

Stormwater Management - Grading & Drainage - Storm & Sanitary Sewers - Watermains

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DRAINAGE STUDY
PART OF CARDEVCO SUBDIVISION
106 TO 181 WESCAR LANE
& 121 TO 135 CARDEVCO ROAD
AND THE
REMOVAL OF A 9.0M DRAINAGE EASEMENT
AT 151-159 WESCAR LANE, OTTAWA

REPORT No. 22111-DS

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1.0 Introduction

It is understood that City staff is prepared to review the request to remove the 9.0 m drainage easement located to the west and south of 151-159 Wescar Lane, provided it can be demonstrated that the removal would not have an adverse impact on the subdivision's drainage system and adjacent properties. This Drainage Study provides relevant background information and demonstrates the impact of the removal of the easement and analyses ditches and culverts in drainage areas that include 106 to 181 Wescar Lane (which includes the proposed development at 151-159 Wescar Lane) and 121 to 135 Cardevco Road.

D. B. Gray Engineering Inc has worked on several properties within the subdivision and have topographic information and/or grading plans for the following properties and adjacent roadside ditches and culverts (refer to Appendices H & I):

- 135 Cardevco Road (topographic survey and grading plan).
- 131 Wescar Lane,
- 151-159 Wescar Lane (subject property),
- 159 Wescar Lane (including part of 151 Wescar Lane and lands to the west),
- 165 Wescar Lane, and
- 172-180 Wescar Lane.

In addition, topographic information and/or grading plans have been obtained for the following properties and adjacent roadside ditches and culverts (refer to Appendix I):

- 123-127 Cardevco Road,
- 123 Wescar Lane.
- 141 Wescar Lane, and
- 123 Wescar Lane.

2.0 DRAINAGE

The Transfer of Easement, dated November 15, 1982, indicates that the Township of West Carleton (now within the City of Ottawa) has the right to enter the easement to "construct, repair and replace the drainage works". No purpose other than drainage is identified (refer to Appendix A).

Schedule "R" of the Cardevco Subdivision Agreement (dated November 15, 1982), refers to six subdivision drawings, including a Grading Plan. None of these drawings were initially found; however, the original owner of the subdivision has produced three of the drawings including the Grading Plan (refer to Appendix A).

The subdivision Drainage Report is Schedule "H" of the Cardevco Subdivision Agreement (refer to Appendix A). The following are excerpts (with comments):

- "Under present conditions, the subdivision lands drain to an existing creek along the southern boundary with the exception of 2.9 hectares which drain to the Old Almonte Road (in the northwest corner)."
 - (Old Almonte Road is now known as Cavanmore Road. About 1.7 of the 2.9 ha drains from 159 Wescar Lane. However, based on the subdivision Grading Plan, which indicates 'existing' (i.e. 1980) grade elevations, the area is about 2.2 ha (1.9 ha excluding the 11 m Cavanmore Road road widening of which 1.0 ha is draining from 159 Wescar Lane (refer to Figure 2 in Appendix F). Based on recent topographic surveys, the actual area is about 1.5 ha (1.2 ha excluding the 11 m Cavanmore Road road widening of which 0.6 ha is draining from 159 Wescar Lane (refer to Figure 3 in Appendix F).)
- "It is intended to direct the runoff from the lands through a series of roadside ditches and rear lot swales to an existing roadside ditch on Regional Road No.5."

- (Regional Road No.5. is Carp Road. Except for the 2.9 ha it is apparent that the roadside ditches and culverts were intended to be sized to accommodate the entire subdivision. The subdivision Grading Plan indicates that all roadside ditches drain to Carp Road.)
- "The outlet for the 2.9 hectares in the in the northwest corner of the subdivision will also have to be upgraded."
 - (Based on the subdivision Grading Plan the outlet appears to be a 400 mm culvert crossing Cavanmore Road near the northwest corner of the subject property that was intended to be replaced with a 600 mm culvert. The culvert was recently found and measured; it is 400 mm in diameter, so evidently it was not replaced. Also based on the subdivision Grading Plan this culvert outlets to a ditch on the north side of Cavanmore Road that appears to convey the drainage to the west towards the rear yard of 100 Huntley Manor Drive. However, based on recent observations this ditch may no longer exist as it appears that the drainage from the outlet of the culvert is first conveyed about 10 m northeast along the roadside ditch before it drains north, towards the rear lot line of 100 Huntley Manor Drive (refer to Figure 1 in Appendix B).
- "Rear lot swales shall be a minimum depth of 450 mm to a maximum depth of 1500 mm. The side slope shall be 3 horizontal to 1 vertical." "The rear lot swales shall be provided where it is likely that runoff would occur onto property held by others." "It is not proposed at this time to alter the creek which runs through the most southern section of the subdivision. development of this land has negligible effect on the amount of runoff to the creek." (Based on the subdivision Grading Plan, almost the entire swale (about 540 m) would drain to the creek and only about 50 m would drain northwest to the Cavanmore Road. Since it was the intent that the subdivision would have "negligible effect on the amount of runoff to the creek" it is apparent that the swale was intended to convey negligible drainage. Regardless, based on the lot Grading Plan for 123 Wescar Lane (refer to Appendix I) it is not possible construct this rear lot swale to convey drainage to the creek because the stormwater management (SWM) facility for 123 Wescar Lane is located within the easement (this SWM facility is part of an approved site plan, and an Environmental Compliance Approval (ECA) has been issued for this facility). Furthermore, based on individual lot Grading Plans and recent visual inspections, it is evident that the 9.0 m easements on 131 & 141 Wescar Lane are not used to convey drainage to the creek.) Based on the subdivision Drainage Report, the rear lot swales are not intended to convey drainage from adjacent properties; and recent topographic surveys confirm this (refer Figures 1, 2 & 3 and Appendices G & H). Based on the subdivision Grading Plan, topographic surveys and individual lot Grading Plans, about 4.2 ha of the subdivision's pre-development drainage drained to the creek of which 151-159 Wescar Lane contributed about 2.5 ha (refer to Figures 2 & 3 in Appendix F); and about 1.5 ha of the subdivision post development drainage will drain to the creek of which 151-159 Wescar Lane contributes only about 0.3 ha (refer to Figures 1 in Appendix C). Therefore, considering all of the above, especially since drainage to the creek will be reduced by about 88% to about 0.3 ha; the rear lot swales are not required for at least the subject development, and the 9.0m easement can be removed from 151-159 Wescar Lane.)
- "For the design of the ditches and drainage structures, the Rational Formula was used."

 (As is accepted in the Ottawa Sewer Design Guidelines, Rational Formula was used in the calculations in this report.)
- "The 10 year rainfall frequency curve was used to determine the ditch and culvert sizing."

 (Except where noted, the 10-year rainfall frequency curve was used in the calculations in this report. Table 6.4 (Road Type vs. Culvert Design Storm) in the Ottawa Sewer Design Guidelines indicates that the design storm for local rural roads is 10 years.)

Excerpt from the City's Phase 3 Pre-Consultation: Review Feedback, dated February 14, 2024 (with comments):

- "It seems that the direction of drainage of the ... majority of the site draining through the easement system, with final outlet to the tributary south of the site."

 (Based on the above evidence, this was not the intent of the subdivision drainage design.)
- "As the design is looking to convey water to the Wescar Lane ditch, engineering support must be provided to demonstrate that the Wescar ditch system can accommodate the additional

flows from the proposed development, as the original subdivision approval did not consider subject land flows to be accommodated through the Wescar Lane ditches."

(Based on the above evidence, except for about 0.6 to 1.7 ha draining to Cavanmore Road, the original subdivision approval <u>did</u> consider flows from a development on subject property to be accommodated through the Wescar Lane roadside ditches.)

Based on the subdivision Grading Plan, the culvert crossing Wescar Lane at the intersection of Cardevco Road (culvert C-2) was to be 750 mm diameter CSP, but an 800 mm CSP has been installed. Also based on the subdivision Grading Plan, all entrance culverts were to be 600 mm in diameter except at the north and west sides of Cardevco Road which were to be 750 mm in diameter. However, most, if not all, entrance culverts appear to be 500 mm including the two that were measured at 141 Wescar Lane (culvert C-1) and 135 Cardevco Road (culvert C-3). (The Cardevco Road entrance culverts were overtopping following the aftermath of the June 6, 2024 storm (refer to photographs in Appendix J). The Wescar Lane entrance culverts were not observed to be overtopping. According to Environment Canada 44 mm fell at the airport within an hour and estimates based on radar indicated that some parts of the city would have received between 50 and 60 mm. The storm in the Cardevco subdivision area was probably at least a 25-year event, but it could have been a 100-year or rarer event.)

As required by the Ottawa Sewer Design Guidelines, open channel systems (which include ditches) are to be designed based on Manning's Formula, which was used in the calculations in this report. Based on the subdivision Drainage Report, a Manning's roughness coefficient (n-value) of 0.027 was used for the roadside ditches. This n-value is typical of 'gravel / short grass', which could be considered appropriate for the Cardevco Road ditches and culverts analyzed; however, the Wescar Lane roadside ditches are generally not maintained; therefore, a n-value of 0.10 was used, which is typical of 'dense weeds and brush as high as flow.

The U.S. Department of Transportation Federal Highway Administration (FHWA) HY-8 Culvert Analysis Program (HY-8) was used to analyze the culverts.

Summaries of the Calculations:

A. Existing Conditions Plus Proposed Development:

(Refer to calculations In Appendix C.)

Based on existing conditions and the existing developments at 106 to 154 & 162 to 173 Wescar Lane and 121 to 127 Cardevco Road plus the proposed development at 151-159 Wescar Lane:

- the calculated peak flow at 141 Wescar Lane is 0.73 m³/s of which 0.25 m³/s overtops the 500 mm culvert (C-1) at a flow depth of about 70 mm,
- the calculated peak flow at the culvert crossing Wescar Lane at the intersection of Cardevco Road (C-2) is 0.76 m³/s of which 0.15 m³/s overtops the 800mm culvert at a flow depth of about 50 mm,
- the calculated peak flow at 135 Cardevco Road is 0.96 m³/s of which 0.78 m³/s overtops the 500 mm culvert (C-3) with a flow depth of about 130 mm,
- during the 2-year storm event the calculated peak flow does not overtop culverts C-1 and C-2, and
- during the 2-year storm event the calculated peak flow at 135 Cardevco Road is 0.58 m³/s of which 0.42 m³/s overtops the 500 mm culvert (C-3) with a flow depth of about 90 mm.

Most, if not all, of the existing entrance culverts in the subdivision are undersized. It is expected that all the entrance culverts on the west and south side of Wescar Lane (south of the proposed development) will overtop during the 10-year event; but will not during the 2-year. The area of the drainage area on the east and west side of Wescar Lane is 69% less than the other side of the road and the peak flow rate is 74% less; therefore, it is expected that the entrance culverts on the east and north side of Wescar Lane will not overtop during the 10-ear event. Culvert C-2 crossing Wescar Lane at the intersection of Cardevco Road is 800 mm in diameter but, as per the

subdivision Drainage Report, it should have been only 750 mm. Although it is oversized, the peak flow overtops culvert C-2 during the 10-year event, but not the 2-year. As previously mentioned, the entrance culvert at 135 Cardevco Road (C-3) is 500 mm in diameter but, as per the subdivision Drainage Report, it should have been 750 mm. It is expected that all the entrance culverts on the west and north side of Cardevco Road will overtop during both the 10-year and 2-year events. As previously noted, based on the subdivision Drainage Report, a Manning's n-value of 0.027 (typical of a maintained ditch) was originally used for all ditches; however, since the Wescar Lane roadside ditches are generally not maintained, an n-value of 0.10 (typical of 'dense weeds and brush as high as flow') was used in all calculations (except as noted). If the Wescar Lane roadside ditches are maintained (i.e. with n-value of 0.027) the peak flow would overtop culverts C-2 and C-3 more frequently; and it is expected that all the entrance culverts on the west and north side of Cardevco Road would overtop more frequently.

B. If the Culverts are Sized as per Subdivision Drainage Report and 1.7 ha of the Proposed Development Drained to Cavanmore Road:

(Refer to calculations In Appendix D.)

As previously noted, as per the subdivision Drainage Report, 2.9 ha was intended to drain to Cavanmore Road, of which about 1.7 drains from 159 Wescar Lane. Therefore, based on culverts sized as per original subdivision drainage report, the existing developments at 106 to 154 & 162 to 173 Wescar Lane and 121 to 127 Cardevco Road plus the proposed development at 151-159 Wescar Lane with 1.7 ha draining to Cavanmore Road:

- the calculated peak flow at 141 Wescar Lane is 0.60 m³/s the flow does not overtop culvert C-1 if it is 600 mm in diameter,
- the calculated peak flow at the culvert crossing Wescar Lane at the intersection of Cardevco Road (C-2) is 0.73 m³/s of which 0.19 m³/s overtops the 750mm culvert at a flow depth of about 50 mm, and
- the calculated peak flow at 135 Cardevco Road is 1.03 m³/s of which 0.45 m³/s overtops the 750 mm culvert (C-3) with a flow depth of about 100 mm.

If the entrance culverts were sized as per the subdivision Grading Plan, the Wescar Lane culverts would not overtop during the 10-year event. However, the culvert crossing Wescar Lane at the intersection of Cardevco Road (C-2) would still overtop during the 10-year event; as would the entrance culvert at 135 Cardevco Road (C-3). If the entrance culverts were sized correctly, it is expected that all the entrance culverts on the west and north side of Cardevco Road would still overtop during the 10-year event. As previously mentioned, based on the subdivision Drainage Report, a Manning's n-value of 0.027 was used for the roadside ditches (typical of a maintained ditch); therefore, 0.027 was used for all ditch calculations in this scenario. However, since the Wescar Lane roadside ditches are generally not maintained (and n-value of 0.10 was used in all other calculations), if 0.10 was used in this scenario the conditions would improve at all culverts.

C. Existing Conditions Plus Proposed Development Using Restricted Flows:

(Refer to calculations In Appendix E.)

It is known that there are existing or proposed stormwater management facilities that include ICDs (inlet control devises) that restrict the flow, at 165, 151-159, 141 & 131 Wescar Lane (and there may be other properties). Based on existing conditions and the existing developments at 106 to 154 & 162 to 173 Wescar Lane and 121 to 127 Cardevco Road plus the proposed development at 151-159 Wescar Lane and using restricted flows at 165, 151-159, 141 & 131 Wescar Lane:

- the calculated peak flow at 141 Wescar Lane is 0.19 m³/s the flow does not overtop culvert C-1.
- the calculated peak flow at the culvert crossing Wescar Lane at the intersection of Cardevco Road (C-2) is 0.28 m³/s the flow does not overtop the culvert,

- the calculated peak flow at 135 Cardevco Road is 0.51 m³/s of which 0.35 m³/s overtops the culvert C-3 with a flow depth of about 80 mm,
- during the 2-year storm event the calculated peak flow at 135 Cardevco Road is 0.37 m³/s of which 0.22 m³/s overtops culvert C-3 with a flow depth of about 60 mm.

Accounting that some of the flow is restricted flows through the four known ICDs (there may be more), and although the Wescar Lane entrance culverts are undersized, none will be overtopped during the 10-year event; and the culvert C-2 crossing Wescar Lane at the intersection of Cardevco Road is also no longer overtopped. However, since culvert C-3 at 135 Cardevco Road is overtopped, it is expected that, even accounting for the restricted flows, all the entrance culverts on the west and north side of Cardevco Road are expected to overtop during the 10-year event.

D. Existing Conditions Plus Proposed Development with 0.6 ha of the Proposed Development Draining to Cavanmore Road:

(Refer to calculations In Appendix F.)

As previously noted, as per the subdivision Drainage Report, 2.9 ha was intended to drain to Cavanmore Road, of which about 1.7 drains from 159 Wescar Lane. However, also as previously noted, based on the subdivision Grading Plan, the area is about 2.2 ha of which 1.0 ha is draining from 159 Wescar Lane; and based on recent topographic surveys, the actual area is about 1.5 ha of which 0.6 ha is draining from 159 Wescar Lane. It would not be prudent to increase the area that is currently draining to Cavanmore Road. Therefore, based on the existing developments at 106 to 154 & 162 to 173 Wescar Lane and 121 to 127 Cardevco Road plus the proposed development at 151-159 Wescar Lane with 0.6 ha draining to Cavanmore Road:

- the calculated peak flow at 141 Wescar Lane is 0.65 m³/s of which 0.17 m³/s overtops the culvert C-1 at a flow depth of about 50 mm,
- the calculated peak flow at the culvert crossing Wescar Lane at the intersection of Cardevco Road (C-2) is 0.69 m³/s of which 0.07 m³/s overtops the culvert at a flow depth of about 30 mm, and
- the calculated peak flow at 135 Cardevco Road is 0.90 m³/s of which 0.72 m³/s overtops culvert C-3 with a flow depth of about 120 mm.

With 0.6 ha of 159 Wescar Lane draining to Cavanmore Road the peak flow is less than with scenario A, but it is expected that all the entrance culverts on the west and south side of Wescar Lane (south of the proposed development) will still overtop during the 10-year event (but will not during the 2-year). Culvert C-2 crossing Wescar Lane at the intersection of Cardevco Road is overtopped during the 10-year event, but it is expected that it will not during the 2-year. It is expected that all the entrance culverts on the west and north side of Cardevco Road will still overtop during both the 10-year and 2-year events.

E. Proposed Development at 151-159 Wescar Lane and Its Impact on Flooding on Cardevco Road:

(Refer to calculations In Appendix G.)

As previously noted, most, if not all, of the existing entrance culverts in the subdivision are undersized and it is expected that all the entrance culverts on the west and north side of Cardevco Road will overtop during the 10-year event and cause flooding on Cardevco Road. And as previously mentioned the Cardevco Road entrance culverts were overtopping following the aftermath of the June 6, 2024 storm (probably at least a 25-year event, but it could have been a 100-year or rarer event). Based on the subdivision Grading Plan, about 1.2 ha of the predevelopment drainage of 151-159 Wescar Lane drains to the Wescar Lane roadside ditch (refer to Figure 2 in Appendix F); and based on topographic surveys, about 1.7 ha of the predevelopment drainage of 151-159 Wescar Lane drains to the Wescar Lane roadside ditch (refer to Figure 3 in Appendix F). Therefore, based on pre-development conditions it is calculated that 121.28 L/s to 176.01 L/s drains to the Wescar lane roadside ditch during the 100-year event; and

62.29 L/s to 90.41 L/s during the 10-year event (the variation depends on whether 1.2 ha or 1.7 ha draining to Wescar Lane is used for the pre-development conditions). The previously proposed stormwater management facility for 151-159 Wescar Lane would have used an ICD with a 154 mm orifice to restrict the flowrate draining to Wescar Lane to 107.04 L/s during the 100-year event; reducing the flowrate by 12% to 39%. However, during the 10-year event, while the flowrate would be restricted 70.78 L/s; the flowrate would be reduced by 22% or increased by 14%, depending on whether 1.2 ha or 1.7 ha is used for the pre-development conditions. To be conservative, the proposed stormwater management facility for 151-159 Wescar Lane now uses an ICD with a 139 mm orifice to restrict the flowrate draining to Wescar Lane to 94.85 L/s during the 100-year event reducing the flowrate by 22% to 46%; and, during the 10-year event the flowrate will be restricted to 62.24 L/s; reducing the flowrate by 0 to 31%. Therefore, due the proposed stormwater management facility, the proposed development 151-159 Wescar Lane, is expected to have no adverse effect on the existing downstream flooding on Cardevco Road.

3.0 CONCLUSIONS

- 1. Given that:
 - it was the intent that the subdivision would have "negligible effect on the amount of runoff to the creek" it is apparent that the rear lot swale was intended to convey negligible drainage;
 - it is not possible construct this rear lot swale to convey drainage to the creek because the SWM facility for 123 Wescar Lane is located within the easement;
 - the 9.0 m easements on 131 & 141 Wescar Lane are not used convey drainage to the creek;
 - the rear lot swales are not intended to convey drainage from adjacent properties;
 - about 2.5 ha of 151-159 Wescar Lane pre-development drainage drained to the creek; and
 - about 0.3 ha of 151-159 Wescar Lane <u>post</u> development drainage will drain to the creek, an 88% reduction.

The rear lot swales are not required at the subject development, and the 9.0m easement can be removed from 151-159 Wescar Lane.

- 2. As per the subdivision Drainage Report, 2.9 hectares of subdivision land drained to Cavanmore Road, and it was the intent that this area would continue to drain to Cavanmore Road (of which 1.0 ha would be draining from 159 Wescar Lane). However, the actual area is about 1.5 ha (of which 0.6 ha is draining from 159 Wescar Lane). It would not be prudent to increase the area that is currently draining to Cavanmore Road.
- 3. Except for the 2.9 ha, the intent was to direct the runoff from subdivision via roadside ditches to an existing roadside ditch on Carp Road; therefore, it is apparent that the roadside ditches and culverts were intended to be sized to accommodate the entire subdivision (except for 2.9 ha).
- 4. The subdivision Drainage Report states: "The outlet for the 2.9 hectares in the in the northwest corner of the subdivision will also have to be upgraded." As per the subdivision Grading Plan the outlet appears to be a 400 mm culvert crossing Cavanmore Road near the northwest corner of the subject property and that it was intended to be replaced with a 600 mm culvert. It was not replaced.
- 5. Except for the culvert crossing Wescar Lane at the intersection of Cardevco Road, most, if not all, culverts within the subdivision are undersized. As per the subdivision Drainage report entrance culverts were to be 600 mm in diameter except at the north and west sides of Cardevco Road which were to be 750 mm in diameter; however, most, if not all, entrance culverts appear to be 500 mm.
- 6. The Cardevco Road entrance culverts were overtopping following the aftermath of the June 6, 2024 storm (estimated to be a 25 to 100-year or rarer event). The Wescar Lane entrance culverts were not observed to be overtopping.

- 7. Assuming existing conditions plus the proposed development, based on the calculations presented in this report:
 - it is expected that all the entrance culverts on the west and south side of Wescar Lane (south of the proposed development) will overtop during the 10-year event; but will not during the 2-year.
 - it is expected that the entrance culverts on the east and north side of Wescar Lane will not overtop during the 10-ear event,
 - it is expected that culvert C-2 crossing Wescar Lane at the intersection of Cardevco Road will overtop during the 10-year event, but not the 2-year,
 - it is expected that all the entrance culverts on the west and north side of Cardevco Road will overtop during both the 10-year and 2-year events,
 - Wescar Lane roadside ditches are generally not maintained; but if they were maintained, it is
 expected that all culverts, especially all the entrance culverts on the west and north side of
 Cardevco Road, would overtop more frequently.
- 8. Based on the calculations presented in this report, if the culverts were sized as per the subdivision Grading Plan, during the 10-year event it is expected that the culvert crossing Wescar Lane at the intersection of Cardevco Road and all the entrance culverts on the west and north side of Cardevco Road would still overtop.
- 9. Based on the calculations presented in this report: Accounting that some of the flow is restricted flows through the four known ICDs (there may be more), Wescar Lane entrance culverts are not overtopped during the 10-year event; as is the culvert crossing Wescar Lane at the intersection of Cardevco Road. However, it is expected that, even accounting for the restricted flows, all the entrance culverts on the west and north side of Cardevco Road are expected to overtop during the 10-year event.
- 10. Based on the calculations presented in this report, if 0.6 ha of 159 Wescar Lane drained to Cavanmore Road the peak flow is less, but it is expected that:
 - all the entrance culverts on the west and south side of Wescar Lane (south of the proposed development) will still overtop during the 10-year event, but will not during the 2-year,
 - the culvert crossing Wescar Lane at the intersection of Cardevco Road will still overtop during the 10-year event, but not during the 2-year, and
 - it is expected that all the entrance culverts on the west and north side of Cardevco Road will still overtop during both the 10-year and 2-year events.
- 11. Due the proposed stormwater management facility, the proposed development 151-159 Wescar Lane, is expected to have no adverse effect on the existing downstream flooding on Cardevco Road.

Prepared by D.B. Gray Engineering Inc.



APPENDIX A

CARDEVCO SUBDIVISION
DRAINAGE REPORT & GRADING PLANS

SCHEDULE "H"

DRAINAGE REPORT

Under present conditions, the subdivision lands drain to an existing creek along the southern boundary with the exception of 2.9 hectares which drain to the Old Almonte Road (in the northwest corner). The outlet creek, which will continue to provide for the subdivision discharge, is tributary to the Carp River.

It is intended to direct the runoff from the lands through a series of roadside ditches and rear lot swales to an existing roadside ditch on Regional Road No.5. This ditch will have to be upgraded and new culverts installed to accommodate the increased runoff. The outlet for the 2.9 hectares in the northwest corner of the subidivision will also have to be upgraded.

In general, the roadside ditches in the subdivision will follow the gradients of the adjacent roads. The minimum slope will be 0.3% and the maximum slope will be 3.88%. The ditches will be a minimum depth of 850 mm from the crown of the road. The maximum depth shall be 1,000 mm. The ditch side slopes shall be 2 horizontal to 1 vertical.

Rear lot swales shall be a minimum depth of 450 mm to a maximum depth of 1500 mm. The side slopes shall be 3 horizontal to 1 vertical. In all cases, the ditches will be treated with topsoil, seed and mulch. The rear lot swales shall be provided where it is likely that runoff would occur onto property held by others.

For the design of the ditches and drainage structures, the Rational Formula was used. A 1:1 ratio was used for the diameter vs. headwater relationship for the culvert sizing. The 10 year rainfall frequency curve was used to determine the ditch and culvert sizing.

Brosion protection will be provided at all bends in ditches and at the entrance and exits of all culverts. Culverts shall be 1.3 mm guage for 600 mm diameter and 1.8 mm guage for all others.

Although the culvert under the proposed Cardevco Road has been calculated to be 1380 mm in diameter, an inspection by the Township Engineer in the Spring of 1981 will be required to verify the sixing.

OM Bt ne plu

Culvert No.4*-

An arbitrary entry time of 35 min. has been selected for this culvert (conservative)

From existing topographic mapping and visual observation, it has been determined that approximately 80 acres are tributary to this culvert (outside the subdivision).

t_c = '35 min.

i 7 2.1 ins per hr.

 $Q_0 = 0.15 \times 2.1 \times 80 = 25.2 \text{ cfs}$

 $Q_{i} = 0.40 \times 8.71 \times 2.1 = 7.32 \text{ cfs}$

Qtotal = 32.52 cfs
With 3.5 ft. of H_w, Q₃₆ = 37 cfs
Therefore 36° dia. pipe would be satisfactory

Culvert No. 5 Plow time = (420/0.61)/60 = 11.5 min.

t_o ≈ 61.8 min.

i = 1.2 ins per hr.

Area of industrial = 54.76 Ac

Area of agricultural = 11.33 Ac

Area of residential = 2.97 Ac

Therefore flow $Q = (0.40 \pm 54.76 \times 1.2) + (0.15 \times 11.33 \times 1.2)$

+ (0.25 x 2.97 x 1.2) = 29.22 cfs

Therefore 36" diameter culvert OK (Q = 31.2 cfs)

*Although the calculations produce a flow significantly below the capacity of the existing culvert under the Cowan Side Road, we are continuing to investigate the reasons behind the oversizing. In the interim period, it is suggested that a 42" diameter pipe be considered at this location.

BY AX.

Calculations:

General -

Rational Formula - Q = ciA (imperial)

Runoff coefficient c = 0.40 (industrial)

= 0.15 (agricultural)

= 0.25 (rural res.)

Rainfall in ins. per hr. from 10 year curve

Rainfall in ins. per hr. from 10 year curve Minimum time of concentration = 20 minutes Flow time from vel. = 0.61 m per sec. (assumed)

Note: For culvert No.s, see drainage design sheet

Culvert No.1
Flow time = (420/0.61)/60 = 12.8 min.

t_c = 32.8 min.

1 = 2.22 ins per hr.

Area = 16.5 Ac.

Therefore Q = 0.40 x 2.22 x 16.5 = 14.65 cfs

Therefore Q = 0.40 x 2.22 x 16.5 = 14.65 cfs For 30" dia. pipe, H_a = 2.5 ft. S_Q = .003, Q = 17 cfs

Culvert No.2
Flow time = (641/0.61)/60 = 17.5 min.

t_C = \$0.3 min.

i = 1.42 ins per hr.

Area = \$4.76 Ac.

Therefore Q = 0.40 x 1.42 x 54.76 = 31.10 cfs

For 36" dia. pipe, H_s = 3.0 ft. 5 8₀ = .003, Q = 31.2 cfs

Culvert No.3 Minimum inlet time = 20 min.

A = 3.8 Ac. /

Q = 0.40 x 3.8 x 3.10 = 4.71 cfs

Minimum diameter culvert of 24° recommended (Q = 10 cfs)

continued.....

ye Bt pxc

Calculations:

Swale and Ditch Cross Sections

The capacity of the ditches and swales shall be calculated using the Mannings Formula with 'n' = 0.027. The capacities have been calculated to determine the minimum ditch section depths which may be used at any given location. Although in the actual construction, we expect that the 2:1 ditch side slopes will be closer to 3:1, a theoretical 2:1 will be used for these calculations.

Minimum Cross Section:

d = depth of ditch from property line

Assume d = 1.5

Area = 2ª2

For s = .003

R = .6706

Ploy Q = AV = A (1.486/0.027) $R^{2/3}s^{1/2} = 10.40$ cfs

Therefore most of the ditch system may have a minimum depth

of 1.5' from the property line

For the ditch on the west and north side of Cardevco Lane, a minimum depth of 2' produces the following flow:

s = .003

Area = 8 sq.ft., R = .894

Q = AV = 22.4 cfs

The actual flow into culvert No.1 under the 10 year rainfall curve was calculated to be 14.65 cfs. The 2' or 600 mm depth would therefore be sufficient.

Outlet Ditch on Regional Road No.5 -

Available slope = .003

Minimum capacity = 31.10 cfs

With 2' depth and 3:1 side slopes, the capacity is

 $Q=AV=12(1.486/0.027) \times .9486^{2/3} \times 0.003^{1/2} = 32.92 cfs$

Calculations:

Outlet Ditch - (continued)

The section is therefore of sufficient size to accept the flows directed to it.

Rear Lot Swales will have a minimum 1.5' depth and 3 to 1 side slopes. The capacity produced by this section (16.22 cfs) is more than sufficient to carry flows directed to them. The minimum slope of the rear lot swales will be 0.3%.

It is not proposed at this time to alter the creek which runs through the most southern section of the subdivision. The development of this land has negligible effect on the amount of runoff to the creek.

Standard erosion protection methods will be used to protect the entrance and exit of the culvert proposed on the creek.

GRADING PLAN

The Owner covenants and agrees to grade in accordance with Grading Plan No. 80-1040-GR1 as revised on 14/11/80. This plan has been prepared by R. W. Connelly and Associates Limited.

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THE LAND TITLES ACT

TRANSFER OF EASEMENT

CARDEVCO INC., hereinafter referred to as the "Transferor" the registered owner of the freehold land registered in the Land Registry Office No. 4 for the Land Titles Division of Ottawa-Carleton at Ottawa those parcels in the register for the Section more particularly described in Schedule "A" annexed hereto, in consideration of the sum of ONE (\$1.00) DOLLAR paid to it transfers to THE CORPORATION OF THE TOWNSHIP OF WEST CARLETON, hereinafter referred to as the "Township", its successors, licencees and assigns, to be used and enjoyed as appurtenant to the lands of the Township described in Schedule "B" hereto annexed the free uninterrupted and unobstructed right and easement, in perpetuity:

- 1.(a) To enter on and construct, repair and replace the drainage works, catch basins and equipment appurtenant thereto from time to time, including all fixtures and equipment as the Township may from time to time or at any time hereafter deem requisite over, under, along and across the lands described in Schedule "A" together with the right of free and unimpeded access to the Township, its workmen, vehicles, supplies and equipment at all times and for all purposes necessary for or incidental to the exercise and enjoyment of the rights hereby granted, over the lands described in Schedule "A" hereto to and from the said drainage works and fixtures and equipment or any part or parts thereof which are to be constructed, repaired, replaced and maintained:
 - (b) to trim, fell and remove any trees and brush necessary and incidental to permit access to construct, maintain and repair any part of the said drainage system.
- The Township hereby agrees to save harmless and keep indemnified the Transferor from and against all claims and demands and from and against all losses, damages, costs, charges and expenses which the said Transferor may sustain or incur in consequence of the exercise by the Township of the rights granted pursuant to this agreement.
- 3. The Township covenants in the exercise of the rights and easements hereby granted to it, its successors and assigns, it and they will make good all damage at any time and from time to time caused to or suffered by the said lands described in Schedule "A" hereto annexed.
- 4. The Transferor shall not call into question, directly or indirectly in any proceeding whatsoever, in law or in equity or before any administrative tribunal, the right of the Township to enter into this Agreement and to enforce each and every term, covenant and condition herein contained.



THIS INDENTURE and everything herein contained shall enure to the benefit of and be binding upon the parties hereto, and their respective successors and assigns.

IN WITNESS WHEREOF the Transferor has hereunto affixed its corporate seal under the hands of its duly authorized signing officers and the Township has hereunto affixed its corporate seal under the hands of its proper signing officers.

DATED at Ottawa this 15th day of November 1982.

Per:

THE CORPORATION OF THE TOWNSHIP OF WEST CARLETON

Per:		
Mayor		

er:

/

SCHEDULE "A"

FIRSTLY: Part of Block 4 on Plan 4M-356 , Township of West Carleton, registered in the Land Registry Office No. 4 for the Land Titles Division of Ottawa-Carleton at Ottawa, designated as Part 1 on a Plan of Survey of Record deposited in the said Registry Office as No. 4R-395/

Being Part of Parcel 4-1 in the Register for Section 4M-356

SECONDLY: Part of Block 13 on Plan 4M-356, Township of West Carleton, registered in the Land Registry Office No. 4 for the Land Titles Division of Ottawa-Carleton at Ottawa, designated as Part 3 on a Plan of Survey of Record deposited in the said Registry Office as No. 4R-395/

Being Part of Parcel 13-1 in the Register for Section 4M- 356

THIRDLY: Part of Block 14 on Plan 4M-356, Township of West Carleton, registered in the Land Registry Office No. 4 for the Land Titles Division of Ottawa-Carleton at Ottawa, designated as Part 4 on a Plan of Survey of Record deposited in the said Registry Office as No. 4R-395/

Being Part of Parcel 14-1 in the Register for Section 4M-356

FOURTHLY: Part of Block 15 on Plan 4M- 356, Township of West Carleton, registered in the Land Registry Office No. 4 for the Land Titles Division of Ottawa-Carleton at Ottawa, designated as Part 5 on a Plan of Survey of Record deposited in the said Registry Office as No. 4R- 395/

Being Part of Parcel 15-1 in the Register for Section 4M- 356

FIFTHIN: Part of Block 31 on Plan 4M-356, Township of West Carleton, registered in the Land Registry Office No. 4 for the Land Titles Division of Ottawa-Carleton at Ottawa, designated as Part 8 on a Plan of Survey of Record deposited in the said Registry Office as No. 4R-375/

Being Part of Parcel 31-1 in the Register for Section 4M- 356

SCHEDULE "B"

The whole of Parcel Streets -1 in the Register for Section 4M- 356

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THE LAND TITLES ACT

CONSENT OF CHARGEE

IN THE MATTER OF Part of Blocks 4, 13, 14, 15 and 31 on Plan 4M-356 SPRATT SAND AND GRAVEL LIMITED, the Chargee under a Charge registered as No. 210802, hereby consents to the registration of an Easement over the above lands.

IN WITNESS WHEREOF the Corporation has affixed its corporate seal under the hands of its proper signing officers this $15 \, h$ day of November, 1982.

SPRATT SAND AND GRAYEL LIMITED

Form 1 - Land Transfer Tax Act

AFFIDAVIT OF RESIDENCE AND OF VALUE OF THE CONSIDERATION	
	4.7
NCLINAALI AS RESIDENCE AND OF ABILIE OF THE CONSIDERATIO	ч

HE MATTER OF THE CONVEYANCE OF Imsert brief desc and 31 on Plan 4M-356 designat	ted as Parts	1, 3, 4,	5 and 8 on	Reference Plan	4R-3951
BY (print names of all transferors in full) CARDEVCO INC	• ₹₹				
TO (see instruction 1 and print names of all transferees in full) TBE	CORPORATION	OF THE TO	OWNSHIP OF W	EST CARLETON	•••••
I, (see instruction 2 and print name(s) in full) Alan K.	Cohen		· · · · · · · · · · · · · · · · · · ·		
MAKE OATH AND SAY THAT:					
1. I am (place a clear mark within the square opposite that one of the	following paragraphs t	hat describes the	capacity of the depon	ent(s)): (see instruction 2)	
(a) A person in trust for whom the land conveyed in th	e above described c	onveyance is b	eing conveyed;		
(b) A trustee named in the above-described conveyan	ce to whom the land	is being conve	yed;		
(c) A transferee named in the above-described conver					
(d) The authorized agentor solicitor acting in this tran	nsaction for <i>(insert nat</i>	me(s) of principal OF WES	(S)) THE CURPO T CARLETON	KATION OF THE TO	ЖЖЙТЬ
described in p	aragraph(s) (A),	(Š . (c)	above; (strike oc	ut references to inepplicable p	
(e) The President, Vice-President, Manager, Secretary			action (maen name)	sporcorporation(s))	
described in pa	ragraph(s) (a),	(b). (c)	above; (strike ou	t references to inapplicable p	aragraphs)
· _ · _ · _ · _ · _ · _ · _ · _				am making this affidavit o	
behalf and on behalf of (insertname of spouse)					• • • • • • • • • • • • • • • • • • • •
- · · · · · · · · · · · · · · · · · · ·). (insert only one of par	agraph (a), (b) or (c) above, as applicable	,	
and as such, I have personal knowledge of the facts herein	-		dans		4
2. I have read and considered the definitions of "non-res	ident corporation"	and "non-resi	dent person" set o	out respectively in claus	83 T (1)(T)
and (g) of the Act. (see Instruction 3).					
3. The following persons to whom or in trust for whom the					
persons within the meaning of the Act. (see instruction 4) .					

4 THE TATAL ASSOCIATION TO THE TRANSPORTER				••••••••	
4. THE TOTAL CONSIDERATION FOR THIS TRANSACTION			1.00		1
(a) Monies paldor to be paid in cash			nil		
(b) Mortgages (i) Assumed (show principal and interest to be or			nii		
(ii) Given backto vendor			nil		1
(c) Property transferred in exchange (detail below)		•			
(d) Securities transferred to the value of (detail below)		• • • • • • • • • • • • • • • • • • • •	nil		ALL BLANKS
(e) Liens, legacies, annuities and maintenance charges to		-	nil		MUST BE
(f) Other valuable consideration subject to land transfer to	ax (delail below)	.	1000		FILLEDIN
		•-			Z
(g) VALUE OF LAND, BUILDING, FIXTURES AND GOOD!	MILL' SUBJECT TO	-			PREST -18A*
		-	1.00	s 1.00	WHERE
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LAND TRANSFER TAX (TOTAL OF (a) to (f))	al property	- \$.	************	g nil	WHERE
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LAND TRANSFER TAX (TOTAL OF (a) to (b)) (h) VALUE OF ALL CHATTELS—items of tangible persons (heter Sahe) for it payable on the relate of all chambits where example persons on the relate of all chambits where examples for for tax of the case of all chambits where examples for for tax of the case of all chambits where examples for for tax of the case of all chambits where examples for for tax of the consideration for transaction not included in (g) of the consideration is nominal, describe relationship between transfer of an easement to a Muniformation of the consideration is nominal, is the land subject to an Execution of the consideration is nominal, is the land subject to an Execution of the remarks and explanations, if necessary is a finite remarks and explanation of the case	elproperty transferor and transicipality ry encumbrance? Y mbrance does -Carleton 1982 ERTY INFORMATIO Easement available the Assessment Andrease above. Yes REGISTRATION N	N RECORD ATTO KUA Not Not Not Not For Last	purpose of conveyer part of the part of th	mil s nil s 1.00 snco.(see instruction59 consideration. signature(s)	WHERE APPLICABLE.

Received at 3:42 o'clock P M. CM.

DATED the 15th day of November, 1982.

LAND TITLES ACT

DEC 17 1982

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Land Titles Division of Ottawa-Catterion

CARDEVCO INC.

JOHN E. STADEN
D.P.IY LAND REGISTRAR THE CORPORATION OF THE TOWNSHIP

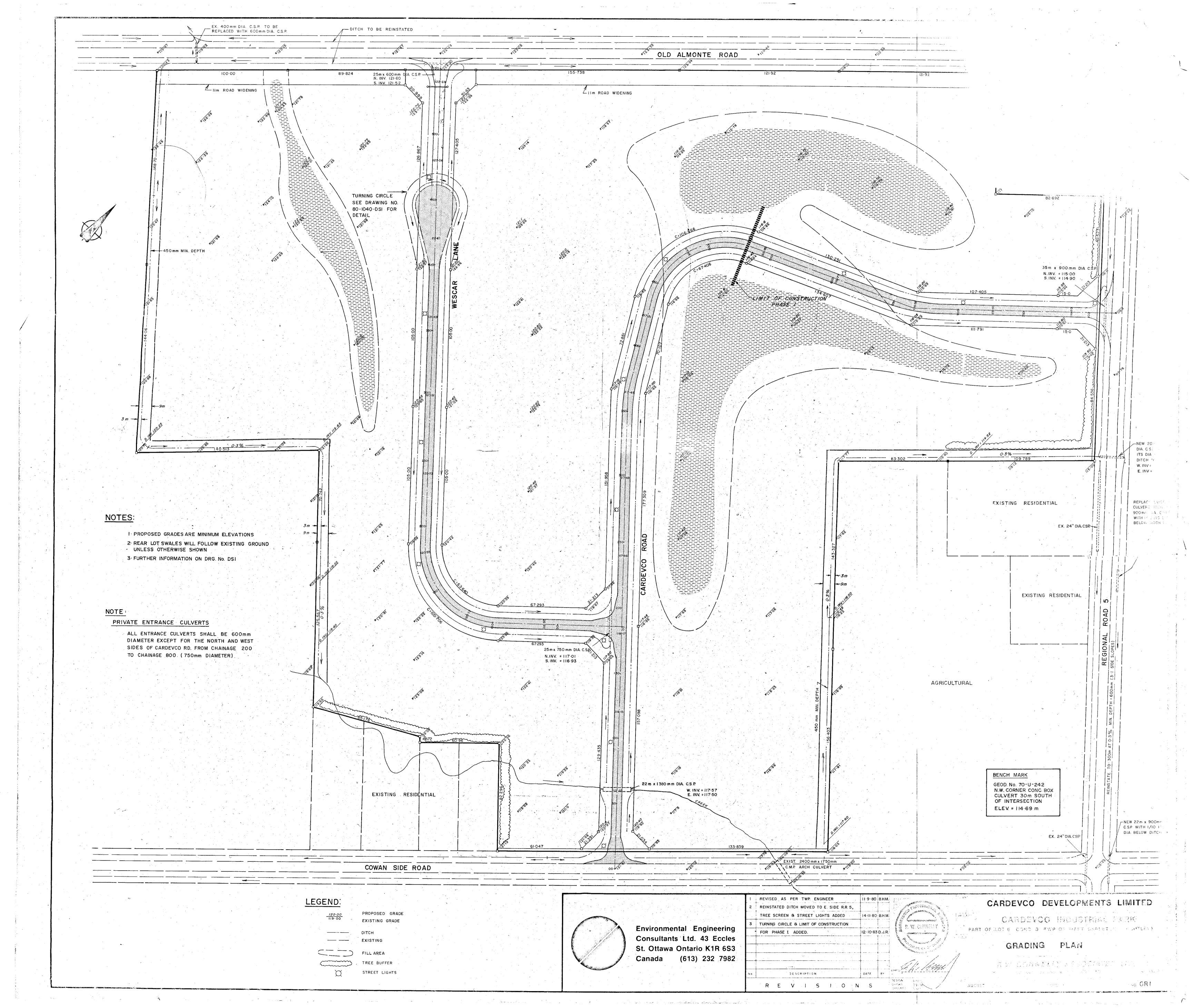
OF WEST CARLETON

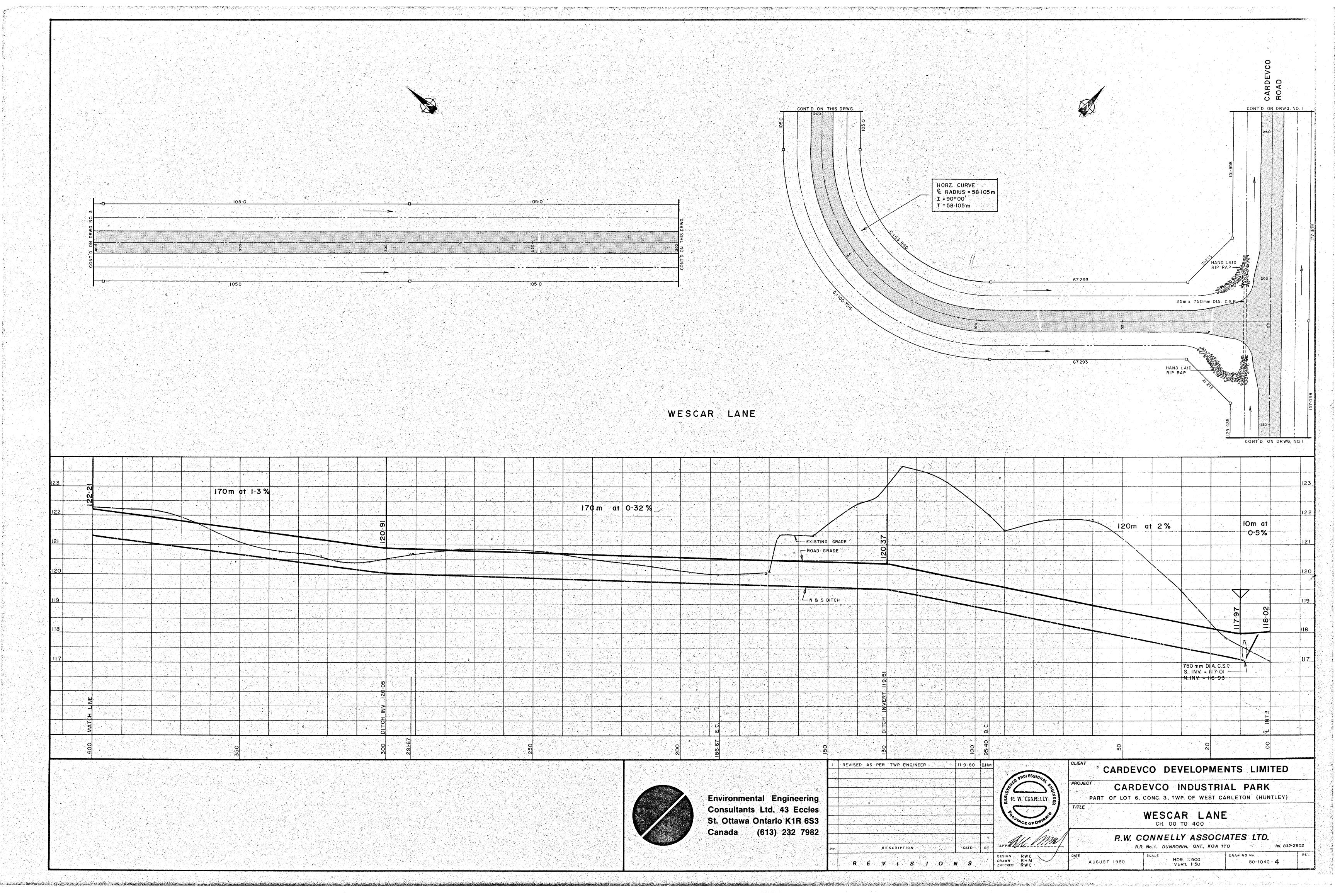
LAND REGISTRY #4

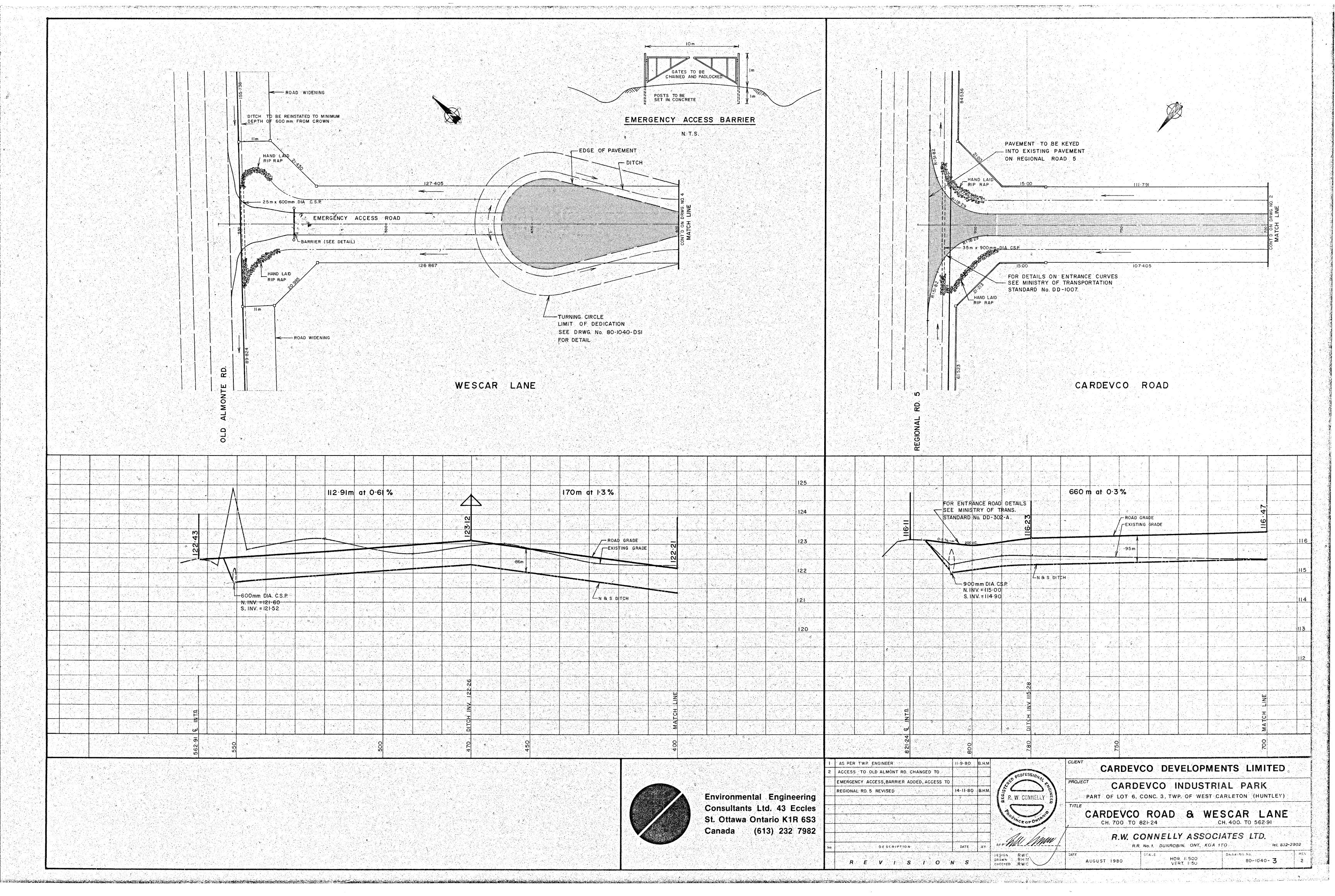
TRANSPER OF EASEMENT

CHECKED

AKC: d4 1254-3070 100







APPENDIX B

AREA & RUNOFF CALCULATIONS

Existing Conditions 107 to 154 & 162 to 173 Wescar Lane and 121 to 127 Cardevco Road

+

Proposed Development 151-159 Wescar Lane Cardevco Subdivision Ottawa, Ontario

Drainage Area A

31-May-24

		Area Dr	aining to t	he ROW			ROW Area				TOTAL			
Address	Roof	Hard	Gravel	Soft	Total	Hard	Gravel	Soft	Total	Roof	Hard	Gravel	Soft	Total
			sq.m.				sq.	m.				sq.m.		
173 Wescar			2147		2147	82	150	79	311	0	82	2297	79	2458
165 Wescar	589	868	1055	4064	6576	368	123	483	974	589	1236	1177	4547	7550
159-151 Wescar	3530	31941		6566	42038	772	404	864	2040	3530	32713	404	7430	44078
141 Wescar	535	334	294	1574	2737	313	81	405	799	535	647	374	1980	3536
					53498				4124	4654	34678	4254	14036	57622
				_	С									
		Roof Area:	0.47	ha	0.90									
		Hard Area:	3.47	ha	0.90									
	(Gravel Area:	0.43	ha	0.80									
		Soft Area:	1.40	ha	0.20									
	Total Catch	nment Area:	5.76	ha	0.72									

Drainage Area B

	Area Draining to the ROW						ROW Area			TOTAL					
Address	Roof	Hard	Gravel	Soft	Total	Hard	Gravel	Soft	Total	Roof	Hard	Gravel	Soft	Total	
			sq.m.				sq.	m.		sq.m.					
131 Wescar	585	1302		1150	3037	317	54	305	675	585	1619	54	1455	3712	
123 Wescar		329		478	807	227	30	170	427	0	556	30	649	1235	
117 Wescar	203	99	965	821	2089	204	34	192	430	203	303	999	1013	2518	
107 Wescar	435	980		520	1935	246	27	179	452	435	1226	27	699	2387	
121 Cardevco	270	277	1824	2717	5088	901	274	1341	2517	270	1178	2098	4058	7605	
					12956				4500	1494	4881	3208	7873	17456	
					С										
		Roof Area:	0.15	ha	0.90										
		Hard Area:	0.49	ha	0.90										
	G	Gravel Area:	0.32	ha	0.80										
		Soft Area:	0.79	ha	0.20										
	Total Catch	ment Area:	1.75	ha	0.57										

Drainage Area C

		Area Dr	he ROW			ROW Area			TOTAL						
Address	Roof	Hard	Gravel	Soft	Total	Hard	Gravel	Soft	Total	Roof	Hard	Gravel	Soft	Total	
	sq.m.						sq.	m.		sq.m.					
180/172 Wescar				161	161	80	45	127	252	0	80	45	287	412	
168 Wescar	321	730		435	1486	194	42	125	360	321	924	42	560	1847	
162 Wescar	610	770		487	1866	196	50	119	364	610	965	50	605	2231	
154 Wescar			216	3384	3600	231	115	407	753	0	231	331	3791	4353	
144 Wescar	494	701		554	1748	232	47	113	392	494	933	47	667	2140	
138 Wescar	507	506		730	1744	193	40	160	394	507	699	40	891	2138	
132 Wescar			935	1007	1942	112	128	144	384	0	112	1063	1151	2326	
126 Wescar	484	1074		469	2028	167	59	161	388	484	1241	59	630	2415	
118 Wescar	29		3940	267	4236	488	393	642	1523	29	488	4333	909	5759	
123 Cardevco					0	360	371	227	957	0	360	371	227	957	
					18812				4810	2446	5675	6010	9491	23622	
					С										
		Roof Area:	0.24	ha	0.90										
		Hard Area:	0.57	ha	0.90										
	G	Gravel Area:	0.60	ha	0.80										
		Soft Area:	0.95	ha	0.20										
				_											
	Total Catch	nment Area:	2.36	ha	0.59										

Drainage Area D

		Area Dr	aining to t	he ROW			ROW	Area		TOTAL				
Address	Roof	Hard	Gravel	Soft	Total	Hard	Gravel	Soft	Total	Roof	Hard	Gravel	Soft	Total
	sq.m.						sq.	m.				sq.m.		
123 Cardevco	126	61	3750		3936	360	371	227	957	126	421	4120	227	4894
127 Cardevco	483	537	442	568	2030	226	141	46	413	483	763	583	614	2443
					5966				1370	609	1184	4703	841	7337
					С									
		Roof Area:	0.06	ha	0.90									
		Hard Area:	0.12	ha	0.90									
	G	Gravel Area:	0.47	ha	0.80									
		Soft Area:	0.08	ha	0.20									
	Total Catch	ment Area:	0.73	ha	0.76									

APPENDIX C

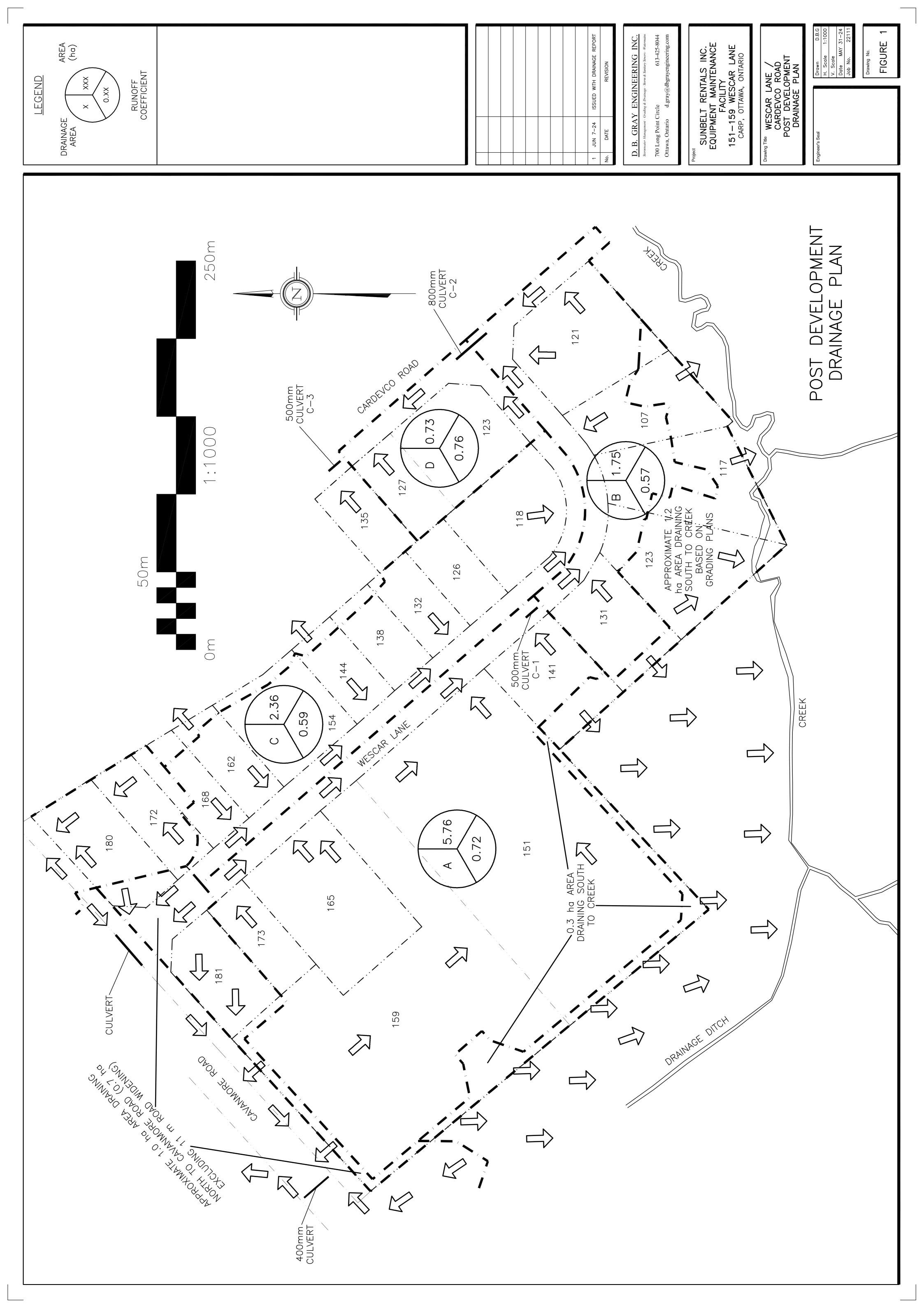
DITCH & CULVERT CALCULATIONS

EXISTING CONDITIONS

106 TO 154 & 162 TO 173 WESCAR LANE
AND 121 TO 127 CARDEVCO ROAD

+

PROPOSED DEVELOPMENT AT 151-159 WESCAR LANE



Peak Flow Calculations - Roadside Ditches Existing Conditions 106 to 154 & 162 to 173 Wescar Lane and 121 to 127 Cardevco Road

+

Proposed Development 151-159 Wescar Lane Cardevco Subdivision Ottawa, Ontario

10-Year Event

Drainage Area A

			С
Roof Area:	0.47	ha	0.90
Hard Area:	3.47	ha	0.90
Gravel Area:	0.43	ha	0.80
Soft Area:	1.40	_ha	0.20
Total Catchment Area:	5.76	ha	0.72

Time of Concentration:	20	min
Length of Ditch (Ld): Ditch Flow Velocity (V): Time of Concentration (Ditch Flow):	263 0.45 9.7	m m/s min
Time of Concentration (Tc):	29.7	min
Area (A): Time of Concentration: Rainfall Intensity (i): Runoff Coefficient (C):	5.76 29.7 63 0.72	ha min mm/hr (10-Year Event)
Rational Method 10-Year Flow (Q):	733.9	L/s

Ditch Slope: 0.8%

Ditch Manning Roughness Coefficient n: 0.10 dense weeds / brush as high as flow

Side Slope: 3 :1

Lot Side Slope: 3 :1

Ditch Bottom Width: 1 m

Water Depth: 0.59 m

Water Top Width: 4.54 m

Water Cross-Section Area:
Wetted Perimeter:
Hydraulic Radius:
4.54 III
4.54 III
4.73 m
0.35 m

Velocity: 0.45 m/s Based on water depth
Velocity: 0.45 m/s Using Manning's Formula:

Drainage Area B

(10-Year Event)

			С
Roof Area:	0.15	ha	0.90
Hard Area:	0.49	ha	0.90
Gravel Area:	0.32	ha	0.80
Soft Area:	0.79	ha	0.20
_		<u></u>	
Total Catchment Area:	1.75	ha	0.57

Drainage Area A + B

		С
0.61	ha	0.90
3.96	ha	0.90
0.75	ha	0.70
2.19	_ha	0.20
7.51	ha	0.68
	3.96 0.75 2.19	3.96 ha 0.75 ha 2.19 ha

Time of Concentration:	29.7	min (from Drainage Area A)
Length of Ditch (Ld):	238	m
Ditch Flow Velocity (V):	0.52	m/s
Time of Concentration (Ditch Flow):	7.6	min

Time of Concentration (Tc): 37.4 min

Area (A): 7.51 ha
Time of Concentration: 37.4 min

Rainfall Intensity (i): 54 mm/hr (10-Year Event)

Runoff Coefficient (C): 0.68

Rational Method 10-Year Flow (Q): 764.3 L/s

Ditch Slope: 1.2%

Ditch Manning Roughness Coefficient n: 0.10 dense weeds / brush as high as flow

Road Side Slope: 3 :1

Lot Side Slope: 3 :1

Ditch Bottom Width: 1 m

Water Depth: 0.55 m

Water Top Width: 4.30 m
Water Cross-Section Area: 1.46 sq.m
Wetted Perimeter: 4.48 m
Hydraulic Radius: 0.33 m

Velocity: 0.52 m/s Based on water depth
Velocity: 0.52 m/s Using Manning's Formula:

Drainage Area C

(10-Year Event)

			С
Roof Area:	0.24	ha	0.90
Hard Area:	0.57	ha	0.90
Gravel Area:	0.60	ha	0.80
Soft Area: _	0.95	ha	0.20
Total Catchment Area:	2.36	ha	0.59

Time of Concentration: 20 min

Length of Ditch (Ld): 452 m

Ditch Flow Velocity (V): 0.36 m/s

Time of Concentration (Ditch Flow): 20.9 min

Time of Concentration (Tc):

Area (A): 2.36 ha
Time of Concentration: 40.9 mir

Rainfall Intensity (i): 51 mm/hr (10-Year Event)

40.9

min

Runoff Coefficient (C): 0.59

Rational Method 10-Year Flow (Q): 198.0 L/s

Ditch Slope: 1.2%

Ditch Manning Roughness Coefficient n: 0.10 dense weeds / brush as high as flow

Side Slope: 3 :1
Lot Side Slope: 3 :1
Ditch Bottom Width: 1 m
Water Depth: 0.30 m

Water Top Width: 2.77 m
Water Cross-Section Area: 0.56 sq.m
Wetted Perimeter: 2.87 m
Hydraulic Radius: 0.19 m

Velocity: 0.36 m/s Based on water depth
Velocity: 0.36 m/s Using Manning's Formula:

Drainage Area D

(10-Year Event)

			С
Roof Area:	0.06	ha	0.90
Hard Area:	0.12	ha	0.90
Gravel Area:	0.47	ha	0.80
Soft Area:	0.08	_ha	0.20
		_	
Total Catchment Area:	0.73	ha	0.76

Drainage Area A + B + C + D

			C
Roof Area:	0.92	ha	0.90
Hard Area:	4.64	ha	0.90
Gravel Area:	1.82	ha	0.80
Soft Area:	3.22	_ha	0.20

Total Catchment Area: 10.60 ha 0.67

Time of Concentration: 40.9 min (from Drainage Area C)

 $\begin{array}{ccc} & Length \ of \ Ditch \ (Ld): & 129 & m \\ & Ditch \ Flow \ Velocity \ (V): & 0.90 & m/s \\ \hline Time \ of \ Concentration \ (Ditch \ Flow): & 2.4 & min \\ \end{array}$

Time of Concentration (Tc): 43.3 min

Area (A): 10.60 ha
Time of Concentration: 43.3 min

Rainfall Intensity (i): 49 mm/hr (10-Year Event)

Runoff Coefficient (C): 0.67

Rational Method 10-Year Flow (Q): 963.7 L/s

Ditch Slope: 0.3%

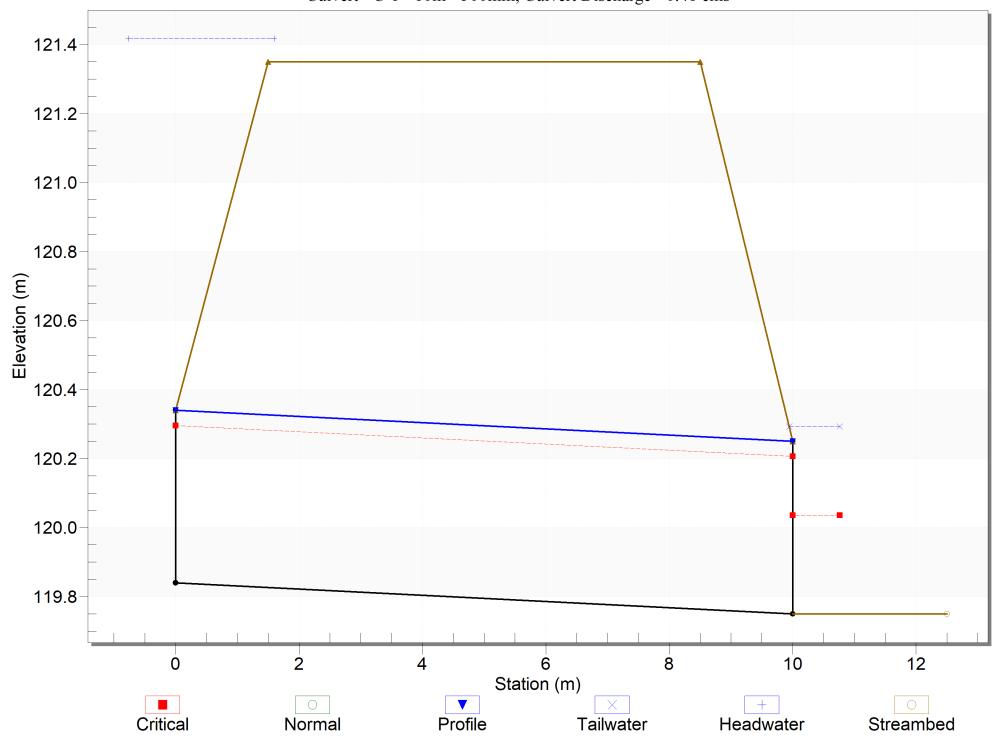
Ditch Manning Roughness Coefficient n: 0.027 gravel / short grass

Road Side Slope: 3 :1
Lot Side Slope: 3 :1
Ditch Bottom Width: 1 m
Water Depth: 0.45 m

Water Top Width: 3.72 m
Water Cross-Section Area: 1.07 sq.m
Wetted Perimeter: 3.87 m
Hydraulic Radius: 0.28 m

Velocity: 0.90 m/s Based on water depth Velocity: 0.90 m/s Using Manning's Formula:

Crossing - 141 Wescar Ln Entrance Culvert (Drainage Area A), Design Discharge - 0.73 cms
Culvert - C-1 - 10m - 500mm, Culvert Discharge - 0.48 cms



Culvert Data: C-1 - 10m - 500mm

Culvert Data Summary - C-1 - 10m - 500mm

Barrel Shape: Circular

Barrel Diameter: 500.00 mm

Barrel Material: Corrugated Steel

Embedment: 0.00 mm

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Site Data - C-1 - 10m - 500mm Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 119.84 m

Outlet Station: 10.00 m

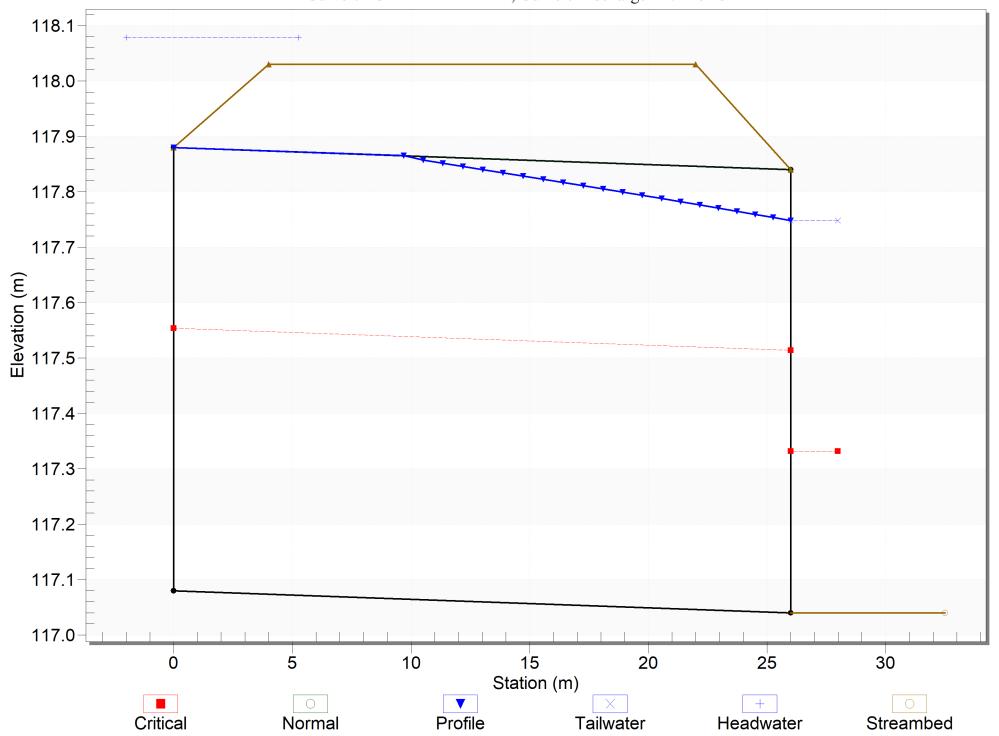
Outlet Elevation: 119.75 m

Culvert Crossing: 141 Wescar Ln Entrance Culvert (Drainage Area A)

Culvert Summary Table - C-1 - 10m - 500mm

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth(m)	Outlet Control Depth(m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.00	0.00	119.84	0.00	0.0	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
0.07	0.07	120.14	0.27	0.30	2- M2c	0.21	0.18	0.18	0.17	1.14	0.28
0.15	0.15	120.28	0.41	0.44	2- M2c	0.32	0.26	0.26	0.25	1.42	0.34
0.22	0.22	120.41	0.55	0.57	7- M2c	0.50	0.32	0.32	0.31	1.65	0.37
0.29	0.29	120.60	0.72	0.76	7- M2c	0.50	0.37	0.37	0.35	1.88	0.40
0.37	0.37	120.87	0.93	1.03	7- M2c	0.50	0.41	0.41	0.39	2.12	0.43
0.44	0.44	121.17	1.20	1.33	7- M2c	0.50	0.44	0.44	0.43	2.39	0.45
0.51	0.48	121.37	1.38	1.53	7- M2t	0.50	0.46	0.46	0.46	2.55	0.47
0.59	0.48	121.39	1.39	1.55	7- M2t	0.50	0.46	0.50	0.49	2.48	0.49
0.66	0.48	121.40	1.39	1.56	4-FFf	0.50	0.46	0.50	0.52	2.45	0.50
0.73	0.48	121.42	1.38	1.58	4-FFf	0.50	0.46	0.50	0.54	2.44	0.51

Crossing - Wescar Ln Culvert at Cardevco Rd (Drainage Area A+B), Design Discharge - 0.76 cms
Culvert - C-2 - 26m -800mm, Culvert Discharge - 0.61 cms



Culvert Data: C-2 - 26m -800mm

Culvert Data Summary - C-2 - 26m -800mm

Barrel Shape: Circular

Barrel Diameter: 800.00 mm

Barrel Material: Corrugated Steel

Embedment: 0.00 mm

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Site Data - C-2 - 26m -800mm

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 117.08 m

Outlet Station: 26.00 m

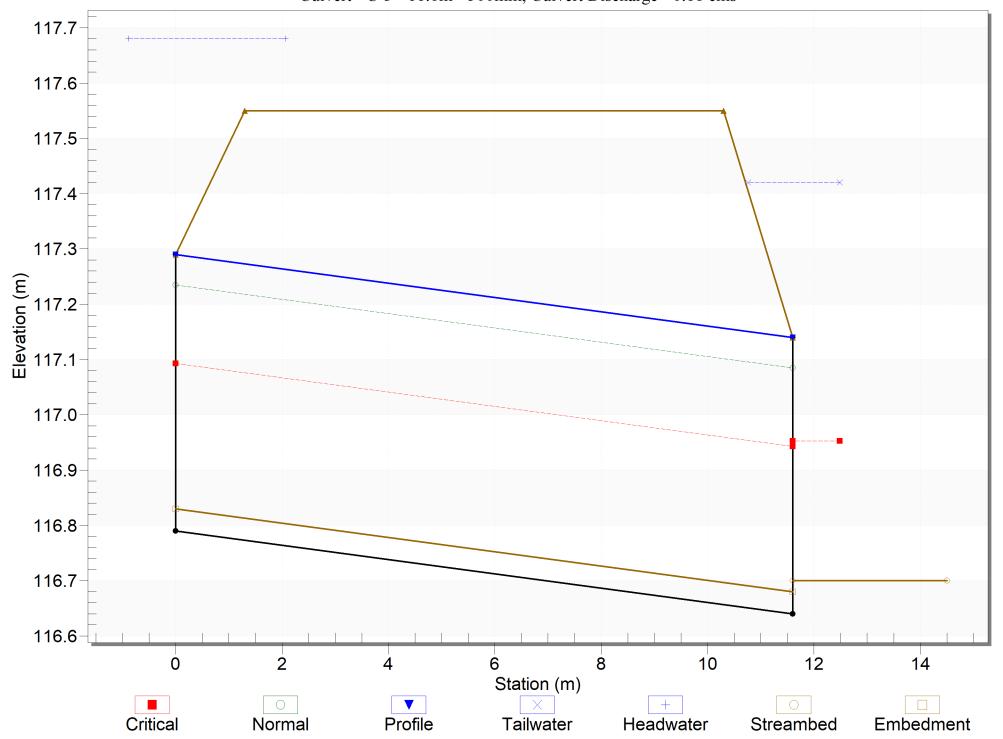
Outlet Elevation: 117.04 m

Culvert Crossing: Wescar Ln Culvert at Cardevco Rd (Drainage Area A+B)

Culvert Summary Table - C-2 - 26m -800mm

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth(m)	Outlet Control Depth(m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.00	0.00	117.08	0.00	0.0	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
80.0	0.08	117.37	0.24	0.29	3- M2t	0.28	0.16	0.24	0.24	0.61	0.19
0.15	0.15	117.50	0.34	0.42	3- M2t	0.42	0.23	0.34	0.34	0.77	0.23
0.23	0.23	117.60	0.43	0.52	3- M2t	0.55	0.28	0.41	0.41	0.89	0.25
0.31	0.31	117.68	0.50	0.60	3- M2t	0.80	0.33	0.47	0.47	1.00	0.27
0.38	0.38	117.77	0.57	0.69	3- M2t	0.80	0.37	0.52	0.52	1.11	0.29
0.46	0.46	117.85	0.64	0.77	3- M2t	0.80	0.41	0.56	0.56	1.21	0.30
0.53	0.53	117.93	0.71	0.85	3- M2t	0.80	0.44	0.60	0.60	1.31	0.32
0.61	0.61	118.03	0.78	0.95	7- M2t	0.80	0.47	0.64	0.64	1.42	0.33
0.69	0.62	118.06	0.79	0.98	7- M2t	0.80	0.48	0.68	0.68	1.36	0.34
0.76	0.61	118.08	0.78	1.00	7- M2t	0.80	0.47	0.71	0.71	1.30	0.35

Crossing - 135 Cardevco Rd Entrance Culvert (Drainage Areas A+B+C+D), Design Discharge - 0.96 cms Culvert - C-3 - 11.6m - 500mm, Culvert Discharge - 0.18 cms



Culvert Data: C-3 - 11.6m - 500mm

Culvert Data Summary - C-3 - 11.6m - 500mm

Barrel Shape: Circular

Barrel Diameter: 500.00 mm

Barrel Material: Corrugated Steel

Embedment: 40.00 mm

Barrel Manning's n: 0.0240 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Site Data - C-3 - 11.6m - 500mm

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 116.79 m

Outlet Station: 11.60 m

Outlet Elevation: 116.64 m

Culvert Crossing: 135 Cardevco Rd Entrance Culvert (Drainage Areas A+B+C+D)

Culvert Summary Table - C-3 - 11.6m - 500mm

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth(m)	Outlet Control Depth(m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.00	0.00	117.42	0.00	0.59	0-NF	0.00	0.00	0.46	0.72	0.00	0.00
0.10	0.10	117.51	0.31	0.68	4-FFf	0.25	0.18	0.46	0.72	0.51	0.00
0.19	0.13	117.57	0.38	0.74	4-FFf	0.31	0.22	0.46	0.72	0.70	0.00
0.29	0.14	117.59	0.40	0.76	4-FFf	0.33	0.23	0.46	0.72	0.75	0.00
0.39	0.15	117.61	0.41	0.78	4-FFf	0.34	0.24	0.46	0.72	0.79	0.00
0.48	0.15	117.62	0.42	0.79	4-FFf	0.35	0.24	0.46	0.72	0.82	0.00
0.58	0.16	117.64	0.43	0.81	4-FFf	0.36	0.25	0.46	0.72	0.85	0.00
0.67	0.16	117.65	0.44	0.82	4-FFf	0.37	0.25	0.46	0.72	0.88	0.00
0.77	0.17	117.66	0.45	0.83	4-FFf	0.38	0.26	0.46	0.72	0.90	0.00
0.87	0.17	117.67	0.46	0.84	4-FFf	0.39	0.26	0.46	0.72	0.93	0.00
0.96	0.18	117.68	0.47	0.85	4-FFf	0.40	0.26	0.46	0.72	0.95	0.00

Peak Flow Calculations - Roadside Ditches Existing Conditions 106 to 154 & 162 to 173 Wescar Lane and 121 to 127 Cardevco Road

+

Proposed Development 151-159 Wescar Lane Cardevco Subdivision Ottawa, Ontario

2-Year Event

Drainage Area A

			С
Roof Area:	0.47	ha	0.90
Hard Area:	3.47	ha	0.90
Gravel Area:	0.43	ha	0.80
Soft Area:	1.40	_ha	0.20
Total Catchment Area:	5.76	ha	0.72

Time of Concentration:	20	min
Length of Ditch (Ld): Ditch Flow Velocity (V): Time of Concentration (Ditch Flow):	263 0.39 11.2	m m/s min
Time of Concentration (Tc):	31.2	min
Area (A): Time of Concentration: Rainfall Intensity (i): Runoff Coefficient (C):	5.76 31.2 39 0.72	ha min mm/hr (2-Year Event)
Rational Method 2-Year Flow (Q):	450.9	L/s

Ditch Slope: 0.8%

Ditch Manning Roughness Coefficient n: 0.10 dense weeds / brush as high as flow

Side Slope: 3 :1

Lot Side Slope: 3 :1

Ditch Bottom Width: 1 m

Water Depth: 0.48 m

Water Top Width: 3.85 m
Water Cross-Section Area: 1.15 sq.m
Wetted Perimeter: 4.00 m
Hydraulic Radius: 0.29 m

Velocity: 0.39 m/s Based on water depth
Velocity: 0.39 m/s Using Manning's Formula:

Drainage Area B

(10-Year Event)

			С
Roof Area:	0.15	ha	0.90
Hard Area:	0.49	ha	0.90
Gravel Area:	0.32	ha	0.80
Soft Area:	0.79	ha	0.20
Total Catchment Area:	1.75	ha	0.57

Drainage Area A + B

			C
Roof Area:	0.61	ha	0.90
Hard Area:	3.96	ha	0.90
Gravel Area:	0.75	ha	0.70
Soft Area:	2.19	ha	0.20
		_	

Total Catchment Area: 7.51 ha 0.68

> Time of Concentration: 31.2 min (from Drainage Area A)

> > min

Length of Ditch (Ld): 238 m Ditch Flow Velocity (V): 0.46 m/s Time of Concentration (Ditch Flow): 8.6 min

Time of Concentration (Tc): 39.8

> Area (A): 7.51 ha Time of Concentration: 39.8

Rainfall Intensity (i): 33 mm/hr (2-Year Event)

Runoff Coefficient (C): 0.68

Rational Method 2-Year Flow (Q): 464.9

> Ditch Slope: 1.2%

Ditch Manning Roughness Coefficient n: 0.10 dense weeds / brush as high as flow

> Road Side Slope: 3 :1 Lot Side Slope: 3 :1 Ditch Bottom Width: 1 m Water Depth: 0.44 m

Water Top Width: 3.64 m Water Cross-Section Area: 1.02 sq.m Wetted Perimeter: 3.78 m Hydraulic Radius: 0.27 m

> Velocity: 0.46 m/s Based on water depth Using Manning's Formula: Velocity: 0.46 m/s

Drainage Area C

(10-Year Event)

			С
Roof Area:	0.24	ha	0.90
Hard Area:	0.57	ha	0.90
Gravel Area:	0.60	ha	0.80
Soft Area:	0.95	_ha	0.20
•			
Total Catchment Area:	2.36	ha	0.59

Time of Concentration: 20 min

Length of Ditch (Ld): 452 m
Ditch Flow Velocity (V): 0.31 m/s
Time of Concentration (Ditch Flow): 24.3 min

Time of Concentration (Tc): 44.3 min

Area (A): 2.36 ha
Time of Concentration: 44.3 mir

Rainfall Intensity (i): 31 mm/hr (2-Year Event)

Runoff Coefficient (C): 0.59

Rational Method 2-Year Flow (Q): 119.2 L/s

Ditch Slope: 1.2%

Ditch Manning Roughness Coefficient n: 0.10 dense weeds / brush as high as flow

Side Slope: 3 :1
Lot Side Slope: 3 :1
Ditch Bottom Width: 1 m
Water Depth: 0.23 m

Water Top Width: 2.36 m
Water Cross-Section Area: 0.38 sq.m
Wetted Perimeter: 2.43 m
Hydraulic Radius: 0.16 m

Velocity: 0.31 m/s Based on water depth
Velocity: 0.31 m/s Using Manning's Formula:

Drainage Area D

(10-Year Event)

			С
Roof Area:	0.06	ha	0.90
Hard Area:	0.12	ha	0.90
Gravel Area:	0.47	ha	0.80
Soft Area:	0.08	ha	0.20
		_	
Total Catchment Area:	0.73	ha	0.76

Drainage Area A + B + C + D

			C
Roof Area:	0.92	ha	0.90
Hard Area:	4.64	ha	0.90
Gravel Area:	1.82	ha	0.80
Soft Area: _	3.22	ha	0.20
_		<u></u>	

Total Catchment Area: 10.60 ha 0.67

Time of Concentration: 44.3 min (from Drainage Area C)

Length of Ditch (Ld): 129 m
Ditch Flow Velocity (V): 0.79 m/s
Time of Concentration (Ditch Flow): 2.7 min

Time of Concentration (Tc): 47.0 min

Area (A): 10.60 ha
Time of Concentration: 47.0 min

Rainfall Intensity (i): 29 mm/hr (2-Year Event)

Runoff Coefficient (C): 0.67

Rational Method 2-Year Flow (Q): 579.1 L/s

Ditch Slope: 0.3%

Ditch Manning Roughness Coefficient n: 0.027 gravel / short grass

Road Side Slope: 3 :1
Lot Side Slope: 3 :1
Ditch Bottom Width: 1 m
Water Depth: 0.36 m

Water Top Width:

Water Cross-Section Area:

Wetted Perimeter:

Hydraulic Radius:

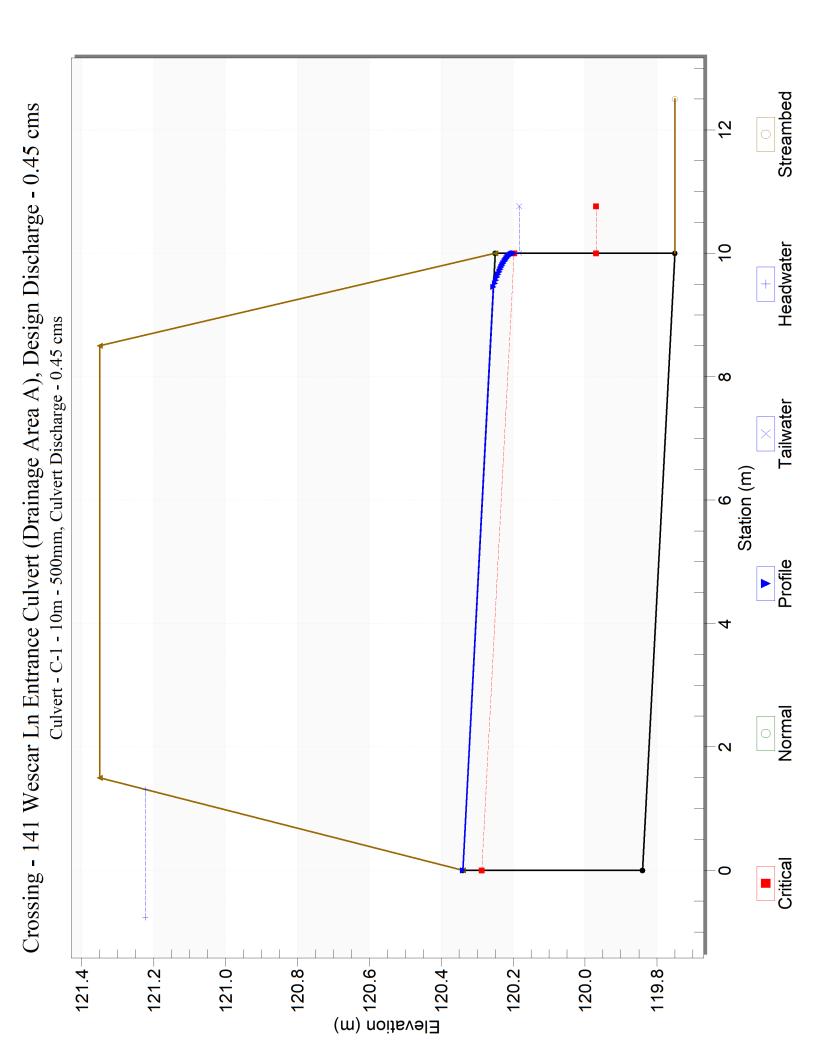
3.14 m

0.74 sq.m

3.25 m

0.23 m

Velocity: 0.79 m/s Based on water depth Velocity: 0.79 m/s Using Manning's Formula:



Culvert Data: C-1 - 10m - 500mm

Culvert Data Summary - C-1 - 10m - 500mm

Barrel Shape: Circular

Barrel Diameter: 500.00 mm

Barrel Material: Corrugated Steel

Embedment: 0.00 mm

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Site Data - C-1 - 10m - 500mm Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 119.84 m

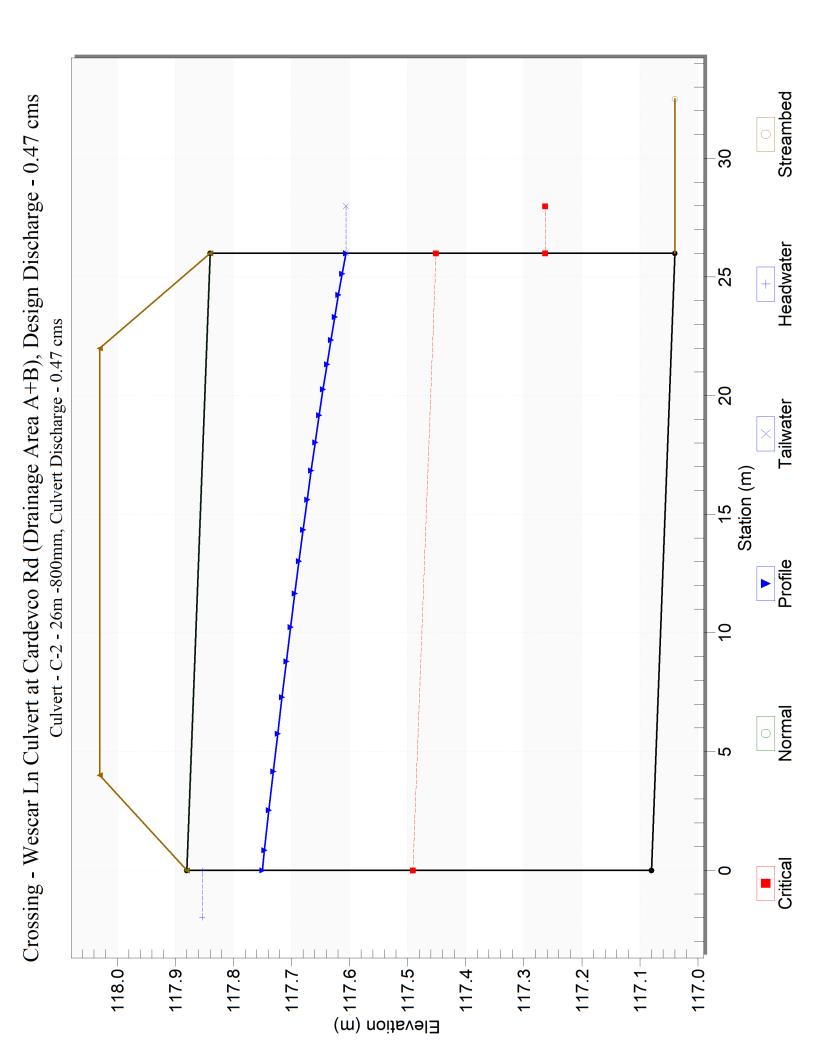
Outlet Station: 10.00 m

Outlet Elevation: 119.75 m

Culvert Crossing: 141 Wescar Ln Entrance Culvert (Drainage Area A)

Culvert Summary Table - C-1 - 10m - 500mm

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth(m)	Outlet Control Depth(m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.00	0.00	119.84	0.00	0.0	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
0.05	0.05	120.07	0.21	0.23	2- M2c	0.16	0.14	0.14	0.13	0.99	0.24
0.09	0.09	120.17	0.30	0.33	2- M2c	0.24	0.20	0.20	0.19	1.22	0.29
0.14	0.14	120.26	0.39	0.42	2- M2c	0.31	0.25	0.25	0.24	1.38	0.33
0.18	0.18	120.34	0.47	0.50	2- M2c	0.38	0.29	0.29	0.28	1.53	0.36
0.23	0.23	120.42	0.56	0.58	7- M2c	0.50	0.33	0.33	0.31	1.67	0.38
0.27	0.27	120.53	0.66	0.69	7- M2c	0.50	0.36	0.36	0.34	1.80	0.40
0.32	0.32	120.67	0.77	0.83	7- M2c	0.50	0.39	0.39	0.37	1.95	0.41
0.36	0.36	120.84	0.91	1.00	7- M2c	0.50	0.41	0.41	0.39	2.10	0.43
0.41	0.41	121.02	1.07	1.18	7- M2c	0.50	0.43	0.43	0.41	2.26	0.44
0.45	0.45	121.22	1.25	1.38	7- M2c	0.50	0.45	0.45	0.43	2.43	0.45



Culvert Data: C-2 - 26m -800mm

Culvert Data Summary - C-2 - 26m -800mm

Barrel Shape: Circular

Barrel Diameter: 800.00 mm

Barrel Material: Corrugated Steel

Embedment: 0.00 mm

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Site Data - C-2 - 26m -800mm

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 117.08 m

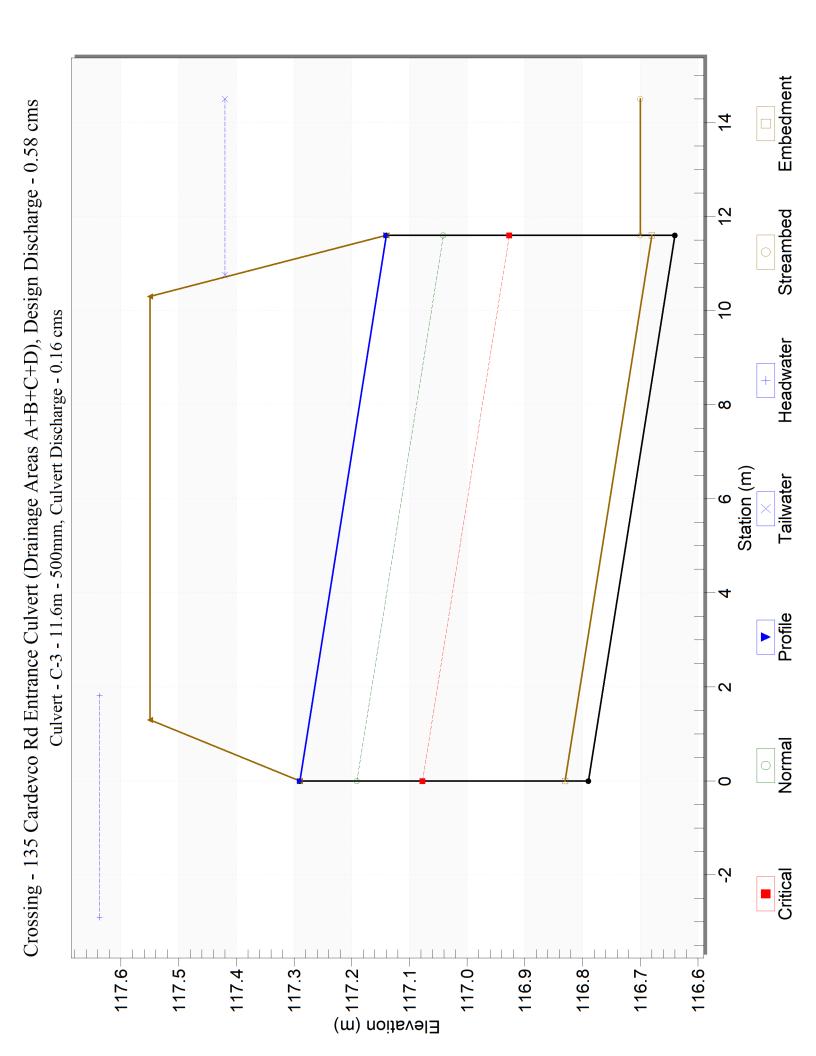
Outlet Station: 26.00 m

Outlet Elevation: 117.04 m

Culvert Crossing: Wescar Ln Culvert at Cardevco Rd (Drainage Area A+B)

Culvert Summary Table - C-2 - 26m -800mm

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth(m)	Outlet Control Depth(m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.00	0.00	117.08	0.00	0.0	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
0.05	0.05	117.31	0.18	0.23	3- M2t	0.22	0.13	0.18	0.18	0.54	0.16
0.09	0.09	117.40	0.26	0.32	3- M2t	0.32	0.18	0.26	0.26	0.65	0.20
0.14	0.14	117.48	0.33	0.40	3- M2t	0.40	0.22	0.32	0.32	0.74	0.22
0.19	0.19	117.54	0.38	0.46	3- M2t	0.47	0.26	0.37	0.37	0.82	0.24
0.23	0.23	117.60	0.43	0.52	3- M2t	0.55	0.29	0.41	0.41	0.90	0.25
0.28	0.28	117.65	0.48	0.57	3- M2t	0.65	0.31	0.45	0.45	0.97	0.27
0.33	0.33	117.71	0.52	0.63	3- M2t	0.80	0.34	0.48	0.48	1.03	0.28
0.37	0.37	117.76	0.56	0.68	3- M2t	0.80	0.37	0.51	0.51	1.10	0.29
0.42	0.42	117.80	0.61	0.72	3- M2t	0.80	0.39	0.54	0.54	1.16	0.30
0.47	0.47	117.85	0.65	0.77	3- M2t	0.80	0.41	0.57	0.57	1.22	0.30



Culvert Data: C-3 - 11.6m - 500mm

Culvert Data Summary - C-3 - 11.6m - 500mm

Barrel Shape: Circular

Barrel Diameter: 500.00 mm

Barrel Material: Corrugated Steel

Embedment: 40.00 mm

Barrel Manning's n: 0.0240 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Site Data - C-3 - 11.6m - 500mm

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 116.79 m

Outlet Station: 11.60 m

Outlet Elevation: 116.64 m

Culvert Crossing: 135 Cardevco Rd Entrance Culvert (Drainage Areas A+B+C+D)

Culvert Summary Table - C-3 - 11.6m - 500mm

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth(m)	Outlet Control Depth(m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.00	0.00	117.42	0.00	0.59	0-NF	0.00	0.00	0.46	0.72	0.00	0.00
0.06	0.06	117.45	0.22	0.62	4-FFf	0.19	0.14	0.46	0.72	0.31	0.00
0.12	0.12	117.54	0.35	0.71	4-FFf	0.28	0.21	0.46	0.72	0.62	0.00
0.17	0.13	117.57	0.37	0.74	4-FFf	0.31	0.22	0.46	0.72	0.69	0.00
0.23	0.14	117.58	0.39	0.75	4-FFf	0.32	0.23	0.46	0.72	0.72	0.00
0.29	0.14	117.59	0.40	0.76	4-FFf	0.33	0.23	0.46	0.72	0.75	0.00
0.35	0.15	117.60	0.40	0.77	4-FFf	0.33	0.23	0.46	0.72	0.78	0.00
0.41	0.15	117.61	0.41	0.78	4-FFf	0.34	0.24	0.46	0.72	0.80	0.00
0.46	0.15	117.62	0.42	0.79	4-FFf	0.35	0.24	0.46	0.72	0.82	0.00
0.52	0.16	117.63	0.43	0.80	4-FFf	0.36	0.24	0.46	0.72	0.84	0.00
0.58	0.16	117.64	0.43	0.81	4-FFf	0.36	0.25	0.46	0.72	0.85	0.00

APPENDIX D

DITCH & CULVERT CALCULATIONS

CULVERTS SIZED AS PER ORIGINAL DRAINAGE REPORT

106 TO 154 & 162 TO 173 WESCAR LANE

AND 121 TO 127 CARDEVCO ROAD

+

PROPOSED DEVELOPMENT 151-159 WESCAR LANE
WITH 1.7 HA DRAINING TO CAVANMORE ROAD

Peak Flow Calculations - Roadside Ditches Existing Conditions 106 to 154 & 162 to 173 Wescar Lane and 121 to 127 Cardevco Road

+

Proposed Development 151-159 Wescar Lane (with 1.7 ha draining to Cavanmore Road) Cardevco Subdivision Ottawa, Ontario

10-Year Event

Drainage Area A (5.76 ha less 1.0 ha)

Time of Concentration (Ditch Flow):

9 (,	
			С
Roof Area:	0.33	ha	0.90
Hard Area:	2.44	ha	0.90
Gravel Area:	0.30	ha	0.80
Soft Area:	0.99	ha	0.20
•		<u>-</u> '	
Total Catchment Area:	4.06	ha	0.72
Time of Cor	ncentration:	20	min
Length of	Ditch (Ld):	263	m
Ditch Flow \	/elocity (V):	1.11	m/s

Time of Concentration (Tc): 23.9 min

Area (A): 4.06 ha
Time of Concentration: 23.9 min

Rainfall Intensity (i): 73 mm/hr (10-Year Event)
Runoff Coefficient (C): 0.72

min

Rational Method 10-Year Flow (Q): 597.5 L/s

Ditch Slope: 0.8%

Ditch Manning Roughness Coefficient n: 0.027 gravel / short grass

 Side Slope:
 3 :1

 Lot Side Slope:
 3 :1

 Ditch Bottom Width:
 1 m

 Water Depth:
 0.29 m

Water Top Width: 2.73 m
Water Cross-Section Area: 0.54 sq.m
Wetted Perimeter: 2.82 m
Hydraulic Radius: 0.19 m

Velocity:

Velocity: 1.11 m/s

1.11 m/s

Based on water depth Using Manning's Formula:

Drainage Area B

(10-Year Event)

			С
Roof Area:	0.15	ha	0.90
Hard Area:	0.49	ha	0.90
Gravel Area:	0.32	ha	0.80
Soft Area:	0.79	ha	0.20
_			

Total Catchment Area: 1.75 ha 0.57

Drainage Area A + B

С Roof Area: 0.90 0.48 ha Hard Area: 2.93 ha 0.90 Gravel Area: 0.62 0.70 ha Soft Area: 1.78 0.20 ha

Total Catchment Area: 5.81 ha 0.66

Time of Concentration: 23.9 min (from Drainage Area A)

Length of Ditch (Ld): 238 m
Ditch Flow Velocity (V): 1.34 m/s
Time of Concentration (Ditch Flow): 3.0 min

Time of Concentration (Tc): 26.9 min

Area (A): 5.81 ha
Time of Concentration: 26.9 min

Rainfall Intensity (i): 68 mm/hr (10-Year Event)

Runoff Coefficient (C): 0.66

Rational Method 10-Year Flow (Q): 727.9 L/s

Ditch Slope: 1.2%

Ditch Manning Roughness Coefficient n: 0.027 gravel / short grass

 Road Side Slope:
 3 :1

 Lot Side Slope:
 3 :1

 Ditch Bottom Width:
 1 m

 Water Depth:
 0.29 m

Water Top Width: 2.74 m
Water Cross-Section Area: 0.54 sq.m
Wetted Perimeter: 2.83 m
Hydraulic Radius: 0.19 m

Velocity: 1.34 m/s Based on water depth
Velocity: 1.34 m/s Using Manning's Formula:

Drainage Area C

(10-Year Event)

			С
Roof Area:	0.24	ha	0.90
Hard Area:	0.57	ha	0.90
Gravel Area:	0.60	ha	0.80
Soft Area:	0.95	ha	0.20

Total Catchment Area: 2.36 ha 0.59

Time of Concentration: 20 min

Length of Ditch (Ld): 452 m
Ditch Flow Velocity (V): 1.00 m/s
Time of Concentration (Ditch Flow): 7.5 min

Time of Concentration (Tc): 27.5 min

Area (A): 2.36 ha
Time of Concentration: 27.5 min

Rainfall Intensity (i): 67 mm/hr (10-Year Event)

Runoff Coefficient (C): 0.59

Rational Method 10-Year Flow (Q): 260.3 L/s

Ditch Slope: 1.2%

Ditch Manning Roughness Coefficient n: 0.027 gravel / short grass

 Side Slope:
 3 :1

 Lot Side Slope:
 3 :1

 Ditch Bottom Width:
 1 m

 Water Depth:
 0.17 m

Water Top Width: 2.03 m
Water Cross-Section Area: 0.26 sq.m
Wetted Perimeter: 2.09 m
Hydraulic Radius: 0.12 m

Velocity:1.00m/sBased on water depthVelocity:1.00m/sUsing Manning's Formula:

Drainage Area D

(10-Year Event)

			С
Roof Area:	0.06	ha	0.90
Hard Area:	0.12	ha	0.90
Gravel Area:	0.47	ha	0.80
Soft Area:	0.08	ha	0.20
_			

Total Catchment Area: 0.73 ha 0.76

Drainage Area A + B + C + D

С Roof Area: 0.90 0.78 ha Hard Area: 3.62 ha 0.90 Gravel Area: 1.69 0.80 ha Soft Area: 2.81 0.20 ha

Total Catchment Area: 8.90 ha 0.66

Time of Concentration: 27.5 min (from Drainage Area C)

Length of Ditch (Ld): 129 m
Ditch Flow Velocity (V): 0.91 m/s
Time of Concentration (Ditch Flow): 2.4 min

Time of Concentration (Tc): 29.9 min

Area (A): 8.90 ha
Time of Concentration: 29.9 mir

Rainfall Intensity (i): 63 mm/hr (10-Year Event)

Runoff Coefficient (C): 0.66

Rational Method 10-Year Flow (Q): 1032.7 L/s

Ditch Slope: 0.3%

Ditch Manning Roughness Coefficient n: 0.027 gravel / short grass

 Road Side Slope:
 3 :1

 Lot Side Slope:
 3 :1

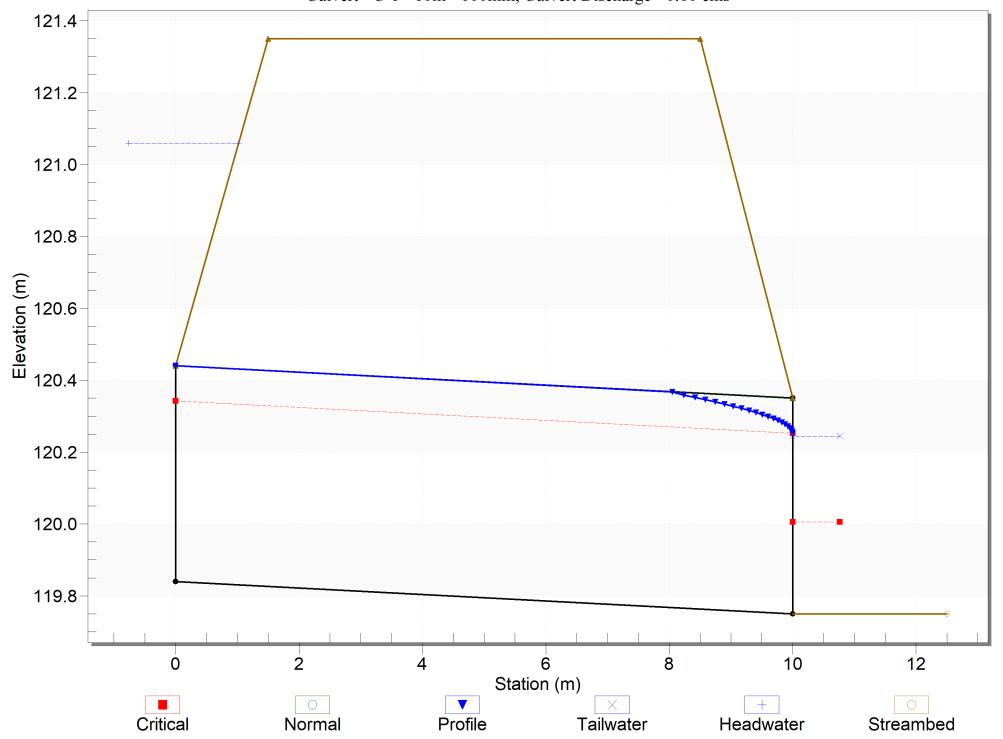
 Ditch Bottom Width:
 1 m

 Water Depth:
 0.47 m

Water Top Width: 3.82 m
Water Cross-Section Area: 1.13 sq.m
Wetted Perimeter: 3.97 m
Hydraulic Radius: 0.28 m

Velocity: 0.91 m/s Based on water depth Velocity: 0.91 m/s Using Manning's Formula:

Crossing - 141 Wescar Ln Entrance Culvert (Drainage Area A), Design Discharge - 0.60 cms
Culvert - C-1 - 10m - 600mm, Culvert Discharge - 0.60 cms



Culvert Data: C-1 - 10m - 600mm

Culvert Data Summary - C-1 - 10m - 600mm

Barrel Shape: Circular

Barrel Diameter: 600.00 mm

Barrel Material: Corrugated Steel

Embedment: 0.00 mm

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Site Data - C-1 - 10m - 600mm Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 119.84 m

Outlet Station: 10.00 m

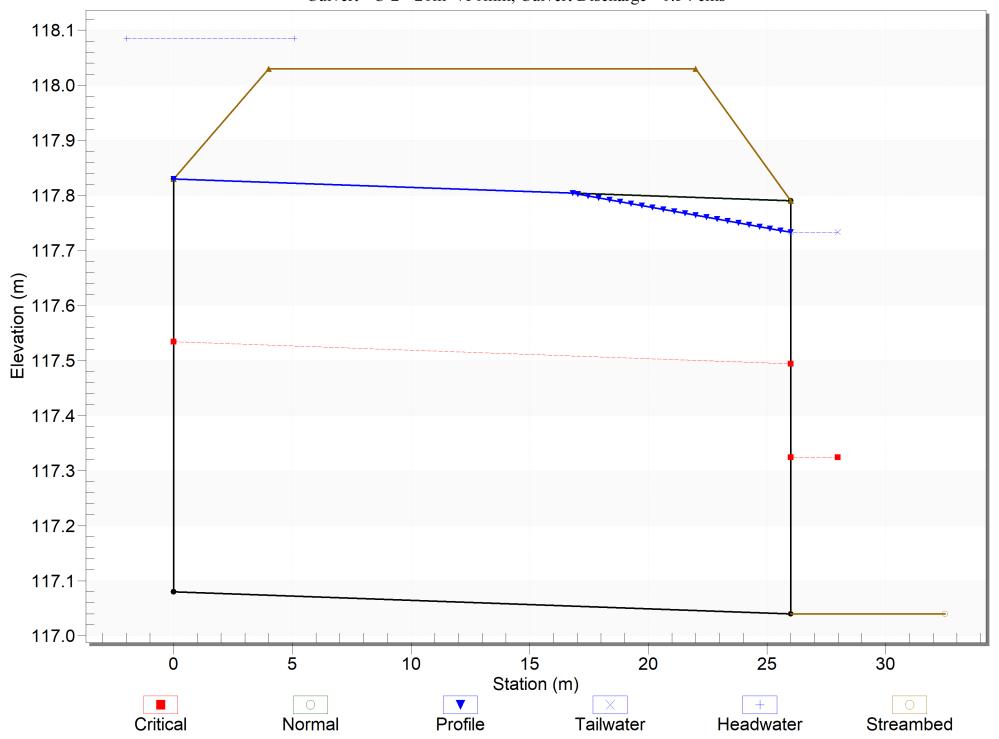
Outlet Elevation: 119.75 m

Culvert Crossing: 141 Wescar Ln Entrance Culvert (Drainage Area A)

Culvert Summary Table - C-1 - 10m - 600mm

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth(m)	Outlet Control Depth(m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.00	0.00	119.84	0.00	0.0	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
0.06	0.06	120.09	0.23	0.25	3- M2t	0.18	0.15	0.16	0.16	1.02	0.26
0.12	0.12	120.20	0.33	0.36	3- M2t	0.26	0.22	0.23	0.23	1.23	0.32
0.18	0.18	120.29	0.42	0.45	3- M2t	0.32	0.27	0.28	0.28	1.41	0.35
0.24	0.24	120.38	0.50	0.54	3- M2t	0.39	0.32	0.32	0.32	1.57	0.38
0.30	0.30	120.46	0.59	0.62	7- M2c	0.46	0.36	0.36	0.36	1.71	0.41
0.36	0.36	120.54	0.68	0.70	7- M2c	0.60	0.39	0.39	0.39	1.83	0.43
0.42	0.42	120.63	0.78	0.79	7- M2c	0.60	0.42	0.42	0.42	1.96	0.44
0.48	0.48	120.75	0.89	0.91	7- M2c	0.60	0.45	0.45	0.45	2.09	0.46
0.54	0.54	120.90	1.02	1.06	7- M2c	0.60	0.48	0.48	0.47	2.22	0.47
0.60	0.60	121.06	1.17	1.22	7- M2c	0.60	0.50	0.50	0.49	2.37	0.49

Crossing - Wescar Ln Culvert at Cardevco Rd (Drainage Area A+B), Design Discharge - 0.73 cms
Culvert - C-2 - 26m -750mm, Culvert Discharge - 0.54 cms



Culvert Data: C-2 - 26m -750mm

Culvert Data Summary - C-2 - 26m -750mm

Barrel Shape: Circular

Barrel Diameter: 750.00 mm

Barrel Material: Corrugated Steel

Embedment: 0.00 mm

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Site Data - C-2 - 26m -750mm

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 117.08 m

Outlet Station: 26.00 m

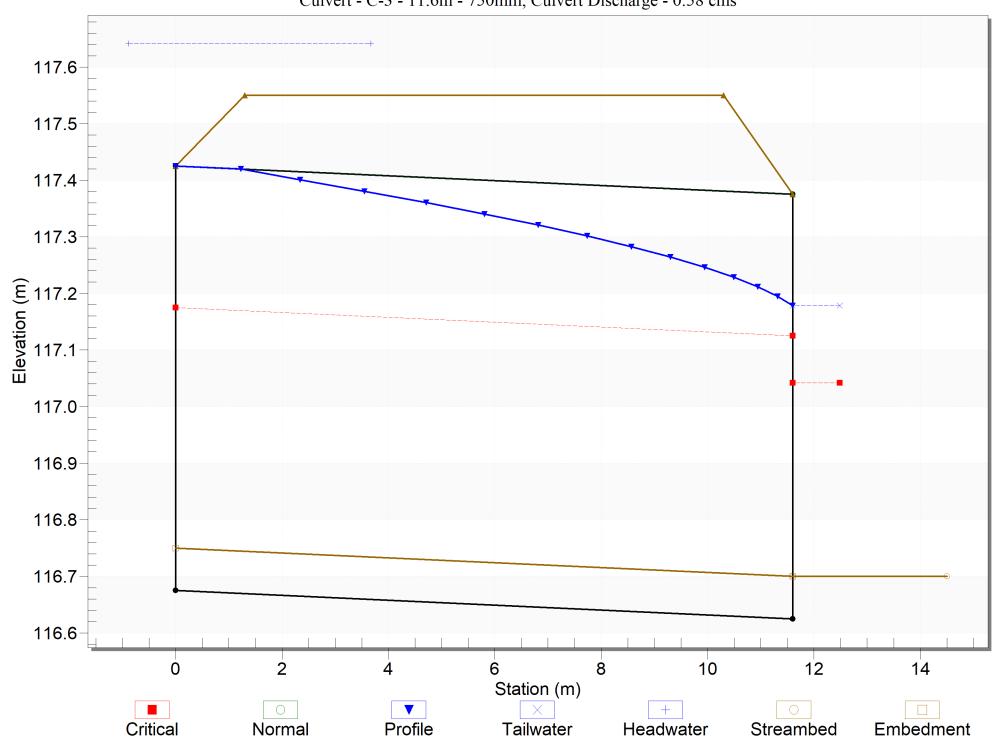
Outlet Elevation: 117.04 m

Culvert Crossing: Wescar Ln Culvert at Cardevco Rd (Drainage Area A+B)

Culvert Summary Table - C-2 - 26m -750mm

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth(m)	Outlet Control Depth(m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.00	0.00	117.08	0.00	0.0	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
0.07	0.07	117.37	0.24	0.29	3- M2t	0.29	0.16	0.23	0.23	0.63	0.19
0.15	0.15	117.49	0.34	0.41	3- M2t	0.42	0.23	0.33	0.33	0.79	0.22
0.22	0.22	117.60	0.43	0.52	3- M2t	0.57	0.28	0.40	0.40	0.92	0.25
0.29	0.29	117.69	0.50	0.61	3- M2t	0.75	0.33	0.46	0.46	1.04	0.27
0.36	0.36	117.77	0.58	0.69	3- M2t	0.75	0.37	0.51	0.51	1.15	0.29
0.44	0.44	117.86	0.65	0.78	3- M2t	0.75	0.41	0.55	0.55	1.26	0.30
0.51	0.51	117.96	0.72	0.88	7- M2t	0.75	0.44	0.59	0.59	1.37	0.31
0.58	0.55	118.05	0.77	0.97	7- M2t	0.75	0.46	0.63	0.63	1.41	0.32
0.66	0.55	118.07	0.76	0.99	7- M2t	0.75	0.46	0.66	0.66	1.33	0.33
0.73	0.54	118.08	0.75	1.00	7- M2t	0.75	0.45	0.69	0.69	1.27	0.34

Crossing - 135 Cardevco Rd Entrance Culvert (Drainage Areas A+B+C+D), Design Discharge - 1.03 cms Culvert - C-3 - 11.6m - 750mm, Culvert Discharge - 0.58 cms



Culvert Data: C-3 - 11.6m - 750mm

Culvert Data Summary - C-3 - 11.6m - 750mm

Barrel Shape: Circular

Barrel Diameter: 750.00 mm

Barrel Material: Corrugated Steel

Embedment: 75.00 mm

Barrel Manning's n: 0.0240 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Site Data - C-3 - 11.6m - 750mm

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 116.67 m

Outlet Station: 11.60 m

Outlet Elevation: 116.62 m

Culvert Crossing: 135 Cardevco Rd Entrance Culvert (Drainage Areas A+B+C+D)

Culvert Summary Table - C-3 - 11.6m - 750mm

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth(m)	Outlet Control Depth(m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.00	0.00	116.75	0.00	0.0	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
0.10	0.10	117.04	0.25	0.29	2- M2c	0.28	0.15	0.15	0.15	1.14	0.47
0.21	0.21	117.19	0.39	0.44	2- M2c	0.43	0.23	0.23	0.22	1.40	0.58
0.31	0.31	117.31	0.51	0.56	2- M2c	0.68	0.30	0.30	0.27	1.60	0.64
0.41	0.41	117.43	0.62	0.68	7- M2c	0.68	0.35	0.35	0.31	1.76	0.70
0.52	0.52	117.55	0.74	0.80	7- M2c	0.68	0.40	0.40	0.34	1.92	0.74
0.62	0.54	117.58	0.77	0.83	7- M2c	0.68	0.41	0.41	0.38	1.95	0.78
0.72	0.56	117.60	0.79	0.85	7- M2c	0.68	0.42	0.42	0.40	1.97	0.81
0.83	0.57	117.61	0.80	0.86	7- M2t	0.68	0.42	0.43	0.43	1.93	0.84
0.93	0.57	117.63	0.81	0.88	7- M2t	0.68	0.42	0.46	0.46	1.84	0.86
1.03	0.58	117.64	0.82	0.89	7- M2t	0.68	0.42	0.48	0.48	1.78	0.89

APPENDIX E

DITCH & CULVERT CALCULATIONS

EXISTING CONDITIONS

106 TO 154 & 162 TO 173 WESCAR LANE
AND 121 TO 127 CARDEVCO ROAD

+

PROPOSED DEVELOPMENT 151-159 WESCAR LANE
RESTRICTED FLOWS OF
165, 151-159, 141 & 131 WESCAR LANE

Peak Flow Calculations - Roadside Ditches Existing Conditions 107 to 154 & 162 to 173 Wescar Lane and 121 to 127 Cardevco Road

+

Proposed Development 151-159 Wescar Lane Cardevco Subdivision Ottawa, Ontario

10-Year Event (restricted flow) (restricted flows of 165, 151-159, 141 & 131 Wescar Lane)

Drainage Area A

(restricted flows of 165, 151-159 & 141 Wescar Lane)

			С
Roof Area:	0.00	ha	0.90
Hard Area:	0.15	ha	0.90
Gravel Area:	0.29	ha	0.70
Soft Area:	0.18	ha	0.20
_			
Total Catchment Area:	0.63	ha	0.60

Time of Concentration:	20	min
Length of Ditch (Ld):	263	m
Ditch Flow Velocity (V):	0.31	m/s
Time of Concentration (Ditch Flow):	14.1	min
Time of Concentration (Tc):	34.1	min
Area (A):	0.63	ha
Time of Concentration:	34.1	min
Rainfall Intensity (i):	58	mm/hr (10-Year Event)
Runoff Coefficient (C):	0.60	
Rational Method 10-Year Flow (Q):	60.7	L/s
Restricted flow 165 Wescar Lane	32.9	L/s
Restricted flow 151-159 Wescar Lane	67.2	L/s
Restricted flow 141Wescar Lane	30.4	L/s

Ditch Slope: 0.8%

Ditch Manning Roughness Coefficient n: 0.10 dense weeds as high as flow

Q: 191.1 L/s

Side Slope: 3 :1

Lot Side Slope: 3 :1

Ditch Bottom Width: 1 m

Water Depth: 0.32 m

Water Top Width: 2.89 m
Water Cross-Section Area: 0.61 sq.m
Wetted Perimeter: 2.99 m
Hydraulic Radius: 0.20 m

Velocity: 0.31 m/s Based on water depth Using Manning's Formula:

Drainage Area B

(10-Year Event (restricted flow) (restricted flows of 131 Wescar Lane)

			С
Roof Area:	0.09	ha	0.90
Hard Area:	0.36	ha	0.90
Gravel Area:	0.32	ha	0.70
Soft Area:	0.67	ha	0.20
_			

Total Catchment Area: 1.44 ha

Drainage Area A + B

(restricted flows of 165, 151-159, 141 & 131 Wescar Lane)

			С
Roof Area:	0.09	ha	0.90
Hard Area:	0.51	ha	0.90
Gravel Area:	0.61	ha	0.70
Soft Area:	0.86	_ha	0.20
		<u></u>	
Total Catchment Area:	2.07	ha	0.55

Time of Concentration: 34.1 min (from Drainage Area A)

0.53

Length of Ditch (Ld): 238 m
Ditch Flow Velocity (V): 0.40 m/s
Time of Concentration (Ditch Flow): 9.9 min

Time of Concentration (Tc): 44.0 min

Area (A): 2.07 ha
Time of Concentration: 44.0 min

Rainfall Intensity (i): 48 mm/hr (10-Year Event)

Runoff Coefficient (C): 0.55

Rational Method 10-Year Flow (Q): L/s 152.9 Restricted flow 165 Wescar Lane 32.9 L/s Restricted flow 151-159 Wescar Lane 67.2 L/s Restricted flow 141Wescar Lane 30.4 L/s Restricted flow 131 Wescar Lane 27.7 L/s Q: 283.3 L/s

Ditch Slope: 1.2%

Ditch Manning Roughness Coefficient n: 0.10 dense weeds as high as flow

Side Slope: 3 :1
Lot Side Slope: 3 :1
Ditch Bottom Width: 1 m
Water Depth: 0.35 m

Water Top Width: 3.07 m
Water Cross-Section Area: 0.70 sq.m
Wetted Perimeter: 3.18 m
Hydraulic Radius: 0.22 m

Velocity: 0.40 m/s Based on water depth
Velocity: 0.40 m/s Using Manning's Formula:

Drainage Area C

(10-Year Event (restricted flow)

(restricted flows of 165, 151-159, 141 & 131 Wescar Lane)

Total Catchment Area:

			С
Roof Area:	0.24	ha	0.90
Hard Area:	0.57	ha	0.90
Gravel Area:	0.60	ha	0.80
Soft Area:	0.95	ha	0.20

Time of Concentration: 20 min

2.36 ha

Length of Ditch (Ld): 452 m
Ditch Flow Velocity (V): 0.36 m/s
Time of Concentration (Ditch Flow): 20.9 min

Time of Concentration (Tc): 40.9 min

Area (A): 2.36 ha
Time of Concentration: 40.9 min

Rainfall Intensity (i): 51 mm/hr (10-Year Event)

0.59

Runoff Coefficient (C): 0.59

Rational Method 10-Year Flow (Q): 198.0 L/s

Ditch Slope: 1.2%

Ditch Manning Roughness Coefficient n: 0.10 dense weeds as high as flow

Side Slope: 3 :1

Lot Side Slope: 3 :1

Ditch Bottom Width: 1 m

Water Depth: 0.30 m

Water Top Width: 2.77 m
Water Cross-Section Area: 0.56 sq.m
Wetted Perimeter: 2.87 m
Hydraulic Radius: 0.19 m

Velocity: 0.36 m/s Based on water depth Using Manning's Formula:

Drainage Area D

(10-Year Event (restricted flow)

			С
Roof Area:	0.06	ha	0.90
Hard Area:	0.12	ha	0.90
Gravel Area:	0.47	ha	0.70
Soft Area:	0.08	ha	0.20
_			
Total Catchment Area:	0.73	ha	0.69

Drainage Area A + B + C + D

			C
Roof Area:	0.40	ha	0.90
Hard Area:	1.20	ha	0.90
Gravel Area:	1.68	ha	0.70
Soft Area:	1.89	ha	0.20
Total Catchment Area:	5.17	ha	0.58

Time of Concentration:	44.0	min (from Drainage Area A + B)
Length of Ditch (Ld):	129	m
Ditch Flow Velocity (V):	0.76	m/s
Time of Concentration (Ditch Flow):	2.8	min

Time of Concentration (Tc): 46.9 min

Area (A):	5.17	ha
Time of Concentration:	46.9	min
Rainfall Intensity (i):	46	mm/hr (10-Year Event)
Runoff Coefficient (C):	0.58	

Rational Method 10-Year Flow (Q):	383.1	L/s
Restricted flow 165 Wescar Lane	32.9	L/s
Restricted flow 151-159 Wescar Lane	67.2	L/s
Restricted flow 141Wescar Lane	30.4	L/s
Restricted flow 131 Wescar Lane	27.7	L/s
Q:	513.5	L/s

Ditch Slope: 0.3%

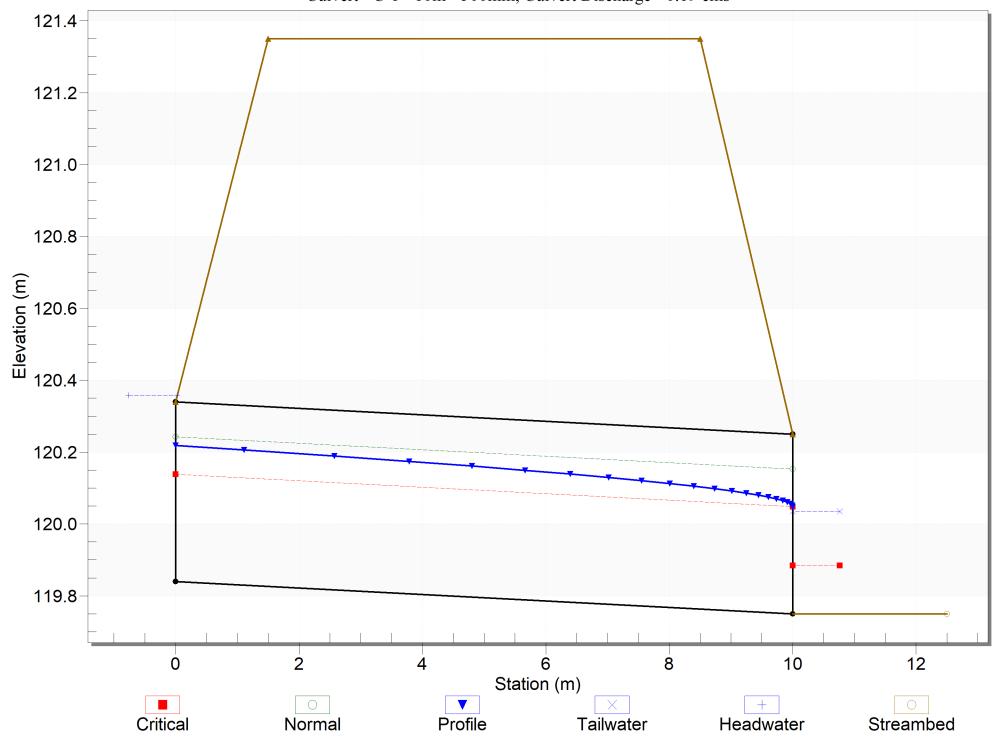
Ditch Manning Roughness Coefficient n: 0.027 gravel / short grass

Side Slope: 3 :1
Lot Side Slope: 3 :1
Ditch Bottom Width: 1 m
Water Depth: 0.34 m

Water Top Width: 3.01 m
Water Cross-Section Area: 0.67 sq.m
Wetted Perimeter: 3.12 m
Hydraulic Radius: 0.22 m

Velocity: 0.76 m/s Based on water depth Using Manning's Formula:

Crossing - 141 Wescar Ln Entrance Culvert (Drainage Area A), Design Discharge - 0.19 cms
Culvert - C-1 - 10m - 500mm, Culvert Discharge - 0.19 cms



Culvert Data: C-1 - 10m - 500mm

Culvert Data Summary - C-1 - 10m - 500mm

Barrel Shape: Circular

Barrel Diameter: 500.00 mm

Barrel Material: Corrugated Steel

Embedment: 0.00 mm

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Site Data - C-1 - 10m - 500mm Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 119.84 m

Outlet Station: 10.00 m

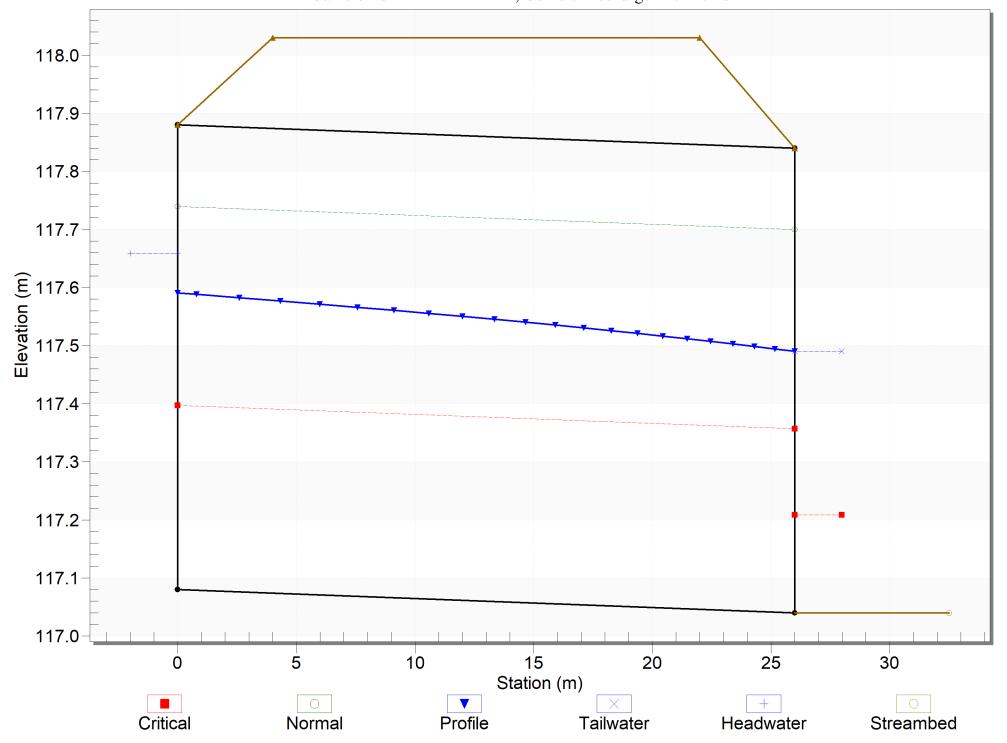
Outlet Elevation: 119.75 m

Culvert Crossing: 141 Wescar Ln Entrance Culvert (Drainage Area A)

Culvert Summary Table - C-1 - 10m - 500mm

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth(m)	Outlet Control Depth(m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.00	0.00	119.84	0.00	0.0	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
0.02	0.02	119.98	0.13	0.14	2- M2c	0.11	0.09	0.09	0.08	0.79	0.18
0.04	0.04	120.05	0.19	0.21	2- M2c	0.15	0.13	0.13	0.12	0.95	0.23
0.06	0.06	120.10	0.24	0.26	2- M2c	0.19	0.16	0.16	0.15	1.06	0.26
0.08	0.08	120.14	0.28	0.30	2- M2c	0.22	0.18	0.18	0.18	1.16	0.28
0.10	0.10	120.18	0.31	0.34	2- M2c	0.25	0.21	0.21	0.20	1.24	0.30
0.11	0.11	120.22	0.35	0.38	2- M2c	0.28	0.23	0.23	0.22	1.31	0.31
0.13	0.13	120.25	0.39	0.41	2- M2c	0.30	0.25	0.25	0.24	1.38	0.33
0.15	0.15	120.29	0.42	0.45	2- M2c	0.33	0.27	0.27	0.26	1.44	0.34
0.17	0.17	120.32	0.45	0.48	2- M2c	0.37	0.28	0.28	0.27	1.50	0.35
0.19	0.19	120.36	0.49	0.52	7- M2c	0.40	0.30	0.30	0.29	1.56	0.36

Crossing - Wescar Ln Culvert at Cardevco Rd (Drainage Area A+B), Design Discharge - 0.28 cms
Culvert - C-2 - 26m -800mm, Culvert Discharge - 0.28 cms



Culvert Data: C-2 - 26m -800mm

Culvert Data Summary - C-2 - 26m -800mm

Barrel Shape: Circular

Barrel Diameter: 800.00 mm

Barrel Material: Corrugated Steel

Embedment: 0.00 mm

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Site Data - C-2 - 26m -800mm

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 117.08 m

Outlet Station: 26.00 m

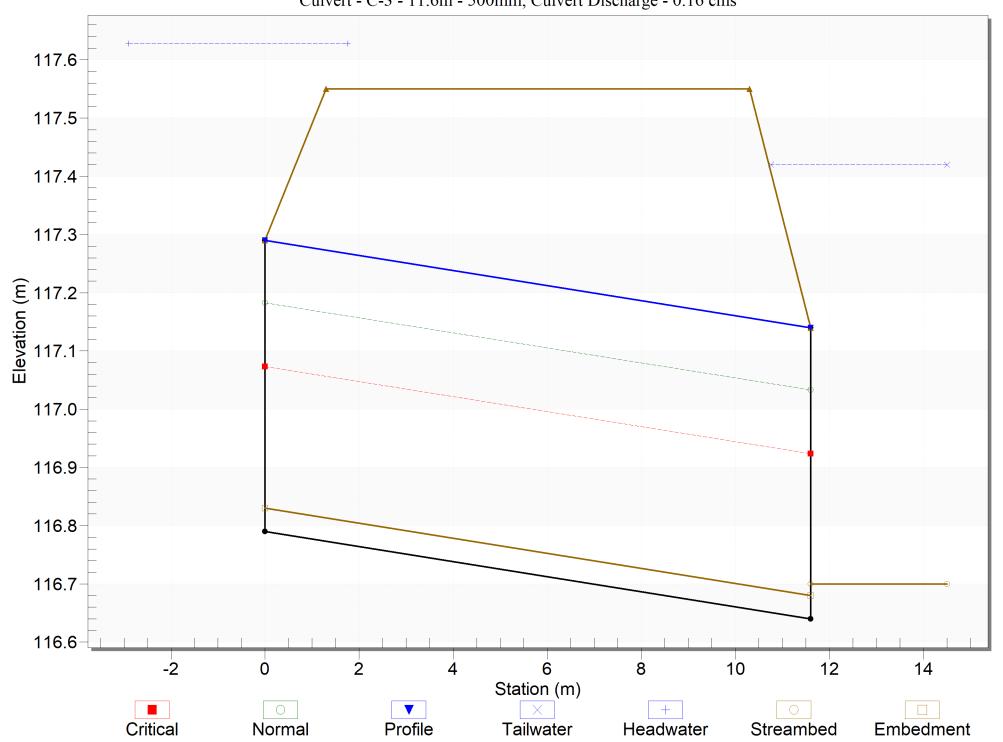
Outlet Elevation: 117.04 m

Culvert Crossing: Wescar Ln Culvert at Cardevco Rd (Drainage Area A+B)

Culvert Summary Table - C-2 - 26m -800mm

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth(m)	Outlet Control Depth(m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.00	0.00	117.08	0.00	0.0	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
0.03	0.03	117.26	0.14	0.18	3- M2t	0.17	0.10	0.14	0.14	0.48	0.14
0.06	0.06	117.33	0.20	0.25	3- M2t	0.24	0.14	0.20	0.20	0.56	0.17
0.08	0.08	117.39	0.25	0.31	3- M2t	0.30	0.17	0.25	0.25	0.63	0.19
0.11	0.11	117.44	0.29	0.36	3- M2t	0.35	0.20	0.29	0.29	0.69	0.21
0.14	0.14	117.48	0.33	0.40	3- M2t	0.40	0.22	0.32	0.32	0.74	0.22
0.17	0.17	117.52	0.36	0.44	3- M2t	0.45	0.24	0.35	0.35	0.79	0.23
0.20	0.20	117.56	0.39	0.48	3- M2t	0.49	0.26	0.38	0.38	0.84	0.24
0.23	0.23	117.59	0.42	0.51	3- M2t	0.54	0.28	0.41	0.41	0.89	0.25
0.25	0.25	117.63	0.45	0.55	3- M2t	0.60	0.30	0.43	0.43	0.93	0.26
0.28	0.28	117.66	0.48	0.58	3- M2t	0.66	0.32	0.45	0.45	0.97	0.27

Crossing - 135 Cardevco Rd Entrance Culvert (Drainage Areas A+B+C+D), Design Discharge - 0.51 cms Culvert - C-3 - 11.6m - 500mm, Culvert Discharge - 0.16 cms



Culvert Data: C-3 - 11.6m - 500mm

Culvert Data Summary - C-3 - 11.6m - 500mm

Barrel Shape: Circular

Barrel Diameter: 500.00 mm

Barrel Material: Corrugated Steel

Embedment: 40.00 mm

Barrel Manning's n: 0.0240 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Site Data - C-3 - 11.6m - 500mm

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 116.79 m

Outlet Station: 11.60 m

Outlet Elevation: 116.64 m

Culvert Crossing: 135 Cardevco Rd Entrance Culvert (Drainage Areas A+B+C+D)

Culvert Summary Table - C-3 - 11.6m - 500mm

Total Discharg e (cms)	Culvert Discharg e (cms)	Headwate r Elevation (m)	Inlet Control Depth(m)	Outlet Control Depth(m)	Flow Typ e	Norma l Depth (m)	Critica l Depth (m)	Outle t Depth (m)	Tailwate r Depth (m)	Outlet Velocit y (m/s)	Tailwate r Velocity (m/s)
0.00	0.00	117.42	0.00	0.59	0-NF	0.00	0.00	0.46	0.72	0.00	0.00
0.05	0.05	117.45	0.20	0.62	4-FFf	0.17	0.13	0.46	0.72	0.27	0.00
0.10	0.10	117.52	0.32	0.69	4-FFf	0.26	0.19	0.46	0.72	0.55	0.00
0.15	0.13	117.56	0.37	0.73	4-FFf	0.30	0.22	0.46	0.72	0.68	0.00
0.21	0.13	117.58	0.38	0.75	4-FFf	0.31	0.22	0.46	0.72	0.71	0.00
0.26	0.14	117.59	0.39	0.76	4-FFf	0.32	0.23	0.46	0.72	0.74	0.00
0.31	0.14	117.60	0.40	0.77	4-FFf	0.33	0.23	0.46	0.72	0.76	0.00
0.36	0.15	117.61	0.41	0.78	4-FFf	0.34	0.24	0.46	0.72	0.78	0.00
0.41	0.15	117.61	0.41	0.78	4-FFf	0.34	0.24	0.46	0.72	0.80	0.00
0.46	0.15	117.62	0.42	0.79	4-FFf	0.35	0.24	0.46	0.72	0.82	0.00
0.51	0.16	117.63	0.42	0.80	4-FFf	0.35	0.24	0.46	0.72	0.83	0.00

Peak Flow Calculations - Roadside Ditches Existing Conditions 107 to 154 & 162 to 173 Wescar Lane and 121 to 127 Cardevco Road

+

Proposed Development 151-159 Wescar Lane Cardevco Subdivision Ottawa, Ontario

2-Year Event (restricted flow) (restricted flows of 165, 151-159, 141 & 131 Wescar Lane)

Drainage Area A

(restricted flows of 165, 151-159 & 141 Wescar Lane)

			C
Roof Area:	0.00	ha	0.90
Hard Area:	0.15	ha	0.90
Gravel Area:	0.29	ha	0.70
Soft Area:	0.18	ha	0.20
-			

Total Catchment Area: 0.63 ha

0.60

20	min
000	l
263	m
0.30	m/s
14.6	min
34.6	min
0.63	ha
34.6	min
36	mm/hr (2 Year Event)
0.60	
38.2	L/s
32.9	L/s
67.2	L/s
30.4	L/s
	263 0.30 14.6 34.6 0.63 34.6 36 0.60 38.2 32.9 67.2

Ditch Slope: 0.8%

Ditch Manning Roughness Coefficient n: 0.10 dense weeds as high as flow

Q: 168.6 L/s

 Side Slope:
 3 :1

 Lot Side Slope:
 3 :1

 Ditch Bottom Width:
 1 m

 Water Depth:
 0.30 m

Water Top Width: 2.77 m
Water Cross-Section Area: 0.56 sq.m
Wetted Perimeter: 2.87 m
Hydraulic Radius: 0.19 m

Velocity: 0.30 m/s Bas Velocity: 0.30 m/s Usir

Based on water depth Using Manning's Formula:

Drainage Area B

(2-Year Event (restricted flow)) (restricted flows of 131 Wescar Lane)

			С
Roof Area:	0.09	ha	0.90
Hard Area:	0.36	ha	0.90
Gravel Area:	0.32	ha	0.70
Soft Area:	0.67	ha	0.20
_			·

Drainage Area A + B

(restricted flows of 165, 151-159, 141 & 131 Wescar Lane)

Total Catchment Area:

Total Catchment Area: 1.44 ha

			O
Roof Area:	0.09	ha	0.90
Hard Area:	0.51	ha	0.90
Gravel Area:	0.61	ha	0.70
Soft Area:	0.86	ha	0.20
_			

Time of Concentration: 34.6 min (from Drainage Area A)

0.53

0.55

Length of Ditch (Ld):	238	m
Ditch Flow Velocity (V):	0.38	m/s
Time of Concentration (Ditch Flow):	10.4	min

Time of Concentration (Tc): 45.0

2.07

Area (A): Time of Concentration: Rainfall Intensity (i): Runoff Coefficient (C):	2.07 45.0 30 0.55	ha min mm/hr (2 Year Event)
Rational Method 2-Year Flow (Q):	95.9	L/s
Restricted flow 165 Wescar Lane	32.9	L/s
Restricted flow 151-159 Wescar Lane	67.2	L/s
Restricted flow 141Wescar Lane	30.4	L/s
Restricted flow 131 Wescar Lane	27.7	L/s

226.3 L/s

Ditch Slope: 1.2%

Ditch Manning Roughness Coefficient n: 0.10 dense weeds as high as flow

> Side Slope: 3 :1 Lot Side Slope: 3 :1 Ditch Bottom Width: 1 m Water Depth: 0.31 m

Water Top Width: 2.86 m Water Cross-Section Area: 0.60 sq.m 2.96 m Wetted Perimeter: Hydraulic Radius: 0.20 m

> 0.38 m/s Velocity: Based on water depth Using Manning's Formula: Velocity: 0.38 m/s

Drainage Area C

(2-Year Event (restricted flow))

(restricted flows of 165, 151-159, 141 & 131 Wescar Lane)

			C
Roof Area:	0.24	ha	0.90
Hard Area:	0.57	ha	0.90
Gravel Area:	0.60	ha	0.80
Soft Area:	0.95	ha	0.20
_	•		

Total Catchment Area: 2.36 ha 0.59

Time of Concentration: 20 min

Length of Ditch (Ld): 452 m

Ditch Flow Velocity (V): 0.32 m/s

Time of Concentration (Ditch Flow): 23.5 min

Time of Concentration (Tc): 43.5 min

Area (A): 2.36 ha
Time of Concentration: 43.5 min

Rainfall Intensity (i): 31 mm/hr (2 Year Event)

Runoff Coefficient (C): 0.59

Rational Method 2-Year Flow (Q): 120.7 L/s

Ditch Slope: 1.2%

Ditch Manning Roughness Coefficient n: 0.10 dense weeds as high as flow

 Side Slope:
 3 :1

 Lot Side Slope:
 3 :1

 Ditch Bottom Width:
 1 m

 Water Depth:
 0.23 m

Water Top Width: 2.36 m
Water Cross-Section Area: 0.38 sq.m
Wetted Perimeter: 2.44 m
Hydraulic Radius: 0.16 m

Velocity: 0.32 m/s Based on water depth Velocity: 0.32 m/s Using Manning's Formula:

Drainage Area D

(2-Year Event (restricted flow))

			С
Roof Area:	0.06	ha	0.90
Hard Area:	0.12	ha	0.90
Gravel Area:	0.47	ha	0.70
Soft Area:	0.08	ha	0.20
_			

Total Catchment Area: 0.73 ha 0.69

Drainage Area A + B + C + D

С 0.90 Roof Area: 0.40 ha Hard Area: 1.20 ha 0.90 Gravel Area: 0.70 1.68 ha Soft Area: 1.89 ha 0.20

Total Catchment Area: 5.17 ha 0.58

Time of Concentration: 45.0 min (from Drainage Area A + B)

Length of Ditch (Ld): 129 m
Ditch Flow Velocity (V): 0.70 m/s
Time of Concentration (Ditch Flow): 3.1 min

Time of Concentration (Tc): 48.1 min

Area (A): 5.17 ha
Time of Concentration: 48.1 min

Rainfall Intensity (i): 29 mm/hr (2 Year Event)

Runoff Coefficient (C): 0.58

Rational Method 2-Year Flow (Q): 239.7 L/s Restricted flow 165 Wescar Lane 32.9 L/s Restricted flow 151-159 Wescar Lane 67.2 L/s Restricted flow 141Wescar Lane 30.4 L/s Restricted flow 131 Wescar Lane 27.7 L/s 370.1 Q: L/s

Ditch Slope: 0.3%

Ditch Manning Roughness Coefficient n: 0.027 gravel / short grass

 Side Slope:
 3 :1

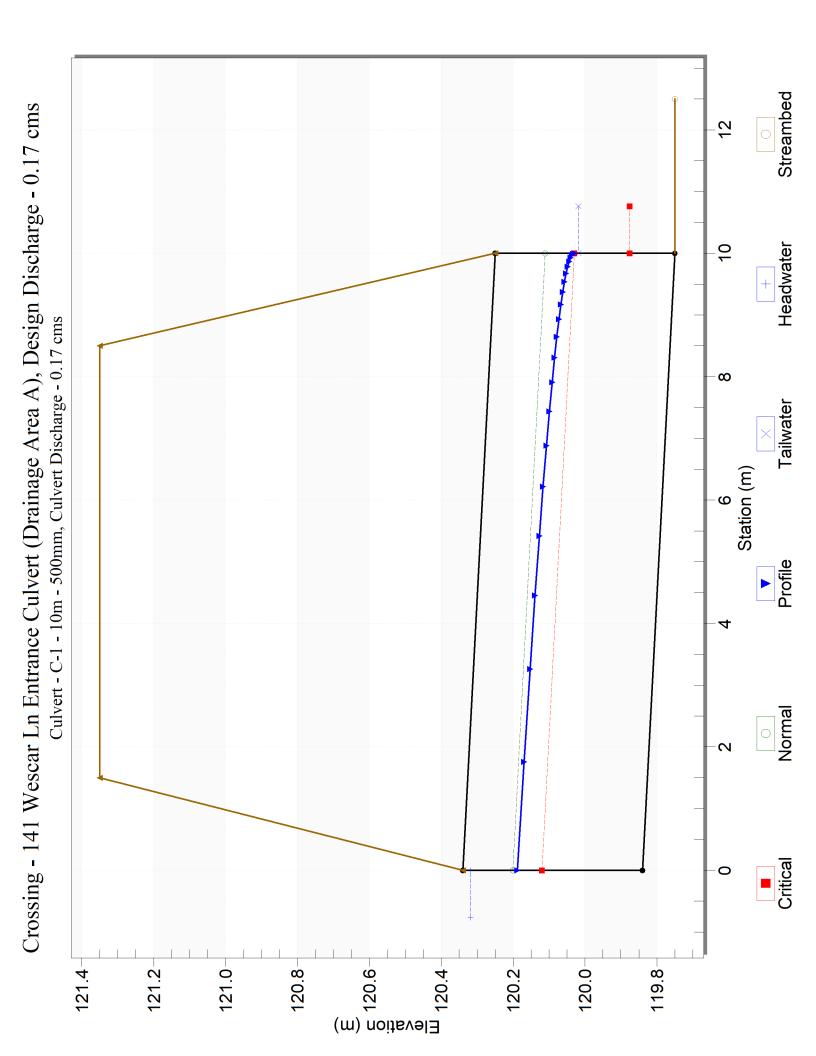
 Lot Side Slope:
 3 :1

 Ditch Bottom Width:
 1 m

 Water Depth:
 0.29 m

Water Top Width: 2.71 m
Water Cross-Section Area: 0.53 sq.m
Wetted Perimeter: 2.80 m
Hydraulic Radius: 0.19 m

Velocity: 0.70 m/s Based on water depth Velocity: 0.70 m/s Using Manning's Formula:



Culvert Data: C-1 - 10m - 500mm

Culvert Data Summary - C-1 - 10m - 500mm

Barrel Shape: Circular

Barrel Diameter: 500.00 mm

Barrel Material: Corrugated Steel

Embedment: 0.00 mm

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Site Data - C-1 - 10m - 500mm Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 119.84 m

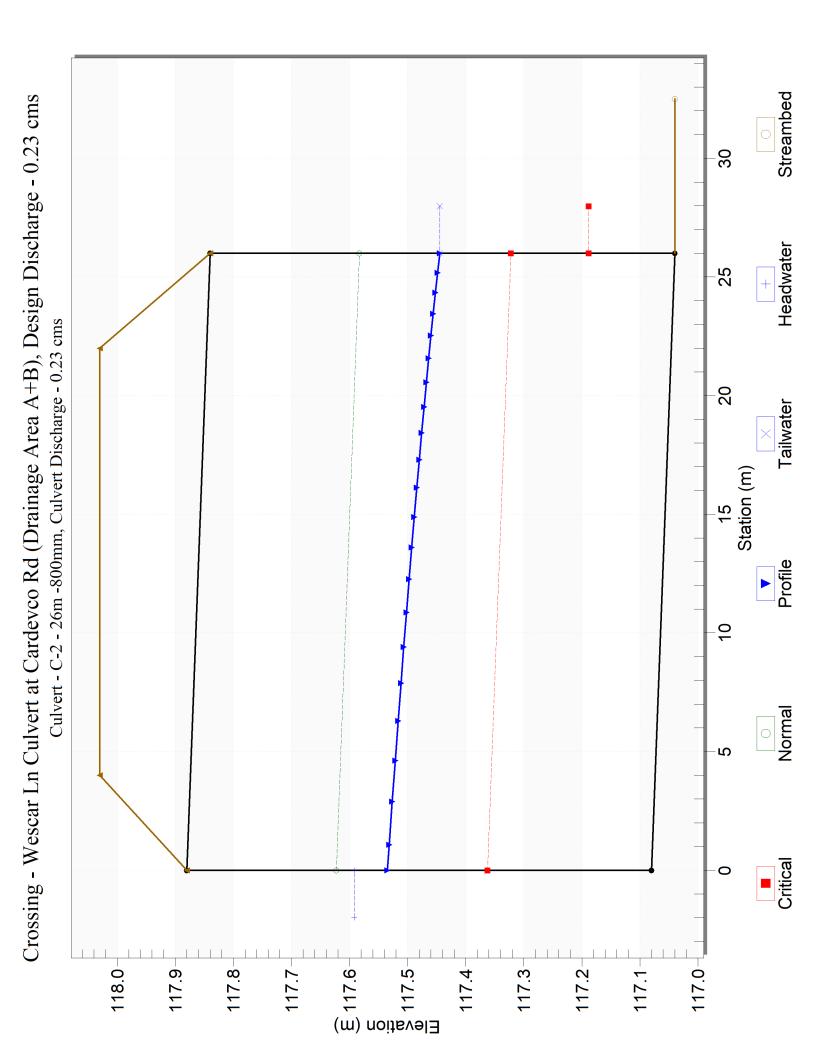
Outlet Station: 10.00 m

Outlet Elevation: 119.75 m

Culvert Crossing: 141 Wescar Ln Entrance Culvert (Drainage Area A)

Culvert Summary Table - C-1 - 10m - 500mm

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth(m)	Outlet Control Depth(m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.00	0.00	119.84	0.00	0.0	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
0.02	0.02	119.98	0.12	0.14	2- M2c	0.10	0.09	0.09	0.08	0.76	0.18
0.03	0.03	120.03	0.18	0.19	2- M2c	0.14	0.12	0.12	0.11	0.92	0.22
0.05	0.05	120.08	0.22	0.24	2- M2c	0.17	0.15	0.15	0.14	1.03	0.25
0.07	0.07	120.12	0.26	0.28	2- M2c	0.20	0.17	0.17	0.17	1.12	0.27
0.08	0.08	120.16	0.29	0.32	2- M2c	0.23	0.19	0.19	0.19	1.19	0.29
0.10	0.10	120.19	0.32	0.35	2- M2c	0.26	0.21	0.21	0.21	1.26	0.30
0.12	0.12	120.23	0.36	0.39	2- M2c	0.28	0.23	0.23	0.22	1.33	0.32
0.14	0.14	120.26	0.39	0.42	2- M2c	0.31	0.25	0.25	0.24	1.38	0.33
0.15	0.15	120.29	0.42	0.45	2- M2c	0.33	0.26	0.26	0.25	1.44	0.34
0.17	0.17	120.32	0.45	0.48	2- M2c	0.36	0.28	0.28	0.27	1.50	0.35



Culvert Data: C-2 - 26m -800mm

Culvert Data Summary - C-2 - 26m -800mm

Barrel Shape: Circular

Barrel Diameter: 800.00 mm

Barrel Material: Corrugated Steel

Embedment: 0.00 mm

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Site Data - C-2 - 26m -800mm

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 117.08 m

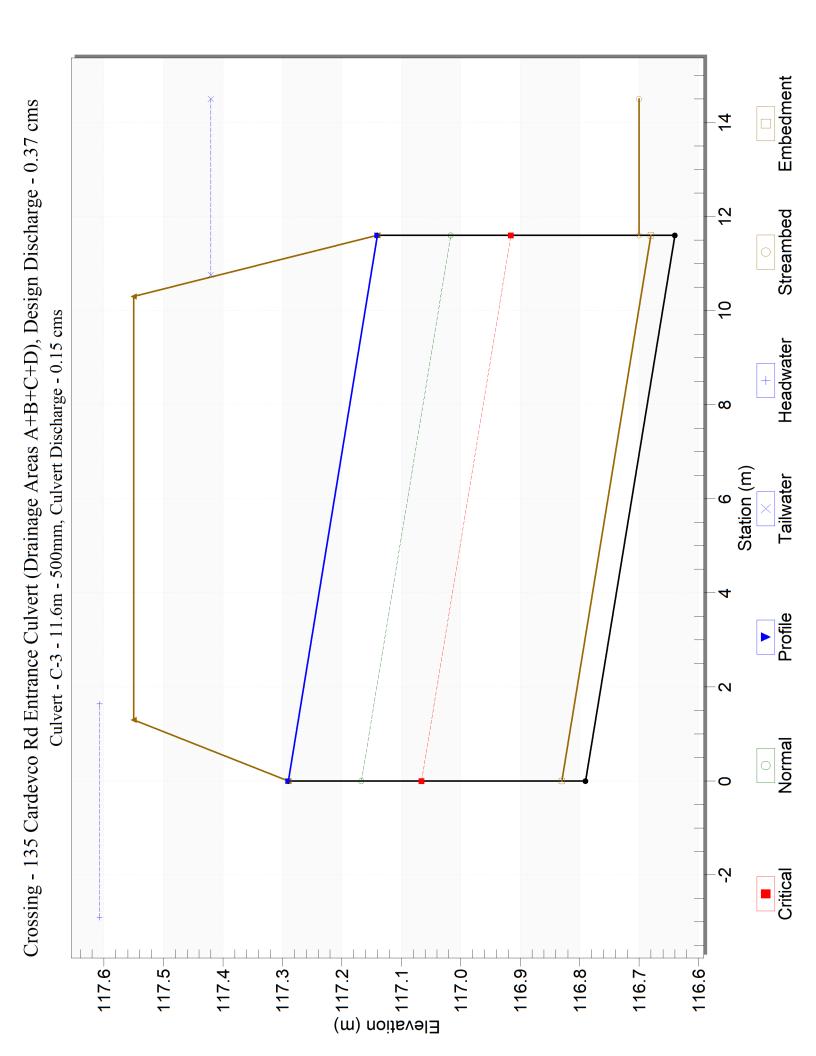
Outlet Station: 26.00 m

Outlet Elevation: 117.04 m

Culvert Crossing: Wescar Ln Culvert at Cardevco Rd (Drainage Area A+B)

Culvert Summary Table - C-2 - 26m -800mm

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth(m)	Outlet Control Depth(m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.00	0.00	117.08	0.00	0.0	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
0.02	0.02	117.24	0.13	0.16	3- M2t	0.15	0.09	0.12	0.12	0.45	0.13
0.05	0.05	117.30	0.18	0.22	3- M2t	0.22	0.12	0.18	0.18	0.53	0.16
0.07	0.07	117.35	0.22	0.27	3- M2t	0.27	0.15	0.22	0.22	0.59	0.18
0.09	0.09	117.40	0.26	0.32	3- M2t	0.31	0.18	0.26	0.26	0.64	0.20
0.11	0.11	117.44	0.29	0.36	3- M2t	0.35	0.20	0.29	0.29	0.69	0.21
0.14	0.14	117.47	0.32	0.39	3- M2t	0.39	0.22	0.32	0.32	0.73	0.22
0.16	0.16	117.50	0.35	0.42	3- M2t	0.43	0.23	0.34	0.34	0.77	0.23
0.18	0.18	117.53	0.37	0.45	3- M2t	0.47	0.25	0.36	0.36	0.81	0.24
0.20	0.20	117.56	0.40	0.48	3- M2t	0.50	0.27	0.38	0.38	0.85	0.25
0.23	0.23	117.59	0.42	0.51	3- M2t	0.54	0.28	0.40	0.40	0.89	0.25



Culvert Data: C-3 - 11.6m - 500mm

Culvert Data Summary - C-3 - 11.6m - 500mm

Barrel Shape: Circular

Barrel Diameter: 500.00 mm

Barrel Material: Corrugated Steel

Embedment: 40.00 mm

Barrel Manning's n: 0.0240 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Site Data - C-3 - 11.6m - 500mm

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 116.79 m

Outlet Station: 11.60 m

Outlet Elevation: 116.64 m

Culvert Crossing: 135 Cardevco Rd Entrance Culvert (Drainage Areas A+B+C+D)

Culvert Summary Table - C-3 - 11.6m - 500mm

Total Discharge	Culvert Discharge	Headwater Elevation	Inlet Control	Outlet Control	Flow Type	Normal Depth	Critical Depth	Outlet Depth	Tailwater Depth	Outlet Velocity	Tailwater Velocity
(cms)	(cms)	(m)	Depth(m)	Depth(m)		(m)	(m)	(m)	(m)	(m/s)	(m/s)
0.00	0.00	117.42	0.00	0.59	0-NF	0.00	0.00	0.46	0.72	0.00	0.00
0.04	0.04	117.43	0.16	0.60	4-FFf	0.14	0.11	0.46	0.72	0.20	0.00
0.07	0.07	117.47	0.26	0.64	4-FFf	0.22	0.16	0.46	0.72	0.39	0.00
0.11	0.11	117.53	0.34	0.70	4-FFf	0.28	0.20	0.46	0.72	0.59	0.00
0.15	0.13	117.56	0.37	0.73	4-FFf	0.30	0.22	0.46	0.72	0.67	0.00
0.18	0.13	117.57	0.38	0.74	4-FFf	0.31	0.22	0.46	0.72	0.70	0.00
0.22	0.14	117.58	0.38	0.75	4-FFf	0.32	0.22	0.46	0.72	0.72	0.00
0.26	0.14	117.59	0.39	0.76	4-FFf	0.32	0.23	0.46	0.72	0.74	0.00
0.30	0.14	117.59	0.40	0.76	4-FFf	0.33	0.23	0.46	0.72	0.75	0.00
0.33	0.14	117.60	0.40	0.77	4-FFf	0.33	0.23	0.46	0.72	0.77	0.00
0.37	0.15	117.61	0.41	0.78	4-FFf	0.34	0.24	0.46	0.72	0.78	0.00

APPENDIX F

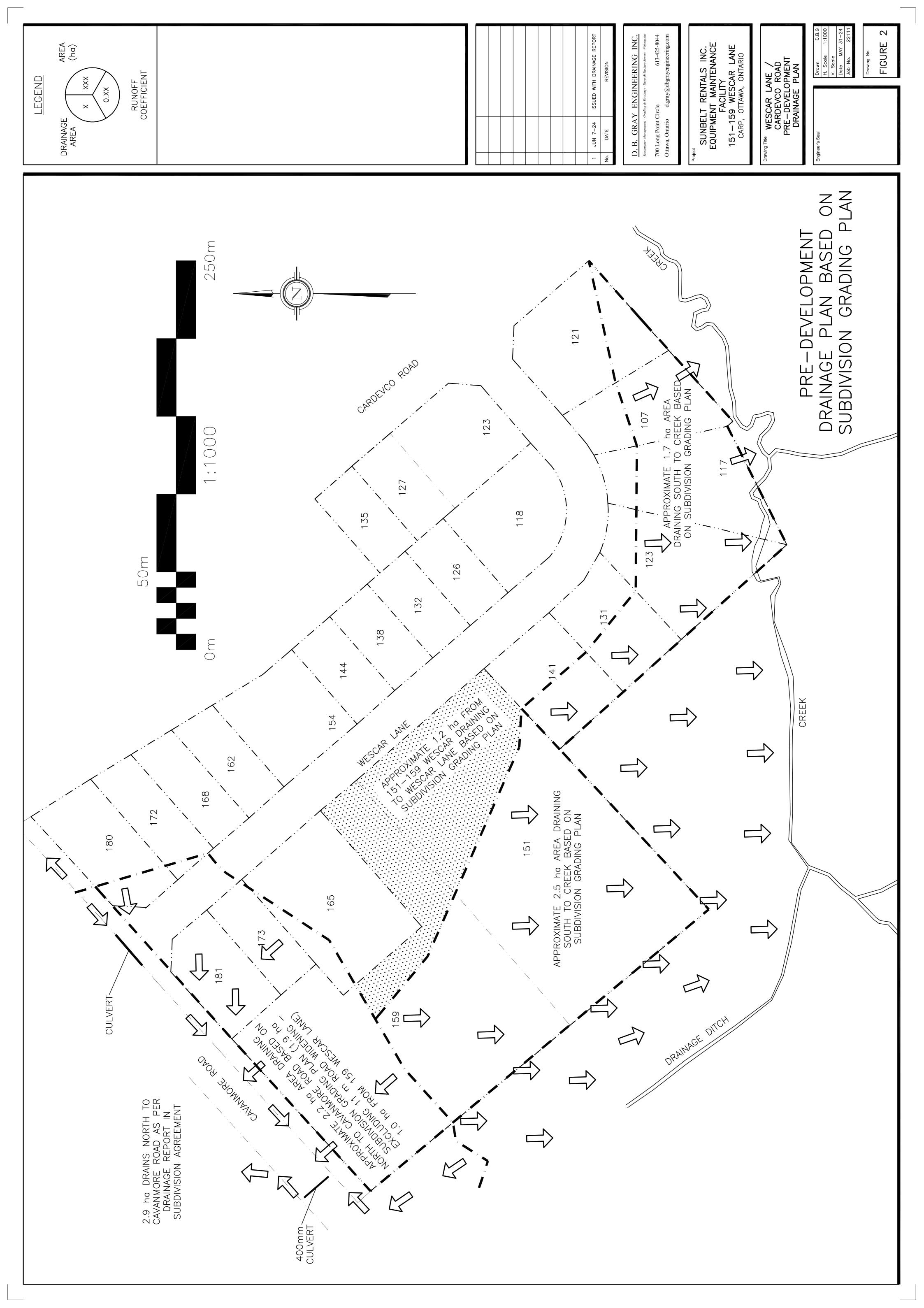
DITCH & CULVERT CALCULATIONS

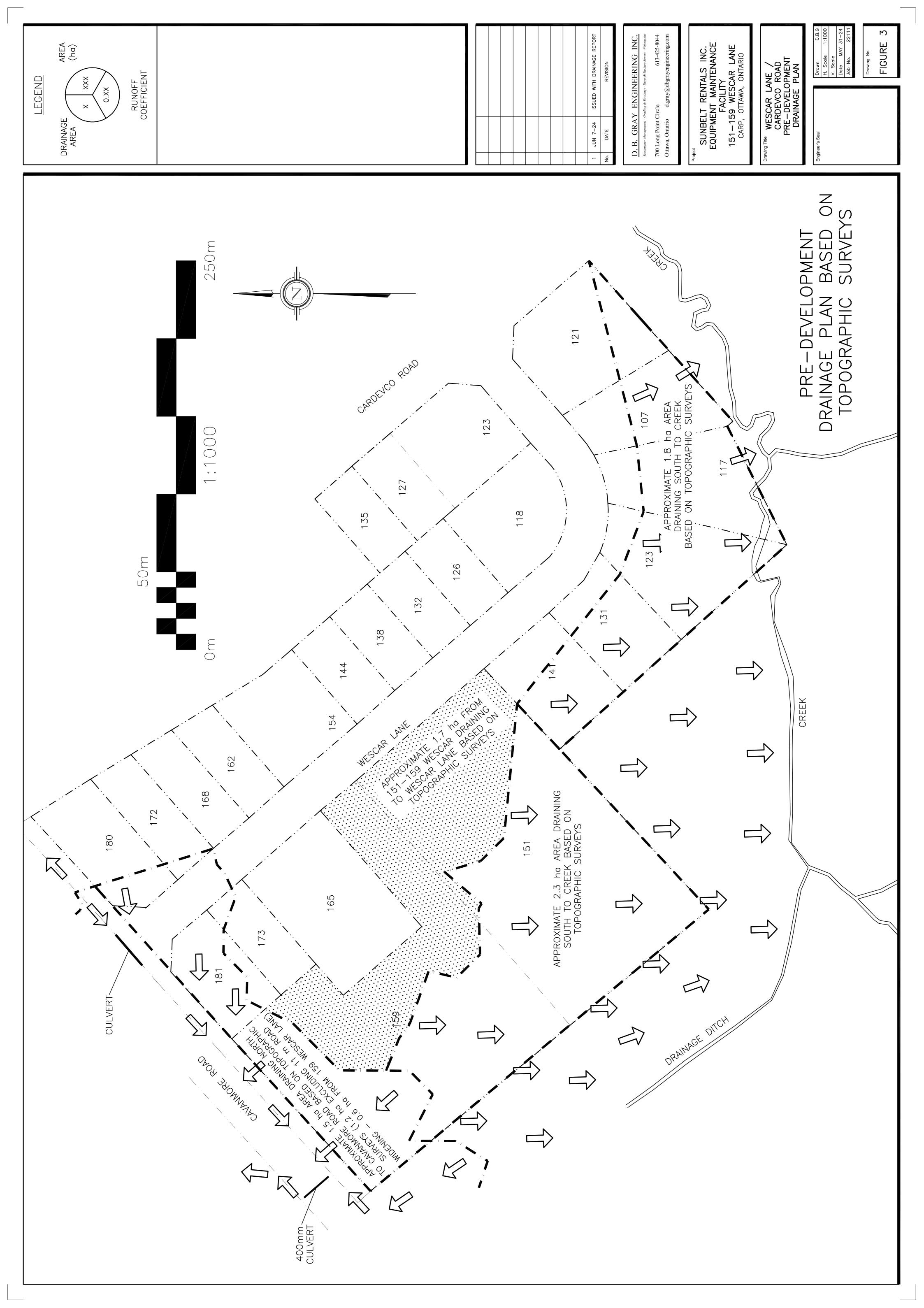
EXISTING CONDITIONS

106 TO 154 & 162 TO 173 WESCAR LANE
AND 121 TO 127 CARDEVCO ROAD

+

PROPOSED DEVELOPMENT 151-159 WESCAR LANE WITH 0.6 HA DRAINING TO CAVANMORE ROAD





Peak Flow Calculations - Roadside Ditches Existing Conditions 106 to 154 & 162 to 173 Wescar Lane and 121 to 127 Cardevco Road

+

Proposed Development 151-159 Wescar Lane (with 0.6 ha draining to Cavanmore Road) Cardevco Subdivision Ottawa, Ontario

10-Year Event

Drainage Area A (5.76 ha less 0.6 ha)

			С
Roof Area:	0.42	ha	0.90
Hard Area:	3.11	ha	0.90
Gravel Area:	0.38	ha	0.80
Soft Area:	1.26	ha	0.20
Total Catchment Area:	5.16	ha	0.72

Time of Concentration:	20	min
Length of Ditch (Ld):	263	m
Ditch Flow Velocity (V):	0.43	m/s
Time of Concentration (Ditch Flow):	10.2	min
Time of Concentration (Tc):	30.2	min
Area (A):	5.16	ha
Time of Concentration:	30.2	min
Rainfall Intensity (i):	63	mm/hr (10-Year Event)
Runoff Coefficient (C):	0.72	,
(0)		

Rational Method 10-Year Flow (Q):	650.8	L/s
Ditch Slope:	0.8%	
Ditch Manning Roughness Coefficient n:	0.10	dense weeds / brush as high as flow
Side Slope:	3	:1
Lot Side Slope:	3	:1
Ditch Bottom Width:	1	m
Water Depth:	0.56	m
Water Top Width:	4.36	m
Water Cross-Section Area:	1.50	sq.m
Wetted Perimeter:	4.54	m
Hydraulic Radius:	0.33	m
Velocity:	0.43	m/s Based on water depth

0.43 m/s

Using Manning's Formula:

Velocity:

Drainage Area B

(10-Year Event)

			С
Roof Area:	0.15	ha	0.90
Hard Area:	0.49	ha	0.90
Gravel Area:	0.32	ha	0.80
Soft Area:	0.79	ha	0.20
-			
Total Catchment Area:	1.75	ha	0.57

Drainage Area A + B

			C
Roof Area:	0.57	ha	0.90
Hard Area:	3.59	ha	0.90
Gravel Area:	0.70	ha	0.70
Soft Area:	2.04	_ha	0.20
Total Catchment Area:	6.91	ha	0.67

Time of Concentration: 30.2 min (from Drainage Area A)

Length of Ditch (Ld): 238 m

Ditch Flow Velocity (V): 0.51 m/s

Time of Concentration (Ditch Flow): 7.8 min

Time of Concentration (Tc): 38.0 min

Area (A): 6.91 ha
Time of Concentration: 38.0 min

Rainfall Intensity (i): 54 mm/hr (10-Year Event) Runoff Coefficient (C): 0.67

Rational Method 10-Year Flow (Q): 691.8 L/s

Ditch Slope: 1.2%

Ditch Manning Roughness Coefficient n: 0.10 dense weeds / brush as high as flow

Road Side Slope: 3 :1
Lot Side Slope: 3 :1
Ditch Bottom Width: 1 m
Water Depth: 0.53 m

Water Top Width:

Water Cross-Section Area:

Wetted Perimeter:

Hydraulic Radius:

4.17 m

1.36 sq.m

4.34 m

0.31 m

Velocity: 0.51 m/s Based on water depth Velocity: 0.51 m/s Using Manning's Formula:

Drainage Area C

(10-Year Event)

•			С
Roof Area:	0.24	ha	0.90
Hard Area:	0.57	ha	0.90
Gravel Area:	0.60	ha	0.80
Soft Area:	0.95	ha	0.20
Total Catchment Area:	2.36	ha	0.59

Time of Concentration: 20 min

Length of Ditch (Ld): 452 m
Ditch Flow Velocity (V): 0.36 m/s
Time of Concentration (Ditch Flow): 20.9 min

Time of Concentration (Tc): 40.9 min

Area (A): 2.36 ha
Time of Concentration: 40.9 mir

Rainfall Intensity (i): 51 mm/hr (10-Year Event)

Runoff Coefficient (C): 0.59

Rational Method 10-Year Flow (Q): 198.0 L/s

Ditch Slope: 1.2%

Ditch Manning Roughness Coefficient n: 0.10 dense weeds / brush as high as flow

Side Slope: 3 :1

Lot Side Slope: 3 :1

Ditch Bottom Width: 1 m

Water Depth: 0.30 m

Water Top Width: 2.77 m
Water Cross-Section Area: 0.56 sq.m
Wetted Perimeter: 2.87 m
Hydraulic Radius: 0.19 m

Velocity: 0.36 m/s Based on water depth
Velocity: 0.36 m/s Using Manning's Formula:

Drainage Area D

(10-Year Event)

			С
Roof Area:	0.06	ha	0.90
Hard Area:	0.12	ha	0.90
Gravel Area:	0.47	ha	0.80
Soft Area:	0.08	_ha	0.20
		_	
Total Catchment Area:	0.73	ha	0.76

Drainage Area A + B + C + D

			C
Roof Area:	0.87	ha	0.90
Hard Area:	4.28	ha	0.90
Gravel Area:	1.77	ha	0.80
Soft Area: _	3.08	_ha	0.20
_			

Total Catchment Area: 10.00 ha 0.67

Time of Concentration: 40.9 min (from Drainage Area C)

 $\begin{array}{cccc} & Length \ of \ Ditch \ (Ld): & 129 & m \\ & Ditch \ Flow \ Velocity \ (V): & 0.88 & m/s \\ \hline Time \ of \ Concentration \ (Ditch \ Flow): & 2.4 & min \\ \end{array}$

Time of Concentration (Tc): 43.3 min

Area (A): 10.00 ha
Time of Concentration: 43.3 min

Rainfall Intensity (i): 49 mm/hr (10-Year Event)

Runoff Coefficient (C): 0.67

Rational Method 10-Year Flow (Q): 904.1 L/s

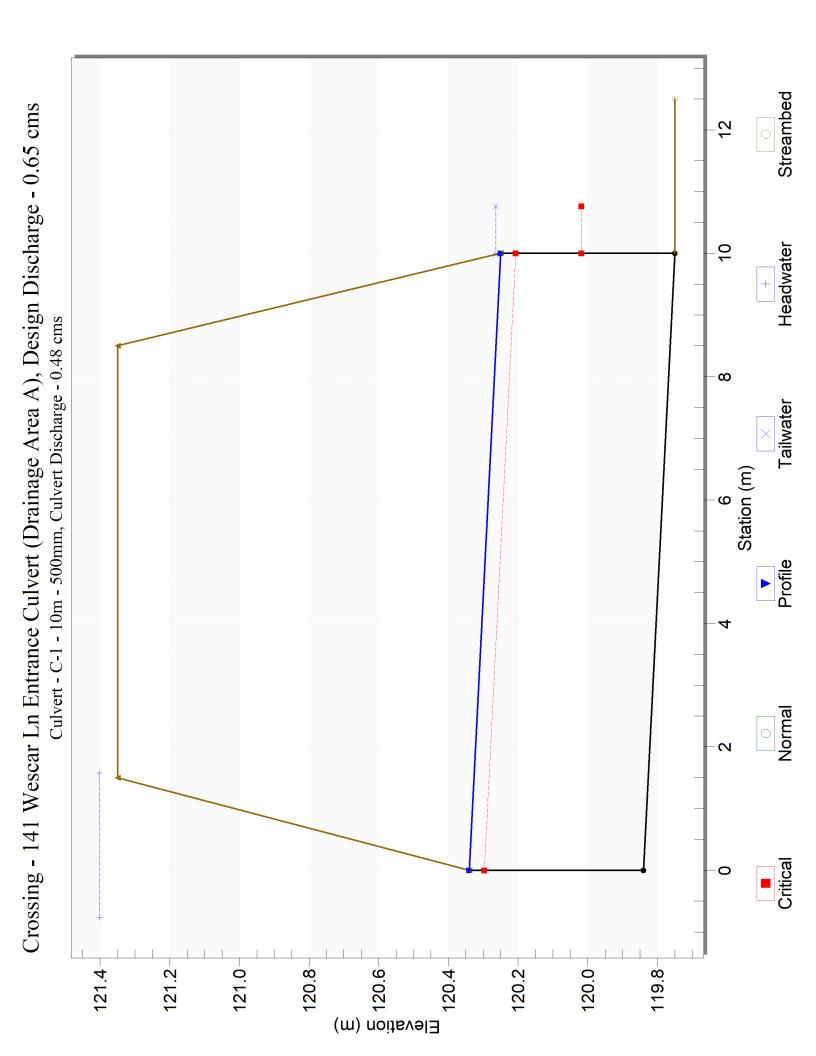
Ditch Slope: 0.3%

Ditch Manning Roughness Coefficient n: 0.027 gravel / short grass

Road Side Slope: 3 :1
Lot Side Slope: 3 :1
Ditch Bottom Width: 1 m
Water Depth: 0.44 m

Water Top Width: 3.65 m
Water Cross-Section Area: 1.03 sq.m
Wetted Perimeter: 3.80 m
Hydraulic Radius: 0.27 m

Velocity: 0.88 m/s Based on water depth
Velocity: 0.88 m/s Using Manning's Formula:



Culvert Data: C-1 - 10m - 500mm

Culvert Data Summary - C-1 - 10m - 500mm

Barrel Shape: Circular

Barrel Diameter: 500.00 mm

Barrel Material: Corrugated Steel

Embedment: 0.00 mm

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Site Data - C-1 - 10m - 500mm Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 119.84 m

Outlet Station: 10.00 m

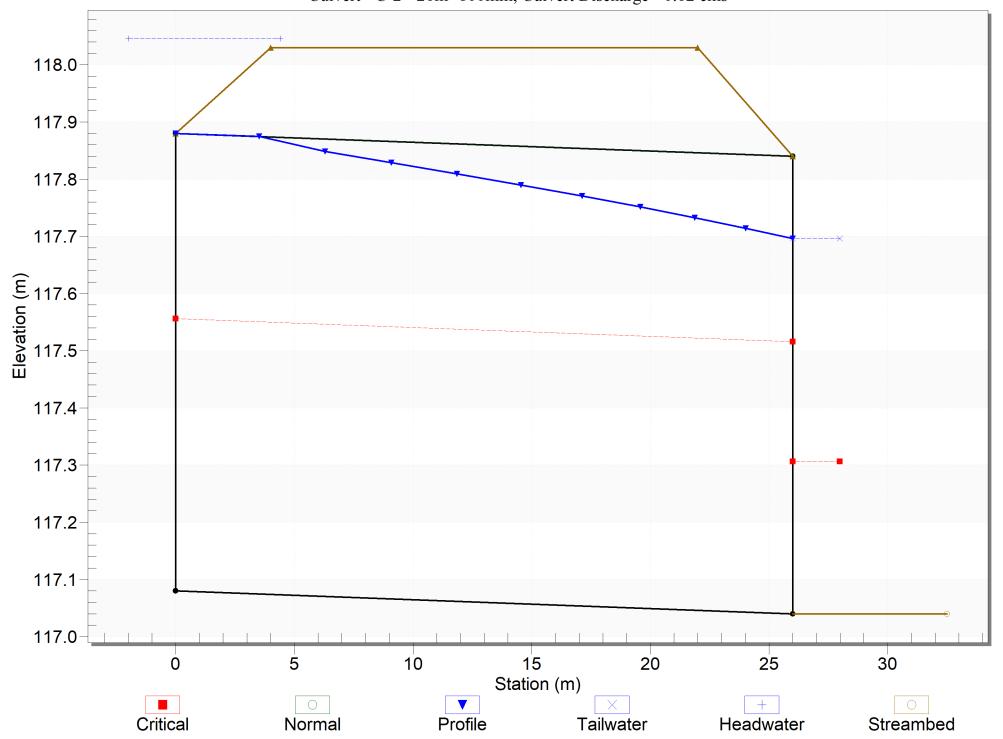
Outlet Elevation: 119.75 m

Culvert Crossing: 141 Wescar Ln Entrance Culvert (Drainage Area A)

Culvert Summary Table - C-1 - 10m - 500mm

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth(m)	Outlet Control Depth(m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.00	0.00	119.84	0.00	0.0	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
0.07	0.07	120.12	0.25	0.28	2- M2c	0.20	0.17	0.17	0.16	1.10	0.27
0.13	0.13	120.25	0.38	0.41	2- M2c	0.30	0.24	0.24	0.24	1.37	0.32
0.20	0.20	120.37	0.50	0.53	7- M2c	0.41	0.30	0.30	0.29	1.58	0.36
0.26	0.26	120.49	0.64	0.65	7- M2c	0.50	0.35	0.35	0.33	1.77	0.39
0.33	0.33	120.71	0.80	0.87	7- M2c	0.50	0.39	0.39	0.37	1.98	0.42
0.39	0.39	120.96	1.01	1.12	7- M2c	0.50	0.42	0.42	0.40	2.20	0.44
0.46	0.46	121.24	1.27	1.40	7- M2c	0.50	0.45	0.45	0.43	2.45	0.45
0.52	0.48	121.37	1.39	1.53	7- M2t	0.50	0.46	0.46	0.46	2.54	0.47
0.59	0.48	121.39	1.40	1.55	7- M2t	0.50	0.46	0.50	0.49	2.48	0.49
0.65	0.48	121.40	1.39	1.56	4-FFf	0.50	0.46	0.50	0.51	2.46	0.50

Crossing - Wescar Ln Culvert at Cardevco Rd (Drainage Area A+B), Design Discharge - 0.64 cms
Culvert - C-2 - 26m -800mm, Culvert Discharge - 0.62 cms



HY-8 Culvert Analysis Report

Culvert Data: C-2 - 26m -800mm

Culvert Data Summary - C-2 - 26m -800mm

Barrel Shape: Circular

Barrel Diameter: 800.00 mm

Barrel Material: Corrugated Steel

Embedment: 0.00 mm

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Site Data - C-2 - 26m -800mm

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 117.08 m

Outlet Station: 26.00 m

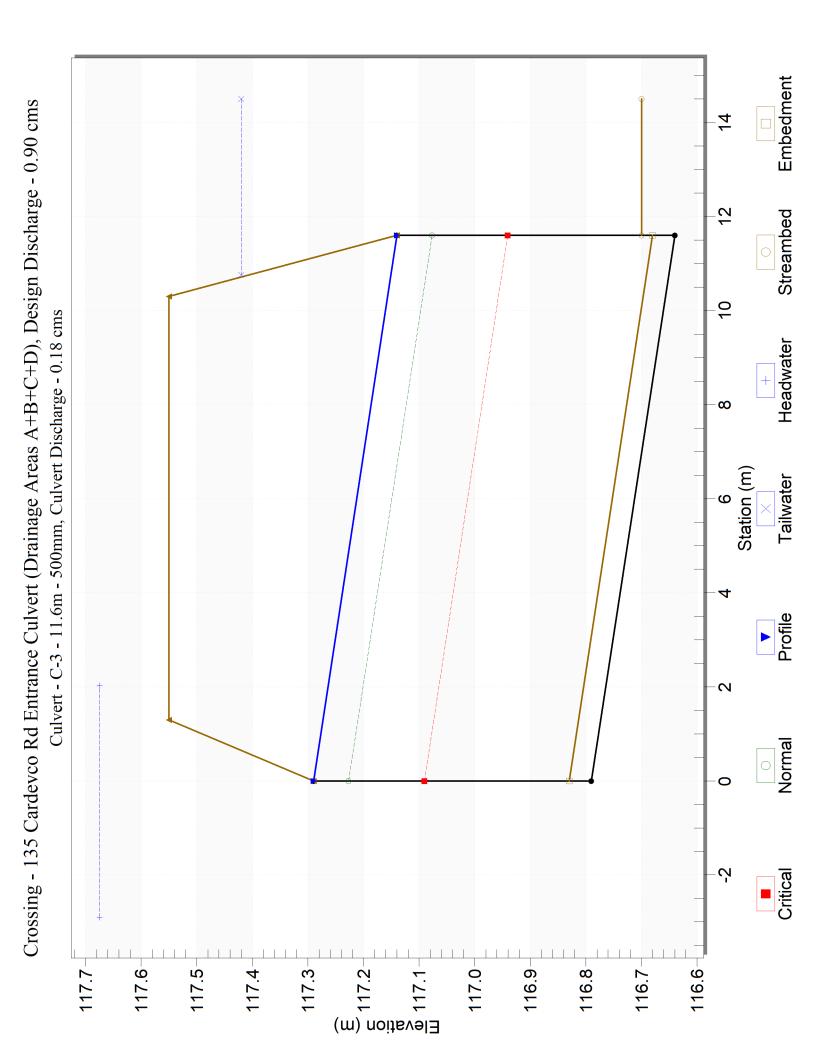
Outlet Elevation: 117.04 m

Number of Barrels: 1

Culvert Crossing: Wescar Ln Culvert at Cardevco Rd (Drainage Area A+B)

Culvert Summary Table - C-2 - 26m -800mm

Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth(m)	Outlet Control Depth(m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)	Tailwater Velocity (m/s)
0.00	0.00	117.08	0.00	0.0	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
0.07	0.07	117.36	0.23	0.28	3- M2t	0.27	0.15	0.23	0.23	0.60	0.18
0.14	0.14	117.48	0.32	0.40	3- M2t	0.40	0.22	0.32	0.32	0.74	0.22
0.21	0.21	117.57	0.40	0.49	3- M2t	0.51	0.27	0.39	0.39	0.86	0.25
0.28	0.28	117.65	0.47	0.57	3- M2t	0.64	0.31	0.45	0.45	0.96	0.27
0.35	0.35	117.73	0.54	0.65	3- M2t	0.80	0.35	0.49	0.49	1.06	0.28
0.42	0.42	117.80	0.60	0.72	3- M2t	0.80	0.39	0.54	0.54	1.16	0.30
0.48	0.48	117.87	0.67	0.79	3- M2t	0.80	0.42	0.58	0.58	1.25	0.31
0.55	0.55	117.95	0.73	0.87	3- M2t	0.80	0.45	0.61	0.61	1.34	0.32
0.62	0.62	118.03	0.79	0.95	7- M2t	0.80	0.48	0.65	0.65	1.42	0.33
0.69	0.62	118.06	0.79	0.98	7- M2t	0.80	0.48	0.68	0.68	1.36	0.34



HY-8 Culvert Analysis Report

Culvert Data: C-3 - 11.6m - 500mm

Culvert Data Summary - C-3 - 11.6m - 500mm

Barrel Shape: Circular

Barrel Diameter: 500.00 mm

Barrel Material: Corrugated Steel

Embedment: 40.00 mm

Barrel Manning's n: 0.0240 (top and sides)

Manning's n: 0.0350 (bottom)

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting (Ke=0.9)

Inlet Depression: None

Site Data - C-3 - 11.6m - 500mm

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 116.79 m

Outlet Station: 11.60 m

Outlet Elevation: 116.64 m

Number of Barrels: 1

Culvert Crossing: 135 Cardevco Rd Entrance Culvert (Drainage Areas A+B+C+D)

Culvert Summary Table - C-3 - 11.6m - 500mm

Total Discharge	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth(m)	Outlet Control Depth(m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth	Outlet Velocity	Tailwater Velocity
(cms)					O ME	• •	` '	` _	(m)	(m/s)	(m/s)
0.00	0.00	117.42	0.00	0.59	0-NF	0.00	0.00	0.46	0.72	0.00	0.00
0.09	0.09	117.50	0.29	0.67	4-FFf	0.24	0.18	0.46	0.72	0.48	0.00
0.18	0.13	117.57	0.38	0.74	4-FFf	0.31	0.22	0.46	0.72	0.70	0.00
0.27	0.14	117.59	0.39	0.76	4-FFf	0.32	0.23	0.46	0.72	0.74	0.00
0.36	0.15	117.61	0.41	0.78	4-FFf	0.34	0.24	0.46	0.72	0.78	0.00
0.45	0.15	117.62	0.42	0.79	4-FFf	0.35	0.24	0.46	0.72	0.81	0.00
0.54	0.16	117.63	0.43	0.80	4-FFf	0.36	0.25	0.46	0.72	0.84	0.00
0.63	0.16	117.64	0.44	0.81	4-FFf	0.37	0.25	0.46	0.72	0.87	0.00
0.72	0.17	117.65	0.45	0.82	4-FFf	0.38	0.25	0.46	0.72	0.89	0.00
0.81	0.17	117.66	0.46	0.83	4-FFf	0.39	0.26	0.46	0.72	0.91	0.00
0.90	0.18	117.67	0.47	0.84	4-FFf	0.40	0.26	0.46	0.72	0.93	0.00

APPENDIX G

DRAINAGE AND STORMWATER MANAGEMENT
CALCULATIONS
PROPOSED DEVELOPMENT AT 151-159 WESCAR LANE
AND ITS IMPACT ON FLOODING ON CARDEVCO ROAD

SUMMARY TABLES

100-YEAR EVENT									
Drainage Area	Pre- Development Flow Rate (L/s)	Maximum Release Rate (L/s)	Maximum Volume Required (cu.m)	Maximum Volume Stored (cu.m)					
AREA I (Uncontrolled Flow Off Site)	-	38.46	ı	-					
AREA II	-	56.39	2027.10	2027.10					
TOTAL	121.28	94.85	2027.10	2027.10					

10-YEAR EVENT									
Drainage Area	Pre- Development Flow Rate (L/s)	Maximum Release Rate (L/s)	Maximum Volume Required (cu.m)	Maximum Volume Stored (cu.m)					
AREA I (Uncontrolled Flow Off Site)	-	22.03	ı	-					
AREA II	-	40.21	1212.38	1212.38					
TOTAL	62.29	62.24	1212.38	1212.38					

151-159 Wescar Lane

Ottawa, Ontario

STORMWATER MANAGEMENT CALCULATIONS Modified Rational Method

PRE-DEVELOPMENT CONDITIONS

(Area Draining to Wescar Lane Based on Subdivision Grading Plan - Refer to Figure 2)

100-YEAR EVENT

Runoff Coefficient (C): 0.375

Sheet Flow Distance (L): 130 m

Slope of Land (Sw): 1 %
Time of Concentration (Sheet Flow): 27 mi

Rainfall Intensity (i): 99 mm/hr (100-year event)

100-Year Pre-Development Flow Rate (2.78AiC): 121.28 L/s

10-YEAR EVENT



Runoff Coefficient (C): 0.30
Sheet Flow Distance (L): 130

eet Flow Distance (L): 130 m Slope of Land (Sw): 1 %

Time of Concentration (Sheet Flow): 30 min

Rainfall Intensity (i): 63 mm/hr (10-Year Event)

5-Year Pre-Development Flow Rate (2.78AiC): 62.29 L/s

100-YEAR EVENT

DRAINAGE AREA I (Uncontrolled Flow Off Site Towards Wescar Lane)

(100-YEAR EVENT)

			С
Roof Area:	0	sq.m	1.00
Hard Area:	290	sq.m	1.00
Detention Area:	0	sq.m	1.00
Gravel Area:	0	sq.m	1.00
Soft Area:	1,939	_sq.m	0.25

Total Catchment Area: 2,229 sq.m 0.35

Area (A): 2,229 sq.m Time of Concentration: 10 min

Rainfall Intensity (i): 179 mm/hr (100-year event)

Runoff Coeficient (C): 0.35

Flow Rate (2.78AiC): 38.46 L/s

DRAINAGE AREA II

(100-YEAR EVENT)

С Roof Area: 3,566 sq.m 1.00 Asphalt/Concrete Area: 31,076 sq.m 1.00 **Detention Area:** 897 1.00 sq.m Gravel Area: 0 1.00 sq.m Soft Area: 4,603 0.25 sq.m

Total Catchment Area: 40,142 sq.m 0.91

Water Elevation: 122.18 m

Head: 1.88 m

Centroid of ICD Orifice: 120.30 m

(ICD in Inlet of Culvert)

Invert of Inlet of Culvert: 121.04 m

Orifice Diameter: 139 mm

Orifice Area: 15,218 sq.mm

Discharge Coefficient: 0.61

Maximum Release Rate: 56.39 L/s

Surface Ponding

		Surface i Origini	<u>9</u>		
Above					
CB or	Top Area	a Depth			
CB/MH	(sq.m)	(m)	Vo	olume	
CB-1	5	0.02	0.04	cu.m	
CB-5	5	0.02	0.04	cu.m	
CB-6	543	0.20	36.32	cu.m	
CB-7	197	0.31	46.51	cu.m	
CB/MH-8	10	0.02	0.07	cu.m	
CB-9	732	0.20	48.97	cu.m	
CB-10	805	0.20	53.81	cu.m	
CB-10A	430	0.43	125.26	cu.m	
CB/MH-11	805	0.20	53.81	cu.m	
CB-12	234	0.20	15.67	cu.m	
CB-12A	320	0.20	21.39	cu.m	
CB/MH-14	678	0.20	45.34	cu.m	
CB/MH-15	232	0.18	13.94	cu.m	
CB-16	742	0.20	49.64	cu.m	
CB/MH-17	761	0.20	50.85	cu.m	
CB-18	501	0.20	33.50	cu.m	
CB/MH-19	646	0.20	43.18	cu.m	
CB-20	747	0.20	49.98	cu.m	
CB/MH-21	844	0.20	56.44	cu.m	
CB-22	355	0.20	23.74	cu.m	
CB/MH-23	499	0.20	33.36	cu.m	
CB/MH-24	631	0.20	42.18	cu.m	
CB/MH-25	366	0.20	24.48	cu.m	
		Volume Stored:	868.52	cu.m	

Stormwater Detention Area

(above outlet invert elevation: 121.04)

•			_	
Average	Average		-	
Length	Width	Depth		
(sq.m)	(sq.m)	(m)	Volume	
68.5	12.7	1.14	988.91	cu.m

Stormwater Detention Area

(below outlet invert elelvation: 121.04)

Length	Width	Depth		
(sq.m)	(sq.m)	(m)	Volume	
66.8	12.7	0.20	169.67	cu.m

Maximum Volume Stored: 2027.10 cu.m

Maximum Volume Required: 2027.10 cu.m

DRAINAGE AREA II (Continued)

(100-YEAR EVENT)

. L v	LIVI)			ICD		Required
				Release	Stored	Storage
	Time	i	2.78AiC	Rate	Rate	Volume
	(min)	(mm/hr)	(L/s)	(L/s)	(L/s)	(cu.m)
_	10	179	1821.26	56.39	1764.87	1058.92
	15	143	1457.48	56.39	1401.10	1260.99
	20	120	1223.46	56.39	1167.08	1400.49
	25	104	1059.21	56.39	1002.83	1504.24
	30	92	937.03	56.39	880.64	1585.16
	35	83	842.28	56.39	785.89	1650.37
	40	75	766.46	56.39	710.07	1704.18
	45	69	704.30	56.39	647.91	1749.35
	50	64	652.32	56.39	595.93	1787.78
	55	60	608.15	56.39	551.76	1820.80
	60	56	570.11	56.39	513.72	1849.40
	65	53	536.98	56.39	480.59	1874.31
	70	50	507.84	56.39	451.45	1896.10
	75	47	481.99	56.39	425.61	1915.22
	80	45	458.90	56.39	402.51	1932.03
	85	43	438.12	56.39	381.73	1946.82
	90	41	419.32	56.39	362.93	1959.83
	95	39	402.22	56.39	345.84	1971.26
	100	38	386.60	56.39	330.21	1981.27
	105	36	372.26	56.39	315.88	1990.01
	110	35	359.06	56.39	302.67	1997.60
	115	34	346.85	56.39	290.46	2004.15
	120	33	335.52	56.39	279.13	2009.74
	125	32	324.98	56.39	268.59	2014.45
	130	31	315.15	56.39	258.76	2018.36
	135	30	305.96	56.39	249.57	2021.53
	140	29	297.34	56.39	240.95	2024.01
	145	28	289.25	56.39	232.86	2025.85
	150	28	281.62	56.39	225.23	2027.10
	180	24	243.80	56.39	187.41	2024.04
	210	21	215.67	56.39	159.28	2006.92
	240	19	193.85	56.39	137.46	1979.49
	270	17	176.40	56.39	120.01	1944.17
	300	16	162.09	56.39	105.70	1902.60
	330	15	150.12	56.39	93.73	1855.94
	360	14	139.96	56.39	83.57	1805.06
	390	13	131.20	56.39	74.81	1750.61
	420	12	123.58	56.39	67.19	1693.11
	450	11	116.87	56.39	60.48	1632.95
	480	11	110.92	56.39	54.53	1570.48
	510	10	105.60	56.39	49.21	1505.96
	540	9.9	100.82	56.39	44.43	1439.62
	570	9.5	96.50	56.39	40.11	1371.63
	600	9.1	92.56	56.39	36.17	1302.17
	630	8.7	88.96	56.39	32.58	1231.36
	660	8.4	85.67	56.39	29.28	1159.34
	690	8.1	82.63	56.39	26.24	1086.19
	720	7.8	79.82	56.39	23.43	1012.01
	750	7.6	77.21	56.39	20.82	936.88
	780	7.3	74.78	56.39	18.39	860.88
	810	7.1	72.52	56.39	16.13	784.05
	840	6.9	70.41	56.39	14.02	706.47
	870	6.7	68.42	56.39	12.03	628.17
	900	6.5	66.56	56.39	10.17	549.20

10-YEAR EVENT

DRAINAGE AREA I (Uncontrolled Flow Off Site)

(10-YEAR EVENT)

			С
Roof Area:	0	sq.m	0.90
Hard Area:	290	sq.m	0.90
Detention Area:	0	sq.m	0.90
Gravel Area:	0	sq.m	0.80
Soft Area:	1,939	sq.m	0.20
Total Catchment Area:	2,229	sq.m	0.29
Area (A):	2,229	sq.m	
Time of Concentration:	10	min	

Rainfall Intensity (i): 122 mm/hr (10-Year Event)

Runoff Coeficient (C): 0.29

Flow Rate (2.78AiC): 22.03 L/s

DRAINAGE AREA II

(10-YEAR EVENT)

С Roof Area: 0.90 3,566 sq.m 31,076 0.90 Asphalt/Concrete Area: sq.m Detention Area: 1.00 897 sq.m Gravel Area: 0 0.80 sq.m Landscaped Area: 4,603 0.20 sq.m

Total Catchment Area: 40,142 sq.m 0.82

m

Water Elevation: 122.07 m

Head: 0.96

Centroid of ICD Orifice: 121.11 m

(ICD in Inlet of Culvert)

Invert of Inlet of Culvert: 121.04 m

Orifice Diameter: 139 mm

Orifice Area: 15,218 sq.mm

Discharge Coefficient: 0.61

Maximum Release Rate: 40.21 L/s

Surface	Ponding

Above					
CB or	Top Area	Depth			
CB/MH	(sq.m)	(m)	Vo	olume	
CB-1	0	0.00	0.00	cu.m	
CB-5	0	0.00	0.00	cu.m	
CB-6	99	0.09	2.84	cu.m	
CB-7	178	0.20	23.74	cu.m	
CB/MH-8	0	0.00	0.00	cu.m	
CB-9	134	0.09	3.82	cu.m	
CB-10	147	0.09	4.20	cu.m	
CB-10A	396	0.32	75.66	cu.m	
CB/MH-11	147	0.09	4.20	cu.m	
CB-12	43	0.09	1.22	cu.m	
CB-12A	58	0.09	1.67	cu.m	
CB/MH-14	124	0.09	3.54	cu.m	
CB/MH-15	31	0.07	0.67	cu.m	
CB-16	136	0.09	3.88	cu.m	
CB/MH-17	139	0.09	3.97	cu.m	
CB-18	92	0.09	2.62	cu.m	
CB/MH-19	118	0.09	3.37	cu.m	
CB-20	137	0.09	3.90	cu.m	
CB/MH-21	154	0.09	4.41	cu.m	
CB-22	65	0.09	1.85	cu.m	
CB/MH-23	91	0.09	2.61	cu.m	
CB/MH-24	115	0.09	3.29	cu.m	
CB/MH-25	67	0.09	1.91	cu.m	

Volume Stored: 153.38 cu.m

Stormwater Detention Area

(above outlet invert elevation: 121.04)				
Average	Average			

Average	Average			
Length	Width	Depth		
(sq.m)	(sq.m)	(m)	Volume	
68.5	12.7	1.03	889.33	cu.m

Stormwater Detention Area

(b	elow	outlet	invert	elelvation	า: 121.(04)

Length	Width	Depth		
(sq.m)	(sq.m)	(m)	Volume	
66.8	12.7	0.20	169.67	_cu.m

Maximum Volume Stored: 1212.38 cu.m

Maximum Volume Required: 1212.38 cu.m

DRAINAGE AREA II (Continued)

(10-YEAR EVENT)

			ICD Release	Stored	Required Storage
Time	i	2.78AiC	Rate	Rate	Volume
(min)	(mm/hr)	(L/s)	(L/s)	(L/s)	(cu.m)
10	122	1120.37	40.21	1080.16	648.10
15	98	897.57	40.21	857.36	771.62
20	82	754.09	40.21	713.89	856.66
25	71	653.32	40.21	613.11	919.66
30	63	578.30	40.21	538.09	968.57
35	57	520.09	40.21	479.89	1007.76
40	52	473.50	40.21	433.29	1039.89
45	47	435.27	40.21	395.06	1066.67
50	44	403.30	40.21	363.09	1089.27
55	41	376.12	40.21	335.91	1108.50
60	38	352.70	40.21	312.50	1124.99
65	36	332.31	40.21	292.10	1139.18
70	34	314.36	40.21	274.15	1151.43
75	33	298.43	40.21	258.23	1162.02
80	31	284.20	40.21	243.99	1171.17
85	30	271.40	40.21	231.19	1179.06
90	28	259.81	40.21	219.60	1185.83
95	27	249.26	40.21	209.06	1191.62
100	26	239.63	40.21	199.42	1196.52
105	25	230.78	40.21	190.58	1200.63
110	24	222.64	40.21	182.43	1204.02
115	23	215.10	40.21	174.89	1206.76
120	23	208.11	40.21	167.90	1208.90
125	22	201.61	40.21	161.40	1210.49
130	21	195.54	40.21	155.33	1211.57
135	21	189.86	40.21	149.65	1212.19
140	20	184.54	40.21	144.33	1212.38
145	20	179.54	40.21	139.33	1212.17
150	19	174.83	40.21	134.62	1211.59
180	17	151.46	40.21	111.25	1201.48
210	15	134.06	40.21	93.85	1182.53
240	13	120.56	40.21	80.35	1157.11
270	12	109.76	40.21	69.55	1126.71
300	11	100.89	40.21	60.69	1092.37

SUMMARY TABLES

100-YEAR EVENT					
Drainage Area	Pre- Development Flow Rate (L/s)	Maximum Release Rate (L/s)	Maximum Volume Required (cu.m)	Maximum Volume Stored (cu.m)	
AREA I (Uncontrolled Flow Off Site)	-	38.46	-	-	
AREA II	-	56.39	2027.10	2027.10	
TOTAL	176.01	94.85	2027.10	2027.10	

10-YEAR EVENT					
Drainage Area	Pre- Development Flow Rate (L/s)	Maximum Release Rate (L/s)	Maximum Volume Required (cu.m)	Maximum Volume Stored (cu.m)	
AREA I (Uncontrolled Flow Off Site)	-	22.03	1	-	
AREA II	-	40.21	1212.38	1212.38	
TOTAL	90.41	62.24	1212.38	1212.38	

151-159 Wescar Lane

Ottawa, Ontario

STORMWATER MANAGEMENT CALCULATIONS Modified Rational Method

PRE-DEVELOPMENT CONDITIONS

(Area Draining to Wescar Lane Based on Topographical Surveys - Refer to Figure 3)

100-YEAR EVENT

Total Catchment Area: 17,091 sq.m

C
1.25 x Woodland or Pasture - Flat - Clay and Silt Loam as per Table 5.7

Ottawa Sewer Design

Guidelines $Tc = \frac{3.26 \cdot (1.1 - C) \cdot L^{1/2}}{Sw^{0.33}}$ min

Runoff Coefficient (C): 0.375
Sheet Flow Distance (L): 130

eet Flow Distance (L): 130 m
Slope of Land (Sw): 1 %

Time of Concentration (Sheet Flow): 27 mir

Rainfall Intensity (i): 99 mm/hr (100-year event)

100-Year Pre-Development Flow Rate (2.78AiC): 176.01 L/s

10-YEAR EVENT

Total Catchment Area: 17,091 sq.m $\begin{array}{c}
C \\
\hline
0.30
\end{array}$ Woodland or Pasture - Flat - Clay and Silt Loam as per Table 5.7 Ottawa Sewer Design Guidelines $Tc = \frac{3.26 \cdot (1.1 - C) \cdot L^{1/2}}{2.00033} \text{ min}$

Runoff Coefficient (C): 0.30

Sheet Flow Distance (L): 130 m Slope of Land (Sw): 1 %

Time of Concentration (Sheet Flow): 30 min

Rainfall Intensity (i): 63 mm/hr (10-Year Event)

5-Year Pre-Development Flow Rate (2.78AiC): 90.41 L/s

100-YEAR EVENT

DRAINAGE AREA I (Uncontrolled Flow Off Site Towards Wescar Lane)

(100-YEAR EVENT)

			С
Roof Area:	0	sq.m	1.00
Hard Area:	290	sq.m	1.00
Detention Area:	0	sq.m	1.00
Gravel Area:	0	sq.m	1.00
Soft Area:	1,939	_sq.m	0.25
			-

Total Catchment Area: 2,229 sq.m 0.35

Area (A): 2,229 sq.m
Time of Concentration: 10 min
Rainfall Intensity (i): 179 mm/hr

Runoff Coeficient (C): 0.35

Flow Rate (2.78AiC): 38.46 L/s

DRAINAGE AREA II

(100-YEAR EVENT)

С Roof Area: 3,566 sq.m 1.00 Asphalt/Concrete Area: 31,076 sq.m 1.00 **Detention Area:** 897 1.00 sq.m 1.00 Gravel Area: 0 sq.m Soft Area: 4,603 0.25 sq.m

Total Catchment Area: 40,142 0.91 sq.m

Water Elevation: 122.18 m

> Head: 1.88 m

Centroid of ICD Orifice: 120.30 m

(ICD in Inlet of Culvert)

Invert of Inlet of Culvert: 121.04 m

> Orifice Diameter: 139 mm

Orifice Area: 15,218 sq.mm

Discharge Coefficient: 0.61

Maximum Release Rate: 56.39 L/s

bove			
CB or	Top Area	Depth	
B/MH	(sq.m)	(m)	
`D 1	F	0.02	

Above					
CB or	Top Area	a Depth			
CB/MH	(sq.m)	(m)	Vo	lume	
CB-1	5	0.02	0.04	cu.m	
CB-5	5	0.02	0.04	cu.m	
CB-6	543	0.20	36.32	cu.m	
CB-7	197	0.31	46.51	cu.m	
CB/MH-8	10	0.02	0.07	cu.m	
CB-9	732	0.20	48.97	cu.m	
CB-10	805	0.20	53.81	cu.m	
CB-10A	430	0.43	125.26	cu.m	
CB/MH-11	805	0.20	53.81	cu.m	
CB-12	234	0.20	15.67	cu.m	
CB-12A	320	0.20	21.39	cu.m	
CB/MH-14	678	0.20	45.34	cu.m	
CB/MH-15	232	0.18	13.94	cu.m	
CB-16	742	0.20	49.64	cu.m	
CB/MH-17	761	0.20	50.85	cu.m	
CB-18	501	0.20	33.50	cu.m	
CB/MH-19	646	0.20	43.18	cu.m	
CB-20	747	0.20	49.98	cu.m	
CB/MH-21	844	0.20	56.44	cu.m	
CB-22	355	0.20	23.74	cu.m	
CB/MH-23	499	0.20	33.36	cu.m	
CB/MH-24	631	0.20	42.18	cu.m	
CB/MH-25	366	0.20	24.48	_cu.m	
		Volume Stored:	868.52	cu.m	

Surface Ponding

Stormwater Detention Area

1			_	
Average	Average			
Length	Width	Depth		
(sq.m)	(sq.m)	(m)	Volume	
68.5	12.7	1.14	988.91	cu.m

Stormwater Detention Area

(below outlet invert elelvation: 121.04)

Length	Width	Depth		
(sq.m)	(sq.m)	(m)	Volume	
66.8	12.7	0.20	169.67	cu.m

Maximum Volume Stored: 2027.10 cu.m

Maximum Volume Required: 2027.10 cu.m

DRAINAGE AREA II (Continued)

(100-YEAR EVENT)

(EVENI)			105		
			ICD	01	Required
T '		0.704:0	Release	Stored	Storage
Time	j (**** *** //5 **)	2.78AiC	Rate	Rate	Volume
(min)	(mm/hr)	(L/s)	(L/s)	(L/s)	(cu.m)
10	179	1821.26	56.39	1764.87	1058.92
15	143	1457.48	56.39	1401.10	1260.99
20	120	1223.46	56.39	1167.08	1400.49
25	104	1059.21	56.39	1002.83	1504.24
30	92	937.03	56.39	880.64	1585.16
35	83	842.28	56.39	785.89	1650.37
40	75	766.46	56.39	710.07	1704.18
45	69	704.30	56.39	647.91	1749.35
50	64	652.32	56.39	595.93	1787.78
55	60	608.15	56.39	551.76	1820.80
60	56	570.11	56.39	513.72	1849.40
65	53	536.98	56.39	480.59	1874.31
70	50	507.84	56.39	451.45	1896.10
75	47	481.99	56.39	425.61	1915.22
80	45	458.90	56.39	402.51	1932.03
85	43	438.12	56.39	381.73	1946.82
90	41	419.32	56.39	362.93	1959.83
95	39	402.22	56.39	345.84	1971.26
100	38	386.60	56.39	330.21	1981.27
105	36	372.26	56.39	315.88	1990.01
110	35	359.06	56.39	302.67	1997.60
115	34	346.85	56.39	290.46	2004.15
120	33	335.52	56.39	279.13	2009.74
125	32	324.98	56.39	268.59	2014.45
130	31	315.15	56.39	258.76	2018.36
135	30	305.96	56.39	249.57	2021.53
140	29	297.34	56.39	240.95	2024.01
145	28	289.25	56.39	232.86	2025.85
150	28	281.62	56.39	225.23	2027.10
180	24	243.80	56.39	187.41	2024.04
210	21	215.67	56.39	159.28	2006.92
240	19	193.85	56.39	137.46	1979.49
270	17	176.40	56.39	120.01	1944.17
300	16	162.09	56.39	105.70	1902.60
330	15	150.12	56.39	93.73	1855.94
360	14	139.96	56.39	83.57	1805.06
390	13	131.20	56.39	74.81	1750.61
420	12	123.58	56.39	67.19	1693.11
450	11	116.87	56.39	60.48	1632.95
480	11	110.92	56.39	54.53	1570.48
510	10	105.60	56.39	49.21	1505.96
540	9.9	100.82	56.39	44.43	1439.62
570	9.5	96.50	56.39	40.11	1371.63
600	9.1	92.56	56.39	36.17	1302.17
630	8.7	88.96	56.39	32.58	1231.36
660	8.4	85.67	56.39	29.28	1159.34
690					
	8.1 7.0	82.63	56.39	26.24	1086.19
720 750	7.8	79.82	56.39	23.43	1012.01
750 700	7.6	77.21	56.39	20.82	936.88
780	7.3	74.78	56.39	18.39	860.88
810	7.1	72.52	56.39	16.13	784.05
840	6.9	70.41	56.39	14.02	706.47
870	6.7	68.42	56.39	12.03	628.17
900	6.5	66.56	56.39	10.17	549.20

10-YEAR EVENT

DRAINAGE AREA I (Uncontrolled Flow Off Site)

(10-YEAR EVENT)

			С
Roof Area:	0	sq.m	0.90
Hard Area:	290	sq.m	0.90
Detention Area:	0	sq.m	0.90
Gravel Area:	0	sq.m	0.80
Soft Area:	1,939	sq.m	0.20
Total Catchment Area:	2,229	sq.m	0.29
Area (A):	2,229	sq.m	
Time of Concentration:	10	min	

Rainfall Intensity (i): 122 mm/hr (10-Year Event)

Runoff Coeficient (C): 0.29

Flow Rate (2.78AiC): 22.03 L/s

DRAINAGE AREA II

(10-YEAR EVENT)

С Roof Area: 0.90 3,566 sq.m 31,076 0.90 Asphalt/Concrete Area: sq.m Detention Area: 1.00 897 sq.m Gravel Area: 0 0.80 sq.m Landscaped Area: 4,603 0.20 sq.m

Total Catchment Area: 40,142 sq.m 0.82

Water Elevation: 122.07 m

Head: 0.96 m

Centroid of ICD Orifice: 121.11 m

(ICD in Inlet of Culvert)

Invert of Inlet of Culvert: 121.04 m

Orifice Diameter: 139 mm

Orifice Area: 15,218 sq.mm

Discharge Coefficient: 0.61

Maximum Release Rate: 40.21 L/s

Surface	Ponding

		indoc i ondii	9	
Above				
CB or	Top Area	Depth		
CB/MH	(sq.m)	(m)	Vo	olume
CB-1	0	0.00	0.00	cu.m
CB-5	0	0.00	0.00	cu.m
CB-6	99	0.09	2.84	cu.m
CB-7	0	0.20	23.74	cu.m
CB/MH-8	0	0.00	0.00	cu.m
CB-9	134	0.09	3.82	cu.m
CB-10	147	0.09	4.20	cu.m
CB-10A	0	0.32	75.66	cu.m
CB/MH-11	147	0.09	4.20	cu.m
CB-12	43	0.09	1.22	cu.m
CB-12A	58	0.09	1.67	cu.m
CB/MH-14	124	0.09	3.54	cu.m
CB/MH-15	31	0.07	0.67	cu.m
CB-16	136	0.09	3.88	cu.m
CB/MH-17	139	0.09	3.97	cu.m
CB-18	92	0.09	2.62	cu.m
CB/MH-19	118	0.09	3.37	cu.m
CB-20	137	0.09	3.90	cu.m
CB/MH-21	154	0.09	4.41	cu.m
CB-22	65	0.09	1.85	cu.m
CB/MH-23	91	0.09	2.61	cu.m
CB/MH-24	115	0.09	3.29	cu.m
CB/MH-25	67	0.09	1.91	cu.m

Volume Stored: 153.38 cu.m

Stormwater Detention Area

(above outlet	invert	elevation:	121.04)
`			,

Average	Average			
Length	Width	Depth		
(sq.m)	(sq.m)	(m)	Volume	
68.5	12.7	1.03	889.33	cu.m

Stormwater Detention Area

(below outlet invert elelvation: 121.04)

Length	Width	Depth		
(sq.m)	(sq.m)	(m)	Volume	
66.8	12.7	0.20	169.67	cu.m

Maximum Volume Stored: 1212.38 cu.m

Maximum Volume Required: 1212.38 cu.m

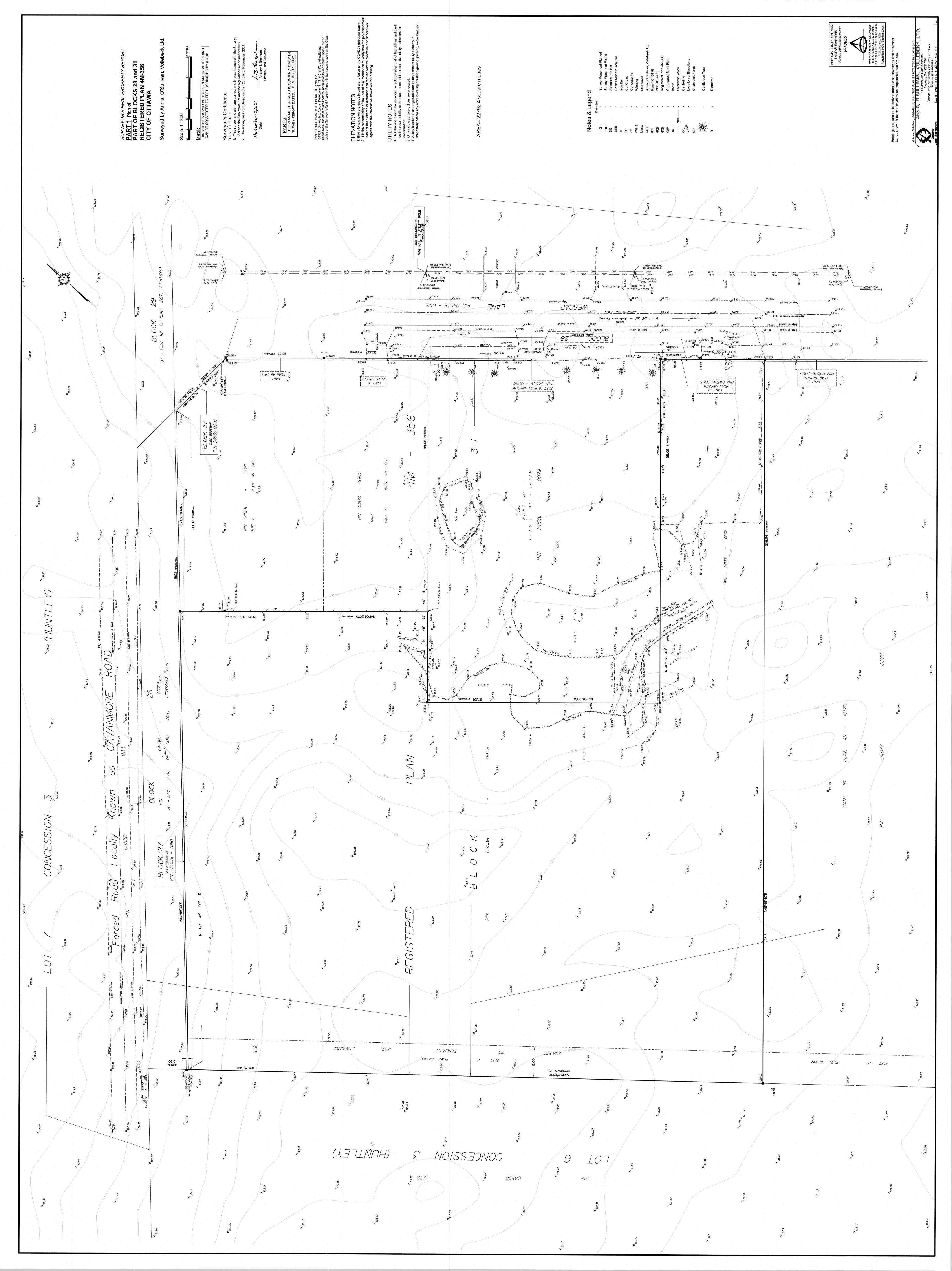
DRAINAGE AREA II (Continued)

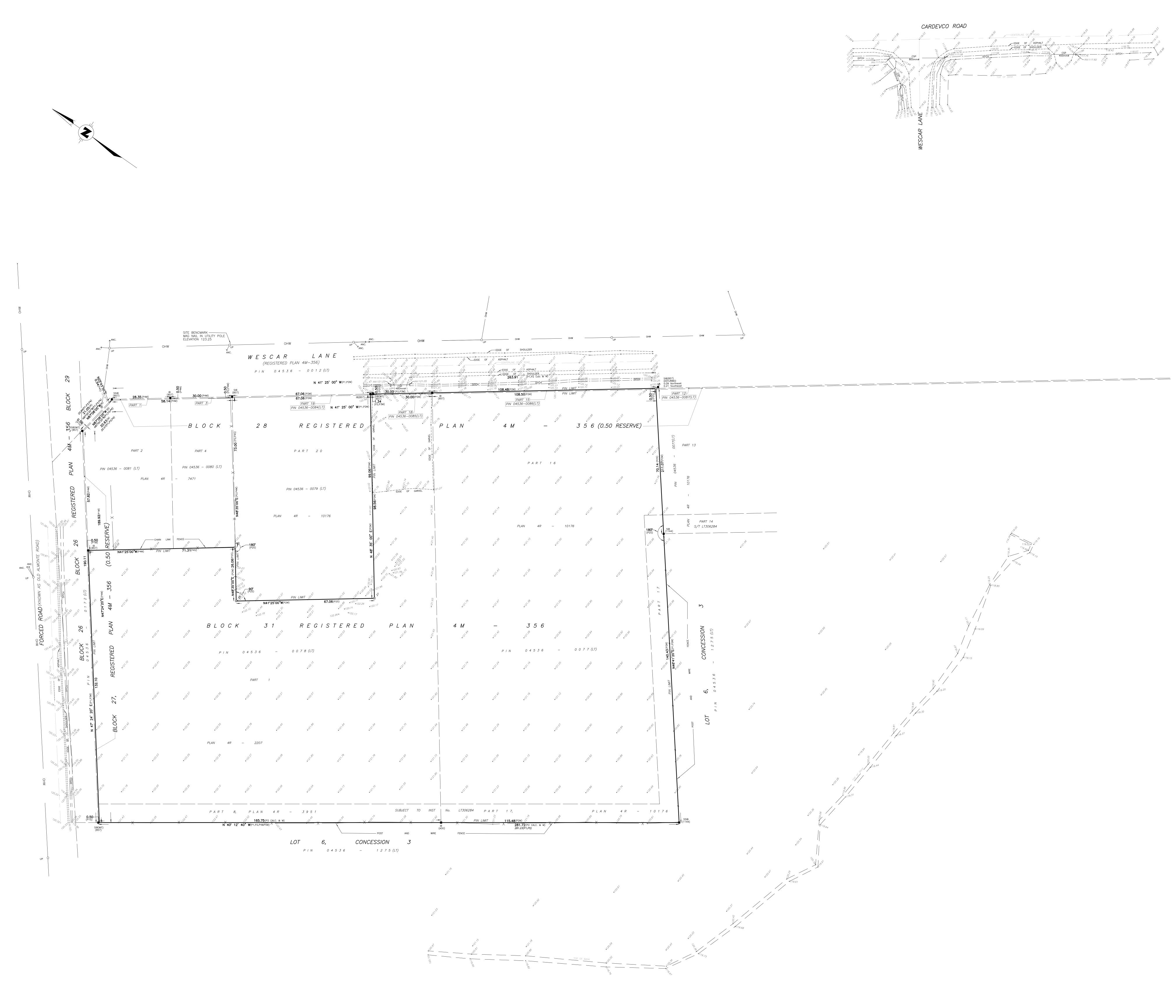
(2-YEAR EVENT)

			ICD		Required
			Release	Stored	Storage
Time	i	2.78AiC	Rate	Rate	Volume
(min)	(mm/hr)	(L/s)	(L/s)	(L/s)	(cu.m)
10	122	1120.37	40.21	1080.16	648.10
15	98	897.57	40.21	857.36	771.62
20	82	754.09	40.21	713.89	856.66
25	71	653.32	40.21	613.11	919.66
30	63	578.30	40.21	538.09	968.57
35	57	520.09	40.21	479.89	1007.76
40	52	473.50	40.21	433.29	1039.89
45	47	435.27	40.21	395.06	1066.67
50	44	403.30	40.21	363.09	1089.27
55	41	376.12	40.21	335.91	1108.50
60	38	352.70	40.21	312.50	1124.99
65	36	332.31	40.21	292.10	1139.18
70	34	314.36	40.21	274.15	1151.43
75	33	298.43	40.21	258.23	1162.02
80	31	284.20	40.21	243.99	1171.17
85	30	271.40	40.21	231.19	1179.06
90	28	259.81	40.21	219.60	1185.83
95	27	249.26	40.21	209.06	1191.62
100	26	239.63	40.21	199.42	1196.52
105	25	230.78	40.21	190.58	1200.63
110	24	222.64	40.21	182.43	1204.02
115	23	215.10	40.21	174.89	1206.76
120	23	208.11	40.21	167.90	1208.90
125	22	201.61	40.21	161.40	1210.49
130	21	195.54	40.21	155.33	1211.57
135	21	189.86	40.21	149.65	1212.19
140	20	184.54	40.21	144.33	1212.38
145	20	179.54	40.21	139.33	1212.17
150	19	174.83	40.21	134.62	1211.59
180	17	151.46	40.21	111.25	1201.48
210	15	134.06	40.21	93.85	1182.53
240	13	120.56	40.21	80.35	1157.11
270	12	109.76	40.21	69.55	1126.71
300	11	100.89	40.21	60.69	1092.37

APPENDIX H

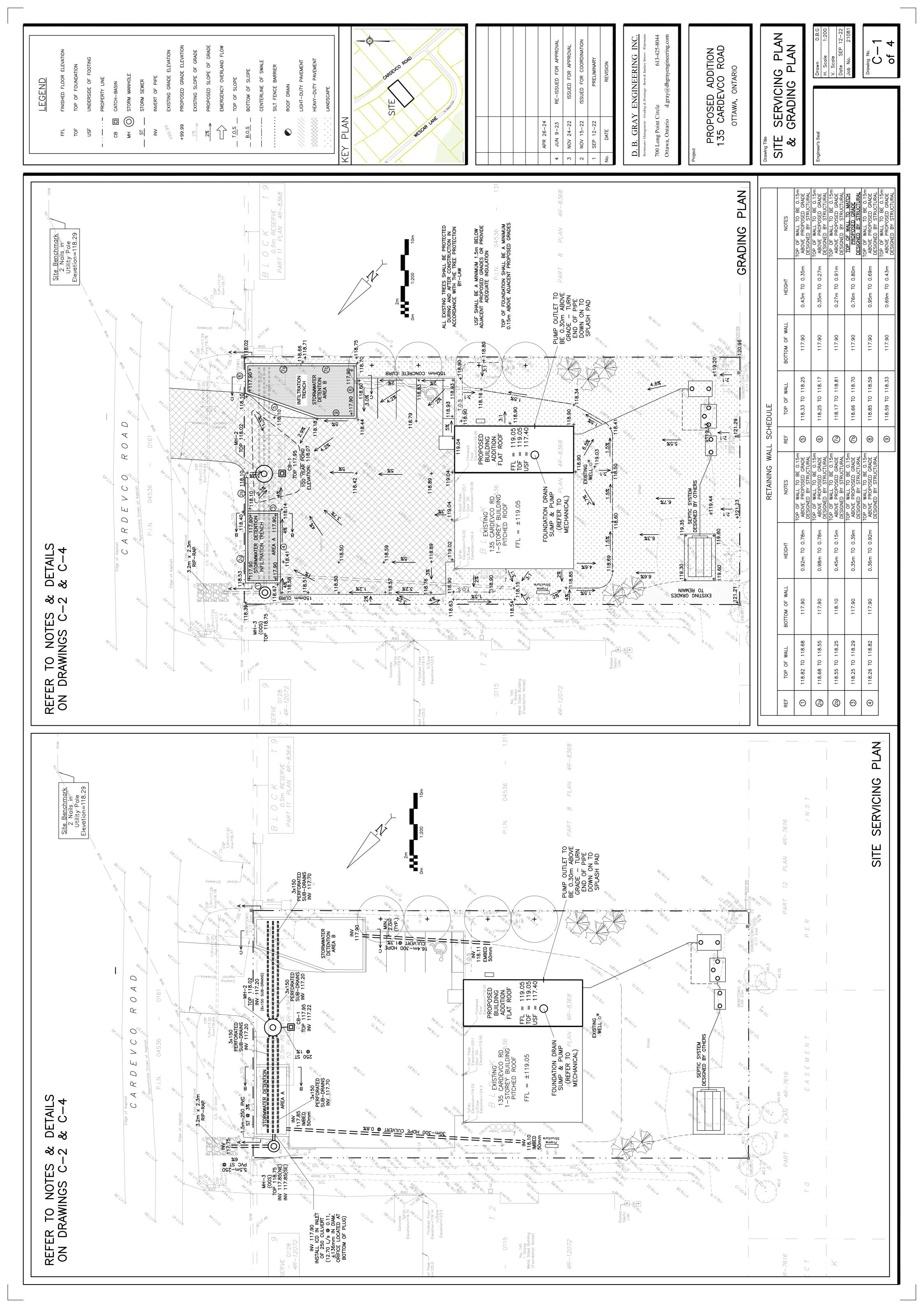
TOPOGRAPHIC SURVEYS

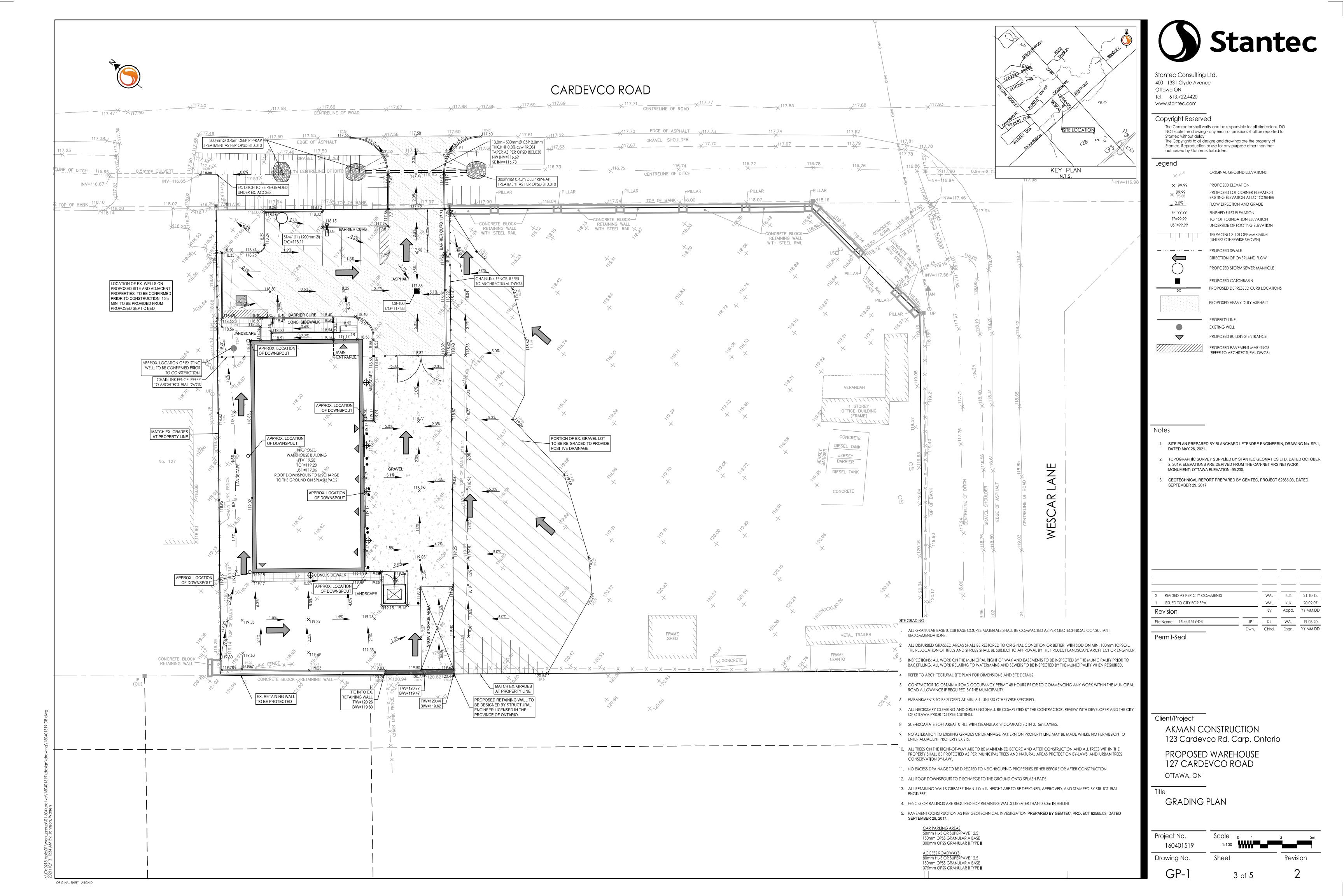


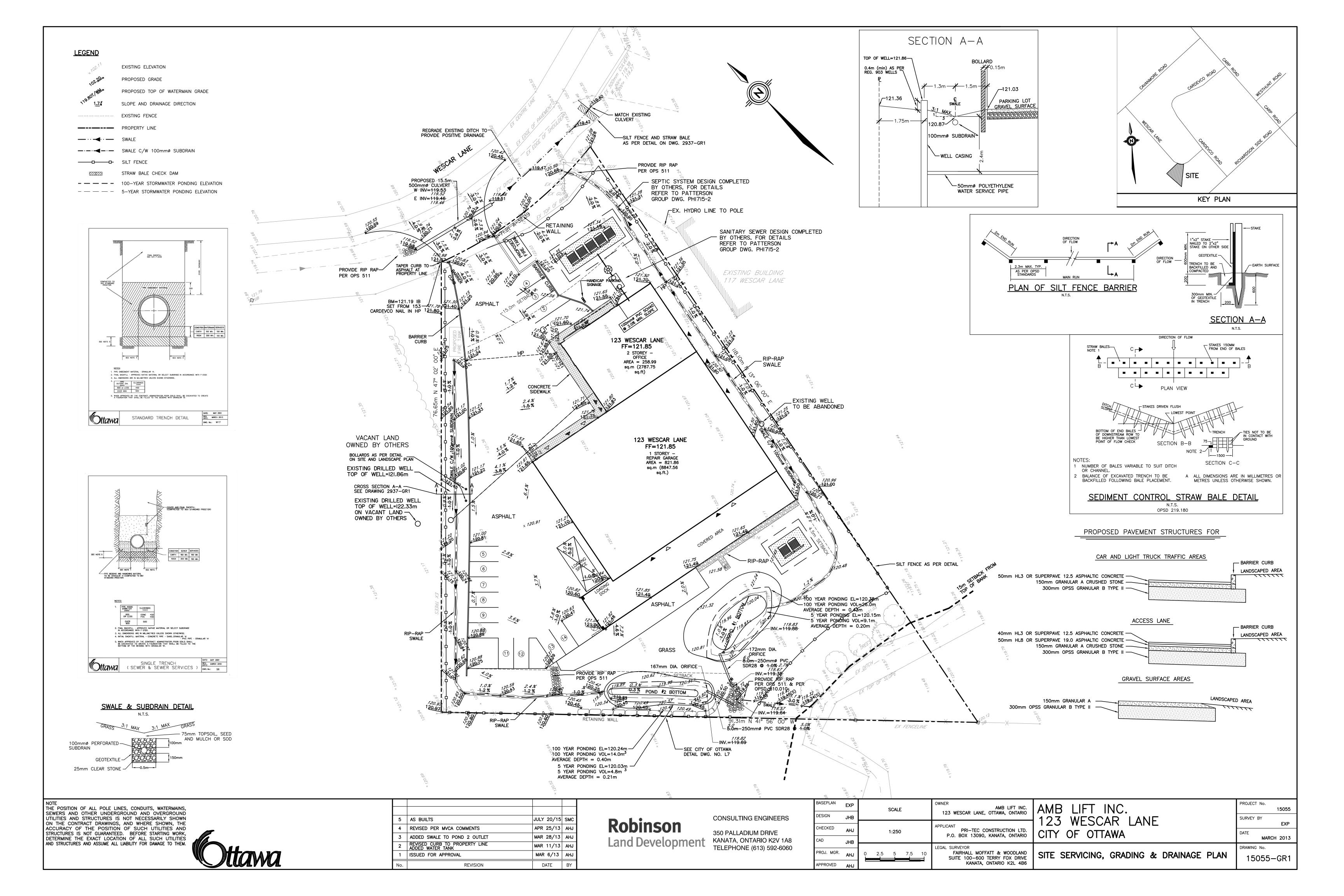


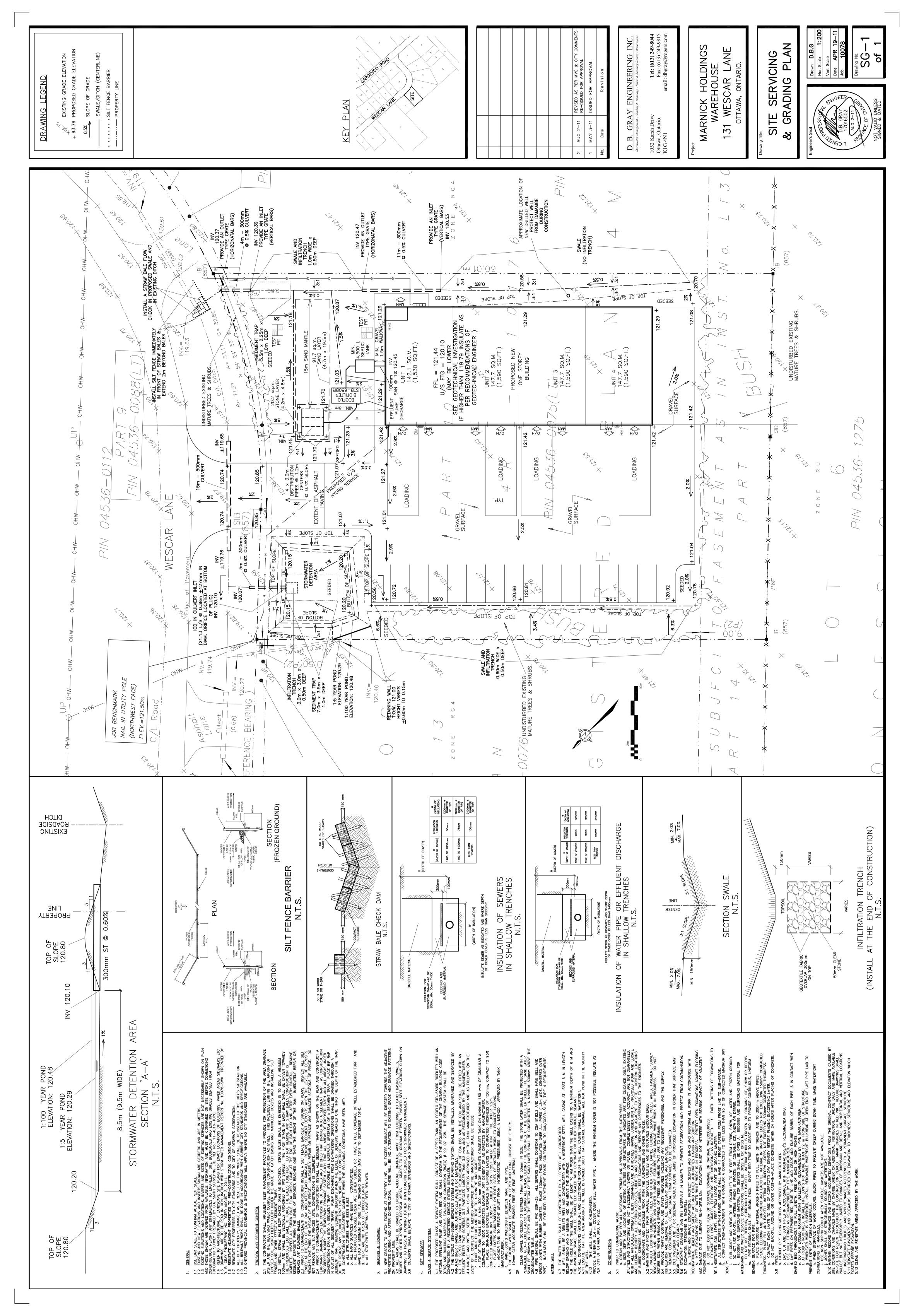
APPENDIX I

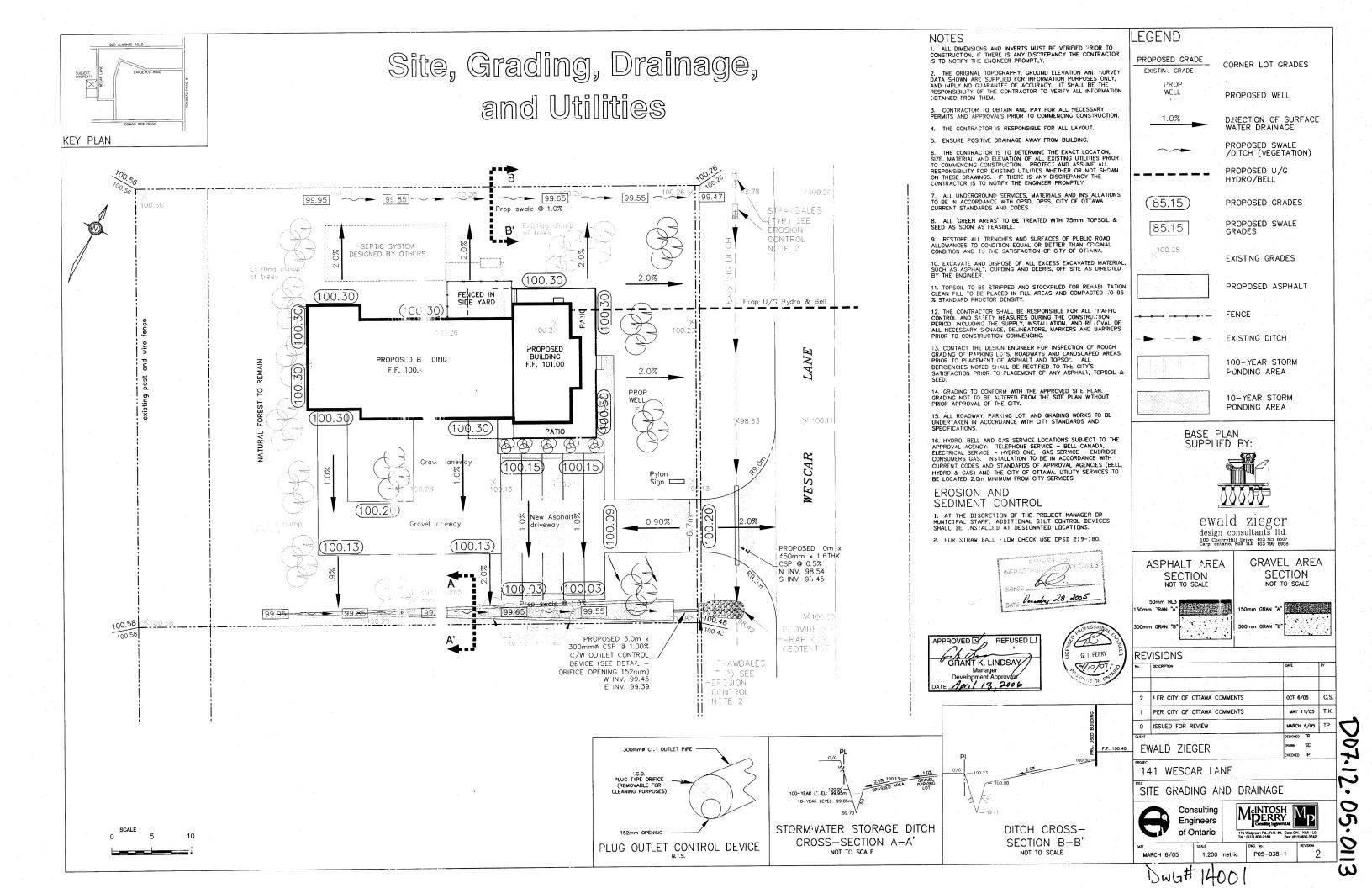
GRADING PLANS 123-127 & 135 CARDEVCO ROAD AND 123, 131, 141, 165, & 180 WESCAR LANE

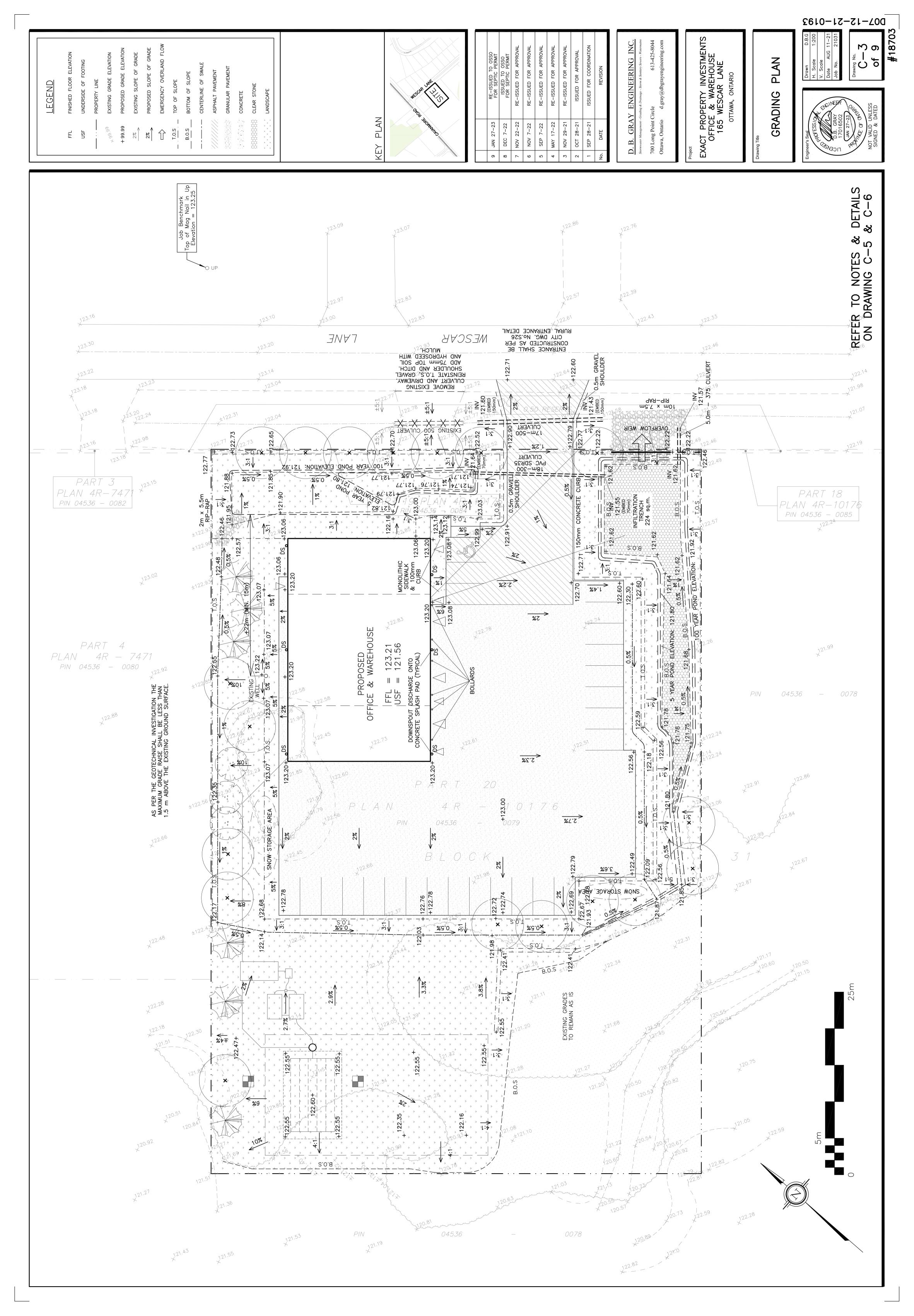


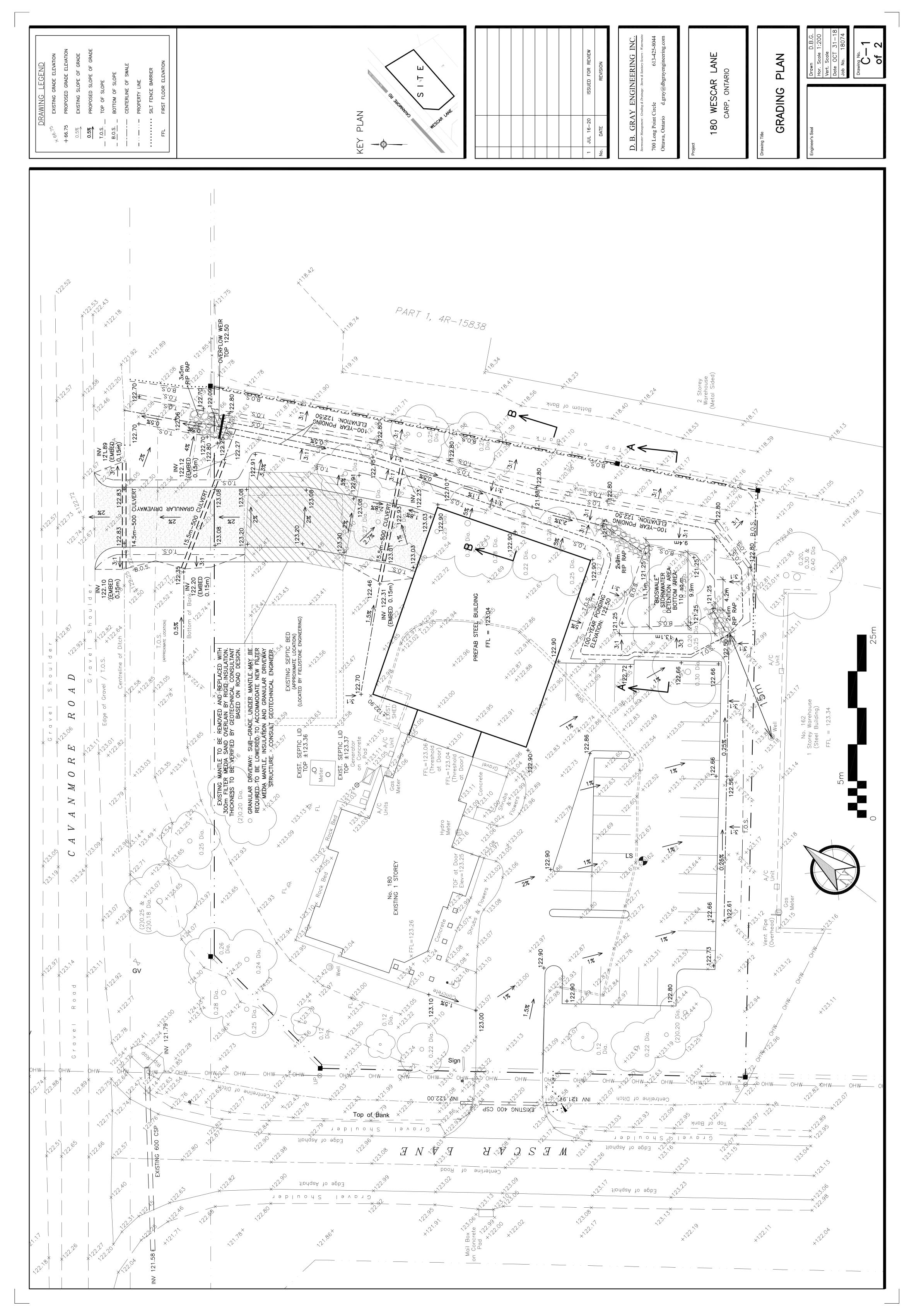












APPENDIX J

PHOTOGRAPHS
JUNE 6, 2024 STORM
121 TO 135 CARDEVCO ROAD









