ENGINEERING REPORT

2127 KAIPARA COAST HIGHWAY, KAKANUI

Prepared for ABIB (OAMARU) TLD
AUGUST 2024

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Document Quality Assurance Statement

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Prepared	Trudy Gao		30/01/2024
Approved	Zibo Yang		30/01/2024
Revised			

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1 Introduction

Crang Consulting Ltd has been commissioned by ABIB (OAMARU) LTD (known as Goodland Developments Ltd formerly) to complete the engineering design for the subdivision of 2127 Kaipara Coast Highway, Kakanui. Legal Description as Pt Sec 50 Blk II Kaipara Survey District SO 51097, Sec 1 SO 328127, Pt Makarau Blk 4A SO 28095, Pt Makarau Blk 4B SO 28095. The total site area is approximately 138 ha and the existing access is off Kaipara Coast Highway.

The site is basically the start of a small peninsula. A ridge runs north-south down the centre with the land sloping from the ridge down to watercourses. The property is used for farming and is largely in pasture. An aerial photo of the site is shown below in Figure 1.

Figure 1 - Existing Site

A scheme plan for the subdivision of the property has been prepared by Survey Worx and it shows 26 rural/residential lifestyle lots (includes an existing farmer residence) and 10 common accessways to vest.

The key engineering issues associated with developing the land are:

- The extent of the earthworks that is necessary to achieve stable finished ground for each lot and to enable the roads and accessways to be constructed.
- The sediment controls are necessary to protect the environment.
- The construction of roads and accessways at acceptable gradients and widths to provide access to the building platforms.
- Stormwater controls to ensure that the runoff volumes are no greater than the existing runoff from the site, that adequate stormwater management is undertaken and that the potential for erosion is minimised.
- The ability to provide adequate services for the development including wastewater disposal fields, and utility services.

These issues are addressed in this report, besides on-site wastewater disposal which is designed by KPG Geotechnical Group Ltd.

2 Earthworks

2.1 Earthworks Description

Earthworks are necessary on site to enable the construction of the new access roads and provide stable building platforms. The design also achieves the following:

- Minimises the earthworks volumes as much as practical.
- Provides an appropriate balance of cut to fill for the project.
- Provides stable access to roads and lots.
- Achieves road gradients that are similar to the existing farm tracks.

A copy of the earthworks design and sediment control plans is included as part of the engineering plans in Appendix A.

The quantities of earthworks are as follows in Table:

Table 1 Earthworks Volumes

Material Source	Cut, m^3	Fill, m^3
Topsoil Stripping	22,385	
Respread of Topsoil		17,000
Surplus Topsoil Spread to Vegetation regeneration Area		5,385
Clay Cut (Incl. Road Gullets & Drainage Spoil)	49,670	
Clay Fill		50,080
TOTAL	72,055	72,465

The total earthworks area is approximately 9.1ha.

Earthworks machinery will comprise hydraulic excavators, trucks, graders and compactors. The final number, type, size and quantity of equipment that will be used will depend on the contractor chosen, their methodology and the resources that they have available.

Any unsuitable material will be disposed of offsite to appropriate locations which will be determined as necessary.

2.2 Timing of Works

It is anticipated that the earthworks will occur over the 2023/ 2024 construction season with completion in June 2024. This timeframe is subject to obtaining the required resource consents.

2.3 Erosion and Sediment Control

Erosion and sediment controls will comply with the requirements of the GD05 “Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region”. A combination of erosion and sediment control measures will be employed as follows:

- The use of cleanwater diversion bunds, to intercept and direct cleanwater away from the proposed area of works. These bunds will be sized to accommodate flows from 5% Annual Exceedance Probability (AEP) storm event.
- The construction of sediment retention ponds at key locations where the sediment control catchment exceeds 3000m^2.
- The use of runoff diversion bunds to direct dirty water to the sediment ponds.
- The construction of topsoil bunds with decants for areas that are outside of the catchment of a sediment pond.
- Installation of contour drains at the completion of each day's work.
- Progressive stabilisation of the earthworks area as it is completed.
- Maintain a stabilised construction entrance at the crossing place off the Kaipara Coast Highway during the works in accordance with the ARC GD05 document. This will ensure that any vehicles leaving the site do not deposit earth onto the public roading network.

The main sediment control measures are the sediment ponds as shown on the sediment control drawings. They have been designed at the 3% criteria for the catchment that they are servicing. Flocculation of the ponds will also be provided. Details are provided on the engineering drawings in Appendix A.

2.4 Sediment Pond Sizing

Sediment ponds will be constructed at key locations during the earthworks as follows in Table 2:

Table 2: Sediment Pond Sizing Table

Sed Pond	Catchment Area	Length	Width	Depth	No of Decants	Min Volume
	Ha	m	m	m		m^3
1	2.37	30	6	2	2	711
2	0.92	12	4	2	1	276
3	0.93	12	4	2	1	279
4	1.29	15	5	2	1	387

2.5 Estimation of Sediment Yield

Stabilisation of earth worked areas will be completed progressively as the earthworks are completed. Silt control measures will remain in place for some time after completion of the grassing.

For the purposes of estimating sediment yield we have assumed that the area of exposed bare ground will correspond to the total earthworks area within three separate areas of earthworks as works will be progressively stabilised as they are undertaken. The calculations have therefore taken a catchment area of 3 ha with a sediment pond being the primary control feature.

Based on the USLE formula: $A = R \times K \times LS \times C \times P$ where:

A=Total sediment generated (tones/hectare/year)
R=Rainfall Erosion Index = $0.00828xp^{2.2}x1.7=82$
K=Resistance of surface to erosion = 0.26 from nomograph = .343 corrected to metric units
L=Length and slope factor = 6.51

C=Ratio of loss under a specified condition compared to that of a bare site = 1.0 (track walked on contour)
P=Surface Roughness Factor = 1.3

From this data A = 238 tonnes/hectare/year.

This translates to a total of 358 tonnes for the project over a 6-month construction period.

Estimation of sediment loss to the environment:

SL = A x SDR x (1-eff), where

SL = Total sediment loss to the receiving environment (tones/hectare/year)

SDR= Sediment Delivery Ratio = 0.5 has been assumed for the area, taking into consideration topography and the proposed sediment retention measures.

Eff = 0.75 (or 75%) which is the efficiency corresponding to a flocculated sediment pond, which is the main sediment control feature.

For the site the total estimated sediment loss to the environment is SL = 45 tonne

This translates to an attenuation of 313 tonne or 87% of the total estimated sediment generated on site being captured and retained.

A calculation of the predevelopment sediment loss has determined that 41 tonne is lost to the receiving environment. This shows that the proposed re sediment controls will provide good protection to the environment and that the increase efficiencies obtained by using a flocculent in the sediment pond is justified.

2.6 Receiving Environment

The immediate receiving environments are watercourses that flow west and discharge to the Kaipara Harbour. These watercourses are highly modified by farming activities however they are likely to have some reaches with high aquatic values.

The area of the Kaipara Harbour that these streams discharge contains areas of intertidal banks and shell banks forming a complex habitat for a variety of animal and plant communities. In the mouth of the Makaurau River grow important areas of mangroves and salt marsh. The vegetation grades from the mangroves and salt marsh into mature kanuka forest with emergent tanekaha and kauri at the Makaurau River. The saline vegetation provides high quality habitat for threatened secretive coastal fringe birds. The Department of Conservation has selected this area, with the addition of an area of intertidal bank to the north, as an Area of Significant Conservation Value (ASCV).

Due to the potential of the watercourses and the natural character of the coastal environment all efforts will be made to protect the existing ecosystem.

3 Access Road Design

The access roads design has been undertaken to ensure the following:

- The stability of the road platform and batters achieves a minimum factor of safety. This is reported in the KGA geotechnical assessment.
- Have gradients that meet the standard required by Council.
- Have appropriate stormwater management.

The location of the access roads follows existing farm tracks as much as possible so that the functioning of the farm can be maintained, and earthworks are minimised.

The accessways will be sealed and include table drains for the primary purpose of stormwater conveyance. The width of the access roads has been designed depending on the number of lots they serve. For the narrower access roads passing bays have been included at approximate 50m intervals. At the locations where cattle cross the road the pavement will be strengthened with a concrete finish.

Some retaining walls are proposed to minimise the earthworks extents. A building consent will be applied once resource consent has been obtained.

There are archaeological features on the property and careful design has been done to avoid these features. A separate report has been completed by an archaeologist.

Access to the site is proposed by the creation of a new access off the Kaipara Coast Highway. This will replace the existing access off the highway which has poor visibility. An approval for the new intersection has been sought from NZTA/Waka Kotahi.

The access roads have been reviewed by Commute consultants and reported on separately.

4 Stormwater Management Plan

4.1 Introduction

The Council Network Discharge Consent only authorises diversion and discharge in urban area, therefore the discharges for this development will require its own stormwater discharge consent.

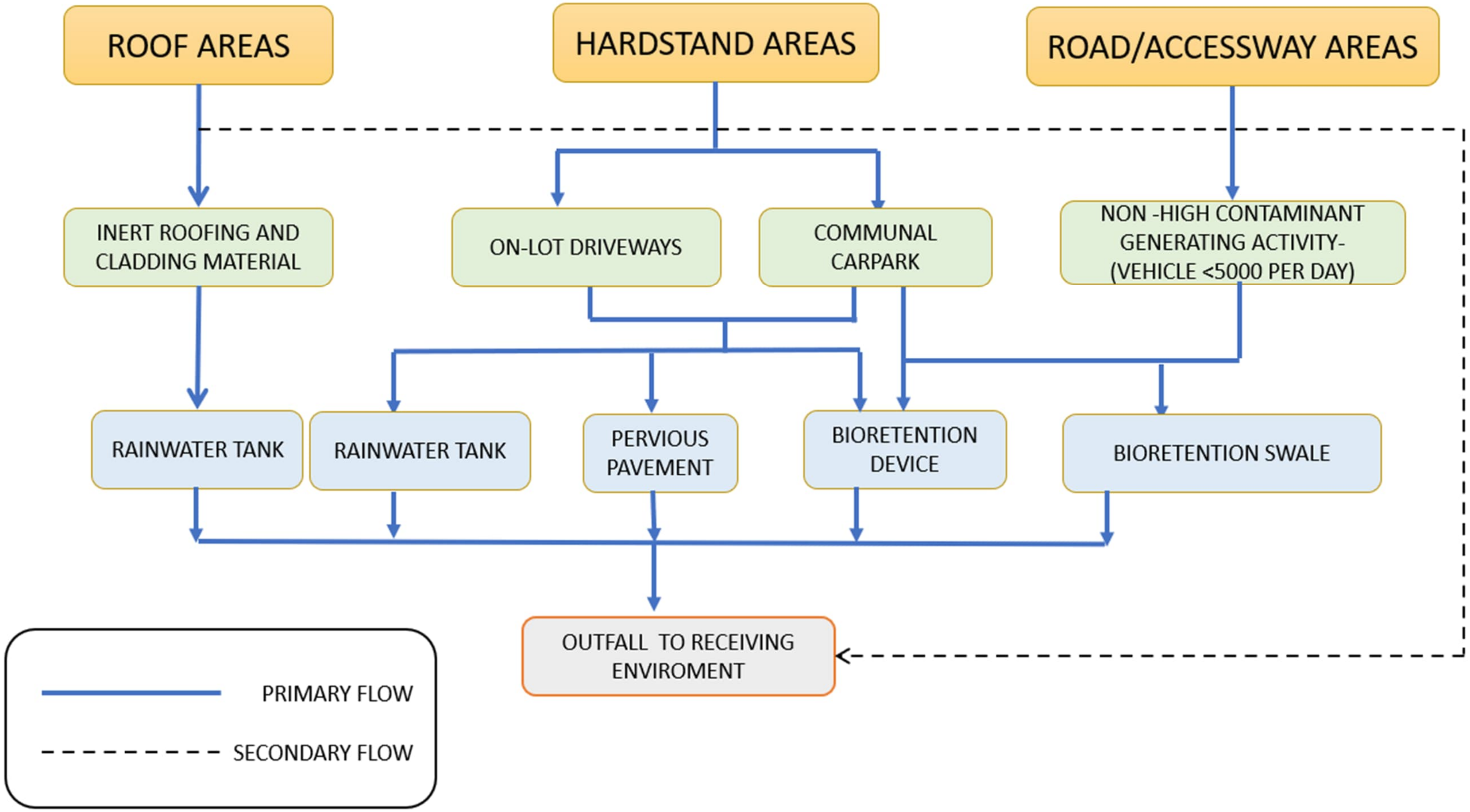
The total impervious area has been estimated at 4.73ha. This allows for approximately 800 to 1100m^2 of impervious area on each lot, as well as the impervious areas associated with the proposed roads and accessways.

A best practical option (BPO) approach has been taken so that the effects on the environment are less than minor. This approach is summarised as follows:

- Stormwater management area – Flow 1 (SMAF 1) has been adopted as hydrology mitigation approach for new impervious areas
- Stormwater quality control on road and on lot
- Hydraulic neutrality by undertaking extensive planting infill and re-vegetation
- Erosion control at outlets in accordance with TR2013/18
- Outlets located prior to streams so that flows are spread on grassed paddocks to mimic predevelopment scenarios
- Ensure all building platforms are located outside of overland flow paths and flood plains.

This BPO approach is detailed below for each type of impervious area, see Table 3.

Table 3: Stormwater management approach summary



4.2 Stormwater Quantity

The development has stormwater runoff from new imperious areas discharged to the existing stream receiving environment, therefore SMAF 1 mitigation has been adopted. It is proposed to achieve the required SMAF retention and detention volumes via the following approach for the 95th percentile rainfall event:

- Retention
  - Within the residential lots, the 5 mm depth reduction will be achieved via water reuse. Whilst for the new impervious areas on roads, the retention requirement will be met by implementing bioretention swale, see calculations in Appendix D.
- Detention
  - Accessways and roads – a bioretention swale has been designed to accommodate the detention volume required for the impervious areas of the accessways and roads.
  - Building roofs – stormwater tank will be used to provide the required detention volume associated with the roof area.
  - Other hardstand areas such as on-lot driveway and communal parking areas, options are rainwater tank, raingarden and permeable pavement.

The proposal includes extensive planting and enhancement planting, which is detailed in the Kaipara Coast Landscape Architecture plans.

The TP108 calculations have been undertaken to assess stormwater runoff from pre and post developments. The key findings are summarised in Table 3 below, while more details can be found in Appendix B.

Table 4: TP108 Hydrology Runoff Calculations

	10yrs ARI Average Peak Flow Rate (m3/s)	100yrs ARI Average Peak Flow Rate (m3/s)	10yrs ARI Runoff Volume (m3)	100yrs ARI Runoff Volume(m3)
Pre-development	1.7	3.3	145,470	283,386
Post-development	1.7	3.3	144,987	282,136

With the assessment results given above, it is considered that the impacts from the proposed development on downstream systems or ecology is negligible.

4.3 Stormwater Quality

To protect the ecosystems downstream of the development, the design has made provisions to implement the following methods to manage stormwater runoff from additional impervious areas before it discharges to the receiving environment. These are:

- Bioretention swales are designed to collect and treat stormwater runoff generated on road following GD 01 guideline.
- Although the grassed table drains for the proposed roads and jointly owned accessways for the primary function of overland flow conveyance, they are designed to be wide and shallow, and intercepted with rock check dams on steep roads and accessways for improving water quality at source to a certain extent.

- Roofs on dwellings will be constructed using inert roofing materials. A consent notice can be put on the titles if required. The discharge from roofs will be collected by rainwater tank for domestic consumption. Dead storage shall be allowed in tank for settling small particles. Any overflows from the tanks will pass through an energy dissipation structure at the outlet to minimise concreted flows and mimic predevelopment conditions.
- The construction of wing wall structures and other required energy dissipation structure for each reticulated outlet. This is to minimise risk of erosion and hence improve water quality.

The proposed development is expected to attract less than 5000 vehicles per day and have less than 30 vehicles in the parking area, therefore any proposed accessway, on-lot driveway and car park are not classified as high use area. These new impervious areas do not trigger the water quality treatment requirements under AUP E9.

Where a stormwater device is required as part of the management approach, Stormwater Management Devices in the Auckland Region (GD 01) shall be used as the main design guidelines. The document aims to create an effective balance of protected ecosystem and residential development.

The construction of rock rip rap across the steeper gullies downstream of outlets to prevent erosion of the slopes, dissipate flows and provide some water filtering. This will provide some additional stormwater treatment and prevent erosion of the soils. The design of the outlets is included in Appendix A.

4.4 Stormwater Reticulation

A stormwater reticulation network is proposed to collect the runoff from the road and upstream areas and discharge it to a suitable discharge location without having any effects on the downstream system.

The stormwater pipe is designed to cater for the 10-year ARI storm. Whist the grassed table drain on each side of the road has been designed to have capacity to convey flow up to 100-year ARI storm.

4.5 Overland Flow Paths and Flooding

Due to the hilly characteristic of the site, the proposed building platforms are well above any overland flow paths, watercourses and 100-year flood plains. It is expected that the minimum freeboard of finished floor levels can easily be achieved. See engineering plan C904 included in Appendix A of the report for details.

5 Wastewater, Water, Power and Telecommunications

Each lot will need to provide its own on-site wastewater disposal system at the time they build a dwelling. There are many suitable wastewater treatment systems that future lot owners can use. Some examples in the marketplace are the Biolytix system, Hynds Lifestyle system and Oasis Clearwater System.

The Urbanist has identified the location where the effluent disposal field should be constructed to ensure that the stability of the site is not compromised.

Potable water will be sourced by the future lot owners by rain harvesting. Typically each dwelling will store rain water in two 25000 litre tanks.

Power and telecommunication services are available for the site from the Kaipara Coast Highway. All internal reticulation will be installed underground. Design details for the reticulation can be provided at a later stage as part of engineering approvals.

6 Conclusions

The following conclusions can be drawn from the engineering assessment of the proposed development at 2127 Kaipara Coast Highway:

- Earthworks can be undertaken in accordance with the geotechnical engineer's recommendations to achieve stable building platforms, suitable road grades and stable batters. This will involve a large embankment fill and extensive groundwater controls.
- Stringent environmental control measures can be maintained to ensure that the potential effects from sediment discharges and dust are no more than minor.
- The proposed crossing place has been designed in accordance with Auckland Transport requirements.
- The proposed roads and accessways have been designed to acceptable gradients and geometry to provide access to the building platforms.
- New stormwater infrastructure will be provided to achieve the followings:
    - Adoption of SMAF 1 mitigation for all new impervious areas
    - 10-year design capacity for the primary pipe network and 100-year design capacity for the secondary stormwater network (i.e. grassed table drain)
- Power and telecommunication infrastructure can be provided for the development.

It is considered that the proposed engineering design will support the development and ensure the potential effects on the environment are less than minor.

APPENDIX A:

ENGINEERING DRAWINGS

APPENDIX B:

STORMWATER HYDROLOGY CALCULATIONS

TP108 Calcs - Hydraulic Neutrality			
Project:	2127 Kaipara coast highway	Prepared B ZY	
Date:	24/07/2023		

Pre-Development - Pervious

Runoff Curve Number (CN) and Initial Abstraction (la)				
Soil Name and classification	Cover Description(cover description, treatment and hydrolic condition)	Curve Number (CN)	Area	Product of CN x area
C	Existing good vegetation	70	18.5	1295
C	Existing average vegetation	71	14.8	1050.8
C	Pasture	74	104.7	7747.8
		Totals=	138	10093.6

CN (weighted) =	73.14	
la (weighted) =	5	mm

Post-Development-Pervious

Runoff Curve Number (CN) and Initial Abstraction (la)				
Soil Name and classification	Cover Description(cover description, treatment and hydraulic condition)	Curve Number (CN)	Area (ha)	Product of CN x area
C	Existing native vegetation to be restored	70	33.47	2342.9
C	Area to be revegetated, Terrestrial	70	15.04	1052.8
C	Area to be revegetated, Wetland/damp areas	70	3.32	232.4
C	Infill areas between existing planting, Terrestrial	70	12.73	891.1
C	Infill areas between existing planting, Wetland	70	0.00	0
C	Wi grassland to regenerate	70	3.48	243.6
C	Planting adjacent to reclaimed land and slopes	70	1.58	110.6
C	Grass within reclaimed land to be left	70	1.80	126
C	Pasture	74	61.85	4576.9

		Totals=	133.27	9576.3

CN (weighted) =	72	
la (weighted) =	5.00	mm

Post-Development-Impervious

Runoff Curve Number (CN) and Initial Abstraction (la)				
Soil Name and classification	Cover Description(cover description, treatment and hydrolic condition)	Curve Number (CN)	Area (ha)	Product of CN x area
C	Building platform	98	2.60	254.8
C	Car parking area	98	0.10	9.7118
C	Roads and accessways	98	2.03	198.94

Totals=	4.73	463.45

CN (weighted) =	98.00	
la (weighted) =	0.00	mm

Pre-Development

Catchment Area =	1.38	km^2
Runoff curve number=	73	
Initial Abstraction=	5	mm

Storage=	93.27	mm
24 Hour rainafall ARI 10yrs=	170	mm
24 Hour rainafall ARI 100yrs=	280	mm
ARI 10yrs Runoff depth Q24 =	105.41	mm
ARI 10yrs Runoff volume =	145470	m^3
ARI 100yrs Runoff depth Q24 =	205.35	mm
ARI 100yrs Runoff volume =	283386	m^3
ARI 10yrs Average peak flow rate=	1.68	m^3/s
ARI 100yrs Average Peak flow rate=	3.28	m^3/s

Post-Development Pervious

Catchment Area =	1.33	km^2
Runoff curve number=	72	
Initial Abstraction=	5.00	mm

Storage=	99.48	mm
24 Hour rainfall ARI 10yrs (CC inclusive)=	170.00	mm
24 Hour rainfall ARI 100yrs (CC inclusive)=	280.00	mm

ARI 10yrs Runoff depth Q24 =	102.94	mm
ARI 10yrs Runoff volume =	137184	m^3
ARI 100yrs Runoff depth Q24 =	201.95	mm
ARI 100yrs Runoff volume =	269132	m^3
ARI 10yrs Average Peak flow rate=	1.59	m^3/s
ARI 100yrs Average Peak flow rate=	3.11	m^3/s

Post-Development Impervious

Catchment Area =	0.05	km^2
Runoff curve number=	98.00	
Initial Abstraction=	0.00	mm

Storage=	5.18	mm
24 Hour rainfall ARI 10yrs (CC inclusive)=	170.00	mm
24 Hour rainfall ARI 100yrs (CC inclusive)=	280	mm

ARI 10yrs Runoff depth Q24 =	164.97	mm
ARI 10yrs Runoff volume =	7803	m^3
ARI 100yrs Runoff depth Q24 =	274.91	mm
ARI 100yrs Runoff volume =	13003	m^3
ARI 10yrs Average Peak flow rate=	0.090	m^3/s
ARI 100yrs Average Peak flow rate=	0.151	m^3/s

APPENDIX C:

CULVERT AND SCOUR & ERSOSION DESIGN CALCULATIONS

Project: 2127 KAIPARA COAST HIGHWAY, KAKANUI
Client: GOODLAND
CALCULATED MA
CHECKED
Culvert 1 Flow Rate Calculation
Date: 21/07/2023

Worksheet 1: Runoff Parameters and Time of Concentration

Circle one: **Present** [✓ **Developed**] *(ENTIRE CATCHMENT, PERVIOUS& IMPERVIOUS)*

1. Runoff Curve Number (CN) and Initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment & hydrologic condition)	Curve Number CN*	Area (ha)	Product of CN x area
Type C	Urbun Lawn	72	**1.1500**	82.80
		Totals =	1.1500	83

CN (weighted) = total producted / total area = **72.00**

Ia (weighted) = 5 x pervious area / total area = **5.0** mm

1. Time of Concentration

Channelisation factor ……… C = 0.90 (from Table 4.2)
Catchment length ……… L = 0.20 km (along drainage path)
Catchment slope ……… S_c = 0.14 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = **0.56**

$t_c = 0.14\ C\ L^{0.66} (CN / (200 - CN))^{-0.55} S_c^{-0.30}$ **0.106** hrs
Adopted tc = **0.17** hrs *0.17hrs min*

SCS Lag for HEC-HMS ………. Tp = 2 / 3 t_c **0.11** hrs

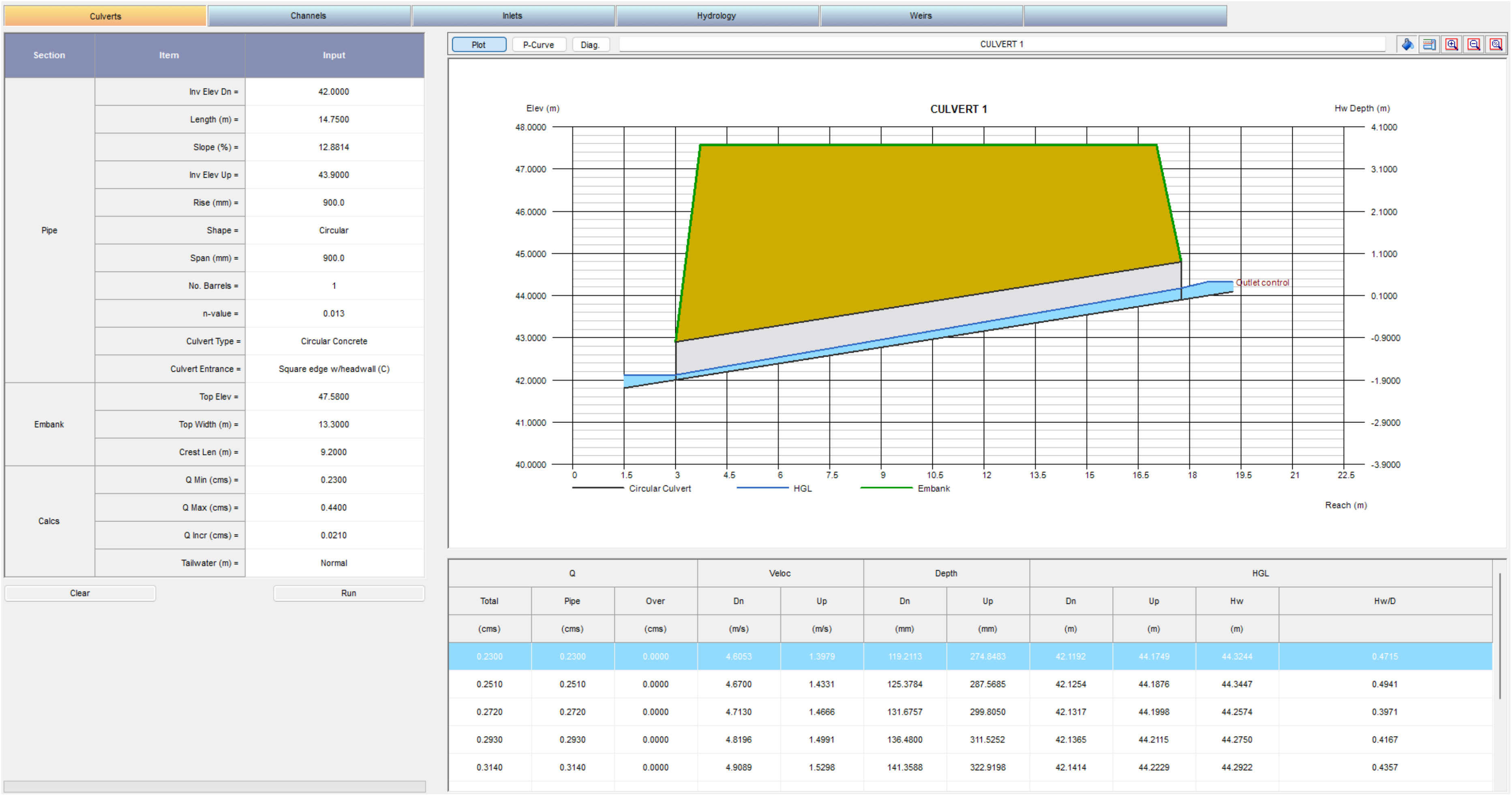
Worksheet 2: Graphical Peak Flow rate

1. Data

Catchment area A = **0.011500** km²
Runoff Curve No CN = **72.00** (from Worksheet 1)
Initial abstraction Ia = **5.00** mm (from Worksheet 1)
Time of concentration t_c = **0.170** hrs (from Worksheet 1)

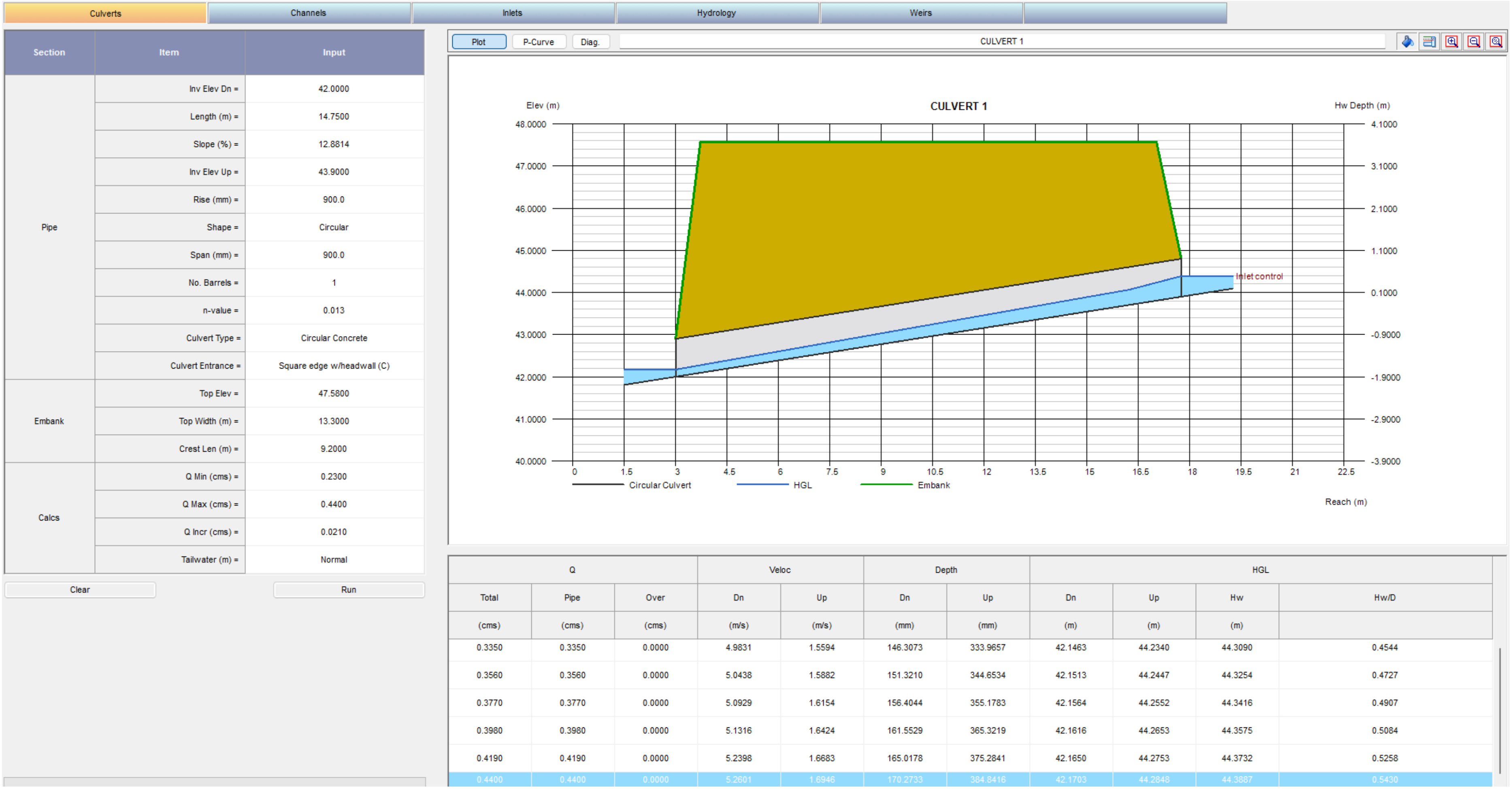
2.Calculate Storage, S = (1000 / CN - 10) x 25.4 **98.8** mm

	Storm#1	**Storm#2**
3. Average recurrence Interval, ARI (yr)	1% AEP	10% AEP
4. 24 hour rainfall depth, P_{24} (mm)	280.3	170.0
5. Compute C*= $\frac{P_{24} - 2Ia}{P_{24} - 2Ia + 2S}$	**0.58**	**0.45**
6. Specific peak flow rate q* (from fig 6.1)	0.136	0.115
7. Peak Flow rate, q_p = $q^* A P_{24}$ (m^3 / s)	**0.438**	**0.225**
8. Runoff depth,Q_{24} (mm) = $\frac{(P_{24} - Ia)^2}{(P_{24} - Ia) + S}$	**202.62**	**103.21**
9. Runoff volume, V_{24} = 1000 x Q_{24} A (m^3)	**2330**	**1187**



Section	Item	Input
Pipe	Inv Elev Dn =	42.0000
	Length (m) =	14.7500
	Slope (%) =	12.8814
	Inv Elev Up =	43.9000
	Rise (mm) =	900.0
	Shape =	Circular
	Span (mm) =	900.0
	No. Barrels =	1
	n-value =	0.013
	Culvert Type =	Circular Concrete
	Culvert Entrance =	Square edge w/headwall (C)
Embank	Top Elev =	47.5800
	Top Width (m) =	13.3000
	Crest Len (m) =	9.2000
Calcs	Q Min (cms) =	0.2300
	Q Max (cms) =	0.4400
	Q Incr (cms) =	0.0210
	Tailwater (m) =	Normal

Q			Veloc		Depth		HGL			
Total	Pipe	Over	Dn	Up	Dn	Up	Dn	Up	Hw	Hw/D
(cms)	(cms)	(cms)	(m/s)	(m/s)	(mm)	(mm)	(m)	(m)	(m)	
0.2300	0.2300	0.0000	4.6053	1.3979	119.2113	274.8483	42.1192	44.1749	44.3244	0.4715
0.2510	0.2510	0.0000	4.6700	1.4331	125.3784	287.5685	42.1254	44.1876	44.3447	0.4941
0.2720	0.2720	0.0000	4.7130	1.4666	131.6757	299.8050	42.1317	44.1998	44.2574	0.3971
0.2930	0.2930	0.0000	4.8196	1.4991	136.4800	311.5252	42.1365	44.2115	44.2750	0.4167
0.3140	0.3140	0.0000	4.9089	1.5298	141.3588	322.9198	42.1414	44.2229	44.2922	0.4357



Section	Item	Input
Pipe	Inv Elev Dn =	42.0000
	Length (m) =	14.7500
	Slope (%) =	12.8814
	Inv Elev Up =	43.9000
	Rise (mm) =	900.0
	Shape =	Circular
	Span (mm) =	900.0
	No. Barrels =	1
	n-value =	0.013
	Culvert Type =	Circular Concrete
	Culvert Entrance =	Square edge w/headwall (C)
Embank	Top Elev =	47.5800
	Top Width (m) =	13.3000
	Crest Len (m) =	9.2000
Calcs	Q Min (cms) =	0.2300
	Q Max (cms) =	0.4400
	Q Incr (cms) =	0.0210
	Tailwater (m) =	Normal

Q			Veloc		Depth		HGL			
Total	Pipe	Over	Dn	Up	Dn	Up	Dn	Up	Hw	Hw/D
(cms)	(cms)	(cms)	(m/s)	(m/s)	(mm)	(mm)	(m)	(m)	(m)	
0.3350	0.3350	0.0000	4.9831	1.5594	146.3073	333.9657	42.1463	44.2340	44.3090	0.4544
0.3560	0.3560	0.0000	5.0438	1.5882	151.3210	344.6534	42.1513	44.2447	44.3254	0.4727
0.3770	0.3770	0.0000	5.0929	1.6154	156.4044	355.1783	42.1564	44.2552	44.3416	0.4907
0.3980	0.3980	0.0000	5.1316	1.6424	161.5529	365.3219	42.1616	44.2653	44.3575	0.5084
0.4190	0.4190	0.0000	5.2398	1.6683	165.0178	375.2841	42.1650	44.2753	44.3732	0.5258
0.4400	0.4400	0.0000	5.2601	1.6946	170.2733	384.8416	42.1703	44.2848	44.3887	0.5430

Project: 2127 KAIPARA COAST HIGHWAY, KAKANUI
Client: GOODLAND

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Culvert 2 Flow Rate Calculation

Worksheet 1: Runoff Parameters and Time of Concentration

Circle one: **Present** [✓ **Developed**] *(ENTIRE CATCHMENT, PERVIOUS& IMPERVIOUS)*

1. Runoff Curve Number (CN) and Initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment & hydrologic condition)	Curve Number CN*	Area (ha)	Product of CN x area
Type C	Urbun Lawn	72	**4.8600**	349.92
		Totals =	4.8600	350

CN (weighted) = total producted / total area = **72.00**

Ia (weighted) = 5 x pervious area / total area = **5.0** mm

1. Time of Concentration

Channelisation factor ……… C = 0.90 (from Table 4.2)
Catchment length ……… L = 0.40 km (along drainage path)
Catchment slope ……… S_c = 0.15 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = **0.56**

$t_c = 0.14\ C\ L^{0.66} (CN / (200 - CN))^{-0.55} S_c^{-0.30}$ **0.167** hrs
Adopted tc = **0.17** hrs *0.17hrs min*

SCS Lag for HEC-HMS ………. Tp = 2 / 3 t_c **0.11** hrs

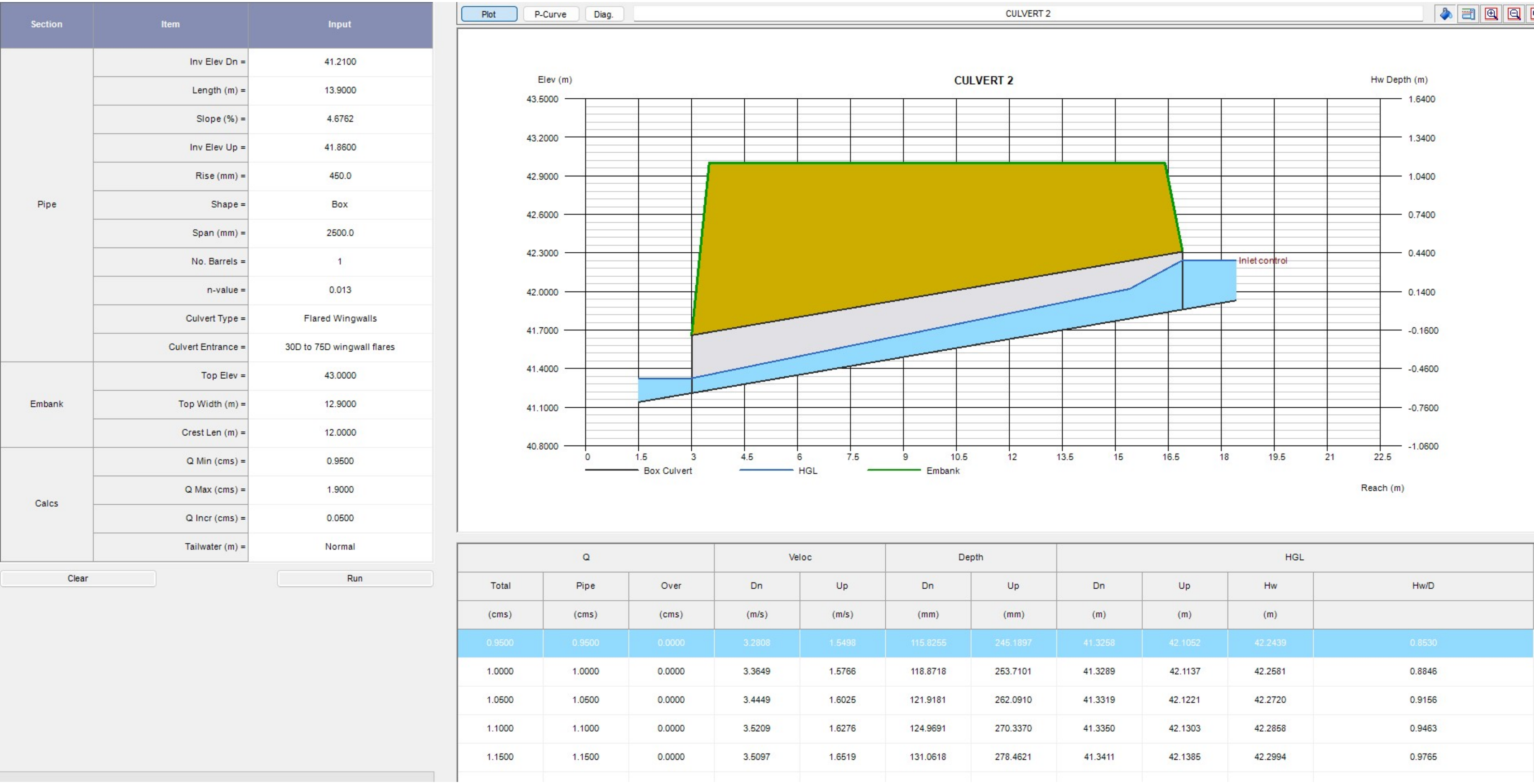
Worksheet 2: Graphical Peak Flow rate

1. Data

Catchment area A = **0.048600** km²
Runoff Curve No CN = **72.00** (from Worksheet 1)
Initial abstraction Ia = **5.00** mm (from Worksheet 1)
Time of concentration t_c = **0.170** hrs (from Worksheet 1)

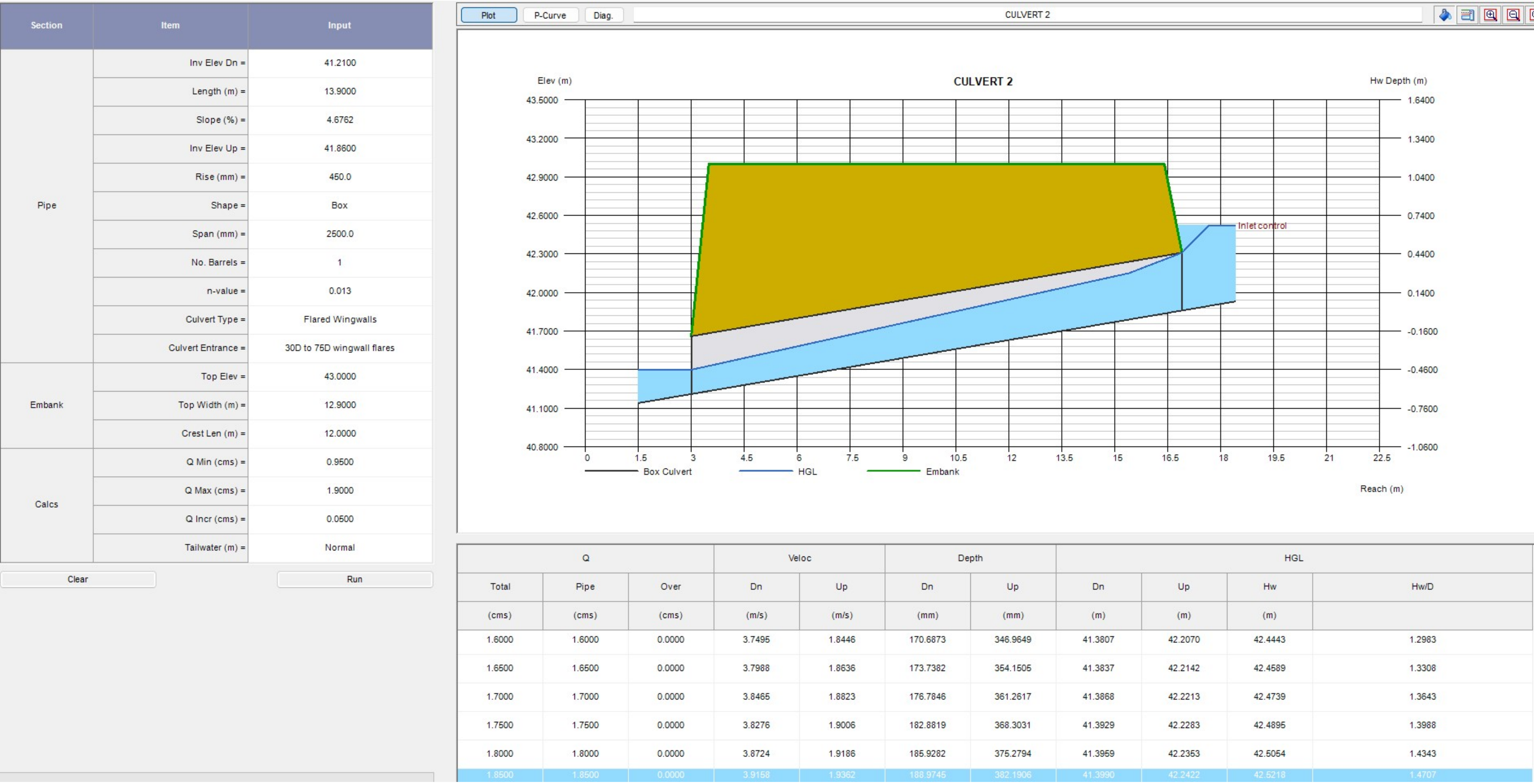
2.Calculate Storage, S = (1000 / CN - 10) x 25.4 **98.8** mm

	Storm#1	**Storm#2**
3. Average recurrence Interval, ARI (yr)	1% AEP	10% AEP
4. 24 hour rainfall depth, P_{24} (mm)	280.32	170
5. Compute C*= $\frac{P_{24} - 2Ia}{P_{24} - 2Ia + 2S}$	**0.58**	**0.45**
6. Specific peak flow rate q* (from fig 6.1)	0.136	0.115
7. Peak Flow rate, $q_p = q^* A P_{24}$ (m^3 / s)	**1.853**	**0.950**
8. Runoff depth,Q_{24} (mm) = $\frac{(P_{24} - Ia)^2}{(P_{24} - Ia) + S}$	**202.62**	**103.21**
9. Runoff volume, V_{24} = 1000 x Q_{24} A (m^3)	**9848**	**5016**



Section	Item	Input
Pipe	Inv Elev Dn =	41.2100
	Length (m) =	13.9000
	Slope (%) =	4.6762
	Inv Elev Up =	41.8600
	Rise (mm) =	450.0
	Shape =	Box
	Span (mm) =	2500.0
	No. Barrels =	1
	n-value =	0.013
	Culvert Type =	Flared Wingwalls
	Culvert Entrance =	30D to 75D wingwall flares
Embank	Top Elev =	43.0000
	Top Width (m) =	12.9000
	Crest Len (m) =	12.0000
Calcs	Q Min (cms) =	0.9500
	Q Max (cms) =	1.9000
	Q Incr (cms) =	0.0500
	Tailwater (m) =	Normal

Q			Veloc		Depth		HGL			
Total	Pipe	Over	Dn	Up	Dn	Up	Dn	Up	Hw	Hw/D
(cms)	(cms)	(cms)	(m/s)	(m/s)	(mm)	(mm)	(m)	(m)	(m)	
0.9500	0.9500	0.0000	3.2808	1.5498	115.8255	245.1897	41.3258	42.1052	42.2439	0.8530
1.0000	1.0000	0.0000	3.3649	1.5766	118.8718	253.7101	41.3289	42.1137	42.2581	0.8846
1.0500	1.0500	0.0000	3.4449	1.6025	121.9181	262.0910	41.3319	42.1221	42.2720	0.9156
1.1000	1.1000	0.0000	3.5209	1.6276	124.9691	270.3370	41.3350	42.1303	42.2858	0.9463
1.1500	1.1500	0.0000	3.5097	1.6519	131.0618	278.4621	41.3411	42.1385	42.2994	0.9765



Section	Item	Input
Pipe	Inv Elev Dn =	41.2100
	Length (m) =	13.9000
	Slope (%) =	4.6762
	Inv Elev Up =	41.8600
	Rise (mm) =	450.0
	Shape =	Box
	Span (mm) =	2500.0
	No. Barrels =	1
	n-value =	0.013
	Culvert Type =	Flared Wingwalls
	Culvert Entrance =	30D to 75D wingwall flares
Embank	Top Elev =	43.0000
	Top Width (m) =	12.9000
	Crest Len (m) =	12.0000
Calcs	Q Min (cms) =	0.9500
	Q Max (cms) =	1.9000
	Q Incr (cms) =	0.0500
	Tailwater (m) =	Normal

Q			Veloc		Depth		HGL			
Total	Pipe	Over	Dn	Up	Dn	Up	Dn	Up	Hw	Hw/D
(cms)	(cms)	(cms)	(m/s)	(m/s)	(mm)	(mm)	(m)	(m)	(m)	
1.6000	1.6000	0.0000	3.7495	1.8446	170.6873	346.9649	41.3807	42.2070	42.4443	1.2983
1.6500	1.6500	0.0000	3.7988	1.8636	173.7382	354.1505	41.3837	42.2142	42.4589	1.3308
1.7000	1.7000	0.0000	3.8465	1.8823	176.7846	361.2617	41.3868	42.2213	42.4739	1.3643
1.7500	1.7500	0.0000	3.8276	1.9006	182.8819	368.3031	41.3929	42.2283	42.4895	1.3988
1.8000	1.8000	0.0000	3.8724	1.9186	185.9282	375.2794	41.3959	42.2353	42.5054	1.4343
1.8500	1.8500	0.0000	3.9158	1.9362	188.9745	382.1906	41.3990	42.2422	42.5218	1.4707

Project: 2127 KAIPARA COAST HIGHWAY, KAKANUI
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Culvert 3 Flow Rate Calculation

Worksheet 1: Runoff Parameters and Time of Concentration

Circle one: **Present** [✓ **Developed**] *(ENTIRE CATCHMENT, PERVIOUS& IMPERVIOUS)*

1. Runoff Curve Number (CN) and Initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment & hydrologic condition)	Curve Number CN*	Area (ha)	Product of CN x area
Type C	Urbun Lawn	72	**1.0600**	76.32
		Totals =	1.0600	76

CN (weighted) = total producted / total area = **72.00**

Ia (weighted) = 5 x pervious area / total area = **5.0** mm

1. Time of Concentration

Channelisation factor ……… C = 0.90 (from Table 4.2)
Catchment length ……… L = 0.12 km (along drainage path)
Catchment slope ……… S_c = 0.29 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = **0.56**

$t_c = 0.14\ C\ L^{0.66}\ (CN / (200 - CN))^{-0.55}\ S_c^{-0.30}$ **0.062** hrs
Adopted tc = **0.17** hrs *0.17hrs min*

SCS Lag for HEC-HMS ………. Tp = 2 / 3 t_c **0.11** hrs

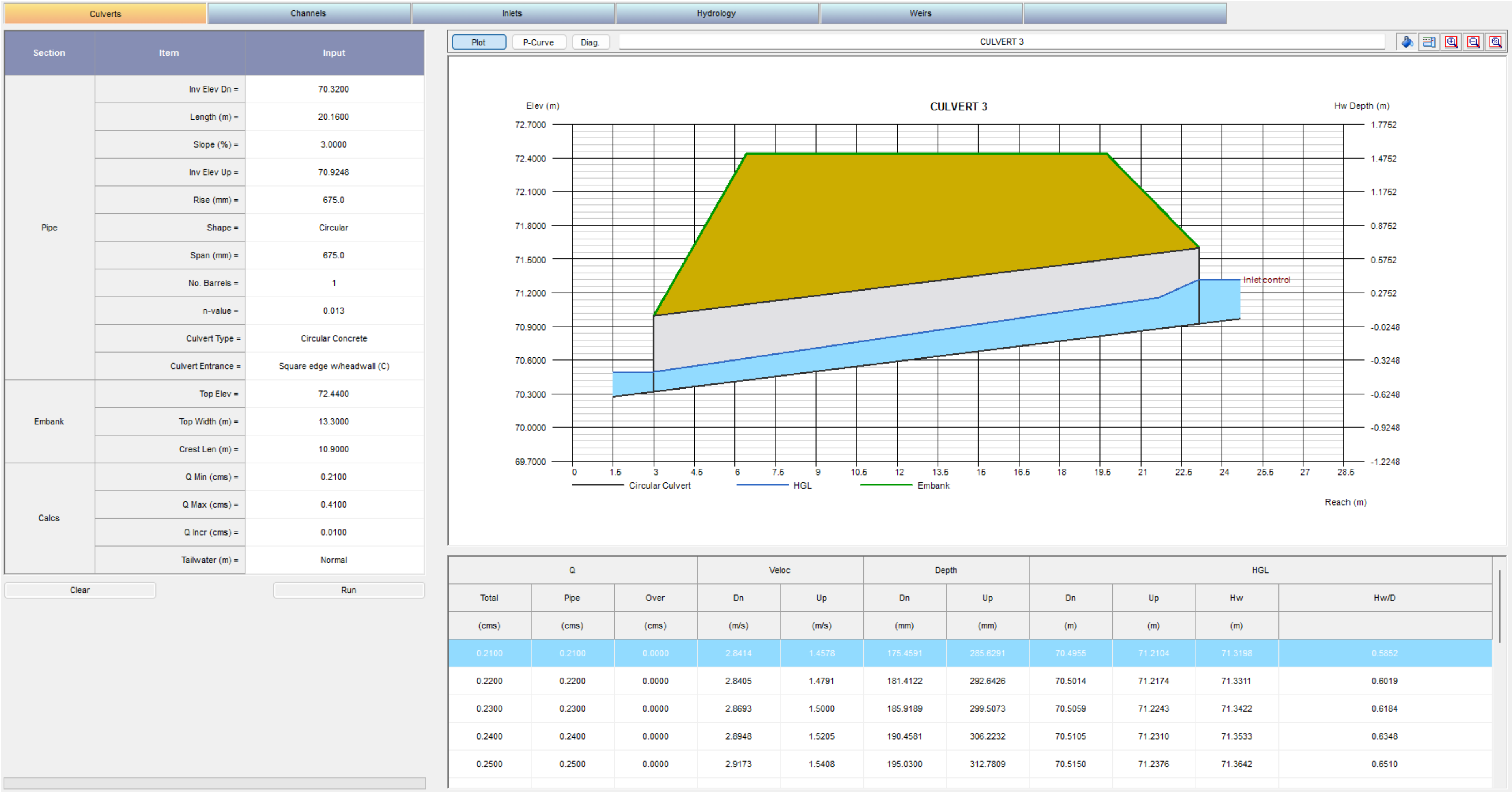
Worksheet 2: Graphical Peak Flow rate

1. Data

Catchment area A = **0.010600** km²
Runoff Curve No CN = **72.00** (from Worksheet 1)
Initial abstraction Ia = **5.00** mm (from Worksheet 1)
Time of concentration t_c = **0.170** hrs (from Worksheet 1)

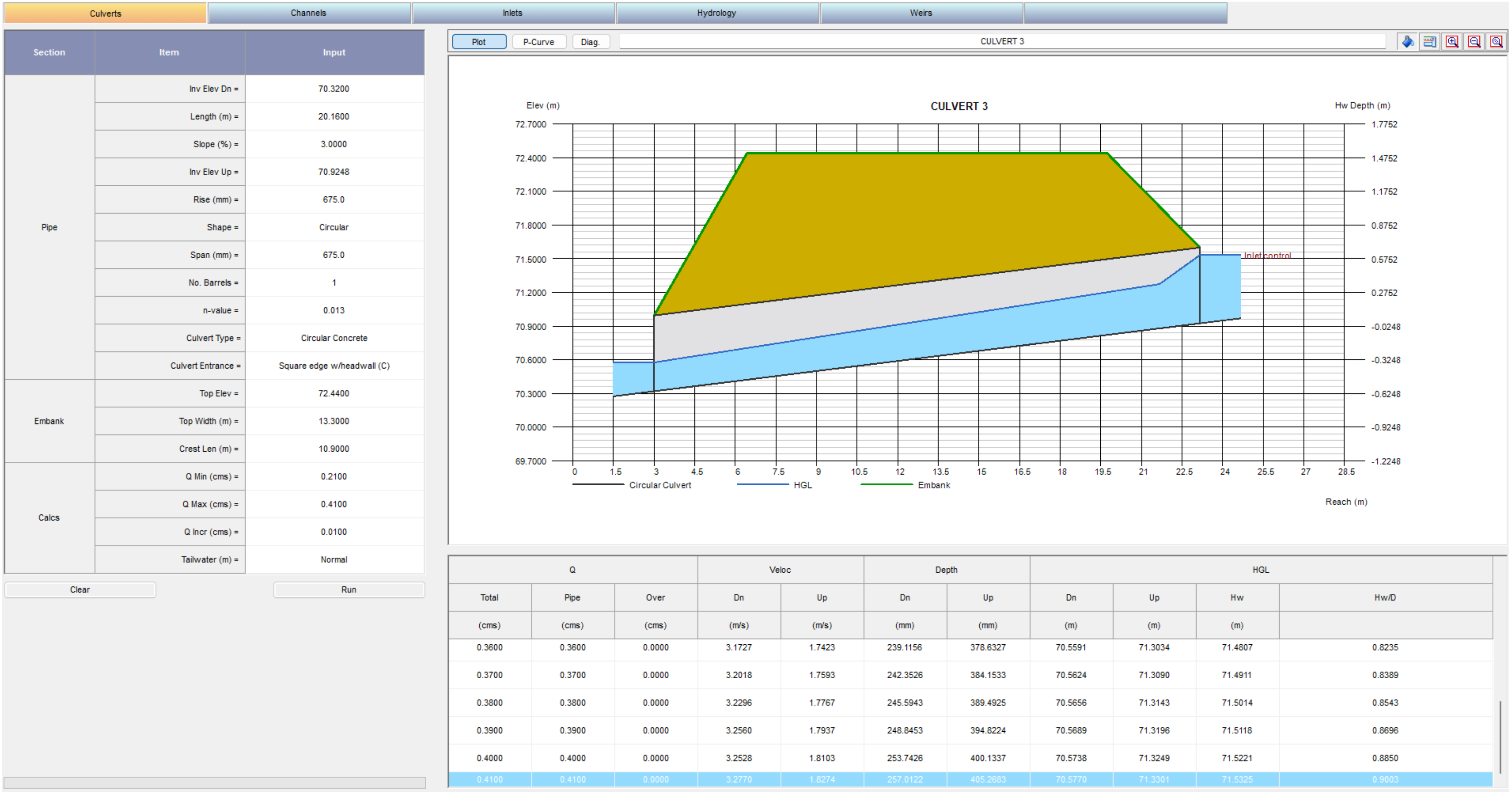
2.Calculate Storage, S = (1000 / CN - 10) x 25.4 **98.8** mm

	Storm#1	**Storm#2**
3. Average recurrence Interval, ARI (yr)	1% AEP	1% AEP
4. 24 hour rainfall depth, P_{24} (mm)	280.32	170
5. Compute C*= $\dfrac{P_{24} - 2Ia}{P_{24} - 2Ia + 2S}$	**0.58**	**0.45**
6. Specific peak flow rate q* (from fig 6.1)	0.136	0.115
7. Peak Flow rate, $q_p = q^* A P_{24}$ (m^3 / s)	**0.404**	**0.207**
8. Runoff depth,Q_{24} (mm) = $\dfrac{(P_{24} - Ia)^2}{(P_{24} - Ia) + S}$	**202.62**	**103.21**
9. Runoff volume, V_{24} = 1000 x Q_{24} A (m^3)	**2148**	**1094**



Section	Item	Input
Pipe	Inv Elev Dn =	70.3200
	Length (m) =	20.1600
	Slope (%) =	3.0000
	Inv Elev Up =	70.9248
	Rise (mm) =	675.0
	Shape =	Circular
	Span (mm) =	675.0
	No. Barrels =	1
	n-value =	0.013
	Culvert Type =	Circular Concrete
	Culvert Entrance =	Square edge w/headwall (C)
Embank	Top Elev =	72.4400
	Top Width (m) =	13.3000
	Crest Len (m) =	10.9000
Calcs	Q Min (cms) =	0.2100
	Q Max (cms) =	0.4100
	Q Incr (cms) =	0.0100
	Tailwater (m) =	Normal

Q			Veloc		Depth		HGL			
Total	Pipe	Over	Dn	Up	Dn	Up	Dn	Up	Hw	Hw/D
(cms)	(cms)	(cms)	(m/s)	(m/s)	(mm)	(mm)	(m)	(m)	(m)	
0.2100	0.2100	0.0000	2.8414	1.4578	175.4591	285.6291	70.4955	71.2104	71.3198	0.5852
0.2200	0.2200	0.0000	2.8405	1.4791	181.4122	292.6426	70.5014	71.2174	71.3311	0.6019
0.2300	0.2300	0.0000	2.8693	1.5000	185.9189	299.5073	70.5059	71.2243	71.3422	0.6184
0.2400	0.2400	0.0000	2.8948	1.5205	190.4581	306.2232	70.5105	71.2310	71.3533	0.6348
0.2500	0.2500	0.0000	2.9173	1.5408	195.0300	312.7809	70.5150	71.2376	71.3642	0.6510



Section	Item	Input
Pipe	Inv Elev Dn =	70.3200
	Length (m) =	20.1600
	Slope (%) =	3.0000
	Inv Elev Up =	70.9248
	Rise (mm) =	675.0
	Shape =	Circular
	Span (mm) =	675.0
	No. Barrels =	1
	n-value =	0.013
	Culvert Type =	Circular Concrete
	Culvert Entrance =	Square edge w/headwall (C)
Embank	Top Elev =	72.4400
	Top Width (m) =	13.3000
	Crest Len (m) =	10.9000
Calcs	Q Min (cms) =	0.2100
	Q Max (cms) =	0.4100
	Q Incr (cms) =	0.0100
	Tailwater (m) =	Normal

Q			Veloc		Depth		HGL			
Total	Pipe	Over	Dn	Up	Dn	Up	Dn	Up	Hw	Hw/D
(cms)	(cms)	(cms)	(m/s)	(m/s)	(mm)	(mm)	(m)	(m)	(m)	
0.3600	0.3600	0.0000	3.1727	1.7423	239.1156	378.6327	70.5591	71.3034	71.4807	0.8235
0.3700	0.3700	0.0000	3.2018	1.7593	242.3526	384.1533	70.5624	71.3090	71.4911	0.8389
0.3800	0.3800	0.0000	3.2296	1.7767	245.5943	389.4925	70.5656	71.3143	71.5014	0.8543
0.3900	0.3900	0.0000	3.2560	1.7937	248.8453	394.8224	70.5689	71.3196	71.5118	0.8696
0.4000	0.4000	0.0000	3.2528	1.8103	253.7426	400.1337	70.5738	71.3249	71.5221	0.8850
0.4100	0.4100	0.0000	3.2770	1.8274	257.0122	405.2683	70.5770	71.3301	71.5325	0.9003

Project: 2127 KAIPARA COAST HIGHWAY, KAKANUI
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Culvert 4 Flow Rate Calculation

Worksheet 1: Runoff Parameters and Time of Concentration

Circle one: **Present** [✓ **Developed**] *(ENTIRE CATCHMENT, PERVIOUS& IMPERVIOUS)*

1. Runoff Curve Number (CN) and Initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment & hydrologic condition)	Curve Number CN*	Area (ha)	Product of CN x area
Type C	Urbun Lawn	72	**3.7042**	266.70
Type C	Building Platform	98	**0.5758**	56.43
		Totals =	4.2800	323

CN (weighted) = total producted / total area = **75.50**

Ia (weighted) = 5 x pervious area / total area = **4.3** mm

1. Time of Concentration

Channelisation factor ……… C = 0.90 (from Table 4.2)
Catchment length ……… L = 0.33 km (along drainage path)
Catchment slope ……… S_c = 0.16 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = **0.61**

$t_c = 0.14\ C\ L^{0.66}\ (CN / (200 - CN))^{-0.55}\ S_c^{-0.30}$ **0.138** hrs
Adopted tc = **0.17** hrs *0.17hrs min*

SCS Lag for HEC-HMS ………. Tp = 2 / 3 t_c **0.11** hrs

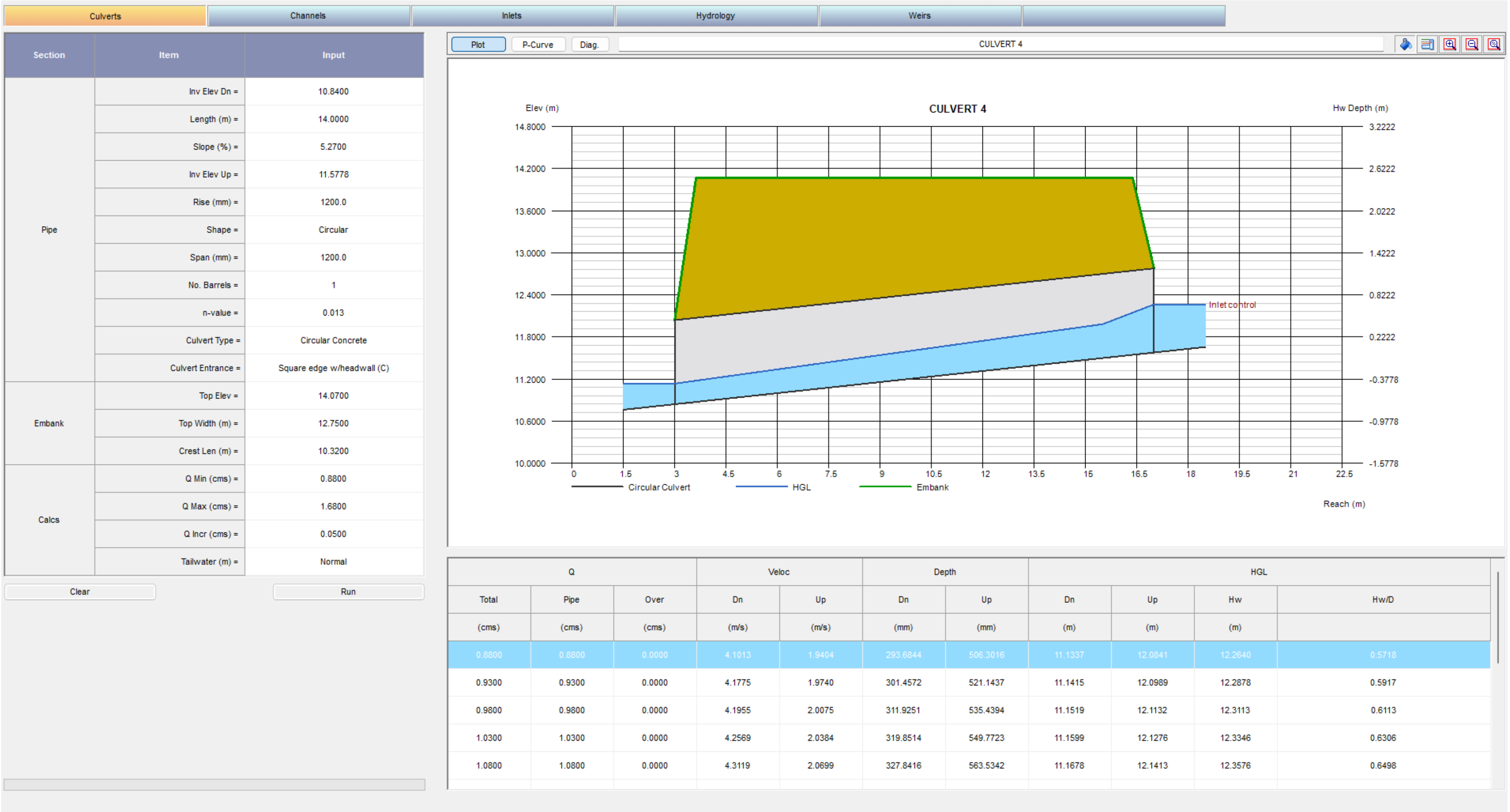
Worksheet 2: Graphical Peak Flow rate

1. Data

Catchment area A = **0.042800** km²
Runoff Curve No CN = **75.50** (from Worksheet 1)
Initial abstraction Ia = **4.33** mm (from Worksheet 1)
Time of concentration t_c = **0.170** hrs (from Worksheet 1)

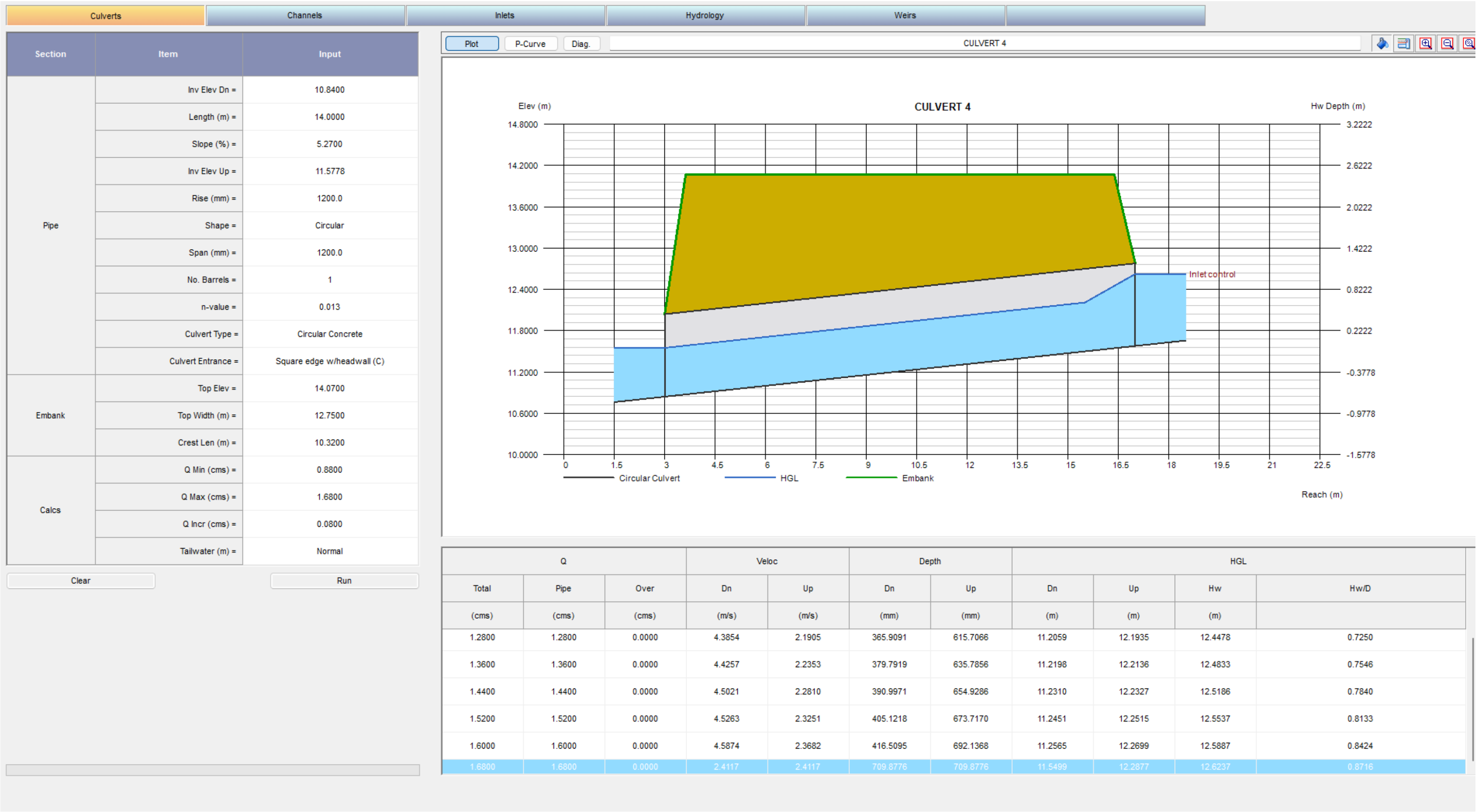
2.Calculate Storage, S = (1000 / CN - 10) x 25.4 **82.4** mm

	Storm#1	**Storm#2**
3. Average recurrence Interval, ARI (yr)	1% AEP	1% AEP
4. 24 hour rainfall depth, P_{24} (mm)	280.32	170
5. Compute C*= $\frac{P_{24} - 2Ia}{P_{24} - 2Ia + 2S}$	**0.62**	**0.49**
6. Specific peak flow rate q* (from fig 6.1)	0.14	0.12
7. Peak Flow rate, $q_p = q^* A P_{24}\ (m^3 / s)$	**1.680**	**0.873**
8. Runoff depth,Q_{24} (mm) = $\frac{(P_{24} - Ia)^2}{(P_{24} - Ia) + S}$	**212.52**	**110.63**
9. Runoff volume, V_{24} = 1000 x Q_{24} A (m^3)	**9096**	**4735**



Section	Item	Input
Pipe	Inv Elev Dn =	10.8400
	Length (m) =	14.0000
	Slope (%) =	5.2700
	Inv Elev Up =	11.5778
	Rise (mm) =	1200.0
	Shape =	Circular
	Span (mm) =	1200.0
	No. Barrels =	1
	n-value =	0.013
	Culvert Type =	Circular Concrete
	Culvert Entrance =	Square edge w/headwall (C)
Embank	Top Elev =	14.0700
	Top Width (m) =	12.7500
	Crest Len (m) =	10.3200
Calcs	Q Min (cms) =	0.8800
	Q Max (cms) =	1.6800
	Q Incr (cms) =	0.0500
	Tailwater (m) =	Normal

Q			Veloc		Depth		HGL			
Total	Pipe	Over	Dn	Up	Dn	Up	Dn	Up	Hw	Hw/D
(cms)	(cms)	(cms)	(m/s)	(m/s)	(mm)	(mm)	(m)	(m)	(m)	
0.8800	0.8800	0.0000	4.1013	1.9404	293.6844	506.3016	11.1337	12.0841	12.2640	0.5718
0.9300	0.9300	0.0000	4.1775	1.9740	301.4572	521.1437	11.1415	12.0989	12.2878	0.5917
0.9800	0.9800	0.0000	4.1955	2.0075	311.9251	535.4394	11.1519	12.1132	12.3113	0.6113
1.0300	1.0300	0.0000	4.2569	2.0384	319.8514	549.7723	11.1599	12.1276	12.3346	0.6306
1.0800	1.0800	0.0000	4.3119	2.0699	327.8416	563.5342	11.1678	12.1413	12.3576	0.6498



Section	Item	Input
Pipe	Inv Elev Dn =	10.8400
	Length (m) =	14.0000
	Slope (%) =	5.2700
	Inv Elev Up =	11.5778
	Rise (mm) =	1200.0
	Shape =	Circular
	Span (mm) =	1200.0
	No. Barrels =	1
	n-value =	0.013
	Culvert Type =	Circular Concrete
	Culvert Entrance =	Square edge w/headwall (C)
Embank	Top Elev =	14.0700
	Top Width (m) =	12.7500
	Crest Len (m) =	10.3200
Calcs	Q Min (cms) =	0.8800
	Q Max (cms) =	1.6800
	Q Incr (cms) =	0.0800
	Tailwater (m) =	Normal

Q			Veloc		Depth		HGL			
Total	Pipe	Over	Dn	Up	Dn	Up	Dn	Up	Hw	Hw/D
(cms)	(cms)	(cms)	(m/s)	(m/s)	(mm)	(mm)	(m)	(m)	(m)	
1.2800	1.2800	0.0000	4.3854	2.1905	365.9091	615.7066	11.2059	12.1935	12.4478	0.7250
1.3600	1.3600	0.0000	4.4257	2.2353	379.7919	635.7856	11.2198	12.2136	12.4833	0.7546
1.4400	1.4400	0.0000	4.5021	2.2810	390.9971	654.9286	11.2310	12.2327	12.5186	0.7840
1.5200	1.5200	0.0000	4.5263	2.3251	405.1218	673.7170	11.2451	12.2515	12.5537	0.8133
1.6000	1.6000	0.0000	4.5874	2.3682	416.5095	692.1368	11.2565	12.2699	12.5887	0.8424
1.6800	1.6800	0.0000	2.4117	2.4117	709.8776	709.8776	11.5499	12.2877	12.6237	0.8716

Project: 2127 KAIPARA COAST HIGHWAY, KAKANUI
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Culvert 5 Flow Rate Calculation

Worksheet 1: Runoff Parameters and Time of Concentration

Circle one: **Present** [✓ **Developed**] *(ENTIRE CATCHMENT, PERVIOUS& IMPERVIOUS)*

1. Runoff Curve Number (CN) and Initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment & hydrologic condition)	Curve Number CN*	Area (ha)	Product of CN x area
Type C	Urbun Lawn	72	**2.3000**	165.60
Type C	Building Platform	98	**0.1400**	13.72
		Totals =	2.4400	179

CN (weighted) = total producted / total area = **73.49**

Ia (weighted) = 5 x pervious area / total area = **4.7** mm

1. Time of Concentration

Channelisation factor ………	C =	0.90	(from Table 4.2)
Catchment length ………	L =	0.38	km (along drainage path)
Catchment slope ………	S_c =	0.14	m/m (by equal area method)

Runoff factor, CN / (200 - CN) = **0.58**

$t_c = 0.14\ C\ L^{0.66}\ (CN / (200 - CN))^{-0.55}\ S_c^{-0.30}$ **0.162** hrs

Adopted tc = **0.17** hrs *0.17hrs min*

SCS Lag for HEC-HMS ………. Tp = 2 / 3 t_c **0.11** hrs

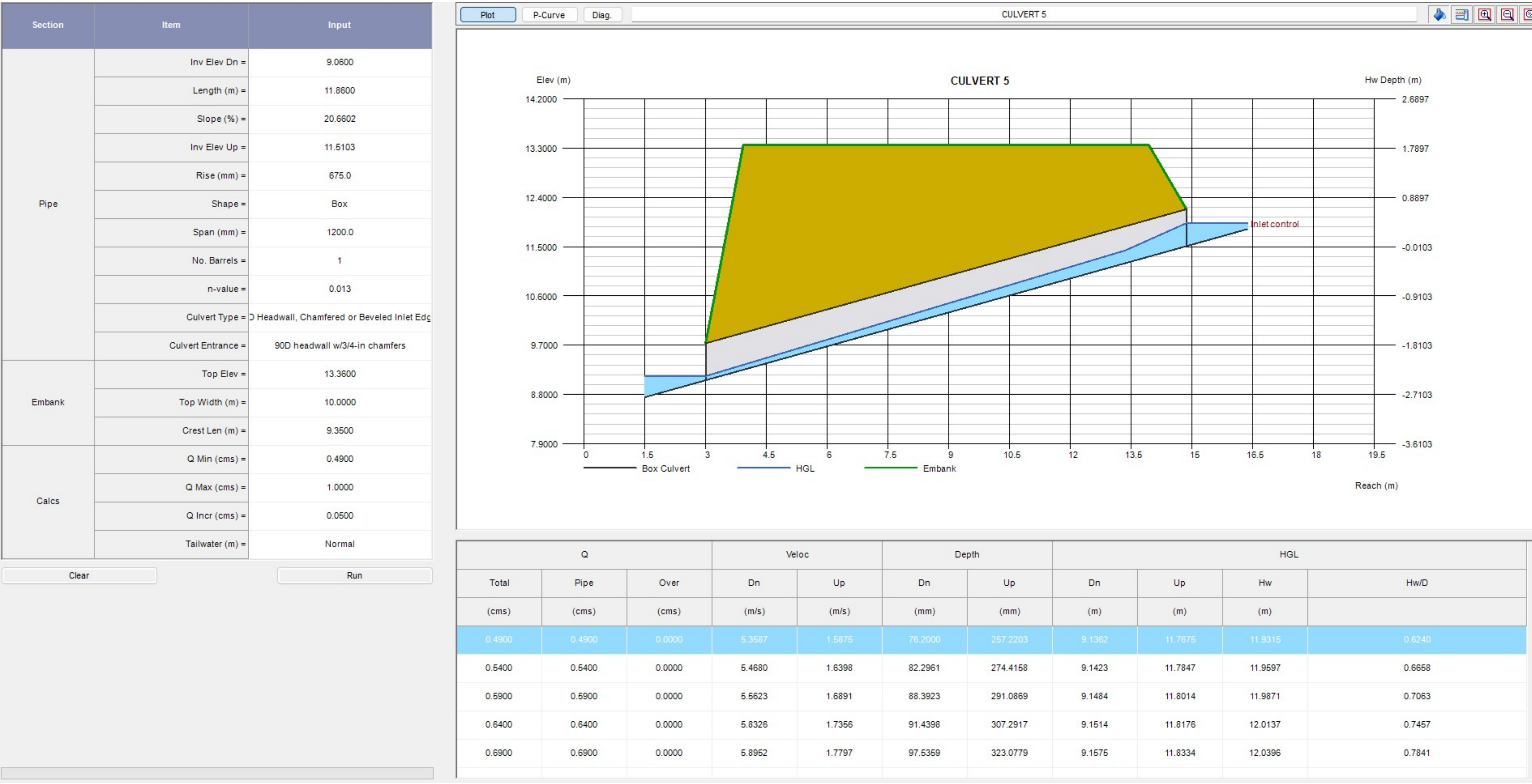
Worksheet 2: Graphical Peak Flow rate

1. Data

Catchment area	A =	**0.024400**	km²
Runoff Curve No	CN =	**73.49**	(from Worksheet 1)
Initial abstraction	Ia =	**4.71**	mm (from Worksheet 1)
Time of concentration	t_c =	**0.170**	hrs (from Worksheet 1)

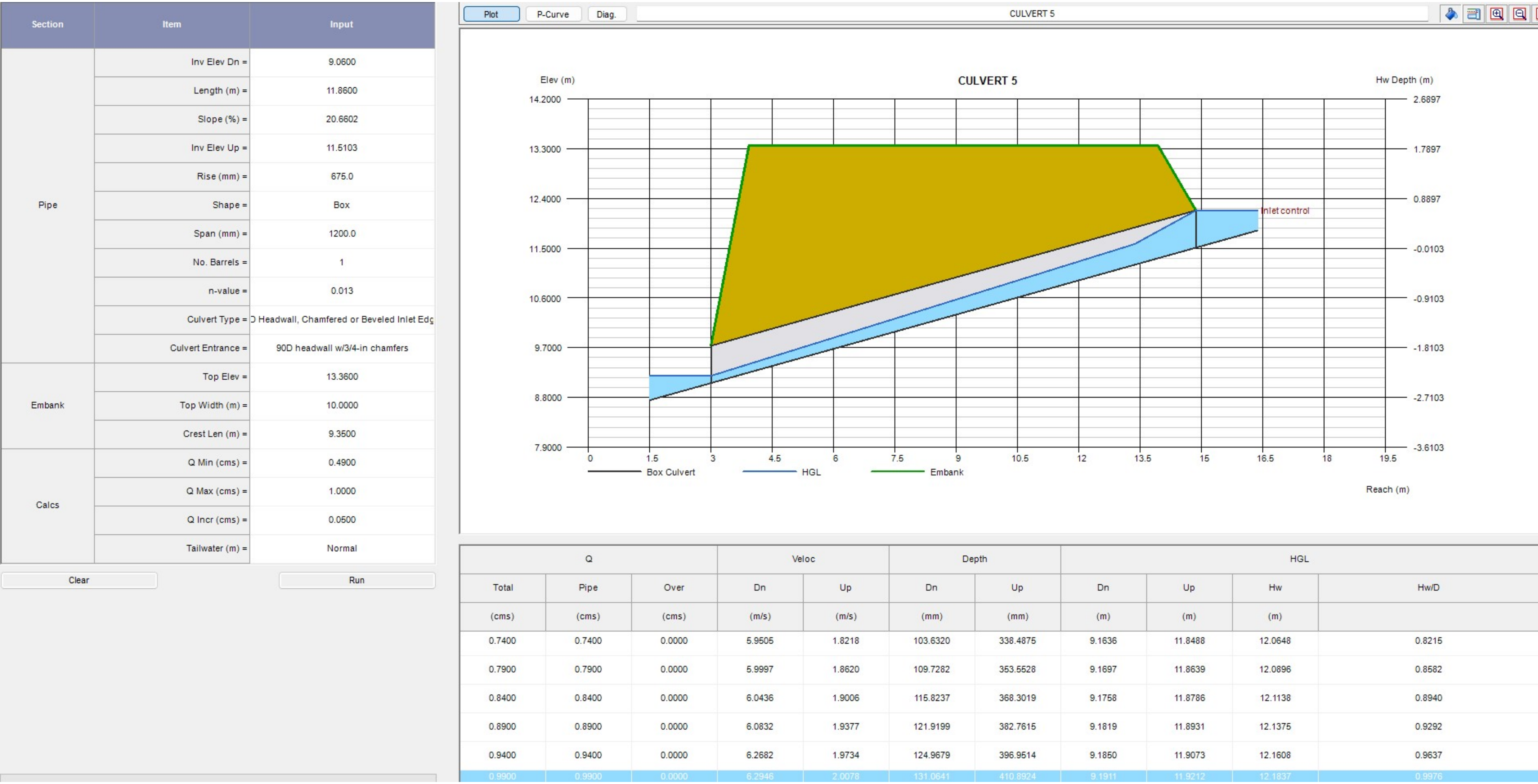
2.Calculate Storage, S = (1000 / CN - 10) x 25.4 **91.6** mm

	Storm#1	**Storm#2**
3. Average recurrence Interval, ARI (yr)	1% AEP	10% AEP
4. 24 hour rainfall depth, P_{24} (mm)	280.32	170
5. Compute C*= $\frac{P_{24} - 2Ia}{P_{24} - 2Ia + 2S}$	**0.60**	**0.47**
6. Specific peak flow rate q* (from fig 6.1)	0.14	0.118
7. Peak Flow rate, $q_p = q^* A P_{24}$ (m^3 / s)	**0.958**	**0.489**
8. Runoff depth, Q_{24} (mm) = $\frac{(P_{24} - Ia)^2}{(P_{24} - Ia) + S}$	**206.85**	**106.34**
9. Runoff volume, V_{24} = 1000 x Q_{24} A (m^3)	**5047**	**2595**



Section	Item	Input
Pipe	Inv Elev Dn =	9.0600
	Length (m) =	11.8600
	Slope (%) =	20.6602
	Inv Elev Up =	11.5103
	Rise (mm) =	675.0
	Shape =	Box
	Span (mm) =	1200.0
	No. Barrels =	1
	n-value =	0.013
	Culvert Type =	D Headwall, Chamfered or Beveled Inlet Edg
	Culvert Entrance =	90D headwall w/3/4-in chamfers
Embank	Top Elev =	13.3600
	Top Width (m) =	10.0000
	Crest Len (m) =	9.3500
Calcs	Q Min (cms) =	0.4900
	Q Max (cms) =	1.0000
	Q Incr (cms) =	0.0500
	Tailwater (m) =	Normal

Q			Veloc		Depth		HGL			
Total	Pipe	Over	Dn	Up	Dn	Up	Dn	Up	Hw	Hw/D
(cms)	(cms)	(cms)	(m/s)	(m/s)	(mm)	(mm)	(m)	(m)	(m)	
0.4900	0.4900	0.0000	5.3587	1.5875	76.2000	257.2203	9.1362	11.7675	11.9315	0.6240
0.5400	0.5400	0.0000	5.4680	1.6398	82.2961	274.4158	9.1423	11.7847	11.9597	0.6658
0.5900	0.5900	0.0000	5.5623	1.6891	88.3923	291.0869	9.1484	11.8014	11.9871	0.7063
0.6400	0.6400	0.0000	5.8326	1.7356	91.4398	307.2917	9.1514	11.8176	12.0137	0.7457
0.6900	0.6900	0.0000	5.8952	1.7797	97.5359	323.0779	9.1575	11.8334	12.0396	0.7841



Section	Item	Input
Pipe	Inv Elev Dn =	9.0600
	Length (m) =	11.8600
	Slope (%) =	20.6602
	Inv Elev Up =	11.5103
	Rise (mm) =	675.0
	Shape =	Box
	Span (mm) =	1200.0
	No. Barrels =	1
	n-value =	0.013
	Culvert Type =	D Headwall, Chamfered or Beveled Inlet Edg
	Culvert Entrance =	90D headwall w/3/4-in chamfers
Embank	Top Elev =	13.3600
	Top Width (m) =	10.0000
	Crest Len (m) =	9.3500
Calcs	Q Min (cms) =	0.4900
	Q Max (cms) =	1.0000
	Q Incr (cms) =	0.0500
	Tailwater (m) =	Normal

Q			Veloc		Depth		HGL			
Total	Pipe	Over	Dn	Up	Dn	Up	Dn	Up	Hw	Hw/D
(cms)	(cms)	(cms)	(m/s)	(m/s)	(mm)	(mm)	(m)	(m)	(m)	
0.7400	0.7400	0.0000	5.9505	1.8218	103.6320	338.4875	9.1636	11.8488	12.0648	0.8215
0.7900	0.7900	0.0000	5.9997	1.8620	109.7282	353.5528	9.1697	11.8639	12.0896	0.8582
0.8400	0.8400	0.0000	6.0436	1.9006	115.8237	368.3019	9.1758	11.8786	12.1138	0.8940
0.8900	0.8900	0.0000	6.0832	1.9377	121.9199	382.7615	9.1819	11.8931	12.1375	0.9292
0.9400	0.9400	0.0000	6.2682	1.9734	124.9679	396.9514	9.1850	11.9073	12.1608	0.9637
0.9900	0.9900	0.0000	6.2946	2.0078	131.0641	410.8924	9.1911	11.9212	12.1837	0.9976

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Outlet Protection Design - Concrete Baffle Block - Culvert 1

CLINET GOODLAND
PROJECT: GOODLAND COASTAL FARM-2127 KAIPARA COAST HIGHWAY
JOB NO. 1366
BY: ZY
DATE: 30/01/2024

1. Typical Baffle Block Inputs

Height of culvert / pipe		0.90	m
Baffle height	d=	0.3	m
Baffle width	w=	**0.5**	m
Flow Cross-sectional Area	A_C=	**0.08**	m2
Wetted permimeter	P_W=	**0.78**	m2
	R_h=	**0.10**	

2. Baffle Block Arrangement

Row spacing	S_d=	0.71	m
Horizontal spacing	S_w =	**0.46**	m

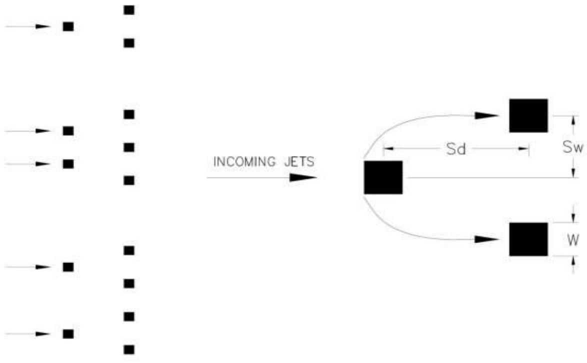
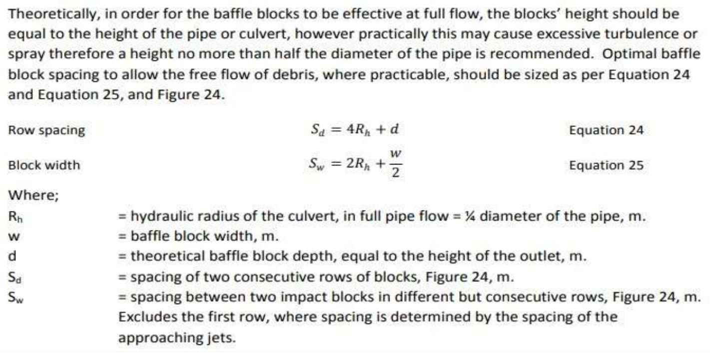


Figure 24: Typical Baffle Block Arrangement and Spacing for Single or Double Outlet Jets



Theoretically, in order for the baffle blocks to be effective at full flow, the blocks' height should be equal to the height of the pipe or culvert, however practically this may cause excessive turbulence or spray therefore a height no more than half the diameter of the pipe is recommended. Optimal baffle block spacing to allow the free flow of debris, where practicable, should be sized as per Equation 24 and Equation 25, and Figure 24.

Row spacing	$S_d = 4R_h + d$	Equation 24
Block width	$S_w = 2R_h + \frac{w}{2}$	Equation 25

Where;

R_h	= hydraulic radius of the culvert, in full pipe flow = ¼ diameter of the pipe, m.
w	= baffle block width, m.
d	= theoretical baffle block depth, equal to the height of the outlet, m.
S_d	= spacing of two consecutive rows of blocks, Figure 24, m.
S_w	= spacing between two impact blocks in different but consecutive rows, Figure 24, m. Excludes the first row, where spacing is determined by the spacing of the approaching jets.

Outlet Protection Design - Concrete Baffle Block - Culvert 2

CLINET	GOODLAND
PROJECT:	GOODLAND COASTAL FARM-2127 KAIPARA COAST HIGHWAY
JOB NO.	1366
BY:	ZY
DATE:	30/01/2024

1. Typical Baffle Block Inputs

Height of culvert / pipe		0.45	m
Baffle height	d=	0.15	m
Baffle width	w=	**0.5**	m
Flow Cross-sectional Area	A_C=	**1.1**	m2
Wetted permimeter	P_W=	**5.9**	m2
	R_h=	**0.19**	

2. Baffle Block Arrangement

Row spacing	S_d=	0.91	m
Horizontal spacing	S_w =	**0.63**	m

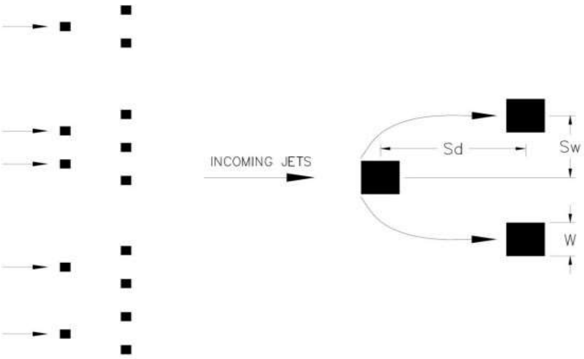


Figure 24: Typical Baffle Block Arrangement and Spacing for Single or Double Outlet Jets

Theoretically, in order for the baffle blocks to be effective at full flow, the blocks' height should be equal to the height of the pipe or culvert, however practically this may cause excessive turbulence or spray therefore a height no more than half the diameter of the pipe is recommended. Optimal baffle block spacing to allow the free flow of debris, where practicable, should be sized as per Equation 24 and Equation 25, and Figure 24.

Row spacing	$S_d = 4R_h + d$	Equation 24
Block width	$S_w = 2R_h + \frac{w}{2}$	Equation 25

Where;

R_h = hydraulic radius of the culvert, in full pipe flow = ¼ diameter of the pipe, m.
w = baffle block width, m.
d = theoretical baffle block depth, equal to the height of the outlet, m.
S_d = spacing of two consecutive rows of blocks, Figure 24, m.
S_w = spacing between two impact blocks in different but consecutive rows, Figure 24, m. Excludes the first row, where spacing is determined by the spacing of the approaching jets.

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Outlet Protection Design - Rip Rap - Culvert 3

CLINET GOODLAND
PROJECT: GOODLAND COASTAL FARM-2127 KAIPARA COAST HIGHWAY
JOB NO. 1366
BY: ZY
DATE: 30/01/2024

1. Discharge Velocity

Determine the discharge velocity for the design storm. For Stormwater management structures the design storm is the maximum flow that can be carried by the pipe. This will normally be the 10 year design flow.

V= 3.3 m/s 100Y

2. Equivalent Diameter of Stone

Enter that value into the following equation to determine the equivalent diameter of the stone

$$d_s = 0.25 \times D_0 \times F_0$$

Where

d_s = riprap diameter (m)
D_0 = pipe diameter (m)
F_0= Froude number = $V/(g \times d_p)^{0.5}$
V = velocity of flow in pipe (m/s)

D_0 = 0.675 m
DS pit HGL = 70.58 m RL
DS IL = 70.32 m RL
d_p = 0.26 m
V = 3.3 m/s
g = 9.81
F_0 = 2.066

d_s = 0.349 m

3. Thickness of Stone Layer

The thickness of the stone layer is 2 times the stone dimension

$$D_A = 2d_s$$

d_s = 0.349 m
D_A = 0.697 m

4. Width of the protected area

The width of the area protected is 3 times diameter of the pipe

$$W_A = 3D_0$$

D_0 = 0.675 m

W_A = 2.025 m

5. Height of the stone

The height of the stone is the crown of the pipe + 300mm

Crown of pipe =	0.675	m
Height of stone =	0.975	m

6. Length of outfall protection

$$L_a = D_0(8 + 17 \times Log\ F_0)$$

D_0 =	0.675	m
F_0 =	2.066	
Log F_0 =	0.315	
L_a =	9.017	m

Summary

Stone Diameter	d_s =	0.349	m
Stone Layer	D_A =	0.697	m
Width	W_A =	2.025	m
Height of stone	H =	0.975	m
Length	L_a =	9.017	m

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Outlet Protection Design - Rip Rap - Culvert 4

CLINET GOODLAND
PROJECT: GOODLAND COASTAL FARM-2127 KAIPARA COAST HIGHWAY
JOB NO. 1366
BY: ZY
DATE: 30/01/2024

1. Discharge Velocity

Determine the discharge velocity for the design storm. For Stormwater management structures the design storm is the maximum flow that can be carried by the pipe. This will normally be the 10 year design flow.

V= 2.41 m/s 100Y

2. Equivalent Diameter of Stone

Enter that value into the following equation to determine the equivalent diameter of the stone

$$d_s = 0.25 \times D_0 \times F_0$$

Where

d_s = riprap diameter (m)
D_0 = pipe diameter (m)
F_0= Froude number = $V/(g \times d_p)^{0.5}$
V = velocity of flow in pipe (m/s)

D_0 =	1.2	m
DS pit HGL =	11.55	m RL
DS IL =	10.84	m RL
d_p =	0.71	m
V =	2.41	m/s
g =	9.81	
F_0 =	0.913	
d_s =	0.274	m

3. Thickness of Stone Layer

The thickness of the stone layer is 2 times the stone dimension

$$D_A = 2d_s$$

d_s = 0.274 m
D_A = 0.548 m

4. Width of the protected area

The width of the area protected is 3 times diameter of the pipe

$$W_A = 3D_0$$

D_0 = 1.2 m

W_A = 3.6 m

5. Height of the stone

The height of the stone is the crown of the pipe + 300mm

Crown of pipe = 1.2 m

Height of stone = 1.5 m

6. Length of outfall protection

$$L_a = D_0(8 + 17 \times Log\ F_0)$$

D_0 = 1.2 m

F_0 = 0.913

Log F_0 = -0.039

L_a = 8.795 m

Summary

Stone Diameter	d_s =	0.274	m
Stone Layer	D_A =	0.548	m
Width	W_A =	3.60	m
Height of stone	H =	1.50	m
Length	L_a =	8.795	m

Outlet Protection Design - Concrete Baffle Block - Culvert 5

CLINET GOODLAND
PROJECT: GOODLAND COASTAL FARM-2127 KAIPARA COAST HIGHWAY
JOB NO. 1366
BY: ZY
DATE: 30/01/2024

1. Typical Baffle Block Inputs

Height of culvert / pipe		0.68	m
Baffle height	d=	0.23	m
Baffle width	w=	**0.5**	m
Flow Cross-sectional Area	A_C=	**0.24**	m2
Wetted permimeter	P_W=	**3.76**	m2
	R_h=	**0.06**	

2. Baffle Block Arrangement

Row spacing	S_d=	0.48	m
Horizontal spacing	S_w =	**0.38**	m

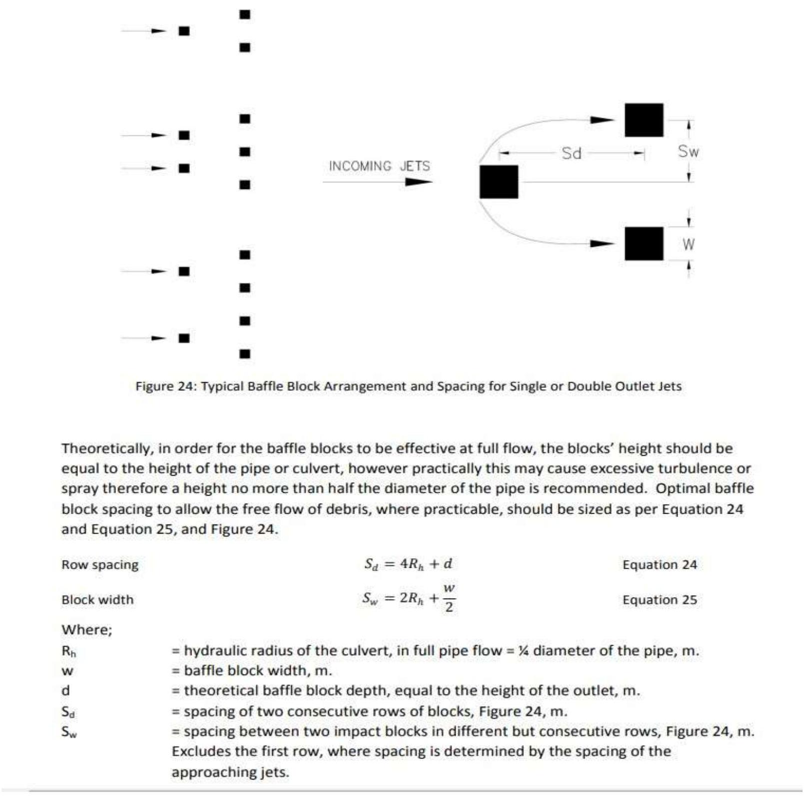


Figure 24: Typical Baffle Block Arrangement and Spacing for Single or Double Outlet Jets

Theoretically, in order for the baffle blocks to be effective at full flow, the blocks' height should be equal to the height of the pipe or culvert, however practically this may cause excessive turbulence or spray therefore a height no more than half the diameter of the pipe is recommended. Optimal baffle block spacing to allow the free flow of debris, where practicable, should be sized as per Equation 24 and Equation 25, and Figure 24.

Row spacing	$S_d = 4R_h + d$	Equation 24
Block width	$S_w = 2R_h + \frac{w}{2}$	Equation 25

Where;
R_h = hydraulic radius of the culvert, in full pipe flow = ¼ diameter of the pipe, m.
w = baffle block width, m.
d = theoretical baffle block depth, equal to the height of the outlet, m.
S_d = spacing of two consecutive rows of blocks, Figure 24, m.
S_w = spacing between two impact blocks in different but consecutive rows, Figure 24, m. Excludes the first row, where spacing is determined by the spacing of the approaching jets.

APPENDIX D:

BIORETENTION SWALE DESIGN CALCULATIONS

SMAF 1 Detention Volume Calculations (Per 150 m Road Length)

Project	2127 KAIPARA COAST HIGHWAY
Design By	ZY
Date	26/08/2024

Parameters

SMAF 1 (95th)	35	mm
Void Ratio for Ponding	1	
Void Ratio for Media (Gravel)	0.35	
Void Ratio for Drainage	0.35	
Subsoils suitable for Infiltration?	No	
Half road width	3m	

🟦 Input Cells
🟧 Key Output Cells
🟨 Check Cells

In Ground Bioretention Device

Catchment Name	Total Impervious		CN	Ia	Area km^2	Storage	Depth	Volume	Retention Volume	Detention Volume	
Road 1, 2, 3 (per 150 m length)	450.00	Pre-development	74	5	0.000450	89.24	7.55	3.40	2.25	8.07	
		Post-development	98	0	0.000450	5.18	30.49	13.72			
Accessway 1, 2, 3, 4,5 (per 150 m length)	300.00	Pre-development	74	5	0.000300	89.24	7.55	2.26	1.50	5.38	
		Post-development	98	0	0.000300	5.18	30.49	9.15			

Catchment Name	Design for Detention												Step 4 Design for Retention				
	Length Ponding	Width Ponding	Height Ponding	Void Ponding	Length Media	Width Media	Height Media	Void Media	Length Drainage	Width Drainage	Height Drainage	Void Drainage	Length Storage	Width Storage	Height Storage	Void Storage	
Road 1, 2, 3 (per 150 m length)	35	2	0.23	1	35	0.6	0.5	0.35	35	0.6	0.25	0.35	35	0.6	0.35	0.35	
	$V_{(ponding)}$	10.47	$A_{(ponding)}$	70.00	$V_{(media)}$	3.68	$A_{(media)}$	21.00	$V_{(drainage)}$	1.84	$A_{(drainage)}$	21.00	$V_{(storage)}$	2.57	Comply	YES	
					$V_{(detention)}$	15.98	Greater than Required Mitigation			YES			$V_{(Retention)}$	2.57	Greater than Required Mitigation		YES
Accessway 1, 2, 3, 4,5 (per 150 m length)	23	2	0.23	1	23	0.6	0.5	0.35	23	0.6	0.25	0.35	23	0.6	0.35	0.35	
	$V_{(ponding)}$	5.29	$A_{(ponding)}$	46.00	$V_{(media)}$	2.42	$A_{(media)}$	13.80	$V_{(drainage)}$	1.21	$A_{(drainage)}$	13.80	$V_{(storage)}$	1.69	Comply	YES	
					$V_{(detention)}$	8.91	Greater than Required Mitigation			YES			$V_{(Retention)}$	1.69	Greater than Required Mitigation		YES

Bioretention swale	Length (m)	Top Width (m)	Ponding Depth (m)	Media Depth (m)	Drainage Layer Depth (m)
1	56.0	2.00	0.23	0.60	0.20
2	56.0	2.00	0.23	0.60	0.20
3	58.3	2.00	0.23	0.60	0.20
4	58.3	2.00	0.23	0.60	0.20
5	39.7	2.00	0.23	0.60	0.20
6	13.1	2.00	0.23	0.60	0.20
7	26.8	2.00	0.23	0.60	0.20
8	26.8	2.00	0.23	0.60	0.20
9	46.7	2.00	0.23	0.60	0.20
10	44.3	2.00	0.23	0.60	0.20
11	39.7	2.00	0.23	0.60	0.20
12	19.8	2.00	0.23	0.60	0.20
13	30.3	2.00	0.23	0.60	0.20
14	30.3	2.00	0.23	0.60	0.20
15	31.5	2.00	0.23	0.60	0.20
16	31.5	2.00	0.23	0.60	0.20
17	22.2	2.00	0.23	0.60	0.20
18	22.2	2.00	0.23	0.60	0.20
19	37.3	2.00	0.23	0.60	0.20
20	37.3	2.00	0.23	0.60	0.20
21	33.8	2.00	0.23	0.60	0.20
22	33.8	2.00	0.23	0.60	0.20
23	43.2	2.00	0.23	0.60	0.20
24	43.2	2.00	0.23	0.60	0.20
25	46.7	2.00	0.23	0.60	0.20
26	46.7	2.00	0.23	0.60	0.20
27	47.8	2.00	0.23	0.60	0.20
28	14.0	2.00	0.23	0.60	0.20
29	18.4	2.00	0.23	0.60	0.20
30	18.4	2.00	0.23	0.60	0.20
31	15.3	2.00	0.23	0.60	0.20
32	15.3	2.00	0.23	0.60	0.20
33	24.5	2.00	0.23	0.60	0.20
34	13.0	2.00	0.23	0.60	0.20
35	13.8	2.00	0.23	0.60	0.20
36	15.3	2.00	0.23	0.60	0.20
37	19.9	2.00	0.23	0.60	0.20
38	28.4	2.00	0.23	0.60	0.20
39	23.8	2.00	0.23	0.60	0.20
40	24.5	2.00	0.23	0.60	0.20
41	12.3	2.00	0.23	0.60	0.20
42	12.3	2.00	0.23	0.60	0.20
43	28.4	2.00	0.23	0.60	0.20
44	28.4	2.00	0.23	0.60	0.20
45	21.5	2.00	0.23	0.60	0.20
46	21.5	2.00	0.23	0.60	0.20
47	22.2	2.00	0.23	0.60	0.20
48	22.2	2.00	0.23	0.60	0.20
49	27.6	2.00	0.23	0.60	0.20
50	27.6	2.00	0.23	0.60	0.20

*The proposed roads 1 to 3 have the same typical cross sectional layout, hence the length of bioretention is prorata based on sizing for a 150m long road catchment. Same design approach used on accessways 1 to 4.

APPENDIX E:

OUTFALL DESIGN CALCULATIONS

STORMWATER RETICULATION CALCULATIONS

CRANGCIVIL
CONSULTING ENGINEERS

PROJECT : 2127 Kaipara Coast Highway
JOB NO : 1366

CALCULATIONS BY : ZY
DATE : 31/01/2024

CHECKED BY : ZY
DATE : 31/01/2024

Storm Frequency (yr) = 10 Storm Duration (min) = 10 Ks= 1.5 D≤1.0m I = 170.00 mm/h 0.047 mm/s

Pipe Section	Start MH	End MH	L (m)	Catchment (m^2)	Run off Coef. C	C*A	Cumm C*A	I (mm/sec)	Q (line) L/s	S(%)	Dia (mm)	V (m/s)	Pipe Cap (L/s)	Pipe OK?
Line 1														
SWMH 1.2 to SW OUTLET 1.1	41.723m	41.741m	3.612m	3360	0.80	2688	2688	0.047	127	3.0%	300	2.41	**170**	**PIPE OK**
SWMH 2.2 to SW OUTLET 2.1	53.873m	54.000m	11.187m	3240	0.80	2592	2592	0.047	122	5.0%	300	3.11	**220**	**PIPE OK**
SWMH 3.2 to SW OUTLET 3.1	69.713m	70.485m	9.533m	3000	0.80	2400	2400	0.047	113	8.1%	300	3.96	**280**	**PIPE OK**
SW OUTLET 4.1 to SWMH 4.2	77.232m	76.599m	9.042m	1920	0.80	1536	1536	0.047	73	7.0%	300	3.68	**260**	**PIPE OK**
SW OUTLET 5.1 to SWMH 5.2	62.915m	62.807m	15.401m	2160	0.80	1728	1728	0.047	82	1.0%	300	1.39	**98**	**PIPE OK**
SWMH 6.2 to SW OUTLET 6.1	35.306m	35.944m	8.636m	1920	0.80	1536	1536	0.047	73	7.4%	300	3.78	**267**	**PIPE OK**
SWMH 7.2 to SW OUTLET 7.1	23.635m	24.010m	9.952m	1200	0.80	960	960	0.047	45	3.8%	300	2.70	**191**	**PIPE OK**
SWMH 8.2 to SW OUTLET 8.1	37.557m	37.679m	6.560m	1100	0.80	880	880	0.047	42	1.9%	300	1.91	**135**	**PIPE OK**
SW OUTLET 9.1 to SWHM 9.2	67.335m	67.000m	11.174m	1920	0.80	1536	1536	0.047	73	3.0%	300	2.41	**170**	**PIPE OK**
SWMH 10.2 to SW OUTLET 10.1	64.736m	64.865m	12.924m	1920	0.80	1536	1536	0.047	73	1.0%	300	1.39	**98**	**PIPE OK**
SWMH 11.2 to SW OUTLET 11.1	47.047m	47.629m	14.702m	1200	0.80	960	960	0.047	45	4.0%	300	2.77	**196**	**PIPE OK**
SWMH 12.2 to SW OUTLET 12.1	40.579m	40.691m	22.314m	1260	0.80	1008	1008	0.047	48	1.0%	300	1.39	**98**	**PIPE OK**
SWMH 13.2 to SW OUTLET 13.1	26.033m	26.217m	38.759m	2160	0.80	1728	1728	0.047	82	1.0%	300	1.39	**98**	**PIPE OK**
SWMH 14.2 to SW OUTLET 14.1	9.530m	9.799m	4.394m	990	0.80	792	792	0.047	37	6.1%	300	3.45	**244**	**PIPE OK**
SW OUTLET 16.1 to SWMH 16.2	6.300m	6.009m	6.170m	1020	0.80	816	816	0.047	39	4.7%	300	3.02	**213**	**PIPE OK**
SW OUTLET 17.1 to SWMH 17.2	84.247m	84.000m	24.656m	1980	0.80	1584	1584	0.047	75	3.0%	300	2.41	**170**	**PIPE OK**
SW OUTLET 18.1 to SWMH 18.2	34.661m	34.604m	5.731m	1650	0.80	1320	1320	0.047	62	5.0%	300	3.11	**220**	**PIPE OK**
SWMH 19.2 to SW OUTLET 19.1	92.874m	92.915m	8.076m	2035	0.80	1628	1628	0.047	77	1.0%	300	1.39	**98**	**PIPE OK**
SWMH 20.2 to SW OUTLET 20.1	85.094m	85.132m	4.832m	1045	0.80	836	836	0.047	39	0.8%	300	1.24	**88**	**PIPE OK**
SWMH 21.2 to SW OUTLET 21.1	81.602m	81.681m	7.836m	1210	0.80	968	968	0.047	46	3.0%	300	2.41	**170**	**PIPE OK**
SW OUTLET 22.1 to SWMH 22.2	70.916m	70.837m	7.820m	1320	0.80	1056	1056	0.047	50	5.0%	300	3.11	**220**	**PIPE OK**
SW OUTLET 23.1 to SWMH 23.2	56.863m	56.616m	57.157m	1540	0.80	1232	1232	0.047	58	0.4%	300	0.91	**64**	**PIPE OK**
SW OUTLET 24.1 to SWMH 24.2	70.608m	70.541m	6.743m	1540	0.80	1232	1232	0.047	58	5.0%	300	3.11	**220**	**PIPE OK**
SW OUTLET 48.1 to SWMH 48.2	56.829m	56.762m	5.110m	2035	0.80	1628	1628	0.047	77	1.3%	300	1.59	**112**	**PIPE OK**
SW OUTLET 49.1 to SWMH 49.2	20.062m	19.983m	7.898m	2090	0.80	1672	1672	0.047	79	1.0%	300	1.39	**98**	**PIPE OK**

Stormwater Outlet Calculations

CRANGCIVIL
CONSULTING ENGINEERS

Project	2127 Kaipara Coast Highway
Client	Abib(Oamaru)
Calculated By	ZY
Checked By	ZY
Date	26/08/2024

2127 Kaipara Coast Highway							
	Outlet	Pipe size (D0)	Min. WA (m)	ds (m)	Adopted ds (m)	DA (m)	La (m)
	SW OUTLET 1.1	300	0.90	0.13	0.15	0.30	3.60
	SW OUTLET 2.1	300	0.90	0.19	0.20	0.40	4.40
	SW OUTLET 3.1	300	0.90	0.26	0.30	0.60	5.16
	SW OUTLET 4.1	300	0.90	0.27	0.30	0.60	5.25
	SW OUTLET 5.1	300	0.90	0.07	0.15	0.30	2.29
	SW OUTLET 6.1	300	0.90	0.28	0.30	0.60	5.32
	SW OUTLET 7.1	300	0.90	0.21	0.25	0.50	4.67
	SW OUTLET 8.1	300	0.90	0.14	0.15	0.30	3.73
	SW OUTLET 9.1	300	0.90	0.16	0.20	0.40	4.03
	SW OUTLET 10.1	300	0.90	0.07	0.15	0.30	2.40
	SW OUTLET 11.1	300	0.90	0.22	0.25	0.50	4.73
	SW OUTLET 12.1	300	0.90	0.09	0.15	0.30	2.72
	SW OUTLET 13.1	300	0.90	0.07	0.15	0.30	2.29
	SW OUTLET 14.1	300	0.90	0.30	0.30	0.60	5.47
	SW OUTLET 16.1	300	0.90	0.25	0.25	0.50	5.07
	SW OUTLET 17.1	300	0.90	0.15	0.15	0.30	4.00
	SW OUTLET 18.1	300	0.90	0.23	0.25	0.50	4.87
	SW OUTLET 19.1	300	0.90	0.07	0.15	0.30	2.35
	SW OUTLET 20.1	300	0.90	0.08	0.15	0.30	2.52
	SW OUTLET 21.1	300	0.90	0.18	0.20	0.40	4.34
	SW OUTLET 22.1	300	0.90	0.24	0.25	0.50	5.00
	SW OUTLET 23.1	300	0.90	0.05	0.15	0.30	1.29
	SW OUTLET 24.1	300	0.90	0.23	0.25	0.50	4.91
	SW OUTLET 48.1	300	0.90	0.09	0.15	0.30	2.74
	SW OUTLET 49.1	300	0.90	0.07	0.15	0.30	2.33

APPENDIX F:

GRASSED TABLE DRAIN DESIGN CALCULATIONS

CRANGCIVIL
CONSULTING ENGINEERS

PEAK FLOW ASSESSMENT - PRIMARY FLOW (Per 250 m Road Length)

PROJECT NUMBER:	1366
ADDRESS:	2127 KAIPARA COAST HIGHWAY
BY:	ZY
DATE:	26/08/2024

DESIGN RAINFALL

RAINFALL EVENT:	100 YEAR, 10 MINUTE +CC
RAINFALL INTENSITY:	195 mm/hr

SITE PARAMETERS

TOTAL SITE AREA (HA):	0.15000
NUMBER OF LOTS:	NA

POST-DEVELOPMENT (TOTAL)

	AREA (HA)	TYPOLOGY	C	Q
1	0.00000	ROOF AREA	0.9	0.00
2	0.07500	HARDSTAND AREA	0.85	34.56
3	0.07500	GRASSED AREA	0.3	12.20
4			0	0.00

SUM AREA (HA):	0.15000	PEAK RUNOFF (L/s):	46.76

MANNING CALCULATION FOR TRAPEZOIDAL CHANNELS

Property Address	2127 KAIPARA COAST HIGHWAY
Job No	1366
	Preliminary design for table drain per 250m road length (100-YR ARI with climate change)

Required Design Flow (m^3/s) Q = 0.05

Choose Channel Parameters

Mannings Coefficient	n =		0.025
Channel Slope (m/m)	S =		0.03
Channel Depth (m)	D =		0.21
Bottom Width of Channel (m)	W =		0.6
Right Side Slope (V:H)	Z_l =	1 :	3
Left Side Slope (V:H)	Z_r =	1 :	3

Mannings Equation

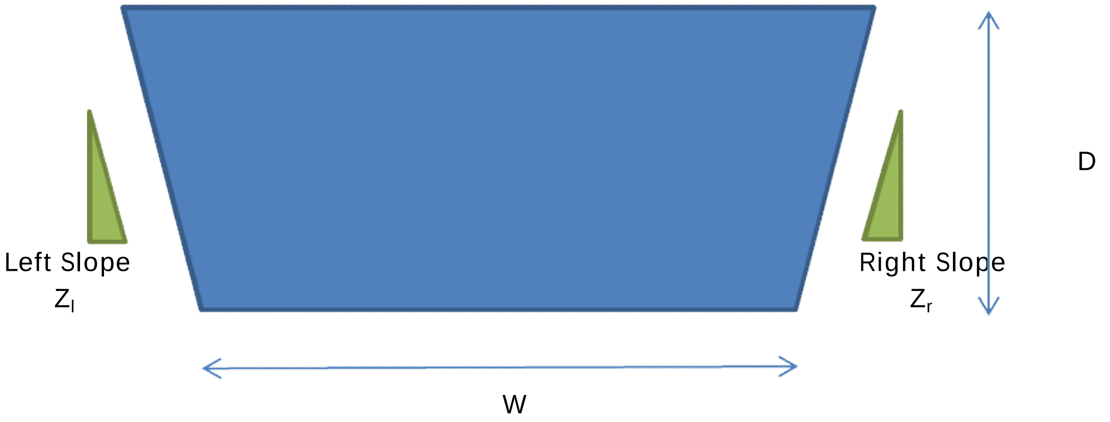
V = 1/n x S^0.5 x R^2/3

Q = A x V

Results

Wetted Perimeter (WP) =	**1.93**
Crossectional Area (A) =	**0.26**
Hydraulic radius (R) =	**0.13**
Velocity (V) =	**1.81**

Check	Channel Capacity (m^3/s)	**0.47**	**OK**



*****Author Ehtesham Owais