Evolugen

South March BESS

Ottawa, ON

Design Criteria

Civil Design Criteria

BBA Document No.-Rev.: 7154023-100000-41-EDC-0001-RAF

February 5, 2026

FOR PERMITTING

Do not use for construction

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2026-02-06

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BBA Document No.-Rev.: 7154023-100000-41-EDC-0001-RAF

REVISION HISTORY

Revision	Document Status – Revision Description	Date
RAA	Preliminary	2025-03-26
RAB	For Permitting	2025-06-19
RAC	For Permitting	2025-11-05
RAD	For Permitting	2026-01-27
RAE	For Permitting	2026-01-30
RAF	For Permitting	2026-02-05

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1. General

Fitzroy BESS Inc., a subsidiary of Evolugen by Brookfield Renewable (Brookfield) in partnership with the Algonquins of Pikwàkanagàn is proposing to develop the South March Battery Energy Storage System (BESS) Project (the Project). The Project will be in the West Carleton-March Ward in the City of Ottawa, Ontario. It is located on two leased parcels of land at 2555 and 2625 Marchurst Road, Ottawa, Ontario, and situated south of Thomas A. Dolan Parkway, west of Marchurst Road, and north of John Aselford Drive. The Project has a Development Area of approximately 9.0 hectares on approximately 84.5 hectares of property. The leased rural lots currently include two residential buildings with an access lane, naturalized areas with woodland and wetland, as well as limited non-commercial pasture use.

The Project is a 250megawatt (MW) energy storage facility that uses lithium ion (lithium iron phosphate) technology and is designed to store up to 1,000 megawatt hours of energy, providing four hours of continuous discharge at full capacity.

The Project will consist of 256 BESS containers at the start of commercial operations and will progressively increase to 307 BESS containers over the duration of the IESO Offtake Agreement. The additional BESS containers will be added through the augmentation process to maintain the required 250 MW capacity. This process is further detailed within the Augmentation Process Memo.

This report considers the full Augmentation Process (a total of 307 BESS containers). Its findings and conclusions are not affected by any stage of augmentation, from 256 to 307 BESS containers.

1.1. Scope of the design criteria

The purpose of this document is to provide basic design requirements for preparing the civil infrastructure deliverables for the South March BESS project.

1.2. Abbreviations and acronyms

The table below lists all abbreviations and acronyms used in this document, along with their definition.

Table 1: Abbreviations and acronyms

Abbreviation or acronym	Definition
ASTM	American Society for Testing Materials
AHJ	Authority having jurisdiction
BESS	Battery Energy Storage System
CSA	Canadian Standards Association
CN	Curve number
MVCA	Mississippi Valley Conservation Authority
IDF	Intensity Duration Frequency
MECP	Ministry of the Environment, Conservation and Parks
MTO	Ministry of Transportation Ontario
NFPA	National Fire Protection Association
OPS	Ontario Provincial Standards
OHSA	Occupational Health and Safety Act
PEO	Professional Engineers Ontario
PSW	Provincially Significant Wetland
RVCA	Rideau Valley Conservation Authority
SCS	Soil Conservation Service
SST	Station Service Transformer
SWMP	Stormwater Management Plan
TSS	Total Suspended Solids
US EPA	United States Environmental Protection Agency
USDA	United States Department of Agriculture
TAC	Transportation Association of Canada

1.3. Units and symbols

All units of measurement must be in accordance with the International Systems of Units (SI). If exceptions need to be made, SI shall be used as the primary dimensions, with the corresponding conversion to the other system of units in brackets.

All units used in this document are listed in the following table:

Table 2: Units and symbols

Unit / Symbol	Description
km	Kilometre
m	Meter
cm	Centimetre
mm	Millimetre
km/h	Kilometre per hour
m3	Cubic metre
L	Litres
km2	Square kilometre
ha	Hectare
kN	Kilo Newton
kPa	Kilopascal
pers	Person
s	Second
min	Minute
h	Hour
pers	Person

1.4. Horizontal and vertical reference system

The project falls under the reference system horizontal NAD83(CSRS MTM Zone 9 – EPSG2952) and vertical CGVD28 projection.

2. Documentation

Unless otherwise specified, the design will be based on applicable sections of the following codes, standards, regulations, and other reference documents.

2.1. Codes, standards, and regulations

Table 3: Codes, standards and regulations

Document code/Author	Document title
AWWA	American Waterworks Association
CAN/CGSB	Canadian General Standards Board
City of Ottawa	Official Plan (November 2022)
City of Ottawa	Ottawa Sewer Design Guidelines, SDG002 (October 2012)
City of Ottawa	Sewer Use Bylaw (Bylaw No. 2003-514) (January 2004)
City of Ottawa	Technical Bulletin ISDTB-2014-01, Revisions to Ottawa Design Guidelines – Sewer (February 2014)
City of Ottawa	Technical Bulletin PIEDTB-2016-01, Revisions to Ottawa Design Guidelines – Sewer (September 2016)
City of Ottawa	Technical Bulletin ISDTB-2018-01, Revisions to Ottawa Design Guidelines – Sewer (March 2018)
City of Ottawa	Technical Bulletin ISDTB-2018-04, Revisions to Ottawa Design Guidelines – Sewer (June 2018)
City of Ottawa	Technical Bulletin ISDTB-2019-02, Revisions to Ottawa Design Guidelines – Sewer (July 2019)
City of Ottawa	Technical Bulletin IWSTB-2024-04, Revisions to Ottawa Design Guidelines – Sewer (April 2024)
CSA	Erosion and sediment control installation and maintenance, W208:20
EPA/Government of Ontario	Environmental Protection Act, R.S.O. 1990, c. E.19
FUS 2020	Water Supply for Public Fire Protection –A Guide to Recommended Practice in Canada (2020), Fire Underwriters Survey
IEEE 980	Guide for Containment and Control of Oil Spills in Substations
OPS	Ontario Provincial Standards
Ontario MOE	Stormwater Management Planning and Design Manual (March 2003)
Ontario MOE	Design Guidelines for Sewage Works (2008)
Ontario MTO	Drainage Management Manual (1995-1997)
Ontario MTO	MTO Hydrotechnical Design Charts (2023)
Ontario MTO	Drainage Design Standards (2008)
Province of Ontario	Conservation Authorities Act – Ontario Regulation 41/24
CSA	MTO Highway Drainage Design Standards (January 2008)

Document code/Author	Document title
NFPA 24	Standard for the Installation of Private Fire Service Mains and Their Appurtances
OHSA/ USC	Occupational Health and Safety Act
Mississippi Valley Conservation Authority (MVCA)	MVCA Regulation Policies (April 2024)
TAC	Geometric Design Guide for Canadian Roads
US EPA	Storm Water Management Model User's Manual Version 5.1 (September 2015)
USDA	Urban Hydrology for Small Watersheds TR-55 (June 1986)

2.2. Reference documents

Table 4: Reference documents

Document code/Author	Document title
Tulloch Geomatics Inc.	Topographic Plan of Survey of Part of the East ½ Lot 25 and Part of the Southeast ½ Lot 26 Concession 1 Geographic Township of March, City of Ottawa (File: 241451), dated: March 11, 2025
Hatch Ltd.	South March Road Battery Energy Storage System (BESS) Geotechnical Investigation report (H375142-0000-2A0-230-0001, Rev.3)
Hatch Ltd.	South March Road Battery Energy Storage System (BESS) - Hydrogeological and Terrain Analysis Study (H375142-0000-2A4-030-0001 R1)
Hatch Ltd.	South March Battery Energy Storage System (BESS) Fluvial Geomorphology Assessment (H375142-0000-2B0-066-0001 R2)

2.3. Conflicting documents

Where there is a discrepancy in requirements between the codes, standards, and regulations, the references, or this document, the most stringent requirements of the conflicting documents always apply.

3. General criteria

The proposed development consists of the BESS area, substation, stormwater pond, and access road. The substation and wet pond are located on the south and north ends of the site, respectively. Access to the site is provided via road from Marchurst Road.

The BESS site runoff is planned to drain north to a proposed stormwater pond. The project site is located within the Ottawa River Watershed. The watercourse that runs through the site will be redirected through a series of ditches and a culvert to exit the developed area and directed to the Marchurst Road ditch. No municipal drains are present within the site. The nearby Old Carp Road, located south of the site, is identified as a Scenic Route as per Schedule C13 of the "Official Plan" (City of Ottawa, 2022). The proposed development must meet the requirements of Section 4.6.2 policy 4 of the "Official Plan" as it is adjacent to the Scenic Route. This project follows the policy by having the site located away from the road and remain hidden by existing trees, berm and the natural property topography.

3.1. Site location

The South March BESS project site is located at 2625 & 2555 Marchurst Road, Ottawa, Ontario.

3.2. Climatic conditions

The climate in the Greater Ottawa Region averages between -14 °C to 27 °C and is rarely below -23 °C or above 30 °C. See Appendix A for the IDF curves used for this project.

3.3. Topographical, geotechnical, and geological data

Based on the survey data completed by Tulloch Geomatics Inc., March 5, 2025, the site is relatively flat with an elevation change of approximately 99 to 104 masl across the site.

Geotechnical Site Investigation by Hatch in 2024 was not conducted in the north-west side of the BESS layout. According to the drilled boreholes, the following stratigraphic layers were encountered on site and are listed from top to bottom as follows:

1. Topsoil: A 100 mm to 600 mm thick layer of topsoil was encountered throughout the site;
2. Native silty sand:

   a. This layer was encountered below the topsoil layer and silty clay layer discussed below and ranged in thickness between 300 mm and 1.1 m;
   b. Based on SPT "N" blow counts ranging between 2 and 13 blows per 300 mm of penetration, this layer can be classified as very loose to compact;
3. Native silty clay:
   a. This layer was encountered below the silty sand layer and had a thickness range of 200 mm to 4.8 m throughout the site;
   b. The layer consisted of a sandy silt with gravel with SPT "N" blow counts ranging between 2 and 29 per 300 mm of penetration in the upper 2-3 m, indicating a firm to stiff compactness and becoming softer with depth;
   c. Field vane tests indicated peak undrained shear strengths between 55 kPa to >96 kPa with remoulded values ranging between 6 to 8 kPa;
4. Native silty clay (glacial till):
   a. This layer was encountered in one borehole at a depth of 3.0 mbgs and extended to the terminus of borehole at approximately 3.6 mbgs, where refusal on inferred bedrock was encountered;
   b. The layer consisted of a sandy silt with gravel with SPT "N" blow counts of 28 per 300 mm of penetration indicating a very stiff compactness;
5. Bedrock: rock coring was completed in one borehole between 6.1 and 9.1 mbgs. The rock encountered on site is classified as fresh and extremely strong Granitic Gneiss bedrock.

3.4. Groundwater

The groundwater level was measured manually during the Geotechnical Site Investigation completed by Hatch in 2024 and was found to range between 1.0 to 1.3 m below the existing ground surface.

4. Site development

Site development refers to construction work related to infrastructure supporting project facilities.

4.1. Site clearing and topsoil removal

Site clearing is carried out to the road's right-of-way or to a minimum of 10 m from circulation areas, ditches, and laydown areas for snowbanks not to impede on the utilized areas. Topsoil with a thickness of 100 to 600 mm will be removed from the development area (refer to the geotechnical report for additional information).

4.2. Impervious geomembrane

To protect the groundwater from any potential contamination from the batteries, an impervious geomembrane layer will be installed across the entire site (except substation area and access road). The use of a geotextile in between 2 layers of sand is to protect the geomembrane from mechanical damage. See drawing 7154023-100000-41-D20-0004 for requirements.

4.3. Excavation and backfill

In-situ soils can be reused as backfill material (refer to recommendations in the geotechnical report) and must be prioritized to borrow materials should they be free from cobbles, boulders, topsoil, organic matter, or other deleterious materials. Oversized materials (i.e., > 150 mm in size) should be removed.

Imported materials used for Engineered Fill should be approved by the Geotechnical Engineer, at its source, prior to importing the material to the site. Suitable soils, free of topsoil, organic matter or other deleterious materials, can be used as Engineered Fill provided that the water content of the soil at the time of placement is within ± 2% the materials' optimum water content for compaction. Otherwise, soils may require treatment (i.e., drying or wetting) prior to placement.

Excavation and embankment maximum slopes are presented in Table 5 and must comply with OSHA regulations. Ratios indicated in Table 5 are for material take-off calculation only. Slopes shall be inspected by an experienced Geotechnical Engineer.

Table 5: Excavation and embankment slopes

Location	Slope (ratio H:V)
Permanent excavations in in-situ soils	*2:1*
Permanent excavations in compacted fill or structural fill	*2:1*
Permanent embankments (compacted)	*2:1*

Location	Slope (ratio H:V)
Temporary excavation in native firm to stiff silty clay (upper 2-3 m)	*1:1*
Temporary excavation in native very soft to soft silty clay (> 3 m depth)	*3:1*

Deep excavations and side slopes should be reviewed by a Geotechnical Engineer.

4.4. Grading

For electrical substations, the following criteria are used:

- Final grade shall present a minimum slope of 0.5 %;
- Equipment base shall be 300±50 mm higher than the final grade;
- Free-draining aggregate shall be 5-20 mm with a minimum thickness of 150 mm.

For the BESS pad, the following criteria are used:

- Final grade shall present a minimum slope of 0.5 %;
- Free draining aggregate shall be 5-20 mm with a minimum thickness of 150 mm.

4.5. Frost depth

The maximum frost penetration depth is 1.8 m, as per the geotechnical report.

For buried pipes, frost depth will be determined based on the fill material used, the pipe manufacturer recommendation, and Geotechnical Engineer recommendations. The freezing index for the area is between 1000 °C-day and 1500 °C-day.

4.6. Roads and traffic areas

Access roads pavement structure preparation and installation should be completed in accordance with the geotechnical recommendations and under the supervision and approval of the Geotechnical Engineer. The pavement structure should consist of the following:

1. Silty clay / Silty clay (till-like) subgrade:
    a. 300 mm thick layer of Granular A base course compaction to 100% SPMDD;
    b. 300-mm thick layer of Granular B Type II subbase course compacted to 98% SPMDD;

   c. Geotextile fabric and geogrid reinforcement are required;
2. Granitic gneiss bedrock subgrade:
   a. 250 mm thick layer of Granular A base course compaction to 100% SPMDD;
   b. 250-mm thick layer of Granular B Type II subbase course compacted to 98% SPMDD;
   c. Geotextile fabric and geogrid reinforcement are not required.

Pavement structure materials should be compacted in 200 mm loose lifts and should be within ±2% of the material's optimum moisture content. Where geotextile fabric is placed, the layers should be overlapped a minimum of 450 mm.

Final roadway surfaces shall be sloped at 2% or greater to promote runoff. The subgrade should be crowned at the centreline and sloped between 3% and 5% towards the roadway perimeter.

4.6.1. Design vehicles

Road and traffic areas installed under these areas are designed according to loads transferred to the pavement with the following vehicles:

Table 6: Design vehicle

Road type/Area	Vehicle
Main access road and substation area	A lowboy semi-trailer tractor truck, Liebherr LR 1300.1 SX Crawler Crane, and fire/emergency vehicles.
Main access road and BESS area	A Tridem Drive Tractor Semi-trailer delivery truck, Liebherr LR 1300.1 SX Crawler Crane, and fire/emergency vehicles.

4.6.2. Road and traffic area geometry

Roads and traffic areas are designed using the following criteria.

Table 7: Road/traffic area geometry

Road type (1)	Design speed (km/h)	Maximum speed posted (km/h)	Max. vertical slope (%)	Curve radius (m) (5)	Width (m) (2) (4)
Main access road	25	20	10	14	8
BESS area roads	10	10	10	14	8
Substation area	10	10	10	14	8

4.6.3. Fences and gates

Fences shall be installed at minimum 1 m from the property line. Install at least one access gate per fenced area.

For electrical substations, the fence shall be located at 1.5 m from the edge of the granular platform. Fence details can be found in BBA drawing 7154023-100000-41-D90-0001 for typical details.

5. Stormwater management

5.1. General and regulatory requirements

In Ottawa, the stormwater management design criteria are based on the guidelines outlined in the Ministry of the Environment, Conservation and Parks (MECP), formerly the Ministry of Environment (MOE) "Stormwater Management Planning and Design Manual" (MOE, 2003), and Ottawa Sewer Design Guidelines Second Edition, October 2012 and the technical bulletins: ISDTB-2014-01, PIEDTB-2016-01, ISDTB-2018-01, ISDTB-2018-04, and ISDTB-2019-02.

In addition, for the Mississippi Valley Conservation Authority (MVCA), the design of stormwater management infrastructure must comply with MVCA Regulation Policies (MVCA, 2024) prescribing the setbacks of infrastructure from watercourses, regulated wetlands, and 100-year floodplains.

5.2. Watershed and sub-watershed definition

Watersheds and sub-watersheds are defined based on Ontario GeoHub and the topographic survey "241451 South March BESS MTM9-Rev0.dwg" completed by Tulloch in March 2025. For post-development conditions, sub-catchment areas were delineated based on the layout of the proposed drainage system.

5.3. Design rainfall

All drainage systems are designed according to a different rainfall data from the Sewer Design Guidelines, Second Edition, document no. SDG002, October 2012, City of Ottawa presented in Appendix A.

In addition, the Ottawa Sewer Design Guidelines require that rainfall intensity be stress tested using design storms increased by 20% for rainfall events to consider the impact of climatic changes. Modifications to the drainage system would be required only if severe flooding is identified by the stress test.

5.4. Computer modelling

PCSWMM software was used to model the existing (pre-development) and proposed stormwater management system for this project. Stormwater management systems are modelled using the PCSWMM software to help size ditches, culverts stormwater pipes and detention structure.

5.4.1. Synthetic design storms

Temporal distribution of precipitation for the City of Ottawa is mostly defined using Chicago and Soil Conservation Service (SCS) type II synthetic storms. The synthetic storms were developed using Dstorm based on the IDF.

5.5. Model parameters

The CN values were determined based on the Hydrogeological and Terrain Analysis Study (Hatch, 2025). The hydrologic soil group is expected to be group "BC" with a CN value of 69 and an estimated Horton infiltration rate of 9 mm/h (minimum) to 170 mm/h (maximum). The CN values are summarized below in Table 8.

Table 8: Curve number

Surface	Curve number
Native site soils / Grass	69
Gravel	85
Concrete	98

The Manning coefficients used in this project are in Table 9.

Table 9: Manning coefficients

Surface	Manning's n
Grass and trees, short (overland flow)	0.15
Gravel (overland flow)	0.09
Concrete	0.013
Grass (open channel)	0.035
Drainage pipe, material type to be finalized (closed conduits)	0.013

5.6. Wet pond design

The design of the wet pond was developed according to the MECP document "Stormwater Management Planning and Design Manual." Ponds are designed to retain runoff volumes with five (5) components: the permanent pool, forebay, active storage (quality/erosion control storage), quantity control storage and an overflow. The pond is sized to ensure the maximum peak flow rate from the 100-year design storm does not exceed the pre-development values for the 2-year return period storms.

5.6.1. Quality control

The watershed receiving watercourse should be protected according to the level of resilience to environmental perturbations. Three 3) levels of protection are given based on the long-term average removal of suspended solids: enhanced protection (80% removal), normal protection (70% removal), and basic protection (60% removal). The site requires enhanced protection according to the definition in the MOE design manual Section 3.3.1.1 as the area has high permeability soils (SCS hydraulic class BC).

The water quality storage volume is calculated based on the level of protection required for the receiving waters and the impervious level of the subcatchment.

Based on the selected level of protection of 80% long-term suspended solids removal, and the requirements of Table 3.2 Water Quality Storage Requirements based on Receiving Waters of the Stormwater Management Planning and Design Manual (MOE, 2003), the storage volume (m^3/ha) for an impervious level of 100 % is 287 (m^3/ha). Therefore, the minimum water quality storage volume to consider is 1722 m^3 for the drainage area.

5.6.2. Erosion control (pond)

Erosion control runoff peak flows and volumes are computed using 25-mm Chicago synthetic distribution for a 4-hour duration precipitation event. This rain event represents a typical rainfall event and is suitable to validate erosion protections in the proposed development. It was proven that most erosion happens with multiple small rainfall events over time.

5.6.3. Erosion control (diversion watercourse)

Erosion control runoff peak flows of the diversion watercourse are computed using the 2-year and 100-year return periods. Capacities and velocities are calculated using the PCSWMM software to validate the vegetation will withstand the water flows over time. Refer to the appendix of the stormwater management report for results.

5.6.4. Quantity control

For flood control, the maximum peak flow from a 100-year post-development storm must not exceed the pre-development flow for a 2-year storm. Existing and post-development rates were determined using a computer simulation modelling.

Quantity control runoff peak flows and volumes are computed using an SCS synthetic distribution for a 100-year return period rainfall of 24 hours.

5.6.5. Settling calculations

To calculate the forebay volume and length, the settling calculations shall be used. The forebay settling length is calculated as follows:

$$Dist = \sqrt{\frac{r * Q_p}{V_s}}$$

Where:

Dist = Forebay length (m)

r = length-to-width ratio of forebay

Q_p = peak flow rate from the pond during design quality storm

V_s = Settling velocity (it is recommended that a value of 0.0003 m/s be used)

5.6.6. Dispersion length

The dispersion length is calculated as follows:

$$Dist = \frac{(8 * Q)}{d * V_f}$$

Where:

Dist = Length of dispersion (m)

Q = Inlet flowrate (m^3/s)

d = depth of the permanent pool in the forebay (m)

V_f = desired velocity in the forebay (m/s)

5.6.7. Bottom width

The total width of the forebay should provide a length-to-width ratio of 2:1

The minimum forebay deep zone width is calculated as follows:

$$Width = \frac{Dist}{8}$$

5.6.8. Wet pond geometry

Wet pond geometry is defined with the following parameters:

Table 10: Geometry of wet ponds*

Design element	Minimum criteria	Preferred criteria
Active storage detention	24 hrs (12 hrs if in conflict with minimum orifice size)	24 hrs
Drainage area	5 hectares	> 10 hectares
Forebay	▪ Minimum depth: 1 m ▪ Sized to ensure non-erosive velocities leaving forebay ▪ Maximum area: 33% of total permanent pool	▪ Minimum depth: 1.5 m ▪ Maximum area: 20% of total permanent pool
Length/Width ratio	Overall: minimum 3:1 Forebay: minimum 2:1	From 4:1 to 5:1

Design element	Minimum criteria	Preferred criteria
Permanent pool depth	Maximum depth: 3 m Mean depth: 1 m – 2 m	Maximum depth: 2.5 m Mean depth: 1 m – 2 m
Active storage depth	Max: 3 m Average: 1 to 2 m	Max: 2 m Average: 1 to 2 m
Side slopes	▪ 5:1 for 3 m on either side of the permanent pool ▪ Maximum 3:1 elsewhere	▪ 7:1 near normal water level plus use of 0.3 m steps ▪ 4:1 elsewhere
Emergency weir	1-100 years storm	
Freeboard	300 mm	450 mm
Inlet pipe	▪ Minimum 450 mm diameter ▪ Preferred pipe slope: >1% ▪ If submerges, obvert 150 mm below expected maximum ice depth	
Outlet pipe	▪ Minimum 450 mm diameter ▪ Reverse sloped pipe should have a minimum diameter of 150 mm ▪ Preferred pipe slope: >1% ▪ If an orifice plate control is used, 75 mm diameter minimum	Minimum 100 mm orifice diameter
Buffer	▪ Minimum 7.5 m above maximum water quality/erosion control water levels ▪ Minimum 3 m above high-water levels for quantity control	
Maintenance access ramp	Provided to approval of the Municipality	
*Adapted from MECP document "Stormwater Management Planning and Design Manual" Table 4.6		

5.7. Culverts

Culvert capacity is computed using PCSWMM modelling.

Riprap is required when the culvert outlet flow velocity is greater than what is shown in Table 11.

Table 11: Riprap and maximum flow velocity[1]

Nominal stone size (mm)	Maximum flow velocity (m/s)
100	2.0
200	2.6
300	3.0
400	3.5
500	4.0
800	4.7
1000	5.2

Where the maximum stone size is 1.5 times the nominal stone size and 80% of stones (by mass) must have a diameter of at least 60% of the nominal stone size.

Minimum culvert diameter shall be 450 mm for cleaning.

Minimum culvert cover shall be 500 mm.

Minimum spacing between culverts shall be as shown in Table 12.

Upstream and downstream inverts shall be 150 mm lower than channel waterbed.

Table 12: Minimum spacing between culverts

Culvert diameter	Minimum spacing between culverts (mm)
450 mm to 600 mm	450 mm
675 mm to 1800 mm	½ of pipe diameter
1950 mm to 3000 mm	900 mm

Flows and capacities of the culverts can be found in the addendum of the stormwater management report.

5.8. Swales and ditches

Swales should be constructed in areas where foundation soils are pervious. Refer to the project geotechnical report (Hatch, 2025) and the MECP document "Stormwater Management Planning and Design Manual."

From MTO document "Drainage Design Standards" - WC-3 Scour and Armouring – Section 3.3.1

Ditches within the site are lined to prevent infiltration. Flows and capacity are validated using PCSWMM and velocities are included in the addendum of the Stormwater management report.

5.9. Diversion watercourse and surface water features

Diversion watercourse and surface water features are evaluated using the 2-year return period (SCS Type 2) and 100-year return period (SCS type 2). The velocities and capacities for both rain events are included in the addendum of the Stormwater management report.

5.10. Pipe hydraulic capacity

Pipes are sized to a maximum of 80% of their hydraulic capacity with the computed peak flow.

Pipe capacity is calculated with the PCSWMM software. For more information about the modelling of the existing condition (pre-development) and the proposed stormwater management system, refer to the Stormwater Management Report (7154023-100000-41-ERA-0001).

Pipes are sized for flow velocity greater than 0.75 m/s and less than 3 m/s when at capacity.

Minimum slope is 0.3% and must comply with the permissible velocities mentioned above.

5.11. Oil-water separator or equivalent

Per Sewer Use Bylaw “Bylaw No. 2003-514” (City of Ottawa, 2004) and the Ontario Technical Guide to Renewable Energy Approval, the maximum allowable concentration of oil and grease is 15 mg/L. The use of a Petro-Pipe is used to prevent any oil from flowing out of the transformer basin. See section 6 of the stormwater management report for more details (7154023-100000-41-ERA-0001.

6. Fire protection distribution

There are no proposed buildings within the new development area. As such, the proposed development does not require any domestic water connection. However, for fire protection, an underground water tank with a capacity of 85,000 L (22,500 gallons) is proposed to be placed near the main access and connected to a series of fire hydrants throughout the site. The size of the water tank has been recommended by the fire service department of the City of Ottawa.

Following the assumption of a flow capacity of 1000GPM at 100PSI at the discharge of the fire truck pump, it was determined that the farthest hydrant would have 1000 GPM at 87.8 PSI. On this site, the water network has been designed to ensure the internal pressure would be withstanding. The HDPE DR11 can resist an internal pressure of 200 PSI. The materials and thrust restraint methods have proven sufficient for water lines with 200 mm diameter. A draft hydrant connected to the water tank was designed to be used by the fire truck in case of fire. The fire truck will connect the hose to this hydrant and then pump the water to the water network in the site. Each fire hydrant covers a circle with a 60 m radius, assuming 30 m for the hose length and a 30 m spray distance.

6.1. Pipe hydraulic capacity

Water pipe hydraulic capacity is calculated using Hazen-Williams equation:

$$v = 0{,}849\ C\ R_h^{0{,}63}\ S^{0{,}54}$$

Where:

v = Velocity (m/s)

C = Hazen-Williams coefficient

Rh = Hydraulic radius (m) = D/4

D = Pipe diameter (m)

S = Hydraulic gradient (m/m)

6.2. Head loss calculation

Minor head loss, mostly due to fittings, valves, accessories, etc., can be calculated using the following equation:

$$H = K\ \frac{v^2}{2g}$$

Where:

H = Head loss (m)

K = Loss coefficient (related to the fitting)

v = velocity (m/s)

g = gravitational acceleration = 9.81 m/s^2

Frictional energy loss is calculated using the Darcy-Weisbach equation:

$$H = f\,\frac{Lv^2}{d2g}$$

Where:

H = friction loss (m)

f = Darcy friction factor

L = pipe length (m)

v = velocity (m/s)

d = pipe diameter (m)

g = gravitational acceleration = 9.81 m/s^2

6.3. Fire hydrant

Remote hydrants shall be located throughout the BESS Site with the number and spacing determined so all equipment requiring fire protection can be reached by hoses from at least two hydrants.

The maximum radius for hydrants is 60 m. The minimum distance between the hydrant and BESS unit is 12 m.

Fire hydrants are connected to the water main with a 150 mm diameter pipe. Each fire hydrant shall be equipped with an isolation valve equipped with an indicating post. Restraint systems tees, elbows, caps, fire hydrants and any other accessories must be restrained with thrust blocks and/or restraint joints.

6.4. Restraint systems

Tees, elbows, caps, fire hydrants and any other accessories must be restrained with thrust blocks and/or restraint joints. Standard detail drawing of these systems can be found on drawing 7154023-100000-41-D50-0001.

Appendix A: IDF Curves

5.4.2 IDF Curves and Equations

An IDF (Intensity Duration Frequency) curve is a statistical description of the expected rainfall intensity for a given duration and storm frequency. In Ottawa, the IDF curve is derived from Meteorological Services of Canada (MSC) rainfall data taken from the Macdonald-Cartier airport. Rainfall collected from 1967 to 1997 was analyzed using the Gumbel Distribution. The following Table 5.1 shows the analysis results provided by MSC. The IDF equations have been derived on the basis of a regression equation of the form:

$$Intensity = \left[\frac{A}{(Td + C)^B} \right]$$

where:

Intensity = mm/hr

Td = time of duration (min)

A,B,C = regression constants for each return period

Table 5.1 Ottawa IDF Table: 1967 to 1997

Time (min)	2 year (mm/hr)	5 year (mm/hr)	10 year (mm/hr)	25 year (mm/hr)	50 year (mm/hr)	100 year (mm/hr)
5	102.80	140.20	165.00	196.00	219.00	242.60
10	77.10	104.40	122.50	145.30	162.20	179.00
15	63.30	85.60	100.40	119.10	133.00	146.80
30	39.90	53.90	63.10	74.70	83.40	91.90
60	24.20	32.00	37.10	43.60	48.50	53.20
120	14.30	18.90	22.00	25.80	28.70	31.50
360	6.20	8.40	9.90	11.70	13.10	14.50
720	3.60	4.80	5.60	6.60	7.30	8.00
1440	2.00	2.60	3.00	3.50	3.90	4.30

APPENDIX 5-A OTTAWA INTENSITY DURATION FREQUENCY (IDF) CURVE