APPENDIX E:
GHG ANALYSIS

Marshall Airport Improvements
Draft Environmental Assessment
State Project Number: NFAPT0000371

Estimated Project Combined CO2 & CO2e Emission Outputs*

Emission Source	1.5-Year Project Emissions (mt)
Mob/Demob	246.2
Material Production**	270.1
Material Haul	1020.5
Construction***	1655.0
TOTALS	**3191.8**

Notes:

* Carbon dioxide (CO2) is the most prevalent greenhouse gas (GHG). On average, it represents more than 95 percent of the impact on climate change that comes from burning transportation fuels. Methane (CH4) and nitrous oxide (N2O) are other GHG assocated with fuel combustion. Because of its prevalence, some models measure CO2 emissions only, and will slightly underestimate GHG overall total. Emissions calculations including all GHG associated with fuel combustion are noted as a CO2 factor – where "e" stands as a CO2 equivalent of other GHGs that have been factored in. Referenced models 1 & 4 in this spreadsheet output only CO2 emissions; while referenced model 5 for asphalt construction yields CO2e as an output to capture GHGs associated asphalt processes.

** Material production includes crushing of aggregate and production of hot-mix asphalt required for asphalt paving.

*** Includes material site development and reclamation, construction of road embankments, fence installation, culvert placement, hot-mix asphalt paving, and all incidental construction.

Assumptions:

• Referenced models do not include potential emission premiums for construction in arctic environments. Such premiums must be independently applied.

• Project will be completed in three construction seasons.

Reference Models and Input Data:

1 Mathers, J. et al. (2023). The Green Freight Handbook. A Practical Guide for Developing a Sustainable Freight Transportation Strategy for Business. Environmental Defense Fund. 67 pp. pdf. Accessed on 03/31/2023 online at https://supplychain.edf.org/resources/the-green-freight-handbook/.

2 J. S. Cole Heavy Equipment Rental Co. 2017. Hourly Fuel Consumption Tables. Accessed on 3/31/2023 at: https://www.jscole.com/fueltables.

3 Various Equipment Industry Specification Sheets (available on request)

4 U.S. Environmental Protection Agency. 2023. Greenhouse Gases Equivalencies Calculator - Calculations and References. Accessed on 3/31/2023 at: https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references.

5 Feng Ma et al. (2016). Greenhouse Gas Emissions from Asphalt Pavement Construction: A Case Study in China. Int. Jour. Environ. Res. Pubic Health. March 13(3): 351. Accessed on 03/30/2023 at https://www.mdpi.com/1660-4601/13/3/351.

6 Klanfar, M. et al. (2016). *Fuel Consumption and Engine Load Factors of Equipment in Quarrying of Crush Stone* . 7 pp. pdf.

Marshall Airport Improvements
Draft Environmental Assessment
State Project Number: NFAPT0000371

Estimated Total Project Mobilization and Demobilization CO2 Emission Output - Barge Effort

Loading/Unloading Barge Emissions											
No.	Equipment	Power Output (HP)	Power Output (kWh)	Hourly Fuel Consumption[2,3] (gal/hr)	Reduced Hourly Fuel Consumption[6] (gal/hr)	Shift Duration (hr)	No. Shifts per Day (ea)	Single Load or Unload Duration (days)	Load and Unload Activities (ea)	Fuel Use (gal)	CO2 Emissions[4] (mt)
1	Cat 966 Loader	325	242.4	4.7	3.29	10	2	7	4	1,842	18.8
1	Cat 988 Loader	580	432.5	13.9	9.73	10	2	7	4	5,449	55.5
4	Cat P30000 Forklift	148	110.4	4.9	3.43	10	2	7	4	7,683	78.2
4	Mobile Light (Kohler KD1003- diesel est.)	24	17.9	0.5	0.35	10	2	7	4	784	8.0
2	Kohler 45Kw generator (55REOZT4 est.)	74	55.2	2.5	1.75	10	2	7	4	1,960	20.0
									TOTAL	**17,718**	**180.5**

150-foot, Ocean-going Tug Emissions				
Seattle to Marshall One-Way Duration (days)	One-Way Fuel Use (gal)	Trips (ea)	Total Fuel Use (gal)	CO2 Emissions[4] (mt)
20	3,200	2	6,400	65.2
			TOTAL	**65.2**

Conversions:

- 1 HP = 0.7457 kWh
- 10,180g CO2 emitted per 1 gal diesel used.[4]

Marshall Airport Improvements
Draft Environmental Assessment
State Project Number: NFAPT0000371

Estimated Total Project Mobilization and Demobilization CO2 Emission Output - Road Mobilization from Barge Landing to Contractor Staging Area

Gravel Road Emissions							
No.	Equipment Hauled or Hauling Freight	Equipment Weight (lbs)	Total Weight (ton)	Haul distance from Old Airport (miles)	No. of Trips (ea)	Total Haul (ton-miles)	CO2 Emissions[1] (mt)
2	Large grader (Cat 24 for est.)	161,700	161.70	3	2	970	0.20
1	D-6 size dozers on spread	51,333	25.67	3	2	154	0.00
1	D-8 size dozer in pit	88,000	44.00	3	2	264	0.00
1	Cat 966 Loader	48,000	24.00	3	2	144	0.00
1	Cat 988 Loader	112,574	56.29	3	2	338	0.10
2	Excavators (100 to 150HP) Cat. 320 est.	48,300	48.30	3	2	290	0.00
2	Compactors (Cat. CS54 est.)	23,265	23.27	3	2	140	0.00
2	ATV Water Truck (Volvo A25)	43000	43.00	3	2	258	0.00
5	Ford F-250 pickup	7,000	17.50	3	2	105	0.00
4	Mobile Light (Kohler KD1003- Diesel)	1,800	3.60	3	2	22	0.00
2	6" pump (United Rent PP66S14 - J.D. Diesel)	4,600	4.60	3	2	28	0.00
2	Kohler 45Kw generator (55REOZT4)	4,941	4.94	3	2	30	0.00
5	Smithco SX side dump trailer	15,000	37.50	3	2	225	0.00
1	35+ ton low-boy	25,000	12.50	3	6	225	0.00
5	Semi tractors	10,000	25.00	3	6	450	0.10
4	Volvo A40	66,000	132.00	3	2	792	0.10
1	Gross Weight 26' x 50' SREB Materials	52,000	26.00	3	1	78	0.00
1	Gross Weight Culverts	10,000	5.00	3	1	15	0.00
1	Gross Weight Electrical Materials	20,000	10.00	3	1	30	0.00
5	Conex (Man Camp/Offices)	8,500	21.25	3	2	128	0.00
						TOTAL	**0.50**

Gravel Road Support Vehicle Emissions						
No.	Truck Type	Haul Distance from Old Airport (miles)	No. of Trips (ea)	Fuel Consumption Rate (mpg)	Fuel Use (gal)	CO2 Emissions[4] (mt)
1	Shop/Service Truck	3	6	12	1.5	0.0
1	Fuel Truck (5000 gal)	3	6	12	1.5	0.0
1	Flatbed 3 Ton Truck	3	6	12	1.5	0.0
					TOTAL	**0.0**

Marshall Airport Improvements
Draft Environmental Assessment
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Estimated Total Project Mobilization and Demobilization CO2 Emission Output - Gravel Road Effort

Conversions:

- 162g CO2 emitted per 1 ton-mile hauled.[1]
- 10,180g CO2 emitted per 1 gal diesel used.[4]

Marshall Airport Improvements
Draft Environmental Assessment
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Estimated Total Project Material Production CO2 Emission Output

Material Type	Weight (ton)	Weight (mt)	CO2e Emissions[5] (mt)
CASC	51,000	46,257	270.1
		TOTAL	**270.1**

Conversions:

• 1 ton = 0.907 metric ton

• 5.84kg C02e emitted per 1 metric ton of crushed aggregate.[5]

Abbreviations:

CASC Crushed Aggregate Surface Course

Marshall Airport Improvements
Draft Environmental Assessment
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Estimated Total Project Material Haul CO2 Emission Output

Riprap (ton)	Borrow (ton)	Subbase (ton)	CASC (ton)	Side Dump Trailer Volume (cy)	Full Side Dump Trailer Weight (ton)	Empty Side Dump Trailer Weight (ton)	Tractor Weight (ton)	Material Source to Project Site (mi)
3,700	0	42,600	51,000	24	48	8	5	6

Side Dump	Total Material Weight (ton)	Total Material Volume (cy)	Haul Trips (ea)	Haul Weight (ton)	Total Haul (ton-miles)	CO2 Emissions[1] (mt)
Full	93,600	46,800	1,950	61	713,700	115.6
Empty	0	0	1,950	13	152,100	24.6
					SUBTOTAL	**140.2**

Riprap (ton)	Borrow (ton)	Subbase (ton)	CASC (ton)	Volvo A40 Rock Truck Volume (cy)	Material Weight per load (ton)	Empty Volvo A40 Rock Truck Weight (ton)	Material Source to Project Site (mi)
0	220,962	0	0	21	43	66	6

Volvo A40	Total Material Weight (ton)	Total Material Volume (cy)	Haul Trips (ea)	Haul Weight (ton)	Total Haul (ton-miles)	CO2 Emissions[1] (mt)
Full	220,962	110,481	5,187	109	3,379,785	547.5
Empty	0	0	5,187	66	2,054,013	332.8
					SUBTOTAL	**880.3**

TOTAL	**1,020.5**

Conversions:

- 1 cy = 2 ton
- 162g CO2 emitted per 1 ton-mile hauled.[1]

Abbreviations:

CASC Crushed Aggregate Surface Course

Marshall Airport Improvements
Draft Environmental Assessment
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Estimated Total Construction CO2 Emission Output

No.	Equipment	Power Output (HP)	Power Output (kWh)	Hourly Fuel Consumption[2,3] (gal/hr)	Reduced Hourly Fuel Consumption[6] (gal/hr)	Shift Duration (hr)	Construction Season (days)	No. of Seasons (ea)	Fuel Use (gal)	CO2 Emissions[4] (mt)
2	Large grader (Cat 24 est.)	535	398.9	13.8	9.66	10	120	1.5	34,776	354.0
1	D-6 size dozers on spread	219	163.3	7.6	5.32	10	120	1.5	9,576	97.5
1	D-8 size dozer in pit	354	264.0	11.7	8.19	10	120	1.5	14,742	150.1
1	Cat 966 Loader	325	242.4	4.7	3.29	10	120	1.5	5,922	60.3
1	Cat 988 Loader	580	432.5	13.9	9.73	10	120	1.5	17,514	178.3
2	Excavators (Cat. 320 est.)	148	110.4	4.9	3.43	10	120	1.5	12,348	125.7
2	Compactors (Cat. CS54 est.)	131	97.7	3.5	2.45	10	120	1.5	8,820	89.8
2	ATV Water Truck (Volvo A25)	240	179.0	6.2	4.34	10	120	1.5	15,624	159.1
5	F-250 Pickup	-	-	1.0	0.70	10	120	1.5	6,300	64.1
1	Shop/Service Truck	-	-	1.5	1.05	10	120	1.5	1,890	19.2
1	Fuel Truck	-	-	2.0	1.40	10	120	1.5	2,520	25.7
1	Flatbed 3 Ton Truck	-	-	1.5	1.05	10	120	1.5	1,890	19.2
4	Mobile Light (Kohler KD1003- diesel est.)	23.7	17.7	0.5	0.35	10	120	1.5	2,520	25.7
2	6" pump (United Rent PP66S14 - J.D. diesel est.)	173	129.0	6.8	4.76	12	120	1.5	20,563	209.3
2	Kohler 45Kw generator (55REOZT4 est.)	74	55.2	2.5	1.75	12	120	1.5	7,560	77.0
								TOTALS	**162,565**	**1,655.0**

Conversions:

- 1 HP = 0.7457 kWh
- 10,180g CO2 emitted per 1 gal diesel used.[4]

Notes:

- Hourly fuel consumption was reduced by 30% to account for equipment not utilizing full power output throughout the entire duration of construction activities.

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Emission Source	1.5-Year Project Emissions (mt)
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Notes:

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Estimated Total Project Mobilization and Demobilization CO2 Emission Output - Barge Effort

Loading/Unloading Barge Emissions											
No.	Equipment	Power Output (HP)	Power Output (kWh)	Hourly Fuel Consumption[2,3] (gal/hr)	Reduced Hourly Fuel Consumption[6] (gal/hr)	Shift Duration (hr)	No. Shifts per Day (ea)	Single Load or Unload Duration (days)	Load and Unload Activities (ea)	Fuel Use (gal)	CO2 Emissions[4] (mt)
1	Cat 966 Loader	325	242.4	4.7	3.29	10	2	7	4	1,842	18.8
1	Cat 988 Loader	580	432.5	13.9	9.73	10	2	7	4	5,449	55.5
4	Cat P30000 Forklift	148	110.4	4.9	3.43	10	2	7	4	7,683	78.2
4	Mobile Light (Kohler KD1003- diesel est.)	24	17.9	0.5	0.35	10	2	7	4	784	8.0
2	Kohler 45Kw generator (55REOZT4 est.)	74	55.2	2.5	1.75	10	2	7	4	1,960	20.0
									TOTAL	**17,718**	**180.5**

150-foot, Ocean-going Tug Emissions				
Seattle to Marshall One-Way Duration (days)	One-Way Fuel Use (gal)	Trips (ea)	Total Fuel Use (gal)	CO2 Emissions[4] (mt)
20	3,200	2	6,400	65.2
			TOTAL	**65.2**

Conversions:

- 1 HP = 0.7457 kWh
- 10,180g CO2 emitted per 1 gal diesel used.[4]

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Estimated Total Project Mobilization and Demobilization CO2 Emission Output - Road Mobilization from Barge Landing to Contractor Staging Area

Gravel Road Emissions							
No.	Equipment Hauled or Hauling Freight	Equipment Weight (lbs)	Total Weight (ton)	Haul distance from Old Airport (miles)	No. of Trips (ea)	Total Haul (ton-miles)	CO2 Emissions[1] (mt)
2	Large grader (Cat 24 for est.)	161,700	161.70	3	2	970	0.20
1	D-6 size dozers on spread	51,333	25.67	3	2	154	0.00
1	D-8 size dozer in pit	88,000	44.00	3	2	264	0.00
1	Cat 966 Loader	48,000	24.00	3	2	144	0.00
1	Cat 988 Loader	112,574	56.29	3	2	338	0.10
2	Excavators (100 to 150HP) Cat. 320 est.	48,300	48.30	3	2	290	0.00
2	Compactors (Cat. CS54 est.)	23,265	23.27	3	2	140	0.00
2	ATV Water Truck (Volvo A25)	43000	43.00	3	2	258	0.00
5	Ford F-250 pickup	7,000	17.50	3	2	105	0.00
4	Mobile Light (Kohler KD1003- Diesel)	1,800	3.60	3	2	22	0.00
2	6" pump (United Rent PP66S14 - J.D. Diesel)	4,600	4.60	3	2	28	0.00
2	Kohler 45Kw generator (55REOZT4)	4,941	4.94	3	2	30	0.00
5	Smithco SX side dump trailer	15,000	37.50	3	2	225	0.00
1	35+ ton low-boy	25,000	12.50	3	6	225	0.00
5	Semi tractors	10,000	25.00	3	6	450	0.10
4	Volvo A40	66,000	132.00	3	2	792	0.10
1	Gross Weight 26' x 50' SREB Materials	52,000	26.00	3	1	78	0.00
1	Gross Weight Culverts	10,000	5.00	3	1	15	0.00
1	Gross Weight Electrical Materials	20,000	10.00	3	1	30	0.00
5	Conex (Man Camp/Offices)	8,500	21.25	3	2	128	0.00
						TOTAL	**0.50**

Gravel Road Support Vehicle Emissions						
No.	Truck Type	Haul Distance from Old Airport (miles)	No. of Trips (ea)	Fuel Consumption Rate (mpg)	Fuel Use (gal)	CO2 Emissions[4] (mt)
1	Shop/Service Truck	3	6	12	1.5	0.0
1	Fuel Truck (5000 gal)	3	6	12	1.5	0.0
1	Flatbed 3 Ton Truck	3	6	12	1.5	0.0
					TOTAL	**0.0**

Estimated Total Project Mobilization and Demobilization CO2 Emission Output - Gravel Road Effort

Conversions:

• 162g CO2 emitted per 1 ton-mile hauled.[1]

• 10,180g CO2 emitted per 1 gal diesel used.[4]

Marshall Airport Improvements
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Estimated Total Project Material Production CO2 Emission Output

Material Type	Weight (ton)	Weight (mt)	CO2e Emissions[5] (mt)
CASC	51,000	46,257	270.1
		TOTAL	**270.1**

Conversions:

- 1 ton = 0.907 metric ton
- 5.84kg C02e emitted per 1 metric ton of crushed aggregate.[5]

Abbreviations:

CASC Crushed Aggregate Surface Course

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Estimated Total Project Material Haul CO2 Emission Output

Riprap (ton)	Borrow (ton)	Subbase (ton)	CASC (ton)	Side Dump Trailer Volume (cy)	Full Side Dump Trailer Weight (ton)	Empty Side Dump Trailer Weight (ton)	Tractor Weight (ton)	Material Source to Project Site (mi)
3,700	0	42,600	51,000	24	48	8	5	6

Side Dump	Total Material Weight (ton)	Total Material Volume (cy)	Haul Trips (ea)	Haul Weight (ton)	Total Haul (ton-miles)	CO2 Emissions[1] (mt)
Full	93,600	46,800	1,950	61	713,700	115.6
Empty	0	0	1,950	13	152,100	24.6
					SUBTOTAL	**140.2**

Riprap (ton)	Borrow (ton)	Subbase (ton)	CASC (ton)	Volvo A40 Rock Truck Volume (cy)	Material Weight per load (ton)	Empty Volvo A40 Rock Truck Weight (ton)	Material Source to Project Site (mi)
0	220,962	0	0	21	43	66	6

Volvo A40	Total Material Weight (ton)	Total Material Volume (cy)	Haul Trips (ea)	Haul Weight (ton)	Total Haul (ton-miles)	CO2 Emissions[1] (mt)
Full	220,962	110,481	5,187	109	3,379,785	547.5
Empty	0	0	5,187	66	2,054,013	332.8
					SUBTOTAL	**880.3**

TOTAL	**1,020.5**

Conversions:

- 1 cy = 2 ton
- 162g CO2 emitted per 1 ton-mile hauled.[1]

Abbreviations:

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Estimated Total Construction CO2 Emission Output

No.	Equipment	Power Output (HP)	Power Output (kWh)	Hourly Fuel Consumption[2,3] (gal/hr)	Reduced Hourly Fuel Consumption[6] (gal/hr)	Shift Duration (hr)	Construction Season (days)	No. of Seasons (ea)	Fuel Use (gal)	CO2 Emissions[4] (mt)
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5	F-250 Pickup	-	-	1.0	0.70	10	120	1.5	6,300	64.1
1	Shop/Service Truck	-	-	1.5	1.05	10	120	1.5	1,890	19.2
1	Fuel Truck	-	-	2.0	1.40	10	120	1.5	2,520	25.7
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4	Mobile Light (Kohler KD1003- diesel est.)	23.7	17.7	0.5	0.35	10	120	1.5	2,520	25.7
2	6" pump (United Rent PP66S14 - J.D. diesel est.)	173	129.0	6.8	4.76	12	120	1.5	20,563	209.3
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								TOTALS	**162,565**	**1,655.0**

Conversions:

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Notes:

- Hourly fuel consumption was reduced by 30% to account for equipment not utilizing full power output throughout the entire duration of construction activities.

Project length

Project start	7/1/2023
Project end	10/1/2024

Quanitites

Unclassified Ex	12,100	CY	24,200	TON
Borrow	110,481	CY	220,962	TON
Subbase	21,300	CY	42,600	TON
CASC	25,500	CY	51,000	TON
Riprap	1,850	CY	3,700	TON

Distance of Haul

Pilcher Mt to apron	6	mi	(5.6mi to edge of material site)
Old to new airport	3	mi	

Barge distance

Seattle to Red Dog Mine Port One

Seattle to ketchikan	659	mi (nautical)
ketchikan close to AK/CAN border		
Alaska Canada border to hooper bay	1058	mi (nautical)
Marshall is 160mi up Yukon	160	mi
Yukon is 450 mi from Red Dog mine	450	
noatak barge distance		