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SWM Shield™ Performance Assessment and Evaluation

March 26, 2025

AGENDA

01 Project Scope & Objectives

02 SWM Shield™ Details

03 Project Background

04 Site Overview & Characteristics

05 Study Design & Methodology

06 Results

07 Conclusions & Discussion

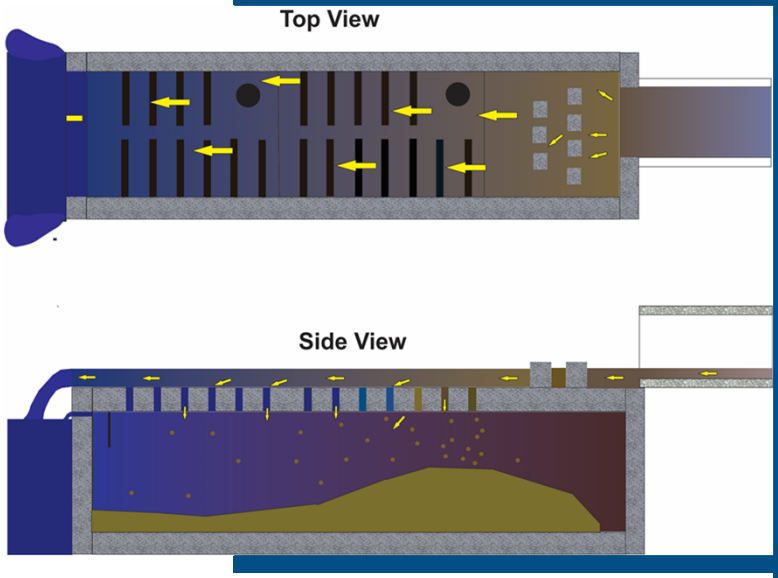
08 Questions

1. Project Scope & Objectives

- Post-construction evaluation and assessment of four (4) SWM Shield at four (4) separate sites:

    1. Villa Park SWMF (City of Vaughan)
    2. Harmonia SWMF (City of Vaughan)
    3. Heart Lake SWMF (Region of Peel, in the City of Brampton)
    4. Kennedy SWMF (Region of Peel, in the City of Brampton)

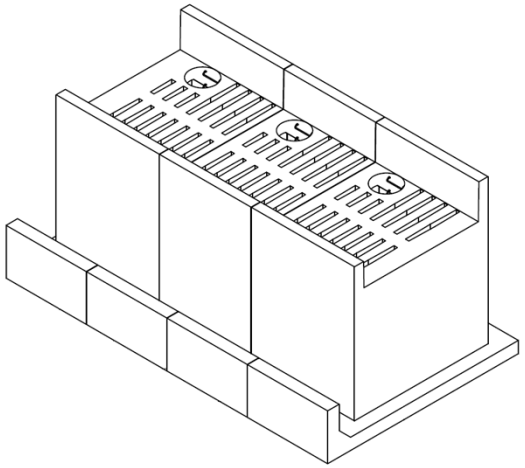
- The primary goal of the SWM Shield assessment was to provide municipalities and the industry with comprehensive data on the:
    - Annual sediment loading,
    - Sediment characteristics,
    - Phosphorus removal, and
    - Total sediment capture capabilities of SWM Shield



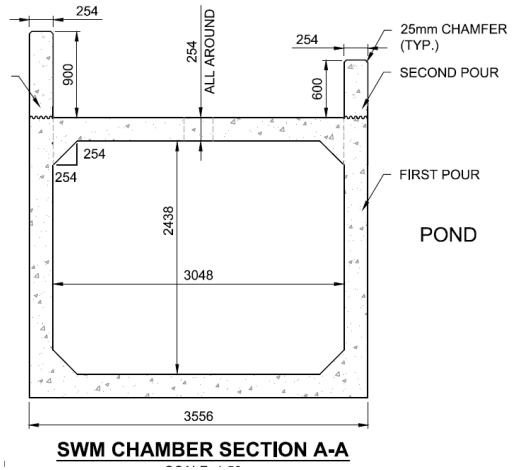
Conceptual SWM Shield™ Installation at the Forebay Inlet

2. SWM Shield Details

- Constructed from standard concrete box culvert units
- Special grated top slots cast into pre-cast box
- Runoff from the pond inlet is directed over the grates
- The top of grate is typically a little above the permanent water level in the pond



Isometric View of the SWM Shield



SWM Shield Details

SWM Shield During Construction

3. Project Background

- **Adopted Methodology:**
  Based on University of Toronto's *CB Shield Testing Report*.

- **Findings from University of Toronto Study:**
  - Enhanced sediment retention and reduced pollutant discharge.
  - Recommendations for maintenance and scalability for municipal applications.

University of Toronto's CB Shield Testing Report

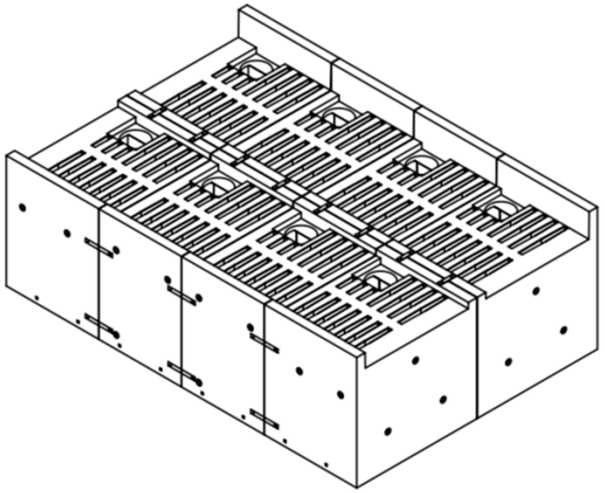
4. Site Overview and Key Characteristics

Site Name	Location (Owner)	Year of Construction	Drainage Area (ha)	Imperviousness	Number of SWM Shield™ units at the site	SWM Shield™ Configuration	Proposed Maintenance Cycle (years)	Est. TSS Capture Rate *
Villa Park SWMF	City of Vaughan (Vaughan)	2023	29.0	53%	8	Parallel (2 rows of 4 units)	6	58%
Harmonia SWMF	City of Vaughan (Vaughan)	2023	11.2	50%	3	In-series	6	57%
Heart Lake SWMF	City of Brampton (Region of Peel)	2018	10.2	45%	3	In-series	5.7	55%
Kennedy SWMF	City of Brampton (Region of Peel)	2018	9.0	58%	3	In-series	4	55%

Unique Features:
Kennedy: Submerged condition.
Heart Lake: 10-meter riprap lined/ vegetated channel to inlet.

4.1. Villa Park SWMF (City of Vaughan)

Aerial Image of Villa Park SWMF Pond, Vaughan



Isometric View of the SWM Shield, Villa Park, Vaughan

Existing Conditions, Villa Park SWMF, Vaughan

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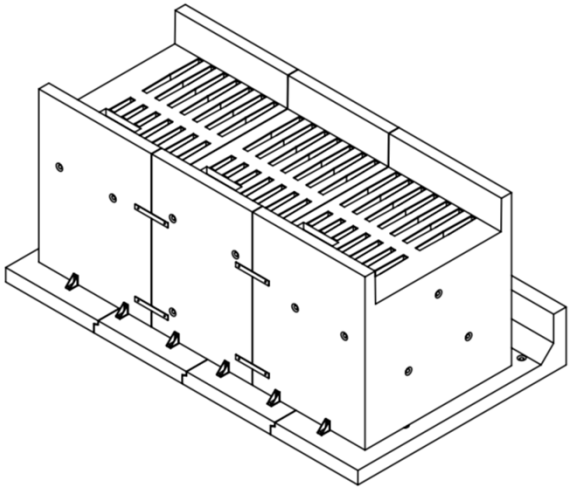
4.2. Harmonia SWMF (City of Vaughan)

Aerial Image of Harmonia SWMF Pond, Vaughan



Isometric View of the SWM Shield, Harmonia, Vaughan

Existing Conditions, Harmonia SWMF, Vaughan

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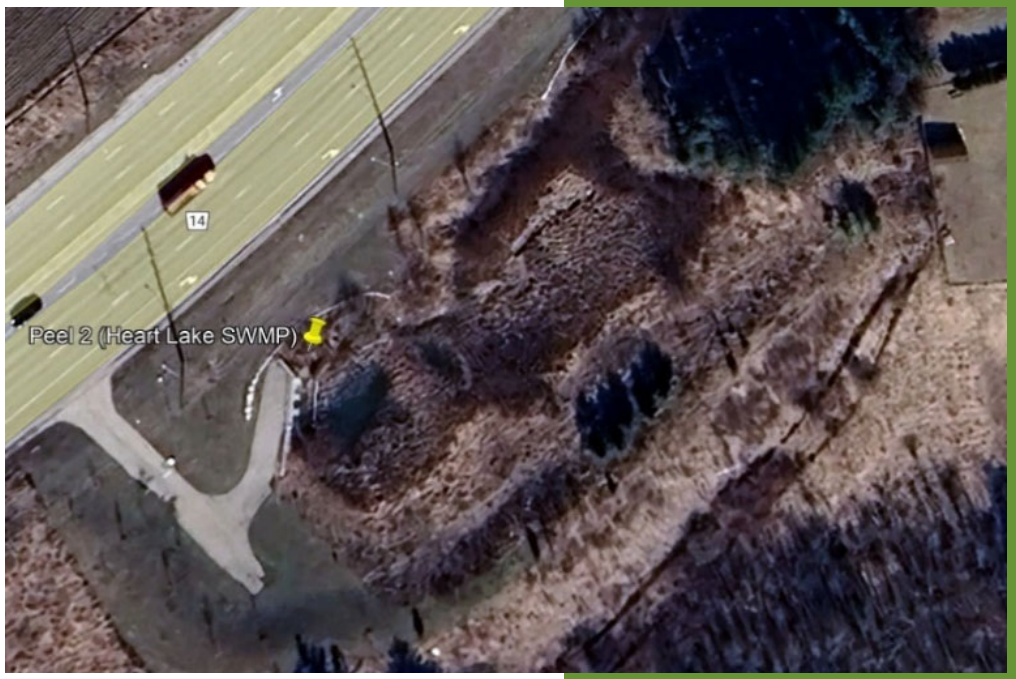
4.3. Heart Lake SWMF (Region of Peel)

Existing Conditions, Heart Lake SWMF (Region of Peel, in the City of Brampton)



Aerial Image of Heart Lake SWMF Pond (Region of Peel, in the City of Brampton)

4.4. Kennedy SWMF (Region of Peel)

Existing Conditions, Kennedy SWMF (Region of Peel, in the City of Brampton)

Aerial Image of Kennedy SWMF Pond (Region of Peel, in the City of Brampton)

5. Study Design & Methodology

- **Bathymetric Surveys**
  - Geo-referenced survey using Total Station and GPS
- **Sediment Sampling**
    - One (1) sample was collected from the inlet area
    - One (1) sample was collected from the outlet area
    - One (1) composite sample (multiple sample locations available within the SWM)
  - Sediment Quality
  - Particle Size Distribution (PSD)
  - Phosphorus, submitted to AGAT
    - Samples collected as composites to represent the average amount of phosphorous contained throughout the SWM Shield. Composites made up of equal parts from three (3) sampling areas

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6. Results

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6.1. Sediment Quality Results

Parameter	Unit	RDL	Site Name																O. Reg. 297/17: GENERAL WASTE MANAGEMENT Concentration (mg/L TCLP)
			Villa Park				Harmonia				Kennedy				Heart Lake				
			Inlet	Outlet	Comp.	Average	Inlet	Outlet	Comp.	Average	Inlet	Outlet	Comp.	Average	Inlet	Outlet	Comp.	Average	
Phosphorus	mg/kg	10	**798**	**744**	**745**	762.3	**598**	**677**	**531**	602	**626**	**633**	**707**	655.3	**652**	**644**	**612**	636	-
Arsenic - Leachate (SWEP)	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	2.5
Barium - Leachate (SWEP)	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	100
Boron - Leachate (SWEP)	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	500
Cadmium - Leachate (SWEP)	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Chromium - Leachate (SWEP)	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	5
Copper - Leachate (SWEP)	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	NA
Lead - Leachate (SWEP)	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	5
Mercury - Leachate (SWEP)	mg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Selenium - Leachate (SWEP)	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1
Silver - Leachate (SWEP)	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	5
Uranium - Leachate (SWEP)	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	10
Zinc - Leachate (SWEP)	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	NA
Fluoride - Leachate (SWEP)	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	150
Nitrate, Leachate (SWEP)	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1000
Nitrite, Leachate (SWEP)	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Cyanide - SWEP	mg/L	0.02	0.003	<0.002	**0.008**	NA	**0.005**	**0.006**	**0.004**	0.005	**0.648**	**0**	**0.37**	0.3	**0.099**	**0.417**	**0.397**	0.30	20

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6.2. Particle Size Distribution Results

Observations

Kennedy & Heart Lake SWM Shield capture 2-3 times less gravel and sand than Villa Park & Harmonia.

Higher silt and clay fractions in Kennedy & Heart Lake compared to other sites.

Potential Influencing Factors:

- Drainage area characteristics
- Land use
- Winter maintenance practices
- Native soil types
- Rainfall patterns
- Facility age

Site Name	Sample Location	Percentage of soil fractions (%)					Soil Grading Coefficients				
		Cobble	Gravel	Sand	Silt	Clay	D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c
Villa Park (Vaughan)	Inlet	0	11.9	82.1	4.8	1.2	2.408	0.938	0.184	13	2
	Outlet	0	6.1	16.8	47.4	29.7	0.014	0.002	NA	NA	NA
	Composite	0	21	59.4	13.2	6.4	2.642	0.389	0.007	380	8
Harmonia (Vaughan)	Inlet	0	11.1	77.9	8.3	2.7	0.8	0.278	0.075	11	1
	Outlet	0	3.8	47.9	39.5	8.8	0.151	0.024	0.003	52	1
	Composite	0	4.3	70.3	21.2	4.2	0.408	0.107	0.011	39	3
Heart Lake (Peel)	Inlet	0	0	30.1	52.1	17.9	0.053	0.007	NA	NA	NA
	Outlet	0	0.3	19.5	60.2	20.1	0.02	0.007	NA	NA	NA
	Composite	0	0.1	15.8	65.9	18.1	0.025	0.007	NA	NA	NA
Kennedy (Peel)	Inlet	0	0	21.1	60.3	18.6	0.026	0.005	NA	NA	NA
	Outlet	0	0	9.8	69.3	20.9	0.01	0.006	NA	NA	NA
	Composite	0	0	25.3	58.1	16.5	0.031	0.009	NA	NA	NA

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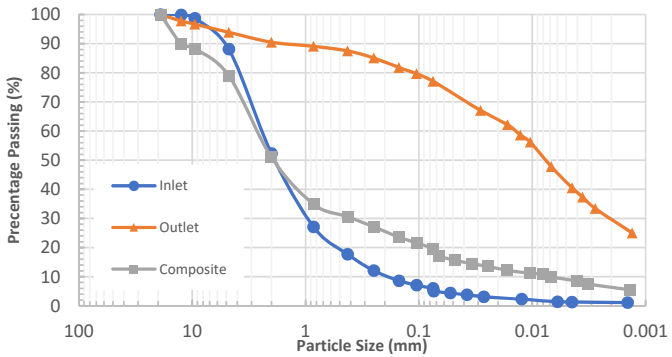
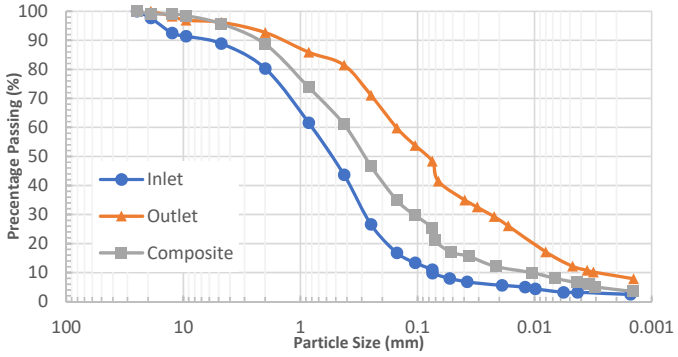
6.3. Particle Size Distribution (PSD) Curve

Vaughan

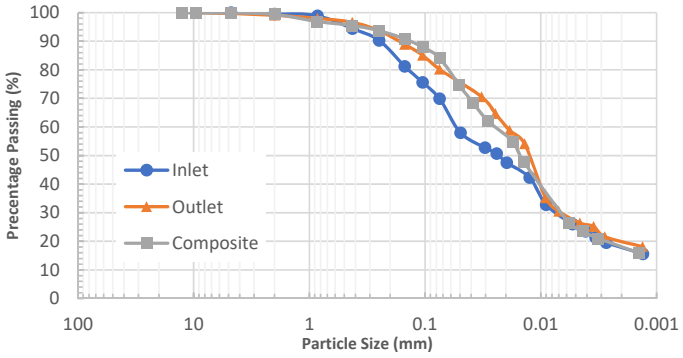


Villa Park SWMF SWM Shield PDS Curve

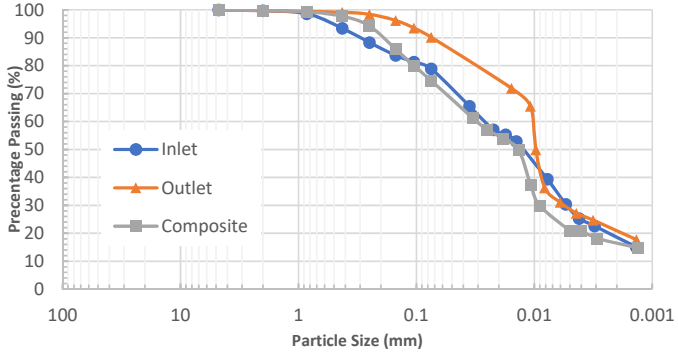


Harmonia SWMF SWM Shield PDS Curve

Peel



Heart Lake SWMF SWM Shield PDS Curve



Kennedy SWMF SWM Shield PDS Curve

6.4. Particle Size Distribution (PSD) Curve

Villa Park & Harmonia SWMFs:

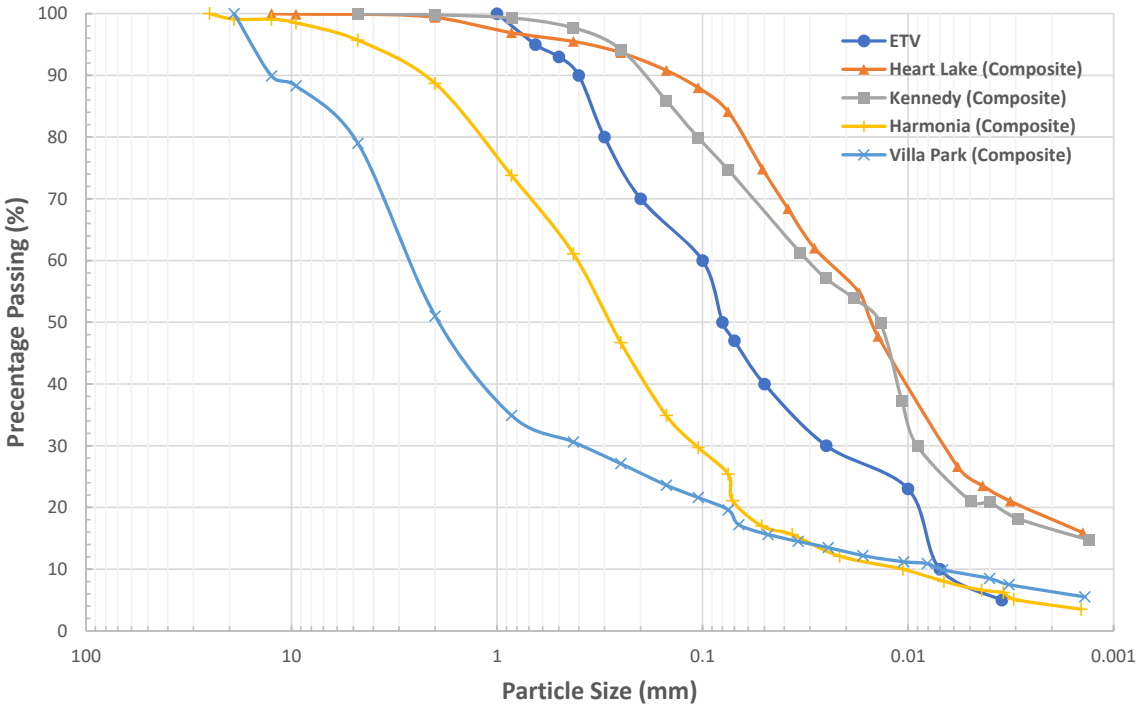
- Show **similar PSD trends** but with key differences.
- **Harmonia captures more large particles (50% between 1-10 mm)** compared to **Villa Park (25%)**.

Kennedy & Heart Lake SWMFs:

- Efficiently capturing **fine particles (0.1-0.01 mm), retaining ~60%**.
- **Lower percentage of particles larger than 0.9 mm.**

ETV PSD Curve:

- Falls **between** the four PSD curves from the study.
- Suggests **variability in sediment size capture** based on drainage area and SWMF characteristics.



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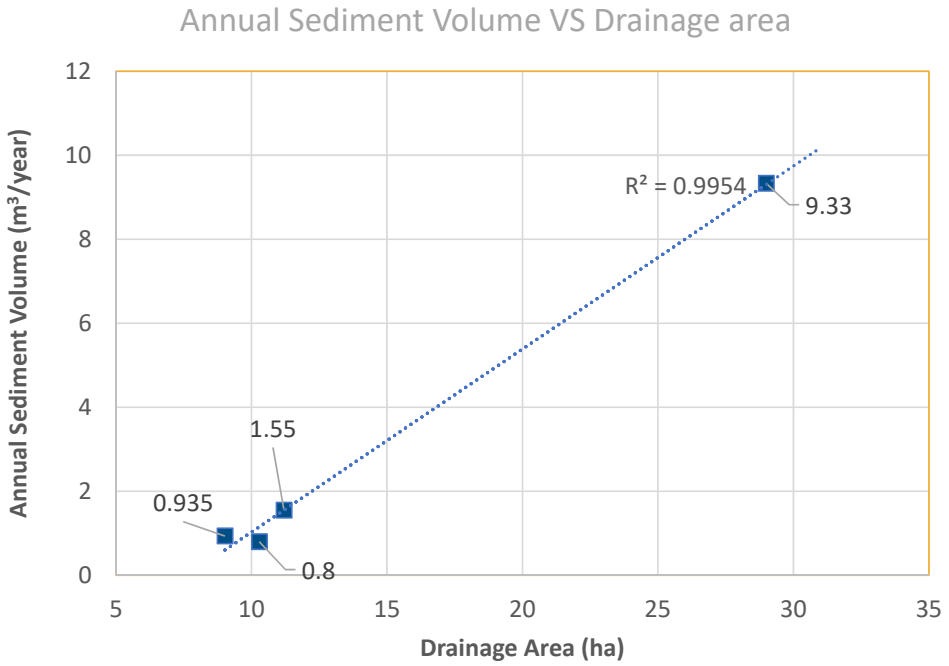
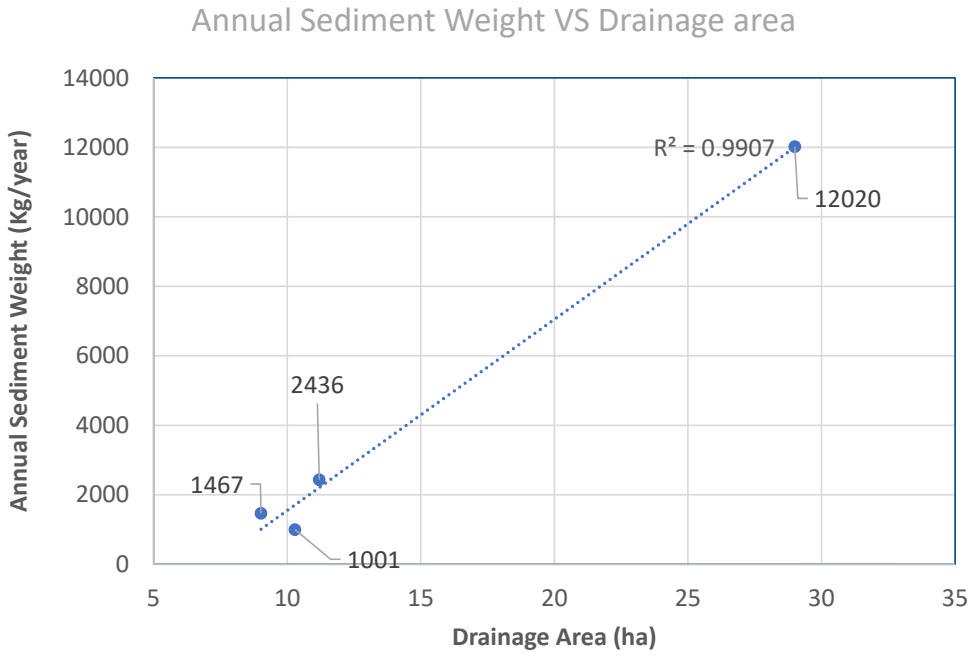
6.5. Sediment Capture Results

To obtain the annual sediment weight, the annual sediment volume was multiplied by the sediment density specific to each site. For normalized results, both annual sediment volume and sediment weight were further divided by the drainage area of each site, ensuring consistency across sites.

Site Name (City)	Drainage Area (ha)	Maximum Sediment Storage Capacity (m^3)	Starting Year of Operation	Accumulated Sediment Volume (m^3)	Wet Density (Kg/m^3)	Weight (Kg)	Annual Sediment Volume (m^3/year)	Annual Sediment Volume per hectare (m^3/year/ha)	Annual Sediment Weight (Kg/year)	Annual Sediment Weight per Hectare (Kg/year/ha)
Villa Park (Vaughan)	29.0	108	2023	6.36	1,890	12,020	6.36	0.22	12,020	414.5
Harmonia (Vaughan)	11.2	40.5	2023	1.38	1,765	2,436	1.38	0.12	2,436	217.5
Heart Lake (Brampton)	10.2	40.5	2018	3.53	1,702	6,008	0.58	0.06	1,001	97.3
Kennedy (Brampton)	9.0	40.5	2018	5.61	1,569	8,802	0.93	0.10	1,467	162.6

6.6. Sediment Capture Results

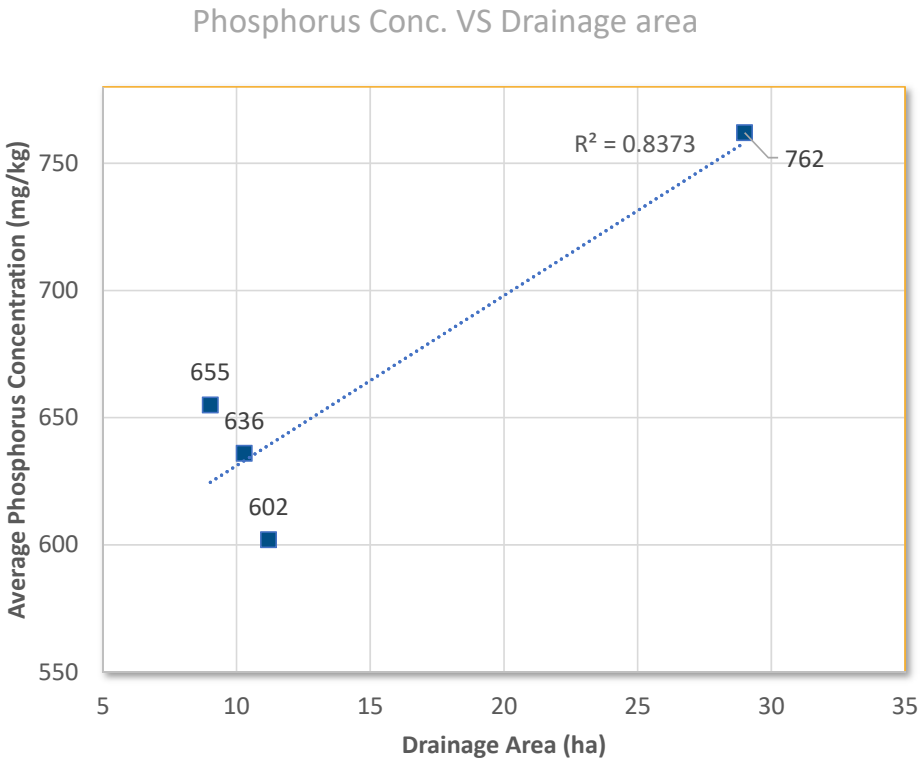


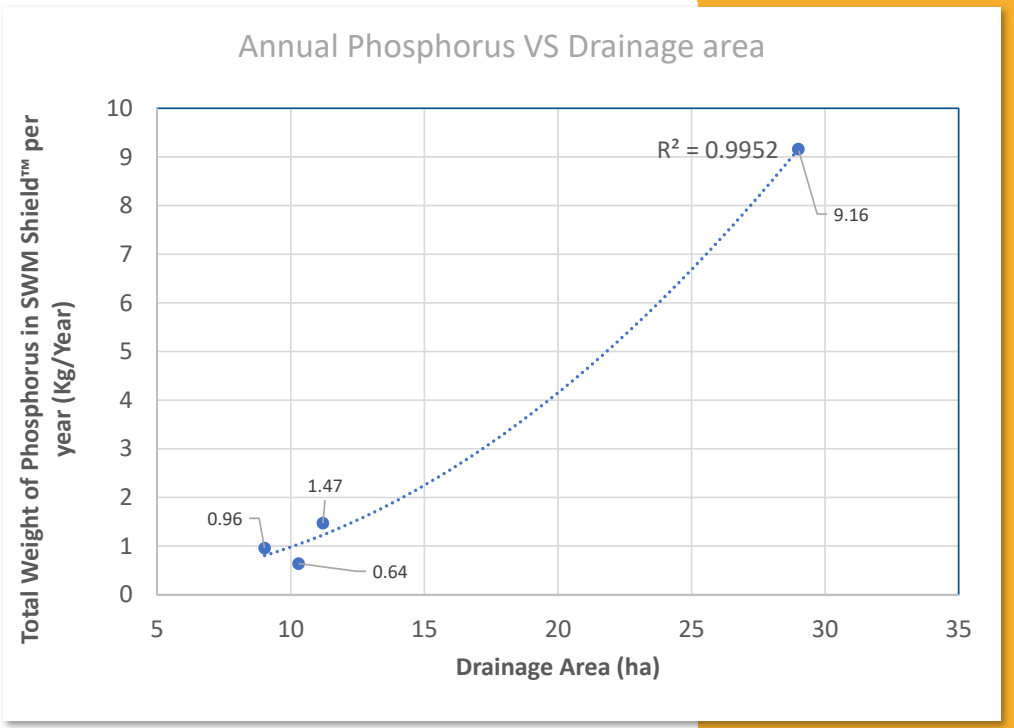


6.7. Phosphorus Results

Site Name	Average Phosphorus Concentration (mg/kg)	Drainage Area (ha)	Total Weight of Sediment (kg)	Total Weight of Phosphorus in SWM Shield™ (Kg)	Total Weight of Phosphorus in SWM Shield™ per year (Kg/Year)	Total Weight of Phosphorus in SWM Shield™ per year per hectare (Kg/Year/ha)
Villa Park (Vaughan)	762	29.0	12,020	9.16	9.16	0.32
Harmonia (Vaughan)	602	11.2	2,436	1.47	1.47	0.13
Heart Lake (Peel)	636	10.3	6,008	3.82	0.64	0.06
Kennedy (Peel)	655	9.0	8,802	5.77	0.96	0.11

6.8. Phosphorus Results





7. Conclusions and Discussions

Sediment Capture

Villa Park retained the highest sediment volume, while Kennedy had the lowest. Sediment capture rates ranged from **0.06 - 0.22 m³/year/ha**.

Phosphorus Retention

Phosphorus concentrations were similar across all sites ranged from 531–798 mg/kg, Phosphorus capture rates ranged from **0.06 - 0.32 kg/year/ha**.

Particle Size Distribution (PSD)

Villa Park and Harmonia captured coarser sediment, while Heart Lake and Kennedy retained mostly finer particles (silt & clay).

Site-Specific Influences

Factors like drainage area size, upstream conditions, and unit characteristics affected performance.

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7.1. Financial Considerations (Clean-out Cost)

The clean-out costs for SWM Shield™ units were determined based on sediment accumulation up to 1.2 meters (50% of the total 2.4-meter capacity). Costs include decanting excess water, hydro-vacuuming sediment, and offsite disposal.

For the sites analyzed:

- **Villa Park**: 70 m³ sediment volume, $40,320 total cost ($576/m³).
- **Harmonia, Heart Lake, Kennedy**: 26 m³ sediment volume each, $14,976 total cost ($576/m³).

A comparison with traditional pond clean-outs from recent projects in Ontario shows an average cost of $700/m³ (all-in) for sediment removal between 0-750 m³, excluding engineering, permitting, and design expenses. The $700/m³ cost includes all expenses related to mobilization/ demobilization, dewatering, sediment and erosion control, sediment sampling and off-site disposal, restoration and other associated costs.

This suggests that while SWM Shield™ clean-outs have lower per-unit costs, and they also eliminate the need for extensive pond excavation and associated, sediment sampling and permitting/design costs.

7.2. Financial Considerations (Funding)

The economic value of phosphorus offsetting was calculated using the Lake Simcoe Region Conservation Authority (LSRCA) phosphorus offsetting policy, which assigns a cost of **$35,770/kg/year**.

Site Name	Drainage Area (ha)	Average Phosphorus Concentration (mg/kg)	Phosphorus Weight (kg/yr)	Potential Phosphorus Offsetting Value ($)	Potential Phosphorus Offsetting Value ($/ha/yr)
Villa Park (Vaughan)	29	762	9.16	**$327,637**	$11,298
Harmonia (Vaughan)	11.2	602	1.47	**$52,456**	$4,684
Kennedy (Peel)	10.3	636	0.64	**$22,780**	$2,212
Heart Lake (Peel)	9	655	0.96	**$34,371**	$3,819

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QUESTIONS ?

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