



Assessment of Potential Nutrient Impact

Former Brockhampton West Landfill, North of Harts Way, Havant

Presented to: **Clowes Developments (UK) Ltd**

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1.0 Introduction

1.1 Context & Purpose

Delta-Simons Environmental Consultants Limited ("Delta-Simons") has been previously instructed by Clowes Developments (UK) Ltd (the "Client") to prepare a Geo-Environmental Assessment of the Former Brockhampton West Landfill, North of Harts Farm Way, Havant, PO9 1HS (the "Site").

The proposed use for the Site is the development of new employment units to provide up to 29,000 m² (gross internal area) for flexible use across use Classes E (Light Industrial), B2 (General Industrial) and B8 (Distribution and Storage) with ancillary offices, car parking, service yards, drainage works, landscaping and associated works to prepare the Site for development. The aim of the study was to complete a geo-environmental assessment of the proposed development area, obtaining information regarding ground conditions, from which risks to end-users, the environment and structures have been assessed, with mitigation measures suggested where necessary.

Langstone Harbour, immediately to the south of the Site, forms part of the Chichester and Langstone Harbours Special Protection Area (SPA) (although the Site itself is outside of the SPA boundary), furthermore Langstone Harbour also forms part of the Solent Maritime Special Area of Conservation (SAC). As a consequence, a Habitats Regulations Assessment (HRA, referenced in Section 2.0 below) was prepared to support an Outline planning application for the scheme (Ref: APP/21/00189) in accordance with the requirements of the Conservation of Habitats and Species Regulations 2017 ('the Habitats Regulations'). These require any project that may have a "likely significant effect" upon a European site (i.e. an SPA, SAC or a listed or proposed Ramsar site) to be subject to "appropriate assessment" with regard to the site's conservation objectives.

The HRA concluded that the proposals would have no direct impact upon the Chichester and Langstone Harbours SPA and, having reviewed and assessed the European site conservation objectives for the SPA with respect to the development proposal, none would be adversely impacted by the development proposals.

Notwithstanding the finding and conclusions of the HRA, as part of regulatory discussions with the Local Authority (Havant Council) following submission of the Outline planning application, the Council requested further assessment of the potential for the proposed development to result in an increased nutrient loading to controlled waters in the environs of the Site, specifically:

"What we need from the applicant is a technical note/document submitted from their consultants which explains and sets out why the site will not cause an increase in nutrients. It will need to include evidence/data for the current land use infiltration rates for nitrogen and the evidence/data for what the infiltration rates would be when it is converted to urban land use. This is needed..... to provide the scientific information required in order to undertake the HRA/AA for the application".

The aim of this document is to provide a suitable technical note for this purpose, thus providing further assessment to determine whether there is risk of a "likely significant effect" and assisting the Local Authority in coming to a decision as to whether "no reasonable scientific doubt" remains as to the absence of such effects.

1.2 Previous Reports

To date, Delta-Simons have produced the following reports for the Site:

- ▲ 'Preliminary Geo-Environmental Risk Assessment' by Delta-Simons, dated February 2021 (Ref: 19-2099.01); and
- ▲ 'Geo-Environmental Assessment Report' by Delta-Simons, dated July 2021 (Ref: 19-2099.04).

The findings of the Geo-Environmental Assessment, which presents a precis of the earlier Preliminary Risk Assessment report, are discussed further in Section 2.0.

The following report should also be reviewed with regard to an assessment of potential impacts to the SPA and SAC-designated areas to the south of the Site:

- ▲ *Harts Farm Way, Havant: Habitats Regulation Assessment* by Applied Ecology, dated April 2021 (Project No. AEL1786).

1.3 Limitations

The scope and extent of report has been determined with due consideration of the following guidance:

- ▲ '*Land Contamination: Risk Management*' pages of the GOV.UK web pages, the relevant requirements of the National Planning Policy Framework 2019 (NPPF) (paragraphs 170 & 178-180) and the Planning Practice Guidance (Land Affected by Contamination); and
- ▲ '*The Habitats and Wild Birds Directives in England and its seas: Core Guidance for Developers, Regulators & Land/Marine Managers*', December 2012 (draft for public consultation).

Notes on limitations associated with this assessment are provided in Appendix A. In addition, there are the following specific limitations that apply to this assessment:

- ▲ This report does not consider Enabling (Construction) Phase effects to the SPA and SAC, which are assumed to be addressed in other documentation supporting the proposed development.

2.0 Geo-Environmental Assessment

2.1 Introduction

Previous assessment of the Site has been undertaken in a staged manner, consistent with current best practice for assessing potential contamination on previously developed land. The *Preliminary Geo-Environmental Risk Assessment* report allowed the formulation of a preliminary Conceptual Site Model (CSM), which underpinned the scoping and design of a subsequent phase of intrusive investigation, which was undertaken following due consultation with the Environment Agency (EA) with regard to assessing potential risks to controlled waters receptors.

2.2 Site History

From reference to historical mapping, the Site is understood to have comprised tidal / estuarine mud flats until circa 1969, when the area was subjected to land reclamation via waste disposal. Authorised waste types are understood to have included concrete waste, construction and demolition wastes, household waste and incinerator residues. Landfilling ceased at the Site by circa 1987 and the Site was briefly used as playing fields, after which no further developments have taken place.

It is understood the landfill was designed to operate on the 'dilute and disperse' system, a common concept for landfills predating the early 1990s. Landfills operating on this principle were not constructed as fully engineered containment systems, as is current best practice for managing wastes via landfill disposal i.e. provision of basal and sidewall lining systems prior to placement of the waste, and construction of a final engineered cap upon cessation of disposal activities, thus facilitating containment and management of landfill leachate and gas.

By contrast, landfills operating on the dilute and disperse principle relied upon landfill leachate egressing the base and sides of the landfill at what might be considered to be environmentally acceptable rates i.e. incorporating natural attenuation of contaminants within the leachate within the unsaturated (vadose) zone, where present, followed by dilution within the receiving groundwater regime.

The Former Brockhampton West Landfill appears to have effectively operated on the dilute and disperse principal throughout its operational and post-closure phases, and Delta-Simons understands that there has been no active management of landfill leachate or gas during this time. On this basis, incident rainfall both during the operational phases of the Site, and through the final restoration soils, has been able to infiltrate the waste mass. Once the absorptive capacity of the waste has been reached, any further infiltration will generate free leachate although, given the heterogeneity of the waste mass and likely preferential flow paths, free leachate is assumed to have egressed the base and sides of the landfill before this time.

2.3 Assessment of Current Risks to Controlled Water Receptors

As part of the 2021 Geo-Environmental Assessment, Delta-Simons undertook a programme of sampling and analysis of soils, groundwater and surface waters within, and in the vicinity of, the Site.

Soil samples were primarily recovered from a topsoil stratum (presumably emplaced as part of a restoration scheme for the Site following cessation of waste disposal activities) and the underlying waste materials, with additional, more limited, sampling of the superficial and bedrock strata below the Site. Samples of groundwater perched within the waste mass (i.e. effectively landfill leachate/delayed infiltration) were recovered for chemical analysis, together with samples of deeper groundwater within the superficial deposits and Chalk bedrock (Secondary Undifferentiated and Principal Aquifers respectively). The Hermitage Stream immediately to the east of the Site was also sampled at three separate locations, including upstream and downstream of the Site's potential influence.

2.3.1 Selection of Appropriate Generic Assessment Criteria

Published, authoritative ecological screening criteria derived from UK sources (i.e. the EA) are limited in terms of the number of contaminants covered and also in the ecological context. The Soil Screening Values (SSVs) that the EA has derived to date are contained within the following documents:

- ▲ <https://webarchive.nationalarchives.gov.uk/20090205032620/http://www.environment-agency.gov.uk/static/documents/5-SP5-091-TR-e-e.pdf>; and
- ▲ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/657722/Soil_screening_values_for_assessing_ecological_risk_-_summary.pdf

The SSV produced by the EA are based on direct evidence of toxicity, i.e. organisms and plants that come into direct contact with soil. They have not been designed in the context of assessing the potential for the re-development of the Former Brockhampton West Landfill to result in detrimental impact to Langstone Harbour i.e. where the risk assessment needs to consider mobilisation of soil contamination into groundwater and subsequent migration into the Hermitage Stream and thence Langstone Harbour. On this basis, the SSV methodology adopted by the EA is likely to be overly conservative, albeit not necessarily so for every contaminant, and Delta-Simons has reviewed the ecotoxicological basis for the individual SSVs to determine appropriateness.

It should also be noted that the EA discounted generating SSVs for some common contaminants on the basis that the SSV concentrations would be at or below typical background concentrations and would never serve to screen out any sites. This is an important consideration, given that the majority of contaminants that Delta-Simons have completed analysis for do not have SSVs, either for the aforementioned reason, or simply due to lack of ecological toxicity data or lack of resources within the EA to undertake a detailed ecotoxicological review and publish a value.

Where necessary, as one line of evidence, Delta-Simons has reviewed and considered other UK threshold criteria where relevant and international ecotoxicological GAC, albeit incorporating a review of limitations and how applicable the method of derivation is to the UK / EA approach. International values include US EPA Ecological Soil Screening Levels, RIVM Serious Risk Concentrations and Canadian CCME Environmental Quality Guidelines.

The risk assessment has incorporated consideration of specific EA priorities and targets for the Chichester and Langstone Harbours SPA following preliminary EA consultation, which in terms of chemistry are currently understood to focus on nitrogen species.

Whilst there some limited GAC for soil contaminant concentrations, there are no published ecotoxicological screening criteria available for groundwater results, either in the UK or internationally. However, there are values available for surface waters, namely the UK Environmental Quality Standards (EQS), specifically designed for WFD assessments. Delta-Simons has screened surface water and groundwater against these EQS/WFD values, whilst acknowledging that the values are based on a number of different ecological and / or human health receptor considerations. EQS values have been utilised as initial GAC for groundwater chemical testing results (following review of appropriateness as discussed above).

Surface water quality data from the Hermitage Stream has been obtained as part of the assessment to inform the assessment of existing risk to the Chichester and Langstone Harbours SPA. Site soil and groundwater concentrations have been reviewed in the context of this data to assess whether there is potential for any additional contaminant loading from impacted groundwater below the Site providing a baseflow component to flow within the Hermitage Stream, since this watercourse passes the Site prior to entry into Langstone Harbour.

The risk assessment has adopted a lines of evidence approach to demonstrate absence of impact to the Hermitage Stream. For each contaminant Delta-Simons has assessed soil, groundwater, surface water and background concentrations and whether any increase in individual contaminant concentrations is anticipated within the Hermitage Stream (and hence the receiving SPA/SAC).

With regard to a consideration of plausible risks to controlled waters receptors, specifically groundwater within the superficial deposits and bedrock aquifer, the Hermitage Stream and the receiving Langstone Harbour (a Special Area of Conservation [SAC]), the assessment concluded that:

- ▲ Groundwater perched within the waste mass (effectively landfill leachate) appears to have been impacted by metals, other inorganic contaminants (in the form of ammoniacal nitrogen, nitrate, nitrite and chlorides), Total Petroleum Hydrocarbons (TPH) and Polyaromatic Hydrocarbons (PAH), as to be anticipated;
- ▲ Groundwater within the underlying superficial deposits and bedrock aquifer also appear to have been impacted as a consequence of the waste disposal operations, with concentrations of metals, other inorganics and TPH/PAH above the adopted Generic Assessment Criteria (GAC), albeit several contaminants (most notably ammoniacal nitrogen) exhibit a trend of decreasing contaminant concentrations between perched groundwater within the waste mass and groundwater in the underlying superficial deposits and Chalk bedrock aquifer. This is to be anticipated given likely natural attenuation and dilution processes; and

- ▲ Metal, ammoniacal nitrogen and TPH/PAH contaminant concentrations were typically below the adopted GAC and/or laboratory limit of detection within the Hermitage Stream, indicating that the anticipated natural attenuation and dilution effects appear to be sufficient as to mitigate against a detrimental impact to this watercourse.

Based upon the findings of the 2021 Delta-Simons investigation, whilst the historical waste disposal operations have resulted in impact to the quality of groundwater within the superficial deposits and underlying Chalk bedrock, the Site in its current state does not appear to be having a detrimental effect upon the quality of the Hermitage Stream. Notably, ammoniacal nitrogen concentrations within the Hermitage Stream do not appear to be elevated above the adopted EQS values. Under low tide conditions, ammoniacal nitrogen concentrations at the midstream and downstream sampling locations, whilst higher than those at the upstream monitoring location, were well below the adopted GAC. Furthermore, under high tide conditions, ammoniacal nitrogen concentrations were higher upstream of the Site's influence than at the midstream and downstream sampling points. Attenuation and/or dilution effects therefore appear to be sufficient as to mitigate effects to aquatic fauna and flora (i.e. that which the designated EQS value is designed to protect).

On this basis, and given the likelihood of further attenuation and dilution effects as the watercourse enters Langstone Harbour (an SPA and SAC), the Site also does not appear to be posing a potential risk to the quality of controlled waters within this receptor.

2.4 Assessment of Future Risks to Controlled Water Receptors

Given that no engineered landfill cap was constructed once landfilling operations had ceased to minimise infiltration of incident rainfall through the waste mass, a substantial proportion of incident rainfall is considered likely to infiltrate through the Site in its current state, resulting in ongoing contaminant leaching from the waste mass into underlying groundwater.

Due consideration has been given as to the potential for the proposed re-development to exacerbate the current situation following development, and the findings are presented in Section 3.0.

The proposed development is considered likely to substantially reduce infiltration rates into the underlying ground in the medium to longer term given the construction of buildings, low permeability hardstanding (access roads, service yards and parking areas) and sealed drainage systems, with a commensurate reduction in contaminant leaching from the underlying waste mass. As a result, the proposed development is considered likely to result in overall betterment in terms of risks to controlled waters receptors when compared to the existing situation. This is discussed in greater detail in Section 4.0, alongside a quantitative assessment of current and future rainfall infiltration rates.

3.0 Assessment of Proposed Development

3.1 Introduction

The potential for the proposed development to exacerbate risks to controlled water receptors can be subdivided into the following:

1. *Enabling phase effects* i.e. those effects that could plausibly be realised during the enabling (construction) phase of the Site's re-development. These are considered to be of relatively short duration (i.e. weeks or months); and
2. *Operational phase effects* i.e. those effects that could plausibly be realised during the operational phase following the Site's initial re-development. These are considered to be of longer duration (i.e. years).

As outlined in Section 1.3, enabling/construction phase effects have not been considered within the scope of this assessment on the basis that they would be addressed in other documentation submitted in support of the proposed development. For the purposes of this assessment, it should also be noted that:

- ▲ Potential enabling phase effects can be readily and effectively managed by the application of well established and proven enabling works and construction techniques and practices; and
- ▲ Potential enabling phase *disbenefits* would be of short-term duration, and are considered to be significantly outweighed by the environmental *benefits* to be realised following Site re-development, with much reduced infiltration rates across a greater area and for a substantially longer duration (years compared to weeks or months).

On this basis, no further consideration of these potential effects is considered to be warranted here.

3.2 Potential Operational Phase Effects

Plausible impacts to groundwater and surface waters during the operational phase are considered to include:

- ▲ Storage of potentially polluting substances (e.g. fuels and lubricants) associated with site operations;
- ▲ An increased loading of the waste mass as a consequence of the Site's re-development, resulting in additional leachate being forced from the waste mass; and
- ▲ The creation of preferential migration pathways via piles through the waste and into the underlying natural strata.

The potential for future Site operations to impact upon the quality of groundwater and/or surface waters is outside the scope of this assessment (which is focussed on the likelihood of additional nutrient loading), although it is worth noting that such risks can effectively be mitigated via the measures outlined previously i.e. the use of bunded storage areas, double-skinned storage tanks and/or impermeable surfacing. No further consideration of such risks are therefore warranted.

Given the inherent variability of the landfilled wastes and the likely design loads, it is anticipated that a piled foundation solution, transferring the building loads to the more competent Chalk bedrock, will be adopted utilising both skin friction and end bearing capacity. Whilst the final piling methodology (i.e. driven [displacement] or replacement piles) has yet to be determined, neither technique will result in a final development that substantially loads the landfill waste mass itself. External areas are also anticipated to require some form of ground improvement (likely in the form of Controlled Modulus Columns [CMC]), consequently effects resulting from ground loadings in areas of hardstanding (access roads, service yards and parking areas) are considered likely to be minor to negligible (given the transfer of loads to the underlying superficial deposits) and outweighed by the overall reduction in surface infiltration rates and thus generation of 'new' leachate following re-development (see Section 4.0).

The Environment Agency documents '*Piling into Contaminated Sites*' and '*Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention*' present guidance on the potential contamination risks that different piling techniques can have on groundwater and, additionally, the potential risks posed to human health. The guidance presents six potential Source-Pathway-Receptor (S-P-R) linkages to be considered as part of a foundation works risk assessment:

1. Pollution Scenario 1: Creation of preferential pathways through an aquitard to allow potential contamination of an aquifer;

2. Pollution Scenario 2: Creation of preferential pathways through a low permeability surface layer, allowing migration of landfill gas, soil gas or contaminant vapours to the surface;
3. Pollution Scenario 3: Direct contact of site workers and others with contaminated soil arisings that have been brought to the surface;
4. Pollution Scenario 4: Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials;
5. Pollution Scenario 5: The driving of solid contaminants down into an aquifer during pile driving; and,
6. Pollution Scenario 6: Contamination of groundwater and, subsequently, surface waters by wet concrete, cement paste or grout.

Only Pollution Scenarios 1 and 6 will be considered further for the purposes of this assessment. Given Delta-Simons' understanding that the preferred piling technique will be one of pre-cast driven concrete piles, (obviating the risk of ground/surface water impact from wet concretes or grouts), only Pollution Scenarios 1 and 5 require further consideration with regard to the adoption of a deep (driven) piled foundation solution.

The 2021 Delta-Simons ground investigation has established that the ground model for the Site comprises restoration soils underlain by landfill waste, River Terrace Deposits and the Lewes Nodular Chalk Formation. The creation of preferential contaminant migration pathways via piles penetrating a low permeability aquitard can therefore be discounted on the basis of the prevailing Site geology i.e. that the River Terrace Deposits (comprising gravels of flint and Chalk) are unlikely to significantly attenuate the downward migration of mobile contaminants within landfill leachate towards the Principal Aquifer. This has been borne out by the results of the Delta-Simons investigation, which has demonstrated that groundwater quality within the Chalk bedrock aquifer has already been impacted as a consequence of the waste disposal activities.

Whether the proposed piling activities could plausibly worsen the existing situation requires due consideration of whether the pile/waste interface could act as a preferential flow pathway between perched leachate within the waste mass and groundwater within the Chalk bedrock. The subject of piled foundation solutions creating preferential migration pathways for fluids (both liquids and gases, moving downwards and upwards respectively), has been the subject of research and debate in recent years. The paper '*Piled Foundations and Pathways for Ground Gas Migration in The UK*' (Wilson and Mortimer, 2017) published in the Institute of Civil Engineers journal provides a useful summary of the more pertinent research in this field.

For a plausible migration pathway to be created, the piling operation would need to either create an open annulus around the pile, or significantly increase the permeability of the surrounding ground with respect to contaminated water and/or hazardous ground gases. Precast concrete driven piles are considered unlikely to create an annulus around the pile due to displacement of the waste materials radially around the pile shaft, and thus densification of those materials in close proximity to the pile.

Whilst heterogeneous in nature, the nature of the surrounding waste materials is such that their permeability is unlikely to be increased given this lateral displacement of materials during the driving process. Research also suggests that there is typically sufficient adhesion between piles and surrounding clay soils to prevent the formation of preferential pathways, and the wastes deposited within the Brockhampton Site have an appreciable proportion of cohesive materials. The Wilson and Mortimer paper documents examples where driven H and I profile piles can form preferential pathways within clay soils, however such a pile design is not anticipated to be utilised on the Site.

It is understood that the pile design to be adopted will be one that utilises both skin friction and end bearing capacity, and the former is such that the piles are unlikely to act as a preferential migration pathway to downward migration of contaminants i.e. to perched leachate within the waste mass moving along the pile/waste interface. The adoption of a pre-formed pointed pile end is such that the waste materials are likely to be displaced laterally during piling operations, obviating the risk of contaminated materials being driven into the Chalk bedrock (Pollution Scenario 5).

The adoption of a CMC ground improvement technique (utilising cast in-situ concrete columns) within external areas is such that Pollution Scenario 6 requires further consideration. However, the use of rapid drying cement during construction of the CMCs will minimise the likelihood of impact to groundwater. The use of concrete or cement grouts is also unlikely to result in an incremental loading in ammoniacal nitrogen or other nitrogen-containing contaminants to groundwater below the Site.

3.3 Risk Assessment

The findings of a recent geo-environmental assessment of the Brockhampton West Site has established that historical waste disposal activities have resulted in detrimental impact to the quality of groundwater in the underlying superficial deposits and bedrock (the latter a Principal Aquifer).

Re-profiling of the Site to create level development platforms may temporarily increase infiltration of incident rainfall over the current situation through removal of the domed topographical profile that naturally encourages surface run-off over a more level ground profile. However, such effects are likely to be short-lived (i.e. restricted to the duration of the construction phase) and outweighed by the substantially reduced infiltration that will result during the operational phase of the development. A more detailed assessment of changes to infiltration rates pre- and post-development, and thus plausible risks to controlled water receptors, that is likely to result from the proposed development is presented in Section 4.0.

It is anticipated that the effects of ground instability within the waste mass on the final development will be mitigated by adopting a driven piled foundation solution that transfers the anticipated building loadings onto the Chalk bedrock and external yard area loading to the River Terrace Deposits. Such foundation and ground improvement solutions are considered unlikely to result in increased leachate migration to groundwater via the creation of preferential flow paths or the below-ground introduction of nitrogen-containing substances.

4.0 Assessment of Potential Significant Effects

4.1 Introduction

As outlined in Section 1.1, the Habitats Regulations require any project that might have a “likely significant effect” upon a European site to be subject to “appropriate assessment” with regard to the site’s conservation objectives. Under the requirements of the Regulations, “appropriate assessment” needs to be more detailed than a preliminary screening exercise, proportionate to the nature and complexity of the proposed development and sufficient to support the competent authority in determining whether the proposals would adversely affect the integrity of the site.

An HRA (referenced in Section 1.2) has already been submitted in support of the proposed Site re-development, which provides a detailed ecological assessment of the potential effects of the proposed development on the SPA/SAC of Langstone Harbour.

A request has been made by Havant Council (as the competent authority) for additional supporting information to demonstrate why the proposed development will not cause an increase in nutrient loading to the Chichester and Langstone Harbours SPA/SAC, thus enabling it to make a decision as to whether there is “*no reasonable scientific doubt*” as to the effects of the proposals. This requires due consideration of the risk of “likely significant effects”.

4.2 Assessment of Likely Significant Effects

Under the Habitats Regulations, a Likely Significant Effect is judged to be:

- ▲ *‘any effect that may reasonably be predicted as a consequence of a plan or project that may affect the conservation objectives of the features for which the site was designated, but excluding trivial or inconsequential effects’.*

The Significant Effect relates to:

- ▲ *‘possible impacts or effects on an interest feature or the supporting environment on which the feature depends’.*

It should be noted that quantitative criteria for “significant effects” are not provided in the Habitats Regulations.

As outlined in Section 2.3 previously, the Site is not considered to be posing an unacceptable impact to the quality of the Hermitage Stream or Langstone Harbour in its current state.

Section 3.0 presents a detailed assessment of plausible risks to controlled waters as a result of re-development of the Site to a commercial end use. A piled foundation solution for future buildings, together with ground improvement to external areas, are not considered to result in an increased risk to controlled water receptors and/or Langstone Harbour, and are consequently not considered to result in Likely Significant Effects.

Ammoniacal nitrogen is typically encountered at high concentrations within landfill leachates, and can be oxidised to nitrates and nitrites, consequently reducing the rate of leachate generation from the waste mass will have a commensurate reduction in nutrient loading to the receiving groundwater regime given the absence of engineered containment of the landfilled wastes. The proposed development, with buildings and substantial areas of hardstanding, is considered likely to result in a marked reduction in the rate of infiltration of incident rainfall into the landform, and thus contaminant leaching from the waste mass into the underlying groundwater regime, and thus receiving watercourses and the SAC of Langstone Harbour.

The Geo-Environmental Assessment Report (referenced in Section 1.2) included a quantitative assessment of the aforementioned reduction in rainfall infiltration into the Site, and this is reproduced in the following section.

Whether the reduction in contaminant loading (in the form of ammoniacal nitrogen or other nitrogen-containing compounds) to the SPA/SAC is likely to represent a Likely Significant Effect would require detailed quantitative risk modelling that is outside the scope of this assessment, furthermore it should be noted that such effects are considered to be *beneficial* (rather than adverse) in nature.

4.3 Quantitative Assessment (Rainwater Infiltration Modelling)

Delta-Simons have undertaken an assessment to determine the existing rate and volume of infiltration at the Site which could contribute to the mobilisation of local contamination.

We have utilised the IH124 methodology to determine the level of infiltration at the Site utilising local catchment characteristics. The Institute of Hydrology carried out a number of studies on revising the runoff equations produced in the original Flood Studies Report (1975). IH124 was specifically produced to address the runoff from small catchments. (Institute of Hydrology, 1994).

The HR Wallingford IH124 calculations sheet is included as Appendix B. The SPR (standard Percentage Runoff coefficient) for the Site is identified as 0.37 meaning that 37% of the total rainfall falling on the Site is predicted to run-off, the remaining 63% will therefore infiltrate.

Table 1 presents the IH124 run-off rates for the existing site and the corresponding infiltration figures for varying return periods:

Table 1: Existing Runoff & Infiltration Rates

	Greenfield Runoff Rate		Greenfield Infiltration Rate	
	l/s	m3/s	l/s	m3/s
QBAR	24.8	0.02481	42.24405	0.042244
1 in 1 year	21.1	0.02109	35.91	0.03591
1 in 30 years	57.1	0.05707	97.17324	0.097173
1 in 100 years	79.2	0.07915	134.7689	0.134769

Post-development, through the introduction of hardstanding in the form of the proposed units, access service yards, car parking and the drainage infrastructure to service the Site, there will be a significant reduction in infiltration into the underlying soils.

The proposed hardstanding is understood to cover an area of approximately 5.1 ha with approximately 3.2 ha of soft landscaping. Table 2 presents the IH124 run-off rates (taken from the HR Wallingford calculation Appendix H) for the proposed development and the corresponding infiltration figures for varying return periods:

Table 2: Proposed Runoff & Infiltration Rates

	Greenfield Runoff Rate		Greenfield Infiltration Rate	
	l/s	m3/s	l/s	m3/s
QBAR	9.63	0.00963	16.39703	0.016397
1 in 1 year	8.18	0.00818	13.92811	0.013928
1 in 30 years	22.2	0.02215	37.71486	0.037715
1 in 100 years	30.7	0.03072	52.30703	0.052307

The difference in infiltration rates pre- and post-development is provided in Table 3:

Table 3: Infiltration Rates Pre- & Post-Development

	Infiltration Rate		Difference Pre and Post Dev	
	Pre Dev m3/s	Post Dev m3/s	Volume m3/s	Reduction %
QBAR	0.042244	0.016397	0.025847	61
1 in 1 year	0.03591	0.013928	0.021982	61
1 in 30 years	0.097173	0.037715	0.059458	61
1 in 100 years	0.134769	0.052307	0.082462	61

Based on the above calculations, infiltration rates into the landfill mass will be reduced by approximately 60% when compared to existing infiltration rates.

5.0 Conclusions

An assessment of Likely Significant Effects, in the context of changes in nutrient loading to the Site's surrounding hydrogeological and hydrological regimes, has been undertaken to support a previous HRA that considers the effects of the proposed re-development of the Former Brockhampton West Landfill on the Chichester and Langstone Harbours SPA. The assessment has been undertaken in response to a request from Havant Council, as the competent authority, for additional information to allow it to make a decision as to whether there is "*no reasonable scientific doubt*" as to the risk of Likely Significant Effects arising from the proposals.

The assessment has concluded that:

1. The findings of a recent detailed geo-environmental assessment demonstrate that the Site, in its current state, is not posing a potential risk to the quality of controlled waters within its vicinity and thus the receptor of Langstone Harbour;
2. Measures to mitigate ground instability as part of the Site's re-development, namely the adoption of piled foundations for new buildings and ground improvement techniques for areas of hardstanding, are not considered to result in an incremental nutrient loading to shallow groundwater, surface watercourses in hydraulic continuity with shallow groundwater and/or Langstone Harbour;
3. The proposed development will result in reduced infiltration of incident rainfall compared to the Site in its current state, and this is supported by calculations utilising current best practice in assessing infiltration rates; and
4. These reduced infiltration rates will reduce contaminant leaching from the historical waste mass, and thus leachate generation, in the medium to longer terms, resulting in a reduction in the loading of ammoniacal nitrogen or other nitrogen-containing compounds to groundwater, surface waters and thus the receiving SPA/SAC in the medium to longer terms.

The assessment presented above demonstrates that the proposed development will result in a quantifiable (60%) reduction in surface water infiltration, generation and migration of landfill leachate and hence a net reduction in leachate migration into the Hermitage Stream and wider environment. Therefore the proposed development represents a reduction in nutrient migration to the SPA and any Likely Significant Effect will be positive.

Appendices

Appendix A – Limitations

Limitations

The recommendations contained in this Report represent Delta-Simons professional opinions, based upon the information listed in the Report, exercising the duty of care required of an experienced Environmental Consultant. Delta-Simons does not warrant or guarantee that the Site is free of hazardous or potentially hazardous materials or conditions.

Due to the evolving regulatory climate specific to Per Fluoro Alkyl Substances (PFAS), the scope of works is not intended to be conclusive as it relates to the identification of any PFAS related issues. While Delta-Simons may advise its Client if Delta-Simons becomes aware of the use of PFAS at the subject property, Delta-Simons makes no representation nor accepts any liability that any or all PFAS issues have been identified and/or revealed to its client through its scope of work, as presented herein.

Delta-Simons obtained, reviewed and evaluated information in preparing this Report from the Client and others. Delta-Simons conclusions, opinions and recommendations has been determined using this information. Delta-Simons does not warrant the accuracy of the information provided to it and will not be responsible for any opinions which Delta-Simons has expressed, or conclusions which it has reached in reliance upon information which is subsequently proven to be inaccurate.

This Report was prepared by Delta-Simons for the sole and exclusive use of the Client and for the specific purpose for which Delta-Simons was instructed. Nothing contained in this Report shall be construed to give any rights or benefits to anyone other than the Client and Delta-Simons, and all duties and responsibilities undertaken are for the sole and exclusive benefit of the Client and not for the benefit of any other party. In particular, Delta-Simons does not intend, without its written consent, for this Report to be disseminated to anyone other than the Client or to be used or relied upon by anyone other than the Client. Use of the Report by any other person is unauthorised and such use is at the sole risk of the user. Anyone using or relying upon this Report, other than the Client, agrees by virtue of its use to indemnify and hold harmless Delta-Simons from and against all claims, losses and damages (of whatsoever nature and howsoever or whensoever arising), arising out of or resulting from the performance of the work by the Consultant.

Appendix B - HR Wallingford IH124 Calculations Sheet – Total Site Area

Calculated by:

Site name:

Site location:

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:

Longitude:

Reference:

Date:

Runoff estimation approach

Site characteristics

Total site area (ha):

Methodology

Q_{BAR} estimation method:

SPR estimation method:

Soil characteristics

	Default	Edited
SOIL type:	3	3
HOST class:	N/A	N/A
SPR/SPRHOST:	0.37	0.37

Hydrological characteristics

	Default	Edited
SAAR (mm):	720	720
Hydrological region:	7	7
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

Notes

(1) Is $Q_{BAR} < 2.0$ l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is $SPR/SPRHOST \leq 0.37$?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	24.81	24.81
1 in 1 year (l/s):	21.09	21.09
1 in 30 years (l/s):	57.07	57.07
1 in 100 year (l/s):	79.15	79.15
1 in 200 years (l/s):	92.8	92.8

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement, which can both be found at www.uksuds.com/terms-and-conditions.htm. The outputs from this tool are estimates of greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of this data in the design or operational characteristics of any drainage scheme.

Appendix C - HR Wallingford IH124 Calculations Sheet – Proposed Development

Calculated by:

Site name:

Site location:

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:

Longitude:

Reference:

Date:

Runoff estimation approach

Site characteristics

Total site area (ha):

Methodology

Q_{BAR} estimation method:

SPR estimation method:

Soil characteristics

	Default	Edited
SOIL type:	3	3
HOST class:	N/A	N/A
SPR/SPRHOST:	0.37	0.37

Hydrological characteristics

	Default	Edited
SAAR (mm):	720	720
Hydrological region:	7	7
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

Notes

(1) Is $Q_{BAR} < 2.0$ l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is $SPR/SPRHOST \leq 0.37$?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	9.63	9.63
1 in 1 year (l/s):	8.18	8.18
1 in 30 years (l/s):	22.15	22.15
1 in 100 year (l/s):	30.72	30.72
1 in 200 years (l/s):	36.01	36.01

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement, which can both be found at www.uksuds.com/terms-and-conditions.htm. The outputs from this tool are estimates of greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of this data in the design or operational characteristics of any drainage scheme.