Stantec Consulting Ltd.
400 - 1331 Clyde Avenue, Ottawa ON K2C 3G4

May 30, 2017
File: 160401012

Attention: Cheryl McWilliams
City of Ottawa
110 Laurier Avenue W., 4th Floor
Ottawa, ON
K1P 1J1

Dear Cheryl McWilliams,

Reference: 1240 Old Prescott Road – Summary of Infiltration Calculations Rev#1

The following letter is submitted for review to summarize the updated design of infiltration features for the proposed rural subdivision development at 1240 Old Prescott Road. It is noted that this letter only addresses infiltration features and the associated Nitrate Impact Assessment calculations. Responses to all other comments on the stormwater management were addressed in previous comments response letter. This letter is to be a stand-alone letter and is not to be compared to previous submissions as the design and calculations have been revised in response to City comments.

The proposed rural residential development includes increased lot densities serviced by wells, septic systems and enhanced grass swales discharging to a dry pond. A nitrate impact assessment was carried out by Paterson Group according to the requirements of MOECC Procedure 5-5-4. This process determines if there will be sufficient post development dilution from precipitation to ensure that nitrates remain below 10 mg/L at the site boundaries. Initial calculations indicated that infiltration from post-development pervious surfaces alone, may not be sufficient to provide adequate nitrate dilution. It was subsequently proposed to include infiltration from the proposed Stormwater management features (dry pond and dray swale infiltration trenches) in the nitrate dilution calculations. The City of Ottawa indicated that the proposed rear-yard bioswales could be used for stormwater quality treatment but could not be included as part of the nitrate dilution calculations. It was later concluded that the roadside infiltration ditches could not be reliably maintained and therefore should not be relied on for infiltration. As a result, stormwater calculations were revised and the dry pond was expanded to include additional infiltration area below the proposed water quantity dry pond.

The following sections outline the design of the infiltration measures and calculations for input to the water balance for the Nitrate Impact Assessment.

Reference: 1240 Old Prescott Road – Summary of Infiltration Calculations

1. SUPPORTING ANALYSES

In support of the design of the proposed infiltration measures, additional investigations and analyses were completed as outlined in the following sections.

1.1. IN-SITU INFILTRATION TESTING

Field testing was completed by Paterson Group to establish in-situ saturated hydraulic conductivity rates using a Pask Permeameter. These results were previously reviewed by the City and are included in the attached Paterson letter for reference. The methodology outlined in the Credit Valley Conservation LID Design Guidelines – Appendix C (CVC, 2012) was then used to calculate the infiltration rate and safety factor for each test location. Test results and calculations results are attached for reference and a summary is included in **Table 1** below.

Table 1: Summary of Infiltration Rates

Auger hole ID	Test interval depth (m)		Calculated K_{fs} (m/s)	Converted K_{fs} (cm/s)	Infiltration rate (i) (mm/hr)	Average infiltration (mm/hr)	Safety factor	Corrected infiltration (mm/hr)
AH1	0.39	0.54	6.40E-05	6.40E-03	140.82	137.59	3.50	40.23
AH2	0.36	0.51	8.00E-05	8.00E-03	149.48			
AH3	0.13	0.28	4.00E-05	4.00E-03	124.17			
AH4	0.51	0.66	5.60E-05	5.60E-03	135.87			
AH5	0.10	0.25	1.60E-05	1.60E-03	97.17	107.07	3.50	27.76
AH6	0.56	0.71	3.20E-05	3.20E-03	116.97			
AH7	0.10	0.25	5.10E-05	5.10E-03	132.52	129.30	3.50	37.86
AH8	0.26	0.41	4.80E-05	4.80E-03	130.38			
AH9	0.46	0.61	4.10E-05	4.10E-03	125.00			
AH10	0.11	0.26	2.70E-06	2.70E-04	60.35	76.95	3.50	17.24
AH11	0.25	0.40	3.50E-06	3.50E-04	64.69			
AH12	0.55	0.70	2.20E-05	2.20E-03	105.81			
AH13	0.09	0.24	9.00E-06	9.00E-04	83.30	70.67	3.50	23.80
AH14	0.26	0.41	2.10E-06	2.10E-04	56.43			
AH15	0.47	0.62	5.30E-06	5.30E-04	72.29			

Reference: 1240 Old Prescott Road – Summary of Infiltration Calculations

1.2. GROUNDWATER LEVELS

Groundwater level measurements were obtained from the on-site piezometers in November 2012, March 2013 and October 2016 by Paterson Group. **Table 2** below summarizes the groundwater elevations on each of these occasions (a reference plan with borehole locations is included in the attached Paterson letter).

Table 2: Summary of Groundwater Elevations

Stand-pipe well ID	Top of Riser Elevation (m)	1st Measurement			2nd Measurement		
		Date measured	Groundwater Depth (m) below top of riser	Groundwater Elevation (m)	Date measured (d/m/y)	Groundwater Depth (m) below top of riser	Groundwater Elevation (m)
BH1	102.809	19/11/12	2.27	100.542	27/10/16	4.357	98.45
BH2	102.518	19/11/12	2.54	99.976	27/10/16	3.311	99.21
BH3	101.713	19/11/12	2.57	99.148	27/10/16	2.946	98.77
BH4	102.617	14/03/13	1.96	100.657	27/10/16	2.587	100.03
BH5	102.330	14/03/13	1.73	100.600	27/10/16	2.361	99.97
BH6	102.707	15/03/13	2.81	99.897	27/10/16	2.813	99.89

Total precipitation for spring and summer in 2016 was well below average and it is assumed that the measured groundwater levels are reflective of this drier year. For the purposes of designing the infiltration measures and estimating total infiltration, the higher groundwater elevations were used.

It is noted that a new groundwater monitoring well was installed within the proposed pond footprint area on March 29, 2017 and equipped with a continuous water level data logger. The data logger was removed on May 15, 2017. The measured groundwater level data will be used at detailed design to evaluate the system performance in wet season conditions. It is noted that for the 2017 season, excessive rainfall has been recorded for the area with wide-spread flooding in the region. It is also noted that 2016 was considered a drought year, so normal groundwater levels would be expected to be between the 2016 and 2017 monitored levels.

1.3. RAINFALL ANALYSIS

The proposed infiltration measures are designed to infiltrate runoff from up to the 15mm event for their contributing drainage area. Typically, infiltration measures are designed to infiltrate up to as much as 25mm event runoff, where site conditions permit, however, due to area restrictions and shallow ground water depths the proposed site is designed for the 15mm event.

Reference: 1240 Old Prescott Road – Summary of Infiltration Calculations

To assess the percentage of average annual rainfall that could be captured and infiltrated during a 15mm event, an analysis was completed using historical rainfall data from the Ottawa MacDonald Cartier International Airport. The historical data was imported into the PCSWMM stormwater management model to utilize the event extraction tools within the model. The tool allows the user to specify a minimum inter-event time (time of no rainfall between two rainfall events) and searches the data set and extracts all events. A summary of the duration and total rainfall for each event is provided as an output from this tool. This summary was then used to assess the number of events with total precipitation less than or equal to 15mm as well as the number of events greater than 15mm for which the first 15mm could be captured and infiltrated. Since the recommended infiltration time per the Credit Valley Conservation LID Design Guidelines is 24 to 48 hours, inter-event times of 24 and 48 hours were used to complete this analysis.

The results of the historical rainfall analysis indicate that approximately 65% of annual rainfall can be captured and infiltrated by capturing the 15mm event. Summary charts for the 24 and 48 hour inter-event times are attached as figures for reference.

2. STORMWATER INFILTRATION MEASURES

Stormwater infiltration measures are proposed within the subdivision to promote groundwater recharge. An infiltration gallery below the dry pond is proposed to provide the required annual infiltration volume for the site. Bioswales and road-side ditches are also proposed throughout the site for water quality treatment and conveyance but are not included in infiltration calculations.

2.1. DRY POND INFILTRATION BASIN

Due to maintenance constraints, the City has indicated that the on-site bio-swales and road-side ditches cannot be relied on for long-term infiltration. As such, additional storage area was provided below the dry pond. The total available infiltration area is approximately 3,772m^2 with a clear stone depth of 300mm which provides approximately 453m^3 of storage for infiltration. Details of the proposed outlet configuration and infiltration basin cross-section are included in the attached **Drawing DS-1**.

2.2. MAINTENANCE AND MONITORING OF INFILTRATION SYSTEMS

As with any stormwater facility the infiltration systems will require routine monitoring and regular maintenance. Tables 4.9.5 and 4.9.6 below are the recommended maintenance and corrective procedures identified by the Credit Valley Conservation LID manual. As the CVC LID manual does not include guidelines for infiltration dry ponds, the procedures for dry swales are referenced since the features are similar in their design. A detailed monitoring plan will be submitted under separate cover at the detailed design stage.

Reference: 1240 Old Prescott Road – Summary of Infiltration Calculations

Table 3:Suggested routine inspection and maintenance activities for dry swales

Activity	Schedule
▪ Inspect for vegetation density (at least 80% coverage), damage by foot or vehicular traffic, channelization, accumulation of debris, trash and sediment, and structural damage to pretreatment devices.	After every major storm event (>25 mm), quarterly for the first two years, and twice annually thereafter.
▪ Regular watering may be required during the first two years while vegetation is becoming established;	As needed for the first two years of operation.
▪ Mow grass to maintain height between 75 to 150 mm; ▪ Remove trash and debris from pretreatment devices, the swale surface and inlet and outlets.	At least twice annually. More frequently if desired for aesthetic reasons.
▪ Remove accumulated sediment from pretreatment devices, inlets and outlets; ▪ Trim trees and shrubs; ▪ Replace dead vegetation, remove invasive growth, dethatch, remove thatching and aerate (PDEP, 2006; ▪ Repair eroded or sparsely vegetated areas; ▪ Remove accumulated sediment on the swale surface when dry and exceeds 25 mm depth (PDEP, 2006); ▪ If gullies are observed along the swale, regrading and revegetating may be required.	Annually or as needed

Table 4.9.5 of Low Impact Development Stormwater Management Planning and Design Guide, Credit Valley Conservation, 2012

Reference: 1240 Old Prescott Road – Summary of Infiltration Calculations

Table 4: Suggested inspection items and corrective actions for dry swales

Inspection Item	Corrective Actions
Vegetation health, diversity and density	• Remove dead and diseased plants. • Add reinforcement planting to maintain desired vegetation density. • Prune woody matter. • Check soil pH for specific vegetation. • Add mulch to maintain 75 mm layer.
Sediment build up and clogging at inlets	• Remove sand that may accumulate at the inlets or on the filter bed surface following snow melt. • Examine drainage area for bare soil and stabilize. Apply erosion control such as silt fence until the area is stabilized. • Check that pretreatment is properly functioning. For example, inspect filter strips for erosion or gullies. Reseed as necessary.
Ponding for more than 48 hours	• Check underdrain for clogging and flush out. • Apply core aeration or deep tilling • Mix amendments into the soil • Remove the top 75 mm of filter media soil • Replace filter media soil

Table 4.9.6 of Low Impact Development Stormwater Management Planning and Design Guide, Credit Valley Conservation, 2012

3. SITE WATER BALANCE

As part of the original stormwater management (SWM) report, a water budget analysis was completed and included in **Section 4.3** of the SWM Report (Stantec, June 2016). With the additional request for nitrate dilution calculations, a detailed water balance assessment was completed by Paterson Group and has replaced the previous calculations completed by Stantec. The complete calculations are attached for reference.

3.1. METHODOLOGY

The methodology implemented for the Nitrate Impact Assessment (NIA) is outlined in detail in the attached update letter prepared by Paterson Group. The following sections summarize the standard NIA assumptions and the methodology for the inclusion of stormwater infiltration.

3.1.1. Standard Infiltration Assumptions for Nitrate Impact Assessment

The attached letter from Paterson Group (dated November 8, 2016) discusses that on-site infiltration is the primary source for overburden groundwater recharge and nitrate dilution. The calculations rely on assumptions for evaporation and evapotranspiration rates for the area, provided by Environment Canada. Infiltration is estimated based on soil texture, topography and vegetative cover type. Impervious areas are normally excluded from the calculation.

Site-specific soil infiltration factors were used to derive a water holding capacity for each of the dominant soil types and a site-specific water balance was provided by Environment Canada, based on these values. The site-specific water balance was used to calculate the surplus water data for the receiving soil which is applied in the NIA calculations.

Additional NIA analysis was completed by Paterson and summarized in the attached February 6, 2017 memo which indicates that a minimum infiltration volume of 9,765m^3 would be required to meet the nitrate concentration limit of 10mg/L.

3.1.2. Infiltration from Stormwater Runoff

The nitrate impact assessment calculation typically only accounts for infiltration of rainfall falling directly on pervious surfaces and assumes that all runoff generated from impervious surfaces is discharged off-site and does not contribute to infiltration. However, the proposed site design includes an infiltrating dry pond that will store the stormwater runoff and provide opportunity for infiltration.

Total required volume and infiltration rate were calculated for the dry pond infiltration basin. The required infiltration rate was assessed based on the depth of water to be infiltrated over 24 hours and 48 hours using the assumption that the porosity of the clear stone storage areas was 0.4 and the equivalent depth of water to infiltrate is 60mm in a 150mm deep clear stone trench or basin. These required rates were then compared to the results of the in-situ testing.

The total annual runoff volume infiltrated was then estimated using the assumption that 65% of annual runoff from contributing impervious surfaces will be captured and infiltrated, based on the rainfall analysis discussed above. This resulting infiltration volume was provided to Paterson for input into the NIA calculation sheet as “Minimum ‘Storminf’ Volume”.

3.2. RESULTS AND DISCUSSION

3.2.1. Stormwater Infiltration

Based on the design of the infiltration basin, runoff from impervious surfaces up to the 15mm event can be captured and infiltrated. The total contributing impervious area is approximately 2.97ha resulting in a total runoff volume of 445m^3 to be infiltrated. The available storage in the infiltration basin is approximately 603m^3, and is therefore sufficient to store the runoff volume for infiltration. Target and minimum required infiltration rates were calculated to meet drawdown time of 48 hours as discussed in **Section 3.1.2** above. A summary of the storage provided and infiltration rates is included in **Table 5** below. Note that the total measured infiltration rate is an average rate for the infiltration basin.

Reference: 1240 Old Prescott Road – Summary of Infiltration Calculations

Table 5: Summary of Storage Volumes and Infiltration Rates

	Storage Volume (m^3)		Target Infiltration Rate for 24hr Drawdown (mm/hr)	Minimum Infiltration Rate for 48hr Drawdown (mm/hr)	Measured Infiltration Rate (mm/hr)
	Required	**Provided**	**Required**	**Required**	**Provided**
Dry Pond Infiltration Basin	445	603	6.67	3.33	23.8

It is noted that measured infiltration rates are higher than required and so additional infiltration may occur during larger and longer duration rainfall events. Similarly, soil or groundwater conditions that may temporarily reduce the infiltration capacity of the soils should still allow for adequate infiltration and drawdown time for the dry pond. Detailed infiltration calculations are attached.

Capture and infiltration of the 15mm rainfall event would result in a total annual infiltration volume of approximately 13,292m^3/yr (65% of annual rainfall over contributing impervious area, or 41% of rainfall over the total impervious area of the site). Calculations do not include evaporation or evapotranspiration as the stored water is subsurface and this is assumed to be negligible over the total volume and drawdown time. This infiltration volume was provided to Paterson for input in the NIA calculations. Paterson has also provided calculations for the minimum stormwater infiltration required to meet dilution targets. Per the attached memo dated February 6, 2017, the minimum required infiltration volume is 9,765m^3/yr. Therefore, a 27% reduction of the design volume of stormwater infiltration could be experienced and the nitrate dilution targets would still be met.

3.2.2.Groundwater Mounding Check

It is acknowledged that the standard recommended clearance from groundwater or impermeable surface (i.e. bedrock) is 1.0m per the MOECC SWM Planning and Design Guidelines (SWMPDG) and the CVC LID Design Guidelines. However, this clearance is a recommendation that is considered sufficient to allow for seasonal variations or short-term groundwater mounding following a rainfall event. If sufficient clearance is provided by the design no subsequent calculations are required. However, designs with less than 1m clearance may still be approved provided sufficient supporting analysis is completed. Correspondence with the MOECC has confirmed that deviation from the guidelines outlined in Table 4.1 of the MOECC SWMPDG does not mean the site cannot be approved but only that it will require direct submission to the MOECC and cannot be approved under the expanded Transfer of Review Program (see attached correspondence).

Reference: 1240 Old Prescott Road – Summary of Infiltration Calculations

Since the clearance from the bottom of the infiltration areas and the reference groundwater level is less than 1m groundwater mounding calculations were completed as a final check for the longer-term function of the infiltration areas. The impact of potential groundwater mounding conditions was considered.

The maximum groundwater mounding that could potentially occur would be if the groundwater level were to rise to the invert of the dry pond outlet pipe. Calculations were provided by Paterson Group (see attached memo February 6, 2017), which indicate that the time for this extent of mounding to recover would be 3 hours to recover to the bottom of the dry pond and 27 hours to recover to normal groundwater levels. The only condition that could cause this groundwater mounding is through recharge from the infiltration basin. Since the basin bedding and bottom 0.1m are designed to provide the necessary storage for a 15mm event, this volume should be available within 7hours after any event.

Based on our analysis of historical rainfall data from 1967 to 2002, approximately 10% of annual rainfall volume occurs from events with interevent times of 3 hours or less, however, almost 95% of those events have rainfall volumes less than 15mm, with an average of 2.2mm per event. Therefore, the average rainfall that might occur within the 3 hour recovery time would not need the full infiltration storage volume. The average 2.2mm event would only require approximately 66m^3 for the entire site impervious area. Therefore, with this approach roughly 5% of rainfall events with a 3hour interevent time would have total volumes greater than 15mm so approximately 0.5% (5% of 10%) of the rainfall previously assumed to infiltrate would be at risk of not having sufficient storage available and might not be fully infiltrated. This would mean rather than 41% infiltration in the Nitrate Impact Assessment there would be 40.5% infiltration of the total annual stormwater runoff volume. Per the attached Paterson Memo, the minimum infiltration required is 30%, so sufficient infiltration would still be achieved.

Note that cumulative mounding calculations were not completed as they are not considered to be representative of the conditions for a stormwater management system. Typical cumulative mounding calculations (short of complex models) assume a constant and continuous recharge which is not the case for the infiltration systems.

4. CONCLUSIONS

Stormwater infiltration measures have been provided on-site to improve post-development groundwater recharge. Calculations have been completed to estimate a total annual infiltration volume that can be incorporated into the Nitrate Impact Assessment calculations for the site. The infiltration areas have been designed to provide the maximum possible clearance from measured groundwater elevations however, many areas do provide less than 0.5m of clearance. As such, groundwater mounding calculations were completed to confirm that clearance is still available at the end of the infiltration period.

Reference: 1240 Old Prescott Road – Summary of Infiltration Calculations

These design revisions and additional analysis are to be integrated into the detailed design submission for the subdivision.

Regards,

STANTEC CONSULTING LTD.

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LICENSED PROFESSIONAL ENGINEER
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PROVINCE OF ONTARIO

Attachment: - Paterson Letters: Further Response to Review Comments and Minimum Infiltration Requirements
- Rainfall Analysis
- Infiltration Calculations
- MOECC Correspondence
- Design Drawings

c. Matt Nesrallah - Cavanagh
Harry Alvey – City of Ottawa
Tessa Dilorio – City of Ottawa

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Paterson Letter: Further Response to Review Comments

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November 8, 2016
File: PH2095-LET.02

City of Ottawa
Planning and Growth Management Department
110 Laurier Avenue West, 4th Floor
Ottawa, Ontario
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Attention: **Mr. Sean Moore**

Subject: **Further Response to Review Comments dated May 3, 2016**
(following meetings at City Hall on August 31 and September 7, 2016)
1240 Old Prescott Road
Ottawa, Ontario

Dear Mr. Moore

This report is provided in response to City of Ottawa/SNCA review comments dated May 3, 2016, and subsequent discussion during a meetings held at City Hall on August 31, and September 7, 2016.

Pask Permeameter Testing

Section 6.2 will be updated in the final report to reflect the methodology used for the permeameter testing conducted in June 2016. The following text will be added:

Paterson conducted additional insitu field permeability testing at the subject site in late June 2016. The Pask Permeameter method was used (this method is supported by Canadian Standard CSA B65-12 Installation Code for Decentralized Wastewater Systems).

Permeameter testing was carried out on June 24, 27 and 28, 2016. A total of 15 hand auger holes were drilled. Two to four tests were carried out at each test location to obtain results at various depths within the upper meter of the soil profile.

Permeameter testing was carried out using a standard Pask Permeameter kit from Engineering Technologies Canada Ltd. (comes with 2" auger and quick reference tables). Soil stratigraphy was logged in the field and recorded on a field data collection sheet. Soil samples were collected at each interval that was tested and representative samples were submitted for grain size analysis.

The following table which summarizes the results that were obtained from the permeameter testing program will be added to Section 6.3 of the report:

Summary of Permeameter Testing Results						
Auger Hole ID	Test Interval depth (m)		Soil Description	a*	Rate of WL change in permeameter (cm/min)	K_{fs} (m/sec)
AH1	0.39	0.54	Dry, brown SAND (fg and mg) massive	0.12	12.0	6.4E-05
AH2	0.36	0.51	Dry, brown, SAND with silt	0.12	15.0	8.0E-05
AH3	0.13	0.28	Dry, orange-brown, SAND with some silt	0.12	7.5	4.0E-05
AH4	0.51	0.66	Dry, orange, SAND (mg) with fg sand and some silt	0.12	10.5	5.6E-05
AH5	0.10	0.25	Dry, brown, SAND with some silt	0.12	3.0	1.6E-05
AH6	0.56	0.71	Dry, brown, SAND with silt	0.12	6.0	3.2E-05
AH7	0.10	0.25	Dry, brown-grey, SAND with silt	0.12	9.6	5.1E-05
AH8	0.26	0.41	Dry, brown, SAND with some silt	0.12	9.0	4.8E-05
AH9	0.46	0.61	Dry, brown SAND with some gravel	0.36	1.0	6.9E-06
AH10	0.11	0.26	Dry, brown-orange, SAND and SILT	0.12	0.5	2.7E-06
AH11	0.25	0.40	Dry-moist, brown-orange, SAND, SILT, GRAVEL	0.36	0.5	3.5E-06
AH12	0.55	0.7	Dry, grey-brown, SAND with some silt	0.12	4.1	2.2E-05
AH13	0.09	0.24	Dry, brown-orange, SAND and SILT	0.12	1.7	9.0E-06
AH14	0.26	0.41	Dry, brown-orange, SAND and SILT	0.12	0.4	2.1E-06
AH15	0.47	0.62	Dry, brown, SAND and SILT	0.12	1.0	5.3E-06

The Test Hole Location Plan will be updated in the final report (Drawing PH2095-1 – Test Hole Location Plan). Previous permeameter testing locations have been removed and the new locations have been added.

Section 6.3 of the final report will be updated. The test results will be updated to reflect the findings of the recent permeameter work. All other references to permeameter testing will be reviewed and adjusted if necessary to reflect the recent permeameter findings.

Recalculation of Nitrate Impact Assessment

The nitrate impact assessment calculation has been recalculated (see attached) with a reduced percentage of stormwater infiltration (41%). The final report will be updated. The Predictive Impact Assessment calculation section in Appendix 4 will be replaced.

Section 7.3 of the report will be updated. The following discussion regarding stormwater infiltration will be updated:

Infiltration Due to Stormwater Management

The nitrate impact assessment calculation normally assumes that all water falling on impervious areas flows offsite without any infiltration. In reality a percentage of that water does infiltrate as it flows across impervious surfaces (e.g. drainage ditches, swales, etc.). It is reasonable to include infiltration of stormwater in the nitrate impact assessment calculation for sites that include stormwater management features that specifically enhance infiltration.

A stormwater management plan for the site was prepared by Stantec of Ottawa, Ontario (Greely Rural Subdivision – 1240 Old Prescott Road, Stormwater management Report, July 21, 2016). The proposed stormwater management plan includes dry swales for conveyance and infiltration of stormwater and a dry pond for end of pipe detention and infiltration. The report includes infiltration calculations for the dry swales east of the existing drain and the proposed dry pond. Infiltration calculations are based on the design and calculation criteria outlined in 'Stormwater Management Planning and Design Manual' (MOE, 2003) where additional calculation or design guidance was required the 'Low Impact Development Stormwater Management Planning and Design Guide' (CVC, 2010) was used.

Stantec's calculations show that stormwater runoff from impervious surfaces draining to the infiltration areas will be fully infiltrated for rainfall depths up to 15 mm (approx. 13,393 m^3 year). This is equivalent to 41% of the total annual runoff volume (i.e. total annual rainfall landing on impervious areas within the site).

We trust that this information satisfies your requirements.

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Russell L. Chown, P.Geo.
Senior Hydrogeologist

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ATTACHMENTS

- **Predictive Nitrate Impact Assessment – recalculated 17-OCT-16**
- **Drawing PH2095-1 - Test Hole Location Plan**

patersongroup

1240 Old Prescott Road | 17-Oct-16 | PH2095

Predictive Nitrate Impact Assessment

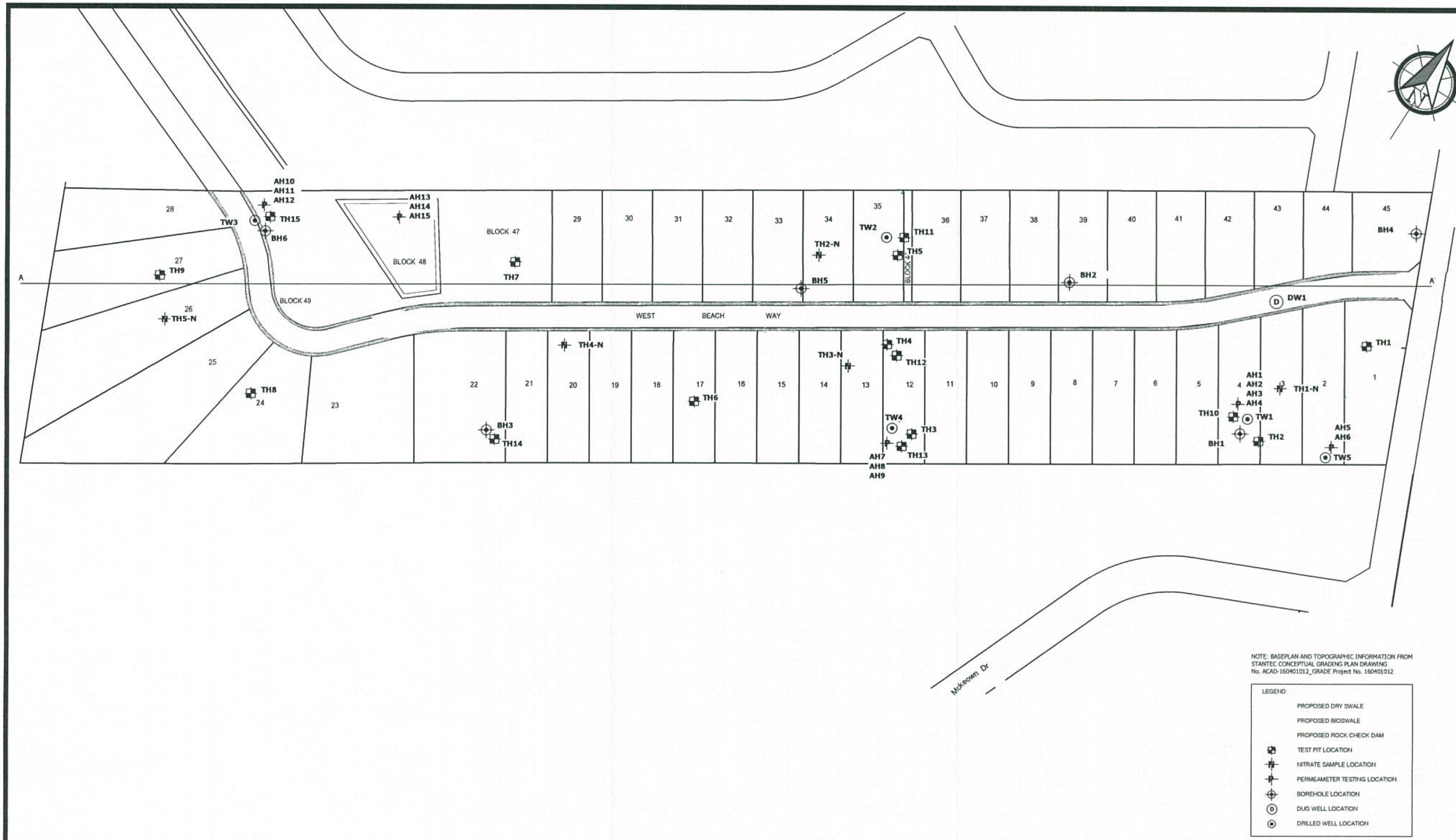
PRE DEVELOPMENT CONDITIONS

Groundwater Flow Through	NOT USED	
~~Background Nitrate Concentration (C_b) =~~	~~0~~	~~mg/L~~
~~Hydraulic Conductivity (k) =~~	~~0~~	~~m/s~~
~~Horizontal Gradient (i) =~~	~~0~~	
~~Length (L) =~~	~~0~~	~~m~~
~~Aquifer Thickness (t) =~~	~~0~~	~~m~~
~~Groundwater Flow (Q_b) =~~	~~0~~	~~m^3/day~~
Infiltration Factors		
Topography	0.15	weighted avg
Soil	0.40	std
Cover	0.18	weighted avg
Total	**0.73**	
Site Characteristics		
Area of Site :	190,422	m^2
Infiltration Area =	190,422	m^2
Septic Effluent		
Concentration of Effluent (Cs) =	0	mg/L
Daily Sewage Flow (Qs)=	0	m^3
Infiltration Calculation		
Nitrate concentration in precipitation (C_i) =	0	mg/L
Preciptation (from Environment Canada climate normals)	943.4	mm/yr
Surplus Water (Environment Canada)	407	mm/yr
Factored Water Surplus =	297	mm/yr
Total volume of Infiltration	56,576	m^3
Infiltration flow entering the system (Q_i) =	155	m^3/day
Mass Balance Model (MOEE, 1995)		
$C_T = (Q_bC_b+Q_eC_e+Q_iC_i)/(Q_b+Q_e+Q_i)$ = Cumulative Nitrate Concentration		
Q_b = flow entering the system across the upgradient area	0	m^3/day
C_b = background nitrate concentration	0	mg/L
Q_e = flow entering the system from the septic drainfield	0	m^3/day
C_e = concentration of nitrates in the septic effluent	0	mg/L
Q_i = flow entering the system from infiltration	155	m^3/day
C_i = Concentration of nitrates in the infiltrate	0	mg/L
C_T =	**0.0**	**mg/L**
Estimate Number of Lots	**1**	**lot**

POST DEVELOPMENT CONDITIONS

Groundwater Flow Through	NOT USED	
~~Background Nitrate Concentration (C_b) =~~	~~0~~	~~mg/L~~
~~Hydraulic Conductivity (k) =~~	~~0~~	~~m/s~~
~~Horizontal Gradient (i) =~~	~~0~~	
~~Length (L) =~~	~~0~~	~~m~~
~~Aquifer Thickness (t) =~~	~~0~~	~~m~~
~~Groundwater Flow (Q_b) =~~	~~0~~	~~m^3/day~~
Infiltration Factors		
Topography	0.14	weighted avg
Soil	0.40	std
Cover	0.12	weighted avg
Total	**0.66**	
Site Characteristics		
Area of Site :	190,422	m^2
Impervious Area	34,504	m^2
Percent Impervious Area =	18.12	%
Infiltration Area =	155,918	m^2
Septic Effluent		
Concentration of Effluent (Cs) =	40	mg/L
Daily Sewage Flow (Qs)=	45	m^3
Infiltration Calculation		
Nitrate concentration in precipitation (C_i) =	0	mg/L
Preciptation (from Environment Canada climate normals)	943.4	mm/yr
Surplus Water (Environment Canada)	384	mm/yr
Factored Water Surplus =	253	mm/yr
Infiltraion % due to stormwater management measures	41%	
Runoff volume (all water running off impervious areas)	32,551	m^3
Minimum 'storminf' volume (**15 mm** event, Stantec, 2016)	13,393	m^3/year
	37	m^3/day
Infiltration Flow Entering the System (Q_i) =	108	m^3/day
Infiltration Flow Entering the System (Q_i with 'storminf') =	145	m^3/day
Mass Balance Model (MOEE, 1995)		
$C_T = (Q_bC_b+Q_eC_e+Q_iC_i)/(Q_b+Q_e+Q_i)$ = Cumulative Nitrate Concentration		
Q_b = flow entering the system across the upgradient area	0	m^3/day
C_b = background nitrate concentration	0	mg/L
Q_e = flow entering the system from the septic drainfield	45	m^3/day
C_e = concentration of nitrates in the septic effluent	40	mg/L
Q_i = flow entering the system from infiltration (with 'storminf')	145	m^3/day
C_i = Concentration of nitrates in the infiltrate	0	mg/L
C_T =	**9.476**	**mg/L**
Estimate Number of Lots	**45**	**lots**

* = see separate weighted infiltration factor calculations



patersongroup
consulting engineers
154 Colonnade Road, Ottawa, Ontario K2E 7J5

Date	Description	Rev
1-SEP-16	PH2095-LET 01	

1384341 ONTARIO INC.

Project
PROPOSED SUBDIVISION
1240 OLD PRESCOTT ROAD
OTTAWA (GREELY), ONTARIO

TEST HOLE LOCATION PLAN

Scale: 1:2500	Drawn by: RLC
Designed by: AVS	Checked by: SW
Drawing no.: **PH2095-1**	

patersongroup

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February 6, 2017
File: PH2095-MEM.01

Stantec
1331 Clyde Ave #400
Ottawa
Ontario
K2C 3G4

MEMO

Attention: **Amanda Lynch, P.Eng.**

Subject: **Further Supporting Information Regarding Review Comments dated May 3, 2016 Minimum Stormwater Infiltration Volume and Mounding 1240 Old Prescott Road, Ottawa, Ontario**

Dear Ms. Lynch

This letter is provided in response to City of Ottawa/SNCA review comments dated May 3, 2016, and subsequent discussions.

Nitrate Impact Assessment Calculation – Minimum Volume for Infiltration Due to Stormwater Management

The nitrate impact assessment calculation that was presented in Paterson's letter dated November 8, 2016 uses 41% as the volume of stormwater infiltration (41%).

Stantec's calculations show that stormwater runoff from impervious surfaces draining to the infiltration areas will be fully infiltrated for rainfall events up to 15 mm (total volume is approx. 13,393 m^3 year). This is equivalent to 41% of the total annual runoff volume (i.e. total annual rainfall landing on impervious areas within the site).

Using the same method, we can calculate the minimum volume of stormwater that would need to be infiltrated in order to keep the nitrate concentration below 10 mg/L. The minimum volume of stormwater that would need to be infiltrated per year is **9,765 m^3** (see calculation below).

Infiltration Calculation		
Nitrate concentration in precipitation (C_i) =	0	mg/L
Preciptation (from Environment Canada climate normals)	943.4	mm/yr
Surplus Water (Environment Canada)	384	mm/yr
Factored Water Surplus =	253	mm/yr
Infiltraion % due to stormw ater management measures	30%	
Runoff volume (all w ater running off impervious areas)	32,551	m^3
Minimum 'storminf' volume	9,765	m^3/year
	27	m^3/day
Infiltration Flow Entering the System (Q_i) =	108	m^3/day
Infiltration Flow Entering the System (Q_i w ith 'storminf') =	135	m^3/day
Mass Balance Model (MOEE, 1995)		
$C_T = (Q_bC_b+Q_eC_e+Q_iC_i)/(Q_b+Q_e+Q_i)$ = Cumulative Nitrate Concentration		
Q_b = flow entering the system across the upgradient area	0	m^3/day
C_b = background nitrate concentration	0	mg/L
Q_e = flow entering the system from the septic drainfield	45	m^3/day
C_e = concentration of nitrates in the septic effluent	40	mg/L
Q_i = flow entering the system from infiltration (w ith 'storminf')	135	m^3/day
C_i = Concentration of nitrates in the infiltrate	0	mg/L
C_T=	**9.999**	**mg/L**
Estimate Number of Lots	**45**	**lots**

Mounding

It has been suggested that groundwater mounding beneath the dry pond could be an issue if inflow due to storm events is relatively ongoing and creates mounding that reaches the base elevation of the dry pond.

The maximum height of water in the pond will be controlled by the pond outlet pipe which will be 10 cm above the base of the pond. So there can only be a maximum of 10 cm water depth in the pond at any time.

We can calculate the approximate amount of time it will take for the mound to dissipate (i.e. for groundwater to go back down to its normal level) by using the equation that is commonly used for falling head permeability tests, i.e.:

$$k = \frac{aL}{At} \ln \frac{h_0}{h_1}$$

Where,

K	= Coefficient of permeability
a	= Area of the burette
L	= Length of soil column
A	= Area of the soil column
h_0	= Initial height of water
h_1	= Final height of water = $h_0 - \Delta h$
t	= Time required to get head drop of Δh

The areas cancel each other out, so, rearranging for time, we can calculate the following:

Time for water level to drop to base of pond			
initial water height	h1	0.35	
final water height	h2	0.25	
length of soil column	L	0.15	
hydraulic conductivity	K	5.50E-06	m/sec
	9177	seconds	
	153	minutes	
	3	hours	

Time for full dissipation of mound			
initial water height	h1	0.35	
final water height	h2	0.01	
length of soil column	L	0.15	
hydraulic conductivity	K	5.50E-06	m/sec
	96964	seconds	
	1616	minutes	
	27	hours	

Based on the analysis we can say that any ponding will recover over three hours with the groundwater level returning to normal levels in 27 hours.

We trust that this information satisfies your requirements.

patersongroup

LICENSED PROFESSIONAL ENGINEER
06/01/17
S.J.G. WALKER
48620504
PROVINCE OF ONTARIO

Russell L. Chown, P.Geo.
Senior Hydrogeologist

(with input from Stephen J. Walker, P.Eng.)

Rainfall Analysis

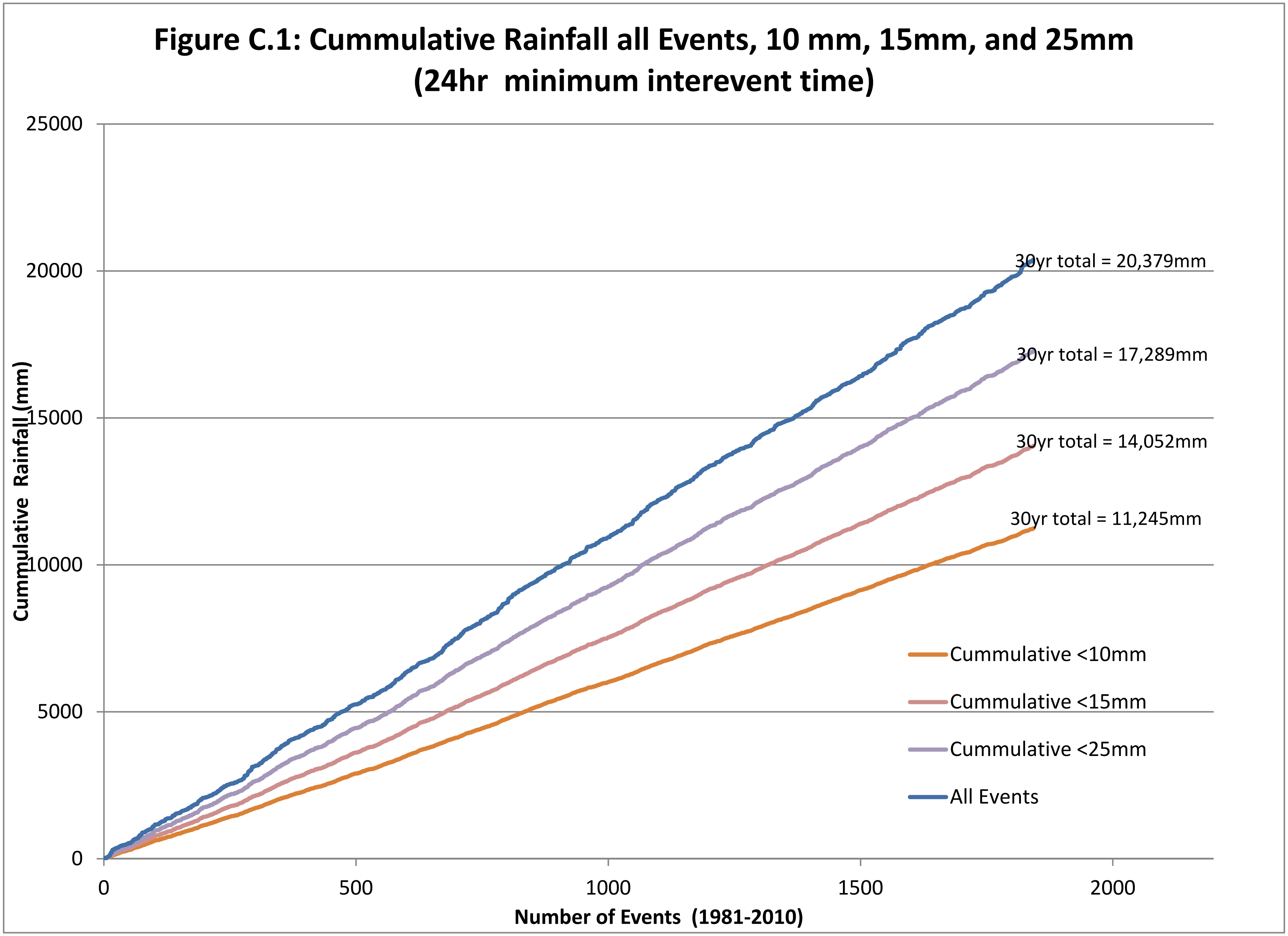


Figure C.1: Cummulative Rainfall all Events, 10 mm, 15mm, and 25mm
(24hr minimum interevent time)
25000
20000
15000
10000
5000
0
Cummulative Rainfall (mm)
0
500
1000
1500
2000
Number of Events (1981-2010)
30yr total = 20,379mm
30yr total = 17,289mm
30yr total = 14,052mm
30yr total = 11,245mm
Cummulative <10mm
Cummulative <15mm
Cummulative <25mm
All Events

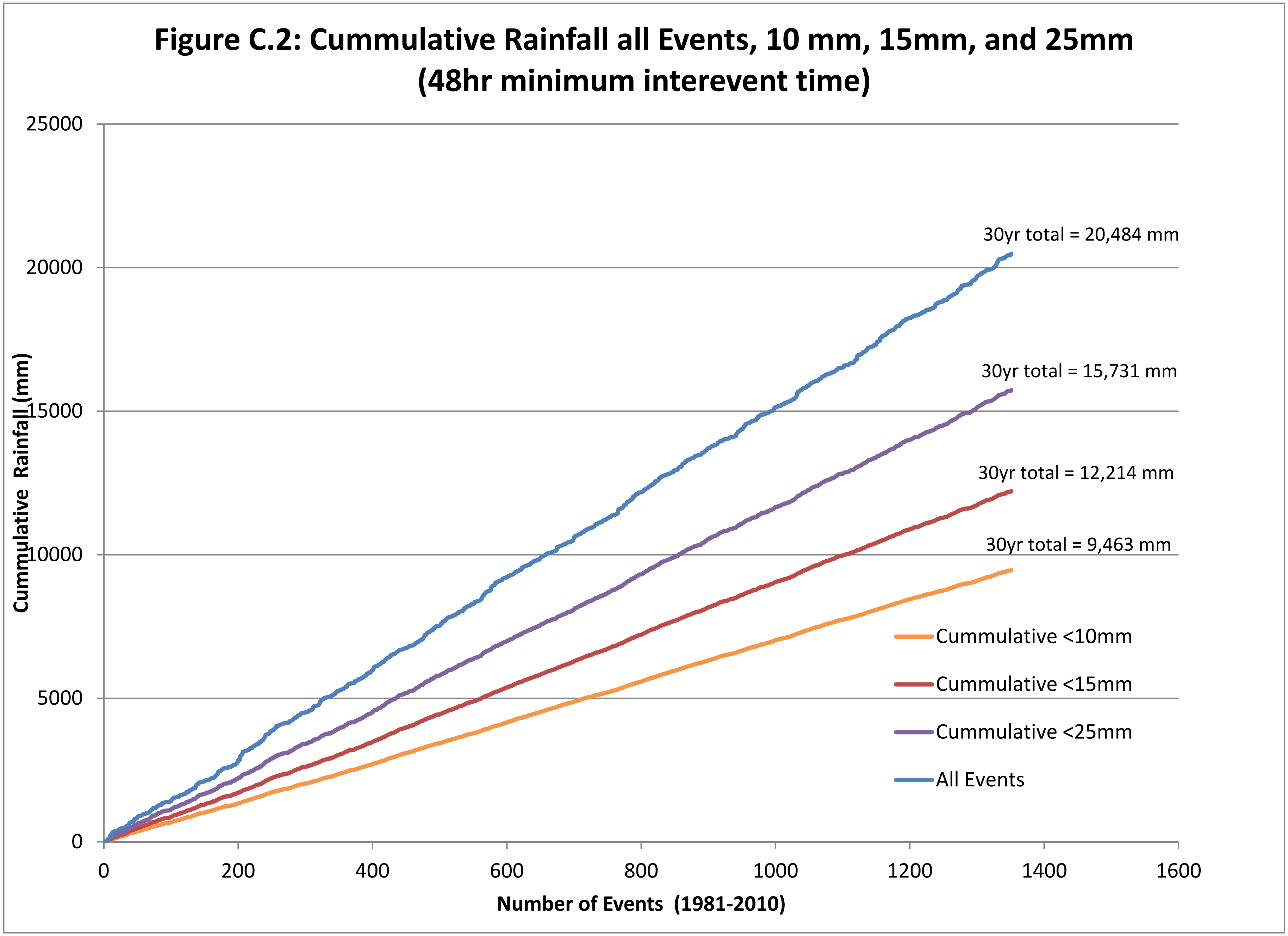
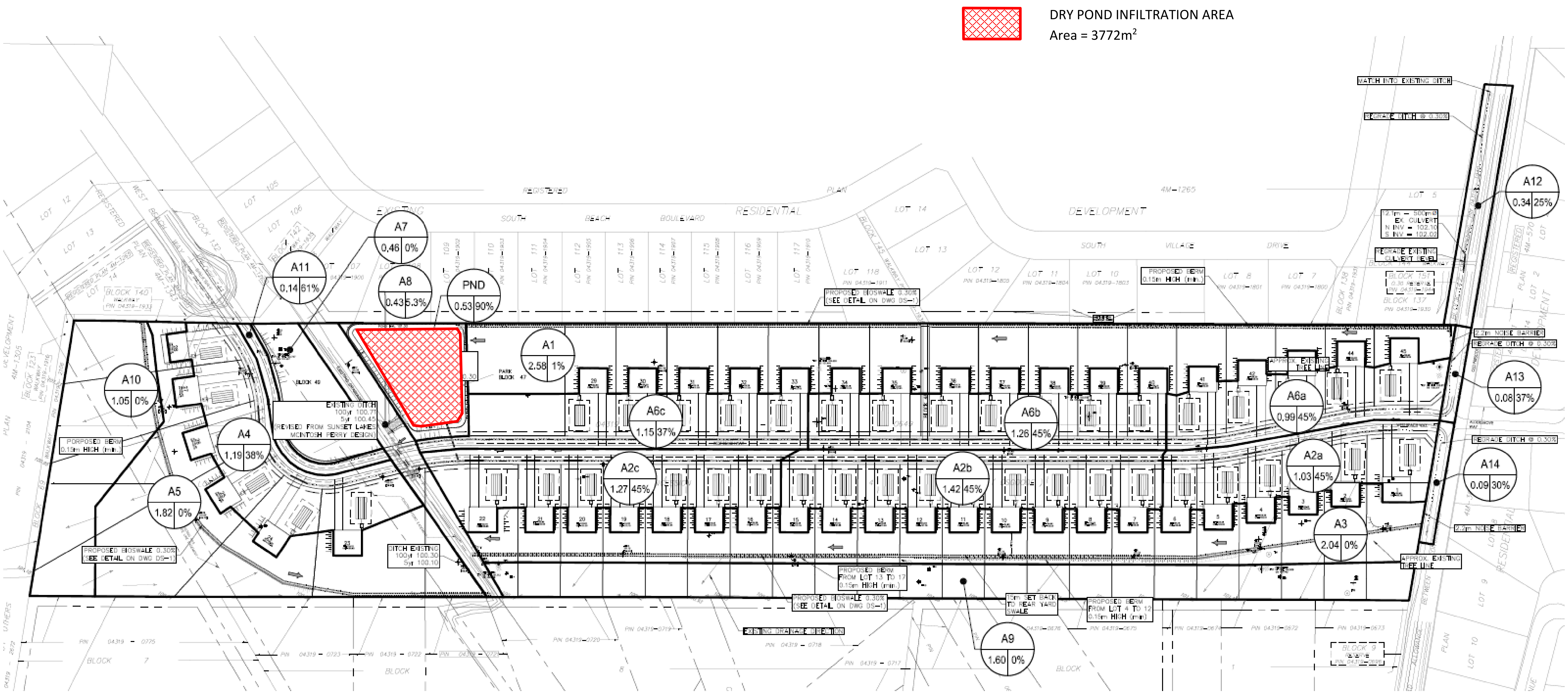


Figure C.2: Cummulative Rainfall all Events, 10 mm, 15mm, and 25mm
(48hr minimum interevent time)
30yr total = 20,484 mm
30yr total = 15,731 mm
30yr total = 12,214 mm
30yr total = 9,463 mm
Cummulative <10mm
Cummulative <15mm
Cummulative <25mm
All Events
Cummulative Rainfall (mm)
Number of Events (1981-2010)
0
5000
10000
15000
20000
25000
0
200
400
600
800
1000
1200
1400
1600

Infiltration Calculations

FIGURE C.3: INFILTRATION AREAS FOR WATER BALANCE CALCULATIONS AND NITRATE DILUTION



Infiltration Rate Calculations from Peremeameter Test Results

Notes:
-test results per Paterson field testing
-infiltration rate calculated per CVC LID Manual Figure C1 where $K_{fs} = 6x10^{-11}i^{3.7363}$
-safety factor per Credit Valley Conservation Low Impact Development Manual for infiltration calculations for dry swales and bioswales (Table C2)

Auger hole ID	Test interval depth (m)		Rate of WL change in permeameter (cm/min)	Calculated K_{fs} (m/s)	Converted K_{fs} (cm/s)	Infiltration rate (i) (mm/hr)	Average infiltration (mm/hr)	Ratio average to lowest rate	Safety factor	Corrected infiltration (mm/hr)
AH1	0.39	0.54	12.00	6.40E-05	6.40E-03	140.82	137.59	1.11	3.50	40.23
AH2	0.36	0.51	15.00	8.00E-05	8.00E-03	149.48				
AH3	0.13	0.28	7.50	4.00E-05	4.00E-03	124.17				
AH4	0.51	0.66	10.50	5.60E-05	5.60E-03	135.87				
AH5	0.10	0.25	3.00	1.60E-05	1.60E-03	97.17	107.07	1.10	3.50	27.76
AH6	0.56	0.71	6.00	3.20E-05	3.20E-03	116.97				
AH7	0.10	0.25	9.60	5.10E-05	5.10E-03	132.52	129.30	1.03	3.50	37.86
AH8	0.26	0.41	9.00	4.80E-05	4.80E-03	130.38				
AH9	0.46	0.61	6.00	4.10E-05	4.10E-03	125.00				
AH10	0.11	0.26	0.50	2.70E-06	2.70E-04	60.35	76.95	1.28	3.50	17.24
AH11	0.25	0.40	0.50	3.50E-06	3.50E-04	64.69				
AH12	0.55	0.70	4.10	2.20E-05	2.20E-03	105.81				
AH13	0.09	0.24	1.70	9.00E-06	9.00E-04	83.30	70.67	1.25	3.50	23.80
AH14	0.26	0.41	0.40	2.10E-06	2.10E-04	56.43				
AH15	0.47	0.62	1.00	5.30E-06	5.30E-04	72.29				

1240 Old Prescott Road
160401012
revised: May 30, 2017

Infiltration Calculations for Basin

1) Summary of Site Areas

Area ID	area (ha)	% imp	imperv area (ha)
A1	2.64	1.00	0.03
A2a,b,c	3.72	38.66	1.44
A6a,b,c	3.40	45.00	1.53
A4	1.16	38.00	0.44
PND	0.53	90.00	0.48
A12	0.34	25.00	0.09
A13	0.08	37.00	0.03
A14	0.09	30.00	0.03
Total	**11.96**	**34.17**	**4.05**

2) Runoff volume for infiltration			
Rainfall depth captured for infiltration	15.00	mm	
total site impervious area	4.05	ha	
Impervious area captured by ditches to pond	2.97	ha	Impervious area from A2a,b,c and A6a,b,c
15mm rainfall event runoff volume	445.2	m3	
Residual volume to be infiltrated in pond	445.2	m3	
3) Infiltration Basin Under Pond			
area	3772.00	m2	
depth	0.15	m	
volume	565.80	m3	
Porosity of clearsone basin	0.40		
storage volume in clear stone	226.32	m3	
Depth of ponded water for infiltration	0.10	m	
Volume of ponded water for infiltration	377.20	m3	
total volume stored for infiltration	603.52	m3	
Volume Check (storage > residual from trenches)	TRUE		
Target drawdown time	48.00	hr	
Required infiltration rate	**3.33**	**mm/hr**	
Target drawdown time	24.00	hr	
Required infiltration rate	**6.67**	**mm/hr**	
Measured infiltration rate	**23.80**	**mm/hr**	average for pond area
Actual drawdown time	**6.72**	**hr**	assumes no groundwater mounding (see report for mounding discussion)
4) Total Annual Runoff Infiltrated			
15mm event is approx	0.65	of annual rainfall	(average of 24 and 48hrl interevent analysis)
total annual rainfall	689	mm/yr	Environment Canada historical rainfall average
Rainfall infiltrated	448	mm/yr	
Min volume infiltrated	**13292**	**m3/yr**	Annual runoff from impervious areas that is infiltrated (for use in nitrate dilution calculations)

Design Drawings