Using the NVCA Phosphorus Loading Development Tool

The "NVCA Tool for Managing New Urban Development in Phosphorus-Sensitive Watersheds" is a generic tool for estimating how phosphorus loads will change as lands are developed in Ontario watersheds located off the Precambrian Shield. It is intended for use by the development community, municipalities, the MOE and Conservation Authorities as a scientifically-sound method to assess if phosphorus loading from new development is maintained or reduced over pre-development conditions by modelling Best management Practices (BMPs) and Low Impact Development (LID) techniques.

The Tool consists of three elements:

1. A **Technical Guidance Manual** (HESL 2014[1]) that provides the reference materials used in developing the Tool and documents the derivation of export coefficients and estimation routines.
2. A Microsoft ACCESS© **Database Tool** that facilitates the calculation of a phosphorus budget for new development in accordance with the technical guidance, and
3. A **Database User's Manual** (this document) that provides step-by-step instructions explaining the operation of the database. The user's manual was prepared by Stoneleigh Data for use with the Microsoft ACCESS© Database Tool. The NVCA has developed a web based application of the Tool that follows the same procedures and calculations as the ACCESS© version but which differs in some features and operations. This manual may not be completely compatible with the NVCA web-based Tool and is intended only for use with the ACCESS© version.

The Technical Guidance Manual and Database Tool are divided into four modules as follows:

- ⚜ **Module 1** – Estimates pre-development phosphorus loads for representative land uses (categorized in separate Natural Heritage, Urban and Cropland sub-types) contained within the study site,
- ⚜ **Module 2** – Estimates post-development phosphorus loads that are representative of the proposed land uses for the study site without BMPs and LID techniques to reduce phosphorus loads,
- ⚜ **Module 3** – Estimates the reduction in phosphorus loads from the post-development scenario with implementation of BMPs and LID techniques, and

---

[1] Hutchinson Environmental Sciences Ltd. 2014. Managing New Urban Development in Phosphorus-Sensitive Watersheds. Prepared for Nottawasaga Valley Conservation Authority. October 2014. 65pp.

- ⊕ **Module 4** – Provides a checklist for users to guide selection and implementation of BMPs for the construction phase of development to minimize sediment loss and resultant phosphorus export.

The following User's Manual is not intended as a "stand alone" description of the Tool or the estimation process, but as a set of instructions on operating the **Microsoft ACCESS**© **Database Tool.** The user must always rely on the **Technical Guidance Manual** as the primary technical source.

To start:

- ⊕ Save the database file to any folder – all support reference data tables are warehoused within this single file.

- ⊕ The database opens to a main screen – all features of the database are accessed from this opening view. The version code and date show in the lower portion of this screen and cannot be adjusted by users.

STEP 1: For a new development you will need to enter information about the development first– a unique development name and date combination are required. Other optional information includes the developer or agent name and a description of the development (e.g., location, size, development type).

The following 3 MODULES are entered in sequence as you enter the information about pre-development conditions, expected post-development conditions (including the development/transformation of existing land uses and the application of BMPs/LIDs). The last MODULE contains a checklist of construction phase BMP's and is not part of the derivative phosphorus modeling.

The landuse options are contained in a drop-down list reference table along with phosphorus export coefficients for all land uses except Cropland and Urban Lands, which are calculated based on site characteristics. With this release version, these values may NOT be adjusted by the user. These values are not watershed dependent and are considered valid for all areas off the Canadian Shield.

MODULE 1: Pre-development conditions are entered by the user as displayed with the screen below. Users must first have selected a development using the drop-down box on the main screen before they will be able to gain access to this screen. A listing of all phosphorus export coefficients and an overall summary of the Pre-development conditions can also be viewed from this screen using the buttons provided. Data is entered in three (3) parts as follows:

⊕ Part 1 – Enter the Natural Heritage Landuses – as selected from the drop-down list. Enter the area of each land use and the corresponding phosphorus export coefficient (P coeff) will automatically populate and be used to derive the phosphorus load.

⊕ Part 2 – Enter the total annual precipitation and the fraction that produces runoff in the boxes provided above the Part 2 data form ("Part 2 Urban Land Use" as shown below). Enter the Urban Landuses – as selected from the drop-down list along with both the total area and the portion that is impervious. The phosphorus export coefficient and load will be derived automatically.

Development	Sample Calculation for Site with 2 Cropland Blocks	Return to MAIN Screen

MODULE 1: Estimate Pre-Development Export of Phosphorus for this Sub-Watershed Development

Part 1: Natural Heritage Landuse

Landuse	Area (ha)	P coeff (kg/ha/year)	P load (kg/year)	Pre-Development NOTES
Forest	2.00	0.060	0.120	
Hay/Pasture	4.00	0.080	0.320	
Low Intensity Residential	0.50	0.130	0.065	
Open Water	1.00	0.260	0.260	
Transition	0.00	0.070	0.000	
Total Area (ha):	8.60		0.90	Total Natural Heritage LOAD (kg/yr):

Part 2: Urban Landuse   Total Annual Precipitation (mm/yr): 850   Fraction of Precipitation that produces Runoff: 0.9

Landuse	Area (ha)	Impervious Area (ha)	P coeff (kg/ha/year)	P load (kg/year)	Pre-Development NOTES
Total Area (ha):				Total URBAN LOAD (kg/yr):	

Part 3: Cropland Landuse   Add or Review Pre-Development Cropland Landuse

Preview Pre-Development EXPORT Summary	View Subwatershed Export Coefficients

⊕ Part 3 - Click on the button beside the Part 3 label ("Part 3: Cropland Landuse") to open the Cropland Landuse screen. Enter the values shaded in yellow. Values in green will be entered as either constants or filled in automatically from reference lookup tables in the database using the values you enter. Fields shaded in blue are derived by the database using the formulae described in the *Guidance Manual*. After users enter the necessary input values and press the tab to advance to the notes field, the phosphorus load in kg/year is derived automatically. For Cropland, areas must be divided into blocks with similar slope and slope length and phosphorus export calculated separately for each block. There is no limit to the number of blocks for Cropland. The total area of the

development site is also derived automatically along with a total P load. A summary of the pre-development conditions can be viewed using the button provided.

MODULE 2: Post-development conditions can be added only after pre-development conditions have been entered (a blank screen will display if this is not the case). You must also have selected a development using the drop-down box on the main screen to display the information screen for post-development conditions. The screen illustration following shows the development and pre- and post-development areas (along with any wetland area) at the top of the screen. This upper information may not be adjusted and displays and updates automatically.

Select the land use and enter the required input data as done for Module 1 using the lower part of the screen. Area values can be entered to hundredths. If the area of wetland is altered from the Pre-Development scenario, a warning flag will be posted on the screen and in the report, as a reminder that wetland areas should be protected in the course of development and a recognition that changes may occur if approved. The default phosphorus export coefficient is automatically entered from the lookup table or based on calculations for Cropland and Urban Land Uses, and may not be adjusted.

The Cropland Landuse screen is identical to that of Module 1. Enter the cropland landuse in blocks as provided earlier.

Development	Sample Calculation for Site with 2 Cropland Blocks			Pre-Development AREA (ha): 16.60	Wetland AREA (ha): 1.00	Return to MAIN Screen
Review Pre-Development EXPORT Summary	Review Post-Development EXPORT Summary			Post Development Area: 16.60		REFRESH and CHECK the Pre and Post Developed Areas

MODULE 2: Estimate Post-Development Export of Phosphorus for this Development

Part 1: Natural Heritage Landuse

Landuse		Area (ha)	P coeff (kg/ha/year)	P load (kg/year)	Pre-Development NOTES
▶ Forest	▼	2.00	0.060	0.120	
Hay/Pasture	▼	0.00	0.080	0.000	4 hay, 0.1 unpaved, 0.5 LIR, 8 crop
Low Intensity Residential	▼	0.00	0.130	0.000	
Open Water	▼	1.00	0.260	0.260	
Transition	▼	0.00	0.070	0.000	
Total Area (ha):		4.00		0.43	Total Natural Heritage LOAD (kg/yr):

Part 2: Urban Landuse   Total Annual Precipitation (mm/yr):   850   Fraction of Precipitation that produces Runoff: 0.9

Landuse		Area (ha)	Impervious Area (ha)	P coeff (kg/ha/year)	P load (kg/year)	Pre-Development NOTES
▶ Commercial	▼	2.60	2.4	1.36	3.54	
Residential	▼	10.00	4	1.19	11.92	
✳	▼					
Total Area (ha):		12.60			15.46	Total URBAN LOAD (kg/yr):

Part 3: Cropland Landuse   Add or Review Post-Development Cropland Landuse

There are several checks against both wetland land use and comparisons against pre and post development site areas on this screen. As users enter the areas in each of the three land use categories, they can, at any time, use the "REFRESH" button at the top of the screen to appraise them of the results of these comparisons. The code is listed on the following page, with comments about the impact of these results. The procedural code is also executed when users push the "Return to Main Screen" button. In some cases, users will be unable to leave the screen and proceed to the next step until the pre- and post-areal totals match. The procedural logic and code is as follows:

Total Development Area

Open two record-sets within the code as follows
- open a record-set for the development the user has open with the total PRE and POST development areas over all of the three land use categories
- derive the difference between the PRE and POST development areas

If PreArea > PostArea Then

- *Message "The Pre-Development Total Area is GREATER than the current Post-Development Total Area by " & AreaDiff & ". Please review development areas to*

ensure that the area of the entire site is included in the pre- and post-development scenarios (pre-development area should equal post-development area)."

If PreArea < PostArea Then

- *Message "The Pre-Development Total Area is LESS than the current PostDevelopment Total Area by " & AreaDiff * -1 & ". Please review development areas to ensure that the area of the entire site is included in the pre- and post-development scenarios (pre-development area should equal post-development area)."*

Otherwise they are equal

- *Message "The PreDevelopment Total Area EQUALS the current PostDevelopment Total Area."*

Wetland Area

Open two other record-sets for the development that show the total PRE and POST development area that is WETLAND
  - If there is none, display it as 0 hectares, otherwise return the value

If WETLAND = 0

Then no need to warn the user about encroaching on wetland areas

If WETLAND > 0

There is WETLAND so check if development is encroaching on wetland areas

Evaluate the PRE and POST Wetland differences (WETdiff = PRE – POST)

If WETdiff > 0 Then

- *Message "Please ensure that you include the Wetland Land Use specified in the Pre-Developed Area (" & WET & " hectares) in the Post-Development"*

If WETdiff < 0 Then

- *Message "Wetland area has been modified from the pre-development scenario. Please provide a rationale"*

.

MODULE 3: The next step is to select the BMPs/LIDs from the drop-down list to be applied on the development site. Some of them have defined efficiencies while others do not. Efficiency values will be applied to reduce the load for that landuse by the value that you select/enter. Note that phosphorus reduction efficiencies that are greater than the default values can be applied to Runoff Reduction techniques (e.g. 100% for infiltration) if these are documented and supported in the Stormwater Management Plan for the site. You will not be allowed to enter a BMP for wetlands. If the removal efficiency for a block is achieved through one BMP then the user would simply choose that technique from the drop down menu. If a SWM treatment train approach has been used then the user must document the rationale for the chosen removal efficiency in the SWM report / plan for review and approval. Enter information to the rationale field (up to 255 characters may be typed) along with the total efficiency in the field provided. If users select "Other" as a BMP, or adjust the efficiency value, they will be prompted to enter a rationale. Users may also adjust the efficiency from the base reference value that is automatically inserted as you select a BMP from the drop-down list. You will be prompted to enter a rationale for this change. The change will also be reflected in the Post Development summary report and both the base reference efficiency and the user adjusted value will display along with an information note. A summary of the total development can also be produced from this page using a button located at the middle of the bottom of the screen.

Development:	Sample Calculation for Site with 2 Cropland Blocks			Return to MAIN Screen

Total PreDevelopment Area (ha):	16.60	Total PreDevelopment Load (kg/yr):	4.04	*Create a replicate Scenario*
PreDevelopment AREA excluding Wetland:	15.60	Total PostDevelopment Load (kg/yr):	15.89	
Total PostDevelopment Area (ha):	16.60	Minimum P Load Reduction Required:	11.85	Refresh Development Summary
Total Area treated by BMP's (ha):	11.90	Total P Load Reduction with BMP's (kg/yr):	10.57	
		Total PostDevelopment Load with BMP's (kg/yr):	5.32	
		Conclusion:	No Net Increase in P Load	

MODULE 3: Estimate Post-Development Export of Phosphorus for this Study Site by selecting MODULE 2 landuses . To apply more than one BMP to a single landuse, you must create separate landuse records using the drop-down list provided below.

Adjust Post-Development Export of Phosphorus for this Sub-Watershed by application of BMP (Best Management Practices). A 'Treatment Train' approach can be selected. Users must enter the overall efficiency % and provide scientific rationale along with individual BMP efficiencies within the treatment train.

Landuse	P coeff (kg/ha/yr)	% Area treated	Area (ha)	Select BMP	Efficiency	BMP P (kg/year)	Rationale
Commercial	0.80	100	2.40	Wet Detention Ponds	70%	0.58	see attached
Residential	1.19	80	8.00	Bioretention Systems	100%	7.63	runoff reduction by infiltration not in the provided list
Residential	1.19	100	1.50	Vegetated Filter Strips/Stream Buffers	65%	1.16	
Residential	1.19	20	8.00	Wet Detention Ponds	63%	1.20	

Landuse	P_coefficient	Block
Commercial	1.36	
Cropland	0.47	Block 1
Cropland	0.26	Block 2
Forest	0.06	
Hay/Pasture	0.08	
Low Intensity Residential	0.13	
Open Water	0.26	
Residential	1.19	
Transition	0.07	
Turf/Sod	0.11	
Unpaved Roads	0.83	

Review PRE Development Summary

Review POST Development Summary

0%

The tool can be used to model multiple BMP/LID scenarios to derive the optimum development plan by creating multiple scenarios of the same development with differing versions of post-development land use and BMP implementation. A procedure to create a replicate scenario can be executed using the button marked 'Create a replicate scenario' at the top right of the screen (and shown below). A new Development will be created (and the message below will display) when this button is pressed. The name of the replicated development will be the same as the one that the user has selected with a suffix added containing the name '-replicate scenario' followed by a data and time stamp (enabling users to create multiple replicates on the same day). Users should adjust this name by returning to the main screen and selecting it from the drop-down list. Adjustments to the post-development information will also be required to distinguish it from the original.

The replication includes all pre- and post-development landuse designations and relevant data. It does not include the application of any BMPs (Module 3).

When users leave this view, there is a check to see if the treatment area total exceeds the Pre-development area total. If so, a warning message displays and users will not be able to leave this screen.

MODULE 4: For this Module, a checklist of Construction Phase BMPs is provided. The User will select BMPs that will be used on the development site to minimize phosphorus loads from construction and provide a description of how the BMPs will be used (i.e., area to be applied, timing and duration of application, etc.).

DATA SUMMARIES:

Each stage of the model allows users to review a data summary as an Access Report. These reports can be printed or distributed as pdf documents. Summaries include:

- Phosphorus export coefficients by Landuse
- Pre-Development landuse and Phosphorus Export – with separate Cropland sub-area review of all derived model parameters
- Post-Development landuse and Phosphorus Export – with separate Cropland sub-area review of all derived model parameters
- Overall Development summary including:
  - Pre-Development including Cropland model parameters
  - Post-Development including Cropland model parameters
  - BMP application by landuse summary with efficiencies and rationale
  - BMP application summary of load reductions with conclusion statement
  - Construction BMP application checklist with rationale statements

October 2014

Sample Summary Reports

PHOSPHORUS EXPORT COEFFICIENTS: Development

Updated: July 2014

Land-Use Specific Phorphorus Export Coefficients for any off Canadian Shield Watersheds for development

	Annual Phosphorus Load (kg/ha/year)											
	Agricultural	Urban				Natural Heritage						
	Cropland	Residential	Commercial	Industrial	Trans-portation	Forest	Transition	Wetland	Turf / Sod	Hay / Pasture	Low Intensity Residential	Unpaved Roads	Open Water
		TPi * Precip * Pj * Rv * 100										
	0.16 + 0.16 * A	TPi = 0.41	TPi = 0.20	TPi = 0.41	TPi = 0.50	0.06	0.07	0.05	0.11	0.08	0.13	0.83	0.26

Notes:

Natural Heritage land uses mean phosphorus export for all 'monitored' Lake Simcoe subwatersheds (n = 7) derived using phosphorus loads from CANWET modeling. Monitored subwatersheds are those with sufficient measured data to validate and calibrate the model.

Open Water land use is calculated from the mean measured atmospheric load of 19 tonnes/yr averaged over 5 years from 2002 to 2007 to the surface of Lake Simcoe (surface area = 722 km2) (Scott et al., 2006; LSRCA, 2009).

Cropland land uses are developed from the relationship between CANWET derived phosphorus export for Lake Simcoe subwatersheds and soil loss. Where A = soil loss determined using the Universal Soil Loss Equation (USLE)

Urban land uses are derived where TP i is total phosphorus concentration (mg/L) in runoff measured from land use (i) from the SWAMP studies (TRCA, 2005), Precip is the annual precipitation (mm/yr), Pj is the fraction of Precip that produces runoff, and Rv is the runoff coefficient = 0.05 + 0.91 x impervious fraction following US EPA's Simple Method.

	Database Version:	V 0.2 BETA Release
	Update Date:	29-Jul-14

PRE-DEVELOPMENT Phosphorus EXPORT

DEVELOPMENT: Sample Calculation for Site with 2 Cropland Blocks

Landuse		Area (ha)	P coeff (kg/ha)	Pload (kg/yr)
Agricultural				
Cropland	Block 1	5	0.47	2.35
Cropland	Block 2	3	0.26	0.79
Agricultural Land use Class Total		*8.0*		*3.14*
Natural Heritage				
Forest		2	0.06	0.12
Hay/Pasture		4	0.08	0.32
Low Intensity Residential		0.5	0.13	0.06
Open Water		1	0.26	0.26
Transition		0	0.07	0.00
Turf/Sod		0	0.11	0.00
Unpaved Roads		0.1	0.83	0.08
Wetland		1	0.05	0.05
Natural Heritage Land use Class Total		*8.6*		*0.90*
Development TOTAL:		16.6		4.04

	Database Version:	V 0.3 BETA Release
	Update Date:	12-Aug-14

Cropland Site Sediment and Phosphorus Pre-Development EXPORT

DEVELOPMENT: Sample Calculation for Site with 2 Cropland Blocks

Site Specific input:		constant / lookup:	
		calculation:	

Sub Area: Block 1

Slope Area (ha):	5.0	R (Rainfall / Runoff for Lake Simcoe)	100
Surface Slope Gradient (%):	4	K (Soil erodability factor):	0.49
Length Of Slope (m):	61.0	NN (determined by slope):	0.4

Crop Type Factor:	0.4	LS (slope length gradient factor):	0.53
Tillage Type Factor:	0.25	C (crop management factor):	0.100
		P (prevention + capture):	0.75
		Soil Loss (kg/year):	1.94
		Phosphorus export (kg/ha/yr):	0.47
		Phosphorus load (kg/yr):	2.35

Sub Area: Block 2

Slope Area (ha):	3.0	R (Rainfall / Runoff for Lake Simcoe)	100
Surface Slope Gradient (%):	2	K (Soil erodability factor):	0.83
Length Of Slope (m):	20.0	NN (determined by slope):	0.3

Crop Type Factor:	0.35	LS (slope length gradient factor):	0.18
Tillage Type Factor:	0.25	C (crop management factor):	0.087
		P (prevention + capture):	0.50
		Soil Loss (kg/year):	0.64
		Phosphorus export (kg/ha/yr):	0.26
		Phosphorus load (kg/yr):	0.79

PRE Developed AREA (ha):	8.0
Phosphorus Export (kg/ha/yr):	0.73
Phosphorus Load (kg/ha):	3.14

POST-DEVELOPMENT Phosphorus EXPORT - Module 2

DEVELOPMENT:	Sample Calculation for Site with 2 Cropland Blocks

Landuse		Area (ha)	P coeff (kg/ha)	P Load (kg/yr)
Agricultural				
Cropland	Block 1	0	0.47	0.00
Cropland	Block 2	0	0.26	0.00
	Agricultural Land use Class Total	*0.0*		*0.00*
Natural Heritage				
Forest		2	0.06	0.12
Hay/Pasture		0	0.08	0.00
LowIntensity Residential		0	0.13	0.00
Open Water		1	0.26	0.26
Transition		0	0.07	0.00
Turf/Sod		0	0.11	0.00
Unpaved Roads		0	0.83	0.00
Wetland		1	0.05	0.05
	Natural Heritage Land use Class Total	*4.0*		*0.43*
Urban				
Commercial		2.6	1.25	3.25
Residential		10	1.19	11.92
	Urban Land use Class Total	*12.6*		*15.16*
	POST Development Total	*16.6*		*15.59*

BMP Application Summary

Area	Treated Area	P coefficient	Efficiency	Pload	Rationale
			BMP		
Residential					
8.00	20.00	1.19	0.63	1.20	
Wet Detention Ponds					
Residential					
1.50	100.00	1.19	0.65	1.16	
Vegetated Filter Strips/Stream Buffers					
Residential					
8.00	80.00	1.19	1.00	7.63	runoff reduction by infiltration not in the provided list
Bioretention Systems					
Commercial					
2.40	100.00	1.25	0.63	1.89	
Wet Detention Ponds					

Total PreDevelopment Area (ha):	16.60
PreDevelopment Area excluding Wetlands (ha):	7.60
Total PostDevelopment Area (ha):	16.60
Total Area treated by BMP's (ha):	19.90
Treated Area total:	11.90
Total PreDevelopment Load (kg/yr):	4.04
PostDevelopment Load (kg/yr):	15.59
Total P Load Reduction with BMP's (kg/yr):	11.88
Minimum P Load Reduction Required:	11.55
Total PostDevelopment Load with BMP's (kg/yr)	3.72
Conclusion:	No Net Increase in P Load

DEVELOPMENT:	Database Version:	V 0.3 BETA Release
	Update Date:	12-Aug-14
Sample Calculation for Site with 2 Cropland Blocks		

Construction Phase BMP Applied	Rationale Description
Erosion Control Measures	
Hydroseeding*	Will be applied to exposed soil on slopes at the west end of property, 4 ha
Sediment Control Measures - Perimeter Controls	
Sediment/Silt Fence	To be used at the base of slopes and along edge of stream at west end of property
Vehicle Tracking Control/Mud Mat	To be installed at the entrance of the site

August-12-14   Page 5 of 5