WAIKATO DISTRICT PLAN REVIEW SUBMISSION

SUBMITTER KONING FAMILY TRUST and MARTIN KONING

TOPIC: Extent of residential zoning at Raglan

STATEMENT OF EVIDENCE OF CONSTANTINOS FOKIANOS

Dated: 15 February 2021

Introduction

1. My full name is Constantinos Fokianos.

2. I am a Civil Engineer employed by Bloxam, Burnett and Olliver (BBO). I currently hold the position of Water Resource Engineer Manager. I have been working for BBO since 2017.

Qualifications and Experience

3. I have the qualifications and experience described in the following paragraphs.

4. I hold a Master in Civil Engineering degree from the Democritus University of Thrace, Greece. I also had post-graduate studies on Hydraulic Engineering at the same university.

5. I have been working in the water resource engineering field since 2005. I have participated on a wide range of consulting, design, and modelling services for infrastructure and development projects. I have also provided peer reviewing services for Waikato Regional Council and Waikato District Council.

Code of Conduct

6. I have read the Environment Court's Code of Conduct for Expert Witnesses in the Environment Court of New Zealand and I agree to comply with it. My qualifications and experience as an expert are set out above. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

7. The evidence that I give in these proceedings is within my area of expertise, except when I rely on the evidence of another witness or other evidence, in which case I have explained that reliance.

Scope of evidence

8. My evidence draws from the 3 Waters Report dated November 2020 that I prepared regarding the proposed rezoning of the land owned by the Koning Family Trust and

Martin Koning at Te Hutewai Road, Raglan ("the site"). A copy of the report is lodged with this evidence.

In my evidence I address the following issues:

a) Existing and proposed wastewater infrastructure and capacity;
b) Existing and proposed water supply infrastructure and capacity;
c) Existing and proposed stormwater infrastructure and capacity.

a. Wastewater.

1. There is no wastewater infrastructure currently at the site as it is agricultural land. The closest wastewater network line to the site is the 160mm Ø HDPE rising main that is laid along Wainui Road. Raglan's Wastewater Treatment Plant (WWTP) is neighbouring the property to the north. The proposal has an indicative developable area of some 30ha.
2. The development configuration is under preliminary design; therefore, it is proposed to use the standard Regional Infrastructure Technical Specifications (RITS) method to calculate wastewater flows. This is based on 45 people per ha and 200 litres per person per day. Applying the RITS rules results in an average daily flow of 338m^3, a peak flow of 9.22l/s and a wet weather flow of 14.95l/s. The most important challenges that the proposed development will face regarding wastewater are briefly discussed below:
3. <u>Connection to existing network</u>. The most apparent point of connection is at the site access to Wainui Road at the location shown as 1 in the plan that is attached as Appendix 1. The existing 160mm Ø HDPE rising main conveys wastewater from the seaside areas of Manu Bay and Whale Bay. An initial response from Watercare indicates that the existing wastewater rising main's capacity is used/committed for the existing area served, therefore, an additional line would be needed for the rezoned land.
4. An alternative connection point could be placed immediately upstream of the screening facility inside the WWTP at the location marked 2 on the plan at Appendix 1. This could be fed by a gravity wastewater main deployed parallel with the existing stream that flows through the site and down to the WWTP. It is understood that the Council are planning an upgrade to the existing treatment plant. This connection could be included in the planned upgrade.
5. <u>Capacity of the existing WWTP</u>. The capacity of the existing WWTP to receive, treat and discharge the additional load from the proposed development needs to be confirmed. Should the additional wastewater flows from the proposal result in a breach to the peak flow discharge limit, a storage

facility could be introduced to the proposed development's wastewater infrastructure to create lag and reduce the peak flow discharges to the WWTP. The proposed development and other known future development areas should be factored into design when the upgrade option of the existing WWTP is finally decided. According to a response from Watercare, an application for a discharge consent required for the ongoing operation of the Raglan WWTP is under preparation, with the maximum possible term envisaged to be sought. Wastewater flows for that application are anticipated to cater for all theoretical Waikato 2070 growth projections.

6. Pumping facilities. Due to the ground morphology and depending on the chosen/approved connection option, the wastewater produced by some areas of the proposed development is expected to be pumped to the gravity main. The pump stations needed will be designed and constructed according to RITS.

b. Water

1. There is no water supply infrastructure currently at the site as it is agricultural land. The closest water main line to the site is the 150mm Ø AC water main that is laid east of Te Hutewai Road at the location marked 3 in Appendix 1. This water main supplies Raglan with potable water that is collected from Riki Spring located to the east of Te Hutewai Road, in the upper reaches of the Omahina Creek.
2. The spring has a maximum output capacity of 4,800 m^3/d. The current consented take of the spring is 3,100m^3/day (70% of the flow of the stream). In 2001 an additional water source (bore) was installed approximately 40 m away from the springs to supplement the spring supply and cater for increased demand over summer, but due to quality issues, the use of the bore has discontinued. The bore has a maximum output capacity of 500 m^3/day.
3. Water drawn from the spring undergoes chlorination only, before being pumped via two high lift pumps to the storage reservoir, which is a concrete reservoir with 1000m^3 capacity. From the concrete reservoir, the water is gravity fed to the distribution network and to two additional storage reservoirs in the town of Raglan.
4. Currently, there is not a detailed development plan completed. It is therefore proposed to use standard Regional Infrastructure Technical Specifications (RITS) method to calculate potable water demand. This is based on

residential land use and 45 people per ha and 260 litres per person per day. Considering 30ha of future development, that results in average daily flow of 350m^3 and a peak flow of 20.25l/s.

5. The most important challenges that the proposed development will face regarding potable water supply are briefly discussed below:
6. Connection to the existing network. The connection to Raglan's water main could be located within the proposed development, in the Koning Family owned land (Title No 406847), approximately 200m east of Te Hutewai Road at the location marked 4 in Appendix 1.
7. Capacity of the existing supply infrastructure. According to Waikato District Council's Water Supply Activity Plan (December 2014), the current average daily demand of Raglan's water supply scheme is 1,555m^3/d, while the peak daily demand is 3,197m^3/d. The maximum consented daily take is 3,100m^3/d. This means that on a daily average basis, the proposed development demand (349.9m^3/d) could be provided by the current water supply scheme, keeping the total average demand below the consented limits.
8. The peak daily demand, however, is already exceeding the maximum consented take, therefore the proposed development water supply network could not connect into the existing scheme's water main without the provision for a dedicated water supply storage. The development's individual water supply storage could regulate the demand peaks from the development without putting additional stress on the existing scheme. Watercare confirmed that while the present water treatment plant has the capacity to cater for theoretical maximum predictions of Waikato 2070, the limit on the consented daily water take is the limiting factor.
9. The design of the development's water storage will be based on a Raglan-specific demand profile that will be made based on the last year's demand records. The storage volume will be defined by the demand profile, the allowable daily period of inflow and the operation cycle length (24h or more). The storage will be sized to cater for all the cycle's balancing and fire/emergency needs.
10. A model should be built to demonstrate the intake/uptake function of the tank over a 24h, 48h or even 72h period and its effect on the daily peak of Raglan's water supply scheme. The final configuration would be decided in discussions with WDC and Watercare.
11. Residual pressure. Part of the proposed development's water supply network will have to incorporate a pressure enhancement layout (i.e. pressure booster)

to meet RITS minimum requirement of 200 kPa (20m) residual pressure for 25 l/min flow.

12. Based on initial estimates, completed using a scheme-level approach, an area of approximately 14 hectares will require additional pressure to meet RITS. This area corresponds to approximately 46% of the developable area.
13. For the rest of the proposed development, the water supply pressure will be adequate and within a range of 200-450kPa (20-45m) which meets the RITS requirements.

c. Stormwater

1. The site is currently agricultural, with a very small percentage of impervious surfaces, about 0.5%. Due to the hilly surface, the catchment is fragmented into smaller sub-catchments and a network of small streams has been formed.
2. Most of the network converges around the area where the Raglan Wastewater Treatment Plant (WWTP) is located. The converged stream eventually crosses Wainui Road through a culvert to discharge to Wainui Stream.
3. The predominant land cover is pasture. Few structures exist, most of them related to farming activity. More information on the current condition of the existing streams and their sub-catchments can be found in the Ecological Opportunities and Constraints Assessment, prepared by Ecology New Zealand for the purposes of the proposed development.
4. Stormwater was assessed based on the conceptual layout for roading, water and wastewater. The final subdivision lot layout of the site is yet to be determined and will be influenced by a number of factors. As a result, preliminary modelling for this report must rely on some "conservative scenario" assumptions regarding impervious areas and future runoff characteristics. The 3 waters impact assessment report prepared for this development includes:
   - General catchment analysis pre-development and post-development;
   - Initial estimate of stormwater attenuation volumes for certain indicative sub-catchments;
   - Discussion of criteria applied;
   - Identification of challenges regarding stormwater treatment and attenuation;
   - General drainage patterns of proposed development to address the identified challenges;

- Summaries of future stormwater modelling to be undertaken during detailed design; and
- Assessment of the ability of the proposal to adequately service the general development plan.

5. The most important challenges that the proposed development will face regarding stormwater are briefly discussed below:
6. Raglan Wastewater Treatment Plant. As discussed earlier, the majority of the site's streams converge at the area where the Raglan Wastewater Treatment Plant (WWTP) is located. Although currently there are not any documented flooding issues regarding these streams, the WWTP is reported to experience inundation during wet weather (WDC Wastewater Activity Management Plan, 2014). The cause of inundation has not been documented. Some potential causes could include stream flow inundating the plant, or high infiltration rates in the existing wastewater network resulting in pump stations working continuously and overloading the plant.
7. Further investigation into the flooding conditions (if any) downstream of the proposed development is recommended during the next stages of the design, including modelling of the existing streams down to their discharge to Wainui stream, based on LIDAR terrain modelling, supplemented with topographic survey. Tidal activity should also be included in the model to assess the existing flood risk and the effects of the proposed development. Using Waikato Regional Council's Coastal Inundation Tool, an initial estimation of tidal inundation indicates that the area of the stream confluence near the WWTP ponds B and C could be tidally influenced. Stage 2 of the Waikato District Council's District Plan Review relates to hazards, with the maps showing that land near to the WWTP is subject to a "High Risk Coastal Hazard (Inundation) Area" and a "Coastal Sensitivity Area (Inundation)" overlay.
8. Until more information is acquired regarding the existing flood risk level at the location of the WWTP, it is recommended that flood control is included in the stormwater design of the proposed development. That means that stormwater detention is required to limit the post development 100-year ARI event flow rates to 80% of the pre-development 100-year ARI event flow rates. Based on the information currently available I cannot see any technical reason why that limitation cannot be achieved.
9. Water Quality. The stormwater modelling included water quality runoff calculations based on the initial preliminary concept plan and the assumptions described previously. A total water quality treatment volume of approximately

5,650m^3 was calculated using scheme-level modelling. The total Extended Detention Volume therefore would be 6,780m^3.

10. The calculated volume along with the ground morphology make the option of concentrating the water quality treatment to a small number of large treatment devices (like treatment ponds or wetlands) more expensive as it will require a large conveyance network throughout the development. An at-source treatment approach, including small on-site treatment devices like raingardens, rain tanks, and swales would be more cost-effective. This approach would also reduce the impact of the proposed development as the release of the treated flow will be spread throughout the development. Finally, the proposed approach is consistent with the WRC guidelines for low impact development practices. Based on the information currently available I cannot see any technical reason why appropriate water quality outcomes cannot be achieved.
11. Attenuation. Flow attenuation will also need to be included in the stormwater design to match pre-development flow rates for the 2-year and the 10-year ARI events. An initial analysis has been undertaken on some of the proposed development sub-catchments to determine the volumes needed for attenuation and flood control.
12. The analysis shows that the volumes needed for attenuation and flood control can be achieved through a multi-staged, at source treatment and storage layout. Further analysis on one of the sub-catchments indicates that a 42m^3 rain tank on each typical 500m^2 lot, along with linear 1.5m^3/m storage volume rate for the road reserve (raingarden and/or swale along the road) can provide the storage needed to meet the attenuation and flood control requirements.
13. Fish Passage. Although a freshwater fauna assessment has not been undertaken at this stage, the ecological report suggests that given the various freshwater habitat types found throughout the site and the connectivity to high quality habitat environments, a list of all native species found within Wainui Stream could either inhabit or migrate through the site during certain life stages. It is therefore recommended that all stream crossings of the proposed development are designed to accommodate fish passage.
14. Stream Modelling. The proposed residential areas at the west side of the development are located close to Ahiawa Stream, one of Wainui Stream's major tributaries. Hydraulic modelling of the stream should be undertaken to delineate the design flood limits.

15. Low Impact Development practices. In addition to the proposed at-source treatment and attenuation approach, other LID practices could be incorporated into the developments design approach to minimize the quantity of runoff. These practices could include water reuse, clustering and alternative lot configuration, reduction of kerbing lengths and use of permeable hardscape surfaces where possible. Based on the information currently available I cannot see any reason why these practices could not be successfully adopted.

Summary of evidence

1. Wastewater. There are a few options for wastewater configuration, regarding the point of connection to the existing network. Some minor pumping of wastewater is expected to be required inside the development's wastewater network. The pump station(s) will be designed according to the RITS standards. The possible WWTP upgrade will be sized to cater for the wastewater of the proposed development.

2. Water. The connection of the proposed development's water supply infrastructure can take place inside Koning Family's property. Dedicated water supply storage will be needed to regulate the demand peaks from the development, without putting additional stress on the existing scheme. Additional information regarding Raglan's water supply scheme daily demand profile will be required to model the intake/uptake function of the proposed tank over a 24h, 48h period or more and its effect to the daily peak of the existing network. Part of the proposed development's water reticulation will require additional pressure to meet RITS standards.

3. Stormwater. Based on the scheme level hydrologic and hydraulic modelling, the stormwater management of the proposed development could:
    - Achieve water quality and quantity requirements within the special constraints of the site. LID practices are proposed to treat, attenuate and control stormwater at source;
    - Be in general accordance with Waikato District Council's requirements; and

- Not cause any adverse effects such as flooding, erosion, or other environmental impacts by ensuring the peak flows from the site do not exceed the existing peak flows and the downstream flood level does not exceed the existing flood levels.

4. Based on the information currently available, I do not foresee any significant technical barriers to achieving appropriate outcomes in relation to the 3 waters servicing of the Koning development site.

5. In addition to ensuring the detailed design is in compliance with the Waikato District Plan and Waikato Regional Council guidelines, it is recommended that the following actions are taken during the detailed design phase of development:

   - Detailed hydraulic modelling of Ahiawa Stream, in both its existing and proposed conditions, should be undertaken to delineate the flood limits of the stream and the available area for residential development.
   - Further investigation on the flooding conditions (if any) downstream of the proposed development is recommended during the next stages of the design, including modelling of the existing streams down to their discharge to Wainui stream. Tidal influences should also be included in the model to assess the existing flood risk and the effects of the proposed development.
   - Design of appropriate measures to positively support fish passage and habitat enhancement within the stream.

Dated: 15/02/2021

Constantinos Fokianos

Attachment 1

BBO 3 Waters Infrastructure Assessment Report for Koning Family Trust Development Plan, dated November 2020

Koning Family Trust

Koning Family Trust Development Plan

3 Waters Infrastructure Assessment Report

November 2020

BLOXAM BURNETT & OLLIVER

Document control

Project identification		
Client	Koning Family Trust	
Client representative	Martin Koning	
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Date / period ending	11 November 2020	
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Report prepared by	Constantinos Fokianos		
Checked by	Eugene Vodjansky		
Approved for issue	Jarred Stent		

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Version	**Changes**	**Signature**	**Issue date**
V1			
V2			
V3			

Table of contents

1. INTRODUCTION

This report provides a high-level assessment of water, wastewater and stormwater needs for Koning Family Trust submission to the proposed Waikato District Plan.

Koning Family Trust (KFT) seeks the rezoning (through a private Plan Change application) of approximately 92 ha of land, out of each approximately 30ha is classified as developable area, located in Raglan from the current rural and coastal zonings to residential zoning. The proposed rezoning is to enable the development of between 270 and 480 residential dwelling units[1].

It is anticipated that the landholdings will be developed in likely stages over a 20-year period. The anticipated time horizon for development is summarised as follows

- 2024 (Development Year 1) - start of construction
- 2034 (Development Year 10) – 140 to 250 dwellings
- 2044 (Development Year 20) full development – 270 to 480 dwellings

The Plan Change also seeks an amendment of the Proposed Indicative Urban Limit to include the entire site within the township's urban limit. The proposed development is planned to absorb a portion of the anticipated growth that Raglan is expected to experience during this period.

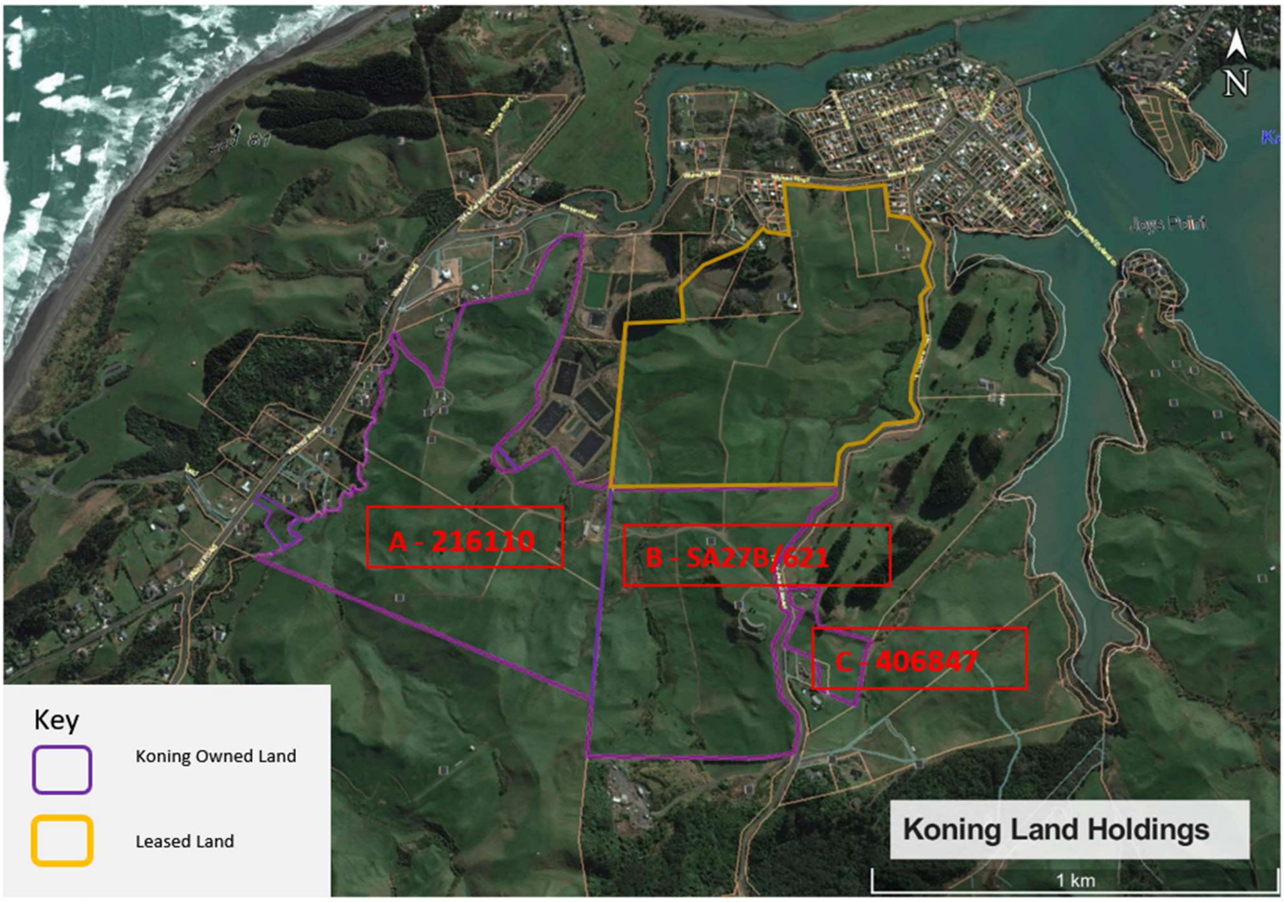


Figure 1. Koning Family Trust land holdings.

[1] Values calculated based on minimum ad average lot sizes:
- Maximum development of 480 dwellings: based on minimum lot size of 400 m^2
- Development of 270 dwellings: based on average number of lots when ranging from 400 m^2 to 1,000 m^2

2. WASTEWATER

2.1 Current situation

There is no wastewater infrastructure currently at the site as it is agricultural land. The closest wastewater network line to the site is the 160mm Ø HDPE rising main that is laid along Wainui Road. Raglan's Wastewater Treatment Plant (WWTP) is neighbouring the property at the north.

2.2 Predicted Flows

The indicative area to be developed is approximately 30ha. The development configuration is under preliminary design; therefore, it is proposed to use the standard Regional Infrastructure Technical Specifications (RITS) method to calculate wastewater flows. This is based on 45 people per ha and 200 litres per person per day.

Total flows and required storage calculations are shown in Table 1 below.

Table No: 1 Calculated flows for residential development

Standard Values Used

Standard Values Used		
Avarage Daily Flow	200.00	l/p/d
Infiltration Allowance	2,250.00	l/h/d
Surface Water Ingress Allowance	16,500.00	l/h/d
Residential Population Desnity	45.00	p/ha

Wastewater Flow Calculations

Catchment	Area (ha)	Zone	Eq. Pop. (persons)	Waste Water (l/d)	P/A Ratio	Infiltration (l/d)	SWI (l/d)	ADF (m^3/d)	PDF (l/s)	PWWF (l/s)
Proposed Development Area	30	Res.	1,350.00	270,000.00	2.7	67,500.00	495,000.00	338	9.22	14.95

2.3 Identified Challenges – Proposed Options

The most important challenges that the proposed development will face regarding wastewater are briefly discussed below:

- Connection to existing network. The most apparent point of connection is at the site access to Wainui Road. The existing 160mm Ø HDPE rising main conveys wastewater from the seaside areas of Manu Bay and Whale Bay. An initial response from Watercare indicates that the existing wastewater rising main's capacity is used/committed for the existing area served, therefore, an additional line would be needed for the rezoned land.

  An alternative connection point could be placed right upstream of the screening facility inside the WWTP, should a gravity wastewater main be deployed along the existing stream that flows through the site and down to the existing WWTP. It is understood that an option of upgrading of the existing treatment plant is currently under assessment. This connection could be included in the planned upgrade.

- Capacity of the existing WWTP. The capacity of the existing WWTP to receive, treat and discharge the additional load from the proposed development needs to be confirmed. In case that the additional wastewater flow results in peak flow discharge limit breach, a storage facility could be introduced to the proposed development's wastewater infrastructure to create lag and reduce the peak flow discharges to the WWTP. The proposed development should be considered if the upgrade option of the existing Wastewater Treatment Plant (WWTP) is finally decided. According to Watercare initial response, The Raglan WWTP discharge consent application for a long term consent (max duration is envisaged) is under preparation, where wastewater flows have been calculated to cater for all theoretical Waikato 2070 growth projections.

- Pumping facilities. Due to the ground morphology and depending on the chosen/approved connection option, the wastewater produced by some areas of the proposed development is expected to be pumped to the gravity main. The pump stations needed will be designed and constructed according to RITS.

According to Waikato District Council Wastewater Activity Management Plan (2014), Raglan's wastewater scheme has been modelled. The proposed options stated above could be assessed by being introduced into the existing model.

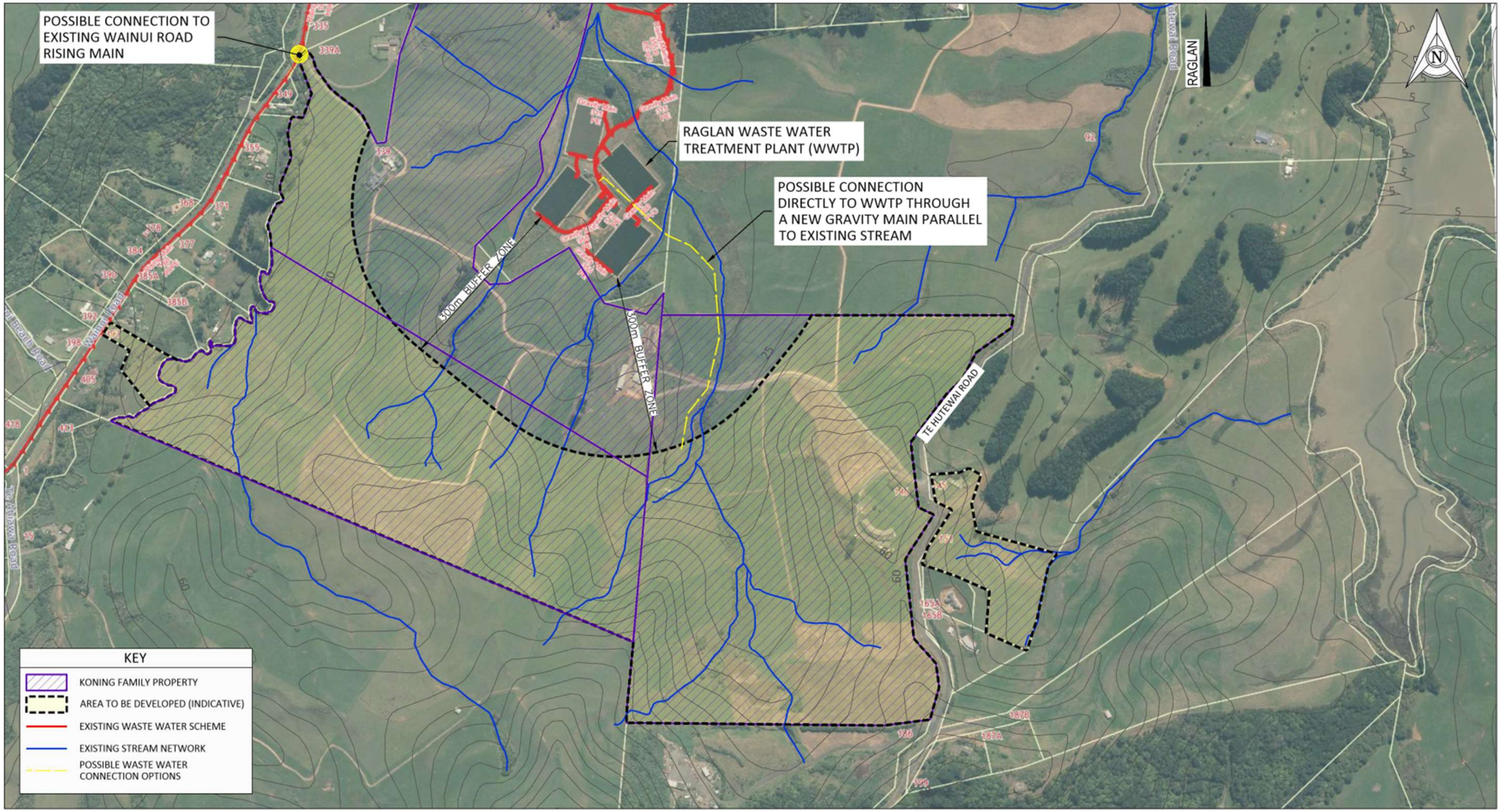


Figure 2. Diagram of Wastewater Layout.

3. WATER

3.1 Current situation

There is no water supply infrastructure currently at the site as it is agricultural land. The closest water main line to the site is the 150mm Ø AC water main that is laid east of Te Hutewai Road. This water main supplies raglan with potable water that is collected from Riki Spring located to the east of Te Hutewai Road, in the upper reaches of the Omahina Creek.

The spring has a maximum output capacity of 4,800 m^3/d. The current consented take of the spring is 3,100m^3/day (70% of the flow of the stream). In 2001 an additional water source (bore) was installed approximately 40 m away from the springs to supplement the spring supply and cater for increased demand over summer, but due to quality issues, the use of the bore has discontinued. The bore has a maximum output capacity of 500 m^3/day.

Water drawn from the spring undergoes chlorination only, before being pumped via two high lift pumps to the storage reservoir, which is a concrete reservoir with 1000m^3 capacity. From the concrete reservoir, the water is gravity fed to the distribution network and to two additional storage reservoirs in the town of Raglan.

3.2 Predicted Flows

Currently, there is not a detailed development plan completed. It is therefore proposed to use standard Regional Infrastructure Technical Specifications (RITS) method to calculate potable water demand. This is based on residential land use and 45 people per ha and 260 litres per person per day.

The Council standard for supply is:

Proposed Development Area	:	30 ha
Pressure	:	The residual pressure and flow at point of supply to residential lots shall be a minimum of 200 kPa (20m) and 25 l/min.
Firefighting supply	:	FW 2 as defined in SNZ PAS 4509 (25 l/s)
Potable consumption	:	11,700 litres per hectare per day (based on 260 l/p/d and 45 people per hectare from the RITS)
Average flow (per ha)	:	0.135 l/s
Peaking factor	:	5 (from RITS)
Peak flow (per ha)	:	0.675 l/s
Average Daily flow	:	349.9 m^3/d

3.3 Identified Challenges – Proposed Options

The most important challenges that the proposed development will face regarding potable water supply are briefly discussed below:

- Connection to the existing network. The connection to Raglan's water main could take place inside the Koning Family owned land (Title No 406847), approximately 200m east of Te Hutewai Road.

- Capacity of the existing supply infrastructure. According to Waikato District Council's Water Supply Activity Plan (December 2014), the current average daily demand of Raglan's water supply scheme is 1,555m^3/d, while the peak daily demand is 3,197m^3/d. The consented daily take is 3,100m^3/d. This means that on a daily average basis, the proposed development demand (349.9m^3) could be provided by the current water supply scheme, keeping the total average demand below the consented limits.

Table No: 2 Water Production and consumption (abstracted from WDC Water Supply Activity Plan)

Scheme	Water Production (Maximum Treatment Plant Capacity) m3/day	Maximum Consent (m³/day)	Annual Consumption (m3/year) (From Annual Report 2013/14)	Real Losses (CARL), Thomas Consultants Water Balance Report	Non Revenue Water (Financial Indicator %)	Total No. of Connections	Average Daily Demand (m³/day)	Peak Daily Demand (m³/day)
Hopuhopu/Taupiri	750	700	126,021	0.3m³/km/d	3.6	265	418	578
Huntly	8,000	6,000	1,179,472	207 l/conn/d	20.7	2,896 approx (473 metered connections)	3,235	4,426
Ngaruawahia	3,360	3,800	983,892	261 l/conn/d	25.4	2,513 approx (481 metered connections)	2,698	4,016
Mid Waikato	3,080	22,900 (4,000) As per agreement with TKIA)		7.4 m³/km/d	37.6	1,011		
Raglan	3,300	3,100 (Riki spring)	577,280	439 l/conn/d	40.3	1,650 (89 metered	1,555	3,197

The peak daily demand, however, is already exceeding the consented take, therefore the proposed development water supply network could not connect into the existing scheme's water main without the provision for a dedicated water supply storage. The development's individual water supply storage could regulate the demand peaks from the development without putting additional stress on the existing scheme. Watercare confirmed that while the present water treatment plant has the capacity to cater for theoretical maximum predictions of Waikato 2070, the abstraction capacity of the spring is the limiting factor.

The design of the development's water storage will be based on a Raglan-specific demand profile that will be made based on the last years demand records. The storage volume will be defined by the demand profile, the allowable daily period of inflow and the operation cycle length (24h or more). The storage will be sized to cater for all the cycle's balancing and fire/emergency needs. An indicative calculation of operating and equalizing storage based on typical 24h demand profiles for three different supply scenarios is presented in **Appendix A**.

A model will be built to demonstrate the intake/uptake function of the tank over a 24h, 48h or even 72h period and its effect to the daily peak of Raglan's water supply scheme. The final configuration would be decided in discussions with WDC and Watercare.

- Residual pressure. Part of the proposed development's water supply network will have to incorporate a pressure enhancement layout (i.e. pressure booster) to meet RITS minimum requirement of 200 kPa (20m) residual pressure for 25 l/min flow.

  Based on initial estimates, completed using a scheme-level approach, an area of approximately 14 hectares will require additional pressure to meet RITS. This area corresponds to approximately 46% of the developable area.

  For the rest of the proposed development, the water supply pressure will be adequate and within a range of 200-450kPa (20-45m) which meets the RITS requirements.

Figure 3 below shows the diagram of the proposed water supply layout.

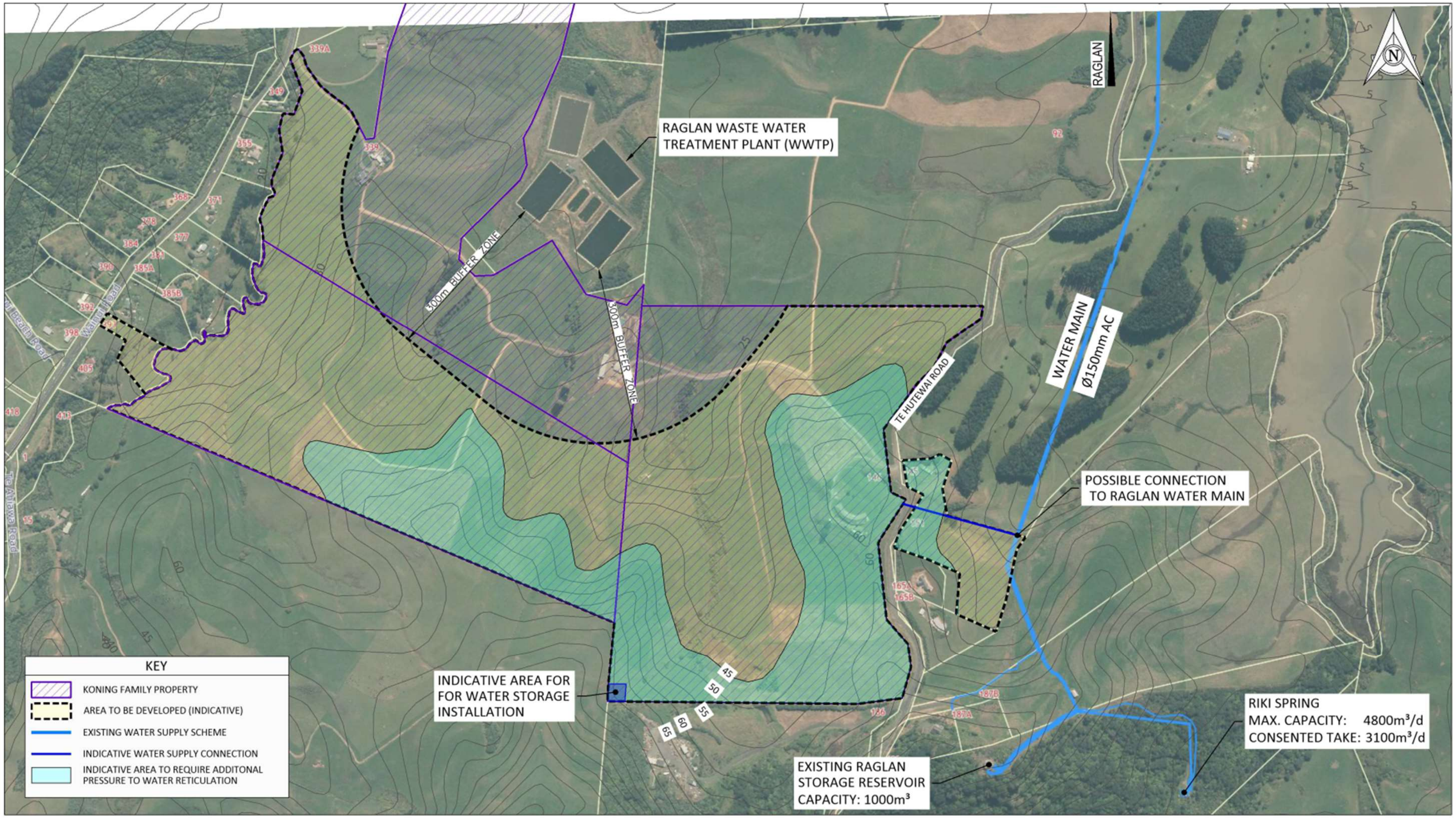


Figure 3. Diagram of Water Supply Layout.

4. STORMWATER

4.1 Current Situation

The site is currently agricultural, with a very small percentage of imperviousness, about 0.5%. Due to the hilly surface, the catchment is fragmented into smaller sub-catchments and a network of small streams has been formed.

Most of the network converges around the area where the Raglan Wastewater Treatment Plant (WWTP) is located. The converged stream eventually crosses Wainui Road through a culvert to discharge to Wainui Stream.

The predominant land cover is pasture. Few constructions exist, most of them related to farming activity. More information on the current condition of the existing streams and their sub-catchments can be found in the Ecological Opportunities and Constrains Assessment, prepared by Ecology New Zealand for the purposes of the proposed development.

4.2 Scope of this Assessment

Stormwater was assessed based on the conceptual layout for roading, water and wastewater. The final subdivision lot layout of the site is yet to be determined and will be influenced by several factors, primarily land sales. As a result, preliminary modelling for this report must rely on some “conservative scenario” assumptions regarding impervious areas and future runoff characteristics.

This section of the report includes:

- General catchment analysis pre-development and post-development;
- Initial estimate of stormwater attenuation volumes for certain indicative sub-catchments;
- Discussion of criteria applied;
- Identification of challenges regarding stormwater treatment and attenuation;
- General drainage patterns of proposed development to address the identified challenges;
- Summaries of future stormwater modelling to be undertaken during detailed design; and
- Assessment of the ability of the proposal to adequately service the general development plan.

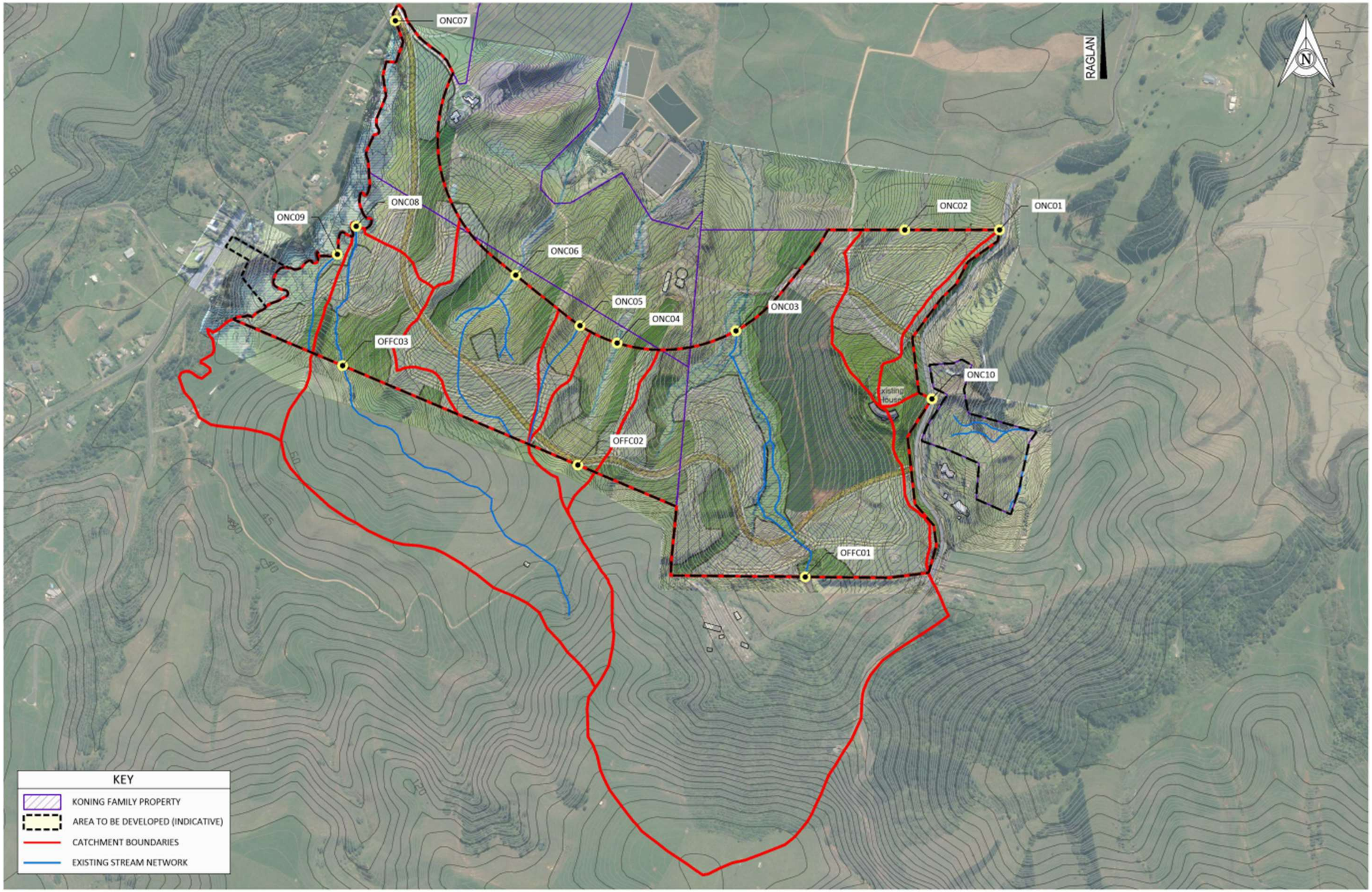


Figure 4. General Catchment Layout.

4.3 Existing Catchment Model (Pre-Development Conditions)

Stormwater hydrology and hydraulics were modelled using EPA SWMM-5 (SWMM). SWMM develops sub-catchment runoff flows, based on imported rainfall patterns (synthetic design storms or continuous rainfall data), soil infiltration characteristics, and soil cover complexes. SWMM was used to route the stormwater flows, using the Dynamic Wave Method (application of the full Saint-Venant Equations).

Appendix B details the extent of the existing sub-catchments. The total area of the catchment is 58.24ha. Sub-catchment characteristics are based on a mixture of drone LiDAR and LINZ information, aerial imaging, and soil information data available through Land Research New Zealand. Where needed, the upstream off-site catchments were also introduced into the model. Their discharges were then routed though the onsite catchments. The stream routing characteristics (length, slope, cross-section) were derived from the drone – Lidar information. Each catchment and it's off-site (where applicable) routed flow were then discharged to a common outfall. **Appendix B** provides details of the sub-catchment characteristics incorporated into the modelling.

The following assumptions have been made regarding the existing catchment for high level modelling purposes:

- 100% perviousness across all existing (undeveloped) sub-catchments;
- 5mm of depression storage available across each sub-catchment; and
- Manning's roughness coefficient of 0.015 for impervious areas.
- Soil textures from the site were derived from NZ Landcare Soils mapping. The predominant soil textures were loam and loam over clay, falling within hydrologic soil group C. Maximum infiltration rate was set to 25mm/h while the minimum rate was set to 6mm/h. The infiltration method applied was the Horton's Infiltration Equation with a decay rate constant of 4.0.

24-hour duration storms have been modelled, using rainfall intensities from High Intensity Rainfall System (HIRDS). The 24-hour design storms modelled were 2-year, 10-year, and 100-year ARI storm events.

A second scenario was run for the existing condition with the storm events adjusted to account for a 2.1^{o}C temperature increase due to climate change. This scenario was run to define the portion the runoff increase due to climate change.

The existing catchment modelling results are presented in **Appendix B**.

4.4 Proposed Catchment (Post-Development Conditions)

The proposed subdivision layout of the site is yet to be detailed. For high level modelling purposes, the following assumptions have been made, based on the Overview Preliminary Concept Plan provided by KFT:

- Since the current design of the roads does not contain elevation information, the sub-catchment boundaries are the same as the pre-development condition, following the existing ground morphology.
- Residential imperviousness was considered as 70% for general residential areas;
- Road reserve imperviousness was considered as 68%;
- Open space imperviousness was considered as 5%;
- 2mm of depression storage available for the impervious part of the sub-catchments;
- Manning's roughness coefficients of 0.015 for impervious areas and 0.15 for pervious areas; and
- 100% of runoff is to be routed for treatment and attenuation, assuming that no stormwater being reused on site.

Appendix C provides details of the post-development sub-catchment characteristics incorporated into the modelling.

From a stormwater perspective, the proposed development is considered to be a relatively balanced proposal, consisting of nearly 48% non-residential uses (gulley reserve, open space, planting and farming reserve). The total catchment perviousness exceeds 60%. Figures 5, 6 and Table 3 below present more information regarding the pervious and impervious areas of the proposed development.

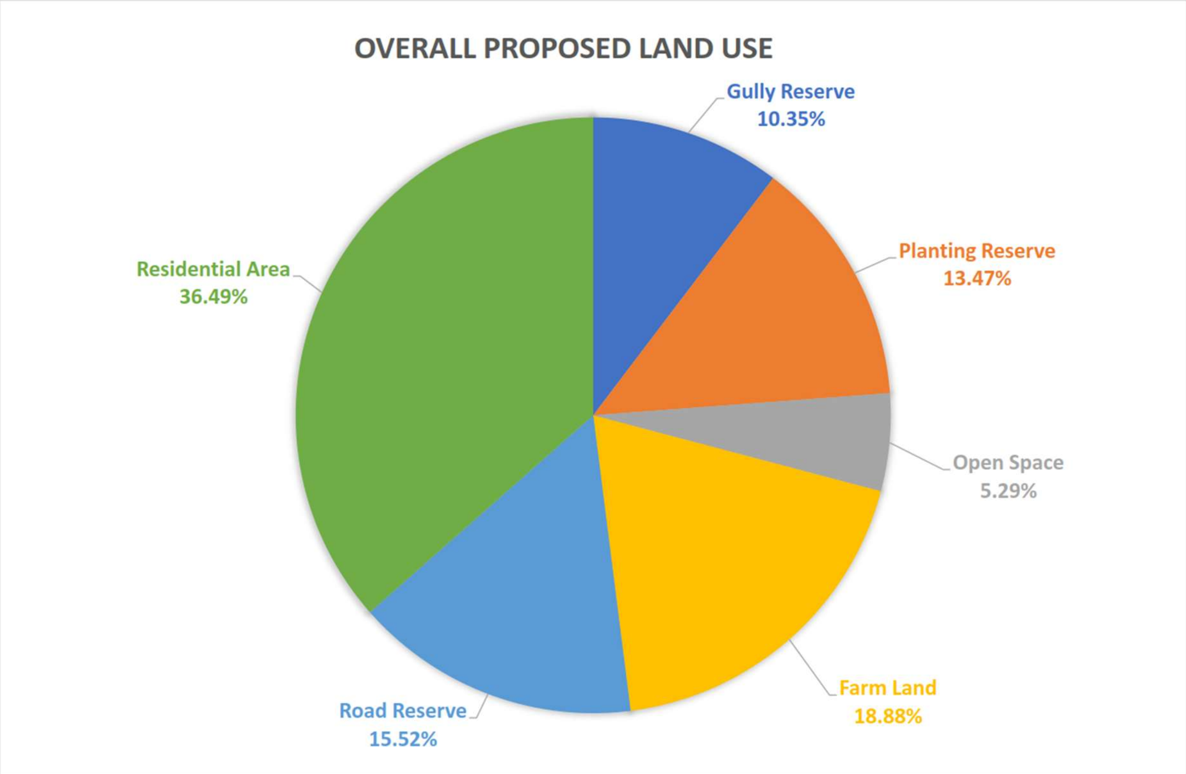


Figure 5. Overall land use graph.

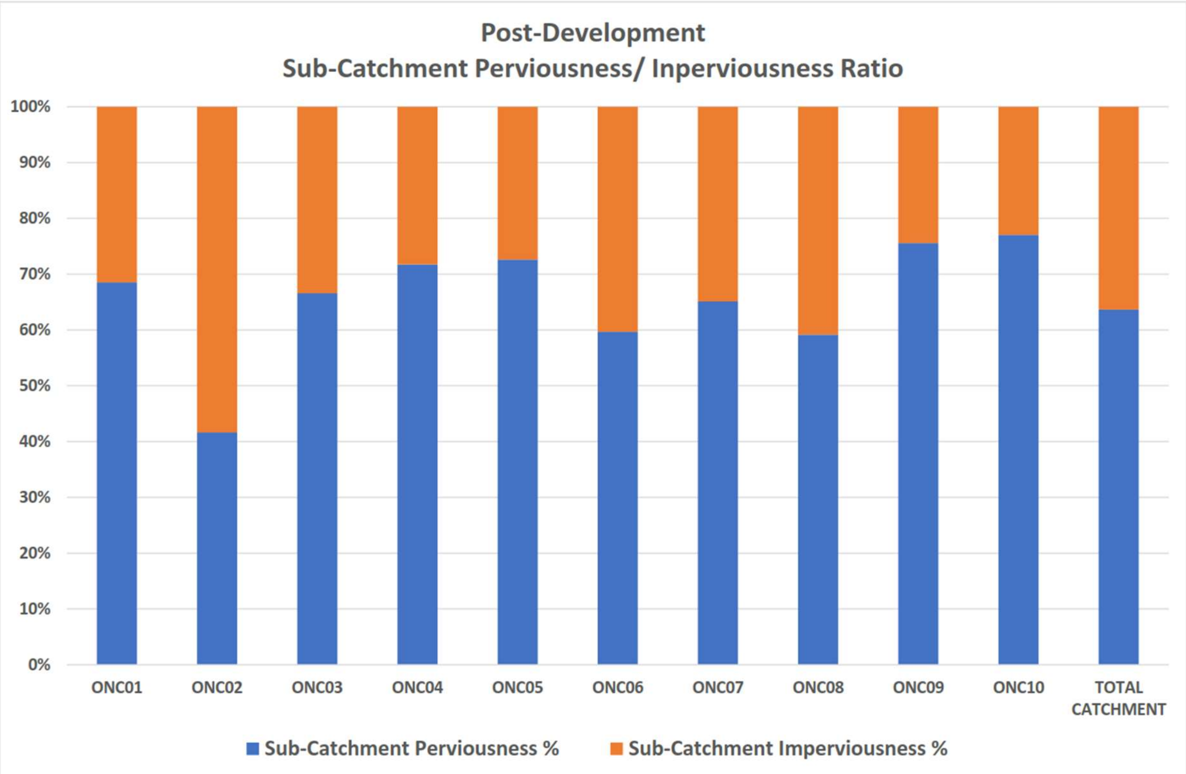


Figure 6. Perviousness ratio on each individual sub-catchment.

Table No: 3 Catchment perviousness analysis

Sub-Catchment	Total Area		Gully Reserve		Planting Reserve		Open Space		Farm Land		Road Reserve		Residential Area		Sub-Catchment Perviousness	Sub-Catchment Imperviousnes
			Area	Pervious	Area	Pervious	Area	Pervious	Area	Pervious	Area	Pervious	Area	Pervious		
	m^2	ha	m^2	%	m^2	%	m^2	%	m^2	%	m^2	%	m^2	%	%	%
ONC01	11511	1.151	0	100.00%	1159	100.00%	5560	95.00%	0	100.00%	452	32.00%	4340	30.00%	68.52%	31.48%
ONC02	52066	5.207	0	100.00%	35	100.00%	8875	95.00%	0	100.00%	13655	32.00%	29501	30.00%	41.65%	58.35%
ONC03	255897	25.590	24759	100.00%	34951	100.00%	8758	95.00%	65267	100.00%	21390	32.00%	100772	30.00%	66.58%	33.42%
ONC04	36034	3.603	2772	100.00%	5348	100.00%	0	95.00%	13184	100.00%	6594	32.00%	8136	30.00%	71.75%	28.25%
ONC05	11959	1.196	0	100.00%	0	100.00%	0	95.00%	7231	100.00%	1693	32.00%	3035	30.00%	72.61%	27.39%
ONC06	74325	7.433	6864	100.00%	9256	100.00%	0	95.00%	14990	100.00%	14270	32.00%	28945	30.00%	59.68%	40.32%
ONC07	63503	6.350	12515	100.00%	10138	100.00%	0	95.00%	8682	100.00%	17674	32.00%	14494	30.00%	65.10%	34.90%
ONC08	48406	4.841	2702	100.00%	12370	100.00%	4459	95.00%	630	100.00%	11248	32.00%	16997	30.00%	59.16%	40.84%
ONC09	20253	2.025	10637	100.00%	2468	100.00%	0	95.00%	0	100.00%	3022	32.00%	4126	30.00%	75.59%	24.41%
ONC10	8440	0.844	0	100.00%	2704	100.00%	3185	95.00%	0	100.00%	374	32.00%	2177	30.00%	77.04%	22.96%
TOTAL CATCHMENT	582394	58.24	60249	100.00%	78429	100.00%	30837	95.00%	109984	100.00%	90372	32.00%	212523	30.00%	63.64%	36.36%

The proposed development stormwater model results are presented in **Appendix C**. **Appendix D** provides overall results table and comparative information for each modelled rainfall.

As expected, the proposed development is going to produce additional runoff due to the impervious areas introduced, while the climate change is also resulting in additional runoff. Based on the high-level modelling, the effect of the proposed development on the increase of the runoff is more intense during the intermediate events (2-year and 10-year).

4.5 Identified Challenges – Proposed Options

The most important challenges that the proposed development will face regarding stormwater are briefly discussed below:

- Raglan Wastewater Treatment Plant. As discussed earlier, the majority of the site's streams converge at the area where the Raglan Wastewater Treatment Plant (WWTP) is located. Although currently there are not any documented flooding issues regarding these streams, the WWTP is reported to experience inundation during wet weather (WDC Wastewater Activity Management Plan, 2014). The cause of inundation has not been documented. Some potential causes could include stream flow inundating the plant, or high infiltration rates in the existing wastewater network resulting in pump stations working continuously and overloading the plant.

  Further investigation into the flooding conditions (if any) downstream of the proposed development is recommended during the next stages of the design, including modelling of the existing streams down to their discharge to Wainui stream, based on LIDAR terrain modelling, supplemented with topographic survey. Tidal activity should also be included in the model to assess the existing flood risk and the effects of the proposed development. Using Waikato Regional Council Coastal Inundation Tool, an initial estimation of tidal inundation indicates that the area of the stream confluence near the WWTP ponds B and C could be tidally influenced. Figure 7 below shows the inundated area according to the Coastal Inundation Tool, for a 0.5m Sea Level rise projection and a 3.62m upper Storm Tide Estimation.

Figure 7. WRC Coastal Inundation Tool estimation for the Raglan WWTP area.

  Until more information is acquired regarding the existing flood risk level at the location of the WWTP, it is recommended that flood control is included in the stormwater design of the proposed development. That means that stormwater detention is required to limit the post development 100-year ARI event flow rates to 80% of the pre-development 100-year ARI event flow rates.

- Water Quality. The stormwater modelling included water quality runoff calculations based on the initial preliminary concept plan and the assumptions described previously. A total water quality treatment volume of approximately 5,650m^3 was calculated using scheme-level modelling. The total Extended Detention Volume therefore would be 6,780m^3.
  The calculated volume along with the ground morphology make the option of concentrating the water quality treatment to a small number of large treatment devices (like treatment ponds or wetlands) more expensive as it will require a large conveyance network throughout the development. An at-source treatment approach, including small on-site treatment devices like raingardens, rain tanks, and swales would be more cost-effective. This approach would also reduce the impact of the proposed development as the release of the treated flow will be spread throughout the development. Finally, the proposed approach is consistent with the WRC guidelines for low impact development practises.

- Attenuation. Flow attenuation will also need to be included in the stormwater design to match pre-development flow rates for the 2-year and the 10-year ARI events. An initial analysis has been undertaken on some of the proposed development sub-catchments to determine the volumes needed for attenuation and flood control. Sub-catchments ONC01, ONC02, ONC03 and ONC08 were modelled in SWMM to examine different sub-catchment properties. The following Table 4 presents the calculated volumes needed for each sub-catchment and design event.

Table No: 4 Stormwater Attenuation & Flood Control Modelling output

Sub-Catchment	Peak Flows (m^3/s)						Required volume (m^3)		
	2-Year ARI		10-year ARI		100-year ARI		2-year	10-year	100-year
	Pre	Post	Pre	Post	Pre	Post			
ONC01	0.01	0.006	0.034	0.031	0.1	0.08	197	288	457
ONC02	0.032	0.03	0.112	0.097	0.33	0.264	1,657	2,351	3,455
ONC03	0.378	0.371	1.294	1.209	3.804	3.04	2,989	4,869	8,341
ONC08	0.111	0.109	0.387	0.342	1.148	0.906	946	1,978	3,516

The analysis shows that the volumes needed for attenuation and flood control can be achieved through a multi-staged, at source treatment and storage layout. Further analysis on sub-catchment ONC02 indicates that a 42m^3 rain tank on each typical 500m^2 lot, along with linear 1.5m^3/m storage volume rate for the road reserve (raingarden and/or swale along the road) can provide the storage needed to meet the attenuation and flood control requirements.

- Fish Passage. Although a freshwater fauna assessment has not undertaken at this stage, the ecological report suggests that given the various freshwater habitat types found throughout the site and the connectivity to high quality habitat environments, a list of all native species found within Wainui Stream could either inhabit or migrate through the site during certain life stages. It is therefore recommended that all stream crossings of the proposed development are designed to accommodate fish passage.

- Stream Modelling. The proposed residential areas at the west side of the development are located close to Ahiawa Stream, one of Wainui Stream's major tributaries. Hydraulic modelling of the stream should be undertaken to delineate the design flood limits.

- Low Impact Development practises. In addition to the proposed at-source treatment and attenuation approach, other LID practices could be incorporated into the developments design approach to minimize the quantity of runoff. These practises could include water reuse, clustering and alternative lot configuration, reduction of kerbing lengths and use of permeable hardscape surfaces where possible.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Wastewater

There are a few options for wastewater configuration. The existing network will possibly not able to cater for the development's wastewater flows, that means a separate line needs to be installed to convey wastewater to the WWTP. Some minor pumping of wastewater is expected to be required inside the development's wastewater network. The pump station(s) will be designed according to the RITS standards. The upcoming WWTP upgrade will be sized to cater for the wastewater of the proposed development.

5.2 Water

The connection of the proposed development's water supply infrastructure could take place inside Koning Family's property.

Dedicated water supply storage will be needed to regulate the demand peaks from the development, without putting additional stress on the existing scheme. Additional information regarding Raglan's water supply scheme daily demand profile will be required to model the intake/uptake function of the proposed tank over a 24h, 48h period or more and its effect to the daily peak of the existing network.

Part of the proposed development's water reticulation will require additional pressure to meet RITS standards.

5.3 Stormwater

Based on the scheme level hydrologic and hydraulic modelling, the stormwater management of the proposed development will:

- Achieve water quality and quantity requirements within the special constraints of the site. LID practises are proposed to treat, attenuate and control stormwater at source;
- Be in general accordance with the Waikato DC requirements; and
- Not cause any adverse effects such as flooding, erosion or other environmental impacts by ensuring the peak flows from the site do not exceed the existing peak flows and the downstream flood level does not exceed the existing flood levels.

In addition to ensuring the detailed design is in compliance with the Waikato District Plan and Waikato Regional Council guidelines, it is recommended that the following actions are taken during the detailed design phase of development:

- Detailed hydraulic modelling of Ahiawa Stream, in both its existing and proposed conditions, should be undertaken to delineate the flood limits of the stream and the available area for residential development.
- Further investigation on the flooding conditions (if any) downstream of the proposed development is recommended during the next stages of the design, including modelling of the existing streams down to their discharge to Wainui stream. Tidal influences should also be included in the model to assess the existing flood risk and the effects of the proposed development.
- Design of appropriate measures to positively support fish passage and habitat enhancement within the stream.

Appendix A – Water Supply Reservoir Storage Calculations

TIME (HOURS)	INFLOW	CONSUMPTION PROFILES											
		RURAL VILLAGE			SMALL TOWN			MID-SIZE TOWN			CITY		
		CONSUMPTION	SUM	DEFICIT	CONSUMPTION	SUM	DEFICIT	CONSUMPTION	SUM	DEFICIT	CONSUMPTION	SUM	DEFICIT
0-1	-8.33%	1.00%	-7.33%	0.00%	2.00%	-6.33%	0.00%	1.50%	-6.83%	0.00%	2.60%	-5.73%	0.00%
1-2	-8.33%	0.50%	-7.83%	0.00%	1.50%	-6.83%	0.00%	1.50%	-6.83%	0.00%	2.40%	-5.93%	0.00%
2-3	-8.33%	0.50%	-7.83%	0.00%	1.00%	-7.33%	0.00%	1.50%	-6.83%	0.00%	2.20%	-6.13%	0.00%
3-4	-8.33%	0.50%	-7.83%	0.00%	0.50%	-7.83%	0.00%	1.50%	-6.83%	0.00%	2.10%	-6.23%	0.00%
4-5	-8.33%	0.50%	-7.83%	0.00%	0.50%	-7.83%	0.00%	2.00%	-6.33%	0.00%	2.20%	-6.13%	0.00%
5-6	-8.33%	6.50%	-1.83%	0.00%	1.50%	-6.83%	0.00%	3.00%	-5.33%	0.00%	4.20%	-4.13%	0.00%
6-7	-8.33%	12.00%	3.67%	3.67%	2.50%	-5.83%	0.00%	4.50%	-3.83%	0.00%	5.30%	-3.03%	0.00%
7-8	-8.33%	8.50%	0.17%	0.17%	3.00%	-5.33%	0.00%	5.50%	-2.83%	0.00%	5.70%	-2.63%	0.00%
8-9	-8.33%	3.50%	-4.83%	0.00%	3.50%	-4.83%	0.00%	6.00%	-2.33%	0.00%	5.60%	-2.73%	0.00%
9-10	0.00%	3.00%	3.00%	3.00%	4.00%	4.00%	4.00%	5.50%	5.50%	5.50%	5.40%	5.40%	5.40%
10-11	0.00%	3.00%	3.00%	3.00%	5.00%	5.00%	5.00%	6.00%	6.00%	6.00%	5.30%	5.30%	5.30%
11-12	0.00%	4.50%	4.50%	4.50%	7.00%	7.00%	7.00%	6.00%	6.00%	6.00%	5.30%	5.30%	5.30%
12-13	0.00%	10.00%	10.00%	10.00%	9.50%	9.50%	9.50%	5.50%	5.50%	5.50%	5.20%	5.20%	5.20%
13-14	0.00%	9.00%	9.00%	9.00%	10.00%	10.00%	10.00%	5.50%	5.50%	5.50%	5.10%	5.10%	5.10%
14-15	0.00%	1.50%	1.50%	1.50%	8.50%	8.50%	8.50%	5.50%	5.50%	5.50%	4.90%	4.90%	4.90%
15-16	0.00%	1.50%	1.50%	1.50%	5.00%	5.00%	5.00%	6.00%	6.00%	6.00%	4.50%	4.50%	4.50%
16-17	0.00%	2.00%	2.00%	2.00%	3.50%	3.50%	3.50%	5.50%	5.50%	5.50%	4.20%	4.20%	4.20%
17-18	0.00%	2.00%	2.00%	2.00%	3.00%	3.00%	3.00%	6.00%	6.00%	6.00%	4.70%	4.70%	4.70%
18-19	0.00%	3.00%	3.00%	3.00%	5.00%	5.00%	5.00%	5.50%	5.50%	5.50%	5.00%	5.00%	5.00%
19-20	0.00%	5.50%	5.50%	5.50%	8.00%	8.00%	8.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
20-21	0.00%	9.00%	9.00%	9.00%	6.00%	6.00%	6.00%	4.00%	4.00%	4.00%	4.20%	4.20%	4.20%
21-22	-8.33%	8.50%	0.17%	0.17%	4.00%	-4.33%	0.00%	3.00%	-5.33%	0.00%	3.30%	-5.03%	0.00%
22-23	-8.33%	3.00%	-5.33%	0.00%	3.00%	-5.33%	0.00%	2.00%	-6.33%	0.00%	2.90%	-5.43%	0.00%
23-24	-8.33%	1.00%	-7.33%	0.00%	2.50%	-5.83%	0.00%	2.00%	-6.33%	0.00%	2.70%	-5.63%	0.00%
	100.00%	100.00%			100.00%			100.00%			100.00%		
Column's minimum			-7.83%	58.00%		-7.83%	74.50%		-6.83%	66.00%		-6.23%	58.80%
Column's maximum			10.00%			10.00%			6.00%			5.40%	
|min|+max			17.83%			17.83%			12.83%			11.63%	
MINIMUM REQUIRED BALANCING STORAGE (m^3)				**203**			**261**			**231**			**206**

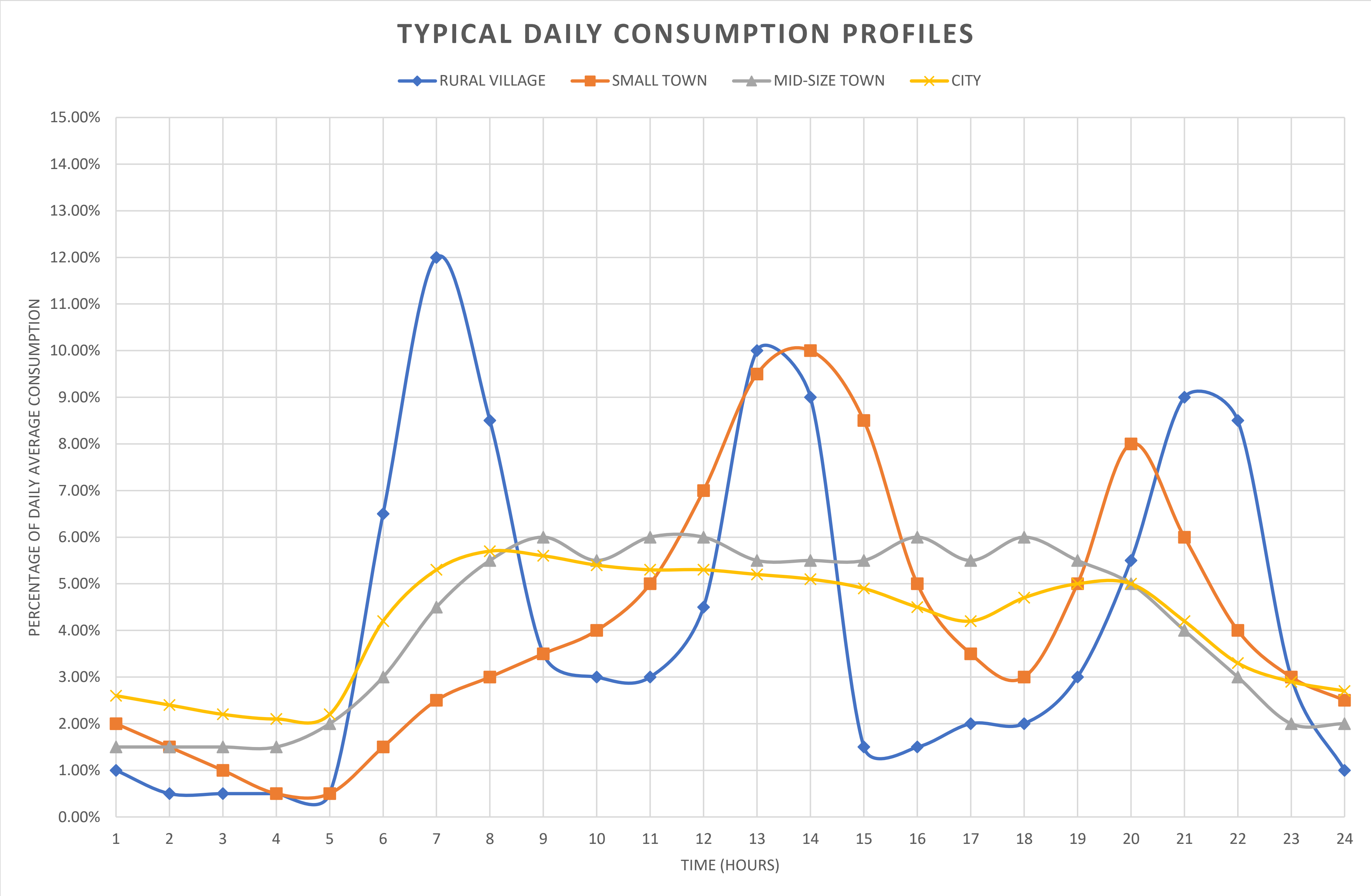
AVERAGE DAILY FLOW **349.9** m^3/d

TIME (HOURS)	INFLOW	CONSUMPTION PROFILES											
		RURAL VILLAGE			SMALL TOWN			MID-SIZE TOWN			CITY		
		CONSUMPTION	SUM	DEFICIT	CONSUMPTION	SUM	DEFICIT	CONSUMPTION	SUM	DEFICIT	CONSUMPTION	SUM	DEFICIT
0-1	-6.25%	1.00%	-5.25%	0.00%	2.00%	-4.25%	0.00%	1.50%	-4.75%	0.00%	2.60%	-3.65%	0.00%
1-2	-6.25%	0.50%	-5.75%	0.00%	1.50%	-4.75%	0.00%	1.50%	-4.75%	0.00%	2.40%	-3.85%	0.00%
2-3	-6.25%	0.50%	-5.75%	0.00%	1.00%	-5.25%	0.00%	1.50%	-4.75%	0.00%	2.20%	-4.05%	0.00%
3-4	-6.25%	0.50%	-5.75%	0.00%	0.50%	-5.75%	0.00%	1.50%	-4.75%	0.00%	2.10%	-4.15%	0.00%
4-5	-6.25%	0.50%	-5.75%	0.00%	0.50%	-5.75%	0.00%	2.00%	-4.25%	0.00%	2.20%	-4.05%	0.00%
5-6	-6.25%	6.50%	0.25%	0.25%	1.50%	-4.75%	0.00%	3.00%	-3.25%	0.00%	4.20%	-2.05%	0.00%
6-7	0.00%	12.00%	12.00%	12.00%	2.50%	2.50%	2.50%	4.50%	4.50%	4.50%	5.30%	5.30%	5.30%
7-8	0.00%	8.50%	8.50%	8.50%	3.00%	3.00%	3.00%	5.50%	5.50%	5.50%	5.70%	5.70%	5.70%
8-9	0.00%	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	6.00%	6.00%	6.00%	5.60%	5.60%	5.60%
9-10	0.00%	3.00%	3.00%	3.00%	4.00%	4.00%	4.00%	5.50%	5.50%	5.50%	5.40%	5.40%	5.40%
10-11	0.00%	3.00%	3.00%	3.00%	5.00%	5.00%	5.00%	6.00%	6.00%	6.00%	5.30%	5.30%	5.30%
11-12	0.00%	4.50%	4.50%	4.50%	7.00%	7.00%	7.00%	6.00%	6.00%	6.00%	5.30%	5.30%	5.30%
12-13	0.00%	10.00%	10.00%	10.00%	9.50%	9.50%	9.50%	5.50%	5.50%	5.50%	5.20%	5.20%	5.20%
13-14	0.00%	9.00%	9.00%	9.00%	10.00%	10.00%	10.00%	5.50%	5.50%	5.50%	5.10%	5.10%	5.10%
14-15	-6.25%	1.50%	-4.75%	0.00%	8.50%	2.25%	2.25%	5.50%	-0.75%	0.00%	4.90%	-1.35%	0.00%
15-16	-6.25%	1.50%	-4.75%	0.00%	5.00%	-1.25%	0.00%	6.00%	-0.25%	0.00%	4.50%	-1.75%	0.00%
16-17	-6.25%	2.00%	-4.25%	0.00%	3.50%	-2.75%	0.00%	5.50%	-0.75%	0.00%	4.20%	-2.05%	0.00%
17-18	-6.25%	2.00%	-4.25%	0.00%	3.00%	-3.25%	0.00%	6.00%	-0.25%	0.00%	4.70%	-1.55%	0.00%
18-19	-6.25%	3.00%	-3.25%	0.00%	5.00%	-1.25%	0.00%	5.50%	-0.75%	0.00%	5.00%	-1.25%	0.00%
19-20	-6.25%	5.50%	-0.75%	0.00%	8.00%	1.75%	1.75%	5.00%	-1.25%	0.00%	5.00%	-1.25%	0.00%
20-21	-6.25%	9.00%	2.75%	2.75%	6.00%	-0.25%	0.00%	4.00%	-2.25%	0.00%	4.20%	-2.05%	0.00%
21-22	-6.25%	8.50%	2.25%	2.25%	4.00%	-2.25%	0.00%	3.00%	-3.25%	0.00%	3.30%	-2.95%	0.00%
22-23	-6.25%	3.00%	-3.25%	0.00%	3.00%	-3.25%	0.00%	2.00%	-4.25%	0.00%	2.90%	-3.35%	0.00%
23-24	-6.25%	1.00%	-5.25%	0.00%	2.50%	-3.75%	0.00%	2.00%	-4.25%	0.00%	2.70%	-3.55%	0.00%
	100.00%	100.00%			100.00%			100.00%			100.00%		
Column's minimum			-5.75%	58.75%		-5.75%	48.50%		-4.75%	44.50%		-4.15%	42.90%
Column's maximum			12.00%			10.00%			6.00%			5.70%	
|min|+max			17.75%			15.75%			10.75%			9.85%	
MINIMUM REQUIRED BALANCING STORAGE (m^3)				**206**			**170**			**156**			**150**

AVERAGE DAILY FLOW	**349.9 m^3/d**

TIME (HOURS)	INFLOW	CONSUMPTION PROFILES											
		RURAL VILLAGE			SMALL TOWN			MID-SIZE TOWN			CITY		
		CONSUMPTION	SUM	DEFICIT	CONSUMPTION	SUM	DEFICIT	CONSUMPTION	SUM	DEFICIT	CONSUMPTION	SUM	DEFICIT
0-1	-4.17%	1.00%	-3.17%	0.00%	2.00%	-2.17%	0.00%	1.50%	-2.67%	0.00%	2.60%	-1.57%	0.00%
1-2	-4.17%	0.50%	-3.67%	0.00%	1.50%	-2.67%	0.00%	1.50%	-2.67%	0.00%	2.40%	-1.77%	0.00%
2-3	-4.17%	0.50%	-3.67%	0.00%	1.00%	-3.17%	0.00%	1.50%	-2.67%	0.00%	2.20%	-1.97%	0.00%
3-4	-4.17%	0.50%	-3.67%	0.00%	0.50%	-3.67%	0.00%	1.50%	-2.67%	0.00%	2.10%	-2.07%	0.00%
4-5	-4.17%	0.50%	-3.67%	0.00%	0.50%	-3.67%	0.00%	2.00%	-2.17%	0.00%	2.20%	-1.97%	0.00%
5-6	-4.17%	6.50%	2.33%	2.33%	1.50%	-2.67%	0.00%	3.00%	-1.17%	0.00%	4.20%	0.03%	0.03%
6-7	-4.17%	12.00%	7.83%	7.83%	2.50%	-1.67%	0.00%	4.50%	0.33%	0.33%	5.30%	1.13%	1.13%
7-8	-4.17%	8.50%	4.33%	4.33%	3.00%	-1.17%	0.00%	5.50%	1.33%	1.33%	5.70%	1.53%	1.53%
8-9	-4.17%	3.50%	-0.67%	0.00%	3.50%	-0.67%	0.00%	6.00%	1.83%	1.83%	5.60%	1.43%	1.43%
9-10	-4.17%	3.00%	-1.17%	0.00%	4.00%	-0.17%	0.00%	5.50%	1.33%	1.33%	5.40%	1.23%	1.23%
10-11	-4.17%	3.00%	-1.17%	0.00%	5.00%	0.83%	0.83%	6.00%	1.83%	1.83%	5.30%	1.13%	1.13%
11-12	-4.17%	4.50%	0.33%	0.33%	7.00%	2.83%	2.83%	6.00%	1.83%	1.83%	5.30%	1.13%	1.13%
12-13	-4.17%	10.00%	5.83%	5.83%	9.50%	5.33%	5.33%	5.50%	1.33%	1.33%	5.20%	1.03%	1.03%
13-14	-4.17%	9.00%	4.83%	4.83%	10.00%	5.83%	5.83%	5.50%	1.33%	1.33%	5.10%	0.93%	0.93%
14-15	-4.17%	1.50%	-2.67%	0.00%	8.50%	4.33%	4.33%	5.50%	1.33%	1.33%	4.90%	0.73%	0.73%
15-16	-4.17%	1.50%	-2.67%	0.00%	5.00%	0.83%	0.83%	6.00%	1.83%	1.83%	4.50%	0.33%	0.33%
16-17	-4.17%	2.00%	-2.17%	0.00%	3.50%	-0.67%	0.00%	5.50%	1.33%	1.33%	4.20%	0.03%	0.03%
17-18	-4.17%	2.00%	-2.17%	0.00%	3.00%	-1.17%	0.00%	6.00%	1.83%	1.83%	4.70%	0.53%	0.53%
18-19	-4.17%	3.00%	-1.17%	0.00%	5.00%	0.83%	0.83%	5.50%	1.33%	1.33%	5.00%	0.83%	0.83%
19-20	-4.17%	5.50%	1.33%	1.33%	8.00%	3.83%	3.83%	5.00%	0.83%	0.83%	5.00%	0.83%	0.83%
20-21	-4.17%	9.00%	4.83%	4.83%	6.00%	1.83%	1.83%	4.00%	-0.17%	0.00%	4.20%	0.03%	0.03%
21-22	-4.17%	8.50%	4.33%	4.33%	4.00%	-0.17%	0.00%	3.00%	-1.17%	0.00%	3.30%	-0.87%	0.00%
22-23	-4.17%	3.00%	-1.17%	0.00%	3.00%	-1.17%	0.00%	2.00%	-2.17%	0.00%	2.90%	-1.27%	0.00%
23-24	-4.17%	1.00%	-3.17%	0.00%	2.50%	-1.67%	0.00%	2.00%	-2.17%	0.00%	2.70%	-1.47%	0.00%
	100.00%	100.00%			100.00%			100.00%			100.00%		
Column's minimum			-3.67%	36.00%		-3.67%	26.50%		-2.67%	19.67%		-2.07%	12.93%
Column's maximum			7.83%			5.83%			1.83%			1.53%	
|min|+max			11.50%			9.50%			4.50%			3.60%	
MINIMUM REQUIRED BALANCING STORAGE (m^3)				**126**			**93**			**69**			**45**

AVERAGE DAILY FLOW **349.9** **m^3/d**



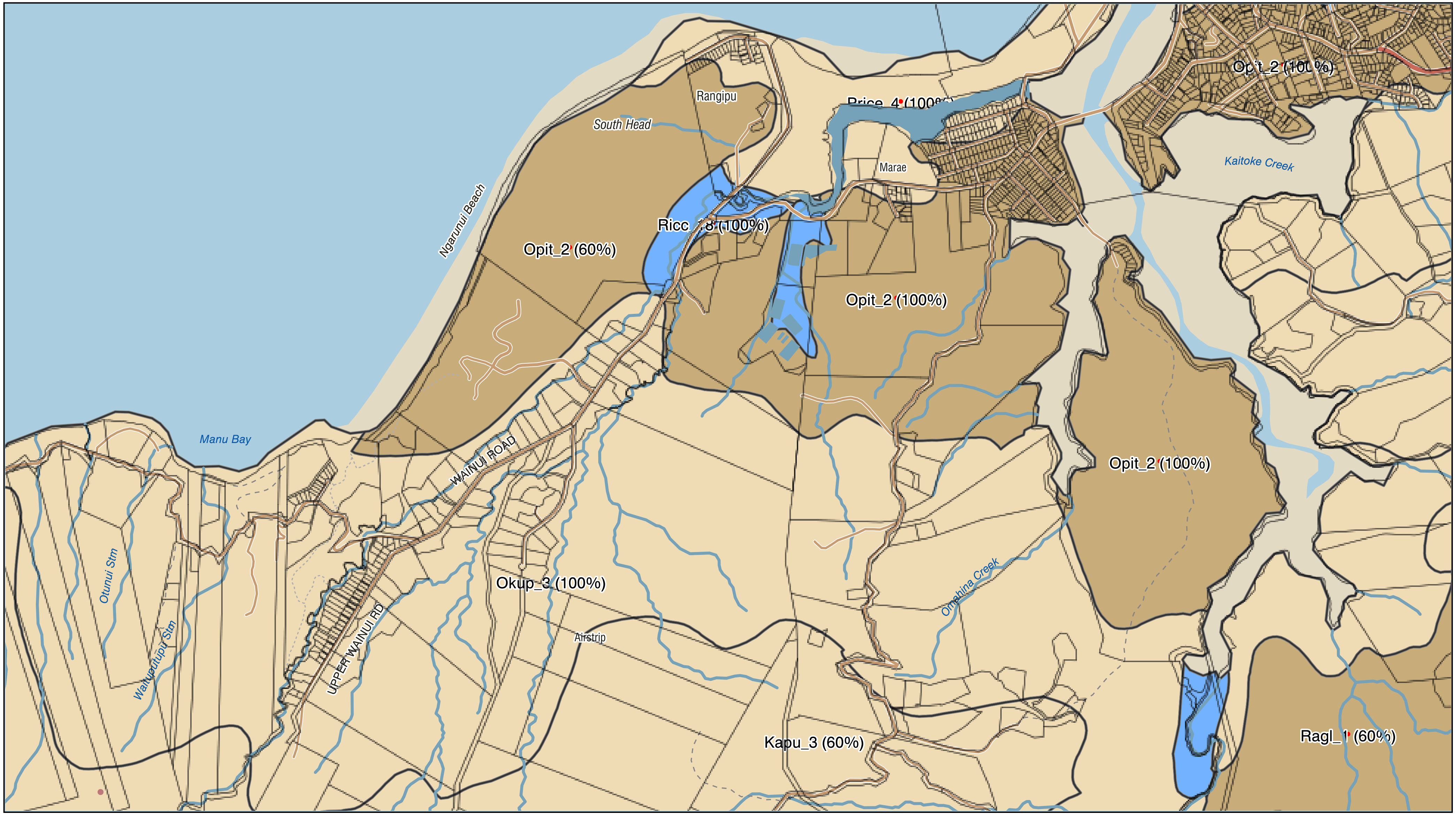
TYPICAL DAILY CONSUMPTION PROFILES
RURAL VILLAGE
SMALL TOWN
MID-SIZE TOWN
CITY
PERCENTAGE OF DAILY AVERAGE CONSUMPTION
15.00%
14.00%
13.00%
12.00%
11.00%
10.00%
9.00%
8.00%
7.00%
6.00%
5.00%
4.00%
3.00%
2.00%
1.00%
0.00%
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
TIME (HOURS)

Appendix B – Pre-Development Hydrologic & Hydraulic Data

1. Soil Information
2. HIRDS rainfall. Current Conditions
3. SWMM Catchment Diagram
4. Sub-Catchment Average Slope Calculation
5. Pre-Development Catchment Characteristics
6. SWMM Output Report
7. Model Result Tables

Appendix B

1. Soil Information



S-MAPONLINE

Manaaki Whenua
Landcare Research

Scale: 1:25,000

0 200 400 600 800m

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Landcare Research shall not be liable on any legal basis (including without limitation negligence) and expressly excludes all liability for loss or damage howsoever and whenever caused to a user of this map.

Printed: 12:27:11 PM Thu, 20 Sep 2018

Legend

Soil Drainage

- Very Poorly Drained
- Poorly Drained
- Imperfectly drained
- Moderately well drained
- Well drained

S-map Polygons & Labels

- S-map soil data

S-MAPONLINE

Manaaki Whenua
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Manaaki Whenua
Landcare Research

S-map Soil Report

Environment Waikato

Report generated: 20-Sep-2018 from https://smap.landcareresearch.co.nz

S-map maps soils at a nominal scale of 1:50,000. At this scale it is common to identify two or more soil siblings that are likely to be present at the selected location. A more detailed resolution is needed to produce map units comprising a single soil sibling. Therefore, it is recommended that users consider the characteristics of each of the identified siblings, the expected proportion of each, and select the S-map sibling that best matches their field observations of the paddock. If no local information is available then it is common practice to select the dominant S-map sibling, i.e. the first listed sibling.

This information sheet describes the typical average properties of the specified soil to a depth of 1 metre, and should not be the primary source of data when making land use decisions on individual farms and paddocks.

Opita*f*

Typic Orthic Granular Soil

Opit_2a.1 (100% of the mapunit at location (1762830, 5812538), Confidence: High)

Key physical properties

Depth class (diggability)		Deep (> 1 m)
Texture profile		Loam Over Clay
Potential rooting depth		Unlimited
Rooting barrier		No significant barrier within 1 m
Topsoil stoniness		Stoneless
Topsoil clay range		20 - 30 %
Drainage class		Moderately well drained
Aeration in root zone		Unlimited
Permeability profile		Moderate
Depth to slowly permeable horizon		No slowly permeable horizon
Permeability of slowest horizon		Moderate (4 - 72 mm/h)
Profile available water	(0 - 100cm or root barrier)	High (163 mm)
	(0 - 60cm or root barrier)	Very high (122 mm)
	(0 - 30cm or root barrier)	High (75 mm)
Dry bulk density, topsoil		1.09 g/cm³
Dry bulk density, subsoil		1.61 g/cm³
Depth to hard rock		No hard rock within 1 m
Depth to soft rock		No soft rock within 1 m
Depth to stony layer class		No significant stony layer within 1 m

Key chemical properties

Topsoil P retention	Medium (46%)

About this publication

- This information sheet describes the *typical average properties* of the specified soil to a depth of 1 metre.
- For further information on individual soils, contact Landcare Research New Zealand Ltd: www.landcareresearch.co.nz
- Advice should be sought from soil and land use experts before making decisions on individual farms and paddocks.
- The information has been derived from numerous sources. It may not be complete, correct or up to date.
- This information sheet is licensed by Landcare Research on an "as is" and "as available" basis and without any warranty of any kind, either express or implied.
- Landcare Research shall not be liable on any legal basis (including without limitation negligence) and expressly excludes all liability for loss or damage howsoever and whenever caused to a user of this factsheet.

Opita*f*

Opit_2a.1 (100% of the mapunit at location (1762830, 5812538), Confidence: High)

Additional factors to consider in choice of management practices

Vulnerability classes relate to soil properties only and do not take into account climate or management

Soil structure integrity

Structural vulnerability	Low (0.46)
Pugging vulnerability	not available yet

Water management

Water logging vulnerability	Very low
Drought vulnerability - if not irrigated	Low
Bypass flow	High
Hydrological soil group	A
Irrigability	Rolling land with good drainage/permeability and soils with high to very high PAW

Contaminant management

N leaching vulnerability	Low
P leaching vulnerability	not available yet
Bypass flow	High
Dairy effluent (FDE) risk category	C
Relative Runoff Potential	Very Low

Additional information

Soil classification	Typic Orthic Granular Soils
Family	Opita*f*
Sibling number	2
Profile texture group	Loamy
Soil profile material	Tephric soil
Rock class of stones/rocks	Not Applicable
Rock origin of fine earth	From Rhyolitic Rock
Parent material origin	Tephra

Characteristics of functional horizons in order from top to base of profile:

Functional Horizon	Thickness	Stones	Clay*	Sand*
Loamy Fine Firm, Acidic Tephric	10 - 20 cm	0 %	20 - 30 %	40 - 50 %
Loamy Fine Firm, Acidic Tephric	20 - 30 cm	0 %	25 - 30 %	40 - 50 %
Clayey Fine Firm, Acidic Tephric	45 - 70 cm	0 %	60 - 70 %	20 - 25 %

* clay and sand percent values are for the mineral fines (excludes stones). Silt = 100 - (clay + sand)

Soil information for OVERSEER

The following information can be entered in the OVERSEER® Nutrient Budget model. This information is derived from the S-map soil properties which are matched to the most appropriate OVERSEER categories. Please read the notes below for further information.

Soil description page

1. Select **Link to S-map**
2. Under S-map sibling data enter the S-map name/ref: **Opit_2a.1**

Considerations when using Smap soil properties in OVERSEER

- The soil water values are estimated using a regression model based on soil order, parent rock, soil functional horizon information (stone content, soil density class), as well as texture (field estimates of sand, silt and clay percentages). The model is based on laboratory - measured water content data held in the National Soils Database and other Manaaki Whenua datasets. Most of this data comes from soils under long-term pasture and may vary from land under arable use, irrigation, etc.

- Each value is an estimate of the water content of the whole soil within the target depth range or to the depth of the root barrier (if this occurs above the base of the target depth). Where soil layers contain stones, the soil water content has been decreased according to the stone content.

- S-map only contains information on soils to a depth of 100 cm. The soil water estimates in the > 60 cm depth category assume that the bottom functional horizon that extends to 100 cm, continues down to a depth of 150cm. Where it is known by the user that there is an impermeable layer or non-fractured bedrock between 100 and 150 cm, this depth should be entered into OVERSEER. Where there is a change in the soil profile characteristics below 100 cm, the user should be aware that the values provided on this factsheet for the > 60 cm depth category will not reflect this change. For example, the presence of gravels at 120 cm would usually result in lower soil water estimates in the > 60 cm depth category. Note though that this assumption only impacts on a cropping block, as OVERSEER uses soil data from just the top 60 cm in pastoral blocks.

- OVERSEER requires the soil water values to be non-zero integers (even though zero is a valid value below a root barrier), and the wilting point value must be less than the field capacity value which must be less than the saturation value. The S-map water content estimates supplied by the S-map web service have been rounded to integers and may be assigned minimal values to meet these OVERSEER requirements. These modifications will result in a slightly less accurate estimate of Available Water to 60 cm (labelled PAW in OVERSEER) than that provided on the first page of this factsheet, but this is not expected to lead to any significant difference in outputs from OVERSEER .

S-map Soil Report

Environment Waikato

Report generated: 20-Sep-2018 from https://smap.landcareresearch.co.nz

S-map maps soils at a nominal scale of 1:50,000. At this scale it is common to identify two or more soil siblings that are likely to be present at the selected location. A more detailed resolution is needed to produce map units comprising a single soil sibling. Therefore, it is recommended that users consider the characteristics of each of the identified siblings, the expected proportion of each, and select the S-map sibling that best matches their field observations of the paddock. If no local information is available then it is common practice to select the dominant S-map sibling, i.e. the first listed sibling.

This information sheet describes the typical average properties of the specified soil to a depth of 1 metre, and should not be the primary source of data when making land use decisions on individual farms and paddocks.

Okupata*f*

Typic Oxidic Brown Soil

Okup_3a.1 (100% of the mapunit at location (1762505, 5811945), Confidence: High)

Key physical properties

Depth class (diggability)		Moderately Deep (70 - 80 cm)
Texture profile		Silty Loam Over Clay
Potential rooting depth		70 - 80 (cm)
Rooting barrier		Fractured rock
Topsoil stoniness		Stoneless
Topsoil clay range		20 - 25 %
Drainage class		Well drained
Aeration in root zone		Unlimited
Permeability profile		Moderate
Depth to slowly permeable horizon		No slowly permeable horizon
Permeability of slowest horizon		Moderate (4 - 72 mm/h)
Profile available water	(0 - 100cm or root barrier)	Moderate to low (80 mm)
	(0 - 60cm or root barrier)	Moderate (74 mm)
	(0 - 30cm or root barrier)	Moderate (50 mm)
Dry bulk density, topsoil		1.09 g/cm³
Dry bulk density, subsoil		1.61 g/cm³
Depth to hard rock		Moderately deep
Depth to soft rock		No soft rock within 1 m
Depth to stony layer class		Moderately deep

Key chemical properties

Topsoil P retention	High (62%)

About this publication

- This information sheet describes the *typical average properties* of the specified soil to a depth of 1 metre.
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- Landcare Research shall not be liable on any legal basis (including without limitation negligence) and expressly excludes all liability for loss or damage howsoever and whenever caused to a user of this factsheet.

Okupata*f*

S-map ref: Okup_3a.1

Okup_3a.1 (100% of the mapunit at location (1762505, 5811945), Confidence: High)

Additional factors to consider in choice of management practices

Vulnerability classes relate to soil properties only and do not take into account climate or management

Soil structure integrity

Structural vulnerability	Very low (0.40)
Pugging vulnerability	not available yet

Water management

Water logging vulnerability	Very low
Drought vulnerability - if not irrigated	Moderate
Bypass flow	Medium
Hydrological soil group	C
Irrigability	Strongly rolling land with good drainage/permeability and soils with moderate PAW

Contaminant management

N leaching vulnerability	High
P leaching vulnerability	not available yet
Bypass flow	Medium
Dairy effluent (FDE) risk category	C
Relative Runoff Potential	Very Low

Additional information

Soil classification	Typic Oxidic Brown Soils
Family	Okupata*f*
Sibling number	3
Profile texture group	Clayey
Soil profile material	Moderately deep soil
Rock class of stones/rocks	From Basalt Rock
Rock origin of fine earth	From Basalt Rock
Parent material origin	Rock

Characteristics of functional horizons in order from top to base of profile:

Functional Horizon	Thickness	Stones	Clay*	Sand*
Loamy Fine Firm	10 - 15 cm	0 %	20 - 25 %	40 - 50 %
Loamy Fine Firm	5 - 10 cm	0 %	20 - 30 %	40 - 50 %
Clayey Fine Firm	30 - 35 cm	0 %	60 - 80 %	20 - 30 %
Very Stony Clayey Compact	15 - 25 cm	35 - 60 %	70 - 80 %	10 - 30 %

* clay and sand percent values are for the mineral fines (excludes stones). Silt = 100 - (clay + sand)

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Soil information for OVERSEER

The following information can be entered in the OVERSEER® Nutrient Budget model. This information is derived from the S-map soil properties which are matched to the most appropriate OVERSEER categories. Please read the notes below for further information.

Soil description page

1. Select **Link to S-map**
2. Under S-map sibling data enter the S-map name/ref: **Okup_3a.1**

Considerations when using Smap soil properties in OVERSEER

- The soil water values are estimated using a regression model based on soil order, parent rock, soil functional horizon information (stone content, soil density class), as well as texture (field estimates of sand, silt and clay percentages). The model is based on laboratory - measured water content data held in the National Soils Database and other Manaaki Whenua datasets. Most of this data comes from soils under long-term pasture and may vary from land under arable use, irrigation, etc.

- Each value is an estimate of the water content of the whole soil within the target depth range or to the depth of the root barrier (if this occurs above the base of the target depth). Where soil layers contain stones, the soil water content has been decreased according to the stone content.

- S-map only contains information on soils to a depth of 100 cm. The soil water estimates in the > 60 cm depth category assume that the bottom functional horizon that extends to 100 cm, continues down to a depth of 150cm. Where it is known by the user that there is an impermeable layer or non-fractured bedrock between 100 and 150 cm, this depth should be entered into OVERSEER. Where there is a change in the soil profile characteristics below 100 cm, the user should be aware that the values provided on this factsheet for the > 60 cm depth category will not reflect this change. For example, the presence of gravels at 120 cm would usually result in lower soil water estimates in the > 60 cm depth category. Note though that this assumption only impacts on a cropping block, as OVERSEER uses soil data from just the top 60 cm in pastoral blocks.

- OVERSEER requires the soil water values to be non-zero integers (even though zero is a valid value below a root barrier), and the wilting point value must be less than the field capacity value which must be less than the saturation value. The S-map water content estimates supplied by the S-map web service have been rounded to integers and may be assigned minimal values to meet these OVERSEER requirements. These modifications will result in a slightly less accurate estimate of Available Water to 60 cm (labelled PAW in OVERSEER) than that provided on the first page of this factsheet, but this is not expected to lead to any significant difference in outputs from OVERSEER.

Appendix B

2. HIRDS rainfall. Current Conditions

HIRDS V4 Depth-Duration-Frequency Results
Sitename: Custom Location
Coordinate system: WGS84
Longitude: 174.8455
Latitude: -37.8222

DDF Mode Parameter	c	d	e	f	g	h	i	
Values:	-0.00081	0.430215	-0.01732	0	0.23535245	-0.00869	3.031692	
Example:	Duration (h	ARI (yrs)	x	y	Rainfall Depth (mm)			
	24	100	3.178054	4.600149	165.8224814			

Rainfall depths (mm) :: Historical Data

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	9.07	12.6	15.3	20.7	27.7	42.4	54.2	68.3	84.5	95	103	109
2	0.5	9.88	13.8	16.6	22.6	30.2	46.1	59	74.3	92	103	112	119
5	0.2	12.7	17.7	21.3	28.9	38.6	59	75.5	95	117	132	143	152
10	0.1	14.8	20.6	24.8	33.7	45	68.7	87.8	110	136	153	166	176
20	0.05	17	23.6	28.5	38.6	51.5	78.6	101	126	156	175	190	201
30	0.033	18.3	25.5	30.7	41.6	55.5	84.7	108	136	168	189	204	217
40	0.025	19.3	26.8	32.3	43.8	58.4	89.1	114	143	177	198	215	228
50	0.02	20	27.9	33.6	45.5	60.7	92.5	118	148	183	206	223	236
60	0.017	20.6	28.7	34.6	46.9	62.5	95.4	122	153	189	212	230	243
80	0.012	21.7	30.1	36.3	49.2	65.5	99.9	128	160	198	222	240	255
100	0.01	22.4	31.2	37.6	50.9	67.9	103	132	166	205	230	249	264
250	0.004	25.7	35.8	43.1	58.3	77.7	118	151	189	234	262	284	301

HIRDS 4 Table 6

Percentage change factors to project rainfall depths derived from the current climate to a future climate that is 1 degree warmer.

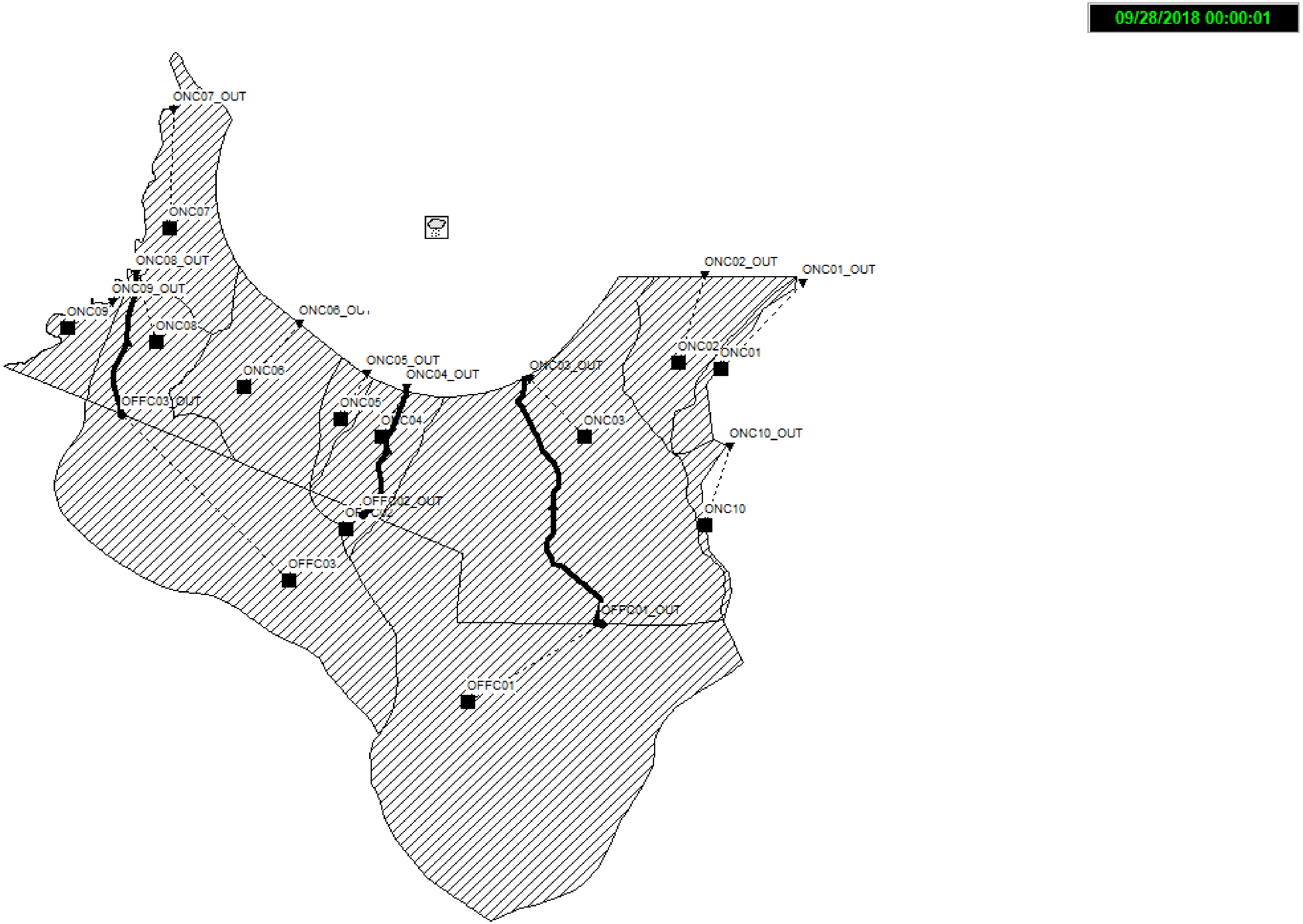
DURATION/ARI	**2yr**	**5yr**	**10yr**	**20yr**	**30yr**	**40yr**	**50yr**	**60yr**	**80yr**	**100yr**
1 h	12.2	12.8	13.1	13.3	13.4	13.4	13.5	13.5	13.6	13.6
2 h	11.7	12.3	12.6	12.8	12.9	12.9	13	13	13.1	13.1
6 h	9.8	10.5	10.8	11.1	11.2	11.3	11.3	11.4	11.4	11.5
12 h	8.5	9.2	9.5	9.7	9.8	9.9	9.9	10	10	10.1
24 h	7.2	7.8	8.1	8.2	8.3	8.4	8.4	8.5	8.5	8.6
48 h	6.1	6.7	7	7.2	7.3	7.3	7.4	7.4	7.5	7.5
72 h	5.5	6.2	6.5	6.6	6.7	6.8	6.8	6.9	6.9	6.9
96 h	5.1	5.7	6	6.2	6.3	6.3	6.4	6.4	6.4	6.5
120 h	4.8	5.4	5.7	5.8	5.9	6	6	6	6.1	6.1

			Climate Change Adjusted Rainfall Data -				**0**	degrees Celsius		
Rainfall intensities (mm/h)			Duration							
ARI(y)	aep	10m	20m	30m	60m	2h	6h	12h	24h	48h	72h
2	0.5	59.28	41.4	33.2	22.6	15.1	7.68	4.92	3.1	1.55	1.03
5	0.2	76.2	53.1	42.6	28.9	19.3	9.83	6.29	3.96	3.96	3.96
10	0.1	88.8	61.8	49.6	33.7	22.5	11.45	7.32	4.58	4.58	4.58
20	0.05	102	70.8	57	38.6	25.75	13.1	8.42	5.25	5.25	5.25
50	0.02	120	83.7	67.2	45.5	30.35	15.42	9.83	6.17	6.17	6.17
100	0.01	134.4	93.6	75.2	50.9	33.95	17.17	11	6.92	6.92	6.92

Appendix B

3. SWMM Catchment Diagram

SWMM MODEL LAYOUT



Appendix B

4. Sub-Catchment Average Slope Calculation

Channel Average Slope Estimation Using the Modified Taylor - Schwarz Method

Design By	CF
Checked By	EV

Catchment:	**On-Site Catchment ONC01**

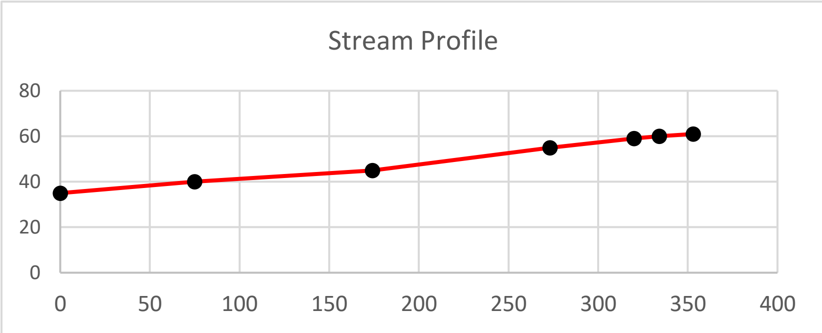
Formula: $S_a = \left(\frac{\sum L_i}{\sum \frac{L_i}{\sqrt{S_i}}}\right)^2$

Step 1: Complete the following table using a survey of the main channel or a topographic plan

Length of Section (Li)	Elevation		Δ Elevation (m)	Cumulative Distance (m)	Slope (Si)	$Si^{0.5}$	$Li / Si^{0.5}$
	Downstream End (m)	Upstream end (m)					
75	35	40	5	75	0.0667	0.2582	290.47
99	40	45	5	174	0.0505	0.2247	440.52
99	45	55	10	273	0.1010	0.3178	311.50
47	55	59	4	320	0.0851	0.2917	161.11
14	59	60	1	334	0.0714	0.2673	52.38
19	60	61	1	353	0.0526	0.2294	82.82
353			26				**1338.80**
Total length of channel (X)			Total Change in Elevation				Sum of $Li / Si^{0.5}$ (Y)

Step 2: Calculate the average slope of the channel using the following formula

$S_a = \left(\frac{X}{Y}\right)^2 =$ **0.0695 m/m**



Channel Average Slope Estimation Using the Modified Taylor - Schwarz Method

Design By	CF
Checked By	EV

Catchment:	On-Site Catchment ONC02

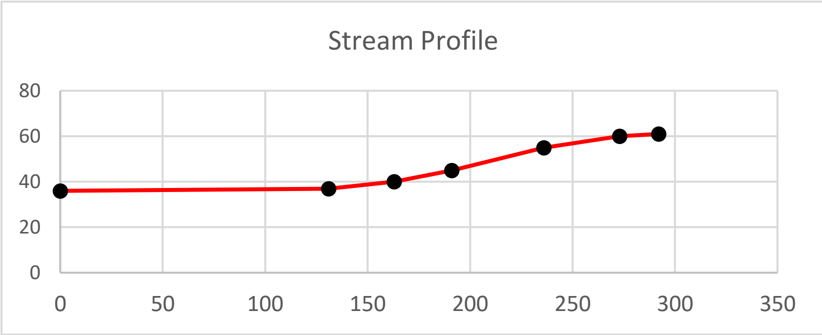
Formula: $S_a = \left(\frac{\sum L_i}{\sum \frac{L_i}{\sqrt{S_i}}}\right)^2$

Step 1: Complete the following table using a survey of the main channel or a topographic plan

Length of Section (Li)	Elevation Downstream End (m)	Elevation Upstream end (m)	Δ Elevation (m)	Cumulative Distance (m)	Slope (Si)	$Si^{0.5}$	$Li / Si^{0.5}$
131	36	37	1	131	0.0076	0.0874	1499.36
32	37	40	3	163	0.0938	0.3062	104.51
28	40	45	5	191	0.1786	0.4226	66.26
45	45	55	10	236	0.2222	0.4714	95.46
37	55	60	5	273	0.1351	0.3676	100.65
19	60	61	1	292	0.0526	0.2294	82.82
292			25				**1949.06**
Total length of channel (X)			Total Change in Elevation				Sum of $Li / Si^{0.5}$ (Y)

Step 2: Calculate the average slope of the channel using the following formula

$S_a = \left(\frac{X}{Y}\right)^2$ = **0.0224 m/m**



Channel Average Slope Estimation Using the Modified Taylor - Schwarz Method

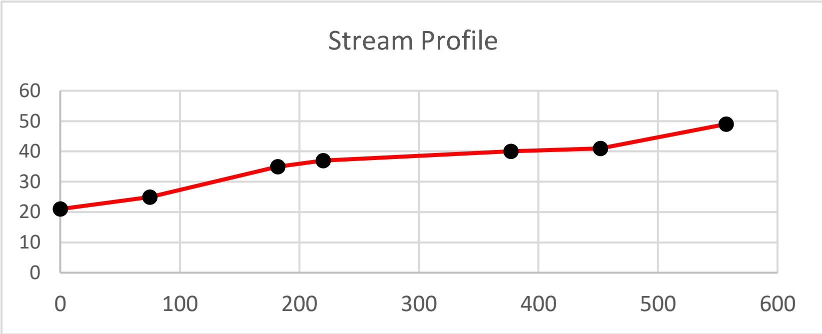
Design By	CF
Checked By	EV

Catchment:	**On-Site Catchment ONC03**

Formula: $S_a = \left(\frac{\sum L_i}{\sum \frac{L_i}{\sqrt{S_i}}} \right)^2$

Step 1: Complete the following table using a survey of the main channel or a topographic plan

Length of Section (Li)	Elevation Downstream End (m)	Elevation Upstream end (m)	Δ Elevation (m)	Cumulative Distance (m)	Slope (Si)	$Si^{0.5}$	$Li / Si^{0.5}$
75	21	25	4	75	0.0533	0.2309	324.76
107	25	35	10	182	0.0935	0.3057	350.01
38	35	37	2	220	0.0526	0.2294	165.64
157	37	40	3	377	0.0191	0.1382	1135.77
75	40	41	1	452	0.0133	0.1155	649.52
105	41	49	8	557	0.0762	0.2760	380.40
557			28				**3006.09**
Total length of channel (X)			Total Change in Elevation				Sum of Li / $Si^{0.5}$ (Y)



Step 2: Calculate the average slope of the channel using the following formula

$S_a = \left(\frac{X}{Y}\right)^2$ = **0.0343 m/m**

Channel Average Slope Estimation Using the Modified Taylor - Schwarz Method

Design By	CF
Checked By	EV

Catchment:	**On-Site Catchment ONC04**

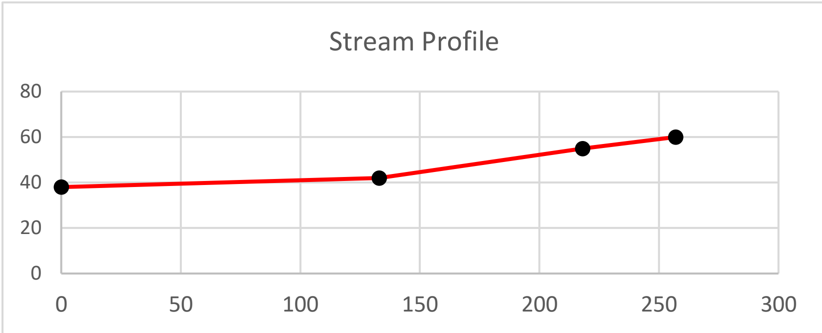
Formula: $$S_a = \left(\frac{\sum L_i}{\sum \frac{L_i}{\sqrt{S_i}}} \right)^2$$

Step 1: Complete the following table using a survey of the main channel or a topographic plan

Length of Section (Li)	Elevation Downstream End (m)	Elevation Upstream end (m)	Δ Elevation (m)	Cumulative Distance (m)	Slope (Si)	$Si^{0.5}$	$Li / Si^{0.5}$
133	38	42	4	133	0.0301	0.1734	766.92
85	42	55	13	218	0.1529	0.3911	217.35
39	55	60	5	257	0.1282	0.3581	108.92
257			22				**1093.19**
Total length of channel (X)			Total Change in Elevation				Sum of $Li / Si^{0.5}$ (Y)

Step 2: Calculate the average slope of the channel using the following formula

$S_a = \left(\frac{X}{Y}\right)^2$ = **0.0553 m/m**



Channel Average Slope Estimation Using the Modified Taylor - Schwarz Method

Design By	CF
Checked By	EV

Catchment:	**On-Site Catchment ONC05**

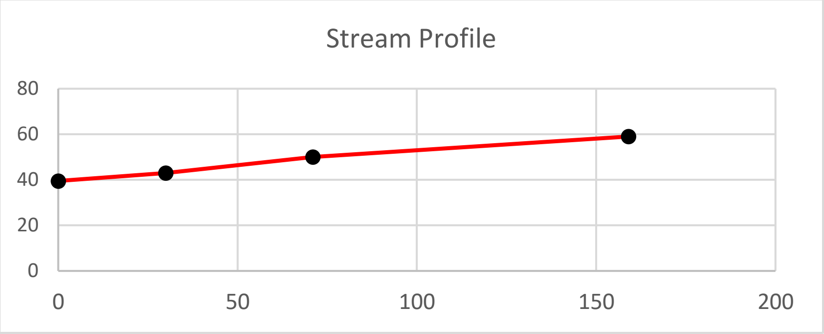
Formula: $$S_a = \left(\frac{\sum L_i}{\sum \frac{L_i}{\sqrt{S_i}}} \right)^2$$

Step 1: Complete the following table using a survey of the main channel or a topographic plan

Length of Section (Li)	Elevation Downstream End (m)	Elevation Upstream end (m)	Δ Elevation (m)	Cumulative Distance (m)	Slope (Si)	$Si^{0.5}$	$Li / Si^{0.5}$
30	39.5	43	3.5	30	0.1167	0.3416	87.83
41	43	50	7	71	0.1707	0.4132	99.23
88	50	59	9	159	0.1023	0.3198	275.17
159			19.5				**462.23**
Total length of channel (X)			Total Change in Elevation				Sum of $Li / Si^{0.5}$ (Y)

Step 2: Calculate the average slope of the channel using the following formula

$$S_a = \left(\frac{X}{Y}\right)^2 =$$ **0.1183 m/m**



Channel Average Slope Estimation Using the Modified Taylor - Schwarz Method

Design By	CF
Checked By	EV

BLOXAM BURNETT & OLLIVER

Catchment:	On-Site Catchment ONC06

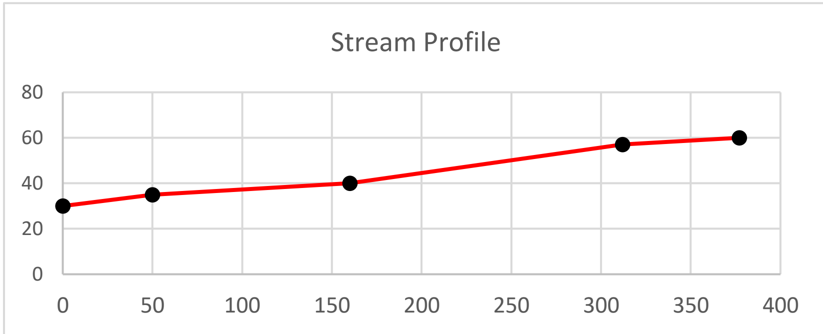
Formula: $$S_a = \left(\frac{\sum L_i}{\sum \frac{L_i}{\sqrt{S_i}}} \right)^2$$

Step 1: Complete the following table using a survey of the main channel or a topographic plan

Length of Section (Li)	Elevation: Downstream End (m)	Elevation: Upstream end (m)	Δ Elevation (m)	Cumulative Distance (m)	Slope (Si)	$Si^{0.5}$	$Li / Si^{0.5}$
50	30	35	5	50	0.1000	0.3162	158.11
110	35	40	5	160	0.0455	0.2132	515.95
152	40	57	17	312	0.1118	0.3344	454.51
65	57	60	3	377	0.0462	0.2148	302.56
377			30				**1431.13**
Total length of channel (X)			Total Change in Elevation				Sum of $Li / Si^{0.5}$ (Y)

Step 2: Calculate the average slope of the channel using the following formula

$$S_a = \left(\frac{X}{Y}\right)^2 =$$ **0.0694 m/m**



Channel Average Slope Estimation Using the Modified Taylor - Schwarz Method

	Design By	CF	
	Checked By	EV	
Catchment:	**On-Site Catchment ONC07**		

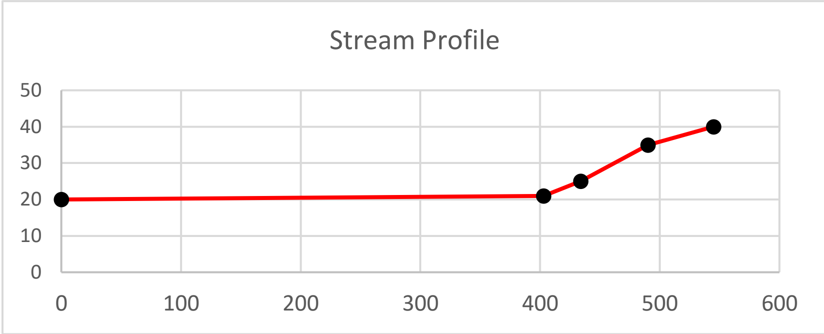
Formula: $S_a = \left(\frac{\sum L_i}{\sum \frac{L_i}{\sqrt{S_i}}}\right)^2$

Step 1: Complete the following table using a survey of the main channel or a topographic plan

Length of Section (Li)	Elevation Downstream End (m)	Elevation Upstream end (m)	Δ Elevation (m)	Cumulative Distance (m)	Slope (Si)	$Si^{0.5}$	$Li / Si^{0.5}$
403	20	21	1	403	0.0025	0.0498	8090.17
31	21	25	4	434	0.1290	0.3592	86.30
56	25	35	10	490	0.1786	0.4226	132.52
55	35	40	5	545	0.0909	0.3015	182.41
545			20				**8491.40**
Total length of channel (X)			Total Change in Elevation				Sum of $Li / Si^{0.5}$ (Y)

Step 2: Calculate the average slope of the channel using the following formula

$S_a = \left(\frac{X}{Y}\right)^2$ = **0.0041 m/m**



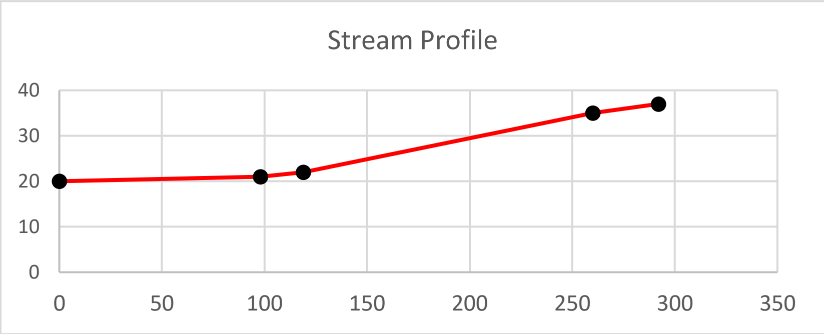
Channel Average Slope Estimation Using the Modified Taylor - Schwarz Method

	Design By	CF
	Checked By	EV
Catchment:	**On-Site Catchment ONC08**	

Formula: $$S_a = \left(\frac{\sum L_i}{\sum \frac{L_i}{\sqrt{S_i}}}\right)^2$$

Step 1: Complete the following table using a survey of the main channel or a topographic plan

Length of Section	**Elevation**		**Δ Elevation**	**Cumulative Distance**	**Slope**	**$Si^{0.5}$**	**$Li / Si^{0.5}$**
	Downstream End	**Upstream end**	**(m)**	**(m)**	**(Si)**		
(Li)	**(m)**	**(m)**					
98	20	21	1	98	0.0102	0.1010	970.15
21	21	22	1	119	0.0476	0.2182	96.23
141	22	35	13	260	0.0922	0.3036	464.36
32	35	37	2	292	0.0625	0.2500	128.00
292			17				**1658.75**
Total length of channel (X)			Total Change in Elevation				Sum of Li / $Si^{0.5}$ (Y)



Step 2: Calculate the average slope of the channel using the following formula

$S_a = \left(\frac{X}{Y}\right)^2 =$	**0.031 m/m**

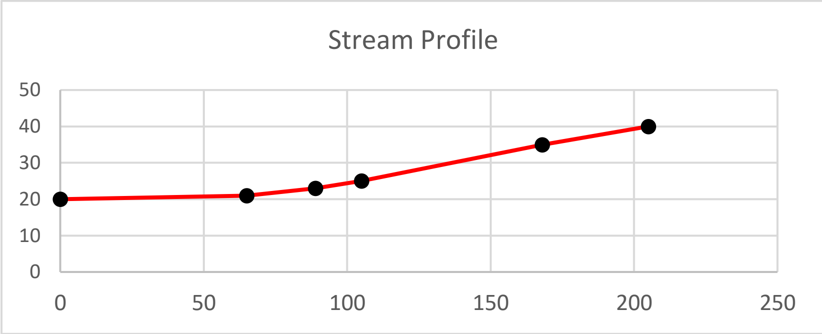
Channel Average Slope Estimation Using the Modified Taylor - Schwarz Method

	Design By	CF	BLOXAM BURNETT & OLLIVER
	Checked By	EV	
Catchment:	**On-Site Catchment ONC09**		

Formula: $S_a = \left(\frac{\sum L_i}{\sum \frac{L_i}{\sqrt{S_i}}}\right)^2$

Step 1: Complete the following table using a survey of the main channel or a topographic plan

Length of Section (Li)	**Elevation Downstream End (m)**	**Elevation Upstream end (m)**	**Δ Elevation (m)**	**Cumulative Distance (m)**	**Slope (Si)**	**$Si^{0.5}$**	**$Li / Si^{0.5}$**
65	20	21	1	65	0.0154	0.1240	524.05
24	21	23	2	89	0.0833	0.2887	83.14
16	23	25	2	105	0.1250	0.3536	45.25
63	25	35	10	168	0.1587	0.3984	158.13
37	35	40	5	205	0.1351	0.3676	100.65
205			20				**911.22**
Total length of channel (X)			Total Change in Elevation				Sum of $Li / Si^{0.5}$ (Y)



Step 2: Calculate the average slope of the channel using the following formula

$S_a = \left(\frac{X}{Y}\right)^2 =$ **0.0506 m/m**

Channel Average Slope Estimation Using the Modified Taylor - Schwarz Method

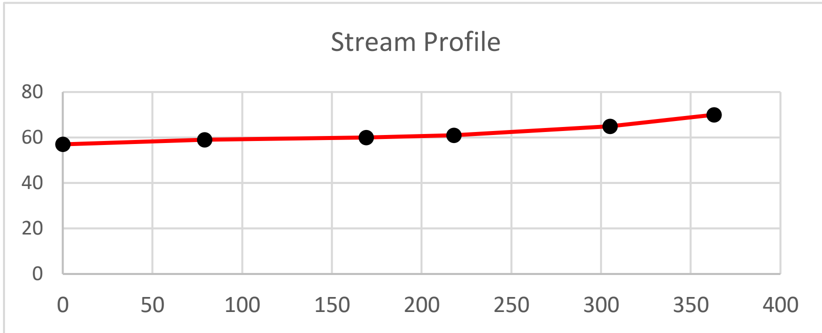
Design By	CF
Checked By	EV

Catchment:	**On-Site Catchment ONC10**

Formula: $S_a = \left(\frac{\sum L_i}{\sum \frac{L_i}{\sqrt{S_i}}} \right)^2$

Step 1: Complete the following table using a survey of the main channel or a topographic plan

Length of Section (Li)	**Elevation**		**Δ Elevation (m)**	**Cumulative Distance (m)**	**Slope (Si)**	**$Si^{0.5}$**	**$Li / Si^{0.5}$**
	Downstream End (m)	**Upstream end (m)**					
79	57	59	2	79	0.0253	0.1591	496.51
90	59	60	1	169	0.0111	0.1054	853.82
49	60	61	1	218	0.0204	0.1429	343.00
87	61	65	4	305	0.0460	0.2144	405.74
58	65	70	5	363	0.0862	0.2936	197.54
363			13				**2296.60**
Total length of channel (X)			Total Change in Elevation				Sum of $Li / Si^{0.5}$ (Y)



Step 2: Calculate the average slope of the channel using the following formula

$S_a = \left(\frac{X}{Y}\right)^2$ = **0.025 m/m**

Channel Average Slope Estimation Using the Modified Taylor - Schwarz Method	Design By	CF
	Checked By	EV
Catchment:	Off-Site Catchment OFFC01	

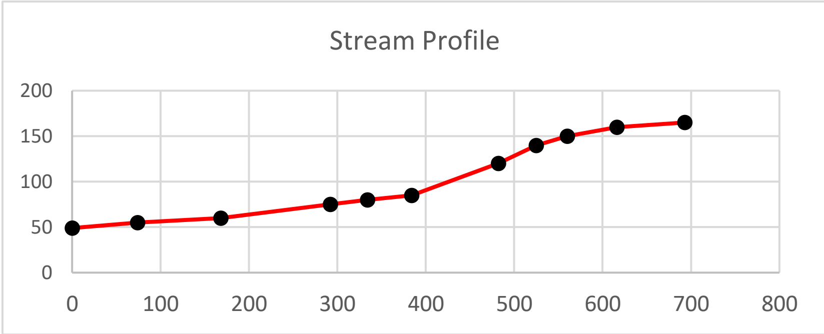
Formula: $S_a = \left(\frac{\sum L_i}{\sum \frac{L_i}{\sqrt{S_i}}} \right)^2$

Step 1: Complete the following table using a survey of the main channel or a topographic plan

Length of Section (Li)	Elevation Downstream End (m)	Elevation Upstream end (m)	Δ Elevation (m)	Cumulative Distance (m)	Slope (Si)	$Si^{0.5}$	$Li / Si^{0.5}$
74	49	55	6	74	0.0811	0.2847	259.88
94	55	60	5	168	0.0532	0.2306	407.57
124	60	75	15	292	0.1210	0.3478	356.52
42	75	80	5	334	0.1190	0.3450	121.73
50	80	85	5	384	0.1000	0.3162	158.11
98	85	120	35	482	0.3571	0.5976	163.99
43	120	140	20	525	0.4651	0.6820	63.05
35	140	150	10	560	0.2857	0.5345	65.48
56	150	160	10	616	0.1786	0.4226	132.52
77	160	165	5	693	0.0649	0.2548	302.17
693			116				**2031.02**
Total length of channel (X)			Total Change in Elevation				Sum of $Li / Si^{0.5}$ (Y)

Step 2: Calculate the average slope of the channel using the following formula

$S_a = \left(\frac{X}{Y}\right)^2 =$ **0.1164 m/m**



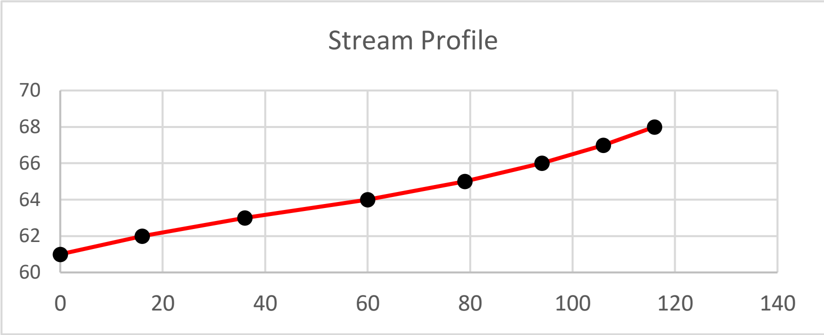
Channel Average Slope Estimation Using the Modified Taylor - Schwarz Method

	Design By	CF	
	Checked By	EV	
Catchment:	**Off-Site Catchment OFFC02**		

Formula: $S_a = \left(\frac{\sum L_i}{\sum \frac{L_i}{\sqrt{S_i}}}\right)^2$

Step 1: Complete the following table using a survey of the main channel or a topographic plan

Length of Section (Li)	**Elevation Downstream End (m)**	**Elevation Upstream end (m)**	**Δ Elevation (m)**	**Cumulative Distance (m)**	**Slope (Si)**	**$Si^{0.5}$**	**$Li / Si^{0.5}$**
16	61	62	1	16	0.0625	0.2500	64.00
20	62	63	1	36	0.0500	0.2236	89.44
24	63	64	1	60	0.0417	0.2041	117.58
19	64	65	1	79	0.0526	0.2294	82.82
15	65	66	1	94	0.0667	0.2582	58.09
12	66	67	1	106	0.0833	0.2887	41.57
10	67	68	1	116	0.1000	0.3162	31.62
116			7				**485.12**
Total length of channel (X)			Total Change in Elevation				Sum of $Li / Si^{0.5}$ (Y)



Step 2: Calculate the average slope of the channel using the following formula

$S_a = \left(\frac{X}{Y}\right)^2 =$ **0.0572 m/m**

Channel Average Slope Estimation Using the Modified Taylor - Schwarz Method

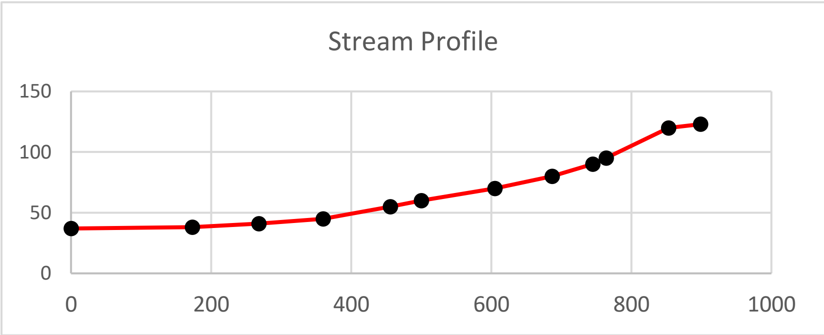
Design By	CF
Checked By	EV

Catchment: **Off-Site Catchment OFFC03**

Formula: $S_a = \left(\frac{\sum L_i}{\sum \frac{L_i}{\sqrt{S_i}}} \right)^2$

Step 1: Complete the following table using a survey of the main channel or a topographic plan

Length of Section (Li)	Elevation Downstream End (m)	Elevation Upstream end (m)	Δ Elevation (m)	Cumulative Distance (m)	Slope (Si)	$Si^{0.5}$	Li / $Si^{0.5}$
173	37	38	1	173	0.0058	0.0760	2275.46
95	38	41	3	268	0.0316	0.1777	534.59
92	41	45	4	360	0.0435	0.2085	441.22
96	45	55	10	456	0.1042	0.3227	297.45
44	55	60	5	500	0.1136	0.3371	130.53
105	60	70	10	605	0.0952	0.3086	340.24
82	70	80	10	687	0.1220	0.3492	234.81
58	80	90	10	745	0.1724	0.4152	139.68
19	90	95	5	764	0.2632	0.5130	37.04
89	95	120	25	853	0.2809	0.5300	167.92
46	120	123	3	899	0.0652	0.2554	180.13
899			86				**4779.06**
Total length of channel (X)			Total Change in Elevation				Sum of Li / $Si^{0.5}$ (Y)



Step 2: Calculate the average slope of the channel using the following formula

$S_a = \left(\frac{X}{Y}\right)^2$ = **0.0354 m/m**

Appendix B

5. Pre-Development Catchment Characteristics

Client :	KONING FAMILY TRUST	By	CF
		Checked	EV
		Approved	TK
Project :	RAGLAN REZONING	Revision	**A**
		Date	4/10/2018

Koning Family Trust

Pre-Development Sub-Catchment Characteristics

ID	A	A	A_{imp}	A_{perv}	L_{fp}	Width (A/L_{fp})	Slope	Percent Impervious	n_{impwev}	n_{perv}	D-Store Imperv.	D-Store Perv.	Infiltration (Horton) f_i	f_o	Decay Const.
	m^2	ha	m^2	m^2	m	m	%	%			mm	mm			
ONC01	11511	1.1511	0	11511	440	26.16	6.95	0.00	0.015	0.15	2	5	25	6	4
ONC02	52066	5.2066	0	52066	398	130.82	2.24	0.00	0.015	0.15	2	5	25	6	4
ONC03	255897	25.5897	0	255897	576	444.27	3.43	0.00	0.015	0.15	2	5	25	6	4
ONC04	36034	3.6034	0	36034	266	135.47	5.53	0.00	0.015	0.15	2	5	25	6	4
ONC05	11959	1.1959	0	11959	262	45.65	11.83	0.00	0.015	0.15	2	5	25	6	4
ONC06	74325	7.4325	0	74325	421	176.54	6.94	0.00	0.015	0.15	2	5	25	6	4
ONC07	63503	6.3503	0	63503	563	112.79	0.41	0.00	0.015	0.15	2	5	25	6	4
ONC08	48406	4.8406	0	48406	293	165.21	3.1	0.00	0.015	0.15	2	5	25	6	4
ONC09	20253	2.0253	0	20253	210	96.44	5.06	0.00	0.015	0.15	2	5	25	6	4
ONC10	8440	0.844	0	8440	377	22.39	2.5	0.00	0.015	0.15	2	5	25	6	4
OFFC01	310314	31.0314	0	310314	690	449.73	11.64	0.00	0.015	0.15	2	5	25	6	4
OFFC02	6040	0.604	0	6040	116	52.07	5.72	0.00	0.015	0.15	2	5	25	6	4
OFFC03	181269	18.1269	0	181269	900	201.41	3.54	0.00	0.015	0.15	2	5	25	6	4

GLOSSARY:

A_{imp}: Impervious area of a catchment

A_{per}: Pervious area of a catchment

L_{fp}: Length of overland flow

Slope: Average surface slope

n_{imperv}: Manning Number for impervious area

n_{perv}: Manning Number for pervious area

D-Store Imperv.: Depth of depression storage on impervious area

D-Store Perv.: Depth of depression storage on pervious area

f_i:Maximum rate on the Horton infiltration curve

f_o:Minimum rate on the Horton infiltration curve

Decay Const.: Decay constant for the Horton infiltration curve

Appendix B

6. SWMM Output Report

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)

Current Conditions, 2-Year/24h ARI

```
*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 09/28/2018 00:00:00
Ending Date .............. 09/30/2018 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:00:01
Wet Time Step ............ 00:00:01
Dry Time Step ............ 00:00:01
Routing Time Step ........ 1.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 20
Number of Threads ........ 1
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         8.124        75.222
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         7.720        71.483
Surface Runoff ...........         0.404         3.739
Final Storage ............         0.000         0.000
Continuity Error (%) .....         0.000


**************************        Volume        Volume
Flow Routing Continuity        hectare-m     10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.404         4.038
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         0.404         4.038
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....        -0.002


***************************
Time-Step Critical Elements
***************************
None


********************************
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.50 sec
Average Time Step           :     1.00 sec
Maximum Time Step           :     1.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.00
Percent Not Converging      :     0.00
```

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
ONC01	75.22	0.00	0.00	70.64	0.00	4.58	4.58	0.05	0.01	0.061
ONC02	75.22	0.00	0.00	71.50	0.00	3.72	3.72	0.19	0.03	0.050
ONC03	75.22	0.00	0.00	71.78	0.00	3.44	3.44	0.88	0.14	0.046
ONC04	75.22	0.00	0.00	69.97	0.00	5.25	5.25	0.19	0.04	0.070
ONC05	75.22	0.00	0.00	69.35	0.00	5.87	5.87	0.07	0.02	0.078
ONC06	75.22	0.00	0.00	70.57	0.00	4.66	4.66	0.35	0.07	0.062
ONC07	75.22	0.00	0.00	73.45	0.00	1.77	1.77	0.11	0.01	0.024
ONC08	75.22	0.00	0.00	70.64	0.00	4.58	4.58	0.22	0.04	0.061
ONC09	75.22	0.00	0.00	70.24	0.00	4.98	4.98	0.10	0.02	0.066
ONC10	75.22	0.00	0.00	71.30	0.00	3.93	3.93	0.03	0.01	0.052
OFFC01	75.22	0.00	0.00	70.99	0.00	4.23	4.23	1.31	0.24	0.056
OFFC02	75.22	0.00	0.00	68.75	0.00	6.47	6.47	0.04	0.01	0.086
OFFC03	75.22	0.00	0.00	72.54	0.00	2.68	2.68	0.49	0.07	0.036

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
OFFC01_OUT	JUNCTION	0.00	0.11	47.36	0 12:38	0.11
OFFC02_OUT	JUNCTION	0.00	0.03	59.78	0 12:21	0.03
OFFC03_OUT	JUNCTION	0.00	0.06	39.31	0 12:46	0.06
ONC01_OUT	OUTFALL	0.00	0.00	32.75	0 00:00	0.00
ONC02_OUT	OUTFALL	0.00	0.00	23.25	0 00:00	0.00
ONC03_OUT	OUTFALL	0.00	0.11	17.61	0 12:38	0.11
ONC04_OUT	OUTFALL	0.00	0.03	26.53	0 12:21	0.03
ONC05_OUT	OUTFALL	0.00	0.00	31.00	0 00:00	0.00
ONC06_OUT	OUTFALL	0.00	0.00	19.50	0 00:00	0.00
ONC07_OUT	OUTFALL	0.00	0.00	9.75	0 00:00	0.00
ONC08_OUT	OUTFALL	0.00	0.06	12.81	0 12:46	0.06
ONC09_OUT	OUTFALL	0.00	0.00	14.75	0 00:00	0.00
ONC10_OUT	OUTFALL	0.00	0.00	54.75	0 00:00	0.00

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
OFFC01_OUT	JUNCTION	0.239	0.239	0 12:35	1.31	1.31	-0.000
OFFC02_OUT	JUNCTION	0.013	0.013	0 12:15	0.0391	0.0391	-0.001
OFFC03_OUT	JUNCTION	0.070	0.070	0 12:45	0.487	0.487	-0.000
ONC01_OUT	OUTFALL	0.010	0.010	0 12:30	0.0527	0.0527	0.000
ONC02_OUT	OUTFALL	0.032	0.032	0 12:40	0.194	0.194	0.000
ONC03_OUT	OUTFALL	0.141	0.378	0 12:40	0.88	2.19	0.000
ONC04_OUT	OUTFALL	0.042	0.055	0 12:25	0.189	0.228	0.000
ONC05_OUT	OUTFALL	0.018	0.018	0 12:25	0.0702	0.0702	0.000
ONC06_OUT	OUTFALL	0.068	0.068	0 12:30	0.346	0.346	0.000
ONC07_OUT	OUTFALL	0.014	0.014	0 12:50	0.112	0.112	0.000
ONC08_OUT	OUTFALL	0.043	0.111	0 12:40	0.222	0.708	0.000
ONC09_OUT	OUTFALL	0.021	0.021	0 12:30	0.101	0.101	0.000
ONC10_OUT	OUTFALL	0.006	0.006	0 12:35	0.0331	0.0331	0.000

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
ONC01_OUT	6.58	0.005	0.010	0.053
ONC02_OUT	7.39	0.015	0.032	0.194
ONC03_OUT	15.59	0.081	0.378	2.192
ONC04_OUT	6.23	0.021	0.055	0.228
ONC05_OUT	5.42	0.007	0.018	0.070
ONC06_OUT	6.63	0.030	0.068	0.346
ONC07_OUT	8.83	0.007	0.014	0.112
ONC08_OUT	10.85	0.038	0.111	0.708
ONC09_OUT	6.29	0.009	0.021	0.101
ONC10_OUT	7.06	0.003	0.006	0.033
System	8.09	0.217	0.006	4.038

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
SONC03	CHANNEL	0.238	0 12:38	1.00	0.00	0.06
SONC04	CHANNEL	0.012	0 12:21	0.69	0.00	0.02
SONC08	CHANNEL	0.070	0 12:46	0.90	0.00	0.03

****
Flow Classification Summary
****

	Adjusted	---------- Fraction of Time in Flow Class ----------								
Conduit	/Actual Length	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
SONC03	1.00	0.25	0.00	0.00	0.72	0.03	0.00	0.00	0.25	0.00
SONC04	1.00	0.71	0.00	0.00	0.23	0.06	0.00	0.00	0.67	0.00
SONC08	1.00	0.64	0.00	0.00	0.28	0.08	0.00	0.00	0.55	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Tue Nov 10 10:51:15 2020
Analysis ended on: Tue Nov 10 10:51:19 2020
Total elapsed time: 00:00:04

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EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)
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Current Conditions, 10-Year/24h ARI

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*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 09/28/2018 00:00:00
Ending Date .............. 09/30/2018 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:00:01
Wet Time Step ............ 00:00:01
Dry Time Step ............ 00:00:01
Routing Time Step ........ 1.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 20
Number of Threads ........ 1
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......        12.002       111.130
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........        10.212        94.557
Surface Runoff ...........         1.790        16.572
Final Storage ............         0.000         0.000
Continuity Error (%) .....         0.000


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         1.790        17.899
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         1.790        17.899
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....        -0.001


***************************
Time-Step Critical Elements
***************************
None


********************************
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.50 sec
Average Time Step           :     1.00 sec
Maximum Time Step           :     1.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.00
Percent Not Converging      :     0.00
```

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
ONC01	111.13	0.00	0.00	92.95	0.00	18.18	18.18	0.21	0.03	0.164
ONC02	111.13	0.00	0.00	94.33	0.00	16.80	16.80	0.87	0.11	0.151
ONC03	111.13	0.00	0.00	94.88	0.00	16.25	16.25	4.16	0.49	0.146
ONC04	111.13	0.00	0.00	92.08	0.00	19.05	19.05	0.69	0.14	0.171
ONC05	111.13	0.00	0.00	91.43	0.00	19.70	19.70	0.24	0.06	0.177
ONC06	111.13	0.00	0.00	92.84	0.00	18.29	18.29	1.36	0.23	0.165
ONC07	111.13	0.00	0.00	99.49	0.00	11.64	11.64	0.74	0.06	0.105
ONC08	111.13	0.00	0.00	92.94	0.00	18.19	18.19	0.88	0.14	0.164
ONC09	111.13	0.00	0.00	92.41	0.00	18.72	18.72	0.38	0.07	0.168
ONC10	111.13	0.00	0.00	93.97	0.00	17.16	17.16	0.14	0.02	0.154
OFFC01	111.13	0.00	0.00	93.47	0.00	17.66	17.66	5.48	0.81	0.159
OFFC02	111.13	0.00	0.00	90.91	0.00	20.22	20.22	0.12	0.04	0.182
OFFC03	111.13	0.00	0.00	96.62	0.00	14.51	14.51	2.63	0.26	0.131

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
OFFC01_OUT	JUNCTION	0.01	0.21	47.46	0 12:30	0.21
OFFC02_OUT	JUNCTION	0.00	0.06	59.81	0 12:14	0.06
OFFC03_OUT	JUNCTION	0.01	0.12	39.37	0 12:45	0.12
ONC01_OUT	OUTFALL	0.00	0.00	32.75	0 00:00	0.00
ONC02_OUT	OUTFALL	0.00	0.00	23.25	0 00:00	0.00
ONC03_OUT	OUTFALL	0.01	0.21	17.71	0 12:30	0.21
ONC04_OUT	OUTFALL	0.00	0.06	26.56	0 12:14	0.06
ONC05_OUT	OUTFALL	0.00	0.00	31.00	0 00:00	0.00
ONC06_OUT	OUTFALL	0.00	0.00	19.50	0 00:00	0.00
ONC07_OUT	OUTFALL	0.00	0.00	9.75	0 00:00	0.00
ONC08_OUT	OUTFALL	0.01	0.12	12.87	0 12:45	0.12
ONC09_OUT	OUTFALL	0.00	0.00	14.75	0 00:00	0.00
ONC10_OUT	OUTFALL	0.00	0.00	54.75	0 00:00	0.00

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
OFFC01_OUT	JUNCTION	0.805	0.805	0 12:25	5.48	5.48	-0.001
OFFC02_OUT	JUNCTION	0.042	0.042	0 12:10	0.122	0.122	-0.000
OFFC03_OUT	JUNCTION	0.255	0.255	0 12:45	2.63	2.63	-0.000
ONC01_OUT	OUTFALL	0.034	0.034	0 12:25	0.209	0.209	0.000
ONC02_OUT	OUTFALL	0.112	0.112	0 12:30	0.875	0.875	0.000
ONC03_OUT	OUTFALL	0.491	1.294	0 12:30	4.16	9.64	0.000
ONC04_OUT	OUTFALL	0.140	0.181	0 12:15	0.686	0.809	0.000
ONC05_OUT	OUTFALL	0.061	0.061	0 12:15	0.236	0.236	0.000
ONC06_OUT	OUTFALL	0.227	0.227	0 12:25	1.36	1.36	0.000
ONC07_OUT	OUTFALL	0.056	0.056	0 12:55	0.739	0.739	0.000
ONC08_OUT	OUTFALL	0.144	0.387	0 12:35	0.88	3.51	0.000
ONC09_OUT	OUTFALL	0.070	0.070	0 12:20	0.379	0.379	0.000
ONC10_OUT	OUTFALL	0.020	0.020	0 12:30	0.145	0.145	0.000

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
ONC01_OUT	11.06	0.011	0.034	0.209
ONC02_OUT	12.43	0.041	0.112	0.875
ONC03_OUT	20.25	0.275	1.294	9.637
ONC04_OUT	10.27	0.046	0.181	0.809
ONC05_OUT	9.31	0.015	0.061	0.236
ONC06_OUT	11.09	0.071	0.227	1.359
ONC07_OUT	16.00	0.027	0.056	0.739
ONC08_OUT	16.85	0.121	0.387	3.511
ONC09_OUT	10.56	0.021	0.070	0.379
ONC10_OUT	11.95	0.007	0.020	0.145
System	12.98	0.633	0.020	17.899

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
SONC03	CHANNEL	0.804	0 12:30	1.43	0.01	0.12
SONC04	CHANNEL	0.041	0 12:14	1.00	0.00	0.03
SONC08	CHANNEL	0.255	0 12:45	1.35	0.00	0.07

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	---------- Fraction of Time in Flow Class ---------- Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
SONC03	1.00	0.25	0.00	0.00	0.68	0.07	0.00	0.00	0.21	0.00
SONC04	1.00	0.68	0.00	0.00	0.23	0.09	0.00	0.00	0.64	0.00
SONC08	1.00	0.58	0.00	0.00	0.28	0.14	0.00	0.00	0.49	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Tue Nov 10 10:51:36 2020
Analysis ended on: Tue Nov 10 10:51:40 2020
Total elapsed time: 00:00:04

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)

Current Conditions, 100-Year/24h ARI

```
*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 09/28/2018 00:00:00
Ending Date .............. 09/30/2018 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:00:01
Wet Time Step ............ 00:00:01
Dry Time Step ............ 00:00:01
Routing Time Step ........ 1.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 20
Number of Threads ........ 1
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......        18.134       167.908
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........        12.804       118.556
Surface Runoff ...........         5.330        49.351
Final Storage ............         0.000         0.000
Continuity Error (%) .....         0.000


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         5.330        53.301
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         5.330        53.301
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....        -0.001


***************************
Time-Step Critical Elements
***************************
None


********************************
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.50 sec
Average Time Step           :     1.00 sec
Maximum Time Step           :     1.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.00
Percent Not Converging      :     0.00
```

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
ONC01	167.91	0.00	0.00	116.71	0.00	51.20	51.20	0.59	0.10	0.305
ONC02	167.91	0.00	0.00	118.11	0.00	49.79	49.79	2.59	0.33	0.297
ONC03	167.91	0.00	0.00	118.73	0.00	49.18	49.18	12.58	1.46	0.293
ONC04	167.91	0.00	0.00	115.91	0.00	51.99	51.99	1.87	0.40	0.310
ONC05	167.91	0.00	0.00	115.35	0.00	52.55	52.55	0.63	0.17	0.313
ONC06	167.91	0.00	0.00	116.60	0.00	51.31	51.31	3.81	0.67	0.306
ONC07	167.91	0.00	0.00	125.39	0.00	42.51	42.51	2.70	0.18	0.253
ONC08	167.91	0.00	0.00	116.70	0.00	51.21	51.21	2.48	0.42	0.305
ONC09	167.91	0.00	0.00	116.21	0.00	51.70	51.70	1.05	0.20	0.308
ONC10	167.91	0.00	0.00	117.73	0.00	50.18	50.18	0.42	0.06	0.299
OFFC01	167.91	0.00	0.00	117.22	0.00	50.69	50.69	15.73	2.39	0.302
OFFC02	167.91	0.00	0.00	114.92	0.00	52.99	52.99	0.32	0.11	0.316
OFFC03	167.91	0.00	0.00	120.91	0.00	47.00	47.00	8.52	0.77	0.280

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
OFFC01_OUT	JUNCTION	0.02	0.35	47.60	0 12:18	0.35
OFFC02_OUT	JUNCTION	0.00	0.10	59.85	0 12:11	0.10
OFFC03_OUT	JUNCTION	0.02	0.21	39.46	0 12:30	0.21
ONC01_OUT	OUTFALL	0.00	0.00	32.75	0 00:00	0.00
ONC02_OUT	OUTFALL	0.00	0.00	23.25	0 00:00	0.00
ONC03_OUT	OUTFALL	0.02	0.35	17.85	0 12:18	0.35
ONC04_OUT	OUTFALL	0.00	0.09	26.59	0 12:11	0.09
ONC05_OUT	OUTFALL	0.00	0.00	31.00	0 00:00	0.00
ONC06_OUT	OUTFALL	0.00	0.00	19.50	0 00:00	0.00
ONC07_OUT	OUTFALL	0.00	0.00	9.75	0 00:00	0.00
ONC08_OUT	OUTFALL	0.02	0.21	12.96	0 12:30	0.21
ONC09_OUT	OUTFALL	0.00	0.00	14.75	0 00:00	0.00
ONC10_OUT	OUTFALL	0.00	0.00	54.75	0 00:00	0.00

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
OFFC01_OUT	JUNCTION	2.386	2.386	0 12:15	15.7	15.7	-0.001
OFFC02_OUT	JUNCTION	0.108	0.108	0 12:10	0.32	0.32	-0.000
OFFC03_OUT	JUNCTION	0.772	0.772	0 12:30	8.52	8.52	-0.000
ONC01_OUT	OUTFALL	0.100	0.100	0 12:15	0.589	0.589	0.000
ONC02_OUT	OUTFALL	0.330	0.330	0 12:20	2.59	2.59	0.000
ONC03_OUT	OUTFALL	1.458	3.804	0 12:19	12.6	28.3	0.000
ONC04_OUT	OUTFALL	0.404	0.504	0 12:10	1.87	2.19	0.000
ONC05_OUT	OUTFALL	0.170	0.170	0 12:10	0.628	0.628	0.000
ONC06_OUT	OUTFALL	0.666	0.666	0 12:15	3.81	3.81	0.000
ONC07_OUT	OUTFALL	0.176	0.176	0 12:45	2.7	2.7	0.000
ONC08_OUT	OUTFALL	0.423	1.148	0 12:20	2.48	11	0.000
ONC09_OUT	OUTFALL	0.204	0.204	0 12:10	1.05	1.05	0.000
ONC10_OUT	OUTFALL	0.058	0.058	0 12:15	0.424	0.424	0.000

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
ONC01_OUT	17.49	0.020	0.100	0.589
ONC02_OUT	18.84	0.080	0.330	2.593
ONC03_OUT	26.71	0.613	3.804	28.315
ONC04_OUT	16.88	0.075	0.504	2.194
ONC05_OUT	16.05	0.023	0.170	0.628
ONC06_OUT	17.57	0.126	0.666	3.813
ONC07_OUT	23.05	0.068	0.176	2.700
ONC08_OUT	23.47	0.271	1.148	10.998
ONC09_OUT	17.08	0.035	0.204	1.047
ONC10_OUT	18.30	0.013	0.058	0.424
System	19.54	1.324	0.058	53.301

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
SONC03	CHANNEL	2.352	0 12:18	1.86	0.02	0.20
SONC04	CHANNEL	0.102	0 12:11	1.29	0.00	0.05
SONC08	CHANNEL	0.771	0 12:30	1.87	0.01	0.12

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	---------- Fraction of Time in Flow Class ---------- Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
SONC03	1.00	0.23	0.00	0.00	0.64	0.13	0.00	0.00	0.16	0.00
SONC04	1.00	0.61	0.00	0.00	0.23	0.16	0.00	0.00	0.59	0.00
SONC08	1.00	0.51	0.00	0.00	0.29	0.20	0.00	0.00	0.16	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Tue Nov 10 10:52:01 2020
Analysis ended on: Tue Nov 10 10:52:04 2020
Total elapsed time: 00:00:03

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)

Climate Change, 2-Year/24h ARI

```
*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 09/28/2018 00:00:00
Ending Date .............. 09/30/2018 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:00:01
Wet Time Step ............ 00:00:01
Dry Time Step ............ 00:00:01
Routing Time Step ........ 1.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 20
Number of Threads ........ 1
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         9.330        86.383
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         8.578        79.426
Surface Runoff ...........         0.751         6.957
Final Storage ............         0.000         0.000
Continuity Error (%) .....         0.000


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.751         7.514
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         0.751         7.514
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....        -0.001


***************************
Time-Step Critical Elements
***************************
None


********************************
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.50 sec
Average Time Step           :     1.00 sec
Maximum Time Step           :     1.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.00
Percent Not Converging      :     0.00
```

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
ONC01	86.38	0.00	0.00	78.24	0.00	8.14	8.14	0.09	0.02	0.094
ONC02	86.38	0.00	0.00	79.37	0.00	7.01	7.01	0.37	0.05	0.081
ONC03	86.38	0.00	0.00	79.78	0.00	6.60	6.60	1.69	0.23	0.076
ONC04	86.38	0.00	0.00	77.43	0.00	8.95	8.95	0.32	0.07	0.104
ONC05	86.38	0.00	0.00	76.74	0.00	9.64	9.64	0.12	0.03	0.112
ONC06	86.38	0.00	0.00	78.15	0.00	8.24	8.24	0.61	0.11	0.095
ONC07	86.38	0.00	0.00	82.50	0.00	3.88	3.88	0.25	0.02	0.045
ONC08	86.38	0.00	0.00	78.24	0.00	8.14	8.14	0.39	0.07	0.094
ONC09	86.38	0.00	0.00	77.75	0.00	8.63	8.63	0.17	0.03	0.100
ONC10	86.38	0.00	0.00	79.10	0.00	7.29	7.29	0.06	0.01	0.084
OFFC01	86.38	0.00	0.00	78.69	0.00	7.69	7.69	2.39	0.39	0.089
OFFC02	86.38	0.00	0.00	76.13	0.00	10.25	10.25	0.06	0.02	0.119
OFFC03	86.38	0.00	0.00	80.93	0.00	5.46	5.46	0.99	0.12	0.063

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
OFFC01_OUT	JUNCTION	0.01	0.15	47.40	0 12:35	0.15
OFFC02_OUT	JUNCTION	0.00	0.04	59.79	0 12:17	0.04
OFFC03_OUT	JUNCTION	0.00	0.08	39.33	0 12:47	0.08
ONC01_OUT	OUTFALL	0.00	0.00	32.75	0 00:00	0.00
ONC02_OUT	OUTFALL	0.00	0.00	23.25	0 00:00	0.00
ONC03_OUT	OUTFALL	0.01	0.15	17.65	0 12:35	0.15
ONC04_OUT	OUTFALL	0.00	0.04	26.54	0 12:17	0.04
ONC05_OUT	OUTFALL	0.00	0.00	31.00	0 00:00	0.00
ONC06_OUT	OUTFALL	0.00	0.00	19.50	0 00:00	0.00
ONC07_OUT	OUTFALL	0.00	0.00	9.75	0 00:00	0.00
ONC08_OUT	OUTFALL	0.00	0.08	12.83	0 12:47	0.08
ONC09_OUT	OUTFALL	0.00	0.00	14.75	0 00:00	0.00
ONC10_OUT	OUTFALL	0.00	0.00	54.75	0 00:00	0.00

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
OFFC01_OUT	JUNCTION	0.389	0.389	0 12:30	2.39	2.39	-0.001
OFFC02_OUT	JUNCTION	0.021	0.021	0 12:15	0.0619	0.0619	-0.000
OFFC03_OUT	JUNCTION	0.118	0.118	0 12:45	0.989	0.989	-0.000
ONC01_OUT	OUTFALL	0.017	0.017	0 12:30	0.0937	0.0937	0.000
ONC02_OUT	OUTFALL	0.053	0.053	0 12:35	0.365	0.365	0.000
ONC03_OUT	OUTFALL	0.233	0.619	0 12:36	1.69	4.08	0.000
ONC04_OUT	OUTFALL	0.068	0.087	0 12:20	0.323	0.385	0.000
ONC05_OUT	OUTFALL	0.030	0.030	0 12:20	0.115	0.115	0.000
ONC06_OUT	OUTFALL	0.110	0.110	0 12:30	0.612	0.612	0.000
ONC07_OUT	OUTFALL	0.025	0.025	0 12:55	0.247	0.247	0.000
ONC08_OUT	OUTFALL	0.070	0.184	0 12:40	0.394	1.38	0.000
ONC09_OUT	OUTFALL	0.034	0.034	0 12:25	0.175	0.175	0.000
ONC10_OUT	OUTFALL	0.009	0.009	0 12:35	0.0615	0.0615	0.000

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
ONC01_OUT	8.09	0.007	0.017	0.094
ONC02_OUT	9.18	0.023	0.053	0.365
ONC03_OUT	17.19	0.137	0.619	4.077
ONC04_OUT	7.44	0.030	0.087	0.385
ONC05_OUT	6.59	0.010	0.030	0.115
ONC06_OUT	8.12	0.044	0.110	0.612
ONC07_OUT	11.48	0.012	0.025	0.247
ONC08_OUT	13.06	0.061	0.184	1.383
ONC09_OUT	7.67	0.013	0.034	0.175
ONC10_OUT	8.78	0.004	0.009	0.062
System	9.76	0.342	0.009	7.514

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
SONC03	CHANNEL	0.387	0 12:35	1.16	0.00	0.08
SONC04	CHANNEL	0.020	0 12:17	0.80	0.00	0.02
SONC08	CHANNEL	0.118	0 12:47	1.06	0.00	0.04

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	---------- Fraction of Time in Flow Class ---------- Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
SONC03	1.00	0.25	0.00	0.00	0.70	0.05	0.00	0.00	0.24	0.00
SONC04	1.00	0.70	0.00	0.00	0.23	0.07	0.00	0.00	0.66	0.00
SONC08	1.00	0.62	0.00	0.00	0.28	0.10	0.00	0.00	0.53	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Tue Nov 10 10:52:27 2020
Analysis ended on: Tue Nov 10 10:52:31 2020
Total elapsed time: 00:00:04

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)

Climate Change, 10-Year/24h ARI

```
*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 09/28/2018 00:00:00
Ending Date .............. 09/30/2018 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:00:01
Wet Time Step ............ 00:00:01
Dry Time Step ............ 00:00:01
Routing Time Step ........ 1.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 20
Number of Threads ........ 1
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......        14.047       130.060
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........        11.227       103.948
Surface Runoff ...........         2.820        26.112
Final Storage ............         0.000         0.000
Continuity Error (%) .....         0.000


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         2.820        28.202
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         2.820        28.202
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....        -0.001


***************************
Time-Step Critical Elements
***************************
None


********************************
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.50 sec
Average Time Step           :     1.00 sec
Maximum Time Step           :     1.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.00
Percent Not Converging      :     0.00
```

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
ONC01	130.06	0.00	0.00	102.20	0.00	27.86	27.86	0.32	0.05	0.214
ONC02	130.06	0.00	0.00	103.62	0.00	26.44	26.44	1.38	0.17	0.203
ONC03	130.06	0.00	0.00	104.21	0.00	25.85	25.85	6.61	0.76	0.199
ONC04	130.06	0.00	0.00	101.36	0.00	28.70	28.70	1.03	0.22	0.221
ONC05	130.06	0.00	0.00	100.77	0.00	29.29	29.29	0.35	0.09	0.225
ONC06	130.06	0.00	0.00	102.09	0.00	27.97	27.97	2.08	0.35	0.215
ONC07	130.06	0.00	0.00	109.79	0.00	20.27	20.27	1.29	0.09	0.156
ONC08	130.06	0.00	0.00	102.19	0.00	27.87	27.87	1.35	0.22	0.214
ONC09	130.06	0.00	0.00	101.68	0.00	28.39	28.39	0.57	0.11	0.218
ONC10	130.06	0.00	0.00	103.24	0.00	26.82	26.82	0.23	0.03	0.206
OFFC01	130.06	0.00	0.00	102.72	0.00	27.34	27.34	8.48	1.23	0.210
OFFC02	130.06	0.00	0.00	100.31	0.00	29.75	29.75	0.18	0.06	0.229
OFFC03	130.06	0.00	0.00	106.19	0.00	23.87	23.87	4.33	0.40	0.184

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
OFFC01_OUT	JUNCTION	0.02	0.26	47.51	0 12:25	0.26
OFFC02_OUT	JUNCTION	0.00	0.07	59.82	0 12:12	0.07
OFFC03_OUT	JUNCTION	0.01	0.15	39.40	0 12:40	0.15
ONC01_OUT	OUTFALL	0.00	0.00	32.75	0 00:00	0.00
ONC02_OUT	OUTFALL	0.00	0.00	23.25	0 00:00	0.00
ONC03_OUT	OUTFALL	0.02	0.26	17.76	0 12:25	0.26
ONC04_OUT	OUTFALL	0.00	0.07	26.57	0 12:12	0.07
ONC05_OUT	OUTFALL	0.00	0.00	31.00	0 00:00	0.00
ONC06_OUT	OUTFALL	0.00	0.00	19.50	0 00:00	0.00
ONC07_OUT	OUTFALL	0.00	0.00	9.75	0 00:00	0.00
ONC08_OUT	OUTFALL	0.01	0.15	12.90	0 12:40	0.15
ONC09_OUT	OUTFALL	0.00	0.00	14.75	0 00:00	0.00
ONC10_OUT	OUTFALL	0.00	0.00	54.75	0 00:00	0.00

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
OFFC01_OUT	JUNCTION	1.233	1.233	0 12:20	8.48	8.48	-0.001
OFFC02_OUT	JUNCTION	0.064	0.064	0 12:10	0.18	0.18	-0.000
OFFC03_OUT	JUNCTION	0.396	0.396	0 12:40	4.33	4.33	-0.000
ONC01_OUT	OUTFALL	0.052	0.052	0 12:20	0.321	0.321	0.000
ONC02_OUT	OUTFALL	0.172	0.172	0 12:30	1.38	1.38	0.000
ONC03_OUT	OUTFALL	0.759	1.984	0 12:25	6.61	15.1	0.000
ONC04_OUT	OUTFALL	0.216	0.275	0 12:15	1.03	1.21	0.000
ONC05_OUT	OUTFALL	0.094	0.094	0 12:10	0.35	0.35	0.000
ONC06_OUT	OUTFALL	0.348	0.348	0 12:15	2.08	2.08	0.000
ONC07_OUT	OUTFALL	0.088	0.088	0 12:55	1.29	1.29	0.000
ONC08_OUT	OUTFALL	0.220	0.597	0 12:30	1.35	5.68	0.000
ONC09_OUT	OUTFALL	0.109	0.109	0 12:15	0.575	0.575	0.000
ONC10_OUT	OUTFALL	0.030	0.030	0 12:25	0.226	0.226	0.000

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
ONC01_OUT	13.19	0.014	0.052	0.321
ONC02_OUT	14.60	0.055	0.172	1.377
ONC03_OUT	22.39	0.390	1.984	15.097
ONC04_OUT	12.46	0.056	0.275	1.214
ONC05_OUT	11.56	0.018	0.094	0.350
ONC06_OUT	13.23	0.091	0.348	2.079
ONC07_OUT	18.64	0.040	0.088	1.287
ONC08_OUT	19.20	0.171	0.597	5.676
ONC09_OUT	12.72	0.026	0.109	0.575
ONC10_OUT	14.09	0.009	0.030	0.226
System	15.21	0.870	0.030	28.202

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
SONC03	CHANNEL	1.231	0 12:25	1.62	0.01	0.15
SONC04	CHANNEL	0.061	0 12:12	1.12	0.00	0.04
SONC08	CHANNEL	0.396	0 12:40	1.54	0.00	0.09

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class								
		Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
SONC03	1.00	0.25	0.00	0.00	0.66	0.09	0.00	0.00	0.19	0.00
SONC04	1.00	0.65	0.00	0.00	0.23	0.11	0.00	0.00	0.62	0.00
SONC08	1.00	0.56	0.00	0.00	0.28	0.16	0.00	0.00	0.47	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Tue Nov 10 10:52:52 2020
Analysis ended on: Tue Nov 10 10:52:56 2020
Total elapsed time: 00:00:04

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EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)
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Climate Change, 100-Year/24h ARI

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*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 09/28/2018 00:00:00
Ending Date .............. 09/30/2018 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:00:01
Wet Time Step ............ 00:00:01
Dry Time Step ............ 00:00:01
Routing Time Step ........ 1.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 20
Number of Threads ........ 1
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......        21.410       198.238
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........        13.673       126.601
Surface Runoff ...........         7.737        71.636
Final Storage ............         0.000         0.000
Continuity Error (%) .....         0.000


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         7.737        77.369
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         7.737        77.370
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....        -0.000


***************************
Time-Step Critical Elements
***************************
None


********************************
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.50 sec
Average Time Step           :     1.00 sec
Maximum Time Step           :     1.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.00
Percent Not Converging      :     0.00
```

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
ONC01	198.24	0.00	0.00	124.70	0.00	73.53	73.53	0.85	0.14	0.371
ONC02	198.24	0.00	0.00	126.12	0.00	72.12	72.12	3.76	0.49	0.364
ONC03	198.24	0.00	0.00	126.74	0.00	71.49	71.49	18.30	2.17	0.361
ONC04	198.24	0.00	0.00	123.91	0.00	74.33	74.33	2.68	0.56	0.375
ONC05	198.24	0.00	0.00	123.34	0.00	74.89	74.89	0.90	0.23	0.378
ONC06	198.24	0.00	0.00	124.60	0.00	73.64	73.64	5.47	0.95	0.371
ONC07	198.24	0.00	0.00	133.88	0.00	64.36	64.36	4.09	0.27	0.325
ONC08	198.24	0.00	0.00	124.70	0.00	73.54	73.54	3.56	0.60	0.371
ONC09	198.24	0.00	0.00	124.20	0.00	74.03	74.03	1.50	0.29	0.373
ONC10	198.24	0.00	0.00	125.73	0.00	72.51	72.51	0.61	0.08	0.366
OFFC01	198.24	0.00	0.00	125.21	0.00	73.02	73.02	22.66	3.43	0.368
OFFC02	198.24	0.00	0.00	122.90	0.00	75.34	75.34	0.46	0.14	0.380
OFFC03	198.24	0.00	0.00	128.99	0.00	69.24	69.24	12.55	1.16	0.349

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
OFFC01_OUT	JUNCTION	0.03	0.41	47.66	0 12:16	0.41
OFFC02_OUT	JUNCTION	0.01	0.11	59.86	0 12:10	0.11
OFFC03_OUT	JUNCTION	0.03	0.26	39.51	0 12:25	0.26
ONC01_OUT	OUTFALL	0.00	0.00	32.75	0 00:00	0.00
ONC02_OUT	OUTFALL	0.00	0.00	23.25	0 00:00	0.00
ONC03_OUT	OUTFALL	0.03	0.41	17.91	0 12:16	0.41
ONC04_OUT	OUTFALL	0.00	0.11	26.61	0 12:11	0.11
ONC05_OUT	OUTFALL	0.00	0.00	31.00	0 00:00	0.00
ONC06_OUT	OUTFALL	0.00	0.00	19.50	0 00:00	0.00
ONC07_OUT	OUTFALL	0.00	0.00	9.75	0 00:00	0.00
ONC08_OUT	OUTFALL	0.03	0.26	13.01	0 12:25	0.26
ONC09_OUT	OUTFALL	0.00	0.00	14.75	0 00:00	0.00
ONC10_OUT	OUTFALL	0.00	0.00	54.75	0 00:00	0.00

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
OFFC01_OUT	JUNCTION	3.432	3.432	0 12:15	22.7	22.7	-0.001
OFFC02_OUT	JUNCTION	0.138	0.138	0 12:10	0.455	0.455	-0.000
OFFC03_OUT	JUNCTION	1.156	1.156	0 12:25	12.6	12.6	-0.000
ONC01_OUT	OUTFALL	0.143	0.143	0 12:10	0.846	0.846	0.000
ONC02_OUT	OUTFALL	0.488	0.488	0 12:15	3.76	3.76	0.000
ONC03_OUT	OUTFALL	2.166	5.548	0 12:16	18.3	41	0.000
ONC04_OUT	OUTFALL	0.560	0.688	0 12:10	2.68	3.13	0.000
ONC05_OUT	OUTFALL	0.227	0.227	0 12:10	0.896	0.896	0.000
ONC06_OUT	OUTFALL	0.946	0.946	0 12:10	5.47	5.47	0.000
ONC07_OUT	OUTFALL	0.268	0.268	0 12:40	4.09	4.09	0.000
ONC08_OUT	OUTFALL	0.601	1.709	0 12:16	3.56	16.1	0.000
ONC09_OUT	OUTFALL	0.288	0.288	0 12:10	1.5	1.5	0.000
ONC10_OUT	OUTFALL	0.085	0.085	0 12:15	0.612	0.612	0.000

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
ONC01_OUT	21.82	0.022	0.143	0.846
ONC02_OUT	23.08	0.094	0.488	3.755
ONC03_OUT	31.05	0.763	5.548	40.956
ONC04_OUT	21.28	0.085	0.688	3.133
ONC05_OUT	20.48	0.025	0.227	0.896
ONC06_OUT	21.92	0.145	0.946	5.473
ONC07_OUT	27.15	0.087	0.268	4.087
ONC08_OUT	27.63	0.338	1.709	16.111
ONC09_OUT	21.45	0.040	0.288	1.499
ONC10_OUT	22.54	0.016	0.085	0.612
System	23.84	1.616	0.085	77.369

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
SONC03	CHANNEL	3.386	0 12:16	1.95	0.03	0.23
SONC04	CHANNEL	0.131	0 12:11	1.38	0.00	0.05
SONC08	CHANNEL	1.155	0 12:25	2.09	0.01	0.15

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	---------- Fraction of Time in Flow Class ----------								
		Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
SONC03	1.00	0.21	0.00	0.00	0.63	0.16	0.00	0.00	0.14	0.00
SONC04	1.00	0.56	0.00	0.00	0.24	0.20	0.00	0.00	0.57	0.00
SONC08	1.00	0.47	0.00	0.00	0.29	0.24	0.00	0.00	0.16	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Tue Nov 10 10:53:19 2020
Analysis ended on: Tue Nov 10 10:53:23 2020
Total elapsed time: 00:00:04

Appendix B

7. Model Result Tables

Pre-Development Condition

2-Year / 24h ARI, without Climate Change

Sub-Catchment Runoff

Sub-Catchment	Total Precip	Total Infil	Imperv Runoff	Perv Runoff	Total Runoff	Total Runoff	Peak Runoff	Runoff Coeff
	mm	mm	mm	mm	mm	10^6 ltr	CMS	
OFFC01	75.22	70.99	0	4.23	4.23	1.31	0.24	0.056
OFFC02	75.22	68.75	0	6.47	6.47	0.04	0.01	0.086
OFFC03	75.22	72.54	0	2.68	2.68	0.49	0.07	0.036
ONC01	75.22	70.64	0	4.58	4.58	0.05	0.01	0.061
ONC02	75.22	71.5	0	3.72	3.72	0.19	0.03	0.05
ONC03	75.22	71.78	0	3.44	3.44	0.88	0.14	0.046
ONC04	75.22	69.97	0	5.25	5.25	0.19	0.04	0.07
ONC05	75.22	69.35	0	5.87	5.87	0.07	0.02	0.078
ONC06	75.22	70.57	0	4.66	4.66	0.35	0.07	0.062
ONC07	75.22	73.45	0	1.77	1.77	0.11	0.01	0.024
ONC08	75.22	70.64	0	4.58	4.58	0.22	0.04	0.061
ONC09	75.22	70.24	0	4.98	4.98	0.1	0.02	0.066
ONC10	75.22	71.3	0	3.93	3.93	0.03	0.01	0.052

Oufall Loading

Outfall Node	Flow Freq.	Avg. Flow	Max. Flow	Total Volume
	Pcnt.	CMS	CMS	10^6 ltr
ONC01_OUT	6.58	0.005	0.01	0.053
ONC02_OUT	7.39	0.015	0.032	0.194
ONC03_OUT	15.59	0.081	0.378	2.192
ONC04_OUT	6.23	0.021	0.055	0.228
ONC05_OUT	5.42	0.007	0.018	0.07
ONC06_OUT	6.63	0.03	0.068	0.346
ONC07_OUT	8.83	0.007	0.014	0.112
ONC08_OUT	10.85	0.038	0.111	0.708
ONC09_OUT	6.29	0.009	0.021	0.101
ONC10_OUT	7.06	0.003	0.006	0.033

Pre-Development Condition

2-Year / 24h ARI, with Climate Change

Sub-Catchment Runoff

Sub-Catchment	Total Precip	Total Infil	Imperv Runoff	Perv Runoff	Total Runoff	Total Runoff	Peak Runoff	Runoff Coeff
	mm	mm	mm	mm	mm	10^6 ltr	CMS	
OFFC01	86.38	78.69	0	7.69	7.69	2.39	0.39	0.089
OFFC02	86.38	76.13	0	10.25	10.25	0.06	0.02	0.119
OFFC03	86.38	80.93	0	5.46	5.46	0.99	0.12	0.063
ONC01	86.38	78.24	0	8.14	8.14	0.09	0.02	0.094
ONC02	86.38	79.37	0	7.01	7.01	0.37	0.05	0.081
ONC03	86.38	79.78	0	6.6	6.6	1.69	0.23	0.076
ONC04	86.38	77.43	0	8.95	8.95	0.32	0.07	0.104
ONC05	86.38	76.74	0	9.64	9.64	0.12	0.03	0.112
ONC06	86.38	78.15	0	8.24	8.24	0.61	0.11	0.095
ONC07	86.38	82.5	0	3.88	3.88	0.25	0.02	0.045
ONC08	86.38	78.24	0	8.14	8.14	0.39	0.07	0.094
ONC09	86.38	77.75	0	8.63	8.63	0.17	0.03	0.1
ONC10	86.38	79.1	0	7.29	7.29	0.06	0.01	0.084

Oufall Loading

Outfall Node	Flow Freq.	Avg. Flow	Max. Flow	Total Volume
	Pcnt.	CMS	CMS	10^6 ltr
ONC01_OUT	8.09	0.007	0.017	0.094
ONC02_OUT	9.18	0.023	0.053	0.365
ONC03_OUT	17.19	0.137	0.619	4.077
ONC04_OUT	7.44	0.03	0.087	0.385
ONC05_OUT	6.59	0.01	0.03	0.115
ONC06_OUT	8.12	0.044	0.11	0.612
ONC07_OUT	11.48	0.012	0.025	0.247
ONC08_OUT	13.06	0.061	0.184	1.383
ONC09_OUT	7.67	0.013	0.034	0.175
ONC10_OUT	8.78	0.004	0.009	0.062

Pre-Development Condition

10-Year / 24h ARI, without Climate Change

Sub-Catchment Runoff

Sub-Catchment	Total Precip	Total Infil	Imperv Runoff	Perv Runoff	Total Runoff	Total Runoff	Peak Runoff	Runoff Coeff
	mm	mm	mm	mm	mm	10^6 ltr	CMS	
OFFC01	111.13	93.47	0	17.66	17.66	5.48	0.81	0.159
OFFC02	111.13	90.91	0	20.22	20.22	0.12	0.04	0.182
OFFC03	111.13	96.62	0	14.51	14.51	2.63	0.26	0.131
ONC01	111.13	92.95	0	18.18	18.18	0.21	0.03	0.164
ONC02	111.13	94.33	0	16.8	16.8	0.87	0.11	0.151
ONC03	111.13	94.88	0	16.25	16.25	4.16	0.49	0.146
ONC04	111.13	92.08	0	19.05	19.05	0.69	0.14	0.171
ONC05	111.13	91.43	0	19.7	19.7	0.24	0.06	0.177
ONC06	111.13	92.84	0	18.29	18.29	1.36	0.23	0.165
ONC07	111.13	99.49	0	11.64	11.64	0.74	0.06	0.105
ONC08	111.13	92.94	0	18.19	18.19	0.88	0.14	0.164
ONC09	111.13	92.41	0	18.72	18.72	0.38	0.07	0.168
ONC10	111.13	93.97	0	17.16	17.16	0.14	0.02	0.154

Oufall Loading

Outfall Node	Flow Freq.	Avg. Flow	Max. Flow	Total Volume
	Pcnt.	CMS	CMS	10^6 ltr
ONC01_OUT	11.06	0.011	0.034	0.209
ONC02_OUT	12.43	0.041	0.112	0.875
ONC03_OUT	20.25	0.275	1.294	9.637
ONC04_OUT	10.27	0.046	0.181	0.809
ONC05_OUT	9.31	0.015	0.061	0.236
ONC06_OUT	11.09	0.071	0.227	1.359
ONC07_OUT	16	0.027	0.056	0.739
ONC08_OUT	16.85	0.121	0.387	3.511
ONC09_OUT	10.56	0.021	0.07	0.379
ONC10_OUT	11.95	0.007	0.02	0.145

Pre-Development Condition

10-Year / 24h ARI, with Climate Change

Sub-Catchment Runoff

Sub-Catchment	Total Precip	Total Infil	Imperv Runoff	Perv Runoff	Total Runoff	Total Runoff	Peak Runoff	Runoff Coeff
	mm	mm	mm	mm	mm	10^6 ltr	CMS	
OFFC01	130.06	102.72	0	27.34	27.34	8.48	1.23	0.21
OFFC02	130.06	100.31	0	29.75	29.75	0.18	0.06	0.229
OFFC03	130.06	106.19	0	23.87	23.87	4.33	0.4	0.184
ONC01	130.06	102.2	0	27.86	27.86	0.32	0.05	0.214
ONC02	130.06	103.62	0	26.44	26.44	1.38	0.17	0.203
ONC03	130.06	104.21	0	25.85	25.85	6.61	0.76	0.199
ONC04	130.06	101.36	0	28.7	28.7	1.03	0.22	0.221
ONC05	130.06	100.77	0	29.29	29.29	0.35	0.09	0.225
ONC06	130.06	102.09	0	27.97	27.97	2.08	0.35	0.215
ONC07	130.06	109.79	0	20.27	20.27	1.29	0.09	0.156
ONC08	130.06	102.19	0	27.87	27.87	1.35	0.22	0.214
ONC09	130.06	101.68	0	28.39	28.39	0.57	0.11	0.218
ONC10	130.06	103.24	0	26.82	26.82	0.23	0.03	0.206

Oufall Loading

Outfall Node	Flow Freq.	Avg. Flow	Max. Flow	Total Volume
	Pcnt.	CMS	CMS	10^6 ltr
ONC01_OUT	13.19	0.014	0.052	0.321
ONC02_OUT	14.6	0.055	0.172	1.377
ONC03_OUT	22.39	0.39	1.984	15.097
ONC04_OUT	12.46	0.056	0.275	1.214
ONC05_OUT	11.56	0.018	0.094	0.35
ONC06_OUT	13.23	0.091	0.348	2.079
ONC07_OUT	18.64	0.04	0.088	1.287
ONC08_OUT	19.2	0.171	0.597	5.676
ONC09_OUT	12.72	0.026	0.109	0.575
ONC10_OUT	14.09	0.009	0.03	0.226

Pre-Development Condition

100-Year / 24h ARI, without Climate Change

Sub-Catchment Runoff

Sub-Catchment	Total Precip	Total Infil	Imperv Runoff	Perv Runoff	Total Runoff	Total Runoff	Peak Runoff	Runoff Coeff
	mm	mm	mm	mm	mm	10^6 ltr	CMS	
OFFC01	167.91	117.22	0	50.69	50.69	15.73	2.39	0.302
OFFC02	167.91	114.92	0	52.99	52.99	0.32	0.11	0.316
OFFC03	167.91	120.91	0	47	47	8.52	0.77	0.28
ONC01	167.91	116.71	0	51.2	51.2	0.59	0.1	0.305
ONC02	167.91	118.11	0	49.79	49.79	2.59	0.33	0.297
ONC03	167.91	118.73	0	49.18	49.18	12.58	1.46	0.293
ONC04	167.91	115.91	0	51.99	51.99	1.87	0.4	0.31
ONC05	167.91	115.35	0	52.55	52.55	0.63	0.17	0.313
ONC06	167.91	116.6	0	51.31	51.31	3.81	0.67	0.306
ONC07	167.91	125.39	0	42.51	42.51	2.7	0.18	0.253
ONC08	167.91	116.7	0	51.21	51.21	2.48	0.42	0.305
ONC09	167.91	116.21	0	51.7	51.7	1.05	0.2	0.308
ONC10	167.91	117.73	0	50.18	50.18	0.42	0.06	0.299

Oufall Loading

Outfall Node	Flow Freq.	Avg. Flow	Max. Flow	Total Volume
	Pcnt.	CMS	CMS	10^6 ltr
ONC01_OUT	17.49	0.02	0.1	0.589
ONC02_OUT	18.84	0.08	0.33	2.593
ONC03_OUT	26.71	0.613	3.804	28.315
ONC04_OUT	16.88	0.075	0.504	2.194
ONC05_OUT	16.05	0.023	0.17	0.628
ONC06_OUT	17.57	0.126	0.666	3.813
ONC07_OUT	23.05	0.068	0.176	2.7
ONC08_OUT	23.47	0.271	1.148	10.998
ONC09_OUT	17.08	0.035	0.204	1.047
ONC10_OUT	18.3	0.013	0.058	0.424

Pre-Development Condition

100-Year / 24h ARI, with Climate Change

Sub-Catchment Runoff

Sub-Catchment	Total Precip	Total Infil	Imperv Runoff	Perv Runoff	Total Runoff	Total Runoff	Peak Runoff	Runoff Coeff
	mm	mm	mm	mm	mm	10^6 ltr	CMS	
OFFC01	198.24	125.21	0	73.02	73.02	22.66	3.43	0.368
OFFC02	198.24	122.9	0	75.34	75.34	0.46	0.14	0.38
OFFC03	198.24	128.99	0	69.24	69.24	12.55	1.16	0.349
ONC01	198.24	124.7	0	73.53	73.53	0.85	0.14	0.371
ONC02	198.24	126.12	0	72.12	72.12	3.76	0.49	0.364
ONC03	198.24	126.74	0	71.49	71.49	18.3	2.17	0.361
ONC04	198.24	123.91	0	74.33	74.33	2.68	0.56	0.375
ONC05	198.24	123.34	0	74.89	74.89	0.9	0.23	0.378
ONC06	198.24	124.6	0	73.64	73.64	5.47	0.95	0.371
ONC07	198.24	133.88	0	64.36	64.36	4.09	0.27	0.325
ONC08	198.24	124.7	0	73.54	73.54	3.56	0.6	0.371
ONC09	198.24	124.2	0	74.03	74.03	1.5	0.29	0.373
ONC10	198.24	125.73	0	72.51	72.51	0.61	0.08	0.366

Oufall Loading

Outfall Node	Flow Freq.	Avg. Flow	Max. Flow	Total Volume
	Pcnt.	CMS	CMS	10^6 ltr
ONC01_OUT	21.82	0.022	0.143	0.846
ONC02_OUT	23.08	0.094	0.488	3.755
ONC03_OUT	31.05	0.763	5.548	40.956
ONC04_OUT	21.28	0.085	0.688	3.133
ONC05_OUT	20.48	0.025	0.227	0.896
ONC06_OUT	21.92	0.145	0.946	5.473
ONC07_OUT	27.15	0.087	0.268	4.087
ONC08_OUT	27.63	0.338	1.709	16.111
ONC09_OUT	21.45	0.04	0.288	1.499
ONC10_OUT	22.54	0.016	0.085	0.612

Appendix C – Post-Development Hydrologic & Hydraulic Data

1. HIRDS rainfall. Climate Change
2. SWMM Catchment Diagram
3. Post-Development Catchment Characteristics
4. SWMM Output Report
5. Model Result Tables

Appendix C

1. HIRDS rainfall. Climate Change

HIRDS V4 Depth-Duration-Frequency Results
Sitename: Custom Location
Coordinate system: WGS84
Longitude: 174.8455
Latitude: -37.8222

DDF Model	Parameter	c	d	e	f	g	h	i
	Values:	-0.00081	0.430215	-0.01732	0	0.235352	-0.00869	3.031692
	Example:	Duration (ł	ARI (yrs)	x	y	Rainfall Depth (mm)		
		24	100	3.178054	4.600149	165.8225		

Rainfall depths (mm) :: Historical Data

ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	9.07	12.6	15.3	20.7	27.7	42.4	54.2	68.3	84.5	95	103	109
2	0.5	9.88	13.8	16.6	22.6	30.2	46.1	59	74.3	92	103	112	119
5	0.2	12.7	17.7	21.3	28.9	38.6	59	75.5	95	117	132	143	152
10	0.1	14.8	20.6	24.8	33.7	45	68.7	87.8	110	136	153	166	176
20	0.05	17	23.6	28.5	38.6	51.5	78.6	101	126	156	175	190	201
30	0.033	18.3	25.5	30.7	41.6	55.5	84.7	108	136	168	189	204	217
40	0.025	19.3	26.8	32.3	43.8	58.4	89.1	114	143	177	198	215	228
50	0.02	20	27.9	33.6	45.5	60.7	92.5	118	148	183	206	223	236
60	0.017	20.6	28.7	34.6	46.9	62.5	95.4	122	153	189	212	230	243
80	0.012	21.7	30.1	36.3	49.2	65.5	99.9	128	160	198	222	240	255
100	0.01	22.4	31.2	37.6	50.9	67.9	103	132	166	205	230	249	264
250	0.004	25.7	35.8	43.1	58.3	77.7	118	151	189	234	262	284	301

HIRDS 4 Table 6 Percentage change factors to project rainfall depths derived from the current climate to a future climate that is 1 degree warmer.

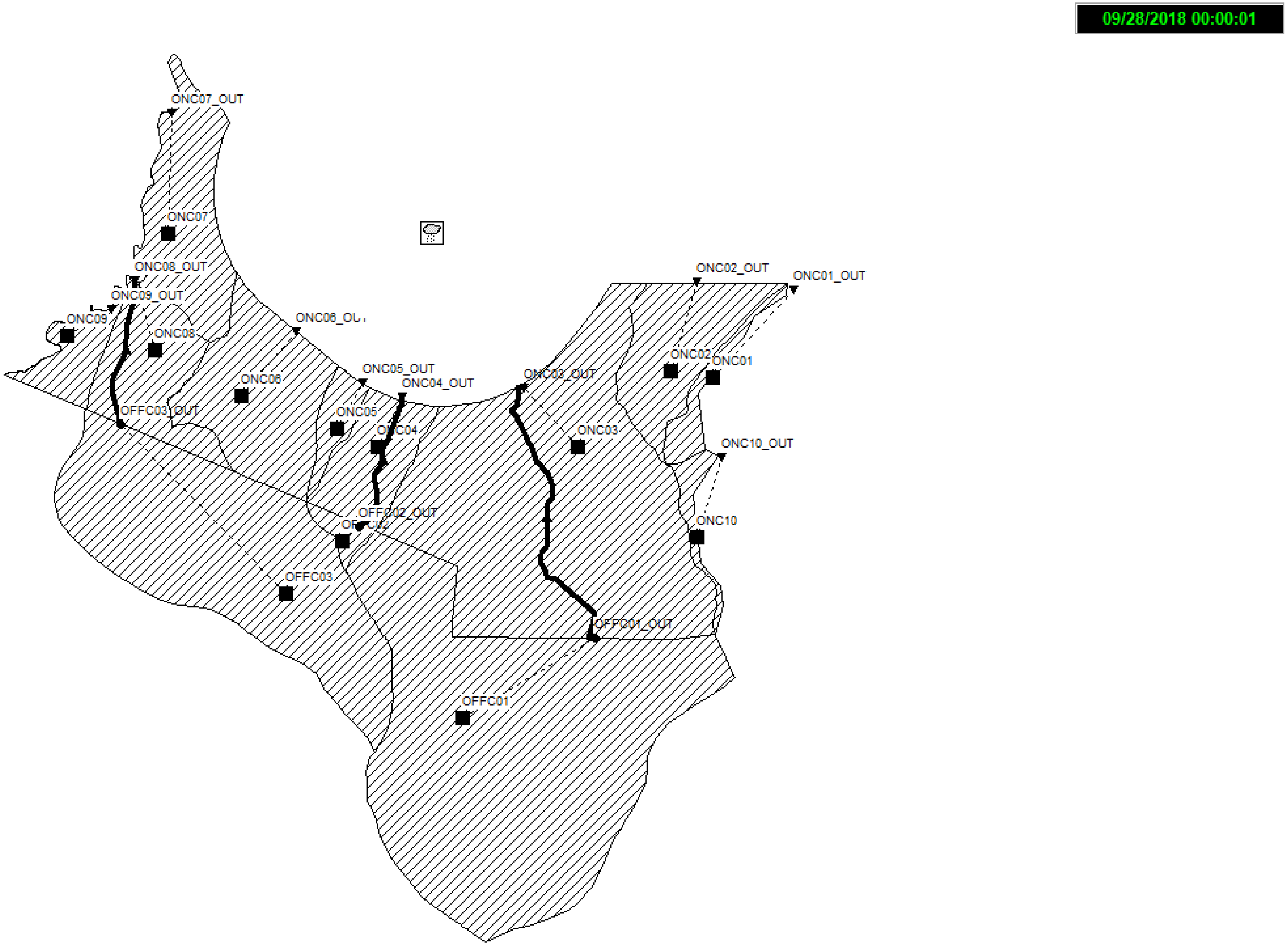
DURATION/ARI	**2yr**	**5yr**	**10yr**	**20yr**	**30yr**	**40yr**	**50yr**	**60yr**	**80yr**	**100yr**
1 h	12.2	12.8	13.1	13.3	13.4	13.4	13.5	13.5	13.6	13.6
2 h	11.7	12.3	12.6	12.8	12.9	12.9	13	13	13.1	13.1
6 h	9.8	10.5	10.8	11.1	11.2	11.3	11.3	11.4	11.4	11.5
12 h	8.5	9.2	9.5	9.7	9.8	9.9	9.9	10	10	10.1
24 h	7.2	7.8	8.1	8.2	8.3	8.4	8.4	8.5	8.5	8.6
48 h	6.1	6.7	7	7.2	7.3	7.3	7.4	7.4	7.5	7.5
72 h	5.5	6.2	6.5	6.6	6.7	6.8	6.8	6.9	6.9	6.9
96 h	5.1	5.7	6	6.2	6.3	6.3	6.4	6.4	6.4	6.5
120 h	4.8	5.4	5.7	5.8	5.9	6	6	6	6.1	6.1

			Climate Change Adjusted Rainfall Data - **2.1** degrees Celsius								
Rainfall intensities (mm/h)			Duration								
ARI(y)	aep	10m	20m	30m	60m	2h	6h	12h	24h	48h	72h
2	0.5	74.47	52.01	41.71	28.39	18.81	9.26	5.79	3.56	1.75	1.15
5	0.2	96.68	67.37	54.05	36.67	24.29	12	7.51	4.61	4.52	4.47
10	0.1	113.23	78.8	63.24	42.97	28.45	14.05	8.78	5.36	5.26	5.21
20	0.05	130.49	90.57	72.92	49.38	32.67	16.15	10.13	6.15	6.04	5.98
50	0.02	154.02	107.43	86.25	58.4	38.64	19.08	11.88	7.25	7.12	7.12
100	0.01	172.78	120.33	96.68	65.44	43.29	21.31	13.33	8.17	8.01	7.92

Appendix C

2. SWMM Catchment Diagram

SWMM MODEL LAYOUT



Appendix C

3. Post-Development Catchment Characteristics

BLOXAM BURNETT & OLLIVER

Client :	KONING FAMILY TRUST	By	CF
		Checked	EV
		Approved	TK
Project :	RAGLAN REZONING	Revision	**A**
		Date	10/11/2020

Koning Family Trust

Post-Development Sub-Catchment Characteristics

ID	A	A	A_{imp}	A_{perv}	L_{fp}	Width (A/L_{fp})	Slope	Percent Impervious	n_{impwev}	n_{perv}	D-Store Imperv.	D-Store Perv.	Infiltration (Horton) f_i	f_o	Decay Const.
	m^2	ha	m^2	m^2	m	m	%	%			mm	mm			
ONC01	11511	1.1511	3624	7887	440	26.16	6.95	31.48	0.015	0.15	2	5	25	6	4
ONC02	52066	5.2066	30381	21685	398	130.82	2.24	58.35	0.015	0.15	2	5	25	6	4
ONC03	255897	25.5897	85521	170376	576	444.27	3.43	33.42	0.015	0.15	2	5	25	6	4
ONC04	36034	3.6034	10180	25854	266	135.47	5.53	28.25	0.015	0.15	2	5	25	6	4
ONC05	11959	1.1959	3276	8683	262	45.65	11.83	27.39	0.015	0.15	2	5	25	6	4
ONC06	74325	7.4325	29968	44357	421	176.54	6.94	40.32	0.015	0.15	2	5	25	6	4
ONC07	63503	6.3503	22163	41340	563	112.79	0.41	34.90	0.015	0.15	2	5	25	6	4
ONC08	48406	4.8406	19769	28637	293	165.21	3.1	40.84	0.015	0.15	2	5	25	6	4
ONC09	20253	2.0253	4944	15309	210	96.44	5.06	24.41	0.015	0.15	2	5	25	6	4
ONC10	8440	0.844	1938	6502	377	22.39	2.5	22.96	0.015	0.15	2	5	25	6	4
OFFC01	310314	31.0314	0	310314	690	449.73	11.64	0.00	0.015	0.15	2	5	25	6	4
OFFC02	6040	0.604	0	6040	116	52.07	5.72	0.00	0.015	0.15	2	5	25	6	4
OFFC03	181269	18.1269	0	181269	900	201.41	3.54	0.00	0.015	0.15	2	5	25	6	4

GLOSSARY:

A_{imp}: Impervious area of a catchment

A_{per}: Pervious area of a catchment

L_{fp}: Length of overland flow

Slope: Average surface slope

n_{imperv}: Manning Number for impervious area

n_{perv}: Manning Number for pervious area

D-Store Imperv.: Depth of depression storage on impervious area

D-Store Perv.: Depth of depression storage on pervious area

f_i:Maximum rate on the Horton infiltration curve

f_o:Minimum rate on the Horton infiltration curve

Decay Const.: Decay constant for the Horton infiltration curve

Appendix C

4. SWMM Output Report

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)

Water Quality. 1/3rd of the 2-year/24h ARI

```
*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 09/28/2018 00:00:00
Ending Date .............. 09/29/2018 06:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:00:01
Wet Time Step ............ 00:00:01
Dry Time Step ............ 00:00:01
Routing Time Step ........ 1.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 20
Number of Threads ........ 1
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         3.110        28.792
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         2.501        23.154
Surface Runoff ...........         0.566         5.242
Final Storage ............         0.043         0.395
Continuity Error (%) .....         0.000


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.566         5.661
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         0.566         5.661
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....         0.000


***************************
Time-Step Critical Elements
***************************
None


********************************
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :      0.50 sec
Average Time Step           :      1.00 sec
Maximum Time Step           :      1.00 sec
Percent in Steady State     :      0.00
Average Iterations per Step :      2.00
Percent Not Converging      :      0.00
```

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
ONC01	28.79	0.00	0.00	19.73	8.43	0.00	8.43	0.10	0.02	0.293
ONC02	28.79	0.00	0.00	11.99	15.61	0.00	15.61	0.81	0.11	0.542
ONC03	28.79	0.00	0.00	19.17	8.95	0.00	8.95	2.29	0.34	0.311
ONC04	28.79	0.00	0.00	20.66	7.57	0.00	7.57	0.27	0.05	0.263
ONC05	28.79	0.00	0.00	20.91	7.47	0.00	7.47	0.09	0.02	0.260
ONC06	28.79	0.00	0.00	17.18	10.80	0.00	10.80	0.80	0.13	0.375
ONC07	28.79	0.00	0.00	18.74	9.32	0.00	9.32	0.59	0.06	0.324
ONC08	28.79	0.00	0.00	17.03	10.94	0.00	10.94	0.53	0.09	0.380
ONC09	28.79	0.00	0.00	22.18	6.15	0.00	6.15	0.12	0.02	0.214
ONC10	28.79	0.00	0.00	22.18	6.15	0.00	6.15	0.05	0.01	0.214
OFFC01	28.79	0.00	0.00	28.79	0.00	0.00	0.00	0.00	0.00	0.000
OFFC02	28.79	0.00	0.00	28.79	0.00	0.00	0.00	0.00	0.00	0.000
OFFC03	28.79	0.00	0.00	28.79	0.00	0.00	0.00	0.00	0.00	0.000

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
OFFC01_OUT	JUNCTION	0.00	0.00	47.25	0 00:00	0.00
OFFC02_OUT	JUNCTION	0.00	0.00	59.75	0 00:00	0.00
OFFC03_OUT	JUNCTION	0.00	0.00	39.25	0 00:00	0.00
ONC01_OUT	OUTFALL	0.00	0.00	32.75	0 00:00	0.00
ONC02_OUT	OUTFALL	0.00	0.00	23.25	0 00:00	0.00
ONC03_OUT	OUTFALL	0.00	0.00	17.50	0 00:00	0.00
ONC04_OUT	OUTFALL	0.00	0.00	26.50	0 00:00	0.00
ONC05_OUT	OUTFALL	0.00	0.00	31.00	0 00:00	0.00
ONC06_OUT	OUTFALL	0.00	0.00	19.50	0 00:00	0.00
ONC07_OUT	OUTFALL	0.00	0.00	9.75	0 00:00	0.00
ONC08_OUT	OUTFALL	0.00	0.00	12.75	0 00:00	0.00
ONC09_OUT	OUTFALL	0.00	0.00	14.75	0 00:00	0.00
ONC10_OUT	OUTFALL	0.00	0.00	54.75	0 00:00	0.00

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
OFFC01_OUT	JUNCTION	0.000	0.000	0 00:00	0	0	0.000 ltr
OFFC02_OUT	JUNCTION	0.000	0.000	0 00:00	0	0	0.000 ltr
OFFC03_OUT	JUNCTION	0.000	0.000	0 00:00	0	0	0.000 ltr
ONC01_OUT	OUTFALL	0.017	0.017	0 12:10	0.0971	0.0971	0.000
ONC02_OUT	OUTFALL	0.106	0.106	0 12:10	0.813	0.813	0.000
ONC03_OUT	OUTFALL	0.337	0.337	0 12:10	2.29	2.29	0.000
ONC04_OUT	OUTFALL	0.050	0.050	0 12:10	0.273	0.273	0.000
ONC05_OUT	OUTFALL	0.017	0.017	0 12:10	0.0894	0.0894	0.000
ONC06_OUT	OUTFALL	0.132	0.132	0 12:10	0.803	0.803	0.000
ONC07_OUT	OUTFALL	0.060	0.060	0 12:10	0.592	0.592	0.000
ONC08_OUT	OUTFALL	0.086	0.086	0 12:10	0.529	0.529	0.000
ONC09_OUT	OUTFALL	0.023	0.023	0 12:10	0.125	0.125	0.000
ONC10_OUT	OUTFALL	0.009	0.009	0 12:10	0.0519	0.0519	0.000

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
ONC01_OUT	70.51	0.001	0.017	0.097
ONC02_OUT	87.65	0.009	0.106	0.813
ONC03_OUT	87.72	0.024	0.337	2.289
ONC04_OUT	72.73	0.003	0.050	0.273
ONC05_OUT	80.40	0.001	0.017	0.089
ONC06_OUT	83.82	0.009	0.132	0.803
ONC07_OUT	87.55	0.006	0.060	0.592
ONC08_OUT	80.89	0.006	0.086	0.529
ONC09_OUT	70.05	0.002	0.023	0.125
ONC10_OUT	68.61	0.001	0.009	0.052
System	78.99	0.062	0.009	5.661

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
SONC03	CHANNEL	0.000	0 00:00	0.00	0.00	0.00
SONC04	CHANNEL	0.000	0 00:00	0.00	0.00	0.00
SONC08	CHANNEL	0.000	0 00:00	0.00	0.00	0.00

****
Flow Classification Summary
****

Conduit	Adjusted /Actual Length	Fraction of Time in Flow Class								
		Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
SONC03	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SONC04	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SONC08	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Tue Nov 10 12:45:20 2020
Analysis ended on: Tue Nov 10 12:45:22 2020
Total elapsed time: 00:00:02

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)
--------------------------------------------------------------
```

2-year/24h ARI with Climate Change

```
*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 09/28/2018 00:00:00
Ending Date .............. 09/29/2018 06:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:00:01
Wet Time Step ............ 00:00:01
Dry Time Step ............ 00:00:01
Routing Time Step ........ 1.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 20
Number of Threads ........ 1
Head Tolerance ........... 0.001500 m

**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......         9.330        86.383
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         6.862        63.532
Surface Runoff ...........         2.425        22.455
Final Storage ............         0.043         0.396
Continuity Error (%) .....         0.000

**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         2.425        24.252
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         2.425        24.252
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....        -0.000

***************************
Time-Step Critical Elements
***************************
None

********************************
Highest Flow Instability Indexes
********************************
All links are stable.

*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.50 sec
Average Time Step           :     1.00 sec
Maximum Time Step           :     1.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.00
Percent Not Converging      :     0.00
```

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
ONC01	86.38	0.00	0.00	53.07	26.56	6.12	32.68	0.38	0.07	0.378
ONC02	86.38	0.00	0.00	32.23	49.21	3.75	52.96	2.76	0.42	0.613
ONC03	86.38	0.00	0.00	52.43	28.19	5.08	33.28	8.52	1.33	0.385
ONC04	86.38	0.00	0.00	55.13	23.84	6.85	30.68	1.11	0.21	0.355
ONC05	86.38	0.00	0.00	55.39	23.25	7.33	30.58	0.37	0.08	0.354
ONC06	86.38	0.00	0.00	46.02	34.02	5.53	39.55	2.94	0.52	0.458
ONC07	86.38	0.00	0.00	52.99	29.41	3.24	32.65	2.07	0.25	0.378
ONC08	86.38	0.00	0.00	45.66	34.46	5.45	39.91	1.93	0.34	0.462
ONC09	86.38	0.00	0.00	59.51	19.37	7.04	26.42	0.53	0.10	0.306
ONC10	86.38	0.00	0.00	60.45	19.37	6.10	25.47	0.21	0.04	0.295
OFFC01	86.38	0.00	0.00	78.69	0.00	7.69	7.69	2.39	0.39	0.089
OFFC02	86.38	0.00	0.00	76.13	0.00	10.25	10.25	0.06	0.02	0.119
OFFC03	86.38	0.00	0.00	80.93	0.00	5.46	5.46	0.99	0.12	0.063

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
OFFC01_OUT	JUNCTION	0.01	0.15	47.40	0 12:35	0.15
OFFC02_OUT	JUNCTION	0.00	0.04	59.79	0 12:17	0.04
OFFC03_OUT	JUNCTION	0.01	0.08	39.33	0 12:47	0.08
ONC01_OUT	OUTFALL	0.00	0.00	32.75	0 00:00	0.00
ONC02_OUT	OUTFALL	0.00	0.00	23.25	0 00:00	0.00
ONC03_OUT	OUTFALL	0.01	0.15	17.65	0 12:35	0.15
ONC04_OUT	OUTFALL	0.00	0.04	26.54	0 12:17	0.04
ONC05_OUT	OUTFALL	0.00	0.00	31.00	0 00:00	0.00
ONC06_OUT	OUTFALL	0.00	0.00	19.50	0 00:00	0.00
ONC07_OUT	OUTFALL	0.00	0.00	9.75	0 00:00	0.00
ONC08_OUT	OUTFALL	0.01	0.08	12.83	0 12:47	0.08
ONC09_OUT	OUTFALL	0.00	0.00	14.75	0 00:00	0.00
ONC10_OUT	OUTFALL	0.00	0.00	54.75	0 00:00	0.00

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
OFFC01_OUT	JUNCTION	0.389	0.389	0 12:30	2.39	2.39	0.004
OFFC02_OUT	JUNCTION	0.021	0.021	0 12:15	0.0619	0.0619	-0.000
OFFC03_OUT	JUNCTION	0.118	0.118	0 12:45	0.989	0.989	-0.000
ONC01_OUT	OUTFALL	0.066	0.066	0 12:10	0.376	0.376	0.000
ONC02_OUT	OUTFALL	0.423	0.423	0 12:10	2.76	2.76	0.000
ONC03_OUT	OUTFALL	1.330	1.437	0 12:10	8.52	10.9	0.000
ONC04_OUT	OUTFALL	0.211	0.222	0 12:10	1.11	1.17	0.000
ONC05_OUT	OUTFALL	0.077	0.077	0 12:10	0.366	0.366	0.000
ONC06_OUT	OUTFALL	0.521	0.521	0 12:10	2.94	2.94	0.000
ONC07_OUT	OUTFALL	0.250	0.250	0 12:10	2.07	2.07	0.000
ONC08_OUT	OUTFALL	0.339	0.379	0 12:10	1.93	2.92	0.000
ONC09_OUT	OUTFALL	0.098	0.098	0 12:10	0.535	0.535	0.000
ONC10_OUT	OUTFALL	0.035	0.035	0 12:10	0.215	0.215	0.000

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
ONC01_OUT	79.52	0.004	0.066	0.376
ONC02_OUT	95.10	0.027	0.423	2.757
ONC03_OUT	95.13	0.106	1.437	10.902
ONC04_OUT	81.39	0.013	0.222	1.168
ONC05_OUT	81.85	0.004	0.077	0.366
ONC06_OUT	92.88	0.029	0.521	2.939
ONC07_OUT	95.05	0.020	0.250	2.074
ONC08_OUT	90.09	0.030	0.379	2.921
ONC09_OUT	78.70	0.006	0.098	0.535
ONC10_OUT	77.71	0.003	0.035	0.215
System	86.74	0.243	0.035	24.252

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
SONC03	CHANNEL	0.387	0 12:35	1.16	0.00	0.08
SONC04	CHANNEL	0.020	0 12:17	0.80	0.00	0.02
SONC08	CHANNEL	0.118	0 12:47	1.06	0.00	0.04

****
Flow Classification Summary
****

	Adjusted	---------- Fraction of Time in Flow Class ----------								
Conduit	/Actual Length	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
SONC03	1.00	0.40	0.00	0.00	0.52	0.08	0.00	0.00	0.00	0.00
SONC04	1.00	0.52	0.00	0.00	0.37	0.11	0.00	0.00	0.46	0.00
SONC08	1.00	0.40	0.00	0.00	0.44	0.16	0.00	0.00	0.24	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Tue Nov 10 12:45:56 2020
Analysis ended on: Tue Nov 10 12:45:58 2020
Total elapsed time: 00:00:02

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)

10-year/24h ARI with Climate Change

```
*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 09/28/2018 00:00:00
Ending Date .............. 09/29/2018 06:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:00:01
Wet Time Step ............ 00:00:01
Dry Time Step ............ 00:00:01
Routing Time Step ........ 1.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 20
Number of Threads ........ 1
Head Tolerance ........... 0.001500 m


**************************        Volume         Depth
Runoff Quantity Continuity     hectare-m            mm
**************************     ---------       -------
Total Precipitation ......        14.047       130.060
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         8.978        83.124
Surface Runoff ...........         5.026        46.540
Final Storage ............         0.043         0.396
Continuity Error (%) .....         0.000


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         5.026        50.264
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........         5.026        50.264
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         0.000         0.000
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.000         0.000
Continuity Error (%) .....        -0.000


***************************
Time-Step Critical Elements
***************************
None


********************************
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.50 sec
Average Time Step           :     1.00 sec
Maximum Time Step           :     1.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.00
Percent Not Converging      :     0.00
```

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
ONC01	130.06	0.00	0.00	69.47	40.31	19.65	59.96	0.69	0.13	0.461
ONC02	130.06	0.00	0.00	42.20	74.70	11.97	86.66	4.51	0.75	0.666
ONC03	130.06	0.00	0.00	68.44	42.79	18.15	60.94	15.60	2.45	0.469
ONC04	130.06	0.00	0.00	72.36	36.18	20.96	57.13	2.06	0.43	0.439
ONC05	130.06	0.00	0.00	72.92	35.21	21.52	56.73	0.68	0.16	0.436
ONC06	130.06	0.00	0.00	60.32	51.63	17.30	68.92	5.12	0.98	0.530
ONC07	130.06	0.00	0.00	69.76	44.65	14.91	59.56	3.78	0.44	0.458
ONC08	130.06	0.00	0.00	59.83	52.29	17.12	69.41	3.36	0.63	0.534
ONC09	130.06	0.00	0.00	77.96	29.40	22.24	51.64	1.05	0.21	0.397
ONC10	130.06	0.00	0.00	78.93	29.40	21.27	50.67	0.43	0.07	0.390
OFFC01	130.06	0.00	0.00	102.72	0.00	27.34	27.34	8.48	1.23	0.210
OFFC02	130.06	0.00	0.00	100.31	0.00	29.75	29.75	0.18	0.06	0.229
OFFC03	130.06	0.00	0.00	106.19	0.00	23.87	23.87	4.33	0.40	0.184

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
OFFC01_OUT	JUNCTION	0.03	0.26	47.51	0 12:25	0.26
OFFC02_OUT	JUNCTION	0.00	0.07	59.82	0 12:12	0.07
OFFC03_OUT	JUNCTION	0.02	0.15	39.40	0 12:40	0.15
ONC01_OUT	OUTFALL	0.00	0.00	32.75	0 00:00	0.00
ONC02_OUT	OUTFALL	0.00	0.00	23.25	0 00:00	0.00
ONC03_OUT	OUTFALL	0.03	0.26	17.76	0 12:25	0.26
ONC04_OUT	OUTFALL	0.00	0.07	26.57	0 12:12	0.07
ONC05_OUT	OUTFALL	0.00	0.00	31.00	0 00:00	0.00
ONC06_OUT	OUTFALL	0.00	0.00	19.50	0 00:00	0.00
ONC07_OUT	OUTFALL	0.00	0.00	9.75	0 00:00	0.00
ONC08_OUT	OUTFALL	0.02	0.15	12.90	0 12:40	0.15
ONC09_OUT	OUTFALL	0.00	0.00	14.75	0 00:00	0.00
ONC10_OUT	OUTFALL	0.00	0.00	54.75	0 00:00	0.00

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
OFFC01_OUT	JUNCTION	1.233	1.233	0 12:20	8.48	8.48	0.001
OFFC02_OUT	JUNCTION	0.064	0.064	0 12:10	0.18	0.18	-0.000
OFFC03_OUT	JUNCTION	0.396	0.396	0 12:40	4.33	4.33	-0.000
ONC01_OUT	OUTFALL	0.129	0.129	0 12:10	0.69	0.69	0.000
ONC02_OUT	OUTFALL	0.747	0.747	0 12:10	4.51	4.51	0.000
ONC03_OUT	OUTFALL	2.446	3.247	0 12:10	15.6	24.1	0.000
ONC04_OUT	OUTFALL	0.434	0.490	0 12:10	2.06	2.24	0.000
ONC05_OUT	OUTFALL	0.163	0.163	0 12:10	0.678	0.678	0.000
ONC06_OUT	OUTFALL	0.977	0.977	0 12:10	5.12	5.12	0.000
ONC07_OUT	OUTFALL	0.442	0.442	0 12:10	3.78	3.78	0.000
ONC08_OUT	OUTFALL	0.634	0.880	0 12:10	3.36	7.69	0.000
ONC09_OUT	OUTFALL	0.208	0.208	0 12:10	1.05	1.05	0.000
ONC10_OUT	OUTFALL	0.070	0.070	0 12:10	0.428	0.428	0.000

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
ONC01_OUT	81.49	0.008	0.129	0.690
ONC02_OUT	96.60	0.043	0.747	4.512
ONC03_OUT	96.63	0.231	3.247	24.078
ONC04_OUT	83.27	0.025	0.490	2.238
ONC05_OUT	82.22	0.008	0.163	0.678
ONC06_OUT	94.87	0.050	0.977	5.123
ONC07_OUT	96.57	0.036	0.442	3.783
ONC08_OUT	92.20	0.077	0.880	7.687
ONC09_OUT	80.57	0.012	0.208	1.046
ONC10_OUT	79.70	0.005	0.070	0.428
System	88.41	0.495	0.070	50.264

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
SONC03	CHANNEL	1.231	0 12:25	1.62	0.01	0.15
SONC04	CHANNEL	0.061	0 12:12	1.12	0.00	0.04
SONC08	CHANNEL	0.396	0 12:40	1.54	0.00	0.09

****
Flow Classification Summary
****

	Adjusted	---------- Fraction of Time in Flow Class ----------								
Conduit	/Actual Length	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
SONC03	1.00	0.39	0.00	0.00	0.46	0.15	0.00	0.00	0.00	0.00
SONC04	1.00	0.44	0.00	0.00	0.37	0.18	0.00	0.00	0.40	0.00
SONC08	1.00	0.39	0.00	0.00	0.35	0.26	0.00	0.00	0.15	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Tue Nov 10 12:46:34 2020
Analysis ended on: Tue Nov 10 12:46:37 2020
Total elapsed time: 00:00:03

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)

100-year/24h ARI with Climate Change

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

```
****************
Analysis Options
****************
Flow Units ............... CMS
Process Models:
  Rainfall/Runoff ........ YES
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Infiltration Method ...... HORTON
Flow Routing Method ...... DYNWAVE
Surcharge Method ......... EXTRAN
Starting Date ............ 09/28/2018 00:00:00
Ending Date .............. 09/29/2018 06:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:00:01
Wet Time Step ............ 00:00:01
Dry Time Step ............ 00:00:01
Routing Time Step ........ 1.00 sec
Variable Time Step ....... YES
Maximum Trials ........... 20
Number of Threads ........ 1
Head Tolerance ........... 0.001500 m
```

************************** Runoff Quantity Continuity **************************	Volume hectare-m	Depth mm
Total Precipitation	21.410	198.238
Evaporation Loss	0.000	0.000
Infiltration Loss	10.940	101.296
Surface Runoff	10.427	96.545
Final Storage	0.043	0.397
Continuity Error (%)	0.000	

************************** Flow Routing Continuity **************************	Volume hectare-m	Volume 10^6 ltr
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	10.427	104.271
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	0.000	0.000
External Outflow	10.427	104.271
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	-0.000	

```
***************************
Time-Step Critical Elements
***************************
None

********************************
Highest Flow Instability Indexes
********************************
All links are stable.

*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.50 sec
Average Time Step           :     1.00 sec
Maximum Time Step           :     1.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     2.00
Percent Not Converging      :     0.00
```

****
Subcatchment Runoff Summary
****

Subcatchment	Total Precip mm	Total Runon mm	Total Evap mm	Total Infil mm	Imperv Runoff mm	Perv Runoff mm	Total Runoff mm	Total Runoff 10^6 ltr	Peak Runoff CMS	Runoff Coeff
ONC01	198.24	0.00	0.00	84.92	61.77	50.92	112.69	1.30	0.25	0.568
ONC02	198.24	0.00	0.00	51.59	114.48	30.97	145.45	7.57	1.33	0.734
ONC03	198.24	0.00	0.00	83.41	65.57	48.57	114.15	29.21	4.76	0.576
ONC04	198.24	0.00	0.00	88.55	55.44	53.68	109.12	3.93	0.85	0.550
ONC05	198.24	0.00	0.00	89.32	53.89	54.62	108.51	1.30	0.31	0.547
ONC06	198.24	0.00	0.00	73.79	79.12	44.52	123.64	9.19	1.82	0.624
ONC07	198.24	0.00	0.00	84.76	68.45	44.29	112.73	7.16	0.84	0.569
ONC08	198.24	0.00	0.00	73.17	80.14	44.10	124.24	6.01	1.18	0.627
ONC09	198.24	0.00	0.00	95.33	45.06	57.39	102.44	2.07	0.43	0.517
ONC10	198.24	0.00	0.00	96.26	45.05	56.46	101.52	0.86	0.15	0.512
OFFC01	198.24	0.00	0.00	125.21	0.00	73.02	73.02	22.66	3.43	0.368
OFFC02	198.24	0.00	0.00	122.90	0.00	75.34	75.34	0.46	0.14	0.380
OFFC03	198.24	0.00	0.00	128.99	0.00	69.24	69.24	12.55	1.16	0.349

****
Node Depth Summary
****

Node	Type	Average Depth Meters	Maximum Depth Meters	Maximum HGL Meters	Time of Max Occurrence days hr:min	Reported Max Depth Meters
OFFC01_OUT	JUNCTION	0.05	0.41	47.66	0 12:16	0.41
OFFC02_OUT	JUNCTION	0.01	0.11	59.86	0 12:10	0.11
OFFC03_OUT	JUNCTION	0.04	0.26	39.51	0 12:25	0.26
ONC01_OUT	OUTFALL	0.00	0.00	32.75	0 00:00	0.00
ONC02_OUT	OUTFALL	0.00	0.00	23.25	0 00:00	0.00
ONC03_OUT	OUTFALL	0.05	0.41	17.91	0 12:16	0.41
ONC04_OUT	OUTFALL	0.01	0.11	26.61	0 12:11	0.11
ONC05_OUT	OUTFALL	0.00	0.00	31.00	0 00:00	0.00
ONC06_OUT	OUTFALL	0.00	0.00	19.50	0 00:00	0.00
ONC07_OUT	OUTFALL	0.00	0.00	9.75	0 00:00	0.00
ONC08_OUT	OUTFALL	0.04	0.26	13.01	0 12:25	0.26
ONC09_OUT	OUTFALL	0.00	0.00	14.75	0 00:00	0.00
ONC10_OUT	OUTFALL	0.00	0.00	54.75	0 00:00	0.00

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CMS	Maximum Total Inflow CMS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 ltr	Total Inflow Volume 10^6 ltr	Flow Balance Error Percent
OFFC01_OUT	JUNCTION	3.432	3.432	0 12:15	22.7	22.7	-0.000
OFFC02_OUT	JUNCTION	0.138	0.138	0 12:10	0.455	0.455	-0.000
OFFC03_OUT	JUNCTION	1.156	1.156	0 12:25	12.6	12.6	-0.000
ONC01_OUT	OUTFALL	0.252	0.252	0 12:10	1.3	1.3	0.000
ONC02_OUT	OUTFALL	1.330	1.330	0 12:10	7.57	7.57	0.000
ONC03_OUT	OUTFALL	4.756	7.614	0 12:10	29.2	51.9	0.000
ONC04_OUT	OUTFALL	0.846	0.973	0 12:10	3.93	4.39	0.000
ONC05_OUT	OUTFALL	0.308	0.308	0 12:10	1.3	1.3	0.000
ONC06_OUT	OUTFALL	1.816	1.816	0 12:10	9.19	9.19	0.000
ONC07_OUT	OUTFALL	0.839	0.839	0 12:10	7.16	7.16	0.000
ONC08_OUT	OUTFALL	1.177	2.146	0 12:10	6.01	18.6	0.000
ONC09_OUT	OUTFALL	0.425	0.425	0 12:10	2.07	2.07	0.000
ONC10_OUT	OUTFALL	0.145	0.145	0 12:10	0.857	0.857	0.000

****
Node Surcharge Summary
****

No nodes were surcharged.

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CMS	Max Flow CMS	Total Volume 10^6 ltr
ONC01_OUT	83.01	0.014	0.252	1.297
ONC02_OUT	97.71	0.072	1.330	7.573
ONC03_OUT	97.72	0.492	7.614	51.870
ONC04_OUT	84.72	0.048	0.973	4.387
ONC05_OUT	82.54	0.015	0.308	1.298
ONC06_OUT	96.41	0.088	1.816	9.189
ONC07_OUT	97.68	0.068	0.839	7.159
ONC08_OUT	94.01	0.183	2.146	18.566
ONC09_OUT	82.00	0.023	0.425	2.075
ONC10_OUT	81.24	0.010	0.145	0.857
System	89.70	1.012	0.145	104.271

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CMS	Time of Max Occurrence days hr:min	Maximum |Veloc| m/sec	Max/ Full Flow	Max/ Full Depth
SONC03	CHANNEL	3.386	0 12:16	1.95	0.03	0.23
SONC04	CHANNEL	0.131	0 12:11	1.38	0.00	0.05
SONC08	CHANNEL	1.155	0 12:25	2.09	0.01	0.15

****
Flow Classification Summary
****

	Adjusted	---------- Fraction of Time in Flow Class ----------								
Conduit	/Actual Length	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Norm Ltd	Inlet Ctrl
SONC03	1.00	0.33	0.00	0.00	0.41	0.26	0.00	0.00	0.00	0.00
SONC04	1.00	0.33	0.00	0.00	0.35	0.32	0.00	0.00	0.32	0.00
SONC08	1.00	0.33	0.00	0.00	0.29	0.38	0.00	0.00	0.08	0.00

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Tue Nov 10 12:47:00 2020
Analysis ended on: Tue Nov 10 12:47:03 2020
Total elapsed time: 00:00:03

Appendix C

5. Model Result Tables

Post-Development Condition

Water Quality Flow: 1/3rd of the 2-Year / 24h ARI, with Climate Change

Sub-Catchment Runoff

Sub-Catchment	Total Precip	Total Infil	Imperv Runoff	Perv Runoff	Total Runoff	Total Runoff	Peak Runoff	Runoff Coeff
	mm	mm	mm	mm	mm	10^6 ltr	CMS	
OFFC01	28.79	28.79	0	0	0	0	0	0
OFFC02	28.79	28.79	0	0	0	0	0	0
OFFC03	28.79	28.79	0	0	0	0	0	0
ONC01	28.79	19.73	8.43	0	8.43	0.1	0.02	0.293
ONC02	28.79	11.99	15.61	0	15.61	0.81	0.11	0.542
ONC03	28.79	19.17	8.95	0	8.95	2.29	0.34	0.311
ONC04	28.79	20.66	7.57	0	7.57	0.27	0.05	0.263
ONC05	28.79	20.91	7.47	0	7.47	0.09	0.02	0.26
ONC06	28.79	17.18	10.8	0	10.8	0.8	0.13	0.375
ONC07	28.79	18.74	9.32	0	9.32	0.59	0.06	0.324
ONC08	28.79	17.03	10.94	0	10.94	0.53	0.09	0.38
ONC09	28.79	22.18	6.15	0	6.15	0.12	0.02	0.214
ONC10	28.79	22.18	6.15	0	6.15	0.05	0.01	0.214

Oufall Loading

Outfall Node	Flow Freq.	Avg. Flow	Max. Flow	Total Volume
	Pcnt.	CMS	CMS	10^6 ltr
ONC01_OUT	70.51	0.001	0.017	0.097
ONC02_OUT	87.65	0.009	0.106	0.813
ONC03_OUT	87.72	0.024	0.337	2.289
ONC04_OUT	72.73	0.003	0.05	0.273
ONC05_OUT	80.4	0.001	0.017	0.089
ONC06_OUT	83.82	0.009	0.132	0.803
ONC07_OUT	87.55	0.006	0.06	0.592
ONC08_OUT	80.89	0.006	0.086	0.529
ONC09_OUT	70.05	0.002	0.023	0.125
ONC10_OUT	68.61	0.001	0.009	0.052

Post-Development Condition

2-Year / 24h ARI, with Climate Change

Sub-Catchment Runoff

Sub-Catchment	Total Precip	Total Infil	Imperv Runoff	Perv Runoff	Total Runoff	Total Runoff	Peak Runoff	Runoff Coeff
	mm	mm	mm	mm	mm	10^6 ltr	CMS	
OFFC01	86.38	78.69	0	7.69	7.69	2.39	0.39	0.089
OFFC02	86.38	76.13	0	10.25	10.25	0.06	0.02	0.119
OFFC03	86.38	80.93	0	5.46	5.46	0.99	0.12	0.063
ONC01	86.38	53.07	26.56	6.12	32.68	0.38	0.07	0.378
ONC02	86.38	32.23	49.21	3.75	52.96	2.76	0.42	0.613
ONC03	86.38	52.43	28.19	5.08	33.28	8.52	1.33	0.385
ONC04	86.38	55.13	23.84	6.85	30.68	1.11	0.21	0.355
ONC05	86.38	55.39	23.25	7.33	30.58	0.37	0.08	0.354
ONC06	86.38	46.02	34.02	5.53	39.55	2.94	0.52	0.458
ONC07	86.38	52.99	29.41	3.24	32.65	2.07	0.25	0.378
ONC08	86.38	45.66	34.46	5.45	39.91	1.93	0.34	0.462
ONC09	86.38	59.51	19.37	7.04	26.42	0.53	0.1	0.306
ONC10	86.38	60.45	19.37	6.1	25.47	0.21	0.04	0.295

Oufall Loading

Outfall Node	Flow Freq.	Avg. Flow	Max. Flow	Total Volume
	Pcnt.	CMS	CMS	10^6 ltr
ONC01_OUT	79.52	0.004	0.066	0.376
ONC02_OUT	95.1	0.027	0.423	2.757
ONC03_OUT	95.13	0.106	1.437	10.902
ONC04_OUT	81.39	0.013	0.222	1.168
ONC05_OUT	81.85	0.004	0.077	0.366
ONC06_OUT	92.88	0.029	0.521	2.939
ONC07_OUT	95.05	0.02	0.25	2.074
ONC08_OUT	90.09	0.03	0.379	2.921
ONC09_OUT	78.7	0.006	0.098	0.535
ONC10_OUT	77.71	0.003	0.035	0.215

Post-Development Condition

10-Year / 24h ARI, with Climate Change

Sub-Catchment Runoff

Sub-Catchment	Total Precip	Total Infil	Imperv Runoff	Perv Runoff	Total Runoff	Total Runoff	Peak Runoff	Runoff Coeff
	mm	mm	mm	mm	mm	10^6 ltr	CMS	
OFFC01	130.06	102.72	0	27.34	27.34	8.48	1.23	0.21
OFFC02	130.06	100.31	0	29.75	29.75	0.18	0.06	0.229
OFFC03	130.06	106.19	0	23.87	23.87	4.33	0.4	0.184
ONC01	130.06	69.47	40.31	19.65	59.96	0.69	0.13	0.461
ONC02	130.06	42.2	74.7	11.97	86.66	4.51	0.75	0.666
ONC03	130.06	68.44	42.79	18.15	60.94	15.6	2.45	0.469
ONC04	130.06	72.36	36.18	20.96	57.13	2.06	0.43	0.439
ONC05	130.06	72.92	35.21	21.52	56.73	0.68	0.16	0.436
ONC06	130.06	60.32	51.63	17.3	68.92	5.12	0.98	0.53
ONC07	130.06	69.76	44.65	14.91	59.56	3.78	0.44	0.458
ONC08	130.06	59.83	52.29	17.12	69.41	3.36	0.63	0.534
ONC09	130.06	77.96	29.4	22.24	51.64	1.05	0.21	0.397
ONC10	130.06	78.93	29.4	21.27	50.67	0.43	0.07	0.39

Oufall Loading

Outfall Node	Flow Freq.	Avg. Flow	Max. Flow	Total Volume
	Pcnt.	CMS	CMS	10^6 ltr
ONC01_OUT	81.49	0.008	0.129	0.69
ONC02_OUT	96.6	0.043	0.747	4.512
ONC03_OUT	96.63	0.231	3.247	24.078
ONC04_OUT	83.27	0.025	0.49	2.238
ONC05_OUT	82.22	0.008	0.163	0.678
ONC06_OUT	94.87	0.05	0.977	5.123
ONC07_OUT	96.57	0.036	0.442	3.783
ONC08_OUT	92.2	0.077	0.88	7.687
ONC09_OUT	80.57	0.012	0.208	1.046
ONC10_OUT	79.7	0.005	0.07	0.428

Post-Development Condition

100-Year / 24h ARI, with Climate Change

Sub-Catchment Runoff

Sub-Catchment	Total Precip	Total Infil	Imperv Runoff	Perv Runoff	Total Runoff	Total Runoff	Peak Runoff	Runoff Coeff
	mm	mm	mm	mm	mm	10^6 ltr	CMS	
OFFC01	198.24	125.21	0	73.02	73.02	22.66	3.43	0.368
OFFC02	198.24	122.9	0	75.34	75.34	0.46	0.14	0.38
OFFC03	198.24	128.99	0	69.24	69.24	12.55	1.16	0.349
ONC01	198.24	84.92	61.77	50.92	112.69	1.3	0.25	0.568
ONC02	198.24	51.59	114.48	30.97	145.45	7.57	1.33	0.734
ONC03	198.24	83.41	65.57	48.57	114.15	29.21	4.76	0.576
ONC04	198.24	88.55	55.44	53.68	109.12	3.93	0.85	0.55
ONC05	198.24	89.32	53.89	54.62	108.51	1.3	0.31	0.547
ONC06	198.24	73.79	79.12	44.52	123.64	9.19	1.82	0.624
ONC07	198.24	84.76	68.45	44.29	112.73	7.16	0.84	0.569
ONC08	198.24	73.17	80.14	44.1	124.24	6.01	1.18	0.627
ONC09	198.24	95.33	45.06	57.39	102.44	2.07	0.43	0.517
ONC10	198.24	96.26	45.05	56.46	101.52	0.86	0.15	0.512

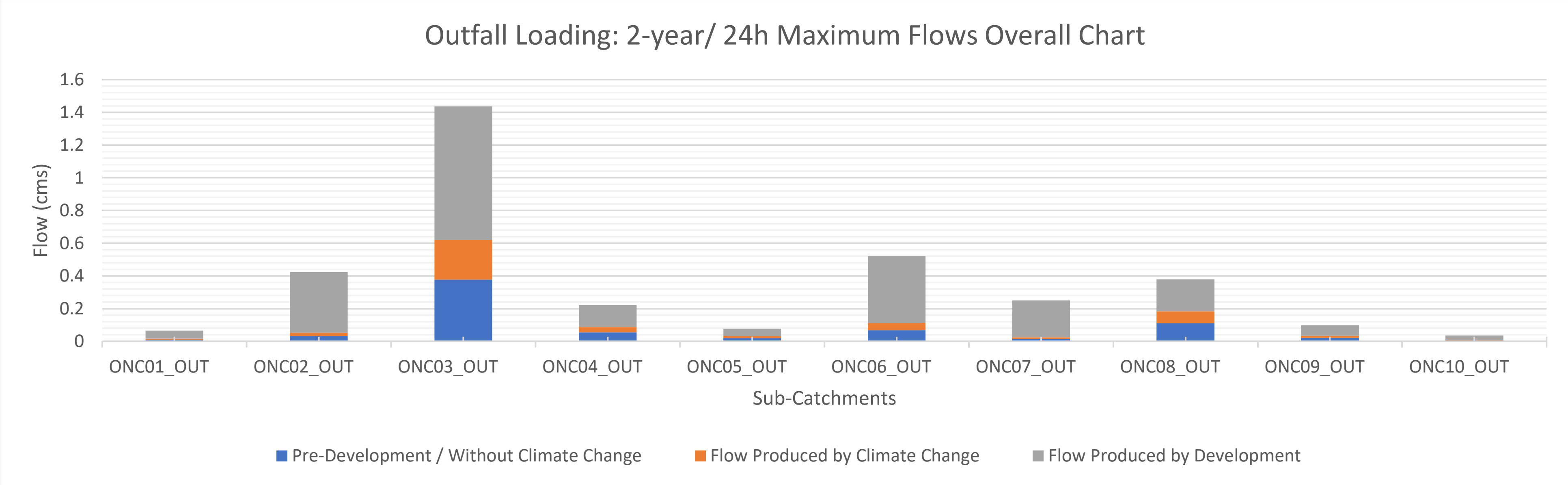
Oufall Loading

Outfall Node	Flow Freq.	Avg. Flow	Max. Flow	Total Volume
	Pcnt.	CMS	CMS	10^6 ltr
ONC01_OUT	83.01	0.014	0.252	1.297
ONC02_OUT	97.71	0.072	1.33	7.573
ONC03_OUT	97.72	0.492	7.614	51.87
ONC04_OUT	84.72	0.048	0.973	4.387
ONC05_OUT	82.54	0.015	0.308	1.298
ONC06_OUT	96.41	0.088	1.816	9.189
ONC07_OUT	97.68	0.068	0.839	7.159
ONC08_OUT	94.01	0.183	2.146	18.566
ONC09_OUT	82	0.023	0.425	2.075
ONC10_OUT	81.24	0.01	0.145	0.857

Appendix D – Overall Results Table

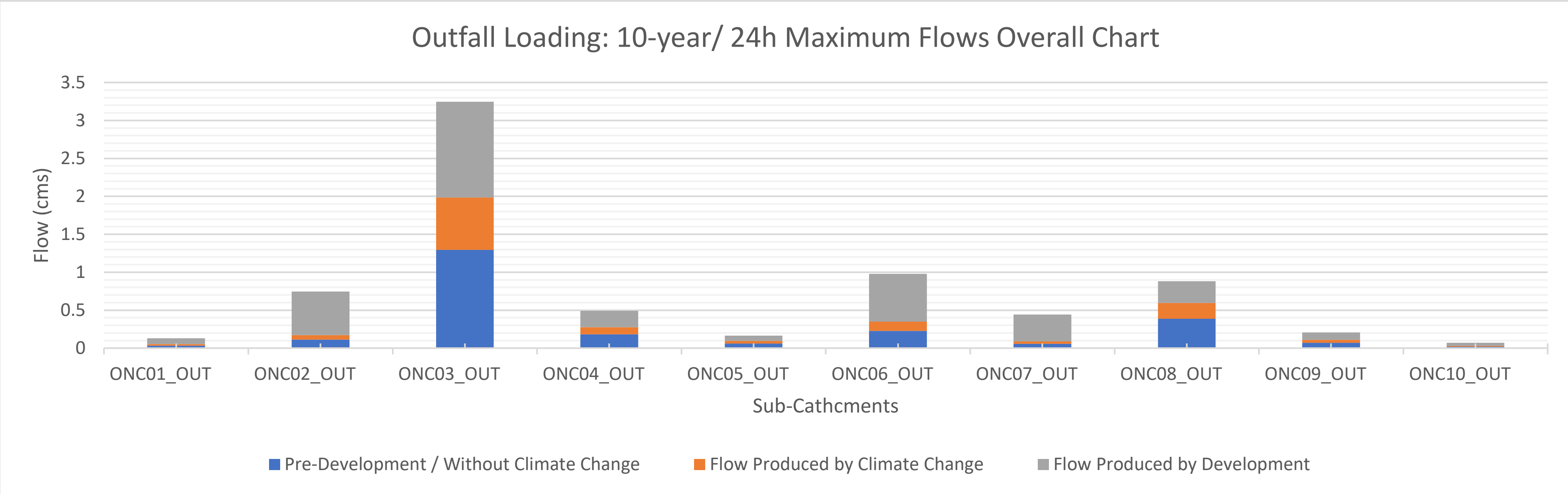
2-year/24h ARI Overall Results Table

Outfall Node	Pre-Development / Without Climate Change		Pre-Development / With Climate Change		Post-Development / With Climate Change		Flow to Match (100% of Pre-Development Flow)	Flow Produced by Climate Change				Flow Produced by Development			
	Max. Flow	Total Volume	Max. Flow	Total Volume	Max. Flow	Total Volume	Max. Flow	Max. Flow		Total Volume		Max. Flow		Total Volume	
	CMS	10^6 ltr	CMS	10^6 ltr	CMS	10^6 ltr	CMS	CMS	%	10^6 ltr	%	CMS	%	10^6 ltr	%
ONC01_OUT	0.01	0.053	0.017	0.094	0.066	0.376	0.01	0.007	10.61	0.007	1.86	0.049	74.24	0.049	13.03
ONC02_OUT	0.032	0.194	0.053	0.365	0.423	2.757	0.032	0.021	4.96	0.021	0.76	0.37	87.47	0.37	13.42
ONC03_OUT	0.378	2.192	0.619	4.077	1.437	10.902	0.378	0.241	16.77	0.241	2.21	0.818	56.92	0.818	7.5
ONC04_OUT	0.055	0.228	0.087	0.385	0.222	1.168	0.055	0.032	14.41	0.032	2.74	0.135	60.81	0.135	11.56
ONC05_OUT	0.018	0.07	0.03	0.115	0.077	0.366	0.018	0.012	15.58	0.012	3.28	0.047	61.04	0.047	12.84
ONC06_OUT	0.068	0.346	0.11	0.612	0.521	2.939	0.068	0.042	8.06	0.042	1.43	0.411	78.89	0.411	13.98
ONC07_OUT	0.014	0.112	0.025	0.247	0.25	2.074	0.014	0.011	4.4	0.011	0.53	0.225	90	0.225	10.85
ONC08_OUT	0.111	0.708	0.184	1.383	0.379	2.921	0.111	0.073	19.26	0.073	2.5	0.195	51.45	0.195	6.68
ONC09_OUT	0.021	0.101	0.034	0.175	0.098	0.535	0.021	0.013	13.27	0.013	2.43	0.064	65.31	0.064	11.96
ONC10_OUT	0.006	0.033	0.009	0.062	0.035	0.215	0.006	0.003	8.57	0.003	1.4	0.026	74.29	0.026	12.09



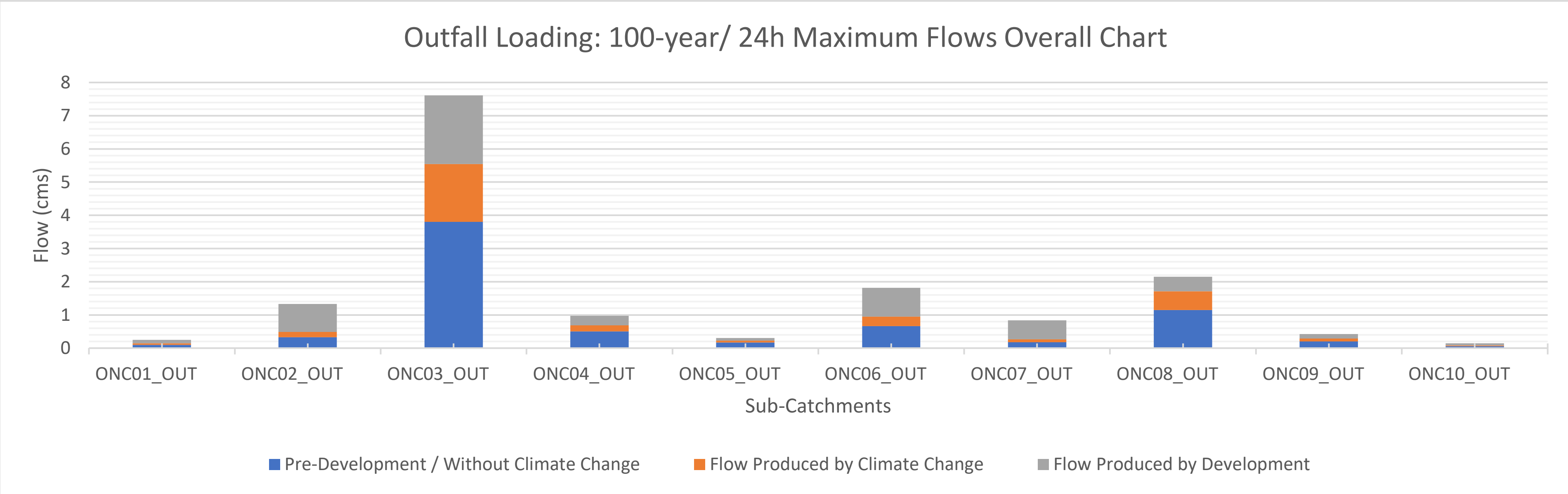
10-year/24h ARI Overall Results Table

Outfall Node	Pre-Development / Without Climate Change		Pre-Development / With Climate Change		Post-Development / With Climate Change		Flow to Match (100% of Pre-Development Flow)	Flow Produced by Climate Change				Flow Produced by Development			
	Max. Flow	Total Volume	Max. Flow	Total Volume	Max. Flow	Total Volume	Max. Flow	Max. Flow		Total Volume		Max. Flow		Total Volume	
	CMS	10^6 ltr	CMS	10^6 ltr	CMS	10^6 ltr	CMS	CMS	%	10^6 ltr	%	CMS	%	10^6 ltr	%
ONC01_OUT	0.034	0.209	0.052	0.321	0.129	0.69	0.034	0.018	13.95	0.018	2.61	0.077	59.69	0.077	11.16
ONC02_OUT	0.112	0.875	0.172	1.377	0.747	4.512	0.112	0.06	8.03	0.06	1.33	0.575	76.97	0.575	12.74
ONC03_OUT	1.294	9.637	1.984	15.097	3.247	24.078	1.294	0.69	21.25	0.69	2.87	1.263	38.9	1.263	5.25
ONC04_OUT	0.181	0.809	0.275	1.214	0.49	2.238	0.181	0.094	19.18	0.094	4.2	0.215	43.88	0.215	9.61
ONC05_OUT	0.061	0.236	0.094	0.35	0.163	0.678	0.061	0.033	20.25	0.033	4.87	0.069	42.33	0.069	10.18
ONC06_OUT	0.227	1.359	0.348	2.079	0.977	5.123	0.227	0.121	12.38	0.121	2.36	0.629	64.38	0.629	12.28
ONC07_OUT	0.056	0.739	0.088	1.287	0.442	3.783	0.056	0.032	7.24	0.032	0.85	0.354	80.09	0.354	9.36
ONC08_OUT	0.387	3.511	0.597	5.676	0.88	7.687	0.387	0.21	23.86	0.21	2.73	0.283	32.16	0.283	3.68
ONC09_OUT	0.07	0.379	0.109	0.575	0.208	1.046	0.07	0.039	18.75	0.039	3.73	0.099	47.6	0.099	9.46
ONC10_OUT	0.02	0.145	0.03	0.226	0.07	0.428	0.02	0.01	14.29	0.01	2.34	0.04	57.14	0.04	9.35



100-year/24h ARI Overall Results Table

Outfall Node	Pre-Development / Without Climate Change		Pre-Development / With Climate Change		Post-Development / With Climate Change		Flow to Match (80% of Pre-Development Flow)	Flow Produced by Climate Change				Flow Produced by Development			
	Max. Flow	Total Volume	Max. Flow	Total Volume	Max. Flow	Total Volume	Max. Flow	Max. Flow		Total Volume		Max. Flow		Total Volume	
	CMS	10^6 ltr	CMS	10^6 ltr	CMS	10^6 ltr	CMS	CMS	%	10^6 ltr	%	CMS	%	10^6 ltr	%
ONC01_OUT	0.1	0.589	0.143	0.846	0.252	1.297	0.08	0.043	17.06	0.043	3.32	0.109	43.25	0.109	8.4
ONC02_OUT	0.33	2.593	0.488	3.755	1.33	7.573	0.264	0.158	11.88	0.158	2.09	0.842	63.31	0.842	11.12
ONC03_OUT	3.804	28.315	5.548	40.956	7.614	51.87	3.043	1.744	22.91	1.744	3.36	2.066	27.13	2.066	3.98
ONC04_OUT	0.504	2.194	0.688	3.133	0.973	4.387	0.403	0.184	18.91	0.184	4.19	0.285	29.29	0.285	6.5
ONC05_OUT	0.17	0.628	0.227	0.896	0.308	1.298	0.136	0.057	18.51	0.057	4.39	0.081	26.3	0.081	6.24
ONC06_OUT	0.666	3.813	0.946	5.473	1.816	9.189	0.533	0.28	15.42	0.28	3.05	0.87	47.91	0.87	9.47
ONC07_OUT	0.176	2.7	0.268	4.087	0.839	7.159	0.141	0.092	10.97	0.092	1.29	0.571	68.06	0.571	7.98
ONC08_OUT	1.148	10.998	1.709	16.111	2.146	18.566	0.918	0.561	26.14	0.561	3.02	0.437	20.36	0.437	2.35
ONC09_OUT	0.204	1.047	0.288	1.499	0.425	2.075	0.163	0.084	19.76	0.084	4.05	0.137	32.24	0.137	6.6
ONC10_OUT	0.058	0.424	0.085	0.612	0.145	0.857	0.046	0.027	18.62	0.027	3.15	0.06	41.38	0.06	7



Appendix E – Correspondence with WRC/Watercare

Constantinos Fokianos

From: SHoward (Stephen) <Stephen.Howard@water.co.nz>
Sent: Tuesday, 1 December 2020 12:55 PM
To: Constantinos Fokianos; RPullar (Richard) 1
Subject: FW: Raglan Water & wastewater Infrastructure capacity

Hi Constatinos. Thank you for your message. Please see feedback to your response in red on the two specific comments you have sought. These are broad asset engineering observations, rather than review/feedback on your report. I hope this assists.

- capacity of the existing water and wastewater infrastructure in respect to proposed rezoned areas;
  - Wastewater: The Raglan WWTP discharge consent application for a long term consent (max duration is envisaged) is under preparation, where wastewater flows have been calculated to cater for all theoretical Waikato 2070 growth projections;
  - Water: The present usage rate is 260L/p/day, where the present treatment plant capacity could cater for theoretical maximum population predictions of Waikato 2070. The abstraction capacity of the spring is the limiting factor, dependent if usage nears limits, due to growth (max volume 500m3/24hrs and 5.78l/sec. FYI – the water take expires in 2034

- whether connections to existing infrastructure are possible.
  - Please see the image below. The waterline is 100mm which would likely need an upgrade with any future significant residential connection. The wastewater line shown is a rising main (i.e. no direct connection), where capacity is used/committed for the existing area served. An additional line would be needed for any future residential supply for rezoned land, where an engineering plan would consider internal methods to efficiently connect to the network and transport wastewater

From: RPullar (Richard) 1
Sent: Thursday, 12 November 2020 8:43 AM
To: SHoward (Stephen) <Stephen.Howard@water.co.nz>
Subject: FW: Raglan Water & wastewater Infrastructure capacity

FYI

From: Constantinos Fokianos <cfokianos@bbo.co.nz>
Sent: Thursday, 12 November 2020 8:36 am
To: RPullar (Richard) 1 <Richard.Pullar2@water.co.nz>
Cc: Aidan Kirkby-McLeod <aidan@bbo.co.nz>; Chris Dawson <cdawson@bbo.co.nz>
Subject: Raglan Water & wastewater Infrastructure capacity

CAUTION:External Email!

Hi Richard,
my name is Constantinos, I'm a water resource engineer working for BBO in Hamilton.
My colleague Chris Dawson gave me your details, and I tried to call you yesterday but could get through.
We have been engaged to prepare a 3 Water Impact Assessment report for a proposed rezoning in Raglan. The property is located south of the Raglan Wastewater Treatment Plant. I have attached a draft copy of the 3 Waters Report.
We would like your feedback/comments, especially on the capacity of the existing water and wastewater infrastructure and whether connections to this infrastructure are possible.
Please feel free to contact me for any queries.
Kind regards,
Constantinos

bbo
BLOXAM BURNETT & OLLIVER

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