



Nitrate Neutrality Study – First Residential Parcel One Horton Heath

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Executive Summary

Hilson Moran has been appointed by the One Horton Heath Project Team (HHPT) at Eastleigh Borough Council (EBC) to provide a Nitrate Neutrality Study for the development of its One Horton Heath site in Hampshire, centred approximately on National Grid Reference SU 48815 17105.

To facilitate timely delivery, initially two planning applications will be submitted:

1. An Outline Planning Application (OPA) for the whole One Horton Heath project which will comprise:
“the comprehensive development of the site, delivering up to 2,500 No. residential dwellings, local employment, local retail, leisure, employment and community facilities, primary school, formal and informal publicly accessible open space, including formal sports facilities, landscaping, green infrastructure and sustainable drainage systems [SuDS]”; and
2. A full planning application for the first phase of the One Horton Heath project, located in the south east corner of the OPA site, which will comprise;
“Erection of 381 residential units with public open space, hard and soft landscape works, internal roads, footway/cycleways, associated parking spaces, substation, SuDS and associated infrastructure (This application is subject to Environmental Impact Assessment).”

The First Residential Parcel application (hereafter referred to as FRP) forms Phase 1 of the wider Outline Planning Application, providing 381 of the 2,500 dwellings for which outline consent is sought. The FRP has been submitted as a standalone planning application to enable the early delivery of homes within the One Horton Heath development. However, the FRP proposal is entirely consistent with the outline parameter plans, with detailed assessment of the OPA and FRP having been considered in tandem to ensure consistency throughout the design process. In part, the FRP is reliant on the mitigation and enhancements of the OPA.

A detailed Nitrate Neutrality Study for the wider OPA scheme has been prepared by Hilson Moran, namely report 25709-RP-SU-02, dated 17/09/21.

This report provides a summary of the evidence gathered to support the Nitrate Neutrality Study for the Horton Heath OPA scheme, of which the FRP constitutes the first phase.

The OPA Nitrate Neutrality Study has demonstrated that

- 1) The total nitrogen (N)-loss from pre-existing agricultural uses from the whole pre-existing OPA site has been derived using site visits, farmer questionnaires and interviews, together with Farmscoper modelling (including an appropriate allowance (-4.3 %) to reflect the adoption of nitrate reducing farming practices within a Nitrate Vulnerable Zone (NVZ)) as **3,452.2 N/yr**. Spread over a farmed area of 115.82 ha, this equates to an average N-loss of **29.8 kg N/ha/yr**, which is slightly above the 26.9 kg N/ha/yr figure cited by NE as an average N-loss for all farm types within the Solent catchment area.
- 2) In addition, in line with Natural England (NE) guidance, the remaining 8.88 ha of pre-existing dwellings, other buildings and highways are classed as “urban development” with an assumed N-loss of 14.3 kg/ha/yr, equating to **127.0 kg N/yr**.
- 3) The wastewater generated by the proposals will be conveyed to Chickenhall Wastewater Treatment Works (WwTW) where it will be treated and discharged without any permit

concentration limit for total nitrogen (TN), with an estimated discharge concentration of 27 mg/l TN.

- 4) A standard NE Methodology has been used together with Farmscoper modelling of existing agricultural N losses and a bespoke calculation for the assessment of wastewater N from pre-existing dwellings, as none of them are connected to the adopted foul water sewer system or discharge through a WwTW;
- 5) The results identify that a total of **4,374.5 TN/yr** will need to be neutralised in order to mitigate against the proposed development.
- 6) As part of the proposals, it is intended to construct a network of Sustainable Drainage System (SuDS) features across the site comprising permeable pavements, rain gardens, swales and basins to sustainably manage runoff from the scheme. All detention basins will be planted and optimised for N-removal, including permanently wet areas around inlets (sediment forebays), outlets (secondary sedimentation areas) and wetland areas within the base of the features.
- 7) Stormwater wetlands have been shown to remove N from runoff through processes such as denitrification and sedimentation. 65.4 % of the runoff from the developed areas of the proposed scheme will be intercepted and conveyed through the network of “*Strategic SuDS Features*” (detention basins). 57.98 ha of developed areas will be positively drained. Using an average TN leaching rate from urban areas of 14.3 kg/ha/yr (as recommended by NE) and assuming that a N removal efficiency of 61% can be readily achieved with the network of optimised detention basins and associated swales, it is estimated that **330.8 kg N/yr** can be removed by the system.
- 8) Parcel 51 in the south-eastern corner of the masterplan, is covered by a separate planning application (Ref. X/19/86475). The 5.29 ha parcel of land, which lies on freely draining soils, is currently used for agriculture but will be used to provide the south eastern access road and roundabout for the scheme, together with public open space (POS). Consequently, it has been calculated that removal of this land from agricultural will result in a reduction of **37.6 kg N/yr** from the catchment.
- 9) It is intended that the remaining **4006.1 kg N /yr** increase in N-loss to the Solent, associated with the One Horton Heath (OHH) scheme, will be wholly mitigated through EBC’s own nitrate offsetting scheme.

As the FRP forms part of the wider OPA scheme, it will serve to contribute to the above N budget through:

- a. The elimination of N-losses from pre-existing agricultural uses by taking arable and pastoral farmland out of production;
- b. Limiting sewage-related N-loss, by conveying foul sewage to Chickenhall Lane WwTW, where it will be treated and discharged at an estimated concentration of 27.0 mg/l TN; and
- c. Treating N in runoff from the development by means of a network of SuDS features, included as part of the FRP scheme.

Calculations provided in this report estimate that:

1. As part of the wider scheme, the FRP will equate to a loading of **-2,452.4 kg TN /yr** required to be neutralised at this stage of the OHH development.

2. 4.573 ha (33.3 % of the FRP area) will be positively drained, with all intercepted runoff draining through at least 1 detention basin. Of this, 0.952 ha will drain through two detention basins, whilst additional water quality enhancement will be provided by 110 m of interconnecting vegetated swales. Consequently, it is assumed that a 61 % N removal efficiency will be achieved for all positively drained stormwater, with the remaining stormwater lost to infiltration through the soft landscaped areas of the development (including gardens, verges, POS and other small areas of open space within the urban fabric). This will result in a further **38.9 kg/TN /yr** prevented from reaching the Solent and influencing the qualifying features of its internationally designated sites.
3. Subsequently, as part of the wider scheme, the FRP will equate to a loading of **-2,491.3 kg TN /yr** required to be neutralised at this stage of the OHH development (*i.e.* a net reduction in N-loss compared to the pre-existing situation) and thus, there is no requirement for mitigation using EBC's own nitrate offsetting scheme at this stage of the OHH development

Consequently, the impacts of the FRP and the wider OPA scheme proposals will be fully mitigated and will ensure that they do not detrimentally affect local biodiversity or the conservation status of the downstream European Designated Sites

1. Introduction

Hilson Moran has been appointed by HHPT at EBC to provide a Nitrate Neutrality Study for the development of its Horton Heath site in Hampshire, centred approximately on National Grid Reference SU 48815 17105 and identified in Figure 1.1.

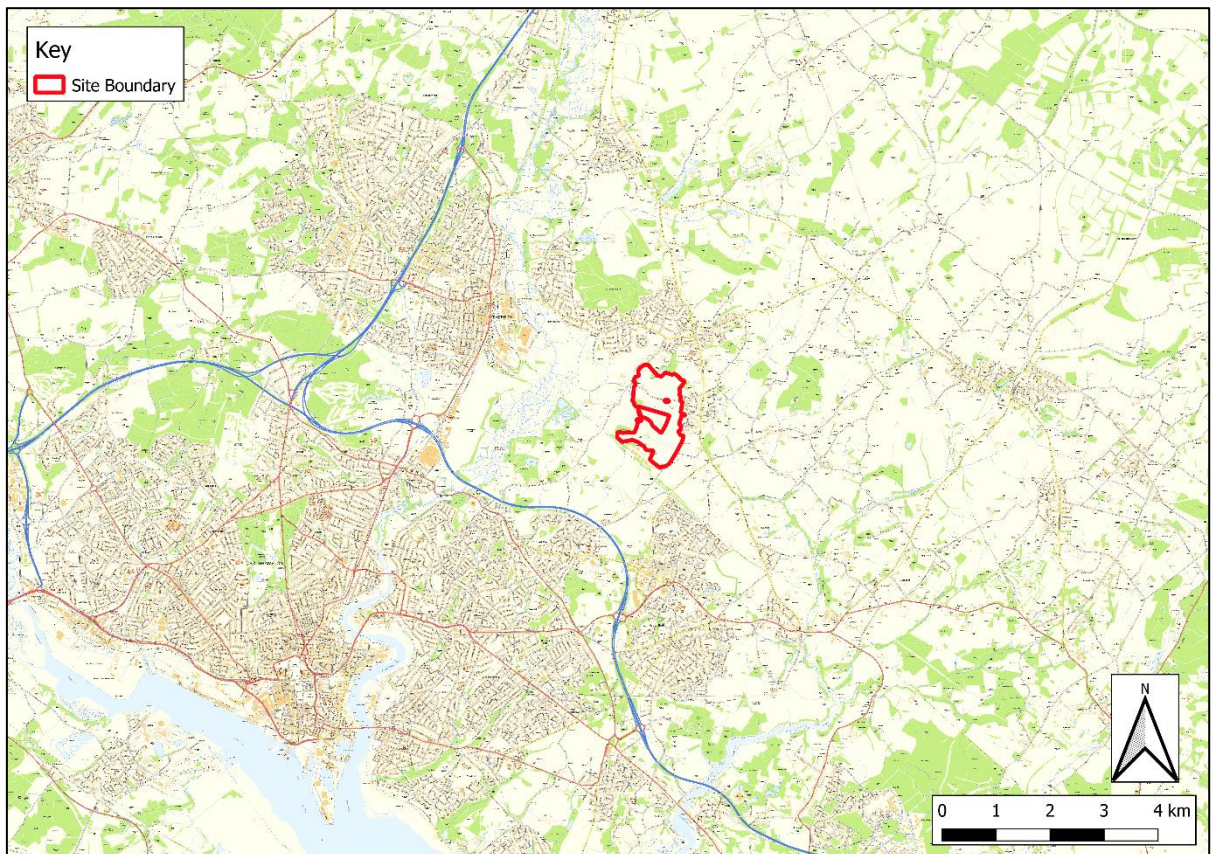


Figure 1.1 OPA Site location and boundary

The OPA for the whole One Horton Heath project which will comprise:

“the comprehensive development of the site, delivering up to 2,500 No. residential dwellings, local employment, local retail, leisure, employment and community facilities, primary school, formal and informal publicly accessible open space, including formal sports facilities, landscaping, green infrastructure and sustainable drainage systems [SuDS]”; and

The FRP is located in the south-east corner of the OPA site and constitutes the first phase of the One Horton Heath project. It will comprise:

“Erection of 381 residential units with public open space, hard and soft landscape works, internal roads, footway/cycleways, associated parking spaces, substation, SuDS and associated infrastructure (This application is subject to Environmental Impact Assessment).”

The FRP forms Phase 1 of the wider Outline Planning Application, providing 381 of the 2,500 dwellings for which outline consent is sought. The FRP has been submitted as a standalone planning application to enable the early delivery of homes within the One Horton Heath development. However, the FRP proposal is entirely consistent with the outline parameter plans, with detailed assessment of the OPA and FRP having been considered in tandem to ensure

consistency throughout the design process. In part, the FRP is reliant on the mitigation and enhancements of the OPA.

The layout of the FRP scheme is presented in Figure 1.2 below:



Figure 1.2 **Layout of FRP**

1.1. Background

Residential and tourism development applications within the Hampshire area have been being delayed or not permitted for more than a year due to the impacts associated with nitrate concentrations reaching the Solent and influencing the qualifying features of internationally designated sites associated with the Solent. These designated sites are the Solent Maritime Special Area of Conservation (SAC), Portsmouth Harbour Special Protection Area (SPA), Chichester and Langstone Harbours SPA and Solent and Southampton Water SPA).

Additional nitrate loadings from new development, principally associated with increased wastewater generation, has been identified to be causing algal blooms within the Solent that influence dissolved oxygen levels within the marine waterbody as well as smothering food resources for birds and marine life.

Developments that can provide mitigation that delivers nitrogen neutrality are permissible, *i.e.* those that include mitigation to remove an equal volume of nitrate from the catchment as they contribute can proceed as they demonstrate no impact upon the qualifying features of the designated sites.

1.2. Purpose

This Nitrate Neutrality Study has been produced to accompany the full application for the FRP scheme and to provide sufficient evidence to both EBC and Natural England (NE) that nitrate neutrality can be achieved as part of the OPA scheme, in order to avoid any detrimental impacts on downstream European Designated Sites.

1.3. Structure

The following sections of the report provide an introduction to the study, followed by a summary of the OPA nitrate neutrality study.

References are included at the end of the report with document control information included at the front.

1.4. Scope of the Assessment

This document comprises the Nitrate Neutrality Study for the FRP, as part of the wider One Horton Heath scheme.

1.5. Limitation and Copyright

This report has been prepared on behalf of and for the exclusive use of EBC and is subject to and issued in connection with the provisions of the agreement set out by Hilson Moran. Hilson Moran accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this report by any third party.

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1.6. Declaration of Competency

This assessment has been carried out by Dr Paul Bond PhD MSc BSc CEnv CSci MEnvSc MCIEEM. Paul possesses over 30 years' experience of environmental, civil engineering and industrial projects within commercial, public and academic sectors. Paul has previously worked as a Local Authority Drainage Engineer and holds a doctorate in SuDS design. He possesses post-doctoral research experience in bacterial nitrogen transformations and is also a competent Ecologist, possessing 20 years environmental consultancy experience. He has particular expertise in sustainable surface water management, water resource studies and flood risk assessment. As such, Dr Paul Bond is suitably qualified and experienced to conduct and direct the Horton Heath Nitrate Neutrality Study.

Paul is Associate within Hilson Moran's Infrastructure and Environment Team, which includes a number of other highly skilled and multi disciplined Engineers, Hydrologists and Ecologists with extensive practical experience in the design of surface water management networks. Our team are highly experienced in wetland, drainage and SuDS feasibility studies, strategies and detailed design. At the time of writing this report Hilson Moran's application as an Accredited Member of the Constructed Wetland Association (CWA) was pending. The CWA exists to promote the application of Constructed Wetland technology for water pollution control.

2. Approach

2.1. Background

There is currently uncertainty surrounding whether the condition of designated ecological areas located within the Solent Region will be detrimentally impacted by increases in discharges of treated sewage effluent from future housing growth in the area. This issue has been subject to ongoing detailed work commissioned by local planning authorities in association with NE, the EA and water companies. Until this work is complete, NE maintains the stance that the uncertainty remains and the potential for future housing developments across the Solent Region to exacerbate these impacts creates a risk to the potential future conservation status of designated sites. Consequently, NE has stated that one way to address this uncertainty is for new development to achieve nutrient neutrality by securing the required mitigation in compliance with the Habitats Regulations.

NE has developed a recommended methodology to determine the potential impact of new developments on local designated sites. Hilson Moran has been appointed by HHPT to provide a detailed Nitrate Neutrality Study for the development of its Horton Heath site in Hampshire. The aim of the study is to refine the NE approach, in order to provide a robust assessment of the impact of the development on downstream European Designated Sites and to inform the selection of appropriate mitigation measures for the scheme.

2.2. European Designated Sites

The Habitats Directive and Conservation of Habitats and Species Regulations 2017 (as amended) make reference to the consideration of likely significant effects of a project or plan on one or more European Sites, including Special Protection Areas (SPAs) and Special Areas of Conservation (SACs).

However, national planning policy provided by the National Planning Policy Framework (NPPF)¹, also expects those sites under consideration for designation, *i.e.* potential SPAs (pSPAs) and candidate SACs (cSACs), Ramsar sites and areas identified to provide compensatory sites, to be considered through the Habitats Regulations Assessment (HRA) process. The legislation/agreement governing the designation of the sites are described further below:

- SPAs – classified under the European Council Directive 79/49/EEC ‘on the conservation of wild birds’ (also known as the ‘Birds Directive’) for the protection of wild birds and their habitats, including particularly rare and vulnerable species listed in Annex I of the Directive and migratory species;
- SACs – designated under European Council Directive 92/43/EEC ‘on the conservation of natural habitats and of wild fauna and flora’ (also known as the ‘Habitats Directive’), targeting particular habitats (listed on Annex I) and/or species (listed on Annex II) that are identified as being of European importance;
- Ramsar – listed under the Convention on Wetlands of International Importance (Ramsar Convention, 1971) as sites that support important wetland habitats and species, especially waterfowl habitat; and,
- Compensatory Sites – sites that have been identified to provide compensatory habitat for that impacted by plans or projects permitted through the ‘imperative reasons for overriding public interest’ (IROPI) assessment.

For ease of reference, these designations are collectively referred to within this Nitrate Neutrality Study report as 'European Designated Sites', despite Ramsar designations being made at the international level. SPAs and SACs are also referred to in guidance documents as 'Natura 2000' sites.

2.3. Methodology

The Nitrate Neutrality Study methodology is based on the standard NE approach (included in **Appendix 1**) with Farmscoper modelling of existing agricultural N losses and a bespoke calculation for the assessment of wastewater N from pre-existing dwellings, as none of them are connected to the adopted foul water sewer system or discharge through a WwTW.

3. Results

3.1.1. OPA Results

The OPA Nitrate Neutrality Study demonstrated that:

- 1) The TN-loss from pre-existing agricultural uses from the whole pre-existing OPA site has been derived using site visits, farmer questionnaires and interviews, together with Farmscoper modelling (including an appropriate allowance (-4.3 %) to reflect the adoption of nitrate reducing farming practices within a NVZ) as **3,452.2 N/yr**. Spread over a farmed area of 115.82 ha, this equates to an average N-loss of **29.8 kg N/ha/yr**, which is slightly above the 26.9 kg N/ha/yr figure cited by NE as an average N-loss for all farm types within the Solent catchment area.
- 2) In addition, in line with NE guidance, the remaining 8.88 ha of pre-existing dwellings, other buildings and highways are classed as “urban development” with an assumed N-loss of 14.3 kg/ha/yr, equating to **127.0 kg N/yr**.
- 3) The wastewater generated by the proposals will be conveyed to Chickenhall WwTW where it will be treated and discharged without any permit concentration limit for TN, with an estimated discharge concentration of 27 mg/l TN.
- 4) A standard NE Methodology has been used together with Farmscoper modelling of existing agricultural N losses and a bespoke calculation for the assessment of wastewater N from pre-existing dwellings, as none of them are connected to the adopted foul water sewer system or discharge through a WwTW;
- 5) The results identify that a total of **4,374.5 TN/yr** will need to be neutralised in order to mitigate against the proposed development.
- 6) As part of the proposals, it is intended to construct a network of SuDS features across the site comprising permeable pavements, rain gardens, swales and basins to sustainably manage runoff from the scheme. All detention basins will be planted and optimised for N-removal, including permanently wet areas around inlets (sediment forebays), outlets (secondary sedimentation areas) and wetland areas within the base of the features.
- 7) Stormwater wetlands have been shown to remove N from runoff through processes such as denitrification and sedimentation. 65.4 % of the runoff from the developed areas of the proposed scheme will be intercepted and conveyed through the network of “*Strategic SuDS Features*” (detention basins). 57.98 ha of developed areas will be positively drained. Using an average TN leaching rate from urban areas of 14.3 kg/ha/yr (as recommended by NE) and assuming that a N removal efficiency of 61% can be readily achieved with the network of optimised detention basins and associated swales, it is estimated that **330.8 kg N/yr** can be removed by the system.
- 8) Parcel 51 in the south-eastern corner of the masterplan, is covered by a separate planning application (Ref. X/19/86475). The 5.29 ha parcel of land, which lies on freely draining soils, is currently used for agriculture but will be used to provide the south eastern access road and roundabout for the scheme, together with public open space (POS). Consequently, it has been calculated that removal of this land from agricultural will result in a reduction of **37.6 kg N/yr** from the catchment.

- 9) It is intended that the remaining **4006.1 kg N /yr** increase in N-loss to the Solent, associated with the One Horton Heath (OHH) scheme, will be wholly mitigated through EBC's own nitrate offsetting scheme.

3.1.1. NE Methodology Calculation for FRP

With regard to the contribution to overall N-loss that the FRP scheme:

1. As demonstrated in the OPA Nitrate Neutrality Study, the OHH development will result in the cessation of **3,452.2 kg N/yr** from pre-existing agricultural uses reaching the Solent and influencing the qualifying features of its internationally designated sites.
2. With reference to the OPA Nitrate Neutrality Study, the OHH development will also result in the cessation of **86.6 kg N/yr** from pre-existing sewage emissions from the site.
3. The FRP has a site area of 13.75 ha (137,471 m²). Of this area, 10.78 ha (107,765 m²) comprises the "urban development area" made up of the built form, gardens, road verges and small areas of open space within the urban fabric (as delineated by the yellow boundary in Appendix 1 of this document), with the remaining 2.97 ha comprising new open space and green infrastructure, including "soft SuDS" features such as detention basins and swales.
4. The FRP will include the construction of 381 residential units. Using the 2.4 residents per dwelling national occupancy rate (calculated by the Office for National Statistics (ONS)) as recommended by NE, this equates to the introduction of (381 x 2.4) = 914 residents. This equates to $914 / 6,005 \times 100 = 15.2\%$ of the total number of residents associated with the entire OPA scheme.
5. Following the NE Methodology steps, the approximate net change that would result from the FRP development is presented below:

3.1.1.1. Stage 1 - Calculate Total Nitrogen (TN) in kilograms per annum derived from the development that would exit the Wastewater Treatment Works (WwTW) after treatment

Note that:

1. The bespoke approach used in the OPA for the assessment of wastewater N losses from pre-existing dwellings has been used for the FRP (as none of them are connected to the adopted foul water sewer system or discharge through a WwTW).
2. A dwelling occupancy rate of 2.4 persons per dwellings has been used in line with NE guidance.
3. The post-development wastewater discharge volume has been calculated assuming a daily water usage of 110 l/person/day and a 100 % "return-to-sewer" rate, as per NE guidance.

STAGE 1 – CALCULATION OF TOTAL NITROGEN (TN) LOAD FROM DEVELOPMENT WASTEWATER				
Step	Measurement	Value	Unit	Explanation
Development proposal	Development types that would increase the population served by a wastewater system	381	Residential dwellings	
Step 1	Development residential population	914	Persons	Refer to point 4 in Section 3.1.1 above for derivation of development residential population.
Step 2	Wastewater volume generated by development	100,540	litres/day	914 persons (step 1) x 110 litres.
Step 3	Receiving WwTW environmental TN permit limit.	27.0	mg/l TN	No consent limit for Chickenhall WwTW, so assumed to be a discharge concentration of 27.0 mg/l as per NE Methodology.
Step 4	Deduct acceptable TN loading (@ 2 mg/l TN) as per NE Methodology.	25.0	mg/l TN	27.0 (step 3) – 2.0 mg/l TN.
Step 5	TN discharged after WwTW treatment	2,513,500	mg TN/day	100,540 (step 2) x 25.0 (step 4) = 2,513,500
Step 6	Convert mg/TN to kg/TN per day	2.51	kg TN/day	Divide by 1,000,000
Step 7	Convert kg/TN per day to kg/TN per year	917.4	kg TN/yr	2.59 x 365 days
Step 8	Calculate pre-existing foul sewage N loss	86.6	kg TN/yr	Bespoke calculation as per Section 3.1.7 and Appendix 12 of the OPA Nitrate Neutrality Study, as no pre-existing dwellings connected to Southern Water adopted foul water sewage network.
Step 9	Calculate wastewater total nitrogen load by subtracting pre-existing load from post-development load	830.8	kg TN/yr	917.4 (step 7) – 86.6 (step 8)

Wastewater total nitrogen load	830.8 kg TN/yr
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3.1.1.2. Stage 2 - Adjust nitrogen load to account for existing nitrogen from current land use

Note that a bespoke calculation using Farmscoper has been conducted to determine agricultural nitrate loss, in line with NE methodology (refer to Section 3.1.6 and Appendices 2, 3, 7, 8, 9 and 10 of the OPA Nitrate Neutrality Study for details).

STAGE 2 – NITROGEN LOAD FROM CURRENT LAND USE	
Nitrogen load from current land use	3,452.2 kg TN/yr

3.1.1.3. Stage 3 - Adjust nitrogen load to account for land uses with the proposed development

STAGE 3 – CALCULATION OF NITROGEN LOAD FROM FUTURE LAND USES				
Step	Measurement	Value	Unit	Explanation
Step 1	New urban area	10.78	Hectares	Refer to point 3, Section 3.1.1 above.
Step 2	Nitrogen load from future urban area	154.15	kg N/yr	10.78 ha x 14.3 kg N/yr
Step 3	New open space (greenspace and soft landscaping)	2.97	Hectares	Refer to point 3, Section 3.1.1 above.
Step 4	Nitrogen load from open space	14.85	kg N/yr	2.97 ha x 5.0 kg N/yr
Step 5	Combine nitrogen load from future land uses	169.0	kg N/yr	154.15 (step 2) + 14.85 (step 4) =
Nitrogen load - future land uses	169.0 kg TN/yr			

3.1.1.4. Stage 4 - Calculate the net change in the Total Nitrogen load that would result from the development

STAGE 4 – CALCULATION OF THE NET CHANGE IN NITROGEN LOAD FROM THE DEVELOPMENT				
Step	Measurement	Value	Unit	Explanation
Step 1	Identify nitrogen load from wastewater (Stage 1)	830.8	kg TN/yr	Refer to Stage 1 above

Step 2	Calculate the net change in nitrogen from land use change - subtract existing land uses nitrogen load (stage 2) from future land uses nitrogen load (stage 3)	-3,283.2	kg TN/yr	169.0 (Stage 3) - 3,452.2 (Stage 2) = -3,283.2 kg TN/yr
Step 3	Determine nitrogen budget – the Total Nitrogen wastewater load for the proposed development plus the change in nitrogen load from land use change	-2,452.4	kg TN/yr	830.8 (step 1) + -3,283.2 (step 2) = -2,452.4 kg TN/yr
Step 4	Where TN budget is positive add 20% precautionary buffer	-2,452.4	Kg TN /yr	N/A
Total Nitrogen that needs to be neutralised	-2,452.4 kg TN /yr			

4. Mitigation Measures

4.1. General Mitigation Measures

As part of this Nitrate Neutrality Study, a high-level assessment of mitigation measures suitable for the proposed scheme was conducted early on in order to inform the design process and final mitigation measures, if required. The results of this assessment are presented as **Appendix 15** of the Hilson Moran OPA Nitrate Neutrality Study.

The report identified 4 main mitigation options that could have potential for the scheme. These comprised:

- 1) Addressing agricultural inputs within the catchment through the application of best practise measures, incorporating technology and providing intercepting wetlands. Although the success of these measures would be dependent upon identifying appropriate farmsteads within the River Itchen Fluvial Catchment and willing individuals to engage with the process, it was identified within the report that the provision of wetlands could be a valuable measure provided within the boundary of the post-development scheme, providing multifunctional water quality, flood prevention, biodiversity and amenity features.
- 2) The introduction of a suitable Reverse Auction Scheme for nitrogen reduction, in collaboration with Southern Water, which would offer funding to farmers in exchange for commitments that provide a reduction in the input of nitrogen in to the catchment. Whilst this mitigation option has significant and proven potential to reduce nitrogen inputs at a catchment level for the benefit of sensitive habitats downstream, it is currently unclear whether it is a realistic option for Horton Heath within the timeframe associated with the increase in residential occupancy resulting from the scheme.
- 3) On-site wastewater denitrification, either by providing a number of appropriate package treatment works across the proposed development or alternatively providing a single centralised on-site wastewater treatment plant. The report identified that this approach could wholly deliver the nitrate neutrality required and even result in a nitrate deficit, compared to the pre-existing agricultural uses of the site.
- 4) Offsetting, with the removal of low-grade agricultural land within the same catchment and returning it to unproductive green infrastructure with biodiversity and amenity value.

With regard to the mitigation measures listed above:

- 1) Horton Heath and its environs already lie within a NVZ which has been designated by DEFRA to protect water quality from nitrates from agricultural sources. As such, all farmers within the Itchen catchment are obliged to follow an Action Programme and follow a series of measures on fertilizer application to minimise the risk of nitrates polluting ground or surface water. Those who do not comply can be fined by the Government. Consequently, as the regulation of NVZs and the encouragement of farmers to adopt nutrient reduction measures lie largely with the government bodies such as the Environment Agency, DEFRA, the Rural Payments Agency and Natural England, the ability of EBC to influence farmers further may well be limited, however, the use of wetlands has been identified as a necessary measure to remove nitrate in runoff from within the site, whilst providing multifunctional water quality, flood prevention, biodiversity and amenity features.

- 2) It is understood that the UK Government is planning to establish an online ‘nitrate trading’ auction platform in the medium term, where developers will be able to buy credits from landowners looking to create new and less ‘nitrogen intensive’ habitats. The platform is expected to be rolled out over the next two years and will be delivered jointly between DEFRA, Ministry of Housing, Communities & Local Government, Natural England and the Environment Agency. However, this initiative will not be up and running in time to provide mitigation for the One Horton Heath scheme.
- 3) The Environment Agency has a presumption against private sewage treatment works in sewered areas and will always seek connection to the mains sewer where possible and practicable. A principal concern relates to the failure rates of package treatment plants (PTPs) and the lack of review and periodic upgrades via regulatory systems that apply to mains. Consequently, there may be some regulatory inertia against the adoption of development-scale package treatment plants, at least for the foreseeable future.
- 4) EBC are currently putting in place a land assembly project that will provide a permanent Borough wide nitrate mitigation approach. Consequently, it is anticipated that this scheme will be used to wholly offset the remaining increase in N-loss to the Solent associated with the OHH scheme.

4.2. Provision of Sustainable Drainage Systems (SuDS)

As part of the OPA proposals, it is intended to construct a network of SuDS features across the site comprising basins, swales, ponds and wetlands to sustainably manage runoff from the scheme as illustrated in **Appendix 2** of this report.

It is intended that all the proposed SuDS features will be planted and incorporate permanently wet areas around inlets (sediment forebays), outlets (secondary sedimentation areas) and wetland areas within the base of the features, as illustrated in Appendix 15.

With reference to the NE Nitrate Neutrality Methodology (refer to **Appendix 1** of the of the Hilson Moran OPA Nitrate Neutrality Study), the ability of wetlands to remove nitrogen from runoff through processes such as denitrification and sedimentation has been demonstrated in numerous studies.

In particular, NE cites a recent systematic review of the effectiveness of wetlands for N (and P) removal conducted by Land *et al*, 2016³ which used data from 203 wetlands worldwide. The median N removal rate for wetlands that were included in this review was 93 g/m²/yr, which equates to a median N removal efficiency of 37%. The Land *et al* paper considers a range of different types of wetlands receiving a variety of inputs including effluents, agricultural runoff *etc*. Only 7 of the 203 wetlands reviewed received urban stormwater/runoff and these have not been separately identified in the paper.

Furthermore, the study considers a wide range of wetland areas from between <100 m² to 6.7 x 10⁷ m² with a negative correlation noted between wetland area and removal rate. Conversely, positive correlations were observed between N-removal rate and inlet N-concentration, together with hydraulic loading, although the removal efficiency maximised at intermediate concentrations (0.05–0.5 mg/l) at the wetland inlet. From the literature, urban runoff typically possess a N concentration ranging from around 0.5 to 5 mg/L so it is anticipated that the removal rate in the OHH SuDS will be greater than the 37 % median N removal rate observed by Land *et al* for all wetland types and sizes.

Alternatively, a similar, yet more relevant review has been conducted by Koch *et al* (2014)⁴ which is restricted to 701 papers on drainage features only receiving stormwater, such as urban stormwater ponds, wetlands, and swales. The paper demonstrates that wet ponds exhibited a median N-removal rate of 40 %, wetlands 61 % and swales 50 %. The paper also highlights the importance of utilising a SuDS treatment train in maximizing N removal, with associated peak flow and sediment reduction. N removal efficiency increased not only cumulatively but also for individual SuDS features further along a treatment train.

A similar review of nutrient (and other pollutant) removal efficiencies by stormwater treatment features was conducted by the US EPA and presented in their “*National Pollutant Removal Performance Database for Stormwater Treatment Practices*” (2000)⁵. This review of 139 individual stormwater practices, incorporating 39 stormwater wetlands, reported a median NOx percentage removal efficiency of 67 % (as such, a precautionary approach has been taken in this report and the lower median N- removal rate of 61 % cited by Koch *et al* (2014) has been deemed as readily achievable by the optimised detention basins to be provided throughout the OHH scheme).

Jani *et al* (2020)⁶ have demonstrated that particulate organic nitrogen (PON) constitutes c.22 % of the total N in stormwater runoff, with the remaining 78 % comprising dissolved forms (*i.e.* dissolved organic nitrogen (DON): 47 %, nitrate/nitrite-N: 17 % and ammonium-N: 14 %). Consequently, Koch *et al* state that

“treatment trains that begin with a large pond or wetland that is effective at slowing runoff and reducing particulate delivery may also minimize N export via a series of smaller cells that target dissolved nutrients. Successively shallower cells may have high surface area-to-volume ratios, greater light penetration, and increasing water temperatures that are favorable for biotic uptake of N. Sediment forebays, which are depressions near the inlets of stormwater ponds and wetlands, can also increase retention of coarse sediments and particulate nitrogen and thereby minimize clogging of drainage infrastructure and ease maintenance requirements.”

The paper therefore advocates initial sedimentation in deeper water to remove PON, followed by shallower more extensive wetted areas where microbial removal of nitrate by denitrification can take place in saturated anoxic sediments. The inclusion of sediment forebays within detention basins will therefore maximise not only PON removal, but also P removal which largely takes place through sedimentation of particulate P and subsequent uptake by aquatic plants.

The Koch *et al* paper also highlights the importance of the saturated zone in maintaining N-removal in SuDS features, together with the presence of plant species with extensive and fine root systems in enhancing the removal of nitrate and TN from the stormwater effluent. The paper demonstrates that all plant species were effective under conditions of frequent dosing, but extended drying increased variation between species and highlighted the importance of a saturated zone in maintaining biofilter function. The saturated zone also effectively treats the volume of stormwater stored between inflow events. As such, it was demonstrated that the saturated zone reduced performance differences between plant species, and potentially acted as an 'insurance policy' against poor sub-optimal plant selection.

Similarly, McPhillips *et al* (2017)⁷, also attached, looked at nutrient leaching (and greenhouse gas emissions) in grassed detention and bioretention stormwater basins. The paper notes that the primary case where substantial nitrate reductions have been observed has been in basins with IWS (*i.e.* internal water storage) which maintain a subsurface saturated zone to promote nitrate removal via microbial denitrification within a saturated zone.

4.2.1. Detention basins

Consequently, with reference to the above studies, the following general enhancements for N, P and sediment removal will be included in the OHH detention basins:

1. They possess a sediment forebay to enhance the removal of particulate N and P, together with sediment;
2. The area of wetland within the remaining basal areas of the basins is maximised (*e.g.* by excavating below the outfall invert) in order to maximise the extent of the saturated zone and encourage denitrification in anoxic areas below the water surface.
3. Detention basins will be linked in series, wherever possible, to maximise the cascading nature of the SuDS train;
4. The basin bases are planted up with suitable vegetation to slow flow rates, maximise residence time, encourage denitrification around root areas and also uptake of P;
5. The basin maintenance schedule will include periodic dredging of forebays, which will permit removal of sediment/particulate P/PON from the catchment (refer to separate Odyssey Silt Management Plan);
6. Basin maintenance will also include rotational harvesting of vegetation to remove P loads from the catchment.

The plant species selection is subject to confirmation, although there will be an avoidance of reed (*Phragmites*) bulrush (*Typha*) due to their invasive nature. Consequently, as outlined in the Tyler Grange Open Space Landscape Principles report, plant species selection will focus on native, non-invasive and nitrate removing species, tolerant of wet conditions with habitat and biodiversity enhancing qualities. Suggested species will include:

- Water forget-me-not (*Myosotis scorpioides*);
- Common bistort (*Persicaria bistorta*);
- Flag iris (*Iris pseudacorus*);
- Purple looserife (*Lythrum salicaria*);
- Marsh marigold (*Caltha palustris*);
- Ragged Robin (*Lychnis flos-cuculi*);
- Sweet woodruff (*Galium odoratum*); and
- Soft rush (*Juncus effusus*).

The maintenance plan includes for seasonal annual cropping of up to one third of marginal wetland plants. These will be left for seven days next to the pond (to permit wildlife to return to the adjacent habitat) before being removed off site or to a designated composting facility (refer to the Tyler Grange Framework Soft Landscape Management Plan).

With regard to flow rates from the detention basins, outflow will be constrained to Q_{MED} (the median annual peak greenfield rate of runoff), which is equivalent to a return period of 2 years, and hence a reduced rate of runoff for higher return periods. Consequently, by limiting the developed rate of runoff to Q_{MED} , for all rainfall events up to the 100 year return period event, including an allowance for climate change (40 %), the proposed development will reduce flood risk overall when compared to existing greenfield rates. Consequently, all flow will be attenuated

within the basins and other SuDS features for all storms up to and including the 1 in 100 year (+40% CC event), which will maximise hydrological retention times and minimise nutrients being remobilised and flushed through the system during storm events. Drain down times during the 1 in 100-year + 40 % storm event will typically range from around 9 ¼ hours to 50 % of capacity and 14 ½ hours for 90 % of capacity.

A typical detention basin structure to be used across the scheme is included within **Appendix 1** of this report.

The adoption of the above principles within all basins across the scheme will enable the 61 % median N removal rate for stormwater wetlands cited by Koch *et al* to be achieved for the lifetime of the scheme.

4.2.2. Swales

In addition to the detention basins, flow conveyance and bioretention swales will be included within the scheme, largely to convey runoff to detention basins, but also to provide attenuation of flow and a reduction in nutrient, sediment and other contaminants in receiving waters. As with detention basins, where practical, the provision of an IWS within the swale is desirable to maximise N removal through denitrification, as described by Ekka *et al* (2021).⁸ Koch *et al* (2014)¹¹ cites a median N removal efficiency of 50 % for “dry” swales (*i.e.* comprising “grass channels”, “grass swales”, and “dry swales” without underdrains, and do not include “bioswales.”), although wet swales are not specifically identified (being included in wetlands with a median N removal efficiency of 61 %). Alternatively, the EPA “National Pollutant Removal Performance Database for Stormwater Treatment Practices” (2000)⁵, specifically provides median removal efficiencies for “Water Quality Swales” of 31 % for NO_x (nitrate and nitrite), 84 % for TN, 38 % for soluble P, 34 % for TP and 81 % for TSS.

Consequently, the provision of swales across the site as part of the SuDS strategy, will serve to contribute to N, P and sediment reduction in surface water runoff from the scheme and ensure that an overall N removal rate of 61 % can readily be achieved by the system.

4.2.3. N removal by FRP SuDS

With reference to the Odyssey “Horton Heath, Eastleigh Flood Risk Assessment & Drainage Strategy – Addendum 1” (May 2021), 4.573 ha (33.3 % of the FRP area) will be positively drained, with all intercepted runoff draining through at least 1 detention basin. Of this, 0.952 ha will drain through two detention basins, whilst additional water quality enhancement will be provided by 110 m of interconnecting vegetated swales. Consequently, it is assumed that the 61 % N removal efficiency will be achieved for all positively drained stormwater, with the remaining stormwater lost to infiltration through the soft landscaped areas of the development (including gardens, verges, POS and other small areas of open space within the urban fabric). It is calculated, therefore, that the SuDS will remove the following N from the FRP: 4.573 ha x 14.3 Kg N/ha/yr x 0.61 (% N removal efficiency by SuDS network) = **38.9 kg N/yr**.

5. Summary and Conclusion

This report provides a summary of the evidence gathered to support the Nitrate Neutrality Study for the Horton Heath OPA scheme, of which the FRP constitutes the first phase.

The OPA Nitrate Neutrality Study has demonstrated that

- 1) The TN-loss from pre-existing agricultural uses from the whole pre-existing OPA site has been derived using site visits, farmer questionnaires and interviews, together with Farmscoper modelling (including an appropriate allowance (-4.3 %) to reflect the adoption of nitrate reducing farming practices within a NVZ) as **3,452.2 N/yr**. Spread over a farmed area of 115.82 ha, this equates to an average N-loss of **29.8 kg N/ha/yr**, which is slightly above the 26.9 kg N/ha/yr figure cited by NE as an average N-loss for all farm types within the Solent catchment area.
- 2) In addition, in line with NE guidance, the remaining 8.88 ha of pre-existing dwellings, other buildings and highways are classed as “urban development” with an assumed N-loss of 14.3 kg/ha/yr, equating to **127.0 kg N/yr**.
- 3) The wastewater generated by the proposals will be conveyed to Chickenhall WwTW where it will be treated and discharged without any permit concentration limit for TN, with an estimated discharge concentration of 27 mg/l TN.
- 4) A standard NE Methodology has been used together with Farmscoper modelling of existing agricultural N losses and a bespoke calculation for the assessment of wastewater N from pre-existing dwellings, as none of them are connected to the adopted foul water sewer system or discharge through a WwTW;
- 5) The results identify that a total of **4,374.5 TN/yr** will need to be neutralised in order to mitigate against the proposed development.
- 6) As part of the proposals, it is intended to construct a network of SuDS features across the site comprising permeable pavements, rain gardens, swales and basins to sustainably manage runoff from the scheme. All detention basins will be planted and optimised for N-removal, including permanently wet areas around inlets (sediment forebays), outlets (secondary sedimentation areas) and wetland areas within the base of the features.
- 7) Stormwater wetlands have been shown to remove N from runoff through processes such as denitrification and sedimentation. 65.4 % of the runoff from the developed areas of the proposed scheme will be intercepted and conveyed through the network of “*Strategic SuDS Features*” (detention basins). 57.98 ha of developed areas will be positively drained. Using an average TN leaching rate from urban areas of 14.3 kg/ha/yr (as recommended by NE) and assuming that a N removal efficiency of 61% can be readily achieved with the network of optimised detention basins and associated swales, it is estimated that **330.8 kg N/yr** can be removed by the system.
- 8) Parcel 51 in the south-eastern corner of the masterplan, is covered by a separate planning application (Ref. X/19/86475). The 5.29 ha parcel of land, which lies on freely draining soils, is currently used for agriculture but will be used to provide the south eastern access road and roundabout for the scheme, together with public open space (POS). Consequently, it has been calculated that removal of this land from agricultural will result in a reduction of **37.6 kg N/yr** from the catchment.

- 9) It is intended that the remaining **4006.1 kg N /yr** increase in N-loss to the Solent, associated with the OHH scheme, will be wholly mitigated through EBC's own nitrate offsetting scheme.

As the FRP forms part of the wider OPA scheme, it will serve to contribute to the above N budget through:

- a. The elimination of N-losses from pre-existing agricultural uses by taking arable and pastoral farmland out of production;
- b. Limiting sewage-related N-loss, by conveying foul sewage to Chickenhall Lane WwTW, where it will be treated and discharged at an estimated concentration of 27.0 mg/l TN; and
- c. Treating N in runoff from the development by means of a network of SuDS features, included as part of the FRP scheme.

Calculations provided in this report estimate that:

1. As part of the wider scheme, the FRP will equate to a loading of **-2,452.4 kg TN /yr** required to be neutralised at this stage of the OHH development.
2. 4.573 ha (33.3 % of the FRP area) will be positively drained, with all intercepted runoff draining through at least 1 detention basin. Of this, 0.952 ha will drain through two detention basins, whilst additional water quality enhancement will be provided by 110 m of interconnecting vegetated swales. Consequently, it is assumed that a 61 % N removal efficiency will be achieved for all positively drained stormwater, with the remaining stormwater lost to infiltration through the soft landscaped areas of the development (including gardens, verges, POS and other small areas of open space within the urban fabric). This will result in a further **38.9 kg/TN /yr** prevented from reaching the Solent and influencing the qualifying features of its internationally designated sites.
3. Subsequently, as part of the wider scheme, the FRP will equate to a loading of **-2,491.3 kg TN /yr** required to be neutralised at this stage of the OHH development (*i.e.* a net reduction in N-loss compared to the pre-existing situation) and thus, there is no requirement for mitigation using EBC's own nitrate offsetting scheme at this stage of the OHH development

Consequently, the impacts of the FRP and the wider OPA scheme proposals will be fully mitigated and will ensure that they do not detrimentally affect local biodiversity or the conservation status of the downstream European Designated Sites.



Appendix 1: Red line boundary and development area





Appendix 2: Proposed SuDS



Stratton Park House, Wanborough Road
Swindon, SN3 4HG

Telephone
01793 828000

Website
www.pfapl.com

Preliminary
This drawing is produced for initial discussion and illustrative purposes only, and should not be relied upon for tender or pricing purposes.

NOTES

1. This drawing is based on the Topographical Survey undertaken by Mayer Brown Limited, Drawing No:R/SAV.1.21.1, Rev E, dated 05 May 2014.
2. This site layout is based on Thrive's Concept Masterplan, Drawing number EAST200403 CMP 01 Rev P1, dated 28.08.20
3. Main River designation based on Flood Map for Planning.
4. The swale/conveyance features shown indicatively in this drawing are subject to detailed design levels to assess their feasibility.

Key

- Risk of Flooding from Surface Water Outline
- Basin Catchment Allocation
- Flood Zone 2
- Flood Zone 3
- Indicative Location of Southern Foul Water Sewage Pumping Station
- 5m offset from Watercourse
- 8m offset from Main Rivers
- Opportunity for swale conveyance feature

Rev	Date	Description	Drawn	Check
#	24/08/20	First Issue	DAB	MWS
A	10/09/20	Addition of Basin 8 and revision of Basin South	DAB	MWS
B	14/09/20	Client details updated. Catchment numbers added	BF	

Status

PRELIMINARY

Client

Eastleigh Borough Council

Project

**One Horton Heath,
Hampshire**

Drawing Title

**Indicative Location of
Strategic SuDS Features**

Drawing No.

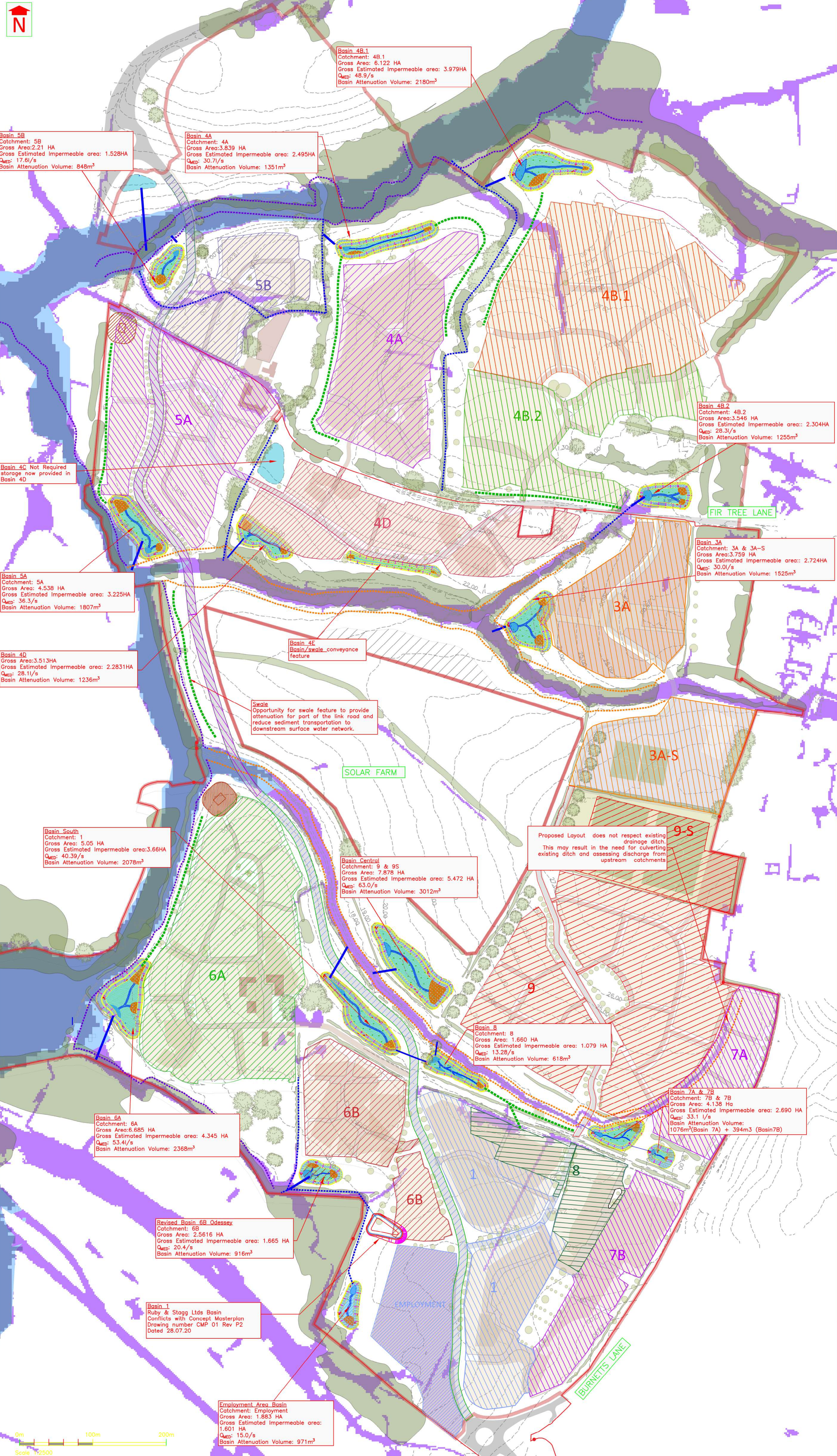
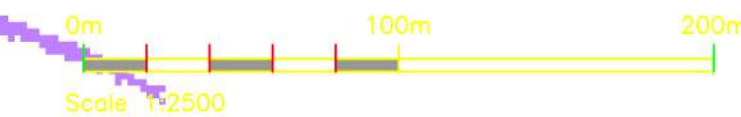
G277/12

REV B

Date: September 2020

Scale: 1:2500 @ A1

E-Mail: DBuciak@pfapl.com



Basin 4B.1
Catchment: 4B.1
Gross Area: 6.122 HA
Gross Estimated Impermeable area: 3.979HA
Q_{dep}: 48.9/s
Basin Attenuation Volume: 2180m³

Basin 5B
Catchment: 5B
Gross Area: 2.21 HA
Gross Estimated Impermeable area: 1.528HA
Q_{dep}: 17.6/s
Basin Attenuation Volume: 848m³

Basin 4A
Catchment: 4A
Gross Area: 3.839 HA
Gross Estimated Impermeable area: 2.495HA
Q_{dep}: 30.7/s
Basin Attenuation Volume: 1351m³

Basin 4B.2
Catchment: 4B.2
Gross Area: 3.546 HA
Gross Estimated Impermeable area: 2.304HA
Q_{dep}: 28.3/s
Basin Attenuation Volume: 1255m³

Basin 4C Not Required
storage now provided in
Basin 4D

Basin 5A
Catchment: 5A
Gross Area: 4.538 HA
Gross Estimated Impermeable area: 3.225HA
Q_{dep}: 36.3/s
Basin Attenuation Volume: 1807m³

Basin 4D
Gross Area: 3.513HA
Gross Estimated Impermeable area: 2.2831HA
Q_{dep}: 28.1/s
Basin Attenuation Volume: 1236m³

Basin 4E
Basin/swale conveyance
feature

Swale
Opportunity for swale feature to provide
attenuation for part of the link road and
reduce sediment transportation to
downstream surface water network.

Basin South
Catchment: 1
Gross Area: 5.05 HA
Gross Estimated Impermeable area: 3.66HA
Q_{dep}: 40.39/s
Basin Attenuation Volume: 2078m³

Basin Central
Catchment: 9 & 9S
Gross Area: 7.878 HA
Gross Estimated Impermeable area: 5.472 HA
Q_{dep}: 63.0/s
Basin Attenuation Volume: 3012m³

Proposed Layout does not respect existing
drainage ditch.
This may result in the need for culverting
existing ditch and assessing discharge from
upstream catchments

Basin 8
Catchment: 8
Gross Area: 1.660 HA
Gross Estimated Impermeable area: 1.079 HA
Q_{dep}: 13.28/s
Basin Attenuation Volume: 618m³

Basin 7A & 7B
Catchment: 7B & 7B
Gross Area: 4.138 HA
Gross Estimated Impermeable area: 2.690 HA
Q_{dep}: 33.1/s
Basin Attenuation Volume:
1076m³(Basin 7A) + 394m³ (Basin 7B)

Basin 6A
Catchment: 6A
Gross Area: 6.685 HA
Gross Estimated Impermeable area: 4.345 HA
Q_{dep}: 53.4/s
Basin Attenuation Volume: 2368m³

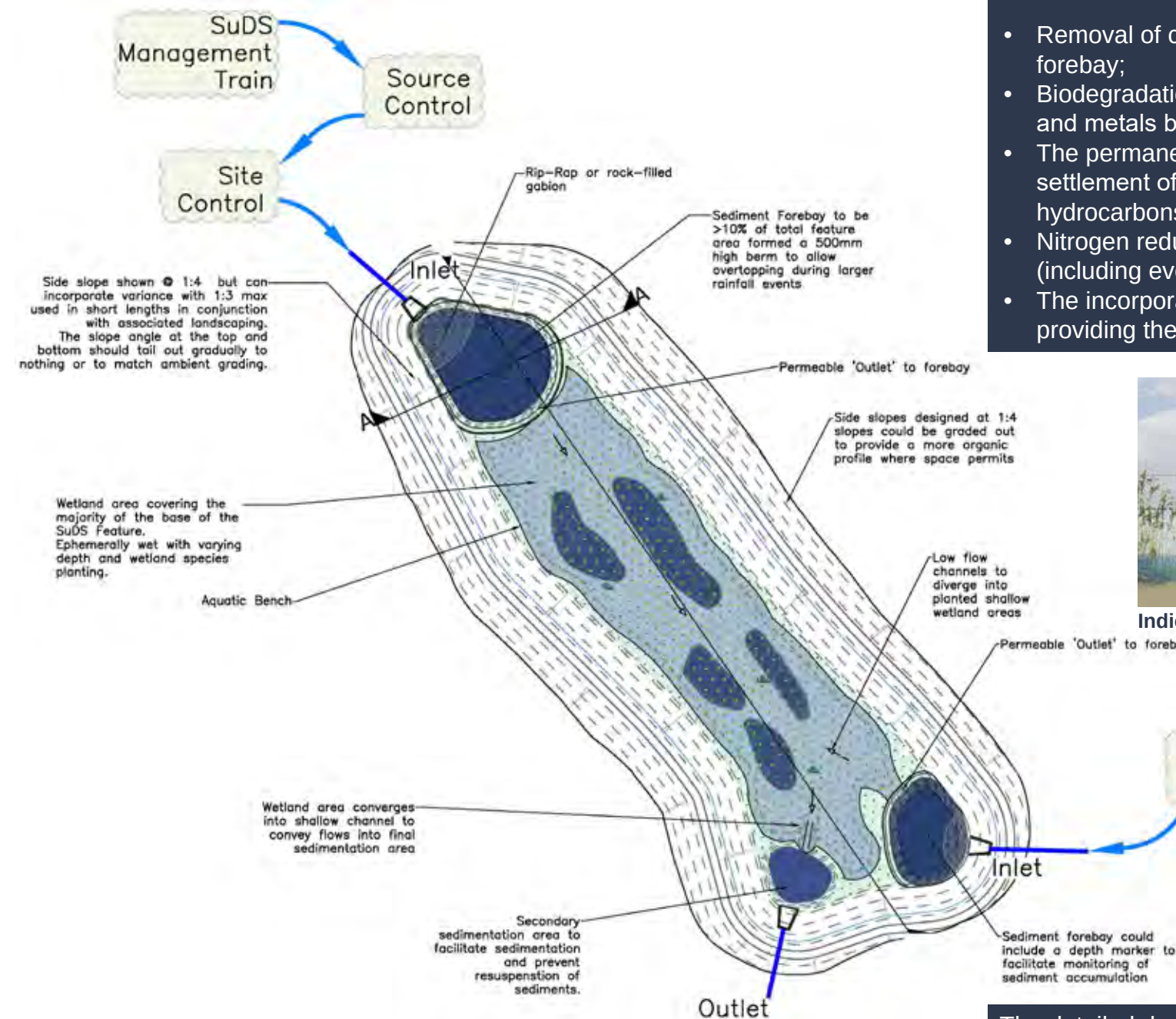
Revised Basin 6B Odyssey
Catchment: 6B
Gross Area: 2.5616 HA
Gross Estimated Impermeable area: 1.665 HA
Q_{dep}: 20.4/s
Basin Attenuation Volume: 916m³

Basin 1
Ruby & Stag Ltds Basin
Conflicts with Concept Masterplan
Drawing number CMP 01 Rev P2
Dated 28.07.20

Employment Area Basin
Catchment: Employment
Gross Area: 1.883 HA
Gross Estimated Impermeable area:
1.601 HA
Q_{dep}: 15.0/s
Basin Attenuation Volume: 971m³

1 Chalcroft Tolls

Enhanced Basins



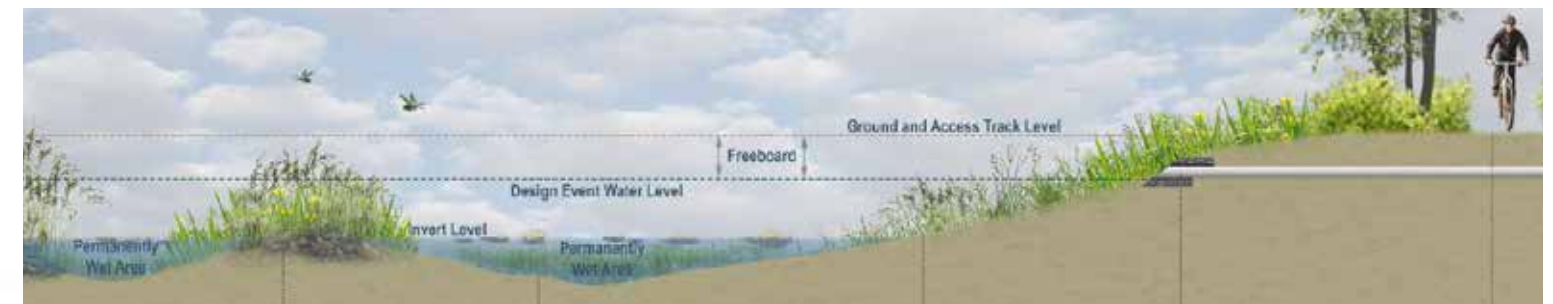
Enhanced Basins

The 3 stages of filtering and nitrate cleansing within the enhanced basins would be:

- Removal of coarse sediments within the sediment forebay;
- Biodegradation and removal of hydrocarbons, nutrients and metals by the specific planting; and
- The permanent pool of water provides further settlement of fine sediments and removal of nutrients, hydrocarbons and metals.
- Nitrogen reducing native marginal and aquatic species (including evergreen plants).
- The incorporation of distinct zones in the large basins providing the water quality and quantity volume

storage in a number of independent cells. These features create increased attenuation, longer pollutant removal pathways (and therefore enhanced pollution removal) an easier maintenance regime and more varied ecology.

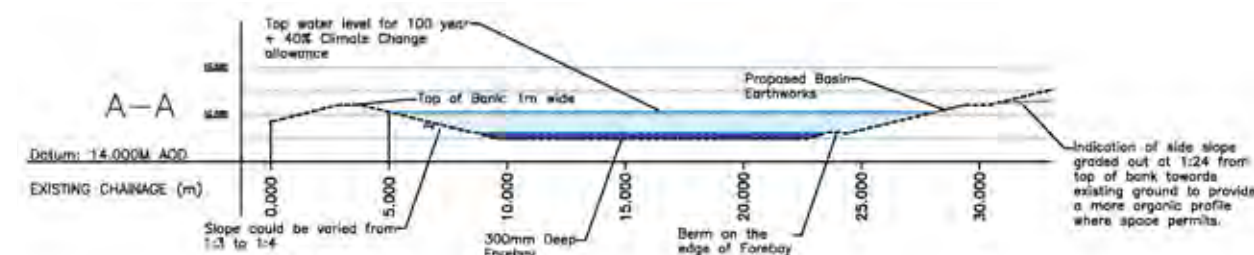
- Basin Zones include a sediment forebay, permanent micro pools, attenuation storage volume above permanent pool water level and aquatic benches surrounding the permanent micro pools, which support wetland planting, acting as a biological filter and providing ecology amenity and safety benefits. Around the micro pools shallow wet/marshy grassland areas provide further filtration.
- Basins will be lined and anchored to prevent impact on functions from rising groundwater.



Indicative Section (ref: Jacobs A9 Basin Proposals)



Indicative Section showing forebay, benches and pools



The detailed design of basins will be subject to the CDM Regulations 2015. CDM Measures can include:

- High vertical drops/headwalls avoided
- Avoidance of fast flowing water (preference of velocities below 0.5m/s)
- Side slopes designed at 1 in 4 or shallower to 1 in 24 (no steeper than 1 in 3 in short lengths) to provide safe access and egress including for maintenance operations
- Restrictions on water depth
- Marginal planting designed to a height designed to not obstruct visibility of the water from the surrounding area
- Safety grilles at a 45 degree angle (to avoid blocking) can be placed on any pipes greater than 350mm diameter
- Removal of many pollutants and nutrients from a wider conveyance train closer to source
- A level dry bench at the top of all open structures, 1m wide and a wet bench 1m wide allows stationary rest for a person and safety access
- Danger signs and safety equipment should not be required if the final design incorporates built in safety measures

References

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- ⁴ Koch B.J., Febria C.M., Gevrey M., Wainger L.A , and Palmer M.A. (2014). *Nitrogen Removal by Stormwater Management Structures: A Data Synthesis.* Journal of the American Water Resources Association (JAWRA) 50(6): 1594-1607. DOI: 10.1111/jawr.12223
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