



BULFORD CAMP NNAMS

DATE:	29 January 2026	CONFIDENTIALITY:	Confidential
SUBJECT:	Bulford Camp Nutrient Neutrality Assessment & Mitigation Strategy		
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EXECUTIVE SUMMARY

The Ministry of Defence (MOD) is proposing to construct eight service family dwellings on Bulford Camp in Wiltshire.

A November 2018 European Court of Justice decision regarding the EU Habitats Directive resulted in Natural England (NE) imposing nutrient neutrality requirements to protect multiple 'Habitats' sites that are adversely affected by nitrogen and/or phosphorus enrichment. The River Avon is a 'Habitats' site that is adversely affected by phosphorus enrichment. The proposed development at Bulford Camp is located within the catchment of the River Avon and the proposed development must therefore achieve phosphorus neutrality.

Foul flow nutrient loads will be treated through Wessex Water's Ratfyn Sewage Treatment Works (STW).

The sustainable drainage strategy (SuDS) consists of infiltration of surface water into the ground.

The preferred mitigation option is the purchase of nutrient mitigation credits from an approved credit scheme in the River Avon catchment. The scheme must be upstream of Ratfyn STW. Only one such scheme is known – that currently being developed by Greenshank Environmental.

As credit availability in the catchment is highly constrained, and demand is likely to be high, it is recommended that the MOD immediately engage with Greenshank Environmental to secure a provisional credit allocation.

The Bulford Camp development will achieve phosphorus neutrality.

INTRODUCTION

The Ministry of Defence (MOD) is proposing to construct eight service family dwellings on Bulford Camp in Wiltshire.

A November 2018 European Court of Justice decision regarding the EU Habitats Directive resulted in Natural England (NE) imposing nutrient neutrality requirements to protect 'Habitats' sites that are adversely affected by nitrogen and/or phosphorus enrichment. Habitats sites are:

- Special Areas of Conservation (SAC).
- Special Protection Areas (SPA).
- Ramsar sites.

The proposed development at Bulford Camp is located within the catchment of the River Avon SAC, which is adversely affected by phosphorus enrichment.

NE's nutrient neutrality requirements apply to all new developments that will cause an increase in nutrient loads that affect 'Habitats' sites that are deteriorating because of nutrient enrichment. All such developments must demonstrate nutrient neutrality before planning approval can be granted. The Bulford Camp development must therefore achieve phosphorus neutrality.

Natural England has published generic technical guidance¹ and a nutrient neutrality calculator for the River Avon catchment². These documents have been used to inform the nutrient load calculations for the proposed development which have been developed in a bespoke Microsoft Excel spreadsheet to accurately reflect the percentage impermeability of the development.

EXISTING AND PROPOSED LAND USES

The existing and proposed land use areas are detailed in Table 1. Figures and full details are provided in Appendix A.

Table 1 – Bulford Camp Development Site Existing and Proposed Land Use Areas (ha)

Land Use	Existing	Proposed
Residential Urban	0.00	0.51
Open Urban	0.06	0.04
Greenspace	1.07	0.58
Total Site Area	1.13	1.13

SUSTAINABLE DRAINAGE SYSTEM – PHOSPHORUS REMOVAL

The proposed development is underlain by freely draining soils. Surface water will be attenuated through the sustainable drainage system (SuDS) and then infiltrated.

CIRIA C808 *Using SuDS to reduce phosphorus in surface water runoff* specifies phosphorus removal efficiency values for a range of SuDS features. Row 4 of Table 2.1 in CIRIA C808 specifies that 100% removal of phosphorus can be achieved through infiltration of runoff to ground, based on compliance with the criteria detailed in Table 2.

Table 2 – CIRIA C808 Surface Water Runoff Infiltration Criteria

Criterion	Bulford Camp Compliance
<i>The SuDS device will not be subject to significant flooding (i.e. it is not in flood zone 2 or 3)</i>	<i>Complies, the whole site is in FZ1.</i>
<i>The SuDS device is in an area where the high-water table depth is at least 1m below the base of the infiltration device (taking account of season variations and any underlying trends)</i>	<i>Complies, this is a lesser standard than required by the Lead Local Flood Authority.</i>
<i>The total pollution risk score for the SuDS device (calculated in accordance with Appendix C Groundwater quality and runoff of Highways England LA113 (2020) and Table 26.6 of CIRIA C753 is <180</i>	<i>Complies, the total pollution risk score is, conservatively, 130.</i>
<i>The SuDS device is at least 5m away from any surface water feature including a river, stream or lake.</i>	<i>Complies.</i>

The total phosphorus load in runoff that can be infiltrated to ground can be deducted from the development's TP load. The total phosphorus load in surface water runoff generated from the urban land uses on the development is 0.27kg/year, all of which will be removed through infiltration.

¹ <https://publications.naturalengland.org.uk/publication/5143927928913920>

² <https://www.gov.uk/government/publications/river-avon-sac-nutrient-neutrality-calculator>



WASTEWATER TREATMENT STRATEGY

Foul flows from the proposed development will be treated at Wessex Water's Ratfyn STW which has a current total phosphorus (TP) discharge consent limit of 1.00mg/l.

The *Levelling Up and Regeneration Act* (LURA) 2023 requires larger wastewater treatment works in nutrient neutrality affected catchments to be upgraded to achieve a Technically Achievable Limit (TAL) for total phosphorus of 0.25mg/l by 1 April 2030. Ratfyn STW's permit limit will therefore be improved to 0.25mg/l by 1 April 2030.

The treated effluent will be discharged into the River Avon catchment.

The nutrient load calculations and mitigation strategy are detailed below.

NUTRIENT LOAD CALCULATIONS

The phosphorus load has been calculated based on foul flow treatment at Ratfyn STW. The calculations are informed by Natural England's Nutrient Neutrality Calculator for the River Avon modified with a site-specific PIMP value of 39% as measured from the indicative layout and uplifted by 10% to account for urban creep. The calculations use the following site-specific information:

- Soils: Freely draining.
- Within a Nitrate Vulnerable Zone: Yes.
- Annual rainfall: 750 – 800mm/year.
- Number of dwellings: 8.
- Ratfyn STW phosphorus treatment performance (pre-2030): 1.00mgTP/l.
- Ratfyn STW phosphorus treatment performance (post-2030): 0.25mgTP/l.

A summary of the nutrient load generated by the development is provided in Table 1. Full calculations are provided in **Appendix A**.

The calculations indicate that phosphorus mitigation will be required to deliver nutrient neutrality for the development both pre- and post-2030.

Table 1 – Phosphorus Load Calculations

Load Contribution	Total Phosphorus Load (kg/year)	
	Pre-2030	Post-2030
Wastewater load (A)	0.76	0.19
Future land use load (B)	0.29	0.29
Existing land use load (C)	0.07	0.07
Nutrient load removed through the SuDS (D)	0.27	0.27
Future nutrient load (= A + (B - C) - D)	0.70	0.13
Precautionary buffer (20%)	0.14	0.03
Future nutrient load	0.84	0.16

PREFERRED MITIGATION STRATEGY

The pre-2030 phosphorus load will be mitigated through the purchase of the relevant number of TP mitigation credits from a mitigation scheme approved by Natural England in the River Avon catchment. This will mitigate both the pre-2030 and post-2030 phosphorus loads.

The post-2030 phosphorus load of 0.16kg/year will require the purchase of *permanent* phosphorus credits. In contrast, the pre-2030 phosphorus load of 0.84kg/year could be mitigated through the purchase of 0.68kg of *temporary* phosphorus credits (if available in the catchment) plus the 0.16kg/year of *permanent* phosphorus credits required post-2030. If temporary credits are not available in the catchment, all of the 0.84kg of mitigation credits must be permanent.

This mitigation strategy will deliver phosphorus neutrality for the development.

MITIGATION CREDIT SCHEMES

Wiltshire Council is developing a mitigation credit scheme for the Avon catchment³. However, the Bulford Camp development does not qualify as ‘planned development’ which is defined as:

‘applications that comply with housing site allocation policies (Appendix D, Wiltshire Core Strategy) and / or Core Policy 2 (Delivery Strategy) of the Wiltshire Core Strategy apart from Core Policy 37 (Military Establishments).’

The Council scheme also does not currently have any credits available in the relevant sub-catchment for Bulford Camp or, indeed, any sub-catchment in the River Avon catchment.

Private developers of phosphorus mitigation schemes in the Hampshire Avon catchment are:

- **Greenshank Environmental** has a credit scheme in development in the relevant sub-catchment. They anticipate credits being priced at around £55,000 per kilogram of TP. Regulatory approvals are expected to be obtained in Spring 2026 with credit allocations available shortly thereafter.
- **PO4 Limited** operates a phosphorus credit scheme in Bicton, near Fordingbridge. Credits are priced at £75,000 per kilogram of phosphorus. Unfortunately, as Bicton is downstream of Ratfyn STW, credits from this scheme are not suitable for mitigation of the Bulford Camp development.
- **Environmental Trading Platform** is a broker of nutrient mitigation credits. ETP’s website currently shows no credit availability in the River Avon catchment. ETP has responded to a request for information confirming that they do not have any suitable credits available.
- **EnTrade** is a broker of nutrient mitigation credits. Their website currently shows no credit availability in the River Avon catchment. EnTrade have responded to a request for information confirming that they also do not have any suitable credits available.

The availability of phosphorus credits in the Avon catchment is very low, and the demand is likely to significantly exceed supply. It is recommended that the MOD immediately enter negotiations with Greenshank Environmental to secure a provisional allocation of credits.

ALTERNATIVE MITIGATION OPTIONS

If mitigation credits aren’t secured, alternative mitigation options exist but are likely to incur significantly higher costs and will require significant time, effort and costs to address design, planning, regulatory, delivery, commissioning and in-perpetuity⁴ management and operation. Potential examples include:

- Replacement of any existing septic tanks on Bulford Camp (or in the catchment upstream) with higher quality package treatment plants.
- Agricultural reversion to greenspace, meadow or wetland on MOD (or other) land holdings.
- Water efficiency improvements to existing properties on the base to reduce the volume of effluent discharged to Ratfyn STW.

³ <https://www.wiltshire.gov.uk/article/6209/Phosphorus-and-nitrogen-mitigation>

⁴ Defined by Natural England as the 90 – 125 year design life of the dwellings.



- Removal of surface water from the on-site combined network to reduce volumes of effluent discharged to Ratfyn STW.

Given the complexity of these approaches, they are only recommended if mitigation credits cannot be secured.

CONCLUSION

The surface water phosphorus load from the development will be treated through SuDS and infiltrated, removing 100% of the surface water phosphorus load. The foul flow phosphorus load will be treated through Ratfyn STW.

Without mitigation, the development will increase the phosphorus load in the River Avon catchment, and will not achieve phosphorus neutrality.

The preferred mitigation option is the purchase of nutrient mitigation credits from a Natural England-approved scheme in the River Avon catchment upstream of Ratfyn STW. The availability of phosphorus mitigation credits in the catchment is very low, and demand is likely to significantly exceed supply.

It is recommended that the MOD immediately enters into negotiations with Greenshank Environmental, the operators of the only known and potentially viable mitigation scheme in the catchment.

The purchase of mitigation credits will deliver phosphorus neutrality for the development.



APPENDIX A – NUTRIENT LOAD CALCULATIONS

Existing Landuse

Google Earth historic aerial mapping confirms that the land use has been primarily greenspace with a small area of unused road classed as open urban since at least 2005.

Land Use Classification	Area (ha)
Greenspace	1.07
Open urban	0.06
Total Area	1.13

2025



2017



2005

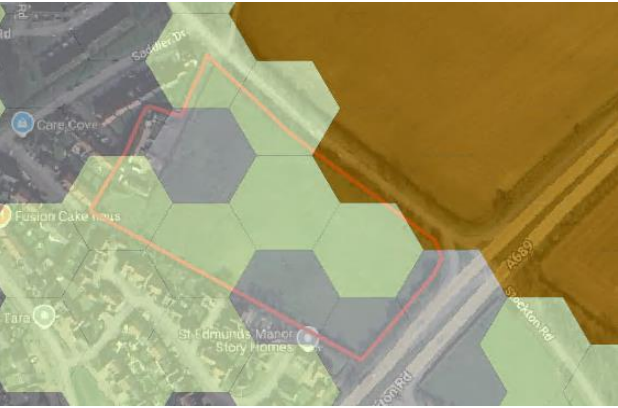


The Crop Map of England (CROME) confirms that the majority of the site is lowland grazing (light green tiles refer to 'Grass') plus a small area of existing urban (grey tile)

2023



2019



Future Landuse

Land Use Classification	Area (ha)
Residential urban land	0.51
Open urban	0.04
Greenspace	0.58
Total	1.13



Rainfall: Rainfall across site is in the range of 750mm to 80mm per year, based on information from the NRFA.

43021 - Avon at Knapp Mill

Soil Types: Soilscape 3 - freely draining shallow lime-rich soils over chalk or limestone

Nitrate Vulnerable Zone: The site is located within a Nitrate Vulnerable Zone

Table A.3: EMCs for nitrogen and phosphorus for three key types of urban land use.

Land use	Nitrogen concentration (mg N/l)	event mean	Phosphorus concentration (mg P/l)	event mean
Residential	2.85		0.41	
Commercial/industrial	1.52		0.30	
Open urban land	1.68		0.22	

The EMCs were combined with a standard method for calculating urban runoff which requires only rainfall as an input. The HR Wallingford Modified Rational Method was used, as shown in equation 1.

Equation 1

$$L = R * Pr$$

Where:

L = annual average runoff (mm)

R = annual average rainfall (mm)

Pr = percentage runoff (%)

$$Pr = 0.829 * PIMP + 0.078 * U - 20.7$$

$PIMP$ = the percentage of land that is impervious (whole number)

U = catchment wetness index. Calculated by (use 41 if rainfall over 760 mm):

$$U = -129.5 + (0.424 * R) - (2.28 * 10^{-4} * R^2) - (4.56 * 10^{-8} * R^3)$$

For phosphorus, the value for PIMP was set as 80%, as this has been suggested as the proportion of impervious surfaces once urban creep (the paving over of pervious surfaces) reaches a maximum. The use of an 80% PIMP value, while high, accounts for the potential increases in impervious surfaces that may occur over the lifetime of a development. Research has also suggested that non-paved gardens account for between 19-27% of the entire urban area. As gardens are the primary type of permeable surface within residential areas, the use of an 80% PIMP value is considered to be precautionary as an area with 19% coverage by non-paved gardens would indicate that around 80% of the remaining urban residential area would be impermeable surfaces.

Values based on 80% PIMP specified by Natural England

Variable	Residential Urban			Commercial/Industrial			Open Urban		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
L - Annual average runoff (mm)	366.14	390.54		366.14	390.54		366.14	390.54	
R - Annual average rainfall (mm)	750	800		750	800		750	800	
Pr - Percentage runoff (%)	48.82	48.82		48.82	48.82		48.82	48.82	
PIMP - Percentage of land that is impervious (%)	80	80		80	80		80	80	
U - Catchment wetness index (use 41 if rainfall > 760mm)	41.00	41.00		41.00	41.00		41.00	41.00	
Annual runoff (mm)	366.14	390.54		366.14	390.54		366.14	390.54	
Annual runoff (m)	0.37	0.39		0.37	0.39		0.37	0.39	
Volume per hectare (m ³ /ha/yr)	3661.35	3905.44		3661.35	3905.44		3661.35	3905.44	
TP EMC (mg/l)	0.41	0.41		0.30	0.30		0.22	0.22	
TP EMC (kg/l)	0.0004	0.0004		0.0003	0.0003		0.0002	0.0002	
TP Export Rate (kg/ha/yr)	1.50	1.60	1.55	1.10	1.17	1.14	0.81	0.86	0.83

Site-specific values based on housing density

A site-specific PIMP value of 35% has been adopted for the residential urban land use based on the development consisting of 'open housing' plus a 10% uplift to account for urban creep. The measured impermeable surface area is 0.17ha (33%) of the residential land use of 0.51ha.	
The site-specific PIMP:	35%
Urban creep allowance (10%)	4%
Site specific PIMP for the residential landuse	39%

Variable	Residential Urban			Commercial/Industrial			Open Urban		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
L - Annual average runoff (mm)	111.22	118.63		366.14	390.54		366.14	390.54	
R - Annual average rainfall (mm)	750	800		750	800		750	800	
Pr - Percentage runoff (%)	14.83	14.83		48.82	48.82		48.82	48.82	
PIMP - Percentage of land that is impervious (%)	39	39		80	80		80	80	
U - Catchment wetness index (use 41 if rainfall > 760mm)	41.00	41.00		41.00	41.00		41.00	41.00	
Annual runoff (mm)	111.22	118.63		366.14	390.54		366.14	390.54	
Annual runoff (m)	0.11	0.12		0.37	0.39		0.37	0.39	
Volume per hectare (m ³ /ha/yr)	1112.18	1186.32		3661.35	3905.44		3661.35	3905.44	
TP EMC (mg/l)	0.41	0.41		0.3	0.3		0.22	0.22	
TP EMC (kg/l)	0.0004	0.0004		0.0003	0.0003		0.0002	0.0002	
TP Export Rate (kg/ha/yr)	0.46	0.49	0.47	1.10	1.17	1.14	0.81	0.86	0.83

Figure 11.1 and Table 11.2 from Urban Drainage, Second Edition by David Butler and John Davies, 2004

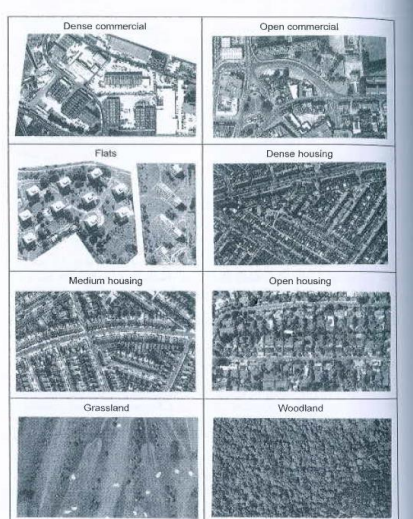


Table 11.2 Approximate percentage imperviousness of land-use types in London

Land-use category	PIMP
Dense commercial	100
Open commercial	65
Dense housing	55
Flats	50
Medium housing	45
Open housing	35
Grassland	<10
Woodland	<10

Fig. 11.1 Various land use categories in London (developed by Thames Water Utilities Ltd on their Beckton and Crossness sewerage modelling projects in association with consulting engineers BGP Reid Crowther Ltd and Montgomery Watson Ltd and reproduced with permission)

Bulford Camp - Nutrient Neutrality Calculation - 29 January 2026

Notes

- These calculations are based on the May 2024 Natural England calculation method modified with:
A) A site-specific PIMP value of 39% for the residential urban land use based on open density housing (35%) plus a 10% uplift to account for urban creep.
B) Urban runoff infiltrated with a TP removal efficiency of 100% as detailed in CIRIA C808.
- The proposed development consists of 8 residential dwellings.
- Foul flows will be treated at Ratfyn STW which has an existing TP discharge limit of 1.00mg/l and a post-2030 limit of 0.25mg/l.

LOAD CALCULATION

Site Characteristics

Total site area (ha)	1.13
Number of dwellings	8
No. of residents per dwelling (No.)	2.40
Wastewater volume - dwellings (litres/person/day)	120
Wastewater generated (litres/day)	2304

Wastewater Load

	Pre-2030	Post-2030
WWTW discharge consent limit (mg/l)	1.00	0.25
90% of WWTW consent limit (mg/l)	0.90	0.23
Nutrient load from wastewater (mg/day)	2074	518
Nutrient load from wastewater (mg/year)	757382	189346
Nutrient load from wastewater (kg/year)	0.76	0.19

Existing Landuse Load

Existing Land use	Area (ha)	Total Phosphorus Export Rate (kg/ha/year)	Total Phosphorus Load (kg/year)
Greenspace	1.07	0.02	0.02
Open Urban	0.06	0.83	0.05
Total	1.13	-	0.07

Future Landuse Load

Future Land use	Area (ha)	Total Phosphorus Export Rate (kg/ha/year)	Total Phosphorus Load (kg/year)
Residential urban land	0.51	0.47	0.24
Open urban	0.04	0.83	0.03
Greenspace	0.58	0.02	0.01
Total	1.13	-	0.29

SuDS Urban Land Use Load Reduction

Total nutrient load from urban land draining to the SuDS (kg/year)	0.27
Estimated SuDS removal efficiency (%)	100.0%
Total SuDS nutrient reduction (kg/year)	0.27

Future Nutrient Load

	Total Phosphorus Load (kg/year)	
Load Contribution	Pre-2030	Post-2030
Wastewater load (A)	0.76	0.19
Future land use load (B)	0.29	0.29
Existing land use load (C)	0.07	0.07
Nutrient load removed through the SuDS (D)	0.27	0.27
Future nutrient load (= A + (B - C) - D)	0.70	0.13
Precautionary buffer (20%)	0.14	0.03
Future nutrient load	0.84	0.16

Conclusions

- The existing land use has been split into greenspace and open urban based on Google Earth historical aerial imagery.
- The existing landuse TP export rates have been obtained from the Natural England Calculator.
- The future landuse areas have been taken from the Indicative Masterplan.
- A site-specific residential urban land use phosphorus export rate has been derived using a site-specific percentage impermeability (PIMP) value and has been used instead of the default value specified by NE which was based on unrealistically high PIMP values (80%). The calculations are detailed in the 'Urban P Export Rate & PIMP' tab.
- The SuDS strategy for the development consists of infiltration to ground. The SuDS will be designed in accordance with CIRIA C753 *The SuDS Manual* to treat all sub-annual rainfall events. In accordance with CIRIA C808 *Using SuDS to reduce phosphorus in surface water runoff* a SuDS total phosphorus removal efficiency of 100% has been adopted.
- The development will not be phosphorus neutral and will require mitigation of the pre-2030 residual TP load of 0.84kg/year. As the post-2030 load is smaller than the pre-2030 load, no further mitigation would be required post-2030.
- The pre-2030 residual phosphorus load will be fully mitigated through the purchase of 0.84kg of TP mitigation credits. The credits will then fully mitigate the post-2030 development and provide nutrient neutrality.
- The proposed development will be phosphorus neutral.

Screenshot of Natural England's Nutrient Export Coefficients

Current land use information		Data entry column - user inputs required			
Description of required information					
Operational catchment:				Avon Hampshire	
Soil drainage type:				Freely draining	
Annual average rainfall (mm):				750.1 - 800	
Within nitrate vulnerable zone (NVZ):				Yes	
Current land uses					
Existing land use type(s) - user inputs required		Area (ha) - user inputs required	Annual phosphorus export (kg TP/yr)		
Greenspace		1.00	0.02		
Open urban land		1.00	0.83		
Residential urban land		1.00	1.55		