Exmouth STW: Assessment of Bacterial Reductions

Info

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Client	South West Water
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1 Introduction

1.1 Overview

A new outfall has recently been installed to take the effluent flows from Exmouth STW. The new discharge location is about 50 m further offshore than the current discharge location. The new outfall has a diffuser section comprising 16 ports, while the current outfall has a diffuser section comprising 8 ports. It should be noted that the discharge location on the current permit for the Exmouth STW discharge appears to be in error, in that the last two digits of the eastings have been transposed. The three locations, comprising two locations for the current outfall (permitted and actual) and the new outfall location are shown on Figure 1.

The Shellfish Production Area of Sandy Bay has been classified for thick trough shells (*Spisula solida*). The Shellfish Production Area is also shown in Figure 1 as a polygon, together with the four corners which have NGRs.

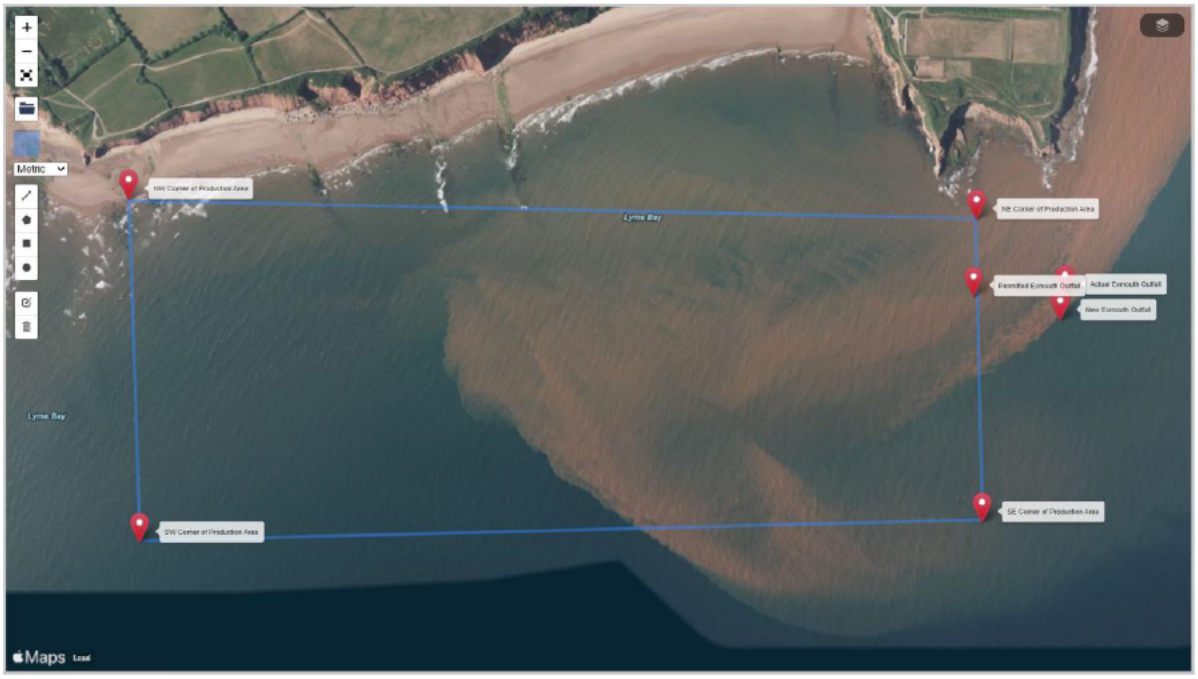

Figure 1 Location of Sandy Bay Shellfish Production Area and the Existing and New Discharge Locations for Exmouth STW off Straight Point (Source of image: Grid Reference Finder)

In 2022, a new Shellfish Water for Sandy Bay was defined as a protected area under the Water Framework Directive. The WFD Shellfish Waters Area is larger than the Shellfish Production Area. The two areas and the location of both the existing and new discharges for Exmouth STW are shown in Figure 2 below. The location of the discharges is shown in more detail in Figure 3, which is the area just to the south if Straight Point.

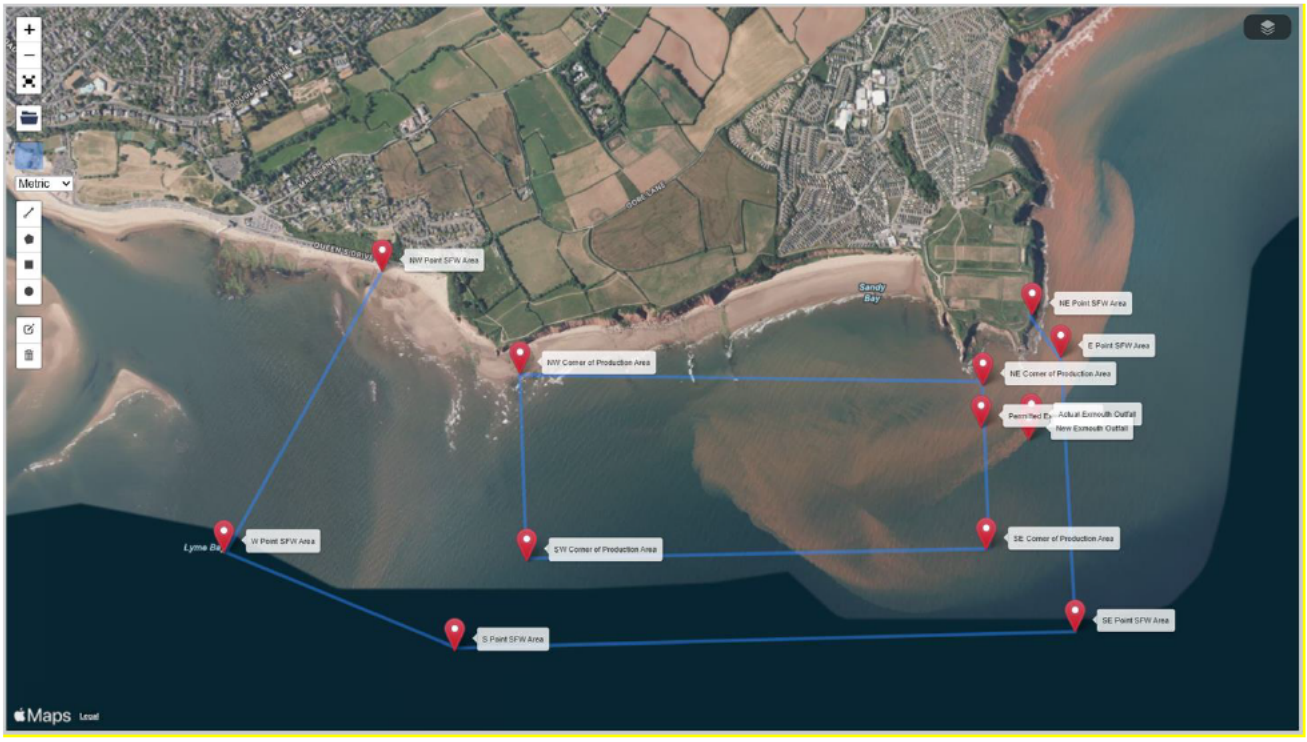

Figure 2 Location of Sandy Bay WFD Shellfish Water, Sandy Bay Shellfish Production Area and the Existing and New Discharge Locations for Exmouth STW off Straight Point (Source of image: Grid Reference Finder)

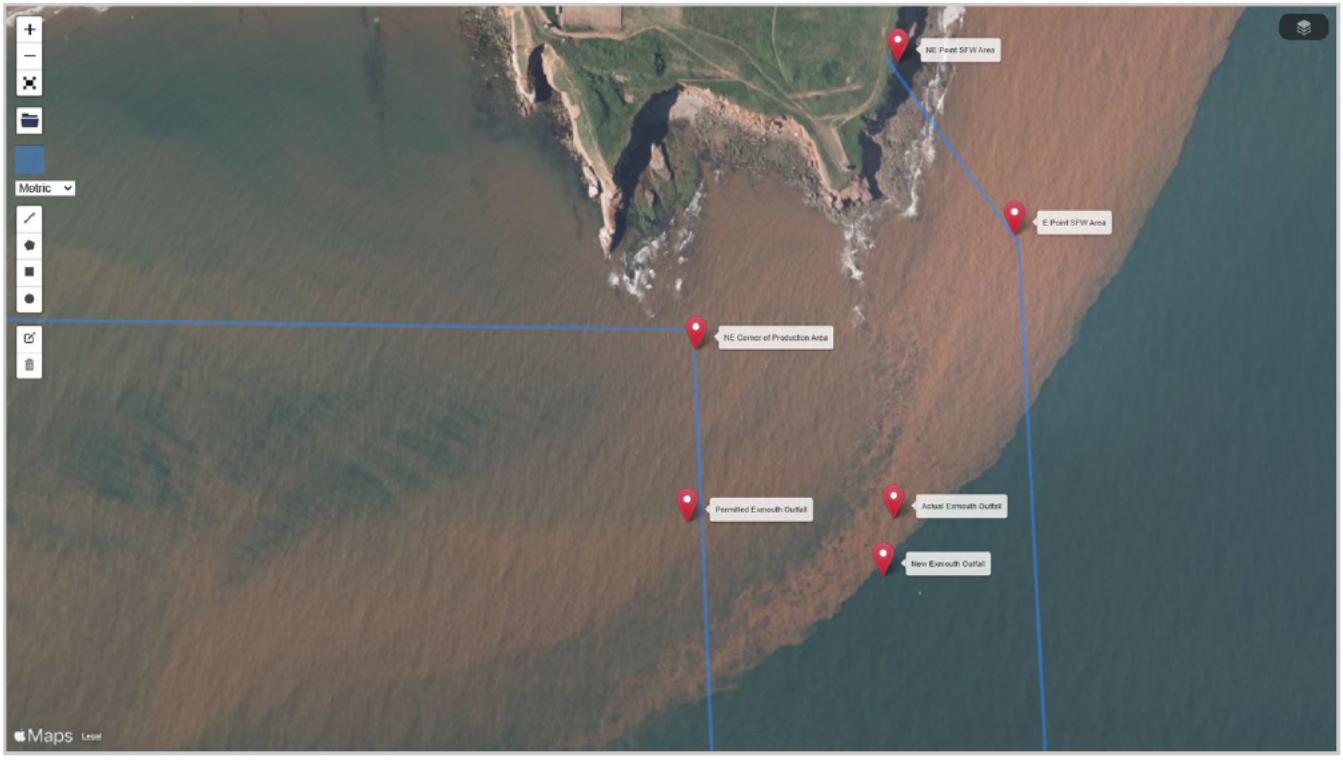

Figure 3 Detail showing the Existing and New Discharge Locations for Exmouth STW and the eastern boundaries of the Sandy Bay WFD Shellfish Water and the Sandy Bay Shellfish Production Area off Straight Point (Source of image: Grid Reference Finder)

1.2 Target Bacterial Reductions

The 5.25 target of bacterial reductions as a geomean log reduction is the total reduction from the effluent arriving at the STW (known as the influent) and the boil on the surface in the coastal waters above the outfall. The bacterial levels of interest in relation to shellfish are faecal coliforms, in particular *E.coli,* as the classification of the shellfish production areas uses the levels of *E.coli* in the shellfish flesh as the relevant indicator of shellfish quality. It is assumed that the bacterial levels in the influent to the STW have a geomean of $2 * 10^7$ as *E.coli* in number per 100 ml. This bacterial level in the influent equates to 7.30 as a logarithm. The 5.25 log reduction would result in a bacterial level in the boil of 110 *E.coli* in number per 100 ml. If this target reduction is achieved, it is considered to allow compliance with the Food Standards Agency (FSA) classification of Class B in the Shellfish Production Area, according to guidance from the Environment Agency (EA).

The bacterial reductions required to meet the target of 5.25 as a geomean log reduction consist of two components: onshore treatment at the STW and initial dilution as the effluent plume mixes with the coastal waters. Although the location of the new outfall is outside the boundary of the Shellfish Production Area, it is within the WFD Shellfish Water Area, so no consideration has been given to any secondary dilution, i.e. no further dilution of the effluent after initial dilution has been included.

Each of the components of bacterial reductions is considered in the sections below.

2 Components of Bacterial Reductions

2.1 Onshore Treatment

Exmouth STW provides secondary treatment and UV disinfection to all STW flows up to 273 l/s. This flow represents what is called flow to full treatment (or FFT). Treated flows from the STW are measured daily in terms of the daily volume discharged. The average of these daily volumes for the last 3 years (August 2022 to August 2025) is 15,329 m^3, which equates to a flow of 177.4 l/s (Source: SWW Operator Self-Monitoring (OSM) Data). The daily volume as a geomean from the same period of data is 14,532 m^3, which equates to a flow of 168.2 l/s.

The simplest way to assess the reduction achieved through the treatment at the STW is to relate the geomean of the available data on bacterial levels to an assumed influent level of $2 * 10^7$ as *E.coli* in number per 100 ml. Data on bacterial levels are required by the EA to assess the efficacy of the UV treatment at the STW.

Based on the last 3 years monitoring data for Exmouth STW which equates to 36 samples, the geomean for presumptive *E.coli* in number per 100 ml was 4,291(Source: SWW Operator Self-Monitoring (OSM) Data). This number is 3.63 as a logarithm.

The resulting bacterial reduction in logarithms through treatment at Exmouth STW using data for the last 3 years is calculated to be 3.67. Given that the target log reduction in *E.coli* is 5.25, the reduction in bacterial levels required by initial dilution is 1.58 as a logarithm, which is a dilution of 38.

2.2 Initial Dilution

Initial dilution in the context of the Exmouth STW discharge represents the dilution afforded to the buoyant plume as it rises from the seabed to the sea surface. The plume arising from the STW is essentially freshwater, so that it is buoyant relative to the saline coastal waters into which it is being discharged. The initial dilution is calculated as the minimum dilution at the centreline of the buoyant plume as it mixes. This minimum dilution increases as the plume develops and spreads.

Historically, initial dilution was calculated using equations developed by the Water Research Centre (WRc) for the water industry (WRc 1990). These equations were derived from a combination of research work on plumes in the laboratory and survey work on real discharges using tracers of various types.

More recently, theoretical and survey work on plumes by researchers in the USA resulted in the development of a set of computer programmes to model for the mixing zones of plumes called CORMIX. The CORMIX modelling was undertaken by HR Wallingford (HR Wallingford 2023).

There are differences in the approach between the two methods, but it is not the remit of this note to consider or discuss these. In addition, it is likely that with the diffuser configuration that the WRc equations will over-predict the initial dilution as the plume from each port is assumed not to interact with any other, which is not strictly correct. However, the results from both are used here to provide a comparison, which is believed to be helpful.

Initial dilution has been assessed for the discharge from Exmouth STW through the new outfall using both methods, when the flows are 273 l/s, ie. when the treated flow is at a maximum. This represents a worst case in terms of initial dilution, as the average flow is about 100 l/s smaller, and initial dilution decreases as the discharge flow rate increases.

The average dilutions for a discharge at FFT for a mean Spring tide, a mean Neap tide, and over both tidal ranges using both the CORMIX modelling and the WRc equations are shown below in Table 1.

Table 1 Initial Dilutions for Flows to Full Treatment for the Exmouth STW Discharge through a16 Port Diffuser (consisting of 4 in number rosettes each with 4 ports)

Calculation Method	Average Mean Spring Tide Dilution	Average Mean Neap Tide Dilution	Average Dilution over Both Tidal Ranges
CORMIX	230	130	180
WRc Equations	396	194	295

In addition to these average values, the minimum predicted dilution for flows to full treatment using the CORMIX model is 46 (HR Wallingford 2023).

The main conclusion from this assessment of initial dilution is that the dilutions afforded to the discharge through the new outfall are considerably in excess of the 38 or 1.58 log required to achieve an overall 5.25 log reduction in *E.coli* as a geomean.

3 Conclusions

Using existing data on the bacterial levels in the treated discharge from Exmouth STW and two different methods of assessing the initial dilution of the discharge through the new outfall with a 16-port diffuser, the overall bacterial reduction between the influent and the 'boil' of the buoyant plume exceeds the target of 5.25 log reduction in relation to the both the WFD Shellfish Water Area and the Shellfish Production Area of Sandy Bay. This would suggest that the discharge through the new outfall will allow compliance of the shellfish of the Production Area with an FSA classification of Class B.

The Sandy Bay shellfish Production Area is not classified at present, as sampling of the shellfish ceased in 2021. However, a classification in 2019 indicated that the Production Area was Class B, see Figure 4 in Appendix A .

Unfortunately, there are no recent classifications of the Sandy Bay shellfish Production Area, so that there are no data available to support the implication that the new outfall will not compromise a Class B classification. However, the new 16 port diffuser approximately doubles the initial dilution of the discharge at FFT according to the CORMIX modelling. On this basis, the new outfall can only be an improvement on the existing outfall and is more likely to support the achievement of a Class B classification, which has been achieved in the past.

4 References

WRc 1990 Design Guide for Marine Treatment Schemes.
Volume I - Introduction and Volume II Environmental Design and Data Collection.
Water Research Centre plc. Report No. UM 1009, Volumes I and II. May 1990. 288 pp.

HR Wallingford 2023 Exmouth Sea Outfall. Concept diffuser design and near field dispersion assessment.
HR Wallingford. Report No. RT001. August 2023. 27 pp.

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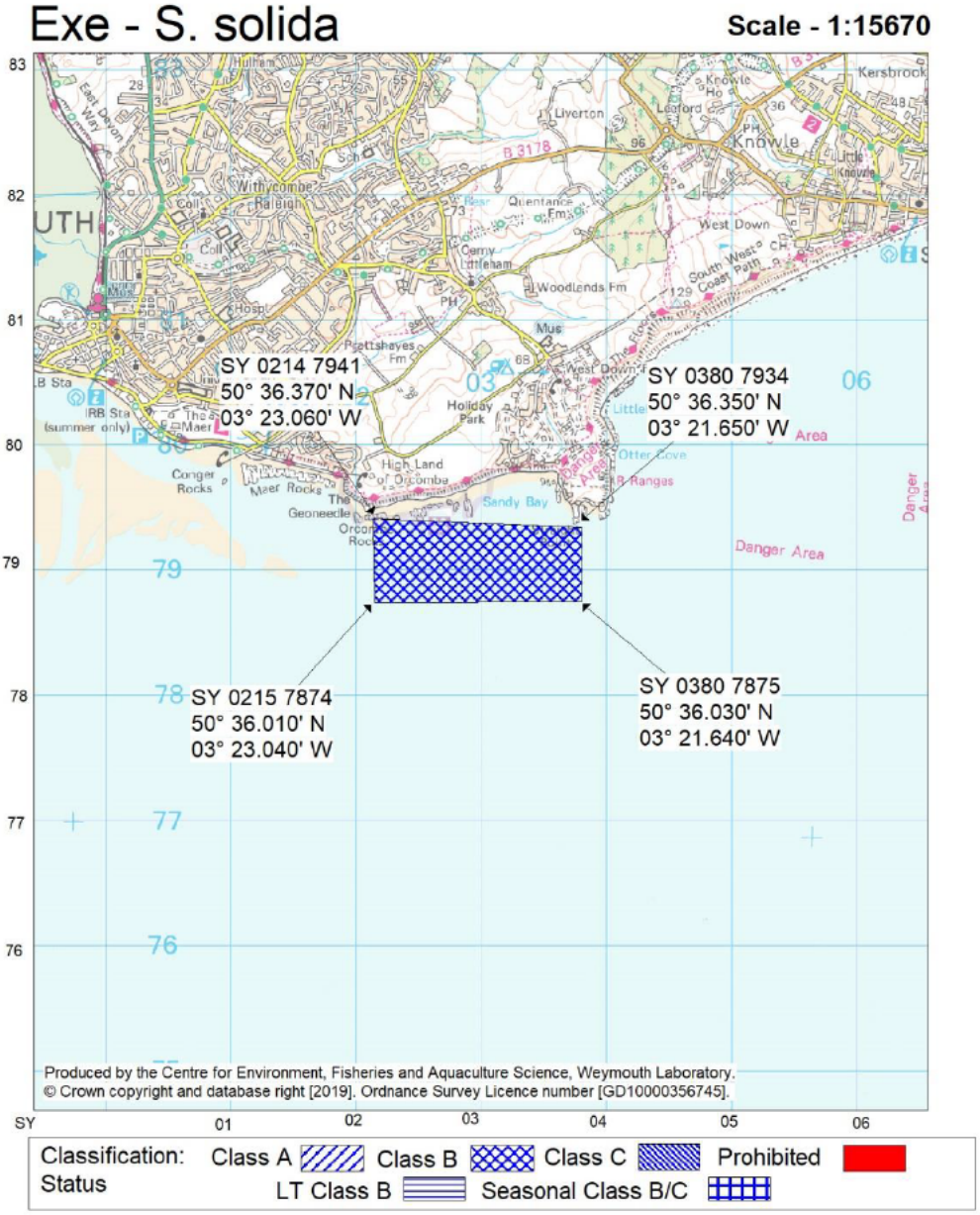
Rev	Suit	Description	Date	Originator	Checker	Approver
P01	S4	First Issue	15/10/2025	P Jonas	M Duquemin / L Wardell	L Wardell
P02	S4	Minor revisions and References added	20/10/2025	P. Jonas	M Duquemin / L Wardell	L Wardell
P03	S4	Revisions following EA Comments	05/01/2026	P. Jonas	L Wardell	L Wardell

Ref. reference. Rev revision. Suit suitability.

Appendix A Classification of the Sandy Bay Shellfish Production Area 2019



Classification of Bivalve Mollusc Production Areas: Effective from 1 September 2019

The areas delineated above are those classified as bivalve mollusc production areas under EU Regulation 854/2004.

Further details on the classified species and the areas may be obtained from the responsible Food Authority. Enquiries regarding the maps should be directed to: Shellfish Microbiology, CEFAS Weymouth Laboratory, Barrack Road, The Nothe, Weymouth, Dorset DT4 8UB.
(Tel: 01305 206600 Fax: 01305 206601)
N.B. Lat/Longs quoted are WGS84
Unless otherwise stated, non-straight line boundaries between co-ordinates follow the OS 1:25,000 mean high water line.

Food Authority: East Devon District Council

Figure 4 Classification of the Sandy Bay Shellfish Production Area 2019 (Source: Cefas)