# Land Development Report

REV C

strata group CONSULTING ENGINEERS

## Mangakuri Station subdivision

### Subdivision of Lot 2 DP 481291

CLIENT: **SR & BJ Williams Charitable Trust**

308 Queen St East, PO Box 758, Hastings 4122 P: 06 876 7646 F: 06 876 7645 E: admin@sgl.nz. W: www.stratagroup.net.nz

# Land Development report

Document Prepared for and on behalf of Strata Group Consulting Engineers Ltd By:

Simon Gabrielle
Civil Engineer

Document Reviewed By
Russell Nettlingham
Director and Chartered Professional Engineer

Strata Group Consulting Engineers Ltd
P.O Box 758
Hastings 4156
New Zealand

Telephone + 64 6 876 7646
Email simon@sgl.nz
Website www.stratagroup.net.nz

**Document Control**

Project Name: **Mangakuri Station subdivision**

Project Ref J5864

| Version | Date | Status | Prepared |
|---|---|---|---|
| ~~A~~ | ~~01/12/22~~ | ~~Issued for supporting information for Resource Consent application~~ | ~~SG~~ |
| ~~B~~ | ~~13/02/23~~ | ~~Issued for supporting information for Resource Consent application.~~ | ~~SG~~ |
| C | 11/08/23 | Issued for supporting information for Resource Consent application | SG |

| Version | Extent of Revision |
|---|---|
| C | Revised for RC application. Addressing review comments received from Stantec and incorporating the removal of Lots 2 and 5 from the proposal |

# Contents

# 1 INTRODUCTION & SCOPE

Strata Group Ltd (SGL) was engaged by **SR and BJ Williams Charitable Trust** (the Applicant) to investigate the civil engineering aspects for a proposed subdivision at Williams Road, Mangakuri. The proposed subdivision will consist of **8** lifestyle lots (plus rights of way), which will be developed by the applicant. Works to be completed by the developer are.

- Access to all building platforms,
- Stormwater attenuation/detention via one existing pond and two new dry stormwater ponds,
- Stormwater culverts and general stormwater conveyance improvements,
- Significant landscaped areas and new fencing

The purpose of this report is to accompany the subdivision resource consent application to Central Hawkes Bay District Council (CHBDC) for the proposed subdivision.

This report includes the assessment of all civil engineering aspects of the development including,

- Stormwater design
    - Achieving stormwater neutrality for the subdivision works
    - Managing stormwater run-off and mitigating any downstream adverse effects resulting from the proposal
    - Pipe conveyance and discharge
- Access to all lots (private access)
- Earthworks and building platforms
- Consideration for potable water supply
- Consideration for wastewater disposal

Following Cyclone Gabrielle, on the Clients request, a full design review was undertaken by all Consultants involved. Alongside this review process, a peer review for the Geotechnical assessment was also undertaken. Considering the outcomes of these reviews, Lots 2 and 5 have been removed from the proposal, and this report (revision C) has been updated to incorporate these changes.

### 1.1.3 Information and Standards

**Appendix A** provides a scheme plan outlining the proposed lot arrangement and easements

Surveying the Bay have undertaken a topographical survey (ground survey) at specific locations of interests which has been incorporated with LiDAR data from HBRC to create a combined existing ground model on which the design surfaces are based.

This report referenced the following resources:

- Proposed Subdivision scheme plan from Surveying The Bay
- Geotechnical Report from RDCL
- Landscape Management Zone plans from Wayfinder
- Archaeological Survey: Proposed Subdivision; Mangakuri Station, 402 Mangakuri Road, Mangakuri Beach from Heritage Services, Hawke's Bay
- Central Hawke's Bay District Council – Operative plan
- Central Hawkes Bay District Council – *IntraMaps CHBDC*;
- Hawke's Bay Regional Council - *Hawke's Bay Waterway Guidelines Stormwater Management* (dated May 2009)
- Hawke's Bay Regional Council – Regional Rules (14th August 20221)
- Ministry of Business, Innovation & Employment - *Acceptable Solutions and Verification Methods for New Zealand Building Code Clause – E1 Surface Water V9* dated February 2014 (NZBC E1)
- NZS 4404:2010 - *Land Development and Subdivision Infrastructure*; and
- New Zealand Building Code G13 (Wastewater)
- New Zealand Building Code G12 (Water)
- NZS 4431:1989 Earth fill for residential construction (incorporating all amendments).
- NZS 4402 1 TO 7:1986 Methods of testing soils for civil engineering purposes - soil tests

### 1.1.4 Design Risks

The following design risks have been identified as specific items that may impact the design cost or delivery

- Unforeseen Resource consent conditions
- Deeper pockets of topsoil, soft spots, underground features, or contaminated materials
- Changes to scheme plan design resulting in Civil modifications
- Delayed delivery of external information
- Clashes with existing services
- Site delivery delays – material and resource lead times and prioritising

### 1.1.5 Site Location

The Site is located between Williams Road and Okura Road, Mangakuri as illustrated in Figure 1. The address for the parent lot is 42 Okura Road, Kairakau.

The proposed development resides within a 112-hectare rural lot as part of the SR and BJ Williams Charitable Trust farm as highlighted in Figure 1. The total Mangakuri Station size is 1304 Hectares. The proposed 8 lots and the accessways occupy an area of approximately 11 Ha. The balance of the area will remain as part of the farm.


*Figure 1 - Site location*

The Northern boundary of the subdivision is Williams Road. There are two existing farm access points on Williams Road and direct legal access (unformed) at Okura Road as illustrated in Figure 2.


*Figure 2 - Existing access*

The eastern boundary is flanked by ten residential coastal properties along Okura Road with titles ranging between approximately 2000m² – 5000m². Some of these properties are understood to be permanent residences and some are utilised as holiday homes. Included in these lots is 38 Okura Road which owned by a party related to the applicant.

The development site is currently in pasture, with poplar trees planted on some of the slopes. The existing terrain is moderate to steep with interspersed flatter areas. The development area includes other features such as an existing pond and two ephemeral streams.

Figures 3 – 8 are site photos illustrating the general terrain and features within the development area.

*Figure 3 - site photo near proposed lot 3 - 5 entrance off Williams Road*

*Figure 4 - Existing Pond*

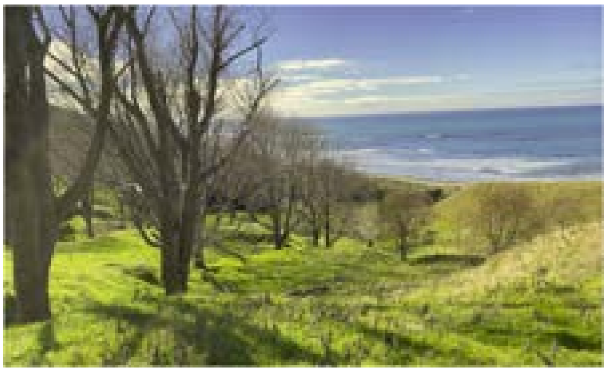


*Figure 5 - site photo looking downhill from southeast of pond*

*Figure 6 - Site photo looking southeast from lot 6 platform position*

*Figure 7 - site photo looking northeast from lot 5 platform*

*Figure 8 - site photo looking east in approximate location of lot 1-2 access*

#### 1.1.6 Information for detailed design

The following information will be required to complete the detailed design

- CHBDC resource consent approval and any subsequent conditions
- Discussions with Contractors and suppliers for suitable aggregate for access construction and possible on-site trials
- Further dialogue with utility providers (power and telecommunications)
- Developed/confirmed stormwater calculations and analysis following further communications with CHBDC and their Engineering consultant Stantec

## 2 PRE-DEVELOPMENT STORMWATER DISCHARGE

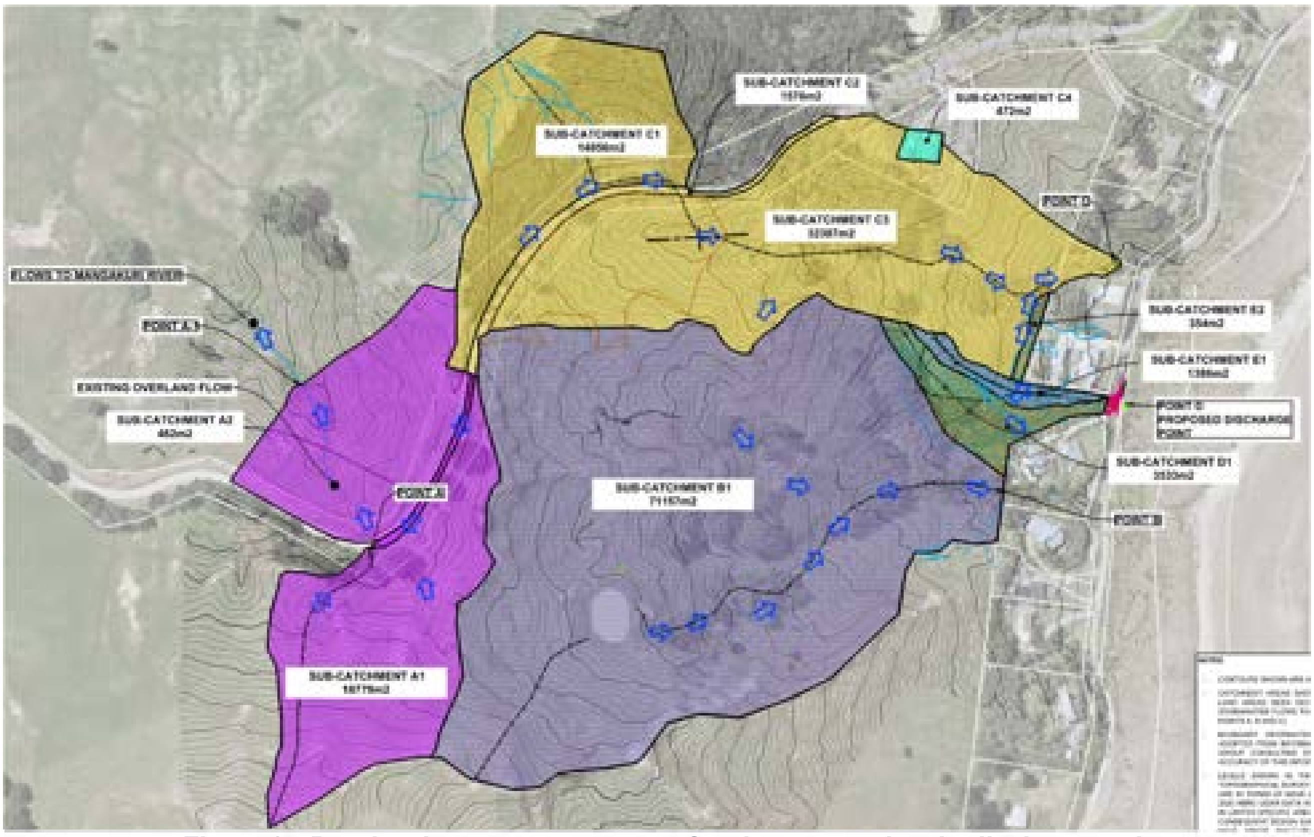



*Figure 9 - Pre-development stormwater Catchments and main discharge points*

The topographical information has been used to analyse the existing stormwater run-off, subsequent Catchment areas and points of discharge from the development area. As illustrated in Figure 9 (full drawing included in Appendix A), the development and surrounding area attributes stormwater run-off to three main stormwater Catchments and four main points of discharge, being points A, B, C and A-1. Discharge point A-1 is downstream of the proposed dry stormwater detention pond B and is relevant to the post development calculations. Two smaller Catchments (D and E) are discussed below.

*Figure 10 - Photo looking up Catchment A from Williams Road*

Catchment A run-off flows downhill toward Williams Road in an unchanneled form before being conveyed through an existing 375mm diameter culvert crossing Williams Road at point A, as shown on Figure 9. The land on the northern side of Williams Road (Catchment AA1) receiving flow from this culvert is also owned by the Williams Charitable Trust (Mangakuri Station). The discharge from Catchments A and AA1 flow through the Mangakuri Station land to Mangakuri Road and the Mangakuri River beyond.

Catchment B run-off commences as sheet flow across steep pasture before becoming channelised downstream of the existing pond forming an ephemeral stream. In the lower half of Catchment B, a flatter area resides in the toe of the gully (Figure 11) where poplar trees are present. During site visits in winter (2022) after extended rainfall periods, the toe of this gully was boggy throughout but draining to the ephemeral stream that flanks the southern side of the gully (Figure 12). The discharge from this Catchment is point B, at 44 Okura Road (Lot 5 DP 17304).

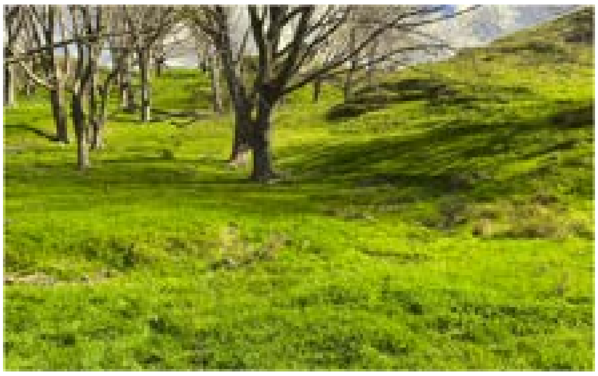


*Figure 11 - toe of gully in Catchment B*

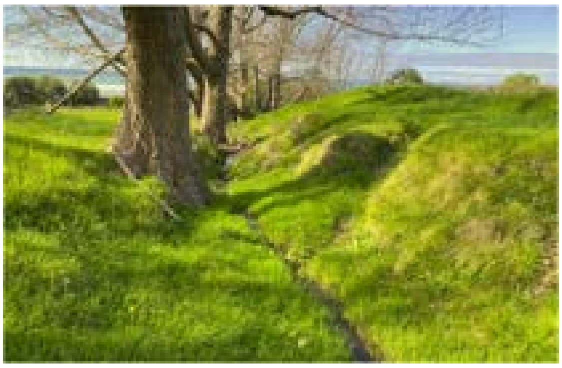


*Figure 12 - lower end of ephemeral stream in Catchment B*

Catchment C starts on the uphill side of Williams Road, northwest of the development. Run-off from this area is collected via an existing 375mm diameter culvert which discharges to the development area on the southern side of Williams Road. A minor channel is present in the last 40 metres of Catchment C (Figures 13 – 14). This channel is categorized as an ephemeral stream, which discharges at point C, north of number 38 Okura Road. This Lot is owned by trustees of the SR and BJ Williams charitable trust.

*Figure 13 - Ephemeral stream located at 38 Okura Road, receiving Catchment C*

*Figure 14 - Ephemeral Stream, just upstream of 38 Okura Road (boundary fence in background)*

Two smaller Catchments (D and E) as shown in Figure 15, attribute stormwater run-off to the properties below (east), but run-off from these two Catchments is of a sheet flow nature and not via any observed discernible concentrated channel or flow path from within the development area.

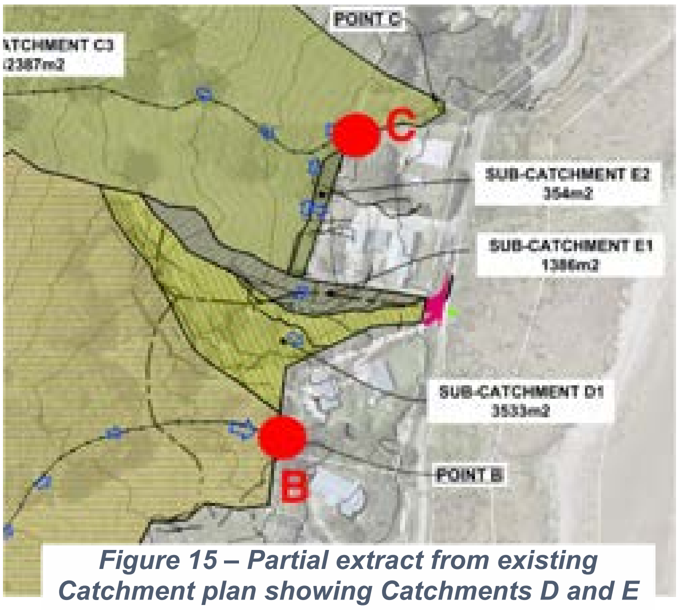



*Figure 15 – Partial extract from existing Catchment plan showing Catchments D and E*

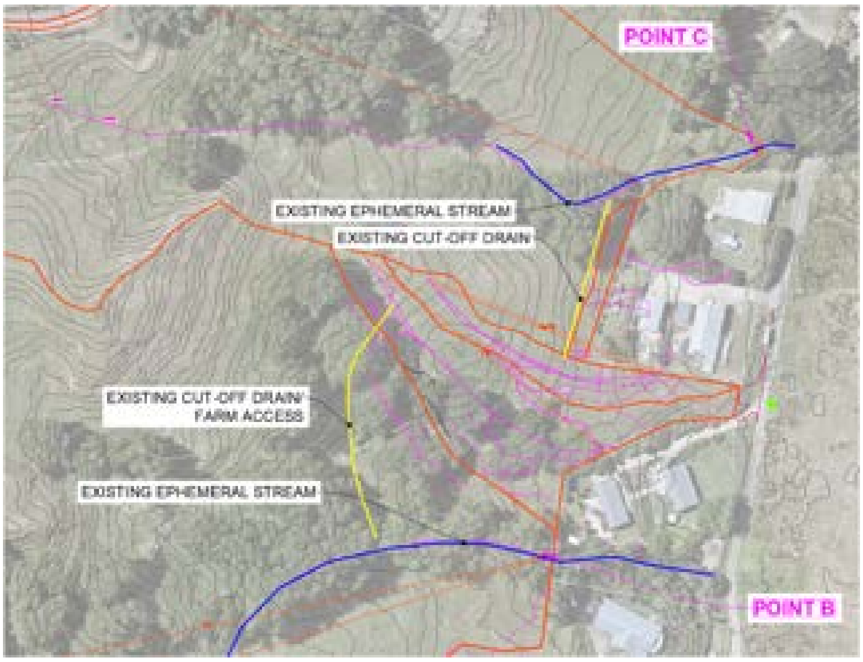



*Figure 16 - Existing cut-off drains*

There are two existing cut-off drains as shown in yellow in Figure 16. The western drain is a result of the farm access track and informally intercepts some run-off (Figure 18), conveying it to the southern ephemeral stream. The eastern cut-off drain (Figure 17) appears to be purposely constructed to prevent run-off from the Catchment above entering number 40 Okura Road.

*Figure 17 - Existing cut-off drain uphill of 40 Okura Road*

*Figure 18 - Existing farm access which functions (in part) as a cut-off drain*

The ephemeral stream that runs through 44 Okura Road has not been analysed as it is outside of the development area, and the proposal seeks to reduce predevelopment flow rates to this point.

As 38 Okura Road is owned by the applicant, the ephemeral stream that runs through it will be analysed during developed design to ensure the channel shape and condition is suitable for the pre-development flow. If improvements are necessary these will be presented as part of the Engineering Approval package (developed design), noting that the design intention is that there will be no increase in flow rates to this stream.

The development area and adjacent properties are outside the study area for the HBRC flood hazard mapping.

# 3 POST DEVELOPMENT STORMWATER

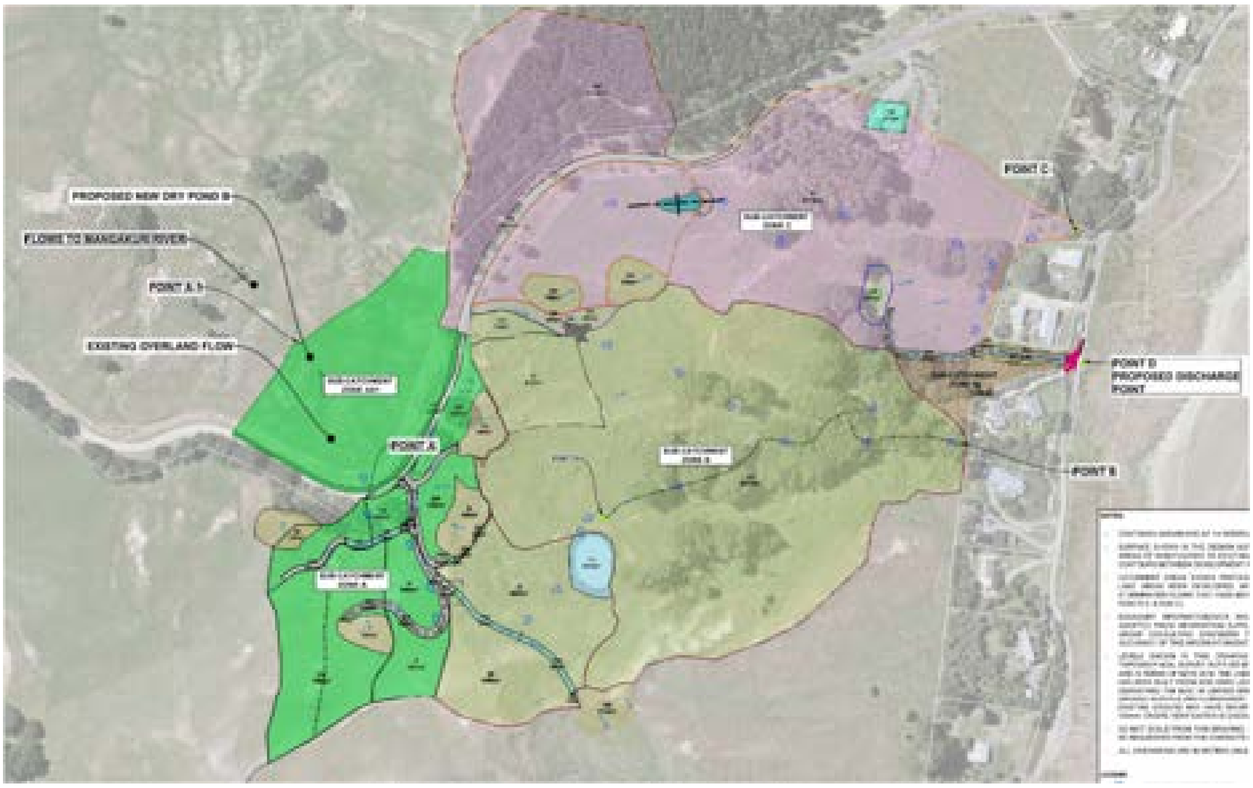



*Figure 19 - Post development stormwater Catchment plan (partial)*

Due to the receiving environment along the eastern boundary of the development, it has been paramount for the stormwater design to achieve neutrality, and not increase stormwater flow rates to any of the properties that flank the eastern boundary. As the development will result in an increase in impervious surfaces (sealed access and roofs), the following measures are proposed to mitigate the change in run-off.

1. Impose a consent notice to enforce all Lot owners to install stormwater detention measures during building consent works
2. Redirect run-off from the proposed lot 6, 7 and 8 platforms – conveying this to the west for lots 6 and 7 and south for lot 8
3. Modify the existing pond so a portion of the pond volume is utilised for stormwater detention and restrict flow rates in Catchment B
4. Construct a dry stormwater detention pond to restrict flow rates in Catchment C
5. Construct a dry stormwater detention pond (dry pond B) to restrict flow rates from Catchment A
6. Significant landscaped areas will increase evapotranspiration as well as improve slope stability and biodiversity

### 3.1.1 Consent notices for stormwater attenuation

It is proposed that a consent notice is imposed on all 8 new buildable Lots created by the subdivision. Calculations prepared to date have adopted assumed roof areas of 150m² on every lot. Assuming larger roof areas would result in less detention required at the ponds considering total detention objectives. The pre and post development run-off calculations have used a conservative run-off coefficient of 0.75 for the platform areas.

The storage volume recommended for detention at each platform has been calculated to cater for up to a 300m² roof area and provide detention for a period equal or greater than the time of concentration (T.O.C) that applies to the Catchment that each given platform resides in (not related to the T.O.C for the lot or dwelling).

As each Lot will be required to collect rainwater for a potable water supply, it is recommended that lot owners install water tanks for the dual purpose of water storage and stormwater detention. It is anticipated that most Lots will install a minimum of two 25,000 litre tanks to provide a year-round potable water supply.

To simplify the detention requirements for each Lot, the following two conditions are recommended referring to the conditions specified in table 1.

**A.** Top 700mm of one 25,000 litre tank, or top 350mm of two 25,000 litre tanks to be available for detention at all times

**B.** Top 500mm of two 25,000 litre tanks to be available for detention at all times

The table below demonstrates the proposed detention on each platform recommended to be enforced through a consent notice.

| LOT | WATER TANK VOLUME REQUIRED FOR DETENTION (L) | DETENTION CONDITION REQUIRED | APPLICABLE TIME OF CONCENTRATION (VOL. REQ. = INFLOW-OUTFLOW x T.O.C) IN MINUTES | TARGET RESTRICTED OUTFLOW FROM TANK (L) |
|---|---|---|---|---|
| 1 | 7800 | A | 10 | 0.87 |
| 3 | 11000 | B | 30 | 0.74 |
| 4 | 11000 | B | 30 | 0.74 |
| 6 | 7800 | A | 10 | 0.87 |
| 7 | 7800 | A | 10 | 0.87 |
| 8 | 7800 | A | 20 | 0.87 |
| 9 | 7800 | A | 30 | 0.87 |
| 10 | 7800 | A | 10 | 0.87 |

*Table 1 – Proposed Lot detention summary*

For any building consent where the roof area is greater than 300m² or where the proposed detention is in underground tanks, a specific design by a competent Civil Engineer will be required to meet the same objectives (restricted outflows equal to or less than those shown in Table 1 and a volume suitable for the time of concentration (T.O.C) as shown in Table 1.

As per the calculations included in appendix B, the resulting detention from all 8 house platforms is equivalent to 30 litres per second (100 year rainfall event), noting there are three different T.O.C applied in these calculations, and results are more clearly summarised in the post development flow calculations.

A typical drawing is included in Appendix A showing the recommended detention arrangement for above ground tanks.

In addition to the detention to be enforced by consent notice, the method of stormwater discharge from each tank is also recommended to be enforced via the consent notice. It is proposed that this notice reads as follows or similar.

*"All water tank discharges from all 8 Lots within the subdivision shall be via bubble up trenches, and any other stormwater discharge from the building platforms shall be installed in a manner that does not result in any scouring or erosion at or downstream of the discharge point".*

A typical detail for a bubble up trench is included in appendix A. Rather than any tank overflows discharging in a concentrated manner which may result in scouring or erosion, the bubble up trenches will disperse the flow over a wider area and shall be installed in a level line across the slopes, below the toe of any engineered fill. The recommended bubble up trench positions as shown on sheet C210 in appendix A are positioned away from areas of fill, and also coordinated (away from) with the anticipated wastewater disposal fields. The bubble up trenches for all 8 platforms will be formed as part of the subdivision works, with a pipe connection available at each building platform.

### 3.1.2 Redirect run-off from lots 6, 7 and 8 building platforms

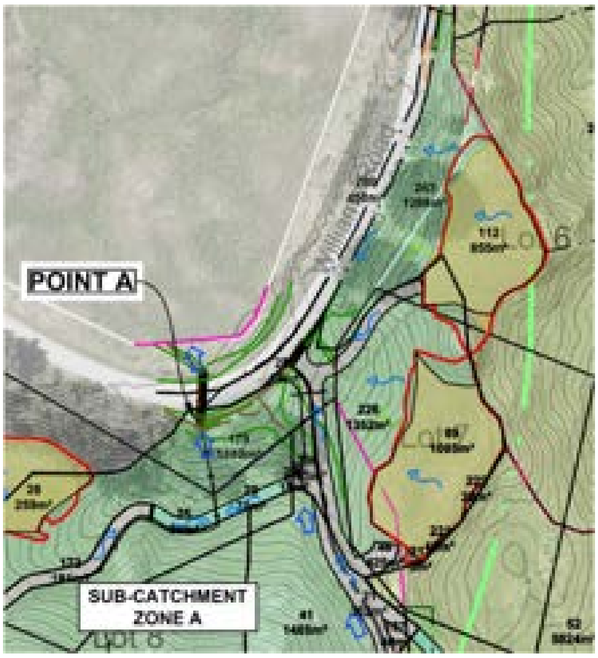



*Figure 20 - Lot 6 and 7 platforms and Catchment flow direction*

The platforms for lots 6, and 7 are located at the top of the hill where a subtle ridge currently tips in an east-west direction. The proposed building platforms from these 2 lots have been designed with a slight grade (circa -1%) to encourage any surface flows to travel in a westward direction. The roof water discharge has also been designed to discharge to the western side of the platforms.

At 50% of each platform area this totals 1945m2. Adopting a 100-year, 30-minute rainfall event (refer to time of concentration calculations in appendix B) and adopting rainfall intensities using RCP 8.5 (refer to section 4 – Stormwater Hydrology). The resulting predevelopment flow rate for this area = 14.6 litre per second. This represents a decrease in flow rate to Catchment B to the same value.

*Figure 21 - Lot 8 platform and Catchment flow direction*

Similar to that described above, the Lot 8 platform is located on an existing ridge. The building platform has been designed to grade to the south to encourage surface run-off to discharge in this direction. The roof water discharge has also been directed to the southern side of the platform.

Using the same calculation methods as described for lot 6 and 7 platforms, the 450m² reduction in Catchment results in a decrease in flow rate to Catchment B of 3.4 litres per second.

### 3.1.3 Utilising existing pond for stormwater detention


*Figure 22 existing pond and attributing post development Catchments*

The origin of the existing pond is unknown, but there are no signs of failure of the pond. The depth of the pond has not yet been determined and will need to be approximately understood before developed design. The depth of the pond has currently been assumed as suitable for the following proposal.

The pond currently has 2 points of overflow. One to the steep face on the eastern side and one to the gentler slope on the northern side.

It is proposed that the top of the bank around the pond is regraded, and the eastern overflow point plugged. To allow the pond to provide detention for the upstream Catchment area, it is proposed that an outlet structure is installed with a restricted outlet (50mm orifice plate) and a scruffy dome grate atop the outlet structure for high level flows and a discharge pipe appropriately sized, discharging to a rock lined spillway (also emergency overflow) to the north, as illustrated in Figure 22. The emergency overflow will be designed to spread flow across a wide face, and the immediate receiving environment will have ground shaping to encourage the lateral dispersion (sheet flow) of stormwater from the pond. The immediate receiving environment is also included in the proposed landscape zone.

Referring to the “Detention calculations at the existing pond” included in appendix B, the resulting detention achieved by utilising 350mm of depth across the pond equates to 129 litres per second, and the available detention volume will provide for 48 minutes of inflow during a 100-year 20-minute rainfall event. The capacity is more than double the required volume for this event using rational peak flow analysis.

As the pond will continue to reside in Mangakuri Station ownership, it is proposed that maintenance of the pond is carried out by the Station. A maintenance register shall be created upon completion of the subdivision works to facilitate the regulate monitoring and any necessary maintenance to this pond, the dry stormwater ponds, and any culverts and stormwater structures that reside within the land owned by Mangakuri Station.

### 3.1.4 Dry Stormwater detention pond

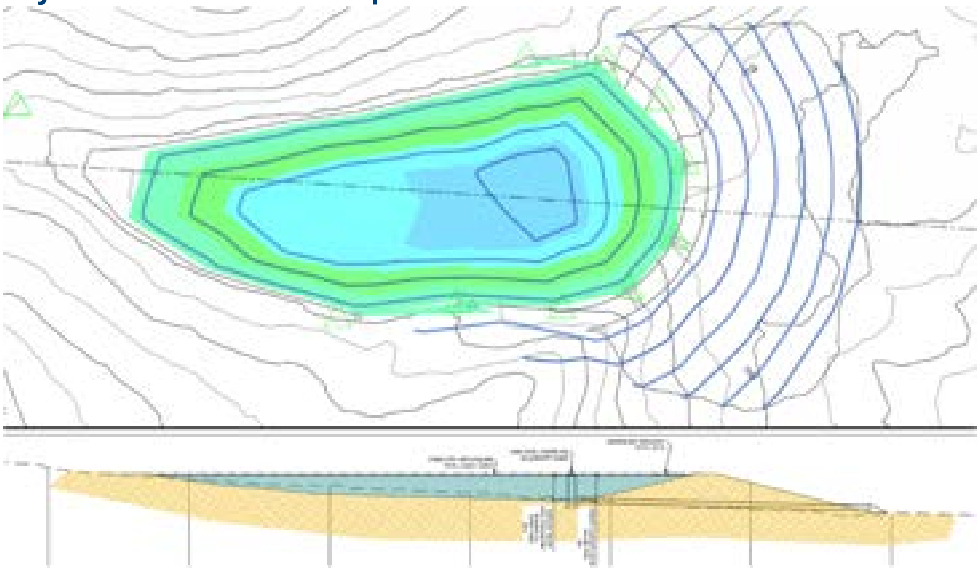


*Figure 23 - Dry stormwater pond model and profile*

The dry stormwater pond has been designed to detain stormwater flows in Catchment C, and limit post development flows. The pond will have a restricted orifice plate that will limit outflow from the pond, allowing the pond to fill during rainfall events, and slowly drain out. As such, reducing downstream peak flow rates and increasing the time of concentration for the Catchment.

A suitable natural gully northeast of Lot 3 provides suitable terrain to construct the dry stormwater pond without excessive excavation. The toe of the pond will require up to 2.3m of fill from existing ground levels but the balance of the dry pond will be within 0.5m of existing ground level. The preliminary pond design is classified as a permitted activity, conforming with conditions outlined in the HBRC Regional Rules – section 6.8.2, including a maximum structure height less than four metres.

The outlet structure and overflow from the dry stormwater pond will be constructed in much the same manner as described for the existing pond.

Referring to the “Detention calculations at new dry pond” included in appendix B, the detention achieved by utilising 425m³ of storage created by the dry pond results in a detention rate of 151 litres per second, and the available detention volume will provide for 47 minutes of inflow during a 100-year 20-minute rainfall event. The capacity is more than required for this event using rational peak flow analysis.

### 3.1.5 Dry stormwater detention pond B


*Figure 24 - Dry stormwater pond B - north of Williams Road*

Due to the unsuitable steep topography at the toe of Catchment A, a dry pond has been designed within the Mangakuri Station land, north of Williams Road where the terrain is more suitable.

The pond will have a restricted orifice plate that will limit outflow from the pond, allowing the pond to fill during rainfall events, and slowly drain out, as such reducing downstream peak flow rates and increasing the time of concentration for the Catchment.

Several iterations of calculations and modeling was undertaken to try and maximize the range of rainfall events that this pond would mitigate. However, without oversizing the pond to enable a more restricted outlet, the 2-year rainfall events are not completely mitigated (refer to calculations in appendix B). The increase in stormwater run-off to point A-1 is considered minor in the context of the overall Catchment and the land in which it is discharged is owned by the applicant who is prepared to accept the slight increase in flow at this location.

The existing 375mm culvert at point A has a gradient of 1 in 9 and is capable of conveying flows for 100-year rainfall events post-development. However, due the expected flow and the pipe gradient, flow velocities will be in excess of 5m per second. To mitigate the potential scouring velocities at the existing culvert, some minor regrading of the land at the existing culvert outlet is required. It will be designed during the developed design phase and will include rip-rap lining. A portion of the paddock will also be fenced off and planted.

### 3.1.6 Stormwater piped conveyance

Piped conveyance for the development is limited to short runs, generally for culverts crossing under the proposed accessways and the construction of the new dry stormwater ponds. All pipes will be designed to conveys flows for 100-year events with rainfall intensities applied respective of the upstream Catchment characteristics.

### 3.1.7 Stormwater discharge to Mangakuri beach

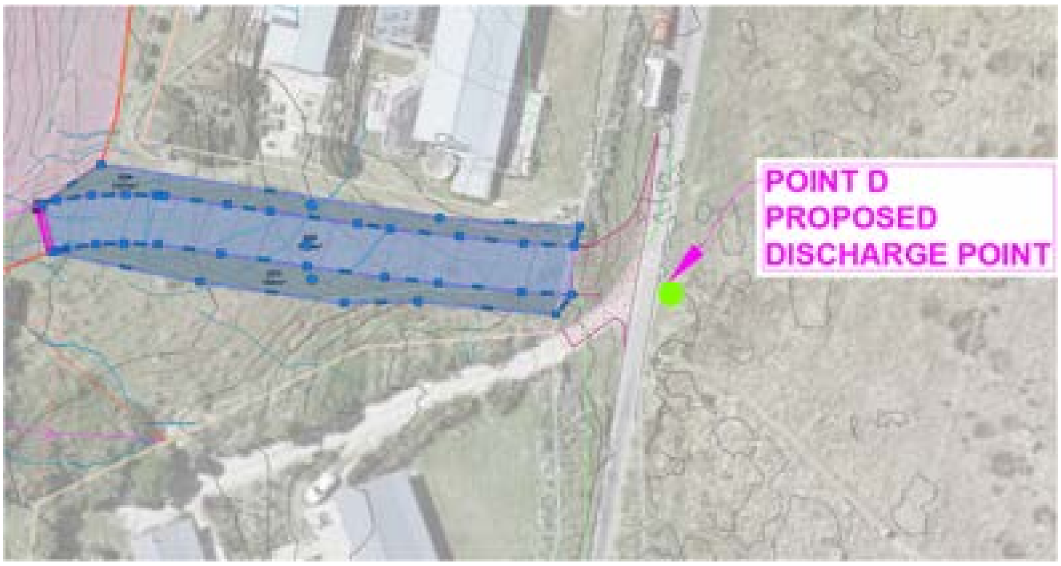



*Figure 25 - Stormwater Catchment proposed to discharge to Mangakuri beach*

There is an increase in stormwater run-off to Okura Road resulting from the formation of R.O.W Three. There is 340m² of new seal and approximately 300m² of grassed or planted batters that will flow to new roadside drains on the southern side of the R.O.W. This area has limited options for stormwater discharge within the development due to this Catchment being lower in elevation than the rest of the development. Stormwater flow generation from this area is approximately 15 litres per second in a 100-year event, approximately 5 litres per second more than that generated from this area in the pre-development scenario. The pre-development scenario however does not discharge to Okura Road and is dispersed to the north and the south of this Catchment area (to numbers 40 and 44 Okura Road). Therefore, this new discharge to the beach will be to the benefit of these 2 properties.

Geotechnical investigations were undertaken to see if there was the ability for this small Catchment to soak to ground within the lowest reach of the development, but investigations found there is little to no soakage potential in the in-situ soils in this location.

Figure 25 and the underlying sub-catchments shown have not been updated to align with the reduced access width (Lot 2 removed from the proposal). This change represents a minor reduction in proposed sealed area which will result in a minor reduction in stormwater flow to point D.

As such it is proposed that this small Catchment is collected via a sump within the accessway or at Okura Road and discharged to the beach sands on the opposite side of Okura Road as illustrated in Figure 25. To prohibit the transmissions of any silt and debris, a syphon outlet sump will be installed with a suitably designed outlet structure, a bottomless sump barrel with the surface grate residing below and away from the edge of the Okura Road formation is proposed. Figure 26 provides an indicative representation of the type of discharge sump proposed.

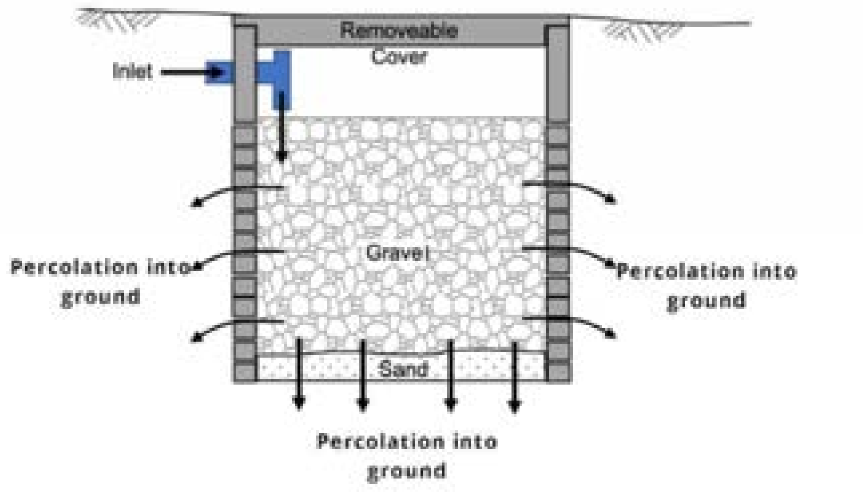



*Figure 26 - indicative type of discharge sump proposed for beach sands*

Advice has been sought from HBRC regarding the discharge of stormwater to the beach. Due to the Catchment size and activity type, this is a permitted activity provided it complies with the conditions/standards and terms as set out in Chapter 42 of the HBRC Regional resource management plan (RRMP).

The ability for the vegetated dunes to receive stormwater flows is evidenced at the 750mm culvert opposite 38 Okura Road. This stormwater discharge point receives flows from Catchment C (5.5 Ha) and as illustrated in Figure 27 below, flows appear to readily dissipate. Infiltration testing at the proposed discharge point will be undertaken during developed design.

*Figure 27 - 750mm culvert at 38 Okura Road and receiving environment*

### 3.1.8 Improved Cut off drain

The existing cut-off drain located uphill (west) of 38-40 Okura Road will be regraded and planted as part of the development works. The drain will be sized to convey flows received from the immediate upstream Catchment which will include the upper reaches of the sealed R.O.W servicing Lot 1. The drain will be sized during developed design and will include a comfortable freeboard to ensure no overtopping of the drain occurs.

### 3.1.9 Landscaped effects on stormwater flows

The landscape zone plan as imposed on the Scheme plan from Surveying the Bay (included in Appendix A) illustrates the extensive planting planned for the development. These landscaped areas will have various benefits including improved slope stability, improved biodiversity, positive visual impacts, and stormwater management benefits.

A reduction in the stormwater run-off coefficient has not been included or assumed in this report or the calculations provided. But it is worth noting that various studies in New Zealand have been undertaken, primarily to review the differences in total water yield between pasture and forested land. Although there is a wide range of variables that affect results, it is accepted that forested or planted areas result in less total water yield than pasture. The proposed significant landscape zones within the development can be expected to have a range of positive effects including a reduction in stormwater run-off over time as plantings mature.

### 3.1.10 Overland flow

Most of the existing overland flow paths will remain in their current locations post development as indicated on the stormwater overview (Sheet C210) included in Appendix A. The exception being immediately downstream of the existing pond and where new access routes will divert flows in the roadside drains and connecting culvert pipes. The existing pond as discussed in Section 3.1.3 has two existing overflow points. The eastern overflow presents a risk for scouring of the pond outer bank, as well as discharging to steep terrain that in sections is channelised and prone to scouring in heavy flows. Therefore, this point of overflow is recommended to be removed/plugged with all pond overflow/discharge being via the northern side of the pond into a rock-lined discharge swale - landscaped zone. This will spread flows across a wider flow path and on gentler terrain. This area ultimately discharges to the same destination downhill, with no change in alignment where flows exit the property.

All culverts and roadside drains will be sized accordingly during developed design.

With all the proposed measures as discussed in the preceding sections, with the exception of Catchment A and AA1 (discharging to point A-1), all overland flow rates all will be reduced for the rainfall events considered in the calculations included in Appendix B.

# 4 STORMWATER HYDROLOGY

Post-development runoff flows were determined using Rational method calculations. The following sections summarises the Rational method calculation undertaken in accordance with *NZBC E1.* The quantity analysis was undertaken for the Catchments of the proposed development.

Primary stormwater conveyance calculations for pipe sizing (access culverts) will be undertaken during developed design and will be based on a 100-year, rainfall events, using the time of concentrations calculated for the post development scenario to select the event durations applicable to each stormwater Catchment. The representative concentration pathway of (RCP) 8.5 for the period 2081-2100 as published by NIWA has been adopted to allow for the most conservative allowance for future climate pathways.

A run-off coefficient of 0.4 has been adopted for all pastural areas, pre and post development, this is higher than the standard pastural coefficient, due to slope correction in accordance with NZBC E1. A significant portion of the development is less than 20% gradient, so this slope correction applied throughout adds more conservatism to the calculations.

Rainfall intensity data was generated using NIWA's High Intensity Rainfall Design System - V4 for the Site. Calculations were based on the RCP8.5 for period 2081-2100 rainfall data.

The Catchment Data is summarized in the tables below, full Catchment data is included in Appendix B.

| **DISCHARGE POINT** | **2 YEAR PRE-DEVELOPMENT DISCHARGE (L/S)** | **2 YEAR POST-DEVELOPMENT DISCHARGE (L/S)** | **DIFFERENCE PRE - POST DEVELOPMENT (NEG. VALUES = DECREASE) L/S** |
|---|---|---|---|
| A-1 | 114 | 130 | 16 |
| B | 235 | 183 | **-52** |
| C | 149 | 135 | **-14** |
| D | 0 | 10.9 | **10.9** |
| 40 OKURA RD | 5 | 0 | **-5** |
| 44 OKURA ROAD | 14 | 11 | **-3** |
| ***TOTALS*** | ***517*** | ***469*** | ***-48*** |

*Table 2-4 Pre – post-development peak flow comparison for 2-year rainfall events*

| DISCHARGE POINT | 100 YEAR PRE-DEVELOPMENT DISCHARGE (L/S) | 100 YEAR POST-DEVELOPMENT DISCHARGE (L/S) | DIFFERENCE PRE - POST DEVELOPMENT<br>(NEG. VALUES = DECREASE) L/S |
|---|---|---|---|
| A-1 | 359 | 130 | **-229** |
| B | 729 | 557 | **-172** |
| C | 457 | 376 | **-82** |
| D | NA | 15 | **15** |
| 40 OKURA RD | 17 | 0 | **-17** |
| 44 OKURA ROAD | 43 | 31 | **-12** |
| ***TOTALS*** | ***1606*** | ***1108*** | ***-498*** |

***Table 2-5 Pre – post development peak flow comparison for 100-year rainfall events***

The Catchment data in the tables above has been summarised by comparing the pre and post development flow to given discharge points. This analysis is more appropriate than comparing total pre and post development flows, as different time of concentrations apply to the post development conditions, and the post development Catchments are not equal to the predevelopment Catchments due to the earthworks and drainage works proposed.

The above data can be summarized as follows

a) For all Catchments within the development, the post development stormwater discharge to all points tabled is 90% of the predevelopment flow for 2-year rainfall events

b) For all Catchments within the development, the post development stormwater discharge to all points tabled is 69% of the predevelopment flow for 100-year rainfall events

c) Disregarding Catchment A and AA1 (discharge to Mangakuri Station land to the north of Williams Road) the post development stormwater discharge to the eastern discharge points is 84% of the predevelopment flow for 2-year rainfall events

d) Disregarding Catchment A and AA1 (discharge to Mangakuri Station land to the north of Williams Road) the post development stormwater discharge to the eastern discharge points is 78% of the predevelopment flow for 100-year rainfall events

e) With the exception of Catchment A, the post development stormwater discharge is less than the predevelopment discharge for the rainfall events analysed.

# 5 WATER SUPPLY

All Lots will be responsible for their own potable water supply and rainwater harvesting is recommended. Part of the rainwater tanks will also be utilised for stormwater detention from all building platforms, with minimum detention volumes and design parameters to be enforced through consent notices.

Firefighting provisions will be considered during detailed design. This may be by way of communal dedicated water tanks for firefighting, or by means of a consent notice on each title to ensure compliance with SNZ PAS 4509:2008

The water tank sizing will be at the discretion of each lot owner, but the tank sizing will need to ensure the minimum stormwater detention volumes are allowed for. It is expected that most if not all sites will require two 25,000 litres water tanks to meet their potable demand and include the necessary detention requirements. Even with two 25,000 litre tanks, future Lot owners can expect that the water tanks may run dry during extended dry periods, depending on water usage. In this circumstance, water tanker supplied/delivered water to top up water tanks can be arranged by the Lot owner.

The potable water supply and associated plumbing for each lot will be subject to building consent approval, and Lot owners may require first flush systems and filtering to ensure the water collected from their roof areas is fit for consumption.

# 6 WASTEWATER

All wastewater disposal for the site will be the lot owner’s responsibility and will be subject to building consent. Advice has been sought from Steve Crockford at EMS as to the type and size of the effluent fields appropriate for the development. After visiting the site and reviewing the soil profiles provided by RDCL, his recommendations for the type of disposal is shallow buried dripper lines, and disposal fields of 750m² minimum, increasing to 1000m² minimum where slopes are more than 20%.

These recommendations have been considered and plotted on sheet C300 (included in Appendix A), to avoid conflicts with proposed stormwater flows and a safe distance from any water bodies. The parcels and landscaped areas have been adjusted to accommodate the indicated disposal fields, ensuring that appropriate effluent disposal is achievable within the parcels and legal arrangements.

# 7 EARTHWORKS

Earthworks and finished levels will be required to align with the overland flow and design levels for the site to achieve the design requirements. A preliminary surface design and cut - fill plan is included in Appendix A. All house platforms will be formed as part of the development works and all earthworks and testing will be undertaken in accordance with,

- NZS 4431:1989 Earth fill for residential construction (incorporating all amendments).
- NZS 4402 1 TO 7:1986 Methods of testing soils for civil engineering purposes - soil tests

The entire development design has carefully considered the Archaeological report prepared by Stella August and Elizabeth Pishief. The platform and access positions have been modified since receiving this report and all earthworks will be undertaken in accordance with the Archaeological report, including the requirement for Archaeological stand over during earthworks where applicable. The archaeological sites of interest have been plotted on the scheme plan provided by Surveying The Bay.

The foundation design for the dwellings will be undertaken at building consent stage, with consideration of the geotechnical reporting undertaken during the development works. The house platform areas will be formed by the developer, with all topsoil being removed, prior to engineered fill placement. The cut-fill plan included in Appendix A illustrates that the majority of the house platforms are in cut material, some fill has been utilised to extend the platforms to allow for onsite maneuvering and parking. The cut-fill extents across the subdivision are recommended to be included in the as-built information provided to CHBDC at the completion of the development works.

The geomorphology of the site as reported by RDCL has been carefully considered with the final position of all building platforms. Extensive geotechnical investigations have been undertaken to obtain a thorough understanding of the ground conditions. Parts of the site once considered for building platforms have now been completely avoided. A preliminary access model has also been created to ensure access to the platforms is possible with access gradients optimised with the platform levels.

Battering around the building platforms will be required as illustrated in the surface design sheets included in Appendix A. Cut and fill batters have been designed in accordance with the recommendations made in the RDCL report, with fill batters no greater than 1V:2H and cut batters no steeper than 1V:1.5H. Typically the design batters have been limited with a maximum cut batter slope of 1V:2H, and fill batters 1V:2.5, however in both cut and fill, these batters have currently predominantly been designed at 1V:2.5 or flatter. The design intention is to limit cut faces and for the earthworks to blend with existing topography.

The accessways will have a pavement designed to manage vehicle movements and loadings applicable for the completed development. The anticipated pavement design will see the topsoil and organic matter stripped. Depending on the difference between stripped levels and design levels, suitable cohesive engineered fill may be used beneath a crushed granular pavement. Much of the access routes will be sealed due to the design gradients. A preference for metaled only access has been maintained for part of the access to Lot 8 due to the geomorphology in this location (excludes building platform), and the potential for natural ground movement.

There is potential for the earthworks to produce adverse effects from erosion and sediments onsite. An Erosion and Sediment Control Plan (ESCP) will be developed in accordance with the requirements of the Hawke's Bay Regional Council Guidelines for Erosion and Sediment Controls and shall be submitted to CHBDC for approval with the developed design drawings for the proposed development.

#### 7.1.1 Preliminary Earthworks volumes

In accordance with the preliminary plans included in Appendix A, preliminary volumes are as follows,

| | | |
|---|---|---|
| 1 | Topsoil stripping (generalised at 300mm) | 6,150m³ |
| 2 | Cut from topsoil strip to subgrade (platforms and access) | 8,200m³ |
| 3 | Cohesive/approved fill required from subgrade level | 7,380m³ |
| 4 | Imported granular fill for access formations | 1520m³ |
| 5 | Cut to waste (#2 - #3) | 820m³ |

Notes on above volumes.

- All topsoil will be respread onsite and discreet stockpiles will be left on each of the building platforms for landscaping purposes
- #3 Cohesive fill required to be site-won where suitable, some imported cohesive fill may be required if sitewon material is not suitable
- It is anticipated that a suitable location within the wider Mangakuri station will be sought to dispose cut to waste material

# 8 ACCESS

### 8.1.1 Accessways

All accessways within the development will be kept in private ownership and ongoing maintenance will be the responsibility of the Lot owners.

The following operative district plan rules have been adhered to with the design of the access routes. The design is currently only in draft format and all junctions and terminations have not yet been modelled, but the following rules will be maintained as a minimum criterion for the developed design.

***CHBDC Operative plan - Standard 9.10(g) Property Access***

*C). If the subdivision is in the Rural Zone and if the subdivision is for residential activities then:*

1. *If the vehicle access to the Road has to serve 2 to 4 residential units each lot shall have direct vehicle access to a vehicle access lot with a minimum legal width of 6.0m and a minimum formed width of 3.5m. A turning area is required.*
2. *If the vehicle access to the Road has to serve 5 to 10 residential units each lot shall have direct vehicle access to a vehicle access lot with a minimum legal width of 6.0m and a minimum formed width of 5.0m. A turning area is required.*

The proposed access routes widths are dimensioned on the surface enlargement sheets included in Appendix A. The design has adopted a minimum formed width of 5m + shoulders on both sides for all shared residential access routes. The single user private access (driveways) have in places been limited to a minimum 3m formed width + shoulders, the narrower width providing adequate manoeuvrability whilst achieving reduced earthworks – particularly where located in steeper terrain. The 3m formed width may be deemed a discretionary activity in terms of the district plan but does comply with the standards established in NZS 4404 and also complies with the HDC access requirements (Table C4 HDC district plan).

Right of way 2 (R.O.W 2) design has been modified following the removal of Lot 2 from the proposal. The 1st 50 metres of R.O.W 2 have maintained a 5m wide seal formation to allow for safe manoeuvring of vehicles in both directions with consideration of the longitudianal gradient and the limited width of Okura Road.

Vehicle tracking using an 8m rigid truck has been undertaken on the access routes' horizontal curvature and in places, the width has been widened to accommodate the vehicle tracking.

The overall preliminary access has been designed to keep earthworks to a minimum whilst achieving longitudinal gradients of less than 20%. As discussed in section 7, most of the access routes will be constructed with a sealed surface (chip seal, asphaltic concrete, or concrete), due to the longitudinal gradients. The proposed metal access for Lot 8 has a longitudinal gradient of less than 10% where a metal surface is suitable.

Turning heads/junctions will be provided on R.O. W's 1 – 3 as indicated on sheet C001 (refer to Appendix A), noting that all internal junctions and vehicle crossings are subject to detailed design.

### 8.1.3 Vehicle crossings

A traffic impact assessment has been completed by East Cape Consultants Limited in November 2022. This assessment supports the three proposed vehicle crossing positions indicating adequate sight lines.

Two new vehicle crossings are proposed onto Williams Road and one new crossing onto Okura Road. All crossings have been designed using vehicle tracking for an 8m rigid truck. This is considered appropriate for the expected traffic movements. The vehicle crossings have also adopted, in part, the design parameters of the CHBDC drawing TS – LT – 2009 – Minimum vehicle crossing for multiple rural residential property.

The preliminary design for the vehicle crossings is shown on the surface enlargement sheets included in Appendix A. Full details for the crossings will be prepared as part of the developed design package for Engineering approval.

# 9 UTILITY SERVICES

The utility companies Centralines (power), Chorus and Gecko (telecommunications) have been consulted regarding the potential for servicing the site. It has been indicated that both power and telecommunications are available for reticulation throughout the site. It is anticipated and has been discussed with Centralines that in-ground ducts to service the development will be installed within the access corridors during construction.

Pricing options are being explored by the developer to either underground the existing overhead power lines that traverse the northern part of the site – currently crossing Lots 3 and 4, or re-route the overhead alignment. One of these options will be required to relocate the overhead power at this location. The Client is continuing discussions with Centralines on this matter.

There is also existing in-ground chorus cables that traverse the proposed Lots 3, 4 and 1, residing in part in the proposed building platform areas. These cables will also require relocation. The Client is continuing the discussion with Chorus on this matter.

The development site currently has a broadband repeater station located at the proposed Lot 8 platform. This repeater station is owned by Gecko broadband and they have an existing agreement with Mangakuri Station. Communications with Gecko have commenced to relocate the repeater station, as well as exploring options to provide hard-wired internet to all platforms.

A plan will be prepared ahead of Engineering approval/building consent submission, with all services servicing the development.

# 10 CONCLUSION

The preliminary servicing, earthworks and access proposed for the development has been designed with guidance from external consultants, regulatory standards and guidelines as stated in section 1 of this report.

With the recommendations made within this report, and the preliminary civil design undertaken to date, we consider the proposed development to be serviceable and feasible from an engineering perspective.

The servicing strategy is summarised below:

- Stormwater – The proposed stormwater system will utilise onsite detention on all Lots via water tanks, enforced via a consent notice on each title. Further detention will be achieved via improvements to the existing pond and include the construction of a new dry pond. These methods of detention along with the access and platform surface design and proposed drainage will result in a decrease in stormwater run-off to the eastern side of the development for the rainfall events analysed.
- Multiple avenues of conservatism are built into the stormwater design including,
    - 100-year rainfall events used in calculations including worse case future climate pathway predictions
    - The detention tanks calculations have been undertaken with 150m² roof areas on each building platform. Larger roof areas will result in increased detention
    - The discharge from the tanks has been calculated at the maximum flow rate. Actual flow rates will be less, until the maximum head of pressure is reached
    - The bubble up discharge trenches from the water/detention tanks will increase the time of concentration and by virtue reduce flow rates to the downstream environment.
- An increase in stormwater run-off will occur at the discharge point located at Williams Road (northwest of the development), where channel improvements will be made to reduce initial velocities to discourage possible scouring to this area which is owned by the developer.
- It is also proposed that a new discharge point is constructed at Mangakuri beach, which will receive a small amount of run-off. This has been discussed with HBRC and is considered a permitted activity in terms of HBRC regional rules.
- Wastewater – Wastewater disposal will be care of each Lot owner, but the development layout has considered the terrain, surrounding environment and proposed stormwater improvements and the Lot arrangements have been coordinated with these factors.
- Water – Each Lot will be responsible for their own water supply, with rainwater harvesting considered appropriate. The water tanks will need to accommodate the on-site stormwater retention requirements as enforced by consent notice on all titles.
- Earthworks – Earthworks will be undertaken by the developer, including the construction of a new access routes, building platforms and drainage aspects
- Access – the preliminary geometric access design has been undertaken in accordance with NZS4404:2010 and has accounted for the recommendations made in the East Cape Consultants traffic assessment. Pavement design will be carried out ahead of Engineering approval.
- Utilities – The relevant utility companies have confirmed the development is serviceable for both power and telecommunications.

# 11 Appendix A – Preliminary Drawings

***REFER TO SEPERATE APPENDIX FILE: STRATA GROUP "J5864 - APPENDIX A-DRG COMBINED RC PLANS_230811"***

## *Rainfall intensities (mm/hr) :: RCP8.5 for the period 2081-2100 (downloaded from https://hirds.niwa.co.nz on the 14th Sept 2022*

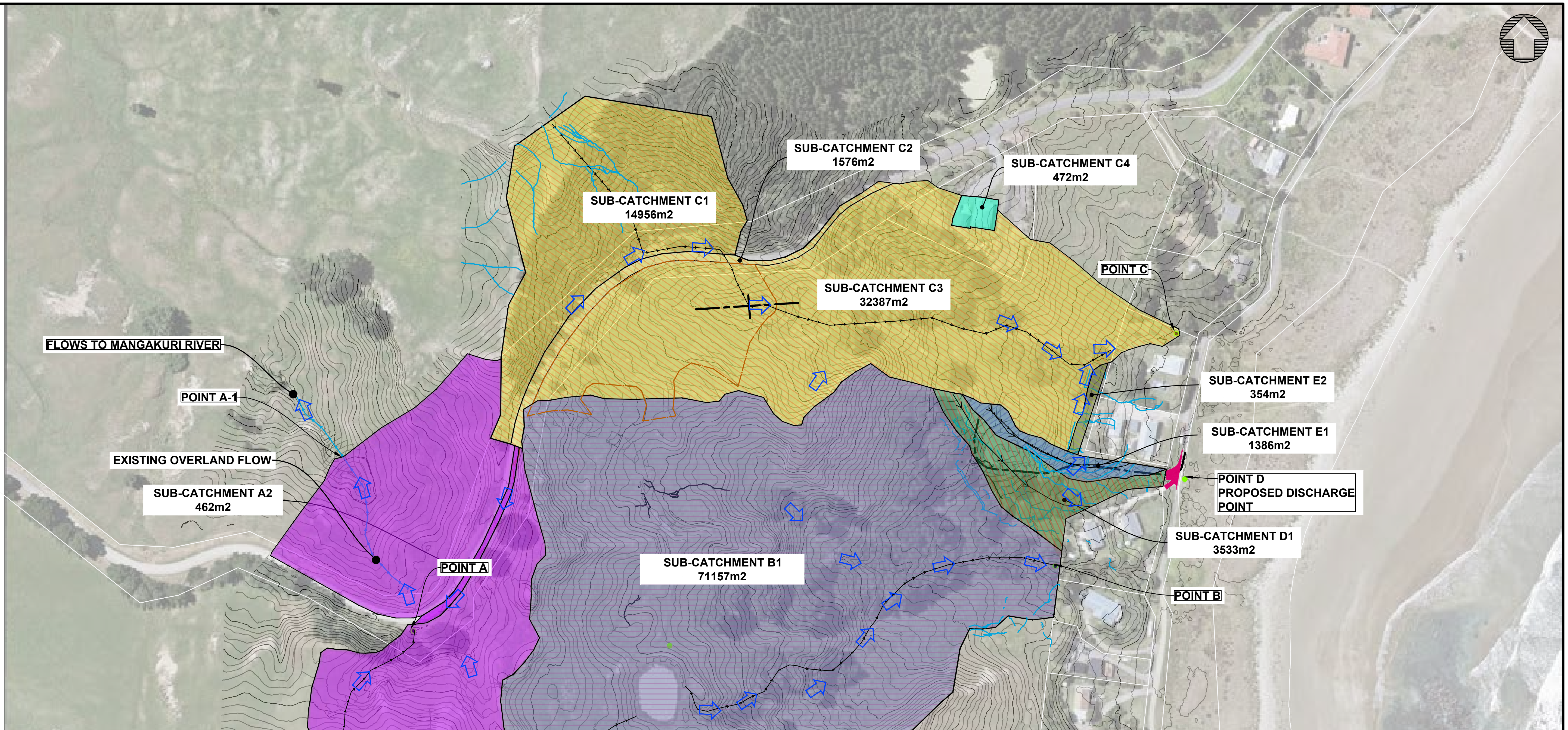
Rainfall intensities (mm/h)
Rainfall intensities (mm/hr) :: RCP8.5 for the period 2081-2100

| ARI | AEP | 10m | 20m | 30m | 1h | 2h | 6h | 12h | 24h | 48h | 72h | 96h | 120h |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.58 | 0.633 | 40.9 | 30.6 | 25.6 | 18.8 | 13.4 | 7.4 | 4.94 | 3.25 | 2.07 | 1.58 | 1.29 | 1.11 |
| 2 | 0.5 | 46.6 | 34.6 | 29 | 21.1 | 15.1 | 8.28 | 5.52 | 3.59 | 2.29 | 1.74 | 1.42 | 1.22 |
| 5 | 0.2 | 67.3 | 49.5 | 41.2 | 29.7 | 20.9 | 11.3 | 7.45 | 4.79 | 3.02 | 2.29 | 1.86 | 1.58 |
| 10 | 0.1 | 84.4 | 61.6 | 51 | 36.5 | 25.5 | 13.6 | 8.91 | 5.68 | 3.56 | 2.68 | 2.17 | 1.84 |
| 20 | 0.05 | 103 | 74.8 | 61.6 | 43.8 | 30.3 | 16.1 | 10.4 | 6.59 | 4.1 | 3.07 | 2.49 | 2.1 |
| 30 | 0.033 | 115 | 83.1 | 68.3 | 48.3 | 33.4 | 17.6 | 11.3 | 7.13 | 4.42 | 3.3 | 2.67 | 2.25 |
| 40 | 0.025 | 124 | 89.2 | 73.2 | 51.6 | 35.5 | 18.7 | 12 | 7.53 | 4.65 | 3.47 | 2.8 | 2.36 |
| 50 | 0.02 | 131 | 94.2 | 77.2 | 54.3 | 37.3 | 19.5 | 12.5 | 7.83 | 4.83 | 3.6 | 2.9 | 2.44 |
| 60 | 0.017 | 137 | 98.3 | 80.4 | 56.5 | 38.7 | 20.2 | 13 | 8.1 | 4.97 | 3.71 | 2.98 | 2.51 |
| 80 | 0.013 | 147 | 105 | 85.9 | 60.2 | 41.1 | 21.3 | 13.6 | 8.48 | 5.21 | 3.87 | 3.11 | 2.62 |
| 100 | 0.01 | 155 | 110 | 90.1 | 62.9 | 42.9 | 22.2 | 14.2 | 8.81 | 5.38 | 3.99 | 3.21 | 2.7 |
| 250 | 0.004 | 189 | 133 | 108 | 74.8 | 50.6 | 25.8 | 16.3 | 10 | 6.08 | 4.48 | 3.59 | 3.01 |

## *Historical rainfall data*

Rainfall intensities (mm/hr) :: Historical Data

| ARI | AEP | 10m | 20m | 30m | 1h | 2h | 6h | 12h | 24h | 48h | 72h | 96h | 120h |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.58 | 0.633 | 31.3 | 23.4 | 19.6 | 14.4 | 10.4 | 5.96 | 4.09 | 2.75 | 1.8 | 1.39 | 1.15 | 0.991 |
| 2 | 0.5 | 35.4 | 26.4 | 22 | 16.1 | 11.6 | 6.61 | 4.52 | 3.03 | 1.98 | 1.52 | 1.26 | 1.08 |
| 5 | 0.2 | 50.6 | 37.2 | 31 | 22.3 | 15.9 | 8.9 | 6.02 | 3.99 | 2.58 | 1.97 | 1.62 | 1.39 |
| 10 | 0.1 | 63 | 46 | 38.1 | 27.3 | 19.2 | 10.7 | 7.16 | 4.7 | 3.01 | 2.3 | 1.88 | 1.61 |
| 20 | 0.05 | 76.8 | 55.7 | 45.9 | 32.6 | 22.8 | 12.5 | 8.34 | 5.44 | 3.46 | 2.62 | 2.14 | 1.83 |
| 30 | 0.033 | 85.6 | 61.7 | 50.7 | 35.9 | 25 | 13.6 | 9.05 | 5.88 | 3.72 | 2.82 | 2.3 | 1.96 |
| 40 | 0.025 | 92.1 | 66.3 | 54.4 | 38.4 | 26.7 | 14.4 | 9.56 | 6.19 | 3.91 | 2.95 | 2.41 | 2.05 |
| 50 | 0.02 | 97.3 | 69.9 | 57.2 | 40.3 | 27.9 | 15.1 | 9.97 | 6.44 | 4.06 | 3.06 | 2.49 | 2.12 |
| 60 | 0.017 | 102 | 72.9 | 59.7 | 41.9 | 29 | 15.6 | 10.3 | 6.64 | 4.18 | 3.15 | 2.56 | 2.17 |
| 80 | 0.013 | 109 | 77.8 | 63.6 | 44.5 | 30.7 | 16.5 | 10.8 | 6.96 | 4.37 | 3.28 | 2.67 | 2.26 |
| 100 | 0.01 | 115 | 81.7 | 66.7 | 46.6 | 32.1 | 17.1 | 11.2 | 7.21 | 4.51 | 3.39 | 2.75 | 2.33 |
| 250 | 0.004 | 140 | 98.6 | 80 | 55.4 | 37.8 | 19.9 | 12.9 | 8.21 | 5.09 | 3.8 | 3.07 | 2.6 |




**NOTES:**

- CONTOURS SHOWN ARE AT 1m INTERVALS
- CATCHMENT AREAS SHOWN PERTAIN TO THE WIDER CACTMENTS OF THE LAND AREAS BEEN DEVELOPED, WITH REGARD TO THE INFLUENCE OF STORMWATER FLOWS THAT PASS BEYOND THE DEVELOPMENT PARCELS (AT POINTS A, B AND C)
- BOUNDARY INFORMATION/DATA SHOWN IN THIS DRAWING HAS BEEN ADOPTED FROM INFORMATION SUPPLIED BY SURVEYING THE BAY. STRATA GROUP CONSULTING ENGINEERS TAKE NO RESPONSIBILITY FOR THE ACCURACY OF THIS INFORMATION/DATA.
- LEVELS SHOWN IN THIS DRAWING HAVE BEEN ADOPTED FROM THE TOPOGRAPHICAL SURVEY SUPPLIED BY SURVEYING THE BAY (28/07/2022) AND ARE IN TERMS OF NZVD 2016. THE SURFACE SHOWN HAS BEEN BUILT FROM 2020 HBRC LiDAR DATA WITH GROUND SURVEY INPUT (SURVEYING THE BAY) IN LIMITED SPECIFIC AREAS. AS SUCH THE EXISTING GROUND SURFACE AND CONSEQUENT DESIGN SURFACE THAT DAYLIGHTS TO EXISTING GROUND MAY HAVE MINOR INACCURACIES, EXPECTED TO BE +/- 100mm. ONSITE VERIFICATION IS ENCOURAGED DURING CONSTRUCTION
- DO NOT SCALE FROM THIS DRAWING. ANY ADDITIONAL DIMENSIONS SHOULD BE REQUESTED FROM THE CONTACTS BELOW.
- ALL DIMENSIONS ARE IN METRES UNLESS SHOWN OTHERWISE.

**LEGEND**

= EXISTING OVERLAND FLOW CONCENTRATIONS

= TIME OF CONCENTRATION PATHWAYS

SAFETY IN DESIGN

ALL REASONABLY PRACTICABLE STEPS HAVE BEEN TAKEN TO ENSURE SAFETY IN DESIGN HAS BEEN CONSIDERED WITHIN STRATA GROUP'S SCOPE OF WORK FOR THIS DESIGN IN ACCORDANCE WITH IPENZ PRACTICE NOTE 07 "DESIGN FOR SAFETY IN BUILDINGS AND OTHER STRUCTURES (JULY 2006)". IT REMAINS THE RESPONSIBILITY OF THE OWNER AND/OR OPERATOR TO ENSURE APPROPRIATE PRACTICES ARE IN PLACE TO PROTECT THE SAFETY OF THE WORKERS AND THE PUBLIC IN THE OPERATION OF THE FACILITY.

| REV | REASON FOR ISSUE | DATE | BY |
|---|---|---|---|
| 1 | FOR RESOURCE CONSENT | 28/09/22 | SG |

THE CONTRACTOR IS TO BE AWARE OF ALL INSPECTIONS TO BE MADE BY THE ENGINEER AS A REQUIREMENT OF THE PRODUCER STATEMENT PS4 CONSTRUCTION REVIEW DOCUMENTATION. THE ENGINEER WILL REQUIRE 24 HOURS PRIOR NOTIFICATION FOR ALL INSPECTIONS.

stratagroup
CONSULTING ENGINEERS
P 06 876 7646
F 06 876 7645
www.stratagroup.net.nz
PO BOX 758
Business HQ
1/308 Queen Street East
Hastings, New Zealand
Structural Fire Civil Project Management

CLIENT: SR & BJ WILLIAMS CHARITABLE TRUST BOARD

PROJECT: MANGAKURI STATION SUBDIVISION
402 MANGAKURI ROAD, MANGAKURI

TITLE: PRE-DEVELOPMENT STORMWATER CATCHMENT PLAN



| | |
|---|---|
| DESIGNED | SG |
| DRAWN | SG |
| CHECKED | RN |
| DATE | 29/11/22 |

0 25 50 75
Full Size 1:1250 ; Half Size 1:2500
Scale (m)

| PROJECT NO.: | SHEET: | REVISION: |
|---|---|---|
| J5864 | C200 | 1 |

PRELIMINARY
NOT FOR CONSTRUCTION

PATH:J:\SR & BJ WILLIAMS CHARITABLE TRUST BOARD\J5864 - MANGAKURI ROAD SUBDIVISION\2 - DWGS\CIVIL3D\DESIGN\SHEETS\J5864-DRG-CATCHMENT PLAN.DWG DATE:01/12/2022

strata group

**Client :** SR & BJ Williams Charitable Trust
**Project:** 402 mangakuri Road, Mangakuri

Date: 1/02/2022
Revision 1
Page No. X

## PRE-DEVELOPMENT TIME OF CONCENTRATION CALCULATION

By: SG

***FRIEND FORMULA FOR TIME OF CONCENTRATION (NON CHANELLISED FLOW USING SURFACE ROUGHNESS)***

**Horton's n roughness values for overland flow**

| Surface Type | n |
|---|---|
| Asphalt/concrete | 0.010 – 0.012 |
| Bare sand | 0.010 – 0.060 |
| Bare clay/loam | 0.012 – 0.033 |
| Gravelled surface | 0.012 – 0.030 |
| Short grass | 0.100 – 0.200 |
| Lawns | 0.200 – 0.300 |
| Pasture | 0.300 – 0.400 |
| Dense shrubbery | 0.400 |

**SUB-CATCHMENT ZONE A**

| Formula value | Entered values | Unit |
|---|---|---|
| n = | 0.1 | |
| L = | 190 | m |
| s = | 24 | % |
| **Calculated result** | | |
| t = | 29.9 | minutes |

**SUB-CATCHMENT ZONE B (PART 1) TO POND**

| Formula value | Entered values | Unit |
|---|---|---|
| n = | 0.1 | |
| L = | 115 | m |
| s = | 26 | % |
| **Calculated result** | | |
| t = | 24.9 | minutes |

**SUB-CATCHMENT ZONE C**

| Formula value | Entered values | Unit |
|---|---|---|
| n = | 0.1 | |
| L = | 418 | m |
| s = | 18 | % |
| **Calculated result** | | |
| t = | 41.1 | minutes |

**SUB-CATCHMENT ZONE D**

| Formula value | Entered values | Unit |
|---|---|---|
| n = | 0.1 | |
| L = | 113 | m |
| s = | 16 | % |
| **Calculated result** | | |
| t = | 27.3 | minutes |

**SUB-CATCHMENT ZONE E**

| Formula value | Entered values | Unit |
|---|---|---|
| n = | 0.1 | |
| L = | 98 | m |
| s = | 17 | % |
| **Calculated result** | | |
| t = | 25.8 | minutes |

***BRANSBY WILLIAMS FORMULA FOR TIME OF CONCENTRATION IN CHANNELISED RURAL CATCHMENTS (NO SURFACE ROUGHNESS ADJUSTMENT)***

$T_c$ (minutes) = $14LA^{-0.1}S_e^{-0.2}$

where L = length of catchment in kilometres measured along the flow path

A = catchment area ($km^2$)

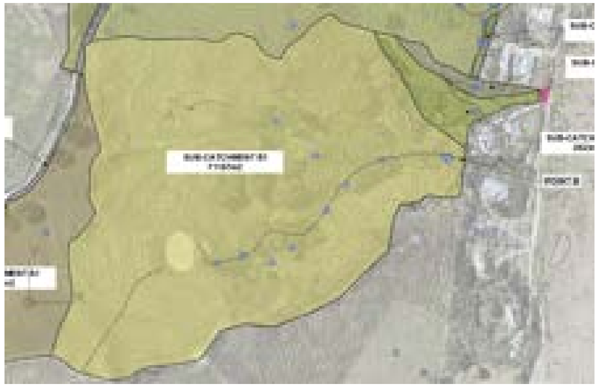
$S_e$ = average slope H/L (metres vertical per metre horizontal)

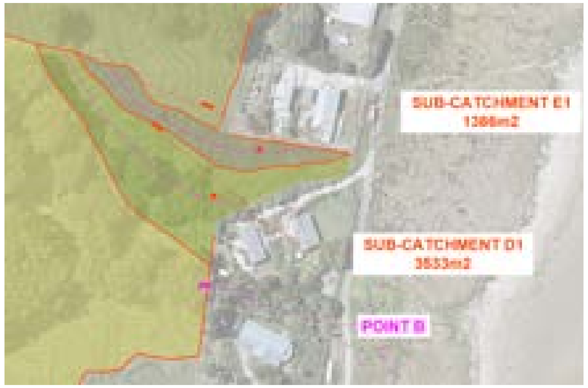
**OVERLAND CHANNELISED FLOW SUB-CATCHMENT ZONE B (PART 2) (D.S OF POND)**

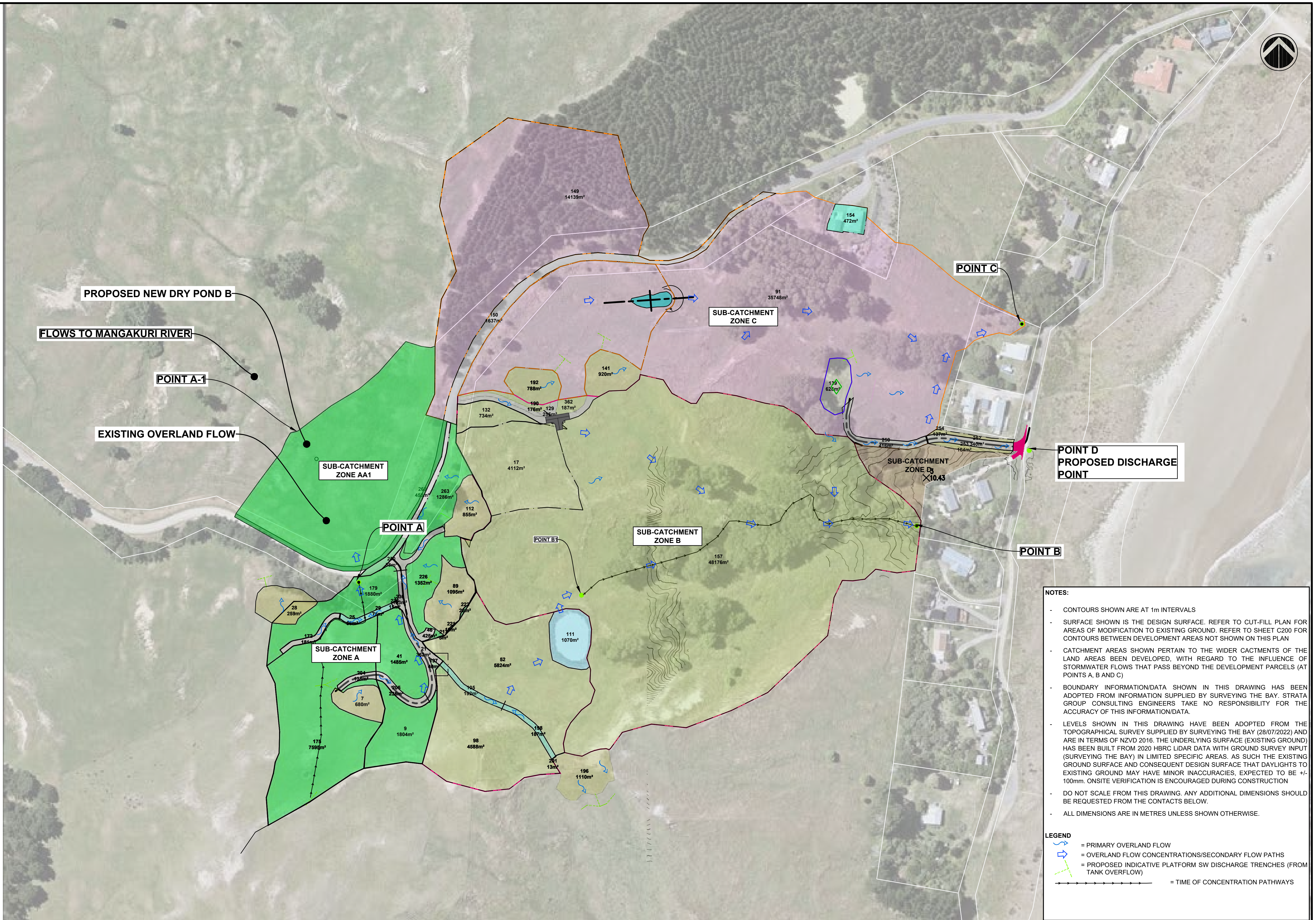
| Formula value | Entered values | Unit |
|---|---|---|
| A = | 47534 | m2 |
| A = | 0.047534 | km 2 |
| L = | 0.273 | km |
| s = | 0.1900 | |
| **Calculated result** | | |
| t (MINUTES)= | 7.2 | minutes |

***A GOOD PORTION OF THIS FLOW PATH IS NOT CHANNELISED, BUT FOR CONSERVATISM (SHORTER DURATION = INCREASED FLOW RATE), THE CHANELISED CALCULATION HAS BEEN APPLIED TO THE ENTIRE ROUTE DOWNSTREAM OF THE POND***

**OVERLAND FLOW TIME FOR SUB-CATCHMENT ZONE B = 32.2 MINUTES**


NOTES:

- CONTOURS SHOWN ARE AT 1m INTERVALS
- SURFACE SHOWN IS THE DESIGN SURFACE. REFER TO CUT-FILL PLAN FOR AREAS OF MODIFICATION TO EXISTING GROUND. REFER TO SHEET C200 FOR CONTOURS BETWEEN DEVELOPMENT AREAS NOT SHOWN ON THIS PLAN
- CATCHMENT AREAS SHOWN PERTAIN TO THE WIDER CACTMENTS OF THE LAND AREAS BEEN DEVELOPED, WITH REGARD TO THE INFLUENCE OF STORMWATER FLOWS THAT PASS BEYOND THE DEVELOPMENT PARCELS (AT POINTS A, B AND C)
- BOUNDARY INFORMATION/DATA SHOWN IN THIS DRAWING HAS BEEN ADOPTED FROM INFORMATION SUPPLIED BY SURVEYING THE BAY. STRATA GROUP CONSULTING ENGINEERS TAKE NO RESPONSIBILITY FOR THE ACCURACY OF THIS INFORMATION/DATA.
- LEVELS SHOWN IN THIS DRAWING HAVE BEEN ADOPTED FROM THE TOPOGRAPHICAL SURVEY SUPPLIED BY SURVEYING THE BAY (28/07/2022) AND ARE IN TERMS OF NZVD 2016. THE UNDERLYING SURFACE (EXISTING GROUND) HAS BEEN BUILT FROM 2020 HBRC LiDAR DATA WITH GROUND SURVEY INPUT (SURVEYING THE BAY) IN LIMITED SPECIFIC AREAS. AS SUCH THE EXISTING GROUND SURFACE AND CONSEQUENT DESIGN SURFACE THAT DAYLIGHTS TO EXISTING GROUND MAY HAVE MINOR INACCURACIES, EXPECTED TO BE +/- 100mm. ONSITE VERIFICATION IS ENCOURAGED DURING CONSTRUCTION
- DO NOT SCALE FROM THIS DRAWING. ANY ADDITIONAL DIMENSIONS SHOULD BE REQUESTED FROM THE CONTACTS BELOW.
- ALL DIMENSIONS ARE IN METRES UNLESS SHOWN OTHERWISE.

LEGEND

= PRIMARY OVERLAND FLOW
= OVERLAND FLOW CONCENTRATIONS/SECONDARY FLOW PATHS
= PROPOSED INDICATIVE PLATFORM SW DISCHARGE TRENCHES (FROM TANK OVERFLOW)
= TIME OF CONCENTRATION PATHWAYS

SAFETY IN DESIGN

ALL REASONABLY PRACTICABLE STEPS HAVE BEEN TAKEN TO ENSURE SAFETY IN DESIGN HAS BEEN CONSIDERED WITHIN STRATA GROUP'S SCOPE OF WORK FOR THIS DESIGN IN ACCORDANCE WITH IPENZ PRACTICE NOTE 07 "DESIGN FOR SAFETY IN BUILDINGS AND OTHER STRUCTURES (JULY 2006)". IT REMAINS THE RESPONSIBILITY OF THE OWNER AND/OR OPERATOR TO ENSURE APPROPRIATE PRACTICES ARE IN PLACE TO PROTECT THE SAFETY OF THE WORKERS AND THE PUBLIC IN THE OPERATION OF THE FACILITY.

| REV | REASON FOR ISSUE | DATE | BY |
|---|---|---|---|
| 1 | FOR INFORMATION | 19/07/23 | SG |

THE CONTRACTOR IS TO BE AWARE OF ALL INSPECTIONS TO BE MADE BY THE ENGINEER AS A REQUIREMENT OF THE PRODUCER STATEMENT PS4 CONSTRUCTION REVIEW DOCUMENTATION. THE ENGINEER WILL REQUIRE 24 HOURS PRIOR NOTIFICATION FOR ALL INSPECTIONS.


stratagroup CONSULTING ENGINEERS
P 06 876 7646
F 06 876 7645
www.stratagroup.net.nz
PO BOX 758
Business HQ
1/308 Queen Street East
Hastings, New Zealand
Structural Fire Civil Project Management


CLIENT: SR & BJ WILLIAMS CHARITABLE TRUST BOARD

PROJECT: MANGAKURI STATION SUBDIVISION
402 MANGAKURI ROAD, MANGAKURI

TITLE: POST-DEVELOPMENT STORMWATER CATCHMENT PLAN



| | |
|---|---|
| DESIGNED | SG |
| DRAWN | SG |
| CHECKED | RN |
| DATE | 19/07/23 |

0 25 50 75
Full Size 1:1250 ; Half Size 1:2500
Scale (m)

| PROJECT NO.: | SHEET: | REVISION: |
|---|---|---|
| J5864 | C201 | 2 |

PATH:J:\SR & BJ WILLIAMS CHARITABLE TRUST BOARD\J5864 - MANGAKURI ROAD SUBDIVISION\2 - DWGS\CIVIL3D\DESIGN\SHEETS\J5864-DRG-CATCHMENT PLAN.DWG DATE:19/07/2023

Client : SR & BJ Williams Charitable Trust
Project: 402 mangakuri Road, Mangakuri

Date: 1/02/2022
Revision 1
Page No. X
By: SG

## POST DEVELOPMENT TIME OF CONCENTRATION CALCULATION

$$t = \frac{107 \cdot n \cdot L^{0.333}}{s^{0.2}}$$

Where: [illegible]

**FRIEND FORMULA FOR TIME OF CONCENTRATION (NON CHANELLISED FLOW USING SURFACE ROUGHNESS)**

**Horton's n roughness values for overland flow**

| Surface Type | n |
|---|---|
| Asphalt/concrete | 0.010 – 0.013 |
| Bare sand | 0.010 - 0.060 |
| Bare clay/loam | 0.012 - 0.033 |
| Gravelled surface | 0.012 – 0.030 |
| Short grass | 0.100 – 0.200 |
| Lawns | 0.200 - 0.300 |
| Pasture | 0.300 – 0.400 |
| Dense shrubbery | 0.400 |

**SUB-CATCHMENT ZONE A**

| Formula value | Entered values | Unit |
|---|---|---|
| n = | 0.1 | |
| L = | 190 | m |
| s = | 30 | % |
| **Calculated result** | | |
| t = | 28.6 | minutes |

**SUB-CATCHMENT ZONE B (PART 1) TO POND**

| Formula value | Entered values | Unit |
|---|---|---|
| n = | 0.1 | |
| L = | 110 | m |
| s = | 26 | % |
| **Calculated result** | | |
| t = | 24.6 | minutes |

**SUB-CATCHMENT ZONE C**

| Formula value | Entered values | Unit |
|---|---|---|
| n = | 0.1 | |
| L = | 346 | m |
| s = | 16 | % |
| **Calculated result** | | |
| t = | 39.5 | minutes |

$T_c$ (minutes) = $14LA^{-0.1} S_e^{-0.2}$

where L = length of catchment in kilometres measured along the flow path

A = catchment area ($km^2$)

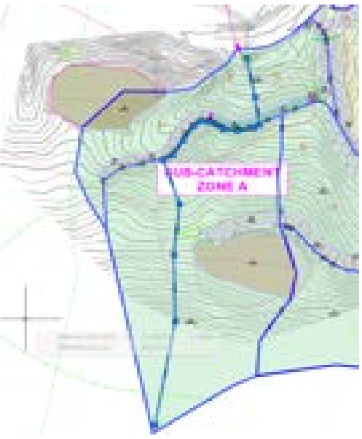
$S_e$ = average slope H/L (metres vertical per metre horizontal

**BRANSBY WILLIAMS FORMULA FOR TIME OF CONCENTRATION IN CHANNELISED RURAL CATCHTMENTS (NO SURFACE ROUGHNESS ADJUSTMENT)**

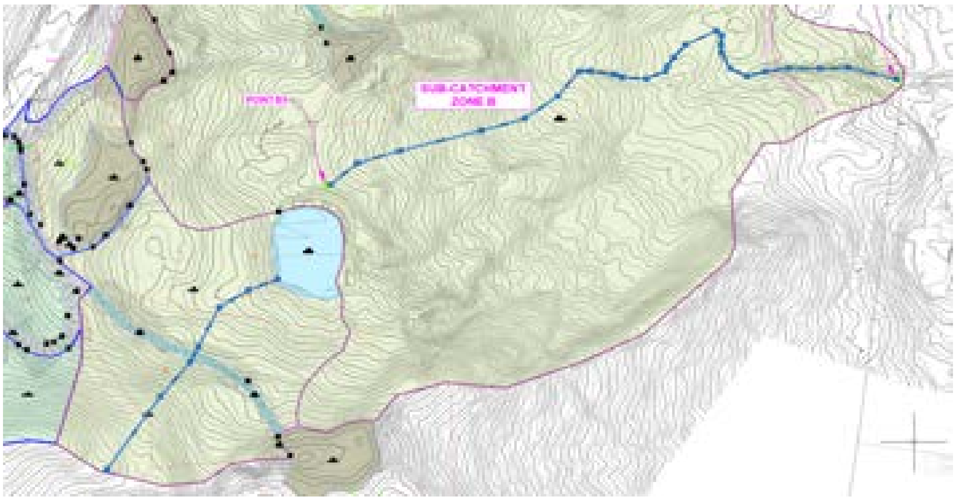
**OVERLAND CHANNELISED FLOW SUB-CATCHMENT ZONE B (PART 2) (D.S OF POND)**

| Formula value | Entered values | Unit |
|---|---|---|
| A = | 45947 | m2 |
| A = | 0.045947 | km 2 |
| L = | 0.273 | km |
| s = | 0.1800 | |
| **Calculated result** | | |
| t (MINUTES)= | 7.3 | minutes |

**TOTAL COMBINED OVERLAND FLOW TIME FOR SUB-CATCHMENT ZONE B = 31.9** MINUTES




FIGURES HAVE NOT BEEN UPDATED TO REFLECT RREMOVAL OF LOTS 2 AND 5, HOWEVER THIS HAS NO EFFECT ON THE POST DEVELOPMENT T.O.C




## PRE DEVELOPMENT STORMWATER CATCHMENT ANALYSI

| | | | |
|---|---|---|---|
| | | Date: | 8/11/2022 |
| | | Revision | 1 |
| **Client :** | SR & BJ Williams Charitable Trust | Page No. | X |
| **Project:** | Mangakuri Station Subdivision | By: | SG |

| RAINFALL INTENSITIES | |
|---|---|
| INTENSITY (2 YEAR - 10 MIN) | 46.60 |
| INTENSITY (10 YEAR - 10 MIN) | 84.40 |
| INTENSITY (50 YEAR - 10 MIN) | 131.00 |
| INTENSITY (100 YEAR - 10 MIN) | 131.00 |
| INTENSITY (2 YEAR - 20 MIN) | 34.60 |
| INTENSITY (10 YEAR - 20 MIN) | 61.60 |
| INTENSITY (100 YEAR - 20 MIN) | 110.00 |
| INTENSITY (2 YEAR - 30 MIN) | 29.00 |
| INTENSITY (10 YEAR - 30 MIN) | 51.00 |
| INTENSITY (100 YEAR - 30 MIN) | 90.10 |
| INTENSITY (2 YEAR - 40 MIN) | 26.63 |
| INTENSITY (10YEAR - 40 MIN) | 46.65 |
| INTENSITY (100 YEAR - 40 MIN) | 81.94 |

**SUB-CATCHMENT A**

**100 YEAR**

TIME OF CONCENTRATION SELECTED = 30 MINUTES

**Q=2.78CIA** l/s

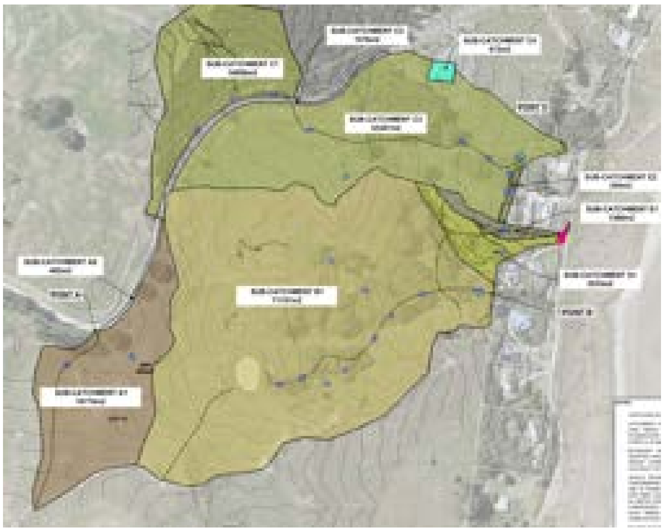
| | | | | | | | | Ha | | (I) 30 MIN |
|---|---|---|---|---|---|---|---|---|---|---|
| **seal** | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | = | 0.000 |
| **metal** | Q= | 2.78 | X | 0.50 | X | I | X | 0.046 | | 5.786 |
| **roof** | Q= | 2.78 | X | 0.40 | X | I | X | 0.000 | | 0.000 |
| **pasture** | Q= | 2.78 | X | 0.40 | X | I | X | 1.878 | | 188.149 |
| **Total Flow l/s** | | | | | | | | 1.924 | | 193.94 |

**2 YEAR**

TIME OF CONCENTRATION SELECTED = 30 MINUTES

**Q=2.78CIA** l/s

| | | | | | | | | Ha | | (I) 30 MIN |
|---|---|---|---|---|---|---|---|---|---|---|
| **seal** | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | = | 0.000 |
| **metal** | Q= | 2.78 | X | 0.50 | X | I | X | 0.046 | | 1.862 |
| **roof** | Q= | 2.78 | X | 0.40 | X | I | X | 0.000 | | 0.000 |
| **pasture** | Q= | 2.78 | X | 0.40 | X | I | X | 1.878 | | 60.559 |
| **Total Flow l/s** | | | | | | | | 1.924 | | 62.42 |



***REFER TO PRE-DEVELOPMENT CATCHMENT PLAN - SHEET C200***

**SUB-CATCHMENT B**

**100 YEAR**

TIME OF CONCENTRATION SELECTED = 30 MINUTES

**Q=2.78CIA** l/s

| | | | | | | | | Ha | | (I) 30 MIN |
|---|---|---|---|---|---|---|---|---|---|---|
| **seal** | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | = | 0.000 |
| **metal** | Q= | 2.78 | X | 0.50 | X | I | X | 0.000 | | 0.000 |
| **roof** | Q= | 2.78 | X | 0.90 | X | I | X | 0.000 | | 0.000 |
| **pond** | Q= | 2.78 | X | 1.00 | X | I | X | 0.107 | | 26.801 |
| **pasture** | Q= | 2.78 | X | 0.40 | X | I | X | 7.009 | | 702.210 |
| **Total Flow l/s** | | | | | | | | 7.116 | | 729.01 |

**2 YEAR**

TIME OF CONCENTRATION SELECTED = 30 MINUTES

**Q=2.78CIA** l/s

| | | | | | | | | Ha | | (I) 30 MIN |
|---|---|---|---|---|---|---|---|---|---|---|
| **seal** | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | = | 0.000 |
| **metal** | Q= | 2.78 | X | 0.50 | X | I | X | 0.000 | | 0.000 |
| **roof** | Q= | 2.78 | X | 0.90 | X | I | X | 0.000 | | 0.000 |
| **pond** | Q= | 2.78 | X | 1.00 | X | I | X | 0.107 | | 8.626 |
| **pasture** | Q= | 2.78 | X | 0.40 | X | I | X | 7.009 | | 226.017 |
| **Total Flow l/s** | | | | | | | | 7.116 | | 234.64 |

**SUB-CATCHMENT C**

**100 YEAR**

TIME OF CONCENTRATION SELECTED = 40 MINUTES

**Q=2.78CIA** l/s

| | | | | | | | | Ha | | (I) 40 MIN |
|---|---|---|---|---|---|---|---|---|---|---|
| **seal** | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | = | 0.000 |
| **metal** | Q= | 2.78 | X | 0.50 | X | I | X | 0.158 | | 17.950 |
| **roof** | Q= | 2.78 | X | 0.90 | X | I | X | 0.000 | | 0.000 |
| **124 Williams Rd** | Q= | 2.78 | X | **0.75** | X | I | X | 0.047 | | 8.064 |
| **pasture** | Q= | 2.78 | X | 0.40 | X | I | X | 4.734 | | 431.377 |
| **Total Flow l/s** | | | | | | | | 4.939 | | 457.39 |

**2 YEAR**

TIME OF CONCENTRATION SELECTED = 40 MINUTES

**Q=2.78CIA** l/s

| | | | | | | | | Ha | | (I) 40 MIN |
|---|---|---|---|---|---|---|---|---|---|---|
| **seal** | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | = | 0.000 |
| **metal** | Q= | 2.78 | X | 0.50 | X | I | X | 0.158 | | 5.834 |
| **roof** | Q= | 2.78 | X | 0.90 | X | I | X | 0.000 | | 0.000 |
| **124 Williams Rd** | Q= | 2.78 | X | **0.75** | X | I | X | 0.047 | | 2.621 |
| **pasture** | Q= | 2.78 | X | 0.40 | X | I | X | 4.734 | | 140.195 |
| **Total Flow l/s** | | | | | | | | 4.939 | | 148.65 |

**SUB-CATCHMENT D**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **100 YEAR** | | | | | | | | | | | |
| TIME OF CONCENTRATION SELECTED | | | | | = | 20 | MINUTES | | | | |
| **Q=2.78CIA** | **l/s** | | | | | | | | | | |
| | | | | | | | | Ha | | **(I) 20 MIN** | |
| **seal** | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | = | 0.000 | |
| **metal** | Q= | 2.78 | X | 0.50 | X | I | X | 0.000 | | 0.000 | |
| **roof** | Q= | 2.78 | X | 0.90 | X | I | X | 0.000 | | 0.000 | |
| **pasture** | Q= | 2.78 | X | 0.40 | X | I | X | 0.353 | | 43.216 | |
| **Total Flow l/s** | | | | | | | | 0.353 | | 43.22 | |
| **2 YEAR** | | | | | | | | | | | |
| TIME OF CONCENTRATION SELECTED | | | | | = | 20 | MINUTES | | | | |
| **Q=2.78CIA** | **l/s** | | | | | | | | | | |
| | | | | | | | | Ha | | **(I) 20 MIN** | |
| **seal** | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | = | 0.000 | |
| **metal** | Q= | 2.78 | X | 0.50 | X | I | X | 0.000 | | 0.000 | |
| **roof** | Q= | 2.78 | X | 0.90 | X | I | X | 0.000 | | 0.000 | |
| **pasture** | Q= | 2.78 | X | 0.40 | X | I | X | 0.353 | | 13.593 | |
| **Total Flow l/s** | | | | | | | | 0.353 | | 13.59 | |

**SUB-CATCHMENT E1**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **100 YEAR** | | | | | | | | | | |
| TIME OF CONCENTRATION SELECTED | | | | | = | 20 | MINUTES | | | |
| **Q=2.78CIA** | **l/s** | | | | | | | | | |
| | | | | | | | | Ha | | **(I) 20 MIN** |
| **seal** | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | = | 0.000 |
| **metal** | Q= | 2.78 | X | 0.50 | X | I | X | 0.000 | | 0.000 |
| **roof** | Q= | 2.78 | X | 0.90 | X | I | X | 0.000 | | 0.000 |
| **pasture** | Q= | 2.78 | X | 0.40 | X | I | X | 0.139 | | 16.954 |
| | | | | | | | | 0.139 | | 16.95 |
| **2 YEAR** | | | | | | | | | | |
| TIME OF CONCENTRATION SELECTED | | | | | = | 20 | MINUTES | | | |
| **Q=2.78CIA** | **l/s** | | | | | | | | | |
| | | | | | | | | Ha | | **(I) 20 MIN** |
| **seal** | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | = | 0.000 |
| **metal** | Q= | 2.78 | X | 0.50 | X | I | X | 0.000 | | 0.000 |
| **roof** | Q= | 2.78 | X | 0.90 | X | I | X | 0.000 | | 0.000 |
| **pasture** | Q= | 2.78 | X | 0.40 | X | I | X | 0.139 | | 5.333 |
| | | | | | | | | 0.139 | | 5.33 |

**SUB-CATCHMENT E2**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **100 YEAR** | | | | | | | | | | |
| TIME OF CONCENTRATION SELECTED | | | | | = | 10 | MINUTES | | | |
| **Q=2.78CIA** | **l/s** | | | | | | | | | |
| | | | | | | | | Ha | | **(I) 20 MIN** |
| **seal** | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | = | 0.000 |
| **metal** | Q= | 2.78 | X | 0.50 | X | I | X | 0.000 | | 0.000 |
| **roof** | Q= | 2.78 | X | 0.90 | X | I | X | 0.000 | | 0.000 |
| **pasture** | Q= | 2.78 | X | 0.40 | X | I | X | 0.035 | | 4.330 |
| **Total Flow l/s** | | | | | | | | 0.035 | | 4.33 |
| **2 YEAR** | | | | | | | | | | |
| TIME OF CONCENTRATION SELECTED | | | | | = | 10 | MINUTES | | | |
| **Q=2.78CIA** | **l/s** | | | | | | | | | |
| | | | | | | | | Ha | | **(I) 20 MIN** |
| **seal** | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | = | 0.000 |
| **metal** | Q= | 2.78 | X | 0.50 | X | I | X | 0.000 | | 0.000 |
| **roof** | Q= | 2.78 | X | 0.90 | X | I | X | 0.000 | | 0.000 |
| **pasture** | Q= | 2.78 | X | 0.40 | X | I | X | 0.035 | | 1.834 |
| **Total Flow l/s** | | | | | | | | 0.035 | | 1.83 |

stratagroup CONSULTING ENGINEERS
Ph 06 876 7646 Fax 06 876 7645
PO Box 758 Hastings 4156

SR & BJ Williams Charitable trust
402 Mangakuri Rd, Mangakuri

| | |
|---|---|
| Project No. | J5864 |
| Page No. | x |
| By SG | Date 20/10/2022 |

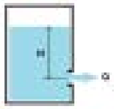
## ORIFICE CALCULATIONS FOR WATER TANK DETENTION

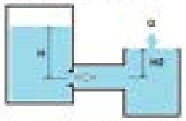
Q = C x A √(2g x H) FOR FREE OUTLET, Q = C x A √(2g x H-H2) FOR FLOODED OUTLET

| | | |
|---|---|---|
| Q = FLOW | | $m^3$ |
| C = DISCHARGE CO-EFFICIENT | 0.75 | |
| A = AREA OF ORIFICE ($m^2$) | 0.0003 | $m^2$ |
| H = HEIGHT FROM CENTRE OF ORIFICE TO MAX WATER LEVEL (m) | 0.5 | m |
| H2 = BUBBLE UP LID LEVEL ABOVE CENTRE OF ORIFICE | 0 | |
| g = GRAVITY | 9.8 | $m/s^2$ |

**COMMON PIPE AREAS**

| DIA | AREA |
|---|---|
| 15 | 0.0002 |
| 20 | 0.0003 |
| 25 | 0.0005 |
| 40 | 0.0013 |
| 50 | 0.0020 |
| 100 | 0.0079 |
| 150 | 0.0177 |
| 200 | 0.0314 |
| 225 | 0.0398 |
| 300 | 0.0707 |
| 375 | 0.1104 |
| 450 | 0.1590 |
| 525 | 0.2165 |
| 600 | 0.2827 |


FREE OUTLET


FLOODED OUTLET

| | | |
|---|---|---|
| CALCULATED DISCHARGE = | 0.738 | l/s |
| ORIFICE = | N/A | mm DIA |
| FLOW = | 0.738 | l/s |
| ORIFICE = | N/A | mm DIA |

**DEVAN 25000 LITRE WATER TANK**

Code: TT255
Empty weight: 375kg
Specific gravity – max: 1.0
Max working temperature: 30°C
Raw material type: Medium density polyethylene
Raw material standards: AS/NZS 2070 – Food contact requirements
AS/NZS4020:2005 – Potable drinking water
AS/NZS4766 Polyethylene storage tanks for water
Complying water tank standard: AS/NZS4766 Polyethylene storage tanks for water
Manhole size: 600mm (located at 6 o'clock)
Diameter: 3.5m
Overall height: 3m
Bottom of Overflow panel: 2.5m
Overflow panels: 4 off (1, 5, 7 & 11 o'clock)
Height to dome part line: 2.29m
Outlet size: 50mm BSPT (2 off)
Outlet – base to centre line: 135mm
Maximum no. of moulded in outlets: 4
Outlet location(s) – standard: 1 & 7 o'clock
Other available locations – non standard: 5 & 11 o'clock
Lifting eyes: 4 (1, 5, 7 & 11 o'clock)

strata group
CONSULTING ENGINEERS

**STORM WATER SYSTEMS DESIGN - ONSITE TANK DETENTION CALCULATIONS**

**Client :** SR & BJ Williams Charitable Trust
**Project:** Mangakuri Station Subdivision

Date: 19/07/2023
Revision 3
Page No. X
By: SG

| MANNINGS COEFFICIENT | |
|---|---|
| ROOF | 0.90 |
| SEALED & CONC | 0.85 |
| METALLED | 0.50 |
| PASTURE | 0.30 |
| PLATFORM ESTIMATED AVERAGE COEF | 0.75 |
| ** 0.1 SLOPE CORRECTION APPLIED TO ALL PASTURE AREAS* | |

**Design Parameters**

Q - CIA / 3600

C = As per Table 1 E1 / VMI
I = Rainfall intensity adopting RCP 8.5, 2081 - 2100
A = As per Catchment Plan

Q = l/s

| | |
|---|---|
| INTENSITY (10 YEAR - 10 MIN) | 84.40 |
| INTENSITY (50 YEAR - 10 MIN) | 131.00 |
| INTENSITY (100 YEAR - 10 MIN) | 155.00 |
| INTENSITY (100 YEAR - 20 MIN) | 110.00 |
| INTENSITY (100 YEAR - 30 MIN) | 90.10 |

| RAINFALL INTENSITIES | |
|---|---|
| INTENSITY (2 YEAR - 10 MIN) | 46.60 |
| INTENSITY (10 YEAR - 10 MIN) | 84.40 |
| INTENSITY (50 YEAR - 10 MIN) | 131.00 |
| INTENSITY (100 YEAR - 10 MIN) | 131.00 |
| INTENSITY (2 YEAR - 20 MIN) | 34.60 |
| INTENSITY (10 YEAR - 20 MIN) | 61.60 |
| INTENSITY (100 YEAR - 20 MIN) | 110.00 |
| INTENSITY (2 YEAR - 30 MIN) | 29.00 |
| INTENSITY (10 YEAR - 30 MIN) | 51.00 |
| INTENSITY (100 YEAR - 30 MIN) | 90.10 |
| INTENSITY (2 YEAR - 40 MIN) | 26.63 |
| INTENSITY (10YEAR - 40 MIN) | 46.65 |
| INTENSITY (100 YEAR - 40 MIN) | 81.94 |

**PLATFORM (ON-SITE) DETENTION (100 year storm event)**

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LOT # | CIVIL3D CATCHMENT ID# | SUB-CATCHMENT ZONE | APPLICABLE PLATFORM AREA | T.O.C TARGET (EVENT DURATION) (MINUTES) | PRE DEVELOPMENT FLOW (L/S) | POST DEVELOPMENT FLOW (L/S) (ENTIRE PLATFORM) | PRE - POST DIFFERNCE (L/S) | EST ROOF AREA | EST ROOF FLOW (L/S) | TARGET MAX RESTRICTED TANK OUTFLOW (L/S)* | RESULTING DETENTION (L/S) | DETENTION DEFECIT (L/S) (H-L) | TIME TO FILL TANKS (MINUTES) | TANK VOLUME AVAILABLE FOR DETENTION (L) | TANK CONDITION REQUIRED FOR DETENTION |
| 1 | 139 | C | 628 | 10 | 8.11 | 20.28 | 12.17 | 150 | 5.81 | 0.87 | 4.94 | 7.23 | 26.21 | 7772 | A |
| 3 | 141 | C | 920 | 30 | 6.91 | 17.27 | 10.36 | 150 | 3.38 | 0.74 | 2.64 | 7.72 | 69.48 | 11000 | B |
| 4 | 192 | C | 788 | 30 | 5.92 | 14.79 | 8.87 | 150 | 3.38 | 0.74 | 2.64 | 6.24 | 69.48 | 11000 | B |
| 6 | 112 | A | 855 | 10 | 11.04 | 27.61 | 16.57 | 150 | 5.81 | 0.87 | 4.94 | 11.62 | 26.21 | 7772 | A |
| 7 | 89 | A | 1095 | 10 | 14.14 | 35.36 | 21.22 | 150 | 5.81 | 0.87 | 4.94 | 16.27 | 26.21 | 7772 | A |
| 11 | 7 | A | 680 | 20 | 6.23 | 15.58 | 9.35 | 150 | 4.13 | 0.87 | 3.26 | 6.10 | 39.80 | 7772 | A |
| 8 | 196 | na (to south) | 450 | 30 | 3.38 | 8.45 | 5.07 | 150 | 3.38 | 0.87 | 3.38 | NA* | 38.34 | 7772 | A |
| 10 | 28 | A | 289 | 10 | 3.73 | 9.33 | 5.60 | 150 | 5.81 | 0.87 | 3.73 | NA* | 34.70 | 7772 | A |
| | | | 5705.00 | | | | | | | | 30.47 | 55.18 | | | |

| TANK CONDITION DETENTION REQUIREMENT | |
|---|---|
| CONDITION A | TOP 700mm OF 1 x 25,000l TANK, OR TOP 350mm OF 2 x 25,000l TANKS |
| CONDITION B | TOP 500mm OF 2 x 25,000L TANKS |

**PLATFORM (ON-SITE) DETENTION (2year storm event)**

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LOT # | CIVIL3D CATCHMENT ID# | SUB-CATCHMENT ZONE | APPLICABLE PLATFORM AREA | T.O.C TARGET (EVENT DURATION) (MINUTES) | PRE DEVELOPMENT FLOW (L/S) | POST DEVELOPMENT FLOW (L/S) (ENTIRE PLATFORM) | PRE - POST DIFFERNCE (L/S) | EST ROOF AREA | EST ROOF FLOW (L/S) | TARGET MAX RESTRICTED TANK OUTFLOW (L/S)* | RESULTING DETENTION (L/S) | DETENTION DEFECIT (L/S) (H-L) | TIME TO FILL TANKS (MINUTES) | TANK VOLUME AVAILABLE FOR DETENTION (L) | TANK CONDITION REQUIRED FOR DETENTION |
| 1 | 139 | C | 628 | 10 | 3.25 | 6.10 | 2.85 | 150 | 1.75 | 0.87 | 0.88 | 1.97 | 147.62 | 7772 | A |
| 3 | 141 | C | 920 | 30 | 2.96 | 5.56 | 2.59 | 150 | 1.09 | 0.74 | 0.35 | 2.25 | 527.58 | 11000 | B |
| 4 | 192 | C | 788 | 30 | 2.54 | 4.76 | 2.22 | 150 | 1.09 | 0.74 | 0.35 | 1.87 | 527.58 | 11000 | B |
| 6 | 112 | A | 855 | 10 | 4.43 | 8.30 | 3.87 | 150 | 1.75 | 0.87 | 0.88 | 3.00 | 147.62 | 7772 | A |
| 7 | 89 | A | 1095 | 10 | 5.67 | 10.63 | 4.96 | 150 | 1.75 | 0.87 | 0.88 | 4.08 | 147.62 | 7772 | A |
| 11 | 7 | A | 680 | 20 | 2.61 | 4.90 | 2.29 | 150 | 1.30 | 0.87 | 0.43 | 1.86 | 303.00 | 7772 | A |
| 8 | 196 | na (to south) | 450 | 30 | 1.45 | 2.72 | 1.27 | 150 | 1.09 | 0.87 | 1.45 | NA* | 89.33 | 7772 | A |
| 10 | 28 | A | 289 | 10 | 1.50 | 2.81 | 1.31 | 150 | 1.75 | 0.87 | 1.50 | NA* | 86.56 | 7772 | A |

**5705.00**

** TOC TARGETS HAVE BEEN SET AT THE TOC APPLICABLE TO THE DOWNSTREAM CATCHMENT*
**RESTRICTED TANK OUTFLOW BASED ON 500mm OF STORAGE AT THE TOP OF 3.66M DIA WATER TANK WITH 20mm ORIFICE. MAX OUTFLOW (AT 500mm HEAD) = 0.74 L/S*
**LOT 8 DISCHARGE TO OUTSIDE OF SUB-CATCHMENT B, SO THE PREDEVELOPMENT FLOW FOR THE PORTION OF THE PLATFORM HAS BEEN INCLUDED AS RESULTING DETENTION (NET DECREASE IN RUN-OFF)*
**LOT 10 DISCHARGE TO OUTSIDE OF SUB-CATCHMENT A, SO RESULTING DETENTION IS EQUAL TO THE PREDEVELOPPMENT FLOW FOR THE PORTION OF THE PLATFORM INCLUDED*

## ACCESS AREAS, PRE - POST DEVELOPMENT SCENARIO

| ACCESS AREAS | CIVIL3D CATCHMENT ID# | POST DEVELOPMENT RUN-OFF COEF | SUB-CATCHMENT ZONE | ACCESS AREA | T.O.C TARGET (EVENT DURATION) (MINUTES) | 100 YEAR PRE DEVELOPMENT FLOW (L/S) | 2 YEAR PRE DEVELOPMENT FLOW (L/S) | 100 year POST DEVELOPMENT FLOW (L/S) | 2 year POST DEVELOPMENT FLOW (L/S) | 100 year PRE - POST DIFFERNCE (L/S) | 2 year PRE - POST DIFFERNCE (L/S) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 252 | 0.85 | D | 340 | 10 | 5.86 | 1.76 | 12.4 | 3.74 | 6.59 | 1.98 | |
| | | | | | | **5.86** | **1.76** | **12.44** | **3.74** | **6.59** | **1.98** | ***SUB-TOTAL*** |
| | 250 | 0.85 | C | 416 | 10 | 7.16 | 2.15 | 15.2 | 4.58 | 8.06 | 2.42 | |
| | | | | | | **7.16** | **2.15** | **15.22** | **4.58** | **8.06** | **2.42** | ***SUB-TOTAL*** |
| | 129 | 0.85 | B | 255 | 30 | 2.55 | 1.32 | 5.4 | 1.75 | 2.87 | 0.43 | |
| | 131 | 0.85 | B | 402 | 30 | 4.02 | 1.30 | 8.6 | 2.75 | 4.53 | 1.46 | |
| | | | | | | **6.58** | **2.62** | **13.98** | **4.50** | **7.40** | **1.88** | ***SUB-TOTAL*** |
| | 46 | 0.85 | A | 425 | 10 | 7.32 | 2.20 | 15.6 | 4.68 | 8.23 | 2.48 | |
| | 236 | 0.85 | A | 103 | 10 | 1.77 | 0.53 | 3.8 | 1.13 | 2.00 | 0.60 | |
| | 21 | 0.85 | A | 352 | 10 | 6.06 | 1.82 | 12.9 | 3.87 | 6.82 | 2.05 | |
| | 205 | 0.85 | A | 236 | 20 | 2.88 | 0.91 | 6.1 | 1.93 | 3.25 | 1.02 | |
| | 204 | 0.85 | A | 138 | 20 | 1.69 | 0.53 | 3.6 | 1.13 | 1.90 | 0.60 | |
| | 235 | 0.85 | A | 15 | 10 | 0.26 | 0.08 | 0.5 | 0.17 | 0.29 | 0.09 | |
| | 29 | 0.50 | A | 76 | 10 | 1.31 | 0.39 | 1.6 | 0.49 | 0.33 | 0.10 | |
| | 25 | 0.50 | A | 68 | 10 | 1.17 | 0.35 | 1.5 | 0.44 | 0.29 | 0.09 | |
| | 240 | 0.85 | A | 38 | 10 | 0.65 | 0.20 | 1.4 | 0.42 | 0.74 | 0.22 | |
| | 172 | 0.85 | A | 181 | 10 | 3.12 | 0.94 | 6.6 | 1.99 | 3.51 | 1.05 | |
| | | | | | | **26.24** | **7.95** | **53.58** | **16.24** | **27.35** | **8.29** | ***SUB-TOTAL*** |
| | | | | | | **45.83** | **14.48** | **95.23** | **29.06** | **49.39** | **14.58** | ***TOTAL*** |

## COMBINED DETENTION DEFECITS BY SUB-CATCHMENT ZONE (WITH ONSITE TANK DETENTION)

| SUB-CATCHMENT ZONE | 100 year COMBINED DETENTION DEFECIT (PLATFORMS + ACCESS) (L/S) | 2 year COMBINED DETENTION DEFECIT (PLATFORMS + ACCESS) (L/S) | T.O.C APPLIED TO CATCHMENT (MIN) | EXTRA STORAGE REQUIRED (m3) |
|---|---|---|---|---|
| **A** | 61.34 | 17.23 | 20 | NA - DOWNSTREAM OWNED BY CLIENT (ENERGY DISSIPATION DEVICE TO BE INSTALLED) |
| **B** | 7.40 | 1.88 | 30 | **13** |
| **C** | 29.24 | 8.51 | 30 | **53** |
| **D** | 6.59 | 1.98 | 10 | **4** |

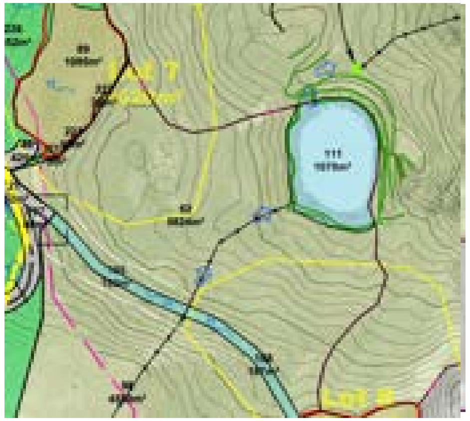
** CATCHMENT E IGNORED AS THERE IS NO INCREASE IN RUN-OFF*

strata group

| | | |
|---|---|---|
| | Date: | 8/11/2022 |
| | Revision | 2 |
| Client : SR & BJ Williams Charitable Trust | Page No. | X |
| Project: Mangakuri Station Subdivision | By: | SG |

## EXISTING POND - DETENTION CALCULATIONS

| civil3d # | AREA (m²) | COEFFICIENT* |
|---|---|---|
| | | |
| 98 | 4588 | 0.40 |
| 198 | 187 | 0.50 |
| 105 | 192 | 0.50 |
| 52 | 5824 | 0.40 |



| RAINFALL INTENSITIES | |
|---|---|
| INTENSITY (2 YEAR - 10 MIN) | 46.60 |
| INTENSITY (10 YEAR - 10 MIN) | 84.40 |
| INTENSITY (50 YEAR - 10 MIN) | 131.00 |
| INTENSITY (100 YEAR - 10 MIN) | 131.00 |
| INTENSITY (2 YEAR - 20 MIN) | 34.60 |
| INTENSITY (10 YEAR - 20 MIN) | 61.60 |
| INTENSITY (100 YEAR - 20 MIN) | 110.00 |
| INTENSITY (2 YEAR - 30 MIN) | 29.00 |
| INTENSITY (10 YEAR - 30 MIN) | 51.00 |
| INTENSITY (100 YEAR - 30 MIN) | 90.10 |
| INTENSITY (2 YEAR - 40 MIN) | 26.63 |
| INTENSITY (10YEAR - 40 MIN) | 46.65 |
| INTENSITY (100 YEAR - 40 MIN) | 81.94 |

**100 YEAR TOTALISED PEAK FLOW TO EXISTING POND**

TIME OF CONCENTRATION SELECTED = 20 MINUTES

| Q=2.78CIA | l/s | | | C | | I | | A | | Q |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Ha | | (I) 20 MIN |
| metal | Q= | 2.78 | X | 0.50 | X | I | X | 0.038 | = | 5.795 |
| seal | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | = | 0.000 |
| platform | Q= | 2.78 | X | 0.75 | X | I | X | 0.000 | = | 0.000 |
| pasture | Q= | 2.78 | X | 0.40 | X | I | X | 1.041 | = | 127.360 |
| Total Flow l/s | | | | | | | | 1.079 | | 133.15 |

**2 YEAR TOTALISED PEAK FLOW TO EXISTING POND**

TIME OF CONCENTRATION SELECTED = 20 MINUTES

| Q=2.78CIA | l/s | | | C | | I | | A | | Q |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Ha | | (I) 20 MIN |
| metal | Q= | 2.78 | X | 0.50 | X | I | X | 0.038 | = | 1.823 |
| seal | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | = | 0.000 |
| platform | Q= | 2.78 | X | 0.75 | X | I | X | 0.000 | = | 0.000 |
| pasture | Q= | 2.78 | X | 0.40 | X | I | X | 1.041 | = | 40.060 |
| Total Flow l/s | | | | | | | | 1.079 | | 41.88 |

**100 YEAR RAINFALL EVENT - POND FLOWS**

| | | | |
|---|---|---|---|
| FLOW TO POND | = | 133.15 | L/S |
| MAX. RESTRICTED OUTFLOW | = | 3.86 | L/S |
| AVE. RESTRICTED OUTFLOW | = | 2.73 | L/S |
| RESULTING DETENTION (USING AVE OUTFLOW) | = | 129.30 | L/S |
| STORAGE DEPTH | = | 0.35 | m |
| APPROX STORAGE VOL. | = | 374.5 | m3 |
| TIME TO FILL POND USING AVE DISCHARGE | = | 48.3 | MINUTES |
| TIME TO DRAIN POND USING AVE DISCHARGE | | 2288.6 | MINUTES |

**2 YEAR RAINFALL EVENT - POND FLOWS**

| | | | |
|---|---|---|---|
| FLOW TO POND | = | 41.88 | L/S |
| MAX. RESTRICTED OUTFLOW | = | 3.86 | L/S |
| AVE. RESTRICTED OUTFLOW | = | 2.73 | L/S |
| RESULTING DETENTION (USING AVE OUTFLOW) | = | 38.02 | L/S |
| STORAGE DEPTH | = | 0.35 | m |
| APPROX STORAGE VOL. | = | 374.5 | m3 |
| TIME TO FILL POND USING AVE DISCHARGE | = | 164.2 | MINUTES |
| TIME TO DRAIN POND USING AVE DISCHARGE | | 2288.6 | MINUTES |

**IN SUMMARY, A RESULTING DETENTION RATE OF 129 L/S CAN BE ACHIEVED DURING 100 YEAR RAINFALL EVENTS, UTILISING THE EXISTING POND AND INSTALLING A RESTRICTED OUTFLOW OF 50mm DIAMETER WITH A MAXIMUM HEAD OF 350mm. THIS EQUATES TO A VOLUME (POND AREA x 350mm) SUITABLE TO DETAIN 129 L/S FOR UP TO 48 MINUTES WHICH IS LONGER THAN THE EVENT DURATION APPLICABLE FOR THE UPPER CATCMENT SIZE AND ALSO GREATER THAN THE APPLICABLE EVENT DURATION FOR THE GREATER CATCHMENT (SUB-CATCHMENT ZONE B).**

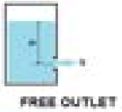
## ORIFICE CALCULATIONS FOR DETENTION AT EXISTING POND MAX OUTFLOW

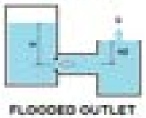
Q = C x A √(2g x H) FOR FREE OUTLET, Q = C x A √(2g x H-H2) FOR FLOODED OUTLET

| | | |
|---|---|---|
| Q = FLOW | | m³ |
| C = DISCHARGE CO-EFFICIENT | 0.75 | |
| A = AREA OF ORIFICE (m²) | 0.0020 | m² |
| H = HEIGHT FROM CENTRE OF ORIFICE TO MAX WATER LEVEL (m) | 0.35 | m |
| H2 = BUBBLE UP LID LEVEL ABOVE CENTRE OF ORIFICE | 0 | |
| g = GRAVITY | 9.8 | m/s² |

**COMMON PIPE AREAS**

| DIA | AREA |
|---|---|
| 15 | 0.0002 |
| 20 | 0.0003 |
| 25 | 0.0005 |
| 40 | 0.0013 |
| 50 | 0.0020 |
| 100 | 0.0079 |
| 150 | 0.0177 |
| 200 | 0.0314 |
| 225 | 0.0398 |
| 300 | 0.0707 |
| 375 | 0.1104 |
| 450 | 0.1590 |
| 525 | 0.2165 |
| 600 | 0.2827 |




CALCULATED DISCHARGE = 3.857 l/s

ORIFICE = N/A mm DIA

FLOW = 3.857 l/s

ORIFICE = N/A mm DIA

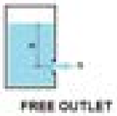
## ORIFICE CALCULATIONS FOR DETENTION AT EXISTING POND AVERAGE OUTFLOW

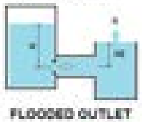
Q = C x A √(2g x H) FOR FREE OUTLET, Q = C x A √(2g x H-H2) FOR FLOODED OUTLET

| | | |
|---|---|---|
| Q = FLOW | | m³ |
| C = DISCHARGE CO-EFFICIENT | 0.75 | |
| A = AREA OF ORIFICE (m²) | 0.0020 | m² |
| H = HEIGHT FROM CENTRE OF ORIFICE TO MAX WATER LEVEL (m) | 0.175 | m |
| H2 = BUBBLE UP LID LEVEL ABOVE CENTRE OF ORIFICE | 0 | |
| g = GRAVITY | 9.8 | m/s² |

**COMMON PIPE AREAS**

| DIA | AREA |
|---|---|
| 15 | 0.0002 |
| 20 | 0.0003 |
| 25 | 0.0005 |
| 40 | 0.0013 |
| 50 | 0.0020 |
| 100 | 0.0079 |
| 150 | 0.0177 |
| 200 | 0.0314 |
| 225 | 0.0398 |
| 300 | 0.0707 |
| 375 | 0.1104 |
| 450 | 0.1590 |
| 525 | 0.2165 |
| 600 | 0.2827 |




CALCULATED = 2.727 l/s

ORIFICE = N/A mm DIA

FLOW = 2.727 l/s

ORIFICE = N/A mm DIA

stratagroup
CONSULTING ENGINEERS

| | |
|---|---|
| Date: | 8/11/2022 |
| Revision | 2 |
| Page No. | X |
| By: | SG |

**Client :** SR & BJ Williams Charitable Trust

**Project:** Mangakuri Station Subdivision

## DETENTION CALCULATIONS FOR NEW DRY POND

| | | |
|---|---|---|
| 192 | 788 | 0.75 |
| 141 | 920 | 0.75 |
| 150 | 1637 | 0.50 |
| x | 8380 | 0.40 |

| RAINFALL INTENSITIES | |
|---|---|
| INTENSITY (10 YEAR - 10 MIN) | 84.40 |
| INTENSITY (50 YEAR - 10 MIN) | 131.00 |
| INTENSITY (100 YEAR - 10 MIN) | 131.00 |
| INTENSITY (2 YEAR - 20 MIN) | 34.60 |
| INTENSITY (10 YEAR - 20 MIN) | 61.60 |
| INTENSITY (100 YEAR - 20 MIN) | 110.00 |
| INTENSITY (2 YEAR - 30 MIN) | 29.00 |
| INTENSITY (10 YEAR - 30 MIN) | 51.00 |
| INTENSITY (100 YEAR - 30 MIN) | 90.10 |
| INTENSITY (2 YEAR - 40 MIN) | 26.63 |
| INTENSITY (10YEAR - 40 MIN) | 46.65 |
| INTENSITY (100 YEAR - 40 MIN) | 81.94 |

**100 YEAR TOTALISED PEAK FLOW TO NEW DRY POND**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| TIME OF CONCENTRATION SELECTED | | | | | = | 20 | MINUTES | | | |
| Q=2.78CIA | l/s | | | C | | I | | A | | Q |
| | | | | | | | | Ha | | (I) 20 MIN |
| metal | Q= | 2.78 | X | 0.50 | X | I | X | 0.164 | = | 25.030 |
| seal | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | = | 0.000 |
| platform | Q= | 2.78 | X | 0.75 | X | I | X | 0.171 | = | 39.173 |
| pasture | Q= | 2.78 | X | 0.40 | X | I | X | 0.838 | = | 102.504 |
| Total Flow l/s | | | | | | | | 1.173 | | 166.71 |

**2 YEAR TOTALISED PEAK FLOW TO NEW DRY POND**

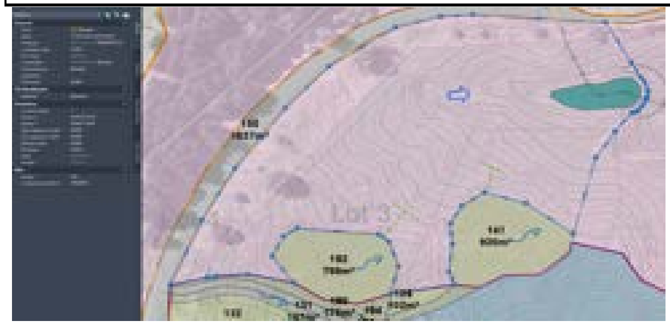
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| TIME OF CONCENTRATION SELECTED | | | | | = | 20 | MINUTES | | | |
| Q=2.78CIA | l/s | | | C | | I | | A | | Q |
| | | | | | | | | Ha | | (I) 20 MIN |
| metal | Q= | 2.78 | X | 0.50 | X | I | X | 0.164 | = | 7.873 |
| seal | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | = | 0.000 |
| platform | Q= | 2.78 | X | 0.75 | X | I | X | 0.171 | = | 12.322 |
| pasture | Q= | 2.78 | X | 0.40 | X | I | X | 0.838 | = | 32.242 |
| Total Flow l/s | | | | | | | | 1.173 | | 52.44 |

**100 YEAR RAINFALL EVENT - DRY POND FLOWS**

| | | | |
|---|---|---|---|
| FLOW TO POND | = | 166.71 | L/S |
| MAX RESTRICTED OUTFLOW | = | 21.63 | L/S |
| AVE RESTRICTED OUTFLOW | = | 15.30 | L/S |
| RESULTING DETENTION (USING AVE OUTFLOW) | = | 151.41 | L/S |
| MAX STORAGE DEPTH | = | 1.68 | m |
| APPROX STORAGE VOL. | = | 425 | m3 |
| TIME TO FILL POND USING AVERAGE DISCHARGE | = | 46.8 | MINUTES |
| IME TO DRAIN POND USING AVERAGE DISCHARGE (WITH NO INFLOW) | | 463.1 | MINUTES |

**2 YEAR RAINFALL EVENT - DRY POND FLOWS**

| | | | |
|---|---|---|---|
| FLOW TO POND | = | 52.44 | L/S |
| MAX RESTRICTED OUTFLOW | = | 21.63 | L/S |
| AVE RESTRICTED OUTFLOW | = | 15.30 | L/S |
| RESULTING DETENTION (USING AVE OUTFLOW) | = | 37.14 | L/S |
| MAX STORAGE DEPTH | = | 1.68 | m |
| APPROX STORAGE VOL. | = | 425 | m3 |
| TIME TO FILL POND USING AVERAGE DISCHARGE | = | 190.7 | MINUTES |
| TIME TO DRAIN POND USING AVERAGE DISCHARGE (WITH NO INFLOW) | | 463.1 | MINUTES |



IN SUMMARY, A RESULTING DETENTION RATE OF up to 151 L/S CAN BE ACHIEVED, UTILISING A NEW DRY POND AND INSTALLING A RESTRICTED OUTFLOW OF 80mm DIAMETER WITH A MAXIMUM HEAD OF 1.68m. THE MODELLED POND VOLUME OF 425m³ WILL BE CAPABLE OF DETAINING AT THIS FLOW RATE FOR 47 MINUTES (during 100 year event), WHICH IS LONGER THAN THE EVENT DURATION APPLICABLE FOR THE RECEIVING CATCHMENT SIZE AND ALSO GREATER THAN THE APPLICABLE EVENT DURATION FOR THE GREATER CATCHMENT (SUB-CATCHMENT ZONE C).

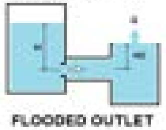
## ORIFICE CALCULATION FOR MAX DEPTH

Q = C x A √(2g x H) FOR FREE OUTLET, Q = C x A √(2g x H-H2) FOR FLOODED OUTLET

| | | |
|---|---|---|
| Q = FLOW | | $m^3$ |
| C = DISCHARGE CO-EFFICIENT | 0.75 | |
| A = AREA OF ORIFICE ($m^2$) | 0.0050 | $m^2$ |
| H = HEIGHT FROM CENTRE OF ORIFICE TO MAX WATER LEVEL (m) | 1.68 | m |
| H2 = BUBBLE UP LID LEVEL ABOVE CENTRE OF ORIFICE | 0 | |
| g = GRAVITY | 9.8 | $m/s^2$ |

**COMMON PIPE AREAS**

| DIA | AREA |
|---|---|
| 15 | 0.0002 |
| 20 | 0.0003 |
| 25 | 0.0005 |
| 40 | 0.0013 |
| 50 | 0.0020 |
| 80 | 0.0050 |
| 100 | 0.0079 |
| 120 | 0.0113 |
| 150 | 0.0177 |
| 200 | 0.0314 |
| 225 | 0.0398 |
| 300 | 0.0707 |
| 375 | 0.1104 |
| 450 | 0.1590 |
| 525 | 0.2165 |
| 600 | 0.2827 |


| | | |
|---|---|---|
| CALCULATED DISCHARGE = | 21.633 | l/s |
| ORIFICE = | N/A | mm DIA |
| FLOW = | 21.633 | l/s |
| ORIFICE = | N/A | mm DIA |

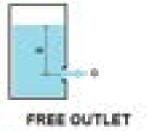
## ORIFICE CALCULATION FOR AVERAGE DEPTH

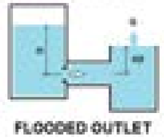
Q = C x A √(2g x H) FOR FREE OUTLET, Q = C x A √(2g x H-H2) FOR FLOODED OUTLET

| | | |
|---|---|---|
| Q = FLOW | | $m^3$ |
| C = DISCHARGE CO-EFFICIENT | 0.75 | |
| A = AREA OF ORIFICE ($m^2$) | 0.0050 | $m^2$ |
| H = HEIGHT FROM CENTRE OF ORIFICE TO MAX WATER LEVEL (m) | 0.84 | m |
| H2 = BUBBLE UP LID LEVEL ABOVE CENTRE OF ORIFICE | 0 | |
| g = GRAVITY | 9.8 | $m/s^2$ |

**COMMON PIPE AREAS**

| DIA | AREA |
|---|---|
| 15 | 0.0002 |
| 20 | 0.0003 |
| 25 | 0.0005 |
| 40 | 0.0013 |
| 50 | 0.0020 |
| 100 | 0.0079 |
| 150 | 0.0177 |
| 200 | 0.0314 |
| 225 | 0.0398 |
| 300 | 0.0707 |
| 375 | 0.1104 |
| 450 | 0.1590 |
| 525 | 0.2165 |
| 600 | 0.2827 |




| | | |
|---|---|---|
| CALCULATED DISCHARGE = | 15.297 | l/s |
| ORIFICE = | N/A | mm DIA |
| FLOW = | 15.297 | l/s |
| ORIFICE = | N/A | mm DIA |

stratagroup
CONSULTING ENGINEERS

| | |
|---|---|
| Date: | 29/11/2022 |
| Revision | 1 |
| Page No. | X |
| By: | SG |

**Client :** SR & BJ Williams Charitable Trust
**Project:** Mangakuri Station Subdivision

# DETENTION CALCULATIONS FOR NEW DRY POND B (on northern side of Williams Rd)

| civil3d # | AREA (m²) | COEFFICIENT* |
|---|---|---|
| 278 | 597 | 0.50 |
| 281 | 12761 | 0.40 |
| | | |
| | | |

| RAINFALL INTENSITIES | |
|---|---|
| INTENSITY (10 YEAR - 10 MIN) | 84.40 |
| INTENSITY (50 YEAR - 10 MIN) | 131.00 |
| INTENSITY (100 YEAR - 10 MIN) | 131.00 |
| INTENSITY (2 YEAR - 20 MIN) | 34.60 |
| INTENSITY (10 YEAR - 20 MIN) | 61.60 |
| INTENSITY (100 YEAR - 20 MIN) | 110.00 |
| INTENSITY (2 YEAR - 30 MIN) | 29.00 |
| INTENSITY (10 YEAR - 30 MIN) | 51.00 |
| INTENSITY (100 YEAR - 30 MIN) | 90.10 |
| INTENSITY (2 YEAR - 40 MIN) | 26.63 |
| INTENSITY (10YEAR - 40 MIN) | 46.65 |
| INTENSITY (100 YEAR - 40 MIN) | 81.94 |

ALSO RECEIVING FLOWS FROM POINT A (DISCHARGE FROMEXISTING CULVERT AT WILLIAMS RD) = (L/S)
**282.8** (100 YEAR - 20 MINUTE EVENT)
**90.6** (2 YEAR - 20 MINUTE EVENT)

**UPSTREAM FLOW TO POINT A HAS BEEN ASSESSED TO HAVE A TIME OF CONCENTRATION OF 20 MINUTES. FOR CONSERVATISM, 20 MINUTES HAS BEEN ADOPTED AS THE TIME OF CONCENTRATION FOR DRY POND B**

## 100 YEAR TOTALISED PEAK FLOW TO NEW DRY POND

TIME OF CONCENTRATION SELECTED = 20 MINUTES

| Q=2.78CIA | l/s | | | C | | I | | A Ha | | Q (I) 20 MIN |
|---|---|---|---|---|---|---|---|---|---|---|
| **metal** | Q= | 2.78 | X | 0.50 | X | I | X | 0.060 | = | 9.128 |
| **seal** | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | = | 0.000 |
| **platform** | Q= | 2.78 | X | 0.75 | X | I | X | 0.000 | = | 0.000 |
| **pasture** | Q= | 2.78 | X | 0.40 | X | I | X | 1.276 | = | 156.093 |
| **FLOW FROM POINT A** | | | | | | | | | | **282.84** |
| **Total Flow l/s** | | | | | | | | | | **448.06** |

## 2 YEAR TOTALISED PEAK FLOW TO NEW DRY POND

TIME OF CONCENTRATION SELECTED = 20 MINUTES

| Q=2.78CIA | l/s | | | C | | I | | A Ha | | Q (I) 20 MIN |
|---|---|---|---|---|---|---|---|---|---|---|
| **metal** | Q= | 2.78 | X | 0.50 | X | I | X | 0.060 | = | 2.871 |
| **seal** | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | = | 0.000 |
| **platform** | Q= | 2.78 | X | 0.75 | X | I | X | 0.000 | = | 0.000 |
| **pasture** | Q= | 2.78 | X | 0.40 | X | I | X | 1.276 | = | 49.098 |
| **FLOW FROM POINT A** | | | | | | | | | | **90.59** |
| **Total Flow l/s** | | | | | | | | | | **142.56** |

## 100 YEAR RAINFALL EVENT - DRY POND FLOWS

| | | | |
|---|---|---|---|
| FLOW TO POND | = | 448.06 | L/S |
| MAX RESTRICTED OUTFLOW | = | 183.66 | L/S |
| AVE RESTRICTED OUTFLOW | = | 129.87 | L/S |
| RESULTING DETENTION (USING AVE OUTFLOW) | = | **318.19** | L/S |
| MAX STORAGE DEPTH | = | 3.1 | m |
| APPROX STORAGE VOL. | = | 586 | m3 |
| TIME TO FILL POND USING AVERAGE DISCHARGE | = | **30.7** | MINUTES |
| ME TO DRAIN POND USING AVERAGE DISCHARGE (WITH NO INFLOW) | | **75.2** | MINUTES |

## 2 YEAR RAINFALL EVENT - DRY POND FLOWS

| | | | |
|---|---|---|---|
| FLOW TO POND | = | 142.56 | L/S |
| MAX RESTRICTED OUTFLOW | = | 183.66 | L/S |
| AVE RESTRICTED OUTFLOW | = | 129.87 | L/S |
| RESULTING DETENTION (USING AVE OUTFLOW) | = | **12.69** | L/S |
| MAX STORAGE DEPTH | = | 1.65 | m |
| APPROX STORAGE VOL. | = | 586 | m3 |
| TIME TO FILL POND USING AVERAGE DISCHARGE | = | **769.4** | MINUTES |
| TIME TO DRAIN POND USING AVERAGE DISCHARGE (WITH NO INFLOW) | | **75.2** | MINUTES |

## 10 YEAR RAINFALL EVENT - DRY POND FLOWS

| | | | |
|---|---|---|---|
| FLOW TO POND | = | 250.91 | L/S |
| MAX RESTRICTED OUTFLOW | = | 183.66 | L/S |
| AVE RESTRICTED OUTFLOW | = | 129.87 | L/S |
| RESULTING DETENTION (USING AVE OUTFLOW) | = | **121.04** | L/S |
| MAX STORAGE DEPTH | = | 3.1 | m |
| APPROX STORAGE VOL. | = | 586 | m3 |
| TIME TO FILL POND USING AVERAGE DISCHARGE | = | **80.7** | MINUTES |
| ME TO DRAIN POND USING AVERAGE DISCHARGE (WITH NO INFLOW) | | **75.2** | MINUTES |

**IN SUMMARY, A RESULTING DETENTION RATE OF up to 318 L/S CAN BE ACHIEVED, UTILISING A NEW DRY POND AND INSTALLING A RESTRICTED OUTFLOW OF 200mm DIAMETER WITH A MAXIMUM HEAD OF 3.1m. THE MODELLED POND VOLUME OF 586m³ WILL BE CAPABLE OF DETAINING AT THIS FLOW RATE FOR 31 MINUTES (during 100-year event), WHICH IS LONGER THAN THE EVENT DURATION APPLICABLE FOR THE UPSTREAM CATCHMENT. THE DRY POND IS ALSO EFFECTIVE FOR MITIGATING THE INCREASED INFLOWS FROM CATCHMENTS A + AA1 FOR 10-YEAR RAINFALL EVENTS, BUT 2-YEAR RAINFALL EVENTS WILL RESULT IN AN INCREASE FROM PRE-DEVELOPMENT FLOWS AT THIS LOCATION.**

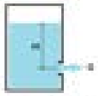
## ORIFICE CALCULATION FOR MAX DEPTH

Q = C x A √(2g x H) FOR FREE OUTLET, Q = C x A √(2g x H-H2) FOR FLOODED OUTLET

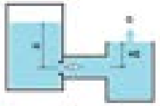
| | | |
|---|---|---|
| Q = FLOW | | m³ |
| C = DISCHARGE CO-EFFICIENT | 0.75 | |
| A = AREA OF ORIFICE (m²) | 0.0314 | m² |
| H = HEIGHT FROM CENTRE OF ORIFICE TO MAX WATER LEVEL (m) | 3.1 | m |
| H2 = BUBBLE UP LID LEVEL ABOVE CENTRE OF ORIFICE | 0 | |
| g = GRAVITY | 9.8 | m/s² |

**COMMON PIPE AREAS**

| DIA | AREA |
|---|---|
| 15 | 0.0002 |
| 20 | 0.0003 |
| 25 | 0.0005 |
| 40 | 0.0013 |
| 50 | 0.0020 |
| 80 | 0.0050 |
| 100 | 0.0079 |
| 120 | 0.0113 |
| 150 | 0.0177 |
| 180 | 0.0254 |
| 200 | 0.0314 |
| 225 | 0.0398 |
| 250 | 0.0491 |
| 300 | 0.0707 |
| 375 | 0.1104 |
| 450 | 0.1590 |
| 525 | 0.2165 |
| 600 | 0.2827 |



FREE OUTLET



FLOODED OUTLET

| | | |
|---|---|---|
| CALCULATED DISCHARGE = | 183.662 | l/s |
| ORIFICE = | N/A | mm DIA |
| FLOW = | 183.662 | l/s |
| ORIFICE = | N/A | mm DIA |

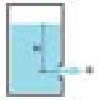
## ORIFICE CALCULATION FOR AVERAGE DEPTH

Q = C x A √(2g x H) FOR FREE OUTLET, Q = C x A √(2g x H-H2) FOR FLOODED OUTLET

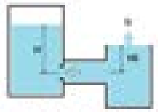
| | | |
|---|---|---|
| Q = FLOW | | m³ |
| C = DISCHARGE CO-EFFICIENT | 0.75 | |
| A = AREA OF ORIFICE (m²) | 0.0314 | m² |
| H = HEIGHT FROM CENTRE OF ORIFICE TO MAX WATER LEVEL (m) | 1.55 | m |
| H2 = BUBBLE UP LID LEVEL ABOVE CENTRE OF ORIFICE | 0 | |
| g = GRAVITY | 9.8 | m/s² |

**COMMON PIPE AREAS**

| DIA | AREA |
|---|---|
| 15 | 0.0002 |
| 20 | 0.0003 |
| 25 | 0.0005 |
| 40 | 0.0013 |
| 50 | 0.0020 |
| 100 | 0.0079 |
| 150 | 0.0177 |
| 200 | 0.0314 |
| 225 | 0.0398 |
| 300 | 0.0707 |
| 375 | 0.1104 |
| 450 | 0.1590 |
| 525 | 0.2165 |
| 600 | 0.2827 |



FREE OUTLET



FLOODED OUTLET

| | | |
|---|---|---|
| CALCULATED DISCHARGE = | 129.869 | l/s |
| ORIFICE = | N/A | mm DIA |
| FLOW = | 129.869 | l/s |
| ORIFICE = | N/A | mm DIA |

| | |
|---|---|
| Date: | 19/07/2023 |
| Revision | 3 |
| Page No. | X |
| By: | SG |

| | |
|---|---|
| Client : | SR & BJ Williams Charitable Trust |
| Project: | Mangakuri Station Subdivision |

## POST DEVELOPMENT STORMWATER CATCHMENT ANALYSIS

| RAINFALL INTENSITIES | |
|---|---|
| INTENSITY (2 YEAR - 10 MIN) | 46.60 |
| INTENSITY (10 YEAR - 10 MIN) | 84.40 |
| INTENSITY (50 YEAR - 10 MIN) | 131.00 |
| INTENSITY (100 YEAR - 10 MIN) | 131.00 |
| INTENSITY (**2 YEAR** - 20 MIN) | 34.60 |
| INTENSITY (**10 YEAR** - 20 MIN) | 61.60 |
| INTENSITY (100 YEAR - 20 MIN) | 110.00 |
| INTENSITY (**2 YEAR** - 30 MIN) | 29.00 |
| INTENSITY (**10 YEAR** - 30 MIN) | 51.00 |
| INTENSITY (100 YEAR - 30 MIN) | 90.10 |
| INTENSITY (2 YEAR - 40 MIN) | 26.63 |
| INTENSITY (10YEAR - 40 MIN) | 46.65 |
| INTENSITY (100 YEAR - 40 MIN) | 81.94 |

| MANNINGS COEFFICIENT | |
|---|---|
| ROOF | 0.90 |
| SEALED & CONC | 0.85 |
| METALLED | 0.50 |
| PASTURE | 0.30 |
| PLATFORM ESTIMATED AVERAGE COEF | 0.75 |

** 0.1 SLOPE CORRECTION APPLIED TO ALL PASTURE AREAS*

### SUB-CATCHMENT AREA A

**SUB-CATCHMENT A AREA BREAK DOWN**

| civil3d # | AREA (m²) | COEFFICIENT* |
|---|---|---|
| 175 | 7595 | 0.4 |
| 7 | 680 | 0.75 |
| 204 | 138 | 0.85 |
| | | |
| | | |
| 9 | 1804 | 0.40 |
| 205 | 236 | 0.85 |
| 21 | 352 | 0.85 |
| 41 | 1485 | 0.40 |
| 197 | 40 | 0.40 |
| | | |
| 222 | 22 | 0.40 |
| 221 | 10 | 0.40 |
| 89 | 1095 | 0.75 |
| 226 | 1352 | 0.40 |
| 46 | 425 | 0.85 |
| | | |
| 28 | 259 | 0.75 |
| 172 | 181 | 0.85 |
| 25 | 68 | 0.50 |
| 29 | 76 | 0.50 |
| 235 | 18 | 0.85 |
| 179 | 1880 | 0.40 |
| | | |
| 260 | 450 | 0.50 |
| 263 | 1286 | 0.40 |
| 112 | 855 | 0.75 |

**100 YEAR SUB CATCHMENT A TOTALISED PEAK FLOW TO POINT A**

TIME OF CONCENTRATION SELECTED = 20 MINUTES

| Q=2.78CIA l/s | | | | C | | I | | A (Ha) | | Q (L/S) (I) 20 MIN |
|---|---|---|---|---|---|---|---|---|---|---|
| metal | Q= | 2.78 | X | 0.50 | X | I | X | 0.059 | = | 9.082 |
| seal | Q= | 2.78 | X | 0.85 | X | I | X | 0.135 | | 35.091 |
| platform | Q= | 2.78 | X | 0.75 | X | I | X | 0.289 | | 66.259 |
| pasture | Q= | 2.78 | X | 0.40 | X | I | X | 1.547 | | 189.278 |
| Total Flow l/s | | | | | | | | 2.031 | | 299.71 |

| | | |
|---|---|---|
| DETAINED FLOWS FROM HOUSE PLATFORMS | = | 16.87 |
| ADJUSTED TOTAL FLOW TO POINT A | = | 282.84 |
| PRE DEVELOPMENT FLOW TO POINT A (30 MIN T.O.C) | = | 193.94 |
| PRE DEVELOPMENT TO POST DEVELOPMENT DIFF. (L/S) | = | 88.90 |
| | | INCREASE IN RUN-OFF |

**2 YEAR SUB CATCHMENT A TOTALISED PEAK FLOW TO POINT A**

TIME OF CONCENTRATION SELECTED = 20 MINUTES

| Q=2.78CIA l/s | | | | C | | I | | A (Ha) | | Q (L/S) (I) 20 MIN |
|---|---|---|---|---|---|---|---|---|---|---|
| metal | Q= | 2.78 | X | 0.50 | X | I | X | 0.059 | = | 2.857 |
| seal | Q= | 2.78 | X | 0.85 | X | I | X | 0.135 | | 11.038 |
| platform | Q= | 2.78 | X | 0.75 | X | I | X | 0.289 | | 20.842 |
| pasture | Q= | 2.78 | X | 0.40 | X | I | X | 1.547 | | 59.537 |
| Total Flow l/s | | | | | | | | 2.031 | | 94.27 |

| | | |
|---|---|---|
| DETAINED FLOWS FROM HOUSE PLATFORMS | = | 3.68 |
| ADJUSTED TOTAL FLOW TO POINT A | = | 90.59 |
| PRE DEVELOPMENT FLOW TO POINT A (30 MIN T.O.C) | = | 62.42 |
| PRE DEVELOPMENT TO POST DEVELOPMENT DIFF. (L/S) | = | 28.17 |
| | | INCREASE IN RUN-OFF |

### SUB-CATCHMENT AREA AA1 (FLOW TO NEW DRY POND B, DOWNSTREAM OF CATCHMENT A

**SUB-CATCHMENT A AREA BREAK DOWN**

| civil3d # | AREA (m²) | COEFFICIENT* |
|---|---|---|
| 278 | 597 | 0.5 |
| 281 | 12761 | 0.40 |

**100 YEAR SUB CATCHMENT AA1 TOTALISED PEAK FLOW TO DRY POND B**

TIME OF CONCENTRATION SELECTED = 20 MINUTES

| Q=2.78CIA l/s | | | | C | | I | | A (Ha) | | Q (L/S) (I) 20 MIN |
|---|---|---|---|---|---|---|---|---|---|---|
| metal | Q= | 2.78 | X | 0.50 | X | I | X | 0.060 | = | 9.128 |
| seal | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | | 0.000 |
| platform | Q= | 2.78 | X | 0.75 | X | I | X | 0.000 | | 0.000 |
| pasture | Q= | 2.78 | X | 0.40 | X | I | X | 1.276 | | 156.093 |
| Total Flow l/s | | | | | | | | 1.336 | | 165.22 |

| | | |
|---|---|---|
| PRE DEVELOPMENT FLOW TO POINT AA (20 MIN T.O.C) | = | 165.22 |
| PRE DEVELOPMENT TO POST DEVELOPMENT DIFF. (L/S) | = | 0.00 |
| | | NEUTRAL |

**2 YEAR SUB CATCHMENT AA1 TOTALISED PEAK FLOW TO DRY POND B**

TIME OF CONCENTRATION SELECTED = 20 MINUTES

| Q=2.78CIA l/s | | | | C | | I | | A (Ha) | | Q (L/S) (I) 20 MIN |
|---|---|---|---|---|---|---|---|---|---|---|
| metal | Q= | 2.78 | X | 0.50 | X | I | X | 0.060 | = | 2.871 |
| seal | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | | 0.000 |
| platform | Q= | 2.78 | X | 0.75 | X | I | X | 0.000 | | 0.000 |
| pasture | Q= | 2.78 | X | 0.40 | X | I | X | 1.276 | | 49.098 |
| Total Flow l/s | | | | | | | | 1.336 | | 51.97 |

| | | |
|---|---|---|
| PRE DEVELOPMENT FLOW TO POINT AA (20 MIN T.O.C) | = | 51.97 |
| PRE DEVELOPMENT TO POST DEVELOPMENT DIFF. (L/S) | = | 0.00 |
| | | NEUTRAL |

### TOTALISED FLOW FOR SUB-CATCHMENT AREA A + AA1 TO DISCHARGE POINT A-1 (DOWNSTREAM OF NEW DRY POND E

**100 YEAR SUB CATCHMENT A TOTALISED PEAK FLOW TO POINT A-1**

| TIME OF CONCENTRATION SELECTED = 20 MINUTES | Q (L/S) |
|---|---|
| ADJUSTED FLOW FROM SUB-CATCHMENT A | 282.84 |
| ADJUSTED FLOW FROM SUB-CATCHMENT AA1 | 165.22 |
| DETAINED FLOW FROM NEW DRY POND B | 318.19 |
| TOTAL POST DEVELOPMENT FLOW | 129.87 |
| PRE DEVELOPMENT FLOW TO POINT A-1 (20 MIN T.O.C) | 359.16 |
| PRE DEVELOPMENT TO POST DEVELOPMENT DIFF. (L/S) | -229.29 |
| | LESS THAN PRE DEVELOPMENT FLOW |

**2 YEAR SUB CATCHMENT A TOTALISED PEAK FLOW TO POINT A-1**

| TIME OF CONCENTRATION SELECTED = 20 MINUTES | Q (L/S) |
|---|---|
| ADJUSTED FLOW FROM SUB-CATCHMENT A | 90.59 |
| ADJUSTED FLOW FROM SUB-CATCHMENT AA1 | 51.97 |
| DETAINED FLOW FROM NEW DRY POND B | 12.69 |
| ADJUSTED TOTAL POST DEVELOPMENT FLOW | 129.87 |
| PRE DEVELOPMENT FLOW TO POINT A-1 (20 MIN T.O.C) | 114.39 |
| PRE DEVELOPMENT TO POST DEVELOPMENT DIFF. (L/S) | 15.48 |
| | MORE THAN PRE DEVELOPMENT FLOW |

## SUB-CATCHMENT AREA B

### SUB-CATCHMENT B AREA BREAK DOWN

| civil3d # | AREA (m²) | COEFFICIENT* |
|---|---|---|
| | | |
| 98 | 4588 | 0.40 |
| 198 | 187 | 0.50 |
| 105 | 192 | 0.50 |
| 52 | 5824 | 0.40 |
| | | |
| | | |
| | | |
| 111 | 1070 | 1.00 |
| | | |
| 132 | 734 | 0.40 |
| 129 | 255 | 0.85 |
| 131 | 402 | 0.85 |
| 190 | 176 | 0.40 |
| | | |
| 362 | 187 | 0.40 |
| | | |
| | | |
| 17 | 4112 | 0.40 |
| | | |
| | | |
| | | |
| | | |
| | | |
| 157 | 48176 | 0.40 |
| | | |

**100 YEAR SUB CATCHMENT B TOTALISED PEAK FLOW TO POINT B**

TIME OF CONCENTRATION SELECTED = 30 MINUTES

| Q=2.78CIA | l/s | | | C | | I | | A | | Q (L/S) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Ha | | (I) 30 MIN |
| metal | Q= | 2.78 | X | 0.50 | X | I | X | 0.038 | = | 4.747 |
| seal | Q= | 2.78 | X | 0.85 | X | I | X | 0.066 | | 13.988 |
| platform | Q= | 2.78 | X | 0.75 | X | I | X | 0.000 | | 0.000 |
| pasture | Q= | 2.78 | X | 0.40 | X | I | X | 6.380 | | 639.190 |
| pond | Q= | 2.78 | X | 1.00 | X | I | X | 0.107 | | 26.801 |
| Total Flow l/s | | | | | | | | 6.590 | | 684.73 |

| | | |
|---|---|---|
| DETAINED FLOWS FROM HOUSE PLATFORMS | = | 0.00 |
| ADJUSTED TOTAL FLOW TO POINT B | = | 684.73 |
| DETAINED FLOW FROM IMPROVED EXISTING POND | = | 129.30 |
| TOTAL POST DEVELOPMENT FLOW | = | 555.43 |
| PRE DEVELOPMENT FLOW TO POINT B (30 MIN T.O.C) | = | 729.01 |
| PRE DEVELOPMENT TO POST DEVELOPMENT DIFF. (L/S) | = | -173.58 |
| | = | LESS THAN PRE DEVELOPMENT FLOW |

**2 YEAR SUB CATCHMENT B TOTALISED PEAK FLOW TO POINT B**

TIME OF CONCENTRATION SELECTED = 30 MINUTES

| Q=2.78CIA | l/s | | | C | | I | | A | | Q (L/S) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Ha | | (I) 30 MIN |
| metal | Q= | 2.78 | X | 0.50 | X | I | X | 0.038 | = | 1.528 |
| seal | Q= | 2.78 | X | 0.85 | X | I | X | 0.066 | | 4.502 |
| platform | Q= | 2.78 | X | 0.75 | X | I | X | 0.000 | | 0.000 |
| pasture | Q= | 2.78 | X | 0.40 | X | I | X | 6.380 | | 205.733 |
| pond | Q= | 2.78 | X | 1.00 | X | I | X | 0.107 | | 8.626 |
| Total Flow l/s | | | | | | | | 6.590 | | 220.39 |

| | | |
|---|---|---|
| DETAINED FLOWS FROM HOUSE PLATFORMS | = | 0.00 |
| ADJUSTED TOTAL FLOW TO POINT B | = | 220.39 |
| DETAINED FLOW FROM IMPROVED EXISTING POND | = | 38.02 |
| TOTAL POST DEVELOPMENT FLOW | = | 182.37 |
| PRE DEVELOPMENT FLOW TO POINT B (30 MIN T.O.C) | = | 234.64 |
| PRE DEVELOPMENT TO POST DEVELOPMENT DIFF. (L/S) | = | -52.28 |
| | | LESS THAN PRE DEVELOPMENT FLOW |

## SUB-CATCHMENT AREA C

### SUB-CATCHMENT C AREA BREAK DOWN

| civil3d # | AREA (m²) | COEFFICIENT* |
|---|---|---|
| | | |
| 149 | 14139 | 0.40 |
| 150 | 1637 | 0.85 |
| 91 | 35748 | 0.40 |
| 154 | 472 | 0.75 |
| | | |
| 192 | 788 | 0.75 |
| 141 | 920 | 0.75 |
| | | |
| 139 | 628 | 0.75 |
| | | |
| 250 | 416 | 0.85 |
| POND | 230 | xref |
| | | |
| | | |
| TOTAL | 54978 | |

**100 YEAR SUB CATCHMENT C TOTALISED PEAK FLOW TO POINT C**

TIME OF CONCENTRATION SELECTED = 40 MINUTES

| Q=2.78CIA | l/s | | | C | | I | | A | | Q (L/S) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Ha | | (I) 40 MIN |
| metal | Q= | 2.78 | X | 0.50 | X | I | X | 0.164 | = | 18.645 |
| seal | Q= | 2.78 | X | 0.85 | X | I | X | 0.042 | | 8.055 |
| platform | Q= | 2.78 | X | 0.75 | X | I | X | 0.281 | | 47.973 |
| pasture | Q= | 2.78 | X | 0.40 | X | I | X | 4.989 | | 454.557 |
| pond | Q= | 2.78 | X | 1.00 | X | I | X | 0.023 | | 5.239 |
| Total Flow l/s | | | | | | | | 5.498 | | 534.47 |

| | | |
|---|---|---|
| DETAINED FLOWS FROM HOUSE PLATFORMS (l/s) | = | 10.22 |
| ADJUSTED TOTAL FLOW TO POINT B (l/s) | = | 524.25 |
| DETAINED FLOW FROM NEW DRY POND | = | 151.41 |
| TOTAL POST DEVELOPMENT FLOW | = | 372.84 |
| PRE DEVELOPMENT FLOW TO POINT C (40 MIN T.O.C) | = | 457.39 |
| PRE DEVELOPMENT TO POST DEVELOPMENT DIFF. (L/S) | = | -84.55 |
| | = | LESS THAN PRE DEVELOPMENT FLOW |

**2 YEAR SUB CATCHMENT C TOTALISED PEAK FLOW TO POINT C**

TIME OF CONCENTRATION SELECTED = 40 MINUTES

| Q=2.78CIA | l/s | | | C | | I | | A | | Q (L/S) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Ha | | (I) 40 MIN |
| metal | Q= | 2.78 | X | 0.50 | X | I | X | 0.164 | = | 6.059 |
| seal | Q= | 2.78 | X | 0.85 | X | I | X | 0.042 | | 2.618 |
| platform | Q= | 2.78 | X | 0.75 | X | I | X | 0.281 | | 15.591 |
| pasture | Q= | 2.78 | X | 0.40 | X | I | X | 4.989 | | 147.728 |
| pond | Q= | 2.78 | X | 1.00 | X | I | X | 0.023 | | 1.703 |
| Total Flow l/s | | | | | | | | 5.498 | | 173.70 |

| | | |
|---|---|---|
| DETAINED FLOWS FROM HOUSE PLATFORMS | = | 1.57 |
| ADJUSTED TOTAL FLOW TO POINT B | = | 172.13 |
| DETAINED FLOW FROM NEW DRY POND | = | 37.14 |
| TOTAL POST DEVELOPMENT FLOW | = | 134.99 |
| PRE DEVELOPMENT FLOW TO POINT C (40 MIN T.O.C) | = | 148.65 |
| PRE DEVELOPMENT TO POST DEVELOPMENT DIFF. (L/S) | | -13.66 |
| | | LESS THAN PRE DEVELOPMENT FLOW |

## SUB-CATCHMENT AREA D (FLOWING TO 44 OKURA ROAD)

**SUB-CATCHMENT E AREA BREAK DOWN**

| civil3d # | AREA (m²) | COEFFICIENT* |
|---|---|---|
| | | |
| 252 | 2112 | 0.40 |
| | | |
| | | |
| | | |
| TOTAL | 2112 | |

** Zone D has no obvious channelised discharge - considered sheet flow across catchment bounds. Zone D catchment has reduced in area from the predevelopment scenario. Some of the land previously in this catchment is redirected into catchment C*

**<u>100 YEAR SUB CATCHMENT E TOTALISED PEAK FLOW IN CATCHMENT D</u>**

TIME OF CONCENTRATION SELECTED = 10 MINUTES

| Q=2.78CIA l/s | | | | C | | I | | A (Ha) | | Q (L/S) (I) 10 MIN |
|---|---|---|---|---|---|---|---|---|---|---|
| metal | Q= | 2.78 | X | 0.50 | X | I | X | 0.000 | = | 0.000 |
| seal | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | | 0.000 |
| platform | Q= | 2.78 | X | 0.75 | X | I | X | 0.000 | | 0.000 |
| pasture | Q= | 2.78 | X | 0.40 | X | I | X | 0.211 | | 30.766 |
| Total Flow l/s | | | | | | | | 0.211 | | 30.77 |

| | | |
|---|---|---|
| **TOTAL POST DEVELOPMENT FLOW** | = | 30.77 |
| **PRE DEVELOPMENT FLOW TO POINT D (10 MIN T.O.C)** | = | **43.22** |
| **PRE DEVELOPMENT TO POST DEVELOPMENT DIFF. (L/S)** | = | **-12.45** |

**<u>2 YEAR SUB CATCHMENT E TOTALISED PEAK FLOW IN CATCHMENT D</u>**

TIME OF CONCENTRATION SELECTED = 10 MINUTES

| Q=2.78CIA l/s | | | | C | | I | | A (Ha) | | Q (L/S) (I) 10 MIN |
|---|---|---|---|---|---|---|---|---|---|---|
| metal | Q= | 2.78 | X | 0.50 | X | I | X | 0.000 | = | 0.000 |
| seal | Q= | 2.78 | X | 0.85 | X | I | X | 0.000 | | 0.000 |
| platform | Q= | 2.78 | X | 0.75 | X | I | X | 0.000 | | 0.000 |
| pasture | Q= | 2.78 | X | 0.40 | X | I | X | 0.211 | | 10.944 |
| Total Flow l/s | | | | | | | | 0.211 | | 10.94 |

| | | |
|---|---|---|
| **TOTAL POST DEVELOPMENT FLOW** | = | 10.94 |
| **PRE DEVELOPMENT FLOW TO POINT D (10 MIN T.O.C)** | = | **13.59** |
| **PRE DEVELOPMENT TO POST DEVELOPMENT DIFF. (L/S)** | = | -2.65 |
| | | **LESS THAN PRE DEVELOPMENT FLOW** |

## SUB-CATCHMENT AREA E (FLOWING TO MANGAKURI BEACH DISCHARGE)

**SUB-CATCHMENT E AREA BREAK DOWN**

| civil3d # | AREA (m²) | COEFFICIENT* |
|---|---|---|
| | | |
| 252 | 340 | 0.85 |
| 253 | 164 | 0.40 |
| 254 | 137 | 0.40 |
| | | |
| TOTAL | 641 | |

** the existing topography suggests that only a negligible amount of stormwater run-off is discharged to point D in the pre-development scenario. Pre-development run-off from this area is discharged to the north and south (to 40 and 44 Okura road)*

**<u>100 YEAR TOTALISED PEAK FLOW TO POINT D</u>**

TIME OF CONCENTRATION SELECTED = 10 MINUTES

| Q=2.78CIA l/s | | | | C | | I | | A (Ha) | | Q (L/S) (I) 10 MIN |
|---|---|---|---|---|---|---|---|---|---|---|
| metal | Q= | 2.78 | X | 0.50 | X | I | X | 0.000 | = | 0.000 |
| seal | Q= | 2.78 | X | 0.85 | X | I | X | 0.034 | | 10.525 |
| platform | Q= | 2.78 | X | 0.75 | X | I | X | 0.000 | | 0.000 |
| pasture | Q= | 2.78 | X | 0.40 | X | I | X | 0.030 | | 4.385 |
| Total Flow l/s | | | | | | | | 0.064 | | 14.91 |

| | | |
|---|---|---|
| **TOTAL POST DEVELOPMENT FLOW** | = | 14.91 |
| **PRE DEVELOPMENT FLOW TO POINT D (10 MIN T.O.C)** | = | **na*** |
| **PRE DEVELOPMENT FLOW RATE FROM POST DEVELOPMENT AREA** | = | **9.34** |

**<u>2 YEAR TOTALISED PEAK FLOW TO POINT D</u>**

TIME OF CONCENTRATION SELECTED = 10 MINUTES

| Q=2.78CIA l/s | | | | C | | I | | A (Ha) | | Q (L/S) (I) 10 MIN |
|---|---|---|---|---|---|---|---|---|---|---|
| metal | Q= | 2.78 | X | 0.50 | X | I | X | 0.000 | = | 0.000 |
| seal | Q= | 2.78 | X | 0.85 | X | I | X | 0.034 | | 3.744 |
| platform | Q= | 2.78 | X | 0.75 | X | I | X | 0.000 | | 0.000 |
| pasture | Q= | 2.78 | X | 0.40 | X | I | X | 0.030 | | 1.560 |
| Total Flow l/s | | | | | | | | 0.064 | | 5.30 |

| | | |
|---|---|---|
| **TOTAL POST DEVELOPMENT FLOW** | = | 5.30 |
| **PRE DEVELOPMENT FLOW TO POINT D (10 MIN T.O.C)** | = | **na*** |
| **PRE DEVELOPMENT FLOW RATE FROM POST DEVELOPMENT AREA** | = | **3.32** |

| DISCHARGE POINT | 2 YEAR PRE-DEVELOPMENT DISCHARGE (L/S) | 2 YEAR POST-DEVELOPMENT DISCHARGE (L/S) | DIFFERENCE PRE - POST DEVELOPMENT (NEG. VALUES = DECREASE) L/S |
|---|---|---|---|
| A-1 | 114.4 | 129.9 | 15.5 |
| B | 234.6 | 182.4 | -52.2 |
| C | 148.7 | 135.0 | -13.7 |
| D | 0.0 | 10.9 | 10.9 |
| 40 OKURA RD | 5.3 | 0.0 | -5.3 |
| 44 OKURA ROAD | 13.6 | 10.9 | -2.7 |
| ***TOTALS*** | ***516.6*** | ***469.1*** | ***-47.6*** |

| DISCHARGE POINT | 100 YEAR PRE-DEVELOPMENT DISCHARGE (L/S) | 100 YEAR POST-DEVELOPMENT DISCHARGE (L/S) | DIFFERENCE PRE - POST DEVELOPMENT (NEG. VALUES = DECREASE) L/S |
|---|---|---|---|
| A-1 | 359.2 | 129.9 | -229.3 |
| B | 729.0 | 556.5 | -172.5 |
| C | 457.4 | 375.6 | -81.8 |
| D | 0.0 | 14.9 | 14.9 |
| 40 OKURA RD | 17.0 | 0.0 | -17.0 |
| 44 OKURA ROAD | 43.2 | 30.8 | -12.4 |
| ***TOTALS*** | ***1605.7*** | ***1107.7*** | ***-498.1*** |

strata group CONSULTING ENGINEERS
Ph 06 876 7646 Fax 06 876 7645
Unit 1,308 Queen Street East, PO Box 758 Hastings 4156

SR and BJ Williams Charitable Trust

Williams Road, Mangakuri

**PAVEMENT DESIGN**

| | |
|---|---|
| **Project No.** | J5864 |
| **Date:** | 28/11/22 |
| **By** | SG |
| **Checked** | DJ |

## PAVEMENT DESIGN FOR LIGHTLY TRAFFICKED URBAN STREETS (WHERE *DESA* IS LESS THAN 100,000)

### DESIGN TRAFFIC CALCULATIONS

**ROW 1 (LOT 6 -**

= **INPUT**

= **CALCULATED RESULT**

| INPUT # | INPUT DESCRIPTION | | |
|---|---|---|---|
| 1 | DESIGN PERIOD | 40 | (TABLE 12.2) |
| 2 | ANNUAL AVERAGE DAILY TRAFFIC (AADT) | 35 | (TRAFFIC ASEESSMENT/DESIGN ASSUMPTION) |
| 3 | DIRECTION FACTOR (DF) | 0.5 | (TABLE 12.2 - Note 1) |
| 4 | % OF HEAVY VEHICLES (%HV) | 3 | (TABLE 12.2) |
| 5 | LANE DISTRIBUTION FACTOR (LDF) | 1 | (table 7.3) |
| 6 | HEAVY VEHICLE GROWTH RATE (COMPOUND) | 1 | (TABLE D 1) |
| 7 | TRAFFIC PROJECT LOAD DISTRIBUTION | - | (TABLE I 1) |

**I.1 Total Number of Heavy Vehicle Axle Groups**

The initial daily heavy vehicles in the design lane is (Equation A16).

$$N_i = AADT \times DF \times \%HV/100 \times LDF \qquad \text{A16}$$

where

$N_i$ = initial daily heavy vehicles traversing the design lane (Section 7.4.4)

$AADT$ = Annual Average Daily Traffic in vehicles per day in the first year (Section 7.4.4)

$DF$ = Direction Factor (Section 7.4.4)

$\%HV$ = average percentage heavy vehicles (Section 7.4.4)

$LDF$ = Lane Distribution Factor (Section 7.4.3)

$N_i$ = AADT x DF x %HV/100 x LDF

**THEREFORE Ni =** **0.525**

| INPUT # | | | |
|---|---|---|---|
| 8 | ANNUAL GROWTH RATE ( R) | 0 | (TABLE 12.2) |
| 8a | WHERE R = 0, USE P (DESIGN PERIOD) | 40 | |

31

$$CGF = \frac{(1+0.01R)^P - 1}{0.01R} \text{ for } R > 0$$

$$= P \text{ for } R = 0$$

where

$CGF$ = cumulative growth factor

$R$ = annual growth rate (%)

$P$ = design period (years)

**THEREFORE CGF =** **40**

$N_{HV}$ = CULMULATIVE NUMBER OF HEAVY VEHICLES TRAVERSING THE DESIGN LANE DURING THE DESIGN PERIOD

$N_{HV}$ = 365 x CGF x $N_i$

**THEREFORE NHV=** **7665**

$$N_{DT} = N_{HV} \times N_{HVAG} \quad \text{A19}$$

where

$N_{DT}$ = cumulative number of heavy vehicle axle groups in the design lane during the design period (Section 7.4.7)

$N_{HV}$ = cumulative number of heavy vehicles traversing the design lane during the design period (Section 7.4.5)

$N_{HVAG}$ = average number of axle groups per heavy vehicle (Section 7.4.7)

As stated in Section 7.4.7, the average number of axle groups per heavy vehicle ($N_{HVAG}$) may be obtained from:

- weigh-in-motion survey data
- vehicle classification counts
- presumptive values (e.g. Appendix E).

**Table 7.6: Presumptive numbers of heavy vehicle axle groups per heavy vehicle ($N_{HVAG}$)**

| Location | $N_{HVAG}$ |
|---|---|
| Rural roads | 2.8 |
| Urban roads | 2.5 |

**INPUT #9** $N_{HV\ AG}$ = 2.8

$N_{DT} = N_{HV} \times N_{HVAG}$

**THEREFORE NDT = 21462**

**DESIGN EQUIVALENT STANDARD AXLES (DESA)**

**INPUT # 10** **ESA = 8000** (from Table 12.2)

**INPUT # 11** **ESA/HVAG = 0.45** (from Appendix O for lightly trafficked roads)

$$DESA = ESA/HVAG \times N_{DT}$$

**THEREFORE DESA = 9657.90**

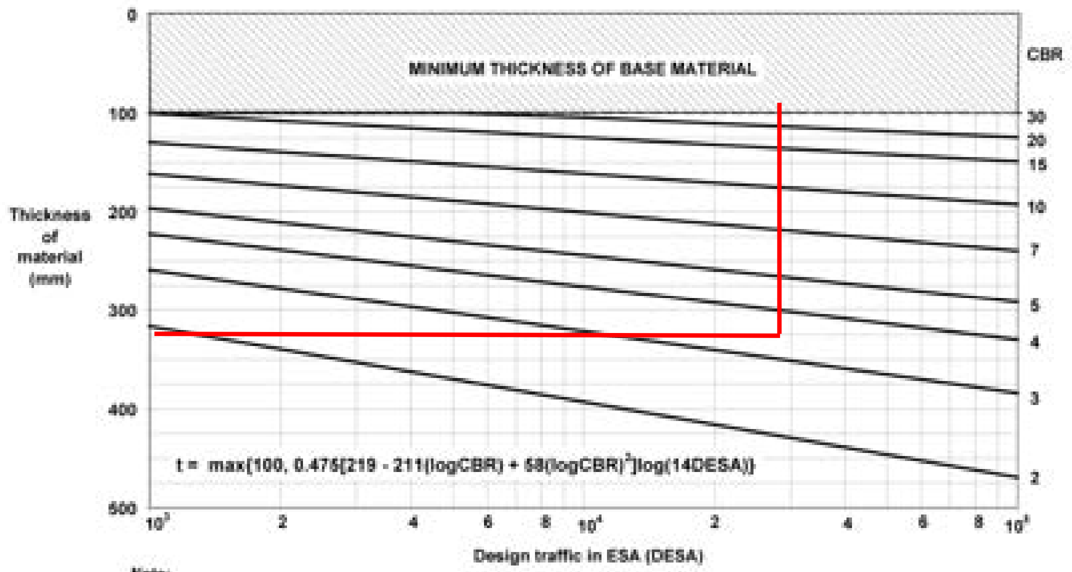
**Table O 6: Example traffic load distribution – minor road**

| Axle group load (kN) | Axle group type SAST % | SADT % | TADT % |
|---|---|---|---|
| 44.1 | 85.8000 | 0.0000 | 0.0000 |
| 52.9 | 14.2000 | 0.0000 | 0.0000 |
| 53.9 | 0.0000 | 80.1120 | 0.0000 |
| 83.1 | 0.0000 | 19.8880 | 0.0000 |
| 91.1 | 0.0000 | 0.0000 | 100.0000 |
| Total | 100.0000 | 100.0000 | 100.0000 |
| Proportion of each axle group | 0.5 | 0.357 | 0.143 |

| Measure | Value |
|---|---|
| $N_{HVAG}$ | 2.00 |
| ESA/HVAG | 0.45 |
| ESA/HV | 0.89 |

## PAVEMENT DESIGN

**Figure 12.2: Example design chart for lightly-trafficked granular pavements with thin bituminous surfacings**




Note:
1. Appropriate local conditions, environmental and drainage issues must be considered in using these design curves.
2. Thin asphalt surfacings may be included in total granular thickness. However, the minimum thickness of the granular base is 100 mm.

| | | | |
|---|---|---|---|
| **INPUT # 12** | **SUBGRADE CBR =** | 3 | |
| | **CALCULATED TOTAL PAVEMENT THICKNESS =** | 321 | mm |
| | **BASECOURSE THICKNESS =** | 100 | mm |
| | **SUB-BASE THICKNESS =** | 221 | mm |
| | **SUB-GRADE IMPROVEMENT LAYER =** | 110 | mm |
| | **ADJUSTED TOTAL PAVEMENT THICKNESS =** | 431 | mm |

| | | | |
|---|---|---|---|
| **INPUT # 13** | **SUBGRADE CBR =** | 5 | |
| | **CALCULATED TOTAL PAVEMENT THICKNESS =** | 243 | mm |
| | **BASECOURSE THICKNESS =** | 100 | mm |
| | **SUB-BASE THICKNESS =** | 143 | |

| | | | |
|---|---|---|---|
| **INPUT # 14** | **SUBGRADE CBR =** | 6 | |
| | **CALCULATED TOTAL PAVEMENT THICKNESS =** | 219 | mm |
| | **BASECOURSE THICKNESS =** | 100 | mm |
| | **SUB-BASE THICKNESS =** | 119 | |

## SUBGRADE IMPROVEMENT LAYER UTILISING CRUSHED ROCKS AND SELECTED SUBGRADE MATERIALS

Example 2: Utilising Crushed Rocks and Selected Subgrade Materials

$$CBR_{\text{selected subgrade}} = CBR_{\text{underlying material}} \times 2^{\left(\frac{\text{thickness of selected subgrade}}{150}\right)} = 3 \times 2^{(200/150)} = 8\%$$

Equation (54)

| | | |
|---|---|---|
| **INPUT # 14** | **Existing SG CBR** | 3 |
| **INPUT # 15** | **SIL( SG Improvement layer) / Thickness of selected Subgrade (mm)** | 110 |
| | **RESULTING CBR** | 5 |

## PAVEMENT SUMMARY

CONSERVATIVE PAVEMENT DESIGN ADOPTED. 100mm MIN TNZ M4 AP40 BASECOURSE AND THE FOLLOWING SUB-BASE THICKNESSES;

- WHERE IN-SITU CBR VALUES ARE 3, 300mm THICK LAYER OF CRUSHED GAP65
- WHERE IN-SITU CBR VALUES ARE 4-5, 250mm THICK LAYER OF CRUSHED GAP65
- WHERE IN-SITU CBR VALUES ARE 5+, 200mm THICK LAYER OF CRUSHED GAP65

## 12 Appendix B – Preliminary Calculations