Scottish Environment Protection Agency
Buidheann Dìon Àrainneachd na h-Alba

AQUACULTURE MODELLING SCREENING & RISK IDENTIFICATION REPORT: Setterness South (SETW1)

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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 outputs 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 Setterness South (SETW1). This is located within Ness of Setter at location: 447254, 1171142 (Easting, Northing). The purpose of this application is to allow an increase in biomass at the existing site, from 2357.6t to 4000t. The proposed pens will also be moved onto new seabed.

No screening modelling has been undertaken for this site, however other data has been assessed as part of the risk identification, and we have concluded the following:

- It is unlikely that discharges from Setterness South (SETW1), as currently proposed, will be able to comply with the relevant aspects of the SEPA Aquaculture Regulatory Framework.
- There is a significant probability that the cumulative effects on the features at risk, identified at this stage, will influence the feasibility of the proposed site with respect to the regulatory framework. These risks should be examined using a detailed marine model. Nutrient influence was also considered likely to be a risk at this site. Nutrient modelling will be required to ensure the risk posed by this biomass increase is low.
- If the applicant still wishes to proceed, Setterness South (SETW1) can progress to the next stage of the pre-application process outlined on the SEPA website.

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 influence of discharges on 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 initial 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 influence of sediment and bath treatment discharges from 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. 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 influence 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 influence of 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.

2 Screening modelling

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

2.1 Site proposal

A risk assessment has been carried out for a biomass increase at a CAR licenced farm: Setterness South (SETW1). There is an existing farm at this location with a current biomass of 2357.6t. This application is to increase the biomass at this farm to 4000t. The proposal is to site the farm at location: 447254, 1171142 (Easting, Northing), and the proposed pens will be over new seabed. Should this application succeed, the nearby existing site Hamnavoe (HAML1), which has a biomass of 1910t, will be surrendered. For the risk assessment presented here all relevant licenced sites have been considered in conjunction with the proposed new site.

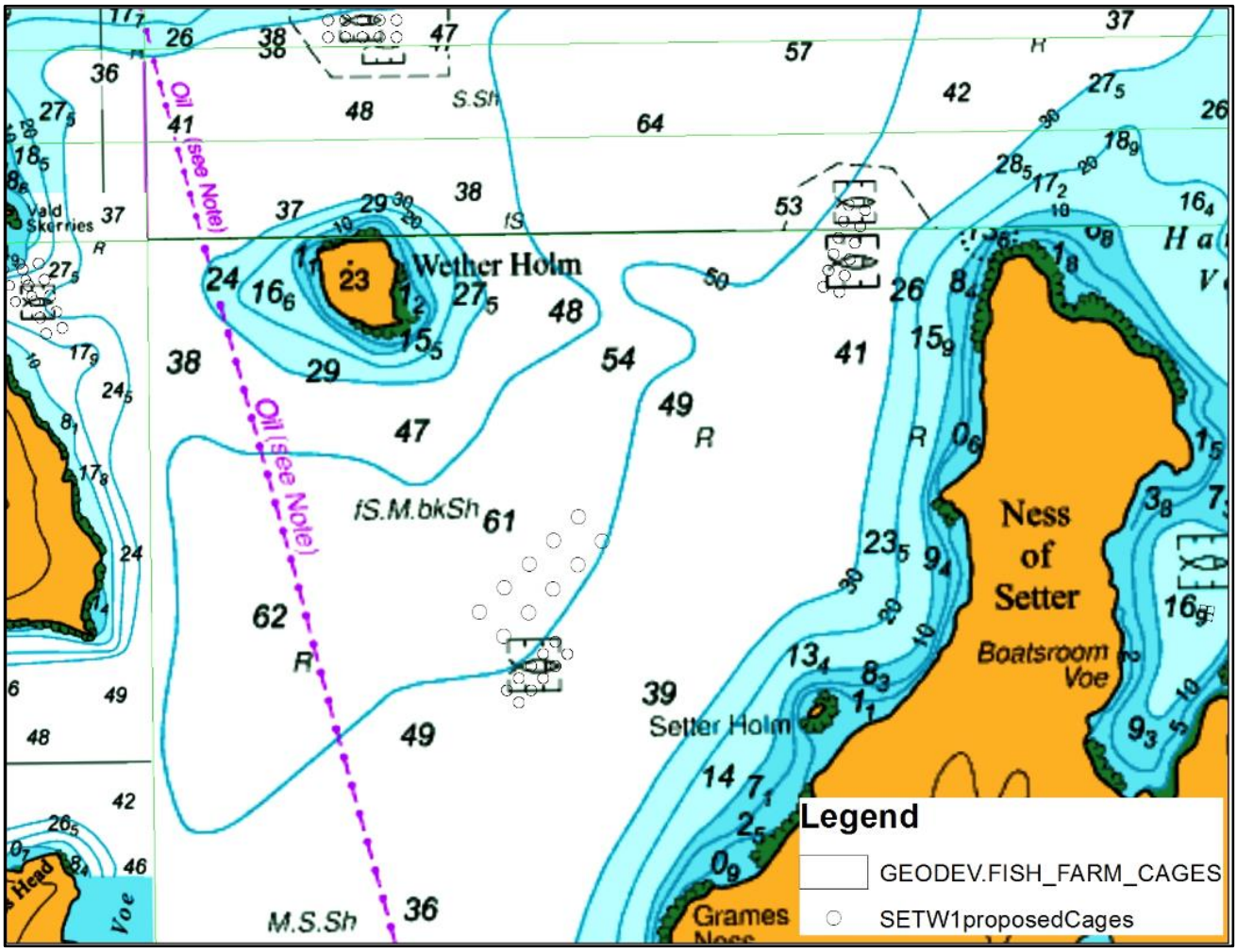

Figure 1. Existing and proposed pen layouts for Setterness South (SETW1).

2.1.1 Accuracy of model in the area surrounding the proposed site

The Pentland Firth and Orkney Waters model which covers this area, has very low resolution over the entirety of Shetland, making it unusable for the purposes of screening modelling. A new Shetland model is currently in development, however for this application, screening modelling has not been undertaken, and other evidence has instead been considered.

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.

Based on previously submitted current meter data and knowledge of this area we can make the following observations about the proposed site location:

- It lies in a moderate dispersion area. Dispersion is generally low within the sea loch, and higher offshore.
- It lies in an area where water flow has a fairly low capacity to erode material on the seabed.

3 Risk identification

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

3.1.1 Table of identified features

Based on an assessment of the area, the following features of interest have been identified.

Table 1: Table of identified features

No.	Feature Name	Feature Type	Location (Easting, Northing)	Brief Reason For Identification
1	COL3	Fish Farm	(446380, 1169735) (Fig.2)	Risk from sediment and bath medicine plume interaction.
2	COLL3	PMF Fish Farm	(445455, 1170490) (Fig.2)	Risk from sediment and bath medicine plume interaction.
3	DAL1	Fish Farm	(443200,1170350) (Fig.2)	Risk from sediment and bath medicine plume interaction.
4	FISH1	Fish Farm	(448208,1172303) (Fig.2)	Risk from sediment and bath medicine plume interaction.
5	HMNV1	Fish Farm	(448905, 1179405) (Fig.2)	Risk from sediment and bath medicine plume interaction.
6	LING1	Fish Farm	(4467777,1172750) (Fig.2)	Risk from sediment and bath medicine plume interaction.
7	NCH1	Fish Farm	(450308, 1178936) (Fig.2)	Risk from sediment and bath medicine plume interaction.

8	NWSCA1	Fish Farm	(442750, 1170600) (Fig.2)	Risk from sediment and bath medicine plume interaction.
9	SETN1	Fish Farm	(448136, 1172099) (Fig.2)	Risk from sediment and bath medicine plume interaction.
10	SWI2	Fish Farm	(445724, 1172004) (Fig.2)	Risk from sediment and bath medicine plume interaction.
11	WTAI1	Fish Farm	(444100, 1170950) (Fig.2)	Risk from sediment and bath medicine plume interaction.
12	Lunna	Shellfish Water Protected Area	Shapefile 1. (Fig.2)	Risk from sediment and bath medicine influence.

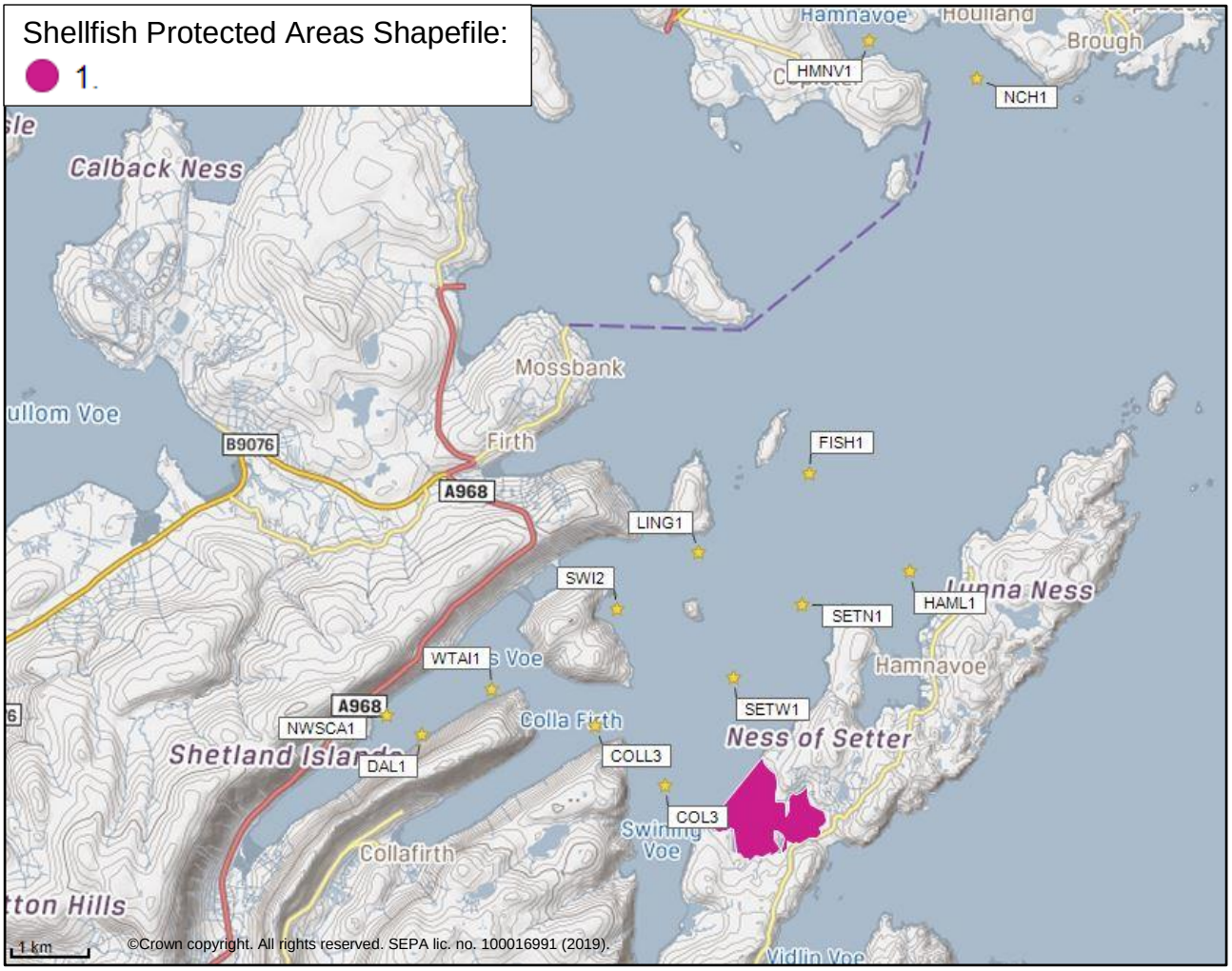

Figure 2. Existing sites in the vicinity of the proposed site (Setterness South (SETW1)).

3.2 Additional comments on identified features

Although screening model has not been carried out, the density of existing farms in this area poses a considerable risk of interactions of both sediment and bath medicine plumes, as well as cumulative risks. Detailed marine modelling will be required to ensure that the influence and interactions between all sites highlighted in Figure 2 are low.

Lunna Shellfish Water Protected Area has also been identified as a sensitive feature at risk of sediment and bath medicines. Marine modelling will need to ensure influence from Setterness South (SETW1) on this Shellfish Protected Water is low.

This site is also situated within a Marine Scotland cat. 2 locational guideline area. This means any increase in biomass can be allowed only if the nutrient risk would not cause the area to be reclassified as a cat. 1. Whilst this application is for a slight decrease in biomass within the overall Voe, HAML1 has only undergone a single production cycle in 2015-16 (with a maximum biomass of 1052t), meaning the risk from nutrients within the Voe are hard to determine. Additionally the relocation of biomass from HAML1 to SETW1, is further into the Voe, and less exposed waters. Therefore nutrient modelling will be required to ensure the risk from nutrients is low.

3.3 Risks identified from contextual site data

Since 2000, there have been 16 Unsatisfactory surveys at Setterness South (SETW1), including the most recent 2018 survey. In this most recent survey, there was enrichment at the AZE station 120m (at 29degrees) away. Considering the new mixing zone area is nominally 100m from the cage edge, this data suggests the site may fail the new standards at the current biomass of 2357.6t.

A SEPA survey in 2017 showed impact more widespread from the farm, with potential cumulative impacts. The furthest NE transect station only reached moderate status, whilst the NW transect reached good status at 350m, but had a moderate IQI value at 400m.

Setterness North (SETN1), which is 1.5km north of the existing site and approx. 1km from the proposed site, had Borderline surveys in 2018 and 2016, and Unsatisfactory surveys in 2012 and 2014.

This monitoring data suggests this area is already at capacity and unlikely to be able to support additional biomass within the less exposed area of Setterness South (SETW1).

Should this application proceed, the total licenced biomass in this area would be 19389.5t.

Table 2: Table of licenced biomass from farms identified as likely to add to cumulative risks.

Site ID	Biomass (tonnes)
SETW1	4000
COL3	1920
COLL3	1200
DAL1	100
FISH1	1910
HMNV1	190
LING1	2299
NCH1	2420.5
NWSCA1	250
SETN1	2500
SWI2	2100
WTAI1	500

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 (Setterness South (SETW1)) is in an area of moderate dispersion and has a fairly low capacity to erode the seabed.
- From assessment of flow in this area, and previous monitoring data:
    - Information presented in section 3 indicates that the relative influence of Setterness South (SETW1) is likely to be high compared to other sites for a similar tonnage.
    - There is likely to be significant influence on the surrounding sea area from Setterness South (SETW1).
    - The areas of influence from Setterness South (SETW1) and other existing sites in this area (highlighted in Figure 2) may interact.
    - It is likely that discharges of bath medicines from Setterness South (SETW1) will be dispersed to moderate levels over a moderate area.
    - Setterness South (SETW1) is likely to result in a moderate increase in the total influence of all sites modelled. Bath medicine plume interactions are likely to occur between other existing sites in this area (highlighted in Figure 2).
- Due to the locational guideline cat. 2 status of the waters within which Setterness South (SETW1) is located, there is potential that this application will result in an unacceptable level of nutrient influence. Therefore nutrient modelling will be required for this site.

4.1.2 Risk Identification

Although screening modelling was not undertaken, due to the proximity and large combined tonnage of existing sites in this area, there is significant potential for interactions between existing farms, as well as cumulative influence. This is demonstrated in the monitoring data from Setterness South (SETW1) and nearby sites, which suggests this area is nearing/at capacity. Detailed marine modelling would be required to demonstrate that the increased biomass at this site would create no additional risk to this area.

4.2 Recommendations

4.2.1 Site suitability

Consideration of risk identification suggests that it is unlikely that discharges from the site, as currently proposed, will be able to comply with the relevant aspects of the SEPA Aquaculture Regulatory Framework. Should the applicant wish to proceed with this application, detailed marine modelling will be required.

It is also unlikely that this site, will be able to comply with our mixing zone regulatory framework. Compliance will need to be demonstrated using the NewDepomod 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

- This application is for an increase in biomass and movement of cages onto new seabed. Whilst screening modelling has not been carried out, the risk identification process has highlighted significant concerns. If the applicant wishes to proceed with this application, detailed marine modelling will be required for both sediment and bath medicines, to ensure there are no additional risks from this application. All sites highlighted in this report will need to be modelled together to highlight any cumulative risks. Nutrient modelling will also be required.
- It is strongly recommended that default NewDepomod modelling is undertaken prior to any marine modelling, to ensure the local impacts of the proposed biomass are acceptable.

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.*