

AQUACULTURE MODELLING SCREENING & RISK IDENTIFICATION REPORT: Site1 (EXAMPLE REPORT)

Version One: August 2019

Please note that this is an example of a Screening Modelling and Risk Identification report we intend to produce as part of the Pre-application process outlined on the SEPA Aquaculture website: (<https://www.sepa.org.uk/regulations/water/aquaculture/pre-application/>). The sites modelled within this report are fictional. Text highlighted in bold are comments on the information within the report.

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Scope of report

As part of the SEPA Aquaculture Regulatory Framework it is recommended that a proposed application for a marine fin fish aquaculture site should undergo a Screening Modelling and Risk Identification process. SEPA carries out this work and this is described on the SEPA aquaculture website Pre-application section:

(<https://www.sepa.org.uk/regulations/water/aquaculture/pre-application/>)

This report presents information arising from that process. Screening modelling methods are outlined and maps and tables describing the modelled impacts are shown. Risks arising from consideration of the model output are listed. Conclusions and recommendations are made regarding the proposed site.

Executive summary

SEPA has received a proposal for a marine fin fish aquaculture site called Site1. This is located to the south of Shuna Sound at location: 175691, 700279 (Easting, Northing). There is no existing site at this location and the proposed weight of fish to be farmed is 3500t.

Following screening modelling and risk identification we have concluded the following:

- It is possible that discharges from Site1 will be able to comply with the relevant aspects of the SEPA Aquaculture Regulatory Framework.
- Features at risk, identified at this stage, do not appear to influence the feasibility of the proposed site with respect to the regulatory framework. These risks should be examined using a detailed marine model.
- Site1 is suitable to progress to the next stage of the pre-application process outlined on the SEPA website.

The example site in the report has received a positive outcome. This may not be the case for all future site proposals.

List of abbreviations

SEPA Scottish Environment Protection Agency

List of chemical abbreviations

AZA Azamethiphos

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1 Introduction

Screening Modelling and Risk Identification are important steps in the SEPA regulatory framework for marine pen fish farms. They are carried out by SEPA at the pre-application stage, which is described in detail at:

<https://www.sepa.org.uk/regulations/water/aquaculture/pre-application/>.

This document briefly describes the objectives of screening and risk identification and summarises the methods used. Screening output for the proposed site is then presented with comments. Risks identified from the screening output are detailed. Conclusions and recommendations about the suitability of the proposed site are then made.

1.1 The objectives of screening modelling and risk identification

A summary of the modelling methods employed during screening modelling is outlined in section 1.2. The objectives of screening modelling and risk identification are outlined below.

1.1.1 Screening modelling

Marine Modelling technology can be used to simulate and predict the potential impacts from discharges to the marine environment. SEPA will require the majority of proposed farms to conduct **detailed** marine modelling, as outlined in our Aquaculture Modelling guidance [1] and on the SEPA Website.

Marine modelling can also be used at an earlier stage to provide an estimate of the influence of material discharged from a proposed site.

SEPA will carry out marine modelling at the screening and risk identification stage. This is a simplified version of the detailed modelling required of the applicant. However, it will be sufficient to perform an initial risk assessment of a proposal. Screening marine modelling will also include discharges from other relevant aquaculture sites and major sources.

The objectives of the simplified screening modelling are to:

- Produce maps of the predicted dispersive and erosive capacity of the sea areas in the vicinity of aquaculture sites
- Produce maps of the predicted spread of sediment discharged from aquaculture sites
- Produce maps of the predicted spread of bath treatment medicines from aquaculture sites
- Present an analysis of the potential sediment and bath treatment impacts of the proposed site alongside existing sites within the surrounding sea area
- Present information on the sensitive features and sites of interest within the surrounding sea area, which must be addressed during pre-application work
- Present a summary of the suitability of the proposal with respect to the dispersal of waste and how this may be modelled.

1.1.2 Risk identification

Maps and analysis of screening output will be compared to information relating to sensitive features and relevant areas of interest. These may include:

- Marine Protected Area (MPA)
- Special Area of Conservation (SAC)
- Priority Marine Feature (PMF)
- Any site identified via consideration of other permitted or regulatory activities.

SEPA Staff will meet to discuss screening model output and the relevant sensitive features information. Following this meeting, a list of identified risks will be added to this report.

1.1.3 Conclusion of screening modelling and risk identification

Following the identification of risks, SEPA will present a summary of the suitability of the proposal with respect to the:

- Dispersal of waste from the proposed site and other sources
- Risks posed to sensitive features
- Likely level of modelling that will be required to address the risks identified.

1.2 Screening modelling methods

Marine models divide the sea up into a “grid” of boxes or triangles (often called cells). Each of these is given a water depth. For the screening modelling presented in this report the SEPA “Southern Hebrides” (SH) has been used. An image of the SH model grid is shown in Figure 1. This grid has been set up within a marine modelling software package called MIKE 21 which is manufactured by the company DHI A/S (<https://www.dhigroup.com/>).

Marine models carry out calculations across a grid to work out how seawater moves and mixes in response to tidal and weather forces. Marine models can also be used to simulate how seawater moves and mixes due to salinity and temperature differences across an area, particularly in response to inputs of freshwater from rivers. For pollutant impact assessments the mixing (dispersion) of dissolved (bath medicine) and particulate (sediment) pollutants can also be estimated. Calculations within a marine model can be performed in three dimensions (3D), where the grid is split into layers to better represent how properties of the sea change with depth. Two dimensional (2D) models can also be created where processes over the water depth are simplified. The amount of mixing in a marine model can be varied using settings in the software.

Screening modelling is currently carried out with 2D models using average mixing settings in the model software. In many areas, this approach will be sufficient to make an initial estimate of the impact from a proposed site. Our screening assessment will take into account factors which may limit a 2D approach. We will also consider whether a particular location is adequately represented by the available models.

1.2.1 Water movement and mixing modelling

Water movement and mixing modelling (hydrodynamics) has been carried out to generate one month of results. The boundaries (edge(s) of) the model have been driven using the “wider domain” Scottish Shelf Model [2]. Wind forces and freshwater inputs have been applied to the model from the same source. The results generated are an estimate of the average water movement and mixing conditions within the model area.

1.2.2 Sediment waste modelling

Screening modelling provides a precautionary and **indicative** estimate of the size, location and intensity of waste organic material released from aquaculture sites.

The release of sediment from sources within the model area is simulated using one month of hydrodynamic results along with particle tracking modelling technology. Virtual particles are continually introduced to the model grid to represent the potential dispersion of sediment from the sources. Particles in the model are moved and mixed by the hydrodynamics. Additionally, particles are assigned simplified properties, which allow them to settle through the water and be re-suspended (eroded and lifted) from the sea bed.

1.2.3 Bath medicine modelling

Screening modelling provides a precautionary and **indicative** estimate of the size, location and concentration of bath medicine releases.

The release of bath treatment medicine from sources within the model area is simulated using hydrodynamic results along with particle tracking modelling technology. Virtual particles are introduced to the model grid to represent the potential dispersion of bath medicines from the sources. Particles in the model are moved and mixed by the hydrodynamics. Releases of bath medicines are simulated under worst case mixing (dispersion) conditions, which occur under neap tides. The maximum treatment amount likely to be used at each site is released into the model at the same time and plumes are tracked over the following 96 hours (4 days). Treatment amounts used at screening have been derived from an analysis of historical data. Additionally, all bath medicine particles are concentrated within the top 5 m of the sea area. As all bath medicines are likely to disperse in a similar way, only Azamethiphos (AZA) has been modelled at the screening stage.

1.2.4 Nutrient assessment

Whilst nutrients are not directly modelled during screening, the dispersion of bath medicine releases will give an indication of the likely level of nutrient dispersion. This will be considered alongside any pre-existing nutrient assessment information that may be available.

1.2.5 Analysis of modelling output

SEPA processes the screening modelling output and places it into a standard analysis application built in [TIBCO Spotfire](#). The application allows for the production of standard maps and tables, which are presented below.

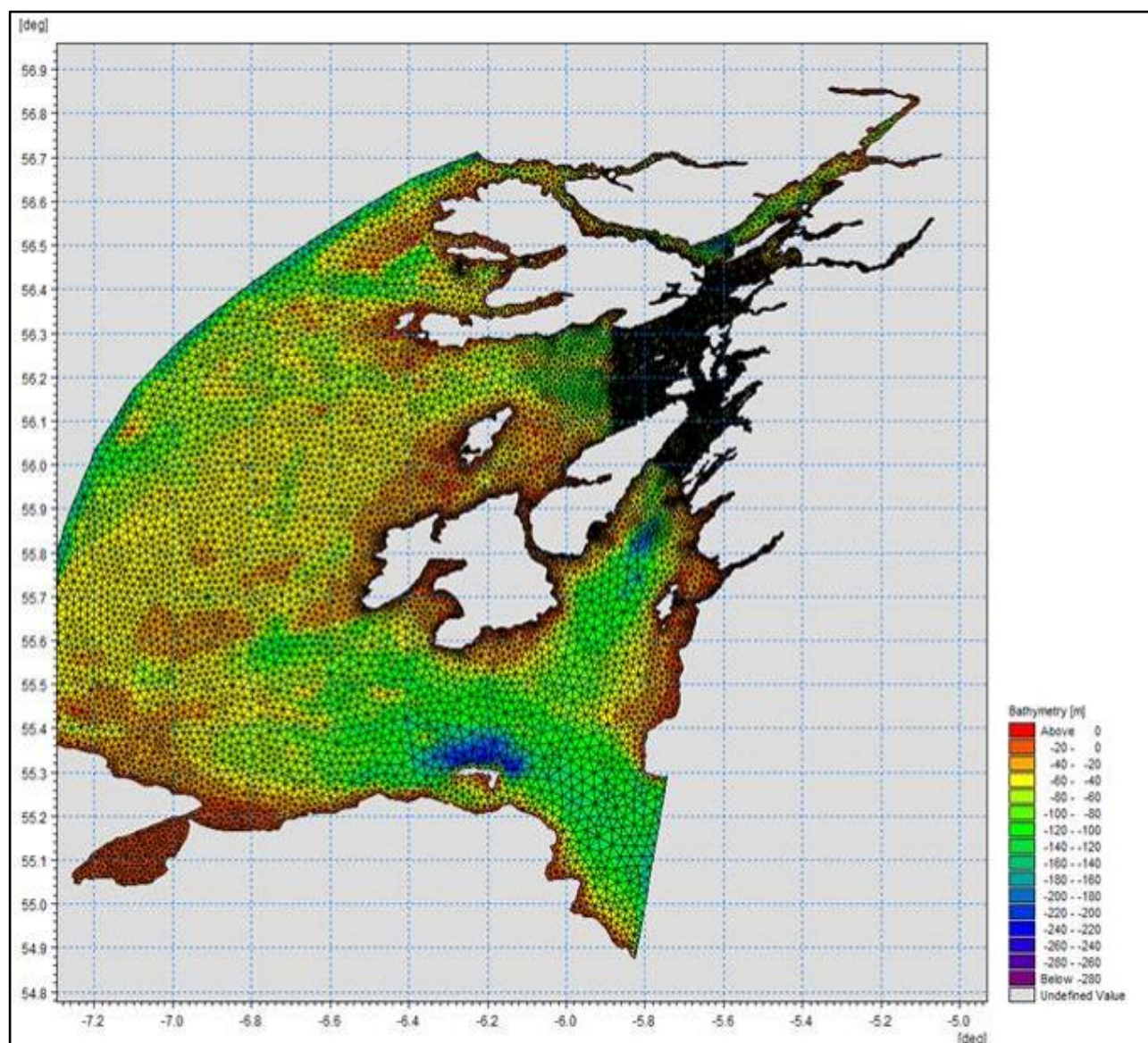


Figure 1: Southern Hebrides model grid.

2 Screening modelling (example using a fictional site proposal)

Please note that all maps are collated at the end of this section.

2.1 Site proposal

Screening modelling has been carried out a proposed new farm: Site1. The proposal is to site the farm at location: 175691, 700279 (Easting, Northing). The proposed weight of the fish to be farmed at this location is 3500 tonnes. For the screening modelling presented here all relevant licenced sites have been modelled in conjunction with the proposed new site.

2.1.1 Accuracy of model in the area surrounding the proposed site

The Southern Hebrides model used for screening modelling has been compared against various sources of observed current meter data. This comparison indicates that the model provides a good description of the physical processes in the vicinity of the proposed site.

If the model used at screening does not perform well in the area around the proposed site we will adjust our recommendations to reflect any uncertainty.

2.2 Dispersion and erosion capacity maps

Modelled water movement in a sea area can be analysed and presented to show the capacity of the water to move and disperse discharged substances. It is also possible to show the capacity available to erode substances from the seabed. This information is a useful guide to the potential size of a marine fin fish aquaculture farm at a particular location.

Marine fin fish aquaculture farms using open-net pens will benefit from operating in locations where there are strong, repeating, water currents to erode and disperse waste.

For the purposes of screening we consider locations which meet the following water flow criteria to be generally suitable for larger farms:

Locations with average water flow speeds of greater than, or equal to, 0.12 metres per second (0.23 knots)

Locations where water flow speeds are often above the threshold of 0.095 meters per second (0.18 knots).

Locations with these properties are likely to disperse discharged material rapidly, and regularly erode sediment discharged to the seabed. In general, we would look for these properties to be maintained over a large area around a proposed site.

The thresholds stated above are indicative.

A map of modelled average water flow speed for the area surrounding the proposed site is shown in Figure 2. The average water flow speed in each cell of the model grid (see section 1.2) has been assigned a shade. The key for the shading is shown in the top left of the figure. Grid cells that have average speeds less than 0.12 m/s (metres per second) are marked on the figure. The greater the shading, the slower the average current speed and the lower the capacity for dispersion.

Figure 3 is a map of the percentage of time the modelled water flow speed in a grid cell is above 0.095 m/s (metres per second). The greater the shading, the lower the capacity for material to be eroded from the seabed.

Licensed aquaculture farms in the vicinity of the proposed site are also marked on Figure 2 and Figure 3. Discharges of material from these sites have been included in the screening modelling.

Based on the maps of the modelled water flow properties we can make the following observations about the proposed site location:

- It lies in a high dispersion area. Dispersion is higher to the south and lower to the north and east.
- It lies in an area where water flow has a high capacity to erode material on the seabed.

2.3 Sediment impact maps and analysis

Modelled particles in a sea area can be analysed for each modelled grid cell and presented to show the potential impact of discharged sediment on the surrounding sea area.

2.3.1 Sediment impact maps

Figure 4 shows a map of the modelled average sediment intensity over one month (time average) for the proposed site only. Grid cells within the model which experience a sediment impact are shaded according to the intensity of impact in grams per square metre (g/m²).

Values less than 1 g/m² have been excluded from the map and subsequent calculations. These low concentration cells are produced by the particle tracking approach but they are not considered to be representative of the main impact from a discharge.

The shading key is shown in the top left of the figure. Cells which are shaded black are similar to the average intensity in the total impacted area shown in the map. Cells shaded pink are similar to the median (middle value in the range) intensity value shown on the map. White shaded cells are similar to the minimum intensity value shown on the map.

- The average and median sediment intensity over the impacted cells is 1.74 g/m² and 1.41 g/m² respectively.
- Impacted cells from the proposed site do not appear to lie close to existing farm sites.

Figure 5 shows a map of the modelled average sediment intensity over one month for the proposed site and other relevant sites. Grid cells within the model which experience a sediment impact are shaded according to the intensity of impact in grams per square metre (g/m^2). The shading key is shown in the top left of the figure and is in a similar format as that shown in Figure 4. The average sediment impact, after including all relevant sites, is increased.

- The average and median sediment intensities over impacted cells are 34.62 g/m^2 and 3.24 g/m^2 respectively.
- Impacted cells arising from existing sites do not appear to lie close to the proposed site.

2.3.2 Sediment impact analysis

Model grid cells can be analysed to estimate the size and concentration of the potential sediment impacts from the modelled sites.

- The total area of sediment impact from the six sites modelled is estimated to be 3.41 km^2 .
- As shown in Figure 5, the average and median impacts over this area are 34.62 and 3.24 g/m^2 respectively.
- The total weight of fish that generates this modelled impact is 21000 tonnes.

Table 1 shows the information for each individual site modelled. It is important to note that the total impact for all sites is not the sum of the numbers in Table 1. The total impact worked out above takes into account that impacted areas from different sites will overlap.

Table 1: Sediment impact information for each site.

Site Name	Average Impact (g/m^2)	Impact Area (km^2)	Median Impact (g/m^2)	Max weight Of Fish (tonnes)
Site1	1.74	0.39	1.41	3500
Site2	9.58	1.11	3.16	3500
Site3	50.03	0.67	4.82	3500
Site4	17.50	1.46	2.51	3500
Site5	2751.51	0.02	555.68	3500
Site6	1.78	0.53	1.65	3500

2.4 Bath medicine impact maps and analysis

Modelled particles in a sea area can be analysed for each modelled grid cell and presented to show the potential impact of discharged bath medicine on the surrounding sea area. Results presented are for the AZA medicine (see section 1.2.3).

2.4.1 Bath medicine impact maps

Figure 6 shows a map of the modelled average AZA concentration over four days for the proposed site only. Grid cells within the model which experience an AZA impact are shaded according to the concentration of AZA in nanograms per litre (ng/l).

Values less than 10 ng/l have been excluded from the map and subsequent calculations. These low concentration cells are produced by the particle tracking approach but they are not considered to be representative of the main impact from a discharge.

The shading key is shown in the top left of the figure. Cells which are shaded black are similar to the average concentration in the total impacted area shown in the map. Cells shaded pink are similar to the median (middle value in the range) concentration shown on the map. White shaded cells are similar to the minimum concentration value shown on the map.

- The average and median concentrations over the impacted cells are 20.51 ng/l and 17.82 ng/l respectively.
- Impacted cells from the proposed site do not appear to lie close to most existing farm sites, although some interaction with releases from Site 6 may occur.

Figure 7 shows a map of the modelled average AZA impact over four days for the proposed site and other relevant sites. The average AZA impact, after including all relevant sites, is increased.

- The average and median AZA concentrations over impacted cells are 68.21 ng/l and 46.00 ng/l respectively.
- Most impacted cells arising from existing sites do not appear to lie close to the proposed site.

2.4.2 Bath medicine analysis

Model grid cells can be analysed to estimate the size and concentration of the potential AZA impacts from the modelled sites.

- The total area of AZA impact from all sites modelled is estimated to be 42.25 square kilometres (km²).
- As shown in Figure 5, the average and median concentrations over this area are 68.21 and 46.00 ng/l respectively.
- The total weight of fish that generates this modelled impact is 21000 tonnes.

Table 2 shows the information for each individual site modelled. It is important to note that the total impact for all sites quoted above is not the sum of the numbers in Table 2. The total impact worked out above takes into account that impacted areas from different sites will overlap.

Table 2: Azamethiphos impact information for each site.

Site Name	Average Impact (ng/l)	Impact Area (km ²)	Median Impact (ng/l)	Weight Of Fish (tonnes)
Site1	20.51	9.03	17.82	3500
Site2	110.13	5.42	43.19	3500
Site3	83.68	7.57	51.77	3500
Site4	64.74	9.23	35.98	3500
Site5	93.67	6.50	59.88	3500
Site6	20.24	12.87	17.89	3500

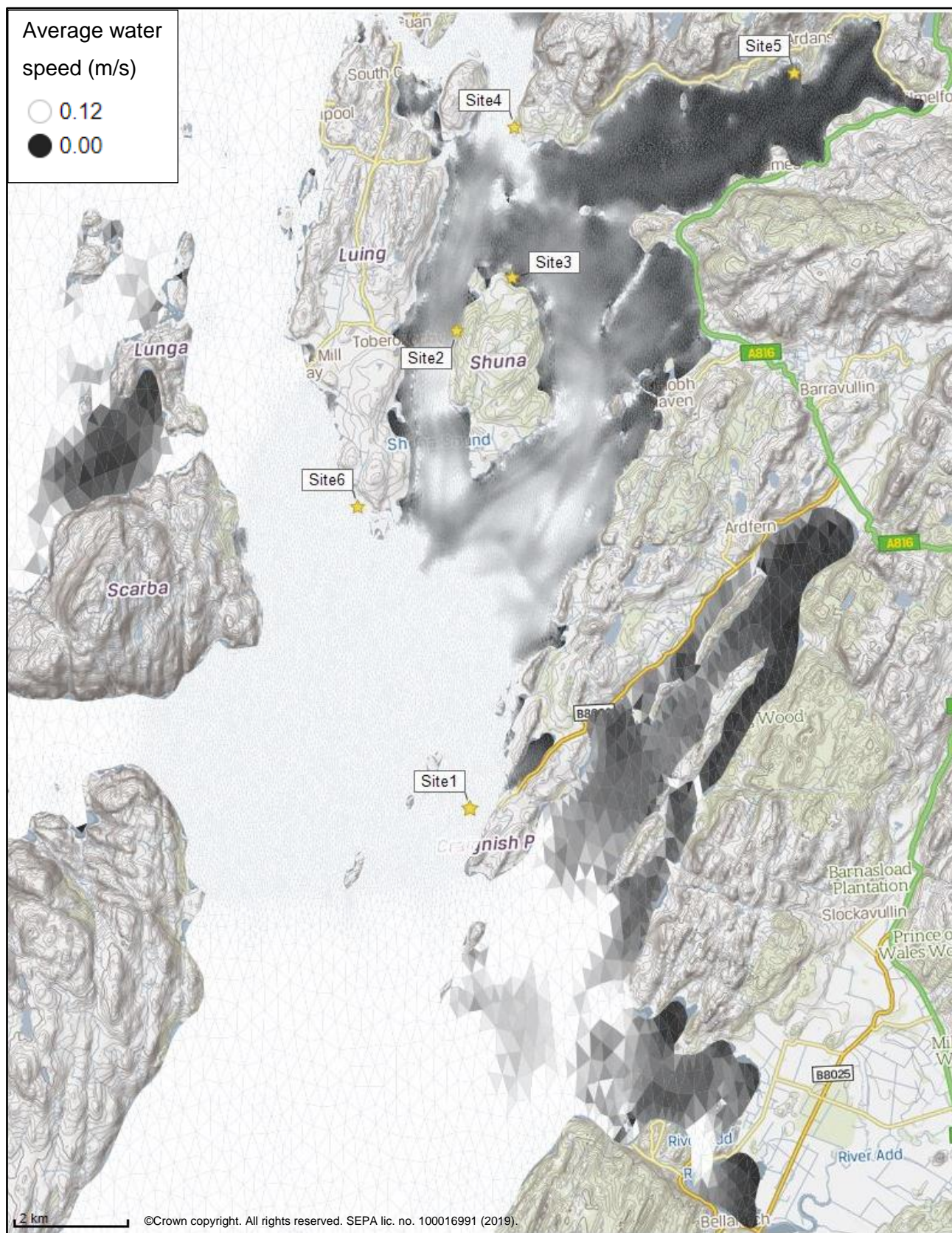


Figure 2: Modelled average water speed (metres per second – m/s) in the sea area surrounding the proposed site (Site1).

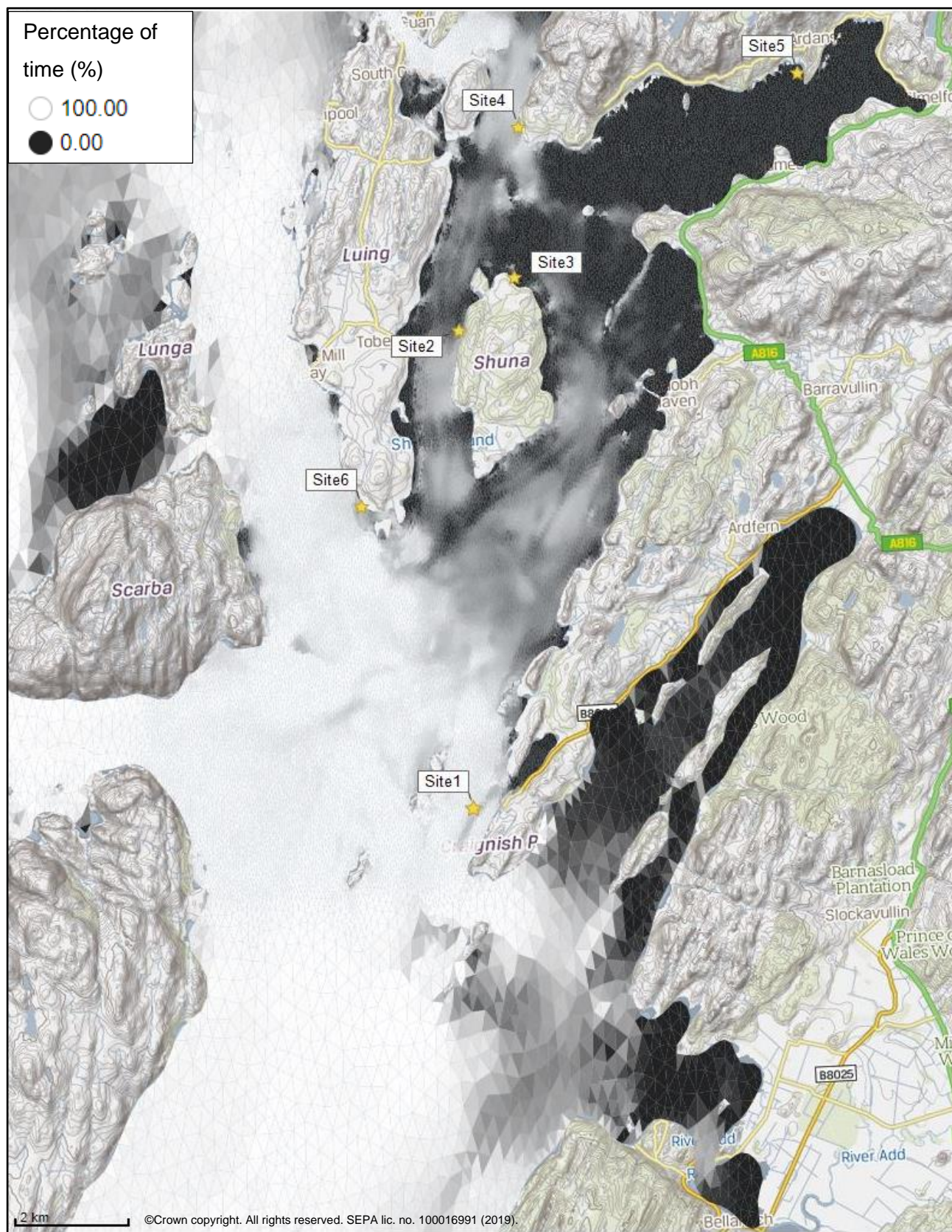


Figure 3: Modelled percentage of time the water flow speed is above 0.095 m/s in the sea area surrounding the proposed site (Site1).

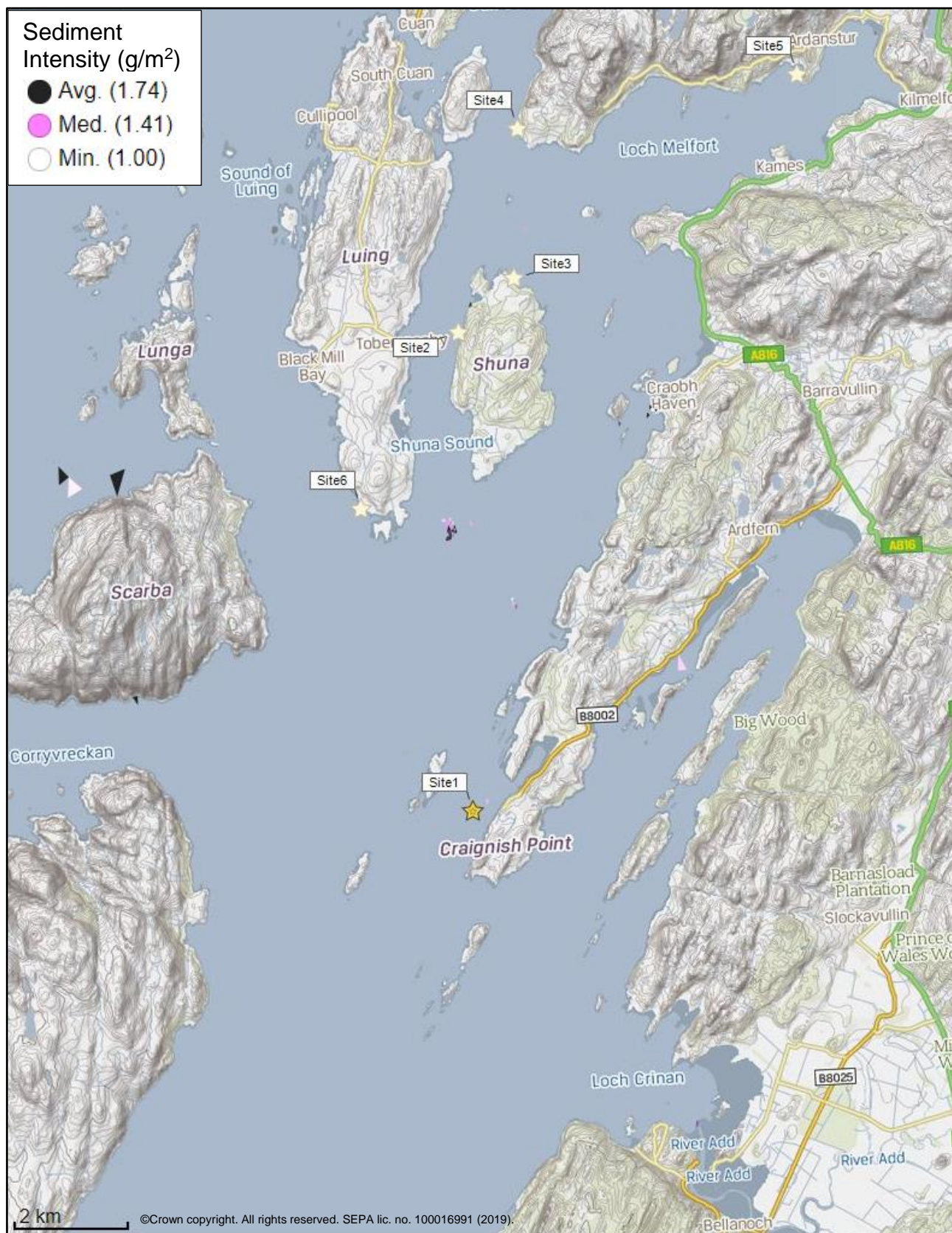


Figure 4: Modelled average sediment intensity over one month for the proposed site only (Site 1).

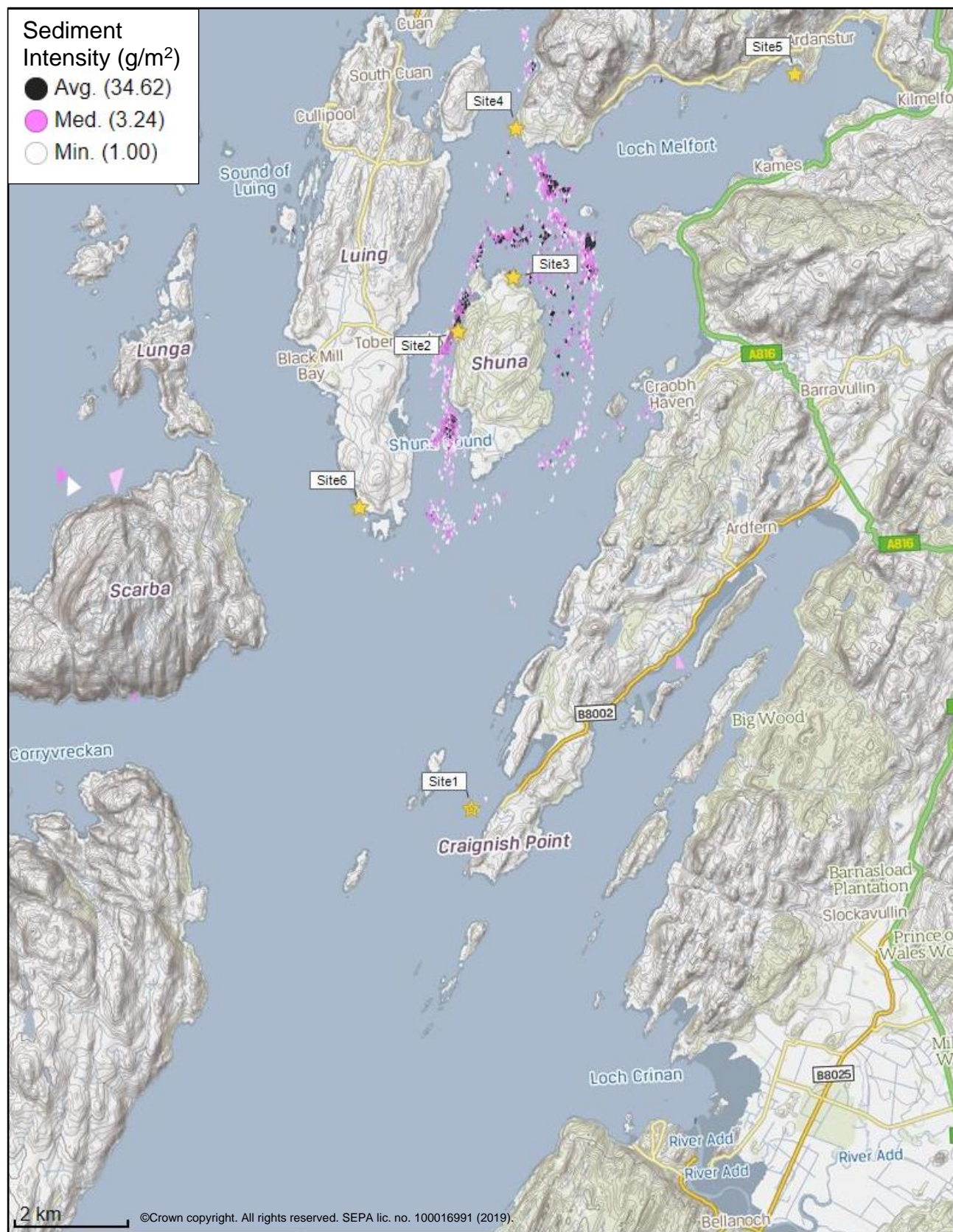


Figure 5: Modelled average sediment intensity over one month for the proposed site (Site1) and other relevant sites.

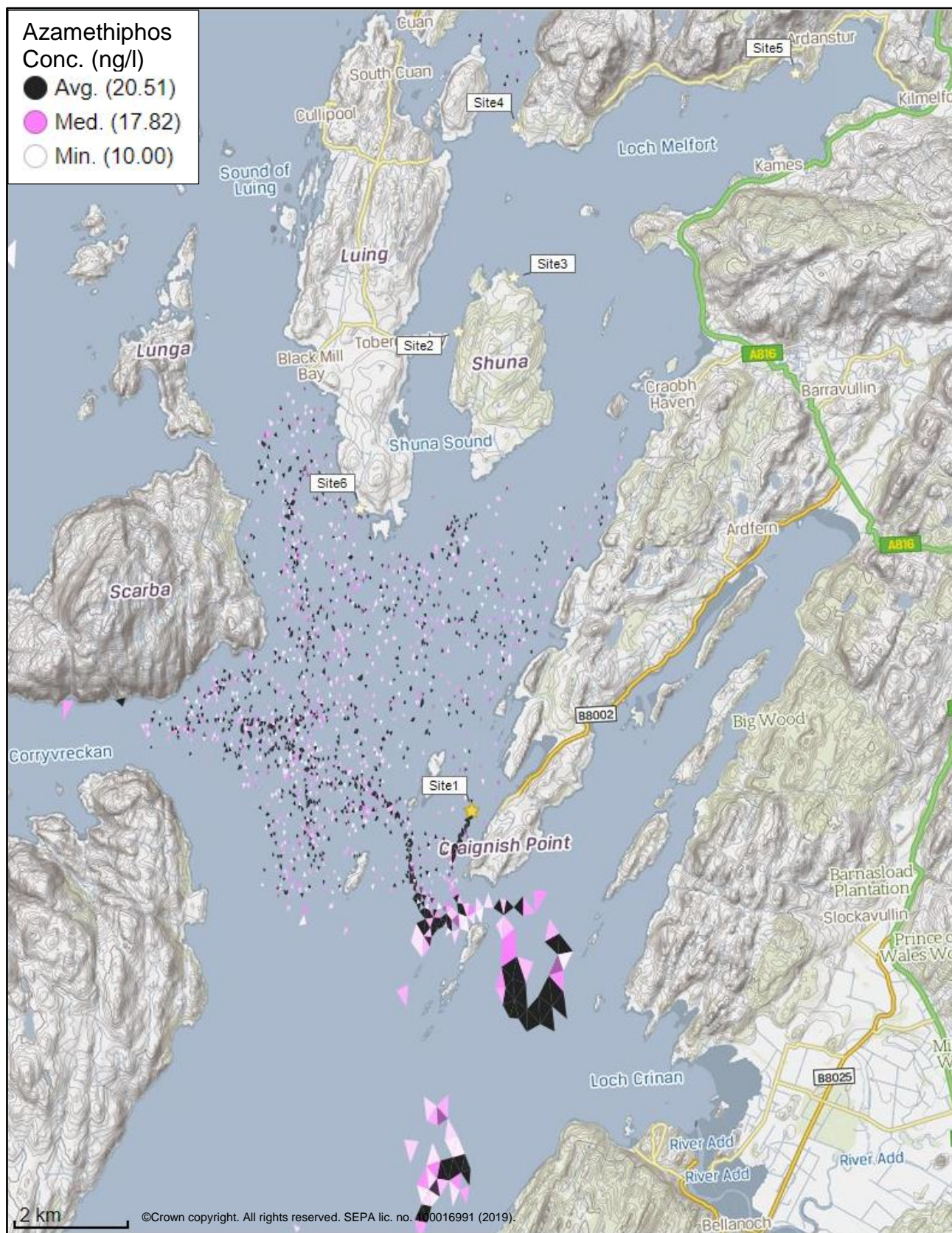


Figure 6: Modelled average Azamethiphos concentration over four days from neap tide release for the proposed site only (Site1).

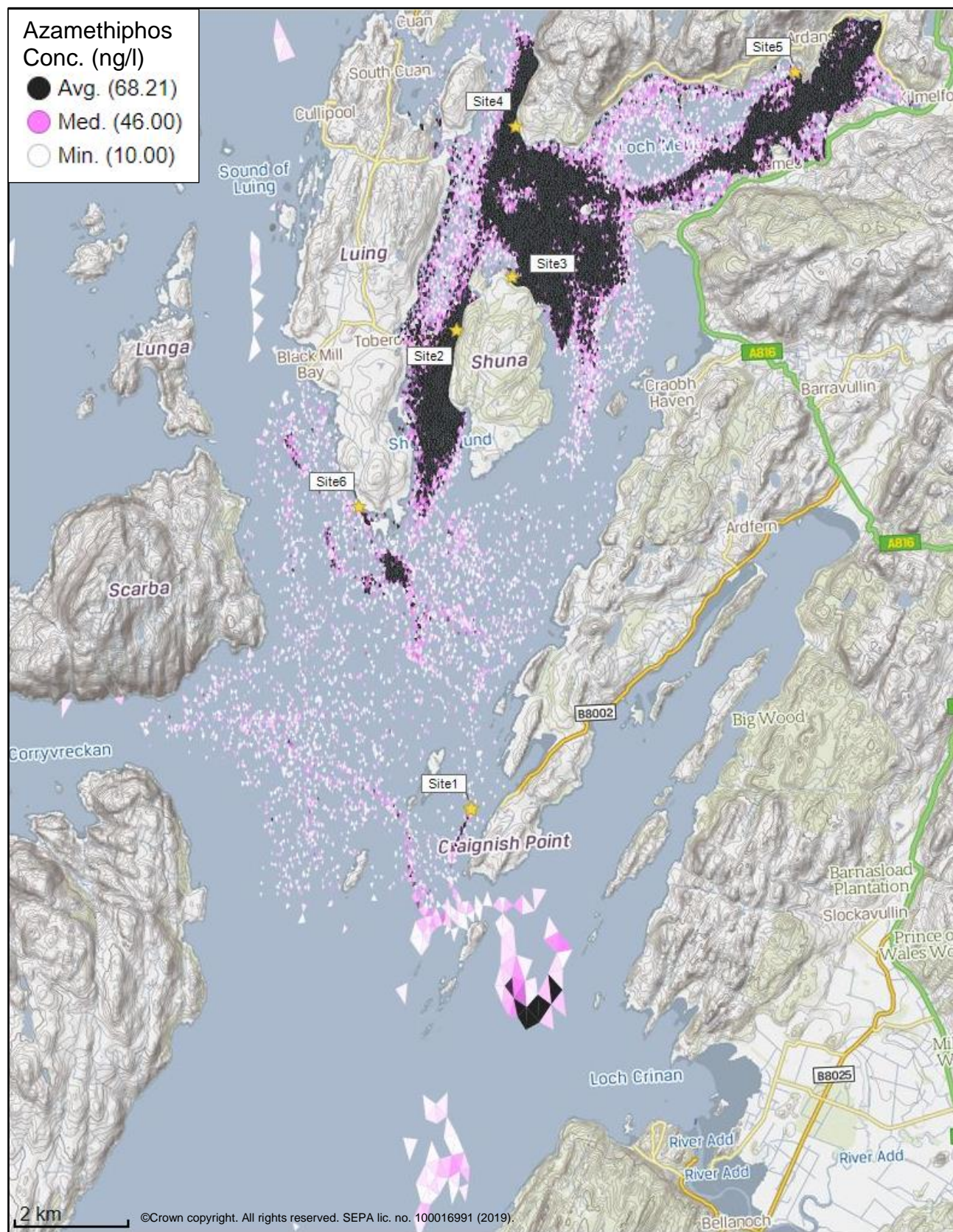


Figure 7: Modelled average Azamethiphos concentration over four days from neap tide release for the proposed site (Site1) and other relevant sites.

3 Risk identification

The screening modelling output summarised in section 2 is compared against available information on features of interest (see section 1.1.2). Features which require attention are presented with any additional comments. Identified features will need to be considered during the pre-application phase.

These should be addressed in the applicant "Method Statement". Please refer to the Modelling Method Statement section on the SEPA Website.

(<https://www.sepa.org.uk/regulations/water/aquaculture/pre-application/>)

3.1 Identified features which require attention

As this is a sample screening report no real features have been identified. However, the format in which they will be presented is shown.

3.1.1 Table of identified features

Based on screening output the following features of interest have been identified (**For example purposes only**).

Table 3: Table of identified features

No.	Feature Name	Feature Type	Location (Easting, Northing)	Brief Reason For Identification
1	Marine Feature One	MPA	(172877, 702836)	At risk from sediment impact.
2	Marine Feature Two	PMF: Species Name	(174557, 700252)	At risk from bath medicine impact.
3	Marine Feature Three	SAC	(178531, 707216)	At risk from sediment and bath medicine impact.

If an area of seabed is identified, we may include a map with a list of locations which define a shape.

3.2 Additional comments on identified features

In this section we may provide further detail on the reasons why a feature has been identified. We may also clarify the information required from the applicant to address the identified risk.

3.2.1 Additional comments on feature number 1

Additional text will be provided.

4 Conclusion of screening modelling and risk identification

Following screening modelling and risk identification we make a number of conclusions and recommendations.

4.1 Conclusions

4.1.1 Screening Modelling

- The proposed site (Site 1) is in an area of high dispersion and has a high capacity for erosion of material on the sea bed.
- From sediment and bath treatment modelling:
 - Information presented in section 2 indicates that the relative impact of Site 1 is likely to be lower than other sites for a similar tonnage.
 - Impacts on the surrounding sea area from Site 1 are likely to be low.
 - Impacts from Sites 1 and 6 may interact slightly. Impacts from other sites modelled do not appear to strongly interact with those from Site 1.
 - It is likely that discharges of bath medicines from Site 1 will be dispersed to low levels over a relatively large area.
 - Site 1 is likely to result in a small increase in the total impact from all sites modelled. This is mostly separate from impacts generated by existing sites.
- Due to the high dispersion nature of the waters surrounding the site, nutrient discharges from Site 1 are unlikely to create a significant environmental impact.

4.1.2 Risk Identification

Although impacts from Site 1 appear to be low, several features of interest have been identified, which require further attention during pre-application work. These are outlined in section 3. These have been identified due to a possible medium risk of impact. Further detailed modelling will need to demonstrate that these are at a low risk of impact.

4.2 Recommendations

4.2.1 Site suitability

Consideration of screening modelling and risk identification suggests that it is possible that discharges from the proposed site will be able to comply with the relevant aspects of the SEPA Aquaculture Regulatory Framework. This must be demonstrated with a detailed marine model.

It is also possible that the site will be able to comply with our mixing zone regulatory framework. This will need to be demonstrated using the NewDepomod model.

Features at risk, identified at this stage, do not appear to influence the feasibility of the proposed site, with respect to the regulatory framework. These risks should be examined using a detailed marine model.

Following the engagement meeting(s), this report will be revised and this should allow to the applicant to submit a method statement which address the issues raised in this document.

4.2.2 Further modelling

- Due to the large scale of the discharges and the identified risks, 2D marine modelling should be carried out.
- The size of the marine model should be slightly larger than the area illustrated the sediment and bath impact maps.
- The resolution of the marine model should be relatively fine around the proposed site and identified features at risk.

The example site in the report has received a positive outcome. This may not be the case for all future site proposals.

5 References

- [1] *Regulatory Modelling Guidance For The Aquaculture Sector. Published on SEPA website.*
- [2] *<http://marine.gov.scot/information/wider-domain-scottish-shelf-model>.*

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