CAPITAL ENGINEERING GROUP LTD
Municipal / Environmental / Land development

SERVICING AND STORMWATER MANAGEMENT REPORT
PROPOSED ADDITION - PLAYVALUE TOYS
130 DAVID MANCHESTER ROAD
FORMER TOWNSHIP OF WEST CARLETON

November 30, 2020

EXISTING CONDITIONS

This property is located on the north side of David Manchester Road, just west of the Hazeldean Road and Highway 7 interchange, within the Geographic Township of Huntley now part of the City of Ottawa metropolitan area. The site is trapezoidal in shape and borders the Highway 7 right of way. The site dimensions are roughly 180 m (frontage along David Manchester) with a mean depth of about 90 m, resulting in a total site area of approximately 1.64 ha.

The lot is currently developed with a one storey combination warehouse and retail building, with a footprint of 1,282 m^2. The existing site development includes an access entry off David Manchester Road, paved loading docks along the south side of the building and paved parking on the north side.

The existing building is serviced by on-site sewage disposal system and water supply well. The sewage system is made up of septic tanks and a pump chamber located near the southeast corner of the building with a forcemain to pump the flow to the tile bed located at the southeast corner of the property.

Fire protection is provided by a 50,000 gallon (227,000 liter) underground (below floor slab) storage tank, connected to a dry hydrant located near the southwest corner of the building.

The site plan application for the existing building and site development included engineering drawings and a stormwater management report. SWM measures were included to meet the criteria set by the City of Ottawa, Ontario Ministry of Transportation and Mississippi Valley Conservation Authority. The measures included flow controls and onsite retention as well as quality control. Copies of the original Servicing and Grading Plan, Drainage Areas Plan and SWM report are available in the City, MVCA and MTO files for this site.

The current drainage patterns are summarized as follows:

- A small landscaped area west of the site entrance sheet drains to the David Manchester roadside ditch.
- Drainage from the southern portion of the site, including the existing building, loading area and surrounding landscaping is directed to the existing retention area near David Manchester Road right of way.

- Drainage from the northern portion of the site including the parking area and adjacent landscaping is directed to the existing retention area near the north property line.

- Outflows from the above noted retention areas go through flow restrictor culverts to the existing downstream grassed swales, where quality control of the runoff is achieved. The two swales merge to create a combined outlet to the Highway 7 ditch.

- Surface drainage from the septic field and remaining site landscaping sheet drain to the adjacent grassed swales or directly to Highway 7 ditch.

Highway 7 ditch flows easterly approximately 250 m passed this property, then crosses under the highway eventually outletting to Poole Creek. Poole Creek is a tributary to the Carp River and falls under the jurisdiction of the Mississippi Valley Conservation Authority.

Overhead utilities are available along David Manchester Road just north of the site.

PROPOSED DEVELOPMENT

The original site plan application included provisions for a future addition. The addition expands the current warehouse and retail area by approximately 1,557 m^2. The existing site development of laneways, loading area and parking will remain largely the same, with the exception of the following minor modifications.

The hammerhead east of the existing loading area will be extended a short distance to create a new loading dock at the southeast end of the addition; and the site entrance will be modified to facilitate truck turning movements.

BUILDING SERVICES

The existing building is serviced by on-site sewage disposal system and supply water well. The adequacy of the existing systems to accommodate the new addition will be reviewed and confirmed by Gemtec Consulting Engineers and Scientists. Their report will be issued separately.

FIRE FLOW

Fire protection is currently provided by the existing 50,000 gallon (227,000 liters) underground storage tank, connected to a dry fire hydrant located in the landscaped island near the supply well.

The common wall between the existing building and the addition will be upgraded to provide a 4-hour fire wall.

The required fire storage volume to accommodate the addition can be estimated as follows

Fire Underwriters Survey Guidelines (1999)

$F = 220\ C\ A^{0.5}$

Where F is the required fire flow in liters per minute
C = 0.8 for non-combustible construction
A is the floor area of the addition = 1,557 m^2

F = 6,944 L/minute (**round to 7,000)**

Separation charge is zero. As noted above, the common wall between the exiting building and addition has a fire rating of 4 hours.

Required Storage for 30 minute duration 210,000 liters

Ontario Building Code

From Appendix A-3.2.5.7 of the Ontario Building Code.

From Appendix A-3.2.5.7 - Q = KVS

Building Volume	V = 14,636 m^3
Building Classification	E/F2
Water Supply Coefficient	K = 27 (Table 1)
Spatial Coefficient	S = 1.0

Required Storage Volume Q = KVS = 14,636 x 27 x 1.0 = 395,000 liters

From Table 2 for Q > 270,000 liters, the required minimum flow rate is 9,000 liters per minute. For 30 minute duration, resulting in a required water supply storage volume of 270,000 liters.

The existing storage tank capacity of 227,000 liters meets the requirements under the FUS guidelines, but marginally lower than the OBC calculations.

POST DEVELOPMENT GRADING AND DRAINAGE

The post development grading and drainage design is indicated on the Servicing, Grading and Drainage Plan prepared by Capital Engineering Group Ltd (Dwg. 2020 – 06, G1).

The current drainage patterns described above will be maintained.

STORMWATER MANAGEMENT

Criteria

The SWM criteria for this site are set by the City of Ottawa, MTO and MVCA. They are summarized as follows

- Post development peak flows to be limited to predevelopment levels. This requirement was set for the original site plan application, based on the undeveloped site conditions at the time.
- Enhanced level quality control (80 % TSS removal). This criterion has been upgraded from the normal level (70 %) required for the original site plan application

The other MVCA criteria, including infiltration targets and / or water budget calculations will be addressed by the hydrogeological consultant for this project.

Quantity Control

The allowable outflow rates from the site were calculated in the original approved SWM report and will be applied to the new updated site plan, as follows:

To David Manchester Roadside ditch

Q_5 = 3.5 l/s
Q_{100} = 7.5 l/s

The original report did not require flow controls for this area. No additional calculations will be done, as the drainage area has not been altered.

To Highway 7 ditch

Q_5 = 57 l/s
Q_{100} = 122 l/s

The SWM calculations will be updated based on the new site plan layout

Quantity control – Highway 7 ditch

Unrestricted drainage

Drainage from the septic fields and adjacent landscaping are not subject to flow controls. This area remains the same as the original site plan.

Area = 0.08 + 0.25 + 0.17 = 0.50 ha
C_5 = 0.20, C_{100} = 0.25

I_5 = 70 mm/hr, I_{100} = 120 mm/hr

Q_5 = 2.78 x 0.20 x 70 x 0.50 = 19.0 l/s
Q_{100} = 2.78 x 0.25 x 120 x 0.50 = 42.0 l/s

Balance of Allowable Outflow Rates

Q_5 = 57.0 – 19.0 = 38.0 l/s
Q_{100} = 122.0 – 42.0 = 80.0 l/s

North Drainage Area

This area remains the same as the original site plan.

Asphalt	2,050 m^2	C = 0.90 (1.00 for 100 year storm)
Landscaping	1,850 m^2	C = 0.20 (0.25 for 100 year storm)
Total	3,900 m^2	

Combined C_5 = 0.57, C_{100} = 0.64

South Drainage Area

This area has been updated as follows

Building	2,840 m^2	C = 0.90 (1.00 for 100 year storm)
Asphalt	1,920 m^2	C = 0.90 (1.00 for 100 year storm)
Landscaping	1,840 m^2	C = 0.20 (0.25 for 100 year storm)
Total	6,600 m^2	

Combined C_5 = 0.70, C_{100} = 0.79

The attached spreadsheet provides detailed calculations for the required on site storm retention volumes during the 5 and 100 year storm events for each drainage area and are summarized below:

Drainage Area	5 Year Outflow Rate	5 Year Retention	100 Year Outflow Rate	100 Year Retention
North	17 l/s	32 m^3	20.2 l/s	78 m^3
South	21 l/s	87 m^3	24.5 l/s	205 m^3
	38 l/s		44.7 l/s	

On site storage is accommodated as follows:

North Area

	5 year storm	100 year storm
Ponding Area	370 m^2	700 m^2
Ponding Depth (at culvert)	0.26 m	0.35 m
Storage Capacity	32 m^3	81 m^3

The outflow rate is limited by the existing 5 inch (135 mm) diameter culvert.

5 year storm	Depth at culvert = 0.26 m (h = 0.19 m) - flow rate is 17 l/s
100 year storm	Depth at culvert = 0.35 m (h = 0.28 m) - flow rate is 20.2 l/s

Overflow from the retention area will occur after the depth at the culvert reaches the top of berm elevation (h = 0.40 m). 5 cm free board is provided.

South Area

	5 year storm	100 year storm
Swale		
Length	83 m	83 m
Ponding Depth (at culvert)	0.32 m	0.48 m
Average Cross Sectional Area	0.94 m^2	1.84 m^2
Storage Capacity	78 m^3	153 m^3
Loading Area		
Ponding Area	220 m^2	670 m^2
Maximum Ponding Depth	0.12 m	0.28 m
Storage Capacity	9 m^3	62 m^3
Total Available Storage	87 m^3	215 m^3

The outflow rate is limited by the existing 5 inch (135 mm) diameter culvert.

5 year storm	Depth at culvert = 0.32 m (h = 0.25 m) - flow rate is 21.0 l/s
100 year storm	Depth at culvert = 0.48 m (h = 0.41 m) - flow rate is 24.5 l/s

Overflow from the retention area will occur after the depth at the culvert reaches the top of berm elevation (h = 0.5 m). 2 cm free board is provided.

Quality Control

Quality control of runoff is achieved by the existing grassed swales. The swale cross sections are shown on the Servicing and Drainage Plan. They have a bottom width of 0.75 m and side slopes of 3 to 1. The longitudinal slopes are 0.6 % and 0.8%.

The 5 year peak flows through the swales are limited to the outflow rates from the retention areas plus direct sheet drainage from the landscaped areas downstream of the flow restrictors. The flows are calculated as follows:

North Swale

Outflow from the retention area 17 l/s

Direct sheet drainage
Area = 1,700 m^2
$C_5 = 0.2$
$Q_5 = 7$ l/s

Total 5 year peak flow 24 l/s

South Swale

Outflow from the retention area 21 l/s

Direct sheet drainage
Area = 800 m^2
$C_5 = 0.2$
$Q_5 = 3$ l/s

Total 5 year peak flow 24 l/s

The flow depths and velocities can be estimated by applying Manning's formula to the swale cross section

$$Q = A \times R^{0.67} \times S^{0.5} / n$$

Where Q is the peak flow, Q = 24 l/s = 0.024 m^3/s
A is the area of flow, varies with the depth of flow
S is the longitudinal slopes, S = 0.6 % and 0.8 %
n is the roughness coefficient, n = 0.035.

The calculated depths of flow are 0.07 m and 0.08 m and the velocities are 0.35 m/s and 0.40 m/s for the north and south swales respectively.

The swale cross sections (0.75 m bottom width) and longitudinal slope (< 1%) as well as the flow depths and velocities (< 0.5 m/s) all conform to the recommendations in the MOE SWM Planning and Design Manual (relevant pages attached). Rock check dams will be installed at two locations along the swales to improve their water quality control effectiveness. Enhanced level treatment (80 % TSS removal) is assumed, which meets the MVCA criteria.

On Site Infiltration

In order to promote on site infiltration, all runoff from hard surfaces (roofs and pavement) are re-routed through landscaped area and / or flat grassed swales with check dams.

As mentioned above, water balance calculations and infiltration targets are included in the hydrogeological report prepared by Gemtec Consulting Engineers and Scientists.

EROSION AND SEDIMENT CONTROL

Erosion and sediment control measures will be put in place prior construction to minimize off site silt runoff. The measures will conform to MOE Guideline B-6, "Guidelines for Evaluating Construction Activities Impacting on Water Resources". They will remain in place until landscaping work is completed

The measures are detailed on the Sediment and Erosion Control Plan (Dwg. 2020-06, G2). They include silt fence along the perimeter of the site, rock check dams along the drainage swales and a rip rap spillway at the outlet to the Highway 7 ditch.

Prepared by
Capital Engineering Group Ltd.

Andy Naoum, P.Eng.
Senior Consultant

Pre-Application Consultation Meeting Notes

Property Address: 130 David Manchester Road
PC2020-0133
Tuesday, June 16, 2020; Online Zoom meeting

Attendees:
Sarah McCormick, City of Ottawa, Planner II
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Kevin Hall, City of Ottawa, Senior Project Manager
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Sami Rehman, City of Ottawa, Environmental Planner II
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Andy Naoum, CEGL, civil engineer
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Regrets:
Mike Giampa, City of Ottawa, Transportation Engineer
Mike.Giampa@ottawa.ca

Subject: 130 David Manchester Road

Meeting notes:

Overview of Proposal

- Original build was mixed use; retail (45%) and warehouse (50%); approximately 1,280m^2.
- Worked with MTO for signage
- Existing building is a cross laminated timber; proposed additional will be of the same material.
- The proposal is for a 1-storey warehouse addition of approximately 1,280m^2 to the existing Playvalue building. This will double the footprint of the existing building, with all warehouse, in order to accommodate more demand in online sales.
- One additional loading bay will form part of the proposed addition.
- No anticipated staffing changes; perhaps a couple of extra staff, but don't anticipate additional demand for water or septic.
- The original civic drawings did account for a future phase, including the vehicular entrance.
- Requested slightly larger entrance width to accommodate the turning radius.

Preliminary comments and questions from staff and agencies, including follow-up actions:

- Planning
  - <u>Official Plan:</u> Rural Natural Features (policies of the General Rural Area also apply)
    - The property is designated Rural Natural Features in Schedule A of the Official Plan.
    - As per policy 3.2.4(7); development and site alteration will not be permitted for development in or within 120 metres of the boundary of a natural heritage feature, unless an Environmental Impact Statement demonstrates that there will be no negative impacts on the natural features within the area.
    - Policies of the General Rural Area designation also apply to properties designated Rural Natural Features

  - <u>Current Zoning:</u> Rural General Industrial Zone (RG)
    - Warehouse is a permitted use within the RG zone.
    - Please ensure the minimum parking and loading requirements of the Zoning By-law are met.

  - <u>Discussion</u>
    - The application will need to demonstrate there is sufficient parking provided for both the existing and the proposed uses. From the details provided on the concept plan, based on a total building area of 2,795 sq metres, and a 55%/45% split between warehouse and retail space, a minimum of 55 parking spaces are required. Only 51 spaces are shown on the site plan.
    - The Site Plan will require a full zoning table illustrating how the proposal meets the zoning provisions of the RG zone.
    - Given Highway 416 is identified as a Scenic Entry Route in Schedule I of the Official Plan, staff will be paying particular attention to the design of the building.
    - The façade of the building which faces the Highway should have more architectural detail, particularly of a rural nature. A mix of materials, including brick, finishes and colours are encouraged to break up the white massing of the building.
    - The MTO will be circulated on the application. Approval from the MTO is required in relation to various reports/plans (please see below).
    - Additional landscaping will be required.
    - The landscape plan will need to identify the existing landscaping as well as the proposed. Please ensure the existing versus new landscaping can be differentiated from each other.
    - The landscape plan will need to demonstrate that all landscaping from the previously approved site plan application has been introduced on the property. Where that landscaping has not been introduced, those plantings will need to be implemented through this development. Missing landscaping should be identified on the plan as new.
    - The proposed development will trigger a Standard Rural Site Plan.

- Engineering
  - Staff confirm that the Subject Property is not located within the Feedmill Creek Study area, therefore the restrictive stormwater requirements are not application for the site.

    - The requirements of the Carp River Subwatershed Study will be required.
    - A Hydrogeological Report update will be required. Staff can also consider an engineering memo to confirm the well can service the addition.
    - Similarly, staff will also required confirmation from an engineer that the septic system has sufficient capacity for the proposed development.
    - Site lighting control (full cut-off) is required.
    - A Geotech Report will be required.
    - An ECA application from the MECP will be required.

- Hydrogeology
    - The Subject Property is identified as thin soils and potential/inferred karst.
    - The supporting documents will need to confirm the soil thickness and soil type onsite to determine if the area is hydrogeologically sensitive.
    - A servicing report that identifies the water and septic demand compared to the existing demand and existing capacity. The suitability of well water quantity and quality is also required and can be a scoped analysis if demand is not changing.
    - If an increase in demand or a change to the well or septic system (i.e. if a new well or septic system is installed) is required, then a complete hydrogeological report and terrain analysis will be required.
    - It should be noted that the area is identified as thin soils and potential karst, so if there are any changes to the well or septic, then hydrogeological sensitivity will need to be confirmed onsite and additional mitigative measures will be required if the site (i.e. extended well casing, increased separation distance between well and septic, siting well and septic based on overburden thickness distribution and groundwater flow direction, etc.).
    - The fact that the area is in a moderate to high recharge area is directly related to it being hydrogeologically sensitive.
    - To account for the high recharge area, within the hydrogeological report (or stormwater management report), measures must be identified to ensure clean infiltration onsite.
    - Infiltration targets from the Carp Subwatershed Study must be met. As per the Subwatershed Study, the applicant can alternatively prepare a local-scale water budget to determine site-specific infiltration targets.

- Transportation
    - A Transportation Impact Assessment will not be required for the proposed addition.
    - A Noise Study will not be required.
    - While the access is existing, there is a vertical curve on David Manchester Road approximately 130 metres to the south. The applicant must demonstrate adequate southerly sightlines on David Manchester to accommodate additional WB-20 truck traffic. Vehicles travelling northbound around the curve must be able to see an entering/existing WB-20 and be able to come to a stop, if necessary. If this can’t be achieved, mitigation is required (flashing beacon, signage, tree branch removal, etc.).

- Environmental
    - The property is located within the Rural Natural Feature designation and is adjacent to significant woodlands.
    - There is also potential for habitat for Species at Risk.

- It appears there are trees over 10cm in diameter, therefore a Tree Conservation Report will be required.
- There are no watercourses present on or near the site.
- An Environmental Impact Statement will be required. The EIS will need to address potential species at risk. The season for this study is right now.
- There is identified habitat for species at risk further down avid Manchester Road; the EIS will need to consider any potential impacts the proposed addition will have on that habitat.
- The additional projects into the existing trees; the applicant is encouraged to preserve as much of the existing vegetation as possible. Staff will be looking for enhancements where possible, including trees, shrubs and perennials.
- Staff acknowledge that there was a report prepared for the Site Plan associated with the existing building. Policies and regulations have changed since the preparation and approval of that report with the field work being conducted approximately 10 years ago. The previous report can be used in part, however a new site visit(s) will be required and the report will need to be updated and brought to standards.

- Mississippi Valley Conservation Authority
    - MVCA staff have confirm that this property does not fall within the area that requires compensation related to Poole Creek.
    - MVCA's information sources do not identify any potential hazard features within the scope of their review as being associated with the subject lands.
    - The subject property is not regulated under Ontario Regulation 153/06.
    - With regards to stomwater management:
        - The subject property is located within the Carp River Watershed Study, and has been identified as a mix of:
            - Sand and gravel which has High Recharge and an infiltration target of 262 mm/yr;
            - Paleozoic Bedrock which has a Moderate Recharge and an infiltration target of 104mm/yr;
            - For sites located with a mix of soils types a weighted average based on site conditions should be applied.
        - An enhanced level of protection, 80% TSS removal, is required.
    - The initial stormwater management design for the site completed in 2012 included only normal levels of protection with 70% TSS removal and did not include specific information regarding achieving infiltration targets.

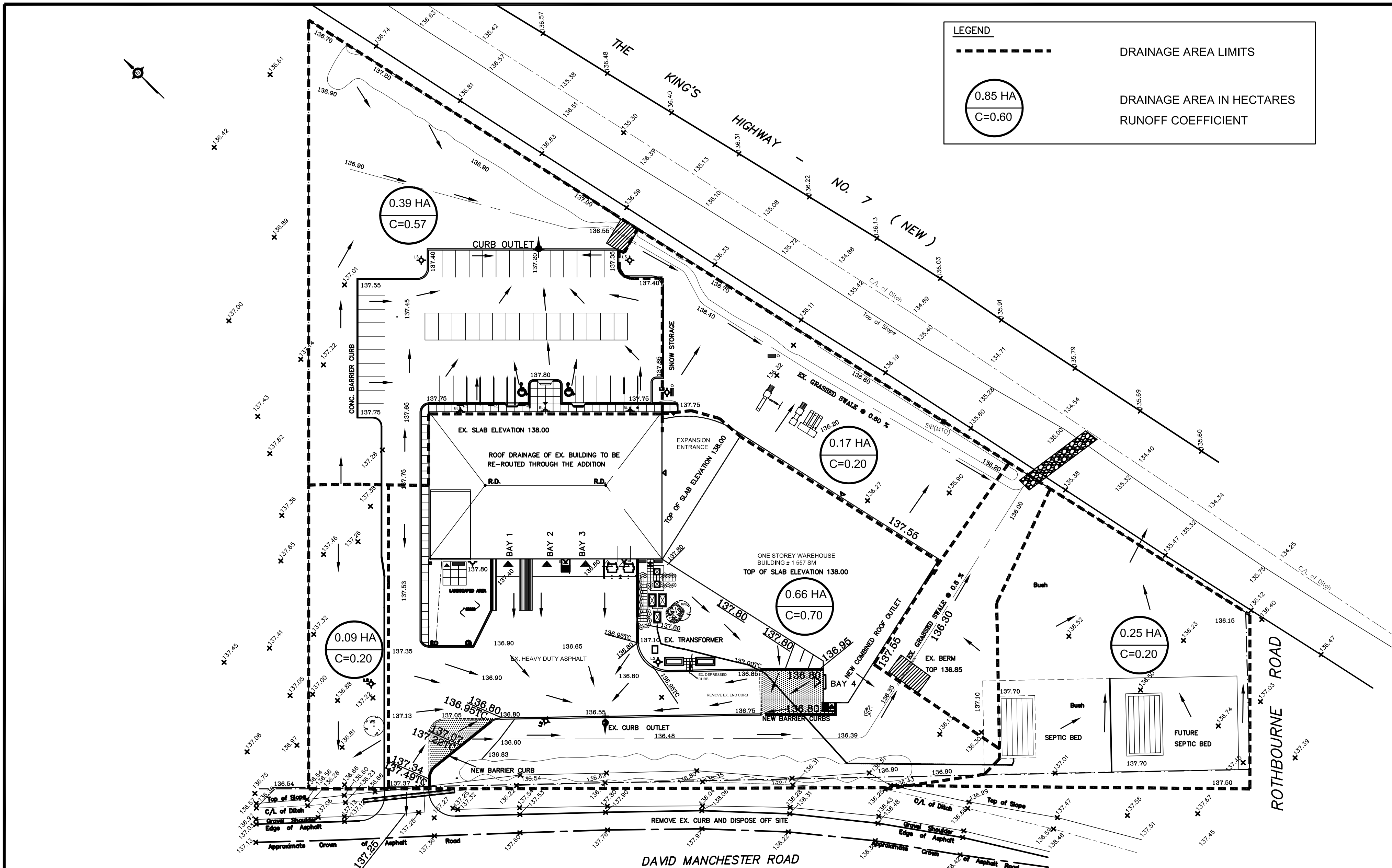
- MTO
    - An updated photometric plan must be completed demonstrating there is no light spillover onto the highway right-of-way.
    - The MTO standards for stormwater management has not changed. New reports will need to meet these standards.
    - A building and land use permit will be required from the MTO.
    - Any additional signs will require a permit from the MTO (on top of any permit or permission required from the City).

Submission requirements and fees

- The proposal triggers a Rural Standard Site Plan application. The application form with associated fees can be found here.
- Additional information regarding fees related to planning applications can be found here.
- Please refer to the accompanying required plans and studies list for all documents required to form a complete Site Plan application.
- Please refer to the Guide(s) to Preparing Plans and Studies, found here.

Next steps

- The applicant is encouraged to discuss the proposal with Councillor, community groups and neighbours.



PLAYVALUE TOYS - PHASE 2
130 DAVID MANCHESTER ROAD

Drainage Areas Plan

SCALE 1:1000

STORMWATER MANAGEMENT CALCULATIONS
PLAYVALUE TOYS - PHASE 2
130 DAVID MANCHESTER ROAD
November 30, 2020

ON SITE RETENTION FOR 5 YEAR STORM	AREA	RUNOFF	2.78 CA	DURATION	INTENSITY	PEAK FLOW	OUTFLOW	RETENTION	STORED
SOUTH DRAINAGE AREA	(ha)	COEFF.		(min)	(mm/hr)	(L/s)	RATE(L/s)	RATE(L/s)	VOLUME(m3)
	0.660	0.70	1.28	5	141	181.32	21.00	160	48.10
	0.660	0.70	1.28	10	104	133.82	21.00	113	67.69
	0.660	0.70	1.28	15	84	107.32	21.00	86	77.69
	0.660	0.70	1.28	20	70	90.23	21.00	69	83.07
	0.660	0.70	1.28	25	61	78.21	21.00	57	85.82
	0.660	0.70	1.28	30	54	69.26	21.00	48	86.87
	0.660	0.70	1.28	35	49	62.31	21.00	41	**86.76**
	0.660	0.70	1.28	40	44	56.75	21.00	36	85.80
	0.660	0.70	1.28	45	41	52.18	21.00	31	84.19
	0.660	0.70	1.28	50	38	48.36	21.00	27	82.08
	0.660	0.70	1.28	55	35	45.11	21.00	24	79.57
	0.660	0.70	1.28	60	33	42.31	21.00	21	76.72

ON SITE RETENTION FOR 100 YEAR STORM	AREA	RUNOFF	2.78 CA	DURATION	INTENSITY	PEAK FLOW	OUTFLOW	RETENTION	STORED
SOUTH DRAINAGE AREA	(ha)	COEFF.		(min)	(mm/hr)	(L/s)	RATE(L/s)	RATE(L/s)	VOLUME(m3)
	0.660	0.79	1.45	5	243	351.80	24.50	327	98.19
	0.660	0.79	1.45	10	179	258.82	24.50	234	140.59
	0.660	0.79	1.45	15	143	207.12	24.50	183	164.36
	0.660	0.79	1.45	20	120	173.87	24.50	149	179.24
	0.660	0.79	1.45	25	104	150.53	24.50	126	189.04
	0.660	0.79	1.45	30	92	133.16	24.50	109	195.59
	0.660	0.79	1.45	35	83	119.70	24.50	95	199.91
	0.660	0.79	1.45	40	75	108.92	24.50	84	202.61
	0.660	0.79	1.45	45	69	100.09	24.50	76	204.09
	0.660	0.79	1.45	50	64	92.70	24.50	68	**204.60**
	0.660	0.79	1.45	55	60	86.42	24.50	62	204.35
	0.660	0.79	1.45	60	56	81.02	24.50	57	203.47

STORMWATER MANAGEMENT CALCULATIONS
PLAYVALUE TOYS
CONT'D

ON SITE RETENTION FOR 5 YEAR STORM	AREA	RUNOFF	2.78 CA	DURATION	INTENSITY	PEAK FLOW	OUTFLOW	RETENTION	STORED
NORTH DRAINAGE AREA	(ha)	COEFF.		(min)	(mm/hr)	(L/s)	RATE(L/s)	RATE(L/s)	VOLUME(m3)
	0.390	0.57	0.62	5	141	87.25	17.00	70	21.07
	0.390	0.57	0.62	10	104	64.39	17.00	47	28.43
	0.390	0.57	0.62	15	84	51.64	17.00	35	31.17
	0.390	0.57	0.62	20	70	43.41	17.00	26	**31.70**
	0.390	0.57	0.62	25	61	37.63	17.00	21	30.95
	0.390	0.57	0.62	30	54	33.33	17.00	16	29.39
	0.390	0.57	0.62	35	49	29.98	17.00	13	27.27
	0.390	0.57	0.62	40	44	27.31	17.00	10	24.73
	0.390	0.57	0.62	45	41	25.11	17.00	8	21.89
	0.390	0.57	0.62	50	38	23.27	17.00	6	18.81
	0.390	0.57	0.62	55	35	21.71	17.00	5	15.53
	0.390	0.57	0.62	60	33	20.36	17.00	3	12.09

ON SITE RETENTION FOR 100 YEAR STORM	AREA	RUNOFF	2.78 CA	DURATION	INTENSITY	PEAK FLOW	OUTFLOW	RETENTION	STORED
NORTH DRAINAGE AREA	(ha)	COEFF.		(min)	(mm/hr)	(L/s)	RATE(L/s)	RATE(L/s)	VOLUME(m3)
	0.390	0.64	0.69	5	243	168.41	20.20	148	44.46
	0.390	0.64	0.69	10	179	123.90	20.20	104	62.22
	0.390	0.64	0.69	15	143	99.15	20.20	79	71.06
	0.390	0.64	0.69	20	120	83.23	20.20	63	75.64
	0.390	0.64	0.69	25	104	72.06	20.20	52	77.79
	0.390	0.64	0.69	30	92	63.75	20.20	44	**78.38**
	0.390	0.64	0.69	35	83	57.30	20.20	37	77.91
	0.390	0.64	0.69	40	75	52.14	20.20	32	76.66
	0.390	0.64	0.69	45	69	47.91	20.20	28	74.83
	0.390	0.64	0.69	50	64	44.38	20.20	24	72.53
	0.390	0.64	0.69	55	60	41.37	20.20	21	69.87
	0.390	0.64	0.69	60	56	38.78	20.20	19	66.90

Winter Operation

In general, infiltration facilities are unsuitable for water quality treatment during the winter/ spring period. They are subject to reductions in capacity due to freezing or saturation of the soil. If road runoff is received, there is an increased likelihood of clogging due to high sediment loads and an increased risk of groundwater contamination from road salt.

If infiltration practices are used as an all-season water quality treatment facility, then doubling the design storage volume for surface infiltration devices to account for reduced infiltration rates is recommended. Redundant pre-treatment (more than one pre-treatment device in series) is recommended for all infiltration facilities receiving road runoff. A pre-treatment volume of about 15 mm/impervious hectare is recommended.

Technical Effectiveness

Centralized infiltration trenches have a poor historical record of success (Lindsey et al., 1992; Metropolitan Washington Council of Governments, 1992). This lack of success is attributable to many factors:

- poor site selection (industrial/commercial land use, high water table depth, poor soil type);
- poor design (lack of pre-treatment, clogging by native material);
- poor construction techniques (smearing, over-compaction, trench operation during construction period); and
- large drainage area (high sediment loadings, groundwater mounding).

There are many reasons why an infiltration trench can fail. One of the main problems with centralized infiltration trenches is that water from a large area is expected to infiltrate into a relatively small area. This does not reflect the natural hydrologic cycle and generally leads to problems (groundwater mounding, clogging, compaction).

Water quality enhancement can be achieved using infiltration trenches. However, care must be taken to avoid degradation of groundwater quality. Trenches are ineffective quantity control facilities unless substantial storage is provided and the soil conditions are optimum.

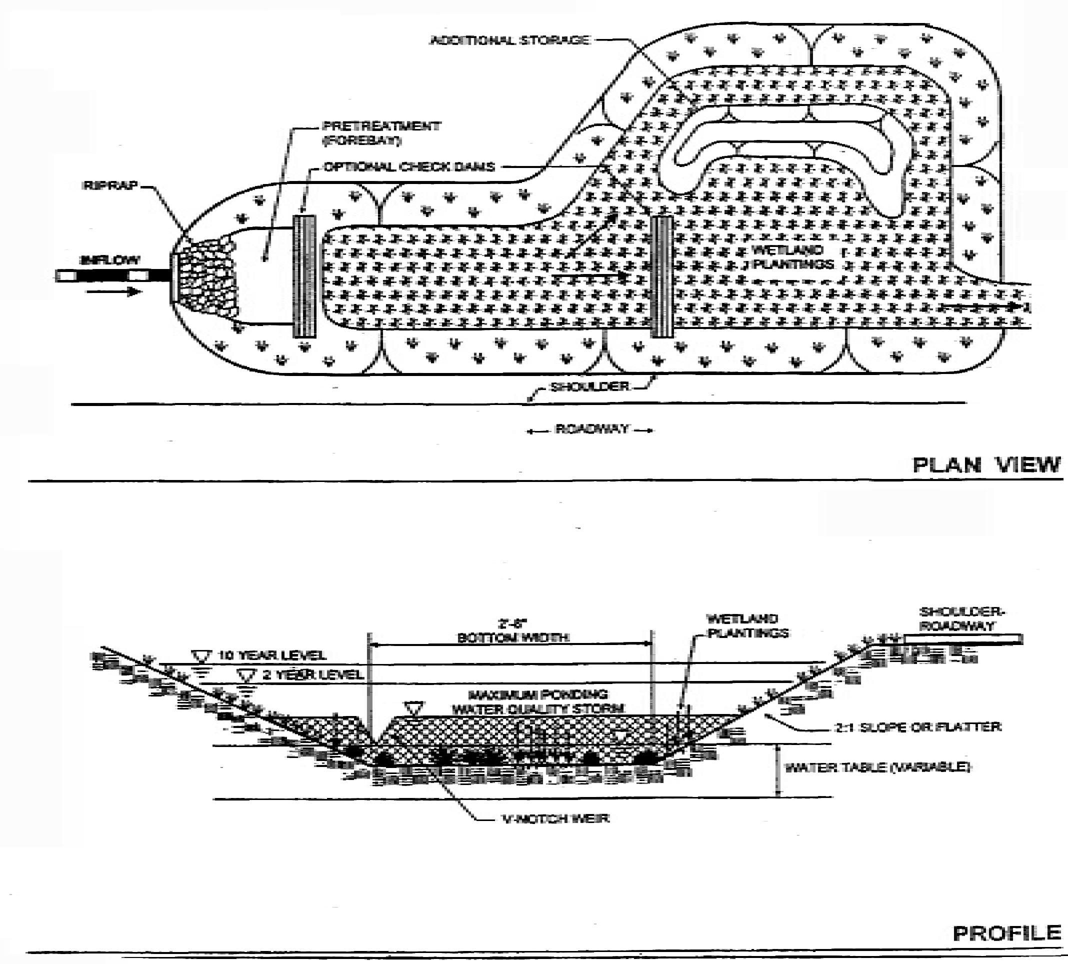
4.5.9 Grassed Swales

Grassed swales have historically been associated with rural drainage and have been constructed primarily for stormwater conveyance. Stormwater management objectives have changed and grassed swales are now being promoted to filter and detain stormwater runoff. Swale drainage can be a useful technique in areas of low grade, as long as the distance that the flow is to be conveyed is not too long.

The majority of swale systems in Ontario have been designed as "dry" swales. The guidance provided below is for such systems. An alternate design, the "wet" swale, can also be useful in areas where there is sufficient space, especially where soils are not highly permeable, or where there are low lying areas with a high water table.

Wet swales combine elements of dry swale systems and wetland systems. Wet swales are typically wider than dry swales (e.g., 4 m - 6 m) and the check dams are used to create shallow impoundments in which wetland vegetation is planted or allowed to colonize. Because of their width, wet swales are not generally implemented along the front of residential properties, but rather are included where overland flow routes use linear open space areas. Combined systems of dry and wet ponds may be used. Wet swales have been implemented in several highway projects, but monitoring results are limited. A schematic of a wet swale is provided in Figure 4.9.

Figure 4.9: Schematic of a Wet Swale



Wet swales are ideal for treating highway runoff in low lying or flat terrain areas.

Source: Maryland Stormwater Manual, Volume 1, 1998.

Design Guidance

Swale Cross-section

Grassed swales can be effective SWMPs for pollutant removal if designed properly. The water quality benefits associated with grassed swales depend on the contact area between the water and the swale and the swale slope. Deep narrow swales are less effective for pollutant removal compared to shallow wide swales. Given typical urban swale dimensions (0.75 m bottom width, 2.5:1 side slopes and 0.5 m depth), the contributing drainage area is generally limited to ≤ 2 ha (to maintain flow ≤ 0.15 m³/s and velocity ≤ 0.5 m/s). Table 4.5 indicates drainage area restrictions for various degrees of imperviousness, based on the assumptions given regarding channel cross-section, slope and cover. The swales evaluated in Table 4.5 are indicative of swales servicing an urban subdivision and not a transportation corridor.

Table 4.5: Grassed Swale Drainage Area Guidelines*

% Imperviousness	Maximum Drainage Area (ha)
35	2.0
75	1.5
90	1.0

* *Based on the following assumptions: trapezoidal channel, grassed lined (n = 0.035), slope of drainage area = 2%, 2.5:1 side slopes, 0.75 m bottom width, 0.5% channel slope, max. allowable Q = 0.15 m³/s, max. allowable V = 0.5 m/s.*

Grassed swales are most effective for stormwater treatment when depth of flow is minimized, bottom width is maximized (≥ 0.75 m) and channel slope is minimized (e.g., ≤ 1%). Grassed swales with a slope up to 4% can be used for water quality purposes, but effectiveness diminishes as velocity increases. Grass should be allowed to grow higher than 75 mm to enhance the filtration of suspended solids.

Flow Velocity

As a general guideline, grassed swales designed for water quality enhancement should be designed to convey the peak flow from a 4 hour 25 mm Chicago storm with a velocity ≤ 0.5 m/s. This guideline results in a requirement for wide, flat swales for larger drainage areas.

All grass swales must be evaluated under major system and minor system events to ensure that the swale can convey these storms effectively.

Ditch and Culvert Servicing

Ditch and culvert servicing is viable for lots which will accommodate swale lengths ≥ the culvert length underneath the driveway (not just the driveway pavement width). The swale length should also be ≥ 5 m for aesthetic and maintenance purposes. This is generally achievable for small lots (9 m) with single driveways or larger lots (15 m) with double driveways.

Winter Operation

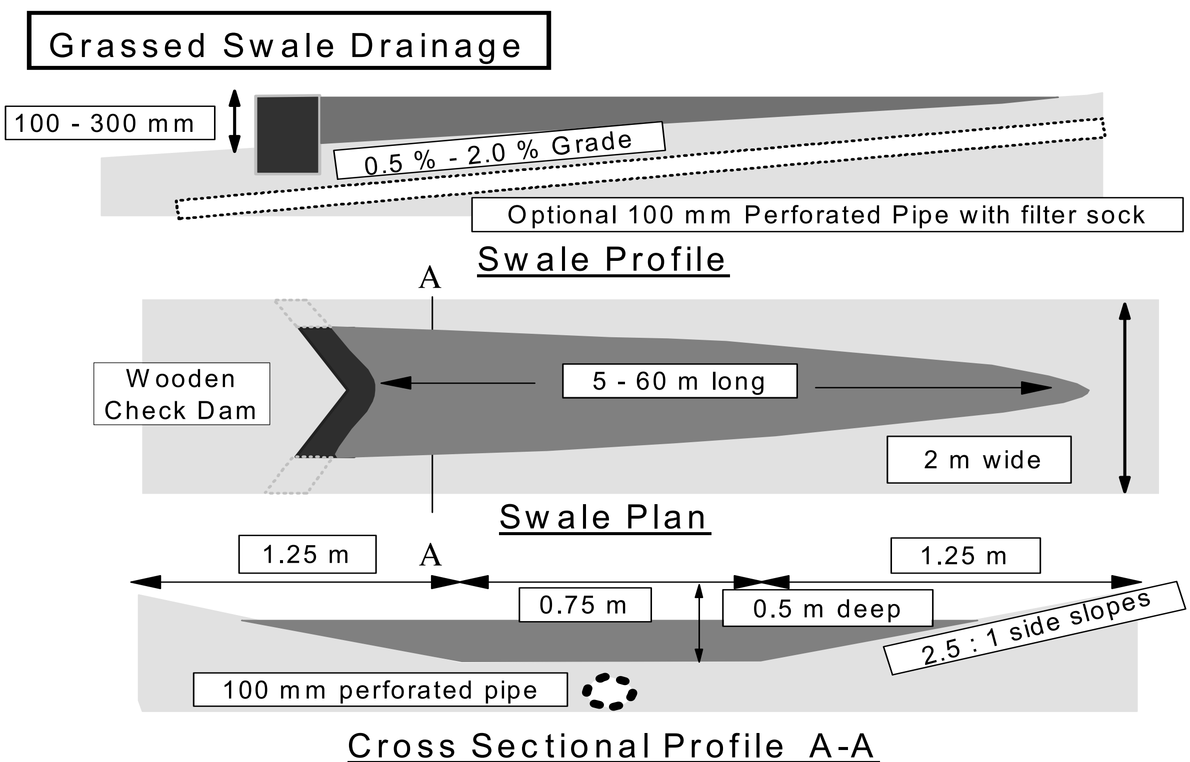
Swale systems which receive road runoff may have their infiltration capacity diminished over time, as salt effects on soil structure and clogging occur. Swale systems need to be maintained periodically (removal of accumulated sand and addition of mulch to the soil structure) in order to maintain their ability to infiltrate.

Relatively few design modifications are warranted for swales in cold climates, primarily due to their inherent simplicity. The following design modifications will tend to enhance their performance:

- Culverts should have a minimum diameter of 450 mm and a slope of 1% or greater; and
- For swale systems with an underdrain system, the underdrain should have a minimum diameter of 200 mm and should be bedded in gravel.

Performance Enhancements
In order to promote infiltration of stormwater and the settling of pollutants, permanent check dams can be constructed at intervals along the swale system. These enhancements are best utilized on large swales where the cumulative flow depth and rate is not conducive to water quality enhancement ($V \geq 0.5$ m/s or $Q \geq 0.15$ m³/s during the 25 mm 4 hour storm). The distance between check dams can be calculated based on the depth of water at the check dam and the swale channel slope. For example, if a swale has a 1% slope and a check dam height of 0.3 m, the distance between check dams should be 30 metres (or less). Figure 4.10 illustrates an enhanced grassed swale design.

Figure 4.10: Enhanced Grass Swale



The dam should be constructed out of durable material (wood) which blends into the surrounding landscape. A rock check dam can be used if the swale is located in a remote area which is not subject to vandalism. The dam should be configured in a V shape to help minimize scour and erosion of the downstream swale banks (V points upstream). The dam should be securely embedded in the swale banks and some rip-rap should be placed downstream of the dam to prevent scour and erosion. The velocity of the design conveyance storm should be kept to approximately 1 m/s whereby smaller stone sizes can be utilized (75 mm diameter).

In areas where the swales are separated by driveway culverts, the culverts can be raised such that the driveway embankment (up to the invert of the driveway culvert) acts as the check dam. This design is more aesthetically appealing and negates the need for rip-rap erosion protection. The driveway culvert should be underdrained, however, to ensure that a permanent pool of water is not created in the swale.

A low flow opening can be created in the check dam to ensure a drawdown time $\leq$ 24 hours. However, recognizing the potential for clogging of the low flow opening, it is recommended that swales with check dams be underdrained in soils with poor infiltration potential (e.g., clays).

Standard 100 mm perforated pipe (or larger) should be used in combination with a filter sock in any type of underdrain system. Stone storage can be provided around perforated pipes that are installed under swales as a secondary storage medium to promote exfiltration. The appropriate depth of soil cover for the stone storage should be based on the surrounding soil conditions and the potential for frost heave. Figure 4.4 indicates the recommended soil cover based on the native soil type and trench depth.

All grass swales must be evaluated under major system and minor system events neglecting the storage/conveyance below the overflow of any check dam to ensure that the swale can convey these storms effectively.

Technical Effectiveness

The effectiveness of swale systems is highly dependent on their design and maintenance. It is therefore recommended that they be used as part of a multi-component approach (i.e., one measure in a series of stormwater quality measures). They may be used for pre-treatment or polishing.