STORMWATER MANAGEMENT DESIGN BRIEF
WANDER THE RESORT

February 23, 2024

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1 Background

Jewell Engineering Inc. (Jewell) was retained by Wander the Resort to assist with the proposed Official Plan Amendment (OPA) and severances. The subject lands are located at 15841 Loyalist Parkway in Bloomfield Ontario.

The property is approximately 2 ha and features 10 resort cottages, a spa/reception building, pool area, and parking facilities. The site is located approximately 3km east of Wellington and 6.5km west of Bloomfield as shown in the Figure 1-1.

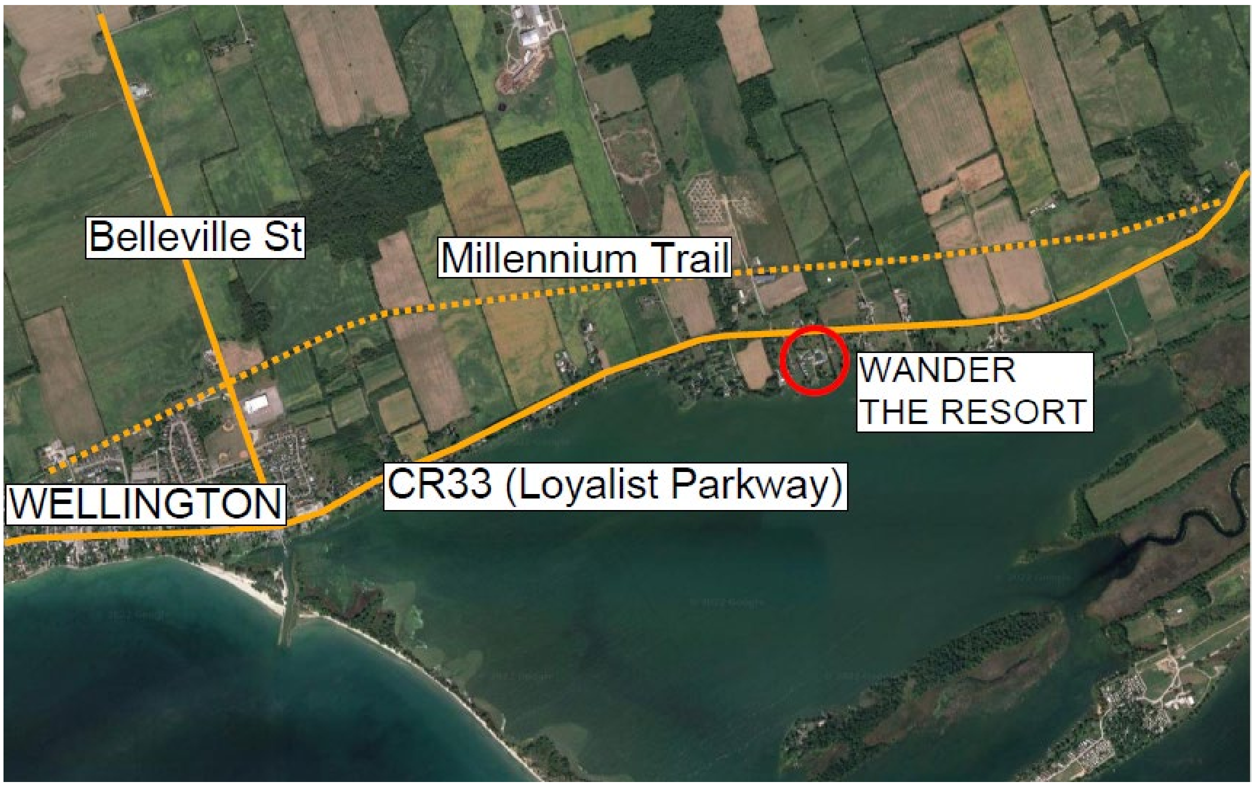

Figure 1-1: Site Location

The lands primarily drain southeast through grass and sand surfaces towards West Lake. The site is composed of grassy areas with buildings, driveways, gravel roads, and a beach. The site has an existing impervious area of approximately 30%.

The proposed development includes:

- 8 new resort cottages,
- Road improvements to add parking and provide access to the new cottages,
- a spa.

The site will maintain its existing drainage pattern through grassy and sandy areas ultimately discharging to West Lake.

2 Drainage

The newly developing areas will drain to one of two drainage routes – the west route and the east route.

2.1 West Route – Catchment 1

The west route will receive the surface hardening from Catchment 1. This includes the roadway and parking that will collectively have the surface treatment shown in Table 2-1.

The surfacing replaces 1,500m^2 of existing gravel and 300m^2 of grass. The existing runoff coefficient of the Catchment 1 is calculated in Table 2-1 as 0.54 and the coefficient will increase to 0.85 in the proposed conditions.

Table 2-1: Landcover Contributing to West Route with Weighted Runoff Coefficient

Surface	Pre	R.C.	Post	R.C.
	m^2		m^2	
Grassed	304	0.25	26	0.25
Gravel	1490	0.6	469	0.6
Patio	0	0.95	131	0.95
Asphalt	0	0.95	1164	0.95
Total	1794	**0.54**	1790	**0.85**

The west route will drain to a grassed swale situated along the west side of the gravel portion of the road. Drainage from the asphalted surface will discharge to a 2m x 4m sump where grit will be collected and then into the grassed swale. Drainage from the gravel portion will drain laterally into the swale.

2.2 East Route

The east route features an enhanced swale to be constructed south of the cul-de-sac along the east property line. The enhanced swale will be vegetated similar to a Rain Garden. Drainage will first be received by a sump that will capture the larger sediment fraction and then will pass to the enhanced swale. The enhanced swale will terminate at the gazebo area, but a smaller swale will convey flows that do not infiltrate past the bar and discharge toward the sand approximately 25m from the water’s edge.

It will receive drainage from the east parking area and driveway (Catchment 2). In addition, the internal lands (Catchment 3) will also drain through this swale as well as pumped discharge from the spa area. Each is discussed below.

2.2.1 Catchment 2 – Road

The existing land cover within Catchment 2 is mostly gravel and some grass. The new road surface will be asphalt. The surface hardening is increased from a weighted runoff coefficient of 0.51 to 0.94.

Table 2-2: Landcover Contributing to East Route from Catchment 2 with Weighted Runoff Coefficient

Surface	Pre	R.C.	Post	R.C.
	m^2		m^2	
Grassed	621	0.25	22	0.25
Gravel	1817	0.6	0	0.6
Asphalt	0	0.95	2416	0.95
Total	2438	**0.51**	2438	**0.94**

2.2.2 Catchment 3 – Central Area

The central area is bounded by the road on the north, east and south sides. It will contribute drainage to the proposed enhanced swale. The central area will see some surface hardening with the addition of eight new cabins and associated walkways. The walkways will be constructed of asphalt pavers that will help to minimize runoff impacts.

The total area of the eight new cabins is 616m^2 and area of the walkways is 759m^2. This will increase the weighted runoff coefficient of the central area from 0.47 to 0.56.

Table 2-3: Landcover Contributing to East Route from Catchment 3 with Weighted Runoff Coefficient

Surface	Pre	R.C.	Post	R.C.
	m^2		m^2	
Grassed	3087.5	0.25	2398	0.25
Gravel	686	0.6	0	0.6
Concrete	652.5	0.95	652.5	0.95
Pavers	0	0.6	759	0.6
Building	574	0.95	1190	0.95
Total	5000	**0.47**	5000	**0.56**

2.2.3 Spa

Although the spa area is not located within the Catchment 3 area, there will be pumped discharge from the outdoor spa contributing to the enhanced swale.

The area of the spa is approximately 600m^2 and is proposed to be constructed below grade. It is also open to the environment. Precipitation falling over the spa will fall into the pools and also onto hard surfaces. The portion falling onto the pools will be retained by the pools. The portion falling onto the hard surfaces will need to be pumped out. Approximately 400m^2 of the spa hard surfaces will contribute to runoff.

3 Site Design Features – Low Impact Development

The Wander site plans incorporate design features that will reduce the overall imperviousness and drainage impacts. These include green roofs, porous pavers (sidewalks) and raised cabins over parking areas. Each is discussed below.

3.1 Grassed Lined Conveyance Routes

Drainage conveyance will primarily be provided using grassed swales. These are very simple, but effective techniques to encourage infiltration of low intensity runoff events. Grassed swales impose green surfaces on the landscape that otherwise may be hard surfaced if storm sewer systems are used.

3.2 Sidewalk Pavers – Porous Pavement

The walkways will be finished with concrete pavers that will permit infiltration of precipitation in the gaps, which will be filled with sand. This porous pavement strategy is preferred over concrete or asphalt sidewalks as a low impact design feature. The porous pavement reduces the area of the property that contributes to peak flows and reduces the impact on water quality.

The porous paver drawings are included within the Architectural and Landscape drawings.

4 Quantity and Quality Controls

This section discusses the overall stormwater management approach with regard to quantity and quality controls.

4.1 Quantity Control

Quantity controls can be used to limit peak flows to pre-development levels to ensure rainfall events have no negative effect on downstream areas. These controls can include on-site storage to attenuate the increased runoff volume.

The resort naturally drains south via sheet flow to West Lake and **no quantity controls are required.**

4.2 Stormwater Quality

The site plan includes low impact development features intended to reduce overall imperviousness and impacts to water quality. These include the green roof and porous pavement discussed in Section 3.

There will still be some overall increase to the surface hardening in the proposal and therefore **quality controls are required**.

JE reviewed several technologies to provide some remedial water quality treatment. The site grades and limitations due to the West Lake flooding elevation are not conducive for installation of storm sewer systems. Additionally, the site will be serviced by private septic systems that take considerable amounts of the available green space. This leaves little opportunity for infiltration technologies that require considerable land assignment. Instead, surface treatment technologies are preferred.

Enhanced grassed swales are recommended to achieve *Enhanced* treatment objectives. JE designed these facilities based on the guidance provided in the following documents.

- *2010 Low Impact Development Planning and Design Guide*, prepared by Credit Valley Conservation (CVC) and Toronto and Region Conservation Authority (TRCA)
- *2003 SWM Planning and Design Guide*, prepared by the Ontario Ministry of the Environment
- *2012 Stormwater Management Criteria*, prepared by TRCA

The following subsections describe the proposed technologies in more detail.

As discussed in Section 2, two drainage routes are proposed. Each of the routes will provide some water quality improvement. Both routes are discussed below.

4.2.1 West Route – Enhanced Grassed Swale

The west route features a roadside swale that will convey flows south toward West Lake. The swale will, however, not connect to West Lake, but will end at the sand beach. The overall length of the swale is 39m and the depth is 0.2m. The bottom of the swale is enhanced with clear stone and filter fabric to improve infiltration into the underlying sandy soils.

The swale is designed to provide quality treatment and also to convey the 100-yr peak flow.

Quality Treatment

The water quality event is estimated using the Equation 4.9 from the design manual. The equation estimates the rainfall intensity that is supplied to the Rational Method.

$$i = 43C + 5.9$$

Where:

i = rainfall intensity in mm/hr
C = runoff coefficient

The weighted runoff coefficient for Catchment 1 is 0.85. The calculated intensity is **42.5mm/hr**.

The grassed swale is acceptable for water quality treatment for catchment areas less than 2ha. The area contributing to the swale is approximately 0.179ha.

Quality peak flow for the Catchment 1 is found using the Rational Method to be **0.018cms** (See Appendix C). This is less than the 0.15cms limit recommended in the manual and therefore an enhanced grassed swale is an acceptable alternative.

Using the open channel flow equation, we found that the peak quality flow would have a depth of approximately 0.12m in the given channel configuration and a velocity of 0.42m/s (see Appendix B). This assumes a slope of 1.0% and a Mannings n value of 0.035. The quality swale velocity is less than the upper limit of 0.5m/s recommended in the design manual.

The swale design summary is provided in Table 4-1 indicating the proposed swale satisfies the minimum requirements for water quality treatment design and satisfies the *Enhanced* treatment objective.

Table 4-1: West Drainage Route Summary

Surface	Design Objective	Provided	Satisfied
Area	< 2ha	0.179ha	Yes
Flow	< 0.15m^3/s	0.018m^3/s	Yes
Velocity	< 0.5m/s	0.42m/s	Yes
Length	> 20m	39	Yes

100-Yr Flow Capacity

The swale capacity must also be sufficient to convey the 100-yr event. Assuming the swale section with a V-shaped, 3:1 side slopes, 1.0% longitudinal slope and minimum 0.2m depth, one finds a capacity at full depth is 0.071cms (see Appendix B). This is in excess of the 0.051cms 100-yr peak flow. The swale has capacity to convey the 100-yr peak flows safely.

4.2.2 East Route – Enhanced Grassed Swale

Catchments 2 and 3 drain through the east swale. Additionally, the discharge from the spa will also drain through the east swale. The spa discharge rate is dependant upon the final pump selection, but has been estimated to be 0.016m^3/s, which is twice the peak flow rate into the sump pit.

The cross-section of this swale will be enlarged with a flat bottom. The overall length of the flat bottomed portion is 19m due to spatial constraints. This is 1m short of a typical minimum 20m. To compensate, an additional 15m of 0.3m deep V-shaped swale is also provided.

The contributing area to the swale from Catchment 2 is 0.24ha and from Catchment 3 is 0.50ha plus the small area from the spa (400m^2).

Quality Treatment

The water quality event is estimated using the Equation 4.9 from the design manual. The equation estimates the rainfall intensity that is supplied to the Rational Method.

$$i = 43C + 5.9$$

Where:

i = rainfall intensity in mm/hr
C = runoff coefficient

The weighted runoff coefficient for Catchments 2 and 3 is 0.68 (see Appendix B). The calculated intensity is **35.3mm/hr**.

The area contributing to the swale is approximately 0.74ha. The quality peak flow is found using the Rational Method to be 0.050cms (See Appendix C). With the addition of the pumped portion (0.016cms) a peak quality flow of **0.066cms** is found. This is less than the 0.15cms limit recommended in the manual and therefore an enhanced grassed swale is an acceptable alternative.

Using the open channel flow equation, we found during the water quality event a modest depth of flow of approximately 0.07m in the given channel configuration with a corresponding velocity of 0.33m/s can be expected. This assumes a slope of 0.5% and a Mannings n value of 0.035. The quality swale velocity is less than the upper limit of 0.5m/s recommended in the design manual.

The swale design summary is provided in Table 4-1 indicating the proposed swale satisfies the minimum requirements for water quality treatment design and satisfies the *Enhanced* treatment objective.

Table 4-2: East Drainage Route Summary

Surface	Design Objective	Provided	Satisfied
Area	< 2ha	0.74ha*	Yes
Flow	< 0.15m^3/s	0.066m^3/s**	Yes
Velocity	< 0.5m/s	0.33m/s	Yes
Length	> 20m	19m + 15m	Yes

** With Spa area considered, this is increased to 0.78ha*
*** With Spa contribution of 0.016m^3/s*

Surface Treatment

The enhanced grass swale will be finished as a rain garden. The rain garden will provide water quality benefits through bioretention as outlined in the LID Design Guidelines. The surface will be completed with a 75mm layer of mulch to encourage vegetation growth. A conceptual cross section of the enhanced grass swale/rain garden is shown below.

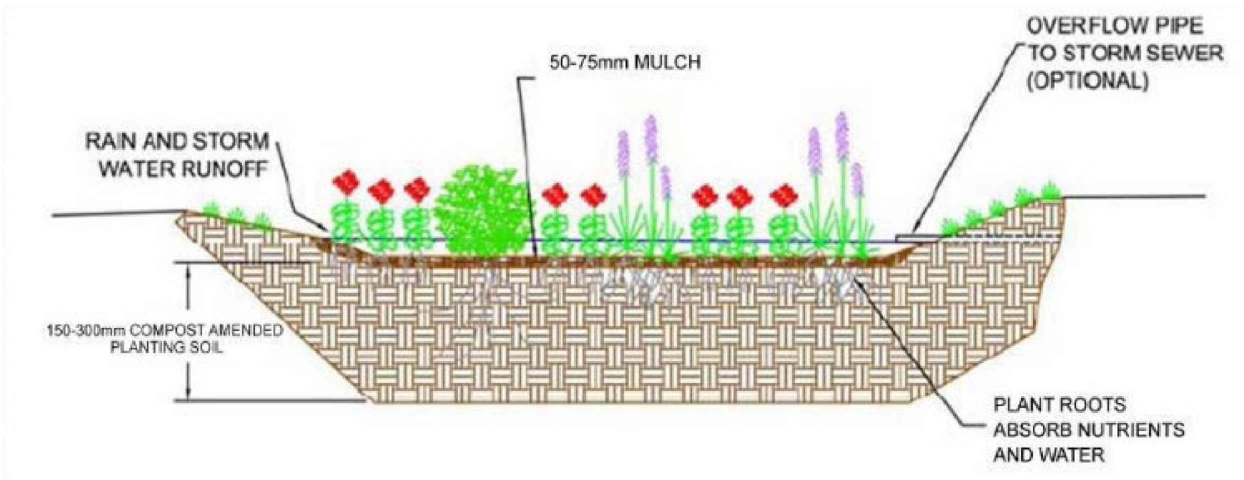

Figure 2-1: Enhanced Grass Swale/Rain Garden Cross Section

Sump

The effectiveness of the enhanced grassed swale will be improved with pre-treatment. A sump is provided for this purpose. The sump is simply a depressed area ahead of the swale that is lined with rock. It will collect the larger fraction of sediment allowing maintenance efforts to be focussed and reducing the frequency of sediment removal operations in the enhanced grassed swale. The sump will further reduce the annualized cost of any replanting and reinstatement of the grassed swale.

100-Yr Flow Capacity

The enlarged enhanced swale has a flow capacity of 0.41cms which exceeds the 100-yr peak flow of 0.168cms. The enhanced swale terminates in a smaller V-shaped swale that is 0.3m deep. The capacity of that section is 0.176cms. It is also sufficient to convey the expected 100-yr peak flows.

4.3 Summary

The anticipated water quality impacts from the proposed development may be mitigated to the MECP standard for *Enhanced* water quality treatment. Water quality treatment objectives will be met with a combination of enhanced grassed swales and low impact development technologies.

5 Erosion and Sediment Controls – During Construction

Site development results in the loss of some vegetated cover. While it is the intention to limit vegetation removal for the construction of the site improvements, exposed soils from the work will be at risk of eroding into the receiving drainage system. Light duty silt fences and straw bale check dams are thus proposed for the site and will be placed in all areas downgradient from the worksite to control sediment runoff. These measures will be required to be put in place to reduce erosion during construction and for a period of up to one year after construction is completed. Controls should also be placed around stockpiles of any construction materials.

Typical sediment and erosion control measures will be applied as required and include:

- Siltation fencing
- Strawbale check dams
- Rip-rap check dams

Typical OPSDs provide good instruction on the correct placement and construction of the controls. The controls provide some protection if they are properly maintained, but they should be considered last resort measures. The most effective means of control are those which prevent or reduce erosion at the source. This would include diligent stabilization of exposed areas immediately after grading is completed. Stabilization measures include sod, erosion blankets or rip-rap and filter cloth on steep slopes as well as topsoil and hydroseed on gently sloped areas (<10%).

6 Maintenance

The enhanced grassed swales, if working as designed, will collect sediment. A sump is provided at the upstream end of the east swale to assist with capture of the major grit fraction. The sump will concentrate sediment accumulation and maintenance staff can focus removal efforts at the sump instead of along the

A sump has not been proposed upstream of the west swale since drainage will enter the swale along its entire length. However, site operators may consider adding a rock lined sump if their experience with sediment removal suggests a benefit.

Quarterly

Grass mowing and weed control is typically recommended at least quarterly during the growing season. Since the Wander site will be finely landscaped and maintained, the swales may be mowed as frequently as desired.

Site operation staff should note any standing water or loss of stone material in the bottoms of the swales as this may indicate functional impairment. Major maintenance may be required.

Debris should be removed when encountered.

Infrequent (Major Maintenance)

Sediment will accumulate in the swales. For the east swale as sump has been provided that can help to focus sediment removal efforts within the swale. When sediment fills the sump, site operators should remove it with excavation equipment. Removed sediment may be dried on site and disposed in an acceptable receiving facility. Regulations for handling of sediment are outlined in O. Reg. 406/19. The east swale will require the bottom to be reinstated as shown in Figure 2-1.

The bottom of the west swale is completed with clear stone and filter fabric. Their purpose is to help encourage infiltration of stormwater into the underlying sands. But if the filter fabric becomes clogged, the infiltration benefits will be lost. This will be evidenced by standing water in the swale. In this event, the stone may be raked aside to expose the filter fabric which may be cut out and replaced. The fabric originally designed is Terrafix 270R. The stone may be replaced.

Records

It is helpful to maintain a record of inspections and this should include the date, name of operations staff, weather conditions over the past 48 hours and any observations and recommended corrective actions. Photographs of the facility are also helpful for documentation and for comparison.

7 Conclusion

Jewell studied the site and proposed development to review feasibility of servicing the proposed development with private servicing. The conclusions are as follows:

7.1 Quantity Control

No quantity controls are required due to the proximity of the site with West Lake. There will be no flooding impacts.

7.2 Quality Control

The site hardening results in an increase in site imperviousness is expected and any water quality degradation can be mitigated to the *Enhanced* water quality treatment target using the enhanced grass swales.

West Swale

The west swale is 39m long and is V-shaped. The bottom of the swale is enhanced with clear stone to encourage infiltration into the underlying sandy soil. The west swale treats Catchment 1. The swale meets the minimum requirements for Enhanced treatment.

Table 7-1: West Swale Summary

Surface	Design Objective	Provided	Satisfied
Area	< 2ha	0.179ha	**Yes**
Flow	< 0.15m^3/s	0.018m^3/s	**Yes**
Velocity	< 0.5m/s	0.42m/s	**Yes**
Length	> 20m	39	**Yes**

East Swale

The east swale treats Catchments 2 and 3 as well as any drainage discharged from the outdoor spa. The swale has an enlarged cross section for the first 19m with a 2.75m bottom width. The second portion of the swale is 15m long and is narrowed into a shallow V-bottom shape due to site constraints.

Table 7-2: East Swale Summary

Surface	Design Objective	Provided	Satisfied
Area	< 2ha	0.74ha*	**Yes**
Flow	< 0.15m^3/s	0.066m^3/s**	**Yes**
Velocity	< 0.5m/s	0.33m/s	**Yes**
Length	> 20m	19m + 15m	**Yes**

7.3 100-Yr Conveyance

The west swale has sufficient capacity to convey the 100-yr event. Calculations show that a 0.2m deep V-shaped swale at 1% slope has a capacity of 0.071cms, which is sufficient to convey the 100-yr peak flow of 0.051cms.

The east swale will have a capacity of 0.41cms, which exceeds the 100-yr peak flow of 0.168cms. The second stage swale has a capacity of 0.176cms.

Site drainage will be safely managed through the proposed drainage system.

The stormwater management objectives are achieved.

Bryon Keene, P. Eng
Jewell Engineering Inc.

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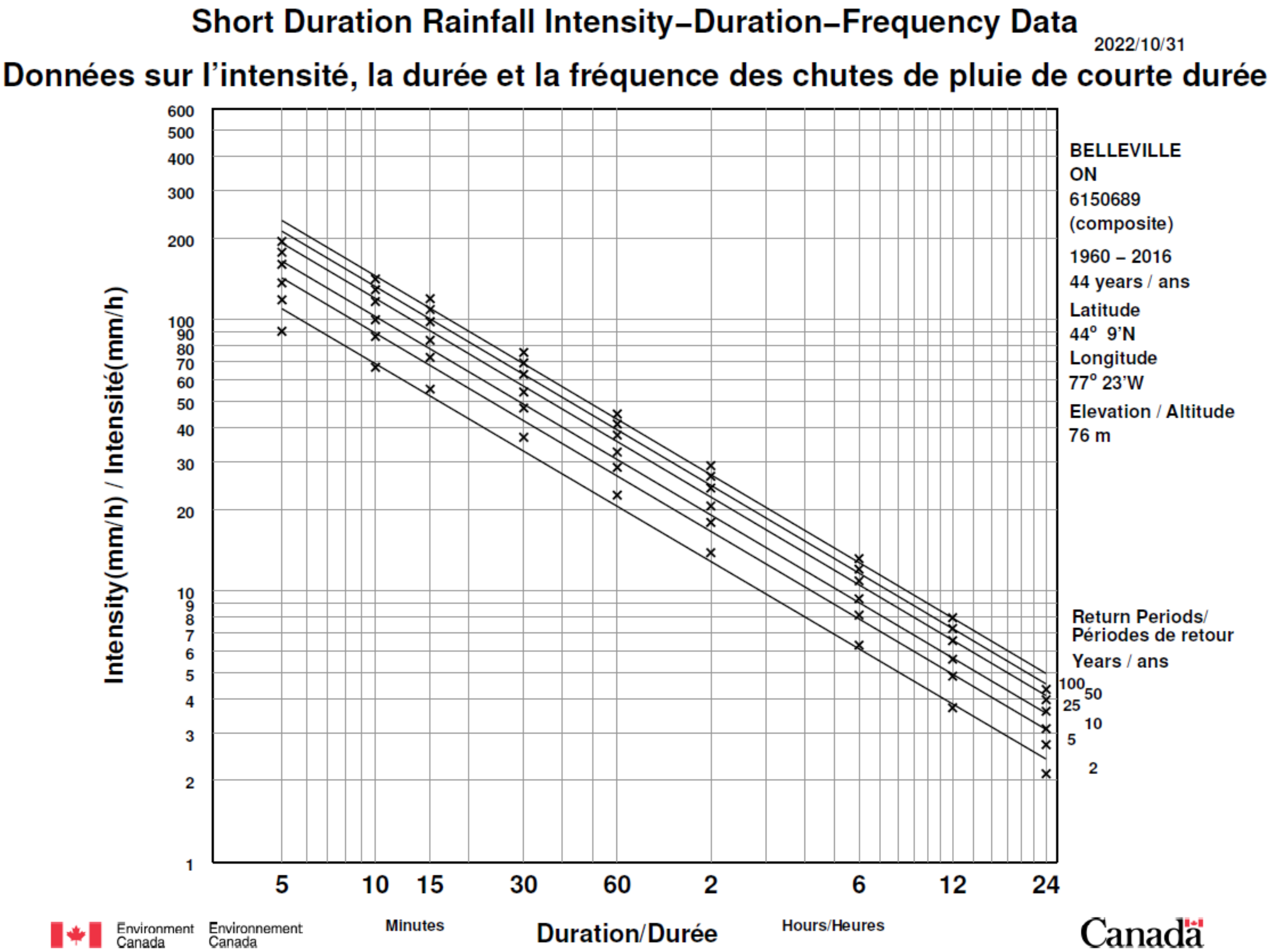
8 References

The information used to prepare this report is based on the following documents and information provided as noted below:

- Credit Valley Conservation Authority – Low Impact Development Stormwater Management Planning and Design Guide, 2010
- Oak Ridges Moraine Conservation Plan (OMRCP) Technical Paper #13
- Ontario Building Code O. Reg 332/12
- Ontario Ministry of Environment – Stormwater Management Planning and Design Manual, 2003
- Ontario Ministry of Transportation
    - Drainage Management Manual, 1997

APPENDIX A:
IDF CURVES – BELLEVILLE


Short Duration Rainfall Intensity–Duration–Frequency Data
2022/10/31
Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée
BELLEVILLE
ON
6150689
(composite)
1960 – 2016
44 years / ans
Latitude
44° 9'N
Longitude
77° 23'W
Elevation / Altitude
76 m
Return Periods/
Périodes de retour
Years / ans
100
50
25
10
5
2
Intensity(mm/h) / Intensité(mm/h)
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
5
10
15
30
60
2
6
12
24
Minutes
Duration/Durée
Hours/Heures
Environment Canada
Environnement Canada
Canada

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Short Duration Rainfall Intensity-Duration-Frequency Data
Données sur l'intensité, la durée et la fréquence des chutes de pluie de courte durée

Gumbel - Method of moments/Méthode des moments

2022/10/31

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BELLEVILLE (composite) ON 6150689
Latitude: 44 9'N Longitude: 77 23'W Elevation/Altitude: 76 m

Years/Années : 1960 - 2016 # Years/Années : 44

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Table 1 : Annual Maximum (mm)/Maximum annuel (mm)

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Year Année	5 min	10 min	15 min	30 min	1 h	2 h	6 h	12 h	24 h
1960	6.3	9.1	12.4	23.4	25.4	35.1	53.8	55.1	55.9
1961	6.1	7.9	8.9	12.2	18.0	18.8	23.9	34.0	36.3
1963	12.4	19.0	23.1	28.4	30.7	31.0	31.0	31.7	44.4
1964	4.3	5.6	7.4	12.2	12.4	20.6	45.2	45.7	45.7
1966	6.3	8.9	10.4	11.9	13.2	16.0	32.8	37.8	38.1
1967	7.4	9.9	10.4	10.4	11.9	13.2	26.4	42.4	58.7
1968	7.9	11.9	13.7	18.5	21.8	27.2	43.9	57.1	57.1
1969	5.8	9.7	13.0	17.5	24.4	31.0	37.8	43.2	62.2
1971	7.4	11.4	13.0	23.9	25.1	25.4	25.7	25.7	32.5
1972	9.4	10.7	11.7	12.4	14.7	20.6	28.2	33.5	50.5
1973	7.4	10.7	11.9	18.0	21.3	21.8	37.3	45.5	48.0
1974	10.9	15.2	17.8	25.4	25.4	25.4	34.3	42.7	42.7
1977	4.8	8.1	9.9	14.7	25.1	30.2	60.5	66.0	66.0
1980	13.2	16.9	19.0	20.5	20.5	34.6	46.9	47.6	59.6
1981	-99.9	-99.9	13.3	25.5	29.4	34.6	46.2	49.2	57.4
1982	4.6	8.5	10.1	14.2	18.3	24.7	39.8	45.0	45.0
1983	6.5	8.9	10.5	18.4	22.2	30.7	39.6	39.6	50.3
1984	5.1	8.1	10.1	11.3	19.7	23.7	33.4	51.4	55.1
1985	10.5	16.2	20.0	27.0	27.4	42.3	42.3	44.5	44.5
1986	9.1	14.4	16.4	23.2	25.2	35.0	59.2	68.8	78.9
1987	4.3	6.6	9.3	14.2	24.7	37.1	39.2	39.2	39.2
1988	3.7	6.2	7.4	8.6	9.2	10.6	20.8	22.2	28.2
1989	14.5	16.7	17.9	18.4	24.2	24.2	27.7	27.7	37.7

1990	6.9	8.3	10.0	12.3	13.6	20.8	29.7	34.8	38.7
1991	8.5	13.8	18.5	18.8	32.0	32.4	32.4	32.4	32.7
1992	6.3	7.6	8.4	13.2	18.8	21.9	38.2	48.3	50.1
1993	8.2	15.8	23.6	28.3	28.3	28.3	-99.9	-99.9	69.6
1994	8.8	10.2	14.5	18.3	23.6	25.5	38.2	49.2	52.8
1995	8.0	12.9	14.9	19.3	27.5	31.5	48.5	58.5	67.3
1996	6.9	10.4	13.4	19.2	25.1	41.3	41.5	53.8	53.8
1997	10.3	16.8	20.9	25.5	42.8	50.0	56.0	56.0	56.0
1998	9.5	12.1	15.1	22.1	25.0	32.6	38.6	38.6	50.2
1999	9.6	13.1	17.9	23.2	29.4	36.9	42.8	72.7	72.7
2000	10.4	13.4	14.7	16.8	29.0	39.8	52.0	52.4	53.0
2001	7.4	10.1	11.0	11.8	16.7	17.4	21.2	31.6	39.8
2002	7.1	9.4	14.0	21.0	22.4	26.0	39.4	44.2	49.8
2003	7.6	13.5	20.1	26.2	27.0	27.0	31.1	-99.9	56.2
2004	14.4	22.1	28.8	33.3	33.3	49.0	89.9	114.4	124.5
2006	9.0	14.7	18.8	19.5	19.5	19.5	37.3	42.7	59.8
2009	6.3	10.7	14.1	20.2	21.7	30.6	36.9	52.3	68.0
2011	12.7	20.3	25.8	31.1	39.7	44.3	49.1	49.1	51.2
2012	6.2	11.3	16.1	26.0	30.0	30.8	44.4	64.6	65.4
2013	7.4	11.6	15.7	19.3	21.5	23.2	29.0	32.8	33.9
2014	7.7	12.0	14.7	16.6	18.1	26.7	34.0	42.4	63.2
2015	5.3	8.5	11.4	17.0	29.0	48.2	56.4	60.6	73.7
2016	7.0	9.8	14.7	22.9	24.4	24.6	32.2	41.6	41.6
# Yrs. Années	45	45	46	46	46	46	45	44	46
Mean Moyenne	8.0	11.8	14.7	19.4	23.7	29.2	39.9	47.0	53.4
Std. Dev. Écart-type	2.6	3.8	4.9	5.9	6.8	9.2	12.5	15.5	16.1
Skew. Dissymétrie	0.80	0.78	0.86	0.26	0.30	0.43	1.54	1.96	1.88
Kurtosis	3.48	3.43	3.72	2.61	3.95	3.11	7.71	10.31	10.23

*-99.9 Indicates Missing Data/Données manquantes

Warning: annual maximum amount greater than 100-yr return period amount
Avertissement : la quantité maximale annuelle excède la quantité pour une période de retour de 100 ans

Year/Année	Duration/Durée	Data/Données	100-yr/ans
2004	6 h	89.9	78.9
2004	12 h	114.4	95.6
2004	24 h	124.5	104.0

****

Table 2a : Return Period Rainfall Amounts (mm)
Quantité de pluie (mm) par période de retour

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	7.6	9.9	11.4	13.3	14.8	16.2	45
10 min	11.1	14.5	16.7	19.5	21.5	23.6	45
15 min	13.9	18.2	21.0	24.6	27.3	29.9	46
30 min	18.4	23.6	27.1	31.4	34.7	37.9	46
1 h	22.6	28.5	32.5	37.5	41.3	45.0	46
2 h	27.7	35.8	41.1	47.9	52.9	57.9	46
6 h	37.8	48.8	56.1	65.3	72.2	78.9	45
12 h	44.5	58.1	67.2	78.6	87.1	95.6	44
24 h	50.8	65.0	74.5	86.4	95.2	104.0	46

****

Table 2b :

Return Period Rainfall Rates (mm/h) - 95% Confidence limits
Intensité de la pluie (mm/h) par période de retour - Limites de confiance de 95%

****

Duration/Durée	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans	#Years Années
5 min	90.7	118.5	136.9	160.1	177.4	194.5	45
	+/- 8.4	+/- 14.2	+/- 19.2	+/- 25.9	+/- 31.0	+/- 36.1	45
10 min	66.8	86.8	100.0	116.7	129.1	141.4	45
	+/- 6.1	+/- 10.2	+/- 13.8	+/- 18.6	+/- 22.2	+/- 25.9	45
15 min	55.5	72.7	84.0	98.4	109.1	119.6	46
	+/- 5.2	+/- 8.7	+/- 11.7	+/- 15.8	+/- 18.9	+/- 22.0	46
30 min	36.9	47.3	54.2	62.9	69.3	75.8	46
	+/- 3.1	+/- 5.3	+/- 7.1	+/- 9.6	+/- 11.5	+/- 13.4	46
1 h	22.6	28.5	32.5	37.5	41.3	45.0	46
	+/- 1.8	+/- 3.0	+/- 4.1	+/- 5.5	+/- 6.6	+/- 7.7	46
2 h	13.8	17.9	20.6	24.0	26.5	29.0	46
	+/- 1.2	+/- 2.0	+/- 2.8	+/- 3.7	+/- 4.5	+/- 5.2	46
6 h	6.3	8.1	9.4	10.9	12.0	13.2	45
	+/- 0.6	+/- 0.9	+/- 1.3	+/- 1.7	+/- 2.0	+/- 2.4	45
12 h	3.7	4.8	5.6	6.6	7.3	8.0	44
	+/- 0.3	+/- 0.6	+/- 0.8	+/- 1.1	+/- 1.3	+/- 1.5	44
24 h	2.1	2.7	3.1	3.6	4.0	4.3	46
	+/- 0.2	+/- 0.3	+/- 0.4	+/- 0.5	+/- 0.7	+/- 0.8	46

****

Table 3 : Interpolation Equation / Équation d'interpolation: R = A*T^B

```
R = Interpolated Rainfall rate (mm/h)/Intensité interpolée de la pluie (mm/h)
RR = Rainfall rate (mm/h) / Intensité de la pluie (mm/h)
 T = Rainfall duration (h) / Durée de la pluie (h)

********************************************************************************
```

Statistics/Statistiques	2 yr/ans	5 yr/ans	10 yr/ans	25 yr/ans	50 yr/ans	100 yr/ans
Mean of RR/Moyenne de RR	33.1	43.0	49.6	57.9	64.0	70.1
Std. Dev. /Écart-type (RR)	31.6	41.3	47.7	55.8	61.9	67.8
Std. Error/Erreur-type	7.6	9.6	10.9	12.6	13.9	15.1
Coefficient (A)	20.5	26.5	30.5	35.5	39.3	43.0
Exponent/Exposant (B)	-0.676	-0.677	-0.678	-0.679	-0.679	-0.679
Mean % Error/% erreur moyenne	8.5	8.1	8.0	7.8	7.7	7.7

APPENDIX B:
OPEN CHANNEL FLOW – SWALE CALCULATIONS

Proposed Swale Configuration – West

Quality Control

Manning's - Open Channel Flow - West

Determines the full flow capacity of a trapezoidal channel
(V-shaped if Bottom Width is set to 0)

Project:	Wander the Resort
Design:	Colby Fritz
Checked:	B. Keene, P.Eng.
Date:	24-Feb-24

Equations: **Continuity** **Manning's**

$$Q = VA \qquad V = \frac{R^{2/3}S^{1/2}}{n}$$

Where:

V = Channel Velocity (m/s)
Q = Channel Flow Capacity
R = Hydraulic Radius = A/P
P = Wetted Perimeter (m)
A= Area (m^2)
n = Manning's Roughness Coefficient

Desired Flow Capacity = **0.018** **cms**

Channel Configuration *Does not include Freeboard*

Given:			**Find:**		
Bottom Width	**0**	m	V =	**0.423**	
Side Slopes	**3**	:1	Q =	**0.018**	**cms**
Slope	**0.01**	m/m	R =	0.043	
Roughness	**0.035**		P =	0.759	
Channel Depth	**0.12**	m	A =	0.057	

100-Yr Conveyance

Manning's - Open Channel Flow - West

Determines the full flow capacity of a trapezoidal channel
(V-shaped if Bottom Width is set to 0)

Project: Wander the Resort
Design: Colby Fritz
Checked: B. Keene, P.Eng.
Date: 24-Feb-24

Equations: **Continuity** **Manning's**

$$Q = VA \qquad V = \frac{R^{2/3}S^{1/2}}{n}$$

Where:

V = Channel Velocity (m/s)
Q = Channel Flow Capacity
R = Hydraulic Radius = A/P
P = Wetted Perimeter (m)
A= Area (m^2)
n = Manning's Roughness Coefficient

Desired Flow Capacity = **0.051** **cms**

Channel Configuration *Does not include Freeboard*

Given:			**Find:**		
Bottom Width	**0**	m	V =	**0.594**	
Side Slopes	**3**	:1	Q =	**0.071**	**cms**
Slope	**0.01**	m/m	R =	0.120	
Roughness	**0.035**		P =	1.265	
Channel Depth	**0.2**	m	A =	0.095	

Capacity of the Proposed Channel is 0.07 cms, which is adequate to convey desired flow of 0.051 cms.

Proposed Swale Configuration – East

Quality

Manning's - Open Channel Flow - East

Determines the full flow capacity of a trapezoidal channel
(V-shaped if Bottom Width is set to 0)

Project: Wander the Resort
Design: Colby Fritz
Checked: B. Keene, P.Eng.
Date: 30-Mar-23

Equations: **Continuity** **Manning's**

$$Q = VA \qquad V = \frac{R^{2/3}S^{1/2}}{n}$$

Where:
V = Channel Velocity (m/s)
Q = Channel Flow Capacity
R = Hydraulic Radius = A/P
P = Wetted Perimeter (m)
A= Area (m^2)
n = Manning's Roughness Coefficient

Desired Flow Capacity = **0.066** **cms**

Channel Configuration *Does not include Freeboard*

Given:			**Find:**		
Bottom Width	**2.75**	m	V =	**0.326**	
Side Slopes	**3**	:1	Q =	**0.07**	**cms**
Slope	**0.005**	m/m	R =	0.207	
Roughness	**0.035**		P =	3.193	
Channel Depth	**0.07**	m	A =	0.065	

Capacity of the Proposed Channel is 0.07 cms, which is adequate to convey desired flow of 0.066 cms.

100-Yr Conveyance – Flat Bottomed

Manning's - Open Channel Flow - East

Determines the full flow capacity of a trapezoidal channel
(V-shaped if Bottom Width is set to 0)

Project: Wander the Resort
Design: Colby Fritz
Checked: B. Keene, P.Eng.
Date: 30-Mar-23

Equations: **Continuity** **Manning's**

Q = VA

$$V = \frac{R^{2/3}S^{1/2}}{n}$$

Where:

V = Channel Velocity (m/s)
Q = Channel Flow Capacity
R = Hydraulic Radius = A/P
P = Wetted Perimeter (m)
A= Area (m^2)
n = Manning's Roughness Coefficient

Desired Flow Capacity = **0.17** **cms**

Channel Configuration *Does not include Freeboard*

Given:			**Find:**		
Bottom Width	**2.75**	m	V =	**0.612**	
Side Slopes	**3**	:1	Q =	**0.41**	**cms**
Slope	**0.005**	m/m	R =	0.670	
Roughness	**0.035**		P =	4.015	
Channel Depth	**0.2**	m	A =	0.167	

Capacity of the Proposed Channel is 0.41 cms, which is adequate to convey desired flow of 0.17 cms.

100-Yr Conveyance – V-Shaped

Manning's - Open Channel Flow - East

Determines the full flow capacity of a trapezoidal channel
(V-shaped if Bottom Width is set to 0)

Project: Wander the Resort
Design: Colby Fritz
Checked: B. Keene, P.Eng.
Date: 30-Mar-23

Equations: **Continuity** **Manning's**

Q = VA

$$V = \frac{R^{2/3}S^{1/2}}{n}$$

Where:

V = Channel Velocity (m/s)
Q = Channel Flow Capacity
R = Hydraulic Radius = A/P
P = Wetted Perimeter (m)
A= Area (m^2)
n = Manning's Roughness Coefficient

Desired Flow Capacity = **0.17** **cms**

Channel Configuration *Does not include Freeboard*

Given:			**Find:**		
Bottom Width	**0**	m	V =	**0.652**	
Side Slopes	**3**	:1	Q =	**0.176**	**cms**
Slope	**0.007**	m/m	R =	0.270	
Roughness	**0.035**		P =	1.897	
Channel Depth	**0.3**	m	A =	0.142	

Capacity of the Proposed Channel is 0.18 cms, which is adequate to convey desired flow of 0.17 cms.

APPENDIX C:
RATIONAL METHOD CALCULATIONS

Rational Method – East Drainage

Rational Method For East Side

	100-Yr			Quality	
Post			**Post**		
Drainage Area =	0.74	ha	Drainage Area =	0.74	ha
Runoff Coefficient =	0.68		Runoff Coefficient =	0.68	
Time of Concentration =	15.0	min	Time of Concentration =	15.0	min
Peak Intensity =	119.6	mm/hr	Peak Intensity =	35.3	mm/hr
Peak Flow =	**0.169**	cms	Peak Flow =	**0.050**	cms

$$i = 43C + 5.9$$

Weighted Runoff Coefficient For East Side

	Area	R.C
Catchment 2	0.24	0.94
Catchment 3	0.50	0.56
	WRC	0.68

Rational Method – West Drainage

100-Yr

Post		
Drainage Area =	0.179	ha
Runoff Coefficient =	0.85	
Time of Concentration =	15.0	min
Peak Intensity =	119.6	mm/hr
Peak Flow =	**0.051**	cms

Quality

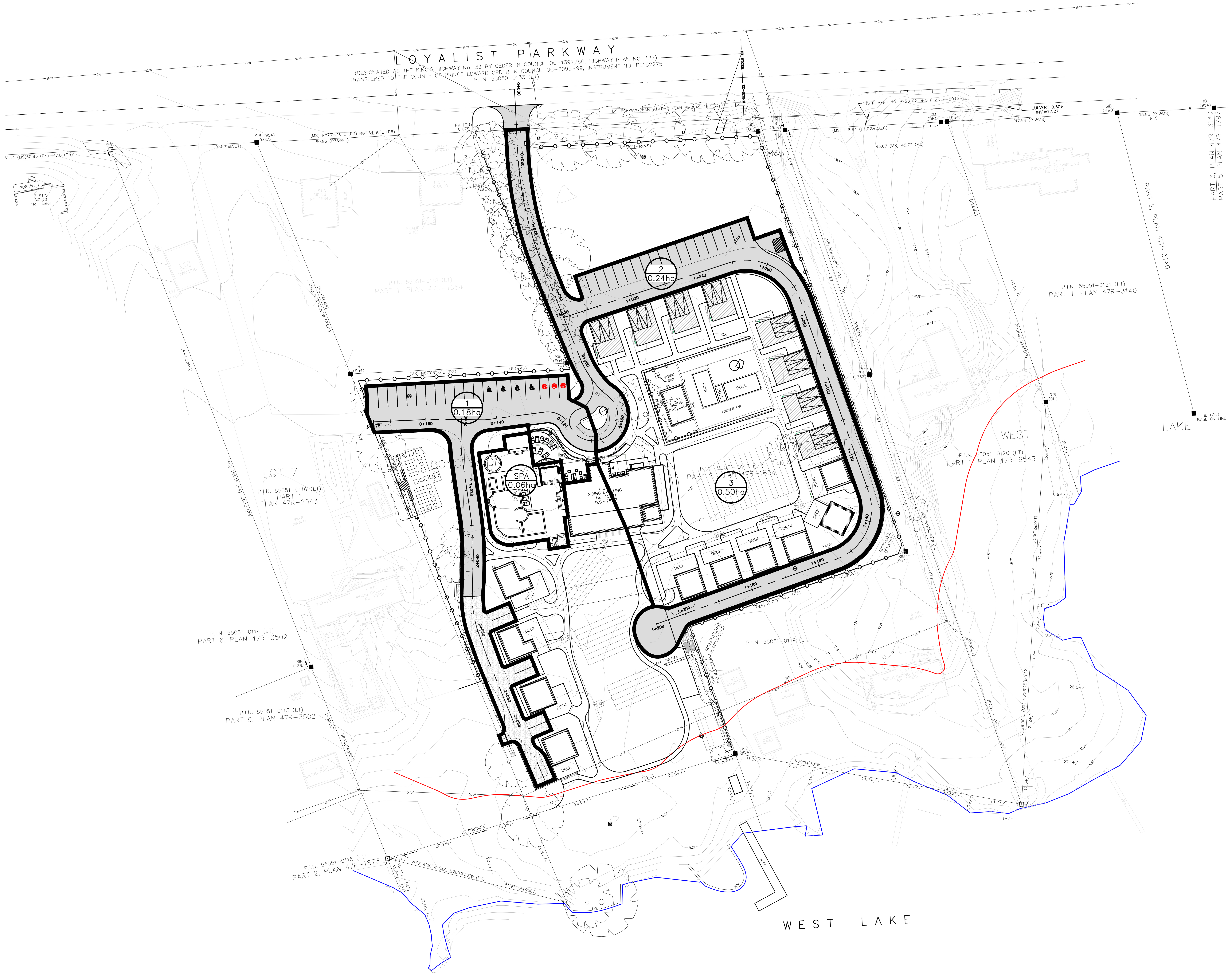
Post		
Drainage Area =	0.179	ha
Runoff Coefficient =	0.85	
Time of Concentration =	15.0	min
Peak Intensity =	42.5	mm/hr
Peak Flow =	**0.018**	cms

$$i = 43C + 5.9$$

APPENDIX D:
GRADING PLAN AND CATCHMENT DRAWINGS

02/23/2024

F:\FTP\PROJECT FILES\1 CIVIL 3D PROJECT FILES\2205130 - WANDER THE RESORT\2. SHEET FILES\2205130 - WANDER THE RESORT - CATCHMENT PLAN



NOTE: TOPOGRAPHIC SURVEY PROVIDED BY ALTIMAP LAND SURVEYORS INC.

GENERAL NOTES:

- ALL INFORMATION TO BE VERIFIED ON SITE PRIOR TO COMMENCING ANY WORK. ANY DISCREPANCIES ARE TO BE REPORTED TO THE CONSULTANT IMMEDIATELY.
- ALL UTILITY LOCATIONS SHOWN ON THE DRAWINGS ARE APPROXIMATE. THE CONTRACTOR SHALL CONFIRM THE LOCATION ON SITE AND ASSUME ALL LIABILITY FOR DAMAGE TO ALL UTILITIES.
- EXCLUDING THE BENCHMARK AND DESCRIPTION PROVIDED FOR THIS PROJECT, NO OTHER ELEVATIONS ARE TO BE USED AS A REFERENCE ELEVATION FOR ANY PURPOSE.

METRIC NOTE:

- ALL DIMENSIONS SHOWN ARE IN METRES OR MILLIMETRES, UNLESS OTHERWISE NOTED.

GEOMETRIC NOTE:

- ALL SURVEY DATA SHOWN ON THIS DRAWING WAS RECORDED USING REAL-TIME KINETIC (RTK) GPS OBSERVATIONS IN REFERENCE TO UTM 18 NORTH COORDINATE SYSTEM.
- ALL ELEVATIONS ARE IN REFERENCE TO LOCAL DATUM NAD83 - GEODETIC MODEL HT2_0, UNLESS DESCRIBED OTHERWISE.

* * DRAWINGS ARE NOT TO BE SCALED * *

REVISIONS

NO.	DATE	DESCRIPTION	BY
1	07/26/2022	ISSUED FOR CLIENT APPROVAL	JH
2	08/19/22	ISSUED FOR SITE PLAN APPROVAL	BND
3	03/03/23	ISSUED FOR SITE PLAN APPROVAL	BND
4	03/24/23	ISSUED FOR SITE PLAN APPROVAL	BND
5	04/03/23	ISSUED FOR SITE PLAN APPROVAL	BND
6	04/24/23	ISSUED FOR CONSTRUCTION	BND
7	08/24/23	ISSUED FOR CONSTRUCTION	BND
8	12/18/23	ZBA	BND
9	02/23/24	ZBA	BND

LEGEND

1 / 0.16ha — CATCHMENT ID / AREA (ha)

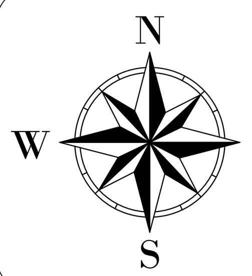
AREAS:

CATCHMENT AREA 1:
ASPHALT AREA = 1164.5 sq.m.
GRAVEL AREA = 468.9 sq.m.
GRASSED AREA = 7.1 sq.m.

CATCHMENT AREA 2:
ASPHALT AREA = 2,442.5 sq.m.
GRASSED AREA = 25.5 sq.m.

CATCHMENT AREA 3:
EXISTING BUILDINGS = 574.0 sq.m.
EXISTING CONCRETE AREA = 652.5 sq.m.
PROPOSED BUILDINGS = 616.3 sq.m.
INTERLOCKING BRICK PATHWAYS = 759.0 sq.m.
GRASSED AREA = 2,398.2 sq.m.

TOTAL AREA OF GREEN ROOF = 110.25 sq.m.



LICENSED PROFESSIONAL ENGINEER
B. C. KEENE
Feb 23/24
PROVINCE OF ONTARIO

JEWELL ENGINEERING

WANDER THE RESORT
15841 LOYALIST PARKWAY
BLOOMFIELD, ONTARIO

CATCHMENT PLAN

DRAWN BY: BND	PROJECT NO: 220-5130
DESIGNED BY: BND	DATE: FEBRUARY 2024
CHECKED BY: BK	SCALE: HORIZONTAL - 1:500 VERTICAL -
APPROVED BY: BK	CONTRACT NO:
	DRAWING NO: CP-01