Neptun Deep Project

Emissions Inventory Report

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Revision history

Revision No	Section Ref	Description of Change
P02	2.1, Table 6-1 2.2, Table 6-5	Offshore construction emissions numbers updated in line with assumptions used for operations. CO figure updated for Onshore construction emissions.
P03	Table 3-1 and Table 6-2 Table 5-1 and Table 6-4	Drilling emissions numbers updated for diesel generators in line with comments received on Chapter 7 of ESIA. Update abnormal emissions for ICSS control response to overpressure, partial blowdown of Pelican and Domino pipeline as component numbers mixed up for NO_X, CO, PM, CH_4 and VOCs.

Holds

Hold No	Section Ref	Description of Hold

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Tables

1 Introduction

Neptun Deep is a proposed offshore natural gas development in the Neptun Deep block, located in the Romanian section of the Black Sea. The objective of the project is to develop the natural gas reserves from the Pelican and Domino fields, at shallow and deep water respectively. Pelican is located on the continental shelf at approximately 120 m water depth. Domino is located off the continental shelf at approximately 1000 m depth. The gas fields are tied back to a normally unattended Shallow Water Platform (SWP) on the continental shelf.

The SWP is linked to land via a 160 km Gas Production Pipeline (GPP) that feeds into the normally unattended Natural Gas Metering Station (NGMS) for measurement and transmission of processed gas to the Romanian National Transmission System. Also onshore, next to the NGMS, is the Central Control Room (CCR) which serves as the primary operations monitoring and control centre for all Neptun Deep project facilities, offshore and onshore.

The purpose of this document is to tabulate the emissions, effluents and waste that are expected from the Neptun Deep offshore and onshore facilities whilst in Romanian waters/ jurisdiction. Emission inventories at fabrication sites and transit to Romania are not included. The information in this document has been prepared in line with the Environmental and Social Impact Assessment (ESIA) and details emissions generated during the following phases of the project:

- Construction/ Commissioning and Start-up.
- Drilling.
- Normal operation.
- Abnormal operation.

Decommissioning is not covered in this Emissions Inventory as there is insufficient information at this time. Decommissioning will be covered later in a separate ESIA and Environmental Impact Assessment (EIA) prior to the decommissioning phase.

2 Construction (Including Commissioning and Start-Up)

2.1 Offshore

2.1.1 Emissions to air

The emissions generated from construction and commissioning activities include CO_2, CO, NO_X, CH_4, PM and VOCs. A summary of offshore construction and commissioning emissions is shown in Table 2-1, with a detailed account of sources highlighted in detail, within Section 6.

Table 2-1 Offshore Atmospheric Emissions during Construction

POLLUTANT	AMOUNT (tpa)	AMOUNT (tpa)
	Continuous	Intermittent
NO_X	3.01	3,056
CO	0.77	361.92
PM	0.06	1,395
CH_4	0.08	134.17
VOC	0.02	73.98
SO_2	0.01	76.28
N_2O	-	0.00
CO_2	2,825	238,173

Sources of air emissions from offshore construction equipment include:

- Engine exhaust emissions from diesel-fuelled miscellaneous offshore plant and equipment generating CO_2, CO, NO_X, N_2O, CH_4, SO_2 and VOCs. An assumption is made that two forklifts and a crawler crane operate for 24 hours per day, 6 days per week, and consume 3 L and 8 L of fuel per hour of operation respectively.
- Engine exhaust emissions from diesel-fuelled pre-commissioning spread on construction vessels for Pelican (filling, hydrotest, dewatering and packing) generating CO_2, CO, NO_X, N_2O, CH_4, SO_2 and Volatile Organic Compounds (VOCs). Duration for Pelican pre-commissioning over 7 days temporary spread based on offshore construction vessel diesel driven units. An assumption is made that filling, hydrotest, dewatering and packing occur over 1, 4 and 2 days respectively and consume 205, 70 and 2,470 L/h respectively.
- Engine exhaust emissions from diesel-fuelled pre-commissioning spread on construction vessels for Domino (filling, hydrotest, dewatering and packing) generating CO_2, CO, NO_X, N_2O, CH_4, SO_2 and VOCs. Duration for Domino pre-commissioning over 15 days temporary spread based on offshore construction vessel diesel driven units. An assumption is made that filling, hydrotest, dewatering and packing occur over 4, 5 and 6 days respectively and consume 365, 287 and 2,458 L/h respectively.
- Engine exhaust emissions from diesel-fuelled pre-commissioning spread on construction vessels for GPP (filling and leak test) generating CO_2, CO, NO_X, N_2O, CH_4, SO_2 and VOCs. Duration for GPP pre-commissioning over 7.5 days temporary spread based on offshore construction vessel diesel driven units. An assumption is made that filling, and leak test occur over 6, and 1.5 days respectively and consume 765, and 70 L/h respectively.

- Engine exhaust emissions from diesel-fuelled temporary power generators for SWP hook-up, black start and essential services generators for commissioning and start-up generating CO_2, CO, NO_X, N_2O, CH_4, SO_2 and VOCs. An assumption is made that the diesel generators operate for 24 hours per day and that the temporary power generator for SWP hook-up, black start generator and essential services generator are utilised for 120, 7 and 7 days respectively.
- Exhaust emissions from Gas Turbine Generators (GTGs) for commissioning generating CO_2, CO, NO_X, N_2O, CH_4, SO_2 and VOCs. An assumption is made that that the gas turbine generators operate for 24 hours per day with 2 units in operation and fuel flowrate of 2,200 kg/h.
- Nitrogen venting (not calculated).

Air emissions from offshore flaring and venting during construction (including commissioning and start-up) include:

- Offshore LP/HP Flare Pilot – The Low Pressure (LP) Flare is only used during this phase when transitioning from Commissioning to Operations. The LP Flare will be lit when the first of the SPS's commences forward gas (expected to be Pelican). A combined LP & High Pressure (HP) Flare tip with 3 pilots is assumed. Pilots will be lit during the GPP N_2/ back gassing process. This is assumed to be a 2-day process, noting that the pilots cannot be lit until natural gas is present in the vent gas as N_2 will snuff the pilots, generating gas combustion products, including CO_2, CO, NO_X, CH_4, Particulate Matter (PM) and VOCs.
- HP Flare - Initial Cold Start (Pelican well ramp-up) – Based on the Pelican system being brought online first and may take up to 5 days generating gas combustion products, including CO_2, CO, NO_X, CH_4, PM and VOCs.
- Flaring - Start Up Gas - Domino Flowline Purging (Flaring). The Domino flowline is initially filled with N_2 with Pelican production flared while N_2 system purges (24h – slow well ramp up). This assumes a mixing zone of 50% of total Domino flowline volume with a worst case 100% CH_4 in the mixing zone to be flared generating gas combustion products, including CO_2, CO, NO_X, CH_4, PM and VOCs.
- Venting of start-up gas (pre-flare ignition) generating CO_2, CH_4, and VOCs. An assumption is made that there is no pig train barrier during the back gas operation with relative plug flow assumed, and some mixing will take place. Estimated mass of methane vented prior to ignition of HP Flare is 66 te (assuming 100% methane in the mixing zone). Venting is calculated as an average over the year; however, the peak flow is 96,500 kg/h over a 41-minute duration.

Sources of air emissions from offshore transportation include:

- Helicopter engine exhaust emissions generating CO_2, CO, NO_X, CH_4, SO_2 and VOCs. The distance to the SWP and back is taken as 320km, based on the length of the GPP. An assumption is made that during construction there will be 4 Helicopter trips per day over 90 days assumed to cover the winter period.
- Vessel exhaust emissions from numerous vessels generating CO_2, CO, NO_X, CH_4, SO_2 and VOCs. The assumptions for number of days of operation for each vessel and the fuel consumption are tabulated below in Table 2-2.

Table 2-2 Assumptions for Vessel Exhaust Emissions during Construction

Vessel	Days of Operation	Fuel Consumption (L/hr)
Pipeline Installation Vessel	190	35
Supply Vessel	802	10
Heavy Lift Vessel (10,000 t)	88	50
Heavy Transportation Vessel	10	20
Flexlay Installation Vessel	43	15
Subsea Construction Vessel (Heavy)	101	15
Subsea Construction Vessel (Light)	299	15
Survey Vessel	146	8
Cargo Barge including Tugs or Coaster	553	15
Flotel	300	12
Crew Transfer Vessel (CTV)	540	3
Emergency Response and Rescue Vessel (ERRV)	140	5
Dredger	45	10
Rock Dumper	10	10

2.1.2 Liquid effluents

Sources of offshore liquid effluents during the construction period include the following:

- Sewage from vessels (21,600 te) from an assumed 450 personnel generating 200 L per person per day over a period of 240 days which is discharged to sea in accordance with MARPOL requirements.
- Hydrotest water consisting of water contaminated with chemicals. This volume is made up of an assumed 97 m^3 from Pelican, 4,794 m^3 from Domino and 68,261 m^3 from sales gas pipeline to shore.
- Wash water (26 m^3) which is discharged directly to the sea.
- Hydraulic fluid (1 m^3) associated with valve movements is discharged to the sea during commissioning activities for the XTs.
- Produced Water (PW) (3,600 m^3) during early life including Tri-ethylene Glycol (TEG), Corrosion Inhibitor (CI), Scale Inhibitor (SI), antifoam, and sand with the Domino wells left underbalanced prior to start-up, will be discharged to the sea in the anoxic zone. The liquids will be 'brine' but some surfactant maybe expected.
- Produced Fluids for drilling and completion at start-up (400 m^3) to be taken onshore for treatment and disposal. Assumes 50 m^3 for each Domino well (x6) and 25 m^3 for each Pelican well (x4).
- Cooling Water (CW) including Sodium Hypochlorite (70,560 m^3) is mixed with PW and discharged to sea in the anoxic zone.
- Testing of Deck Integrated Firefighting (DIFF) systems (water with chemicals) is discharged directly to sea (5 m^3).
- Open drains discharge (rainwater) is discharged directly to sea (130 m^3).
- Ballast water with an assumption that ballast water will be discharged at some point. An estimated 150,000 m^3 is assumed based on capacity of vessels.

2.1.3 Solid waste

Sources of offshore solid waste during the construction period are tabulated in Section 6 and include the following assumption:

- Domestic waste (54 te) generated from 450 personnel working on the construction site, assuming 0.5 kg of waste per person per day over 240 days.

2.2 Onshore

2.2.1 Emissions to air

The emissions generated from onshore construction and commissioning activities include CO_2, CO, NO_X, CH_4, PM and VOCs. A summary of onshore construction emissions is shown in Table 2-3, with a detailed account of sources highlighted in detail, within Section 6.

Table 2-3 Onshore Atmospheric Emissions during Construction

POLLUTANT	AMOUNT (tpa)
	Continuous
NO_X	164.50
CO	43.478
PM	-
CH_4	-
VOC	5.539
SO_2	11.077
N_2O	-
CO_2	8,862.0

Sources of air emissions from onshore construction equipment for the duration of the construction period onshore include the following:

- Engine exhaust emissions from a diesel-fuelled crane generating CO_2, CO, NO_X, N_2O, CH_4, SO_2 and VOCs. An assumption is made that cranes operate for 8 hours per day and consume 2.5 L of fuel per hour of operation.
- Engine exhaust emissions from diesel-fuelled heavy machinery (cranes, excavators, trucks and transportation, loaders, concrete trucks, compactors, cherry pickers, welding plant generators, air compressors) generating CO_2, CO, NO_X, N_2O, CH_4, SO_2 and VOCs. An assumption is made that the heavy machinery operates for 8 hours per day and consume 1 – 42 L of fuel per hour of operation dependent on the machinery.

Table 2-4 Assumptions for Heavy Machinery Emissions during Construction

Machinery	Hours of Operation	Fuel Consumption (L/hr)
Cranes	3,200	2.5
Excavators	21,760	15
Truck and Transportation	86,400	30
Loaders	26,880	12
Concrete Trucks	6,400	1
Compactors	2,240	5
Cherry Pickers	6,720	4
Welding Plant Generators	14,400	1.25
Air Compressor	360	42

2.2.2 Liquid effluents

Sources of onshore liquid effluents during the construction period include the following:

- Sewage from personnel working on the tunnel and shore crossing (192 te) from an assumed 40 personnel generating 40 L per person per day over a period of 120 days which is collected and disposed of by a third party. This is temporary until a connection with RAJA is established.
- Sewage from the personnel working on the construction site (1,400 te) from an assumed 70 personnel generating 40 L per person per day over a period of 500 days which is collected and disposed of by a third party until a connection with RAJA is established.
- PW from the tunnelling process (3,140 m^3 made up of 1,740 m^3 from the drilling fluid system and 1,400 m^3 from the cleaning process), which undergoes treatment prior to discharge to sea.
- PW from shaft construction (200 m^3) which undergoes treatment prior to discharge to sea.
- Wheel wash wastewater based on an assumed volume of 5 m^3 water per day, which may be a higher or lower quantity based on activities at the site, which is discharged to sea.
- Displaced tunnel water from backfilling (3,250 m^3) which is pumped, treated, and stored prior to discharge to sea.
- Hydrotest water associated with the onshore components (980 m^3), which is assumed to undergo treatment prior to discharge to the sea. This contaminated water is treated, pumped and stored prior to discharge to the sea.
- Hydrotest fluid for NGMS pipework (80 m^3) which is treated and disposed onshore following hydrotesting.
- Stormwater runoff (rainwater) which is collected in a buffer tank and routed via an oil separator before disposal to ditches. Based on average rainfall in the area (450 mm/year/m^2) and total onshore concrete and buildings area this results in a yearly average of 4000 m^3 of rainwater.

2.2.3 Solid Waste

Sources of onshore solid waste generated during the construction period are tabulated in Section 6 and assumptions include the following:

- Domestic waste (24.5 te) generated from 70 personnel working on the construction site assuming 0.5 kg of waste per person per day over 700 days.

3 Drilling

3.1 Offshore

3.1.1 Emissions to air

The emissions generated from drilling activities include CO_2, CO, NO_X, CH_4, PM and VOCs. A summary of drilling emissions is shown in Table 3-1, with a detailed account of sources highlighted in detail, within Section 6.

Table 3-1 Offshore Atmospheric Emissions during Drilling

POLLUTANT	AMOUNT (tpa)	AMOUNT (tpa)
	Continuous	Intermittent
NO_X	2.6930	9,476.8
CO	0.7153	595.82
PM	0.0842	0.0162
CH_4	-	-
VOC	-	231.14
SO_2	0.8500	238.97
N_2O	-	-
CO_2	121.09	428,540

Sources of air emissions from offshore construction equipment during drilling include:

- Engine exhaust emissions from a diesel-fuelled crane generating CO_2, CO, NO_X, N_2O, CH_4, SO_2 and VOCs. An assumption is made that cranes operate for 12 hours per day, for a total of 800 days during the drilling period and consume 2.5 L of fuel per hour of operation.
- Engine exhaust emissions from eight diesel-fuelled generators generating CO_2, CO, NO_X, N_2O, CH_4, and VOCs, assuming 24 hours of operation per day for 800 days with an assumed diesel flow rate of 50 te/day.
- Engine exhaust emissions from temporary diesel-powered equipment generating CO_2, CO, NO_X, N_2O, CH_4, SO_2 and VOCs. An assumption is made that the Riserless Mud Recovery (RMR) consumes 500 L of fuel per hour of operation over 80 days. It is assumed the Wireline (WL) and General Pump (GP) skids consume 458.37 L of fuel per hour of operation over 5 and 2 days respectively.

Sources of air emissions from offshore transportation during drilling include the following:

- Exhaust emissions from helicopters generating CO_2, CO, NO_X, CH_4, SO_2 and VOCs. An assumption is made that during the 800-day drilling campaign, there will be one helicopter trip per day and another every second day. The distance from the NGMS to Pelican and to Domino is approximately 218 km and 238 km, respectively. A fuel consumption rate of 5.5 km/L was assumed for the calculation.
- Vessel exhaust emissions from supply vessel, Anchor Handling Tug (AHT) vessel, standby vessel, and Multi-purpose Service Vessel (MSV) include CO_2, CO, NO_X, CH_4, SO_2 and VOCs. An assumption is made that the supply vessel and standby vessel are operational for a total

of 800 days and the AHT and MSV are operational for only 60 days for the entire drilling campaign. A worst-case fuel consumption rate of 35 te/day is assumed.

3.1.2 Liquid effluents

Sources of liquid effluents during the drilling period include:

- Water-based fluids for top-hole drilling (24,000 m^3), assuming 15,000 bbl per well for 10 wells, which are discharged directly to the seabed.
- Mono-ethylene glycol (MEG) injection for the Blow Out Preventer (BOP) (500 m^3) assuming 50m^3 per well.
- BOP hydraulic control fluid (350 m^3) assuming 0.25m^3 per well (2.5m^3 for the drilling campaign) plus 100% contingency included.
- Water-based drill cuttings (7,500 m^3) with 50% contingency included to account for washout.
- Sewage (31,040 te) from an assumed 194 personnel generating 40 L per person per day over a period of 800 days which is disposed in accordance with MARPOL requirements.

3.1.3 Solid waste

Sources of solid waste generated during the drilling campaign are tabulated in Section 6 and assumptions include the following:

- Domestic waste (77.6 te) generated from 194 personnel working during the drilling campaign assuming 0.5 kg of waste per person per day over 800 days.

4 Normal operation

4.1 Offshore

4.1.1 Emissions to air

Table 4-1 Offshore Atmospheric Emissions during Normal Operations

Pollutants	AMOUNT (tonnes/year)	AMOUNT (tonnes/year)
	Continuous	Intermittent
NO_X	159.79	179.96
CO	46.724	45.569
PM	3.3107	0.2279
CH_4	8.4219	13.755
VOC	-	4.2000
SO_2	-	4.3688
N_2O	0.0120	-
CO_2	70,454	18,744
Note: these relate to combustion emissions. Venting emissions can be found in Table 6.3		

Sources of air emissions from offshore equipment during normal operation include the following:

- Exhaust emissions from GTGs generating CO_2, CO, NO_X, N_2O, CH_4, SO_2 and VOCs. An assumption is made that that the GTGs operate for 24 hours per day with 2 units in operation and fuel flowrate of 2,251 kg/h as documented in the Heat & Material Balance (H&MB).
- Fugitive emissions due to flange leaks (venting) generating CO_2, CH_4, and VOCs. An assumption is made regarding the number of flanges and the current estimate is 750 (this may increase) with each flange having an acceptable leak rate of <1.4 m^3/yr. Fugitive emissions from flange leakage are not contained within the SWP Flare systems and therefore will not be combusted upon release.
- Vent from analyser (venting) generating CO_2, CO, NO_X, CH_4, and VOCs. An assumption is made based on the wet gas dewpoint analyser which is expected to be a 'grab' type with sequenced analysis. As the volumes of grab and emission will be very small, emissions are assumed to be 0.0024 te/day.
- Exhaust emissions from testing the diesel fuelled Essential Service Generator (ESG) and Black Start Generator (BSG) generating CO_2, CO, NO_X, N_2O, CH_4, SO_2 and VOCs. An assumption is made that there will be a 4-hour run test every two weeks for each generator with the ESG and BSG rated at 1 MW and 800 kW respectively.
- Exhaust emissions from testing the diesel fuelled Totally Enclosed Motor Propelled Survival Craft (TEMPSC) generating CO_2, CO, NO_X, N_2O, CH_4, SO_2 and VOCs. An assumption is made that TEMPSC tests will occur during visits to the SWP for 4hrs per day and 4 times per year, duration 16 hours per year.

Air emissions from offshore transportation during normal operation include the following:

- Vessel exhaust emissions from the Field Service Vessel (FSV) and FSV for subsea Inspection, Repair and Maintenance (IRM), Domino pigging include CO_2, CO, NO_X, CH_4, SO_2 and VOCs. The FSV and FSV for subsea IRM, Domino pigging are assumed to be operational for 90 and 30 days per year, with a fuel consumption rate of 20 te/day.

Air emissions from offshore flaring, fugitive emissions and venting during normal operations include:

- LP Flare continuous venting from TEG Regen and PW Degasser plus Header Purge generating gas combustion products, including CO_2, CO, NO_X, CH_4, PM and VOCs.
- LP/HP Flare Purge and Pilots generating CO_2, CO, NO_X, CH_4, and VOCs. An assumption is made that the LLP, LP header and HP header purge gas is required on a continuous basis and fuel consumption based on GBA flare tips.
- Fugitive emissions due to Pressure Safety Valve (PSV) & Pressure Control Valve (PCV) leakage generating CO_2, CH_4, and VOCs. The PSVs are expected to be 'leak tight' as they will be tested and replaced in service if lifted to confirm reseating. PCV leakage is due to operational wear and tear. The Leakage Class is assumed to be V for both PSVs and PCVs. Emissions with a 100% margin are assumed to be 1.2 te/year.
- Methanol, TEG Tank Blanket Gas (Flaring) generating CO_2, CO, NO_X, CH_4, and VOCs. Resupply of full storage tank inventories is assumed to be on a quarterly basis with low pressure assuming a density of 1kg/m^3 and an additional 20% valve leakage over the course of the year.
- TAR (Inspection and Maintenance) to HP flare generating CO_2, CO, NO_X, N_2O, CH_4, SO_2 and VOCs. Five TARs are planned over field life, one every 4 years and lasting 2 days with 4,000 te per TAR event.
- Planned SWP pig receiver/launcher inspection to HP flare generating CO_2, CO, NO_X, N_2O, CH_4, SO_2 and VOCs. SWP pig receiver/launcher blowdown to occur annually for the first two years and from then to be aligned with the SWP TAR. Hence, two additional inspections to the TAR over field life with 0.72 te per event over a duration of 27 seconds.

These offshore emissions during normal operation are shown in Table 4-1, with a detailed account of sources highlighted in detail, within Section 6. Peak rates for intermittent events will be calculated for the air dispersion model and for the purpose of the emissions inventory all calculated figures are averaged over the year to support the average tpa calculation.

4.1.2 Liquid effluents

Sources of offshore liquid effluents during normal operation include the following:

- Sewage effluents (480 te) from 40 personnel working during four Operations and Maintenance (O&M) campaigns, with 20 of these being vessel crew members, assuming a sewage generation rate of 200 L per person per day over 60 days.
- PW (5,292,500 m^3) is assumed to be discharged to sea in the anoxic zone over life of field based on an assumption that during the first 10 years of field life 50 m^3 per day is generated, with a volume of 1400 m^3 per day for the following 10 years.
- Used potable water (wash water – 200 m^3) from open drains tank with oil/water separator and hydrocarbon analyser. It is assumed that 50m^3 of wash water is pumped back to the FSV for onshore disposal. Prior to wash water activities, open drains tanks are to be pumped out

via PW Caisson route to minimise the volumes pumped back to the FSV following wash down.

- Used potable water from washing down of GTGs (18 m^3) generated twice per year. This wastewater is pumped out and routed to FSV for onshore disposal.
- Discharge of subsea actuator fluid (hydraulic fluid) directly to sea generating 1 m^3 per year, based on each Partial Shutdown (PSD)/Emergency Shutdown (ESD) start up and shutdown of an XT and assuming 20 well single shutdowns and restarts for the first 2 years, 12 single well shutdown and re-starts for 18 years.
- CW including sodium hypochlorite is assumed to be discharged to sea with the PW in the anoxic zone based on an assumption that during the first year 420 m^3/hr is generated, with a decrease in rate of 100 m^3/hr for the following 5 years.
- Subsea leak from Subsea Directional Control Valves (DCVs) over field life (6.3072 m^3/year) discharged directly to sea based on an assumed leakage of 24 valves @ 3 ml/hr equating to 72 ml/hr per Subsea Control Module (SCM) (project has 10 SCM's).
- Open drains water (rainwater) is discharged to sea (130 m^3) via the PW caisson 4 times per year.
- TEG water from Domino subsea pigging (1 m^3/year) is discharged directly to sea based on some treated water being released when replacing the cartridge assuming pigging occurs every two years (expected to be less than this).
- Methanol for startup, re-start - Normal Restart (954 m^3/year) is discharged to sea mixed with the PW. A volume of 159 m^3 is assumed per PSD re-start with 6 PSDs per year.
- Methanol for shutdown and re-start of single well (161 m^3/year) is discharged to sea mixed with the PW. An assumption is made that there are 20 well single shutdowns and restarts for the first 2 years with 12 single well shutdown and re-starts for 18 years.
- Methanol for startup, re-start - TAR planned shutdown (318 m^3/event) is discharged to sea mixed with the PW. Five planned TARs are assumed over life of field occurring once every 4 years.
- Methanol for startup, re-start - ESD trip (159 m^3/year) is discharged to sea mixed with the PW. An assumption of 1 event per year is made with a short ESD and no bull heading.

4.1.3 Solid waste

Offshore solid waste during normal operations is tabulated in Section 6 and assumes domestic waste (1.2 te) is from 40 personnel working during the O&M campaign with 0.5 kg of waste generated per person per day over 60 days.

4.2 Onshore

4.2.1 Emissions to air

Table 4-2 Onshore Atmospheric Emissions during Normal Operations

POLLUTANT	AMOUNT (tpa)	AMOUNT (tpa)
	Continuous	Intermittent
NO_X	0.01	0.000205
CO	0.01	0.00005
PM	0.00	0.00001
CH_4	-	9.6626
VOC	0.00	0.0644
SO_2	0.00	0.00010
N_2O	0.00	-
CO_2	0.07	9.2265

Sources of onshore air emissions from equipment during normal operation include:

- Exhaust from the standby diesel power generators generating CO_2, CO, NO_X, N_2O, CH_4 and VOCs. An assumption is made that this is for one hour of operation per week. For the majority of the time, the NGMS and CCR is powered by the Romanian electricity grid.

Sources of onshore air emissions from transport during normal operation include:

- Engine exhaust emissions from vehicles, including petrol and diesel cars. These generate CO_2, CO, NO_X, N_2O, CH_4, SO_2, VOCs and NH_3. It is assumed that crew cars travel 60km per day for 365 days per year and 50% of crew cars in Romania use diesel and 50% use petrol.

Sources of onshore air emissions from venting during normal operation include the following:

- Venting as a result of filter replacement, occurs twice per year over a 20-minute duration to change out filters and drain the separator (0.6 te/event).
- Venting as a result of inspection pigging calibration, assumed to occur annually for the first two years and once every 4 years after that based on RBI (together with TAR) (0.19 te/event), over a 20-minute duration.
- Venting during plant turnaround (8 te/event) based on an entire onshore facility physical volume of 170m^3 (in between inlet and outlet SDVs), assumed to occur every 4 years aligned with the SWP TAR, over a 40-minute duration.
- Fugitive emissions – PSV Leakage occurring across valve seats of PSVs assuming a leakage Class of V. Emissions on an annual basis are 0.11 te/year including 100% contingency.
- Fugitive emissions from flange leakage (0.25 te/year) based on a current estimate of 200 flanges (may increase) with each flange having an acceptable leak rate of <1.4m^3/year. Fugitive emissions from flange leakage are not contained within the SWP Flare systems and therefore will not be combusted upon release.

These onshore emissions during normal operation are shown in Table 4-2, with a detailed account of sources highlighted in Section 6.

4.2.2 Liquid effluents

Sources of offshore liquid effluents during normal operation include the following:

- Sewage effluents (164 tpa) from 6 personnel working, assuming a sewage generation rate of 75 L per person per day. Sewage from the site ties into the local sewage company RAJA.
- Slops tank for equipment drainage (20m^3) based on an assumption that the 10 m^3 tank will be emptied twice a year. The wastewater is collected and removed by a third party.
- Stormwater runoff (rainwater) (4,000 m^3/year) based on average rainfalls in the area and total onshore concrete and buildings area. This runoff is collected in a buffer tank and routed via an oil separator before disposal to drainage ditches and discharged safely to fields nearby.

4.2.3 Solid waste

Onshore solid waste during normal operations is tabulated in Section 6 and assumptions include:

- Domestic waste (1.1 tpa) generated from 6 personnel working and assuming 0.5 kg of waste per person per day over a year.

5 Abnormal operation

5.1 Offshore

5.1.1 Emissions to air

Table 5-1 Offshore Atmospheric Emissions during Abnormal Operations

POLLUTANT	AMOUNT (tpa)	AMOUNT (tpa)
	Continuous	Intermittent
NO_X	-	73.370
CO	-	276.30
PM	-	1.7163
CH_4	-	555.23
VOC	-	0.5790
SO_2	-	0.5834
N_2O	-	-
CO_2	-	82,946

The emissions generated from flaring include CO_2, CO, NO_X, CH_4, PM and VOCs. Sources of abnormal emissions to air with relief to HP flare include the following:

- Integrated Control and Safety System (ICSS) control response to overpressure. Based on Full Flow Relief (950MMscfd equivalent) for 5 mins, then reduced flaring at 100MMscfd for 2 hours and assumed to occur 6 times a year with 225 te per event.
- SWP PSD – warm restart. Shutdown assumed to occur for up to 24 hrs with no blowdown required, 6 times per year with 2,000 te per event.
- ESD – cold restart. Requires full SWP blowdown and investigation time up to 7 days with cold re-start as wells will have cooled significantly. An assumption is made that high level ESD trips occur once a year with 4,000 te per event over a duration of 2 days.
- ESD – cold restart for initial plant stability and surveillance. Assuming high level ESD trips occur 6 times during early field life due to initial plant stability issues and surveillance activities. Full SWP blowdown and cold re-start (Pelican – 48h flaring) required with 2,000 te per event and occurs only for the first two years of early field life
- Partial blowdown – Pelican pipeline. Occurs in early field life with restart requiring blowdown from Shut In Tubing Hanger/Head Pressure (SITHP) to restart pressure. Assumed one per year event (18 te) over a duration of 11-minutes and is expected to be less frequent as ICSS would be configured to avoid SITHP conditions in the Pelican Flowline.
- Partial blowdown – Domino pipeline. Occurs in early field life with restart requiring blowdown from SITHP to restart pressure. Assumed one per year event (605 te) over a duration of 6.3 hours and is expected to be less frequent as ICSS would be configured to avoid SITHP conditions in the Domino Flowline.

Sources of abnormal emissions to air from transportation used in emergencies include the following:

- Engine exhaust emissions from helicopters generating CO_2, CO, NO_X, CH_4, SO_2 and VOCs. One emergency trip per year is assumed for either maintenance or other emergency with a fuel consumption rate of 5.5 km/L.
- Engine exhaust emissions from a supply boat for the SWP and a subsea intervention vessel generating CO_2, CO, NO_X, CH_4, SO_2 and VOCs. The supply boat for the SWP and subsea intervention vessel are assumed to be operational for 3 and 4 days per year, with a fuel consumption rate of 20 te/day.

These offshore abnormal emissions during normal operation are shown in Table 5-1, with a detailed account of sources highlighted in detail, within Section 6.

5.1.2 Liquid effluents

The main source of offshore liquid effluents during abnormal operation include:

- Methanol for well start-up (1,446 m^3) mixed with PW and discharged to sea in anoxic zone. It is assumed that high level ESD trips occur 6 times during early field life due to initial plant stability issues and surveillance activities with full SWP blowdown and cold re-start required.

6 Detailed Emissions Tables

6.1 Offshore atmospheric emissions

6.1.1 Construction

Table 6-1 Offshore Atmospheric Emissions during Construction

Offshore Construction							
DESCRIPTION	WASTE	TYPE	HAZARDOUS WASTE	AMOUNT (tpa)	PRODUCTION	RECEPTOR	COMMENTS
Temporary Power Generators - SWP Hook Up	NO_X	Diesel	No	0.040355	Continuous	Air	24hrs per day 1MW power gen for duration of Hook Up (120 days).
	CO			0.010719			
	PM			0.001261			
	CH_4			-			
	VOC			-			
	SO_2			0.012737			
	N_2O			-			
	CO_2			1,814.59			
Main Power Generation for Commissioning & Start Up	NO_X	Fuel Gas	No	2.972131	Continuous	Air	2 off GTGs online for Commissioning 24hrs per day for 7 days. 4.605 MW, 2.73 MMSCFd (2,200 kg/hr)
	CO			0.761609			
	PM			0.0613			
	CH_4			0.079876			
	VOC			0.019505			
	SO_2			-			
	N_2O			-			
	CO_2			1,010.059943			
Black Start Generator for Commissioning and Start-up	NO_X	Diesel	No	0.000566	Intermittent	Air	800 kW @ 50 kg/hr for 24 hours a day for 7 days.
	CO			0.000150			
	PM			0.000018			
	CH_4			-			
	VOC			-			
	SO_2			0.000178			
	N_2O			-			
	CO_2			25.43			
Essential Services for Commissioning and Start-up	NO_X	Diesel	No	0.003608	Intermittent	Air	1.4 MW @ 319 kg/hr for 24 hours a day for 7 days.
	CO			0.017493			
	PM			1,394.229375			
	CH_4			-			
	VOC			-			

Offshore Construction							
DESCRIPTION	WASTE	TYPE	HAZARDOUS WASTE	AMOUNT (tpa)	PRODUCTION	RECEPTOR	COMMENTS
	SO_2			0.001139			
	N_2O			-			
	CO_2			162.2410			
Offshore Pre-Com Spread on Construction Vessels - Pelican - Filling	NO_X	Diesel	No	0.000380	Intermittent	Air	Duration for Pelican pre-com over 7 days temp spread based on offshore construction vessel diesel driven units. L/hr is based on diesel consumption. Total activity basis is 7 days. Filling - 24hrs, Filling Pump - x1 @ 80 L/hr, Service Air Compressor x 1 @ 80 L/hr and Power Generator x 1 @ 45 L/hr.
	CO			0.000082			
	PM			0.000027			
	CH_4			-			
	VOC			-			
	SO_2			0.000025			
	N_2O			-			
	CO_2			12.399665			
Offshore Pre-Com Spread on Construction Vessels - Pelican - Hydrotest	NO_X	Diesel	No	0.0005190	Intermittent	Air	Duration for Pelican pre-com over 7 days temp spread based on offshore construction vessel diesel driven units. L/hr is based on diesel consumption. Total activity basis is 7 days. Hydrotest - 4 days, Service Air Compressor x 1 @ 45 L/hr, Power Generator x 1 @ 25 L/hr = 70 L/h.
	CO			0.000112			
	PM			0.000036			
	CH_4			-			
	VOC			-			
	SO_2			0.000034			
	N_2O			-			
	CO_2			16.93613			
Offshore Pre-Com Spread on Construction Vessels - Pelican - Dewatering and Packing	NO_X	Diesel	No	0.00916	Intermittent	Air	Total activity basis is 7 days. De-Watering and Packing - 2 days, Primary Compressor x 12 @ 140 L/hr, Generator for NPU x 2 @ 50 L/hr, Booster x 3 @ 155 L/hr, Displacement Pump x 2 @ 100 L/hr, Power Generator x 1 @ 25 L/hr.
	CO			0.001973			
	PM			0.000644			
	CH_4			-			
	VOC			-			
	SO_2			0.000602			
	N_2O			-			
	CO_2			298.80168			
Offshore Pre-Com Spread on Construction Vessels - Domino - Filling	NO_X	Diesel	No	0.000271	Intermittent	Air	Duration for GPP pre-com Offshore over 15 days temp spread based on offshore construction vessel diesel driven units. Total activity basis is 15 days. Filling - 4 days, Lift Pump - x1 @ 160 L/hr, Flooding Pump - x1 @ 80 L/hr, Power Generator x 1 @ 45 L/hr, Service Air Compressor x 1 @ 80 L/hr.
	CO			0.000058			
	PM			0.000019			
	CH_4			-			
	VOC			-			
	SO_2			0.000018			
	N_2O			-			
	CO_2			8.830908			
Offshore Pre-Com Spread on Construction Vessels - Domino - Hydrotest	NO_X	Diesel	No	0.000266	Intermittent	Air	Duration for GPP pre-com Offshore over 15 days temp spread based on offshore construction vessel diesel driven units. Total activity basis is 15 days Hydrotest - 5 days, Lift Pump - x1 @ 77 L/hr, HP Pump - x2 @ 70 L/hr, Power Generator x 1 @ 25 L/hr, Service Air Compressor x 1 @ 45 L/hr.
	CO			0.000057			
	PM			0.000019			
	CH_4			-			
	VOC			-			
	SO_2			0.000017			

Offshore Construction							
DESCRIPTION	WASTE	TYPE	HAZARDOUS WASTE	AMOUNT (tpa)	PRODUCTION	RECEPTOR	COMMENTS
	N_2O			-			
	CO_2			8.679856			
Offshore Pre-Com Spread on Construction Vessels - Domino - Dewatering and Packing	NO_X	Diesel	No	0.027339	Intermittent	Air	Duration for GPP pre-com Offshore over 15 days temp spread based on offshore construction vessel diesel driven units. Total activity basis is 15 days. De-Watering and Packing - 6 days, Primary Compressor x 12 @ 140 L/hr, Generator for NPU x 2 @ 50 L/hr, Booster x 3 @ 155 L/hr, Displacement Pump x 2 @ 100 L/hr, Power Generator x 1 @ 13 L/hr.
	CO			0.005889			
	PM			0.001922			
	CH_4			-			
	VOC			-			
	SO_2			0.001798			
	N_2O			-			
	CO_2			892.050039			
Offshore Pre-Com Spread on Construction Vessels - GPP - Filling	NO_X	Diesel	No	0.000851	Intermittent	Air	Duration for Domino pre-com over 15 days temp spread based on offshore construction vessel diesel driven units. Total activity basis is 7.5 days. Filling - 6 days, Lift Pump - x3 @ 160 Lt/hr, Flooding Pump - x2 @ 80 L/hr, Power Generator x 1 @ 45 L/hr, Service Air Compressor x 1 @ 80 L/hr.
	CO			0.000183			
	PM			0.00006			
	CH_4			-			
	VOC			-			
	SO_2			0.000056			
	N_2O			-			
	CO_2			27.763043			
Offshore Pre-Com Spread on Construction Vessels - GPP - Leak Test	NO_X	Diesel	No	0.000195	Intermittent	Air	Duration for Domino pre-com over 15 days temp spread based on offshore construction vessel diesel driven units. Assumption based on engagement with pre-com contractor L/hr is based on diesel consumption. Total activity basis is 7.5 days. Leak Test - 1.5 days, Power Generator x 1 @ 25 L/hr, Service Air Compressor x 1 @ 45 L/hr = 70 L/h.
	CO			0.000042			
	PM			0.000014			
	CH_4			-			
	VOC			-			
	SO_2			0.0000128			
	N_2O			-			
	CO_2			6.351048			
Offshore LP Flare Pilot	NO_X	Fuel Gas	No	0.000571	Intermittent	Air	LP Flare only used during this phase when transitioning from Commissioning to Operations. The LP Flare will be lit when the first of the SPS's commences forward gas (expected to be Pelican). Expected to be a combined LP and HP Flare, so assumption that pilot gas is included in the HP Flare allowance = 0.09 te/day.
	CO			0.000143			
	PM			0.00020			
	CH_4			0.0016			
	VOC			0.00003			
	SO_2			-			
	N_2O			0.000015			
	CO_2			0.492			
Offshore LP/HP Flare Pilot	NO_X	Fuel Gas	No	0.00057	Intermittent	Air	Assumes a combined LP & HP Flare tip with 3 pilots. Pilots to be lit during GPP N_2/ back gassing process. Assumes 2-day process, noting that the pilots cannot be lit until natural gas is present in the vent gas as N_2 will snuff the pilots. bottled propane gas to be provided = 0.09 te/day.
	CO			0.000143			
	PM			0.0002			
	CH_4			0.0016			
	VOC			0.00003			
	SO_2			-			
	N_2O			0.000015			

Offshore Construction							
DESCRIPTION	WASTE	TYPE	HAZARDOUS WASTE	AMOUNT (tpa)	PRODUCTION	RECEPTOR	COMMENTS
	CO_2			0.492			
HP Flare - Initial Cold Start (Pelican well ramp-up)	NO_X	Gas	No	25.04936	Intermittent	Air	Based on Pelican system being brought online first. Achieved after 2 days, but 5 days allowed for. Cumulative gas to HP Flare estimated at 15,000 Te . Faster re-starts expected once well performances have been monitored and understood (HP Flare - Re-Start) Bottled Propane required for HP Flare Pilot during initial Pelican system start-up.
	CO			136.29797			
	PM			0.854156			
	CH_4			51.5722			
	VOC			-			
	SO_2			-			
	N_2O			-			
	CO_2			40,993			
Flaring - Start Up Gas - Domino Flowline Purging (Flaring)	NO_X	Gas	No	8.3498	Intermittent	Air	Domino flowline initially filled with N_2; System to be assumed to be left at 95 bara. Slow Domino well bean-up while Pelican is producing at stable conditions (250 MMscfd). Pelican production being flared while N_2 system purge (24h – slow well ramp up). Assuming mixing zone of 50% of total Domino flowline volume – worst case 100% CH_4 in mixing zone to be flared.
	CO			45.4327			
	PM			0.28472			
	CH_4			17.1907			
	VOC			-			
	SO_2			-			
	N_2O			-			
	CO_2			13,664			
Onshore Pre-Com Spread for GPP - Filling	NO_X	Diesel	No	0.000389	Intermittent	Air	Duration for GPP pre-com Onshore over 15 days temp spread based on offshore construction vessel diesel driven units. Assumption based on engagement with pre-com contractor L/hr is based on diesel consumption. Total activity basis is 15 days. Assumed 12-hour day. Filling - 6 days, Power Generator x 1 @ 25 L/hr, Service Air Compressor x 1 @ 45 L/hr.
	CO			0.000084			
	PM			0.000027			
	CH_4			-			
	VOC			-			
	SO_2			0.000026			
	N_2O			-			
	CO_2			12.70210			
Onshore Pre-Com Spread for GPP - Hydrotest	NO_X	Diesel	No	0.002920	Intermittent	Air	Duration for GPP pre-com Onshore over 15 days temp spread based on offshore construction vessel diesel driven units. Total activity basis is 15 days. Assumed 12-hour day. Hydrotest - 5 days, Transfer Pump - x1 @ 80 L/hr, HP Pump - x4 @ 120 L/hr, Power Generator x 1 @ 25 L/hr, Service Air Compressor x 1 @ 45 L/hr.
	CO			0.000629			
	PM			0.000205			
	CH_4			-			
	VOC			-			
	SO_2			0.000192			
	N_2O			-			
	CO_2			95.2657			
Onshore Pre-Com Spread for GPP - Dewatering and Packing	NO_X	Diesel	No	0.061484	Intermittent	Air	GPP pre-com Onshore over 15 days temp spread based on offshore construction vessel diesel driven units. Total activity basis is 15 days. Assumed 12-hour day. De-Watering and Packing - 32 days, Primary Compressor x 10 @ 140 L/hr, Generator for NPU x 5 @ 50 L/hr, Booster x 2 @ 155 L/hr, Displacement
	CO			0.013245			
	PM			0.004322			
	CH_4			-			
	VOC			-			
	SO_2			0.004043			
	N_2O			-			

Offshore Construction							
DESCRIPTION	WASTE	TYPE	HAZARDOUS WASTE	AMOUNT (tpa)	PRODUCTION	RECEPTOR	COMMENTS
	CO_2			2,006.2053			Pump x 1 @ 100 L/hr, Power Generator x 1 @ 13 L/hr.
Misc Offshore Plant and Equipment	NO_X	Diesel	No	1.401416	Intermittent	Air	Assume 24 hrs per day 2 number forklifts and 1 off crawler crane. Assumes 3 L per hour forklift. Assumes 8 L per hour crawler crane. Assume 350 L per day.
	CO			0.301892			
	PM			0.098512			
	CH_4			-			
	VOC			-			
	SO_2			0.092157			
	N_2O			-			
	CO_2			45,727.545			
Venting - Start Up Gas - Pre Flare Ignition (Venting)	NO_X	Gas	No	-	Intermittent	Air	Assumption is mixing zone of 10% of GPP required, or c16km N_2 at 14bara assumed in GPP. Estimated mass of Methane vented prior to ignition of HP Flare: 65Te (assume 100% Ch_4 in mixing zone). Pelican: 1.5km tie back + manifolds. Assume system left at 14bara N_2 full system sweep *1.5 before HP Pilot is lit. Assume the *0.5 is CH_4 cold vent prior to HP Flare Pilot ignition: 1Te = 66 te.
	CO			-			
	PM			-			
	CH_4			65.408372			
	VOC			0.447550			
	SO_2			-			
	N_2O			-			
	CO_2			0.144078			
Transportation Emissions (Helicopter)	NO_X	Aviation Fuel	No	0.063842	Intermittent	Air	Distance to SWP and back is 160 km (*2=320km). During construction, 4 helicopter trips per day. Used value of 5.5 km/L divided by aviation fuel density of 762 kg/m3
	CO			19.152524			
	PM			-			
	CH_4			-			
	VOC			0.303248			
	SO_2			0.01596			
	N_2O			-			
	CO_2			49.477			
Transportation Emissions (Vessels using MGO)	NO_X	MGO	No	3,021.425600	Intermittent	Air	Operational days during construction period and fuel consumption taken from [Ref 2].
	CO			160.696320			
	PM			-			
	CH_4			-			
	VOC			73.234000			
	SO_2			76.16336			
	N_2O			-			
	CO_2			134,164.688			

6.1.2 Drilling

Table 6-2 Atmospheric Emissions during Drilling

Drilling							
DESCRIPTION	WASTE	TYPE	HAZARDOUS WASTE	AMOUNT (tpa)	PRODUCTION	RECEPTOR	COMMENTS
Diesel Generators	NO_X	Diesel	No	2.6930	Continuous	Air	31.5 MW @ 50 te/day for 24 hours a day for 800 days. Assumed 24 hours of operation per day. 8 Diesel Generators (42 MW) assuming 75% utilisation in normal operations(drilling package, DP thrusters, utilities) for 24 hours of operation per day. Assuming diesel flow rate of 50 tonnes per day.
	CO			0.7153			
	PM			0.0842			
	CH_4			-			
	VOC			-			
	SO_2			0.8500			
	N_2O			-			
	CO_2			121,093.			
Temp Diesel-Powered Equipment	NO_X	Diesel	No	0.2285	Intermittent	Air	RMR use 12 m^3/ day 80 days = 500 L/hr WL - 5 days 1 m^3 / day / well = 458.37 L/hr GP pump skids - 2 days/ well 1m^3 / day = 458.37 L/hr allow for 10 wells + 1 redrill = 1416.74 L/hr
	CO			0.0492			
	PM			0.0161			
	CH_4			-			
	VOC			-			
	SO_2			0.01503			
	N_2O			-			
	CO_2			7,455.3			
Crane	NO_X	Diesel	No	0.0019	Intermittent	Air	Assumed cranes operate for an average of 12 hrs/day and for a total of 800 days with 2.5 L/hr fuel consumption rate.
	CO			0.0004			
	PM			0.0001			
	CH_4			-			
	VOC			-			
	SO_2			0.00012			
	N_2O			-			
	CO_2			60.486			
Transportation Emissions (Helicopter)	NO_X	Aviation Fuel	No	0.30591	Intermittent	Air	During 800-day drilling campaign, one helicopter trip per day and another every second day (800 + 400). Distance from NGMS to Pelican and to Domino is approximately 218 km and 238 km, respectively. A fuel consumption rate of 5.5 km/L assumed for the calculation divided by aviation fuel density of 762 kg/m^3 [Ref 16].
	CO			91.773			
	PM			-			
	CH_4			-			
	VOC			1.4531			
	SO_2			0.0765			
	N_2O			-			
	CO_2			237.08			
Transportation Emissions (Vessels using MGO)	NO_X	MGO	No	9,476.3	Intermittent	Air	Operational days during construction period and fuel consumption taken from [Ref 2]. 2 Supply Vessels for campaign, 2-3 standby vessels on continuous rotation (rig/transit/port) [Ref 2].
	CO			504.00			
	PM			-			
	CH_4			-			
	VOC			229.69			

Drilling							
DESCRIPTION	WASTE	TYPE	HAZARDOUS WASTE	AMOUNT (tpa)	PRODUCTION	RECEPTOR	COMMENTS
	SO_2			238.88			Anchor Handler for Pelican - 1 month to lay and 1-month de-mob.
	N_2O			-			
	CO_2			420,787.5			

6.1.3 Normal Operation Offshore

Table 6-3 Atmospheric Emissions during Normal Operation

Normal Operations							
DESCRIPTION	WASTE	TYPE	HAZARDOUS WASTE	AMOUNT (tpa)	PRODUCTION	RECEPTOR	COMMENTS
Essential Services Diesel Generator	NO_X	Diesel	No	0.0022	Intermittent	Air	Assume pump is tested for 4 hours every 2 weeks. (Total hours per annum = 104 at 1 MW).
	CO			0.0006			
	PM			0.0001			
	CH_4			-			
	VOC			-			
	SO_2			0.0007			
	N_2O			-			
	CO_2			100.43			
Black Start Diesel Generator	NO_X	Diesel	No	0.00035	Intermittent	Air	Assume pump is tested for 4 hours every 2 weeks. (Total hours per annum = 104 at 800 kW).
	CO			0.00009			
	PM			0.00001			
	CH_4			-			
	VOC			-			
	SO_2			0.00011			
	N_2O			-			
	CO_2			15.74			
Gas Turbine Generators	NO_X	Fuel Gas	No	158.68	Continuous	Air	Assumed gas turbine generators operate for 24 hours per day with 2 units in operation and fuel flowrate of 2,251 kg/h as documented in the H&MB. Chapter 5 of ESIA: 3 x 50% gas fired turbines (2 operating and 1 stand-by) supplying 9.2 MW of power at SWP, with a thermal efficiency of 30%.
	CO			40.661			
	PM			3.2727			
	CH_4			4.2644			
	VOC			1.0413			
	SO_2			-			
	N_2O			0.011963			
	CO_2			53,925			
TEMPSC Tests	NO_X	Diesel	No	0.0000004	Intermittent	Air	TEMPSC tests during visits to platform – 4 hrs per day and 4 times per year. In total 16 hours per year.
	CO			0.0000001			
	PM			0.00000003			
	CH_4			-			
	VOC			-			

Normal Operations							
DESCRIPTION	WASTE	TYPE	HAZARDOUS WASTE	AMOUNT (tpa)	PRODUCTION	RECEPTOR	COMMENTS
	SO_2			0.00000002			
	N_2O			-			
	CO_2			0.012109			
LP Flare - Purge and Pilots	NO_X	Fuel Gas	No	0.434471	Continuous	Air	LLP and LP Header purge gas required on continuous basis - 0.6 tonnes/day. Based on GBA Flare Tip, 1.2 kg/hr per pilot, 3 off pilots - 0.09 tonnes/day. Total Fuel consumption = 0.69 te/day.
	CO			2.36403602			
	PM			0.01481501			
	CH_4			0.89450012			
	VOC			-			
	SO_2			-			
	N_2O			-			
	CO_2			694.728			
HP Flare Purge Gas & Pilot Lights	NO_X	Fuel Gas	No	0.4831	Continuous	Air	HP Header purge gas required on continuous basis - 0.7 tonnes/day. Based on GBA Flare Tip, 1.2 kg/hr per pilot, 3 off pilots - 0.09 tonnes/day. Total Fuel consumption = 0.79 te/day.
	CO			2.6285			
	PM			0.0165			
	CH_4			0.9946			
	VOC			-			
	SO_2			-			
	N_2O			-			
	CO_2			790.55			
HP Flare - TAR (Inspection and Maintenance) - 1 TAR event (amount - te/event)	NO_X	Gas	No	6.6798	Intermittent	Air	5 TARs over field life, one every 4 years and lasts 7 days. 4,000 te per TAR event.
	CO			36.346			
	PM			0.2278			
	CH_4			13.753			
	VOC			-			
	SO_2			-			
	N_2O			-			
	CO_2			10,931			
HP Flare - Planned SWP Pig Receiver/Launcher Inspection (amount - te/event)	NO_X	Gas	No	0.00121	Intermittent	Air	SWP Pig Receiver/Launcher blowdown to occur annually for the first two years and from then to be aligned with the SWP TAR. Hence, two additional inspections to the TAR over field life = 0.72 te per event. Assumed over 7 days as per TAR.
	CO			0.00658			
	PM			0.00004			
	CH_4			0.0025			
	VOC			-			
	SO_2			-			
	N_2O			-			
	CO_2			1.9779			
Methanol, TEG Tank Blanket Gas (Flaring)	NO_X	Fuel Gas	No	0.0048	Continuous	Air	Re-supply of full storage tank inventories on a quarterly basis: Methanol 400 x 4 m^3, TEG 200 x 4m^3 Total (outbreathing) 2,400 m^3. Low pressure so assume density of 1 kg/m^3. Assume additional 20% valve leakage over the course of the year = 2.9 te/year.
	CO			0.0264			
	PM			0.0002			
	CH_4			0.0100			
	VOC			-			
	SO_2			-			
	N_2O			-			

Normal Operations							
DESCRIPTION	WASTE	TYPE	HAZARDOUS WASTE	AMOUNT (tpa)	PRODUCTION	RECEPTOR	COMMENTS
	CO_2			7.9253			
LP Flare Continuous Flare	NO_X	Gas	No	0.1920	Continuous	Air	LP continuous venting from TEG Regeneration and Produced Water Degasser. From H&MB Case 3 (Max water), combine total of 0.253 MMscfd (assume all hydrocarbon, CH_4) Header purges are additional and on a continuous basis (26.1 kg/hr) estimate (extra line) = 4.9 tonnes/day.
	CO			1.0445			
	PM			0.0065			
	CH_4			0.3952			
	VOC			-			
	SO_2			-			
	N_2O			-			
	CO_2			4,891.0			
Fugitive Emissions - Flange Leaks (Venting)	CH_4	Gas	No	0.9904	Continuous	Air	The current estimate of flanges is c.750. Each flange has an acceptable leak rate of <1.4 m^3/yr. The number of flanges at the final count may increase. Fugitive emissions from flange leakage not contained within SWP Flare systems and will not be combusted upon release = 1 te/year.
	C_2H_6			0.0013			
	C_3H_8			0.00055			
	iC_4H_{10}			0.00036			
	iC_5H_{12}			0.00045			
	nC_5H_{12}			0.00045			
	nC_6H_{14}			0.00107			
	N_2			0.00260			
	CO_2			0.00218			
Fugitive Emissions - PSV & PCV Leakage (Flaring)	CH_4	Gas	No	0.00200	Continuous	Air	Leakage occurring across valve seats of PSV's and PCV's. PSVs expected to be 'leak tight' as they will be tested and replaced in service if lifted to confirm reseating. PCV leakage due to operational wear and tear. Both based on Leakage Class - V (tbc during EPC phase). 1 x 16" PCV (Primary Separator), 1 x 6" PCV (TEG Contactor, 1 x 12" PSV (Primary Separator), 1 x 4" PSV (TEG Contactor) = 1.2 te/year.
	C_2H_6			0.01091			
	C_3H_8			0.00007			
	iC_4H_{10}			0.00413			
	iC_5H_{12}			-			
	nC_5H_{12}			-			
	nC_6H_{14}			-			
	N_2			-			
	CO_2			3.2794			
Vent from Analyser (Venting)	CH_4	Gas	No	0.86874	Continuous	Air	Details of the analysers have yet to be received as this will be carried out during the EPC phase. The primary sample of interest is the Wet Gas Dewpoint analyser. This is expected to be a 'grab' type with sequenced analysis. The volumes of grab and emission will be very small. Quoted volume is prelim and to be confirmed during EPC = 0.0024 te/day.
	C_2H_6			0.00114			
	C_3H_8			0.00048			
	iC_4H_{10}			0.00032			
	iC_5H_{12}			0.00039			
	nC_5H_{12}			0.00039			
	nC_6H_{14}			0.0009			
	N_2			0.00228			
	CO_2			0.00191			
Transportation Emissions (Vessels using MGO)	NO_X	MGO	No	173.3	Intermittent	Air	Operational days during operation period and fuel consumption taken from [Ref 2].
	CO			9.2160			
	PM			-			
	CH_4			-			
	VOC			4.2000			
	SO_2			4.3680			

Normal Operations							
DESCRIPTION	WASTE	TYPE	HAZARDOUS WASTE	AMOUNT (tpa)	PRODUCTION	RECEPTOR	COMMENTS
	N_2O			-			
	CO_2			7,694.4			

6.1.4 Abnormal Operation Offshore

Table 6-4 Atmospheric Emissions during Abnormal Operation

Abnormal Operations							
DESCRIPTION	WASTE	TYPE	HAZARDOUS WASTE	AMOUNT (tpa)	PRODUCTION	RECEPTOR	COMMENTS
HP Flare - ICSS Control Response to Overpressure - Relief to HP Flare	NO_X	Gas	No	2.254442	Intermittent	Air	Based on Full Flow Relief (950 MMscfd equivalent) for 5 mins. Then reduced flaring at 100 MMscfd for 2 hours. Assumed to occur 6 times a year with 225 te per event and 1,350 te/year.
	CO			12.266818			
	PM			0.076874			
	CH_4			4.641499			
	VOC			-			
	SO_2			-			
	N_2O			-			
	CO_2			3,689.3423			
HP Flare - Partial Shutdown Warm Restart	NO_X	Gas	No	20.037531	Intermittent	Air	SWP PSD – shutdown up to 24 h (no blowdown required). Warm re-start required as wells only slightly cooled. Assuming full well bean-up on each well within 1 day. Assuming to start-up Pelican first which is less effective due to Pelican EH limitations. Assuming SWP sufficient operating temperature to be achieved within 24 hours. Assuming SWP PSDs to occur 6 times per year (2,000 te per event = 12,000 te/year.
	CO			109.027742			
	PM			0.683258			
	CH_4			237.955006			
	VOC			-			
	SO_2			-			
	N_2O			-			
	CO_2			32,793.31			
HP Flare - Emergency Shutdown Cold Restart	NO_X	Gas	No	6.6792	Intermittent	Air	ESD – confirmed F&G requires full SWP blowdown and investigation time up to 7 days. Cold re-start required as wells will have cooled significantly. Assuming full well bean-up on each well within 2 days and to start-up Pelican first which is less effective due to Pelican EH limitations. Assuming high level ESD trips to occur once a year = 4,000 te/year.
	CO			36.709			
	PM			0.2301			
	CH_4			79.318			
	VOC			-			
	SO_2			-			
	N_2O			-			
	CO_2			10,931			
HP Flare - Emergency Shutdown Cold Restart - Initial Plant Stability and Surveillance	NO_X	Gas	No	20.240	Intermittent	Air	Assuming high level ESD trips to occur 3 times per year for the first 2 years due to initial plant stability issues and surveillance activities. Full SWP blowdown and cold re-start (Pelican – 48 h flaring)
	CO			110.127			
	PM			0.6902			
	CH_4			237.96			

Abnormal Operations							
DESCRIPTION	WASTE	TYPE	HAZARDOUS WASTE	AMOUNT (tpa)	PRODUCTION	RECEPTOR	COMMENTS
	VOC			-			required. = 2,000 te per event.
	SO_2			-			
	N_2O			-			
	CO_2			32,793			
HP Flare - Partial Blowdown - Pelican Pipeline	NO_X	Gas	No	0.02984	Intermittent	Air	Early field life - Max Pressure - Partial Blowdown. SWP Trip (320 barg) on HH Pressure - Restart requires blowdown from SITHP. Assumed 1 per year event (18 te); expected to be less frequent as ICSS configured to avoid SITHP conditions in Domino Flowline. Volume of 1.5km tie back and 140m riser section (+10% margin on volume to cover manifolds etc). Total Volume for ESIA assumed 106 m^3.
	CO			0.16236			
	PM			0.00102			
	CH_4			0.35082			
	VOC						
	SO_2			-			
	N_2O			-			
	CO_2			48.347			
HP Flare - Partial Blowdown - Domino Pipeline	NO_X	Gas	No	1.0254	Intermittent	Air	Early field life - Max Pressure - Partial Blowdown SWP Trip (320 barg) on HH pressure - Restart requires blowdown from SITHP. Assumed 1 per year event (605 te); expected to be less frequent as ICSS would be configured to avoid SITHP conditions in Domino Flowline. Volume of 26 km tie back to DC1 and further 10km tieback to DC2 Total Volume for ESIA assumed 3,600m^3.
	CO			5.5793			
	PM			0.0350			
	CH_4			12.055			
	VOC						
	SO_2			-			
	N_2O			-			
	CO_2			1,661.4			
Transportation Emissions (Helicopter) Emergency-Maintenance	NO_X	Aviation Fuel	No	0.0002	Intermittent	Air	One emergency trip per year assumed for either maintenance or another emergency.
	CO			1.2000			
	PM			-			
	CH_4			-			
	VOC			0.0190			
	SO_2			0.0010			
	N_2O			-			
	CO_2			3.1000			
Transportation Emissions (Vessels using MGO)	NO_X	MGO	No	23.104	Intermittent	Air	Operational days during operation period and fuel consumption taken from [Ref 2].
	CO			1.2288			
	PM			-			
	CH_4			-			
	VOC			0.5600			
	SO_2			0.5824			
	N_2O			-			
	CO_2			1,025.9			

6.2 Onshore Atmospheric Emissions

6.2.1 Onshore Construction

Table 6-5 Onshore Atmospheric Emissions during Construction

Construction - Onshore							
DESCRIPTION	WASTE	TYPE	HAZARDOUS WASTE	AMOUNT (tpa)	PRODUCTION	RECEPTOR	COMMENTS
Onshore Construction Equipment	NO_X	Diesel	No	164.50	Continuous	Air	For duration of construction period. Operational hours and equipment taken from [Ref 2].
	CO			43.479			
	PM			-			
	CH_4			-			
	VOC			5.5387			
	SO_2			11.077			
	N_2O			-			
	CO_2			8,862.0			

6.2.2 Normal Operation Onshore

Table 6-6 Onshore Atmospheric Emissions during Normal Operation

Normal Operations							
DESCRIPTION	WASTE	TYPE	HAZARDOUS WASTE	AMOUNT (tpa)	PRODUCTION	RECEPTOR	COMMENTS
Standby Power Generation	NO_X	Diesel	No	0.00021	Intermittent	Air	Assumed for one hour of operation per week. For the majority of the time, the NGMS and CCR is powered from the Romanian electricity grid. 305 KVA unit assumed with a 70 L/hr fuel consumption rate at full load.
	CO			0.00005			
	PM			0.000006			
	CH_4			-			
	VOC			-			
	SO_2			0.00007			
	N_2O			-			
	CO_2			9.2052			
Venting - Filter Replacement (Venting)	NO_X	Gas	No		Intermittent	Air	Occurs twice per year to change out filters and drain separator. 40 times over field life in total 48 te. 1.2 te per year = 0.6 te per event.
	CO			-			
	PM			-			
	CH_4			1.1892			
	VOC			0.0081			
	SO_2			-			
	N_2O			-			
	CO_2			0.0026			

Normal Operations							
DESCRIPTION	WASTE	TYPE	HAZARDOUS WASTE	AMOUNT (tpa)	PRODUCTION	RECEPTOR	COMMENTS
Venting - Inspection Pigging Calibration (Venting)	NO_X	Gas	No	-	Intermittent	Air	Occurs annually for the first two years and once every 4 years after that based on RBI (together with TAR) 2 times at early field life in total 0.38 te and 0.19 te per event.
	CO			-			
	PM			-			
	CH_4			0.1883			
	VOC			0.0013			
	SO_2			-			
	N_2O			-			
	CO_2			0.0004			
Venting - Plant Turnaround (Venting)	NO_X	Gas	No	-	Intermittent	Air	Entire onshore facility physical volume is 170 m^3 (in between inlet and outlet SDVs) - assumed depressurisation volume and pressure at 55 Bar - per ND-D-IO-90-PR-BPHY-0001-0001. Every 4 years aligned with SWP TAR. 5 times over field life in total 40 te - 8 te per event.
	CO			-			
	PM			-			
	CH_4			7.928			
	VOC			0.0542			
	SO_2			-			
	N_2O			-			
	CO_2			0.0175			
Fugitive Emissions - PSV Leakage (venting)	NO_X	Gas	No	-	Intermittent	Air	Based on Leakage Class - V (tbc during EPC phase). 3 x 40E50 PSV (Heaters), 2 x 80J100 PSV (Filter Separator - 1 in operation and 1 isolated, in stand-by) - only 1 considered in the calculation. Emissions on Annual basis (100% margin on preliminary estimate as Class V is liquid based testing, not gas emission based) = 0.11 te/year.
	CO			-			
	PM			-			
	CH_4			0.1090			
	VOC			0.0007			
	SO_2			-			
	N_2O			-			
	CO_2			0.0002			
Fugitive Emissions (Venting)	NO_X	Gas	No	-	Intermittent	Air	The current estimate of flanges is c.200. Each flange has an acceptable leak rate of <1.4 m^3/yr. The number of flanges at the final count may increase. Fugitive emissions from flange leakage are not contained within SWP Flare systems and will not be combusted upon release = 0.25 te/year.
	CO			-			
	PM			-			
	CH_4			0.2478			
	VOC			0.0017			
	SO_2			-			
	N_2O			-			
	CO_2			0.0005			
Transportation Emissions (Diesel and Petrol usage)	NO_X	Diesel and Petrol	No	0.0072	Continuous	Air	Crew car travels 60 km per day for 365 days per year [Ref 2]. Assuming 50% of crew cars in Romania use diesel and 50% use petrol.
	CO			0.0101			
	PM			0.0001			
	CH_4			-			
	VOC			0.0011			
	SO_2			0.000014			
	N_2O			0.000087			
	CO_2			0.07013			

6.3 Effluents

Table 6-7 Effluents Generated during Construction, Drilling and Operations

DESCRIPTION	WASTE	EWC WASTE CODE	TYPE	HAZARDOUS WASTE	AMOUNT	Units	PRODUCTION	RECEPTOR	COMMENTS
Construction Offshore									
Wash Water	Seawater	n/a	Liquid	No	26	m^3	Intermittent	Sea	No treatment.
Hydraulic Discharge	Hydraulic Fluid	n/a	Liquid	Yes	1	m^3	Intermittent	Sea	Discharge to Sea During Commissioning associated with valve movements from commissioning activities for the XTs per ND-D-OP-10-CG-REIS-0001-0001. Assumes - PMV – 10 cycles, PWV – 10 cycles, FIV – 10 cycles, ASV – 6 cycles, AMV – 6 cycles, AWV – 6 cycles, CV – 4 cycles, CIV-01 – 6 cycles, CIV-02 – 6 cycles, CIV-03 – 6 cycles, CIV-04 – 6 cycles, CIV-05 – 6 cycles, CIV-06 – 6 cycles, CIV-07 – 6 cycles, CIV-08 – 6 cycles. Total of 0.10204 m^3 per XT - 10 wells - 1.02 m^3.
Produced Water	Oily-Water	n/a	Liquid	Yes	3,600	m^3	Intermittent	Sea (at depth)	Early life rate including TEG, CI, SI, Antifoam and Sand. The Domino wells will be left underbalanced prior to start-up. The liquids will be 'brine' but some surfactant maybe expected. It is estimated that the completion fluids will total 500 m^3. Up to c.40 m /day of condensed water + 0 m^3/day condensed water assumed early field life (prior to pw breakthrough). Aqueous stream routed to the Open Drains for 3 months during start-up of field(s).
Produced Fluids (Drilling & Completion) at start-up	Oily-Water	n/a	Liquid	Yes	400	m^3	Intermittent	To be taken onshore for treatment and disposal	50 m^3 for each Domino well (x6) and 25 m^3 for each Pelican well (x4). Assumes Domino liquid filled and Pelican Displace to N_2.

DESCRIPTION	WASTE	EWC WASTE CODE	TYPE	HAZARDOUS WASTE	AMOUNT	Units	PRODUCTION	RECEPTOR	COMMENTS
Cooling Water including Sodium Hypochlorite	Water with chemicals	n/a	Liquid	Yes	70,560	m^3	Intermittent	Sea - mixed with produced water	22 litres/day of Sodium Hypochlorite in the water. Based on 10,080 m^3 day over 7 days.
Testing of DIFF Systems	Water with chemicals	n/a	Liquid	Yes	5	m^3	Intermittent	Sea	Based on 4 m^3 water and 120 litres (3%) AFFF.
Open Drains Discharge	Rainwater	n/a	Liquid	Yes	130	m^3	Intermittent	Sea	Rainwater collected only from Upper Deck plated areas with drain boxes Cumulative rainfall during summer months taken from Project BoD is 141 mm. Assumed plated area on upper deck taken as 750 m^2. Total cumulative rainwater rounded up to 130 m^3 to assume a bit of margin. Periodic pump out as and when Open Drains tank fills.
Sewage from Vessels	Black water	20 03 06	Liquid	No	21,600	te	Continuous	MARPOL	Based on 450 POB generating 200 L/d/person [Ref 2] over 240 days.
Hydrotest Water (water with chemicals)	Treated seawater	n/a	Liquid	No	73,152	m^3	Intermittent	Sea	Total Discharge / Collected per field (m^3) is 4,794 m^3 (Domino), 97 m^3 (Pelican) & 68,261 m^3 (Export).
Ballast Water	Seawater	n/a	Liquid	No	150,000	m^3	Intermittent	Sea	Assume required - no information available, judgement made on capacity. HLV S7000 = 75k m^3; 2 x HTV = 25k m^3; Allow 2 barges 10k m^3 ea.
Construction Onshore									
Produced water from Tunnelling Process	Water/Barite mix	01 05 07	Liquid	Yes	3,140	m^3	Intermittent	Treatment prior to discharge to sea	Assumed to undergo treatment prior to discharge to sea. 1,740 drilling fluid system, 1,400 from cleaning process.
Produced water from Shaft Construction	Water/Barite mix	01 05 07	Liquid	Yes	200	m^3	Intermittent	Treatment prior to discharge to sea	Assumed to undergo treatment prior to discharge to sea.
Wheel Wash Wastewater	Contaminated water	13 05 07*	Liquid	Yes	5	m^3/day	Intermittent	Sea	5 m^3 /day for wheel washing. This may be higher or lower quantity based on activities on site.
Displaced Tunnel Water from Backfilling	Water/Barite mix	01 05 07	Liquid	Yes	3,250	m^3	Intermittent	Treatment prior to discharge to sea	Assumed to undergo treatment prior to discharge to sea. Pumped and stored prior to discharge to sea.
Hydrotest Water (associated with the onshore components)	Contaminated Water	16 10 01*	Liquid	Yes	980	m^3	Intermittent	Subsea Anoxic Layer of Sea	Assumed to undergo treatment prior to discharge to sea. Pumped and stored prior to discharge to sea.

DESCRIPTION	WASTE	EWC WASTE CODE	TYPE	HAZARDOUS WASTE	AMOUNT	Units	PRODUCTION	RECEPTOR	COMMENTS
Hydrotest Fluids for NGMS Pipework	Chemically Treated Water	16 10 01*	Liquid	Yes	80	m^3	Intermittent	Treated and disposed onshore.	Treated and disposed onshore following hydrotesting.
Stormwater Runoff	Rainwater	n/a	Liquid	Yes	4,000	m^3	Intermittent	Collected in drainage ditches and discharged safely to fields nearby.	Collected in Buffer tank and routed via oil separator before disposal to ditches. Average rainfall in the area: 450 mm/year/m^2. Total onshore concrete and buildings area (rainwater that is collected): 8,700 m^2, resulting in a yearly average of 4,000 m^3 of rainwater.
Sewage from Personnel working on Tunnel and Shore Crossing	Black water	20 03 06	Liquid	No	192	te	Continuous	Collected and disposed to third party	Based on 40 POB generating 40 L/d/person [Ref 2] over 120 days. Temporary until connection with RAJA.
Sewage from Personnel working on Construction Site	Black water	20 03 06	Liquid	No	1,400	te	Continuous	Collected and disposed to third party	Based on 70 POB generating 40 L/d/person [Ref 2] over 500 days. Temp until connection made to RAJA black water system.
Drilling									
Water Based Fluids for Top Hole Drilling	WBDF	01 05 04	Liquid	Yes	15,000	bl/well	Intermittent	Sea	Assumes 15,000 bbl per well for 10 wells.
MEG Injection for BOP	MEG	n/a	Liquid	Yes	500	m^3	Intermittent	Sea	Allowance of 50 m^3 per well.
BOP Hydraulic Control Fluid	Koomey Control Fluid (90% seawater, 10% additives)	16 01 15	Liquid	Yes	350	m^3	Intermittent	Sea	Based on 650 gal test fluid including BOP functions actuated outside API statutory tests (1 function test per week) for tubing and casing pressure tests; WH actuations and testing of disconnect systems etc. actual chemical discharge (0.25 m^3 per well 2.5 m^3 for the campaign). 100% contingency allowed
Water Based Drill Cuttings	Drill Cuttings	01 05 04	Liquid	No	7,500	m^3	Intermittent	Discharged to seafloor	36in and 26in hole section per well with 1 respud allowed. 3 x 12.1/4in pilot hole. Added 50% contingency over theoretical volumes to account for washout etc.
Sewage	Black water	20 03 06	Liquid	No	31,040	te	Continuous	MARPOL	Based on 194 POB generating 200 L/d/person [Ref 2] over 800 days.
Normal Operations Offshore									
Wash Water	Potable Water	16 10 01*	Liquid	No	200	m^3	Intermittent	15PPM OIW limit before over boarding	Assumed that 50 m^3 of wash water is pumped back to FSV for onshore disposal, Prior to wash water

DESCRIPTION	WASTE	EWC WASTE CODE	TYPE	HAZARDOUS WASTE	AMOUNT	Units	PRODUCTION	RECEPTOR	COMMENTS
									activities open drains tanks to be pumped out via PW Caisson route to minimise volumes pumped back to FSV following wash down.
Water Wash for GTGs	Potable Water	n/a	Liquid	No	18	m^3	Intermittent	Pumped out and routed to FSV for onshore disposal.	Twice per year assumed for wash down of GTGs with 9 m^3 per event.
Subsea Actuator Fluid	Hydraulic Fluid	n/a	Liquid	Yes	1	m^3/year	Intermittent	Sea	Each PSD start up and shutdown of an XT will equate to 8.52 L of discharge. Each ESD start Up and Shutdown of an XT will equate to 19.7 L per full shutdown. Assume 20 well single shutdowns and restarts for the first 2 years, 12 single well shutdown and re-starts for 18 years, conservative assumption is that move all valves in each XT with 2 cycles. (PSD Shutdown) - 256 Total = 2181 L. 1 ESD Trp per year = 10 wells - 100 XT operations – 1970 L. PSD 6 Shutdowns and re-starts per year - 10 wells operated per PSD - 10,224 L. 6 ESD events occurring in early field life Initial Plant Stability and Surveillance - 1182L. Total for Life of Field - 15.557 L - yearly average of 0.78 m^3.
Produced Water (over life of field)	Oily water	n/a	Liquid	Yes	5,292,500	m^3	Continuous	Sea (at depth)	Assuming 50 m^3 per day for first 10 years then 1,400 m^3 per day for next 10 years.
Produced Water (per year over first 10 years)	Oily water	n/a	Liquid	Yes	182,500	m^3	Continuous	Sea (at depth)	50 m^3 per day for first 10 years.
Produced Water (per year over next 10 years)	Oily water	n/a	Liquid	Yes	5,110,000	m^3	Continuous	Sea (at depth)	1,400 m^3 per day for next 10 years.
Cooling Water including Sodium Hypochlorite (for first year)	Water with chemicals	n/a	Liquid	Yes	420	m^3/hr	Intermittent	Sea - mixed with produced water	22 L/day of Sodium Hypochlorite in the water. 1 year at rated demand. 1 seawater lift pump at 420 m^3/hr and dosed at max 2 ppm 23 hours and 1 hour at 6ppm means 22 L of Sodium Hypochlorite. Refer ND-D-

DESCRIPTION	WASTE	EWC WASTE CODE	TYPE	HAZARDOUS WASTE	AMOUNT	Units	PRODUCTION	RECEPTOR	COMMENTS
									IO-50-ME-STDS-0008-0001. Assume that this operation will take place at rated demand i.e., 420 m^3/hr for 1 year. Seawater demand is not a confirmed operation over field life.
Cooling Water including Sodium Hypochlorite (for next 5 years)	Water with chemicals	n/a	Liquid	Yes	100	m^3/hr	Intermittent	Sea - mixed with produced water	5 L/day of Sodium Hypochlorite for 5 years. Assume that this operation will take place at rated demand i.e., 100 m^3/hr for 5 years. Seawater demand is not a confirmed operation over field life.
Subsea Leak from Subsea DCV over field life	Hydraulic Fluid	n/a	Liquid	Yes	6.3072	m^3/hr	Intermittent	Sea	SCM DCV leak rate based on information from SPS Team. In relation to quiescent leakage 24 valves @ 3 ml / hr equates to 72 ml per hour per SCM. Project has 10 0ff SCM's 720 ml/hr, and 6.3072 cubic meters per annum.
Open Drains Water	Rainwater	16 10 01*	Liquid	Yes	130	m^3	Intermittent	To sea via PW Caisson	Pumped out 4 times per year and discharged via PW caisson.
Sewage from O&M Campaigns	Black water	20 03 06	Liquid	No	480	te	Intermittent	MARPOL	Based on 40 POB (including 20 vessel crew members) generating 200 L/d/person [Ref 2] over 60 days. Four O&M campaigns per year.
Domino Subsea Pigging	TEG Water	n/a	Liquid	Yes	1	m^3/year	Intermittent	Sea	No significant discharge is expected to happen due to pigging. However, when replacing the cartridge, some treated water will be released. the volume expected to be below 1cu.m. assuming pigging every two years (which is excessive) will result to a total or 20 cu.m max during the life of field.
Methanol for startup, re-start - Normal Restart	Methanol	n/a	Liquid	Yes	954	m^3/year	Intermittent	Sea - mixed with produced water	Volume for PSD re-start for 10 off XTs - 6 off PSD assumed per year = 159 m^3 per PSD.
Methanol for shutdown and re-start of single well	Methanol	n/a	Liquid	Yes	161	m^3/year	Intermittent	Sea - mixed with produced water	Assume that there are 20 well single shutdowns and restarts for the first 2 years, 12 single well shutdown and re-starts for 18 years. MEOH volume based on single well jumper displacement volume plus,-

DESCRIPTION	WASTE	EWC WASTE CODE	TYPE	HAZARDOUS WASTE	AMOUNT	Units	PRODUCTION	RECEPTOR	COMMENTS
									5.2 m^3 volume to displace jumper. Yearly Average of 13 single well shut-down and restarts per year - 12.4 m^3 per well shut-down and restart.
Methanol for startup, re-start - TAR Planned Shutdown	Methanol	n/a	Liquid	Yes	318	m^3/TAR	Intermittent	Sea - mixed with produced water	Full Shutdown TARs 5 planned TARs.
Methanol for startup, re-start - ESD Trip	Methanol	n/a	Liquid	Yes	159	m^3/year	Intermittent	Sea - mixed with produced water	Aligned with start-up and volume required with number of re-starts - Assume 1 per Year - Assumes short ESD with no bull heading.
Normal Operations Onshore									
Slops Tank for Equipment Drainage	Oily-Water	16 10 01*	Liquid	Yes	20	m^3	Continuous	Third party	Assumes tank (10 m^3) will be emptied twice per year.
Stormwater Runoff	Rainwater	n/a	Liquid	Yes	4,000	m^3/year	Intermittent	Collected in Buffer tank and routed via oil separator before disposal to ditches	Average rainfall in the area: 450 mm/year/m^2. Total onshore concrete and buildings area (rainwater that is collected): 8,700 m^2, resulting in a yearly average of 4,000 m^3 of rainwater.
Sewage	Black water	20 03 06	Liquid	No	164	tpa	Intermittent	Connected to RAJA	Average of 6 personnel working assuming a sewage generation rate of 75L per person per day over 365 days.
Abnormal Operations Offshore									
Well Start-up - Methanol	Methanol	n/a	Liquid	Yes	1,446	m^3	Intermittent	Sea- mixed with produced water	Assuming high level ESD trips to occur 6 times during early field life due to initial plant stability issues and surveillance activities. Full SWP blowdown and cold re-start (Pelican – 48h flaring) required.

6.4 Wastes

Table 6-8 Wastes Generated during Construction, Drilling and Operations

DESCRIPTION	WASTE	EWC WASTE CODE	TYPE	HAZARDOUS WASTE	AMOUNT	UNITS	PRODUCTION	RECEPTOR	COMMENTS
Construction Offshore									
Paint	Paint	08 01 11	Liquid	Yes	0.5	te	Intermittent	Third Party	Construction phase only.
Waste Oil	Oil	13 02 05*	Liquid	Yes	0.5	m^3/year	Intermittent	Third Party	
Contaminated Water with Oil	Oil and Water	16 10 01*	Liquid	Yes	1	m^3	Intermittent	Third Party	Construction phase only.
Well Start-up (all wells)	Methanol, Corrosion Inhibitor, Scale Inhibitor, TEG, water mixture, & well suspension fluids	16 10 01*	Liquid	Yes	3,500	m^3	Intermittent	Third Party	Backloaded to shore for onshore treatment/disposal.
Medical Waste	Bandages, used syringes, etc.	18 01 03*	Solid	Yes	0.02	te/year	Intermittent	Third Party	
Wastepaper and Cardboard Packaging	Paper/Card	15 01 01	Solid	No	10.0	te/year	Intermittent	Third Party	
Domestic Waste	Domestic Waste	20 03 01	Solid	No	54	te	Continuous	Third Party	450 personnel working on the construction site and 0.5 kg of waste per person per day over 240 days.
Waste Wood	Wood	15 01 03	Solid	No	10	te/year	Intermittent	Third Party	
Bulk Solids (Uncontaminated) – Cement	Cement	11 01 98*	Solid	No	15	te	Intermittent	Third Party	Construction phase only.
Ferrous Metal	Scrap Metal	16 01 17	Solid	No	5	te	Intermittent	Third Party	
Non-ferrous Metals	Scrap Metal	16 01 18	Solid	No	3	te	Intermittent	Third Party	
Plastic Materials	Plastic	16 01 19	Solid	No	3	te	Intermittent	Third Party	Based on a 25% annual degradation rate of the hot oil heating medium [Ref 2].
Topsides Support Frame	Scrap Metal	16 01 17	Solid	No	600	te	Intermittent	Third Party	Construction phase only.
Jacket Support Frame	Scrap Metal	16 01 17	Solid	No	600	te	Intermittent	Third Party	Construction phase only.
Jacket and Topsides	Scrap Metal	16 01 17	Solid	No	200	te	Intermittent	Third Party	Construction phase only.

DESCRIPTION	WASTE	EWC WASTE CODE	TYPE	HAZARDOUS WASTE	AMOUNT	UNITS	PRODUCTION	RECEPTOR	COMMENTS
Installation Aids, Grillage, Transport Bracing, Guides, Bumpers, Slings									
Jackets, Piles, Caisson Trimmed Steel	Scrap Metal	16 01 17	Solid	No	20	te	Intermittent	Third Party	Construction phase only.
Subsea equipment installation aids, grillage, transport bracing, guides, bumpers, slings	Scrap Metal	16 01 17	Solid	No	500	te	Intermittent	Third Party	
Batteries	Batteries	20 01 33*	Solid	Yes	0.1	te/year	Intermittent	Third Party	
Launch shaft (deep option) (pile volume & excavation)	Excavated Material	17 05 04	Solid	No	3,270	m^3	Intermittent	Third Party	
Tunnelling (spoil)	Spoil	17 05 04	Solid	No	4,030	m^3	Intermittent	Third Party	
Offshore (recovery pit, pipe trench)	Excavated Material	17 05 04	Solid	No	40,950	m^3	Intermittent	Third Party	
Construction Onshore									
Oily Water in Slops Tank for Equipment Drainage	Contaminated Fluids	16 10 01*	Liquid	Yes	10	m^3	Intermittent	Third Party	
Paint	Paint	08 01 11	Liquid	Yes	0.5	te	Intermittent	Third Party	Construction phase only.
Domestic Waste	Domestic Waste	20 03 01	Solid	No	17.50	te	Continuous	Third Party	70 personnel working on the construction site assuming 0.5 kg of waste per person per day over 500 days.
Launch Shaft + Ramp (Shallow Option) (Sheet Pile Walls, Steel Whaler Bracing, Excavation, Concrete + Sealing Body)	Excavated Material	17 05 04	Solid	No	2,900	m^3	Intermittent	Third Party	
Tunnelling (Drilling, Jacking Pipes, Bentonite,	Excavated Material	17 05 04	Solid	No	4,500	m^3	Intermittent	Third Party	

DESCRIPTION	WASTE	EWC WASTE CODE	TYPE	HAZARDOUS WASTE	AMOUNT	UNITS	PRODUCTION	RECEPTOR	COMMENTS
Disposal mob./demob.)									
Waste Wood	Wood	15 01 03	Solid	No	10	te/year	Intermittent	Third Party	
Plastic Materials	Plastic	16 01 19	Solid	No	3	te	Intermittent	Third Party	Based on a 25% annual degradation rate of the hot oil heating medium [Ref 2].
Batteries	Batteries	20 01 33*	Solid	Yes	0.1	te/year	Intermittent	Third Party	
Waste Paper and Cardboard Packaging	Paper/Card	15 01 01	Solid	No	10.0	te/year	Intermittent	Third Party	
Drilling									
NADF Based Drill Cuttings	Drill Cuttings	01 05 05*	Solid	Yes	6,250	m^3	Intermittent	SBM wet cuttings are skipped and shipped to shore for disposal.	10 wells + 1 redrill, 17.1/2in - 2125m, 14in – 500 m and 9.5in – 250 m. 25% contingency allowed for hole break out.
Paint	Paint	08 01 11	Liquid	Yes	0.5	te	Intermittent	Third Party	
Domestic Waste	Domestic Waste	20 03 01	Solid	No	77.60	te	Continuous	Third Party	194 personnel assuming 0.5 kg of waste per person per day over 800 days.
Slops from Non-hazardous Drains	Contaminated Fluids	16 10 01*	Solid	No	31,300	m^3	Intermittent	Sea	600 mm of rain per year - 100 x 100m rig footprint x 2 years. Potable water and seawater lift use to wash decks 5 m^3 per day. 100% contingency.
NADF Contaminated Water/Brine Slops (Tank Cleaning, Deck Drain from NADF Areas, Rig Floor Environmental Pan Catchment etc)	Contaminated Fluids	16 10 01*	Liquid	Yes	61,480	m^3	Intermittent	Taken onshore for disposal / separation oil / fluid phase not possible due to surfactant	Tripping wet 25bbl / trip (7 trips per well), Displacement interfaces (2,500bbl per well), Rig floor wash down volumes (1,000 bbl / well), Tank and flowline cleaning rig (10,000 bbl / well), PSV and other vessel cleaning (25,000 bbl per well), Total 386,750 bbl per well (inc. 100% contingency).
Hazardous Disposal of Filters	Contaminated Waste	16 01 07*	Solid	Yes	7	te	Intermittent	Third Party	10 kg of used filters generated per day of operation. Conservative assumption.
Drill Pipe / Scrap	Scrap Metal	20 01 40	Solid	No	250	te	Intermittent	Third Party	Rig up and rig down materials; brackets, welding scrap; Damaged subs pups and joints slings, worn or damaged rigging assume 25 tons per well.

DESCRIPTION	WASTE	EWC WASTE CODE	TYPE	HAZARDOUS WASTE	AMOUNT	UNITS	PRODUCTION	RECEPTOR	COMMENTS
Cement	Cement	16 10 01*	Solid	No	100	bbl per well	Intermittent	Third Party	Assumes 50 BBL of spacer used per well
Cement	Cement	16 10 01*	Solid	No	2,000	bbl per well	Intermittent	Third Party	Assumes 2,000 BBL used per well, includes circulation cement.
Waste Wood	Wood	15 01 03	Solid	No	10	te/year	Intermittent	Third Party	
Batteries	Batteries	20 01 33*	Solid	Yes	0.1	te/year	Intermittent	Third Party	
Scrap Metal	Scrap Metal	20 01 40	Solid	No	10	te/year	Intermittent	Third Party	
Plastic Materials	Plastic	16 01 19	Solid	No	3	te/year	Intermittent	Third Party	
Medical Waste	Bandages, used syringes, etc.	18 01 03*	Solid	Yes	0.02	te/year	Intermittent	Third Party	
Wastepaper and Cardboard Packaging	Paper/Card	15 01 01	Solid	No	10	te/year	Intermittent	Third Party	
Normal Operations Offshore									
Domestic Waste	Domestic Waste	20 03 01	Solid	No	1.20	te	Continuous	Third Party	40 personnel assuming 0.5 kg of waste per person per day over 60 days.
Paint	Paint	08 01 11	Liquid	Yes	0.5	te	Intermittent	Third Party	
Batteries	Batteries	20 01 33*	Solid	Yes	0.1	te/year	Intermittent	Third Party	
Waste Wood	Wood	15 01 03	Solid	No	2	te/year	Continuous	Third Party	194 personnel assuming 0.5 kg of waste per person per day over 800 days.
Medical Waste	Bandages, used syringes, etc.	18 01 03*	Solid	Yes	0.005	te/year	Intermittent	Third Party	
Wastepaper and Cardboard Packaging	Paper/Card	15 01 01	Solid	No	3	te/year	Intermittent	Third Party	
Plastic Materials	Plastic	16 01 19	Solid	No	2	te/year	Intermittent	Third Party	
Normal Operations Onshore									
Paint	Paint	08 01 11	Liquid	Yes	2	te	Intermittent	Third Party	
Medical Waste	Bandages, used syringes, etc.	18 01 03*	Solid	Yes	0.01	te/year	Intermittent	Third Party	
Waste Paper and Cardboard Packaging	Paper/Card	15 01 01	Solid	No	1	te/year	Intermittent	Third Party	
Batteries	Batteries	20 01 33*	Solid	Yes	0.05	te/year	Intermittent	Third Party	
Waste Wood	Wood	15 01 03	Solid	No	1	te/year	Intermittent	Third Party	
Plastic Materials	Plastic	16 01 19	Solid	No	2	te	Intermittent	Third Party	Based on a 25% annual degradation rate of the hot oil heating medium [Ref 2].
Scrap Metal	Scrap Metal	20 01 40	Solid	No	15	te/year	Intermittent	Third Party	

Appendix A – References and acronyms

References

Table A1.1 References

Ref	Description
1	ND-D-IO-50-PR-CHMB-0001-0001-REV P01 - Heat and Material Balance (Max Flow 790 End)
2	Neptun Deep ESIA Emissions Assumptions List Rev P01 23022023
3	EPA Air Emissions Factors Quantification AP-42: Compilation of Air Emissions Factors, Chapter 3 – Stationary Internal Combustion Sources
4	EPA Air Emissions Factors Quantification AP-42: Compilation of Air Emissions Factors, Chapter 13 – Miscellaneous Sources
5	EEMS, Atmospheric Emissions Calculations, Oil and Gas UK, Department of Energy and Climate Change
6	OMV Petrom Delivery Specification R-36, Diesel EN 590/10 ppm
7	Waste Quantification Report ND-D-OP-00-EV-REIS-0001-0001, P01, Sept 2022
8	EF for MGO from EMEP/EEA air pollutant emission inventory guidebook 2016
9	EMEP/EEA Air Pollutant Emission Inventory Guidebook, 1.A.3.d Navigation-Shipping 2019 - update 2021. (Efs for MGO users)
10	EMEP/EEA Air Pollutant Emission Inventory Guidebook, 1.A.3.a Aviation 2019. (Efs for helicopters)
11	Aviation Fuels Technical Review, Chevron
12	https://www.verifavia.com/greenhouse-gas-verification/fq-how-are-aircraft-co2-emissions-calculated-11.php
13	https://www.verifavia-shipping.com/shipping-carbon-emissions-verification/faq-which-emission-factors-shall-be-used-110.php
14	Rev 01/790MMSCFD_2bbl_MMSCF_Rev01.hsc HYSIS LHV and HHV output for Streams 9, 11 and 13

Acronyms

Table A1.2 Acronyms

Acronym	Definition
AHT	Anchor Handling Tug
BOP	Blow Out Preventer
BSG	Black Start Generator
CCR	Central Control Room
CI	Corrosion Inhibitor
CTV	Crew Transfer Vessel
CW	Cooling Water

DCV	Directional Control Valve
DIFF	Deck Integrated Fire Fighting
EIA	Environmental Impact Assessment
ERRV	Emergency Response and Rescue Vessel
ESD	Emergency Shutdown
ESG	Essential Services Generator
ESIA	Environmental and Social Impact Report
FSV	Field Service Vessel
GP	General Pump
GPP	Gas Production Pipeline
GTG	Gas Turbine Generator
H&MB	Heat and Material Balance
HP	High Pressure
ICSS	Integrated Control and Safety System
IRM	Inspection, Repair and Maintenance
LP	Low Pressure
MEG	Mono-ethylene Glycol
MSV	Multi-purpose Service Vessel
NGMS	Natural Gas Metering Station
PCV	Pressure Control Valve
PM	Particulate Matter
PSD	Partial Shutdown
PSV	Pressure Safety Valve
PW	Produced Water
RMR	Riserless Mud Recovery
SCM	Subsea Control Module
SI	Scale Inhibitor
SITHP	Shut In Tubing Hanger/Head Pressure
SWP	Shallow Water Platform
TAR	Inspection and Maintenance
TEG	Tri-ethylene Glycol
TEMPSC	Totally Enclosed Motor Propelled Survival Craft
VOC	Volatile Organic Compound
WL	Wireline