

Marine Aquaculture Site **Port na Mine Etive 3**

Annex 2. Waste Solids Modelling Report

December 2024

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Port na Mine (Etive 3)
Waste Solids & In-feed Medicine Deposition
Modelling Report

CAR/L/1010366

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December 2024

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CONTENTS

	Page
EXECUTIVE SUMMARY	4
1 INTRODUCTION	5
1.1 Site Details	5
2 MODEL DETAILS	7
2.1 Local Deposition: NewDepomod	7
2.1.1 <i>Waste Feed and Faeces</i>	7
2.1.2 <i>In-feed Medicine Modelling</i>	8
3. RESULTS	8
3.1 Local Deposition: NewDepomod	8
3.1.1 <i>Waste Feed and Faeces</i>	8
3.1.2 <i>In-feed Medicine Modelling</i>	9
4. SUMMARY AND CONCLUSIONS	12
5. REFERENCES	12

List of Figures

Figure 1. Location of the Port na Mine (Etive 3) site in Loch Etive.	5
Figure 2. Existing (●) and proposed (●) pen layouts at the Port na Mine (Etive 3) salmon farm. The current meter deployment locations are also shown (●).....	6
Figure 3. The modelled footprint for Port na Mine (Etive 3) for the existing biomass, of 458.4 tonnes, and pen layout, using the SEPA standard default method.	8
Figure 4. The modelled footprint for Port na Mine (Etive 3) for the proposed biomass increase to 700 tonnes, using the SEPA standard default method.....	9
Figure 5. Predicted mean Enamectin Benzoate deposition over days 116 – 118 for the existing 10 x 70m pens at Port na Mine following a treatment of the total allowable quantity (TAQ) of 802.26 g.	10
Figure 6. Predicted mean Enamectin Benzoate deposition over days 116 – 118 for the proposed 6 x 120m pens at Port na Mine following a treatment 140.0 g, giving a Maximum Environmental Quantity of 100.8 g.	10
Figure 7. Area of predicted “new” Enamectin Benzoate deposition.....	10
Figure 8. Modelled Enamectin Benzoate (EmBz) deposition footprints for the existing TAQ quantity of 802.26 g (green) and the proposed MEQ quantity of 100.8 g, equating to a modelled maximum quantity of 140 g (brown). The existing 70 m pens (○) and proposed 120 m pens (○) are shown.	11

List of Tables

<i>Table 1. Site details & summary of results.....</i>	<i>4</i>
<i>Table 2. Summary of hydrographic data from near bed currents</i>	<i>6</i>
<i>Table 3. Details of the individual pen centre locations and net depths used in the modelling for Port na Mine (Etive 3).....</i>	<i>6</i>
<i>Table 4. The modelled footprint area and mean footprint deposition for Port na Mine (Etive 3) for the existing and proposed biomass, using the SEPA standard default method.....</i>	<i>9</i>
<i>Table 5. Comparison between EmBz deposition areas (m²) at Port na Mine from the existing layout with a TAQ treatment of 802.26 g and the proposed layout following a treatment of 140 g.</i>	<i>11</i>
<i>Table 7. Summary of Results</i>	<i>12</i>

EXECUTIVE SUMMARY

Model simulations have been performed to assess the likely deposition of waste solids and in-feed medicine for an increased biomass and change of pens at the salmon farm site at **Port na Mine (Etive 3)** in Loch Etive. This report explains the application of the NewDepomod model to describe the deposition of waste solids and in-feed medicine beneath the pens and in the surrounding environment. The modelling procedure followed as far as possible guidance presented by the Scottish Environment Protection Agency (SEPA) in April 2023 (SEPA, 2023a).

Results indicated that deposition at Port na Mine will be within the allowable mixing zone with a maximum consented biomass of 700 tonnes. The predicted deposition footprint area, where the deposition exceeded the critical deposition rate of 250 g m^{-2} , was $122,500 \text{ m}^2$ (Table 1). The intensity of deposition, 1989.1 g m^{-2} was less than the critical value of $2,000 \text{ g m}^{-2}$. Modelling of in-feed medicine emamectin benzoate indicated that a treatment quantity of 140 g, with a corresponding Maximum Environmental Quantity (MEQ) of 100.8 g, would comply with the Environmental Quality Standard (EQS).

These results indicate that the proposed new layout, with a maximum biomass of 700 tonnes, at Port na Mine will meet pertinent Environmental Quality Standards for salmon farm waste solids.

Table 1. Site details & summary of results

Site Details	
Site Name:	Port na Mine
Site Location:	Loch Etive
Peak Biomass (T):	700
Feed Load (T/year):	1788.5
Pen Details	
Number of Pens:	6
Pen Dimensions:	120m Circumference
Working Depth (m):	17
Configuration:	1x6, 75 m matrix
NewDepomod Solids Results	
Allowable Mixing Zone (m^2):	132,388
Maximum Deposition (g m^{-2}):	6177.6
Modelled Footprint (m^2):	122,500
Mean Footprint Deposition (g m^{-2}):	1989.1
In-Feed Medicine Results	
Emamectin Benzoate MTQ (g)	140.0
Emamectin Benzoate MEQ (g)	100.8

1 INTRODUCTION

This report has been prepared by Mowi Scotland Ltd. to describe the deposition of waste solids and in-feed medicine from a marine salmon farm at **Port na Mine (Etive 3)** in Loch Etive (Figure 1 and Figure 2). Mowi proposes to increase the consented biomass at the site from 458.4 tonnes to 700 tonnes through consolidation with the nearby Inverawe (Etive 2) site (current consent 250 tonnes), which will be relinquished. A new configuration of 6 x 120 m circumference pens is also proposed at Port na Mine, replacing the existing 10 x 70 m pens. The report explains the application of the NewDepomod model to describe the deposition of waste solids and in-feed medicine beneath the pens and in the surrounding environment. The modelling procedure followed as far as possible guidance presented by the Scottish Environment Protection Agency (SEPA) in April 2023 (SEPA, 2023a) in order to meet the depositional modelling requirements outlined in the screening report (SEPA, 2024).

Current meter measurements were made in 2023 (ID426) and 2024 (ID434) at locations close to the site (Figure 2). Details of the measurements are provided in the relevant hydrographic reports (Mowi, 2024a, b), with a summary of the key information provided in Table 2.

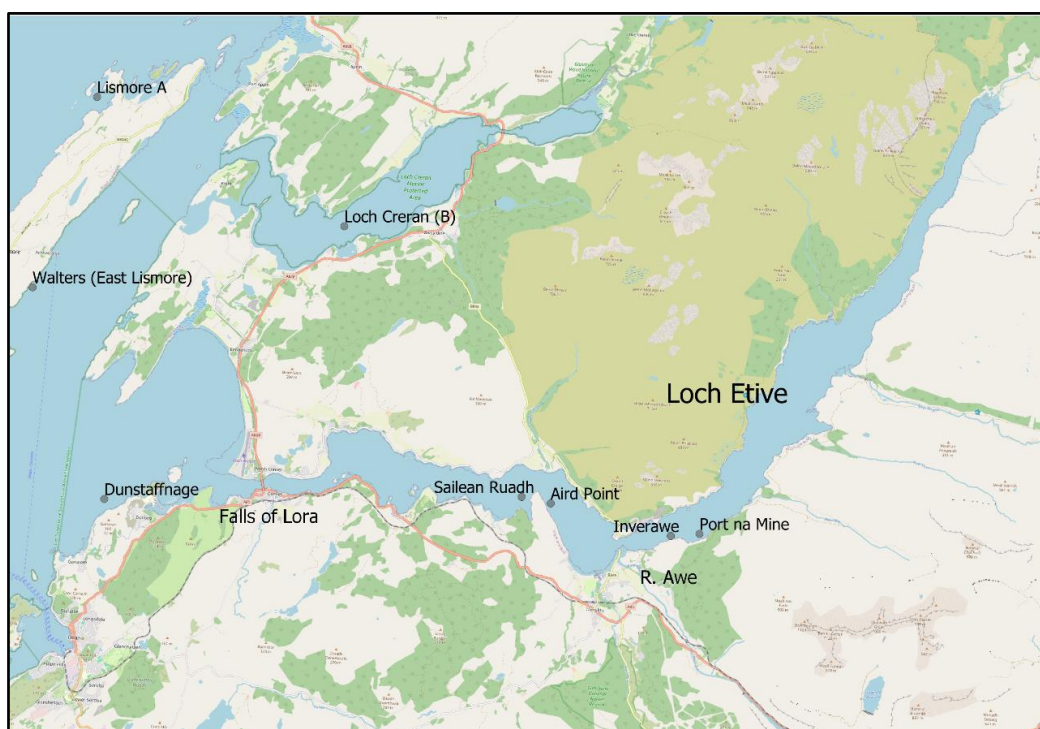


Figure 1. Location of the Port na Mine (Etive 3) site in Loch Etive.

1.1 Site Details

The existing site is situated in the upper basin of Loch Etive, landward of the mouth of the River Awe (Figure 1 and Figure 2). Details of the site and hydrographic summary are provided in Table 1 and Table 2. The receiving water is defined as open water. The pen center locations are given in Table 3. These locations were used in the computer modelling (Section 2).



Figure 2. Existing (●) and proposed (●) pen layouts at the Port na Mine (Etive 3) salmon farm. The current meter deployment locations are also shown (●).

Table 2. Summary of hydrographic data from near bed currents

Hydrographic Summary	ID426	ID434
Deployment Date	27.10.2023 – 18.01.2024	18.01.2024 – 18.03.2024
Easting	203110	203195
Northing	733258	733172
Mean Speed (m/s)	1.96	0.024
Residual Speed (m/s)	0.005	0.005
Residual Direction (°G)	68	216
Tidal Amplitude Parallel (m/s)	0.027	0.036
Tidal Amplitude Normal (m/s)	0.016	0.018
Major Axis (°G)	80	260

Table 3. Details of the individual pen centre locations and net depths used in the modelling for Port na Mine (Etive 3).

Cage	Easting	Northing	Net Depth (m)
1	203210	733096	17
2	203271	733139	17
3	203333	733182	17
4	203394	733225	17
5	203455	733268	17
6	203517	733311	17

The most recent seabed compliance survey at Port na Mine was carried out in November 2023 and has been classed as satisfactory.

2 MODEL DETAILS

Local deposition of solids waste and in-feed medicine were modelled using the NewDepomod model. Simulations were performed for the exiting pens and consented biomass at Port na Mine, and for the proposed pen layout and consented biomass. The model was configured in the default parameter values specified by SEPA and used measured flow data to force the simulation.

2.1 Local Deposition: NewDepomod

NewDepomod is a bespoke modelling software designed to simulate the dispersion of particulate wastes from salmon farms. The model (SAMS, 2021) has been developed by the Scottish Association for Marine Science (SAMS) and is supplied under licence. The version used for the modelling described here was:

library version:

numerics version: Beta 1.20230720111216.1689149157

datatypes version: Beta 1.20230720111143.1689149157

util version: v1.5.0-final-(SEPA)

A regular model grid was prepared. The grid covered a 2.5 km x 1.8 km area, with a 25 m grid spacing in both directions. The grid size was 100 x 72 cells. The water depth was 70.31 m, the minimum depth recorded across the two ADCP deployments. The flowmetry file combined the data from ID426 and ID434; after merging the length of the combined record was 90 days in total. The same grid size, grid spacing and water depth was used for the Emamectin Benzoate (EmBz) modelling.

2.1.1 Waste Feed and Faeces

The model was configured exactly as specified by SEPA in the modelling guidance published in April 2023 (SEPA, 2023a). The site was modelled for a maximum biomass of 700 tonnes with a feed load of 7 kg/tonne/day. This configuration of the model produces a conservative estimate of the benthic footprint, with a deposition rate of 250 g m⁻² equating approximately to an Infaunal Quality Index (IQI) of 0.64 (the boundary between moderate and good status). Work by SEPA has shown that footprints predicted by this “standard default” configuration broadly match the footprint area derived from seabed samples, although there is a great deal of variability from site to site.

Following the standard default approach, NewDepomod was used to simulate one year of deposition at the maximum farm biomass. Results were analysed over the final 90 days of the simulation, with the mean deposition rate across the model domain being calculated and the footprint area being delimited by the 250 g m⁻² contour (SEPA, 2023a). The results are presented in Section 3.1.

2.1.2 In-feed Medicine Modelling

Port na Mine salmon farm has a current EmBz Total Allowable Quantity (TAQ) consent of 802.26 g. To check that the proposed 6 x 120m pens do not negatively affect the deposition, the in-feed medicine model of NewDepomod was used. It was run for 118 days, with hourly results over the final two days (Days 116 – 118) saved to file. This approach followed that of the standard default modelling approach outlined in the SEPA Regulatory Modelling Guidance (SEPA, 2023a). The mean concentrations of EmBz were calculated from this output for comparison with the EQS value of 136 ng/kg (wet weight, equivalent to 272 ng/kg dry weight), which is the current EQS (SEPA, 2023b).

Because Port na Mine has an existing EmBz consent, we modelled to ensure that the area of seabed newly affected by deposition above the EQS did not exceed 15% of the existing deposition footprint arising from the consented TAQ (SEPA, 2023a). This was achieved by iteratively reducing the treatment amount from 802.26 g until the new deposition area was less than 15% of the existing deposition area. These results are shown in Section 3.2.2.

3. RESULTS

3.1 Local Deposition: NewDepomod

3.1.1 Waste Feed and Faeces

The modelled footprints for the Port na Mine farm using the SEPA standard default method are shown for both the existing and proposed biomass and pen layouts (Figure 3 and Figure 4). The proposed layout footprint area, as defined by the deposition rate of 250 g m^{-2} , was $122,500 \text{ m}^2$ (Table 4). The maximum 90-day mean deposition was 6177.6 g m^{-2} . The intensity of deposition was 1989.1 g m^{-2} which is below the threshold value of $2,000 \text{ g m}^{-2}$. These results indicate that the proposed equipment change and biomass increase will meet pertinent Environmental Quality Standards for salmon farm waste solids.

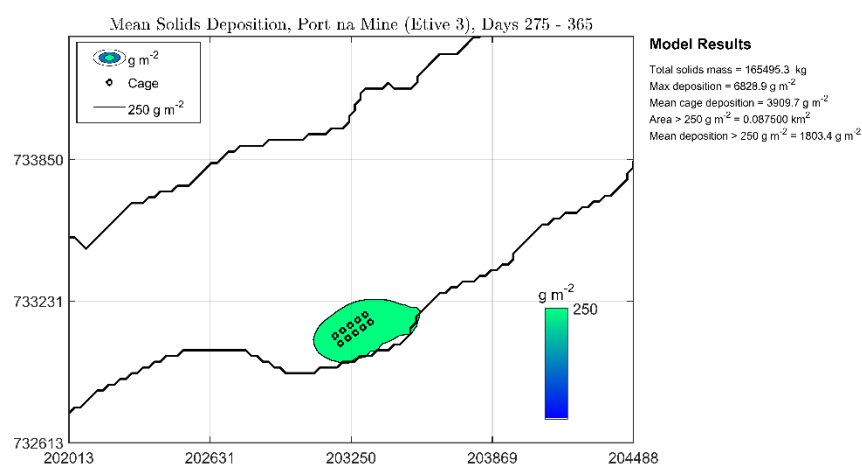


Figure 3. The modelled footprint for Port na Mine (Etive 3) for the existing biomass, of 458.4 tonnes, and pen layout, using the SEPA standard default method.

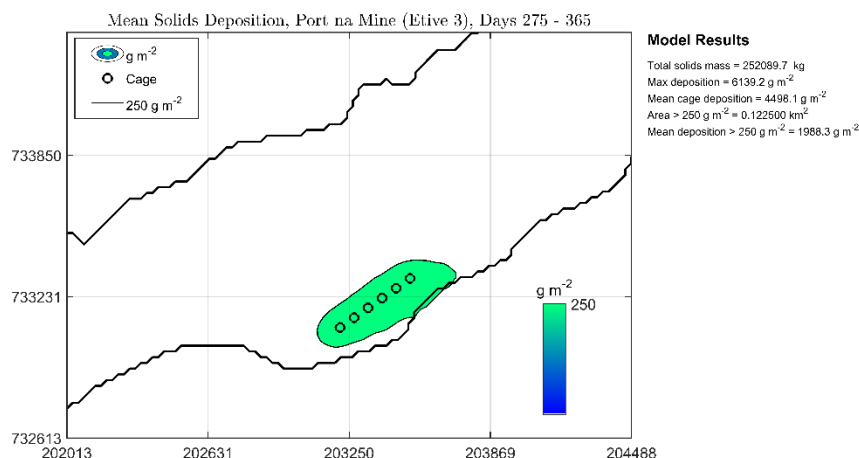


Figure 4. The modelled footprint for Port na Mine (Etive 3) for the proposed biomass increase to 700 tonnes, using the SEPA standard default method.

Table 4. The modelled footprint area and mean footprint deposition for Port na Mine (Etive 3) for the existing and proposed biomass, using the SEPA standard default method.

NewDepomod Results Summary	Existing	Proposed
Maximum Biomass (T)	458.4	700
Feed Load (T/year)	1,171.2	1788.5
Solid Waste Release Rate (kg/day)	3,208.8	4,900.0
Allowable Mixing Zone (m ²)	89,431	132,343
Maximum Deposition (g m ⁻²)	6,828.9	6,139.2
Modelled Footprint (m ²)	87,500	122,500
Mean Footprint Deposition (g m ⁻²)	1,803.4	1,988.3

3.1.2 In-feed Medicine Modelling

The in-feed medicine model of NewDepomod was run using both the existing layout of 10 x 70m pens and the proposed 6 x 120m pens. The modelled EmBz deposition from the existing layout with the TAQ of 802.26 g is shown in Figure 5. The area where deposition exceeded the EQS (136 ng kg⁻¹ wet weight) was 221,875 m² (Table 5). For the proposed pen layout, a treatment mass of 140 g resulted in an EmBz deposition footprint with new deposition occurring in an area less than 15% of the existing footprint (Figure 6 and Figure 8, Table 5). The modelled deposition of Emamectin Benzoate from the existing and proposed layouts and biomasses are shown superimposed in Figure 8.

The results show that new emamectin deposition from the proposed layout is less than 15% of the existing deposition area (Table 5), and that the actual predicted area of deposition (218,750 m²) is smaller than the existing impacted area. Based on these results, Mowi seeks a revised Emamectin Benzoate consent (MEQ) of 100.8 g.

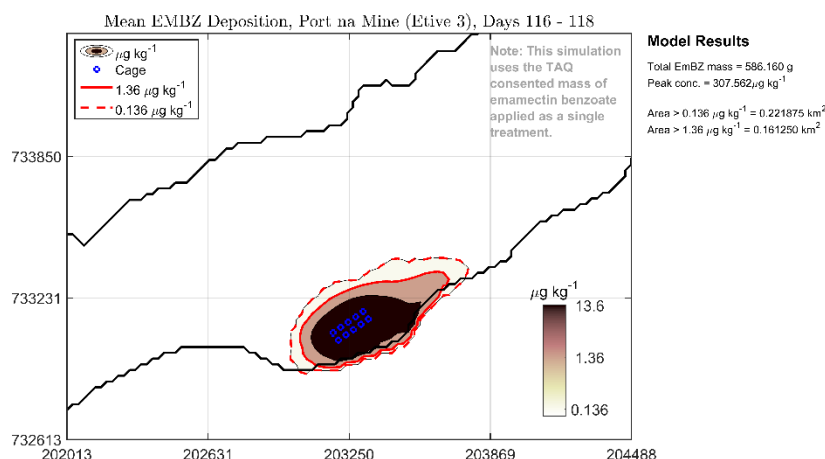


Figure 5. Predicted mean Emamectin Benzoate deposition over days 116 – 118 for the existing 10 x 70m pens at Port na Mine following a treatment of the total allowable quantity (TAQ) of 802.26 g.

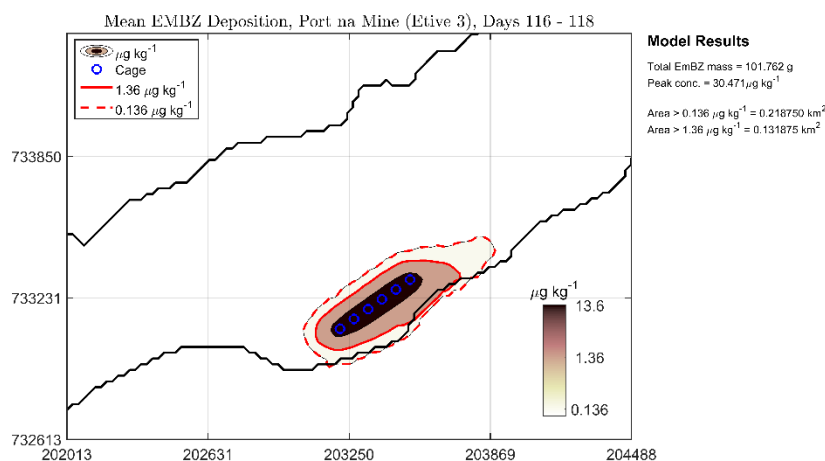


Figure 6. Predicted mean Emamectin Benzoate deposition over days 116 – 118 for the proposed 6 x 120m pens at Port na Mine following a treatment 140.0 g, giving a Maximum Environmental Quantity of 100.8 g.

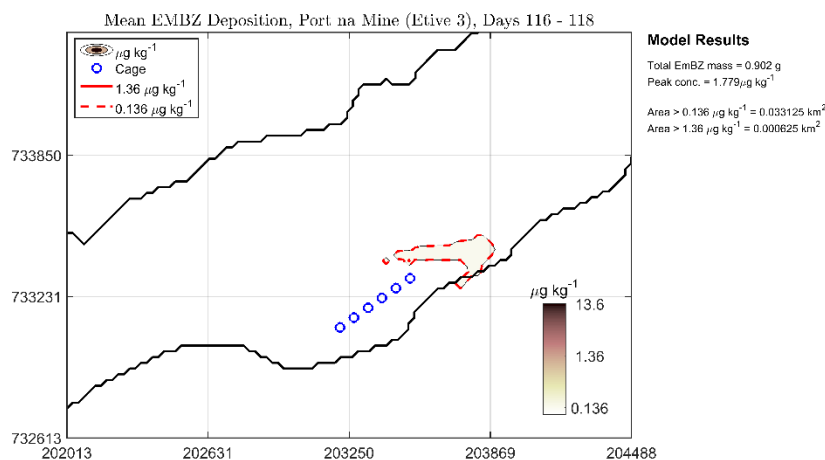


Figure 7. Area of predicted "new" Emamectin Benzoate deposition.

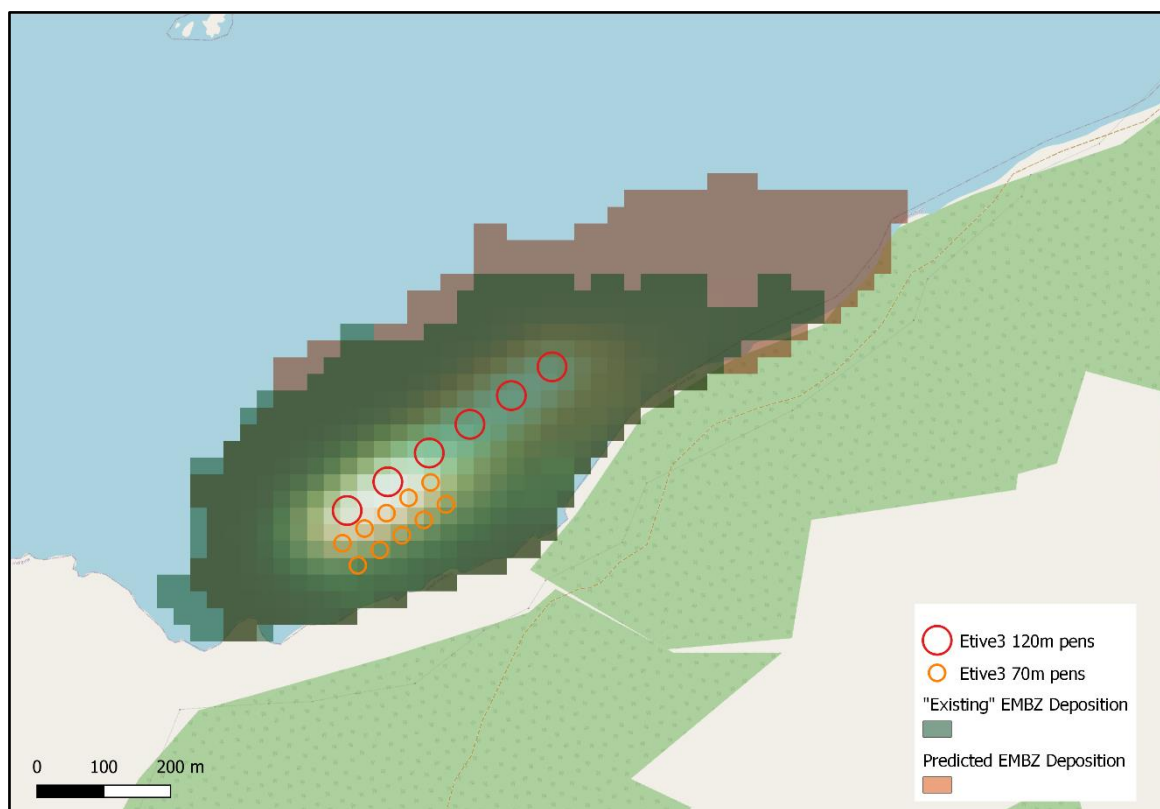


Figure 8. Modelled Emamectin Benzoate (EmBz) deposition footprints for the existing TAQ quantity of 802.26 g (green) and the proposed MEQ quantity of 100.8 g, equating to a modelled maximum quantity of 140 g (brown). The existing 70 m pens (○) and proposed 120 m pens (○) are shown.

Table 5. Comparison between EmBz deposition areas (m²) at Port na Mine from the existing layout with a TAQ treatment of 802.26 g and the proposed layout following a treatment of 140 g.

	Existing	Proposed
EmBz Treatment Quantity (g)	802.26	140.0
Equivalent MEQ (g)	577.63	100.8
Area > 136 ng kg ⁻¹ (m ²)	221,875	218,750
New deposition area (m ²)	-	33,125
Ratio new:existing (%)	-	14.93

4. SUMMARY AND CONCLUSIONS

The biomass of 700 tonnes requested for consent at the Port na Mine site, and the associated feed loading (Table 6), has been shown to meet pertinent Environmental Quality Standards. The SEPA standard default method, which is designed to provide a conservative prediction of particulate deposition, suggested that deposition at the site will meet both mixing zone and deposition intensity criteria. Modelling of in-feed medicine Enamectin Benzoate deposition indicates that a revised consent (MEQ) of 100.8 g will meet the pertinent EQS.

Table 6. Summary of Results

Site Details	
Site Name:	Port na Mine
Site Location:	Loch Etive
Peak Biomass (T):	700
Feed Load (T/year):	1788.5
Pen Details	
Number of Pens:	6
Pen Dimensions:	120m Circumference
Working Depth (m):	17
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Mean Footprint Deposition (g m ⁻²):	1989.1
In-Feed Medicine Results	
Enamectin Benzoate MTQ (g)	140.0
Enamectin Benzoate MEQ (g)	100.8

5. REFERENCES

Scottish Association for Marine Science (SAMS), 2021, NewDEPOMOD Modelling Software. <https://depomod.sams.ac.uk>

SEPA, 2023a. New Depomod Draft Guidance. Scottish Environment Protection Agency, Air & Marine Modelling Unit, April 2023, 26 pp.

SEPA, 2023b. Interim position statement for protecting the water environment in relation to emamectin benzoate in finfish farm regulation. Scottish Environment Protection Agency, March 2023, 6 pp.

SEPA, 2024. Aquaculture Modelling Screening & Risk Identification Report: Etive 3 (Port na Mine) (FFMC84). Scottish Environment Protection Agency, October 2024, 39 pp.