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Report on

SALTBOX SITE – BOGNOR REGIS

FLOOD RISK ASSESSMENT

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Revision History

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P2	Renumbered. Planning Issue	09/08/2017	KJ	KJ
P3	Changes to included Mango planning amendments	09/08/2017	KJ	KJ
P4	General amendments following the issue of the revised SFRA and the main modification version of the Local Plan	21/09/2017	GW	KJ
P5	General amendments	04/10/2017	GW	KJ

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1. Executive Summary

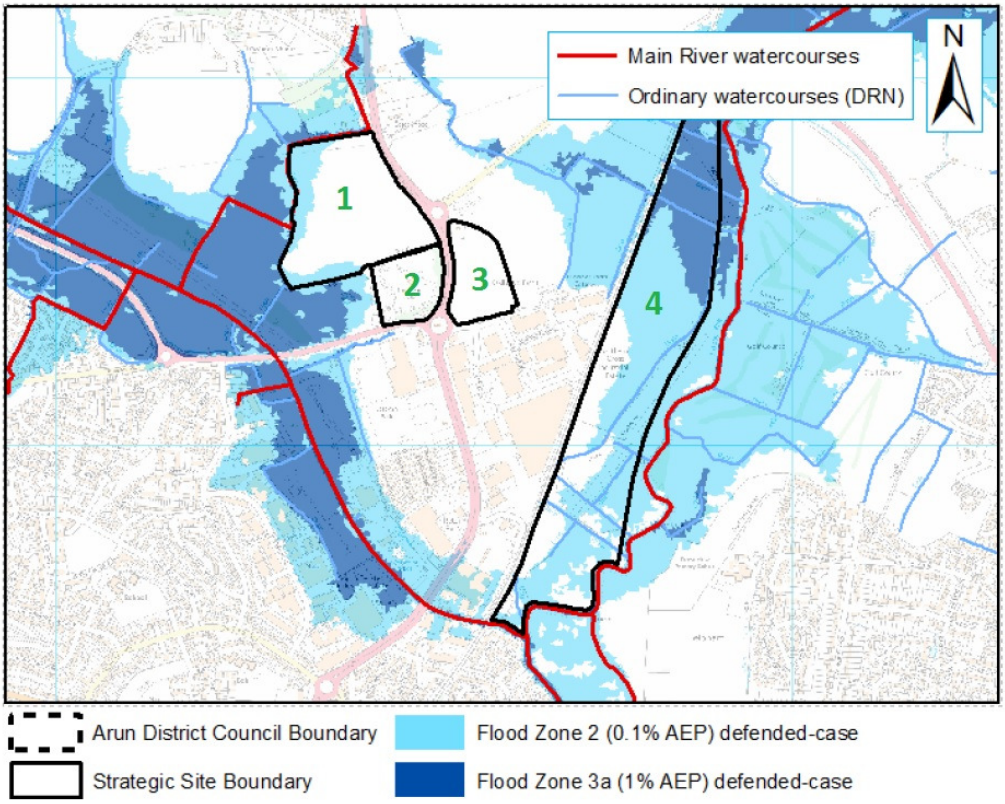
Kirksaunders (KSA) has been commissioned by Landlink Estates to undertake a site-specific Flood Risk Assessment (FRA) for the proposed Saltbox site development north of Bognor Regis.

Enterprise Bognor Regis is a 70 hectare commercial and employment development opportunity located on the northern edge of Bognor Regis in West Sussex.

It comprises four adjoining sites that can support a mix of business accommodation for advanced manufacturing, warehousing, offices and small business/studio units (B1, B2 & B8 uses). The development parcels are listed as follows:

1. **Salt Box**
2. Rowan Caravan Park
3. Oldlands Farm
4. Airfield Park

Table 1: Flood Zones Map (Present Day) with Enterprise Bognor Regis Parcels Illustrated.



This FRA relates to the Saltbox parcel only, listed above as parcel number 1 on figure 1.

Full planning permission is sought for the Phase 1 development of 6.492 hectares of employment space (B1, B2 and B8) with associated parking, landscaping and public open space. In addition, outline planning permission is sought for the Phase 2 development of 5.512 hectares for additional

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employment units, warehousing, hotel, drive thru's, public house, gym and associated works. Based on Table 2 (Flood Risk Vulnerability Classification) of the NPPF Planning Practice Guide, the Proposed Development is classified as 'Less Vulnerable'.

The site is located within Flood Zones 1, 2 and 3. However coastal flood defences protect the site from tidal flooding up to the 0.5% (1 in 200 year) annual probability event and the modelled level of flood risk from fluvial sources is less than 1% (1 in 100 year) annual probability to all built development. As all built development is effectively in Flood Zone 2 the Proposed Development is considered appropriate development in accordance with Table 3 of the NPPF Technical Guidance.

Flood risk to and arising from the Proposed Development has been classified as low to negligible and the proposed buildings are located outside all areas of flood zone 2 and 3.

A drainage strategy has been prepared to support the Proposed Development through the planning process. The strategy demonstrates the Proposed Development can comply with the requirements of the NPPF and does not increase flood risk either to or from the Proposed Development.

This FRA demonstrates that the Proposed Development site can be drained in a sustainable manner through attenuation and infiltration and that the development is not at flood risk from all sources and will not increase flood risk to other parties.

This FRA has been reissued in September 2017 to revision P4, to take account of the updated Strategic Flood Risk Assessment (SFRA) and main modification version of the local plan.

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2. Planning Policy

2.1 National Planning Policy Framework (NPPF)

The National Planning Policy Framework (NPPF) provides a clear and concise framework to ensure sustainability through planning and development. The framework sets out the Government's expectations as to how planning policies should be applied. The NPPF replaces previous Guidance and Policy set out in PPS25:- Development and Flood Risk.

The NPPF identifies flood risk as a specific material consideration in Section 10; "Meeting the challenge of climate change, flooding and coastal change" which provides guidance in determining planning applications whilst reducing the current and future threats of flood risk.

As outlined in the NPPF, a Flood Risk Assessment is generally required for any site which is designated as being within Flood Zone 2 and Flood Zone 3, including minor developments or changes in use. FRA's are required within Flood Zone 1 areas for development over 1 hectare; or less than 1 hectare but may be affected by sources of flooding other than rivers and sea and for sites which may encounter critical drainage problems as notified by the Environment Agency.

There are four levels to the designated Flood Zones, with Zone 1 being the 'least risk' and Zone 3b being a functional floodplain. The Flood Zones are defined as follows:

- Flood Zone 1 has a low risk of flooding having a less than 1 in 1,000 annual probability of river or sea flooding.
- Flood Zone 2 has a moderate risk of flooding with land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.
- A Flood Zone 3A has high risk of flooding with a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea in any year.
- Flood Zone 3B is land considered to act as functional flood plain

The above criteria does not account for any previous flood defences, unless otherwise stated, and estimate current levels of risk not taking into account future uncertainties of climate change.

The NPPF builds on previous legislation to empower Local Authorities in implementing suitable plans to mitigate flood risk. The NPPF expects Local Authorities to adopt a risk-based approach at all levels of planning by applying the 'Source – Pathway – Receptor' model to development in flood-susceptible areas.

Local Plans are guided by the NPPF and should account for the future uncertainty of climate change and avoid development in areas which are vulnerable to flooding. Unavoidable development in flood risk zones must undergo a Sequential Test to assess the extent of flood risk, followed by an Exception test to demonstrate that the site has wider sustainable benefits that outweigh flood risk, that the site is previously developed land and that the development will be safe for the lifetime of the development. Highly vulnerable developments such as Police/Ambulance stations which are required to remain operational during flooding are not suitable for High Risk Zone 3 sites. More vulnerable development

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such as housing, nurseries and educational establishments are suitable for Flood Zone 3A provided they pass the Exception test. The NPPF also states that "For individual developments on sites allocated in development plans through the Sequential Test, applicants need not apply the Sequential Test. Applications for minor development and changes of use should not be subject to the Sequential or Exception Tests but should still meet the requirements for site-specific flood risk assessments".

Local Plans should be supported by a Strategic Flood Risk Assessment to develop policies which involve contributions from all stakeholders such as the Environment Agency and other statutory bodies.

2.2 The Water Resources Act 1991

The Water Resources Act 1991 (Section 105) also requires the Environment Agency to exercise a general supervision over all flood defence matters, including flood plains and washlands which accommodate waters during periods of flood. The Environment Agency is a statutory consultee in the planning process, providing current information on Flood Risk Maps. The EA are able to define the extent of the flood plain that is under threat from flood risk.

2.3 Further Guidance

Further Guidance from CIRIA publication 'C624 Development and Flood Risk Guidance for the Construction Industry'[1] define three levels of FRA which can be undertaken:

FRA Level	Description/Scope
Level 1	**Screening Study** to identify whether there is any flooding or surface water management issues related to a development site that may warrant further consideration. This should be based on readily available existing information, including the SFRA, Environment Agency Flood Map and Standing Advice. The Screening Study will ascertain whether a FRA is required.
Level 2	**Scoping Study** to be undertaken if the Level 1 FRA indicates that the site may lie within an area that is at risk of flooding or that the site may increase flood risk due to increased run-off. This Study should confirm the sources of flooding which may affect the site and should include the following: - an appraisal of the availability and adequacy of existing information; - a qualitative appraisal of the flood risk posed to the site, and potential impact of the development on flood risk elsewhere; - an appraisal of the scope of possible measures to reduce the flood risk to acceptable levels.

[1] CIRIA Publication: *C624 Development and Flood Risk – Guidance for Construction Industry*, 2004

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	The Scoping Study may identify that sufficient quantitative information is already available to complete a FRA appropriate to the scale and nature of the development.
Level 3	**Detailed Study** to be undertaken if the Level 2 FRA concludes that further quantitative analysis is required to assess flood risk issues related to the development site. The Study should include: - quantitative appraisal of the potential flood risk to the development; - quantitative appraisal of the potential impact of development site on flood risk elsewhere; - quantitative demonstration of the effectiveness of any proposed mitigation measures.

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3. Local Planning Policy

3.1 Updated Strategic Flood Risk Assessment (SFRA) for Arun District Council

This work was commissioned to update the Strategic Flood Risk Assessment for the District outside of the National Park. This was necessary to support decisions around Main Modifications to the Arun Local Plan 2011-2031 during the period of suspension during the examination process. The SFRA Level 1 published in August 2016 and also a hybrid report incorporating Levels 1 & 2. The hybrid report sets out the current situation regarding flooding from differing sources across the District, supported by Appendices A - I, followed by a broad assessment of strategic sites/locations being considered by the Local Plan with more detailed assessments of the flood risk for each, contained in Appendix J, which the Bognor enterprise zone is included from pages 25 – 34.

3.2 General Summary of SFRA Recommendations

3.2.1 Site allocations

It is recommended that the outputs from this study are used as an evidence base for the allocation of potential development areas, directing new development to areas of lowest risk. The Council should use the information provided within this SFRA to apply the Sequential Test to their potential site allocations.

The Level 2 detailed site summary tables provided in Appendix A should be used by the Council to apply the Exception Test. In order to pass the Exception Test, a number of criteria will need to be met:

- It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk;
- It must be demonstrated that the development will be safe, without increasing flood risk elsewhere, and where possible, reduce flood risk overall;
- These tables also provide information and guidance for developers at the detailed flood risk assessment and planning application stage.

3.3 Policy

3.3.1 Future development

The Council should consult the Environment Agency's 'Flood Risk Standing Advice (FRSA) for Local Planning Authorities', published in March 2014, when reviewing planning applications for proposed developments at risk of flooding. Planning permission for development affecting watercourses should normally only be granted where

- the natural watercourse system which provides drainage of land is not adversely affected;
- a minimum 8m width access strip is provided adjacent to the top of both banks of any Main River (5m for Ordinary Watercourses) for maintenance purposes and is appropriately landscaped for open space and biodiversity benefits;
- it would not result in the loss of open water features through draining, culverting or enclosure by other means and culverts are opened up where ever possible;
- surface water drainage is delivered by SuDS;

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- betterment in the surface water runoff regime is achieved; with any residual risk of flooding, from drainage features either on or off site not placing people and property at unacceptable risk; and
- the application is compliant with the conditions set out by the Lead Local Flood Authority (LLFA).

At the planning application stage, developers need to undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent, inform development zoning within the site and prove, if required, whether the Sequential and Exception Tests can be satisfied. The assessment should also identify the risk of existing flooding to adjacent land and properties to establish whether there is a requirement to secure land to implement strategic flood risk management measures to alleviate existing and future flood risk.

3.3.2 Surface water management

Planners should be aware of the conditions set by the LLFA for surface water management so that development proposals and applications are compliant with the Council's policy. These policies should also be incorporated into the Local Plan.

3.3.3 Infrastructure and Access

Safe access and egress will need to be demonstrated at development sites. Consideration of alternative access and egress routes should be made in the event that primary routes are inundated with flood water. Resilience measures will be required if buildings are situated in the flood risk area, and opportunities to enhance green infrastructure and reduce flood risk by making space for water should be sought.

3.3.4 Green Infrastructure and WFD

Opportunities to enhance green infrastructure and reduce flood risk by making space for water should be sought. In addition, opportunities where it may be possible to improve the WFD status of watercourses, for example by opening up culverts, weir removal, and river restoration, should be considered. Green infrastructure should be considered within the mitigation measures for surface water runoff from development.

3.3.5 Strategic solutions

The information provided in the SFRA should be used as a base for investigating potential strategic flood risk solutions within Arun District. Opportunities to incorporate strategic flood risk solutions, such as storage areas, defences, land raising and attenuation ponds should be investigated as part of potential development proposals.

3.3.6 Assessing Flood Risk and Developments

- The NPPF supports a risk-based and sequential approach to development and flood risk in England, so that development is located in the lowest flood risk areas where possible; it is recommended that this approach is adopted for all future developments within the district;

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- A site-specific FRA is required for all developments which are located in the Environment Agency's Flood Zones 2 and 3, or developments greater than 1ha in size in Flood Zone 1. They are also required for developments less than 1ha in Flood Zone 1 where there is a change in use to a more vulnerable development where they could be affected by sources of flooding other than rivers and the sea (e.g. surface water drains, reservoirs). All developments located in areas of Flood Zone 1 highlighted as having critical drainage problems must also be accompanied by an FRA. The FRA should be proportionate to the degree of flood risk, as well as the scale, nature and location of the development;
- It is recommended that the impact of climate change to a proposed site is considered in FRAs and that the percentage increases which relate to the proposed lifetime of the development and the vulnerability classification of the development is identified and taken into account. The Environment Agency and LLFA should be consulted to confirm a suitable approach to climate change in light of the latest guidance;
- Opportunities to reduce flood risk to wider communities could be sought through the regeneration of Brownfield sites, through reductions in the amount of surface water runoff generated on a site;
- Arun District Council, the Environment Agency and LLFA should be consulted to confirm the level of assessment required and to provide any information on any known local issues;
- When assessing sites not identified in the Local Plan (windfall sites), developers should use evidence provided in this SFRA to apply the Sequential Test as well as provide evidence to show that they have adequately considered other reasonably available sites.

3.3.7 Promotion of SuDS

Planners should be aware of the conditions set by the LLFA for surface water management so that development proposals and applications are compliant with the Council's policy. These policies should also be incorporated into the Local Plan.

- A detailed site-specific assessment of SuDS would be needed to incorporate SuDS successfully into the development proposals. New or re-development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff.
- For proposed developments, it is imperative that a site-specific infiltration test is conducted early on as part of the design of the development, to confirm whether the water table is low enough to allow for SuDS techniques that are designed to encourage infiltration;
- 2016s3756 - Arun District Council Level 1 and Level 2 SFRA - Final Report (v5 November 2016).docx 115;
- Where sites lie within or close to Groundwater Source Protection Zones or aquifers, there may be a requirement for a form of pre-treatment prior to infiltration. Further guidance can be found in the CIRIA SuDS manual on the level of water quality treatment required for drainage via infiltration. Further restrictions may still be applicable and guidance should be sought from the LLFA;
- Developers need to ensure that new development does not increase the surface water runoff rate from the site and should therefore contact the LLFA and other key stakeholders at an early stage to ensure surface water management is undertaken and that SuDS are promoted and implemented, designed to overcome site-specific constraints;

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- In coastal areas consideration should be given to increased volumes of discharge from new development particularly in areas where discharges are affected by tide levels. The effect of changes to mean sea level as a consequence of climate change must also be taken into account;
- Arun District Council will need to consider drainage schemes for major applications, but it is advised developers utilise the LLFA's Polices and Guidance to develop their drainage scheme for minor applications.

3.3.8 Use of SFRA data and future updates

It is important to recognise that the SFRA has been developed using the best available information at the time of preparation. This relates both to the current risk of flooding from rivers, and the potential impacts of future climate change.

The Environment Agency regularly reviews their flood risk mapping, and it is important that they are approached to determine whether updated information is available prior to commencing a detailed Flood Risk Assessment.

The SFRA should be periodically updated when new information on flood risk, flood warning or new planning guidance or legislation becomes available. New information on flood risk may be provided by Arun District Council, the Highways Authority, West Sussex County Council, Southern Water and the Environment Agency. It is recommended that the SFRA is reviewed internally on an annual basis, allowing a cycle of review, by checking with the above bodies for any new information to allow a periodic update.

3.3.9 Note on the Environment Agency Flood Map for Planning

Where outlines are not informed by detailed hydraulic modelling, the Flood Map for Planning is based on generalised modelling to provide an indication of flood risk. Whilst the generalised modelling is generally accurate on a large scale, they are not provided for specific sites or for land where the catchment of the watercourse falls below 3km2. For this reason, the Flood Map for Planning may not be of an appropriate resolution to be used as application evidence, where details are material with respect to possible flooding for individual properties or sites and for any sites with watercourses on, or adjacent to the site. Accordingly, for site specific assessments it may be necessary to perform more detailed studies in circumstances where flood risk is an issue.

3.3.10 Implications of potential future development

It is noted in the SFRA that developers should ensure that third party property and land are not adversely affected by future development, both in terms of flood risk and other environmental factors (e.g. water quality and ecology). Future development at this site may have potential to influence the following receptors:

- Property and land located in the adjacent areas of Shripney, South Bersted
- Industrial Estate and Felpham;
- The Lidsey Rife, Shripney Manor Ditch and ordinary watercourses flowing
- through the site boundary;
- Settlements downstream of these watercourses, such as North Bersted, Felpham and Bognor Regis.

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3.4 Sequential and Exception Test

3.4.1 Sequential Test (General)

The NPPF 2012 requires a Sequential Approach to ensure preference is given to land within Flood Zone 1 prior to Flood Zones 2 and 3. It also ensures that flood vulnerability of the development proposals is taken into consideration when locating development in Flood Zones 2 and 3.

3.4.2 Sequential Test (Specific to the Bognor Enterprise Zone) Background

During the suspension period of the Arun Local Plan 2011-2031 examination, further work relating to flood risk was done. As a result of this and due to challenge over the content of the 2014 submitted document, a new document was produced to inform Main Modifications. This reflects the latest information from the new evidence documents, such as any changes to flood extents and as much detail as possible regarding expected delivery. This document is titled 'Arun Sequential and Exception test to inform Main Modifications', February 2017.

The opportunity was taken during the examination suspension period of the Local Plan to update and undertake a number of further evidence documents to support the local plan. It is understood that the following directly related to flood risk and have informed the content of this document:

- Arun DC (June 2016). Littlehampton Economic Growth Area (LEGA) Development Delivery Study Arun DC (Aug. 2016);
- Level 1 Strategic Flood Risk Assessment (SFRA);
- Arun DC (Sept. 2016). Level 2 Strategic Flood Risk Assessment; and
- Arun DC (Oct. 2016). Strategic Surface Water Management Study (SSWMS).

3.4.3 Sequential Test (Specific to the Bognor Enterprise Zone) Details

Following the screening process, a total of 12 sites have been identified as potentially suitable, to be taken forward for consideration within the Sequential Test, to inform the Main Modifications of the local plan, of which the Bognor Enterprise Zone was one, and hence the Salt Box Parcel was included.

The majority of the Bognor Enterprise Zone flooding, occurs outside our Saltbox development boundary, with the exception of the western boundary, which is located outside the area of proposed buildings.

Does this pass the Sequential Test? No. The site is intended for employment ('Less Vulnerable') and is considered suitable for development in Flood Zone 3a. However, the site is indicated to suffer from more than one form of flooding, which requires further consideration.

Exception Test Required? Yes. Consideration is needed to ensure the continued safety of the sites and their users from flooding throughout the development lifetime, with no consequent increase in flood risk downstream arising from development proposals. Upgrade if the flood defences serving the LEC Airfield site would be required before this site could be developed.

3.4.4 Exception Test (General)

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The Exception test is a method to demonstrate and help ensure that the flood risk will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites with lower flood risks are not available. For the Exception Test to be passed, the following must be demonstrated:

- The development provides sustainability benefits to the community that outweigh the flood risk, informed by the SFRA if applicable;
- The development should be on developable, previously developed land or, if not, then there are no other reasonable alternative sites on developable or previously developed land; and
- A FRA must establish that the development will be safe, without increasing the flood risk on site or elsewhere, and where possible will reduce the overall flood risk.

As stated above the NPPF paragraph 104 states that "For individual developments on sites allocated in development plans through the Sequential Test, applicants need not apply the Sequential Test. Applications for minor development and changes of use should not be subject to the Sequential or Exception Tests but should still meet the requirements for site-specific flood risk assessments."[2]
The advice regarding flooding matters in the NPPF is supplemented by additional guidance in the National Planning Policy Guidance (NPPG). Table 3 sets out the Flood Risk Vulnerability and Flood Zone "Compatibility". Outdoor sports and recreation is defined within the Water-Compatible Development classification and car parking is defined as Less Vulnerable Development. According to Table 3 such use classifications are acceptable within a Flood Zone 2 and 3 provided that the Sequential Test is passed. (There is no requirement to pass the Exception Test).

The normal approach for a Sequential Test is to demonstrate that there are no sequentially preferable "reasonably available" sites at a lower flood risk (i.e. in flood Zone 1 or 2) within a defined area. Such an approach is feasible when there are realistic available options to site a new development in alternative locations. However, such options clearly do not exist for this scheme (which is seeking to enhance an existing operation which does not have any alternative business premises).

Paragraph 033 of the NPPG provides advice on how the Sequential Test should be reasonably applied. It states that "When applying the Sequential Test, a pragmatic approach on the availability of alternatives should be taken. For example, in considering planning applications for extensions to existing business premises it might be impractical to suggest that there are more suitable alternative locations for that development elsewhere."[3]

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[2] National Planning Policy Framework, Planning Practice Guidance website:
http://planningguidance.communities.gov.uk/blog/policy/achieving-sustainable-development/delivering-sustainable-development/10-meeting-the-challenge-of-climate-change-flooding-and-coastal-change/#paragraph_104

[3] National Planning Policy Framework, Planning Practice Guidance website:
http://planningguidance.communities.gov.uk/blog/guidance/flood-risk-and-coastal-change/applying-the-sequential-test-to-individual-planning-applications/#paragraph_033

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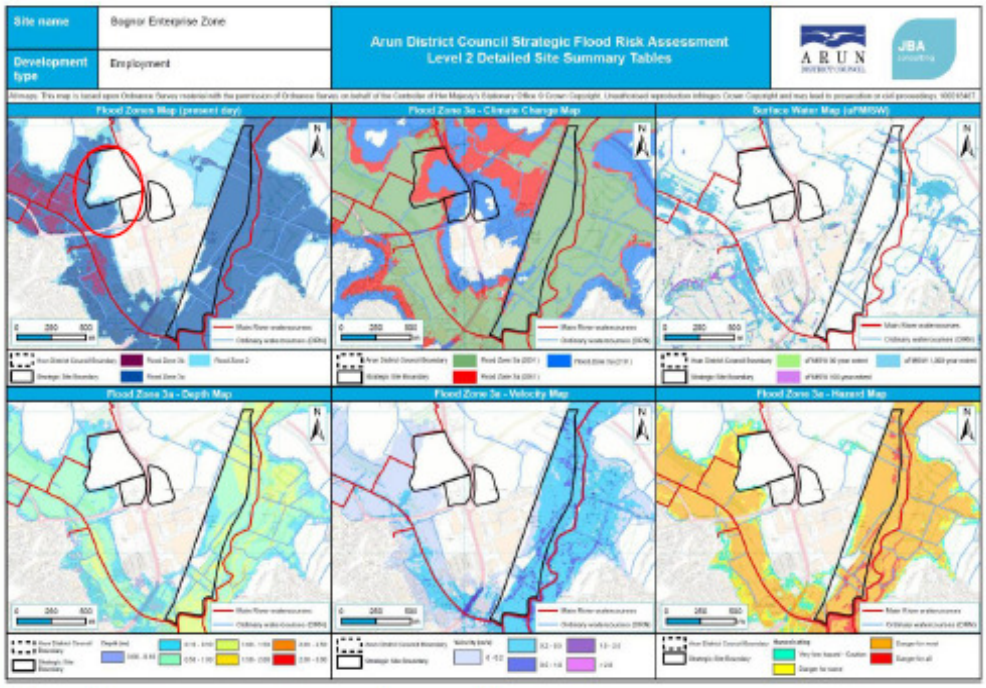
3.4.5 Exception Test (Specific to the Bognor Enterprise Zone)

The Bognor Enterprise Zone was assessed for the Western Site, which the Saltbox parcel was included. See figure 2 below for an extract of the Arun Sequential and Exception test to inform Main Modifications.

Table 2: Extract of the Arun Sequential and Exception test to inform Main Modifications

Bognor Enterprise Zone (Western Sites – Salt Box / Rowan Park)



Size and Use	14.9ha	Employment		
Development Lifetime	50-100 Years			
Are there any alternate sites in a lower risk flood zone?	No, all alternates have gone through the sequential test or are contained within this Exception Test. No other sites of a comparable size were available for these uses.			
Proportion of site in Flood Zone 3	Present	2031	2061	2111
	8%	14%	51%	96%
Proportion of site in Flood Zone 2	6%			

Flood Mechanisms

Although flood defences are present, which generally protect the sites from fluvial and tidal flooding now and in the future (2111), some minor ingress is seen on the north western boundary associated with the Aldingbourne Rife. Flood maps from Appendix J of the Level 2 SFRA indicate low flow velocities (0.0-0.2m/s) and flood depths (0.1m-0.5m).

Surface water flooding is indicated to be low, although is noted to contribute to flooding within the adjacent watercourses.

Groundwater flooding is noted within the site, although no data is available with which to quantify this.

Design Considerations (on-site)

- Strategic level flood risk management measures are proposed in the northern section of the Salt Box site to free up development land within the area. This should be accounted for within

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the development masterplan.

- Masterplanning to apply a site level sequential approach locating development in areas at least risk of flooding.
- Based on consideration of the defended flood outlines it is unlikely that impacts to floodplain storage will arise from development, although this should be fully assessed with floodplain compensation provided where required.
- Flood proof measures to be incorporated within the development design, including:
  - Setting of finished floor levels / entry points for services; and
  - Flood resilience measures.
- A commitment must be made to the long term management, maintenance and upgrade of flood defences serving the site, including contributions to tidal defences.
- Residual flood risks to the site should be fully assessed, including the impacts of overtopping and breach or failure of flood defences.
- Emergency response requirements to be fully assessed through the production of a Flood Management Plan.
- Significant surface water storage and water quality treatment requirements linked to potentially contaminating nature of site use. Source control measures are recommended including green roofs, lined permeable paving, rain gardens and swales. Oil separators to be specified where required. Further assessment required to ensure feasibility of delivery outside of the floodplain.
- Groundwater and percolation monitoring is required to inform the effective design of surface water attenuation / SuDS measures and determine the feasibility of infiltration methods for surface water disposal. Refer to *General Recommendations*.
- SuDS / surface water storage / flow conveyance measures may require lining to prevent groundwater emergence and to address water quality issues associated with underlying contaminated soils.
- SuDS measures should be situated remote from the Rifes / watercourses to maximise performance.
- Peak flows and downstream tidal locking within adjacent watercourses should be considered when designing site drainage and attenuation.
- Drainage arrangements to include exceedance pathways for overland flow.
- Opportunities to reduce discharges from the site and improve flood risk within the wider catchment to be fully investigated, including creating space for flooding and the use of SuDS (e.g. green roofs, water butts).
- Green corridors to be established through daylighting of culverts / naturalisation of watercourses, to reduce sedimentation and increase fluvial storage and conveyance capacity, subject to EA / LLFA approval.
- A site specific Flood Risk Assessment should be completed which considers the potential sources of flooding (including climate change), the associated hazard and required flood mitigation measures, safe access and egress, and the flood risk from ordinary watercourses, which may not be captured within the flood zone maps.

Refer also to *General Recommendations* section at rear of report which expands on the points noted above.

Design Considerations (off-site)

- Off Site SuDS measures are recommended including formalising the floodplain on the Lidsey Rife to provide additional flood storage.
- Introduction of lowered areas, ponds or reed beds within the Bersted Brooks nature reserve to

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increase flood storage and enhance wildlife. ▪ Aldingbourne Rife Integrated Flood Risk Management and Works (ARIFRM) study is due to be published in spring 2017. This may have implications for consideration of flood risk at the site. ▪ Upgrade of the Waste Water Treatment Works	
Expected Delivery	Developers
SA Conclusions	
The site is of sufficient scale to provide significant opportunities for employment. It is in a strategically advantageous position as it is within close proximity to residential settlements (South Bersted, North Bersted, Bognor Regis), and public transport alternatives. Development of the site will contribute to the regeneration of Bognor Regis and would improve efficiency in land use as the site contains some elements of previously developed land. The site contains areas at high risk from flooding (Flood Zone 3). However, the site is allocated for employment land, which is considered a 'less vulnerable' use, and which is considered appropriate within Flood Zone 3. This is subject to demonstration (via a site specific FRA) that flood mitigation can be achieved which ensures the safety of the development from flooding throughout its lifetime and which will not increase flood risk to other areas. The design of the development should also incorporate improvements to mitigate the impacts on the transport network and the landscape. Delivery of the site may be affected by the timing schedule for the upgrade of the Lidsey WWTW.	
Exception Test Conclusions	It is considered that the flood risks identified within the site can be appropriately managed through the incorporation of flood mitigation and resilient design. It is recommended that groundwater monitoring be undertaken at the earliest opportunity to establish areas of the site at greatest risk and to inform the site masterplan and drainage design arrangements. Proposed surface water management measures and funding for sewer network upgrades would have a beneficial impact on flooding within the wider district, including the Bognor Enterprise Zone, downstream.
Compliance for Allocation	Yes

3.4.6 Exception text conclusion and general requirements

Following application of the Exception test it can be demonstrated that the Saltbox site is considered to provide wider sustainability benefits to the community that outweigh flood risk. It has also been demonstrated that, where required, flood mitigation and management measures can be employed which will ensure the safety of the proposed strategic sites throughout their anticipated lifetime and which, in many instances, reduce the flood risk within the wider community.

The Arun District catchment is predominated by elevated groundwater and tidally influenced watercourses, both of which affect the management of flood risk. The district is also characterised by rural and coastal areas, many of which carry an environmental designation.

As a result of these factors there are a number of specific requirements which should be applied across all strategic sites and which are outlined below. These are in addition to the site-specific recommendations sited throughout the report. NB, not been tailored for this FRA.

- Groundwater monitoring and percolation testing during the winter period is required to determine the feasibility of infiltration methods for the disposal of surface water runoff. A minimum monitoring period of 6 months is recommended to capture the influence of significant storm activity and seasonal variation on groundwater elevation.

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- The main constraint to the delivery of surface water management across the district is high groundwater, which prevents the use of deep infiltration measures such as soakaways. Attenuation measures have therefore been recommended as the main storage component for strategic sites, storing surface water and discharging to local watercourses at controlled rates.
- Flood conveyance and attenuation storage measures may require the installation of impermeable liners to prevent the ingress of groundwater and to achieve the required level of flood storage.
- Many of the catchment areas exhibit low topographical relief, with difficulty in achieving gravitational drainage using traditional piped networks. For most sites, it is therefore recommended that swales or permeable paving be installed as the primary method of flow conveyance.
- Local watercourses also exhibit shallow gradients leading to slow flows and sedimentation. Where possible development should remediate these watercourses, incorporating a two-stage channel, comprising a narrow lower channel to increase the velocities of normal flows, with a stepped overflow capacity to accommodate runoff from storm activity. This will be subject to EA / LLFA approval.
- Many of the district's main rivers and coastal outfalls are tidally affected, as a result surface water cannot always freely drain. This needs to be considered within the design of surface water management measures specified for sites.
- SuDS measures should be incorporated throughout sites as close as possible to the source of runoff, to promote infiltration at source and reduce off-site discharges of surface water. Site drainage should follow the SuDS hierarchy considering infiltration, harvesting, slowing, storage, conveying and treatment on site where possible; controlled discharge to watercourse, and as a final option restricted discharge to surface water sewers.
- Opportunities for amenity and ecological enhancement should be promoted wherever possible. This includes the opening of culverted watercourses, input of additional swales, and naturalisation of watercourses, wherever possible, to increase the presence green infrastructure throughout the district.
- A site-specific Flood Risk Assessment should be completed which considers the potential sources of flooding (including climate change), the associated hazard and required flood mitigation measures, safe access and egress, and the flood risk from ordinary watercourses, which is not included within the indicative flood maps.

3.4.7 Arun Strategic Surface Water Management Study Stage 2 Report August 2016

Enterprise Bognor Regis is a site designated for industrial units and is within both tidal and fluvial flood zones 2 and 3. Due to the high percentage of impermeable area and the industrial use of the site, storage at source and pollution control is particularly important for the surface water management.

Green roofs are recommended across the site to capture the first occurrence of rainfall. Lined permeable paving is also recommended to both capture, store and convey surface water flow. Additional storage could be provided in the form of rain gardens or swales throughout the site. Downpipes from the green roofs could connect directly into the swales, instead of using deep pipework.

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Due to the large amount of hardstanding and industrial use of the site, there is a risk of pollution to surface water, typically from oil spills from vehicles. The site will require pollution prevention measures under the Environment Agency's Pollution Prevention Guidelines (PPG3). Oil interceptors are often used for removing oil from surface water; however, the SuDS measures recommended can provide this function without the need for underground tanks. The granular subbase of the permeable paving acts to filter oil from surface water. Additionally, a geotextile membrane designed to remove hydrocarbons can be installed within the subbase of the paving. Tree pits could also be incorporated to provide surface water treatment through filtration and phytoremediation.

3.4.8 Record of meeting/discussion 11/05/16 (Section 1.2 relating to the meeting minutes Bognor Enterprise Zone);

- Area highlighted on plan as a potential surface water management area is already a flood compensation area. Various issues due to water not draining – assume this is resolved for the purposes of this study;
- Potential to increase area;
- Standing water issues with flood tunnels and adjacent service road adjacent to the Oldlands Farm site need to be resolved;
- Tesco's car park is designed to flood regularly;
- Proposed impermeable area less than previously suggested. Potential for more natural SuDs features;
- Potential to utilise excavated material from flood compensation areas;
- To raise land (out of floodplain) on Enterprise site. Alternatively raise units above flood level, or design to allow flooding.
- Culverts under railway line – may need additional culverts for drainage;
- Network Rail to be involved';
- The Brooks - confirm ownership and look to extend beyond the Arun district boundary;
- A29 realignment could potentially affect site;
- ADC to confirm the Bognor golf course development proposals;
- Potential SuDS opportunities;
- Aldingbourne Rife project currently undertaken by EA has additional information on reducing flood risk within the area;
- Close public consultation will be required with Shripney Village.

Note, not all of the items listed above relate specifically to the Saltbox application.

3.4.9 Implications of the Environment Agency's FCERM programme (extract taken from Appendix J of the Arun SFRA Update)

There are several FCERM schemes that cover different parts of Arun District. It is recommended that the outcomes and actions from these schemes are considered in the development proposals for this site. The FCERM schemes relevant to the Bognor Enterprise Zone as a whole include:

- Lidsey Surface Water Management Plan (SWMP) and Actions – the scheme was managed by West Sussex County Council, and the SWMP was published in October 2014 to help understand

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the flood risk from local sources and establish a long-term action plan for surface water management;

- Aldingbourne Rife Integrated Flood Risk Management Project – the project is investigating approaches in which flood risk from combined sources can be managed within the Aldingbourne Rife catchment. The project is managed by the Environment Agency;
- Arun Partnership Watercourse Management – extensive capitalised improvement work is planned in order to improve the condition of the assets throughout the District and contribute to recommendations of the local strategies currently being prepared. This scheme is managed by Arun District Council and is expected to commence between 2016 and 2018.

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4. Scope of Flood Risk Assessment

4.1 General

The detail and complexity of a Flood Risk Assessment should reflect the level of risk to the site. The NPPF lists the general requirements of a Flood Risk Assessment and provides that Flood Risk Assessments should:

- be proportionate to the risk and appropriate to the scale, nature, and location of the site;
- consider the risk of flooding arising from development in addition to the risk of flooding to the site;
- take the impacts of climate change into account;
- consider both the potential adverse and beneficial effects of flood risk management infrastructure including raised defences, flow channels, flood storage areas and other artificial features together with the consequences of their failure;
- consider the vulnerability of those that could occupy and use the site, taking account of the Sequential and Exception Tests and the vulnerability, including arrangements for safe access;
- consider and quantify the different types of flooding (whether from natural and human sources and including joint and cumulative effects) and identify flood risk reduction measures, so that assessments are fit for the purpose of the decisions being made;
- consider the effects of a range of flooding events including extreme events on people, property, the natural and historic environment and river and coastal processes;
- include the assessment of the remaining (known as 'residual') after risk reduction measures have been considered and demonstrate that this is acceptable for the particular development or land use;
- consider how the ability of water to soak into the ground may change with development, along with how the proposed layout of development may affect drainage systems; and
- be supported by appropriate data and information, including historical information on previous events.

4.2 Sources of Flooding

Based on the CIRIA Report 624, Table A2, and as shown above, the following potential sources of flooding could be considered to apply to the site:

- Fluvial – Flooding as a result of rising water levels in nearby river;
- Overland Flow – Flooding as a result of overland surface water run-off from higher ground; and
- Infrastructure Failure – Flooding as a result of failure of infrastructure designated to store or carry water or pipe blockage.

4.3 Site Overview

Flood risk at the site is generally low from rivers, the sea and intense rainfall (surface water flooding).

Groundwater flooding may also be likely, with the available datasets showing the entire site to be located within a 1km grid square where between 25-50% of the 1km2 area may be susceptible to groundwater flooding. Note: information on the exact location, frequency and magnitude of this flooding is unclear.

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It is acknowledged that additional site investigation will be completed to confirm the exact depth of ground water across the site. The monitoring should be completed over a worst case seasonal scenario, and depths should be plotted over the proposed site plan and co-ordinated with the finished site levels.

A small proportion of the Saltbox site is located in Flood Zone 3a, meaning that it has greater than 1% and 0.5% annual probability of flooding from the Rivers and Sea respectively. Much of the land in Flood Zone 3a is located across western-most boundary of the Saltbox parcel of the site.

However, there are defences that are influential at protecting the Saltbox site from flooding. Therefore, the actual flood risk to the site may differ from that represented by the Flood Zone information.

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5. Flood Risk Assessment

5.1 General Requirements for the Site-Specific Flood Risk Assessment

- The peak flows of the Lidsey Rife and the Shripney Manor Ditch, and potential flooding of the site, should be considered when designing site drainage and attenuation;
- Assessment of runoff should include allowances for climate change effects, and discharge rates from the site should not increase downstream;
- Safe access and egress would need to be demonstrated. This should include consideration of the effects of climate change to ensure that access and egress remains safe throughout the lifetime of the development;
- New development should seek opportunities to reduce the overall level of flood risk at the site and in surrounding areas. This may include:
    - reducing volume rate and runoff;
    - relocating development to zones with lower flood risk, and
    - creating space (where possible) for flooding
- Consultation with the Local Authority and the Environment Agency should be undertaken at an early stage.

5.2 Actual Flood Risk (Overview)

A raised wall and embankment is located at Bognor Regis Promenade (located between Gloucester Road to the west, Sea Road to the east, and to the south of Felpham Pumping station) which provides protection against ingress of coastal flood water. Whilst Flood Zones (representing an undefended case) show flooding in Flood Zone 3a (0.5% AEP tidal event), the site and the surrounding area has a less than a 0.5% annual probability of tidal flooding when defences are considered.

Actual fluvial flood risk is present from the Aldingbourne Rife, Lidsey Rife and Shripney Manor Ditch. Flood Risk from ordinary watercourses is not captured by this flood risk information and should be considered as development proposals are taken forward. The actual fluvial flood risk is shown in as Table 1 of this report.

Proposed infrastructure in locations of actual risk should be implemented along with appropriate measures so that development is safe from fluvial flood risk. A commitment must be made to the long-term management and maintenance of such measures and to any additional requirements to address the residual risk that may be attached. The commitment required to long term contributions to the tidal defences should also be included when developing development details.

The maps provided within appendix J of the SRFA (Page 34) display the predicted depth, velocity and hazard rating of flood water at the site in the Flood Zone 3a event. These provide an indication of the level of hazard from fluvial flooding.

Flood depths and velocities are typically predicted to be up to 0.50m and 0.20m/s, respectively where flooding is predicted on the site.

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Given the relatively short length of the Shripney Manor Ditch flowing along the site's western boundary, the timing of the rise and fall in flood levels associated with a flood event will be fairly consistent for the western parcel of the site. However, since it contributes to the Aldingbourne Rife that subsequently discharges to the sea at Bognor, consideration should be given to the potential effects of reduced discharges during high tide events.

The Lidsey Rife at this location is a larger watercourse compared with Shripney Manor Ditch with a greater contributing catchment (including Barnham Rife for instance). Therefore, the timing of the rise and fall in flood levels associated with a flood event may be more variable for the eastern parcel of the site.

It has been noted in the SFRA that there may be longer duration of flooding, but also potential for double peaked events if rainfall over the Lidsey Rife and Barnham Rife catchments varies. Ground levels are relatively flat, with relatively wide and extensive flooding predicted, suggesting flood water may be resident on floodplain for some time (e.g. several days) before it is able to drain away.

Any groundwater flooding will typically last for longer durations than fluvial and surface water flooding, often for periods of days/weeks.

5.3 Flood Zones (General)

The map shown in figure 1 of this report displays the location of Flood Zones at the site.

There is a band of Flood Zone 3a, much of which is located across western-most boundary of the site. Although smaller proportions of Flood Zone 3b and 2 are predicted in both parcels of land, a significant proportion of the western parcel of the site is located in Flood Zone 1; the lowest flood risk zone. Ordinary watercourses may also present a flood risk that is not captured in the Flood Zone information.

The Shripney Manor Ditch runs along the majority of the western boundary, and can be seen on page 11 of the part 1 of Appendix B to the SFRA update.

5.4 Fluvial Flooding

Three Main Rivers are located in the vicinity of the site (refer to figures in Appendix D), these are:

- Aldingbourne Rife, 200m to the west;
- Lidsey Rife, 600m to the east;
- Shripney Manor Ditch which forms the boundary to the north and most of the west of the site, before flowing (north east to south west) into the Aldingbourne Rife.

The Site drains to the Shripney Manor Ditch and the Aldingbourne Rife. The Site is located within the Arun Internal Drainage District (IDB), which is managed by the Environment Agency as the Internal Drainage Board (IDB). There are a number of ordinary watercourses located in and within the vicinity of the site managed by the Arun IDB, these include the following:

- Oldlands Farm Ditch;
- Bersted Brooks to the west of the Rowan Caravan Park that flows southwards and then beneath Rowan Way to join a drainage channel that runs westwards along the southern side of Rowan Way (refer to figure in Appendix D);

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- Several unnamed drainage ditches on the western boundary of the site that flow into the Aldingbourne Rife.

The Environment Agency's detailed flood mapping (refer to Appendix D) shows that the Site is located within Flood Zone 2 and 3. This mapping shows the flood risk without the presence of flood defences (i.e. the tidal flood risk).

To establish the risk from fluvial flooding, modelled flood levels have been obtained from the Environment Agency. The modelled flood level for the 0.1% (1 in 1000 year) annual probability fluvial flood event is 1.67m AOD for the Site. This indicates that the majority of the site is not affected by this event. No further information is available for more frequent fluvial flood events from the Environment Agency's modelling.

The land adjacent to the Shripney Manor Ditch is predominantly soft landscaped, and it is intended that proposed site levels for the buildings and external areas are to be situated away from this zone and designed to be higher than these levels by a minimum of 600mm and or a minimum of 150mm above the existing site levels. Refer to Section 5.2 of this report for more details regarding the Lidsey Rife which is located CIRCA 600m east of the development site.

The risk of flooding from fluvial sources to the developed area of the Site is considered to be low for the majority of the site and moderate for a small area as part of the Proposed Development is located within Flood Zone 2 and 3, however the risk to the majority of the site from fluvial flooding is less than 1% (1 in 100 year) annual probability.

The Proposed Development will not impact on the floodplain as there will be no development in areas of the site subject to fluvial flood risk. The Proposed Development will have no impact on flood risk from this source on neighbouring property.

5.5 Pluvial and Overland Flow

Climate change is predicted to increase rainfall intensity in the future by up to 40%, 53 under the new range of allowances published by the Environment Agency. This will increase the likelihood and frequency of surface water flooding, particularly in impermeable urban areas, and areas that are already susceptible. Changes to predicted rainfall should be incorporated into flood risk assessments and drainage and surface water attenuation schemes associated with developments.

The Environment Agency's Flood Map for Surface Water (refer to Appendix D) shows that the site is mostly at very low risk of surface water flooding less than 0.1% (1 in 1000 year) chance in any given year. However, there are some small isolated areas of low risk (less than 1 in 100 (1%) but greater than or equal to 1 in 1000 (0.1%) chance in any given year).

The site is located outside of the smaller event magnitudes tested as part of the uFMfSW extent.

The risk of pluvial or overland flooding to the Application Site is considered to be low to negligible.

By developing the site, there is a risk of pluvial/overland flows from the Proposed Development increasing. The risk of flooding to and arising from the Proposed Development, regarding

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pluvial/overland flow, is moderate as overland flow will to be manged through SuDS and flow routes to less vulnerable areas such as soft landscaped areas and car parks and the proposed surface water management and drainage strategy for the site will be designed as to manage surface water flows from the development Site.

5.5 Coastal flood risk

5.5.1 General Bognor Enterprise Zone

In coastal locations, the risk of flooding is linked to the stability of the coastline. If the coast is eroding, then the potential effect is that tidal flood defences near to the sea will be lost and flood risk will increase. To maintain an appropriate standard of safety from flooding it is sometimes necessary to implement works to slow down or stop the rate of coastal erosion and so maintain the integrity of the tidal defences. The Shoreline Management Plan 37 describes the arrangements and strategy for managing coastal erosion and the influential measures.

More detailed strategies have been developed to address coastal erosion and flood risk, describing the approach to meeting the outcomes of the SMP, and these are described in the following documents:

- Rivers Arun to Adur flood and erosion management strategy (2010)38;
- River Arun to Pagham flood and coastal erosion risk management strategy (2015)39;
- Pagham to East Head coastal defence strategy (2009)40.

Historic flooding information held by the Environment Agency does not report historic coastal flooding events within Arun District, but it should be noted that this dataset cannot be guaranteed to capture all events. Incidences of wave overtopping events are known to have occurred in the district, but it unclear whether these resulted in flooding.

Climate change is predicted to influence the rate of sea level rise, in addition to offshore wind speed and extreme wave height. However, sea level rise will influence the tidal levels which propagate upstream along the tidal rivers in the district, thereby impacting flood risk. Guidance on required net sea level rise allowances (after adjustment for land movement changes) is presented within the updated guidance released by the Environment Agency. The adjustments to the allowances from previous guidance are less marked.

5.5.2 Defences

Preparation of the SFRA has included within Section 6.0, a high-level review of available information on formal flood defences and involved interrogation of existing evidence on asset condition and standards of protection. Details of the flood defence locations and condition were provided by the Environment Agency for the purpose of preparing this assessment, in addition to some supplementary explanation on asset performance. Defences are categorised as either raised flood defences (e.g. walls/embankments) or flood storage areas (FSAs). The assessment has considered man-made defences and not natural defences which may arise for instance due to the presence of naturally high ground adjacent to a settlement.

This site is not protected by any formal flood defences within the immediate vicinity of the site. However, coastal flood defences to the south at Felpham in Bognor Regis offer a standard of protection

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of approximately 1 in 200 years (0.5%) from tidal flooding. A foreshore and wave return wall forms the primary defence, with a concrete wall forming the secondary defence. These are fronted by a shingle beach which is controlled by timber and rock groynes.

The foreshore and wave return wall measures approximately 800m in length and the crest levels vary between 6.5m AOD and 5.64m AOD. The concrete secondary defence mirrors the primary defence in both length and crest level.

Environment Agency records show the foreshore and wave return wall to be in good condition, whilst the concrete wall is in both fair and poor condition along its length.

The Environment Agency's detailed flood mapping (refer to Appendix C) shows that a large part of the Site is located within Flood Zones 2 and 3. The Environment Agency's modelled flood level for the 0.5% (1 in 200 year) annual probability tidal event is 2.74m AOD.

This mapping shows the flood risk without the presence of flood defences. The tidal flood risk area in Bognor Regis which affects this site protected by coastal flood defences.

The coastal flood defences provide a standard of protection of 0.5% (1 in 200 year) annual probability. Therefore, the site is at a residual risk of flooding in the event that these tidal defences fail or are overtopped.

It is acknowledged that part of the Proposed Development is located in Flood Zone 2 and 3, however due to the presence of coastal flood defences the residual risk to the site from tidal flooding is less than 0.5% (1 in 200 year) annual probability. Also, the proposed development will be comprised of 'Less Vulnerable' Site uses appropriate to the Flood Zone.

The Proposed Development will have no impact on flood risk from this source on neighbouring property.

5.5.3 Additional Note

Appendix J of the SFRA includes site summaries for all the locations that were being considered for inclusion in the Main Modifications, including Bognor Enterprise. In particular, responding to a question from the new Inspector there is an additional bullet point that is being inserted into policy SP1 a Strategic Approach, specifically covering the need to take account of the coastal topography and incorporation of adaptations to deal with climate change particularly in high risk flood areas.

5.6 Flood history

The Environment Agency's historic flood map for the Bognor Enterprise Zone as a whole, shows that the northern part of the eastern parcel of land has flooded in the past. However, this area is outside the Saltbox application site. In addition, dataset does not necessarily capture all historic flooding and further information provided by the Environment Agency confirms that the area also flooded during 2012.

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5.7 Infrastructure Failure

Southern Water sewer records do not show any Southern Water infrastructure within the Application Site. Assets are located to the south of the site in Bognor Regis and to the north in Shripney.

No other records have been made available of sewer flooding at the Application Site.

The risk of flooding from sewers and drainage infrastructure at the Application Site is considered to be low.

Southern Water has not been consulted regarding capacity of their infrastructure to meet the increased demand for foul sewerage provision from the Proposed Development.

All surface water drainage will be routed to the nearby watercourses via adequate water quality control measures and therefore there will be no impact from the Proposed Development on the local public surface water sewer system. It is acknowledged that the Aldingbourne Rife already fails due to discharges from Tangmere further north. We understand this will be addressed as part of Southern Water's business plan.

The proposed loading on the foul sewer is not known, any infrastructure improvements needed to cope with increases in foul sewer loading due to the development of the site will be made as required.

The risk of flooding to and arising from the Proposed Development, regarding sewers, is low.

5.8 Artificial Sources

Flooding can occur because of infrastructure failure, for example breach and/or overtopping of retaining structures for raised bodies of water such as canals or reservoirs.

The site does not lie within the inundation area of any reservoirs. There are no raised sections of canal within 500m of the Application Site.

The risk of flooding from dam and canal infrastructure at the Application Site is considered to be negligible.

The site is not within a 500m search radius of any dams or canal infrastructure.

The risk of flooding to and arising from the Proposed Development, regarding artificial sources, is negligible.

5.9 Groundwater

AStGWF mapping indicates that the site is located within a 1km grid area where the susceptibility to groundwater flooding is >=25% but <50%.

The areas at risk of groundwater flooding are based on the Environment Agency's strategic-scale map which shows the Areas Susceptible to Groundwater Flooding (AStGWF) on a 1km square grid. The data shows the proportion of each 1km grid square, where geological and hydrogeological conditions indicate that groundwater might emerge and has been used to define areas at risk of groundwater flooding.

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Chalk aquifers such as that which underlies the Application Site are more likely to cause groundwater flooding because of its geological formation. However, it notes that there are no historical records of groundwater flooding in Arun District.

Existing borehole records for the Application Site do not indicate groundwater near the surface.

The risk of groundwater flooding to the Application Site is low.

Basements or underground car parks are not proposed as part of the Proposed Development and foundations for the buildings will be of typical construction with piled foundations which may be terminated in chalk. It is considered unlikely there will be any laterally continuous barrier to ground water created by the Proposed Development. The results of the proposed groundwater monitoring will be considered as part of the detailed design.

The Proposed Development will not exacerbate the risk of groundwater flooding to the surrounding area.

5.10 Groundwater Source Protection Zone

The site is not located within any Environment Agency designated Source Protection Zone.

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6. Residual Risks and Impacts

6.1 Residual Risks

Table 2 outlines the initial qualitative assessment of risk posed by the potential source of flooding, the mechanisms for flooding and the likely consequences. The tables also include potential mitigation measures to minimise the residual risk.

Categories of risk have been qualitatively defined as:

- 'High' Risk: flooding is likely to result in significant damage to property and pose a significant risk to life;
- 'Medium' Risk: flooding may result in possible minor damage to property but flood progress would allow adequate time for residents to be warned and safely evacuated to higher ground or appropriate places of safety;
- 'Low' Risk: flooding is unlikely to result in any damage to property damage and pose little or no risk to life.

6.2 Flood Probability

The SFRA and EA show that the development site areas are largely situated within Flood Zone 1 with small areas of the site situated within Flood Zone 2 and 3. The EA Flood data and levels show that the site would be affected from fluvial flooding. However, there is no development planned within these areas.

The SFRA and EA Flood information show that the 1 in 100-year climate change flood level is 1.330m AOD for the site. The proposed site levels will be designed to be above this.

6.3 Flood Impact

The Proposed Development will be comprised of 'Less Vulnerable' Site uses appropriate to the Flood Zone and will not impact on the floodplain as there will be no development in areas of the site subject to fluvial flood risk and due to the presence of coastal flood defences the residual risk to the site from tidal flooding is less than 0.5% (1 in 200 year) annual probability for areas of built development subject to tidal flooding.

The Proposed Development will have no impact on flood risk from this source on neighbouring property.

6.4 Impact of Displaced Water

Redevelopment of the site will not result in the displacement of floodwaters. The proposed development will be comprised of 'Less Vulnerable' and 'Water Compatible' site uses.

According to information published by the EA new development must provide level for level and volume for volume compensation as a replacement for volumes lost from the flood plain through development with new flood plain volume by reducing nearby ground levels. The compensatory volume must be at the same level (within reasonable working limits) as the lost storage. The proposals ensure that there is no loss in flood plain storage as a direct result of the development by not increasing levels within the

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1 in 100-year climate change flood event. The proposed levels within the flood extents will be at or below that of the existing ground level, therefore providing an overall increase of the existing flood plain volume. In tidal areas, raising ground levels is unlikely to impact on maximum tidal levels so the provision of compensatory storage should not be necessary.

The proposed redevelopment will not have any significant impact on the volumes of storage available on site.

6.5 SRFA Residual Risks

It is worth noting, the SFRA (refer to section 6.6) does not assess the probability of failure other than noting that such events are very rare. However, in accordance with NPPF, all sources of flooding need to be considered. If a breach or overtopping event were to occur, then the consequences to people and property could be high. There is also advice within the SFRA that developers should be aware that any site that is at or below defence level may be subject to flooding if an event occurs that exceeds the design capacity of the defences, or the defences fail and this should be considered when building resilience into low level properties.

6.6 Impact of Fluvial Morphology

It is considered there will be no impact on the fluvial morphology as a result of this development.

Table 2: Qualitative Assessment of Residual Flood Risk

Flood Hazard	Flood Mechanism and Possible Consequence	Initial Assessment of Risk	Comments/Recommended Mitigation Measures	Residual Risk
Tidal		MODERATE	All built development is located is areas assessed as having less than 0.5% annual probability (equivalent to the 1 in 200 year) of tidal flooding. Safe and dry access to the Proposed Development is available from the A29 for all events up to the 0.5% annual probability (1 in 200 year) tidal and 0.1% annual probability (1 in 1,000 year) fluvial events. Despite this it is recommended that all buildings have finished floor levels set a minimum of 600mm above the existing ground levels, providing	

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Flood Hazard	Flood Mechanism and Possible Consequence	Initial Assessment of Risk	Comments/Recommended Mitigation Measures	Residual Risk
			mitigation from localised flooding from extreme events.	
Fluvial Flooding	Site located within a Flood Zone 3 shown on the EA/SFRA maps, considered high risk of fluvial flooding. Site is affected by a 1 in 100-year flood level of 16.330m AOD including climate change.	MODERATE	All built development (i.e. residential dwellings, and onsite highways) are located is areas assessed as having less than 1% annual probability (equivalent to the 1 in 100 year) of river flooding. Safe and dry access to the Proposed Development is available from the A29 for all events up to the 0.5% annual probability (1 in 200 year) tidal and 0.1% annual probability (1 in 1,000 year) fluvial events. Despite this it is recommended that all buildings have finished floor levels set a minimum of 150mm above the existing ground levels, providing mitigation from localised flooding from extreme events.	LOW
Pluvial and Overland Flooding	Minor overland/ surface water flooding due to surface water ponding in low lying areas of the site	LOW	Overland flow to be manged through SuDS and flow routes to less vulnerable areas such as soft landscaped areas and car parks.	LOW
Infrastructure Failure	Minor flooding from culverted watercourse	LOW	The culverted watercourse situated west of the site is a maintained watercourse and the risk and likelihood of this blocking and flooding is fairly low.	LOW
Artificial Sources		LOW		LOW
Groundwater		LOW		LOW

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6.7 Climate Change

The NPPF outlines the importance of Climate Change with respect to planning. The issues of Climate Change are discussed with impacts likely on sea levels, peak rainfall intensities, peak river flows, wind speeds and wave heights.

The national maps were updated in March 2017 taking into account the new Emsworth to Littlehampton model. The revised peak river flows are shown as table 3 below.

Table 3: Peak river flow allowances

River basin district	Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
South East	Upper end	25%	50%	105%
	Higher central	**15%**	**30%**	**45%**
	Central	10%	20%	35%

6.7 Climate Change SFRA

Hydraulic modelling was completed as part of the updated SFRA to provide updated climate change flood mapping in the Arun District for Flood Zone 3a. This modelling followed the latest guidance for climate change in FRAs/SFRAs released by the Environment Agency in February 2016 (and updated in April 2016).

Climate change for fluvial events was based on the Higher Central estimates for the years 2031, 2061 and 2111. Arun District is within the South-East River Basin District and therefore allowances were: 2031 = +15% flows, 2061 = +30% flows and 2111 = + 45% flows.

For tidal/coastal models, undefended case still water levels and defended case still water levels with wave overtopping simulations have been completed to inform future flood risk within the Arun District. Again, climate change allowance predictions are for the years 2031, 2061 and 2111, with present day outputs for comparison.

The site is likely to be affected by fluvial flooding and the additional climate change effects in terms of increases in peak river flows and rainfall intensities will therefore affect the site. These have been taken into account and the FRA demonstrates how these risks are to be managed so that the development is safe.

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7. Drainage Strategy

7.1 General Design

The NPPF requires that flood risk to land and property is not increased as a result of development.

Changes in the volume and rate of surface water runoff from the development as a result of increases in impermeable land uses could increase the risk of flooding downstream unless sufficient steps are taken within the Proposed Development to prevent this happening.

A fundamental principle of sustainable development in terms of flood defence is the reduction of surface water run-off from new developments. It is best practice that the surface water drainage arrangements should be such that the volumes and peak discharge rates of surface water leaving a development site are no greater than the rates prior to the Proposed Development, and where possible are returned to those associated with the greenfield conditions of the site. Any increase in run-off (rates and/or volumes) above the pre-development (or greenfield) volumes must be attenuated on site.

The drainage network is to be designed as a gravity system to accommodate run off from a:

- 1 in 2 year storm event with no surcharge,
- The network is to be checked for a 1 in 30-year storm event with surcharge permitted but with no surface flooding,
- The network is to be checked for a 1 in 100-year storm event with surface flooding permitted providing that there is no risk of flooding to buildings and there is no off site overland flow.

7.2 Existing Site Drainage Regime

The site is classified as a Greenfield development, with a gross area of approximately 12 ha. The site is not currently served by an existing sewer system; therefore, it is assumed that the site drains via infiltration and overland flows towards watercourses on the boundaries of the site.

As the Proposed Development area is less than 50ha, the Institute of Hydrology (IoH) Report 124

Flood Estimation for Small Catchments (1994) method has been used to estimate the Greenfield site peak flow rate, which is an approved methodology specified within the Environment Agency's Rainfall Runoff Management for Developments Report4.

Table 4 summarises the Greenfield discharge rates for 1 ha of developable area and the estimated discharge rates for the current site. Full calculations are provided in the drainage calculation pack in Appendix.

ARUN DISTRICT COUNCIL BE/102/17/OUT

Table 4 – Greenfield Runoff Rates

Annual Rainfall Event	Greenfield Runoff Rates (litres/sec/ha)	Development Runoff Rates (litres/ sec)
Qbar	2.90	34.20
1 in 1 year	2.40	28.30
1 in 30 year	6.50	76.70
1 in 100 year	9.10	107.40

7.3 Proposed Drainage Strategy

For the purposes of this Planning Application the site has been split into two phases. Phase 1 is seeking full planning permission with an area of 6.492ha and Phase 2 is seeking only outline permission with a total area of 5.512ha.

The Proposed Development will result in a net increase of impermeable area at the Application site. Of the total site area, an area of 8.3 ha will be developed. It has been assumed that the Percentage Impervious (PIMP) factor at the site will be 80% of the developed area. Therefore, it has been assumed for this drainage strategy that the Proposed Development will have a total impermeable area of 6.65ha.

It is proposed that the development will discharge to the watercourse flowing along the Western boundary of the site; Bersted Brooks (Ordinary Watercourse). In order to comply with the guidance for providing long-term storage as outlined in the Environment Agency's Rainfall Runoff Management for Developments, the proposed discharge rate from the Site has been restricted to 2 l/s/ha.

Table 5 – Proposed Peak Surface Water Discharge Flow Rates

Annual Rainfall Event	Proposed Flow Rates (litres/ sec)	Proposed Betterment (%)
1 in 1 year	23.60	17%
1 in 30 year	23.60	70%
1 in 100 year	23.60	78%
1 in 100 year +45% C/C	23.60	N/A

Due to the requirement to provide a betterment on the existing surface water discharge rates post development for all storm events up to and including the 100-year return period +45% allowance for climate change, the surface water will be restricted via flow control devices and attenuated with a total required storage volume of approximately 7,650m^3. There is potential scope for the storage volume to be rationalised at a later stage following detailed design and further hydraulic modelling.

ARUN DISTRICT COUNCIL BE/102/17/OUT

It is proposed that onsite attenuation will be provided by a series of attenuation basins and permeable pavements. The site control structures will be located primarily in the topographical low points of each catchment. These will be in the form of retention/detention basins.

These structures will be designed to attenuate flow prior to discharge to the ordinary watercourse via a control structure to achieve the maximum allowable peak discharge rates for the 1 in 1 the 1 in 30 and 1 in 100-year events (plus a 45% allowance for climate change). The location of the retention/detention basin will not be within an area designated as public open space. It will however provide significant ecological and amenity benefit for the residents.

The site has been split into three catchment areas each with individual outfalls to the watercourse. The proposed surface water discharge rates and attenuation requirements are further broken down in Table 6 below:

Table 6 – Proposed Peak Surface Water Discharge Flow Rates

Catchment	Proposed Flow Rates (litres/ sec)	Proposed Attenuation (m^3)
1	11.30	3900
2	2	500
3	10.30	3250

As per the Environment Agency's Rainfall Runoff Management for Developments, long term storage can be provided to store the additional runoff caused by the development compared to the volume that would have been contributed from the Site in its Greenfield state. The current design rule is to use the 100-year 6-hour event to determine this additional volume.

<u>Long term storage can be incorporated through one of three basic approaches:</u>

1. Ensure that the drainage system provides sufficient infiltration volume to dispose of the volume difference,
2. Design a storage system which only comes into effect above a storm size threshold (effectively an off-line design) which captures the required volume and discharges at the appropriate rate,
3. Design a storage system which comes into effect for all events (effectively an on-line design) that captures the required volume difference which is designed to empty at a rate of less than 2 l/s/ha.

Approaches 1 and 2 provide the long-term storage volume in a separate system from the attenuation storage or offset the volume of runoff via infiltration devices. This allows the long-term storage to be activated for specific events and the volume difference discharged at the appropriate rate or infiltrated to ground, in order to mimic the behaviour of the Site in its Greenfield state.

The drainage strategy for the site proposes to adopt approach 3. By storing the additional volume in a central storage area, the long-term storage volume will be appropriately activated and discharged at a

ARUN DISTRICT COUNCIL BE/102/17/OUT

rate (2 l/s/ha) that would mimic the Greenfield behaviour of the Site, which is the overall aim of providing long term storage.

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8. Sustainable Urban Drainage Systems (SuDS)

8.1 SuDS constraints

Most source control techniques are likely to be suitable for the Saltbox site.

Infiltration may be suitable. Mapping suggests a medium risk of groundwater flooding and areas of the site have been designated as containing historic landfill. Therefore, a further site investigation should be carried out and the potential for infiltration techniques should be assessed. Infiltration should typically be avoided in areas where the depth to the water table is <1m. However, shallow soakage tests results should be carried out to confirm if infiltration is suitable and permit the use of shallow infiltration features. All tests to be in accordance with BRE 365. The attenuation volumes stated within this report, do not take account of infiltration. Once detailed site investigation has been completed, there may be a surplus volume provided if infiltration is deemed to be achievable.

Mapping suggests that the site slopes are suitable for all forms of detention. A liner may be required to prevent the possible egress of groundwater and address any contamination issues from designated landfill within the site boundary.

All filtration techniques are likely to be suitable. A liner may be required to prevent the possible egress of groundwater and address any contamination issues from designated landfill within the site boundary.

All forms of conveyance are likely to be suitable. As a general note, where the slopes are >5% features should follow contours, or utilise check dams to slow flows. A liner may be required to prevent the possible egress of groundwater and address any contamination issues from designated landfill within the site boundary.

For the Saltbox site, proposed site gradients are not expected to be greater than 5%.

8.2 SuDS selection

The following destinations must be considered for surface runoff in order of preference:

1. Discharge into the ground (infiltration)
2. Controlled discharge to a surface water body
3. Controlled discharge to a surface water sewer

Surface water must not be discharged into the foul sewer system. Infiltration structures include soakaways, basins, swales and permeable paving. Discharge to surface water bodies and surface water sewers must be restricted to an agreed rate.

8.3 Flow exceedance routes

The drainage design should show flow routes through the proposed development, demonstrating where surface water will be conveyed for three types of flow:

1. Low flow routes Regular flow from source control features such as permeable pavements should travel in low flow channels through the development in a controlled way contributing to landscape quality.

ARUN DISTRICT COUNCIL BE/102/17/OUT

2. Overflows in the event of local blockages or surcharge a simple overflow arrangement should allow water to bypass the obstruction and return to the management train sequence until conditions return to normal.

3. Exceedance routes When SuDS are overwhelmed by exceptional rainfall, then exceedance routes are required to protect people and property. These provide unobstructed overland flow routes from the development and should be considered for all drainage schemes.

The proposed levels have been designed, to fall towards the west. Hence in the event of an exceedance, the overland flow path will direct the water towards the storm water outfall and away from the proposed buildings. The levels will not increase flooding offsite as a result of the development.

8.4 Responsibilities for SuDS maintenance

Development shall not commence until full details of the maintenance and management of the SuDS system is set out in a site-specific maintenance manual and submitted to, and approved in writing, by the Local Planning Authority.

As a minimum requirement, the manual is to include:

(a) details of financial management of the site including arrangements made in the event that the management company (or any subsequent management company) is no longer able to fulfil its duties; and

(b) arrangements for the replacement of major components at the end of the manufacturers recommended design life.

Further information on maintenance and management of SuDS is provided in section 8.6 of the main SFRA report.

8.5 Implementation of SuDS for the Saltbox Site

The proposed drainage strategy which can be found as appendix D of this report, demonstrates that a combination of permeable paving, swales, and ponds can be incorporated within the design.

This is in accordance with the advice within the SFRA and Arun Strategic Surface Water Management Study, in particular the workshop section appendices B and C which refers to the Bognor Regis Enterprise site as a whole.

All SuDS should be designed in accordance with CIRIA 753. In summary, the updated SuDS Manual incorporates the very latest research, industry practice and guidance. In delivering SuDS there is a requirement to meet the framework set out by the Government's 'non-statutory technical standards' and the revised SuDS Manual complements these but goes further to support the cost-effective delivery of multiple benefits.

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9. Conclusions

Kirksaunders (KSA) has been commissioned by Landlink Estates to undertake a site-specific Flood Risk Assessment (FRA) for the proposed Saltbox site development north of Bognor Regis, Sussex.

Full planning permission is sought for the Phase 1 development of 6.492 hectares of employment space (B1, B2 and B8) with associated parking, landscaping, and public open space. In addition, outline planning permission is sought for the Phase 2 development of 5.512 hectares for additional employment units, warehousing, hotel, drive thru's, public house, gym and associated works. Based on Table 2 (Flood Risk Vulnerability Classification) of the NPPF Planning Practice Guide, the Proposed Development is classified as 'Less Vulnerable'.

The site is located within Flood Zones 1, 2 and 3. However coastal flood defences protect the site from tidal flooding up to the 0.5% (1 in 200 year) annual probability event and the modelled level of flood risk from fluvial sources is less than 1% (1 in 100 year) annual probability to all built development. As all built development is effectively in Flood Zone 2 the Proposed Development is considered appropriate development in accordance with Table 3 of the NPPF Technical Guidance.

The updated SRFA dated November 2016 and the main modification version of the local plan have been considered within this site-specific FRA.

The surface water network for the site is designed to convey and store surface water from site for all storms up to and including the 1 in 30-year storm event without flooding on site habitable spaces or to adjoining properties with controlled flooding during the 1 in 100-year storm event (plus a 45% allowance for climate change). It is proposed that the Site discharge at 2 l/s/ha to comply with the rate and volume of runoff requirements.

The total required storage volume for the Site is 7,650m3. There may be scope for the storage volume to be rationalised at a later stage following detailed design and specific hydraulic modelling. This attenuation volume will be provided in the form of retention/detention basins, swales and permeable pavements.

A drainage strategy has been prepared to support the Proposed Development through the planning process. The strategy demonstrates the Proposed Development can comply with the requirements of the NPPF and does not increase flood risk either to or from the Proposed Development.

The proposed areas of car parking will require treatment in line with the water quality parameters for the outfall watercourse / stream.

The on-site drainage should be maintained and inspected on a regular basis to ensure it remains fit for purpose. Maintenance plans are to be submitted in accordance with the approving authorities' requirements. Which shall include access roads to the detention basins for ongoing maintenance.

This FRA demonstrates that the Proposed Development site can be drained in a sustainable manner through attenuation and infiltration and that the development is not at flood risk from all sources and

ARUN DISTRICT COUNCIL BE/102/17/OUT

will not increase flood risk to other parties. All SuDS are to be designed and implemented in accordance with CIRCIA 753.

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Appendix A – Site Masterplan

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LIST OF INFORMANTS
Ordnance Survey - Masterplan - Licence No. 100019980

REVISIONS	DATE	DRN	REV
MINOR EXTERNAL AREA AMENDMENTS (LANDSCAPE / FOOTWAY - UNIT 2)	08.08.17	HA	A

NOTES:

- LANDSCAPING - WORK IN PROGRESS
- LEVELS SUBJECT TO FLOOD RISK ASSESSMENT AND TO BE CONFIRMED BY CIVIL AND HIGHWAY ENGINEER

  EXISTING LEVELS SHOWN IN **BLACK**

  PROPOSED LEVELS SHOWN IN **RED**
- **FOR FULL DETAILED PARKING & AREA SCHEDULE SEE DRAWING No.1744 - P34**

1 / P02

P02 - BLOCK PLAN

1 : 1000

SALT BOX SITE - BOGNOR REGIS

North

0m 20m 40m 60m 80m 100m

VISUAL SCALE 1:1000 @ A1

MountfordPigott
Architecture Masterplanning Design

SITE MASTER PLAN - PROPOSED - BLOCK PLAN

1744 - P02 - A

1 : 1000@ A1 04/08/17

DRAWN BY HA

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LIST OF INFORMANTS

Ordnance Survey - Masterplan - Licence No. 100019980

REVISIONS	DATE	DRN	REV

KEY:

APPLICATION SITE BOUNDARY

1
P05

P05 - SITE LOCATION PLAN

1 : 2500

North

0m 25m 50m 75m 100m 125m

VISUAL SCALE 1:2500 @ A3

MountfordPigott
Architecture Masterplanning Design

SITE LOCATION PLAN

1744 - P05

1 : 2500@ A3 07/08/17
DRAWN BY HA

Appendix B – Site Phasing Plan

ARUN DISTRICT COUNCIL BE/102/17/OUT

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LIST OF INFORMANTS
Ordnance Survey - Masterplan - Licence No. 100019980

REVISIONS DATE DRN REV

PHASING KEY

PHASE 1	FULL PLANNING SUBMISSION	6.492 hectare
PHASE 2	OUTLINE PLANNING SUBMISSION	5.512 hectare
	SALT BOX SITE BOUNDARY	12.004 hectare

1 / P03 **PHASE PLAN**
1 : 1000

SALT BOX SITE - BOGNOR REGIS

0m 20m 40m 60m 80m 100m
VISUAL SCALE 1:1000 @ A1

MountfordPigott
Architecture Masterplanning Design

SITE PHASING PLAN

1744 - P03

As indicated@ A1 04/08/17
DRAWN BY HA

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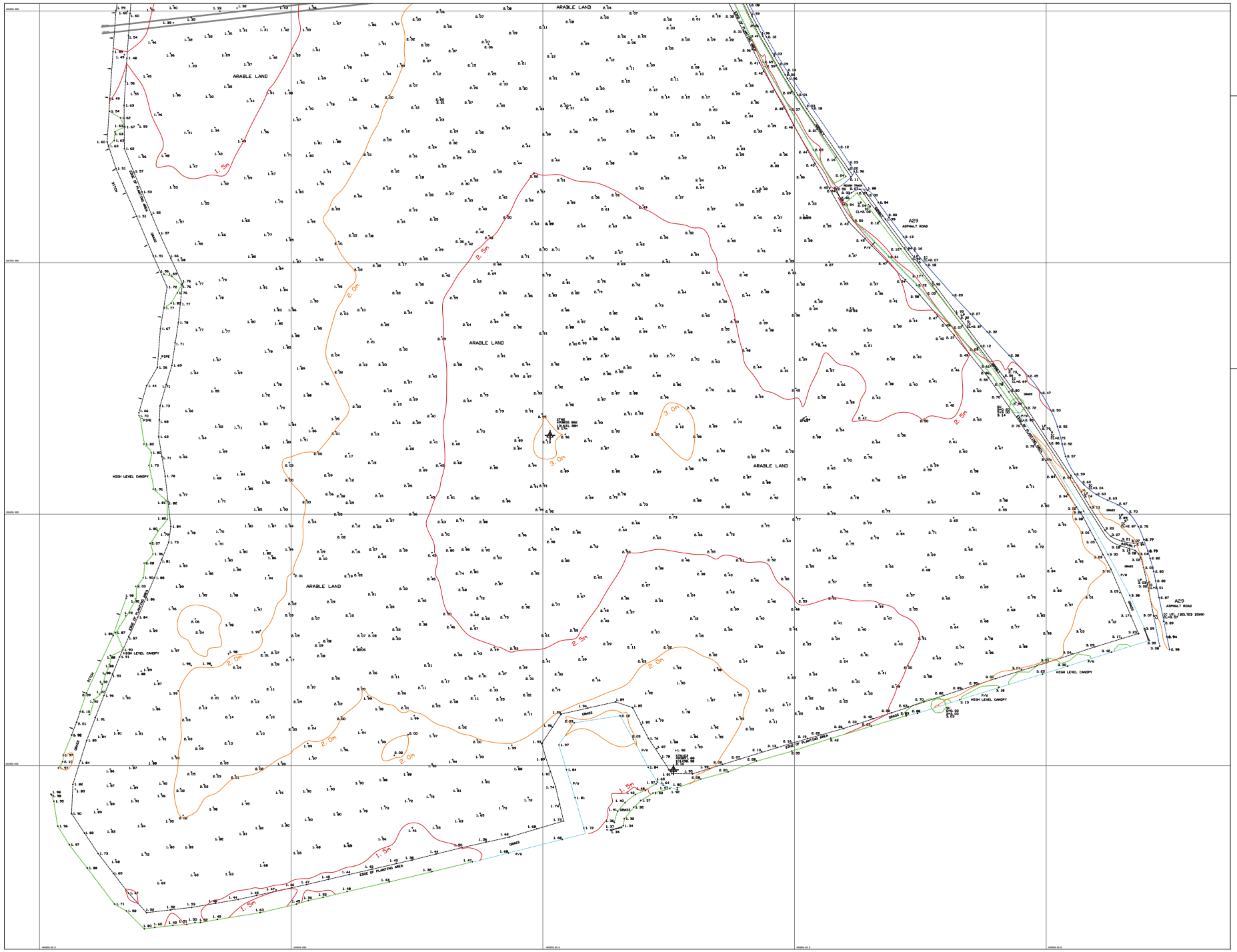
Appendix C – Topographical Survey

ARUN DISTRICT COUNCIL BE/102/17/OUT



NOTES:

ALL LEVELS RELATIVE TO OUL DATUM (FROM G.P.S)
SURVEY GRID ORIENTATED TO OS NATIONAL GRID

WHILE ALL POSSIBLE EFFORT HAS BEEN MADE TO IDENTIFY SERVICES, WE ARE UNABLE TO DETAIL COVERS BURIED OR OBSCURED AT THE TIME OF SURVEY.

ALL LEVELS AND DIMENSIONS SHOULD BE CHECKED ON SITE PRIOR TO THE COMMENCEMENT OF WORKS.

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ROOFLINE DETAIL IS INDICATIVE ONLY

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KEY:

BB	- BELLEVIA BEACON	OHW	- OVERHEAD WIRE
BIN	- LITTER BIN	OH	- OVERHEAD
BL	- BED LEVEL	PIL	- PILLAR
BOLL	- BOLLARD	PL	- PAVEMENT LIGHT
BRW	- BRICK WALL	POT	- TELECOM
BS	- BUS STOP	PLEYE	- RODDING EYE
CATV	- CABLE TELEVISION	RS	- ROAD SIGN
CL	- COVER LEVEL	RTW	- RETAINING WALL
CONC	- CONCRETE	RWP	- RAIN WATER PIPE
ELEC	- ELECTRIC	SAP	- SAPLING
EP	- ELECTRICITY POLE	SB	- SIGNBOARD
FB	- FLOWER BED	SL	- SILT LEVEL
FFL	- FINISHED FLOOR LEVEL	SU	- SPECIES UNKNOWN
FH	- FIRE HYDRANT	SVP	- SOIL VENT PIPE
FP	- FLAG POLE	TBM	- TEMPORARY BENCH MARK
G	- GULLY	TCB	- TELEPHONE CALL BOX
GL	- GROUND LEVEL	TF	- TOP OF FENCE
GV	- GAS VALVE	TH	- TOP OF HEDGE
HT	- HEIGHT	TL	- TRAFFIC LIGHT
IC	- INSPECTION COVER	TP	- TELEGRAPH POLE
IL	- INVERT LEVEL	TT	- TOP OF TREE
LB	- LETTER BOX	TW	- TOP OF WALL
LP	- LAMP POST	U/S	- UNDERSIDE CEILING
LT	- LIGHT	UTL	- UNABLE TO LIFT
MH	- MANHOLE	WL	- WATER LEVEL
MKR	- MARKER	WV	- WATER VALVE

FENCE TYPES:

B/W	- BARBED WIRE	I/R	- IRON RAILING
C/B	- CLOSE BOARD	P/R	- POST & RAIL
C/L	- CHAIN LINK	P/W	- POST & WIRE
C/P	- CHESTNUT PALING		

STN0 SURVEY STATION
AUXILIARY BUILDING
SLOPE DIRECTION
GATE
EAVES 17.00 ROOF LEVELS
TREE SPECIES
GIRTH (diameter)
SPREAD (radius)
ASH
GRID 20
SHED 00

FENCE
WALL
BARKSPACK
OVERHEAD
SHRUBBERY
BUILDING
ON WIRE
SECTION
KERB
TRACK/
DROP KERB
HIGH LVL
CANOPY

DRAINAGE:

FOUL DRAINAGE
STORM (SURFACE WATER) DRAINAGE
1000 = 100mm DIAMETER PIPE

ISO 9001
REGISTERED FIRM

Shaw Colegate
LAND & BUILDING SURVEYORS
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Fax: (01243) 378840 Web: www.shawcolegate.com

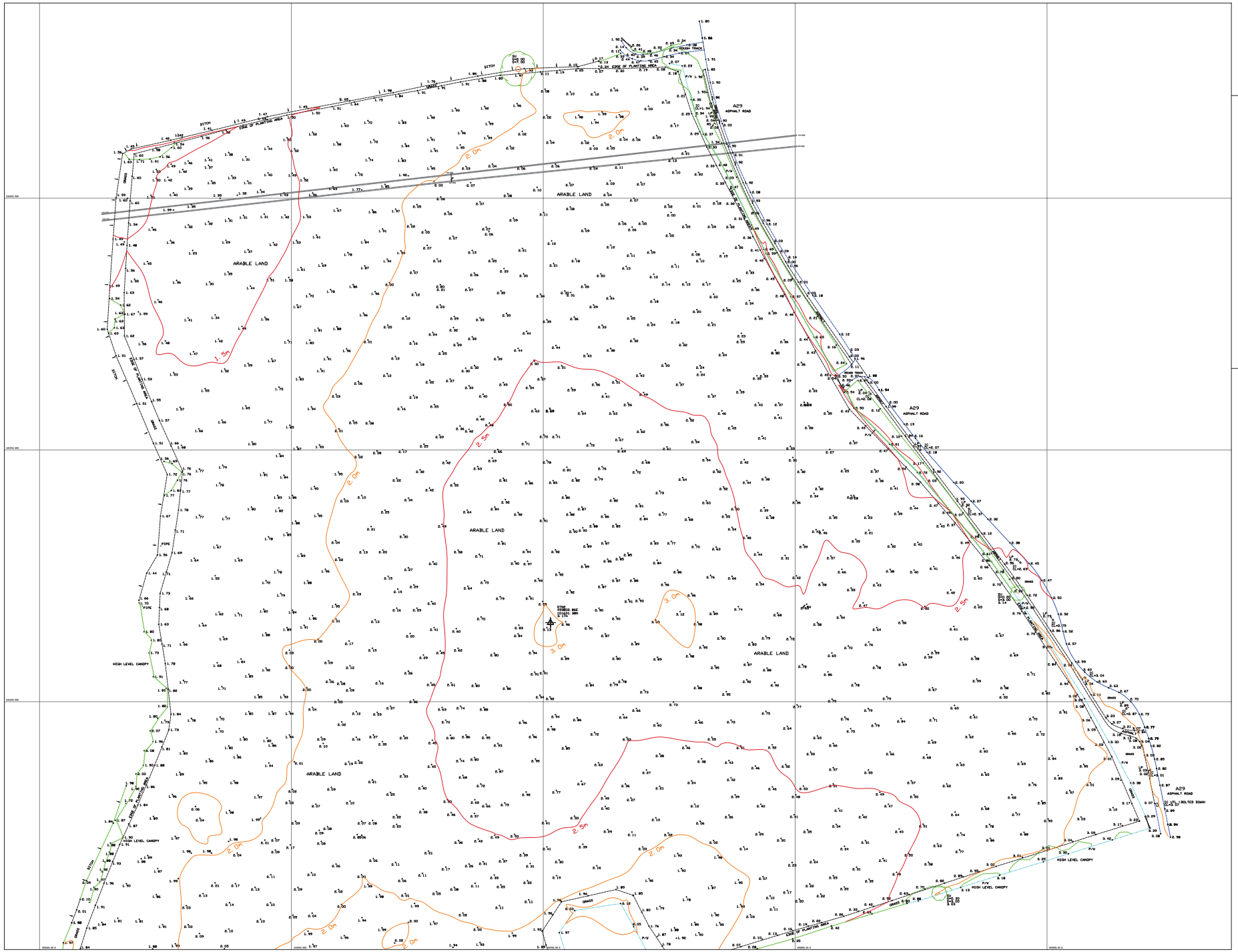
Title: FIELDS AT SALTBOX, SHRIPNEY
TOPOGRAPHIC SURVEY
SHEET 1 of 2

Job No.: 23113_TOPO
Original Scale: 1:500
Sheet Size: A0

Surveyed By: AB/CW Date: DECEMBER 2013
Drawn By: AB/CW Date: DECEMBER 2013

Client: Kingsbridge Estates Ltd
The Courtyard, Vinnetrow Business Park,
Vinnetrow Road, Chichester

ARUN DISTRICT COUNCIL BE/102/17/OUT



NOTES:

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ROOF LINE DETAIL IS INDICATIVE ONLY

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KEY:

BB	- BELISHA BEACON	OHW	- OVERHEAD WIRE
BM	- LETTER BM	OH	- OVERHEAD
BOL	- BOLLARD	PL	- PLANTER
BOLL	- BOLLARD	PL	- PUBLIC LIGHT
BRW	- BRICK WALL	PCT	- TELECOM
BS	- BUS STOP	SLDYE	- ROODING EYE
CATV	- CABLE TELEVISION	RS	- ROAD SIGN
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MKR	- MARKER	WV	- WATER VALVE

FENCE TYPES:

B/W	- BARBED WIRE	I/R	- IRON RAILING
C/B	- CLOSE BOARD	P/R	- POST & RAIL
C/L	- CHAIN LINK	P/W	- POST & WIRE
C/P	- CHESTNUT PALING		

STN 4	SURVEY STATION	FENCE	
		WALL	
	ANCILLARY BUILDING	BAMPATH	
		OVERHEAD	
	SLOPE DIRECTION	SHRUBBERY	
	GATE	BUILDING	
0.00	ROOF LEVELS	CRYSTREE	
0.00		SECTION	
	TREE SPECIES (GIRTH x diameter)	KERB	
		TRACK/	
		DROP KERB	
	SPREAD (radius)	HIGH LVL	
		CANOPY	

DRAINAGE:

FOUL DRAINAGE

STORM (SURFACE WATER) DRAINAGE

150Ø = 150mm DIAMETER PIPE

SCALE 1:500

N

ISO 9001 REGISTERED FIRM

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Tel.: (01243) 371472 Email: info@shawcolegate.com
Fax: (01243) 375840 Web: www.shawcolegate.com

Title: FIELDS AT SALTBOX, SHRIPNEY
TOPOGRAPHIC SURVEY
SHEET 2 of 2

Job No.: 23113_TOPO
Original Scale: 1:500
Sheet Size: A0

Surveyed By: ABC/W Date: DECEMBER 2013
Drawn By: ABC/W Date: DECEMBER 2013

Client: Aquaculture Entities Ltd
The Courtyard, Wineshow Business Park,
Wineshow Road, Chichester

ARUN DISTRICT COUNCIL BE/102/17/OUT

Appendix D – Proposed Drainage Strategy

ARUN DISTRICT COUNCIL BE/102/17/OUT

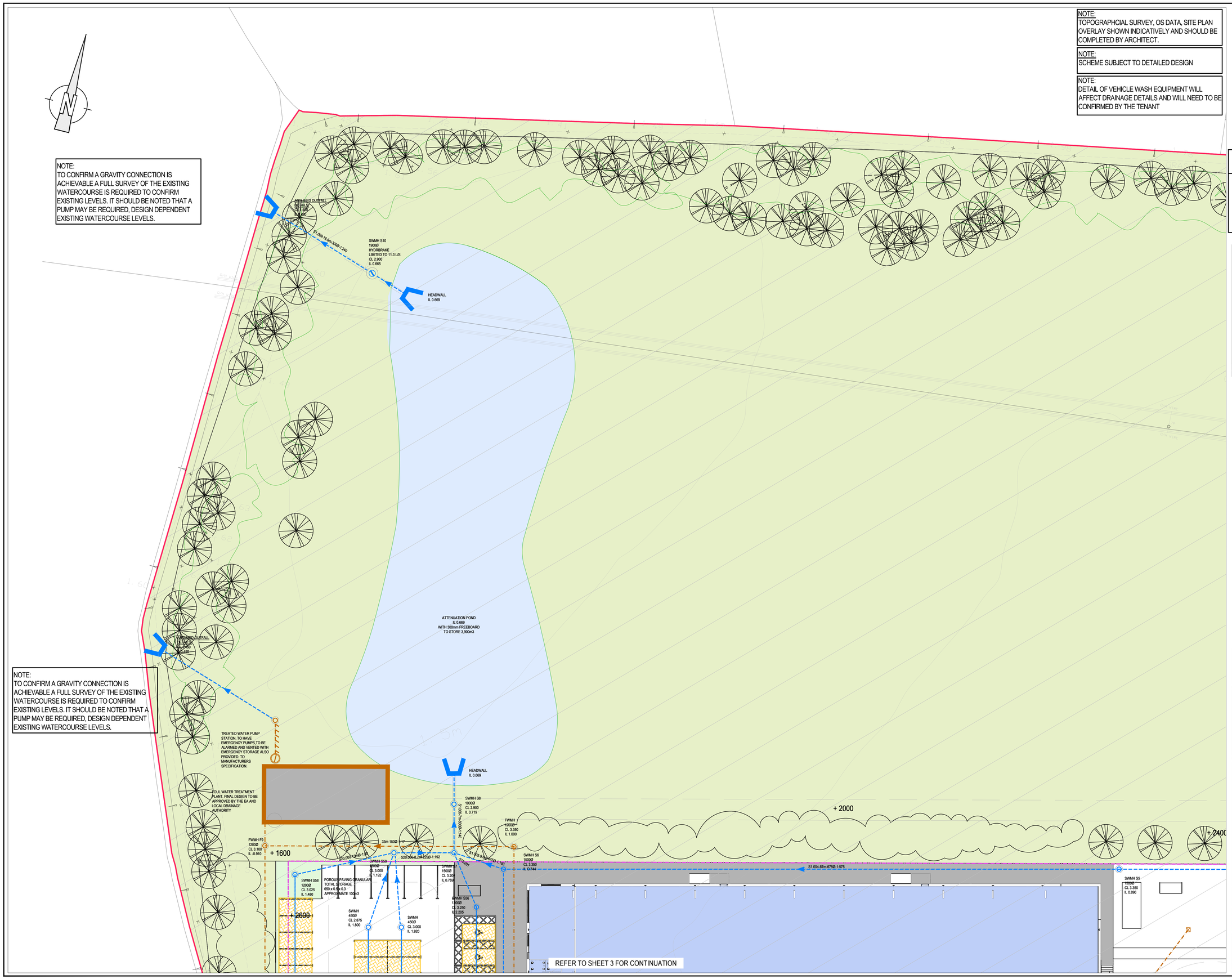
NOTE:
TO CONFIRM A GRAVITY CONNECTION IS ACHIEVABLE A FULL SURVEY OF THE EXISTING WATERCOURSE IS REQUIRED TO CONFIRM EXISTING LEVELS. IT SHOULD BE NOTED THAT A PUMP MAY BE REQUIRED, DESIGN DEPENDENT EXISTING WATERCOURSE LEVELS.

NOTE:
TO CONFIRM A GRAVITY CONNECTION IS ACHIEVABLE A FULL SURVEY OF THE EXISTING WATERCOURSE IS REQUIRED TO CONFIRM EXISTING LEVELS. IT SHOULD BE NOTED THAT A PUMP MAY BE REQUIRED, DESIGN DEPENDENT EXISTING WATERCOURSE LEVELS.

NOTE:
TOPOGRAPHCIAL SURVEY, OS DATA, SITE PLAN OVERLAY SHOWN INDICATIVELY AND SHOULD BE COMPLETED BY ARCHITECT.

NOTE:
SCHEME SUBJECT TO DETAILED DESIGN

NOTE:
DETAIL OF VEHICLE WASH EQUIPMENT WILL AFFECT DRAINAGE DETAILS AND WILL NEED TO BE CONFIRMED BY THE TENANT



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2. DO NOT SCALE FROM THIS DRAWING, WORK FROM FIGURED DIMENSIONS ONLY.

3. ALL DIMENSIONS SHOWN ON THIS DRAWING ARE IN METRES UNLESS OTHERWISE STATED.

4. ALL DIMENSIONS, LEVELS AND SURVEY GRID CO-ORDINATES ARE TO BE CHECKED ON SITE AND THE ENGINEER NOTIFIED IMMEDIATELY OF ANY DISCREPANCIES PRIOR TO THE COMMENCEMENT OF THE WORKS.

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PROPOSED PEAK SURFACE WATER DISCHARGE FLOW RATES AND ATTENUATION TABLE.

CATCHMENT AREA	PROPOSED FLOW RATE	PROPOSED ATTENUATION
1	11.30 L/S	3,900m³
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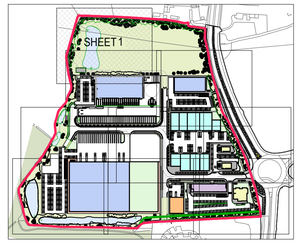
3	10.30 L/S	3,250m³



KEY

1500Ø-10m-1:100 SURFACE WATER PIPE
SURFACE WATER MANHOLE
BEANY
CHANNEL LINEAR CHANNEL
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CATCHMENT 1 BOUNDARY
CATCHMENT 2 BOUNDARY
CATCHMENT 3 BOUNDARY
DETAILED PLANNING APPLICATION HATCHED AREA
SITE BOUNDARY

Rev.	Description:	Drn:	Chk:	Date:
P3	REVISED TO SUIT MOUNTFORD PIGOTT'S LATEST PLANS RECEIVED 07/08/17	DO	KJ	08.08.17
P2	ISSUED FOR INFORMATION	KW	GW	12.06.17
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01689 896464 | www.kirksaunders.co.uk

Client: LANDLINK ESTATES

Architect: MOUNTFORD PIGOTT

Project: SALTBOX SITE BOGNOR REGIS

Drawing Title: PRELIMINARY DRAINAGE STRATEGY SHEET 1 OF 9

Drawn:	Chkd/Appd:	Date:	Sheet Size:	Scale:
RI		02.06.17	A1	1:250

KSA Project Number.	Suit:	Revision:
6090	S1	P3

Project:	Originator:	Zone:	Level:	Type:	Role:	Number:
6090	KSA	ZO	XX	DR	C	6000

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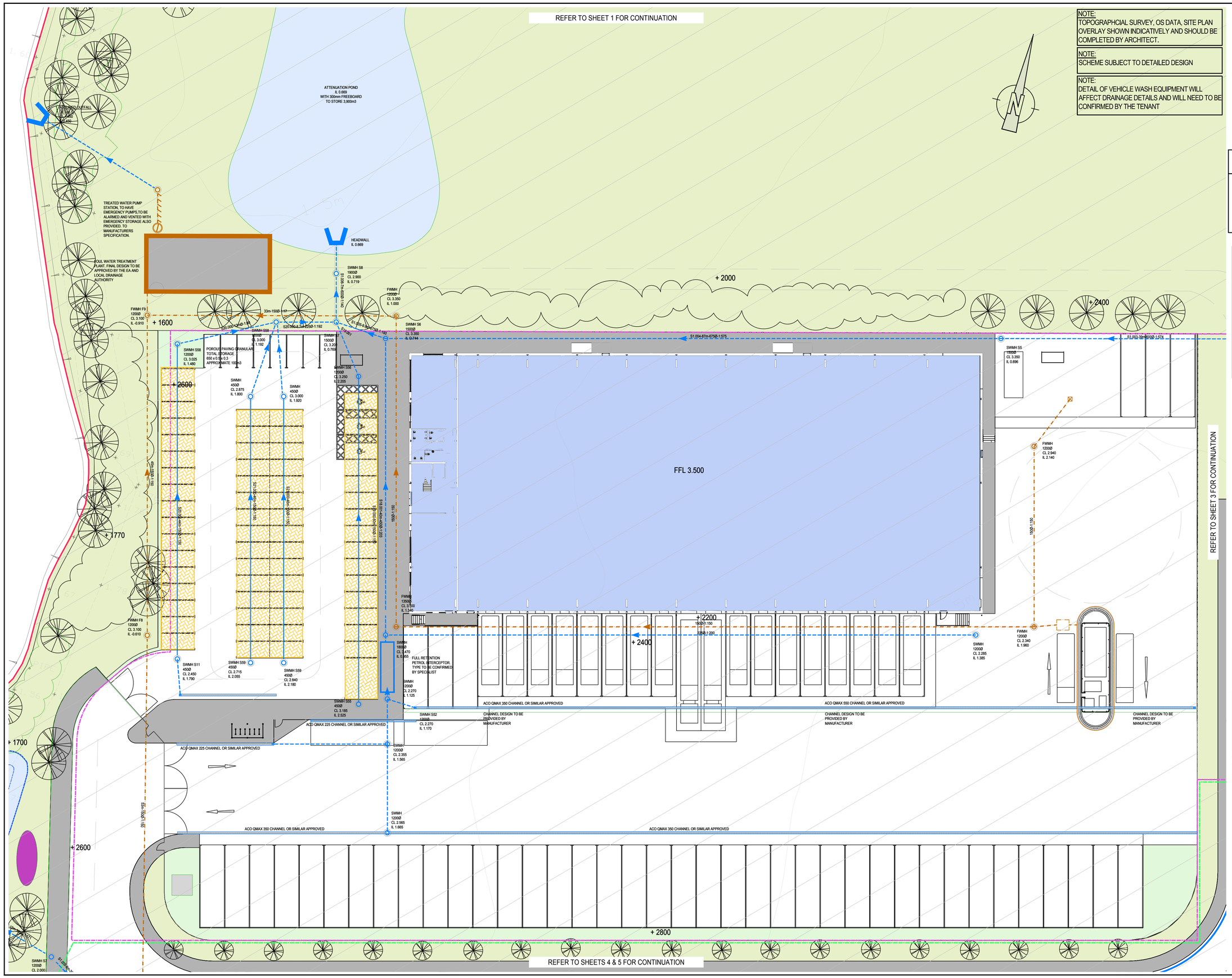

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KEY

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- SURFACE WATER MANHOLE
- BEANY
- CHANNEL — LINEAR CHANNEL
- HYDROBRAKE MANHOLE TO BE ALARMED AND VENTED TO MANUFACTURERS SPECIFICATION
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- SWALE/STORAGE BASIN WITH CHECK DAMS.PLANTING BY LANDSCAPE ARCHITECT.
- HEADWALL. FINAL DETAILS TO MANUFACTURERS SPECIFICATION
- 150Ø-10m-1:100 — FOUL WATER PIPE
- FOUL WATER MANHOLE
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Client: LANDLINK ESTATES

Architect: MOUNTFORD PIGOTT

Project: SALTBOX SITE BOGNOR REGIS

Drawing Title: PRELIMINARY DRAINAGE STRATEGY SHEET 2 OF 9

Drawn:	Chkd/Appd:	Date:	Sheet Size:	Scale:
KW		02.06.17	A1	1:250

KSA Project Number.	Suit:	Revision:
6090	S1	P3

Project:	Originator:	Zone:	Level:	Type:	Role:	Number:
6090	KSA	ZO	XX	DR	C	6001

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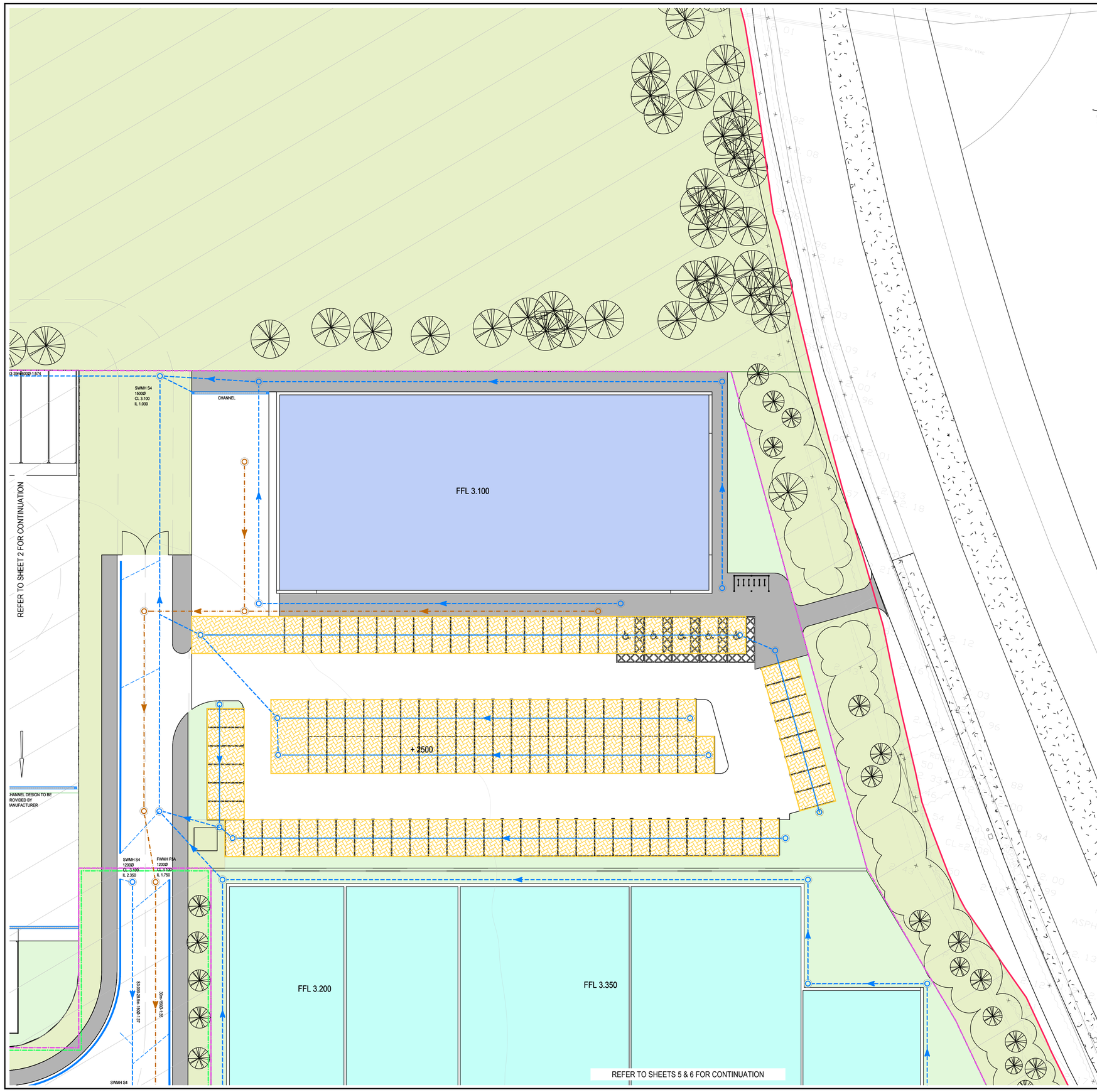

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Client: LANDLINK ESTATES

Architect: MOUNTFORD PIGOTT

Project: SALTBOX SITE BOGNOR REGIS

Drawing Title: PRELIMINARY DRAINAGE STRATEGY SHEET 3 OF 9

Drawn:	Chkd/Appd:	Date:	Sheet Size:	Scale:
KW		02.06.17	A1	1:250

KSA Project Number.	Suit:	Revision:
6090	S1	P3

Project:	Originator:	Zone:	Level:	Type:	Role:	Number:
6090	KSA	ZO	XX	DR	C	6002

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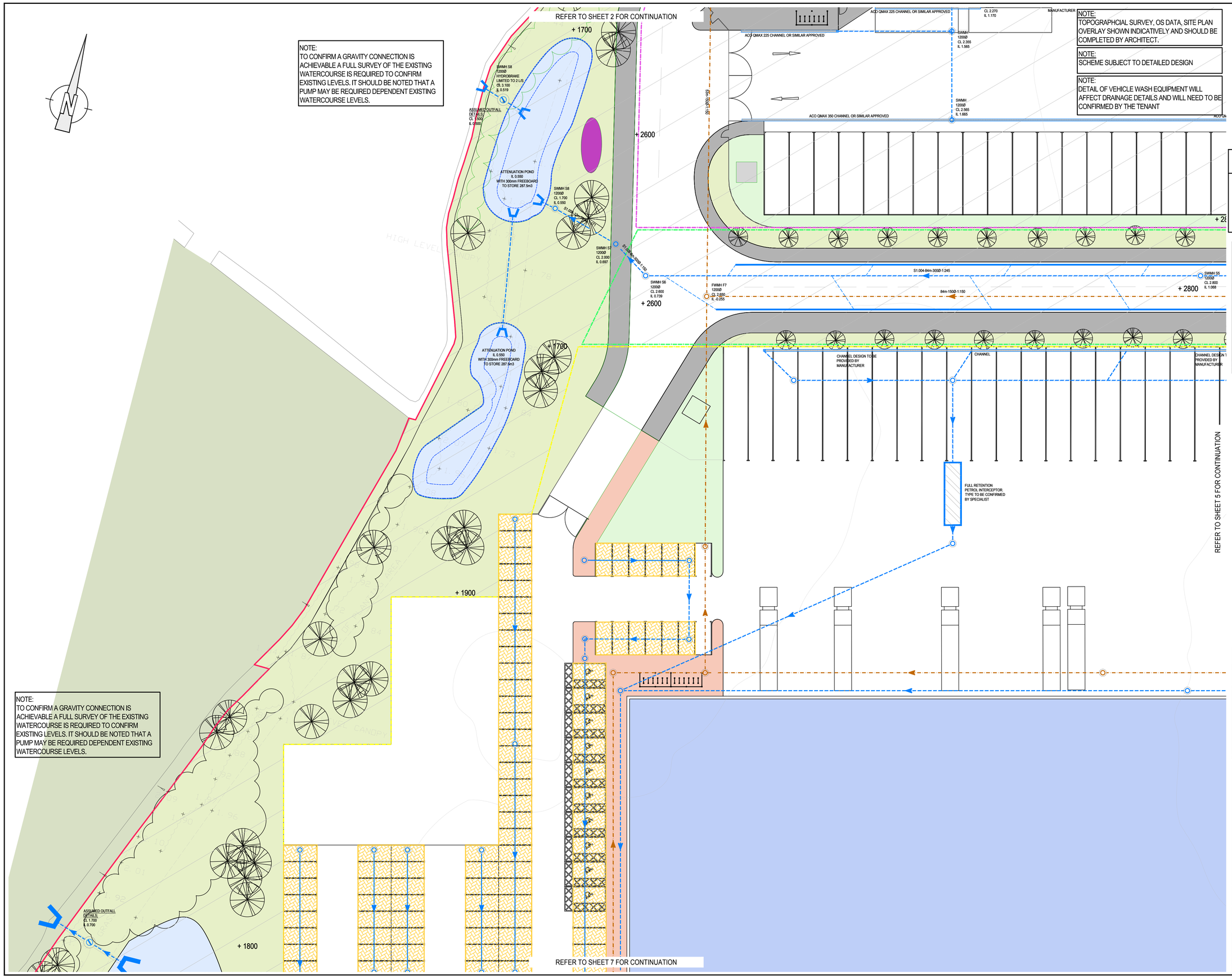

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KEY

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P3	REVISED TO SUIT MOUNTFORD PIGOTTS LATEST PLANS RECEIVED 07/08/17	DO	KJ	08.08.17
P2	ISSUED FOR INFORMATION	KW	GW	12.06.17
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Client: LANDLINK ESTATES

Architect: MOUNTFORD PIGOTT

Project: SALTBOX SITE BOGNOR REGIS

Drawing Title: PRELIMINARY DRAINAGE STRATEGY SHEET 4 OF 9

Drawn:	Chkd/Appd:	Date:	Sheet Size:	Scale:
KW		02.06.17	A1	1:250

KSA Project Number.	Suit:	Revision:
6090	S1	P3

Project:	Originator:	Zone:	Level:	Type:	Role:	Number:
6090	KSA	ZO	XX	DR	C	6003

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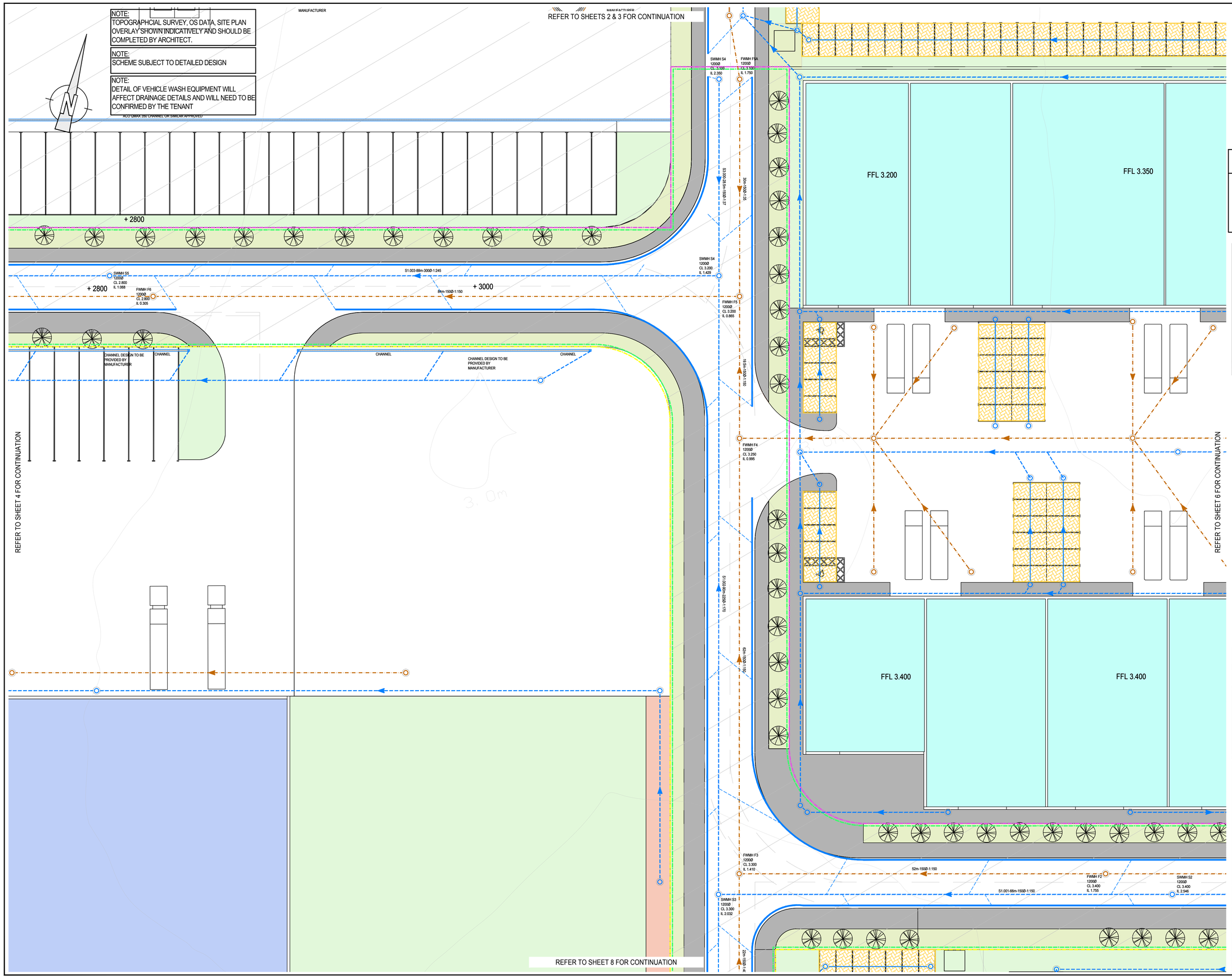

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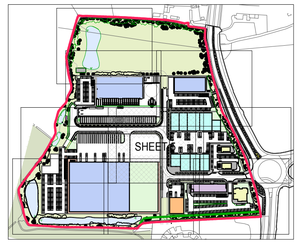

KEY

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Client: LANDLINK ESTATES

Architect: MOUNTFORD PIGOTT

Project: SALTBOX SITE BOGNOR REGIS

Drawing Title: PRELIMINARY DRAINAGE STRATEGY SHEET 5 OF 9

Drawn:	Chkd/Appd:	Date:	Sheet Size:	Scale:
KW		02.06.17	A1	1:250

KSA Project Number.	Suit:	Revision:
6090	S1	P3

Project:	Originator:	Zone:	Level:	Type:	Role:	Number:
6090	KSA	ZO	XX	DR	C	6004

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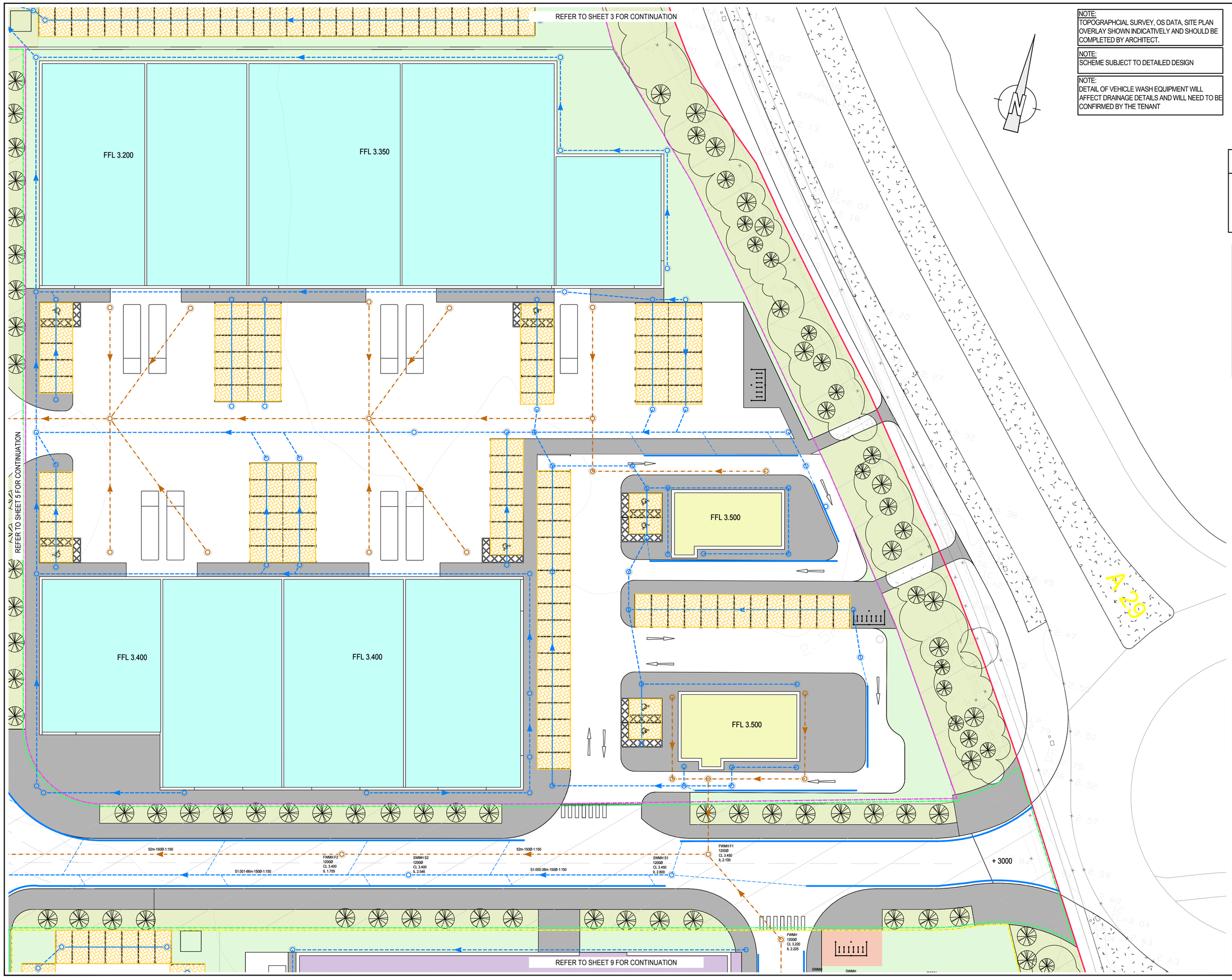

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CATCHMENT AREA	PROPOSED FLOW RATE	PROPOSED ATTENUATION
1	11.30 L/S	3,900m³
2	2.00 L/S	500m³
3	10.30 L/S	3,250m³

KEY

150Ø-10m-1:100	SURFACE WATER PIPE
	SURFACE WATER MANHOLE
	BEANY
CHANNEL	LINEAR CHANNEL
	HYDROBRAKE MANHOLE TO BE ALARMED AND VENTED TO MANUFACTURERS SPECIFICATION
	POROUS PAVING WITH PERFORATED PIPE. (TYPE 3 STONE)
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	HEADWALL. FINAL DETAILS TO MANUFACTURERS SPECIFICATION
150Ø-10m-1:100	FOUL WATER PIPE
	FOUL WATER MANHOLE
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	CATCHMENT 2 BOUNDARY
	CATCHMENT 3 BOUNDARY
	DETAILED PLANNING APPLICATION HATCHED AREA
	SITE BOUNDARY

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Client: LANDLINK ESTATES

Architect: MOUNTFORD PIGOTT

Project: SALTBOX SITE BOGNOR REGIS

Drawing Title: PRELIMINARY DRAINAGE STRATEGY SHEET 6 OF 9

Drawn:	Chkd/Appd:	Date:	Sheet Size:	Scale:
KW		02.06.17	A1	1:250

KSA Project Number.	Suit:	Revision:
6090	S1	P3

Project:	Originator:	Zone:	Level:	Type:	Role:	Number:
6090	KSA	ZO	XX	DR	C	6005

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ARUN DISTRICT COUNCIL 18/1203/TOUT

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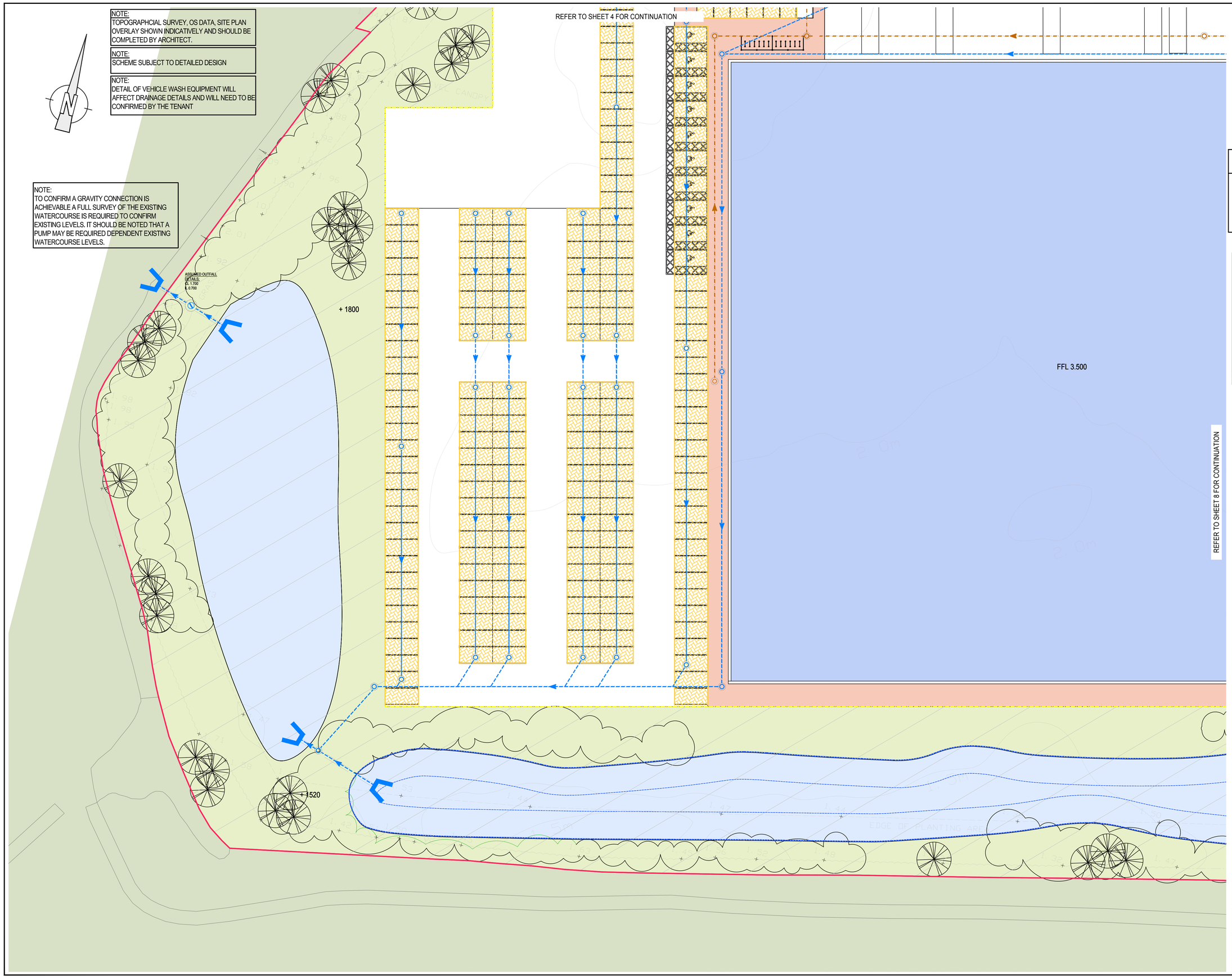
NOTE:
SCHEME SUBJECT TO DETAILED DESIGN

NOTE:
DETAIL OF VEHICLE WASH EQUIPMENT WILL AFFECT DRAINAGE DETAILS AND WILL NEED TO BE CONFIRMED BY THE TENANT

NOTE:
TO CONFIRM A GRAVITY CONNECTION IS ACHIEVABLE A FULL SURVEY OF THE EXISTING WATERCOURSE IS REQUIRED TO CONFIRM EXISTING LEVELS. IT SHOULD BE NOTED THAT A PUMP MAY BE REQUIRED DEPENDENT EXISTING WATERCOURSE LEVELS.



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2	2.00 L/S	500m³
3	10.30 L/S	3,250m³

KEY

- 150Ø-10m-1:100 — SURFACE WATER PIPE
- SURFACE WATER MANHOLE
- BEANY
- CHANNEL — LINEAR CHANNEL
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Drawing Title: PRELIMINARY DRAINAGE STRATEGY SHEET 7 OF 9

Drawn:	Chkd/Appd:	Date:	Sheet Size:	Scale:
KW	—	02.06.17	A1	1:250

KSA Project Number.	Suit:	Revision:
6090	S1	P3

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6090	KSA	ZO	XX	DR	C	6006

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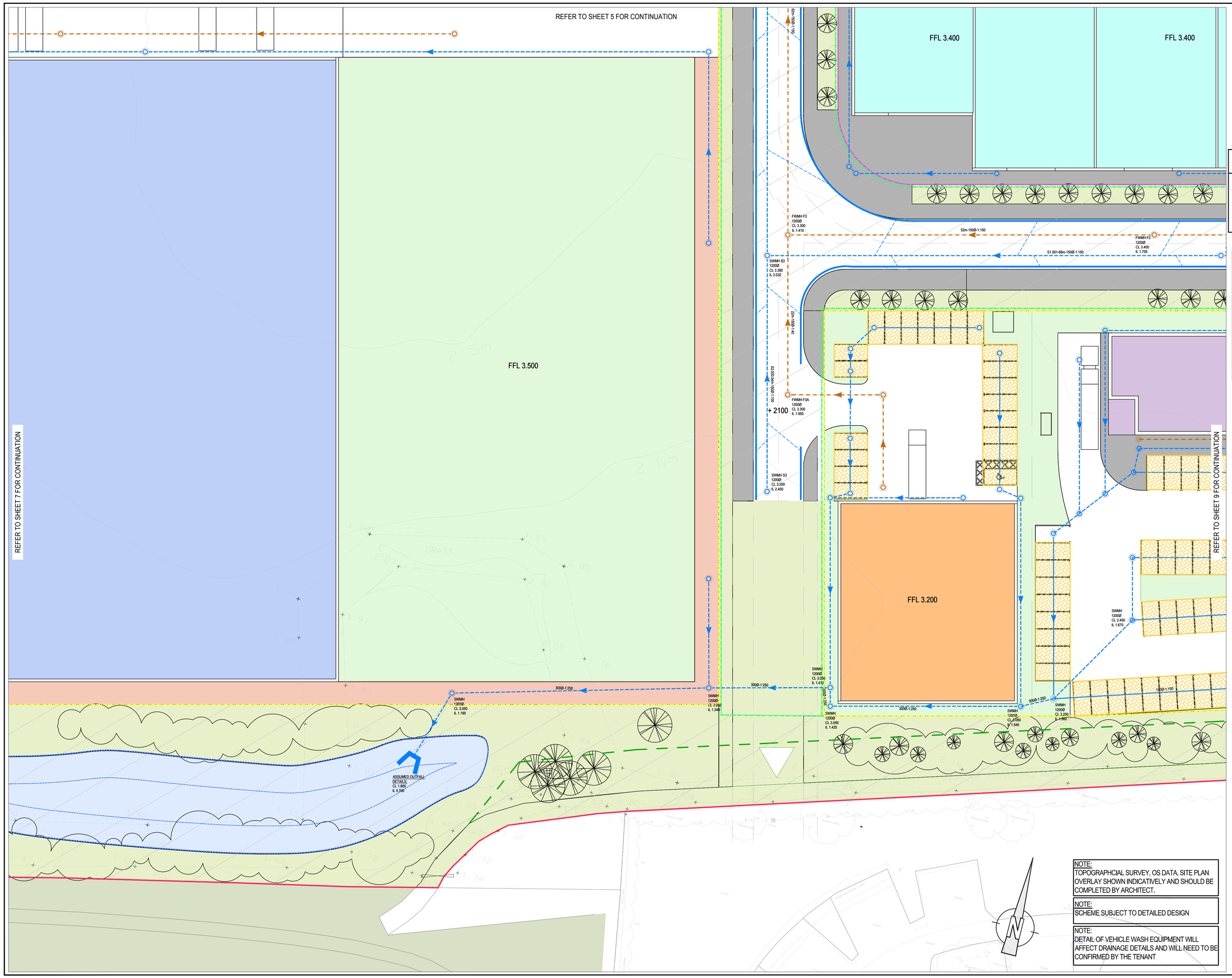
ARUN DISTRICT COUNCIL BR/0203/15OUT



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KSA Project Number.	Suit:	Revision:
6090	S1	P3

Project:	Originator:	Zone:	Level:	Type:	Role:	Number:
6090	KSA	ZO	XX	DR	C	6007

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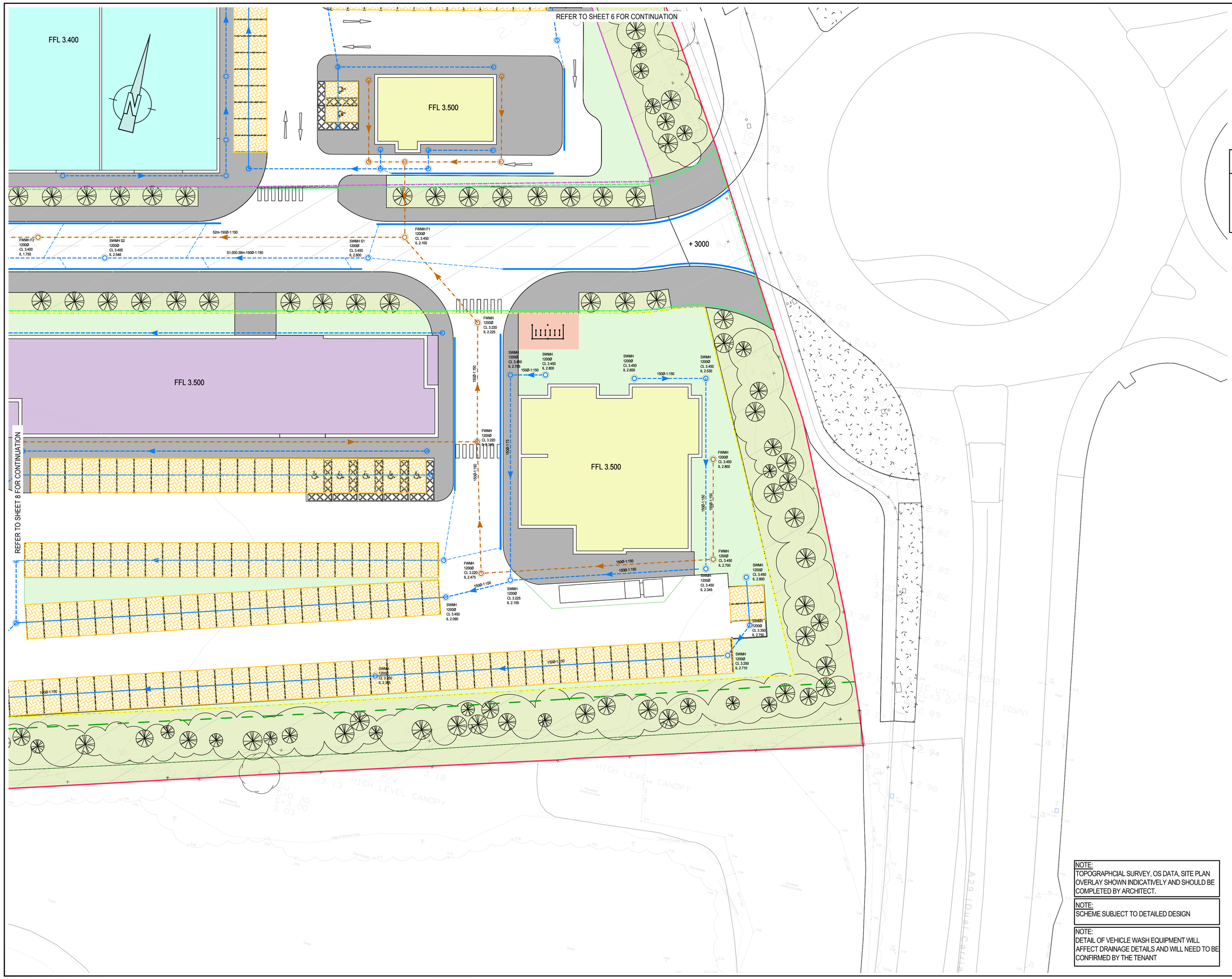
ARUN DISTRICT COUNCIL 08/2033/TIOUT



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GW	__	02.06.17	A1	1:250

KSA Project Number.	Suit:	Revision:
6090	S1	P3

Project:	Originator:	Zone:	Level:	Type:	Role:	Number:
6090	KSA	ZO	XX	DR	C	6008

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ARUN DISTRICT COUNCIL 06/10/2017 17:07

Appendix E – Proposed Drainage Calculations

ARUN DISTRICT COUNCIL BE/102/17/OUT

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.187	4-8	1.618	8-12	1.423	12-16	0.168

Total Area Contributing (ha) = 3.396

Total Pipe Volume (m^3) = 180.338

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STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	26.836	0.179	150.0	0.000	5.00	0.0	0.600	o	150	Pipe/Conduit	
S1.001	60.241	0.402	150.0	0.049	0.00	0.0	0.600	o	150	Pipe/Conduit	
S2.000	47.059	0.314	150.0	0.038	5.00	0.0	0.600	o	150	Pipe/Conduit	
S2.001	28.836	0.267	108.0	0.037	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.002	12.837	0.380	33.8	0.045	0.00	0.0	0.600	o	150	Pipe/Conduit	
S3.000	20.310	0.135	150.0	0.030	5.00	0.0	0.600	o	150	Pipe/Conduit	
S3.001	4.985	0.033	150.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S3.002	70.130	0.543	129.1	0.097	0.00	0.0	0.600	o	225	Pipe/Conduit	
S4.000	53.659	0.405	132.5	0.045	5.00	0.0	0.600	o	150	Pipe/Conduit	
S5.000	55.944	0.373	150.0	0.047	5.00	0.0	0.600	o	150	Pipe/Conduit	
S5.001	4.801	0.032	150.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S4.001	14.702	0.307	47.9	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S3.003	5.949	0.232	25.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S6.000	10.479	0.070	149.7	0.000	5.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	5.55	2.450	0.000	0.0	0.0	0.0	0.82	14.5	0.0
S1.001	50.00	6.77	2.271	0.049	0.0	0.0	0.0	0.82	14.5	6.6
S2.000	50.00	5.96	2.450	0.038	0.0	0.0	0.0	0.82	14.5	5.1
S2.001	50.00	6.46	2.136	0.074	0.0	0.0	0.0	0.97	17.1	10.1
S1.002	50.00	6.90	1.869	0.168	0.0	0.0	0.0	1.74	30.7	22.8
S3.000	50.00	5.41	2.500	0.030	0.0	0.0	0.0	0.82	14.5	4.1
S3.001	50.00	5.52	2.365	0.030	0.0	0.0	0.0	0.82	14.5	4.1
S3.002	50.00	6.53	2.256	0.128	0.0	0.0	0.0	1.15	45.7	17.3
S4.000	50.00	6.03	2.500	0.045	0.0	0.0	0.0	0.87	15.4	6.1
S5.000	50.00	6.14	2.500	0.047	0.0	0.0	0.0	0.82	14.5	6.4
S5.001	50.00	6.24	2.127	0.047	0.0	0.0	0.0	0.82	14.5	6.4
S4.001	50.00	6.41	2.095	0.092	0.0	0.0	0.0	1.46	25.8	12.5
S3.003	50.00	6.57	1.713	0.220	0.0	0.0	0.0	2.59	103.2	29.8
S6.000	50.00	5.21	2.850	0.000	0.0	0.0	0.0	0.82	14.5	0.0

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STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S6.001	18.989	0.127	149.5	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S6.002	36.445	0.243	150.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S7.000	23.672	0.158	149.8	0.030	5.00	0.0	0.600	o	150	Pipe/Conduit	
S7.001	5.201	0.182	28.6	0.024	0.00	0.0	0.600	o	150	Pipe/Conduit	
S6.003	26.557	0.177	150.0	0.027	0.00	0.0	0.600	o	150	Pipe/Conduit	
S8.000	38.611	0.257	150.0	0.047	5.00	0.0	0.600	o	150	Pipe/Conduit	
S8.001	10.705	0.110	97.7	0.048	0.00	0.0	0.600	o	150	Pipe/Conduit	
S9.000	10.998	0.157	70.1	0.092	5.00	0.0	0.600	o	150	Pipe/Conduit	
S10.000	23.564	0.157	150.1	0.024	5.00	0.0	0.600	o	150	Pipe/Conduit	
S9.001	12.372	0.083	149.1	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S11.000	20.160	0.240	84.0	0.029	5.00	0.0	0.600	o	150	Pipe/Conduit	
S9.002	5.263	0.031	170.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S9.003	14.372	0.346	41.5	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S6.004	71.534	0.298	240.0	0.111	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S6.001	50.00	5.60	2.780	0.000	0.0	0.0	0.0	0.82	14.5	0.0
S6.002	50.00	6.34	2.653	0.000	0.0	0.0	0.0	0.82	14.5	0.0
S7.000	50.00	5.48	2.750	0.030	0.0	0.0	0.0	0.82	14.5	4.1
S7.001	50.00	5.53	2.592	0.054	0.0	0.0	0.0	1.89	33.4	7.4
S6.003	50.00	6.88	2.410	0.081	0.0	0.0	0.0	0.82	14.5	11.0
S8.000	50.00	5.79	2.600	0.047	0.0	0.0	0.0	0.82	14.5	6.4
S8.001	50.00	5.96	2.343	0.095	0.0	0.0	0.0	1.02	18.0	12.9
S9.000	50.00	5.15	2.850	0.092	0.0	0.0	0.0	1.20	21.3	12.5
S10.000	50.00	5.48	2.850	0.024	0.0	0.0	0.0	0.82	14.5	3.3
S9.001	50.00	5.67	2.618	0.117	0.0	0.0	0.0	1.07	42.5	15.8
S11.000	50.00	5.31	2.850	0.029	0.0	0.0	0.0	1.10	19.4	3.9
S9.002	50.00	5.76	2.535	0.145	0.0	0.0	0.0	1.00	39.8	19.7
S9.003	50.00	5.88	2.504	0.145	0.0	0.0	0.0	2.04	80.9	19.7
S6.004	50.00	8.06	2.083	0.434	0.0	0.0	0.0	1.01	71.4	58.7

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STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S12.000	21.446	0.214	100.2	0.045	5.00	0.0	0.600	o	150	Pipe/Conduit	
S12.001	30.758	0.401	76.7	0.032	0.00	0.0	0.600	o	150	Pipe/Conduit	
S6.005	20.508	0.085	240.0	0.128	0.00	0.0	0.600	o	375	Pipe/Conduit	
S13.000	109.108	0.651	167.7	0.092	5.00	0.0	0.600	o	150	Pipe/Conduit	
S6.006	20.392	0.068	299.9	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
S14.000	14.499	0.145	100.0	0.053	5.00	0.0	0.600	o	150	Pipe/Conduit	
S14.001	17.608	0.176	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S14.002	76.694	0.497	154.2	0.095	0.00	0.0	0.600	o	225	Pipe/Conduit	
S6.007	34.019	0.101	337.9	0.160	0.00	0.0	0.600	o	450	Pipe/Conduit	
S15.000	17.111	0.171	100.0	0.029	5.00	0.0	0.600	o	150	Pipe/Conduit	
S15.001	15.500	0.155	100.0	0.025	0.00	0.0	0.600	o	150	Pipe/Conduit	
S15.002	13.508	0.135	100.0	0.052	0.00	0.0	0.600	o	150	Pipe/Conduit	
S15.003	76.094	0.408	186.5	0.041	0.00	0.0	0.600	o	225	Pipe/Conduit	
S6.008	12.099	0.050	242.0	0.056	0.00	0.0	0.600	o	450	Pipe/Conduit	
S16.000	70.264	0.703	100.0	0.071	5.00	0.0	0.600	o	150	Pipe/Conduit	
S16.001	4.717	0.047	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S12.000	50.00	5.36	2.550	0.045	0.0	0.0	0.0	1.00	17.7	6.2
S12.001	50.00	5.80	2.336	0.077	0.0	0.0	0.0	1.15	20.3	10.4
S6.005	50.00	8.36	1.710	0.639	0.0	0.0	0.0	1.17	128.7	86.6
S13.000	50.00	7.35	2.500	0.092	0.0	0.0	0.0	0.77	13.7	12.4
S6.006	50.00	8.68	1.624	0.731	0.0	0.0	0.0	1.04	115.0	99.0
S14.000	50.00	5.24	2.600	0.053	0.0	0.0	0.0	1.00	17.8	7.2
S14.001	50.00	5.53	2.455	0.053	0.0	0.0	0.0	1.00	17.8	7.2
S14.002	50.00	6.75	2.204	0.149	0.0	0.0	0.0	1.05	41.8	20.1
S6.007	50.00	9.20	1.481	1.040	0.0	0.0	0.0	1.10	175.0	140.8
S15.000	50.00	5.28	2.550	0.029	0.0	0.0	0.0	1.00	17.8	3.9
S15.001	50.00	5.54	2.379	0.054	0.0	0.0	0.0	1.00	17.8	7.3
S15.002	50.00	5.76	2.224	0.106	0.0	0.0	0.0	1.00	17.8	14.3
S15.003	50.00	7.09	2.014	0.146	0.0	0.0	0.0	0.95	37.9	19.8
S6.008	50.00	9.35	1.381	1.242	0.0	0.0	0.0	1.30	207.2	168.2
S16.000	50.00	6.17	2.500	0.071	0.0	0.0	0.0	1.00	17.8	9.6
S16.001	50.00	6.24	1.797	0.071	0.0	0.0	0.0	1.00	17.8	9.6

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STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S16.002	6.028	0.119	50.7	0.018	0.00	0.0	0.600	o	150	Pipe/Conduit	
S6.009	25.581	0.075	341.1	0.026	0.00	0.0	0.600	o	525	Pipe/Conduit	
S3.004	30.273	0.067	451.8	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
S1.003	39.040	0.068	574.1	0.075	0.00	0.0	0.600	o	600	Pipe/Conduit	
S17.000	37.830	0.579	65.3	0.384	5.00	0.0	0.600	o	300	Pipe/Conduit	
S1.004	87.288	0.152	574.3	0.000	0.00	0.0	0.600	o	675	Pipe/Conduit	
S18.000	12.698	0.042	302.3	0.433	5.00	0.0	0.600	o	450	Pipe/Conduit	
S18.001	39.830	0.589	67.6	0.433	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.005	9.665	0.050	193.3	0.129	0.00	0.0	0.600	o	675	Pipe/Conduit	
S19.000	50.136	0.334	150.0	0.050	5.00	0.0	0.600	o	150	Pipe/Conduit	
S19.001	5.570	0.297	18.8	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S20.000	44.107	0.294	150.0	0.060	5.00	0.0	0.600	o	150	Pipe/Conduit	
S20.001	13.278	0.089	150.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S21.000	46.667	0.383	121.8	0.086	5.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S16.002	50.00	6.31	1.750	0.089	0.0	0.0	0.0	1.42	25.0	12.0
S6.009	50.00	9.71	1.256	1.357	0.0	0.0	0.0	1.21	261.3	183.8
S3.004	50.00	10.19	1.181	1.578	0.0	0.0	0.0	1.05	226.7	213.6
S1.003	50.00	10.83	1.039	1.820	0.0	0.0	0.0	1.01	285.3	246.5
S17.000	50.00	5.32	1.850	0.384	0.0	0.0	0.0	1.95	137.7	52.0
S1.004	50.00	12.17	0.896	2.204	0.0	0.0	0.0	1.09	388.8	298.5
S18.000	50.00	5.18	1.600	0.433	0.0	0.0	0.0	1.16	185.1	58.6
S18.001	50.00	5.45	1.558	0.866	0.0	0.0	0.0	2.48	393.7	117.3
S1.005	50.00	12.26	0.744	3.199	0.0	0.0	0.0	1.88	673.3	433.2
S19.000	50.00	6.02	1.850	0.050	0.0	0.0	0.0	0.82	14.5	6.8
S19.001	50.00	6.06	1.516	0.050	0.0	0.0	0.0	2.34	41.3	6.8
S20.000	50.00	5.90	1.650	0.060	0.0	0.0	0.0	0.82	14.5	8.2
S20.001	50.00	6.17	1.356	0.060	0.0	0.0	0.0	0.82	14.5	8.2
S21.000	50.00	5.86	1.650	0.086	0.0	0.0	0.0	0.91	16.1	11.7

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STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S20.002	8.706	0.048	181.4	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.006	7.037	0.050	140.7	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.007	41.875	0.050	837.5	0.000	0.00	0.0	0.600	o	1000	Pipe/Conduit	
S1.008	37.541	0.004	9385.3	0.000	0.00	0.0	0.600	o	1000	Pipe/Conduit	
S1.009	16.832	0.070	240.5	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S20.002	50.00	6.32	1.192	0.147	0.0	0.0	0.0	0.97	38.5	19.8
S1.006	50.00	12.31	0.769	3.396	0.0	0.0	0.0	2.05	579.9	459.8
S1.007	50.00	12.92	0.719	3.396	0.0	0.0	0.0	1.15	901.2	459.8
S1.008	50.00	14.79	0.669	3.396	0.0	0.0	0.0	0.33	263.1«	459.8
S1.009	50.00	15.07	0.669	3.396	0.0	0.0	0.0	1.01	71.4«	459.8

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
S1	3.100	0.650	Open Manhole	1200	S1.000	2.450	150				
S2	3.100	0.829	Open Manhole	1200	S1.001	2.271	150	S1.000	2.271	150	
S3	3.100	0.650	Open Manhole	1200	S2.000	2.450	150				
S4	3.100	0.964	Open Manhole	1200	S2.001	2.136	150	S2.000	2.136	150	
S3	3.100	1.231	Open Manhole	1200	S1.002	1.869	150	S1.001	1.869	150	
								S2.001	1.869	150	
S6	3.150	0.650	Open Manhole	1200	S3.000	2.500	150				
S7	3.100	0.735	Open Manhole	1200	S3.001	2.365	150	S3.000	2.365	150	
S8	3.100	0.844	Open Manhole	1200	S3.002	2.256	225	S3.001	2.331	150	
S9	3.150	0.650	Open Manhole	1200	S4.000	2.500	150				
S10	3.150	0.650	Open Manhole	1200	S5.000	2.500	150				
S11	3.150	1.023	Open Manhole	1200	S5.001	2.127	150	S5.000	2.127	150	
S10	3.150	1.055	Open Manhole	1200	S4.001	2.095	150	S4.000	2.095	150	
								S5.001	2.095	150	
S9	3.100	1.387	Open Manhole	1200	S3.003	1.713	225	S3.002	1.713	225	
								S4.001	1.788	150	
S10	3.500	0.650	Open Manhole	1200	S6.000	2.850	150				
S11	3.500	0.720	Open Manhole	1200	S6.001	2.780	150	S6.000	2.780	150	
S12	3.500	0.847	Open Manhole	1200	S6.002	2.653	150	S6.001	2.653	150	
S17	3.400	0.650	Open Manhole	1200	S7.000	2.750	150				
S18	3.400	0.808	Open Manhole	1200	S7.001	2.592	150	S7.000	2.592	150	
S13	3.400	0.990	Open Manhole	1200	S6.003	2.410	150	S6.002	2.410	150	
								S7.001	2.410	150	
S20	3.250	0.650	Open Manhole	1200	S8.000	2.600	150				
S21	3.200	0.857	Open Manhole	1200	S8.001	2.343	150	S8.000	2.343	150	
S22	3.500	0.650	Open Manhole	1200	S9.000	2.850	150				
S23	3.500	0.650	Open Manhole	1200	S10.000	2.850	150				
S23	3.500	0.882	Open Manhole	1200	S9.001	2.618	225	S9.000	2.693	150	
								S10.000	2.693	150	
S25	3.500	0.650	Open Manhole	1200	S11.000	2.850	150				
S24	3.400	0.865	Open Manhole	1200	S9.002	2.535	225	S9.001	2.535	225	
								S11.000	2.610	150	
S25	3.400	0.896	Open Manhole	1200	S9.003	2.504	225	S9.002	2.504	225	
S14	3.400	1.317	Open Manhole	1200	S6.004	2.083	300	S6.003	2.233	150	
								S8.001	2.233	150	
								S9.003	2.158	225	
S43	3.400	0.850	Open Manhole	1200	S12.000	2.550	150				
S20	3.400	1.064	Open Manhole	1200	S12.001	2.336	150	S12.000	2.336	150	
S15	3.400	1.690	Open Manhole	1350	S6.005	1.710	375	S6.004	1.785	300	
								S12.001	1.935	150	
S20	3.350	0.850	Open Manhole	1200	S13.000	2.500	150				
S16	3.150	1.526	Open Manhole	1350	S6.006	1.624	375	S6.005	1.624	375	

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
								S13.000	1.849	150	
S21	3.250	0.650	Open Manhole	1200	S14.000	2.600	150				
S22	3.300	0.845	Open Manhole	1200	S14.001	2.455	150	S14.000	2.455	150	
S23	3.300	1.096	Open Manhole	1200	S14.002	2.204	225	S14.001	2.279	150	
S17	3.200	1.719	Open Manhole	1350	S6.007	1.481	450	S6.006	1.556	375	
								S14.002	1.706	225	
S22	3.200	0.650	Open Manhole	1200	S15.000	2.550	150				
S23	3.200	0.821	Open Manhole	1200	S15.001	2.379	150	S15.000	2.379	150	
S24	3.200	0.976	Open Manhole	1200	S15.002	2.224	150	S15.001	2.224	150	
S25	3.200	1.186	Open Manhole	1200	S15.003	2.014	225	S15.002	2.089	150	
S18	3.200	1.819	Open Manhole	1350	S6.008	1.381	450	S6.007	1.381	450	
								S15.003	1.606	225	
S23	3.150	0.650	Open Manhole	1200	S16.000	2.500	150				
S24	3.150	1.353	Open Manhole	1200	S16.001	1.797	150	S16.000	1.797	150	
S25	3.150	1.400	Open Manhole	1200	S16.002	1.750	150	S16.001	1.750	150	
S19	3.200	1.944	Open Manhole	1500	S6.009	1.256	525	S6.008	1.331	450	
								S16.002	1.631	150	
S10	3.100	1.919	Open Manhole	1500	S3.004	1.181	525	S3.003	1.481	225	
								S6.009	1.181	525	
S4	3.100	2.061	Open Manhole	1500	S1.003	1.039	600	S1.002	1.489	150	
								S3.004	1.114	525	
S49	3.350	1.500	Open Manhole	1200	S17.000	1.850	300				
S5	3.350	2.454	Open Manhole	1500	S1.004	0.896	675	S1.003	0.971	600	
								S17.000	1.271	300	
S52	2.550	0.950	Open Manhole	1350	S18.000	1.600	450				
S52	2.500	0.942	Open Manhole	1350	S18.001	1.558	450	S18.000	1.558	450	
S6	3.350	2.606	Open Manhole	1500	S1.005	0.744	675	S1.004	0.744	675	
								S18.001	0.969	450	
S55	2.600	0.750	Open Manhole	1200	S19.000	1.850	150				
S56	3.250	1.734	Open Manhole	1200	S19.001	1.516	150	S19.000	1.516	150	
S57	2.400	0.750	Open Manhole	1200	S20.000	1.650	150				
S58	2.400	1.044	Open Manhole	1200	S20.001	1.356	150	S20.000	1.356	150	
S59	2.400	0.750	Open Manhole	1200	S21.000	1.650	150				
S59	3.000	1.808	Open Manhole	1200	S20.002	1.192	225	S20.001	1.267	150	
								S21.000	1.267	150	
S7	3.200	2.506	Open Manhole	1500	S1.006	0.769	600	S1.005	0.694	675	
								S19.001	1.219	150	
								S20.002	1.144	225	
S8	2.000	1.281	Open Manhole		S1.007	0.719	1000	S1.006	0.719	600	
SPond	2.000	1.331	Junction	0	S1.008	0.669	1000	S1.007	0.669	1000	
S10	2.000	1.335	Open Manhole	1900	S1.009	0.669	300	S1.008	0.665	1000	
S	1.600	1.001	Open Manhole	0		OUTFALL		S1.009	0.599	300	

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PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	150	S1	3.100	2.450	0.500	Open Manhole	1200
S1.001	o	150	S2	3.100	2.271	0.679	Open Manhole	1200
S2.000	o	150	S3	3.100	2.450	0.500	Open Manhole	1200
S2.001	o	150	S4	3.100	2.136	0.814	Open Manhole	1200
S1.002	o	150	S3	3.100	1.869	1.081	Open Manhole	1200
S3.000	o	150	S6	3.150	2.500	0.500	Open Manhole	1200
S3.001	o	150	S7	3.100	2.365	0.585	Open Manhole	1200
S3.002	o	225	S8	3.100	2.256	0.619	Open Manhole	1200
S4.000	o	150	S9	3.150	2.500	0.500	Open Manhole	1200
S5.000	o	150	S10	3.150	2.500	0.500	Open Manhole	1200
S5.001	o	150	S11	3.150	2.127	0.873	Open Manhole	1200
S4.001	o	150	S10	3.150	2.095	0.905	Open Manhole	1200
S3.003	o	225	S9	3.100	1.713	1.162	Open Manhole	1200
S6.000	o	150	S10	3.500	2.850	0.500	Open Manhole	1200
S6.001	o	150	S11	3.500	2.780	0.570	Open Manhole	1200
S6.002	o	150	S12	3.500	2.653	0.697	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	26.836	150.0	S2	3.100	2.271	0.679	Open Manhole	1200
S1.001	60.241	150.0	S3	3.100	1.869	1.081	Open Manhole	1200
S2.000	47.059	150.0	S4	3.100	2.136	0.814	Open Manhole	1200
S2.001	28.836	108.0	S3	3.100	1.869	1.081	Open Manhole	1200
S1.002	12.837	33.8	S4	3.100	1.489	1.461	Open Manhole	1500
S3.000	20.310	150.0	S7	3.100	2.365	0.585	Open Manhole	1200
S3.001	4.985	150.0	S8	3.100	2.331	0.619	Open Manhole	1200
S3.002	70.130	129.1	S9	3.100	1.713	1.162	Open Manhole	1200
S4.000	53.659	132.5	S10	3.150	2.095	0.905	Open Manhole	1200
S5.000	55.944	150.0	S11	3.150	2.127	0.873	Open Manhole	1200
S5.001	4.801	150.0	S10	3.150	2.095	0.905	Open Manhole	1200
S4.001	14.702	47.9	S9	3.100	1.788	1.162	Open Manhole	1200
S3.003	5.949	25.6	S10	3.100	1.481	1.394	Open Manhole	1500
S6.000	10.479	149.7	S11	3.500	2.780	0.570	Open Manhole	1200
S6.001	18.989	149.5	S12	3.500	2.653	0.697	Open Manhole	1200
S6.002	36.445	150.0	S13	3.400	2.410	0.840	Open Manhole	1200

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PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S7.000	o	150	S17	3.400	2.750	0.500	Open Manhole	1200
S7.001	o	150	S18	3.400	2.592	0.658	Open Manhole	1200
S6.003	o	150	S13	3.400	2.410	0.840	Open Manhole	1200
S8.000	o	150	S20	3.250	2.600	0.500	Open Manhole	1200
S8.001	o	150	S21	3.200	2.343	0.707	Open Manhole	1200
S9.000	o	150	S22	3.500	2.850	0.500	Open Manhole	1200
S10.000	o	150	S23	3.500	2.850	0.500	Open Manhole	1200
S9.001	o	225	S23	3.500	2.618	0.657	Open Manhole	1200
S11.000	o	150	S25	3.500	2.850	0.500	Open Manhole	1200
S9.002	o	225	S24	3.400	2.535	0.640	Open Manhole	1200
S9.003	o	225	S25	3.400	2.504	0.671	Open Manhole	1200
S6.004	o	300	S14	3.400	2.083	1.017	Open Manhole	1200
S12.000	o	150	S43	3.400	2.550	0.700	Open Manhole	1200
S12.001	o	150	S20	3.400	2.336	0.914	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S7.000	23.672	149.8	S18	3.400	2.592	0.658	Open Manhole	1200
S7.001	5.201	28.6	S13	3.400	2.410	0.840	Open Manhole	1200
S6.003	26.557	150.0	S14	3.400	2.233	1.017	Open Manhole	1200
S8.000	38.611	150.0	S21	3.200	2.343	0.707	Open Manhole	1200
S8.001	10.705	97.7	S14	3.400	2.233	1.017	Open Manhole	1200
S9.000	10.998	70.1	S23	3.500	2.693	0.657	Open Manhole	1200
S10.000	23.564	150.1	S23	3.500	2.693	0.657	Open Manhole	1200
S9.001	12.372	149.1	S24	3.400	2.535	0.640	Open Manhole	1200
S11.000	20.160	84.0	S24	3.400	2.610	0.640	Open Manhole	1200
S9.002	5.263	170.0	S25	3.400	2.504	0.671	Open Manhole	1200
S9.003	14.372	41.5	S14	3.400	2.158	1.017	Open Manhole	1200
S6.004	71.534	240.0	S15	3.400	1.785	1.315	Open Manhole	1350
S12.000	21.446	100.2	S20	3.400	2.336	0.914	Open Manhole	1200
S12.001	30.758	76.7	S15	3.400	1.935	1.315	Open Manhole	1350

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PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S6.005	o	375	S15	3.400	1.710	1.315	Open Manhole	1350
S13.000	o	150	S20	3.350	2.500	0.700	Open Manhole	1200
S6.006	o	375	S16	3.150	1.624	1.151	Open Manhole	1350
S14.000	o	150	S21	3.250	2.600	0.500	Open Manhole	1200
S14.001	o	150	S22	3.300	2.455	0.695	Open Manhole	1200
S14.002	o	225	S23	3.300	2.204	0.871	Open Manhole	1200
S6.007	o	450	S17	3.200	1.481	1.269	Open Manhole	1350
S15.000	o	150	S22	3.200	2.550	0.500	Open Manhole	1200
S15.001	o	150	S23	3.200	2.379	0.671	Open Manhole	1200
S15.002	o	150	S24	3.200	2.224	0.826	Open Manhole	1200
S15.003	o	225	S25	3.200	2.014	0.961	Open Manhole	1200
S6.008	o	450	S18	3.200	1.381	1.369	Open Manhole	1350
S16.000	o	150	S23	3.150	2.500	0.500	Open Manhole	1200
S16.001	o	150	S24	3.150	1.797	1.203	Open Manhole	1200
S16.002	o	150	S25	3.150	1.750	1.250	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S6.005	20.508	240.0	S16	3.150	1.624	1.151	Open Manhole	1350
S13.000	109.108	167.7	S16	3.150	1.849	1.151	Open Manhole	1350
S6.006	20.392	299.9	S17	3.200	1.556	1.269	Open Manhole	1350
S14.000	14.499	100.0	S22	3.300	2.455	0.695	Open Manhole	1200
S14.001	17.608	100.0	S23	3.300	2.279	0.871	Open Manhole	1200
S14.002	76.694	154.2	S17	3.200	1.706	1.269	Open Manhole	1350
S6.007	34.019	337.9	S18	3.200	1.381	1.369	Open Manhole	1350
S15.000	17.111	100.0	S23	3.200	2.379	0.671	Open Manhole	1200
S15.001	15.500	100.0	S24	3.200	2.224	0.826	Open Manhole	1200
S15.002	13.508	100.0	S25	3.200	2.089	0.961	Open Manhole	1200
S15.003	76.094	186.5	S18	3.200	1.606	1.369	Open Manhole	1350
S6.008	12.099	242.0	S19	3.200	1.331	1.419	Open Manhole	1500
S16.000	70.264	100.0	S24	3.150	1.797	1.203	Open Manhole	1200
S16.001	4.717	100.0	S25	3.150	1.750	1.250	Open Manhole	1200
S16.002	6.028	50.7	S19	3.200	1.631	1.419	Open Manhole	1500

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PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S6.009	o	525	S19	3.200	1.256	1.419	Open Manhole	1500
S3.004	o	525	S10	3.100	1.181	1.394	Open Manhole	1500
S1.003	o	600	S4	3.100	1.039	1.461	Open Manhole	1500
S17.000	o	300	S49	3.350	1.850	1.200	Open Manhole	1200
S1.004	o	675	S5	3.350	0.896	1.779	Open Manhole	1500
S18.000	o	450	S52	2.550	1.600	0.500	Open Manhole	1350
S18.001	o	450	S52	2.500	1.558	0.492	Open Manhole	1350
S1.005	o	675	S6	3.350	0.744	1.931	Open Manhole	1500
S19.000	o	150	S55	2.600	1.850	0.600	Open Manhole	1200
S19.001	o	150	S56	3.250	1.516	1.584	Open Manhole	1200
S20.000	o	150	S57	2.400	1.650	0.600	Open Manhole	1200
S20.001	o	150	S58	2.400	1.356	0.894	Open Manhole	1200
S21.000	o	150	S59	2.400	1.650	0.600	Open Manhole	1200
S20.002	o	225	S59	3.000	1.192	1.583	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S6.009	25.581	341.1	S10	3.100	1.181	1.394	Open Manhole	1500
S3.004	30.273	451.8	S4	3.100	1.114	1.461	Open Manhole	1500
S1.003	39.040	574.1	S5	3.350	0.971	1.779	Open Manhole	1500
S17.000	37.830	65.3	S5	3.350	1.271	1.779	Open Manhole	1500
S1.004	87.288	574.3	S6	3.350	0.744	1.931	Open Manhole	1500
S18.000	12.698	302.3	S52	2.500	1.558	0.492	Open Manhole	1350
S18.001	39.830	67.6	S6	3.350	0.969	1.931	Open Manhole	1500
S1.005	9.665	193.3	S7	3.200	0.694	1.831	Open Manhole	1500
S19.000	50.136	150.0	S56	3.250	1.516	1.584	Open Manhole	1200
S19.001	5.570	18.8	S7	3.200	1.219	1.831	Open Manhole	1500
S20.000	44.107	150.0	S58	2.400	1.356	0.894	Open Manhole	1200
S20.001	13.278	150.0	S59	3.000	1.267	1.583	Open Manhole	1200
S21.000	46.667	121.8	S59	3.000	1.267	1.583	Open Manhole	1200
S20.002	8.706	181.4	S7	3.200	1.144	1.831	Open Manhole	1500

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PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.006	o	600	S7	3.200	0.769	1.831	Open Manhole	1500
S1.007	o	1000	S8	2.000	0.719	0.281	Open Manhole	1900
S1.008	o	1000	SPond	2.000	0.669	0.331	Junction	
S1.009	o	300	S10	2.000	0.669	1.031	Open Manhole	1900

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.006	7.037	140.7	S8	2.000	0.719	0.681	Open Manhole	1900
S1.007	41.875	837.5	SPond	2.000	0.669	0.331	Junction	
S1.008	37.541	9385.3	S10	2.000	0.665	0.335	Open Manhole	1900
S1.009	16.832	240.5	S	1.600	0.599	0.701	Open Manhole	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.009	S	1.600	0.599	0.500	0	0

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Online Controls for Storm

Complex Manhole: S10, DS/PN: S1.009, Volume (m³): 32.5

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0139-1130-2000-1130
Design Head (m)	2.000
Design Flow (l/s)	11.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	139
Invert Level (m)	0.669
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	11.3	Kick-Flo®	1.214	8.9
Flush-Flo™	0.593	11.3	Mean Flow over Head Range	-	9.9

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.0	0.800	11.1	2.000	11.3	4.000	15.7	7.000	20.5
0.200	9.4	1.000	10.5	2.200	11.8	4.500	16.6	7.500	21.2
0.300	10.4	1.200	9.1	2.400	12.3	5.000	17.5	8.000	21.9
0.400	11.0	1.400	9.5	2.600	12.8	5.500	18.3	8.500	22.5
0.500	11.2	1.600	10.2	3.000	13.7	6.000	19.1	9.000	23.1
0.600	11.3	1.800	10.7	3.500	14.7	6.500	19.8	9.500	23.8

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Storage Structures for Storm

Porous Car Park Manhole: S6, DS/PN: S3.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	21.0
Max Percolation (l/s)	28.0	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.500	Cap Volume Depth (m)	0.500

Porous Car Park Manhole: S9, DS/PN: S4.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	56.0
Max Percolation (l/s)	74.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.500	Cap Volume Depth (m)	0.500

Porous Car Park Manhole: S10, DS/PN: S5.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	56.0
Max Percolation (l/s)	74.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.500	Cap Volume Depth (m)	0.500

Porous Car Park Manhole: S9, DS/PN: S3.003

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	72.0
Max Percolation (l/s)	96.0	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	1.713	Cap Volume Depth (m)	0.500

Porous Car Park Manhole: S18, DS/PN: S7.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	19.1
Max Percolation (l/s)	25.5	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.592	Cap Volume Depth (m)	0.500

Porous Car Park Manhole: S20, DS/PN: S8.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	38.0
Max Percolation (l/s)	50.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.600	Cap Volume Depth (m)	0.500

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Porous Car Park Manhole: S22, DS/PN: S9.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	14.4
Max Percolation (l/s)	19.2	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.850	Cap Volume Depth (m)	0.500

Porous Car Park Manhole: S23, DS/PN: S10.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	21.5
Max Percolation (l/s)	28.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.850	Cap Volume Depth (m)	0.500

Porous Car Park Manhole: S25, DS/PN: S11.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	21.5
Max Percolation (l/s)	28.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.850	Cap Volume Depth (m)	0.500

Porous Car Park Manhole: S15, DS/PN: S6.005

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	60.0
Max Percolation (l/s)	80.0	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	1.710	Cap Volume Depth (m)	0.500

Porous Car Park Manhole: S16, DS/PN: S6.006

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	7.3
Membrane Percolation (mm/hr)	1000	Length (m)	110.0
Max Percolation (l/s)	223.1	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	1.624	Cap Volume Depth (m)	0.500

Porous Car Park Manhole: S17, DS/PN: S6.007

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	87.0
Max Percolation (l/s)	116.0	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	1.481	Cap Volume Depth (m)	0.500

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Porous Car Park Manhole: S23, DS/PN: S16.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	71.0
Max Percolation (l/s)	94.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.500	Cap Volume Depth (m)	0.500

Porous Car Park Manhole: S25, DS/PN: S16.002

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	14.5
Max Percolation (l/s)	19.3	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	1.750	Cap Volume Depth (m)	0.500

Porous Car Park Manhole: S55, DS/PN: S19.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	55.0
Max Percolation (l/s)	73.3	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.450	Cap Volume Depth (m)	0.500

Porous Car Park Manhole: S58, DS/PN: S20.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	4.8
Membrane Percolation (mm/hr)	1000	Length (m)	45.0
Max Percolation (l/s)	60.0	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.009	Cap Volume Depth (m)	0.500

Porous Car Park Manhole: S59, DS/PN: S21.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	9.6
Membrane Percolation (mm/hr)	1000	Length (m)	40.0
Max Percolation (l/s)	106.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.450	Cap Volume Depth (m)	0.500

Tank or Pond Manhole: SPond, DS/PN: S1.008

Invert Level (m) 0.669

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2500.0	1.331	2500.0

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2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 1 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 18 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH C (1km) -0.026 D3 (1km) 0.415 Cv (Summer) 0.750
FEH Rainfall Version 1999 D1 (1km) 0.396 E (1km) 0.308 Cv (Winter) 0.840
Site Location D2 (1km) 0.253 F (1km) 2.312

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status OFF
Inertia Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 2, 30, 100
Climate Change (%) 0, 0, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S1.000	S1	60 Winter	2	+0%	100/15 Summer	100/15 Summer			2.450	-0.150	0.000
S1.001	S2	15 Winter	2	+0%	30/15 Summer	100/15 Summer			2.336	-0.085	0.000
S2.000	S3	15 Winter	2	+0%	30/15 Summer	100/15 Summer			2.512	-0.088	0.000
S2.001	S4	15 Winter	2	+0%	30/15 Summer	100/15 Winter			2.215	-0.071	0.000
S1.002	S3	15 Winter	2	+0%	30/15 Summer	100/15 Summer			1.960	-0.060	0.000
S3.000	S6	60 Winter	2	+0%	100/15 Summer				2.534	-0.116	0.000
S3.001	S7	60 Winter	2	+0%	100/15 Summer				2.401	-0.113	0.000
S3.002	S8	15 Winter	2	+0%	100/15 Summer				2.333	-0.149	0.000
S4.000	S9	120 Winter	2	+0%					2.528	-0.122	0.000
S5.000	S10	120 Winter	2	+0%					2.530	-0.120	0.000
S5.001	S11	120 Winter	2	+0%	100/15 Winter				2.160	-0.117	0.000
S4.001	S10	120 Winter	2	+0%	100/15 Winter				2.127	-0.118	0.000
S3.003	S9	60 Winter	2	+0%	100/15 Summer				1.761	-0.177	0.000
S6.000	S10	60 Winter	2	+0%					2.850	-0.150	0.000
S6.001	S11	60 Winter	2	+0%	100/15 Winter				2.780	-0.150	0.000
S6.002	S12	60 Winter	2	+0%	100/15 Summer				2.653	-0.150	0.000
S7.000	S17	15 Winter	2	+0%	100/15 Summer				2.806	-0.094	0.000
S7.001	S18	15 Winter	2	+0%	100/15 Summer				2.634	-0.108	0.000
S6.003	S13	15 Winter	2	+0%	30/15 Summer				2.486	-0.074	0.000
S8.000	S20	60 Winter	2	+0%	100/15 Summer				2.636	-0.114	0.000
S8.001	S21	15 Winter	2	+0%	30/15 Summer				2.404	-0.089	0.000
S9.000	S22	15 Winter	2	+0%	30/15 Summer				2.928	-0.072	0.000
S10.000	S23	60 Winter	2	+0%	100/15 Winter				2.878	-0.122	0.000
S9.001	S23	15 Winter	2	+0%	100/15 Summer				2.700	-0.143	0.000
S11.000	S25	30 Winter	2	+0%	100/15 Winter				2.879	-0.121	0.000
S9.002	S24	15 Winter	2	+0%	30/15 Winter				2.632	-0.128	0.000
S9.003	S25	15 Winter	2	+0%	100/15 Summer				2.564	-0.165	0.000

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2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.00		0.0	OK	4
S1.001	S2	0.37		5.2	OK	4
S2.000	S3	0.34		4.8	OK	6
S2.001	S4	0.53		8.6	OK	1
S1.002	S3	0.66		18.6	OK	1
S3.000	S6	0.11		1.6	OK	
S3.001	S7	0.14		1.6	OK	
S3.002	S8	0.25		11.0	OK	
S4.000	S9	0.08		1.2	OK	
S5.000	S10	0.09		1.2	OK	
S5.001	S11	0.11		1.2	OK	
S4.001	S10	0.10		2.4	OK	
S3.003	S9	0.10		7.1	OK	
S6.000	S10	0.00		0.0	OK	
S6.001	S11	0.00		0.0	OK	
S6.002	S12	0.00		0.0	OK	
S7.000	S17	0.29		4.0	OK	
S7.001	S18	0.17		4.7	OK	
S6.003	S13	0.50		6.9	OK	
S8.000	S20	0.13		1.9	OK	
S8.001	S21	0.34		5.6	OK	
S9.000	S22	0.53		10.1	OK	
S10.000	S23	0.08		1.1	OK	
S9.001	S23	0.28		10.3	OK	
S11.000	S25	0.08		1.5	OK	
S9.002	S24	0.39		11.5	OK	
S9.003	S25	0.16		11.4	OK	

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2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S6.004	S14	15 Winter	2	+0%	30/15 Summer				2.231	-0.152	0.000
S12.000	S43	15 Winter	2	+0%	30/15 Summer	100/15 Summer			2.613	-0.087	0.000
S12.001	S20	15 Winter	2	+0%	30/15 Summer				2.410	-0.076	0.000
S6.005	S15	30 Winter	2	+0%	100/15 Summer				1.867	-0.218	0.000
S13.000	S20	15 Winter	2	+0%	30/15 Summer	30/15 Summer			2.612	-0.038	0.000
S6.006	S16	60 Winter	2	+0%	100/15 Summer				1.752	-0.248	0.000
S14.000	S21	15 Winter	2	+0%	30/15 Summer	100/15 Summer			2.669	-0.081	0.000
S14.001	S22	15 Winter	2	+0%	30/15 Summer				2.524	-0.081	0.000
S14.002	S23	15 Winter	2	+0%	30/15 Summer				2.308	-0.121	0.000
S6.007	S17	120 Winter	2	+0%	100/15 Summer				1.623	-0.308	0.000
S15.000	S22	15 Winter	2	+0%	30/15 Summer	100/15 Summer			2.599	-0.101	0.000
S15.001	S23	15 Winter	2	+0%	30/15 Summer	100/15 Summer			2.445	-0.083	0.000
S15.002	S24	15 Winter	2	+0%	30/15 Summer				2.323	-0.051	0.000
S15.003	S25	15 Winter	2	+0%	30/15 Summer				2.120	-0.118	0.000
S6.008	S18	120 Winter	2	+0%	100/15 Summer				1.533	-0.298	0.000
S16.000	S23	120 Winter	2	+0%					2.535	-0.115	0.000
S16.001	S24	120 Winter	2	+0%	100/15 Summer				1.837	-0.111	0.000
S16.002	S25	120 Winter	2	+0%	100/15 Summer				1.785	-0.115	0.000
S6.009	S19	120 Winter	2	+0%	100/15 Summer				1.423	-0.358	0.000
S3.004	S10	120 Winter	2	+0%	100/15 Summer				1.359	-0.347	0.000
S1.003	S4	15 Winter	2	+0%	30/15 Winter				1.257	-0.382	0.000
S17.000	S49	15 Winter	2	+0%	100/15 Summer	100/15 Summer			1.983	-0.167	0.000
S1.004	S5	15 Winter	2	+0%	30/15 Summer				1.188	-0.383	0.000
S18.000	S52	15 Winter	2	+0%	100/15 Summer	100/15 Summer			1.805	-0.245	0.000
S18.001	S52	15 Winter	2	+0%	100/15 Summer	100/15 Summer			1.727	-0.281	0.000
S1.005	S6	15 Winter	2	+0%	30/15 Summer				1.125	-0.293	0.000
S19.000	S55	15 Winter	2	+0%	30/15 Summer				1.921	-0.079	0.000
S19.001	S56	15 Winter	2	+0%	100/15 Summer				1.560	-0.106	0.000
S20.000	S57	15 Winter	2	+0%	30/15 Summer	100/15 Summer			1.732	-0.068	0.000
S20.001	S58	15 Winter	2	+0%	30/15 Summer				1.438	-0.068	0.000
S21.000	S59	15 Winter	2	+0%	30/15 Summer	100/15 Summer			1.745	-0.055	0.000
S20.002	S59	15 Winter	2	+0%	30/15 Summer				1.317	-0.100	0.000
S1.006	S7	15 Winter	2	+0%	30/15 Summer				1.108	-0.261	0.000
S1.007	S8	15 Winter	2	+0%					0.982	-0.737	0.000
S1.008	SPond	960 Winter	2	+0%					0.909	-0.760	0.000
S1.009	S10	960 Winter	2	+0%	30/15 Summer		2/240 Summer	34	0.908	-0.061	0.000

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S6.004	S14	0.47		32.4	OK	
S12.000	S43	0.35		5.9	OK	2
S12.001	S20	0.49		9.6	OK	
S6.005	S15	0.37		39.9	OK	
S13.000	S20	0.89		12.0	OK	8
S6.006	S16	0.25		24.4	OK	
S14.000	S21	0.43		7.0	OK	4
S14.001	S22	0.42		7.0	OK	
S14.002	S23	0.44		17.7	OK	
S6.007	S17	0.21		32.4	OK	
S15.000	S22	0.23		3.7	OK	4
S15.001	S23	0.40		6.6	OK	3
S15.002	S24	0.76		12.4	OK	

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2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S15.003	S25	0.46		16.8	OK	
S6.008	S18	0.25		38.0	OK	
S16.000	S23	0.12		2.1	OK	
S16.001	S24	0.16		2.1	OK	
S16.002	S25	0.13		2.6	OK	
S6.009	S19	0.19		41.3	OK	
S3.004	S10	0.25		48.0	OK	
S1.003	S4	0.22		52.3	OK	
S17.000	S49	0.39		50.2	OK	2
S1.004	S5	0.23		80.6	OK	
S18.000	S52	0.42		56.7	OK	4
S18.001	S52	0.30		105.5	OK	4
S1.005	S6	0.44		176.1	OK	
S19.000	S55	0.42		5.9	OK	
S19.001	S56	0.18		6.0	OK	
S20.000	S57	0.55		7.7	OK	4
S20.001	S58	0.58		7.6	OK	
S21.000	S59	0.66		10.4	OK	6
S20.002	S59	0.59		18.2	OK	
S1.006	S7	0.61		197.8	OK	
S1.007	S8	0.16		108.6	OK	
S1.008	SPond	0.01		9.9	OK*	
S1.009	S10	0.16	8.9	9.9	OK	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 1 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 18 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH C (1km) -0.026 D3 (1km) 0.415 Cv (Summer) 0.750
FEH Rainfall Version 1999 D1 (1km) 0.396 E (1km) 0.308 Cv (Winter) 0.840
Site Location D2 (1km) 0.253 F (1km) 2.312

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status OFF
Inertia Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 2, 30, 100
Climate Change (%) 0, 0, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S1.000	S1	15 Winter	30	+0%	100/15 Summer	100/15 Summer			2.566	-0.034	0.000	0.06
S1.001	S2	15 Winter	30	+0%	30/15 Summer	100/15 Summer			2.578	0.157	0.000	0.83
S2.000	S3	15 Winter	30	+0%	30/15 Summer	100/15 Summer			2.737	0.137	0.000	0.72
S2.001	S4	15 Winter	30	+0%	30/15 Summer	100/15 Winter			2.608	0.322	0.000	1.01
S1.002	S3	15 Winter	30	+0%	30/15 Summer	100/15 Summer			2.330	0.311	0.000	1.34
S3.000	S6	15 Winter	30	+0%	100/15 Summer				2.570	-0.080	0.000	0.44
S3.001	S7	15 Winter	30	+0%	100/15 Summer				2.442	-0.073	0.000	0.52
S3.002	S8	15 Winter	30	+0%	100/15 Summer				2.416	-0.066	0.000	0.79
S4.000	S9	30 Winter	30	+0%					2.556	-0.094	0.000	0.30
S5.000	S10	30 Winter	30	+0%					2.559	-0.091	0.000	0.32
S5.001	S11	60 Winter	30	+0%	100/15 Winter				2.194	-0.083	0.000	0.41
S4.001	S10	60 Winter	30	+0%	100/15 Winter				2.159	-0.086	0.000	0.38
S3.003	S9	30 Winter	30	+0%	100/15 Summer				1.808	-0.130	0.000	0.38
S6.000	S10	60 Winter	30	+0%					2.850	-0.150	0.000	0.00
S6.001	S11	60 Winter	30	+0%	100/15 Winter				2.780	-0.150	0.000	0.00
S6.002	S12	15 Winter	30	+0%	100/15 Summer				2.674	-0.129	0.000	0.01
S7.000	S17	15 Winter	30	+0%	100/15 Summer				2.848	-0.052	0.000	0.73
S7.001	S18	15 Winter	30	+0%	100/15 Summer				2.712	-0.030	0.000	0.50
S6.003	S13	15 Winter	30	+0%	30/15 Summer				2.690	0.130	0.000	1.19
S8.000	S20	30 Winter	30	+0%	100/15 Summer				2.674	-0.076	0.000	0.49
S8.001	S21	15 Winter	30	+0%	30/15 Summer				2.613	0.121	0.000	1.00
S9.000	S22	15 Winter	30	+0%	30/15 Summer				3.039	0.039	0.000	1.13
S10.000	S23	15 Winter	30	+0%	100/15 Winter				2.908	-0.092	0.000	0.31
S9.001	S23	15 Winter	30	+0%	100/15 Summer				2.803	-0.040	0.000	0.68
S11.000	S25	15 Winter	30	+0%	100/15 Winter				2.911	-0.089	0.000	0.34
S9.002	S24	15 Winter	30	+0%	30/15 Winter				2.764	0.004	0.000	1.02
S9.003	S25	15 Winter	30	+0%	100/15 Summer				2.606	-0.123	0.000	0.42

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1		0.9	OK	4
S1.001	S2		11.8	SURCHARGED	4
S2.000	S3		10.1	SURCHARGED	6
S2.001	S4		16.6	SURCHARGED	1
S1.002	S3		37.4	SURCHARGED	1
S3.000	S6		5.9	OK	
S3.001	S7		6.0	OK	
S3.002	S8		34.9	OK	
S4.000	S9		4.5	OK	
S5.000	S10		4.6	OK	
S5.001	S11		4.6	OK	
S4.001	S10		9.0	OK	
S3.003	S9		25.5	OK	
S6.000	S10		0.0	OK	
S6.001	S11		0.0	OK	
S6.002	S12		0.2	OK	
S7.000	S17		10.0	OK	
S7.001	S18		13.4	OK	
S6.003	S13		16.4	SURCHARGED	
S8.000	S20		6.8	OK	
S8.001	S21		16.2	SURCHARGED	
S9.000	S22		21.6	SURCHARGED	
S10.000	S23		4.3	OK	
S9.001	S23		24.6	OK	
S11.000	S25		6.2	OK	
S9.002	S24		30.0	SURCHARGED	
S9.003	S25		30.0	OK	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S6.004	S14	15 Winter	30	+0%	30/15 Summer				2.525	0.142	0.000
S12.000	S43	15 Winter	30	+0%	30/15 Summer	100/15 Summer			2.753	0.053	0.000
S12.001	S20	15 Winter	30	+0%	30/15 Summer				2.609	0.123	0.000
S6.005	S15	15 Winter	30	+0%	100/15 Summer				2.009	-0.076	0.000
S13.000	S20	15 Winter	30	+0%	30/15 Summer	30/15 Summer			3.350	0.700	0.474
S6.006	S16	30 Winter	30	+0%	100/15 Summer				1.876	-0.123	0.000
S14.000	S21	15 Winter	30	+0%	30/15 Summer	100/15 Summer			2.803	0.053	0.000
S14.001	S22	15 Winter	30	+0%	30/15 Summer				2.666	0.061	0.000
S14.002	S23	15 Winter	30	+0%	30/15 Summer				2.528	0.099	0.000
S6.007	S17	30 Winter	30	+0%	100/15 Summer				1.754	-0.178	0.000
S15.000	S22	15 Winter	30	+0%	30/15 Summer	100/15 Summer			2.843	0.143	0.000
S15.001	S23	15 Winter	30	+0%	30/15 Summer	100/15 Summer			2.808	0.279	0.000
S15.002	S24	15 Winter	30	+0%	30/15 Summer				2.698	0.324	0.000
S15.003	S25	15 Winter	30	+0%	30/15 Summer				2.294	0.056	0.000
S6.008	S18	15 Winter	30	+0%	100/15 Summer				1.709	-0.122	0.000
S16.000	S23	30 Winter	30	+0%					2.570	-0.080	0.000
S16.001	S24	30 Winter	30	+0%	100/15 Summer				1.877	-0.070	0.000
S16.002	S25	60 Winter	30	+0%	100/15 Summer				1.818	-0.082	0.000
S6.009	S19	15 Winter	30	+0%	100/15 Summer				1.694	-0.087	0.000
S3.004	S10	15 Winter	30	+0%	100/15 Summer				1.678	-0.028	0.000
S1.003	S4	15 Winter	30	+0%	30/15 Winter				1.657	0.018	0.000
S17.000	S49	15 Winter	30	+0%	100/15 Summer	100/15 Summer			2.115	-0.035	0.000
S1.004	S5	15 Winter	30	+0%	30/15 Summer				1.629	0.058	0.000
S18.000	S52	15 Winter	30	+0%	100/15 Summer	100/15 Summer			2.029	-0.021	0.000
S18.001	S52	15 Winter	30	+0%	100/15 Summer	100/15 Summer			1.886	-0.122	0.000
S1.005	S6	15 Winter	30	+0%	30/15 Summer				1.579	0.160	0.000
S19.000	S55	15 Winter	30	+0%	30/15 Summer				2.063	0.063	0.000
S19.001	S56	15 Winter	30	+0%	100/15 Summer				1.585	-0.080	0.000
S20.000	S57	15 Winter	30	+0%	30/15 Summer	100/15 Summer			2.014	0.214	0.000
S20.001	S58	15 Winter	30	+0%	30/15 Summer				1.688	0.182	0.000
S21.000	S59	15 Winter	30	+0%	30/15 Summer	100/15 Summer			2.267	0.467	0.000
S20.002	S59	15 Winter	30	+0%	30/15 Summer				1.576	0.159	0.000
S1.006	S7	15 Winter	30	+0%	30/15 Summer				1.520	0.151	0.000
S1.007	S8	960 Winter	30	+0%					1.190	-0.529	0.000
S1.008	SPond	960 Winter	30	+0%					1.189	-0.480	0.000
S1.009	S10	960 Winter	30	+0%	30/15 Summer		2/240 Summer	34	1.190	0.221	0.000

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S6.004	S14	1.18		81.1	SURCHARGED	
S12.000	S43	0.81		13.6	SURCHARGED	2
S12.001	S20	1.14		22.3	SURCHARGED	
S6.005	S15	0.99		107.2	OK	
S13.000	S20	1.45		19.5	FLOOD	8
S6.006	S16	0.79		76.0	OK	
S14.000	S21	0.97		15.8	SURCHARGED	4
S14.001	S22	1.04		17.3	SURCHARGED	
S14.002	S23	1.10		44.6	SURCHARGED	
S6.007	S17	0.62		95.0	OK	
S15.000	S22	0.53		8.7	SURCHARGED	4
S15.001	S23	0.93		15.3	SURCHARGED	3
S15.002	S24	1.72		27.9	SURCHARGED	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S15.003	S25	1.06		39.1	SURCHARGED	
S6.008	S18	0.67		101.7	OK	
S16.000	S23	0.43		7.6	OK	
S16.001	S24	0.56		7.6	OK	
S16.002	S25	0.43		8.9	OK	
S6.009	S19	0.53		111.9	OK	
S3.004	S10	0.74		140.2	OK	
S1.003	S4	0.74		180.2	SURCHARGED	
S17.000	S49	0.98		125.4	OK	2
S1.004	S5	0.59		210.6	SURCHARGED	
S18.000	S52	1.00		136.1	OK	4
S18.001	S52	0.82		287.4	OK	4
S1.005	S6	1.07		429.5	SURCHARGED	
S19.000	S55	1.07		15.1	SURCHARGED	
S19.001	S56	0.44		15.0	OK	
S20.000	S57	1.16		16.3	SURCHARGED	4
S20.001	S58	1.20		15.9	SURCHARGED	
S21.000	S59	1.33		20.7	FLOOD RISK	6
S20.002	S59	1.23		37.9	SURCHARGED	
S1.006	S7	1.47		477.0	SURCHARGED	
S1.007	S8	0.09		63.7	OK	
S1.008	SPond	0.02		13.9	OK*	
S1.009	S10	0.19	2.3	11.3	SURCHARGED	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 1 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 18 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH C (1km) -0.026 D3 (1km) 0.415 Cv (Summer) 0.750
FEH Rainfall Version 1999 D1 (1km) 0.396 E (1km) 0.308 Cv (Winter) 0.840
Site Location D2 (1km) 0.253 F (1km) 2.312

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status OFF
Inertia Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 2, 30, 100
Climate Change (%) 0, 0, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S1.000	S1	15 Winter	100	+30%	100/15 Summer	100/15 Summer			3.100	0.500	0.137	0.38
S1.001	S2	15 Winter	100	+30%	30/15 Summer	100/15 Summer			3.104	0.683	4.222	1.27
S2.000	S3	15 Winter	100	+30%	30/15 Summer	100/15 Summer			3.107	0.507	6.634	1.28
S2.001	S4	15 Winter	100	+30%	30/15 Summer	100/15 Winter			3.101	0.815	1.035	1.21
S1.002	S3	15 Summer	100	+30%	30/15 Summer	100/15 Summer			3.100	1.081	0.029	1.61
S3.000	S6	15 Winter	100	+30%	100/15 Summer				2.729	0.079	0.000	1.11
S3.001	S7	15 Winter	100	+30%	100/15 Summer				2.767	0.252	0.000	1.38
S3.002	S8	15 Winter	100	+30%	100/15 Summer				2.828	0.346	0.000	1.23
S4.000	S9	15 Winter	100	+30%					2.601	-0.049	0.000	0.76
S5.000	S10	15 Winter	100	+30%					2.606	-0.044	0.000	0.81
S5.001	S11	30 Winter	100	+30%	100/15 Winter				2.387	0.110	0.000	0.97
S4.001	S10	30 Winter	100	+30%	100/15 Winter				2.359	0.114	0.000	0.90
S3.003	S9	30 Winter	100	+30%	100/15 Summer				2.114	0.176	0.000	0.98
S6.000	S10	15 Winter	100	+30%					2.962	-0.038	0.000	0.04
S6.001	S11	15 Winter	100	+30%	100/15 Winter				2.962	0.032	0.000	0.09
S6.002	S12	15 Winter	100	+30%	100/15 Summer				2.968	0.165	0.000	0.16
S7.000	S17	15 Winter	100	+30%	100/15 Summer				3.187	0.287	0.000	1.20
S7.001	S18	15 Winter	100	+30%	100/15 Summer				3.029	0.287	0.000	0.59
S6.003	S13	15 Winter	100	+30%	30/15 Summer				2.995	0.435	0.000	1.35
S8.000	S20	30 Winter	100	+30%	100/15 Summer				2.864	0.114	0.000	1.04
S8.001	S21	15 Winter	100	+30%	30/15 Summer				3.082	0.589	0.000	1.24
S9.000	S22	15 Winter	100	+30%	30/15 Summer				3.463	0.463	0.000	1.63
S10.000	S23	15 Winter	100	+30%	100/15 Winter				3.034	0.034	0.000	0.72
S9.001	S23	15 Winter	100	+30%	100/15 Summer				3.020	0.177	0.000	0.95
S11.000	S25	15 Winter	100	+30%	100/15 Winter				3.010	0.010	0.000	0.63
S9.002	S24	15 Winter	100	+30%	30/15 Winter				2.983	0.223	0.000	1.60
S9.003	S25	15 Winter	100	+30%	100/15 Summer				2.968	0.239	0.000	0.67

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1		5.3	FLOOD	4
S1.001	S2		18.0	FLOOD	4
S2.000	S3		18.0	FLOOD	6
S2.001	S4		19.9	FLOOD	1
S1.002	S3		45.1	FLOOD	1
S3.000	S6		15.2	SURCHARGED	
S3.001	S7		15.8	SURCHARGED	
S3.002	S8		54.6	FLOOD RISK	
S4.000	S9		11.5	OK	
S5.000	S10		11.5	OK	
S5.001	S11		10.8	SURCHARGED	
S4.001	S10		21.3	SURCHARGED	
S3.003	S9		66.2	SURCHARGED	
S6.000	S10		0.5	OK	
S6.001	S11		1.3	SURCHARGED	
S6.002	S12		2.3	SURCHARGED	
S7.000	S17		16.5	FLOOD RISK	
S7.001	S18		15.7	SURCHARGED	
S6.003	S13		18.6	SURCHARGED	
S8.000	S20		14.5	SURCHARGED	
S8.001	S21		20.0	FLOOD RISK	
S9.000	S22		31.1	FLOOD RISK	
S10.000	S23		9.9	SURCHARGED	
S9.001	S23		34.5	SURCHARGED	
S11.000	S25		11.5	SURCHARGED	
S9.002	S24		46.8	SURCHARGED	
S9.003	S25		47.3	SURCHARGED	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S6.004	S14	15 Winter	100	+30%	30/15 Summer				2.936	0.553	0.000
S12.000	S43	15 Winter	100	+30%	30/15 Summer	100/15 Summer			3.402	0.702	2.039
S12.001	S20	15 Winter	100	+30%	30/15 Summer				3.281	0.795	0.000
S6.005	S15	60 Winter	100	+30%	100/15 Summer				2.514	0.429	0.000
S13.000	S20	15 Winter	100	+30%	30/15 Summer	30/15 Summer			3.361	0.711	10.863
S6.006	S16	60 Winter	100	+30%	100/15 Summer				2.442	0.443	0.000
S14.000	S21	15 Winter	100	+30%	30/15 Summer	100/15 Summer			3.256	0.506	5.550
S14.001	S22	15 Winter	100	+30%	30/15 Summer				3.273	0.668	0.000
S14.002	S23	15 Winter	100	+30%	30/15 Summer				3.287	0.858	0.000
S6.007	S17	60 Winter	100	+30%	100/15 Summer				2.343	0.412	0.000
S15.000	S22	15 Winter	100	+30%	30/15 Summer	100/15 Summer			3.205	0.505	5.266
S15.001	S23	15 Winter	100	+30%	30/15 Summer	100/15 Summer			3.203	0.674	2.844
S15.002	S24	15 Winter	100	+30%	30/15 Summer				3.197	0.823	0.000
S15.003	S25	15 Winter	100	+30%	30/15 Summer				2.878	0.639	0.000
S6.008	S18	60 Winter	100	+30%	100/15 Summer				2.225	0.394	0.000
S16.000	S23	30 Winter	100	+30%					2.632	-0.018	0.000
S16.001	S24	30 Winter	100	+30%	100/15 Summer				2.197	0.249	0.000
S16.002	S25	30 Winter	100	+30%	100/15 Summer				2.149	0.249	0.000
S6.009	S19	15 Winter	100	+30%	100/15 Summer				2.112	0.331	0.000
S3.004	S10	15 Winter	100	+30%	100/15 Summer				2.098	0.392	0.000
S1.003	S4	15 Winter	100	+30%	30/15 Winter				2.089	0.450	0.000
S17.000	S49	15 Winter	100	+30%	100/15 Summer	100/15 Summer			3.356	1.206	6.333
S1.004	S5	15 Winter	100	+30%	30/15 Summer				2.080	0.509	0.000
S18.000	S52	15 Winter	100	+30%	100/15 Summer	100/15 Summer			2.574	0.524	23.504
S18.001	S52	15 Winter	100	+30%	100/15 Summer	100/15 Summer			2.516	0.508	16.085
S1.005	S6	15 Winter	100	+30%	30/15 Summer				2.013	0.594	0.000
S19.000	S55	15 Winter	100	+30%	30/15 Summer				2.475	0.475	0.000
S19.001	S56	15 Winter	100	+30%	100/15 Summer				1.853	0.188	0.000
S20.000	S57	15 Winter	100	+30%	30/15 Summer	100/15 Summer			2.404	0.604	4.186
S20.001	S58	15 Winter	100	+30%	30/15 Summer				1.989	0.483	0.000
S21.000	S59	15 Winter	100	+30%	30/15 Summer	100/15 Summer			2.409	0.609	8.857
S20.002	S59	15 Winter	100	+30%	30/15 Summer				1.837	0.420	0.000
S1.006	S7	15 Winter	100	+30%	30/15 Summer				1.768	0.399	0.000
S1.007	S8	960 Winter	100	+30%					1.663	-0.056	0.000
S1.008	SPond	960 Winter	100	+30%					1.661	-0.008	0.000
S1.009	S10	960 Winter	100	+30%	30/15 Summer		2/240 Summer	34	1.658	0.689	0.000

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S6.004	S14	1.58		108.4	SURCHARGED	
S12.000	S43	1.37		23.0	FLOOD	2
S12.001	S20	1.70		33.1	FLOOD RISK	
S6.005	S15	1.21		130.6	SURCHARGED	
S13.000	S20	1.45		19.6	FLOOD	8
S6.006	S16	1.37		132.3	SURCHARGED	
S14.000	S21	1.61		26.3	FLOOD	4
S14.001	S22	1.59		26.4	FLOOD RISK	
S14.002	S23	1.58		64.0	FLOOD RISK	
S6.007	S17	1.07		163.6	SURCHARGED	
S15.000	S22	1.43		23.6	FLOOD	4
S15.001	S23	1.47		24.1	FLOOD	3
S15.002	S24	1.89		30.7	FLOOD RISK	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S15.003	S25	1.38		50.9	SURCHARGED	
S6.008	S18	1.32		199.9	SURCHARGED	
S16.000	S23	0.83		14.5	OK	
S16.001	S24	1.08		14.7	SURCHARGED	
S16.002	S25	1.22		25.5	SURCHARGED	
S6.009	S19	0.91		194.1	SURCHARGED	
S3.004	S10	1.39		264.6	SURCHARGED	
S1.003	S4	1.23		299.0	SURCHARGED	
S17.000	S49	1.51		192.7	FLOOD	2
S1.004	S5	0.84		297.6	SURCHARGED	
S18.000	S52	1.64		223.8	FLOOD	4
S18.001	S52	1.05		366.5	FLOOD	4
S1.005	S6	1.55		620.8	SURCHARGED	
S19.000	S55	1.40		19.7	FLOOD RISK	
S19.001	S56	0.66		22.6	SURCHARGED	
S20.000	S57	1.40		19.7	FLOOD	4
S20.001	S58	1.59		21.1	SURCHARGED	
S21.000	S59	1.55		24.2	FLOOD	6
S20.002	S59	1.52		47.0	SURCHARGED	
S1.006	S7	2.07		674.4	SURCHARGED	
S1.007	S8	0.18		125.7	OK	
S1.008	SPond	0.02		16.3	OK*	
S1.009	S10	0.19	1.4	11.3	SURCHARGED	

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Time Area Diagram for Storm 1

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.120	4-8	0.285	8-12	0.106

Total Area Contributing (ha) = 0.511

Total Pipe Volume (m^3) = 21.129

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STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for Storm 1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	38.174	0.254	150.3	0.060	5.00	0.0	0.600	o	150	Pipe/Conduit	
S1.001	65.838	0.439	150.0	0.027	0.00	0.0	0.600	o	150	Pipe/Conduit	
S2.000	34.230	0.343	99.8	0.033	5.00	0.0	0.600	o	150	Pipe/Conduit	
S1.002	89.765	0.528	170.0	0.100	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.000	28.524	0.771	37.0	0.039	5.00	0.0	0.600	o	150	Pipe/Conduit	
S1.003	88.393	0.361	244.9	0.111	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.004	80.511	0.329	244.7	0.063	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.005	6.316	0.042	150.0	0.079	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.006	12.339	0.072	171.4	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.007	8.708	0.036	241.9	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.008	7.391	0.031	238.4	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.009	3.067	0.013	235.9	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	5.78	2.800	0.060	0.0	0.0	0.0	0.82	14.4	8.1
S1.001	50.00	7.12	2.546	0.087	0.0	0.0	0.0	0.82	14.5	11.7
S2.000	50.00	5.57	2.450	0.033	0.0	0.0	0.0	1.01	17.8	4.4
S1.002	50.00	8.62	2.032	0.220	0.0	0.0	0.0	1.00	39.8	29.8
S3.000	50.00	5.29	2.350	0.039	0.0	0.0	0.0	1.66	29.3	5.2
S1.003	50.00	10.09	1.429	0.369	0.0	0.0	0.0	1.00	70.7	50.0
S1.004	50.00	11.43	1.068	0.432	0.0	0.0	0.0	1.00	70.7	58.5
S1.005	50.00	11.51	0.739	0.511	0.0	0.0	0.0	1.28	90.6	69.2
S1.006	50.00	11.68	0.697	0.511	0.0	0.0	0.0	1.20	84.7	69.2
S1.007	50.00	11.83	0.550	0.511	0.0	0.0	0.0	1.01	71.1	69.2
S1.008	50.00	11.95	0.550	0.511	0.0	0.0	0.0	1.01	71.7	69.2
S1.009	50.00	12.00	0.550	0.511	0.0	0.0	0.0	1.02	72.0	69.2

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Manhole Schedules for Storm 1

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
S1	3.450	0.650	Open Manhole	1200	S1.000	2.800	150				
S2	3.400	0.854	Open Manhole	1200	S1.001	2.546	150	S1.000	2.546	150	
S3	3.200	0.750	Open Manhole	1200	S2.000	2.450	150				
S3	3.300	1.268	Open Manhole	1200	S1.002	2.032	225	S1.001	2.107	150	
								S2.000	2.107	150	
S4	3.100	0.750	Open Manhole	1200	S3.000	2.350	150				
S4	3.200	1.771	Open Manhole	1200	S1.003	1.429	300	S1.002	1.504	225	
								S3.000	1.579	150	
S5	3.200	2.132	Open Manhole	1200	S1.004	1.068	300	S1.003	1.068	300	
S6	3.100	2.361	Open Manhole	1200	S1.005	0.739	300	S1.004	0.739	300	
S7	3.100	2.403	Open Manhole	1200	S1.006	0.697	300	S1.005	0.697	300	
S8	3.100	2.550	Open Manhole	1200	S1.007	0.550	300	S1.006	0.625	300	75
S9	3.100	2.586	Open Manhole	1200	S1.008	0.550	300	S1.007	0.514	300	
S10	3.100	2.581	Open Manhole	1200	S1.009	0.550	300	S1.008	0.519	300	
S	1.800	1.263	Open Manhole	0		OUTFALL		S1.009	0.537	300	

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PIPELINE SCHEDULES for Storm 1

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	150	S1	3.450	2.800	0.500	Open Manhole	1200
S1.001	o	150	S2	3.400	2.546	0.704	Open Manhole	1200
S2.000	o	150	S3	3.200	2.450	0.600	Open Manhole	1200
S1.002	o	225	S3	3.300	2.032	1.043	Open Manhole	1200
S3.000	o	150	S4	3.100	2.350	0.600	Open Manhole	1200
S1.003	o	300	S4	3.200	1.429	1.471	Open Manhole	1200
S1.004	o	300	S5	3.200	1.068	1.832	Open Manhole	1200
S1.005	o	300	S6	3.100	0.739	2.061	Open Manhole	1200
S1.006	o	300	S7	3.100	0.697	2.103	Open Manhole	1200
S1.007	o	300	S8	3.100	0.550	2.250	Open Manhole	1200
S1.008	o	300	S9	3.100	0.550	2.250	Open Manhole	1200
S1.009	o	300	S10	3.100	0.550	2.250	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	38.174	150.3	S2	3.400	2.546	0.704	Open Manhole	1200
S1.001	65.838	150.0	S3	3.300	2.107	1.043	Open Manhole	1200
S2.000	34.230	99.8	S3	3.300	2.107	1.043	Open Manhole	1200
S1.002	89.765	170.0	S4	3.200	1.504	1.471	Open Manhole	1200
S3.000	28.524	37.0	S4	3.200	1.579	1.471	Open Manhole	1200
S1.003	88.393	244.9	S5	3.200	1.068	1.832	Open Manhole	1200
S1.004	80.511	244.7	S6	3.100	0.739	2.061	Open Manhole	1200
S1.005	6.316	150.0	S7	3.100	0.697	2.103	Open Manhole	1200
S1.006	12.339	171.4	S8	3.100	0.625	2.175	Open Manhole	1200
S1.007	8.708	241.9	S9	3.100	0.514	2.286	Open Manhole	1200
S1.008	7.391	238.4	S10	3.100	0.519	2.281	Open Manhole	1200
S1.009	3.067	235.9	S	1.800	0.537	0.963	Open Manhole	0

Free Flowing Outfall Details for Storm 1

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.009	S	1.800	0.537	0.800	0	0

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Online Controls for Storm 1

Hydro-Brake® Optimum Manhole: S10, DS/PN: S1.009, Volume (m³): 3.3

Unit Reference	MD-SHE-0057-2000-2000-2000
Design Head (m)	2.000
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	57
Invert Level (m)	0.550
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	2.0	Kick-Flo®	0.506	1.1
Flush-Flo™	0.247	1.3	Mean Flow over Head Range	-	1.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.2	0.800	1.3	2.000	2.0	4.000	2.7	7.000	3.6
0.200	1.3	1.000	1.5	2.200	2.1	4.500	2.9	7.500	3.7
0.300	1.3	1.200	1.6	2.400	2.2	5.000	3.0	8.000	3.8
0.400	1.3	1.400	1.7	2.600	2.3	5.500	3.2	8.500	3.9
0.500	1.1	1.600	1.8	3.000	2.4	6.000	3.3	9.000	4.0
0.600	1.2	1.800	1.9	3.500	2.6	6.500	3.4	9.500	4.1

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Storage Structures for Storm 1

Tank or Pond Manhole: S9, DS/PN: S1.008

Invert Level (m) 0.550

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	250.0	2.000	250.0

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2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm 1

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 1 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH C (1km) -0.026 D3 (1km) 0.415 Cv (Summer) 0.750
FEH Rainfall Version 1999 D1 (1km) 0.396 E (1km) 0.308 Cv (Winter) 0.840
Site Location D2 (1km) 0.253 F (1km) 2.312

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status OFF
Inertia Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 2, 30, 100
Climate Change (%) 0, 0, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S1.000	S1	15 Winter	2	+0%	30/15 Summer	100/15 Summer			2.882	-0.068	0.000
S1.001	S2	15 Winter	2	+0%	30/15 Summer	100/15 Summer			2.643	-0.053	0.000
S2.000	S3	15 Winter	2	+0%	30/15 Summer	100/15 Summer			2.501	-0.099	0.000
S1.002	S3	15 Winter	2	+0%	30/15 Summer	100/15 Summer			2.162	-0.095	0.000
S3.000	S4	15 Winter	2	+0%	100/15 Summer	100/15 Summer			2.393	-0.107	0.000
S1.003	S4	15 Winter	2	+0%	30/15 Summer	100/15 Summer			1.590	-0.139	0.000
S1.004	S5	15 Winter	2	+0%	30/15 Summer				1.237	-0.131	0.000
S1.005	S6	960 Winter	2	+0%	30/15 Summer				0.942	-0.097	0.000
S1.006	S7	960 Winter	2	+0%	30/15 Summer				0.944	-0.053	0.000
S1.007	S8	960 Winter	2	+0%	2/240 Winter				0.944	0.094	0.000
S1.008	S9	960 Winter	2	+0%	2/240 Winter				0.938	0.088	0.000
S1.009	S10	960 Winter	2	+0%	2/240 Winter		2/15 Winter	53	0.947	0.097	0.000

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.55		7.7	OK	6
S1.001	S2	0.70		9.9	OK	4
S2.000	S3	0.25		4.3	OK	6
S1.002	S3	0.59		22.8	OK	4
S3.000	S4	0.18		5.0	OK	4
S1.003	S4	0.52		35.8	OK	2
S1.004	S5	0.58		39.3	OK	
S1.005	S6	0.10		6.4	OK	
S1.006	S7	0.10		6.4	OK	

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2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm 1

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.007	S8	0.26		14.2	SURCHARGED	
S1.008	S9	0.20		10.5	SURCHARGED	
S1.009	S10	0.03	13.5	1.3	SURCHARGED	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm 1

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 1 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH C (1km) -0.026 D3 (1km) 0.415 Cv (Summer) 0.750
FEH Rainfall Version 1999 D1 (1km) 0.396 E (1km) 0.308 Cv (Winter) 0.840
Site Location D2 (1km) 0.253 F (1km) 2.312

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status OFF
Inertia Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 2, 30, 100
Climate Change (%) 0, 0, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S1.000	S1	15 Winter	30	+0%	30/15 Summer	100/15 Summer			3.419	0.469	0.000
S1.001	S2	15 Winter	30	+0%	30/15 Summer	100/15 Summer			3.228	0.532	0.000
S2.000	S3	15 Winter	30	+0%	30/15 Summer	100/15 Summer			2.728	0.128	0.000
S1.002	S3	15 Winter	30	+0%	30/15 Summer	100/15 Summer			2.651	0.394	0.000
S3.000	S4	15 Winter	30	+0%	100/15 Summer	100/15 Summer			2.422	-0.078	0.000
S1.003	S4	15 Winter	30	+0%	30/15 Summer	100/15 Summer			1.953	0.224	0.000
S1.004	S5	15 Winter	30	+0%	30/15 Summer				1.559	0.191	0.000
S1.005	S6	960 Winter	30	+0%	30/15 Summer				1.383	0.344	0.000
S1.006	S7	960 Winter	30	+0%	30/15 Summer				1.382	0.385	0.000
S1.007	S8	960 Winter	30	+0%	2/240 Winter				1.381	0.531	0.000
S1.008	S9	960 Winter	30	+0%	2/240 Winter				1.375	0.525	0.000
S1.009	S10	960 Winter	30	+0%	2/240 Winter		2/15 Winter	53	1.382	0.532	0.000

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.90		12.6	FLOOD RISK	6
S1.001	S2	1.19		16.9	FLOOD RISK	4
S2.000	S3	0.54		9.3	SURCHARGED	6
S1.002	S3	1.13		43.7	SURCHARGED	4
S3.000	S4	0.45		12.8	OK	4
S1.003	S4	1.08		73.8	SURCHARGED	2
S1.004	S5	1.12		76.4	SURCHARGED	
S1.005	S6	0.19		11.7	SURCHARGED	
S1.006	S7	0.18		11.8	SURCHARGED	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm 1

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.007	S8	0.28		15.4	SURCHARGED	
S1.008	S9	0.18		9.3	SURCHARGED	
S1.009	S10	0.03	8.4	1.3	SURCHARGED	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm 1

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 1 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH C (1km) -0.026 D3 (1km) 0.415 Cv (Summer) 0.750
FEH Rainfall Version 1999 D1 (1km) 0.396 E (1km) 0.308 Cv (Winter) 0.840
Site Location D2 (1km) 0.253 F (1km) 2.312

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status OFF
Inertia Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 2, 30, 100
Climate Change (%) 0, 0, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S1.000	S1	15 Winter	100	+30%	30/15 Summer	100/15 Summer			3.459	0.509	9.147
S1.001	S2	15 Winter	100	+30%	30/15 Summer	100/15 Summer			3.405	0.709	4.585
S2.000	S3	15 Winter	100	+30%	30/15 Summer	100/15 Summer			3.210	0.610	10.028
S1.002	S3	15 Winter	100	+30%	30/15 Summer	100/15 Summer			3.308	1.051	7.796
S3.000	S4	15 Winter	100	+30%	100/15 Summer	100/15 Summer			3.104	0.604	4.289
S1.003	S4	15 Winter	100	+30%	30/15 Summer	100/15 Summer			3.201	1.472	0.653
S1.004	S5	15 Winter	100	+30%	30/15 Summer				2.737	1.369	0.000
S1.005	S6	960 Winter	100	+30%	30/15 Summer				2.074	1.035	0.000
S1.006	S7	960 Winter	100	+30%	30/15 Summer				2.074	1.077	0.000
S1.007	S8	960 Winter	100	+30%	2/240 Winter				2.073	1.223	0.000
S1.008	S9	960 Winter	100	+30%	2/240 Winter				2.070	1.220	0.000
S1.009	S10	960 Winter	100	+30%	2/240 Winter		2/15 Winter	53	2.072	1.222	0.000

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	1.33		18.6	FLOOD	6
S1.001	S2	1.41		20.0	FLOOD	4
S2.000	S3	1.44		24.7	FLOOD	6
S1.002	S3	1.20		46.6	FLOOD	4
S3.000	S4	0.96		27.0	FLOOD	4
S1.003	S4	1.32		90.1	FLOOD	2
S1.004	S5	1.65		112.5	SURCHARGED	
S1.005	S6	0.32		19.6	SURCHARGED	
S1.006	S7	0.29		19.6	SURCHARGED	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm 1

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.007	S8	0.39		21.3	SURCHARGED	
S1.008	S9	0.21		11.0	SURCHARGED	
S1.009	S10	0.03	10.6	1.7	SURCHARGED	

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