Pt Orient Eelgrass Restoration: Emissions Summary
Criteria Air Pollutants and Greenhouse Gases

Year 1 2022 Source	ROG (tons)	CO (tons)	NO_X (tons)	PM_{10} (tons)	$PM_{2.5}$ (tons)	CO_2e (MT)
Off-Road Equipment	0.04	0.82	0.72	0.03	0.03	48.84
On-Road Emissions/Crew Boat Emissions	0.02	0.13	0.14	0.00	0.00	35.07
Work Boat Emissions	0.03	0.07	0.08	0.00	0.00	8.10
Tug Emissions	0.12	0.81	0.92	0.03	0.03	114.20
Total Emissions	**0.20**	**1.83**	**1.86**	**0.07**	**0.07**	**206.22**

Year 2 2023 Source	ROG (tons)	CO (tons)	NO_X (tons)	PM_{10} (tons)	$PM_{2.5}$ (tons)	CO_2e (MT)
Off-Road Equipment	0.06	1.38	1.06	0.03	0.03	83.50
On-Road Emissions/Crew Boat Emissions	0.02	0.13	0.14	0.00	0.00	36.03
Work Boat Emissions	0.03	0.11	0.11	0.01	0.01	12.48
Tug Emissions	0.12	0.81	0.92	0.03	0.03	114.20
Total Emissions	**0.23**	**2.43**	**2.23**	**0.08**	**0.08**	**246.22**

Average Daily Emissions Year	ROG (lbs/day)	CO (lbs/day)	NO_X (lbs/day)	PM_{10} (lbs/day)	$PM_{2.5}$ (lbs/day)
2022	4.01	36.57	37.20	1.37	1.35
2023	4.51	48.53	44.70	1.55	1.53
BAAQMD Threshold	54	-	54	82	54
Exceeds Threshold?	*No*	*No*	*No*	*No*	*No*

Notes

Year 1 Construction Days	100
Year 2 Construction Days	100

Based on assumption of 25 available weeks of construction per year, 4 working days per week.

Constants	
ton	lbs
1	2000

Energy Consumption

2022		
Description	**Total Gallons**	**Total Energy Consumption (MMBtu)**
Off-Road Equipment (Diesel)	4,731	653.27
On-Road Equipment (Gasoline-Fueled)	1,632	204.02
On-Road Equipment (Diesel-Fueled)	1,357	187.44
Crew Boat (Gasoline)	1,550	193.75
Work Boat (Gasoline)	923	115.38
Tug (Diesel)	11,185	1,544.64

2023		
Description	**Total Gallons**	**Total Energy Consumption (MMBtu)**
Off-Road Equipment (Diesel)	8,090	1,117.15
On-Road Equipment (Gasoline-Fueled)	1,694	211.75
On-Road Equipment (Diesel-Fueled)	1,398	193.00
Crew Boat (Gasoline)	1,550.00	193.75
Work Boat (Gasoline)	1,421.87	177.73
Tug (Diesel)	11,185	1,544.64

Total Energy Consumption	**6,336.53**	**MMBtu**

Conversion Factors	
Diesel (MT/gallon)	0.0102
Gasoline (MT/gallon)	0.0088

Category	**Amount**	**Units**
Diesel (heat content)	5.8	MMBtu/barrel
Motor Gasoline	5.25	MMBtu/gallon
Gallons per Barrel	42	gallons/barrel

Source:
The Climate Registry (April 2020): 2020 Default Emission Factors: https://www.theclimateregistry.org/wp-content/uploads/2020/04/The-Climate-Registry-2020-Default-Emission-Factor-Document.pdf

Off-Road Construction Emissions

2022 Equipment	Equipment Type	Number	Usage Factor (hrs/day)	Total Days	Horsepower	Total Runtime Hours	Engine Tier	Model Year	Load Factor	ROG EF (g/bhp-hr)	CO EF (g/bhp-hr)	NOx EF (g/bhp-hr)	PM_{10} EF (g/bhp-hr)	$PM_{2.5}$ EF (g/bhp-hr)	CO_2 EF (g/bhp-hr)	CH_4 EF (g/gal)	N_2O EF (g/gal)	gal/hp-hr	Total Gallons	ROG (tons)	CO (tons)	NO_X (tons)	PM_{10} (tons)	$PM_{2.5}$ (tons)	CO_2 (metric tons)	CH_4 (metric tons)	N_2O (metric tons)	CO_2e (metric tons)
Air Compressors-Air Compressor	Air Compressors	1	4	48	49	192	T4I	2009	0.48	0.12	4.1	4.55	0.128	0.128	272.6994624	0.227	0.472	0.027662957	124.9214881	0.000597343	0.020409	0.022649	0.000637166	0.000637166	1.2314671	2.83572E-05	5.89629E-05	1.2478863
Kobelco SK230SR (excavator)	Excavators	1	8	6	166	48	T4F	-	0.38	0.06	3.7	0.26	0.008	0.008	201.6427399	0.227	0.472	0.019757273	60.12097028	0.000201259	0.012411	0.000872	2.68345E-05	2.68345E-05	0.6135947	1.36475E-05	2.83771E-05	0.6214967
Excavator - PC400LC-7	Excavators	1	8	82	353	656	T3	2006	0.38	0.12	2.6	2.32	0.088	0.088	195.7452209	0.227	0.472	0.019179425	1696.148131	0.011698056	0.253458	0.226162	0.008578574	0.008578574	17.310889	0.000385026	0.000800582	17.533824
Cranes-DB Alameda Derrick Barge																											
Draw-works Engine (crane)	Cranes	1	8	37	400	296	T3	2010	0.29	0.12	2.6	2.32	0.088	0.088	151.2620697	0.227	0.472	0.014820896	505.5561601	0.004512118	0.097763	0.087234	0.003308886	0.003308886	5.1597065	0.000114761	0.000238623	5.2261548
Genset Engine - main house	Generator Sets	1	8	37	400	296	T3	2010	0.74	0.12	2.6	2.32	0.088	0.088	157.973502	0.227	0.472	0.015478492	1356.163574	0.011589612	0.251108	0.224066	0.008499049	0.008499049	13.841006	0.000307849	0.000640109	14.019255
Deck Air Compressor	Air Compressors	1	2	37	49	74	T4I	2009	0.48	0.12	4.1	4.55	0.128	0.128	272.6994624	0.227	0.472	0.027662957	48.14682353	0.000230226	0.007866	0.008729	0.000245574	0.000245574	0.474628	1.09293E-05	2.27253E-05	0.4809562
Anchor/Spud Winch Engine A	Other General Industrial Equipment	1	0.5	10	117	5	T3	2011	0.34	0.12	3.7	2.74	0.192	0.192	269.2918115	0.227	0.472	0.026385635	5.274343373	2.64415E-05	0.000815	0.000604	4.23064E-05	4.23064E-05	0.05383	1.19728E-06	2.48949E-06	0.0545232
Anchor/Spud Winch Engine B	Other General Industrial Equipment	1	0.5	10	117	5	T3	2011	0.34	0.12	3.7	2.74	0.192	0.192	269.2918115	0.227	0.472	0.026385635	5.274343373	2.64415E-05	0.000815	0.000604	4.23064E-05	4.23064E-05	0.05383	1.19728E-06	2.48949E-06	0.0545232
Deck Generator	Generator Sets	1	8	37	274	296	T3	2010	0.74	0.12	2.6	2.32	0.088	0.088	157.973502	0.227	0.472	0.015478492	928.9720482	0.007938884	0.172009	0.153485	0.005821849	0.005821849	9.4810894	0.000210877	0.000438475	9.6031897
Other-Work Boat	*see Work Boat Emissions*																										
																			Total Emissions	**0.036820381**	**0.816655**	**0.724406**	**0.027202546**	**0.027202546**	48.220041	0.001073841	0.002232833	**48.841809**

2023 Equipment	Equipment Type	Number	Usage Factor (hrs/day)	Total Days	Horsepower	Total Runtime Hours	Engine Tier	Model Year	Load Factor	ROG EF (g/bhp-hr)	CO EF (g/bhp-hr)	NOx EF (g/bhp-hr)	PM_{10} EF (g/bhp-hr)	$PM_{2.5}$ EF (g/bhp-hr)	CO_2 EF (g/bhp-hr)	CH_4 EF (g/gal)	N_2O EF (g/gal)	gal/hp-hr	Total Gallons	ROG (tons)	CO (tons)	NO_X (tons)	PM_{10} (tons)	$PM_{2.5}$ (tons)	CO_2 (metric tons)	CH_4 (metric tons)	N_2O (metric tons)	CO_2e (metric tons)
Air Compressors-Air Compressor	Air Compressors	1	8	56	49	448	T4I	2009	0.48	0.12	4.1	4.55	0.128	0.128	272.6994624	0.227	0.472	0.027662957	291.4834722	0.001393801	0.047622	0.052848	0.001486721	0.001486721	2.8734233	6.61667E-05	0.00013758	2.9117347
Excavator - PC400LC-7	Excavators	1	8	80	353	640	T3	2006	0.38	0.12	2.6	2.32	0.088	0.088	195.7452209	0.227	0.472	0.019179425	1654.778664	0.011412737	0.247276	0.220646	0.008369341	0.008369341	16.888672	0.000375635	0.000781056	17.10617
Cranes-DB Alameda Derrick Barge																											
Draw-works Engine (crane)	Cranes	1	8	35	400	280	T3	2010	0.29	0.12	2.6	2.32	0.088	0.088	151.2620697	0.227	0.472	0.014820896	478.2288001	0.00426822	0.092478	0.082519	0.003130028	0.003130028	4.8808035	0.000108558	0.000225724	4.9436599
Genset Engine - main house	Generator Sets	1	8	35	400	280	T3	2010	0.74	0.12	2.6	2.32	0.088	0.088	157.973502	0.227	0.472	0.015478492	1282.857435	0.010963147	0.237535	0.211954	0.008039641	0.008039641	13.092844	0.000291209	0.000605509	13.261457
Deck Air Compressor	Air Compressors	1	2	35	49	70	T4I	2009	0.48	0.12	4.1	4.55	0.128	0.128	272.6994624	0.227	0.472	0.027662957	45.54429253	0.000217781	0.007441	0.008258	0.0002323	0.0002323	0.4489724	1.03386E-05	2.14969E-05	0.4549586
Anchor/Spud Winch Engine A	Other General Industrial Equipment	1	0.5	10	117	5	T3	2011	0.34	0.12	3.7	2.74	0.192	0.192	269.2918115	0.227	0.472	0.026385635	5.274343373	2.64415E-05	0.000815	0.000604	4.23064E-05	4.23064E-05	0.05383	1.19728E-06	2.48949E-06	0.0545232
Anchor/Spud Winch Engine B	Other General Industrial Equipment	1	0.5	10	117	5	T3	2011	0.34	0.12	3.7	2.74	0.192	0.192	269.2918115	0.227	0.472	0.026385635	5.274343373	2.64415E-05	0.000815	0.000604	4.23064E-05	4.23064E-05	0.05383	1.19728E-06	2.48949E-06	0.0545232
Deck Generator	Generator Sets	1	8	35	274	280	T3	2010	0.74	0.12	2.6	2.32	0.088	0.088	157.973502	0.227	0.472	0.015478492	878.7573429	0.007509755	0.162711	0.145189	0.005507154	0.005507154	8.968598	0.000199478	0.000414773	9.0840984
Cranes-DB Pacific Derrick Barge																											
Draw-works Engine (crane)	Cranes	1	8	17	750	136	T4I	2013	0.29	0.08	2.6	1.29	0.008	0.008	151.9186251	0.227	0.472	0.014885226	437.4202239	0.002591419	0.084221	0.041787	0.000259142	0.000259142	4.4643111	9.92944E-05	0.000206462	4.5218039
Genset Engine - main house	Generator Sets	1	8	17	750	136	T4I	2013	0.74	0.08	2.6	1.29	0.008	0.008	157.973502	0.227	0.472	0.015478492	1168.316592	0.006656196	0.216326	0.107331	0.00066562	0.00066562	11.92384	0.000265208	0.000551445	12.077399
Deck Air Compressor	Air Compressors	1	2	17	49	34	T4F	2018	0.48	0.12	4.1	2.75	0.008	0.008	272.8380655	0.227	0.472	0.027411298	21.92026643	0.00010578	0.003614	0.002424	7.05197E-06	7.05197E-06	0.2181831	4.9759E-06	1.03464E-05	0.2210643
Anchor/Spud Winch Engine A	Other General Industrial Equipment	1	0.5	17	225	8.5	T3	2006	0.34	0.12	2.6	2.32	0.088	0.088	269.2918115	0.227	0.472	0.026385635	17.24304564	8.64434E-05	0.001873	0.001671	6.33918E-05	6.33918E-05	0.1759825	3.91417E-06	8.13872E-06	0.1782489
Anchor/Spud Winch Engine B	Other General Industrial Equipment	1	0.5	17	225	8.5	T3	2006	0.34	0.12	2.6	2.32	0.088	0.088	269.2918115	0.227	0.472	0.026385635	17.24304564	8.64434E-05	0.001873	0.001671	6.33918E-05	6.33918E-05	0.1759825	3.91417E-06	8.13872E-06	0.1782489
Deck Generator	Generator Sets	1	8	17	170	136	T4F	2018	0.74	0.06	3.7	0.26	0.008	0.008	157.973502	0.227	0.472	0.015478492	264.8184276	0.001131553	0.069779	0.004903	0.000150874	0.000150874	2.7027371	6.01138E-05	0.000124994	2.7375437
Other-APE 200 Vibratory Hammer	Other Construction Equipment	1	8	36	595	288	T3	2010	0.42	0.12	2.60	2.32	0.09	0.09	218.0090228	0.227	0.472	0.021360867	1520.529398	0.009415891	0.204011	0.182041	0.006904987	0.006904987	15.518524	0.00034516	0.00071769	15.718376
Other-Work Boat	*see Work Boat Emissions*																										
																			Total Emissions	**0.055892051**	**1.378391**	**1.06445**	**0.034964255**	**0.034964255**	82.440533	0.00183636	0.003818334	**83.50381**

On-Road Construction Emissions

On-Road Vehicles	Year	Total Trips	Trip Distance (One-way)	Total VMT	ROG RunEx (total tons)	ROG StartEx (total tons)	CO RunEx (total tons)	CO StartEX (total tons)	NO_x RunEx (total tons)	NO_x StartEx (total tons)	PM_{10} RunEx (total tons)	PM_{10} StartEx (total tons)	$PM_{2.5}$ RunEx (total tons)	$PM_{2.5}$ StartEx (total tons)	CO_2 RunEx (total metric tons)	CO_2 StartEx (total metric tons)	CH_4 RunEx (total metric tons)	CH_4 StartEx (total metric tons)	N_2O RunEx (total metric tons)	N_2O StartEx (total metric tons)	CO_2e (total metric tons)
Staff Personal Vehicles to Van/Boat + Staff for On-Shore Work	2022	2464	10.8	26,611	0.0003	0.0008	0.0202	0.0067	0.0015	0.0006	0.0000	0.0000	0.0000	0.0000	7.3965	0.1457	0.0001	0.0001	0.0001	0.0001	7.604871
15 Passenger Van	2022	240	27.5	6,600	0.0004	0.0000	0.0073	0.0005	0.0019	0.0001	0.0000	0.0000	0.0000	0.0000	6.6887	0.0046	0.0001	0.0000	0.0001	0.0000	6.725317
Haul Trucks from Pier 96 to Landfill (exc. TWW) + On-Shore Work Truckloads	2022	198	20.0	3,960	0.0008	0.0000	0.0029	0.0000	0.0205	0.0009	0.0002	0.0000	0.0002	0.0000	7.1033	0.0000	0.0000	0.0000	0.0011	0.0000	7.400102
Haul Trucks from Pier 96 to Ox Mountain (TWW)	2022	128	27.0	3,456	0.0007	0.0000	0.0025	0.0000	0.0179	0.0006	0.0002	0.0000	0.0002	0.0000	6.1992	0.0000	0.0000	0.0000	0.0010	0.0000	6.458271
Staff Personal Vehicles to Van/Boat	2023	2400	10.8	25,920	0.0003	0.0007	0.0197	0.0065	0.0015	0.0006	0.0000	0.0000	0.0000	0.0000	7.2044	0.1419	0.0001	0.0001	0.0001	0.0001	7.407342
15 Passenger Van	2023	240	27.5	6,600	0.0004	0.0000	0.0073	0.0005	0.0019	0.0001	0.0000	0.0000	0.0000	0.0000	6.6887	0.0046	0.0001	0.0000	0.0001	0.0000	6.725317
Staff Personal Vehicles - Restoration Activities	2023	240	10.8	2,592	0.0000	0.0001	0.0020	0.0007	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.7204	0.0142	0.0000	0.0000	0.0000	0.0000	0.740734
Haul Trucks from Pier 96 to Landfill (exc. TWW)	2023	209	20	4,180	0.0008	0.0000	0.0031	0.0000	0.0217	0.0009	0.0002	0.0000	0.0002	0.0000	7.4979	0.0000	0.0000	0.0000	0.0012	0.0000	7.811219
Haul Trucks from Pier 96 to Ox Mountain (TWW)	2023	128	27.0	3,456	0.0007	0.0000	0.0025	0.0000	0.0179	0.0006	0.0002	0.0000	0.0002	0.0000	6.1992	0.0000	0.0000	0.0000	0.0010	0.0000	6.458271

Notes:
15 passenger van trip distance assumes average 55 mph speed, for 30 min trip length
Assumes maximum of 10 workers traveling in personal vehicles for the demolition activities and maximum of 8 for restoration activities. On-shore work is anticipated to require 4 workers over 8 days.
Personal vehicle trip length of 10.8 miles based on CalEEMod H-W default for Contra Costa County
Haul truck trip length for treated wood waste based on distance between Pier 96 and Ox Mountain Sanitary Landfill via I-280. Other haul truck trip lengths assumed to be 20 miles based on CalEEMod default.

On-Road Emissions Summary

Vehicle Type	Year	ROG (tons)	CO (tons)	NO_x (tons)	PM_{10} (tons)	$PM_{2.5}$ (tons)	CO_2e (tons)
Staff Personal Vehicles to Van/Boat + Staff for On-Shore Work	2022	0.0011	0.0269	0.0021	0.0000	0.0000	7.604871144
15 Passenger Van	2022	0.0004	0.0078	0.0020	0.0000	0.0000	6.725317218
Haul Trucks from Pier 96 to Landfill (exc. TWW) + On-Shore Work	2022	0.0008	0.0029	0.0214	0.0002	0.0002	7.400102281
Haul Trucks from Pier 96 to Ox Mountain (TWW)	2022	0.0007	0.0025	0.0185	0.0002	0.0002	6.458271081
Staff Personal Vehicles to Van/Boat	2023	0.0011	0.0262	0.0021	0.0000	0.0000	7.407342024
Staff Personal Vehicles - Restoration Activities	2023	0.0001	0.0026	0.0002	0.0000	0.0000	0.740734202
15 Passenger Van Option	2023	0.0004	0.0078	0.0020	0.0000	0.0000	6.725317218
Haul Trucks from Pier 96 to Landfill (exc. TWW)	2023	0.0008	0.0031	0.0226	0.0002	0.0002	7.811219074
Haul Trucks from Pier 96 to Ox Mountain (TWW)	2023	0.0007	0.0025	0.0185	0.0002	0.0002	6.458271081

Fuel Consumption Calculations		
Source	Fuel	Gallons
Staff Vehicles	Gasoline	866.1584447
Passenger Va	Gasoline	765.9814599
Haul Trucks	Diesel	724.7896455
Haul Trucks	Diesel	632.5436906
Staff Vehicles	Gasoline	843.6608228
Staff Vehicles	Gasoline	84.36608228
Passenger Va	Gasoline	765.9814599
Haul Trucks	Diesel	765.0557369
Haul Trucks	Diesel	632.5436906

Vehicle Type	ROG RunEx (g/mi)	ROG EF StartEx (g/trip)	CO EF RunEx (g/mi)	CO EF StartEX (g/trip)	NO_x EF RunEx (g/mi)	NO_x EF StartEx (g/trip)	PM_{10} EF RunEx (g/mi)	PM_{10} EF StartEx (g/trip)	$PM_{2.5}$ EF RunEx (g/mi)	$PM_{2.5}$ EF StartEx (g/trip)	CO_2 EF RunEx (g/mi)	CO_2 EF StartEx (g/trip)	CH_4 EF RunEx (g/mi)	CH_4 EF StartEx (g/trip)	N_2O EF RunEx (g/mi)	N_2O EF StartEx (g/trip)
15 Passenger Van (assumes 150 hp gas engine)	0.0545	0.1342	1.0009	1.7943	0.2567	0.5528	0.0024	0.0004	0.0022	0.0004	1013.4413	19.1009	0.0113	0.0266	0.0155	0.0425
Staff Vehicles	0.01	0.28	0.69	2.4592	0.0509	0.2283	0.0015	0.0019	0.0014	0.0018	277.9460	59.1116	0.0028	0.0607	0.0054	0.0284
Haul Trucks from Pier 96 to Ox Mountain/Landfill	0.1785	0.0000	0.6644	0.0000	4.7022	3.9869	0.0442	0.0000	0.0423	0.0000	1793.7626	0.0000	0.0083	0.0000	0.2820	0.0000

Constants	
year	days
1	365
lbs	grams
1	453.5924
ton	lbs
1	2000
metric ton	grams
1	1000000
CH4 GPW	CO2
28	1
N2O GPW	CO2
265	1

Factors	MT CO2/gallon
Diesel	0.0102
Gasoline	0.0088

Work Boat Emissions

Type of Boat and Engine Type (Main Engine or Auxiliary Engine)	Year	Number of Engines	Horsepower	Load Factor	Hrs/Day	Total Days of Use	ROG (tons)	CO (tons)	NO_x (tons)	PM (tons)	CO_2 (metric tons)	CH_4 (metric tons)	N_2O (metric tons)	CO_2e (metric tons)
Work Boat - ME	2022	1.46	50	0.45	8	43	0.022924053	0.062151043	0.065927	0.003753	6.68	0.00	0.00	6.70
Work Boat - AE	2022	0.32	50	0.43	8	43	0.005272523	0.012159588	0.013638	0.000744	1.40	0.00	0.00	1.40
Total							**0.028196576**	**0.074310632**	**0.079565**	**0.004497**				**8.10**
Work Boat - ME	2023	1.46	50	0.45	8	45	0.024497125	0.066214487	0.069226	0.003984	6.99	0.00	0.00	7.01
Work Boat - AE	2023	0.32	50	0.43	8	45	0.005611123	0.012906686	0.014308	0.000788	1.46	0.00	0.00	1.47
Restoration - Crew Boat	2023	2	250	0.45	2	15	0.00387474	0.028762657	0.02904	0.000558	3.99	0.00	0.00	4.00
Total							**0.033982988**	**0.107883829**	**0.112573**	**0.00533**	**12.44**			**12.48**

Crew Boat Option for Worker Commutes	Year	Number of Engines	Horsepower	Load Factor	Hrs/Day	Total Days of Use	ROG (tons)	CO (tons)	NO_x (tons)	PM (tons)	CO_2 (metric tons)	CH_4 (metric tons)	N_2O (metric tons)	CO_2e (metric tons)
Main Engine	2022	1	250	0.45	2	102	0.013174117	0.097793035	0.098735	0.001897	13.56	0.00	0.00	**13.61**
Auxillary Engine	2022	0	250	0.43	2	102								
Main Engine	2023	1	250	0.45	2	102	0.013331756	0.098479302	0.099344	0.001931	13.56	0.00	0.00	**13.61**
Auxillary Engine	2023	0	250	0.43	2	102								

Total days of use based on assumption of 102 days of crew boat operation each year.

E = EF0 x F x (1 + D x A/UL) x HP x LF x HR

EF_0	specific zero hour emission factor
F	fuel correction factor
D	deterioration factor
A	age of engine when emissions are estimated
UL	engine useful life
HP	horsepower
LF	load factor
Hr	operating hours

USEFUL LIFE

Vessel_Type	Average number of maine engines	Average of number auxiliary engines	Main Engine Load	Auxiliary Engine Load	Main Engine Annual Hours of Operation	Auxiliary Engine Annual Hours of Operation	Main Engine Useful Life (years)	Auxiliary Engine Useful Life (years)
Tow Boats	2.1	1.17	0.68	0.43	1,993.00	2,964.62	26	25
Tug Boats	1.92	1.59	0.5	0.31	2,274.06	2,486.21	21	22.5
Ferries	2.01	1.23	0.42	0.43	1,842.64	1,254.17	20	20
Others	1.11	0.46	0.52	0.43	778.71	805.39	23	22
Work Boats	1.46	0.32	0.45	0.43	674.99	750.00	17	23
Pilot Vessels	1.7	0.14	0.51	0.43	1,030.71	994.00	19	25
Crew and Supply	2.5	1.1	0.45	0.43	787.52	3,035.80	22	22
Charter Fishing	1.77	0.75	0.52	0.43	1,622.28	2,077.00	16	15
Commercial Fishing	1.12	0.46	0.27	0.43	1,249.86	1,633.45	21	15

Boat Type Age by Construction Year	2022	2023	Engine Year
Work Boat Engine	14	15	2008
Crew Boat Engine	5	6	2017
Crew Boat Engine (Restoration)	4	5	2018

DETERIORATION FACTOR

HP Range	HC	CO	NOx	PM
25-50	0.51	0.41	0.06	0.31
51-250	0.28	0.16	0.14	0.44
>251	0.44	0.25	0.21	0.67

From OFFROAD Harborcraft Emissions Inventory Appendix B

FUEL CORRECTION FACTOR

Calendar Years	Horsepower Range	Model Years	ROG	CO	NO_x	PM
1994-2006	<25	Pre-1995				
	25-50	Pre-1999				
	51-100	Pre-1998	1.0	1.0	0.930	0.750
	101-175	Pre-1997				
	176+	Pre-1996				
	<25	1995+				
	25-50	1999-2010				
	51-100	1998-2010	1.0	1.0	0.948	0.822
	101-175	1997-2010				
	176+	1996-2010				
2007+	<25	Pre-1995				
	25-50	Pre-1999				
	51-100	Pre-1998	1.0	1.0	0.930	0.720
	101-175	Pre-1997				
	176+	Pre-1996				
	<25	1995+				
	25-50	1999-2010				
	51-100	1998-2010	0.7	1.0	0.948	0.800
	101-175	1997-2010				
	176+	1996-2010				
	All	2011+	0.7	1.0	0.948	0.852

From OFFROAD Harborcraft Emissions Inventory Appendix B and ROG deterioration factor from SMAQMD_HC _Calculator_30June2017

ZERO HOUR EMISSION FACTOR (g/hp-hr)

HP Range	Model Year	ME ROG	ME CO	ME NOx	ME PM	AE ROG	AE CO	AE Nox	AE PM
- Implies 25-50 hp	2008	1.8	3.73	5.32	0.3	2.142	3.73	5.32	0.3
- Implies 176-250 hp	2008	0.68	3.73	5.1015	0.15	0.8092	3.73	5.1015	0.15
- Implies 176-250 hp	2017	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08
- Implies 176-250 hp	2018	0.68	3.73	3.99	0.08	0.8092	3.73	3.99	0.08

GHG Emission Rates from SMAQMD_HC_Calculator_30June2017

Type of Boat, Year and Horsepower	CO_2 (g/bhp-hr)	CH_4 (g/bhp-hr)	N_2O (g/bhp-hr)
Work Boat (2008, 50 hp)	591.04	0.02	0.00
Crew Boat (2018, 250 hp)	591.04	0.02	0.00

Tugboat Engines Emissions

Main Engine Emission Factors with Deterioration

EF0 * F *(1+(D*(A/UL))

Tug	Main Engine MY	Engine Power (kw)	Total Number of Operating Hrs	NO_x (g/kwh)	PM_{10} (g/kwh)	$PM_{2.5}$ (g/kwh)	CO (g/kwh)	ROG (g/kwh)	SO_x (g/kwh)	CO_2 (g/kwh)
Solana	2017	746	330	5.59	0.21	0.20	5.06	0.69	0.01	788.72

Notes:
Tier 3 Engine assumed for main engine

Tug	Main Engine MY	Engine Power (kw)	Total Number of Operating Hrs	NO_x (g/kwh)	PM_{10} (g/kwh)	$PM_{2.5}$ (g/kwh)	CO (g/kwh)	ROG (g/kwh)	SO_x (g/kwh)	CO_2 (g/kwh)
Betty L	2015	492	330	5.59	0.21	0.20	5.06	0.69	0.01	788.72

Notes:
Tier 3 Engine assumed for main engine

Auxiliary Engine Emission Factors with Deterioration

EF0 * F *(1+(D*(A/UL))

Tug	Aux Engine MY	Engine Power (kw)	Number of Operating Hrs	NO_x (g/kwh)	PM_{10} (g/kwh)	$PM_{2.5}$ (g/kwh)	CO (g/kwh)	ROG (g/kwh)	SO_x (g/kwh)	CO_2 (g/kwh)
Solana	2017	55	330	6.77	0.27	0.26	5.01	1.14	0.01	788.72

Tug	Aux Engine MY	Engine Power (kw)	Number of Operating Hrs	NO_x (g/kwh)	PM_{10} (g/kwh)	$PM_{2.5}$ (g/kwh)	CO (g/kwh)	ROG (g/kwh)	SO_x (g/kwh)	CO_2 (g/kwh)
Betty L	2015	55	330	6.77	0.27	0.26	5.01	1.14	0.01	788.72

Tug boats Emissions		
# of MEs	2	ME: Main Engine
# of AuxEs	2	AuxE: Auxiliary Engine
LF (Main E)	0.31	LF: Load Factor
LF (Aux E)	0.5	LF: Load Factor

Tug	Tug Total Operating Hrs	Main Engine Power (kw)	Auxiliary Engine Power (kw)	Total NO_x Emissions (tons)	Total PM_{10} Emissions (tons)	Total $PM_{2.5}$ Emissions (tons)	Total CO Emissions (tons)	Total ROG Emissions (tons)	Total SO_x Emissions (tons)	Total CO_2 Emissions (tons)
Solana	330	746	55	1.08	0.04	0.04	0.95	0.14	0.00	148.48
Betty L	330	492	55	0.76	0.03	0.03	0.66	0.10	0.00	103.30
Total tons				**1.83**	**0.07**	**0.07**	**1.61**	**0.24**	**0.00**	251.77
Total metric tons										**228.40**

Conversion Factors	
1.34	hp/kW
0.907185	metric tons/ton
2000	lbs/ton

Emissions Estimation Methodology for Commercial Harbor Craft Operating in California

E = EF0 *F *(1+D*(A/UL))*HP*LF*Hr

E = the amount of emissions of a pollutant (ROG, CO, NOx, or PM) emitted during one period (e.g., lb/day);
EF0 = the engine zero hour emission factor (when engine is new);
F = fuel correction factor which accounts for emission reduction benefits from burning cleaner fuel;
D = the horsepower and pollutant specific engine *deterioration factor*;
A = age of the engine ;
UL = engine useful life;
HP = rated horsepower of the engine;
LF = engine *load factor*;

OFFROAD2017 (v1.0.1) Emissions Inventory
Region Type: County
Region: Contra Costa
Calendar Year: 2022
Scenario: All Adopted Rules - Exhaust
Vehicle Classification: OFFROAD2017 Equipment Types
Units: Emissions: tons/day, Fuel Consumption: gallons/year, Activity: hours/year, HP-Hours: HP-hours/year

Constants	
year	days
1	365
lbs	grams
1	453.5924
ton	lbs
1	2000

Region	CalYr	VehClass	MdlYr	HP_Bin	Fuel	CO2_tpd	Fuel_gpy	Horsepower_Hours_hhpy	CO2_tpy	CO2_g_hp-hr	gal/hp-hr
Contra Costa	2022	CHE - Port Other General Industrial Equipment	2011	175	Diesel	0.005785732	187.711688	7114.162156	2.111792013	269.292	0.026385635
Contra Costa	2022	ConstMin - Cranes	2010	600	Diesel	0.023609184	765.9739877	51682.03138	8.617352314	151.262	0.014820896
Contra Costa	2022	ConstMin - Excavators	2006	600	Diesel	0.390049178	12654.71602	659806.8633	142.36795	195.745	0.019179425
Contra Costa	2022	ConstMin - Other Construction Equipment	2010	600	Diesel	0.152648958	4952.527315	231850.4825	55.71686951	218.009	0.021360867
Contra Costa	2022	OFF - Light Commercial - Air Compressors	2009	50	Diesel	0.02836158	952.65	34437.75	10.3519767	272.699	0.027662957
Contra Costa	2022	Portable Equipment - Rental Generator	2010	300	Diesel	0.208962066	6779.54411	437997.7078	76.2711542	157.974	0.015478492
Contra Costa	2022	Portable Equipment - Rental Generator	2010	600	Diesel	0.820974229	26635.60472	1720813.911	299.6555937	157.974	0.015478492
Contra Costa	2022	ConstMin - Cranes	2013	9999	Diesel	0.011825258	383.6574873	25774.38133	4.316219335	151.919	0.014885226
Contra Costa	2022	Portable Equipment - Rental Generator	2013	750	Diesel	2.203534012	71491.23425	4618746.662	804.2899142	157.974	0.015478492
Contra Costa	2022	OFF - Light Commercial - Air Compressors	2018	50	Diesel	0.04695949	1562.2	56991.1	17.14021385	272.838	0.027411298
Contra Costa	2022	CHE - Port Other General Industrial Equipment	2006	300	Diesel	3.67E-17	1.19008E-12	4.51032E-11	1.33886E-14	269.292	0.026385635
Contra Costa	2022	Portable Equipment - Rental Generator	2018	175	Diesel	0.602579847	19550.03953	1263045.473	219.9416443	157.974	0.015478492
Contra Costa	2022	ConstMin - Excavators	Aggregated	175	Diesel	5.595198653	181530.0583	9188011.92	2042.247508	201.643	0.019757273

CH4 Emissions Factor (g/gallon diesel): 0.227
N2O Emissions Factor (g/gallon diesel): 0.472

Sources:
CARB OFFROAD 2017: https://www.arb.ca.gov/orion/
TCR 2020 Default Emission Factors: https://www.theclimateregistry.org/wp-content/uploads/2020/04/The-Climate-Registry-2020-Default-Emission-Factor-Document.pdf

CalEEMod
Equipment HP and Load Factors

OFFROAD Equipment Type	Horsepower	Load Factor
Aerial Lifts	63	0.31
Air Compressors	78	0.48
Bore/Drill Rigs	221	0.50
Cement and Mortar Mixers	9	0.56
Concrete/Industrial Saws	81	0.73
Cranes	231	0.29
Crawler Tractors	212	0.43
Crushing/Proc. Equipment	85	0.78
Dumpers/Tenders	16	0.38
Excavators	158	0.38
Forklifts	89	0.201
Generator Sets	84	0.74
Graders	187	0.41
Off-Highway Tractors	124	0.44
Off-Highway Trucks	402	0.38
Other Construction Equipment	171	0.42
Other General Industrial Equipmen	88	0.34
Other Material Handling Equipmen	168	0.40
Pavers	130	0.42
Paving Equipment	132	0.36
Plate Compactors	8	0.43
Pressure Washers	13	0.3
Pumps	84	0.74
Rollers	80	0.38
Rough Terrain Forklifts	100	0.40
Rubber Tired Dozers	247	0.4
Rubber Tired Loaders	203	0.36
Scrapers	367	0.48
Signal Boards	6	0.82
Skid Steer Loaders	65	0.37
Surfacing Equipment	263	0.30
Sweepers/Scrubbers	64	0.46
Tractors/Loaders/Backhoes	97	0.37
Trenchers	78	0.50
Welders	46	0.45

OFFROAD Emission Factor Based on Engine Tier

Tier	Low HP	High HP	ROG, g/bhp-hr	CO, g/bhp-hr	NO_x, g/bhp-hr	PM_{10}, g/bhp-hr	$PM_{2.5}$, g/bhp-hr
Tier 1	25	49	1.74	4.1	5.26	0.48	0.48
	50	74	1.19	6.9	6.54	0.552	0.552
	75	119	1.19	6.9	6.54	0.552	0.552
	120	174	0.82	6.9	6.54	0.274	0.274
	175	299	0.38	6.9	5.93	0.108	0.108
	300	599	0.38	6.9	5.93	0.108	0.108
	600	750	0.38	6.9	5.93	0.108	0.108
	751	2000	0.38	6.9	5.93	0.108	0.108
Tier 2	25	49	0.29	4.1	4.63	0.28	0.28
	50	74	0.23	3.7	4.75	0.192	0.192
	75	119	0.23	3.7	4.75	0.192	0.192
	120	174	0.19	3.7	4.17	0.128	0.128
	175	299	0.12	2.6	4.15	0.088	0.088
	300	599	0.12	2.6	3.79	0.088	0.088
	600	750	0.12	2.6	3.79	0.088	0.088
	751	2000	0.12	2.6	3.79	0.088	0.088
Tier 3	25	49	0.29	4.1	4.63	0.28	0.28
	50	74	0.12	3.7	2.74	0.192	0.192
	75	119	0.12	3.7	2.74	0.192	0.192
	120	174	0.12	3.7	2.32	0.112	0.112
	175	299	0.12	2.6	2.32	0.088	0.088
	300	599	0.12	2.6	2.32	0.088	0.088
	600	750	0.12	2.6	2.32	0.088	0.088
	751	2000	0.12	2.6	2.32	0.088	0.088
Tier 4 Interim	25	49	0.12	4.1	4.55	0.128	0.128
	50	74	0.12	3.7	2.74	0.112	0.112
	75	119	0.11	3.7	2.14	0.008	0.008
	120	174	0.06	3.7	2.15	0.008	0.008
	175	299	0.08	2.6	1.29	0.008	0.008
	300	599	0.08	2.6	1.29	0.008	0.008
	600	750	0.08	2.6	1.29	0.008	0.008
	751	2000	0.12	2.6	2.24	0.048	0.048
Tier 4 Final	25	49	0.12	4.1	2.75	0.008	0.008
	50	74	0.12	3.7	2.74	0.008	0.008
	75	119	0.06	3.7	0.26	0.008	0.008
	120	174	0.06	3.7	0.26	0.008	0.008
	175	299	0.06	2.2	0.26	0.008	0.008
	300	599	0.06	2.2	0.26	0.008	0.008
	600	750	0.06	2.2	0.26	0.008	0.008
	751	2000	0.06	2.6	2.24	0.016	0.016

Source:

CalEEMod Appendix D (Based on ARB. 2011. The Carl Moyer Program Guidelines. Available at: http://www.arb.ca.gov/msprog/moyer/guidelines/2011gl/2011cmpgl_3_27_13.pdf.)