# PROPOSED STORMWATER MANAGEMENT PLAN
# FOR BEACH HAVEN ROAD APARTMENTS LTD.
# AT 96 BEACH HAVEN ROAD/13 CRESTA AVE
# BEACH HAVEN

**Job No:** 200626/01

**Issue Date:** 03 November 2023

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Engineering *Ingenuity*

# Document Control Record

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**Client:**
Beach Haven Road Apartments Ltd.
96 Beach Haven Road/13 Cresta Ave

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| Revision | Description | Issue Date | Prepared by | Reviewed by |
|---|---|---|---|---|
| A | Plan Change Issue | 3/11/2023 | NNN | MTW |
| | | | | |
| | | | | |
| | | | | |

# Executive Summary

This Stormwater Management Plan addresses the stormwater management and treatment considerations for the proposed development at 96 Beach Haven Road and 13 Cresta Avenue, Beach Haven. The proposed development will involve the development of 75-100 Residential units in four separate apartment blocks. As the development has over 20 lots on a Brownfields development, this Stormwater Management Plan has been prepared to accompany the Stormwater Network Discharge Consent application.

This plan is intended to provide a framework for the design of new stormwater reticulation and treatment associated with the development of the site. Stormwater flows from the development will be attenuated in accordance with the requirements of GD01 to limit stormwater runoff from the 10% AEP 10-minute storm event to no more than the stormwater flows existing pre-development. This will remove any increased demand on the existing downstream stormwater infrastructure.

# Contents

# 1 INTRODUCTION

This Stormwater Management Plan describes the stormwater management approach to the proposed development at 96 Beach Haven Road/13 Cresta Avenue.

The Stormwater Assessment has been undertaken in accordance with the Auckland Council Unitary Plan requirements, along with the requirements of the Network Discharge Consent (NDC), Auckland Design Manual, and GD01.

# 2 EXISTING SITE APPRAISAL

## 2.1 Summary of Data sources and dates

| *Existing site appraisal item* | *Source and date of data used* |
|---|---|
| Topography | • Third-party topographic survey, Easdale Surveyors Ltd, 2021 |
| Geotechnical/soil conditions | • Third-party geotechnical report, Lander Geotechnical, 2021 |
| Existing stormwater network | • Auckland Council GeoMaps data, 2020<br>• Third-party topographic survey, Easdale Surveyors Ltd, 2021 |
| Existing hydrological features | • Auckland Council GeoMaps Overland Flow Paths and Stream Layers, 2021<br>• Auckland Land Surveys, 2019 Auckland Council Unitary Plan Viewer, significant ecological area layer, 2021 |
| Flooding and flowpaths | • Auckland Council GeoMaps Overland Flow Paths Layer, 2021<br>• Auckland Council GeoMaps Flood Plain Layer, 2021 |
| Coastal Inundation | • Auckland Council GeoMaps Emergency Management Layer, 2021 |
| Ecological/environmental areas | • Auckland Council GeoMaps Unitary Plan Viewer, Significant Ecological Area Layer, 2021<br>• Auckland Council GeoMaps Unitary Plan Viewer, Significant Vegetation Layer, 2021 |
| Cultural and heritage sites | • Auckland Council GeoMaps Cultural Heritage Site Layer, 2021 |

## 2.2 Location

The subject site comprises of the following two parcels of land totalling 7,147.00m².

| *Existing site elements* | | |
|---|---|---|
| Site address | • | 96 Beach Haven Road and 13 Cresta Avenue |
| Legal description | • | Lot 1 and Lot 2 DP 157383 |
| Current Land Use | • | Residential – Single Housing Zone |
| Current building coverage | • | 305.17m² (4.27%) |
| Historical Land Use | • | Residential |


*Figure 1. Aerial view of Subject Site – Council Geomaps*

## 2.3 Topography

The subject site slopes in a Northerly direction towards 29 Cresta Avenue, with gradients ranging from 4% in the central portion of the site, to approximately 6% towards the Northern section of the site.

A 100-year overland Flowpath is present within the site currently flowing along a depression on the Western side of the site and thereafter existing into the property at 15 Cresta Avenue.

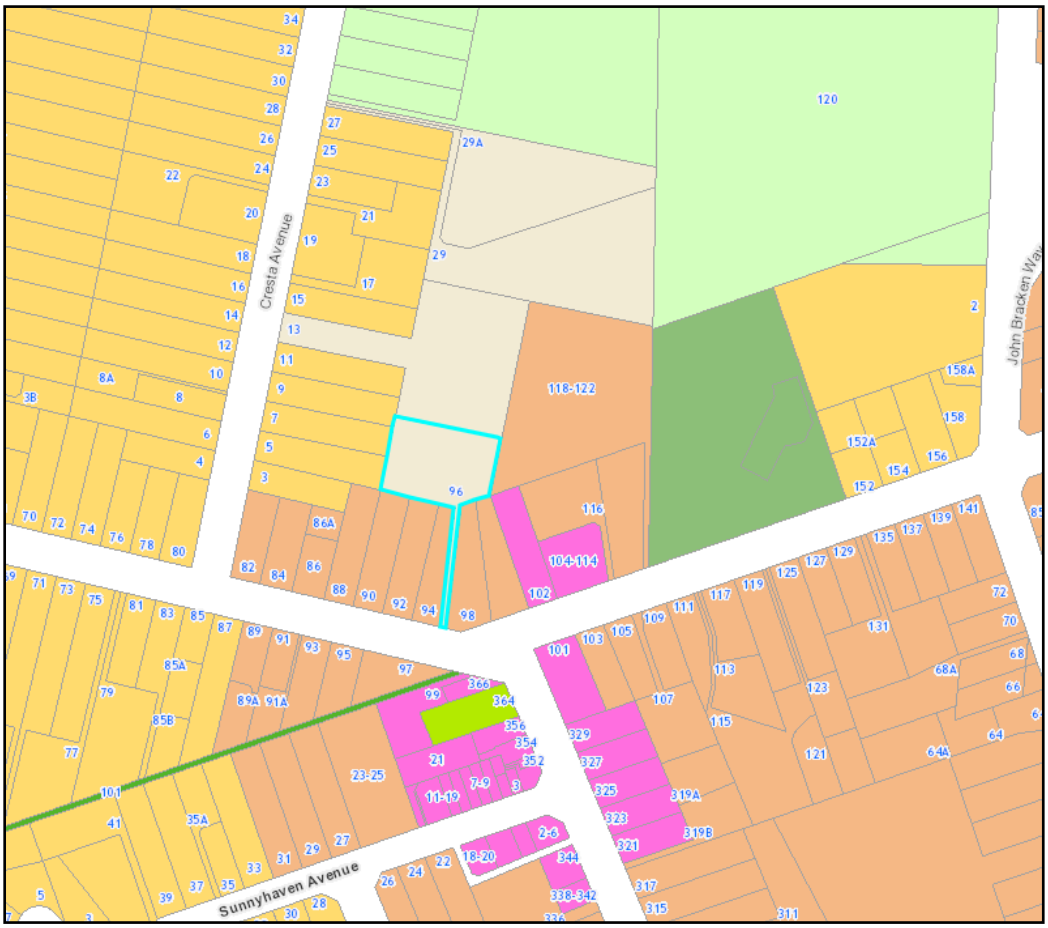
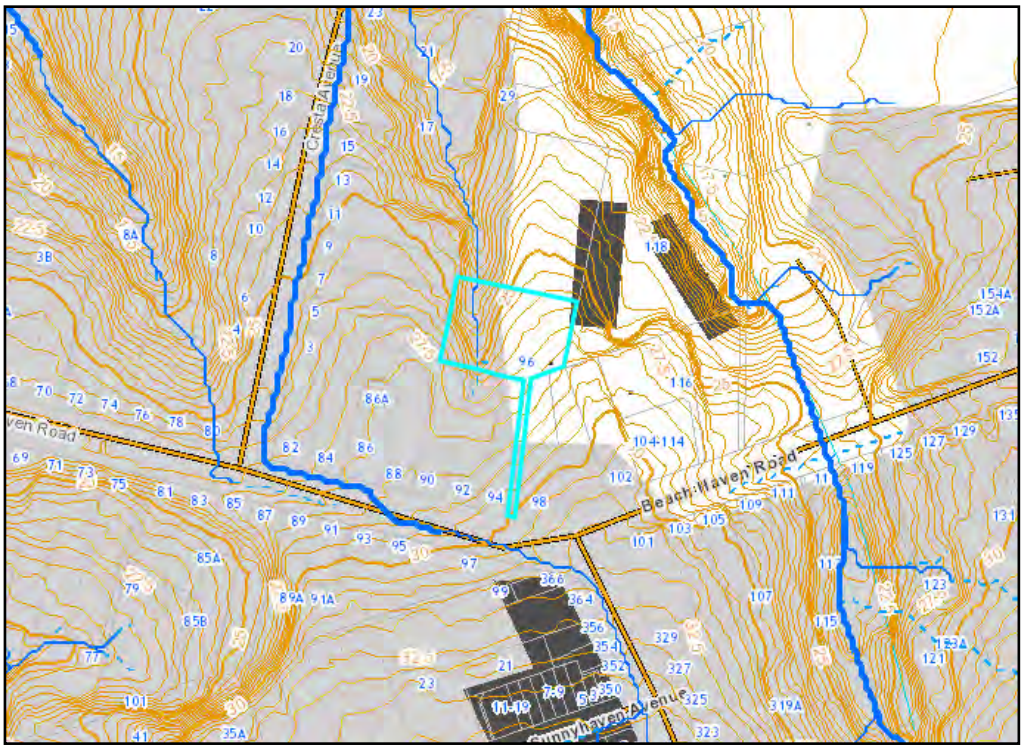



*Figure 2. Auckland Unitary Plan, Operative in Part: Zoning Map*



## 2.4 Geotechnical

Below is an extract from the Geotechnical Report as prepared by Lander Geotechnical, dated 2 March 2021:

*A review of GNS digital Q Maps indicated that the site is located within the East Coast Bays Formation (ECBF) of the Waitemata Group flysch deposits which consist of alternation beds of sandstones and mudstones. These deposits generally weather to a dark grey, partially weathered 'transitional' soils before weathering completely to orange, light grey and brown silts, clays and sands.* Please refer to Appendix F for Lander Geotechnical, Geotechnical Report, 2 March 2021.

## 2.5 Existing Drainage Features and Stormwater Infrastructure

According to a topographical survey prepared by Easdale Surveyors and Auckland Council Geomaps, there is an existing 300mmØ public stormwater line running along the southern boundary and the Western boundary of the site. This line connects to an existing 750mmØ public stormwater line running in a North-westerly direction through 13 Cresta Avenue. Please refer to Appendix A, Existing Site Features.

| Asset Type | Legacy Asset ID | Size |
|---|---|---|
| Stormwater Line | Null | 300mmØ |
| Stormwater Manhole | Null | 1050mmØ |
| Stormwater Line | Null | 300mmØ |
| Stormwater Manhole | Null | 1500mmØ |
| Stormwater Line | NSC_483772 | 750mmØ |
| Stormwater Manhole | Null | - |
| Stormwater Line | NSC_483770 | 750mmØ |

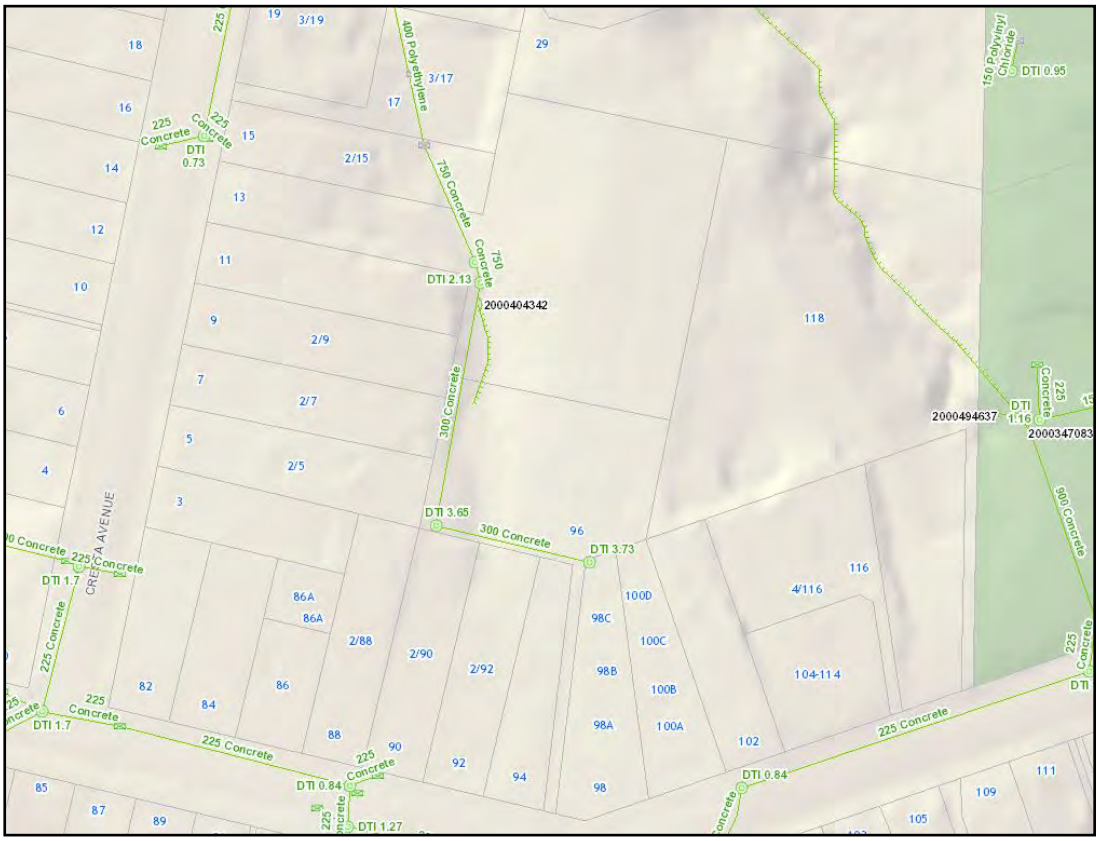



*Figure 4. Existing Public Stormwater Network (Auckland Council Geomaps)*

## 2.6 Receiving Environment

From the subject sites, the public stormwater network collects stormwater from a number of other upstream properties forming what was formerly known as the Tramway Catchment. This catchment discharges through a stream/watercourse, approximately 497m from the subject site into the Waitemata Harbour

The Tramway catchment was one of the lower priority catchments in the North Shore, with the last CMP published in February 2000. No recent stormwater models for this catchment have been undertaken.


*Figure 5. Existing Public Stormwater Network (Auckland Council Geomaps)*

## 2.7 Existing Hydrological Features

There are no natural streams, wetlands or ponds in the development area.

## 2.8 Flooding and Flowpaths

### 2.8.1 Flood plain and Flood Sensitive Areas

The site is not situated within the 100-year flood plain, nor flood sensitive area.

### 2.8.2 Overland Flow Paths

Council GIS Indicates that there is an overland flow path traversing the site, along the western boundary of 96 Beach Haven Road. Following a site visit and a desktop Flood Assessment, it is apparent the overland flow path is a local feature originating in 92 Beach Haven Road, immediately upstream of the subject site. It is concluded that the overland flow path can easily be accommodated down the western boundary within the proposed development.

## 2.9 Coastal Inundation

Auckland Council GeoMaps indicates that the sites are not subject to coastal inundation.

### 2.10 Biodiversity

Auckland Council GeoMaps indicates that there is no Significant Ecological Area (SEA) located within the subject sites. The downstream discharge point of the public network is located within a SEA.

### 2.11 Cultural and Heritage Sites

No cultural or heritage site have been identified within the development area.

### 2.12 Contaminated Land

All contamination matters have been addressed as part of the approved Bulk Earthworks Consent. Refer LUC60384512-A.

### 2.13 Mana Whenua Consultation and Engagement

An email was sent on the 21 December 2020 to the following mana whenua groups requesting feedback on the proposed private plan change:

- Ngāi Tai ki Tāmaki - Ngāi Tai ki Tāmaki Tribal Trust
- Ngāti Maru - Ngāti Maru Rūnanga Trust
- Ngāti Pāoa - Ngāti Paoa Iwi Trust
- Ngāti Pāoa - Ngāti Paoa Trust Board
- Ngāti Tamaterā - Ngāti Tamaterā Settlement Trust
- Ngāti Te Ata - Te Ara Rangatu o Te Iwi o Ngāti Te Ata Waiohua
- Ngāti Whanaunga - Ngāti Whanaunga Incorporated
- Ngāti Whātua o Kaipara - Ngā Maunga Whakahii o Kaipara Development Trust
- Ngāti Whātua Ōrākei - Ngāti Whātua Ōrākei Trust
- Te Ākitai Waiohua - Te Ākitai Waiohua Iwi Authority
- Te Kawerau ā Maki - Te Kawerau Iwi Settlement Trust
- Te Rūnanga o Ngāti Whātua - Te Rūnanga o Ngāti Whātua

A response was received from Ngā Maunga Whakahii o Kaipara Development Trust, Ngāti Whātua Ōrākei Trust and Ngāi Tai ki Tāmaki Tribal Trust confirming that no further action was required.

# 3 STORMWATER MANAGEMENT

The stormwater management strategy for the development has been developed in accordance with the objectives of the Auckland Regionwide Stormwater Network Discharge Consent.

## 3.1 General

As per the Auckland Unitary Plan, the subject site is not situated within the areas of Stormwater Management Areas, SMAF 1 or SMAF 2.

Discharge of Stormwater from the Proposed Development will not require resource consent as this is considered a permitted activity per the AUP: OP, Section E8.4.1 Item A1 – *Diversion of stormwater runoff from lawfully established impervious areas directed into an authorised stormwater network or a combined sewer network that complies with Standard E8.6.2.1.*

The proposed future development of the site will increase the impervious area on site from its current situation. Per AUP: OP, Section H4.6.8 Item 1 – the maximum impervious area must not exceed 60 percent of the site area.

Stormwater attenuation will be provided by installing Detention tanks with a throttle discharge to attenuate the Stormwater discharge from the post development flows back to the pre-development flows. The Stormwater design will be undertaken to comply with the Auckland Unitary Plan stormwater mitigation requirements, providing attenuation for the 10% AEP storm event (including 2.1°C climate change). A throttle system will be proposed to attenuate the discharge to predeveloped conditions in accordance with GD01Both roofed and paved areas will be drained by means of catch pits and downpipes respectively and discharge directly into the piped network.

A table of site catchment areas as follows:

| Description | Catchment Areas ($m^2$) |
|---|---|
| Total Impervious Area | 4,083 |
| Total Pervious Area | 3,064 |
| Total Gross Area | 7,147 |

The existing connection currently servicing No. 13 Cresta Avenue will be upgraded to form a new public connection for the proposed development. The existing connection currently servicing No. 96 Beach Haven Road will be abandoned. The existing Public Stormwater Lines currently located on site

including all neighbouring Stormwater connections will be retained. During Earthworks, if sufficient cover is not achieved over the existing Public Stormwater Lines, then these lines will be protected or upgraded as required.

### 3.2 Water Quality

The stormwater will be discharged into an existing public system which, in turn, discharges to the Waitemata Harbour through a river/watercourse located to the North of the subject sites.

The downstream receiving environment is located within a Significant Ecological Area (SEA) under the Auckland Unitary Plan, Section D9. Stormwater treatment will be provided to runoff from all impervious surfaces (roof and paved) by an Auckland Council Approved stormwater treatment device designed in accordance with Auckland Council Guideline Document GD01 2017/001 (GD01) along with the requirements of Schedule 4 of the Networks Discharge Consent for Large Brownfield Areas.

Although inert Building Materials are proposed for the new dwellings, stormwater treatment has still been provided for the roofed areas also. All roof stormwater runoff will be treated by means of a Hynds Upflo System or similar approved.

### 3.3 Flooding

#### 3.3.1 10 Percent AEP event (Network Capacity)

The downstream pipe capacity of the existing network has been assessed up to the Stormwater Manhole located within 21 Cresta Avenue (Council ID NSC_1507244).

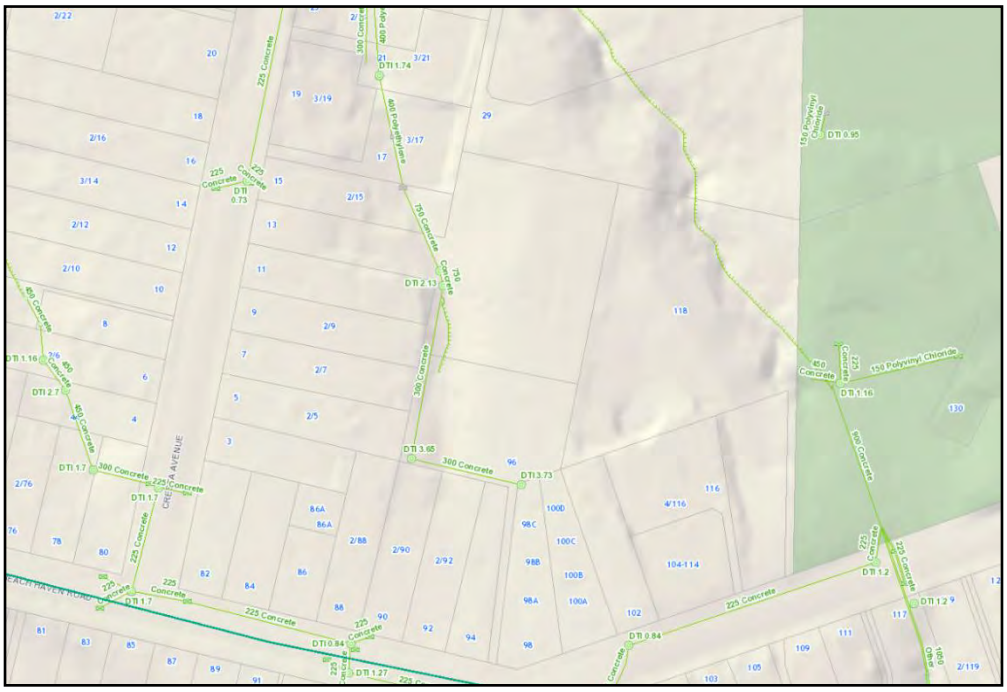



*Figure 6. Existing Public Stormwater Network (Auckland Council Geomaps)*

The existing 400 diameter line running into this Manhole has sufficient capacity to convey the 10% AEP stormwater event from the full catchment including the proposed development.

We note that it is proposed to provide Stormwater detention to limit post developed Stormwater flows to those existing in the pre-developed condition which will throttle the stormwater flows from the 10% AEP 10 minutes storm event. This will ensure there is no additional demand on the downstream network.

### 3.3.2 1 Percent AEP event

The proposal will lead to a small increase in peak runoff flow rates during the 1% AEP storm. Our calculations show that the 1% storm event can easily be catered for within the proposed development. Currently, overland flow from the 1% AEP storm event exits the site at the lowest point in the northwest corner, and follows the topography in a Northward Direction through 15 Cresta Avenue. From there the overland flow continues in a Northerly direction on through a number of properties on Cresta Avenue.

### 3.3.3 Overland Flowpath and Floodplain Management

An overland Flowpath has been identified on Auckland Council GIS entering the site at the Southern Boundary, traversing along the Western Boundary, and exiting the site at the Northwest Boundary.

Following a site visit and a review of the topography of the area, it has been established that the overland Flowpath does behave in the manner as presented on GIS. The following table is a summary of the pre-development and post development flows:

| Cross Section | Q100 Pre-development m3/s | Q100 Post Development m3/s | Flood Depth Pre-Development (mm) | Flood Depth Post Development (mm) | Velocity Pre-Development (m/s) | Velocity Post-Development (m/s) |
|---|---|---|---|---|---|---|
| A-A | 0.444 | 0.457 | 130 | 150 | 2.166 | 1.738 |
| B-B | 0.444 | 0.457 | 130 | 150 | 2.257 | 1.785 |
| C-C | 0.444 | 0.457 | 130 | 100 | 2.201 | 3.027 |
| No. 15 Cresta Avenue | 0.525 | 0.532 | 360 | 370 | 1.021 | 1.031 |
| No. 17 Cresta Avenue | 0.619 | 0.650 | 470 | 480 | 0.734 | 0.749 |

We have assessed the catchment from the Auckland Council GIS records. We note as per our attached catchment plan, there is a small area of the site that currently discharges to the Northeast that has not been included in our calculations. This is a very minor catchment and will have very little effect on the calculations completed to date.

Several cross sections of the overland flowpath were developed along the western boundary of the proposed development and within the properties of No.15 and No. 17 Cresta Avenue. This was to determine the flood levels post development. We have adopted a hypothetical channel based loosely on Auckland Council GIS levels to create the cross sections at the location shown in the attached Section Plan. In reality the channel will be much wider than assessed and will result in a lower flood depth.

The overland flow path is through generally well-maintained grassed areas through the site and traverses through the properties of No. 15 and No. 17 Cresta Avenue. The design has been based on a Manning's co-efficient of 0.03 for the well-maintained grass areas, and a co-efficient of 0.1 for the downstream properties based on the Auckland Council Stormwater Code of Practice.

Based on the 100yr Overland Flow, all cross sections indicate a minimal increase in the water levels along the overland flow path in the post development scenario. The maximum flood depth increase is circa 10mm. These changes in the overland flow behaviour will not cause any adverse effect to downstream properties.

A grassed conveyance channel is proposed within the site of the proposed development to accommodate for the 100yr Overland Flow. Due to the low flows, this will be more of a localised small depression in the grass surface. The channel will discharge into a scruffy dome manhole located at the low point of the site. The scruffy dome will outlet into the existing public network. This is primarily to remove the overland flow from discharging over the proposed retaining wall at the intersection of 15 Cresta Avenue. There is sufficient capacity in the 750mm diameter stormwater line at this location. The 750mm SW line decreases to a 400mm diameter line at the boundary with 17 Cresta Avenue and a cesspit is located there which will allow the flood flows to bubble up to the surface again should the pipe capacity be exceeded. This is considered to be the same philosophy adopted previously given the current configuration of the change in SW lines through the development, so it matched with what is currently happening in the area.

Based on the above assessment, we conclude that the flood depths will have no measurable impact on the downstream properties at No. 15 and No. 17 Cresta Avenue, and further down the catchment.

#### 3.3.4 Development staging

The construction works will not be undertaken in a Staged approach.

### 3.4 Assets

With the exception of the existing 300mm diameter and 750mm diameter Public Stormwater Line, all other assets within the development will be private. A pipe network will service the units collecting roof runoff into attenuation tanks from downpipes and catch pits will collect driveway runoff and discharge into a communal attenuation tank. All this collected stormwater will discharge to the public system via a proprietary Auckland Council approved stormwater treatment device, designed in accordance with the requirements of Auckland Council GD01/TP10. The private infrastructure will be constructed in accordance with the NZ Building Code and Stormwater Bylaw 2015. Unless otherwise approved, the private stormwater system connecting to the public system will be designed and built-in compliance with the design processes and standards per the Auckland Council Stormwater Code of Practice. This will be further designed under the Building Consent for the development.

The public infrastructure will be constructed in accordance with the Auckland Council Stormwater Code of Practice and will be vested in the Auckland Council. The private infrastructure will be jointly

owned by the residents of the development (by way of an owner's corporation or similar mechanism). Responsibility for maintenance of the system will, therefore, be held by the owner's corporation. An operations and maintenance manual for the private stormwater system will be prepared and will be provided at the Building Consent stage for the private drainage.

### 3.5 Ongoing Maintenance Requirements

There will be ongoing maintenance requirements for the Stormwater Treatment System which will fall on the Body Corporate. These will be detailed in the Building Consent documentation.

## 4 CONCLUSION

We consider that the stormwater management proposed for the development at 96 Beach Haven Road and 13 Cresta Avenue is in accordance with the objectives and policies of the Auckland Unitary Plan, the Regionwide Stormwater Network Discharge Consent, Auckland Design Manual and GD01. The proposed development will have minimal effects on the downstream receiving environment.

Report prepared by

**Natalie Naidoo**
**Senior Civil Engineer**
**MEngNZ**
Airey Consultants Ltd

Reviewed and approved by

**Michael Williams**
**Director**
**CPEng(NZ), CMEngNZ, IntPE(NZ), BE(Civil)**
Airey Consultants Ltd

# Appendix A

**Existing Site Features**


| No. | Revision Details | Date | No. | Revision Details | Date |
|---|---|---|---|---|---|
| | | | | | |

| | |
|---|---|
| Design | N.N.N. |
| Survey | EASDALE SURVEYORS LTD |
| Drawn | B.T.S. |
| Checked | M.T.W. |
| Date | 14/04/2021 |
| Scale | A3 1:750 |
| CAD Filename | |

FINAL



Job Title.
PROPOSED STORMWATER MANAGEMENT PLAN
FOR
BEACH HAVEN ROAD APARTMENTS LIMITED
96 BEACH HAVEN ROAD & 13 CRESTA AVENUE
BEACH HAVEN

FOR CONSENT

Airey

Drawing Title.
EXISTING SERVICES PLAN

| File No. | Rev. | Dwg. No. |
|---|---|---|
| 200626/1 | - | P100 |

J:\200000\200626 DA_SILVA_96 Beach Haven\CAD\WORKING DRAWINGS\96 BEACH HAVEN RD 200626-1.dwg, P100, 14/04/2021 12:59:16 PM

# Appendix B

**Proposed Zoning Plans**

# REZONING PROPOSAL

## 96 Beach Haven Road & 13 Cresta Road
## Beach Haven

NOVEMBER 2020

B&A

Urban & Environmental

Prepared by: Nick Mitchell
Reviewed: Rachel Morgan
B&A Job Ref: 18230

# WIDER CONTEXT

B&A
Urban & Environmental

# LOCAL CONTEXT

B&A
Urban & Environmental

# SURROUNDING AREA

B&A
Urban & Environmental


Site entry to Beach Haven Road


Looking east along Beach Haven Road from site entry - towards Local Centre


Looking west down Beach Haven Road from site entry - towards Ferry.
Note: Bus stops in each direction outside of site

Looking east along Beach Haven Road from corner of Cresta Avenue

# PUBLIC TRANSPORT

B&A
Urban & Environmental

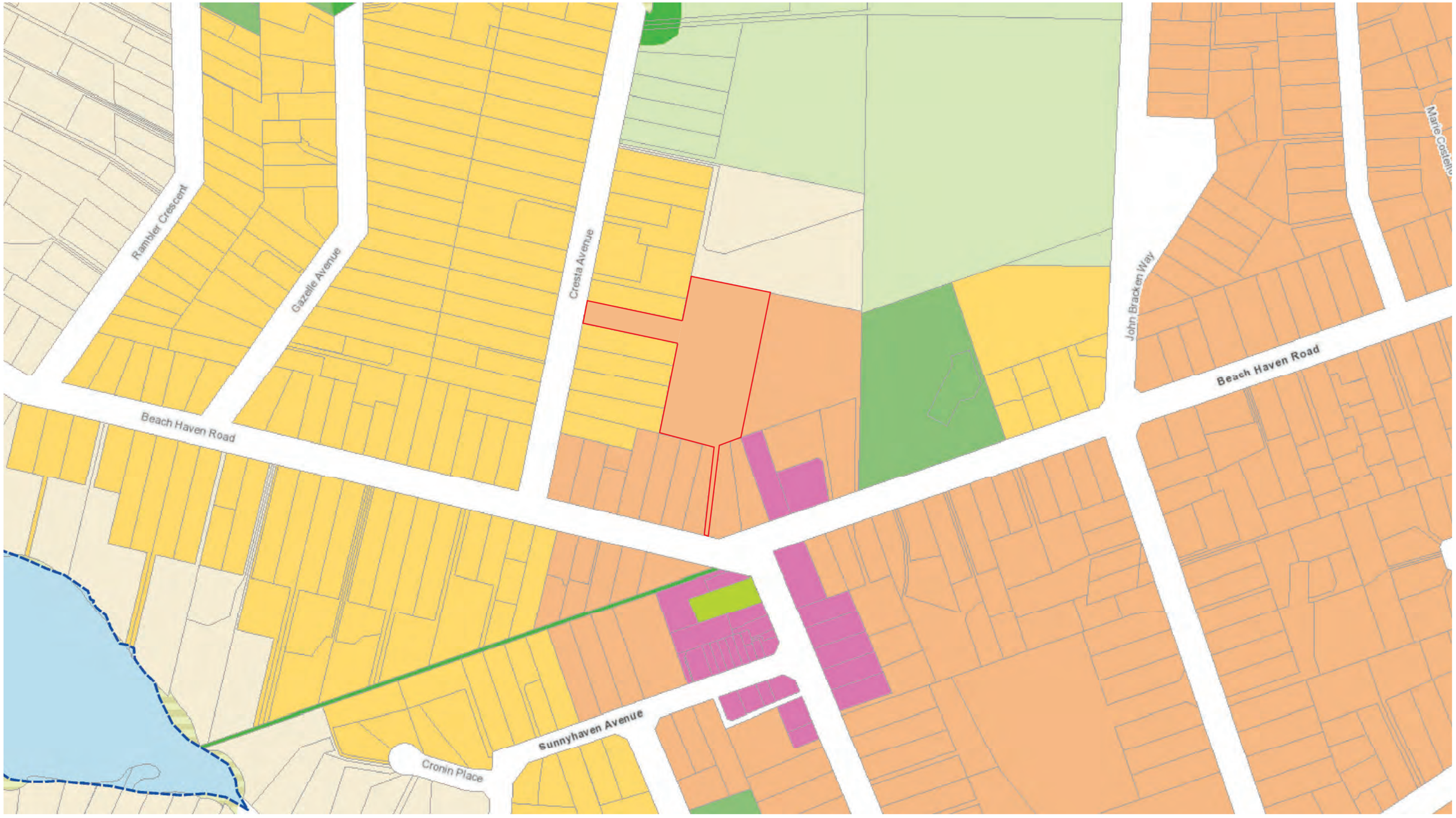
SITE


## FERRY TIMETABLE

| TO: AUCKLAND CITY | TO: BEACH HAVEN |
|---|---|
| MON - FRI | MON - FRI |
| 6:25 AM | 7:05 AM |
| 7:40 AM | 8:25 AM |
| 9:00 AM | 2:40 PM |
| 3:15 PM | 3:55 PM |
| 4:30 PM | 5:10 PM |
| 5:45 PM | 6:25 PM |
| 7:00 PM | 7:40 PM |

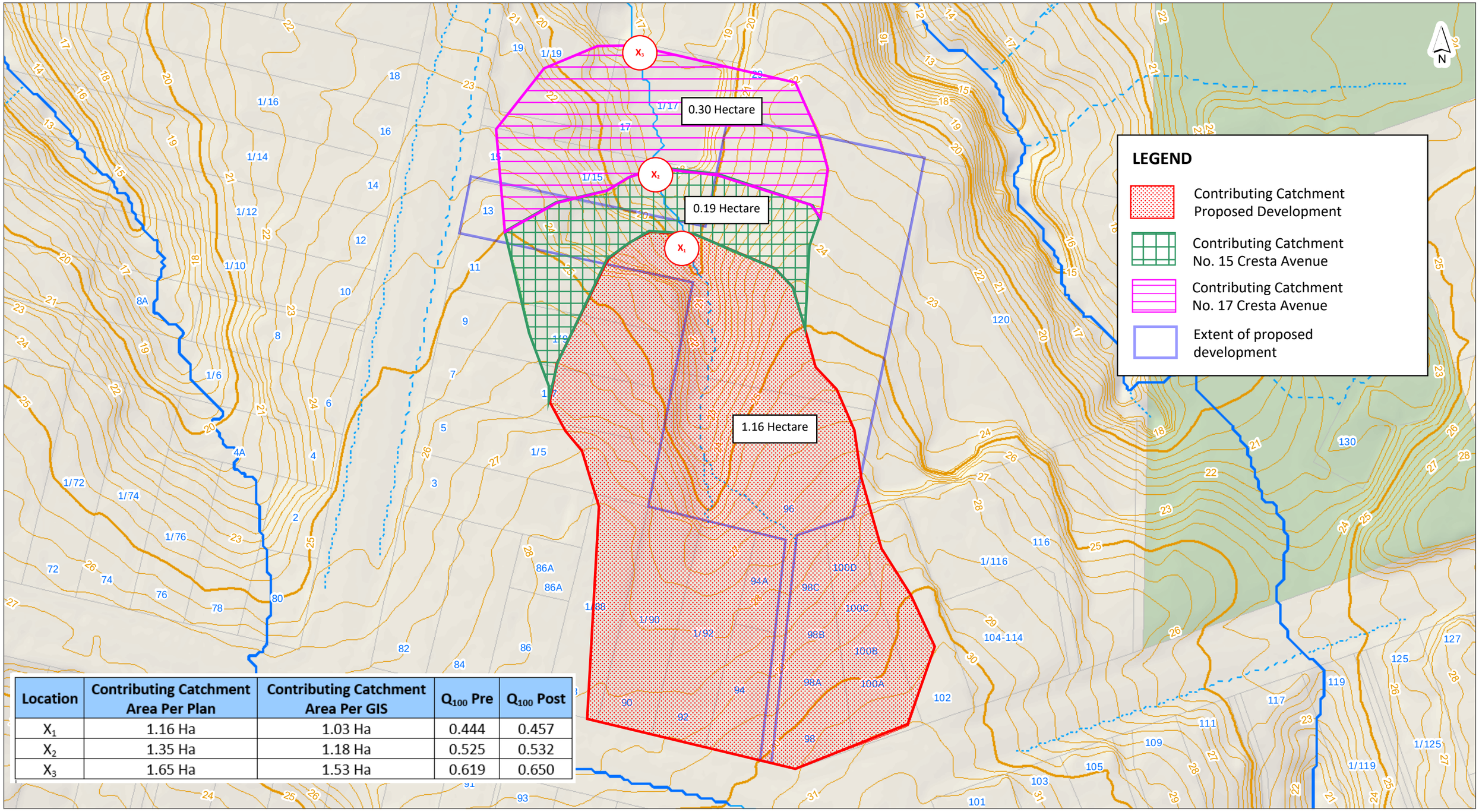
# PROPOSED ZONING

B&A
Urban & Environmental



# Appendix C

**Engineering Calculations**




| Location | Contributing Catchment Area Per Plan | Contributing Catchment Area Per GIS | $Q_{100}$ Pre | $Q_{100}$ Post |
|---|---|---|---|---|
| $X_1$ | 1.16 Ha | 1.03 Ha | 0.444 | 0.457 |
| $X_2$ | 1.35 Ha | 1.18 Ha | 0.525 | 0.532 |
| $X_3$ | 1.65 Ha | 1.53 Ha | 0.619 | 0.650 |



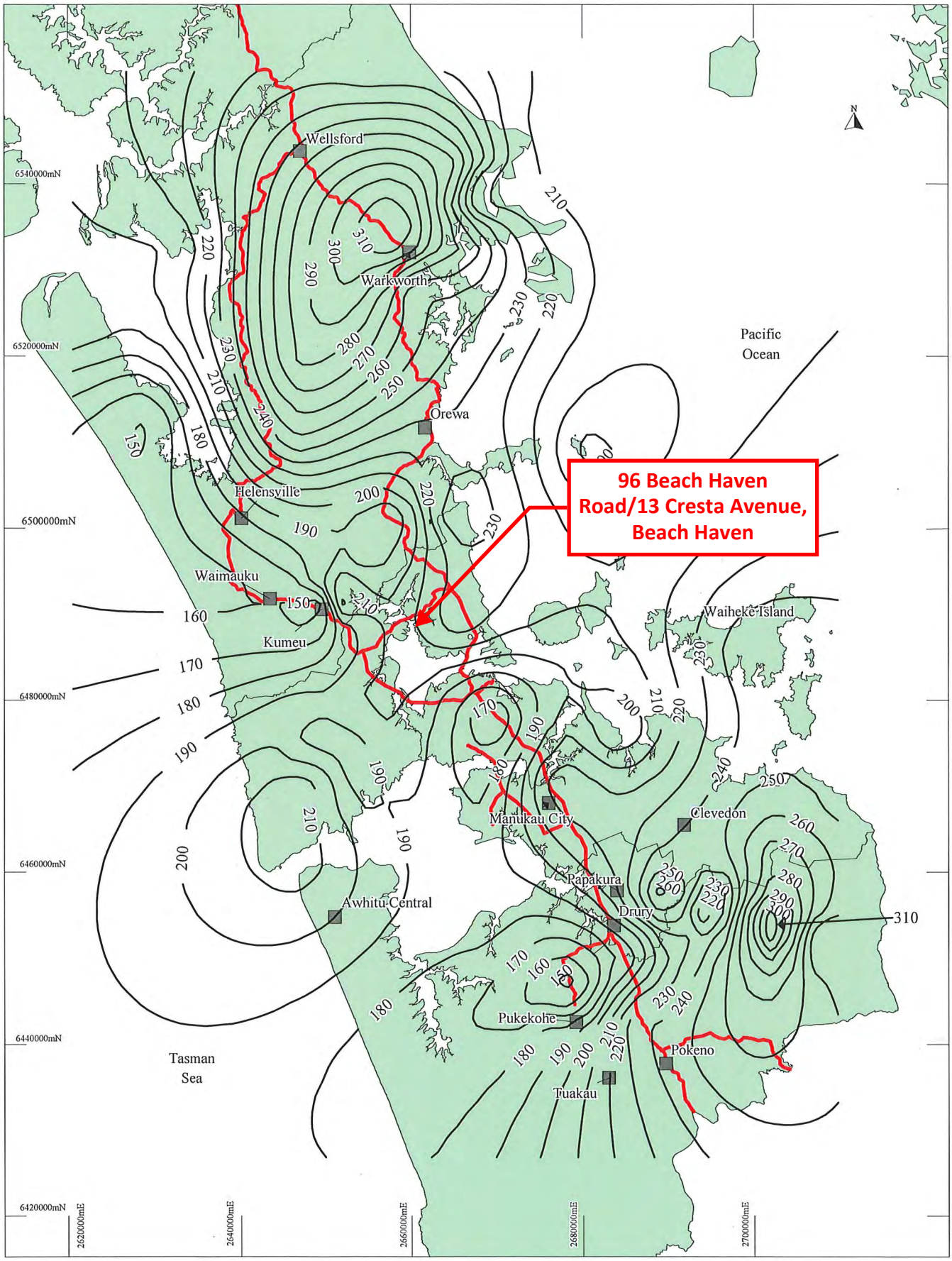
# Overland Flowpath Catchment Plan

0 10 20 30
Meters

Scale @ A3
= 1:1,000

Date Printed:
4/08/2021

Auckland Council
Te Kaunihera o Tāmaki Makaurau




A

Auckland *Regional* Council

**Legend:** — 90 — Rainfall Contour (mm)

State Highways

**Figure A.6**
**100 Year ARI**
**Daily Rainfall Depth**

Scale: 1:600,000 (at A4)
(Revised 25/08/1999)

Workspace: N:(civil)\25\2507757\gis\mapinfo\wor\100yrari.wor Date: 25/08/1999

## TP108 Rainfall - Overland Flowpath

**Job location**: 96 Beach Haven Road/13 Cresta Avenue, Beach Haven

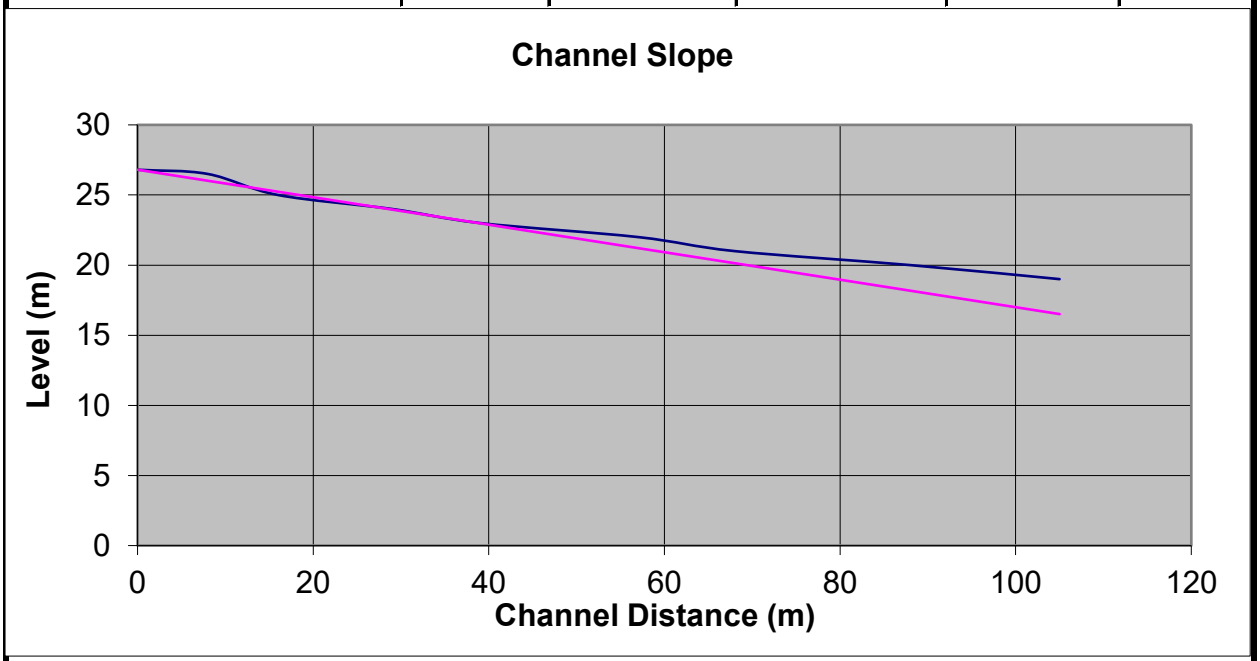
| | | |
|---|---|---|
| **Rainfall Depth** | 210 | mm |
| **ARI** | 100 | years |

| **Duration** hr | **Duration** mins | **Depth** mm | **Intensity** mm/hr ($Q_{10}$) |
|---|---|---|---|
| | | | |
| 0.166 | 10.0 | 28.26 | 170.22 |
| 0.333 | 20.0 | 43.45 | 130.49 |
| 0.5 | 30 | 53.59 | 107.19 |
| 1 | 60 | 75.55 | 75.55 |
| 2 | 120 | 102.04 | 51.02 |
| 6 | 360 | 156.00 | 26.00 |
| 12 | 720 | 200.15 | 16.68 |
| 24 | 1440 | **245.28** | 10.30 |
| 48 | 2880 | 494.48 | 10.30 |
| 72 | 4320 | 741.73 | 10.30 |

| | |
|---|---|
| Job | 96 Beach Haven Road/13 Cresta Avenue, Beach Haven |
| Job No | 200626-01 |
| Designer | Natalie Naidoo |
| Date | 6/08/2021 |

**SLOPE CALCULATIONS - EQUAL AREA METHOD - TP10**

| Description | Level (m) | Incremental distance (m) | Running distance (m) | "Area" from TP108 | Average Slope Level |
|---|---|---|---|---|---|
| Inlet point | 26.8 | 0 | 0 | | 27 |
| | 26.5 | 8 | 8 | 213.2 | 26 |
| | 25 | 8 | 16 | 206 | 25 |
| | 24 | 13 | 29 | 318.5 | 24 |
| | 23 | 10 | 39 | 235 | 23 |
| | 22 | 18 | 57 | 405 | 21 |
| | 21 | 11 | 68 | 236.5 | 20 |
| | 20 | 16 | 88 | 328 | 18 |
| | 19 | 17 | 105 | 331.5 | 17 |
| | | | 105 | 0 | 17 |
| | | | 105 | 0 | 17 |
| | | | 105 | 0 | 17 |
| | | | 105 | 0 | 17 |
| | | | 105 | 0 | 17 |
| **Channel length (m)** | | | **105** | 2273.7 | |
| **Average Channel Slope** | **-0.09801** | | | | |






# Overland Flowpath Cross Sections

0 10 20 30
Meters

**Scale @ A3**
= 1:1,000

**Date Printed:**
16/07/2021

Auckland Council
Te Kaunihera o Tāmaki Makaurau

# Hydrographs- SCS Method - Predevelopment flow from Proposed Development

**Project Description** 96 Beach Haven Road/13 Cresta Avenue
Beach Haven

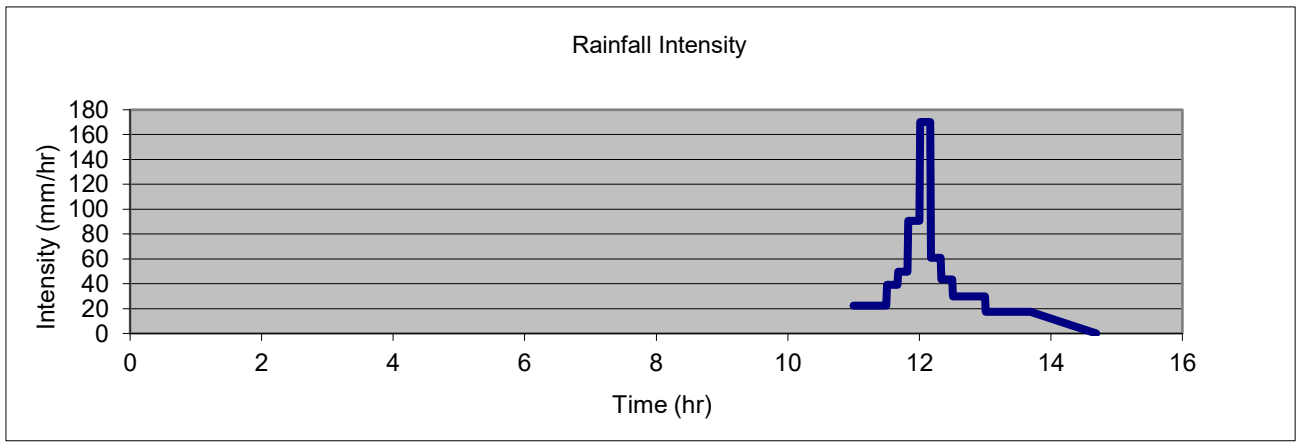
Rainfall Depth (mm) 245.28 100 YEAR ARI

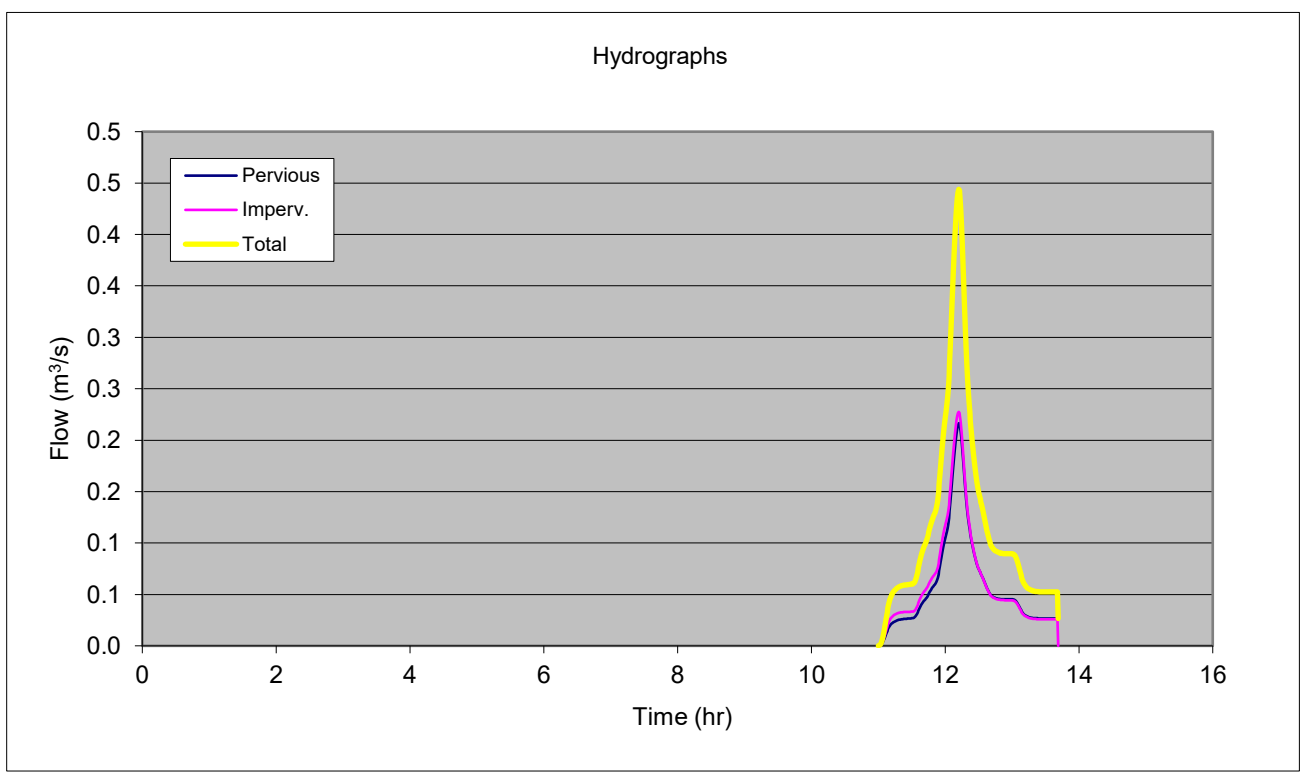
**Notes:**

1. Inputs
2. Typical inputs for CN, Ia, CF are in 'Typical Inputs' Sheet.
3. Method based on ARC TP108.

| Catchment Data | Pervious Area | Impervious Area |
|---|---|---|
| Area (ha) | 0.6264 | 0.5336 |
| Runoff No (CN) | 74 | 98 |
| Initial Loss (Ia-mm) | 5 | 0 |
| Channel Length (L-m) | 101 | 101 |
| Channel Slope (Sc-m/m) | 0.1 | 0.1 |
| Channel Factor (CF-0.6 to 1.0) | 0.8 | 0.6 |
| Time of Concentration (tc-min) | 10.0 | 10.0 |
| Soil storage (S-mm) | 89.2 | 5.2 |

| Outputs | | | Total |
|---|---|---|---|
| Runoff (mm) | 175.2 | 240.2 | 205.1 |
| Peak Flow ($m^3/s$) | 0.216 | 0.228 | 0.444 |
| Time (hr) at Peak Flow | 12.20 | 12.20 | 12.20 |
| Rainfall (mm/h) over tc | 165.26 | 165.26 | 165.26 |
| Runoff Coefficient - Peak | 0.75 | 0.93 | 0.83 |
| Runoff Coefficient - Volume | 0.71 | 0.98 | 0.84 |



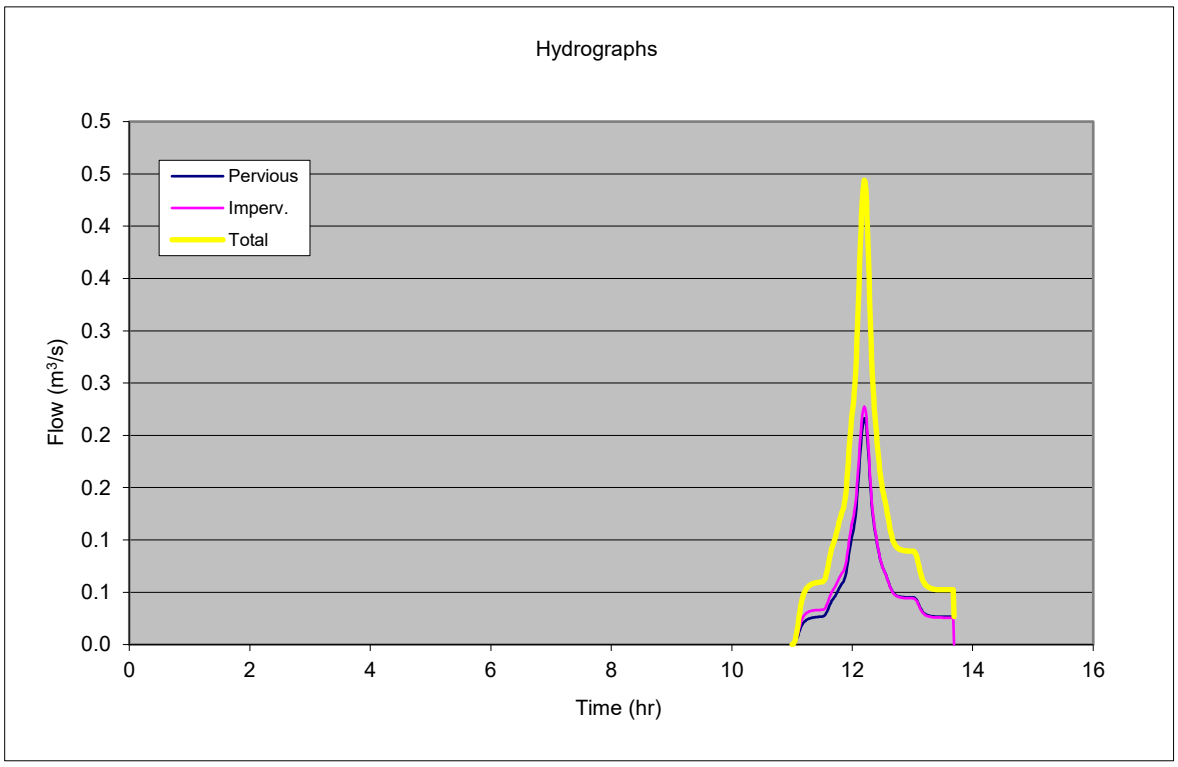
# Hydrographs- SCS Method:

**Project Description**

96 Beach Haven Road/13 Cresta Avenue
Beach Haven

**Total Hydrograph in tabular form:** (based on simualtion from above)

Volumetric error in scaling 1.70%




| Time (hr) | Flow ($m^3/s$) |
|---|---|
| 11.001 | 0.000 |
| 11.347 | 0.058 |
| 11.491 | 0.060 |
| 11.601 | 0.076 |
| 11.694 | 0.098 |
| 11.776 | 0.115 |
| 11.850 | 0.130 |
| 11.918 | 0.161 |
| 11.981 | 0.210 |
| 12.040 | 0.246 |
| 12.096 | 0.320 |
| 12.150 | 0.403 |
| 12.201 | 0.444 |
| 12.230 | 0.430 |
| 12.259 | 0.387 |
| 12.290 | 0.330 |
| 12.320 | 0.278 |
| 12.352 | 0.240 |
| 12.384 | 0.214 |
| 12.417 | 0.191 |
| 12.451 | 0.170 |
| 12.486 | 0.154 |
| 12.522 | 0.143 |
| 12.559 | 0.133 |
| 12.597 | 0.121 |
| 12.637 | 0.108 |
| 12.678 | 0.099 |
| 12.721 | 0.094 |
| 12.767 | 0.092 |
| 12.814 | 0.090 |
| 12.864 | 0.090 |
| 12.917 | 0.089 |
| 12.975 | 0.089 |
| 13.037 | 0.088 |
| 13.106 | 0.075 |
| 13.184 | 0.060 |
| 13.277 | 0.054 |
| 13.398 | 0.053 |
| 13.690 | 0.027 |
| -1.000 | 0.000 |

# CHANNEL CAPACITY SECTION PRE-DEVELOPMENT A-A

| | |
|---|---|
| **PROJECT NO:** | 200626-01 |
| **PROJECT NAME:** | 96 Beach Haven Road/ 13 Cresta Avenue |
| **DATE:** | 6.08.2021 |
| **BY:** | Natalie Naidoo |
| **REF:** | Overland Flowpath Cross Sections |

**INPUTS**

| | |
|---|---|
| Case (A or B) | B |
| **Case A** | |
| Flow ($m^3/s$) | 0.444 |
| **Case B** | |
| Slope ($S_o$) | 10% |
| Water level (m) | 23.53 |
| MFFL | 23.68 |

0.13

| Channel Geometry | | Mannings | Sinuosity | |
|---|---|---|---|---|
| x (m) | y (m) | "n" value | | |
| 0 | 23.7 | 0.03 | | Short Grass |
| 0.5 | 23.5 | 0.03 | | Short Grass |
| 1 | 23.4 | 0.03 | | Short Grass |
| 2 | 23.4 | 0.03 | | Short Grass |
| 2.5 | 23.50 | 0.03 | | Short Grass |
| 3 | 23.7 | 0.03 | | Short Grass |
| -1 | | | | |

The table can input 10 (x,y) co-ordinates.
The (x,y) pairs should be in order
Terminate list by making x = -1.0

Flow distribution is based on velocity and energy gradient common to all parts of the channel. i.e.
$n=(\sum(P_1 n_1^{1.5}+....)/P)^{0.67}$

Sinuosity is the relative length of that flow channel element compared to other elements and input $S_o$.
Default value is 1.0.

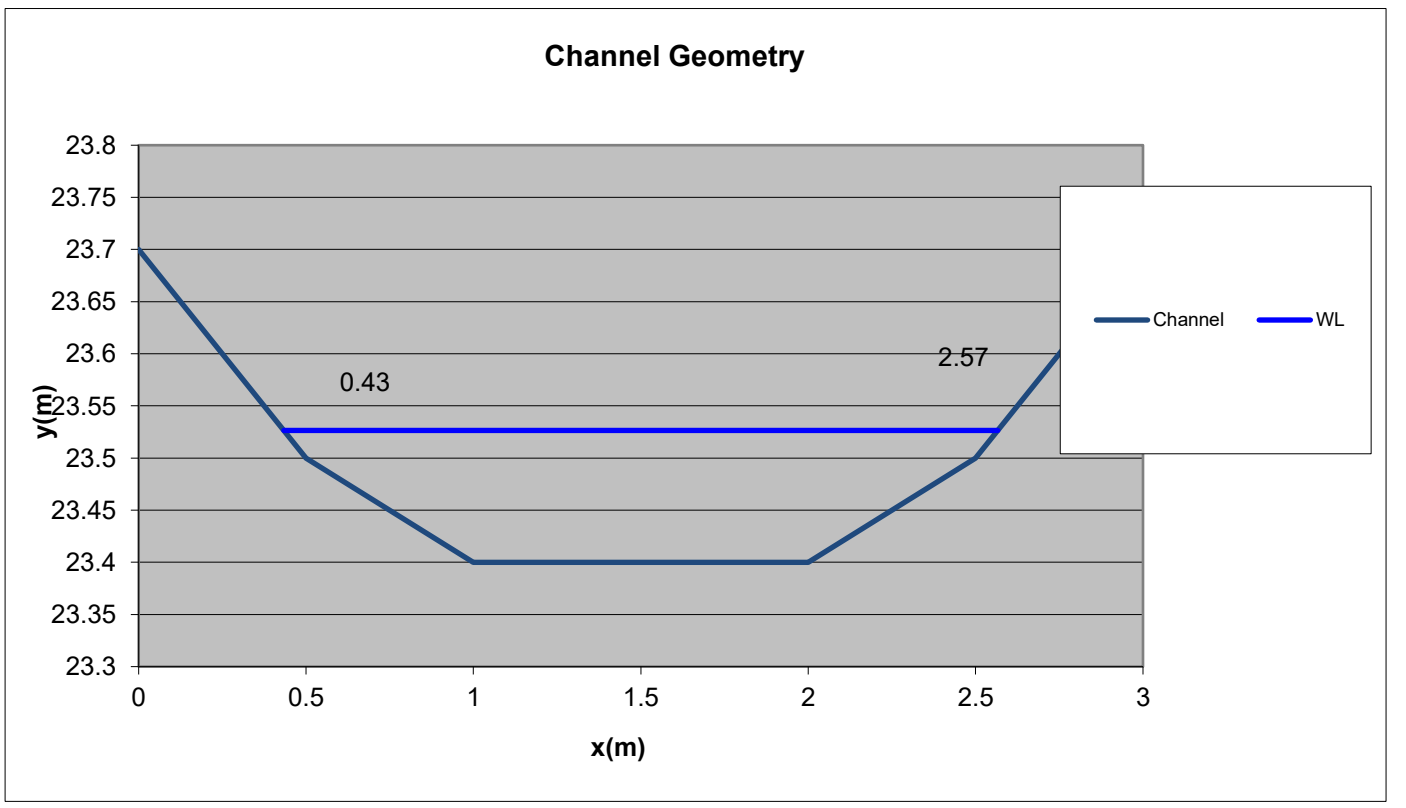
**OUTPUTS**

| **Normal Flow Conditions** | |
|---|---|
| Flow ($m^3/s$) | **0.445** OK |
| Velocity (m/s) | 2.173 |
| $S_o$ or $S_f$ | 0.1000 |
| Energy (m) | 23.767 |
| Froude No | 2.239 |
| Bed Stress (Pa) | 92.885 |
| Equivalent "n" | 0.030 |
| Equivalent $k_s$(mm) | N/A |

| **Geometry for wetted conditions** | |
|---|---|
| Depth (d-m) | 23.527 |
| Area (A-$m^2$) | 0.205 |
| Width (B-m) | 2.132 |
| Perimeter (P-m) | 2.163 |

| **Critical Flow Conditions** | |
|---|---|
| Flow ($m^3/s$) | **0.199** INCREASE CHA |
| Velocity (m/s) | 0.971 |
| Energy (m) | 23.575 |

| **Typical "n" values** | |
|---|---|
| Concrete | 0.013 |
| Gunite | 0.017 |
| Smooth earth | 0.02 |
| Clean channel | 0.03 |
| Natural Channel | 0.035-0.065 |
| Floodplain | 0.05-0.15 |
| Overland flow (grass) | 0.2-0.5 |



# CHANNEL CAPACITY SECTION PRE-DEVELOPMENT B-B

| | |
|---|---|
| **PROJECT NO:** | 200626-01 |
| **PROJECT NAME:** | 96 Beach Haven Road/ 13 Cresta Avenue |
| **DATE:** | 6.08.2021 |
| **BY:** | Natalie Naidoo |
| **REF:** | Overland Flowpath Cross Sections |

## INPUTS

| | |
|---|---|
| Case (A or B) | B |
| **Case A** | |
| Flow ($m^3/s$) | 0.444 |
| **Case B** | |
| Slope ($S_o$) | 10% |
| Water level (m) | 21.53 |
| MFFL | 21.68 |

0.13

| Channel Geometry | | Mannings | Sinuosity | |
|---|---|---|---|---|
| x (m) | y (m) | "n" value | | |
| 0 | 22 | 0.03 | | Short Grass |
| 0.5 | 21.5 | 0.03 | | Short Grass |
| 1 | 21.4 | 0.03 | | Short Grass |
| 2 | 21.4 | 0.03 | | Short Grass |
| 2.5 | 21.50 | 0.03 | | Short Grass |
| 3 | 22 | 0.03 | | Short Grass |
| -1 | | | | |

The table can input 10 (x,y) co-ordinates.
The (x,y) pairs should be in order
Terminate list by making x = -1.0

Flow distribution is based on velocity and energy gradient common to all parts of the channel. i.e.
$n=(\sum(P_1 n_1^{1.5}+....)/P)^{0.67}$

Sinuosity is the relative length of that flow channel element compared to other elements and input $S_o$.
Default value is 1.0.

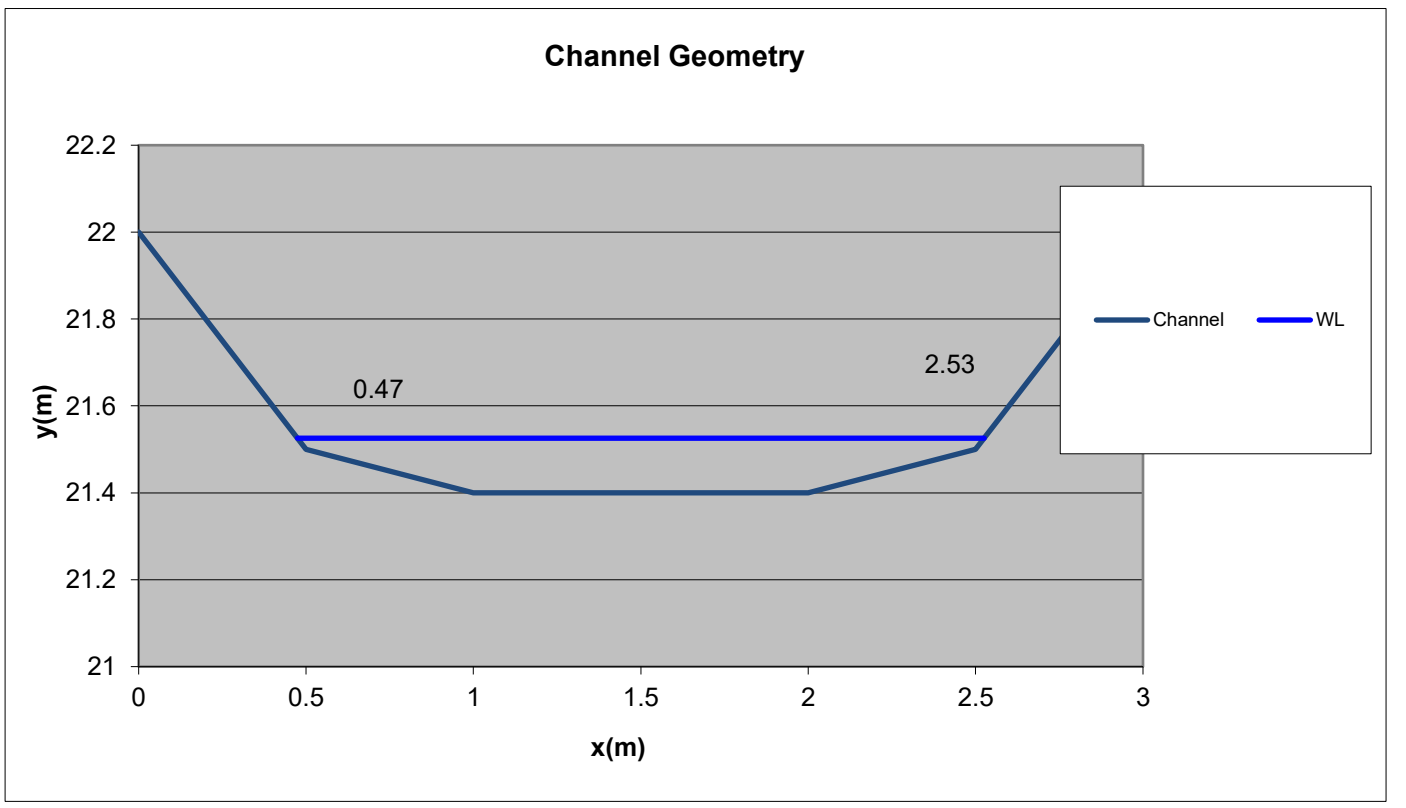
## OUTPUTS

| **Normal Flow Conditions** | |
|---|---|
| Flow ($m^3/s$) | **0.445** OK |
| Velocity (m/s) | 2.201 |
| $S_o$ or $S_f$ | 0.1000 |
| Energy (m) | 21.773 |
| Froude No | 2.240 |
| Bed Stress (Pa) | 94.730 |
| Equivalent "n" | 0.030 |
| Equivalent $k_s$(mm) | N/A |

| **Geometry for wetted conditions** | |
|---|---|
| Depth (d-m) | 21.526 |
| Area (A-$m^2$) | 0.202 |
| Width (B-m) | 2.051 |
| Perimeter (P-m) | 2.092 |

| **Critical Flow Conditions** | |
|---|---|
| Flow ($m^3/s$) | **0.199** INCREASE CHA |
| Velocity (m/s) | 0.983 |
| Energy (m) | 21.575 |

| **Typical "n" values** | |
|---|---|
| Concrete | 0.013 |
| Gunite | 0.017 |
| Smooth earth | 0.02 |
| Clean channel | 0.03 |
| Natural Channel | 0.035-0.065 |
| Floodplain | 0.05-0.15 |
| Overland flow (grass) | 0.2-0.5 |



# CHANNEL CAPACITY SECTION PRE-DEVELOPMENT C-C

| | |
|---|---|
| **PROJECT NO:** | 200626-01 |
| **PROJECT NAME:** | 96 Beach Haven Road/ 13 Cresta Avenue |
| **DATE:** | 6.08.2021 |
| **BY:** | Natalie Naidoo |
| **REF:** | Overland Flowpath Cross Sections |

**INPUTS**

| | |
|---|---|
| Case (A or B) | B |
| **Case A** | |
| Flow ($m^3/s$) | 0.444 |
| **Case B** | |
| Slope ($S_o$) | 10% |
| Water level (m) | 20.03 |
| MFFL | 20.18 |

0.13

| Channel Geometry | | Mannings | Sinuosity | |
|---|---|---|---|---|
| x (m) | y (m) | "n" value | | |
| 0 | 20.5 | 0.03 | | Property/Parcels |
| 0.5 | 20.00 | 0.03 | | Property/Parcels |
| 1 | 19.9 | 0.03 | | Property/Parcels |
| 2 | 19.9 | 0.03 | | Property/Parcels |
| 2.5 | 20.00 | 0.03 | | Property/Parcels |
| 3 | 20.5 | 0.03 | | Property/Parcels |
| -1 | | | | |

The table can input 10 (x,y) co-ordinates.
The (x,y) pairs should be in order
Terminate list by making x = -1.0

Flow distribution is based on velocity and energy gradient common to all parts of the channel. i.e.
$n=(\sum(P_1 n_1^{1.5}+....)/P)^{0.67}$

Sinuosity is the relative length of that flow channel element compared to other elements and input $S_o$.
Default value is 1.0.

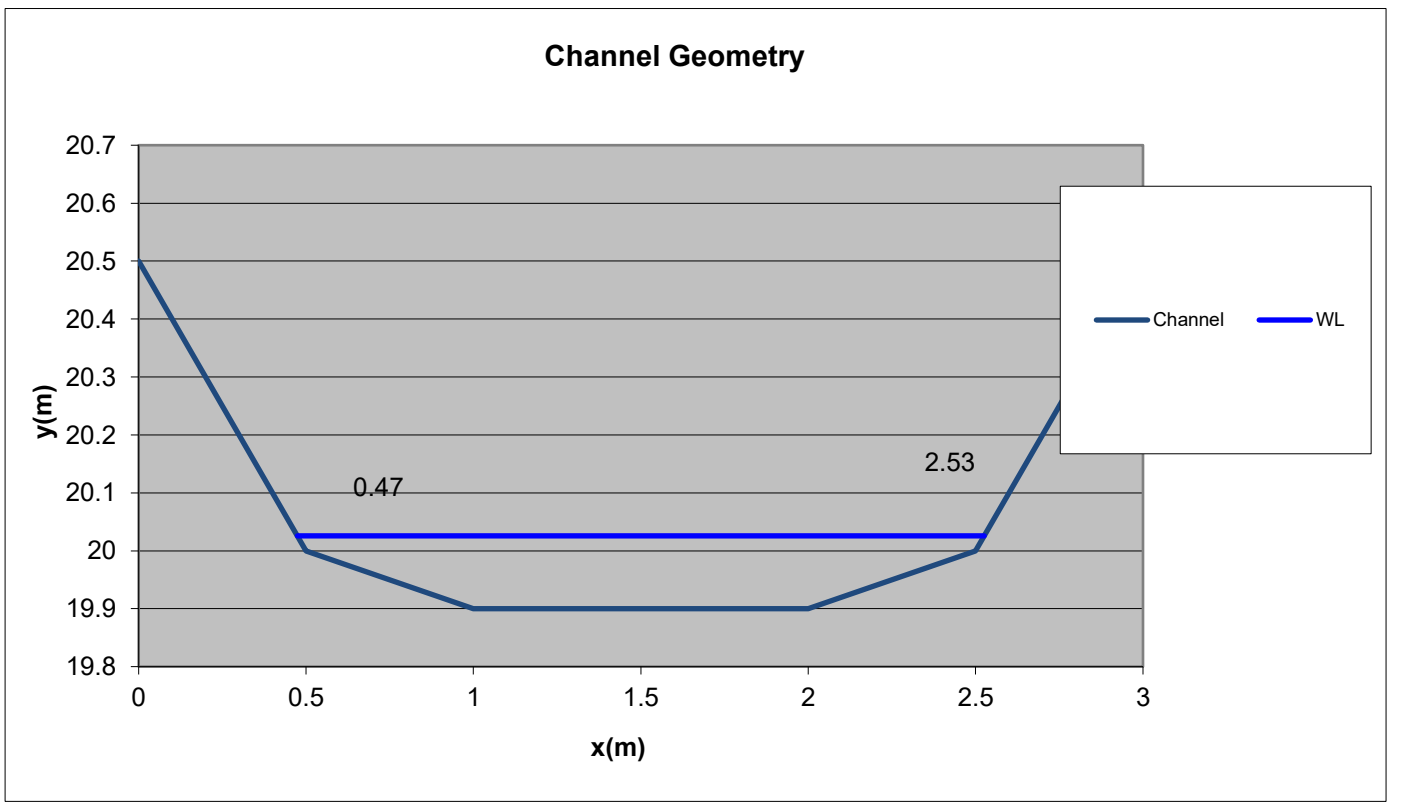
**OUTPUTS**

| **Normal Flow Conditions** | |
|---|---|
| Flow ($m^3/s$) | **0.445** OK |
| Velocity (m/s) | 2.201 |
| $S_o$ or $S_f$ | 0.1000 |
| Energy (m) | 20.273 |
| Froude No | 2.240 |
| Bed Stress (Pa) | 94.730 |
| Equivalent "n" | 0.030 |
| Equivalent $k_s$(mm) | N/A |

| **Geometry for wetted conditions** | |
|---|---|
| Depth (d-m) | 20.026 |
| Area (A-$m^2$) | 0.202 |
| Width (B-m) | 2.051 |
| Perimeter (P-m) | 2.092 |

| **Critical Flow Conditions** | |
|---|---|
| Flow ($m^3/s$) | **0.199** INCREASE CHA |
| Velocity (m/s) | 0.983 |
| Energy (m) | 20.075 |

| **Typical "n" values** | |
|---|---|
| Concrete | 0.013 |
| Gunite | 0.017 |
| Smooth earth | 0.02 |
| Clean channel | 0.03 |
| Natural Channel | 0.035-0.065 |
| Floodplain | 0.05-0.15 |
| Overland flow (grass) | 0.2-0.5 |



## Hydrographs- SCS Method - Post Development Flow from the Proposed Development

**Project Description** 96 Beach Haven Road/13 Cresta Avenue
Proposed Development

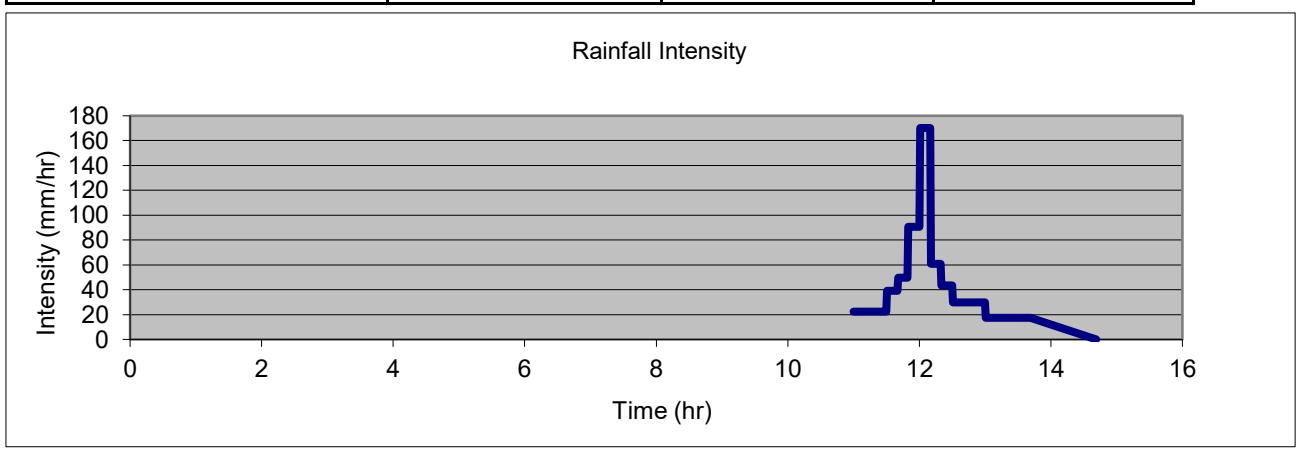
Rainfall Depth (mm) 245.28 100 YEAR ARI

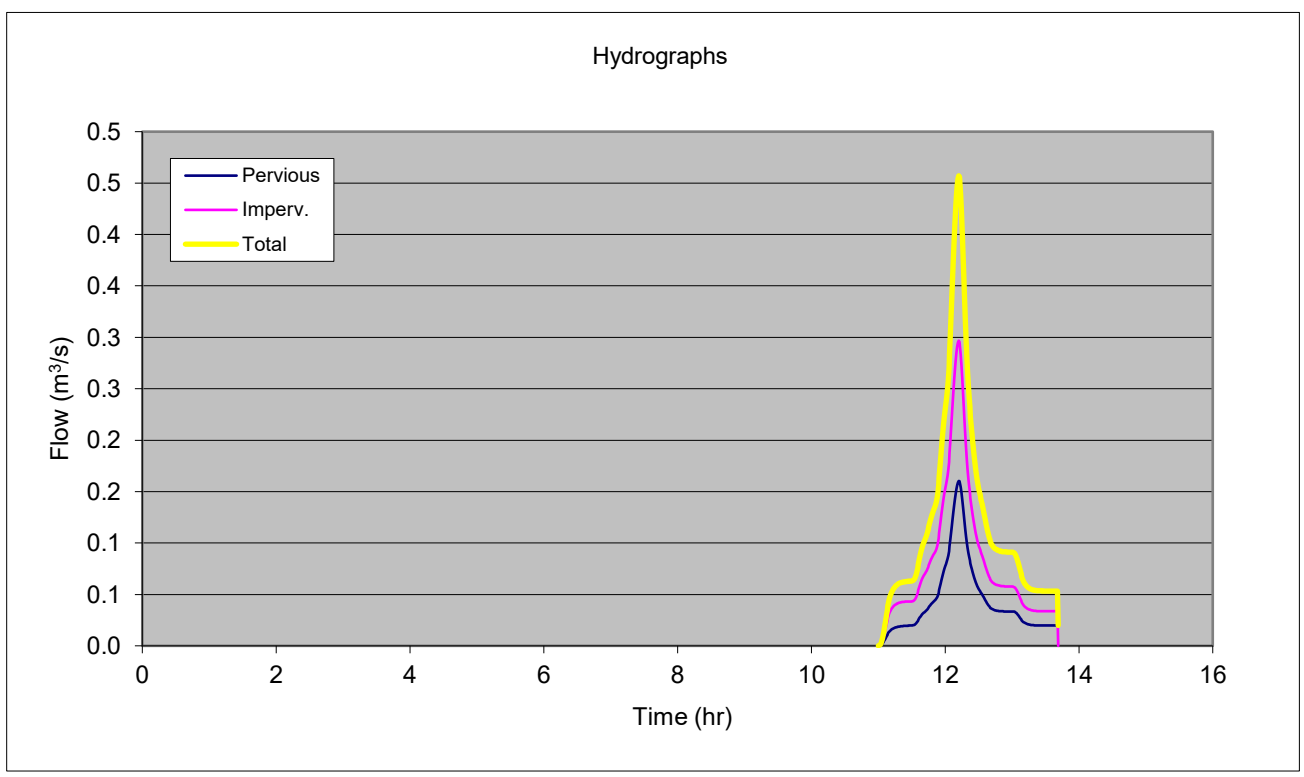
**Notes:**

1. Inputs
2. Typical inputs for CN, Ia, CF are in 'Typical Inputs' Sheet.
3. Method based on ARC TP108.

| Catchment Data | Pervious Area | Impervious Area |
|---|---|---|
| Area (ha) | 0.464 | 0.696 |
| Runoff No (CN) | 74 | 98 |
| Initial Loss (Ia-mm) | 5 | 0 |
| Channel Length (L-m) | 101 | 101 |
| Channel Slope (Sc-m/m) | 0.1 | 0.1 |
| Channel Factor (CF-0.6 to 1.0) | 0.8 | 0.6 |
| Time of Concentration (tc-min) | 10.0 | 10.0 |
| Soil storage (S-mm) | 89.2 | 5.2 |

| Outputs | | | Total |
|---|---|---|---|
| Runoff (mm) | 175.2 | 240.2 | 214.2 |
| Peak Flow ($m^3/s$) | 0.160 | 0.297 | 0.457 |
| Time (hr) at Peak Flow | 12.20 | 12.20 | 12.20 |
| Rainfall (mm/h) over tc | 165.26 | 165.26 | 165.26 |
| Runoff Coefficient - Peak | 0.75 | 0.93 | 0.86 |
| Runoff Coefficient - Volume | 0.71 | 0.98 | 0.87 |



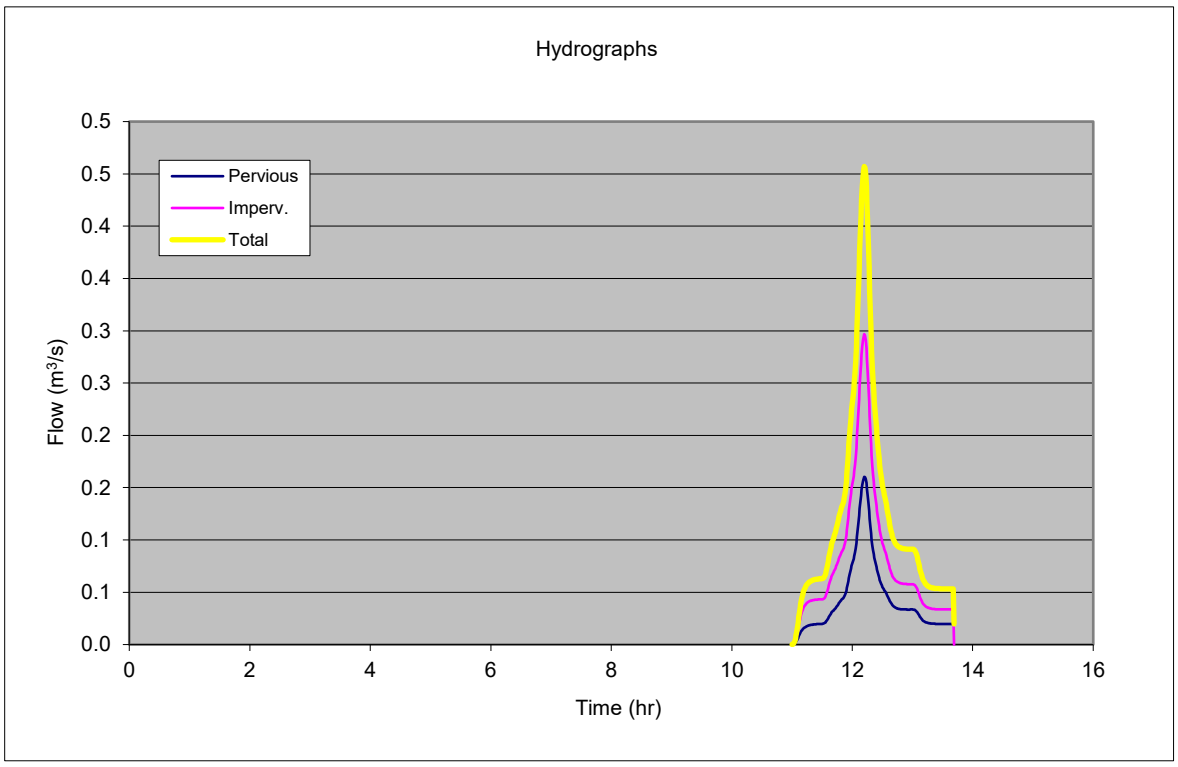
# Hydrographs- SCS Method:

**Project Description**

96 Beach Haven Road/13 Cresta Avenue
Proposed Development

**Total Hydrograph in tabular form:** (based on simualtion from above)

Volumetric error in scaling 2.02%




| Time (hr) |
|---|
| 11.001 |
| 11.347 |
| 11.491 |
| 11.601 |
| 11.694 |
| 11.776 |
| 11.850 |
| 11.918 |
| 11.981 |
| 12.040 |
| 12.096 |
| 12.150 |
| 12.201 |
| 12.230 |
| 12.259 |
| 12.290 |
| 12.320 |
| 12.352 |
| 12.384 |
| 12.417 |
| 12.451 |
| 12.486 |
| 12.522 |
| 12.559 |
| 12.597 |
| 12.637 |
| 12.678 |
| 12.721 |
| 12.767 |
| 12.814 |
| 12.864 |
| 12.917 |
| 12.975 |
| 13.037 |
| 13.106 |
| 13.184 |
| 13.277 |
| 13.398 |
| 13.690 |
| -1.000 |

# CHANNEL CAPACITY SECTION POST DEVELOPMENT A-A

| | |
|---|---|
| **PROJECT NO:** | 200626-01 |
| **PROJECT NAME:** | 96 Beach Haven Road/ 13 Cresta Avenue |
| **DATE:** | 5.08.2021 |
| **BY:** | Natalie Naidoo |
| **REF:** | Overland Flowpath Cross Sections |

**INPUTS**

| | |
|---|---|
| Case (A or B) | B |
| **Case A** | |
| Flow ($m^3/s$) | 0.457 |
| **Case B** | |
| Slope ($S_o$) | 5% |
| Water level (m) | 23.55 |
| MFFL | 23.70 |

0.15

| Channel Geometry | | Mannings | Sinuosity | |
|---|---|---|---|---|
| x (m) | y (m) | "n" value | | |
| 0 | 23.7 | 0.03 | | Short Grass |
| 0.5 | 23.5 | 0.03 | | Short Grass |
| 1 | 23.4 | 0.03 | | Short Grass |
| 2 | 23.4 | 0.03 | | Short Grass |
| 2.5 | 23.49 | 0.03 | | Short Grass |
| 3 | 23.7 | 0.03 | | Short Grass |
| -1 | | | | |

The table can input 10 (x,y) co-ordinates.
The (x,y) pairs should be in order
Terminate list by making x = -1.0

Flow distribution is based on velocity and energy gradient common to all parts of the channel. i.e.
$n=(\sum(P_1 n_1^{1.5}+....)/P)^{0.67}$

Sinuosity is the relative length of that flow channel element compared to other elements and input $S_o$.
Default value is 1.0.

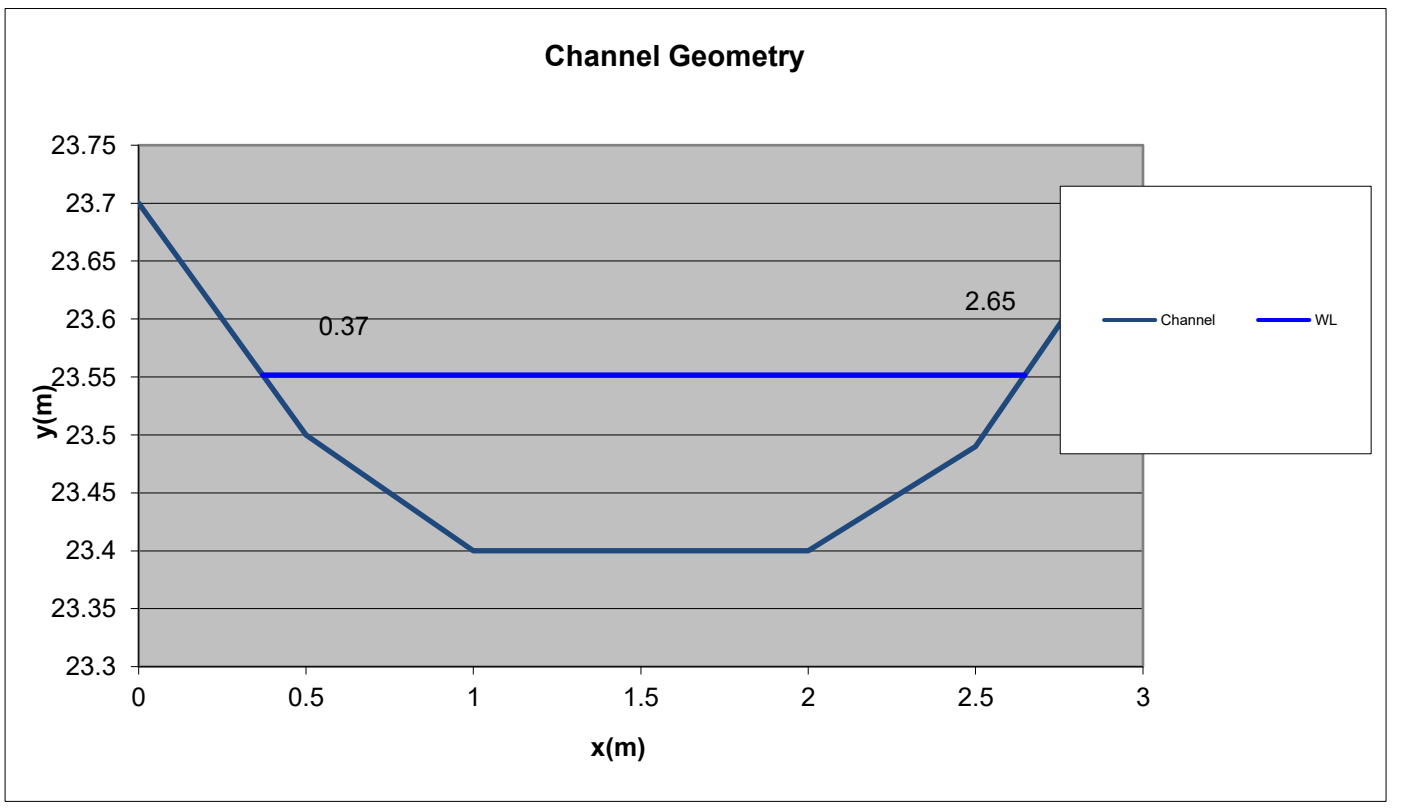
**OUTPUTS**

| **Normal Flow Conditions** | |
|---|---|
| Flow ($m^3/s$) | **0.458** OK |
| Velocity (m/s) | 1.738 |
| $S_o$ or $S_f$ | 0.0500 |
| Energy (m) | 23.705 |
| Froude No | 1.630 |
| Bed Stress (Pa) | 55.817 |
| Equivalent "n" | 0.030 |
| Equivalent $k_s$(mm) | N/A |

| **Geometry for wetted conditions** | |
|---|---|
| Depth (d-m) | 23.552 |
| Area (A-$m^2$) | 0.264 |
| Width (B-m) | 2.276 |
| Perimeter (P-m) | 2.316 |

| **Critical Flow Conditions** | |
|---|---|
| Flow ($m^3/s$) | **0.281** INCREASE CHA |
| Velocity (m/s) | 1.066 |
| Energy (m) | 23.610 |

| **Typical "n" values** | |
|---|---|
| Concrete | 0.013 |
| Gunite | 0.017 |
| Smooth earth | 0.02 |
| Clean channel | 0.03 |
| Natural Channel | 0.035-0.065 |
| Floodplain | 0.05-0.15 |
| Overland flow (grass) | 0.2-0.5 |



# CHANNEL CAPACITY SECTION POST DEVELOPMENT B-B

| | |
|---|---|
| **PROJECT NO:** | 200626-01 |
| **PROJECT NAME:** | 96 Beach Haven Road/ 13 Cresta Avenue |
| **DATE:** | 5.08.2021 |
| **BY:** | Natalie Naidoo |
| **REF:** | Overland Flowpath Cross Sections |

## INPUTS

| | |
|---|---|
| Case (A or B) | B |
| **Case A** | |
| Flow ($m^3/s$) | 0.457 |
| **Case B** | |
| Slope ($S_o$) | 5% |
| Water level (m) | 21.55 |
| MFFL | 21.70 |

0.15

| Channel Geometry | | Mannings | Sinuosity | |
|---|---|---|---|---|
| x (m) | y (m) | "n" value | | |
| 0 | 22 | 0.03 | | Short Grass |
| 0.5 | 21.5 | 0.03 | | Short Grass |
| 1 | 21.4 | 0.03 | | Short Grass |
| 2 | 21.4 | 0.03 | | Short Grass |
| 2.5 | 21.50 | 0.03 | | Short Grass |
| 3 | 22 | 0.03 | | Short Grass |
| -1 | | | | |

The table can input 10 (x,y) co-ordinates.
The (x,y) pairs should be in order
Terminate list by making x = -1.0

Flow distribution is based on velocity and energy gradient common to all parts of the channel. i.e.
$n=(\sum(P_1 n_1^{1.5}+....)/P)^{0.67}$

Sinuosity is the relative length of that flow channel element compared to other elements and input $S_o$.
Default value is 1.0.

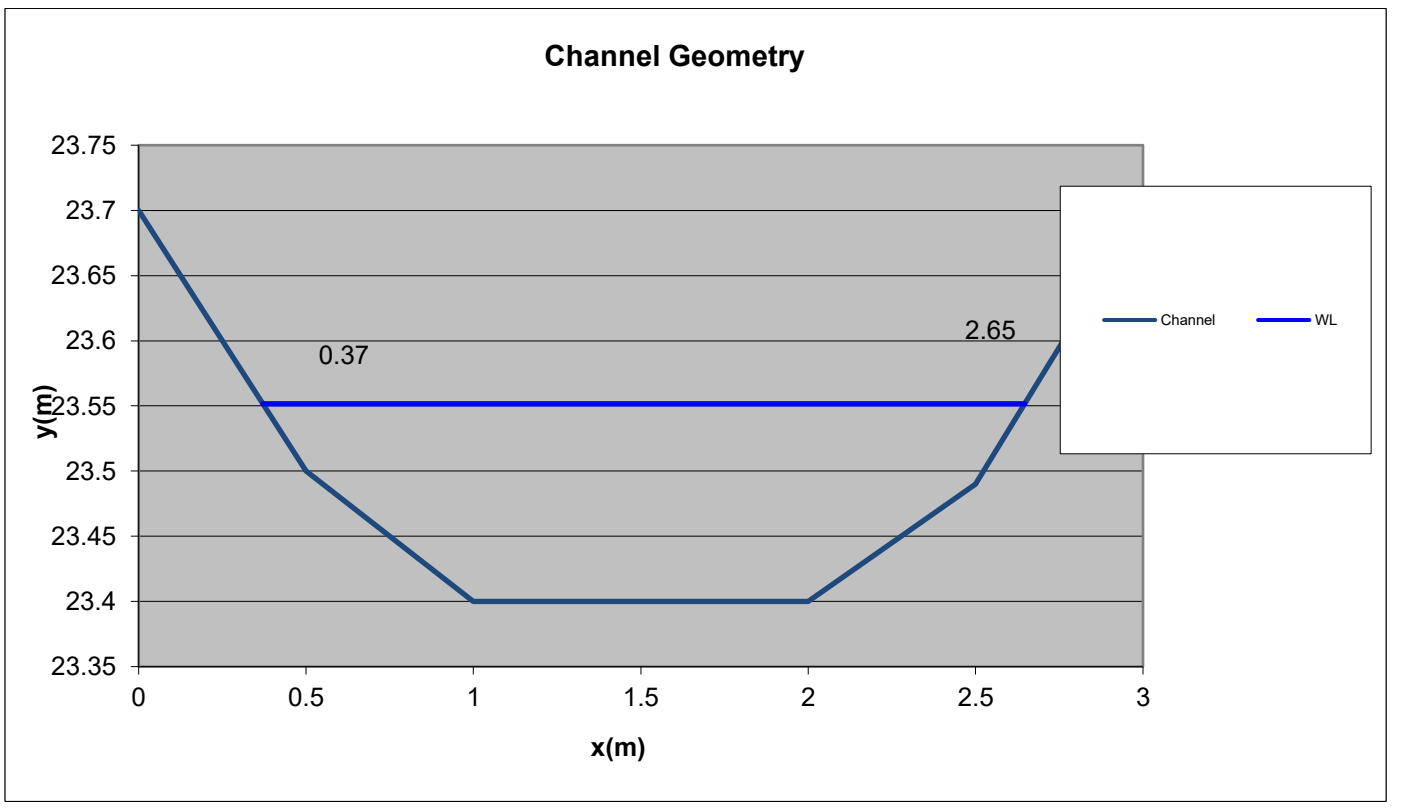
## OUTPUTS

| Normal Flow Conditions | |
|---|---|
| Flow ($m^3/s$) | **0.458** OK |
| Velocity (m/s) | 1.785 |
| $S_o$ or $S_f$ | 0.0500 |
| Energy (m) | 21.714 |
| Froude No | 1.632 |
| Bed Stress (Pa) | 58.108 |
| Equivalent "n" | 0.030 |
| Equivalent $k_s$(mm) | N/A |

| Geometry for wetted conditions | |
|---|---|
| Depth (d-m) | 21.552 |
| Area (A-$m^2$) | 0.257 |
| Width (B-m) | 2.104 |
| Perimeter (P-m) | 2.167 |

| Critical Flow Conditions | |
|---|---|
| Flow ($m^3/s$) | **0.281** INCREASE CHA |
| Velocity (m/s) | 1.094 |
| Energy (m) | 21.613 |

| Typical "n" values | |
|---|---|
| Concrete | 0.013 |
| Gunite | 0.017 |
| Smooth earth | 0.02 |
| Clean channel | 0.03 |
| Natural Channel | 0.035-0.065 |
| Floodplain | 0.05-0.15 |
| Overland flow (grass) | 0.2-0.5 |



# CHANNEL CAPACITY SECTION POST DEVELOPMENT C-C - REVISION 1

| | |
|---|---|
| **PROJECT NO:** | 200626-01 |
| **PROJECT NAME:** | 96 Beach Haven Road/ 13 Cresta Avenue |
| **DATE:** | 16.06.2022 |
| **BY:** | Natalie Naidoo |
| **REF:** | Overland Flowpath Cross Sections |

**INPUTS**

| | |
|---|---|
| Case (A or B) | B |
| **Case A** | |
| Flow ($m^3/s$) | 0.457 |
| **Case B** | |
| Slope ($S_o$) | 5% |
| Water level (m) | 20.00 |
| MFFL | 20.15 |

0.10

| Channel Geometry | | Mannings | Sinuosity | |
|---|---|---|---|---|
| x (m) | y (m) | "n" value | | |
| 0 | 20.5 | 0.013 | | COAL |
| 0.5 | 20.00 | 0.013 | | COAL |
| 1 | 19.9 | 0.013 | | COAL |
| 2 | 19.9 | 0.013 | | COAL |
| 2.5 | 20.00 | 0.013 | | COAL |
| 3 | 20.5 | 0.013 | | COAL |
| -1 | | | | |

The table can input 10 (x,y) co-ordinates.
The (x,y) pairs should be in order
Terminate list by making x = -1.0

Flow distribution is based on velocity and energy gradient common to all parts of the channel. i.e.
$n=(\sum(P_1 n_1^{1.5}+....)/P)^{0.67}$

Sinuosity is the relative length of that flow channel element compared to other elements and input $S_o$.
Default value is 1.0.

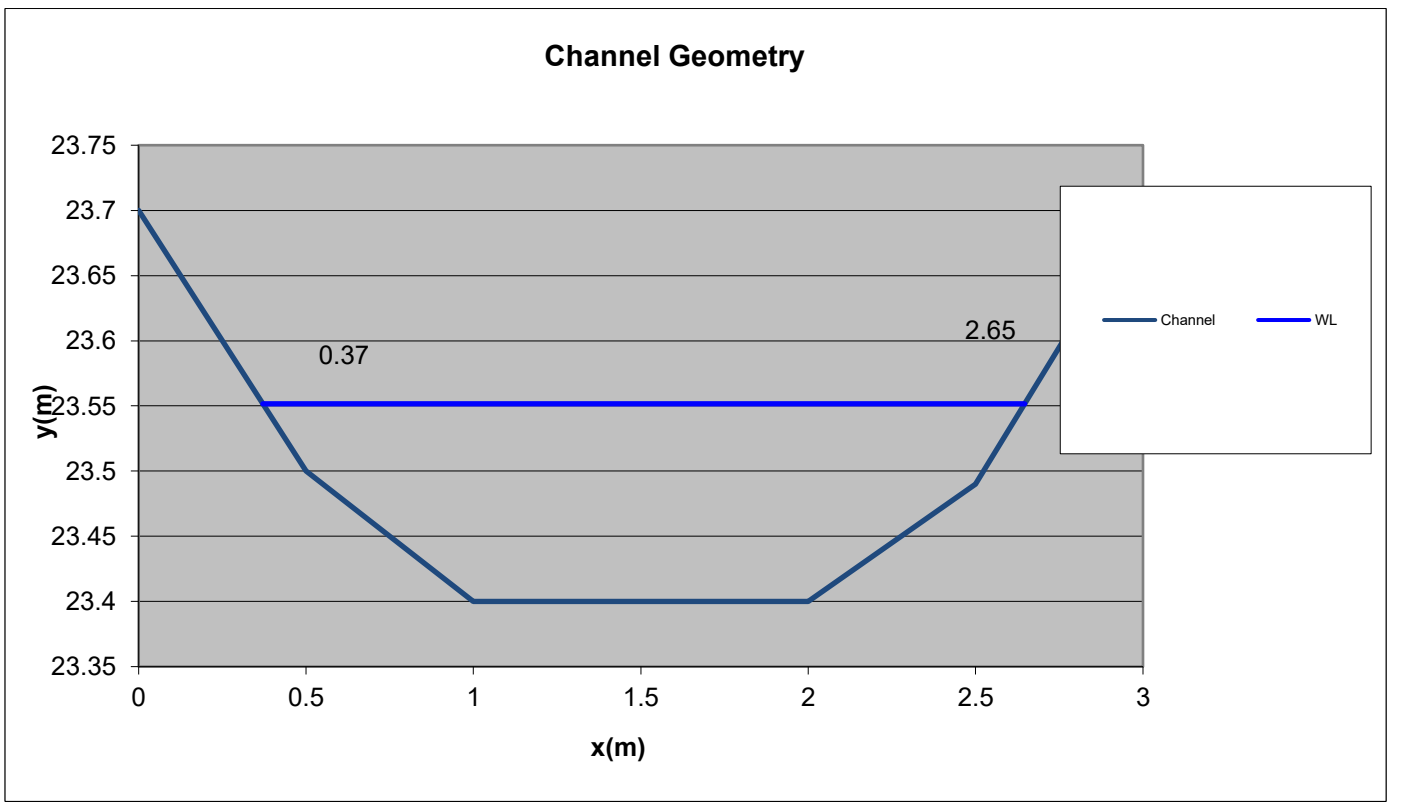
**OUTPUTS**

| **Normal Flow Conditions** | |
|---|---|
| Flow ($m^3/s$) | **0.458** OK |
| Velocity (m/s) | 3.027 |
| $S_o$ or $S_f$ | 0.0500 |
| Energy (m) | 20.468 |
| Froude No | 3.516 |
| Bed Stress (Pa) | 36.687 |
| Equivalent "n" | 0.013 |
| Equivalent $k_s$(mm) | 1.75 |

| **Geometry for wetted conditions** | |
|---|---|
| Depth (d-m) | 20.001 |
| Area (A-$m^2$) | 0.151 |
| Width (B-m) | 2.001 |
| Perimeter (P-m) | 2.022 |

| **Critical Flow Conditions** | |
|---|---|
| Flow ($m^3/s$) | **0.130** INCREASE CHA |
| Velocity (m/s) | 0.861 |
| Energy (m) | 20.038 |

| **Typical "n" values** | |
|---|---|
| Concrete | 0.013 |
| Gunite | 0.017 |
| Smooth earth | 0.02 |
| Clean channel | 0.03 |
| Natural Channel | 0.035-0.065 |
| Floodplain | 0.05-0.15 |
| Overland flow (grass) | 0.2-0.5 |



# Hydrographs- SCS Method - Predevelopment Flow from No. 15 Cresta Avenue

**Project Description**

96 Beach Haven Road/13 Cresta Avenue
No. 15 Cresta Avenue

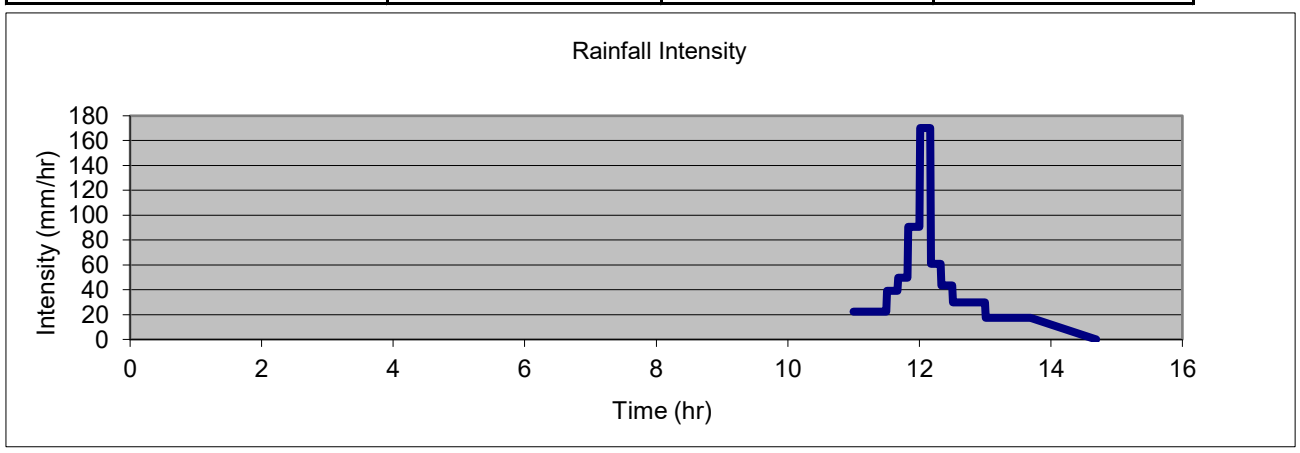
Rainfall Depth (mm) 245.28 100 YEAR ARI

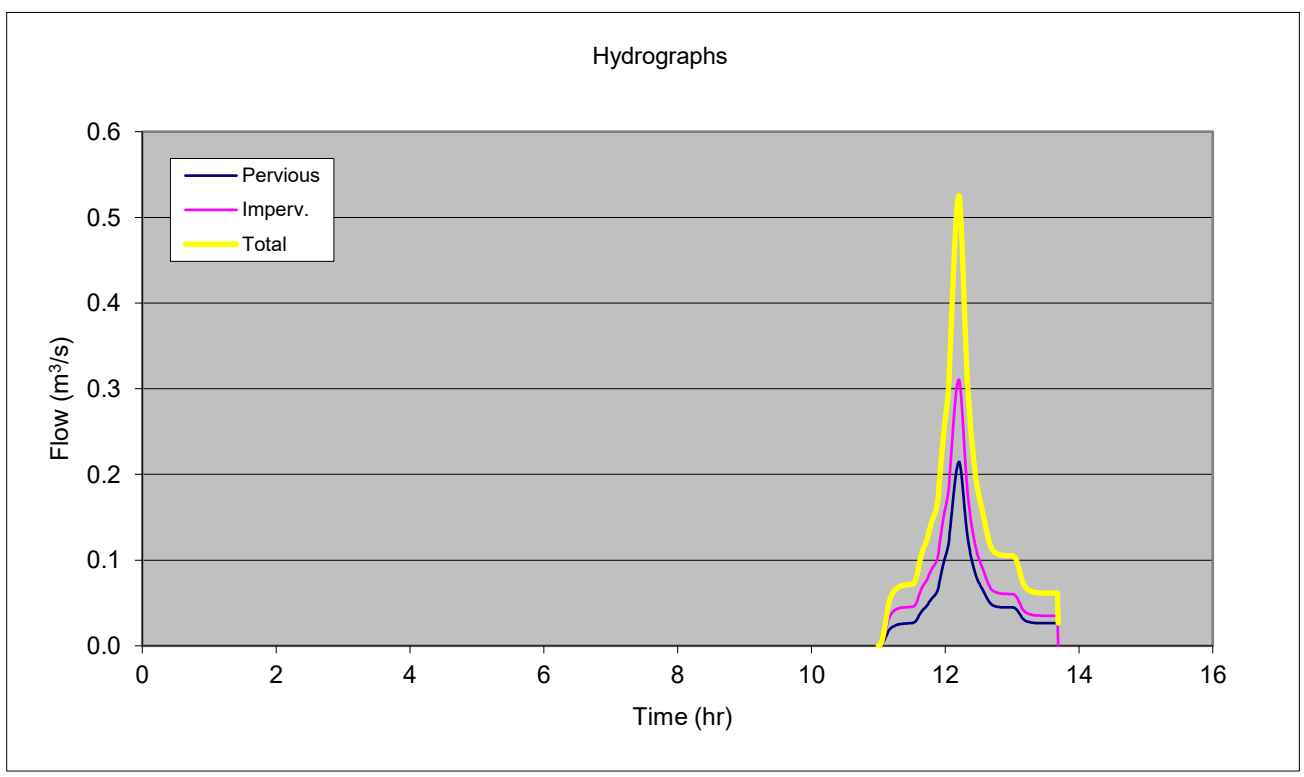
**Notes:**

1. Inputs
2. Typical inputs for CN, Ia, CF are in 'Typical Inputs' Sheet.
3. Method based on ARC TP108.

| Catchment Data | Pervious Area | Impervious Area |
|---|---|---|
| Area (ha) | 0.621 | 0.729 |
| Runoff No (CN) | 74 | 98 |
| Initial Loss (Ia-mm) | 5 | 0 |
| Channel Length (L-m) | 120 | 120 |
| Channel Slope (Sc-m/m) | 0.1 | 0.1 |
| Channel Factor (CF-0.6 to 1.0) | 0.8 | 0.6 |
| Time of Concentration (tc-min) | 10.0 | 10.0 |
| Soil storage (S-mm) | 89.2 | 5.2 |

| Outputs | | | Total |
|---|---|---|---|
| Runoff (mm) | 175.2 | 240.2 | 210.3 |
| Peak Flow ($m^3/s$) | 0.215 | 0.311 | 0.525 |
| Time (hr) at Peak Flow | 12.20 | 12.20 | 12.20 |
| Rainfall (mm/h) over tc | 165.26 | 165.26 | 165.26 |
| Runoff Coefficient - Peak | 0.75 | 0.93 | 0.85 |
| Runoff Coefficient - Volume | 0.71 | 0.98 | 0.86 |



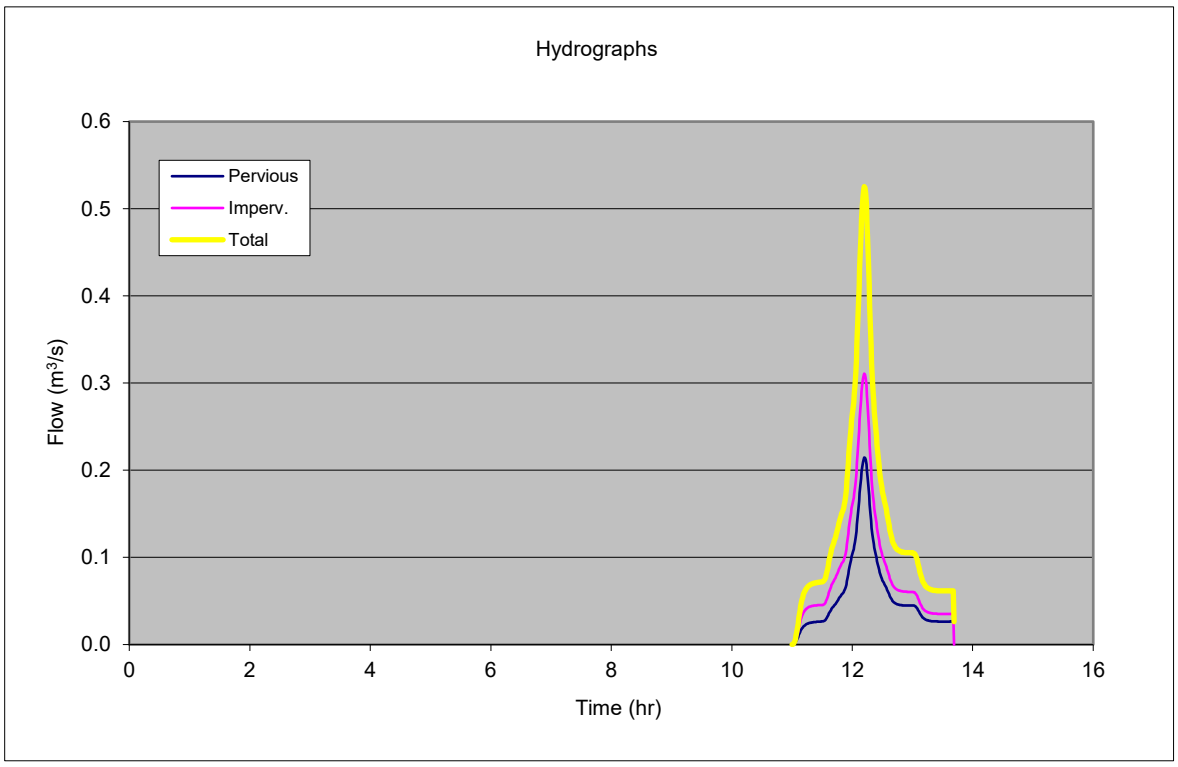
# Hydrographs- SCS Method:

**Project Description**

96 Beach Haven Road/13 Cresta Avenue
No. 15 Cresta Avenue

**Total Hydrograph in tabular form:** (based on simualtion from above)

Volumetric error in scaling 1.88%




| Time (hr) | Flow ($m^3/s$) |
|---|---|
| 11.001 | 0.000 |
| 11.347 | 0.070 |
| 11.491 | 0.072 |
| 11.601 | 0.091 |
| 11.694 | 0.117 |
| 11.776 | 0.138 |
| 11.850 | 0.155 |
| 11.918 | 0.192 |
| 11.981 | 0.250 |
| 12.040 | 0.292 |
| 12.096 | 0.380 |
| 12.150 | 0.478 |
| 12.201 | 0.525 |
| 12.230 | 0.509 |
| 12.259 | 0.457 |
| 12.290 | 0.390 |
| 12.320 | 0.328 |
| 12.352 | 0.284 |
| 12.384 | 0.253 |
| 12.417 | 0.226 |
| 12.451 | 0.201 |
| 12.486 | 0.182 |
| 12.522 | 0.169 |
| 12.559 | 0.157 |
| 12.597 | 0.142 |
| 12.637 | 0.127 |
| 12.678 | 0.117 |
| 12.721 | 0.111 |
| 12.767 | 0.108 |
| 12.814 | 0.106 |
| 12.864 | 0.106 |
| 12.917 | 0.105 |
| 12.975 | 0.105 |
| 13.037 | 0.104 |
| 13.106 | 0.089 |
| 13.184 | 0.071 |
| 13.277 | 0.064 |
| 13.398 | 0.062 |
| 13.690 | 0.026 |
| -1.000 | 0.000 |

# CHANNEL CAPACITY SECTION PRE-DEVELOPMENT NO. 15 CRESTA AVE.

| | |
|---|---|
| **PROJECT NO:** | 200626-01 |
| **PROJECT NAME:** | 96 Beach Haven Road/ 13 Cresta Avenue |
| **DATE:** | 6.08.2021 |
| **BY:** | Natalie Naidoo |
| **REF:** | Overland Flowpath Cross Sections |

**INPUTS**

| | |
|---|---|
| Case (A or B) | B |
| **Case A** | |
| Flow ($m^3/s$) | 0.525 |
| **Case B** | |
| Slope ($S_o$) | 7% |
| Water level (m) | 17.66 |
| MFFL | 17.81 |

0.36

| Channel Geometry | | Mannings | Sinuosity | |
|---|---|---|---|---|
| x (m) | y (m) | "n" value | | |
| 0 | 18 | 0.1 | | Property/Parcels |
| 0.5 | 17.7 | 0.1 | | Property/Parcels |
| 1 | 17.3 | 0.1 | | Property/Parcels |
| 2 | 17.3 | 0.1 | | Property/Parcels |
| 2.5 | 17.70 | 0.1 | | Property/Parcels |
| 3 | 18 | 0.1 | | Property/Parcels |
| -1 | | | | |

The table can input 10 (x,y) co-ordinates.
The (x,y) pairs should be in order
Terminate list by making x = -1.0

Flow distribution is based on velocity and energy gradient common to all parts of the channel. i.e.
$n=(\sum(P_1 n_1^{1.5}+....)/P)^{0.67}$

Sinuosity is the relative length of that flow channel element compared to other elements and input $S_o$.
Default value is 1.0.

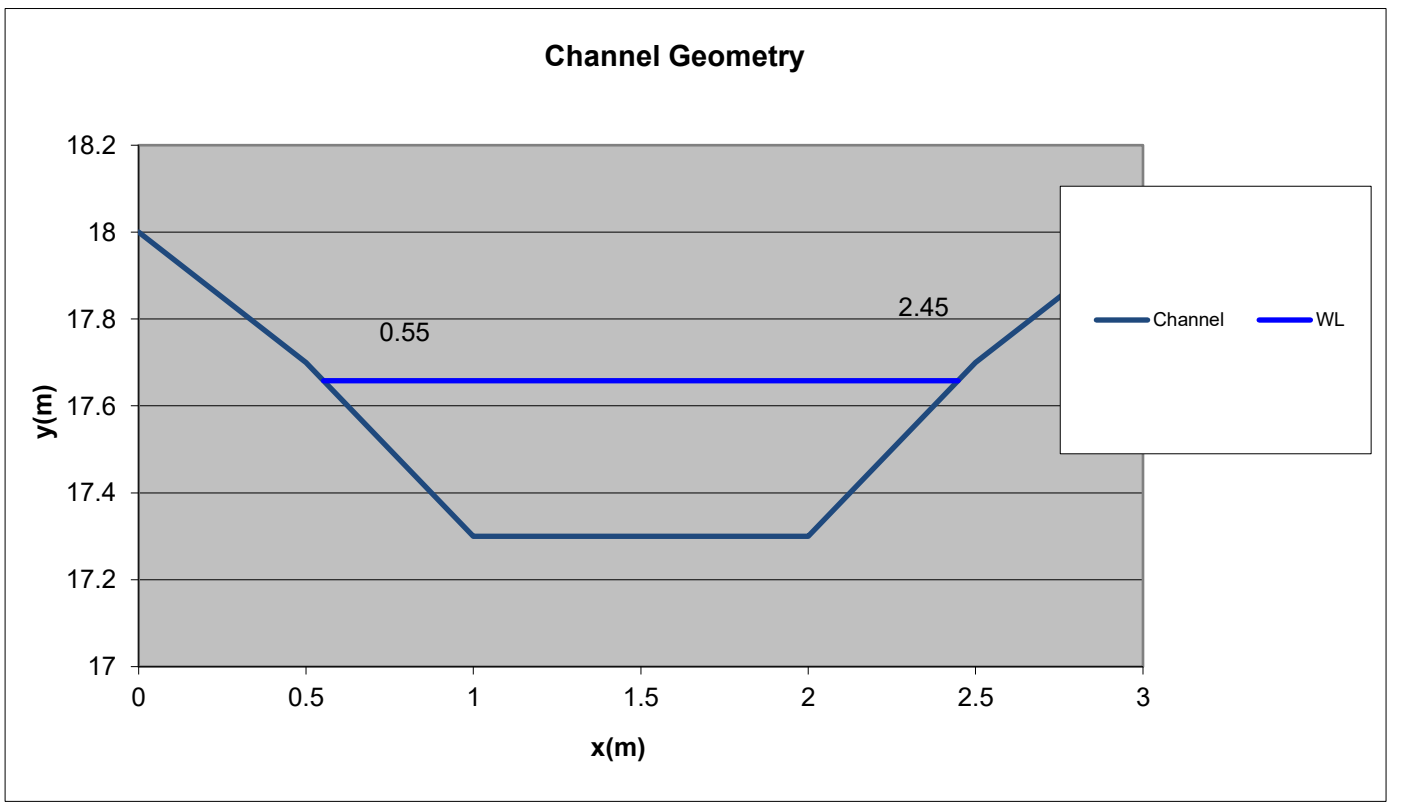
**OUTPUTS**

| **Normal Flow Conditions** | |
|---|---|
| Flow ($m^3/s$) | **0.529** OK |
| Velocity (m/s) | 1.021 |
| $S_o$ or $S_f$ | 0.0700 |
| Energy (m) | 17.711 |
| Froude No | 0.623 |
| Bed Stress (Pa) | 165.808 |
| Equivalent "n" | 0.100 |
| Equivalent $k_s$(mm) | N/A |

| **Geometry for wetted conditions** | |
|---|---|
| Depth (d-m) | 17.658 |
| Area (A-$m^2$) | 0.518 |
| Width (B-m) | 1.895 |
| Perimeter (P-m) | 2.146 |

| **Critical Flow Conditions** | |
|---|---|
| Flow ($m^3/s$) | **0.849** OK |
| Velocity (m/s) | 1.638 |
| Energy (m) | 17.795 |

| **Typical "n" values** | |
|---|---|
| Concrete | 0.013 |
| Gunite | 0.017 |
| Smooth earth | 0.02 |
| Clean channel | 0.03 |
| Natural Channel | 0.035-0.065 |
| Floodplain | 0.05-0.15 |
| Overland flow (grass) | 0.2-0.5 |



# Hydrographs- SCS Method - Post Development Flow from No. 15 Cresta Avenue

**Project Description**

96 Beach Haven Road/13 Cresta Avenue
No. 15 Cresta

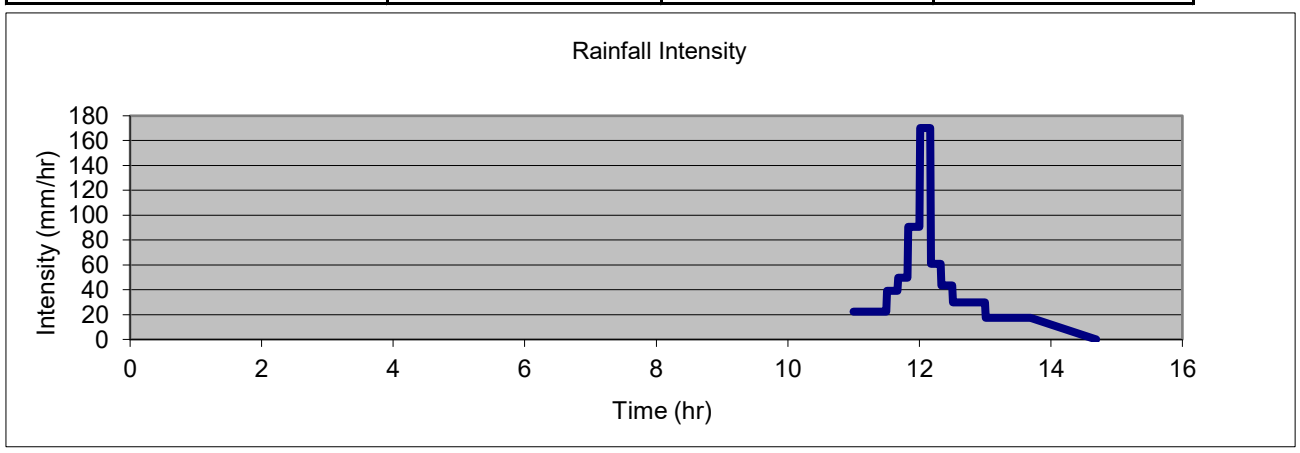
Rainfall Depth (mm) 245.28 100 YEAR ARI

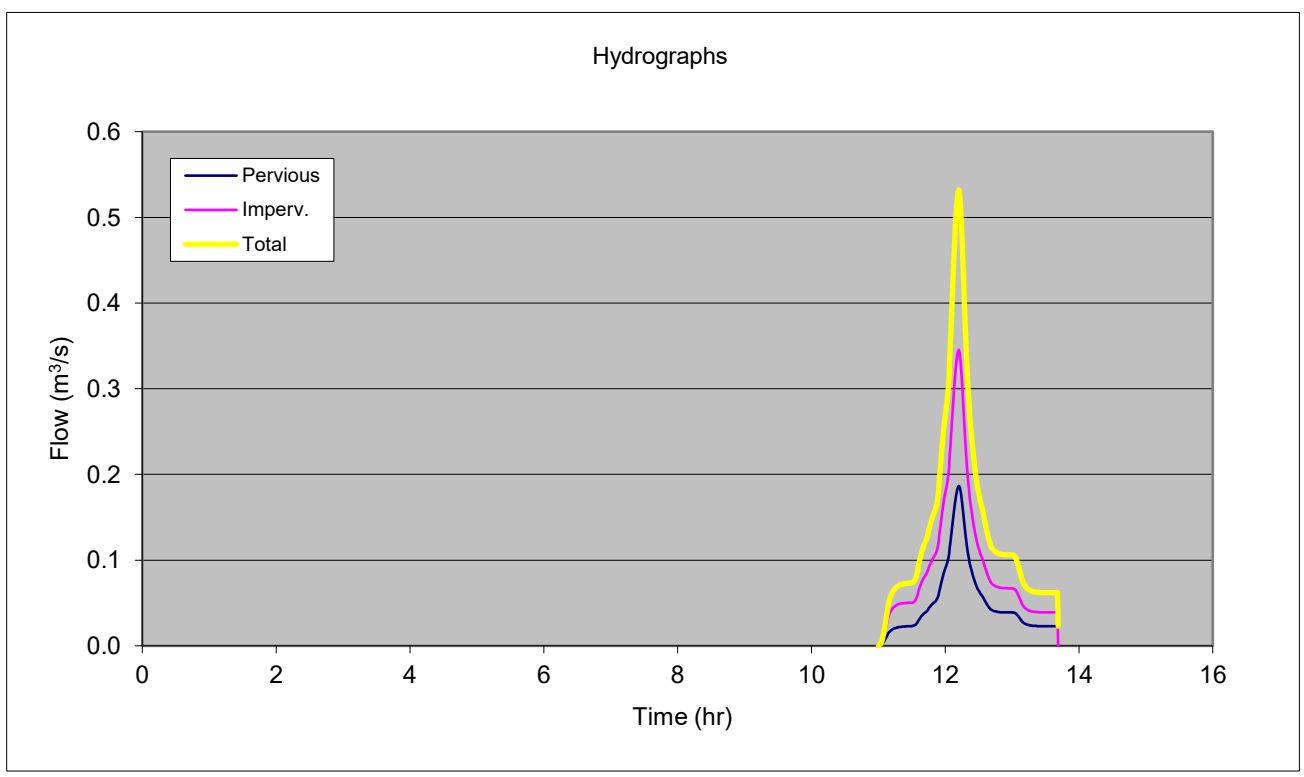
**Notes:**

1. Inputs
2. Typical inputs for CN, Ia, CF are in 'Typical Inputs' Sheet.
3. Method based on ARC TP108.

| Catchment Data | Pervious Area | Impervious Area |
|---|---|---|
| Area (ha) | 0.54 | 0.81 |
| Runoff No (CN) | 74 | 98 |
| Initial Loss (Ia-mm) | 5 | 0 |
| Channel Length (L-m) | 120 | 120 |
| Channel Slope (Sc-m/m) | 0.1 | 0.1 |
| Channel Factor (CF-0.6 to 1.0) | 0.8 | 0.6 |
| Time of Concentration (tc-min) | 10.0 | 10.0 |
| Soil storage (S-mm) | 89.2 | 5.2 |

| Outputs | | | Total |
|---|---|---|---|
| Runoff (mm) | 175.2 | 240.2 | 214.2 |
| Peak Flow ($m^3/s$) | 0.187 | 0.345 | 0.532 |
| Time (hr) at Peak Flow | 12.20 | 12.20 | 12.20 |
| Rainfall (mm/h) over tc | 165.26 | 165.26 | 165.26 |
| Runoff Coefficient - Peak | 0.75 | 0.93 | 0.86 |
| Runoff Coefficient - Volume | 0.71 | 0.98 | 0.87 |



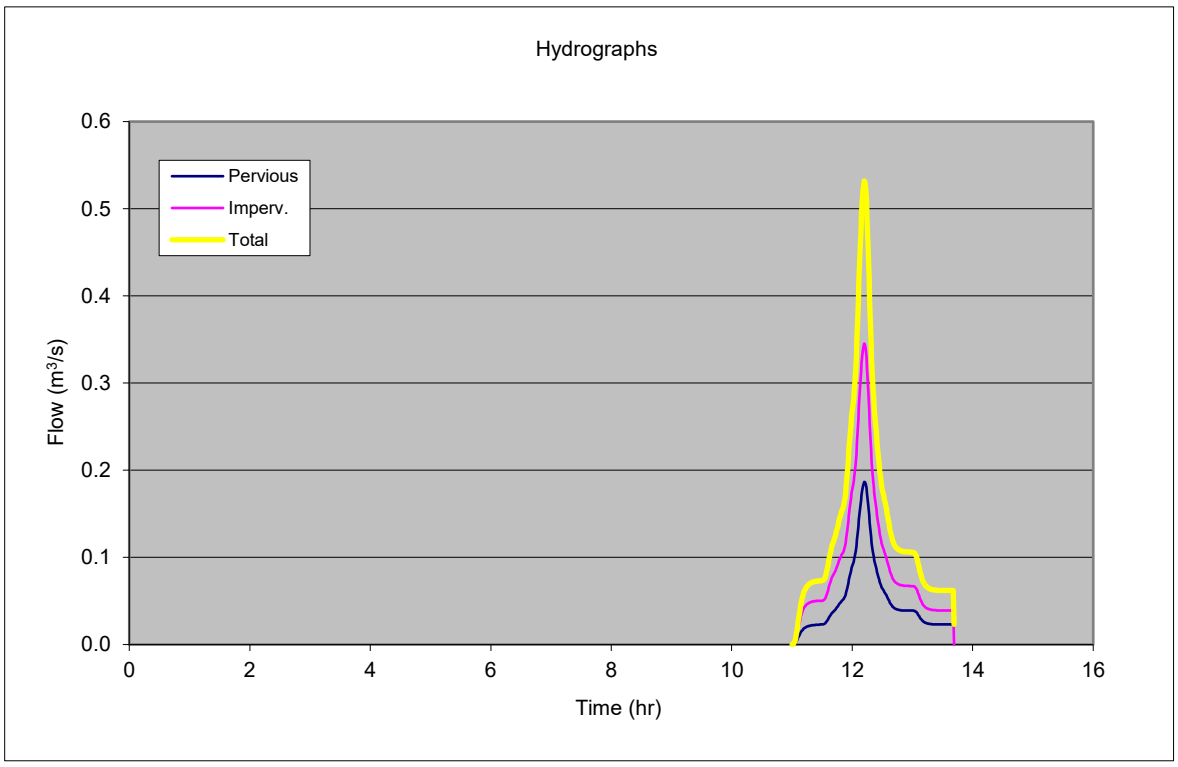
# Hydrographs- SCS Method:

**Project Description**

96 Beach Haven Road/13 Cresta Avenue
No. 15 Cresta

**Total Hydrograph in tabular form:** (based on simualtion from above)

Volumetric error in scaling 2.02%




| Time (hr) | Flow ($m^3/s$) |
|---|---|
| 11.001 | 0.000 |
| 11.347 | 0.072 |
| 11.491 | 0.073 |
| 11.601 | 0.092 |
| 11.694 | 0.119 |
| 11.776 | 0.140 |
| 11.850 | 0.158 |
| 11.918 | 0.196 |
| 11.981 | 0.254 |
| 12.040 | 0.296 |
| 12.096 | 0.385 |
| 12.150 | 0.484 |
| 12.201 | 0.532 |
| 12.230 | 0.515 |
| 12.259 | 0.463 |
| 12.290 | 0.395 |
| 12.320 | 0.332 |
| 12.352 | 0.287 |
| 12.384 | 0.256 |
| 12.417 | 0.228 |
| 12.451 | 0.203 |
| 12.486 | 0.184 |
| 12.522 | 0.170 |
| 12.559 | 0.159 |
| 12.597 | 0.144 |
| 12.637 | 0.129 |
| 12.678 | 0.118 |
| 12.721 | 0.112 |
| 12.767 | 0.109 |
| 12.814 | 0.107 |
| 12.864 | 0.107 |
| 12.917 | 0.106 |
| 12.975 | 0.106 |
| 13.037 | 0.105 |
| 13.106 | 0.089 |
| 13.184 | 0.071 |
| 13.277 | 0.064 |
| 13.398 | 0.062 |
| 13.690 | 0.023 |
| -1.000 | 0.000 |

# CHANNEL CAPACITY SECTION POST DEVELOPMENT NO. 15 CRESTA AVE.

| | |
|---|---|
| **PROJECT NO:** | 200626-01 |
| **PROJECT NAME:** | 96 Beach Haven Road/ 13 Cresta Avenue |
| **DATE:** | 5.08.2021 |
| **BY:** | Natalie Naidoo |
| **REF:** | Overland Flowpath Cross Sections |

**INPUTS**

| | |
|---|---|
| Case (A or B) | B |
| **Case A** | |
| Flow ($m^3/s$) | 0.532 |
| **Case B** | |
| Slope ($S_o$) | 7% |
| Water level (m) | 17.67 |
| MFFL | 17.82 |

0.37

| Channel Geometry | | Mannings | Sinuosity | |
|---|---|---|---|---|
| x (m) | y (m) | "n" value | | |
| 0 | 18 | 0.1 | | Property/Parcel |
| 0.5 | 17.7 | 0.1 | | Property/Parcel |
| 1 | 17.3 | 0.1 | | Property/Parcel |
| 2 | 17.3 | 0.1 | | Property/Parcel |
| 2.5 | 17.70 | 0.1 | | Property/Parcel |
| 3 | 18 | 0.1 | | Property/Parcel |
| -1 | | | | |

The table can input 10 (x,y) co-ordinates.
The (x,y) pairs should be in order
Terminate list by making x = -1.0

Flow distribution is based on velocity and energy gradient common to all parts of the channel. i.e.
$n=(\sum(P_1 n_1^{1.5}+....)/P)^{0.67}$

Sinuosity is the relative length of that flow channel element compared to other elements and input $S_o$.
Default value is 1.0.

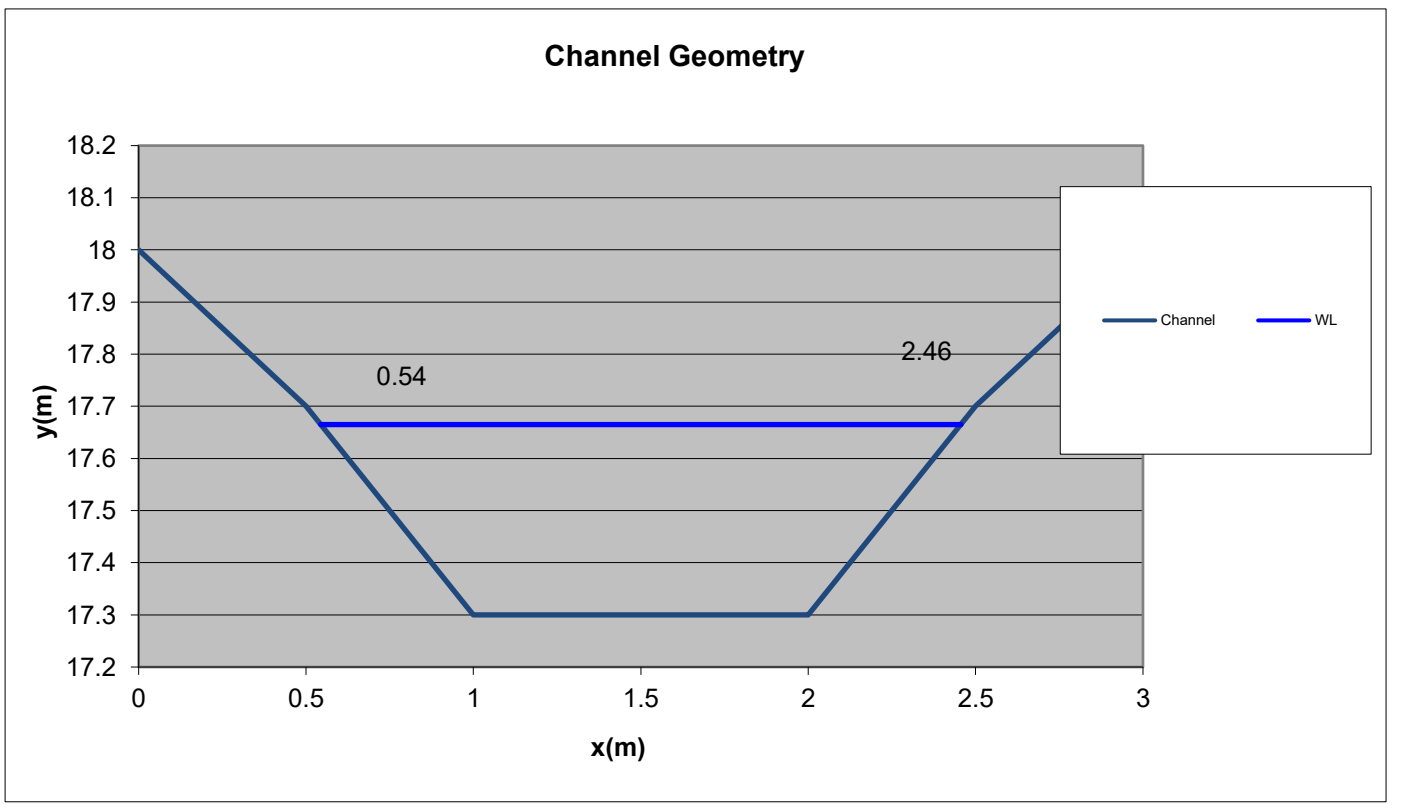
**OUTPUTS**

| **Normal Flow Conditions** | |
|---|---|
| Flow ($m^3/s$) | **0.548** OK |
| Velocity (m/s) | 1.031 |
| $S_o$ or $S_f$ | 0.0700 |
| Energy (m) | 17.719 |
| Froude No | 0.625 |
| Bed Stress (Pa) | 168.315 |
| Equivalent "n" | 0.100 |
| Equivalent $k_s$(mm) | N/A |

| **Geometry for wetted conditions** | |
|---|---|
| Depth (d-m) | 17.665 |
| Area (A-$m^2$) | 0.532 |
| Width (B-m) | 1.913 |
| Perimeter (P-m) | 2.169 |

| **Critical Flow Conditions** | |
|---|---|
| Flow ($m^3/s$) | **0.878** OK |
| Velocity (m/s) | 1.651 |
| Energy (m) | 17.804 |

| **Typical "n" values** | |
|---|---|
| Concrete | 0.013 |
| Gunite | 0.017 |
| Smooth earth | 0.02 |
| Clean channel | 0.03 |
| Natural Channel | 0.035-0.065 |
| Floodplain | 0.05-0.15 |
| Overland flow (grass) | 0.2-0.5 |



# Hydrographs- SCS Method - Predevelopment Flow from No. 17 Cresta Avenue

**Project Description**

96 Beach Haven Road/13 Cresta Avenue
No. 17 Cresta Avenue

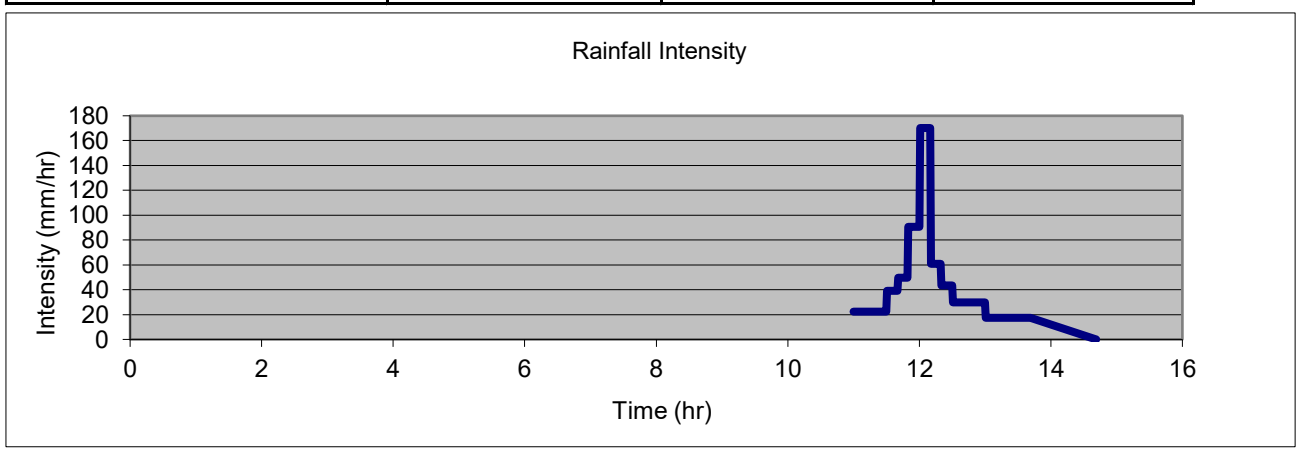
Rainfall Depth (mm) 245.28 100 YEAR ARI

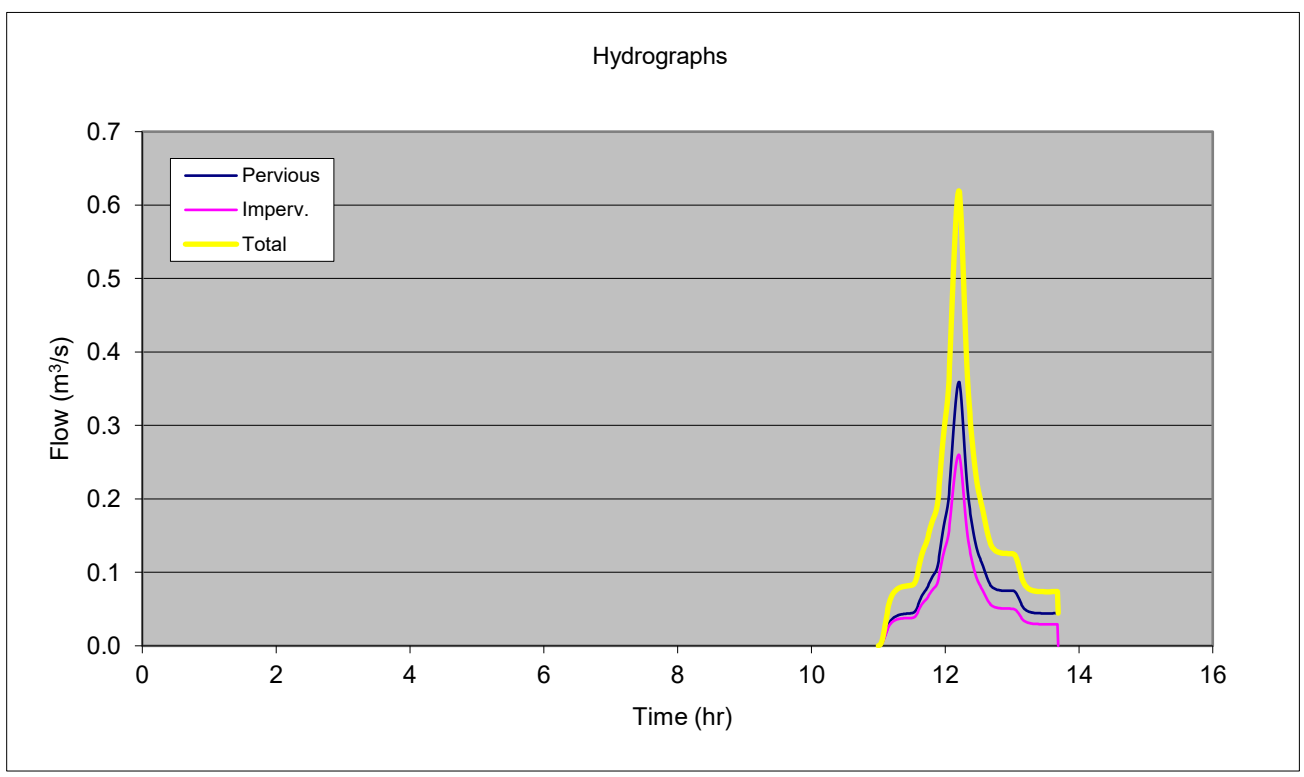
**Notes:**

1. Inputs
2. Typical inputs for CN, Ia, CF are in 'Typical Inputs' Sheet.
3. Method based on ARC TP108.

| Catchment Data | Pervious Area | Impervious Area |
|---|---|---|
| Area (ha) | 1.0395 | 0.6105 |
| Runoff No (CN) | 74 | 98 |
| Initial Loss (Ia-mm) | 5 | 0 |
| Channel Length (L-m) | 157 | 157 |
| Channel Slope (Sc-m/m) | 0.1 | 0.1 |
| Channel Factor (CF-0.6 to 1.0) | 0.8 | 0.6 |
| Time of Concentration (tc-min) | 10.0 | 10.0 |
| Soil storage (S-mm) | 89.2 | 5.2 |

| Outputs | | | Total |
|---|---|---|---|
| Runoff (mm) | 175.2 | 240.2 | 199.3 |
| Peak Flow ($m^3/s$) | 0.359 | 0.260 | 0.619 |
| Time (hr) at Peak Flow | 12.20 | 12.20 | 12.20 |
| Rainfall (mm/h) over tc | 165.26 | 165.26 | 165.26 |
| Runoff Coefficient - Peak | 0.75 | 0.93 | 0.82 |
| Runoff Coefficient - Volume | 0.71 | 0.98 | 0.81 |



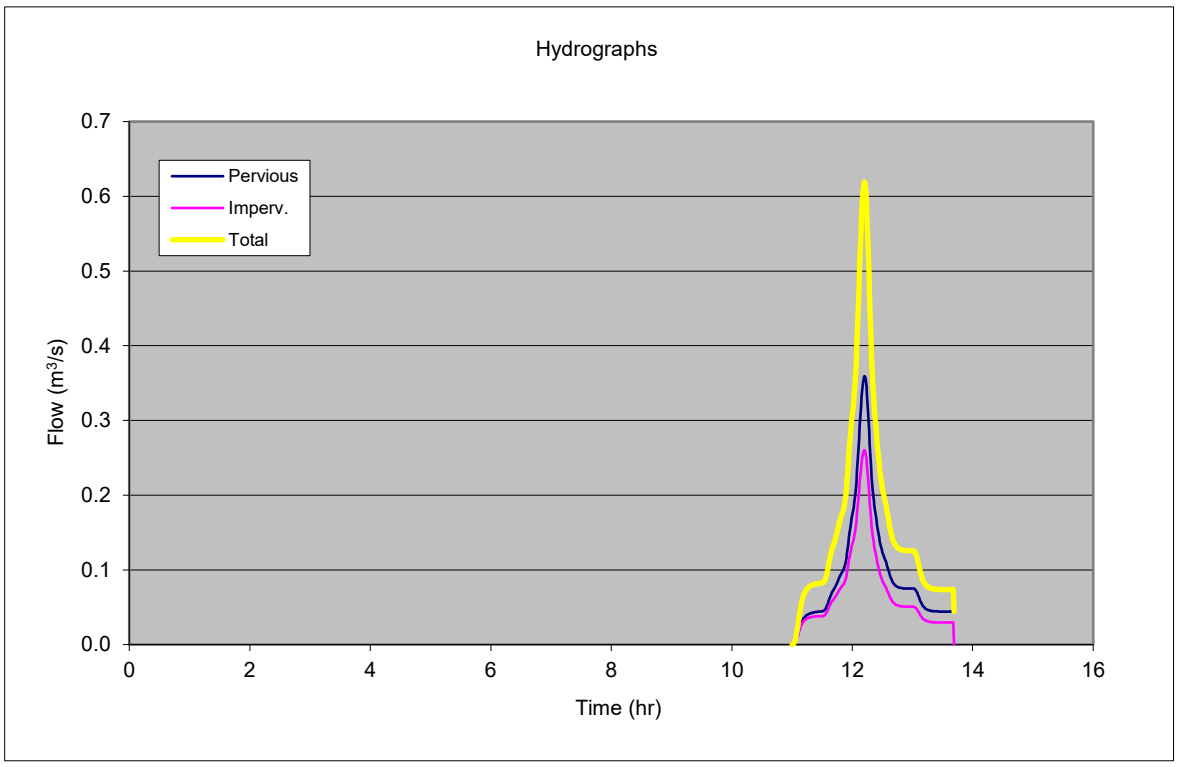
# Hydrographs- SCS Method:

**Project Description**

96 Beach Haven Road/13 Cresta Avenue
No. 17 Cresta Avenue

**Total Hydrograph in tabular form:** (based on simualtion from above)

Volumetric error in scaling 1.48%




| Time (hr) | Flow ($m^3/s$) |
|---|---|
| 11.001 | 0.000 |
| 11.347 | 0.080 |
| 11.491 | 0.082 |
| 11.601 | 0.104 |
| 11.694 | 0.135 |
| 11.776 | 0.159 |
| 11.850 | 0.180 |
| 11.918 | 0.223 |
| 11.981 | 0.291 |
| 12.040 | 0.341 |
| 12.096 | 0.445 |
| 12.150 | 0.562 |
| 12.201 | 0.619 |
| 12.230 | 0.601 |
| 12.259 | 0.541 |
| 12.290 | 0.462 |
| 12.320 | 0.389 |
| 12.352 | 0.336 |
| 12.384 | 0.300 |
| 12.417 | 0.268 |
| 12.451 | 0.239 |
| 12.486 | 0.216 |
| 12.522 | 0.201 |
| 12.559 | 0.187 |
| 12.597 | 0.169 |
| 12.637 | 0.152 |
| 12.678 | 0.139 |
| 12.721 | 0.132 |
| 12.767 | 0.129 |
| 12.814 | 0.127 |
| 12.864 | 0.126 |
| 12.917 | 0.126 |
| 12.975 | 0.126 |
| 13.037 | 0.124 |
| 13.106 | 0.106 |
| 13.184 | 0.084 |
| 13.277 | 0.076 |
| 13.398 | 0.074 |
| 13.690 | 0.044 |
| -1.000 | 0.000 |

# CHANNEL CAPACITY SECTION PRE-DEVELOPMENT NO. 17 CRESTA AVE.

| | |
|---|---|
| **PROJECT NO:** | 200626-01 |
| **PROJECT NAME:** | 96 Beach Haven Road/ 13 Cresta Avenue |
| **DATE:** | 6.08.2021 |
| **BY:** | Natalie Naidoo |
| **REF:** | Overland Flowpath Cross Sections |

**INPUTS**

| | |
|---|---|
| Case (A or B) | B |
| **Case A** | |
| Flow ($m^3/s$) | 0.619 |
| **Case B** | |
| Slope ($S_o$) | 3% |
| Water level (m) | 17.47 |
| MFFL | 17.62 |

0.47

| Channel Geometry | | Mannings | Sinuosity | |
|---|---|---|---|---|
| x (m) | y (m) | "n" value | | |
| 0 | 17.5 | 0.1 | | Property/Parcels |
| 0.5 | 17.3 | 0.1 | | Property/Parcels |
| 1 | 17 | 0.1 | | Property/Parcels |
| 2 | 17 | 0.1 | | Property/Parcels |
| 2.5 | 17.30 | 0.1 | | Property/Parcels |
| 3 | 17.5 | 0.1 | | Property/Parcels |
| -1 | | | | |

The table can input 10 (x,y) co-ordinates.
The (x,y) pairs should be in order
Terminate list by making x = -1.0

Flow distribution is based on velocity and energy gradient common to all parts of the channel. i.e.
$n=(\sum(P_1 n_1^{1.5}+....)/P)^{0.67}$

Sinuosity is the relative length of that flow channel element compared to other elements and input $S_o$.
Default value is 1.0.

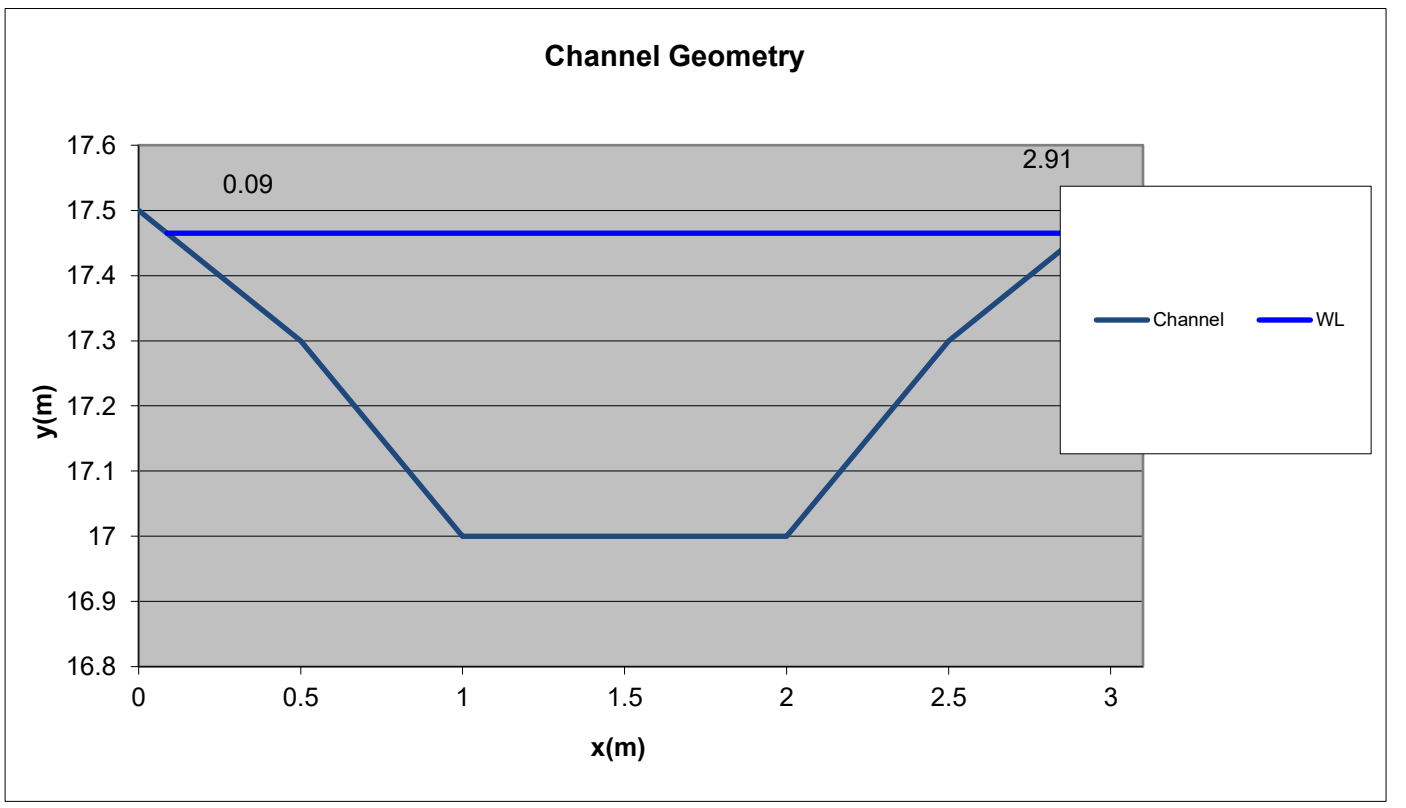
**OUTPUTS**

| **Normal Flow Conditions** | |
|---|---|
| Flow ($m^3/s$) | **0.622** OK |
| Velocity (m/s) | 0.734 |
| $S_o$ or $S_f$ | 0.0300 |
| Energy (m) | 17.492 |
| Froude No | 0.428 |
| Bed Stress (Pa) | 81.704 |
| Equivalent "n" | 0.100 |
| Equivalent $k_s$(mm) | N/A |

| **Geometry for wetted conditions** | |
|---|---|
| Depth (d-m) | 17.465 |
| Area (A-$m^2$) | 0.848 |
| Width (B-m) | 2.825 |
| Perimeter (P-m) | 3.055 |

| **Critical Flow Conditions** | |
|---|---|
| Flow ($m^3/s$) | **1.455** OK |
| Velocity (m/s) | 1.716 |
| Energy (m) | 17.615 |

| **Typical "n" values** | |
|---|---|
| Concrete | 0.013 |
| Gunite | 0.017 |
| Smooth earth | 0.02 |
| Clean channel | 0.03 |
| Natural Channel | 0.035-0.065 |
| Floodplain | 0.05-0.15 |
| Overland flow (grass) | 0.2-0.5 |



# Hydrographs- SCS Method - Post Development Flow from No. 17 Cresta Avenue

**Project Description**

96 Beach Haven Road/13 Cresta Avenue
No. 17 Cresta Avenue

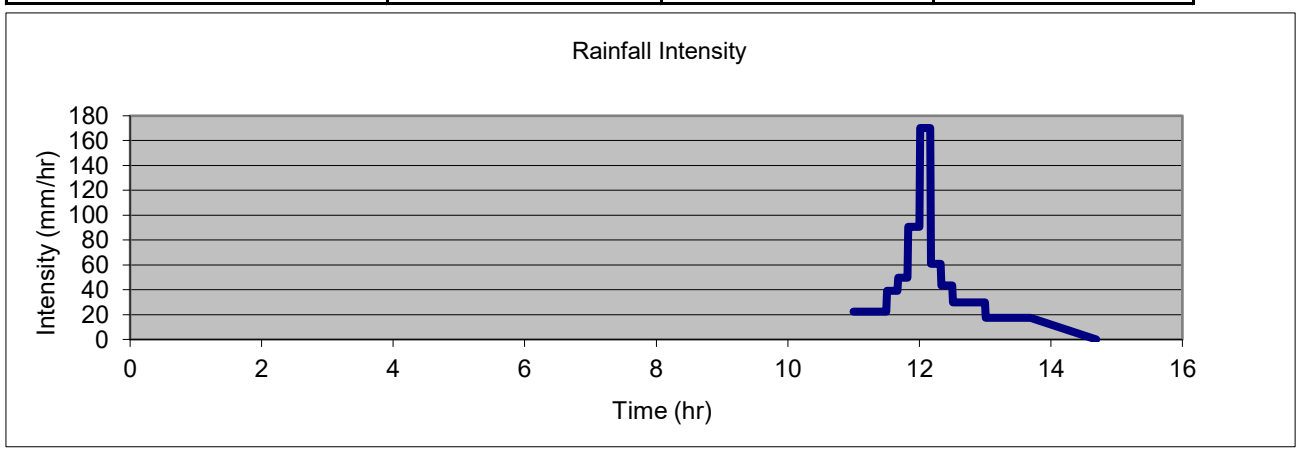
Rainfall Depth (mm) 245.28 100 YEAR ARI

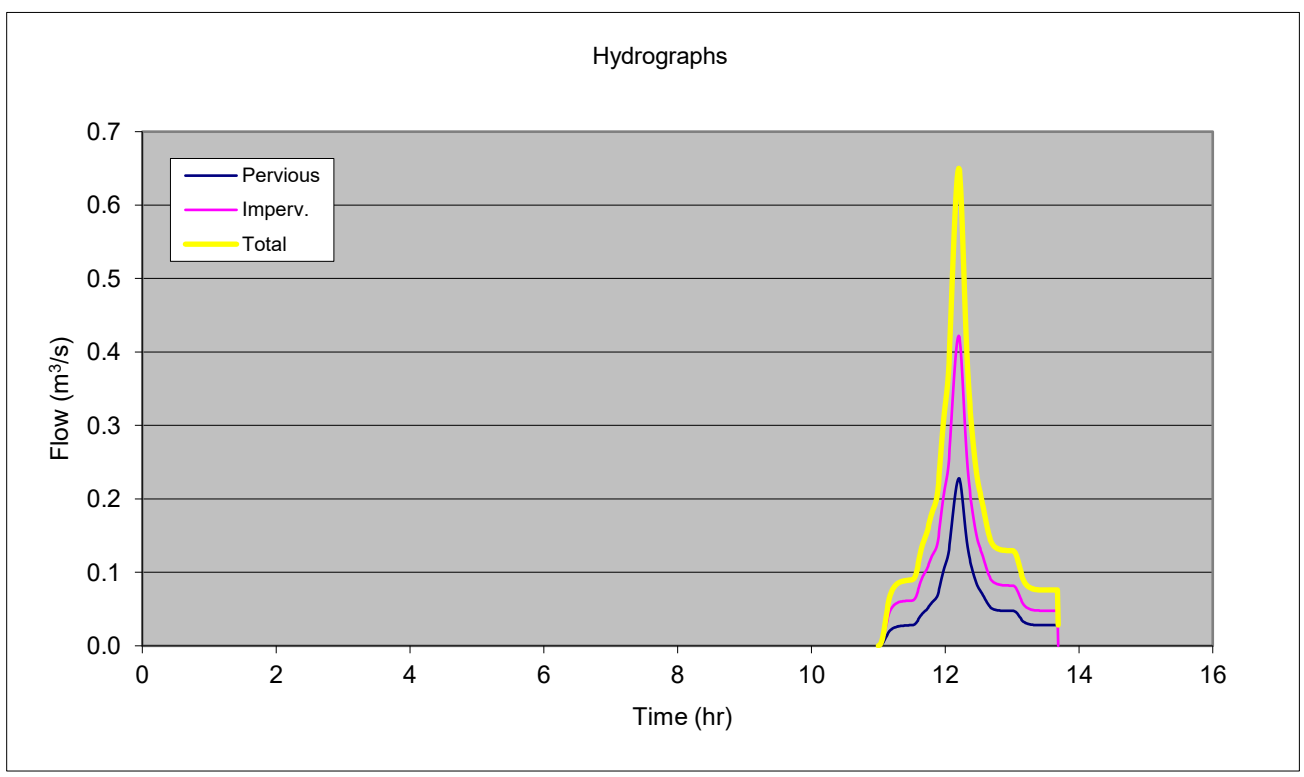
**Notes:**

1. Inputs
2. Typical inputs for CN, Ia, CF are in 'Typical Inputs' Sheet.
3. Method based on ARC TP108.

| Catchment Data | Pervious Area | Impervious Area |
|---|---|---|
| Area (ha) | 0.66 | 0.99 |
| Runoff No (CN) | 74 | 98 |
| Initial Loss (Ia-mm) | 5 | 0 |
| Channel Length (L-m) | 157 | 157 |
| Channel Slope (Sc-m/m) | 0.1 | 0.1 |
| Channel Factor (CF-0.6 to 1.0) | 0.8 | 0.6 |
| Time of Concentration (tc-min) | 10.0 | 10.0 |
| Soil storage (S-mm) | 89.2 | 5.2 |

| Outputs | | | Total |
|---|---|---|---|
| Runoff (mm) | 175.2 | 240.2 | 214.2 |
| Peak Flow ($m^3/s$) | 0.228 | 0.422 | 0.650 |
| Time (hr) at Peak Flow | 12.20 | 12.20 | 12.20 |
| Rainfall (mm/h) over tc | 165.26 | 165.26 | 165.26 |
| Runoff Coefficient - Peak | 0.75 | 0.93 | 0.86 |
| Runoff Coefficient - Volume | 0.71 | 0.98 | 0.87 |



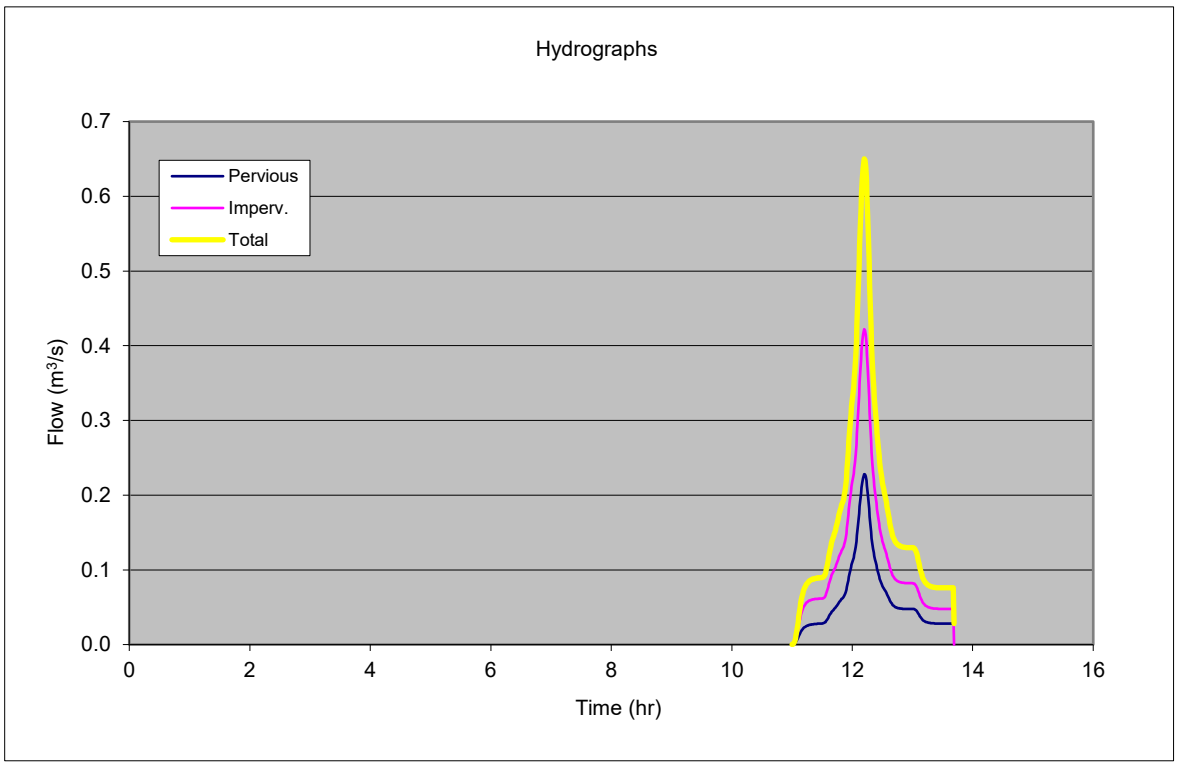
# Hydrographs- SCS Method:

**Project Description**

96 Beach Haven Road/13 Cresta Avenue
No. 17 Cresta Avenue

**Total Hydrograph in tabular form:** (based on simualtion from above)

Volumetric error in scaling 2.02%




| Time (hr) | Flow ($m^3/s$) |
|---|---|
| 11.001 | 0.000 |
| 11.347 | 0.088 |
| 11.491 | 0.090 |
| 11.601 | 0.113 |
| 11.694 | 0.146 |
| 11.776 | 0.172 |
| 11.850 | 0.193 |
| 11.918 | 0.239 |
| 11.981 | 0.311 |
| 12.040 | 0.362 |
| 12.096 | 0.471 |
| 12.150 | 0.592 |
| 12.201 | 0.650 |
| 12.230 | 0.630 |
| 12.259 | 0.566 |
| 12.290 | 0.482 |
| 12.320 | 0.406 |
| 12.352 | 0.351 |
| 12.384 | 0.312 |
| 12.417 | 0.279 |
| 12.451 | 0.248 |
| 12.486 | 0.224 |
| 12.522 | 0.208 |
| 12.559 | 0.194 |
| 12.597 | 0.175 |
| 12.637 | 0.157 |
| 12.678 | 0.144 |
| 12.721 | 0.137 |
| 12.767 | 0.133 |
| 12.814 | 0.131 |
| 12.864 | 0.130 |
| 12.917 | 0.130 |
| 12.975 | 0.130 |
| 13.037 | 0.128 |
| 13.106 | 0.109 |
| 13.184 | 0.087 |
| 13.277 | 0.079 |
| 13.398 | 0.076 |
| 13.690 | 0.028 |
| -1.000 | 0.000 |

# CHANNEL CAPACITY SECTION POST DEVELOPMENT NO. 17 CRESTA AVE.

| | |
|---|---|
| **PROJECT NO:** | 200626-01 |
| **PROJECT NAME:** | 96 Beach Haven Road/ 13 Cresta Avenue |
| **DATE:** | 5.08.2021 |
| **BY:** | Natalie Naidoo |
| **REF:** | Overland Flowpath Cross Sections |

**INPUTS**

| | |
|---|---|
| Case (A or B) | B |
| **Case A** | |
| Flow ($m^3/s$) | 0.650 |
| **Case B** | |
| Slope ($S_o$) | 3% |
| Water level (m) | 17.48 |
| MFFL | 17.63 |

0.48

| Channel Geometry | | Mannings | Sinuosity | |
|---|---|---|---|---|
| x (m) | y (m) | "n" value | | |
| 0 | 17.5 | 0.1 | | Property/Parcel |
| 0.5 | 17.3 | 0.1 | | Property/Parcel |
| 1 | 17 | 0.1 | | Property/Parcel |
| 2 | 17 | 0.1 | | Property/Parcel |
| 2.5 | 17.30 | 0.1 | | Property/Parcel |
| 3 | 17.5 | 0.1 | | Property/Parcel |
| -1 | | | | |

The table can input 10 (x,y) co-ordinates.
The (x,y) pairs should be in order
Terminate list by making x = -1.0

Flow distribution is based on velocity and energy gradient common to all parts of the channel. i.e.
$n=(\sum(P_1 n_1^{1.5}+....)/P)^{0.67}$

Sinuosity is the relative length of that flow channel element compared to other elements and input $S_o$.
Default value is 1.0.

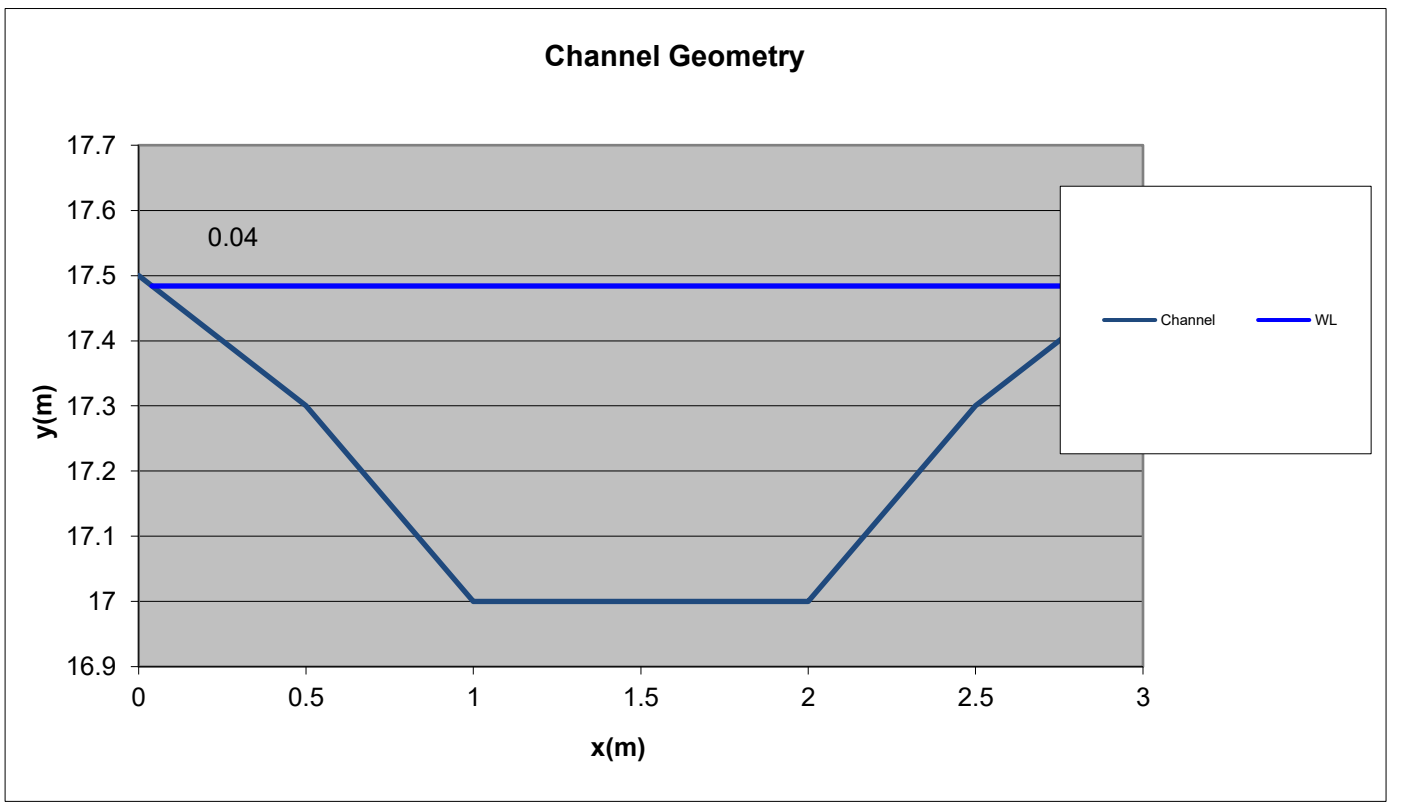
**OUTPUTS**

| **Normal Flow Conditions** | |
|---|---|
| Flow ($m^3/s$) | **0.676** OK |
| Velocity (m/s) | 0.749 |
| $S_o$ or $S_f$ | 0.0300 |
| Energy (m) | 17.513 |
| Froude No | 0.430 |
| Bed Stress (Pa) | 84.144 |
| Equivalent "n" | 0.100 |
| Equivalent $k_s$(mm) | N/A |

| **Geometry for wetted conditions** | |
|---|---|
| Depth (d-m) | 17.484 |
| Area (A-$m^2$) | 0.903 |
| Width (B-m) | 2.920 |
| Perimeter (P-m) | 3.157 |

| **Critical Flow Conditions** | |
|---|---|
| Flow ($m^3/s$) | **1.572** OK |
| Velocity (m/s) | 1.741 |
| Energy (m) | 17.639 |

| **Typical "n" values** | |
|---|---|
| Concrete | 0.013 |
| Gunite | 0.017 |
| Smooth earth | 0.02 |
| Clean channel | 0.03 |
| Natural Channel | 0.035-0.065 |
| Floodplain | 0.05-0.15 |
| Overland flow (grass) | 0.2-0.5 |



# Appendix D

**Lander Geotechnical – Geotechnical Report**

14 April 2021 Ref No: J01675 (Rev1)

Bentley Studios Limited

**Attention: Mr L Da-Silva**

Dear Leon

**RE: Geotechnical Investigation Report for Private Plan Change at 96 Beach Haven Road & 13 Cresta Avenue, Beach Haven**

# 1 PROJECT BRIEF

This report has been prepared for Bentley Studios Limited in support of an application to the Auckland Council for a Private Plan Change (PPC).

1.1 I have undertaken a review of the private plan change, on behalf of Auckland Council in relation to the geotechnical effects.

I hold a NZCE (Civil) and BE (Civil; Hons 1st class, 1st division) and am a Chartered Professional Engineer. My work experience includes significant land subdivisions across South Auckland over the past 20 years on steep and/or compressible ground. I hold the position of Managing Director and Principal Geotechnical Engineer at Lander Geotechnical Consultants Limited based in Manukau.

1.2 In writing this report, the following documents have been reviewed:

- Geotechnical Due Diligence Desktop Study, CMW Geosciences Ltd, Ref No. AKL2020-0310AA Rev.0, dated 30 November 2020.

# 2 SCOPE AND OBJECTIVES

The scope of this report encompasses the geotechnical suitability and stability of the land associated with the PPC;

- Geotechnical setting and ground conditions for the site, including assessment of natural features and geohazards that may affect future residential development upon the land.
- Geotechnical guidance for future earthworks based on ground conditions likely to be encountered during site stripping and bulk cut operations.
- Broad stability of the site to safely support typical residential structures for likely end use.
- Available historical aerial photographs to infer fills and/or land modification that may have occurred within the watercourse near the north-eastern corner of the site.
- Shallow surface investigations have only been completed within the site boundaries and it is unknown as the characteristics of the soils encountered within the existing watercourse near the north-eastern corner of the site.

- Review groundwater depths and complete a 14 day assessment for reference to the Auckland Unitary Plan (AUP) permanent drawdown effects assessment (E7.) to be completed at a later stage (e.g. during a subdivision Resource Consent stage) if required, once the nature of development concepts (e.g. building and earthworks) are known.

# 3 SITE DESCRIPTION AND DEVELOPMENT PROPOSALS

Number 96 Beach Haven Road, Beach Haven is legally described as Lot 1 DP 157383, with an area of 2251m$^2$. Along the northern boundary of this site sits 13 Cresta Avenue with the legal description of Lot 2 DP 157383 comprising an area of 4896m$^2$. Land gradients across the site are generally flat around 1(v) in 6(h), but steepen to 1(v) in 4(h) towards the gully located along the western boundary of the site which appears to contains the overland flow path from south to north.

There are currently two dwellings located on each site with two separate garage structures located at 96 Beach Haven Road. A stormwater line runs along the western and southern boundary of 96 beach Haven Road as well as a sewer line that cuts through 13 Cresta Avenue.

We understand that the site is proposed for a zone change for the development of future residential housing which will likely require minor earthworks i.e. cuts and fills to develop the proposed housing foundation platforms

# 4 FIELDWORK AND FINDINGS

## 4.1 Fieldwork Programme

Our fieldwork was conducted on 4 February 2021 which involved drilling of 16 hand auger boreholes with target depths of between 3.0m and 5.0m in the positions indicated on the appended site plan (refer Figure 1). Three piezometer standpipes were also installed in HA05, HA11 and HA16.

Results of all in-situ tests, detailed descriptions and depths of strata encountered during drilling of the boreholes are appended.

## 4.2 Geology

A review of GNS digital QMaps indicates that the site is located within the East Coast Bays Formation (ECBF) of the Waitemata Group flysch deposits which consist of alternating beds of sandstones and mudstones. These deposits generally weather to a dark grey, partially weathered ‘transitional’ soils before weathering completely to orange, light grey and brown silts, clays and sands

## 4.3 Findings

### 4.3.1 Topsoil

Topsoil was encountered in each of the hand auger boreholes to a depth of between 100m to 800mm (the latter isolated to HA15) but averaged around 300mm.

### 4.3.2 Residual East Coast Bays Formation

Residual East Coast Bays Formation (ECBF) soils were noted in each hand auger borehole underlying surficial topsoil and alluvial deposits. These deposits consisted of grey, black, orange and

brown clays and silts. Undrained shear strength readings were generally greater than 75 kPa (Stiff) and up to more than 216 kPa (Hard).

### 4.3.3 Transitional East Coast Bays Formation

The transitional ECBF was encountered within HA12 underlying the residual ECBF at a depth of 3.85m. These soils were described grey silty Clay and undrained shear strengths within this formation were hard as the shear vane was unable to penetrate the soil.

### 4.3.4 Groundwater

Groundwater was encountered in HA09 and HA15 at depths of 4.0m and 3.0m respectively. Piezometers standpipes were installed in hand auger boreholes, HA05, HA11 and HA16. Results are tabulated below in table 1.

It is worth noting HA05 was tampered with after its installation and was found partially removed from the ground only allowing a monitoring depth of 3.5m BEGL before an obstruction was met. Additionally during the final round of groundwater monitoring HA16 recorded elevated levels of groundwater compared to the other piezometers, this outlying data point has been determined to have been caused due to excess runoff from a period of heaving rainfall just prior to its measurement and is deemed inaccurate (i.e. higher than the actual groundwater level).

**Table 1: Groundwater Levels Following Drilling**

| **Borehole** | **Groundwater Depth Encountered During Drilling** (m BEGL) | **Standing Groundwater Depth** (m BEGL) | | | |
|---|---|---|---|---|---|
| | | **4 February 2021** (Completion of drilling) | **9 February 2021** (5 Days) | **12 February 2021** (15 Days) | **19 February 2021** (22 Days) |
| **HA05** | N/A | N/A | N/A | N/A | N/A |
| **HA11** | N/A | N/A | 4.05 | 3.85 | 3.85 |
| **HA16** | N/A | N/A | 4.10 | 3.70 | 1.70 |

## 5 LABORATORY RESULTS

Atterberg limit soils testing of material from HA11 at a depth of 0.5-1.0m returned the following index properties to aid in the determination of an expansive site class for this site.

- Liquid Limit: 103
- Plastic Limit: 40
- Linear Shrinkage: 22%
- Moisture Content 31.4%

# 6 PROJECT EVALUATIONS AND RECOMMENDATIONS

Based on our site observations and field investigations we are of the opinion the site contains no insurmountable geotechnical hazards that would prevent future residential intensification.

Specific comments and recommendations follow:

## 6.1 Foundations for Buildings

### 6.1.1 Bearing Capacity and Settlement Potential

A geotechnical ultimate bearing capacity of 300 kPa should generally be available for all shallow and pad foundations constructed on engineer certified filling and on the natural ground. Anticipated differential settlements are assessed to be within the required building code limits.

Please note, following earthworks, if existing fill is found to underlay any future building platforms then it will need to be undercut and replaced with engineer certified fill (i.e. compacted GAP65 hardfill), subject to engineering direction from the observing geo-professional.

### 6.1.2 Expansive Site Class

Based on the Atterberg Limit laboratory testing, refer Section 6, visual-tactile assessment of the soils and knowledge of the area, the preliminary assessed expansive site class for this site is H(High); as defined in MBIE Acceptable Solutions and Verification Methods for NZ Building Code Clause B1 Structures, effective 28 November 2019) with characteristic ground movement ($Y_s$) of up to 78mm.

This site class should be re-assessed during the detailed design (i.e. at Building Consent stage) via Shrink-Swell testing as outlined in MBIE (extract attached)

## 6.2 Pavement Subgrade

Given the generally very stiff surficial subsoils present across the site, we consider that a design CBR value of 4% maybe adopted for the natural soils if this is a design requirement for driveways. As CBR values are affected by moisture content and trafficking, we recommend that subgrades are only trimmed to final level immediately prior to placing base course and that a programme of Scala Penetrometer testing be carried out during construction to confirm the design value.

## 6.3 Preliminary Earthworks Comments

Generally speaking, following the removal/ demolition of the existing dwellings and structures located on site, all debris and excavation which is surplus to requirements should be removed from site, in addition if any existing deep topsoil and pre-existing non engineered fill deposits were encountered on site will require undercutting and replacement with engineered fill if located beneath the proposed building platforms, at the discretion of the observing geo-professional.

All vegetation should be removed, and topsoil stripped well clear of the proposed works and stockpiled clear of the building platform also.

This should be re-addressed at a later phase (e.g. a Resource Consent Application).

## 7 FURTHER WORK

Further geotechnical assessments should be undertaken to support any subsequent Resource Consent or Building Consent applications commensurate with the nature of future development proposals.

## 8 LIMITATIONS

This report has been prepared solely for the use of our client, Bentley Studios Limited, their professional advisers and the relevant Territorial Authorities in relation to the specific project described herein. No liability is accepted in respect of its use for any other purpose or by any other person or entity. All future owners of this property should seek professional geotechnical advice to satisfy themselves as to its ongoing suitability for their intended use.

The opinions, recommendations and comments given in this report result from the application of normal methods of site investigation. As factual evidence has been obtained solely from boreholes which by their nature only provide information about a relatively small volume of subsoils, there may be special conditions pertaining to this site which have not been disclosed by the investigation and which have not been taken into account in the report.

If variations in the subsoils occur from those described or assumed to exist, then the matter should be referred back to us immediately.

For and on behalf of Lander Geotechnical Consultants Limited

**S.G. Lander**

Principal Geotechnical Engineer
CMEngNZ, CPEng

Attachments:

Figure 01: Site Investigation Plan
Hand Auger Boreholes Records
Laboratory Results
MBIE Acceptable Solutions and Verifications Methods for NZ Building Code Clause B1 Structure (extract)

**Legend and/or Notes:**

- 5m Hand Auger Borehole
- 3m Hand Auger Borehole
- 5m Hand Auger Borehole with Piezometer


BASEMAP: AUCKLAND COUNCIL GEOMAPS DATABASE [RETRIEVED 12.02.21]

| revision | description | drawn | approved | date |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

0 10.0 20.0 30.0
Horizontal Scale (metres)

0 10.0 20.0 30.0
Vertical Scale (metres)

| | |
|---|---|
| drawn | PL |
| approved | RP |
| date | 12.02.21 |
| scale | 1:500 |
| original size | A3 |

LANDER geotechnical

client: **BENTLEY STUDIO LIMITED**

project: **96 BEACH HAVEN ROAD & 13 CRESTA AVENUE BEACH HAVEN**

title: **SITE INVESTIGATION PLAN**

project no: **J01675** figure no: **01**

*Template revision: 1:500 (10/12/14)*

**Client :** BENTLEY STUDIOS LIMITED

**Project Location :** 96 BEACH HAVEN ROAD & 13 CRESTA AVENUE BEACH HAVEN

**Job Number:** J01675

# Auger Borehole No. HA01

Sheet 1 of 16

| Vane Head: | Logged By: | Processor : | Date: |
|---|---|---|---|
| 1900 | RG | PL | 04.02.21 |

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

## SOIL DESCRIPTION

| Depth (m) | Standing Water Level | Vane Shear(kPa) peak / residual | Soil Sensitivity | Sample and Laboratory / Other Test Details |
|---|---|---|---|---|
| TOPSOIL | | | | |
| slightly clayey SILT, light grey mottled orange/brown. Very stiff, moist, low plasticity [RESIDUAL EAST COAST BAYS FORMATION] | | | | |
| 0.5 | | 193+ | | |
| with trace fine sand | | | | |
| 1.0 | | 193+ | | |
| becoming hard | | | | |
| 1.5 | | UTP | | |
| 2.0 | | UTP | | |
| becoming very stiff, moderately sensitive | | | | |
| 2.5 | | 157/72 | 2.2 | |
| 3.0 | | 141/50 | 2.8 | |
| EOB at 3.0m. Target Depth. | | | | |
| 3.5 | | | | |
| 4.0 | | | | |
| 4.5 | | | | |
| 5.0 | | | | |
| 5.5 | | | | |
| 6.0 | | | | |

LANDER geotechnical

**Comments:**
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: JM

| | | | | | |
|---|---|---|---|---|---|
| Topsoil | Sand | Sandstone | Plutonic | | |
| Fill | Gravel | Siltstone | No Core | | |
| Clay | Organic | Limestone | | | |
| Silt | Pumice | Volcanic | | | |

**Client :** BENTLEY STUDIOS LIMITED

**Project Location :** 96 BEACH HAVEN ROAD & 13 CRESTA AVENUE BEACH HAVEN

**Job Number:** J01675

## Auger Borehole No. HA02

Sheet 2 of 16

| Vane Head: | Logged By: | Processor : | Date: |
|---|---|---|---|
| 1750 | NM | PL | 04.02.21 |

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

| SOIL DESCRIPTION | Legend | Depth (m) | Standing Water Level | Vane Shear(kPa) peak / residual | Soil Sensitivity | Sample and Laboratory / Other Test Details |
|---|---|---|---|---|---|---|
| TOPSOIL | | | | | | |
| silty CLAY, black, light orange/brown and red mottled brown. Hard, dry to moist, medium plasticity [RESIDUAL EAST COAST BAYS FORMATION] | | 0.5 | | 216+ | | |
| becoming black and light orange/brown mottled brown | | 1.0 | | 216+ | | |
| becoming orange/brown streaked grey, moist | | 1.5 | | 216+ | | |
| becoming very stiff, insensitive<br>becoming orange streaked light grey, high plasticity | | 2.0 | | 151/114 | 1.3 | |
| becoming slightly pumiceous silty CLAY, orange and light grey/white streaked light grey, with trace fine sand | | 2.5 | | 194/108 | 1.8 | |
| EOB at 3.0m. Target Depth. | | 3.0 | | 148/117 | 1.3 | |
| | | 3.5 | | | | |
| | | 4.0 | | | | |
| | | 4.5 | | | | |
| | | 5.0 | | | | |
| | | 5.5 | | | | |
| | | 6.0 | | | | |

LANDER geotechnical

**Comments:**
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: JM

| | | | | | |
|---|---|---|---|---|---|
| Topsoil | Sand | Sandstone | Plutonic | | |
| Fill | Gravel | Siltstone | No Core | | |
| Clay | Organic | Limestone | | | |
| Silt | Pumice | Volcanic | | | |

**Client :** BENTLEY STUDIOS LIMITED

**Project Location :** 96 BEACH HAVEN ROAD & 13 CRESTA AVENUE BEACH HAVEN

**Job Number:** J01675

## Auger Borehole No. HA03

Sheet 3 of 16

| Vane Head: | Logged By: | Processor : | Date: |
|---|---|---|---|
| 2153 | JM | PL | 04.02.21 |

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

| SOIL DESCRIPTION | Depth (m) | Vane Shear(kPa) peak / residual | Soil Sensitivity | Sample and Laboratory / Other Test Details |
|---|---|---|---|---|
| TOPSOIL | | | | |
| silty CLAY, orange mottled light grey. Hard, moist, medium to high plasticity [RESIDUAL EAST COAST BAYS FORMATION] | 0.5 | 216+ | | |
| with trace fine sand | | | | |
| with trace limonite to 1.2m | 1.0 | 216+ | | |
| becoming medium plasticity, with minor fine sand | 1.5 | 216+ | | |
| becoming high plasticity, with trace fine sand | 2.0 | 216+ | | |
| becoming very stiff, insensitive | 2.5 | 120/77 | 1.6 | |
| with trace rootlets | | | | |
| becoming hard, moist to wet | 3.0 | 216+ | | |
| slightly clayey fine to medium SAND, orange mottled light grey. Hard, wet, low to no plasticity<br>at 3.3m, becoming light grey | 3.5 | UTP | | Scala Penetrometer Test (blows/100mm) |
| becoming grey | | UTP | | |
| EOB at 3.9m. Too hard to auger further. Scala penetrometer test commenced to 4.9m. | 4.0 | | | 6<br>11<br>12<br>12<br>10<br>10<br>10<br>10<br>11<br>10 |
| | 4.5 | | | |
| | 5.0 | | | |
| | 5.5 | | | |
| | 6.0 | | | |

LANDER geotechnical

**Comments:**
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: JM

| | | | |
|---|---|---|---|
| Topsoil | Sand | Sandstone | Plutonic |
| Fill | Gravel | Siltstone | No Core |
| Clay | Organic | Limestone | |
| Silt | Pumice | Volcanic | |

**Client :** BENTLEY STUDIOS LIMITED

**Project Location :** 96 BEACH HAVEN ROAD & 13 CRESTA AVENUE BEACH HAVEN

**Job Number:** J01675

## Auger Borehole No. HA04

Sheet 4 of 16

| Vane Head: | Logged By: | Processor : | Date: |
|---|---|---|---|
| 1750 | NM | PL | 04.02.21 |

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

| SOIL DESCRIPTION | Depth (m) | Standing Water Level | Vane Shear(kPa) peak / residual | Soil Sensitivity | Sample and Laboratory / Other Test Details |
|---|---|---|---|---|---|
| TOPSOIL | | | | | |
| clayey SILT, grey mottled orange/brown. Hard, dry to moist, medium plasticity [RESIDUAL EAST COAST BAYS FORMATION] | | | | | |
| becoming grey streaked orange/brown | 0.5 | | 216+ | | |
| becoming orange streaked grey | | | | | |
| becoming moist, insensitive | 1.0 | | 201/114 | 1.8 | |
| becoming medium plasticity | 1.5 | | 216+ | | |
| becoming very stiff, moderately sensitive<br>becoming grey streaked orange/brown, low plasticity, with trace sand | 2.0 | | 194/74 | 2.6 | |
| becoming hard | 2.5 | | 216+ | | |
| becoming brown/orange streaked grey | | | | | |
| | 3.0 | | 216+ | | |
| | 3.5 | | 216+ | | |
| | 4.0 | | 216+ | | |
| | 4.5 | | 216+ | | |
| EOB at 5.0m. Target Depth. | 5.0 | | 216+ | | |
| | 5.5 | | | | |
| | 6.0 | | | | |

LANDER geotechnical

**Comments:**
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: JM

| | | | | | |
|---|---|---|---|---|---|
| Topsoil | Sand | Sandstone | Plutonic | | |
| Fill | Gravel | Siltstone | No Core | | |
| Clay | Organic | Limestone | | | |
| Silt | Pumice | Volcanic | | | |

**Client :** BENTLEY STUDIOS LIMITED

**Project Location :** 96 BEACH HAVEN ROAD & 13 CRESTA AVENUE BEACH HAVEN

**Job Number:** J01675

## Auger Borehole No. HA05

Sheet 5 of 16

| Vane Head: | Logged By: | Processor : | Date: |
|---|---|---|---|
| 1900 | RG | PL | 04.02.21 |

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

| SOIL DESCRIPTION | Depth (m) | Vane Shear(kPa) peak / residual | Soil Sensitivity | Sample and Laboratory / Other Test Details |
|---|---|---|---|---|
| TOPSOIL | | | | Piezometer Details: |
| clayey SILT, orange mottled light grey. Very stiff, moist, low plasticity [RESIDUAL EAST COAST BAYS FORMATION] | | | | 0.0m-0.5m - Bentonite Seal |
| | 0.5 | 193+ | | 0.5m-5.0m - Screened with Filter Sock |
| becoming medium plasticity | | | | |
| | 1.0 | 193+ | | |
| becoming low plasticity, with trace fine sand | | | | |
| becoming moderately sensitive | 1.5 | 152/66 | 2.3 | |
| | 2.0 | 160/52 | 3.1 | |
| | 2.5 | 171/83 | 2.1 | |
| fine sandy SILT with minor clay, orange mottled light grey. Loose, moist, low to no plasticity, with trace limonite | | | | |
| | 3.0 | 193+ | | |
| | 3.5 | 193+ | | |
| becoming moderately sensitive | 4.0 | 182/58 | 3.1 | |
| becoming medium dense | 4.5 | UTP | | |
| slightly clayey SILT with trace fine sand, light grey mottled orange. Hard, wet, low plasticity, with trace limonite | | | | |
| EOB at 5.0m. Target Depth. | 5.0 | UTP | | |
| | 5.5 | | | |
| | 6.0 | | | |

LANDER geotechnical

**Comments:**
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: JM

| | | | | | |
|---|---|---|---|---|---|
| Topsoil | Sand | Sandstone | Plutonic | | |
| Fill | Gravel | Siltstone | No Core | | |
| Clay | Organic | Limestone | | | |
| Silt | Pumice | Volcanic | | | |

**Client :** BENTLEY STUDIOS LIMITED

**Project Location :** 96 BEACH HAVEN ROAD & 13 CRESTA AVENUE BEACH HAVEN

**Job Number:** J01675

## Auger Borehole No. HA06

Sheet 6 of 16

| Vane Head: | Logged By: | Processor : | Date: |
|---|---|---|---|
| 307 | RZ | RZ | 04.02.21 |

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

| SOIL DESCRIPTION | Legend | Depth (m) | Standing Water Level | Vane Shear(kPa) peak / residual | Soil Sensitivity | Sample and Laboratory / Other Test Details |
|---|---|---|---|---|---|---|
| TOPSOIL | | | | | | |
| silty CLAY, orange mottled light brown. Very stiff, moist, medium plasticity, moderately sensitive [RESIDUAL EAST COAST BAYS FORMATION] | | | | | | |
| | | 0.5 | | 173/78 | 2.2 | |
| becoming orange mottled light grey | | | | | | |
| becoming high plasticity, insensitive | | 1.0 | | 153/101 | 1.5 | |
| | | 1.5 | | 121/72 | 1.8 | |
| becoming hard | | 2.0 | | 201+ | | |
| clayey SILT, orange mottled light grey. Hard, moist, low to medium plasticity | | | | | | |
| | | 2.5 | | 201+ | | |
| | | 3.0 | | 201+ | | |
| EOB at 3.0m. Target Depth. | | | | | | |
| | | 3.5 | | | | |
| | | 4.0 | | | | |
| | | 4.5 | | | | |
| | | 5.0 | | | | |
| | | 5.5 | | | | |
| | | 6.0 | | | | |

LANDER geotechnical

**Comments:**
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: JM

| | | | | | |
|---|---|---|---|---|---|
| Topsoil | Sand | Sandstone | Plutonic | | |
| Fill | Gravel | Siltstone | No Core | | |
| Clay | Organic | Limestone | | | |
| Silt | Pumice | Volcanic | | | |

**Client :** BENTLEY STUDIOS LIMITED

**Project Location :** 96 BEACH HAVEN ROAD & 13 CRESTA AVENUE BEACH HAVEN

**Job Number:** J01675

## Auger Borehole No. HA07

Sheet 7 of 16

| Vane Head: | Logged By: | Processor : | Date: |
|---|---|---|---|
| 307 | RZ | RZ | 04.02.21 |

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

| SOIL DESCRIPTION | Legend | Depth (m) | Standing Water Level | Vane Shear(kPa) peak / residual | Soil Sensitivity | Sample and Laboratory / Other Test Details |
|---|---|---|---|---|---|---|
| TOPSOIL | | | | | | |
| EOB at 0.3m. Too hard to auger further. Scala penetrometer test commenced and found effective refusal (ER) at 0.4m. | | 0.5<br>1.0<br>1.5<br>2.0<br>2.5<br>3.0<br>3.5<br>4.0<br>4.5<br>5.0<br>5.5<br>6.0 | | | | 3<br>20+ (ER)<br>Scala Penetrometer Test (blows/100mm) |

LANDER geotechnical

**Comments:**
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: JM

| | | | | | |
|---|---|---|---|---|---|
| Topsoil | Sand | Sandstone | Plutonic | | |
| Fill | Gravel | Siltstone | No Core | | |
| Clay | Organic | Limestone | | | |
| Silt | Pumice | Volcanic | | | |

**Client :** BENTLEY STUDIOS LIMITED

**Project Location :** 96 BEACH HAVEN ROAD & 13 CRESTA AVENUE BEACH HAVEN

**Job Number:** J01675

## Auger Borehole No. HA08

Sheet 8 of 16

| Vane Head: | Logged By: | Processor : | Date: |
|---|---|---|---|
| 1750 | NM | PL | 04.02.21 |

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

| SOIL DESCRIPTION | Depth (m) | Vane Shear(kPa) peak / residual | Soil Sensitivity |
|---|---|---|---|
| TOPSOIL | | | |
| silty CLAY, light brown. Hard, dry to moist, medium plasticity [RESIDUAL EAST COAST BAYS FORMATION] | | | |
| becoming grey and orange/brown mottled light brown, moist | 0.5 | 216+ | |
| becoming grey streaked orange/brown | | | |
| becoming insensitive | 1.0 | 201/111 | 1.8 |
| becoming very stiff<br>becoming orange/brown streaked grey | 1.5 | 182/105 | 1.7 |
| | 2.0 | 139/108 | 1.3 |
| | 2.5 | 139/102 | 1.4 |
| | 3.0 | 170/120 | 1.4 |
| becoming high plasticity | 3.5 | 127/99 | 1.3 |
| | 4.0 | 167/130 | 1.3 |
| becoming hard | 4.5 | 216+ | |
| EOB at 5.0m. Target Depth. | 5.0 | 201/139 | 1.4 |
| | 5.5 | | |
| | 6.0 | | |

Standing Water Level | Sample and Laboratory / Other Test Details

LANDER geotechnical

**Comments:**
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: JM

| | | | |
|---|---|---|---|
| Topsoil | Sand | Sandstone | Plutonic |
| Fill | Gravel | Siltstone | No Core |
| Clay | Organic | Limestone | |
| Silt | Pumice | Volcanic | |

**Client :** BENTLEY STUDIOS LIMITED

**Project Location :** 96 BEACH HAVEN ROAD & 13 CRESTA AVENUE BEACH HAVEN

**Job Number:** J01675

# Auger Borehole No. HA09

Sheet 9 of 16

| Vane Head: | Logged By: | Processor : | Date: |
|---|---|---|---|
| 2153 | JM | PL | 04.02.21 |

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

| SOIL DESCRIPTION | Depth (m) | Vane Shear(kPa) peak / residual | Soil Sensitivity | Sample and Laboratory / Other Test Details |
|---|---|---|---|---|
| TOPSOIL | | | | |
| silty CLAY, orange mottled light grey. Hard, moist, high plasticity [RESIDUAL EAST COAST BAYS FORMATION] | 0.5 | 216+ | | |
| becoming moderately sensitive | 1.0 | 213/58 | 3.7 | |
| with trace fine sand | | | | |
| becoming very stiff, insensitive | 1.5 | 173/89 | 1.9 | |
| | 2.0 | 164/99 | 1.7 | |
| becoming medium to high plasticity, with minor fine sand | | | | |
| becoming moist to wet | 2.5 | 130/83 | 1.6 | |
| becoming moderately sensitive | 3.0 | 178/85 | 2.1 | |
| becoming wet, with some fine sand | | | | |
| | 3.5 | 160/67 | 2.4 | |
| clayey fine to medium SAND, orange mottled light grey. Very stiff, wet, low plasticity | | | | |
| becoming grey, saturated, with minor woody inclusions with moderately thin bed of wood | 4.0 | 178/45 | 4.0 | |
| becoming grey/brown, without woody inclusions | 4.5 | 159/51 | 3.1 | |
| EOB at 5.0m. Target Depth. | 5.0 | 190/49 | 3.9 | |
| | 5.5 | | | |
| | 6.0 | | | |

Standing Water Level: ▽ at 4.0

LANDER geotechnical

**Comments:**
Groundwater encountered at 4.0m.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: JM

| | | | | | |
|---|---|---|---|---|---|
| Topsoil | Sand | Sandstone | Plutonic | | |
| Fill | Gravel | Siltstone | No Core | | |
| Clay | Organic | Limestone | | | |
| Silt | Pumice | Volcanic | | | |

**Client :** BENTLEY STUDIOS LIMITED

**Project Location :** 96 BEACH HAVEN ROAD & 13 CRESTA AVENUE BEACH HAVEN

**Job Number:** J01675

## Auger Borehole No. HA10

Sheet 10 of 16

| Vane Head: | Logged By: | Processor : | Date: |
|---|---|---|---|
| 307 | RZ | RZ | 04.02.21 |

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

| SOIL DESCRIPTION | Depth (m) | Standing Water Level | Vane Shear(kPa) peak / residual | Soil Sensitivity | Sample and Laboratory / Other Test Details |
|---|---|---|---|---|---|
| TOPSOIL | | | | | |
| silty CLAY, orange/brown and light grey mottled light orange. Hard, dry, medium plasticity [RESIDUAL EAST COAST BAYS FORMATION] | | | | | |
| | 0.5 | | UTP | | |
| becoming moist | | | | | |
| becoming orange mottled light grey | 1.0 | | 201+ | | |
| becoming very stiff, insensitive | 1.5 | | 170/124 | 1.4 | |
| | 2.0 | | 173/132 | 1.3 | |
| becoming high plasticity | 2.5 | | 147/109 | 1.3 | |
| | 3.0 | | 112/72 | 1.6 | |
| becoming stiff | 3.5 | | 92/72 | 1.3 | |
| becoming very stiff<br>becoming medium plasticity, with some fine sand | 4.0 | | 118/78 | 1.5 | |
| with minor fine sand<br>becoming hard | 4.5 | | 201+ | | |
| EOB at 5.0m. Target Depth. | 5.0 | | 201+ | | |
| | 5.5 | | | | |
| | 6.0 | | | | |

LANDER geotechnical

**Comments:**
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: JM

| | | | | | |
|---|---|---|---|---|---|
| Topsoil | Sand | Sandstone | Plutonic | | |
| Fill | Gravel | Siltstone | No Core | | |
| Clay | Organic | Limestone | | | |
| Silt | Pumice | Volcanic | | | |

**Client :** BENTLEY STUDIOS LIMITED

**Project Location :** 96 BEACH HAVEN ROAD & 13 CRESTA AVENUE BEACH HAVEN

**Job Number:** J01675

# Auger Borehole No. HA11

Sheet 11 of 16

| Vane Head: | Logged By: | Processor : | Date: |
|---|---|---|---|
| 1900 | RG | PL | 04.02.21 |

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

## SOIL DESCRIPTION

| Depth (m) | Soil Description | Standing Water Level | Vane Shear(kPa) peak / residual | Soil Sensitivity | Sample and Laboratory / Other Test Details |
|---|---|---|---|---|---|
| | TOPSOIL | | | | Piezometer Details: 0.0m-0.5m - Bentonite Seal; 0.5m-5.0m - Screened with Filter Sock |
| 0.5 | clayey SILT, light grey mottled orange/brown. Very stiff, moist, low to medium plasticity, moderately sensitive [RESIDUAL EAST COAST BAYS FORMATION] | | 152/44 | 3.5 | Sample 1 Disturbed 0.5-1.0m |
| | becoming orange streaked light grey | | | | |
| 1.0 | | | 155/55 | 2.8 | |
| 1.5 | becoming insensitive | | 149/97 | 1.5 | |
| 2.0 | | | 138/91 | 1.5 | |
| | silty CLAY, orange streaked grey. Very stiff, moist, high plasticity, insensitive, with trace limonite | | | | |
| 2.5 | | | 108/72 | 1.5 | |
| 3.0 | | | 105/72 | 1.5 | |
| 3.5 | | | 105/69 | 1.5 | Standing Groundwater Level as on 12.02.21 and 19.02.21 (3.85m) |
| 4.0 | becoming stiff | | 72/41 | 1.8 | Standing Groundwater Level as on 09.02.21 (4.05m) |
| 4.5 | becoming very stiff | | 127/77 | 1.6 | |
| | at 5.0m, becoming moderately sensitive | | | | |
| 5.0 | EOB at 5.0m. Target Depth. | | 110/52 | 2.1 | |
| 5.5 | | | | | |
| 6.0 | | | | | |

LANDER geotechnical

**Comments:**
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: JM

| | | | | | |
|---|---|---|---|---|---|
| Topsoil | Sand | Sandstone | Plutonic | | |
| Fill | Gravel | Siltstone | No Core | | |
| Clay | Organic | Limestone | | | |
| Silt | Pumice | Volcanic | | | |

**Client :** BENTLEY STUDIOS LIMITED

**Project Location :** 96 BEACH HAVEN ROAD & 13 CRESTA AVENUE BEACH HAVEN

**Job Number:** J01675

# Auger Borehole No. HA12

Sheet 12 of 16

| Vane Head: | Logged By: | Processor : | Date: |
|---|---|---|---|
| 2153 | JM | PL | 04.02.21 |

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

## SOIL DESCRIPTION

| Depth (m) | Standing Water Level | Vane Shear(kPa) peak / residual | Soil Sensitivity | Sample and Laboratory / Other Test Details |
|---|---|---|---|---|
| TOPSOIL | | | | |
| silty CLAY with trace fine sand, orange mottled light grey. Very stiff, moist, medium to high plasticity, sensitive [RESIDUAL EAST COAST BAYS FORMATION] | | | | |
| 0.5 | | 167/24 | 7.0 | |
| becoming moderately sensitive<br>becoming high plasticity, without fine sand | | | | |
| 1.0 | | 191/55 | 3.5 | |
| 1.5 | | 157/80 | 2.0 | |
| becoming insensitive | | | | |
| 2.0 | | 160/111 | 1.4 | |
| 2.5 | | 141/93 | 1.5 | |
| 3.0 | | 179/105 | 1.7 | |
| becoming moist to wet | | | | |
| becoming stiff, moderately sensitive | | | | |
| 3.5 | | 96/43 | 2.2 | Scala Penetrometer Test (Blows/100mm) |
| silty CLAY with trace fine sand, grey. Hard, moist to wet, medium to high plasticity at 3.8m, becoming dark grey/blue | | UTP | | 4 |
| EOB at 3.85m. Too Hard to Auger Further. Scala penetrometer test commenced and found effective refusal (ER) at 4.1m. | | | | 12 |
| 4.0 | | | | 20+ (ER) |
| 4.5 | | | | |
| 5.0 | | | | |
| 5.5 | | | | |
| 6.0 | | | | |

LANDER geotechnical

**Comments:**
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: JM

| | | | | | |
|---|---|---|---|---|---|
| Topsoil | Sand | Sandstone | Plutonic | | |
| Fill | Gravel | Siltstone | No Core | | |
| Clay | Organic | Limestone | | | |
| Silt | Pumice | Volcanic | | | |

**Client :** BENTLEY STUDIOS LIMITED

**Project Location :** 96 BEACH HAVEN ROAD & 13 CRESTA AVENUE BEACH HAVEN

**Job Number:** J01675

## Auger Borehole No. HA13

Sheet 13 of 16

| Vane Head: | Logged By: | Processor : | Date: |
|---|---|---|---|
| 307 | RZ | RZ | 04.02.21 |

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

| SOIL DESCRIPTION | Depth (m) | Standing Water Level | Vane Shear(kPa) peak / residual | Soil Sensitivity | Sample and Laboratory / Other Test Details |
|---|---|---|---|---|---|
| TOPSOIL | | | | | |
| silty CLAY, orange, brown and light grey mottled. Hard, dry, medium plasticity [RESIDUAL EAST COAST BAYS FORMATION] | 0.5 | | UTP | | |
| becoming moist | | | | | |
| becoming orange mottled light grey | 1.0 | | 201+ | | |
| | 1.5 | | 201+ | | |
| | 2.0 | | 201+ | | |
| with trace fine sand | | | | | |
| becoming very stiff, moderately sensitive | 2.5 | | 184/89 | 2.1 | |
| becoming stiff, high plasticity, insensitive, without fine sand | 3.0 | | 95/58 | 1.6 | |
| becoming light brown, with some woody inclusions | | | | | |
| becoming orange mottled light grey/white, without woody inclusions | | | | | |
| becoming very stiff | 3.5 | | 130/112 | 1.2 | |
| becoming light grey | | | | | |
| becoming orange mottled light grey | 4.0 | | 132/75 | 1.8 | |
| | 4.5 | | 158/109 | 1.4 | |
| EOB at 5.0m. Target Depth. | 5.0 | | 176/115 | 1.5 | |
| | 5.5 | | | | |
| | 6.0 | | | | |

LANDER geotechnical

**Comments:**
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: JM

| | | | | | |
|---|---|---|---|---|---|
| Topsoil | Sand | Sandstone | Plutonic | | |
| Fill | Gravel | Siltstone | No Core | | |
| Clay | Organic | Limestone | | | |
| Silt | Pumice | Volcanic | | | |

**Client :** BENTLEY STUDIOS LIMITED

**Project Location :** 96 BEACH HAVEN ROAD & 13 CRESTA AVENUE BEACH HAVEN

**Job Number:** J01675

## Auger Borehole No. HA14

Sheet 14 of 16

| Vane Head: | Logged By: | Processor : | Date: |
|---|---|---|---|
| 1750 | NM | PL | 04.02.21 |

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

| SOIL DESCRIPTION | Depth (m) | Vane Shear(kPa) peak / residual | Soil Sensitivity |
|---|---|---|---|
| TOPSOIL | | | |
| clayey SILT, light brown. Hard, dry to moist, low to no plasticity [RESIDUAL EAST COAST BAYS FORMATION] | | | |
| becoming red and light grey mottled light brown | 0.5 | 216+ | |
| becoming red mottled light brown | | | |
| becoming medium plasticity | 1.0 | 188/108 | 1.7 |
| silty CLAY, grey streaked orange/brown. Very stiff, moist, medium to high plasticity, insensitive | 1.5 | 177/68 | 1.7 |
| becoming orange/brown streaked grey | 2.0 | 154/139 | 1.1 |
| becoming red and orange/brown streaked grey | 2.5 | 170/120 | 1.4 |
| becoming orange/brown streaked grey | | | |
| becoming high plasticity | 3.0 | 167/127 | 1.3 |
| | 3.5 | 182/139 | 1.3 |
| | 4.0 | 145/120 | 1.2 |
| | 4.5 | 142/139 | 1.0 |
| EOB at 5.0m. Target Depth. | 5.0 | 139/108 | 1.3 |
| | 5.5 | | |
| | 6.0 | | |

LANDER geotechnical

**Comments:**
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: JM

| | | | | | |
|---|---|---|---|---|---|
| Topsoil | Sand | Sandstone | Plutonic | | |
| Fill | Gravel | Siltstone | No Core | | |
| Clay | Organic | Limestone | | | |
| Silt | Pumice | Volcanic | | | |

**Client :** BENTLEY STUDIOS LIMITED

**Project Location :** 96 BEACH HAVEN ROAD & 13 CRESTA AVENUE BEACH HAVEN

**Job Number:** J01675

## Auger Borehole No. HA15

Sheet 15 of 16

| Vane Head: | Logged By: | Processor : | Date: |
|---|---|---|---|
| 307 | RZ | PL | 04.02.21 |

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

| SOIL DESCRIPTION | Depth (m) | Vane Shear(kPa) peak / residual | Soil Sensitivity |
|---|---|---|---|
| TOPSOIL | | | |
| | 0.5 | 132/106 | 1.2 |
| silty CLAY, orange and brown mottled. Hard, moist, medium plasticity [RESIDUAL EAST COAST BAYS FORMATION] | 1.0 | 201+ | |
| becoming orange and light grey motted, with trace fine sand | | | |
| becoming very stiff, insensitive | 1.5 | 115/81 | 1.4 |
| becoming moderately sensitive | 2.0 | 124/55 | 2.3 |
| becoming high plasticity, without sand | | | |
| becoming insensitive | 2.5 | 104/72 | 1.4 |
| becoming stiff, saturated | 3.0 | 86/52 | 1.7 |
| becoming hard, grey | 3.5 | 201+ | |
| becoming very stiff, insensitive | 4.0 | 118/63 | 1.9 |
| becoming orange mottled grey | | | |
| becoming hard | 4.5 | 201+ | |
| EOB at 5.0m. Target Depth. | 5.0 | 201+ | |
| | 5.5 | | |
| | 6.0 | | |

Standing Water Level: ▽ at 2.3m

Sample and Laboratory / Other Test Details

LANDER geotechnical

**Comments:**
Groundwater encountered at 3.0m.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: JM

| | | | | | |
|---|---|---|---|---|---|
| Topsoil | Sand | Sandstone | Plutonic | | |
| Fill | Gravel | Siltstone | No Core | | |
| Clay | Organic | Limestone | | | |
| Silt | Pumice | Volcanic | | | |

**Client :** BENTLEY STUDIOS LIMITED

**Project Location :** 96 BEACH HAVEN ROAD & 13 CRESTA AVENUE BEACH HAVEN

**Job Number:** J01675

# Auger Borehole No. HA16

Sheet 16 of 16

| Vane Head: | Logged By: | Processor : | Date: |
|---|---|---|---|
| 1900 | RG | PL | 04.02.21 |

Borehole Location: mN | mE | Ground R.L.

Description: Refer to site plan

## SOIL DESCRIPTION

| Depth (m) | Soil Description | Vane Shear(kPa) peak / residual | Soil Sensitivity | Sample and Laboratory / Other Test Details |
|---|---|---|---|---|
| 0.0 | TOPSOIL | | | Piezometer Details: |
| | clayey SILT, orange streaked grey. Very stiff, moist, low to medium plasticity [RESIDUAL EAST COAST BAYS FORMATION] | | | 0.0m-0.5m - Bentonite Seal |
| 0.5 | | 193+ | | 0.5m-5.0m - Screened with Filter Sock |
| | becoming medium plasticity | | | |
| 1.0 | | 193+ | | |
| 1.5 | | 193+ | | Standing Groundwater Level as on 19.02.21 (1.70m) |
| | with trace coarse sand sized white pumiceous inclusions | | | |
| | silty CLAY, orange streaked grey. Very stiff, moist, medium to high plasticity, insensitive | | | |
| 2.0 | | 144/86 | 1.7 | |
| | with black organic streaks, with trace fine sand | | | |
| | clayey SILT, orange mottled light grey. Very stiff, moist, medium plasticity, moderately sensitive, with trace limonite | | | |
| 2.5 | | 127/50 | 2.5 | |
| 3.0 | becoming stiff, insensitive | 97/52 | 1.9 | |
| | silty CLAY, orange streaked light grey. Stiff, moist, medium plasticity, insensitive, with trace limonite | | | |
| 3.5 | | 86/52 | 1.7 | Standing Groundwater Level as on 12.02.21 (3.70m) |
| | becoming moderately sensitive | | | |
| 4.0 | | 75/36 | 2.1 | Standing Groundwater Level as on 09.02.21 (4.10m) |
| 4.5 | becoming insensitive | 97/64 | 1.5 | |
| | becoming grey | | | |
| 5.0 | EOB at 5.0m. Target Depth. | 75/41 | 1.8 | |
| 5.5 | | | | |
| 6.0 | | | | |

LANDER geotechnical

**Comments:**
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm

Checked: JM

| | | | | | |
|---|---|---|---|---|---|
| Topsoil | Sand | Sandstone | Plutonic | | |
| Fill | Gravel | Siltstone | No Core | | |
| Clay | Organic | Limestone | | | |
| Silt | Pumice | Volcanic | | | |

GEOTECHNICS

Our Ref: 1009521.1123.0.0/Rep1
Customer Ref: J01675
19 February 2021

Lander Geotechnical Consultants Limited
Level 3, 3 Osterley way
Manukau
Auckland 2104

Attention: Rosie Garrill

Dear Rosie

## 96 Beach Haven & 13 Cresta Avenue Beach Haven

## Laboratory Test Report

Samples from the above mentioned site have been tested as received according to your instructions and the results are included in this report. Results apply only to the sample(s) tested.

Descriptions are enclosed for your information, but are not covered under the IANZ endorsement of this report.

This report has been prepared for the benefit of Lander Geotechnical Consultants Limited , with respect to the particular brief given to us and it cannot be relied upon in other contexts or for any other purpose without our prior review and agreement.

This report may be reproduced only in full.

Samples not destroyed during testing will be retained for one month from the date of this report before being discarded. If we can be of any further assistance, feel free to get in touch. Contact details are provided at the bottom of this page.

GEOTECHNICS LTD

Report prepared by:

.....
Tylah Wardrope
Laboratory Technician

Authorised for Geotechnics by:

.....
Paul Burton
Project Director

Report checked by:

.....
Ryan Milligan
Project Manager
Approved Signatory

ACCREDITED IANZ TESTING LABORATORY

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

19-Feb-21
t:\geotechnicsgroup\projects\1009521\1009521.1123\workingmaterial\20210219.96 beach haven & 13 cresta avenue beach haven .tywa.docx

GEOTECHNICS
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| | |
|---|---|
| **Geotechnics Project Number** | 1009521.1123.0.0 |
| **QESTLab Work Order ID** | W21TG-0027 |
| **Customer Project ID** | J01675 |

# Determination of Liquid & Plastic Limit, Plasticity Index - NZS 4402: 1986 Tests 2.2 (4 Point), 2.3 & 2.4

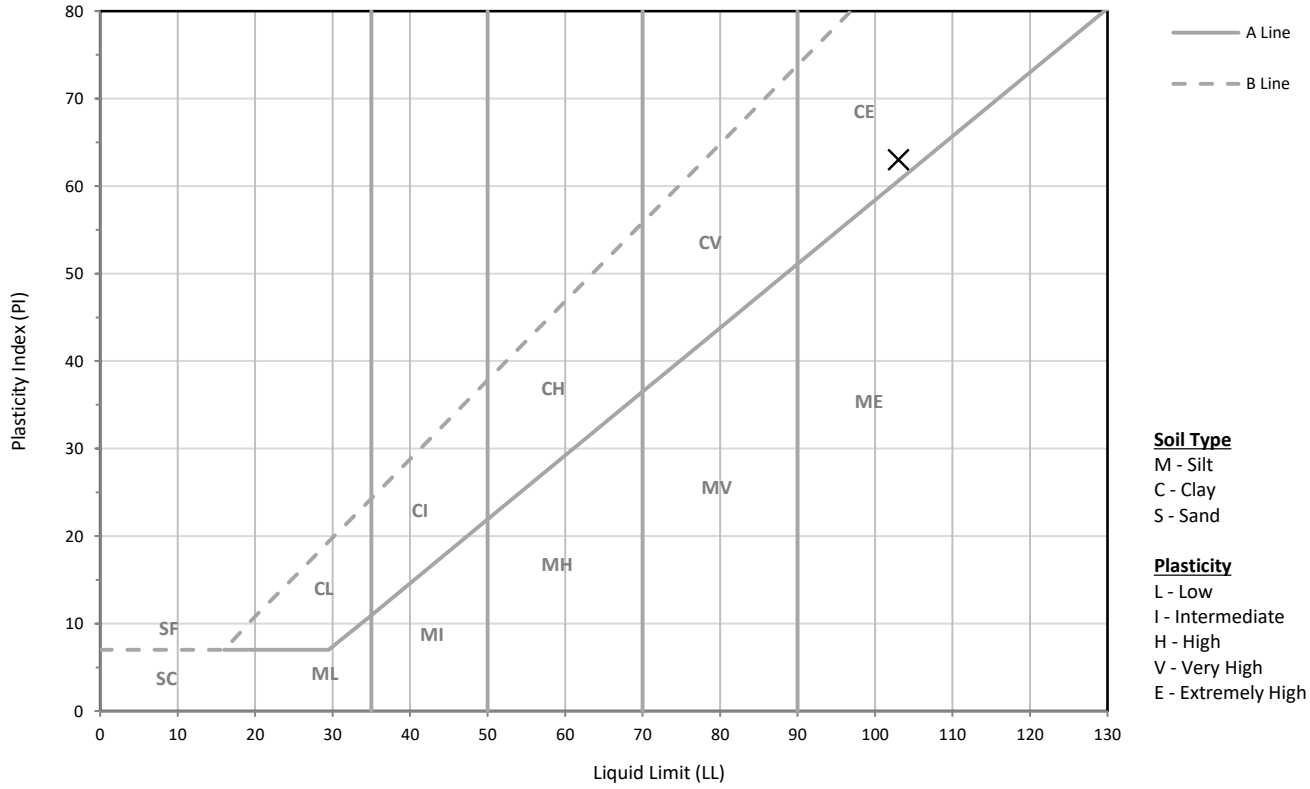
## TEST DETAILS

| | | | | |
|---|---|---|---|---|
| **LOCATION** | **Description** | 96 Beach Haven & 13 Cresta Avenue Beach Haven | | |
| | **Data** | N/A | | |
| **SAMPLE** | **Geotechnics ID** | S21TG000063 | | |
| | **Reference** | HA11 | **Top Depth** | 0.5m |
| | **Sampled By** | Others, Tested As Received | **Bottom Depth** | 1.0m |
| | **Description** | Silty CLAY, with trace rootlets; light brown mixed orange brown. Dry to moist, extremely high plasticity. | | |
| **SPECIMEN** | **Reference** | N/A | **Depth** | N/A |
| | **Description** | N/A | | |

## TEST RESULTS

| | |
|---|---|
| **Liquid Limit** | **103** |
| **Plastic Limit** | **40** |
| **Plasticity Index** | **63** |

**Plasticity Chart - BS 5930:1999**




## TEST REMARKS

• The material used for testing was natural, fraction passing a 425um sieve. • This test result is IANZ accredited.•Date tested 18/02/2021

| | |
|---|---|
| **Approved Signatory** | Ryan Milligan |
| **Date** | 19/02/2021 |

GEOTECHNICS

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| | |
|---|---|
| **Geotechnics Project Number** | 1009521.1123.0.0 |
| **QESTLab Work Order ID** | W21TG-0027 |
| **Customer Project ID** | J01675 |

# Determination of the Linear Shrinkage - NZS 4402:1986 Test 2.6

## TEST DETAILS

| | | | | |
|---|---|---|---|---|
| **LOCATION** | **Description** | 96 Beach Haven & 13 Cresta Avenue Beach Haven | | |
| | **Data** | N/A | | |
| **SAMPLE** | **Geotechnics ID** | S21TG000063 | | |
| | **Reference** | HA11 | **Top Depth** | 0.5m |
| | **Sampled By** | Others, Tested As Received | **Bottom Depth** | 1.0m |
| | **Description** | Silty CLAY, with trace rootlets; light brown mixed orange brown. Dry to moist, extremely high plasticity. | | |
| **SPECIMEN** | **Reference** | | **Depth** | |
| | **Description** | | | |

**Linear Shrinkage** **22%**

## TEST REMARKS

• This test result is IANZ accredited.•Date tested 17/02/2021

**Approved Signatory** Ryan Milligan

**Date** 19/02/2021

**Tauranga**
15C Amber Crescent
Judea
Tauranga 3110
New Zealand

p +64 7 571 0280

# Material Test Report

**Report No: MAT:S21TG000063**
**Issue No: 1**

**Customer:** Lander Geotechnical
**Address:** Level 3, 3 Osterley Way
Manukau, 2104
**Project:** 96 Beach Haven & 13 Cresta Avenue Beach Haven
**Project No.:** 1009521.1123.0.0
**Customer Reference No.:** J01675
**Report Authorised By :** Ryan Milligan

Approved By:
Ryan Milligan
(Development Manager)
Date of Issue: 19/02/2021



## Sample Details

| | |
|---|---|
| **Location** | 96 Beach Haven & 13 Cresta Avenue Beach Haven |
| **Geotechnics ID** | S21TG000063 |
| **Sample Reference** | HA11 |
| **Sample Description** | Silty CLAY, with trace rootlets; light brown mixed orange brown. Dry to moist, extremely high plasticity. |
| **Sample Depth** | 0.5m |
| **Bottom Depth** | 1.0m |

## Test Results

| Description | Method | Result | Limits |
|---|---|---|---|
| Moisture Content [NZS 4402:1986 Test 2.1] | | | |
| Moisture Content (%) | | 31.4 | |
| Date Tested | | 15/02/2021 | |

## Comments

This test result is IANZ accredited.

If samples have been taken, and were not destroyed during testing, they will be retained for one month from the date of this report before being discarded.

## 3.2 Slab-on-ground in expansive soils

### 3.2.1 NZS 3604 Clause 1.1.2 Buildings covered by this Standard

Amend 1.1.2(a) to read:

"Buildings founded on good ground or on expansive soils where the requirements of 1.1.5 are met"

### 3.2.2 NZS 3604 New Clause

Add new: "**Clause 1.1.5 Buildings on expansive soils**

Buildings on expansive soils shall be supported on slab-on-ground foundations complying with 7.5.13 and in addition to 1.1.2 shall be limited as follows:

(a) single storey, stand-alone household unit, and

(b) maximum length or width of floor of 24.0 m including any attached garage, and

(c) simple plan shapes such as rectangular, L, T or boomerang, and

(d) concrete slab-on-ground with a minimum thickness of 100 mm and a minimum concrete compressive strength of 20 MPa, and

(e) simple roof forms, incorporating hips, valleys, gables or mono pitches, and

(f) maximum overall height of 7.0 m to roof apex from lowest cleared ground level, and

(g) maximum roof height of 3.0 m, and

(h) roof slope between 10° and 35° from the horizontal, and

(i) maximum span of roof truss 12.0 m, and

(j) external walls maximum of 2.4 m height studs, other than gable end walls and walls to mono-pitched roofs, which shall not exceed 4.0 m.

**COMMENT:**

**Floor plans**

Where floor plans incorporate re-entrant corners then continuity of the exterior ground beam shall be maintained by continuing it as an internal beam, with the exterior beam details continued for a length of at least 1.0 m into the internal beam. This is only applicable where internal beams are specified in Tables 7.4A and 7.4B. This is aimed to bring the solution in NZS 3604 in line with Clause 5.3.8 of AS 2870:2011.

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**Ground movement**

Provision for the additional ground movement effects from trees near to foundations in expansive soils should be considered. Trees remove moisture from the soil for a radius equal to the height of the tree. This causes expansive soils to shrink to varying degrees, and when near houses leads to differential settlement occurring under foundations. Movement of the foundations may lead to cracks in the building and door jamming.

Where existing trees (including trees that have been recently removed) are located closer to the foundations than 1.5 times the mature height of a tree, then additional geotechnical advice should be obtained. Planting of new trees should be avoided near foundations of new buildings or neighbouring buildings on sites with expansive soils.

### 3.2.3 NZS 3604 Clause 7.5.1

Add the following paragraph at the end of Clause 7.5.1:

"Slabs on expansive soils for buildings meeting the requirements of 1.1.5 shall, in addition to meeting the requirements of 7.5.1 to 7.5.12, meet the requirements of 7.5.13. Where there is conflict the requirements of 7.5.13 shall apply."

### 3.2.4 NZS 3604 New clause, tables and figures

Add new: **Clause 7.5.13 Slab-on-ground in expansive soils**

**7.5.13.1 Identification of expansive soils**

7.5.13.1.1 Should reasonable enquiry as outlined in 3.1.3 show any signs of expansive soils, the expansive soil class, as defined in AS 2870, shall be established by one or all of:

(a) enquiry to the local territorial authority, and/or

(b) reference to the certificate of suitability issued in terms of NZS 4431, and/or

(c) a soil test undertaken by a suitably qualified soils engineer.

**7.5.13.1.2 Expansive soil class shall be defined as:**

(a) Slightly 'S', having an $I_{SS}$ range of 0–1.9%, and a 500 year design characteristic surface movement return ($y_S$) of 22 mm, or

(b) Moderately 'M', having an $I_{SS}$ range of 2.0–3.7% and a 500 year design characteristic surface movement return ($y_S$) of 44 mm, or

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(c) Highly 'H', having an $I_{SS}$ range of 3.8–6.5%and a 500 year design characteristic surface movement return ($y_S$) of 78 mm, or

(d) Extremely 'E', having an $I_{SS}$ range of 6.6–7.5% and a 500 year design characteristic surface movement return ($y_S$) of 90 mm.

### 7.5.13.2 Maximum aspect ratio of concrete slabs

The aspect ratio of the concrete slabs or bays of concrete slabs, such as in the case of L, T or boomerang concrete slab shapes, shall not exceed 5 to 1 (length to width).

### 7.5.13.3 Foundation details

7.5.13.3.1 For the identified expansive soil class the foundation details, external and internal thickenings shall be as follows.

(a) For light wall claddings refer to Table 7.4A and Figure 7.22.

(b) For medium wall or heavy wall claddings refer to Table 7.4B and Figure 7.23.

7.5.13.3.2 Situations where no internal thickenings shall be required are limited to a rectangular slab with long side not exceeding 17.0 m. Where this limit is exceeded, add additional internal thickenings across the slab with the same cross section dimensions and reinforcing as the external footing, so that the centre to centre spacing of thickenings is always less than 17.0 m.

**COMMENT:**

**Design constraints:**

a) The characteristic surface movements and the corresponding expansivity classifications have been calculated based on design for ultimate limit state (ULS) conditions for a 1 in 1000 year "extreme" drought event, and the serviceability limit state (SLS) conditions for a 1 in 500 year drought event.

b) Maximum soil movements are calculated to be based on a 500 year return period for SLS, and a 1000 year return period for ULS*;

(*NB: *This differed from the recommendations contained within BRANZ Study Report 120A (BSR120A) which used a 300 year return period for the design level drought conditions)*

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c) Climate parameters adopted from BSR120A of $\Delta u$ = 1.2 pF, Hs = 1.5 m, and a crack depth of 0.5 Hs

d) The $I_{SS}$ (soil stability index) ranges attributed to the expansivity classifications as defined in 3.2.4 above have been calculated using the parameters presented in BSR120A and Equation 2.3.1 of AS 2870:2011.

e) Sites subject to parameters that differ from those mentioned above, in particular sites where the crack depth is less than 0.75 m, such as cut natural ground or clay backfill, require specific engineering assessment to confirm their appropriate site classification.

f) The effects of nearby trees (whether existing, recently removed, or future planting) are not considered in these solutions. It is recommended that specific geotechnical engineering advice is obtained where a tree is within a lateral distance of 1.5 times its mature height of the foundations.

**Maintenance of foundations in expansive soils**

Normal maintenance is that work generally recognised as necessary to achieve the expected performance over time of the foundation located on expansive soils. Unless otherwise specified by the designer and noted on the drawings, basic normal maintenance tasks should ensure that:

a) the drainage and wetting of the site is controlled so that extremes of wetting and drying of the soils are prevented, and

b) the position and operation of gardens adjacent to the dwelling are controlled, and the planting of trees near to foundations is suitably restricted, and

c) any leaks which develop in plumbing, storm water or sanitary sewage systems are repaired promptly.

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**Table 7.4A** **Reinforced concrete foundations in expansive soils for light wall claddings**
Clause 7.5.13 and Figure 7.22

| Expansive soil class | Slightly 'S' | Moderately 'M' | Highly 'H' | Extremely 'E' |
|---|---|---|---|---|
| Soil embedment (De) | 375 mm | 525 mm | 575 mm | 625 mm |
| Top steel ($A_S$ top) | 2/D 16 | 2/ D16 | 2/ D16 | 2/ D16 |
| Bottom steel ($A_S$ bottom) | 1/ D16 | 1/ D25 | 1/ D20 | 1/ D25 |
| Stirrups | R6/ 125 crs. | R6/ 125 crs. | R6/ 300 crs. | R6/ 300 crs. |
| Maximum spacing of internal thickenings | no internal thickening | no internal thickening | 2.5 m crs. | 2.5 m crs. |
| Depth of thickening (D1) | – | – | 400 mm | 450 mm |
| Base width (B1) | – | – | 300 mm | 350 mm |
| Top steel ($A_S$ top) | – | – | 2/ D20 | 2/ D20 |
| Bottom steel ($A_S$ bottom) | – | – | 2/ D16 | 2/ D20 |
| Stirrups | – | – | R6/ 150 crs. | R6/ 150 crs. |

**Table 7.4B** **Reinforced concrete foundations in expansive soils for medium wall and heavy wall claddings**
Clause 7.5.13 and Figure 7.23

| Expansive soil class | Slightly 'S' | Moderately 'M' | Highly 'H' | Extremely 'E' |
|---|---|---|---|---|
| Soil embedment (De) | 500 mm | 550 mm | 775 mm | 800 mm |
| Top steel ($A_S$ top) | 2/ D16 | 2/ D20 | 2/ D20 | 3/ D20 |
| Bottom steel ($A_S$ bottom) | 2/ D16 | 2/ D16 | 2/ D20 | 2/ D20 |
| Stirrups | R6/ 125 crs. | R6/ 250 crs. | R6/ 300 crs. | R6/ 300 crs. |
| Maximum spacing of internal thickenings | – | 2.5 m crs. | 2.5 m crs. | 2.5 m crs. |
| Depth of thickening (D1) | – | 350 mm | 450 mm | 500 mm |
| Base width (B1) | – | 300 mm | 300 mm | 350 mm |
| Top steel ($A_S$ top) | – | 2/ D16 | 3/ D20 | 3/ D20 |
| Bottom steel ($A_S$ bottom) | – | 2/ D16 | 2/ D16 | 2/ D20 |
| Stirrups | – | R6/ 125 crs. | R6/ 150 crs. | R6/ 150 crs. |

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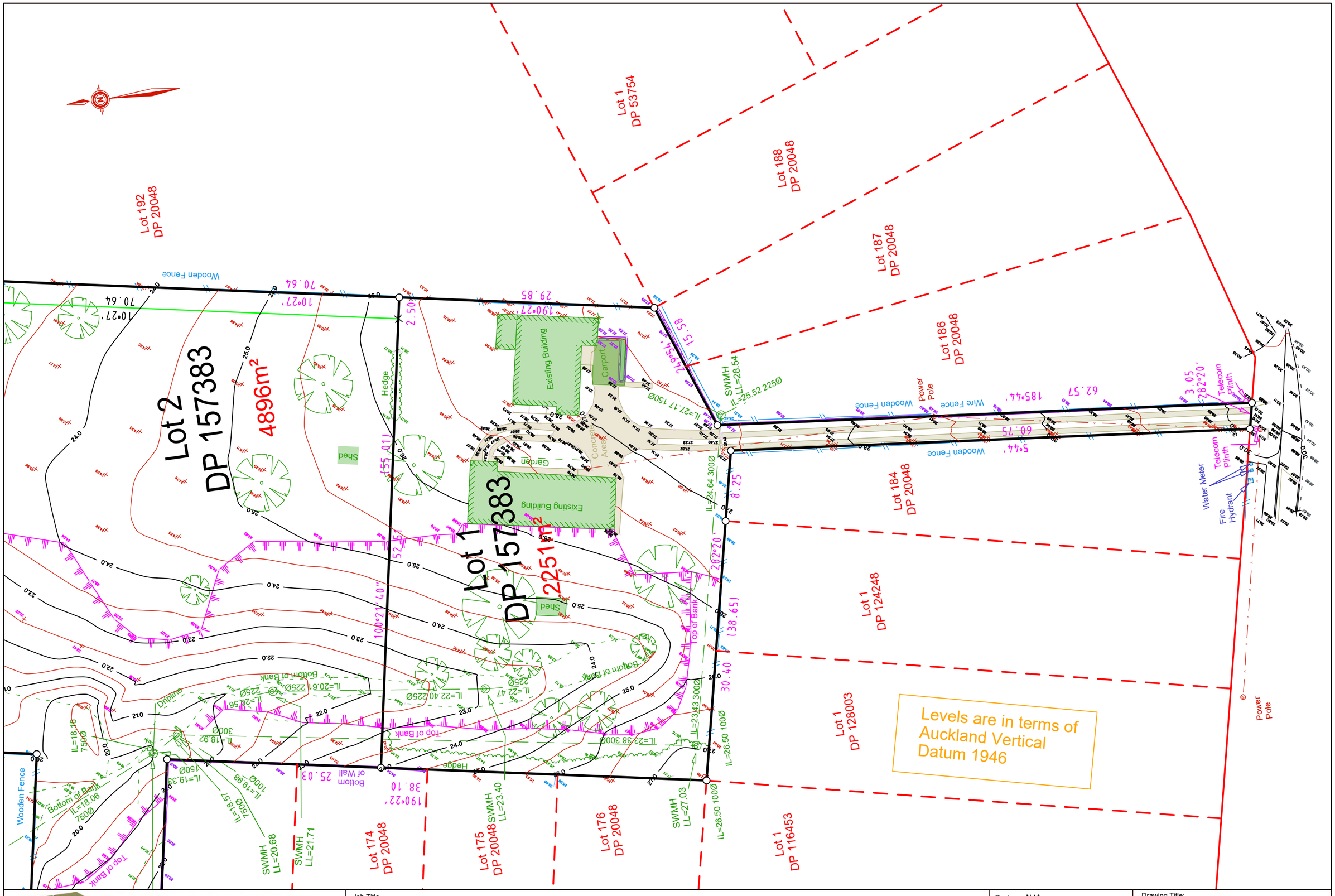
# Appendix E

**Easdale Surveyors – Topographical Survey Plans**




EASDALE SURVEYORS LTD
39 Meadowland Drive, Howick p: 09 5348452 e: surveyors@easdales.co.nz

Job Title

Topographical Survey
For
Da-Silva Builders
13 Cresta Ave & 96 Beach Haven Rd
Lot 1 and Lot 2 DP 157383

| | |
|---|---|
| Design | N/A |
| Survey | ZN&JS |
| Drawn | ZN |
| Checked | ML |
| Date | February 2021 |
| Scale | 1: 400 (A3) |



Drawing Title:
Site Plan Sheet 1
Surveyed on 03/02/2021

| File No. | Rev. | Dwg No. |
|---|---|---|
| 14424 | N/A | |

Lot 1
DP 73789

Lot 2
DP 67318

Lot 2
DP 73789

Lot 2
DP 122566

Lot 171
DP 20048

Lot 174
DP 20048

Lot 192
DP 20048

Lot 2
DP 157383

4896m²

Levels are in terms of Auckland Vertical Datum 1946

Adopted from the City Council Database

Power Pole
Telecom Plinth
Dripline
Gate
Garden
Wooden Fence
Existing Building
Concrete Area
Wooden Deck
Paving
Top of Bank
Bottom of Bank
Footpath
Channel
Edge of Seal
Bottom of Wall
Wooden Fence
Garden
Shed
Hedge
Tank
Bottom of Wall
Top of Bank

100°27' 65.98
280°27' 65.98
190°27' 30.48
(55.04) 52.54 280°28'50"
10°27' 70.64
100°21'40" 52.51
(55.01)
190°22' 38.10
10°27' 70.64
5.24
2.50
2.50

WWMH LL=21.50
IL=19.90 150Ø
IL=20.04 150Ø
IL=18.15 750Ø
IL=18.06 750Ø
WW CONN GL=23.31
SWMH LL=19.97
IL=19.33 150Ø
IL=18.92 300Ø
IL=18.57 750Ø
IL=19.98 100Ø
SWMH LL=20.68
IL=20.56 225Ø
IL=20.61 225Ø
SWMH LL=21.71
IL=24.89 150Ø
WWMH LL=25.81
IL=24.92 150Ø
IL=22.40 225Ø
SW CONN GL=21.81
WWMH LL=22.13
IL=21.36 100Ø
IL=19.4 150Ø
IL=19.45 150Ø

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39 Meadowland Drive, Howick p: 09 5348452 e: surveyors@easdales.co.nz

Job Title

Topographical Survey
For
Da-Silva Builders
13 Cresta Ave & 96 Beach Haven Rd
Lot 1 and Lot 2 DP 157383

| | |
|---|---|
| Design | N/A |
| Survey | ZN&JS |
| Drawn | ZN |
| Checked | ML |
| Date | February 2021 |
| Scale | 1: 400 (A3) |



Drawing Title:
Site Plan Sheet 2
Surveyed on 03/02/2021

| File No. | Rev. | Dwg No. |
|---|---|---|
| 14424 | N/A | |