Calcutta Farms Ltd

Calcutta Industrial Zone Plan Change

Infrastructure Report

November 2021

BLOXAM BURNETT & OLLIVER

Document control

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1. Introduction

Bloxam Burnett & Olliver Ltd (BBO) has been commissioned by Veros, on behalf of Calcutta Farms Ltd (Calcutta), to come up with a workable three waters design solution in support of the Calcutta Plan Change application. The Plan Change seeks to rezone approximately 41ha of land, directly south of Tauranga Road/SH24 in Matamata from its current rural land use and zoning to an Industrial Zone. Of this 41ha, the developable area is 32.5ha, with the balance being set aside for roads and landscape buffer/swale networks.

1.1 Purpose of this report

The purpose of this report is to provide an overview, at conceptual level, of the anticipated infrastructure associated with the Plan Change Area. The information provided herein outlines the existing situation, the alternatives considered and thereafter outlines the preferred approach for the purposes of demonstrating that there is a workable design solution in terms of both feasibility and capacity. It is expected that the preferred approach will be refined through the plan change process, once further engagement with Regional Council has been completed and upon the receipt of further information from Council around capacity at the Matamata wastewater treatment plant.

1.2 Relevant background

Calcutta is a farming entity owned by Kevin and Rosemary Balle. The Balle Family have a strong presence in Matamata as a large-scale vegetable grower, employer of local people and provider of work to Matamata small business.

With a vision to extend Matamata to the east in a sustainable manner by bringing together a connected, engaged and resilient community, Calcutta has developed a Master Plan for a 250ha pocket of land spanning from Tauranga Road on the north-east boundary to Banks Road on the south-west boundary in Matamata (See **Figure 1**). Whilst this plan is conceptual in nature, it creates a spatial framework from which the Balle's intend to progressively and sustainably develop, in the best interests of the Matamata community.

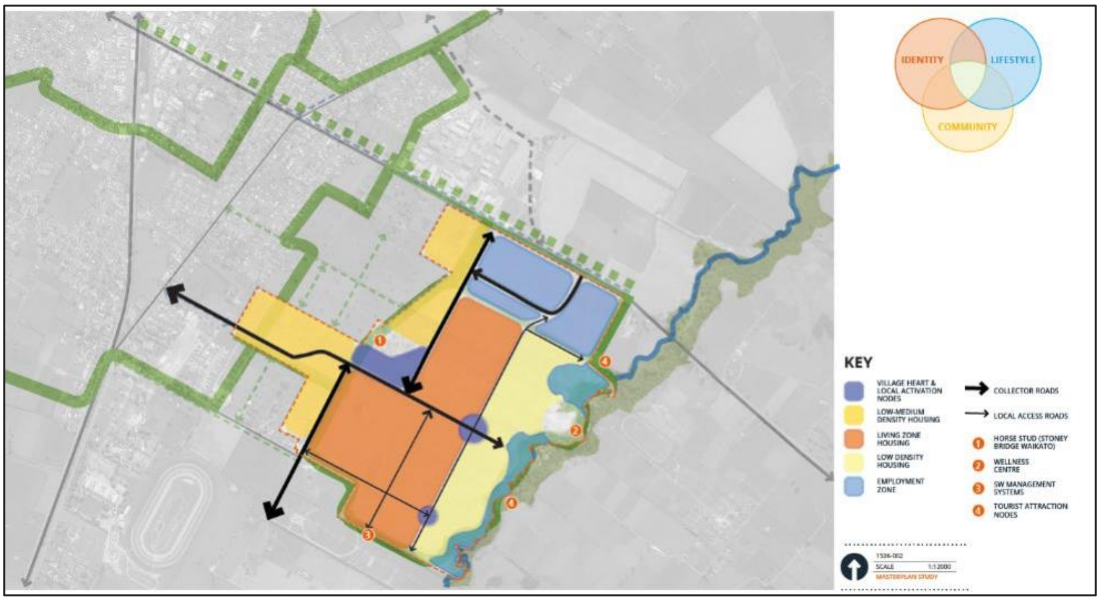

Figure 1: Calcutta Master Plan (Employment Zone identified in light blue)

Calcutta intends to develop specific areas of this land holding in an integrated and staged manager, refining the 250ha masterplan concept as more detailed development plans for each stage are prepared and the associated plan changes and resource consents sought.

Under the Master Plan, an approximately 32.5ha portion of the land adjoining Tauranga Road (State Highway 24) has been identified as an 'Employment Zone'.

The Plan Change gives effect to the Master Plan by rezoning the identified Employment Zone to an Industrial.

For the purpose of this report, the water and wastewater calculations have been provided for both Commercial and Industrial land uses to encapsulate the previous terminology for the zoning.

1.3 Site and legal description

The site for the proposed Plan Change is land that is currently zoned rural which is located on the eastern edge of Matamata, and directly east of its existing urban zone extent. The site is bounded by Tauranga Road (or State Highway 24) to the north, Council's transfer station to the east and rural zoned land to the south and west that is owned by Calcutta. Further east is the Mangawhero Stream.

The Plan Change area compromises approximately 41ha as shown in Figure 2 below.

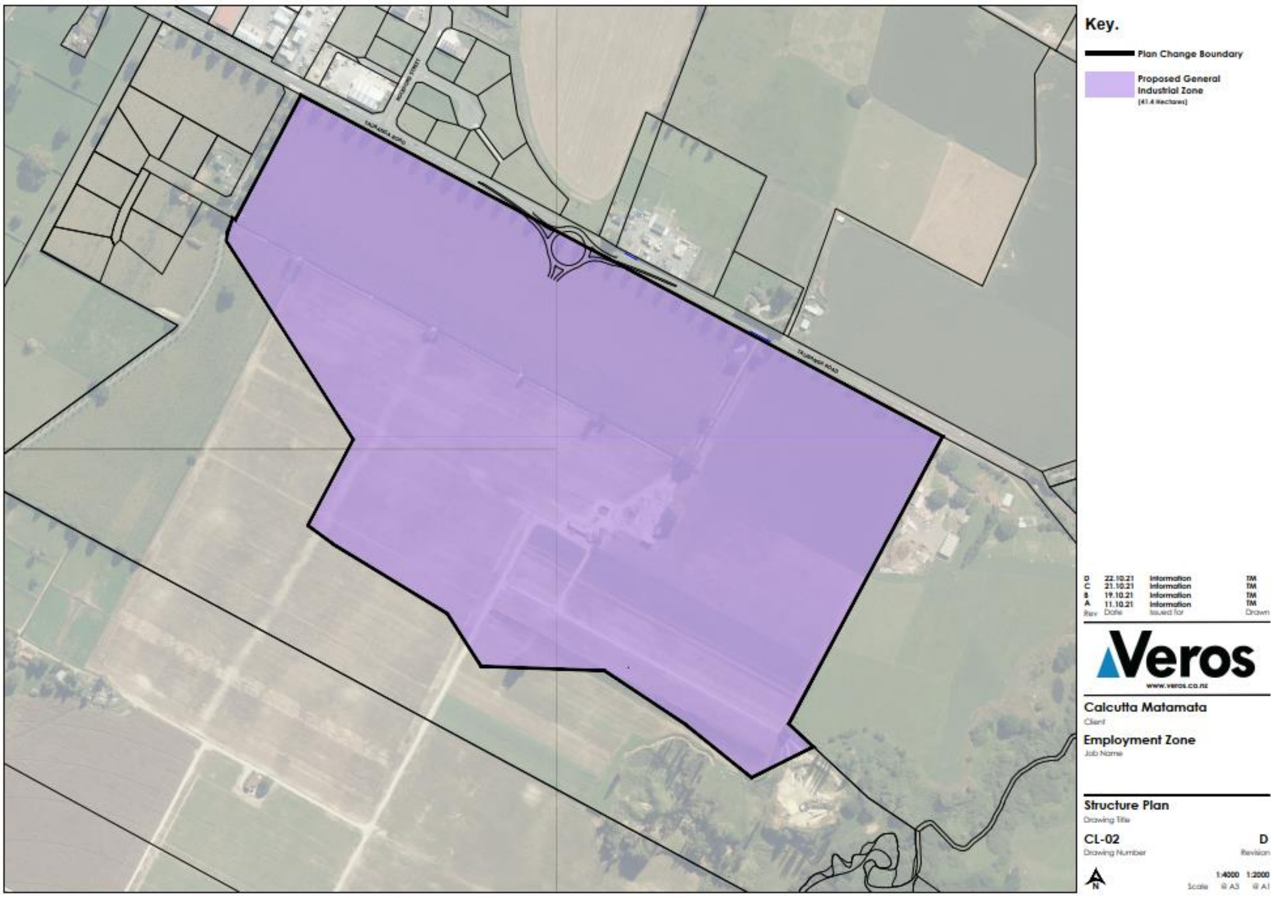

Figure 2: Plan Change Area (Source - Veros)

The Plan Change Area is contained within one Certificate of Title legally described as Lot 200 DP 548170 (937553). That underlying title has a size of 68ha and is owned by Calcutta Farms No 2 Ltd.

2. Earthworks

2.1 Earthworks philosophy

Earthworks will be undertaken, as required, throughout the Plan Change area and will include excavations for installation of drainage networks, recontouring and formation of future building platforms and roading networks which will support the stormwater management of the site.

The volume of the earthworks will be determined with each stage as it is developed. Preliminary modelling to ascertain expected volumes associated with the earthworks has not been completed at the time of preparing this report. However, given the relatively level nature of the landform, proposed earthworks are expected to typically involve and average cut and fill of approximately 1m for the purpose of creating level to very gently graded lots and to enable stormwater flows to grade towards the wetland network on the southern boundary of the Plan Change site.

2.2 Erosion and sediment control

The site will be subject to a Waikato Regional Council earthworks consent and will be monitored by them throughout the earthworks process. That consent will be sought prior to development and once preliminary modelling of earthworks has been completed.

Within each development stage, the site will be further divided into different sub-catchments where specific erosion and sediment control measures will be adopted. The specific erosion and sediment control details will be provided at time of construction, with those measures being designed in accordance with Waikato Regional Council's Erosion and Sediment Control Guide for Soil Disturbing Activities 2009 and where needed, the Auckland Council GD05 document will be used for further guidance.

Areas where earthworks are completed will be stabilised progressively with either pavement aggregates being constructed across the completed road subgrades or through topsoiling and regrassing within the berms and lots. Progressive stabilisation will ensure that the duration of soil exposure is minimised and will also aid with mitigation of potential dust effects.

2.3 Geotechnical investigations

A site-specific Geotechnical Investigation Report (GIR) has been prepared for the Plan Change area by CMW Geosciences, dated 16 September 2021. This is supplemented with a letter from CMW Geosciences regarding site soil permeability, dated 30 August 2021.

The CMW Geoscience reporting showed the site has an average topsoil thickness of 200mm. Under the topsoil a Hinuera Formation was identified which is broken down as follows:

- Stiff to hard clayey silt and silt ranging from 0.7 to 2.5m in thickness.
- Loose to medium dense sand and silty sand ranging from 0.9 to 4.8m in thickness.
- Medium dense to dense pumiceous sand with a depth unknown.
- Dense to very dense pumiceous sand, with its depth also unknown.

The reporting identified that geohazards primarily exist in the form of fault rupture, liquefaction, lateral spread, slope stability and fill induced static settlement and the level of risk presented by each of these is low to very low.

The reporting also concludes that the site is suitable for future industrial development and provides recommendations for earthworks, building foundations and civil infrastructure which all present as relatively standard engineering constraints that can readily be accommodated in design and construction.

The geotechnical reporting shows that the standing groundwater table is approximately 12m to 15m below the existing ground surface. A shallower (i.e. perched) groundwater table was also observed between 2.7m and 4.8m below existing ground surface.

The calculated rates for soakage to ground exceed the minimum design soakage rate of outlined by the MPDC Guidelines, demonstrating that soakage is a viable solution for stormwater disposal from the development. The actual stormwater philosophy is described in more detail in section 6.2 of this report and provides for a combination of soakage, treatment, conveyance, and attenuation devices with a new discharge point to the Mangawhero Stream gully network for residual treated water.

2.4 Future consents

Bulk earthworks across the site are likely to require consent authorisation from both the District and Regional Council. These consents will be sought prior to development of the site and once the extent of the works and the proposed erosion and sediment controls are further understood. A stormwater discharge consent may also be required.

3. Transportation

An Integrated Transportation Assessment (ITA) has been completed by BBO which considers the traffic and transportation effects of the Plan Change area on the wider transportation environment. It also provides recommendations in relation to access arrangements, the configuration of that access, the internal roading network, pedestrian connections and other off-site transportation improvements that are required.

Some of these matters are touched on below, however, for further detail please refer directly to that report.

3.1 Access arrangements

The plan change area is proposed to be serviced by one connection point (intersection) to Tauranga Road (State Highway 24) approximately 285m southeast of the SH24/Rockford Street intersection. This access will be in the form of a proposed three leg single circulate lane roundabout, with single entry and exit lane approaches, which is shown in **Figure 3**.

This roundabout will be the sole connection point from SH24 into the Plan Change site. This roundabout may also be adapted to become a four-leg roundabout in the future to provide access to the land to the north, as and when developed for industrial purposes.

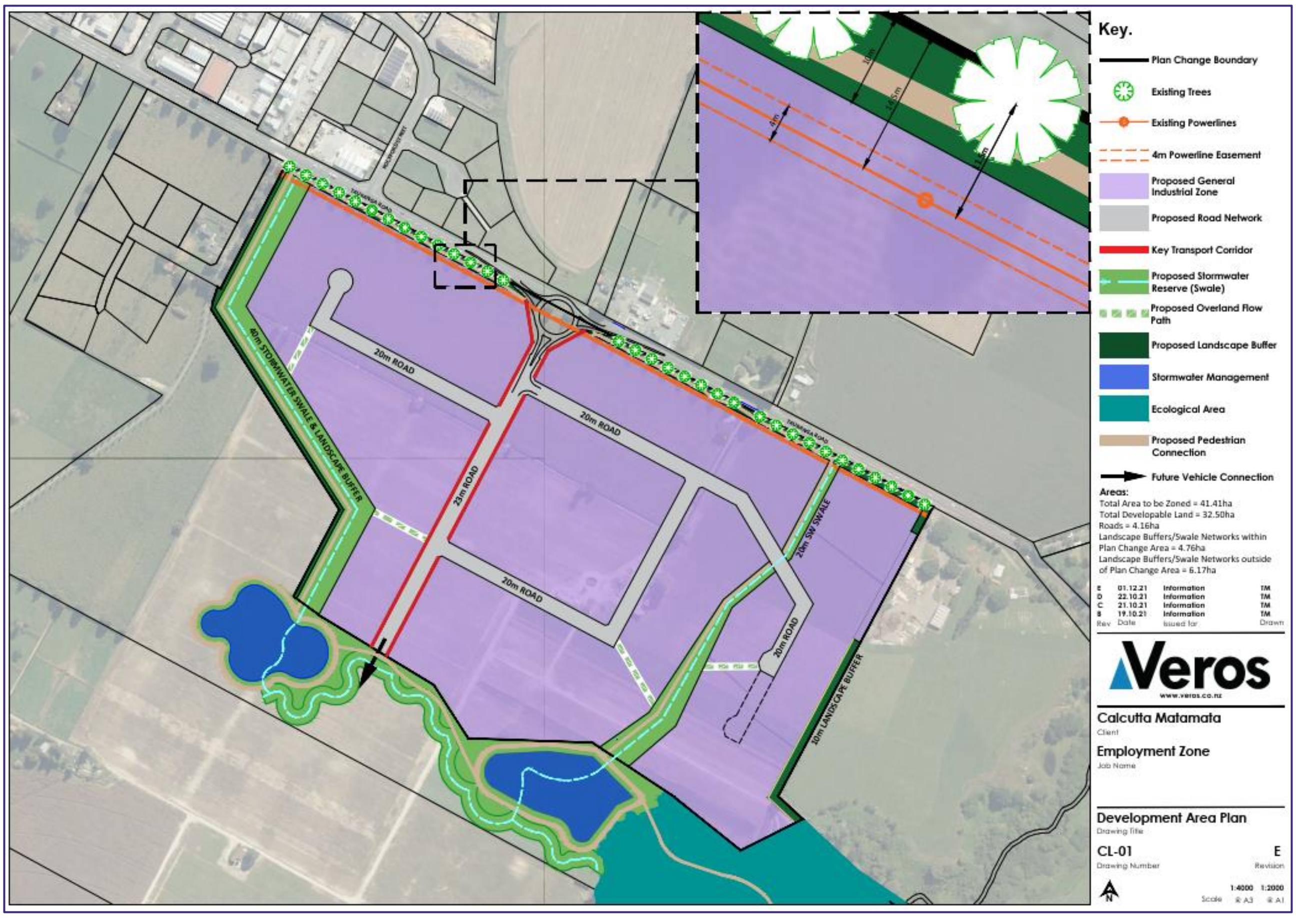

Figure 3: Development Area Plan (Source - Veros)

Thereafter a network or local and collector roads will be required to service the development. The Development Area Plan (**Figure 3** above) provides an indication of the likely location of these roads to demonstrate how the area will be serviced. The key road being the Spine Road (i.e. the north-south road) that links to the roundabout and provides a future connection to the land south of the site.

3.2 Design standards

The transportation network for the plan change area will be designed in accordance with the RITS and the recommendations of the BBO ITA.

Typical cross sections are proposed in the ITA with the typical section for the Spine Road (Collector Road) replicated below in **Figure 4** and the local road replicated below in **Figures 4** and **5** respectively. These cross sections will be refined taking into account Council feedback through the consenting and detailed design stages, however, at present they generally provide for the following:

- Collector Road
    - 23m road reserve that provides for a 10m wide carriageway, with an additional 2.5m rain garden/planted berm and parking on both sides, 1 to 1.2m wide berms, a 3m wide shared path on one side and a 1.8m wide path on the other side.
- Local Road
    - 20m road reserve that provides for a carriageway width of 7m with an additional 2.5m parking on both sides, a single cross-fall to a rain-garden on one side, 1m berms, a 1.8m wide footpaths on either side.

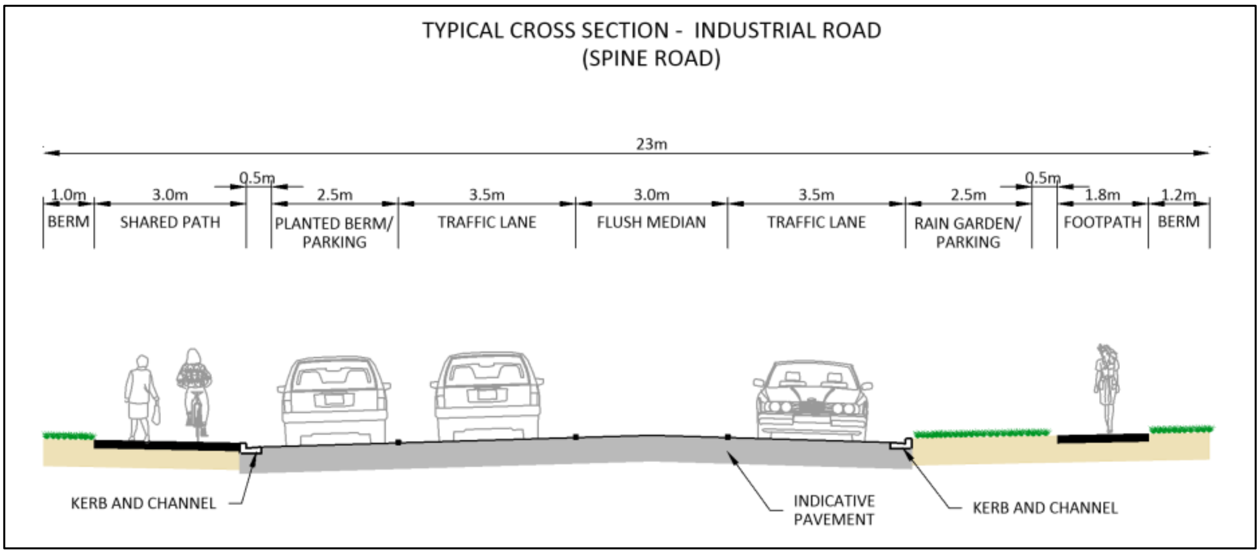

Figure 4: Indicative Cross-Section for the Spine Road (Collector Road)

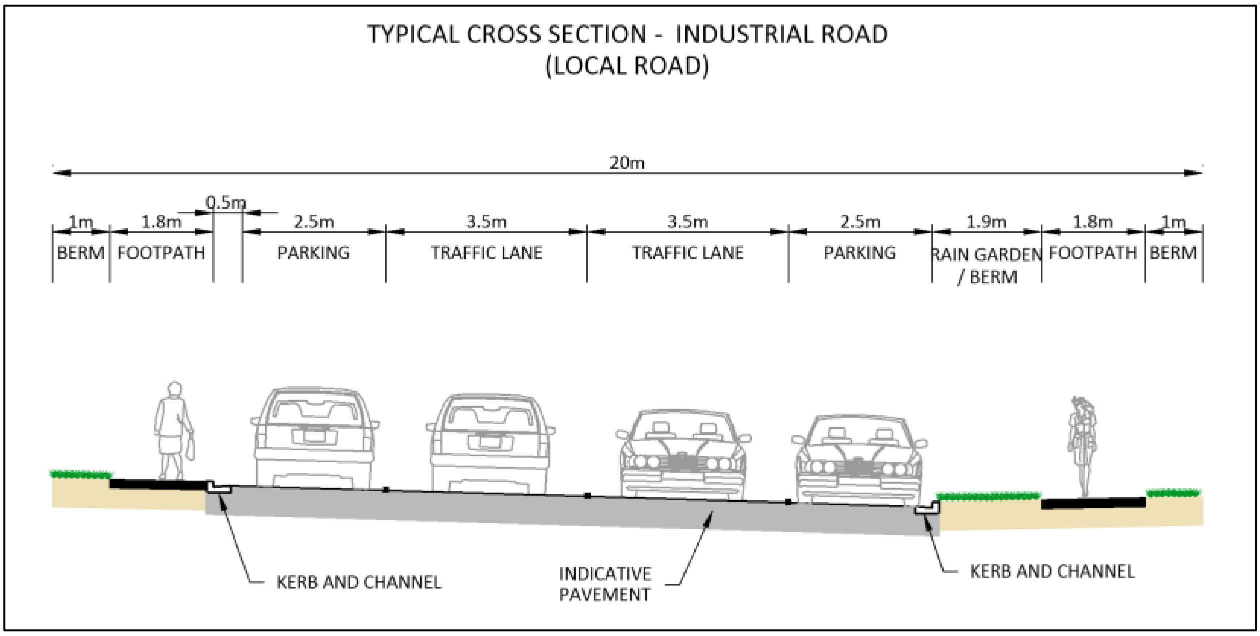

Figure 5: Indicative Cross-Section for Local Road

4. Water

4.1 Existing reticulation

The only water reticulation adjacent the plan change site is a 50mm diameter rider main, installed in 1946, that is located along the northern boundary of the site and within Tauranga Road/SH24. The Council's GIS portal noted the line is in a poor condition. The intersection of Tauranga Road and Rockford Street, just west of the site, has a 150mm diameter uPVC watermain located in the berm which was installed in 2009 and it is noted as being in excellent condition. Refer to **Figure 6** below for the location of this infrastructure.

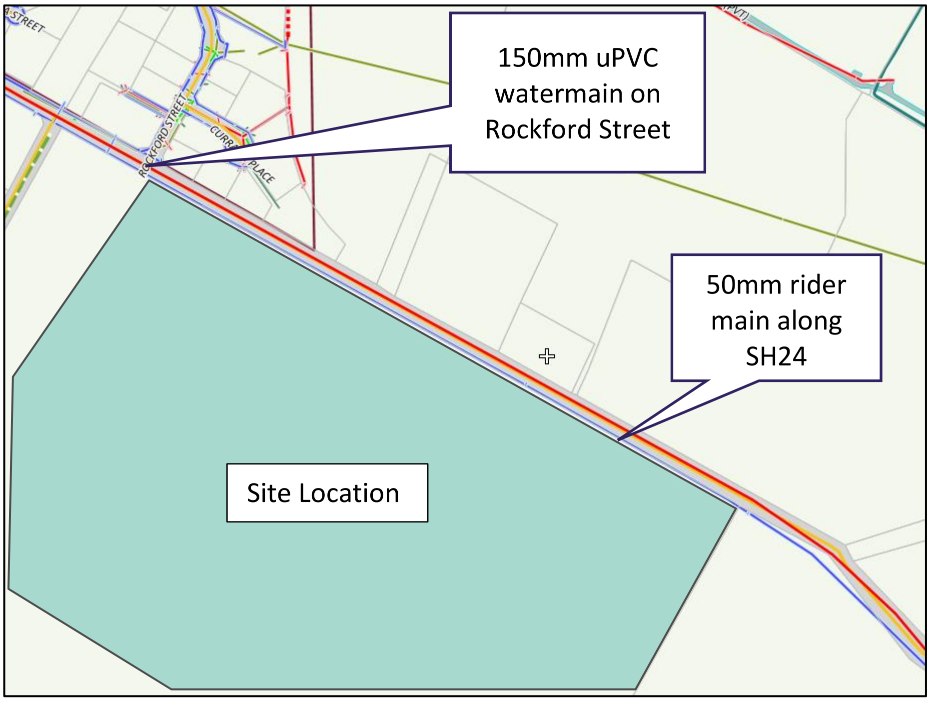

Figure 6: Existing Water Reticulation (Source - MPDC GIS October 2021)

Preliminary engagement with Matamata Piako District Council staff was undertaken, during which, they indicated that development of the plan change area would trigger significant pipe upgrades because the existing network and current zoned catchment is already at capacity. Furthermore, Council confirmed they do not have additional supply capacity available to service the plan change site.

MPDC have also confirmed that the works associated with the Raungaiti bore and wastewater treatment plant has been allocated to currently zoned land in Waharoa and Matamata, and thus has limited capacity to service the Calcutta site. Furthermore, the current funding window for this work is between 2023/2031, as set out in the LTP. As such, the timing around availability of this supply is uncertain. Council also has funding it its LTP to scope another bore in close proximity to their existing bore by the racecourse in Matamata. No water volume, quality or allocation matters relating to this bore have been scoped at present.

4.2 Demand calculations and assumptions

The demand and assumptions around the demand calculations were based on the requirements set out in the Waikato Regional Infrastructure Technical Specification (RITS) for water demand requirements. The standard values used are listed as follows:

- 260 litres per person per day was used (RITS 6.2.3).
- 45 people per hectare used for Industrial zoning (RITS Table 5.3) and 30 people per hectare used for a Commercial zoning (RITS Table 5.3) - for comparison purposes.
- Peaking factor of 5 used as recommended by the RITS.

- Assumes 12% of the area to be developed will be used for roads/accessways.

Table 1 below shows the resulting peak flow and average daily demand using the above assumptions and parameters. Please refer to **Appendix A** for a breakdown of the calculation spreadsheet. These calculations are based on standard industrial land uses, and not wet industries.

Table 1: Water supply demand calculations

	Peak Flow	Average daily demand
Industrial land use	22.01 l/s	380.3m³
Commercial land use	14.67 l/s	253.5m³

For the purpose of this assessment, the industrial flows are what the design is based on as they are higher than the commercial thresholds. The proposed water usage of 380.3m³/day would equate to a maximum annual volume of 138,809m³. The actual usage is likely to be less than this due to non-working days and commercial shut down periods.

4.3 Proposed water supply network options

A number of options have been considered as to how to provide a suitable and sufficient potable water supply. These are summarised below, along with the preferred approach.

4.3.1 Option 1 – Upgrade Existing Network

This option would involve a connection to the existing public network for both the potable and firefighting water supply and with the associated upgrades of the water reticulation network. Ultimately, this option would have been the preferred option as it is considered to be a simpler, more standard, long-term solution for the development and Council.

The following are the advantages and disadvantages associated with this option:

- **Advantages**
  - The system can be vested to Council once completed.
  - There will be no need for storage tanks or ponds for firefighting purposes.

- **Disadvantages**
  - Full extent of upgrades required are unknown. Upgrades will need to be identified with detailed modelling of the network (by others or Council), taking existing consented development and future development into consideration.
  - Council has no funding or upgrades planned in the Long-term Plan (LTP) for this area.
  - This option is only feasible if there is water supply capacity.

4.3.2 Option 2 – Use Existing Onsite Boreholes/Groundwater Take

There are a number of existing bores on the wider Calcutta Farm holding, as shown in **Figure 7.** Three of these have active groundwater take permits. The groundwater take permits for each bore, its purpose and its expiration are summarised in **Table 2** below. Figure 7 shows the location of these bores relative to the plan change site, noting that bore 72_6680 is the closest bore, being located just west of the plan change area.

Table 2: Existing Boreholes Consents

Consent Holder	Bore Number	Consent Number	Max daily and annual volume	Use	Expiry
Calcutta Farms	72_6068	125705	16.45m³ maximum daily volume.	Shed wash down and milk cooling	30 June 2028
Waipa Valley Holdings (Kevin Balle)	72_6680	AUTH130710.01	7,200m³ maximum daily volume and 327,570m³ maximum seasonal volume[1].	Crop irrigation	1 March 2029
Calcutta Farms	72_7181	AUTH134035.01.02	5,400m³ maximum daily volume, or which 100,000 litres can be used for dust suppression on any given day and maximum annual volume of 248,400m³.	For irrigation and dust suppression purposes	9 February 2030

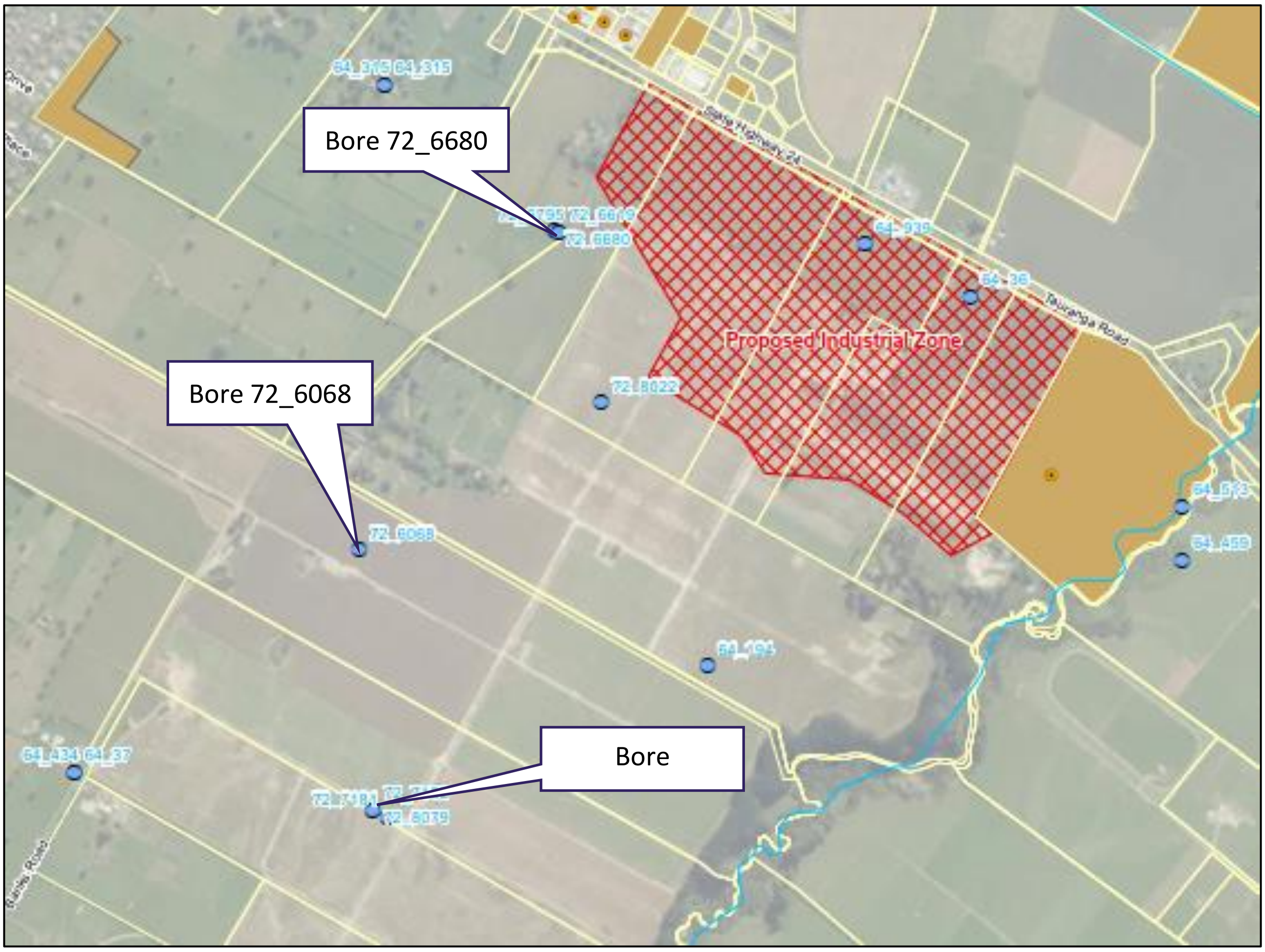

Figure 7: Existing Boreholes Location (Source - WGA)

Two of the above groundwater takes are consented for volumes larger than the proposed requirements of 380.3m³/day (and 138,809m³per annum).

Due to the proximity of bore 72_6680 to the plan change site, further investigations have been undertaken by Calcutta Farms to ascertain, what volume of the consented supply is currently used for irrigation purposes

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[1] Season volume is from 1 July to 30 June the following year.

and what is potentially surplus. That investigation[2], based on bore results from the period of 1 January 2017 to July 2021, is that:

- The highest daily take was 6,487m³;
- The average daily take is 1,425m³; and
- Annual take fluctuates between 27,000m³ to 133,000m³ which is significantly less than the 327,570m³ consented volume.

This investigation shows that there is additional capacity for water extraction within bore 72_6680 which can be reallocated to Council, to service the plan change area, subject to Regional Council approval and confirmation that the water quality in the bore is feasible for use for a potable water supply.

Engagement with the Regional Council has been undertaken with Waikato Regional Council whereby they have confirmed that the allocation transfer is appropriate.

In relation to water quality, Wallbridge Gilbert Aztec (WGA) were engaged to assess water security, (i.e. potential sources of contamination and the likelihood of these contaminating the groundwater supply) water availability, water quality and to provide recommendations of potential treatment options. As part of this work, they have undertaken water quality samples with the results of those samples being compared to the Ministry of Health Guideline Values and Maximum Acceptable Values (MAV)[3] for drinking water where applicable (MOH, 2018).

Their report can be found in **Appendix B** and confirms the following:

- Onsite bores and associated water permits have sufficient volumes to provide water supply to the proposed plan change site. The bore infrastructure is also sound with only minor repairs required.
- Water quality testing has identified that water from bore 72_6680 has high concentrations of iron and manganese and will require treatment to meet the guidelines for aesthetics and in the case of manganese, the MAV of 0.4 g/m³.
- These results are indicative of relatively long residence time in the aquifer which is common in deeper aquifer systems and is an indicator of a more confined system with older groundwater which has dissolved minerals from the rocks that make up the aquifer along the groundwater flow path.
- Iron and manganese treatment generally involves oxidation and filtration. The oxidant chemically oxidizes the iron or manganese (forming a particle) and kills iron bacteria and any other disease-causing bacteria that may be present. The filter then removed the iron and/or manganese particles.
- Arsenic concentrations are below the MAV of 0.01 g/m³ by a small margin which is potentially due to the long periods that the bore is shutdown in winter. Regular monitoring of the arsenic levels will be required to account for seasonal variations.
- There are potential sources of contamination in the surrounding area (i.e. adjacent land uses that are recorded on WRC's HAIL database), however these are downgradient from the water sources so pose a low risk.
- Treatment of at source water to reach potable requirements is not a limiting factor.

Having established that the water from bore 72_6680 has surplus capacity that can be reallocated and is of a suitable quality, the advantages and disadvantages of this option are as follows:

- **Advantages**
  - No existing public reticulation upgrades required.
  - No restriction to potable water supply to the development.
  - No requirements to provide re-use tanks on the lots.
  - Ability to vest the new reticulation and system to Council.
  - Potential bolstering of water supply for Matamata, if connected to the existing reticulation.

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[2] Refer Table 3 of the WGA report for the bore usage for bore 72_6880 for the period described.

[3] The Maximum Acceptable Values (MAVs) have been defined by the Ministry of Health for parameters of health significance and should not be exceeded. The Guideline Values are the limits for aesthetic determinants that, if exceeded, may render the water unattractive to consumers.

- **Disadvantages**
  - Requires a water treatment system to be installed on-site that will need to be transferred to Council for future ownership/management.
  - Ongoing water monitoring will be required to ensure water meets Health (Drinking-Water) Amendment Act, October 2007
  - The current consent for the groundwater take will need changing to a municipal supply take which creates a consenting risk.
  - A dedicated tank, and pumpset, will be required for firefighting requirements of the entire plan change site. This can be provided with a dedicated tank trickle fed from the borehole or potentially making use of the of stormwater ponds for firefighting purposes. Discussions with council will be required for potentially vesting this system.

4.3.3 Preferred Option

Although option 1 is simpler, option 2 is the preferred option due to the supply issues that Council has identified and uncertainty of when additional supply would become available. A conceptual reticulation layout, based on option 2 is provided in **Appendix C**.

4.4 Design requirements

Detailed water design will be required for each stage in the development. At the first stage, the design will need to address:

- Design and construction of a new water treatment plant, the location of which is to be confirmed.
- An internal reticulation network including connection to the existing Council mains.
- Requirements for firefighting.

Subsequent stages will connect to the above reticulation.

4.5 Proposed reticulation

The Matamata-Piako District Council Development Manual sets out design and construction standards for water reticulation, potable water supply and firefighting supply in accordance with SNZPAS 4509:2008 (NZ Fire Service Fire Fighting Water Supply Code of Practice). Most often compliance with the code of practice is achieved through traditional pipes and hydrants, however, compliance is possible though alternative means, for example a central tank with booster pump and dedicated supply lines is an acceptable solution.

The proposed water reticulation network will most likely consist of principle mains of either DN250 PE, DN180 PE, &/or DN125 PE and DN63 PE rider mains. The network will be located in the road reserve berms with sluice valves and hydrants located at appropriate locations throughout as required by the RITS.

4.6 Firefighting design requirements

The firefighting for this development will need to satisfy the FW3 requirements as set out in SNZ PAS 4509:2008 – New Zealand Fire Service Firefighting Water Supplies Code of Practice.

The principle main and associated hydrant will be provided internal to the development to comply with the Matamata Piako District Council Development Manual and associated firefighting standards. The development will need the following water supply requirements:

- A primary water flow of 25 litres/sec within a radial distance of 135m.
- An additional secondary flow of 25 litres/sec within a radial distance of 270m.
- The required flow will be achieved from a maximum of three hydrants operating simultaneously.

The firefighting water requirements for individual buildings will be accessed during the building consent process. If this identifies that demand exceeds FW3 then the additional supply shall be provided by a privately owned and maintained on lot system, such as a tank and pump.

5. Wastewater

5.1 Existing reticulation

The reticulation near the proposed development is a 150mm diameter PVC gravity main located in Rockford Street. The intersection of Tauranga Road and Rockford Street has a 150mm diameter PVC gravity main located in the berm which was installed in 2009 and it is noted this line is in and excellent condition. Refer to **Figure** below.

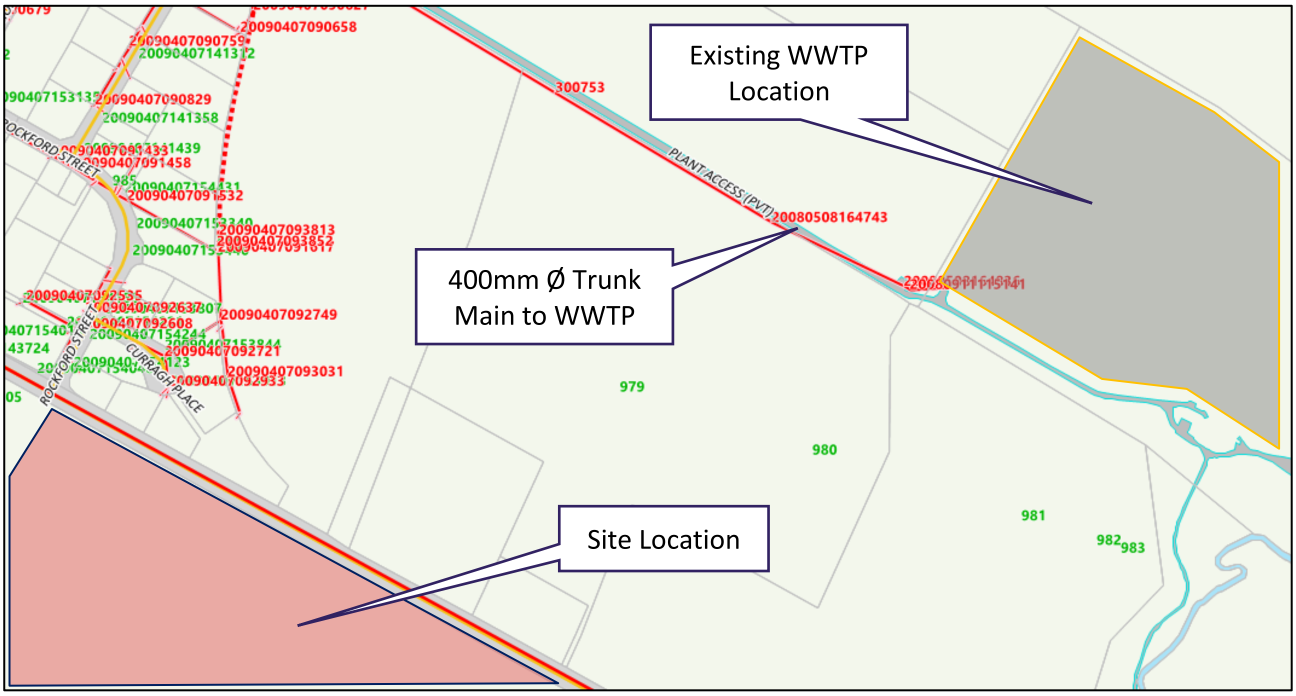

Figure 8: Existing Wastewater Network (Source: MPDC GIS)

Based on GIS there is a 400mmØ Trunk Main which conveys all the wastewater from the Matamata catchment into the WWTP which is located on the eastern side of town, north of Tauranga Road.

Preliminary engagement with Matamata Piako District Council staff was undertaken, during which, they indicated that development of the plan change area would trigger significant upgrades because the existing network (i.e. the trunk main discussed above) and current zoned catchment is already at capacity, for both the network and the wastewater treatment plant.

In relation to the wastewater treatment plant (WWTP) capacity, the WWTP has an existing discharge consent, from the Regional Council, which enables the discharge of 4,000m³ per day of membrane treated effluent. MPDC have noted this limit is being breached during substantial rain events due to infiltration into the network. MPDC are consequently undertaking infiltration improvement works in their network to reduce this risk. These works along with operational changes and upgrades to the plant are also proposed to help manage the discharge.

5.2 Demand calculations and assumptions

The demand and assumptions around the demand calculations were based on the requirements set out in the Waikato Regional Infrastructure Technical Specification (RITS) for water demand requirements. The standard values used are listed as follows:

- 200 litres per person per day was used (RITS 5.2.4.2).
- Infiltration Allowance of 2250 litres per hectare per day (RITS 5.2.4.2)

- Surface water ingress allowance of 16,500 litres per hectare per day (RITS 5.2.4.2)
- 45 people per hectare recommended for Industrial Zoning (RITS Table 5.3) and 30 people per hectare used for Commercial Zoning (RITS Table 5.3) included for comparison purposes.
- Peaking factor of 2.7 used as recommended by the RITS.
- Assumes 12% of the area to be developed will be used for roads/accessways.

Using the above assumptions and parameters **Table 3** below summarised the total flows. As with water, the commercial volumes are provided for comparison purposes. Please refer to **Appendix A** for the calculation spreadsheet.

Table 3: Wastewater demand calculations

	Designed for (per ha)	ADDWF	PDDWF	PWWF
Industrial land use	45 people	4.24 l/s.	8.99 l/s.	15.19 l/s.
Commercial land use	30 people	3.10 l/s.	6.49 l/s.	12.70 l/s.

The calculated flows are conservative and likely over-estimated with the amount of infiltration and ingress allowed into the system given the system is new and unlikely to leak at the same rate as older pipes (in particular earthenware pipes). In addition, the ratio between the amount of pipes and land area serviced varies greatly between the proposed industrial use and residential land which the RITS assumptions for infiltration are based on. Residential land generally has a much higher density of connections compared with other land uses driven by considerably smaller lots. For this reason, the ingress and infiltration rates have been reduced on similar projects such as that applied to the Ruakura Superhub project in Hamilton City. These options will be discussed with PDP and Matamata Piako District Council, as part of the detailed design, to potentially reduce the flows as calculated above.

5.3 Proposed wastewater network options

A number of options have been considered to provide for the treatment and disposal of wastewater. These are summarised below, along with the preferred approach.

5.3.1 Option 1 – Upgrade Existing Network and WWTP

This option would involve providing a localised network with a centralised pump station, within the plan change site, which conveys the wastewater into the WWTP located to the north of the development.

PDP is currently working with Council to look at operational changes and upgrades to the WWTP that may increase capacity, within its consented discharge. Until such time as that work has been concluded, the following statements apply:

- Other developments proposed in the currently zoned land will utilise any residual spare capacity in the Matamata wastewater piped network and WWTP.
- As this development is not currently zoned, it will assume lower priority to land that is currently zoned for residential, future residential or other (employment development) within Matamata.

For these reasons, this option may only be feasible if the developer finances the conveyance of wastewater to the Matamata wastewater treatment plant and contributes to a “modular” partial upgrade that would accommodate the additional flow and load produced. This would, in our opinion, be the better long-term solution. Being a modular system also enables the system to be upgraded in the future as the development grows. Furthermore, the and the modular approach would not preclude other developers (not zoned) in the area from also adding modules to accommodate their developments.

Under this option, **Figure 9** set out the proposed location of the wastewater pump station and the indicative alignment of the rising main which will connect into the WWTP. Coordination with Council (as the owner of the land to the north of the site) will be required for the approval and installation of the rising main and associated easement framework. This plan is also provided in **Appendix C**. Should that alignment be unable to be achieved, an alternative alignment is available along SH24 and through Lot 3 DP 313622, which has been purchased by Calcutta Farms Ltd. This alternative alignment is annotated into **Figure 9**.

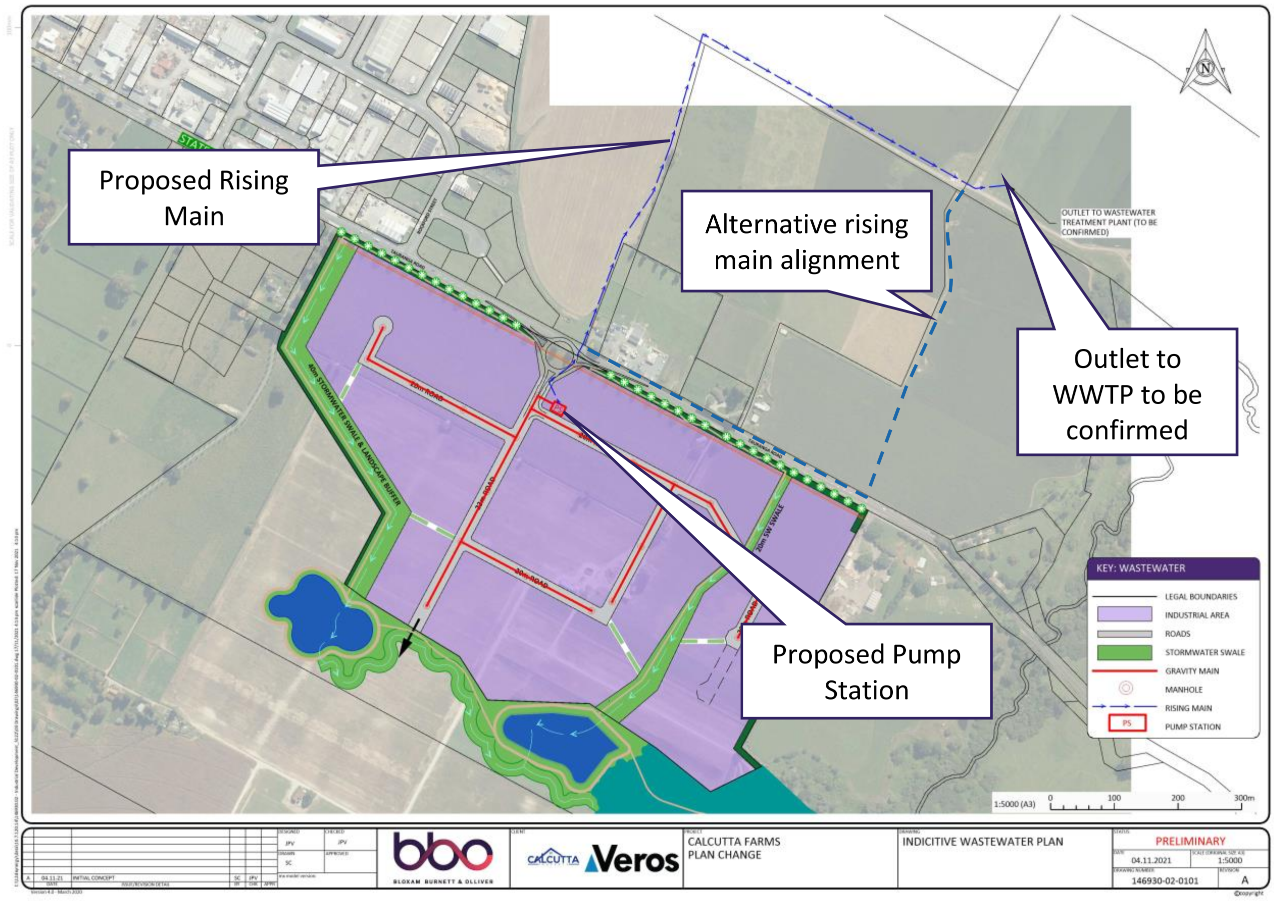

Figure 9: Wastewater Option 1

5.3.2 Option 2 – Centralised Treatment Plant

Option 2 consists of a centralised wastewater treatment facility within the proposed plan change site that solely services the site. This option allows the development to work independently form the public system so as not to require upgrades to the reticulation or the WWTP.

Council have expressed concern with an onsite treatment system due to its proximity to the existing wastewater treatment plant. For this reason and due to risks obtaining the required regional council consent, long term operating costs and compliance risk this option has been abandoned.

5.3.3 Option 3 – On-site Wastewater Disposal

Option 3 is to require individual on-site wastewater treatment and disposal systems for each individual lot. These systems would be designed and constructed as part of the development of the individual lot and would take into consideration the anticipated flows volumes and makeup of waste, based on the individual users needs, as well as the consented limits for discharge of treated effluent.

A likely that some sites may require discharge consent from Waikato Regional Council if their discharge is unable to comply with the permitted activity standards. It is also anticipated that the discharge limits will be stringent requiring a tertiary treatment system that treat wastewater to a standard that can be used for irrigation or safely discharged to ground.

Whilst this is not the preferred option, the site conditions do not preclude this option. Furthermore, this approach has been used for industrial land uses previously. The Western Precinct at Titanium Park being one such example.

5.3.4 Preferred Option

Option 1 is preferred as it follows the traditional wastewater model with Council ownership and maintenance of all related infrastructure. This option presents the lowest risk both for consenting and long-term operation, however, does present a challenge in the short term as an upgrade or provision of additional capacity is required in the WWTP.

5.4 Design requirements

Detailed wastewater design, if Option 1 applies, will be required for each stage in the development. At the first stage, the design will need to address:

- A new wastewater pump station and rising main that connects the site to the WWTP.
- Coordination with MPDC regarding connection and discharge into the WWTP, including required upgrades or expansion to accommodate the additional flows.
- A gravity reticulation network that can be extended for future stages.

Subsequent stages will connect to the above reticulation and will require an extension of the gravity reticulation.

5.5 Reticulation

The Matamata-Piako District Council Development Manual sets out design and construction standards for wastewater, and the design will also be done in accordance with the Waikato Regional Infrastructure Technical Specification (RITS).

The proposed wastewater network will most likely consist of DN150 PVC mains with 150mm connections to each site. The network will be located in the road corridor with manholes situated at appropriate locations throughout, based on RITS standards.

6. Stormwater

6.1 Catchment description

The project's catchment lays within the flat floodplain area east of Matamata and is located within the Mangawhero Stream's general catchment. There are no stream formations within the plan change footprint and the runoff flows in the form of sheet flow during rainfall events. Some flow path patterns may occur during high rainfall events, but currently there is not any form of waterway. The general overland flow arrangement relative to the site is shown in **Figure 10**.

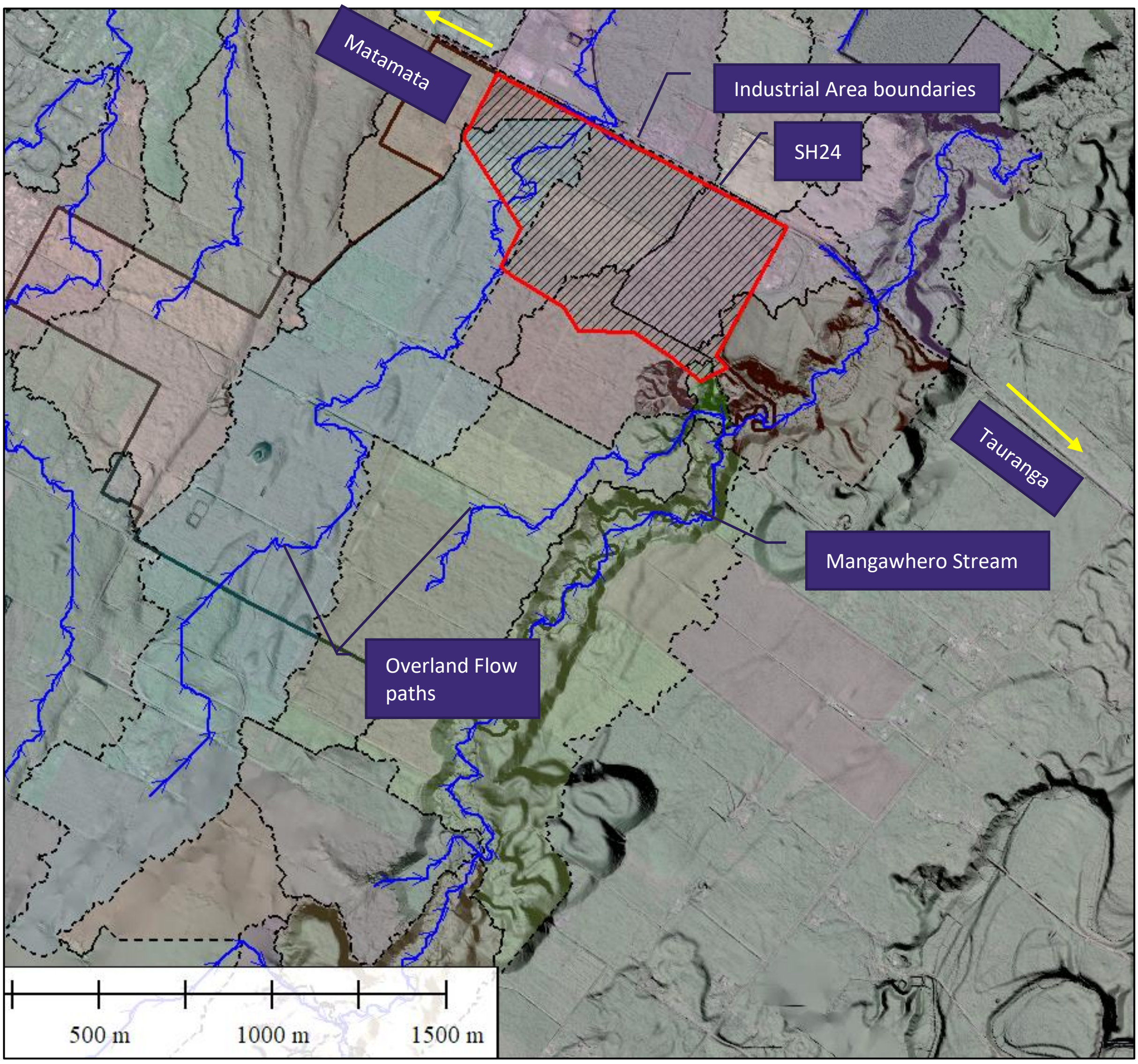

Figure 10: General overland flow network relative to the site

In its current situation, the majority of the surface runoff discharges towards and into Tauranga Road, it has a flat grade, varying from 0.1 to 0.5%, towards the North. The eastern part of the area is discharges into Mangawhero Stream as a flow path has been formed alongside the southern side of Tauranga Road. A small part of the area on the south-eastern boundary currently drains into a gully that is part of the Mangawhero Stream network.

In its current state, the land use of the site is agricultural/farming. Impervious areas are limited consisting mostly of the internal gravel road network and a few farming structures, mostly barns. The current imperviousness of the catchment has been assessed to 5%. The predominant soils are sands, sandy silts, with a topsoil layer that consists of dark brown sandy silts with high concentration of organics, typical for agricultural lands.

6.2 Stormwater design philosophy

The proposed stormwater management layout has been designed to comply with the RITS and the WRC stormwater management guidelines. A combination of treatment, conveyance, and attenuation devices are proposed that promote stormwater treatment chain approach, positive aesthetics output, and the spatial requirements that industrial developments usually pose. The proposed stormwater management Layout (see **Figure 11** below) is presented in **Appendix E**.

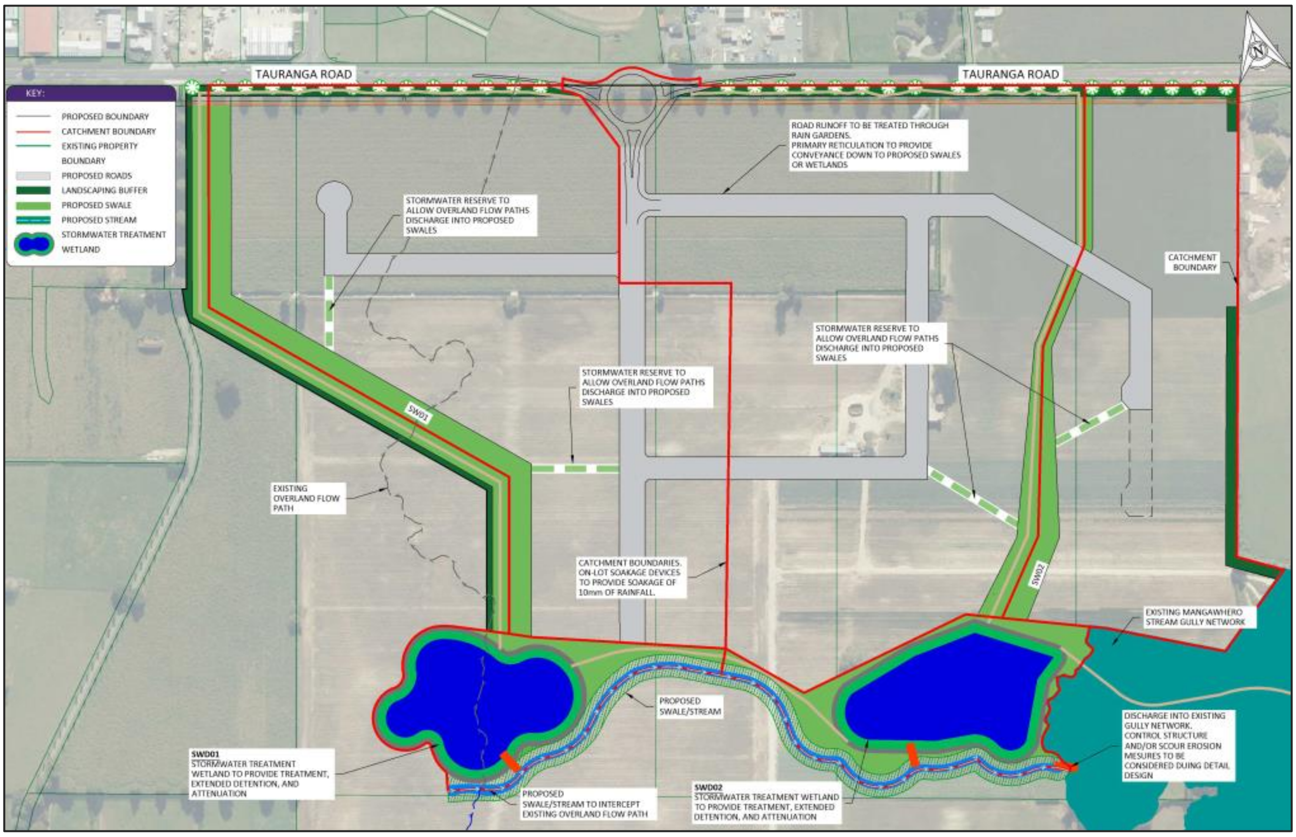

Figure 11: Proposed Stormwater Management layout

The proposed stormwater management philosophy is presented in the form of the following diagram:

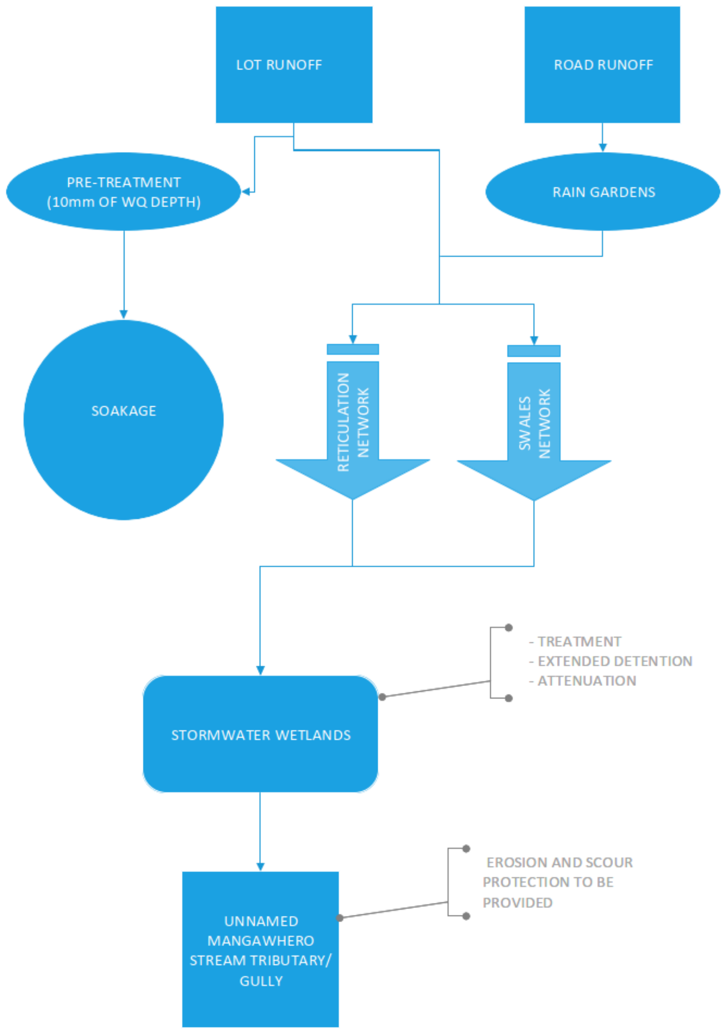

Figure 11a: Diagram of Proposed Stormwater Management layout

6.2.1 Stormwater treatment

The stormwater treatment philosophy is briefly presented in the following bullet points:

- Road surface to be treated via raingardens. The treated runoff will then be collected via a primary reticulation and discharged into the wetlands or the proposed swales.
- Lot surface to be treated initially through soakage. On-Lot soakage devices will be sized to soak 1/3rd of the WQ rainfall depth (10mm of 30mm WQ event). Soakage devices will be underground and could be located under parking or green areas. For a typical site it is anticipated that the soakage device footprint will take up approximately 1.5% of the lot area.
- The remaining 20mm of the WQ rainfall will be collected through reticulation and discharged into the proposed swales and from there into the proposed wetlands. The proposed wetlands will provide water quality treatment, extended detention, and attenuation.

The proposed layout provides a treatment train that will enhance treatment efficiency while functions as amenity features (swales, wetlands, rain gardens). It also includes groundwater recharge without the need for large soakage devices that require a large footprint.

Finally, the proposed layout provides a new discharge point to the Mangawhero Stream gully network. Currently flows from the catchment discharge/overtop onto Tauranga Road leading to a risk of flooding. The proposed layout provides an alternative discharge point, south of the plan change site, so as to provide stormwater/flood protection to the existing state highway.

6.2.2 Drainage

A reticulation system under the proposed road network will provide conveyance of the collected runoff and, along with the proposed swales will be part of the primary system.

The road reserve will function as a secondary system to allow for overland flow during events higher than the 10-year ARI. Additional stormwater reserves are proposed to ensure continuity of the overland flow path network to ensure that no properties are at risk of flooding.

6.2.3 Attenuation

Attenuation of the flows to pre-development levels will be provided through the proposed stormwater wetlands, and the swale/stream network. The wetlands will be sized to also provide extended detention to prevent erosion at the downstream receiving system (Mangawhero Stream gully system).

6.2.4 Swales

The proposed swales will function as conveyance and pre-treatment devices. It is proposed that the swales will be planted so that they can provide higher biological uptake while also providing amenity and aesthetics. Furthermore, once the vegetation is established, the maintenance needs will be limited when compared to grassed swales which require regular mowing.

The swales will emulate stream function and will consist of a main channel, and floodplain areas. The alignment of the main channel will be curved to provide irregularities and sinuosity. The swales' flood plain will also contribute to flow attenuation allowing water to back up.

6.2.5 Alternative options

Other options considered for the stormwater layout were:

- Full on-lot soakage and a centralised treatment/soakage system for the road runoff. This system would require large portions of the industrial lots to accommodate soakage devices which would lead to high cost and would restrict development options within the lots. It would also not cover the attenuation requirements, leading to the need for additional areas for attenuation ponds. WRC generally do not support the use of systems that rely fully on onsite solutions as they are concerned with the long-term operation of these systems. Consent compliance is difficult to monitor and enforce unless Council can undertake regular inspections of the system to ensure they are fit for purpose.

- Centralised stormwater treatment device(s) (wetland) and a primary reticulation network. This option would require larger treatment device(s) and the designation of more stormwater reserves to ensure that during rainfall events higher than the 10-year ARI, the overland flows would be safely guided into the device(s). Additionally, the solution would not benefit ground water recharge.

The above reasons, the proposed stormwater solution is a well-balanced approach that maximises benefits for both the development and the environment.

6.3 High level modelling results

6.3.1 Drainage and hydrology

Stormwater hydrology and hydraulics were modelled using EPA SWMM-5 (SWMM). **Figure 12** presents the high-level model layout that was built for the needs of this report. Refer to **Appendix J** for modelling output. 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). This allows hydraulic losses in manholes, bends or junctions to be accounted for and ponds with complex outlet structures to be modelled.

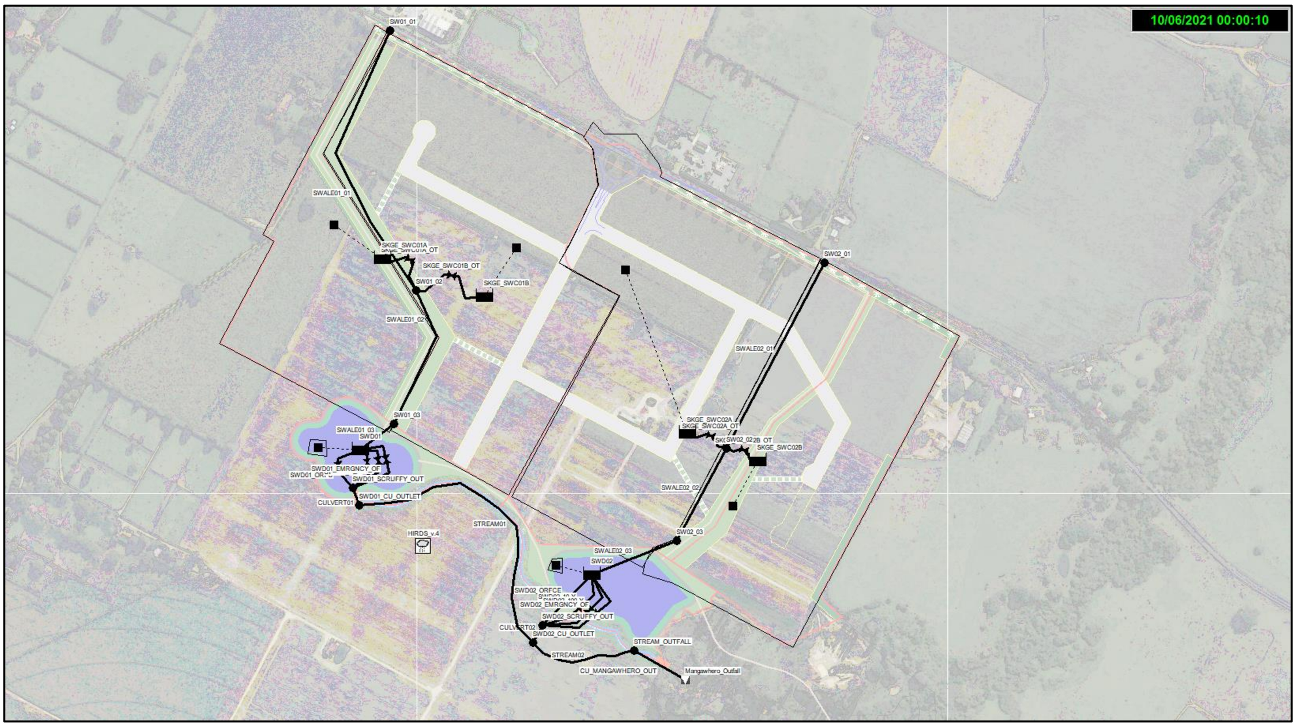

Figure 12: High-Level SWMM model of the proposed Stormwater Management Plan.

24-hour duration storms have been modelled, using rainfall intensities from High Intensity Rainfall System (HIRDS). The 24-hour design storms modelled were Water Quality (1/3rd of the 2-year/ 24hour storm, 10-year, and 100-year ARI storm events. All design storm events were adjusted to account for a 2.3°C temperature increase due to climate change. An additional 100-year ARI design storm adjusted for a 3.8oC temperature increase was also used to verify freeboards and possible overtopping for the RCP8.5 scenario, following peer review and WRC recommendations.

Infiltration was estimated based on typical hydraulic characteristics of typical soil texture classes, taken from the EPA SWMM-5 Manual and Rawles, W.J. et al., Journal of Hydraulic Engineering, 109:1316. Soil textures from the site were derived from the S-Map, and sieving laboratory tests conducted by WSP (**Appendix F**).

The infiltration method applied was the Horton's Infiltration Equation. Horton's Equation uses infiltration rates for typical soil types in the sub-catchment. This method uses an initial infiltration rate, adjusted for an appropriate antecedent moisture condition, and decreases it exponentially to a final infiltration rate for saturated soil conditions. The rate that the infiltration is decreased by is determined by a decay rate. Initial infiltration rate of 33.87mm/hr and final infiltration rate of 6.6mm/hr respectively were used, along with a decay rate of 4.0. The infiltration rate reaches saturated hydraulic conductivity within the first 2 hours, long before the peak of 24-hour design events. **Figure 13** below shows a plot of infiltration versus time, using Horton's Equation with the inputs that have been applied.

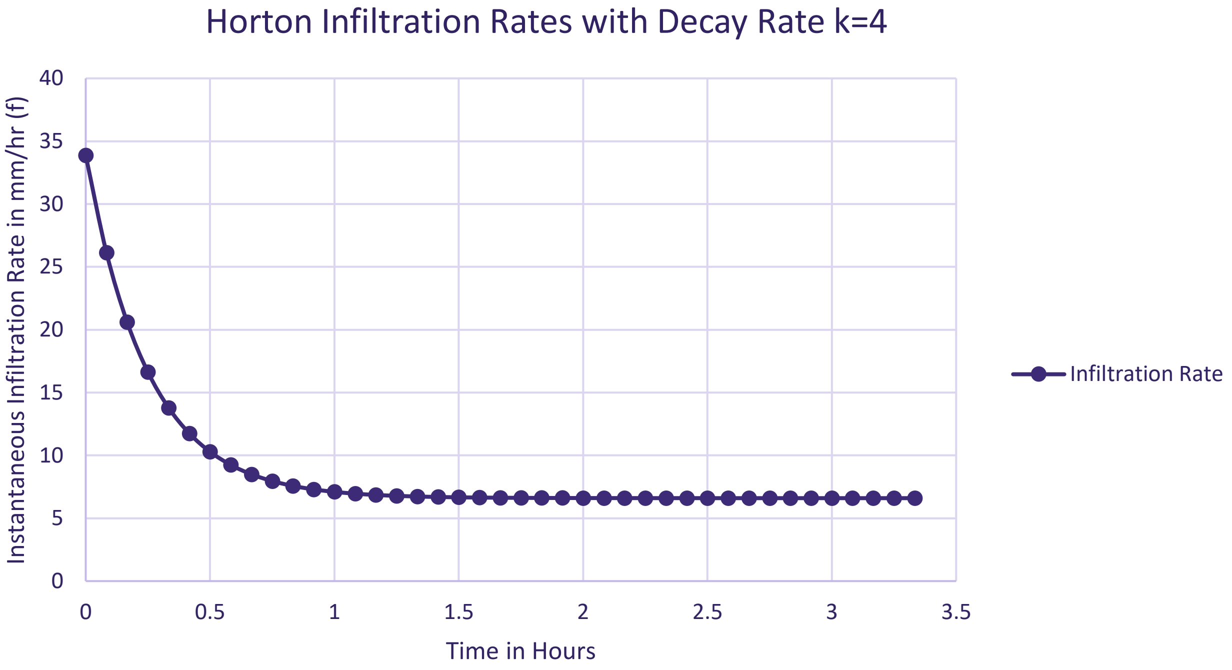

Figure 13: Horton's equation plot

Depression storage was input at 5mm for pervious areas and 2mm for impervious areas.

Peak flow estimates were calculated for 2year, 10year, 50year and 100year, 24h storm events. Design rainfall curves were introduced for existing conditions and future, climate change adjusted conditions. The curves derived from HIRDS v.4 information and WRC TR2020/06 (Waikato Stormwater Runoff Modelling Guide).

6.3.2 Soakage

The on-lot soakage devices were sized according to MPDC Soakage Design Procedures and Guidelines, and the RITS, but for a target volume of 1/3rd of the Water Quality Volume. All devices were inserted in the SWMM model to review/verify their performance, and Green & Ampt equation was used to model them. **Appendix I** provides an example of on-lot sizing calculation. The on-lot soakage trenches were modelled in groups, depending on the sub-catchment that they were servicing. A soakage rate of 90mm/h was used for all soakage devices. This rate corresponds to the average rate calculated by CMW during the onsite soakage tests, apply a factor of 0.5 according to RITS and WRC Stormwater Guidelines. Refer to **Appendix G**.

Raingardens have not been modelled in this high-level model. During detail design, soakage will also be also applied for the raingardens that will be included in the SWMM model, as LID controls in the road sub-catchments' properties. For the raingardens, a more conservative soakage rate will be used to comply with WRC guidelines (0.75m/day).

6.3.3 Reticulation

Stormwater reticulation has not been designed for the needs of this high-level model. During detail design the reticulation network will be designed in 12D and imported in EPA SWMM for modelling and sizing. The design will be based on RITS. Entry and exit loss coefficients on every pipe section will be applied. Overland flow paths will also be included in the model to allow for depth and velocity checking during higher design events (50-year, 100-year).

6.3.4 Flood Control

Flood control will be applied though attenuation of the overall flows in the proposed wetlands and swales. Outlet structures will be sized to allow the discharges to match pre-development flows for the 2-year and 10-year ARI design rainfalls, and the 80% of the pre-development flows for the 100-year ARI event. The outlet structures have been preliminary sized in the high-level SWMM model and provide evidence that the proposed areas and volume for the wetlands and swale network can provide sufficient storage to achieve the attenuation goals. **Figure 14** and **Figure 15** below demonstrate the attenuation provided by the proposed layout.

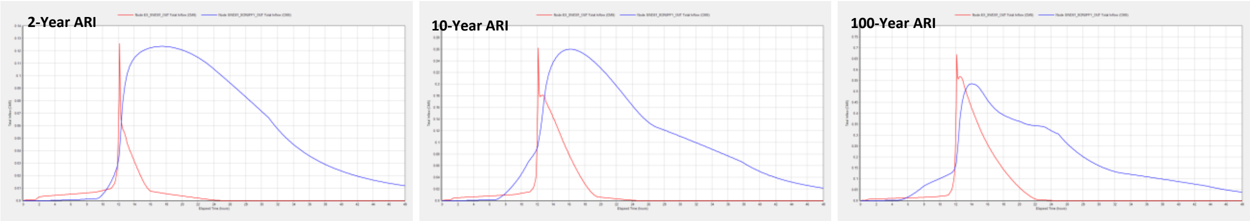

Figure 14: Attenuation Performance graphs of SWD01 discharge during the design 2-year, 10-year, and 100 year ARI rainfall. The red line represents pre-development flow, and the blue line represents post-development attenuated flow.

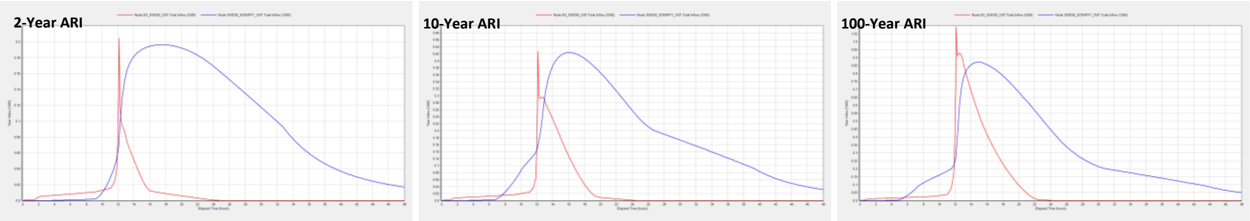

Figure 15: Attenuation Performance graphs of SWD02 discharge during the design 2-year, 10-year, and 100-year ARI rainfall. The red line represents pre-development flow, and the blue line represents post-development attenuated flow.

The discharge into the existing Mangawhero Stream gully system will be by way of new stream that will convey the attenuated flows from the treatment devices and release it into the gully network through a control discharge device. The proposed new stream will also divert the overland flows that enter the site from the south under the existing conditions. Erosion and scour control measures will be considered and designed during detail design the ensure that the receiving gully system will be protected against the discharges.

The proposed stream is part of a wider stream network currently modelled and designed under a stormwater Masterplan that is being developed for the entire Calcutta Farms properties catchment. The masterplan considers the same design principals regarding stormwater treatment, attenuation, flood control and ground water discharge. The stormwater masterplan will inform the detailed design of the proposed Industrial Area, and vice-versa. Once developed, the overall masterplan will provide an extension of the Mangawhero Stream gully network that will accommodate off-line stormwater treatment and attenuation wetlands, as well as a network of amenities for the future residential areas.

6.3.5 Stormwater conclusions

The design of the proposed stormwater management system is in general conformance with the Waikato Regional RITS, the Waikato Stormwater Guidelines and any future consent conditions.

Currently only high-level design and modelling is available, it is therefore expected that some changes may occur during the detail design of the development. The changes will comply to the same standards that the current design is based on and will be refined to conform with conditions of any future consents.

Based on the design described in this report, the proposed stormwater management system will achieve the following:

- All of the development's stormwater runoff will be treated by at least one treatment device that meets RITS standards.
- During intermediate storm events, soakage devices are proposed that will promote groundwater recharge through infiltration.
- The overall approach is intended to maximise the stormwater management benefits, within the constraints of the existing site, while minimizing impacts to the off-site environment.

6.3.6 Additional Stormwater Information/Assessment

In response to the peer review of this report, undertaken by CKL, two additional appendices have been added to this report. **Appendix L** is a memo that provides a high-level catchment analysis of the Mangawhero Stream catchment, to assess the effects on the Mangawhero Stream from the plan change. **Appendix K** is a memo that specifically addresses four points of the peer review and provides updated hydrological and hydraulic calculations and an updated assessment of the overland flow path on the south-western boundary of the development. Refer to those two appendices for further information.

7. Utility services

7.1 Power supply

The majority of the existing properties along Tauranga Road are serviced by overhead powerlines. These overhead power lines are situated on within the site boundary (approximately 14.5m back from the site boundary with the road). Vero's, on behalf of Calcutta, are investigating the option of undergrounding these lines, however, for the purpose of the plan change it should be assumed that they will be retained and will be subject to an easement in gross in favour of PowerCo. Their alignment is such that they are expected to be located within a future reserve that runs parallel with Tauranga Road.

PowerCo/Northpower has been engaged to verify the demand of the existing reticulation and to provide guidance on the serviceability of the development. PowerCo has confirmed that the development can be connected from the Taihoa Feeder (see **Figure 16** below for location). Please refer to **Appendix D** for the full email setting out the serviceability from PowerCo.

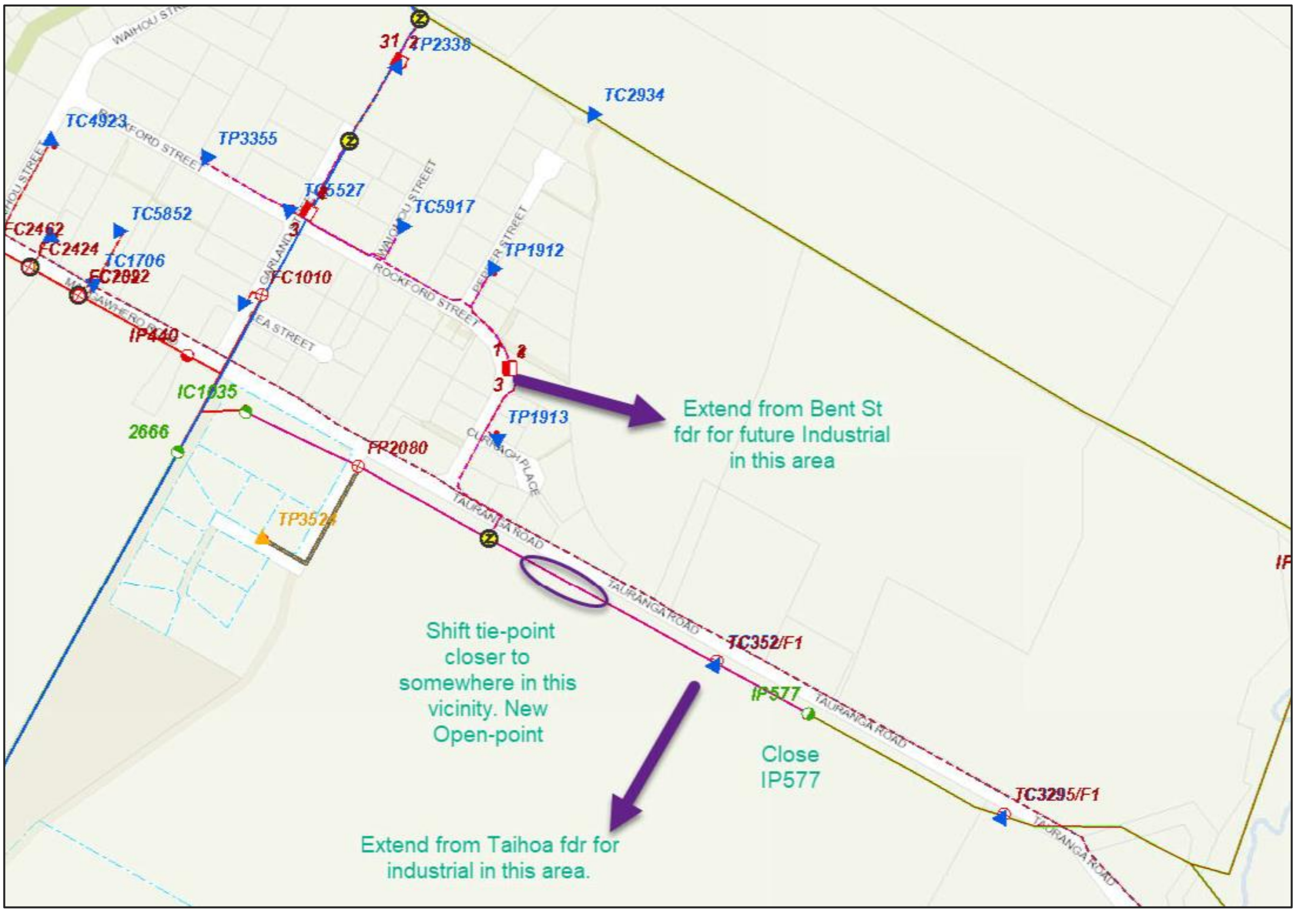

Figure 16: PowerCo reticulation alignment to service Industrial Zone

All power reticulation will be carried out in accordance with the New Zealand Standard – Land Development and Subdivision Infrastructure NZS: 4404:2010 and PowerCo's requirements.

7.2 Telecommunications

Ultrafast Fibre has been engaged to verify the demand and serviceability of the development. They have confirmed that UFF telecommunications network is achievable for the development. Please refer to **Appendix D** for the letter of serviceability from Ultrafast Fibre.

All telecommunications will be carried out in accordance with the New Zealand Standard – Land Development and Subdivision Infrastructure NZS: 4404:2010 and suppliers' requirements.

8. Conclusion and recommendations

The conceptual infrastructure design for the plan change, as set out in this reporting, has been carried out in accordance with the Waikato Regional Infrastructure Technical Specifications and the Matamata Piako District Council Development Manual and taking into consideration the network constraints and opportunities.

The site is considered to be well located for the proposed activity, as it can be serviced by roading and stormwater relatively easily. There are constraints around supply of water and disposal of wastewater, however viable options exist to address these constraint as detailed within this report. We expect to work through these capacity issues further as the plan change progresses and as further information becomes available from Council in relation to the WWTP.

These preferred options are summarised below in **Table 3**.

Table 3: Infrastructure Matrix

Infrastructure	Preferred Option	Next Steps
Water Supply	• Utilise the existing borehole on site for supply of water. • Construct onsite water treatment plant. • Provide potable water network from treatment plant through the development. • Provide firefighting tank and pump system.	• Post approval of the plan change - close out investigation on the water quality and progress and engage specialist for treatment plant design. • Discuss all options with Council.
Wastewater Supply	• Provide local network to pump station to service lots. • Provide centralised pump station and rising main to WWTP. • Upgrade existing MPDC WWTP.	• Finalise extent of proposed PDP capacity and treatment upgrades. • Lock in parameters around the upgrade and discuss timing of these upgrades in relation to the development program.
Stormwater Management	• Use a combination of soakage, treatment, conveyance, and attenuation devices with a new discharge point to the Mangawhero Stream gully network • Soakage devices proposed to promote groundwater recharge. • All the runoff will be treated by at least one treatment device designed in accordance with the RITS.	• Advance to preliminary design stage and discuss with Regional Council.

Based on this report we consider that the proposed future industrial development outcome can be accommodated and designed without generating adverse effects on the existing infrastructure and stormwater receiving environment.

Appendix A – Water and wastewater demand calculations

Project :	Calcutta Development	Date :	17-Oct-2021
Client :	Veros		
Description :	Estimated Future Flow/Demand calculations		

Standard Values used

Residential - Water Consumption	260	litres per person per day	RITS 6.2.3
General Residential/Industrial - Population Density/Equivalent	45	persons per hectare	RITS TABLE 5.3
General Residential	2.7	persons per HOUSEHOLD (RITS Table 5-7)	
Commercial - Population Density/Equivalent	30	persons per hectare	RITS TABLE 5.3

Using Lot Occupancy Method

Development/Lot	Catchment Gross Area (Ha)	Zone	Population (persons)	Average Consumption (l/day)	(Peaking Factor)	Peak Flow (l/s)	Average Daily Demand (m3/day)	Comments
Employment Zone	32.50	Commercial	975	253,500	5	14.67	**253.5**	LW3 FF required
Employment Zone	32.50	Industrial	1463	380,250	5	22.01	**380.3**	LW3 FF required
Total Average Daily Demand								

Notes

Employment Zone: based on 32.3ha at 88% developed area (12% roads)

Project :	Calcutta Development	Date :	17-Oct-2021
Client :	Veros		
Description :	Estimated Future Flow/Demand calculations		

Standard Values used

Average Daily wastewater flow		200	litres per person per day	RITS 5.2.4.2
Infiltration Allowance		2250	litres per hectare per day	RITS 5.2.4.2
Surface water ingress allowance		16500	litres per hectare per day	
General Residential/Industrial Population Density/Equivalent		45	persons per hectare	RITS TABLE 5.3
General Residential		2.7	persons per HOUSEHOLD (RITS Table 5-7)	
Commercial Population Density/Equivalent		30	persons per hectare	RITS TABLE 5.3

Using Lot Occupancy Method

Catchment/Lot	Catchment Area (Ha)	Units	Zone (RES,IND,COM)	Population (persons)	Consumption (l/day)	P/A Ratio (Peaking Factor)	Infiltration (l/day)	SWI (l/day)	ADDWF (l/sec)	PDDWF (l/sec)	PWWF (l/sec)	Comments
Employment Zone (Commercial)	32.50	NA	COM	975	195,000	2.5	73,125	536,250	3.10	6.49	12.70	
Employment Zone (Industrial)	32.50	NA	IND	1465	293,000	2.4	73,125	536,250	4.24	8.99	15.19	

Summary of Flows

Total Flow

Notes

C:\12dsynergy\data\10.7.120.14\146930 - Calcutta Farms_5070\04 Infrastructure\[Calcutta Farm Calcs.xlsx]RITS Water Demand

Appendix B – Hydrological advice on water supply prepared by WGA

Calcutta Farms Ltd

Hydrogeological Advice on Water Supply

GROUNDWATER ASSESSMENT

Project No. WGA211905
Doc No. WGA211905-RP-HG-0001
Rev. B
17 November 2021

Revision History

Rev	Date	Issue	Originator	Checker	Approver
A	03 Nov 2021	Draft to Client	CMH	CHO	CHO
B	17 Nov 2021	Final	CMH	CHO	CHO

CONTENTS

Figures

Tables

Appendices

1 INTRODUCTION

1.1 INTRODUCTION

Calcutta Farms Limited (Calcutta) is seeking a hydrogeological assessment of the available water sources to support a land development which includes rezoning approximately 41 ha from rural zone to industrial zone to the south of Matamata (Figure 1). Matamata Piako District Council has identified that they have limited to no spare water capacity to cater for the demand likely to eventuate from the zone change. They are accordingly looking for Calcutta to demonstrate and provide a suitable water resource to service the development through either a new water take or a reallocation of some or all of one of Calcutta's existing water takes. There are three current Waikato Regional Council water permits to take groundwater associated with the property. One of these permits is for a small water take for dairy shed wash down and milk cooling. The other two, provide larger water volumes for irrigation and dust suppression and are considered potential options for reallocation of water with a particular focus on the Java bore (AUTH130710.01.01) which has a consented daily take of 7,200 m^3/day from bore numbered 72_6680.

1.2 SCOPE OF SERVICES

WGA was retained to provide support by undertaking the following tasks:

- Site visit to confirm site layout and take a water quality sample.
- Review the relevant documents, groundwater level data, pumping test data if available and water quality results to undertake an assessment of the feasibility of using the existing bore for potable water supply.
- Prepare a report documenting the findings of our feasibility assessment and provide recommendations for next steps.

1.3 CONSIDERATIONS FOR A POTABLE GROUNDWATER SUPPLY.

When considering a water source for potable supply, water security must be assessed. Drawing water from the source, and the risks associated with it, cannot be viewed in isolation; the process influences, and is influenced by, other water supply elements (MOH 2014a):

- Land use and activities carried out in the area where water enters the aquifer may affect the quality of the water being abstracted.
- The quality of the groundwater will influence the type of treatment it requires.

This report will address, water security by reviewing potential sources of contamination and the likelihood of these contaminating the groundwater supply through a detailed hydrogeological risk review. In addition to this water availability and quality will be assessed with potential treatment options recommended.

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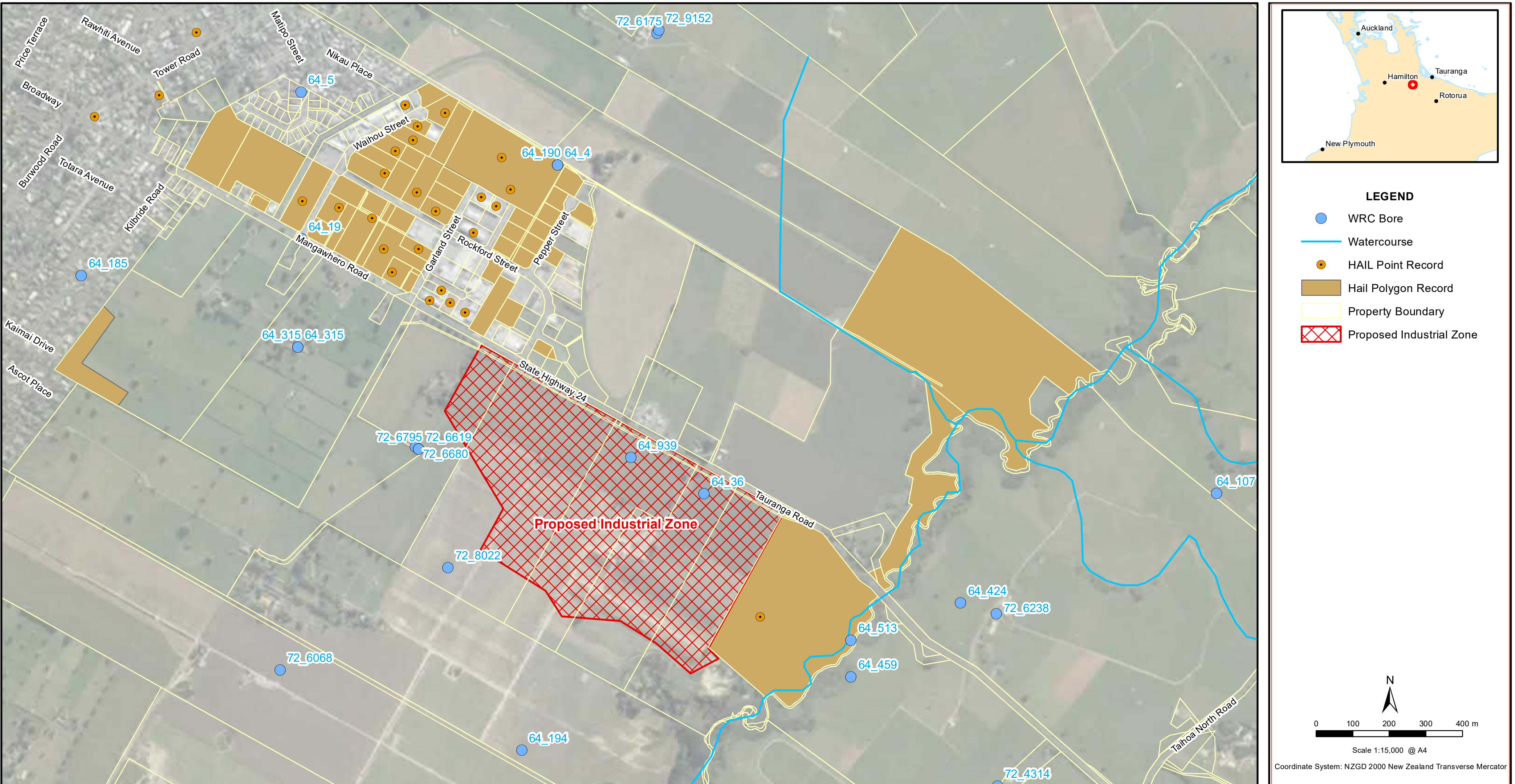

WGA
WALLBRIDGE GILBERT AZTEC

Figure 1

Calcutta Farm
Proposed Plan Change

Site Location Plan

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Any relevance placed on such information shall be at the risk of the user.

Note: The information shown on this map is a copyright of WGA 2020

1.4 SITE DESCRIPTION

The site is located on the southwest edge of the Matamata township on a gently sloping area. Ground elevation across the site varies from 63 m above mean sea level (RL) in the eastern area, down to 59 m RL at the western edge of the site. There are no surface water features on site however, a gully extends from the southwest edge of the site and flows to the Mangawhero Stream located approximately 160 m west of the site. The Mangawhero Stream flows into the Waihou River approximately 4,400 m to the northwest of the site. The site is not located within a defined land drainage scheme area.

The site is currently an active farm with associated infrastructure including abstraction and monitoring groundwater bores.

1.5 WATER USE AND REQUIREMENTS

Water demand calculations have been undertaken for the employment zone based on a population of 1,530 people (assuming 45 persons per hectare at 85 % developed). The calculations indicate an average daily demand of 398 m^3 is required with a peak flow rate of 23 L/s.

1.6 CURRENT CONSENTS

There are currently three active groundwater permits owned by Waipa Valley Holdings /Calcutta as detailed in Table 1. Two of the groundwater takes are consented for volumes larger than the proposed requirements of 398 m^3/day and could potentially provide the water source for the development. The location of the Java bore (72_6680) on the edge of the proposed development site makes this the preferred option for a water supply. In accordance with the conditions of the current resource consent, water levels are measured at 15 minute intervals using pressure transducers in two adjacent observation bores (72_6619 and 72_6795). Bore number 72_6619 is screened at the same depth as the Java bore (72_6680) and is used to monitor the water level in the pumped aquifer. Bore number 72_6795 is screened in the aquifer zone above the pumped aquifer. The abstracted water flow is measured in the Java bore (72_6680) at 15-minute intervals.

Table 1. Current Consents to Take Water.

Consent Number	Consent Owner	Bore Number	Max Daily Volume (m^3)	Use	Expiry
AUTH130710.01.01	Waipa Valley Holdings	72_6680	7,200	Crop Irrigation	1 March 2029
AUTH134035.01.02	Calcutta Farms	72_7181	5,400	Irrigation and dust suppression	9 February 2030
125705	Calcutta Farms	72_6068	16.45	Shed wash down and milk cooling	30 June 2028

1.7 BORE CONSTRUCTION

The bore construction details for the pumped and observation bores for the two larger water permits are summarised in Table 2.

Table 2: Bore Construction (Calcutta Limited bores).

Parameter (1)	AUTH130710.01.01			AUTH134035.01.02
Bore Number	72_6680	72_6619	72_6795	72_7181
Purpose	Production	Monitoring	Monitoring	Production
Owner	Waipa Valley Holdings Ltd			E G Balle Holdings Ltd
Address	126 & 194 Tauranga Road			121 Banks Road
Date Drilled	30 May 2013	4 April 2013	4 April 2014	26 May 2014
Easting NZTM	1845792	1845801	1845801	1845476
Northing NZTM	5810369	5810362	5810362	5809254
Depth (m)	73.5	100	100	57
Casing Depth (m bgl) (2)	65	N/A	N/A	48.1
Screened Interval (m bgl)	65.5 to 72.5	70.5 to 73.5	50 to 54.6	46.8 to 55.8
Diameter of Casing (mm)	300	32	50	250
Static Water Level (m bgl) (3)	16.4	16.09	16.17	20.7
Ground Elevation (m RL)	62	62	62	66

Note:
1) Information sourced from WRC records.
2) m bgl = metres below ground level.
3) Water level sourced from pumping test reports (Terra Aqua 2013 and Terra Aqua 2014).

1.8 SITE VISIT

A site visit was undertaken on 29 September 2021. A water quality sample was taken from the Java bore in accordance with current best practice. The bore was purged at a flow rate between 40 L/s and 80 L/s for 15 minutes prior to sample collection. Substantially more than three times the bore volume was removed prior to sampling the bore water as per New Zealand protocols[1]. The bore had not been operational since March 2021 prior to being purged. A groundwater level measurement of 16.60 m bgl was taken in the Java bore (72_6680) prior to pumping using the conduit in the headworks (Figure 2).

There was visible iron staining on the bore head (Figure 3) indicating that management of high concentrations of iron in the source water will be a challenge for a potable supply from this bore. The groundwater will require ongoing testing and water treatment. Calcutta Farm staff indicated that iron was less of an issue in the other large diameter bore (72_7181), although this bore is located approximately one kilometre from the development site.

The neighbouring monitoring wells and associated monitoring equipment were inspected (Figure 4).

A review of neighbouring properties was conducted to establish any potential sources of contamination.

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[1] https://bucketeer-54c224c2-e505-4a32-a387-75720cbeb257.s3.amazonaws.com/public/Documents/NEMS-Water-Quality-Part-1-Sampling-Measuring-Processing-and-Archiving-of-Discrete-Groundwater-Quality-Data-v1.0.0.pdf

Figure 2: Java Bore (72_6680) Headworks.

Figure 3: Sampling Point on Java Bore (72_6680) Showing Iron Staining.

Figure 4: On site Monitoring Bores Near the Java Bore (72_6619 and 72_6795).

2 POTABLE WATER SUPPLY

2.1 WATER AVAILABILITY

2.1.1 Current Usage

The monthly water usage records for the Java bore (72_6680) are presented for years 2017 to 2021 in Table 3. Proposed water usage of 398 m^3/day would equate to a maximum annual volume of 111,507 m^3. The actual usage is likely to be less than this due to non working days and commercial shut down periods. During the period between 1 January 2017 and July 2021, the highest daily take was 6,487 m^3 with an average daily take of 1,425 m^3 during the pumping seasons. Unlike the current seasonal usage, water will be required throughout the year, with a lower daily demand. The current usage indicates the required annual volume is achievable.

Table 3: Java Bore (72_6680) Current Water Usage.

Month	Water Volume (m^3)				
	2017	2018	2019	2020	2021
January	42,157	18,607	49,218	8,788	15,347
February	7,704	0	39,713	38,200	18,555
March	0	0	44,120	11,045	4,882
April	0	0	0	0	3
May	0	0	120	450	0
June	1	3	136	0	0
July	0	1	0	0	0
August	0	0	0	0	0
September	0	0	0	0	0
October	0	0	0	0	0
November	0	8,426	0	0	0
December	67,746	0	0	0	0
Total	**117,608**	**27,037**	**133,307**	**58,483**	**38,787**

2.1.2 Water Level Monitoring

Water level monitoring is undertaken in the adjacent monitoring bores screened in the pumped aquifer (70.5 and 73.5 m bgl) and a shallower aquifer between 50.0 and 54.6 m bgl. WGA have reviewed the water level records from January 2017 to July 2021. Pumping rates during a season vary by up to 84 L/s with an average pumping rate of 50 L/s. A maximum pumping induced drawdown of 6.6 m is noted in January 2017. If the bore was to be solely used for water supply the flow rates would be reduced and the drawdown would also be expected to be less. Winter groundwater levels appear to have declined by approximately one metre over the period. However, currently low groundwater levels had been noted across the region following drier conditions over approximately two years.

Regional groundwater level data is available on WRC's Environmental Data Hub[2] The closest bore to the site with available groundwater level data is bore 64_831 located near Matamata. The graph for the bore (Figure 5) shows that water levels recorded during the last 12 months since the last measurement was taken have been at or below the minimum level previously recorded during the same time of year (WRC 2021).

Figure 5: Groundwater Levels Recorded at WRC Monitoring Bore 64_831.

The Calcutta site is within the management area for the Southern Hauraki Aquifer. A recent search of the Waikato Regional Council (WRC) database indicated that the allocation for groundwater is currently at 3 % of the management level set for the Southern Hauraki Aquifer. The management level for the Southern Hauraki is 335,000,000 m^3/year according to Table 3-6 of the Waikato Regional Plan (WRC 2012).

2.2 WATER QUALITY

2.2.1 Laboratory Results

Results of laboratory analysis undertaken on a water sample from the Java bore (72_6680) are recorded in the WRC database. All results are included in Table 4. The laboratory reports for the 2021 sampling are included in Appendix B of this report.

The results of the analyses have been compared to the Ministry of Health Guideline Values and Maximum Acceptable Values for drinking water where applicable (MOH 2018). The Maximum Acceptable Values (MAVs) have been defined by the Ministry of Health for parameters of health significance and should not be exceeded. The Guideline Values are the limits for aesthetic determinants that, if exceeded, may render the water unattractive to consumers.

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[2] https://waikatoregion.govt.nz/environment/envirohub/environmental-maps-and-data?dt=Groundwater+Level

Iron and manganese are high in both water quality samples taken and will require treatment to meet the guideline values for aesthetics and in the case of manganese, the MAV of 0.4 g/m^3. Both iron and manganese can cause staining and particularly in the case of iron, iron bacteria can precipitate and cause clogging of the water supply infrastructure. The presence of high iron and manganese is common in deeper aquifer systems and is an indicator of a more confined system with older groundwater which has dissolved minerals from the rocks that make up the aquifer along the groundwater flow path.

Arsenic concentrations in the water samples are below the MAV of 0.01 g/m^3 by a small margin which is potentially due to the long periods of the bore shutdown in the winter period. Regular sampling would be required to ensure the arsenic concentration does not vary seasonally and is consistently below the MAV.

The water quality samples taken are a taken at single points and do not reflect any potential seasonal variation.

Table 4: Results of Laboratory Analysis for Java Bore (72_6680).

Analyte	Unit	Sample 17 Dec 2014	Sample 29 Sep 2021	Guideline Value	Max Acceptable Value (MAV)
Escherichia coli	MPN/100mL	-	<1	-	<1
pH	pH	6.8	7	7.0 - 8.5	-
Turbidity	NTU	-	40	<2.5	-
Alkalinity Total	g/m^3-CACO3	116	89	-	-
Free Carbon Dioxide	g/m^3-CO2	33	16.4	-	-
Dissolved Oxygen	g/m^3	8.9	-	-	-
Conductivity at 25 DegC	mS/m @25°C	32.9	19.2	-	-
Total Hardness	g/m^3-CACO3	65	42	<200	-
Total Dissolved Solids	g/m^3	220	129	<1000	-
Total Arsenic	g/m^3	0.0053	0.0074	-	0.01
Total Boron	g/m^3	0.093	0.045	-	1.4
Total Calcium	g/m^3	12.2	6.2	-	-
Total Copper	g/m^3	0.0039	<0.00053	<1	2
Total Iron	g/m^3	5.9	7.9	<0.2	-
Dissolved Iron	g/m^3	2.3	-	-	-
Total Lead	g/m^3	-	<0.00011	-	0.01
Total Magnesium	g/m^3	8.3	6.4	-	-
Total Manganese	g/m^3	0.3	0.56	<0.04 (Staining) <0.10 (Taste)	0.4
Dissolved Manganese	g/m^3	0.31	-	-	-
Total Potassium	g/m^3	5.3	4.7	-	-
Total Sodium	g/m^3	41	25	<200	-
Total Zinc	g/m^3	0.0032	0.02	<1.5	-
Dissolved Chloride	g/m^3	34	7.4	<250	-
Nitrate-N	g/m^3-N	0.05	<0.05	-	11.3
Ammoniacal Nitrogen	g/m^3-N	0.56	-	-	-
Reactive Silica	g/m3 as SiO2	92	-	-	-

Analyte	Unit	Sample 17 Dec 2014	Sample 29 Sep 2021	Guideline Value	Max Acceptable Value (MAV)
Dissolved Reactive Phosphorus	g/m^3-P	0.018	-	-	-
Sulphate Dissolved	g/m^3	0.5	<0.5	<250	-

2.3 WATER TREATMENT

Iron and manganese water treatment generally involves oxidation and filtration of the water. The oxidant chemically oxidizes the iron or manganese (forming a particle) and kills iron bacteria and any other disease-causing bacteria that may be present. The filter then removes the iron and/or manganese particles.

In general, manganese oxidation is considered more difficult than iron oxidation because the reaction rate is slower. A longer detention time (10 to 30 minutes) following chemical addition is needed prior to filtration to allow the reaction to take place. There are different filtration media for the removal of iron and manganese, including manganese greensand, anthra/sand or iron-man sand, electromedia, and ceramic.

Manganese greensand can be applied in one step, combining the oxidation and filtration phases for the removal of iron and manganese through pressure filtration. Greensand is a processed material consisting of nodular grains of the zeolite mineral glauconite. The material is coated with manganese oxide. The ion exchange properties of the glauconite facilitates the bonding of the coating. This treatment gives the media a catalytic effect in the chemical oxidation-reduction reactions necessary for iron and manganese removal. This coating is maintained through either continuous or intermittent feed of potassium permanganate. The source water must be monitored to determine proper oxidant dosage, and the treated water should be monitored to determine if the process was successful. (MOH 2007)

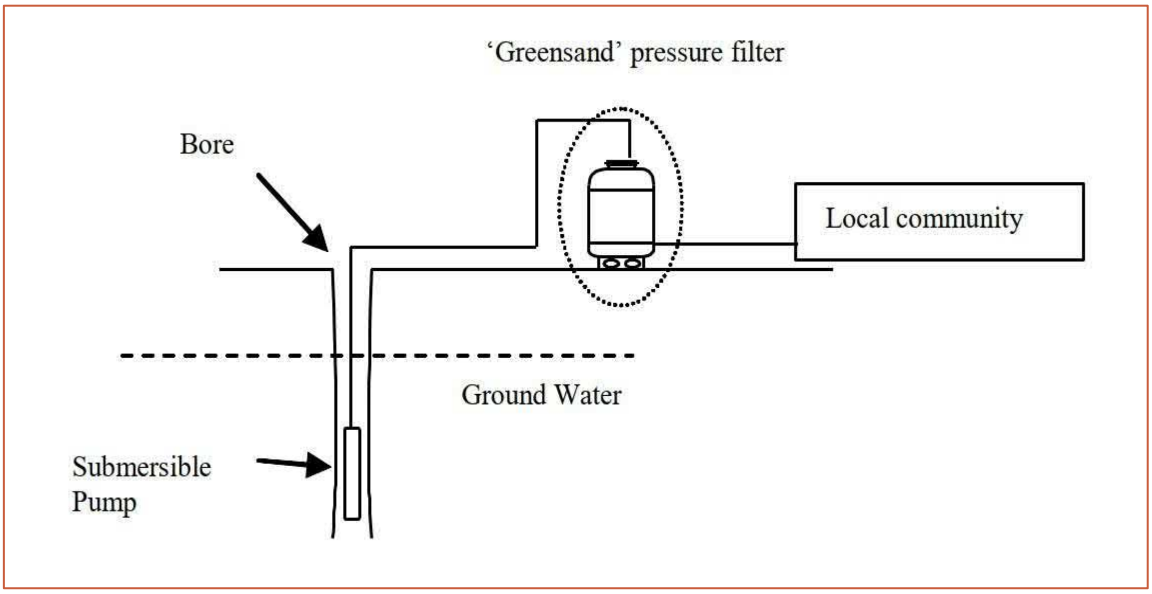

Figure 6: Simplified Diagram of Greensand filtration of Groundwater (MOH 2007).

The MoH’s Water Safety Plan guide P8.2 (MOH 2014b) states that the two events creating the greatest risk involved in the removal of iron and manganese from water are adding too much oxidant to the water and germs getting into the water during aeration.

The most important preventive measures are:

- Monitor the process to be sure the right dose is used, regardless of how the quality of the incoming water may change.
- Regularly maintain the dosing equipment.
- Place netting over aerator grills to stop entry of larger animals.

Water treatment for high iron and manganese requires ongoing maintenance and regular testing of the water supply to ensure parameters of concern are managed to an acceptable level.

3 WATER SECURITY

3.1 POTENTIAL SOURCES OF CONTAMINATION

As outlined in Section 1.3, to assess water security for a proposed water supply, the potential for contamination, the risk these pose to the water source and the condition and type of infrastructure need to be considered.

During the site visit, a number of industrial uses were observed within a 1.5 km radius of the site, including an industrial area, petrol station and refuse transfer station. These activities were noted to be to the northeast of the proposed water supply and therefore downgradient in terms of the groundwater flow direction.

A search of the Waikato Regional Council (WRC) Land Use Information Register for information on nearby sites was conducted. WRC maintains the Land Use Information Register of properties known to be contaminated on the basis of chemical measurements, or potentially contaminated on the basis of past land use. The 'potentially contaminated' category is gradually being compiled with reference to past or present land uses that have a greater than average chance of causing contamination, as outlined in the Ministry for the Environment's Hazardous Activities and Industries List (HAIL).

A number of verified HAIL sites were identified in the industrial area to the north of Java bore (72_6680), including the petrol station (Figure 1). A combined Preliminary Site Investigation (PSI) and Detailed Site Investigation (DSI) was undertaken in November 2021 (4Sight Consulting (2021). 4Sight Consulting concluded that all soil sampling analytical results were below the adopted human health criteria and it is highly unlikely that HAIL activity has occurred at the Site ('Any other land that has been subject to the intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment'). Based on this information we consider it is unlikely the shallow groundwater at the site will pose a risk to the deeper groundwater.

3.2 HYDROGEOLOGICAL REVIEW

A review of the hydrogeological setting of the water source has been carried out to assess the potential risks of contaminants influencing the water quality. This includes a review of the regional geology and our current understanding of the local aquifer properties based on previous onsite testing and literature.

3.2.1 Regional Geology and Hydrogeology

The site lies within the Hauraki Plains, which form part of a young continental rift structure bounded by major normal faults. The plains are bounded to the west by poorly permeable greywacke of the Hapuakohe and Pakaroa Ranges and to the east by the Kaimai Ranges, which consist predominantly of andesitic and rhyolitic rock (Hadfield 2001). A large thickness of predominantly Tauranga Group sediments deposited by ancient Waikato River channels infills the depression structure to a depth of up to 3 km.

The Tauranga Group alluvial sediments constitute a large leaky hydraulic system incorporating numerous lensoidal aquifers. The volcanogenic alluvial deposits form a sequence of layers of sands, gravels, silts, clays and peat. The geological map of the area (Edbrooke 2005) indicates the majority of the site is underlain by the older Tauranga Group sediments of the Walton Subgroup. The map indicates the younger Peria Formation overlies the Walton Subgroup in a limited section at the southern edge of the site.

Sand and gravel aquifers are utilised widely across the plains for water supply and irrigation purposes. The variability of paleochannel alluvial sediments in the basin results in a large range of transmissivities, ranging from less than 5 m^2/day up to 25,000 m^2/day (Hadfield 2001). The general groundwater flow direction is northwards toward the Firth of Thames coastline. Deeper groundwater is considered to discharge offshore beneath the Firth of Thames (GNS 2018).

3.2.2 Local Hydrogeological Setting

The geological description of the two large diameter bores (72_6680 and 72_7181) are summarised from the driller's log in Appendix C. The geological log indicates that Java bore (72_6680) is drilled into a pumiceous sand/gravel aquifer, which is part of the Quaternary Tauranga Group sediments. It is noted that the geological logs provided are simple representations and potentially exclude stratigraphic detail. Based on the geological log descriptions, the source aquifer is considered confined or semi-confined beneath low permeability units consisting mainly of silts and clays. The geological log for bore 72_7181 shows a similar sequence of sand and gravel layers interspersed with layers of lower permeability silts. The bore is screened in a shallower sand aquifer than Java bore (72_6680).

Recharge to the Tauranga Group sediments is likely to be from rainfall infiltration across the area to the south of the site. The exact age and origins of the source water in bore the Java bore (72_6680) is unknown. Iron in the water indicates confined older groundwater source as the metals dissolve into the groundwater from the aquifer through time. The longer residence time in the aquifer leads to naturally higher metal concentrations. Isotope testing can provide insight on the origins and age of the groundwater and enable an assessment of the source of the water and potential sources of contamination in the specific recharge area.

In October 2013, a 7 day (168-hour) constant rate pumping test was carried out on the Java bore (72_6680) in support of an application for a resource consent to take groundwater at a rate of 7,200 m^3/day. In addition, a 72 hour pumping test was undertaken in August 2014 on bore 72_7181 at a rate of 5,400 m^3/day. Previous pumping test data and analysis provide evidence of multiple overlying layers causing to leaky characteristics in the source aquifers for both bores (72_6680 and 72_7181).

Drawdown and recovery data from the constant rate pumping tests undertaken were analysed and aquifer parameters were derived as follows (Terra Aqua 2013, Terra Aqua 2014):

- Transmissivity: 387 m^2/day to 911 m^2/day (72_6680).
- Transmissivity: 349 m^2/day to 659 m^2/day (72_7181).
- Storativity: 0.0003 to 0.0005 (72_7181).

Storativity values were not derived in the pumping test analysis for the Java bore (72_6680). Although WGA has not reviewed the pumping test data in detail, the aquifer parameters derived appear to be reasonable given the geological setting, literature values and observations.

3.2.3 Aquifer Flow Gradients

There are no shallow bores in the WRC database with groundwater levels in the vicinity of Java bore (72_6680), however a geotechnical investigation was conducted on site in June 2021 with shallow groundwater depths recorded, in hand augers, between 2.9 m bgl and 4.8 m bgl (CMW 2021). WGA also carried out a search of the New Zealand Geotechnical database. A number of shallow hand augers and CPT bores have been drilled at site to the west of Java bore (72_6680). These indicate groundwater levels in the shallower aquifer units to be between 5 and 9 m bgl. These relative groundwater levels indicate a downward flow gradient with depth which could lead to pumping induced recharge occurring from the overlying aquifers through the lower permeability silt layers.

The groundwater levels recorded in the shallower monitoring bore (72_6795) from October 2020 to July 2021 show a declining trend (Figure 7). Pumping from the underlying aquifer for irrigation occurred between 5 January 2021 and 28 March 2021. A declining trend would be expected through spring and summer. From the end of January, the water levels decline at a faster rate than earlier in the irrigation season. This increased decline in water levels coincides with intensification of the irrigation season, allowing for a delay in potential leakage from the overlying aquifer. The trend line in Figure 7 shows the water level decrease we might expect in the aquifer with no pumping in the deeper aquifer. WGA consider there is a difference of approximately 0.02 m between the projected and recorded groundwater levels on 1 April 2021, at the end of the pumping period. To estimate the hydraulic conductivity of the unit between the two screened aquifers, WGA used the Hunt and Scott (2007) solution for a two-aquifer system. The results of this analysis suggest that the vertical hydraulic conductivity between the pumped and overlying aquifer is approximately 0.015 m/day.

There are other factors which may also influence monitored groundwater levels, for example influence of pumping in the overlying aquifer itself, however, we note that leakage was observed during the 72 hour pumping test (Terra Aqua 2013). Therefore, WGA consider that some degree of vertical downward leakage is occurring. Leakage through the overlying silts could induce any contamination that may be present in the overlying groundwater to enter the aquifer being used as a potable supply. The degree of leakage would decrease if the flow rate was decreased.

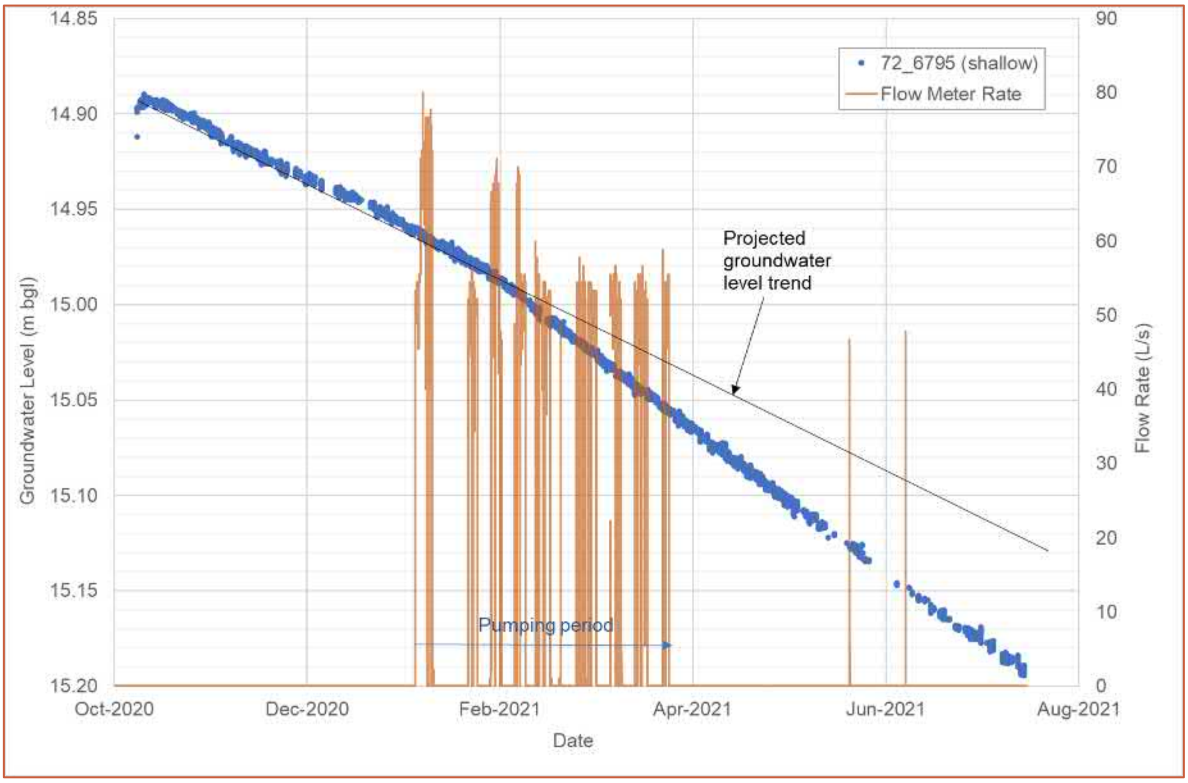

Figure 7: Groundwater Levels in the Overlying Aquifers During Pumping in Java bore (72_6680).

3.2.4 Surface Water and Groundwater Interaction

There are no surface water features on site however, a gully extends from the southwest edge of the site and flows to the Mangawhero Stream located approximately 160 m west of the site. The Mangawhero Stream flows into the Waihou River approximately 4,400 m to the northwest of the site. The site is not located within a defined land drainage scheme area. The base of the Mangawhero Stream is at an elevation of 42 m RL. The aquifer pumped aquifer unit is approximately 40 m below the base of the stream and these are unlikely to be in directly hydraulically connected.

3.3 BORE INFRASTRUCTURE SECURITY

A general assessment of the bore headworks was carried out during the site visit. The headworks are constructed to a relatively high standard and is in good condition. The area is flat and therefore reducing the risk of runoff entering any damaged headworks. In addition, the headworks and associated infrastructure is located above ground which is best practice for a drinking water supply. There are some minor upgrades that will be required to provide water security for a potable supply as follows:

- Small cracks were noted in the concrete around the wellhead. These cracks can be repaired prior to a change of use for the bore.

- A security fence will need to be erected around the bore and treatment infrastructure.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

WGA's review of the onsite bores indicates that the Java bore (72_6680) and associated water permit have sufficient volumes to provide for the proposed development. The bore infrastructure is sound with minor repairs needed and additional security fencing required if the bore is used for potable water in the future. A water treatment system would need to be set up at the site to cope with the high concentrations of iron and manganese. Treatment of the source water to reach potable requirements is not a limiting factor but further assessments can be carried out to ensure the initial costs and ongoing maintenance of the treatment system is achievable for the development.

The water has high concentrations of iron and manganese which can cause issues with staining and, in the case of manganese can be harmful to human health at these concentrations. Water treatment options for these metals include oxidation followed by filtration. The arsenic concentration measured in the water sample is below the guideline limit but will need to be monitored for seasonal variations.

The hydrogeological assessment indicated that there are numerous lenses of alternating aquifer and aquitard layers which could be discontinuous. Some degree of leakage can be seen across these upper lower permeability layers which may lead to recharge from the surrounding surface area to the deeper groundwater. There are some potential sources of contamination in the surrounding area, however most of these are downgradient from the water source so the risk is lower. The high concentration of metals in the water indicates relatively long residence time in the aquifer and therefore the majority of the recharge is likely to be in an area further upgradient than the nearby contamination sources. Further delineation of the source zone can be carried out to manage the risk.

4.2 RECOMMENDATIONS

It is recommended that in the next stages of the development that further assessment is undertaken to fully understand the risks associated with the supply:

- Three monthly water quality sampling should be undertaken in order to account for seasonal variability, particularly with respect to arsenic concentrations.
- Review costs associated with required treatment, ongoing maintenance and sampling.
- Carry out further hydrogeological assessments to define the source water zone once the final flow rates are known. Part of this assessment could include isotope testing of the water to determine the age of the water which will provide assurances for water security.
- Consider options for another groundwater supply such as the onsite bore 72_7181 which potentially requires less water treatment but longer distribution pipelines.

5 REFERENCES

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APPENDIX A

CURRENT CONSENTS

Resource Consent Certificate

Resource Consent: 125705

File Number: 60 68 10A

Pursuant to the Resource Management Act 1991, the Waikato Regional Council hereby grants consent to:

Calcutta Farms Limited
166 Heights Road
RD1
Pukekohe 2676

(hereinafter referred to as the Consent Holder)

Consent Type: Water permit

Consent Subtype: Ground water take

Activity authorised: To take groundwater

Location: 80 Burwood Road - Matamata (Fonterra 77481)

Spatial Reference: NZTM 1845422 E 5809759 N

Consent Duration: This consent will commence on the date of decision notification, unless otherwise stated in the consent's conditions, and expire on 30 June 2028

Subject to the conditions overleaf:

General

1. The activity authorised by this resource consent shall be undertaken:
   i) In general accordance with the application for this resource consent received 28 November 2012 (as recorded on the Waikato Regional Council's electronic document management system document no. 2305419) and any documentation supporting the application.
   ii) As specified in the resource consent conditions below.

   Where there is any disagreement between the application and the consent conditions set out below, then the consent conditions shall prevail.

2. Groundwater taken in association with this consent shall be used for dairy shed wash down and milk cooling purposes at the 80 Burwood Road, Matamata site.

Operational Limits

3. The maximum daily volume of groundwater taken for shed wash down and milk cooling water shall not exceed **16.45 cubic metres[1].**

[1] This volume includes the 15 cubic metres per day provided for under permitted activity rule 3.3.4.12 of the Waikato Regional Plan.

Measuring, Recording and Reporting

4. Access to the bores to perform pumping tests, and for the measurement of static water levels shall be provided to the staff and agents of the Waikato Regional Council at all times.

5. The consent holder shall maintain a system of leak detection mechanisms for the reticulation network for the water taken in association with this consent. These mechanisms shall include, as a minimum, those stated in the application for this resource consent, and evidence of leak detection mechanisms shall be provided to Waikato Regional Council upon written request.

Review

6. At any time during the years 2016, 2019, 2022 and 2025, the Waikato Regional Council may, following service of notice on the consent holder, commence a review of the conditions of this resource consent pursuant to section 128(1) of the Resource Management Act 1991 for the following purposes:

   i) to review the effectiveness of the conditions of this resource consent in avoiding or mitigating any adverse effects on the environment from the exercise of this resource consent and if necessary to avoid, remedy or mitigate such effects by way of further or amended resource consent conditions; or
   ii) to review the adequacy of and the necessity for monitoring undertaken by the consent holder.

7. At any time during the period 1 July 2024 to 30 June 2025 the Waikato Regional Council may, following service of notice on the consent holder, commence a review of the conditions of this resource consent pursuant to section 128(1) of the Resource Management Act 1991 to take into account any change to the Waikato Regional Plan being proposed as a result of any catchment investigation undertaken by the Waikato Regional Council.

8. Within 12 months of any co-management legislation commencing for the Hauraki Gulf catchment, the Waikato Regional Council may, following service of notice on the consent holder pursuant to section 129 of the Resource Management Act 1991, commence a review of the conditions of this consent pursuant to section 128 of the Resource Management Act 1991, for the purpose of ensuring that this consent is consistent with the provisions of any such legislation

Administration

9. The consent holder shall pay to the Waikato Regional Council any administrative charge fixed in accordance with section 36 of the Resource Management Act 1991, or any charge prescribed in accordance with regulations made under section 360 of the Resource Management Act.

For and on behalf of the
Waikato Regional Council

....

Administration

9. The consent holder shall pay to the Waikato Regional Council any administrative charge fixed in accordance with section 36 of the Resource Management Act 1991, or any charge prescribed in accordance with regulations made under section 360 of the Resource Management Act.

For and on behalf of the
Waikato Regional Council

....

Advice notes

1. In accordance with section 125 RMA, this consent shall lapse five (5) years after the date on which it was granted unless it has been given effect to before the end of that period.
2. Where a resource consent has been issued in relation to any type of construction (e.g. dam, bridge, jetty) this consent does not constitute authority to build and it may be necessary to apply for a Building Consent from the relevant territorial authority.
3. This resource consent does not give any right of access over private or public property. Arrangements for access must be made between the consent holder and the property owner.
4. This resource consent is transferable to another owner or occupier of the land concerned, upon application, on the same conditions and for the same use as originally granted (s.134-137 RMA).
5. The consent holder may apply to change the conditions of the resource consent under s.127 RMA.
6. The reasonable costs incurred by Waikato Regional Council arising from supervision and monitoring of this/these consents will be charged to the consent holder. This may include but not be limited to routine inspection of the site by Waikato Regional Council officers or agents, liaison with the consent holder, responding to complaints or enquiries relating to the site, and review and assessment of compliance with the conditions of consents.
7. Note that pursuant to s333 of the RMA 1991, enforcement officers may at all reasonable times go onto the property that is the subject of this consent, for the purpose of carrying out inspections, surveys, investigations, tests, measurements or taking samples.
8. If you intend to replace this consent upon its expiry, please note that an application for a new consent made at least 6 months prior to this consent's expiry gives you the right to continue exercising this consent after it expires in the event that your application is not processed prior to this consent's expiry.

RESOURCE CONSENT CERTIFICATE

Resource Consent:	AUTH130710.01.01
File Number:	61 60 44A

Pursuant to the Resource Management Act 1991, the Waikato Regional Council hereby grants consent to:

Waipa Valley Holdings Limited
C/- Kevin Balle
166 Heights Road
RD 1
Pukekohe

(hereinafter referred to as the Consent Holder)

Consent Type:	Water Permit
Consent Subtype:	Groundwater take
Activity authorised:	To take groundwater from production bore 72_6680
Location:	Tauranga Road – Matamata
Spatial Reference:	NZTM 1845792E 5810369N
Consent Duration:	This consent will commence on the date of decision notification and expire on 1 March 2029.

Subject to the conditions overleaf:

CONDITIONS

1. The activity authorised by this resource consent shall be undertaken:

    1. In general accordance with the application for this resource consent lodged 18 November 2013 (as recorded in the Waikato Regional Council's electronic document management system document No. 2910799), and any documentation supporting the application; and
    2. As specified in the resource consent conditions below.

    Where there is any disagreement between the application documentation and resource consent conditions the resource consent conditions below shall prevail.

2. The water taken pursuant to this resource consent shall be used for crop irrigation.

3. The maximum volume to be taken from the production bore (identified as Waikato Regional Council Located ID 72_6680) in any 24 hour period shall not exceed 7200 cubic metres.

4. The maximum seasonal volume of groundwater to be taken from production bore 72_6680 shall not exceed 327,570 cubic metres. For the purposes of this consent the irrigation season is defined as the period 1 July to 30 June the following year, inclusive.

5. A water measuring system shall quantify water taken from the take location on a cumulative basis. The system shall have a reliable calibration to water flow and shall be maintained to an accuracy of +/- 5%. Prior to first commencing to take water under this consent, evidence of the water measuring system's calibration to an accuracy of +/- 5% shall be provided to the Waikato Regional Council.

6. An 'as-built' plan of the water measuring system shall be provided to the Waikato Regional Council prior to giving any effect to take water under this consent.

7. Additional calibration of the water measuring system shall be undertaken by the consent holder:

    1. at the written request of the Waikato Regional Council; and
    2. at a frequency of no less than five yearly from the date of the first calibration required by condition 5; and
    3. to the satisfaction of the Waikato Regional Council.

    Evidence documenting each respective additional calibration shall be forwarded to the Waikato Regional Council within one month of the calibration being completed.

8. The consent holder shall record with a tamper-proof data logger continuous 15 minute values of take volume (in units of cubic metres). These data shall be reported by the consent holder via either of the following:

    - A telemetry system developed after liaison with the Waikato Regional Council to ensure that the telemetry system is compatible with Waikato Regional Council telemetry system standards and data protocols. The data shall be submitted once daily to the Waikato Regional Council and there shall be 96 values per daily report. When no water is being taken during the irrigation season, the data must specify the take volume as zero.

<u>OR</u>

- An email system requiring that, within the first 10 working days of each month, the data for the preceding month are submitted to the Waikato Regional Council via email in agreed electronic format. There shall be 96 values for each respective day in the reporting month of interest. When no water is being taken during the irrigation season, the data must specify the take volume as zero.

9. The consent holder shall measure and record water level in the observation bore identified as Waikato Regional Council Located ID 72_6619. As a minimum the consent holder shall record water level on a weekly basis and electronically record:

    1. The date and time on which the record is taken; and
    2. The water level (in metres) below the top of the casing.

    This data required by 9.1. and 9.2. shall be reported to the Waikato Regional Council twice per year, on 1 May and 1 November for each year the consent is current. Records must also be supplied when requested by the Waikato Regional Council.

10. Prior to the exercise of this consent the consent holder in consultation with the Waikato Regional Council, shall identify a suitable monitoring bore to monitor water level within the shallow aquifer. In the event that the consent holder cannot identify such an existing bore, the consent holder in consultation with the Waikato Regional Council, shall establish and maintain a new bore for this purpose. As a minimum the consent holder shall record water level on a weekly basis and electronically record:

    1. The date and time on which the record is taken; and
    2. The water level (in metres) below the top of the casing.

    This data required by 10.1. and 10.2. shall be reported to the Waikato Regional Council twice per year, on 1 May and 1 November for each year the consent is current. Records must also be supplied when requested by the Waikato Regional Council.

11. At any time during the period July through September, inclusive, of each year that this water take is authorised the Waikato Regional Council may, following service of notice on the consent holder, commence a review of the conditions of this resource consent pursuant to section 128(1) of the Resource Management Act 1991 for the following purposes:

    1. to review the effectiveness of the conditions of this resource consent in avoiding or mitigating any adverse effects on the environment from the exercise of this resource consent and if necessary to avoid, remedy or mitigate such effects by way of further or amended resource consent conditions; or
    2. to review the adequacy of and the necessity for monitoring undertaken by the consent holder.

12. At any time during the period 1 July 2027 through 30 June 2028 the Waikato Regional Council may, following service of notice on the consent holder, commence a review of the conditions of this resource consent pursuant to section 128(1) of the Resource Management Act 1991 to take account of any change to the Waikato Regional Plan being proposed as a result of any catchment investigation undertaken by the Waikato Regional Council.

13. The consent holder shall pay to the Waikato Regional Council any administrative charge fixed in accordance with section 36 of the Resource Management Act 1991, or any charge prescribed in accordance with regulations made under section 360 of the Resource Management Act 1991.

In terms of s116 of the Resource Management Act 1991, this consent commences on 15 January 2014.

ADVICE NOTES

1. In accordance with s125 RMA, this consent shall lapse five (5) years after the date on which it was granted unless it has been given effect to before the end of that period.

2. This resource consent does not give any right of access over private or public property. Arrangements for access must be made between the consent holder and the property owner.

3. This resource consent is transferable to another owner or occupier of the land concerned, upon application, on the same conditions and for the same use as originally granted (s.134-137 RMA).

4. The consent holder may apply to change the conditions of the resource consent under s.127 RMA.

5. The reasonable costs incurred by Waikato Regional Council arising from supervision and monitoring of this/these consents will be charged to the consent holder. This may include but not be limited to routine inspection of the site by Waikato Regional Council officers or agents, liaison with the consent holder, responding to complaints or enquiries relating to the site, and review and assessment of compliance with the conditions of consents.

6. Note that pursuant to s333 of the RMA 1991, enforcement officers may at all reasonable times go onto the property that is the subject of this consent, for the purpose of carrying out inspections, surveys, investigations, tests, measurements or taking samples.

7. If you intend to replace this consent upon its expiry, please note that an application for a new consent made at least 6 months prior to this consent's expiry gives you the right to continue exercising this consent after it expires in the event that your application is not processed prior to this consent's expiry.

8. The water taken pursuant to this resource consent shall be used to irrigate crops in accordance with the Waikato Regional Plan’s 3.4.5.6 Permitted Activity Rule – Use of Water for Crop and Pasture Irrigation.

RESOURCE CONSENT CERTIFICATE

Resource Consent: AUTH134035.01.02

File Number: 60 68 04A

Pursuant to the Resource Management Act 1991, the Regional Council hereby grants consent to:

Calcutta Farms Limited
166 Heights Road
RD 1
Pukekohe 2676

(hereinafter referred to as the Consent Holder)

Consent Type: Water Permit

Consent Subtype: Ground water take

Activity authorised: To take and use groundwater for irrigation and dust suppression purposes

Location: 121 Banks Road: Matamata

Map reference: NZTM 1845476 E 5809254 N

Consent duration: This consent will commence on the date of decision notification
and will expire on 9 February 2030

Subject to the conditions overleaf:

CONDITIONS

1) The activity authorised by this resource consent shall be undertaken:
   (1) in general accordance with the application for this resource consent lodged 2 October 2013 (as recorded on the Waikato Regional Council's electronic document management system document no. 3204092), and any documentation supporting that application; and
   (2) as specified in the resource consent conditions below.

   Where there is any disagreement between the application and the consent conditions set out below, then the consent conditions shall prevail.

1A) That the landuse activity shall be carried out generally in accordance with the Resource Consent Certificate AUTH134035.01.01 at 121 Banks Road, Matamata except where amended by the following variations:

- Application for variation by Maven BOP Ltd on behalf of Calcutta Farms Limited titled Application for s127 Variation to Resource Consent AUTH134035.01.01 – Calcutta Farms Limited – 121 Banks Road Matamata.

Unless otherwise amended by the following conditions.

2) The water taken pursuant to this resource consent shall be used for horticultural, pasture irrigation purposes and dust suppression only.

   (1) Water taken for dust suppression purposes can be up to a maximum of 100,000 litres on any given day**.**

2A Pursuant to this resource consent, dust suppression measures can occur over a 10 year period. The 10 year period will expire on the 9 February 2030.

3) The maximum volume to be taken from the production bore identified as Waikato Regional Council Located ID 72_7181 (hereinafter referred to as "72_7181") shall not exceed 5400 cubic metres in any 24 hour period.

4) The maximum annual volume to be taken from the production bore 72_7181 shall not exceed 248,400 cubic metres.

5) Prior to exercise of consent a sealed tamper-proof water measuring device suited to the quality of water it is measuring, capable of electronic recording and reporting shall be installed on the production bore 72_7181:
   (1) to the manufacturer's specifications, and
   (2) at the take location from which water is taken

   to record the quantity of water taken on a cumulative basis. The water measuring device shall have a reliable calibration to water flow which shall be maintained to an accuracy of plus or minus five percent. Evidence of the water measuring device's accuracy to water flow shall be provided to the Waikato Regional Council by 31 July 2015.

6) Calibration of the water measuring device to water flow shall be undertaken by the consent holder:
   (1) At the written request of the Waikato Regional Council; and/or
   (2) At a frequency of no less than five yearly from the date of the first calibration required by condition 5.

The consent holder shall engage an independent and suitably qualified person to conduct the calibration and evidence documenting the calibration to water flow and level of accuracy shall be forwarded to the Waikato Regional Council within one month of the calibration being completed.

7) The consent holder must telemeter – via a telemetry system developed after liaison with the Waikato Regional Council to ensure that the telemetry system is compatible with Waikato Regional Council telemetry system standards and data protocols – continuous 1 – hourly values of net take volume (in units of cubic metres) for irrigation purposes.

   The data must be reported once daily to the Waikato Regional Council via the telemetry system and there must be 24 irrigation values per daily report. When no water for irrigation purposes is taken the data must specify the net take volume as zero.

8) By 31 July each year, the consent holder shall provide a summary of the crop(s) and areas(s) under irrigation management during the preceding year. The summary shall include on a monthly basis, the volume of water irrigated (cubic metres), application rate (mm), crop type and area irrigated (ha).

9) The consent holder must measure and record the depth to water within the monitored piezometers (applicant ID OB30 and OB 54 collectively known as Waikato Regional Council Located ID 72_7182). The measurement point above ground must be provided to the Waikato Regional Council prior to the exercise of this consent for each piezometer. Water level must be:

   (1) Measured with electronic continuous water level monitoring equipment;
   (2) Recorded at a 1-hourly frequency.

10) The consent holder must telemeter – via a telemetry system developed after liaison with the Waikato Regional Council to ensure that the telemetry system is compatible with Waikato Regional Council telemetry system standards and data protocols – the monitoring data recorded pursuant to condition 9. The data must be reported once daily to the Waikato Regional Council via the telemetry system and there must be 24 values per daily report.

11) At any time during the:
    (1) years of 2017, 2020, 2023 and 2027, the Waikato Regional Council may, following service of notice on the consent holder, commence a review of this consent under section 128(1) of the Resource Management Act 1991, for the following purposes:
        (i) to review the effectiveness of the conditions of this resource consent in avoiding or mitigating any adverse effects on the environment from the exercise of this resource consent and if necessary to avoid, remedy or mitigate such effects by way of further or amended conditions; and/or
        (ii) to review the adequacy of and the necessity for monitoring undertaken by the consent holder and/or
        (iii) to review the appropriateness of the volumes specified within conditions 3 and 4 and, if necessary, to address any inappropriateness of these volumes by way of reducing these volumes.
        (iv) To review the effectiveness of the conditions in managing effects during times of water shortage.
    (2) period 1 July 2027 to 30 June 2029 the Waikato Regional Council may, following service of notice on the consent holder, commence a review of the conditions of this resource consent pursuant to section 128(1) of the Resource Management Act 1991 to take into account of any

change to the Waikato Regional Plan being proposed as a result of any catchment investigation undertaken by the Waikato Regional Council.

Note: Costs associated with any review of the conditions of this resource consent will be recovered from the consent holder in accordance with the provisions of section 36 of the Resource Management Act 1991.

12) The consent holder shall pay to the Waikato Regional Council any administrative charge fixed in accordance with section 36 of the Resource Management Act 1991, or any charge prescribed in accordance with regulations made under section 360 of the Resource Management Act.

In terms of s116 of the Resource Management Act 1991, this consent commences on 9 February 2015.

Advice Notes - General

1. In accordance with section 125 RMA, this consent shall lapse five (5) years after the date on which it was granted unless it has been given effect to before the end of that period.
2. This resource consent does not give any right of access over private or public property. Arrangements for access must be made between the consent holder and the property owner.
3. This resource consent is transferable to another owner or occupier of the land concerned, upon written notice to Waikato Regional Council, on the same conditions and for the same use as originally granted (s.134-137 RMA). The transfer of water, including changes of location, may occur as provided for in Chapter 3.4 of the Waikato Regional Plan, subject to the requirements of those rules.
4. The consent holder may apply to change the conditions of the resource consent under s.127 RMA.
5. The reasonable costs incurred by Waikato Regional Council arising from supervision and monitoring of this/these consents will be charged to the consent holder. This may include but not be limited to routine inspection of the site by Waikato Regional Council officers or agents, liaison with the consent holder, responding to complaints or enquiries relating to the site, and review and assessment of compliance with the conditions of consents.
6. Note that pursuant to s332 of the RMA 1991, enforcement officers may at all reasonable times go onto the property that is the subject of this consent, for the purpose of carrying out inspections, surveys, investigations, tests, measurements or taking samples.
7. If you intend to replace this consent upon its expiry, please note that an application for a new consent made at least 6 months prior to this consent's expiry gives you the right to continue exercising this consent after it expires in the event that your application is not processed prior to this consent's expiry.

APPENDIX B

LABORATORY ANALYSIS RESULTS

Hill Laboratories
TRIED, TESTED **AND TRUSTED**

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Certificate of Analysis

Client:	WGANZ Pty Limited	**Lab No:**	2719355 DWAPv1
Contact:	Catherine Howell C/- WGANZ Pty Limited 4 Ash Street Central Christchurch 8011	**Date Received:**	29-Sep-2021
		Date Reported:	06-Oct-2021
		Quote No:	
		Order No:	
		Client Reference:	WGA211905
		Submitted By:	Catherine Howell

Sample Type: Aqueous

	Sample Name:	72_6680 29-Sep-2021 1:58 pm	**Guideline Value**	**Maximum Acceptable Values (MAV)**
	Lab Number:	2719355.1		
Routine Water + E.coli profile Kit				
Escherichia coli	MPN / 100mL	< 1	-	< 1
Routine Water Profile				
Turbidity	NTU	40	< 2.5	-
pH	pH Units	7.0	7.0 - 8.5	-
Total Alkalinity	g/m^3 as $CaCO_3$	89	-	-
Free Carbon Dioxide	g/m^3 at 25°C	16.4	-	-
Total Hardness	g/m^3 as $CaCO_3$	42	< 200	-
Electrical Conductivity (EC)	mS/m	19.2	-	-
Electrical Conductivity (EC)	µS/cm	192	-	-
Approx Total Dissolved Salts	g/m^3	129	< 1000	-
Total Arsenic	g/m^3	0.0074	-	0.01
Total Boron	g/m^3	0.045	-	1.4
Total Calcium	g/m^3	6.2	-	-
Total Copper	g/m^3	< 0.00053	< 1	2
Total Iron	g/m^3	7.9	< 0.2	-
Total Lead	g/m^3	< 0.00011	-	0.01
Total Magnesium	g/m^3	6.4	-	-
Total Manganese	g/m^3	0.56	< 0.04 (Staining) < 0.10 (Taste)	0.4
Total Potassium	g/m^3	4.7	-	-
Total Sodium	g/m^3	25	< 200	-
Total Zinc	g/m^3	0.020	< 1.5	-
Chloride	g/m^3	7.4	< 250	-
Nitrate-N	g/m^3	< 0.05	-	11.3
Sulphate	g/m^3	< 0.5	< 250	-

Note: The Guideline Values and Maximum Acceptable Values (MAV) are taken from the publication 'Drinking-water Standards for New Zealand 2005 (Revised 2018)', Ministry of Health. Copies of this publication are available from https://www.health.govt.nz/publication/drinking-water-standards-new-zealand-2005-revised-2018

The Maximum Acceptable Values (MAVs) have been defined by the Ministry of Health for parameters of health significance and should not be exceeded. The Guideline Values are the limits for aesthetic determinands that, if exceeded, may render the water unattractive to consumers.

Note that the units g/m^3 are the same as mg/L and ppm.

Routine Water Assessment for Sample No 2719355.1 - 72_6680 29-Sep-2021 1:58 pm

pH/Alkalinity and Corrosiveness Assessment

The pH of a water sample is a measure of its acidity or basicity. Waters with a low pH can be corrosive and those with a high pH can promote scale formation in pipes and hot water cylinders.
The guideline level for pH in drinking water is 7.0-8.5. Below this range the water will be corrosive and may cause problems with disinfection if such treatment is used.

The alkalinity of a water is a measure of its acid neutralising capacity and is usually related to the concentration of carbonate, bicarbonate and hydroxide. Low alkalinities (25 g/m^3) promote corrosion and high alkalinities can cause problems with scale formation in metal pipes and tanks.

The pH of this water is within the NZ Drinking Water Guidelines, the ideal range being 7.0 to 8.0.
With the pH and alkalinity levels found, this water could be corrosive towards metal piping and fixtures.

Hardness/Total Dissolved Salts Assessment

The water contains a low amount of dissolved solids and would be regarded as being soft.

Nitrate Assessment

Nitrate-nitrogen at elevated levels is considered undesirable in natural waters as this element can cause a health disorder called methaemaglobinaemia. Very young infants (less than six months old) are especially vulnerable. The Drinking-water Standards for New Zealand 2005 (Revised 2018) suggests a maximum permissible level of 11.3 g/m^3 as Nitrate-nitrogen (50 g/m^3 as Nitrate).

Nitrate-nitrogen was not found in this water.

Boron Assessment

Boron may be present in natural waters and if present at high concentrations can be toxic to plants.
Boron was found at a low level in this water but would not give any cause for concern.

Metals Assessment

Iron and manganese are two problem elements that commonly occur in natural waters. These elements may cause unsightly stains and produce a brown/black precipitate. Iron is not toxic but manganese, at concentrations above 0.5 g/m^3, may adversely affect health. At concentrations below this it may cause stains on clothing and sanitary ware.

Iron was found in this water at a very high level.
Manganese was found in this water at a high level.
Treatment to remove iron and/or manganese will be required.

Bacteriological Tests

The NZ Drinking Water Standards state that there should be no Escherichia coli (E coli) in water used for human consumption. The presence of these organisms would indicate that other pathogens of faecal origin may be present. Results obtained for Total Coliforms are only significant if the sample has not also been tested for E coli.

Escherichia coli was not detected in this sample.

Final Assessment

The parameters Turbidity, Total Iron and Total Manganese did NOT meet the guidelines laid down in the publication 'Drinking-water Standards for New Zealand 2005 (Revised 2018)' published by the Ministry of Health for water which is suitable for drinking purposes.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Routine Water Profile		-	1
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) 23rd ed. 2017.	-	1
Turbidity	Analysis by Turbidity meter. APHA 2130 B 23rd ed. 2017 (modified).	0.05 NTU	1
pH	pH meter. APHA 4500-H^+ B 23rd ed. 2017. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1
Total Alkalinity	Titration to pH 4.5 (M-alkalinity), autotitrator. APHA 2320 B (modified for Alkalinity <20) 23rd ed. 2017.	1.0 g/m³ as $CaCO_3$	1
Free Carbon Dioxide	Calculation: from alkalinity and pH, valid where TDS is not >500 mg/L and alkalinity is almost entirely due to hydroxides, carbonates or bicarbonates. APHA 4500-CO_2 D 23rd ed. 2017.	1.0 g/m³ at 25°C	1
Total Hardness	Calculation from Calcium and Magnesium. APHA 2340 B 23rd ed. 2017.	1.0 g/m³ as $CaCO_3$	1
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	0.1 mS/m	1
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 23rd ed. 2017.	1 µS/cm	1
Approx Total Dissolved Salts	Calculation: from Electrical Conductivity.	2 g/m³	1
Total Arsenic	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017 / US EPA 200.8.	0.0011 g/m³	1
Total Boron	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.0053 g/m³	1
Total Calcium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.053 g/m³	1
Total Copper	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017 / US EPA 200.8.	0.00053 g/m³	1
Total Iron	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.021 g/m³	1
Total Lead	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017 / US EPA 200.8.	0.00011 g/m³	1
Total Magnesium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.021 g/m³	1
Total Manganese	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017 / US EPA 200.8.	0.00053 g/m³	1
Total Potassium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.053 g/m³	1
Total Sodium	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017.	0.021 g/m³	1
Total Zinc	Nitric acid digestion, ICP-MS, trace level. APHA 3125 B 23rd ed. 2017 / US EPA 200.8.	0.0011 g/m³	1
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m³	1
Nitrate-N	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.05 g/m³	1
Sulphate	Filtered sample. Ion Chromatography. APHA 4110 B (modified) 23rd ed. 2017.	0.5 g/m³	1
Escherichia coli	MPN count using Colilert 18 (Incubated at 35°C for 18 hours) and 97 wells. APHA 9223 B 23rd ed. 2017.	1 MPN / 100mL	1

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 30-Sep-2021 and 06-Oct-2021. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

Carole Rodger-Carroll

Carole Rodgers-Carroll BA, NZCS
Client Services Manager - Environmental

APPENDIX C

BORE LOGS

Geological Log for Java Bore (72_6680).

Depth (m)		Predominant Lithologies	Geological Unit	Aquifer Definition
From	To			
0	3.5	Brown clay	Tauranga Group	Aquitard
3.5	22.5	Sands pumice		Aquifer
22.5	25.3	Heavy gravel layer		
25.3	29	Grey clay		Aquitard
29	29.6	Blue sandy silt		
29.6	32.4	Grey silt		
32.4	34	Sandy pumice		Aquifer
34	35	Sandy pumice gravel		
35	37.5	Green gravel, silty sand		
37.5	44.6	Green and grey silty sand		
44.6	47.6	Green gravel, sand and pumice		
47.6	48.6	Green silt layers		Aquitard
48.6	49	Sand, gravel, pumice		Aquifer
49	55	Sand, gravel, pumice with silt		
55	56.6	Brown silt pumice, gravel sand		Aquitard
56.6	57.6	Green sand, gravel		Aquifer
57.6	58.6	Green sand, silt		Aquitard
58.6	59.6	Green sand, gravel		Aquifer
59.6	65.6	Green sand, silt		Aquitard
65.6	72.5	Sand pumice gravel		Aquifer
72.5	73.5	Blue silt		Aquitard

Geological Log for Bore 72_7181.

Depth (m)		Predominant Lithologies	Geological Unit	Aquifer Definition
From	To			
0	27.5	Sand, pumice	Tauranga Group	Aquifer
27.5	30	Brown sands, gravels		
30	33	Brown silts		Aquitard
33	40	Brown sands, gravels		Aquifer
40	41	Brown silts		Aquitard
41	48.1	Brown sands, gravels		Aquifer
48.1	48.7	Brown silts		Aquitard
48.7	54	Brown sands, gravels		Aquifer
54	57	White green clay		Aquitard

Appendix C – Water and wastewater indicative layouts

C:\12dsynergy\data\10.7.120.14\146930.02 - Industrial Development_5122\03 Drawings\02\146930-02-0106.dwg 26/11/2021 11:39 am scarlisle Plotted: 26 Nov 2021 11:39 am

	DATE	ISSUE/REVISION DETAIL	BY	CHK	APPR
B	26.11.21	MINOR AMENDMENT TO KEY	SC	JPV	
A	04.11.21	INITIAL CONCEPT	SC	JPV	

Version 4.0 - March 2020

DESIGNED JPV
CHECKED JPV
DRAWN SC
APPROVED
mx model version:

BLOXAM BURNETT & OLLIVER

CLIENT
CALCUTTA
Veros

PROJECT
CULCUTTA FARMS
PLAN CHANGE

DRAWING
INDICATIVE WATER SUPPLY PLAN

STATUS
PRELIMINARY
DATE 04.11.2021
SCALE (ORIGINAL SIZE A3) 1:5000
DRAWING NUMBER 146930-02-0106
REVISION B

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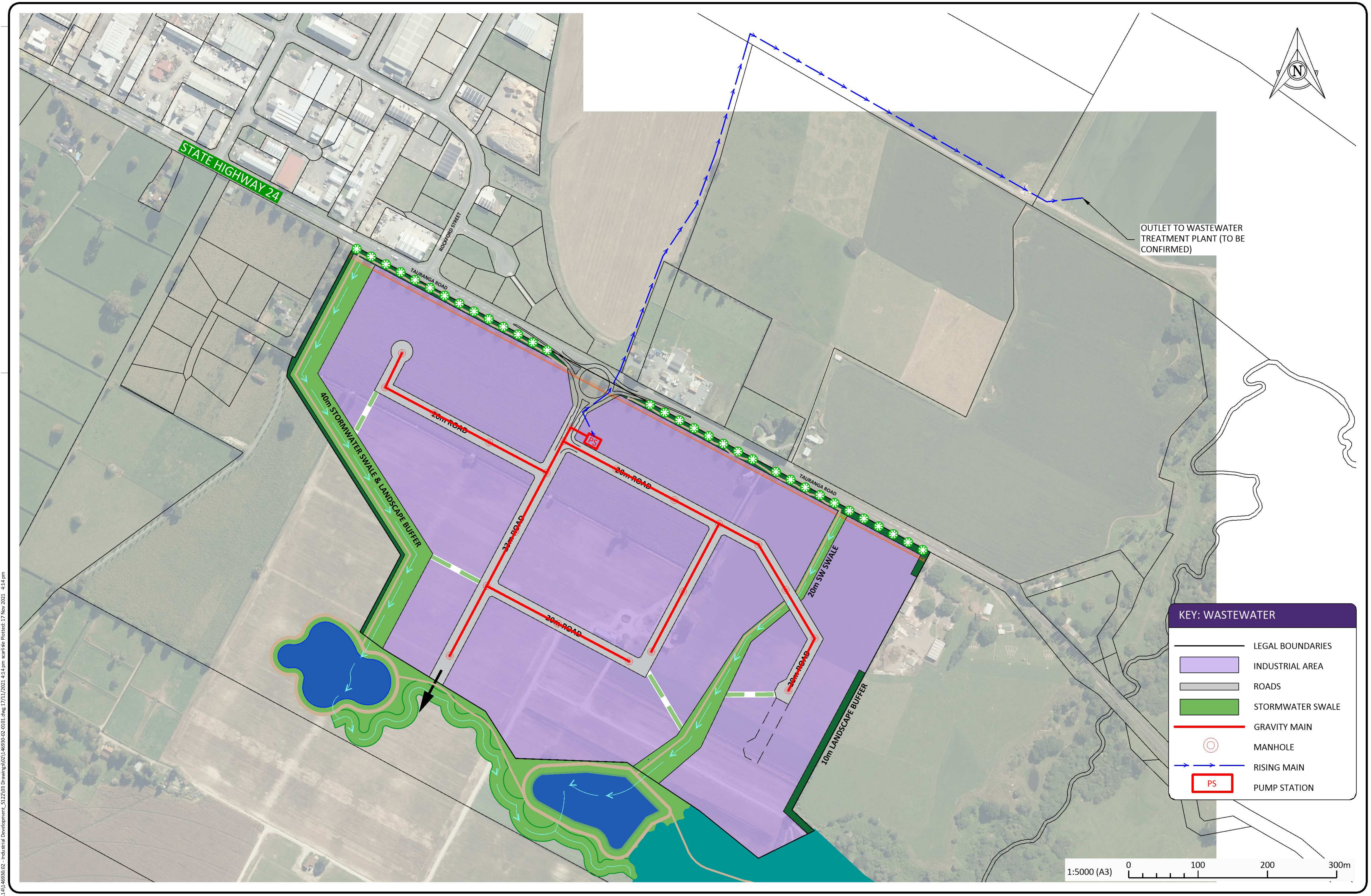


C:\12dsynergy\data\10.7.120.14\146930.02 - Industrial Development_5122\03 Drawings\02\146930-02-0101.dwg 17/11/2021 4:14 pm scarlisle Plotted: 17 Nov 2021 4:14 pm

A	04.11.21	INITIAL CONCEPT	SC	JPV	
	DATE	ISSUE/REVISION DETAIL	BY	CHK	APPR

Version 4.0 - March 2020

DESIGNED JPV	CHECKED JPV
DRAWN SC	APPROVED
mx model version:	

BLOXAM BURNETT & OLLIVER

CLIENT
CALCUTTA PROPERTY
Veros

PROJECT
CALCUTTA FARMS
PLAN CHANGE

DRAWING
INDICITIVE WASTEWATER PLAN

STATUS PRELIMINARY	
DATE 04.11.2021	SCALE (ORIGINAL SIZE A3) 1:5000
DRAWING NUMBER 146930-02-0101	REVISION A

Appendix D – Utility providers correspondence

Jean-Pierre Velloen

From: Resource Consents <Resourceconsents@powerco.co.nz>
Sent: Thursday, 18 November 2021 10:30 am
To: Jean-Pierre Velloen
Cc: Malcolm Rhodes; Jethro Pease; Customer Works Eastern
Subject: RE: Calcutta Farm - Employment Zone
Attachments: Matamata Employment Zone_Structure Plan_211011_LR.pdf; Calcutta Industrial.png

Importance: High

Follow Up Flag: Follow up
Flag Status: Flagged

Hi Jean-Pierre

Sorry with 800+ applications per month for our team of three, it does take time to respond.

Please see official response below.

BBO
jpvellloen@bbo.co.nz

Att: Jean-Pierre

Electricity Supply to: Calcutta Farms, Tauranga Road, Matamata – Employment Zone.

The existing 11kV line that runs parallel to this development, is fed from the Banks Street feeder (CB2) out of the Tower Rd Substation. The new development will need to be connected from the Taihoa Feeder (CB4) as noted below and in the attached screen shot.

1. Supply from Taihoa feeder (currently not highly loaded) and carved off from the Te Poi feeder last year.
2. Close IP577 normal open point tie between Banks St and Taihoa feeder. Install a new open point tie between Banks St and Taihoa (at either pole 248837 or 248836).
3. Extend Taihoa feeder south through industrial (feeder strength cabling to be used and ducting to the boundary edge for future extension).
4. Use Bent St feeder for the zoned industrial east of Rockford St.

This would be on top of the required reticulation of this development.

NZECP:34 obligations will need to be adhered to, for building and excavating near overhead HV lines, poles and support structures, driveway entrances shall not be closer than 1m from roadside poles.

An easement in gross in favour of Powerco will be required for any works located within private property.

There will be a cost to complete this work.

Please contact a Powerco Approved Contractor for a price and design. Conditions may apply. These conditions will be advised as part of the quotation from the Contractor.

Standard connection fees will apply once this upgrade work has been completed.

Please be advised the information contained herein, is current as of the date of this letter, but could be subject to change, as changes on the load changes on the Network over the coming weeks, months and years to completion.

Kind Regards
Janice

Customer Works Team - **Eastern**
POWERCO
Web www.powerco.co.nz

From: Jean-Pierre Velloen <jpvelloen@bbo.co.nz>
Sent: Thursday, 18 November 2021 10:05 am
To: Customer Works Eastern <CustomerWorksEastern@powerco.co.nz>
Cc: Malcolm Rhodes <malcolm.rhodes@northpower.com>
Subject: RE: Calcutta Farm - Employment Zone

Thanks Janice

A update on the status would be appreciated as the resource consent will be lodged on Monday.
Having a letter form Powerco to summarise the high level upgrades would be appreciated before this date. Comms were able to send us their details a couple of weeks ago.

Regards

BLOXAM BURNETT & OLLIVER

Jean-Pierre Velloen LAND DEVELOPMENT ENGINEER (CIVIL)
BEng(Civil), CPEng, IntPE(NZ), CMEngNZ
Level 4, 18 London Street, PO Box 9041, Hamilton 3240
R +64 7 838 0144 D +64 7 838 6041 M +64 27 333 6626
E jpvelloen@bbo.co.nz W www.bbo.co.nz

From: Customer Works Eastern <CustomerWorksEastern@powerco.co.nz>
Sent: Monday, 15 November 2021 8:43 am
To: Jean-Pierre Velloen <jpvelloen@bbo.co.nz>

Extend from Bent St fdr for future Industrial in this area

Shift tie-point closer to somewhere in this vicinity. New Open-point

Close IP577

Extend from Taihoa fdr for industrial in this area.

Ref: Calcutta Farms Limited – Employment Zone

JP Velloen
c/o Bloxam Burnett & Olliver Ltd

2ND November 2021

1. Ultrafast Fibre Limited (UFF) confirms that a UFF telecommunications network is achievable, **providing a commercial agreement is reached between the Developer and Ultrafast Fibre.** Upon approval of this agreement, UFF will undertake to become the telecommunications operator of the telecommunications reticulation in the proposed public roads for Calcutta Farms Limited (the "**Developer**"), to provide network connections to all lots in the Subdivision (the "**Reticulation**").

2. The Reticulation will be installed in accordance with:

   (a) the requirements and standards set by the Matamata-Piako District Council and advised to UFF via the Council's website; and

   (b) the requirements of the Telecommunications Act 2001 and all other applicable laws, regulations and codes (as amended).

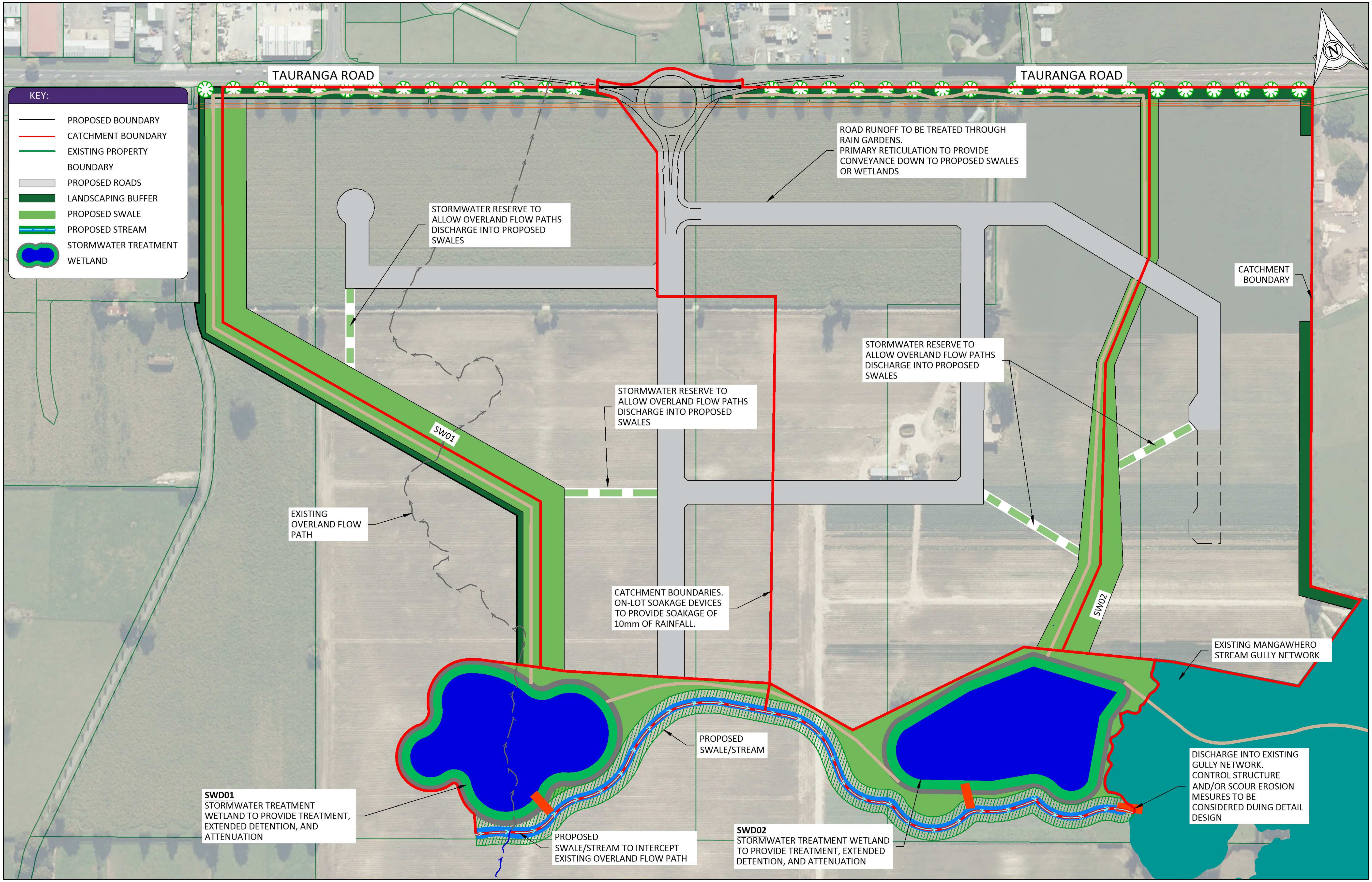
3. The Reticulation will be installed by our nominated contractor to UFF's satisfaction.

4. UFF will be the owner, operator and maintainer of the Reticulation.

5. One or more retail service providers will be available to supply telecommunications services over the completed Reticulation when service is available, provided that UFF shall not be responsible if the retail service provider's offer to supply such telecommunications services or the number of such providers varies from time to time.

Yours Sincerely,
Jonathan Campbell
Business Development Solutions Manager
Ultrafast Fibre

Appendix E – Stormwater indicative layout plan



100mm

SCALE FOR VALIDATING SIZE OF A3 PLOT ONLY

0

C:\12ds\data\10.7.120.14\146930.02 - Industrial Development_5122\03 Drawings\02\146930-02-0701.dwg 23/6/2022 3:31 pm cfokianos Plotted: 23 Jun 2022 3:31 pm

	DATE	ISSUE/REVISION DETAIL	BY	CHK	APPR
B	21.06.2022	UPDATED TO PEER REVIEW COMMENTS	WR	CF	
A	05.10.2021	INTIAL ISSUE	SD	CF	

Version 4.0 - March 2020

DESIGNED CF
CHECKED CF
DRAWN SD
APPROVED
mx model version:

BLOXAM BURNETT & OLLIVER

CLIENT
CALCUTTA
Veros

PROJECT
CALCUTTA FARMS PLAN CHANGE
INDUSTRIAL DEVELOPMENT

DRAWING
STORMWATER MANAGEMENT
OVERVIEW PLAN

STATUS
PRELIMINARY

DATE
01.11.2021

SCALE (ORIGINAL SIZE A3)
1:3000

DRAWING NUMBER
146930-02-0701

REVISION
B

Appendix F – WSP laboratory sieving test results

PARTICLE SIZE ANALYSIS (HYDROMETER METHOD)

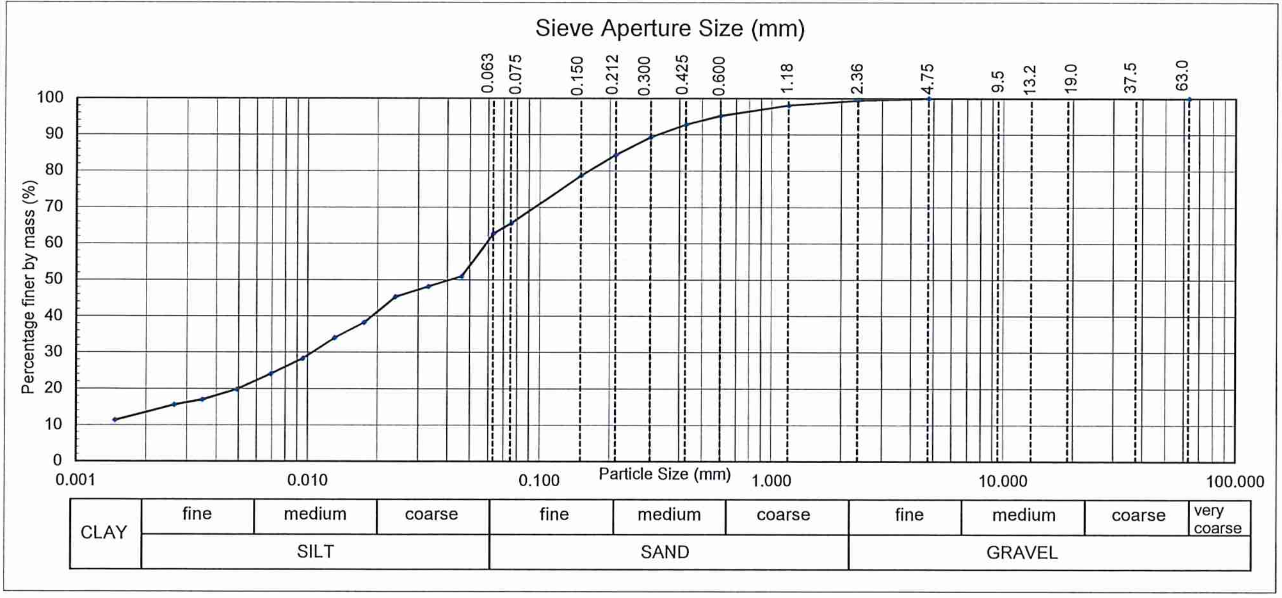
TEST REPORT

wsp

Project :	Tauranga Road Industrial Subdivision
Location :	Matamata
Client :	CMW (NZ) Ltd
Client ref :	TGA2020-0304
Contractor :	N/A
Sample no:	S11 - T05 Depth: 0.0 - 0.2 Metres
Sampled by :	CMW Staff
Date sampled :	27 July 2021
Date received :	11 August 2021
Sampling method :	Unknown
Sample condition :	Natural State (as received)
Sample description :	Dark brown sandy SILT, some clay, trace of fine gravel
Solid particle density :	2.65 t/m^3 (assumed)
Water content :	68.9 % (as received)

Project No:	255155.00/0TL
Lab Ref No:	TG5385
Client Ref:	TGA114025

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	100	0.300	89	0.0461	51	0.0069	24
37.5	--	2.36	99	0.212	85	0.0331	48	0.0049	20
19.0	--	1.18	98	0.150	79	0.0238	45	0.0035	17
13.2	--	0.600	95	0.075	66	0.0175	38	0.0026	16
9.5	--	0.425	93	0.063	63	0.0131	34	0.0015	11
Note:	"--" denotes sieve not used and/or hydrometer analysis not tested					0.0095	28		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.4 (Washed Grading & Hydrometer Method)	pH of suspension : 9.5 (pH Indicator stick) This report may only be reproduced in full.

Date Tested: 14 September 2021

Date Reported: 30 September 2021

IANZ Approved Signatory
Designation : *Laboratory Manager*
Date : 30 September 2021

ACCREDITED
IANZ
TESTING LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

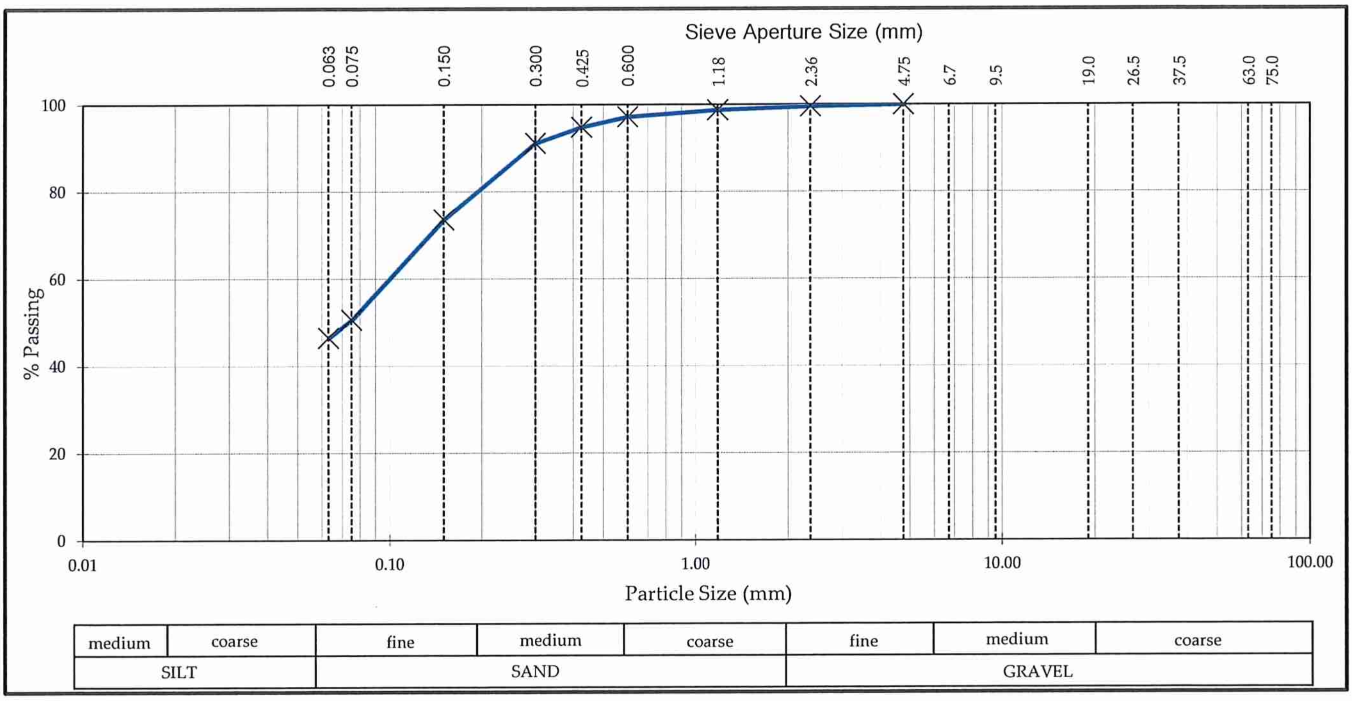
PARTICLE SIZE DISTRIBUTION
TEST REPORT

Project :	Tauranga Road Industrial Subdivision
Location :	Matamata
Client :	CMW (NZ) Ltd
Contractor :	N/A
Sampled by :	CMW Staff
Date sampled :	27 July 2021
Sampling method :	Unknown
Sample description :	Light greyish brown sandy SILT
Sample condition	Natural State (as received)
Sample no :	S01-T02
Depth :	1.8 - 2.2m
Date received :	11 August 2021

Project No :	255155.00/OTL
Lab Ref No :	TG5385
Client Ref No :	TGA2020-0304

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	-	2.36	100	0.300	91
63.00	-	9.50	-	1.18	99	0.150	74
37.50	-	6.70	-	0.60	97	0.075	51
26.50	-	4.75	100	0.425	95	0.063	46



Test Method		Notes
Particle Size Distribution	NZS 4402 : 1986 Test 2.8.1	Fraction passing the finest sieve obtained by difference. This report may only be reproduced in full.

Date tested : 14 September 2021
Date reported : 30 September 2021

IANZ Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 30 September 2021

ACCREDITED IANZ TESTING LABORATORY

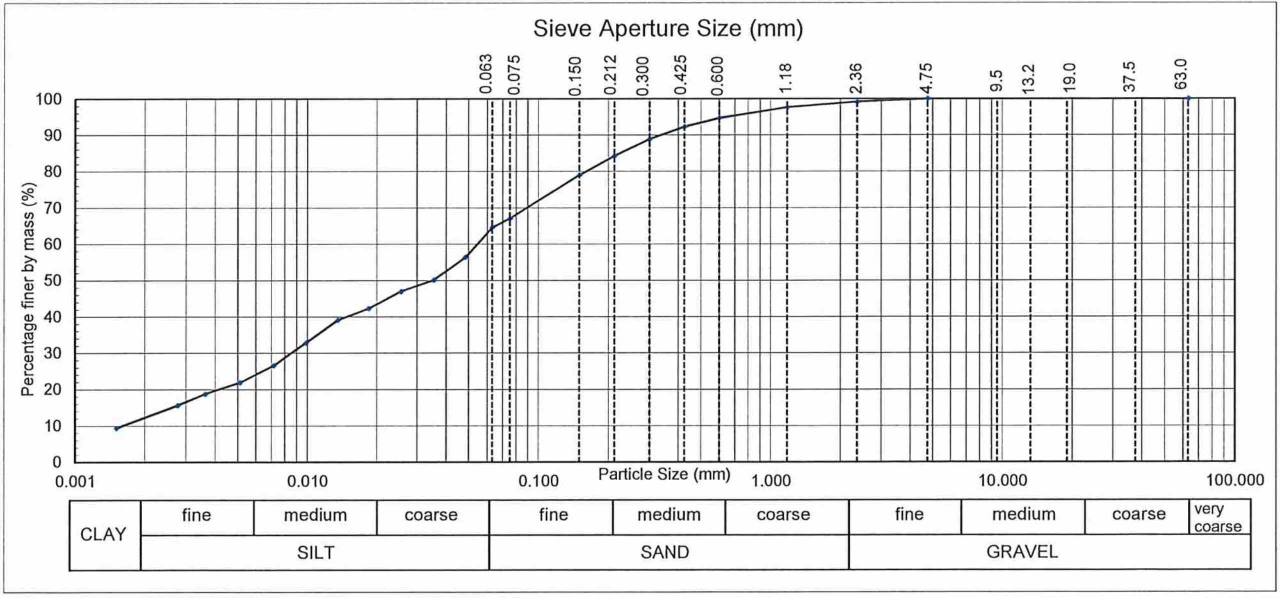
All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

PARTICLE SIZE ANALYSIS (HYDROMETER METHOD)
TEST REPORT

Project :	Tauranga Road Industrial Subdivision
Location :	Matamata
Client :	CMW (NZ) Ltd
Client ref :	TGA2020-0304
Contractor :	N/A
Sample no:	S07 - T03 Depth: 0.0 - 0.2 Metres
Sampled by :	CMW Staff
Date sampled :	27 July 2021
Date received :	11 August 2021
Sampling method :	Unknown
Sample condition :	Natural State (as received)
Sample description :	Dark brown sandy SILT, some clay, trace of fine gravel
Solid particle density :	2.65 t/m^3 (assumed)
Water content :	66.2 % (as received)

Project No:	255155.00/0TL
Lab Ref No:	TG5385
Client Ref:	TGA114025

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	100	0.300	89	0.0484	56	0.0072	27
37.5	--	2.36	99	0.212	84	0.0354	50	0.0051	22
19.0	--	1.18	98	0.150	79	0.0254	47	0.0036	19
13.2	--	0.600	95	0.075	67	0.0184	42	0.0028	16
9.5	--	0.425	92	0.063	65	0.0135	39	0.0015	9
Note:	"--" denotes sieve not used and/or hydrometer analysis not tested					0.0099	33		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.4 (Washed Grading & Hydrometer Method)	pH of suspension : 10.0 (pH Indicator stick) This report may only be reproduced in full.

Date Tested:	9 September 2021
Date Reported:	30 September 2021

IANZ Approved Signatory

Designation :	*Laboratory Manager*
Date :	30 September 2021

ACCREDITED IANZ TESTING LABORATORY

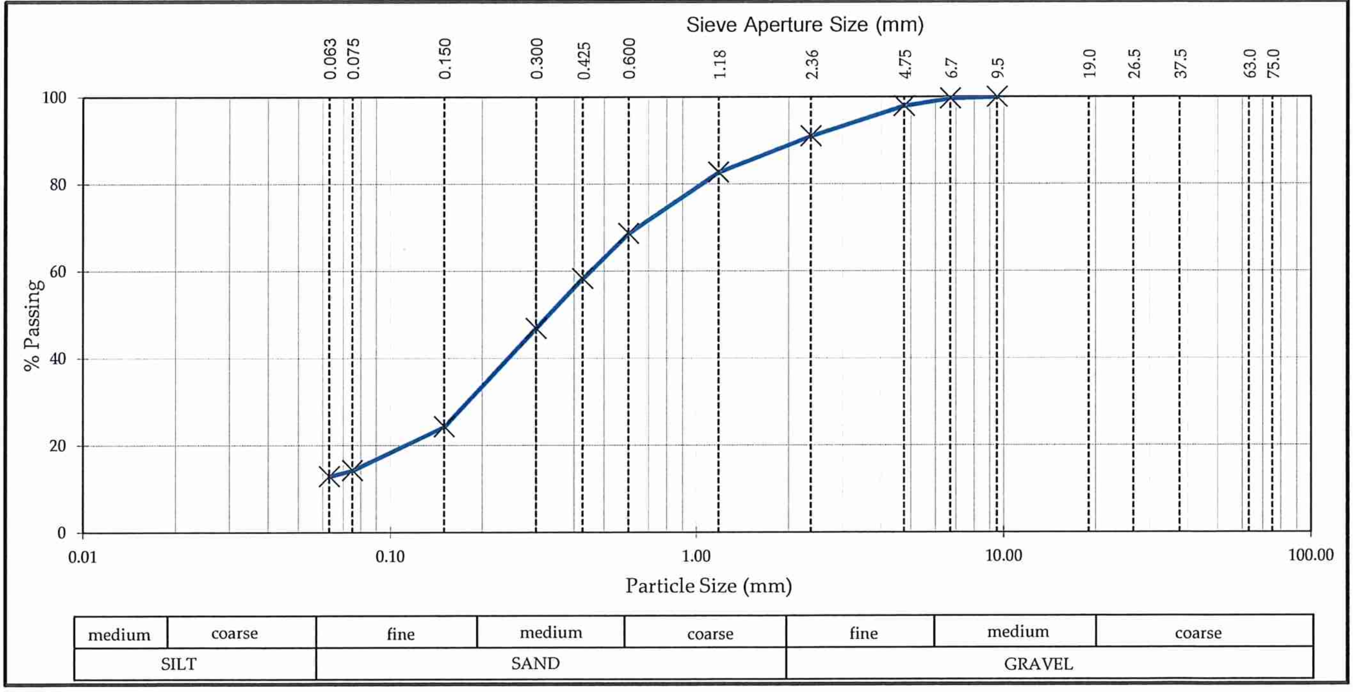
All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

PARTICLE SIZE DISTRIBUTION
TEST REPORT

Project :	Tauranga Road Industrial Subdivision
Location :	Matamata
Client :	CMW (NZ) Ltd
Contractor :	N/A
Sampled by :	CMW Staff
Date sampled :	27 July 2021
Sampling method :	Unknown
Sample description :	Light greyish brown SAND, some silt & minor gravel
Sample condition	Natural State (as received)
Sample no :	S07-T04
Depth :	1.8 - 2.2m
Date received :	11 August 2021

Project No :	255155.00/0TL
Lab Ref No :	TG5385
Client Ref No :	TGA2020-0304

Sieve Analysis							
Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	-	2.36	91	0.300	47
63.00	-	9.50	100	1.18	83	0.150	24
37.50	-	6.70	100	0.60	69	0.075	14
26.50	-	4.75	98	0.425	58	0.063	13



Test Method		Notes
Particle Size Distribution	NZS 4402 : 1986 Test 2.8.1	Fraction passing the finest sieve obtained by difference. This report may only be reproduced in full.

Date tested : 14 September 2021
Date reported : 30 September 2021

IANZ Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 30 September 2021

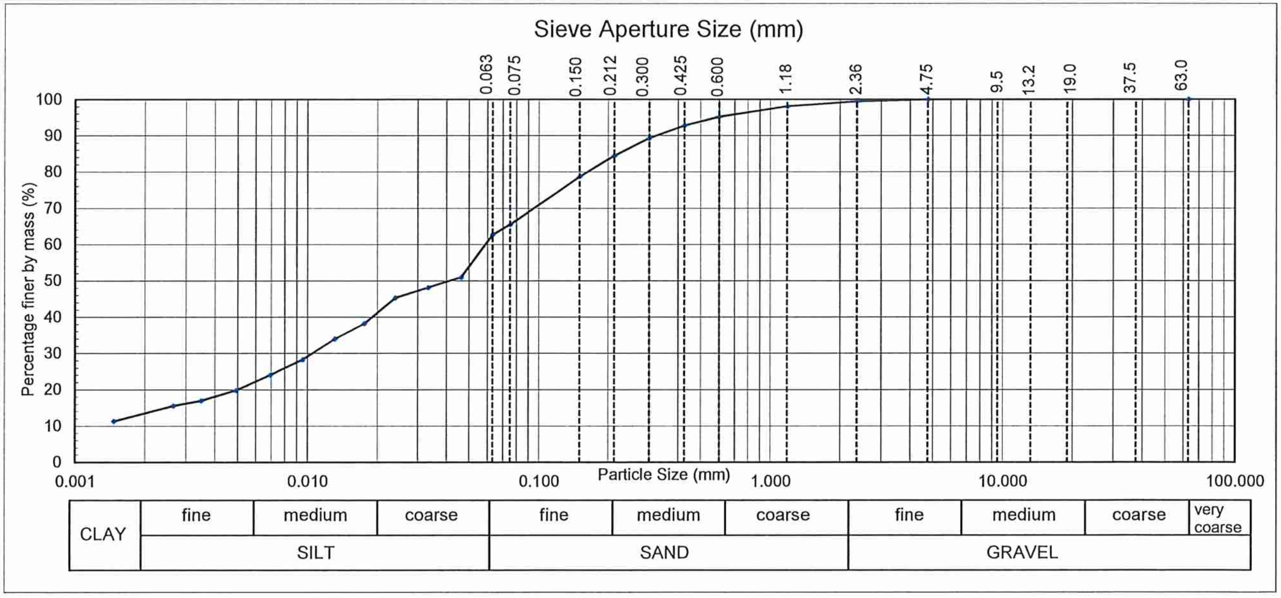
All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

PARTICLE SIZE ANALYSIS (HYDROMETER METHOD)
TEST REPORT

Project :	Tauranga Road Industrial Subdivision
Location :	Matamata
Client :	CMW (NZ) Ltd
Client ref :	TGA2020-0304
Contractor :	N/A
Sample no:	S11 - T05 Depth: 0.0 - 0.2 Metres
Sampled by :	CMW Staff
Date sampled :	27 July 2021
Date received :	11 August 2021
Sampling method :	Unknown
Sample condition :	Natural State (as received)
Sample description :	Dark brown sandy SILT, some clay, trace of gravel
Solid particle density :	2.65 t/m^3 (assumed)
Water content :	68.9 % (as received)

Project No:	255155.00/0TL
Lab Ref No:	TG5385
Client Ref:	TGA114025

Sieve Analysis						Hydrometer Analysis			
Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Sieve Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)	Particle Size (mm)	Passing (%)
63.0	--	4.75	100	0.300	89	0.0461	51	0.0069	24
37.5	--	2.36	99	0.212	85	0.0331	48	0.0049	20
19.0	--	1.18	98	0.150	79	0.0238	45	0.0035	17
13.2	--	0.600	95	0.075	66	0.0175	38	0.0026	16
9.5	--	0.425	93	0.063	63	0.0131	34	0.0015	11
Note:	"--" denotes sieve not used and/or hydrometer analysis not tested					0.0095	28		



Test Methods	Notes
Particle Size Analysis: NZS 4402:1986: Test 2.8.4 (Washed Grading & Hydrometer Method)	pH of suspension : 9.5 (pH Indicator stick) This report may only be reproduced in full.

Date Tested: 14 September 2021

Date Reported: 30 September 2021

IANZ Approved Signatory

Designation : *Laboratory Manager*

Date : 30 September 2021

ACCREDITED
IANZ
TESTING LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

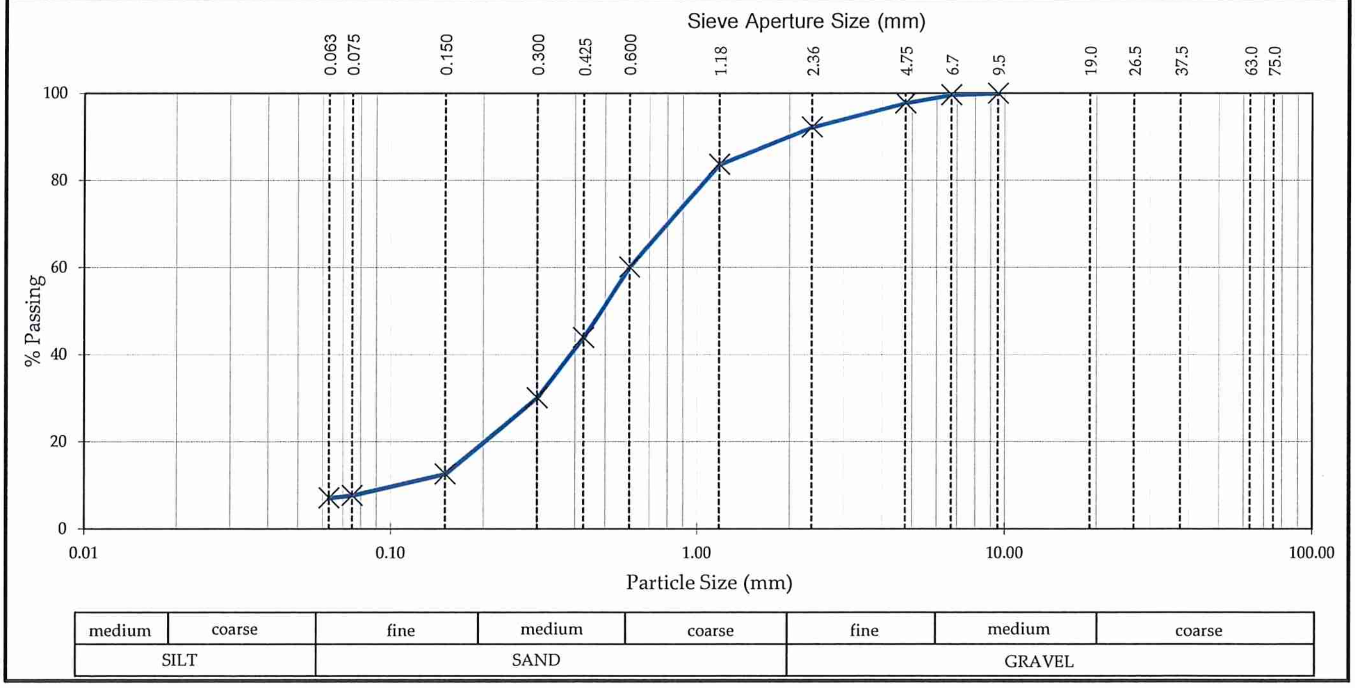
PARTICLE SIZE DISTRIBUTION
TEST REPORT

Project :	Tauranga Road Industrial Subdivision
Location :	Matamata
Client :	CMW (NZ) Ltd
Contractor :	N/A
Sampled by :	CMW Staff
Date sampled :	27 July 2021
Sampling method :	Unknown
Sample description :	Light greyish brown SAND, minor silt & fine gravel
Sample condition	Natural State (as received)
Sample no :	S11-T06
Depth :	1.8 - 2.2m
Date received :	11 August 2021

Project No :	255155.00/OTL
Lab Ref No :	TG5385
Client Ref No :	TGA2020-0304

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	-	2.36	92	0.300	30
63.00	-	9.50	100	1.18	84	0.150	13
37.50	-	6.70	100	0.60	60	0.075	8
26.50	-	4.75	98	0.425	44	0.063	7



Test Method		Notes
Particle Size Distribution	NZS 4402 : 1986 Test 2.8.1	Fraction passing the finest sieve obtained by difference. This report may only be reproduced in full.

Date tested : 14 September 2021
Date reported : 30 September 2021

IANZ Approved Signatory

Designation : *Senior Civil Engineering Technician*
Date : 30 September 2021

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

Appendix G – Permeability testing results from CMW Geoscience

30 August 2021 Document Ref: TGA2020-0304AD Rev 0

Calcutta Farms Limited
166 Heights Road
Pukekohe 2676

Attention: Matt Carnachan

Dear Matt

RE: FACTUAL SOIL PERMEABILITY TESTING FOR PROPOSED INDUSTRIAL SUBDIVISION 194 TAURANGA ROAD (SH24), MATAMATA

1 INTRODUCTION

CMW Geosciences (CMW) was appointed by Veros Property Group (Veros) on behalf of Calcutta Farms Limited to carry out onsite permeability testing to determine representative seepage rates for the near surface soils at the proposed Tauranga Road industrial subdivision in Matamata.

It is understood concentrated stormwater flows generated from within the subdivision may discharge to soakage parks, designed by Bloxam Burnett and Olliver (BBO).

The scope of work and associated terms and conditions of our engagement were detailed in our services proposal letter dated 26 March 2021 (ref. TGA2020-0304AA Rev 2).

2 SCOPE OF WORK

As detailed in our above referenced services proposal letter, the scope of work to be conducted by CMW is defined as follows:

- The drilling of 12 hand augers to undertake soakage testing down to depths of 2.0m and 4.0m below ground level and determine permeability rates for future soakage design;
- Calculate representative permeability rates for the various site soils;
- Compile a letter providing details around soakage test methodology and providing permeability rates for site soils, depths of tests and basic soil logs.

3 FIELD INVESTIGATION

The field investigation was carried out between 14 and 27 July 2021. All fieldwork was carried out under the direction of CMW Geosciences in general accordance with the NZGS guidance[1] and Matamata Piako District Council (MPDC) Soakage Design Procedures and Guidelines.

The number of soakage tests undertaken was less than that prescribed in the MPDC guidance, on the basis that if the test results did not show great variation then the lower number of tests may be acceptable to Council. If the results showed great variation, then further testing may be required to determine representative rates for design.

From previous investigation findings the anticipated near surface soil profile was a veneer of silty deposits over sandy deposits. The testing strategy adopted was therefore to target the deeper and possibly more permeable sand layer at the majority of the test locations, with a smaller number of tests targeted at the upper silt soils which were expected to be of lower permeability.

The scope of fieldwork carried out was as follows:

- Twelve hand auger boreholes, denoted HA02, HA04, HA06, HA07, HA08, HA09, HA13, HA16, HA18, HA19, HA22 and HA23, were drilled using a 50mm diameter auger to depths of up to 4.0m below existing ground levels to visually observe the near surface soil profile and for permeability testing purposes. The boreholes were logged by CMW Geologists in general accordance with NZGS guidelines[2]. Engineering logs of the hand auger boreholes are attached;
- Twelve falling head permeability tests (referred to as S01 to S12) were carried out in HA02, HA04, HA06, HA07, HA08, HA09, HA13, HA16, HA18, HA19, HA22 and HA23 respectively to depths of 2.0m to 4.0m below existing ground levels. The holes were augered down to the targeted test strata/ depth and permeability testing was carried out. Following completion of the test the hand auger boreholes were then advanced down to deeper levels in order to observe the deeper level soil profile as part of the overall site investigation.
- The permeability tests in HA07, HA08, HA09, HA16, HA18 and HA23 (S06, S04, S03, S10, S09, and S12 respectively) targeted the shallow upper silt only. Results of the falling head permeability tests are attached.
- The permeability tests undertaken within HA02, HA04, HA06, HA13, HA19, and HA22 (S01, S02, S05, S07, S08 and S11 respectively) targeted the underlying sand unit. Results of the falling head permeability tests are attached.
- The 50mm diameter HA holes were reamed out to 100mm using a larger auger head. A slotted 80mm diameter PVC pipe was installed to the base of the holes and the holes were pre-soaked prior to undertaking the permeability tests. Following pre-soaking, the holes were filled with water and the rate of water level fall over time was monitored. Test results were used to calculate the soakage rates of the soil in accordance with the MPDC Soakage Design Procedures and Guidelines.
- Constant head permeability testing was also undertaken in HA02, HA09, HA13, HA19, and HA22 to provide a comparison with falling head permeability test results. In this case a flow of water maintained to provide a constant head of water. Test results were used to calculate the hydraulic conductivity (k) of the soil using the constant head method. Results of the constant head permeability tests are attached.

The approximate locations of the respective augers referred to above are shown on ***Drawing 01***.

---

[1] NZ Geotechnical Society et al, New Zealand Ground Investigation Specification, Vol 1, April 2017

[2] NZ Geotechnical Society (2005), Field Description of Soil and Rock, Guideline for the field classification and description of soil and rock for engineering purposes.

4 PERMEABILITY TEST RESULTS

The results of the falling and constant head permeability tests are appended and have been summarised in Tables 1 and 2 below.

Table 1: Summary of Falling Head Permeability Test Results

Test Location	Depth of hole	Test targeting silt or sand layer	Average soakage rate (L/min/m^2)	Hydraulic Conductivity (k) (m/sec)
S01(HA02)	4.0	Sand	2.9	4.8×10^{-5}
S02 (HA04)	2.0	Silt	2.8	4.8×10^{-5}
S03 (HA09)	2.5	Sand	1.5	2.6×10^{-5}
S04 (HA08)	2.0	Silt	3.0	4.9×10^{-5}
S05 (HA06)	2.5	Sand	0.9	1.6×10^{-5}
S06 (HA07)	2.0	Silt	6.1	1.0×10^{-4}
S07 (HA13)	4.0	Sand	4.3	7.2×10^{-5}
S08 (HA19)	2.5	Sand	4.9	8.1×10^{-5}
S09 (HA18)	2.0	Silt	3.0	5.1×10^{-5}
S10 (HA16)	2.0	Silt	2.0	3.4×10^{-5}
S11 (HA22)	4.0	Sand	4.3	7.2×10^{-5}
S12 (HA23)	2.0	Silt	3.3	5.6×10^{-5}

As shown in Table 1, the average soakage rates range from 0.9 to 6.1 L/min/m^2, with an average of 3.2 L/min/m^2.

Table 2: Summary of Constant Head Permeability Test Results

Test Location	Depth of hole	Test targeting silt or sand layer	Average soakage rate (L/min/m^2)	Hydraulic Conductivity (k) (m/sec)
S01(HA02)	4.0	Sand	-	4.4×10^{-5}
S03 (HA09)	2.5	Sand	-	1.1×10^{-5}
S07 (HA13)	4.0	Sand	-	4.1×10^{-5}
S08 (HA19)	2.5	Sand	-	7.0×10^{-5}
S11 (HA22)	4.0	Sand	-	3.7×10^{-5}

As required by the MPDC guidelines, a reduction factor of 0.5 must be applied to the soakage rates in Table 1 and Table 2 to provide design soakage rates.

5 GROUNDWATER

Based on the results of the CMW Geotechnical Investigation[3] carried out in mid 2021 to support a resource consent application for the subdivision, the standing groundwater table is approximately 12m to 15m below the existing ground surface (RL45 to 48m relative to Moturiki Datum). However it should be noted that a shallower (ie. perched) groundwater table was also observed between 2.7m and 4.8m below existing ground levels. A summary of these findings is provided in Table 3 below:

Table 2: Groundwater Data

Test Location	Groundwater Depth (mbgl)	Elevation (m RL)	Measured or inferred
CPT01	14.8	46.2	Inferred
CPT02	12.2	47.8	Measured
CPT03	14.8	47.2	Inferred
CPT04	13.5	46.5	Measured
CPT05	13.2	46.8	Measured
CPT06	14.9	45.1	Measured
CPT07	2.9	57.1	Measured
CPT08	3.7	55.3	Measured
CPT09	4.2	55.8	Measured
CPT10	4.8	56.2	Measured
HA12	2.7	57.3	Measured
HA14	3.6	57.4	Measured
HA16	4.0	56.0	Measured
HA17	3.0	58.0	Measured
HA18	2.9	57.1	Measured
HA19	3.4	56.6	Measured
HA20	3.0	56.0	Measured
HA21	3.6	56.4	Measured
HA23	3.8	56.2	Measured
HA24	3.8	55.2	Measured
Note: mbgl = metres below ground level			

The near surface groundwater levels encountered at CPT07 to CPT10 and hand auger boreholes HA12, HA14, HA16, HA17, HA18, HA19, HA20, HA21, HA23 and HA24 are interpreted to represent a perched groundwater within the variable and layered near surface deposits.

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[3] CMW Geotechnical Investigation Report for the Tauranga Road Industrial Subdivision, Ref. TGA2020-0304AC Rev 0, dated 30 August 2021

6 DISCUSSION OF RESULTS

Based on the above permeability test results, soakage to ground is permitted as calculated rates exceed the minimum design soakage rate of 0.5L/min/m^2 outlined by the MPDC Guidelines.

The range of calculated soakage rates from across the site are typical of this type of testing and the soil types and are therefore not considered highly variable.

Given the results obtained and the number of tests undertaken we consider the testing adequate to provide representative rates for soakage design.

Soakage design must be undertaken by a Chartered Professional Engineer as part of a building consent application, with reference to the conclusions and recommendations of this report, the MPDC Soakage Design Procedures and Guidelines documentation, when roof and hardstand areas are known.

For and on behalf of CMW Geosciences

Prepared by:	Reviewed by:
Luke McCann Engineering Geologist	Matt Packard Principal Geotechnical Engineer CMEngNZ, CPEng (Geotechnical)

Authorised by:

Ken Read
Principal Geotechnical Engineer
CMEngNZ, CPEng

Distribution:
1 electronic copy to Calcutta Farms Limited via email
1 electronic copy to Veros Property Group Limited via email
1 electronic copy to Bloxam, Burnett and Olliver Limited via email
Original held at CMW Geosciences

Attachments:
Use of this Report
Geotechnical Investigation Plan
Borehole logs
Permeability Calculations

USE OF THIS REPORT

Site subsurface conditions cause more construction problems than any other factor and therefore are generally the largest technical risk to a project. These notes have been prepared to help you understand the limitations of your geotechnical report.

Your geotechnical report is based on project specific criteria

Your geotechnical report has been developed on the basis of our understanding of your project specific requirements and applies only to the site area investigated. Project requirements could include the general nature of the project; its size and configuration; the location of any structures on or around the site; and the presence of underground utilities. If there are any subsequent changes to your project you should seek geotechnical advice as to how such changes affect your report's recommendations. Your geotechnical report should not be applied to a different project given the inherent differences between projects and sites.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface investigation, the conditions may have changed, particularly when large periods of time have elapsed since the investigations were performed.

Interpretation of factual data

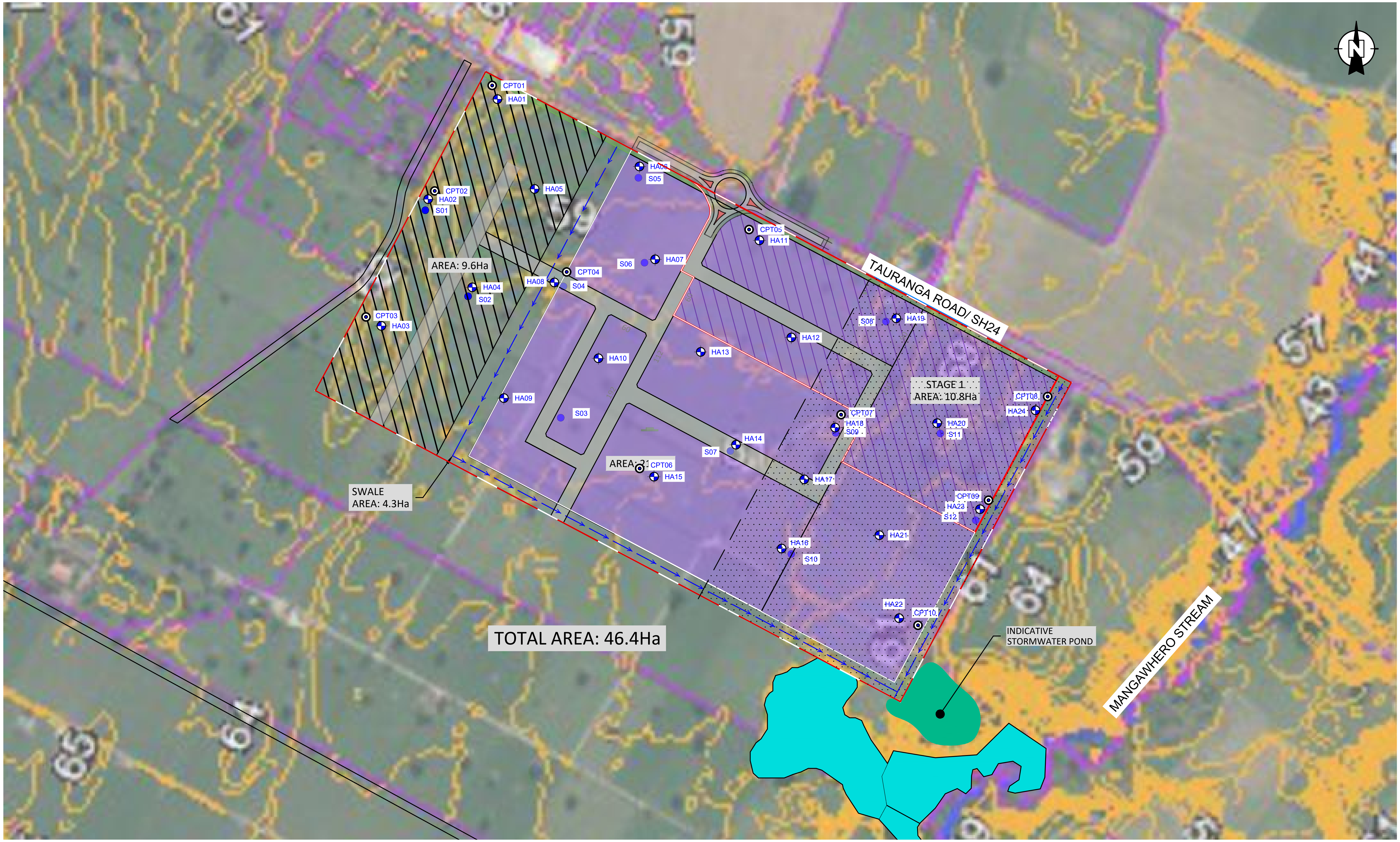
Site investigations identify actual subsurface conditions at points where samples are taken. Additional geotechnical information (e.g., literature and external data source review, laboratory testing on samples, etc) are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can exactly predict what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions.

Your report's recommendations require confirmation during construction

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced. For this reason, you should retain geotechnical services throughout the construction stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site. A geotechnical designer, who is fully familiar with the background information, is able to assess whether the report's recommendations are valid and whether changes should be considered as the project develops. An unfamiliar party using this report increases the risk that the report will be misinterpreted.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical report. Read all geotechnical documents closely and do not hesitate to ask any questions you may have. To help avoid misinterpretations, retain the assistance of geotechnical professionals familiar with the contents of the geotechnical report to work with other project design professionals who need to take account of the contents of the report. Have the report implications explained to design professionals who need to take account of them, and then have the design plans and specifications produced reviewed by a competent Geotechnical Engineer.



LEGEND:

⊕	HA01	HAND AUGER (HA) LOCATION
◉	CPT01	CONE PENETROMETER TEST (CPT) LOCATION
●	S01	SOAKAGE TEST LOCATION
— —		SITE BOUNDARY
▒		APPROXIMATE AREA OF POTENTIAL LIQUEFACTION SETTLEMENT RISK
▧		LIGHT INDUSTRIAL
🟪		GENERAL INDUSTRIAL
▧		STAGE ONE
🟩		INDICATIVE STORMWATER POND
🟦		PROPOSED CONSERVATION COVENANT SCHEDULE

NOTES:

1. BASE PLAN ADAPTED FROM: WAIKATO REGIONAL COUNCIL MAPS.
2. CONTOURS ARE IN 1.0m INTERVALS AND ARE IN TERMS OF MOTURIKI DATUM.
3. PROPOSED SCHEME PLAN ADAPTED FROM BBO PRELIMINARY CONCEPT PLAN STAGE 1, DRAWING NO. 146930-02-0001, REV. B, DATED 07/12/2020
4. TEST LOCATIONS ARE APPROXIMATE ONLY.

0 40 80 120 160 200 m

1:4000

CMW Geosciences

CLIENT: **CALCUTTA FARMS LIMITED.**	DRAWN: PB	PROJECT No: TGA2020-0304
PROJECT: **194 TAURANGA ROAD MATAMATA**	CHECKED: LPM	DRAWING: 01
	REVISION: 0	SCALE: 1:4000
TITLE: **GEOTECHNICAL INVESTIGATION PLAN**	DATE: 24/06/2021	SHEET: A3

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MATAMATA\DRAWINGS\TGA2020-0304 REV.0.DWG

CMW Geosciences – SOIL (Field Logging Guide)

SEQUENCE OF TERMS:
Fine: Soil Symbol – Soil Type – Colour – Structure – (Consistency) – (Moisture) – Bedding – Plasticity – Sensitivity – Additional Comments – Origin/Geological Unit
Coarse: Soil Symbol – Soil Type – Colour – Structure – Grading – Particle shape – (Relative Density) – (Moisture) – Bedding – Additional Comments – Origin/Geological Unit

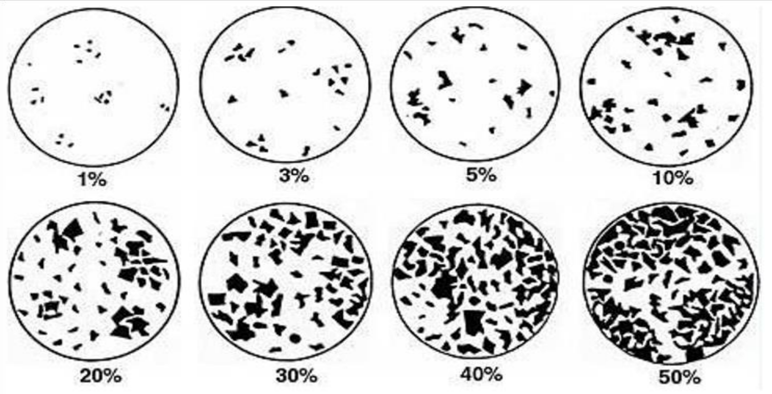
BEHAVIOURAL SOIL CLASSIFICATION SYSTEM

Major Divisions (behaviour based logging)			Soil Symbol	Soil Name
Coarse grained soils more than 65%>0.06mm	Gravel >50% of coarse fraction >2mm	Clean gravel <5% smaller 0.075mm	GW	Well graded gravel, fine to coarse gravel
			GP	Poorly graded gravel
		Gravel with >12% fines	GM	Silty gravel
			GC	Clayey gravel
	Sand ≥50% of coarse fraction <2mm	Clean sand	SW	Well-graded sand, fine to coarse sand
			SP	Poorly graded sand
		Sand with >12% fines	SM	Silty sand
			SC	Clayey sand
Fine grained soils 35% or more <0.06mm	Exhibits dilatant behaviour	inorganic	ML	Silt
			MH	Silt of high plasticity
		organic	OL	Organic silt
	No dilatant behaviour	inorganic	CL	Clay of low plasticity
			CH	Clay of high plasticity
		organic	OH	Organic clay
Highly Organic Soils			Pt	Peat

PROPORTIONAL TERMS DEFINITION

Fraction	Term	% of Soil Mass	Example
Major	(…) [UPPER CASE]	≥50 [major constituents]	GRAVEL
Subordinate	(…) [lower case]	20 – 50	Sandy
Minor	with some…	12 – 20	with some sand
	with minor…	5 – 12	with minor sand
	with trace of (or slightly)	< 5	with trace of sand (slightly sandy)

VISUAL PROPORTION PERCENTAGE



GRAIN SIZE CRITERIA

TYPE	COARSE								FINE		ORGANIC
			Gravel			Sand					
	Boulders	Cobbles	coarse	medium	fine	coarse	medium	fine	Silt	Clay	Organic Soil
Size Range (mm)	200	60	20	6	2	0.6	0.2	0.06	0.002		
Graphic Symbol	●	● ●	○○○○			∴∴∴			×××	═══	ψ ψ ψ

ADDITIONAL GRAPHIC LOG SYMBOLS

Term	Symbol
Topsoil	▧
Fill	⊠
Bitumen	▩
Concrete	∴

ORGANIC SOILS / DESCRIPTORS

Term	Description
Topsoil	Surficial organic soil layer that may contain living matter. However, topsoil may occur at greater depth, having been buried by geological processes or man-made fill, and should be termed a buried topsoil.
Organic clay, silt or sand	Contains finely divided organic matter; may have distinctive smell; may stain; may oxidize rapidly. Describe as for inorganic soils.
Peat	Consists predominantly of plant remains. **Firm:** Fibres already compressed together **Spongy:** Very compressible and open structure **Plastic:** Can be moulded in hand and smears in fingers **Fibrous:** Plant remains recognisable and retain some strength **Amorphous:** No recognisable plant remains
Rootlets	Fine, partly decomposed roots, normally found in the upper part of a soil profile or in a redeposited soil (e.g. colluvium or fill)
Carbonaceous	Discrete particles of hardened (carbonised) plant material.

SHADE AND COLOUR

1	2	3
light dark mottled streaked	pinkish reddish yellowish brownish greenish bluish greyish	pink red orange yellow brown green blue white grey black

SOIL STRUCTURE

Term	Description
Homogeneous	The total lack of visible bedding and the same colour and appearance throughout
Bedded	The presence of layers
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Polished	Fracture planes are polished or glossy
Slickensided	Fracture planes are striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensoidal	Discontinuous pockets of a soil within a different soil mass

GRADING (GRAVELS & SANDS)

Term	Description	
Well Graded	Good representation of all particle size ranges from largest to smallest	
Poorly Graded	Limited representation of grain sizes – further divided into:	
	Uniformly graded	Most particles about the same size
	Gap graded	Absence of one or more intermediate sizes

ROUNDING/PARTICLE SHAPE

Rounded	Subrounded	Subangular	Angular
			

CONSISTENCY TERMS FOR FINE SOILS

Descriptive term	Undrained Shear Strength (kPa)	Diagnostic Features	Abbreviation
Very Soft	<12	Easily exudes between fingers when squeezed	VS
Soft	12-25	Easily indented by fingers	S
Firm	25-50	Indented by strong finger pressure and can be indented by thumb pressure	F
Stiff	50-100	Cannot be indented by thumb pressure	St
Very Stiff	100-200	Can be indented by thumb nail	VSt
Hard	200-500	Difficult to indent by thumb nail	H

DENSITY INDEX (RELATIVE DENSITY) TERMS FOR COARSE SOILS

Descriptive term	Density Index (RD)	SPT "N" value (blows/300mm)	Dynamic Cone (blows/100mm)	Abbreviation
Very Dense	> 85	> 50	> 17	VD
Dense	65 - 85	30 - 50	7 - 17	D
Medium dense	35 - 65	10 - 30	3 - 7	MD
Loose	15 - 35	4 - 10	1 - 3	L
Very loose	< 15	< 4	0 - 2	VL

Note:
- Where strength data cannot be confirmed Loosely Packed (LP) and Tightly Packed (TP) may be used.
- No correlation is implied between Standard Penetration Test (SPT) and Dynamic Cone Penetrometer (Scala) Test values.
- SPT "N" values are uncorrected.

MOISTURE CONDITION

Condition	Description	Coarse Soils	Fine Soils	Abbreviation
Dry	Looks and feels dry	Runs freely through hands	Hard, powdery or friable	D
Moist	Feels cool, darkened in colour	Tends to cohere	Weakened by moisture, but no free water on hands when remoulding	M
Wet			Weakened by moisture, free water forms on hands when handling	W
Saturated	Feels cool, darkened in colour and free water is present on the sample			S

BEDDING THICKNESS (Sedimentary)

Term	Bed Thickness
Thinly laminated	< 2mm
Laminated	2mm - 6mm
Very thin	6mm - 20mm
Thin	20mm - 60mm
Moderately thin	60mm - 200mm
Moderately thick	0.2m - 0.6m
Thick	0.6m - 2m
Very thick	> 2m

BEDDING INCLINATION

Term	Inclination (from horizontal)
Sub-horizontal	0º - 5º
Gently inclined	6º - 15º
Moderately inclined	16º - 30º
Steeply inclined	31º - 60º
Very steeply inclined	61º - 80º
Sub vertical	81º - 90º

SENSITIVITY OF SOIL

Descriptive Term	Shear Strength Ratio = $\frac{undisturbed}{remoulded}$
Insensitive, normal	< 2
Moderately sensitive	2 – 4
Sensitive	4 – 8
Extra sensitive	8 – 16
Quick	> 16

PLASTICITY (CLAYS & SILTS)

Term	Description
High plasticity	Can be moulded or deformed over a wide range of moisture contents without cracking or showing any tendency to volume change
Low plasticity	When moulded can be crumbled in the fingers; may show quick or dilatant behaviour

Revision 3 April 2018

HAND AUGER BOREHOLE LOG - HA02 & S01

Client: Calcutta Farms Ltd
Project: Tauranga Road Industrial Subdivision
Site Location: Matamata
Project No.: TGA2020-0304
Date: 17/06/2021
Borehole Location: Refer to Drawing 01 Logged by: MS Checked by: LPM Scale: 1:25 Sheet 1 of 1

CMW Geosciences

Position: 1845912.0mE; 5810463.0mN Projection: BOP 2000
Datum: Moturiki Survey Source: Hand held GPS

Samples & Insitu Tests

Depth	Type & Results
0.3	Peak = 80kPa Residual = 21kPa
0.6	Peak = 148kPa Residual = 33kPa
0.9	Peak = 74kPa Residual = 24kPa
1.2	Peak = 124kPa Residual = 36kPa

Material Description
Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit)
Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)

OL: Organic SILT: black. Non plastic.
(Topsoil)

ML: Clayey SILT with trace sand: orange brown. Low plasticity; sand, fine to medium.
(Hinuera Formation)
... at 0.70m, Becoming light brown.
... at 0.90m, Contains some fine to medium sand.

ML: Sandy SILT: light brownish grey. Non plastic, loosely packed; sand, fine.
(Hinuera Formation)

SP: Fine to medium SAND with minor silt: dark grey mottled yellowish brown. Well graded, silicious, subangular.
(Hinuera Formation)

SP: Silty fine SAND: white. Poorly graded.
(Hinuera Formation)

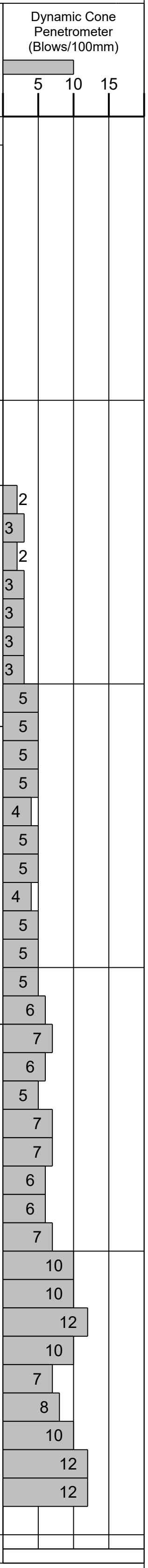
SW: Fine to medium SAND with some silt: light grey mottled yellowish brown. Well graded, silicious, subangular.
(Hinuera Formation)

SW: Fine to coarse SAND with minor silt: grey. Well graded, silicious, subangular.
(Hinuera Formation)
... at 3.40m, Contains trace fine to medium gravel, siliceous.

Borehole terminated at 5.0 m

Moisture Condition: M; W; D to M

Consistency/ Relative Density: St to VSt; VSt; L to MD; MD; MD to D



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Termination Reason: Target depth
Shear Vane No: 2562 DCP No: 17
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA04 & S02

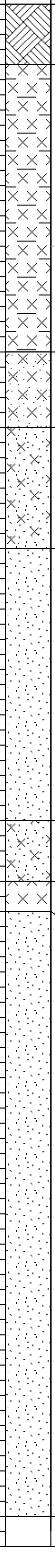
Client: Calcutta Farms Ltd
Project: Tauranga Road Industrial Subdivision
Site Location: Matamata
Project No.: TGA2020-0304
Date: 16/06/2021
Borehole Location: Refer to Drawing 01
Logged by: MS
Checked by: LPM
Scale: 1:25
Sheet 1 of 1

Position: 1845966.0mE; 5810338.0mN
Projection: BOP 2000
Datum: Moturiki
Survey Source: Hand held GPS

Samples & Insitu Tests

Depth	Type & Results
0.3	Peak = 118kPa Residual = 18kPa
0.6	Peak = 74kPa Residual = 15kPa
0.9	Peak = 139kPa Residual = 18kPa
1.2	Peak = 175kPa Residual = 38kPa
3.0	Peak = 175kPa Residual = 50kPa

Graphic Log

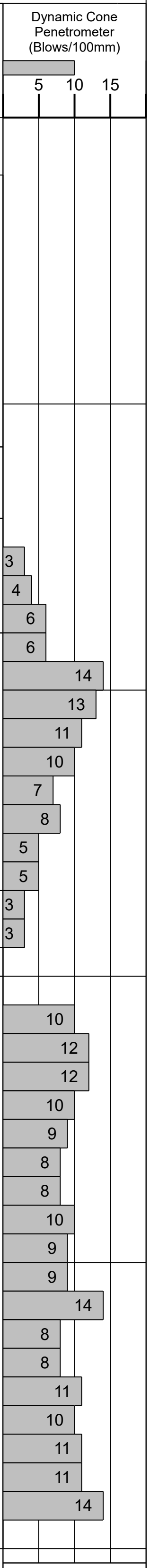


Material Description
Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit)
Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)

Material Description	Moisture Condition	Consistency/ Relative Density
OL: Organic SILT: black. Non plastic. (Topsoil)		
ML: Clayey SILT with trace sand: orange brown. Low plasticity; sand, fine to medium. (Hinuera Formation) ... *at 0.80m, Becoming light brown.*	M to W	St to VSt
SM: Sandy SILT: light brownish grey. Non plastic, loosely packed; sand, fine. (Hinuera Formation)	D to M	VSt
SM: Silty fine SAND: white. Poorly graded. (Hinuera Formation)		MD
SW: Fine to coarse SAND with minor silt and trace gravel: dark grey. Well graded; gravel, fine, siliceous, subangular. (Hinuera Formation)		MD to D
SM: Silty fine SAND: dark grey. Poorly graded. (Hinuera Formation)		MD
ML: SILT: grey mottled brownish orange. Non plastic, loosely packed. (Hinuera Formation)		VSt
SW: Fine to coarse SAND with minor silt and minor gravel: dark grey. Well graded; gravel, fine to medium, siliceous, subangular. (Hinuera Formation)		D

Borehole terminated at 5.0 m

Dynamic Cone Penetrometer (Blows/100mm)



Termination Reason: Target depth
Shear Vane No: 2562
DCP No: 17
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA06 & S05

Client: Calcutta Farms Ltd
Project: Tauranga Road Industrial Subdivision
Site Location: Matamata
Project No.: TGA2020-0304
Date: 16/06/2021
Borehole Location: Refer to Drawing 01 Logged by: MS Checked by: LPM Scale: 1:25 Sheet 1 of 1

Position: 1846204.0mE; 5810507.0mN Projection: BOP 2000
Datum: Moturiki Survey Source: Hand held GPS

Samples & Insitu Tests – Depth	Type & Results
0.3	Peak = 151kPa Residual = 30kPa
0.6	Peak = >207kPa
0.9	Peak = >207kPa

Material Description
Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit)
Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)

Material Description	Moisture Condition	Consistency/ Relative Density
OL: Organic SILT: black. Non plastic. (Topsoil)	M	
ML: Clayey SILT with trace sand: orange brown. Low plasticity; sand, fine to medium. (Hinuera Formation) ... *at 0.55m, Becoming light brown.* ... *at 0.80m, Becoming mottled orange brown.*		VSt to H
SM: Silty fine SAND: white. Poorly graded. (Hinuera Formation)	D to M	MD
SW: Fine to medium SAND with some silt: dark grey mottled light grey. Well graded, siliceous, subangular. (Hinuera Formation)	M	MD to D
SW: Fine to coarse SAND with minor silt and trace gravel: dark grey. Well graded; gravel, fine to medium, siliceous, subangular. (Hinuera Formation) ... *at 3.30m, Contains minor fine to medium gravel, siliceous.*	D to M	D
Borehole terminated at 5.0 m		

Dynamic Cone Penetrometer (Blows/100mm)

Depth (m)	
1	4
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4	11
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	11
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	8
	7
	10
	11
5	

Termination Reason: Target depth
Shear Vane No: 2562 DCP No: 17
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

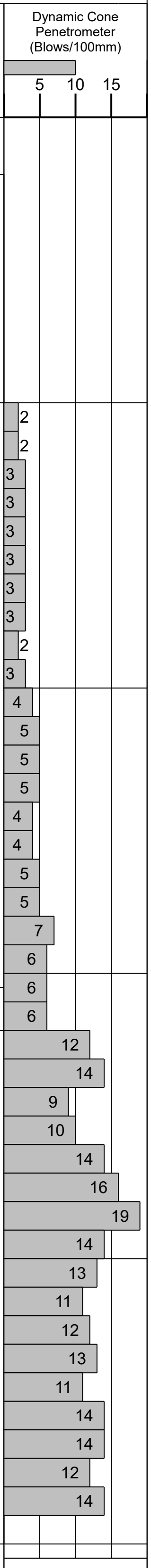
HAND AUGER BOREHOLE LOG - HA07 & S06

Client: Calcutta Farms Ltd
Project: Tauranga Road Industrial Subdivision
Site Location: Matamata
Project No.: TGA2020-0304
Date: 16/06/2021
Borehole Location: Refer to Drawing 01 Logged by: MS Checked by: LPM Scale: 1:25 Sheet 1 of 1

CMW Geosciences

Position: 1846223.0mE; 5810376.0mN Projection: BOP 2000
Datum: Moturiki Survey Source: Hand held GPS

Groundwater	Samples & Insitu Tests Depth	Samples & Insitu Tests Type & Results	RL (m)	Depth (m)	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density
					OL: Organic SILT: black. Non plastic. (Topsoil)	M	
	0.3	Peak = 163kPa Residual = 30kPa			ML: Clayey SILT with trace sand: orange brown. Low plasticity; sand, fine to medium. (Hinuera Formation)		St to VSt
					... *at 0.50m, Becoming light brown.*		
	0.6	Peak = 80kPa Residual = 30kPa			... *at 0.65m, Contains some fine sand.*		
	0.9	Peak = 124kPa Residual = 27kPa					
				1	SM: Silty fine SAND: white. Poorly graded. (Hinuera Formation) ... *at 1.10m, Contains 100mm wide silt lenses every 100mm.*	D to M	L to MD
				2	SP: Silty fine SAND: white. Poorly graded. (Hinuera Formation)		
				3	ML: SILT: grey mottled brownish orange. Non plastic, tightly packed. (Hinuera Formation)		H
					SW: Fine to coarse SAND with minor silt and trace gravel: dark yellowish grey. Well graded; gravel, fine to medium, siliceous, subangular. (Hinuera Formation) *... from 3.40m to 3.50m, Contains minor fine to medium gravel, pumiceous, becoming brownish orange.* ... *at 3.60m, Becoming grey.* ... *at 3.70m, Contains minor fine to medium gravel, siliceous.*		D to VD
				4			
				5	Borehole terminated at 5.0 m		



Termination Reason: Target depth
Shear Vane No: 2562 DCP No: 17
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA08 & S04

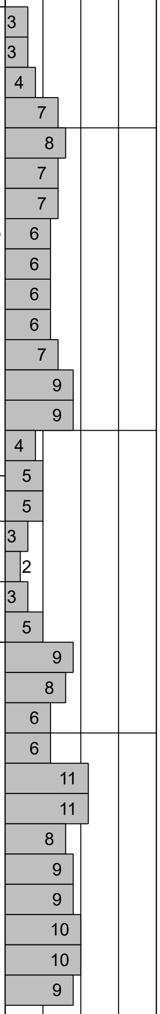
Client: Calcutta Farms Ltd
Project: Tauranga Road Industrial Subdivision
Site Location: Matamata
Project No.: TGA2020-0304
Date: 17/06/2021
Borehole Location: Refer to Drawing 01 Logged by: MS Checked by: LPM Scale: 1:25 Sheet 1 of 1

Position: 1846084.0mE; 5810342.0mN Projection: BOP 2000
Datum: Moturiki Survey Source: Hand held GPS

Groundwater	Samples & Insitu Tests Depth	Samples & Insitu Tests Type & Results	RL (m)	Depth (m)	Graphic Log
	0.3	Peak = 89kPa Residual = 24kPa			
	0.6	Peak = 136kPa Residual = 36kPa			
	0.9	Peak = 89kPa Residual = 15kPa			
	1.2	Peak = 80kPa Residual = 21kPa			
	1.6	Peak = UTP			

Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density
OL: Organic SILT: black. Non plastic. (Topsoil)		
ML: Clayey SILT with trace sand: orange brown. Low plasticity; sand, fine to medium. (Hinuera Formation) *... at 0.60m, Contains some fine to medium sand.*	M W	St to VSt
SW: Fine to coarse SAND with trace silt and trace gravel: grey. Well graded; gravel, fine, siliceous, subangular. (Hinuera Formation) *... at 2.10m, Contains minor fine to medium gravel, siliceous.*	D to M	MD to D
SM: Silty fine SAND: white. Poorly graded. (Hinuera Formation)		MD
ML: SILT: grey mottled brownish orange. Non plastic, loosely packed. (Hinuera Formation)	M to W	
SM: Silty fine SAND: grey. Poorly graded. (Hinuera Formation)		MD
SW: Fine to coarse SAND with trace silt and minor gravel: grey. Well graded; gravel, fine, siliceous, subangular. (Hinuera Formation) *... from 4.30m to 4.50m, Contains pumiceous gravel.*	D to M	D
Borehole terminated at 5.0 m		

Dynamic Cone Penetrometer (Blows/100mm)



Termination Reason: Target depth
Shear Vane No: 2562 DCP No: 17
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

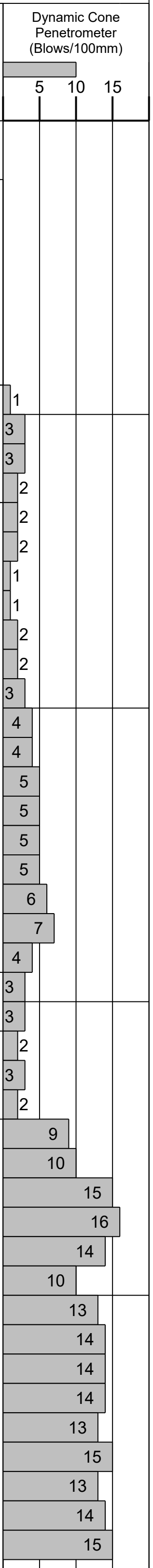
HAND AUGER BOREHOLE LOG - HA09 & S03

Client: Calcutta Farms Ltd
Project: Tauranga Road Industrial Subdivision
Site Location: Matamata
Project No.: TGA2020-0304
Date: 17/06/2021
Borehole Location: Refer to Drawing 01 Logged by: MS Checked by: LPM Scale: 1:25 Sheet 1 of 1

Position: 1846012.0mE; 5810185.0mN Projection: BOP 2000
Datum: Moturiki Survey Source: Hand held GPS

Groundwater	Samples & Insitu Tests Depth	Samples & Insitu Tests Type & Results	RL (m)	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density
				OL: Organic SILT: black. Non plastic. (Topsoil)	M	
	0.3 0.6	Peak = 130kPa Residual = 21kPa Peak = 95kPa Residual = 18kPa		ML: Clayey SILT with trace sand: orange brown. Low plasticity; sand, fine to medium. (Hinuera Formation)		St to VSt
				SM: Silty fine to medium SAND: brown. Poorly graded, siliceous, subangular. (Hinuera Formation)		L
				SW: Fine to coarse SAND with some silt: grey mottled yellowish brown. Well graded, siliceous, subangular. (Hinuera Formation)		L to MD
				SM: Silty fine SAND: light grey. Poorly graded. (Hinuera Formation)		MD
				ML: SILT: grey mottled brownish orange. Non plastic, loosely packed. (Hinuera Formation)	M to W	
				SW: Fine to coarse SAND with minor gravel and trace silt: grey. Well graded; gravel, fine to medium, siliceous, subangular. (Hinuera Formation)	D to M	D
				Borehole terminated at 5.0 m		

Depth (m): 1, 2, 3, 4, 5



Dynamic Cone Penetrometer (Blows/100mm)
1
3
3
2
2
2
1
1
2
2
3
4
4
5
5
5
5
6
7
4
3
3
2
3
2
9
10
15
16
14
10
13
14
14
14
13
15
13
14
15

Termination Reason: Target depth
Shear Vane No: 2562 DCP No: 17
Remarks: Groundwater not encountered.

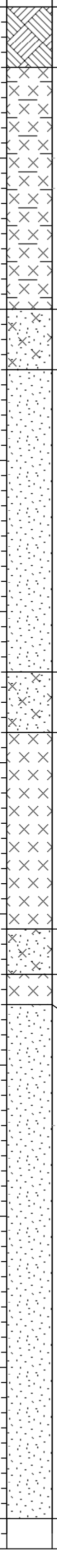
This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA13 & S07

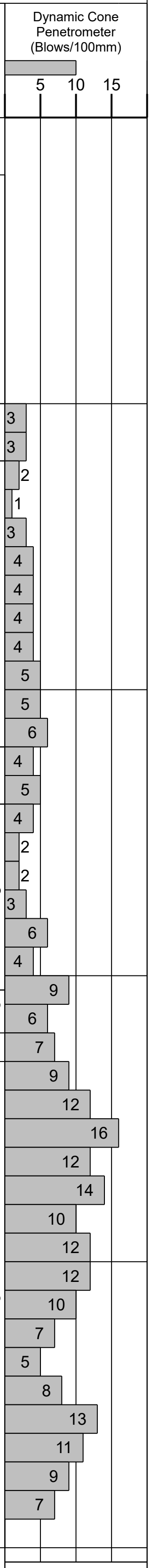
Client: Calcutta Farms Ltd
Project: Tauranga Road Industrial Subdivision
Site Location: Matamata
Project No.: TGA2020-0304
Date: 17/06/2021
Borehole Location: Refer to Drawing 01 Logged by: MS Checked by: LPM Scale: 1:25 Sheet 1 of 1

Position: 1846287.0mE; 5810243.0mN Projection: BOP 2000
Datum: Moturiki Survey Source: Hand held GPS

Groundwater	Samples & Insitu Tests Depth	Samples & Insitu Tests Type & Results	RL (m)
	0.3	Peak = 133kPa Residual = 30kPa	
	0.6	Peak = 127kPa Residual = 33kPa	
	0.9	Peak = 148kPa Residual = 36kPa	
	3.0	Peak = UTP	



Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density
OL: Organic SILT: black. Non plastic. (Topsoil)	M	
ML: Clayey SILT with trace sand: orange brown. Low plasticity; sand, fine to medium. (Hinuera Formation) *... at 0.50m, Becoming light brown.* *... at 0.60m, Contains some fine to medium sand.*		VSt
SM: Silty fine to coarse SAND with trace gravel: brown mottled grey. Well graded; gravel, fine, siliceous, subangular. (Hinuera Formation)	D to M	L
SW: Fine to coarse SAND with minor silt and trace gravel: grey. Well graded; gravel, fine, siliceous, subangular. (Hinuera Formation)		L to MD
SM: Silty fine SAND: white. Poorly graded. (Hinuera Formation)		MD
ML: SILT: grey mottled orange. Non plastic. (Hinuera Formation)		VSt to H
SM: Silty fine SAND: white. Poorly graded. (Hinuera Formation)		MD to D
ML: SILT: grey mottled orange. Non plastic. (Hinuera Formation)		
SW: Fine to coarse SAND with minor silt and trace gravel: grey. Well graded; gravel, fine, siliceous, subangular. (Hinuera Formation) *... at 3.70m, Contains minor fine to medium gravel, siliceous.*		MD to D
Borehole terminated at 5.0 m		



Termination Reason: Target depth
Shear Vane No: 2562 DCP No: 17
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA16 & S10

Client: Calcutta Farms Ltd
Project: Tauranga Road Industrial Subdivision
Site Location: Matamata
Project No.: TGA2020-0304
Date: 27/07/2021
Borehole Location: Refer to Drawing 01

PRELIMINARY

CMW Geosciences

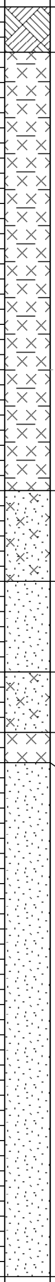
Logged by: MS Checked by: Scale: 1:25 Sheet 1 of 1

Position: 1846393.0mE; 5809968.0mN Projection: BOP 2000
Datum: Motuirki Survey Source: Hand held GPS

Groundwater | Samples & Insitu Tests | RL (m) | Depth (m) | Graphic Log | Material Description | Moisture Condition | Consistency/ Relative Density | Dynamic Cone Penetrometer (Blows/100mm)

Material Description
Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit)
Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)

Depth	Type & Results
0.3	Peak = 104kPa Residual = 18kPa
0.6	Peak = 89kPa Residual = 15kPa
0.9	Peak = 151kPa Residual = 30kPa
1.2	Peak = 104kPa Residual = 44kPa



OL: Organic SILT: black. Non plastic.
(Topsoil)

ML: Clayey SILT with trace sand: orange brown. Low plasticity; sand, fine to medium.
(Hinuera Formation)

... *at 1.20m, Contains some fine to medium sand, becoming greyish brown.*

SM: Silty fine SAND: white. Poorly graded.
(Hinuera Formation)

SP: Fine to medium SAND with some silt: greyish brown. Poorly graded, siliceous.
(Hinuera Formation)

SM: Silty fine SAND: white. Poorly graded.
(Hinuera Formation)

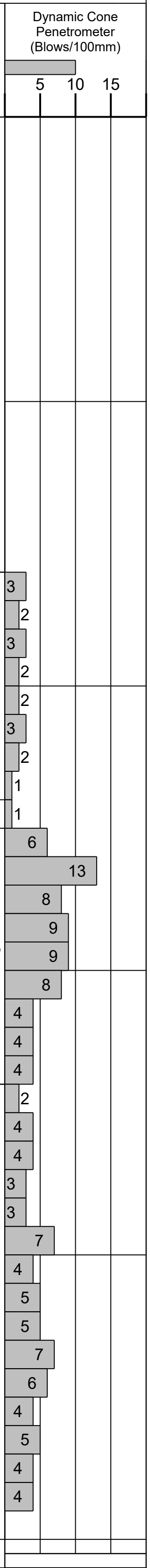
ML: SILT: grey mottled orange. Non plastic.
(Hinuera Formation)

SW: Fine to coarse SAND with minor silt and trace gravel: grey. Well graded, silicious; gravel, fine, siliceous.
(Hinuera Formation)

Borehole terminated at 4.2 m

Moisture Condition: M, W, M, W, S

Consistency/Relative Density: St to VSt, L, MD to D, L to MD



Termination Reason: Hole collapse
Shear Vane No: 2562 DCP No: 17
Remarks:

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA18 & S09

Client: Calcutta Farms Ltd
Project: Tauranga Road Industrial Subdivision
Site Location: Matamata
Project No.: TGA2020-0304
Date: 16/06/2021
Borehole Location: Refer to Drawing 01 Logged by: MS Checked by: LPM Scale: 1:25 Sheet 1 of 1
Position: 1846475.0mE; 5810141.0mN Projection: BOP 2000
Datum: Moturiki Survey Source: Hand held GPS

Groundwater	Samples & Insitu Tests		RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density
	Depth	Type & Results						
						OL: Organic SILT: black. Non plastic. (Topsoil)		
	0.3	Peak = 133kPa Residual = 36kPa				ML: Clayey SILT with trace sand: orange brown. Low plasticity; sand, fine to medium. (Hinuera Formation)	M	VSt to H
	0.6	Peak = 104kPa Residual = 21kPa						
	0.9	Peak = >207kPa				*... from 0.85m to 1.00m, Becoming brown, contains some fine to coarse sand.*		
	1.2	Peak = 109kPa Residual = 30kPa		1		*... at 1.00m, Becoming mottled brownish grey.*		
	1.6	Peak = 112kPa Residual = 30kPa				ML: Sandy SILT: light grey streaked orange brown. Non plastic; sand, fine. (Hinuera Formation)		VSt
	2.0	Peak = 118kPa Residual = 44kPa		2		SW: Fine to coarse SAND with minor silt and trace gravel: orange brown mottled grey. Well graded; gravel, fine, siliceous, subangular. (Hinuera Formation)	W	L to MD
				3			S	
						Borehole terminated at 3.1 m		
				4				
				5				

Dynamic Cone Penetrometer (Blows/100mm)

5 10 15

2.0	2
2.1	3
2.2	3
2.3	3
2.4	3
2.5	2
2.6	2
2.7	2
2.8	3
2.9	4
3.0	4
3.1	5
3.2	5
3.3	6
3.4	5
3.5	6
3.6	6
3.7	6
3.8	4
3.9	4
4.0	6
4.1	6
4.2	7
4.3	6
4.4	6
4.5	7
4.6	5
4.7	5
4.8	6

Termination Reason: Hole collapse
Shear Vane No: 2562 DCP No: 17
Remarks:

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA19 & S08

Client: Calcutta Farms Ltd
Project: Tauranga Road Industrial Subdivision
Site Location: Matamata
Project No.: TGA2020-0304
Date: 16/06/2021
Borehole Location: Refer to Drawing 01
Logged by:
Checked by: LPM
Scale: 1:25
Sheet 1 of 1

CMW Geosciences

Position: 1846560.0mE; 5810287.0mN
Projection: BOP 2000
Datum: Moturiki
Survey Source: Hand held GPS

Samples & Insitu Tests

Depth	Type & Results
0.3	Peak = 109kPa Residual = 30kPa
0.6	Peak = 163kPa Residual = 33kPa
0.9	Peak = UTP

Material Description
Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit)
Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)

OL: Organic SILT: black. Non plastic.
(Topsoil)

ML: Clayey SILT with trace sand: orange brown. Low plasticity; sand, fine to medium.
(Hinuera Formation)

SW: Fine to coarse SAND with minor silt and trace gravel: orange brown. Well graded; gravel, fine, siliceous subangular.
(Hinuera Formation)

... *at 1.60m, Contains minor fine to medium gravel, siliceous, becoming mottled light grey*

... *at 2.60m, Becoming light grey.*

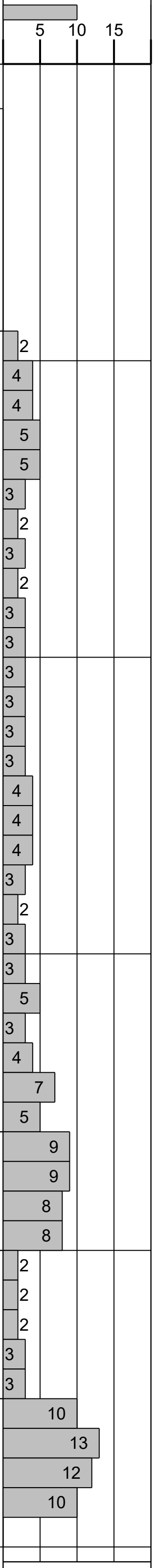
Borehole terminated at 3.5 m

Groundwater: ▼

Moisture Condition	Consistency/ Relative Density
M	VSt
M	L to MD
W	L to MD
S	L to MD
	D
	L
	D

Depth (m): 1, 2, 3, 4, 5

Dynamic Cone Penetrometer (Blows/100mm)



Depth (m)	Blows/100mm
0.9–1.0	2
1.0–1.1	4
1.1–1.2	4
1.2–1.3	5
1.3–1.4	5
1.4–1.5	3
1.5–1.6	2
1.6–1.7	3
1.7–1.8	2
1.8–1.9	3
1.9–2.0	3
2.0–2.1	3
2.1–2.2	3
2.2–2.3	3
2.3–2.4	3
2.4–2.5	4
2.5–2.6	4
2.6–2.7	4
2.7–2.8	3
2.8–2.9	2
2.9–3.0	3
3.0–3.1	3
3.1–3.2	5
3.2–3.3	3
3.3–3.4	4
3.4–3.5	7
3.5–3.6	5
3.6–3.7	9
3.7–3.8	9
3.8–3.9	8
3.9–4.0	8
4.0–4.1	2
4.1–4.2	2
4.2–4.3	2
4.3–4.4	3
4.4–4.5	3
4.5–4.6	10
4.6–4.7	13
4.7–4.8	12
4.8–4.9	10

Termination Reason: Hole collapse
Shear Vane No: 2562
DCP No: 17
Remarks:

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA22 & S11

Client: Calcutta Farms Ltd
Project: Tauranga Road Industrial Subdivision
Site Location: Matamata
Project No.: TGA2020-0304
Date: 14/06/2021
Borehole Location: Refer to Drawing 01 Logged by: MS Checked by: LPM Scale: 1:25 Sheet 1 of 1

CMW Geosciences

Position: 1846557.0mE; 5809868.0mN Projection: BOP 2000
Datum: Moturiki Survey Source: Hand held GPS

Material Description
Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit)
Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)

Depth (m)	Material Description	Moisture Condition	Consistency/ Relative Density
0.0 – 0.15	OL: Organic SILT: black. Non plastic. (Topsoil)	M	
0.15 – 0.95	ML: Clayey SILT with trace sand: orange brown. Low plasticity; sand, fine to medium. (Hinuera Formation) ... *at 0.90m, Contains some sand.*	M	St to VSt
0.95 – 5.0	SW: Fine to coarse SAND with minor silt and trace gravel: greyish brown mottled orange brown. Well graded; gravel, fine, siliceous, subangular. (Hinuera Formation) ... *at 1.50m, Contains minor silt, becoming light orange.* ... *at 1.80m, Becoming yellowish grey.* ... *at 2.30m, Becoming brownish grey.* ... *at 2.90m, Becoming light grey.*	M	L to MD

Borehole terminated at 5.0 m

Samples & Insitu Tests

Depth	Type & Results
0.3	Peak = 80kPa Residual = 30kPa
0.6	Peak = 98kPa Residual = 24kPa

Dynamic Cone Penetrometer (Blows/100mm)

Depth (m)	Blows
1.0	3
1.1	3
1.2	3
1.3	2
1.4	1
1.5	1
1.6	2
1.7	1
1.8	1
1.9	2
2.0	2
2.1	3
2.2	2
2.3	1
2.4	4
2.5	1
2.6	1
2.7	1
2.8	3
2.9	2
3.0	1
3.1	3
3.2	1
3.3	3
3.4	4
3.5	3
3.6	4
3.7	3
3.8	4
3.9	4
4.0	7
4.1	5
4.2	5
4.3	5
4.4	6
4.5	6
4.6	5
4.7	4
4.8	4

Termination Reason: Target depth
Shear Vane No: 2562 DCP No: 17
Remarks: Groundwater not encountered.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA23 & S12

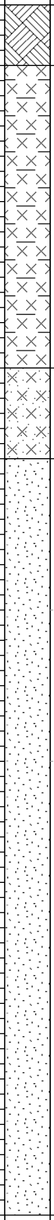
Client: Calcutta Farms Ltd
Project: Tauranga Road Industrial Subdivision
Site Location: Matamata
Project No.: TGA2020-0304
Date: 18/06/2021
Borehole Location: Refer to Drawing 01 Logged by: MS Checked by: LPM Scale: 1:25 Sheet 1 of 1

Position: 1846672.0mE; 5810017.0mN Projection: BOP 2000
Datum: Moturiki Survey Source: Hand held GPS

Groundwater | Samples & Insitu Tests | RL (m) | Depth (m) | Graphic Log | Material Description | Moisture Condition | Consistency/ Relative Density | Dynamic Cone Penetrometer (Blows/100mm)

Material Description
Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit)
Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)

Depth	Type & Results
0.3	Peak = 121kPa Residual = 21kPa
0.6	Peak = 109kPa Residual = 18kPa
0.9	Peak = 104kPa Residual = 24kPa
1.2	Peak = 118kPa Residual = 36kPa



OL: Organic SILT: black. Non plastic.
(Topsoil)

ML: Clayey SILT with trace sand: orange brown. Low plasticity; sand, fine to medium.
(Hinuera Formation)

St

ML: Sandy SILT: grey mottled brownish grey. Non plastic, loosely packed; sand, fine.
(Hinuera Formation)

VSt

SW: Fine to coarse SAND with minor silt and trace gravel: greyish brown mottled orange brown. Well graded; gravel, fine, siliceous, subangular.
(Hinuera Formation)

M
M

... at 2.00m, Becoming grey.

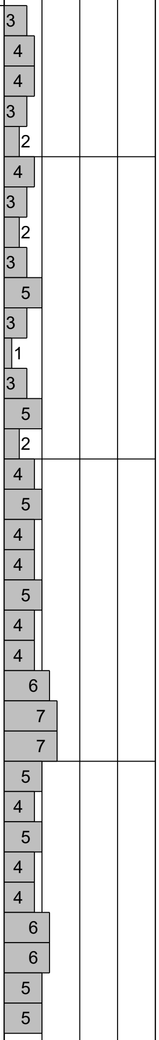
... at 2.50m, Contains minor fine to medium gravel, siliceous.

W

S

L to MD

Borehole terminated at 4.0 m



Termination Reason: Hole collapse
Shear Vane No: 2562 DCP No: 17
Remarks:

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

FALLING HEAD SOAKAGE TEST

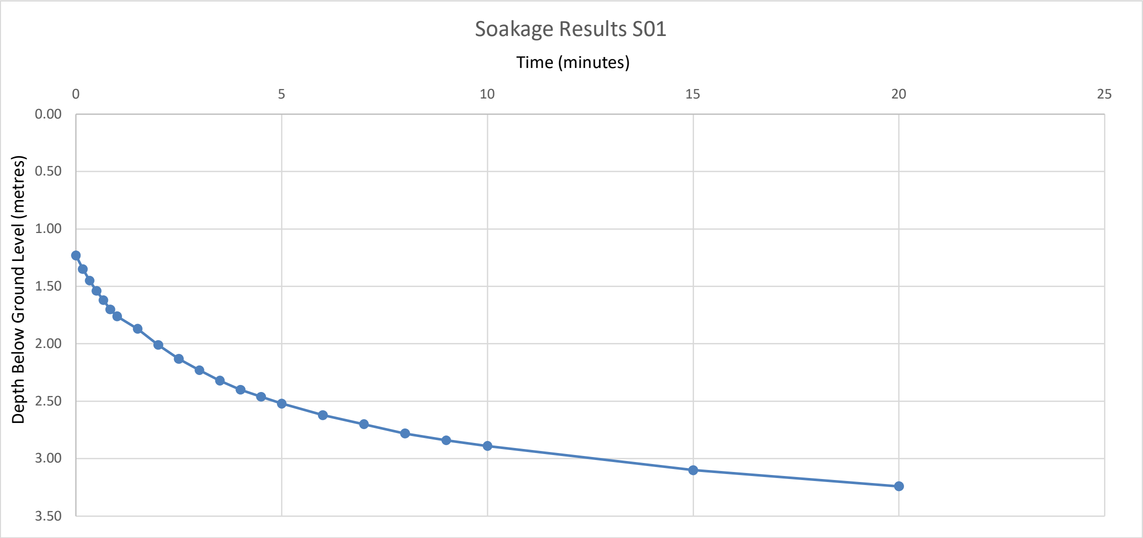
CLIENT:	**Calcutta Farms**	**LOCATION:**	**Matamata**
PROJECT:	**Tauranga Road Industrial Subdivision**	**JOB NUMBER:**	**TGA2020-0304**
TEST LOCATION:	**S01**	**TEST DATE:**	**27/07/2021**

Test Hole Diameter	0.10 m		Base Area 'B'	0.008 m2
Test Hole Depth 'D'	4.00 m		Circumference 'C'	0.314 m2
Groundwater Level	Not Encountered m			

Time	**Water Level BGL**	**Water depth**	**Time steps**		**Depth steps**		**Volume soaked**	**Soakage surface area**	**Soakage Rate**	
T	***d***	***=D-d***	***t0***	***t1***	***h0***	***h1***	***V=(h0-h1)*B***	***A=(C*(h0+h1)/2)+B***	***SR=V/A/(t1-t0)***	***SR*60*60*1000***
min	***m***	***m***	***sec***	***sec***	***m***	***m***	***m3***	***m2***	***m3/m2/sec***	***litres/m2/hour***
0	1.23	2.77	-	-	-	-	-	-	-	-
0.17	1.35	2.65	0	10	2.77	2.65	9.42E-04	0.86	1.1E-04	394.9
0.33	1.45	2.55	10	20	2.65	2.55	7.85E-04	0.82	9.5E-05	342.9
0.50	1.54	2.46	20	30	2.55	2.46	7.07E-04	0.79	8.9E-05	320.2
0.67	1.62	2.38	30	40	2.46	2.38	6.28E-04	0.77	8.2E-05	294.5
0.83	1.70	2.30	40	50	2.38	2.30	6.28E-04	0.74	8.5E-05	304.4
1.00	1.76	2.24	50	60	2.30	2.24	4.71E-04	0.72	6.5E-05	235.3
1.50	1.87	2.13	60	90	2.24	2.13	8.64E-04	0.69	4.1E-05	149.3
2.00	2.01	1.99	90	120	2.13	1.99	1.10E-03	0.66	5.6E-05	201.4
2.50	2.13	1.87	120	150	1.99	1.87	9.42E-04	0.61	5.1E-05	184.1
3.00	2.23	1.77	150	180	1.87	1.77	7.85E-04	0.58	4.5E-05	162.6
3.50	2.32	1.68	180	210	1.77	1.68	7.07E-04	0.55	4.3E-05	154.3
4.00	2.40	1.60	210	240	1.68	1.60	6.28E-04	0.52	4.0E-05	144.1
4.50	2.46	1.54	240	270	1.60	1.54	4.71E-04	0.50	3.1E-05	112.9
5.00	2.52	1.48	270	300	1.54	1.48	4.71E-04	0.48	3.3E-05	117.3
6.00	2.62	1.38	300	360	1.48	1.38	7.85E-04	0.46	2.9E-05	103.1
7.00	2.70	1.30	360	420	1.38	1.30	6.28E-04	0.43	2.4E-05	87.9
8.00	2.78	1.22	420	480	1.30	1.22	6.28E-04	0.40	2.6E-05	93.4
9.00	2.84	1.16	480	540	1.22	1.16	4.71E-04	0.38	2.1E-05	74.1
10.00	2.89	1.11	540	600	1.16	1.11	3.93E-04	0.36	1.8E-05	64.7
15.00	3.10	0.90	600	900	1.11	0.90	1.65E-03	0.32	1.7E-05	61.2
20.00	3.24	0.76	900	1200	0.90	0.76	1.10E-03	0.27	1.4E-05	49.1

Considered average	4.8E-05	173.9
Design rate	2.4E-05	86.9

Note: Tests struck out were not included in the average



FALLING HEAD SOAKAGE TEST

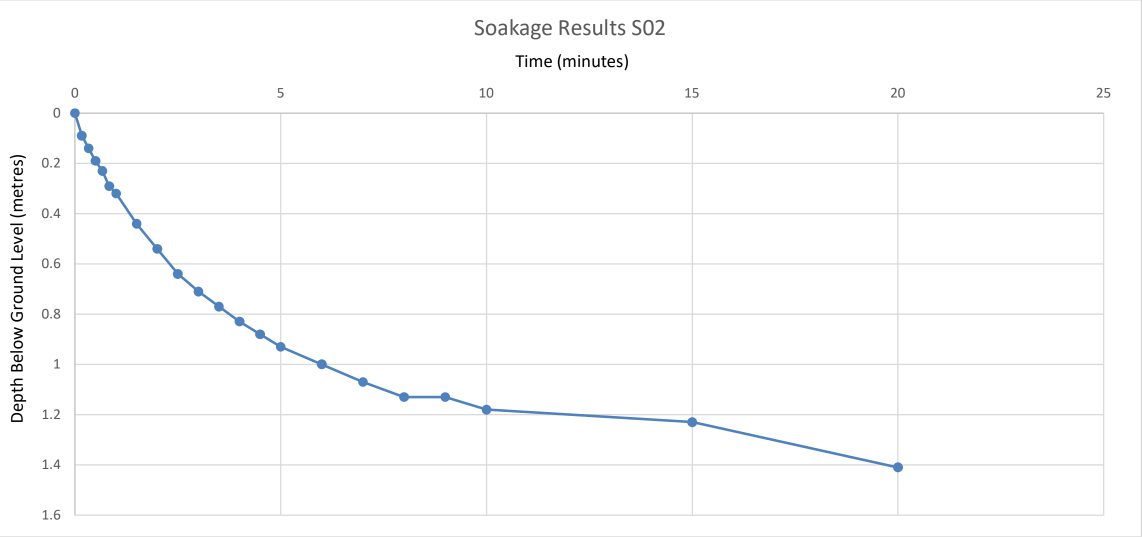
CLIENT:	**Calcutta Farms**	**LOCATION:**	**Matamata**
PROJECT:	**Tauranga Road Industrial Subdivision**	**JOB NUMBER:**	**TGA2020-0304**
TEST LOCATION:	**S02**	**TEST DATE:**	**15/07/2021 - 16/07/2021**

Test Hole Diameter	0.10	m	Base Area 'B'	0.008	m2
Test Hole Depth 'D'	2.00	m	Circumference 'C'	0.314	m2
Groundwater Level	Not Encountered	m			

Time	**Water Level BGL**	**Water depth**	**Time steps**		**Depth steps**		**Volume soaked**	**Soakage surface area**	**Soakage Rate**	
T	***d***	***=D-d***	***t0***	***t1***	***h0***	***h1***	***V=(h0-h1)*B***	***A=(C*(h0+h1)/2)+B***	***SR=V/A/(t1-t0)***	***SR*60*60*1000***
min	***m***	***m***	***sec***	***sec***	***m***	***m***	***m3***	***m2***	***m3/m2/sec***	***litres/m2/hour***
0	0	1.91	-	-	-	-	-	-	-	-
0.17	0.09	1.86	0	10	1.91	1.86	3.93E-04	0.60	6.5E-05	235.6
0.33	0.14	1.81	10	20	1.86	1.81	3.93E-04	0.58	6.7E-05	241.9
0.50	0.19	1.77	20	30	1.81	1.77	3.14E-04	0.57	5.5E-05	198.3
0.67	0.23	1.71	30	40	1.77	1.71	4.71E-04	0.55	8.5E-05	305.9
0.83	0.29	1.68	40	50	1.71	1.68	2.36E-04	0.54	4.4E-05	157.0
1.00	0.32	1.56	50	60	1.68	1.56	9.42E-04	0.52	1.8E-04	656.5
1.50	0.44	1.46	60	90	1.56	1.46	7.85E-04	0.48	5.4E-05	195.4
2.00	0.54	1.36	90	120	1.46	1.36	7.85E-04	0.45	5.8E-05	209.1
2.50	0.64	1.29	120	150	1.36	1.29	5.50E-04	0.42	4.3E-05	155.6
3.00	0.71	1.23	150	180	1.29	1.23	4.71E-04	0.40	3.9E-05	140.1
3.50	0.77	1.17	180	210	1.23	1.17	4.71E-04	0.38	4.1E-05	146.9
4.00	0.83	1.12	210	240	1.17	1.12	3.93E-04	0.37	3.6E-05	128.2
4.50	0.88	1.07	240	270	1.12	1.07	3.93E-04	0.35	3.7E-05	133.9
5.00	0.93	1.00	270	300	1.07	1.00	5.50E-04	0.33	5.5E-05	198.1
6.00	1.00	0.93	300	360	1.00	0.93	5.50E-04	0.31	2.9E-05	106.1
7.00	1.07	0.87	360	420	0.93	0.87	4.71E-04	0.29	2.7E-05	97.3
8.00	1.13	0.87	420	480	0.87	0.87	0.00E+00	0.28	0.0E+00	0.0
9.00	1.13	0.82	480	540	0.87	0.82	3.93E-04	0.27	2.4E-05	86.2
10.00	1.18	0.77	540	600	0.82	0.77	3.93E-04	0.26	2.5E-05	91.5
15.00	1.23	0.59	600	900	0.77	0.59	1.41E-03	0.22	2.1E-05	76.6
20.00	1.41	0.47	900	1200	0.59	0.47	9.42E-04	0.17	1.8E-05	64.9

Considered average	4.8E-05	172.6
Design rate	2.4E-05	86.3

Note: Tests struck out were not included in the average



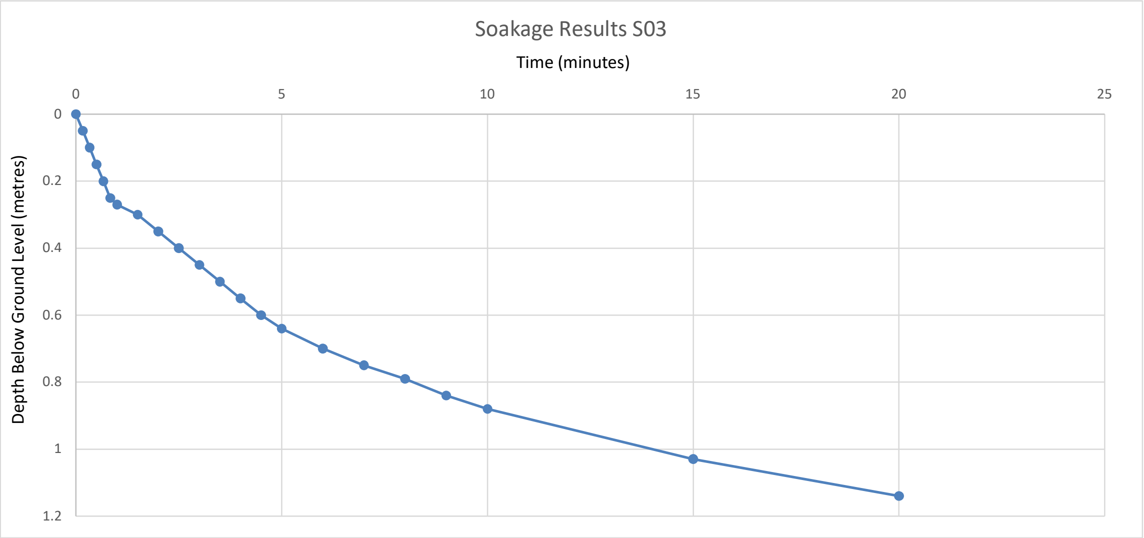
FALLING HEAD SOAKAGE TEST

CLIENT:	**Calcutta Farms**	**LOCATION:**	**Matamata**
PROJECT:	**Tauranga Road Industrial Subdivision**	**JOB NUMBER:**	**TGA2020-0304**
TEST LOCATION:	**S03**	**TEST DATE:**	**15/07/2021 - 16/07/2021**

Test Hole Diameter	0.10 m		Base Area 'B'	0.008 m2
Test Hole Depth 'D'	2.50 m		Circumference 'C'	0.314 m2
Groundwater Level	Not Encountered m			

Time	**Water Level BGL**	**Water depth**	**Time steps**		**Depth steps**		**Volume soaked**	**Soakage surface area**	**Soakage Rate**	
T	***d***	***=D-d***	***t0***	***t1***	***h0***	***h1***	***V=(h0-h1)*B***	***A=(C*(h0+h1)/2)+B***	***SR=V/A/(t1-t0)***	***SR*60*60*1000***
min	***m***	***m***	***sec***	***sec***	***m***	***m***	***m3***	***m2***	***m3/m2/sec***	***litres/m2/hour***
0	0	2.45	-	-	-	-	-	-	-	-
0.17	0.05	2.40	0	10	2.45	2.40	3.93E-04	0.77	5.1E-05	183.7
0.33	0.10	2.35	10	20	2.40	2.35	3.93E-04	0.75	5.2E-05	187.5
0.50	0.15	2.30	20	30	2.35	2.30	3.93E-04	0.74	5.3E-05	191.5
0.67	0.20	2.25	30	40	2.30	2.25	3.93E-04	0.72	5.4E-05	195.7
0.83	0.25	2.23	40	50	2.25	2.23	1.57E-04	0.71	2.2E-05	79.5
1.00	0.27	2.20	50	60	2.23	2.20	2.36E-04	0.70	3.3E-05	120.5
1.50	0.30	2.15	60	90	2.20	2.15	3.93E-04	0.69	1.9E-05	68.2
2.00	0.35	2.10	90	120	2.15	2.10	3.93E-04	0.68	1.9E-05	69.8
2.50	0.40	2.05	120	150	2.10	2.05	3.93E-04	0.66	2.0E-05	71.4
3.00	0.45	2.00	150	180	2.05	2.00	3.93E-04	0.64	2.0E-05	73.2
3.50	0.50	1.95	180	210	2.00	1.95	3.93E-04	0.63	2.1E-05	75.0
4.00	0.55	1.90	210	240	1.95	1.90	3.93E-04	0.61	2.1E-05	76.9
4.50	0.60	1.86	240	270	1.90	1.86	3.14E-04	0.60	1.7E-05	63.0
5.00	0.64	1.80	270	300	1.86	1.80	4.71E-04	0.58	2.7E-05	97.0
6.00	0.70	1.75	300	360	1.80	1.75	3.93E-04	0.57	1.2E-05	41.7
7.00	0.75	1.71	360	420	1.75	1.71	3.14E-04	0.55	9.5E-06	34.2
8.00	0.79	1.66	420	480	1.71	1.66	3.93E-04	0.54	1.2E-05	43.9
9.00	0.84	1.62	480	540	1.66	1.62	3.14E-04	0.52	1.0E-05	36.0
10.00	0.88	1.47	540	600	1.62	1.47	1.18E-03	0.49	4.0E-05	143.3
15.00	1.03	1.36	600	900	1.47	1.36	8.64E-04	0.45	6.4E-06	22.9
20.00	1.14	1.12	900	1200	1.36	1.12	1.88E-03	0.40	1.6E-05	56.9
								Considered average	2.6E-05	92.0
								Design rate	1.3E-05	46.0

Note: Tests struck out were not included in the average



FALLING HEAD SOAKAGE TEST

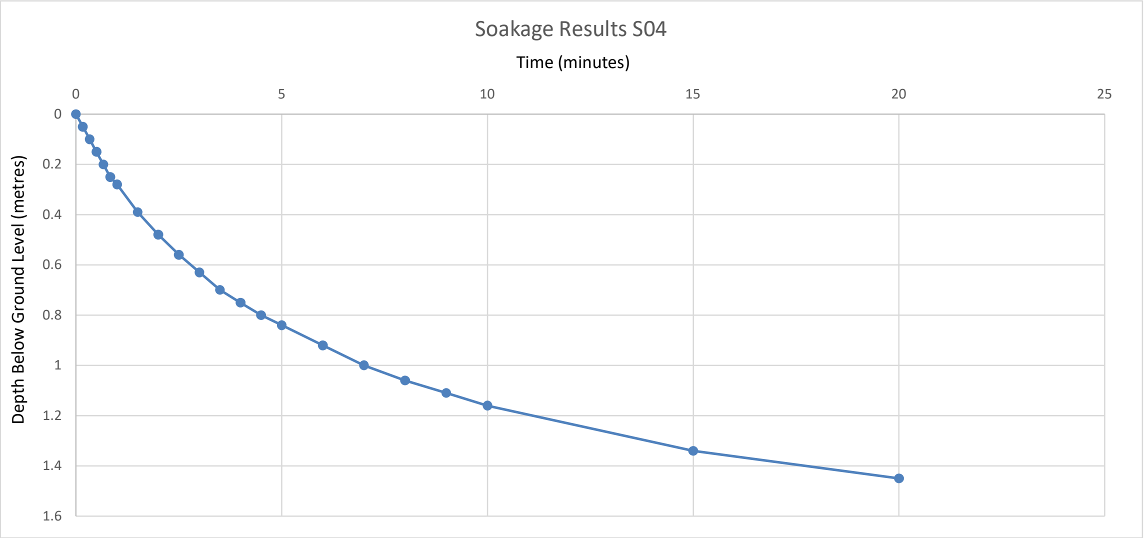
CLIENT:	**Calcutta Farms**	**LOCATION:**	**Matamata**
PROJECT:	**Tauranga Road Industrial Subdivision**	**JOB NUMBER:**	**TGA2020-0304**
TEST LOCATION:	**S04**	**TEST DATE:**	**15/07/2021 - 16/07/2021**

Test Hole Diameter	0.10	m	Base Area 'B'	0.008	m2
Test Hole Depth 'D'	2.00	m	Circumference 'C'	0.314	m2
Groundwater Level	Not Encountered	m			

Time	**Water Level BGL**	**Water depth**	**Time steps**		**Depth steps**		**Volume soaked**	**Soakage surface area**	**Soakage Rate**	
T	***d***	***=D-d***	***t0***	***t1***	***h0***	***h1***	***V=(h0-h1)*B***	***A=(C*(h0+h1)/2)+B***	***SR=V/A/(t1-t0)***	***SR*60*60*1000***
min	***m***	***m***	***sec***	***sec***	***m***	***m***	***m3***	***m2***	***m3/m2/sec***	***litres/m2/hour***
0	0	1.95	-	-	-	-	-	-	-	-
0.17	0.05	1.90	0	10	1.95	1.90	3.93E-04	0.61	6.4E-05	230.8
0.33	0.10	1.85	10	20	1.90	1.85	3.93E-04	0.60	6.6E-05	236.8
0.50	0.15	1.80	20	30	1.85	1.80	3.93E-04	0.58	6.8E-05	243.2
0.67	0.20	1.75	30	40	1.80	1.75	3.93E-04	0.57	6.9E-05	250.0
0.83	0.25	1.72	40	50	1.75	1.72	2.36E-04	0.55	4.3E-05	153.4
1.00	0.28	1.61	50	60	1.72	1.61	8.64E-04	0.53	1.6E-04	585.8
1.50	0.39	1.52	60	90	1.61	1.52	7.07E-04	0.50	4.7E-05	169.8
2.00	0.48	1.44	90	120	1.52	1.44	6.28E-04	0.47	4.4E-05	159.5
2.50	0.56	1.37	120	150	1.44	1.37	5.50E-04	0.45	4.1E-05	146.9
3.00	0.63	1.30	150	180	1.37	1.30	5.50E-04	0.43	4.3E-05	154.4
3.50	0.70	1.25	180	210	1.30	1.25	3.93E-04	0.41	3.2E-05	115.4
4.00	0.75	1.20	210	240	1.25	1.20	3.93E-04	0.39	3.3E-05	120.0
4.50	0.80	1.16	240	270	1.20	1.16	3.14E-04	0.38	2.8E-05	99.6
5.00	0.84	1.08	270	300	1.16	1.08	6.28E-04	0.36	5.8E-05	209.6
6.00	0.92	1.00	300	360	1.08	1.00	6.28E-04	0.33	3.1E-05	112.7
7.00	1.00	0.94	360	420	1.00	0.94	4.71E-04	0.31	2.5E-05	90.5
8.00	1.06	0.89	420	480	0.94	0.89	3.93E-04	0.30	2.2E-05	79.8
9.00	1.11	0.84	480	540	0.89	0.84	3.93E-04	0.28	2.3E-05	84.3
10.00	1.16	0.66	540	600	0.84	0.66	1.41E-03	0.24	9.7E-05	348.4
15.00	1.34	0.55	600	900	0.66	0.55	8.64E-04	0.20	1.5E-05	52.4
20.00	1.45	0.41	900	1200	0.55	0.41	1.10E-03	0.16	2.3E-05	83.2

Considered average	4.9E-05	177.4
Design rate	2.5E-05	88.7

Note: Tests struck out were not included in the average



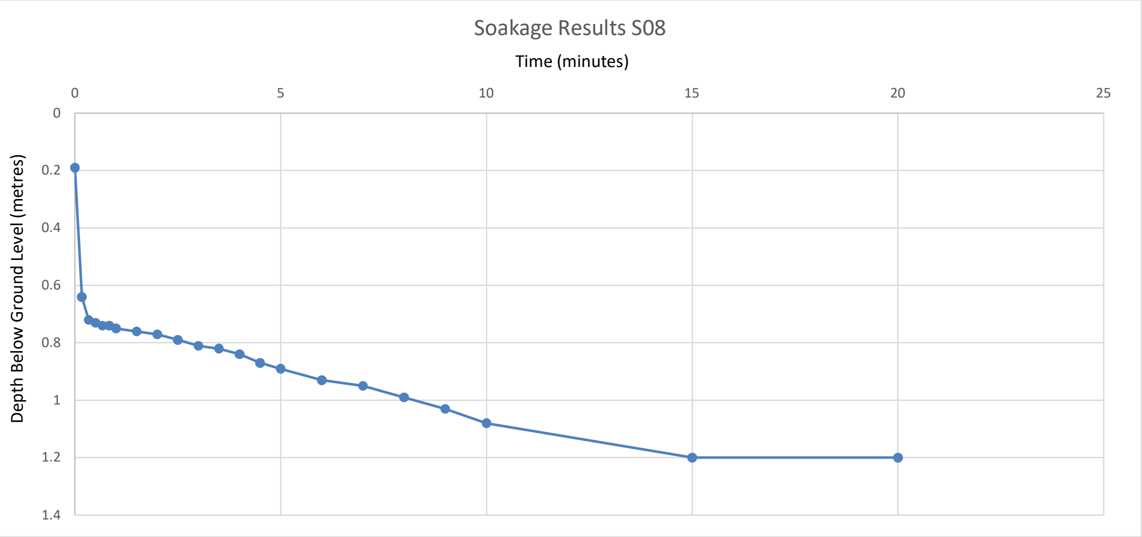
FALLING HEAD SOAKAGE TEST

CLIENT:	**Calcutta Farms**	**LOCATION:**	**Matamata**
PROJECT:	**Tauranga Road Industrial Subdivision**	**JOB NUMBER:**	**TGA2020-0304**
TEST LOCATION:	**S05**	**TEST DATE:**	**15/07/2021 - 16/07/2021**

Test Hole Diameter	0.10	m	Base Area 'B'	0.008	m2
Test Hole Depth 'D'	2.50	m	Circumference 'C'	0.314	m2
Groundwater Level	Not Encountered	m			

Time	**Water Level BGL**	**Water depth**	**Time steps**		**Depth steps**		**Volume soaked**	**Soakage surface area**	**Soakage Rate**	
T	***d***	***=D-d***	***t0***	***t1***	***h0***	***h1***	***V=(h0-h1)*B***	***A=(C*(h0+h1)/2)+B***	***SR=V/A/(t1-t0)***	***SR*60*60*1000***
min	***m***	***m***	***sec***	***sec***	***m***	***m***	***m3***	***m2***	***m3/m2/sec***	***litres/m2/hour***
0	0.19	1.86	-	-	-	-	-	-	-	-
0.17	0.64	1.78	0	10	1.86	1.78	6.28E-04	0.58	1.1E-04	390.2
0.33	0.72	1.77	10	20	1.78	1.77	7.85E-05	0.57	1.4E-05	50.0
0.50	0.73	1.76	20	30	1.77	1.76	7.85E-05	0.56	1.4E-05	50.3
0.67	0.74	1.76	30	40	1.76	1.76	0.00E+00	0.56	0.0E+00	0.0
0.83	0.74	1.75	40	50	1.76	1.75	7.85E-05	0.56	1.4E-05	50.6
1.00	0.75	1.74	50	60	1.75	1.74	7.85E-05	0.56	1.4E-05	50.8
1.50	0.76	1.73	60	90	1.74	1.73	7.85E-05	0.55	4.7E-06	17.0
2.00	0.77	1.71	90	120	1.73	1.71	1.57E-04	0.55	9.6E-06	34.4
2.50	0.79	1.69	120	150	1.71	1.69	1.57E-04	0.54	9.7E-06	34.8
3.00	0.81	1.68	150	180	1.69	1.68	7.85E-05	0.54	4.9E-06	17.5
3.50	0.82	1.66	180	210	1.68	1.66	1.57E-04	0.53	9.8E-06	35.4
4.00	0.84	1.63	210	240	1.66	1.63	2.36E-04	0.52	1.5E-05	53.9
4.50	0.87	1.61	240	270	1.63	1.61	1.57E-04	0.52	1.0E-05	36.5
5.00	0.89	1.57	270	300	1.61	1.57	3.14E-04	0.51	2.1E-05	74.3
6.00	0.93	1.55	300	360	1.57	1.55	1.57E-04	0.50	5.3E-06	18.9
7.00	0.95	1.51	360	420	1.55	1.51	3.14E-04	0.49	1.1E-05	38.6
8.00	0.99	1.47	420	480	1.51	1.47	3.14E-04	0.48	1.1E-05	39.6
9.00	1.03	1.42	480	540	1.47	1.42	3.93E-04	0.46	1.4E-05	51.0
10.00	1.08	1.30	540	600	1.42	1.30	9.42E-04	0.44	3.6E-05	130.0
15.00	1.20	1.30	600	900	1.30	1.30	0.00E+00	0.42	0.0E+00	0.0
20.00	1.20	1.21	900	1200	1.30	1.21	7.07E-04	0.40	5.9E-06	21.1
								Considered average	1.6E-05	56.9
								Design rate	7.9E-06	28.5

Note: Tests struck out were not included in the average



FALLING HEAD SOAKAGE TEST

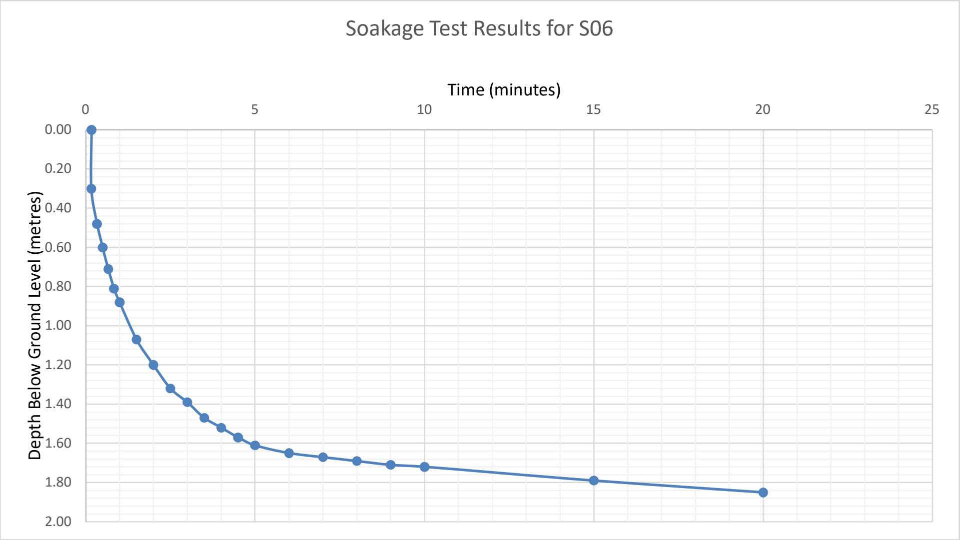
CLIENT: **Calcutta Farms**
PROJECT: **Tauranga Road Industrial Subdivision**
TEST LOCATION: **S06**
LOCATION: **Matamata**
JOB NUMBER: **TGA2020-0304**
TEST DATE: **15/07/2021 - 16/07/2021**

Test Hole Diameter 0.10 m
Test Hole Depth 'D' 2.00 m
Groundwater Level Not Encountered m
Base Area 'B' 0.008 m2
Circumference 'C' 0.314 m2

Time	Water Level BGL	Water depth	Time steps		Depth steps		Volume soaked	Soakage surface area	Soakage Rate	
T	*d*	*=D-d*	*t0*	*t1*	*h0*	*h1*	*V=(h0-h1)*B*	*A=(C*(h0+h1)/2)+B*	*SR=V/A/(t1-t0)*	*SR*60*60*1000*
min	*m*	*m*	*sec*	*sec*	*m*	*m*	*m3*	*m2*	*m3/m2/sec*	*litres/m2/hour*
0	0.00	2	-	-	-	-	-	-	-	-
0.17	0.30	1.70	10.2	10	2	1.7	2.36E-03	0.59	-0.02	-72000.00
0.33	0.48	1.52	10	20	1.7	1.52	1.41E-03	0.51	2.8E-04	990.8
0.50	0.60	1.4	20	30	1.52	1.4	9.42E-04	0.47	2.0E-04	727.3
0.67	0.71	1.29	30	40	1.4	1.29	8.64E-04	0.43	2.0E-04	722.6
0.83	0.81	1.19	40	50	1.29	1.19	7.85E-04	0.40	2.0E-04	711.5
1.00	0.88	1.12	50	60	1.19	1.12	5.50E-04	0.37	1.5E-04	533.9
1.50	1.07	0.93	60	90	1.12	0.93	1.49E-03	0.33	1.5E-04	542.9
2.00	1.20	0.8	90	120	0.93	0.8	1.02E-03	0.28	1.2E-04	438.2
2.50	1.32	0.68	120	150	0.8	0.68	9.42E-04	0.24	1.3E-04	470.6
3.00	1.39	0.61	150	180	0.68	0.61	5.50E-04	0.21	8.7E-05	313.4
3.50	1.47	0.53	180	210	0.61	0.53	6.28E-04	0.19	1.1E-04	403.4
4.00	1.52	0.48	210	240	0.53	0.48	3.93E-04	0.17	7.9E-05	283.0
4.50	1.57	0.43	240	270	0.48	0.43	3.93E-04	0.15	8.7E-05	312.5
5.00	1.61	0.39	270	300	0.43	0.39	3.14E-04	0.14	7.7E-05	275.9
6.00	1.65	0.35	300	360	0.39	0.35	3.14E-04	0.12	4.2E-05	151.9
7.00	1.67	0.33	360	420	0.35	0.33	1.57E-04	0.11	2.3E-05	82.2
8.00	1.69	0.31	420	480	0.33	0.31	1.57E-04	0.11	2.4E-05	87.0
9.00	1.71	0.29	480	540	0.31	0.29	1.57E-04	0.10	2.6E-05	92.3
10.00	1.72	0.28	540	600	0.29	0.28	7.85E-05	0.10	1.3E-05	48.39
15.00	1.79	0.21	600	900	0.28	0.21	5.50E-04	0.08	2.2E-05	77.8
20.00	1.85	0.15	900	1200	0.21	0.15	4.71E-04	0.06	2.4E-05	87.8

Considered average	1.0E-04	367.7
Design rate	5.1E-05	183.8

Note: Tests struck out were not included in the average



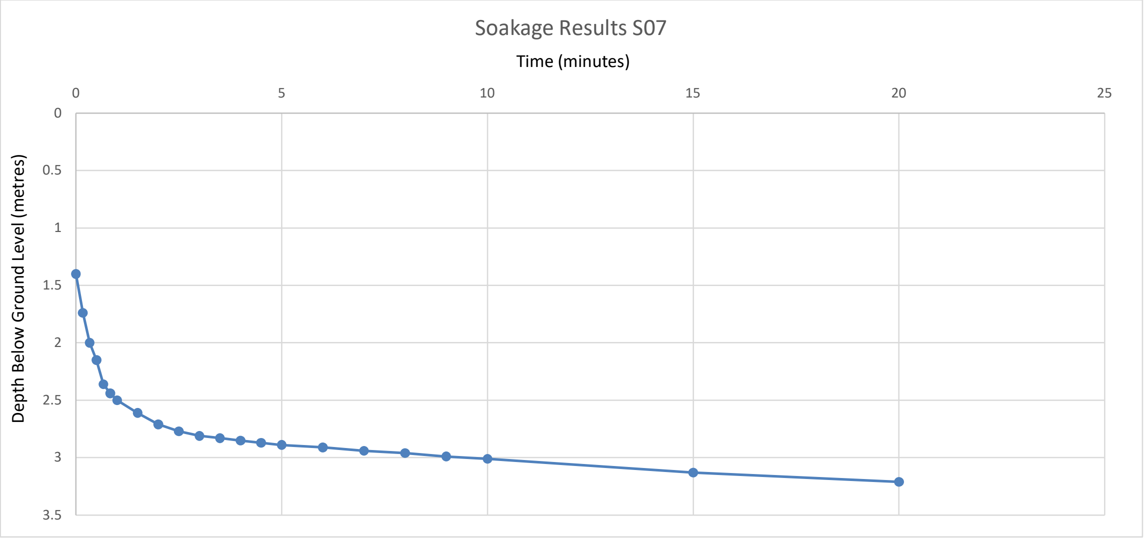
FALLING HEAD SOAKAGE TEST

CLIENT:	**Calcutta Farms**	**LOCATION:**	**Matamata**
PROJECT:	**Tauranga Road Industrial Subdivision**	**JOB NUMBER:**	**TGA2020-0304**
TEST LOCATION:	**S07**	**TEST DATE:**	**27/07/2021**

Test Hole Diameter	0.10 m	Base Area 'B'	0.008 m2
Test Hole Depth 'D'	4.00 m	Circumference 'C'	0.314 m2
Groundwater Level	Not Encountered m		

Time	**Water Level BGL**	**Water depth**	**Time steps**		**Depth steps**		**Volume soaked**	**Soakage surface area**	**Soakage Rate**	
T	***d***	***=D-d***	***t0***	***t1***	***h0***	***h1***	***V=(h0-h1)*B***	***A=(C*(h0+h1)/2)+B***	***SR=V/A/(t1-t0)***	***SR*60*60*1000***
min	***m***	***m***	***sec***	***sec***	***m***	***m***	***m3***	***m2***	***m3/m2/sec***	***litres/m2/hour***
0	1.4	2.26	-	-	-	-	-	-	-	-
0.17	1.74	2.00	0	10	2.26	2.00	2.04E-03	0.68	3.0E-04	1085.8
0.33	2	1.85	10	20	2.00	1.85	1.18E-03	0.61	1.9E-04	692.3
0.50	2.15	1.64	20	30	1.85	1.64	1.65E-03	0.56	3.0E-04	1067.8
0.67	2.36	1.56	30	40	1.64	1.56	6.28E-04	0.51	1.2E-04	443.1
0.83	2.44	1.50	40	50	1.56	1.50	4.71E-04	0.49	9.6E-05	347.3
1.00	2.5	1.39	50	60	1.50	1.39	8.64E-04	0.46	1.9E-04	673.5
1.50	2.61	1.29	60	90	1.39	1.29	7.85E-04	0.43	6.1E-05	219.8
2.00	2.71	1.23	90	120	1.29	1.23	4.71E-04	0.40	3.9E-05	140.1
2.50	2.77	1.19	120	150	1.23	1.19	3.14E-04	0.39	2.7E-05	97.2
3.00	2.81	1.17	150	180	1.19	1.17	1.57E-04	0.38	1.4E-05	49.8
3.50	2.83	1.15	180	210	1.17	1.15	1.57E-04	0.37	1.4E-05	50.6
4.00	2.85	1.13	210	240	1.15	1.13	1.57E-04	0.37	1.4E-05	51.5
4.50	2.87	1.11	240	270	1.13	1.11	1.57E-04	0.36	1.5E-05	52.4
5.00	2.89	1.09	270	300	1.11	1.09	1.57E-04	0.35	1.5E-05	53.3
6.00	2.91	1.06	300	360	1.09	1.06	2.36E-04	0.35	1.1E-05	40.9
7.00	2.94	1.04	360	420	1.06	1.04	1.57E-04	0.34	7.8E-06	27.9
8.00	2.96	1.01	420	480	1.04	1.01	2.36E-04	0.33	1.2E-05	42.9
9.00	2.99	0.99	480	540	1.01	0.99	1.57E-04	0.32	8.1E-06	29.3
10.00	3.01	0.87	540	600	0.99	0.87	9.42E-04	0.30	5.2E-05	188.5
15.00	3.13	0.79	600	900	0.87	0.79	6.28E-04	0.27	7.8E-06	28.1
20.00	3.21	0.65	900	1200	0.79	0.65	1.10E-03	0.23	1.6E-05	56.4
								Considered average	7.2E-05	259.0
								Design rate	3.6E-05	129.5

Note: Tests struck out were not included in the average



FALLING HEAD SOAKAGE TEST

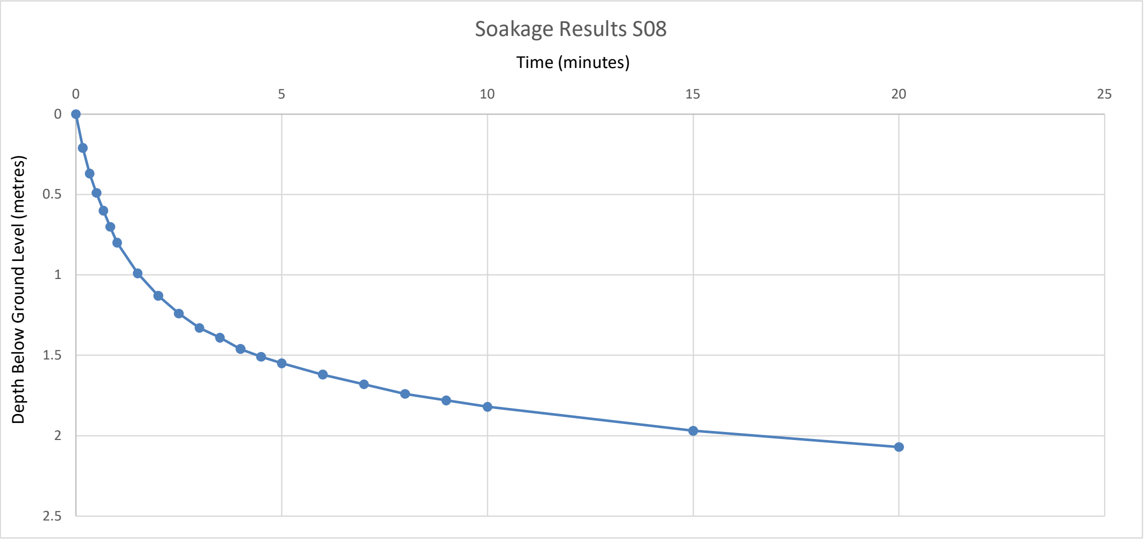
CLIENT:	**Calcutta Farms**	**LOCATION:**	**Matamata**
PROJECT:	**Tauranga Road Industrial Subdivision**	**JOB NUMBER:**	**TGA2020-0304**
TEST LOCATION:	**S08**	**TEST DATE:**	**15/07/2021 - 16/07/2021**

Test Hole Diameter	0.10	m	Base Area 'B'	0.008	m2
Test Hole Depth 'D'	2.50	m	Circumference 'C'	0.314	m2
Groundwater Level	Not Encountered	m			

Time	Water Level BGL	Water depth	Time steps		Depth steps		Volume soaked	Soakage surface area	Soakage Rate	
T	d	=D-d	t0	t1	h0	h1	V=(h0-h1)*B	A=(C*(h0+h1)/2)+B	SR=V/A/(t1-t0)	SR*60*60*1000
min	m	m	sec	sec	m	m	m3	m2	m3/m2/sec	litres/m2/hour
0	0	2.29	-	-	-	-	-	-	-	-
0.17	0.21	2.13	0	10	2.29	2.13	1.26E-03	0.70	1.8E-04	644.3
0.33	0.37	2.01	10	20	2.13	2.01	9.42E-04	0.66	1.4E-04	515.5
0.50	0.49	1.90	20	30	2.01	1.90	8.64E-04	0.62	1.4E-04	500.0
0.67	0.60	1.80	30	40	1.90	1.80	7.85E-04	0.59	1.3E-04	480.0
0.83	0.70	1.70	40	50	1.80	1.70	7.85E-04	0.56	1.4E-04	507.0
1.00	0.80	1.51	50	60	1.70	1.51	1.49E-03	0.51	2.9E-04	1049.1
1.50	0.99	1.37	60	90	1.51	1.37	1.10E-03	0.46	8.0E-05	286.7
2.00	1.13	1.26	90	120	1.37	1.26	8.64E-04	0.42	6.8E-05	246.3
2.50	1.24	1.17	120	150	1.26	1.17	7.07E-04	0.39	6.0E-05	217.7
3.00	1.33	1.11	150	180	1.17	1.11	4.71E-04	0.37	4.3E-05	154.5
3.50	1.39	1.04	180	210	1.11	1.04	5.50E-04	0.35	5.3E-05	190.9
4.00	1.46	0.99	210	240	1.04	0.99	3.93E-04	0.33	4.0E-05	144.2
4.50	1.51	0.95	240	270	0.99	0.95	3.14E-04	0.31	3.4E-05	120.6
5.00	1.55	0.88	270	300	0.95	0.88	5.50E-04	0.30	6.2E-05	223.4
6.00	1.62	0.82	300	360	0.88	0.82	4.71E-04	0.27	2.9E-05	102.9
7.00	1.68	0.76	360	420	0.82	0.76	4.71E-04	0.26	3.1E-05	110.4
8.00	1.74	0.72	420	480	0.76	0.72	3.14E-04	0.24	2.2E-05	78.4
9.00	1.78	0.68	480	540	0.72	0.68	3.14E-04	0.23	2.3E-05	82.8
10.00	1.82	0.53	540	600	0.68	0.53	1.18E-03	0.20	9.9E-05	357.1
15.00	1.97	0.43	600	900	0.53	0.43	7.85E-04	0.16	1.7E-05	59.4
20.00	2.07	0.32	900	1200	0.43	0.32	8.64E-04	0.13	2.3E-05	82.5

Considered average	8.1E-05	293.0
Design rate	4.1E-05	146.5

Note: Tests struck out were not included in the average



FALLING HEAD SOAKAGE TEST

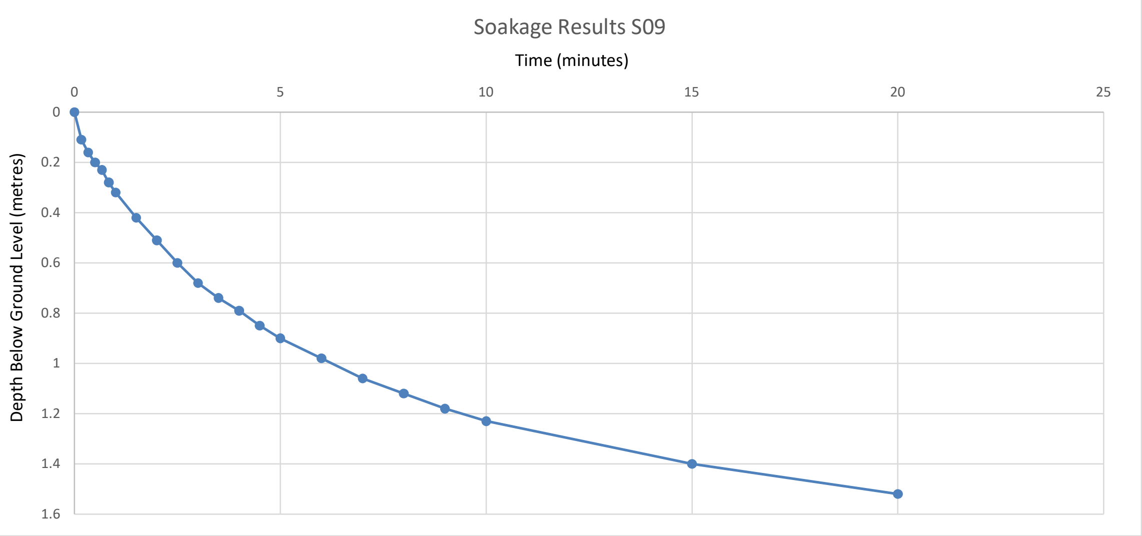
CLIENT:	**Calcutta Farms**	**LOCATION:**	**Matamata**
PROJECT:	**Tauranga Road Industrial Subdivision**	**JOB NUMBER:**	**TGA2020-0304**
TEST LOCATION:	**S09**	**TEST DATE:**	**15/07/2021 - 16/07/2021**

Test Hole Diameter	0.10	m	Base Area 'B'	0.008	m2
Test Hole Depth 'D'	2.00	m	Circumference 'C'	0.314	m2
Groundwater Level	Not Encountered	m			

Time	**Water Level BGL**	**Water depth**	**Time steps**		**Depth steps**		**Volume soaked**	**Soakage surface area**	**Soakage Rate**	
T	***d***	***=D-d***	***t0***	***t1***	***h0***	***h1***	***V=(h0-h1)*B***	***A=(C*(h0+h1)/2)+B***	***SR=V/A/(t1-t0)***	***SR*60*60*1000***
min	***m***	***m***	***sec***	***sec***	***m***	***m***	***m3***	***m2***	***m3/m2/sec***	***litres/m2/hour***
0	0	1.89	-	-	-	-	-	-	-	-
0.17	0.11	1.84	0	10	1.89	1.84	3.93E-04	0.59	6.6E-05	238.1
0.33	0.16	1.80	10	20	1.84	1.80	3.14E-04	0.58	5.4E-05	195.1
0.50	0.20	1.77	20	30	1.80	1.77	2.36E-04	0.57	4.1E-05	149.2
0.67	0.23	1.72	30	40	1.77	1.72	3.93E-04	0.56	7.1E-05	254.2
0.83	0.28	1.68	40	50	1.72	1.68	3.14E-04	0.54	5.8E-05	208.7
1.00	0.32	1.58	50	60	1.68	1.58	7.85E-04	0.52	1.5E-04	543.8
1.50	0.42	1.49	60	90	1.58	1.49	7.07E-04	0.49	4.8E-05	173.1
2.00	0.51	1.40	90	120	1.49	1.40	7.07E-04	0.46	5.1E-05	183.7
2.50	0.60	1.32	120	150	1.40	1.32	6.28E-04	0.44	4.8E-05	173.3
3.00	0.68	1.26	150	180	1.32	1.26	4.71E-04	0.41	3.8E-05	136.9
3.50	0.74	1.21	180	210	1.26	1.21	3.93E-04	0.40	3.3E-05	119.0
4.00	0.79	1.15	210	240	1.21	1.15	4.71E-04	0.38	4.1E-05	149.4
4.50	0.85	1.10	240	270	1.15	1.10	3.93E-04	0.36	3.6E-05	130.4
5.00	0.90	1.02	270	300	1.10	1.02	6.28E-04	0.34	6.1E-05	221.2
6.00	0.98	0.94	300	360	1.02	0.94	6.28E-04	0.32	3.3E-05	119.4
7.00	1.06	0.88	360	420	0.94	0.88	4.71E-04	0.29	2.7E-05	96.3
8.00	1.12	0.82	420	480	0.88	0.82	4.71E-04	0.27	2.9E-05	102.9
9.00	1.18	0.77	480	540	0.82	0.77	3.93E-04	0.26	2.5E-05	91.5
10.00	1.23	0.60	540	600	0.77	0.60	1.34E-03	0.22	1.0E-04	359.2
15.00	1.40	0.48	600	900	0.60	0.48	9.42E-04	0.18	1.8E-05	63.7
20.00	1.52	0.32	900	1200	0.48	0.32	1.26E-03	0.13	3.1E-05	112.9

Considered average	5.1E-05	182.0
Design rate	2.5E-05	91.0

Note: Tests struck out were not included in the average



FALLING HEAD SOAKAGE TEST

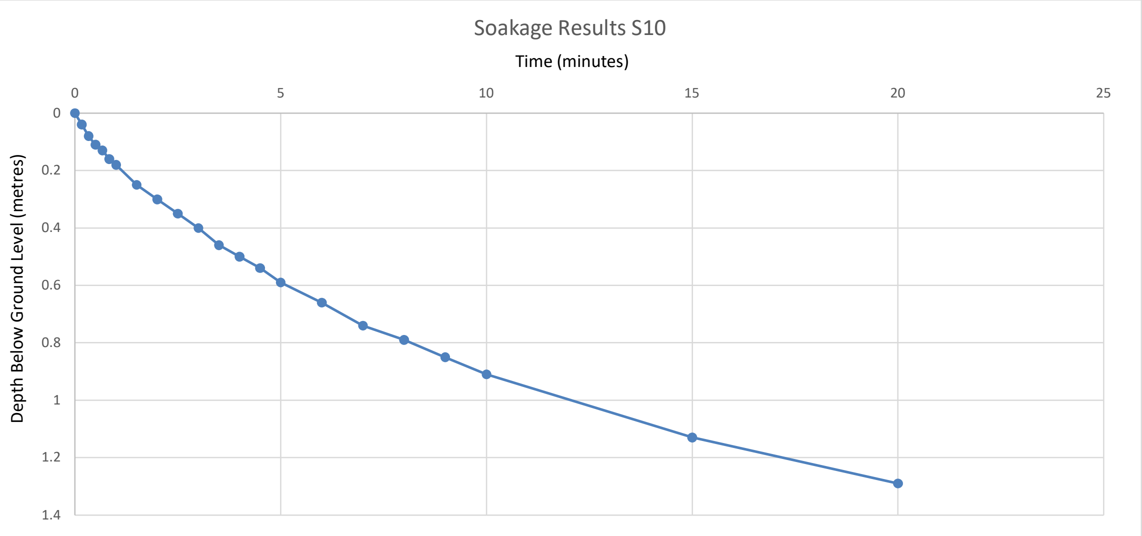
CLIENT:	**Calcutta Farms**	**LOCATION:**	**Matamata**
PROJECT:	**Tauranga Road Industrial Subdivision**	**JOB NUMBER:**	**TGA2020-0304**
TEST LOCATION:	**S10**	**TEST DATE:**	**15/07/2021 - 16/07/2021**

Test Hole Diameter	0.10 m	Base Area 'B'	0.008 m2
Test Hole Depth 'D'	2.00 m	Circumference 'C'	0.314 m2
Groundwater Level	Not Encountered m		

Time	**Water Level BGL**	**Water depth**	**Time steps**		**Depth steps**		**Volume soaked**	**Soakage surface area**	**Soakage Rate**	
T	***d***	***=D-d***	***t0***	***t1***	***h0***	***h1***	***V=(h0-h1)*B***	***A=(C*(h0+h1)/2)+B***	***SR=V/A/(t1-t0)***	***SR*60*60*1000***
min	***m***	***m***	***sec***	***sec***	***m***	***m***	***m3***	***m2***	***m3/m2/sec***	***litres/m2/hour***
0	0	1.96	-	-	-	-	-	-	-	-
0.17	0.04	1.92	0	10	1.96	1.92	3.14E-04	0.62	5.1E-05	183.2
0.33	0.08	1.89	10	20	1.92	1.89	2.36E-04	0.61	3.9E-05	139.9
0.50	0.11	1.87	20	30	1.89	1.87	1.57E-04	0.60	2.6E-05	94.5
0.67	0.13	1.84	30	40	1.87	1.84	2.36E-04	0.59	4.0E-05	143.6
0.83	0.16	1.82	40	50	1.84	1.82	1.57E-04	0.58	2.7E-05	97.0
1.00	0.18	1.75	50	60	1.82	1.75	5.50E-04	0.57	9.7E-05	348.1
1.50	0.25	1.70	60	90	1.75	1.70	3.93E-04	0.55	2.4E-05	85.7
2.00	0.3	1.65	90	120	1.70	1.65	3.93E-04	0.53	2.5E-05	88.2
2.50	0.35	1.60	120	150	1.65	1.60	3.93E-04	0.52	2.5E-05	90.9
3.00	0.40	1.54	150	180	1.60	1.54	4.71E-04	0.50	3.1E-05	112.9
3.50	0.46	1.50	180	210	1.54	1.50	3.14E-04	0.49	2.2E-05	77.7
4.00	0.50	1.46	210	240	1.50	1.46	3.14E-04	0.47	2.2E-05	79.7
4.50	0.54	1.41	240	270	1.46	1.41	3.93E-04	0.46	2.9E-05	102.7
5.00	0.59	1.34	270	300	1.41	1.34	5.50E-04	0.44	4.2E-05	150.0
6.00	0.66	1.26	300	360	1.34	1.26	6.28E-04	0.42	2.5E-05	90.6
7.00	0.74	1.21	360	420	1.26	1.21	3.93E-04	0.40	1.7E-05	59.5
8.00	0.79	1.15	420	480	1.21	1.15	4.71E-04	0.38	2.1E-05	74.7
9.00	0.85	1.09	480	540	1.15	1.09	4.71E-04	0.36	2.2E-05	78.6
10.00	0.91	0.87	540	600	1.09	0.87	1.73E-03	0.32	9.1E-05	328.4
15.00	1.13	0.71	600	900	0.87	0.71	1.26E-03	0.26	1.6E-05	58.9
20.00	1.29	0.49	900	1200	0.71	0.49	1.73E-03	0.20	2.9E-05	105.6

Considered average	3.4E-05	123.4
Design rate	1.7E-05	61.7

Note: Tests struck out were not included in the average



FALLING HEAD SOAKAGE TEST

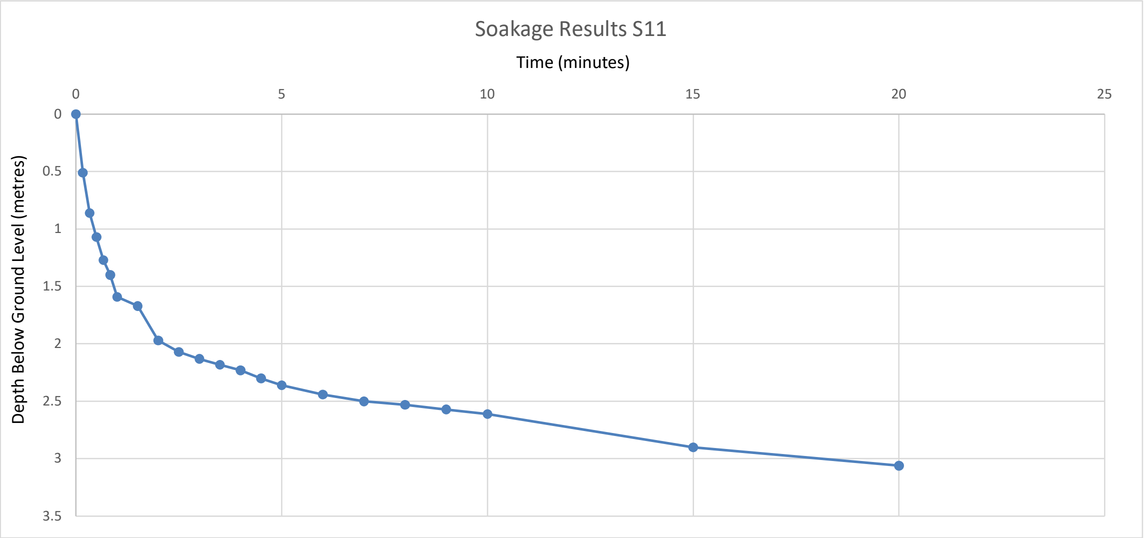
CLIENT:	**Calcutta Farms**	**LOCATION:**	**Matamata**
PROJECT:	**Tauranga Road Industrial Subdivision**	**JOB NUMBER:**	**TGA2020-0304**
TEST LOCATION:	**S11**	**TEST DATE:**	**27/07/2021**

Test Hole Diameter	0.10	m	Base Area 'B'	0.008	m2
Test Hole Depth 'D'	4.00	m	Circumference 'C'	0.314	m2
Groundwater Level	Not Encountered	m			

Time	**Water Level BGL**	**Water depth**	**Time steps**		**Depth steps**		**Volume soaked**	**Soakage surface area**	**Soakage Rate**	
T	***d***	***=D-d***	***t0***	***t1***	***h0***	***h1***	***V=(h0-h1)*B***	***A=(C*(h0+h1)/2)+B***	***SR=V/A/(t1-t0)***	***SR*60*60*1000***
min	***m***	***m***	***sec***	***sec***	***m***	***m***	***m3***	***m2***	***m3/m2/sec***	***litres/m2/hour***
0	0	3.49	-	-	-	-	-	-	-	-
0.17	0.51	3.14	0	10	3.49	3.14	2.75E-03	1.05	2.6E-04	943.4
0.33	0.86	2.93	10	20	3.14	2.93	1.65E-03	0.96	1.7E-04	617.8
0.50	1.07	2.73	20	30	2.93	2.73	1.57E-03	0.90	1.8E-04	630.7
0.67	1.27	2.60	30	40	2.73	2.60	1.02E-03	0.84	1.2E-04	435.1
0.83	1.40	2.41	40	50	2.60	2.41	1.49E-03	0.79	1.9E-04	676.2
1.00	1.59	2.33	50	60	2.41	2.33	6.28E-04	0.75	8.4E-05	300.8
1.50	1.67	2.03	60	90	2.33	2.03	2.36E-03	0.69	1.1E-04	408.3
2.00	1.97	1.93	90	120	2.03	1.93	7.85E-04	0.63	4.2E-05	149.7
2.50	2.07	1.87	120	150	1.93	1.87	4.71E-04	0.60	2.6E-05	93.6
3.00	2.13	1.82	150	180	1.87	1.82	3.93E-04	0.59	2.2E-05	80.3
3.50	2.18	1.77	180	210	1.82	1.77	3.93E-04	0.57	2.3E-05	82.5
4.00	2.23	1.70	210	240	1.77	1.70	5.50E-04	0.55	3.3E-05	119.4
4.50	2.30	1.64	240	270	1.70	1.64	4.71E-04	0.53	3.0E-05	106.3
5.00	2.36	1.56	270	300	1.64	1.56	6.28E-04	0.51	4.1E-05	147.8
6.00	2.44	1.50	300	360	1.56	1.50	4.71E-04	0.49	1.6E-05	57.9
7.00	2.50	1.47	360	420	1.50	1.47	2.36E-04	0.47	8.3E-06	29.8
8.00	2.53	1.43	420	480	1.47	1.43	3.14E-04	0.46	1.1E-05	40.7
9.00	2.57	1.39	480	540	1.43	1.39	3.14E-04	0.45	1.2E-05	41.8
10.00	2.61	1.10	540	600	1.39	1.10	2.28E-03	0.40	9.5E-05	342.8
15.00	2.90	0.94	600	900	1.10	0.94	1.26E-03	0.33	1.3E-05	46.0
20.00	3.06	0.73	900	1200	0.94	0.73	1.65E-03	0.27	2.0E-05	73.3

Considered average	7.2E-05	258.3
Design rate	3.6E-05	129.1

Note: Tests struck out were not included in the average



FALLING HEAD SOAKAGE TEST

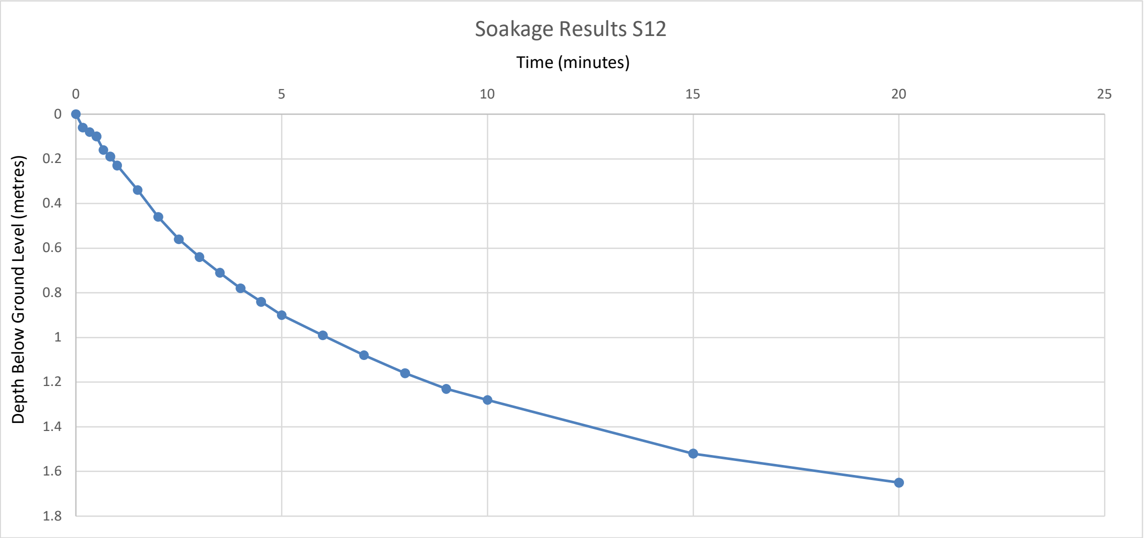
CLIENT:	**Calcutta Farms**	**LOCATION:**	**Matamata**
PROJECT:	**Tauranga Road Industrial Subdivision**	**JOB NUMBER:**	**TGA2020-0304**
TEST LOCATION:	**S12**	**TEST DATE:**	**15/07/2021 - 16/07/2021**

Test Hole Diameter	0.10	m	Base Area 'B'	0.008	m2
Test Hole Depth 'D'	2.00	m	Circumference 'C'	0.314	m2
Groundwater Level	Not Encountered	m			

Time	**Water Level BGL**	**Water depth**	**Time steps**		**Depth steps**		**Volume soaked**	**Soakage surface area**	**Soakage Rate**	
T	***d***	***=D-d***	***t0***	***t1***	***h0***	***h1***	***V=(h0-h1)*B***	***A=(C*(h0+h1)/2)+B***	***SR=V/A/(t1-t0)***	***SR*60*60*1000***
min	***m***	***m***	***sec***	***sec***	***m***	***m***	***m3***	***m2***	***m3/m2/sec***	***litres/m2/hour***
0	0	1.94	-	-	-	-	-	-	-	-
0.17	0.06	1.92	0	10	1.94	1.92	1.57E-04	0.61	2.6E-05	92.1
0.33	0.08	1.90	10	20	1.92	1.90	1.57E-04	0.61	2.6E-05	93.0
0.50	0.10	1.84	20	30	1.90	1.84	4.71E-04	0.60	7.9E-05	285.0
0.67	0.16	1.81	30	40	1.84	1.81	2.36E-04	0.58	4.1E-05	145.9
0.83	0.19	1.77	40	50	1.81	1.77	3.14E-04	0.57	5.5E-05	198.3
1.00	0.23	1.66	50	60	1.77	1.66	8.64E-04	0.55	1.6E-04	569.0
1.50	0.34	1.54	60	90	1.66	1.54	9.42E-04	0.51	6.2E-05	221.5
2.00	0.46	1.44	90	120	1.54	1.44	7.85E-04	0.48	5.5E-05	198.0
2.50	0.56	1.36	120	150	1.44	1.36	6.28E-04	0.45	4.7E-05	168.4
3.00	0.64	1.29	150	180	1.36	1.29	5.50E-04	0.42	4.3E-05	155.6
3.50	0.71	1.22	180	210	1.29	1.22	5.50E-04	0.40	4.6E-05	164.1
4.00	0.78	1.16	210	240	1.22	1.16	4.71E-04	0.38	4.1E-05	148.1
4.50	0.84	1.10	240	270	1.16	1.10	4.71E-04	0.36	4.3E-05	155.8
5.00	0.90	1.01	270	300	1.10	1.01	7.07E-04	0.34	6.9E-05	250.0
6.00	0.99	0.92	300	360	1.01	0.92	7.07E-04	0.31	3.8E-05	136.4
7.00	1.08	0.84	360	420	0.92	0.84	6.28E-04	0.28	3.7E-05	132.6
8.00	1.16	0.77	420	480	0.84	0.77	5.50E-04	0.26	3.5E-05	126.5
9.00	1.23	0.72	480	540	0.77	0.72	3.93E-04	0.24	2.7E-05	97.4
10.00	1.28	0.48	540	600	0.72	0.48	1.88E-03	0.20	1.6E-04	576.0
15.00	1.52	0.35	600	900	0.48	0.35	1.02E-03	0.14	2.5E-05	88.6
20.00	1.65	0.16	900	1200	0.35	0.16	1.49E-03	0.09	5.7E-05	203.6

Considered average	5.6E-05	200.3
Design rate	2.8E-05	100.1

Note: Tests struck out were not included in the average



CLIENT: Calcutta Farms
LOCATION: Tauranga Road, Matamata

JOB NUMBER: TGA2020-0304
DATE: 16-Jul-2021

Sheet 1 of 1

SOIL HYDRAULIC CONDUCTIVITY DETERMINATION (CONSTANT HEAD METHOD)

HVORSLEV CASE G:
Soakage out base and sides of test hole with no overlying restrictive layer

Hydraulic conductivity (k) =

$$\frac{q \ x \ \ln [(m.L/D) + (1 + (m.L/D)\text{^}2)\text{^}0.5]}{2.PI.L.Hc}$$

where
q = water flow rate (m3/sec)
Hc = constant water level head (m)
d = D = test hole diameter (m)
m = transformation ratio = 1
L = average soakage length (m)

SOAKHOLE S03

Test Hole diameter:	0.1	m	
Test hole depth:	2.5	m	
Groundwater depth:			
Soakage Length:	2.5		
Soakhole water level:	0	mbgl	
Average constant head (Hc):	1.25	m	
Water volume:	20	litres	(Reference Container Capacity)
Time:	366	sec	(Average after 6 consecutive tests)
Flow rate (q):	5.5E-05	m3/sec	
Hydraulic Conductivity (k):	**1.1E-05**	**m/sec**	

SOAKHOLE S08

Test Hole diameter:	0.1	m	
Test hole depth:	2.5	m	
Groundwater depth:	3.4		
Soakage Length:	2.5		
Soakhole water level:	0	mbgl	
Average constant head (Hc):	1.25	m	
Water volume:	20	litres	(Reference Container Capacity)
Time:	57.1833	sec	(Average after 6 consecutive tests)
Flow rate (q):	3.5E-04	m3/sec	
Hydraulic Conductivity (k):	**6.97E-05**	**m/sec**	

SOIL HYDRAULIC CONDUCTIVITY DETERMINATION (CONSTANT HEAD METHOD)

HVORSLEV CASE G:
Soakage out base and sides of test hole with no overlying restrictive layer

Hydraulic conductivity (k) = $\frac{q \ x \ \ln[(m.L/D) + (1 + (m.L/D)^2)^{0.5}]}{2.PI.L.Hc}$

where q = water flow rate (m3/sec)
Hc = constant water level head (m)
d = D = test hole diameter (m)
m = transformation ratio = 1
L = average soakage length (m)

SOAKHOLE S01

Test Hole diameter:	0.1	m	
Test hole depth:	4	m	
Groundwater depth:			
Soakage Length:	2.56		
Soakhole water level:	1.4	mbgl	
Average constant head (Hc):	1.28	m	
Water volume:	20	litres	(Reference Container Capacity)
Time:	87.483	sec	(Average after 6 consecutive tests)
Flow rate (q):	2.3E-04	m3/sec	
Hydraulic Conductivity (k):	**4.4E-05**	**m/sec**	

SOAKHOLE S07

Test Hole diameter:	0.1	m	
Test hole depth:	4	m	
Groundwater depth:			
Soakage Length:	2.56		
Soakhole water level:	1.4	mbgl	
Average constant head (Hc):	1.28	m	
Water volume:	20	litres	(Reference Container Capacity)
Time:	93.02	sec	(Average after 6 consecutive tests)
Flow rate (q):	2.2E-04	m3/sec	
Hydraulic Conductivity (k):	**4.11E-05**	**m/sec**	

SOAKHOLE S11

Test Hole diameter:	0.1	m	
Test hole depth:	4	m	
Groundwater depth:			
Soakage Length:	2.6		
Soakhole water level:	1.4	mbgl	
Average constant head (Hc):	1.3	m	
Water volume:	20	litres	(Reference Container Capacity)
Time:	101.126	sec	(Average after 6 consecutive tests)
Flow rate (q):	2.0E-04	m3/sec	
Hydraulic Conductivity (k):	**3.68E-05**	**m/sec**	

Appendix H – SWWM model catchment characteristics

BLOXAM BURNETT & OLLIVER

Client :		By	SD/JL
		Checked	CF
		Approved	
Project :	MAEA INDUSTRIAL DEVELOPMENT	Revision	**A**
		Date	5/10/2021

Calcutta Industrial Zone

Catchment Characteristics

													Infiltration (Horton)		
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.	f_i	f_o	Decay Const.
	m^2	ha	m^2	m^2	m	m	%	%			mm	mm			
SWC01B	153424	15.34238	138081.4	15342.38	670	229.0	0.5	90.0	0.015	0.15	2	5	33.87	6.6	4
SWC02A	166475	16.6475	149827.5	16647.49	730	228.0	0.5	90.0	0.015	0.15	2	5	33.87	6.6	4
SWC02B	82134	8.213361	73920.25	8213.361	550	149.3	0.5	90.0	0.015	0.15	2	5	33.87	6.6	4
Offsite Catchment	1097841	109.7841	21956.82	1075884	2480	442.7	0.1	2.0	0.015	0.15	2	5	33.87	6.6	4
Mangawhero_Existing_Conditions [1]	49305433	4930.543	2465272	46840161	28430	1734.3	0.1	5.0	0.015	0.15	2	5	33.87	6.6	4
Mangawhero_Extended [2]	50643543	5064.354	2704365	47939178	28420	1782.0	0.1	5.3	0.015	0.15	2	5	33.87	6.6	4
Mangawhero_Trimmed [3]	49131553	4913.155	2456578	46674975	28420	1728.8	0.1	5.0	0.015	0.15	2	5	33.87	6.6	4

[1] Mangawhero_Existing Conditions refers to Mangawhero Catchment in current conditions, as delineated based on LIDAR, LINZ elevation data, and aerial photographic information.

[2] Mangawhero_Extended refers to the extended catchment with the attachment of the additional off-site catchment and sub-catchment of Calcutta Farms Industrial Area that currently drains across SH24 and discharges into Mangawhero Stream approximately 500 meters downstream of SH24 bridge

[3] Mangawhero_Trimmed refers to Mangawhero Stream Catchment without the Calcutta Farms Industrial Area sub-catchment that currently drains into the stream upstream of the SH24 bridge.

GLOSSARY:

A: Catchment area
A_{imp}: Impervious area of a catchmen
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 I – Soakage sizing calculations

Catchment	**SC01**		**Soakage Device Sizing Calculations**
Parameter	**Value**	**Unit**	**Comment/Calculation formula**
A=	67,253	m^2	*input*
$d_{10y/1h}$=	10	mm	*input*
Imperviousness	90%	pct	*input*
Perviousness	10%	pct	*input*
Pervious/porous paving:	0%	pct	*input*
A_I=	60527.7	m^2	$A*Imperviousssness$
A_P=	6725.3	m^2	$A*Perviousssness$
A_{PP}=	0	m^2	$A*Pervious/porous\ paving$
$D_{store-imperv}$ =	2	mm	*Depth of depression storage on the impervious portion of the subcatchment*
$D_{store-perv}$ =	5	mm	*Depth of depression storage on the pervious portion of the subcatchment*
% Zero-imperv	75%	mm	*Percent of the impervious area with no depression storage*
A_T =	62545.3	m^2	$A_I+0.3*A_P+0.3*A_{PP}$
$d_{10y/1h, Design}$ =	9.5	mm	$d10y/1h-[D_{store-imperv}*(100-\%Zero-imperv)]$
V_{SOAK} =	**594.18**	**m^3**	$A_T*D_{10y/1h, Design}$
Voids Ratio =	0.38	-	*input*
$V_{SOAKAGE\_TRENCH}$ =	**1563.63**	**m^3**	$V_{SOAK}/(Voids\ Ratio)$
d_{Trench} =	1.5	m	*Input*
$A_{SOAKAGE\_TRENCH}$ =	**1042.42**	**m^2**	$V_{SOAKAGE\_TRENCH}/d_{TRENCH}$
$A_{SWMM, required}$ =	396.12	m^2	V_{SOAK}/d_{Trench}
$A_{SWMM, provided}$ =	420	m	*input*

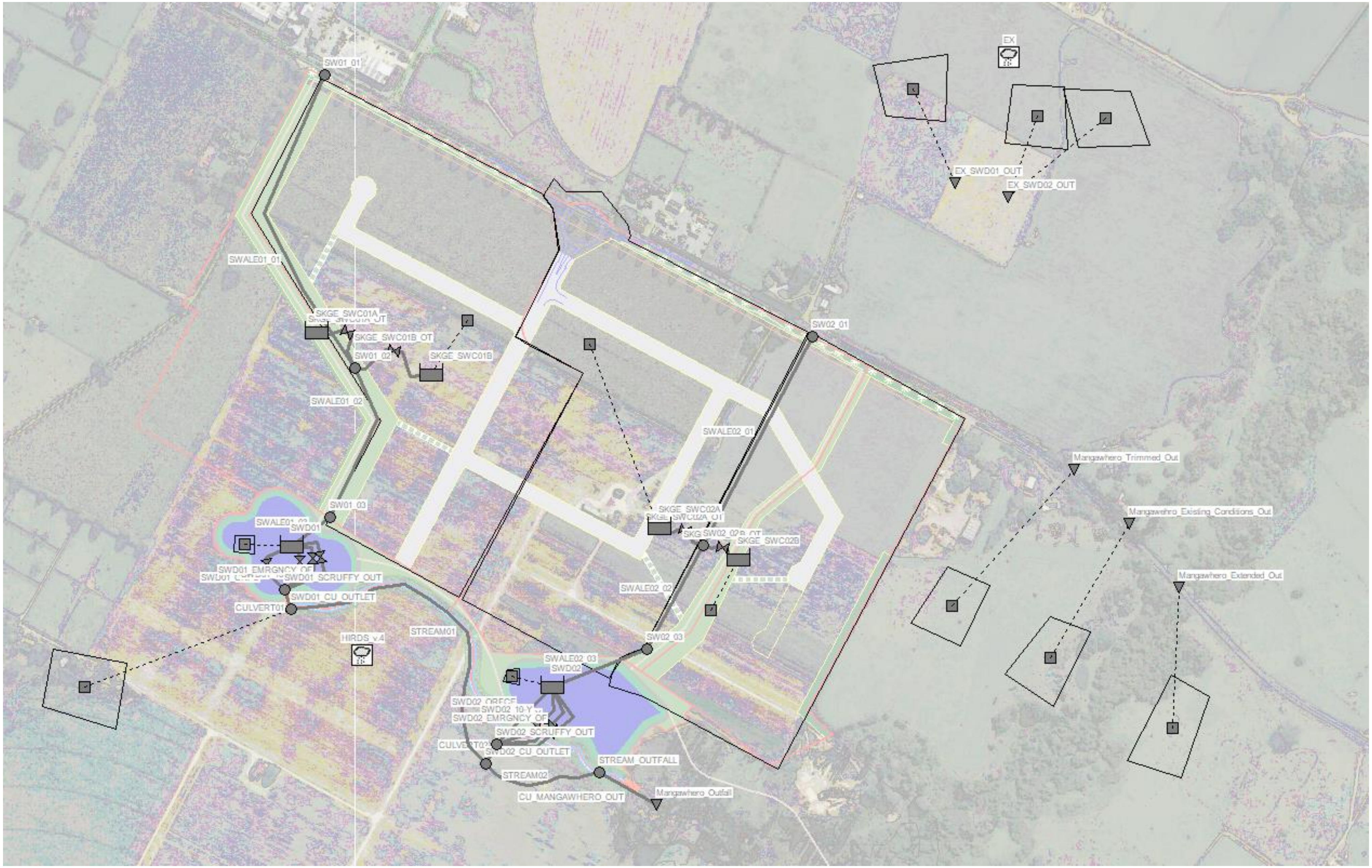
Catchment	**SC02**		**Soakage Device Sizing Calculations**
Parameter	**Value**	**Unit**	**Comment/Calculation formula**
A=	153,424	m^2	*input*
$d_{10y/1h}$=	10	mm	*input*
Imperviousness	90%	pct	*input*
Perviousness	10%	pct	*input*
Pervious/porous paving:	0%	pct	*input*
A_I=	138081	m^2	*A*Imperviousness*
A_P=	15342.4	m^2	*A*Perviousness*
A_{PP}=	0	m^2	*A*Pervious/porous paving*
$D_{store\text{-}imperv}$ =	2	mm	*Depth of depression storage on the impervious portion of the subcatchment*
$D_{store\text{-}perv}$ =	5	mm	*Depth of depression storage on the pervious portion of the subcatchment*
% Zero-imperv	75%	mm	*Percent of the impervious area with no depression storage*
A_T =	142684	m^2	$A_I+0.3*A_P+0.3*A_{PP}$
$d_{10y/1h,\ Design}$ =	9.5	mm	$d10y/1h-[D_{store\text{-}imperv}*(100-\%Zero\text{-}imperv)]$
V_{SOAK} =	**1355.5**	$\mathbf{m^3}$	$A_T*D_{10y/1h,\ Design}$
Voids Ratio =	0.38	-	*input*
$V_{SOAKAGE\_TRENCH}$ =	**3567.11**	$\mathbf{m^3}$	$V_{SOAK}/(Voids\ Ratio)$
d_{Trench} =	1.5	m	*Input*
$A_{SOAKAGE\_TRENCH}$ =	**2378.07**	$\mathbf{m^2}$	$V_{SOAKAGE\_TRENCH}/d_{TRENCH}$
$A_{SWMM,\ required}$ =	903.667	m^2	V_{SOAK}/d_{Trench}
$A_{SWMM,\ provided}$ =	950	m	*input*

Catchment	**SC03**		**Soakage Device Sizing Calculations**
Parameter	**Value**	**Unit**	**Comment/Calculation formula**
A=	166,475	m^2	*input*
$d_{10y/1h}$=	10	mm	*input*
Imperviousness	90%	pct	*input*
Perviousness	10%	pct	*input*
Pervious/porous paving:	0%	pct	*input*
A_I=	149827	m^2	*A*Imperviousness*
A_P=	16647.5	m^2	*A*Perviousness*
A_{PP}=	0	m^2	*A*Pervious/porous paving*
$D_{store-imperv}$ =	2	mm	*Depth of depression storage on the impervious portion of the subcatchment*
$D_{store-perv}$ =	5	mm	*Depth of depression storage on the pervious portion of the subcatchment*
% Zero-imperv	75%	mm	*Percent of the impervious area with no depression storage*
A_T =	154822	m^2	$A_I + 0.3*A_P + 0.3*A_{PP}$
$d_{10y/1h, Design}$ =	9.5	mm	$d10y/1h-[D_{store-imperv}*(100-\%Zero-imperv)]$
V_{SOAK} =	**1470.81**	$\mathbf{m^3}$	$A_T * D_{10y/1h, Design}$
Voids Ratio =	0.38	-	*input*
$V_{SOAKAGE\_TRENCH}$ =	**3870.55**	$\mathbf{m^3}$	$V_{SOAK}/(Voids\ Ratio)$
d_{Trench} =	1.5	m	*Input*
$A_{SOAKAGE\_TRENCH}$ =	**2580.37**	$\mathbf{m^2}$	$V_{SOAKAGE\_TRENCH}/d_{TRENCH}$
$A_{SWMM, required}$ =	980.54	m^2	V_{SOAK}/d_{Trench}
$A_{SWMM, provided}$ =	1000	m	*input*

Catchment	**SC04**		**Soakage Device Sizing Calculations**
Parameter	**Value**	**Unit**	**Comment/Calculation formula**
A=	82,134	m^2	*input*
$d_{10y/1h}$=	10	mm	*input*
Imperviousness	90%	pct	*input*
Perviousness	10%	pct	*input*
Pervious/porous paving:	0%	pct	*input*
A_I=	73920.2	m^2	*A*Impervioussness*
A_P=	8213.36	m^2	*A*Pervioussness*
A_{PP}=	0	m^2	*A*Pervious/porous paving*
$D_{store\text{-}imperv}$ =	2	mm	*Depth of depression storage on the impervious portion of the subcatchment*
$D_{store\text{-}perv}$ =	5	mm	*Depth of depression storage on the pervious portion of the subcatchment*
% Zero-imperv	75%	mm	*Percent of the impervious area with no depression storage*
A_T =	76384.3	m^2	$A_I+0.3*A_P+0.3*A_{PP}$
$d_{10y/1h,\ Design}$ =	9.5	mm	$d10y/1h-[D_{store\text{-}imperv}*(100-\%Zero\text{-}imperv)]$
V_{SOAK} =	**725.65**	$\mathbf{m^3}$	$A_T*D_{10y/1h,\ Design}$
Voids Ratio =	0.38	-	*input*
$V_{SOAKAGE\_TRENCH}$ =	**1909.61**	$\mathbf{m^3}$	$V_{SOAK}/(Voids\ Ratio)$
d_{Trench} =	1.5	m	*Input*
$A_{SOAKAGE\_TRENCH}$ =	**1273.07**	$\mathbf{m^2}$	$V_{SOAKAGE\_TRENCH}/d_{TRENCH}$
$A_{SWMM,\ required}$ =	483.767	m^2	V_{SOAK}/d_{Trench}
$A_{SWMM,\ provided}$ =	500	m	*input*

Appendix J – SWMM modelling outputs

SWMM MODEL LAYOUT



WATER QUALITY STORM: 1/3RD OF THE 2-YEAR/24-HOUR ARI WITH CLIMATE CHANGE

```
 EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.0)
  ------------------------------------------------------------

  ****************
  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 ............ 10/06/2021 00:00:00
  Ending Date .............. 10/09/2021 00:00:00
  Antecedent Dry Days ...... 0.0
  Report Time Step ......... 00:05:00
  Wet Time Step ............ 00:00:01
  Dry Time Step ............ 00:00:01
  Routing Time Step ........ 0.50 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 ......       475.180        31.462
  Evaporation Loss .........         0.000         0.000
  Infiltration Loss ........       449.833        29.783
  Surface Runoff ...........        23.876         1.581
  Final Storage ............         1.471         0.097
  Continuity Error (%) .....         0.000


  **************************        Volume        Volume
  Flow Routing Continuity        hectare-m      10^6 ltr
  **************************     ---------     ---------
  Dry Weather Inflow .......         0.000         0.000
  Wet Weather Inflow .......        23.876       238.760
  Groundwater Inflow .......         0.000         0.000
  RDII Inflow ..............         0.000         0.000
  External Inflow ..........         0.000         0.000
  External Outflow .........        22.894       228.947
  Flooding Loss ............         0.000         0.000
  Evaporation Loss .........         0.000         0.000
  Exfiltration Loss ........         0.948         9.481
  Initial Stored Volume ....         0.000         0.000
  Final Stored Volume ......         0.032         0.323
  Continuity Error (%) .....         0.004


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


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


  *********************************
  Most Frequent Nonconverging Nodes
  *********************************
  Convergence obtained at all time steps.


  *************************
  Routing Time Step Summary
  *************************
  Minimum Time Step           :      0.45 sec
  Average Time Step           :      0.50 sec
  Maximum Time Step           :      0.50 sec
  % of Time in Steady State   :      0.00
  Average Iterations per Step :      2.00
  % of Steps Not Converging   :      0.00
  Time Step Frequencies       :
      0.500 -  0.315 sec      :    100.00 %
      0.315 -  0.199 sec      :      0.00 %
      0.199 -  0.126 sec      :      0.00 %
      0.126 -  0.079 sec      :      0.00 %
      0.079 -  0.050 sec      :      0.00 %


  ***************************
  Subcatchment Runoff Summary
  ***************************

  ------------------------------------------------------------------------------------------------------------------------------
                            Total      Total      Total      Total     Imperv       Perv      Total       Total     Peak  Runoff
                           Precip      Runon       Evap      Infil     Runoff     Runoff     Runoff      Runoff   Runoff   Coeff
```

```
  Subcatchment                    mm         mm         mm         mm         mm         mm         mm    10^6 ltr      CMS
  --------------------------------------------------------------------------------------------------------------------------------
  C_W01                        31.46       0.00       0.00      15.73      14.73       0.00      14.73        0.35     0.04   0.468
  C_W02                        31.46       0.00       0.00      15.73      14.73       0.00      14.73        0.42     0.05   0.468
  EX_SWC01B                    31.46       0.00       0.00      29.89       1.50       0.00       1.50        0.23     0.04   0.048
  EX_SWC02A                    31.46       0.00       0.00      29.89       1.50       0.00       1.50        0.25     0.04   0.048
  EX_SWC02B                    31.46       0.00       0.00      29.89       1.50       0.00       1.50        0.12     0.02   0.048
  Mangawhero_Existing_Conditions      31.46       0.00       0.00      29.89       1.48       0.00       1.48       73.05      2.30
0.047
  Mangawhero_Extended          31.46       0.00       0.00      29.78       1.58       0.00       1.58       80.05     2.44   0.050
  Mangawhero_Trimmed           31.46       0.00       0.00      29.89       1.48       0.00       1.48       72.79     2.29   0.047
  Off-Site_Catchment           31.46       0.00       0.00      30.83       0.60       0.00       0.60        0.66     0.09   0.019
  SWC01B                       31.46       0.00       0.00       3.15      26.94       0.00      26.94        4.13     0.27   0.856
  SWC02A                       31.46       0.00       0.00       3.15      26.93       0.00      26.93        4.48     0.28   0.856
  SWC02B                       31.46       0.00       0.00       3.15      26.94       0.00      26.94        2.21     0.16   0.856


  ******************
  Node Depth Summary
  ******************

  ---------------------------------------------------------------------------------
                                 Average  Maximum  Maximum  Time of Max    Reported
                                   Depth    Depth      HGL   Occurrence   Max Depth
  Node                 Type       Meters   Meters   Meters  days hr:min      Meters
  ---------------------------------------------------------------------------------
  STREAM_OUTFALL       JUNCTION     0.03     0.08    54.37     0  12:42        0.08
  SW01_01              JUNCTION     0.00     0.00    57.00     0  00:00        0.00
  SW01_02              JUNCTION     0.01     0.22    56.62     0  14:22        0.22
  SW01_03              JUNCTION     0.01     0.19    56.29     0  14:31        0.19
  SW02_01              JUNCTION     0.00     0.00    58.50     0  00:00        0.00
  SW02_02              JUNCTION     0.02     0.29    58.19     0  14:10        0.29
  SW02_03              JUNCTION     0.02     0.24    57.84     0  14:16        0.24
  SWD01_CU_OUTLET      JUNCTION     0.05     0.22    55.62     0  12:17        0.22
  SWD01_SCRUFFY_OUT    JUNCTION     0.03     0.12    55.62     0  12:18        0.12
  SWD02_CU_OUTLET      JUNCTION     0.10     0.25    54.90     0  12:39        0.25
  SWD02_SCRUFFY_OUT    JUNCTION     0.02     0.05    55.25     0  19:22        0.05
  EX_SWD01_OUT         OUTFALL      0.00     0.00    55.50     0  00:00        0.00
  EX_SWD02_OUT         OUTFALL      0.00     0.00    54.65     0  00:00        0.00
  Mangawehro_Existing_Conditions_Out OUTFALL      0.00     0.00    41.45     0  00:00        0.00
  Mangawhero_Extended_Out OUTFALL      0.00     0.00    41.45     0  00:00        0.00
  Mangawhero_Outfall   OUTFALL      0.03     0.08    52.08     0  12:42        0.08
  Mangawhero_Trimmed_Out OUTFALL      0.00     0.00    41.45     0  00:00        0.00
  SKGE_SWC01A          STORAGE      0.00     0.00    56.00     0  00:00        0.00
  SKGE_SWC01B          STORAGE      0.40     1.52    57.52     0  14:07        1.52
  SKGE_SWC02A          STORAGE      0.40     1.53    59.53     0  14:00        1.53
  SKGE_SWC02B          STORAGE      0.40     1.52    59.52     0  13:43        1.52
  SWD01                STORAGE      0.03     0.08    56.08     0  19:39        0.08
  SWD02                STORAGE      0.04     0.11    57.11     0  19:21        0.11


  *******************
  Node Inflow Summary
  *******************

  -------------------------------------------------------------------------------------------------
                                  Maximum  Maximum                  Lateral       Total        Flow
                                  Lateral    Total  Time of Max      Inflow      Inflow     Balance
                                   Inflow   Inflow   Occurrence      Volume      Volume       Error
  Node                 Type           CMS      CMS  days hr:min    10^6 ltr    10^6 ltr     Percent
  -------------------------------------------------------------------------------------------------
  STREAM_OUTFALL       JUNCTION     0.000    0.043     0  12:40           0        2.45       0.072
  SW01_01              JUNCTION     0.000    0.000     0  00:00           0           0       0.000 ltr
  SW01_02              JUNCTION     0.000    0.065     0  14:07           0       0.587      -0.278
  SW01_03              JUNCTION     0.000    0.060     0  14:26           0       0.579       0.284
  SW02_01              JUNCTION     0.000    0.000     0  00:00           0           0       0.000 ltr
  SW02_02              JUNCTION     0.000    0.114     0  13:58           0        1.07      -0.196
  SW02_03              JUNCTION     0.000    0.106     0  14:12           0        1.06       0.199
  SWD01_CU_OUTLET      JUNCTION     0.085    0.085     0  12:09       0.658        1.45       0.049
  SWD01_SCRUFFY_OUT    JUNCTION     0.000    0.010     0  19:39           0       0.789       0.007
  SWD02_CU_OUTLET      JUNCTION     0.000    0.065     0  12:20           0        2.56       0.639
  SWD02_SCRUFFY_OUT    JUNCTION     0.000    0.019     0  19:21           0        1.31       0.004
  EX_SWD01_OUT         OUTFALL      0.039    0.039     0  12:09        0.23        0.23       0.000
  EX_SWD02_OUT         OUTFALL      0.064    0.064     0  12:09       0.372       0.372       0.000
  Mangawehro_Existing_Conditions_Out OUTFALL      2.300    2.300     0  12:39        73.1        73.1       0.000
  Mangawhero_Extended_Out OUTFALL      2.441    2.441     0  12:39        80.1        80.1       0.000
  Mangawhero_Outfall   OUTFALL      0.000    0.043     0  12:42           0        2.45       0.000
  Mangawhero_Trimmed_Out OUTFALL      2.292    2.292     0  12:39        72.8        72.8       0.000
  SKGE_SWC01A          STORAGE      0.000    0.000     0  00:00           0           0       0.000 ltr
  SKGE_SWC01B          STORAGE      0.272    0.272     0  12:14        4.13        4.13      -0.000
  SKGE_SWC02A          STORAGE      0.285    0.285     0  12:14        4.48        4.48      -0.000
  SKGE_SWC02B          STORAGE      0.157    0.157     0  12:09        2.21        2.21      -0.000
  SWD01                STORAGE      0.044    0.065     0  14:30       0.353        0.93       0.002
  SWD02                STORAGE      0.051    0.113     0  14:16       0.423        1.48       0.001


  **********************
  Node Surcharge Summary
  **********************

  No nodes were surcharged.


  *********************
  Node Flooding Summary
  *********************

  No nodes were flooded.


  **********************
  Storage Volume Summary
  **********************
```

```
  --------------------------------------------------------------------------------------------------
                         Average     Avg  Evap Exfil       Maximum     Max    Time of Max    Maximum
                          Volume    Pcnt  Pcnt  Pcnt        Volume    Pcnt     Occurrence    Outflow
  Storage Unit           1000 m3    Full  Loss  Loss       1000 m3    Full    days hr:min        CMS
  --------------------------------------------------------------------------------------------------
  SKGE_SWC01A              0.000       0     0     0         0.000       0       0  00:00      0.000
  SKGE_SWC01B              0.377      20     0    86         1.447      76       0  14:07      0.100
  SKGE_SWC02A              0.403      20     0    84         1.526      76       0  14:00      0.116
  SKGE_SWC02B              0.198      20     0    84         0.759      76       0  13:43      0.060
  SWD01                    0.294       1     0     0         0.720       2       0  19:39      0.010
  SWD02                    0.411       1     0     0         1.115       2       0  19:21      0.019


  ***********************
  Outfall Loading Summary
  ***********************

  -----------------------------------------------------------
                         Flow       Avg       Max       Total
                         Freq      Flow      Flow      Volume
  Outfall Node           Pcnt       CMS       CMS    10^6 ltr
  -----------------------------------------------------------
  EX_SWD01_OUT          35.45     0.002     0.039       0.230
  EX_SWD02_OUT          36.45     0.004     0.064       0.372
  Mangawehro_Existing_Conditions_Out  99.90     0.282     2.300      73.050
  Mangawhero_Extended_Out  99.90     0.309     2.441      80.050
  Mangawhero_Outfall    93.51     0.010     0.043       2.451
  Mangawhero_Trimmed_Out  99.90     0.281     2.292      72.793
  -----------------------------------------------------------
  System                77.52     0.889     7.098     228.946


  ********************
  Link Flow Summary
  ********************

  -----------------------------------------------------------------------------
                                 Maximum  Time of Max   Maximum    Max/    Max/
                                  |Flow|   Occurrence   |Veloc|    Full    Full
  Link                 Type          CMS  days hr:min     m/sec    Flow   Depth
  -----------------------------------------------------------------------------
  CU_MANGAWHERO_OUT    CONDUIT     0.043     0  12:42      1.72    0.02    0.11
  CULVERT01            CONDUIT     0.010     0  19:39      0.46    0.01    0.22
  CULVERT02            CONDUIT     0.019     0  19:22      0.34    0.01    0.18
  STREAM01             CHANNEL     0.064     0  12:20      0.26    0.00    0.04
  STREAM02             CHANNEL     0.043     0  12:40      0.27    0.00    0.03
  SWALE01_01           CHANNEL     0.000     0  00:00      0.00    0.00    0.07
  SWALE01_02           CHANNEL     0.060     0  14:26      0.26    0.00    0.10
  SWALE01_03           CHANNEL     0.059     0  14:31      0.45    0.00    0.07
  SWALE02_01           CHANNEL     0.000     0  00:00      0.00    0.00    0.10
  SWALE02_02           CHANNEL     0.106     0  14:12      0.31    0.00    0.12
  SWALE02_03           CHANNEL     0.105     0  14:16      0.54    0.00    0.09
  SWD01_ORFC           ORIFICE     0.010     0  19:39                      0.28
  SWD02_ORFCE          ORIFICE     0.019     0  19:21                      0.34
  SKGE_SWC01A_OT       WEIR        0.000     0  00:00                      0.00
  SKGE_SWC01B_OT       WEIR        0.065     0  14:07                      0.02
  SKGE_SWC02A_OT       WEIR        0.078     0  14:00                      0.03
  SKGE_SWC02B_OT       WEIR        0.041     0  13:43                      0.02
  SWD01_100-Y          WEIR        0.000     0  00:00                      0.00
  SWD01_10-Y           WEIR        0.000     0  00:00                      0.00
  SWD01_EMRGNCY_OF     WEIR        0.000     0  00:00                      0.00
  SWD02_100-Y          WEIR        0.000     0  00:00                      0.00
  SWD02_10-Y           WEIR        0.000     0  00:00                      0.00
  SWD02_EMRGNCY_OF     WEIR        0.000     0  00:00                      0.00


  ***************************
  Flow Classification Summary
  ***************************

  -------------------------------------------------------------------------------------
                      Adjusted    ---------- Fraction of Time in Flow Class ----------
                       /Actual         Up    Down   Sub   Sup   Up    Down  Norm  Inlet
  Conduit               Length    Dry  Dry   Dry    Crit  Crit  Crit  Crit  Ltd   Ctrl
  -------------------------------------------------------------------------------------
  CU_MANGAWHERO_OUT       1.00   0.04  0.00  0.00  0.03  0.93  0.00  0.00  0.03  0.00
  CULVERT01               1.00   0.00  0.05  0.00  0.69  0.25  0.00  0.00  0.58  0.00
  CULVERT02               1.00   0.01  0.04  0.00  0.95  0.00  0.00  0.00  0.95  0.00
  STREAM01                1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.91  0.00
  STREAM02                1.00   0.01  0.00  0.00  0.99  0.00  0.00  0.00  0.00  0.00
  SWALE01_01              1.00   0.19  0.81  0.00  0.00  0.00  0.00  0.00  0.00  0.00
  SWALE01_02              1.00   0.19  0.00  0.00  0.81  0.00  0.00  0.00  0.76  0.00
  SWALE01_03              1.00   0.19  0.00  0.00  0.00  0.00  0.00  0.81  0.00  0.00
  SWALE02_01              1.00   0.19  0.81  0.00  0.00  0.00  0.00  0.00  0.00  0.00
  SWALE02_02              1.00   0.19  0.00  0.00  0.81  0.00  0.00  0.00  0.74  0.00
  SWALE02_03              1.00   0.19  0.00  0.00  0.00  0.00  0.00  0.81  0.00  0.00


  *************************
  Conduit Surcharge Summary
  *************************

  No conduits were surcharged.


  Analysis begun on:  Thu Jun 23 16:26:13 2022
  Analysis ended on:  Thu Jun 23 16:26:27 2022
  Total elapsed time: 00:00:14
```

2-YEAR/24-HOUR ARI WITH CLIMATE CHANGE (EXISTING CONDITIONS CATCHMENT CACLUCATIONS CONSIDER NON-CLIMATE CHANGE ADJUSTED RAINFALL)

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.0)
------------------------------------------------------------

****************
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 ............ 10/06/2021 00:00:00
Ending Date .............. 10/09/2021 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:00:01
Dry Time Step ............ 00:00:01
Routing Time Step ........ 0.50 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 ......      1410.353        93.379
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........      1333.857        88.314
Surface Runoff ...........        75.005         4.966
Final Storage ............         1.491         0.099
Continuity Error (%) .....         0.000


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......        75.005       750.053
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........        73.794       737.951
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         1.139        11.390
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.069         0.695
Continuity Error (%) .....         0.002


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


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


*********************************
Most Frequent Nonconverging Nodes
*********************************
Convergence obtained at all time steps.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.45 sec
Average Time Step           :     0.50 sec
Maximum Time Step           :     0.50 sec
% of Time in Steady State   :     0.00
Average Iterations per Step :     2.00
% of Steps Not Converging   :     0.00
Time Step Frequencies       :
    0.500 -  0.315 sec      :   100.00 %
    0.315 -  0.199 sec      :     0.00 %
    0.199 -  0.126 sec      :     0.00 %
    0.126 -  0.079 sec      :     0.00 %
    0.079 -  0.050 sec      :     0.00 %
```

```
  ***************************
  Subcatchment Runoff Summary
  ***************************

  ------------------------------------------------------------------------------------------------------------------------------
                              Total      Total      Total      Total     Imperv       Perv      Total       Total     Peak  Runoff
                             Precip      Runon       Evap      Infil     Runoff     Runoff     Runoff      Runoff   Runoff   Coeff
  Subcatchment                   mm         mm         mm         mm         mm         mm         mm    10^6 ltr      CMS
  ------------------------------------------------------------------------------------------------------------------------------
  C_W01                       93.41       0.00       0.00      42.36      45.71       4.34      50.05        1.20     0.17   0.536
  C_W02                       93.41       0.00       0.00      42.48      45.71       4.23      49.93        1.43     0.20   0.535
  EX_SWC01B                   80.08       0.00       0.00      74.34       3.93       1.73       5.66        0.87     0.13   0.071
  EX_SWC02A                   80.08       0.00       0.00      74.45       3.93       1.62       5.55        0.92     0.13   0.069
  EX_SWC02B                   80.08       0.00       0.00      74.08       3.93       2.00       5.93        0.49     0.07   0.074
  Mangawhero_Existing_Conditions      93.41       0.00       0.00      88.67       4.58       0.07       4.65      229.18     9.83
0.050
  Mangawhero_Extended         93.41       0.00       0.00      88.36       4.89       0.07       4.96      251.08    10.47   0.053
  Mangawhero_Trimmed          93.41       0.00       0.00      88.67       4.58       0.07       4.65      228.38     9.79   0.050
  Off-Site_Catchment          93.41       0.00       0.00      90.79       1.84       0.75       2.59        2.84     0.34   0.028
  SWC01B                      93.41       0.00       0.00       8.32      82.69       1.02      83.72       12.84     1.14   0.896
  SWC02A                      93.41       0.00       0.00       8.33      82.69       1.01      83.70       13.93     1.19   0.896
  SWC02B                      93.41       0.00       0.00       8.28      82.70       1.06      83.76        6.88     0.66   0.897


  ******************
  Node Depth Summary
  ******************

  ---------------------------------------------------------------------------------
                                 Average  Maximum  Maximum  Time of Max    Reported
                                   Depth    Depth      HGL   Occurrence   Max Depth
  Node                 Type       Meters   Meters   Meters  days hr:min      Meters
  ---------------------------------------------------------------------------------
  STREAM_OUTFALL       JUNCTION     0.11     0.26    54.55     0  14:34        0.26
  SW01_01              JUNCTION     0.00     0.10    57.10     0  12:23        0.10
  SW01_02              JUNCTION     0.06     0.70    57.10     0  12:20        0.70
  SW01_03              JUNCTION     0.13     0.54    56.64     0  12:24        0.54
  SW02_01              JUNCTION     0.00     0.22    58.72     0  12:22        0.21
  SW02_02              JUNCTION     0.08     0.81    58.71     0  12:20        0.81
  SW02_03              JUNCTION     0.07     0.61    58.21     0  12:24        0.61
  SWD01_CU_OUTLET      JUNCTION     0.15     0.43    55.83     0  12:15        0.43
  SWD01_SCRUFFY_OUT    JUNCTION     0.10     0.33    55.83     0  12:15        0.33
  SWD02_CU_OUTLET      JUNCTION     0.28     0.59    55.24     0  14:32        0.59
  SWD02_SCRUFFY_OUT    JUNCTION     0.07     0.17    55.37     0  17:33        0.17
  EX_SWD01_OUT         OUTFALL      0.00     0.00    55.50     0  00:00        0.00
  EX_SWD02_OUT         OUTFALL      0.00     0.00    54.65     0  00:00        0.00
  Mangawehro_Existing_Conditions_Out OUTFALL      0.00     0.00    41.45     0  00:00        0.00
  Mangawehro_Extended_Out OUTFALL      0.00     0.00    41.45     0  00:00        0.00
  Mangawhero_Outfall   OUTFALL      0.10     0.23    52.23     0  14:34        0.23
  Mangawhero_Trimmed_Out OUTFALL      0.00     0.00    41.45     0  00:00        0.00
  SKGE_SWC01A          STORAGE      0.00     0.00    56.00     0  00:00        0.00
  SKGE_SWC01B          STORAGE      0.56     1.65    57.65     0  12:13        1.65
  SKGE_SWC02A          STORAGE      0.57     1.65    59.65     0  12:13        1.65
  SKGE_SWC02B          STORAGE      0.56     1.61    59.61     0  12:11        1.60
  SWD01                STORAGE      0.19     0.63    56.63     0  17:28        0.63
  SWD02                STORAGE      0.26     0.88    57.88     0  17:33        0.88


  *******************
  Node Inflow Summary
  *******************

  -------------------------------------------------------------------------------------------------
                                  Maximum  Maximum                  Lateral       Total        Flow
                                  Lateral    Total  Time of Max      Inflow      Inflow     Balance
                                   Inflow   Inflow   Occurrence      Volume      Volume       Error
  Node                 Type           CMS      CMS  days hr:min    10^6 ltr    10^6 ltr     Percent
  -------------------------------------------------------------------------------------------------
  STREAM_OUTFALL       JUNCTION     0.000    0.388     0  14:33           0          27       0.013
  SW01_01              JUNCTION     0.000    0.048     0  12:15           0       0.027       9.083
  SW01_02              JUNCTION     0.000    1.072     0  12:13           0        8.68      -0.265
  SW01_03              JUNCTION     0.000    0.960     0  12:21           0        8.63       0.286
  SW02_01              JUNCTION     0.000    0.099     0  12:13           0      0.0729       6.228
  SW02_02              JUNCTION     0.000    1.747     0  12:12           0        14.3      -0.079
  SW02_03              JUNCTION     0.000    1.554     0  12:21           0        14.1       0.067
  SWD01_CU_OUTLET      JUNCTION     0.339    0.378     0  12:09        2.84        12.3      -0.027
  SWD01_SCRUFFY_OUT    JUNCTION     0.000    0.124     0  17:28           0         9.5       0.001
  SWD02_CU_OUTLET      JUNCTION     0.000    0.389     0  14:18           0        27.2       0.149
  SWD02_SCRUFFY_OUT    JUNCTION     0.000    0.196     0  17:33           0        15.2       0.001
  EX_SWD01_OUT         OUTFALL      0.126    0.126     0  12:09       0.869       0.869       0.000
  EX_SWD02_OUT         OUTFALL      0.205    0.205     0  12:09        1.41        1.41       0.000
  Mangawehro_Existing_Conditions_Out OUTFALL      9.825    9.825     0  12:24         229         229       0.000
  Mangawehro_Extended_Out OUTFALL     10.473   10.473     0  12:24         251         251       0.000
  Mangawhero_Outfall   OUTFALL      0.000    0.388     0  14:34           0          27       0.000
  Mangawhero_Trimmed_Out OUTFALL      9.790    9.790     0  12:24         228         228       0.000
  SKGE_SWC01A          STORAGE      0.000    0.000     0  00:00           0           0       0.000 ltr
  SKGE_SWC01B          STORAGE      1.138    1.138     0  12:09        12.8        12.8      -0.000
  SKGE_SWC02A          STORAGE      1.188    1.188     0  12:09        13.9        13.9      -0.000
  SKGE_SWC02B          STORAGE      0.663    0.663     0  12:09        6.88        6.88      -0.000
  SWD01                STORAGE      0.174    1.044     0  12:23         1.2         9.8      -0.031
  SWD02                STORAGE      0.203    1.653     0  12:22        1.43        15.6      -0.006


  **********************
  Node Surcharge Summary
  **********************

  No nodes were surcharged.
```

```
*********************
Node Flooding Summary
*********************

No nodes were flooded.


**********************
Storage Volume Summary
**********************

--------------------------------------------------------------------------------------------------
                       Average     Avg  Evap Exfil       Maximum     Max    Time of Max    Maximum
                        Volume    Pcnt  Pcnt  Pcnt        Volume    Pcnt     Occurrence    Outflow
Storage Unit           1000 m3    Full  Loss  Loss       1000 m3    Full    days hr:min        CMS
--------------------------------------------------------------------------------------------------
SKGE_SWC01A              0.000       0     0     0         0.000       0       0  00:00      0.000
SKGE_SWC01B              0.536      28     0    33         1.568      83       0  12:13      1.106
SKGE_SWC02A              0.570      28     0    32         1.655      83       0  12:13      1.159
SKGE_SWC02B              0.280      28     0    32         0.803      80       0  12:11      0.648
SWD01                    1.788       4     0     0         6.027      14       0  17:28      0.124
SWD02                    2.712       6     0     0         9.591      20       0  17:33      0.196


***********************
Outfall Loading Summary
***********************

-----------------------------------------------------------
                       Flow       Avg       Max       Total
                       Freq      Flow      Flow      Volume
Outfall Node           Pcnt       CMS       CMS    10^6 ltr
-----------------------------------------------------------
EX_SWD01_OUT          36.09     0.009     0.126       0.869
EX_SWD02_OUT          37.06     0.015     0.205       1.411
Mangawehro_Existing_Conditions_Out  99.97     0.885     9.825     229.184
Mangawhero_Extended_Out  99.97     0.969    10.473     251.076
Mangawhero_Outfall    96.61     0.108     0.388      27.032
Mangawhero_Trimmed_Out  99.97     0.881     9.790     228.376
-----------------------------------------------------------
System                78.28     2.867    30.559     737.948


********************
Link Flow Summary
********************

-----------------------------------------------------------------------------
                               Maximum  Time of Max   Maximum    Max/    Max/
                                |Flow|   Occurrence   |Veloc|    Full    Full
Link                 Type          CMS  days hr:min     m/sec    Flow   Depth
-----------------------------------------------------------------------------
CU_MANGAWHERO_OUT    CONDUIT     0.388     0  14:34      3.10    0.21    0.33
CULVERT01            CONDUIT     0.124     0  17:28      0.82    0.12    0.50
CULVERT02            CONDUIT     0.196     0  17:33      0.92    0.11    0.50
STREAM01             CHANNEL     0.291     0  12:15      0.33    0.00    0.08
STREAM02             CHANNEL     0.388     0  14:33      0.51    0.00    0.07
SWALE01_01           CHANNEL     0.048     0  12:15      0.08    0.01    0.27
SWALE01_02           CHANNEL     0.960     0  12:21      0.54    0.04    0.29
SWALE01_03           CHANNEL     0.953     0  12:24      1.10    0.04    0.25
SWALE02_01           CHANNEL     0.099     0  12:13      0.12    0.01    0.34
SWALE02_02           CHANNEL     1.554     0  12:21      0.60    0.07    0.33
SWALE02_03           CHANNEL     1.543     0  12:24      1.24    0.07    0.26
SWD01_ORFC           ORIFICE     0.124     0  17:28                      1.00
SWD02_ORFCE          ORIFICE     0.196     0  17:33                      1.00
SKGE_SWC01A_OT       WEIR        0.000     0  00:00                      0.00
SKGE_SWC01B_OT       WEIR        1.072     0  12:13                      0.15
SKGE_SWC02A_OT       WEIR        1.123     0  12:13                      0.15
SKGE_SWC02B_OT       WEIR        0.631     0  12:11                      0.11
SWD01_100-Y          WEIR        0.000     0  00:00                      0.00
SWD01_10-Y           WEIR        0.000     0  00:00                      0.00
SWD01_EMRGNCY_OF     WEIR        0.000     0  00:00                      0.00
SWD02_100-Y          WEIR        0.000     0  00:00                      0.00
SWD02_10-Y           WEIR        0.000     0  00:00                      0.00
SWD02_EMRGNCY_OF     WEIR        0.000     0  00:00                      0.00


***************************
Flow Classification Summary
***************************

-------------------------------------------------------------------------------------
                      Adjusted    ---------- Fraction of Time in Flow Class ----------
                      /Actual          Up    Down  Sub   Sup   Up    Down  Norm  Inlet
Conduit                 Length    Dry  Dry   Dry   Crit  Crit  Crit  Crit  Ltd   Ctrl
-------------------------------------------------------------------------------------
CU_MANGAWHERO_OUT         1.00   0.02  0.00  0.00  0.01  0.96  0.00  0.00  0.01  0.00
CULVERT01                 1.00   0.00  0.02  0.00  0.98  0.00  0.00  0.00  0.44  0.00
CULVERT02                 1.00   0.01  0.02  0.00  0.98  0.00  0.00  0.00  0.98  0.00
STREAM01                  1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.95  0.00
STREAM02                  1.00   0.01  0.00  0.00  0.99  0.00  0.00  0.00  0.00  0.00
SWALE01_01                1.00   0.13  0.19  0.00  0.69  0.00  0.00  0.00  0.83  0.00
SWALE01_02                1.00   0.13  0.00  0.00  0.87  0.00  0.00  0.00  0.69  0.00
SWALE01_03                1.00   0.13  0.00  0.00  0.52  0.00  0.00  0.36  0.07  0.00
SWALE02_01                1.00   0.12  0.18  0.00  0.70  0.00  0.00  0.00  0.82  0.00
SWALE02_02                1.00   0.12  0.00  0.00  0.88  0.00  0.00  0.00  0.72  0.00
SWALE02_03                1.00   0.12  0.00  0.00  0.16  0.00  0.00  0.71  0.01  0.00


*************************
Conduit Surcharge Summary
*************************

No conduits were surcharged.
```

```
Analysis begun on:  Thu Jun 23 16:27:27 2022
Analysis ended on:  Thu Jun 23 16:27:40 2022
Total elapsed time: 00:00:13
```

10-YEAR/24-HOUR ARI WITH CLIMATE CHANGE (EXISTING CONDITIONS CATCHMENT CACLUCATIONS CONSIDER NON-CLIMATE CHANGE ADJUSTED RAINFALL)

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.0)
------------------------------------------------------------

****************
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 ............ 10/06/2021 00:00:00
Ending Date .............. 10/09/2021 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:00:01
Dry Time Step ............ 00:00:01
Routing Time Step ........ 0.50 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 ......      2208.909       146.251
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........      2076.735       137.500
Surface Runoff ...........       130.676         8.652
Final Storage ............         1.498         0.099
Continuity Error (%) .....         0.000


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......       130.676      1306.777
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........       129.360      1293.609
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         1.227        12.273
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.088         0.882
Continuity Error (%) .....         0.001


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


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


*********************************
Most Frequent Nonconverging Nodes
*********************************
Convergence obtained at all time steps.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.45 sec
Average Time Step           :     0.50 sec
Maximum Time Step           :     0.50 sec
% of Time in Steady State   :     0.00
Average Iterations per Step :     2.00
% of Steps Not Converging   :     0.00
Time Step Frequencies       :
    0.500 -  0.315 sec      :   100.00 %
    0.315 -  0.199 sec      :     0.00 %
    0.199 -  0.126 sec      :     0.00 %
    0.126 -  0.079 sec      :     0.00 %
    0.079 -  0.050 sec      :     0.00 %
```

```
  ***************************
  Subcatchment Runoff Summary
  ***************************

  ------------------------------------------------------------------------------------------------------------------------------
                                 Total      Total      Total      Total     Imperv       Perv      Total       Total     Peak  Runoff
                                Precip      Runon       Evap      Infil     Runoff     Runoff     Runoff      Runoff   Runoff   Coeff
  Subcatchment                      mm         mm         mm         mm         mm         mm         mm    10^6 ltr      CMS
  ------------------------------------------------------------------------------------------------------------------------------
  C_W01                     146.31       0.00       0.00      56.77      72.15      16.39      88.54        2.12     0.33   0.605
  C_W02                     146.31       0.00       0.00      56.91      72.15      16.25      88.40        2.54     0.38   0.604
  EX_SWC01B                 123.26       0.00       0.00     103.95       6.09      13.15      19.24        2.95     0.26   0.156
  EX_SWC02A                 123.26       0.00       0.00     104.42       6.09      12.68      18.77        3.13     0.28   0.152
  EX_SWC02B                 123.26       0.00       0.00     102.91       6.09      14.19      20.28        1.67     0.15   0.165
  Mangawhero_Existing_Conditions     146.31       0.00       0.00     138.14       7.22       0.86       8.08      398.28    17.91
0.055
  Mangawhero_Extended       146.31       0.00       0.00     137.64       7.71       0.86       8.57      433.86    19.08   0.059
  Mangawhero_Trimmed        146.31       0.00       0.00     138.14       7.22       0.86       8.08      396.88    17.85   0.055
  Off-Site_Catchment        146.31       0.00       0.00     135.73       2.90       7.66      10.55       11.59     0.66   0.072
  SWC01B                    146.31       0.00       0.00      11.20     130.30       3.43     133.73       20.52     2.09   0.914
  SWC02A                    146.31       0.00       0.00      11.22     130.30       3.42     133.71       22.26     2.18   0.914
  SWC02B                    146.31       0.00       0.00      11.17     130.31       3.46     133.77       10.99     1.21   0.914


  ******************
  Node Depth Summary
  ******************

  ---------------------------------------------------------------------------------
                                 Average  Maximum  Maximum  Time of Max    Reported
                                   Depth    Depth      HGL   Occurrence   Max Depth
  Node                 Type       Meters   Meters   Meters  days hr:min      Meters
  ---------------------------------------------------------------------------------
  STREAM_OUTFALL       JUNCTION     0.16     0.49    54.78     0  15:29        0.49
  SW01_01              JUNCTION     0.00     0.24    57.24     0  12:21        0.24
  SW01_02              JUNCTION     0.15     0.84    57.24     0  12:17        0.83
  SW01_03              JUNCTION     0.25     0.91    57.01     0  16:11        0.91
  SW02_01              JUNCTION     0.01     0.39    58.89     0  12:20        0.39
  SW02_02              JUNCTION     0.12     0.97    58.87     0  12:18        0.97
  SW02_03              JUNCTION     0.17     0.82    58.42     0  16:04        0.82
  SWD01_CU_OUTLET      JUNCTION     0.21     0.56    55.96     0  15:00        0.56
  SWD01_SCRUFFY_OUT    JUNCTION     0.16     0.51    56.01     0  15:21        0.51
  SWD02_CU_OUTLET      JUNCTION     0.36     0.75    55.40     0  15:13        0.75
  SWD02_SCRUFFY_OUT    JUNCTION     0.10     0.29    55.49     0  16:01        0.29
  EX_SWD01_OUT         OUTFALL      0.00     0.00    55.50     0  00:00        0.00
  EX_SWD02_OUT         OUTFALL      0.00     0.00    54.65     0  00:00        0.00
  Mangawehro_Existing_Conditions_Out OUTFALL      0.00     0.00    41.45     0  00:00        0.00
  Mangawhero_Extended_Out OUTFALL      0.00     0.00    41.45     0  00:00        0.00
  Mangawhero_Outfall   OUTFALL      0.14     0.40    52.40     0  15:29        0.40
  Mangawhero_Trimmed_Out OUTFALL      0.00     0.00    41.45     0  00:00        0.00
  SKGE_SWC01A          STORAGE      0.00     0.00    56.00     0  00:00        0.00
  SKGE_SWC01B          STORAGE      0.62     1.73    57.73     0  12:11        1.72
  SKGE_SWC02A          STORAGE      0.63     1.73    59.73     0  12:12        1.73
  SKGE_SWC02B          STORAGE      0.61     1.66    59.66     0  12:10        1.66
  SWD01                STORAGE      0.32     1.01    57.01     0  16:11        1.01
  SWD02                STORAGE      0.43     1.42    58.42     0  16:05        1.42


  *******************
  Node Inflow Summary
  *******************

  -------------------------------------------------------------------------------------------------
                                  Maximum  Maximum                  Lateral       Total        Flow
                                  Lateral    Total  Time of Max      Inflow      Inflow     Balance
                                   Inflow   Inflow   Occurrence      Volume      Volume       Error
  Node                 Type           CMS      CMS  days hr:min    10^6 ltr    10^6 ltr     Percent
  -------------------------------------------------------------------------------------------------
  STREAM_OUTFALL       JUNCTION     0.000    1.029     0  15:25           0        56.9       0.010
  SW01_01              JUNCTION     0.000    0.120     0  12:13           0      0.0921      10.692
  SW01_02              JUNCTION     0.000    1.987     0  12:11           0        16.2      -0.454
  SW01_03              JUNCTION     0.000    1.750     0  12:19           0        16.1       0.441
  SW02_01              JUNCTION     0.000    0.270     0  12:13           0       0.208       7.707
  SW02_02              JUNCTION     0.000    3.238     0  12:11           0        26.5      -0.290
  SW02_03              JUNCTION     0.000    2.760     0  12:18           0        26.3       0.266
  SWD01_CU_OUTLET      JUNCTION     0.658    0.756     0  12:09        11.6        29.3      -0.102
  SWD01_SCRUFFY_OUT    JUNCTION     0.000    0.260     0  16:11           0        17.7       0.001
  SWD02_CU_OUTLET      JUNCTION     0.000    1.031     0  15:23           0        57.1       0.132
  SWD02_SCRUFFY_OUT    JUNCTION     0.000    0.423     0  16:05           0        28.3       0.000
  EX_SWD01_OUT         OUTFALL      0.263    0.263     0  12:09        2.95        2.95       0.000
  EX_SWD02_OUT         OUTFALL      0.428    0.428     0  12:09        4.79        4.79       0.000
  Mangawehro_Existing_Conditions_Out OUTFALL     17.912   17.912     0  12:19         398         398       0.000
  Mangawhero_Extended_Out OUTFALL     19.081   19.081     0  12:19         434         434       0.000
  Mangawhero_Outfall   OUTFALL      0.000    1.029     0  15:29           0        56.8       0.000
  Mangawhero_Trimmed_Out OUTFALL     17.849   17.849     0  12:19         397         397       0.000
  SKGE_SWC01A          STORAGE      0.000    0.000     0  00:00           0           0       0.000 ltr
  SKGE_SWC01B          STORAGE      2.087    2.087     0  12:09        20.5        20.5      -0.000
  SKGE_SWC02A          STORAGE      2.184    2.184     0  12:09        22.3        22.3      -0.000
  SKGE_SWC02B          STORAGE      1.212    1.212     0  12:09          11          11      -0.000
  SWD01                STORAGE      0.327    1.909     0  12:21        2.12        18.1      -0.041
  SWD02                STORAGE      0.380    2.994     0  12:18        2.54        28.7      -0.029


  *********************
  Node Surcharge Summary
  *********************

  No nodes were surcharged.
```

```
*********************
Node Flooding Summary
*********************

No nodes were flooded.


**********************
Storage Volume Summary
**********************

--------------------------------------------------------------------------------------------------
                       Average     Avg  Evap Exfil       Maximum     Max    Time of Max    Maximum
                        Volume    Pcnt  Pcnt  Pcnt        Volume    Pcnt     Occurrence    Outflow
Storage Unit           1000 m3    Full  Loss  Loss       1000 m3    Full    days hr:min        CMS
--------------------------------------------------------------------------------------------------
SKGE_SWC01A              0.000       0     0     0         0.000       0       0  00:00      0.000
SKGE_SWC01B              0.589      31     0    21         1.640      86       0  12:11      2.020
SKGE_SWC02A              0.626      31     0    21         1.734      87       0  12:12      2.116
SKGE_SWC02B              0.307      31     0    21         0.829      83       0  12:10      1.184
SWD01                    3.042       7     0     0        10.065      23       0  16:11      0.260
SWD02                    4.678      10     0     0        16.215      34       0  16:05      0.423


***********************
Outfall Loading Summary
***********************

-----------------------------------------------------------
                       Flow       Avg       Max       Total
                       Freq      Flow      Flow      Volume
Outfall Node           Pcnt       CMS       CMS    10^6 ltr
-----------------------------------------------------------
EX_SWD01_OUT          36.31     0.031     0.263       2.951
EX_SWD02_OUT          37.27     0.050     0.428       4.791
Mangawehro_Existing_Conditions_Out  99.98     1.537    17.912     398.280
Mangawhero_Extended_Out  99.98     1.674    19.081     433.860
Mangawhero_Outfall    97.42     0.225     1.029      56.845
Mangawhero_Trimmed_Out  99.98     1.532    17.849     396.876
-----------------------------------------------------------
System                78.49     5.049    55.875    1293.603


********************
Link Flow Summary
********************

-----------------------------------------------------------------------------
                               Maximum  Time of Max   Maximum    Max/    Max/
                                |Flow|   Occurrence   |Veloc|    Full    Full
Link                 Type          CMS  days hr:min     m/sec    Flow   Depth
-----------------------------------------------------------------------------
CU_MANGAWHERO_OUT    CONDUIT     1.029     0  15:29      3.80    0.55    0.59
CULVERT01            CONDUIT     0.260     0  16:11      0.91    0.25    0.71
CULVERT02            CONDUIT     0.423     0  16:05      1.30    0.23    0.69
STREAM01             CHANNEL     0.613     0  15:00      0.36    0.00    0.11
STREAM02             CHANNEL     1.029     0  15:25      0.57    0.00    0.10
SWALE01_01           CHANNEL     0.120     0  12:13      0.13    0.01    0.36
SWALE01_02           CHANNEL     1.750     0  12:19      0.62    0.08    0.36
SWALE01_03           CHANNEL     1.725     0  12:22      1.24    0.08    0.43
SWALE02_01           CHANNEL     0.270     0  12:13      0.15    0.03    0.45
SWALE02_02           CHANNEL     2.760     0  12:18      0.70    0.13    0.40
SWALE02_03           CHANNEL     2.757     0  12:20      1.24    0.13    0.39
SWD01_ORFC           ORIFICE     0.165     0  16:11                      1.00
SWD02_ORFCE          ORIFICE     0.260     0  16:05                      1.00
SKGE_SWC01A_OT       WEIR        0.000     0  00:00                      0.00
SKGE_SWC01B_OT       WEIR        1.987     0  12:11                      0.23
SKGE_SWC02A_OT       WEIR        2.081     0  12:12                      0.23
SKGE_SWC02B_OT       WEIR        1.166     0  12:10                      0.16
SWD01_100-Y          WEIR        0.000     0  00:00                      0.00
SWD01_10-Y           WEIR        0.095     0  16:11                      0.13
SWD01_EMRGNCY_OF     WEIR        0.000     0  00:00                      0.00
SWD02_100-Y          WEIR        0.000     0  00:00                      0.00
SWD02_10-Y           WEIR        0.164     0  16:05                      0.20
SWD02_EMRGNCY_OF     WEIR        0.000     0  00:00                      0.00


***************************
Flow Classification Summary
***************************

-------------------------------------------------------------------------------------
                    Adjusted    ---------- Fraction of Time in Flow Class ----------
                     /Actual         Up    Down  Sub   Sup   Up    Down  Norm  Inlet
Conduit               Length    Dry  Dry   Dry   Crit  Crit  Crit  Crit  Ltd   Ctrl
-------------------------------------------------------------------------------------
CU_MANGAWHERO_OUT       1.00   0.02  0.00  0.00  0.01  0.97  0.00  0.00  0.01  0.00
CULVERT01               1.00   0.00  0.02  0.00  0.98  0.00  0.00  0.00  0.29  0.00
CULVERT02               1.00   0.01  0.01  0.00  0.98  0.00  0.00  0.00  0.87  0.00
STREAM01                1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.96  0.00
STREAM02                1.00   0.01  0.00  0.00  0.99  0.00  0.00  0.00  0.00  0.00
SWALE01_01              1.00   0.09  0.14  0.00  0.77  0.00  0.00  0.00  0.80  0.00
SWALE01_02              1.00   0.09  0.00  0.00  0.91  0.00  0.00  0.00  0.55  0.00
SWALE01_03              1.00   0.09  0.00  0.00  0.64  0.00  0.00  0.27  0.07  0.00
SWALE02_01              1.00   0.09  0.19  0.00  0.73  0.00  0.00  0.00  0.82  0.00
SWALE02_02              1.00   0.09  0.00  0.00  0.91  0.00  0.00  0.00  0.65  0.00
SWALE02_03              1.00   0.09  0.00  0.00  0.28  0.00  0.00  0.64  0.01  0.00


*************************
Conduit Surcharge Summary
*************************

No conduits were surcharged.
```

```
Analysis begun on:  Thu Jun 23 16:28:31 2022
Analysis ended on:  Thu Jun 23 16:28:44 2022
Total elapsed time: 00:00:13
```

100-YEAR/24-HOUR ARI WITH CLIMATE CHANGE (EXISTING CONDITIONS CATCHMENT CACLUCATIONS CONSIDER NON-CLIMATE CHANGE ADJUSTED RAINFALL)

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.0)
------------------------------------------------------------

****************
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 ............ 10/06/2021 00:00:00
Ending Date .............. 10/09/2021 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:00:01
Dry Time Step ............ 00:00:01
Routing Time Step ........ 0.50 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 ......      3490.952       231.135
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........      3201.126       211.946
Surface Runoff ...........       288.321        19.090
Final Storage ............         1.505         0.100
Continuity Error (%) .....         0.000


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......       288.321      2883.245
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........       286.834      2868.368
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         1.379        13.787
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.109         1.088
Continuity Error (%) .....         0.000


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


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


*********************************
Most Frequent Nonconverging Nodes
*********************************
Convergence obtained at all time steps.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.12 sec
Average Time Step           :     0.50 sec
Maximum Time Step           :     0.50 sec
% of Time in Steady State   :     0.00
Average Iterations per Step :     2.00
% of Steps Not Converging   :     0.00
Time Step Frequencies       :
    0.500 -  0.315 sec      :    99.99 %
    0.315 -  0.199 sec      :     0.00 %
    0.199 -  0.126 sec      :     0.00 %
    0.126 -  0.079 sec      :     0.00 %
    0.079 -  0.050 sec      :     0.00 %
```

```
  ***************************
  Subcatchment Runoff Summary
  ***************************

  ------------------------------------------------------------------------------------------------------------------------------
                          Total      Total      Total      Total     Imperv       Perv      Total       Total     Peak  Runoff
                         Precip      Runon       Evap      Infil     Runoff     Runoff     Runoff      Runoff   Runoff   Coeff
  Subcatchment               mm         mm         mm         mm         mm         mm         mm    10^6 ltr      CMS
  ------------------------------------------------------------------------------------------------------------------------------
  C_W01                  231.24       0.00       0.00      69.80     114.62      45.82     160.44        3.85     0.62   0.694
  C_W02                  231.24       0.00       0.00      69.93     114.62      45.69     160.30        4.60     0.73   0.693
  EX_SWC01B              193.14       0.00       0.00     132.74       9.58      50.75      60.33        9.26     0.67   0.312
  EX_SWC02A              193.14       0.00       0.00     133.56       9.58      49.92      59.50        9.91     0.69   0.308
  EX_SWC02B              193.14       0.00       0.00     131.00       9.58      52.49      62.07        5.10     0.40   0.321
  Mangawhero_Existing_Conditions      231.24       0.00       0.00     213.20      11.47       6.47      17.94      884.44    34.02
0.078
  Mangawhero_Extended    231.24       0.00       0.00     212.42      12.25       6.47      18.71      947.74    36.15   0.081
  Mangawhero_Trimmed     231.24       0.00       0.00     213.20      11.47       6.47      17.94      881.33    33.90   0.078
  Off-Site_Catchment     231.24       0.00       0.00     185.52       4.59      41.09      45.68       50.15     1.51   0.198
  SWC01B                 231.24       0.00       0.00      13.81     206.73       9.31     216.04       33.15     3.81   0.934
  SWC02A                 231.24       0.00       0.00      13.83     206.73       9.30     216.03       35.96     4.00   0.934
  SWC02B                 231.24       0.00       0.00      13.78     206.74       9.34     216.08       17.75     2.19   0.934


  ******************
  Node Depth Summary
  ******************

  ---------------------------------------------------------------------------------
                                 Average  Maximum  Maximum  Time of Max    Reported
                                   Depth    Depth      HGL   Occurrence   Max Depth
  Node                 Type       Meters   Meters   Meters  days hr:min      Meters
  ---------------------------------------------------------------------------------
  STREAM_OUTFALL       JUNCTION     0.57     2.92    57.21     0  19:10        2.92
  SW01_01              JUNCTION     0.07     0.47    57.47     0  15:41        0.47
  SW01_02              JUNCTION     0.29     1.07    57.47     0  15:41        1.07
  SW01_03              JUNCTION     0.42     1.37    57.47     0  15:47        1.37
  SW02_01              JUNCTION     0.06     0.62    59.12     0  12:17        0.60
  SW02_02              JUNCTION     0.24     1.20    59.10     0  12:17        1.19
  SW02_03              JUNCTION     0.32     1.44    59.04     0  14:58        1.44
  SWD01_CU_OUTLET      JUNCTION     0.42     1.81    57.21     0  19:10        1.81
  SWD01_SCRUFFY_OUT    JUNCTION     0.37     1.76    57.26     0  19:05        1.76
  SWD02_CU_OUTLET      JUNCTION     0.68     2.56    57.21     0  19:10        2.56
  SWD02_SCRUFFY_OUT    JUNCTION     0.41     2.30    57.50     0  18:32        2.30
  EX_SWD01_OUT         OUTFALL      0.00     0.00    55.50     0  00:00        0.00
  EX_SWD02_OUT         OUTFALL      0.00     0.00    54.65     0  00:00        0.00
  Mangawehro_Existing_Conditions_Out OUTFALL      0.00     0.00    41.45     0  00:00        0.00
  Mangawehro_Extended_Out OUTFALL      0.00     0.00    41.45     0  00:00        0.00
  Mangawhero_Outfall   OUTFALL      0.24     0.75    52.75     0  14:44        0.75
  Mangawehro_Trimmed_Out OUTFALL      0.00     0.00    41.45     0  00:00        0.00
  SKGE_SWC01A          STORAGE      0.00     0.00    56.00     0  00:00        0.00
  SKGE_SWC01B          STORAGE      0.66     1.84    57.84     0  12:11        1.83
  SKGE_SWC02A          STORAGE      0.67     1.85    59.85     0  12:11        1.84
  SKGE_SWC02B          STORAGE      0.65     1.74    59.74     0  12:10        1.73
  SWD01                STORAGE      0.50     1.47    57.47     0  15:47        1.47
  SWD02                STORAGE      0.62     2.04    59.04     0  14:59        2.04


  *******************
  Node Inflow Summary
  *******************

  -------------------------------------------------------------------------------------------------
                                  Maximum  Maximum                  Lateral       Total        Flow
                                  Lateral    Total  Time of Max      Inflow      Inflow     Balance
                                   Inflow   Inflow   Occurrence      Volume      Volume       Error
  Node                 Type           CMS      CMS  days hr:min    10^6 ltr    10^6 ltr     Percent
  -------------------------------------------------------------------------------------------------
  STREAM_OUTFALL       JUNCTION     0.000    2.118     0  16:47           0         131       0.033
  SW01_01              JUNCTION     0.000    0.301     0  12:13           0       0.346       4.938
  SW01_02              JUNCTION     0.000    3.651     0  12:11           0        28.9      -0.285
  SW01_03              JUNCTION     0.000    3.057     0  12:16           0        28.3       0.239
  SW02_01              JUNCTION     0.000    0.599     0  12:11           0       0.594       1.823
  SW02_02              JUNCTION     0.000    5.947     0  12:10           0          47      -0.231
  SW02_03              JUNCTION     0.000    5.073     0  12:19           0        46.3       0.249
  SWD01_CU_OUTLET      JUNCTION     1.514    1.851     0  14:39        50.2        81.7      -0.089
  SWD01_SCRUFFY_OUT    JUNCTION     0.000    0.534     0  14:02           0        31.6       0.000
  SWD02_CU_OUTLET      JUNCTION     0.000    2.594     0  13:36           0         131       0.069
  SWD02_SCRUFFY_OUT    JUNCTION     0.000    0.872     0  14:59           0        50.2       0.000
  EX_SWD01_OUT         OUTFALL      0.669    0.669     0  12:09        9.26        9.26       0.000
  EX_SWD02_OUT         OUTFALL      1.093    1.093     0  12:09          15          15       0.000
  Mangawehro_Existing_Conditions_Out OUTFALL     34.024   34.024     0  12:14         884         884       0.000
  Mangawehro_Extended_Out OUTFALL     36.146   36.146     0  12:14         948         948       0.000
  Mangawhero_Outfall   OUTFALL      0.000    2.073     0  19:11           0         131       0.000
  Mangawehro_Trimmed_Out OUTFALL     33.904   33.904     0  12:14         881         881       0.000
  SKGE_SWC01A          STORAGE      0.000    0.000     0  00:00           0           0       0.000 ltr
  SKGE_SWC01B          STORAGE      3.806    3.806     0  12:09        33.1        33.1      -0.000
  SKGE_SWC02A          STORAGE      3.997    3.997     0  12:09          36          36      -0.000
  SKGE_SWC02B          STORAGE      2.188    2.188     0  12:09        17.7        17.7      -0.000
  SWD01                STORAGE      0.625    3.290     0  12:15        3.85        32.1      -0.038
  SWD02                STORAGE      0.729    5.374     0  12:14         4.6        50.8      -0.040


  **********************
  Node Surcharge Summary
  **********************

  No nodes were surcharged.
```

```
*********************
Node Flooding Summary
*********************

No nodes were flooded.


**********************
Storage Volume Summary
**********************

--------------------------------------------------------------------------------------------------
                       Average     Avg  Evap Exfil       Maximum     Max    Time of Max    Maximum
                        Volume    Pcnt  Pcnt  Pcnt        Volume    Pcnt     Occurrence    Outflow
Storage Unit           1000 m3    Full  Loss  Loss       1000 m3    Full    days hr:min        CMS
--------------------------------------------------------------------------------------------------
SKGE_SWC01A              0.000       0     0     0         0.000       0       0  00:00      0.000
SKGE_SWC01B              0.632      33     0    14         1.748      92       0  12:11      3.684
SKGE_SWC02A              0.671      34     0    13         1.852      93       0  12:11      3.870
SKGE_SWC02B              0.327      33     0    13         0.869      87       0  12:10      2.141
SWD01                    4.938      11     0     0        15.255      35       0  15:47      0.534
SWD02                    7.021      15     0     0        24.630      52       0  14:59      0.872


***********************
Outfall Loading Summary
***********************

-----------------------------------------------------------
                       Flow       Avg       Max       Total
                       Freq      Flow      Flow      Volume
Outfall Node           Pcnt       CMS       CMS    10^6 ltr
-----------------------------------------------------------
EX_SWD01_OUT          36.51     0.098     0.669       9.256
EX_SWD02_OUT          37.46     0.155     1.093      15.004
Mangawehro_Existing_Conditions_Out  99.99     3.414    34.024     884.446
Mangawhero_Extended_Out  99.99     3.658    36.146     947.738
Mangawhero_Outfall    98.05     0.514     2.073     130.583
Mangawhero_Trimmed_Out  99.99     3.402    33.904     881.327
-----------------------------------------------------------
System                78.66    11.240   106.763    2868.355


********************
Link Flow Summary
********************

-----------------------------------------------------------------------------
                               Maximum  Time of Max   Maximum    Max/    Max/
                                |Flow|   Occurrence   |Veloc|    Full    Full
Link                 Type          CMS  days hr:min     m/sec    Flow   Depth
-----------------------------------------------------------------------------
CU_MANGAWHERO_OUT    CONDUIT     2.073     0  19:11      4.69    1.10    1.00
CULVERT01            CONDUIT     0.534     0  14:01      1.21    0.52    1.00
CULVERT02            CONDUIT     0.872     0  14:59      1.97    0.47    1.00
STREAM01             CHANNEL     1.761     0  13:36      0.44    0.01    0.36
STREAM02             CHANNEL     2.118     0  16:47      0.61    0.01    0.46
SWALE01_01           CHANNEL     0.301     0  12:13      0.17    0.03    0.51
SWALE01_02           CHANNEL     3.057     0  12:16      0.65    0.14    0.57
SWALE01_03           CHANNEL     2.865     0  12:16      0.74    0.13    0.65
SWALE02_01           CHANNEL     0.599     0  12:11      0.17    0.07    0.60
SWALE02_02           CHANNEL     5.073     0  12:19      0.84    0.23    0.61
SWALE02_03           CHANNEL     4.911     0  12:19      1.41    0.23    0.68
SWD01_ORFC           ORIFICE     0.185     0  13:37                      1.00
SWD02_ORFCE          ORIFICE     0.318     0  14:59                      1.00
SKGE_SWC01A_OT       WEIR        0.000     0  00:00                      0.00
SKGE_SWC01B_OT       WEIR        3.651     0  12:11                      0.34
SKGE_SWC02A_OT       WEIR        3.835     0  12:11                      0.35
SKGE_SWC02B_OT       WEIR        2.124     0  12:10                      0.24
SWD01_100-Y          WEIR        0.049     0  15:47                      0.17
SWD01_10-Y           WEIR        0.321     0  14:38                      0.29
SWD01_EMRGNCY_OF     WEIR        0.000     0  00:00                      0.00
SWD02_100-Y          WEIR        0.017     0  14:59                      0.29
SWD02_10-Y           WEIR        0.537     0  14:59                      0.44
SWD02_EMRGNCY_OF     WEIR        0.000     0  00:00                      0.00


***************************
Flow Classification Summary
***************************

-------------------------------------------------------------------------------------
                    Adjusted    ---------- Fraction of Time in Flow Class ----------
                     /Actual         Up    Down  Sub   Sup   Up    Down  Norm  Inlet
Conduit               Length    Dry  Dry   Dry   Crit  Crit  Crit  Crit  Ltd   Ctrl
-------------------------------------------------------------------------------------
CU_MANGAWHERO_OUT       1.00   0.01  0.00  0.00  0.14  0.85  0.00  0.00  0.01  0.00
CULVERT01               1.00   0.00  0.01  0.00  0.99  0.00  0.00  0.00  0.20  0.00
CULVERT02               1.00   0.01  0.01  0.00  0.99  0.00  0.00  0.00  0.79  0.00
STREAM01                1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.80  0.00
STREAM02                1.00   0.01  0.00  0.00  0.99  0.00  0.00  0.00  0.00  0.00
SWALE01_01              1.00   0.06  0.10  0.00  0.84  0.00  0.00  0.00  0.64  0.00
SWALE01_02              1.00   0.06  0.00  0.00  0.94  0.00  0.00  0.00  0.47  0.00
SWALE01_03              1.00   0.06  0.00  0.00  0.77  0.00  0.00  0.17  0.07  0.00
SWALE02_01              1.00   0.06  0.09  0.00  0.85  0.00  0.00  0.00  0.68  0.00
SWALE02_02              1.00   0.06  0.00  0.00  0.94  0.00  0.00  0.00  0.58  0.00
SWALE02_03              1.00   0.06  0.00  0.00  0.34  0.00  0.00  0.59  0.01  0.00
```

```
*************************
Conduit Surcharge Summary
*************************

----------------------------------------------------------------------------
                                                          Hours        Hours
                       --------- Hours Full --------   Above Full   Capacity
Conduit                Both Ends  Upstream  Dnstream   Normal Flow   Limited
----------------------------------------------------------------------------
CU_MANGAWHERO_OUT           9.64     14.25      9.64       9.64         9.64
CULVERT01                  12.38     12.38     12.70       0.01         3.26
CULVERT02                  12.87     12.87     14.32       0.01         0.01


Analysis begun on:  Thu Jun 23 16:43:14 2022
Analysis ended on:  Thu Jun 23 16:43:28 2022
Total elapsed time: 00:00:14
```

100-YEAR/24-HOUR ARI WITH 3.8°C ADJUSTED CLIMATE CHANGE (RCP8.5) (EXISTING CONDISTIONS CATCHMENT CACLUCATIONS CONSIDER NON-CLIMATE CHANGE ADJUSTED RAINFALL)

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.2 (Build 5.2.0)
------------------------------------------------------------

****************
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 ............ 10/06/2021 00:00:00
Ending Date .............. 10/09/2021 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:00:01
Dry Time Step ............ 00:00:01
Routing Time Step ........ 0.50 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 ......      3867.370       256.058
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........      3507.492       232.230
Surface Runoff ...........       358.371        23.728
Final Storage ............         1.507         0.100
Continuity Error (%) .....         0.000


**************************        Volume        Volume
Flow Routing Continuity        hectare-m      10^6 ltr
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......       358.372      3583.757
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........         0.000         0.000
External Outflow .........       356.656      3566.599
Flooding Loss ............         0.000         0.000
Evaporation Loss .........         0.000         0.000
Exfiltration Loss ........         1.594        15.937
Initial Stored Volume ....         0.000         0.000
Final Stored Volume ......         0.122         1.222
Continuity Error (%) .....        -0.000


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


********************************
Highest Flow Instability Indexes
********************************
Link SKGE_SWC01A_OT (11)
Link SKGE_SWC01B_OT (10)
Link SWD01_10-Y (1)
Link SWD01_ORFC (1)
Link SWD01_100-Y (1)


*********************************
Most Frequent Nonconverging Nodes
*********************************
Convergence obtained at all time steps.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     0.14 sec
Average Time Step           :     0.50 sec
Maximum Time Step           :     0.50 sec
% of Time in Steady State   :     0.00
Average Iterations per Step :     2.02
% of Steps Not Converging   :     0.00
Time Step Frequencies       :
    0.500 -  0.315 sec      :   100.00 %
    0.315 -  0.199 sec      :     0.00 %
    0.199 -  0.126 sec      :     0.00 %
    0.126 -  0.079 sec      :     0.00 %
    0.079 -  0.050 sec      :     0.00 %
```

```
  ***************************
  Subcatchment Runoff Summary
  ***************************

  -------------------------------------------------------------------------------------------------------------------------------
                            Total      Total      Total      Total     Imperv       Perv      Total       Total     Peak   Runoff
                           Precip      Runon       Evap      Infil     Runoff     Runoff     Runoff      Runoff   Runoff    Coeff
  Subcatchment                 mm         mm         mm         mm         mm         mm         mm    10^6 ltr      CMS
  -------------------------------------------------------------------------------------------------------------------------------
  C_W01                    256.23       0.00       0.00      71.96     127.11      56.15     183.26        4.39     0.71    0.715
  C_W02                    256.23       0.00       0.00      72.10     127.11      56.01     183.12        5.26     0.83    0.715
  EX_SWC01B                193.14       0.00       0.00     132.74       9.58      50.75      60.33        9.26     0.67    0.312
  EX_SWC02A                193.14       0.00       0.00     133.56       9.58      49.92      59.50        9.91     0.69    0.308
  EX_SWC02B                193.14       0.00       0.00     131.00       9.58      52.49      62.07        5.10     0.40    0.321
  Mangawhero_Existing_Conditions     256.23       0.00       0.00     233.71      12.72       9.70      22.42     1105.56    39.54
0.088
  Mangawhero_Extended      256.23       0.00       0.00     232.84      13.58       9.70      23.28     1179.06    42.00    0.091
  Mangawhero_Trimmed       256.23       0.00       0.00     233.71      12.72       9.70      22.42     1101.66    39.41    0.088
  Off-Site_Catchment       256.23       0.00       0.00     195.34       5.09      55.76      60.85       66.81     1.87    0.237
  SWC01B                   256.23       0.00       0.00      14.24     229.22      11.38     240.60       36.91     4.33    0.939
  SWC02A                   256.23       0.00       0.00      14.26     229.22      11.37     240.58       40.05     4.55    0.939
  SWC02B                   256.23       0.00       0.00      14.21     229.23      11.41     240.64       19.76     2.49    0.939


  ******************
  Node Depth Summary
  ******************

  ---------------------------------------------------------------------------------
                                 Average  Maximum  Maximum  Time of Max    Reported
                                   Depth    Depth      HGL   Occurrence   Max Depth
  Node                 Type       Meters   Meters   Meters  days hr:min      Meters
  ---------------------------------------------------------------------------------
  STREAM_OUTFALL       JUNCTION     0.76     3.44    57.73     0  19:36        3.44
  SW01_01              JUNCTION     0.13     0.75    57.75     0  20:26        0.75
  SW01_02              JUNCTION     0.39     1.35    57.75     0  20:26        1.35
  SW01_03              JUNCTION     0.54     1.65    57.75     0  20:26        1.65
  SW02_01              JUNCTION     0.09     0.71    59.21     0  14:57        0.71
  SW02_02              JUNCTION     0.29     1.31    59.21     0  14:56        1.31
  SW02_03              JUNCTION     0.37     1.60    59.20     0  14:58        1.60
  SWD01_CU_OUTLET      JUNCTION     0.57     2.33    57.73     0  19:36        2.33
  SWD01_SCRUFFY_OUT    JUNCTION     0.52     2.24    57.74     0  19:51        2.24
  SWD02_CU_OUTLET      JUNCTION     0.85     3.08    57.73     0  19:36        3.08
  SWD02_SCRUFFY_OUT    JUNCTION     0.57     2.87    58.07     0  18:20        2.87
  EX_SWD01_OUT         OUTFALL      0.00     0.00    55.50     0  00:00        0.00
  EX_SWD02_OUT         OUTFALL      0.00     0.00    54.65     0  00:00        0.00
  Mangawehro_Existing_Conditions_Out OUTFALL      0.00     0.00    41.45     0  00:00        0.00
  Mangawhero_Extended_Out OUTFALL      0.00     0.00    41.45     0  00:00        0.00
  Mangawhero_Outfall   OUTFALL      0.27     0.75    52.75     0  13:45        0.75
  Mangawhero_Trimmed_Out OUTFALL      0.00     0.00    41.45     0  00:00        0.00
  SKGE_SWC01A          STORAGE      0.41     1.75    57.75     0  20:26        1.75
  SKGE_SWC01B          STORAGE      0.69     1.87    57.87     0  12:11        1.86
  SKGE_SWC02A          STORAGE      0.68     1.88    59.88     0  12:11        1.88
  SKGE_SWC02B          STORAGE      0.66     1.76    59.76     0  12:10        1.76
  SWD01                STORAGE      0.62     1.75    57.75     0  20:26        1.75
  SWD02                STORAGE      0.68     2.20    59.20     0  14:58        2.20


  *******************
  Node Inflow Summary
  *******************

  -------------------------------------------------------------------------------------------------
                                  Maximum  Maximum                  Lateral       Total        Flow
                                  Lateral    Total  Time of Max      Inflow      Inflow     Balance
                                   Inflow   Inflow   Occurrence      Volume      Volume       Error
  Node                 Type           CMS      CMS  days hr:min    10^6 ltr    10^6 ltr     Percent
  -------------------------------------------------------------------------------------------------
  STREAM_OUTFALL       JUNCTION     0.000    2.339     0  12:18           0         156       0.031
  SW01_01              JUNCTION     0.000    0.360     0  12:12           0       0.695       2.310
  SW01_02              JUNCTION     0.000    4.162     0  12:11           0        32.9      -0.021
  SW01_03              JUNCTION     0.000    3.421     0  12:15           0        30.4       0.216
  SW02_01              JUNCTION     0.000    0.697     0  12:11           0       0.776       1.380
  SW02_02              JUNCTION     0.000    6.778     0  12:10           0        53.2      -0.214
  SW02_03              JUNCTION     0.000    5.781     0  12:18           0        52.3       0.203
  SWD01_CU_OUTLET      JUNCTION     1.866    2.251     0  13:59        66.8         101      -0.080
  SWD01_SCRUFFY_OUT    JUNCTION     0.000    0.602     0  13:26           0        34.1      -0.006
  SWD02_CU_OUTLET      JUNCTION     0.000    3.053     0  13:06           0         157       0.064
  SWD02_SCRUFFY_OUT    JUNCTION     0.000    0.993     0  13:54           0        56.8       0.000
  EX_SWD01_OUT         OUTFALL      0.669    0.669     0  12:09        9.26        9.26       0.000
  EX_SWD02_OUT         OUTFALL      1.093    1.093     0  12:09          15          15       0.000
  Mangawehro_Existing_Conditions_Out OUTFALL     39.545   39.545     0  12:14    1.11e+03    1.11e+03       0.000
  Mangawhero_Extended_Out OUTFALL     41.999   41.999     0  12:14    1.18e+03    1.18e+03       0.000
  Mangawhero_Outfall   OUTFALL      0.000    2.191     0  19:36           0         156       0.000
  Mangawhero_Trimmed_Out OUTFALL     39.405   39.405     0  12:14     1.1e+03     1.1e+03       0.000
  SKGE_SWC01A          STORAGE      0.000    0.187     0  14:07           0        1.34      -5.118
  SKGE_SWC01B          STORAGE      4.331    4.331     0  12:09        36.9        36.9      -0.001
  SKGE_SWC02A          STORAGE      4.552    4.552     0  12:09        40.1        40.1      -0.000
  SKGE_SWC02B          STORAGE      2.485    2.485     0  12:09        19.8        19.8      -0.000
  SWD01                STORAGE      0.712    3.687     0  12:14        4.39        34.7      -0.014
  SWD02                STORAGE      0.832    6.048     0  12:16        5.26        57.4      -0.025


  **********************
  Node Surcharge Summary
  **********************

  No nodes were surcharged.
```

```
*********************
Node Flooding Summary
*********************

No nodes were flooded.


**********************
Storage Volume Summary
**********************

--------------------------------------------------------------------------------------------------
                       Average     Avg  Evap Exfil       Maximum     Max    Time of Max    Maximum
                        Volume    Pcnt  Pcnt  Pcnt        Volume    Pcnt     Occurrence    Outflow
Storage Unit           1000 m3    Full  Loss  Loss       1000 m3    Full    days hr:min        CMS
--------------------------------------------------------------------------------------------------
SKGE_SWC01A              0.173      21     0   105         0.736      88       0  20:26      0.029
SKGE_SWC01B              0.659      35     0    12         1.778      94       0  12:11      4.195
SKGE_SWC02A              0.680      34     0    12         1.884      94       0  12:11      4.410
SKGE_SWC02B              0.331      33     0    12         0.879      88       0  12:10      2.433
SWD01                    6.265      14     0     0        18.728      43       0  20:26      0.602
SWD02                    7.845      16     0     0        26.961      57       0  14:58      0.993


***********************
Outfall Loading Summary
***********************

-----------------------------------------------------------
                       Flow       Avg       Max       Total
                       Freq      Flow      Flow      Volume
Outfall Node           Pcnt       CMS       CMS    10^6 ltr
-----------------------------------------------------------
EX_SWD01_OUT          36.50     0.098     0.669       9.256
EX_SWD02_OUT          37.46     0.155     1.093      15.004
Mangawehro_Existing_Conditions_Out  99.99     4.267    39.545    1105.562
Mangawhero_Extended_Out  99.99     4.550    41.999    1179.066
Mangawhero_Outfall    98.17     0.613     2.191     156.031
Mangawhero_Trimmed_Out  99.99     4.252    39.405    1101.664
-----------------------------------------------------------
System                78.68    13.934   123.925    3566.582


********************
Link Flow Summary
********************

-----------------------------------------------------------------------------
                               Maximum  Time of Max   Maximum    Max/    Max/
                                |Flow|   Occurrence   |Veloc|    Full    Full
Link                 Type          CMS  days hr:min     m/sec    Flow   Depth
-----------------------------------------------------------------------------
CU_MANGAWHERO_OUT    CONDUIT     2.191      0  19:36      4.96    1.16    1.00
CULVERT01            CONDUIT     0.602      0  13:26      1.36    0.59    1.00
CULVERT02            CONDUIT     0.993      0  13:54      2.25    0.54    1.00
STREAM01             CHANNEL     2.132      0  13:06      0.48    0.01    0.45
STREAM02             CHANNEL     2.339      0  12:18      0.61    0.01    0.54
SWALE01_01           CHANNEL     0.360      0  12:12      0.17    0.04    0.70
SWALE01_02           CHANNEL     3.421      0  12:15      0.63    0.16    0.71
SWALE01_03           CHANNEL     3.177      0  12:15      0.76    0.15    0.78
SWALE02_01           CHANNEL     0.697      0  12:11      0.17    0.08    0.67
SWALE02_02           CHANNEL     5.781      0  12:18      0.85    0.27    0.68
SWALE02_03           CHANNEL     5.514      0  12:18      1.18    0.26    0.76
SWD01_ORFC           ORIFICE     0.185      1  04:03                      1.00
SWD02_ORFCE          ORIFICE     0.329      0  13:54                      1.00
SKGE_SWC01A_OT       WEIR        0.187      0  14:07                      0.25
SKGE_SWC01B_OT       WEIR        4.162      0  12:11                      0.37
SKGE_SWC02A_OT       WEIR        4.375      0  12:11                      0.38
SKGE_SWC02B_OT       WEIR        2.416      0  12:10                      0.26
SWD01_100-Y          WEIR        0.064      0  14:36                      0.29
SWD01_10-Y           WEIR        0.371      0  13:37                      0.39
SWD01_EMRGNCY_OF     WEIR        0.000      0  00:00                      0.00
SWD02_100-Y          WEIR        0.024      0  14:58                      0.37
SWD02_10-Y           WEIR        0.657      0  14:58                      0.50
SWD02_EMRGNCY_OF     WEIR        0.000      0  00:00                      0.00


***************************
Flow Classification Summary
***************************

-------------------------------------------------------------------------------------
                    Adjusted    ---------- Fraction of Time in Flow Class ----------
                     /Actual         Up    Down  Sub   Sup   Up    Down  Norm  Inlet
Conduit               Length    Dry  Dry   Dry   Crit  Crit  Crit  Crit  Ltd   Ctrl
-------------------------------------------------------------------------------------
CU_MANGAWHERO_OUT       1.00   0.01  0.00  0.00  0.19  0.79  0.00  0.00  0.01  0.00
CULVERT01               1.00   0.00  0.01  0.00  0.99  0.00  0.00  0.00  0.15  0.00
CULVERT02               1.00   0.00  0.01  0.00  0.99  0.00  0.00  0.00  0.75  0.00
STREAM01                1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.76  0.00
STREAM02                1.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
SWALE01_01              1.00   0.06  0.10  0.00  0.84  0.00  0.00  0.00  0.58  0.00
SWALE01_02              1.00   0.06  0.00  0.00  0.94  0.00  0.00  0.00  0.42  0.00
SWALE01_03              1.00   0.06  0.00  0.00  0.83  0.00  0.00  0.11  0.07  0.00
SWALE02_01              1.00   0.06  0.07  0.00  0.87  0.00  0.00  0.00  0.66  0.00
SWALE02_02              1.00   0.06  0.00  0.00  0.94  0.00  0.00  0.00  0.56  0.00
SWALE02_03              1.00   0.06  0.00  0.00  0.38  0.00  0.00  0.56  0.01  0.00
```

```
*************************
Conduit Surcharge Summary
*************************

----------------------------------------------------------------------------
                                                         Hours        Hours
                       --------- Hours Full --------   Above Full   Capacity
Conduit                Both Ends  Upstream  Dnstream   Normal Flow   Limited
----------------------------------------------------------------------------
CU_MANGAWHERO_OUT          13.38     16.87     13.38     13.38        13.38
CULVERT01                  15.55     15.55     15.71      0.01         2.57
CULVERT02                  15.75     15.75     16.94      0.01         0.01


Analysis begun on:  Thu Jun 23 16:47:24 2022
Analysis ended on:  Thu Jun 23 16:47:38 2022
Total elapsed time: 00:00:14
```

Appendix K – Mangawhero Stream Memo

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Memo

To	Amir Montakhab - CKL
From	Constantinos Fokianos
Date	23 June 2022
Job No.	146930.02
Job name	Calcutta Farms – Industrial Area
Subject	**Analysis on the impacts on proposed Industrial Are stormwater Management plan to Mangawhero Stream - Updated**

A high-level catchment analysis of Mangawhero Stream catchment was conducted to assess possible effects to Mangawhero Stream by the proposed Calcutta Farms Industrial Area plan change.

The stream's catchment was delineated using the available topographic mapping and aerial photographic information. The catchment was delineated to occupy an area of approximately 4,930ha. Stream's average slope was estimated using the modified Taylor-Schwarz Method to approximately 0.1%. The flat grade of the stream is evident from the extended meandering of the stream, yielding a sinuosity of over 1.5.

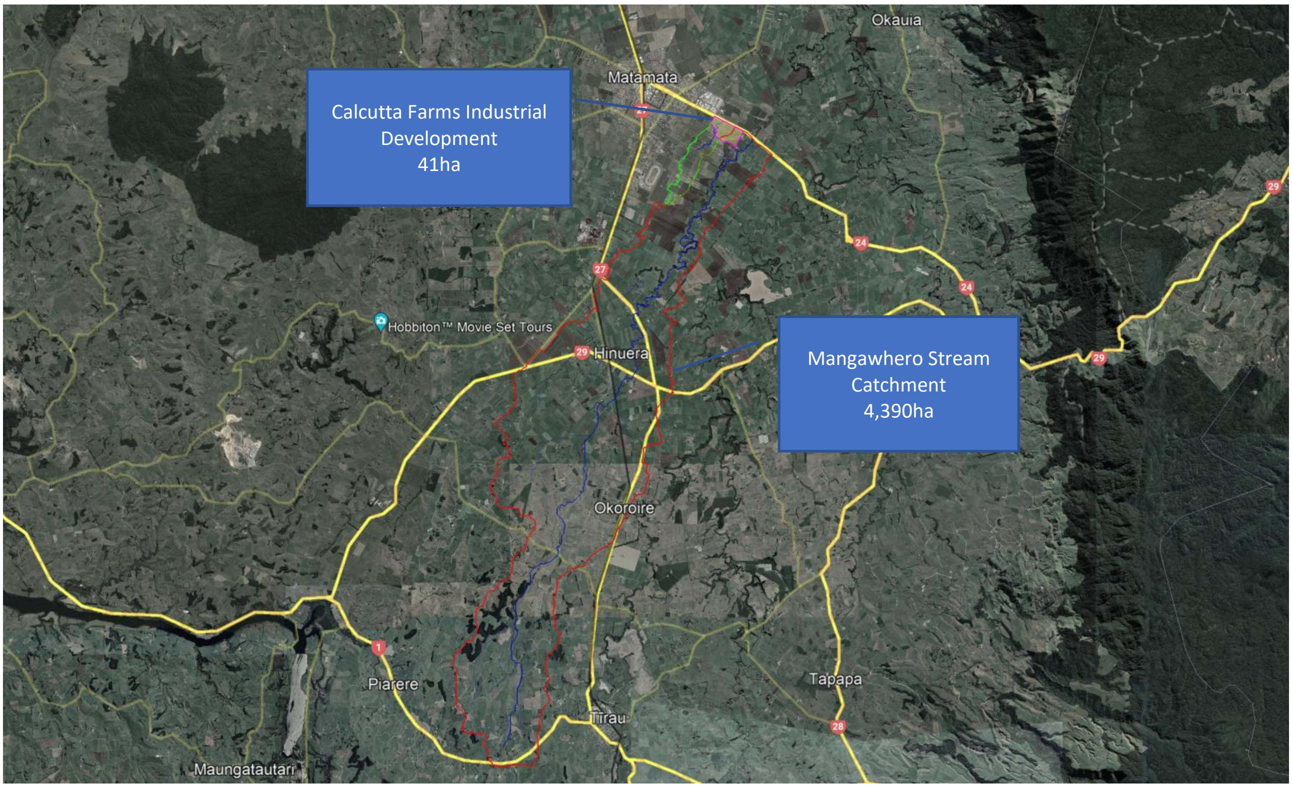

Figure 1. Mangawhero Stream Catchment at SH24 bridge. Aerial imagery by Google Earth.

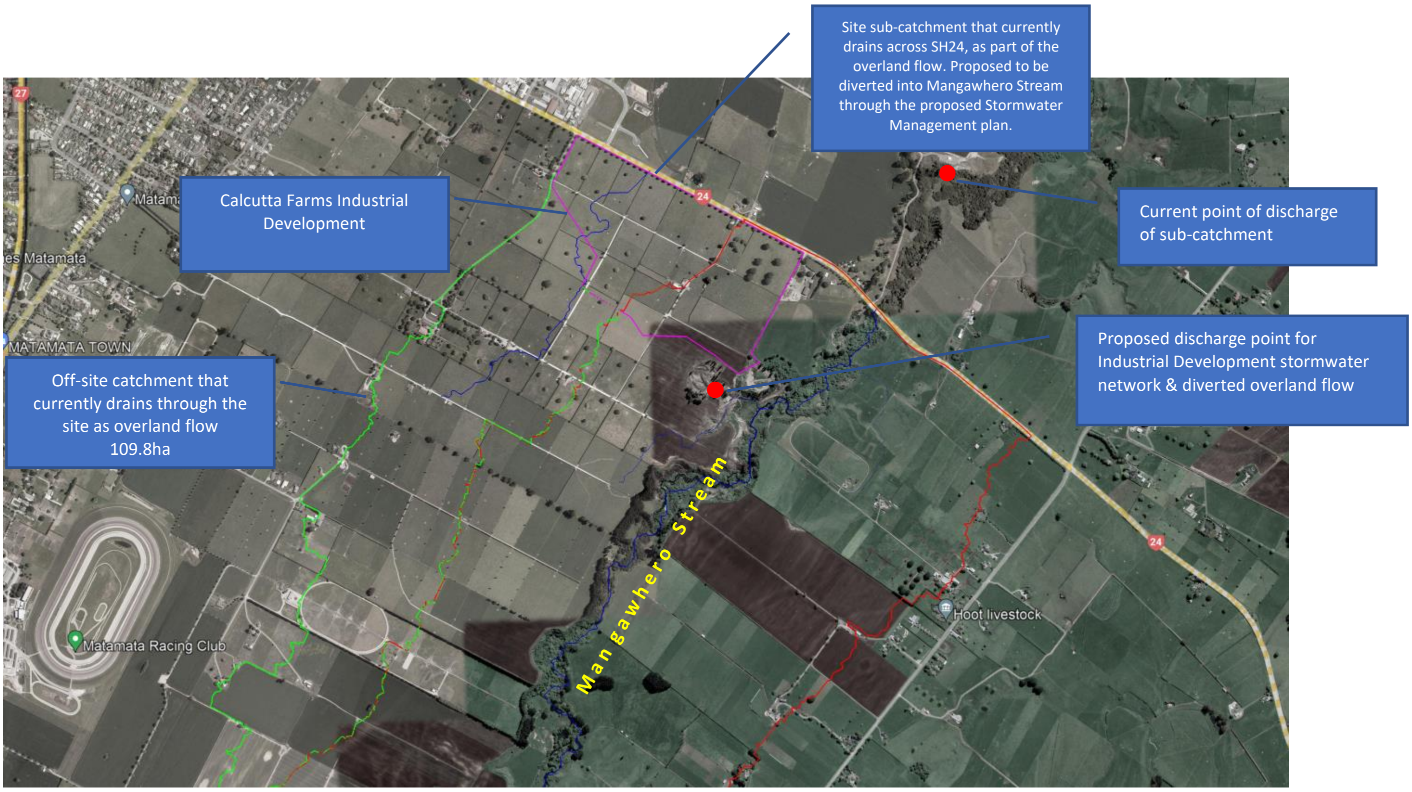

Figure 2. Calcutta Farms Industrial Development Catchment. Aerial imagery by Google Earth.

Due to the lack of any actual flow data from Mangawhero Stream, two different methods were used to determine the design flows. The first method included modelling the sub-catchment in EPA SWMM using HIRDS rainfall data (as described previously on the stormwater section of the engineering report). The second method that was used to confirm the model's output was the method described in "Flood Frequency in New Zealand" by McKerchar & Pearson. This method was used to calculate the 100-year, non-climate change adjusted flow and compare it to the SWMM model output. This method was used as an additional reference in the stormwater analysis and design of the new SH27 bridge over Mangawhero Stream which has been reviewed and accepted by Waka Kotahi. **Appendix A** provides brief description of the calculations based on this method.

In EPA SWMM model, three catchment configurations were considered:

- *Mangawhero_Existing_Conditions* refers to Mangawhero Catchment in current conditions, as delineated based on LIDAR, LINZ elevation data, and aerial photographic information.
- *Mangawhero_Extended* refers to the extended catchment with the attachment of the additional sub-catchment (24ha) of Calcutta Farms Industrial Area that currently drains across SH24 and discharges into Mangawhero Stream approximately 500 meters downstream of SH24 bridge and the off-site upstream catchment (110ha) of the overland flow. This Catchment was used to estimate the raise of the imperviousness percentage to of the whole catchment due to the proposed development, and total runoff into the proposed point of discharge.
- *Mangawhero_Trimmed* refers to Mangawhero Stream Catchment without the Calcutta Farms Industrial Area sub-catchment that currently drains into the stream upstream of the SH24 bridge. This catchment was then used in combination with the proposed Industrial Area layout to determine the discharge rate at SH24 bridge and compare it to the current conditions Catchment flows.

The catchments characteristics are shown in the table below.

Table 1. Modelled catchments Characteristics

BLOXAM BURNETT & OLLIVER

Client :		By	SD
		Checked	CF
		Approved	
Project :	CALCUTTA INDUSTRIAL DEVELOPMENT	Revision	**A**
		Date	03/05/20222

Mangawhero Stream

Catchment Characteristics at SH24 Bridge

													Infiltration (Horton)		
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.	f_i	f_o	Decay Const.
	m^2	ha	m^2	m^2	m	m	%	%			mm	mm			
Mangawhero_Existing_Conditions [1]	49305433	4930.543	2465271.7	46840161	28430	1734.3	0.1	5.0	0.015	0.15	2	5	33.87	6.6	4
Mangawhero_Extended [2]	50643543	5064.354	2704365.2	47939178	28420	1782.0	0.1	5.3	0.015	0.15	2	5	33.87	6.6	4
Mangawhero_Trimmed [3]	49131553	4913.155	2456577.7	46674975	28420	1728.8	0.1	5.0	0.015	0.15	2	5	33.87	6.6	4
Offsite Catchment	1097840.8	109.7841	21956.82	1075884	2480	442.7	0.1	2.0	0.015	0.15	2	5	33.87	6.6	4

[1] Mangawhero_Existing Conditions refers to Mangawhero Catchment in current conditions, as delineated based on LIDAR, LINZ elevation data, and aerial photographic information.

[2] Mangawhero_Extended refers to the extended catchment with the attachment of the additional off-site catchment and sub-catchment of Calcutta Farms Industrial Area that currently drains across SH24 and discharges into Mangawhero Stream approximately 500 meters downstream of SH24 bridge

[3] Mangawhero_Trimmed refers to Mangawhero Stream Catchment without the Calcutta Farms Industrial Area sub-catchment that currently drains into the stream upstream of the SH24 bridge.

GLOSSARY:

A: Catchment area
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

Table 2 presents all the calculated flows. The 100-year flows estimated by two entirely different methods seem to converge to a satisfactory level. Considering that the peak discharge from the proposed industrial area occurs on a different time than the Mangawhero Stream peak flow, the combined 100-year flow at SH24 bridge is 0.14m^3/s higher than the calculated flow for the current catchment runoff during the 100-year, climate change adjusted design rainfall.

Table 2. Calculated flows (m^3/s)

ARI	**SWMM MODEL**				**McKerchar & Pearson** **"Flood Frequency in New Zealand"**
	Mangawhero Stream - Existing Catchment		Proposed conditions (combination of *Mangawhero_Trimmed, Industrial Catchment and Offsite Catchment* discharge)		
	Non-Climate Change Adjusted	Climate Change Adjusted	Non-Climate Change Adjusted	Climate Change Adjusted	
2-year	8.00	9.96	8.28	10.18	-
10-year	14.2	17.91	14.84	18.88	-
100-year	26.26	34.02	27.9	35.94	30.54

A Flowmaster model was built to conduct normal depth hydraulic calculations of the various flows. The section derived from the 2008 WRC LIDAR grid. Based on the same data, a 0.1% slope was measured for Magawhero stream at the sections position. A manning's coefficient of 0.06 was used for flood plains with light brush and trees, according to both HEC-RAS and Flowmaster manuals. The results are presented in the **Appendix B** of this memo.

The calculations show minimum to negligible effects to the stream from the proposed diversion. For the 2-year ARI design event, the proposed diversion results in 9mm of depth increase and just 0.004m/s velocity increase. For the 10-year ARI design event, the corresponding effects are 29mm of depth and 0.009m/s velocity. Finally, for the 100-year ARI design event the effects are 32mm of depth and 0.010m/s velocity. This means that Mangawhero Stream can accommodate the additional flows without having any adverse effect on its flow capacity and without the increase of scour or erosion risk, as the flow characteristics remain practically unchanged. The proposed diversion also provides protection from flooding to both the proposed development and SH24 that currently does not have stormwater infrastructure to manage this overland flow, apart from two soak pits.

Based on the results, the proposed stormwater management layout for the Calcutta Farms industrial development is not expected to cause any adverse effects to Mangawhero Stream as the increase to the 100-year ARI discharge in the climate change adjusted scenario is $0.14m^3/s$ corresponds to 0.4% increase which is negligible. It is therefore proposed that bank stabilisation and scour and erosion control stream works for Mangawhero Stream are not required.

Yours sincerely
Bloxam Burnett & Olliver

Constantinos Fokianos
Water Resource Engineering Manager
0275101062
cfokianos@bbo.co.nz

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APPENDIX A

100-year ARI flow estimate based on McKerchar & Pearson "Flood Frequency in New Zealand" method

$A=49.31km^2$

From figure 3.4 (see below) → $\bar{Q}/A^{0.8}$ = 0.5

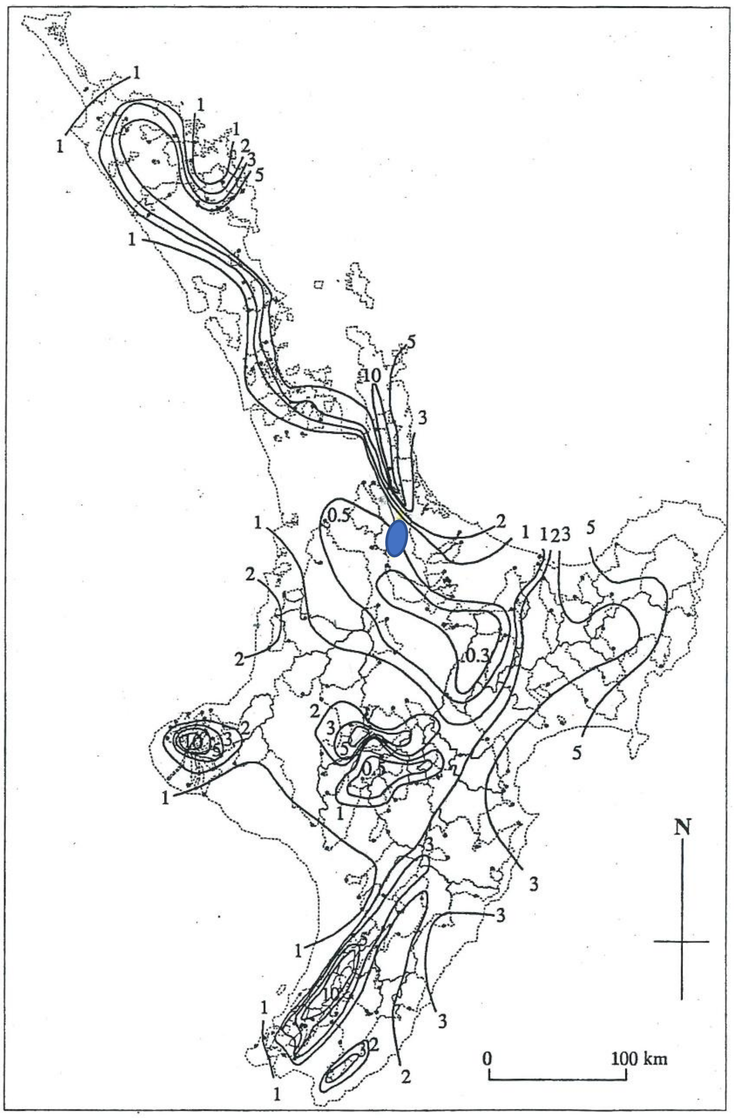


Fig. 3.4 North Island contour map of $\bar{Q}/A^{0.8}$. The contours have been fitted by eye to the data shown in Fig. 3.2. $\bar{Q}$ is in m^3/s, A is in km^2.

From Figure 4.8 (see below) → q_{100}= 2.7

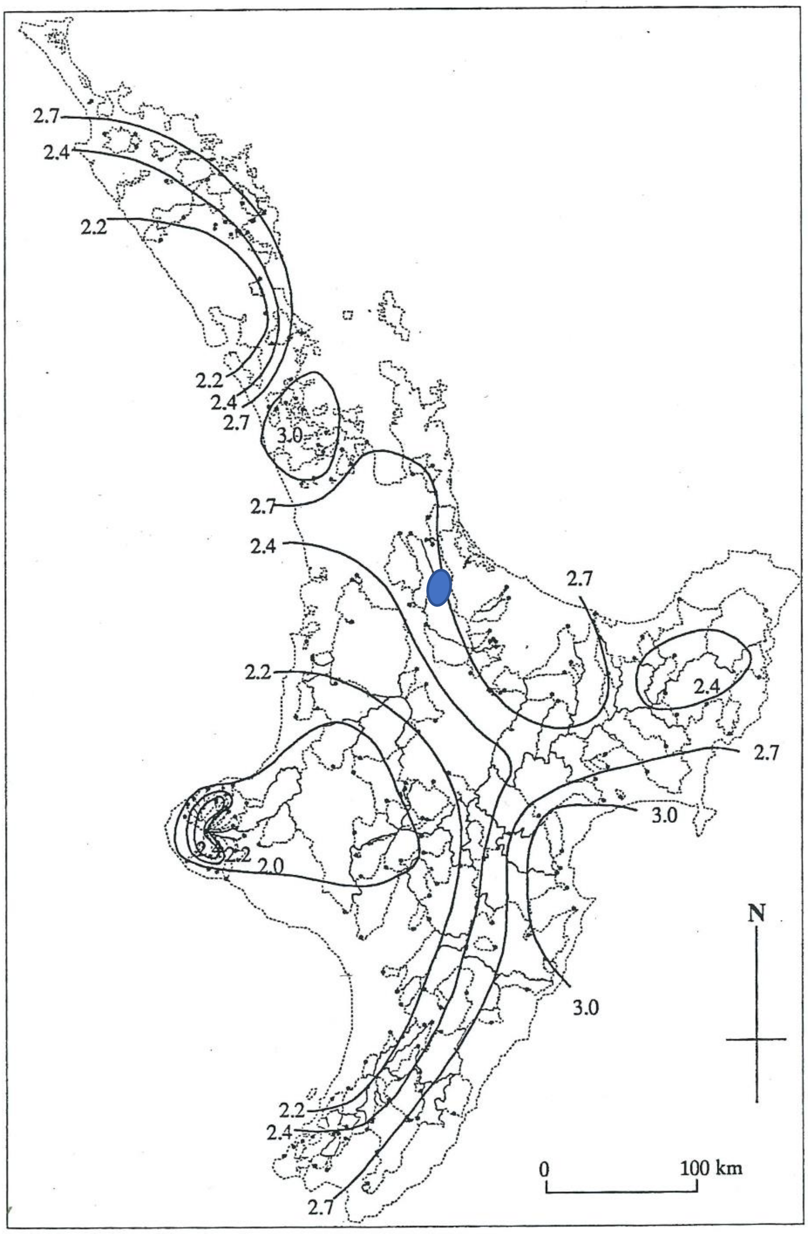


Fig. 4.8 North Island contour map of q_{100}. The contours are fitted by eye to the data shown in Fig. 4.6

$\bar{Q}_{map} = (\bar{Q}/A^{0.8}) \cdot (A)^{0.8}$ = 11.31 m^3/s

$\bar{Q}_{100,map} = \bar{Q}_{map} \cdot q_{100}$ = **30.54 m^3/s**

APPENDIX B

Flowmaster hydraulic calculations report on Mangawhero Stream Section

Irregular Section (Mangawhero Stream Flow Checks.fm8) Report

Label	Notes	Channel Slope (m/m)	Critical Depth (m)	Critical Slope (m/m)	Discharge (m³/s)
Existing Conditions - 100yr ARI_CC		0.00100	0.649	0.04760	34.02
Proposed Conditions - 100yr ARI_CC		0.00100	0.664	0.04706	35.94
Existing Conditions - 2yr ARI_CC		0.00100	0.405	0.06086	9.96
Proposed Conditions - 2yr ARI_CC		0.00100	0.408	0.06065	10.18
Existing Conditions - 10yr ARI_CC		0.00100	0.500	0.05442	17.91
Proposed Conditions - 10yr ARI_CC		0.00100	0.510	0.05383	18.88

Water Surface Elevation (m)	Flow Area (m²)	Flow Type	Friction Factor	Friction Method	Froude Number
43.94	67.78	Subcritical	0.0000	Manning Formula	0.17
43.97	70.14	Subcritical	0.0000	Manning Formula	0.17
43.14	26.25	Subcritical	0.0000	Manning Formula	0.15
43.15	26.61	Subcritical	0.0000	Manning Formula	0.16
43.41	38.00	Subcritical	0.0000	Manning Formula	0.16
43.44	39.30	Subcritical	0.0000	Manning Formula	0.16

Hydraulic Radius (m)	Maximum Elevation (m)	Minimum Elevation (m)	Normal Depth (m)	Number Of Steps	Roughness Coefficient
0.929	60.94	42.27	1.669	0	0.060
0.959	60.94	42.27	1.701	0	0.060
0.611	60.94	42.27	0.870	0	0.060
0.618	60.94	42.27	0.879	0	0.060
0.846	60.94	42.27	1.139	0	0.060
0.870	60.94	42.27	1.168	0	0.060

Roughness Height (m)	Solve For	Specific Energy (m)	Top Width (m)	Velocity (m/s)	Velocity Head (m)
0.000	Normal Depth	1.68	72.56	0.502	0.01
0.000	Normal Depth	1.71	72.77	0.512	0.01
0.000	Normal Depth	0.88	42.82	0.379	0.01
0.000	Normal Depth	0.89	42.88	0.383	0.01
0.000	Normal Depth	1.15	44.73	0.471	0.01
0.000	Normal Depth	1.18	44.94	0.480	0.01

Irregular Section (Mangawhero Stream Flow Checks.fm8) Report

Wetted Perimeter (m)	Profile Description
72.93	
73.16	
42.96	
43.02	
44.94	
45.17	

Cross Section for Existing Conditions - 100yr ARI_CC

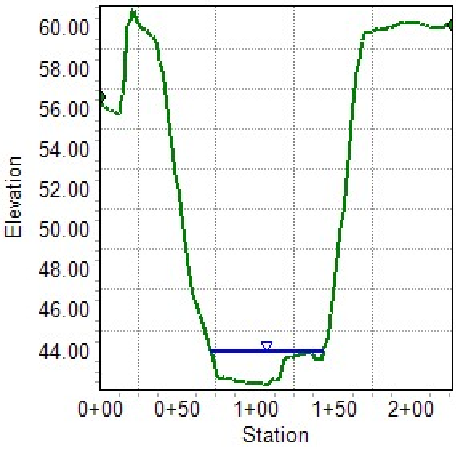
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00100	m/m
Normal Depth	1.669	m
Discharge	34.02	m³/s

Cross Section Image



Cross Section for Proposed Conditions - 100yr ARI_CC

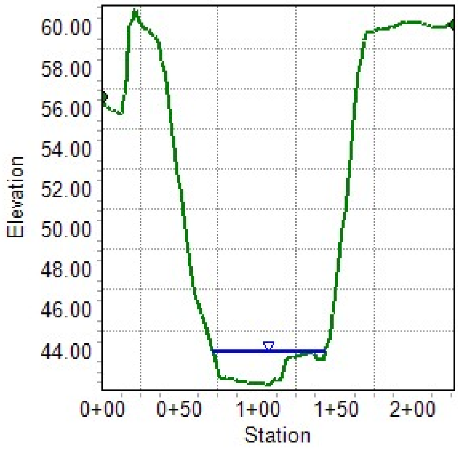
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00100	m/m
Normal Depth	1.701	m
Discharge	35.94	m³/s

Cross Section Image



Cross Section for Existing Conditions - 2yr ARI_CC

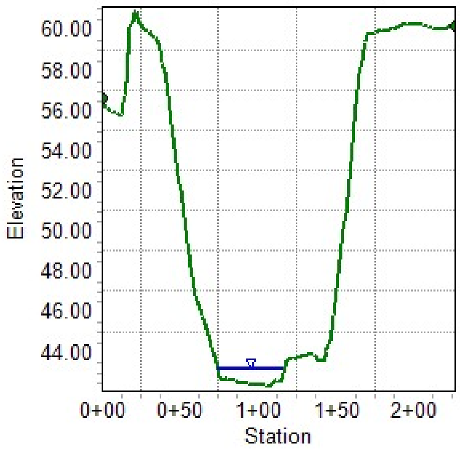
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00100	m/m
Normal Depth	0.870	m
Discharge	9.96	m³/s

Cross Section Image



Cross Section for Proposed Conditions - 2yr ARI_CC

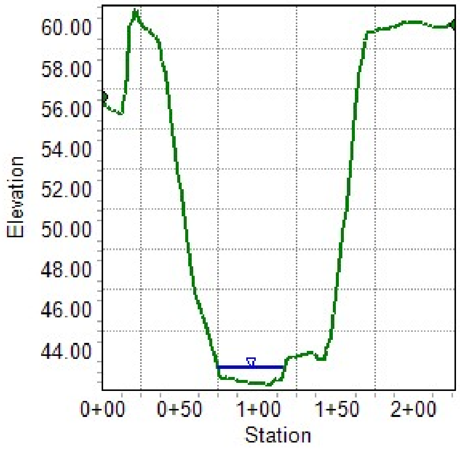
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00100	m/m
Normal Depth	0.879	m
Discharge	10.18	m³/s

Cross Section Image



Cross Section for Existing Conditions - 10yr ARI_CC

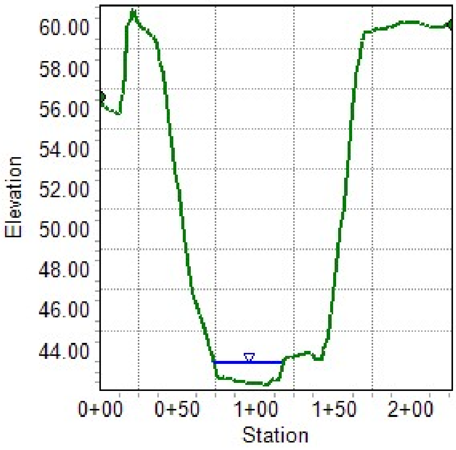
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00100	m/m
Normal Depth	1.139	m
Discharge	17.91	m³/s

Cross Section Image



Cross Section for Proposed Conditions - 10yr ARI_CC

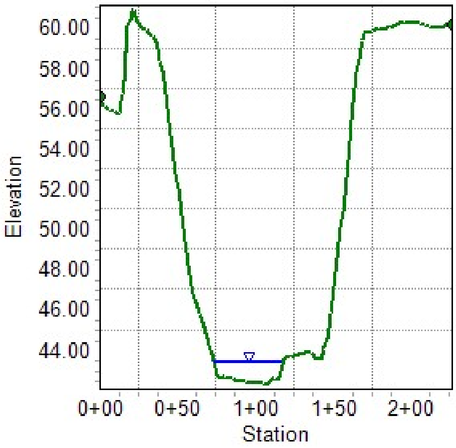
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00100	m/m
Normal Depth	1.168	m
Discharge	18.88	m³/s

Cross Section Image



Appendix L – Response to Peer Review Matters

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Memo

To	Amir Montakhab - CKL
From	Constantinos Fokianos
Date	23 June 2022
Job No.	146930.02
Job name	Calcutta Farms – Industrial Area
Subject	**Regarding Peer Review Items 2, 3, 4, & 10**

Items 2, 3, & 4

BBO contacted Waikato Regional Council (Brian Richmond and Megan Wood) regarding the hydrology matters and climate change factors that were used for this report. The response was that the proposed methodology appears to be acceptable. They also advised that the climate change factors will be changing soon and will be adjusted according to BECA's memo, and it is therefore recommended (not currently mandatory, though) to use the approach that is described on the document.

Based on WRC recommendations, we have updated the hydrological and hydraulic calculations to meet the upcoming requirements to future proof the proposed plan change. The design rainfall hyetographs were adjusted to 2.3°C temperature rise instead of the previously used 2.1°C. Also, a scenario of 3.8°C temperature rise was added to assess the elevated flood levels to the proposed wetlands and swales. As previously, the temperature change factors provided in HRDSv4 technical document were applied to the historical rainfall information to provide the future projection of the design rainfall depths and intensities.

Additional hydrological calculations were conducted to provide comparison of the proposed methodology using EPA SWMM in relation to WRC guidelines Worksheets 1 & 2 (graphical method), and calculations with the use of HEC-HMS and SCS Curve number and SCS Unit hydrograph, according to WRC TR20-06 and ARC TP108. Refer to Appendices A & B.

Table 1 below summarises the hydrological calculations and modelling that took place to provide an assessment of the three methods and how well they correlate. Catchment SWC01B was used for reference.

Table 1. Hydrological calculations table

Methodology & Software Used	Climate Change Scenario																							
	Existing Conditions												2.1°C Increase											
	2yr/24h				10yr/24h				100yr/24h				2yr/24h				10yr/24h				100yr/24h			
	P_{24}	Q_{24}	V	q	P_{24}	Q_{24}	V	q	P_{24}	Q_{24}	V	q	P_{24}	Q_{24}	V	q	P_{24}	Q_{24}	V	q	P_{24}	Q_{24}	V	q
	mm	mm	m^3	m^3/s	mm	mm	m^3	m^3/s	mm	mm	m^3	m^3/s	mm	mm	m^3	m^3/s	mm	mm	m^3	m^3/s	mm	mm	m^3	m^3/s
WRC Worksheets 1 & 2	79.3	10.3	1580	0.146	122	26.1	4004	0.393	191	61.3	9405	0.967	91.2	78.2	11997	1.231	142.8	129.2	19822	2.016	225.6	211.5	32448	3.288
HEC-HMS: WRC Temporal Pattern Rainfall, SCS CN Numbers, & SCS Unit Hydrograph	80.06	10.53	1610	0.125	123.27	26.56	4075	0.333	193.17	62.43	9579	0.808	92.25	86.55	13278	1.01	144.41	137.09	21032	1.603	228.09	219.11	33615	2.568
EPA SWMM: WRC Temporal Pattern Rainfall, Imperviousness + Horton's Infiltration	80.08	3.32	510	0.064	123.26	15.83	2430	0.128	193.14	55.88	8570	0.542	92.21	82.45	12650	1.117	144.38	131.73	20210	2.05	228.09	212.8	32650	3.74

Methodology & Software Used	Climate Change Scenario																							
	2.3°C Increase												3.8°C Increase											
	2yr/24h				10yr/24h				100yr/24h				2yr/24h				10yr/24h				100yr/24h			
	P_{24}	Q_{24}	V	q	P_{24}	Q_{24}	V	q	P_{24}	Q_{24}	V	q	P_{24}	Q_{24}	V	q	P_{24}	Q_{24}	V	q	P_{24}	Q_{24}	V	q
	mm	mm	m^3	m^3/s	mm	mm	m^3	m^3/s	mm	mm	m^3	m^3/s	mm	mm	m^3	m^3/s	mm	mm	m^3	m^3/s	mm	mm	m^3	m^3/s
WRC Worksheets 1 & 2	92.4	79.4	12482	1.247	144.72	131.1	20113	2.043	228.72	214.7	32939	3.334	101	87.9	13486	1.395	159.6	145.9	22384	2.277	253.4	239.3	36713	3.693
HEC-HMS: WRC Temporal Pattern Rainfall, SCS CN Numbers, & SCS Unit Hydrograph	93.41	87.67	13450	1.02	146.33	138.96	21319	1.626	231.19	222.16	34084	2.606	102.16	96.11	14745	1.122	161.32	153.6	23565	1.799	256.2	246.8	37864	2.895
EPA SWMM: WRC Temporal Pattern Rainfall, Imperviousness + Horton's Infiltration	93.41	83.57	12820	1.138	146.31	133.58	20490	2.087	231.24	215.88	33120	3.805	102.15	91.76	14080	1.284	161.36	148	22710	2.381	256.23	240.44	36890	4.331

Notes:

- The HEC-HMS model used lag time and SCS CN curve numbers as calculated in WRC Worksheets 1 & 2. The temporal pattern for rainfall was used as provided in WRC Stormwater Runoff Modelling Guideline (TR20-06), and the SCS Unit Hydrograph was used as the transform method.
- The EPA SWMM model is based on the methodology used for the hydrological calculations is briefly described in section 1.3.1 Drainage and Hydrology. It follows WRC guidelines regarding the Temporal Pattern for the design rainfalls. Imperviousness and initial and saturated hydraulic conductivity are used instead of Curve numbers CN. Pervious and impervious depression storage depths (mm) are defined instead of initial abstraction.
- WRC Worksheets attached at the end of the document.

The results show that there is reasonable correlation between the different models/methodologies for the post-development conditions, with the proposed EPA-SWMM model to provide a more conservative, higher peak runoff. On the existing conditions scenarios, WRC graphical method and HEC-HMS have good correlation, with EPA-SWMM providing a significantly lower estimate of the current peak flow. This is due to the different approach that the EPA SWMM and SCS method have regarding the runoff calculation on pervious surfaces (Horton's infiltration for SWMM and Curve Numbers for SCS). The imperviousness percentage was then revised from 2% to 5% to include all the gravel tracks. The undated flows from EPA SWMM correlated better with the HEC-HMS and WRC worksheets, but still remained lower. We believe that the proposed EPA SWMM model provides a better approach as it is based on the on-site investigations, infiltration test results on the higher levels of the ground, and measurement of impervious areas where the CN numbers have been defined based on rural catchments in the Midwest in United States, a few decades ago. Also, using the EPA SWMM results constitutes a more conservative approach as these lower flows have been determined as the attenuation target for the proposed wetlands outlet structures, providing more attenuation volume to the proposed system. Table 1 was then updated to include revised existing conditions flows.

Table 2. Hydrological calculations table (updated as per Existing Conditions)

Methodology & Software Used	Climate Change Scenario																							
	Existing Conditions												2.1°C Increase											
	2yr/24h				10yr/24h				100yr/24h				2yr/24h				10yr/24h				100yr/24h			
	P_{24}	Q_{24}	V	q	P_{24}	Q_{24}	V	q	P_{24}	Q_{24}	V	q	P_{24}	Q_{24}	V	q	P_{24}	Q_{24}	V	q	P_{24}	Q_{24}	V	q
	mm	mm	m^3	m^3/s	mm	mm	m^3	m^3/s	mm	mm	m^3	m^3/s	mm	mm	m^3	m^3/s	mm	mm	m^3	m^3/s	mm	mm	m^3	m^3/s
WRC Worksheets 1 & 2	79.3	10.3	1580	0.146	122	26.1	4004	0.393	191	61.3	9405	0.967	91.2	78.2	11997	1.231	142.8	129.2	19822	2.016	225.6	211.5	32448	3.288
HEC-HMS: WRC Temporal Pattern Rainfall, SCS CN Numbers, & SCS Unit Hydrograph	80.06	10.53	1610	0.125	123.27	26.56	4075	0.333	193.17	62.43	9579	0.808	92.25	86.55	13278	1.01	144.41	137.09	21032	1.603	228.09	219.11	33615	2.568
EPA SWMM: WRC Temporal Pattern Rainfall, Imperviousness + Horton's Infiltration	80.08	5.66	870	0.126	123.26	19.24	2950	0.263	193.14	60.33	9260	0.669	92.21	82.45	12650	1.117	144.38	131.73	20210	2.05	228.09	212.8	32650	3.74

Methodology & Software Used	Climate Change Scenario																							
	2.3°C Increase												3.8°C Increase											
	2yr/24h				10yr/24h				100yr/24h				2yr/24h				10yr/24h				100yr/24h			
	P_{24}	Q_{24}	V	q	P_{24}	Q_{24}	V	q	P_{24}	Q_{24}	V	q	P_{24}	Q_{24}	V	q	P_{24}	Q_{24}	V	q	P_{24}	Q_{24}	V	q
	mm	mm	m^3	m^3/s	mm	mm	m^3	m^3/s	mm	mm	m^3	m^3/s	mm	mm	m^3	m^3/s	mm	mm	m^3	m^3/s	mm	mm	m^3	m^3/s
WRC Worksheets 1 & 2	92.4	79.4	12482	1.247	144.72	131.1	20113	2.043	228.72	214.7	32939	3.334	101	87.9	13486	1.395	159.6	145.9	22384	2.277	253.4	239.3	36713	3.693
HEC-HMS: WRC Temporal Pattern Rainfall, SCS CN Numbers, & SCS Unit Hydrograph	93.41	87.67	13450	1.02	146.33	138.96	21319	1.626	231.19	222.16	34084	2.606	102.16	96.11	14745	1.122	161.32	153.6	23565	1.799	256.2	246.8	37864	2.895
EPA SWMM: WRC Temporal Pattern Rainfall, Imperviousness + Horton's Infiltration	93.41	83.57	12820	1.138	146.31	133.58	20490	2.087	231.24	215.88	33120	3.805	102.15	91.76	14080	1.284	161.36	148	22710	2.381	256.23	240.44	36890	4.331

The figures group below (Figure 1) presents the results for the various scenarios that were modelled for one catchment (SWC01B). The result show that on the post-development scenarios, EPA SWMM provides more conservative, higher peak runoff then the graphical method and HEC-HMS. EPA SWMM and the graphical method correlate better, while HEC-HMS provides smaller peak flows.

Figure 1. Catchment SWC01B peak flows calculated with different methods and under various climate change scenarios

Figures 2 and 3 below present the precipitation/runoff hydrographs of catchment SWC01B for both pre- and post-development conditions and the 100year ARI scenario.

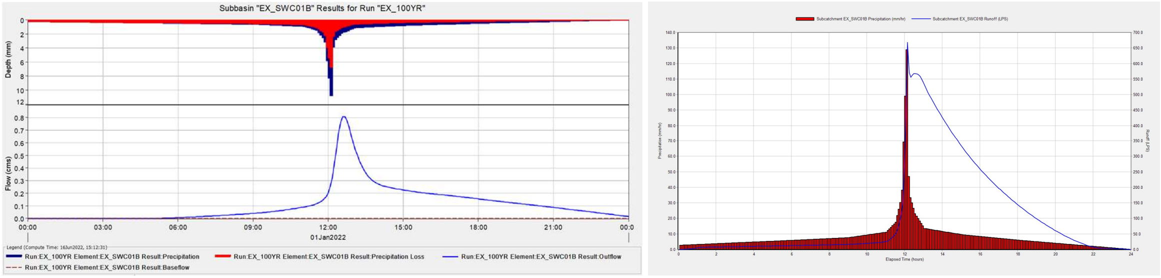


Figure 2. Catchment SWC01B precipitation/runoff hydrograph. Existing conditions, 100year ARI storm.

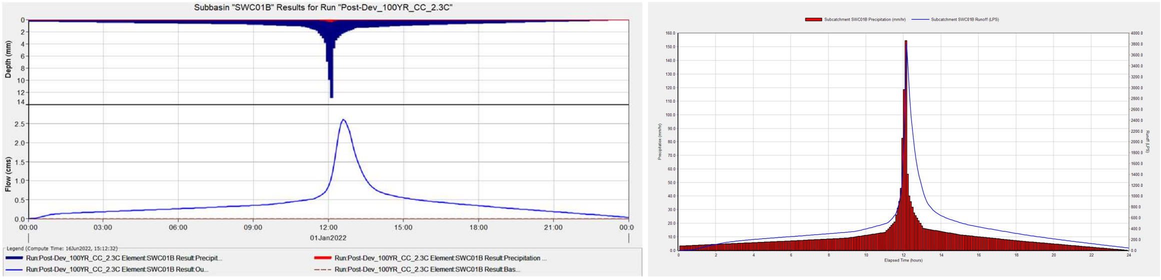


Figure 3. Catchment SWC01B precipitation/runoff hydrograph. Post-development conditions, 100year ARI storm with climate change (2.3°C increase).

The information above shows that the proposed methodology is in line with the methodology that WRC proposes, and that is why it has been accepted on all occasions in the past by the regional council. The proposed methodology provides a conservative approach that is consistent with the current maturity of the project (plan change).

Item 10

Overland flow path on the southwest boundary of the development.

The existing overland flow path that crosses the site will be intercepted by the proposed swale/stream that conveys the treated/attenuated flows from the wetlands to the unnamed Mangawhero Stream tributary/gully. Figure 11 and drawing 701 have been amended and updated to include the proposed diversion. The upstream catchment that is diverted into the proposed swale/stream has an area of approximately 110ha. It is cultivated land that belongs to Calcutta Farms. As mentioned in the stormwater section of the infrastructure report, an overall stormwater masterplan is being developed for the full Calcutta Farms property, that includes the treatment, attenuation, and conveyance of the future residential and commercial development.

For the needs of the proposed plan change, the design was updated to include the management of the runoff from the offsite catchment upstream of the industrial area, as shown on figure 10 of the report. The proposed stream has been extended to intercept the overland flow path and divert it into the unnamed Mangawhero Stream tributary/gully.

The assessment of the effects of this diversion has been included in an updated version of the memo that was originally released on 3 of May 2022 and is attached to this memo (referred as “Mangawhero Stream Memo” from now on).

The diversion of the upstream catchment to discharge into Mangawhero Stream approximately 500m upstream of its current point of discharge increases the flow downstream of the confluence of the unnamed tributary and Mangawhero stream. There is an approximately 2.2% increase to the 2-year ARI, climate adjusted flow (from 9.96m^3/s to 10.18m^3/s), a 5.4% increase to the 10-year ARI, climate adjusted flow (from 17.91m^3/s to 18.88m^3/s), and a 5.6% increase to the 100-year ARI, climate adjusted flow (from 34.02m^3/s to 35.94m^3/s). A section right downstream of the confluence was used to assess the effects of the increased flows to Mangawhero Stream. Refer to Figure 4 below.

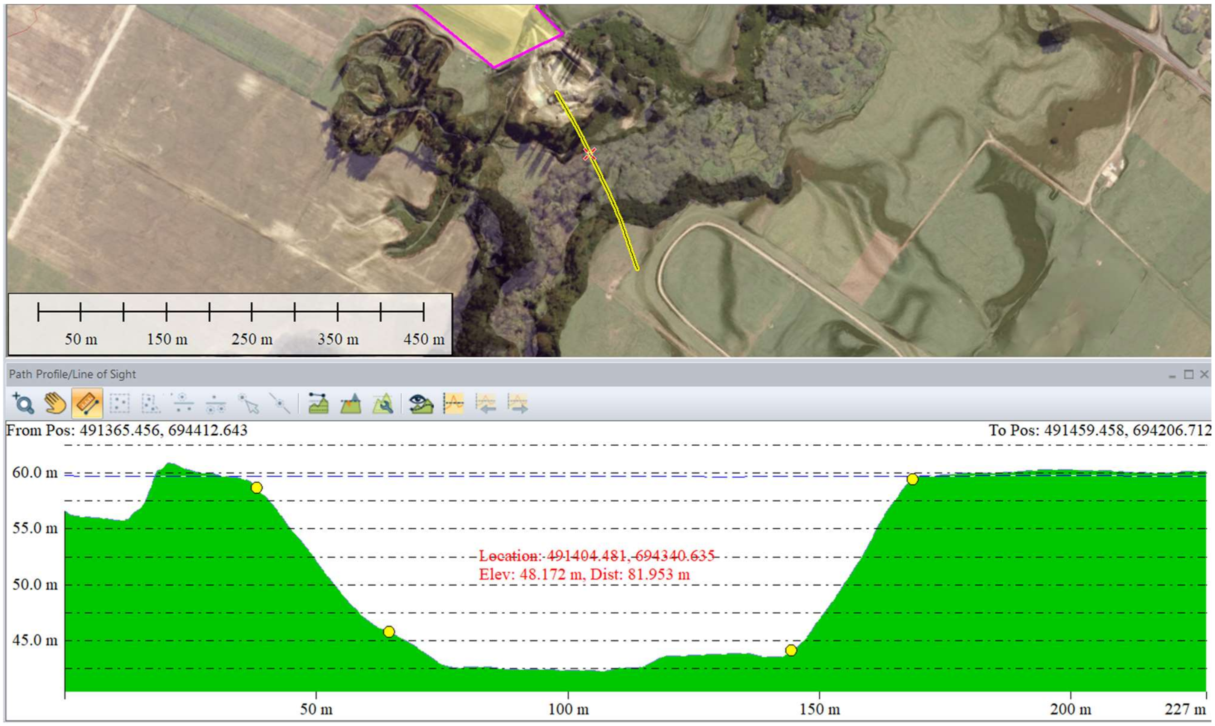


Figure 4. Section of Mangawhero stream used to assess the effects of the proposed off-site catchment diversion.

A Flowmaster model was built to conduct normal depth hydraulic calculations of the various flows. The section derived from the 2008 WRC LIDAR grid. Based on the same data, a 0.1% slope was measured for Magawhero stream at the sections position. A manning's coefficient of 0.06 was used for flood plains with light brush and trees, according to both HEC-RAS and Flowmaster manuals. The results are presented in the Mangawhero Stream memo.

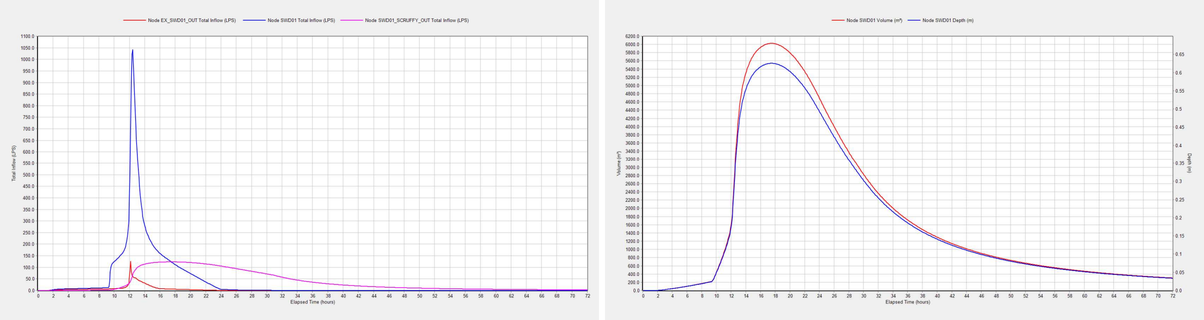
The calculations show minimum to negligible effects to the stream from the proposed diversion. For the 2-year ARI design event, the proposed diversion results in 9mm of depth increase and just 0.004m/s velocity increase. For the 10-year ARI design event, the corresponding effects are 29mm of depth and 0.009m/s velocity. Finally, for the 100-year ARI design event the effects are 32mm of depth and 0.010m/s velocity. This means that Mangawhero Stream can accommodate the additional flows without having any adverse effect on its flow capacity and without the increase of scour or erosion risk, as the flow characteristics remain practically unchanged. The proposed diversion also provides protection from flooding to both the proposed development and SH24 that currently does not have stormwater infrastructure to manage this overland flow, apart from two soak pits.

Figures 14 and 15, wetlands hydrographs.

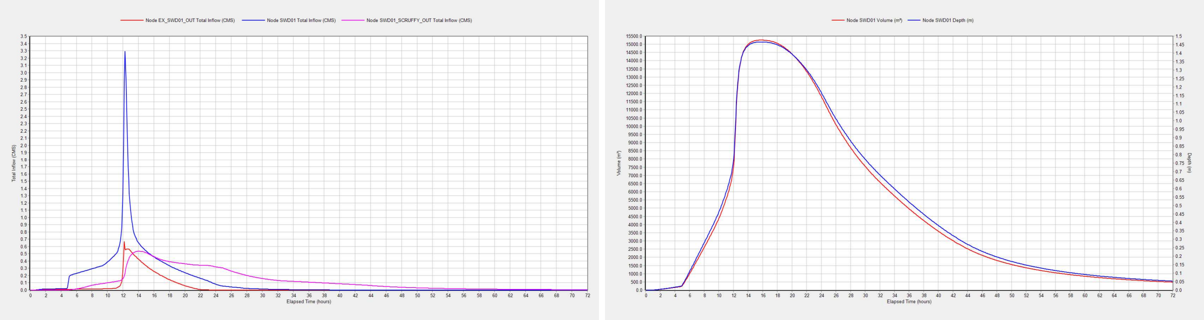
The diagrams have been updated to correspond to updated model (2.3°C increase instead of 3.8, and catchment updates), as well as the increased existing conditions discharge flows that the outlet structures need to meet.

(1). The attenuation flows indeed have duration more than 24hours and that is how attenuation works. It is impossible to attenuate and release a 24hour post-development rainfall within 24 hours and meet pre-development flows. A simple example is the following: Sub-catchment SWC01B 2-year ARI post-development total runoff volume is 12,820m^3. To release this volume within 24hours, it would need an average discharge flow of 12,820m^3/ 24hours/ 60minutes/ 60seconds = 0.149m^3/s, which is higher than the pre-development 2-year ARI peak flow (0.126m^3/s). There is no reference in RITS about the attenuated flows having to drain within 24hours. WRC TR20-07 in section 7.2.1 refers to a 48-hour period within which the retained volume (i.e. volume that being captured for infiltration) needs to be drained/infiltrated. The same section provides information about the average days between rain events. For the Hauraki Plains area, the minimum average time is 3 days. The proposed wetlands release most of the post-development volume within the 3 days period (72 hours). There is residual flow draining after the 72 hours but is very small and the wetlands have the available storage volumes for the next storm.

(2). Figure 5 below shows the 2year ARI hydrographs for SWD01. Red line represents existing conditions hydrograph, the blue line shows the post-development inflow into the wetland, and the fuchsia line represents the attenuated flow being discharged from the wetland. Figure 6 below shows the storage volume/depth graph for SWD01 during the same 2-year design storm. At the end of the 72-hours period, there is 300m^3 of volume occupied, which is less than 2% of the total available volume of SWD01 (approximately 15,255m^3 for the 100-year ARI), which means that there is capacity to receive, store, and attenuate the next storm. The same applies for the 100-year ARI design storm, where at the end of the 72-hours period there is approximately 500m^3 of volume occupied, that correspond to 3.3% of the available volume (refer to Figures 7 & 8). In the 100-year ARI case, there is additional 800mm of freeboard up to the emergency overflow level which provides additional volume.



Figures 5 & 6. Wetland SWD01 2-year ARI hydrograph and depth/volume graph.



Figures 7 & 8. Wetland SWD01 100-year ARI hydrograph and depth/volume graph.

We believe that with the information provided int this memorandum, along with the updated Mangawhero Stream memorandum and the updated stormwater section of the infrastructure report, we have provided enough information to establish that the proposed high-level design and modelling conforms to the local, regional, and national guidelines and requirements/ specifications.

Yours sincerely
Bloxam Burnett & Olliver

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APPENDIX A

Hydrological calculations using Worksheets 1 & 2, APPENDIX B of WRC TR20/06: Waikato stormwater runoff modelling guideline. Applied for catchment SWC01B.

Worksheet 1: Runoff Parameters and Time of Concentration

Project: Calcutta Farms Industrial
By: WR
Date: 08.06.2022
Location: Matamata
Checked: CF
Date: 08.06.2022
Scenario: Pre-Developed SWC01B (Pre-developed or post-developed)

1. Runoff Curve Number (CN) and Initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment and hydrologic condition)	Curve Number (CN)	Area (m^2)	Area (km^2)	Product of CN x Area
Sand and Silt	range, Soil Group A, between fair and good	44	153420	0.15342	6.75
				0.00000	0
		TOTALS	153420	0.15342	6.75

$$CN_{(weighted)} = \frac{Total\ Product\ of\ CNxArea}{Total\ Area} = 44$$

Initial Abstraction

$$S = \left(\frac{1000}{CN} - 10\right) 25.4 \quad (mm) = 323.3mm$$

$$I_\alpha = 0.05\ S = 16.2mm$$

2. Time of Concentration (T_c)

(a) Sheet and shallow concentrated flow
From Equation 7-2 or from Figure 7-1:

Length L = 670m
Slope S = 0.5%
mannings n= 0.045

$$T_t = {100nL^{0.33}}/{S^{0.2}} = 44.3min$$

(b) Concentrated network flow

i. Road channel flow from Figure 7-2:

= 0.00hr

ii. Pipe network flow from Table 7-2 and Figure 7-3:

= 0.00hr

iii. Open channel flow from Equation 7-3:

$$V = {R^{2/3}S^{1/2}}/{n} = 0.00hr$$

(c) Time of concentration

$$T_c = T_{t1} + T_{t2} + \cdots..T_{tm} = 0.74hr$$

SCS Lag for HEC-HMS: $t_p = \frac{2}{3}t_c$ = 0.49hr

Worksheet 2: Graphical Peak Flow Rate

Project: Calcutta Farms Industrial
By: WR
Date: 08.06.2022
Location: Matamata
Checked: CF
Date: 08.06.2022
Scenario: Pre-Developed SWC01B (Pre-developed or post-developed)

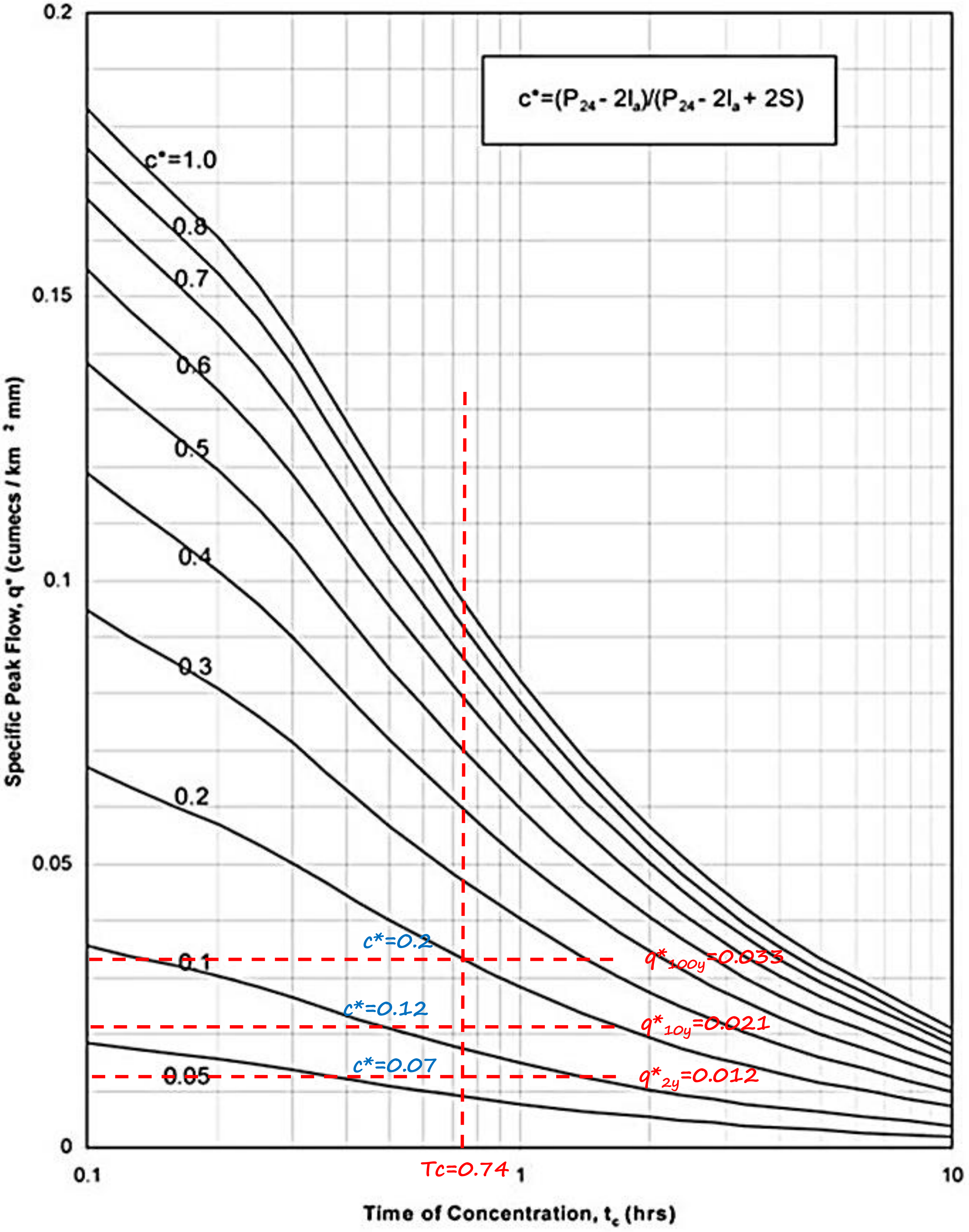
1. Data

Catchment area (A)=	0.15342	km^2
Runoff curve number (CN)=	44	(from Worksheet 1)
Initial abstraction (Ia)=	16.2	(from Worksheet 1)
Time of concentration (Tc)=	0.74	hours (from Worksheet 1)

2. Storage

Storage (S) = 323.3 mm (from Worksheet 1)

	Storm #1	**Storm #2**	**Storm #3**
Average Recurrence Interval (ARI)	2	10	100
24-hour rainfall depth P_{24} (mm)	79.3	122	191
Compute c*: $c^* = \frac{P_{24} - 2I_a}{P_{24} - 2I_a + 2S}$	0.07	0.12	0.2
Specific peak flow rate q* (from Figure 8-1)	0.012	0.021	0.033
Peak flow rate $q_p = q^* A P_{24}$ (m^3/s)	**0.146**	**0.393**	**0.967**
Runoff depth (mm) $Q_{24} = \frac{(P_{24} - I_a)^2}{(P_{24} - I_a) + S}$	**10.3**	**26.1**	**61.3**
Runoff volume $V_{24} = 1000 x Q_{24} A$ (m^3)	**1580**	**4004**	**9405**


0.2
0.15
0.1
0.05
0
Specific Peak Flow, q* (cumecs / km ² mm)
c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
c*=0.2
c*=0.12
c*=0.07
q*100y=0.033
q*10y=0.021
q*2y=0.012
Tc=0.74
0.1
1
10
Time of Concentration, tc (hrs)

Worksheet 1: Runoff Parameters and Time of Concentration

Project: Calcutta Farms Industrial
By: WR
Date: 08.06.2022
Location: Matamata
Checked: CF
Date: 08.06.2022
Scenario: Post-Developed SWC01B (Pre-developed or post-developed)

1. Runoff Curve Number (CN) and Initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment and hydrologic condition)	Curve Number (CN)	Area (m^2)	Area (km^2)	Product of CN x Area
Sand and Silt	Impervious	98	138078	0.13808	13.532
Sand and Silt	Open Space, Soil Group B, between fair and good	65	15342	0.01534	0.997
		TOTALS	153420	0.15342	14.529

CN $_{\text{(weighted)}}$ = $\frac{Total\ Product\ of\ CNxArea}{Total\ Area}$ = 94.7

Initial Abstraction

$$S = \left(\frac{1000}{CN} - 10\right) 25.4 \quad (mm) =$$ 14.2mm

I_α = 0.05 · S = 0.7mm

2. Time of Concentration (T_c)

(a) Sheet and shallow concentrated flow
From Equation 7-2 or from Figure 7-1:

Length L =	220m
Slope S =	0.5%
mannings n=	0.045

$$T_t = 100nL^{0.33} / S^{0.2}$$ = 30.6min

(b) Concentrated network flow

i. Road channel flow from Figure 7-2: = 0.00hr

ii. Pipe network flow from Table 7-2 and Figure 7-3:

Flat gradient (v=0.6m/s) and 220m of length = 0.10hr

iii. Open channel flow from Equation 7-3:

$$V = R^{2/3}S^{1/2} / n$$ R=0.273, n=0.045, s=0.002, L=230m, v=0.42m/s = 0.15hr

(c) Time of concentration

$$T_c = T_{t1} + T_{t2} + \cdots . . T_{tm} =$$ 0.76hr

SCS Lag for HEC-HMS: $t_p = \frac{2}{3} t_c$ = 0.51hr

Worksheet 2: Graphical Peak Flow Rate

Project: Calcutta Farms Industrial
By: WR
Date: 08.06.2022
Location: Matamata
Checked: CF
Date: 08.06.2022
Scenario: Post-Developed SWC01B (Pre-developed or post-developed)

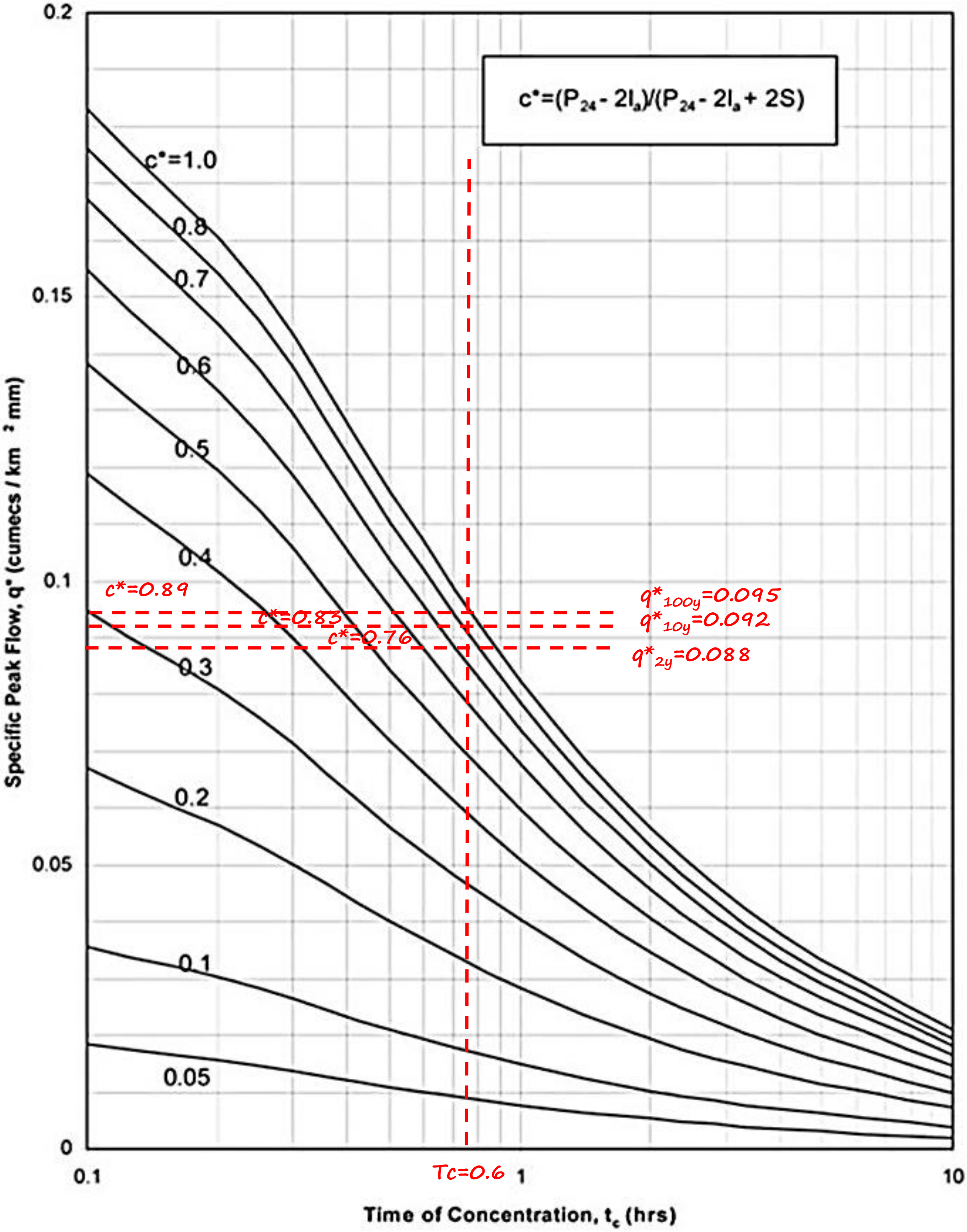
1. Data

Catchment area (A)=	0.15342	km^2
Runoff curve number (CN)=	94.7	(from Worksheet 1)
Initial abstraction (Ia)=	0.7	(from Worksheet 1)
Time of concentration (Tc)=	0.76	hours (from Worksheet 1)

2. Storage

Storage (S) = 14.2 mm (from Worksheet 1)

	Storm #1	Storm #2	Storm #3
Average Recurrence Interval (ARI)	2	10	100
24-hour rainfall depth P_{24} (mm)	91.2	142.8	225.6
Compute c*: $c^* = \frac{P_{24} - 2I_a}{P_{24} - 2I_a + 2S}$	0.76	0.83	0.89
Specific peak flow rate q* (from Figure 8-1)	0.088	0.092	0.095
Peak flow rate $q_p = q^* A P_{24}$ (m^3/s)	1.231	2.016	3.288
Runoff depth $Q_{24} = \frac{(P_{24} - I_a)^2}{(P_{24} - I_a) + S}$	78.2	129.2	211.5
Runoff volume $V_{24} = 1000xQ_{24}A$ (m^3)	11997	19822	32448


c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km² mm)
Time of Concentration, tc (hrs)
c*=0.89
c*=0.83
c*=0.76
q*100y=0.095
q*10y=0.092
q*2y=0.088
Tc=0.6

Worksheet 1: Runoff Parameters and Time of Concentration

Project: Calcutta Farms Industrial
By: WR
Date: 08.06.2022
Location: Matamata
Checked: CF
Date: 08.06.2022
Scenario: Post-Developed SWC01B (Pre-developed or post-developed)

1. Runoff Curve Number (CN) and Initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment and hydrologic condition)	Curve Number (CN)	Area (m^2)	Area (km^2)	Product of CN x Area
Sand and Silt	Impervious	98	138078	0.13808	13.532
Sand and Silt	Open Space, Soil Group B, between fair and good	65	15342	0.01534	0.997
		TOTALS	153420	0.15342	14.529

CN $_{(weighted)}$ = $\frac{Total\ Product\ of\ CNxArea}{Total\ Area}$ = 94.7

Initial Abstraction

$S = \left(\frac{1000}{CN} - 10\right) 25.4 \quad (mm) =$ 14.2mm

I_α = $0.05 \cdot S$ = 0.7mm

2. Time of Concentration (Tc)

(a) Sheet and shallow concentrated flow
From Equation 7-2 or from Figure 7-1:

Length L = 220m
Slope S = 0.5%
mannings n= 0.045

$T_t = {100nL^{0.33}}/{S^{0.2}}$ = 30.6min

(b) Concentrated network flow

i. Road channel flow from Figure 7-2:
= 0.00hr

ii. Pipe network flow from Table 7-2 and Figure 7-3:
Flat gradient (v=0.6m/s) and 220m of length = 0.10hr

iii. Open channel flow from Equation 7-3:
$V = {R^{2/3}S^{1/2}}/{n}$ R=0.273, n=0.045, s=0.002, L=230m, v=0.42m/s = 0.15hr

(c) Time of concentration
$T_c = T_{t1} + T_{t2} + \cdots .. T_{tm} =$ 0.76hr

SCS Lag for HEC-HMS: $t_p = \frac{2}{3} t_c =$ 0.51hr

Worksheet 2: Graphical Peak Flow Rate

Project: Calcutta Farms Industrial

By: WR

Date: 08.06.2022

Location: Matamata

Checked: CF

Date: 08.06.2022

Scenario: Post-Developed SWC01B (Pre-developed or post-developed)

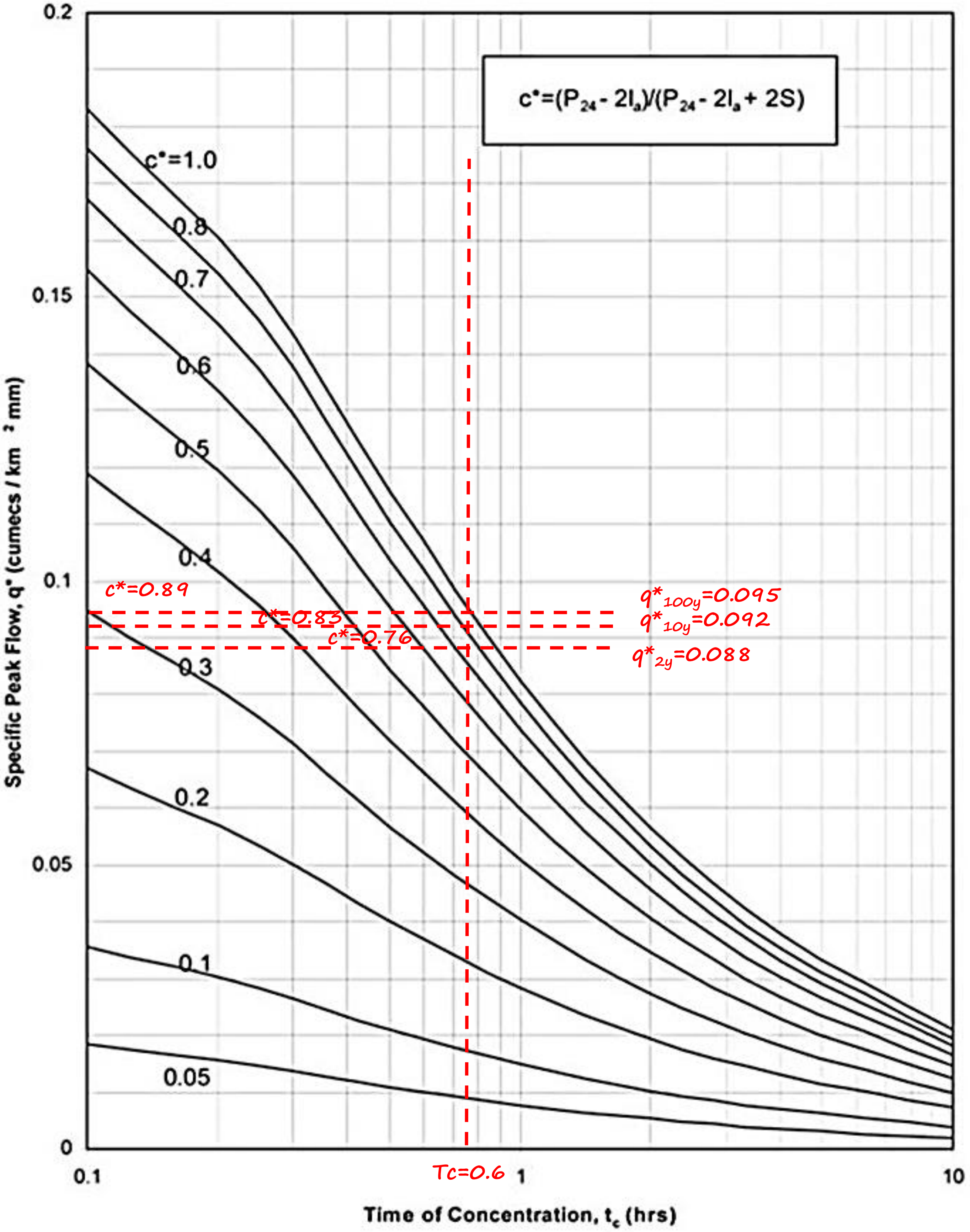
1. Data

Catchment area (A)=	0.15342	km^2
Runoff curve number (CN)=	94.7	(from Worksheet 1)
Initial abstraction (Ia)=	0.7	(from Worksheet 1)
Time of concentration (Tc)=	0.76	hours (from Worksheet 1)

2. Storage

Storage (S) = 14.2 mm (from Worksheet 1)

	Storm #1	Storm #2	Storm #3
Average Recurrence Interval (ARI)	2	10	100
24-hour rainfall depth P_{24} (mm)	92.4	144.72	228.72
Compute c*: $c^* = \frac{P_{24} - 2I_a}{P_{24} - 2I_a + 2S}$	0.76	0.83	0.89
Specific peak flow rate q* (from Figure 8-1)	0.088	0.092	0.095
Peak flow rate $q_p = q^* A P_{24}$ (m^3/s)	1.247	2.043	3.334
Runoff depth $Q_{24} = \frac{(P_{24} - I_a)^2}{(P_{24} - I_a) + S}$	79.4	131.1	214.7
Runoff volume $V_{24} = 1000xQ_{24}A$ (m^3)	12182	20113	32939


c*=(P24 - 2Ia)/(P24 - 2Ia + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km 2 mm)
Time of Concentration, tc (hrs)
c*=0.89
c*=0.83
c*=0.76
q*100y=0.095
q*10y=0.092
q*2y=0.088
Tc=0.6

Worksheet 1: Runoff Parameters and Time of Concentration

bbo
BLOXAM BURNETT & OLLIVER

Project: *Calcutta Farms Industrial*
By: *WR*
Date: *08.06.2022*
Location: *Matamata*
Checked: *CF*
Date: *08.06.2022*
Scenario: *Post-Developed SWC01B* (Pre-developed or post-developed)

1. Runoff Curve Number (CN) and Initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment and hydrologic condition)	Curve Number (CN)	Area (m^2)	Area (km^2)	Product of CN x Area
Sand and Silt	Impervious	98	138078	0.13808	13.532
Sand and Silt	Open Space, Soil Group B, between fair and good	65	15342	0.01534	0.997
		TOTALS	153420	0.15342	14.529

CN $_{(weighted)}$ = $\dfrac{Total\ Product\ of\ CNxArea}{Total\ Area}$ = 94.7

Initial Abstraction

$S = \left(\frac{1000}{CN} - 10\right) 25.4 \quad (mm)$ = 14.2mm

I_α = $0.05 \cdot S$ = 0.7mm

2. Time of Concentration (T_c)

(a) Sheet and shallow concentrated flow
From Equation 7-2 or from Figure 7-1:

Length L = 220m
Slope S = 0.5%
mannings n= 0.045

$T_t = 100nL^{0.33}/_{S^{0.2}}$ = 30.6min

(b) Concentrated network flow

i. Road channel flow from Figure 7-2:

= 0.00hr

ii. Pipe network flow from Table 7-2 and Figure 7-3:

Flat gradient (v=0.6m/s) and 220m of length = 0.10hr

iii. Open channel flow from Equation 7-3:

$V = R^{2/3}S^{1/2}/_n$ R=0.273, n=0.045, s=0.002, L=230m, v=0.42m/s = 0.15hr

(c) Time of concentration

$T_c = T_{t1} + T_{t2} + \cdots .. T_{tm}$ = 0.76hr

SCS Lag for HEC-HMS: $t_p = \frac{2}{3}t_c$ = 0.51hr

Worksheet 2: Graphical Peak Flow Rate

Project: Calcutta Farms Industrial

By: WR

Date: 08.06.2022

Location: Matamata

Checked: CF

Date: 08.06.2022

Scenario: Post-Developed SWC01B (Pre-developed or post-developed)

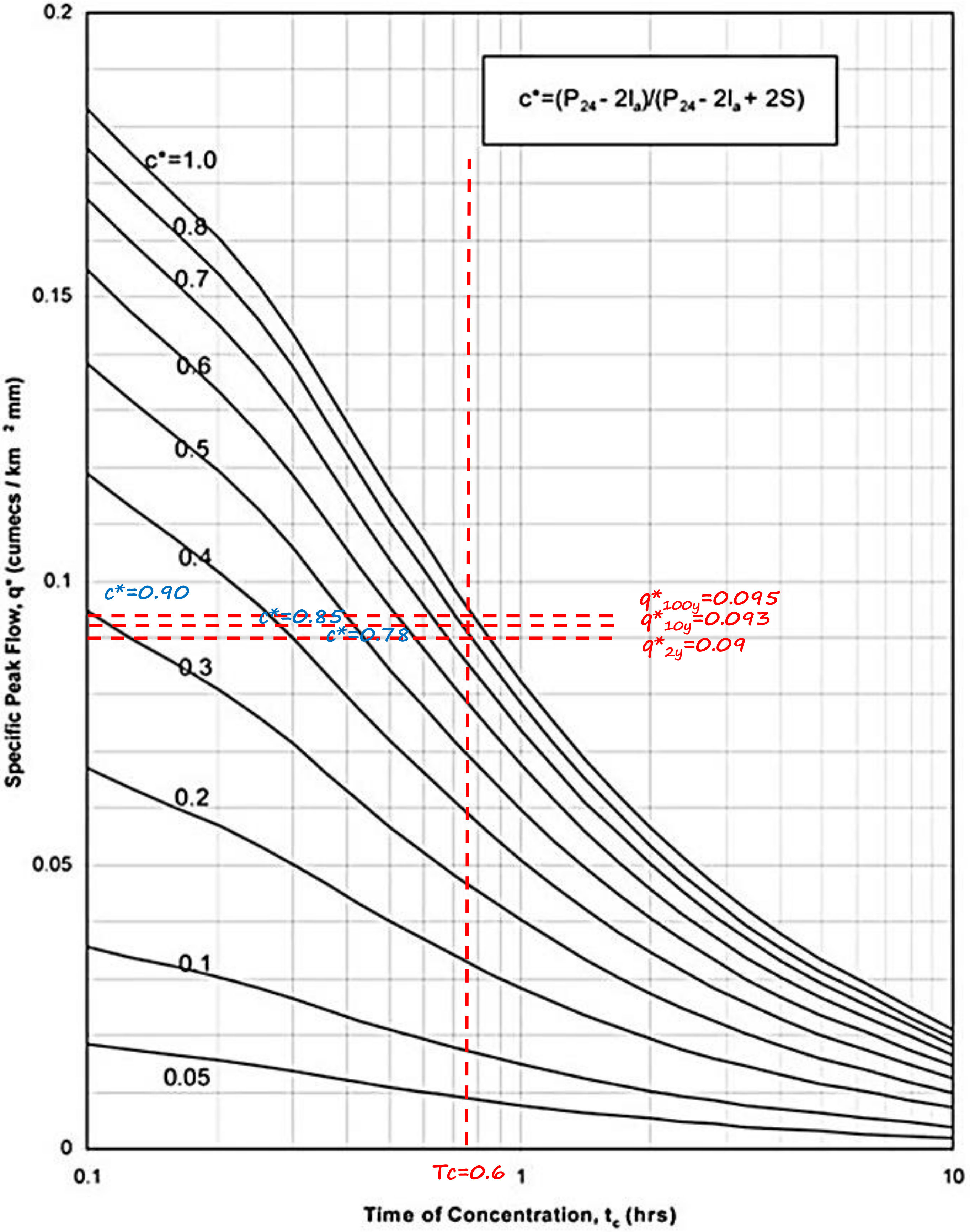
1. Data

Catchment area (A)=	0.15342	km^2
Runoff curve number (CN)=	94.7	(from Worksheet 1)
Initial abstraction (Ia)=	0.7	(from Worksheet 1)
Time of concentration (Tc)=	0.76	hours (from Worksheet 1)

2. Storage

Storage (S) = 14.2 mm (from Worksheet 1)

	Storm #1	Storm #2	Storm #3
Average Recurrence Interval (ARI)	2	10	100
24-hour rainfall depth P_{24} (mm)	101	159.6	253.4
Compute c*: $c^* = \frac{P_{24} - 2I_a}{P_{24} - 2I_a + 2S}$	0.78	0.85	0.9
Specific peak flow rate q* (from Figure 8-1)	0.09	0.093	0.095
Peak flow rate $q_p = q^* A P_{24}$ (m^3/s)	1.395	2.277	3.693
Runoff depth $Q_{24} = \frac{(P_{24} - I_a)^2}{(P_{24} - I_a) + S}$	87.9	145.9	239.3
Runoff volume $V_{24} = 1000xQ_{24}A$ (m^3)	13486	22384	36713


c*=(P₂₄ - 2Iₐ)/(P₂₄ - 2Iₐ + 2S)
c*=1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.2
0.15
0.1
0.05
0
0.1
1
10
Specific Peak Flow, q* (cumecs / km² mm)
Time of Concentration, tc (hrs)
c*=0.90
c*=0.85
c*=0.78
q*100y=0.095
q*10y=0.093
q*2y=0.09
Tc=0.6

APPENDIX B

HEC-HMS output. Model was based on WRC TR20/06: Waikato stormwater runoff modelling guideline, and ARC TP108. Applied for catchment SWC01B.

Project: Calcutta_Farms_Industrial
Simulation Run: EX_2YR
Simulation Start: 31 December 2021, 24:00
Simulation End: 1 January 2022, 24:00

HMS Version: 4.9
Executed: 16 June 2022, 03:12

Global Parameter Summary - Subbasin

Area (KM²)

Element Name	Area (KM²)
Ex Swc01b	0.15

Downstream

Element Name	Downstream
Ex Swc01b	Sink - 1

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Ex Swc01b	0	44	16.2

Transform: Scs

Element Name	Lag	Unitgraph Type
Ex Swc01b	29.4	Standard

Global Results Summary

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
Sink - 1	0.15	0.12	01Jan2022, 12:40	10.5
Ex Swc01b	0.15	0.12	01Jan2022, 12:40	10.5

Subbasin: EX_SWC01B

Area (KM²) : 0.15
Downstream : Sink - 1

Loss Rate: Scs

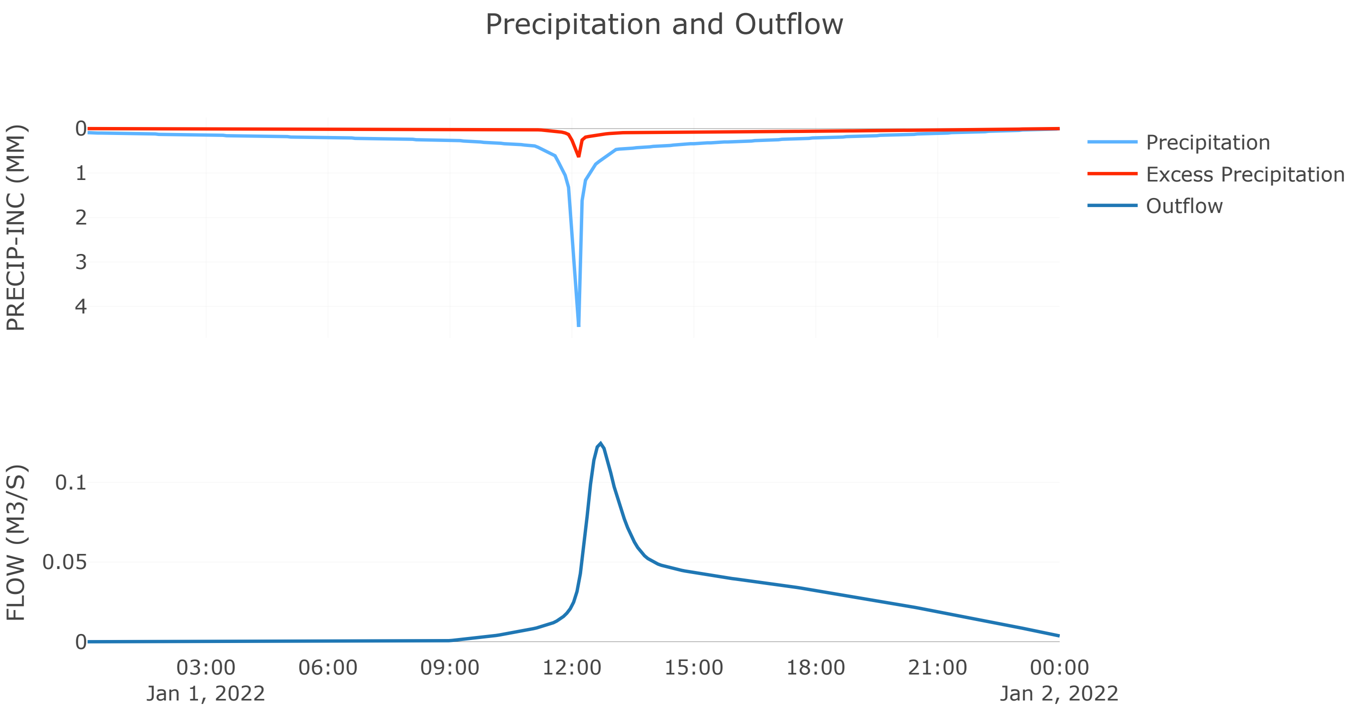
Percent Impervious Area	0
Curve Number	44
Initial Abstraction	16.2

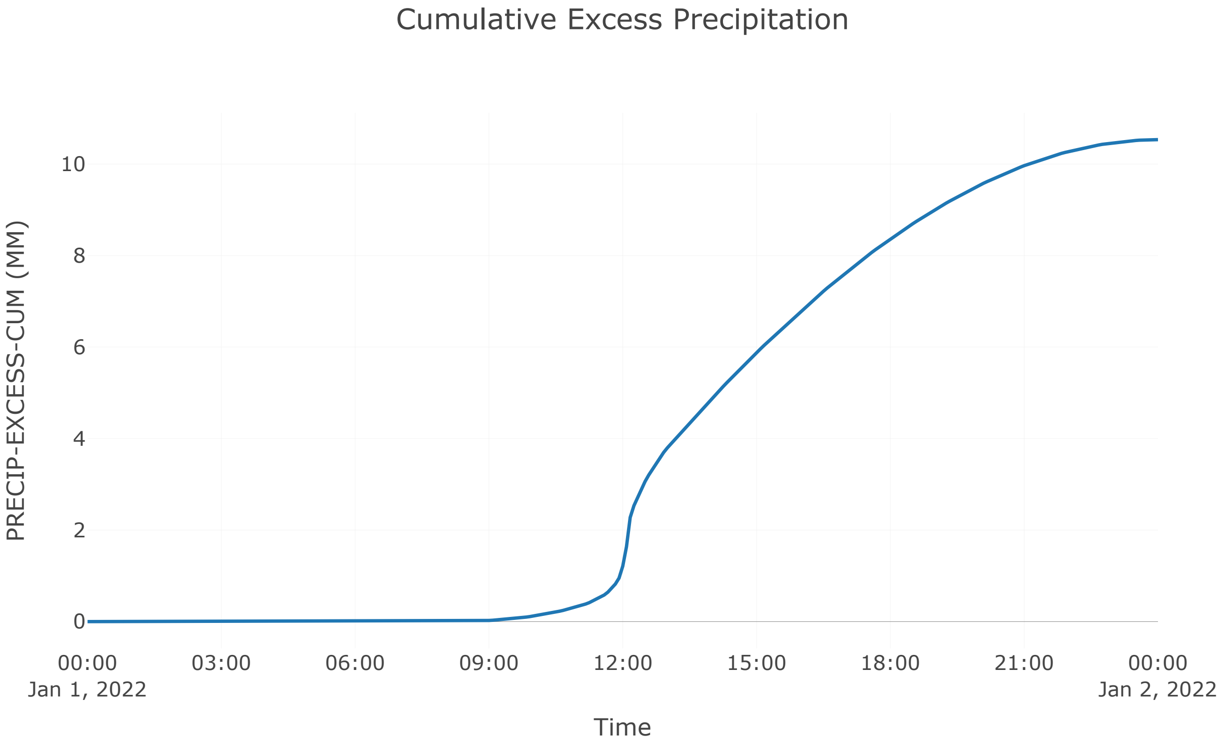
Transform: Scs

Lag	29.4
Unitgraph Type	Standard

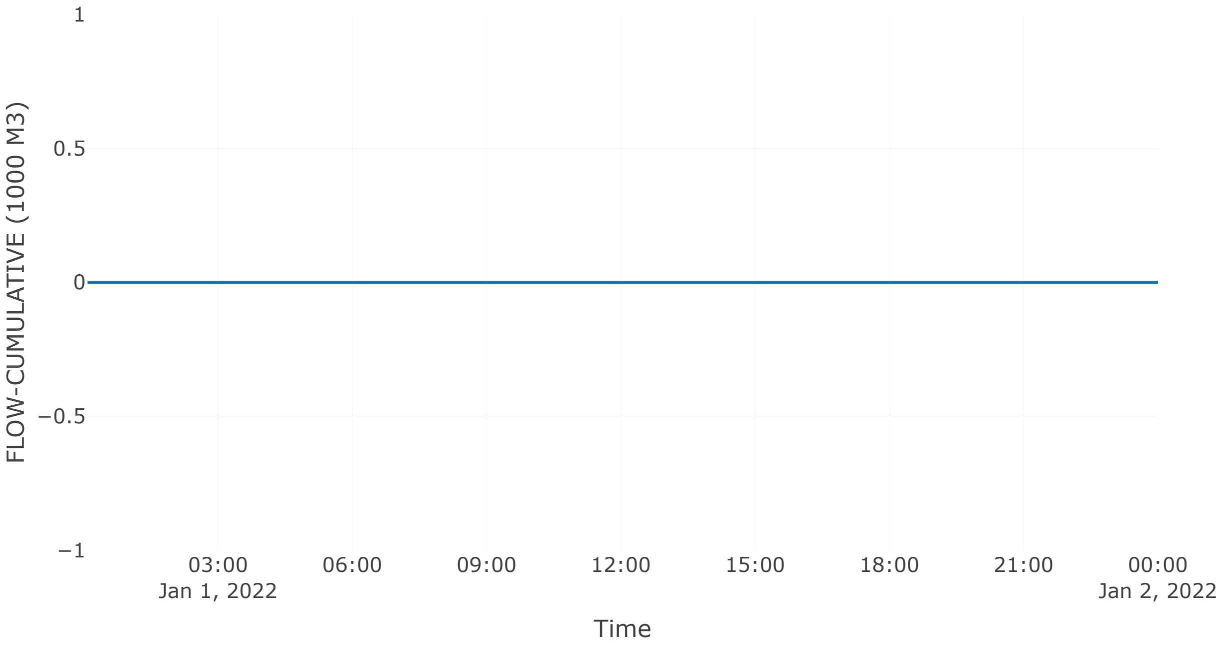
Results: EX_SWC01B

Peak Discharge (M3/S)	0.12
Time of Peak Discharge	01Jan2022, 12:40
Volume (MM)	10.5
Precipitation Volume (M3)	12282.81
Loss Volume (M3)	10666.66
Excess Volume (M3)	1616.14
Direct Runoff Volume (M3)	1610.47
Baseflow Volume (M3)	0

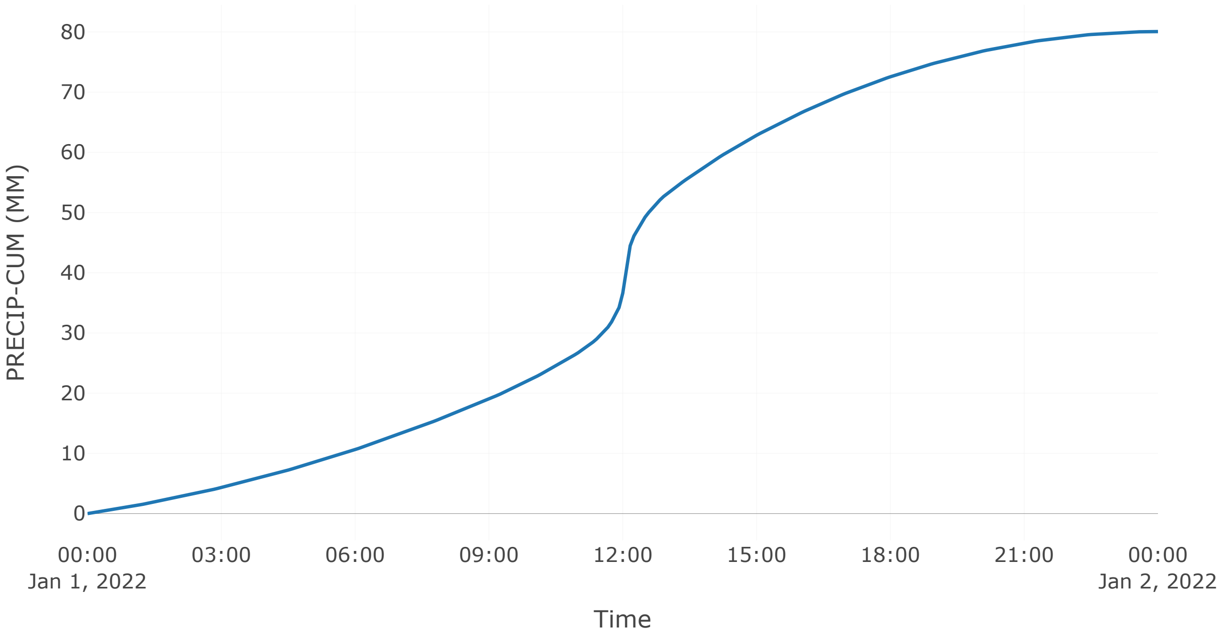

Precipitation and Outflow
PRECIP-INC (MM)
0
1
2
3
4
Precipitation
Excess Precipitation
Outflow
FLOW (M3/S)
0.1
0.05
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022


Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (MM)
10
8
6
4
2
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

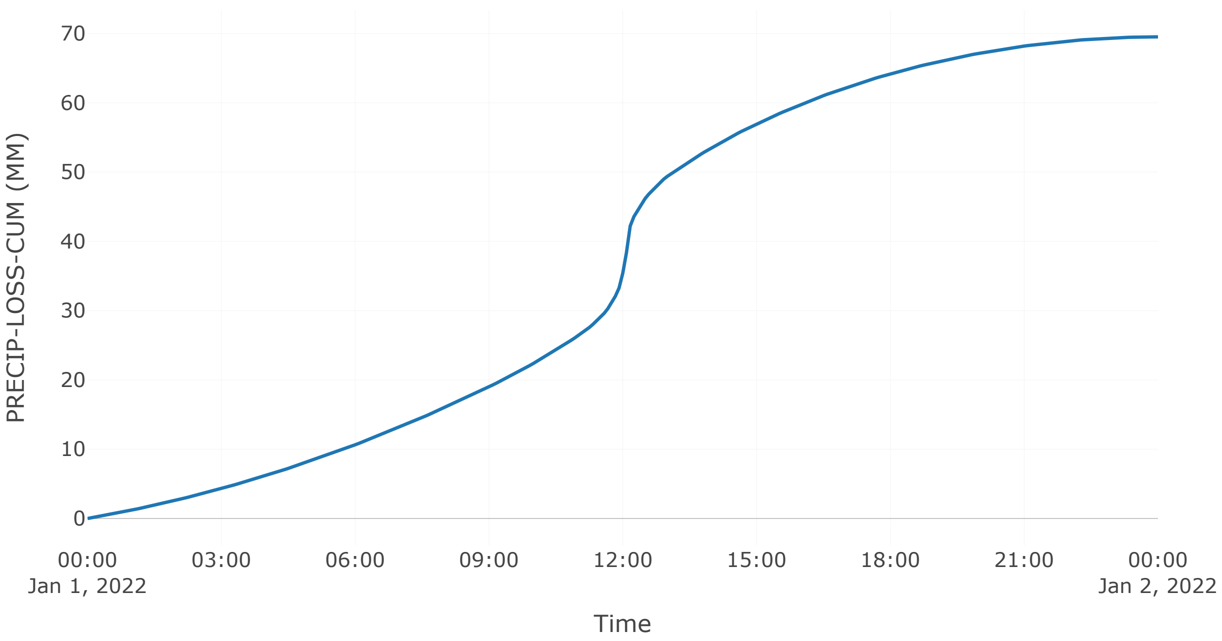
Cumulative Outflow



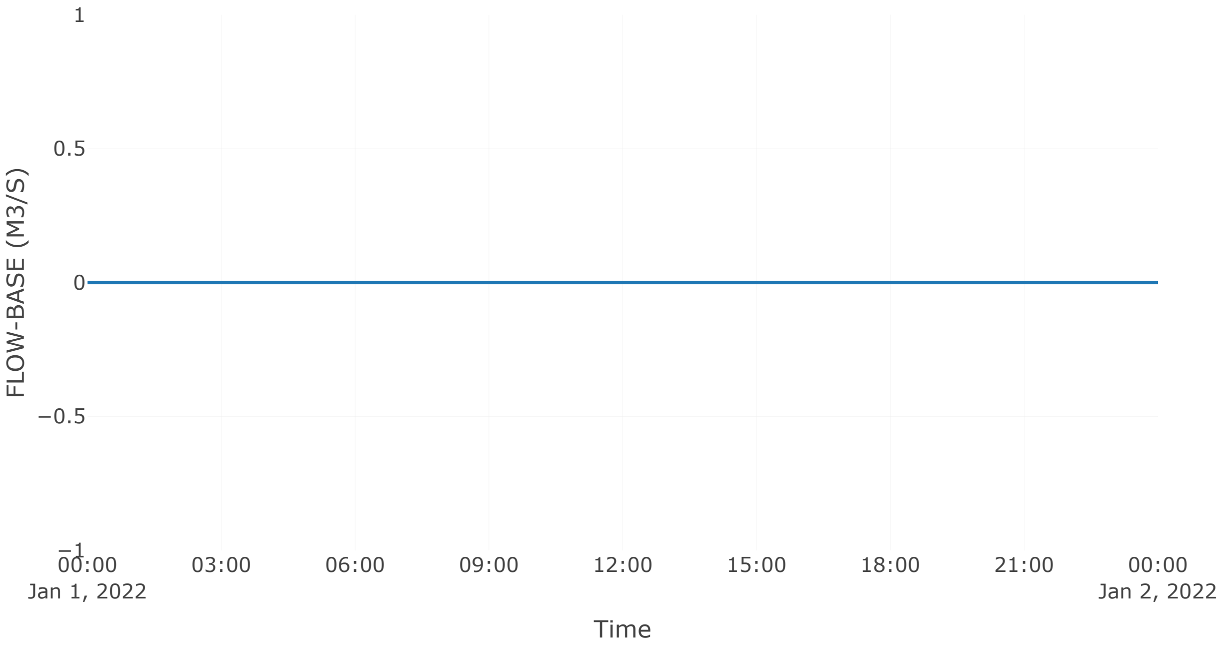
Cumulative Precipitation

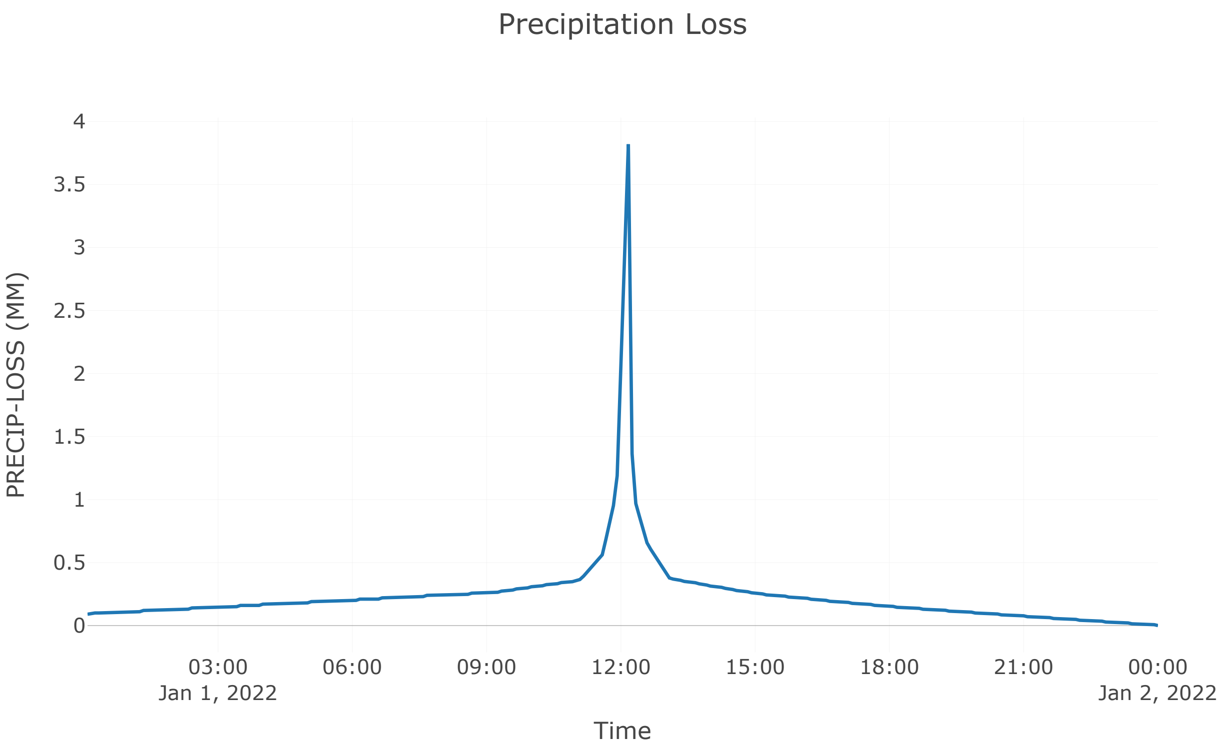


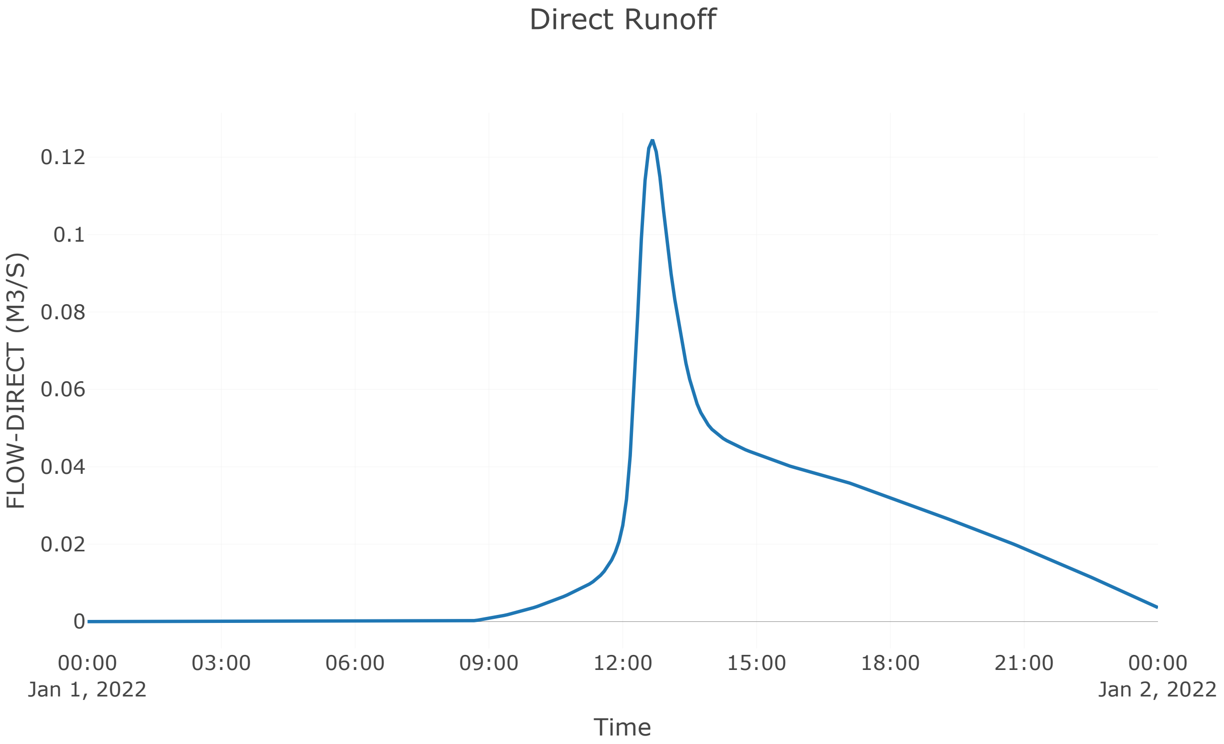
Cumulative Precipitation Loss

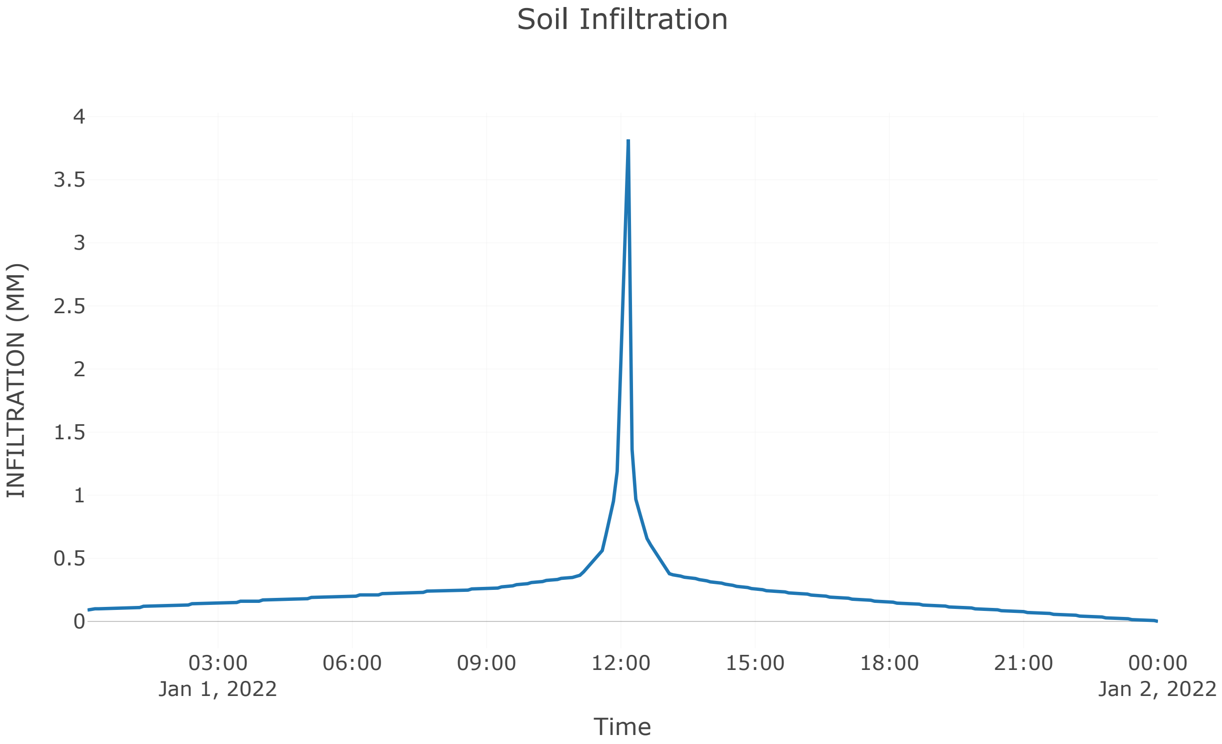


Baseflow




Precipitation Loss
PRECIP-LOSS (MM)
4
3.5
3
2.5
2
1.5
1
0.5
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Direct Runoff
FLOW-DIRECT (M3/S)
0.12
0.1
0.08
0.06
0.04
0.02
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Soil Infiltration
INFILTRATION (MM)
4
3.5
3
2.5
2
1.5
1
0.5
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

Project: Calcutta_Farms_Industrial
Simulation Run: EX_10YR
Simulation Start: 31 December 2021, 24:00
Simulation End: 1 January 2022, 24:00

HMS Version: 4.9
Executed: 16 June 2022, 03:12

Global Parameter Summary - Subbasin

Area (KM²)

Element Name	Area (KM²)
Ex Swc01b	0.15

Downstream

Element Name	Downstream
Ex Swc01b	Sink - 1

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Ex Swc01b	0	44	16.2

Transform: Scs

Element Name	Lag	Unitgraph Type
Ex Swc01b	29.4	Standard

Global Results Summary

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
Sink - 1	0.15	0.33	01Jan2022, 12:40	26.56
Ex Swc01b	0.15	0.33	01Jan2022, 12:40	26.56

Subbasin: EX_SWC01B

Area (KM²) : 0.15
Downstream : Sink - 1

Loss Rate: Scs

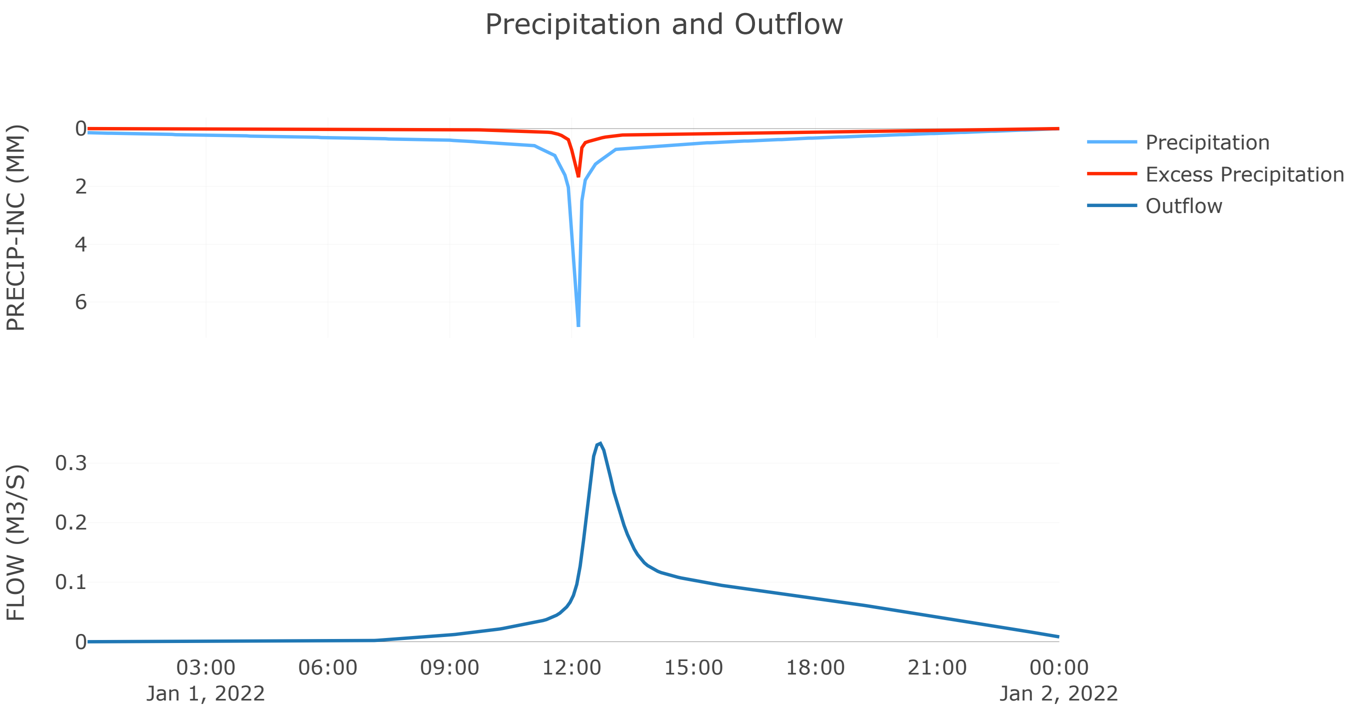
Percent Impervious Area	0
Curve Number	44
Initial Abstraction	16.2

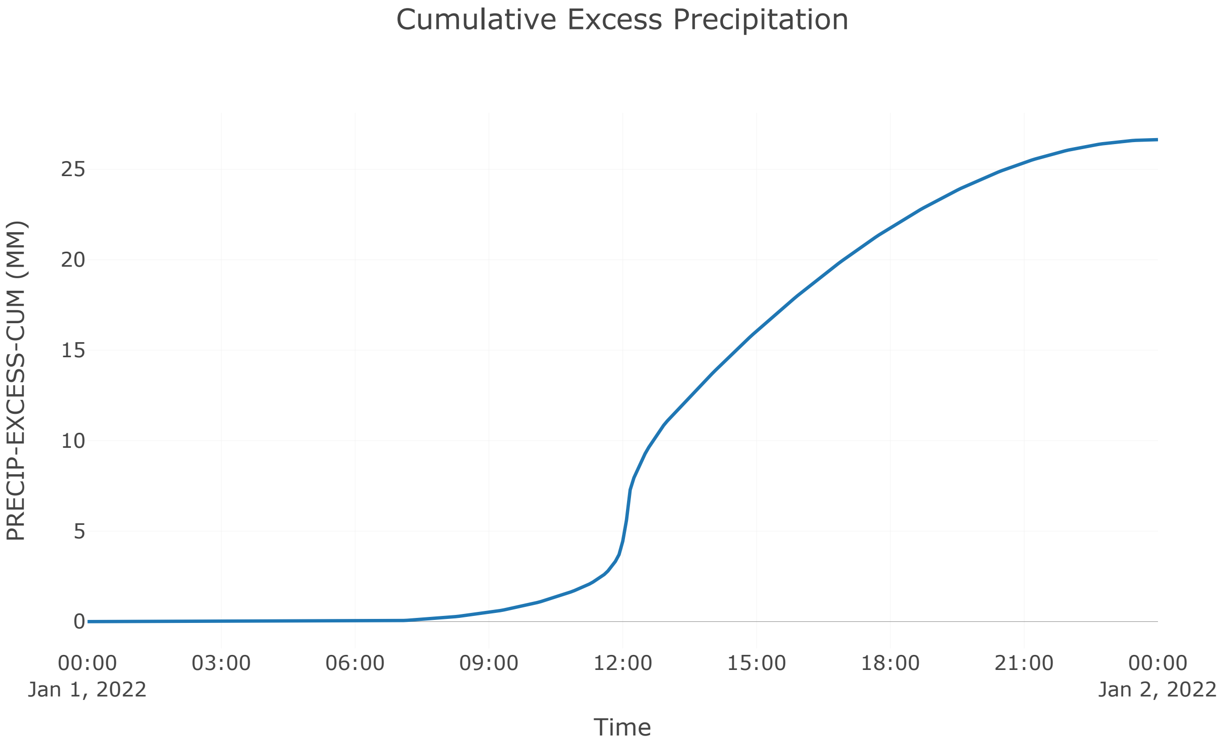
Transform: Scs

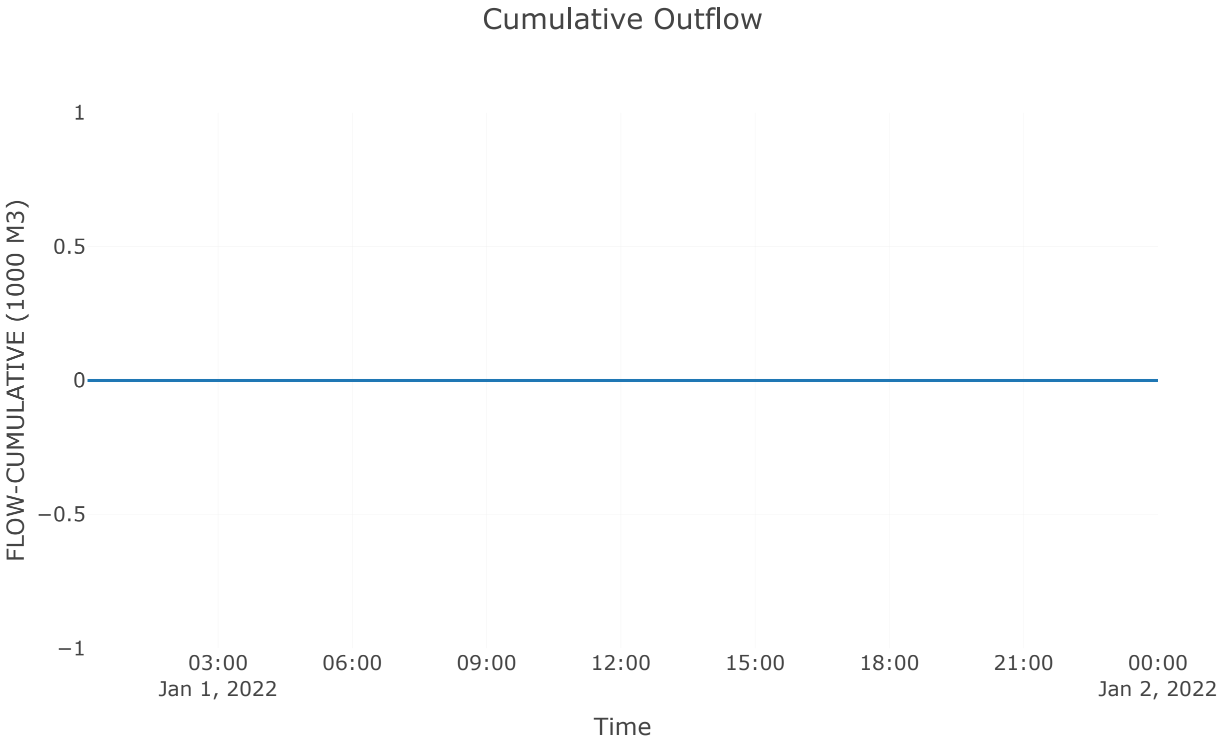
Lag	29.4
Unitgraph Type	Standard

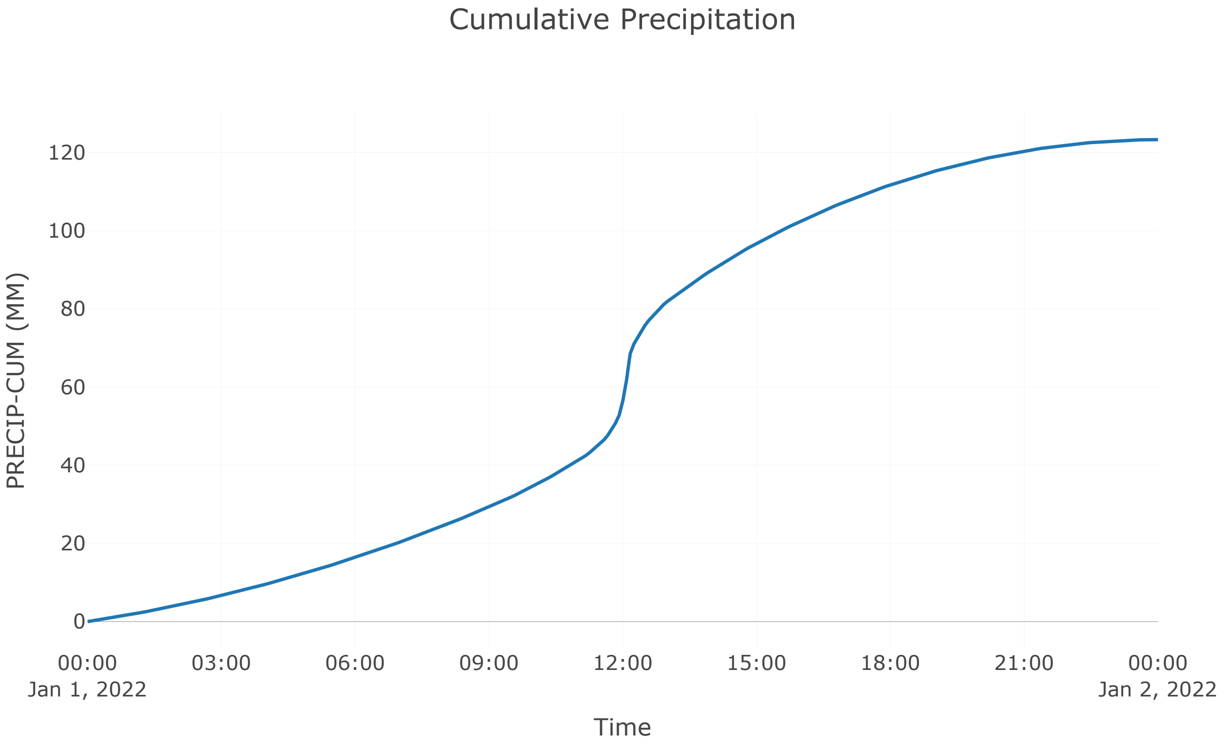
Results: EX_SWC01B

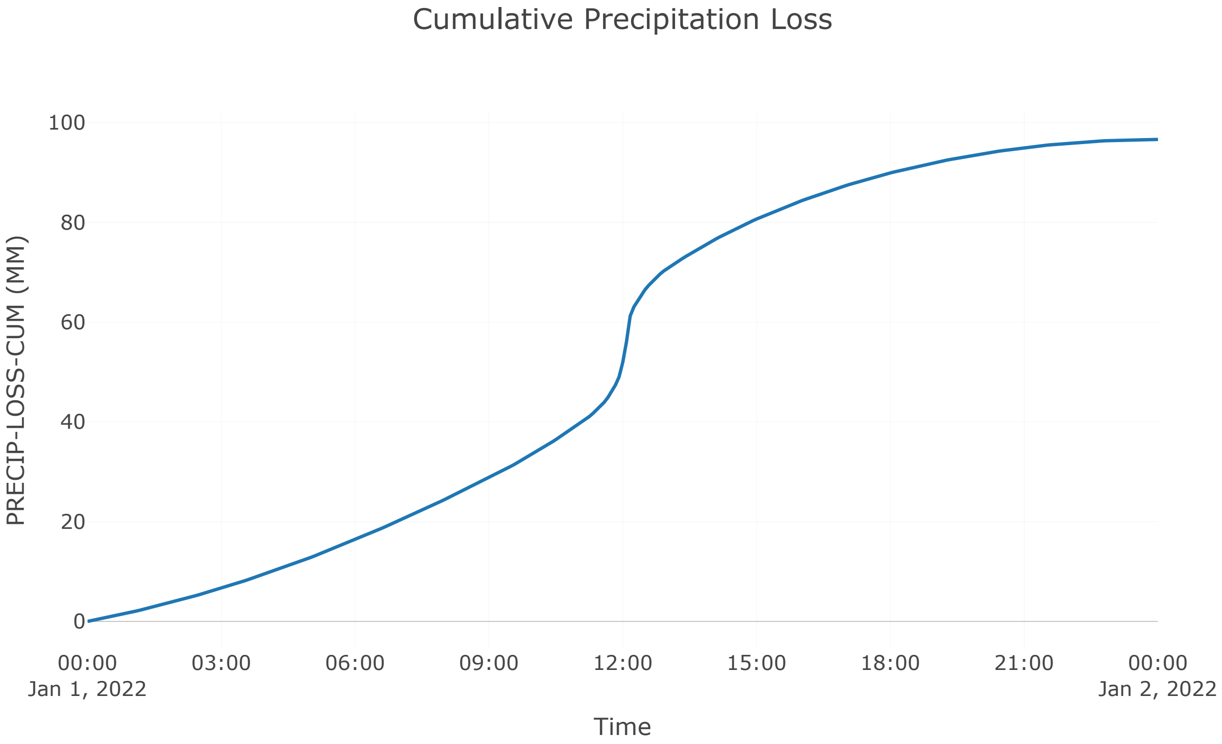
Peak Discharge (M3/S)	0.33
Time of Peak Discharge	01Jan2022, 12:40
Volume (MM)	26.56
Precipitation Volume (M3)	18912.08
Loss Volume (M3)	14825.1
Excess Volume (M3)	4086.99
Direct Runoff Volume (M3)	4074.56
Baseflow Volume (M3)	0

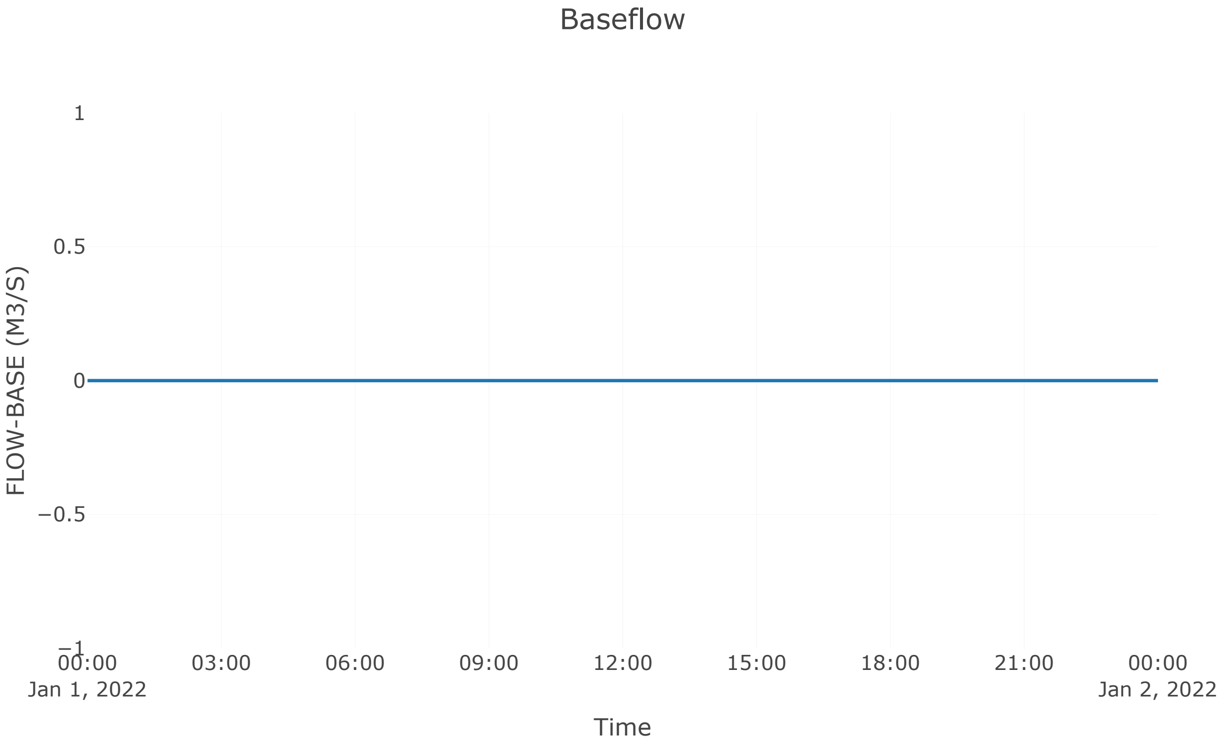

Precipitation and Outflow
PRECIP-INC (MM)
0
2
4
6
Precipitation
Excess Precipitation
Outflow
FLOW (M3/S)
0.3
0.2
0.1
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022

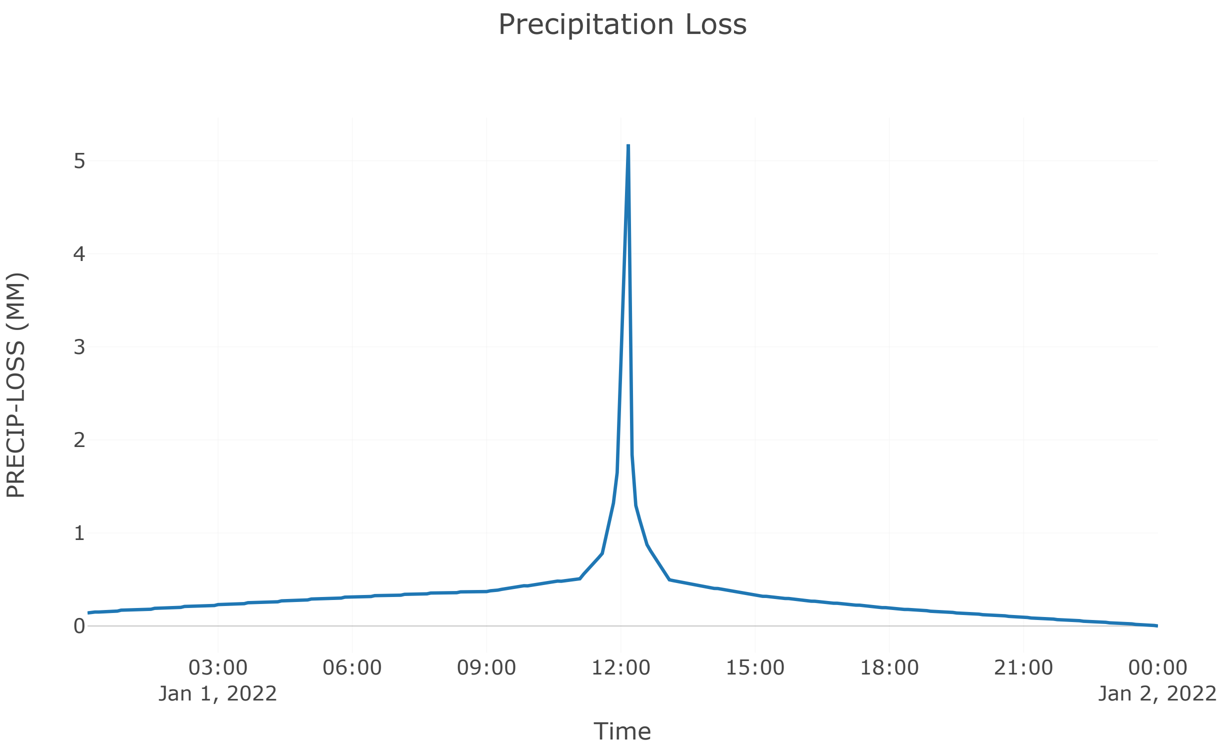

Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (MM)
25
20
15
10
5
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

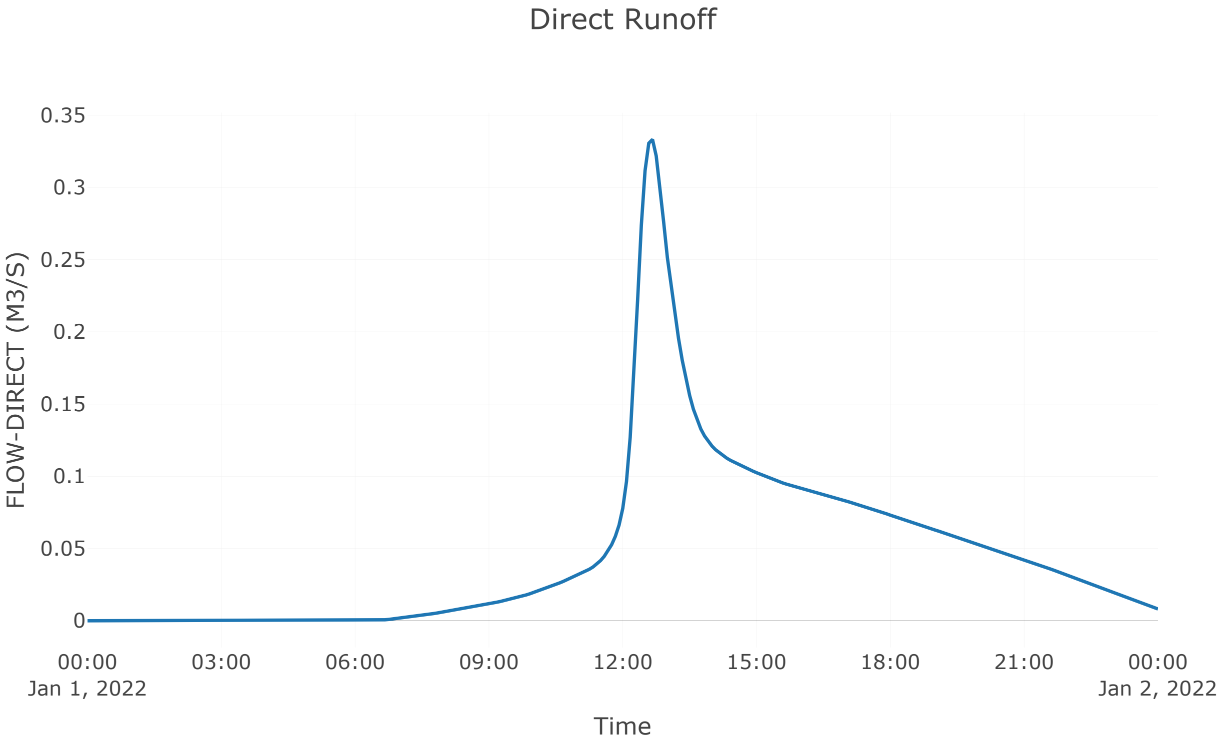

Cumulative Outflow
FLOW-CUMULATIVE (1000 M3)
1
0.5
0
−0.5
−1
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

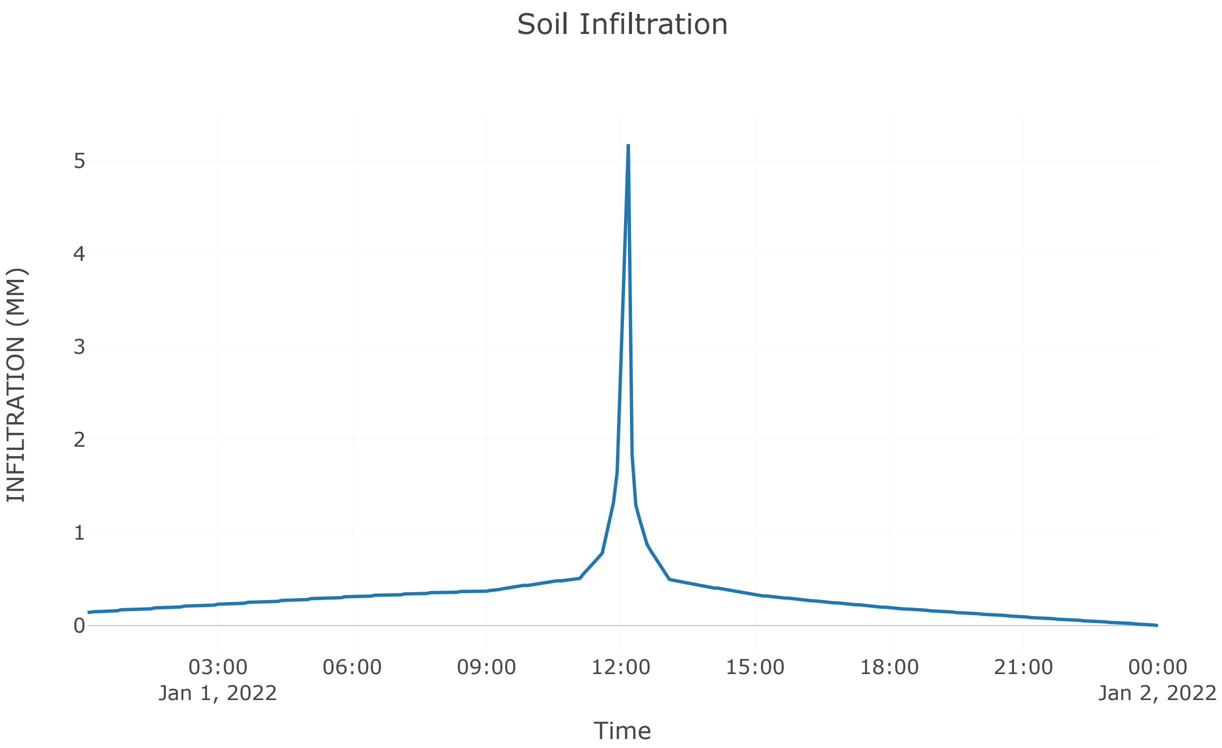

Cumulative Precipitation
PRECIP-CUM (MM)
120
100
80
60
40
20
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (MM)
100
80
60
40
20
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Baseflow
FLOW-BASE (M3/S)
1
0.5
0
−0.5
−1
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Precipitation Loss
PRECIP-LOSS (MM)
0
1
2
3
4
5
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Direct Runoff
FLOW-DIRECT (M3/S)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Soil Infiltration
INFILTRATION (MM)
5
4
3
2
1
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

Project: Calcutta_Farms_Industrial
Simulation Run: EX_100YR
Simulation Start: 31 December 2021, 24:00
Simulation End: 1 January 2022, 24:00

HMS Version: 4.9
Executed: 16 June 2022, 03:12

Global Parameter Summary - Subbasin

Area (KM²)

Element Name	Area (KM²)
Ex Swc01b	0.15

Downstream

Element Name	Downstream
Ex Swc01b	Sink - 1

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Ex Swc01b	0	44	16.2

Transform: Scs

Element Name	Lag	Unitgraph Type
Ex Swc01b	29.4	Standard

Global Results Summary

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
Sink - 1	0.15	0.81	01Jan2022, 12:40	62.43
Ex Swc01b	0.15	0.81	01Jan2022, 12:40	62.43

Subbasin: EX_SWC01B

Area (KM²) : 0.15
Downstream : Sink - 1

Loss Rate: Scs

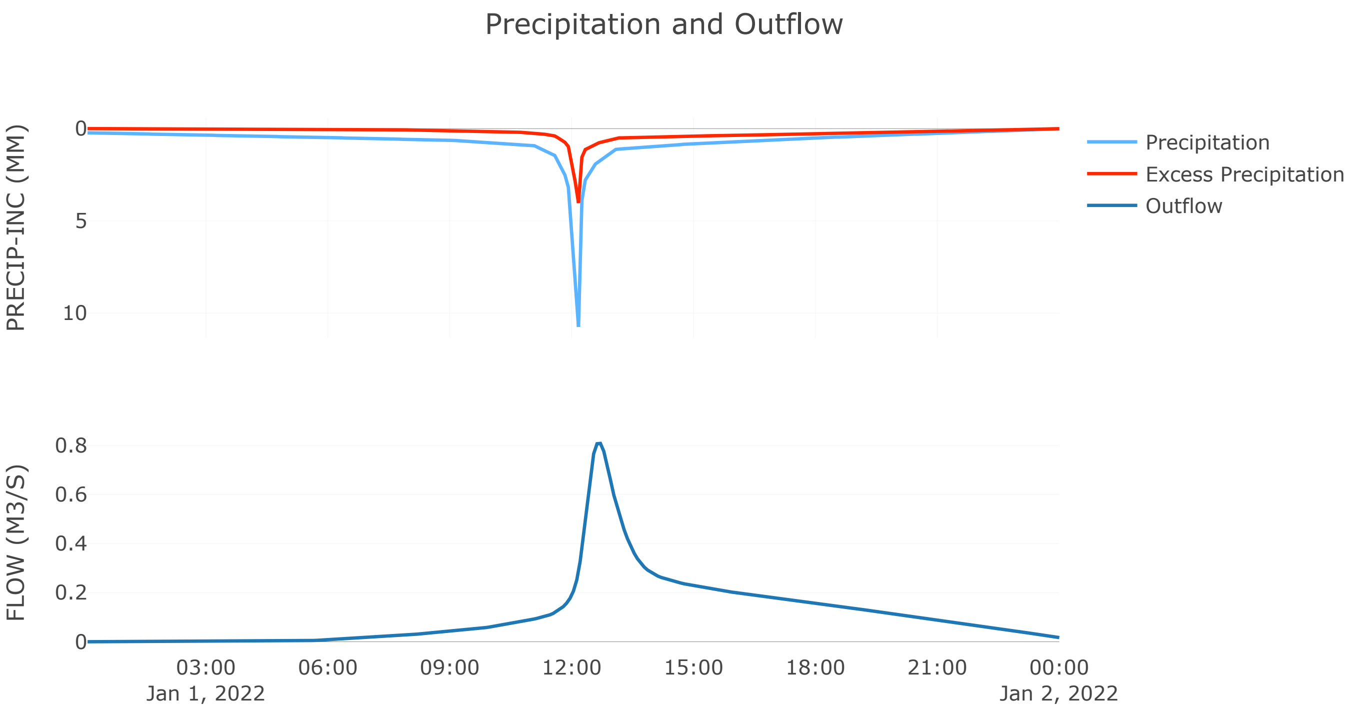
Percent Impervious Area	0
Curve Number	44
Initial Abstraction	16.2

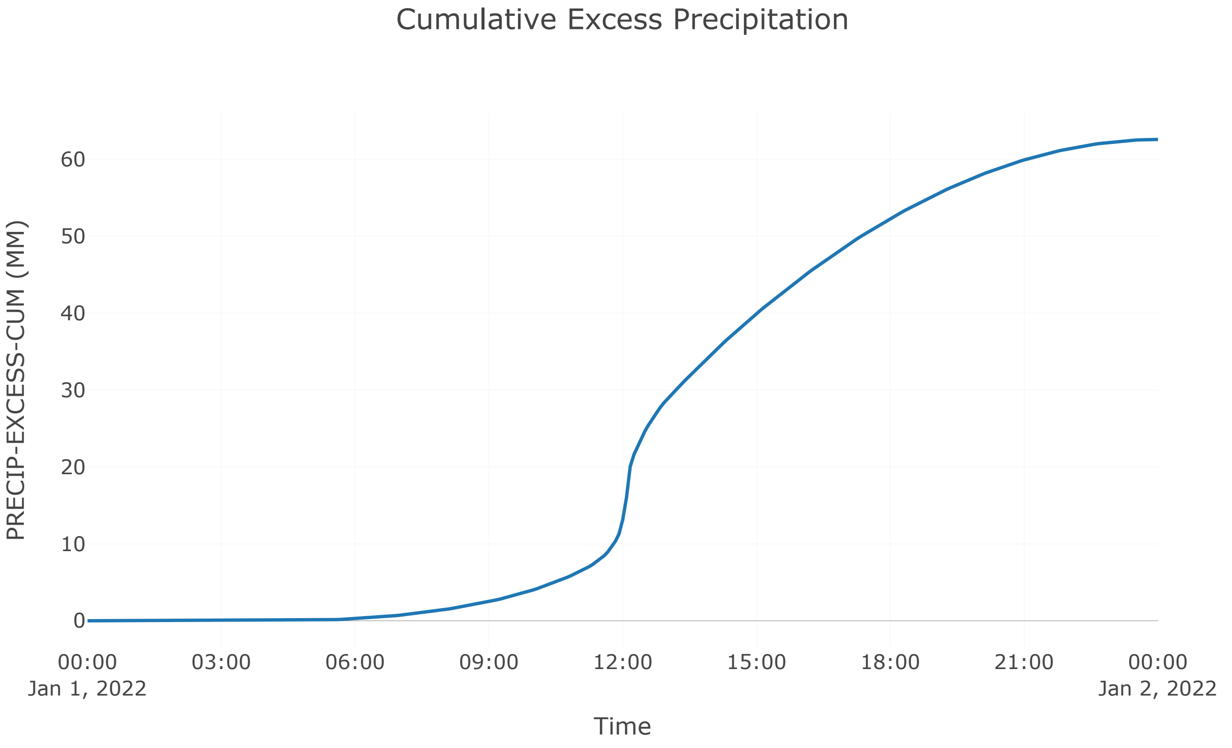
Transform: Scs

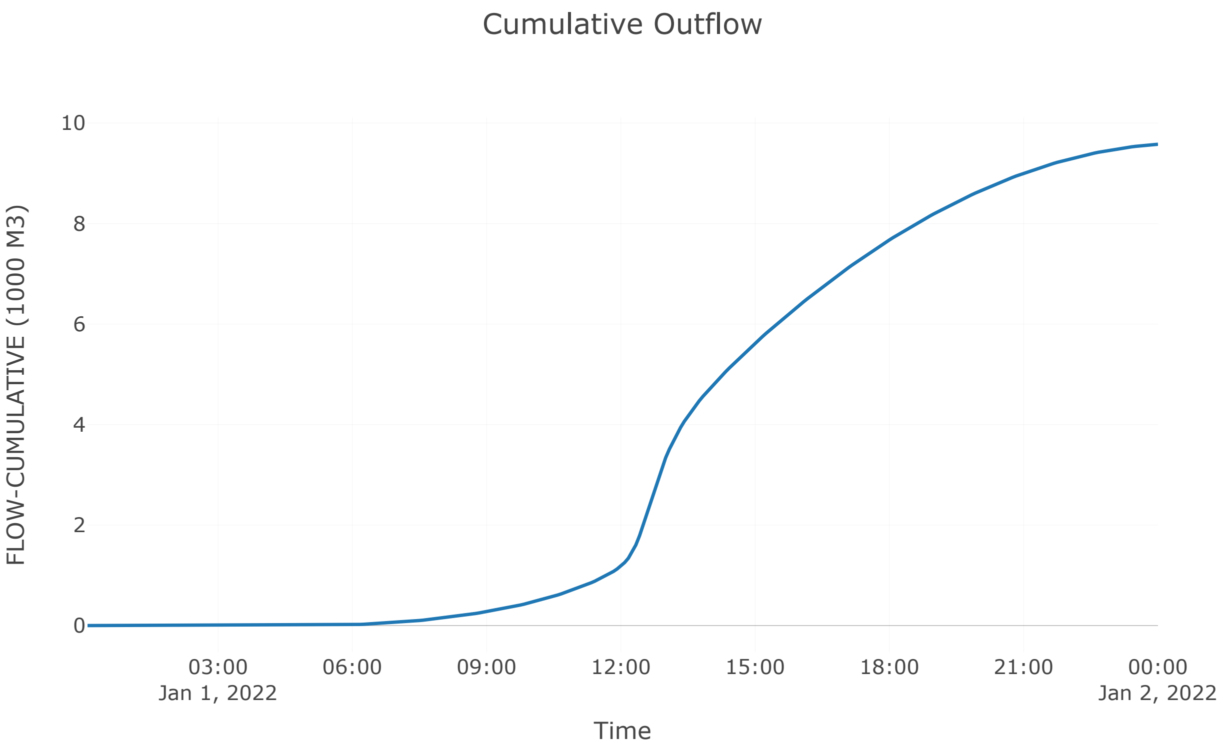
Lag	29.4
Unitgraph Type	Standard

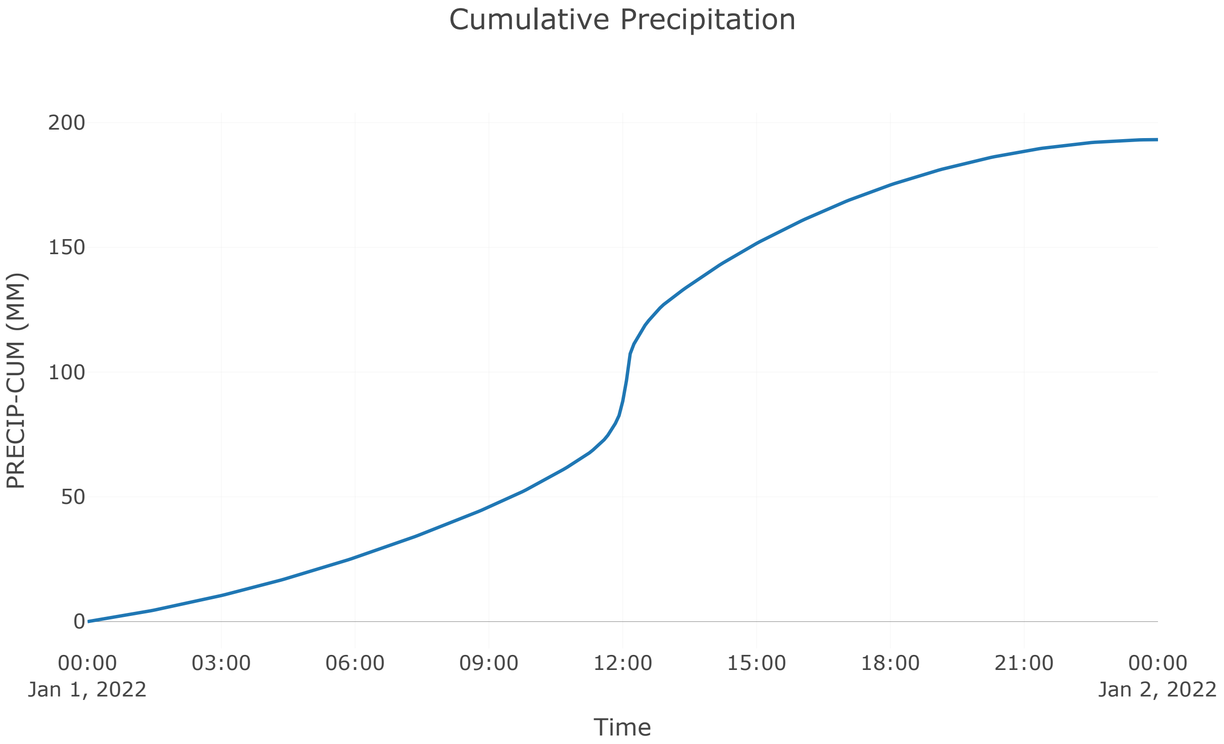
Results: EX_SWC01B

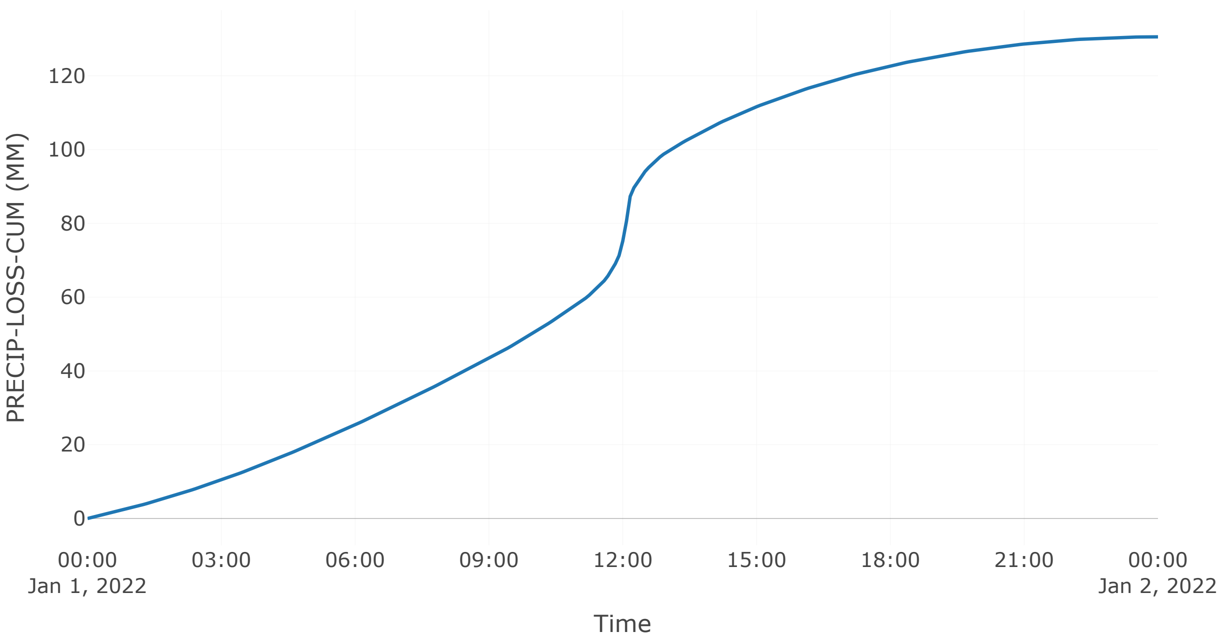
Peak Discharge (M3/S)	0.81
Time of Peak Discharge	01Jan2022, 12:40
Volume (MM)	62.43
Precipitation Volume (M3)	29636.14
Loss Volume (M3)	20031.07
Excess Volume (M3)	9605.07
Direct Runoff Volume (M3)	9578.72
Baseflow Volume (M3)	0


Precipitation and Outflow
PRECIP-INC (MM)
0
5
10
Precipitation
Excess Precipitation
Outflow
FLOW (M3/S)
0.8
0.6
0.4
0.2
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022

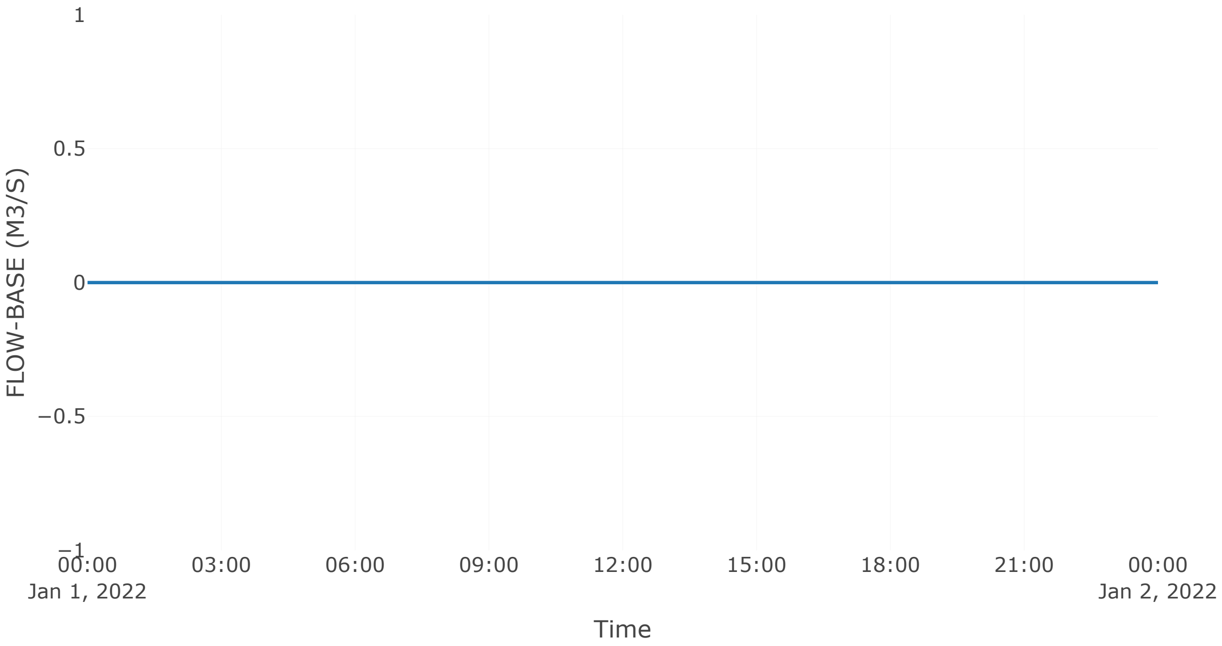

Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (MM)
60
50
40
30
20
10
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Cumulative Outflow
FLOW-CUMULATIVE (1000 M3)
10
8
6
4
2
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

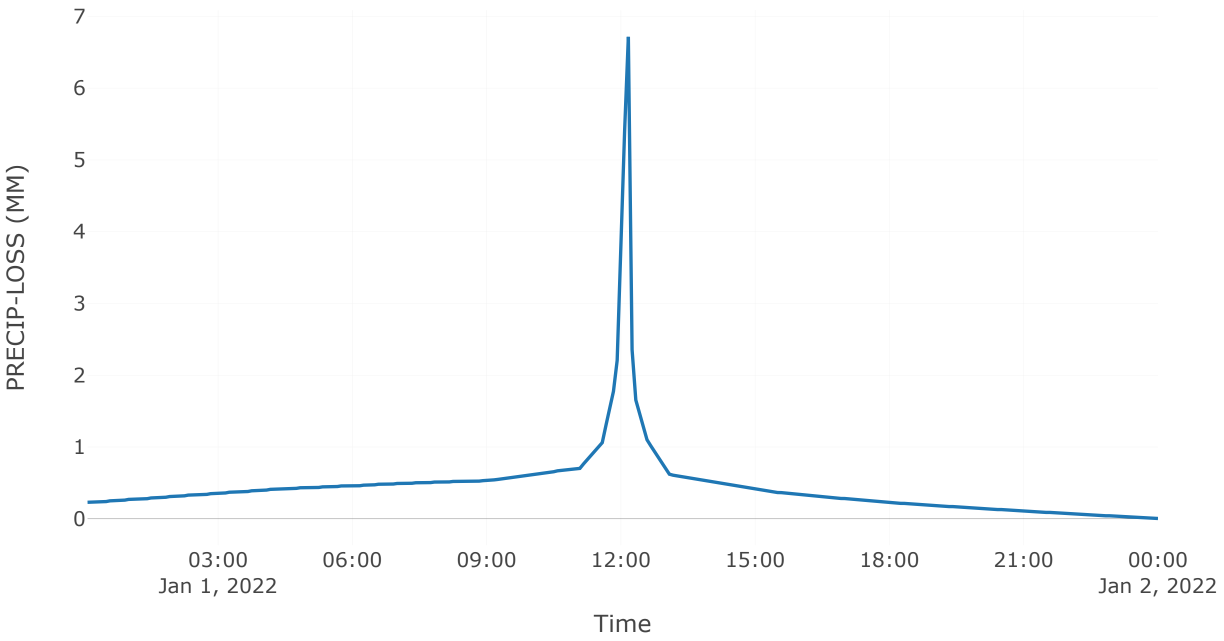

Cumulative Precipitation
PRECIP-CUM (MM)
200
150
100
50
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time



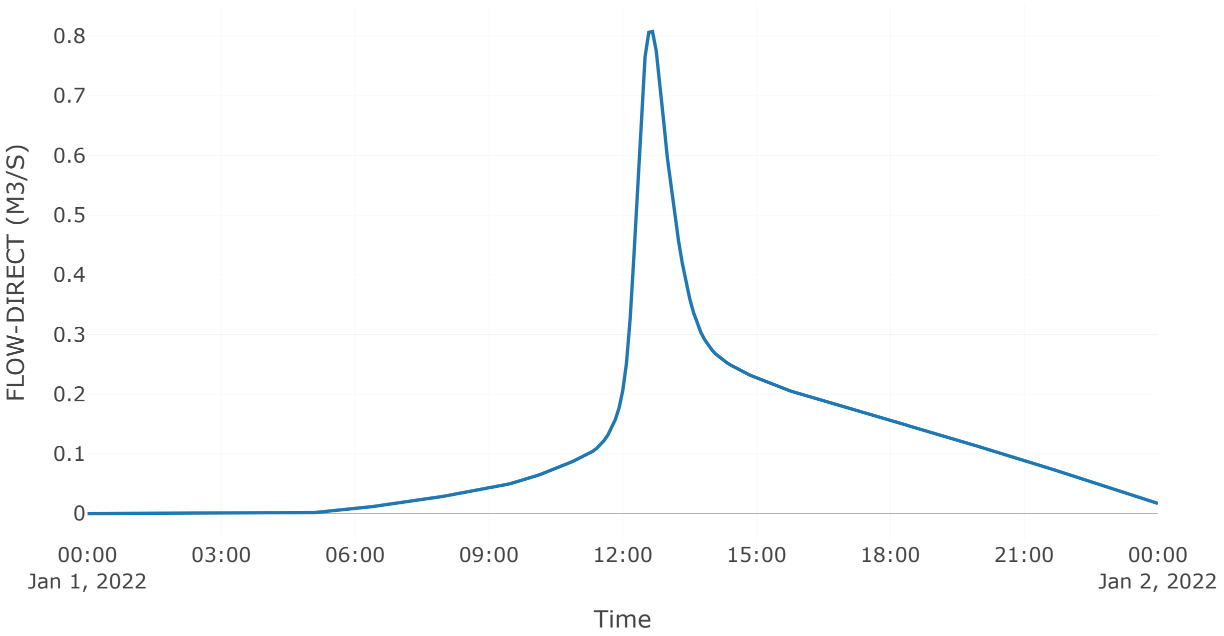
Cumulative Precipitation Loss



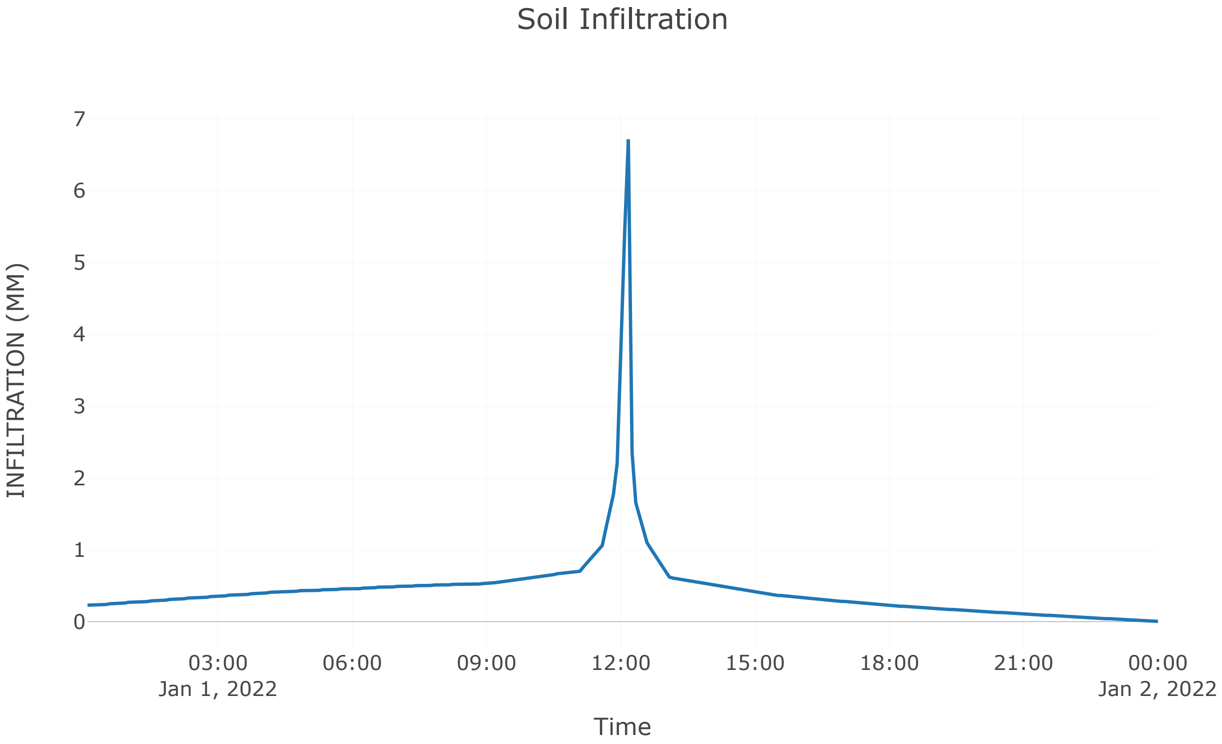
Baseflow



Precipitation Loss



Direct Runoff


Soil Infiltration
INFILTRATION (MM)
0
1
2
3
4
5
6
7
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

Project: Calcutta_Farms_Industrial
Simulation Run: Post-Dev_2YR_CC_2.1C
Simulation Start: 31 December 2021, 24:00
Simulation End: 1 January 2022, 24:00

HMS Version: 4.9
Executed: 16 June 2022, 03:12

Global Parameter Summary - Subbasin

Area (KM²)

Element Name	Area (KM²)
Swc01b	0.15

Downstream

Element Name	Downstream
Swc01b	Sink - 1 - Post - dev

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Swc01b	90	65	0.7

Transform: Scs

Element Name	Lag	Unitgraph Type
Swc01b	30.6	Standard

Global Results Summary

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
Swc01b	0.15	1.01	01Jan2022, 12:35	86.55
Sink - 1 - Post - dev	0.15	1.01	01Jan2022, 12:35	86.55

Subbasin: SWC01B

Area (KM^2) : 0.15
Downstream : Sink - 1 - Post - dev

Loss Rate: Scs

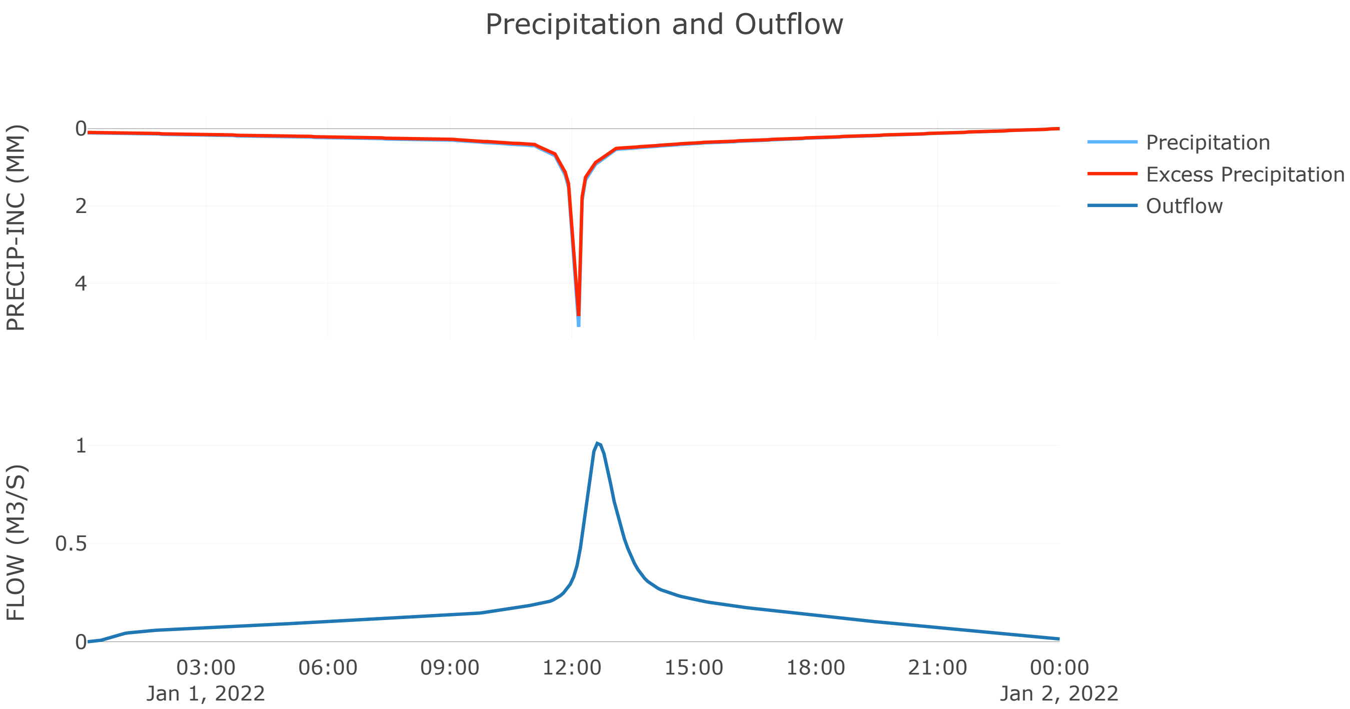
Percent Impervious Area	90
Curve Number	65
Initial Abstraction	0.7

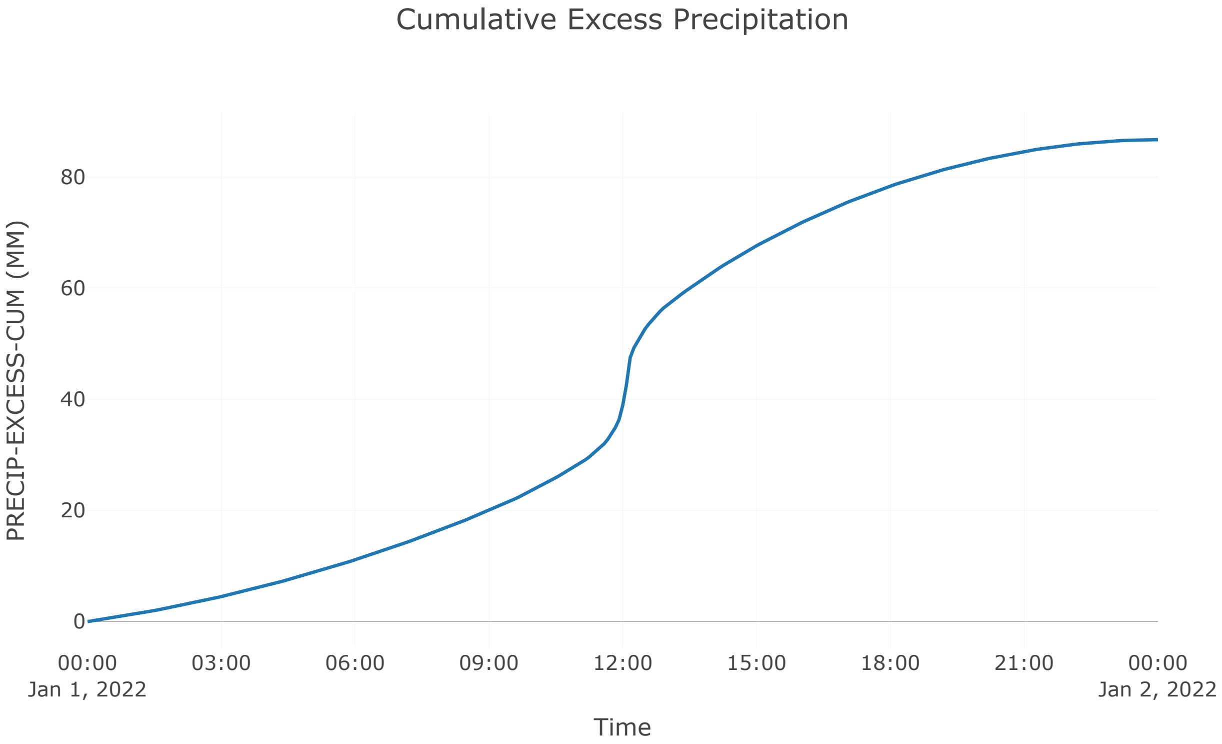
Transform: Scs

Lag	30.6
Unitgraph Type	Standard

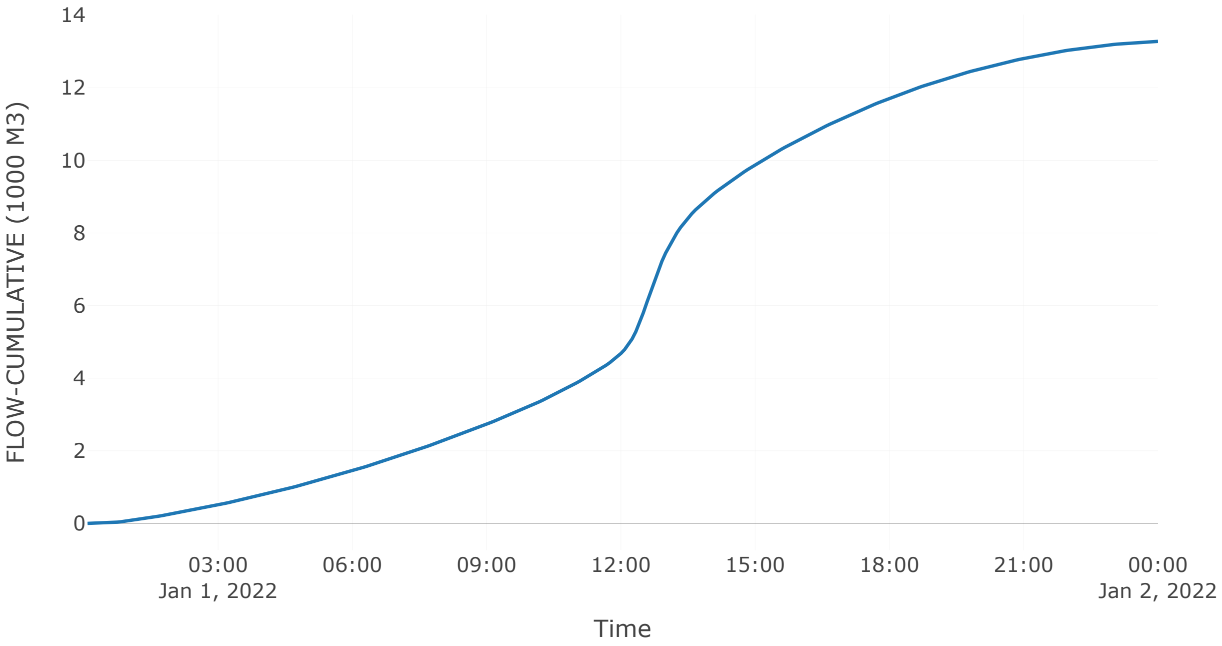
Results: SWC01B

Peak Discharge (M3/S)	1.01
Time of Peak Discharge	01Jan2022, 12:35
Volume (MM)	86.55
Precipitation Volume (M3)	14153
Loss Volume (M3)	852.11
Excess Volume (M3)	13300.89
Direct Runoff Volume (M3)	13278.3
Baseflow Volume (M3)	0

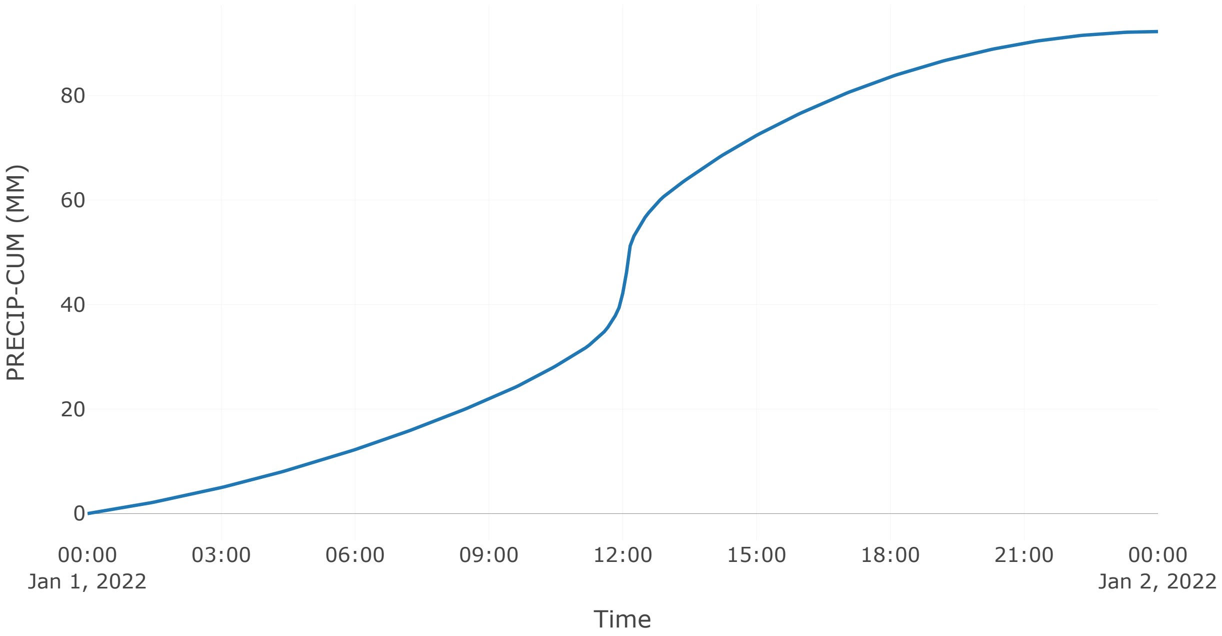

Precipitation and Outflow
PRECIP-INC (MM)
0
2
4
Precipitation
Excess Precipitation
Outflow
FLOW (M3/S)
1
0.5
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022


Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (MM)
80
60
40
20
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

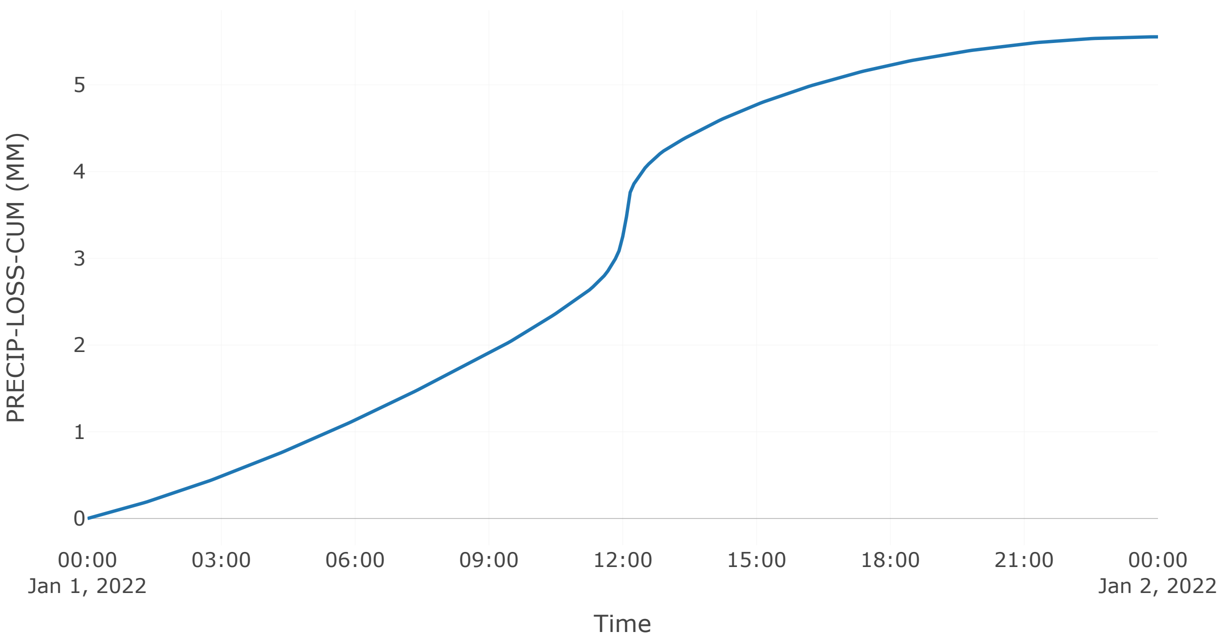
Cumulative Outflow



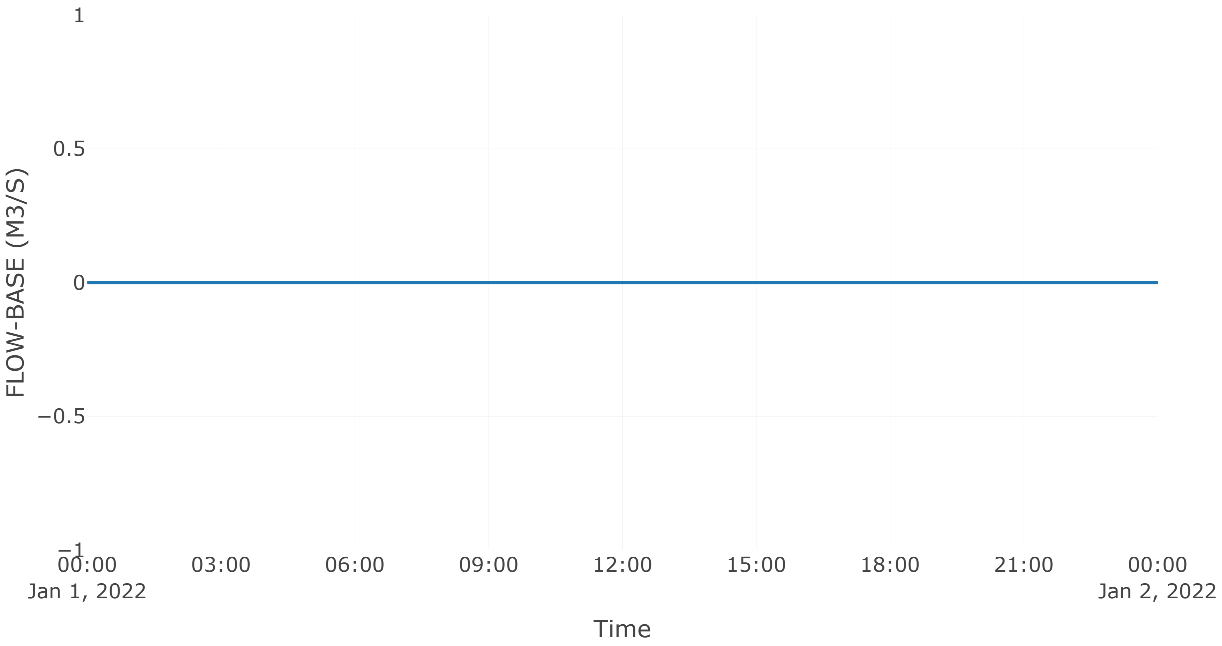
Cumulative Precipitation



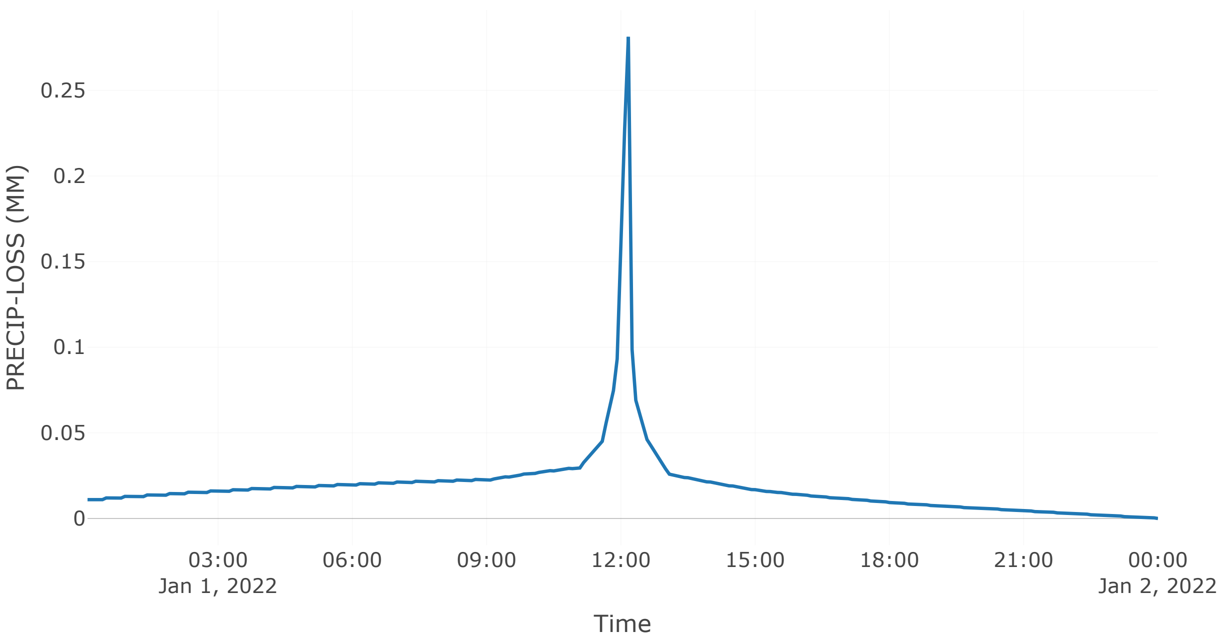
Cumulative Precipitation Loss



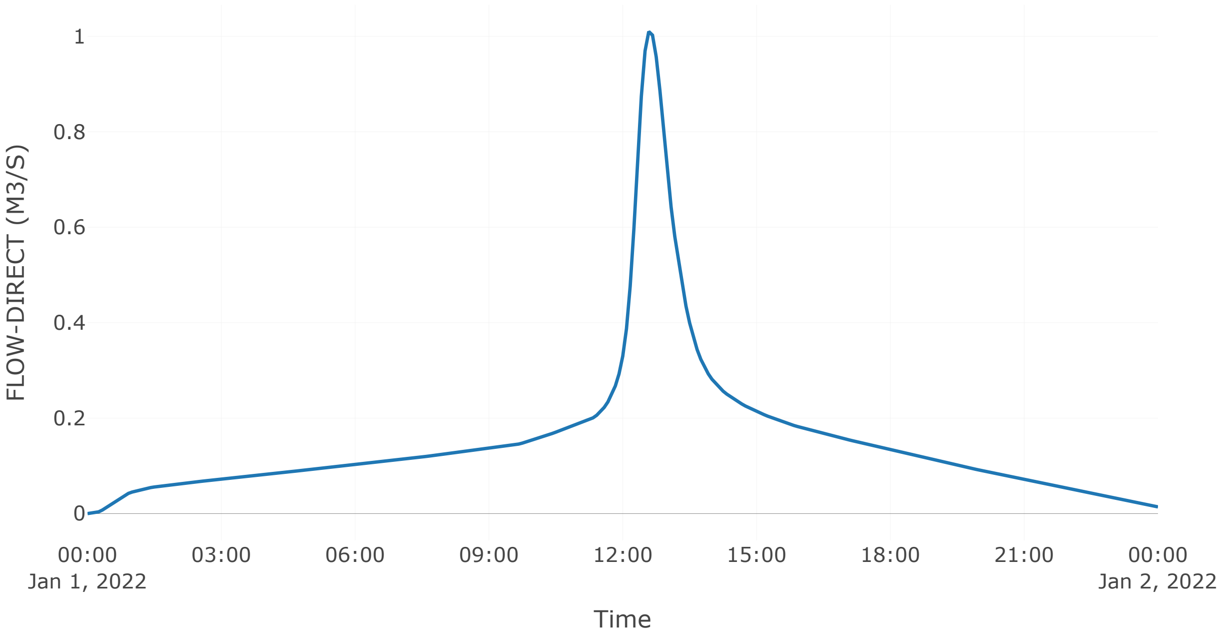
Baseflow

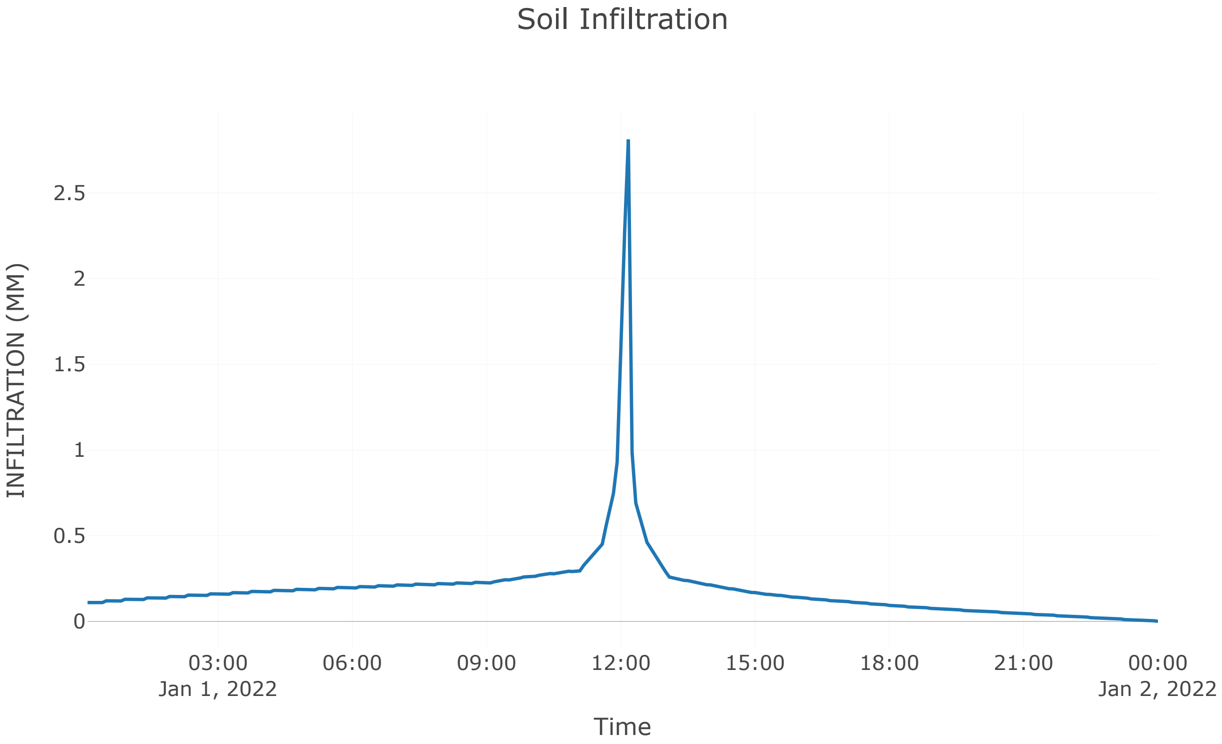


Precipitation Loss



Direct Runoff




Soil Infiltration
INFILTRATION (MM)
2.5
2
1.5
1
0.5
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

Project: Calcutta_Farms_Industrial
Simulation Run: Post-Dev_10YR_CC_2.1C
Simulation Start: 31 December 2021, 24:00
Simulation End: 1 January 2022, 24:00

HMS Version: 4.9
Executed: 16 June 2022, 03:12

Global Parameter Summary - Subbasin

Area (KM²)

Element Name	Area (KM²)
Swc01b	0.15

Downstream

Element Name	Downstream
Swc01b	Sink - 1 - Post - dev

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Swc01b	90	65	0.7

Transform: Scs

Element Name	Lag	Unitgraph Type
Swc01b	30.6	Standard

Global Results Summary

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
Swc01b	0.15	1.6	01Jan2022, 12:35	137.09
Sink - 1 - Post - dev	0.15	1.6	01Jan2022, 12:35	137.09

Subbasin: SWC01B

Area (KM²) : 0.15
Downstream : Sink - 1 - Post - dev

Loss Rate: Scs

Percent Impervious Area	90
Curve Number	65
Initial Abstraction	0.7

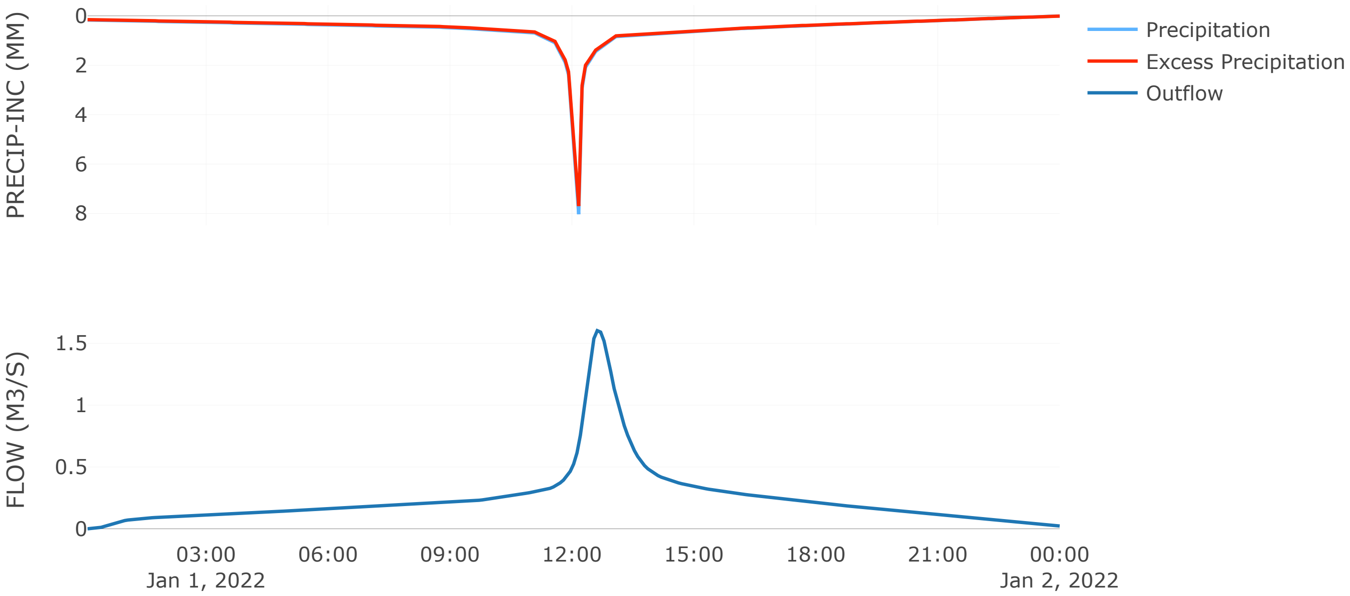
Transform: Scs

Lag	30.6
Unitgraph Type	Standard

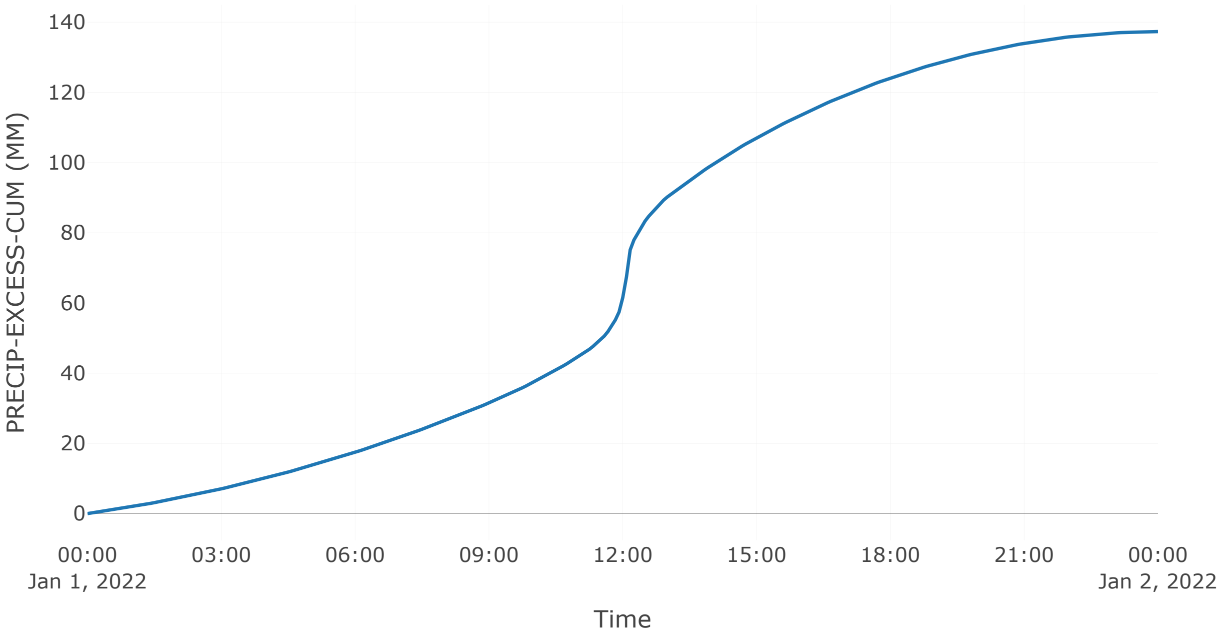
Results: SWC01B

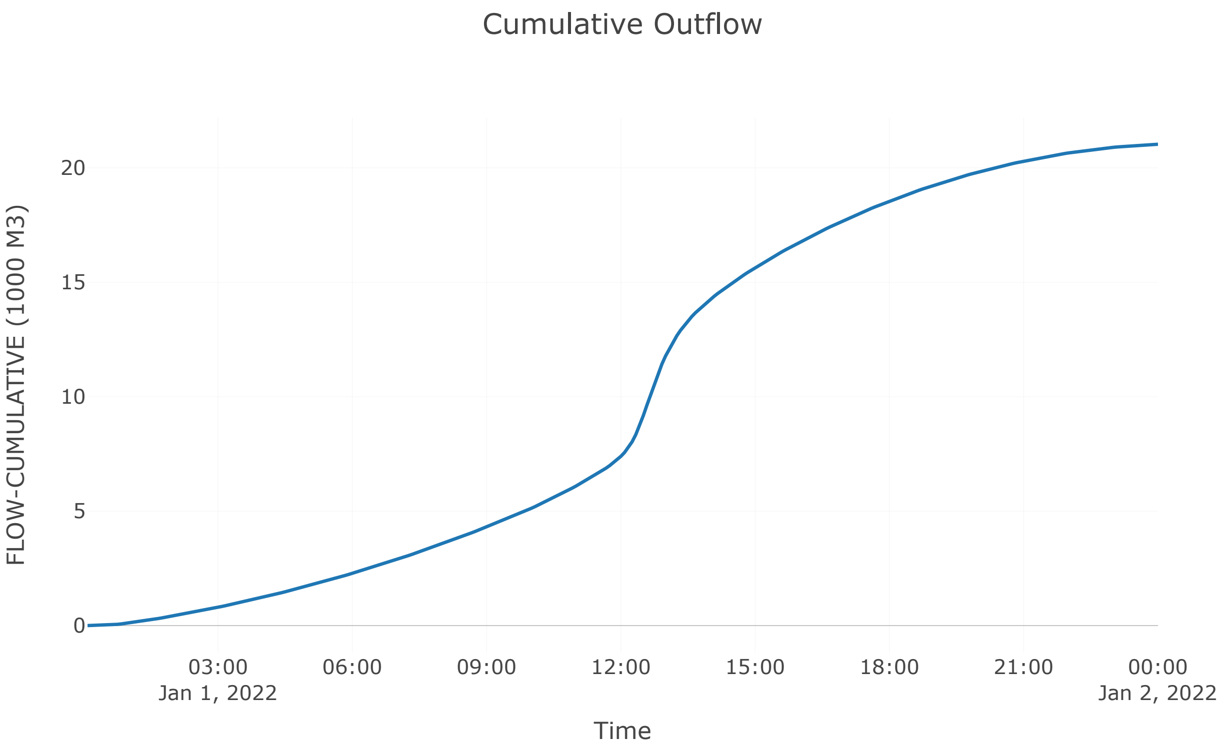
Peak Discharge (M3/S)	1.6
Time of Peak Discharge	01Jan2022, 12:35
Volume (MM)	137.09
Precipitation Volume (M3)	22155.38
Loss Volume (M3)	1085.86
Excess Volume (M3)	21069.52
Direct Runoff Volume (M3)	21031.77
Baseflow Volume (M3)	0

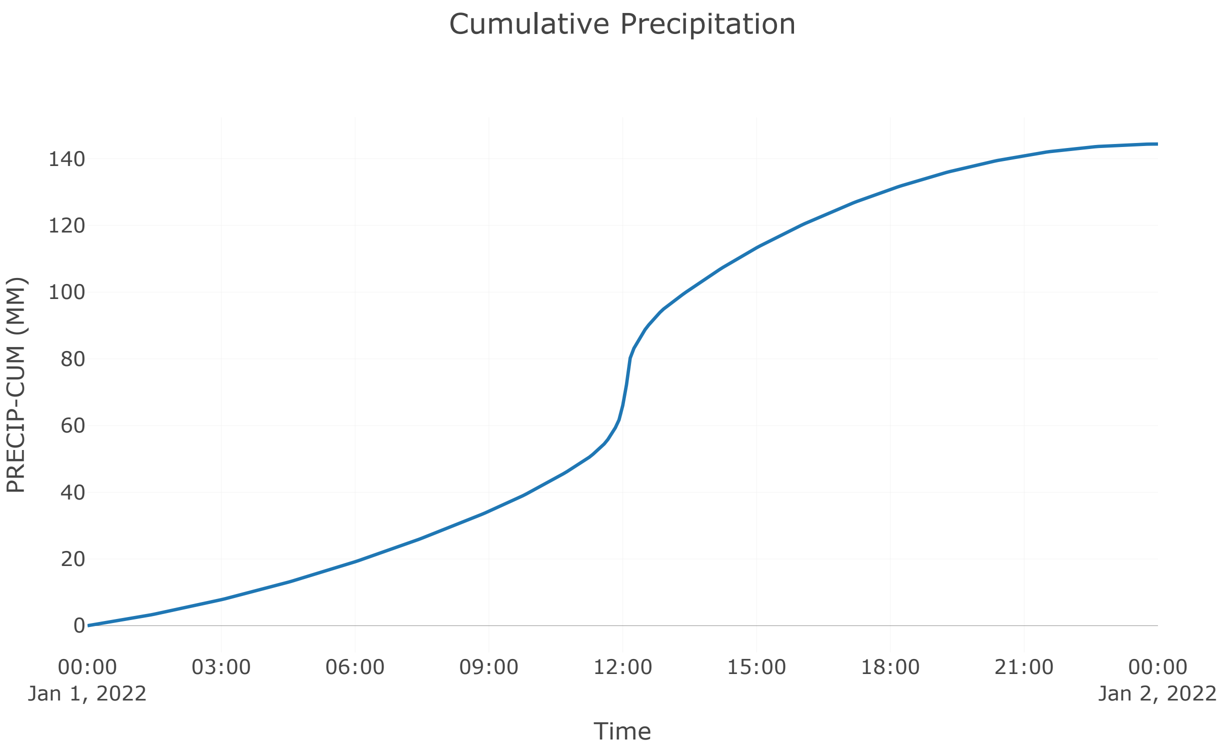
Precipitation and Outflow



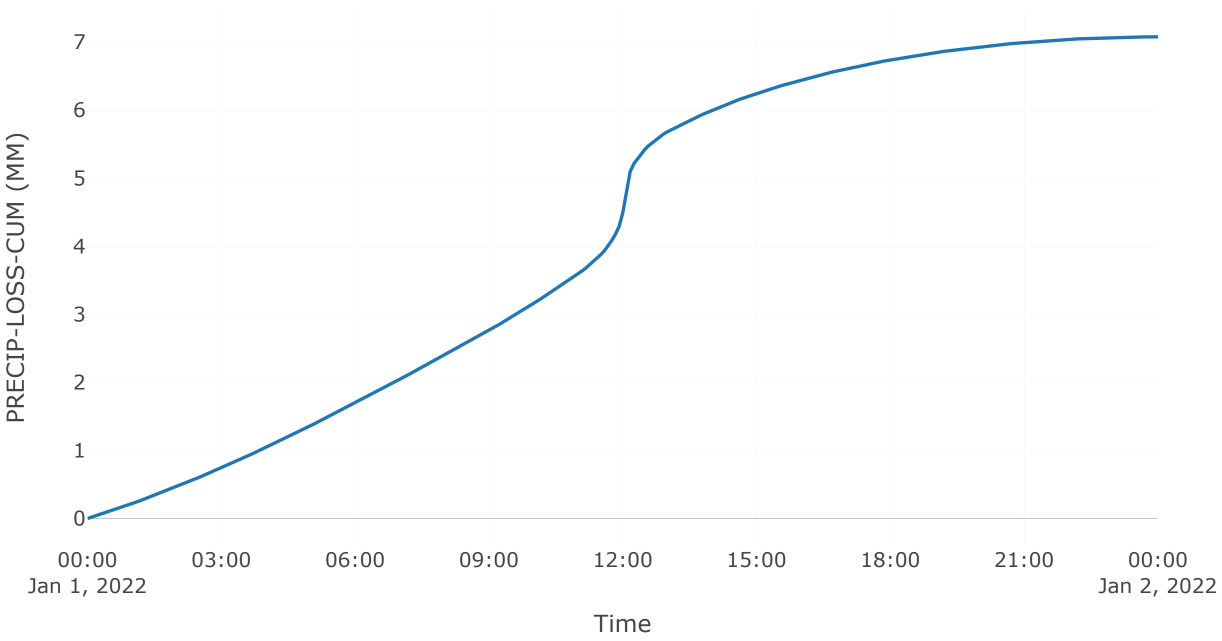
Cumulative Excess Precipitation



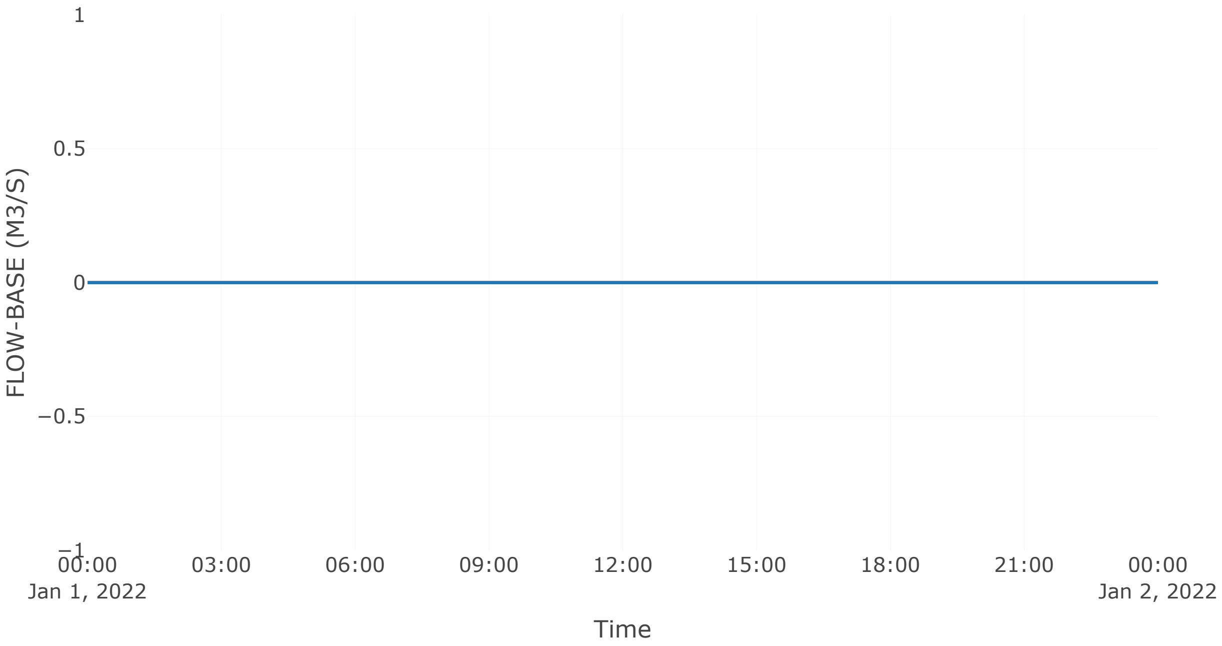

Cumulative Outflow
FLOW-CUMULATIVE (1000 M3)
0
5
10
15
20
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

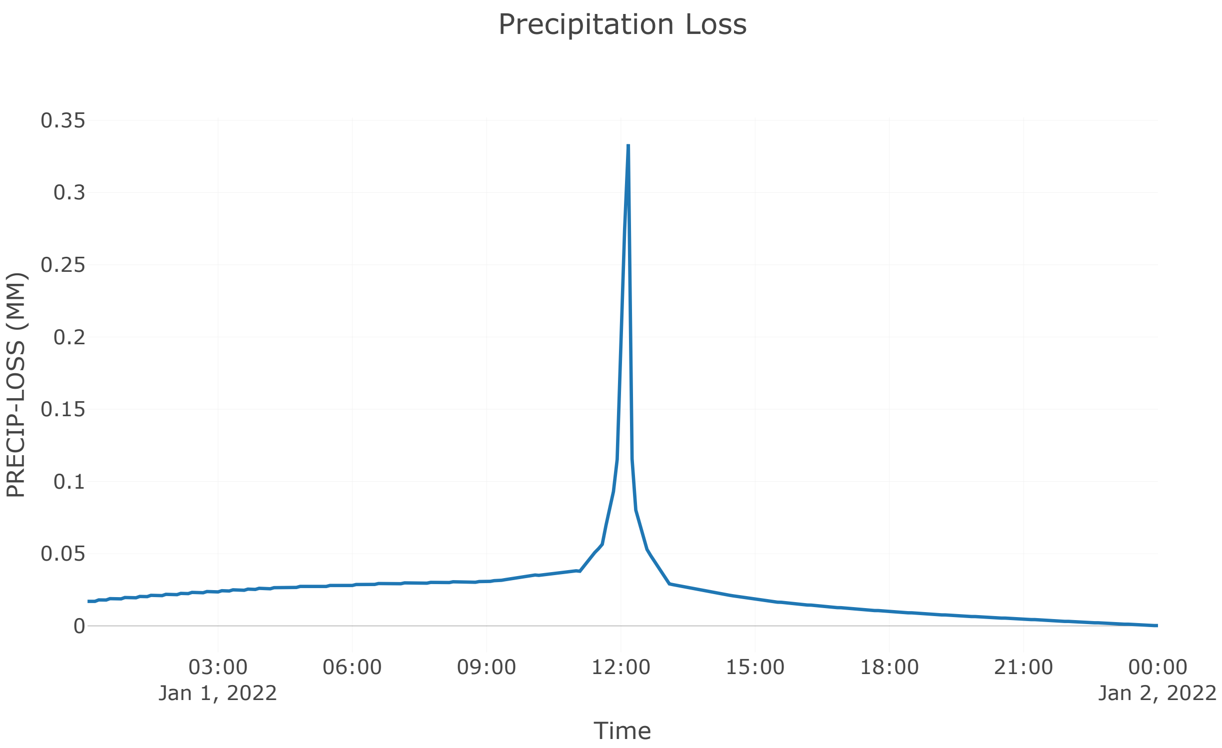

Cumulative Precipitation
PRECIP-CUM (MM)
0
20
40
60
80
100
120
140
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

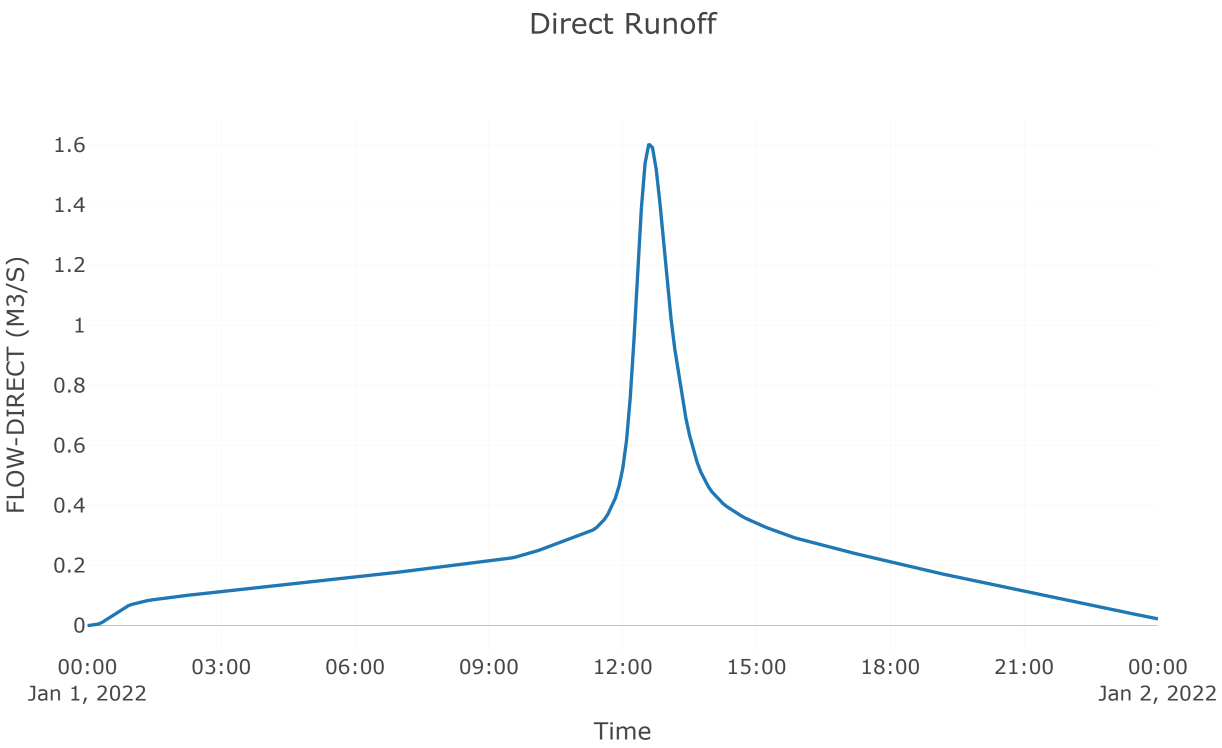
Cumulative Precipitation Loss

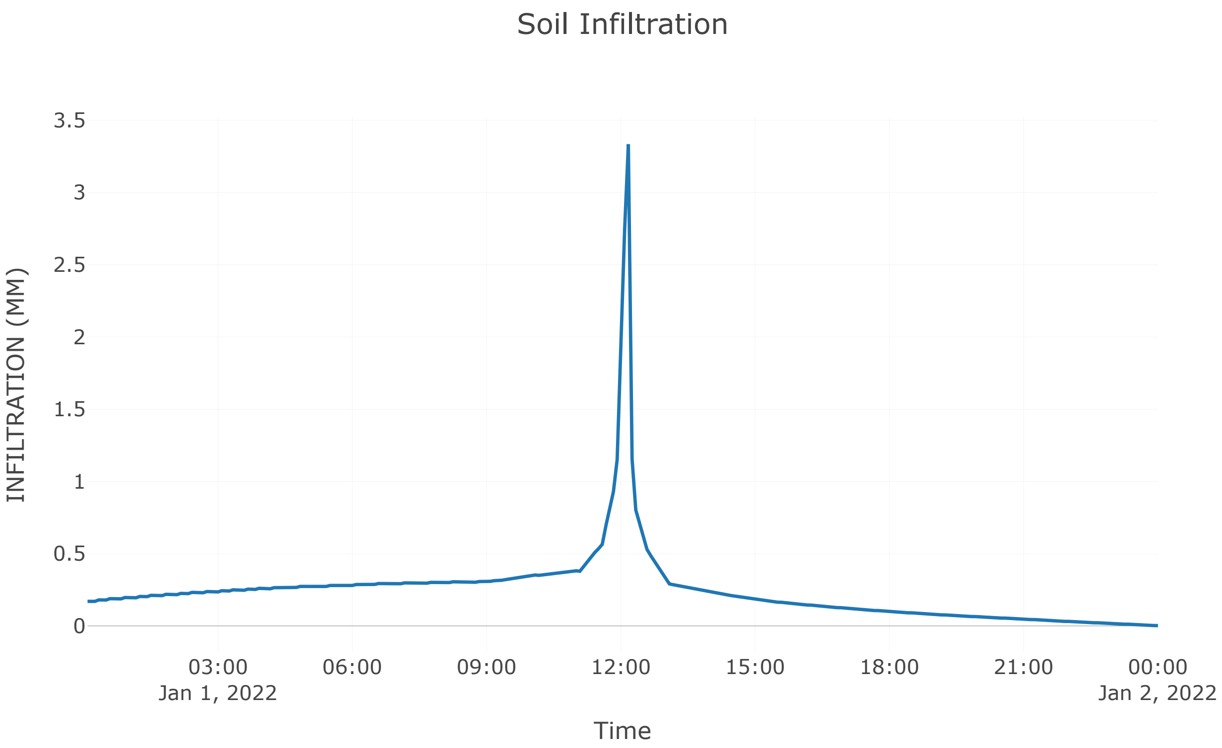


Baseflow




Precipitation Loss
PRECIP-LOSS (MM)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Direct Runoff
FLOW-DIRECT (M3/S)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Soil Infiltration
INFILTRATION (MM)
3.5
3
2.5
2
1.5
1
0.5
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

Project: Calcutta_Farms_Industrial
Simulation Run: Post-Dev_100YR_CC_2.1C
Simulation Start: 31 December 2021, 24:00
Simulation End: 1 January 2022, 24:00

HMS Version: 4.9
Executed: 16 June 2022, 03:12

Global Parameter Summary - Subbasin

Area (KM²)

Element Name	Area (KM²)
Swc01b	0.15

Downstream

Element Name	Downstream
Swc01b	Sink - 1 - Post - dev

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Swc01b	90	65	0.7

Transform: Scs

Element Name	Lag	Unitgraph Type
Swc01b	30.6	Standard

Global Results Summary

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
Swc01b	0.15	2.57	01Jan2022, 12:35	219.11
Sink - 1 - Post - dev	0.15	2.57	01Jan2022, 12:35	219.11

Subbasin: SWC01B

Area (KM²) : 0.15
Downstream : Sink - 1 - Post - dev

Loss Rate: Scs

Percent Impervious Area	90
Curve Number	65
Initial Abstraction	0.7

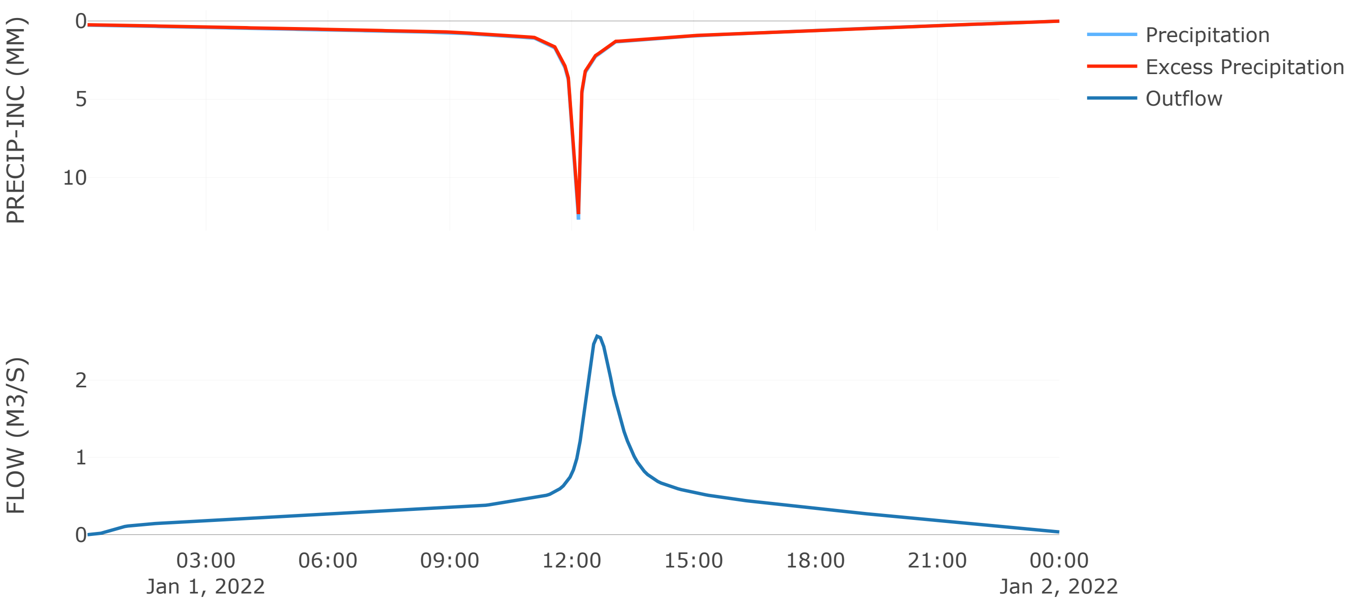
Transform: Scs

Lag	30.6
Unitgraph Type	Standard

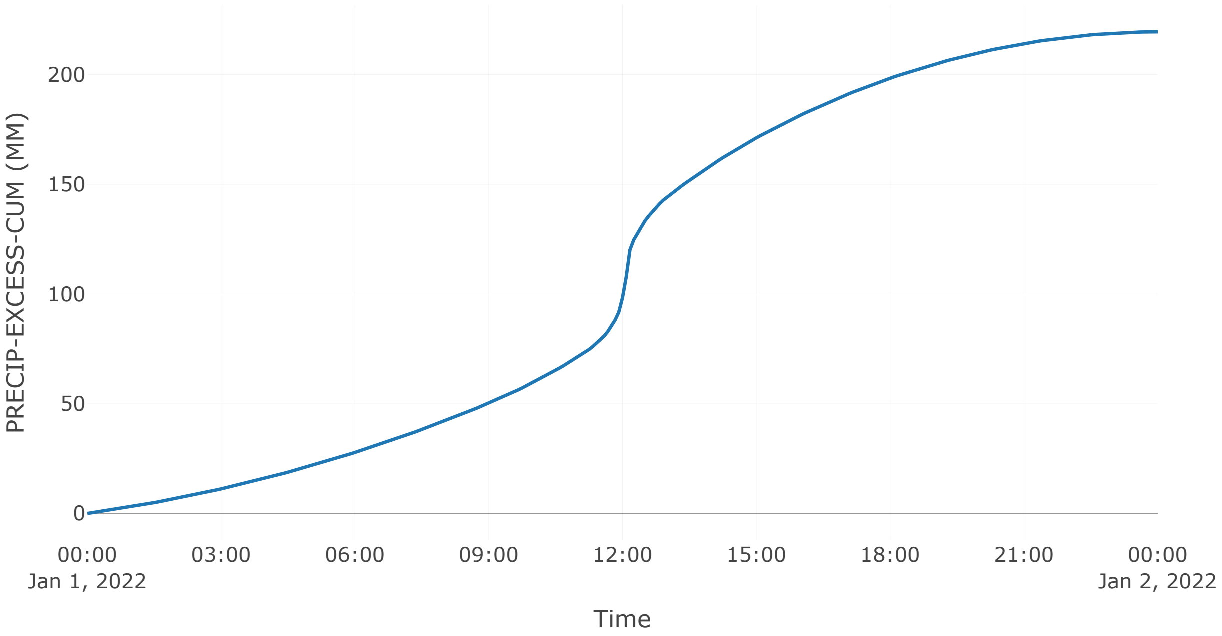
Results: SWC01B

Peak Discharge (M3/S)	2.57
Time of Peak Discharge	01Jan2022, 12:35
Volume (MM)	219.11
Precipitation Volume (M3)	34993.57
Loss Volume (M3)	1320.98
Excess Volume (M3)	33672.59
Direct Runoff Volume (M3)	33615.4
Baseflow Volume (M3)	0

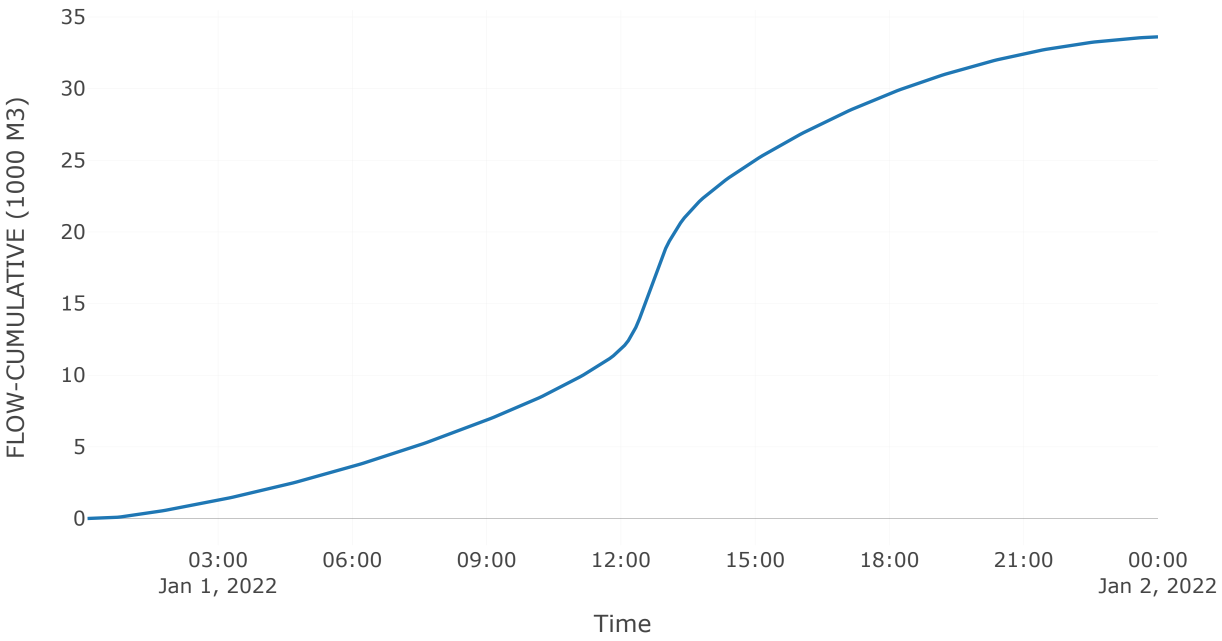
Precipitation and Outflow



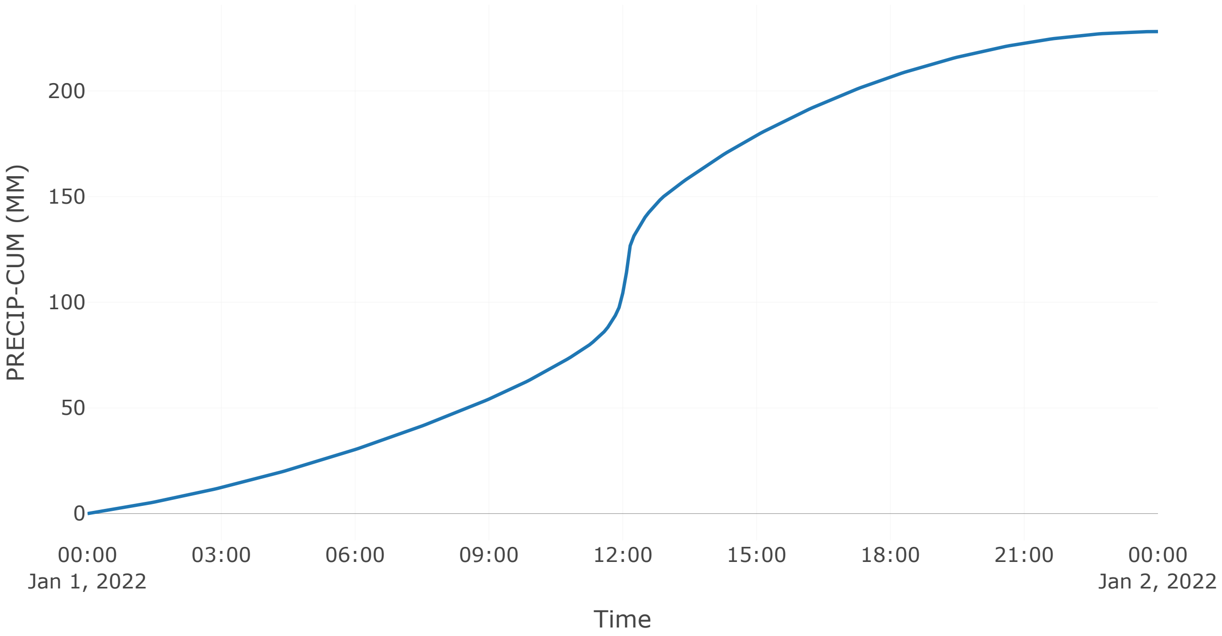
Cumulative Excess Precipitation



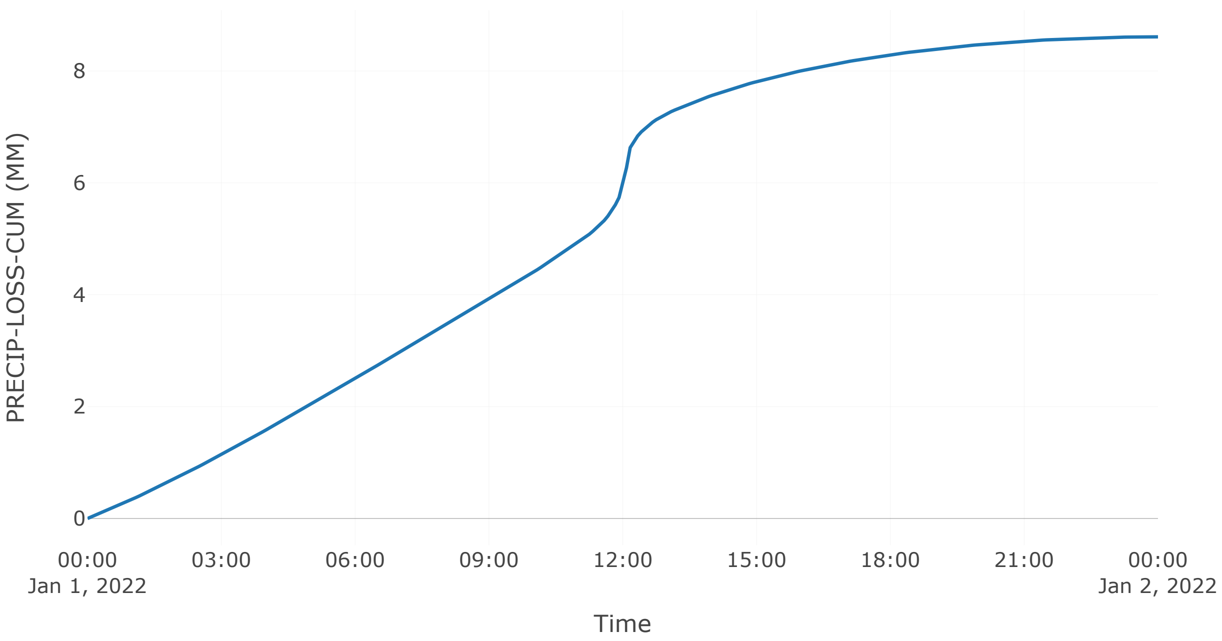
Cumulative Outflow



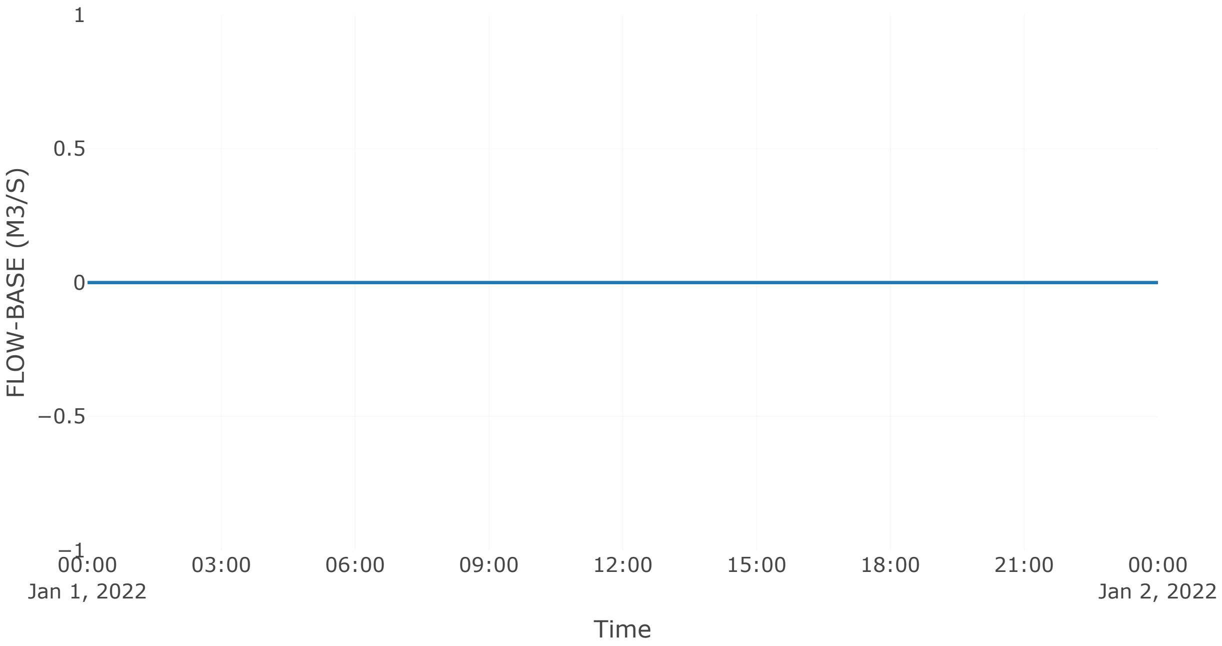
Cumulative Precipitation



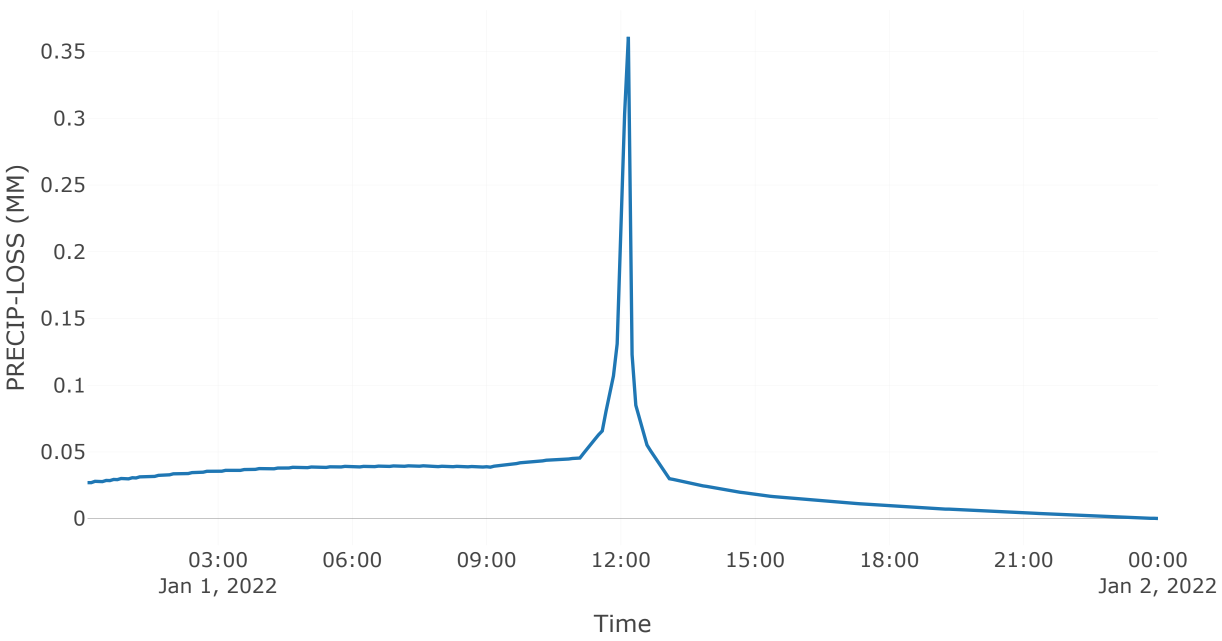
Cumulative Precipitation Loss



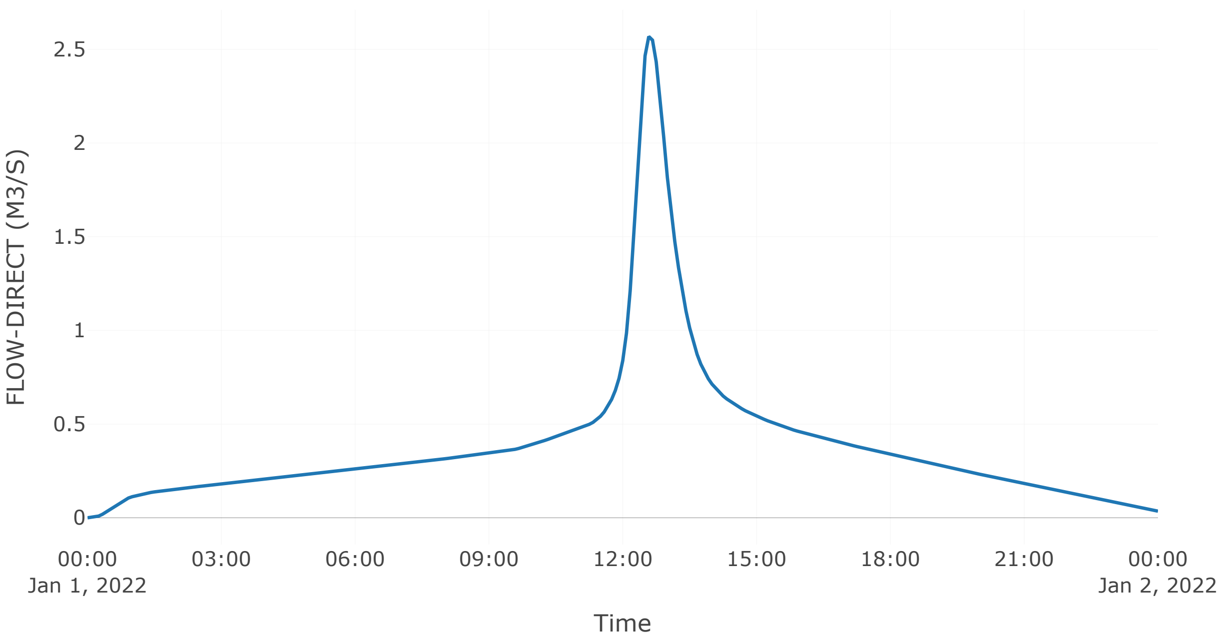
Baseflow

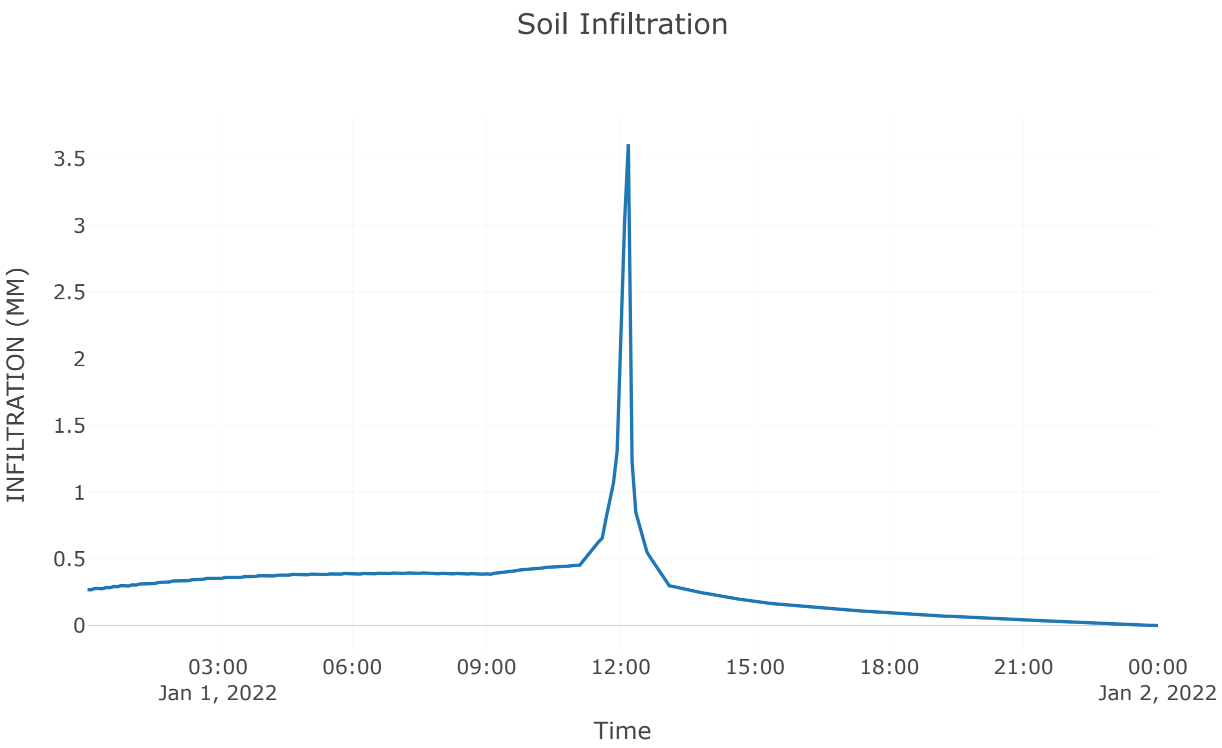


Precipitation Loss



Direct Runoff





Soil Infiltration
INFILTRATION (MM)
3.5
3
2.5
2
1.5
1
0.5
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

Project: Calcutta_Farms_Industrial
Simulation Run: Post-Dev_2YR_CC_2.3C
Simulation Start: 31 December 2021, 24:00
Simulation End: 1 January 2022, 24:00

HMS Version: 4.9
Executed: 16 June 2022, 03:12

Global Parameter Summary - Subbasin

Area (KM²)

Element Name	Area (KM²)
Swc01b	0.15

Downstream

Element Name	Downstream
Swc01b	Sink - 1 - Post - dev

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Swc01b	90	65	0.7

Transform: Scs

Element Name	Lag	Unitgraph Type
Swc01b	30.6	Standard

Global Results Summary

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
Swc01b	0.15	1.02	01Jan2022, 12:35	87.67
Sink - 1 - Post - dev	0.15	1.02	01Jan2022, 12:35	87.67

Subbasin: SWC01B

Area (KM²) : 0.15
Downstream : Sink - 1 - Post - dev

Loss Rate: Scs

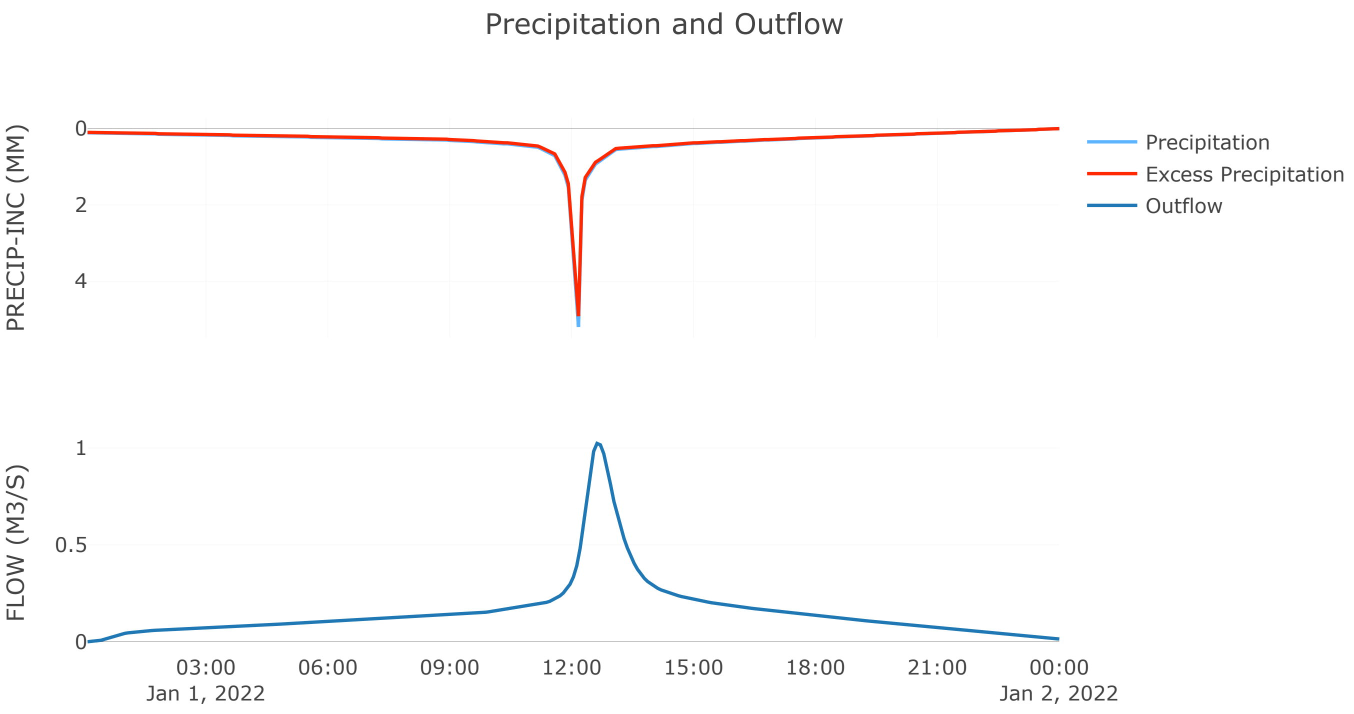
Percent Impervious Area	90
Curve Number	65
Initial Abstraction	0.7

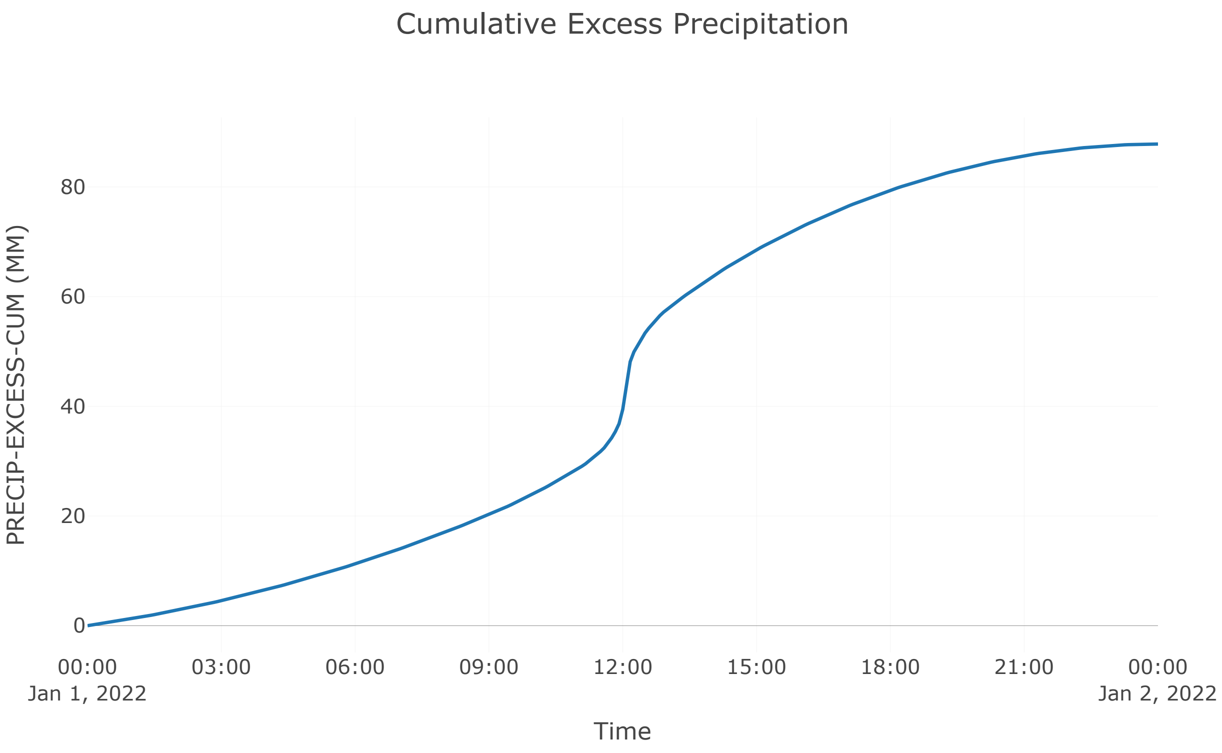
Transform: Scs

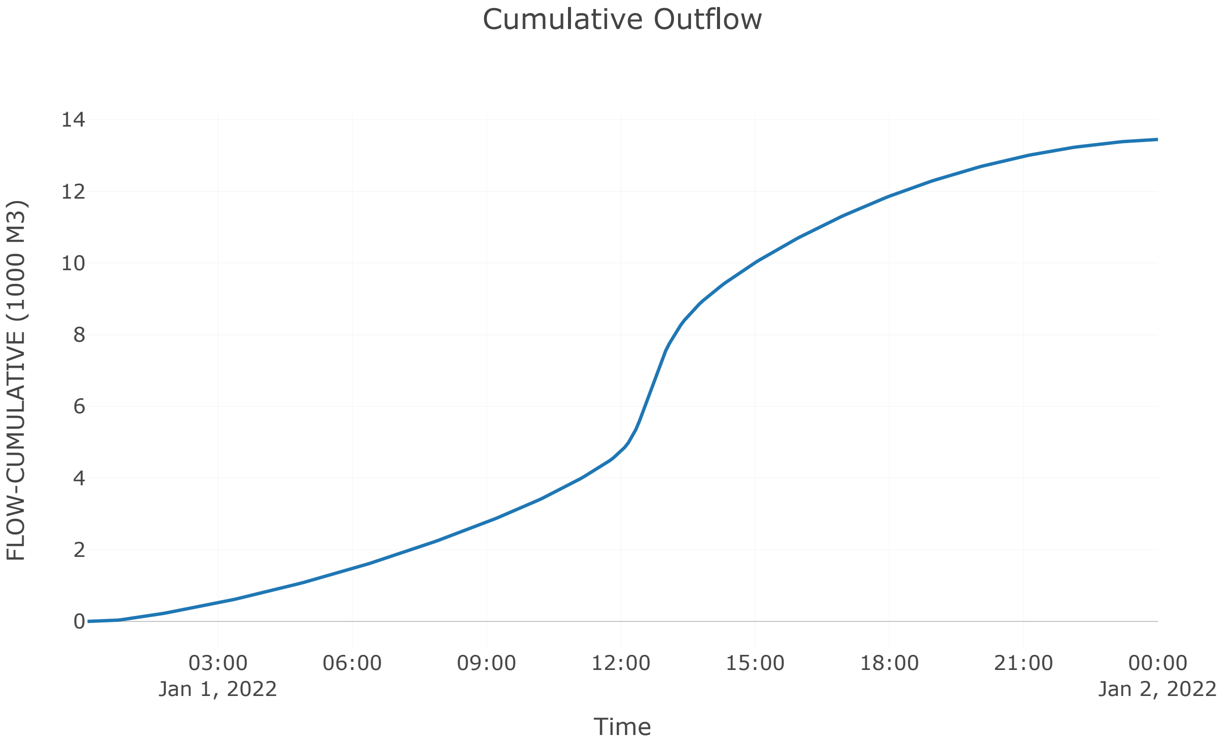
Lag	30.6
Unitgraph Type	Standard

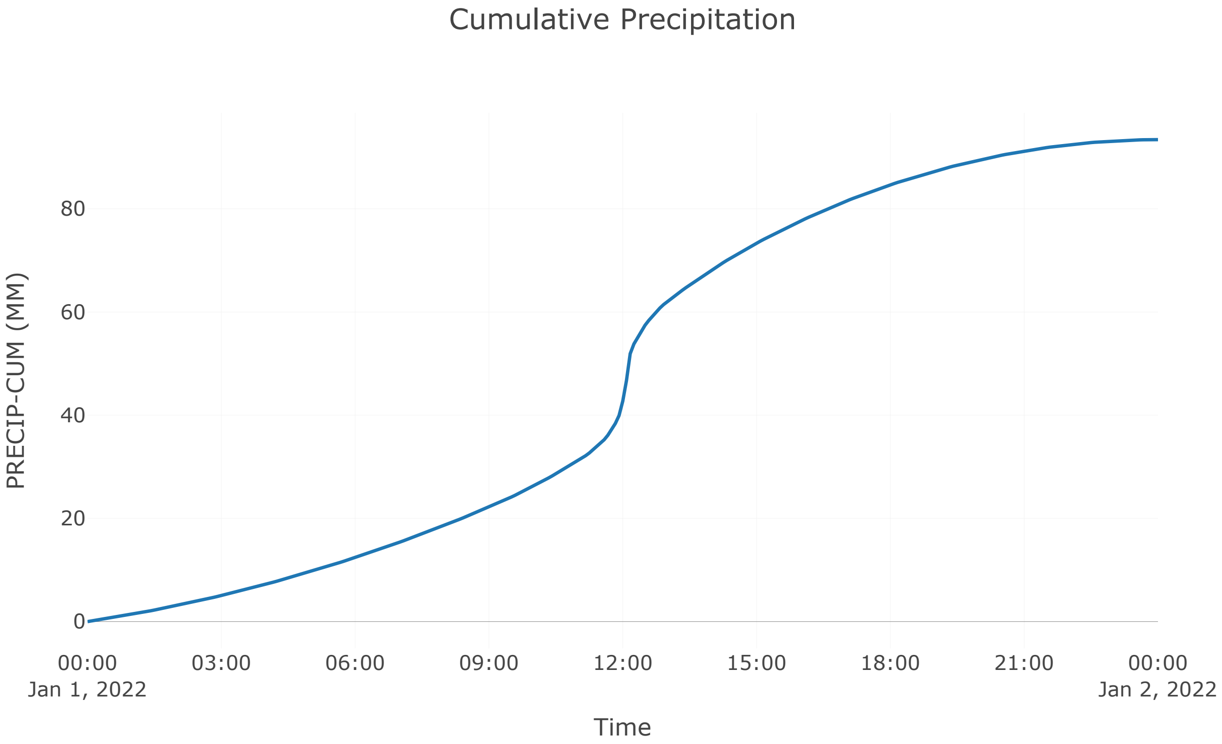
Results: SWC01B

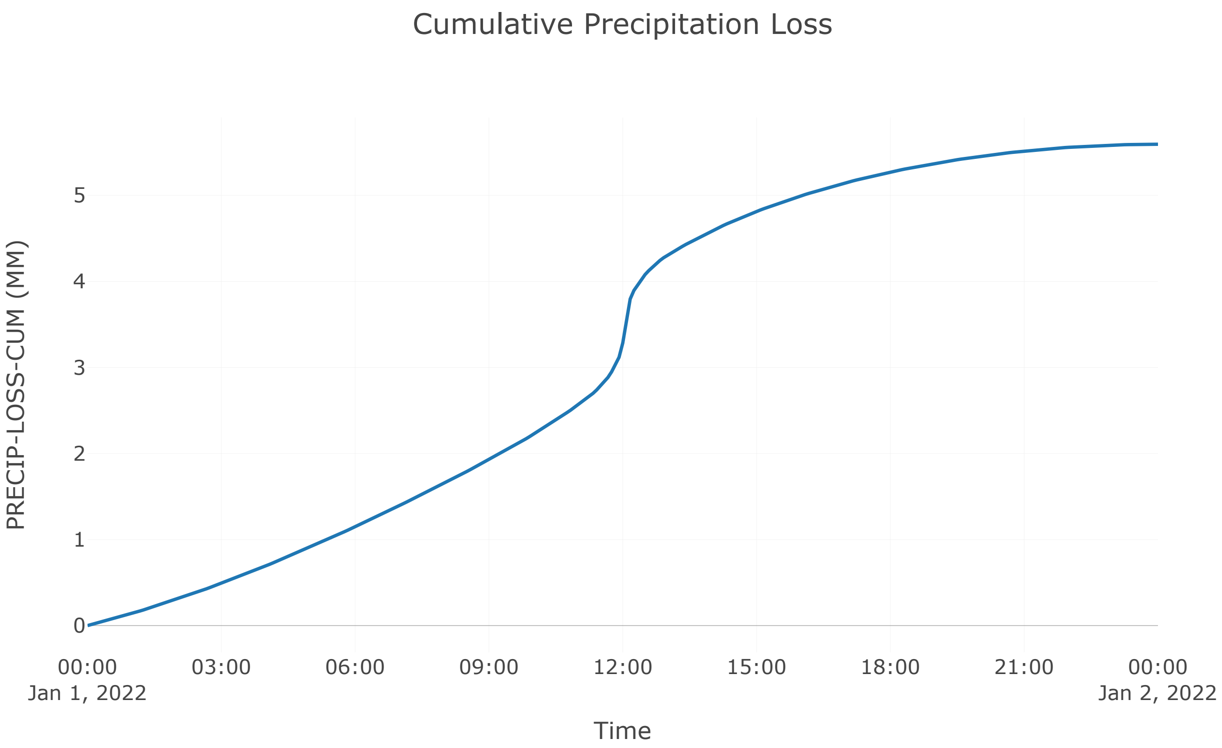
Peak Discharge (M3/S)	1.02
Time of Peak Discharge	01Jan2022, 12:35
Volume (MM)	87.67
Precipitation Volume (M3)	14330.96
Loss Volume (M3)	858.46
Excess Volume (M3)	13472.5
Direct Runoff Volume (M3)	13449.91
Baseflow Volume (M3)	0

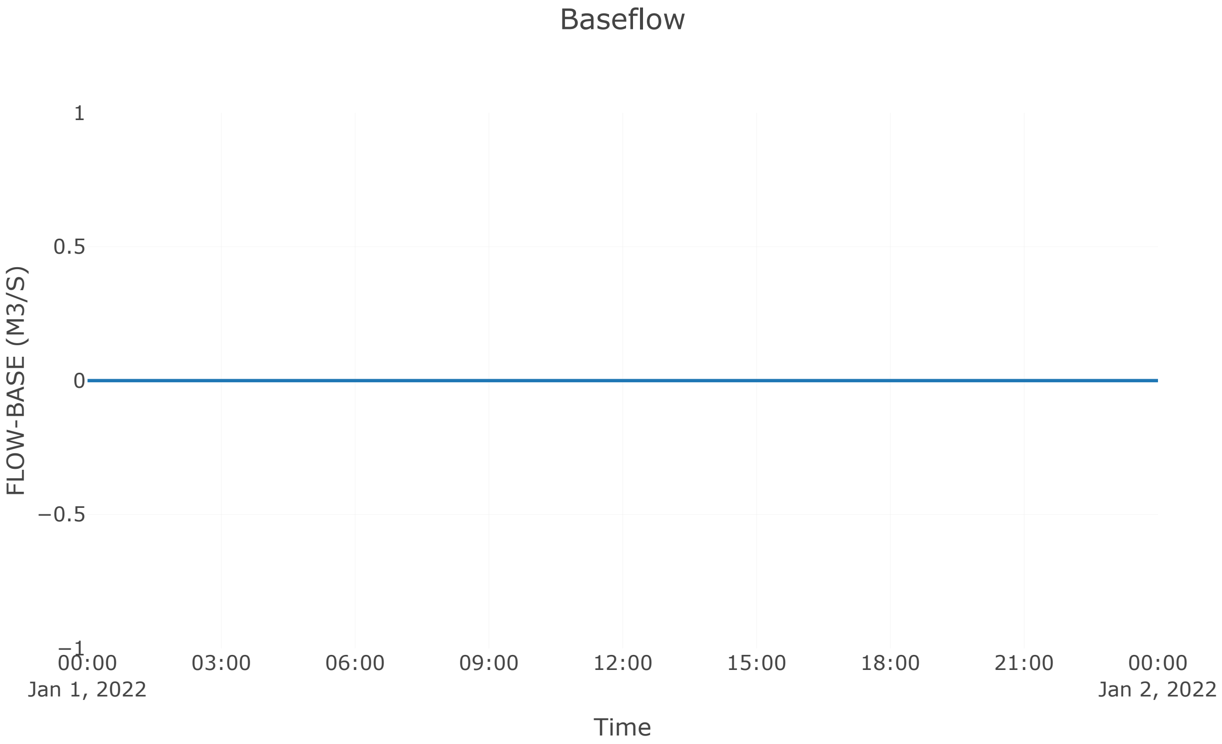

Precipitation and Outflow
PRECIP-INC (MM)
0
2
4
FLOW (M3/S)
1
0.5
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Precipitation
Excess Precipitation
Outflow

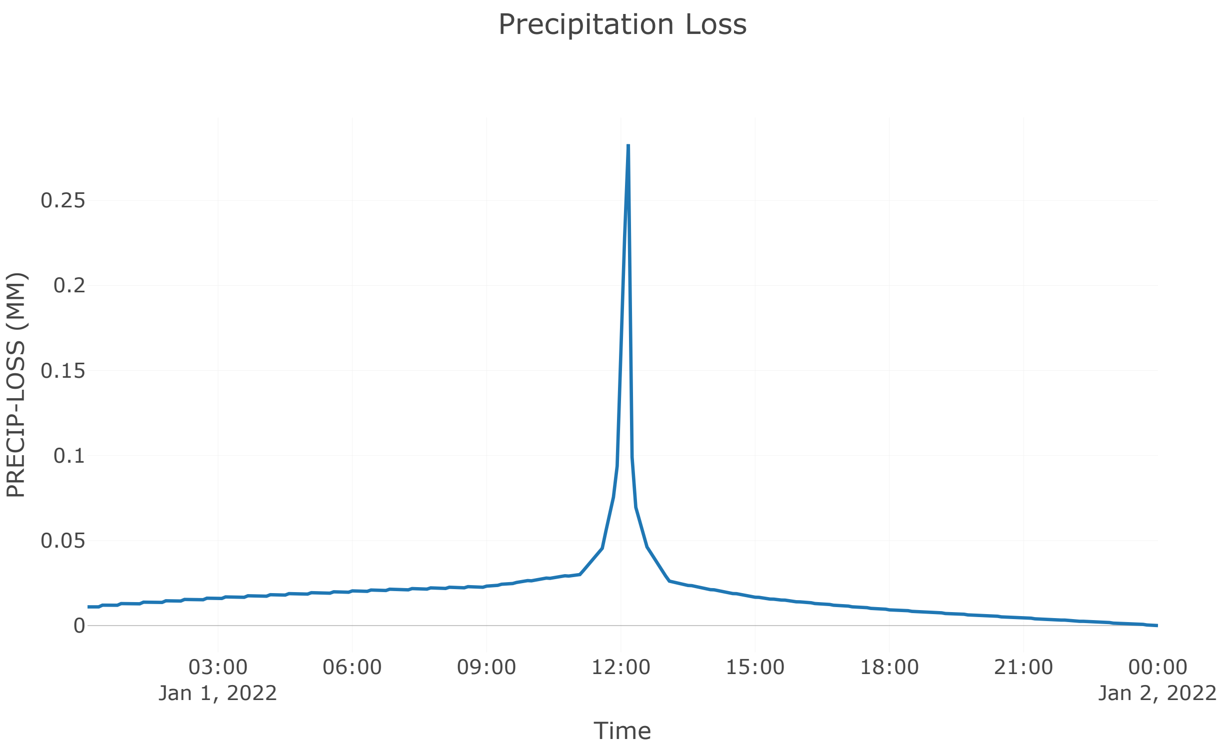

Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (MM)
80
60
40
20
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

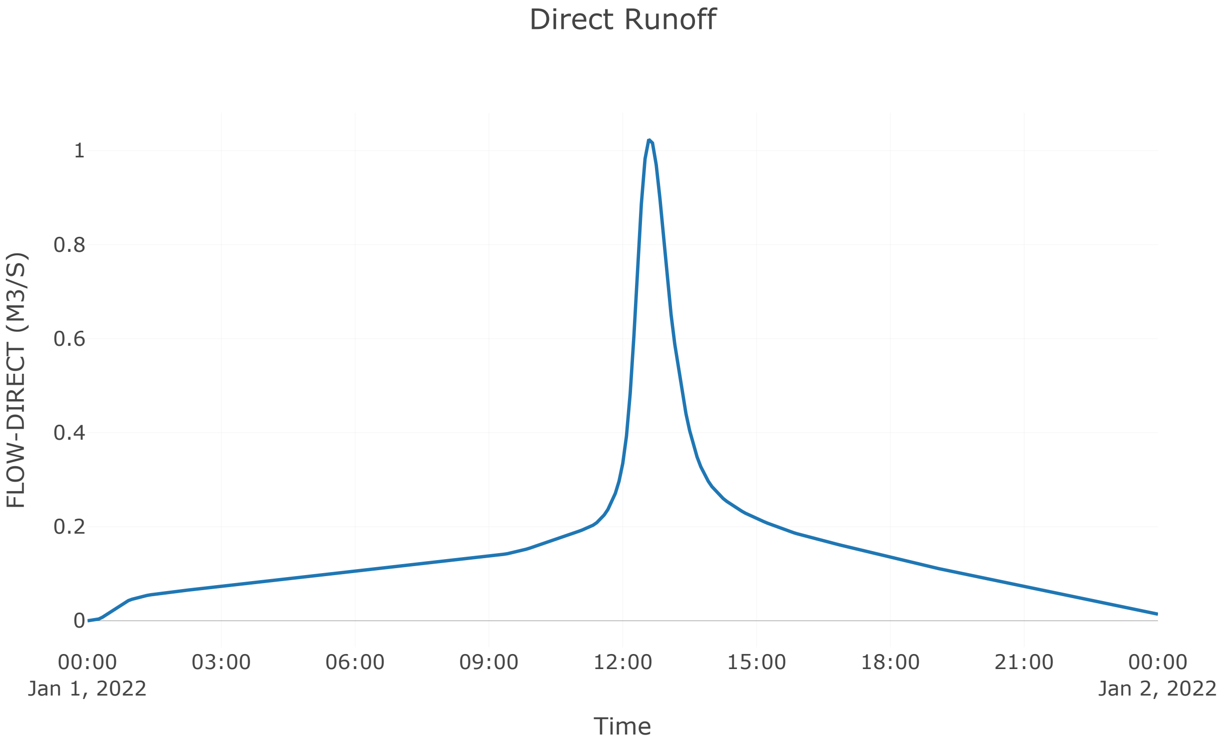

Cumulative Outflow
FLOW-CUMULATIVE (1000 M3)
14
12
10
8
6
4
2
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

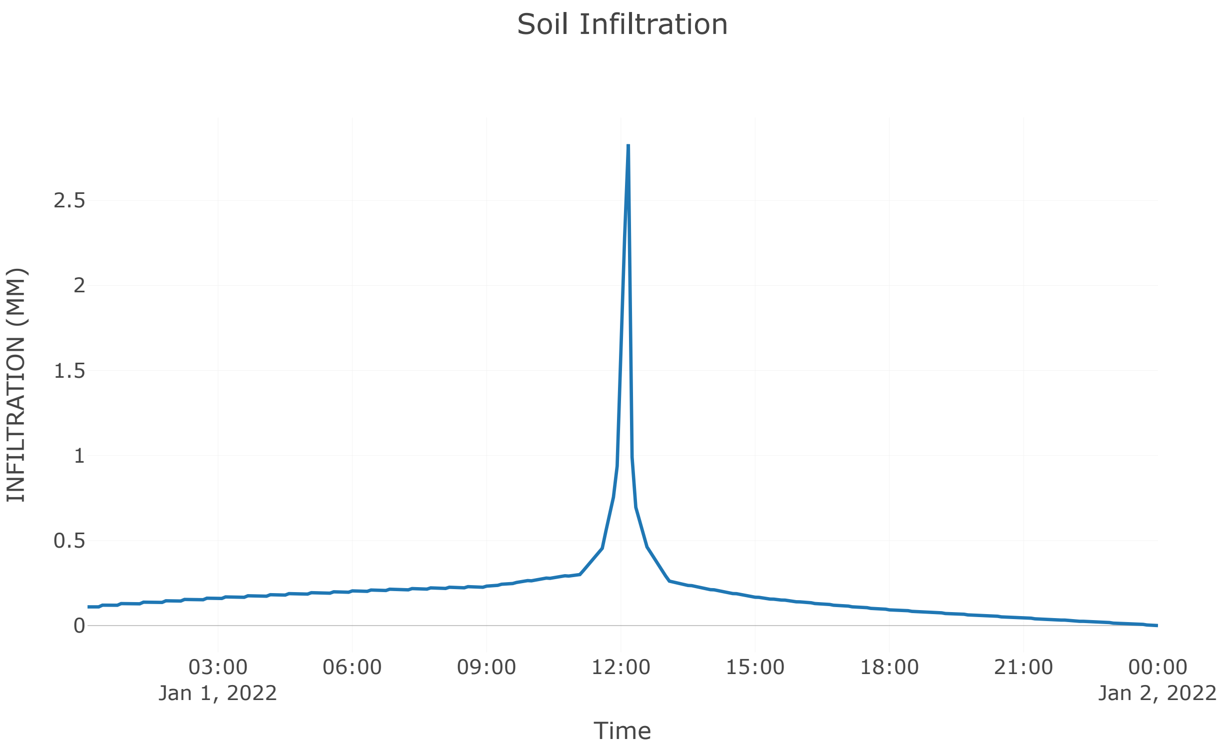

Cumulative Precipitation
PRECIP-CUM (MM)
80
60
40
20
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (MM)
0
1
2
3
4
5
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Baseflow
FLOW-BASE (M3/S)
1
0.5
0
−0.5
−1
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Precipitation Loss
PRECIP-LOSS (MM)
0.25
0.2
0.15
0.1
0.05
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Direct Runoff
FLOW-DIRECT (M3/S)
1
0.8
0.6
0.4
0.2
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Soil Infiltration
INFILTRATION (MM)
2.5
2
1.5
1
0.5
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

Project: Calcutta_Farms_Industrial
Simulation Run: Post-Dev_10YR_CC_2.3C
Simulation Start: 31 December 2021, 24:00
Simulation End: 1 January 2022, 24:00

HMS Version: 4.9
Executed: 16 June 2022, 03:12

Global Parameter Summary - Subbasin

Area (KM²)

Element Name	Area (KM²)
Swc01b	0.15

Downstream

Element Name	Downstream
Swc01b	Sink - 1 - Post - dev

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Swc01b	90	65	0.7

Transform: Scs

Element Name	Lag	Unitgraph Type
Swc01b	30.6	Standard

Global Results Summary

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
Swc01b	0.15	1.63	01Jan2022, 12:35	138.96
Sink - 1 - Post - dev	0.15	1.63	01Jan2022, 12:35	138.96

Subbasin: SWC01B

Area (KM²) : 0.15
Downstream : Sink - 1 - Post - dev

Loss Rate: Scs

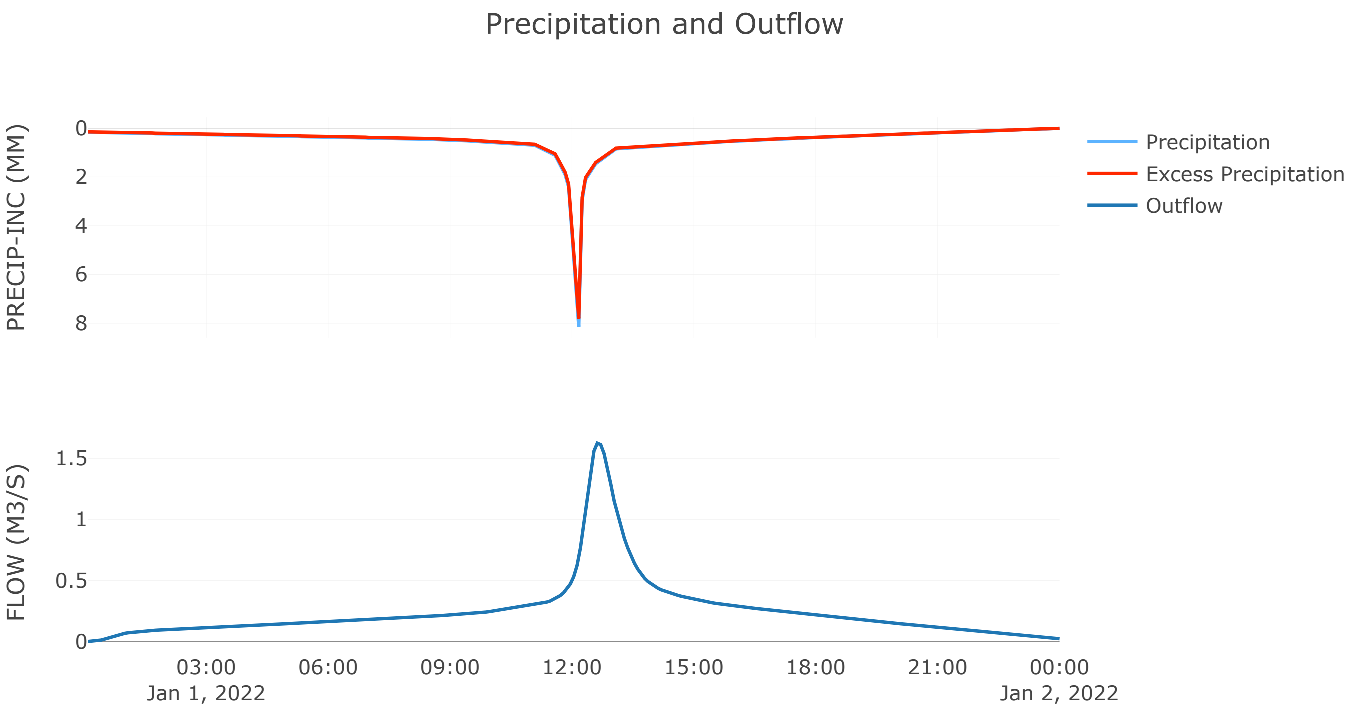
Percent Impervious Area	90
Curve Number	65
Initial Abstraction	0.7

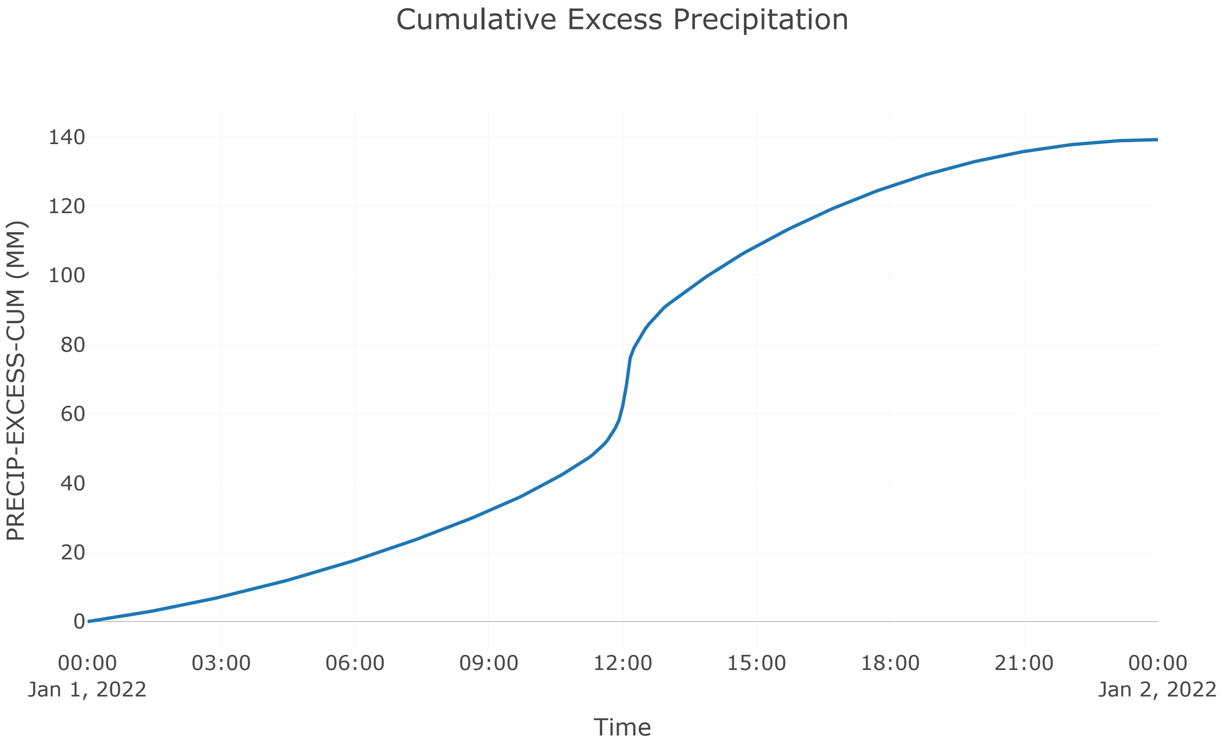
Transform: Scs

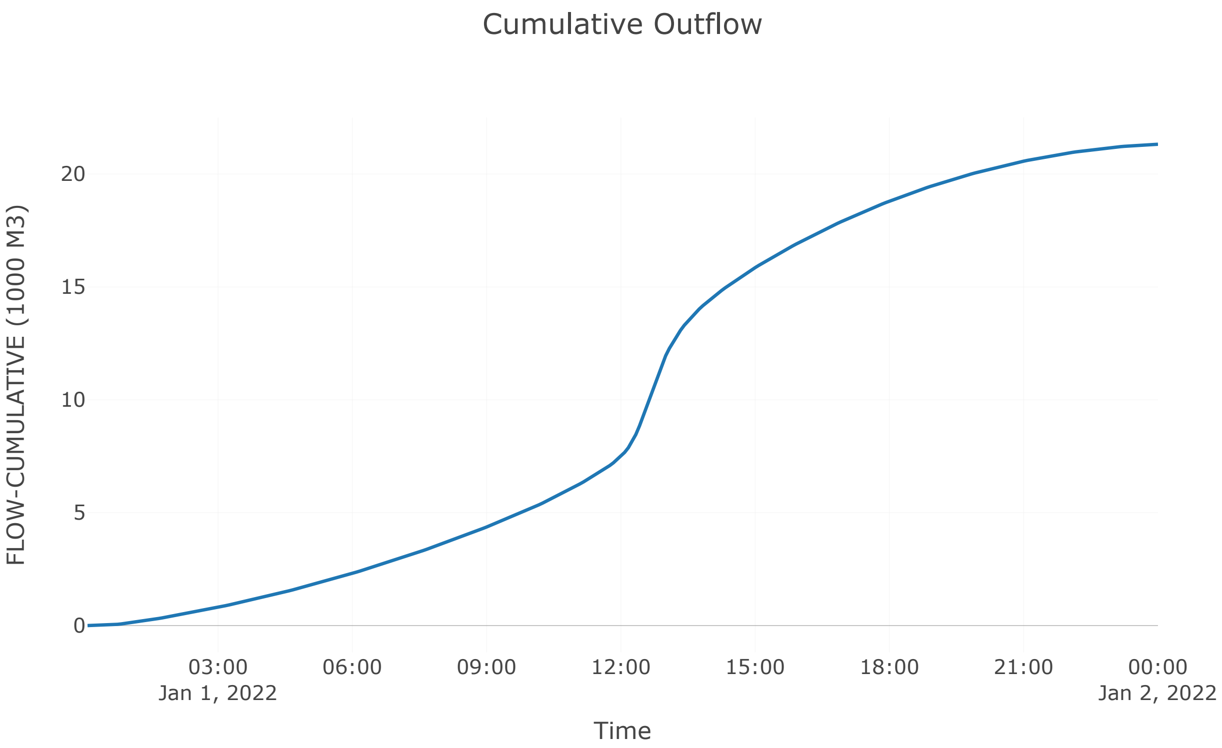
Lag	30.6
Unitgraph Type	Standard

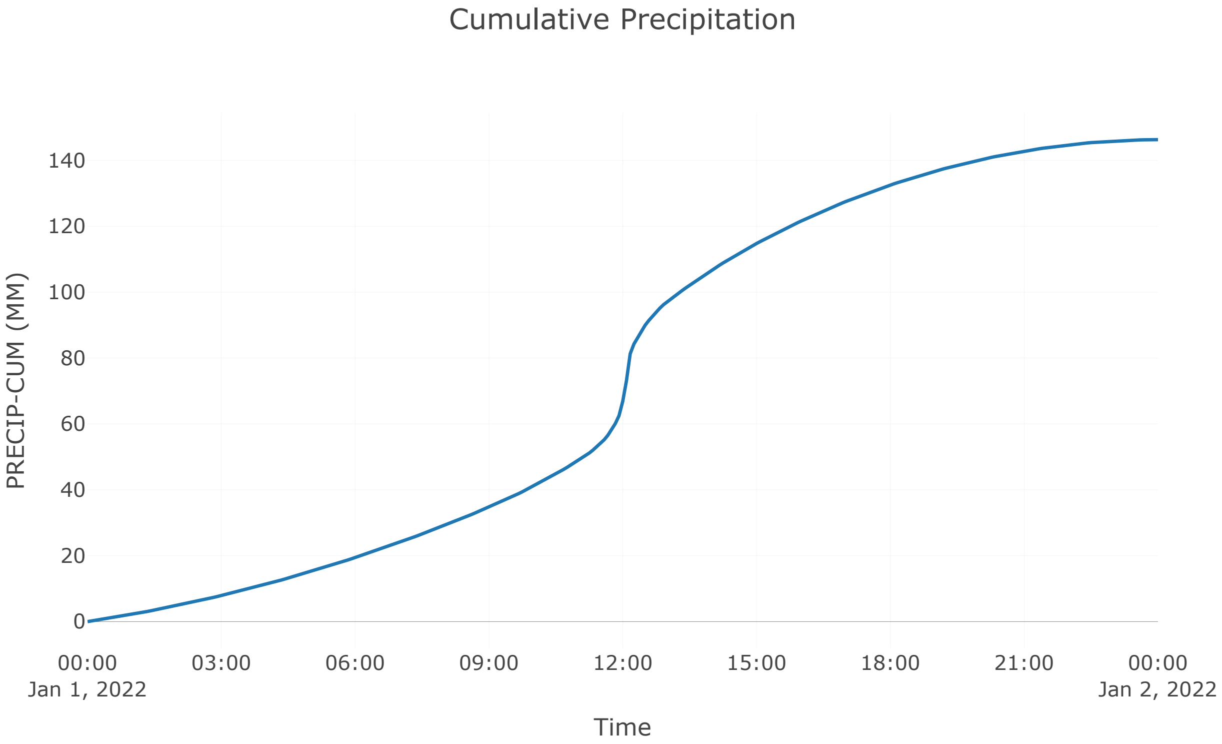
Results: SWC01B

Peak Discharge (M3/S)	1.63
Time of Peak Discharge	01Jan2022, 12:35
Volume (MM)	138.96
Precipitation Volume (M3)	22449.95
Loss Volume (M3)	1092.82
Excess Volume (M3)	21357.13
Direct Runoff Volume (M3)	21319.32
Baseflow Volume (M3)	0

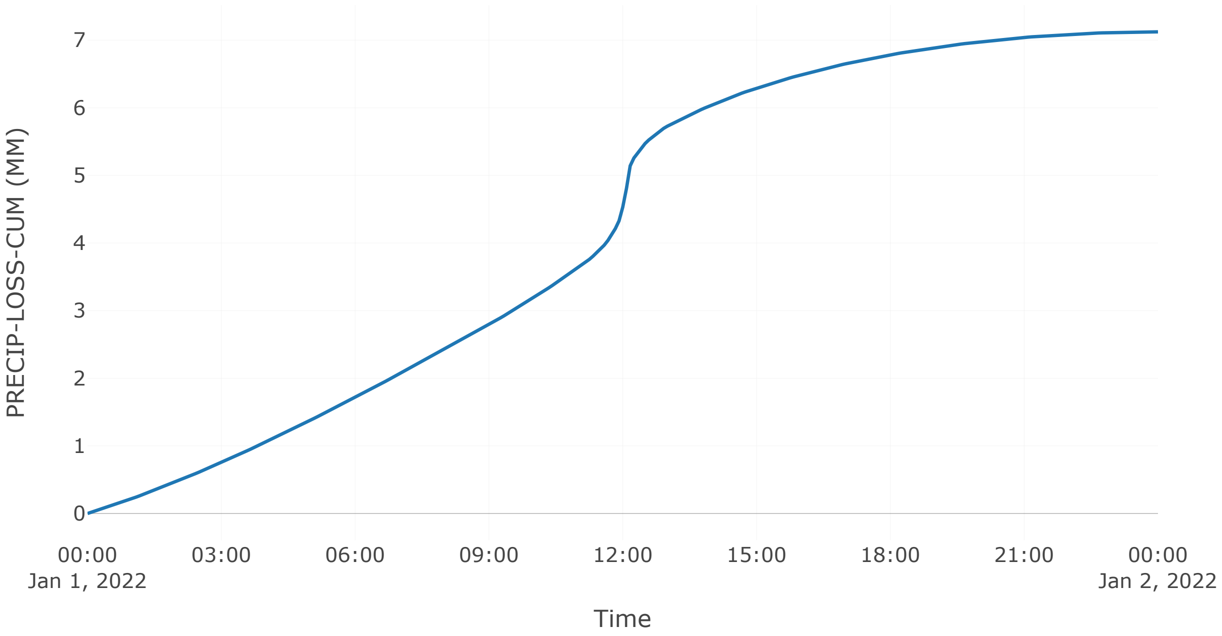

Precipitation and Outflow
PRECIP-INC (MM)
0
2
4
6
8
Precipitation
Excess Precipitation
Outflow
FLOW (M3/S)
1.5
1
0.5
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022


Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (MM)
140
120
100
80
60
40
20
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

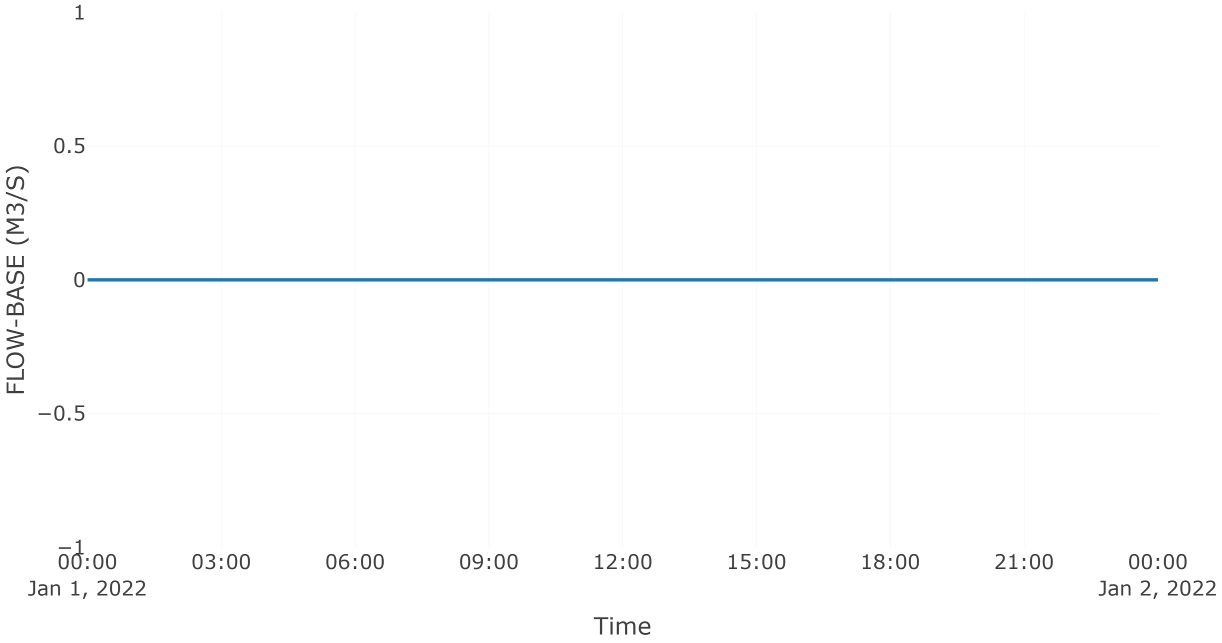

Cumulative Outflow
FLOW-CUMULATIVE (1000 M3)
0
5
10
15
20
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

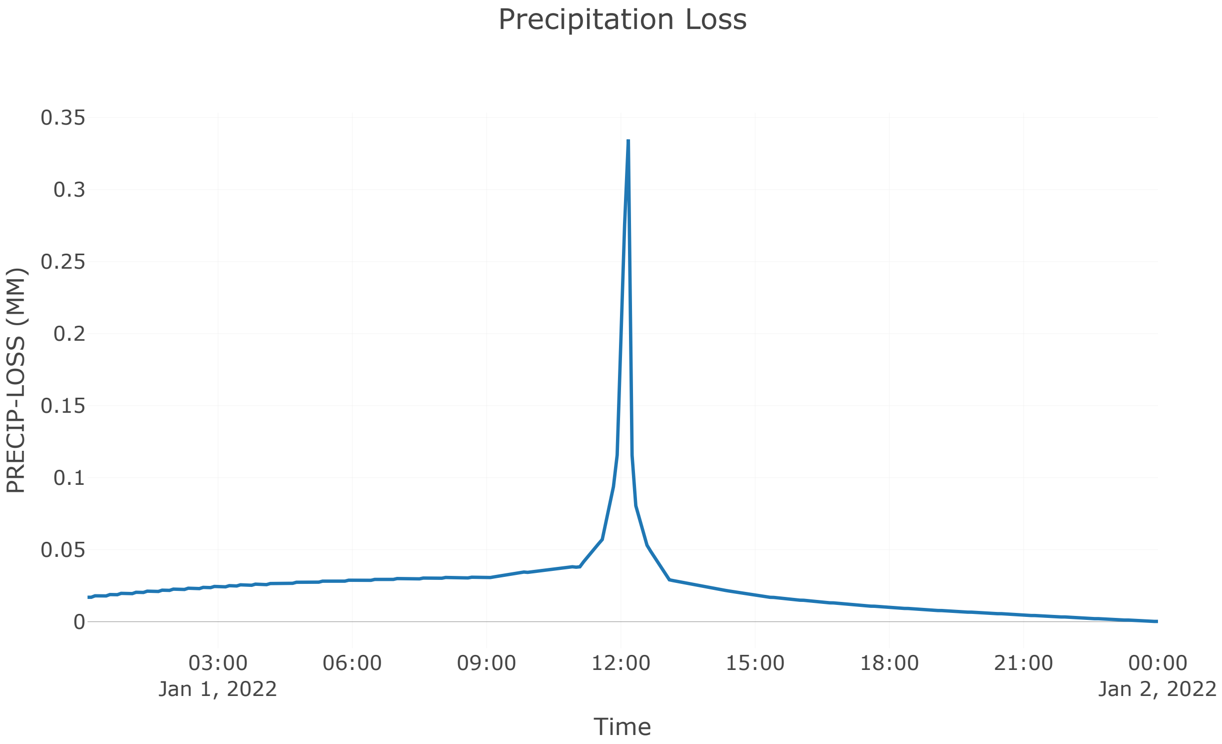

Cumulative Precipitation
PRECIP-CUM (MM)
0
20
40
60
80
100
120
140
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

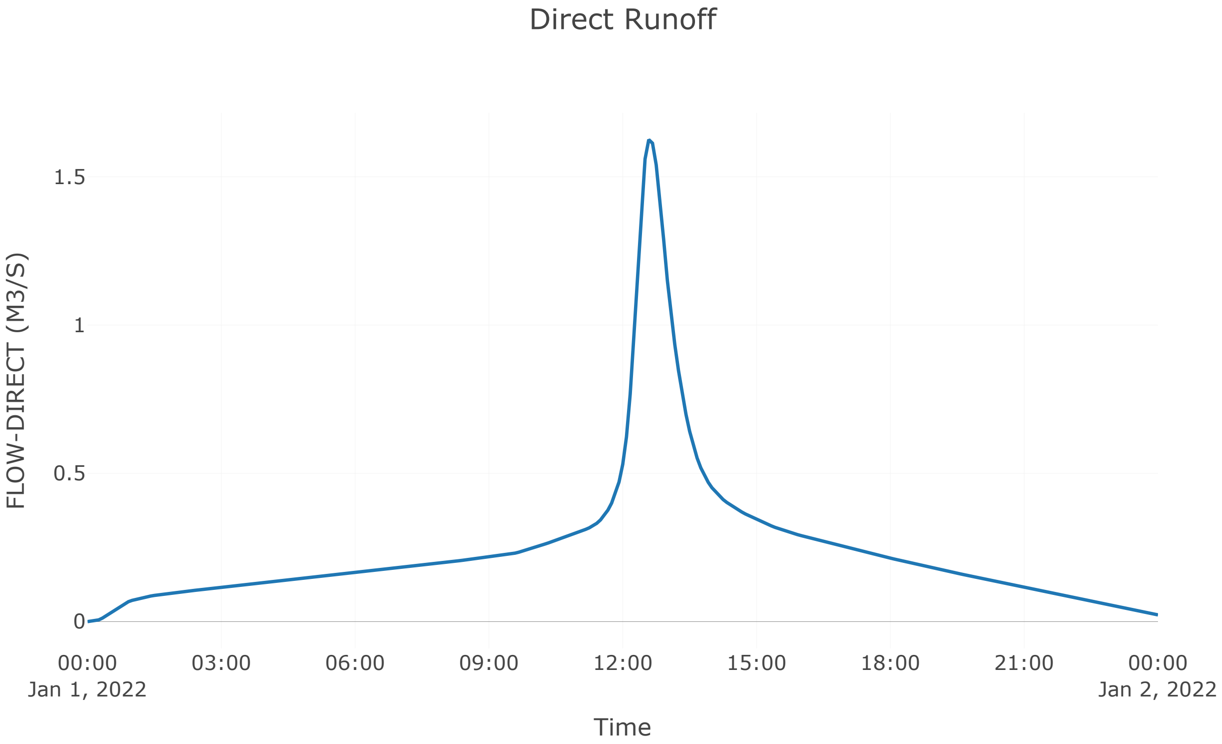
Cumulative Precipitation Loss

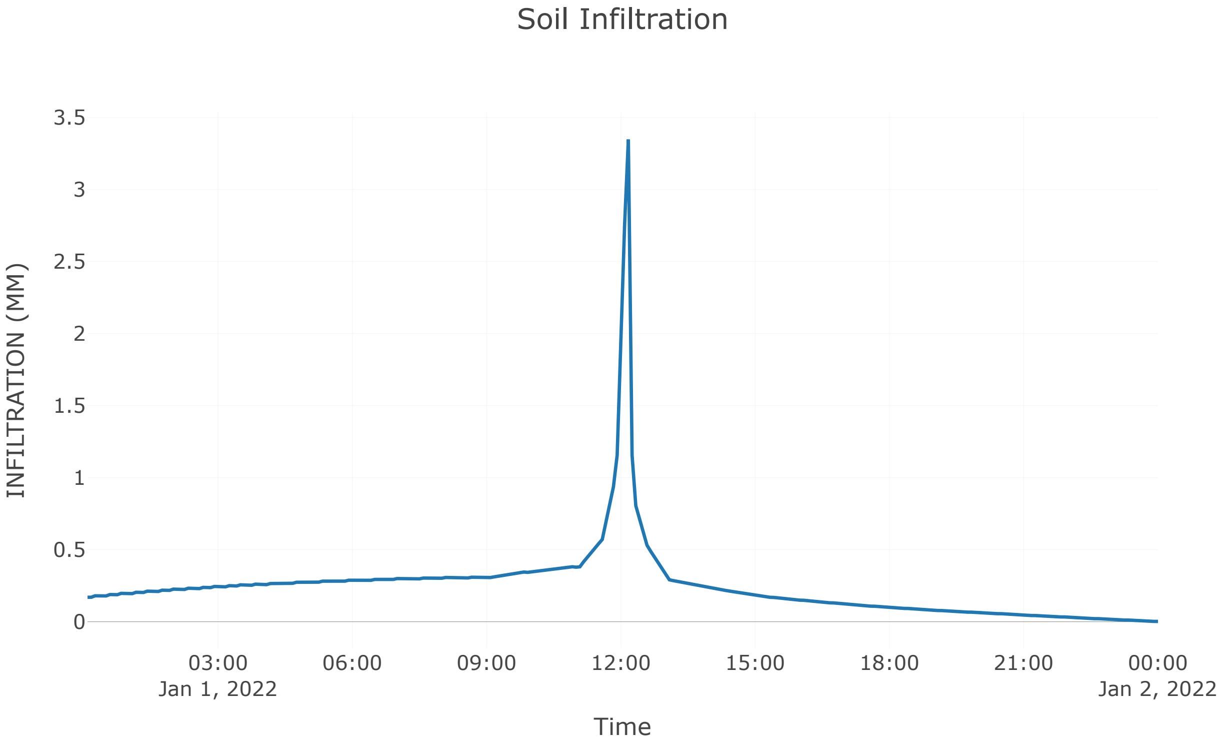


Baseflow




Precipitation Loss
PRECIP-LOSS (MM)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Direct Runoff
FLOW-DIRECT (M3/S)
1.5
1
0.5
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Soil Infiltration
INFILTRATION (MM)
3.5
3
2.5
2
1.5
1
0.5
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

Project: Calcutta_Farms_Industrial
Simulation Run: Post-Dev_100YR_CC_2.3C
Simulation Start: 31 December 2021, 24:00
Simulation End: 1 January 2022, 24:00

HMS Version: 4.9
Executed: 16 June 2022, 03:12

Global Parameter Summary - Subbasin

Area (KM²)

Element Name	Area (KM²)
Swc01b	0.15

Downstream

Element Name	Downstream
Swc01b	Sink - 1 - Post - dev

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Swc01b	90	65	0.7

Transform: Scs

Element Name	Lag	Unitgraph Type
Swc01b	30.6	Standard

Global Results Summary

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
Swc01b	0.15	2.61	01Jan2022, 12:35	222.16
Sink - 1 - Post - dev	0.15	2.61	01Jan2022, 12:35	222.16

Subbasin: SWC01B

Area (KM²) : 0.15
Downstream : Sink - 1 - Post - dev

Loss Rate: Scs

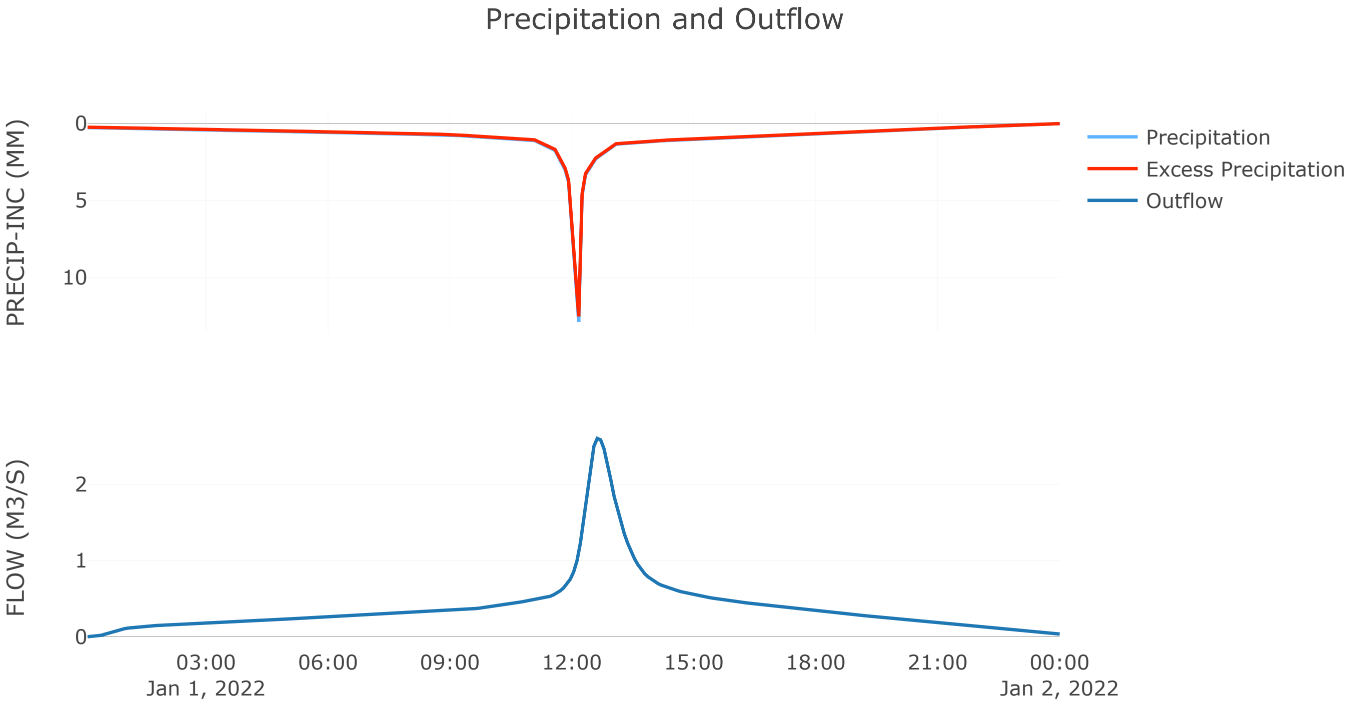
Percent Impervious Area	90
Curve Number	65
Initial Abstraction	0.7

Transform: Scs

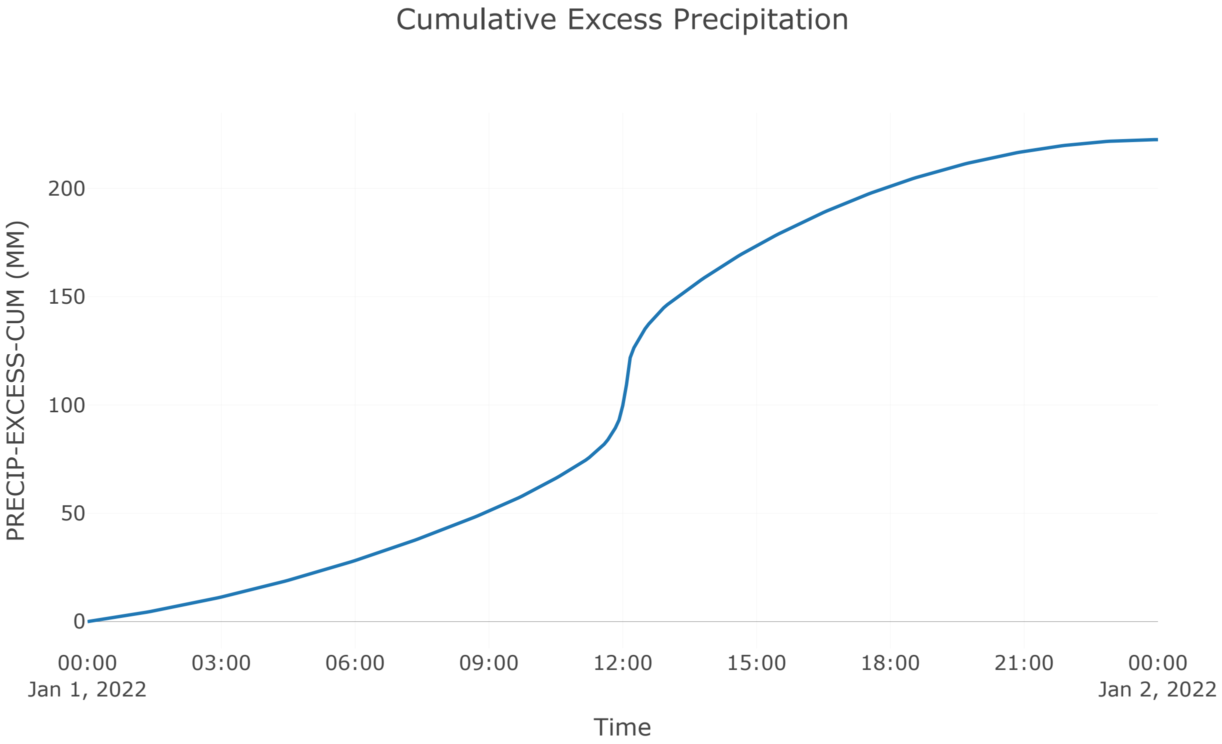
Lag	30.6
Unitgraph Type	Standard

Results: SWC01B

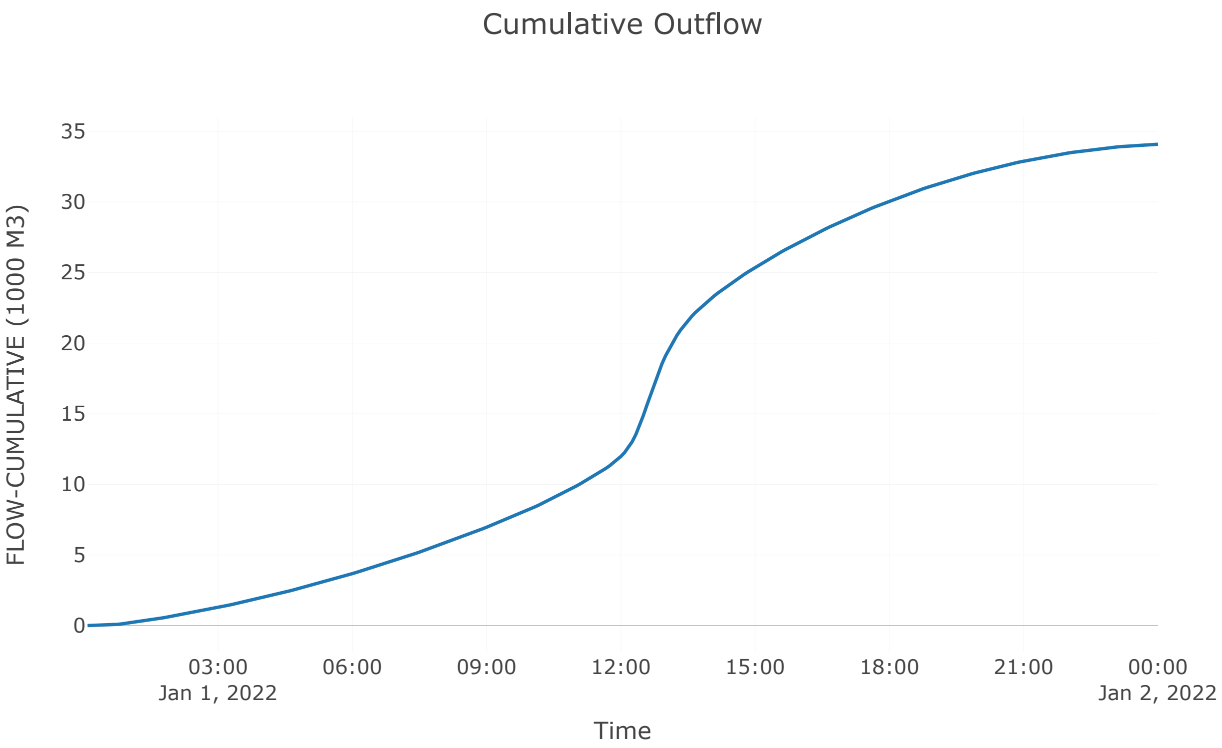
Peak Discharge (M3/S)	2.61
Time of Peak Discharge	01Jan2022, 12:35
Volume (MM)	222.16
Precipitation Volume (M3)	35469.17
Loss Volume (M3)	1327.63
Excess Volume (M3)	34141.54
Direct Runoff Volume (M3)	34084.12
Baseflow Volume (M3)	0

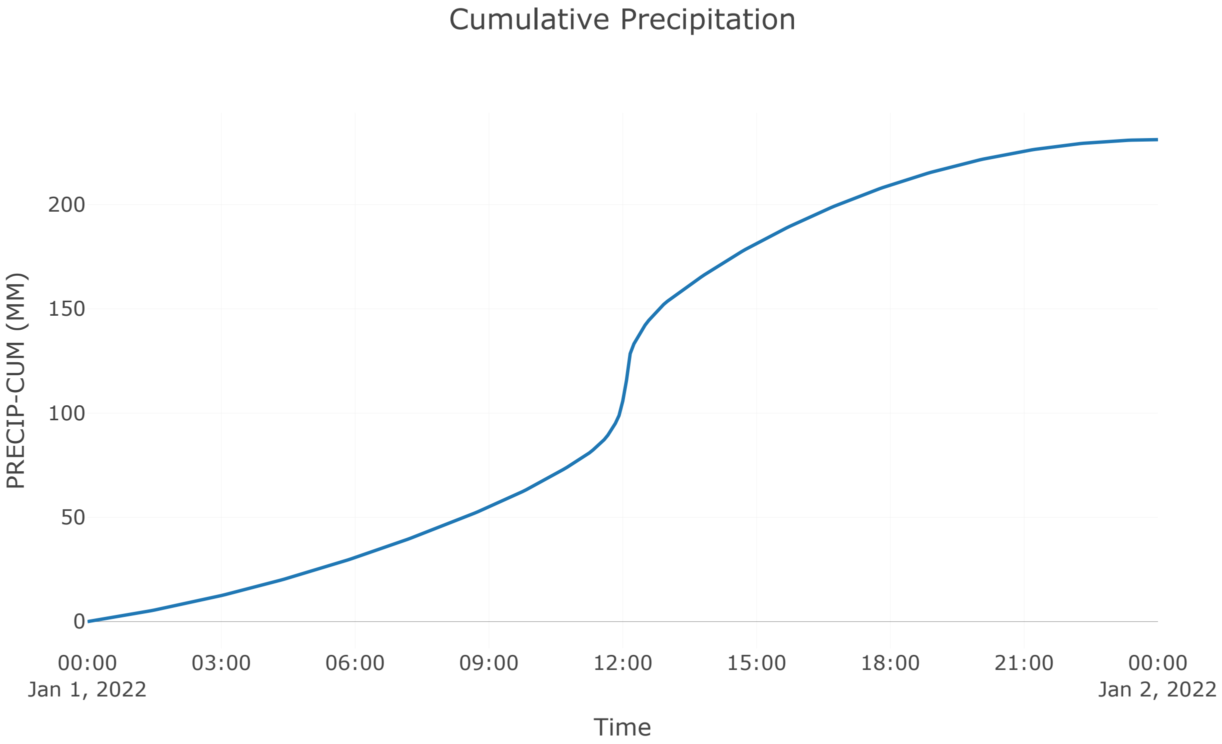


Precipitation and Outflow
PRECIP-INC (MM)
0
5
10
Precipitation
Excess Precipitation
Outflow
FLOW (M3/S)
2
1
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022

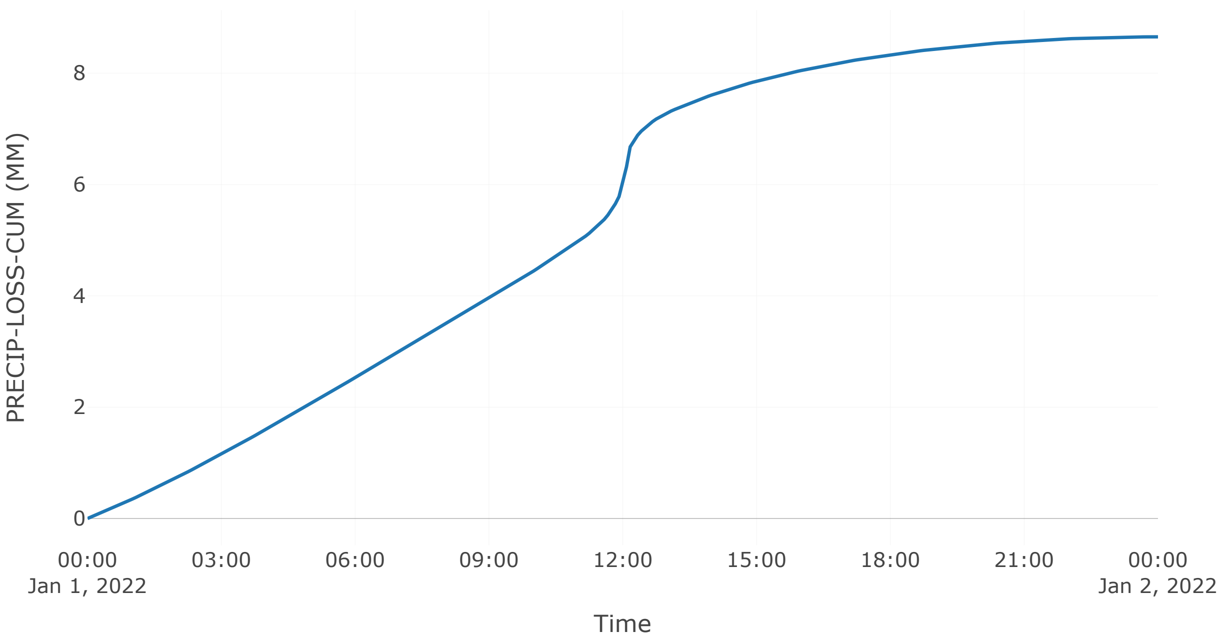


Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (MM)
200
150
100
50
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

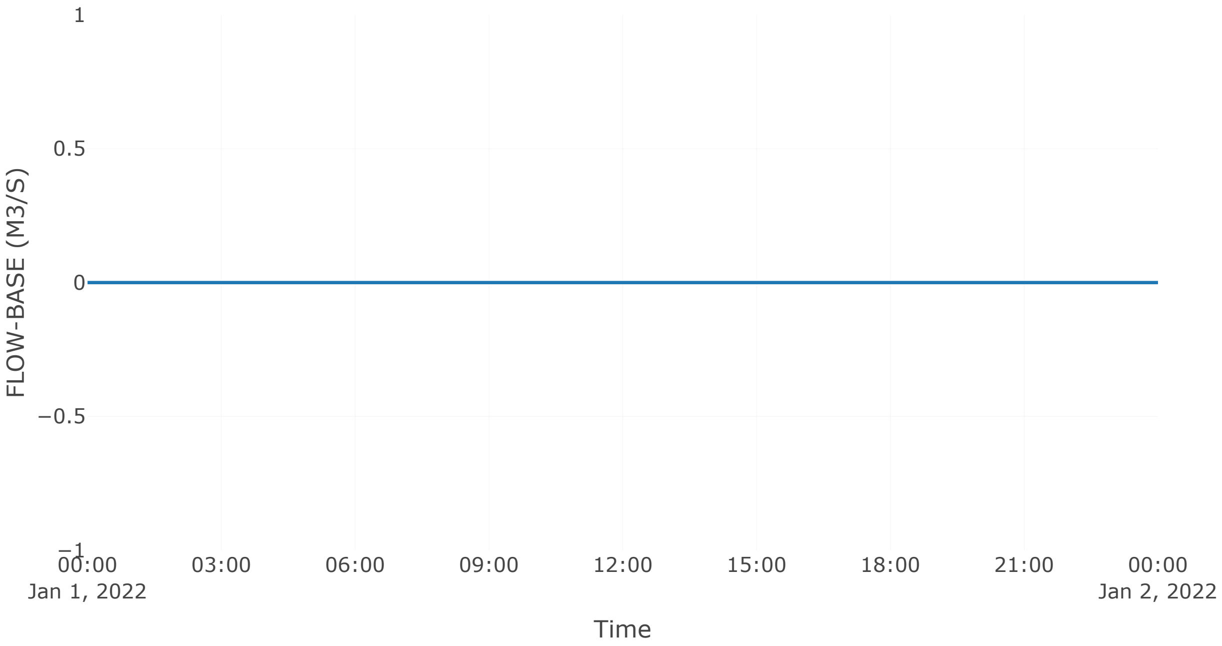

Cumulative Outflow
FLOW-CUMULATIVE (1000 M3)
35
30
25
20
15
10
5
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Cumulative Precipitation
PRECIP-CUM (MM)
200
150
100
50
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

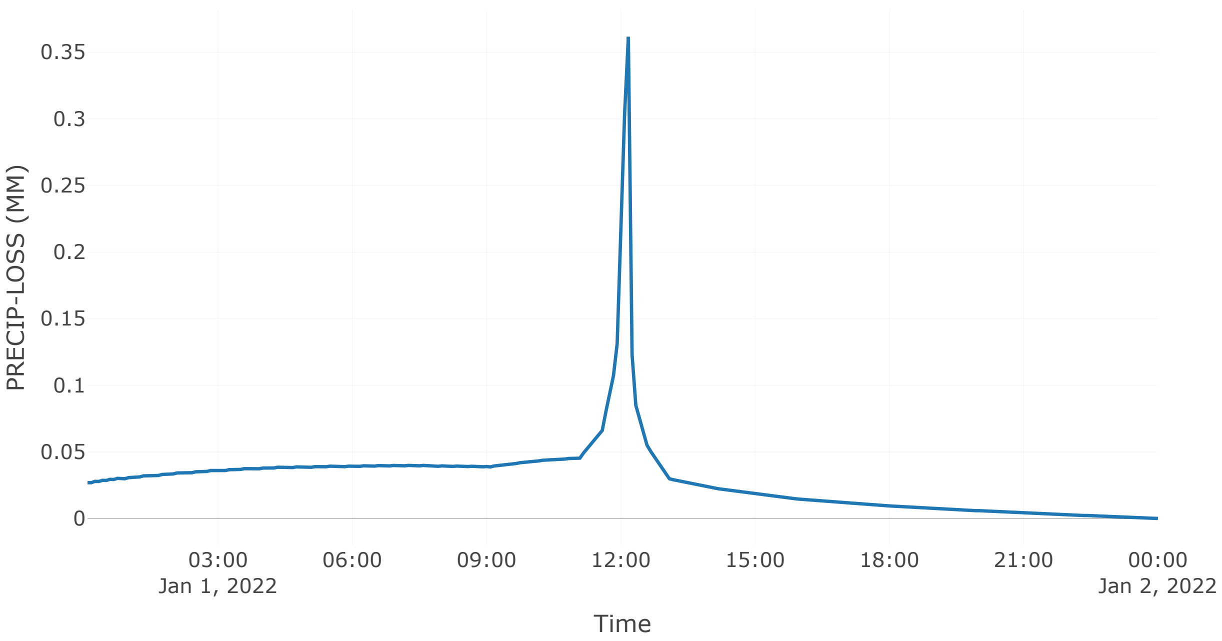
Cumulative Precipitation Loss



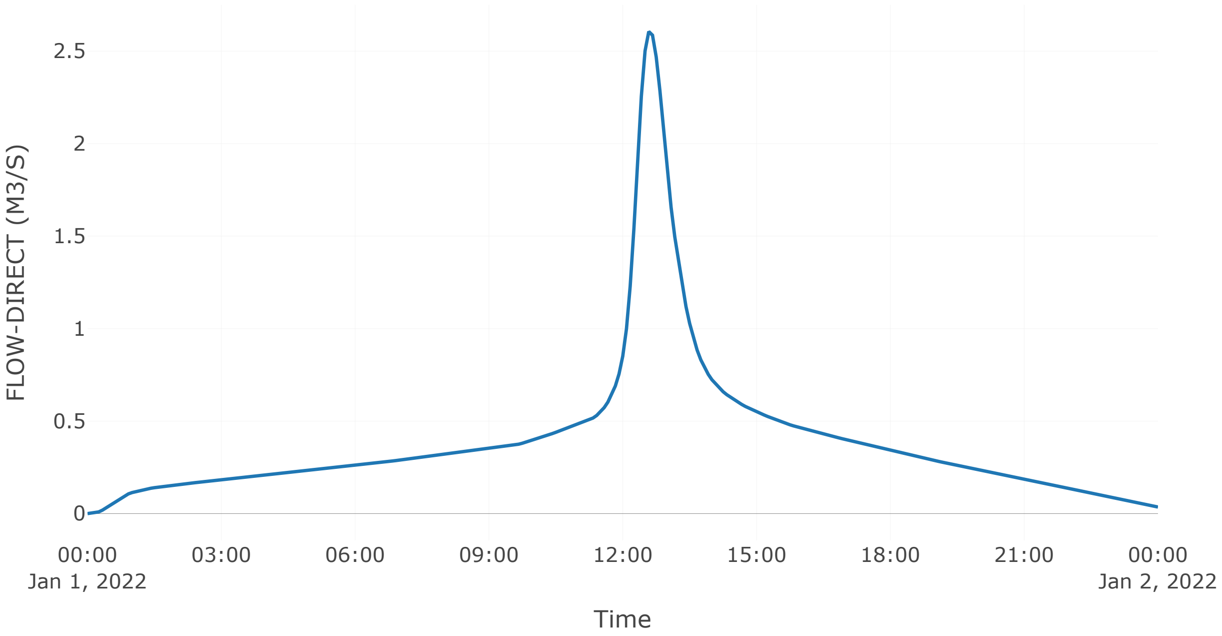
Baseflow

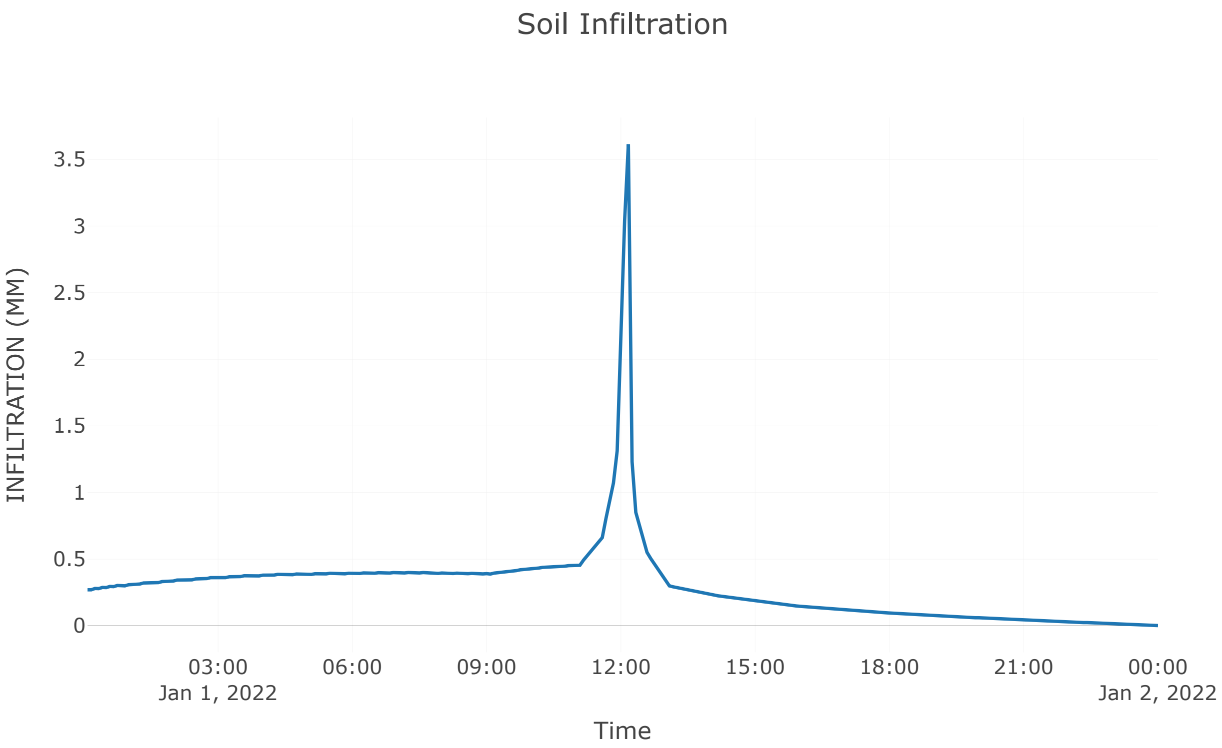


Precipitation Loss



Direct Runoff




Soil Infiltration
INFILTRATION (MM)
3.5
3
2.5
2
1.5
1
0.5
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

Project: Calcutta_Farms_Industrial
Simulation Run: Post-Dev_2YR_CC_3.8C
Simulation Start: 31 December 2021, 24:00
Simulation End: 1 January 2022, 24:00

HMS Version: 4.9
Executed: 16 June 2022, 03:12

Global Parameter Summary - Subbasin

Area (KM²)

Element Name	Area (KM²)
Swc01b	0.15

Downstream

Element Name	Downstream
Swc01b	Sink - 1 - Post - dev

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Swc01b	90	65	0.7

Transform: Scs

Element Name	Lag	Unitgraph Type
Swc01b	30.6	Standard

Global Results Summary

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
Swc01b	0.15	1.12	01Jan2022, 12:35	96.11
Sink - 1 - Post - dev	0.15	1.12	01Jan2022, 12:35	96.11

Subbasin: SWC01B

Area (KM²) : 0.15
Downstream : Sink - 1 - Post - dev

Loss Rate: Scs

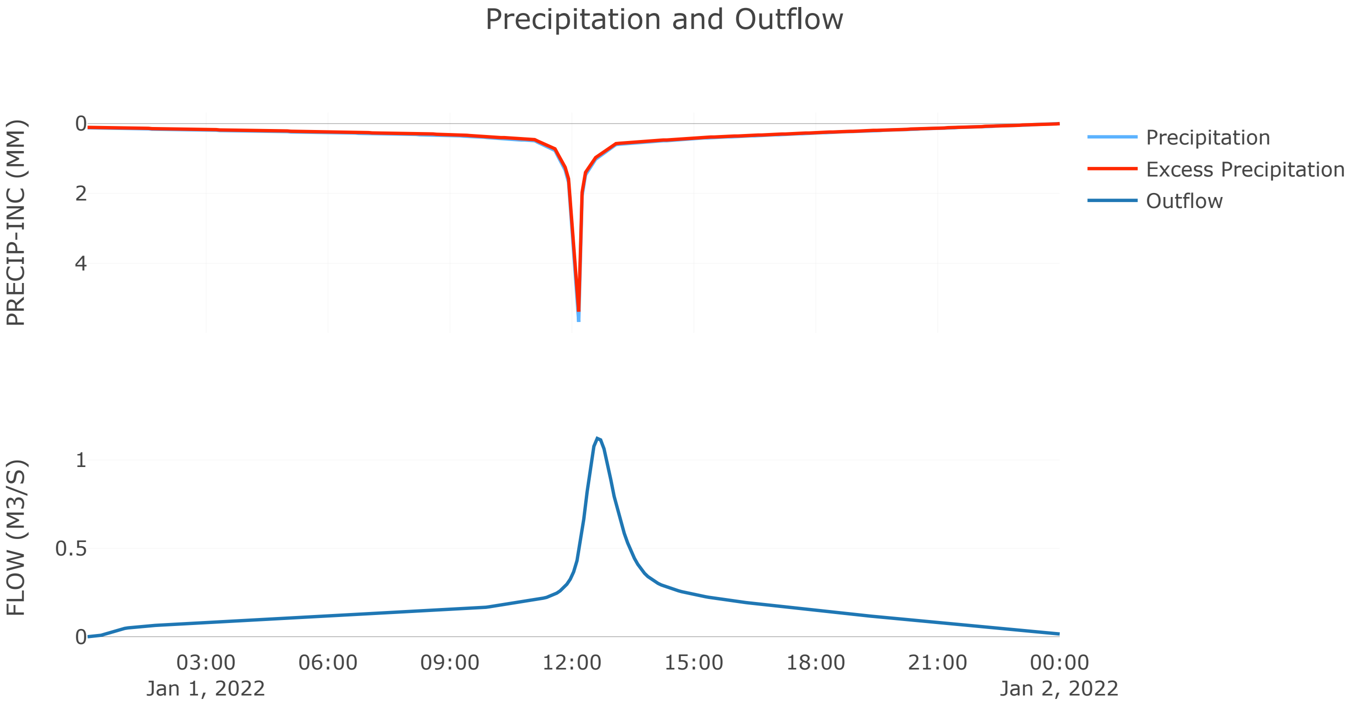
Percent Impervious Area	90
Curve Number	65
Initial Abstraction	0.7

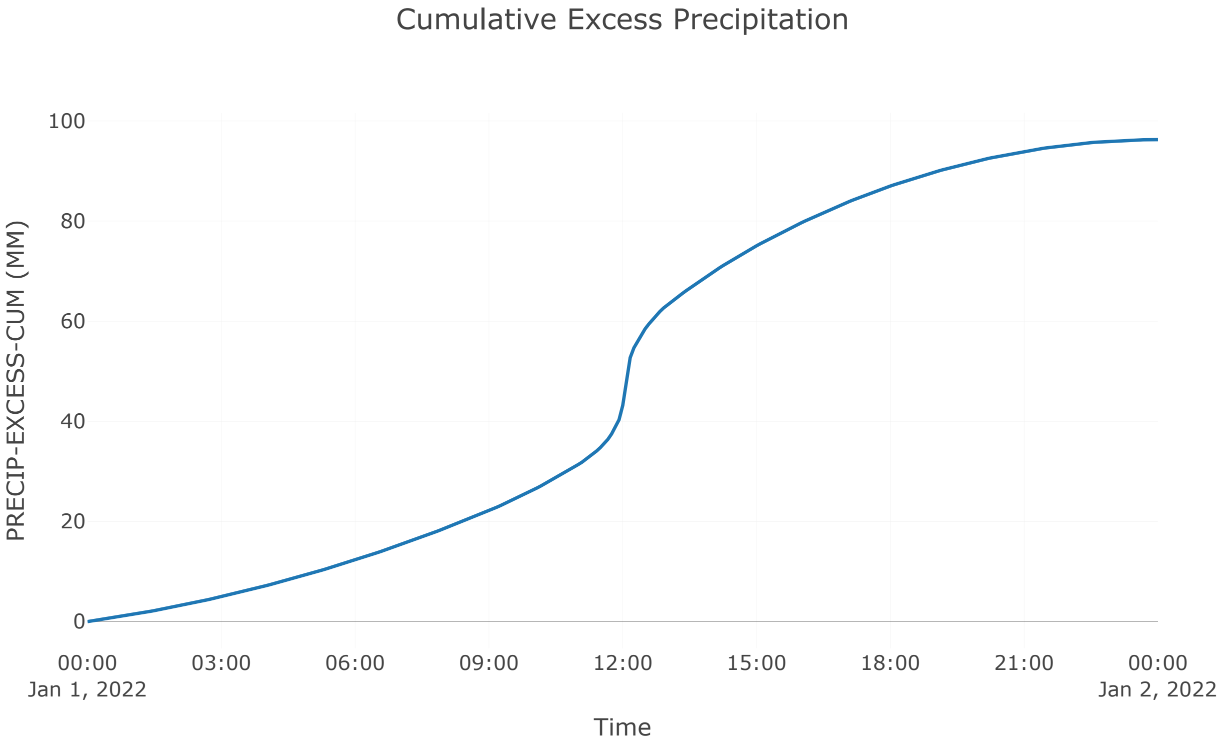
Transform: Scs

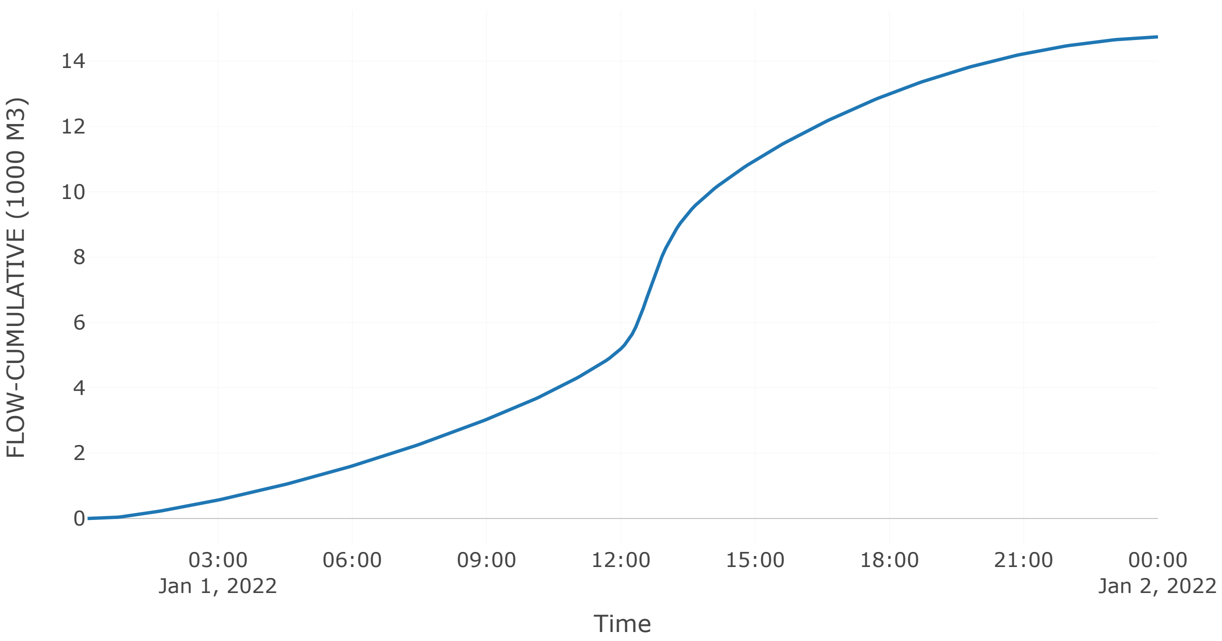
Lag	30.6
Unitgraph Type	Standard

Results: SWC01B

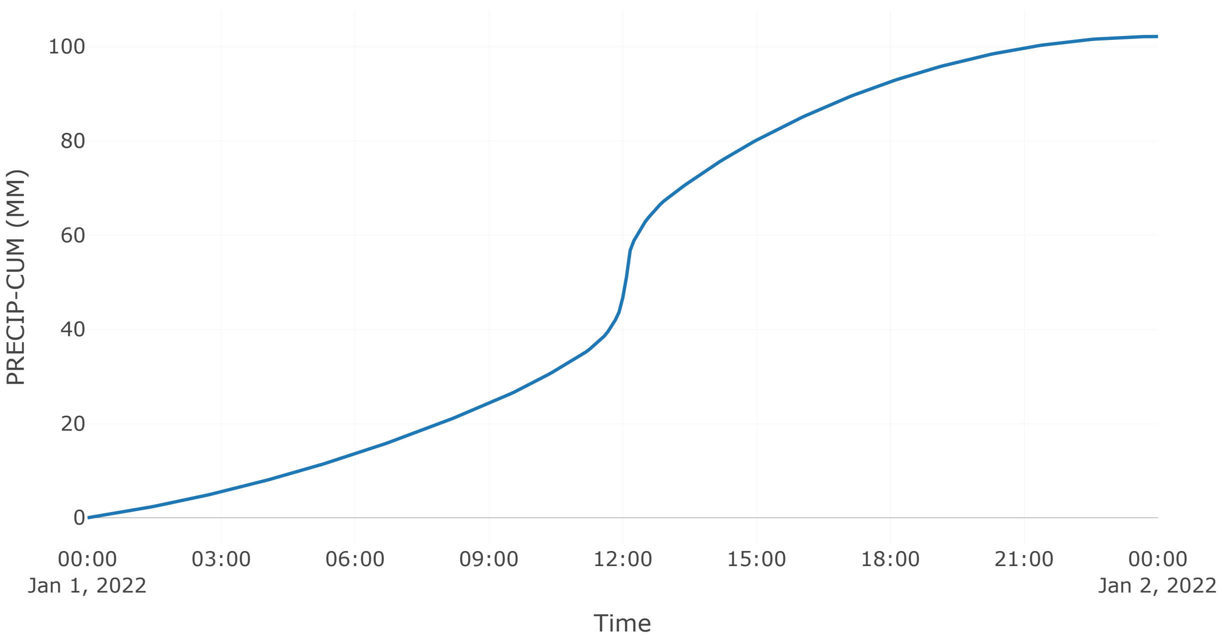
Peak Discharge (M3/S)	1.12
Time of Peak Discharge	01Jan2022, 12:35
Volume (MM)	96.11
Precipitation Volume (M3)	15673.39
Loss Volume (M3)	904.4
Excess Volume (M3)	14768.99
Direct Runoff Volume (M3)	14744.55
Baseflow Volume (M3)	0


Precipitation and Outflow
PRECIP-INC (MM)
0
2
4
Precipitation
Excess Precipitation
Outflow
FLOW (M3/S)
1
0.5
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022

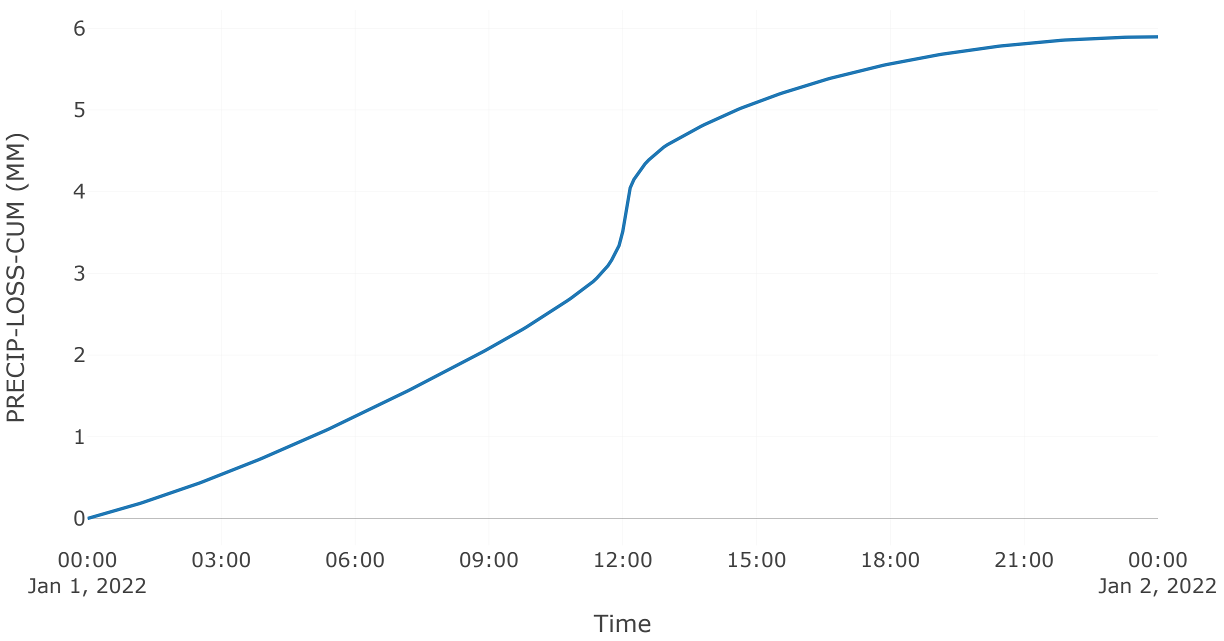

Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (MM)
100
80
60
40
20
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time



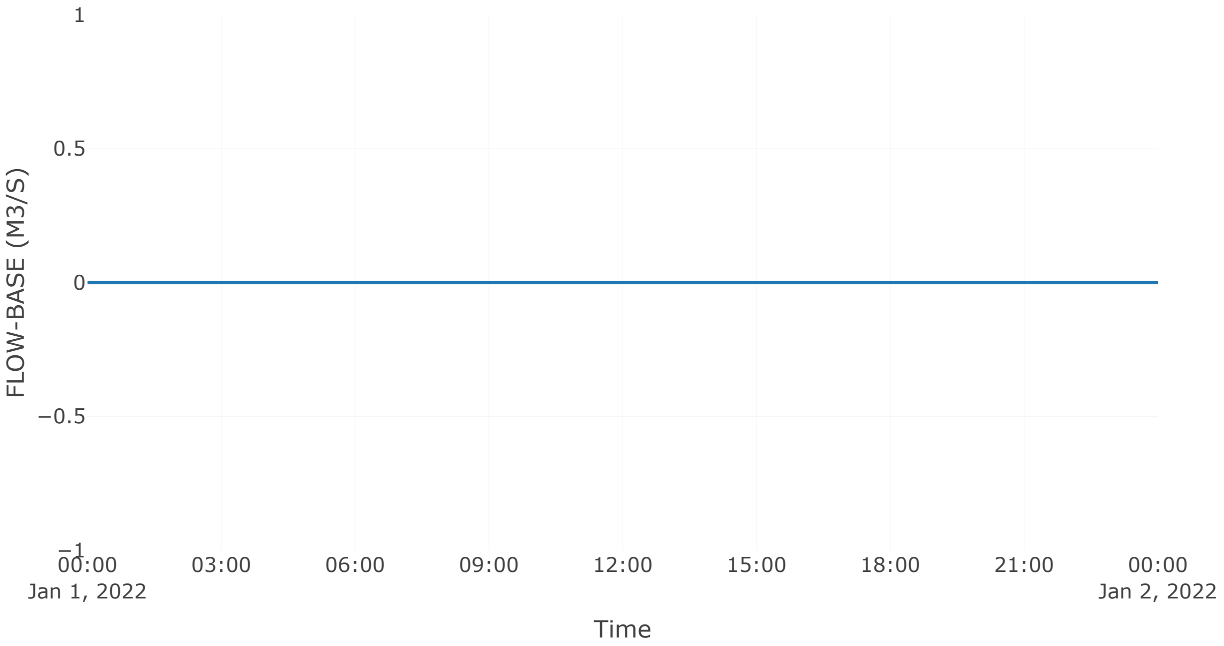
Cumulative Outflow



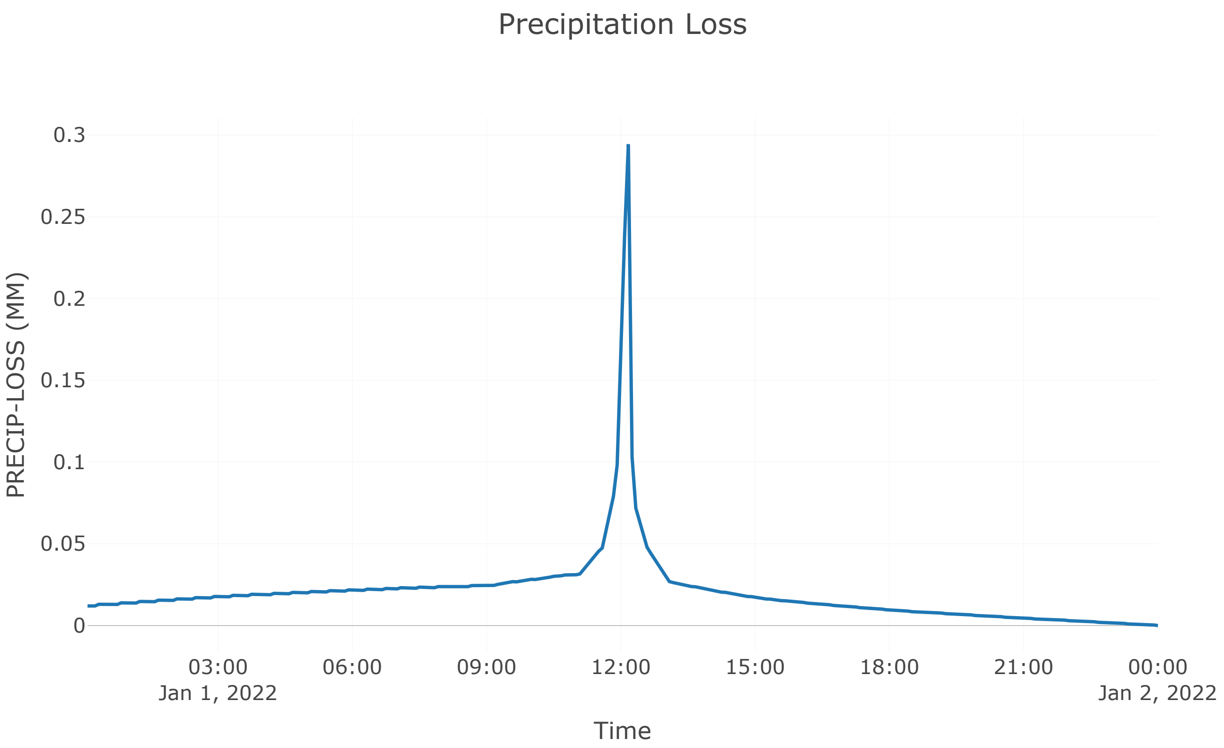
Cumulative Precipitation

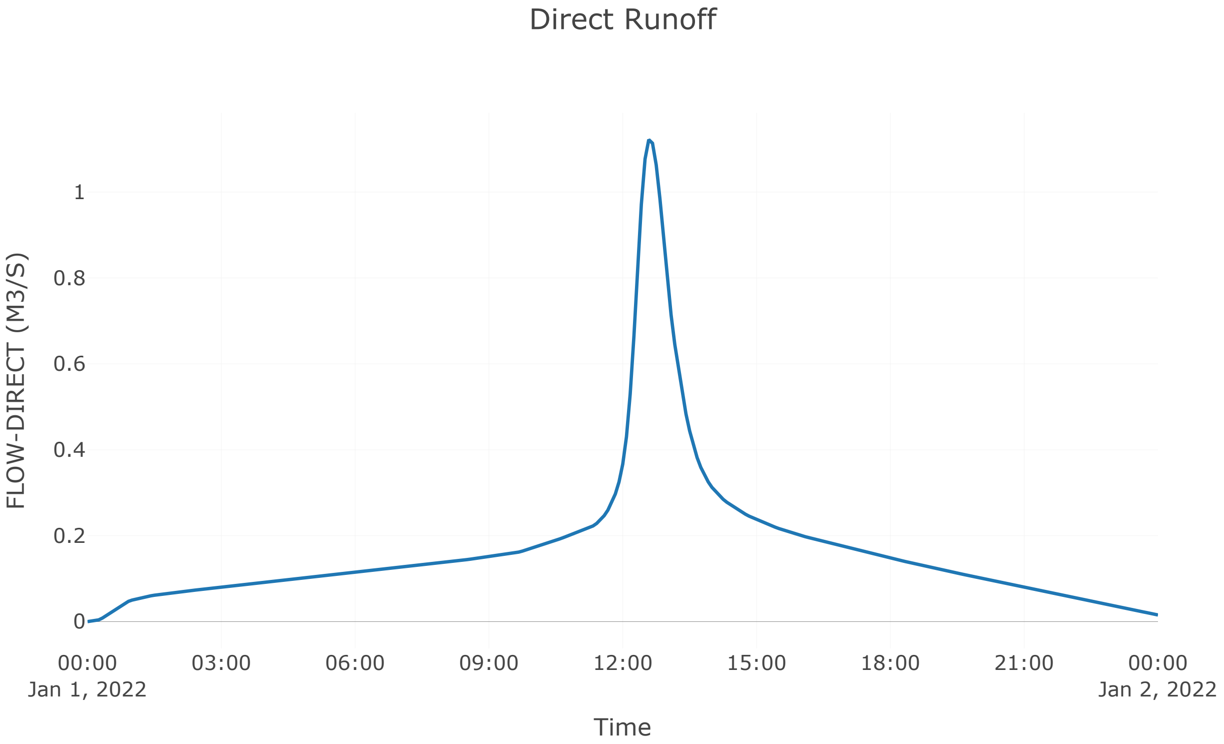


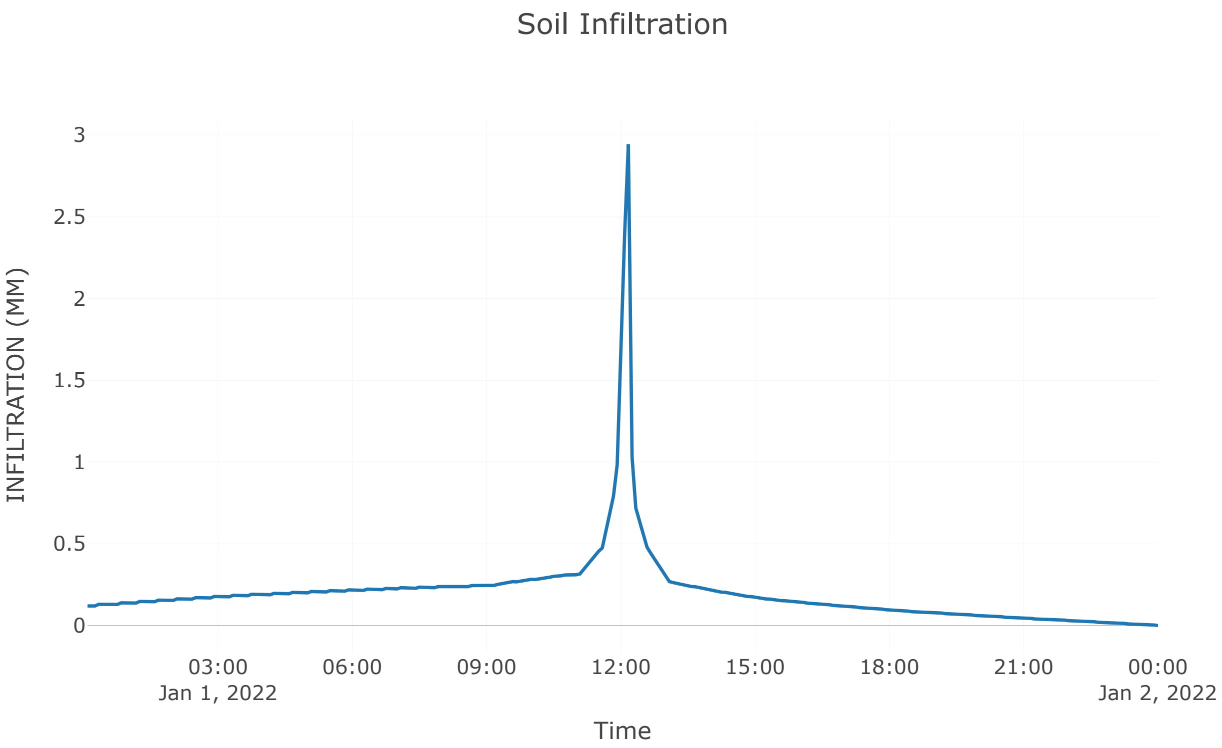
Cumulative Precipitation Loss



Baseflow


Precipitation Loss
PRECIP-LOSS (MM)
0.3
0.25
0.2
0.15
0.1
0.05
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Direct Runoff
FLOW-DIRECT (M3/S)
1
0.8
0.6
0.4
0.2
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Soil Infiltration
INFILTRATION (MM)
3
2.5
2
1.5
1
0.5
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

Project: Calcutta_Farms_Industrial
Simulation Run: Post-Dev_10YR_CC_3.8C
Simulation Start: 31 December 2021, 24:00
Simulation End: 1 January 2022, 24:00

HMS Version: 4.9
Executed: 16 June 2022, 03:12

Global Parameter Summary - Subbasin

Area (KM²)

Element Name	Area (KM²)
Swc01b	0.15

Downstream

Element Name	Downstream
Swc01b	Sink - 1 - Post - dev

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Swc01b	90	65	0.7

Transform: Scs

Element Name	Lag	Unitgraph Type
Swc01b	30.6	Standard

Global Results Summary

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
Swc01b	0.15	1.8	01Jan2022, 12:35	153.6
Sink - 1 - Post - dev	0.15	1.8	01Jan2022, 12:35	153.6

Subbasin: SWC01B

Area (KM²) : 0.15
Downstream : Sink - 1 - Post - dev

Loss Rate: Scs

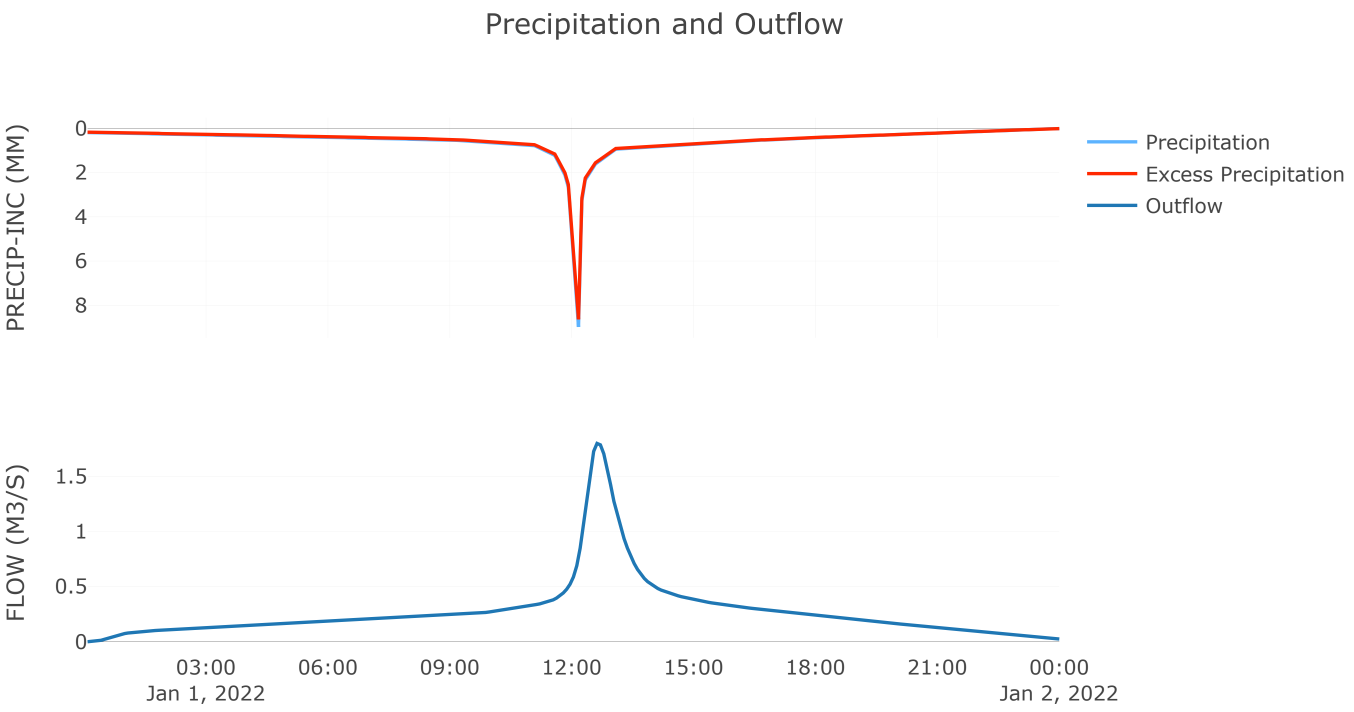
Percent Impervious Area	90
Curve Number	65
Initial Abstraction	0.7

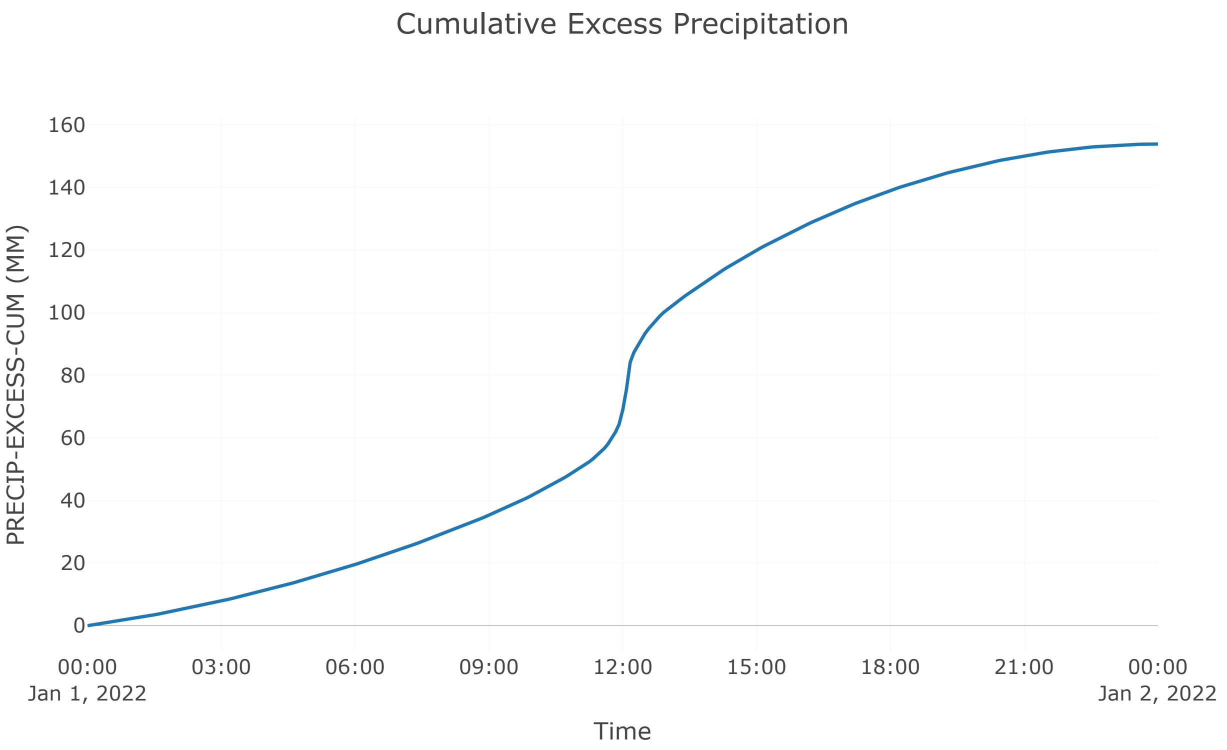
Transform: Scs

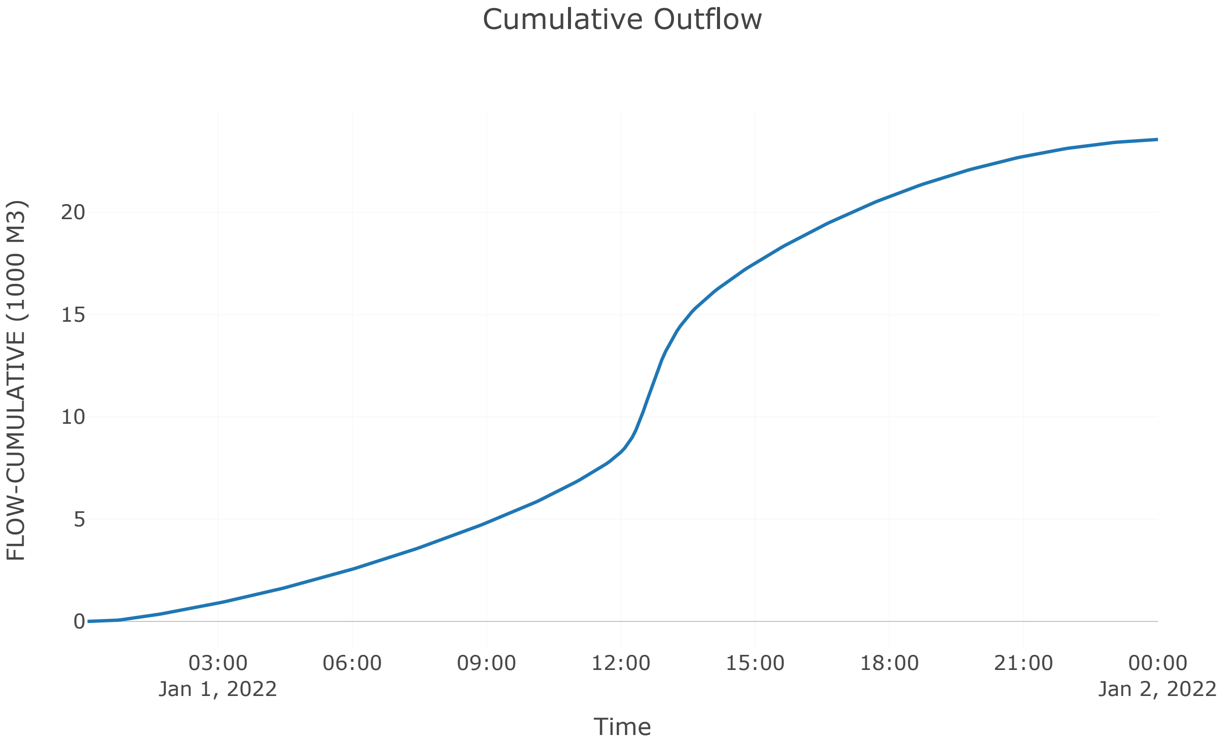
Lag	30.6
Unitgraph Type	Standard

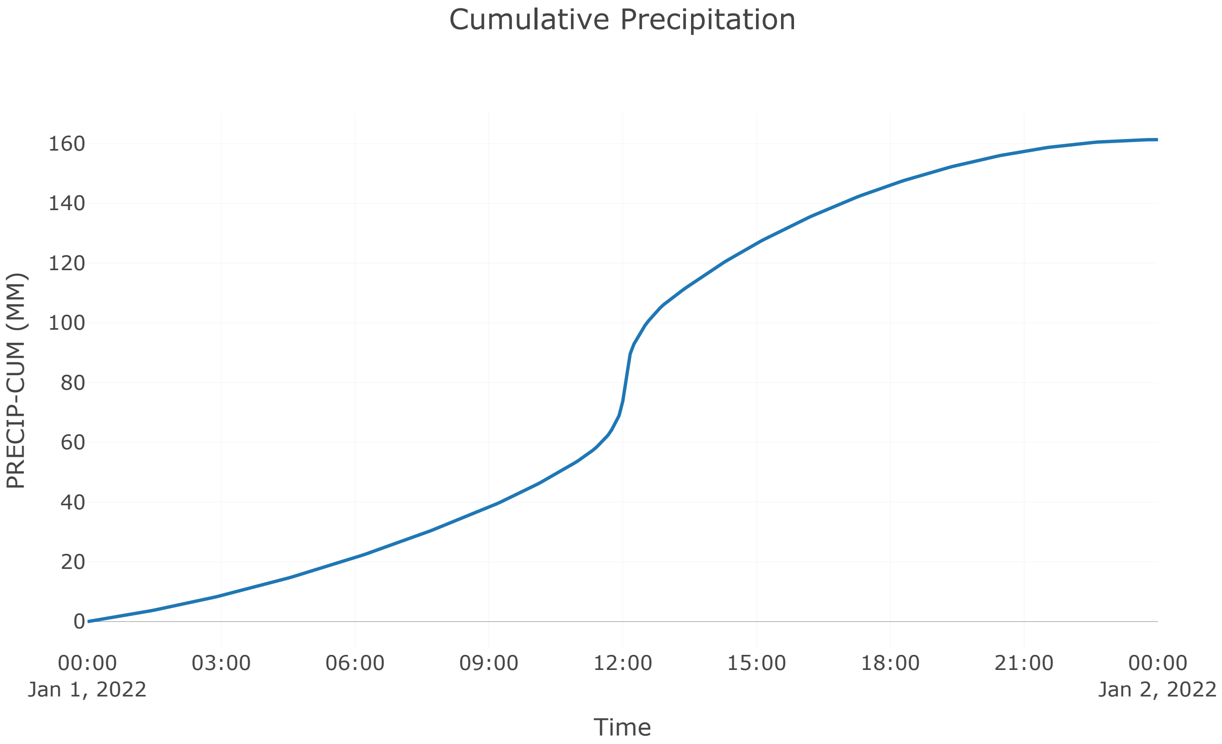
Results: SWC01B

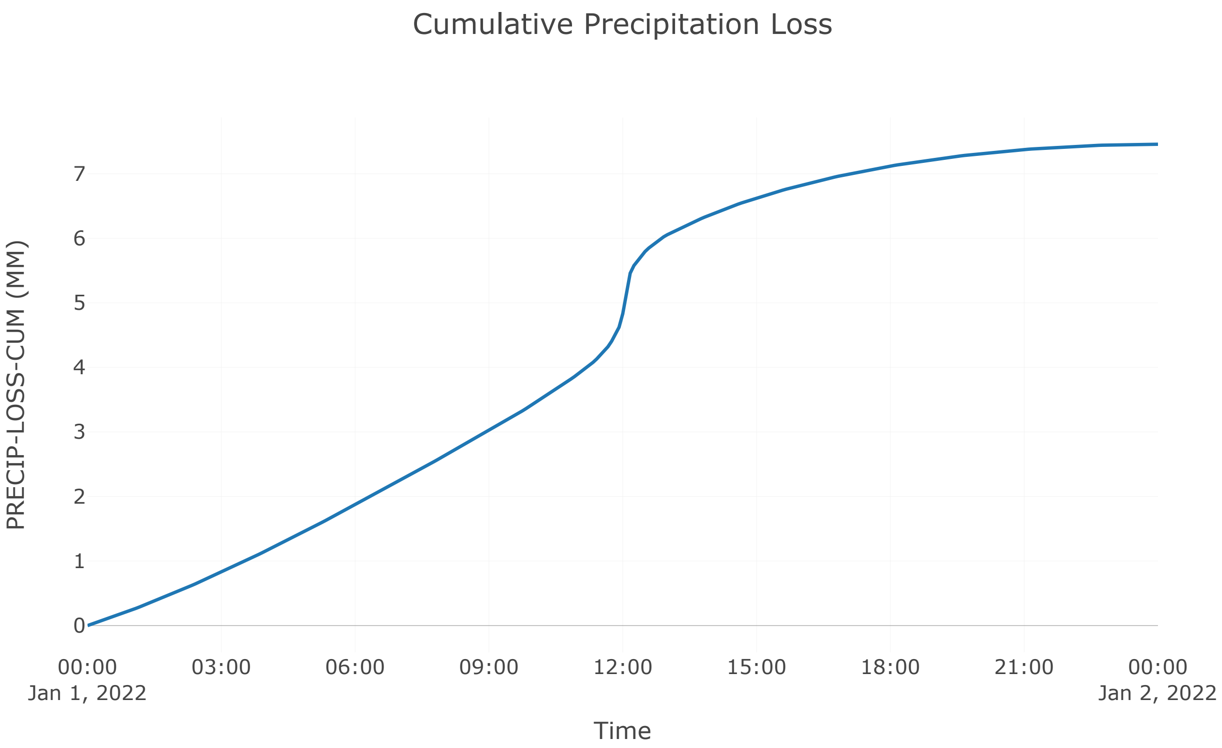
Peak Discharge (M3/S)	1.8
Time of Peak Discharge	01Jan2022, 12:35
Volume (MM)	153.6
Precipitation Volume (M3)	24749.71
Loss Volume (M3)	1144.04
Excess Volume (M3)	23605.68
Direct Runoff Volume (M3)	23565.41
Baseflow Volume (M3)	0

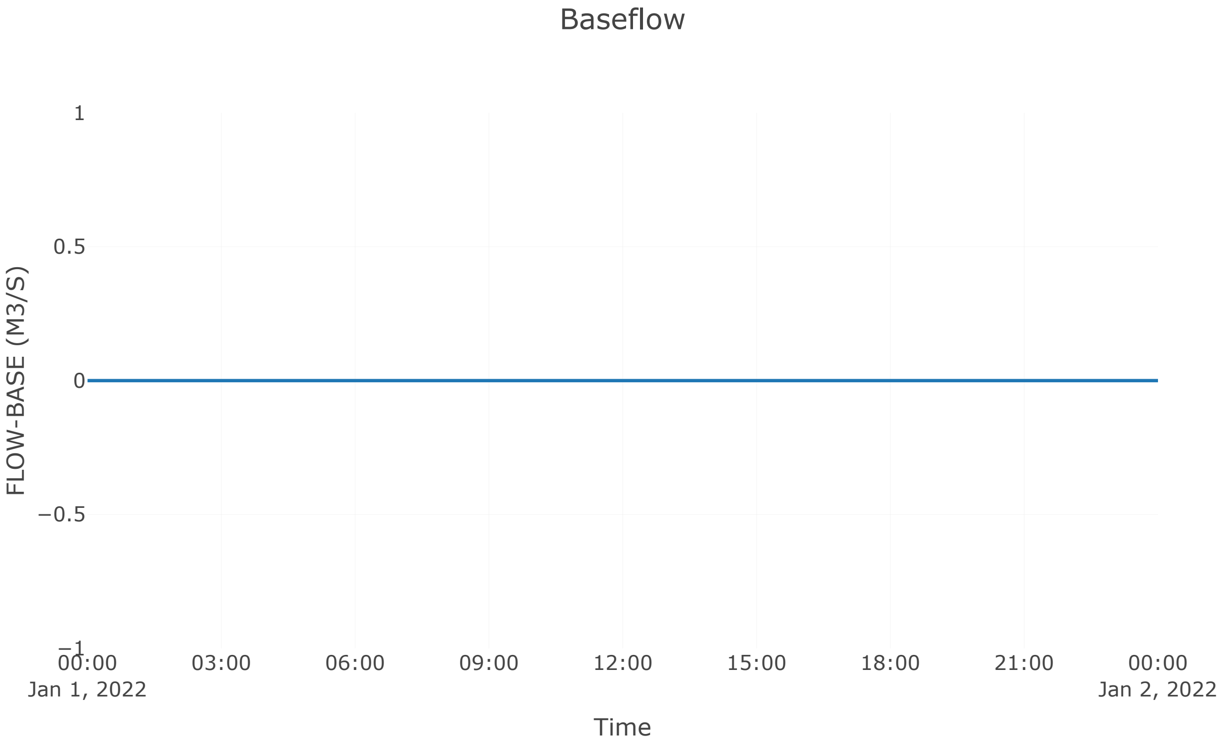

Precipitation and Outflow
PRECIP-INC (MM)
0
2
4
6
8
Precipitation
Excess Precipitation
Outflow
FLOW (M3/S)
1.5
1
0.5
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022

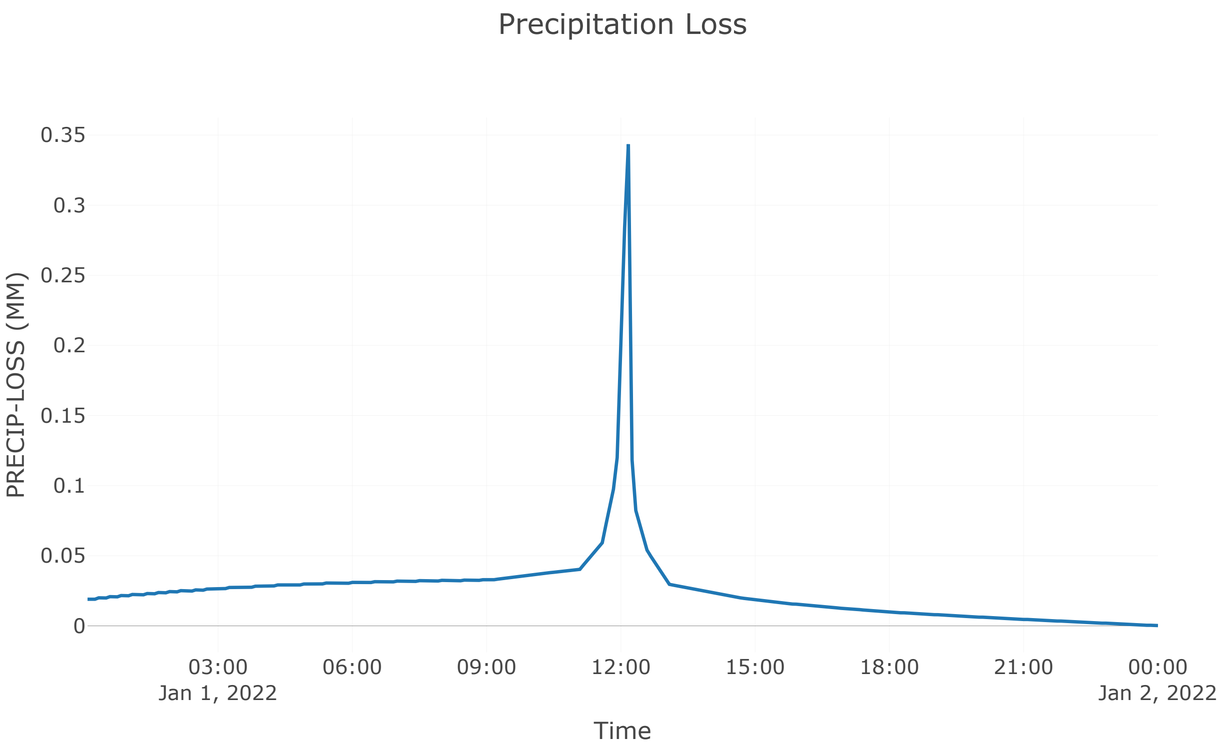

Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (MM)
160
140
120
100
80
60
40
20
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

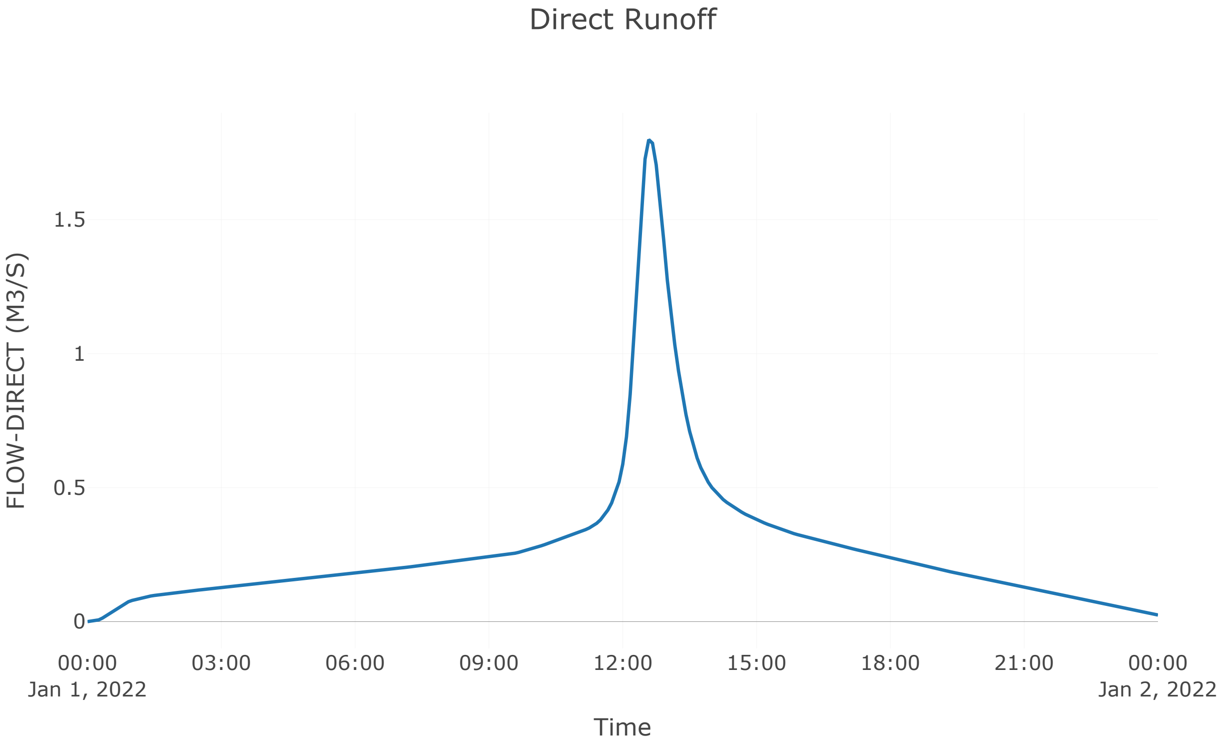

Cumulative Outflow
FLOW-CUMULATIVE (1000 M3)
0
5
10
15
20
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

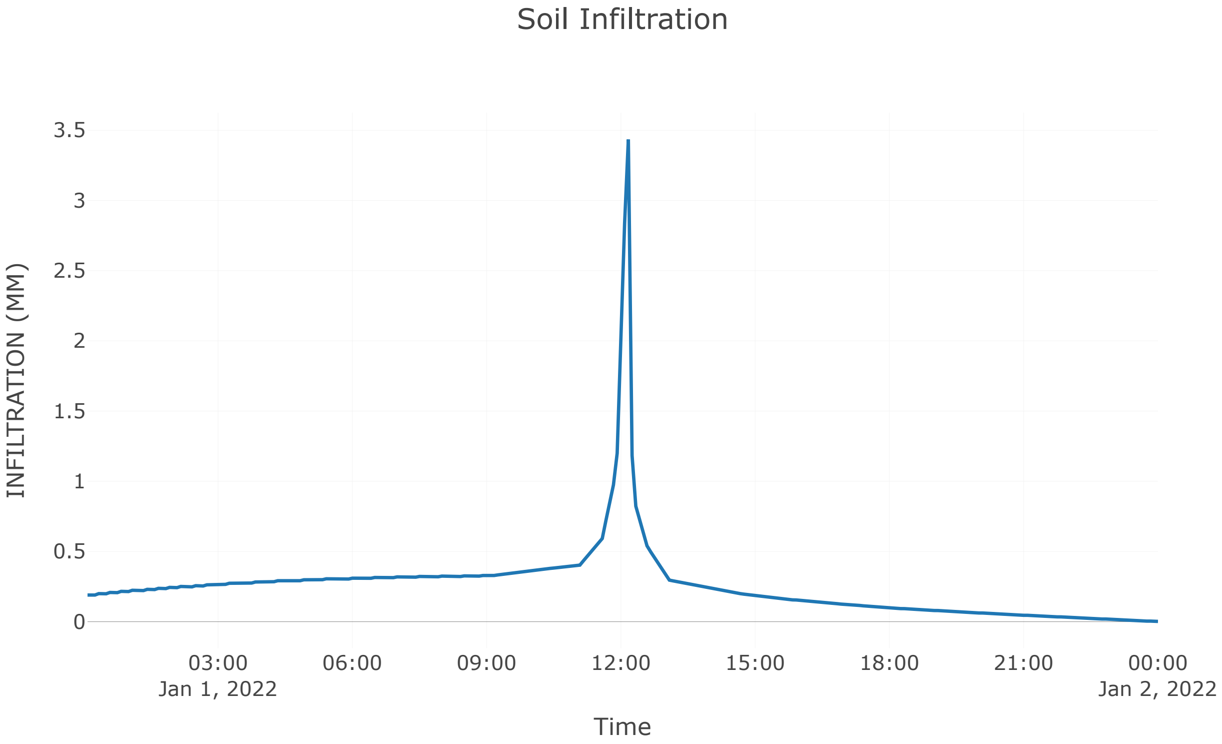

Cumulative Precipitation
PRECIP-CUM (MM)
0
20
40
60
80
100
120
140
160
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Cumulative Precipitation Loss
PRECIP-LOSS-CUM (MM)
0
1
2
3
4
5
6
7
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Baseflow
FLOW-BASE (M3/S)
1
0.5
0
−0.5
−1
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Precipitation Loss
PRECIP-LOSS (MM)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Direct Runoff
FLOW-DIRECT (M3/S)
1.5
1
0.5
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Soil Infiltration
INFILTRATION (MM)
3.5
3
2.5
2
1.5
1
0.5
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

Project: Calcutta_Farms_Industrial
Simulation Run: Post-Dev_100YR_CC_3.8C
Simulation Start: 31 December 2021, 24:00
Simulation End: 1 January 2022, 24:00

HMS Version: 4.9
Executed: 16 June 2022, 03:12

Global Parameter Summary - Subbasin

Area (KM²)

Element Name	Area (KM²)
Swc01b	0.15

Downstream

Element Name	Downstream
Swc01b	Sink - 1 - Post - dev

Loss Rate: Scs

Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Swc01b	90	65	0.7

Transform: Scs

Element Name	Lag	Unitgraph Type
Swc01b	30.6	Standard

Global Results Summary

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
Swc01b	0.15	2.89	01Jan2022, 12:35	246.8
Sink - 1 - Post - dev	0.15	2.89	01Jan2022, 12:35	246.8

Subbasin: SWC01B

Area (KM²) : 0.15
Downstream : Sink - 1 - Post - dev

Loss Rate: Scs

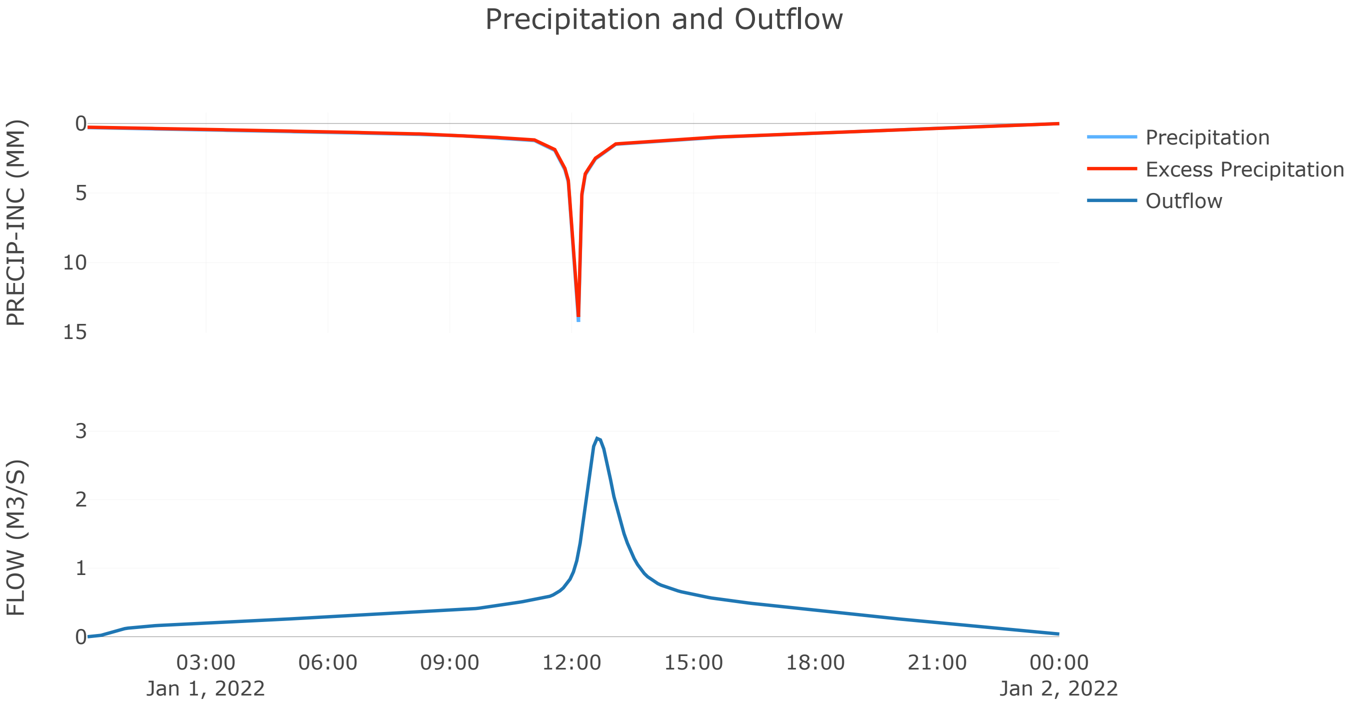
Percent Impervious Area	90
Curve Number	65
Initial Abstraction	0.7

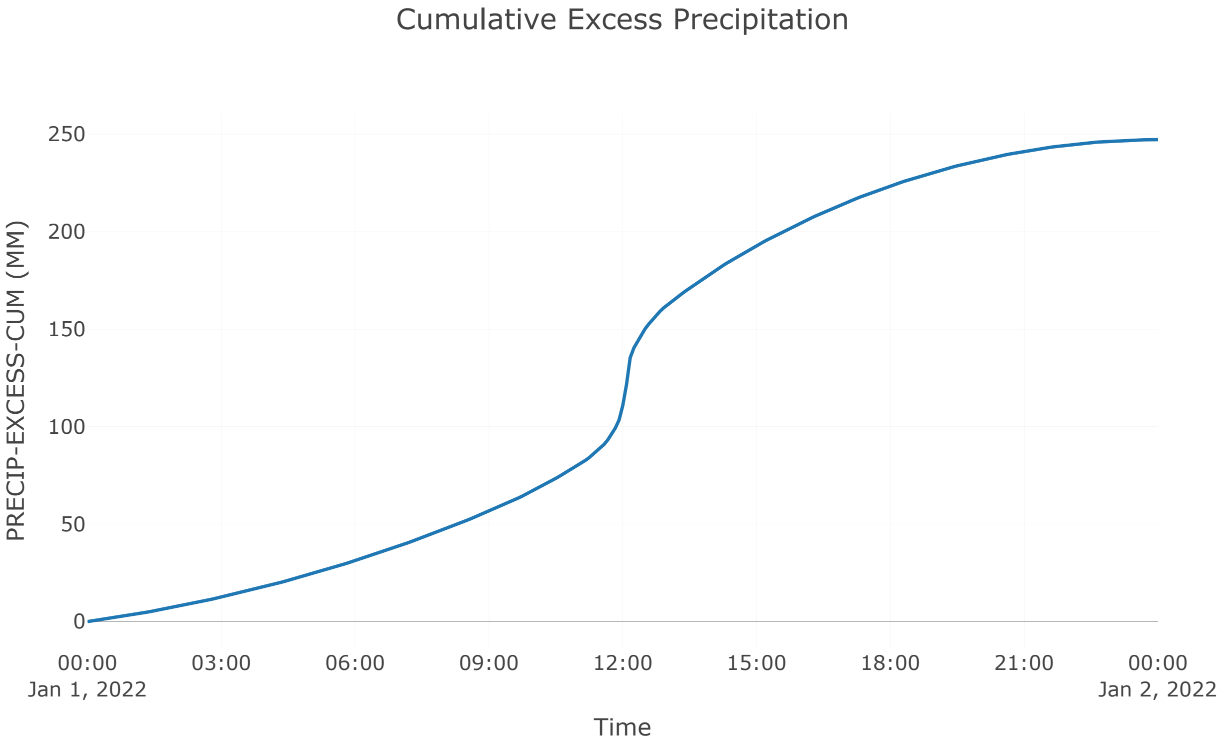
Transform: Scs

Lag	30.6
Unitgraph Type	Standard

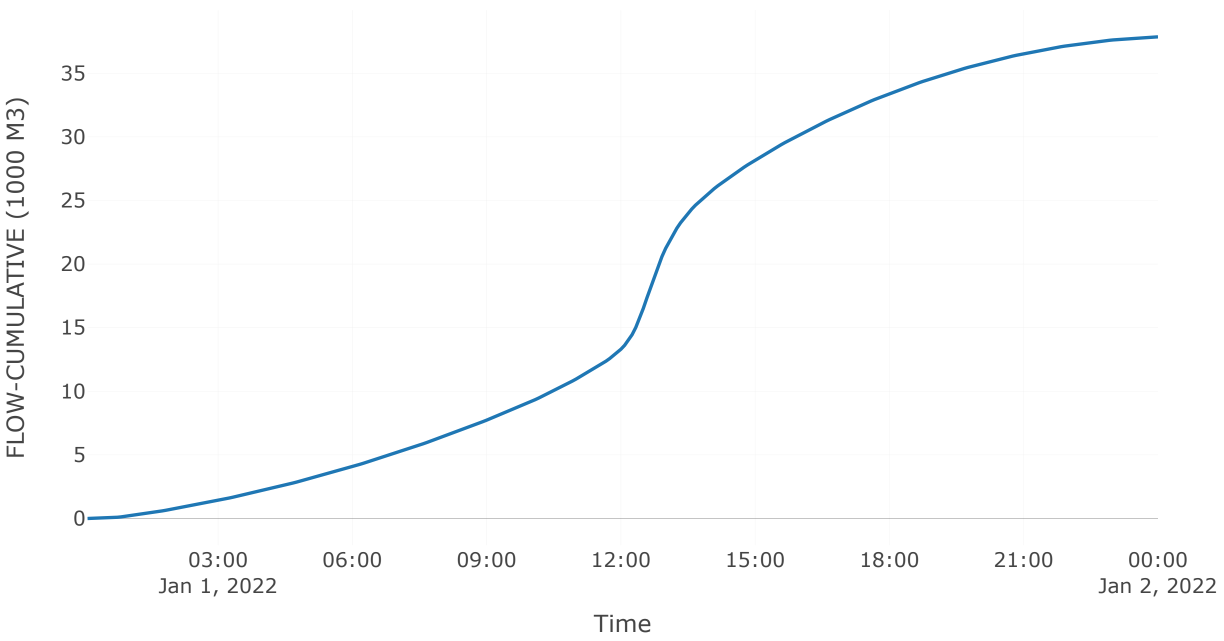
Results: SWC01B

Peak Discharge (M3/S)	2.89
Time of Peak Discharge	01Jan2022, 12:35
Volume (MM)	246.8
Precipitation Volume (M3)	39306.2
Loss Volume (M3)	1377.45
Excess Volume (M3)	37928.75
Direct Runoff Volume (M3)	37864.27
Baseflow Volume (M3)	0

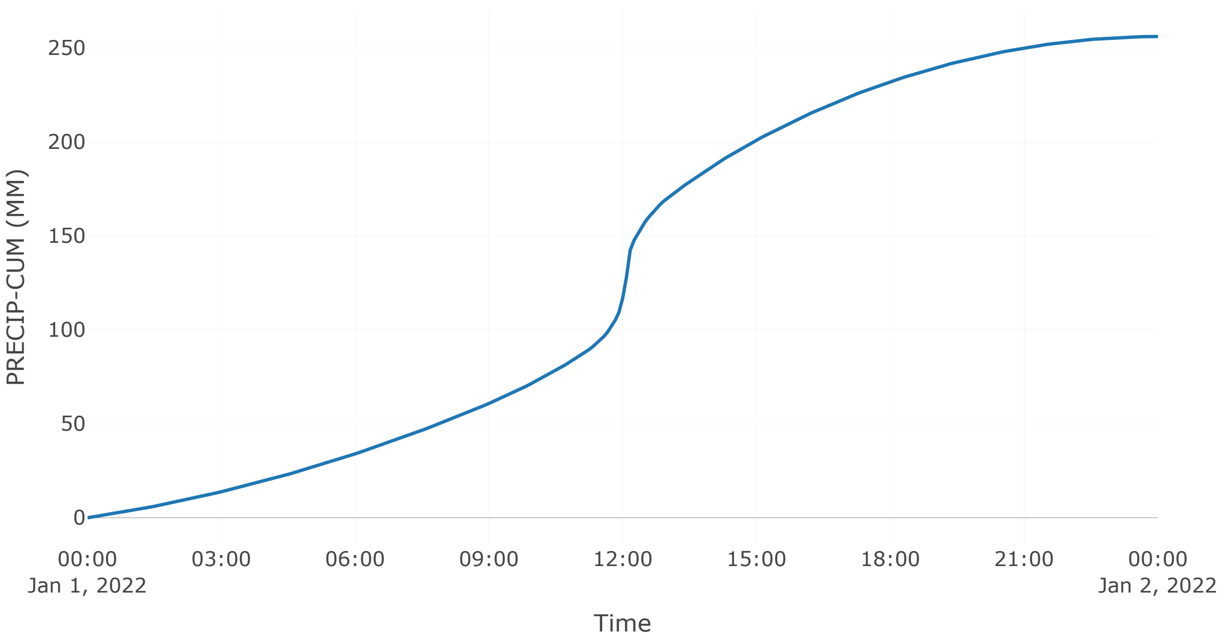

Precipitation and Outflow
PRECIP-INC (MM)
0
5
10
15
Precipitation
Excess Precipitation
Outflow
FLOW (M3/S)
3
2
1
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022

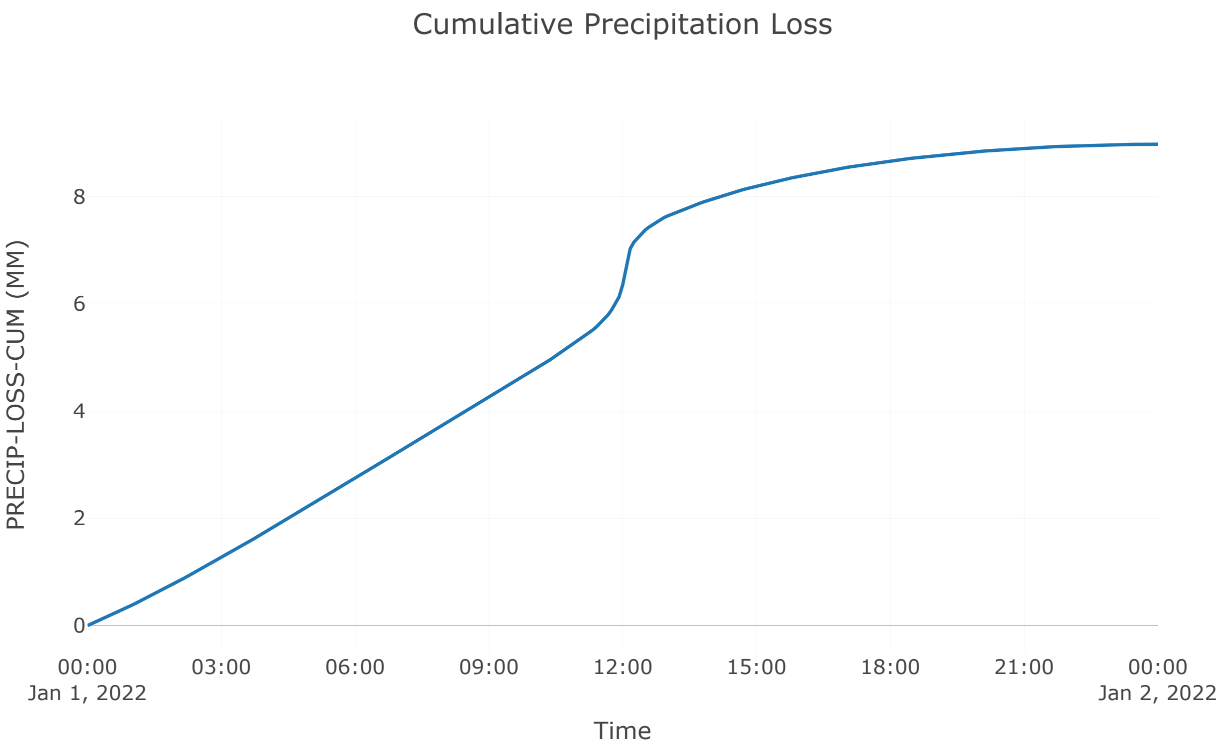

Cumulative Excess Precipitation
PRECIP-EXCESS-CUM (MM)
250
200
150
100
50
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time

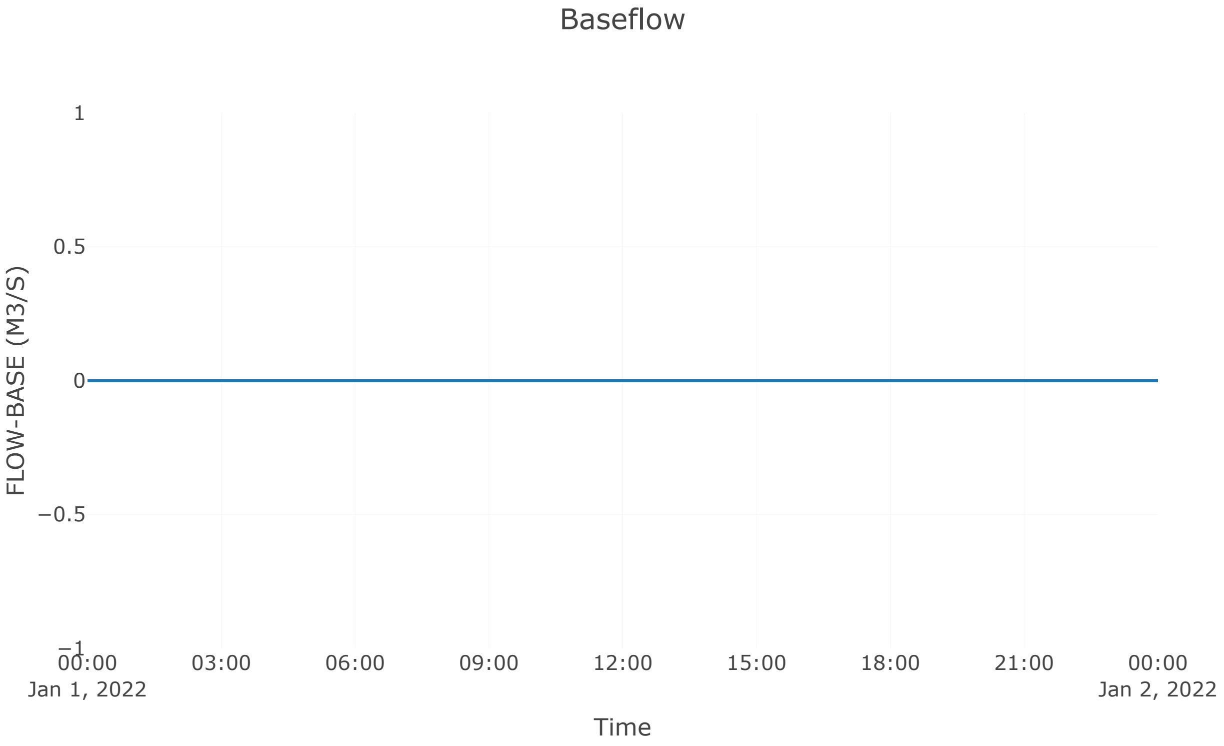
Cumulative Outflow

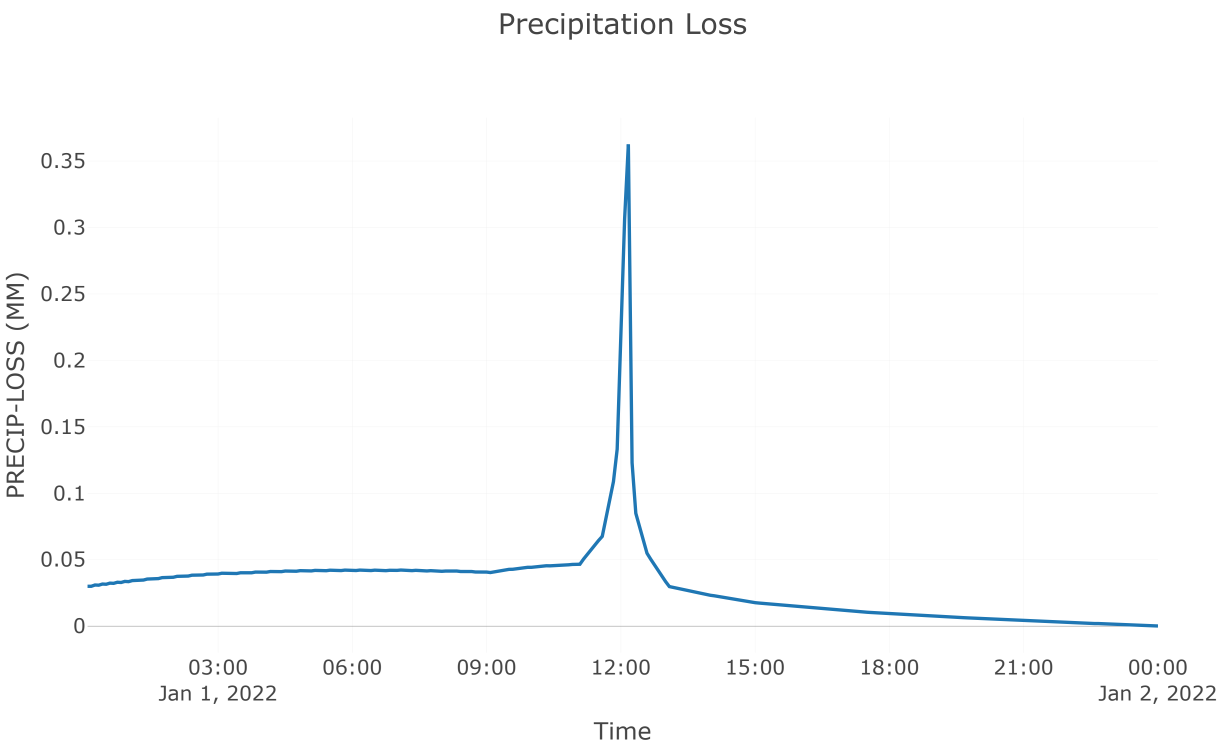


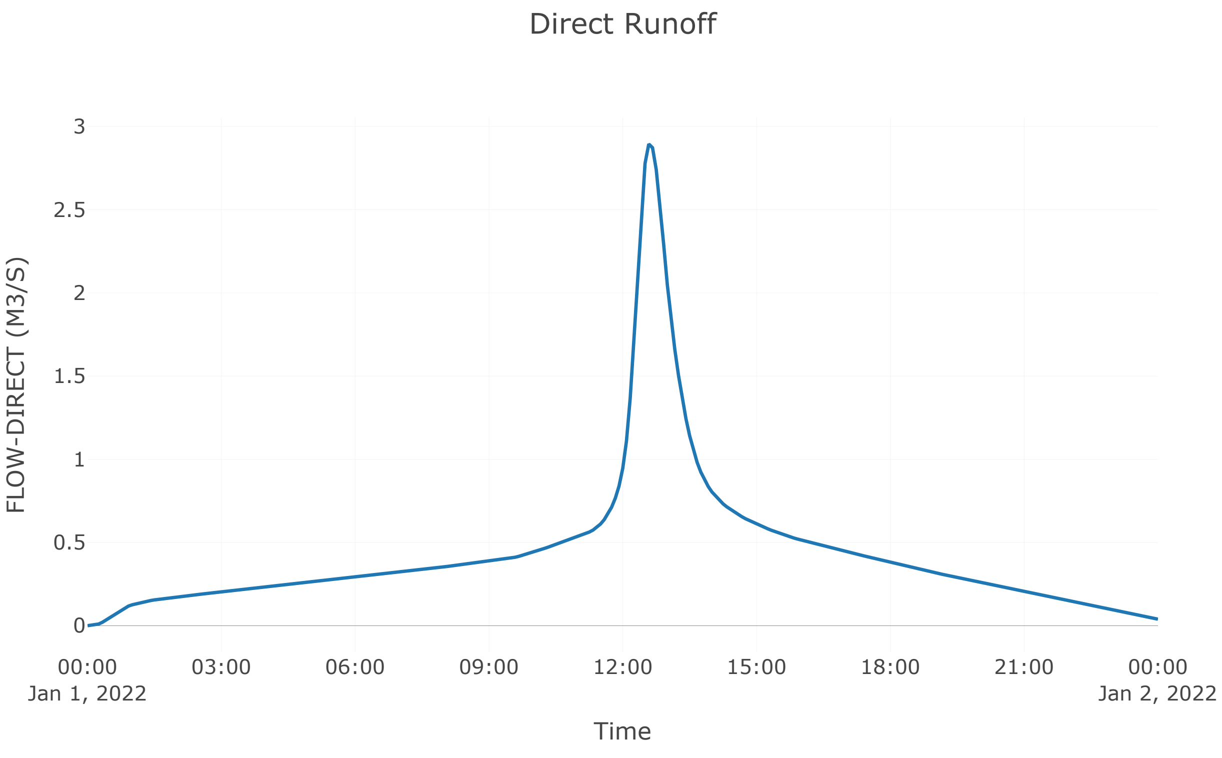
Cumulative Precipitation

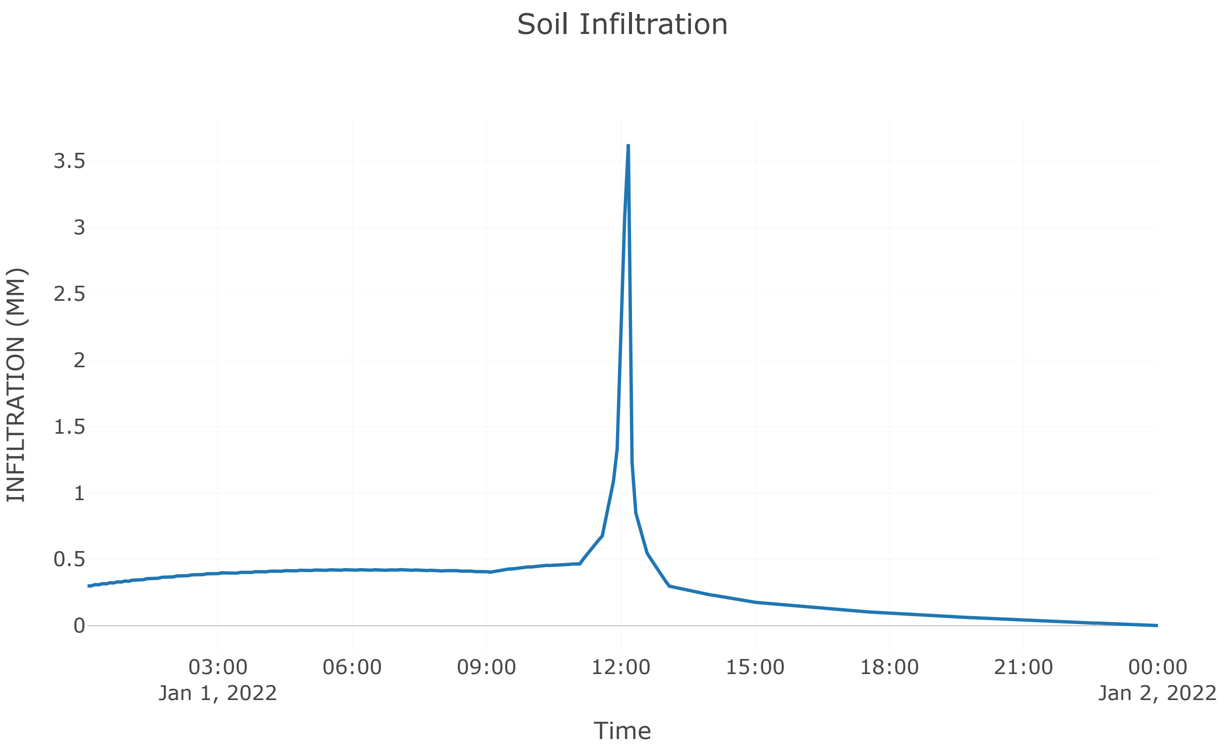



Cumulative Precipitation Loss
PRECIP-LOSS-CUM (MM)
0
2
4
6
8
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Baseflow
FLOW-BASE (M3/S)
1
0.5
0
−0.5
−1
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Precipitation Loss
PRECIP-LOSS (MM)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Direct Runoff
FLOW-DIRECT (M3/S)
3
2.5
2
1.5
1
0.5
0
00:00
Jan 1, 2022
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time


Soil Infiltration
INFILTRATION (MM)
3.5
3
2.5
2
1.5
1
0.5
0
03:00
Jan 1, 2022
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Jan 2, 2022
Time