PM-10 to TSP = 1.56 [Conversion factors used are forum's. Army. FEIS, Transformation of the 2nd Brigade, 25th Infantry Division (L) to a Stryker Brigade]

Conversion factor for PM_{10} to $PM_{2.5}$= 0.1 [Conversion factors used are from Pace, Thompson, G. , U.S. EPA., Examination of the Multiplier Used to Estimate PM-2.5 Fugitive Dust Emissions from PM-10.

[4] Estimates of area disturbed land for construction activities from *Stryker Brigade Combat Team Final EIS, Hawai'I, May 2004.*

Table D-10 shows the expected net increase in fugitive dust emissions for heavy construction activities for the three proposed locations within the existing impact area where the IPBA may be constructed.

Table D-10. Annual Criteria Pollutant Emissions from Heavy Construction Activities

Year	Construction Site	Disturbed Area (acres)	Estimated Construction Days	Emissions					
				(lb/year)			(tons/year)		
				TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Year 1	IPBA	200	270	1,764,828	1,131,300	194,400	882.4	565.7	56.6
Year 1	IPBA	200	270	1,764,828	1,131,300	194,400	882.4	565.7	56.6
Life of the Proposed Action (2 years)	IPBA	200	540	3,529,656	2,262,600	388,800	1764.8	1131.3	113.1

Emissions from Employee Commuting (POVs)

Additional sources of emissions identified as part of the Proposed Action include commuter vehicles. Criteria pollutant and GHG emissions from vehicle exhaust have been estimated for support personnel traveling to and from the IBPC facilities on unpaved roads. The methods used to calculate emissions from these sources are discussed below.

The IPBA facilities would be contractor run and personnel would drive their own vehicles to the ranges (POVs). Three (3) additional support personnel are expected to be required to operate the IPBA facilities when the ranges are open (242 days per year). It was assumed that all POVs will be light duty trucks with a fuel economy of 16.2 miles per gallon (DOE, 2010). Emissions from commuter vehicular traffic traveling to and from the proposed range locations were calculated based on the profile in Table D-11. The following assumptions were made for the three additional employees commuting from the Cantonment Area and average round-trip travel distances to the proposed new range locations.

Table D-11: POV Commuting Profile

Range Location	Average Speed (mph)	Vehicle Fuel Economy (mpg)	Estimated Round Trip Distance from Cantonment Area to new proposed Range areas (miles)
Western Range	30	16.2	14
Charlie's Circle	30	16.2	13
Southwest Range	30	16.2	10

Employee Commuting Criteria Pollutant Emissions

$$E_{POV} = VMT_{POV} * EF * .002205$$

E_{POV} = emissions of criteria pollutant generated by POVs

EF = EPA emission factor for light-duty truck vehicle category (grams/mile)) [Emission factors used are from IERA AEI Guidance for Mobile Sources Rev. 2003 Table 4-2, 4-3, 4-4 as shown in Table D.11]**:**

VMT_{POV} = estimated vehicle miles traveled

0.002205 = factor to convert grams to pounds

Table D-12 shows expected net increase in annual exhaust emissions from POVs traveling to the three proposed locations within the existing impact area where the IPBA may be constructed.

Table D-11. Emission Factors for Personal Vehicle Use

Trucks (Low Altitude LDGT1)	Emission Factors		
	VOC (g/mi)	NOx (g/mi)	CO (g/mi)
2009 MY 2001	2.4	1.9	28.3

Table D-12. Annual Criteria Pollutant Emissions from Personnel Commuting to Western Ranges from the Cantonment Area

Location	Emissions (lbs)/year			Emissions (tons)/year		
	VOC (lbs)	NOx (lbs)	CO (lbs)	VOC (tons)	NOx (tons)	CO (tons)
Western Range	99.9	79.1	1,177.9	0.05	0.04	0.59
Charlie's Circle	103.7	82.1	1,223.2	0.05	0.04	0.61
Southwest 20	53.8	42.6	634.25	0.03	0.02	0.32

Employee Commuting Greenhouse Gas Emissions

Calculations of GHG emissions from the mobility energy sources followed The Climate Registry protocol which estimates emissions of GHGs from mobile combustion sources based on vehicle fuel use and miles traveled data. The majority of emissions from mobile sources are from CO2 , methane (CH4) and nitrous oxide (N2O) and are associated with the quantity of fuel combusted; therefore can be calculated using fuel consumption data. Annual GHG emissions are then calculated by multiplying the total fuel consumed by a GHG specific emission factor. The individual GHG emissions were converted into a CO2-equivalent (CO2e) based on global warming potentials (GWP). The cumulative warming effect over a specified time period of an emission of a mass unit of CO2 is assigned the value of 1. Effects of emissions of a mass unit of non-CO2 GHG are estimated as multiples of CO2. For example, CH4 has a GWP of 21, which means that 1 kg of CH4 has the same heat-trapping potential as 21 kg of CO2 and N2O has a GWP of 310 (IPCC,2007).

$$\mathbf{E_{GHG} = Fuel\ Use \times EF_{GHG}}$$

For CH_4 and N_2O

$$\mathbf{Fuel\ Use = VMT_{POV} \times Fuel\ Economy}$$

E_{GHG} = GHG emissions generated by POV commuting.

EF_{GHG} = Emission factor for combustion of gasoline (kg/gallon or grams/liter)

Fuel Economy = 16.2 mph for light-duty trucks (DOE, 2010)

VMT_{POV} = estimated vehicle miles traveled per year

Table D-14 shows GHG emissions (e.g., CO2, CH4, and N2O) calculated for employee commuting by determining the total fuel combusted during the Proposed Action and applying the emissions factor specific to the fuel from generally accepted GHG protocols.

Table D-13. Greenhouse Gas Emission Factors for Combustion of Gasoline

Vehicle	Fuel	Emission Factor		
		CO2 (kg/gal)	CH4 (g/L)	N2O (g/L)
Light Duty Truck	Gasoline	8.81	0.22	0.32
Light Duty Truck	Gasoline	8.81	0.22	0.32
Light Duty Truck	Gasoline	8.81	0.22	0.32

Table D-14. Annual Commuting Personnel Greenhouse Gas Emissions

Location	Emissions Calculations			CO2 - Equivalent Calculations			Total CO2e MT/yr
	CO2 MT/yr	CH4 MT/yr	N2O MT/yr	CO2 MT/yr	CH4 MT/yr	N2O MT/yr	
Western Range	22,635.0	565.2	822.2	11.3	0.28	0.41	12.01
Charlie's Circle	23,505.5	587.0	853.8	11.8	0.29	0.43	12.47
Southwest 20	12,188.0	304.4	442.7	6.1	0.15	0.22	6.47