RAMBOLL ENVIRON

Via electronic mail

Mr. Paul Mitchell
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RE: ANALYSIS OF ENERGY USE ASSOCIATED WITH THE PROPOSED GOLDEN STATE WARRIORS PROJECT, SAN FRANCISCO, CALIFORNIA

Date October 19, 2015

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Dear Mr. Mitchell:

At the request of Environmental Science Associates (ESA), Ramboll Environ conducted an energy use analysis for the proposed Event Center and Mixed-Use Development at Mission Bay Blocks 29-32 in San Francisco, California (the "Project"). The energy use analysis evaluates the Project's energy consumption including electricity and fuel usage associated with project construction and operation.

1 Project Construction

The energy consumption associated with Project construction includes electricity usage associated with dust control and use of electric equipment, diesel fuel consumption from on-road hauling trips and off-road construction diesel equipment, and gasoline consumption from on-road worker commute and vendor trips. The methodology for each category is discussed below. This analysis relies on the construction equipment list and project operational characteristics as stated in Chapter 5.4 Air Quality and Appendix AQ of the Subsequent Environmental Impact Report (SEIR); the project refinements discussed in Chapter 12 of the SEIR, Project Refinements (see Sections 12.3.1, Revised Construction Crane Plan and 12.3.2, Other Construction Refinements); and Chapter 14 of the SEIR, Draft SEIR Revisions (see Section 14.2.11, Appendix AQ). Energy usage is also provided for construction of the Muni UCSF/Mission Bay Station Variant described in Section 12.4 of the SEIR.

1.1 Electricity Usage – Water Consumption for Construction Dust Control

The electricity usage associated with water consumption for construction dust control is calculated based on total water consumption and the energy intensity for

supply, distribution, and treatment of water. The total gallons of water usage is calculated based on acreage disturbed during grading and site preparation (i.e., Mass Excavation and Rapid Impact Compacting phases) and the daily water consumption rate per acre disturbed. The total acres disturbed are calculated using the methodology described in Chapter 4.2 of Appendix A of the CalEEMod® User's Guide (Grading Equipment Passes).[1] The water application rate of 3,020 gallon per acre per day is from Air & Waste Management Association's Air Pollution Engineering Manual.[2] The energy intensity value is based on the CalEEMod® default energy intensity per gallon of water for San Francisco County. As summarized in Table 1, the total electricity consumption associated with water consumption for construction dust control is approximately 6,524 kilowatt-hour (kWh), over the duration of construction for the Project, and 5,126 kWh for the Project with Refinements. The Muni Variant does not require any additional water use. All construction requiring water use occurs in 2015. The detailed calculation is presented in Supplemental Table A1.

1.2 Electricity Usage – Construction Electric Equipment

The electricity usage associated with electric construction equipment is calculated based on the size of the equipment and total hours of usage. The electric equipment types are identified in Supplemental Table A2. Since the equipment sizes were not provided, this analysis assumes that the drywall stud impact guns are 1 kilowatt each and cutting or chopping saws are 5 kilowatts each. As summarized in Table 1, the electric construction equipment consume approximately 499,147 kWh of electricity, over the duration of construction for the Project and Project with Refinements (none of the Refinements affect electric equipment). The Project and Muni Variant combined consume approximately 499,187 kWh of electricity. The maximum annual electricity use for the Project with Refinements occurs in 2016, with 292,365 kWh. Year 2016 is also the maximum for the Refined Project with Muni Variant, with the same electricity use, as this analysis assumes the Muni Variant construction occurs in 2015 and it does not exceed the 2015 usage. Note that this calculation is a conservative overestimate because the electric equipment is assumed to operate continuously at full power during the construction period, which is an unlikely case. The detailed calculation is presented in Supplemental Table A2.

1.3 Diesel Usage – On-Road Construction Trips

The diesel usage associated with on-road construction mobile trips is calculated based on vehicle miles travelled (VMT) from hauling and vendor trips and vehicle fuel efficiency in miles per gallon. The VMT are from the SEIR Air Quality analysis and cover the entire construction period. The vehicle fuel efficiency is calculated based on ARB's EMFAC2011 model output, which includes the Pavley Clean Car Standards and the Low Carbon Fuel Standard. The 2015 fuel efficiency is used for the duration of construction, which is a conservative assumption since the fleet will become cleaner over time with new standards and vehicle replacement. As summarized in Table 1, the total diesel consumption associated with on-road construction trips is approximately 248,857 gallons, over the duration of construction for the Project and Project with Refinements (none of the Refinements affect on-road trips). The Refined Project with Muni Variant estimated diesel usage is 249,222 gallons. The maximum annual on-road diesel use for the Project with

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[1] California Air Pollution Control Officers Association. 2013. California Emissions Estimator Model – Appendix A Calculation Details for CalEEMod®. Available at: http://www.aqmd.gov/docs/default-source/caleemod/caleemod-appendixa.pdf?sfvrsn=2

[2] Air & Waste Management Association. 1992. Air Pollution Engineering Manual.

Refinements is 166,686 gallons, in 2015. The maximum for the Refined Project with Muni Variant also occurs in 2015, with 167,051 gallons. The detailed calculation is presented in Supplemental Table A3. The fuel efficiency calculation is presented in Supplemental Table A5.

1.4 Diesel Usage – Off-Road Construction Diesel Equipment

The construction diesel usage associated with the off-road construction equipment is calculated based on the total equipment horsepower-hour and the off-road mobile source fuel usage rate of 0.05 gallons of diesel per horsepower-hour from the South Coast Air Quality Management District (SCAQMD) CEQA Air Quality Handbook (Table A9-3E). As summarized in Table 1, the total diesel consumption associated with off-road construction equipment is approximately 480,854 gallons for the Project, over the duration of construction. The off-road diesel use for construction of the Project with Refinements is 522,895 gallons, and Refined Project with Muni Variant is 529,364 gallons. The maximum annual off-road diesel use for the Project with Refinements occurs in 2015, with 403,404 gallons. The maximum annual use for the Refined Project with Muni Variant also occurs in 2015, with 409,873 gallons. The detailed calculation is presented in Supplemental Table A4.

1.5 Gasoline Usage – On-Road Construction Trips

The construction gasoline usage associated with on-road construction mobile trips is calculated based on VMT from worker commute trips and vehicle fuel efficiency in miles per gallon. The VMT are from the SEIR Air Quality analysis and cover the entire construction period. The vehicle fuel efficiency is calculated based on ARB's EMFAC2011 model output, which includes the Pavley Clean Car Standards and the Low Carbon Fuel Standard. The 2015 fuel efficiency is used for the duration of construction, which is conservative since the fleet will become cleaner over time with new standards and vehicle replacement. As summarized in Table 1, the total gasoline consumption associated with on-road construction trips is approximately 314,926 gallons for the Project and Project with Refinements (none of the Refinements affect on-road trips), over the duration of construction. The on-road gasoline use for the Refined Project with Muni Variant is 315,357 gallons. The maximum annual on-road gasoline use for the Project with Refinements occurs in 2016 with 254,242 gallons. The maximum annual use for the Refined Project with Muni Variant also occurs in 2016, with the same fuel use, as this analysis assumes the Muni Variant construction occurs in 2015. The detailed calculation is presented in Supplemental Table A2. The fuel efficiency calculation using EMFAC2011 outputs is presented in Supplemental Table A5.

2 Project Operation

The energy consumption associated with Project operation includes Project building electricity, water, and natural gas usage and fuel usage from on-road mobile sources. The methodology for each category is discussed below. Note that this energy resources analysis is consistent with the air quality analysis in the SEIR, which includes the event center, the Golden State Warriors office space, the two office towers, parking, and retail uses including food service. This analysis does not include any energy consumption associated with the Oracle Arena.

2.1 Electricity Usage – Project Building Envelope

The electricity usage associated with the event center, the office towers, and the Golden State Warriors office is from the "100% Schematic Design Sustainability Narrative" for the Project (SSR Inc.). The

electricity usage associated with other portions of the Project is based on CalEEMod® defaults. As summarized in Table 2, the Project buildings consume approximately 16,178,175 kWh of electricity per year. Note that peak daily electricity demand of the Project (e.g., during a game day) would reach approximately 9,850 kW.[3]

The electricity use intensity for a standard office building is 12.8 kWh per year per square foot (kWh/yr/sf), or 43.7 kBTU per year per square foot (kBTU/yr/sf), based on 2013 Title 24 standards for new office buildings. The electricity use intensity values based on the Title 24 standards assume additional natural gas use to complement the electricity use. The 2013 Title 24 standard for natural gas is 17.1 kBTU/yr/sf. Therefore, the total energy use for a standard office building built to 2013 Title 24 standards is 60.7 kBTU/yr/sf. The Project's proposed office towers are expected to have an energy intensity of 11.5 kWh/yr/sf (39.4 kBTU/yr/sf) with no natural gas use. As such, the office towers represent a decrease in electricity use from the 2013 Title 24 standards and a complete elimination of natural gas use. The total energy use intensity for the office towers is 35% lower than it would be if it were built solely according to 2013 Title 24 standards.

2.2 Electricity Usage – Project Water Consumption

The electricity usage associated with Project water consumption is estimated based on the annual water consumption and the energy intensity factor per gallon of water discussed in Section 1.1. The total water usage is from the Water and Sewer Analyses for Golden State Warriors Arena @ Mission Bay Blocks 29-32 dated November 14, 2014.[4] The water usage associated with other portions of the Project is based on CalEEMod® default values. As summarized in Table 2, the electricity usage associated with the Project water usage would be 198,033 kWh per year.

2.3 Natural Gas Usage – Project Building Envelope

The methodology used to calculate the natural gas usage associated with the Project building envelope is the same as the methodology discussed in Section 2.1. No natural gas consumption is expected at the office towers, which will use electric heating. As summarized in Table 2, the Project building envelope would consume 25,464,623 kBTU of natural gas per year.

2.4 Fuel Usage – Mobile Sources

The gasoline and diesel usage associated with on-road mobile trips is calculated based on total VMT from the SEIR Air Quality analysis and average fuel efficiency from EMFAC2011 model for the first operational year of 2017. The EMFAC2011 fuel efficiency data incorporate the Pavley Clean Car Standards and the Low Carbon Fuel Standard. As summarized in Table 1, the total gasoline and diesel consumption associated with on-road trips is approximately 2,714,483 gallons per year and 438,350 gallons per year, respectively.

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[3] Provided by SSR Inc., on behalf of the Project Sponsor. The peak daily electricity demand includes 6,500 kW from the event center, 1,300 kW from the north office tower, 1,220 kW from the south office tower, 480 kW from the market hall, and 350 kW from the parking garage.

[4] BKF Engineers. 2014. Water and Sewer Analyses for Golden State Warriors Arena @ Mission Bay Blocks 29-32.

3 Closing

Please feel free to contact Michael Keinath or Catherine Mukai if you have any questions. Thank you for the opportunity to assist you with this matter.

Yours sincerely,

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Attachments:

Tables
Supplemental Tables

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TABLES

Table 1. Summary of Energy Use During Construction

Source	Resource Use	
Electricity		
Project Water Consumption[1]	6,524	kWh
Project Construction Electric Equipment[2,3]	499,147	kWh
Project Electricity Total	**505,670**	**kWh**
Project + Refinements Water Consumption[1]	5,126	kWh
Project + Refinements Construction Electric Equipment[2]	499,147	kWh
Project + Refinements Electricity Total	**504,273**	**kWh**
Project + Refinements + Muni Variant Water Consumption[1]	5,126	kWh
Project + Refinements + Muni Variant Construction Electric Equipment[2]	499,187	kWh
Project + Refinements + Muni Variant Electricity Total	**504,312**	**kWh**
Diesel		
Project On-Road Construction Trips[4,5]	248,857	Gallons
Project Off-Road Construction Equipment[6]	480,854	Gallons
Project Diesel Total	**729,711**	**Gallons**
Project + Refinements On-Road Construction Trips[4,5]	248,857	Gallons
Project + Refinements Off-Road Construction Equipment[6]	522,895	Gallons
Project + Refinements Diesel Total	**771,752**	**Gallons**
Project + Muni Variant On-Road Construction Trips[5]	249,222	Gallons
Project + Refinements + Muni Variant Off-Road Construction Equipment[6]	529,364	Gallons
Project + Refinements + Muni Variant Diesel Total	**778,586**	**Gallons**
Gasoline		
Project On-Road Construction Trips[4,5]	314,926	Gallons
Project Gasoline Total	**314,926**	**Gallons**
Project + Refinements On-Road Construction Trips[4,5]	314,926	Gallons
Project + Refinements Gasoline Total	**314,926**	**Gallons**
Project + Refinements + Muni Variant On-Road Construction Trips[5]	315,357	Gallons
Project + Refinements + Muni Variant Gasoline Total	**315,357**	**Gallons**

Notes

1. Construction water use estimated based on acres disturbed per day per construction phase, construction days per phase, and estimated water use per acre (AWMA 1992). Water use is not affected by the Muni Variant.

2. The power input of the electric equipment was not provided. This analysis assumes that the handheld tools are 1 kw and other electric tools are 5 kw.

3. Electric construction equipment use is not affected by Refinements.

4. Onroad trips are not affected by Refinements.

5. On-road mobile source fuel use based on vehicle miles traveled (VMT) from CalEEMod® for all years of construction and fleet-average fuel consumption in gallons per mile from EMFAC2011 for 2015 in San Francisco County.

6. Off-road mobile source fuel usage based on a fuel usage rate of 0.05 gallons of diesel per horsepower (hp)-hour, based on SCAQMD CEQA Air Quality Handbook, Table A9-3E.

Abbreviations

CalEEMod®: California Emission Estimation Model

EMFAC2011: California Air Resources Board EMission FACtor model.

hp: horsepower

kw: kilowatt

kWh: kilowatt-hour

SCAQMD: South Coast Air Quality Management District

Sources

Air & Waste Management Association. 1992. Air Pollution Engineering Manual.

SCAQMD CEQA Air Quality Handbook, Table A9-3E.

Table 2. Summary of Operational Annual Energy Resource Use

Source	Project Mission Bay Annual Resource Use	Units
Electricity		
Building[1]	16,178,175	kWh/year
Water[1]	198,033	kWh/year
Total Electricity	**16,376,207**	**kWh/year**
Natural Gas		
Building[1]	15,575,623	kBTU/year
Diesel		
Backup Generators[2]	16,763	gallons/year
Mobile[3]	438,350	gallons/year
Gasoline		
Mobile[3]	2,714,483	gallons/year

Notes

1. The electricity, natural gas, and water usage are based on Project-specific estimates and CalEEMod®.
2. Diesel use from backup generators was calculated from the provided horsepower, assuming 50 hours/year/generator (consistent with the Air Quality analysis) and 0.05 gallons/horsepower-hour (consistent with construction equipment fuel use).
3. Calculated based on the mobile source fuel use based on vehicle miles traveled (VMT) from CalEEMod® for air quality and GHG analyses and the fleet-average fuel consumption (in gallons per mile) from EMFAC2011 for operational year 2017.

Abbreviations

BAAQMD: Bay Area Air Quality Management District

CalEEMod®: California Emission Estimation Model

EMFAC2011: California Air Resources Board EMission FACtor model.

kBTU: thousand British Thermal Unit

kWh: kilowatt-hour

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SUPPLEMENTAL TABLES

Table A1. Electricity Usage for Construction Water Usage

Phase ID	Construction Phase	Project Equipment	Off-Road Equipment Type[1]	Number of Units	Hours Per Day	Acres Disturbed /Day/Unit[2]	Number of Days	Total Gallons[3]	Total kWh[4]
2	Mass Excavation	Scraper	Scrapers	3	7	0.9	196	516,703	2,796
		Wheel Loader	Tractors/Loaders/Backhoes	3	7	0.4	196	258,352	1,398
		Track Type Tractor Blde/Ripper	Tractors/Loaders/Backhoes	2	7	0.4	130	172,234	932
~~3~~	~~Rapid Impact Compaction~~ (Refinement)	~~Track type tractor with hammer~~	~~Tractors/Loaders/Backhoes~~	~~3~~	~~7~~	~~0.4~~	~~196~~	~~258,352~~	~~1,398~~
								Total	**5,126**

Notes

1. Construction off-road equipment use, hours per day, and days per phase from project specific construction equipment list. Only the equipment types here are assumed to have associated water control.
2. Acres disturbed per day calculated from CalEEMod® Appendix D Table 3.7.
3. Gallons of water usage for dust control is calculated based on a minimum control efficiency of 66% (three times daily) with an application rate of 3,020 gal/acre/day (AWMA 1992) and average of 26
4. Calculated based on the CalEEMod® default BAAQMD energy intensity of 0.005411 kWh per gallon for supply, distribution, and treatment of water.

Abbreviation

BAAQMD: Bay Area Air Quality Management District
kWh: kilowatt-hour

Reference

Air & Waste Management Association. 1992. Air Pollution Engineering Manual.

Table A2. Electricity Usage of Off-road Construction Electric Equipment

Phase ID	Phase	Project Equipment	OFFROAD Equipment	Fuel Type	kW[1]	Quantity	Total Hours	Calendar Year	Constr. Year	Electricity Usage (kWh)	Electricity Usage Subtotals (kWh)
1	Demolition/Mass Excavation	Street Sweeper	Sweepers/Scrubbers	Diesel	0	2	3,042	2015	1	0	
2	Mass Excavation (Refinement)	Pugmill Generator	Other Construction Equipment	Diesel	0	1	521	2015	1	0	
2	Mass Excavation (Refinement)	Dewatering Generator	Other Construction Equipment	Diesel	0	5	21,900	2015	1	0	
2	Mass Excavation (Refinement)	Dewatering Generator	Other Construction Equipment	Diesel	0	4	17,520	2015	1	0	
2	Mass Excavation	Large Excavator	Excavators	Diesel	0	3	1,369	2015	1	0	
2	Mass Excavation	Scraper	Scrapers	Diesel	0	3	1,369	2015	1	0	
2	Mass Excavation	Wheel Loader	Tractors/Loaders/Backhoes	Diesel	0	3	1,369	2015	1	0	
2	Mass Excavation	Track Type Tractor Blde/Ripper	Tractors/Loaders/Backhoes	Diesel	0	2	913	2015	1	0	
~~3~~	~~Rapid Impact Compaction~~ (Refinement)	~~Track type tractor with hammer~~	~~Tractors/Loaders/Backhoes~~	~~Diesel~~	~~0~~	~~3~~	~~1,369~~	~~2015~~	~~1~~	~~0~~	
4	Pile Installation	Drill Rig (for installation of Auger Cast piles)	Bore/Drill Rigs	Diesel	0	4	1,825	2015	1	0	
4	Pile Installation	Crawler Cranes	Cranes	Diesel	0	4	1,825	2015	1	0	
4	Pile Installation	Large Forklifts	Forklifts	Diesel	0	2	913	2015	1	0	
4	Pile Installation	Bobcat or small excavators	Rubber Tired Loaders	Diesel	0	4	1,825	2015	1	0	
4	Pile Installation	Cutting and chopping saws	Other Construction Equipment	Electric	5	4	1,825	2015	1	9,125	
5	Shoring	Drill Rig	Bore/Drill Rigs	Diesel	0	2	913	2015	1	0	
5	Shoring	Support Crane	Cranes	Diesel	0	2	913	2015	1	0	
5	Shoring	Grout-mixing plant	Other Material Handling Equipment	Diesel	0	2	913	2015	1	0	
5	Shoring	Small Excavator	Excavators	Diesel	0	2	913	2015	1	0	
5	Shoring	Cut off wall (CDSM) equipment	Bore/Drill Rigs	Diesel	0	4	1,217	2015	1	0	
6	Building Construction (including arena)	Concrete Boom Pumps	Other Construction Equipment	Diesel	0	2	3,346	2015	1	0	
6	Building Construction (including arena)	Bobcat	Rubber Tired Loaders	Diesel	0	2	3,346	2015	1	0	
6	Building Construction (including arena)	Small Excavator	Excavators	Diesel	0	2	3,346	2015	1	0	
6	Building Construction (including arena)	Large Excavator	Excavators	Diesel	0	2	3,346	2015	1	0	
6	Building Construction (including arena)	Crawler Cranes	Cranes	Diesel	0	4	6,083	2015	1	0	
6	Building Construction (including arena)	Mobile Cranes	Cranes	Diesel	0	4	6,083	2015	1	0	
6	Building Construction (including arena)	Grandall-type Forklifts	Forklifts	Diesel	0	8	12,167	2015	1	0	
6	Building Construction (including arena)	Cutting/chopping saws	Other Construction Equipment	Electric	5	15	22,813	2015	1	114,063	
6	Building Construction (including arena)	Tile cutting saws	Other Construction Equipment	Electric	5	10	7,604	2015	1	38,021	
6	Building Construction (including arena)	Drywall stud impact guns	Other Construction Equipment	Electric	1	25	19,010	2015	1	19,010	
6	Building Construction (including arena)	Tower Cranes	Other Construction Equipment	Electric	179	4	6,083	2015	1	22,579	
6	Building Construction (including arena)	Tower Cranes	Other Construction Equipment	Electric	178	1	1,065	2015	1	3,925	
7	Muni Stop Extension	Digger	Excavators	Diesel	0	1	288	2015	1	0	
7	Muni Stop Extension	Backhoe	Tractors/Loaders/Backhoes	Diesel	0	2	576	2015	1	0	
7	Muni Stop Extension	Jackhammers	Other Construction Equipment	Diesel	0	1	288	2015	1	0	
7	Muni Stop Extension	Dump truck	Off-Highway Trucks	Diesel	0	1	288	2015	1	0	
7	Muni Stop Extension	Truck crane	Cranes	Diesel	0	1	288	2015	1	0	
7	Muni Stop Extension	Bobcat	Rubber Tired Loaders	Diesel	0	1	288	2015	1	0	
7	Muni Stop Extension	Saw cutter	Other Construction Equipment	Electric	5	2	576	2015	1	60	
									2015 Subtotal[2]		206,782

Table A2. Electricity Usage of Off-road Construction Electric Equipment

Phase ID	Phase	Project Equipment	OFFROAD Equipment	Fuel Type	kW[1]	Quantity	Total Hours	Calendar Year	Constr. Year	Electricity Usage (kWh)	Electricity Usage Subtotals (kWh)
6	Building Construction (including arena)	Concrete Boom Pumps	Other Construction Equipment	Diesel	0	2	304	2016	2	0	
6	Building Construction (including arena)	Bobcat	Rubber Tired Loaders	Diesel	0	2	3,346	2016	2	0	
6	Building Construction (including arena)	Small Excavator	Excavators	Diesel	0	2	3,346	2016	2	0	
6	Building Construction (including arena)	Large Excavator	Excavators	Diesel	0	2	304	2016	2	0	
6	Building Construction (including arena)	Crawler Cranes	Cranes	Diesel	0	4	2,433	2016	2	0	
6	Building Construction (including arena)	Mobile Cranes	Cranes	Diesel	0	4	6,692	2016	2	0	
6	Building Construction (including arena)	Grandall-type Forklifts	Forklifts	Diesel	0	8	14,600	2016	2	0	
6	Building Construction (including arena)	Cutting/chopping saws	Other Construction Equipment	Electric	5	15	27,375	2016	2	136,875	
6	Building Construction (including arena)	Tile cutting saws	Other Construction Equipment	Electric	5	10	18,250	2016	2	91,250	
6	Building Construction (including arena)	Drywall stud impact guns	Other Construction Equipment	Electric	1	25	30,417	2016	2	30,417	
6	Building Construction (including arena)	Tower Cranes	Other Construction Equipment	Electric	179	4	7,300	2016	2	27,095	
6	Building Construction (including arena)	Tower Cranes	Other Construction Equipment	Electric	178	1	1,825	2016	2	6,728	
										2016 Subtotal[2]	292,365
7	Muni Stop (Variant)	Digger	Excavators	Diesel	0	1	192	2015	1	0	
7	Muni Stop (Variant)	Backhoe	Tractors/Loaders/Backhoes	Diesel	0	2	384	2015	1	0	
7	Muni Stop (Variant)	Jackhammers	Other Construction Equipment	Diesel	0	1	192	2015	1	0	
7	Muni Stop (Variant)	Dump truck	Off-Highway Trucks	Diesel	0	1	192	2015	1	0	
7	Muni Stop (Variant)	Truck crane	Cranes	Diesel	0	1	192	2015	1	0	
7	Muni Stop (Variant)	Bobcat	Rubber Tired Loaders	Diesel	0	1	192	2015	1	0	
7	Muni Stop (Variant)	Saw cutter	Other Construction Equipment	Electric	5	2	384	2015	1	40	
										2015 Muni Variant Subtotal	40
										Project Total	499,147
										Project + Refinements Total	499,147
										Project + Refinements + Muni Variant Total	499,187

Notes

1. Assume the power input of impact guns is 1 kw and that of other construction saws is 5 kw.
2. Subtotal not affected by Refinements.

Abbreviations

HP: horsepower
kWh: kilowatt hour

Table A3. Fuel Usage from Construction On-road Mobile Sources

Site	Trip Type[1]	Vehicle Type[1]	Fuel	% of Fleet[1]	Total One-way Trips	One-way Trip Length (mile)	Fuel Efficiency[2] (mpg)	Fuel Usage (gal)
Project[3]	Worker	LDA	GAS	50%	490,568	12.4	21.8	139,310
	Worker	LDT1	GAS	25%	490,568	12.4	18.8	80,681
	Worker	LDT2	GAS	25%	490,568	12.4	16.0	94,935
	Vendor	T6	DSL	50%	95,056	7.3	8.4	41,205
	Vendor	T7	DSL	50%	95,056	7.3	5.5	62,868
	Hauling	T7	DSL	100%	39,952	20	5.5	144,785
2015 Project Subtotal[3]							Gasoline	60,683
							Diesel	166,686
2016 Project Subtotal[3]							Gasoline	254,242
							Diesel	82,171
Project Subtotal[3]							Gasoline	314,926
							Diesel	248,857
Muni Variant	Worker	LDA	GAS	50%	672	12.4	21.8	191
	Worker	LDT1	GAS	25%	672	12.4	18.8	111
	Worker	LDT2	GAS	25%	672	12.4	16.0	130
	Vendor	T6	DSL	50%	256	7.3	8.4	111
	Vendor	T7	DSL	50%	256	7.3	5.5	169
	Hauling	T7	DSL	100%	23	20	5.5	84
2015 Muni Variant Subtotal							Gasoline	431
							Diesel	364
Muni Variant Subtotal							Gasoline	431
							Diesel	364
Total							**Gasoline**	**315,357**
							Diesel	**249,222**

Notes

1. CalEEMod® default vehicle mix of light-duty auto (LDA), light-duty truck type 1 (LDT1), and light-duty truck type 2 (LDT2) for worker trips, mix of medium heavy-duty vehicles (MHDT) and heavy heavy-duty trucks (HHDT) for vendor trips, and all HHDT for hauling trips.
2. Based on EMFAC2011 output. See Table A5.
3. On-Road activity is not affected by any refinements, thus "Project + Refinement" results are identical to "Project" results.

Abbreviations

gal: gallon

mpg: miles per gallon

Table A4. Fuel Usage of Off-road Construction Diesel Equipment

Phase ID	Phase	Project Equipment	OFFROAD Equipment	Fuel Type	Hp	LF	Quantity	Total Hours	Calendar Year	Constr. Year	Hp-Hour[1]	Fuel Usage[2] (gal)	Fuel Usage Subtotals (gal)
1	Demolition/Mass Excavation	Street Sweeper	Sweepers/Scrubbers	Diesel	285	0.4556	2	3,042	2015	1	394,948	19,747	
2	Mass Excavation (Refinement)	Pugmill Generator	Other Construction Equipment	Diesel	335	0.4154	1	521	2015	1	72,617	3,631	
2	Mass Excavation (Refinement)	Dewatering Generator	Other Construction Equipment	Diesel	40	0.4154	5	21,900	2015	1	365,710	18,285	
2	Mass Excavation (Refinement)	Dewatering Generator	Other Construction Equipment	Diesel	66	0.4154	4	17,520	2015	1	478,152	23,908	
2	Mass Excavation	Large Excavator	Excavators	Diesel	523	0.3819	3	1,369	2015	1	273,386	13,669	
2	Mass Excavation	Scraper	Scrapers	Diesel	500	0.4824	3	1,369	2015	1	330,143	16,507	
2	Mass Excavation	Wheel Loader	Tractors/Loaders/Backhoes	Diesel	211	0.3685	3	1,369	2015	1	106,425	5,321	
2	Mass Excavation	Track Type Tractor Blde/Ripper	Tractors/Loaders/Backhoes	Diesel	150	0.3685	2	913	2015	1	50,438	2,522	
~~3~~	~~Rapid Impact Compaction~~ (Refinement)	~~Track type tractor with hammer~~	~~Tractors/Loaders/Backhoes~~	~~Diesel~~	~~150~~	~~0.3685~~	~~3~~	~~1,369~~	~~2015~~	~~1~~	~~75,658~~	~~3,783~~	
4	Pile Installation	Drill Rig (for installation of Auger Cast piles)	Bore/Drill Rigs	Diesel	1,205	0.5025	4	1,825	2015	1	1,105,060	55,253	
4	Pile Installation	Crawler Cranes	Cranes	Diesel	530	0.2881	4	1,825	2015	1	278,665	13,933	
4	Pile Installation	Large Forklifts	Forklifts	Diesel	93	0.201	2	913	2015	1	17,057	0,853	
4	Pile Installation	Bobcat or small excavators	Rubber Tired Loaders	Diesel	71	0.3618	4	1,825	2015	1	46,880	2,344	
4	Pile Installation	Cutting and chopping saws	Other Construction Equipment	Electric	0	0.4154	4	1,825	2015	1	0	0	
5	Shoring	Drill Rig	Bore/Drill Rigs	Diesel	150	0.5025	2	913	2015	1	68,780	3,439	
5	Shoring	Support Crane	Cranes	Diesel	530	0.2881	2	913	2015	1	139,332	6,967	
5	Shoring	Grout-mixing plant	Other Material Handling Equipment	Diesel	20	0.3953	2	913	2015	1	7,214	0,361	
5	Shoring	Small Excavator	Excavators	Diesel	71	0.3819	2	913	2015	1	24,742	1,237	
5	Shoring	Cut off wall (CDSM) equipment	Bore/Drill Rigs	Diesel	150	0.5025	4	1,217	2015	1	91,706	4,585	
6	Building Construction (including arena)	Concrete Boom Pumps	Other Construction Equipment	Diesel	480	0.4154	2	3,346	2015	1	667,132	33,357	
6	Building Construction (including arena)	Bobcat	Rubber Tired Loaders	Diesel	71	0.3618	2	3,346	2015	1	85,947	4,297	
6	Building Construction (including arena)	Small Excavator	Excavators	Diesel	404	0.3819	2	3,346	2015	1	516,221	25,811	
6	Building Construction (including arena)	Large Excavator	Excavators	Diesel	523	0.3819	2	3,346	2015	1	668,276	33,414	
6	Building Construction (including arena)	Crawler Cranes	Cranes	Diesel	530	0.2881	4	6,083	2015	1	928,882	46,444	
6	Building Construction (including arena)	Mobile Cranes	Cranes	Diesel	530	0.2881	4	6,083	2015	1	928,882	46,444	
6	Building Construction (including arena)	Grandall-type Forklifts	Forklifts	Diesel	93	0.201	8	12,167	2015	1	227,432	11,372	
6	Building Construction (including arena)	Cutting/chopping saws	Other Construction Equipment	Electric	0	0.4154	15	22,813	2015	1	0	0	
6	Building Construction (including arena)	Tile cutting saws	Other Construction Equipment	Electric	0	0.4154	10	7,604	2015	1	0	0	
6	Building Construction (including arena)	Drywall stud impact guns	Other Construction Equipment	Electric	0	0.4154	25	19,010	2015	1	0	0	
6	Building Construction (including arena)	Tower Cranes	Other Construction Equipment	Electric	0	0.4154	4	6,083	2015	1	0	0	
6	Building Construction (including arena)	Tower Cranes	Other Construction Equipment	Electric	0	0.4154	1	1,065	2015	1	0	0	
7	Muni Stop Extension	Digger	Excavators	Diesel	523	0.3819	1	288	2015	1	57,523	2,876	
7	Muni Stop Extension	Backhoe	Tractors/Loaders/Backhoes	Diesel	150	0.3685	2	576	2015	1	31,838	1,592	
7	Muni Stop Extension	Jackhammers	Other Construction Equipment	Diesel	78	0.4154	1	288	2015	1	9,332	467	
7	Muni Stop Extension	Dump truck	Off-Highway Trucks	Diesel	400	0.3819	1	288	2015	1	43,995	2,200	
7	Muni Stop Extension	Truck crane	Cranes	Diesel	530	0.2881	1	288	2015	1	43,976	2,199	
7	Muni Stop Extension	Bobcat	Rubber Tired Loaders	Diesel	71	0.3618	1	288	2015	1	7,398	370	
7	Muni Stop Extension	Saw cutter	Other Construction Equipment	Electric	0	0.4154	2	576	2015	1	0	0	
											2015 Subtotal Project		361,364
											2015 Subtotal Project + Refinements		403,404

Table A4. Fuel Usage of Off-road Construction Diesel Equipment

Phase ID	Phase	Project Equipment	OFFROAD Equipment	Fuel Type	Hp	LF	Quantity	Total Hours	Calendar Year	Constr. Year	Hp-Hour[1]	Fuel Usage[2] (gal)	Fuel Usage Subtotals (gal)
6	Building Construction (including arena)	Concrete Boom Pumps	Other Construction Equipment	Diesel	480	0.4154	2	304	2016	2	60,648	3,032	
6	Building Construction (including arena)	Bobcat	Rubber Tired Loaders	Diesel	71	0.3618	2	3,346	2016	2	85,947	4,297	
6	Building Construction (including arena)	Small Excavator	Excavators	Diesel	404	0.3819	2	3,346	2016	2	516,221	25,811	
6	Building Construction (including arena)	Large Excavator	Excavators	Diesel	523	0.3819	2	304	2016	2	60,752	3,038	
6	Building Construction (including arena)	Crawler Cranes	Cranes	Diesel	530	0.2881	4	2,433	2016	2	371,553	18,578	
6	Building Construction (including arena)	Mobile Cranes	Cranes	Diesel	530	0.2881	4	6,692	2016	2	1,021,771	51,089	
6	Building Construction (including arena)	Grandall-type Forklifts	Forklifts	Diesel	93	0.201	8	14,600	2016	2	272,918	13,646	
6	Building Construction (including arena)	Cutting/chopping saws	Other Construction Equipment	Electric	0	0.4154	15	27,375	2016	2	0	0	
6	Building Construction (including arena)	Tile cutting saws	Other Construction Equipment	Electric	0	0.4154	10	18,250	2016	2	0	0	
6	Building Construction (including arena)	Drywall stud impact guns	Other Construction Equipment	Electric	0	0.4154	25	30,417	2016	2	0	0	
6	Building Construction (including arena)	Tower Cranes	Other Construction Equipment	Electric	0	0.4154	4	7,300	2016	2	0	0	
6	Building Construction (including arena)	Tower Cranes	Other Construction Equipment	Electric	0	0.4154	1	1,825	2016	2	0	0	
												2016 Subtotal[3]	119,490
7	Muni Stop (Variant)	Digger	Excavators	Diesel	523	0.3819	1	192	2015	1	38,349	1,917	
7	Muni Stop (Variant)	Backhoe	Tractors/Loaders/Backhoes	Diesel	150	0.3685	2	384	2015	1	21,226	1,061	
7	Muni Stop (Variant)	Jackhammers	Other Construction Equipment	Diesel	78	0.4154	1	192	2015	1	6,221	311	
7	Muni Stop (Variant)	Dump truck	Off-Highway Trucks	Diesel	400	0.3819	1	192	2015	1	29,330	1,466	
7	Muni Stop (Variant)	Truck crane	Cranes	Diesel	530	0.2881	1	192	2015	1	29,317	1,466	
7	Muni Stop (Variant)	Bobcat	Rubber Tired Loaders	Diesel	71	0.3618	1	192	2015	1	4,932	247	
7	Muni Stop (Variant)	Saw cutter	Other Construction Equipment	Electric	0	0.4154	2	384	2015	1	0	0	
												2015 Muni Variant Subtotal	6,469
												Project Total	480,854
												Project + Refinements Total	522,895
												Project + Refinements + Muni Variant Total	529,364

Notes

1. HP-Hour is the basis for the fuel calculation. HP-Hour is calculated using the following formula:
   HP-Hour = Total Hours x LF x HP
2. Off-road mobile source fuel usage is calculated using a fuel usage rate of 0.05 gallons of diesel per horsepower (HP)-hour, based on SCAQMD CEQA Air Quality Handbook, Table A9 -3E.
3. Subtotal not affected by Refinements.

Abbreviations

Gal: gallon
HP: horsepower
LF: load factor

Sources

SCAQMD CEQA Air Quality Handbook, Table A9-3E.

Table A5. Vehicle Fuel Efficiency Calculation based on EMFAC2011 output

EMFAC2011 Emissions Inventory
Region Type: County
Region: San Francisco
Calendar Year: 2015
Season: Annual
Vehicle Classification: EMFAC2007 Categories

Region	CalYr	Season	Vehicle Class	Fuel	MdlYr	Speed (miles/hr)	Population (vehicles)	VMT (miles/day)	Trips (trips/day)	Fuel_GAS (1000 gallons/day)	Fuel_DSL (1000 gallons/day)	Miles/Gallon
San Francisco	2015	Annual	T6	DSL	Aggregated	Aggregated	5356.469641	306551.7041	0	0	36.40649699	8.42
San Francisco	2015	Annual	T7	DSL	Aggregated	Aggregated	326.0663573	45446.48532	0	0	8.234842665	5.52
San Francisco	2015	Annual	LDA	GAS	Aggregated	Aggregated	266732.4289	8720397.008	1681087.252	399.416799	0	21.83
San Francisco	2015	Annual	LDT1	GAS	Aggregated	Aggregated	25557.41484	812429.3798	157025.5872	43.10195991	0	18.85
San Francisco	2015	Annual	LDT2	GAS	Aggregated	Aggregated	61882.51901	2079479.009	389928.3834	129.8136514	0	16.02