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February 7, 2023

Brandy Lane Homes
4580 Dufferin Street, Suite 307
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Attention: David Hirsh
President and CEO

Re: Technical Memo for Detailed Channel Restoration Design
Wyldewood Creek
Town of Collingwood, Ontario
GEO Morphix Project No. PN21032

This memo provides recommendations for the detailed channel restoration design for the West Watercourse of Cranberry Marsh, associated with the Wyldewood Creek Development in the Town of Collingwood, Ontario. It is our understanding that a natural area block and corridor dimensions were defined as part of the Draft Plan for the development, the development fabric has been finalized, and the Conservation Authority has agreed with the corridor requirements. The proposed design will provide a hybrid approach consisting of hard engineering with geomorphological and ecological design elements.

The hybrid approach will provide ecological benefits to the system while also limiting future channel migration and minimizing potential erosion. The design will provide an open watercourse that is cognizant of existing constraints while offering habitat benefits and improvements to channel form and function. A cascade-pool system is proposed within a channel corridor that is lined with an engineered Redi-Rock (or equivalent) retaining wall, which will protect adjacent infrastructure from channel migration. In addition to the cascade-pool system, plantings will be provided along a vegetated terrace beside the channel banks to enhance the natural condition of the proposed feature.

In developing the design of these features, the following activities were completed:

- A review of relevant background materials, including surficial geology, topography, physiography, available watershed data, and previously completed studies for the subject site
- A review of hydraulic data to appropriately size channel features

This design memo is provided to facilitate review of the design, which outlines the existing conditions and design considerations, and provides technical details and recommendations for implementation and monitoring of the proposed design. The accompanying drawings, in **Appendix A**, provide design details and direction for implementation of the proposed designs and should be reviewed in conjunction with this technical design memo.

Existing Conditions

In this instance, the existing condition characterisations were completed by C.F. Crozier & Associates as part of the work completed for the Flood Study Report (2020). These observations have guided the design of the channel restoration proposed within this design memo. These observations are provided within **Section 4.2** of the Crozier (2020) report.

Channel Design

A stone core wetland feature and a cascade type channel system are proposed for the restoration design of a section of the West Watercourse of Cranberry Marsh. These features will discharge into the Cranberry Marsh, located at the downstream extent. The wetland stone core refers to hydraulically sized rounded stone, which is the subsurface material used to ensure wetland stability. Benefits of the proposed design include additional organic inputs, temperature regulation, polishing, energy dissipation, and dispersion of flows. Additionally, by retaining flows, the wetland can provide opportunities for infiltration, evapotranspiration, and detention.

The cascade treatment serves to reduce the potential for downcutting and undercutting of the proposed bed and bank treatments and along the proposed retaining wall. The cascades are proposed to be top-dressed with finer gravels. This will create a riffle pool like channel form within a vegetated and terraced floodplain floor. The series of cascades will reduce erosion along the channel banks by concentrating flow towards the centre of the channel and dissipating energy by creating turbulence.

Channel design dimensions are determined by bankfull discharge, as this represents what is generally referred to as the "*channel-forming discharge*" or the "*dominant discharge*". Several methods can be applied to select an appropriate bankfull discharge. Back calculation of discharge from a reference reach and support from hydrological modelling is usually the most appropriate.

Given the significant historical channel modifications, and anticipated hydrology changes likely to occur due to the proposed development, a discharge based on hydrologic modelling was determined. This discharge was then used to define the channel bankfull geometry. The bankfull discharge used to size the bankfull channel was assumed to be equivalent to the modelled 1.5-year flow return period post-development flow. The 1.25-year flow was estimated at approximately half of the 2-year flow of 0.88 m^3/s provided by C.F. Crozier & Associates Inc. (2022). As such, the bankfull discharge was defined as 0.44 m^3/s. Bankfull capacity for channels generally ranges from the 1- to 2-year return events.

A simple Manning's approach was used to iteratively back-calculate bankfull dimensions for the proposed design. Since pools are designed to contain ineffective space, this model over-predicts the amount of discharge they convey. The modelled values for the cascades better predicts the channel's capacity. Geometries and anticipated bankfull conditions for the proposed channel are provided in **Table 1.**

Table 1. Flow conditions of the proposed cascades and pools

Channel parameter	Cascade	Pool
Bankfull width (m)	2.10	2.10
Average bankfull depth (m)	0.26	0.38
Maximum bankfull depth (m)	0.30	0.50
Bankfull width-to-depth ratio	7.00	4.2
Channel gradient (%)	0.90	0.30
Manning's *n* roughness coefficient	0.0375	0.03
Mean bankfull velocity (m/s) *	0.88	0.78
Bankfull discharge (m^3/s) *	0.48	0.62
Tractive force at bankfull (N/m^2)	27	15
Stream power (W/m)	42	18
Unit stream power (W/m^2)	23	12
Froude Number (unitless)	0.56	0.40
Maximum grain size entrained (m) **	0.03	0.02
Mean grain size entrained (m) **	0.02	0.01

* Based on Manning's equation; as pools contain ineffective space, the velocity and discharge conveyed in them are not presented
** Based on Shields equation (Miller et al. (1977)), assuming Shields parameter equals 0.06 (gravel)

The cascade keystones were hydraulically sized to withstand the anticipated peak velocity of 2.94 m/s during the Regional storm event. Cascade keystones are proposed to consist of 450-500 mm diameter subrounded stones due to the anticipated flow conditions. Additional cascade substate is proposed to surround the keystones slope towards to cascade pools. This substrate is proposed to be 60% 50 mm – 100 mm diameter riverstone mixed with 40% granular 'B' and is expected to be stable under the predicted flow conditions during the peak velocity of 1.12 m/s during the 2-year event. This substrate is also proposed to make up the stone core within the wetland at the upstream extent of the site. Within the cascade pools, 60% 25 mm – 50 mm diameter riverstone mixed with 40% granular 'B' is proposed to provide a stable bed. The stone was hydraulically sized to withstand the anticipated peak velocity of 0.72 m/s during the 2-year storm event upstream of the proposed crossing. Granular 'b' consists of a mix of stone where approximately 20% - 50% of the stone is greater than 0.005 m in diameter, but nothing larger than 0.15 m in diameter.

The channel corridor outside of the proposed channel will be a vegetated terrace. The subsurface will be comprised of a layer of the above noted cascade and pool substrates mixed with 50% topsoil. A 150 mm layer of 50% topsoil and 50% compost will cover the substrate layers and will be seeded with the proposed native seed mix.

A range of techniques were utilized to determine the appropriate stone sizes, as summarized in the National Engineering Handbook (NRCS, 2007). These techniques are provided in **Table 2**.

All proposed stone and substrate for the treatments proposed were hydraulically sized to limit entrainment and stone sizes include a factor of safety to provide additional stability. All hydraulic sizing has been completed using anticipated flow conditions provided by C.F. Crozier & Associates Inc. The larger stone size provides increased stability, while allowing for storage and infiltration at lower flows. A layer of topsoil will be installed on top of the stone mix within the stone core wetland to improve vegetation establishment.

Table 2. Substrate sizes for cascades, pools, and stone core wetland, based on a range of techniques

Model	Formula	Velocity (m/s)	Stone Size* (mm)
Cascade Keystones			
Isbash Method (Isbash, 1936)	$D_{50} = (\frac{V_c}{C * \left(2 * g * \frac{\gamma_S - \gamma_w}{\gamma_w}\right)^{0.5}})^2$	2.94	433
USBR Method (Peterka, 1958)	$D_{50} = 0.0122 * V^{2.06}$	2.94	476
Maynord's Method (Maynord, 1988)	$D_{100} = C_s * C_v * C_T * d * [(\frac{\gamma_W}{\gamma_S - \gamma_W})^{0.5} * \frac{V}{\sqrt{K_1 * g * d}}]^{2.5}$	2.94	441
Cascade and Stone Core in Wetland			
Isbash Method (Isbash, 1936)	$D_{50} = (\frac{V_c}{C * \left(2 * g * \frac{\gamma_S - \gamma_w}{\gamma_w}\right)^{0.5}})^2$	1.12	63
USBR Method (Peterka, 1958)	$D_{50} = 0.0122 * V^{2.06}$	1.12	65
Maynord's Method (Maynord, 1988)	$D_{100} = C_s * C_v * C_T * d * [(\frac{\gamma_W}{\gamma_S - \gamma_W})^{0.5} * \frac{V}{\sqrt{K_1 * g * d}}]^{2.5}$	1.12	40
Cascade Pool			
Isbash Method (Isbash, 1936)	$D_{50} = (\frac{V_c}{C * \left(2 * g * \frac{\gamma_S - \gamma_w}{\gamma_w}\right)^{0.5}})^2$	0.72	26
USBR Method (Peterka, 1958)	$D_{50} = 0.0122 * V^{2.06}$	0.72	26
Maynord's Method (Maynord, 1988)	$D_{100} = C_s * C_v * C_T * d * [(\frac{\gamma_W}{\gamma_S - \gamma_W})^{0.5} * \frac{V}{\sqrt{K_1 * g * d}}]^{2.5}$	0.72	13

*Includes 20% factor of safety

The Isbash method (Isbash, 1936) was developed for the construction of dams by placing rock into moving water. This model predicts the median stone size (D_{50}; ft) under the given flow conditions, given by:

$$D_{50} = (\frac{V_c}{C*(2*g*\frac{\gamma_S-\gamma_W}{\gamma_W})^{0.5}})^2 \quad \text{[Eq.1]}$$

Where:

V_c = critical velocity (ft/s)
C = Isbash constant (dimensionless)
g = gravity (ft/s)
γ_s = stone density (lb/ft^3)
γ_w = water density (lb/ft^3)

The USBR Method (Peterka, 1958) was developed for sizing riprap below a stilling basin. This model predicts the median stone size (D_{50}; ft) under the given flow conditions, given by:

$$D_{50} = 0.0122 * V^{2.06} \quad \text{[Eq.2]}$$

Where:

V = average channel velocity (ft/s)

Maynord's Method (Maynord, 1988) was developed for sizing riprap in open channel flows. This model predicts the largest stone size (D_{100}; ft) under the given flow conditions, given by:

$$D_{100} = C_s * C_v * C_T * d * [(\frac{\gamma_W}{\gamma_S-\gamma_W})^{0.5} * \frac{V}{\sqrt{K_1*g*d}}]^{2.5} \quad \text{[Eq.3]}$$

Where:

d = water depth (ft)
C_s = stability coefficient
C_v = velocity distribution coefficient
C_T = thickness coefficient
γ_s = stone density (lb/ft^3)
γ_w = water density (lb/ft^3)
V = velocity (ft/s)
g = gravity (ft/s)
K_1 = side slope correction, calculated by:

$$K_1 = \sqrt{1 - \frac{sin^2\theta}{sin^2\emptyset}} \quad \text{[Eq.4]}$$

where:
θ= angle of rock from the horizontal
∅ = angle of repose (typically 40°)

The values used for each variable in the Isbash method, USBR method, and Maynord's method are provided in **Table 3.**

Table 3. Variables and values associated with hydraulic sizing of stone

Variable	Value*			
Isbash Method				
	Cascade Keystones	**Cascade**	**Cascade Pool**	**Under Crossing**
Critical velocity (V_c)	9.65	3.67	2.36	5.22
Isbash constant (C)	0.86	0.86	0.86	0.86
Gravity (g)	32.2	32.2	32.2	32.2
Stone density (γ_s)	164.43	164.43	164.43	164.43
Water density (γ_w)	62.43	62.43	62.43	62.43
USBR Method				
Velocity (V)	9.65	3.67	2.36	5.22
Maynord Method				
Water depth (d)	1.64	1.64	1.64	1.64
Stability coefficient (C_s)	0.375	0.375	0.375	0.375
Velocity distribution coefficient (C_v)	1	1	1	1
Thickness coefficient (C_T)	1.5	1.5	1.5	1.5
Stone density (γ_s)	164.43	164.43	164.43	164.43
Water density (γ_w)	62.43	62.43	62.43	62.43
Velocity (V)	9.65	3.67	2.36	5.22
Gravity (g)	32.2	32.2	32.2	32.2
Side slope correction (K_1)	1	1	1	1
θ	20	20	20	20
∅	40	40	40	40

*Note: Values used in modelling are in imperial units. Final values for stone size have been converted to SI units.

A landscape restoration plan is proposed along the channel to provide shading over the features. This planting plan will also reduce erosion by augmenting the stability of the banks as vegetation establishes. Live staking around the periphery will provide thermal mitigation through shading and will also provide a source of coarse organic matter. The incorporation of a native seed mix within the vegetated terrace will promote polishing of flows once the vegetation has established.

Proposed Crossing

There is a proposed road crossing over the realigned portion of the West Watercourse, at Street 'A'. Two concrete box culverts, at a length of 15 m, are proposed under the crossing to convey flows. The north box culvert is proposed to have an opening of 3 m wide and 2.1 m high and will be set at a lower elevation than the south culvert and will contain a low flow notch. The south box culvert is proposed to have an opening of 2.4 m wide and 1.8 m high and will be set at a higher elevation than the north culvert and will serve to convey flows during larger flow events. The dimensions for the cascades and pools are also applied to the low flow notch within the substrate in the north culvert, to provide seamless tie-in with the channel upstream and downstream of the crossing.

The proposed north culvert under Street 'A' has a span of 3 m and based on the proposed channel alignment through the culvert and given the maximum channel width for the low flow notch is 2.1 m, a shelf width of 0.45 m is provided on either side of the low flow within the culvert for wildlife passage. As the south culvert is only to be accessed by flows during larger flow events, the entire culvert will provide for wildlife passage during typical flow conditions.

To provide for a stable bed and a level of sorting, a mix of 70% 100 mm – 150 mm diameter riverstone and 30% granular 'b' is proposed throughout the culverts. The north culvert is proposed to have a minimum substrate depth of 300 mm under the bed of the low flow notch and the south culvert will have a stone lining 300 mm in depth. This stone was hydraulically sized to limit entrainment during the proposed post development Regional event, corresponding to a velocity of 1.59 m/s. A range of techniques were utilized to determine the appropriate stone size, as summarized in the National Engineering Handbook (NRCS, 2007). These techniques are provided in **Table 4**. A 20% factor of safety was provided. The larger stone sizing is expected to be stable under predicted flow conditions, particularly as vegetation will not establish under the structure.

Table 4: Substrate sizes for the channel under the future road crossings, based on a range of techniques

Model	Formula	Velocity (m/s)	Stone Size* (mm)
Isbash Method (Isbash, 1936)	$D_{50} = \left(\frac{V_c}{C * \left(2 * g * \frac{\gamma_S - \gamma_w}{\gamma_w}\right)^{0.5}}\right)^2$	1.59	127
USBR Method (Peterka, 1958)	$D_{50} = 0.0122 * V^{2.06}$	1.59	134
Maynord's Method (Maynord, 1988)	$D_{100} = C_s * C_v * C_T * d * \left[\left(\frac{\gamma_W}{\gamma_S - \gamma_w}\right)^{0.5} * \frac{V}{\sqrt{K_1 * g * d}}\right]^{2.5}$	1.59	95

*Includes 20% factor of safety

Natural Erosion Control

Newly constructed features can be vulnerable to erosion. This is particularly true before vegetation has been established along the channel banks. Low-flow events should not intensify erosion. The concern for erosion occurs when there are high flows or precipitation events during construction.

For immediate erosion protection, mechanical stabilization with biodegradable erosion control mats (e.g., coir cloth, jute mat, etc.) should be used. The mats will biodegrade over time, serving as a short-term stabilization measure.

For long-term stability, the implementation of a planting plan is recommended. This includes deep-rooting native grasses and other herbaceous species seeded along and within channel sections, prescription of flood-tolerant native shrub and tree species, and use of seed banks within the local soil.

Live staking and shrub stock should be used adjacent to the channel bank to provide immediate benefit and long-term infilling. If appropriate live staking methods are followed, this method should provide greater than simple potted or bare root shrub planting. This is because of the potential for higher densities with live staking.

Recommendations for Construction and Implementation

The design elements are unique and as such, the designer or representative should be part of construction supervision to ensure proper installation and function of the design elements. The designer should confirm materials are appropriate prior to installation. This will ensure the feature functions as intended. On-site supervision will ensure a rapid response to construction issues. The constructed feature should be deemed stable by the designer, prior to flow introduction.

All works should be isolated from the natural watercourse in order to mitigate potential impacts, such as sediment loading. The perimeter of the constructed feature should be stabilized using the prescribed combination of biodegradable erosion control blankets, live staking, and seed. If required, unwatering discharge should be pumped at least 30 m from the existing creek through a filter bag prior to release on the floodplain. The water should be dispersed through straw bales or Filtrexx® SiltSoxx™.

All materials and equipment will be stored and operated in such a manner that prevents any deleterious substances from entering the water. Vehicle and equipment refuelling and/or maintenance will be conducted away from the watercourse and be free of fluid leaks and externally cleaned/degreased to prevent the release of deleterious substances. Machinery should arrive on site in a clean condition (including free of mud/soil/dirt from other locations; including clean wheels/tires/tracks) and should be maintained free of fluid leaks. In order to reduce the spread of invasive species, equipment should be cleaned before being brought on-site and before leaving site. For guidance in this regard, please refer to the Clean Equipment Protocol for Industry available online: (https://www.ontarioinvasiveplants.ca/wp-content/uploads/2016/07/Clean-Equipment-Protocol_June2016_D3_WEB-1.pdf).

Recommendations for Monitoring

Monitoring of the channel will allow issues to be identified and addressed promptly. The features should be monitored for a period of three years after construction. Monitoring should include general observations, identification of any erosion issues, monumented photographs, and an annual survey of prescribed plant materials noting the survival. General observations should also be completed after construction and after the first large flooding event to identify any areas of potential erosion. In addition to observational monitoring, monumented cross sections along the restored section of channel shall be established. This includes installation and monitoring of erosion pins at each cross section and a photographic record of site conditions. We would install the monitoring sites immediately after construction and review sites annually in the spring and fall to identify natural variability of the system. Interim reporting would be provided annually, with a final summary report at the end of the last year. The cross sections should be monitored for a period of three years following construction completion.

We trust this memo meets your current requirements. Should you have any questions, please contact us.

Respectfully submitted,

PROFESSIONAL GEOSCIENTIST
PAUL V. VILLARD
PRACTISING MEMBER
0957
ONTARIO

Paul Villard Ph.D., P.Geo., CAN-CISEC, EP, CERP
Director, Principal Geomorphologist

Ben Miller, B.Sc., CAN-CISEC
River Scientist, Project Manager

References

C.F. Crozier & Associates Inc. 2020. Flood Study Report. Wyldewood Creek. Town of Collingwood. September 2020. CFCA File No. 1535-4897 / 1107-4134

Isbash, S.V. 1936. Construction of dams by depositing rock in running water. Transactions, Second Congress on Large Dams. Washington, D.C.

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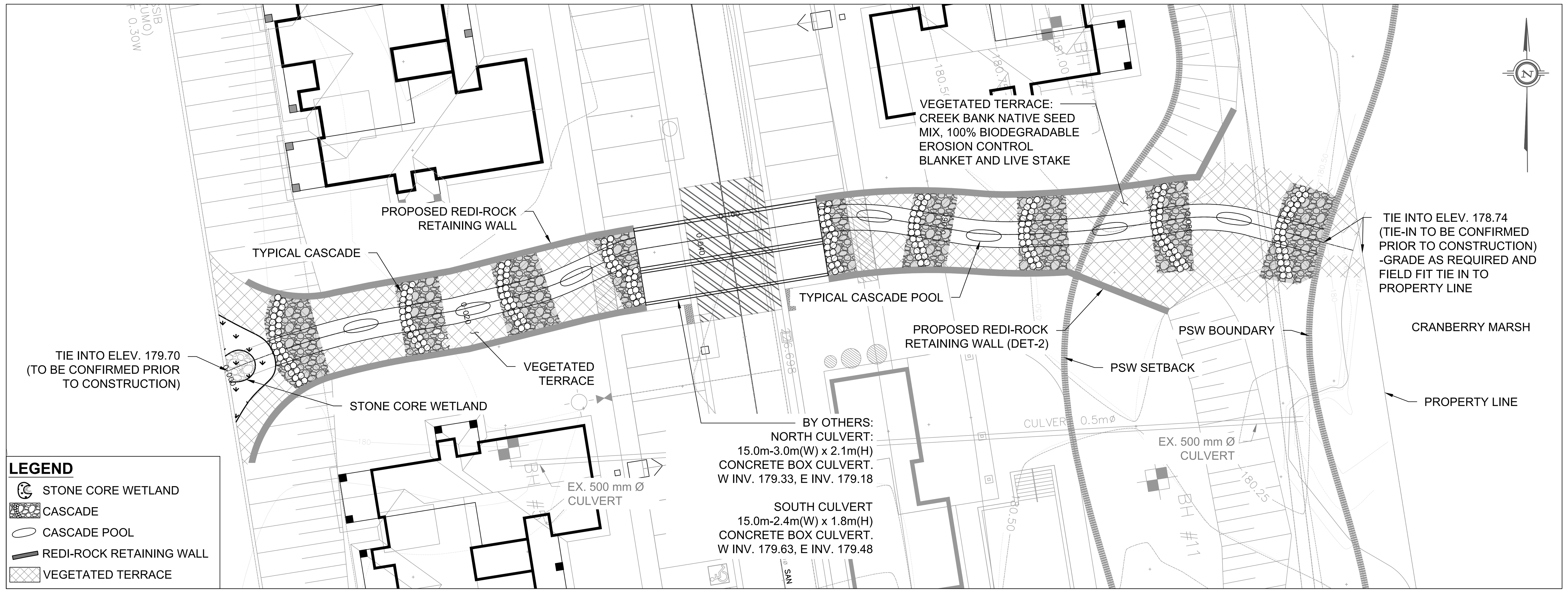
Appendix A
Design Drawings



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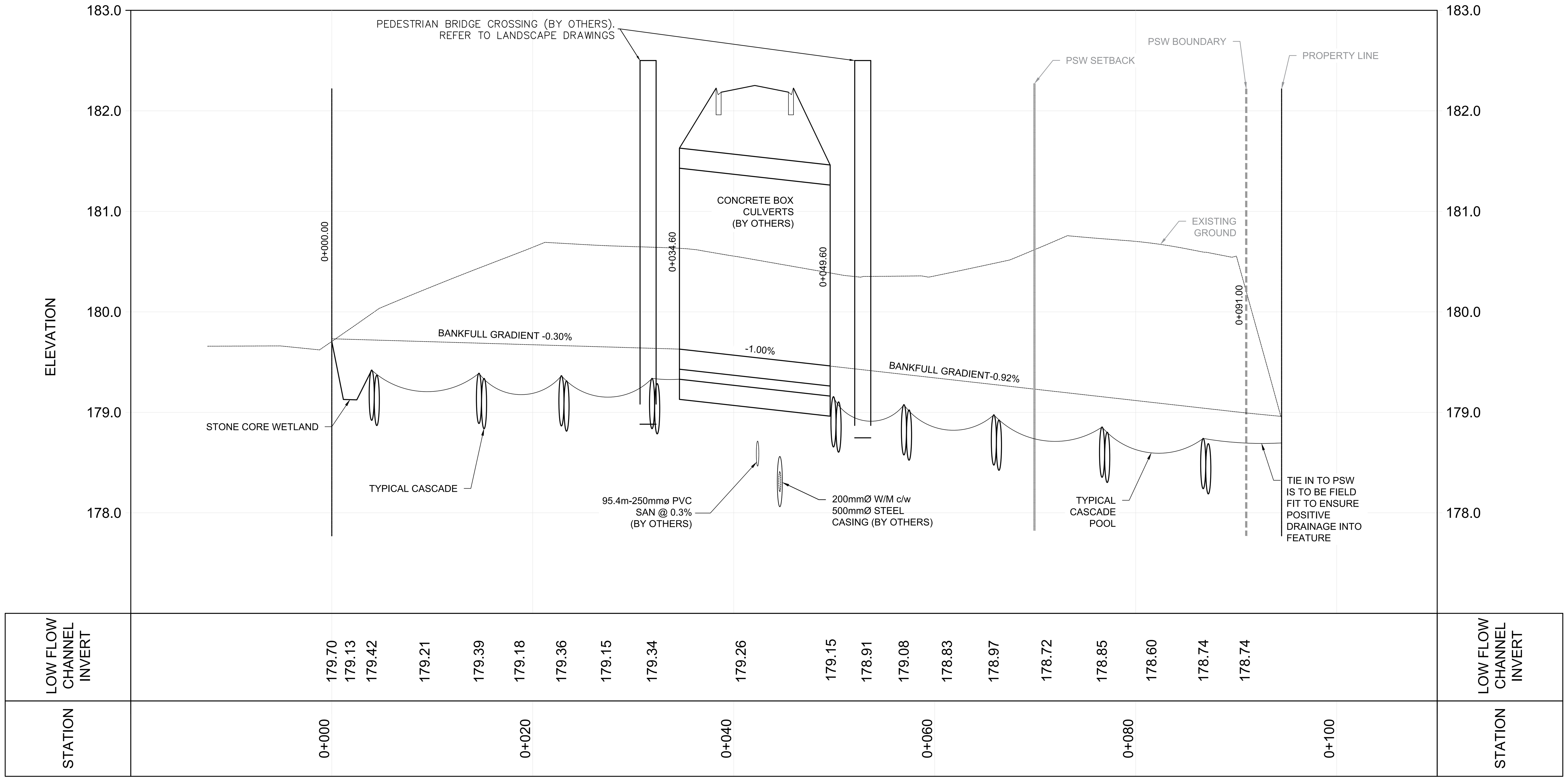

PROFILE
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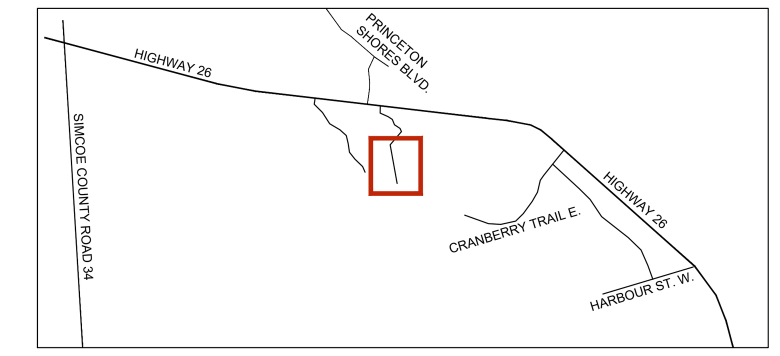
SCALED FOR PLOT ON 'ARCH D'



N
N.T.S.

KEY MAP
N.T.S.

GENERAL NOTES

1. ALL CONTRACT DRAWINGS, SPECIFICATIONS AND APPLICABLE PERMITS MUST BE KEPT ON SITE DURING CONSTRUCTION FOR REFERENCE.
2. THE CONTRACTOR MUST NOTIFY THE CONTRACT ADMINISTRATOR AND CONSERVATION AUTHORITY OF THE INTENT TO COMMENCE WORK AT LEAST 48 HOURS IN ADVANCE.
3. THE CONTRACTOR IS RESPONSIBLE FOR ALL UTILITY LOCATES.
4. LAYOUT MUST BE REVIEWED AND APPROVED BY THE CONTRACT ADMINISTRATOR.

TIMING OF WORKS

1. WORKS SHALL BE COMPLETED BETWEEN JULY 1ST TO MARCH 31ST.
2. TREE CLEARING SHOULD BE COMPLETED OUTSIDE THE BIRD NESTING SEASON TO COMPLY WITH THE FEDERAL MIGRATORY BIRDS CONVENTION ACT. ANY TREES THAT REQUIRE REMOVAL OUTSIDE OF THIS TIMING WINDOW MUST FIRST BE INSPECTED BY A QUALIFIED BIOLOGIST TO DETERMINE THE PRESENCE OF NESTING BIRDS.
3. THE WEATHER FORECAST SHOULD BE CONTINUALLY MONITORED TO ENSURE THAT WORKS ARE UNDERTAKEN ONLY DURING FAVOURABLE WEATHER CONDITIONS.
4. COMPLETE THE WORKS WITH MINIMAL AVOIDABLE INTERRUPTIONS ONCE THEY COMMENCE.

SITE AND MATERIAL MANAGEMENT

1. ALL CONSTRUCTION EQUIPMENT AND MATERIALS (IMPORTED OR EXCAVATED) MUST BE STORED AT LEAST 30 m AWAY FROM ANY WATERBODY IN A STABLE AREA ABOVE THE ACTIVE FLOODPLAIN, OR IN A DESIGNATED STAGING/STORAGE AREA.
2. IN THE EVENT OF AN UNEXPECTED STORM, ALL UNFIXED ITEMS THAT HAVE THE POTENTIAL TO CAUSE A SPILL OR AN OBSTRUCTION TO FLOW MUST BE MOVED A STABLE AREA ABOVE ACTIVE FLOODPLAIN.
3. STOCKPILES MUST BE LOCATED OUTSIDE THE ISOLATED WORK AREAS.
4. STABILIZE STOCKPILED SOILS THAT ARE STORED FOR PROLONGED PERIODS WITH THE APPLICATION OF A NURSE CROP AT A RATE OF 60 kg/ha.
5. STABILIZE, TEMPORARILY OR PERMANENTLY, ANY DISTURBED AREAS AS WORK PROGRESSES, OR SOON AS CONDITIONS ALLOW. ON SOILS THAT WILL BE EXPOSED FOR PROLONGED PERIODS, TEMPORARILY INSTALL A BIODEGRADABLE EROSION CONTROL BLANKET ON EXPOSED SOILS, OR APPLY A NURSE CROP AT A RATE OF 60 KG/HA.
6. MINIMIZE THE AREA OF DISTURBANCE TO THE EXTENT POSSIBLE.
7. ALL VEGETATION, ADJACENT TO THE WORK AREA, MUST BE PROTECTED AND DELINEATED WITH CONSTRUCTION FENCING OR TREE PROTECTION BARRIERS.
8. ALL GRADES IN THE AREA REGULATED BY THE CONSERVATION AUTHORITY MUST BE MAINTAINED OR MATCHED, UNLESS OTHERWISE AUTHORIZED IN THE APPLICABLE PERMIT.

EROSION AND SEDIMENT CONTROL

1. ALL TEMPORARY EROSION AND SEDIMENT CONTROL MEASURES MUST BE INSTALLED PRIOR TO START OF WORKS.
2. SEDIMENT CONTROLS MUST BE INSPECTED DAILY TO ENSURE THAT THEY ARE IN GOOD REPAIR AND FUNCTIONING AS INTENDED.
3. EROSION AND SEDIMENT CONTROLS MUST BE MAINTAINED DURING CONSTRUCTION, AND ANY REQUIRED REPAIRS OR REPLACEMENTS MUST BE COMPLETED WITHIN 24 HOURS AFTER THEY HAVE BEEN IDENTIFIED DURING THE MONITORING.
4. EROSION AND SEDIMENT CONTROLS MAY REQUIRE PERIODIC ADJUSTMENTS TO REFLECT CHANGING SITE CONDITIONS. THE CONTRACTOR WILL BE RESPONSIBLE FOR THESE ADJUSTMENTS TO ENSURE PROPER FUNCTION.
5. ANY CHANGES TO THE EROSION AND SEDIMENT CONTROL PLAN BEYOND MINOR ADJUSTMENTS MUST BE APPROVED BY THE CONTRACT ADMINISTRATOR.
6. ADDITIONAL EROSION AND SEDIMENT CONTROL SUPPLIES MUST BE KEPT ON SITE IN ORDER TO FACILITATE IMMEDIATE REPAIRS AND/OR UPGRADES AS NEEDED.
7. ALL TEMPORARY SEDIMENT CONTROLS MUST BE REMOVED AFTER THE CONTRACT ADMINISTRATOR DEEMS THE SITE TO BE STABLE.
8. ANY ADJUSTMENTS TO EROSION AND SEDIMENT CONTROLS MADE BY THE CONTRACTOR WILL BE DOCUMENTED IN WRITING.

DELETERIOUS SUBSTANCE CONTROL/SPILL MANAGEMENT

1. PREVENT THE RELEASE OF SEDIMENT, SEDIMENT-LADEN WATER, RAW CONCRETE, CONCRETE LEACHATE OR ANY OTHER DELETERIOUS SUBSTANCES INTO ANY WATERBODY, RAVINE OR STORM SEWER SYSTEM.
2. ENSURE EQUIPMENT AND MACHINERY ARE IN GOOD OPERATING CONDITION (POWER WASHED), FREE OF LEAKS, EXCESS OIL, AND GREASE.
3. NO EQUIPMENT REFUELLING OR SERVICING SHOULD BE UNDERTAKEN WITHIN 30 m OF ANY WATERCOURSE OR SURFACE WATER DRAINAGE.
4. A SPILL CONTAINMENT KIT MUST BE READILY ACCESSIBLE ON SITE IN THE EVENT OF A RELEASE OF A DELETERIOUS SUBSTANCE TO THE ENVIRONMENT. ONSITE STAFF MUST BE TRAINED IN ITS USE.
5. THE CONTRACT ADMINISTRATOR MUST BE NOTIFIED IMMEDIATELY IN THE EVENT OF A SPILL OF DELETERIOUS SUBSTANCE.

WORK AREA ISOLATION

1. ALL WORK IN ISOLATED WORK AREAS MUST BE COMPLETED IN THE DRY. AN ADEQUATE NUMBER OF PUMPS MUST BE USED FOR UNWATERING.
2. THE UNWATERING DISCHARGE LOCATION MUST BE LOCATED AT LEAST 30 M FROM ANY WATERCOURSE OR WETLAND IN AN AREA WITH DENSE VEGETATIVE GROUNDCOVER, AND WHERE THE DISCHARGE CAN RETURN TO THE WATERBODY DOWNSTREAM OF THE WORK AREA OVER THE GROUNDCOVER.
3. FISH MUST BE REMOVED FROM THE WORK AREA ONCE ISOLATED. FISH SALVAGE MUST BE COMPLETED BY A QUALIFIED TECHNICIAN WITH A LICENSE FROM THE ONTARIO MINISTRY OF NATURAL RESOURCES AND FORESTRY.

1.	2023-02-07	BWM	THIRD SUBMISSION
	DATE	BY	REVISIONS

DESIGNED BY: P.V.	CHECKED BY: P.V.
DRAWN BY: B.W.M.	DATE: FEBRUARY 2023

PROFESSIONAL GEOSCIENTIST
PAUL V. VILLARD
PRACTISING MEMBER
0957
ONTARIO
2023-02-07

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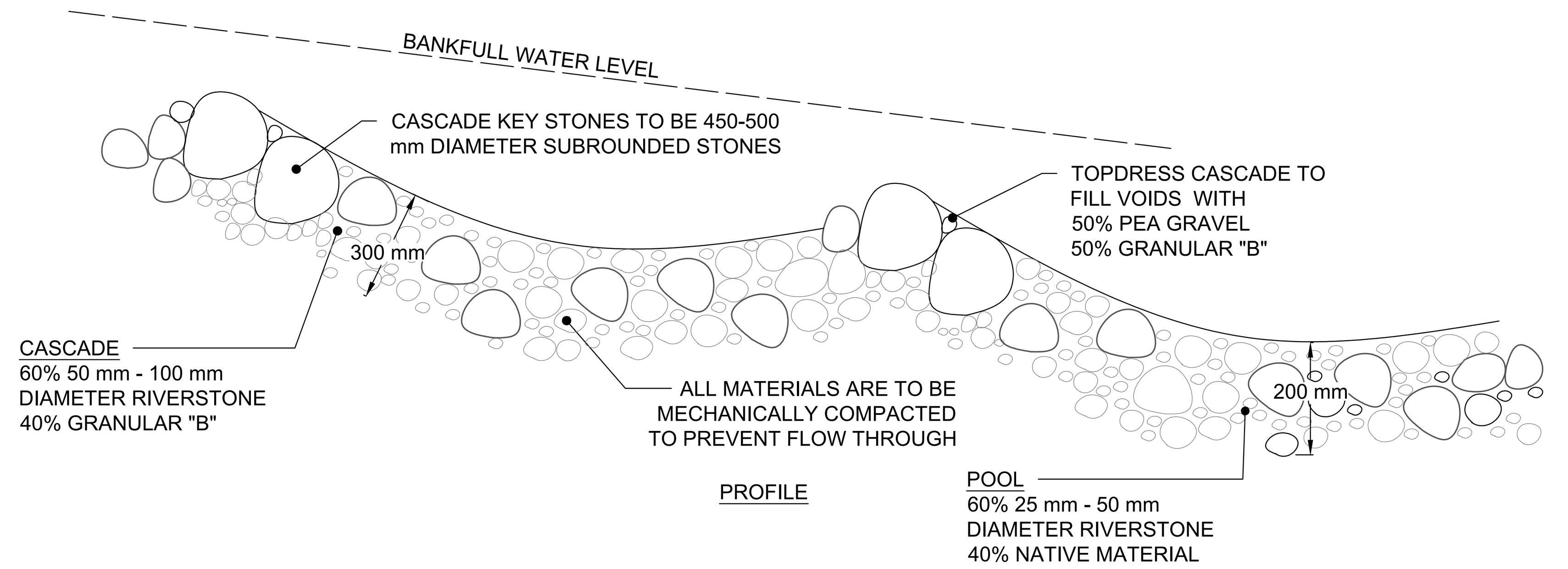
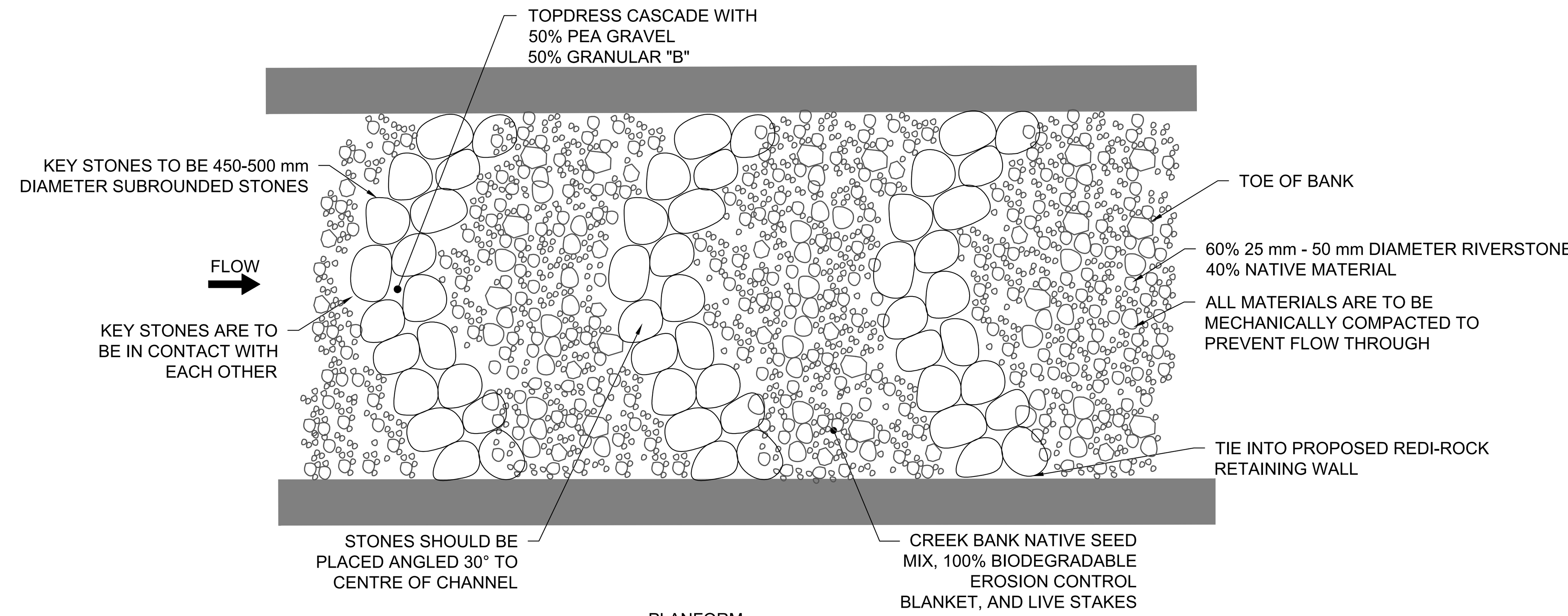
WYLDEWOOD CREEK
BRANDY LANE HOMES

CHANNEL RESTORATION DESIGN
PLANFORM AND PROFILE

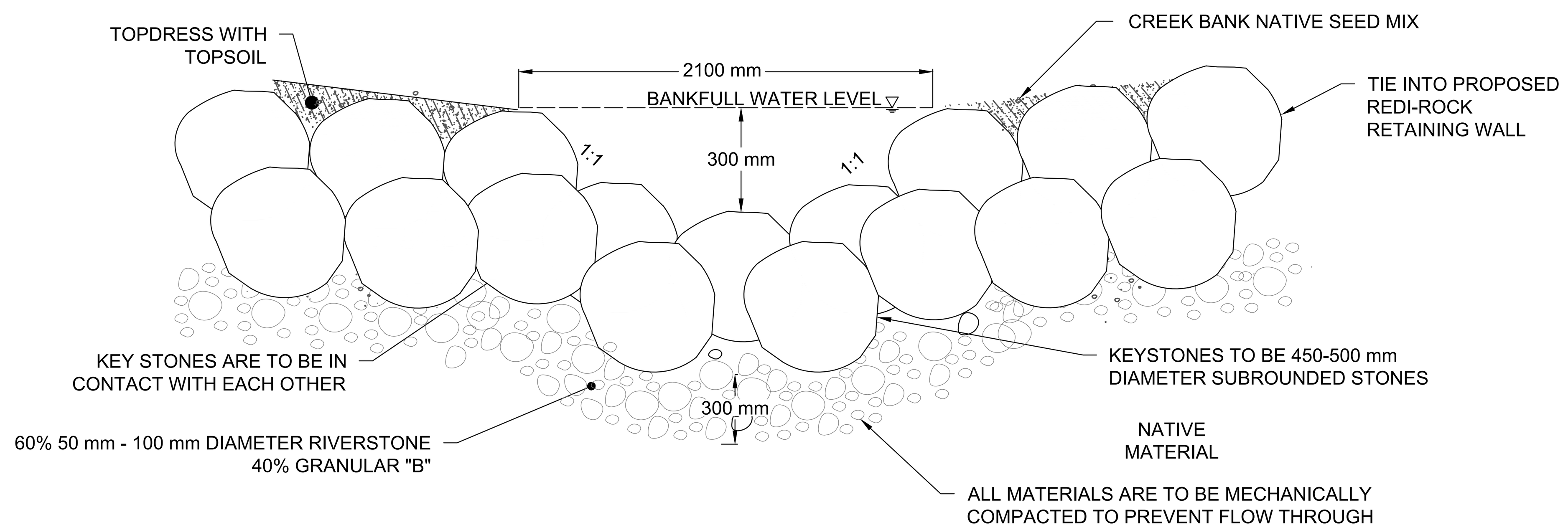
PROJECT No.: 21032	DRAWING No.: GEO-1
SCALE: AS NOTED	SHEET 1 OF 4



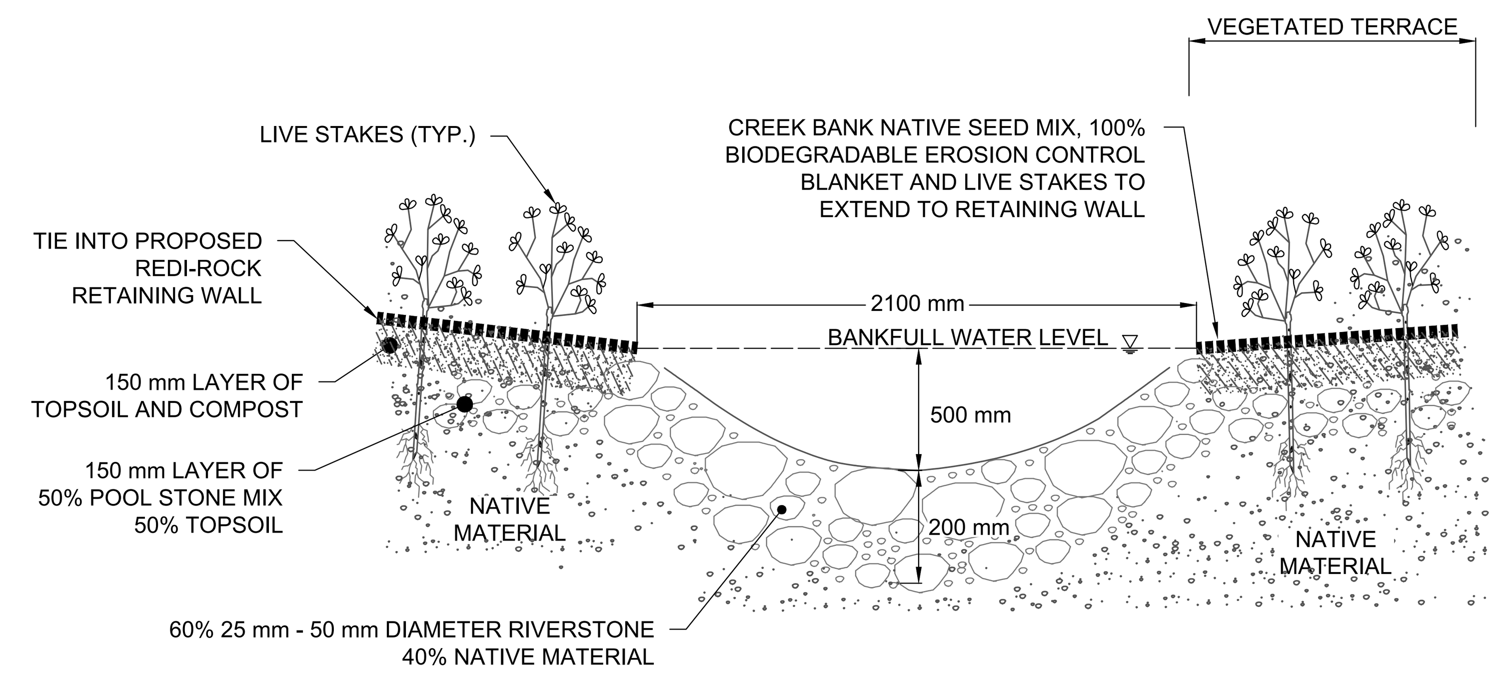
PROFILE



PLANFORM



CASCADE CROSS SECTION



POOL CROSS SECTION

TYPICAL CASCADE

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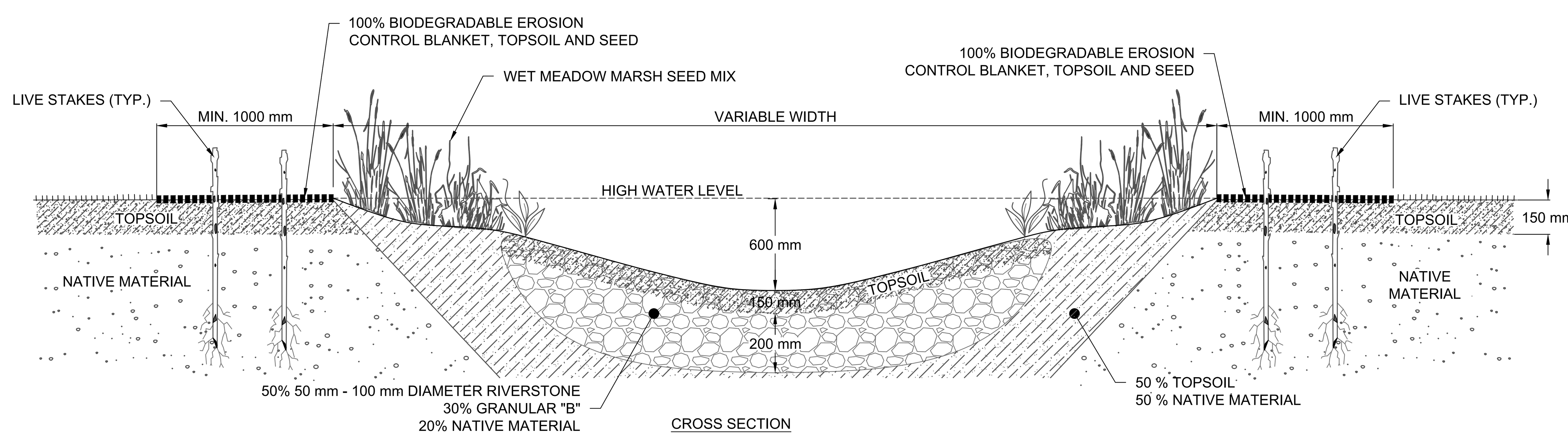
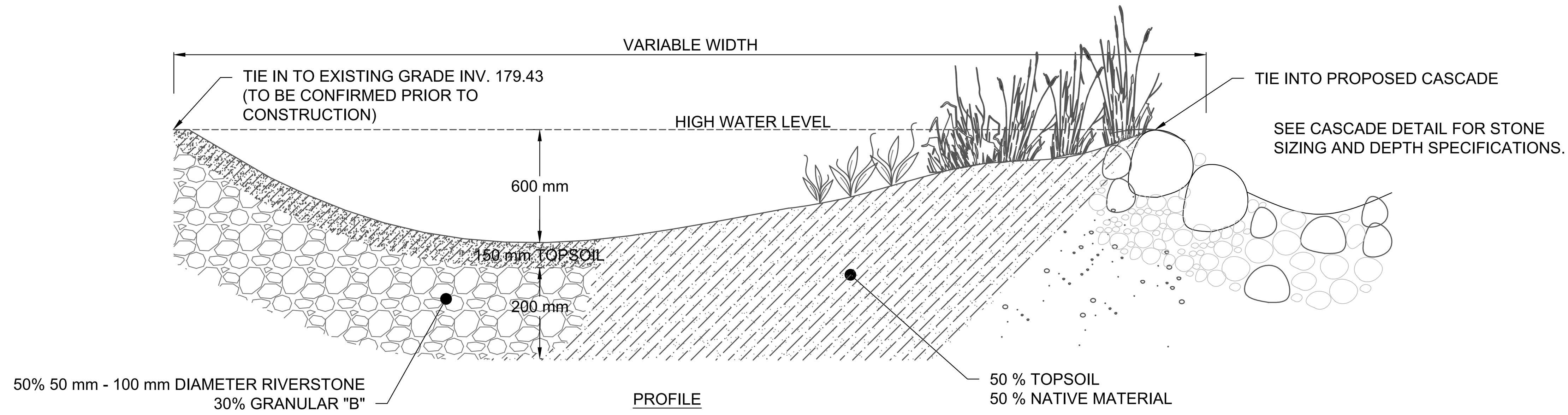


CROSS SECTION

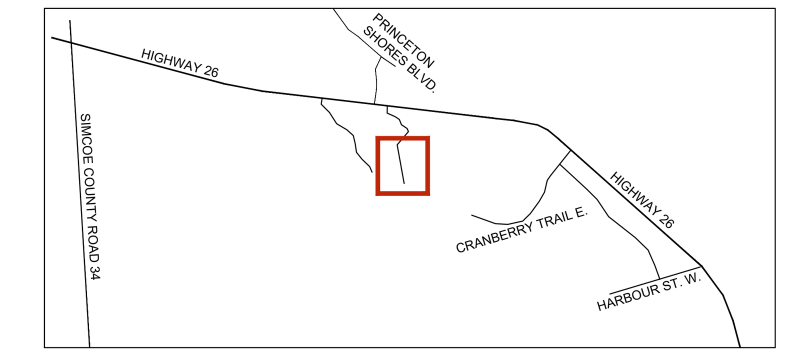


PROFILE

STONE CORE WETLAND

N.T.S

SCALED FOR PLOT ON 'ARCH D'



N.T.S.

KEY MAP

N.T.S.

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1.	2023-02-07	BWM	THIRD SUBMISSION
	DATE	BY	REVISIONS

DESIGNED BY: P.V.	CHECKED BY: P.V.
DRAWN BY: B.W.M.	DATE: FEBRUARY 2023

PROFESSIONAL GEOSCIENTIST
PAUL V. VILLARD
PRACTISING MEMBER
0957
ONTARIO
2023-02-07

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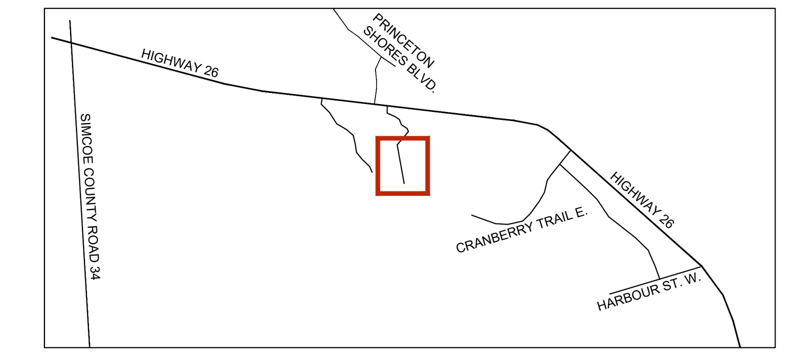
WYLDEWOOD CREEK
BRANDY LANE HOMES

CHANNEL RESTORATION DESIGN
RESTORATION DETAILS

PROJECT No.: 21032	DRAWING No.: DET-1
SCALE: AS NOTED	SHEET 2 OF 4



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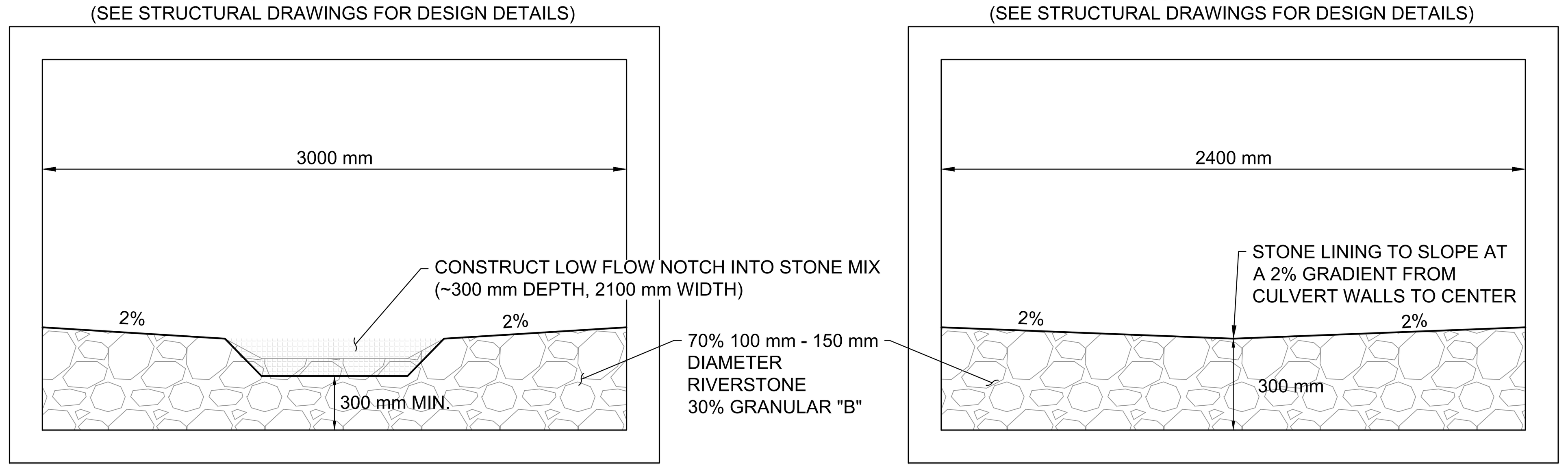
CHANNEL SUBSTRATE NOTES

1. SUBSTRATES TO BE COMPACTED TO 90% SPD TO PREVENT PIPING/FLOW-THROUGH.
2. FINE NATIVE MATERIAL TO BE ADDED TO SUBSTRATE MIX TO FILL INTERSTITIAL VOIDS, AS REQUIRED.
3. GRANULAR 'B' TO BE SOURCED FROM PIT-RUN MATERIAL AND ROUNDED IN NATURE. NO CRUSHED ROCK, LIMESTONE OR POST-CONSTRUCTION MATERIALS ARE TO BE USED WITHIN THE CHANNEL. MATERIAL TO BE REVIEWED BY THE DESIGNER OR REPRESENTATIVE PRIOR TO INSTALLATION.

NORTH BOX CULVERT
(SEE STRUCTURAL DRAWINGS FOR DESIGN DETAILS)

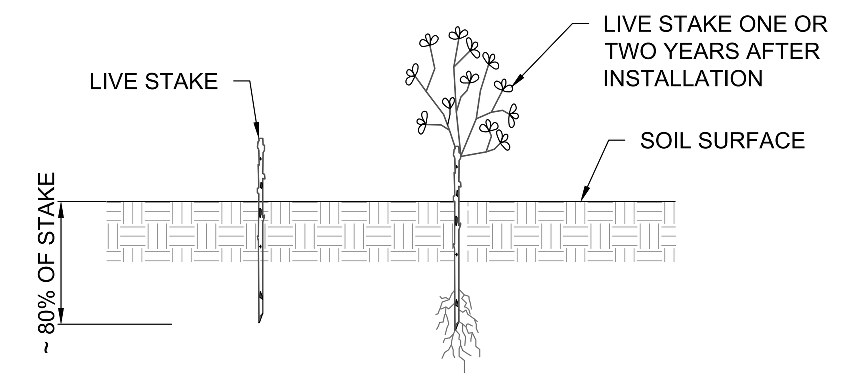
SOUTH BOX CULVERT
(SEE STRUCTURAL DRAWINGS FOR DESIGN DETAILS)



SUBSTRATE NOTE: ADD FINE NATIVE MATERIAL OR GRANULAR "B" TO FILL INTERSTITIAL SPACE, TOPDRESS AS NEEDED, AND COMPACT TO PREVENT PIPING. SUBSTRATE DEPTHS TO BE CONFIRMED.

CHANNEL CROSS SECTIONS IN CULVERT

N.T.S.



SPECIES AND QUANTITIES

COMMON NAME	SCIENTIFIC NAME	QTY	CONDITION
RED OSIER DOGWOOD	*Cornus stolonifera*	150	1 m, BARE ROOT
PUSSY WILLOW	*Salix discolor*	150	1 m, BARE ROOT
SANDBAR WILLOW	*Salix exigua*	150	1 m, BARE ROOT

NOTES

1. QUANTITY TO BE DETERMINED BASED ON AREA OF DISTURBANCE TO BE RESTORED
2. LIVE STAKES SHOULD BE FROM AT MINIMUM 2-YEAR OLD STOCK.
3. LIVE STAKES ARE TO BE INSTALLED AT A DENSITY OF 3 STAKES PER SQUARE METRE.
4. LIVE STAKES SHOULD BE PRE-SOAKED (SUBMERGED IN WATER) FOR AT LEAST 24 HOURS AFTER HARVESTING AND IMMEDIATELY BEFORE INSTALLATION.
5. LIVE STAKES SHOULD NOT BE STORED FOR A PERIOD LONGER THAN 2 DAYS, UNLESS THEY ARE BEING SOAKED.
6. THE CONTRACTOR SHALL PROTECT PLANT MATERIALS FROM DRYING FROM THE TIME OF HARVEST UNTIL INSTALLED.
7. LIVE STAKES ARE TO BE A MINIMUM OF 25 mm IN DIAMETER AND CUT TO A LENGTH OF 1000 mm.
8. CUT ANGLE AT THE BOTTOM OF THE STAKE AND FLAT ON THE TOP.
9. TRIM ALL SIDE BRANCHES WHILE TAKING CARE NOT TO DAMAGE THE BARK.
10. INSTALL STAKES WITH BUDS POINTING UPWARDS AND THICKER STEM IN THE BED.
11. LIVE STAKES SHOULD BE INSTALLED USING A LARGE RUBBER MALLET.
12. 80% OF THE STAKE IS TO BE BELOW SURFACE.
13. TAMP THE LIVE STAKE INTO THE GROUND AT RIGHT ANGLE TO THE SURFACE.
14. IN COMPACT SOIL A PILOT HOLE SHOULD BE USED TO LIMIT DAMAGE TO THE STAKES.
15. IF USING A PILOT HOLE REPACK SOIL AROUND THE LIVE STAKE.
16. LIVE STAKES SHOULD STAND FIRM FROM THE SOIL FOLLOWING INSTALLATION.
17. ALL STAKES NOT PLANTED TO THE SPECIFICATIONS ABOVE WILL BE REPLACED AT THE CONTRACTOR'S EXPENSE.

LIVE STAKE

N.T.S.

CREEK BANK NATIVE SEED MIX - OSC 8215

COMMON NAME	SPECIES
BIG BLUESTEM	*Andropogon gerardii*
NEW ENGLAND ASTER	*Aster novae-angliae*
FOX SEDGE	*Carex vulpinoidea*
BOTTLEBRUSH GRASS	*Elymus hystrix*
FOWL MANNGRASS	*Glyceria striata*
FOWL BLUEGRASS	*Poa palustris*
BLACK EYED SUSAN	*Rudbeckia hirta*

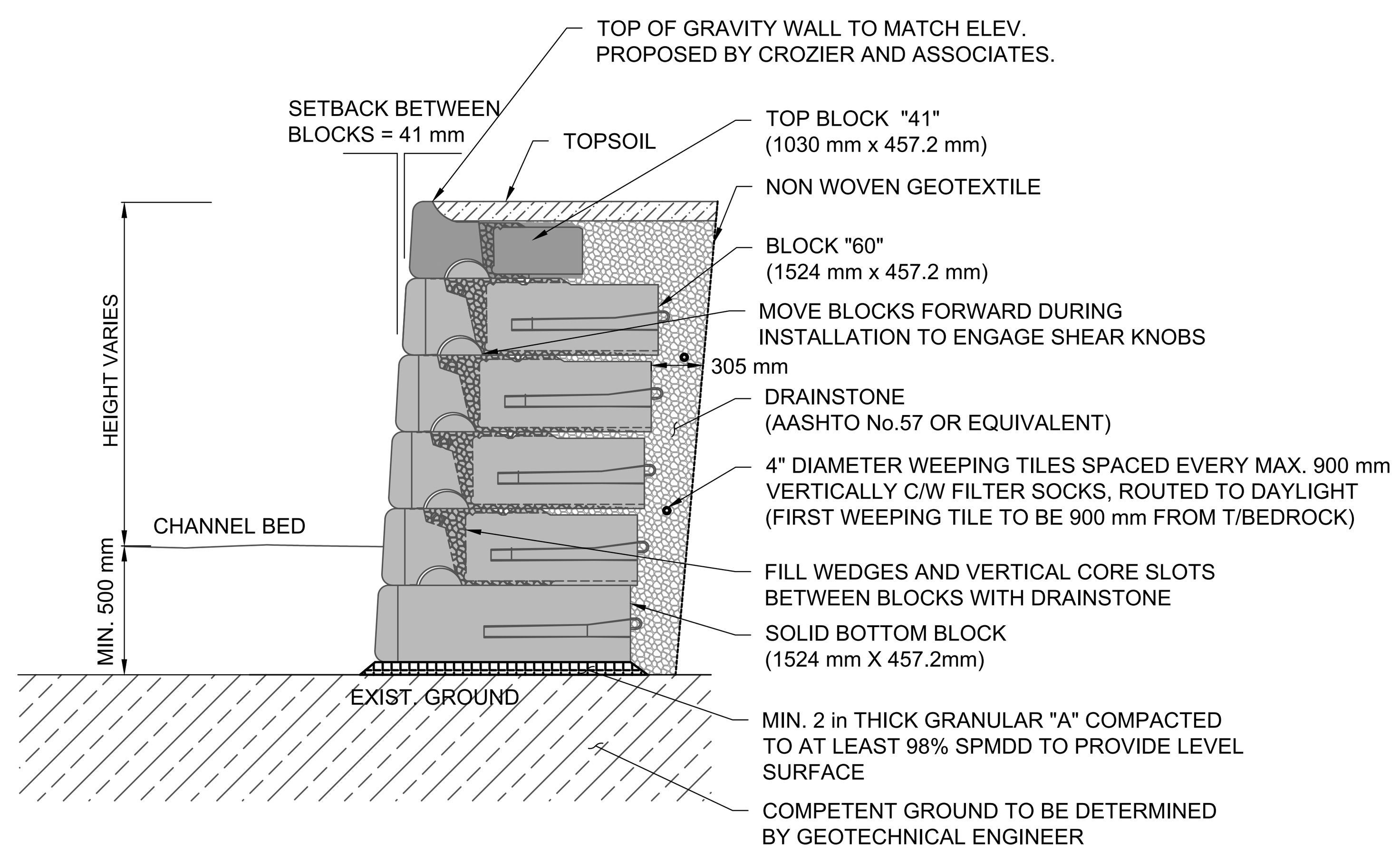
NOTES

1. SPECIES PERCENT OF MIX AS PER PRE-MIXED OSC SEED PACKET, OR EQUIVALENT.
2. APPLY SEED MIX AT A RATE OF 25 kg PER HECTARE.
3. SEEDING SHALL OVERLAP ADJACENT GROUND COVER BY 300 mm.
4. APPLY ANNUAL RYE GRASS / ANNUAL OATS NURSE CROP AT A RATE OF 30 kg PER HECTARE.

WET MEADOW MARSH SEED MIX - OSC 8195

COMMON NAME	SPECIES
SWAMP MILKWEED	*Asclepias incarnate*
NEW ENGLAND ASTER	*Aster novae-angliae*
FLAT TOPPED ASTER	*Aster umbellatus*
FRINGED SEDGE	*Carex crinita*
BLUNT BROOM SEDGE	*Carex scoparia*
FOX SEDGE	*Carex vulpinoidea*
VIRGINIA WILD RYE	*Elymus virginicus*
SPOTTED JOE PYE WEED	*Eupatorium maculatum*
SOFT RUSH	*Juncus effusus*
RICE CUTGRASS	*Leersia oryzoides*
SQUARE STEMMED MONKEY FLOWER	*Mimulus ringens*
GREEN BULLRUSH	*Scirpus atrovirens*
WOOLGRASS	*Scirpus syperinus*
BLUE VERVIAN	*Verbena hastata*

NOTE: SEED IS TO BE PLACED PRIOR TO INSTALLATION OF EROSION CONTROL BLANKET AND IS TO HAVE GOOD CONTACT WITH THE SOIL.



TYPICAL REDI-ROCK GRAVITY RETAINING WALL (OR EQUIVALENT)

N.T.S

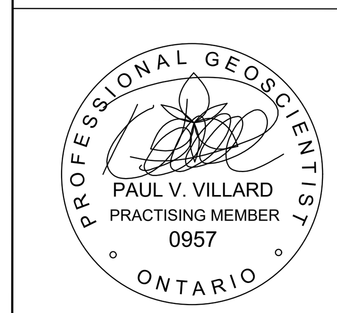
FINAL RETAINING WALL DESIGN SPECIFICATIONS TO BE CONFIRMED AND APPROVED BY ENGINEER.
NOTE: CONTRACTOR SHALL INSTALL WALL PER MANUFACTURER'S RECOMMENDATIONS AND WILL PROVIDE SHOP DRAWINGS.

EROSION CONTROL BLANKET SPECIFICATIONS

1. A BIODEGRADABLE EROSION CONTROL BLANKET (ECB) SHALL BE INSTALLED ON ALL DISTURBED NATURAL SURFACES FOLLOWING THE PLACEMENT OF TOPSOIL AND APPLICATION OF THE NATIVE SEED MIX.
2. THE ECB MUST BE CONSTRUCTED OF 100% WOVEN COCONUT FIBRE (E.G., COIR) OR STRAW MAT WITHIN A GEOJUTE NETTING (TOP AND BOTTOM) WITH BIODEGRADABLE THREAD. NON-BIODEGRADABLE MATERIAL INCLUDING POLYPROPELENE OR PLASTICS WITH A BIODEGRADABLE RATING ARE NOT ACCEPTABLE. THE MINIMUM WEIGHT OF THE ECB MUST BE 400 g/m^2 (12 $oz./yd^2$).
3. TO INSTALL, THE ECB MUST BE UNROLLED DOWNSLOPE OR IN DIRECTION OF WATER FLOW. ADJACENT ECBS SHOULD OVERLAP A MINIMUM OF 150 mm ALONG THE EDGES. AT THE END OF EACH ROLL, FOLD BACK 100 mm TO 200 mm OF THE ECB. OVERLAP THIS 100 mm TO 200 mm OVER THE START OF THE NEXT ROLL. SECURE THE TWO LAYERS TO THE GROUND SECURELY.
4. BIODEGRADABLE OR TAPERED WOODEN STAKES SHALL BE USED TO SECURE THE BLANKET. STAKES SHALL BE INSTALLED AT THE SPACING RECOMMENDED BY THE ECB MANUFACTURER TO PREVENT SURFACE RUNOFF FROM ERODING THE UNDERLYING SOIL.

	DATE	BY	REVISIONS
1.	2023-02-07	BWM	THIRD SUBMISSION

DESIGNED BY: P.V. | CHECKED BY: P.V.
DRAWN BY: B.W.M. | DATE: FEBRUARY 2023



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WYLDEWOOD CREEK
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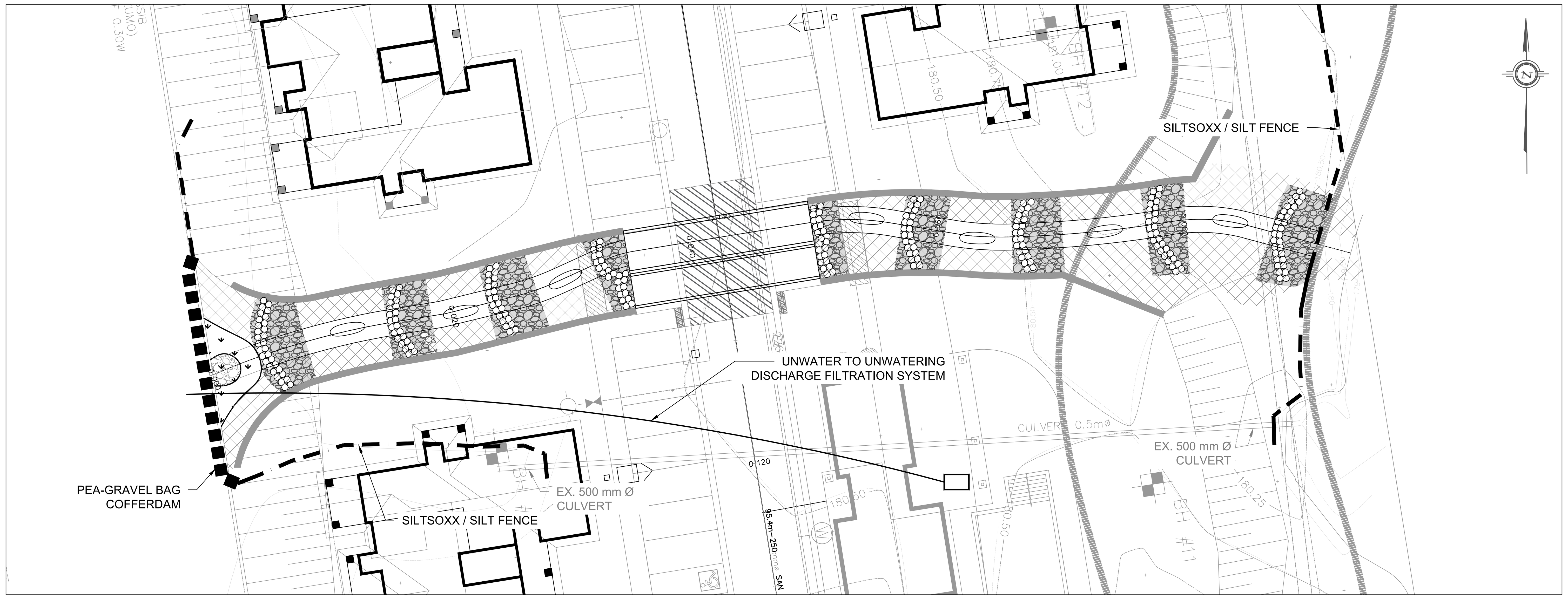
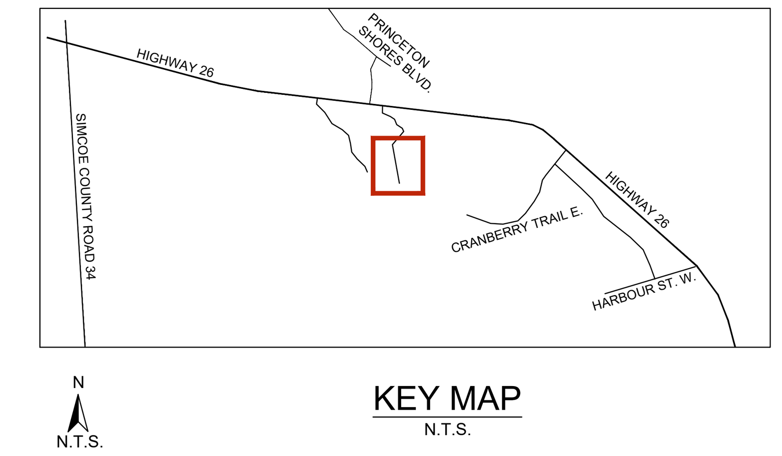
CHANNEL RESTORATION DESIGN
RESTORATION DETAILS

PROJECT No.: 21032 | DRAWING No.: DET-2
SCALE: AS NOTED | SHEET 3 OF 4

SCALED FOR PLOT ON 'ARCH D'





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3. EROSION AND SEDIMENT CONTROLS MUST BE MAINTAINED DURING CONSTRUCTION, AND ANY REQUIRED REPAIRS OR REPLACEMENTS MUST BE COMPLETED WITHIN 24 HOURS AFTER THEY HAVE BEEN IDENTIFIED DURING THE MONITORING.
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5. ANY CHANGES TO THE EROSION AND SEDIMENT CONTROL PLAN BEYOND MINOR ADJUSTMENTS MUST BE APPROVED BY THE CONTRACT ADMINISTRATOR.
6. ADDITIONAL EROSION AND SEDIMENT CONTROL SUPPLIES MUST BE KEPT ON SITE IN ORDER TO FACILITATE IMMEDIATE REPAIRS AND/OR UPGRADES AS NEEDED.
7. ALL TEMPORARY SEDIMENT CONTROLS MUST BE REMOVED AFTER THE CONTRACT ADMINISTRATOR DEEMS THE SITE TO BE STABLE.
8. ANY ADJUSTMENTS TO EROSION AND SEDIMENT CONTROLS MADE BY THE CONTRACTOR WILL BE DOCUMENTED IN WRITING.

DELETERIOUS SUBSTANCE CONTROL/SPILL MANAGEMENT

1. PREVENT THE RELEASE OF SEDIMENT, SEDIMENT-LADEN WATER, RAW CONCRETE, CONCRETE LEACHATE OR ANY OTHER DELETERIOUS SUBSTANCES INTO ANY WATERBODY, RAVINE OR STORM SEWER SYSTEM.
2. ENSURE EQUIPMENT AND MACHINERY ARE IN GOOD OPERATING CONDITION (POWER WASHED), FREE OF LEAKS, EXCESS OIL, AND GREASE.
3. NO EQUIPMENT REFUELLING OR SERVICING SHOULD BE UNDERTAKEN WITHIN 30 m OF ANY WATERCOURSE OR SURFACE WATER DRAINAGE.
4. A SPILL CONTAINMENT KIT MUST BE READILY ACCESSIBLE ON SITE IN THE EVENT OF A RELEASE OF A DELETERIOUS SUBSTANCE TO THE ENVIRONMENT. ONSITE STAFF MUST BE TRAINED IN ITS USE.
5. THE CONTRACT ADMINISTRATOR MUST BE NOTIFIED IMMEDIATELY IN THE EVENT OF A SPILL OF DELETERIOUS SUBSTANCE.

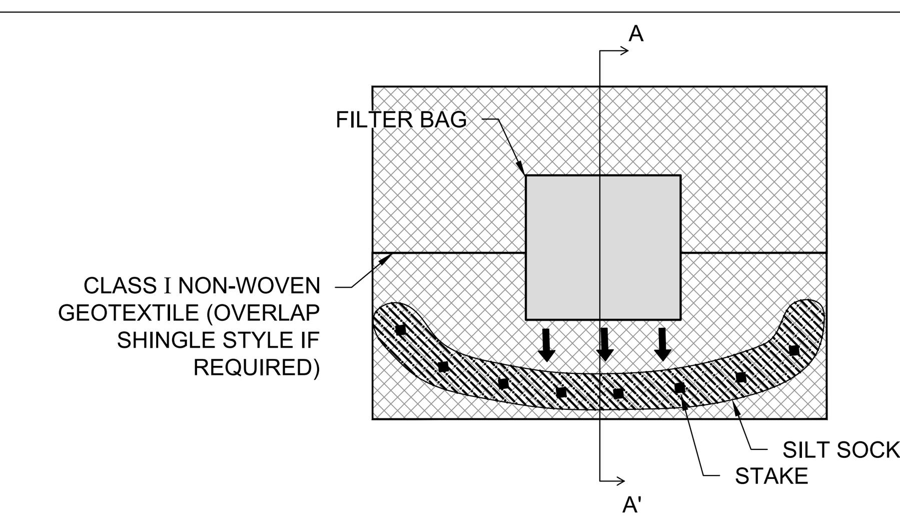
WORK AREA ISOLATION

1. ALL WORK IN ISOLATED WORK AREAS MUST BE COMPLETED IN THE DRY. AN ADEQUATE NUMBER OF PUMPS MUST BE USED FOR UNWATERING.
2. THE UNWATERING DISCHARGE LOCATION MUST BE LOCATED AT LEAST 30 M FROM ANY WATERCOURSE OR WETLAND IN AN AREA WITH DENSE VEGETATIVE GROUNDCOVER, AND WHERE THE DISCHARGE CAN RETURN TO THE WATERBODY DOWNSTREAM OF THE WORK AREA OVER THE GROUNDCOVER.
3. FISH MUST BE REMOVED FROM THE WORK AREA ONCE ISOLATED. FISH SALVAGE MUST BE COMPLETED BY A QUALIFIED TECHNICIAN WITH A LICENSE FROM THE ONTARIO MINISTRY OF NATURAL RESOURCES AND FORESTRY.

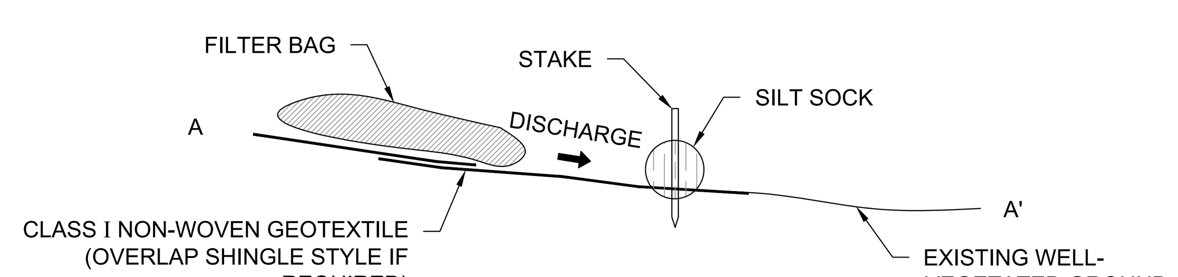
SUGGESTED SEQUENCE OF CONSTRUCTION

1. CONSTRUCTION CONTRACT ADMINISTRATOR TO REVIEW SITE CONDITIONS PRIOR TO COMMENCEMENT OF WORK.
2. MONITOR WEATHER TO ENSURE IN-WATER WORKS ARE COMPLETED UNDER LOW-FLOW CONDITIONS.
3. INSTALL PERIMETER CONTROL SILTSOXX / SILT FENCE AROUND WORK AREA (AS DEEMED NECESSARY BY THE CONTRACT ADMINISTRATOR, TO BE FIELD LOCATED AS REQUIRED).
4. INSTALL COFFERDAMS ENSURING COMPLETE ISOLATION OF WORK AREA (SEE PLAN).
5. IF REQUIRED, CONDUCT FISH AND AMPHIBIAN RESCUE FROM ISOLATED WORK AREAS. FISH RESCUE MUST BE COMPLETED BY A QUALIFIED TECHNICIAN WITH A LICENSE FROM THE ONTARIO MINISTRY OF NATURAL RESOURCES AND FORESTRY.
6. UNWATER WORK AREAS TO UNWATERING DISCHARGE FILTRATION SYSTEM AS REQUIRED TO CONDUCT WORK UNDER 'DRY' CONDITIONS.
7. INSTALL RETAINING WALLS.
8. INSTALL CASCADE AND POOLS.
9. INSTALL STONE CORE WETLAND.
10. INSTALL VEGETATED TERRACE AND ASSOCIATED SUBSTRATES.
11. STABILIZE CHANNEL CORRIDOR WITH SEED, BIODEGRADABLE EROSION CONTROL BLANKET, AND LIVESTAKES.
12. REMOVE COFFERDAMS AND INTRODUCE FLOWS TO THE CONSTRUCTED CHANNEL ONCE THE SITE HAS BEEN DEEMED STABLE BY THE DESIGNER.
13. ENSURE FLOWS ARE NOT ENTERING OLD CHANNEL. IF REQUIRED, CONDUCT FISH AND AMPHIBIAN RESCUE FROM ISOLATED EXISTING CHANNEL AREAS. FISH RESCUE MUST BE COMPLETED BY A QUALIFIED TECHNICIAN WITH A LICENSE FROM THE ONTARIO MINISTRY OF NATURAL RESOURCES AND FORESTRY. REMOVE EX. CULVERT AND FILL AS REQUIRED.
14. STABILIZE AREAS DISTURBED FROM CONSTRUCTION ACTIVITIES WITH SEED AND BIODEGRADABLE EROSION CONTROL BLANKET, AS REQUIRED.
15. RESTORE SURFACES DISTURBED BY THE CONSTRUCTION WORK OR STAGING AREA(S) TO ORIGINAL CONDITION.

NOTE: STEPS 7-10 CAN COINCIDE DURING CONSTRUCTION



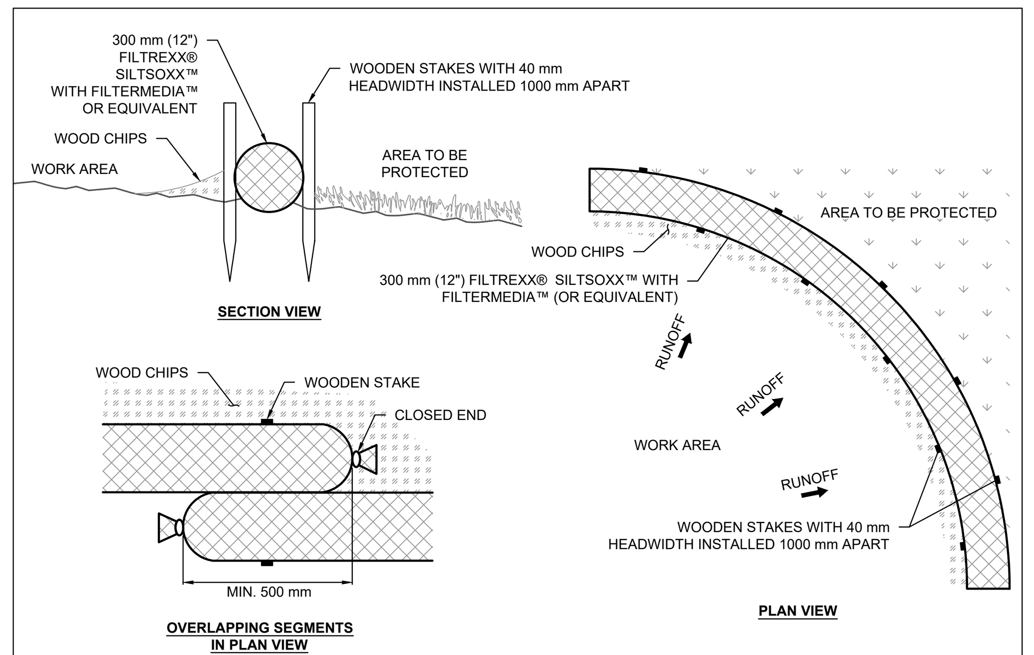
PLAN VIEW



CROSS SECTION A - A'

NOTES
1. SELECT LOCATION OF FILTRATION SYSTEM TO ENSURE PLACEMENT ON WELL-VEGETATED SURFACE AT LEAST 30 m FROM CHANNEL.
2. PLACE NON-WOVEN GEOTEXTILE ON WELL-VEGETATED SURFACE. OVERLAP NON-WOVEN GEOTEXTILE SHINGLE STYLE, IF REQUIRED.
3. SECURE SILT SOCK WITH STAKES AT 0.5 m O/C.
4. ENSURE CONTINUOUS AND FIRM CONTACT BETWEEN SILT SOCK AND NON-WOVEN GEOTEXTILE/GROUND.
5. REPLACE FILTER BAG AS REQUIRED TO ENSURE PROPER FUNCTION.

UNWATERING DISCHARGE FILTRATION SYSTEM
N.T.S.



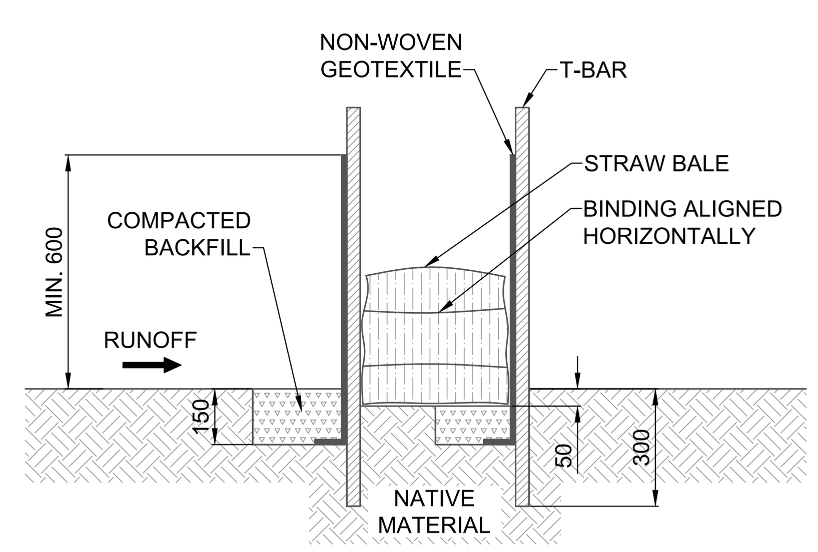
INSTALLATION NOTES

1. PERIMETER CONTROL WILL BE PLACED AT LOCATIONS INDICATED ON PLANS AND IN A MANNER AS DIRECTED BY THE ENGINEER OR MANUFACTURER.
2. PERIMETER CONTROL SHOULD BE INSTALLED PARALLEL TO THE BASE OF THE SLOPE OR OTHER DISTURBED AREA. IN CHALLENGING CONDITIONS (E.G., 2:1 SLOPES), A SECOND PERIMETER CONTROL SHALL BE CONSTRUCTED AT THE TOP OF THE SLOPE, OR STAKING MAY BE INCREASED.
3. EFFECTIVE SOXX HEIGHT IN THE FIELD SHOULD BE 12" DIAMETER SOXX (APPROXIMATELY 9" HIGH).
4. STAKES SHOULD BE INSTALLED ALTERNATELY AROUND THE PERIMETER CONTROL AT 1 m INTERVALS, USING 1 m WOODEN STAKES WITH 40 mm HEADWIDTH.
5. STAKING DEPTH FOR SAND AND SILT LOAM SOILS SHALL BE 300 mm AND 200 mm FOR CLAY SOILS.
6. STRAIGHTEN OR POSITION THE SOXX AS NEEDED ON THE GROUND, ENSURING THERE IS GOOD GROUND CONTACT AND NO VOID SPACES UNDER THE SOXX
7. DO NOT DRAG SOXX ACROSS ROUGH SURFACES TO PREVENT TEARING.
8. LOOSE WOOD CHIP MAY BE BACKFILLED ALONG THE UPSLOPE SIDE OF THE PERIMETER CONTROL, FILLING THE SEAM BETWEEN THE SOIL SURFACE AND THE DEVICE, IMPROVING FILTRATION AND SEDIMENT RETENTION.
9. IF THE PERIMETER CONTROL IS TO BE LEFT AS A PERMANENT FILTER OR PART OF THE NATURAL LANDSCAPE, IT MAY BE SEEDED AT TIME OF INSTALLATION FOR ESTABLISHMENT OF PERMANENT VEGETATION.

MAINTENANCE AND DISPOSAL NOTES

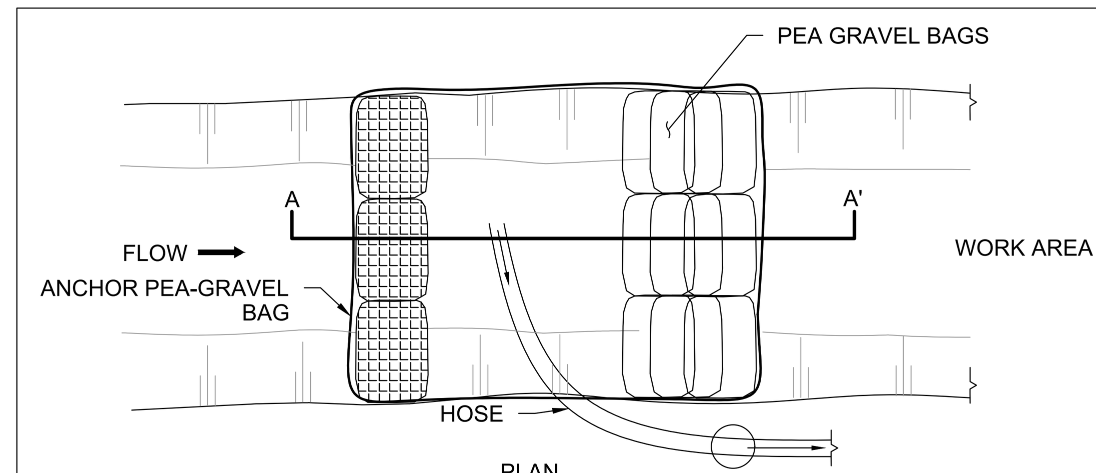
1. THE CONTRACTOR SHALL REMOVE SEDIMENT AT THE BASE OF THE UPSLOPE SIDE OF THE PERIMETER WHEN ACCUMULATION HAS REACHED HALF OF THE EFFECTIVE HEIGHT OF THE SOCK, OR AS DIRECTED BY THE ENGINEER. ALTERNATIVELY, A NEW PERIMETER CONTROL SOCK CAN BE PLACED ON TOP OF AND SLIGHTLY BEHIND THE ORIGINAL ONE CREATING MORE SEDIMENT STORAGE CAPACITY WITHOUT SOIL DISTURBANCE.
2. PERIMETER CONTROL SHALL BE MAINTAINED UNTIL DISTURBED AREAS HAVE BEEN PERMANENTLY STABILIZED AND CONSTRUCTION ACTIVITY HAS CEASED.
3. THE FILTERMEDIA (WOOD CHIP) WILL BE DISPERSED ON SITE ONCE DISTURBED AREA HAS BEEN PERMANENTLY STABILIZED, CONSTRUCTION ACTIVITY HAS CEASED, OR AS DETERMINED BY THE ENGINEER.

FILTREXX® SILTSOXX™ (OR EQUIVALENT)
N.T.S.

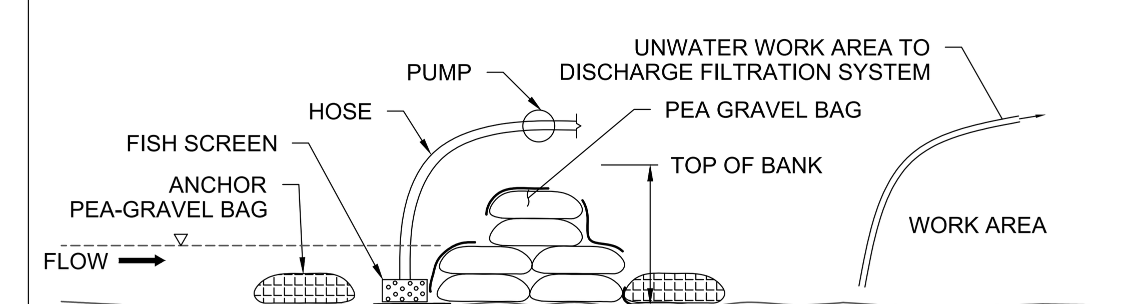


NOTE: MAX. 2 m T-BAR SPACING

STRAW BALE REINFORCED DOUBLE SILT FENCE
N.T.S.



PLAN



SECTION A - A'

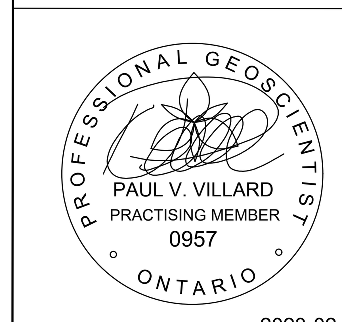
NOTES
1. PUMPING RATE MUST MATCH WORKING FLOW CONDITIONS.
2. BAGS TO BE FILLED WITH PEA-GRAVEL.
3. BAGS TO BE INSTALLED TO MATCH EXISTING TOP OF BANK.
4. IMPERMEABLE BARRIER (PLASTIC SHEET) TO COVER THE BAGS TO LIMIT SEEPAGE INTO WORK AREA.
5. BACKUP PUMP AND HOSE SHALL BE KEPT ONSITE TO ADDRESS FAILURES AND HIGH FLOW CONDITIONS.
6. PEA-GRAVEL WITHIN BAGS TO BE DISPOSED OF OFFSITE ONCE CONSTRUCTION IS COMPLETE.

PEA-GRAVEL BAG COFFERDAM AND BYPASS PUMPING
N.T.S.

1.	2023-02-07	BWM	THIRD SUBMISSION
	DATE	BY	REVISIONS

DESIGNED BY: P.V. | CHECKED BY: P.V.

DRAWN BY: B.W.M. | DATE: FEBRUARY 2023



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WYLDEWOOD CREEK
BRANDY LANE HOMES

CHANNEL RESTORATION DESIGN
RESTORATION DETAILS

SCALED FOR PLOT ON 'ARCH D'

PROJECT No.: 21032 | DRAWING No.: PESC

SCALE: AS NOTED | SHEET 4 OF 4