
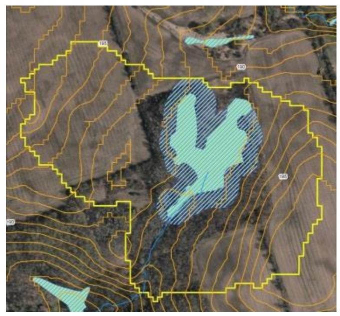


WETLAND WATER BALANCE RISK EVALUATION

Toronto and Region Conservation Authority

November 2017

Toronto and Region Conservation for The Living City

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We gratefully acknowledge the contributions of the members of the Wetland Water Balance External Stakeholder Committee throughout the development of this document. The stakeholder committee included technical experts in water resources engineering, ecology, hydrogeology, and planning with representation from both the public and private sectors.

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Wetland Water Balance Risk Evaluation, Toronto and Region Conservation Authority, 2017

This document was endorsed by the TRCA Authority Board on November 17, 2017.

<u>RES.#A210/17</u> - WETLAND WATER BALANCE RISK EVALUATION

Approval of TRCA's Wetland Water Balance Risk Evaluation, a technical guideline developed to streamline implementation of Water Balance for Protection of Natural Features of TRCA's Stormwater Management Criteria document (2012) and The Living City Policies for Planning and Development in the Watersheds of the Toronto and Region Conservation Authority.

Moved by: Ronald Chopowick
Seconded by: David Barrow

WHEREAS wetlands play a crucial role as part of the "green infrastructure" of the Toronto region by providing flood attenuation, filtering of air and water pollutants, wildlife habitat and greenspace for communities to enjoy;

AND WHEREAS Toronto and Region Conservation Authority (TRCA) staff review and provide advice and recommendations on applications for development, infrastructure and site alteration affecting wetlands for planning, environmental assessment and permitting applications;

AND WHEREAS in 2016, TRCA staff developed the draft Wetland Water Balance Risk Evaluation (Risk Evaluation) to provide guidance to proponents on how to assess the risk that their proposal may pose to the water balance of a wetland and streamline the application review process by indicating under which scenarios TRCA would request a wetland water balance analysis, and if so, to identify the level and scope of the analysis required;

AND WHEREAS in April of 2017, TRCA staff sought input into the development of the draft Risk Evaluation from partner municipalities, provincial agencies, the Building Industry and Land Development Association (BILD), consulting firms and neighbouring conservation authorities, and have now finalized the Risk Evaluation based on the input received;

THEREFORE LET IT BE RESOLVED THAT the TRCA Wetland Water Balance Risk Evaluation be endorsed for use by proponents of development and infrastructure, consultants and TRCA staff in the planning and development submission, review and approval process;

AND FURTHER THAT the Ministry of Natural Resources and Forestry (MNRF), the Ministry of Transportation (MTO), the Ministry of the Environment and Climate Change (MOECC), the Ministry of Municipal Affairs (MMA), TRCA's member municipalities, Conservation Ontario and neighbouring conservation authorities be so advised.

CARRIED

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1. INTRODUCTION

1.1 Purpose

The *Wetland Water Balance Risk Evaluation* (Hereafter *Risk Evaluation*) supports the Stormwater Management Criteria Document (*SWM document;* TRCA, 2012) that describes requirements for proposals to maintain the water balance of natural features designated for protection. The *Risk Evaluation* has been developed to aid proponents of development or infrastructure proposals in determining the level of risk a proposal has to the ecological integrity of a wetland through changes to its hydrology and is intended to be applied early in the planning process (Figure 1). The level of risk assigned to a particular proposal determines whether pre-development hydrological monitoring of the feature is required and the scope of the feature-based water balance analysis that is required. Proponents should refer to the *SWM document* for overarching guidance concerning the water balance requirements, in particular to Appendix D: Water Balance for Protection of Natural Features. The *Risk Evaluation* and other supporting tools under development or completed are indicated in relation to the corresponding steps in the *SWM document* in Figure 2.

1.2 Applicability

The *Risk Evaluation* should be applied when a proposal has the potential to impact the water balance of a wetland that has been determined to be protected as part of a planning or infrastructure review and approval process. A water balance will not generally be required for linear infrastructure, such as roads and railways, where TRCA's regular permitting process would generally be sufficient to address potential impacts to natural features and associated mitigation options.

For the purposes of this document, impact to wetland water balance occurs in the following circumstances:

- When there is alteration to the surface water catchment of a wetland determined to be protected;
- When water taking requiring Ministry of Environment and Climate Change (MOECC) Environmental Activity and Sector Registry (EASR) registration (i.e. > 50,000 L/day) is anticipated within the surface water catchment of a wetland or on a property that contains a wetland determined to be protected

The *Risk Evaluation* should be applied to all wetlands determined for protection except for lacustrine wetlands on the Lake Ontario shoreline, riverine wetlands located on stream segments of Strahler order ≥4 or with catchments >2500 ha, stormwater management ponds, or wastewater polishing wetlands.

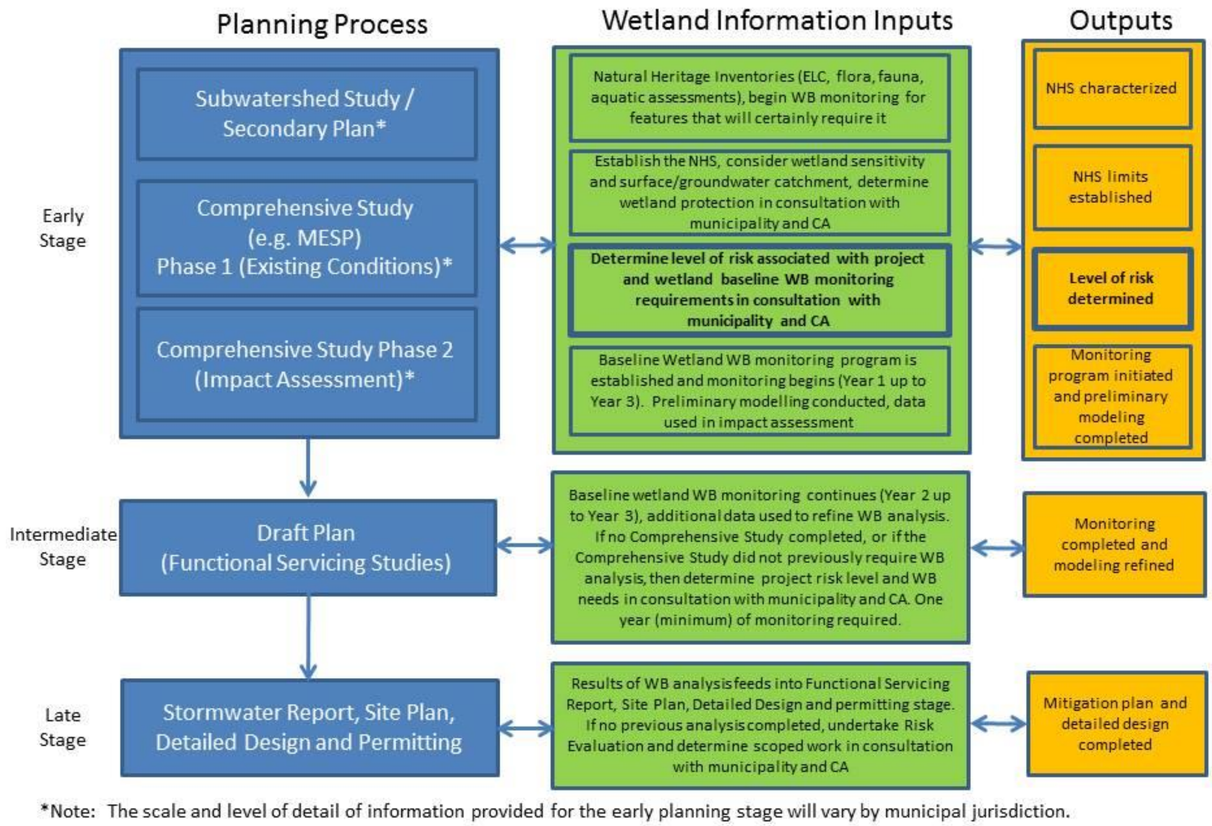

Figure 1: Wetland Water Balance in the planning process. The Risk Evaluation is bolded.

1.3 Relationship between wetland hydrology and ecology

The hydrology of a wetland directly determines many aspects of its physical, chemical, and ecological characteristics, and as such it is perhaps the most important variable influencing ecological function (Mitsch and Gosselink, 2007). Land development and infrastructure construction can affect the hydrology of a wetland in a number of ways, some of which may have a negative impact on the ecological function of a wetland. For example, water taking directly from a wetland or from an aquifer that discharges directly to a wetland has a clear potential to directly alter the wetland's water balance. Land use change within the surface water catchment of a wetland may alter the water balance by changing the ratio of surface runoff to infiltration within the catchment as well as the proportion of water lost to evapotranspiration. This is an issue particularly when there is a substantial increase in the proportion of impervious cover such as paved surfaces and roofs (Hicks and Larson, 1997; Reinelt and Taylor, 2001). Alteration to the size of the catchment area draining to a wetland due to land grading activities or stormwater management system design also has the potential to significantly change the water balance.

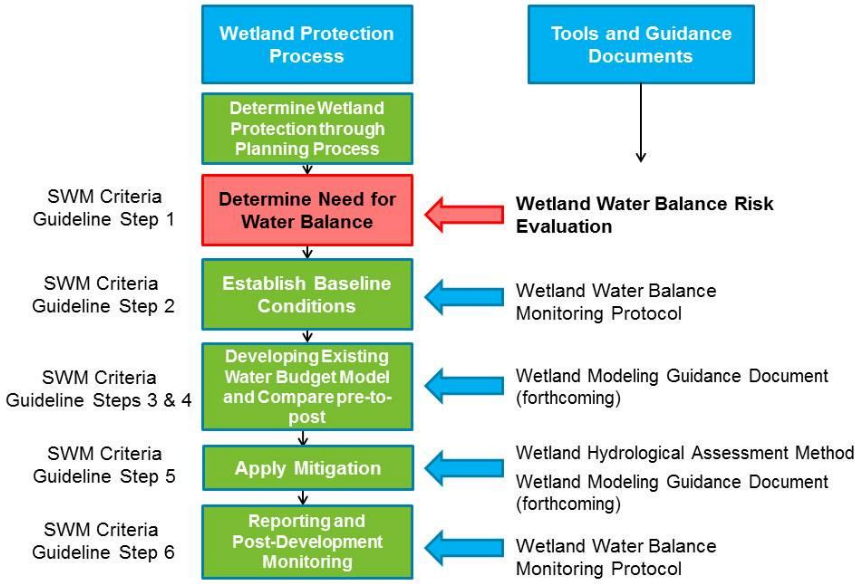

Figure 2: Wetland Water Balance tools and guidelines and their relation to steps in the SWM document.

It is important to note that wetland hydrology encompasses much more than the average annual depth of water in a wetland. Aspects of wetland hydrology such as the proportion of total inflow derived from surface water or groundwater, the timing and duration of inflows, and the timing of water level drawdown over the growing season all contribute to the maintenance of a particular ecological function. For example, amphibian species may require water for breeding during spring but may also require habitat to be seasonally dry to prevent predatory fish from establishing in this habitat. Similarly, some obligate wetland plants will be outcompeted by facultative upland plants if a wetland dries out too early, leading to shifts in the ecological community. Significant differences in wetland ecology and associated ecosystem services can occur between relatively small differences in hydrological regime on the order of tens of centimeters (Baldwin *et al.*, 2001; Mitsch and Gosselink, 2007; Moor *et al.*, 2017).

The term *hydroperiod* is used to refer to the pattern of water level change within a wetland over time, both above and below ground, and is a measure of the net sum of interaction between the different water balance components (i.e. the change in storage). The *hydroperiod* is a key measure by which to track changes in the water balance over time, and is the primary focus of wetland hydrological monitoring, as outlined in the *Wetland Water Balance Monitoring Protocol* (TRCA, 2016).

1.4 Classification of risk

The *Risk Evaluation* assigns a level of risk to a proposal considering two main factors:

i) The potential magnitude of hydrological change that would occur in the absence of a mitigation strategy, and;

ii) The sensitivity of the wetland to hydrological change.

The potential magnitude of change and the sensitivity of the wetland are evaluated together using a decision tree (Figure 3, page 18) which determines the overall level of risk of the proposal to the hydrology of the wetland. This level of risk is important as it determines:

- Whether pre-development water balance monitoring is required (refer to *Wetland Water Balance Monitoring Protocol*), and;
- The scope of modeling that is required to predict hydrological changes, and the corresponding effort required to develop a mitigation strategy

The *Risk Evaluation* recognizes that the effort put into analyzing potential changes to the water balance of a wetland, and designing a mitigation strategy, should be proportional to the magnitude of the potential impact of the proposal if the mitigation strategy is to be successful.

2. COMPLETING A WETLAND WATER BALANCE RISK EVALUATION

The *Risk Evaluation* follows a four step process:

Step 1. Determine which retained wetland(s) may be impacted by the proposal.

Step 2. Determine the magnitude of potential hydrological change.

Step 3. Determine the sensitivity of the wetland and its associated flora and fauna to hydrological change.

Step 4. Integrate information from step 1, 2, and 3 to assign a level of risk to the proposal.

All steps in the *Risk Evaluation* are completed using geospatial information and other data provided by the proponent (Table 1). The majority of the data is derived from previous, existing, or parallel studies. Some of the required data may be available from the appropriate conservation authority (CA).

Table 1: Data required to complete the Risk Evaluation.
All data are to be collected and compiled by the proponent. Some data may be available from the conservation authority (CA) (see suggested data source).

Criteria	Data	Definition and required information	Suggested data source
Magnitude of potential hydrological change	**Wetland feature limits**	The size and shape of the wetland feature(s) in question. Under normal circumstances this should be based on staked and surveyed feature limits.	Feature limits are delineated early in planning process in consultation with the CA, MNRF, and/or municipal staff.
	Extent and size of pre-development catchment	Surface water catchment of the wetland, delineated using appropriate methods.	The CA may be able to provide derived catchment boundaries or raw DEM.
	Total development area of catchment (C_{dev})	Area of the feature's catchment lying outside of any identified natural system (e.g. natural heritage areas, natural hazard zones, and their associated buffers), but inclusive of any existing developed areas within the catchment.	The CA may be able to provide spatial layers containing the natural system and natural hazard limits. Municipalities should be consulted for natural heritage system boundaries too.
	Area of the wetland catchment owned by the proponent	The development area of the wetland catchment (C_{dev}) that is owned by the proponent.	Provided by the proponent.
	Percent of impervious cover planned within the proponent's holdings (*IC*)	The anticipated proportion of impervious cover within the area of the wetland catchment owned by the proponent, as determined from average values for a given land cover type, or from knowledge of proponent's preliminary design.	Analysis conducted by the proponent. The CA and/or municipality can provide average values for given land cover type. Where no information is available, a conservative *IC* value will be assigned based on land use zoning.

	Proposed extent and size of post-development catchment	The anticipated size of the feature's catchment resulting from grade changes and/or implementation of the stormwater management plan, based on the best available information.	Provided by the proponent.
	Anticipated magnitude and duration of water taking	The magnitude and approximate duration of any water taking anticipated from groundwater or surface water bodies directly connected to the wetland, and associated discharge of this water. This is determined using the best data available about site conditions and the proposed development form at the time the *Risk Evaluation* is applied.	Provided by the proponent.
	Location and extent of any Locally Significant Recharge Areas	Locally Significant Recharge Areas are defined in this document as areas within the wetland's catchment covered by sand, gravel, or otherwise having high hydraulic conductivity. These may be identified through preliminary geotechnical site investigations, visual means, monitoring data, or numerical model outputs.	Provided by the proponent. Maps of areas identified as Ecologically Significant Groundwater Recharge Areas (GRAs), High Volume GRAs, or Significant GRAs may be available from the CA (e.g. TRCA SWM Criteria Document, Appendix C).
Sensitivity of the wetland	**Vegetation community type**	Classification according to the Ontario Ecological Land Classification System.	Classification may be available from the CA and/or municipality, and if not, should be carried out by the proponent.

	Fauna species present	A list of species found in the wetland should be created and cross referenced with the sensitivity ranks defined by the CA (Appendix 3).	Data from existing wildlife surveys, or can be collected by the proponent using sampling protocols approved by the CA and/or municipality. The CA may require updated fauna data collection if existing records are considered too old to be reliably representative of current conditions.
	Flora present	A list of floral species found in the wetland should be created and cross referenced with the sensitivity ranks defined by the CA (Appendix 3).	Data from existing surveys, or can be collected by the proponent using approved sampling protocols. The CA may require updated fauna data collection if existing records are considered too old to be reliably representative of current conditions.
	Habitat features	The presence of features which provide habitat for wildlife and/or fish, including amphibian breeding, bird breeding, reptile or amphibian overwintering habitat (see OMNRF, 2014 for further details).	Data is to be collected and provided by the proponent. Interpretation of SWH to be determined by proponent in consultation with the CA and/or municipality.
	Wetland hydrological type	The wetland is hydrologically classified as Isolated, Palustrine, Riverine, or Lacustrine. Hydrological type classification follows the convention of the Ontario Wetland Evaluation System, Southern Manual.	Wetland classification is performed by the proponent.

Step 1: Determine which retained wetland(s) may be impacted

The catchment area of any and all potentially impacted wetlands should be delineated with appropriate techniques and using a high resolution digital elevation model. Impact to the catchment of a wetland occurs when the proposal changes the size of the catchment, the amount of impervious cover within the catchment, or when water taking is anticipated to require MOECC EASR registration (i.e. >50,000 L/day); see Section 1.2 (Applicability) for further details. In recognition of the hydrological connections between many wetland catchments (i.e. the catchment of downstream wetlands may contain those of upstream wetlands), determining which wetlands to evaluate should be done in consultation with CA staff and the municipality. Lacustrine wetlands on the Lake Ontario shoreline and Riverine wetlands located on stream segments of Strahler order ≥4 or catchments >2500 ha are excluded from the *Risk Evaluation*.

Step 2: Determine the magnitude of potential hydrological change

The following criteria are used to evaluate the magnitude of potential hydrological impact that a proposal may have on a wetland:

i) The proportion of impervious cover in the catchment of the wetland that would result from the proposal.

ii) The degree of change in the size of the wetland catchment.

iii) Water taking from, or discharge to, surface water bodies or aquifers directly connected to the wetland.

iv) The impact on locally significant recharge areas.

The data required to evaluate the magnitude of potential hydrological change (Table 1) are collected by the proponent and used as inputs for the criteria listed in Table 2 to evaluate the magnitude of potential hydrological change. The highest magnitude category with one or more criteria satisfied determines the potential magnitude of change (Table 2).

i) Impervious Cover

An increase in impervious cover within the catchment of a wetland will result in an increase in the volume of rain and snowmelt that reaches the wetland as runoff and a higher peak event runoff rate. Further, baseflow and/or interflow contributions may be reduced if infiltration and groundwater recharge are diminished. Untreated stormwater from road surfaces is also linked to increasing sediment loads and concentrations of contaminants such as salt and hydrocarbons. Research into the relationship between impervious cover (IC) within a wetland's catchment and its ecological integrity suggests that there are two thresholds governing wetland response. Between 3.5 and 10 % IC, plant density and the diversity of amphibians and macro-invertebrates begin to significantly decline (Taylor, 1993; Taylor *et al.*, 1995; Hicks and Larson, 1997; Reinelt and Taylor, 2001). A second threshold between 20 and 25 % IC, beyond which only certain hardy and/or exotic plant and amphibian species are able to persist within a wetland (Boward *et al.*, 1999; Reinelt and Taylor, 2001; Chin, 1996). The *Risk Evaluation* uses threshold values of 10 and 25 % IC because there is relative certainty that exceeding these thresholds will lead to ecological degradation in the absence of a well-designed mitigation strategy.

In recognition of both the impact of any one development as well as the cumulative impact of all developments in the catchment of a wetland, an impervious cover score (S) is used to evaluate this criterion (Equation 1). The impervious cover score evenly distributes the proportion of impervious cover that represents a given threshold of hydrological disturbance across all the development land within the wetland's catchment regardless of the number of different landowners. The impervious cover score also considers the area of the catchment that is protected by natural heritage and natural hazard designations to ensure that the thresholds of disturbance that are determined by the score are not unduly restrictive. This creates a fair playing field for all proponents by ensuring that those developing later are not penalized by bearing the full cost of a water balance analysis that is triggered primarily by the actions of earlier developers, while still ensuring adequate protection of the wetland(s). See Appendix 1 for further rationale and example applications of this equation.

Equation 1: $S = \frac{IC \cdot C_{dev}}{C}$

Where S is the impervious cover score, IC is the proportion of impervious cover (as a percentage between 0 and 100) proposed within the area of wetland catchment that is within the proponent's holdings, C_{dev} is the total development area of the catchment (in ha), and C is the size of the wetland's catchment (in ha). I all cases, the pre-development catchment is used.

ii) Catchment Size

Increasing or decreasing the catchment size can change the timing, frequency, and volume of runoff reaching the wetland. The same magnitude thresholds used for impervious cover (10% and 25 %) are used as thresholds to define catchment size alteration. The value used to assess this criterion should be based on the best information available regarding the proposed development form at the time that the *Risk Evaluation* is applied. In all cases, the pre-development catchment size should be used to define changes to catchment size.

Some proposals may involve proposed changes to both catchment size and impervious cover. In such cases, the interaction between these two criteria may produce complex non-linear changes in catchment hydrology. Proposals involving a change in both catchment size and imperviousness may therefore require that the thresholds defining the potential magnitude of hydrological change be modified to reflect interactive effects between these two criteria, as deemed appropriate by a water resources engineer or other qualified CA staff.

iii) Water Taking

Where wetlands are directly connected to surface water bodies or to unconfined aquifers, water takings or associated discharges have potential to impact wetland hydrology, with corresponding impacts to ecology. For the purposes of the *Risk Evaluation*, a wetland within or adjacent to a proposed undertaking is considered impacted when water taking is anticipated to require MOECC EASR registration (>50,000 L/day). This criterion will be assessed using the best available information about site conditions and the proposed undertaking. The key underlying variables of interest from an ecological perspective are the change in surface water or groundwater depth and the timing of drawdown that may result from the activity; this is because these variables are strongly linked to wetland ecology through both physical and biogeochemical parameters. As significant differences in wetland ecology and associated ecosystem services can occur between relatively small differences in hydrological regime on the order of tens of centimeters (Baldwin *et al.*, 2001; Mitsch and Gosselink, 2007; Moor *et al.*, 2017), any water taking which is likely to result in direct alteration of wetland water levels is of potential concern. If proponents anticipate that high volume dewatering will be required but do not believe that this dewatering poses a risk to nearby wetlands, the onus will be on the proponent to demonstrate that no impact to the wetland will occur.

iv) Recharge Areas

Certain areas within a wetland's surface water and groundwater catchments may be more sensitive to change than others, particularly where these areas act as locally significant groundwater recharge areas. When development or infrastructure occurs within these areas, there is an increased risk of a significant change to the wetland's water balance as these areas may contribute disproportionately to shallow groundwater discharge to the wetland. Identification of recharge areas will rely on preliminary site investigations and existing regional data sets, when these data are available (e.g. numerical model outputs). Impacts to recharge areas are defined here as replacement of existing soils with significantly less permeable materials.

Table 2: Criteria used to evaluate the probability and magnitude of hydrological change.

Criteria	High magnitude	Medium magnitude	Low magnitude
Impervious cover Score (*S*) within catchment, as determined using Equation 1	> 25 %	10-25 %	< 10 %
Increase or decrease in catchment size	> 25 %	10-25 %	< 10 %
Water taking or discharge	Dewatering exceeding MOECC EASR limits (> 400,000 L/day) for > 6 months anticipated	Dewatering within MOECC EASR limits (50,000 - 400,000 L/day) for > 6 months anticipated OR Dewatering exceeding MOECC EASR limits (>400,000 L/day) for < 6 months anticipated	Dewatering within MOECC EASR limits (50,000 - 400,000 L/day) for < 6 months anticipated*
Impact to recharge areas*	Impact (e.g. replacement with impervious cover) to >25% of locally significant recharge areas*	Impact (e.g. replacement with impervious cover) to 10-25% of locally significant recharge areas*	Impact (e.g. replacement with impervious cover) to <10% of locally significant recharge areas*

Note: Where there is no proposed alteration to the catchment imperviousness or size and water taking is below MOECC EASR registration requirements (< 50,000 L/day), a feature-based water balance analysis as defined in the TRCA *SWM document* (2012) is not required. See section 1.4 (Applicability).

* Defined in Table 1

Step 3: Determine the sensitivity of the wetland

The sensitivity of a wetland to hydrological change is assessed based on the abiotic and biotic characteristics of the wetland that are directly related to hydrology and/or ecology. Other aspects of wetland ecology not relating directly to hydrology may be evaluated through parallel processes external to this *Risk Evaluation.* To assess the sensitivity of a wetland to hydrological change five criteria are used:

i) The vegetation community
ii) Fauna species
iii) Flora species
iv) Significant wildlife habitat for hydrologically sensitive species
v) Hydrological classification

The sensitivity of a wetland to hydrological change is assessed using the data listed in Table 1 which are compiled and provided by the proponent. The compiled data are then used to determine the sensitivity of the wetland using the criteria listed in Table 3. The highest magnitude sensitivity category in Table 3 with one or more criteria satisfied determines the overall sensitivity of the wetland to hydrological change.

i) Vegetation community

Vegetation communities vary due to abiotic variables including soils, climate, physiography, and hydrology. This variation is used to delineate areas of natural cover in the Ontario Ecological Land Classification (ELC) system. Different ELC communities vary in their sensitivity to hydrological change. Some vegetation communities can withstand some hydrological change without dramatic change to their composition, whereas others require specific hydrological conditions to persist. In recognition of the range of sensitivity between communities, CA ecologists have ranked ELC communities by their sensitivity to hydrological change into three levels (Appendix 2).

ii) Fauna species

Many fauna species are adapted to particular hydrological conditions, or are associated with specific vegetation within wetlands. Some of these fauna have adapted to wetlands with specific hydrology, with some species utilizing temporary pools as refuge from competitors and predators, some requiring permanent water, and others only requiring standing water during certain time periods that coincide with specific biological needs. There is considerable variation in the ability of species to withstand hydrological change of their habitats. Fauna species were categorized based on their sensitivity to hydrological change by CA ecologists into three levels of sensitivity (Appendix 3). The individual species with the highest sensitivity level determines the sensitivity of the fauna community to hydrological change.

iii) Flora species

There a strong correlation between the hydrology of a wetland and the vegetation community present in the wetland. Some vegetation species require specific hydrological conditions while others can make use of a broader range of hydrological conditions. Vegetation species were categorized based on their sensitivity to hydrological change by CA ecologists into three levels of sensitivity (Appendix 3). The high sensitivity category is met when multiple high sensitivity species are detected at a feature, the medium sensitivity category is met when multiple species with medium sensitivity are detected, and the low sensitivity category is meet in all other cases.

iv) Significant wildlife habitat for hydrologically sensitive species

Wetlands provide habitat for a large number of species and some of this habitat is very sensitive to hydrological change. For example, seasonal or vernal pools contain water for short periods of time, and some species have adapted to the seasonality of these pools because it excludes competitors or predators or provides habitat for juveniles. Other wetlands provide habitat during critical life stages at specific times of the year. If the hydrology of the wetland is altered, the timing between the need of the organism and habitat availability may be altered such that the habitat no longer functions for the species. Furthermore, wetlands provide habitat for some species that are difficult to detect at a particular feature because they are locally rare, cryptic, or use habitats seasonally. In recognition of the significant habitat wetlands may provide, and of the fact that some species may not be detected by surveys, CAs exercise the precautionary principle by stating that significant wildlife habitat *for species ranked as having high sensitivity to hydrological change (Appendix 3)* requires increased protection. See OMNRF (2014) for further details on significant wildlife habitat and significant wildlife habitat schedules for the appropriate ecoregion.

v) Hydrological classification

The hydrogeomorphic setting of a wetland influences its sensitivity to hydrological change. For instance, the hydroperiod of riverine wetlands is controlled predominantly by the water levels associated with a river or larger stream, and is therefore less likely to be affected by changes to local-scale hydrology. In contrast, isolated wetlands have no defined surface water outlet, and therefore any increased volume of runoff must either be infiltrated or lost to evapotranspiration, and similarly any reduction in surface water inflows will not be compensated for by any other inflow processes. This makes isolated wetlands more sensitive to hydrological change than other types of wetlands.

The *Risk Evaluation* uses four distinct hydrological wetland classifications defined in the Ontario Wetland Evaluation System (OMNR 2013): *isolated, palustrine, riverine*, and *lacustrine*. Isolated wetlands have no channelized surface water inlets or outlets, and are fed by local runoff and/or groundwater. Palustrine wetlands have either no or intermittent channelized surface water inflows and permanent or intermittent channelized surface water outflows. Lacustrine wetlands are associated with the shorelines of lakes (water bodies 8 ha or larger and deeper than 2 m in places during average low water conditions), and riverine wetlands are associated with the main channel of a permanently flowing watercourse. In assessing the hydrological wetland classification it is important to distinguish true lacustrine and riverine wetlands (in which the hydrology is dominated by larger water bodies) from wetlands that are only ephemerally connected to lakes and rivers (where the hydrology is dominated by local surface water or groundwater). Wetlands classified as lacustrine or riverine may be reviewed by CA staff to ensure classification was appropriate.

Table 3: Criteria used to evaluate the sensitivity of the wetland to hydrological change.

Criteria	High sensitivity	Medium sensitivity	Low sensitivity
Vegetation community type (ELC)*	Presence of a high sensitivity vegetation community	Presence of a medium sensitivity vegetation community	No high or medium sensitivity criteria satisfied
High sensitivity fauna species**	Presence of a high sensitivity species	Presence of a medium sensitivity species	No high or medium sensitivity species
High sensitivity flora species**	Presence of multiple high sensitivity species	Presence of multiple medium sensitivity species OR Presence of one high sensitivity species	No high or medium sensitivity criteria satisfied
Significant Wildlife Habitat	Presence of Significant Wildlife Habitat, as defined by OMNRF (2014), for high sensitivity species**	N/A	No high criteria satisfied
Hydrological classification considering ecology	Isolated/palustrine AND Presence of medium or high sensitivity vegetation communities* OR medium or high sensitivity flora or fauna species**	Isolated/palustrine AND No medium or high sensitivity vegetation communities* AND no medium or high sensitivity flora or fauna species** present	Riverine/lacustrine

* See Appendix 2 for community rankings by hydrological sensitivity
** See Appendix 3 for species rankings by hydrological sensitivity

Step 4: Risk characterization

The risk of a proposal to the hydrological and ecological integrity of a wetland is determined using the criteria evaluated in Steps 2 and 3. The level of risk assigned to a proposal determines whether hydrological monitoring of the wetland is required before the proposal is executed and the scope of the feature-based water balance analysis that is appropriate. The level of risk assigned to a proposal is proportional to the magnitude of change that is likely to occur and the sensitivity of the wetland to hydrological change. In general, a higher risk category means increased water balance monitoring and more detailed modelling, in recognition of the fact that a significant disturbance to the wetland's hydrology is more likely for these scenarios unless the mitigation strategy is informed by a detailed understanding of the water balance. In all cases it is expected that the water balance of all risk-evaluated wetlands will be maintained (there may be some limited exceptions to this, as outlined in Section 3).

Using a decision tree (Figure 3), the proposal will be categorized into one of three possible levels of risk: Low, Medium, or High.

Low Risk: Low risk proposals occur when it is unlikely that the proposed activity will have a substantial impact on wetland hydrology. As the risk is low, pre-development water balance monitoring of wetland hydrology is not required. Proponents are required to calculate the alteration to the water balance that would result from any changes to the catchment size, runoff coefficients, or impervious cover resulting from the proposed activities using a non-continuous model (e.g. Thornthwaite-Mather method) with outputs reported at monthly resolution. A mitigation plan is required to demonstrate that the design and any associated stormwater management system will compensate for any changes to monthly water balance through appropriate mitigation strategies (e.g. low impact development features). The proponent may balance the overall wetland water balance using a variety of techniques, but clean sources of supplemental water (e.g. roof runoff, runoff from greenspace) are preferred. Determination of whether the post-development hydroperiod will be sufficiently close to the pre-development hydroperiod to achieve protection of the wetland should be made in consultation with CA staff and the municipality.

Medium Risk: Monitoring of wetland hydrology is required, as outlined in the *Wetland Water Balance Monitoring Protocol* (TRCA, 2016), to establish pre-development conditions and provide a baseline against which to measure any changes in water balance during and following completion of the proposed undertaking. An estimate of each of the individual terms of the pre- and post-development water balance is required, with the relative proportion of inflow derived from surface water and groundwater estimated using monitoring data in conjunction with other data collected in support of completing the *Risk Evaluation*.

Proponents are required to calculate the alteration to the water balance that would result from the proposal using a continuous model (e.g. EPA SWMM) at daily aggregated to weekly resolution. The model is to be calibrated using monitoring data and should use modeling techniques appropriate to the context of the application (appropriate CA staff can provide direction). If the water balance analysis concerns the impact of groundwater withdrawals on a wetland, a model capable of accurately representing subsurface processes may be required to evaluate the anticipated effects and associated level of risk. All model outputs should be at daily aggregated to weekly resolution.

For medium risk proposals, the mitigation plan should provide details on the design features and water management techniques that will be used to maintain the overall water balance of the wetland in the post-development scenario, including maintaining the relative balance of surface to subsurface inflow processes at pre-development levels. The mitigation plan should include a comparison between: A) the pre-development wetland hydroperiod as derived by running a calibrated wetland model with a long-term climate dataset under pre-development land use, and; B) the post-development hydroperiod derived by running the same calibrated wetland model with a long-term climate dataset under post-development land use conditions, including all mitigation design measures. Determination of whether the post-development hydroperiod will be sufficiently close to the pre-development hydroperiod to achieve protection of the wetland should be made in consultation with CA staff and the municipality. CA staff may be able to provide tools for hydroperiod comparison and statistical analysis, in addition to long-term climate data, upon request.

For proposals in which the period between the start of construction and the implementation of functioning water balance mitigation measures is anticipated to exceed two years (i.e. there is an extended build-out phase), an interim mitigation plan may be required. Proponents should consult with CA and municipal staff to determine whether an interim mitigation plan is required. A mitigation plan should outline active management measures for supplementing the water balance during construction and define triggers for when action is required. Such measures may be necessary to protect the ecological and hydrological functions of the wetland from multi-year disturbances which degrade the wetland to a point where these functions cannot be restored. In the case where supplemental water is needed to augment the interim water balance, clean sources of water are preferred (e.g. roof runoff, runoff from greenspace).

High Risk: Pre-development monitoring of wetland hydrology is required, as outlined in the *Wetland Water Balance Monitoring Protocol* (TRCA, 2016), to establish pre-development conditions and provide a baseline against which to measure any changes in water balance during and following completion of the proposal. An estimate of each of the individual terms of the pre- and post-development water balance is required, with the relative proportion of inflow derived from surface water and groundwater estimated using monitoring data in conjunction with other data collected in support of completing the *Risk Evaluation*. This is also a requirement for Medium Risk undertaking; however additional emphasis is placed on the evaluation of the degree of interaction between the wetland and groundwater for High Risk undertakings.

For high risk proposals, a continuous hydrological model (e.g. EPA SWMM) with daily aggregated to weekly resolution is required. The model is to be calibrated using monitoring data and should use modeling techniques appropriate to the context of the application (appropriate CA staff can provide direction). Where groundwater processes constitute a significant proportion of the total inflows or outflows to the feature, an integrated model (e.g. GSFLOW, MIKE-SHE) may be required to appropriately address the impacts of the proposal and the effectiveness of any associated mitigation measures. The decision by the CA to require an integrated model will always consider the scale of the proposal and the size of the wetland in question, in addition to the value added by integrated modeling of the water balance. If the only issue of concern with an application is the impact of groundwater withdrawals on a wetland, a model capable of accurately representing hydrogeologic processes (only) may be used in place of a fully integrated model to evaluate the anticipated effects of the proposal and mitigation on the feature water balance, as deemed appropriate through consultation with appropriate CA staff.

The mitigation plan for High Risk proposals should provide details on the design features and water management techniques that will be used to maintain a post-development water balance that is similar to the pre-development water balance. Maintaining the water balance requires maintaining a similar ratio of surface to subsurface inflow processes as in the pre-development condition. The mitigation plan should include a comparison between: A) the pre-development wetland hydroperiod as derived by running a calibrated wetland model with a long-term climate dataset under pre-development land use, and; B) the post-development hydroperiod derived by running the same calibrated wetland model with a long-term climate dataset under post-development land use conditions, including all mitigation design measures. Determination of whether the post-development hydroperiod will be sufficiently close to the pre-development hydroperiod to achieve protection of the wetland should be made in consultation with CA staff and the municipality. CA staff may be able to provide tools for hydroperiod comparison and statistical analysis in addition to long-term climate data upon request.

For proposals in which the period between the start of construction and the implementation of functioning water balance mitigation measures is anticipated to exceed two years (i.e. there is an extended build-out phase) , an interim mitigation plan may be required. Proponents should consult with CA and municipal staff to determine whether an interim mitigation plan is required. A mitigation plan should outline active management measures for supplementing the water balance during construction and define triggers for when action is required. Such measures may be necessary to protect the ecological and hydrological functions of the wetland from multi-year disturbances which degrade the wetland to a point where these functions cannot be restored. In the case where supplemental water is needed to augment the interim water balance, clean sources of water are preferred (e.g. roof runoff, runoff from greenspace).

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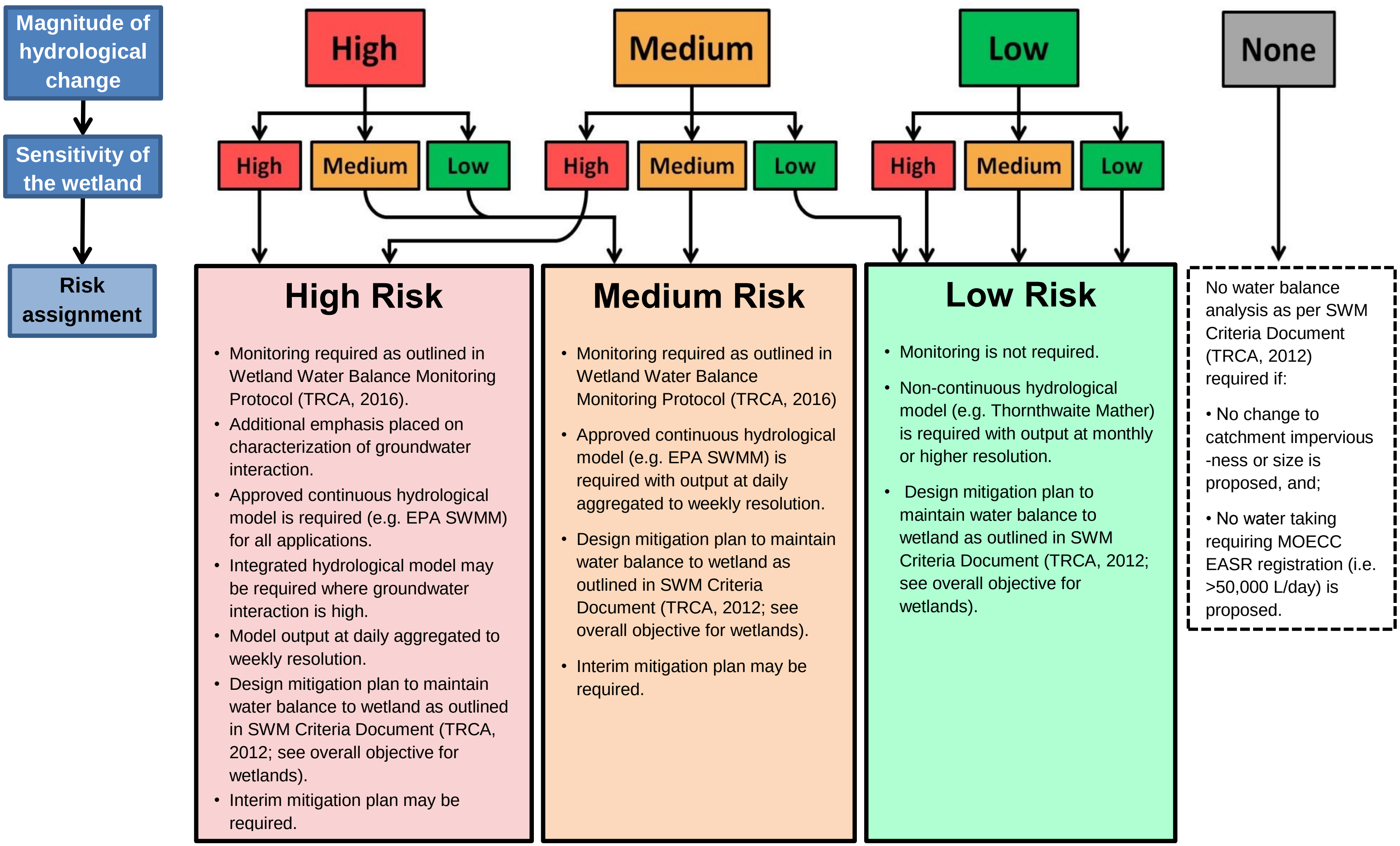

Figure 3: Wetland Risk Evaluation Decision Tree

3. ECOSYSTEM SERVICES AND ADDITIONAL CONSIDERATIONS

Wetlands provide many essential ecosystem services in urban and urbanizing areas. The focus of the *Risk Evaluation* is on protecting the ecology of a wetland by assessing the risk of a proposal to the maintenance of hydrological conditions. However, the focus on ecology does not reduce the importance of other functions wetlands provide such as flood attenuation and runoff detention, groundwater recharge to aquifers, groundwater discharge, nutrient retention, carbon sequestration, and erosion control. In fact, all of the aforementioned ecosystem functions are linked to wetland hydrology. Thus, altering hydrology has the potential to alter the capacity of a wetland to provide several ecosystem services that are of importance at a watershed scale. The intent of the *Risk Evaluation* is not to diminish the importance of any other ecosystem service provided by a wetland that is not explicitly addressed herein. That being said, biological indicators (fauna and flora) are used to characterize the capacity of wetlands to provide certain functions, and by focusing the *Risk Evaluation* on biological endpoints it is assumed that other functions will be protected. It is possible that in some cases particular functions will not be maintained, and in these cases impact on and maintenance of the additional service should be considered as well. If there is doubt about whether a particular ecosystem service will be maintained, the potential threat to that service should be evaluated in consultation with appropriate CA staff and the municipality.

In some cases where the existing level of wetland service provision or ecological function is low, it may be acceptable for there to be a divergence between the pre- and post-development hydroperiod such that the ecological function or other wetland services are enhanced. For example, where there is an opportunity to restore wetland habitat that is degraded or to create wetland habitat in an area with a limited amount of wetland habitat. The CA and municipality should be consulted in these cases to determine whether or not alteration to the water balance of a wetland is acceptable and appropriate.

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APPENDIX 1: CALCULATING THE IMPERVIOUS COVER SCORE

The *Risk Evaluation* uses a calculated value to classify the potential hydrological change that a given proportion of impervious cover within a wetland's catchment represents. Equation 1 allows a proponent to calculate the imperviousness cover score (S) that applies to a proposal, considering the proportion of impervious cover planned within the proponent's land (IC), the total catchment size (C), and the total development area of the catchment (C_{dev}). See Table 1 for definitions of these terms. The value of S is then compared to threshold values defining the boundaries between the low, medium, and high magnitude of potential hydrological change categories (10 % and 25 % respectively).

Equation 1: $S = \frac{IC \cdot C_{dev}}{C}$

This approach to determining the impact of impervious cover was selected over a simpler "total impervious cover within catchment" criterion for two main reasons:

1) The wetland's catchment may be controlled by multiple landowners who do not know each other's development intentions and timelines. This leaves the wetland vulnerable to degradation if none of the proposals individually requires a more stringent water balance analysis (i.e. has a high or medium risk outcome), but the cumulative impact of all proposals is nonetheless substantial and would have triggered a more stringent water balance analysis had they constituted a single proposal. <u>The impervious cover score approach avoids unforeseen cumulative effects.</u>

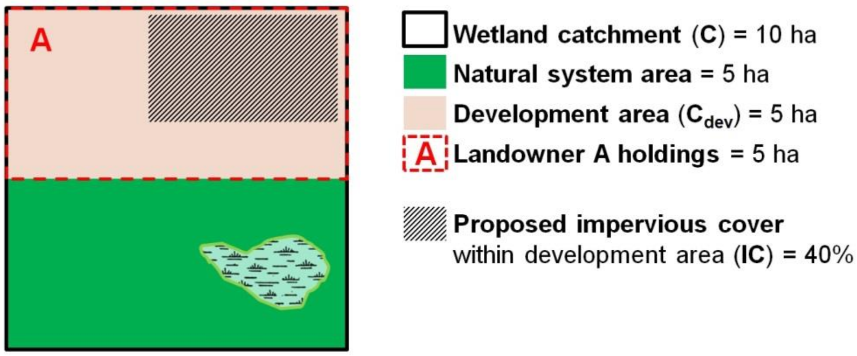
2) The use of a single "total impervious cover within catchment" criterion would mean that, in the case of multiple landowners within a catchment, it would be likely that those developing later would bear the costs of any more stringent water balance analyses required (i.e. a high or medium risk outcome), even if they have contributed a much smaller proportion of impervious cover to the wetland's catchment than those who developed earlier. <u>The impervious cover score approach ensures that proponents do not have to pay for mistakes made in the past or by other actors.</u>

This approach to determining the potential of a proposal to cause hydrological change distributes the impervious cover representing a given threshold of disturbance evenly across all of the development land within the wetland's catchment, regardless of the number of different landowners (see Example 3). It also considers the area of the catchment that is protected by natural heritage or natural hazard designations so as not to be unduly restrictive to proponents in setting the disturbance thresholds for impervious cover. This creates a fair playing field for all developers by ensuring that those developing later are not penalized by bearing the full cost of a water balance analysis that is triggered primarily by the actions of earlier developers

Four examples illustrating the application of this approach to different development scenarios are presented in this appendix. In each example, the shaded area representing various proposed impervious cover values illustrates the area of the catchment that would be covered if all of the impervious area were concentrated into one contiguous block.

Example 1 – One proponent with known impervious cover

Equation 1 can be applied to determine the impervious cover score (S) for a proposal if the proportion of impervious cover within the proponents holdings (IC) is known. Equation 1 considers the area of the wetland catchment that will not be developed by including the development area of the catchment (C_{dev}) as well as the total catchment area (C). In Example 1 the total catchment area is 10 hectares (C = 10), the total development area of the catchment is 5 hectares (C_{dev} = 5), and the proponent wishes to develop their holdings within the catchment to an impervious cover proportion of 40 percent (IC = 40%):



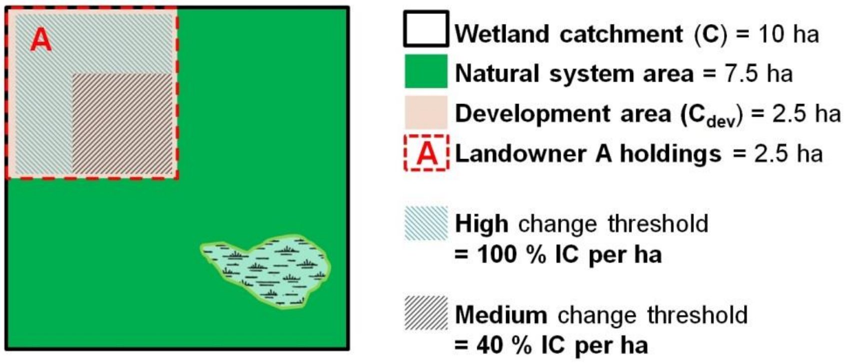
$$S = \frac{IC \cdot C_{dev}}{C} = \frac{40 \cdot 5\ ha}{10\ ha} = 20\ \%$$

The impervious cover score is 20%, and therefore the proposal would be classified as having a medium magnitude of potential hydrological change, because S is greater than 10% but less than 25%.

Example 2a – Determining impervious cover that corresponds to thresholds

In order to find the impervious cover proportion within a landowner's holdings (IC) that corresponds to the threshold impervious cover scores for either a high (**S = 25%**) or medium (**S = 10%**) magnitude of hydrological change classification, Equation 1 can be rearranged to solve for IC (Equation 2).

Equation 2: $$IC = \frac{S \cdot C}{C_{dev}}$$

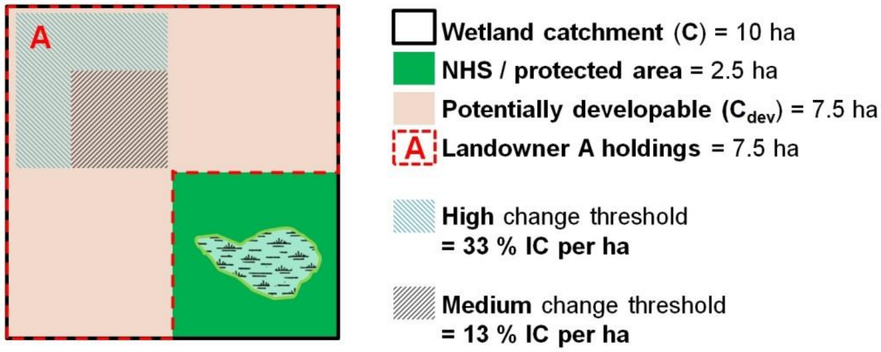


High magnitude: $IC = \frac{S \cdot C}{C_{dev}} = \frac{25 \cdot 10}{2.5} = 100\%$

Medium magnitude: $IC = \frac{S \cdot C}{C_{dev}} = \frac{10 \cdot 10}{2.5} = 40\%$

In Example 2, a "high magnitude of potential hydrological change" (high magnitude) classification is produced if the impervious cover in the proposal exceeds 100 % (that is, a high magnitude classification for the impervious cover criterion is not physically possible in this example). A medium magnitude outcome occurs if the proportion of impervious cover in the proposal is greater than or equal to 40 %. These impervious cover scores correspond to a *total* catchment (C) impervious cover value of 25 % for the lower boundary of the high magnitude category, and 10 % for the lower boundary of the medium magnitude category, in keeping with the threshold impervious cover values established in the scientific literature.

Example 2b – Determining impervious cover that corresponds to threshold scores



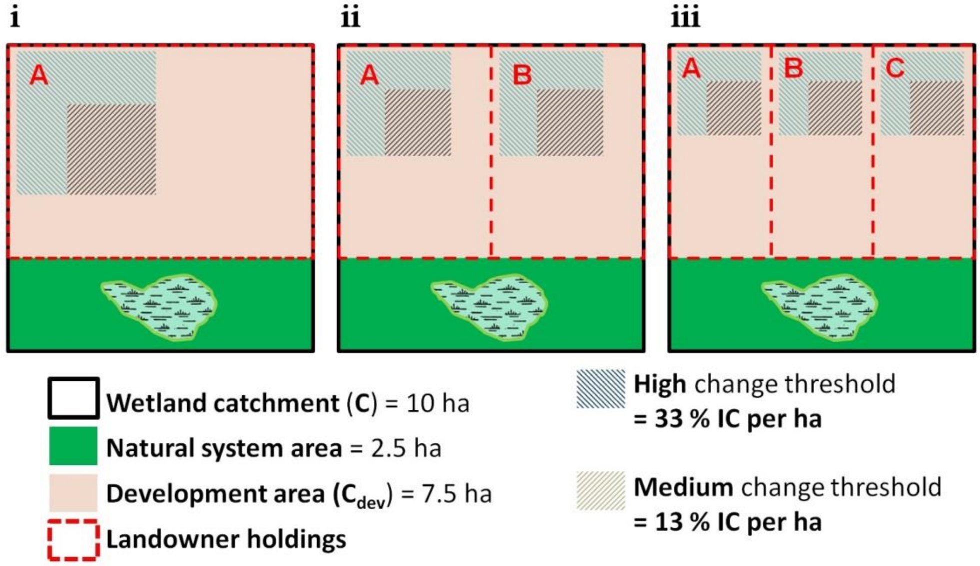
High magnitude: $IC = \frac{S \cdot C}{C_{dev}} = \frac{0.25 \cdot 10}{7.5} =$ 0.33 or 33%

Medium magnitude: $IC = \frac{S \cdot C}{C_{dev}} = \frac{0.1 \cdot 10}{7.5} =$ 0.13 or 13%

In Example 2b, a high magnitude classification is produced if the impervious cover in the proposal exceeds 33%, while a medium magnitude outcome occurs if the proportion of impervious cover in the proposal is between 13% and 33%. The impervious cover scores correspond to a *total* catchment (C) impervious cover value of 25% for the lower boundary of the high magnitude category, and 10% for the lower boundary of the medium magnitude category.

Example 3 – Multiple landowners and proposals

In many cases there will be multiple landowners and developers working within the same wetland catchment. The impervious cover value can be calculated for any of the individual landowners



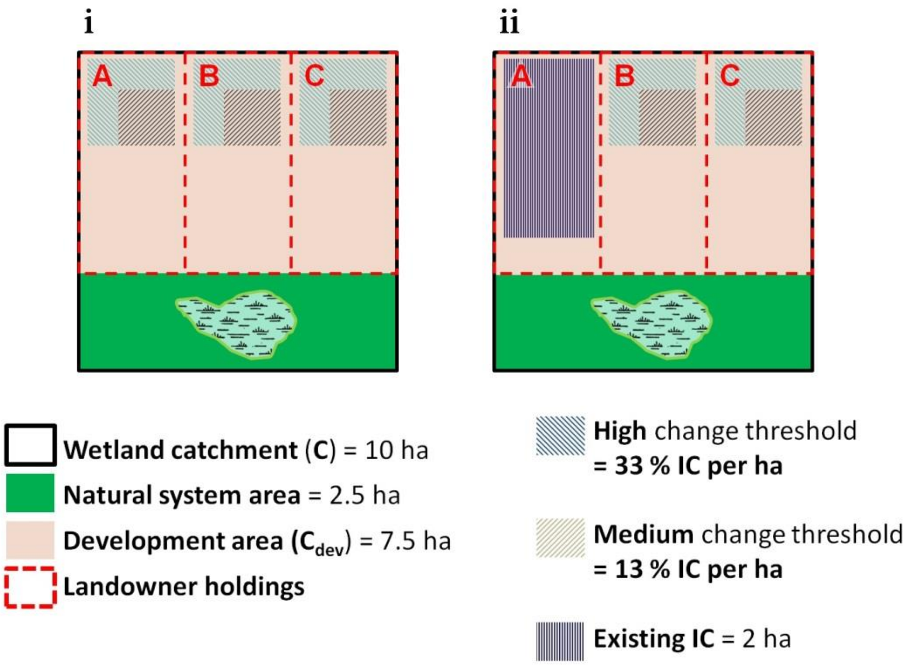
High magnitude: $IC = \frac{S \cdot C}{C_{dev}} = \frac{0.25 \cdot 10}{7.5} =$ 33%

Medium magnitude: $IC = \frac{S \cdot C}{C_{dev}} = \frac{0.1 \cdot 10}{7.5} =$ 13%

In Example 3, three different scenarios are shown with between one and three proponents owning land within the same wetland catchment. This example shows that in each case (i, ii, and iii) a high magnitude classification is produced if the impervious cover in the proposal exceeds 33%, and a medium magnitude outcome occurs if the proportion of impervious cover in the proposal is between 13% and 33%, regardless of the number of different proponents. The calculation does not consider the amount of land each individuals land owner holds, it considers the total development area within the wetland catchment and returns a percent of impervious surface. In each case (i, ii, and iii) the impervious cover scores correspond to a *total* catchment (C) impervious cover value of 25% for the threshold of the high magnitude category, and 10% for the threshold of the medium magnitude category. The same impervious cover score thresholds for the high and medium magnitude categories apply to each landowner in (iii), irrespective of development or land acquisition timelines. This ensures that total catchment imperviousness does not exceed one of the potential hydrological change thresholds without requiring an appropriately scoped water balance study.

Example 4 – Existing development within catchment (infill scenario)

In some cases proposals to develop land within a wetland catchment with existing development will occur. Example 4 is similar to Example 3, except that in Example 4 (ii), there is existing development within the catchment.



High magnitude: $IC = \frac{S \cdot C}{C_{dev}} = \frac{25 \cdot 10}{7.5} =$ 33%

Medium magnitude: $IC = \frac{S \cdot C}{C_{dev}} = \frac{10 \cdot 10}{7.5} =$ 13%

The thresholds corresponding to the high and medium magnitude outcomes do not change between case (i) and case (ii) despite the higher existing total impervious cover within the catchment overall. The equation only considers the proportion of the catchment (C) that is considered development area (C_{dev}), i.e. the area of the catchment outside of the natural system, and does not consider any existing impervious cover. The impervious cover score approach allows the Risk Evaluation to be applied to infill development scenarios and existing urban areas in which a wetland has been determined to be protected. In many older semi-urbanized or fully urbanized areas, remaining wetland communities and functions may have already shifted to reflect the altered drainage conditions within the catchment. Baseline conditions may have changed, and the objective may be to maintain the new hydrological and ecological conditions.

APPENDIX 2: LIST OF WETLAND COMMUNITY TYPES WITHIN TORONTO AND REGION CONSERVATION AUTHORITY JURISDICTION BY HYDROLOGICAL SENSITIVITY

A list of wetland community types (Ecological Land Classification Ontario) ranked by sensitivity to hydrological change is used to evaluate the wetland sensitivity criteria in Step 3 of the *Risk Evaluation* (Section 2.3). Ranking of communities into different sensitivity categories was done by TRCA ecologists. Note that other CAs adopting this document may wish to modify Appendix 2 and Appendix 3 to suit the ecological communities and conservation priorities in their jurisdictions.

Wetland communities were sorted by L-rank (L1-L5) for the native communities and L+ and L+? for exotic communities. Generally, L1-L2 communities were assigned a high-sensitivity rating due to their stringent habitat needs, L3-L4 communities were assigned a medium sensitivity, and L5 communities were assigned a low sensitivity. Further details about this list and the methodology used to produce it can be provided by TRCA upon request.

Vegetation Community	ELC Code	Sensitivity	Assumptions/Basis
White Pine - Red Maple - Birch - Leatherleaf Treed Kettle Bog	BOT2-1A	High	Nutrient poor system. Community slow to recover from hydrological changes
Leatherleaf Shrub Kettle Bog	BOS2-1	High	Nutrient poor system. Community slow to recover from hydrological changes
Tamarack - Leatherleaf Treed Kettle Bog	BOT2-1	High	Nutrient poor system. Community slow to recover from hydrological changes
Slender Sedge Open Fen	FEO1-2	High	Mineral rich community. Groundwater fed. Community slow to recover from hydrological changes
Beaked Sedge Open Fen	FEO1-5	High	Mineral rich community. Groundwater fed. Community slow to recover from hydrological changes
Willow Shrub Fen	FES1-A	High	Mineral rich community. Groundwater fed. Community slow to recover from hydrological changes
Tamarack Treed Fen	FET1-1	High	Mineral rich community. Groundwater fed. Community slow to recover from hydrological changes
Leatherleaf - Forb Shrub Fen	FES1-4	High	Mineral rich community. Groundwater fed. Community slow to recover from hydrological changes
Low White Cedar Shrub Fen	FES1-9	High	Mineral rich community. Groundwater fed. Community slow to recover from hydrological changes
Tamarack - White Cedar Treed Fen	FET1-2	High	Mineral rich community. Groundwater fed. Community slow to recover from hydrological changes
Bog Buckbean - Sedge Open Fen	FEO1-4	High	Mineral rich community. Groundwater fed. Community slow to recover from hydrological changes

Vegetation Community	ELC Code	Sensitivity	Assumptions/Basis
Willow Shrub Mineral Fen	FES2-A	High	Mineral rich community. Groundwater fed. Community slow to recover from hydrological changes
White Cedar - Scots Pine Low Treed Mineral Fen	FET2-B	High	Mineral rich community. Groundwater fed. Community slow to recover from hydrological changes
White Cedar Low Treed Mineral Fen	FET2-A	High	Mineral rich community. Groundwater fed. Community slow to recover from hydrological changes
Bluejoint - Switchgrass Tallgrass Meadow Marsh	MAM6-A	High	Community slow to recover from hydrological changes
Nelson's Scouring Rush - Baltic Rush Coastal Fen	MAM4-A	High	Community slow to recover from hydrological changes
Unvegetated Mineral Vernal Pool	MAS2-H	High	Community slow to recover from hydrological changes
Narrow-leaved Sedge Organic Shallow Marsh	MAS3-3	High	Community slow to recover from hydrological changes
Unvegetated Organic Vernal Pool	MAS3-E	High	Community slow to recover from hydrological changes
Calla Lily Organic Shallow Marsh	MAS3-11	High	Community slow to recover from hydrological changes
Narrow-leaved Sedge Organic Meadow Marsh	MAM3-5	High	Community slow to recover from hydrological changes
Swamp Loosestrife Organic Shallow Marsh	MAS3-12	High	Community slow to recover from hydrological changes
Broad-leaved Sedge Organic Shallow Marsh	MAS3-4	High	Community slow to recover from hydrological changes
Bur-reed Organic Shallow Marsh	MAS3-7	High	Community slow to recover from hydrological changes
Horsetail Organic Shallow Marsh	MAS3-B	High	Community slow to recover from hydrological changes
Manna Grass Organic Shallow Marsh	MAS3-C	High	Community slow to recover from hydrological changes
Bluejoint Organic Meadow Marsh	MAM3-1	High	Community slow to recover from hydrological changes
Broad-leaved Sedge Organic Meadow Marsh	MAM3-6	High	Community slow to recover from hydrological changes
Mineral Fen Meadow Marsh	MAM5-1	High	Community slow to recover from hydrological changes
Forb Organic Shallow Marsh	MAS3-10	High	Community slow to recover from hydrological changes
Bulrush Organic Shallow Marsh	MAS3-2	High	Community slow to recover from hydrological changes
Rice Cut-grass Organic Shallow Marsh	MAS3-8	High	Community slow to recover from hydrological changes
Bur-reed Mixed Shallow Aquatic	SAM1-5	High	Community slow to recover from hydrological changes
Crowfoot Mixed Shallow Aquatic	SAM1-C	High	Community slow to recover from hydrological changes
Bladderwort Mixed Shallow Aquatic	SAM1-6	High	Community slow to recover from hydrological changes
Bushy Naiad Submerged Shallow Aquatic	SAS1-B	High	Community tolerant of slight hydrological change

Vegetation Community	ELC Code	Sensitivity	Assumptions/Basis
Water Lily - Bullhead Lily Mixed Shallow Aquatic	SAM1-A	High	Community slow to recover from hydrological changes
Tamarack - Black Spruce Organic Coniferous Swamp	SWC4-1	High	Community slow to recover from hydrological changes
Tamarack - Balsam Fir - Spruce Organic Coniferous Swamp	SWC4-A	High	Community slow to recover from hydrological changes
Swamp Maple - Conifer Organic Mixed Swamp	SWM5-2	High	Community slow to recover from hydrological changes
Red (Green) Ash - Hemlock Mineral Mixed Swamp	SWMA-A	High	Community slow to recover from hydrological changes
Buttonbush Mineral Thicket Swamp	SWT2-4	High	Community slow to recover from hydrological changes
Mountain Maple Organic Thicket Swamp	SWT3-3	High	Community tolerant of slight hydrological change
Silky Dogwood Organic Thicket Swamp	SWT3-B	High	Community tolerant of slight hydrological change
Tamarack Organic Coniferous Swamp	SWC4-2	High	Community slow to recover from hydrological changes
Buttonbush Organic Thicket Swamp	SWT3-4	High	Community slow to recover from hydrological changes
Spiraea Organic Thicket Swamp	SWT3-A	High	Community slow to recover from hydrological changes
Hemlock Organic Coniferous Swamp	SWCA-A	High	Community slow to recover from hydrological changes
White Birch - Cottonwood Coastal Mineral Deciduous Swamp	SWD4-A	High	Community slow to recover from hydrological changes
Red Maple Organic Deciduous Swamp	SWD6-1	High	Community slow to recover from hydrological changes
Silver Maple Organic Deciduous Swamp	SWD6-2	High	Community slow to recover from hydrological changes
Red Maple - Conifer Organic Mixed Swamp	SWM5-1	High	Community slow to recover from hydrological changes
Poplar - Conifer Organic Mixed Swamp	SWM6-2	High	Community slow to recover from hydrological changes
Winterberry Mineral Thicket Swamp	SWT2-B	High	Community slow to recover from hydrological changes
Winterberry Organic Thicket Swamp	SWT3-7	High	Community slow to recover from hydrological changes
Swamp Maple - Conifer Mineral Mixed Swamp	SWM2-2	High	Community slow to recover from hydrological changes
Hemlock Mineral Coniferous Swamp	SWC2-2	High	Community slow to recover from hydrological changes
Red Maple - Conifer Mineral Mixed Swamp	SWM2-1	High	Community slow to recover from hydrological changes
Yellow Birch Organic Deciduous Swamp	SWD7-2	High	Community slow to recover from hydrological changes
White Cedar - Conifer Organic Coniferous Swamp	SWC3-2	High	Community slow to recover from hydrological changes
Birch - Conifer Organic Mixed Swamp	SWM6-1	High	Community slow to recover from hydrological changes
White Cedar - Hardwood Organic Mixed Swamp	SWM4-1	High	Community slow to recover from hydrological changes
Threesquare Mineral Shallow Marsh	MAS2-6	Medium	Community tolerant of slight hydrological change

Vegetation Community	ELC Code	Sensitivity	Assumptions/Basis
Sweet Flag Mineral Shallow Marsh	MAS2-F	Medium	Community tolerant of slight hydrological change
Jewelweed Organic Meadow Marsh	MAM3-8	Medium	Community tolerant of slight hydrological change
Narrow-leaved Sedge Mineral Shallow Marsh	MAS2-3	Medium	Community tolerant of slight hydrological change
Horsetail Mineral Shallow Marsh	MAS2-C	Medium	Community tolerant of slight hydrological change
Rush Mineral Meadow Marsh	MAM2-C	Medium	Community tolerant of slight hydrological change
Rice Cut-grass Organic Meadow Marsh	MAM3-3	Medium	Community tolerant of slight hydrological change
Buejoint Mineral Meadow Marsh	MAM2-1	Medium	Community tolerant of slight hydrological change
Narrow-leaved Sedge Mineral Meadow Marsh	MAM2-5	Medium	Community tolerant of slight hydrological change
Broad-leaved Sedge Mineral Meadow Marsh	MAM2-6	Medium	Community tolerant of slight hydrological change
Horsetail Mineral Meadow Marsh	MAM2-7	Medium	Community tolerant of slight hydrological change
Forb Organic Meadow Marsh	MAM3-9	Medium	Community tolerant of slight hydrological change
Broad-leaved Sedge Mineral Shallow Marsh	MAS2-4	Medium	Community tolerant of slight hydrological change
Bur-reed Mineral Shallow Marsh	MAS2-7	Medium	Community tolerant of slight hydrological change
Broad-leaved Cattail Organic Shallow Marsh	MAS3-1A	Medium	Community tolerant of slight hydrological change
Bulrush Mineral Meadow Marsh	MAM2-E	Medium	Community tolerant of slight hydrological change
Rice Cut-grass Mineral Shallow Marsh	MAS2-8	Medium	Community tolerant of slight hydrological change
Manna Grass Mineral Shallow Marsh	MAS2-G	Medium	Community tolerant of slight hydrological change
Bulrush Mineral Shallow Marsh	MAS2-2	Medium	Community tolerant of slight hydrological change
Forb Mineral Shallow Marsh	MAS2-9	Medium	Community tolerant of slight hydrological change
Broad-leaved Cattail Mineral Shallow Marsh	MAS2-1A	Medium	Community tolerant of slight hydrological change
Watercress Mixed Shallow Aquatic	SAM1-3	Medium	Community tolerant of slight hydrological change
Water Milfoil Mixed Shallow Aquatic	SAM1-7	Medium	Community tolerant of slight hydrological change
Water Lily - Bullhead Lily Floating-leaved Shallow Aquatic	SAF1-1	Medium	Community tolerant of slight hydrological change
Wild Celery Submerged Shallow Aquatic	SAS1-5	Medium	Community tolerant of slight hydrological change
Pondweed Mixed Shallow Aquatic	SAM1-4	Medium	Community tolerant of slight hydrological change
Waterweed Submerged Shallow Aquatic	SAS1-2	Medium	Community tolerant of slight hydrological change
Water Milfoil Submerged Shallow Aquatic	SAS1-4	Medium	Community tolerant of slight hydrological change

Vegetation Community	ELC Code	Sensitivity	Assumptions/Basis
Coon-tail Submerged Shallow Aquatic	SAS1-A	Medium	Community tolerant of slight hydrological change
Duckweed Floating-leaved Shallow Aquatic	SAF1-3	Medium	Community tolerant of slight hydrological change
Duckweed Mixed Shallow Aquatic	SAM1-2	Medium	Community tolerant of slight hydrological change
Pondweed Submerged Shallow Aquatic	SAS1-1	Medium	Community tolerant of slight hydrological change
Stonewort Submerged Shallow Aquatic	SAS1-3	Medium	Community tolerant of slight hydrological change
Spiraea Mineral Thicket Swamp	SWT2-6	Medium	Community tolerant of slight hydrological change
Nannyberry Mineral Thicket Swamp	SWT2-10	Medium	Community tolerant of slight hydrological change
Mountain Maple Mineral Thicket Swamp	SWT2-3	Medium	Community tolerant of slight hydrological change
White Cedar - Conifer Mineral Coniferous Swamp	SWC1-2	Medium	Community tolerant of slight hydrological change
Bur Oak Mineral Deciduous Swamp	SWD1-2	Medium	Community tolerant of slight hydrological change
Red Maple Mineral Deciduous Swamp	SWD3-1	Medium	Community tolerant of slight hydrological change
Willow Organic Deciduous Swamp	SWD7-A	Medium	Community tolerant of slight hydrological change
Birch - Conifer Mineral Mixed Swamp	SWM3-1	Medium	Community tolerant of slight hydrological change
Poplar - Conifer Mineral Mixed Swamp	SWM3-2	Medium	Community tolerant of slight hydrological change
Silky Dogwood Mineral Thicket Swamp	SWT2-8	Medium	Community tolerant of slight hydrological change
Yellow Birch Mineral Deciduous Swamp	SWD4-4	Medium	Community tolerant of slight hydrological change
Black Ash Organic Deciduous Swamp	SWD5-1	Medium	Community tolerant of slight hydrological change
Swamp Maple Organic Deciduous Swamp	SWD6-3	Medium	Community tolerant of slight hydrological change
Alder Organic Thicket Swamp	SWT3-1	Medium	Community tolerant of slight hydrological change
Red-osier Organic Thicket Swamp	SWT3-5	Medium	Community tolerant of slight hydrological change
White Cedar Organic Coniferous Swamp	SWC3-1	Medium	Community tolerant of slight hydrological change
Paper Birch - Poplar Organic Deciduous Swamp	SWD7-1	Medium	Community tolerant of slight hydrological change
Willow Organic Thicket Swamp	SWT3-2	Medium	Community tolerant of slight hydrological change
White Ash Mineral Deciduous Swamp	SWD2-A	Medium	Community tolerant of slight hydrological change
White Cedar Mineral Coniferous Swamp	SWC1-1	Medium	Community tolerant of slight hydrological change
Black Ash Mineral Deciduous Swamp	SWD2-1	Medium	Community tolerant of slight hydrological change
Swamp Maple Mineral Deciduous Swamp	SWD3-3	Medium	Community tolerant of slight hydrological change

Vegetation Community	ELC Code	Sensitivity	Assumptions/Basis
White Elm Mineral Deciduous Swamp	SWD4-2	Medium	Community tolerant of slight hydrological change
Alder Mineral Thicket Swamp	SWT2-1	Medium	Community tolerant of slight hydrological change
Red (Green) Ash Mineral Deciduous Swamp	SWD2-2	Medium	Community tolerant of slight hydrological change
Silver Maple Mineral Deciduous Swamp	SWD3-2	Medium	Community tolerant of slight hydrological change
Paper Birch - Poplar Mineral Deciduous Swamp	SWD4-3	Medium	Community tolerant of slight hydrological change
Willow Mineral Thicket Swamp	SWT2-2	Medium	Community tolerant of slight hydrological change
White Cedar - Hardwood Mineral Mixed Swamp	SWM1-1	Medium	Community tolerant of slight hydrological change
Fowl Manna Grass Organic Meadow Marsh	MAM3-4	Medium	Maybe sensitive to hydrological change
Fowl Manna Grass Mineral Meadow Marsh	MAM2-4	Medium	Maybe sensitive to hydrological change
Rice Cut-Grass Mineral Meadow Marsh	MAM2-D	Medium	Maybe sensitive to hydrological change
Reed Canary Grass Organic Meadow Marsh	MAM3-2	Medium	Substrate sensitive to change. Organic soils are slow to accumulate
Common Reed Organic Meadow Marsh	MAM3-a	Medium	Substrate sensitive to change. Organic soils are slow to accumulate
Giant Manna Grass Mineral Shallow Marsh	MAS2-e	Medium	
Narrow-leaved Cattail Organic Shallow Marsh	MAS3-1b	Medium	Substrate sensitive to change. Organic soils are slow to accumulate
Common Reed Organic Shallow Marsh	MAS3-9	Medium	Substrate sensitive to change. Organic soils are slow to accumulate
Purple Loosestrife Organic Shallow Marsh	MAS3-a	Medium	Substrate sensitive to change. Organic soils are slow to accumulate
Reed Canary Grass Organic Shallow Marsh	MAS3-d	Medium	Substrate sensitive to change. Organic soils are slow to accumulate
Floating-heart Mixed Shallow Aquatic	SAM1-b	Medium	
Exotic Organic Thicket Swamp	SWT3-c	Medium	Substrate sensitive to change. Organic soils are slow to accumulate
Jewelweed Mineral Meadow Marsh	MAM2-9	Low	Community moderately tolerant of hydrological changes
Forb Mineral Meadow Marsh	MAM2-10	Low	Community moderately tolerant of hydrological changes
Liverwort Floating-leaved Shallow Aquatic	SAF1-A	Low	Community moderately tolerant of hydrological changes
Manitoba Maple Mineral Deciduous Swamp	SWD3-4	Low	Community moderately tolerant of hydrological changes
Willow Mineral Deciduous Swamp	SWD4-1	Low	Community moderately tolerant of hydrological changes

Vegetation Community	ELC Code	Sensitivity	Assumptions/Basis
Red-osier Mineral Thicket Swamp	SWT2-5	Low	Community moderately tolerant of hydrological changes
Red-top Mineral Meadow Marsh	MAM2-3	Low	Community moderately tolerant of hydrological changes
Reed Canary Grass Mineral Meadow Marsh	MAM2-2	Low	
Miscanthus Mineral Meadow Marsh	MAM2-f	Low	
Cool-season Grass Mineral Meadow Marsh	MAM2-g	Low	
Reed Canary Grass Mineral Shallow Marsh	MAS2-d	Low	
European Alder Mineral Deciduous Swamp	SWD4-b	Low	
Exotic Mineral Thicket Swamp	SWT2-a	Low	

APPENDIX 3: LIST OF HYDROLOGICALLY SENSITIVE FAUNA AND FLORA WITHIN TORONTO AND REGION CONSERVATION AUTHORITY JURISDICTION BY HYDROLOGICAL SENSITIVITY

This appendix contains two lists, one of hydrologically sensitive fauna (grouped into herpetofauna, birds, mammals and fish) and a second list of individual flora ranked by sensitivity. Fauna rankings were derived from the sources cited in the references section in addition to the professional experience of TRCA staff. Note that other CAs adopting this document may wish to modify Appendix 2 and Appendix 3 to suit the ecological communities and conservation priorities in their jurisdictions.

Flora rankings were assigned using a combination of co-efficient of Conservatism values (CC), L-Ranks and expert opinion. The Terrestrial Natural Heritage Access Database was queried to produce a list of all species sensitive to hydrology. The coefficient of wetness score (CW, range 5 to - 5), which defines a species' likelihood to occur in a wetland was then used to separate terrestrial species from wetland species (i.e. only facultative to obligate wetland species with a CW score of -2 to -5 were included). Species were then sorted in descending order based on their coefficient of conservatism value, CC (range 0 to 10). Conservatism value describes a species ability to persist and adapt to change in its habitat. Species with higher CC values are unlikely to tolerate change because they are specialists that are confined to specific environmental conditions and habitat types. Species with lower CC values are more generalist in nature, and can tolerate a wider range of conditions and habitats and as such are less sensitive to disturbance. Species with a CC value of 8 to 10 were deemed highly sensitive, 4 to 7 were deemed moderately sensitive and 0 to 3 were deemed mildly sensitive to changes in hydrology. Those species highlighted pale brown may be sensitive to hydrology (currently unclear). Where possible, species that act as groundwater indicators were indicated.

Fauna List			
Fauna	**Sensitivity**	**Sensitive Periods**	**L-Rank**
Herpetofauna-			
gray treefrog	High	late Apr-early Oct	L2
wood frog	High	late Mar-end Aug	L2
northern spring peeper	High	start Apr-end Sep	L2
western chorus frog	High	end Mar-end July	L2
northern leopard frog	High	late Sep-mid Aug	L3
mink frog	High	all year	L2
American bullfrog	High	all year	L2
pickerel frog	High	early Oct-late Aug	L2
mudpuppy	High	all year	LX
eastern newt	High	all year	L2

Fauna	Sensitivity	Sensitive Periods	L-Rank
blue-spotted salamander	High	Mar-Aug	LX
Jefferson salamander complex	High	early Mar-Sep	L1
yellow-spotted salamander	High	Mar-Oct	L1
Blanding's turtle	High	all year	L1
common map turtle	High	all year	L2
common musk turtle	High	all year	LX
common snapping turtle	High	all year	L2
midland painted turtle	High	all year	L3
green frog	Medium	all year	L4
American toad	Medium	late Apr-mid Sep	L4
northern watersnake	Medium	Apr-Oct	L2
Birds-			
American coot	High	early Apr-late Oct	L2
American bittern	High	early Apr-mid Oct	L2
least bittern	High	late Apr-late Oct	L2
common moorhen	High	early Apr-mid Sep	L2
pied-billed grebe	High	early Apr-end Oct	L3
red-necked grebe	High	late Apr-mid Oct	L3
canvasback	High	late Apr-end Sep	L2
hooded merganser	High	mid Mar-late Oct	L3
Virginia Rail	Medium	early Apr-mid Sep	L3
Northern waterthrush	Medium	start May-mid Aug	L3
blue-winged teal	Medium	early Apr-early Oct	L3
green-winged teal	Medium	mid Apr-early Sep	L2
prothonotary warbler	Medium	early May-end Aug	L2
sora	Medium	early Apr-end Sep	L3
American black duck	Medium	early Mar-end Oct	L3
gadwall	Medium	end Mar-mid Oct	L4
marsh wren	Medium	late Apr-mid Sep	L3
wood duck	Medium	early Mar-end Oct	L4
great blue heron	Low	start Apr-early Oct	L3
great egret	Low	mid Apr-late Sep	L3
green heron	Low	early Apr-end Sep	L4
black-crowned night heron	Low	early Apr-late Oct	L3
alder flycatcher	Low	late May-late Aug	L4
Canada goose	Low	early Mar-early Oct	L5
common yellowthroat	Low	start May-late Aug	L4
mallard	Low	mid Mar-end Oct	L5
swamp sparrow	Low	early Apr-end Aug	L4
Wilson's snipe	Low	start Apr-early Sep	L3

Fauna	Sensitivity	Sensitive Periods	L-Rank
Mammals-			
muskrat	High	all year	L4
mink	Low	all year	L4
beaver	Low	all year	L4
star-nosed mole	Low	all year	L3
Fish-			
northern pike	High		
blackchin minnow	High		
northern redbelly dace	Medium		
central mudminnow	Medium		
brook stickleback	Low		
fathead minnow	Low		

Flora List							
Scientific Name	**Common Name**	**Sensitivity**	**L-Rank**	**CC**	**CW**	**GW Obligate**	**GW Fac-ultative**
Acorus americanus	sweet flag	High	L3	8	-5		
Andromeda polifolia var. latifolia	bog rosemary	High	L1	10	-5		
Arethusa bulbosa	dragon's mouth orchid	High	LX	10	-5		
Betula pumila	dwarf birch	High	L1	9	-5		
Bidens beckii	water-marigold	High	L1	8	-5		
Calamagrostis stricta ssp. inexpansa	northern reed grass	High	L2	8	-4		
Calla palustris	water arum	High	L2	8	-5		
Calopogon tuberosus	grass pink	High	L1	9	-5		
Calypso bulbosa	calypso	High	LX	10	-3		
Cardamine bulbosa	spring cress	High	L2	8	-5		
Carex billingsii	Billings' three-seeded sedge	High	L1	9	-5		
Carex buxbaumii	dark-scaled sedge	High	L2	10	-5		
Carex chordorrhiza	creeping sedge	High	L2	10	-5		
Carex disperma	two-seeded sedge	High	L3	8	-5	x	
Carex garberi	Garber's sedge	High	L2	10	-3		
Carex grayi	Gray's sedge	High	L3	8	-4		
Carex laevivaginata	smooth-sheathed sedge	High	L3	8	-5	x	
Carex lasiocarpa	slender woolly sedge	High	L2	8	-5		
Carex leptalea	bristle-stalked sedge	High	L3	8	-5	x	
Carex limosa	mud sedge	High	L2	10	-5		
Carex lupulina	hop sedge	High	L4	10	-4		
Carex magellanica ssp. irrigua	stunted sedge	High	L2	10	-5		
Carex pauciflora	few-flowered sedge	High	LX	10	-5		
Carex prasina	drooping sedge	High	L2	10	-5		
Carex scabrata	rough sedge	High	L4	8	-5	x	
Carex schweinitzii	Schweinitz' sedge	High	L2	9	-5	x	
Carex tenuiflora	sparse-flowered sedge	High	L2	10	-5		
Carex trisperma	three-seeded sedge	High	L3	9	-5	x	
Chamaedaphne calyculata	leatherleaf	High	L3	9	-5		
Chrysosplenium americanum	golden saxifrage	High	L3	8	-5	x	
Cirsium muticum	swamp thistle	High	L1	8	-5		
Cladium mariscoides	twig-rush	High	L1	9	-5		
Dichanthelium acuminatum ssp. lindheimeri	Lindheimer's panic grass	High	L2	8	-5		
Drosera intermedia	spatulate-leaved sundew	High	LX	9	-5		
Eleocharis flavescens var. olivacea	olive-fruited spike-rush	High	L1	8	-5		
Eleocharis quinqueflora	few-flowered spike-rush	High	L2	10	-5		
Epilobium strictum	downy willow-herb	High	L3	9	-5		
Equisetum palustre	marsh horsetail	High	L1	10	-3		
Equisetum pratense	thicket horsetail	High	L3	8	-3		
Eriophorum gracile	slender cotton-grass	High	L1	10	-5		
Eriophorum tenellum	rough cotton-grass	High	L1	10	-5		
Eriophorum vaginatum ssp. spissum	dense cotton-grass	High	L1	10	-5		
Eriophorum virginicum	tawny cotton-grass	High	L2	10	-5		
Eriophorum viridicarinatum	thin-leaved cotton-grass	High	L2	9	-5	x	
Galium labradoricum	Labrador bedstraw	High	L1	9	-5		
Gaultheria hispidula	creeping snowberry	High	L1	8	-3		

Scientific Name	Common Name	Sensitivity	L-Rank	CC	CW	GW Obligate	GW Fac-ultative
Glyceria borealis	northern manna grass	High	L3	8	-5		
Glyceria septentrionalis	eastern manna grass	High	L3	8	-5		
Hippuris vulgaris	mare's tail	High	LX	10	-5		
Hydrophyllum canadense	Canada waterleaf	High	L3	8	-2		
Ilex mucronata	mountain holly	High	L2	8	-5		
Juncus brachycephalus	small-headed rush	High	L2	10	-3		
Kalmia polifolia	bog laurel	High	L2	10	-5		
Listera cordata	heart-leaved twayblade	High	L1	8	-3		
Lobelia kalmii	Kalm's lobelia	High	L1	9	-5		
Lonicera oblongifolia	swamp fly honeysuckle	High	LX	8	-5		
Maianthemum trifolium	three-leaved false Solomon's seal	High	L3	10	-5		
Menyanthes trifoliata	bog buckbean	High	L2	9	-5		
Mimulus moschatus	musk-flower	High	L2	9	-5		
Parnassia parviflora	small-flowered grass of Parnassus	High	L1	9	-5		
Pedicularis lanceolata	swamp lousewort	High	LX	9	-4		
Peltandra virginica	tuckahoe	High	L3	9	-5		
Petasites frigidus	palmate-leaved sweet coltsfoot	High	L1	8	-3		
Picea mariana	black spruce	High	L2	8	-3		
Platanthera blephariglottis var. blephariglottis	white-fringed orchis	High	LX	10	-5		
Platanthera clavellata	club-spur orchis	High	LX	8	-4		
Platanthera obtusata	small northern bog orchis	High	LX	9	-3		
Platanthera psycodes	small purple-fringed orchis	High	LX	8	-3		
Pogonia ophioglossoides	rose pogonia	High	L1	10	-5		
Potamogeton oakesianus	Oake's pondweed	High	L2	10	-5		
Potamogeton spirillus	spiral pondweed	High	LX	8	-5		
Potamogeton strictifolius	narrow-leaved pondweed	High	LU	8	-5		
Rhododendron groenlandicum	Labrador-tea	High	L2	9	-5		
Rhynchospora alba	white beak-rush	High	L1	10	-5		
Ribes hudsonianum	northern black currant	High	L1	8	-5		
Sagittaria graminea ssp. graminea	grass-leaved arrowhead	High	LX	8	-5		
Salix candida	hoary willow	High	L2	10	-5		
Salix pedicellaris	bog willow	High	L2	9	-5		
Samolus parviflorus	Valerand's water-pimpernel	High	LU	8	-5		
Sarracenia purpurea	pitcher-plant	High	L1	10	-5		
Scheuchzeria palustris	bog arrow-grass	High	LX	10	-5		
Schoenoplectus smithii var. smithii	Smith's club-rush	High	LX	10	-5		
Scleria verticillata	low nut-rush	High	L2	10	-5		
Solidago patula	rough-leaved goldenrod	High	L4	8	-5		
Solidago uliginosa	bog goldenrod	High	L2	9	-5		
Sparganium natans	lesser bur-reed	High	L2	8	-5		
Spiranthes lucida	shining ladies' tresses	High	L2	9	-4	x	
Spiranthes romanzoffiana	hooded ladies' tresses	High	L1	9	-4	x	
Stuckenia filiformis ssp. filiformis	thread-leaved pondweed	High	LX	8	-5		
Symphyotrichum boreale	bog aster	High	L2	10	-5		
Torreyochloa pallida var. fernaldii	Fernald's manna grass	High	L2	8	-5		
Toxicodendron vernix	poison sumach	High	LX	8	-5		
Triantha occidentalis ssp. brevistyla	sticky false asphodel	High	LX	10	-5		
Triglochin maritima	seaside arrow-grass	High	L1	8	-5		

Scientific Name	Common Name	Sensitivity	L-Rank	CC	CW	GW Obligate	GW Fac-ultative
Triglochin palustris	marsh arrow-grass	High	LX	10	-5		
Utricularia intermedia	flat-leaved bladderwort	High	L1	8	-5		
Utricularia minor	small bladderwort	High	L2	8	-5		
Vaccinium corymbosum	highbush blueberry	High	L1	8	-3		
Vaccinium macrocarpon	large cranberry	High	L2	10	-5		
Vaccinium oxycoccos	small cranberry	High	L2	10	-5		
Valeriana uliginosa	swamp valerian	High	L1	10	-4		
Viola sagittata var. ovata	arrow-leaved violet	High	L1	9	-2		
Woodwardia virginica	Virginia chain-fern	High	L1	10	-5		
Zizania palustris var. palustris	northern wild rice	High	L2	9	-5		
Agalinis paupercula	small-flowered gerardia	High	L1	8	-5		
Carex trichocarpa	hairy-fruited sedge	High	L3	8	-5		
Elodea nuttallii	Nuttall's water-weed	High	L3	8	-5		
Gentianopsis crinita	fringed gentian	High	L2	8	-4	x	
Physostegia virginiana ssp. virginiana	false dragonhead	High	L3	8	-3		
Platanus occidentalis	sycamore	High	L2	8	-3		
Salix myricoides	blue-leaved willow	High	LX	10	-3		
Abies balsamea	balsam fir	Medium	L3	5	-3		x
Alisma gramineum	grass-like water-plantain	Medium	LX	6	-5		
Alnus incana ssp. rugosa	speckled alder	Medium	L3	6	-5		x
Alopecurus aequalis	short-awned foxtail	Medium	L3	7	-5		
Angelica atropurpurea	angelica	Medium	L3	6	-5		
Anthoxanthum nitens ssp. nitens	sweet grass	Medium	L1	5	-3		
Asclepias incarnata ssp. incarnata	swamp milkweed	Medium	L4	6	-5		
Beckmannia syzigachne	slough grass	Medium	L3	4	-5		
Bidens discoidea	small beggar's-ticks	Medium	L3	6	-3		
Bidens vulgata	tall beggar's-ticks	Medium	L5	5	-3		
Bolboschoenus fluviatilis	river bulrush	Medium	L3	7	-5		
Brasenia schreberi	water-shield	Medium	L1	7	-5		
Bromus ciliatus	fringed brome grass	Medium	L3	6	-3	x	
Callitriche palustris	marsh water starwort	Medium	L3	6	-5		
Caltha palustris	marsh marigold	Medium	L4	5	-5	x	
Campanula aparinoides	marsh bellflower	Medium	L3	7	-5		
Cardamine douglassii	purple cress	Medium	L3	7	-3		
Cardamine nymanii	cuckoo-flower	Medium	L2	7	-5		
Cardamine pensylvanica	bitter cress	Medium	L4	6	-4		
Carex alopecoidea	foxtail wood sedge	Medium	L3	6	-4		
Carex aquatilis	water sedge	Medium	L2	7	-5		
Carex atherodes	awned sedge	Medium	L3	6	-5		
Carex bromoides	brome-like sedge	Medium	L4	7	-4		
Carex brunnescens ssp. brunnescens	brownish sedge	Medium	L3	7	-3		
Carex canescens ssp. canescens	silvery sedge	Medium	L3	7	-5		
Carex castanea	chestnut-scaled sedge	Medium	L3	7	-4		
Carex comosa	bristly sedge	Medium	L3	5	-5		
Carex crinita	fringed sedge	Medium	L3	6	-4		
Carex diandra	lesser panicled sedge	Medium	L3	7	-5		
Carex echinata ssp. echinata	little prickly sedge	Medium	L1	7	-5		
Carex flava	yellow sedge	Medium	L3	5	-5	x	
Carex formosa	handsome sedge	Medium	L2	6	-2		
Carex hystericina	porcupine sedge	Medium	L4	5	-5		x

Scientific Name	Common Name	Sensitivity	L-Rank	CC	CW	GW Obligate	GW Fac-ultative
Carex interior	fen star sedge	Medium	L3	6	-5	x	
Carex lacustris	lake-bank sedge	Medium	L4	5	-5		
Carex lurida	sallow sedge	Medium	L3	6	-5		
Carex prairea	fen panicled sedge	Medium	L2	7	-4		
Carex projecta	necklace sedge	Medium	L4	5	-4		
Carex pseudocyperus	pseudocyperus sedge	Medium	L4	6	-5		
Carex scoparia	pointed broom sedge	Medium	L3	5	-3		
Carex stricta	tussock sedge	Medium	L4	4	-5		x
Carex tribuloides	blunt broom sedge	Medium	L4	5	-4		
Carex tuckermanii	Tuckerman's sedge	Medium	L3	7	-5		
Carex utriculata	beaked sedge	Medium	L3	7	-5		
Carex vesicaria	inflated sedge	Medium	L2	7	-5		
Cephalanthus occidentalis	buttonbush	Medium	L3	7	-5		
Chelone glabra	turtlehead	Medium	L3	7	-5	x	
Cicuta bulbifera	bulblet-bearing water-hemlock	Medium	L5	5	-5		
Cinna latifolia	nodding wood reed	Medium	L4	7	-4		
Circaea alpina	smaller enchanter's nightshade	Medium	L3	6	-3		
Comarum palustre	marsh cinquefoil	Medium	L3	7	-5		
Coptis trifolia	goldthread	Medium	L2	7	-3		
Corallorhiza trifida	early coral-root	Medium	L1	7	-2		
Cornus amomum ssp. obliqua	silky dogwood	Medium	L4	5	-4		
Cuscuta gronovii	swamp dodder	Medium	L4	4	-3		
Cyperus diandrus	low umbrella-sedge	Medium	LX	6	-4		
Cypripedium reginae	showy lady's slipper	Medium	L2	7	-4	x	
Cystopteris bulbifera	bulblet fern	Medium	L4	5	-2	x	
Decodon verticillatus	swamp loosestrife	Medium	L2	7	-5		
Doellingeria umbellata var. umbellata	flat-topped aster	Medium	L3	6	-3		x
Drosera rotundifolia	round-leaved sundew	Medium	L1	7	-5		
Dryopteris clintoniana	Clinton's wood fern	Medium	L3	7	-4		x
Dryopteris cristata	crested wood fern	Medium	L4	7	-5		x
Dryopteris x benedictii	Benedict's wood fern	Medium	L3	7	-3		
Dulichium arundinaceum	three-way sedge	Medium	L2	7	-5		
Eleocharis acicularis	needle spike-rush	Medium	L3	5	-5		
Eleocharis elliptica	elliptic spike-rush	Medium	L2	7	-3		
Eleocharis intermedia	matted spike-rush	Medium	L2	7	-3		
Eleocharis palustris	Small's spike-rush	Medium	L3	6	-5		
Elodea canadensis	common water-weed	Medium	L4	4	-5		
Epilobium leptophyllum	narrow-leaved willow-herb	Medium	L3	7	-5		
Equisetum fluviatile	water horsetail	Medium	L3	7	-5		
Equisetum sylvaticum	woodland horsetail	Medium	L3	7	-3		
Equisetum variegatum ssp. variegatum	variegated scouring-rush	Medium	L4	5	-3	x	
Fraxinus nigra	black ash	Medium	L4	7	-4		x
Galium obtusum	obtuse bedstraw	Medium	L3	6	-5		
Galium palustre	marsh bedstraw	Medium	L5	5	-5		
Galium tinctorium	stiff marsh bedstraw	Medium	L3	5	-5		
Galium trifidum ssp. trifidum	small bedstraw	Medium	L4	5	-4		
Geum rivale	water avens	Medium	L3	7	-5	x	
Glyceria canadensis	rattlesnake grass	Medium	L2	7	-5		
Gratiola neglecta	clammy hedge-hyssop	Medium	L2	7	-5		

Scientific Name	Common Name	Sensitivity	L-Rank	CC	CW	GW Obligate	GW Fac-ultative
Helianthus giganteus	tall sunflower	Medium	LX	6	-3		
Heteranthera dubia	water star-grass	Medium	L2	7	-5		
Hydrocotyle americana	marsh pennywort	Medium	L4	7	-5	x	
Hypericum majus	larger Canada St. John's-wort	Medium	L2	5	-3		
Ilex verticillata	winterberry	Medium	L3	5	-4		
Iris versicolor	blue flag	Medium	L3	5	-5		
Iris virginica var. shrevei	southern blue flag	Medium	L4	5	-5		
Juncus acuminatus	sharp-fruited rush	Medium	L2	6	-5		
Juncus articulatus	jointed rush	Medium	L5	5	-5		
Juncus brevicaudatus	short-tailed rush	Medium	L2	6	-5		
Juncus canadensis	Canada rush	Medium	L2	6	-5		
Juncus effusus	soft rush	Medium	L5	4	-5		
Larix laricina	tamarack	Medium	L3	7	-3		
Lathyrus palustris	marsh vetchling	Medium	L2	6	-3		
Lindera benzoin	spice-bush	Medium	L2	6	-2		
Lindernia dubia var. dubia	false pimpernel	Medium	L3	7	-5		
Liparis loeselii	Loesel's twayblade	Medium	L3	5	-4	x	
Lobelia cardinalis	cardinal flower	Medium	L1	7	-5		
Lobelia siphilitica	great blue lobelia	Medium	L3	6	-4		x
Ludwigia palustris	water purslane	Medium	L3	5	-5		
Lysimachia terrestris	swamp candles	Medium	L3	6	-5		
Lysimachia thyrsiflora	tufted loosestrife	Medium	L4	7	-5		
Mimulus ringens	square-stemmed monkey-flower	Medium	L4	6	-5		
Mitella nuda	naked mitrewort	Medium	L3	6	-3	x	
Muhlenbergia glomerata	marsh wild Timothy	Medium	L3	7	-4		
Myosotis laxa	smaller forget-me-not	Medium	L4	6	-5		
Myrica gale	sweet gale	Medium	L2	6	-5		
Myriophyllum heterophyllum	variable water-milfoil	Medium	L2	7	-5		
Myriophyllum sibiricum	northern water-milfoil	Medium	L2	6	-5		
Myriophyllum verticillatum	whorled water-milfoil	Medium	L1	7	-5		
Najas flexilis	bushy naiad	Medium	L3	5	-5		
Nuphar variegata	bullhead lily	Medium	L3	4	-5		
Nymphaea odorata	fragrant water lily (sensu lato)	Medium	L3	5	-5		
Nymphaea odorata ssp. odorata	fragrant water-lily	Medium	L3	5	-5		
Nymphaea odorata ssp. tuberosa	tuberous water-lily	Medium	L3	5	-5		
Onoclea sensibilis	sensitive fern	Medium	L5	4	-3		x
Osmunda regalis var. spectabilis	royal fern	Medium	L3	7	-5		
Osmundastrum cinnamomeum	cinnamon fern	Medium	L3	7	-3		
Packera aurea	golden ragwort	Medium	L2	7	-3		
Penthorum sedoides	ditch stonecrop	Medium	L4	4	-5		
Persicaria amphibia	swamp smartweed (sensu lato)	Medium	L4	5	-5		
Persicaria hydropiperoides	mild water-pepper	Medium	L4	4	-5		
Persicaria punctata	dotted water-pepper	Medium	L3	4	-5		
Persicaria sagittata	arrow-leaved tear-thumb	Medium	L2	5	-5		
Physocarpus opulifolius	ninebark	Medium	L3	5	-2		
Pilea fontana	spring clearweed	Medium	L4	5	-3		
Platanthera hyperborea	northern green orchis	Medium	LU	5	-4		
Platanthera lacera	ragged fringed orchis	Medium	L1	6	-3		
Pontederia cordata	pickerel-weed	Medium	L2	7	-5		
Potamogeton amplifolius	large-leaved pondweed	Medium	L2	5	-5		

Scientific Name	Common Name	Sensitivity	L-Rank	CC	CW	GW Obligate	GW Fac-ultative
Potamogeton epihydrus	ribbon pondweed	Medium	L2	5	-5		
Potamogeton foliosus	leafy pondweed	Medium	L4	4	-5		
Potamogeton gramineus	grass-like pondweed	Medium	L3	4	-5		
Potamogeton illinoensis	Illinois pondweed	Medium	L2	6	-5		
Potamogeton natans	floating pondweed	Medium	L3	5	-5		
Potamogeton nodosus	knotty pondweed	Medium	L2	7	-5		
Potamogeton perfoliatus	clasping-leaved pondweed	Medium	L2	7	-5		
Potamogeton praelongus	white-stem pondweed	Medium	L2	7	-5		
Potamogeton pusillus ssp. pusillus	small pondweed	Medium	L1	5	-5		
Potamogeton pusillus ssp. tenuissimus	least pondweed	Medium	L2	4	-5		
Potamogeton richardsonii	redhead pondweed	Medium	L3	5	-5		
Potamogeton zosteriformis	flat-stemmed pondweed	Medium	L3	5	-5		
Proserpinaca palustris	mermaid-weed	Medium	LX	7	-5		
Ranunculus aquatilis var. diffusus	white water crowfoot	Medium	L2	5	-5		
Ranunculus flabellaris	yellow water crowfoot	Medium	L2	7	-5		
Ranunculus hispidus var. caricetorum	swamp buttercup	Medium	L4	5	-5		
Rhamnus alnifolia	alder-leaved buckthorn	Medium	L3	7	-5		
Ribes glandulosum	skunk currant	Medium	L3	6	-3		
Ribes hirtellum	smooth gooseberry	Medium	L3	6	-3		
Ribes triste	swamp red currant	Medium	L3	6	-5		
Rosa palustris	swamp rose	Medium	L2	7	-5		
Rubus hispidus	swamp dewberry	Medium	L2	6	-3		
Rubus pubescens	dwarf raspberry	Medium	L4	4	-4		x
Rumex britannica	great water dock	Medium	L4	6	-5		
Rumex verticillatus	swamp dock	Medium	L3	7	-5		
Sagittaria cuneata	arum-leaved arrowhead	Medium	L3	7	-5		
Sagittaria latifolia	common arrowhead	Medium	L4	4	-5		
Sagittaria rigida	sessile-fruited arrowhead	Medium	L2	6	-5		
Salix bebbiana	Bebb's willow	Medium	L4	4	-4		x
Salix lucida	shining willow	Medium	L3	5	-4		x
Salix serissima	autumn willow	Medium	L2	6	-5		
Schoenoplectus acutus var. acutus	hard-stemmed bulrush	Medium	L3	6	-5		
Scirpus cyperinus	woolly bulrush	Medium	L4	4	-5		
Scirpus hattorianus	smooth-sheathed black-fruited bulrush	Medium	LU	6	-3		
Selaginella eclipes	meadow spike-moss	Medium	L1	7	-4		
Sium suave	water-parsnip	Medium	L4	4	-5		
Sparganium americanum	Nuttall's bur-reed	Medium	LU	6	-5		
Sparganium emersum	green-fruited bur-reed	Medium	L3	5	-5		
Spirodela polyrhiza	greater duckweed	Medium	L4	4	-5		
Stuckenia pectinata	sago pondweed	Medium	L4	4	-5		
Symplocarpus foetidus	skunk cabbage	Medium	L4	7	-5	x	
Teucrium canadense ssp. canadense	wood-sage	Medium	L3	6	-2		
Thelypteris palustris var. pubescens	marsh fern	Medium	L4	5	-4		
Triadenum fraseri	marsh St. John's-wort	Medium	L2	7	-5		
Utricularia vulgaris	common bladderwort	Medium	L3	4	-5		
Veronica americana	American speedwell	Medium	L4	6	-5	x	
Veronica anagallis-aquatica	water speedwell	Medium	L4	7	-5		x
Veronica scutellata	marsh speedwell	Medium	L3	7	-5		

Scientific Name	Common Name	Sensitivity	L-Rank	CC	CW	GW Obligate	GW Fac-ultative
Viburnum nudum var. cassinoides	withe-rod	Medium	L2	7	-3		
Viburnum opulus ssp. trilobum	American highbush cranberry	Medium	L2	5	-3		
Viola cucullata	marsh blue violet	Medium	L4	5	-5		
Viola labradorica	dog violet	Medium	L5	4	-2		
Viola macloskeyi	northern white violet	Medium	L3	6	-5		
Viola renifolia	kidney-leaved violet	Medium	L3	7	-3		
Viola sororia var. affinis	Le Conte's violet	Medium	L4	6	-3		
Zannichellia palustris	horned pondweed	Medium	L1	4	-5		
Acer saccharinum	silver maple	Medium	L4	5	-3		
Acer x freemanii	hybrid swamp maple	Medium	L4	5	-4		
Agalinis tenuifolia	slender gerardia	Medium	L3	7	-3		
Arisaema triphyllum	Jack-in-the-pulpit	Medium	L5	5	-2		x
Aronia melanocarpa	black choke-berry	Medium	L2	7	-3		
Bidens tripartita	three-parted beggar's-ticks	Medium	L5	4	-3		
Boehmeria cylindrica	false nettle	Medium	L4	4	-5		
Carex aurea	golden-fruited sedge	Medium	L4	4	-4		
Carex cryptolepis	small yellow sedge	Medium	L2	7	-5		
Carex debilis var. rudgei	white-edged sedge	Medium	L3	4	-3		
Carex intumescens	bladder sedge	Medium	L4	6	-4		
Carex lacustris x trichocarpa	hybrid Paludosae sedge	Medium	L3	6	-5		
Carex pellita	woolly sedge	Medium	L4	4	-5		
Carex sychnocephala	dense long-beaked sedge	Medium	L3	5	-4		
Carex viridula ssp. viridula	greenish sedge	Medium	L3	5	-5		
Ceratophyllum demersum	coontail	Medium	L4	4	-5		
Cicuta maculata	spotted water-hemlock	Medium	L5	6	-5		
Cinna arundinacea	tall wood reed	Medium	L3	7	-3		
Cyperus bipartitus	two-parted umbrella-sedge	Medium	L3	4	-4		
Cyperus odoratus	fragrant umbrella-sedge	Medium	L3	5	-3		
Cyperus strigosus	straw-coloured umbrella-sedge	Medium	L3	5	-3		
Dryopteris carthusiana	spinulose wood fern	Medium	L5	5	-2		
Eleocharis erythropoda	creeping spike-rush	Medium	L5	4	-5		
Eleocharis obtusa	blunt spike-rush	Medium	L3	5	-5		
Gentiana andrewsii	bottle gentian	Medium	L3	6	-3		
Glyceria grandis	tall manna grass	Medium	L5	5	-5		
Impatiens capensis	orange touch-me-not	Medium	L5	4	-3		x
Impatiens pallida	yellow touch-me-not	Medium	L4	7	-3		
Juncus alpinoarticulatus	Richardson's rush	Medium	L3	5	-5		
Juncus arcticus ssp. balticus	Baltic rush	Medium	L4	5	-5		
Juncus nodosus	knotted rush	Medium	L4	5	-5		
Leersia virginica	white grass	Medium	L4	6	-3		
Lycopus americanus	cut-leaved water-horehound	Medium	L4	4	-5		
Lycopus uniflorus	northern water-horehound	Medium	L5	5	-5		
Malaxis monophyllos var. brachypoda	white adder's mouth	Medium	L1	7	-3		
Pilea pumila	dwarf clearweed	Medium	L5	5	-3		
Poa palustris	fowl meadow-grass	Medium	L5	5	-4		
Pyrola asarifolia	pink pyrola	Medium	L2	7	-3		
Salix amygdaloides	peach-leaved willow	Medium	L4	6	-3		
Salix eriocephala	narrow heart-leaved willow	Medium	L5	4	-3		
Salix nigra	black willow	Medium	L3	6	-5		
Schoenoplectus pungens var.	three-square	Medium	L4	6	-5		

Scientific Name	Common Name	Sensitivity	L-Rank	CC	CW	GW Obligate	GW Fac-ultative
pungens							
Schoenoplectus tabernaemontani	soft-stemmed bulrush	Medium	L4	5	-5		
Scirpus microcarpus	barber-pole bulrush	Medium	L5	4	-5		
Scutellaria galericulata	common skullcap	Medium	L5	6	-5		
Scutellaria lateriflora	mad-dog skullcap	Medium	L5	5	-5		
Spartina pectinata	prairie cord grass	Medium	L3	7	-4		
Symphyotrichum puniceum var. puniceum	swamp aster	Medium	L5	6	-5		
Thuja occidentalis	white cedar	Medium	L4	4	-3		x
Vallisneria americana	tape-grass	Medium	L3	6	-5		
Viola blanda	sweet white violet	Medium	L3	6	-2		
Alisma triviale	water-plantain	Low	L5	3	-5		
Bidens cernua	nodding bur-marigold	Low	L5	2	-5		
Carex stipata	awl-fruited sedge	Low	L5	3	-5		
Eupatorium perfoliatum	boneset	Low	L5	2	-4		x
Eutrochium maculatum var. maculatum	spotted Joe-Pye weed	Low	L5	3	-5		x
Salix discolor	pussy willow	Low	L4	3	-3		x
Salix eriocephala x petiolaris	hybrid shrub willow	Low	L4	3	-3		
Sparganium eurycarpum	great bur-reed	Low	L3	3	-5		
Stellaria longifolia	long-leaved chickweed	Low	L4	2	-4		
Typha latifolia	broad-leaved cattail	Low	L4	3	-5		
Bidens frondosa	common beggar's-ticks	Low	L5	3	-3		
Epilobium coloratum	purple-leaved willow-herb	Low	L5	3	-5		
Equisetum hyemale ssp. affine	scouring-rush	Low	L5	2	-2		x
Juncus torreyi	Torrey's rush	Low	L5	3	-3		
Leersia oryzoides	rice cut grass	Low	L5	3	-5		
Persicaria lapathifolia	pale smartweed	Low	L5	2	-4		
Persicaria pensylvanica	Pennsylvania smartweed	Low	L4	3	-4		
Salix petiolaris	slender willow	Low	L4	3	-4		
Scirpus atrovirens	black-fruited bulrush	Low	L5	3	-5		
Scirpus pendulus	drooping bulrush	Low	L3	3	-5		
Spiraea alba	wild spiraea	Low	L4	3	-4		