


Evaluation, Classification and Management of Headwater Drainage Features Guidelines

Approved July 2013 (Finalized January 2014)

Credit Valley Conservation
Inspired by nature

Toronto and Region Conservation Authority

This document received TRCA Authority Board approval on July 26, 2013. Here is the Board resolution:

RES.#A119/13 - **HEADWATER DRAINAGE FEATURES GUIDELINES**
Approval of the final Evaluation, Classification and Management of Headwater Drainage Features Guidelines (Revised July 2013) prepared for Toronto and Region Conservation Authority, Credit Valley Conservation and other conservation authorities.

Moved by: Dave Ryan
Seconded by: Colleen Jordan

WHEREAS Toronto and Region Conservation Authority (TRCA) has been undertaking research on headwater drainage features (HDFs) since 2007;

AND WHEREAS the Interim Headwater Guidelines were developed in 2007 and revised in 2009 to direct proponents of headwater drainage feature alteration on management options in order to protect headwater functions;

AND WHEREAS the guidelines have been updated and finalized based on the results of further research and feedback from those using the guidelines;

AND WHEREAS the updated guidelines include methods for evaluating HDFs consistent with the Ontario Stream Assessment Protocol (OSAP), which is the provincial standard for conducting monitoring in wadable streams;

THEREFORE LET IT BE RESOLVED THAT the updated and finalized Evaluation, Classification and Management of Headwater Drainage Features Guideline (July 2013) be approved;

AND FURTHER THAT that the municipal clerks in TRCA's jurisdiction and the Greater Golden Horseshoe conservation authorities be so advised.

CARRIED

NB: Subsequent to approval of this version by TRCA's board, some changes were made to provide further clarification based on additional comments that were received from industry partners.

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INTRODUCTION

Conservation Authorities (CAs) are concerned with both rural and urban development or activities that can alter and/or eliminate headwater drainage features (HDFs) both individually and cumulatively. Such activities could have broad implications for water quality and quantity, recharge/infiltration, and the overall health of the local HDF and downstream habitats. These HDFs provide a multitude of functions, and alterations to these features can have implications on aquatic and terrestrial integrity within our watersheds. The spatial extent of HDFs can account for 70-80% of the total catchment area within a watershed (Gomi *et al.* 2002). Furthermore, 90% of a river's flow may be derived from catchment headwaters (Saunders *et al.*, 2002). Headwater systems are considered important sources of food, sediment, water, nutrients, and organic matter for downstream reaches. However, due to their small size and because these functions are poorly understood and typically underestimated, headwater drainage features can be vulnerable to impacts resulting from agricultural, aggregate and urban land uses, such as tile drainage, channel lowering, relocation, and enclosure (i.e. piping). In March 2007, Toronto Region Conservation Authority (TRCA) completed a literature review summarizing the state of the science around the natural functions of HDFs. This document has been augmented by several targeted research projects in the GTA designed to better understand both the ecology and the factors that impact HDFs (http://trca.on.ca/the-living-city/water-flood-management/headwater-study.dot). All of the research confirms that these features, though variable in terms of their form and functions, contribute in some way to maintaining healthy watersheds. These Guidelines reflect the best science available and are intended to support future decisions that will ensure the processes and pathways that these features support are maintained or improved.

The 1998 amendments to the *Conservation Authorities Act,* and subsequent approval of individual Section 28(1) Regulations by the Minister of Natural Resources in May 2006, gave all Conservation Authorities the legal right to apply a consistent definition of "watercourse," which is: *"An identifiable depression in the ground in which a flow of water regularly or continuously occurs"* (Section 28 (5) of the Conservation Authorities Act). Characteristics that qualify a feature as an HDF could also qualify that same feature as a watercourse under this definition and be subject to the conservation authorities' Section 28 regulations.

These guidelines have been developed to provide direction to practitioners for those features that are not clearly covered by existing policy and legislation as being important eco-hydrological features (e.g. perennial streams and provincially significant wetlands), but may contribute to the overall health of a watershed. The guidelines are intended to be used by practitioners contemplating alterations to HDFs and to address any type of alteration from restoration to feature removal from the landscape. This guideline can also be used to help direct watershed planning activities such as development of natural system planning, stewardship activities, and watershed planning. Upon consideration of the attributes and functions of HDFs, the evaluation (Part 1), classification (Part 2) and management (Part 3) of each drainage feature must be completed/determined to address the protection, conservation and mitigation of headwater functions (e.g. flow storage and conveyance, fish habitat, amphibian habitat, sediment and nutrient regulation, etc.). While the evaluation and classification is undertaken at the site specific scale, the management recommendations should consider the cumulative effects on the drainage network. The management recommendations are to be implemented through development design, including stormwater management and sustainable management practices, and where available, must take into consideration the recommendations of the relevant Fisheries Management Plan (FMP), Subwatershed or Watershed Plans.

Since HDFs vary widely in their flow, form and function (Williams, 2006), these guidelines utilize standardized survey methods and a tiered study design that directs practitioners to collect more rigorous data based on the risk of functional impairment to an HDF. The methods prescribed herein follow existing modules of the Ontario Stream Assessment Protocol (OSAP; Stanfield, 2010) and new modules have been developed to accommodate the needs of these guidelines. In this way, all data collected using these guidelines will contribute to a better understanding of HDFs facilitate effective comparisons between features and will enable an assessment of the effectiveness of the guidelines over time. As such, this approach supports the adaptive management cycle (Holling, 1978). Training in the application of OSAP modules is highly recommended. The modules can be found at: http://trca.on.ca/the-living-city/monitoring/ontario-stream-assessment-protocol.dot

PART 1: EVALUATION

The data collected in this part of the guideline will be used to classify the features and provide appropriate management options. Part 1, Evaluation is divided into 4 sections. Section A describes the study design considerations to be considered in determining where field work should be conducted. Section B addresses project scoping through a desktop exercise, and is intended to provide a framework for determining which protocols to apply. Sampling effort is described in Section C. Finally, Section D provides advice on information management, to both assist with preparing the data for classification and to ensure the information is available for future analysis.

The guidelines recognize that all HDFs contribute, to some degree, to the overall health of a watershed, and that their individual contribution to watershed health varies. As a result, these guidelines attempt to evaluate, in a consistent way, the contribution of sediment, food and flow transport to downstream reaches, as well as the use of these features by biota. Since not all HDFs are equivalent, a tiered approach is used to inventory the HDFs that balances information needs with the likelihood that alterations to HDF conditions might result in cumulative impacts to local and watershed health. Hence, the level of sampling effort will be commensurate with the sensitivity of the reach and potential impacts of alteration.

Pre-consultation should occur with the Conservation Authority to determine scope and to identify data gaps. Be advised that if the scoping exercise with the CA does not occur prior to the initiation of the assessment and aspects are scoped out of the field program that are not agreeable to the CA, that this may result in delays to the project and the possible requirement for additional data collection during the appropriate seasons. The outcome of applying this guideline should be integrated with the results of other studies such as an Environmental Impact Study/Natural Heritage Evaluation (EIS/NHE), and relevant information should be used to tie back to aquatic functions, and vice versa. Ultimately, the results of this guideline should be incorporated into an EIS/NHE, if one is required.

Since many of the management actions are implemented based on the seasonal contribution of HDFs to biota (fish, amphibians, etc), a large component of the field methods is directed at collecting information on the form and surficial flow patterns of each feature as well as the biota that utilize these habitats. A hierarchical approach is applied that focuses on first determining the nature of the feature, that is, whether it persists over time and the nature of its flow patterns. This information will direct subsequent field sampling efforts that will document conditions for each HDF.

The following definition of a headwater drainage feature will be used for the purposes of this guideline: ***non-permanently flowing drainage features that may not have defined bed or banks; they are first-order and zero-order intermittent and ephemeral channels, swales and connected headwater wetlands*, but do not include rills or furrows.***
[NB: *wetlands that are connected downstream through surface flow are considered to be headwater drainage features for the purposes of this guideline. A wetland definition is provided in the definitions section at the end of this document. Wetland size does not matter with regard to this wetland definition.]

A. STUDY DESIGN

A preliminary study design should be developed through a desktop exercise to help determine where sampling should occur. Local and watershed conditions should be screened using existing secondary information to determine the potential location of HDF's. These guidelines are to be applied to any drainage feature that is:

- part of the drainage network (i.e. drainage channels that are identified from aerial photography, and/or drainage lines result from ArcHydro analysis), or
- a groundwater seepage area or spring, or
- a connected headwater wetland (a surface outlet connects to downstream), **and**
- not a mapped or known perennially flowing stream.

Features within a valley are typically not considered HDFs and therefore are not addressed by this guideline, but still need to be considered through CA policies. In addition, while unconnected wetlands are not considered in this guideline, they still need to be assessed through an EIS, as required. If no HDFs have been identified through these methods, and/or there has been agreement with the Conservation Authority that there is no HDF present on the site through site inspection, then the guideline will not apply.

The study area should be examined using desktop information, such as ArcHydro analysis (may be available from the Conservation Authority), aerial photo interpretation, catchment size information, or using existing watercourse/OBM layers, to determine if there are any potential HDFs present and where they are located. The study design can be developed by conducting and aerial photo interpretation analysis at a scale no greater than 1:20,000, but preferably 1:10,000 or smaller. If available, ArcHydro can also be a helpful tool in determining where flow is expected to occur on the landscape.

Figure 1 shows an example of recommended sampling locations determined at a scale of 1:4,000. Sampling should occur in order to collect data from distinct HDFs within the study area. A new sampling location should occur where vegetation, flow or other habitat conditions change significantly and could result in a different classification. These changes will define the limits of the segment represented by that sampling point. For example, a new sampling location should be located downstream of the confluence of two distinct ArcHydro drainage lines, or where the feature type changes (e.g. defined channel to wetland, pond, etc.). A sample site will include 40 m upstream and downstream of the sampling location (or 40 m upstream depending on scope), so ensure that there is no overlap between sample sites. It is not necessary to sample unconnected wetlands (i.e. wetlands that do not have an obviously surface water outlet draining to downstream). The sampling strategy may change depending on field conditions. The headwater drainage features should be walked from end to end to determine where it is no longer a headwater drainage feature.

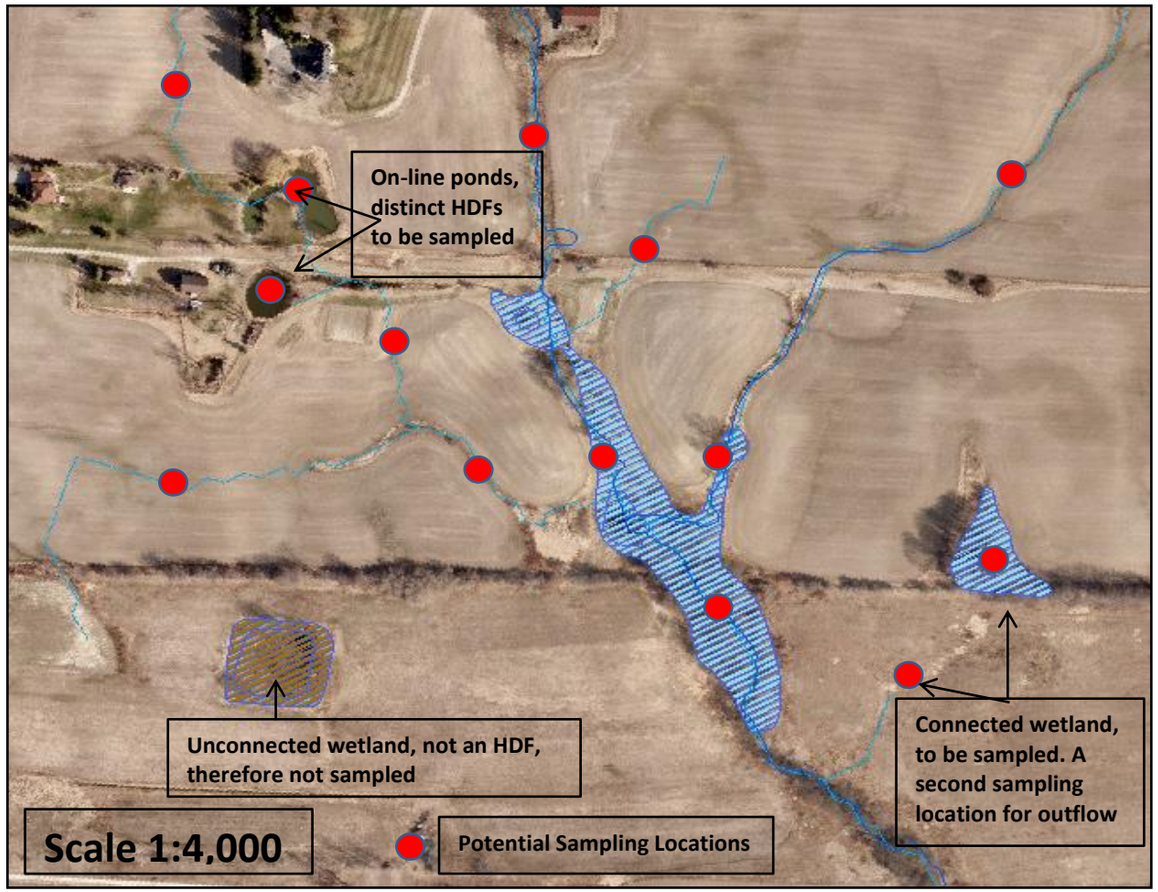


Figure 1: Example study design showing potential sampling locations. Distinct HDFs occur when a new feature type (i.e. pond, wetland, etc.) is encountered or when downstream of a confluence with another feature. Light blue lines indicate drainage lines as identified through ArcHydro analysis. Blue hatch indicates wetlands.

B. DATA GATHERING

The next step is to consult with other secondary sources of information to determine the sensitivity of the features to the proposed alteration. Existing sources of information should be sought to determine:

I. Presence of Sensitive Biota

Once a potential HDF has been identified, existing biological information should be consulted to determine the presence of sensitive species in the study area, including Species at Risk (e.g. Redside Dace, Jefferson salamander), or habitats where sensitive species may be found, such as designated natural areas (e.g. Provincially Significant Wetlands). Conservation Authorities and the Ministry of Natural Resources can be sources of these kinds of information. If any of these are present on, adjacent to or downstream of the study area, there may be regulatory or policy requirements that override the requirements contained within this guideline. It is recommended that the appropriate agencies be consulted. If existing information (e.g. Watershed Plan, Fisheries Management Plan, fish collection records, data points) indicates that there are sensitive species present on, adjacent to or downstream of the site, or that there is a likelihood that these species may be present but no current data exists, this will increase the sensitivity of the HDF and therefore increase the data requirements if alteration is proposed. Likelihood of the presence of habitat should also be considered based on a review of desktop information (e.g. aerial photos). Sensitive species include both terrestrial species, such as breeding amphibians, as well as aquatic species. Presence of sensitive taxa at or downstream of a study area will likely indicate a greater sensitivity to disturbances within an HDF and hence greater information needs.

II. Feature Form and Flow

The hydroperiod (seasonal pattern of water level fluctuation) of HDFs helps determine seasonal use of the feature by species that require water to carry out their life processes. The longer a feature contains water (i.e. longer hydroperiod) and the greater the volume of water, the greater the likelihood that the feature will provide important eco-hydrological functions. Indicators of longer hydroperiods, such as standing/open water, meanders, and channel definition, will necessitate a more intensive field survey than if only poorly defined HDFs with limited flow periods are present. Aerial photos are good sources of this information, but there may be other sources as well, such as Ontario Base Maps, Ecological Land Classification, soil mapping, topographic mapping, etc.

III. Proposed Activity

Some activities pose a greater risk to degrade the natural functionality of an HDF, than do others. Projects that have a neutral or positive benefit to an HDF are therefore of lower risk to ecosystem health than those that that have a negative impact. Table 1 below provides a listing of examples of positive/neutral and negative alterations.

Table 1: Examples of alterations and their expected effects

Positive/Neutral Alterations	Negative Alterations
In-situ restoration	Relocation
Protection	Removal
Cattle fencing	Ditching
Wetland re-creation	Channelization
Flow reinstatement	Channel lowering
Tile drain removal	Terracing
Riparian replanting	Piping
Riparian buffers	Tile drain installation
Natural channel design	Flow diversion

C. SCOPING AND SAMPLING EFFORT

The amount of effort required to document conditions in a study area varies based on the flow conditions, types of habitat present, the presence of sensitive species, and the degree to which alterations to feature/habitat are being considered. Check with the Conservation Authority to ensure that there is agreement on the level of sampling effort required. Where Species at Risk are possible or known to be present, alternate sampling strategies may be necessary, and the local Ministry of Natural Resources (MNR) district office should/must be contacted.

Table 2 below indicates mandatory and additional data requirements, and the associated sampling intensity given sensitivity, hydroperiod and alteration potential. Surveyors can choose to collect only mandatory information at the start of the process if there are no negative alterations to the HDF proposed, or if the proposed alterations are yet unknown. However, if alterations are proposed later, data gaps will need to be addressed during the appropriate seasons, which may delay the project. Alternatively, surveyors can choose to collect additional information at the beginning of the process if it is likely that alterations will be proposed. It should be noted that these additional data requirements are also useful for positive alterations, and facilitate proper enhancement of existing habitat characteristics.

Where an Ontario Stream Assessment Protocol (OSAP) module is noted, the entire module is to be applied. However, the data collected in certain modules, such as OSAP Section 4, Module 10 (or OSAP S4.M10 for short) can be scoped if agreed to in advance with the Conservation Authority. The classification system outlined in Part 2 focuses on data collected through an evaluation of feature type, flow and riparian conditions as determined through application of OSAP S4.M10. However, the other information collected using the OSAP protocols can be useful for a number of other applications and should be collected when these data can assist in addressing other watershed or landuse planning objectives. For example, some data may help design the drainage system if alterations are proposed and to identify restoration opportunities. Additional data may be required to assist in developing natural heritage networks, directing watershed research (e.g. intensive sediment transport studies), or developing integrated watershed restoration priorities or monitoring programs. Table 3 below outlines the data for this module, and recommends how to scope data collection based on the study objectives.

Feature type, flow and riparian conditions should be documented in all circumstances. However, where negative (or sometimes positive) alterations are proposed, more comprehensive information may be necessary in order to adequately document the conditions that will need to be replaced or restored and to evaluate the project.

Table 2: Types of surveys to be carried out based on sensitivity, feature form and flow. In most cases, Standard Survey Type will be used. It may be possible to scope the data collected through these surveys if agreed to in advance by the Conservation Authority/municipality.

Survey Type	**Sensitivity, Feature Form and Flow***	**Mandatory Data Requirements**		**Additional Data Requirements For HDF Alterations**	
		Flow Condition	**Riparian**	**Fish and Fish Habitat**	**Terrestrial Assessment**
Rapid	Sensitive species/habitat unlikely and/or ill-defined form, only ephemeral flow likely	OSAP S4.M10 (Headwaters)	OSAP S4.M10 (Headwaters)		
Standard	Sensitive species/habitat possible and/or ill-defined form, intermittent flow likely	OSAP S4.M10 (Headwaters)	OSAP S4.M10 (Headwaters)	OSAP S3.M1 and/or OSAP S3.M2 (Fish); OSAP S4.M9 (Barriers)	Marsh Monitoring Protocol for amphibians; Ecological Land Classification; Ontario Wetland Evaluation System (for wetlands ≥ 0.5 ha)
Diagnostic	Sensitive species/habitat likely/present and/or perennial flow is possible*	OSAP S4.M10 (Headwaters); OSAP S4.M5 (Standard flow survey); OSAP S4.M6 (Stream response to rainfall)	OSAP S4.M10 (Headwaters)	OSAP S3.M1 and/or OSAP S3.M2 (Fish); OSAP S4:M9 (Barriers)	Marsh Monitoring Protocol for amphibians; Ecological Land Classification; Ontario Wetland Evaluation System (for wetlands ≥ 0.5 ha)

***Prior to completion of field surveys, it is not always possible to discern the hydroperiod of the feature. If the feature is known to have perennial flow, this guideline does not apply. However, if the hydroperiod is uncertain, this guideline should be applied.**

Table 3: Recommendations for scoping of data collection for OSAP S4.M10. Closed circles (●) indicate required data collection, and open circles (○) indicate recommended data collection, which can be further scoped depending on the study design.

	Data Collection Objectives	
Recommended Data Collection (OSAP S4.M10 field sheet)	Minimum to Complete Guideline Classification	*Positive or Negative Alterations Proposed to HDF
Mandatory fields at top of Page 1 (Site description, etc.)	●	●
Upstream Data Only		
Feature Type	●	●
Riparian Conditions	●	●
Flow Conditions	●	●
Feature Vegetation	●	●
Feature/Bankfull Width/Depths		●
Sediment Deposition/Transport		○
Flow Measures		●
Longitudinal Gradient		○
Both Upstream and Downstream Data		
Downstream data for all listed above		●
Water Quality Parameters		○
Site Features	●	●
Downstream Flow Measures		●
Channel Connectivity	●	●

*Positive alterations can include planning, strategic, or research initiatives that ultimately lead to restoration of HDFs, such as Natural Heritage System planning, restoration prioritization, and erosion/nutrient transport research.

Based on the above preliminary assessments, a strategy will emerge for the types of surveys to be conducted in each HDF segment, assuming that data does not already exist for the study area. If there are several HDFs in a study area a sampling strategy table should be generated to guide field work, indicating the sampling effort required for each feature.

Regardless of the data collected in a study area, it is imperative that accurate site descriptions and geo-coordinates are collected so that the information can be placed in time and space. Therefore, surveyors should fill out site description information for each location that represents a new sample site.

The following outlines the recommended sampling approaches based on the sensitivity of the feature to the proposed alteration, and what this will likely mean for watershed functions:

I. Rapid Methods

For low sensitivity sites, all components of the headwater sampling protocol (OSAP S4.M10) are to be applied, unless scoped in advance with the Conservation Authority. This module documents the HDF form and flow conditions, riparian vegetation and site features that are important components of habitat. It is a rapid assessment protocol, and should only take about 15-25 minutes to complete per site. Typically, determining the seasonality of flows within each HDF can be challenging, unless a permanent sampling device is installed (i.e. pressure transducer or crest stage gauge), however vegetation and channel form can be good indicators. However, the guidance provided in Table 3 will assist with determining seasonality. The site features portion of this module extends beyond the site boundaries to include all modifiers that could influence the HDF.

II. Standard Methods

In addition to the OSAP S4.M10 module, an electrofishing survey (OSAP S3.M1) should be conducted at a minimum of one sample site for each stream segment containing water during the sample period. While spring sampling is recommended, there may be timing restrictions on when sampling can occur that must be approved by the local MNR office. The ecological land classification protocol (ELC, 1998) should be applied to the riparian zone of each segment as a means of documenting community type. If appropriate habitat exists to potentially support amphibian breeding, a survey should be conducted following the Marsh Monitoring Protocol. Wetlands are very rare in southern Ontario, therefore, an evaluation as per the Ontario Wetland Evaluation Manual for Southern Ontario (OWES, 3rd Edition) may be required for any areas that contain facultative/obligate wetland species with a surface area that exceeds 0.5 ha and that are hydrologically linked to other wetland areas. Thresholds for these surveys vary by MNR district; therefore surveyors should contact either the local MNR office or the local Conservation Authority staff for clarification. (Note: although a wetland may not need to be evaluated using OWES, all HDF wetlands need to be evaluated and classified using these guidelines.). All potential barriers within the study area should also be assessed to determine whether there are existing barriers to fish that could be considered as part of remediation activities. Apply the barrier assessment module to each potential barrier in the study area (OSAP S4.M9). Additionally, if habitats exist that are not readily sampled by electrofishing, surveyors should consider using alternate methods to ensure that taxa that might utilize only this type of habitat are enumerated (e.g., seining [OSAP S3.M2], minnow traps, dip-nets, etc).

III. Diagnostic Methods

Greater certainty of conditions is required for HDFs that are considered to have higher sensitivity or longer hydroperiods. Existing hydrological models are unable to adequately predict flow in headwater streams, hence more diagnostic methods for quantifying and validating flow needs of the stream will be required (OSAP S4.M5; S4.M6). This information will be helpful in determining the water balance requirements for the feature. Therefore in addition to the modules recommended for rapid and standard methods, one site should be sampled for fish assemblages along each segment containing water in the spring and another in summer.

D. Information Management and Communication

Implementation of these guidelines requires that practitioners make strategic decisions about where, when and how much habitat is to be inventoried within a study area. It is important to document these decisions and the rationale that led to them. Prior discussion with the CA may be beneficial to identify areas to be sampled.

All data should be recorded onto standard OSAP sampling forms and transferred to a database (e.g. Flowing Waters Information System) for long term storage and to assist with information transfer and querying (e.g. classification). Additionally, a study area sampling map should be generated that indicates the geo-referenced location of all sample sites and the connections to other drainage features, particularly watercourses, ponds, wetlands, barriers and tile drains, etc. The data should then be summarized in a table indicating the segment surveyed and associated feature type, flow condition, riparian conditions, and fish and amphibian information (as necessary).

PART 2: CLASSIFICATION

The purpose of this section is to outline a method for using the information collected during the evaluation phase (Part 1 above) in order to apply the appropriate classification to the HDFs being assessed and identify the functions provided by those features that must be considered in subsequent analysis. Classification should occur on a segment-basis and includes fragmentation information collected from the barrier surveys. Therefore, results of all surveys on a segment are combined and the composite results based on the highest level of function observed in a feature are used to generate classifications. The results of the classification should be recorded and summarized in Table 8. Note that the classes are hierarchical.

STEP 1 – HYDROLOGY CLASSIFICATION

Classify the flow conditions into one of the following categories with direction from Table 4 below:

A. Important Functions – Perennial: Water is present throughout the year, as either flowing or standing surface water (wetlands or refuge pools) as a result of year round groundwater discharge (i.e. seeps, springs, wetlands or upwellings). Flow may be interstitial or even subsurface in some segments. Channel form is typically complex with clearly defined bed and banks, evidence of erosion/sedimentation, and sorted substrate. In the case of wetlands, standing water is present through the summer months. Fish and Invertebrates can be used to assist in determining hydroperiod. Organisms that benefit from perennial flow (caddisfly larvae, Mayfly nymphs, stonefly nymphs, black flies, salmonids, darters, white sucker etc.) may be found on the underside of stones and rocks.

B. Valued Functions – Intermittent: Water is present in the spring as a result of seasonally high groundwater discharge or seasonally extended contributions from wetlands or other areas that support intermittent flow or water storage conditions. These features are typically still flowing in late spring but dry or surface-damp by July. There may be some substrate sorting and channel form. Invertebrates can be used to assist in determining hydroperiod, including presence of damselfly nymphs, clams, and scuds and absence of caddisfly larvae, Mayfly nymphs, stonefly nymphs, black flies etc. in summer.

C. Contributing Functions – Ephemeral: Provides ephemeral flow or water storage functions during and (for a short time) after spring freshet and following large rain events only. These features are typically dry or surface-damp by mid-May. Typically, there is limited substrate sorting and channel form. Invertebrates may be used to help determine hydroperiod, including presence of worms, leaches in the absence of the perennial and intermittent indicators or no aquatic macroinvertebrates.

D. Recharge Functions– Dry or Standing Water: No surface flow occurs. Through additional investigations, such as boreholes, soil maps, etc., it has been determined that coarse-textured soils described as sand and/or gravel occurs and the majority of potential flow will be infiltrated. These features may have ill-defined channels as a relic of past flows; however the key function is groundwater recharge and maintenance of downstream aquatic functions via groundwater connections to streams. No surface flow conveyance, allochthonous or sediment transport provided.

E. Limited Functions – Dry or Standing Water - The pre-screened drainage feature has been field verified to confirm that no flow occurs during any of the flow assessment periods outlined in Table 4 below. – generally characterized by no definition or flow, no groundwater seepage or wetland functions, and evidence of cultivation, furrowing, presence of a seasonal crop, lack of natural vegetation, and fine textured soils (i.e. clay and/or silt).

Table 4: Hydrology classification using flow condition and feature type as evaluated using data from OSAP S4.M10. More than one field assessment is required in order to assess hydrology, particularly if the assessment occurs prior to spring plowing/tilling.

Assessment Period	Limited or Recharge	Valued or Contributing	Important
Spring freshet (late March – mid-April)	FC = 1 or 2 AND FT = 4 or 7	FC = 3, 4, or 5 AND FT = 2, 3, 4, or 8; OR if wetland (FT = 6) occurs upstream	FC = 3, 4, or 5 AND FT = 2, 3, 4, or 8; OR if wetland (FT = 6) occurs upstream
Late April - May	FC = 1 or 2 AND FT = 4 or 7	i. FC = 1 or 2 AND FT = 1, 2, 3 or 4 OR if wetland (FT = 6) occurs upstream; OR ii. FC = 3, 4, or 5 AND FT = 4, 5 or 7 OR if wetland (FT = 6) occurs upstream	i. FC = 1 or 2 AND FT = 1, 2, 3 or 4 OR if wetland (FT = 6) occurs upstream; OR ii. FC = 3, 4, or 5 AND FT = 4, 5 or 7 OR if wetland (FT = 6) occurs upstream
July - August			FC = 3, 4 or 5 AND FT = 1 or 2; OR FT = 6 AND FC = 2

The following categories are hierarchical with highest level of function increasing from left to right. The highest level of function satisfied according to the conditions outlined above is to be used to classify hydrology for features.

NB: OSAP Flow condition codes (FC): 1= no surface water (dry), 2 = standing water, 3 = interstitial flow, 4 = surface flow minimal (<0.5l/s), 5 = surface flow substantial (>0.5l/s)
OSAP Feature type codes (FT): 1 = defined natural channel (visible banks), 2 = channelized (historically natural channel, now straight with banks), 3 = multi-thread (> 1 channel), 4 = no defined feature (overland flow only), 5 = tiled drainage (buried stream/pipe with outlet), 6 = wetland, 7 = swale, 8 = roadside ditch (channelized running parallel with roadway), 9 = online pond outlet

Modifiers

Agricultural tilling can make determination of feature type difficult or erroneous. It is strongly recommended that at least one assessment period occur prior to spring tilling/plowing otherwise additional assessments may be required to adequately characterize the feature.

Many headwater drainage features have been negatively affected by agricultural practices or development. Impacts include: dredging, vegetation removal, cultivation, crop planting, piping, tile drains, terracing, nutrient input, etc. The presence or absence of these modifiers can provide clues as to the hydrology of the feature (e.g. a feature that is not plowed through may indicate that in the late spring when a farmer is preparing the fields, this feature is too wet to drive a tractor through or it is wet long into the growing season and does not provide suitable conditions for crop growth). Modifiers should be noted. The suspected impacts of the modifier and changes expected to occur when the modifier is removed should be discussed. Clues from upstream and downstream classification as well as historic aerial photography may be helpful in determining the appropriate, original function of the affected reach.

On-line or in-line ponds are typically created on headwater features to provide a source for irrigation or water for livestock. Although these features can provide flow retention, extended discharge, permanent fish habitat, and amphibian breeding areas, their disruption to natural geomorphological processes and thermal impacts are generally not desirable. On-line and in-line ponds should be assessed to identify their positive contribution and negative impacts to the system. If the pond is to be removed, the positive

attributes should be considered for replication in the restoration of the headwater feature. Barriers can restrict the movement of fish upstream into the features being assessed. Consideration should also be given to the potential for fish to use the habitats of the feature in the event that barrier removal or mitigation is undertaken.

Classification should consider the influence of modifiers and professional judgment used to determine the appropriate classification, where applicable. The results of this process need to be clearly articulated in the table.

STEP 2 – RIPARIAN CLASSIFICATION

Classify the feature with regard to riparian conditions based on criteria provided in Table 5 below:

A. Important Functions – the feature type is wetland and/or any of the riparian corridor categories (0-1.5 m, 1.5-10 m, or 10-30 m on either side of the feature) is dominated by forest or thicket/scrubland communities or wetland.
B. Valued Functions – any of the riparian corridor categories (0-1.5 m, 1.5-10 m, or 10-30 m on either side of the feature) is dominated by meadow and there are no important riparian functions.
C. Contributing Functions – the riparian corridor (0-1.5 m, 1.5-10 m, or 10-30 m on either side of the feature) is dominated by lawn and there are no important or valued riparian functions.
D. Limited Functions – the riparian corridor (0-1.5 m, 1.5-10 m, or 10-30 m on either side of the feature) is dominated by cropped land or no vegetation, and there are no important, valued or contributing riparian functions.

Table 5: Riparian condition classification using data from OSAP S4.M10. If the data for the left and right bank categories differ, classification will be according to that which is highest functioning.

Riparian Conditions	OSAP Riparian Codes Observed	OSAP Code Descriptions	ELC Equivalent Codes for Riparian Codes Observed
Important Functions	5, 6, 7 (and/or feature type=wetland)	Scrubland, forest, or wetland	Thicket, plantation, woodland, forest (CUT, CUS, CUW, CUP, TPS, TPW, FO)
Valued Functions	4	Meadow	Meadow (CUM)
Contributing Functions	2	Lawn	-
Limited Functions	1 or 3	None or cropped land	-

STEP 3 – FISH AND FISH HABITAT CLASSIFICATION

This section only needs to be completed if an alteration (see Part 1) is proposed.

A. Important Functions – Fish are present year round (permanent habitat) in standing pools; or suitable habitat present for fish spawning/rearing; or feature designated as occupied SAR habitat. (Note: if feature has permanent flow in defined channel then it is not considered to be an HDF).
B. Valued Functions – Seasonal habitat provided areas used for feeding, cover, refuge, migration and contributing habitat for species-at-risk.
C. Contributing Functions – Contributing fish habitat. Transport of allochthonous materials (detritus, insects, etc.) to downstream fish-bearing reaches provides sources of food.

Table 6: Fish and fish habitat classification using data from OSAP S3.M1 module.

Fish and Fish Habitat	**Fish Observations**
Important Functions	Any fish present species present in spring and mid-summer; suitable spawning habitat for any fish species; species-at-risk present at any time; or feature provides critical habitat to downstream species-at-risk
Valued Functions	Fish present in spring only or suitable habitat identified for feeding, cover, refuge, migration; or contributing habitat for species-at-risk.
Contributing Functions	Allochthonous transport through feature to downstream habitat

STEP 4 – TERRESTRIAL HABITAT CLASSIFICATION

This section only needs to be completed if an alteration (see Part 1) is proposed.

A. Important Functions - Wetlands with breeding amphibians.
B. Valued Functions – General amphibian habitat: stepping stone habitat (stop over to higher quality habitat) or suitable for feeding or hydration for low mobility wildlife (i.e. amphibians). Wetland habitat occurs within the corridor, but no breeding amphibians are present.
C. Contributing Functions – Movement corridors: the feature has riparian conditions that connects two other features upstream and downstream (e.g. forest or wetland features that will be protected through the planning process), thereby providing movement opportunities for non-amphibian (i.e. higher mobility) species. No wetland habitat occurs within the corridor, but other vegetation may be present to facilitate wildlife movement.
D. Limited Functions – No terrestrial habitat present.

Table 7: Terrestrial habitat classification using data from OSAP S4.M10. and the Marsh Monitoring Protocol (MMP) for amphibians[1]

Terrestrial Habitat	OSAP S4.M10 Feature Type Code (and Description)	Marsh Monitoring Protocol call code
Important Functions	6 (wetland)	1, 2 or 3
Valued Functions	6 (wetland); considering wetland pockets associated with the HDF that are within 400 m of other wetlands upstream and downstream is recommended for assessing stepping stone habitat function	0
Contributing Functions	This is assessed at the landscape scale, potentially with guidance from an EIS. However, one recommendation is to use the following criteria: RC[3] = 5, 6, 7 within 0-10 m that functions as riparian habitat along corridor with the sampling point connecting two habitat features upstream and downstream to facilitate movement of wildlife through the corridor	
Limited Functions	1-5 (one of: defined channel, channelized, no defined channel, buried drainage) or 7-9 (one of: swale, roadside ditch, on-line pond)	0

[1]Both OSAP and MMP criteria need to be satisfied to fulfill the classification category.
[2] Environment Canada (2013) reviews a number of studies that consider the critical function zone from wetland habitat for amphibians. Depending on the species the critical range varies, but for some species such as Green Frog and Bullfrog, the mean range is 485 and 406 m respectively. For other anurans mean ranges are much less. Therefore, it is recommended that 400 m is a reasonable distance to wetlands when considering stepping stone function.
[3]OSAP Riparian condition (RC) codes: 1 = none; 2 = lawn; 3 = cropped land; 4 = meadow; 5 = scrubland; 6 = forest; 7 = wetland

PART 3: MANAGEMENT RECOMMENDATIONS

The Management Recommendations have been structured as a science-based decision making framework that applies the precautionary principle. Upon the evaluation (Part 1) and classification (Part 2) of the flow attributes and functions of HDFs, management recommendations for the protection, conservation and mitigation of the associated functions are to be implemented through the design of the project, including consideration for maintaining flow (e.g. stormwater management and incorporating Low Impact Development (CVC 2010; TRCA 2012; TRCA 2010). The classification categories identified in Part 2 provide the basis of the management recommendations provided here. A flow chart (Figure 2) guides practitioners through the process of translating the classification results to management recommendations.

These guidelines focus on the individual assessment and conservation of HDFs. The cumulative effects and threshold of changes downstream, however, must also be considered, especially when a significant number of HDFs will potentially be altered or replaced. In these situations, it is strongly recommended that cumulative effects be addressed through a subwatershed study that can address such issues. Although hydrological models are often used in such circumstances, other functions and synergistic effects may not be adequately assessed. Scientific tools for cumulative effects or thresholds related to concepts such as “how many and which headwater drainage features can be altered before mainstem reaches of rivers become impaired” are still lacking. There is work currently in progress that is moving towards addressing this scientific question. In the meantime, proponents and agencies are encouraged to heed the precautionary principle, and to share monitoring results to facilitate an adaptive management approach. A more holistic or stream network approach must also be looked at after individual assessments as the ecological result can be greater than the sum of all parts. Related guiding

principles, such as maintaining similar natural ratios of HDF types across a subwatershed should also be considered. Respecting and mimicking natural patterns of transition from seemingly “insignificant” HDFs individually to more intermittent channels using protection or LID may offer a better approach from an ecosystem perspective but some level of cumulative impact assessment should be undertaken to ensure the objectives of a healthy watershed are being achieved.

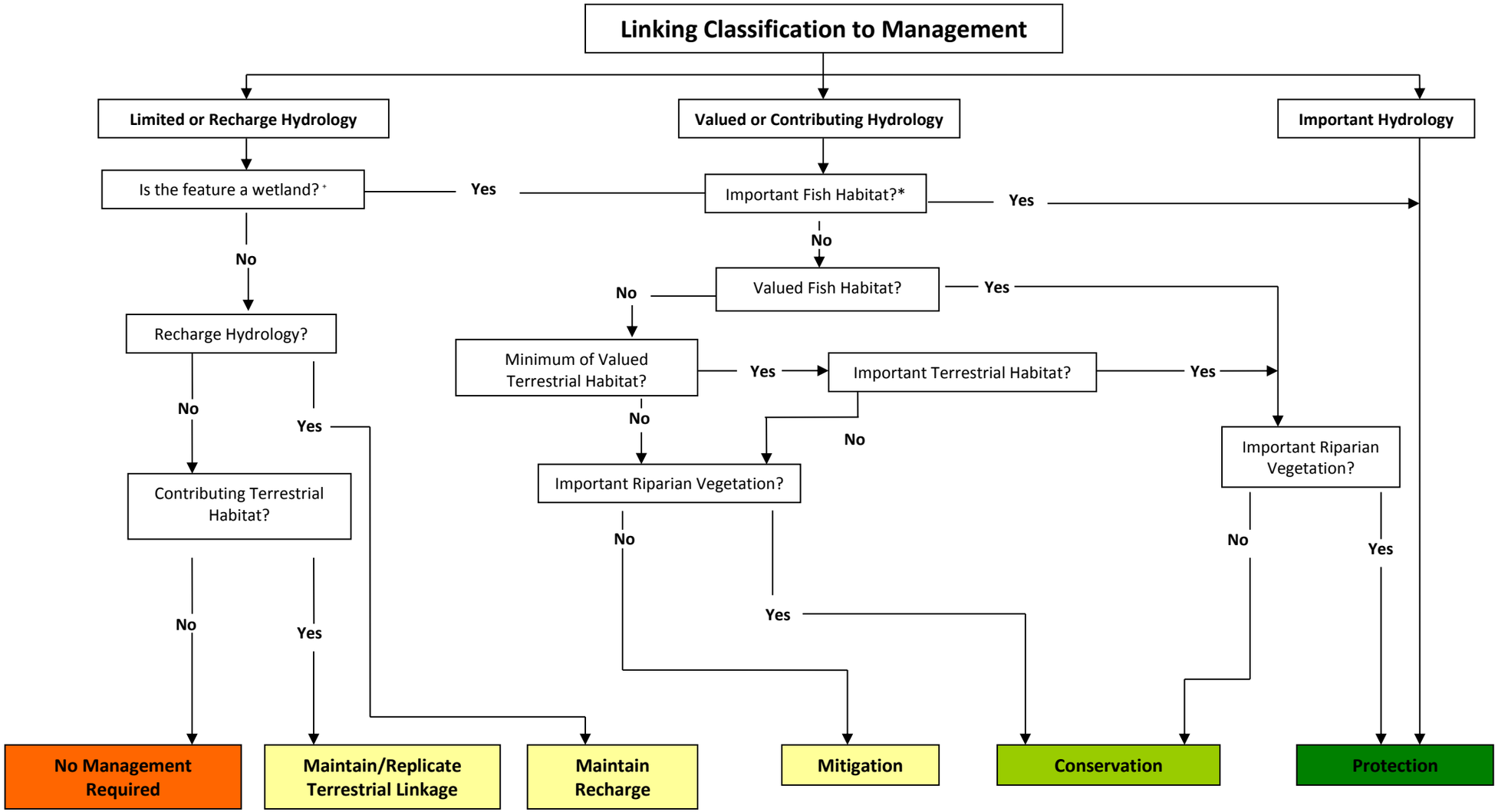
In the event that a lower level of protection is identified for a segment downstream of a segment with a higher level of protection, the more conservative approach shall be adopted for both segments and the downstream segment should be reclassified to match the upstream segment. The management options provided should be considered where efforts to relocate or redesign the proposal have been considered and alteration to the natural feature is deemed acceptable. Be aware that policies for certain areas could apply more restrictive requirements over what is presented below (e.g. fish habitat, both direct and indirect, qualifies as a Key Natural Heritage Feature in the Oak Ridges Moraine Conservation Plan, and is therefore subject to the associated policies).

NOTE: Where an HDF has been altered and/or eliminated without a permit under a conservation authority’s Section 28 Regulation, a “No Management Required” category will not be assigned, and restoration of the HDF may be required.

Summarize the results of step 1-4 in the table below.

Table 8: Summary of functional classifications and management

Drainage Feature Segment	STEP 1		STEP 2	STEP 3	STEP 4	Management Recommendation
	Hydrology	Modifiers * Identify all modifiers provide attachment with discussion regarding impacts and potential restoration options	Riparian	Fish Habitat	Terrestrial Habitat	(see Figure 2)



*Other Conservation Authority policies or other legislation with respect to wetlands, watercourses and/or species at risk need to be assessed in the context of this key.
+Note that headwater wetlands are considered to be HDFs in the context of this guideline.

Figure 2: Flow chart providing direction on management options

RECOMMENDED MANAGEMENT

A. Protection – Important Functions: e.g. swamps with amphibian breeding habitat; perennial headwater drainage features; seeps and springs; SAR habitat; permanent fish habitat with woody riparian cover

- Protect and/or enhance the existing feature and its riparian zone corridor, and groundwater discharge or wetland in-situ;
- Maintain hydroperiod;
- Incorporate shallow groundwater and base flow protection techniques such as infiltration treatment;
- Use natural channel design techniques or wetland design to restore and enhance existing habitat features, if necessary; realignment not generally permitted;
- Design and locate the stormwater management system (e.g. extended detention outfalls) are to be designed and located to avoid impacts (i.e. sediment, temperature) to the feature.

B. Conservation – Valued Functions: e.g. seasonal fish habitat with woody riparian cover; marshes with amphibian breeding habitat; or general amphibian habitat with woody riparian cover.

- Maintain, relocate, and/or enhance drainage feature and its riparian zone corridor;
- If catchment drainage has been previously removed or will be removed due to diversion of stormwater flows, restore lost functions through enhanced lot level controls (i.e. restore original catchment using clean roof drainage), as feasible;
- Maintain or replace on-site flows using mitigation measures and/or wetland creation, if necessary;
- Maintain or replace external flows,
- Use natural channel design techniques to maintain or enhance overall productivity of the reach;
- Drainage feature must connect to downstream.

C. Mitigation – Contributing Functions: e.g. contributing fish habitat with meadow vegetation or limited cover

- Replicate or enhance functions through enhanced lot level conveyance measures, such as well-vegetated swales (herbaceous, shrub and tree material) to mimic online wet vegetation pockets, or replicate through constructed wetland features connected to downstream;
- Replicate on-site flow and outlet flows at the top end of system to maintain feature functions with vegetated swales, bioswales, etc. If catchment drainage has been previously removed due to diversion of stormwater flows, restore lost functions through enhanced lot level controls (i.e. restore original catchment using clean roof drainage);
- Replicate functions by lot level conveyance measures (e.g. vegetated swales) connected to the natural heritage system, as feasible and/or Low Impact Development (LID) stormwater options (refer to Conservation Authority Water Management Guidelines for details);

D. Recharge Protection – Recharge Functions: e.g. features with no flow with sandy or gravelly soils

- Maintain overall water balance by providing mitigation measures to infiltrate clean stormwater, unless the area qualifies as an Area of High Aquifer Vulnerability under the Oak Ridges Moraine Conservation Plan (ORMCP) or Significant Recharge Areas under the Source Water Protection Act. These areas will be subject to specific policies under their respective legislation.
- Terrestrial features may need to be assessed separately through an Environmental Impact Study to determine whether there are other terrestrial functions associated with them.

E. Maintain or Replicate Terrestrial Linkage – Terrestrial Functions: e.g. features with no flow with woody riparian vegetation and connects two other natural features identified for protection

- Maintain the corridor between the other features through in-situ protection or if the other features require protection, replicate and enhance the corridor elsewhere
- If the feature is wider than 20 m, it may need to be assessed separately through an Environmental Impact Study to determine whether there are other terrestrial functions associated with it.

F. No Management Required – Limited Functions: e.g. features with no or minimal flow; cropped land or no riparian vegetation; no fish or fish habitat; and no amphibian habitat.

- The feature that was identified during desktop pre-screening has been field verified to confirm that no feature and/or functions associated with headwater drainage features are present on the ground and/or there is no connection downstream. These features are generally characterized by lack of flow, evidence of cultivation, furrowing, presence of a seasonal crop, and lack of natural vegetation. No management recommendations required.

Table 9: Summary of management recommendation and implications for development proposals

Management implications	Protection	Conservation	Mitigation	Recharge Protection[1]	Maintain Terrestrial Linkage	No Management Recommendation Required
Must remain open	Yes	Yes	Yes	N/A	Yes	N/A
Relocate using natural channel design	Not permitted, enhancement only	May be considered, not preferred	Natural Channel Design not required[2]	N/A	N/A	N/A
Maintain or replicate groundwater or wetlands	Maintain or enhance	Maintain or replicate, restore if possible	N/A	Maintain overall infiltration rates at site	N/A	N/A
Maintain hydroperiod	Yes	Yes	Yes	N/A	N/A	N/A
Direct connection to downstream	Yes	Yes	Yes	N/A	N/A	N/A
Replicate function through enhanced lot level conveyance	N/A	N/A	Replicate using bioswales, LID[3], vegetated swales or constructed wetlands	N/A	N/A	N/A

[1] Recharge zone may qualify as an High Aquifer Vulnerability Area and is therefore subject to the policies of the Oak Ridges Moraine Conservation Plan
[2]Unless the management recommendations call for restoration of lost function or enhancement and creation fish habitat
[3]LID means low impact development measures (see TRCA and CVC's Stormwater Management Criteria Document or Low Impact Development Planning and Design Guide for further detail)
Note: Replicated functions must be located downstream of stormwater management facilities.

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DEFINITIONS

Allochthonous	Energy sources derived from outside the lotic system, that is, from the terrestrial environment. Leaves, twigs, fruits, etc. are typical forms of terrestrial coarse particulate organic matter that have entered the water by direct litterfall or lateral leaf blow.
Ephemeral flow	Water flows for a short period of time in response to localized precipitation (e.g. spring freshet or storm events). Surface water channel is likely above the local groundwater table.

Furrow	A long narrow trench made in the ground by a plow, especially for planting seeds or for irrigation.
Intermittent flow	Water flows for several months during the year because of a connection with seasonally high groundwater table or flow contributions from wetlands. Typically flow ceases during the summer months (July and August).
Ill-defined feature	A feature that has limited discernible bed and/or banks due to intermittent or ephemeral flows. Typical form includes, weakly developed bed material sorting and channel meander definition.
Headwater drainage feature	Non-permanently flowing drainage features that may not have defined bed or banks; they are first-order and zero-order intermittent and ephemeral channels, swales and connected headwater wetlands, but do not include rills or furrows (also see watercourse definition).
Hydroperiod	The seasonal pattern of water level fluctuation.
Perennial flow	Continuous year-round surface flow occurs in most years. Baseflow conditions are supported by year round groundwater discharge and/or wetland/surface storage areas.
Rill	A narrow and shallow incision into soil resulting from erosion by overland flow or surface runoff that has been focused into a 'thin thread' by the soil surface texture or roughness. Generally, rills are less than 0.2 m deep and may have limited downstream/downslope extent.
Watercourse	An identifiable depression in the ground in which a flow of water occurs regularly or continuously (Conservation Authorities Act).
Wetland	land that: (a) is seasonally or permanently covered by shallow water or has a water table close to or at surface, (b) directly contributes to the hydrological function of a watershed through connection with a surface watercourse, (c) has hydric soils, the formation of which has been caused by the presence of abundant water, and (d) has vegetation dominated by hydrophytic plants or water tolerant plants, the dominance of which has been favoured by the presence of abundant water, but does not include periodically soaked or wet land that is used for agricultural purposes and no longer exhibits a wetland characteristic referred to in clause (c) or (d) (*Conservation Authorities Act*).