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Appendix 5-1: Materials Estimates

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1 Materials Estimates

Table 1-1 below provides a summary of the expected materials required for the AAWDCP civil engineering construction activities.

Table 1-1: Summary of principal civil engineering material quantities

Project Component	Material	Quantities	Units
Marine Works	Concrete[1]	-	m^3
	Steel Structures	-	m^2
	Dredging and backfill	17,000	m^2
IPS	Concrete	10,484	m^3
	Steel Structures	Included in Desal estimate	m^2
	Earthworks (cut and fill)	65,379	m^3
Desalination Plant	Concrete	90,466	m^3
	Steel Structures	14,165	m^2
	Excavation	309,184	m^3
	Backfill	199,220	m^3
Conveyance System - Pipeline	Concrete[2]	181,183	m^3
	Steel Pipe	327,228	Ton
	Excavation	12,166,073	m^3
	Backfill	6,656,517	m^3
	Imported Material	4,037,764	m^3
	Transportation (for disposal)	5,499,828	m^3
Conveyance System - Pumping Stations	Concrete[2]	58,154	m^3
	Steel Tanks	10	Unit
	Excavation	2,017,313	m^3
	Backfill	333,260	m^3
	Imported Material	535,672	m^3
	Transportation (for disposal)	380,788	m^3
Conveyance System - Access Roads	Excavation	206,431	m^3
	Transportation (for disposal)	206,431	m^3
	Road Base + Sub-base	375,000	Ton
	Road Reinstatement	360,000	Ton
Renewable Energy Facilities/ OHTL[3]	Concrete	-	m^3
	Steel Structures	-	m^2
	Earthworks (cut and fill)	-	m^3

[1] Intake Tower construction material type to be confirmed. No data available for concrete ballast blocks
[2] Includes plain, reinforced concrete and concrete for encasement
[3] Data for Renewable Energy facility / OHTL steel and concrete quantities unavailable at time of writing

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Appendix 5-2: Plant and Equipment Estimates

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1 Marine Works, Intake Lagoon and Outfall System

Table 1-1 summarises the estimated number of vessels used during marine works construction activities for the outfall system. Vessel operations are expected to take place during daylight hours (12 hrs per day) for three months. Table 1-2 summarises the estimated plant and equipment required for the land-based construction of the intake lagoon and outfall system. Intake lagoon construction is expected to take 12-18 months to complete. Jetty construction and trenching to allow installation of the outfall system are expected to take one to three months to complete.

Table 1-1: Outfall System Construction Vessels

Vessel Type	No.	Estimated Fuel Consumption (m3/d) per vessel type
Crane barge	1	6
Anchor handling vessels	3	15.5
Survey/support vessels	2	13.5
Tugs	2	2
Dive Support Vessel (DSV)	1	18

Table 1-2: Intake and Outfall System Construction Plant and Equipment

Plant / Equipment	Intake Lagoon/ Outfall Jetty & Trenching	Estimated Power Consumption (kW)
Excavator	2	70
Front Loader	2	125
Dozer	1	108
Backhoe loader	1	26
Truck (tipping fill)	2	126
Mobile Crane	1	75
Generators	1	96

2 IPS and Desalination Plant

Table 2-1 summarises the anticipated usage of key plant and equipment during the IPS and Desalination Plant construction. Construction of the IPS and Desalination Plant is expected to take approximately 40 months to complete (including the mobilisation phase).

Table 2-1: IPS and Desalination Plant Construction Plant and Equipment

Plant / Equipment	IPS	Desalination Plant	Estimated Power Consumption (kW)
Excavator	2	4	70
Front Loader	2	4	125
Dozer	1	2	108

Plant / Equipment	IPS	Desalination Plant	Estimated Power Consumption (kW)
Backhoe loader	1	2	26
Truck (tipping fill)	2	4	126
Mobile Crane	1	2	75
Generators	1	2	96

3 Conveyance System

Table 3-1 summarises the anticipated usage of key plant and equipment during the Conveyance Pipeline construction for each spread. Pipeline construction is expected to take approximately 38 months to complete in total across four individual construction spreads, inclusive of six months initial enabling works. Each AGI is expected to take between six and 32 months to complete depending on AGI type and location.

Table 3-1: Conveyance System Construction Plant and Equipment

Plant / Equipment	Pipeline Construction Spread/ AGI Type						Estimated Power Consumption (kW)
	Pipeline Trenching	Pipeline Installation	Pipeline Backfilling	Crushing/ Screening	Pumping Station	Regulating Tank/ Break Pressure Tank	
Excavator	8	-	4	-	2	2	70
Front Loader	4	-	4	-	2	2	125
Dozer	-	-	1	-	1	1	108
Backhoe loader	1	1	1	1	1	1	26
Truck (tipping fill)	2	2	2	2	2	2	126
Dump Truck	4	-	-	-	-	-	142
Water Truck	2	-	2	1	-	-	126
Mobile Crane	-	4	-	-	1	1	75
Generators	-	4	-	-	1	1	96
Air Compressor	2	1	-	-	-	-	75
Grader	-	-	1	-	-	-	81
Roller	-	-	3	-	-	-	48
Crusher	-	-	-	1	-	-	50
Screening Equipment	-	-	-	1	-	-	15

In addition to Table 3-1 above, the expected transportation of materials by Truck, with an assumed engine size of 186 kW, during the Conveyance Pipeline construction is summarised as follows:

- 440km Pipeline Sections (40,000 trips)

- Excavation Material (1,000,000 trips over a distance max distance of 10km)
- Backfill Material (460,000 trips over a distance max distance of 10km)

4 Renewable Energy Facilities and OHTL

Table 4-1 summarises the anticipated usage of key plant and equipment during the Renewable Energy Facility and OHTL construction. Renewable Energy Facility construction is expected to take approximately 16 months to complete. OHTL construction is expected to take approximately 30 months to complete.

Table 4-1: Renewable Energy Facility and OHTL Construction Plant and Equipment

Plant / Equipment	Renewable Energy Facility	OHTL	Estimated Power Consumption (kW)
Excavator	2	2	70
Front Loader	2	2	125
Dozer	1	1	108
Backhoe loader	1	1	26
Truck (tipping fill)	2	2	126
Mobile Crane	1	1	75
Generators	1	1	96

5 Construction Camps and Personnel Transportation

Table 5-1 summarises the anticipated energy demand of the construction camp and the associated annual diesel engine-powered generator fuel consumption. Construction camps will operate for approximately 36 months. Table 5-1 also summarises the anticipated annual fuel consumption associated with personnel transportation to and from the construction camps and Project worksites.

Table 5-1: Construction Camp and Personnel Transportation Annual Fuel Consumption

Construction Camps		Personnel Transportation	
Total Population[1]	4600	**Vehicle Engine Size, kW[3]**	106.6
Per capita consumption, kW	1.2	**Total personnel[4]**	4000
Hours per year	8760	**No. of Daily Trips[5]**	200
Diesel (BSFC)[2], kg/kWh	0.22	**Average Travel Time, Hours[6]**	0.4
Diesel Consumption, T/annum	10,638	**Diesel Consumption, T/annum**	684.6

1. Assumes an average Conveyance Pipeline workforce of 2,600 personnel and a Desalination Plant/IPS workforce of 2,000 personnel housed across upto five autonomous construction camps.
2. Brake Specific Fuel Consumption.
3. Based on typical size for a 40-passenger capacity coach.
4. Assumes 4000 personnel commute daily, with 600 personnel staying in construction camps.
5. Assumes 40 personnel per coach, with 2 trips per day.
6. Assumes an average travel distance of 20km and an average speed of 50 km/h

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Appendix 5-3: Construction Phase GHG Estimates

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1 Introduction

This Appendix provides supplementary information to the Construction phase emissions calculations presented in Chapter 5: Project Description and includes GHG emission factors and the basis of emissions estimates for each AAWDC Project component.

Emissions were calculated using internationally accepted emission factors from the following sources:

- US EPA420-R-05-019 Exhaust Emission Factors for Nonroad Engine Modelling NR-010e
- EMEP/CORINAIR Emission Inventory Guidebook - 2007. Group 8: Other mobile sources and machinery. SNAP Sector 0808 Industry.
- EEMS- Atmospheric Emissions Calculations, UK Department of Energy & Climate Change, 2008, Issue 1.810a
- E&P Forum – Report No. 2.59/197
- IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories - CO_2 , CH_4 , and N_2O emissions from transportation-water-borne navigation

2 Emissions Factors

2.1 Vessels/ Stationary Combustion Sources

Table 2-1 presents emissions factors used to calculate emissions from:

- Vessels used for marine works
- Stationary Combustion Sources

Table 2-1: Stationary Combustion Sources and Vessel Emissions Factors

Type of Source	Fuel	Unit	CO_2	CH_4	N_2O
Engine[1]	Diesel	tonnes emissions/ tonnes of fuel used	3.2	0.00018	0.00022
Vessel[2]	Diesel			0.000087	0.0013[3]
	References: [1] EEMS- Atmospheric Emissions Calculations, UK Department of Energy & Climate Change, 2008, Issue 1.810a [2] E&P Forum - Report No. 2.59/197 [3] IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories - CO_2 , CH_4 , and N_2O emissions from transportation-water-borne navigation				

2.2 Onshore Construction Plant

Table 2-2 presents emissions factors used to calculate emissions from construction plant including trucks, cranes, dozers and loaders etc.

Table 2-2: Construction Plant Emissions Factors

Engine size	Species Emission Factors (g/kWhr)		
	[1]CO_2	[2]CH_4	[2]N_2O
0-20	948	0.05	0.35
20-37			
37-75			
75-130			
>130			
	[1] Carbon Dioxide Calculation from US EPA420-R-05-019 Exhaust Emission Factors for Nonroad Engine Modelling NR-010e [2] EMEP/CORINAIR Emission Inventory Guidebook - 2007. Group 8: Other mobile sources and machinery. SNAP Sector 0808 Industry.		

2.3 Methodology

2.3.1 Marine Works/ Intake and Outfall System

Vessel emissions during the installation of outfall facilities were calculated based on estimated fuel consumption rates of each type of operated vessel multiplied by the expected number and duration of usage of each vessel type (provided in Table 1-1 of Appendix 5-2 – Plant and Machinery Estimates) and relevant emission factors (provided in Table 2-1 of this Appendix). Emissions resulting from land based construction of the intake lagoon and jetty based trenching for the outfall installation were calculated based on the expected number of plant and equipment and duration of usage of each plant type (provided in Table 1-2 in Appendix 5-2) and the relevant emissions factors (provided in Table 2-2 of this Appendix) taking into account engine size.

2.3.2 Onshore Construction Plant

Onshore construction plant emissions will be generated during the construction of:

- Intake Pumping Station (IPS)
- Desalination Plant
- Conveyance System
  - Pipeline (including materials transportation)
  - Above Ground Installations (AGIs)
- Renewable Energy (RE) Facility
- Overhead Transmission Lines (OHTL)

Emissions were calculated based on the expected number of plant and equipment and duration of usage of each plant type (provided in Tables 2-1, 3-1 and 4-1 of Appendix 5-2) and the relevant emissions factors (provided in Table 2-2 of this Appendix) taking into account engine size.

2.3.3 Construction Camps & Personnel Transportation

Onshore Construction Camp emissions will be generated due to:

- Construction Camp diesel engine-powered generators
- Transportation of personnel to and from the Construction Camp and Project worksites

Construction Camp emissions were calculated based on the expected number of personnel and per capita energy consumption to estimate annual diesel fuel consumption (provided in Table 5-1 of Appendix 5-2) and the relevant emissions factors (see Table 2-1 of this Appendix).

Personnel transportation emissions were calculated based on the expected number of personnel journeys and average journey time to estimate annual diesel fuel consumption (provided in Table 5-1 of Appendix 5-2) and the relevant emissions factors (provided in Table 2-1 of this Appendix).

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Appendix 5-4: Operations Phase GHG Estimates

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1 Introduction

This Appendix provides supplementary information to the Operations phase emissions calculations presented in Chapter 5: Project Description and includes CO_2 emission factors and the basis of emissions estimates for the AAWDC Project Operations component.

Emissions were calculated using internationally accepted emission factors from the following sources and assumptions:

- International Finance Institutions (IFI) Default Grid Factor for Jordan
- Assumed network transmission and distribution losses supplied by National Electric Power Company (NEPCO)
- Assumed solar panel degradation rates per annum based on industry best practices.

2 Emissions Factors

2.1 National Grid and Renewables Emission Factors

Table 2-1 presents the GHG emission factor for Jordan's national grid, network transmission and distribution losses, and assumed solar panel degradation rates.

Table 2-1: Operations Phase Emissions Factors and Assumptions

Emissions Factors /Assumptions	Value	Units
Blended Emission Factor[1]	381.86	gCO2/kWh
Transmission & Distribution losses[2]	1.94%	Percent
Solar Degradation Rate[3]	0.5%	Percent/yr
[1] Harmonized IFI grid factors (UNCC 2022) [2] National Electric Power Company (NEPCO) data [3] Industry best practice		

3 Methodology

The method for quantifying GHG emissions in the Operations phase initially calculates the Project's annual electricity demand distribution between the RE Facility renewable available energy supply and the national grid. Then it calculates annual CO_2 emissions based on the IFI grid emission factor, accounting for NEPCO-specified transmission and distribution losses across the network and the cumulative solar panel degradation rate for RE Facility power generation. This calculation is applied to each project year from 2030 to 2055.