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Cloughton-2 Appraisal Well Emissions Report

esg risk emissions engagement

Expected- and reasonable worst-case emissions forecast for the Cloughton-2 appraisal well

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About sustain:able

sustain:able are a UK-based consultancy focussed on providing relevant, honest advice regarding ESG and emissions to companies in the oil & gas, mining and wider energy sectors across the globe. Our people come from geoscience, engineering, commercial, facilities, environmental and project management roles who have worked directly in either oil & gas, mining, or renewable energy, in locations all over the world. We use our industry knowledge and experience to support our clients in addressing the ever-changing ESG and emissions requirements, whilst always being mindful of their core business.

Our expert emissions team hold ISO 14064 and 14067 certifications in Greenhouse Gas Emissions Accounting and Carbon Footprint Analysis, providing emissions forecasts for future projects, accounting of annual emissions, and evaluation of Scope 3 emissions. We also support ESG risk assessment and reporting for companies across the globe, providing both the strategic planning, data and framework reporting activities relevant to their situation, and the narrative and proposed graphics for the publication of ESG information on company websites, in annual reports, sustainability reports, or through investor content.

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Executive Summary

This report is an overview of the emissions calculations undertaken to assess the expected- and reasonable worst-case emissions from the planned Cloughton-2 appraisal well to be drilled within the PEDL 343 license, onshore UK. Details of the appraisal well and associated activities were provided by Europa Oil and Gas (Holdings) plc ('Europa') and combined with relevant emissions factors to produce an overall absolute emissions value for the project.

The expected-case project emissions are **2,408 tCO_2e**.

The reasonable worst-case project emissions are **7,054 tCO_2e**.

The most significant factor contributing to this difference in emissions between the scenarios is accounted for by the volume of gas flared during well testing in the success case, where the reasonable worst-case emissions includes an additional two-week discretionary testing period where flaring would occur.

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1 Glossary of Terms & Conversions

Abbreviation/Term	Definition
BCF	Billion cubic feet of gas
CH_4	Methane
CO_2	Carbon dioxide
EF	Emissions factor
GHG	Greenhouse gas
GWP	Global warming potential
m^3	Cubic metres
MD	Measured depth along the borehole measured from ground level
MMscf*	Million standard cubic feet of gas
$MtCO_2e$	Million tonnes of carbon dioxide equivalent
N_2O	Nitrous oxide
tCO_2e	Tonnes of carbon dioxide equivalent
TVDSS	True vertical depth of the borehole below a sub-sea datum
WTT	Wheel-to-tank upstream emissions factor for fuels

* It is common in the oil and gas industry to represent millions by the notation ‘MM’ (e.g. MMboe to signify millions of barrels of oil equivalent). This may be different to other industries where millions may be represented by one ‘M’ only (e.g. $MtCO_2e$).

Unit	Conversion	Source
1 MMboe	0.146 MMtoe	[1]
1 BCF	0.167 MMboe	[1]
1 BCF	0.028 billion m^3	[1]
1 BCF	0.024 MMtoe	[1]

Source of quoted conversions and densities are noted in the table above and are assumed to be at ambient conditions: [1] BP Approximate Conversion Factors 2022 (bp, 2022).

2 Summary of the Project

Europa Oil and Gas (Holdings) plc ('Europa') is proposing to drill an appraisal well from a well pad within the PEDL 343 license ~0.34 km southeast of Burniston in the north-east of England. The license sits within the Cleveland basin where gas was first discovered by the Cloughton-1 well in a carboniferous sandstone reservoir, sealed by salt and trapped in a four-way anticline.

The appraisal well, designated Cloughton-2, will be targeting the Carboniferous Sandstones (primary target formation). The objective of the well is to assess the potential for dry natural gas accumulations within these formations in the same four-way dip closure as the original discovery well.

Cloughton-2 aims to drill into the target formations with a 1.6 km step-out from the well pad. The well is expected to be drilled to total depth of 2,293m TVDSS (2,988 m MD) with the expectation of finding accumulations of dry gas within the target reservoir intervals.

If natural gas is encountered and is considered suitable for further testing, production casing will be installed in the borehole and the formations will be tested, requiring a proppant squeeze operation and production of gas from the well for 4.5 days, with an additional discretionary flow period of up to 2 weeks.

This report summarises the calculation of the potential Scope 1 and Scope 3 emissions that could result from the Cloughton-2 well, including expected-case and reasonable worst-case scenarios. This was undertaken using activity data provided by Europa and their suppliers, as well as proxies and industry averages where necessary. Emissions were calculated from the mobilisation and site preparation phase all the way through to the site remediation phase. It is expected that there will be no electricity imported from the grid to power the site, therefore Scope 2 emissions will be zero.

The methodology, assumptions and results of this emissions evaluation are discussed below.

It is important to note that there are differences in emissions totals between this report and the Air Quality report produced for Europa by AQIA. This is due to the AQIA study modelling activity data that represents the estimated upper limit of emissions, for example, the rig and crane are assumed to run continuously for the entirety of the drilling phase. This is to ensure air quality thresholds will not be exceeded during the project and will represent an extreme worst-case scenario. The assumptions around the duration and intensity of operations in this report uses activity data that endeavour to capture an expected- and reasonable worst-case scenario for emissions.

3 Methodology and Assumptions

Europa's planned operations are split into four phases, each with an approximate timescale over which the activities will occur (see Table 1). However, while the project is expected to last 37 weeks, delays due to supply chain issues and equipment availability mean that this overall timeline may in reality be extended. Therefore, it is expected that any delays to the project schedule will result in periods of no activity, and the activities contributing to emissions will not be significantly affected by overall project delays.

Table 1 Summary of the four phases comprising Europa's Cloughton-2 Appraisal Well project

Project Phase	Description	Approximate Timescale
Phase 1	Drill Site Preparation	7 weeks
Phase 2	Operational Phase (Includes the drilling phase and demobilisation on completion of drilling operations).	7 weeks
Phase 3	Testing and Completions Operations	(up to) 17 weeks
Phase 4	Site Restoration	6 weeks

3.1 Emissions Factors and Global Warming Potentials

Tables 2 and 3 below show the global warming potentials (GWP) and emissions factors used to calculate emissions for the Cloughton-2 appraisal well. 100-year global warming potentials were taken from the IPCC AR5 report, excluding carbon feedbacks, to ensure alignment and consistency with the UK Government GHG Conversion Factors for Company Reporting, 2024.

Table 2 List of Global Warming Factors used

Global Warming Potential Factors - CO_2 Equivalent (AR5 [1])				
CO_2	CH_4	N_2O	Notes	Reference
1	28	265	100-year factors, excluding carbon feedbacks	2024 UK Govt emissions database references IPCC AR5 GWPs.

[1] IPCC 5th Assessment Report (Greenhouse Gas Protocol, 2016)

Table 3 Emissions Factors for fuel combustion used for emissions calculations

Activity	Fuel Type	Unit	tCO_2e of CO_2 per unit	tCO_2e of CH_4 per unit	tCO_2e of N_2O per unit	Wheel-to-tank tCO_2e per unit
Drilling Rig (onshore)	Diesel (100% mineral)[1]	Tonnes	3.16433	0.0003472	0.0392342	0.75203
Vehicles - Trucks	Diesel (Average biofuel blend) [1]	Tonnes	2.97486	0.0003472	0.0388874	0.73364
Vehicles – Passenger (medium car)	Petrol[1]	Kilometres	0.00018	0.0000004	0.0000003	0.77733
Diesel Combustion	Diesel (Average biofuel blend) [1]	Tonnes	2.97486	0.0003472	0.0388874	0.73364
Well Testing (gas)	Default gas assumed[2]	Tonnes	2.80000	1.2600000	0.0214650	-
Flaring (gas)	Default natural gas assumed[2]	Tonnes	2.71460	0.5040000	0.0214650	-
Venting (gas)	Default natural gas assumed[2]	Tonnes	0.00000	25.200000	0.0000000	-
Mud degassing	Default gas assumed[3]	Tonnes	0.00000	1.2824000	0.0000000	-

[1] Conversion factors 2024, full set, UK Government (Department for Energy Security and Net Zero, 2024), [2] EEMS Atmospheric Emissions Calculations (EEMS, 2008), [3] Onshore well mud degassing 2021 API Compendium (American Petroleum Institute, 2021). Note: GWP factors already applied so all factors are represented in tCO_2e.

3.2 Emission Sources

The following activities and fuel consumption rates were identified as emissions sources for the Cloughton-2 Appraisal well (Table 4). Activity data was either provided by Europa, taken from an industry standard (e.g. API Compendium) or from a representative vehicle/source specification datasheet.

Table 4 Fuel consumption by source for the Cloughton-2 Appraisal Well

Vehicle/ Source	Fuel Type	Assumptions & Notes	Tonnes / Unit	Unit	Scope
HGV - Rigid - Unladen (ca. 26 tonne)	Diesel [1]	Ref [1] quoted fuel consumption of 23.6 L per 100 km (equiv. to 12.0 mpg) for "Diesel Freight Vehicles" Assume 0% laden weight: Conversion: 1 L/km = 0.0008375 tonne/km	0.000198	Tonnes / km	3
HGV - Rigid - Fully Loaded (ca. 26 tonne)	Diesel [1]	Ref [1] quoted fuel consumption of 34.0 L per 100 km (equiv. to 8.3 mpg) for "Diesel Freight Vehicles" Assume 100% laden weight: Conversion: 1 L/km = 0.0008375 tonne/km	0.000285	Tonnes / km	3
HGV - Articulated - Unladen (ca. 44 tonne)	Diesel [1]	Ref [1] quoted fuel consumption of 34.0 L per 100 km (equiv. to 8.3 mpg) for "Diesel Freight Vehicles" Assume 0% laden weight: Conversion: 1 L/km = 0.0008375 tonne/km	0.000261	Tonnes / km	3

HGV - Articulated - Fully Loaded (ca. 44 tonne)	Diesel [1]	Ref [1] quoted fuel consumption of 44.8 L per 100 km (equiv. to 6.3 mpg) for "Diesel Freight Vehicles" Assume 100% laden weight: Conversion: 1 L/km = 0.0008375 tonne/km	0.000375	Tonnes / km	3
Water Tanker	Diesel [2]	Ref [2] Assume same as for rigid HGV = 26.7 L per 100 km (equiv. to 10.6 mpg) for "Diesel Medium- and Heavy-duty Vehicles" Conversion: 1 L/km = 0.0008375 tonne/km	0.000224	Tonnes / km	3
Car / Light Van	Petrol [2]	Ref [2] quotes average of 7.8 litres of fuel per 100 km for medium petrol cars Conversion: 7.8 L/100 km = 0.078 L/km Conversion: 1 L/km = 0.000720 tonne/km	0.000056	Tonnes / km	3
Water-based Mud Degassing	Methane Degassing [3]	Water-based mud degassing for onshore drilling	0.045800	Tonnes CH_4 / drilling day	3
Rig Trailer	Diesel [4]	3rd party haulage contractor - averages 8.2mpg Conversion: 1.8 miles per litre Conversion: 2.9 kilometres per litre or 34.5 L/100km = 0.345L/km	0.000290	Tonnes / km	3
Rig During Drilling	Diesel [4]	Drilling with 1 x 1,600hp MP, 1 x TDS CAT C18 prime mover 700hp and 2 x S60 Detroit 600hp ea flr mtrs - 1,700ltrs per 12 hours Conversion: 1,700 litres = 1.4238 tonne/12 hours Conversion = 1.4238/12 = 0.1187	0.118700	Tonnes / hr	3
Rig During Tripping	Diesel [4]	Tripping running 2 x 600hp ea flr mtrs - 800ltrs per 12 hours Conversion: 800 litres = 0.670 tonnes Conversion: 0.670 per 12 hours to 0.056 tonnes per hour.	0.056000	Tonnes / hr	3
Appraisal Drilling Additional Power	Diesel [4]	Fuel consumption for site generators for utilities cabins, etc Inc 400kva site generator and 60kva camp generator - 800ltrs per 12hrs Conversion: 800 litres = 0.670 tonne Conversion: 0.670 per 12 hours to 0.056 tonnes per hour.	0.056000	Tonnes / hr	1
Crane transport to and from site	Diesel [5]	Fuel consumption for 80-ton crane driving under its own power is assumed to be 45 litres per 100km. Conversion: 0.45L/kms = 0.0.000377 tonne	0.000377	Tonnes / km	3
Crane on site	Diesel [4]	Fuel consumption 200 litres per 12 hours. Conversion: 200 litres = 0.1675 tonne Conversion: 200 litres over 12 hours to 0.014 per hour	0.014000	Tonnes / hr	3
Multistage Stimulation Operational	Diesel [6]	Operational day average consumption: 5064 litres Conversion: 5064 litres = 4.24115 tonnes	4.241150	Tonnes / day	3
Multistage Stimulation standby	Diesel [6]	Operational day average consumption: 1214.4 litres Conversion: 1214.4 litres = 1.01706 tonnes	1.017060	Tonnes / day	3
Water Heater for Multistage Stimulation	Diesel [6]	Operational consumption: 8000 litres Conversion: 8000 litres = 6.7 tonnes	6.700000	Tonnes	3
Surface Well Test - Proppant squeeze execution with clean out	Diesel [6]	Operational consumption: 2600 litres Conversion: 2600 litres = 2.1775 tonnes	2.177500	Tonnes	3
Extended Well Test	Diesel [6]	Operational day average consumption: 500 litres Conversion: 500 litres = 0.41875 tonnes	0.418750	Tonnes / day	3

Wireline Unit - Operational	Diesel [6]	Operational day average consumption: 240 litres Conversion: 240 litres = 0.201 tonnes	0.201000	Tonnes / Day	3
Wireline Unit - Standby	Diesel [6]	Operational day average consumption: 20 litres Conversion: 20 litres = 0.01675 tonnes	0.016750	Tonnes / day	3
Gas flaring during well testing - Firm	Gas[7]	Firm testing program in success case	12.5	MMscf	1
Gas flaring during well testing – Firm + Discretionary	Gas[7]	Firm + discretionary testing program in success case	68.5	MMscf	1
14 t Excavator	Diesel [4]	Fuel consumption 200 litres per 12 hours. Conversion: 200 litres = 0.1675 tonne assuming diesel density of 0.8375 kg/L Conversion: 200 litres over 12 hours to 0.014 tonnes per hour	0.013958	Tonnes / hr	3
Dozer	Diesel [4]	Fuel consumption 250 litres per 12 hours. Conversion: 250 litres = 0.2094 tonne assuming diesel density of 0.8375 kg/L Conversion: 0.2094 tonnes over 12 hours to 0.017 tonnes per hour	0.017448	Tonnes / hr	3
9 t Dumper	Diesel [4]	Fuel consumption 100 litres per 12 hours. Conversion: 100 litres = 0.0838 tonne assuming diesel density of 0.8375 kg/L Conversion: 0.0838 tonnes over 12 hours to 0.007 tonnes per hour	0.006979	Tonnes / hr	3
Roller	Diesel [4]	Fuel consumption 150 litres per 12 hours. Conversion: 150 litres = 0.1256 tonne assuming diesel density of 0.8375 kg/L Conversion: 0.1256 tonnes over 12 hours to 0.010 tonnes per hour	0.010469	Tonnes / hr	3
Surface Conductor Rig	Diesel [4]	Fuel consumption 480 litres per 12 hours. Conversion: 480 litres = 0.402 tonne assuming diesel density of 0.8375 kg/L Conversion: 0.402 tonnes over 12 hours to 0.034 tonnes per hour	0.033500	Tonnes / hr	3
Concrete Pump	Diesel [4]	Fuel consumption 500 litres per 12 hours. Conversion: 500 litres = 0.4188 tonne assuming diesel density of 0.8375 kg/L Conversion: 0.4188 tonnes over 12 hours to 0.035 tonnes per hour	0.034896	Tonnes / hr	3

[1] 2021 API Compendium, Table 4-12 (American Petroleum Institute, 2021), [2] 2021 API Compendium, Table 4-13 (American Petroleum Institute, 2021), [3] Onshore well mud degassing, 2021 API Compendium (American Petroleum Institute, 2021), [4] Consumption data provided by Europa, [5] Specifications of an 80 Ton Crane (Harvest, 2024). Note: all conversions assume diesel density of 0.8375 kg/litre and petrol density of 0.720 kg/litre, [6] Supplier provided Multistage Stimulation Fuel consumption estimate. [7] Indicative testing program provided by Europa.

3.3 Assumptions for emissions calculations

Table 5 outlines the assumptions made during the emissions calculations and shows the variation in assumed activities between the expected-case and reasonable worst-case scenario. Two scenarios were used to try and capture the range of emissions that could occur from the project while also highlighting key uncertainties within the calculations.

Table 5 Expected- and reasonable worst-case assumptions on emissions sources for Cloughton appraisal well

Phase	Emissions Source	Expected-case Assumptions	Reasonable Worst-case Assumptions
Phase 1: Site Preparation & Mob/Demob Phase	Security and Construction Equipment	10 HGV loads Assume all loads will come from Teesside - 40 miles one way from well site = 64.4 km - 80 miles return trip = 128.8 km (50% unladen, 50% fully laden) - Rigid chassis assumed	Same as Expected-Case
	Stone, materials and services	10 HGV loads Assume all loads will come from Teesside - 40 miles one way from well site = 64.4 km - 80 miles return trip = 128.8 km (50% unladen, 50% fully laden) - Rigid chassis assumed	Same as Expected-Case
	Low loaders	10 HGV loads Assume all loads will come from Teesside - 40 miles one way from well site = 64.4 km - 80 miles return trip = 128.8 km (50% unladen, 50% fully laden) - Rigid chassis assumed	Same as Expected-Case
	Excavator	2 x 14 T Excavators working for 15 days Assume working 12 hours a day	Same as Expected-Case
	Dozer	1 x Dozer working for 15 days Assume working 12 hours a day	Same as Expected-Case
	Dumper	2 x Dumpers working for 30 days Assume working 12 hours a day	Same as Expected-Case
	Roller	2 x Rollers working for 15 days Assume working 12 hours a day	Same as Expected-Case
	Concrete Pump	1 x Concrete Pump working for 5 days Assume working 12 hours a day	Same as Expected-Case
	Surface Conductor Rig	1 x Surface Conductor Rig for 1 day Assume working 12 hours a day	Same as Expected-Case
	Personnel during mob/demob and construction phase	- Crew changes occur over 5 weeks for 5 and a half days a week - 5 cars per day over 5.5 days for 5 weeks = 138 trips	- Crew changes occur over 5 weeks for 5 and a half days a week - 10 cars per day over 5.5 days for 5 weeks = 275 trips

	(Car/light goods vehicle trips of personnel engaged in the work on the site)	- Assume all cars will come from Teesside or York (both locations are the same distance from well site) - 40 miles one way from well site = 64.4 km - 80 miles return trip = 128.8 km	- Assume all cars will come from Teesside or York (both locations are the same distance from well site) - 40 miles one way from well site = 64.4 km - 80 miles return trip = 128.8 km
Phase 2: Drilling Operations	Transport of Rig	- Assume rig will mobilise from 50 miles and return to same location - 50 miles one way from well site = 80.5 km - 100 miles return trip = 161.0 km	Same as Expected-Case
	Transport of equipment to/from well location (incl. Rig equipment, ancillary services and. water)	- Mobilisation 80 HGV loads - Demobilisation 80 HGV loads - Assume equipment will mobilise from 50 miles and return to same location - 50 miles one way from well site = 80.5 km - 100 miles return trip = 161.0 km (50% unladen, 50% fully laden) - Rigid chassis assumed	Same as Expected-Case
	Operational crew changes during drilling (Car/light goods vehicle trips of personnel engaged in the work on the site)	- Assume crew changes during drilling phase only over 5-week period = 35 days total - 10 cars per day over 35 days = 350 trips - Assume all cars will come from Teesside or York (both same distance from well site) - 40 miles one way from well site = 64.4 km - 80 miles return trip = 128.8 km	- Assume crew changes during drilling phase only over 6-week period = 42 days total - 10 cars per day over 42 days = 420 trips - Assume all cars will come from Teesside or York (both same distance from well site) - 40 miles one way from well site = 64.4 km - 80 miles return trip = 128.8 km
	Rig Operations Drilling (Once commenced, drilling and associated operations would be 24 hours per day)	- Assume operations of 5 weeks (35 days total) - Assume that drilling consists of 85% drilling, 15% tripping in correlation with 15% NPT.	- Assume operations of 6 weeks (42 days total) - Assume that drilling consists of 85% drilling, 15% tripping in correlation with 15% NPT.
	Rig Operations – Tripping (Once commenced, drilling and associated operations would be 24 hours per day)	- Assume operations of 5 weeks (35 days total) - Assume that drilling consists of 85% drilling, 15% tripping in correlation with 15% NPT.	- Assume operations of 6 weeks (42 days total) - Assume that drilling consists of 85% drilling, 15% tripping in correlation with 15% NPT.
	Drilling Support (Water, equipment, wastes, services)	170 HGV loads - Assume all loads will come from Teesside - 40 miles one way from well site = 64.4 km - 80 miles return trip = 128.8 km (50% unladen, 50% fully laden) - Rigid chassis assumed	Same as Expected-Case
	Drilling Mud degassing (Onshore drilling, water-based mud system, generalised mud degassing values from API compendium calculated based on drilling days)	- Assume: 0.0458 tonnes CH_4/drilling day. - Assume total drilling period 5 weeks (35 days)	- Assume: 0.0458 tonnes CH4/drilling day. - Assume total drilling period 6 weeks (42 days)

	Other Power (Site generators for utilities cabins, etc)	- Inc 400kva site generator and 60kva camp generator - Assume total drilling period 5 weeks (35 days)	- Inc 400kva site generator and 60kva camp generator - Assume total drilling period 6 weeks (42 days)
Phase 3: Testing & Completions	Transport of squeeze equipment to/from well location	- Site Testing Preparation 2 weeks (Temporary Bund) 18 x HGV s – aggregates (sand), sandbags, construction materials, machinery - Assume 18 truck loads over two weeks. - Assume all loads will come from Teesside - 40 miles one way from well site = 64.4 km - 80 miles return trip = 128.8 km (50% unladen, 50% fully laden) - Rigid chassis assumed	Same as Expected-Case
	Mobilisation/ demobilisation of production equipment	40 x HGV deliveries over days 1 to 4 for production equipment - Assume 50% loads will come from Teesside, 50% from Aberdeen to account for specialist equipment **Teesside:** - 40 miles one way from well site = 64.4 km - 80 miles return trip = 128.8 km (50% unladen, 50% fully laden) **Aberdeen:** - 330 miles one way from well site = 531.1 km - 660 miles return trip = 1062.2 km (50% unladen, 50% fully laden) - Rigid chassis assumed Equipment requirements for testing: 1 x Welfare unit/switch room; 1 x generator; Up to 1 x fluid storage tank; 1 x compressor; 2 x transfer/export pumps Depending on gas/water rates, there may also be need for: 1 x separator; 1 x shrouded ground flare; 1 x bath heater	Same as Expected-Case
	Crew moments to/from site during Site Preparation	Personnel on site: - 4 x light vehicles (cars, light vans) per day for the two week site set-up period - Assume all cars will come from Teesside or York (both locations are the same distance from well site) - 40 miles one way from well site = 64.4 km - 80 miles return trip = 128.8 km	Same as Expected-Case

	Crane supporting site preparation operations	- Mobilisation during site prep of 1 x crane to site days for site prep phase - Assume mobilisation to/from Teesside: - 40 miles one way from well site = 64.4 km - 80 miles return trip = 128.8 km Telescopic, 80-ton crane driven under its own power - fuel consumption assumed to be 45 litres/100km	Same as Expected-Case
	Crane operations during site preparation	- Operation during site preparation of 1 x crane Telescopic, 80-ton crane driven under its own power - fuel consumption 200 litres per 12 hours Crane on site days 1-4 (assume 12 hours operation per day)	Same as Expected-Case
	Mobilisation of HGVs for squeeze ops	- Mobilisation of 7 x HGVs for squeeze ops – Pumps, mixing tanks, coiled tubing, wireline unit - Assume mobilisation from Aberdeen: - 330 miles one way from well site = 531.1 km - 660 miles return trip = 1062.2 km (50% unladen, 50% fully laden) - Rigid chassis assumed	Same as Expected-Case
	Crew on site during proppant squeeze	- Personnel on site during squeeze operations: - 5 x light vehicles (cars, light vans) per day for 3 days = 15 trips - Assume all cars will come from Teesside or York (both locations are the same distance from well site) - 40 miles one way from well site = 64.4 km - 80 miles return trip = 128.8 km	Same as Expected-Case
	Crane supporting proppant squeeze operations	- Mobilisation during proppant squeeze of 1 x crane to site days for proppant squeeze phase - Assume mobilisation to/from Teesside: - 40 miles one way from well site = 64.4 km - 80 miles return trip = 128.8 km - Telescopic, 80-ton crane driven under its own power. - Fuel Consumption assumed to be 45 litres/100km	Same as Expected-Case
	Crane Operations during Proppant Squeeze	- Operation during proppant squeeze of 1 x crane - Telescopic, 80-ton crane driven under its own power. - Fuel Consumption 200 litres per 12 hours - 3 days during proppant squeeze.	Same as Expected-Case
	Water tankers during production phase	- Production Test operation up to 15 weeks - 75 tankers during the production testing period - Assume all loads will come from Teesside	Same as Expected-Case

		- 40 miles one way from well site = 64.4 km - 80 miles return trip = 128.8 km - Rigid chassis assumed	
	Crew support on site throughout testing phase	- Crew support on site during testing phase (15 weeks): - 2 x car/light vans per day for site operations for first two weeks post set-up - 1 x car/light van per day for the remainder of the production test phase - Occasional light van deliveries during remainder of the test period - Assume all cars will come from Teesside or York (both locations are the same distance from well site) - 40 miles one way from well site = 64.4 km - 80 miles return trip = 128.8 km	Same as Expected-Case
	Production testing power – generators and electrical motors	- During appraisal drilling the additional power will be from diesel generators - Fuel consumption for site generators for utilities cabins, etc - Inc 400kva site generator and 60kva camp generator - 800ltrs per 12hrs - Assumed running 24 hours a day, 7 days a week for 15 weeks	Same as Expected-Case
	Well proppant squeeze operations - operational	- Well stimulation expected to be in operation for 4.5 days total	Same as Expected-Case
	Well proppant squeeze operations - standby	- Well stimulation expected to be on standby for 4 days total	Same as Expected-Case
	Optional Water Heater	N/A	- Assumed to be required during proppant squeeze operations.
	Well test – proppant squeeze operations with clean out	- As prescribed by supplier for proppant squeeze ops.	Same as Expected-Case
	Well test - extended	N/A	- Assumed to last seven days.
	Wireline Unit - standby	- Assumed to be on standby for a total of 4.5 days	Same as Expected-Case
	Wireline Unit - Operational	- Assumed to be operational for a total of 4 days	Same as Expected-Case
	Volume of flared gas during well test	- Maximum volume of 12.5 MMscf gas flared during well clean-up/well test (excluding discretionary flow period of up to 2 weeks) - EEMS emission factor assumes 95% combustion efficiency. Conversion of MMscf gas to tonnes gas: 1 MMscf natural gas = 28,317 m^3 = 19.8 tonnes. [Gas density assumed = 0.7 kg/m^3]	Maximum volume of 68.5 MMscf gas flared during well clean-up/well test (including discretionary flow period of up to 2 weeks) EEMS emission factor assumes 95% combustion efficiency. Conversion of MMscf gas to tonnes gas: 1 MMscf natural gas = 28,317 m^3 = 19.8 tonnes. [Gas density assumed = 0.7 kg/m^3]

Phase 4: Site Restoration	Reinstatement of site (Removal of site structures, waste and restoration of land for agricultural use)	Restoration would take approximately 6 weeks and generate the need for approx. 350 HGVs. Assume all loads will return to Teesside - 40 miles one way from well site = 64.4 km - 80 miles return trip = 128.8 km (50% unladen, 50% fully laden)	Same as Expected-Case
	Crew changes during restoration phase (Car/light goods vehicle trips of personnel engaged in the work on the site)	- Assume 5 cars per day same as site preparation phase. - Assume crew changes during restoration phases over 6-week period = 42 days total - 5 cars per day over 42 days = 210 trips - Assume all cars will come from Teesside or York (both locations are the same distance from well site) - 40 miles one way from well site = 64.4 km - 80 miles return trip = 128.8 km	- Assume 10 cars per day. - Assume crew changes during restoration phases over 6-week period = 42 days total - 10 cars per day over 42 days = 420 trips - Assume all cars will come from Teesside or York (both locations are the same distance from well site) - 40 miles one way from well site = 64.4 km - 80 miles return trip = 128.8 km
	Excavator	2 x 14 T Excavators working for 15 days Assume working 12 hours a day	Same as Expected-Case
	Dozer	1 x Dozer working for 15 days Assume working 12 hours a day	Same as Expected-Case
	Dumper	2 x Dumpers working for 30 days Assume working 12 hours a day	Same as Expected-Case

3.4 Exclusions

The following activities were excluded from the emissions estimates for Cloughton-2:

- As Cloughton-2 is an appraisal well, any future drilling or production at the field is not within the scope of this report and therefore Scope 3 Category 11 emissions are not included.
- Any imported electricity, heat or energy, known as Scope 2, is not included in these calculations as these operations are assumed not to utilise any grid electricity.
- Embedded emissions from materials used throughout the project are not included.

4 Results

Table 6 below highlights the total emissions for the expected-case and reasonable worst-case scenario split according to the stage of operations.

Table 6 Emissions for the Cloughton 2 Appraisal Well for both expected- and reasonable worst-case scenarios

Stage		Expected-case Emissions (tCO_2e)	Reasonable worst-case Emissions (tCO_2e)	Difference
1	Site preparation, mobilisation and demobilisation	116	120	3%
2	Drilling	618	692	12%
3	Testing and Completions	1,578	6,140	289%
4	Site Restoration	97	102	5%
Total		**2,408**	**7,054**	**193%**

Note: Values are rounded from many decimal places and therefore totals may not sum exactly.

As shown in Figure 1 and 2 below, the majority of emissions (>65%) in both scenarios are emitted during the Testing and Completions phase, with the remainder predominantly occurring during the Drilling Phase.

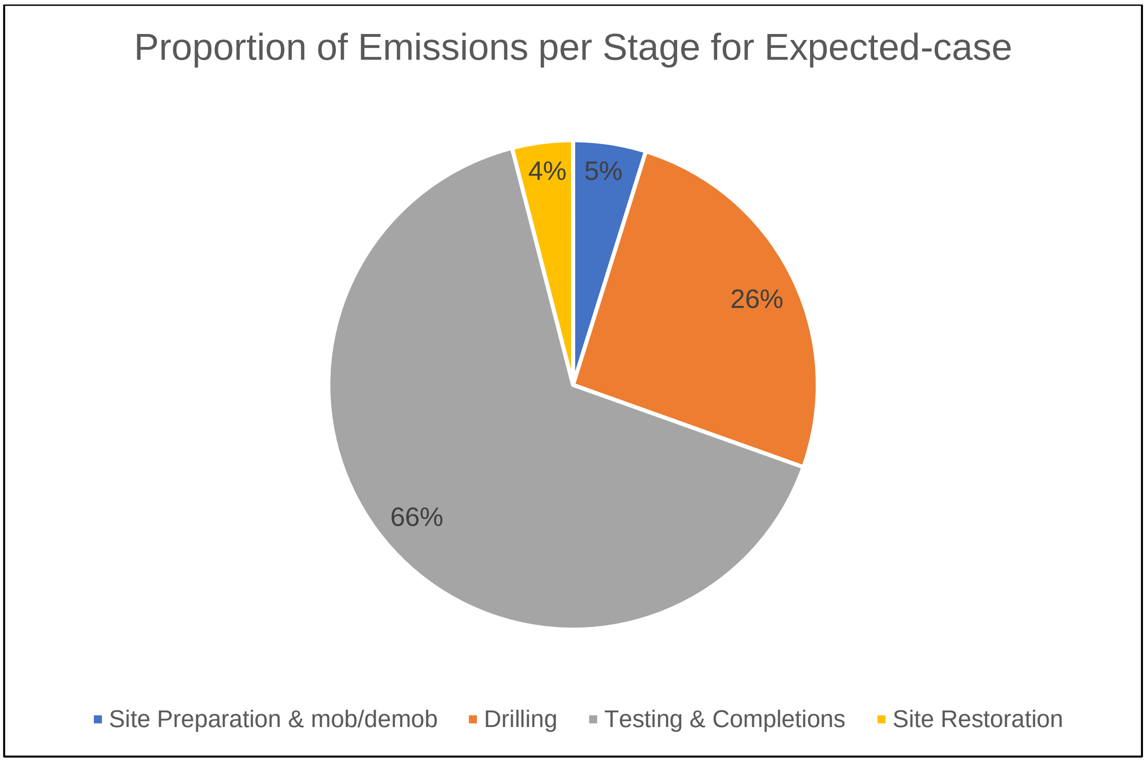

Figure 1 Breakdown of emissions by phase for the expected-case scenario.

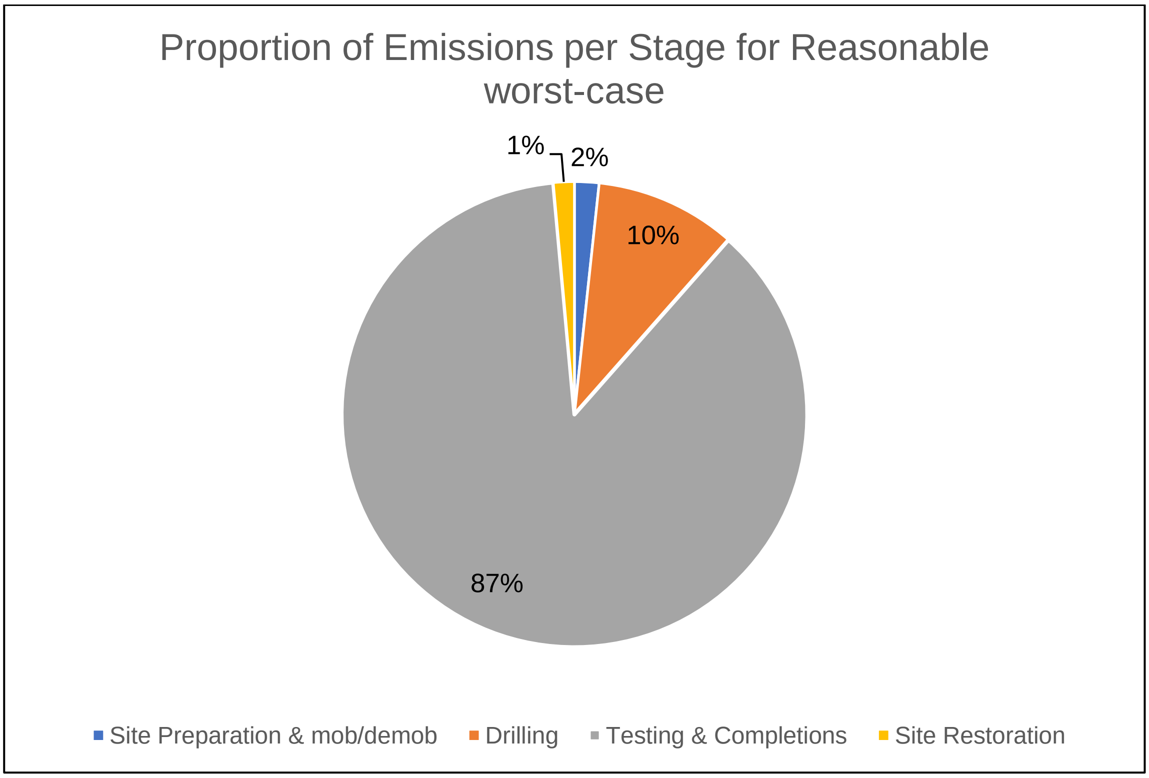

Figure 2 The breakdown of emissions by phase for the reasonable worst-case scenario.

There are only small increases in emissions for the site preparation, mobilisation and demobilisation, and site restoration phases of the operations between the expected-case and the reasonable worst-case scenario. These are primarily due to increases in personnel transport to and from the site assumed for the reasonable worst-case scenario in the event operations take longer than expected.

There is an increase in emissions between the expected-case and reasonable worst-case drilling phase and this is due to the activities running for an extra week in the reasonable worst-case phase i.e. the drilling phase is assumed to last six weeks rather than five weeks as in the expected-case.

The largest difference in emissions between the two scenarios is observed in the Testing and Completions phase. This is accounted for by several factors, including the addition of an extended well test comprising 14 additional days of discretional testing and associated flaring, and the use of a water heater in the reasonable worst-case scenario.

In the expected-case the firm volume of flared gas is used: 12.5 MMscf of gas being flared producing 1,010.2 tCO_2e. This is compared to the reasonable worst-case, assuming a firm and discretionary flared gas volume: 68.5 MMscf, producing 5,535.7 tCO_2e. In both scenarios flaring accounts for a significant part of emissions, 42% of total emissions in the expected-case and 78% of total emissions in the reasonable worst-case.

Scope 1 emissions account for 87% of the total project emissions in the reasonable worst-case scenario whereas they account for 65% of the total project emissions in the expected-case scenario. Figures 3 and 4 show the split between scope 1 and scope 3 emissions for the two scenarios. Flaring accounted for 64% of the expected-case scope 1 emissions and 90% of the reasonable worst-case scope 1 emissions.

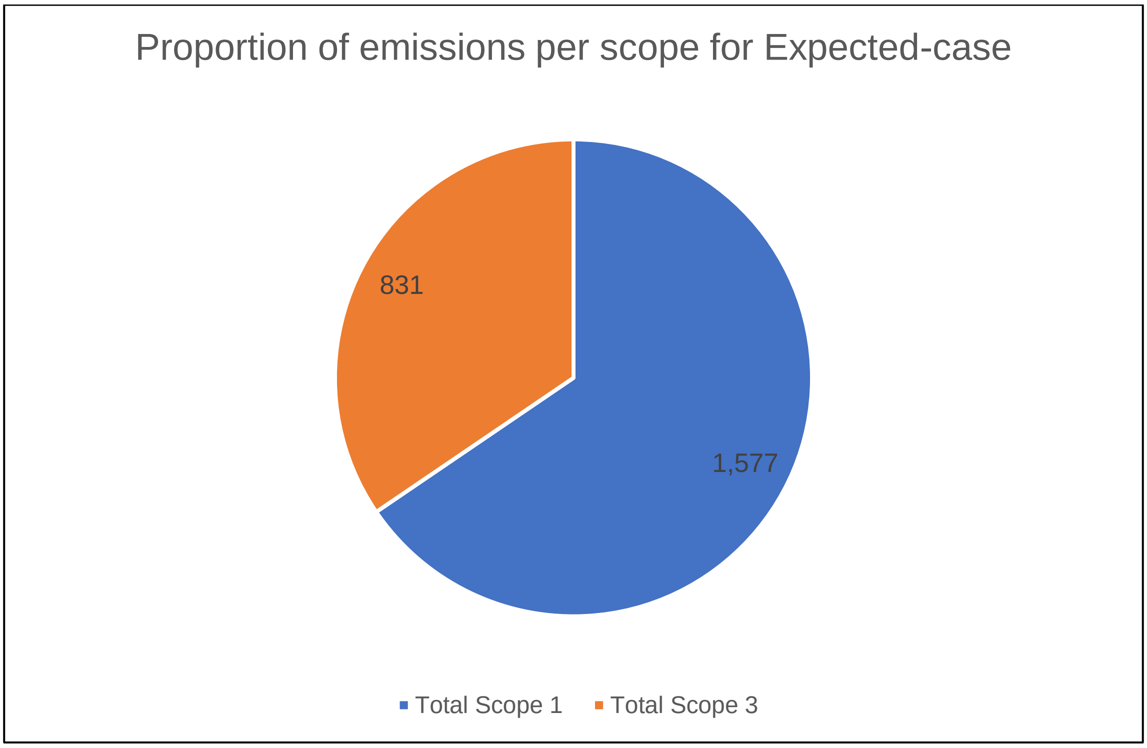

Figure 3 Breakdown of scope 1 and scope 3 emissions for the expected-case scenario

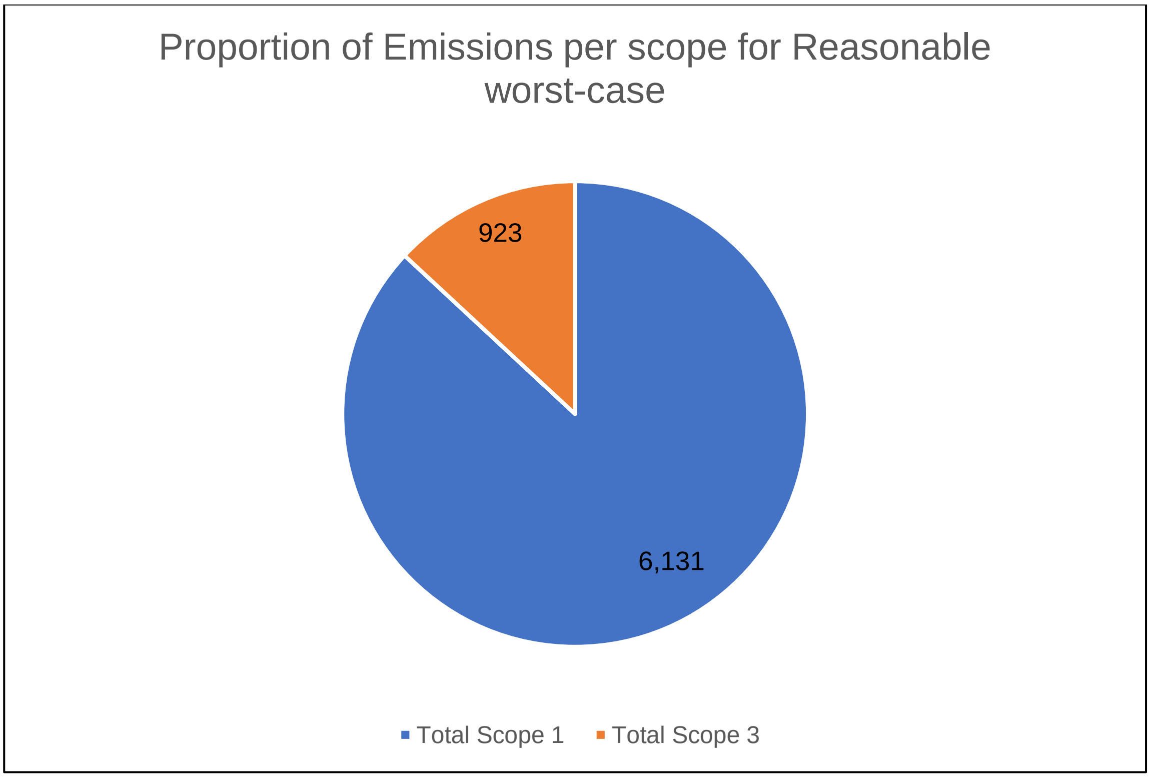

Figure 4 Breakdown of scope 1 and scope 3 emissions for the reasonable worst-case scenario

4.1 Uncertainties

The largest uncertainty for total emissions from the appraisal well operations is around the amount of flaring that may occur during the well testing and completions phase. As can be seen by the expected-case versus reasonable worst-case scenarios, the difference between the firm case and the firm + discretionary case for flare volumes has a significant impact on the total emissions for the project.

There is also uncertainty around the number of drilling days for the project, a successful well (56.8 days) will take longer to drill than a dry hole (51.1 days). The accuracy of these estimates at the current well planning stage is +/- 40%.

Uncertainties also exist around the number of truck loads, the type of trucks used, their fuel consumption and their distance travelled, as the well is still in planning and suppliers and schedules are not yet finalised. However, this is expected to have a much smaller impact on the overall emissions as changes to personnel transport had only a small impact on the overall emissions differences between the reasonable worst-case and expected-case scenarios.

5 Summary

An emissions estimate for a single appraisal well, Cloughton-2, was undertaken with two scenarios being used to assess the impact of key uncertainties in project emissions. Data provided by Europa was combined with industry guidance and proxy data to create an expected-case and reasonable worst-case scenario prediction for emissions. Assumptions have been documented and provided for both scenarios.

The expected-case project emissions are **2,408 tCO2e**.

The reasonable worst-case project emissions are **7,054 tCO2e**.

The most significant factor contributing to this difference in emissions between the scenarios is accounted for by the volume of gas flared during well testing in the success case.

The Cloughton-2 well operations are expected to be conducted during the 4th UK Carbon Budget, which includes the period 2023-2027 and a total budget of 1,950 MtCO2e (Stewart, Hinson, & Burnett, 2024). Comparison of the Cloughton-2 operations to this budget indicates the contribution of emissions to be 0.00012% in the expected-case and 0.00036% in the reasonable worst-case.

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