AMBERFIELD

Civil Infrastructure Responses to HCC Further Information Request

Weston Lea Limited

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1.0 INTRODUCTION

1.1 BACKGROUND

This report refers to the Amberfield site located on Peacockes Road, Hamilton. The site is approximately 105 hectares in area and is subject to a proposed subdivision for approximately 1000 residential lots, reserves, roads and super lots for a future Suburban Centre. The site is located within the Peacockes Structure Plan area.

This report, which has been jointly prepared by Harrison Grierson and O'Callaghan Design, addresses some of the items that Hamilton City Council (HCC) has requested further information on following lodgement of the resource consent application. The response relates to the further information request letter dated 5 July 2018.

1.2 PURPOSE

The purpose of this report is to respond to relevant civil infrastructure matters for which further information has been requested by HCC. This report is intended to be submitted as part of a fuller response which will address other matters contained in the further information request. It should also be read in conjunction with the Civil Infrastructure Report (CIR) for Amberfield prepared by Harrison Grierson and dated 18 May 2018. The CIR was submitted with the resource consent application.

The following items are addressed in this report with reference to the numbering set out in the HCC further information request letter:

Stormwater Management Effects and ICMP Requirements

Items 1-4, 10, 12-23 and 25-28

Transportation

Items 48 and 49

Open Space/Recreation Areas

Item 61

Fresh Water Ecological Effects/ICMP Requirements

Items 81, 88 and 89

2.0 STORMWATER

2.4 ITEM 1

The further information request states:

> ***BPO Options Assessment***
>
> *The Stormwater BPO Options Assessment indicates that the selected BPO "Can have occasional additional larger system near river terrace where feasible (if desired)." This would have potential advantage in considering lower lifecycle costs for device maintenance etc. Please confirm where these additional larger systems are feasible on the site and their implication on the treatment train, operation and maintenance, efficiencies, and the resultant flow profiles for the receiving environments.*
>
> *The stormwater design follows the guiding principles outlined within the Sub-Catchment Integrated Catchment Management Plan (SC-ICMP) prepared by AWA in particular the preferred HCC stormwater management disposal hierarchy of managing stormwater runoff at source by retention and soakage.*

Response:

The stormwater design follows the guiding principles outlined within the Sub-Catchment Integrated Catchment Management Plan (SC-ICMP) prepared by AWA, in particular the preferred HCC stormwater management disposal hierarchy of managing stormwater runoff at source by retention and soakage.

An assessment of potentially feasible locations for communal treatment and soakage basins ('larger system') has been undertaken. The position of each basin and post development contour surface is shown in Drawing numbers SK 281-285 in Appendix 1. Location feasibility was determined using the following criteria:

- Communal soakage basins are to perform a treatment and, in some cases, a soakage function up to the 2 yr ARI level of service (a reduction from a 10 yr LOS proposed in the SC-ICMP). In doing so they will manage the water quality treatment volume as per the RITS (following suitable pre-treatment) as well as volume loss via soakage (mimicking existing initial abstraction) to mitigate potential adverse impacts caused by first flush rapid runoff to the receiving environment, where it is feasible to do so. Soakage and/or discharge will also maintain base flow/environmental flows to the stream, given the post development earthworks maintain existing groundwater catchments outside counterfort drain diversions. Communal treatment and soakage basins located within groundwater catchments draining directly to the Waikato River provide relatively insignificant base flow contributions to the river. For these areas, the water treatment function via infiltration soakage is the primary performance objective to protect the receiving environment.

- Basins are located within currently proposed greenspace/reserve areas. The urban design layout has not been altered (i.e. losing lots, or reconfiguring roads). It is noted that the proposed urban design layout and landscape architecture is based on a fully 'at source' treatment train philosophy allowing optimal use of greenspace for amenity and recreational activities (i.e. no dedicated stormwater reserves).

We have carried out a preliminary assessment of the expected capacity of the seven basins shown on drawings SK 281-285, using the 2 yr ARI 24-hour rainfall hydrograph. This design hydrograph has a total 24hr rain depth of 74mm as per the RITS for Stormwater and as described in Section 5.2.5 Table 1 of the Awa Model Build Report

(Appendix I to the SC-ICMP), with the amendment to adjust from a 10 yr ARI design event to a 2 yr ARI design event. The catchment areas of each basin are shown on drawing SK 314-315. The expected performance of the basins is shown in Table 1 below. Note final treatment areas will be determined at engineering approval stage.

Table 1: Summary of Basin Capacity

Basin No	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**total**
Catchment area to basin (Ha)	6.02	3.04	6.41	3.32	7.95	3.50	2.08	32.32
Base area (m2)	160	709	175	1517	507	390	216	
Basin volume (assumed maximum 0.7m depth) (m3)	148	569	160	435	417	328	193	
Maximum runoff volume to basin (m3)	359	1094	377	1040	996	823	474	
% runoff to basin without overflow	30%	100%	25%	100%	40%	75%	65%	
Effective catchment area treated by basins (Ha)	3.07	3.04	1.60	3.32	3.18	2.62	1.35	18.19

It can be seen from the table above that Basins 2 and 4 have potentially sufficient capacity to cope with the full 2 yr ARI runoff from their catchment. The other 5 basins unlikely to be able to accommodate the full catchment flow (based on pipe reticulated catchment) due to topographical constraints at the basin locations. In these catchments alternative 'at source' treatment devices are still required within the road reserve and on private lots (following pre-treatment). In this respect those at source devices will be the same as those originally proposed and as remain for the majority of the catchment.

As described in the geotechnical report (AEE Report for consent), there are stability concerns along sections of the river escarpment and it is not feasible to discharge all stormwater to ground close to the escarpment. ENGEO have advised that full soakage to ground at the basins close to the river escarpment could compromise the stability of the river escarpment and/or the developed infrastructure close to it. This limitation means that basins 1, 2, 3, 4 and 7 will not have soakage to ground as their final disposal system. They will be constructed with an infiltration treatment zone in the bottom 500mm depth of the basin and have an under-drainage collection system, with impermeable under-layer, to collect the under-flow and convey it to the adjacent watercourse or outlet structure.

Table 1 shows that a total of approximately 18Ha of catchment can be treated and discharged at the basins. The total stormwater catchment area within the Amberfield development is approximately 76Ha. The basins can therefore deal with 25% of the runoff from the development. It is important to note that the final catchment area to be treated within communal basins is to be determined at engineering approval stage following detailed design. It would be inappropriate to have consent conditions attached specifying exact areas for treatment via communal basins.

Treatment Train Implications

The treatment train would be somewhat compromised by changing to a 'pipe to communal treatment/soakage area' system, combined with some limited on-site efficiency measures for private lots. It is also acknowledged that pre-treatment prior to discharge to ground is considered good practice to reduce maintenance pressure on the soakage device and potential environmental effects. Pre-treatment could be provided via a forebay (temporary detention ponding) within the soakage basin or simply catch pit inserts for roads. In this sense pre-treatment prior to communal soakage is considered a form of treatment train.

O+M

More detail on O+M is provided under Item 27. O+M requirements for communal soakage basins are well established. In particular the Christchurch City Council Waterways and Wetland Guide provides usual commentary on maintenance of communal soakage basins - where numerous soakage systems have been in operation for many years. A key consideration for performance is the ability to provide soakage to ground as much as possible over the long term (where performance can be reduced due to fine sediment blocking the soil pores). Such potential reduction in performance can be allowed for by utilising reduced design soakage rates - in comparison with test soakage rates. Typically soakage basins are now designed with an underdrain network of slotted pipe with clean drainage gravel surround. Flush grate inlets or scruffy inlets allow runoff (from the pipe network) to access the subsurface drainage network. As discussed above, five of the seven communal basins would have under-drainage systems to avoid excess discharge to the groundwater system in the geotechnically difficult areas.

Receiving Environment Flow Profiles

Compared to fully distributed soakage along the road reserve, communal basins will focus the infiltration of post development runoff volumes in some areas. The geotechnical assessment carried out for the Amberfield development has identified some areas along the river escarpment as potentially unstable areas and the development has been designed to have setbacks and, in some areas, specific geotechnical remediation works to achieve the required factors of safety for stability. These geotechnical matters and their potential influence on the ability to discharge to soakage from some of the basins without compromising stability, indicates that five of the seven basins will not be able to discharge to the groundwater system. However, this will be assessed in greater detail during detailed design. If that assessment confirms that soakage to ground from the basin is not achievable for stability requirements, an under-drain system will be installed at the specific basin, which will collect the treated flow from beneath the basin treatment zone and discharge it to the adjacent stormwater outlet structure.

In addition, focussing some of the runoff volume to communal soakage areas located closer to the receiving environment (stream or river) will, in essence, shorten the travel time for groundwater movement to the stream/river. A key consideration is the travel time in relation to storm frequency. Distributed recharge will evenly spread groundwater flows and increase travel times creating a buffer against recharge events or frequent storm events. Further geo-hydrological investigation could be undertaken to quantify the distance from basin to stream to ensure adequate buffer between rain events to ensure constant base flow is achieved as currently exists for permanent flowing streams.

Bank full discharge (channel forming flow) is associated with a momentary maximum flow that, on average, has a recurrence interval of 1.5-2 years as determined using flood frequency analysis (Page 15, Regional Stormwater Guidance, 2018). Provided travel times for base flow remain, and considering soakage basins are to meet the 2yr ARI LOS for parts of the catchment, there is no indication that receiving environment flows with be adversely impacted by replacing some of the distributed soakage trenches to basins for those sub catchments identified in the drawing set SK314-315.

2.5 ITEM 2

The further information request states:

Rainwater Reuse System (Rain Tanks)

HCC Practice Note HCC-02 provides guidance on requirements for rainwater reuse system (rain tanks). Please confirm or modify the proposed on-lot water efficiency measure in the Sub-Catchment ICMP (Appendix N) proposing Rain Tanks to align with the Council's practice note requirements:

a. Re-use for laundry and toilet flushing required
b. Below ground tanks to require additional measures (submersible pump, backup water supply with solenoid valve, backflow prevention from downstream surcharge)
c. Roof areas only connected to tank

Please consider allowance for alternative configurations such as above ground rain tanks and confirm the size of the tanks.

Response:

The on-lot water efficiency measures will be aligned with the HCC practice note requirements. It is also noted that the SC-ICMP does not specially require on lot tanks for reuse but they must be considered in accordance with the HCC stormwater disposal hierarchy. For catchments with good potential for soakage and therefore volume loss, re-use should not necessarily be considered as it would remove frequent runoff volumes from base flow and therefore impact on the receiving environment. Other on-site water efficiency measures can also be considered such as simply bypassing re-use tanks directly to on lot soakage (following suitable pre-treatment) – the primary objective being maintaining base flow. This assessment should be considered alongside water demand which, in other cases, could also be a primary driver for re-use – balanced with base flow recharge requirements.

The SC-ICMP does not confirm whether reduction in network demand (on water supply or wastewater) is a desired outcome for Council in this location. As such, tanks for re-use should be considered alongside other on-lot efficiency measures such as pre-treatment, soakage, porous driveways, etc.

2.6 ITEM 3

The further information request states:

Rainwater Reuse System (Rain Tanks)

Subject to above, please provide alternative pre-treatment for on-lot impervious surfaces (e.g. driveways) draining to on lot soakage.

Response:

Pre-treatment for driveway runoff will take the form of catch pit filters combined with a sump or grate drain system at the lower end of the driveway (refer to Plan SK311 for typical pre-treatment from a driveway grate drain - ACO or similar). Alternatively, driveways can be constructed as a porous surface (pavers/concrete) therefore eliminating this area from the impervious calculation. Pre-treatment for roof runoff, prior to tank storage shall be via leaf diverters and first flush systems with trickle drainage to the soakage device (i.e. Marley first flush systems or similar).

The function of re-use tanks can be compromised typically in the following ways:

1. Inadequate water supply where demand exceeds supply, and
2. The tank outlets or downspouts become clogged due to excessive vegetative entry into the tank from roof spouting, and
3. Poor understanding of use, and lack of maintenance by private owners.

The issue where demand exceeds supply is generally an issue during summer months and usage should be monitored during this period. Clogging of tank outlets or downspouts can be reduced if filtering systems are placed in the gutters to prevent discharge of leafy material into the system.

2.7 ITEM 4

The further information request states:

Disposal Via Soakage

The strategy of adopting soakage as the primary treatment and disposal method in the proposed stormwater management system is supported in principal, however as the first point in the system – there are a number of potential issues relating to soakage which require further clarification to determine if the proposal can achieve the design targets and mitigate potential impacts from urban development. Please provide the following information:

i. *Please provide detail on the design life, maintenance, and monitoring for efficacy of on-lot soakage devices:*
   a. *What is the design life?*
   b. *What are the maintenance requirements?*
   c. *What compliance testing/monitoring is required?*
   d. *What contingencies are available if compliance testing of soakage shows failure?*

ii. *Please provide a proposed testing methodology to confirm post-development infiltration rates for on-site soakage. This methodology should be integrated with geotechnical acceptance testing methods.*

iii. *Please also confirm the contingency sizing or alternatives for stormwater management that could be adopted if on-lot infiltration rates cannot be met at time of construction.*

iv. *What is the design life of the public soakage devices? i.e. in greater detail than "<100 years". Is it likely that the soakage will be renewed along with bioretention renewals?*

v. *Please provide confirmation that 10-year soakage capacity for public systems is optimal considering lifecycle (design life, maintenance and renewals) vs the desired hydrology in the receiving waters based on post development flow assessment.*

   HCC does not want to incur the additional cost and complexity for an oversized asset system if it is not required. The presence of a secondary piped system would indicate that the 10-year level of service for the road and connected catchment drainage could be met by adopting a lower design ARI for soakage such that soakage plus secondary pipe capacity meets the 10-year LOS. This should consider the option of reducing the size of the subsurface soakage from the public bio retention that is currently extending beneath footpaths.

Response:

Each of the matters is addressed below.

What is the design life?

Whilst the use of designed soakage systems is still relatively recent (in terms of historical data for design life), an expected design life would be ~25years.

With properly designed pre-treatment, construction and maintenance there is no logical reason why on-site soakage systems cannot remain effective over the course of decades. Typical private stormwater layout is provided in Plan SK311.

What are the maintenance requirements?

With pre-treatment to remove coarse fragments and sediments from driveways and leaf litter – maintenance for private soakage would be controlled by suitable HCC bylaws which will place responsibilities on the home owner. In this respect the maintenance requirements would similar to that of on-lot raingardens required/proposed in the Rotokauri subdivisions.

Roof stormwater is considered to be relatively clean and can be disposed of via soakage to ground via a sealed system that excludes all other stormwater. Discharge occurs via soakage chambers or trenches.

What compliance testing/monitoring is required?

This will be outlined in the HCC checklist for home owners and is to be agreed with HCC prior to 224c. It is expected that PS1-PS4 sign-off will be required prior to installation and commissioning of any on-lot soakage devices. Monitoring would most likely be on an annual basis - or more frequently if performance is obviously impaired from visual inspection with surface flooding during moderate rain events

What contingencies are available if compliance testing of soakage shows failure?

Contingencies include:

1. Remedial action to restore function - including jetting and flushing and checking the pre-treatment system.

2. Replacement of the system - Installation of new soakage chamber

3. Installation of deeper bored soakage holes in the base of the system (to punch through any potential hard pans beneath the system)

Please provide a proposed testing methodology to confirm post-development infiltration rates for on-site soakage. This methodology should be integrated with geotechnical acceptance testing methods.

Please also confirm the contingency sizing or alternatives for stormwater management that could be adopted if on-lot infiltration rates cannot be met at time of construction.

If on-lot infiltration rates cannot be met, then the disposal areas can be increased provided setback from property boundaries and foundations/retaining walls can still be met. Other volume reduction measures can be implemented such as re-use prior to overflow to the pipe network. It is noted there is no 10yr or 100yr flood attenuation requirements, therefore at source re-use to achieve volume reduction (initial abstraction) avoiding soakage is still a viable solution prior to disposal to the primary network.

What is the design life of the public soakage devices? i.e. in greater detail than "<100 years". Is it likely that the soakage will be renewed along with bioretention renewals?

Whilst the use of designed soakage systems is still relatively recent (in terms of historical data for design life), an expected design life would be ~25years.

With properly designed pre-treatment, construction and maintenance there is no logical reason why on-site soakage systems cannot remain effective over the course of decades.

Please provide confirmation that 10-year soakage capacity for public systems is optimal considering lifecycle (design life, maintenance and renewals) vs the desired hydrology in the receiving waters based on post development flow assessment.

The level of service for public soakage systems will be reduced from a 10yr LOS to a 2yr LOS in accordance with the RITS. However, in order to achieve the desired level of surface water control within the Amberfield development, the pipe conveyance system from the roads to the downstream basins and/or outlet structures will be designed to convey a 10-yr design flow. Where basins are part of the pipe system, a flow split chamber will be used to direct first flush and up to the 2 yr ARI flow to the basin, above 2 yr ARI directed to the stream/river/channel discharge chamber.

HCC does not want to incur the additional cost and complexity for an oversized asset system if it is not required. The presence of a secondary piped system would indicate that the 10-year level of service for the road and connected catchment drainage could be met by adopting a lower design ARI for soakage such that soakage plus secondary pipe capacity meets the 10-year LOS. This should consider the option of reducing the size of the subsurface soakage from the public bio retention that is currently extending beneath footpaths.

We have amended the proposal to provide a 2 yr LOS for the treatment and soakage discharge elements. This will apply to both the communal basins and the soakage trenches used in the road reserve where they are needed due to insufficient capacity for communal basins to deal with the full runoff from a 2-yr event within that particular piped sub catchment. The previous runoff volumes resulting from a 10 yr event, that were to go to soakage trenches in the road reserve, are approximately 70% higher (by volume) than a 2-yr event (as modelled by Awa). As described in Item 1 above, we are proposing to cater for approximately 25% of the total catchment with the proposed seven communal basins. Therefore, the combined effect of a significantly reduced design runoff volume from a 2 yr LOS vs a 10 yr LOS and the use of the communal basins, is expected to significantly reduce the length of soakage trenches in the road reserve area from what was proposed in the Application.

The Civil Infrastructure Report, appended to the Application included the Awa stormwater calculation in Appendix 3. Those calculations estimated the expected length of 3.5m wide * 0.8m deep soakage trench for each sub-catchment. Those calculations were based on a design soakage rate of 75mm/hr, which is 25% of the lower soakage test results conducted on the site. Our review of the proposal, with the adoption of a 2 yr LOS for soakage disposal and taking into account HCC's preference to minimise future maintenance liabilities, concludes that the square area of soakage trench will be reduced to approximately 45% of that indicated in the Application by the use of the proposed communal basins and the adoption of the 2 yr LOS design flows.

In addition, there are areas of the site that had much greater soakage than that adopted for the concept design, allowing for the adoption of the reduction to 25% of site soakage for design. In the areas where it is not feasible to discharge the flows through the communal basins, site soakage testing will be carried out after earthworks has been completed in individual sub-catchments to confirm the design soakage rate. Where these are higher than the current concept design rate of 75mm/hr, the extent of soakage trench can be further reduced.

We understand HCC's nervousness of an unacceptably high level of future maintenance risk with respect to the future performance of the soakage trenches. However, as indicated above, the scale, size and extent of the soakage trenches has been significantly reduced by the adoption of the 2 yr LOS and the use of the communal basins. This also allows the opportunity to reduce the width of the soakage trenches from that shown on plan 141842-2212 in the Application drawings. In our view, we consider that the risk of design failure is minimal in this case. The flows will have passed through the infiltration devices/systems in the first flush phase of the event and thus separated floatables and sediment for most storm events. The site has good soakage characteristics which further reduces the likelihood of clogging, the proposal includes a management regime that protects the soakage systems from flow during the first "house building" phase and the use of multiple smaller units, where it is not feasible to discharge to the basins, is extremely unlikely to lead to "mass/entire" catchment wide failure in the future.

We therefore consider that there are advantages in spreading the discharge across the entire longitudinal length of the soakage trenches and bio-retention within the road reserve rather than one device at the end of the pipe, even if it were possible to discharge the full flow from the full catchment to discrete very large basins. The distributed system, including the use of the proposed seven communal basins, is therefore considered more resilient to total failure. It is therefore highly unlikely the soakage trenches that are to be used in the road reserve areas, where they extend beneath the footpath/road/berm area, would need to be 'dug up' over extended lengths to ensure continued soakage performance.

2.8 ITEM 5

The further information request states:

Counterfort Drains

Provide more detail on the installation methodology; e.g. will the lower sections of the counterfort drains be installed via open trench with directional drilling at the slopes?

Refer to separate response by ENGEO.

2.9 ITEM 6

The further information request states:

Counterfort Drains

What impacts will private soakage and counterfort drains have on each other where they overlap?

a. *Has counterfort drain sizing considered additional (and continued) loading from private soakage devices? How?*
b. *What is the design life of the counterfort drains?*
c. *Describe the potential for premature clogging of counterfort drains (particularly for sections installed via directional drilling)*
d. *What is the soakage potential for private soakage devices after counterfort drainage design life is exceeded?*

Response:

Refer to separate response by ENGEO.

2.10 ITEM 7

The further information request states:

Counterfort Drains

Please address the potential for preferential flow (piping) of groundwater from soakage devices to counterfort drains and any mitigation proposed; particularly for sections installed via directional drilling.

Response:

Refer to separate response by ENGEO.

2.11 ITEM 8

The further information request states:

Counterfort Drains

What outfall structures are proposed for each counterfort drain?

Response:

Refer to separate response by ENGEO.

2.12 ITEM 9

The further information request states:

Counterfort Drains

What inspections and maintenance procedures are required for counterfort drains?

Response:

Refer to separate response by ENGEO.

2.13 ITEM 10

The further information request states:

Post-Development Flow Assessment

The Sub-Catchment ICMP does not include a quantitative assessment of the change in impervious areas and flows between pre-development and post-development scenarios including changes to base flow, frequent storm, and 2, 10, and 100-yr ARI events.

Please provide a clear statement of the proposed change in flows, including sensitivity analysis for the elements of the proposal that have ability to change influence on the hydrograph including:

a. Areas of road too steep for soakage
b. Locations where larger centralised devices may be more appropriate
c. Allowance for loss of soakage capacity over time
d. Change to site infiltration from earthworks and compaction

Response:

Each of the matters is addressed below.

Areas of road too steep for soakage

These areas will be treated via bio retention only (pre-cast raingarden units or similar), where they are not able to be discharged to the communal basins. These road sections are relatively short and the soakage potential on an area basis is small. Not achieving soakage on the slope is therefore not considered to have a detrimental impact in terms of reducing base flow recharge to streams.

Locations where larger centralised devices may be more appropriate

The impact of communal basins on pre and post development hydrographs is not expected to be significant. The predeveloped flows are discussed in detail in the Awa Model Build Report (dated 16th May) attached to the SC-ICMP/Application. It can be seen from that report that the sub-catchments within the developed area are short and relatively steep. The change in surface impervious areas will be high, but runoff from house roof areas and parts of impervious driveways will still be to ground. In addition, as discussed in Item 1, more than 50% of the runoff from three of the seven basins and 25% - 35% from another two basins will still be discharged to ground via soakage trenches in road reserve within the sub-catchments. These discharges will go some way to off-setting the potential impact on groundwater flows well upstream of the basins.

Allowance for loss of soakage capacity over time

The soakage design has a factor of safety to minimise loss of infiltration capacity over time. The factor of safety adopted is 25% of the measured soakage rate on the site. The soil type on the site has a high sand content with minimal clay. Given the nature of the soils on the site and the redundancy in the system with both on-lot private soakage and the communal basin or trench network within the road reserve – the risk of the entire system deteriorating over time to a point that negatively impacts on base flow reduction is considered to be very low.

Change to site infiltration from earthworks and compaction

Refer to separate response by ENGEO.

Further discussion on high flows (10yr and 100yr)

The SC-ICMP does not provide a table of pre and post development 10yr and 100yr ARI peak flows and volumes. This is because the management philosophy adopts a 'pass it forward' approach to managing flood flows. There is no requirement to attenuate flood flows and therefore comparing the pre development flows and post development flows – as is typically undertaken for flood attenuation assessments - is not considered relevant. The focus for managing from 10yr ARI up to 100yr ARI shifts to conveying secondary flows safely within the road reserve to protect road users and private property boundaries.

Base flow

It is noted that the overarching stormwater approach is to manage runoff from all impervious areas up to the 2 year LOS by way of soakage. In doing so we mimic the existing drainage regime characterised by high soil infiltration rates (remnant Waikato River terrace) as much as we can achieve, taking into account the constraints of avoiding discharge to ground from 5 of the 7 communal basins.

The base flow changes are expected to be minimal, this is because we are maintaining existing groundwater catchments directed to the freshwater streams to be retained. Plan number SK312 and SK313 show the existing catchments and stream classifications. The post development (following earthworks) catchments are also shown for comparison on SK314-315.

For example - the post development topography on the west side of the island continues to flow towards the stream – See post development catchments (Area 5, 6, 12) in Plan SK315. Compare with the existing sub-catchments 11, 10 and 5 in Plan SK313. Sub catchment 7 is also reinstated to ensure base flow to the intermittent watercourse.

Post development pervious areas will also continue to soak to ground (refer to ENGEO response on post development soil remediation). Impervious surfaces will also be directed to ground via soakage to the water table over a lot of the development catchment and will therefore maintain volumes for base flow - which in turn will flow (sub-surface) under gravity downslope to the stream.

2.14 ITEM 11

The further information request states:

> ***Post-Development Flow Assessment***
>
> *Please provide any specific requirements to preserve the infiltration capacity of soils for pervious areas subject to earthworks and re-compaction across the site used in addressing 10 above including statement of testing required or contingency in sizing of downstream devices.*

Response:

Refer to separate response by ENGEO.

2.15 ITEM 12

The further information request states:

> ***Post-Development Flow Assessment***
>
> *Please assess the likely impact of any increase or reduction in the hydrograph on streams.*

<u>Response:</u>

As for the response under Item 10, the post development runoff hydrographs up to the 2yr LOS will be managed within soakage systems following pre-treatment. The intention is to mimic and retain base flow to streams as much as can be reasonably achieved, bearing in mind that the remaining streams are relatively short. The key factor is to ensure the post development catchments continue to allow groundwater to flow under gravity towards the full length of the stream. Plans SK312 and SK313 show the existing sub-catchment boundaries (1-11), the stream classification and the post development catchment boundaries (light blue dashed lines) and secondary flow arrows (dark blue arrows) are shown in Plan SK314-315.

This issue is not about limiting flows to pre-developed flows because there is no catchment downstream that could detect the change upstream. Therefore, we have not carried out a detailed changed hydrograph and do not see the point in doing so, when considering the overall potential effects of the proposal.

2.16 ITEM 13

The further information request states:

> ***Flooding***
>
> *Please provide details on how overland flow from events exceeding capacity of on-lot soakage devices will safely travel to the road reserve within appropriate easements or public land areas.*

<u>Response:</u>

We understand Council's concerns that there might be a potential issue with excess flow from one property above another, discharging concentrated excess flow onto the lower property in large storm events. This can occur where the catchment areas above the lower properties are large or where concentrated flows are large. We have reviewed the proposed development for potential nuisance on downslope neighbours from flow from upslope neighbours. In this development there are very few areas where this could be a potential problem. This is because the catchment area above is, in almost the entire development, no more than one upstream property depth. The actual flow discharged from a single property, assuming the soakage system serving the roof area etc is overloaded, is only a few litres per second. This can only occur at events well in excess of the 10-yr event as soakage systems meeting the Building Code Section E1 are designed to cater for the 10-yr event without over-flowing. The general site has a flat gradient in the north-south direction, meaning that there is very little opportunity for the flow from a single property to become highly concentrated in one part of the property from where it would flow to the lower property. The secondary surface flow from the upper property would be a very small (less than 5mm depth) sheet flow along the length of the boundary to the lower property. This type of flow has very little potential to cause damage to the lower property, which is why the law relating to stormwater secondary flow discharge has been structured the way it has.

The Building Code does not require this secondary flow to be collected or controlled and it is permitted to flow onto the lower property as an Act of God without any liability on any party, including HCC. The law only begins to control flow from upstream properties when the flows are concentrated or become sufficiently large to cause nuisance. It is therefore preferable, in the first instance, to not try and create a series of stormwater benches cutting across private property along boundaries because to do so would concentrate the flows and could create a greater potential hazard to the lower property in the event of the bench becoming blocked and side spilling the concentrated flow onto the lower property. To do so could also breach the common law requirement not to change catchment boundaries and several court cases involving changed catchments has resulted in several NZ Local Authorities being found responsible for damages.

Notwithstanding the above, we propose to include an assessment, at detailed design, to consider if there are areas within the development that could reasonably and practically achieve some degree of secondary flow control to provide additional protection to downstream properties.

2.17 ITEM 14

The further information request states:

> ***Flooding***
>
> *Please confirm that the relevant devices, pipes and overland flow paths are designed for the inflow catchment from across Peacockes Road to the south of the site.*

Response:

The 12d stormwater model accounts for secondary flows along Peacockes Road, including both sides of Peacocks Road.

2.18 ITEM 15

The further information request states:

> ***Flooding***
>
> *Please confirm the depth and velocity of overland flow for the proposed development for the 1% AEP event.*

Response:

Peak flows during the 100yr ARI event have been modelled in 12d. Runoff is directed into the road reserve once the soakage capacity and pipe capacity is exceeded. Maximum depth and velocity within the road reserve has been calculated using the peak flow results and cross sections from 12d. Taking a conservative approach the largest peak flow from the largest sub catchment was incorporated into 1D flow master software.

The maximum depth and velocity results for the 100yr and 50yr are provided in Appendix 1 Maximum depths exceed 150mm for the 50yr ARI event (at the single cross fall park edge road - where greatest peak flows occur at the bottom of the catchment). Further model refinement will be required prior to the Engineering Approval stage, to ensure depths are within the acceptable limits according to the RITS. The preliminary results are not a cause for concern because they do not represent the entire storage potential within all the road network. The catchment is effectively lumped into a single cross section – certainly depth and velocity will be lower within the catchment. Depths are therefore expected to decrease. Also this result is at the furthest end point of the catchment on the park edge road with no properties on one side. Minor earthworks could also be undertaken to lower the park edge berm to reduce depths further.

2.19 ITEM 16

The further information request states:

> ***Waikato River – Design Water Levels***
>
> *Please confirm the 1% including climate change Waikato River flood levels.*

Response:

As discussed in Section 2 of the Waikato River Adare Flood Hazard Report prepared by Awa Ltd and appended to the Application as Appendix R, the extent of the 1% AEP flood event in the Waipa and Waikato Rivers are based on 1D flood modelling undertaken in 2009 which has been extrapolated to produce a 2D flood extent. The information was provided by

Environment Waikato as an ArcGIS shape file. The design water levels at the upper end and lower end of the development site (RL19.1 to RL18.5) were extracted from the information provided. The water surface had a sufficiently even gradient between the profiles to allow the assessment of peak flood water levels to assume an even gradient between the points.

The information provided did not include an allowance for climate change but included normal industry allowance for freeboard, to account for model reliability etc. An allowance of 1m was added to the model results to cater for climate change and partially for freeboard as we did not know the exact allowance within the modelling included as freeboard. The adoption of a 1m allowance is discussed in Item 17.

Based on the accurate information available, provided by Waikato Regional Council, we consider the design water levels of RL20.1 at the upper section of the site and RL19.5 at the lower section of the site to be appropriate design levels, meeting normal industry standards for determining these levels.

2.20 ITEM 17

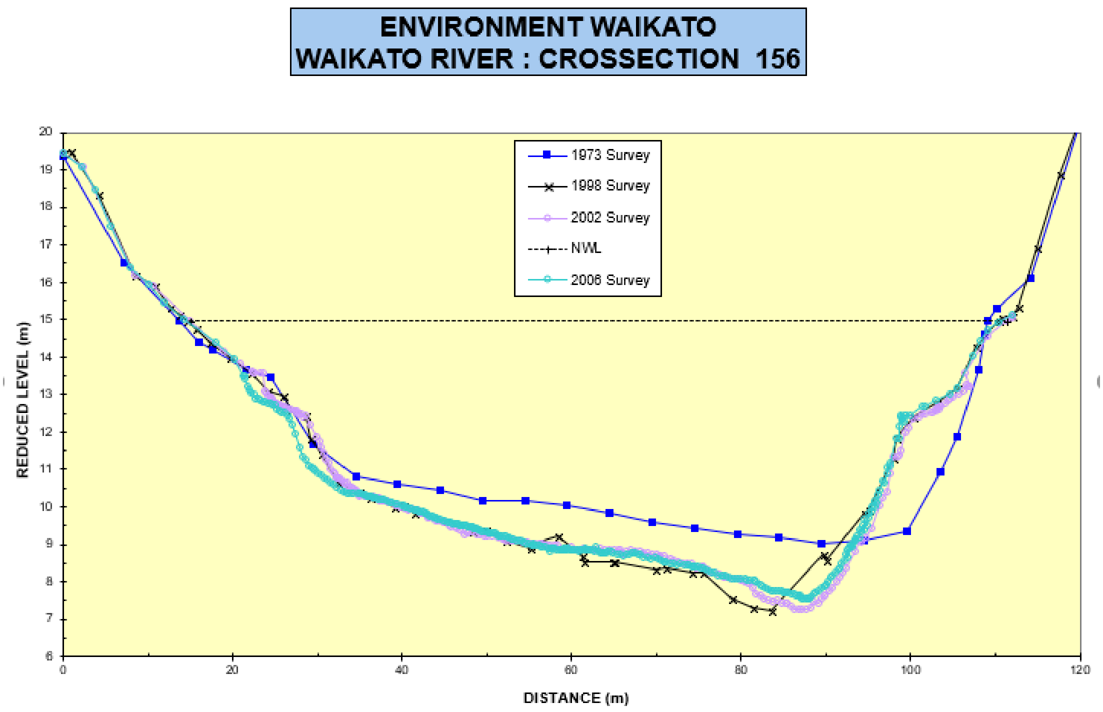
The further information request states:

Waikato River – Adoption of 1m Freeboard Allowance for Climate Change

Please confirm the basis for the 1m freeboard adopted to assume a climate change.

Response:

As discussed in Section 3 of the Waikato River Adare Flood Hazard Report prepared by Awa Ltd and appended to the Application as Appendix R, an allowance of 1m was recommended as an allowance for the effects of climate change on flows in the Waikato River. The river has a top water width of 120m at a typical cross section (i.e. at the wastewater pump station 4 site at the 1% AEP flood level (see cross section below):



The cross-sectional area of the extent of the flow, at cross section 156 at the measured flow has been calculated by Waikato Regional Council to be 450m^2. They also calculated the wetted perimeter to be 100m and the hydraulic radius to be 4.49. An assessment of the slope of the water surface from the cross sections confirms a slope of 1 in 4850. An assessment of the largest flow recorded since 1975, which was 800m^3/s, with a TWL of RL 16.75 at the Victoria Street Bridge in Hamilton indicates a manning's "n" value of 0.05 in a flood event, which seems reasonable for this scale of river and the bank characteristics. Applying this value and a slope of 1:4,700 for a peak flow, with a cross sectional area of 923m^2 at a TWL of RL19.5, we estimate the 1% AEP flow to be 1,100m^3/s at the site. The additional allowance of 1m for climate change and freeboard would result in a peak flow of approximately 1,240m3/s, which is a 13% increase on the "no climate change" model results.

The actual peak flows in the Waikato River are highly influenced by the upstream hydro dams. The river is not a natural flow in extreme storm events and the dams buffer the peak flows through the river. As indicated above, the highest recorded flow in the last 43 years has been 800m^3/s vs a capacity below the adopted maximum water levels of 1,240m^3/s. The maximum capacity is 55% higher than the highest recorded flow since 1975. The fact that the maximum recorded flow is so far below the capacity is a clear indication of the buffering effect of the upstream hydro dams and gives some comfort that the design maximum water levels are conservatively high.

Therefore, in assessing the appropriateness of the 1m allowance for climate change, we consider an allowance for an additional 13% flow in the Waikato River, which is highly controlled by the hydro dams, is reasonable.

Having applied this allowance, bringing the design flood level to RL19.5 (including allowance for freeboard) in the northern area of the development, the site earthworks have been designed with a minimum level on the road (and lowest private section) of RL20.34 on Road 2 at chainage 838. This is 0.84m higher, thus providing some additional freeboard allowance.

2.21 ITEM 18

The further information request states:

> ***Karapiro Dam Break***
>
> *Please provide a risk assessment of the dam break scenario on the proposed development.*

Response:

As discussed in Section 4 of the Waikato River Adare Flood Hazard Report prepared by Awa Ltd and appended to the Application as Appendix R, a dam break analysis has been assessed by the dam operators and is a regional hazard management issue. We cannot carry out a detailed assessment of the risk and nor is it appropriate for us to do so. The site, like all sites downstream of the dam, has a risk, albeit extremely low, of flood damage in a dam break scenario.

In practice, in the event of an imminent dam burst, it is expected that the regional emergency procedures will be implemented. These are expected to include warnings to residents to seek higher ground, similar to emergency provisions for tsunami provisions in our coastal regions.

As described in the Awa Report, the maximum water level predicted at the site in a dam burst scenario is RL 26.3m. It can be seen from drawing 14842-1211 (attached to the Application) that there are approximately 70 properties in the northern area of Road 2 and Road 7 (from the large park to the northern corner of the site) that are below this level. These are sites 41-82, 136-144 & 299 – 319 shown on drawing 14182-9051, attached to the Application.

2.22 ITEM 19

The further information request states:

> ***Effects of Infilling***
>
> *Please provide an assessment of the infilling of the Waikato River flood plain area.*

Response:

The existing ground levels on the northern area of the site are shown by drawing 141842-1021 of the Application. The area of the site within the earthworks footprint, below RL19.5 is approximately 8,780m^2. The lower parts of the site within the zone below RL19.5m, that is to be filled, is at a level of typically RL19, with a couple of very small pockets at RL18.5. The actual volume to be infilled is therefore approximately 4,500m^3.

In terms of affected cross section, the most affected existing cross section area would lose a triangle of flood path 45m wide (at its widest point) by a maximum depth of 0.5m, being an area of 11m^2. As discussed in item 17 above, the cross-sectional area at the 1% AEP flow is approximately 920m^2. The loss of 11m^2 of shallow cross-sectional area, in an outer part of the flow area where there would be an existing high roughness coefficient due to the presence of fences and grass, is considered to have a negligible effect on river water levels. The volume lost, using a manning's "n" of 0.06, is estimated to be approximately 6m^3/s. This is less than 0.5% of the total flood flow in a 1% AEP event. This also equates to a theoretical potential increase in water level (at this worst point) of less than 3mm, taking into account that the infilled area is on the inside curve of the river and the higher velocity will be on the outer bend. In practice, any increase in water depth through this "in-filled" zone would be less than this due to the extremely flat grade on the river (approximately 1 in 4,700) and the greater influences on water surface at full flood flow from existing features on the river such as the bridges.

The loss of approximately 4,500m^3 of flood ponding volume is considered to have a negligible effect on river water levels at peak flood as it only represents 4 seconds of river flow. Therefore, this area is a minor spill area of the river in an extreme event with little flow capacity and negligible storage capacity.

We therefore confirm that the small area of infilling will not result in any measurable effect on river water levels in an extreme flood event.

2.23 ITEM 20

The further information request states:

> ***Stormwater Outfalls***
>
> *Outfalls from the piped stormwater network represent a significant component of the system, yet have not been addressed in sufficient detail to demonstrate their potential impacts on the receiving environment (streams and Waikato River), including the options considered to avoid those impacts. Outfalls that discharge to steep slopes with no pre-existing watercourse structure represent an erosion risk and multiple outfalls in remote locations at the bottoms of banks are difficult to access for monitoring and maintenance.*
>
> *Please provide an assessment of the option of consolidation and adjustment of outfalls to discharge to streams within existing catchment flow path patterns. For example, the large number of outfalls proposed from the island and Watercourse 3 should be reconsidered.*
>
> a. *Outfalls 29/1, 6/1, and 5/1 could discharge to a consolidated outfall to existing watercourses (Watercourse 4 and 5). What is the likely impact to hydrographs from the discharge of stormwater to the receiving streams?*
> b. *Outfalls 16/1 and 17/1 could be discharged to the paleo-channel structure draining to culvert 1.*
> c. *Outfalls 1/1 and 3/1 could be combined to discharge to the invert of the channel at the outlet of culvert 1.*
> d. *Outfall 12/1 could discharge to the bottom of bank.*

Response:

Refer to Appendix 2 for technical memorandum addressing items 20 a) to 20 d).

2.24 ITEM 21

The further information request states:

Stormwater Outfalls

The alternative of "Aquasock" geotextile socks are not supported as a permanent solution in these Waikato riverbank locations for on-going maintenance reasons. Please confirm alternative erosion mitigation at outfalls along the Waikato River and tributary streams such as soft engineering and planting plans.

Response:

Specific survey information for the outfall locations was not available during the original documentation of the stormwater network (survey data was unobtainable because of the existing trees and vegetation). Stormwater outfall locations were therefore initially selected based on site visit observations made from behind the existing fence line along the top of the river bank, and by studying aerial photographs and existing contours and stream positions.

Since the resource consent application has been lodged we have reviewed/obtained additional information for all 16 stormwater outlet locations and the 2 subsoil outlet locations, and have prepared a supporting technical memorandum relating to the new findings (refer to Appendix 2).

The review established that, whilst there is a tree canopy along the majority of the river bank, which extends just beyond the fence line, the existing vegetation is not that dense for the majority of the area. As such, after completing the more comprehensive review of the stormwater outfall positions (including reviewing the GPS locations of the headwalls shown on drawings in the submitted resource consent package), it has become clear that the design can be altered to remove the need for 'Aquasocks' or similar equivalent, and revert back to traditional precast concrete headwall structures.

2.25 ITEM 22

The further information request states:

Stormwater Outfalls

Please confirm the following details regarding proposed outfalls:

a. *Design elements proposed to protect outfalls against damage and/or backflow from flood flows in the Waikato River.*
b. *Operation and maintenance considerations;*
    i. *including but not limited to access for maintenance staff and vehicles/plant*
    ii. *inspection programme*
c. *Estimated stormwater quantities for each stormwater outfall.*
d. *Presence of existing erosion downstream of outfall locations.*

Response:

Refer to Appendix 2 for technical memorandum. In summary:

Design elements proposed to protect outfalls against damage and/or backflow from flood flows in the Waikato River.

The proposed headwalls have been positioned away from the Waikato River to mimic the existing topography and blend in with the existing watercourses. Other than if an unusual storm event occurred, the height of the river is unlikely to reach the headwall locations. During detailed design stage, design checks can be completed to confirm what the R.L. of the headwalls will be and what the maximum height of the river will be to ensure there is sufficient freeboard. If not, the headwalls can be placed in alternative locations at higher ground levels.

Operation and maintenance considerations;

i. *including but not limited to access for maintenance staff and vehicles/plant*
ii. *inspection programme*

The stormwater technical memo in Appendix 2 covers how the headwalls are likely to be constructed and also touches on maintenance (which would be via Council inspectors driving up to the closest point and walking by foot down to the more isolated headwalls). The other headwalls that are not close to the vegetation or river edge should be able to be assessed directly with a maintenance ute. It is noted that 4 of the proposed 18 outlets will most likely need to be visited by foot for the final 10-30m, the rest will likely to be visible from the nearby completed road.

The inspection programme would be as per Council's requirements. With the removal of the 'Aquasock' option and moving the design intent back to traditional concrete headwalls, it is expected that the maintenance would be 6 – 12 month visual inspections with additional visits after particular large storm events. Blockages would be dealt with by water blasting from upstream manholes / scruffy domes, and also rodding brushes.

The stormwater piped network that the outfalls are connected to will cater up to the10yr level of service following soakage to ground in the 2yr event. For basin catchments, the network will be directly to the 10yr to the basin and then outfall to the receiving environment.

Estimated stormwater quantities for each stormwater outfall.

Currently a very preliminary stormwater network sizing has been completed. That sizing is for the interim period (prior to when the soakage becomes available) when the outfalls will be receiving full flows from the road kerb and channel.

Once the primary disposal to ground comes online this network will only serve as an overflow once soakage capacity is exceeded (greater than 2 year). In theory if the soakage is 2 year, the pipe network needs to cater for the balance of flow up to the 10 year. This sizing is to be confirmed at detailed design stage and has other co-ordination that is required.

The design flows for the 2 year level of service (not factoring in soakage losses) for the outfalls are provided below:

HEADWALL	INTERIM FLOW (2 YEAR NO SOAKAGE)
29/1	0.259 m^3/ S
6/1	0.451 m^3 / S
5/1	0.638 m^3 / S
16/1	0.38 m^3 / S
11/1	0.203 m^3 / S
1/1	1.752 m^3 / S
3/1	0.379 m^3 /S

HEADWALL	INTERIM FLOW (2 YEAR NO SOAKAGE)
7/1	0.609 m^3 / S
8/1	0.649 m^3 / S
9/1	0.355 m^3 / S
10/1	0.573 m^3 / S
12/1	0.712 m^3 / S
13/1	0.393 m^3 / S
14/1	0.205 m^3 / S
15/1	0.242 m^3 / S
2/1	0.464 m^3 / S

Please note that the above flow values are:

- Based on information at the time of the original submission (i.e. they reflect the pipe configuration and bio retention layout as per the information submitted at resource consent stage).
- Grades are not fixed and some preliminary high level design assumptions have been made - these will need to be refined at detailed design stage.
- Vertical clashes and crossings are to be reviewed at detailed design stage and may have an effect on grades and flows.
- Not factoring in soakage rates.

In addition to the above, Tables 1, 2 and 3 in the stormwater technical memo in Appendix 2, review the possibility of combining the flows.

Presence of existing erosion downstream of outfall locations.

Based on further post-consent lodgement site visits, we have included supplementary photos showing the surrounding environment in the detailed headwall sketches 141842 SK-321 to SK338 of the stormwater technical memo in Appendix 2. In general, existing active watercourses were encountered but, other than some historic landslips that are outlined in the ENGEO geotechnical report, there was minimal erosion encountered.

2.26 ITEM 23

The further information request states:

> ***Construction Effects***
>
> *What are the environmental impacts of constructing the stormwater outfalls?*
>
> a. *How will construction sites be established on banks of the Waikato River to construct outfalls?*
> b. *What is the proposed construction area for each outfall site? Vegetation removal required?*
> c. *Sediment entrainment pre- and post-physical works*
> d. *Re-establishment requirements, earthworks, planting, etc.*

<u>**Response:**</u>

Refer to the stormwater technical memorandum in Appendix 2. It is expected that the construction area for headwalls will be approximately 3m around the final headwall and outlet location for headwalls with good accessibility. For the less accessible headwalls - as mentioned in the stormwater technical memo in Appendix 2 - the trafficable area is to be kept to a minimum with a combination of construction by hand, wheelbarrowing materials in etc and using low impact ‘Kangas’. It is expected that for the more constrained headwalls, then 1-2m either side of the headwalls and outfalls would be sufficient space - if constructing by hand.

The vegetation removal required is expected to be minimal. Photos within the technical memorandum illustrate selected areas, and for the more remote locations low height shrubs and vegetation less than 1m high may need to be cleared. Isolated roots and possibly the occasional tree (trunks less than 150mm diameter) could be required to be removed.

2.27 ITEM 24

The further information request states:

> ***Construction Effects***
>
> *What are the environmental impacts of directional drilling of counterfort drains?*
>
> a. *What methods will be employed to prevent preferential flow of groundwater along annulus of drain pipes?*
> b. *How will drilling mud and any temporary discharges be managed during directional drilling works?*

<u>**Response:**</u>

Refer to separate response by ENGEO.

2.28 ITEM 25

The further information request states:

> ***Construction Effects***
>
> *Please assess the efficiency of the temporary erosion and sediment management during the interim period when sediment ponds have been decommissioned and while raingardens are blocked off and discharges are directly connected to the outfalls to the streams and Waikato River. Are there any additional measures such as on lot controls, monitoring or end of pipe treatments proposed to manage this temporary effect.*

<u>**Response:**</u>

As noted above, outfall design sizing is based upon the interim period situation, where full road flows go to the outfalls (prior to be soakage being utilised). Any erosion and sediment control measures at outfalls will be designed to cope with these higher flows. Additional sediment capture will be available via road catchpits (and potentially catchpit inserts).

2.29 ITEM 26

The further information request states:

> ***Construction Effects***
>
> *What considerations have been made regarding the sensitivity of receiving environment to sediment discharge from construction outfalls and directional drilling outlets? Please detail any required mitigation measures.*

Response:

Refer to stormwater technical memorandum in Appendix 2 and sketch plans. We have gone into further detail reviewing locations and directional drilling / thrusting is no longer likely to be required. With methods described under the ‘Construction’ and also ‘Erosion & Sediment Control’ sections of the memorandum, the construction of the outfalls will be as low impact as possible, minimising the chances of sediment reaching the surrounding receiving environment. This will be through using multiple smaller sized outlets with less construction footprint and hand construction methods for the sites close to the Waikato River (only 4 of the 18 outfall sites) as well as implementation of traditional erosion and sediment control measures, such as silt fences / hay bales / decanting earth bunds / cut off drains etc during construction.

2.30 ITEM 27

The further information request states:

Operation and Maintenance

Please provide greater detail on operations and maintenance protocols proposed for each stormwater device, including design life, inspection schedule, infiltration testing, cleaning/maintenance, and expected replacement schedule:

a. Private on lot re-use tanks
b. Private on lot soakage devices
c. Public road soakage
d. Public road rain gardens
e. Comment on feasibility and methods to repair/replace soakage devices; private and public

Response:

It is noted that a draft O+M plan will be submitted at the Engineering Approval stage. The plan will reference the relevant sections of the Regional Stormwater Management guideline and the RITS (Section 4.0 Stormwater May 2018) - good design based on the RITS and construction can reduce subsequent maintenance needs and costs but they cannot eliminate the need for maintenance. Asset renewal requirements will be fully documented in the O+M plan submitted to Council for acceptance.

Additional best practice guidance and latest thinking on O+M is provided under Section 17.2 of the Christchurch Waterways and Wetland Guide which will also be referred to - especially in relation to communal soakage basins. In general, for any stormwater device, maintenance tasks shall be prioritised as follows

1. Corrective maintenance
2. Preventive maintenance, and
3. Aesthetic maintenance

The on-lot reuse tanks are discussed in Items 2 and 3 and the maintenance of them would be the responsibility of the property owner.

Rain Gardens/Bio Retention

A summary of requirements for bio retention - which will be fully addressed within the O+M plan - include:

1. Access

Within the road corridor. Roads will be maintained as part of the road maintenance programme.

2. Inspection frequency

Indicative inspection frequencies are identified below for guidance. In some instances, frequency of inspections may require alteration considering a number of factors beyond the design. A full inspection is required one year after construction followed by annual full inspections.

Additional inspections are required after major storm events for blockage or damage. A rainfall event greater than the 2 year Average Recurrence Interval (ARI) can be considered as a major storm event.

3. Regular Maintenance

a. Visual appearance – particular attention to plant growth - monthly inspections of observation wells and overflow grates at manhole connections to the soakage network.
b. Trash and debris – particular attention to inlet structures – monthly.
c. Structural – check pipe work, sediment build up, settlement, erosion and scour.

4. Corrective maintenance – related to potential settlement of the growing media, erosion at inlets and outlets - need to promptly address structural repairs.

5. Long term Maintenance.

Sediment removal check for fine sediment crust above soil mix, replenish soil and mulch if required. Removal of accumulated sediment to ensure required infiltration and pollutants from runoff – monitored annually. 3 monthly checks surrounding inlet and outlets and additional checks following major storm events. Visual cues for sediment removal when surface ponding last significantly longer that one day drain time (24hrs) indicating surface clogging.

6. Bio-retention filter Medias maintenance

3 monthly visual checks on ponding areas and following storm events clear sediment from inflow points, check erosion and top up mulch/soil if necessary.

Communal Basins:

The management objective for the basins is to maintain both their infiltration and storage characteristics. A summary of requirements for communal and road reserve trench soakage - which will be addressed within the final O+M plan - include:

Maintenance of soakage systems will require regular maintenance of the filter bed. This will eventually involve partial reconstruction (i.e. replacing the top layer) or total reconstruction of the filter beds to prolong the life of the system. Mixing and relaying of the filter material is not generally acceptable. This will be achieved through the following measures:

1. Mowing of grass and pruning of vegetation: this will be carried out to maintain a tidy appearance of the basin. All cuttings will be removed from the area. However, if possible, reduce the amount of vegetative maintenance by planting appropriate species and providing sufficient space for plant growth.
2. Control of pests and weeds: minimal applications of fertilisers and pesticides will be used. Any applications will be timed to avoid any runoff effects.
3. Inspections: these will coincide with regular maintenance and will assess erosion of soil or vegetation, accumulation of litter and general basin function and appearance. Tidy up measures will be implemented as required.
4. Maintenance of infiltration rate: maintenance of the infiltration rate is likely to require some occasional tilling or discing and aeration of the soil to prevent clogging. The timing of these maintenance works will be based on monitoring of the infiltration rate, achieved during storm events where ponding occurs.
5. Sediment removal: removal of sediment may be required at some point due to the clogging of infiltration pathways or accumulation of chemical residues. The requirements

for any such sediment removal will involve skimming off the surface layer where fine-grained deposits have accumulated during stormwater inflows.

6. Machinery access: basins will be sited and designed to allow easy access for equipment required for tilling, discing and soil removal.

Overflow Chambers - Scruffy

The management objective for overflow chambers is to maintain a rapid infiltration rate. This will be achieved by maintaining the integrity of the inlet features of the chambers, namely:

1. A continuous cover over the top of the chamber to prevent litter and debris entering the chamber.
2. An underflow weir and grill inlet around the circumference of the chamber to prevent inflow of floating debris. If infiltration rates in the chambers reduce over time, as evidenced by prolonged ponding, maintenance would involve cleaning out the base of the chamber by either suction tanker or drilling rig, or re excavation of horizontal soakage trenches.

Frequency of Monitoring

Monitoring could be required as a condition of consent, and will normally be the responsibility of the consent holder.

Background measurements should be taken prior to commissioning of the soakage basin. Typically, sampling will be repeated one year after commissioning.

Thereafter, monitoring frequency will be determined by a number of factors, including but not limited to the nature of the catchment, previous monitoring results, and other available data for similar basins or catchments.

It is not possible to establish specific times when maintenance needs to be undertaken, as those times could be different for each specific basin site. The frequency of maintenance depends on the contaminant load entering the device and contaminant loads will vary depending on land use or more importantly for Amberfield high use versus lower use roads. Higher loads would necessitate more frequent maintenance.

2.31 ITEM 28

The further information request states:

> ***Wastewater***
>
> *The ICMP (Appendix N) identifies the Best Practical Option (BPO) for wastewater management for the development as being connection of gravity reticulation wastewater system to the existing Far Eastern Interceptor near Crosby Road, based on the Wastewater Disposal Report assessment (Appendix L), and states 'The Amberfield development is therefore being progressed through the planning process on the basis of the preferred Eastern Option being implemented by Weston Lea Ltd, in co-operation with Council.'*
>
> *Section 3 of the AEE report describes the proposed subdivision and development and in Section 3.7 Wastewater describes the Far Eastern Interceptor connection as the proposed method for the management of wastewater for the development, but also refers to an alternative of connection to the Western Interceptor. Again, in Section 5.8 Effects on Water Quality the assessment states 'whether the transmission network adopts the Far Eastern Interceptor or the Western Interceptor option, the system has been designed to avoid any network overflows to the river. This has been through adopting an overall adequate system capacity, with peak storage provision as necessary.' To avoid any uncertainty in assessing the effects of the proposal, please confirm that the proposed development and subdivision is being proposed and is to be assessed on the basis of the wastewater management system being connected to the Far Eastern Interceptor, in accordance with the BPO in the ICMP.*

<u>**Response:**</u>

The Application and AEE reports (including the SC-ICMP) have all been prepared on the basis that the preferred option for the wastewater connection to service the Amberfield development is a connection of the wastewater system to the existing Far Eastern Interceptor (FEI) near Crosby Road. This option is considered feasible and is consistent with HCC's wastewater solution for the Peacockes Structure Plan Area. However, in preparing the application an alternative connection to the Western Interceptor has also been considered.

Given that a final development agreement confirming the FEI option has not been agreed with the Council at this point in time, and that submitters may have particular views about the appropriateness of the FEI interceptor option, the Western Interceptor option is not being ruled out at this stage in the process. Information provided in support of the Application (including in Appendix L) assesses the Western Interceptor option on the basis that it would form an interim option only, until the Council has constructed its proposed Peacockes Structure Plan Area transfer pump station which will pump wastewater across the Waikato River to connect into the FEI. The Western Interceptor option has been modelled to confirm wet weather overflows in the Western Interceptor can be managed with wastewater storage facilities at the Amberfield site and this information is provided in support of the Application. Information showing the route of the Western Interceptor option is also shown in the Appendix L of the Application documents.

2.32 ITEMS 29-40

Refer to separate responses from ENGEO and peer review.

3.0 TRANSPORTATION

3.1 ITEM 48

The further information request states:

Road and Stormwater Design

The proposed development includes roads narrower than the desirable minimums in District Plan Table 15-7a. Please identify the departures from the typical standards so the consequences on operation and servicing can be understood. This information is required so that the implications for detailed design are resolved as part of the consent process.

Response:

Refer to the table below.

ROAD TYPE	DESCRIPTION	PROPOSED WIDTH	PROPOSED CARRIAGE-WAY WIDTH	DISTRICT PLAN ROAD TYPE	DISTRICT PLAN WIDTH	DISTRICT PLAN CARRIAGE-WAY WIDTH	COMPLIANT WIDTH	COMPLIANT CARRIAGEWAY WIDTH
B	LOCAL ROAD	20	6	LOCAL	20	6	YES	YES
C	LOCAL ROAD WITH CYCLE LANE	20	9.6	LOCAL	20	6	YES	YES
D1	LOW VOLUME LOCAL ROAD (PARKING BOTH SIDES)	16.4	5.6	LOCAL	20	6	NO	NO*
D2	LOW VOLUME LOCAL ROAD SINGLE PARK LANE	14.1	5.6	LOCAL	20	6	NO	NO*
E	LOCAL PARK EDGE ROAD	13.5	5.6	LOCAL	20	6	NO	NO*
E (MODIFIED)	LOCAL PARK EDGE ROAD MODIFIED	18m	5.6	LOCAL	20	6	NO	NO*

* Denotes where compliance is not achieved for roads serving 21 or more lots only.

3.2 ITEM 49

The further information request states:

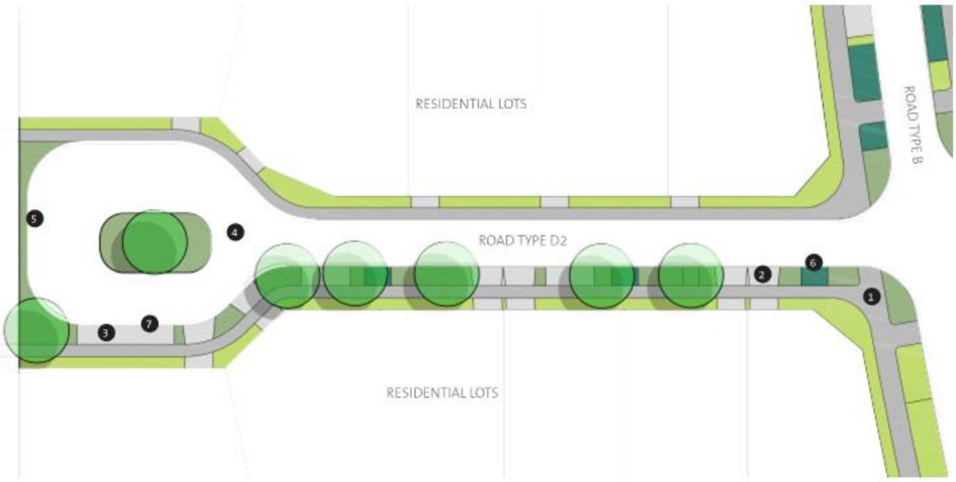
Road and Stormwater Design

The ITA states that to reduce the number of intersections along Peacockes Road and to achieve appropriate separation between intersections, some properties between the north-south local road and Peacockes Road will be served by either cul-de-sacs or accessways to rear lots. Two of the proposed cul-de-sacs will have the head of the cul-de-sac adjacent to Peacockes Road.

The Urban Design Report (Appendix D) states that connectivity between Peacockes Road and the two cul-de-sac roads will be for pedestrians (and cyclists) only, and from an urban design perspective will provide visual connections from Peacockes Road into the site. Please provide a concept design for the landscape treatment (hard and soft landscaping) and the pedestrians connection taking into account the level difference between the roads and available land area outside the carriageway and footpath to better understand the urban design outcome.

Response:

Refer to drawing A17134_210-216_Landscape_Street_Typical_Plan_Cul_de_Sac_Rev_B (contained in Appendix F of the resource consent application) regarding the landscape treatment which has been designed with footpaths either side of the cul-de-sac head, a central island and amenity planting. An extract from this drawing is provided below.



Regarding the change in height and connection between the cul-de-sac and the finished contours, the proposed contours are shown on drawing 141842-SK250. Grades are approximately 9% for the northern cul-de-sac head and 2% for the southern cul-de-sac head. The change in heights do not require any retaining, stairs or other forms of level treatment.

4.0 OPEN SPACE/RECREATION AREAS

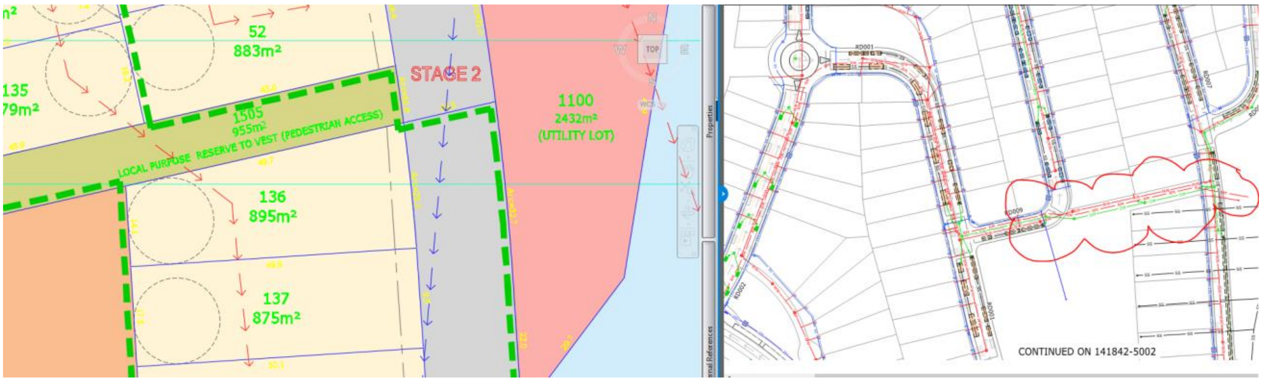
4.1 ITEM 61

The further information request states:

> ***Road and Stormwater Design***
>
> *Please advise if there are to be any services in Lot 1505 (shown as Local Purpose Reserve (Pedestrian Access)). If not, Council will require this lot to be amalgamated with lot 1506 (neighbourhood reserve) and vest as recreation reserve.*

Response:

There are wastewater and stormwater services that are proposed to be located in Lot 1505. Refer to the screen shot below taken from drawing 141842-5001 which is contained in the submitted resource consent application:



5.0 FRESH WATER ECOLOGICAL EFFECTS

5.1 ITEM 81

The further information request states:

> *Only qualitative information is provided on stream erosion status for potential stream receiving environments. An assessment of the current state of receiving environment erosion is required as set out in Table 1.2.2.6b in Appendix 1 of the HCC District Plan and would serve as baseline ICMP data. The assessment should follow HCC's Rapid Geomorphic Erosion Assessment (RGEA) methodology (HCC can provide). Please provide an assessment of erosion susceptibility for stream receiving environments on site in accordance with the methods outlined in HCC's RGEA methodology and including GIS data.*

Response:

The assessment of existing erosion and susceptibility will be carried out during the detailed design stage and submitted prior to construction. This will establish a baseline information for monitoring in the future. This will also allow the detailed design to address any existing areas of erosion, where it is feasible to do so, so that additional environmental benefits can be achieved. This issue can be managed by way of a condition of consent.

Based on a preliminary site walkover there is minimal active bank erosion occurring within the main gully watercourse (either mass wasting, slumping or hotspot) this is largely due to the limited catchment area and volume of runoff. The stream banks are steep in places and degraded most likely due to stock having access to the stream.

5.2 ITEMS 86-88

In relation to these items, information has been provided by HG to Boffa Miskell. This is included in their response to the further information request along with their assessment of related freshwater matters.

5.3 ITEM 89

The further information request states:

> *There may potentially be changes to receiving environment hydrology as a result of the development. This is also required to be addressed by HCC District Plan Appendix 1 Table 1.2.2.6b. Some brief commentary on this issue is included in the Sub-catchment ICMP but it is not clear how the development, the soakage solution and the proposed sub-surface drainage will impact on stream hydrology and therefore stream habitat availability, quality and connectivity. For example, will soakage discharges preferentially follow the subsurface drainage network proposed for some parts of the site and therefore reduce base flows in receiving environment streams (Watercourse 2). Direct discharges to Watercourse 3 may also result in elevated peak flows and have potential for stream erosion. Please provide more detail on potential effects on stream receiving environments as a result of changes to hydrology covering base flows and peak flows. Please relate peak flow assessments to the stream erosion assessment referred to in Further Information Request 81 above.*

Response:

Soakage devices are no longer proposed above the counterfort drain network – these areas will be piped to communal treatment/soakage basins. The counterfort sub surface catchment areas discharge to the Waikato River (and thereby intercept groundwater flows towards the river). They do not intercept any groundwater flows currently migrating towards the more sensitive stream network (watercourse 2+3). The post development catchment areas remain largely graded towards the central gully stream. Soakage (whether distributed or via communal basins) up to the 2yr LOS within the 'stream' catchment areas will ensure base flows are retained. 2yr soakage will also effectively remove stream erosion risk by retaining the total runoff volume and disposing to ground. Flow above the 2yr up to the 10yr will be disposed via the reticulated network (once soakage capacity if exceeded). These flows will pass to the existing stream however for these less frequent events, flows are expected to be out of bank and therefore their erosive impacts are reduced by lowering velocity and dispersing energy across the floodplain.

Please relate peak flow assessments to the stream erosion assessment referred to in Further Information Request 81 above.

6.0 LIMITATIONS

This report is for use by Weston Lea Limited, Hamilton City Council and Waikato Regional Council only, and should not be used or relied upon by any other person or entity or for any other project.

This report has been prepared for the particular project described to us and its extent is limited to the scope of work agreed between the client and Harrison Grierson Consultants Limited. No responsibility is accepted by Harrison Grierson Consultants Limited or its directors, servants, agents, staff or employees for the accuracy of information provided by third parties and/or the use of any part of this report in any other context or for any other purposes.

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APPENDICES

APPENDIX 1
PRELIMINARY ENGINEERING DRAWINGS (HARRISON GRIERSON)

DRAWING NO.	TITLE
141842-SK260	ALTERNATIVE ROAD GRADE LAYOUT PLAN
141842-SK265	ALTERNATIVE ROAD GRADING LONGITUDINAL SECTIONS 1 OF 6
141842-SK266	ALTERNATIVE ROAD GRADING LONGITUDINAL SECTIONS 2 OF 6
141842-SK267	ALTERNATIVE ROAD GRADING LONGITUDINAL SECTIONS 3 OF 6
141842-SK268	ALTERNATIVE ROAD GRADING LONGITUDINAL SECTIONS 4 OF 6
141842-SK269	ALTERNATIVE ROAD GRADING LONGITUDINAL SECTIONS 5 OF 6
141842-SK270	ALTERNATIVE ROAD GRADING LONGITUDINAL SECTIONS 6 OF 6
141842-SK281	SW BASIN LOCATION PLAN 1 OF 5
141842-SK282	SW BASIN LOCATION PLAN 2 OF 5
141842-SK283	SW BASIN LOCATION PLAN 3 OF 5
141842-SK284	SW BASIN LOCATION PLAN 4 OF 5
141842-SK285	SW BASIN LOCATION PLAN 5 OF 5
141842-SK311	TYPICAL PRIVATE SW LAYOUT
141842-SK312	PRE DEVELOPMENT CATCHMENT PLAN 1 OF 2
141842-SK313	PRE DEVELOPMENT CATCHMENT PLAN 2 OF 2
141842-SK314	POST DEVELOPMENT CATCHMENT PLAN 1 OF 2
141842-SK315	POST DEVELOPMENT CATCHMENT PLAN 2 OF 2

APPENDIX 2
STORMWATER OUTFALL MEMO

APPENDIX 3
FLOW DEPTH CALCULATIONS