Appendix B

Air Quality and Greenhouse Gases Technical Report

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APPENDIX B

Air Quality and Greenhouse Gases

Technical Report

Prepared by KB Environmental Sciences, Inc

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1.0 Emissions Inventory

This section of Appendix B presents the data, assumptions, and methodology for the criteria pollutant emissions inventories prepared in support of the air quality impacts analysis associated with the proposed San Diego International Airport (SAN) Airfield Improvements and Terminal 1 Replacement Project's Environmental Assessment (EA). The emissions inventories were prepared for the existing year (2018) and future years (2026 and 2031) for the No Action Alternative and the Proposed Project using the best available data at the time of the analysis. The emissions inventories consider volatile organic compounds (VOC), nitrogen oxides (NO_x), particulate matter less than 10 micrometers in diameter (PM_{10}), particulate matter less than 2.5 micrometers in diameter ($PM_{2.5}$), carbon monoxide (CO), and sulfur oxides (SO_x).

The following sections of this appendix provide a detailed discussion of the methodologies used to prepare the air quality analysis and, by emission source, presents the computer model/calculation input data and assumptions.

1.1 Aircraft

Aircraft-related emissions were estimated using the Federal Aviation Administration's (FAA's) Aviation Environmental Design Tool (AEDT) version 2d, by factoring total aircraft operational activity against a database of aircraft/engine-specific emission factors based on engine manufacturer, model, and aircraft operational mode within the landing/takeoff (LTO) cycle. For purposes of an emissions inventory, a LTO cycle consists of the following operational modes:

- *Approach*: The airborne segment of an aircraft's arrival extending from the start of the flight profile (or the mixing height) to touchdown on the runway;
- *Taxi-In*: The landing ground roll segment (from touchdown to the runway exit) of an arriving aircraft, including reverse thrust, and the taxiing from the runway exit to a gate;
- *Startup*: Aircraft main engine startup (for VOC only) occurs at the gate and is considered in AEDT for International Civil Aviation Organization (ICAO) certified engines only;
- *Taxi-Out*: The taxiing from the gate to a runway end;
- *Takeoff*: The portion from the start of the ground roll on the runway, through wheels off, and the airborne portion of the ascent up to cutback during which the aircraft operates at maximum thrust; and
- *Climb Out*: The portion from engine cutback to the end of the flight profile or the mixing height. The AEDT default "mixing height" of 3,000 feet was used in the modeling analysis. Mixing height is defined as the vertical extent in the atmosphere over which pollutants no longer mix downward to ground level.

AEDT's calculation of emissions within the LTO relies on aircraft fleet, operations, and time data specific to each mode of the LTO cycle.

1.1.1 Fleet and Operations

AEDT requires definition of an aircraft fleet (i.e., the types of aircraft using the airport and their assigned engines) and a level of operations (i.e., either arrivals/departures or LTOs) assigned to each member of the aircraft fleet. AEDT can accept varying levels of detail depending on the extent to which aircraft operational parameters at a given airport are available or known.

For this analysis, aircraft activity (i.e., aircraft arrival and departure operations), mode data (i.e., taxi and delay times), as well as airframe engine assignments were based on results from airport and airspace simulation models (SIMMOD), gate schedules, the SAN aviation demand forecast, and AEDT defaults. The aircraft fleet/operational level data used in the air quality analysis are consistent with those used to assess noise impacts associated with the No Action Alternative and the Proposed Project. **Tables B-1** through **B-3** contain the listing of annual aircraft operations (by category, aircraft, engine, operation type, and stage length) for existing conditions (2018) and future conditions (2026 and 2031) with the No Action Alternative and the Proposed Project. Notably, future year operational levels do not change (increase of operations or fleet mix) between the No Action Alternative and the Proposed Project in each of the evaluated years, as projected aircraft activity levels would be consistent under both the No Action Alternative and the Proposed Project.

1.1.2 Emission Factors

AEDT default emission factors were used to estimate all aircraft emissions. AEDT specifically calculates emissions from aircraft taxiing, aircraft engine startup, and usage of auxiliary power units (APUs).

The four methods listed below are used by AEDT to compute airborne aircraft emissions:

- The Boeing Fuel Flow Method 2 (BFFM2) is used to compute NO_x, hydrocarbons (HC), and CO;
- A First Order Approximation (FOA) 3.0 is used to compute particulate matter below the mixing height;
- Fuel composition-based factors are used to compute SO_x, CO_2, water (H_2O), and particulate matter; and
- Derivative factors are used to compute non-methane hydrocarbons (NMHC), VOC, total organic compounds (TOG), and speciated organic gases.

Table B-1: Annual Aircraft Operations for 2018 (Existing Conditions)

Aircraft Group	Type of Aircraft	Airframe	Number of Operations	Op. Type	Engine	AEDT Equip ID	Stage Length
Passenger	Narrowbody	Bombardier CS-100	365	A	PW1524G	5301	1
Passenger	Narrowbody	Airbus A319-100 Series	1,095	A	V2524-A5	4850	1
Passenger	Narrowbody	Airbus A320-200 Series	6,570	A	V2527-A5	1019	1
Passenger	Narrowbody	Airbus A320-NEO	1,095	A	LEAP-1A26/26E1	5314	1
Passenger	Narrowbody	Airbus A321-100 Series	7,300	A	CFM56-5B3/P	1031	1
Passenger	Narrowbody	Airbus A321-NEO	4,015	A	PW1133G-JM	5315	1
Passenger	Narrowbody	Boeing 717-200 Series	730	A	BR700-715A1-30	83	1
Passenger	Narrowbody	Boeing 737-800 MAX	365	A	LEAP-1A35A/AA/33B2/32/30	4129	1
Passenger	Narrowbody	Boeing 737-700 with winglets	29,565	A	CFM56-7B27/3	4131	1
Passenger	Narrowbody	Boeing 737-800 Series	18,615	A	CFM56-7B26/3	2497	1
Passenger	Narrowbody	Boeing 737-900-ER	9,125	A	CFM56-7B26E	4356	1
Passenger	Narrowbody	Boeing 757-200 Series	2,190	A	PW2037	385	1
Passenger	Widebody	Airbus A330-200 Series	365	A	Trent 772	1094	1
Passenger	Regional Jet	Bombardier CRJ-200	730	A	CF34-3B	1250	1
Passenger	Regional Jet	Bombardier CRJ-700	730	A	CF34-8C5B1	2546	1
Passenger	Regional Jet	Embraer ERJ175	13,140	A	CF34-8E5	1771	1
Passenger	Narrowbody	Airbus A321-100 Series	365	A	CFM56-5B3/P	1031	1
Passenger	Narrowbody	Boeing 737-700 with winglets	730	A	CFM56-7B27/3	4131	1
Passenger	Narrowbody	Boeing 737-800 Series	365	A	CFM56-7B26/3	2497	1
Passenger	Narrowbody	Boeing 737-900-ER	365	A	CFM56-7B26E	4356	1
Passenger	Widebody	Boeing 777-200-ER	365	A	Trent 895	4213	1
Passenger	Widebody	B787-8R	365	A	Trent 1000 Pkg B T1000-A/01	3996	1
Passenger	Regional Jet	Bombardier CRJ-900	730	A	CF34-8C5B1	2426	1
Other Air Carrier	Narrowbody	Airbus A319-100 Series	730	A	V2524-A5	4850	1
Other Air Carrier	Narrowbody	Boeing 737-300 Series	1,095	A	CFM563	150	1
Other Air Carrier	Narrowbody	Boeing 737-700 with winglets	365	A	CFM56-7B27/3	4131	1
Other Air Carrier	Narrowbody	Boeing 757-200 Series	730	A	PW2037	385	1
Other Air Carrier	Regional Jet	Bombardier CRJ-700	365	A	CF34-8C5B1	2546	1
Other Air Carrier	Regional Jet	Embraer ERJ190	365	A	CF34-10E5A1	2563	1
Cargo	Narrowbody	Boeing 757-200 Series	365	A	PW2037	385	1
Cargo	Widebody	Boeing 767-200 Series	1,825	A	JT9D-7R4D-7R4D1	437	1
Cargo	Turboprop	Raytheon Beech 99	730	A	PT6A-27	1495	1

Aircraft Group	Type of Aircraft	Airframe	Number of Operations	Op. Type	Engine	AEDT Equip ID	Stage Length
Cargo	Turboprop	Fairchild SA-226-TC Metro II	365	A	TPE331-11U-601G	3125	1
General Aviation	Business Jet multi-engine heavy	Cessna 560 Citation XLS	704	A	BIZMEDIUMJET_F	3634	1
General Aviation	Business Jet multi-engine heavy	Gulfstream G400	704	A	TAY611-8C	1916	1
General Aviation	Business Jet multi-engine heavy	Bombardier Challenger 300	939	A	HTF7350 (AS907-2-1A)	4856	1
General Aviation	Business Jet multi-engine heavy	Bombardier Challenger 350	469	A	HTF7350 (AS907-2-1A)	5345	1
General Aviation	Business Jet multi-engine heavy	Bombardier Challenger 600	469	A	CF34-3B	1237	1
General Aviation	Business Jet multi-engine light plus	Cessna 525B CitationJet	365	A	BIZLIGHTJET_F	3986	1
General Aviation	Business Jet multi-engine light plus	CX 750 Citation X+	365	A	AE3007C2	4249	1
General Aviation	Business Jet multi-engine light plus	Embraer 500	365	A	BIZLIGHTJET_F	3988	1
General Aviation	Business Jet multi-engine light plus	Dassault Falcon 2000	365	A	PW308C Build Spec 1289	4804	1
General Aviation	Business Jet multi-engine light plus	Raytheon Hawker 800	365	A	TFE731-2/2A	3105	1
General Aviation	Single engine	Cessna 172 Skyhawk	243	A	TSIO-360C	3247	1
General Aviation	Single engine	Pilatus PC-12	487	A	PT6A-67B	1489	1
Military	Multi-engine turboprop	Raytheon Super King Air 200	365	A	PT6A-61	3034	1
Helicopter		Robinson R44 Raven / Lycoming O-540-F1B5	182	A	TIO-540-J2B2	3161	1
Passenger	Narrowbody	Airbus A319-100 Series	365	D	V2524-A5	4850	1
Passenger	Narrowbody	Airbus A319-100 Series	365	D	V2524-A5	4850	2
Passenger	Narrowbody	Airbus A319-100 Series	365	D	V2524-A5	4850	3
Passenger	Narrowbody	Airbus A320-200 Series	1,825	D	V2527-A5	1019	1
Passenger	Narrowbody	Airbus A320-200 Series	1,460	D	V2527-A5	1019	2
Passenger	Narrowbody	Airbus A320-200 Series	1,095	D	V2527-A5	1019	3
Passenger	Narrowbody	Airbus A320-200 Series	2,190	D	V2527-A5	1019	4
Passenger	Narrowbody	Airbus A320-NEO	730	D	LEAP-1A26/26E1	5314	1
Passenger	Narrowbody	Airbus A320-NEO	365	D	LEAP-1A26/26E1	5314	4
Passenger	Narrowbody	Airbus A321-100 Series	730	D	CFM56-5B3/P	1031	1

Aircraft Group	Type of Aircraft	Airframe	Number of Operations	Op. Type	Engine	AEDT Equip ID	Stage Length
Passenger	Narrowbody	Airbus A321-100 Series	730	D	CFM56-5B3/P	1031	2
Passenger	Narrowbody	Airbus A321-100 Series	1,460	D	CFM56-5B3/P	1031	3
Passenger	Narrowbody	Airbus A321-100 Series	4,380	D	CFM56-5B3/P	1031	4
Passenger	Narrowbody	Airbus A321-NEO	730	D	PW1133G-JM	5315	1
Passenger	Narrowbody	Airbus A321-NEO	3,285	D	PW1133G-JM	5315	3
Passenger	Narrowbody	Boeing 717-200 Series	365	D	BR700-715A1-30	83	1
Passenger	Narrowbody	Boeing 717-200 Series	730	D	BR700-715A1-30	83	2
Passenger	Narrowbody	Boeing 737-800 MAX	365	D	LEAP-1A35A/AA/33B2/32/30	4129	2
Passenger	Narrowbody	Boeing 737-700 with winglets	19,345	D	CFM56-7B27/3	4131	1
Passenger	Narrowbody	Boeing 737-700 with winglets	5,110	D	CFM56-7B27/3	4131	2
Passenger	Narrowbody	Boeing 737-700 with winglets	3,285	D	CFM56-7B27/3	4131	3
Passenger	Narrowbody	Boeing 737-700 with winglets	1,825	D	CFM56-7B27/3	4131	4
Passenger	Narrowbody	Boeing 737-800 Series	5,110	D	CFM56-7B26/3	2497	1
Passenger	Narrowbody	Boeing 737-800 Series	2,190	D	CFM56-7B26/3	2497	2
Passenger	Narrowbody	Boeing 737-800 Series	4,745	D	CFM56-7B26/3	2497	3
Passenger	Narrowbody	Boeing 737-800 Series	6,205	D	CFM56-7B26/3	2497	4
Passenger	Narrowbody	Boeing 737-900-ER	2,190	D	CFM56-7B26E	4356	1
Passenger	Narrowbody	Boeing 737-900-ER	3,285	D	CFM56-7B26E	4356	2
Passenger	Narrowbody	Boeing 737-900-ER	2,920	D	CFM56-7B26E	4356	3
Passenger	Narrowbody	Boeing 737-900-ER	1,095	D	CFM56-7B26E	4356	4
Passenger	Narrowbody	Boeing 757-200 Series	365	D	PW2037	385	1
Passenger	Narrowbody	Boeing 757-200 Series	1,825	D	PW2037	385	4
Passenger	Widebody	Airbus A330-200 Series	365	D	Trent 772	1094	4
Passenger	Regional Jet	Bombardier CRJ-200	730	D	CF34-3B	1250	1
Passenger	Regional Jet	Bombardier CRJ-700	730	D	CF34-8C5B1	2546	1
Passenger	Regional Jet	Embraer ERJ175	9,125	D	CF34-8E5	1771	1
Passenger	Regional Jet	Embraer ERJ175	1,825	D	CF34-8E5	1771	2
Passenger	Regional Jet	Embraer ERJ175	2,190	D	CF34-8E5	1771	3
Passenger	Narrowbody	Airbus A321-100 Series	365	D	CFM56-5B3/P	1031	4
Passenger	Narrowbody	Boeing 737-700 with winglets	365	D	CFM56-7B27/3	4131	2
Passenger	Narrowbody	Boeing 737-700 with winglets	365	D	CFM56-7B27/3	4131	3

Aircraft Group	Type of Aircraft	Airframe	Number of Operations	Op. Type	Engine	AEDT Equip ID	Stage Length
Passenger	Narrowbody	Boeing 737-800 Series	730	D	CFM56-7B26/3	2497	2
Passenger	Widebody	Boeing 777-200-ER	365	D	Trent 895	4213	7
Passenger	Widebody	B787-8R	365	D	Trent 1000 Pkg B T1000-A/01	3996	7
Passenger	Regional Jet	Bombardier CRJ-900	730	D	CF34-8C5B1	2426	3
Other Air Carrier	Narrowbody	Airbus A319-100 Series	730	D	V2524-A5	4850	4
Other Air Carrier	Narrowbody	Boeing 737-300 Series	365	D	CFM563	150	1
Other Air Carrier	Narrowbody	Boeing 737-300 Series	365	D	CFM563	150	2
Other Air Carrier	Narrowbody	Boeing 737-300 Series	365	D	CFM563	150	3
Other Air Carrier	Narrowbody	Boeing 737-700 with winglets	365	D	CFM56-7B27/3	4131	7
Other Air Carrier	Narrowbody	Boeing 757-200 Series	365	D	PW2037	385	3
Other Air Carrier	Narrowbody	Boeing 757-200 Series	365	D	PW2037	385	7
Other Air Carrier	Regional Jet	Bombardier CRJ-700	365	D	CF34-8C5B1	2546	1
Other Air Carrier	Regional Jet	Embraer ERJ190	365	D	CF34-10E5A1	2563	1
Other Air Taxi	Business Jet multi-engine heavy	Gulfstream V-SP	365	D	BR700-710A1-10	2432	1
Cargo	Narrowbody	Boeing 757-200 Series	365	D	PW2037	385	5
Cargo	Widebody	Boeing 767-200 Series	1,095	D	JT9D-7R4D-7R4D1	437	3
Cargo	Widebody	Boeing 767-200 Series	730	D	JT9D-7R4D-7R4D1	437	4
Cargo	Turboprop	Raytheon Beech 99	730	D	PT6A-27	1495	1
Cargo	Turboprop	Fairchild SA-226-TC Metro II	365	D	TPE331-11U-601G	3125	1
General Aviation	Business Jet multi-engine heavy	Cessna 560 Citation XLS	704	D	BIZMEDIUMJET_F	3634	1
General Aviation	Business Jet multi-engine heavy	Gulfstream G400	704	D	TAY611-8C	1916	1
General Aviation	Business Jet multi-engine heavy	Bombardier Challenger 300	939	D	HTF7350 (AS907-2-1A)	4856	1
General Aviation	Business Jet multi-engine heavy	Bombardier Challenger 350	469	D	HTF7350 (AS907-2-1A)	5345	1
General Aviation	Business Jet multi-engine heavy	Bombardier Challenger 600	469	D	CF34-3B	1237	1
General Aviation	Business Jet multi-engine light plus	Cessna 525B CitationJet	365	D	BIZLIGHTJET_F	3986	1
General Aviation	Business Jet multi-engine light plus	CX 750 Citation X+	219	D	AE3007C2	4249	1
General Aviation	Business Jet multi-	CX 750 Citation X+	146	D	AE3007C2	4249	7

Aircraft Group	Type of Aircraft	Airframe	Number of Operations	Op. Type	Engine	AEDT Equip ID	Stage Length
	engine light plus						
General Aviation	Business Jet multi-engine light plus	Embraer 500	365	D	BIZLIGHTJET_F	3988	1
General Aviation	Business Jet multi-engine light plus	Dassault Falcon 2000	365	D	PW308C Build Spec 1289	4804	1
General Aviation	Business Jet multi-engine light plus	Raytheon Hawker 800	365	D	TFE731-2/2A	3105	1
General Aviation	Single engine	Cessna 172 Skyhawk	122	D	TSIO-360C	3247	1
General Aviation	Single engine	Pilatus PC-12	243	D	PT6A-67B	1489	1
General Aviation	Multi-engine turboprop	Raytheon Super King Air 200	365	D	PT6A-61	3034	1
Military	Multi-engine turboprop	Raytheon Super King Air 200	365	D	PT6A-61	3034	1
Helicopter		Robinson R44 Raven / Lycoming O-540-F1B5	183	D	TIO-540-J2B2	3161	1
Total			**225,570**				

Source: LeighFisher 2019.

Note: A = arrival and D = departure.

Table B-2: Annual Operations for 2026 (Future Conditions) - No Action Alternative and Proposed Project

Aircraft Group	Type of Aircraft	Airframe	Number of Operations	Op. Type	Engine	AEDT Equip ID	Stage Length
Passenger	Narrowbody	Bombardier CS-100	1,095	A	PW1524G	5301	1
Passenger	Narrowbody	Bombardier CS-100	730	A	PW1524G	5301	1
Passenger	Narrowbody	Airbus A319-100 Series	1,825	A	V2524-A5	4850	1
Passenger	Narrowbody	Airbus A320-200 Series	12,045	A	V2527-A5	1019	1
Passenger	Narrowbody	Airbus A320-NEO	2,190	A	LEAP-1A26/26E1	5314	1
Passenger	Narrowbody	Airbus A321-100 Series	12,775	A	CFM56-5B3/P	1031	1
Passenger	Narrowbody	Airbus A321-NEO	5,840	A	PW1133G-JM	5315	1
Passenger	Narrowbody	Boeing 717-200 Series	365	A	BR700-715A1-30	83	1
Passenger	Narrowbody	Boeing 737-800 MAX	730	A	LEAP-1A35A/AA/33B2/32/30	4129	1
Passenger	Narrowbody	Boeing 737-700 with winglets	33,215	A	CFM56-7B27/3	4131	1
Passenger	Narrowbody	Boeing 737-800 Series	20,805	A	CFM56-7B26/3	2497	1
Passenger	Narrowbody	Boeing 737-900-ER	12,775	A	CFM56-7B26E	4356	1
Passenger	Narrowbody	Boeing 757-200 Series	1,460	A	PW2037	385	1

Aircraft Group	Type of Aircraft	Airframe	Number of Operations	Op. Type	Engine	AEDT Equip ID	Stage Length
Passenger	Widebody	Airbus A330-200 Series	365	A	Trent 772	1094	1
Passenger	Regional Jet	Embraer ERJ175	6,205	A	CF34-8E5	1771	1
Passenger	Narrowbody	Airbus A320-200 Series	365	A	V2527-A5	1019	1
Passenger	Narrowbody	Airbus A321-100 Series	365	A	CFM56-5B3/P	1031	1
Passenger	Narrowbody	Boeing 737-700 with winglets	1,095	A	CFM56-7B27/3	4131	1
Passenger	Narrowbody	Boeing 737-800 Series	1,095	A	CFM56-7B26/3	2497	1
Passenger	Narrowbody	Boeing 737-900-ER	1,095	A	CFM56-7B26E	4356	1
Passenger	Widebody	Airbus A340-300 Series	365	A	CFM56-5C4	1142	1
Passenger	Widebody	Boeing 777-200 ER	365	A	Trent 895	4213	1
Passenger	Widebody	B787-8R	730	A	Trent 1000 Pkg B T1000-A/01	3996	1
Passenger	Widebody	Boeing 787-900 Dreamliner	365	A	Trent 1000-A	4860	1
Passenger	Regional Jet	Bombardier CRJ-900	365	A	CF34-8C5B1	2426	1
Passenger	Regional Jet	Embraer ERJ175	1,095	A	CF34-8E5	1771	1
Other Air Carrier	Regional Jet	Bombardier CRJ-700	365	A	CF34-8C5B1	2546	1
Other Air Taxi	Business Jet multi-engine heavy	Gulfstream V-SP	365	A	BR700-710A1-10	2432	1
Cargo	Narrowbody	Boeing 757-200 Series	365	A	PW2037	385	1
Cargo	Widebody	Boeing 767-200 Series	1,825	A	JT9D-7R4D-7R4D1	437	1
Cargo	Turboprop	Raytheon Beech 99	730	A	PT6A-27	1495	1
Cargo	Turboprop	Fairchild SA-226-TC Metro II	730	A	TPE331-11U-601G	3125	1
General Aviation	Business Jet multi-engine heavy	Cessna 560 Citation XLS	449	A	BIZMEDIUMJET_F	3634	1
General Aviation	Business Jet multi-engine heavy	Gulfstream G400	674	A	TAY611-8C	1916	1
General Aviation	Business Jet multi-engine heavy	Bombardier Challenger 300	449	A	HTF7350 (AS907-2-1A)	4856	1
General Aviation	Business Jet multi-engine heavy	Bombardier Challenger 350	449	A	HTF7350 (AS907-2-1A)	5345	1
General Aviation	Business Jet multi-engine heavy	Bombardier Challenger 600	449	A	CF34-3B	1237	1
General Aviation	Business Jet multi-engine heavy	Gulfstream V-SP	449	A	BR700-710A1-10	2432	1
General Aviation	Business Jet multi-engine light plus	Cessna 525B CitationJet	365	A	BIZLIGHTJET_F	3986	1
General Aviation	Business Jet multi-	CX 750 Citation X+	365	A	AE3007C2	4249	1

Aircraft Group	Type of Aircraft	Airframe	Number of Operations	Op. Type	Engine	AEDT Equip ID	Stage Length
	engine light plus						
General Aviation	Business Jet multi-engine light plus	Dassault Falcon 2000	365	A	PW308C Build Spec 1289	4804	1
General Aviation	Business Jet multi-engine light plus	Raytheon Hawker 800	365	A	TFE731-2/2A	3105	1
General Aviation	Single engine	Pilatus PC-12	365	A	PT6A-67B	1489	1
Military	Multi-engine turboprop	Raytheon Super King Air 200	365	A	PT6A-61	3034	1
Helicopter		Robinson R44 Raven/Lycoming O-540-F1B5	182	A	TIO-540-J2B2	3161	1
Passenger	Narrowbody	Bombardier CS-100	365	D	PW1524G	5301	1
Passenger	Narrowbody	Bombardier CS-100	730	D	PW1524G	5301	2
Passenger	Narrowbody	Bombardier CS-100	730	D	PW1524G	5301	3
Passenger	Narrowbody	Airbus A319-100 Series	730	D	V2524-A5	4850	1
Passenger	Narrowbody	Airbus A319-100 Series	730	D	V2524-A5	4850	2
Passenger	Narrowbody	Airbus A319-100 Series	365	D	V2524-A5	4850	3
Passenger	Narrowbody	Airbus A320-200 Series	2,920	D	V2527-A5	1019	1
Passenger	Narrowbody	Airbus A320-200 Series	3,285	D	V2527-A5	1019	2
Passenger	Narrowbody	Airbus A320-200 Series	3,285	D	V2527-A5	1019	3
Passenger	Narrowbody	Airbus A320-200 Series	2,555	D	V2527-A5	1019	4
Passenger	Narrowbody	Airbus A320-NEO	1,095	D	LEAP-1A26/26E1	5314	1
Passenger	Narrowbody	Airbus A320-NEO	365	D	LEAP-1A26/26E1	5314	3
Passenger	Narrowbody	Airbus A320-NEO	730	D	LEAP-1A26/26E1	5314	4
Passenger	Narrowbody	Airbus A321-100 Series	1,460	D	CFM56-5B3/P	1031	1
Passenger	Narrowbody	Airbus A321-100 Series	730	D	CFM56-5B3/P	1031	2
Passenger	Narrowbody	Airbus A321-100 Series	3,285	D	CFM56-5B3/P	1031	3
Passenger	Narrowbody	Airbus A321-100 Series	7,300	D	CFM56-5B3/P	1031	4
Passenger	Narrowbody	Airbus A321-NEO	1,460	D	PW1133G-JM	5315	1
Passenger	Narrowbody	Airbus A321-NEO	3,650	D	PW1133G-JM	5315	3
Passenger	Narrowbody	Airbus A321-NEO	730	D	PW1133G-JM	5315	4
Passenger	Narrowbody	Boeing 717-200 Series	365	D	BR700-715A1-30	83	2
Passenger	Narrowbody	Boeing 737-800 MAX	365	D	LEAP-1A35A/AA/33B2/32/30	4129	2
Passenger	Narrowbody	Boeing 737-800 MAX	365	D	LEAP-1A35A/AA/33B2/32/30	4129	3

Aircraft Group	Type of Aircraft	Airframe	Number of Operations	Op. Type	Engine	AEDT Equip ID	Stage Length
Passenger	Narrowbody	Boeing 737-700 with winglets	21,902	D	CFM56-7B27/3	4131	1
Passenger	Narrowbody	Boeing 737-700 with winglets	5,475	D	CFM56-7B27/3	4131	2
Passenger	Narrowbody	Boeing 737-700 with winglets	3,650	D	CFM56-7B27/3	4131	3
Passenger	Narrowbody	Boeing 737-700 with winglets	2,190	D	CFM56-7B27/3	4131	4
Passenger	Narrowbody	Boeing 737-800 Series	5,475	D	CFM56-7B26/3	2497	1
Passenger	Narrowbody	Boeing 737-800 Series	2,555	D	CFM56-7B26/3	2497	2
Passenger	Narrowbody	Boeing 737-800 Series	4,380	D	CFM56-7B26/3	2497	3
Passenger	Narrowbody	Boeing 737-800 Series	8,030	D	CFM56-7B26/3	2497	4
Passenger	Narrowbody	Boeing 737-900-ER	2,555	D	CFM56-7B26E	4356	1
Passenger	Narrowbody	Boeing 737-900-ER	3,285	D	CFM56-7B26E	4356	2
Passenger	Narrowbody	Boeing 737-900-ER	4,015	D	CFM56-7B26E	4356	3
Passenger	Narrowbody	Boeing 737-900-ER	3,285	D	CFM56-7B26E	4356	4
Passenger	Narrowbody	Boeing 757-200 Series	1,460	D	PW2037	385	4
Passenger	Widebody	Airbus A330-200 Series	365	D	Trent 772	1094	4
Passenger	Regional Jet	Embraer ERJ175	4,015	D	CF34-8E5	1771	1
Passenger	Regional Jet	Embraer ERJ175	1,095	D	CF34-8E5	1771	2
Passenger	Regional Jet	Embraer ERJ175	1,095	D	CF34-8E5	1771	3
Passenger	Narrowbody	Airbus A320-200 Series	365	D	V2527-A5	1019	2
Passenger	Narrowbody	Airbus A321-100 Series	365	D	CFM56-5B3/P	1031	4
Passenger	Narrowbody	Boeing 737-700 with winglets	365	D	CFM56-7B27/3	4131	2
Passenger	Narrowbody	Boeing 737-700 with winglets	365	D	CFM56-7B27/3	4131	3
Passenger	Narrowbody	Boeing 737-700 with winglets	365	D	CFM56-7B27/3	4131	4
Passenger	Narrowbody	Boeing 737-800 Series	730	D	CFM56-7B26/3	2497	2
Passenger	Narrowbody	Boeing 737-800 Series	730	D	CFM56-7B26/3	2497	3
Passenger	Narrowbody	Boeing 737-900-ER	730	D	CFM56-7B26E	4356	2
Passenger	Widebody	Airbus A340-300 Series	365	D	CFM56-5C4	1142	7
Passenger	Widebody	Boeing 777-200 ER	365	D	Trent 895	4213	7
Passenger	Widebody	B787-8R	730	D	Trent 1000 Pkg B T1000-A/01	3996	7
Passenger	Widebody	Boeing 787-900 Dreamliner	365	D	Trent 1000-A	4860	7
Passenger	Regional Jet	Bombardier CRJ-900	365	D	CF34-8C5B1	2426	3
Passenger	Regional Jet	Embraer ERJ175	1,095	D	CF34-8E5	1771	3

Aircraft Group	Type of Aircraft	Airframe	Number of Operations	Op. Type	Engine	AEDT Equip ID	Stage Length
Other Air Taxi	Business Jet multi-engine heavy	Gulfstream V-SP	365	D	BR700-710A1-10	2432	1
Cargo	Narrowbody	Boeing 757-200 Series	365	D	PW2037	385	4
Cargo	Widebody	Boeing 767-200 Series	1,095	D	JT9D-7R4D-7R4D1	437	3
Cargo	Widebody	Boeing 767-200 Series	730	D	JT9D-7R4D-7R4D1	437	4
Cargo	Turboprop	Raytheon Beech 99	730	D	PT6A-27	1495	1
Cargo	Turboprop	Fairchild SA-226-TC Metro II	730	D	TPE331-11U-601G	3125	1
General Aviation	Business Jet multi-engine heavy	Cessna 560 Citation XLS	449	D	BIZMEDIUMJET_F	3634	1
General Aviation	Business Jet multi-engine heavy	Gulfstream G400	674	D	TAY611-8C	1916	1
General Aviation	Business Jet multi-engine heavy	Bombardier Challenger 300	449	D	HTF7350 (AS907-2-1A)	4856	1
General Aviation	Business Jet multi-engine heavy	Bombardier Challenger 350	449	D	HTF7350 (AS907-2-1A)	5345	1
General Aviation	Business Jet multi-engine heavy	Bombardier Challenger 600	449	D	CF34-3B	1237	1
General Aviation	Business Jet multi-engine heavy	Gulfstream V-SP	449	D	BR700-710A1-10	2432	1
General Aviation	Business Jet multi-engine light plus	Cessna 525B CitationJet	365	D	BIZLIGHTJET_F	3986	1
General Aviation	Business Jet multi-engine light plus	CX 750 Citation X+	274	D	AE3007C2	4249	1
General Aviation	Business Jet multi-engine light plus	CX 750 Citation X+	91	D	AE3007C2	4249	7
General Aviation	Business Jet multi-engine light plus	Dassault Falcon 2000	365	D	PW308C Build Spec 1289	4804	1
General Aviation	Business Jet multi-engine light plus	Raytheon Hawker 800	365	D	TFE731-2/2A	3105	1
General Aviation	Single engine	Pilatus PC-12	365	D	PT6A-67B	1489	1
General Aviation	Multi-engine turboprop	Raytheon Super King Air 200	365	D	PT6A-61	3034	1
Military	Multi-engine turboprop	Raytheon Super King Air 200	365	D	PT6A-61	3034	1
Helicopter		Robinson R44 Raven/Lycoming O-540-F1B5	183	D	TIO-540-J2B2	3161	1
Total			**258,785**				

Source: LeighFisher 2019.

Note: A = arrival and D = departure.

Table B-3: Annual Operations for 2031 (Future Conditions) - No Action Alternative and Proposed Project

Aircraft Group	Type of Aircraft	Airframe	Number of Operations	Op Type	Engine	AEDT Equip ID	Stage Length
Passenger	Narrowbody	Bombardier CS-100	3,285	A	PW1524G	5301	1
Passenger	Narrowbody	Bombardier CS-100	1,095	A	PW1524G	5301	1
Passenger	Narrowbody	Airbus A320-200 Series	7,665	A	V2527-A5	1019	1
Passenger	Narrowbody	Airbus A320-NEO	2,190	A	LEAP-1A26/26E1	5314	1
Passenger	Narrowbody	Airbus A321-100 Series	16,060	A	CFM56-5B3/P	1031	1
Passenger	Narrowbody	Airbus A321-NEO	9,490	A	PW1133G-JM	5315	1
Passenger	Narrowbody	Boeing 737-700 MAX	4,015	A	LEAP-1A35A/AA/33B2/32/30	4128	1
Passenger	Narrowbody	Boeing 737-800 MAX	2,190	A	LEAP-1A35A/AA/33B2/32/30	4129	1
Passenger	Narrowbody	Boeing 737-700 with winglets	21,900	A	CFM56-7B27/3	4131	1
Passenger	Narrowbody	Boeing 737-800 Series	25,550	A	CFM56-7B26/3	2497	1
Passenger	Narrowbody	Boeing 737-900-ER	21,900	A	CFM56-7B26E	4356	1
Passenger	Narrowbody	Boeing 757-200 Series	730	A	PW2037	385	1
Passenger	Widebody	Airbus A330-200 Series	365	A	Trent 772	1094	1
Passenger	Regional Jet	Embraer ERJ175	1,460	A	CF34-8E5	1771	1
Passenger	Narrowbody	Airbus A320-200 Series	365	A	V2527-A5	1019	1
Passenger	Narrowbody	Airbus A321-100 Series	365	A	CFM56-5B3/P	1031	1
Passenger	Narrowbody	Boeing 737-800 MAX	365	A	LEAP-1A35A/AA/33B2/32/30	4129	1
Passenger	Narrowbody	Boeing 737-700 with winglets	365	A	CFM56-7B27/3	4131	1
Passenger	Narrowbody	Boeing 737-800 Series	1,825	A	CFM56-7B26/3	2497	1
Passenger	Narrowbody	Boeing 737-900-ER	1,460	A	CFM56-7B26E	4356	1
Passenger	Widebody	Airbus A340-300 Series	365	A	CFM56-5C4	1142	1
Passenger	Widebody	Boeing 777-200 ER	365	A	Trent 895	4213	1
Passenger	Widebody	B787-8R	730	A	Trent 1000 Pkg B T1000-A/01	3996	1
Passenger	Widebody	Boeing 787-900 Dreamliner	730	A	Trent 1000-A	4860	1
Passenger	Regional Jet	Bombardier CRJ-900	365	A	CF34-8C5B1	2426	1
Passenger	Regional Jet	Embraer ERJ175	1,095	A	CF34-8E5	1771	1
Other Air Taxi	Business Jet multi-engine heavy	Gulfstream V-SP	365	A	BR700-710A1-10	2432	1
Cargo	Narrowbody	Boeing 757-200 Series	365	A	PW2037	385	1
Cargo	Widebody	Boeing 767-200 Series	2,190	A	JT9D-7R4D-7R4D1	437	1
Cargo	Turboprop	Raytheon Beech 99	1,095	A	PT6A-27	1495	1

Aircraft Group	Type of Aircraft	Airframe	Number of Operations	Op Type	Engine	AEDT Equip ID	Stage Length
Cargo	Turboprop	Fairchild SA-226-TC Metro II	730	A	TPE331-11U-601G	3125	1
General Aviation	Business Jet multi-engine heavy	Cessna 560 Citation XLS	449	A	BIZMEDIUMJET_F	3634	1
General Aviation	Business Jet multi-engine heavy	Gulfstream G400	674	A	TAY611-8C	1916	1
General Aviation	Business Jet multi-engine heavy	Bombardier Challenger 300	449	A	HTF7350 (AS907-2-1A)	4856	1
General Aviation	Business Jet multi-engine heavy	Bombardier Challenger 350	449	A	HTF7350 (AS907-2-1A)	5345	1
General Aviation	Business Jet multi-engine heavy	Bombardier Challenger 600	449	A	CF34-3B	1237	1
General Aviation	Business Jet multi-engine heavy	Gulfstream V-SP	449	A	BR700-710A1-10	2432	1
General Aviation	Business Jet multi-engine light plus	Cessna 525B Citation Jet	365	A	BIZLIGHTJET_F	3986	1
General Aviation	Business Jet multi-engine light plus	CX 750 Citation X+	365	A	AE3007C2	4249	1
General Aviation	Business Jet multi-engine light plus	Dassault Falcon 2000	365	A	PW308C Build Spec 1289	4804	1
General Aviation	Business Jet multi-engine light plus	Raytheon Hawker 800	365	A	TFE731-2/2A	3105	1
Military	Multi-engine turboprop	Raytheon Super King Air 200	365	A	PT6A-61	3034	1
Helicopter		Robinson R44 Raven/Lycoming O-540-F1B5	182	A	TIO-540-J2B2	3161	1
Passenger	Narrowbody	Bombardier CS-100	1,825	D	PW1524G	5301	1
Passenger	Narrowbody	Bombardier CS-100	1,460	D	PW1524G	5301	2
Passenger	Narrowbody	Bombardier CS-100	365	D	PW1524G	5301	2
Passenger	Narrowbody	Bombardier CS-100	730	D	PW1524G	5301	3
Passenger	Narrowbody	Airbus A320-200 Series	2,555	D	V2527-A5	1019	1
Passenger	Narrowbody	Airbus A320-200 Series	1,825	D	V2527-A5	1019	2
Passenger	Narrowbody	Airbus A320-200 Series	1,825	D	V2527-A5	1019	3
Passenger	Narrowbody	Airbus A320-200 Series	1,460	D	V2527-A5	1019	4
Passenger	Narrowbody	Airbus A320-NEO	1,095	D	LEAP-1A26/26E1	5314	1
Passenger	Narrowbody	Airbus A320-NEO	365	D	LEAP-1A26/26E1	5314	3
Passenger	Narrowbody	Airbus A320-NEO	730	D	LEAP-1A26/26E1	5314	4
Passenger	Narrowbody	Airbus A321-100 Series	1,460	D	CFM56-5B3/P	1031	1

Aircraft Group	Type of Aircraft	Airframe	Number of Operations	Op Type	Engine	AEDT Equip ID	Stage Length
Passenger	Narrowbody	Airbus A321-100 Series	1,825	D	CFM56-5B3/P	1031	2
Passenger	Narrowbody	Airbus A321-100 Series	4,380	D	CFM56-5B3/P	1031	3
Passenger	Narrowbody	Airbus A321-100 Series	8,395	D	CFM56-5B3/P	1031	4
Passenger	Narrowbody	Airbus A321-NEO	2,920	D	PW1133G-JM	5315	1
Passenger	Narrowbody	Airbus A321-NEO	730	D	PW1133G-JM	5315	2
Passenger	Narrowbody	Airbus A321-NEO	4,745	D	PW1133G-JM	5315	3
Passenger	Narrowbody	Airbus A321-NEO	730	D	PW1133G-JM	5315	4
Passenger	Narrowbody	Boeing 737-700 MAX	2,920	D	LEAP-1A35A/AA/33B2/32/30	4128	1
Passenger	Narrowbody	Boeing 737-700 MAX	365	D	LEAP-1A35A/AA/33B2/32/30	4128	2
Passenger	Narrowbody	Boeing 737-700 MAX	730	D	LEAP-1A35A/AA/33B2/32/30	4128	4
Passenger	Narrowbody	Boeing 737-800 MAX	1,460	D	LEAP-1A35A/AA/33B2/32/30	4129	1
Passenger	Narrowbody	Boeing 737-800 MAX	365	D	LEAP-1A35A/AA/33B2/32/30	4129	2
Passenger	Narrowbody	Boeing 737-800 MAX	365	D	LEAP-1A35A/AA/33B2/32/30	4129	3
Passenger	Narrowbody	Boeing 737-700 with winglets	14,235	D	CFM56-7B27/3	4131	1
Passenger	Narrowbody	Boeing 737-700 with winglets	4,015	D	CFM56-7B27/3	4131	2
Passenger	Narrowbody	Boeing 737-700 with winglets	2,190	D	CFM56-7B27/3	4131	3
Passenger	Narrowbody	Boeing 737-700 with winglets	1,095	D	CFM56-7B27/3	4131	4
Passenger	Narrowbody	Boeing 737-800 Series	8,030	D	CFM56-7B26/3	2497	1
Passenger	Narrowbody	Boeing 737-800 Series	4,015	D	CFM56-7B26/3	2497	2
Passenger	Narrowbody	Boeing 737-800 Series	6,935	D	CFM56-7B26/3	2497	3
Passenger	Narrowbody	Boeing 737-800 Series	6,935	D	CFM56-7B26/3	2497	4
Passenger	Narrowbody	Boeing 737-900-ER	5,110	D	CFM56-7B26E	4356	1
Passenger	Narrowbody	Boeing 737-900-ER	4,380	D	CFM56-7B26E	4356	2
Passenger	Narrowbody	Boeing 737-900-ER	5,475	D	CFM56-7B26E	4356	3
Passenger	Narrowbody	Boeing 737-900-ER	7,300	D	CFM56-7B26E	4356	4
Passenger	Narrowbody	Boeing 757-200 Series	730	D	PW2037	385	4
Passenger	Widebody	Airbus A330-200 Series	365	D	Trent 772	1094	4
Passenger	Regional Jet	Embraer ERJ175	1,095	D	CF34-8E5	1771	1
Passenger	Regional Jet	Embraer ERJ175	365	D	CF34-8E5	1771	2
Passenger	Narrowbody	Airbus A320-200 Series	365	D	V2527-A5	1019	2
Passenger	Narrowbody	Airbus A321-100 Series	365	D	CFM56-5B3/P	1031	4

Aircraft Group	Type of Aircraft	Airframe	Number of Operations	Op Type	Engine	AEDT Equip ID	Stage Length
Passenger	Narrowbody	Boeing 737-800 MAX	365	D	LEAP-1A35A/AA/33B2/32/30	4129	3
Passenger	Narrowbody	Boeing 737-700 with winglets	365	D	CFM56-7B27/3	4131	2
Passenger	Narrowbody	Boeing 737-700 with winglets	365	D	CFM56-7B27/3	4131	4
Passenger	Narrowbody	Boeing 737-800 Series	365	D	CFM56-7B26/3	2497	2
Passenger	Narrowbody	Boeing 737-800 Series	730	D	CFM56-7B26/3	2497	3
Passenger	Narrowbody	Boeing 737-800 Series	365	D	CFM56-7B26/3	2497	4
Passenger	Narrowbody	Boeing 737-900-ER	1,095	D	CFM56-7B26E	4356	2
Passenger	Narrowbody	Boeing 737-900-ER	365	D	CFM56-7B26E	4356	3
Passenger	Widebody	Airbus A340-300 Series	365	D	CFM56-5C4	1142	7
Passenger	Widebody	Boeing 777-200 ER	365	D	Trent 895	4213	7
Passenger	Widebody	B787-8R	730	D	Trent 1000 Pkg B T1000-A/01	3996	7
Passenger	Widebody	Boeing 787-900 Dreamliner	365	D	Trent 1000-A	4860	7
Passenger	Widebody	Boeing 787-900 Dreamliner	365	D	Trent 1000-A	4860	9
Passenger	Regional Jet	Bombardier CRJ-900	365	D	CF34-8C5B1	2426	3
Passenger	Regional Jet	Embraer ERJ175	1,095	D	CF34-8E5	1771	3
Other Air Taxi	Business Jet multi-engine heavy	Gulfstream V-SP	365	D	BR700-710A1-10	2432	1
Cargo	Narrowbody	Boeing 757-200 Series	365	D	PW2037	385	4
Cargo	Widebody	Boeing 767-200 Series	1,460	D	JT9D-7R4D-7R4D1	437	3
Cargo	Widebody	Boeing 767-200 Series	730	D	JT9D-7R4D-7R4D1	437	4
Cargo	Turboprop	Raytheon Beech 99	1,095	D	PT6A-27	1495	1
Cargo	Turboprop	Fairchild SA-226-TC Metro II	730	D	TPE331-11U-601G	3125	1
General Aviation	Business Jet multi-engine heavy	Cessna 560 Citation XLS	449	D	BIZMEDIUMJET_F	3634	1
General Aviation	Business Jet multi-engine heavy	Gulfstream G400	674	D	TAY611-8C	1916	1
General Aviation	Business Jet multi-engine heavy	Bombardier Challenger 300	449	D	HTF7350 (AS907-2-1A)	4856	1
General Aviation	Business Jet multi-engine heavy	Bombardier Challenger 350	449	D	HTF7350 (AS907-2-1A)	5345	1
General Aviation	Business Jet multi-engine heavy	Bombardier Challenger 600	449	D	CF34-3B	1237	1
General Aviation	Business Jet multi-engine heavy	Gulfstream V-SP	449	D	BR700-710A1-10	2432	1

Aircraft Group	Type of Aircraft	Airframe	Number of Operations	Op Type	Engine	AEDT Equip ID	Stage Length
General Aviation	Business Jet multi-engine light plus	Cessna 525B Citation Jet	365	D	BIZLIGHTJET_F	3986	1
General Aviation	Business Jet multi-engine light plus	CX 750 Citation X+	365	D	AE3007C2	4249	1
General Aviation	Business Jet multi-engine light plus	Dassault Falcon 2000	365	D	PW308C Build Spec 1289	4804	1
General Aviation	Business Jet multi-engine light plus	Raytheon Hawker 800	365	D	TFE731-2/2A	3105	1
General Aviation	Multi-engine turboprop	Raytheon Super King Air 200	365	D	PT6A-61	3034	1
Military	Multi-engine turboprop	Raytheon Super King Air 200	365	D	PT6A-61	3034	1
Helicopter		Robinson R44 Raven/Lycoming O-540-F1B5	183	D	TIO-540-J2B2	3161	1
Total			**272,288**				

Source: LeighFisher 2020.
Note: A = arrival and D = departure.

1.1.3 Taxi/Delay

Taxi/delay emissions are based on airport-wide taxi times. **Table B-4** shows the taxi/delay times estimated for SAN and used to prepare the emissions inventories.

Table B-4: Aircraft Taxi/Delay Times for Existing, No Action Alternative, and Proposed Project (minutes)

Year	Scenario	Taxi-in	Taxi-out	Total
2018	Existing	4.2	16.9	21.0
2026	No Action Alternative	4.8	17.6	22.4
	Proposed Project	4.7	15.1	19.8
2031	No Action Alternative	5.0	20.6	25.5
	Proposed Project	4.9	16.9	21.8

Source: CDM Smith and KB Environmental Sciences, Inc., 2019/2020.
Notes:
Totals are subject to rounding.
Airport-specific, ground-based TIM (time-in-mode) for taxi-in, taxi-out and ground delay times were derived from the SIMMOD analysis.

1.1.4 Startup

APU and aircraft startup emissions were also estimated using AEDT defaults. Startup emissions estimated by AEDT include total hydrocarbons (THC), NMHC, VOC, and TOG. Because all passenger-related aircraft gates at SAN are currently equipped with 400 hertz (Hz) electric power (i.e., "ground power") and preconditioned air (PCA) and following FAA's Air Quality Handbook, the analysis assumed APU usage for passenger-related aircraft was seven minutes. For all other aircraft, APU run times were assumed to be AEDT defaults.

1.1.5 Temporal Factors

Temporal factors (also referred to as profiles) are used to describe the relationship of activity levels in one period of time to another (i.e., the relationship of the activity during a 15-minute period to the activity during a 24-hour period). Temporal factors represent a fraction to the peak period. Thus, annual operations can be represented as a weekly, daily, and quarter hour activity. The use of temporal factors gives the model the ability to more accurately reflect real world conditions.

Aircraft temporal profiles that reflect the variation in operations by month, day, and quarter hour were derived from gate schedules developed in support of the proposed SAN Airfield Improvements and Terminal 1 Replacement Project. **Tables B-5** through **B-7** present the aircraft operational temporal factors for monthly, daily, and quarter hourly operations, respectively.

Table B-5: Monthly Operational Profiles for Aircraft

Month	All Aircraft
January	0.85
February	0.74
March	0.90
April	0.92
May	0.91
June	0.95
July	1.00
August	0.98
September	0.90
October	0.93
November	0.89
December	0.90

Source: KB Environmental Sciences, Inc., 2019/2020.

Table B-6: Daily Operational Profiles for Aircraft

Day	All Aircraft
Monday	0.99
Tuesday	0.95
Wednesday	0.96
Thursday	0.99
Friday	1.00
Saturday	0.83
Sunday	0.93

Source: KB Environmental Sciences, Inc., 2019/2020.

Table B-7: Quarter Hourly Operational Profiles for Aircraft

Time	Operational Profile	Time	Operational Profile	Time	Operational Profile
0:00	0.03	8:15	0.86	16:45	0.77
0:15	0.03	8:30	0.86	17:00	0.81
0:30	0.03	9:00	0.81	17:15	0.81
0:45	0.03	9:15	0.81	17:30	0.81
1:00	0.01	9:30	0.81	18:15	0.74
1:15	0.01	9:45	0.81	18:30	0.74
1:30	0.01	10:00	1.00	18:45	0.74
1:45	0.01	10:15	1.00	19:00	0.81
2:00	0.00	10:30	1.00	19:15	0.81
2:15	0.00	10:45	1.00	19:30	0.81
2:30	0.00	11:00	0.93	19:45	0.81
2:45	0.00	11:15	0.93	20:00	0.70
3:00	0.00	11:30	0.93	20:15	0.70
3:15	0.00	11:45	0.93	20:30	0.70
3:30	0.00	12:00	0.90	20:45	0.70
3:45	0.00	12:15	0.90	21:00	0.67
4:00	0.01	12:30	0.90	21:15	0.67

Time	Operational Profile	Time	Operational Profile	Time	Operational Profile
4:15	0.01	12:45	0.90	21:30	0.67
4:30	0.01	13:00	0.84	21:45	0.67
4:45	0.01	13:15	0.84	22:00	0.72
5:00	0.04	13:30	0.84	22:15	0.72
5:15	0.04	13:45	0.84	22:30	0.72
5:30	0.04	14:00	0.83	22:45	0.72
5:45	0.04	14:15	0.83	23:00	0.33
6:00	0.60	14:30	0.83	23:15	0.33
6:15	0.60	14:45	0.83	23:30	0.33
6:30	0.60	15:00	0.81	23:45	0.33
6:45	0.60	15:15	0.81		
7:00	0.83	15:30	0.81		
7:15	0.83	15:45	0.81		
7:30	0.83	16:00	0.77		
7:45	0.83	16:15	0.77		
8:00	0.86	16:30	0.77		
8:45	0.86	17:45	0.81		
9:00	0.81	18:00	0.74		

Source: KB Environmental Sciences, Inc., 2019/2020.

1.2 Ground Support Equipment

Ground support equipment (GSE) are vehicles and equipment that is used to support airport activities. The types of GSE that service aircraft include baggage tractors, belt loaders, and cabin service trucks. These GSE can be either tenant or airport owned. The airport-owned GSE can include police, fire, operations, and maintenance vehicles. Air pollutant emissions resulting from the operation of GSE vary depending on the type of equipment, fuel type (e.g., gasoline, diesel, propane, electric), and the duration of equipment operation (engine run time).

The GSE fleet inventory was provided by San Diego County Regional Airport Authority (SDCRAA) for the existing year 2018 and forecast for 2026 and 2031 with and without the Proposed Project based on expected fleet turnover. The data provided (**Tables B-8** through **B-12**) included the number and type of GSE and fuel type. As shown, there would be a significant shift from diesel and gasoline equipment to electric and alternative fuel equipment with the Proposed Project. These numbers are based on the signed agreement between the SDCRAA and the airlines,[1] which contain two conditions that state:

- By July 2024, all gasoline-fueled baggage tugs, belt loaders, utility carts, maintenance lifts, and pushback tugs at SAN would be replaced with electric GSE and all diesel-fueled GSE at SAN would convert to renewable diesel.

[1] San Diego County Regional Airport Authority, Example Alternative Fuel Vehicles and Vehicle Age Agreement, (i.e., separate Agreement with each airline) July 2019. Available: www.san.org/plan.

- All GSE shall be less than 13years old from their original manufactured date, unless they are zero-emission or U.S. Environmental Protection Agency (USEPA) Tier IV (or higher) emission standards.

The airport will provide adequate electric vehicle charging infrastructure to meet the demand for electric vehicles of airlines and their ground handling contractors.

Equipment usage levels were based on AEDT default annual hours and emission factors were obtained from California Air Resources Board's (CARB) OFFROAD model. OFFROAD does not provide emission factors for biodiesel or renewable diesel; therefore, appropriate engineering assumptions were applied, where applicable, based on data and information from the U.S. Department of Energy Alternative Fuels Data Center.[2]

The formula used to calculate GSE emissions is presented below:

GSE Emissions (Tons/year) = Emission Factor (g/hp-hr) x annual hours x (1 pound/453.59 grams) x (1 ton/2,000 pounds)

Table B-8: Number of GSE by Equipment Type, Fuel, and Average Model Year for 2018

GSE Type	Gas	Diesel	Biodiesel	Renewable Diesel	Hybrid Electric	Propane	Electric	Totals
AC Unit	--	9	--	--	--	--	--	9
Air Start	--	20	--	--	--	--	--	20
Baggage Tug	63	39	--	--	--	3	61	166
Belt Loader	25	27	--	--	--	--	60	112
Boarding Stairs	7	5	--	--	--	--	1	13
Cabin Service Truck	6	27	--	--	--	--	--	33
Container Loader	3	29	--	--	--	--	--	32
Deicer	2	--	--	--	--	--	--	2
Emergency Vehicle	--	6	--	--	--	--	--	6
Forklift	2	4	--	--	--	27	3	36
Fuel Truck	4	21	--	--	--	--	--	25
Generator	2	1	--	--	--	--	--	3
GPU	--	30	--	--	--	--	1	31
Lavatory Truck/Cart	20	1	--	--	--	--	2	23
Light Duty Vehicle	99	7	--	--	--	--	--	106
Light Stand	3	21	--	--	--	--	--	24
Maintenance Lift	10	5	1	--	--	1	12	29
Push Back Tug	11	45	--	--	--	--	24	80
Sort Platform	1	1	--	--	--	--	--	2
Sweeper	--	1	1	--	--	3	1	6
Utility Cart	3	--	--	--	--	--	44	47
Wheel Chair Lift	--	--	--	--	--	--	2	2
Total	**261**	**299**	**2**	**--**	**--**	**34**	**211**	**807**

Sources: San Diego County Regional Airport Authority 2019, KB Environmental Sciences, Inc. 2019.
Note: Years represent the average model year for the GSE type in the fleet.

[2] U.S. Department of Energy Alternative Fuels Data Center https://afdc.energy.gov/vehicles/diesels_emissions.html.

Table B-9: Number of GSE by Equipment Type, Fuel, and Average Model Year for 2026 No Action

GSE Type	Gas	Diesel	Biodiesel	Renewable Diesel	Hybrid Electric	Propane	Electric	Totals
AC Unit	--	9	--	--	--	--	--	9
Air Start	--	20	--	--	--	--	--	20
Baggage Tug	59	39	--	--	--	3	65	166
Belt Loader	24	27	--	--	--	--	61	112
Boarding Stairs	7	5	--	--	--	--	1	13
Cabin Service Truck	6	27	--	--	--	--	--	33
Container Loader	3	29	--	--	--	--	--	32
Deicer	2	--	--	--	--	--	--	2
Emergency Vehicle	--	6	--	--	--	--	--	6
Forklift	2	4	--	--	--	27	3	36
Fuel Truck	4	21	--	--	--	--	--	25
Generator	2	1	--	--	2	--	--	3
GPU	--	30	--	--	--	--	1	31
Lavatory Truck/Cart	20	1	--	--	--	--	2	23
Light Duty Vehicle	97	7	--	--	--	--	--	106
Light Stand	3	21	--	--	--	--	--	24
Maintenance Lift	8	5	1	--	--	1	14	29
Push Back Tug	8	45	--	--	--	--	27	80
Sort Platform	1	1	--	--	--	--	--	2
Sweeper	--	1	1	--	--	3	1	6
Utility Cart	3	--	--	--	--	--	44	47
Wheel Chair Lift	--	--	--	--	--	--	2	2
Total	**249**	**299**	**2**	**--**	**2**	**34**	**221**	**807**

Sources: San Diego County Regional Airport Authority 2019, KB Environmental Sciences, Inc. 2019.
Note: Years represent the average model year for the GSE type in the fleet.

Table B-10: Number of GSE by Equipment Type, Fuel, and Average Model Year for 2026 Proposed Project

GSE Type	Gas	Diesel	Biodiesel	Renewable Diesel	Hybrid Electric	Propane	Electric	Totals
AC Unit	--	--	--	9	--	--	--	9
Air Start	--	--	--	20	--	--	--	20
Baggage Tug	--	--	--	39	--	3	124	166
Belt Loader	--	--	--	27	--	--	85	112
Boarding Stairs	7	--	--	5	--	--	1	13
Cabin Service Truck	6	--	--	27	--	--	--	33
Container Loader	3	--	--	29	--	--	--	32
Deicer	2	--	--	--	--	--	--	2
Emergency Vehicle	--	--	--	3	3	--	--	6
Forklift	2	--	--	4	--	27	3	36
Fuel Truck	4	--	--	21	--	--	--	25
Generator	2	--	--	1	--	--	--	3
GPU	--	--	--	30	--	--	1	31
Lavatory Truck/Cart	20	--	--	1	--	--	2	23
Light Duty Vehicle	49	--	--	7	50	--	--	106
Light Stand	3	--	--	17	4	--	--	24
Maintenance Lift	--	--	1	4	1	1	22	29
Push Back Tug	2	--	--	46	1	--	31	80
Sort Platform	1	--	--	1	--	--	--	2
Sweeper	--	--	1	1	--	3	1	6
Utility Cart	--	--	--	--	--	--	47	47
Wheel Chair Lift	--	--	--	--	--	--	2	2
Total	**101**	**--**	**2**	**292**	**59**	**34**	**319**	**807**

Sources: San Diego County Regional Airport Authority 2019, KB Environmental Sciences, Inc. 2019.
Note: Years represent the average model year for the GSE type in the fleet.

Table B-11: Number of GSE by Equipment Type, Fuel, and Average Model Year for 2031 No Action

GSE Type	Gas	Diesel	Biodiesel	Renewable Diesel	Hybrid Electric	Propane	Electric	Totals
AC Unit	--	9	--	--	--	--	--	9
Air Start	--	20	--	--	--	--	--	20
Baggage Tug	56	39	--	--	--	3	68	166
Belt Loader	21	27	--	--	--	--	64	112
Boarding Stairs	7	5	--	--	--	--	1	13
Cabin Service Truck	6	27	--	--	--	--	--	33
Container Loader	3	29	--	--	--	--	--	32
Deicer	2	--	--	--	--	--	--	2
Emergency Vehicle	--	6	--	--	--	--	--	6
Forklift	2	4	--	--	--	27	3	36
Fuel Truck	4	21	--	--	--	--	--	25
Generator	2	1	--	--	--	--	--	3
GPU	--	30	--	--	--	--	1	31
Lavatory Truck/Cart	20	1	--	--	--	--	2	23
Light Duty Vehicle	90	7	--	--	9	--	--	106
Light Stand	3	21	--	--	--	--	--	24
Maintenance Lift	5	5	1	--	--	1	17	29
Push Back Tug	8	45	--	--	--	--	27	80
Sort Platform	1	1	--	--	--	--	--	2
Sweeper	--	1	1	--	--	3	1	6
Utility Cart	3	--	--	--	--	--	44	47
Wheel Chair Lift	--	--	--	--	--	--	2	2
Total	**233**	**299**	**2**	**--**	**9**	**34**	**230**	**807**

Sources: San Diego County Regional Airport Authority 2019, KB Environmental Sciences, Inc. 2019.
Note: Years represent the average model year for the GSE type in the fleet.

Table B-12: Number of GSE by Equipment Type, Fuel, and Average Model Year for 2031 Proposed Project

GSE Type	Gas	Diesel	Biodiesel	Renewable Diesel	Hybrid Electric	Propane	Electric	Totals
AC Unit	--	--	--	9	--	--	--	9
Air Start	--	--	--	20	--	--	--	20
Baggage Tug	--	--	--	39	--	3	124	166
Belt Loader	--	--	--	27	--	--	85	112
Boarding Stairs	7	--	--	5	--	--	1	13
Cabin Service Truck	6	--	--	27	--	--	--	33
Container Loader	3	--	--	29	--	--	--	32
Deicer	2	--	--	--	--	--	--	2
Emergency Vehicle	--	--	--	3	3	--	--	6
Forklift	2	--	--	4	--	27	3	36
Fuel Truck	4	--	--	21	--	--	--	25
Generator	2	--	--	1	--	--	--	3
GPU	--	--	--	30	--	--	1	31
Lavatory Truck/Cart	20	--	--	1	--	--	2	23
Light Duty Vehicle	--	--	--	7	99	--	--	106
Light Stand	3	--	--	17	4	--	--	24
Maintenance Lift	--	--	1	4	1	1	22	29
Push Back Tug	2	--	--	46	1	--	31	80
Sort Platform	1	--	--	1	--	--	--	2
Sweeper	--	--	1	1	--	3	1	6
Utility Cart	--	--	--	--	--	--	47	47
Wheel Chair Lift	--	--	--	--	--	--	2	2
Total	**52**	**--**	**2**	**292**	**108**	**34**	**319**	**807**

Sources: San Diego County Regional Airport Authority 2019, KB Environmental Sciences, Inc. 2019.
Note: Years represent the average model year for the GSE type in the fleet.

1.3 Stationary Sources

Stationary sources were modeled using project-specific data and AEDT; and consisted of boilers, cooling towers, emergency generators, and fuel storage/transfer facilities. SAN's existing Central Utility Plant (CUP), located along Airport Terminal Road adjacent to the Terminal 2 (T2) Parking Plaza, contains boilers, chillers, and cooling towers providing heated and chilled water for building heating and cooling. The Proposed Project calls for the expansion of the existing CUP, which involves increasing the capacity of these units.

The total firing rate of all the existing boilers at SAN is equal to 27.8 million British Thermal Units per hour (MMBtu/hour) (2 boilers x 6.7 MMBtu/hour + 4 boilers x 3.6 MMBtu/hour). The expansion of the existing CUP involves replacing aging boilers in-place (2 boilers x 6.7 MMBtu/hour) with four new boilers of firing rate 3.6 MMBtu/hour each. Thus, the new firing rate of all the boilers, including the proposed new boilers, is equal to 28.8 MMBtu/hour (8 x 3.6 MMBtu/hour), for an incremental change of 1.0 MMBtu/hour. **Table B-13** presents the annual natural gas usage for all boilers.

Table B-13: Annual Natural Gas Usage for Boilers (ft^3)

Equipment	No Action Alternative	Proposed Project
Total Boilers	234,161,538	242,584,615

Source: KB Environmental Sciences, Inc. 2019/2020.

As a part of the expansion of the CUP, capacity of the cooling tower also would be increased from 5,000 tons to 6,250 tons. Emissions from the existing and proposed cooling towers were computed using a default emission factor provided in the South Coast Air Quality Management District (AQMD) Guidelines for Calculating Emissions from Cooling Towers.[3]

Emissions from the diesel emergency generators were based on an existing and future annual fuel usage of 17,550 gallons and computed using AP-42 emission factors.[4] At the time of the air quality analysis, the Proposed Project's design had not advanced enough to determine whether more emergency generators would be needed. To account for this unknown, the analysis conservatively assumed that all current diesel generators at SAN were operated for the maximum permitted run hours in both the Proposed Project and No Action Alternative scenarios. Further, if any additional generators are needed, the required permits from the local air quality district would address emissions from those sources. Emissions from emergency generators represent a fraction of one percent of the total emissions and, therefore, were not evaluated further.

Emissions from the existing and proposed fuel storage/transfer facilities were computed using the throughputs presented in **Table B-14**.

Table B-14: Annual Throughputs for Fuel Storage/Transfer Facilities (Gallons)

Equipment	2018	2026	2031
Total Fuel Storage/Transfer Facilities	207,102,359	237,598,014	249,995,510

Source: KB Environmental Sciences, Inc. 2019/2020.

[3] South Coast Air Quality Management District (AQMD), *Guidelines for Calculating Emissions from Cooling Towers*. Available: http://www.aqmd.gov/docs/default-source/planning/annual-emission-reporting/guidecalcemiscooltowerdec13.pdf.
[4] USEPA, 1999. "Compilation of Air Pollution Emission Factors. Volume 1: Stationary Point and Area Sources" AP-42, 5th Edition and Supplements, USEPA, Office of Air Quality Planning and Standards, Environmental Sciences Research Laboratory, Research Triangle Park, NC.

With the exception of cooling towers and emergency generators, stationary sources emission factors were assumed to be the default AEDT factors.

1.4 Motor Vehicles

The motor vehicle emissions that would result from the daily operation of airport-related motor vehicles under the No Action Alternative and the Proposed Project depend on several factors including the volume of vehicles, the vehicle fleet and fuel mix, the motor vehicle emission factors, travel distance, speed, and the year of analysis. These factors are obtained from several sources including the SDCRAA, the traffic analysis prepared in support of the EA for the SAN Airfield Improvements and Terminal 1 Replacement Project (see **Appendix G** of the EA), and CARB's emission factor model EMFAC2017.[5] **Table B-15** provides a summary of the data inputs needed to compute motor vehicle emissions, their descriptions, sources, and assumptions.

On November 20, 2019, CARB published off-model factors to adjust the emissions output of NO_x, particulate matter (PM), and CO from EMFAC2017 to account for the impact of the "Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule Part One: One National Program."[6] This rule revokes California's authority to set zero-emission vehicle mandates applicable to vehicles in California. As a result of the reduction in future sales requirements of zero emission vehicles (ZEVs), CARB presumes that fewer ZEVs will be sold and, as a result, more gasoline-fueled vehicles will be sold. This reduction in ZEVs sales is, therefore, assumed to increase emissions of the criteria air pollutants and pollutant precursors.

To account for the potential increase in emissions due to the SAFE Vehicle Rule, the total motor vehicle-related emissions of NO_x, PM, and CO estimated for the years 2026 and 2031 were increased using CARB's EMFAC2017 adjustment factors. Although the factors only apply to estimated emissions resulting from the operation of gasoline light duty vehicles, the factors were applied to total emission estimates (i.e., emission estimates from both gasoline and diesel fueled vehicles and both light- and heavy-duty vehicles). Additionally, the factor that would result in the greatest increase in emissions, by year, was applied to all three of the pollutants (i.e., emission estimates for NO_x, PM, and CO). This approach results in conservative estimates of total vehicle-related emissions, both with and without the proposed improvements at SAN.

Table B-15: Summary of Motor Vehicle Emissions Data Inputs

Data	Description	Source	Assumptions
Vehicle Fleet Mix	Percent of each vehicle type operating on on-airport and off-airport roads.	SDCRAA[a]	Fleet mix is representative of the traffic in the vicinity of the airport.
Fuel Mix	Percent of fuel usage for each vehicle type (e.g., gasoline, diesel, biodiesel, electric etc.)	SDCRAA	Fuel mix is representative of the traffic in the vicinity of the airport.
Roadways	The network of roadway segments on which traffic volume were obtained.	Traffic Analysis	Roadways analyzed are representative of where project impacts will occur.
Off-Airport Daily Traffic Volumes	Traffic volumes on roads in the vicinity of the airport. Volumes were developed in total and for airport- and non-airport-related traffic.	Traffic Analysis	Data provided is representative of daily average conditions and can be applied annually.
On-Airport Daily Traffic Volumes	Traffic volumes occurring on road segments on airport property including	Traffic Analysis	Data provided is representative of daily conditions and can be

[5] CARB, *EMFAC2017 Volume III – Technical Documentation, Version 1.0.2*, July 2018. Available: https://ww3.arb.ca.gov/msei/downloads/emfac2017-volume-iii-technical-documentation.pdf.
[6] CARB, *EMFAC Off-Model Adjustment Factors to Account for the SAFE Vehicle Rule Part One*, November 2019.

Table B-15: Summary of Motor Vehicle Emissions Data Inputs

Data	Description	Source	Assumptions
	terminal roadways, parking facilities, and rental car facilities.		applied annually.
Roadway Lengths	Lengths of roadway segments both on- and off-airport.	Determined using GIS	Lengths based on GIS locations are sufficiently accurate.
Emission Factors	The rate a pollutant is released into the air by a source.	EMFAC2017[b]	The San Diego Air Basin is used for representative emission factors.
Curbside Idle Times	Times cars are idle while waiting at the terminal curbsides for drop-offs and pick-ups.	Traffic Analysis	Idle times occur at terminal curbsides.
Parking Facility Traffic	Traffic counts in and out of parking facilities.	SDCRAA	Traffic counts provided for July 2018 are representative of parking conditions.
SAFE Vehicle Rule: Part One	Off-model adjustments to the motor-vehicle emissions totals resulting from a decrease in the sale of ZEVs that is presumed to occur with the Rule.	CARB[c]	By future year, the factor resulting in the greatest increase in motor vehicle emissions was assumed for the adjustment of NO_x, PM, and CO emissions.

Source: KB Environmental Sciences, Inc., 2019/2020.
Notes:
[a] San Diego County Regional Airport Authority.
[b] CARB, *EMFAC2017 Volume III – Technical Documentation, Version 1.0.2*, July 2018.
[c] CARB, *EMFAC Off-Model Adjustment Factors to Account for the SAFE Vehicle Rule Part One*, November 20, 2019.

The following equation is used to obtain annual emissions for motor vehicles:

Motor Vehicle Emissions (Tons/year) = Emission Factor (g/mile) x vehicle miles travelled per day x (365 days/year) x (1 pound/453.59 grams) x (1 ton/2,000 pounds)

1.4.1 Fleet and Fuel Mix

The emission factors for motor vehicles on roadways in the vicinity of SAN (both on- and off-airport) were based on data from EMFAC2017 and the SDCRAA. The vehicle categories were cars, light duty trucks (i.e., vans, pickup trucks), shuttle buses (with less than 20 seats), and public (i.e., commuter) transit buses (with more than 20 seats). The fuel types considered for each vehicle type was gasoline, diesel, hybrids, compressed natural gas (CNG), biodiesel, propane, and electric.

The recent State of California mandate for airport shuttles to transition to all-electric (i.e., zero emission vehicles) by 2035 was also considered.[7] The mandate for the transition of airport shuttles stipulates that by 2027, 33 percent of the shuttles will be ZEVs; by 2031, 66 percent will be ZEVs; and by 2035, all shuttles will be ZEVs. This initiative is considered for the composite emission factors for each applicable year. Also considered is the inclusion of the shuttle service between the Old Town Transit Center and SAN terminals. The shuttle buses between the Old Town Transit Center and SAN terminals will all be electric and serve to lower the number of cars traveling to SAN beginning in 2022.

The mandate for public transit buses to transition was also considered. The Innovative Clean Transit (ICT) regulation was adopted in December 2018 and requires all public transit agencies to gradually transition

[7] California Air Resources Board Bulletin, *California transitioning to all-electric public bus fleet by 2040*, December 14, 2018. Available: https://ww2.arb.ca.gov/news/california-transitioning-all-electric-public-bus-fleet-2040.

to a 100 percent zero-emission bus (ZEB) fleet. Beginning in 2029, 100 percent of new purchases by transit agencies must be ZEBs, with a goal for full transition by 2040. It applies to all transit agencies that own, operate, or lease buses with a gross vehicle weight rating (GVWR) greater than 14,000 pounds. It includes standard, articulated, over-the-road, double-decker, and cutaway buses.[8]

Table B-16 presents the vehicle categories considered, and the fleet percentages by fuel type for each analysis year. Notably, for the evaluation of future years, the No Action and Proposed Project would have the same vehicle and fuel mix. When compared to existing conditions, the fleet in future years would include electric shuttle service between the Old Town Transit Center and the SAN terminals. The vehicle and fuel mixes for both scenarios, therefore, account for reduced cars and light duty vehicles and increased electric shuttles.

Table B-16: Vehicle and Fuel Mixes for the Existing Year, 2026, and 2031

Vehicle	Fuel	Percentage of Vehicle/Fuel Type by Analysis Year		
		2018	2026	2031
Cars	Gas	59.52	57.61	57.61
	Hybrid	15.79	15.28	15.28
	CNG	<0.01	<0.01	<0.01
Light Duty Trucks	Gas	18	15	15
	Diesel	0.03	0.03	0.03
	CNG	0.22	0.19	0.19
	Biodiesel	0.05	0.05	0.05
	Hybrid	0.01	0.01	0.01
	Propane	0.01	0.01	0.01
Shuttle Buses	Gas	2.6	--	--
	Biodiesel	0.19	--	--
	CNG	0.25	--	--
	Flex Fuel	0.06	--	--
	Diesel	0.06	--	--
	Electric	--	8.84	8.84
Transit Buses	Gas	0.02	0.02	0.02
	Propane	2.04	2.04	2.04
	CNG	0.51	0.51	0.51
	Electric	--	--	--
Total		100	100	100

Source: KB Environmental Sciences, Inc. 2019/2020/2021, and San Diego County Regional Airport Authority.
Note: Values subject to rounding. CNG = Compressed Natural Gas. The symbol "--" denotes not applicable.

1.4.2 Emission Factors

CARB's EMFAC2017 model was used to derive the emission factors for motor vehicles.[9] The model includes updates to emission factors based on new vehicle testing data and the incorporation of state and federal

[8] California Air Resources Board, *Innovative Clean Transit (ICT) Regulation Fact Sheet*, May 16, 2019. Available: https://ww2.arb.ca.gov/resources/fact-sheets/innovative-clean-transit-ict-regulation-fact-sheet.
[9] Information regarding EMFAC2017 and its use in California is available at: https://www.federalregister.gov/documents/2019/08/15/2019-17476/official-release-of-emfac2017-motor-vehicle-emission-factor-model-for-use-in-the-state-of-california (Accessed: October 2020), and at: https://arb.ca.gov/emfac/ (Accessed: October 2020).

regulations. New forecasting methods reflect emission benefits of CARB's recent rulemakings including on-road diesel fleet rules, California's Advanced Clean Car Standards (ACC), and the Smartway/Phase I Heavy Duty Vehicle Greenhouse Gas Regulation. In general, the current model predicts lower emissions after 2020.[10] Notably, the models used to estimate air pollutant emissions are approved by regulatory agencies, such as the USEPA and CARB, and include current and future regulatory emission controls. These data are embedded within the mode. Changes to the emission factors that are a result of these emission controls can only be made by the regulatory agencies that develop the models.

Using EMFAC2017, a composite emission factor representative of the vehicle and fuel mix at an aggregated speed was calculated for each pollutant, scenario, and analysis year. **Table B-17** and **Table B-18** present the cruising speed and idle (terminal curbside) motor vehicle emission factors for 2018, 2026, and 2031 for the No Action Alternative and the Proposed Project for criteria pollutants/precursor pollutants and greenhouse gases (GHGs) (i.e., carbon dioxide [CO_2], methane [CH_4], and nitrous oxide [N_2O]). As stated in the introduction of Section 1.4, due to the SAFE Vehicle Rule Part One, the future year total motor-vehicle emission estimates of NO_x, PM, and CO were increased using off-model adjustment factors released by CARB on November 20, 2019. These adjustments account for the presumed reduction in ZEVs that would result in the future with the Rule.

Table B-17: EMFAC2017 Composite Cruise Emission Factors

Year	Emissions (grams/mile)								
	VOC	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x	CO_2	CH_4	N_2O
2018 (Existing)	0.04	0.16	0.05	0.05	1.15	0.003	362	0.06	0.02
2026	0.01	0.05	0.04	0.04	0.46	0.002	247	0.04	0.01
2031	0.004	0.03	0.04	0.04	0.38	0.002	223	0.03	0.01

Source: CARB's EMFAC2017.
Notes: The Proposed Project emission factors were applied to all of the on-airport roadways anticipated to be impacted by the Old Town Shuttle Service as well as Pacific Highway and North Harbor Drive. The emissions benefit (i.e., reduction in emissions) with the Old Town Shuttle was accounted for by a reduction in the number of passenger-related motor vehicle trips on these roadways. For all other off-airport roadways, the emission factors were the same both with and without the Proposed Project.

Table B-18: EMFAC2017 Composite Idle Emission Factors

Year	Pollutant Emissions (grams/mile)								
	VOC	NO_x	PM_{10}	$PM_{2.5}$	CO	SO_x	CO_2	CH_4	N_2O
2018 (Existing)	2.68	3.31	0.20	0.19	29.85	0.08	8,189	2.64	1.50
2026	0.40	0.69	0.11	0.11	8.9	0.05	5,485	1.27	0.10
2031	0.20	0.5	0.061	0.056	7.2	0.05	4928	0.34	0.10

Source: CARB's EMFAC2017.

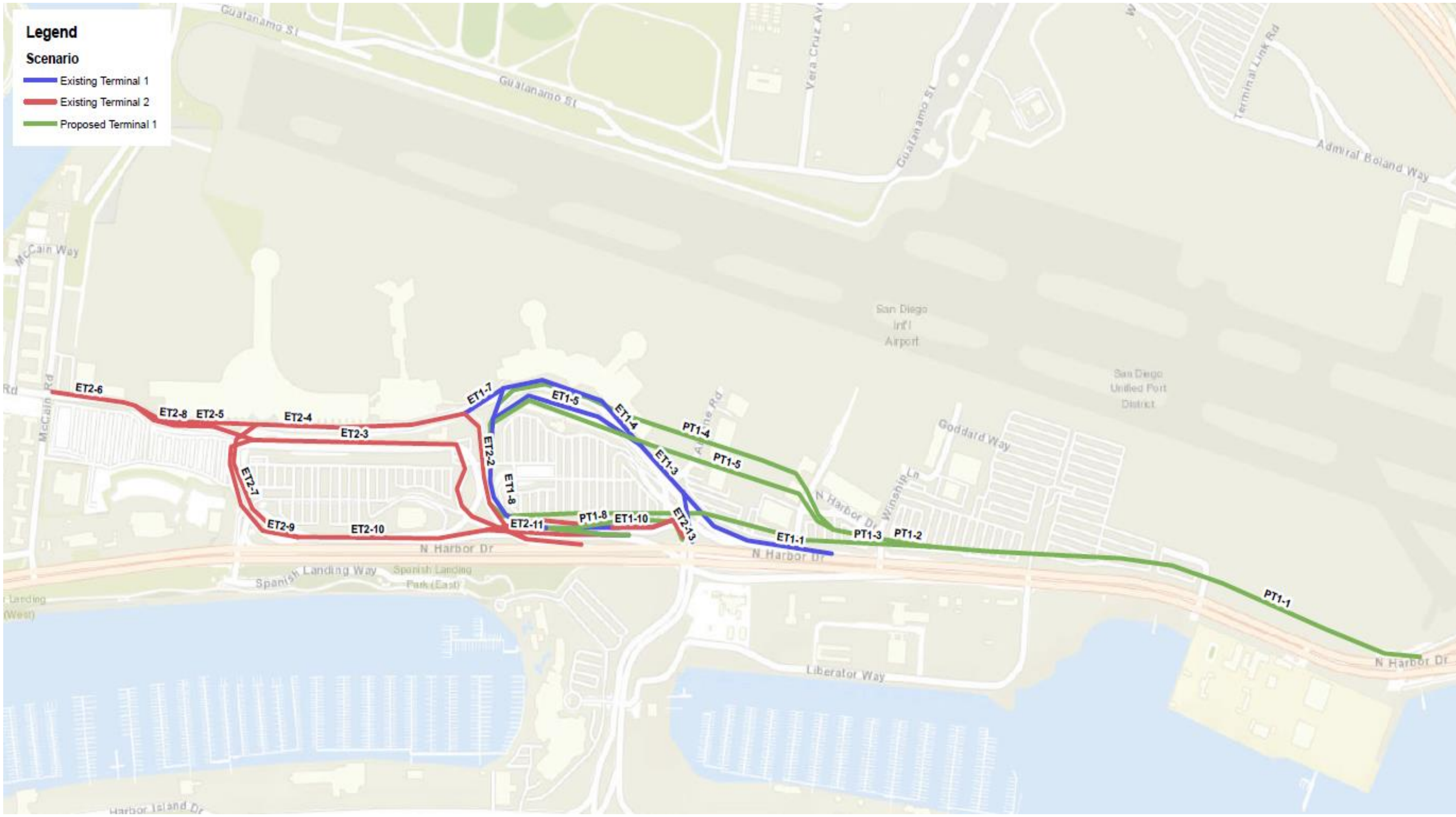
1.4.3 Traffic Volumes

The traffic analysis developed Average Daily Traffic (ADT) for both on-airport and off-airport roadway segments. On-airport ADT includes traffic that enters the airport roadways and travels on Terminal 1 roads, Terminal 2 roads, and associated parking facilities and curbsides. **Figure B-1** shows the on-airport roadways analyzed. The off-airport roadway network extends south of SAN to Harbor Island Drive, north

[10] CARB, *EMFAC2017 Volume III – Technical Documentation, Version 1.0.2*, July 2018. Available: https://ww3.arb.ca.gov/msei/downloads/emfac2017-volume-iii-technical-documentation.pdf.

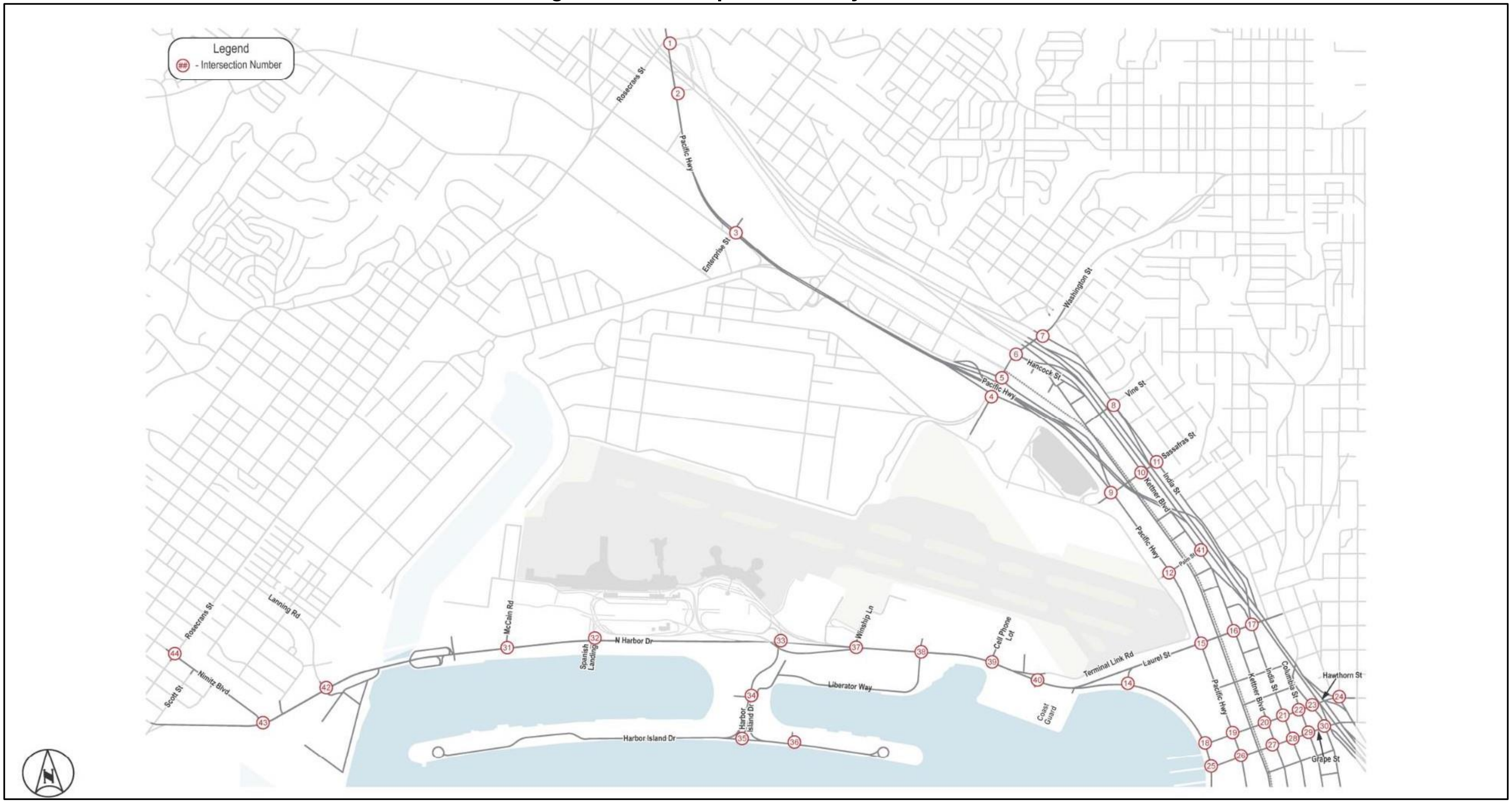
to Pacific Highway, and east to India Street. Also included is North Harbor Drive from Scott Street to Ash Street. The evaluated off-airport roadways are shown on **Figure B-2**. The on-airport and off-airport ADT volumes are provided in **Table B-19** and **Table B-20**, respectively.

Figure B-1 On-Airport Roadway Locations



Source: KB Environmental Sciences, Inc. 2019/2020.

Figure B-2 Off-Airport Roadway Locations



Source: Kimley-Horn, 2021.

Table B-19: On-Airport Daily Traffic Volumes

Link ID	Analysis Years				
	2018	2026		2031	
	Existing	No Action Alternative	Proposed Project	No Action Alternative	Proposed Project
ET1-1	17,050	17,391	--	19,496	--
ET1-10	6,392	6,520	--	7,309	--
ET1-2	2,319	2,365	--	2,652	--
ET1-3	19,369	19,756	--	22,147	--
ET1-4	19,333	19,720	--	22,106	--
ET1-5	1,823	1,859	--	2,084	--
ET1-6	17,159	17,502	--	19,620	--
ET1-7	2,174	2,217	--	2,486	--
ET1-8	18,982	19,362	--	21,705	--
ET1-9	42,956	43,815	--	49,118	--
ET2-1	16,429	16,758	--	18,786	--
ET2-10	28,154	28,717	18,346	32,192	20,641
ET2-11	26,476	27,006	14,677	30,274	16,513
ET2-12	3,830	3,907	1,834	4,379	2,064
ET2-13	6,686	6,820	--	7,645	--
ET2-2	6,872	7,009	5,034	7,858	5,663
ET2-3	9,557	9,748	6,899	10,928	7,762
ET2-4	9,466	9,655	4,986	10,824	5,610
ET2-5	2,000	2,040	2,211	2,287	2,488
ET2-6	4,637	4,730	3,810	5,302	4,287
ET2-7	7,466	7,615	5,269	8,537	5,928
ET2-8	2,637	2,690	1,599	3,015	1,799
ET2-9	17,996	18,356	9,063	20,577	10,197
PT1-1	--	--	42,163	--	47,438
PT1-2	--	--	19,538	--	21,982
PT1-3	--	--	22,626	--	25,457
PT1-4	--	--	11,854	--	13,337
PT1-5	--	--	10,506	--	11,819
PT1-6	--	--	7,307	--	8,221
PT1-7	--	--	38,494	--	43,310
PT1-8	--	--	3,512	--	3,951
T1-P	8,025	7,865	7,865	6,874	6,874
T2-PG	12,483	12,233	12,233	10,692	10,692
T2-PL	7,750	7,595	7,595	6,638	6,638

Source: Kimley-Horn, 2019/2020.
ET1 = Existing Terminal 1, ET2 = Existing Terminal 2, T1-P = Terminal 1 Parking (Existing and Proposed Future), T2-PG = Terminal 2 Parking Garage, T2-PL = Terminal 2 Parking Plaza, and PT1 = Proposed Terminal 1.
The symbol "--" denotes no data applicable.

Table B-20: Off-Airport Daily Traffic Volumes

Roadway	Roadway Segment	2018[a]			2026						2031					
		Existing			No Action Alternative			Proposed Project			No Action Alternative			Proposed Project		
		Total	Airport	Non-Airport	Total	Airport	Non-Airport	Total	Airport	Non-Airport	Total	Airport	Non-Airport	Total	Airport	Non-Airport
Pacific Highway	Kurtz St to Barnett Ave	21,780	2,580	19,200	23,512	2,922	20,590	23,512	2,922	20,590	24,514	3,273	21,241	24,514	3,273	21,241
	Barnett Ave to Washington St	51,778	4,158	47,620	64,178	5,404	58,775	64,178	5,404	58,775	66,410	6,046	60,364	66,410	6,046	60,364
	Washington St to Sassafras St	14,219	4,872	9,347	15,404	4,625	10,780	15,404	4,625	10,780	17,011	5,211	11,800	17,011	5,211	11,800
	Sassafras St to Palm St	18,988	9,991	8,997	22,089	11,387	10,701	22,089	11,387	10,701	24,025	12,801	11,224	24,025	12,801	11,224
	Palm St to Laurel St	20,447	12,428	8,019	23,250	13,502	9,749	23,250	13,502	9,749	26,076	15,209	10,867	26,076	15,209	10,867
	Laurel Dr to Juniper St	10,478	6,924	3,554	14,707	8,016	6,691	14,707	8,016	6,691	16,327	9,021	7,306	16,327	9,021	7,306
Kettner Blvd	Vine St to Sassafras St	26,492	18,117	8,375	33,079	18,347	14,732	33,079	18,347	14,732	37,908	20,690	17,218	37,908	20,690	17,218
	Sassafras St to Palm St	18,406	15,838	2,568	30,512	16,646	13,865	30,512	16,646	13,865	36,086	18,764	17,322	36,086	18,764	17,322
	Palm St to Laurel St	18,406	10,719	7,687	24,811	10,181	14,629	24,811	10,181	14,629	29,038	11,510	17,528	29,038	11,510	17,528
India St	Sassafras St to Laurel St	14,465	11,303	3,162	22,466	16,349	6,117	22,466	16,349	6,117	26,475	18,428	8,047	26,475	18,428	8,047
	Laurel St to Juniper St	3,884	--	3,884	4,063	--	4,063	4,063	--	4,063	4,165	--	4,165	4,165	--	4,165
Washington St	West of Pacific Hwy	4,847	2,683	2,164	6,433	--	2,214	6,433	--	2,214	7,221	--	2,507	7,221	--	2,507
	Hancock St to San Diego Ave	22,972	3,397	19,575	25,897	3,440	22,457	25,897	3,440	22,457	27,372	3,879	23,492	27,372	3,879	23,492
	East of India St	24,710	3,397	21,313	30,396	3,440	26,956	30,396	3,440	26,956	32,112	3,879	28,233	32,112	3,879	28,233
Admiral Boland Wy	Washington St to Terminal Link Rd	13,099	13,099	--	21,583	20,599	984	21,583	20,599	984	24,356	23,017	1,339	24,356	23,017	1,339
	Terminal Link Rd to Pacific Hwy	13,099	13,099	--	21,882	20,731	1,151	21,882	20,731	1,151	24,659	23,149	1,511	24,659	23,149	1,511
Sassafras St	Pacific Hwy to Kettner Blvd	15,983	12,852	3,131	22,781	18,924	3,858	22,781	18,924	3,858	26,183	21,178	5,004	26,183	21,178	5,004
Palm St	Pacific Hwy to Kettner Blvd	1,940	1,700	240	7,900	2,246	5,653	7,900	2,246	5,653	9,085	2,540	6,546	9,085	2,540	6,546
Laurel St	Harbor Dr to Pacific Hwy	35,441	32,004	3,437	50,612	39,030	11,582	50,612	39,030	11,582	59,644	44,122	15,523	59,644	44,122	15,523
	Pacific Hwy to	21,042	16,552	4,490	25,419	15,867	9,552	25,419	15,867	9,552	29,194	17,929	11,265	29,194	17,929	11,265

Roadway	Roadway Segment	2018[a]			2026						2031					
		Existing			No Action Alternative			Proposed Project			No Action Alternative			Proposed Project		
		Total	Airport	Non-Airport	Total	Airport	Non-Airport	Total	Airport	Non-Airport	Total	Airport	Non-Airport	Total	Airport	Non-Airport
	India St															
	India St to State St/ Reynard Wy	14,072	3,397	10,675	14,512	3,440	11,072	14,512	3,440	11,072	15,316	3,879	11,437	15,316	3,879	11,437
Hawthorn St	Harbor Dr to Pacific Hwy	26,337	16,566	9,771	27,728	15,275	12,453	27,728	15,275	12,453	32,109	17,269	14,840	32,109	17,269	14,840
	Pacific Hwy to India St	30,936	16,566	14,370	33,609	15,275	18,334	33,609	15,275	18,334	41,450	17,269	24,182	41,450	17,269	24,182
	India St to State St	30,936	16,566	14,370	34,222	15,275	18,948	34,222	15,275	18,948	42,024	17,269	24,755	42,024	17,269	24,755
	State St to Albatross St	10,483	--	10,483	10,965	--	10,965	10,965	--	10,965	11,242	--	11,242	11,242	--	11,242
Grape St	Harbor Dr to Pacific Hwy	23,826	19,002	4,824	28,464	--	10,943	28,464	--	10,943	36,346	--	16,538	36,346	--	16,538
	Pacific Hwy to India St	28,167	19,002	9,165	38,641	17,521	21,120	38,641	17,521	21,120	45,852	19,808	26,044	45,852	19,808	26,044
	India St to State St	32,386	19,002	13,384	50,065	17,521	32,544	50,065	17,521	32,544	59,849	19,808	40,040	59,849	19,808	40,040
	Albatross St to Front St	2,172	--	2,172	3,415	--	3,415	3,415	--	3,415	4,641	--	4,641	4,641	--	4,641
North Harbor Dr	Scott Rd to Nimitz Blvd	11,759	2,923	8,836	16,574	--	13,879	16,574	--	13,879	17,350	--	14,303	17,350	--	14,303
	Nimitz Blvd to Laning Rd	19,644	8,770	10,874	25,861	8,087	17,774	25,861	8,087	17,774	27,587	9,142	18,445	27,587	9,142	18,445
	Laning Rd to McCain Rd	28,798	11,694	17,104	30,571	10,782	19,789	30,571	10,782	19,789	34,657	12,190	22,467	34,657	12,190	22,467
	McCain Rd to Spanish Landing	29,392	7,980	21,412	30,719	10,782	19,937	30,719	10,782	19,937	34,788	12,190	22,598	34,788	12,190	22,598
	Spanish Landing to Harbor Island Dr	30,278	5,732	24,546	47,521	26,947	20,574	30,512	9,938	20,574	51,513	30,275	21,238	32,411	11,172	21,238
	Harbor Island Dr to Winship Ln	77,384	21,445	55,939	53,580	34,417	19,163	23,882	1,257	22,625	75,853	38,133	37,720	39,127	1,407	37,720
	Winship Ln to Liberator Way	89,066	75,645	13,421	109,768	81,791	27,977	70,560	39,838	30,722	136,790	92,399	44,391	89,421	45,030	44,391
	Liberator Way to Cell Phone Lot	94,942	75,645	19,297	113,945	84,288	29,657	72,570	40,267	32,303	140,780	95,168	45,612	91,110	45,498	45,612
	Cell Phone Lot to Laurel St/ Solar Turbines	95,096	87,131	7,965	117,938	87,450	30,488	73,186	40,267	32,918	144,341	98,671	45,670	91,168	45,498	45,670
	Laurel St/ Solar Turbines to W Laurel St	76,603	70,000	6,603	66,201	40,399	25,802	66,201	40,399	25,802	74,123	45,630	28,492	74,123	45,630	28,492

Roadway	Roadway Segment	2018[a]			2026						2031					
		Existing			No Action Alternative			Proposed Project			No Action Alternative			Proposed Project		
		Total	Airport	Non-Airport	Total	Airport	Non-Airport	Total	Airport	Non-Airport	Total	Airport	Non-Airport	Total	Airport	Non-Airport
	Laurel St to Hawthorn St	59,521	43,364	16,157	67,310	40,248	27,062	67,310	40,248	27,062	83,888	45,467	38,421	83,888	45,467	38,421
	Hawthorn St to Grape St	37,881	26,798	11,083	44,495	24,973	19,522	44,495	24,973	19,522	58,659	28,199	30,460	58,659	28,199	30,460
	Grape St to Ash St	20,437	7,796	12,641	22,279	7,452	14,826	22,279	7,452	14,826	24,220	8,390	15,830	24,220	8,390	15,830
Harbor Island Dr	Harbor Dr to Old Rent A Car Access	12,743	1,132	11,611	16,105	1,147	14,958	16,105	1,147	14,958	26,629	1,293	25,336	26,629	1,293	25,336
	West of Harbor Island Dr	7,661	1,132	6,529	13,649	1,147	12,502	13,649	1,147	12,502	14,139	1,293	12,846	14,139	1,293	12,846
	Harbor Island Dr to Parking Lot	4,801	--	4,801	7,013	--	7,013	7,013	--	7,013	7,332	--	7,332	7,332	--	7,332
	East of Parking Lot	3,929	--	3,929	7,013	--	7,013	7,013	--	7,013	7,332	--	7,332	7,332	--	7,332

Source: Kimley-Horn, 2019/2020/2021.

(a) 2018 traffic volumes provided for informational purposes only.

1.5 Other Sources

Criteria pollutants are emitted as a result of activities in buildings for which natural gas is used as an energy source. Therefore, emissions of the criteria air pollutants and their precursors due to the use of natural gas were estimated for existing conditions and both future years. The estimates were prepared using the California Air Pollution Control Officers Association's (CAPCOA's) California Emissions Estimator Model (CalEEMod-Version 2016.3.2) and were based on project-specific land uses and sizes.

CalEEMod's emission factors for natural gas combustion are based on USEPA's AP-42 Compilation and the California Climate Action Registry (CCAR). For the No Action Alternative, the total square footage of all of the buildings at SAN were used for input to CalEEMod. These are:

- Administrative Building/ Former Commuter Terminal – 132,000 square feet (sf)
- Terminal 1 – 336,000 sf
- Terminal 2 (East) – 350,000 sf
- Terminal 2 (West) – 889,000 sf

The Proposed Project was also modeled using CalEEMod and data were based on the information and square footages provided in Section 1.6.3 of this appendix.

1.6 Construction Activities

For this assessment, construction-related emissions are primarily associated with the exhaust from heavy equipment (e.g., backhoes, loaders, graders, etc.), delivery trucks (e.g., cement trucks, dump trucks, etc.), and construction worker vehicles getting to and from SAN construction site(s); dust from site preparation, land clearing, material handling, equipment movement on unpaved areas, and demolition activities; and fugitive emissions from the storage/transfer of raw materials. These emissions are temporary in nature and generally confined to the construction site and the access/egress roadways.

Emissions of CO, NO_x, VOC, SO_x, $PM_{10/2.5}$, as well as GHG (i.e., CO_2, CH_4, and N_2O) were evaluated for the Proposed Project's 6-year construction period of 2021 to 2026. Emission factors for on-road motor vehicles and off-road construction equipment were developed using CARB's EMFAC2017 and OFFROAD2017, respectively. Fugitive emissions were calculated using emission factors within AP-42.

Data regarding the types of construction activities and equipment/vehicle activity data (e.g., equipment mixes/operating times) were estimated from the Transportation Research Board's (TRB's) Airport Construction Emissions Inventory Tool (ACEIT) based on the Proposed Project's development phasing (i.e., Phases A and B).

1.6.1 On-road Vehicles

For on-road vehicles, the vehicles miles traveled (VMT) were estimated to determine annual emissions. In deriving the VMT, the following was assumed:

- VMT by hauling, delivering, and pickup trucks were based on the number of trips and a roundtrip travel distance of 40 miles.
- In deriving the VMT for each worker traveling to and from the construction site, it was assumed that a composite of cars and trucks would commute a roundtrip distance of 30 miles.

The following equation was used to obtain annual emissions for on-road vehicles:

On-road Vehicle Emissions (tons/year) for on-road vehicles = Emission Factor (g/mile) x vehicle miles travelled per day x days/year x (1 pound/453.59 grams) x (1 ton/2,000 pounds)

EMFAC2017 emission factors for criteria pollutants/precursor pollutants and GHGs associated with commuter vehicles, hauling, delivery, and pickup trucks for the construction period are presented in **Table B-21**.

Table B-21: On-road Vehicle Emission Factors (grams/mile)

Vehicles	EMFAC Vehicle Classification	Pollutant	2021	2022	2023	2024	2025	2026
Employee Commuters	LDA (Gasoline)	CO	0.63	0.59	0.55	0.52	0.49	0.47
		NO_x	0.040	0.035	0.031	0.028	0.026	0.024
		VOC	0.010	0.009	0.008	0.007	0.006	0.005
		SO_x	0.003	0.003	0.003	0.003	0.002	0.002
		PM_{10}	0.002	0.002	0.001	0.001	0.001	0.001
		$PM_{2.5}$	0.002	0.001	0.001	0.001	0.001	0.001
		CO_2	275	268	260	253	246	239
		CH_4	0.003	0.002	0.002	0.002	0.002	0.002
		N_2O	0.005	0.004	0.004	0.004	0.004	0.003
Haul Trucks	T7 Single (Diesel)	CO	1.04	0.48	0.21	0.21	0.21	022
		NO_x	5.76	3.45	2.05	2.08	2.11	2.14
		VOC	0.33	0.13	0.02	0.02	0.02	0.02
		SO_x	0.015	0.014	0.014	0.014	0.013	0.013
		PM_{10}	0.14	0.045	0.012	0.012	0.012	0.012
		$PM_{2.5}$	0.13	0.043	0.011	0.011	0.012	0.012
		CO_2	1,617	1,523	1,446	1,430	1,415	1,400
		CH_4	0.015	0.006	0.001	0.001	0.001	0.001
		N_2O	0.254	0.239	0.227	0.225	0.222	0.220
Material Delivery	T7 Tractor (Diesel)	CO	0.48	0.26	0.16	0.16	0.16	0.16
		NO_x	3.86	2.99	2.02	2.02	2.02	2.01
		VOC	0.12	0.06	0.02	0.02	0.02	0.02
		SO_x	0.013	0.013	0.012	0.012	0.012	0.011
		PM_{10}	0.079	0.040	0.028	0.028	0.029	0.029
		$PM_{2.5}$	0.075	0.038	0.027	0.027	0.028	0.028
		CO_2	1,379	1,333	1,265	1,246	1,226	1,205
		CH_4	0.006	0.003	0.001	0.001	0.001	0.001
		N_2O	0.217	0.210	0.199	0.196	0.193	0.189

Source: CARB's EMFAC2017.
Note: Cars = LDA, Light-Duty Trucks = LDT1, and Heavy Truck = T7.

1.6.2 Off-road Construction Equipment

CARB's OFFROAD2017 model is used to estimate emissions for off-road equipment. **Table B-22** presents the off-road construction equipment used for the analysis, along with the corresponding OFFROAD2017 category description and the horsepower (hp) assigned to each type of construction equipment. A load factor was applied to account for the average operational load level applied to each piece of equipment.

Table B-22: Construction Equipment Data

Equipment	OFFROAD Equipment	Horsepower	Load Factor
40 Ton Crane	Cranes	300	0.43
90 Ton Crane			
Air Compressor	Non-Rental Compressors	100	0.43
Asphalt Paver	Pavers	175	0.59
Backhoe	Tractors/Loaders/Backhoes	100	0.21
Caisson Drilling Rig	Bore/Drill Rigs	175	0.43
Chain Saw	Concrete/Industrial Saws	25	0.7
Chipper/Stump Grinder	Agricultural Construction Equipment	100	0.43
Concrete Pump	Light Commercial Pumps	25	0.43
Concrete Ready Mix Trucks	Off-Highway Trucks	600	0.59
Concrete Saws	Concrete/Industrial Saws	50	0.59
Concrete Truck	Off-Highway Trucks	600	0.59
Curb/Gutter Paver	Pavers	175	0.59
Distributing Tanker	Off-Highway Trucks	600	0.59
Dozer	Rubber Tired Dozers	175	0.59
Dump Truck	Off-Highway Trucks	600	0.59
Excavator	Excavators	175	0.59
Flatbed Truck	Off-Highway Trucks	600	0.59
Fork Lift	Rough Terrain Forklifts	100	0.59
Fork Truck	Rough Terrain Forklifts	100	0.59
Generator	Non-Rental Generator	50	0.43
Grader	Graders	300	0.59
High Lift	Aerial Lifts	100	0.59
Hydroseeder	Agricultural - Others	600	0.59
Loader	Tractors/Loaders/Backhoes	100	0.59
		175	
Man Lift	Aerial Lifts	75	0.21
Material Deliveries	Off-Highway Trucks	600	0.59
Off-Road Truck	Off-Highway Trucks	600	0.59
Other General Equipment	Other Construction Equipment	175	0.43
Pickup Truck	Off-Highway Trucks	600	0.59
Pumps	Light Commercial Pumps	25	0.43
Roller	Rollers	100	0.59
Rubber Tired Loader	Rubber Tire Loaders	175	0.59
Scraper	Scrapers	600	0.59
Skid Steer Loader	Skid Steer Loaders	75	0.21
Slip Form Paver	Paving Equipment	175	0.59
Surfacing Equipment (Grooving)	Paving Equipment	50	0.59
Survey Crew Trucks	Off-Highway Trucks	600	0.59
Tool Truck	Off-Highway Trucks	600	0.59
Tractor Trailer- Material Delivery	Off-Highway Trucks	600	0.59

Equipment	OFFROAD Equipment	Horsepower	Load Factor
Tractor Trailer- Steel Deliveries	Off-Highway Trucks	600	0.59
Tractor Trailers Temp Fac.	Off-Highway Trucks	600	0.59
Tractors/Loader/Backhoe	Tractors/Loaders/Backhoes	75	0.21
		100	
Trencher	Trenchers	75	0.59
Trowel Machine	Other Construction Equipment	600	0.59
Vibratory Compactor	Plate Compactors	25	0.43
Water Truck	Off-Highway Trucks	600	0.59

Source: CARB's OFFROAD2017 and TRB's ACEIT.

The following equation was used to obtain emission estimates for off-road construction equipment:

Construction Equipment Emissions (tons/year) = Emission Factor (grams/hp-hour) x Horsepower (hp) x hours per year x Load Factor x (1 pound/453.59 grams) x (1 ton/2,000 pounds)

Tables B-23 through **B-28** present the off-road construction emissions factors (grams/horsepower-hour) for 2021 through 2026, respectively, for both criteria pollutants/precursor pollutants and GHGs.

Table B-23: 2021 Construction Equipment Emission Factors (grams/hp-hr)

Equipment	Horsepower	VOC	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O
Agricultural - Construction Equipment	100	0.26	1.29	1.76	0.0003	0.143	0.131	28.1	0.0112	0.0051
Agricultural – Others	600	0.10	0.52	1.01	0.0002	0.042	0.039	18.7	0.0074	0.0034
Bore/Drill Rigs	175	0.07	1.26	0.69	0.0021	0.030	0.028	226.9	0.0127	0.0058
Cranes	300	0.08	0.38	0.90	0.0010	0.036	0.033	111.9	0.0062	0.0029
Excavators	175	0.07	0.99	0.65	0.0016	0.032	0.029	168.3	0.0094	0.0043
Graders	300	0.10	0.40	1.19	0.0014	0.039	0.036	155.8	0.0087	0.0040
Off-Highway Trucks	600	0.05	0.32	0.47	0.0012	0.017	0.016	126.5	0.0071	0.0032
Other Construction Equipment	175	0.12	1.15	1.25	0.0018	0.065	0.060	190.1	0.0106	0.0048
	600	0.05	0.40	0.61	0.0013	0.022	0.020	139.1	0.0078	0.0035
Pavers	175	0.10	1.13	1.02	0.0018	0.050	0.046	198.0	0.0111	0.0050
Paving Equipment	50	0.15	1.04	0.96	0.0013	0.050	0.046	143.9	0.0080	0.0037
	175	0.07	0.91	0.72	0.0014	0.036	0.033	156.0	0.0087	0.0040
Rollers	100	0.11	1.14	1.15	0.0016	0.070	0.064	172.8	0.0097	0.0044
Rough Terrain Forklifts	100	0.05	1.25	0.81	0.0019	0.025	0.023	204.4	0.0114	0.0052
Rubber Tired Dozers	175	0.23	1.28	2.22	0.0016	0.127	0.117	175.1	0.0098	0.0045
Rubber Tired Loaders	175	0.11	1.04	0.97	0.0015	0.053	0.049	163.4	0.0091	0.0042
Scrapers	600	0.09	0.68	1.08	0.0017	0.041	0.038	179.4	0.0100	0.0046
Skid Steer Loaders	75	0.06	1.13	0.81	0.0017	0.033	0.030	182.8	0.0102	0.0047
Tractors/Loaders/Backhoes	75	0.57	1.90	4.47	0.0017	0.358	0.330	185.9	0.0104	0.0047
	100	0.09	1.08	0.89	0.0015	0.052	0.047	162.2	0.0091	0.0041
	175	0.07	0.94	0.62	0.0015	0.032	0.029	158.5	0.0089	0.0040
Trenchers	75	0.40	2.07	3.38	0.0023	0.228	0.210	250.7	0.0140	0.0064
Aerial Lifts	75	0.03	0.94	0.48	0.0014	0.011	0.010	156.7	0.0088	0.0040

Equipment	Horsepower	VOC	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O
	100	0.03	0.77	0.48	0.0012	0.006	0.006	127.0	0.0071	0.0032
Concrete/Industrial Saws	25	0.29	1.21	2.23	0.0037	0.083	0.077	293.1	0.0168	0.0076
	50	0.29	2.17	1.96	0.0036	0.089	0.082	274.7	0.0158	0.0072
Plate Compactors	25	0.08	0.48	0.57	0.0012	0.022	0.020	78.2	0.0045	0.0020
Light Commercial – Pumps	25	0.20	0.99	1.46	0.0026	0.068	0.063	184.9	0.0106	0.0048
Non-Rental Compressor	100	0.06	0.91	0.70	0.0012	0.046	0.043	134.3	0.0075	0.0034
Non-Rental Generator	50	0.13	1.52	1.35	0.0014	0.064	0.059	148.0	0.0083	0.0038

Source: CARB's OFFROAD2017.

Table B-24: 2022 Construction Equipment Emission Factors (grams/hp-hr)

Equipment	Horsepower	VOC	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O
Agricultural - Construction Equipment	100	0.25	1.28	1.65	0.0003	0.135	0.124	28.1	0.0112	0.0051
Agricultural – Others	600	0.10	0.50	0.95	0.0002	0.040	0.037	18.7	0.0074	0.0034
Bore/Drill Rigs	175	0.06	1.26	0.56	0.0021	0.025	0.023	227.1	0.0127	0.0058
Cranes	300	0.07	0.38	0.79	0.0010	0.033	0.030	111.7	0.0062	0.0028
Excavators	175	0.06	0.98	0.54	0.0016	0.026	0.024	168.3	0.0094	0.0043
Graders	300	0.09	0.38	1.06	0.0014	0.035	0.032	155.7	0.0087	0.0040
Off-Highway Trucks	600	0.05	0.30	0.36	0.0012	0.013	0.012	126.4	0.0071	0.0032
Other Construction Equipment	175	0.11	1.14	1.09	0.0018	0.057	0.052	190.0	0.0106	0.0048
	600	0.05	0.36	0.50	0.0013	0.018	0.017	139.2	0.0078	0.0035
Pavers	175	0.08	1.13	0.83	0.0018	0.040	0.037	198.2	0.0111	0.0050
Paving Equipment	50	0.14	1.05	0.95	0.0013	0.047	0.043	144.0	0.0080	0.0037
	175	0.07	0.91	0.67	0.0014	0.036	0.033	155.2	0.0087	0.0040
Rollers	100	0.10	1.13	1.02	0.0016	0.059	0.054	172.9	0.0097	0.0044
Rough Terrain Forklifts	100	0.05	1.24	0.75	0.0019	0.020	0.018	204.5	0.0114	0.0052
Rubber Tired Dozers	175	0.21	1.23	1.89	0.0016	0.120	0.111	170.0	0.0095	0.0043
Rubber Tired Loaders	175	0.09	1.02	0.78	0.0015	0.042	0.039	163.3	0.0091	0.0042
Scrapers	600	0.08	0.62	0.90	0.0017	0.034	0.032	179.5	0.0100	0.0046
Skid Steer Loaders	75	0.06	1.13	0.75	0.0017	0.028	0.025	183.0	0.0102	0.0047
Tractors/Loaders/Backhoes	75	0.56	1.87	4.40	0.0017	0.356	0.328	186.0	0.0104	0.0047
	100	0.08	1.07	0.78	0.0015	0.041	0.038	162.4	0.0091	0.0041
	175	0.06	0.93	0.53	0.0015	0.027	0.025	158.6	0.0089	0.0040
Trenchers	75	0.41	2.08	3.45	0.0023	0.236	0.218	249.8	0.0139	0.0064
Aerial Lifts	75	0.03	0.95	0.49	0.0014	0.009	0.008	156.9	0.0088	0.0040
	100	0.02	0.76	0.38	0.0012	0.007	0.007	127.8	0.0071	0.0033
Concrete/Industrial Saws	25	0.30	1.22	2.27	0.0038	0.085	0.078	297.2	0.0170	0.0078
	50	0.26	2.13	1.89	0.0035	0.076	0.070	273.4	0.0157	0.0072
Plate Compactors	25	0.08	0.48	0.57	0.0012	0.022	0.020	78.2	0.0045	0.0020
Light Commercial – Pumps	25	0.19	0.99	1.44	0.0026	0.065	0.060	184.9	0.0106	0.0048
Non-Rental Compressor	100	0.04	0.91	0.56	0.0012	0.037	0.034	134.3	0.0075	0.0034
Non-Rental Generator	50	0.13	1.52	1.35	0.0014	0.064	0.059	148.0	0.0083	0.0038

Source: CARB's OFFROAD2017.

Table B-25: 2023 Construction Equipment Emission Factors (grams/hp-hr)

Equipment	Horsepower	VOC	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O
Agricultural - Construction Equipment	100	0.23	1.27	1.54	0.0003	0.127	0.117	28.1	0.0112	0.0051
Agricultural – Others	600	0.10	0.48	0.89	0.0002	0.037	0.034	18.7	0.0074	0.0034
Bore/Drill Rigs	175	0.05	1.26	0.47	0.0021	0.021	0.019	228.2	0.0127	0.0058
Cranes	300	0.07	0.38	0.73	0.0010	0.031	0.028	111.5	0.0062	0.0028
Excavators	175	0.06	0.98	0.47	0.0016	0.023	0.021	168.3	0.0094	0.0043
Graders	300	0.08	0.38	0.95	0.0014	0.032	0.029	154.7	0.0086	0.0039
Off-Highway Trucks	600	0.04	0.29	0.32	0.0012	0.011	0.011	126.4	0.0071	0.0032
Other Construction Equipment	175	0.10	1.14	0.98	0.0018	0.051	0.047	190.0	0.0106	0.0048
	600	0.05	0.35	0.46	0.0013	0.017	0.016	139.8	0.0078	0.0036
Pavers	175	0.08	1.12	0.74	0.0018	0.035	0.033	198.2	0.0111	0.0050
Paving Equipment	50	0.13	1.05	0.93	0.0013	0.043	0.039	144.2	0.0081	0.0037
	175	0.07	0.92	0.62	0.0014	0.032	0.030	155.5	0.0087	0.0040
Rollers	100	0.09	1.12	0.95	0.0016	0.052	0.048	172.9	0.0097	0.0044
Rough Terrain Forklifts	100	0.05	1.25	0.71	0.0019	0.017	0.016	204.6	0.0114	0.0052
Rubber Tired Dozers	175	0.20	1.23	1.84	0.0016	0.117	0.107	168.9	0.0094	0.0043
Rubber Tired Loaders	175	0.08	1.02	0.69	0.0015	0.037	0.034	163.2	0.0091	0.0042
Scrapers	600	0.08	0.60	0.84	0.0017	0.032	0.030	179.5	0.0100	0.0046
Skid Steer Loaders	75	0.05	1.13	0.71	0.0017	0.024	0.022	183.3	0.0102	0.0047
Tractors/Loaders/Backhoes	75	0.56	1.87	4.38	0.0017	0.356	0.328	186.6	0.0104	0.0048
	100	0.07	1.07	0.71	0.0015	0.034	0.031	162.5	0.0091	0.0041
	175	0.06	0.93	0.46	0.0015	0.023	0.021	158.9	0.0089	0.0040
Trenchers	75	0.42	2.08	3.48	0.0023	0.241	0.222	248.0	0.0139	0.0063
Aerial Lifts	75	0.03	0.91	0.49	0.0014	0.011	0.010	151.6	0.0085	0.0039
	100	0.02	0.76	0.34	0.0012	0.004	0.004	126.1	0.0070	0.0032
Concrete/Industrial Saws	25	0.30	1.23	2.27	0.0038	0.085	0.078	297.7	0.0168	0.0077
	50	0.24	2.11	1.84	0.0035	0.065	0.060	274.0	0.0158	0.0072
Plate Compactors	25	0.08	0.48	0.57	0.0012	0.022	0.020	78.2	0.0045	0.0020
Light Commercial – Pumps	25	0.19	0.98	1.43	0.0026	0.062	0.057	184.9	0.0106	0.0048
Non-Rental Compressor	100	0.04	0.91	0.53	0.0012	0.035	0.032	134.3	0.0075	0.0034
Non-Rental Generator	50	0.13	1.52	1.35	0.0014	0.064	0.059	148.0	0.0083	0.0038

Source: CARB's OFFROAD2017.

Table B-26: 2024 Construction Equipment Emission Factors (grams/hp-hr)

Equipment	Horsepower	VOC	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O
Agricultural - Construction Equipment	100	0.22	1.27	1.44	0.0003	0.120	0.110	28.1	0.0112	0.0051
Agricultural – Others	600	0.09	0.46	0.84	0.0002	0.035	0.032	18.7	0.0074	0.0034
Bore/Drill Rigs	175	0.05	1.27	0.45	0.0021	0.020	0.019	227.9	0.0127	0.0058
Cranes	300	0.06	0.36	0.66	0.0010	0.028	0.025	111.3	0.0062	0.0028
Excavators	175	0.05	0.98	0.43	0.0016	0.021	0.019	168.4	0.0094	0.0043
Graders	300	0.08	0.37	0.85	0.0014	0.028	0.026	154.3	0.0086	0.0039
Off-Highway Trucks	600	0.04	0.29	0.30	0.0012	0.011	0.010	126.5	0.0071	0.0032
Other Construction Equipment	175	0.10	1.14	0.92	0.0018	0.048	0.044	189.9	0.0106	0.0048
	600	0.04	0.35	0.41	0.0013	0.015	0.014	139.7	0.0078	0.0036
Pavers	175	0.07	1.13	0.69	0.0018	0.033	0.030	198.1	0.0111	0.0050
Paving Equipment	50	0.13	1.06	0.93	0.0013	0.041	0.037	144.1	0.0081	0.0037
	175	0.07	0.92	0.59	0.0014	0.031	0.029	155.8	0.0087	0.0040
Rollers	100	0.09	1.12	0.90	0.0016	0.047	0.043	172.9	0.0097	0.0044
Rough Terrain Forklifts	100	0.05	1.25	0.69	0.0019	0.017	0.015	204.6	0.0114	0.0052
Rubber Tired Dozers	175	0.19	1.21	1.66	0.0016	0.107	0.099	169.9	0.0095	0.0043
Rubber Tired Loaders	175	0.08	1.02	0.59	0.0015	0.032	0.029	163.1	0.0091	0.0042
Scrapers	600	0.08	0.58	0.78	0.0017	0.030	0.028	179.6	0.0100	0.0046
Skid Steer Loaders	75	0.05	1.13	0.67	0.0017	0.021	0.019	183.3	0.0102	0.0047
Tractors/Loaders/Backhoes	75	0.57	1.90	4.48	0.0017	0.359	0.330	185.0	0.0103	0.0047
	100	0.07	1.07	0.67	0.0015	0.030	0.027	162.6	0.0091	0.0041
	175	0.05	0.94	0.42	0.0015	0.021	0.019	159.1	0.0089	0.0041
Trenchers	75	0.39	2.04	3.40	0.0023	0.254	0.234	254.9	0.0142	0.0065
Aerial Lifts	75	0.03	0.91	0.47	0.0014	0.010	0.010	151.6	0.0085	0.0039
	100	0.02	0.76	0.34	0.0012	0.004	0.004	126.4	0.0071	0.0032
Concrete/Industrial Saws	25	0.30	1.24	2.30	0.0038	0.086	0.079	301.7	0.0168	0.0077
	50	0.22	2.09	1.78	0.0035	0.056	0.051	273.9	0.0157	0.0072
Plate Compactors	25	0.08	0.48	0.57	0.0012	0.022	0.020	78.2	0.0045	0.0020
Light Commercial – Pumps	25	0.19	0.98	1.42	0.0026	0.060	0.055	184.9	0.0106	0.0048
Non-Rental Compressor	100	0.04	0.91	0.55	0.0012	0.036	0.033	134.3	0.0075	0.0034
Non-Rental Generator	50	0.13	1.52	1.35	0.0014	0.064	0.059	148.0	0.0083	0.0038

Source: CARB's OFFROAD2017.

Table B-27: 2025 Construction Equipment Emission Factors (grams/hp-hr)

Equipment	Horsepower	VOC	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O
Agricultural - Construction Equipment	100	0.21	1.26	1.34	0.0003	0.113	0.104	28.1	0.0112	0.0051
Agricultural – Others	600	0.09	0.45	0.78	0.0002	0.033	0.031	18.7	0.0074	0.0034
Bore/Drill Rigs	175	0.05	1.27	0.39	0.0021	0.017	0.016	227.5	0.0127	0.0058
Cranes	300	0.06	0.32	0.58	0.0010	0.025	0.023	110.9	0.0062	0.0028
Excavators	175	0.05	0.98	0.37	0.0016	0.018	0.017	168.4	0.0094	0.0043
Graders	300	0.07	0.36	0.72	0.0014	0.024	0.022	154.7	0.0086	0.0039
Off-Highway Trucks	600	0.04	0.28	0.26	0.0012	0.009	0.008	126.4	0.0071	0.0032

Equipment	Horsepower	VOC	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O
Other Construction Equipment	175	0.09	1.14	0.79	0.0018	0.041	0.038	190.1	0.0106	0.0048
	600	0.04	0.34	0.38	0.0013	0.014	0.013	141.4	0.0079	0.0036
Pavers	175	0.07	1.13	0.63	0.0018	0.030	0.028	198.1	0.0111	0.0050
Paving Equipment	50	0.12	1.04	0.90	0.0013	0.035	0.032	144.1	0.0080	0.0037
	175	0.06	0.92	0.50	0.0014	0.026	0.024	156.3	0.0087	0.0040
Rollers	100	0.08	1.12	0.85	0.0016	0.042	0.039	172.8	0.0097	0.0044
Rough Terrain Forklifts	100	0.05	1.25	0.66	0.0019	0.014	0.013	204.6	0.0114	0.0052
Rubber Tired Dozers	175	0.17	1.19	1.44	0.0016	0.093	0.086	170.1	0.0095	0.0043
Rubber Tired Loaders	175	0.07	1.02	0.50	0.0015	0.026	0.024	163.1	0.0091	0.0042
Scrapers	600	0.07	0.53	0.65	0.0017	0.025	0.023	179.0	0.0100	0.0046
Skid Steer Loaders	75	0.05	1.13	0.65	0.0017	0.020	0.018	183.2	0.0102	0.0047
Tractors/Loaders/Backhoes	75	0.56	1.87	4.41	0.0017	0.356	0.328	184.4	0.0103	0.0047
	100	0.06	1.07	0.62	0.0015	0.024	0.022	162.8	0.0091	0.0041
	175	0.05	0.93	0.36	0.0015	0.018	0.016	159.1	0.0089	0.0041
Trenchers	75	0.46	2.10	3.63	0.0023	0.277	0.255	246.9	0.0138	0.0063
Aerial Lifts	75	0.03	0.92	0.45	0.0014	0.008	0.008	155.2	0.0087	0.0040
	100	0.02	0.78	0.36	0.0012	0.005	0.005	128.4	0.0072	0.0033
Concrete/Industrial Saws	25	0.30	1.24	2.30	0.0038	0.086	0.079	302.1	0.0172	0.0078
	50	0.21	2.08	1.74	0.0036	0.048	0.044	274.9	0.0158	0.0072
Plate Compactors	25	0.08	0.48	0.57	0.0012	0.022	0.020	78.2	0.0045	0.0020
Light Commercial - Pumps	25	0.19	0.98	1.41	0.0026	0.059	0.054	184.9	0.0106	0.0048
Non-Rental Compressor	100	0.04	0.90	0.48	0.0012	0.034	0.031	134.3	0.0075	0.0034
Non-Rental Generator	50	0.13	1.52	1.02	0.0014	0.039	0.036	148.0	0.0083	0.0038

Source: CARB's OFFROAD2017.

Table B-28: 2026 Construction Equipment Emission Factors (grams/hp-hr)

Equipment	Horsepower	VOC	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O
Agricultural - Construction Equipment	100	0.20	1.25	1.25	0.0003	0.106	0.097	28.1	0.0112	0.0051
Agricultural – Others	600	0.09	0.43	0.73	0.0002	0.031	0.029	18.7	0.0074	0.0034
Bore/Drill Rigs	175	0.05	1.27	0.38	0.0021	0.017	0.016	227.7	0.0127	0.0058
Cranes	300	0.05	0.31	0.53	0.0010	0.022	0.020	111.0	0.0062	0.0028
Excavators	175	0.05	0.98	0.32	0.0016	0.016	0.014	168.4	0.0094	0.0043
Graders	300	0.06	0.35	0.62	0.0014	0.021	0.019	154.7	0.0086	0.0039
Off-Highway Trucks	600	0.04	0.28	0.24	0.0012	0.009	0.008	126.5	0.0071	0.0032
Other Construction Equipment	175	0.08	1.13	0.71	0.0018	0.036	0.034	190.2	0.0106	0.0048
	600	0.04	0.33	0.34	0.0013	0.013	0.012	141.7	0.0079	0.0036
Pavers	175	0.06	1.13	0.56	0.0018	0.027	0.025	198.1	0.0111	0.0050
Paving Equipment	50	0.11	1.03	0.88	0.0013	0.031	0.029	144.1	0.0080	0.0037
	175	0.05	0.90	0.45	0.0014	0.022	0.020	154.6	0.0086	0.0039
Rollers	100	0.08	1.12	0.81	0.0016	0.038	0.035	172.9	0.0097	0.0044
Rough Terrain Forklifts	100	0.04	1.25	0.64	0.0019	0.013	0.012	204.6	0.0114	0.0052
Rubber Tired Dozers	175	0.14	1.18	1.22	0.0016	0.072	0.067	173.6	0.0097	0.0044

Equipment	Horsepower	VOC	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$	CO_2	CH_4	N_2O
Rubber Tired Loaders	175	0.07	1.02	0.43	0.0015	0.023	0.021	163.2	0.0091	0.0042
Scrapers	600	0.07	0.52	0.59	0.0017	0.023	0.021	179.1	0.0100	0.0046
Skid Steer Loaders	75	0.05	1.12	0.63	0.0017	0.018	0.016	183.2	0.0102	0.0047
Tractors/Loaders/Backhoes	75	0.55	1.83	4.28	0.0017	0.353	0.324	186.2	0.0104	0.0047
	100	0.06	1.07	0.58	0.0015	0.020	0.018	162.9	0.0091	0.0042
	175	0.05	0.94	0.33	0.0015	0.016	0.015	159.2	0.0089	0.0041
Trenchers	75	0.48	2.13	3.76	0.0022	0.283	0.260	244.6	0.0137	0.0062
Aerial Lifts	75	0.03	0.93	0.46	0.0014	0.009	0.008	155.6	0.0087	0.0040
	100	0.02	0.76	0.34	0.0012	0.004	0.004	126.9	0.0071	0.0032
Concrete/Industrial Saws	25	0.29	1.22	2.25	0.0038	0.084	0.077	295.6	0.0168	0.0077
	50	0.20	2.06	1.68	0.0035	0.041	0.037	274.4	0.0158	0.0072
Plate Compactors	25	0.08	0.48	0.57	0.0012	0.022	0.020	78.2	0.0045	0.0020
Light Commercial - Pumps	25	0.19	0.97	1.40	0.0026	0.058	0.053	184.9	0.0106	0.0048
Non-Rental Compressor	100	0.04	0.90	0.48	0.0012	0.034	0.031	134.3	0.0075	0.0034
Non-Rental Generator	50	0.13	1.52	1.02	0.0014	0.039	0.036	148.0	0.0083	0.0038

Source: CARB's OFFROAD2017.

1.6.3 Construction Schedules

Tables B-29 and **B-30** provide the demolition and new construction data (including descriptions of each project element, project element location, and approximate areas) along with the construction schedules for the Proposed Project. The construction schedules indicate that construction would begin in 2021 and be completed in 2026. Notably, the construction schedules are intended to provide a reasonable and conservative representation of project-related construction activities for emissions estimation purposes based on information available at the time of the analysis. It should be noted that at the time the air quality analysis for the Proposed Project was completed, the demolition of several existing buildings was included in Phase A of the project, as delineated in Table B-29. It was subsequently determined, however, that such demolition would occur as part of the Airport Support Facilities relocation program, which is separate from, and independent of, the Proposed Project. As such, the construction (demolition) emissions estimates presented for the Proposed Project are considered to be conservative (i.e., high).

Table B-29: Demolition by Phase

Phase	Facility	Approximate Area (SF)	Current Use	Disposition of Facility/Use
Phase A (2021-2024)				
A	Airport Administration Building	132,000	Airport administration offices	Building to be demolished. Function to be moved to a new building constructed on the west side of airport as part of the Proposed Project.
A	*Facilities Maintenance Department (FMD) Administration Building (1)*	10,000	FMD administrative offices	Building to be demolished. Function moved to new support facilities complex developed on the north side to be developed separate from the Proposed Project.
A	*Triturator and Wash Rack (1)*	3,500	Lavatory waste trituration and vehicle washing	Buildings to be demolished. Function relocated to a smaller consolidated facility within the south side support facilities area separate from the Proposed Project.
A	*United Cargo (1)*	17,000	Aircraft belly cargo handling	Building to be demolished. Function relocated to the consolidated Airline Facility Support Building on the south side (east of the new Terminal 1) to be developed separate from the Proposed Project.
A	*Southwest Cargo (1)*	32,000	Aircraft belly cargo handling	Building to be demolished. Function relocated to the consolidated Airline Facility Support Building on the south side (east of the new Terminal 1) to be developed separate from the Proposed Project.
A	*Air Freight (Southwest, Alaska, Hawaiian, Delta, JetBlue) (1)*	30,000	Aircraft belly cargo handling	Building to be demolished. Function relocated to the consolidated Airline Support Building on the south side (east of the new Terminal 1) to be developed separate from the Proposed Project.
A	*Menzies Aviation Maintenance (1)*	9,000	Fueling administration and support facility	Building to be deconstructed and reconstructed at a different location. Function of building will be relocated to the consolidated Airline Support Building on the south side (east of the new Terminal 1) to be developed separate from the Proposed Project.
A	*American Airlines Maintenance (1)*	12,000	Airline maintenance facility	Building to be demolished. Function relocated to the consolidated Airline Support Building on the south side (east of the new Terminal 1) to be developed separate from the Proposed Project.
A	*FMD Workshop; Paint Shop and Procurement (1)*	29,000	FMD maintenance workshop	Building to be demolished. Function moved to new support facilities complex on the north side to be developed separate from the Proposed Project.
A	*FMD Maintenance Shops (1)*	25,000	FMD maintenance workshop	Building to be demolished. Function moved to new support facilities complex on the north side to be developed separate from the Proposed Project.
A	Terminal 1 (Gates 1, 1A, and 2)	36,000	Passenger terminal	Partial structure to be demolished to make way for construction of initial phase of new Terminal 1 (East).
A	On-Airport Roadways	590,000	Arrivals/departure entry roadway	Airport roads and associated features to be demolished for construction of new roadway and parking improvements in Phase

Table B-29: Demolition by Phase

Phase	Facility	Approximate Area (SF)	Current Use	Disposition of Facility/Use
				A.
A	Administration Building Parking Lot and Access Roads	390,000	Airport administration parking and access roads	Surface parking, airport roads, and associated features to be demolished for construction of new roadway improvements in Phase A.
A	Taxiway B	585,000	Taxiway B	Taxiway pavement to be demolished and replaced in conjunction with new Terminal 1 improvements in Phase A.
A	Employee/Public/Taxi Parking Lots	1,493,000	Employee, public, and taxi parking	Surface parking lot and associated features to be demolished in conjunction with new Terminal 1 improvements in Phase A.
A	Terminal 1 Parking Lot	470,000	Terminal 1 surface parking lot	Surface parking lot and associated features to be demolished for construction of new roadway and parking improvements in Phase A.
A	Aircraft Apron	1,265,000	Aircraft apron	Aircraft apron pavement to be demolished and replaced in conjunction with initial phase of new Terminal 1.
Phase A - Buildings Total		**335,500**		
Phase A - Surface Elements Total		**4,793,000**		
Phase A - Total		**5,128,500**		
Phase B (2024-2026)				
B	Terminal 1	300,000	Passenger terminal	Building to be demolished and replaced with remainder of new Terminal 1.
B	Terminal 1 Parking Lot	100,000	Surface parking lot	Surface parking lot and associated features to be demolished for construction of remainder of new Terminal 1 Parking Structure (East).
B	Aircraft Apron	580,000	Aircraft apron	Aircraft apron pavement to be demolished and replaced in conjunction with remaining phase of new Terminal 1.
Phase B - Buildings Total		**300,000**		
Phase B - Surface Elements Total		**680,000**		
Phase B - Total		**980,000**		
Proposed Project Total [demolition]				
Buildings		**635,500**		
Surface Elements		**5,473,000**		
Grand Total		**6,108,500**		

Source: CDM Smith, 2019/2020.

Note: (1) Demolition of facilities indicated in yellow boxes with *italic text* are separate and independent projects from the Proposed Project.

Table B-30: New Construction by Phase

Phase	Facility Type	Approximate Area (square feet)	Building Height (feet above ground level)	Building Stories
Phase A (2021-2024)				
A	Terminal 1 - 19 Gates	835,000	90	3
A	Terminal 1 Parking Plaza	2,250,000	60	5
A	Airport Administration Building	150,000	84	5
A	Existing CUP Capacity Expansion	12,000	45 (Existing)	1 (Existing)
A	Aircraft Apron	1,120,000	-	-
A	Taxiway A	506,000	-	-
A	Taxiway B	640,000	-	-
A	Terminal Area Roads-On Grade	310,000	-	-
A	Terminal Area Roads-Structure	170,000	-	-
A	Airport Access Road-On Grade	165,000	-	-
A	Airport Access Road-Structure	9,300	-	-
A	Aircraft Overnight Parking	230,000	-	-
	Phase A - Buildings Total	**3,247,000**		
	Phase A - Surface Elements Total	**3,150,300**		
	Phase A - Total	**6,397,300**		
Phase B (2024-2026)				
B	Terminal 1 - 11 Gates	375,000	65	3
B	Aircraft Apron	285,000	-	-
B	Taxiway A	269,000	-	-
B	Terminal Area Road-On Grade	20,000	-	-
B	Transit-Ready Area	100,000		
	Phase B - Buildings Total	**375,000**		
	Phase B - Surface Elements Total	**674,000**		
	Phase B - Total	**1,049,000**		
Proposed Project Total [new construction]				
	Buildings	**3,622,000**		
	Surface Elements	**3,824,300**		
	Grand Total	**7,446,300**		

Source: CDM Smith, 2019/2020.

1.6.4 Hours of Construction

Table B-31 lists the construction equipment types and total number of operating hours by equipment type during each major phase of project development (i.e., Phases A and B). These data were used to estimate construction-related air pollutant, pollutant precursor, and GHG emissions for the Proposed Project.

The types of construction activities and equipment/vehicle activity data (e.g., equipment mixes/operating times) were estimated using the (TRB's ACEIT. The ACEIT was developed by the TRB to better ensure how construction equipment is characterized and to more consistently represent the level of activity data that is used in the preparation of airport-related assessments. According to documentation prepared by the TRB for ACEIT, the activity data (hours of use) that is output by the tool was developed for each type of equipment based on expert engineering judgement and experience with airport construction projects.

Table B-31: Hours of Construction

Phase A (2021-2024)

Equipment	Hours of Operation
40 Ton Crane	2,921
90 Ton Crane	15,010
Air Compressor	1,166
Asphalt Paver	1,180
Backhoe	14,651
Caisson Drilling Rig	1,125
Chain Saw	964
Chipper/Stump Grinder	964
Concrete Pump	1,238
Concrete Ready Mix Trucks	8,230
Concrete Saws	1,166
Concrete Truck	9,259
Curb/Gutter Paver	1,090
Distributing Tanker	400
Dozer	11,712
Dump Truck	17,384
Dump Truck (12 cy)	11,014
Excavator	12,788
Flatbed Truck	7,204
Fork Truck	118,873
Forklift	2,250
Generator	14,188
Grader	388
High Lift	34,495
Hydroseeder	349
Loader	5,699
Man Lift	99,940
Man Lift (Fascia Construction)	932
Material Deliveries	2,542
Off-Road Truck	349
Other General Equipment	15,931
Pickup Truck	39,804
Pumps	3,696
Roller	4,589
Rubber Tired Loader	1,166
Scraper	1,458
Skid Steer Loader	2,616
Slip Form Paver	1,166
Surfacing Equipment (Grooving)	1,726
Survey Crew Trucks	427
Tool Truck	27,301
Tractor Trailer- Material Delivery	33,691
Tractor Trailer- Steel Deliveries	3,579
Tractor Trailers Temp Fac.	178
Tractors/Loader/Backhoe	13,903
Trencher	2,993
Trowel Machine	2,644
Vibratory Compactor	2,181
Water Truck	25,928

Phase B (2024-2026)

Equipment	Hours of Operation
40 Ton crane	109
90 Ton Crane	4,001
Air Compressor	212
Asphalt Paver	80
Backhoe	4,171
Caisson Drilling Rig	20
Chain Saw	178
Chipper/Stump Grinder	3,058
Concrete Pump	150
Concrete Ready Mix Trucks	892
Concrete Saws	212
Concrete Truck	1,305
Curb/Gutter Paver	33
Distributing Tanker	84
Dozer	2,076
Dump Truck	7,924
Dump Truck (12 cy)	2,005
Excavator	4,552
Flatbed Truck	1,323
Fork Truck	42,550
Generator	7,350
Grader	67
High Lift	11,679
Hydroseeder	60
Loader	7,761
Man Lift	37,500
Man Lift (Fascia Construction)	300
Material Deliveries	892
Off-Road Truck	80
Other General Equipment	2,433
Pickup Truck	9,176
Pumps	55
Roller	1,091
Rubber Tired Loader	212
Scraper	265
Skid Steer Loader	210
Slip Form Paver	421
Surfacing Equipment (Grooving)	314
Survey Crew Trucks	408
Tool Truck	9,278
Tractor Trailer- Material Delivery	11,634
Tractor Trailer- Steel Deliveries	499
Tractor Trailers Temp Fac.	475
Tractors/Loader/Backhoe	285
Trowel Machine	150
Vibratory Compactor	67
Water Truck	8,076

2.0 Greenhouse Gases

This section presents the overall data, assumptions, and methodology for preparing the GHG emissions inventory in support of the GHG impacts analysis for the SAN Airfield Improvements and Terminal 1 Replacement Project EA. As was prepared for criteria air pollutants, GHG emissions inventories were prepared for future years (2026 and 2031) for the No Action Alternative and the Proposed Project, using the best available data at the time of the analysis.

The GHGs inventoried were CO_2, CH_4, and N_2O. As is customary for GHG emissions inventories, the results are reported in units of metric tons (MT) of carbon dioxide equivalents (CO_2e), by source, and on an annual basis. The GHG emission results were converted to CO_2e values using the Global Warming Potential (GWP) values of 1 for CO_2, 28 for CH_4, and 265 for N_2O, based on a 100-year period.[11] GWP values are relative measures of how much heat a GHG traps in the atmosphere, when compared to carbon dioxide (e.g., CH_4 is 28 times as potent a GHG than CO_2). For this purpose, estimates of CH_4 and N_2O emissions are multiplied by their respective GWP values (28 for CH_4 and 265 for N_2O) to determine the CO_2e.

2.1 Aircraft

The GHG emissions from aircraft activity are directly attributable to the level of fuel consumption by the aircraft. Estimates of fuel consumption for the No Action Alternative and the Proposed Project for future years (2026 and 2031) were obtained from the AEDT output that was prepared for the air quality analysis. This information included fuel consumption for all aircraft operational modes within the LTO below the modeling height elevation of 3,000 feet. With the exception of ground-based delay and taxi times, AEDT default time-in-mode were used to calculate fuel estimates used in the GHG analysis.

For the purpose of calculating aircraft related-GHG emissions, the AEDT fuel usage was segregated by aircraft powered by Jet A fuel (i.e., aircraft with jet or turboprop engines) and those that are powered by aviation gasoline (i.e., piston aircraft).

GHG emissions were calculated using the appropriate emission factors from the USEPA's GHG Emission Factors Hub (as of March 2018).[12] **Table B-32** presents the GHG emission factors used to prepare the GHG emission estimates.

Table B-32: Aircraft Fuel GHG Emission Factors

Fuel	CO_2	N_2O	CH_4	Units
Jet A	21.5	0.0007	--[1]	lb/gallon
AvGas	18.3	0.0002	0.02	lb/gallon

Source: USEPA, Center for Corporate Climate Leadership GHG Emission Factors Hub, March 2018. For additional information see the FAA's Air Quality Handbook, Version 3.

2.2 Ground Support Equipment

GHG emissions from GSE were calculated using the same methodology and input data used to develop the criteria pollutant emissions inventories as presented in Section 1.2, and CARB's OFFROAD model was used to provide emission factors for CO_2. Therefore, emissions for N_2O and CH_4, were calculated using the appropriate emission factors from the USEPA's GHG Emission Factors Hub (as of March 2018).

[11] Intergovernmental Panel on Climate Change (IPCC), *Fifth Assessment Report*, 2014.
[12] USEPA, GHG Emission Factors Hub (March 2018), https://www.epa.gov/sites/default/files/2018-03/documents/emission-factors_mar_2018_0.pdf.

2.3 Stationary Sources

Similar to the criteria air pollutant inventory, stationary source GHG emissions were based on existing and proposed annual fuel usage and/or throughputs (see Section 1.3 of this appendix). GHGs emission factors were derived from the USEPA's GHG Emission Factors Hub.

2.4 Motor Vehicles

GHGs for motor vehicles were calculated using the same methodology and data used to develop the criteria pollutant emissions inventories as presented in Section 1.4. VMT were calculated for airport-related motor vehicles operating on the internal roadway network, terminal building curbsides, and off-airport roadways. Vehicle parameters (e.g., vehicle type, speed, fuel type, etc.) were captured within the EMFAC2017 model. The vehicle and fuel mix data are provided in Tables B-16. Emission factors are provided in Tables B-17 and B-18, and daily on- and off-airport traffic volumes are presented in Tables B-19 and B-20, respectively, of this appendix.

On June 26, 2020, CARB published off-model factors to adjust the emissions output of CO_2 from EMFAC2017 to account for the impact of the SAFE Vehicles Rule Part One and the Final SAFE Rule."[13] As stated in Section 1.4, the SAFE rule revokes California's authority to set zero-emission vehicle mandates and it is therefore assumed to increase emissions of CO_2.

To account for this potential increase in emissions due to the SAFE Vehicle Rule, the total motor vehicle-related emissions of CO_2 estimated for the years 2026 and 2031 were increased using CARB's EMFAC2017 adjustment factors released on June 26th, 2020. Although the factors only apply to estimated emissions resulting from the operation of gasoline light duty vehicles, similar to criteria pollutant emissions estimates, these factors were conservatively applied to total emission estimates (i.e., to emission estimates from both gasoline and diesel fueled vehicles and both light- and heavy-duty vehicles).

The following equation was used to obtain annual GHG emissions for motor vehicle:

Motor Vehicle Emissions (metric tons of CO_2e/year) = Emission Factor (g/mile) x vehicle miles travelled per day x (365 days/year) x (1 pound/453.59 grams) x (1 ton/2,000 pounds) x (1 metric ton/1.102 ton) x global warming potential (GWP)

2.5 Other Sources

As for the criteria pollutants, emissions of GHGs were estimated using CAPCOA's CalEEMod. For GHGs, CalEEMod provides estimate of emissions due to electricity and natural gas usage, water usage, and solid waste disposal. For the Existing condition and the No Action Alternative, the total square footage of all of the buildings at SAN were used for input to CalEEMod (see Section 1.5 of this appendix). The Proposed Project was also modeled using CalEEMod and were based on the information and square footages provided in Section 1.6.3 of this appendix.

The amount of water used and wastewater generated by the project has GHG emissions associated with it. These emissions are a result of the energy used to supply, distribute, and treat the water and wastewater.

[13] CARB, *EMFAC Off-Model Adjustment Factors for CO_2 Emissions to Account for the SAFE Vehicle Rule Part One and the Final SAFE Rule*, June 26, 2020. Available: https://ww3.arb.ca.gov/msei/emfac_off_model_co2_adjustment_factors_06262020-final.pdf.

CalEEMod was used to quantify the energy and associated GHG emissions attributable to water and wastewater use.

Municipal solid waste is the amount of material that is disposed of by land filling, recycling, or composting. CalEEMod was used to estimate the GHG emissions associated with waste disposal. The model uses annual waste disposal rates from the California Department of Resources Recycling and Recovery (CalRecycle) data for individual land uses.

2.6 Construction

GHG emissions were estimated for construction activities categorized as off-road (e.g., graders, excavators, paving equipment) and for on-road vehicles associated with construction (e.g., laborer/worker) trips commuting to and from the worksite and haul trucks. The same methodology and data used to develop the criteria pollutant emission inventory was used for the GHG emissions inventory. Construction equipment data including equipment type, horsepower, and load factors are presented in Table B-24 of this appendix.

GHG emissions including CO_2, CH_4, and N_2O were evaluated for the construction period of 2021 through 2026. Emissions factors for on-road vehicles and off-road construction equipment were developed using CARB's EMFAC2017 and OFFROAD2017, respectively. EMFAC2017 emission factors associated with commuter vehicles, hauling, delivery, and pickup trucks for the construction period are presented in Table B-21 of this appendix. OFFROAD2017 emission factors for off-road construction equipment are presented in Table B-23 through B-28 of this appendix.

The following equation was used to obtain annual GHG emission for off-road construction equipment:

Construction Equipment Emissions (metric tons of CO_2e/year) = Emission Factor (grams/hp-hour) x Horsepower (hp) x hours per year x Load Factor x (1 pound/453.59 grams) x (1 ton/2,000 pounds) x (1 metric ton/1.102 ton) x global warming potential (GWP)

3.0 Hazardous Air Pollutants

Hazardous air pollutants (HAPs) comprise of a wide array of organic and inorganic compounds that are present in the exhaust of aircraft, APUs, GSE, and motor vehicle engines and, to a lesser extent, in boilers, fuel facilities, and other stationary sources; thus, these latter sources were not included in the analysis. It should be noted that there are currently no federal regulatory guidelines specific to HAPs emissions from aircraft engines, specifically, and airports, in general. While development of an inventory of HAPs is useful for disclosure, reporting, and comparative purposes, it does not provide results that are directly comparable to any regulatory threshold or air quality standards. It should also be noted that other than an emissions inventory, a HAPs assessment prepared for the FAA must not include any other type of analysis including, but not limited to, atmospheric dispersion modeling, toxicity weighting, or human health risk analyses. These types of assessments require a more complete understanding of the reactions of HAPs in the atmosphere and downstream plume evolution, as well as human exposure patterns. Because the science of these relationships with respect to aviation-related HAPs is still evolving, the corresponding level of understanding is also currently limited.

Presently, the AEDT model calculates emissions for 394 different organic gases. Of these, 45 are classified as HAPs by the USEPA, while the other 349 are considered to be non-toxic compounds. These 45 HAPs are listed below:

Hazardous Air Pollutants			
1,1,1-Trichloroethane	Chlorobenzene	Isopropylbenzene	o-xylene
1,3-Butadiene	Cyclohexane	m & p-Xylene	Perchloroethylene
2,2,4 Trimethylpentane	Dichloromethane	Methyl alcohol	Phenol (carbolic acid)
2-ethoxyethanol	Ethyl acetate	Methyl chloride	Phthalic anhydride
2-Methylnaphthalene	Ethyl chloride	Methyl ethyl ketone	Propionaldehyde
Acetaldehyde	Ethyl ether	Methyl isobutyl ketone	p-xylene
Acetone	Ethylbenzene	Methyl tert butyl ether	Styrene
Acrolein (2-propenal)	Ethylene dibromide	m-xylene	Toluene
Benzaldehyde	Ethylene glycol	Naphthalene	Trichloroethylene
Benzene	Formaldehyde	n-Butyl alcohol	Trichlorotrifluoroethan
Butyl cellosolve	Isomers of xylene	n-Heptane	Vinyl acetate
		n-Hexane	

The HAPs listed in **Table B-33** were evaluated for aircraft, APUs/GSE, and motor vehicles for future years (2026 and 2031) for the No Action Alternative and the Proposed Project (i.e., only 15 were found to meet or exceed the AEDT model's detection level).[14]

Table B-33: List of Hazardous Air Pollutants

HAPs			
1,3-butadiene	ethylbenzene	p-xylene	propionaldehyde
acetaldehyde	formaldehyde	naphthalene	styrene
acrolein	isopropylbenzene	o-xylene	toluene
benzene	Methyl alcohol	phenol	

Source: FAA's Air Quality Handbook, Version 3.

Similar to the criteria air pollutant inventory, aircraft-related HAPs emissions were prepared using the AEDT by factoring total aircraft operational activity against a database of aircraft/engine-specific emission factors based on engine manufacturer, model, and aircraft operational mode within the LTO cycle. In this application, AEDT applies speciation factors to quantify individual HAP compounds. These factors estimate the quantities of individual HAPs, based on the total emissions of VOCs. This approach was also applied to APUs. Notably, EMFAC2017 and OFFROAD2017 were used to develop individual HAP speciation data for GSE and motor vehicles. **Table B-34** presents estimates of the HAPs associated with the subject scenarios.

Table B-34: Estimates of Hazardous Air Pollutants

HAP	2026 (tons/year)		2031 (tons/year)	
	No Action Alternative	Proposed Project	No Action Alternative	Proposed Project
1,3-butadiene	10.8	9.6	12.1	11.4
acetaldehyde	1.7	1.4	1.9	1.7
acrolein	3.5	3.2	4.0	3.8
benzene	1.1	0.9	1.1	0.9
ethylbenzene	0.5	0.5	0.5	0.5
formaldehyde	0.4	0.1	0.3	0.0

[14] While the AEDT model has the ability to estimate emissions for 45 specific HAPs, the AEDT modeling completed for the Proposed Project and No Action Alternative identified only the 15 HAPs listed in Table B-34 as having values greater than zero.

isopropylbenzene	0.2	0.2	0.3	0.3
methanol	0.3	0.2	0.3	0.3
p-xylene	0.8	0.7	0.8	0.7
naphthalene	1.4	1.3	1.6	1.5
o-xylene	2.3	2.0	2.6	2.4
phenol	0.9	0.9	1.0	1.0
propionaldehyde	0.7	0.5	0.7	0.6
styrene	0.6	0.6	0.7	0.7
toluene	2.0	1.8	1.9	1.6
Total HAPs	27.2	23.9	29.8	27.4

Source: KB Environmental Sciences, Inc., 2021.