Tillbridge Solar

Tillbridge Solar Project

EN010142

Volume 6
Environmental Statement

Appendix 17-5: Unplanned Atmospheric Emissions from Battery Energy Storage Systems

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1. Introduction

1.1 Purpose of this Report

1.1.1 The report has been prepared by AECOM for Tillbridge Solar Ltd, a joint venture between Tribus Clean Energy Ltd and Recurrent Energy, a subsidiary of Canadian Solar (hereafter referred to as 'the Applicant'), to consider the potential consequences of unplanned emissions to air from the use of battery technology within the proposed Tillbridge Solar scheme (hereafter referred to as 'the Scheme').

1.1.2 The scope of this report includes:

a. A review of potential emissions to air from out-gassing and from fire;

b. Consideration of the potential magnitude of emissions;

c. Consideration of likely rates of dilution between potential emission locations and sensitive receptors located outside the Order limits; and

d. Consideration of the likely consequences of emissions to air from the proposed Battery Energy Storage System (BESS).

1.2 Background

1.2.1 Battery technologies are used at renewable energy generation facilities to store electrical power so it can be supplied to the National Grid when it is most needed. In the case of a solar farm, this may be during the hours of darkness, for example.

1.2.2 The BESS of the Scheme will consist of a compound and battery array with a peak output of 500MW. Details of the design for the BESS elements, including their power and energy ratings, and their final enclosure dimensions and appearance, are currently in development and, therefore, the assessment has been based on maximum parameters (which would not be exceeded) representing the reasonable worst case scenario in terms of potential impacts (as set out in **Chapter 3: Scheme Description** of this Environmental Statement (ES) **[EN010142/APP/6.1]** and the design principles that are secured by a requirement of the **draft Development Consent Order [EN010142/APP/3.1]**). At this stage it is known that:

a. Each battery enclosure will be a single storey no higher than 4 metres (m), with a maximum length and width of 12.5m and 3m respectively.

b. There will be no enclosures located within 250 of residential properties, and where practicable, none within 500 .

c. Included within the design, each enclosure will have:

    i. Internal liquid cooling system or Heating, Ventilation, and Cooling System (HVAC);

    ii. Fire suppression sprinkler system or be deigned to safely burn out;

iii. enclosures will have non-combustible walls, floor and ceiling, and will have a minimum internal fire resistance rating of 1-2 hours;

iv. A thermal barrier of 6m between containers is expected to be used, along with 1.5m aisle separation within containers[1].

[1] Best practice guidance recommends a distance between enclosures of 3 feet (0.914 m), used by the United States National Fire Protection Association (NFPA) (Ref 1).

2. Emissions from Incident Fires

2.1 Potential Sources of Emissions to Air

2.1.1 The battery technology for this Scheme has not been confirmed yet but those based on lithium-ion are currently the most widely used in BESS.

2.1.2 The National Fire Chiefs Council (NFCC) have developed guidance to help inform the Fire and Rescue Services (FRS) of design information to help assess risk and form effective emergency response plans (Ref 2). The guidance outlines the need to have effective battery management systems in place, including alerts for battery fault and combustible gas detectors. The guidance further outlines the need for means of suppression, suitable thermal barriers and emergency plans. Each of these items are referred to in the **Framework Battery Safety Management Plan** submitted alongside the DCO application **[EN010142/APP/7.13].**

2.1.3 If the battery cells become damaged by heat or are burnt within a fire affecting a single module, a rack of modules or multiple racks, then the combustible materials consumed in the fire could give rise to a range of organic and inorganic air pollutants. This situation is true of any incident fire and sets of emission factors have been collated by the Environment Agency (Ref 3) for incident fires involving automobiles, buildings, and waste materials, for example. A standardised set of emission factors for BESS is not currently available from the Environment Agency and, therefore, equivalent data must be sourced from manufacturers and the research literature.

2.1.4 In 2016, a U.S. based organisation, the Fire Protection Research Foundation (FPRF), published a report (Ref 4) on 'Hazard Assessment of Lithium-Ion Battery Energy Storage Systems' that included gas sample measurements from batteries subjected to external and internal ignition tests for BESS up to 100 kWh size. While the total BESS size at the Scheme may be greater than 100 kWh, the modular nature of BESS means that different sizes of BESS contain the same materials in proportion to the number of cells they contain and useful lessons can be learnt from studies undertaken using a BESS that is not the same size as is proposed for the Scheme. The gases were measured near the tested unit, and included methane (CH_4), chlorine (Cl_2), hydrogen fluoride (HF) and carbon monoxide (CO).

2.1.5 The observations from the FPRF tests included:

a. The 100kWh BESS unit was located outdoors for the test and with no fire suppressant system in operation, it was on fire for 3.7 hours until it had burnt out.

b. A maximum concentration of 50 parts per million (ppm) of carbon monoxide (CO) was detected in the first 30 minutes of the test and this decreased to near zero during the main period of self-sustaining combustion, which is not unexpected for a fire occurring outdoors.

c. Chlorine and methane were not detected (<1 ppm) during the test.

d. Hydrogen fluoride (HF) was detected at concentrations > 100ppm (i.e., over range for the detector used) after 30 minutes and then for the duration of the fire.

2.1.6 From the FPRF study, the emissions of potential concern are considered to be HF and CO. The conclusion that HF emissions occur is supported by the small-scale laboratory trials undertaken by Anderson et al. at the SP Technical Research Institute of Sweden (Ref 5).

2.1.7 Although Anderson et al.'s study used small 26,650 type cells, laptop battery packs (including housings) or extracts of electrolytes, rather than it being a BESS scale study, it also had access to monitoring equipment that was capable of more precise measurements over a larger concentration range. The observations from Anderson et al. included:

a. HF was always detected in combustion tests.

b. Concentrations of HF in the exhaust duct of the test apparatus were managed by the operator to enable concentrations of between 30 ppm and 50 ppm to be reported, as this aided the study of the relative comparison of hydrogen fluoride and other pollutant abundance. Consequently, the reported concentrations of HF that are presented as ppm values in this study are not representative of HF concentrations near to source, as the volume of air passing through the duct and the resulting dilution rate is unknown.

c. Cells burnt when at 100% SOC (state of charge) produced less HF than cells at 50% SOC.

d. Anderson provides an example of scaling the cell test results up to represent a plug-in hybrid vehicle (PHEV) containing 432 similar cells, that could potentially emit a total of between 400g and 1,200g of HF, if combusted. The lower value being for cells at 100% SOC.

2.1.8 Some information is publicly available on HF content of BESS rack systems from the Cleve Hill Development Consent Order application. As racks are separated by thermal barriers, there would be a delay in heat transfer between racks in the event of a fire and the first modules or racks to catch fire would likely burn out before racks further away within the enclosure would catch fire, assuming no operational fire suppressant system. It should be noted that Scheme's BESS has internal cooling, fire suppression and fire protection as part of the design. A conservative approach of assuming a maximum of five racks with a self-sustaining fire at one time was assumed by manufacturer LeClanche SA (Ref 6) with a total HF content of 2.07kg with five racks. This approach suitably represents a scenario with a fire within a single enclosure.

2.1.9 In summary, only emissions of HF are likely to occur at concentrations that may pose a hazard to health at off-site receptor locations and assessment criteria for the protection of public health are considered in **Section 2.2**. Potential emissions of CH_4, Cl_2 and CO are not considered further in this report, as they are unlikely to be emitted at measurable concentrations and therefore could not cause elevated concentrations at any receptor location.

2.2 Assessment Criteria

2.2.1 The UK Health Security Agency (UKHSA) (formerly Public Health England (PHE)) publish Incident Management guidance for specific air pollutants including HF (Ref 7). These documents summarise the physical and chemical properties of the substance and the hazard they pose to human health. Internationally recognised best practice emergency response guidelines are reported by UKHSA.

2.2.2 Emergency response planning guideline (ERPG) values, that start at ERPG-1 and increase in concentration to ERPG-3. The ERPG-1 criteria define “*the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects”*.

2.2.3 Acute exposure guideline level (AEGL) values start at AEGL-1 and increase in severity of health outcome to AEGL-3. The AEGL-1 criteria define the *“level of the chemical in air or above which the general population could experience notable discomfort”.*

2.2.4 The values adopted as being most protective of receptors (or the most conservative in terms of likely impacts on receptors) surrounding the Scheme are listed in Table 1. Concentrations of 1 ppm and 2 ppm of HF gas are equivalent to 0.82 milligrams per cubic meter (mg/m^3) and 1.64mg/m^3 respectively. The time periods used for ERPG and AEGL are based on different considerations, but for the purposes of this assessment they represent a maximum concentration value in a 10-minute period. These concentration values are also valid at an averaging time of 1 hour, which is the resolution of the meteorological data used in this assessment.

Table 1. Summary of Emergency Response Criteria

Substance	EPRG-1 Value (ppm)	Time period for EPRG	AEGL-1 (ppm)	Time Period AEGL
HF	2	10 minutes & up to 1 hour	1	10 minutes & up to 8 hours

3. Dispersion and Dilution

3.1 Introduction

3.1.1 Any gaseous pollutants emitted from a fire at a BESS would be transported from the BESS towards receptor locations by the air movements occurring at the time of the emission to air. These movements are determined by the direction of the wind and the amount of turbulent mixing of the air as it blows towards the receptor location. Differences in the temperature of the plume of air containing the emission and the surrounding air can also affect the vertical movement of the pollutants. To help understand the minimum rates of dilution likely to occur to pollutant concentrations as they disperse from the source of the emission to receptor locations, the dispersion has been modelled.

3.1.2 The calculations have made use of the dispersion model ADMS (version 6.0.0.1). As a definitive emission rate will not be known until later in the detailed design stage (once battery technology and the number of modules, racks and enclosures is fixed), the dispersion model has not been used to predict absolute impacts at specific receptor locations. Instead, a nominal unit emission rate has been used to calculate concentrations close to the source and at fixed nodes that are at 50 m increments downwind, for all wind directions in 10-degree segments. The relative concentration at the nodes is expressed as the amount of dilution compared to the near source concentration. This is then displayed as a colour scale on a polar plot overlaid onto base mapping.

3.1.3 The dispersion modelling has been undertaken using five years of hourly sequential meteorological data to represent approximately 43,800 sets of meteorological conditions that have been observed at a representative meteorological station. The values reported represent the minimum amount of dilution (maximum concentration at the receptor) predicted in any 1-hour period (100th percentile). In addition, the 99th percentile (upper 1% of cases) and 90th percentile (upper 10% of cases) values have also been calculated to provide context to the likelihood of each outcome. If the magnitude of the maximum (100th percentile) concentration was very similar to the 99th or 90th percentile value, then the likelihood of those meteorological conditions being present at the time of the fire is high. If the 100th percentile concentration value is much larger in magnitude than the 99th or 90th percentile values, then the predicted concentration would only occur under meteorological conditions that are very unusual and that may only occur for a small number of hours per year.

3.2 Emission Parameters

3.2.1 As the exact emissions from the BESS cannot be meaningfully estimated at present, the modelling is based on emissions that have been modelled as a volume source, at a nominal emission rate of 1µg/m^3/s.

3.2.2 A number of simplifications have been made to the model to ensure the assessment approach is precautionary and provides an upper estimate of likely outcomes. Near source temperatures in excess of 300 °C can be reasonably expected to be present, which would result in the plume rising rapidly, reducing near-ground concentrations. However, this model has assumed a volume source with no initial vertical momentum and the temperature has been modelled as if it was emitted at ambient air temperature. These two assumptions represent a very conservative approach in terms of dispersion modelling as they remove the vertical momentum of the emission and consequently the predicted near ground level concentrations from the model are considerably higher than would be experienced under real world conditions, as the plume has been modelled without that initial vertical momentum caused by the fire.

3.2.3 The emission parameters modelled are summarised in **Table 2**, and they are discussed in the following sections.

Table 2. Emission Parameters and General Model Conditions Included with the Model

Variable	Input
Surface Roughness at source	0.3 m
Receptors	Polar grid centred at location of source. Nodes at 50 m intervals, segments at 10 degrees intervals.
Emissions	Indicative scenario at unit emission rate
Sources	A single volume source 2 m (length) by 2 m (width)
Volume Source Vertical height	2 m, located between 1 m and 3 m above ground
Emission Temperature	Ambient (15 °C)
Exit Velocity	None
Emission Rate	1 μg/m^3/s
Source Location	Indicative location
Meteorological data	5 years of hourly sequential data from Doncaster Sheffield meteorological station (2018 – 2022)

3.3 Modelling Domain

3.3.1 The model outputs are at nodes on a polar coordinate grid extending 1.5km from the source (i.e., 1.5km radius circle) with grid nodes at 50m intervals along each of the 36 segments (one every 10 degrees).

3.4 Meteorology

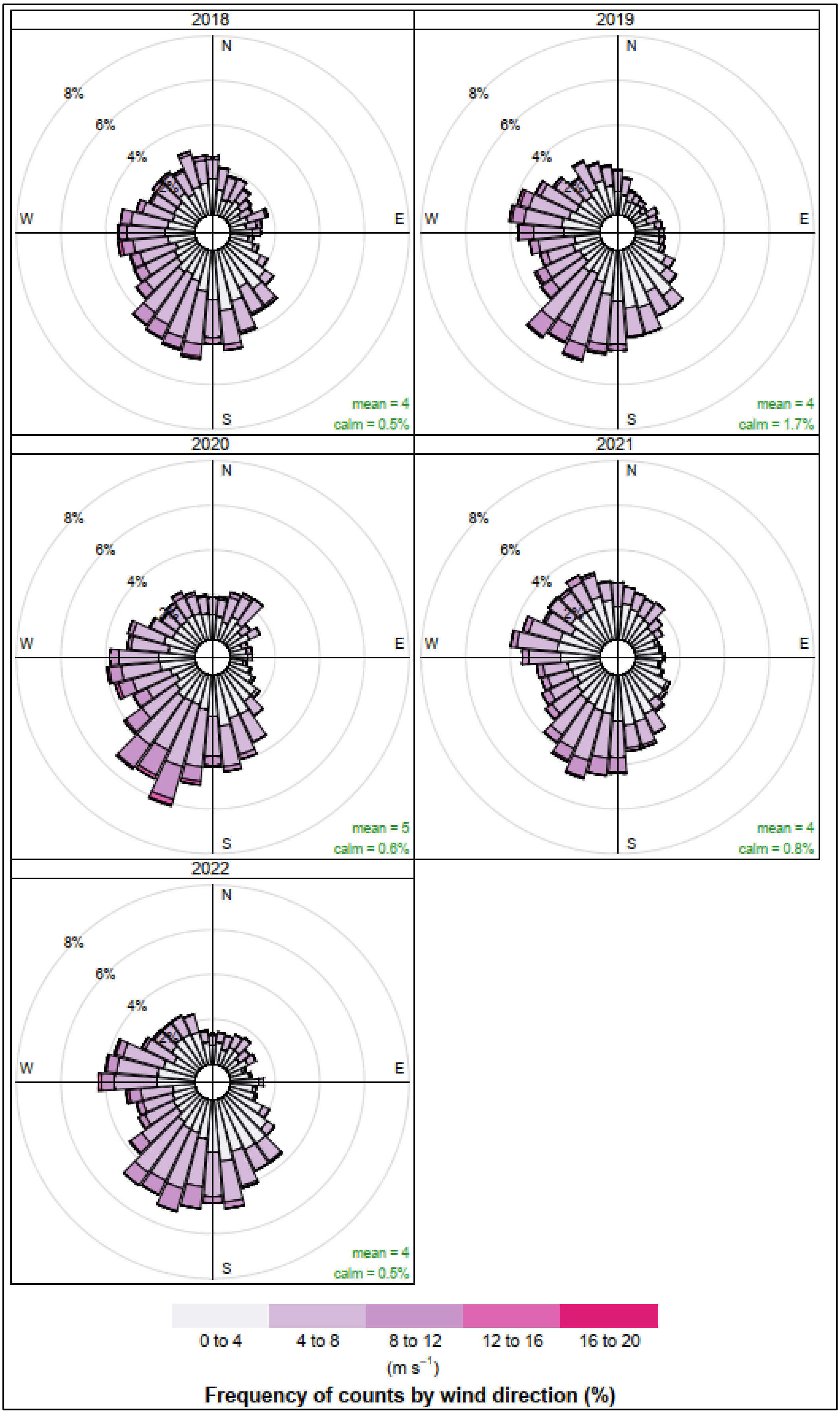
3.4.1 The dispersion of emissions from a point source is largely dependent on atmospheric stability and turbulent mixing in the atmosphere, which in turn are dependent on wind speed and direction, ambient temperature, cloud cover and the friction created by buildings and local terrain.

3.4.2 Actual observed hourly sequential meteorological data is available for input into dispersion models, and it is important to select data as representative as possible for the site that is modelled. This is usually achieved by selecting a meteorological station as close to the site as possible, although other stations may be used if the local terrain and conditions vary considerably, or if the station does not provide sufficient data. For point sources, such as stacks, the Environment Agency recommends the use of five years of the recent available meteorological data be used in modelling assessments to ensure that all typical weather conditions are considered within the modelling.

3.4.3 The meteorological site used in the modelling was Doncaster Sheffield Airport for the years 2018 - 2022. The meteorological site is located between 25 and 30km north-west of the Scheme. The meteorological conditions at the airport are considered representative of those experienced at the Scheme.

3.4.4 The wind-roses for Doncaster Sheffield Airport meteorological data are shown in **Figure 1**.

Figure 1. Wind-roses for Doncaster Sheffield Airport



3.5 Building and Terrain Effects

3.5.1 Another variable that can have a significant effect on the dispersion of emissions from sources is the presence of buildings or structures near to the emissions points. The wind field can become entrained into the wake of buildings, which causes the wind to be directed to ground level more rapidly than in the absence of a building. If an emission is entrained into this deviated wind field, this can give rise to elevated near-field ground-level concentrations. Building effects are typically considered where a structure of a height greater than 40% of the release height is situated within a distance that is less than 10 times the release height of the emissions source. Neighbouring enclosures could potentially fit these criteria. To assess dispersion of emissions in a conservative manner, the potential influence of buildings has not been considered in the assessment, along with the use of a ground level volume source with air at ambient temperature and no initial vertical momentum.

3.5.2 The ADMS model is capable of including topographical data, if required. There are two parameters (surface roughness and terrain) which can be employed in the model to describe local topography.

3.5.3 Surface roughness describes the degree of ground turbulence caused by the passage of winds across surface structures. Ground turbulence is greater in urban areas than in rural areas, for example, due to the presence of tall buildings.

3.5.4 The Scheme is situated on a plain adjacent mostly to agricultural land and surrounded by a few towns and villages. A surface roughness of 0.3m, corresponding to agricultural areas, has been selected to represent the local terrain.

3.5.5 Site-specific terrain data has not been used in the model, as typically terrain data will only have a marked effect on predicted concentrations where hills with a gradient of more than 1 in 10 are present in the vicinity of the source, which is not the case at this site.

3.6 Results of dilution modelling

3.6.1 The conventional output from a consequence model would be a plot illustrating a series of rings denoting a maximum concentration at a stated distance from the source. The output from the dilution modelling is similar, with the plots showing rings of nodes at 50m increments from the source, with the dilution factor illustrated using a colour scale. The reported dilution factors are relative to the concentration at a location 10m out from the centre of the source. **Table** 3 illustrates the smallest rate of dilution likely to be experienced under any meteorological conditions (the 100th percentile). **Table 3** also illustrates a dilution rate that would be achieved under 99% (8,672 out of 8,760 hrs per year) of meteorological conditions and a dilution rate that would be achieved under 90% (7,884 out of 8,760 hours per year) of meteorological conditions. In real world terms, these represent the lowest level of dilution and the longest distances to achieve that level for the stated percentage of the year.

3.6.2 Results indicate that source concentrations would be diluted to 1/1,000th of the source concentration (a dilution factor of 0.001) within 1,100m under any meteorological conditions (the 100th percentile) likely to occur at the application site. The same level of dilution is likely to occur under 99% of meteorological conditions within 750m to the north and north-west of the source.

3.6.3 Source concentrations would be diluted to 1/1,000th of the source concentration (a dilution factor of 0.001) under 90% of the meteorological conditions likely to occur at the application site (see Table 3), within 150 m for all wind directions excluding north of the BESS which would see the same level of dilution within 200m.

3.6.4 For any emission rate at the source, the use of the minimum (100th percentile) dilution rate gives an estimate of dilution rates that is approximately seven times more precautionary that the use of the 90% value. As such, it represents an extreme combination of meteorological conditions that are unlikely to occur should there be a fire incident.

Table 3. Dilution with distance from source

Distance from Source	Dilution factor of 0.001 for 100% of meteorological conditions	Dilution factor of 0.001 for 99% of meteorological conditions	Dilution factor of 0.001 for 90% of meteorological conditions
0° N	1,100 m	750 m	200 m
50° NE	1,050 m	550 m	150 m
90° E	1,050 m	550 m	150 m
130° SE	1,050 m	500 m	150 m
180° S	1,050 m	600 m	150 m
230° SW	1,050 m	450 m	100 m
270° W	1,100 m	500 m	100 m
310° NW	1,050 m	750 m	150 m

*based on 2021 meteorological data as highest impact in the period 2018 – 2022.

4. Likely Consequences of Battery Emissions

4.1.1 At present, the scale of the modules and numbers of racks of BESS are still to be confirmed for the Scheme. Based on information from Section 2 of this Appendix, indicative scenarios to represent the potential emissions of HF are summarised in **Table 4**.

4.1.2 The central estimate of HF content that could be emitted has been taken as 2kg which is rounded from the estimate published by LeClanche SA for the Cleve Hill Development Consent Order. A lower estimate based on 50% of the central estimate and an upper estimate of 150% of the central estimate are included in **Table 4** to reflect uncertainty about the SOC of the cells at the time of a fire incident (SOC effect observed by Anderson et al.).

4.1.3 The HF has been assumed to be released at a steady rate during a fire and a time period based on the FPRF BESS fire test of 3 hours has been adopted as the shorter time period. A longer 6-hour fire period has been adopted as a lower emission rate condition.

Table 4. Indicative Emission Rates

Scenario	HF content in 5 racks	Duration of Fire	Concentration in 2m x 2m x 2m volume at source	Dilution factor to achieve AEGL-1 value of 0.82mg/m^3	Indicative distance to achieve AEGL-1 value for 100% of met conditions (m)
Lower HF shorter fire	1 kg	3 hrs	12mg/m^3	0.068	50 - 100m
Lower HF longer fire	1 kg	6 hrs	6mg/m^3	0.136	50 - 100m
Central HF shorter fire	2 Kg	3 hrs	24mg/m^3	0.034	100 - 150m
Central HF longer fire	2 Kg	6 hrs	12mg/m^3	0.068	50 - 100m
Upper HF shorter fire	3 Kg	3 hrs	36mg/m^3	0.023	150 - 200m
Upper HF longer fire	3 Kg	6 hrs	18mg/m^3	0.046	100 - 150m

4.1.4 Assuming a BESS facility that takes the form of a 5-rack fire before fire control measures bring the fire under control, emissions of HF could cause concentrations over time periods of 10 minutes, 1 hour or up to 6 hours that are below the AEGL-1 value at locations further than 200m of the fire. Given that containers will be sited a minimum of 250m from residential receptors, concentrations will be below AEGL-1 at any existing residential receptor location.

4.1.5 Given the specification reached in detailed design will be required (by a requirement in the **draft DCO [EN010142/APP/3.1]**) to be consistent with the parameters assumed in this study (i.e., 1kg to 3kg of HF from a 5-rack fire) then the potential consequence exposure to HF at actual receptor locations surrounding the BESS would be below the AEGL-1 value.

4.1.6 The design of BESS includes a number of design elements to prevent, detect and control a fire should one occur. These include internal cooling, fire suppression and fire protection. The thermal barrier is intended to ensure that should one cell/module heat up, it will not impact on the adjacent cell/module so as to prevent a thermal cascade. The batteries will be controlled by charging management systems that will detect if a cell or battery is not operating correctly. The whole BESS would be fitted with a fire monitoring system, so if one cell or module were to catch fire, the fire suppression system will automatically be triggered to reduce the temperature and ensure that the burning cell/module does not affect the other cells/modules in the BESS.

4.1.7 Therefore, in the unlikely event that a fire was to break out in a single cell or module, it is very unlikely, given the control measures, that the fire would spread to the rest of the BESS. Even should all the systems fail, and a large-scale fire break out within enclosures, then the resultant HF concentration at the closest receptors would be below the level that UKHSA has identified as resulting in notable discomfort to members of the general population.

4.1.8 The expected HF emissions will be checked against the assumptions in this report at detailed design stage once the make, model and layout of the BESS is known, and, consequence modelling will be undertaken during detailed design to demonstrate that the impacts associated with an unplanned fire would not exceed the effects outlined in this report or cause any significance adverse health effects to the local community.

5. References

Ref 1 NFPA 855 Standard for the Installation of Stationary Energy Storage Systems, 2023, National Fire Protection Association

Ref 2 NFCC, 2023, Grid Scale Battery Energy Storage System planning – Guidance for FRS

Ref 3 Environment Agency, 2009, Review of emission factors for incident fires, Innovation for efficiency science programme, Science Report SC060037/SR3.

Ref 4 Fire Protection Research Foundation, 2016, Hazard Assessment of Lithium-Ion Battery Energy Storage Systems, Final Report.

Ref 5 Anderson et al. 2013, Investigation of Fire emissions from Li-ion batteries, Report SP 2013:15, SP Technical Research Institute of Sweden

Ref 6 LaChance SA, 2018, Cleve Hill Solar Park Air Quality Impact Assessment Li-ion Battery Fire, Appendix C.

Ref 7 Public Health England, 2021, Hydrogen Fluoride Incident Management

6. Abbreviations

Abbreviation/Term	Definition
AEGL	Acute Exposure Guideline Level
BESS	Battery Energy Storage System
CH_4	Methane
CO	Carbon monoxide
DCO	Development Consent Order
ERPG	Emergency Response Planning Guideline
FPRF	Fire Protection Research Foundation
HF	Hydrogen fluoride
KWh	Kilowatt hour
MW	Megawatt
PHE	Public Health England
PHEV	Plug in hybrid electric vehicle
ppm	parts per million
SOC	State of charge
UKHSA	United Kingdom Health Security Agency

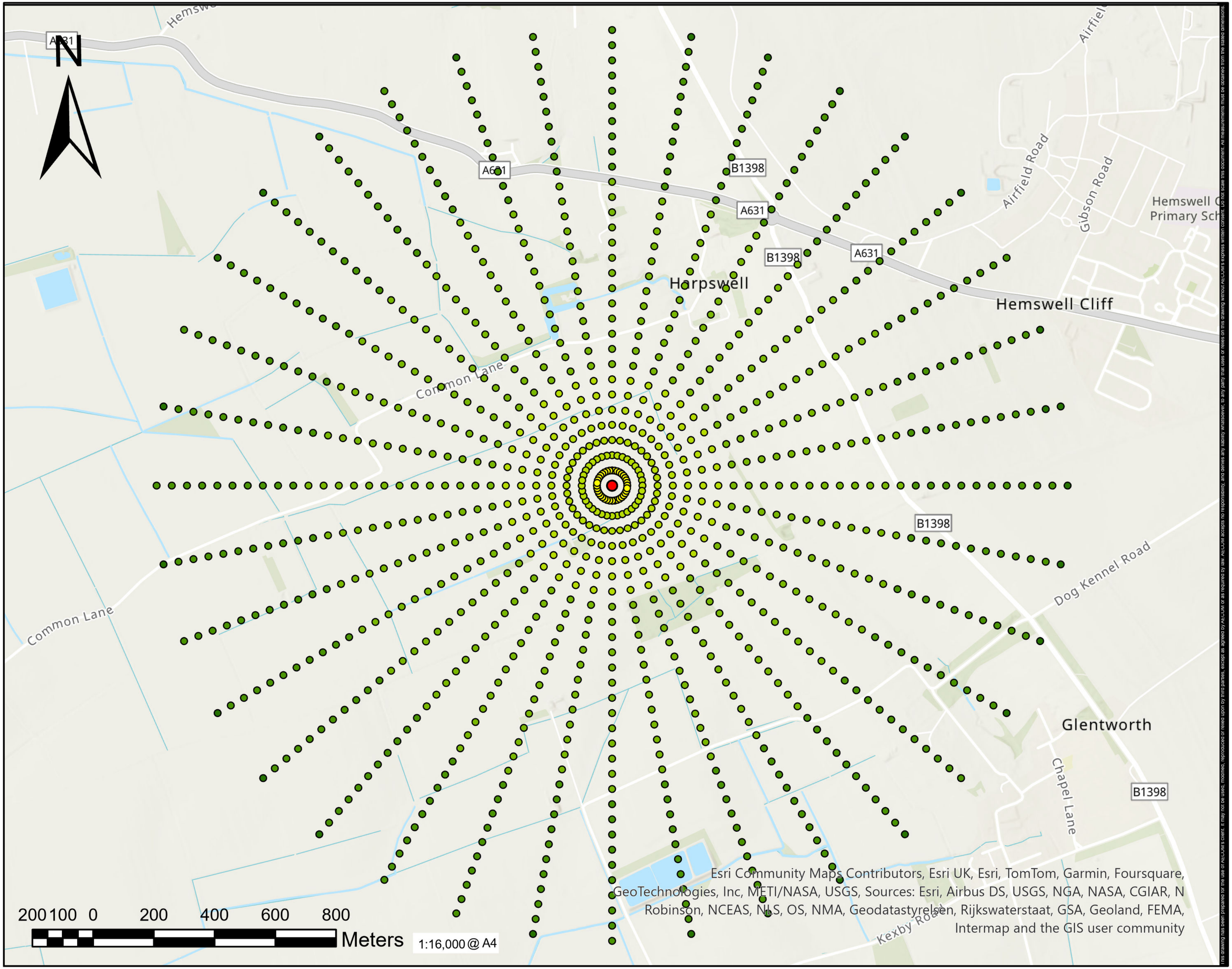
7. Glossary of Frequently Used Terms

Term	Definition
Battery	A generic term for a single cell or a group of cells connected together electrically in series, in parallel or a combination of both.
Battery Energy Storage System	Electrochemical cells (lead acid, Li-ion, solid state batteries, flow batteries, etc.) linked together with control systems and associated housings, to form a facility that can store chemical energy and deliver the stored energy in the form of electricity.
Cabinet	A form of enclosure where doors or hatches enable direct access to equipment but do not enable a person to enter the enclosure.
Cell	The basic electrochemical unit, characterised by an anode and a cathode, used to receive, store, and deliver electrical energy.
Concentration	The total mass or volume of a substance per unit volume of air. Typically expressed as milligrams per cubic metre or as parts per million (ppm).
Container	A form of enclosure where a door and internal walkway enable a person to enter the enclosure to access equipment.
Enclosure	The structure used to house racks of batteries, typically in the form of a container or a cabinet.
Energy Capacity	The amount of energy stored within the BESS, typically expressed in terms of electrical energy using units of kilowatt hour (KWh).
Emission	A substance released into the atmosphere.
Li-ion cell	A rechargeable cell that uses lithium ions as the primary component of its electrolyte.
Module	A self-contained unit made up of multiple cells, insultation, connections and a housing.
Node	A point within a dispersion model output grid, for which a predicted value is reported.
Off-gassing	Venting of electrolyte vapours from a cell.
Power Output	The aggregate net electrical energy that a BESS can provide, typically expressed in units of megawatts (MW) or gigawatts (GW)
Rack	A structure used to hold a group of modules.
Receptor	A component of the natural or man-made environment that is affected by an impact, including people.
State of charge	The ratio of present dischargeable energy storage capacity to the maximum dischargeable energy

Term	Definition
	storage capacity, typically expressed as a percentage value.
Thermal barrier	A physical measure to slow the rate at which heat transfers between two parts of a BESS, i.e., a thermal insulating material or the use of an air-filled gap
Thermal runaway	The condition when an electrochemical cell increases its temperature through self-heating in an uncontrollable fashion and progresses when the cell's heat generation is at a higher rate than it can dissipate, potentially leading to off-gassing or fire.

Figure 2. Relative Dilution from Source Based on 100th Percentile at Tillbridge Solar Project BESS

Drawn: EOC Checked: AB Approved: PF Date: 28/03/2024
Revision: 1



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LEGEND

- BESS Location

Relative Dilution Polar Plot

- ≤0.0005
- >0.0005 - ≤0.001
- >0.001 - ≤0.005
- >0.005 - ≤0.05
- >0.05 - ≤1.0

NOTES
Copyright statements presented on the map

ISSUE PURPOSE
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60682158

SHEET TITLE
Relative Dilution from Source Based on 100th %ile Value at Tillbridge Solar Project BESS

SHEET NUMBER
Figure 2

Figure 3. Relative Dilution from Source Based on 99th Percentile at Tillbridge Solar Project BESS

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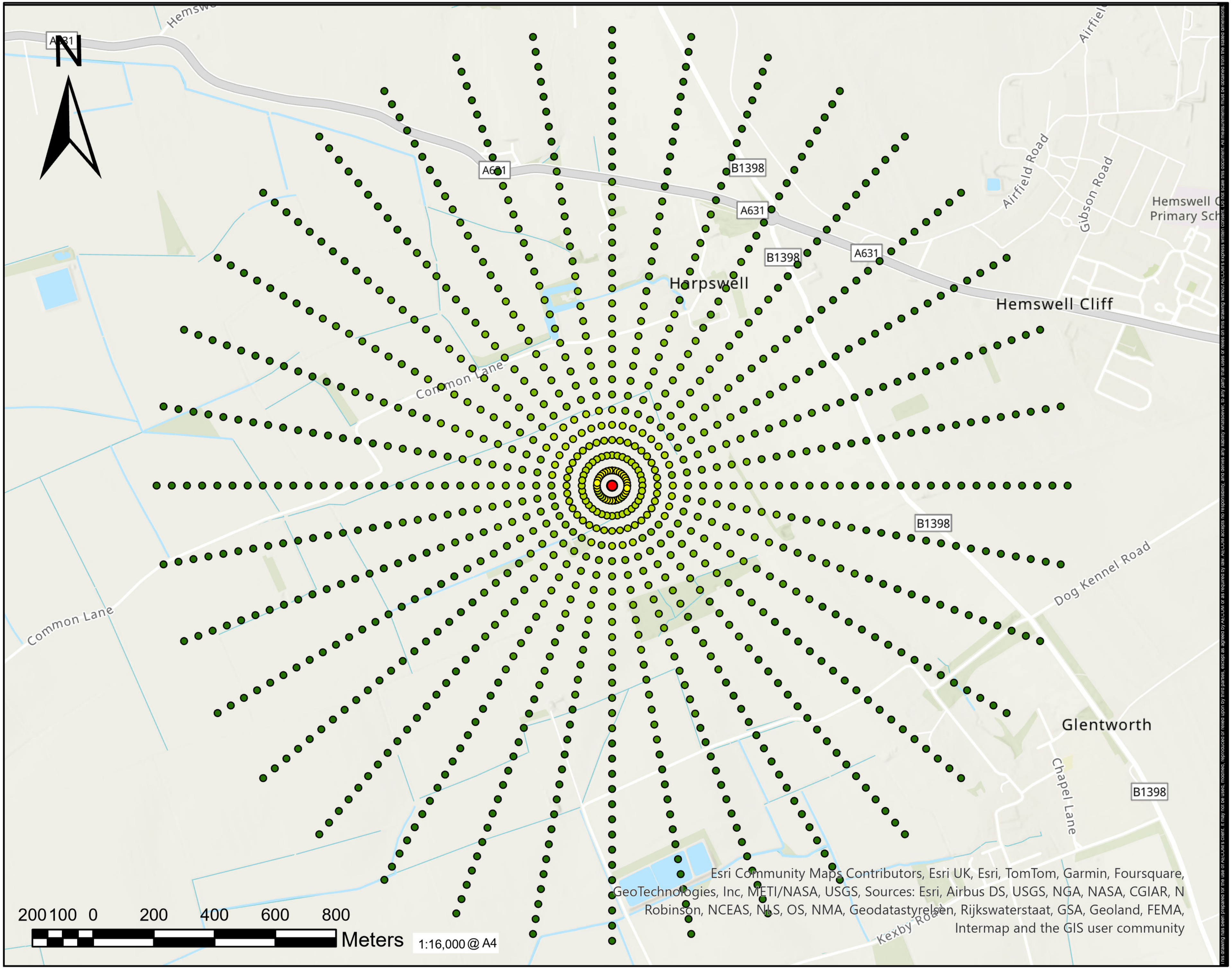

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LEGEND

- BESS Location

Relative Dilution Polar Plot

- ≤0.0005
- >0.0005 - ≤0.001
- >0.001 - ≤0.005
- >0.005 - ≤0.05
- >0.05 - ≤1.0

NOTES

Copyright statements presented on the map

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Relative Dilution from Source Based on 99th %ile Value at Tillbridge Solar Project BESS

SHEET NUMBER

Figure 3

Figure 4. Relative Dilution from Source Based on 90th Percentile at Tillbridge Solar Project BESS

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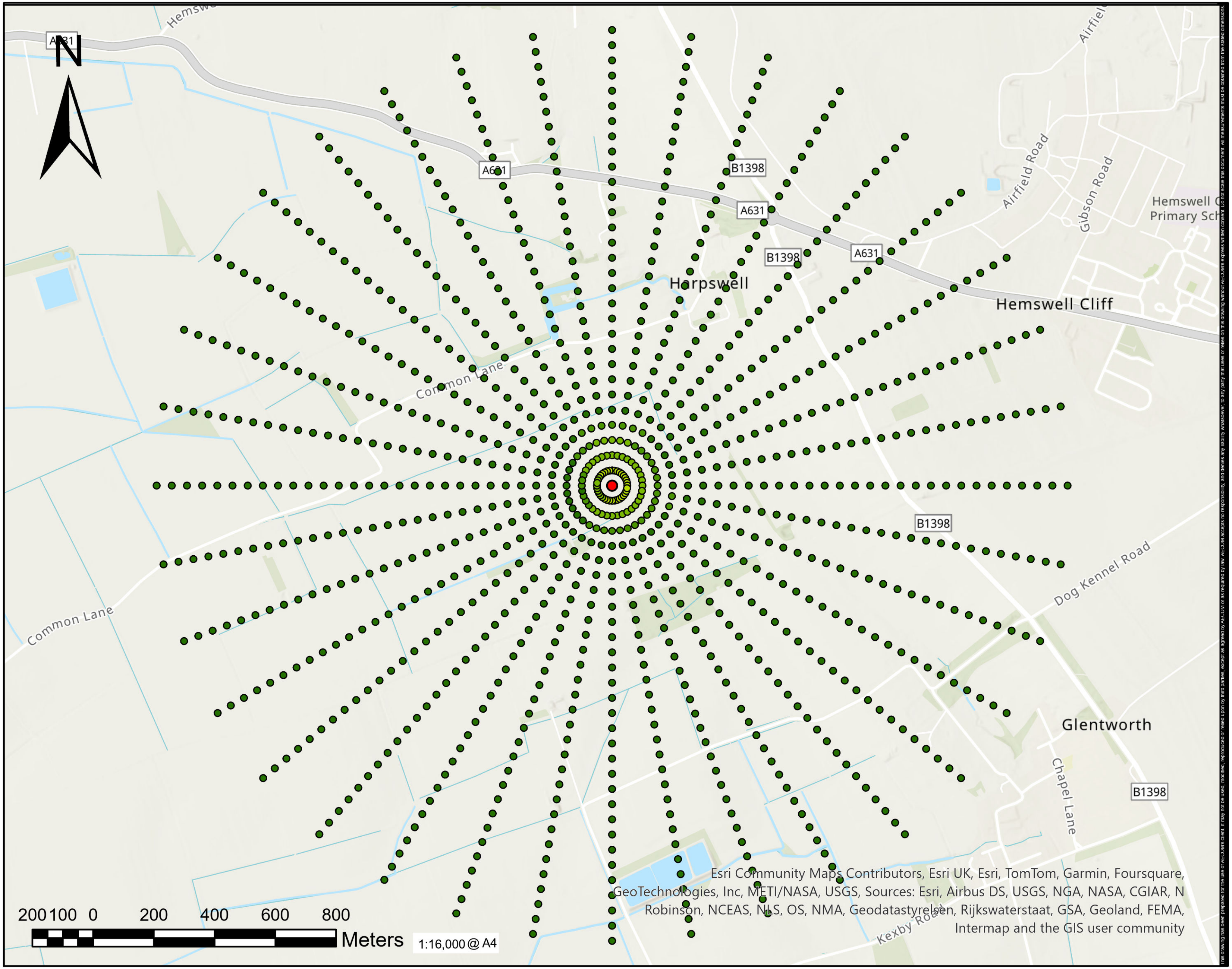

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LEGEND

- BESS Location

Relative Dilution Polar Plot

- ≤0.0005
- >0.0005 - ≤0.001
- >0.001 - ≤0.005
- >0.005 - ≤0.05
- >0.05 - ≤1.0

NOTES

Copyright statements presented on the map

ISSUE PURPOSE

FINAL

PROJECT NUMBER

60682158

SHEET TITLE

Relative Dilution from Source Based on 90th %ile Value at Tillbridge Solar Project BESS

SHEET NUMBER

Figure 4