REPORT

Tonkin+Taylor

Stormwater Management Plan - Appendices B, C and D

Private Plan Change 28

Prepared for CCKV Maitahi Dev Co Lp and Bayview Nelson Ltd Prepared by Tonkin & Taylor Ltd Date June 2022 Job Number 1012397.1000.v2





Exceptional thinking together www.tonkintaylor.co.nz

STORMWATER ASSESSMENT - CATCHMENTS

Project: Kaka Hill Development

Location: Kaka Hill

Calculation Description

Categorise catchment into Pre and Post Development Areas with land cover and soil class

		Total			133.93	10144.5
Built-up Area (settlement)	1/4 Acre	С	Fair	83	32.61	2706.4
Jrban Parkland/Open Space	Open Space (Lawns, Parks, golf courses, cemeteries, etc)	с	Fair	79	10.18	804.2
Low Producing Grassland	Pasture, grassland or range-	С	Poor	86	5.20	447.5
High Producing Exotic Grassland	Pasture , grassland or range- continuous forage for grazing	с	Fair	79	10.41	822.0
Gorse and/or Broom	Brush-weed-grass mixture with brush	С	Fair	70	66.58	4660.8
orest - Harvested	Industrial	С	Fair	91	1.82	165.9
Exotic Forest	Woods-grass combination	С	Fair	76	5.66	430.2
Deciduous Hardwoods	Woods	С	Fair	73	1.47	107.2
Land Cover	SCS Cover Type	Soil Class	Soil Condi C		Area (ha)	Product

Land Cover	SCS Cover Type	Soil Class	Soil Condi	Runoff Co(A	rea (ha)	Product
Deciduous Hardwoods	Woods	С	Fair	73	1.47	107.20
Exotic Forest	Woods-grass combination	С	Fair	76	5.17	393.20
Forest - Harvested	Industrial	С	Fair	91	1.32	120.0
Gorse and/or Broom	Brush-weed-grass mixture with brush	С	Fair	70	29.12	2038.56
High Producing Exotic Grassland	Pasture, grassland or range-	С	Fair	79	9.54	753.35
Low Producing Grassland	Pasture, grassland or range-	С	Fair	86	0.03	2.78
Urban Parkland/Open Space	Open Space (Lawns, Parks, golf	С	Fair	79	9.98	788.57
Built-up Area (settlement)	1/4 Acre	С	Fair	83	32.61	2706.46
Open Space Recreation	Open Space (Lawns, Parks, golf	С	Fair	79	2.68	211.72
Residential	1/8 acre or less (town houses)	С	Fair	90	12.44	1119.26
Residential Lower Density	1/4 Acre	С	Fair	83	29.58	2454.78
		Total			133.93	10696.01

Weighted CN

Weighted CN

79.86

75.74

Checked: BYMU Date: 17/05/2022

By: CHGR

Date: 17/05/2022

STORMWATER ASSESSMENT - PRE-DEVELOPMENT SCENARIO

	Drojest, Kaka Hill (Date:			
	Project: Kaka Hill [By: Checked:					
Calculati	on Description	luff Brooklands Catchment	Brooklands Catchment 1		Date:			1
Determine	e peak flow rate with v e runoff volume for po	•						
1.	SCS Method Runoff Curve Numb	er (CN) and Initial Abstraction (I	a)					
				Curve	SCS Metho		Rational M	ethod
	Soil name and classification		e, treatment, and hydrologic condition)	Number CN*	Area (hectares)	Product of CN x Area	С	Product
	Class C soils	LCDB	CN classification Woods - fair	73	0.000	0	0.25	0.00
	Class C soils Class C soils	Deciduous Hardwoods Exotic Forest	Woods - grass combo - fair	73	0.000	0 130	0.35	0.00
	Class C soils	Forest - Harvested	Newly graded area (pervious areas only, no vegetation)	91	0.000	0	0.70	0.00
	Class C soils	Gorse and/or Broom	Brush-weed-grass mix - fair	70	16.915	1,184	0.35	5.92
	Class C soils	High Producing Exotic Grassland	pasture - fair	79	6.341	501	0.40	2.54
	Class C soils	Low Producing Grassland	Pasture - poor	86	2.597	223	0.40	1.04
	Class C soils	Urban Parkland/Open Space	Open Space - fair	79	1.643	130	0.40	0.66
			ervious Areas		29.206	2,168		10.75
		Impervious Areas (List)	Children 17 - 11				· · ·	
		LCDB	CN classification			500		
	Class C soils	Built-up Area (settlement)	Residential district 1/4 acre size	92	5.469	503 0	0.55	3.01 0.00
		Subtotal for I	mpervious Areas		5.469	503.151		3.01
		Cubiculitor		Totals	34.675	2671.274		13.76
					0.346755			
	CN (weighted) :	total product total area	= 2,671 34.675	=	77.04		0.3968	
Forum	gaged watersheds, the SCS su	Eor ungaged watershe	ds, the SCS suggests that the UH lag time may be related t					•
time of	concentration, t _c , as:	time of concentration, a	e, as:	0				
$t_{lag} = 0$).6 t_	$t_{log} = 0.6 t_c$	G	38)				
ing.								
2.	Time of Concentrati	ion <u>https://www.hec.usa</u>	ce.army.mil/software/hec-hms/document	ation/HEC-F	IMS_Techn	ical%20Refer	ence%20Ma	inual_(CPD
							10.00	
	Time of Concentration		0.64	_	0.33	hrs	19.68	
	SCS Lag for HEC-HN	MS: t _p =	0.6 t _c	-	0.20	hrs	11.81071	min
3.		S = ((1000/CN	I)-10)*25.4 Tota	=	75.7	mm		
			Pervious		88.2	mm		
			Impervious		22.1	mm		
4.	Initial Abstraction							
		45.44000						
	la = 0.2S	= 15.14282						
	above parameters us	ed in SCS method analysis in HE	CHMS					
5.	Rainfall data							
		c temporal patterns produced in HI	RDS v4 by NIWA for 1 hour, 6 hour and 12	hour storm	durations			
	RCP8.5							
5.	Results							
	Pre-Development							
	•	harge (m3/s)						
	hr Q10	Q15 Q100						
	1 2.143							
	6 2.648							
	12 1.545	i 1.728 2.847						
	Rational Method							
			Q10	Q15	Q100			
	20 min	Rainfall int		1	130.4			
		Peak Flow	Rate, Q : 3.15	3.41	4.99	m³/s		
		70.0						
		TOC round	led to 20min					
								I

Brooklands Catchment 2

Determine peak flow rate with variety of methods Determine runoff volume for pond sizing calculations

SCS Method

				SCS Metho	d	Rational M	ethod
Soil name and classification	Cover description (cover typ hydrologic cond		Curve Number CN*	Area (hectares)	Product of CN x Area	С	Product
	LCDB	CN classification					
Class C soils	Deciduous Hardwoods	Woods - fair	73	0.000	0	0.35	0.00
Class C soils	Exotic Forest	oods - grass combo -	<i>t</i> 76	3.811	290	0.35	1.33
Class C soils	Forest - Harvested	(pervious areas only, no vegetation)	91	0.000	0	0.70	0.00
Class C soils	Gorse and/or Broom	ısh-weed-grass mix -	1 70	9.676	677	0.35	3.39
Class C soils	High Producing Exotic Grassland	pasture - fair	79	0.000	0	0.40	0.00
Class C soils	Low Producing Grassland	Pasture - poor	86	2.240	193	0.40	0.90
Class C soils	Urban Parkland/Open Space	Open Space - fair	79	8.537	674	0.40	3.41
	Subtotal for p	ervious Areas		24.265	1,834		9.03
	Impervious Areas (List)						
	LCDB	CN classification					
Class C soils	Built-up Area (settlement)	1/4 acre size	92	14.815	1,363	0.55	8.15
					0		0.00
	Subtotal for I	mpervious Areas		14.815	1362.999		8.15
			Totals	39.080	3197.065		17.18
				0.390798	km²		
CN (weighted) :	total product	= 3,197	=	81.81		0.4396	
	And all some a	39.080					
	total area	00.000					
gaged watersheds, the SCS superior concentration, t_c , as:		ds, the SCS suggests that the	UH lag time ma	y be related to			

2.	Time of Concentration	https://w	ww.hec.usace.army.mil	/software/he	ec-hms/o	documenta	ation/HEC	-HMS Technical%20Refe
	Time of Concentration	t _c =				0.31	hrs	18.71 min
	SCS Lag for HEC-HMS :	t _p =	0.6 t _c		=	0.19	hrs	11.22796 min
3.	Soil Storage Parameter :	S =	((1000/CN)-10)*25.4	Total	=	56.5	mm	
				Pervious	=	82.0	mm	
				Impervious	=	22.1	mm	

4. Initial Abstraction

la = 0.2S = 11.29612

above parameters used in SCS method analysis in HEC HMS

5. Rainfall data

Using Region-specific temporal patterns produced in HIRDS v4 by NIWA for 1 hour, 6 hour and 12 hour storm durations RCP8.5

5. Results

Pre-Development								
Results Peak Discharge (m3/s)								
hr		Q10	Q15	Q100				
	1	3.442	2	t	7.64			
	~	2 200	2 500		F 22			

b	3.309	3.598	5.33
12	1.962	2.173	3.448

Rational Method

19 min

		Q10		Q15		Q100	
Rainfall int	ensity		82.4		89.2	130.4	
Peak Flow	Rate, Q :		3.93		4.26	6.23	m³,

Brooklands Catchment 3

Calculation Description Determine peak flow rate with variety of methods Determine runoff volume for pond sizing calculations

	Runoff Curve Numb				SCS Method		Rational M	ethod
	Soil name and classification	Cover description (cover typ hydrologic cond		Curve Number	Area (hectares)	Product of CN x	с	Produ
ł		LCDB	CN classification	CN*		Area		
ł	Class C soils	Deciduous Hardwoods	Woods - fair	73	1.469	107	0.35	0
ł	Class C soils	Exotic Forest	pods - grass combo -	76	0.121	9	0.35	0
	Class C soils	Forest - Harvested	(pervious areas only,	91	0.000	0	0.70	0
ł	Class C soils	Gorse and/or Broom	no vegetation) ush-weed-grass mix -	70	17.861	1,250	0.35	6
ł	Class C soils	High Producing Exotic Grassland	-	79	3.104	245	0.35	1
ł	Class C soils	Low Producing Grassland	Pasture - poor	86	0.003	0	0.40	0
ł	Class C soils	Urban Parkland/Open Space	Open Space - fair	79	0.000	0	0.40	0
ł			pervious Areas		22.558	1,612	0.40	8
ł		Impervious Areas (List)			22.000	1,012		0
ł		LCDB	CN classification			1		
	Class C soils	Built-up Area (settlement)	Residential district	92	6.470	595	0.55	3.
	01200 0 30113		1/4 acre size	32	0.470	0	0.55	3
		Oubtote (5 1	mponious Arcos		6 470			
l		Subtotal for I	mpervious Areas	Totala	6.470	595.207		3
				Totals	29.028	2207.402		11
		to to the second sector	0.007		0.2902781	кт-	0 2000	
	CN (weighted) :	total product total area	= 2,207 29.028	=	76.04		0.3999	
0	aged watersheds, the SCS su concentration, t _e , as: 6 t _c Time of Concentration	time of concentration, $t_{log} = 0.6 t_c$		/hec-hms/d	(38)	n/HEC-HMS	S Technical	<u>%20Ref</u>
of i	concentration, t _e , as: 16 t _e Time of Concentration	time of concentration, i $t_{log} = 0.6 t_c$ on <u>https://www.hec.usa</u>	t _c , as:	/hec-hms/d	(38) ocumentatio			
of i	concentration, t _e , as: 16 t _e Time of Concentrati Time of Concentration	time of concentration, i t _{lag} = 0.6 t _c on <u>https://www.hec.usa</u> n t _c =	_{te} as: . <u>ce.army.mil/software</u> ,		(38) ocumentatio 0.30	hrs	17.81	min
of i	concentration, t _e , as: 16 t _e Time of Concentration	time of concentration, i t _{lag} = 0.6 t _c on <u>https://www.hec.usa</u> n t _c =	t _c , as:	/hec-hms/d =	(38) ocumentatio			min
of i	concentration, t _e , as: 16 t _e Time of Concentrati Time of Concentration	time of concentration, i $t_{sec} = 0.6 t_c$ on <u>https://www.hec.usa</u> n t _c = 1S : t _p =	_{te} as: . <u>ce.army.mil/software</u> ,	=	(38) ocumentatio 0.30	hrs	17.81	min
of i	concentration, _{fc} as: 6.6.7 _c Time of Concentration Time of Concentration SCS Lag for HEC-HM	time of concentration, i $t_{sec} = 0.6 t_c$ on <u>https://www.hec.usa</u> n t _c = 1S : t _p =	_{te} as: <u>ce.armv.mil/software</u> , 0.6 t _e	=	(38) ocumentatio 0.30 0.18	hrs hrs	17.81	min
of i	concentration, _{fc} as: 6.6.7 _c Time of Concentration Time of Concentration SCS Lag for HEC-HM	time of concentration, i $t_{sec} = 0.6 t_c$ on <u>https://www.hec.usa</u> n t _c = 1S : t _p =	_{to} as: <u>ce.army.mil/software</u> , 0.6 t _o N)-10)*25.4 Total	= = =	(38) ocumentatio 0.30 0.18 80.0	hrs hrs mm	17.81	min
of i	concentration, _{fc} as: 6.6.7 _c Time of Concentration Time of Concentration SCS Lag for HEC-HM	time of concentration, i $t_{sec} = 0.6 t_c$ on <u>https://www.hec.usa</u> n t _c = 1S : t _p =	_{to} as: <u>ce.army.mil/software</u> 0.6 t _o N)-10)*25.4 Total Pervious	= = =	(38) <u>ocumentatio</u> 0.30 0.18 80.0 101.4	hrs hrs mm mm	17.81	min
of i	concentration, t _e , as: 6 t _e Time of Concentrational State Time of Concentration SCS Lag for HEC-HW Soil Storage Parame	time of concentration, i $t_{sec} = 0.6 t_c$ on <u>https://www.hec.usa</u> n $t_c =$ AS : $t_p =$ eter : S = ((1000/CN	_{to} as: <u>ce.army.mil/software</u> 0.6 t _o N)-10)*25.4 Total Pervious	= = =	(38) <u>ocumentatio</u> 0.30 0.18 80.0 101.4	hrs hrs mm mm	17.81	min
of i	concentration, t _e , as: .6 t _e Time of Concentration SCS Lag for HEC-HN Soil Storage Parame Initial Abstraction Ia = 0.25	time of concentration, i $t_{sec} = 0.6 t_c$ on <u>https://www.hec.usa</u> n $t_c =$ AS : $t_p =$ eter : S = ((1000/CN	_{to} as: <u>ce.armv.mil/software</u> , 0.6 t _o N)-10)*25.4 Total Pervious Impervious	= = =	(38) <u>ocumentatio</u> 0.30 0.18 80.0 101.4	hrs hrs mm mm	17.81	min
of i	concentration, t _e , as: .6 t _e Time of Concentration SCS Lag for HEC-HN Soil Storage Parame Initial Abstraction Ia = 0.25	time of concentration, i t _{lag} = 0.6 t _c on <u>https://www.hec.usa</u> n t _c = 1S : t _p = eter : S = ((1000/CN = 16.0031	_{to} as: <u>ce.armv.mil/software</u> , 0.6 t _o N)-10)*25.4 Total Pervious Impervious	= = =	(38) <u>ocumentatio</u> 0.30 0.18 80.0 101.4	hrs hrs mm mm	17.81	min
: 0	concentration, t _e , as: 6.6 t _e Time of Concentration SCS Lag for HEC-HM Soil Storage Paramet Initial Abstraction Ia = 0.2S above parameters us Rainfall data	time of concentration, i t _{lag} = 0.6 t _c on <u>https://www.hec.usa</u> n t _c = 1S : t _p = eter : S = ((1000/CN = 16.0031	t _e , as: <u>ce.army.mil/software</u> , 0.6 t _c 1)-10)*25.4 Total Pervious Impervious C HMS	-	(38) ocumentatio 0.30 0.18 80.0 101.4 22.1	hrs hrs mm mm	17.81 10.68869	min
of (0)	concentration, t _e , as: 6.6.t _e Time of Concentration SCS Lag for HEC-HM Soil Storage Parame Initial Abstraction Ia = 0.2S above parameters us Rainfall data Using Region-specific	time of concentration, i $t_{lag} = 0.6 t_c$ on <u>https://www.hec.usa</u> n $t_c =$ AS : $t_p =$ eter : S = ((1000/CN)) = 16.0031 ed in SCS method analysis in HEC	t _e , as: <u>ce.army.mil/software</u> , 0.6 t _c 1)-10)*25.4 Total Pervious Impervious C HMS	-	(38) ocumentatio 0.30 0.18 80.0 101.4 22.1	hrs hrs mm mm	17.81 10.68869	min
i.	concentration, t _e , as: 16 t _e Time of Concentration SCS Lag for HEC-HW Soil Storage Parame Initial Abstraction Ia = 0.2S above parameters us: Rainfall data Using Region-specific RCP8.5 Results	time of concentration, i $t_{lag} = 0.6 t_c$ on <u>https://www.hec.usa</u> n $t_c =$ AS : $t_p =$ eter : S = ((1000/CN)) = 16.0031 ed in SCS method analysis in HEC	t _e , as: <u>ce.army.mil/software</u> , 0.6 t _c 1)-10)*25.4 Total Pervious Impervious C HMS	-	(38) ocumentatio 0.30 0.18 80.0 101.4 22.1	hrs hrs mm mm	17.81 10.68869	min
i.	concentration, t _e , as: 16 t _e Time of Concentration SCS Lag for HEC-HIV Soil Storage Parame Initial Abstraction Ia = 0.2S above parameters us: Rainfall data Using Region-specific RCP8.5 Results Pre-Development	time of concentration, i $t_{lag} = 0.6 t_c$ on <u>https://www.hec.usa</u> n t _c = AS : t _p = eter : S = ((1000/CN = 16.0031 ed in SCS method analysis in HEC c temporal patterns produced in HI	t _e , as: <u>ce.army.mil/software</u> , 0.6 t _c 1)-10)*25.4 Total Pervious Impervious C HMS	-	(38) ocumentatio 0.30 0.18 80.0 101.4 22.1	hrs hrs mm mm	17.81 10.68869	min
: 0	concentration, t _e , as: .6.t _e Time of Concentration SCS Lag for HEC-HIV Soil Storage Parame Initial Abstraction Ia = 0.25 above parameters us Rainfall data Using Region-specific RCP8.5 Results Pre-Development Results Peak Disch	time of concentration, i $t_{log} = 0.6 t_c$ on <u>https://www.hec.usa</u> n t _c = IS : t _p = eter : S = ((1000/CN = 16.0031 ed in SCS method analysis in HEC c temporal patterns produced in HI	t _e , as: <u>ce.army.mil/software</u> , 0.6 t _c 1)-10)*25.4 Total Pervious Impervious C HMS	-	(38) ocumentatio 0.30 0.18 80.0 101.4 22.1	hrs hrs mm mm	17.81 10.68869	min
: 0	concentration, t _e , as: 16 t _c Time of Concentration SCS Lag for HEC-HIV Soil Storage Parameters Initial Abstraction Ia = 0.25 above parameters us Rainfall data Using Region-specific RCP8.5 Results Pre-Development Results Peak Disct hr Q10	time of concentration, i $t_{lag} = 0.6 t_c$ on <u>https://www.hec.usa</u> n t _c = AS : t _p = eter : S = ((1000/CN = 16.0031 ed in SCS method analysis in HEC temporal patterns produced in HI harge (m3/s) Q15 Q100	t _e , as: <u>ce.army.mil/software</u> , 0.6 t _c 1)-10)*25.4 Total Pervious Impervious C HMS	-	(38) ocumentatio 0.30 0.18 80.0 101.4 22.1	hrs hrs mm mm	17.81 10.68869	min
: 0	concentration, t _e , as: 16 t _e Time of Concentration SCS Lag for HEC-HN Soil Storage Parameters Initial Abstraction Ia = 0.25 above parameters us Rainfall data Using Region-specific RCP8.5 Results Pre-Development Results Peak Disch hr Q10 1 1.719	time of concentration, i $t_{lag} = 0.6 t_c$ on <u>https://www.hec.usa</u> n t _c = 1S : t _p = eter : S = ((1000/CN = 16.0031 ed in SCS method analysis in HEG c temporal patterns produced in HI harge (m3/s) <u>Q15 Q100</u> <u>2.064 4.438</u>	t _e , as: <u>ce.army.mil/software</u> , 0.6 t _c 1)-10)*25.4 Total Pervious Impervious C HMS	-	(38) ocumentatio 0.30 0.18 80.0 101.4 22.1	hrs hrs mm mm	17.81 10.68869	min
: 0	concentration, t _e , as: 16 t _c Time of Concentration SCS Lag for HEC-HIV Soil Storage Parame Initial Abstraction Ia = 0.25 above parameters us Rainfall data Using Region-specific RCP8.5 Results Pre-Development Results Peak Disct hr Q10	time of concentration, i $t_{lag} = 0.6 t_c$ on <u>https://www.hec.usa</u> h t_c = IS : t_p = eter : S = ((1000/CN = 16.0031 ed in SCS method analysis in HEG c temporal patterns produced in HI harge (m3/s) Q15 Q100 2.064 4.438 2.377 3.644	t _e , as: <u>ce.army.mil/software</u> , 0.6 t _c 1)-10)*25.4 Total Pervious Impervious C HMS	-	(38) ocumentatio 0.30 0.18 80.0 101.4 22.1	hrs hrs mm mm	17.81 10.68869	min

18 min

Q10 Q15 Q100 Rainfall intensity 82.4 89.2 130.4 2.66 2.88 4.21 m³/s Peak Flow Rate, Q

Brooklands Catchment 4

Determine peak flow rate with variety of methods Determine runoff volume for pond sizing calculations

> SCS Method Runoff Curve Number (CN) and Initial Abstraction (Ia)

				SCS Metho	b	Rational M	ethod
Soil name and classification	Cover description (cover typ hydrologic cond		Curve Number CN*	Area (hectares)	Product of CN x Area	С	Produ
	LCDB	CN classification					
Class C soils	Deciduous Hardwoods	Woods - fair	73	0.000	0	0.35	0
Class C soils	Exotic Forest	oods - grass combo - f	76	0.000	0	0.35	0
Class C soils Forest - Harvested		(pervious areas only, no vegetation)	91	1.823	166	0.70	1
Class C soils	Gorse and/or Broom	ısh-weed-grass mix - i	70	12.717	890	0.35	4
Class C soils	High Producing Exotic Grassland	pasture - fair	79	0.128	10	0.40	0
Class C soils	Low Producing Grassland	Pasture - poor	86	0.000	0	0.40	0
Class C soils	Urban Parkland/Open Space	Open Space - fair	79	0.000	0	0.40	0
	Subtotal for p	pervious Areas		14.668	1,066		5
	Impervious Areas (List)						
	LCDB	CN classification					
Class C soils	Built-up Area (settlement)	1/4 acre size	92	0.000	0	0.55	0
					0		0
	Subtotal for I	mpervious Areas		0.000	0.000		0
			Totals	14.668	1066.222		5
				0.146683	km²		
CN (weighted) :	total product	= 1,066	=	72.69		0.3939	
	total area	14.668					

For ungaged watersheds, the SCS suggests that the time of concentration, *t_c*, as:

$t_{lag} =$	0.6 t _c	$t_{log} =$	$t_{log} = 0.6 t_c$			(38	3)		
2.	Time of Concentration	https://w	ww.hec.usace.army.mil	<u>/software/h</u>	ec-hms/	documenta	tion/HEC	C-HMS_Technical%20Refe	2
	Time of Concentration	t _e =				0.34	hrs	20.19 min	l
	SCS Lag for HEC-HMS :	t _p =	0.6 t _c		=	0.20	hrs	12.11678 min	l
3.	Soil Storage Parameter :	S =	((1000/CN)-10)*25.4	Total	=	95.4	mm		l
				Pervious	=	95.4	mm		L
				Impervious	=	#DIV/0!	mm		L

4. Initial Abstraction

la = 0.25 = 19.08679

above parameters used in SCS method analysis in HEC HMS

5. Rainfall data

Using Region-specific temporal patterns produced in HIRDS v4 by NIWA for 1 hour, 6 hour and 12 hour storm durations RCP8.5

5. Results

Pre-Development

Results	Peak Discharge (m3/s)						
hr	Q10	Q15	Q100				
1	0.626	0.773	1.814				
6	1.005	1.107	1.736				
12	0.578	0.652	1.115				

Rational Method

20 min

		Q10		Q15		Q100
Rainfall int	ensity		82.4		89.2	130.4
Peak Flow	Rate, Q :		1.32		1.43	2.09

	on Description		Walters	Bluff				
	e peak flow rate with va e runoff volume for por							
1.	SCS Method Runoff Curve Numbe	er (CN) and Initial Abstraction (I	a)					
					SCS Metho		Rational M	ethod
	Soil name and classification	Cover description (cover typ hydrologic cond		Curve Number CN*	Area (hectares)	Product of CN x Area	с	Product
		LCDB	CN classification					
	Class C soils	Deciduous Hardwoods	Woods - fair	73	0.000	0	0.35	0.0
	Class C soils	Exotic Forest	oods - grass combo - f	76	0.019	1	0.35	0.0
	Class C soils	Forest - Harvested	(pervious areas only, no vegetation)	91	0.000	0	0.70	0.0
	Class C soils	Gorse and/or Broom	ısh-weed-grass mix - i	70	9.415	659	0.35	3.3
	Class C soils	High Producing Exotic Grassland	pasture - fair	79	0.832	66	0.40	0.3
	Class C soils	Low Producing Grassland	Pasture - poor	86	0.363	31	0.40	0.1
	Class C soils	Urban Parkland/Open Space	Open Space - fair	79	0.000	0	0.40	0.0
			ervious Areas		10.629	757		3.7
		Impervious Areas (List)						-
		LCDB	CN classification		1			
	Class C soils	Built-up Area (settlement)	Residential district	92	5.854	539	0.55	3.2
		Built up Area (Settlement)	1/4 acre size	52	5.054	0	0.55	0.0
		Quintertal for			E 0E4			
		Subtotal for I	mpervious Areas	-	5.854	538.575		3.2
				Totals	16.484	1296.048		7.0
			4 000		0.164835	km²		
	CN (weighted) :	total product total area	= 1,296 16.484	=	78.63		0.4247	
	concentration, t _c , as: 0.6 t _c Time of Concentratio	time of concentration, $t_{lag} = 0.6 t_c$ https://www.hec.usa	ce.army.mil/software/	'hec-hms/d	(38 locumentat		//S Technic	al%20Ref
	Time of Concentration	t _c =			0.32	hrs	19.18	min
	SCS Lag for HEC-HM		0.6 t _c	=	0.19	hrs	11.51022	
	COO Lag IOI TILO-TIM	ф. ф	0.0 t _c		0.15	1113	11.51022	
•	Call Changes Deserve	6 - ((1000/Ch		=	c0 0			
3.	Soil Storage Parame	s = ((1000/CN	I)-10)*25.4 Total		69.0	mm		
			Pervious	-	102.4	mm		
			Impervious	-	22.1	mm		
4.	Initial Abstraction	10 0000						
	la = 0.2S							
	above parameters use	ed in SCS method analysis in HE	C HMS					
5.	Rainfall data Using Region-specific RCP8.5	temporal patterns produced in HI	RDS v4 by NIWA for 1	hour, 6 ho	ur and 12 h	nour storm d	urations	
5.	Results							
	Pre-Development							
	r	arge (m3/s)						
	hr Q10	Q15 Q100						
	1 1.157	1.368 2.781						
	6 1.305	1.425 2.151						
	12 0.766	0.854 1.388						
	Rational Method							
		Γ	Q10	Q15	Q100	1		
	19 min	Rainfall int		89.2		1		
	13 [[]]]					-		
		Peak Flow	Rate, Q : 1.60	1.74	2.54	m³/s		
		TOC round	led to 20min					

ST

	Project: Kaka Hill D	Development	By:		Date:			
	Location: Walters Bl	uff Brooklands Catchment	Checked:		Date:			
	iption rate with variety of m ume for pond sizing ca		Brooklands Catchment 1					
1.	SCS Method Runoff Curve Numb	er (CN) and Initial Abstraction (I	a)					
	Soil name and classification	Cover description (cover typ	e, treatment, and hydrologic condition)	Curve Number	SCS Method Area (hectares)	Product of CN x Area	Rational M	ethod Produc
		LCDB	CN classification	CN*				
	Class C soils	Deciduous Hardwoods	Woods - fair	73	0.000	0	0.35	0.
	Class C soils	Exotic Forest	Woods - grass combo - fair	76	1.711	130	0.35	0.
	Class C soils	Forest - Harvested	Newly graded area (pervious areas only, no vegetation)	91	0.000	0	0.70	0.
	Class C soils	Gorse and/or Broom	Brush-weed-grass mix - fair	70	2.272	159	0.35	0.
	Class C soils	High Producing Exotic Grassland	pasture - fair	79	6.169	487	0.40	2.4
	Class C soils	Low Producing Grassland	Pasture - poor	86	0.000	0	0.40	0.0
	Class C soils	Urban Parkland/Open Space	Open Space - fair	79	1.484	117	0.40	0.5
	Class C soils	Planning Zone - Open Space	Open Space - fair	79	0.000	0	0.40	0.0
		Subtotal for p Impervious Areas (List)	pervious Areas		11.64	894		4.4
			CN classification			1	1 1	
	Class C soils	Built-up Area (settlement)	Residential district 1/4 acre size	92	5.469	503	0.55	3.
	Class C soils	Planning Zone - Residential_Hatch	Residential district 1/4 acre size	90	8.428	758	0.65	5.
	Class C soils	Planning Zone - Residential Lower Density_Hatch	Residential district 1/4 acre size	83	9.144	759	0.55	5.
		Subtotal for I	mpervious Areas		23.040	2020.555		13.
	<u> </u>	Cubicianion		Totals	34.675	2914.161		17.
	CN (weighted) :	total product total area	= 2,914 34.675	=	84.04		0.5182	
time of concentration, $t_{lag} = 0.6 t_c$	eds, the SCS suggests that the t _c , as: Time of Concentration	time of concentration, t $t_{log} = 0.6 t_c$		18)	IMS Technical	%20Referenc	e%20Manua	al (CPD-
	SCS Lag for HEC-HM	t _c = IS : t _p =	0.6 t _c	=	0.33 0.20	hrs hrs	19.68 11.81071	
2	-			_	48.2			
з.	Soil Storage Parame	eter: S = ((1000/CN	V)-10)*25.4 Total Pervious		46.2	mm mm		
			Impervious		35.6	mm		
4	Initial Abstraction							
-								
	la = 0.2S	= 9.646697						
	above parameters us	ed in SCS method analysis in HEC	C HMS					
5	Rainfall data							
	Using Region-specific	temporal patterns produced in HI	RDS v4 by NIWA for 1 hour, 6 hour and 12	hour storm	durations			
	RCP8.5							
	RCP8.5							

Rational Method							
			Q10		Q15	Q100	
20 min	Rainfall int	ensity		82.4	89.2	130.4	
	Peak Flow	Rate, Q :		4.11	4.46	6.51	m³/s

Brooklands Catchment 2

Determine peak flow rate with variety of methods Determine runoff volume for pond sizing calculations

				SCS Metho	d	Rational M	ethod
Soil name and classification	Cover description (cover typ hydrologic cond		Curve Number CN*	Area (hectares)	Product of CN x Area	С	Produ
	LCDB	CN classification					
Class C soils	Deciduous Hardwoods	Woods - fair	73	0.000	0	0.35	0
Class C soils	Exotic Forest	oods - grass combo - f	76	3.333	253	0.35	1
Class C soils	Forest - Harvested	(pervious areas only, no vegetation)	91	0.000	0	0.70	0
Class C soils	Gorse and/or Broom	ısh-weed-grass mix - I	70	0.663	46	0.35	0
Class C soils	High Producing Exotic Grassland	pasture - fair	79	0.000	0	0.40	0
Class C soils	Low Producing Grassland	Pasture - poor	86	0.032	3	0.40	0
Class C soils	Urban Parkland/Open Space	Open Space - fair	79	8.498	671	0.40	3
Class C soils	Planning Zone - Open Space	Open Space - fair	79	0.002	0	0.40	0
	Subtotal for p	bervious Areas		12.53	974		4
	Impervious Areas (List)						
	LCDB	CN classification					
Class C soils	Built-up Area (settlement)	1/4 acre size	92	14.815	1,363	0.55	8
Class C soils	Planning Zone - Residential_Hatch	Residential district 1/4 acre size	90	2.947	265	0.65	1
Class C soils	Planning Zone - Residential Lower Density_Hatch	Residential district 1/4 acre size	83	8.790	730	0.55	4
					0		0
	Subtotal for I	mpervious Areas		26.552	2357.795		14
			Totals	39.080	3331.741		19
CN (weighted) :	total product	= 3,332 39,080	=	85.25		0.5043	

For ungaged watersheds, the SCS suggests that the time of concentration, $t_{\rm c}$, as: For ungaged watersheds, the SCS suggests that the UH $_{\mbox{lag}}$ time may be related to time of concentration, $t_{\rm c}$ as: $t_{log} = 0.6 t_c$

 $t_{lag} = 0.6 t_c$

2.	Time of Concentration	https://w	ww.hec.usace.army.mil	/software/he	ec-hms/o	documenta	ation/HEC	-HMS Technical%20R
	Time of Concentration	t _e =				0.31	hrs	18.71 min
	SCS Lag for HEC-HMS :	t _p =	0.6 t _c		=	0.19	hrs	11.22796 min
3.	Soil Storage Parameter :	S =	((1000/CN)-10)*25.4	Total	=	43.9	mm	
				Pervious	=	72.7	mm	
				Impervious	=	32.0	mm	

(38)

4. Initial Abstraction

la = 0.25 = 8.786073

above parameters used in SCS method analysis in HEC HMS

5. Rainfall data

Using Region-specific temporal patterns produced in HIRDS v4 by NIWA for 1 hour, 6 hour and 12 hour storm durations RCP8.5

5. Results

Post-Development

Results	Peak Disch	arge (m3/s)
hr	Q10	Q15	Q100
1	4.27	4.884	8.77
6	3.526	3.818	5.551
12	2.115	2.327	3.6

Rational Method

19 min

		Q10		Q15		Q100
Rainfall int	ensity		82.4		89.2	130.4
Peak Flow	Rate, Q :		4.51		4.89	7.15

Brooklands Catchment 3

Determine peak flow rate with variety of methods Determine runoff volume for pond sizing calculations

> SCS Method Runoff Curve Number (CN) and Initial Abstraction (Ia)

1

				SCS Method		Rational M	ethod
Soil name and classification	Cover description (cover typ hydrologic cond		Curve Number CN*	Area (hectares)	Product of CN x Area	с	Produc
	LCDB	CN classification					
Class C soils	Deciduous Hardwoods	Woods - fair	73	1.469	107	0.35	0.
Class C soils	Exotic Forest	oods - grass combo - f	76	0.111	8	0.35	0.
Class C soils	Forest - Harvested	(pervious areas only, no vegetation)	91	0.000	0	0.70	0.
Class C soils	Gorse and/or Broom	ısh-weed-grass mix - 1	70	13.295	931	0.35	4.
Class C soils	High Producing Exotic Grassland	pasture - fair	79	3.104	245	0.40	1.
Class C soils	Low Producing Grassland	Pasture - poor	86	0.000	0	0.40	0.
Class C soils	Urban Parkland/Open Space	Open Space - fair	79	0.000	0	0.40	0.
Class C soils	Planning Zone - Open Space	Open Space - fair	79	0.000	0	0.40	0
	Subtotal for p	pervious Areas		17.98	1,292		6
	Impervious Areas (List)						
	LCDB	CN classification					
Class C soils	Built-up Area (settlement)	1/4 acre size	92	6.470	595	0.55	3.
Class C soils	Planning Zone - Residential_Hatch	Residential district 1/4 acre size	90	0.002	0	0.65	0.
Class C soils	Planning Zone - Residential Lower Density_Hatch	Residential district 1/4 acre size	83	4.576	380	0.55	2.
				-	0		0
	Subtotal for l	mpervious Areas		11.048	975.225		6.
			Totals	29.028	2266.823		12.
				0.2902781			
CN (weighted) :	<u>total product</u> total area	= 2,267 29.028	=	78.09		0.4315	
aged watersheds, the SCS s concentration, t_c , as:	uggests that the For ungaged watershee time of concentration, t	ds, the SCS suggests that the l	JH l <mark>ag</mark> time ma	y be related to			
6 t _c	$t_{log} = 0.6 t_c$			(38)			

2.	Time of Concentration	https://w	ww.hec.usace.army.mil	/software/he	ec-hms/d	ocumentat	on/HEC-H	IMS Technical%20Refere
	Time of Concentration	t _c =				0.30	hrs	17.81 min
	SCS Lag for HEC-HMS :	t _p =	0.6 t _c		=	0.18	hrs	10.68869 min
3.	Soil Storage Parameter :	S =	((1000/CN)-10)*25.4	Total	=	71.3	mm	
				Pervious	=	99.6	mm	
				Impervious	=	33.7	mm	

4. Initial Abstraction

la = 0.25 = 14.25196

above parameters used in SCS method analysis in HEC HMS

5. Rainfall data

Using Region-specific temporal patterns produced in HIRDS v4 by NIWA for 1 hour, 6 hour and 12 hour storm durations RCP8.5

5. Results

Post-Development

Results	Peak Disch	arge (m3/s)
hr	Q10	Q15	Q100
1	2.004	2.378	4.888
6	2.274	2.485	3.762
12	1.33	1.485	2.425

Rational Method

18 min

		Q10		Q15		Q100	
Rainfall intensity			82.4		89.2		130.4
Peak Flow	Rate, Q :		2.87		3.11		4.54

Brooklands Catchment 4

Determine peak flow rate with variety of methods Determine runoff volume for pond sizing calculations

SCS Method

				SCS Metho	b	Rational M	ethod
Soil name and classification	Cover description (cover typ hydrologic cond	lition)	Curve Number CN*	Area (hectares)	Product of CN x Area	С	Produ
	LCDB	CN classification					
Class C soils	Deciduous Hardwoods	Woods - fair	73	0.000	0	0.35	0
Class C soils	Exotic Forest	oods - grass combo - f	76	0.000	0	0.35	0
Class C soils	Forest - Harvested	(pervious areas only, no vegetation)	91	1.319	120	0.70	C
Class C soils	Gorse and/or Broom	ush-weed-grass mix - i	70	10.042	703	0.35	3
Class C soils	High Producing Exotic Grassland	pasture - fair	79	0.128	10	0.40	C
Class C soils	Low Producing Grassland	Pasture - poor	86	0.000	0	0.40	C
Class C soils	Urban Parkland/Open Space	Open Space - fair	79	0.000	0	0.40	(
Class C soils	Planning Zone - Open Space	Open Space - fair	79	0.000	0	0.40	C
	Subtotal for p	bervious Areas		11.49	833		4
	Impervious Areas (List)						
	LCDB	CN classification					
Class C soils	Built-up Area (settlement)	1/4 acre size	92	0.000	0	0.55	(
Class C soils	Planning Zone - Residential_Hatch	Residential district 1/4 acre size	90	0.302	27	0.65	C
Class C soils	Planning Zone - Residential Lower Density_Hatch	Residential district 1/4 acre size	83	2.877	239	0.55	1
					0		0
	Subtotal for I	mpervious Areas		3.179	265.976		1
			Totals	14.668	1099.076		(

total area 14.668 For ungaged watersheds, the SCS suggests that the UH \log time may be related to time of concentration, $t_{\rm c},$ as: For ungaged watersheds, the SCS suggests that the time of concentration, $t_{\rm c}$, as:

12 - 12	0.7	$t_{log} =$	0.67			13	18)		
$t_{lag} =$	0.6 I _c	1 log —	0.01 _c			(.	,		
2.	Time of Concentration	https://w	ww.hec.usace.army.mil	l/software/h	ec-hms/o	documenta	ation/HEC	-HMS Technical%20Ref	2
	Time of Concentration	t _e =				0.34	hrs	20.19 min	
	SCS Lag for HEC-HMS :	t _p =	0.6 t _c		=	0.20	hrs	12.11678 min	
3.	Soil Storage Parameter :	S =	((1000/CN)-10)*25.4	Total	=	85.0	mm		
				Pervious	=	96.3	mm		
				Impervious	=	49.6	mm		

4. Initial Abstraction

la = 0.25 = 16.9977

above parameters used in SCS method analysis in HEC HMS

5. Rainfall data

Using Region-specific temporal patterns produced in HIRDS v4 by NIWA for 1 hour, 6 hour and 12 hour storm durations RCP8.5

5. Results

Post-Development

Results		Peak Discharge (m3/s)							
hr		Q10	Q15	Q100					
	1	0.76	0.92	2.038					
	6	1.064	1.169	1.805					
1	2	0.617 0.693 1							

Rational Method

20 min

		Q10	Q15		Q100	
Rainfall int	ensity	82.4		89.2	130.4	
Peak Flow	Rate, Q :	1.44		1.55	2.27	m³/s

Walters Bluff

Determine peak flow rate with variety of methods Determine runoff volume for pond sizing calculations

					SCS Method	ł	Rational M	ethod
Soil nan classifi		Cover description (cover typ hydrologic cond		Curve Number CN*	Area (hectares)	Product of CN x Area	С	Produc
		LCDB	CN classification					
Class C	C soils	Deciduous Hardwoods	Woods - fair	73	0.000	0	0.35	0.
Class C	C soils	Exotic Forest	oods - grass combo - f	76	0.019	1	0.35	0.
Class C	C soils	Forest - Harvested	(pervious areas only, no vegetation)	91	0.000	0	0.70	0.
Class C	C soils	Gorse and/or Broom	ısh-weed-grass mix - i	70	2.851	200	0.35	1.
Class C	c soils	High Producing Exotic Grassland	pasture - fair	79	0.135	11	0.40	0.
Class C	c soils	Low Producing Grassland	Pasture - poor	86	0.000	0	0.40	0.
Class C	c soils	Urban Parkland/Open Space	Open Space - fair	79	0.000	0	0.40	0.
Class C	c soils	Planning Zone - Open Space	Open Space - fair	79	2.678	212	0.40	1.
		Subtotal for p	ervious Areas		5.68	423		2.
		Impervious Areas (List)						
		LCDB	CN classification					
Class C	c soils	Built-up Area (settlement)	1/4 acre size	92	5.854	539	0.55	3.
Class C	C soils	Planning Zone - Residential_Hatch	Residential district 1/4 acre size	90	0.758	68	0.65	0.
Class C	C soils	Planning Zone - Residential Lower Density_Hatch	Residential district 1/4 acre size	83	4.188	348	0.55	2.
						0		0.
		Subtotal for la	mpervious Areas		10.800	954.425		6.
				Totals	16.484	1377.681		8.
CN (weighte	ed) :	total product total area	= 1,378 16.484	=	83.58		0.4942	
gaged watershed concentration, t _c			ds, the SCS suggests that the I	JH lag time ma	y be related to	,		

2.	Time of Concentration	https://w	ww.hec.usace.army.mil/	software/he	ec-hms/o	documenta	ation/HEC	-HMS Technical%20Refer
	Time of Concentration	t _e =				0.32	hrs	19.18 min
	SCS Lag for HEC-HMS :	t _p =	0.6 t _c		=	0.19	hrs	11.51022 min
3.	Soil Storage Parameter :	S =	((1000/CN)-10)*25.4	Total	=	49.9	mm	
				Pervious	=	87 1	mm	

Impervious

=

33.4 mm

4. Initial Abstraction

la = 0.25 = 9.980694

above parameters used in SCS method analysis in HEC HMS

5. Rainfall data

Using Region-specific temporal patterns produced in HIRDS v4 by NIWA for 1 hour, 6 hour and 12 hour storm durations RCP8.5

5. Results

Post-Development

Results	Peak Discharge (m3/s)							
hr	Q10	Q15	Q100					
1	1.612	1.857	3.436					
6	1.443	1.565	2.296					
12	0.861	0.95	1.488					

Rational Method

19 min

		Q10		Q15		Q100
Rainfall int	ensity		82.4		89.2	130.4
Peak Flow	Rate, Q :		1.86		2.02	2.95

Project: Kaka Hill Development	By: CHGR	Date: 17/05/2022
Location: Kaka Hill	Checked: BYMU	Date: 17/05/2022
Calculation Description		

Categorise catchment into Pre and Post Development Areas with land cover and soil class

Pre-Development

			Total			253.21	19604.77
Forest		Woods	D	Fair	79	10.54	832.42
Jinubianu		the major element	D	Fair	77	197.11	15177.32
Shrubland		Brush-weed-grass mixture with brush	С	Fair	70	6.38	446.81
iastaie		continuous forage for grazing	D	Fair	84	29.66	2491.27
Pasture		Pasture, grassland or range-	В	Fair	69	9.52	656.95
	Land Cover	SCS Cover Type	Soil Class	Soil Condi C		Area (ha)	Product

Weighted CN 7

77.43

Post-Development

Land Cover	SCS Cover Type	Soil Class	Soil Condi	Runoff Cou	Area (ha)	Product
Pasture	Pasture , grassland or range- continuous forage for grazing	В	Fair	69	0.98	67.50
	continuous lorage for grazing	D	Fair	84	1.84	154.24
Shrubland	Brush-weed-grass mixture with brush	D	Fair	77	40.22	3097.11
Forest	Woods	D	Fair	79	10.54	832.46
Open Space Recreation	Brush-weed-grass mixture with brush	В	Good	48	3.78	181.32
Open Space Recreation	Brush-weed-grass mixture with brush	С	Good	65	0.91	58.96
Open Space Recreation	Brush-weed-grass mixture with brush	D	Good	73	18.55	1354.31
Rural	Brush-weed-grass mixture with brush	С	Fair	70	0.69	48.17
Rural	Brush-weed-grass mixture with brush	D	Fair	77	109.31	8416.66
Commercial	Commericial and business	В	Fair	92	0.25	22.56
Commercial	Commericial and business	D	Fair	95	0.13	12.29
Residential/Residential Higher Density	1/4 Acre	С	Fair	83	4.79	397.36
Residential/Residential Higher Density	1/4 Acre	D	Fair	87	33.84	2943.77
Residential Lower Density	1/8 acre or less (town houses)	В	Fair	85	4.52	384.15
Residential Lower Density	1/8 acre or less (town houses)	D	Fair	92	22.87	2104.32
		Total			253.20	20075.18

Weighted CN 79.29

1 Rural zoning is represented as Brush-weed-grass mixture assuming that there will be little to no change to land cover of this area during development

2 Open Space is represented as "Good" Condition Brush-weed-grass mixture to represent the proposed riparian zone around the stream

STORMWATER ASSESSMENT - PRE-DEVELOPMENT SCENARIO

STORIVI	WATER	A33E33I		PRE-DEV		EINT SCE	NARIO					
	Project:	Kaka Hill D	evelopmen	it			By:	CHGR	Date:	17/05/2022		
	Location:	Kaka Hill					Checked:	BYMU	Date:	17/05/2022		
Determine Determine	on Descri peak flow runoff volu	rate with v ime for por					Catchme	ent 1				
	SCS Mether		er (CN) and	l Initial Ab	straction (la)						
ī								Currie	SCS Meth	bd I	Rational M	ethod
	Soil nai classifi		Cove		n (cover typ rologic cond	be, treatmer dition)	nt, and	Curve Number CN*	Area (hectares)	Product of CN x Area	С	Product
			Pervious A	reas (List)	-	1						
	Class I Class (air Conditio	-		84 70	0.365	31 352	0.30	0.11
	Class Class I				l (Fair Cond l (Fair Cond			70	129.691	9,986	0.35	1.76 58.36
	Class Class (ir Conditon			79	129.091	832	0.45	3.69
	0,000			101031 (12		Pervious Area	s	75	145.616	11,201	0.35	63.92
I	Class (C soils	Impervious		st) al district 1/-			I			1	05.52
	* from Table 3	3.3						Totals	145.616	11,201		63.92
	CN (weight	ed) :	1	<u>total produc</u> total area		=	11,201 145.616	=	76.92		0.4389	
For ung	gaged watershe	ds, the SCS s	uggests that th	For un	gaged watershe	eds, the SCS su	ggests that the	UH lag time ma	y be related to			
time of $t_{lag} = 0$	concentration,	t _e , as:		time of $t_{lag} = 0$	concentration,	t _o , as:			(38)		
2.	Time of Co	oncentratio	on	https://ww	ww.hec.usa	ace.army.mi	il/software/	/hec-hms/d	ocumentat	ion/HEC-HMS		%20Refere
	Time of Co SCS Lag fo			t _c = t _p =		0.6 t _c		=	0.59 0.36	hrs hrs	35.60 21.3582	
3.	Soil Stora	ge Parame	eter :	S =	((1000/CI	N)-10)*25.4	Total Pervious Impervious	=	76.2 76.2	mm mm mm		
4.	Initial Abs	traction										
		la = 0.2S	=	15.24195								
	above para	ameters use	ed in SCS r	nethod ana	alysis in HE	C HMS						
5.	Rainfall da	ata										
	Using Regi RCP8.5	on-specific	temporal p	atterns pro	duced in H	IRDS v4 by	NIWA for 1	hour, 6 ho	ur and 12 h	iour storm dur	ations	
5.	Results											
		•	arge (m3/s Q15 7.9) Q100 17.0								
	6 12	10.9 6.4	11.9 7.2	18.2 11.8	-							
	Rational N	lethod										
	36	min			Rainfall in Peak Flow	tensity v Rate, Q :	Q10 61.7 10.97	Q15 71.9 12.78		-		

	SCS Method										
•	Runoff Curve Num	ber (CN) an	d Initial Ab	straction (la)			SCS Metho	d	Rational M	lathad
	Soil name and classification	Cove		n (cover ty ologic cond	oe, treatmer dition)	it, and	Curve Number	Area (hectares)	Product o CN x		Product
		Pervious /	Areas (List)				CN*		Area		
	Class D soils		· · ·	air Conditi	,		84	5.260	442	0.30	1.58
	Class C soils Class D soils	_		(Fair Cond (Fair Cond	,		70 77	1.360 26.572	95 2,046	0.35	0.48
			Shrubland				,,	20.372	2,040	0.45	11.50
				Subtotal for	Pervious Areas	3		33.192	2,583		14.01
	Class C soils	Imperviou	s Areas (Lis Residentia	al district 1/	4 acre size Impervious Are	eas					
	* from Table 3.3						Totals	33.192	2,583		14.01
	CN (weighted) :		<u>total produc</u> total area		=	2,583 33.192	=	77.82		0.4221	
			For un	gaged watersh	eds, the SCS su	ggests that the L	JH l <mark>ag</mark> time ma	y be related to			
			$t_{lag} = 0$	concentration,	I _c , as:			(38)		
	Time of Concentra	41 a.m.				1/2 - 54	lhaa husa (d			MC Tashais	-10/20D-fr
	Time of Concentra	tion	nups://w	ww.nec.usa	ace.army.mi	<u>I/SOItware/</u>	nec-nms/d	locumentat	<u>.1011/HEC-H</u>	MS_Technic	al%20Refe
	Time of Concentrati		t _c =					0.32	hrs	18.99	
	SCS Lag for HEC-H	IMS :	t _p =		0.6 t _c		=	0.19	hrs	11.39346	min
	Soil Storage Parar	neter :	S =	((1000/Cl	N)-10)*25.4	Total Pervious	= =	72.4 72.4	mm mm		
	la = 0.25	=	14.47676								
	above parameters u	ised in SCS	method ana	lysis in HE	C HMS						
5	Rainfall data										
۰.	Using Region-speci RCP8.5	fic temporal p	patterns pro	duced in H	IRDS v4 by	NIWA for 1	hour, 6 ho	our and 12 h	our storm	durations	
5.	Results										
	Pre-Development										
	Results Peak Dis hr Q10	charge (m3/ Q15	s) Q100	1							
	1 2	.2 2.6	5.4								
	6 2 12 1	.6 2.8 .5 1.7	-	-							
	<u> </u>	1 2.7		-							
	Rational Method										
									-		
				Rainfall in		Q10 81.7 3.18	Q15 95.3 3.71		-		
	19 min			Peak Flov	v Rate, Q :	5.10			1		
	19 min			Peak Flov	v Rate, Q :	5.10					
	19 min			Peak Flov	v Rate, Q :	5.10			1		

$\frac{\text{cassmication}}{\text{Pervious Areas}} \frac{\text{(reclares)}}{\text{Pervious Areas}} \frac{\text{Area}}{\text{Pervious Areas}} \frac{\text{(reclares)}}{\text{Pervious Areas}} \frac{\text{Area}}{\text{Area}} \text{$		SCS Method	-									
Contraine and classification Control of the particle (condition) (condition) Number (condition) Area (condition) CA (condition) CA (condition) <th>1.</th> <th>Runoff Curve Nur</th> <th>nber (CN) and</th> <th>d Initial Ab</th> <th>straction (</th> <th>la)</th> <th></th> <th></th> <th>SCS Metho</th> <th>d</th> <th>Rational M</th> <th>ethod</th>	1.	Runoff Curve Nur	nber (CN) and	d Initial Ab	straction (la)			SCS Metho	d	Rational M	ethod
Cless D solts Pesture (Fair Condition) 94 1.060 89 0.30 0 Cless D solts Shrubland (Fair Condition) 77 21.637 1.806 0.45 9 Cless D solts Shrubland (Fair Condition) 77 21.637 1.806 0.45 9 Impervious Areas 22.097 1.755 10 10 10 1.755 10 Impervious Areas Subtation for Pervious Areas 22.097 1.755 10 Cless C solts Residential district 1/4 acre size Subtation for Impervious Areas 22.097 1.755 10 CN (weighted) : Used product total area 1.755 7.7.33 0.4430 2. Time of Concentration SCS Lag for HEC-HMS : $t_p = 0.6$ $t_p = 0.18$ hrs 10.68797 min 3. Soil Storage Parameter : S = ((1000/CN)-10)'25.4 Test = 74.5 mm Pervious = 74.5 mm Is = 0.25 Its 4.89511 above parameters used in SCS method analysis in HEC HMS 5. Rainfall data Using Region-specific temporal patterns produced in HIRDS v4 by NIWA for 1 hour, 6 hour and 12 hour storm durations RCP8.5 5. Results Peak Discharge (m3/s) 11 19 21 10			Cove				nt, and	Number		CN x	С	Product
Imperious Areas Imperious Imperious <thim< th=""> Imperious I</thim<>		Class D soils	Pervious A			on)		84	1.060	89	0.30	0.3
Impervious Areas (List) Impervious Areas (List) Class C sols Residential district 1/4 acre size Subtoal for Impervious Areas Subtoal for Impervious Areas * trom Table 3.3 Totals 22.697 1.755 10 CN (weighted): total product = 1.755 = 77.33 0.4430 2. Time of Concentration L = 1.755 = 0.30 hrs 17.81 min SCS Lag for HEC-HMS : L = 0.6 L = 0.30 hrs 17.81 min 3. Soil Storage Parameter : S = ((1000/CN)-10)'25.4 Total = 74.5 mm 4. Initial Abstraction L = 0.25 = 14.89511 above parameters used in SCS method analysis in HEC HMS 5. 5. Rainfail data Using Region-specific temporal patterns produced in HIRDS v4 by NIWA for 1 hour, 6 hour and 12 hour storm durations RCP8.5 7. Results Pre-Development Results Pre-Development Results Pre-Development Results Pre-Development Results Pre-Development Results Patonal Method <td< th=""><th></th><th>Class D soils</th><th></th><th>Shrubland</th><th>l (Fair Cond</th><th>lition)</th><th></th><th>77</th><th>21.637</th><th>1,666</th><th>0.45</th><th>9.7</th></td<>		Class D soils		Shrubland	l (Fair Cond	lition)		77	21.637	1,666	0.45	9.7
$Impervious Areas (List)$ Class C solis $Residential district 1/4 acre size$ Subtoal for Impervious Areas *trom Table 3.3 CN (weighted): $Iotal product$ total area $Inter of Concentration$ Time of Concentration Time of Concentration Time of Concentration $I_{a} = 0.25 = 14.89511$ above parameters used in SCS method analysis in HEC HMS S. Rainfall data Using Region-specific temporal patterns produced in HIRDS v4 by NIWA for 1 hour, 6 hour and 12 hour storm durations RCP8.5 Results Pre-Development Results Pre-Development Results Result Results Results Result Res									22.697	1,755		10.0
$CN (weighted): total area = 1,755 = 77.33 0.4430$ 2. Time of Concentration $Time of Concentration t_e = 0.30 hrs 17.81 min SCS Lag for HEC-HMS: t_p = 0.6 t_e = 0.18 hrs 10.68797 min 3. Soil Storage Parameter : S = ((1000/CN)-10)'25.4 Total = 74.5 mm Pevicus = 74.5 mm Pevicus = 74.5 mm Timpervicus = 0.18 hrs 10.68797 min 4. Initial Abstraction a = 0.2S = 14.89511 above parameters used in SCS method analysis in HEC HMS 5. Rainfall data Using Region-specific temporal patterns produced in HIRDS v4 by NIWA for 1 hour, 6 hour and 12 hour storm durations RCP8.5 7. Results Pre-Development Results Peak Discharge (m3/s) Tr = 1020 \frac{0.15}{1.5 \frac{1.8}{1.37}} \frac{0.100}{1.1 \frac{1.9}{1.9}} Rational Method Tr = 1000 \frac{11}{1.8 \min} \frac{0.100}{1.8 + 1.9} \frac{0.100}{1.8 + 1.9} \frac{0.100}{1.8 + 1.9} \frac{0.100}{1.33.3}$		Class C soils	Imperviou		st) al district 1/-	4 acre size			22.001	.,	I	10.0
$total area 22.697$ 2. Time of Concentration $\lim_{D \to \infty} \int_{D}^{D} \int_{D}^{D}$		* from Table 3.3						Totals	22.697	1,755		10.0
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		CN (weighted) :				=		=	77.33		0.4430	
4. Initial Abstraction $a = 0.2S = 14.89511$ above parameters used in SCS method analysis in HEC HMS 5. Rainfall data Using Region-specific temporal patterns produced in HIRDS v4 by NIWA for 1 hour, 6 hour and 12 hour storm durations RCP8.5 6. Results Pre-Development Results $results$	3.	SCS Lag for HEC-	HMS :	t _p =	((1000/CI		Pervious	= =	0.18 74.5	hrs mm mm		
above parameters used in SCS method analysis in HEC HMS 5. Rainfall data Using Region-specific temporal patterns produced in HIRDS v4 by NIWA for 1 hour, 6 hour and 12 hour storm durations RCP8.5 5. Results Pre-Development Results Peak Discharge (m3/s) $\frac{\text{Ne} Q10 Q15 Q100}{1.2 1.0 1.1 1.9}$ Rational Method 18 min $\frac{Q10 Q15 Q100}{Rainfall intensity 84.1 98.1 133.3}$	4.			14.89511								
5. Rainfall data Using Region-specific temporal patterns produced in HIRDS v4 by NIWA for 1 hour, 6 hour and 12 hour storm durations RCP8.5 5. Results Pre-Development Results Peak Discharge (m3/s) Im 1 1.5 1.8 1.1 1.2 1.3 1.4 1.8						CHMS						
Using Region-specific temporal patterns produced in HIRDS v4 by NIWA for 1 hour, 6 hour and 12 hour storm durations RCP8.5 5. Results Pre-Development Results Peak Discharge (m3/s) $hr Q10 Q15 Q100 \\ \hline 1 1.5 1.8 3.7 \\ \hline 6 1.7 1.9 2.9 \\ \hline 12 1.0 1.1 1.9 \\ \hline 12 1.0 1.1 1.9 \\ \hline 18 \text{ min}$ Rational Method	5				, e.e "'' '''							
Pre-Development Results Peak Discharge (m3/s) hr Q10 Q15 Q100 1 1.5 1.8 3.7 6 1.7 1.9 2.9 12 1.0 1.1 1.9 Rational Method 18 min Q10 Q15 Q100 18 min Rainfall intensity 84.1 98.1 133.3	σ.	Using Region-spec	cific temporal p	oatterns pro	duced in H	IRDS v4 by	NIWA for 1	hour, 6 ho	ur and 12 h	our storm d	lurations	
Results Peak Discharge (m3/s) hr Q10 Q15 Q100 1 1.5 1.8 3.7 6 1.7 1.9 2.9 12 1.0 1.1 1.9 1.9 1.0 1.1 1.9 Rational Method 18 min Q10 Q15 Q100 18 min Rainfall intensity 84.1 98.1 133.3	5.	Results										
Q10 Q15 Q100 18 min Rainfall intensity 84.1 98.1 133.3		Results Peak Di hr Q10 1 6	Q15 1.5 1.8 1.7 1.9	Q100 3.7 2.9	1							
18 min Rainfall intensity 84.1 98.1 133.3		Rational Method										
		18 min							133.3			

1.	Runoff Curve Nur	nber (CN) an	d Initial Ab	ostraction (la)						
	Soil name and	Cove	r doporintio	n (cover tu	no trootmon	tond	Curve	SCS Metho	d Product o	Rational M	ethod
	Soil name and classification	Cove		rologic con	pe, treatmen dition)	it, and	Number CN*	Area (hectares)	CN x Area	С	Product
	Class D soils	Pervious	Areas (List)	-			04	14.075		0.20	4.2
	Class D soils Class B soils			Fair Conditi Fair Conditi			84 69	14.075 2.115	1,182 146	0.30	4.2
	Class D soils		Shrubland	d (Fair Cond	dition)		77	18.621	1,434	0.45	8.3
				Subtotal for	Pervious Areas			34.811	2,762		13.0
	Class C soils	Imperviou	s Areas (Lis Residentia	al district 1/	4 acre size Impervious Are	as					
	* from Table 3.3						Totals	34.811	2,762		13.0
	CN (weighted) :		<u>total produ</u> total area		=	2,762 34.811	=	79.34		0.3742	
3.	Soil Storage Para	meter :	S =	((1000/CI	N)-10)*25.4	Total Pervious Impervious	= = =	66.1 66.1	mm mm mm		
4.	Initial Abstraction	I.									
	la = 0.2	S =	13.22482	2							
	above parameters	used in SCS	method and	alysis in HE	C HMS						
5.	Rainfall data										
	Using Region-spec RCP8.5	ific temporal p	patterns pro	oduced in H	IRDS v4 by	NIWA for 1	hour, 6 ho	ur and 12 h	our storm	durations	
5.	Results										
	Pre-Development										
	Results Peak Di	scharge (m3/ Q15	s) Q100	1							
	1 2	2.6 3.0	6.1	-							
		2.8 3.1 L.6 1.8	-	-							
	Rational Method										
					1	Q10	Q15	Q100	1		
	19 min			Rainfall in Peak Flov	tensity v Rate, Q :	81.6 2.95	95.2 3.45	129.3	4		

	SCS Method Runoff Curve Num	ber (CN) an	d Initial Ab	straction (la)	1			4	Detterrelat	- 14 - 1
	Soil name and	Cove	r descriptio	n (cover typ	oe, treatmen	t, and	Curve	SCS Metho Area	Product of		
	classification		hydi	rologic cond		·	Number CN*	(hectares)	CN x Area	С	Product
	Class D soils	Pervious /	Areas (List)	air Conditio	(no		84	8.898	747	0.30	2.6
	Class B soils			air Conditio	,		69	7.406	511	0.30	1.4
	Class D soils		Shrubland	l (Fair Cond	lition)		77	0.587	45	0.45	0.2
				Subtotal for	Pervious Areas			16.891	1,304		4.4
	Class C soils	Imperviou	s Areas (Lis Residentia	al district 1/4	4 acre size Impervious Are	as					
	* from Table 3.3						Totals	16.891	1,304		4.4
	CN (weighted) :		<u>total produc</u> total area	_	=	1,304 16.891	=	77.18		0.2614	
	Initial Abstraction la = 0.25 above parameters u		15.02028 method ana		C HMS						
5.	Rainfall data										
	Using Region-speci RCP8.5	fic temporal p	patterns pro	duced in H	IRDS v4 by	NIWA for 1	hour, 6 ho	our and 12 h	our storm o	lurations	
5.	Results										
	hr Q10 1 0. 6 1.	charge (m3/s Q15 8 1.0 3 1.4 8 0.8	Q100 2.1 2.1								
	Rational Method										
	31 min			Rainfall in Peak Flow	tensity	Q10 65.3 0.80	Q15 76.1 0.93				

	Project: Kaka Hill	Development		By:	CHGR	Date:	17/05/2022		
	Location: Kaka Hill			Checked:	BYMU	Date:	17/05/2022		
atio	on Description			Catchme	ent 1				
nine	peak flow rate with va runoff volume for por			•					
inite i	SCS Method								
1.		er (CN) and Initial Abs	traction (la)						
						SCS Metho	d	Rational M	ethod
	Soil name and classification		(cover type, treatmer ogic condition)	nt, and	Curve Number CN*	Area (hectares)	Product of CN x Area	с	Product
		Pervious Areas (List)							
	Class D soils		Fair Condition)		77	39.402	3,034	0.35	13.79
	Class D soils	Forest (Fair	Conditon)		79	10.538	832	0.45	4.74
	Class C soils	Open Space	e (Good Conditon)		65	0.674	44		0.00
	Class D soils	Open Space	e (Good Conditon)		73	11.348	828		0.00
	Class C soils	Rural			70	0.688	48		0.00
	Class D soils	Rural			77	67.999	5,236		0.00
		S	ubtotal for Pervious Area	S		130.648	10,023		18.53
	Class C soils	Impervious Areas (List)	district 1/4 acre size		0.2	3.660	204		0.00
	Class D soils		district 1/4 acre size		83 87	3.660 9.802	304 853		0.00 0.00
	Class D soils		district 1/8 acre size		92	1.496	138		0.00
		s	ubtotal for Impervious Are	eas		14.958	1,294		0.00
	* from Table 3.3				Totals	145.606	11,317		18.53
	CN (weighted) :	<u>total product</u> total area	=	11,317 145.606	=	77.72		0.1273	
						70 70			
			Weighted C Weighted CN		-	76.72 86.52			
2.	Time of Concentrati	ion							
	Time of Concentratio	n t _c =				0.59	hrs	35.60	min
	SCS Lag for HEC-HN		0.6 t _c		=	0.36	hrs	21.3582	
3.	Soil Storage Parame	eter: S =	((1000/CN)-10)*25.4	Total	=	72.8	mm		
	een eterager arann	U	((Pervious		77.1	mm		
				Impervious		39.6	mm		
4.	Initial Abstraction								
	Initial abs	straction - Pervious		la = 0.2S		15.42			
	Initial abs	straction - impervious		la = 0.2S	=	7.91			

above parameters used in SCS method analysis in HEC HMS

5. Rainfall data

Using Region-specific temporal patterns produced in HIRDS v4 by NIWA for 1 hour, 6 hour and 12 hour storm durations RCP8.5

5. Results

Pre-Development

Results		Peak	Disch	arge	(m3/s	;)
hr		Q10		Q15		Q100
	1		7.1		8.5	17.8
	6		11.1		12.1	18.4
1	12		6.5		7.3	11.9

Rational Method

36 min

			Q10		Q15		Q100	
Ra	infall int	ensity		61.7		71.9	ç	97.5
Pe	ak Flow	Rate, Q :		3.18		3.71	Ľ,	5.02

Catchment 2

Determine peak flow rate with variety of methods Determine runoff volume for pond sizing calculations

SCS Method

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

	Soil name and								
	classification		(cover type, treatmen plogic condition)	it, and	Curve Number CN*	Area (hectares)	Product of CN x Area		Product
	F	Pervious Areas (List)							
	Class C soils	Open Spac	e (Good Conditon)		65	0.233	15		0.00
	Class D soils	Open Spac	e (Good Conditon)		73	3.756	274		0.00
	Class D soils	Rural			77	2.852	220		0.00
			Subtotal for Pervious Areas	3	74.39553	6.840	509		0.00
		mpervious Areas (List)						
	Class C soils	Residential	district 1/4 acre size		83	1.127	94		0.00
	Class D soils	Residential	district 1/4 acre size		87	21.549	1,875		0.00
	Class D soils	Residential	district 1/8 acre size		92	3.676	338		0.00
			Subtotal for Impervious Are	as		26.353	2,307		0.00
	* from Table 3.3				Totals	33.193	2,815		0.00
	CN (weighted) :	<u>total product</u> total area	=	2,815 33.193	=	84.82		0.0000	
			Weighted CI	N Pervious	=	74.40			
			Weighted CN I	Impervious	=	87.53			
2.	Time of Concentration	n							
	Time of Concentration	t _c =				0.32	hrs	18.99 m	n
	SCS Lag for HEC-HMS	S: t _p =	0.6 t _c		=	0.19	hrs	11.39346 m	in
3.	Soil Storage Parameter	er: S=	((1000/CN)-10)*25.4	Total	=	45.5	mm		
				Pervious	=	87.4	mm		
				Impervious	=	36.2	mm		
4.	Initial Abstraction								
	Initial abstr	raction - Pervious		la = 0.2S	=	17.48			
	Initial abstr	raction - impervious		la = 0.2S	=	7.24			

above parameters used in SCS method analysis in HEC HMS

5. Rainfall data

Using Region-specific temporal patterns produced in HIRDS v4 by NIWA for 1 hour, 6 hour and 12 hour storm durations **RCP8.5**

5. Results

Pre-Development

Results		Peak	Disch	arge (m3/s)	
hr		Q10		Q15		Q100	
:	1		3.6		4.1		7.3
(5		3.0		3.2		4.7
12	2		1.8		1.9		3.0

Rational Method

			Q10		Q15		Q100
19 min	Rainfall int	ensity		81.7		95.3	129.5
	Peak Flow	Rate, Q :		0.00		0.00	0.00

Catchment 3

Determine peak flow rate with variety of methods Determine runoff volume for pond sizing calculations

SCS Method

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

						SCS Metho	d	Rational M	ethod
	Soil name and classification		n (cover type, treatmer ologic condition)	nt, and	Curve Number CN*	Area (hectares)	Product of CN x Area	С	Product
		Pervious Areas (List)							
	Class D soils	Open Spa	ce (Good Conditon)		65	1.210	79		0.00
	Class D soils	Rural			77	20.631	1,589		0.00
			Subtotal for Pervious Areas	3		21.842	1,667		0.00
		Impervious Areas (Lis	,						
	Class D soils	Residentia	l district 1/8 acre size		92	0.855	79		0.00
			Subtotal for Impervious Are	as		0.855	79		0.00
* from	Table 3.3			l	Totals	22.697	1,746		0.00
CN (weighted) :	<u>total produc</u> total area	<u>zt</u> =	1,746 22.697	=	76.93		0.0000	
			Weighted Cl	N Pervious	=	76.33			
			Weighted CN		=	92.00			
2. Time	e of Concentratio	on							
Time	e of Concentration	t _e =				0.30	hrs	17.81	min
SCS	Lag for HEC-HM		0.6 t _c		=	0.18	hrs	10.68797	min
3. Soil	Storage Parame	ter: S=	((1000/CN)-10)*25.4	Total	=	76.2	mm		
				Pervious	=	78.7	mm		
				Impervious	=	22.1	mm		
4. Initia	al Abstraction								
	Initial abst	traction - Pervious		la = 0.2S	=	15.75			D-
	Initial abst	traction - impervious	3	la = 0.2S	=	4.42			

above parameters used in SCS method analysis in HEC HMS

5. Rainfall data

Using Region-specific temporal patterns produced in HIRDS v4 by NIWA for 1 hour, 6 hour and 12 hour storm durations **RCP8.5**

5. Results

Pre-Development

Results		Peak	Peak Discharge (m3/s)					
hr		Q10		Q15		Q100		
:	1		1.5		1.7		3.6	
(5[1.7		1.9		2.9	
12	2		1.0		1.1		1.9	

Rational Method

			Q10		Q15		Q100
18 min	Rainfall intensity	ensity		84.1		98.1	133.3
	Peak Flow Rate, Q :			0.00		0.00	0.00

Catchment 4

Determine peak flow rate with variety of methods Determine runoff volume for pond sizing calculations

SCS Method

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

	er (CN) and initial Abs		[SCS Metho	d	Rational M	ethod
Soil name and classification		(cover type, treatmen ologic condition)	it, and	Curve Number CN*	Area (hectares)	Product of CN x Area	С	Product
	Pervious Areas (List)							
Class B soils	Pasture (Fa	air Condition)		69	0.776	54	0.00	0.00
Class D soils	Pasture (Fa	air Condition)		84	1.029	86	0.00	0.00
Class D soils	Shrubland	(Fair Condition)		77	0.821	63	0.00	0.00
Class B soils	Open Spac	e (Good Conditon)		48	0.263	13		0.00
Class D soils	Open Spac	e (Good Conditon)		73	0.404	30		0.00
Class D soils	Rural			77	17.825	1,373		0.00
		Subtotal for Pervious Areas			21.118	1,618		0.00
		<u>, </u>						
Class B soils	Impervious Areas (List	/		03	0.000			0.00
Class B solls Class D soils	Commercia			92	0.002	0		0.00
Class D soils Class B soils	Commercia	u district 1/8 acre size		95	0.048	5		0.00
Class D soils		district 1/8 acre size		85	1.075	91		0.00 0.00
Class D solis	Residential	uistrict 1/6 acre size		92	12.569	1,156		0.00
		Subtotal for Impervious Are	as		13.694	1,252		0.00
* from Table 3.3				Totals	34.811	2,870		0.00
CN (weighted) :	<u>total product</u> total area	=	2,870 34.811	=	82.45		0.0000	
		Weighted CI	N Pervious	=	76.61			
		Weighted CN		=	91.46			
2. Time of Concentration	on							
Time of Concentration	n t _e =				0.32	hrs	19.06	min
SCS Lag for HEC-HM	IS : t _p =	0.6 t _c		=	0.19	hrs	11.43574	min
3. Soil Storage Parame	eter: S =	((1000/CN)-10)*25.4	Total	=	54.1	mm		
			Pervious	=	77.5	mm		
			Impervious	=	23.7	mm		
4. Initial Abstraction								
	traction - Pervious		la = 0.2S	=	15.51			
Initial abs	traction - impervious		la = 0.2S	=	4.74			

above parameters used in SCS method analysis in HEC HMS

5. Rainfall data

Using Region-specific temporal patterns produced in HIRDS v4 by NIWA for 1 hour, 6 hour and 12 hour storm durations **RCP8.5**

5. Results

Pre-Development

Results		Peak	Peak Discharge (m3/s)					
hr		Q10		Q15		Q100		
:	1		3.3		3.8		7.0	
(6		2.9		3.2		4.7	
1	2		1.7		1.9		3.1	

Rational Method

			Q10		Q15		Q100
19 min	Rainfall int	ensity	8	81.6		95.2	129.3
	Peak Flow Rate, Q :		(0.00		0.00	0.00

Catchment 5a

Determine peak flow rate with variety of methods Determine runoff volume for pond sizing calculations

SCS Method

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

	Runon Curve Numb					SCS Metho	d	Rational M	ethod
	Soil name and classification		n (cover type, treatmer ologic condition)	nt, and	Curve Number CN*	Area (hectares)	Product of CN x Area	С	Product
		Pervious Areas (List)							
	Class B soils	Pasture (F	air Condition)		69	0.005	0	0.00	0.00
	Class D soils	Pasture (F	air Condition)		84	0.800	67	0.00	0.00
	Class B soils	Open Spa	ce (Good Conditon)		48	0.877	42		0.00
	Class D soils	Open Spa	ce (Good Conditon)		73	1.834	134		0.00
			Subtotal for Pervious Areas	s		3.516	244		0.00
		Impervious Areas (Lis	it)						
	Class B soils	Commerci	al		92	0.244	22		0.00
	Class D soils	Commerci	al		95	0.081	8		0.00
	Class D soils	Residentia	l district 1/4 acre size		87	2.485	216		0.00
	Class B soils		l district 1/8 acre size		85	0.333	28		0.00
	Class D soils	Residentia	l district 1/8 acre size		92	3.972	365		0.00
			Subtotal for Impervious Are	eas		7.115	640		0.00
	* from Table 3.3				Totals	10.630	884		0.00
	CN (weighted) :	<u>total produc</u> total area	<u>st</u> =	884 10.630	=	83.11		0.0000	
			Weighted C	N Pervious	=	69.26			
			Weighted CN	Impervious	=	89.96			
2.	Time of Concentrati	on							
	Time of Concentration	n t _c =				0.52	hrs	31.36	min
	SCS Lag for HEC-HM	1S : t _p =	0.6 t _c		=	0.31	hrs	18.81386	min
3.	Soil Storage Parame	eter: S=	((1000/CN)-10)*25.4	Total	=	51.6	mm		
				Pervious	=	112.7	mm		
				Impervious	=	28.3	mm		
4.	Initial Abstraction								
	Initial abs	traction - Pervious			=	22.546			
	Initial abs	traction - impervious	i	la = 0.2S	=	5.669			

above parameters used in SCS method analysis in HEC HMS

5. Rainfall data

I

Using Region-specific temporal patterns produced in HIRDS v4 by NIWA for 1 hour, 6 hour and 12 hour storm durations RCP8.5

Rational Method

31 min

		Q10	Q15		Q100	
Rainfall int	ensity	65	.3	76.1	103.2	
Peak Flow	Rate, Q :	0.0	00	0.00	0.00	

Catchment 5b

Determine peak flow rate with variety of methods Determine runoff volume for pond sizing calculations

SCS Method

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

	Runon Curve Numbe			[SCS Metho	b	Rational M	ethod
	Soil name and classification		n (cover type, treatmer plogic condition)	nt, and	Curve Number CN*	Area (hectares)	Product of CN x Area	С	Product
		Pervious Areas (List)							
	Class B soils	Pasture (F	air Condition)		69	0.197	14	0.00	0.00
	Class D soils	Pasture (F	air Condition)		84	0.008	1	0.00	0.00
	Class B soils	Open Spac	ce (Good Conditon)		48	2.638	127		0.00
			Subtotal for Pervious Areas	5		2.843	141		0.00
		Impervious Areas (Lis	t)						
	Class B soils		l district 1/8 acre size		85	3.112	265		0.00
	Class D soils	Residentia	l district 1/8 acre size		92	0.305	28		0.00
			Subtotal for Impervious Are	eas		3.417	293		0.00
	* from Table 3.3			l	Totals	6.260	433		0.00
	CN (weighted) :	<u>total produc</u> total area	<u>t</u> =	433 6.260	=	69.24		0.0000	
			Weighted C	N Pervious	=	49.55			
			Weighted CN	Impervious	=	85.62			
2.	Time of Concentratio	n							
	Time of Concentration	t _c =				0.00	hrs	0.00	min
	SCS Lag for HEC-HMS	S : t _p =	0.6 t _c		=	0.00	hrs	0	min
3.	Soil Storage Paramet	er: S=	((1000/CN)-10)*25.4	Total	=	112.8	mm		
				Pervious	=	258.6	mm		
				Impervious	=	42.6	mm		
4.	Initial Abstraction								
		raction - Pervious			=	51.718			
	Initial abst	raction - impervious		la = 0.2S	=	8.529			

above parameters used in SCS method analysis in HEC HMS

5. Rainfall data

Using Region-specific temporal patterns produced in HIRDS v4 by NIWA for 1 hour, 6 hour and 12 hour storm durations **RCP8.5**

5. Results (Full Catchment 5)

Pre-Development

Results		Peak	Peak Discharge (m3/s)					
hr		Q10		Q15		Q100		
	1		1.2		1.4		2.5	
	6		1.3		1.4		2.1	
1	.2		0.8		0.8		1.3	

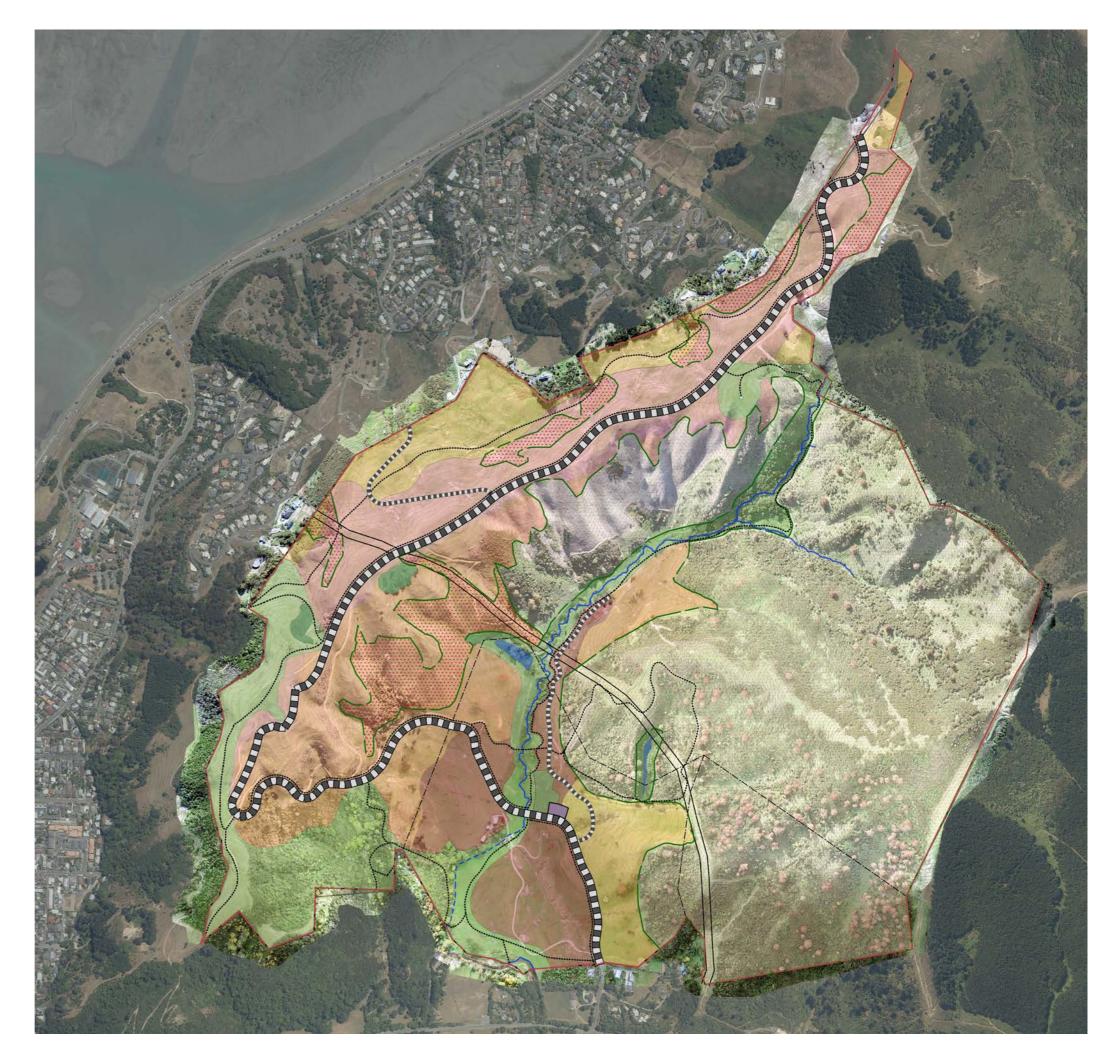
Rational Method

			Q10	Q15	Q100
0 min	Rainfall int	ensity	0.0	0.0	0.0
	Peak Flow	Rate, Q :	0.00	0.00	0.00

Proposed Structure Plan (Over Aerial)

egend	
	Residential Zone
	Residential Zone Higher Density Area
	Residential Zone Lower Density Area
	Residential Zone Lower Density Backdrop Area
	Open Space Recreation Zone
	Suburban Commercial Zone
	Rural Zone
	Higher Density Small Holdings Area
	Neighborhood Reserve
	Indicative Road
[<u>``</u> .	Indicative Walkway/ Cycleway Link
0	Indicative Lookout Locations
	Wetland
~	Existing Stream
N./	Proposed Stream
\sim	Site Boundary
\sim	Internal Cadastral Boundaries
\sim	Secondary Roads
\sim	Network Tasman Limited Corridor - No Earthworks
	Residential Green Overlay
	Revegetation Overlay In Rural Zone
	Kanuka Vegetation and Kahikatea Tree to be Protected

Scale 1:10000@A3



MORPHUM environmental

Memorandum

Date:	[Publish Date]
То:	Neil Donaldson (CCKV Maitai Dev Co LP and Bayview Nelson Ltd)
From:	Stu Farrant
CC:	Maurice Mills (Tonkin & Taylor)
Project Number:	Project Number
Reviewed by:	Mark Lowe
Released by:	Caleb Clarke

Subject: Preliminary water management summary for SMP

Morphum were previously engaged to undertake a *Preliminary Structure Plan Environmental Review* (report dated 13/04/2021). This included 18 recommended principles which were adapted to form the basis of X9 principles and recommendations around how development related stormwater could be managed in a manner which protects the receiving environments from adverse impacts related to water quality and quantity. This supporting report should be referred to for further context.

At this stage of the development planning, no formal development typologies, urban design layouts or stormwater network design has been undertaken which would support more refined sub catchment analysis to inform the SMP. Therefore, a number of assumptions and committed development approaches are instead provided to define how the development will be progressed in a manner which protects the existing ecosystem function and enables restoration activities to enhance values. These approaches and assumptions are outlined in this memorandum with resulting spatial footprints which will need to be incorporated into design development in an integrated manner when it commences. All catchment delineation and estimates of imperviousness are based on catchment analysis undertaken by Tonkin & Taylor to inform their flood flow estimation. It is noted that these assumptions are considered conservative (given the topographical constraints that will limit developable land) with an expectation that spatial footprints for consolidated stormwater treatment devices will be reduced in later stages based on comprehensive water/contaminant balance modelling. Calculated footprints were increased by a factor of 30%.

Maitahi Development approach

The following points summarise the approach to land development which will have a direct influence on site wide stormwater planning.

- 1. All dwellings to include rainwater capture with reuse to service internal and external non potable demands to intercept an initial volume of runoff as a surrogate for naturally occurring evapotranspiration losses. This will include internally plumbed tanks which augment reticulated mains supply for fit for purpose non potable demands including toilet flushing, cold water laundry and external uses as a minimum. Modelling shall be undertaken to develop relationship between roof area and tank size to support an average of 80% reliability of supply and a reduction of roof runoff of at least 60% mean annual volume. This equates to an initial retention depth of between 5 10 mm which will be realised across the majority of daily timesteps and in particular will be met during summer conditions when stream flows are reduced and vulnerable to flashy inflows of contaminated stormwater. Development specific design guidelines will define required tank sizes for a range of connected roof areas.
- 2. All dwellings on suitable ground will include infiltration via porous manholes positioned to receive runoff from driveways and overflow from rainwater tanks. These will be sized based on relationship with roof area (and rainwater harvest) to provide a combined initial retention depth of approximately 10 mm. It is noted that this will only be suitable for dwelling on lower parts of the development due to the risk of ground instability and uncontrolled seepages to downslope properties from higher lots.
- 3. Stormwater sub catchments to be managed with 'traditional' pipe networks to collect excess flows from lots and runoff from roads. Sub catchment stormwater to be managed via consolidated treatment devices to mitigate impacts prior to discharge to any natural waterway or pipe networks which flow beyond the development boundary. Treatment devices will include;
 - a. Consolidated raingardens designed with internal storage and infiltration to shallow groundwater. These can be integrated within the proposed Kaka Stream esplanade (where suitable) or in dispersed parklets which support community connection with water management and support amenity, urban ecology and education. These will be designed with careful consideration of lifecycle maintenance. Raingardens will all be offline to full pipe flow with appropriately design bypass although flood attenuation can be accommodated above the operational water level as required.
 - b. Consolidated constructed wetland designed to be integrated into green spaces and provide a high level of water quality treatment. These will be integrated within the proposed Kaka Stream esplanade, in particular on the lower terrace alongside the realigned channel reach. High quality constructed wetlands will support community connection with water management and support amenity, urban ecology and education. Consideration will be given to options to harvest treated water from wetlands to augment irrigation of high amenity planted gardens, community gardens or irrigation of parks. These will be designed with careful consideration of lifecycle maintenance. Raingardens will all be offline to full pipe flow with appropriately design bypass although flood attenuation can be accommodated above the operational water level as required.
 - c. Passive irrigation of integrated green infrastructure such as street trees, verge planting and restoration planting. Careful design of any passive irrigation will need to ensure that peak flows are appropriately managed to prevent uncontrolled overland flow whilst enabling frequent small rainfall events to support healthy urban greenery with benefits in biodiversity, evapotranspiration and micro climate.

It is noted that modelling has provided recommendations for the required land area for both raingardens and wetlands (i.e. treatment requirements duplicated). In reality the final development design will include either one of the two devices or a combination in response to site conditions.

Maitahi Development assumptions

The following assumptions have been used to inform the nominated preliminary size of required devices in the SMP (refer Tonkin & Taylor).

- 1. Sub catchment delineated based on existing hydrologic catchments. These were delineated by T&T and are consistent with their reporting.
- 2. Residential development types (as proposed in structure plan) used to infer imperviousness which was then agglomerated across the sub catchment to give an estimated impervious area for developable land within each sub catchment. Non development land (rural, open space etc) excluded for the purposes of water quality.
- 3. Residential roofs (connected to rainwater tanks) assumed to comprise 50% of impervious cover
- 4. Residential hardstand (driveways) assumed to be 20% of impervious cover
- 5. Roads assumed to be 30% of impervious cover (15% of total development catchment). Roads assumed to be 80% impervious within corridor
- 6. Roof runoff effectively mitigated for quantity and quality via appropriately sized rainwater reuse tanks
- 7. Hardstand runoff effectively managed for quantity and quality for 50% of lots
- 8. Raingardens sized at 2% of connected impervious catchments (increased by 30% to allow for batters etc). Raingardens to be modelled to demonstrate ability to pass 80-85% of mean annual volume through filter media with underlying saturated zone and infiltration to be refined to meet overall groundwater recharge aspirations,
- 9. Wetlands sized at 4.5% of connected impervious catchments (increased by 30% to allow for batters etc). Wetlands to be modelled to demonstrate ability to pass 80-85% of mean annual volume through wetland with extended detention included. Further detention of flows may be achievable via harvest of a portion of treated stormwater.

Table 1 shows the summary of catchment landuse breakdowns and the resulting required footprint to manage site generated stormwater. It is noted that the reported footprints for raingardens/wetlands are for either of these options (i.e. will not need combined total) and the distribution of these is expected to be split into more than one device per sub catchment. The final selection of optimal treatment devices, layout and distribution will be developed in close co-ordination with urban designers, landscape architects, civil designers and Geotech.

Stu Farrant Water Sensitive Design Lead Morphum Environmental Ltd Phone: 021 578904 <u>stu.farrant@morphum.com</u>

Sub- catchment	Combined Developed Area (m ²)	Impervious %	Sum of Impervious Area (m²)	Assumed roof area (m²)	Managed Hardstand (m²)	Un-managed hardstand (m²)	Road impervious (m ²)	Raingarden Area (m²)	Wetland Area (m²)
1	834,081	19%	158,475	79,238	15,848	15.946	25,356	1,071	2,410
2	297,879	42%	125,109	62,555	12,511	12,511	20,017	846	1,903
3	216,558	30%	64,967	32,484	6,497	6,497	10,395	439	988
4	318,538	39%	124,220	62,115	12,423	12,423	19,877	840	1,890
5A	72,291	57%	41,206	20,603	4,121	4,121	6,593	279	627
5B	34,302	65%	22,296	11,148	2,230	2,230	3,567	151	339
and Total	1,773,649		536,284	268,142	53,628	53,628	85,805	3,625	8,157

NOTE THIS TABLE HAD BEEN SUPERSEDED BY TABLE 5.3 IN THE MAIN BODY OF THE STORMWATER MANAGEMENT PLAN

	+ +	+	+	+ -	+ -	+	
	+ +	+	+	+ -	+ ·	+	
	+ +	1	+	÷ .	. .	+	
		1	1				
	+ +	+	+	+ -	+ -	+	
	+ +	+	+	+ -	+ ·	+	
	+ +	+	+	+ -	+ -	+	
	+ +	+	+	+ -	+ -	+	
	+ +						
	т т	- T	- T	- T	T	Ŧ	
	+ +	+	+	+ -	+ -	+	
	+ +	+	+	+ -	+ ·	+	
	+ +	-	+	÷ .	T .	+	
	+ +	+	+	+ -	+ -	+	
	+ +	+	+	+ -	+ ·	+	
	+ +			+ -			
	+ +	+	+	+ -	+ ·	+	
	+ +	+	+	+ -	+ -	+	
	+ +	+	+	+ -	+ -	+	
				+ -			
	+ +	+	+	+ -	+	+	
	+ +	+	+	+ -	+ •	+	
	+ +	+	+	+ -	+ ·	+	
	1 A		+			_	1
	+ +	+	+	+ -	T .	т	
	+ +	+	+	+ -	+ -	+	
							1
	+ +	+	+	+ -	+	+	
	+ +	+	+	+ -	+	+	
	+ +	+	+	+ -	+ -	+	
	· *	<u> </u>	1	1	<u> </u>	•	
	+ +	+	+	+ -	+ -	+	
	+ +	+	+	+ -	+ ·	+	
	+ +						
	т т	- T	- T		T	Ŧ	
	+ +	+	+	+ -	+ -	+	
	+ +	+	+	+ -	+	+	
	+ +						
	+ +	+	+	+ -	+	+	
	+ +	+	+	+ -	+ -	+	
	+ +	+	+	+ -	+ -	+	
	+ +	+	+	+ -	+ ·	+	
	+ +	+	+	+ -	+ -	+	
	+ +	+	+	+ -	+ -	+	
	+ +	+	+	+ -	+ ·	+	
	+ +	+	+	+ -	÷ .	+	
	+ +	+	+	+ -	+	+	
	+ +	+	+	+ -	+	+	
	+ +	+	+	+ -	+ -	+	
	+ +	+	+	+ -	+ ·	+	
						т.	
	+ +	- T	T		T .	Ŧ	
	+ +	+	+	+ -	+ -	+	
	+ +	+	+	+ -	+ ·	+	
	÷ +	+	+	+ -	+ -	+	
	· +	+	Ŧ		<u> </u>		
	+ +	+	+	+ -	+	+	
	+ +	+	+	+ -	+ ·	+	
	+ +	+	+	+ -	+ -	+	
		1	1				
	+ +	+	+	+ -	+	+	
			1.1				
	+ +	+	+	+ -	+	т	1
	+ +	+	+	+ -	+ -	+	
	+ +	+	+	+ -	+	+	1
	+ +	+	+	+ -	+	+	
	+ +	+	+	+ -	+ -	+	1
	1	1	1				
	+ +	+	+	+ -	+ -	+	
			1.1				
	+ +	+	+	+ -	T	т	
	+ +	+	+	+ -	+ -	+	1
	+ +	+	+	+ -	+	+	
	1 A		+				1
	+ +	+	+	÷ .	T .	т	
	+ +	+	+	+ -	+ -	+	
	1		1				
	+ +	+	+	+ -	+ ·	+	
	1 A					L	
	r +	+	+	т - Т	r	т	
	+ +	+	+	+ -	+ -	+	
www.tonkintaylor.co.nz							
	+ +	+	+	+ -	+ ·	+	
	+ +	+	+	+ -	+ -	+	
		1	1				
	+ +	+	+	+ -	+ -	+	
						+	

+ + +

+ +

4