Wetland Conservation & Stewardship Pilot Project in the Beaver Hills Biosphere:

State of Wetland Policy & Regulation

FINAL REPORT

Prepared for:
Beaver Hills Biosphere Reserve Association

November 2019
Project 1922

FIERA
Biological Consulting

List of Terms

Acronyms

ABWRET - Alberta Wetland Rapid Evaluation Tool

BHB: Beaver Hill Biosphere

BHI: Beaver Hills Initiative

UNSECO: United Nations Education, Scientific and Cultural Organization

Glossary

Intact wetland: undisturbed or minimally disturbed wetlands with normal ecological and hydrologic functions that support natural plant and animal communities.

Degraded wetland: human-caused activities in or near a wetland that have resulted in a loss of ecological and/or hydrologic function and reduced species survival and/or reproductive success.

Drained wetland: the recontouring of land or the placement of ditches and/or drainage tiles to remove surface water from a wetland, resulting in the loss of ecological and hydrologic function.

Wetland: land saturated with water long enough to promote formation of water altered soils, growth of water tolerant vegetation, and various kinds of biological activity that are adapted to a wet environment (GOA 2013, p. 4). Also referred to as sloughs, potholes, swamps, and bogs, amongst other terms.

Wetland conservation: the protection or preservation of wetland ecological and hydrological function and services through the avoidance of impacts. Avoidance can be achieved through planning and policy action, or through long term securement tools, such as land purchase or conservation easements.

Wetland enhancement: any activity that is undertaken to "increase the function and/or health of an existing, albeit degraded, wetland" (GOA 2016, p.6). Some examples of enhancement include re-establishing or improving the condition of riparian habitat or excluding cattle from a wetland through fencing.

Wetland restoration: the "re-establishment of hydrology, vegetation, and wetland processes within a previously drained wetland" (GOA 2016, p. 6). This includes plugging drainage ditches with earthen plugs or engineered structures, removing drainage tiles, or re-establishing a previously diverted water source.

Table of Contents

List of Figures

List of Maps

1.0 Background and Context for the Pilot Project

1.1. The Beaver Hills Biosphere Reserve

The Beaver Hills moraine is a geologically distinct area that covers approximately 1,595 km^2 in central Alberta. The area is characterized by its knob and kettle terrain, which supports a high density of wetlands and small lakes, as well as native forest and grassland habitats that are generally larger and more intact than those located elsewhere in central Alberta. In turn, these habitats provide a range of ecosystem functions that support a high level of biodiversity and a wide range of ecosystem services.

While the Beaver Hills moraine includes a significant proportion of lands that have been set aside for conservation and protection, this area is under significant pressure from land uses such as urban and country residential development, agriculture, oil and gas, and other industrial land uses. In order to manage these growth pressures a multi-stakeholder group came together in 2002 to establish the Beaver Hills Initiative (BHI), and between 2002 and 2016 the BHI developed a vision for sustainable development in the moraine. In 2016, the environmental significance of the Beaver Hills landscape and its contribution to the maintenance of the health and well-being of communities located within and near the moraine was recognized by the United Nations Education, Scientific and Cultural Organization (UNESCO) through the designation of the moraine as the Beaver Hills Biosphere (BHB) Reserve.

Biosphere Reserves are considered by UNESCO to be “Science for Sustainability support sites”, where the relationship and interaction between social and ecological systems can be explored and managed through interdisciplinary approaches (UNESCO 2017). In particular, Biosphere Reserves have three interconnected functions: conservation, development, and logistical support, whereby sustainable development can be achieved through open dialogue with local communities and other stakeholders, as well as through the integration of both cultural and biological diversity. Importantly, a key function of a Biosphere Reserve is to facilitate demonstration projects, environmental education, and sustainable development education and training, research, and monitoring.

To this end, the Beaver Hills Biosphere Reserve Association is initiating a wetland conservation and stewardship pilot project in the Beaver Hills Biosphere that aims to explore alternative approaches to wetland conservation and stewardship in a way that supports both traditional and current cultural attributes of the Biosphere. Through this approach, the BHB will be a living laboratory in which knowledge can be co-created and explored by a wide range of stakeholders, and potential solutions and approaches to land management can be tested and refined in an applied context. A key goal of the BHB wetland pilot is to test and evaluate a diverse set of policy and market approaches for incentivizing wetland stewardship within the Biosphere, such that the multiple benefits associated with wetland conservation and restoration can be maintained or enhanced. Developing new and innovative tools to retain, enhance, and restore wetlands in the Biosphere is particularly important in the context of a changing climate, where increased temperatures and shifting precipitation patterns are expected to reduce surface water quality and quantity, thereby placing increased stress on aquatic ecosystems in the region (All One Sky Foundation 2019).

1.2. Why Wetlands?

From the perspective of water resource management and maintaining both aquatic and terrestrial ecosystem health, wetlands are of critical importance. Ecologically, wetlands are key habitats for a large number of aquatic and terrestrial species and are significant components of larger hydrologic systems that provide important ecosystem services to human communities. For example, wetlands serve a crucial role in water filtration and treatment, stabilize water supplies through the amelioration of floods and droughts, and support recreational opportunities such as hunting and bird watching. Wetlands also provide a number of other less recognized ecosystem services that significantly contribute to human well being, such as nutrient cycling modulation, erosion control, pollination, and aesthetic appreciation. In addition, wetlands are particularly susceptible to changes resulting from atmospheric deposition and the intensification of the hydrologic cycle driven by climate warming. Consequently, wetlands are important sentinels of both local and regional ecosystem change.

Since the inception of the Beaver Hills Initiative in 2002, wetlands have been identified as a critical resource and as a specific target for conservation. Estimates of wetland cover in the Biosphere (circa 2013) range between 26% (Creed and Solstice wetland inventories developed for the BHI) and 33% (Amec Foster Wheeler 2015, calculated using the Provincial Merged Wetland Inventory), which represents a significant opportunity for wetland conservation. Conversely, it is estimated that 63% of the wetland habitat that existed in the BHB prior to European settlement has been lost (Creed et al. 2013), with the primary driver of wetland loss in the Beaver Hills region resulting from agricultural activities and urbanization (Clare and Creed 2014). This result is similar to other studies conducted worldwide that have found the proximate cause of wetland conversion to be agricultural development, with the underlying forces of the loss being economic growth and population density (Van Asselen et al. 2013). These high rates of loss within the BHB present substantial opportunities for the restoration of wetland habitat, either through the enhancement of degraded wetlands or through the re-establishment of wetlands that have been impacted through tile or ditch drainage.

1.3. Report Objectives

In order to effectively design and implement a wetland conservation and stewardship pilot project in the Beaver Hills Biosphere, an important first step is to review and synthesize the type and scope of existing wetland policies, programs, and regulations, such that they can be considered, integrated into, and/or leveraged by the pilot program. While there is a wide range of federal, provincial, and municipal policies and regulations that could be “triggered” or are in some way tangentially associated with wetland management in the BHB, this report focuses on the policies and regulations that will materially impact the implementation and outcomes of the pilot project, and therefore, must be clearly understood and considered in the design of the pilot. This primarily includes the Alberta Wetland Policy and its associated Directives that provide guidance for policy implementation, as well as provincial legislation such as the *Public Lands Act* and the *Water Act*, which generate considerable legal obligations for wetland managers. By focusing on these provincial policies and regulations, and the processes that are associated with securing approvals for undertaking wetland restoration work, we are in no way suggesting that other policies are less important; however, given the complexity that is associated with the provincial policy and the fact that this policy will apply to the management of wetlands on 88% of the lands within the Biosphere, we have chosen to focus on clearly and comprehensively describing where and under what circumstances the provincial policy would apply, what processes and obligations are triggered, and how these obligations could potentially impact the BHB pilot project.

This report is phase one of a “state of” assessment for the BHB, with phase two focusing on the state of wetland science and ecosystem service assessments that will summarize the existing scientific knowledge and existing spatial data that can be leveraged as part of the pilot program.

2.0 Policy Considerations for Pilot Project Design

The purpose of the pilot is to inform a Proof of Concept that can support the multiple benefits of wetland stewardship within the Biosphere, which may include a combination of wetland protection, on the ground action, and/or education and outreach. From a regulatory and practical perspective, there are three primary mechanisms that can be utilized to improve wetland management outcomes in the Biosphere:

- **Wetland conservation**: includes protecting and preserving wetland function and services through the avoidance of impacts. Avoidance can be achieved through planning and policy action, or through long term securement tools, such as land purchase or conservation easements;
- **Wetland enhancement**: as per the provincial wetland restoration directive, enhancement includes activities that are undertaken to "increase the function and/or health of an existing, albeit degraded, wetland" (GOA 2016, p.6). Some examples of enhancement include re-establishing or improving the condition of riparian habitat or excluding cattle from a wetland through fencing;
- **Wetland restoration**: restoration has a number of different definitions, but in the context of the Alberta Wetland policy, restoration is defined as the "re-establishment of hydrology, vegetation, and wetland processes within a previously drained wetland" (GOA 2016, p. 6). This includes plugging drainage ditches with earthen plugs or engineered structures, removing drainage tiles, or re-establishing a previously diverted water source.

Within the context of designing and implementing a pilot project to incentivize wetland stewardship in the BHB, the three mechanisms listed above are each on their own highly complex with respect to the following considerations (Figure 1):

- Is the wetland located on private or public land?
- Is the wetland hydrologically and ecologically intact, or is it degraded or drained?
- What are the existing regulatory requirements and processes that must be considered when trying to conserve, enhance, or restore wetlands in the BHB?
- What are the new or existing policies and/or market-based instruments that can be used to secure the wetland to achieve the goal of wetland conservation, enhancement, or restoration?

What follows in this section is a description of the various practical considerations that should be considered in the design of the BHB pilot as it relates to the conservation, enhancement, and restoration of wetlands. The discussion will focus on the various stakeholders that would have to be engaged and the existing policies, procedures, and regulations that would be triggered for each of the three mechanisms listed above. While we have noted that an important consideration in the success of the pilot is the new or existing policy or market-based instruments that will be used to secure wetlands for conservation, enhancement, or restoration, this report does not focus on the type or design of these potential instruments; rather, we provide basic examples only of what policy or market-based instruments may be employed. The design of the instruments for incentivizing wetland conservation, enhancement, or restoration will be the subject of further study, consideration, and development as the pilot project advances.

2.1. Where is the Wetland Located?

The Beaver Hills Biosphere is a complex and diverse landscape from a land management and ownership perspective, with lands under the jurisdiction of the federal and provincial government, five separate municipalities, and private landowners (Map 1). Whether a wetland is located on public or private land is one of the most important considerations with respect to the design and implementation of the pilot project. This is because the audience and associated messages will be different if the target for the wetland management activity is a private landowner or a public entity such as a municipality or a provincial government department. Further, the type of wetlands that may be available for inclusion in the pilot may vary substantially when considering private or public lands. For example, the availability of drained wetland basins is likely to be much higher on private land than on public land, and the incentives that may be required to recruit private landowners into the program to restore a wetland are likely to be different from those offered to a public entity. Finally, the guarantee or commitment with respect to long-term wetland securement is likely to vary between public and private land. We discuss the specific considerations for wetland stewardship on private and public lands in more detail below.

2.1.1. Public Land

A significant proportion of the lands within the BHB have been designated as protected areas, with large national and provincial parks and recreation areas such as Elk Island National Park, Cooking Lake-Blackfoot Recreation Area, Ministik Game Bird Sanctuary, and Miquelon Lake Provincial Park making up approximately 24% of Biosphere lands (Map 2). Notably, there are a number of other smaller provincial natural areas, such as Antler Lake, Cooking Lake, and Hasting Lake that are scattered throughout the BHB, as well as a number of permanent and naturally occurring water bodies that have been claimed by the crown as provincial lands under the *Public Lands Act* (Map 1). In addition to federal and provincial public lands, approximately 2% of lands in the BHB are under the control of one of the five municipalities in the Biosphere (Map 3). These municipally controlled lands include areas that have been designated as Environmental or Municipal Reserve, Environmental Reserve Easements, Conservation Easements, or Restricted Covenants. In total, approximately 35% of the lands within the BHB are public lands under the control of federal, provincial, or municipal governments.

The large proportion of public lands in the BHB presents a significant opportunity to engage directly with these jurisdictions to advance wetland stewardship. A substantial advantage of working with government entities on issues of wetland stewardship includes a greater level of certainty around wetland securement. For example, wetlands that are located in national or provincial parks or conservation easements will be conserved over the long term, and lands that have been designated as Environmental or Municipal Reserve within a municipality are generally more secure than privately held lands. Further, the federal and provincial governments, along with Strathcona County, have wetland policies that provide direction for the conservation of high value wetlands, as well as for the replacement of lost wetland habitat.

While there are clear advantages of working directly with federal, provincial, and municipal governments within the BHB to advance wetland stewardship, the types of wetland stewardship activities that exist on public lands may be more limited (Figure 1). For example, most wetlands in protected areas are already secured, and there is likely to be a smaller number of drained wetlands located on public lands, thereby limiting the opportunities to secure additional wetland acreage through restoration. However, because the general public has access to wetlands located on federal, provincial, or municipal lands, there are substantial opportunities to work with government partners to develop and deliver outreach and stewardship programs that communicate the value and importance of wetlands, and explore the social norms around wetland conservation and drainage. In terms of wetland enhancement, there may be opportunities to improve the condition of existing but degraded wetlands that are located on federal, provincial, or municipal lands; this may be particularly true in the case of wetlands located on municipally controlled lands. Importantly, cooperation from government partners may be higher in the case of wetland enhancement and/or restoration than with private landowners. So, while there may be fewer opportunities to enhance or restore wetlands, there may be higher rates of success with respect to implementing enhancement or restoration projects on public lands. Notably, the process for obtaining a *Water Act*

approval and adhering to the requirements of the provincial wetland policy and its associated Restoration Directive still apply to wetland enhancement and restoration activities that occur on Provincial and/or Municipal lands. These requirements are described in more detail in Section 2.2.

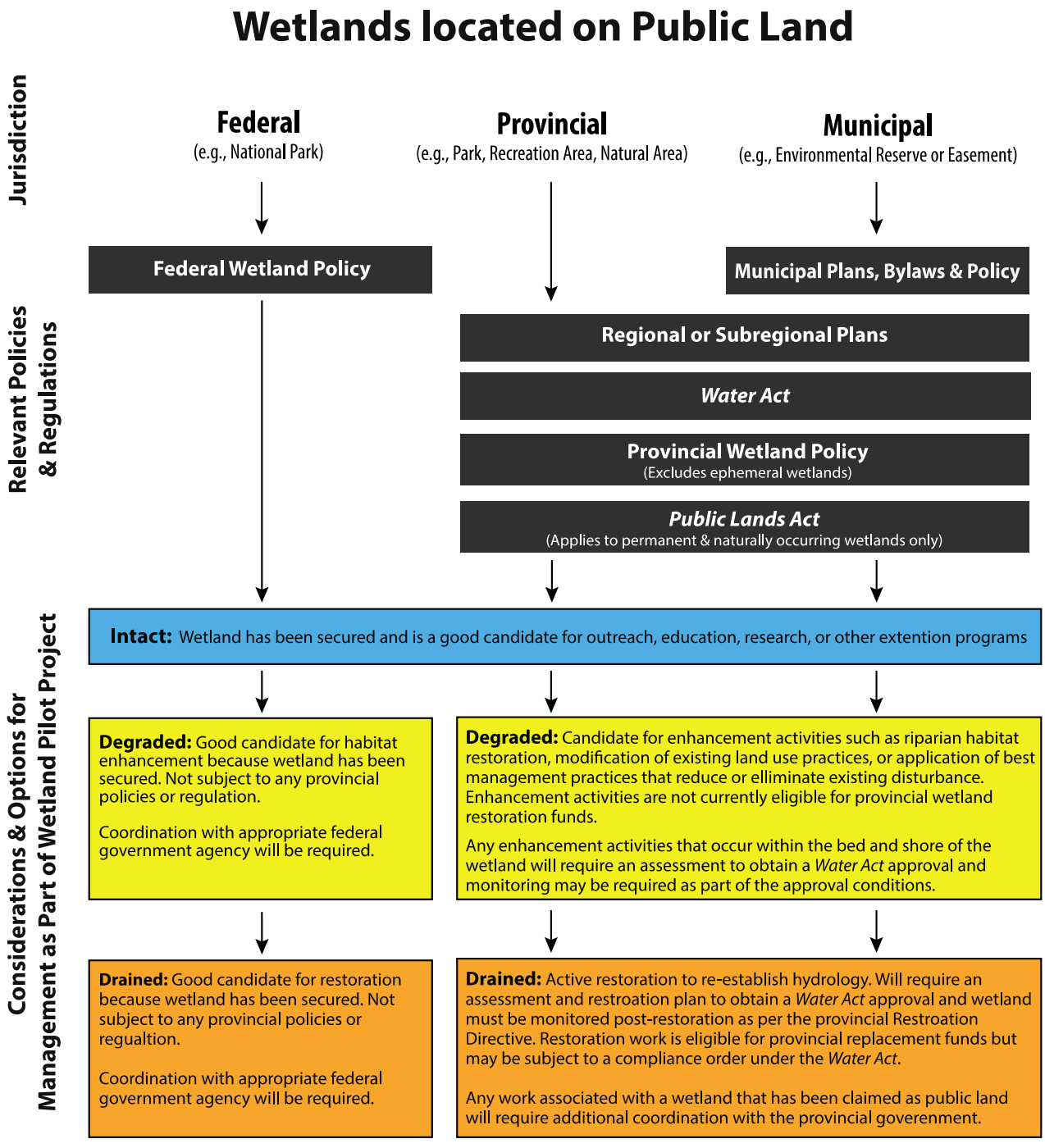
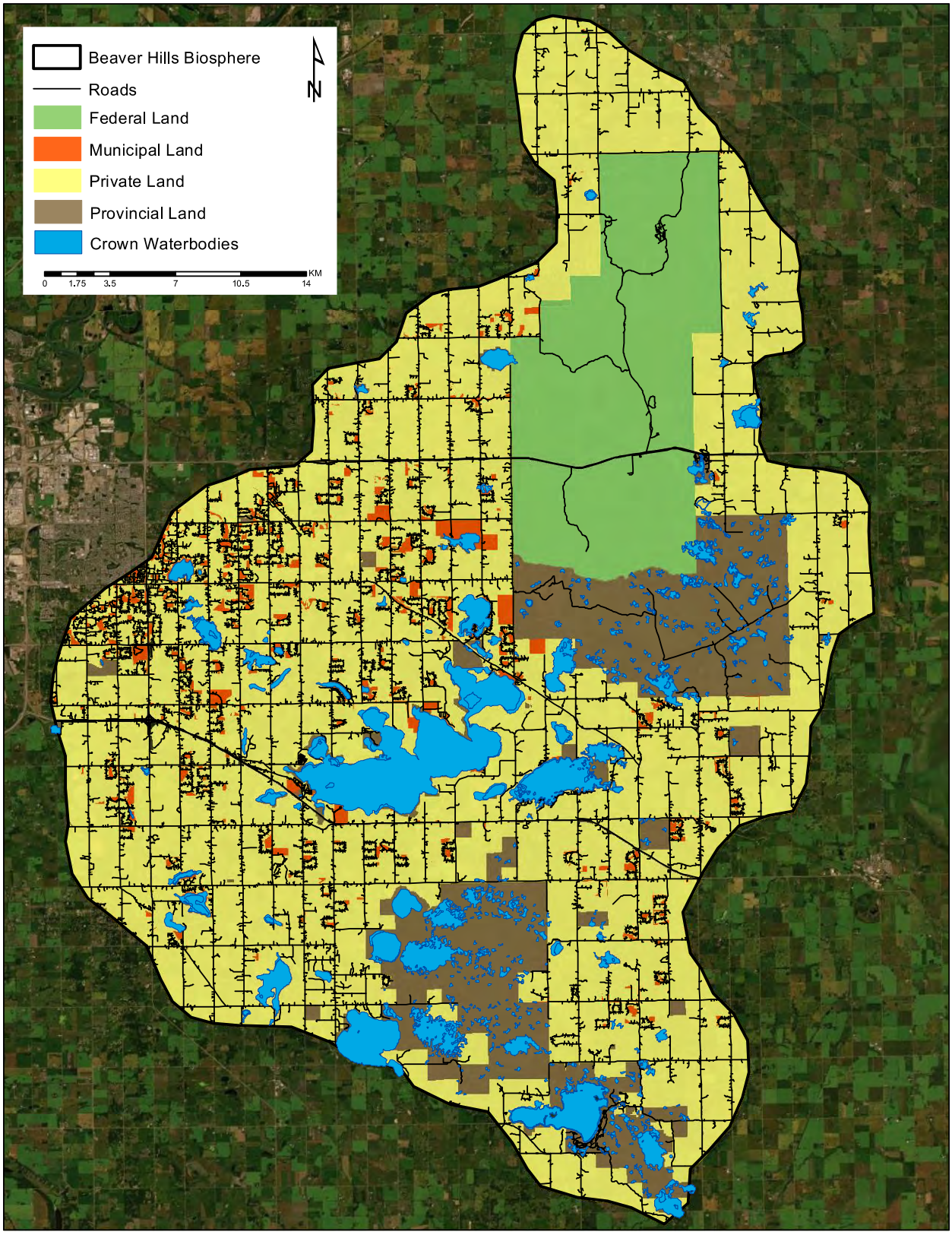
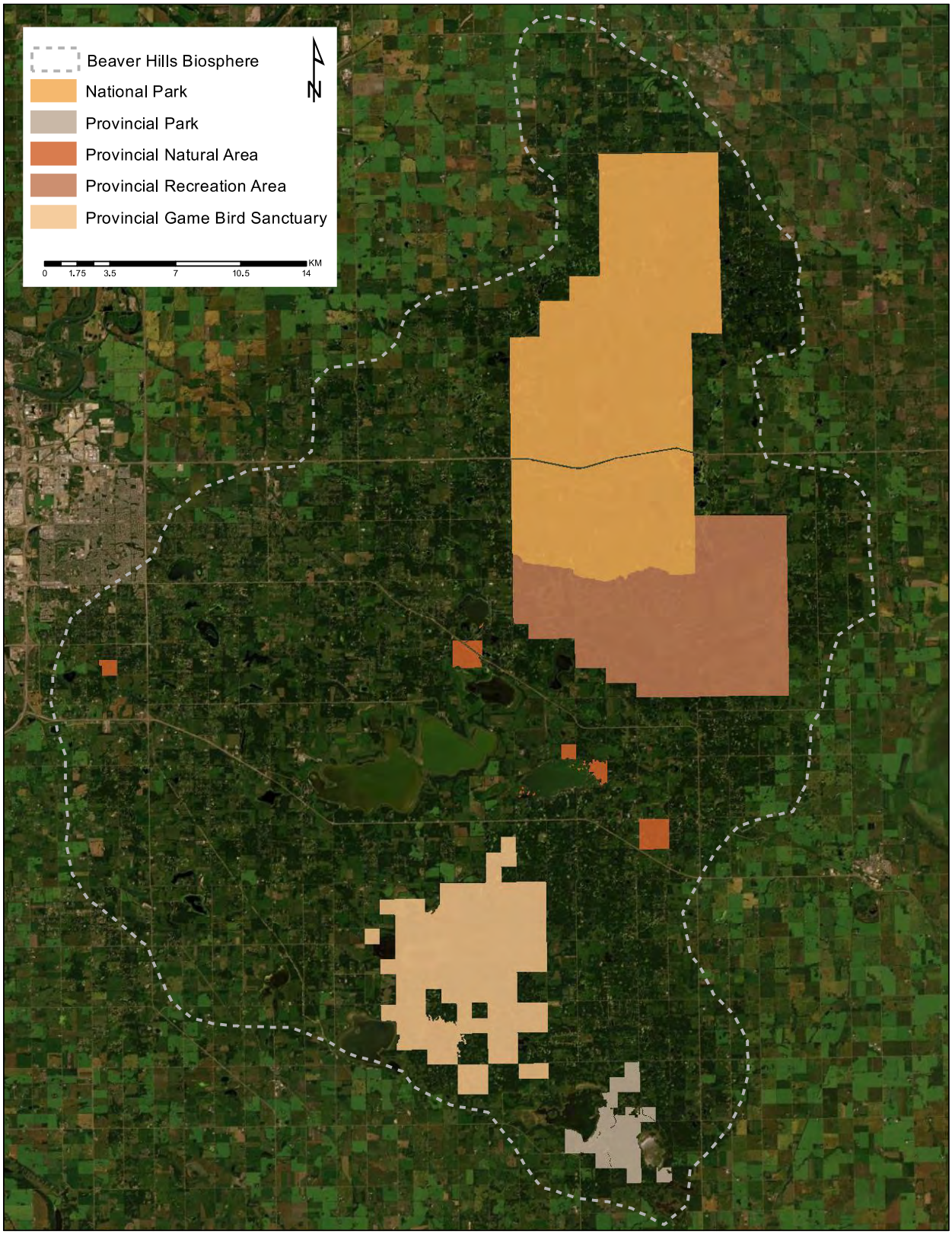


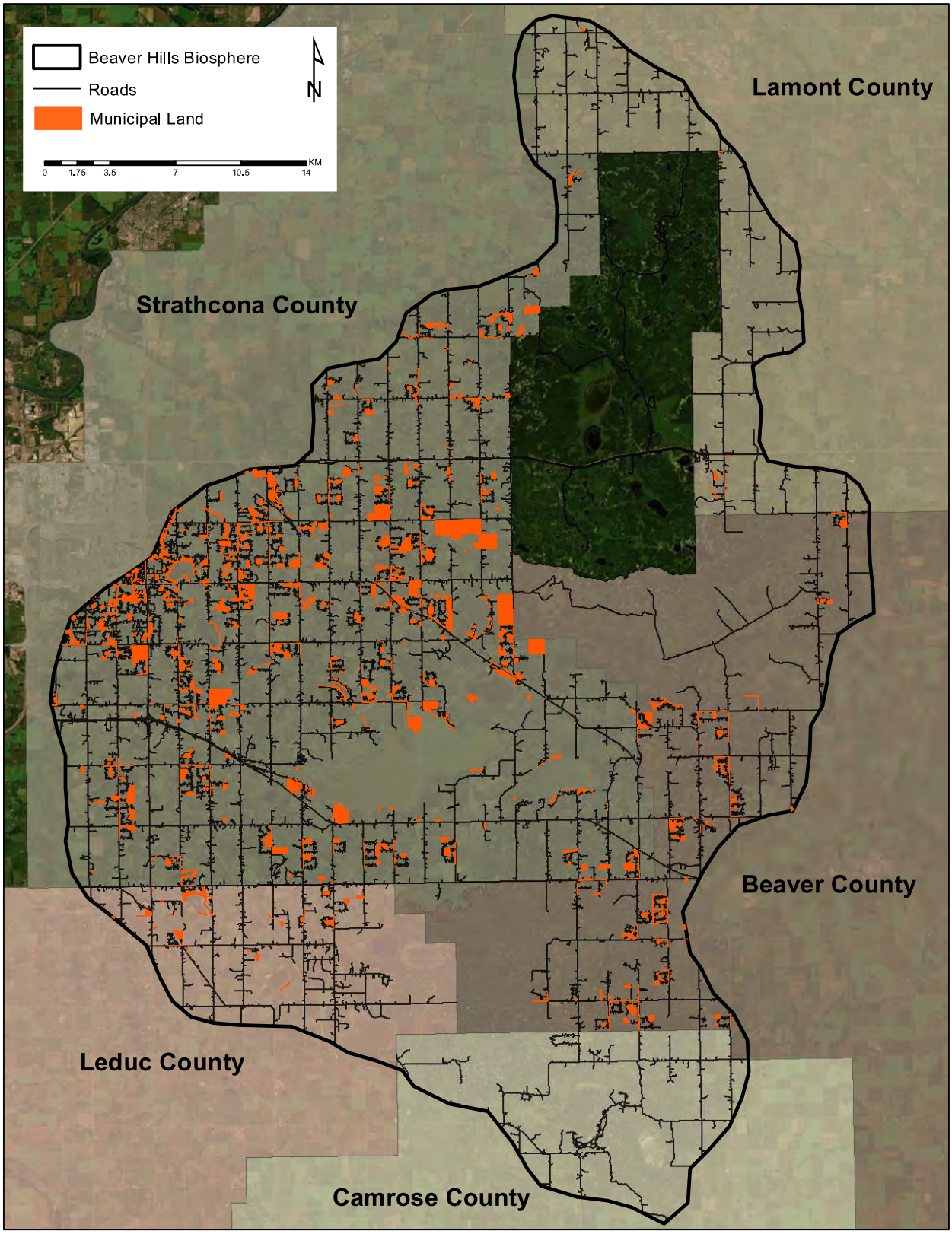
Figure 1. Overview of the key policies and regulations that apply to the management of wetlands on federal, provincial, and municipal lands, and the considerations and options for the management of wetlands as part of the Beaver Hills Biosphere wetland conservation and stewardship project.



Map 1. Private and public land ownership in the Beaver Hills Biosphere. Data source: Government of Alberta, 2017.



Map 2. Location of federally and provincially protected areas in the BHB, including parks, recreation areas, natural areas, and game bird sanctuaries. Data Source: BHI Land Management Framework, 2015.



Map 3. Location of municipally controlled lands within each of the five municipalities in the BHB. The municipally controlled lands are composed of a mixture of lands that have been designated as Environmental Reserve, Municipal Reserve, Environmental Reserve Easement, Conservation Easement, or Restricted Covenant. Data Source: GOA, 2017.

2.1.2. Private Land

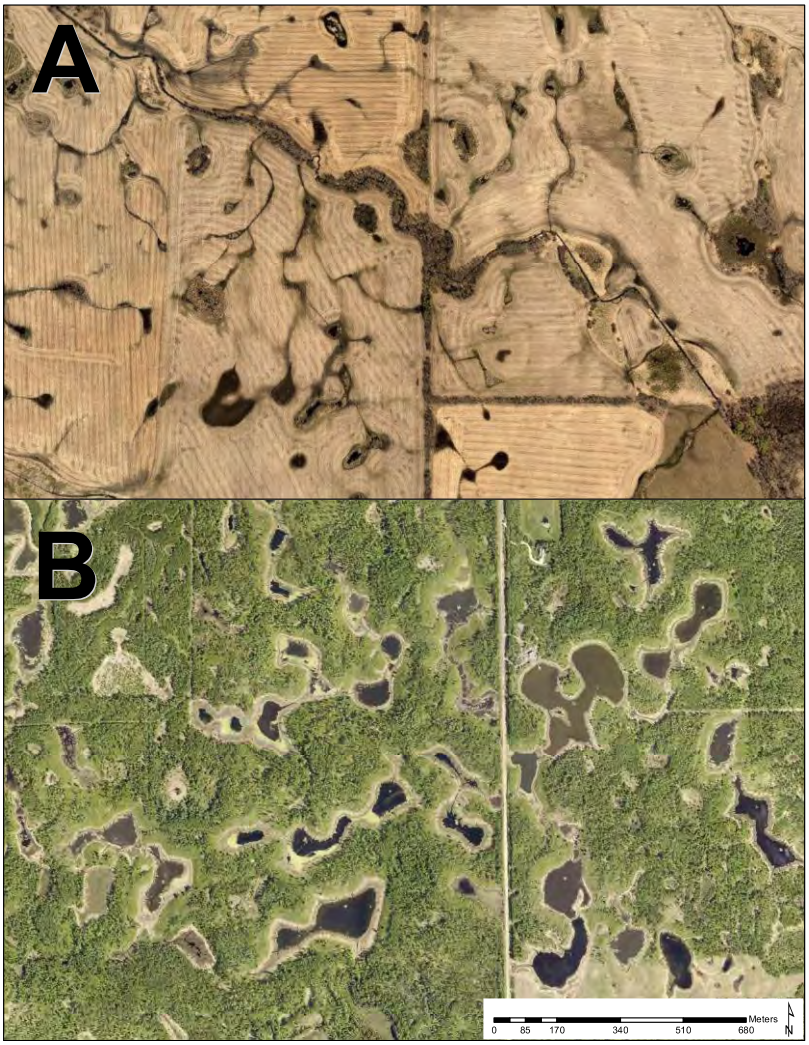
Approximately 65% of the lands within the Biosphere are privately held and are primarily located within areas that have been zoned for agricultural land use. These private lands represent the single greatest opportunity for wetland enhancement and restoration in the Biosphere, as impacts to wetlands on private lands are numerous and are typified by extensive drainage networks, particularly on lands that are utilized for intensive crop production (Map 4). In some cases, these drainage networks were created prior to the 1990s when wetland drainage was more permissible. It wasn't until 1993 that the provincial government introduced a wetland policy that encouraged wetland avoidance; however, landowners could continue to drain wetlands without any legal repercussions until 1999, when the provincial government released the *Water Act*. Under this legislation, the provincial government has jurisdiction over all water in the province, regardless of whether it is on private or public land, and landowners must seek approval from the provincial government (through the issuance of a permit) prior to undertaking any drainage works. In many cases, the wetland drainage that is present in the BHB has occurred since 1999 (Clare and Creed 2014), and in these cases, the drainage activity is considered by the government to be illegal and is technically subject to a compliance order, although most illegal drainage goes unreported, and thus, unenforced (Ibid).

For many landowners, the fact that the crown has jurisdiction or "ownership" over water that is located on private land, and that an approval from the government is required prior to undertaking any activities that may impact water, is either unknown, is not well understood, or is considered a serious infringement on private property rights. To further complicate matters, permanent and naturally occurring water bodies are considered crown land under the *Public Lands Act*, meaning that the bed and shore of all semi-permanent and permanent marsh wetlands and swamps are public land[1], regardless of whether the feature is completely surrounded by private land (Figure 2). This fact generally causes confusion for landowners, as crown-claimable wetlands are not identified on title unless the provincial Water Boundaries Unit has specifically reviewed a wetland and deemed it to be crown land, and a legal survey has been completed and registered on title. As a result, many landowners may have crown-claimable wetlands on their property, but because it has not been identified as such on the land title, the landowner may not know the wetland is public land. Importantly, unless a wetland is registered on tile as crown land, the landowner will pay property tax on those lands, in addition to paying tax on any non-permanent wetlands. For many agricultural producers, the requirement to pay property tax on wetlands is an incentive to drain, in order to make the lands more economically productive.

The complexity associated with the ownership of water and water bodies on private land creates a significant challenge with respect to communicating with potential participants in the BHB wetland pilot project around issues of property rights and legal obligations for water management. Further, many landowners may not share the provincial government's view of what constitutes a "wetland", as the scientific and legislative definition of a wetland is considered by many landowners to be too broad, particularly as it relates to temporary or seasonal wetlands (e.g., Class I-III marshes) that only retain surface water for weeks or months during the growing season (Kauffman 2018). In addition, many landowners do not use the term "wetland", and instead refer to these habitats as sloughs, swamps, marshes, ponds, potholes, or other colloquial terms. This often makes communication about wetlands difficult between landowners and those who use more legal or scientific language. Finally, there is a strong social norm around the primacy of private property rights and the importance of wetland drainage in supporting economic growth and development in agricultural communities (Weber et al. 2017). Overcoming these norms will be difficult and may require a shift towards outreach that includes a focus on environmental values and beliefs, rather than simply "educating" landowners about what a wetland is and the associated legal obligations for the management of these habitats (Cyr 2016).

[1] Notably, peatlands (e.g., bogs and fens) are not considered to have a definable bed and shore, and as such, cannot be claimed as crown land under the *Public Lands Act*.

So, while there is no shortage of opportunities to enhance or restore wetlands on private lands within the BHB, the challenge for this pilot project will be to overcome the negative social perceptions about wetlands and create a range of incentives that will motivate private landowners to participate in wetland stewardship. For some landowners, this may be as simple as appealing to their environmental beliefs and values and their role as members in their community to maintain a minimum standard of environmental quality (Cyr 2016), while for others their participation may be contingent upon designing an economic instrument that will adequately address the opportunity and nuisance costs associated with having a wetland on their property (Novak 2017; Kauffman 2018). At a minimum, this will require an investment in communication with landowners that will build trust and confidence in the program (Novak 2017; Kauffman 2018).



Map 4. An example of the extensive wetland drainage networks that can be found on agricultural lands within the Beaver Hills Biosphere (A), contrasted with an example of an area within the BHB where wetland and surrounding riparian and upland habitats are more intact (B). Wetlands with drainage ditches represent a significant opportunity to restore wetland habitat as part of the pilot project; however, incentivizing private landowners to participate in wetland restoration may be more difficult than incentivizing wetland enhancement or continued avoidance of wetlands that have already been conserved. Image Source: ESRI Basemap, 2017.

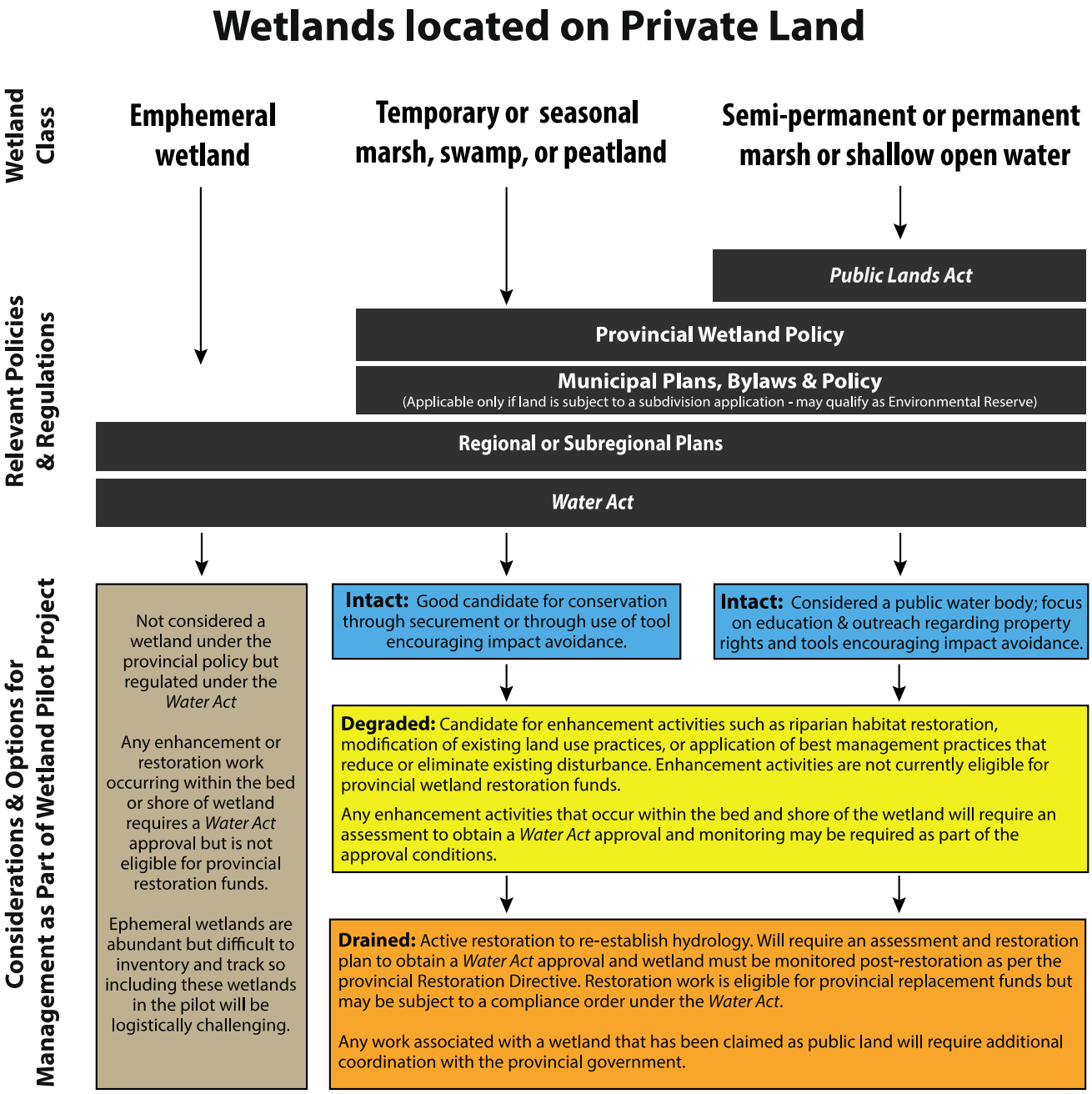


Figure 2. Overview of the key policies and regulations that apply to the management of wetlands on private land, and the considerations and options for the management of wetland on private property as part of the Beaver Hills Biosphere wetland conservation and stewardship project.

2.2. What is the Wetland Condition & Associated Stewardship Action?

While wetland condition can be measured across a continuum of hydrological and ecological function, from a practical and policy perspective, wetlands can generally be categorized into one of three condition categories: intact, degraded, or drained. While these categories are somewhat imprecise scientifically, they are relevant in the context of how the provincial wetland policy frames the management of wetlands with respect to policy objectives and desired outcomes, namely the conservation, enhancement, and restoration of wetland habitat. The connection between wetland condition and the associated stewardship activities that are the focus of the provincial wetland policy and its associated directives are relevant to this pilot project for the following reasons: 1) any wetland restoration, and potentially some wetland enhancement work, must be in compliance with regulatory requirements under the *Water Act*, and 2) there are opportunities for the BHB project and its stakeholders to access provincial wetland replacement funds to support the planning and implementation of the pilot. We discuss these points in more detail in the sections below.

2.2.1. Conservation of Intact Wetlands

Intact wetlands are those that are generally considered to be "healthy" or are in reasonably good condition with respect to their hydrologic and ecological function. From a policy and planning perspective, the conservation of intact wetlands is best achieved through the avoidance of impacts, as the enhancement and restoration of wetland habitat is logistically difficult and expensive, and restored or enhanced wetlands may never achieve the same level of hydrologic or ecological function as intact, natural reference wetlands. As a second step to avoidance, wetland conservation is focused on maintaining intact wetlands and preventing future impacts or impairment of wetland condition, typically (but not always) through some protection mechanism that allows for the long-term securement of the wetland (e.g., conservation easement, designation as a park or protected area, etc.). While long-term securement provides the best guarantee against future impacts, the tools, mechanisms, and resources that are available to governments or conservation organizations to secure wetlands for conservation are generally quite limited; thus, creating practical and feasible mechanisms to incentivize conservation of intact wetlands on private land is the primary goal of payment for ecosystem services programs.

Notably, there are many programs in Alberta that are, or have been, focused on providing a payment to landowners for adopting best management practices for wetland management (see ILUI and LSC 2012 for a comprehensive review), or for restoring a drained wetland (e.g., reverse auctions in Wintering Hills and Nose Creek watershed, various Ducks Unlimited restoration programs); however, these programs have not typically included consideration of a payment for the maintenance or protection of an intact wetland. While paying a landowner to avoid a wetland that they may otherwise retain in absence of the payment may be considered by some to be economically inefficient, such a payment may provide a greater guarantee of securement of the wetland over the long-term, which is an important outcome from a wetland stewardship perspective. Further, in the case of the Wintering Hills and Nose Creek reverse auction programs, landowners expressed their dismay over the fact that the "bad actors" who had drained their wetlands were receiving a payment to restore, over those "good stewards" who voluntarily chose to retain their wetlands (Novak 2016; Kauffman 2018). In the case of the Wintering Hills auction, potential bidders stated their interest in bidding on easements for intact wetlands, as well as for drained wetlands that required restoration (Novak 2016). Experience from these reverse auctions suggests that consideration should be given to designing incentives for landowners to retain, as well as to enhance or restore, and these incentives could be as simple as eliminating property tax on wetland areas that are maintained and avoided by landowners, or could be as complex as providing a payment for flood protection or other ecosystem services provided by the wetland.

It should be noted that an important component to wetland avoidance is good planning, in which key wetlands are identified and mapped, and avoidance of these wetlands is achieved through the implementation of the provincial wetland policy and *Water Act* permitting, as well as through municipal

land use planning processes. The Alberta Wetland Policy employs the "mitigation hierarchy" as a foundational principle for wetland management, whereby impacts to wetlands should first be avoided, and then minimized, and as a last resort, unavoidable impacts should be compensated through habitat replacement (GOA 2013). Importantly, the Policy makes reference to place-based decision making and the need to consider local economic, social, and environmental priorities, as well as considering local land-use and regional planning as part of site-specific regulatory decision making. Specifically, the provincial Wetland Mitigation Directive, which supports the implementation of the provincial policy by providing more detailed information about wetland mitigation activities, reinforces the place-based, local decision-making considerations outlined in the 2013 Policy, and specifically notes that:

> *"Proponents may be required to avoid wetlands and adverse effects on wetlands in consideration of … wetland management objectives in the Alberta Land Stewardship Act Regional Plans, or nested Sub-Regional Plans; Wetland management objectives within any other statutory plan or legislation; Municipal plans and bylaws under the Municipal Government Act" (GOA 2015, pg. 2).*

Thus, the provincial wetland policy and its supporting directives give clear direction to municipalities that local and regional wetland management priorities will be considered in the review of any *Water Act* application related to wetland impacts. This is significant because municipalities are given the authority to manage lands within their jurisdiction under the *Municipal Government Act* (MGA). A primary power given to municipalities is land use planning and development, which allows municipalities to set the conditions under which lands are subdivided and developed. Further, each municipality must develop statutory planning documents (e.g., Municipal Development Plans) that provide a framework and vision for development and land use within their jurisdictions. Within these planning documents, municipalities can provide specific direction for development requirements that may influence the conservation and management of wetlands. In addition to statutory planning documents, municipalities can influence the management of wetlands by enacting Land Use Bylaws that set forth requirements for development setbacks on environmentally sensitive lands. For example, municipalities can provide specific direction for development requirements near wetlands or set forth minimum development setback widths on Environmental Reserve (ER), environmentally sensitive land, or water bodies and watercourses. The MGA also gives municipalities the power to enact land use bylaws, as well as the authority to designate land as Environmental Reserve, which is the primary municipal tool for conserving and protecting wetlands.

The BHB pilot could advance wetland conservation in the Biosphere through a number of different mechanisms, the first being the development of a Beaver Hills Biosphere Wetland Policy. This policy could identify and map key wetlands that should be avoided and retained, or alternatively, could identify criteria for identifying a key wetland. Such a policy would be critical in communicating priorities for wetland retention and protection in the Biosphere, which would be an important engagement and communication tool for dealing with the provincial government as well as other stakeholders. If this policy was adopted by the by the Council of each municipality that is a part of the Biosphere, the policy would be considered a sub-regional plan under the *Alberta Land Stewardship Act.* As such, the policy would hold considerable weight in environmental decision-making within the region and all *Water Act* approvals would have to be consistent with the objectives outline in the BHB wetland policy.

Beyond the development of a regional wetland policy, this pilot could test the use of other incentives that are under the direct control of municipalities; for example, property taxes on intact wetlands could be reduced or eliminated to encourage their retention. Further, this pilot could focus on developing incentives for avoiding wetlands during land development planning and subdivision. It is at this point that municipalities have the greatest influence and control over how land development unfolds, as well as having the authority under the *Municipal Government Act* to designate areas as Environmental Reserve, Environmental Reserve Easement, or Conservation Reserve; however, there may be other more effective tools that could incentivize wetland avoidance at this stage of land development.

2.2.2. Restoration of Drained Wetlands

Restoration has many and varied definitions, but the central tenet of habitat restoration is that it includes active intervention that is intended to reverse the negative impacts of human activities on ecosystems. For example, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) defines restoration as "Any intentional activity that initiates or accelerates the recovery of an ecosystem from a degraded state" (IPBES 2018, p. 666), while the Society of Ecological Restoration (SER) defines restoration as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, and destroyed" (SER, 2004, p. 3). Within this context, restoration ecologists and practitioners generally acknowledge that habitat restoration is a process that occurs along a continuum and is not limited to a single action or a particular approach or method (Hobbs and Norton 1996).

In Alberta, the provincial government specifically defines wetland restoration as the "reestablishment of hydrology, vegetation and wetland processes *within a previously drained wetland*" (GOA 2016, pg. 6, emphasis added). Thus, the primary focus of wetland restoration, as defined by the provincial wetland restoration directive, is the re-establishment of wetland hydrology through the removal of tile drains, the plugging of a drainage ditch with an earthen plug or engineered structure, or through the re-establishment of a previously diverted water source. As mentioned previously, the vast majority of drained wetlands in Alberta are located on private lands in central and southern Alberta, including in the BHB (Map 4).

The large number of drained wetlands that exist in the BHB presents a significant opportunity for the pilot project; however, this opportunity comes with considerable regulatory requirements, any one of which may be a barrier to landowner participation and/or may be cost prohibitive to the project. At present, any restoration work that is conducted on provincial, municipal, or private land as part of this pilot will require a *Water Act* approval, and the provincial government has a clearly articulated process for securing an approval, which includes the following requirements:

- A Restoration Plan must accompany all *Water Act* approvals for wetland restoration and this report must be developed and signed off by an authenticating professional who meets the requirements outlined in the provincial professional practice standard (GOA 2017).
- The Restoration Plan developed by the authenticating professional must meet the assessment and reporting standards outlined in the provincial Restoration Directive (GOA 2016). Notable requirements for the Restoration Pan that may affect the design and viability of the pilot program include the following:
    a. A field assessment, conducted during the growing season, must be completed by a qualified professional and should inform restoration design.
    b. Consent from the landowner (private or Crown-owned) and any third parties that may be affected by the restoration activities must be obtained prior to the submission of the plan.
    c. The plan must include a signed agreement that includes the following:
        i. Terms indicating that the wetland has been secured for a minimum term of 10 years and permission for restoration crews, third-party consultants, and government staff to access the site during the 10-year term to perform site assessments, restoration activities, monitoring, maintenance, and performance audits.
        ii. A description of restricted activities within the restored wetland and copies of any accompanying management plans (e.g., grazing management plan).
        iii. Terms outlining that any activities occurring within the wetland after it has been restored are subject to a *Water Act* authorization and the Alberta Wetland Policy, and that any activities that occur without any such authorization will be reported to the regulatory body.
- As part of the *Water Act* approval process, a review under the *Public Lands Act* will be required to

determine if the wetland is considered crown land. If the wetland is claimed by the crown land, consent to restore the wetland would have to be obtained from both the Crown and the landowner, further complicating the restoration agreement.

- Once complete, the Restoration Plan must be submitted to the government along with an application for a *Water Act* approval through the Environmental Approvals System OneStop (EAS OneStop) application system. This application system requires that the applicant (typically the landowner) and the organization applying for the approval (typically a third party acting on behalf of the landowner, such as an authenticating professional) have a valid MyAlberta Digital ID (MADI).

The process of identifying a suitable wetland for restoration, negotiating with landowners, securing consent from the landowner and other affected parties, completing a field assessment, developing the Restoration Plan, and securing the *Water Act* approval is likely to take between six months and one year to complete. Once the approval has been secured, the restoration activities themselves are likely to take several more months to coordinate and complete. This means that from start to finish, a single restoration project is likely to take over a year and will likely include tens of thousands of dollars in costs associated with landowner engagement, developing the restoration plan, drafting of legal agreements, securing a *Water Act* authorization, completing the restoration activities, and potentially, payment to the landowner for securing the wetland.

Once the wetland has been restored, there are additional requirements for assessment, monitoring, and reporting over a four-year period (GOA 2016), including:

- A Wetland Validation Report submitted by an authenticating professional within 30 days of completing the restoration activity. This assessment must include a desktop review and at least one site visit to determine whether the restoration was completed as outlined in the project-specific Restoration Plan.
- Annual monitoring that includes “basic monitoring and maintenance inspection” of water levels, soils, and wildlife use (GOA 2016, pg. 14).
- Vegetation monitoring in years three and four that includes calculation of vegetation indices and estimation of cover along transects.
- A second verification submitted “a minimum of four years after the wetland has been restored” to determine whether the “wetland has been established and is on a trajectory toward a healthy state” (GOA 2016, pg. 15). This verification is to be completed by an independent third-party professional using desktop and field assessment. The field assessment must also include an assessment of the wetland using the Alberta Wetland Rapid Evaluation Tool – Actual (ABWRET-A) to assess the relative value of the restored wetland.

Notably, the Restoration Directive indicates that additional wetland monitoring guidelines and directives are forthcoming, and so it is difficult to understand the full scope of the monitoring requirements in absence of this additional guidance. Further, the Restoration Directive is not clear about what obligations, if any, the landowner and/or the restoration agency has with respect to ensuring that the wetland “is on a trajectory toward a healthy state” at the end of the four-year monitoring period, adding a great deal of uncertainty (and potentially risk) to restoration projects. With respect to cost, because the monitoring and validation work must be done by a qualified professional, the monitoring and verification is likely to add thousands of dollars to the overall cost of completing a single wetland restoration project.

An important consideration for the BHB pilot is that while there are stringent regulatory requirements that add substantial cost to a restoration project, there may be an opportunity to access funds to pay for the restoration through the provincial Wetland Restoration Program. This program was established in December of 2018 to enable the GOA to collect wetland replacement fees and work with “delivery agents” to direct the money towards restoration projects in priority areas (GOA 2019). The GOA has publicly communicated that the replacement fees will be paid out through contracts with delivery agents

established through a public call for proposal process (Figure 3); however, it is unclear whether the GOA would consider bypassing this process to work directly with a delivery agent (such as the BHB or its partners) in order to provide access to these funds. Thus, engagement with the GOA early in the design of the BHB pilot to inquire about whether and how provincial replacement funds can be accessed for use in the pilot is highly recommended.

As has been outlined above, the regulatory complexity involved in restoring a wetland will add both time and cost to the pilot, and there is a requirement for landowners to provide access to the restored wetland at least once a year during the growing season over a minimum period of four years. These requirements may impact the willingness of landowners to participate in the program, as well as add logistical complexity and some element of risk to each restoration project, as legal agreements will have to be developed and signed, third parties will have to be engaged to provide specific services (e.g., ditch plug construction, wetland assessment, etc.), and the monitoring and validation will have to be tracked and reported as specified by the regulator.

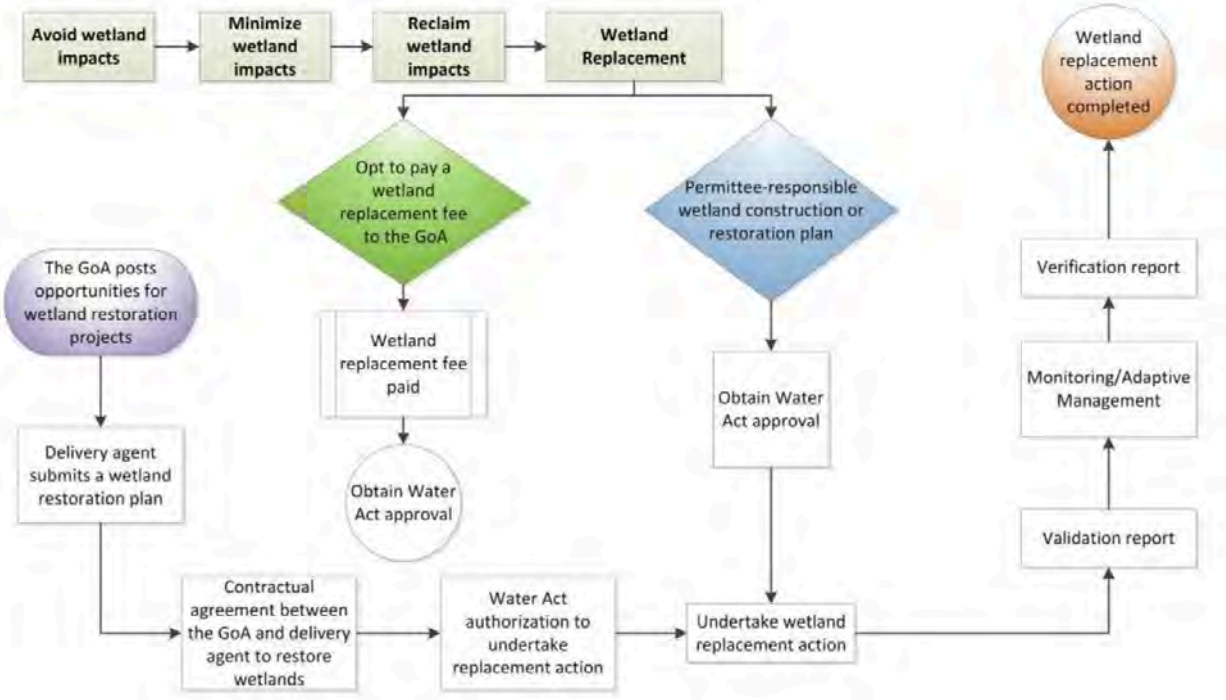


Figure 3. Overview of how the GOA conceives of engaging with delivery agents for wetland restoration projects funded through the Wetland Replacement Program (Source: GOA 2019).

2.2.3. Enhancement of Degraded Wetlands

Wetland enhancement is a common approach to achieving wetland management objectives throughout jurisdictions in North America (Poulton and Bell 2017). While wetland enhancement is generally considered to be an activity that falls along the habitat restoration continuum, the provincial Wetland Restoration Directive considers enhancement and restoration to be separate and distinct activities. As per the Restoration Directive, wetland enhancement is defined as "actions taken to increase the function and/or health of an existing, albeit degraded, wetland" (GOA 2018, pg. 6). This includes wetlands that have an intact basin (i.e., no ditch or tile drainage), but have had their ecological or hydrologic functions impaired as a result of human activities. Examples of degraded wetlands include those that are regularly cultivated, are utilized for livestock watering, and/or or have had their riparian zones cleared of vegetation. The primary difference between wetland restoration and enhancement is that restoration results in a net gain of both wetland area and function, whereas enhancement results in a net gain of wetland function only.

Often, the condition of degraded wetlands can be improved by simply eliminating the activity that is causing the impairment; for example, excluding cattle from the wetland or driving around, rather than through, a wetland in an agricultural field. In other cases, interventions such as riparian vegetation planting may be required to improve wetland condition. Importantly, because many of the management actions associated with improving the condition of degraded wetlands occur outside the bed and shore of the wetland, enhancement activities do not typically require a *Water Act* approval. Given how complicated, time consuming, and expensive the approval process can be, there are distinct advantages associated with focusing the BHB pilot on enhancement, rather than on restoration. Further, many extension agents who promote wetland stewardship in rural communities in Alberta report that agricultural producers have a strong preference for projects that include wetland enhancement, rather than wetland restoration (Fiera Biological 2018).

One potential challenge of including wetland enhancement in the BHB pilot is that unlike the restoration of a drained wetland, where re-establishment of the wetland hydrology tends to result in obvious changes that are easily measured, improvements to wetland function that result from enhancement activities may be more difficult to measure. Thus, if quantifying the change in wetland function and associated levels of ecosystem services that result from enhancement activities is a desired outcome, achieving this may be more difficult, although not impossible. Finally, it should be noted that enhancement activities undertaken within the bed and shore of the wetland (e.g., placement of live wetland soils, emergent vegetation planting) require a *Water Act* approval (and likely a restoration plan), as outlined in Section 2.2.2.

3.0 Key Policy Opportunities & Constraints

3.1. Spatial Targeting & Regional Management

Within the provincial environmental management framework, there are opportunities for municipalities to undertake planning that enables local control over wetland conservation and restoration decisions. This can be done by way of local, sub-regional, or intermunicipal policies or plans that articulate goals and priorities related to the supply of wetland ecosystem services. Specifically, the provincial Wetland Policy articulates the importance of place-based local planning and decision making, and this is reinforced in the Mitigation Directive (GOA 2018), which states that all wetland permitting decisions related to avoidance and minimization must be consistent with (amongst other things):

- Wetland management objectives established under the *Alberta Land Stewardship Act's* Regional Plans or nested Sub-Regional Plans;
- Wetland management objectives within any other statutory plan or legislation;
- Municipal plans and bylaws under the *Municipal Government Act*.

For example, if a municipality adopts a wetland policy that identifies wetlands within their jurisdiction that are critical for flood protection, and therefore, are high priority for retention, this must be considered in provincial decisions regarding a *Water Act* application that proposes an impact to or removal of those wetlands. Similarly, if an intermunicipal or watershed plan endorsed by a municipality identifies environmentally significant wetland areas, this must be taken into consideration by *Water Act* Approvals staff. Thus, municipalities have an important role to play in the identification of priority areas for wetland conservation, as well as locations where wetland restoration should be directed to help achieve local or regional objectives for the management of wetland function and associated ecosystem services.

Within the BHB there are five municipalities, only one of which – Strathcona County - has a municipal wetland policy. Strathcona's Wetland Conservation policy has a stated goal of "No Net Loss of wetlands within the urban and rural areas of Strathcona County based on municipal, community, and environmental needs" (Strathcona County 2009). This policy provides an important foundation for wetland management decision in the County, but the policy goal is ambiguous as to whether the focus is on the no net loss of wetland area or function, and does not provide direction or guidance on how "municipal, community, or environmental needs" are being measured, evaluated, or prioritized in planning and decision making. This type of guidance is important, because in absence of specific criteria or information regarding which priorities (municipal, community, or environmental) are the most important (or even what these priorities entail), or where on the landscape wetland conservation or restoration could be targeted to yield the best municipal, community, or environmental outcomes (i.e., spatial targeting), the policy may not be resulting in the best management outcomes. So, while it is important that Strathcona County has a wetland policy that signals that these habitat are a priority for management in the County, the policy could go further in providing guidance on which wetlands must be avoided, either through identifying and mapping of exceptional wetlands, or through clearly defining criteria for identifying an exceptional wetland.

A good example of a municipality that has undertaken this type of spatial targeting exercise is Parkland County. In 2015, Parkland County commissioned a study to map existing wetlands and prioritize each

wetland based upon a combination of ecological and hydrologic criteria, which were largely based upon provincial ABWRET metrics (Fiera Biological 2015). This mapping provides land managers with environmental information that can be considered alongside other social and economic considerations during the land planning and decision-making process.

A further example of a municipality that has spatially prioritized wetlands for management is the City of Chestermere. In 2012, the City commissioned a study to inventory, classify, and prioritize existing wetlands within the municipal boundary (Fiera Biological 2012). The assessment also included an estimate of the carbon and flood storage potential of existing wetlands, thereby highlighting the ecosystem service value provided by the retained wetlands within the municipality. Chestermere went on to use this information as a basis for developing a municipal wetland policy (Chestermere 2013) and a wetland bylaw (Cherstermere 2015). The bylaw, which was the first of its kind in Alberta, outlines specific expectations regarding wetland management, including buffers, setbacks, and compatible land uses, as well as requirements for site assessment and avoidance analysis.

For both Parkland County and the City of Chestermere, completing a wetland inventory, assessment, and prioritization was possible because of remote sensing and GIS tools that are now widely available for the purpose of undertaking spatial analysis and targeting exercises. These municipalities serve as a good example of what may be possible in the Beaver Hills Biosphere, particularly with respect to the Biosphere acting as a vehicle for developing a sub-regional plan and/or policy for wetland management. The development of such a plan or policy could potentially be one of the most important policy mechanisms for enabling and incentivizing wetland conservation and restoration in the BHB. In absence of a BHB wetland policy or management plan, wetland management objectives could also be integrated into Intermunicipal Development Plans that are required of each municipality within the BHB, many of which are currently under development.

Importantly, the GOA has indicated that it is looking to municipalities to provide direction on wetland conservation and restoration decisions, by undertaking some level of planning to identify priority areas that meet local and/or regional wetland management goals (Fiera Biological 2018). If such planning work is undertaken, the GOA has indicated that this information can be used to target wetlands for restoration, and that such targeted restoration projects would be eligible for provincial wetland replacement funds. Consequently, if the BHB pilot includes an element of spatial planning and targeting related to wetland conservation and restoration, and municipal partners endorse this through a formal plan or policy, then it may be possible to access funds through the provincial Wetland Restoration Program. This would potentially provide important financial resources to the pilot project over a number of years.

3.2. Provincial Wetland Restoration Fees

From the perspective of pilot project design and implementation, the provincial wetland policy presents both opportunities and constraints that must be carefully considered. In terms of opportunity, the Alberta Wetland Policy articulates that wetland replacement can take two forms: 1) Restorative replacement, where the wetland loss is compensated through the restoration, enhancement, or construction of another wetland, or 2) Non-restorative Replacement, which includes alternatives that support the maintenance of wetland value through advancing the state of wetland science and management (GOA 2013). Examples of Non-restorative Replacement given in the Policy include research into wetland restoration measures, development of wetland inventories, wetland securement for long-term conservation, public education, and wetland health assessment, modeling, and monitoring.

To this end, the provincial government initiated the Wetland Replacement Program in December 2018, whereby all wetland replacement fees are being collected in a centralized fund to be directed towards restorative and non-restorative replacement activities. The existence of these funds, and the direction provided in the Policy regarding how these funds may be allocated, present significance opportunities for the BHB and its partners to access money to support both restorative and non-restorative activities as part of the pilot. While the direction in the provincial wetland policy regarding allocation of these funds is

reasonably clear, given that the Restoration Program is relatively new, the actual process for determining how these funds will be paid out, and what activities will be given priority in the funding decisions, is still somewhat unclear. For example, the provincial government does not currently accept wetland enhancements as a replacement option, despite it being articulated as such in the policy, and it appears likely that this preference for restoration over enhancement will extend into the allocation of restoration funds (Fiera Biological 2018). Further, there is currently some uncertainty around whether any of the restoration funds in the near-term will be allocated towards non-restorative activities, and if so, what projects will be prioritized, and what process will be used to pay out these funds. Given the uncertainty around the Restoration Program funds, engagement with the GOA early in the pilot project development will be important in order to understand what components of the pilot, if any, may be eligible for funding through the Restoration Program.

3.3. Provincial Water Act Approvals

Generally speaking, the process for obtaining a *Water Act* approval to fill or drain a wetland is much simpler and easier than obtaining an approval for restoring a wetland. The process of identifying a drained wetland and engaging with a private landowner to inquire about their willingness to restore the wetland is on its own a difficult process. When the additional requirements for developing a Restoration Plan and securing a *Water Act* approval are added, the additional complexity of the process and the obligations placed on the landowner may present significant barriers to participation.

From the perspective of ensuring that policy objectives are being met, these regulatory requirements are logical, particularly if the wetland restoration is being undertaken to satisfy a habitat replacement obligation that was authorized through a specific *Water Act* approval. Whether these same regulatory requirements should be applied to restoration projects that are not tied to a specific compensatory habitat obligation is a question that may warrant some discussion with the GOA, as relaxing some of the assessment, monitoring, and/or reporting requirements is likely to increase participation in the pilot. Further, the BHB pilot could serve to explore whether these existing regulatory requirements act as barriers to participation in wetland restoration projects, and this information could feed back to the government to refine and improve the process of permitting wetland restoration in Alberta.

4.0 Conclusions

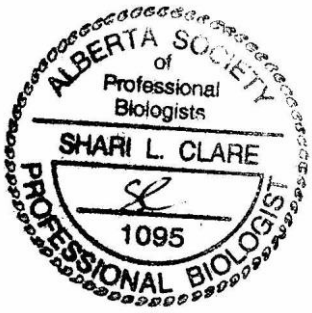
As a living laboratory, the Beaver Hills Biosphere Reserve presents an important opportunity to explore conservation questions and potential management solutions. The combination of both public and private land, as well as a unique blend of land uses and government jurisdictions, makes the Biosphere an ideal location to test a variety of policy and market-based instruments for incentivizing wetland conservation, enhancement, and restoration.

Given that wetlands are the subject of a variety of federal, provincial, and municipal policies and regulations, careful consideration must be given to how, and to what extent, these existing policies and regulations may impact the design and implementation of the Wetland Conservation and Stewardship Pilot Project. In particular, the provincial wetland policy and the regulatory requirement to obtain an authorization under the *Water Act* for wetland restoration activities places considerable constraints on the pilot. The complexity associated with this regulatory requirement is likely to influence how, and to what extent, drained wetlands are included the scope of the pilot.

Conversely, the current policy and regulatory landscape present opportunities that can be leveraged in the design and implementation of the pilot. For example, funding may be available through the provincial Wetland Replacement program for the restoration of drained wetlands, as well as for supporting inventory or modeling work; however, engagement with the GOA is required to determine what funds are available, how those funds can be allocated in the context of this pilot, and to process for accessing the funds through the provincial Restoration Program. Additionally, there may be opportunities through the pilot to advance sub-regional policies or plans that are endorsed by municipal partners, which could provide strong guidance on and direction for the avoidance and conservation of wetlands, in addition to informing provincial government decisions regarding where restoration funds are allocated through the Wetland Restoration Program.

4.1. Closure

This report was written by:



Shari Clare, PhD, PBiol
Director, Sr. Biologist

This report was reviewed by:

Shantel Koenig, MGIS, PhD
Sr. Landscape Ecologist

5.0 Literature Cited

All One Sky Foundation. 2019. Beaver Hills Biosphere Climate Resilience Express Action Plan. Report prepared for the Beaver Hills Biosphere. Pp. 46.

Amec Foster Wheeler Environment & Infrastructure. 2015. Beaver Hills Initiative State of the Beaver Hills Report. Submitted to Research and Monitoring Working Group, Beaver Hills Initiative, Sherwood Park, AB. Pp. 91.

Chestermere. 2013. Wetland Policy #311. City of Chestermere. Available: https://www.chestermere.ca/DocumentCenter/View/2704/Signed-approved-plan?bidId=

Chestermere. 2015. Bylaw #002-15 – Wetland Bylaw. City of Chestermere. Available: https://www.chestermere.ca/DocumentCenter/View/9942/Third-reading-of-Wetland-Bylaw?bidId=

Clare S, Creed IF. 2014. Tracking wetland loss to improve evidence-based wetland policy learning and decision making. Wetlands Ecology and Management **22**:235–245.

Creed, I., A. Spargo, and J. Seran. 2013. Environmental Reserve Mapping Project Final Report. Submitted to Beaver Hills Initiative, Sherwood Park, AB. Pp. 36.

Cyr, K. 2016. Social variables in wetland restoration: the role of values, beliefs, and norms in conservation behaviour. MSc Thesis, Department of Resource Economics and Environmental Sociology, University of Alberta. Pp. 76.

Fiera Biological Consulting and Sassafras Consulting. 2012. Environmental Resources Inventory. Report 1222 Prepared for the Town of Chestermere. Pp. 31.

Fiera Biological Consulting. 2015. Parkland County Wetland Inventory and Historic Loss Assessment. Report 1556 Prepared for Parkland County. Pp. 133.

Fiera Biological Consulting. 2018. An Evaluation of Municipal-Provincial Wetland Management Partnerships in Alberta. Report 1859 Prepared for County of Vermilion River and The City of Calgary. Pp. 46.

GOA (Government of Alberta). 2013. Alberta Wetland Policy. Queen's Printer, Edmonton, AB.

GOA (Government of Alberta). 2016. Alberta Wetland Restoration Directive. Water Policy Branch, Alberta Environment and Parks. Edmonton, Alberta.

GOA (Government of Alberta). 2017. Professional Responsibilities in Completion and Assurance of Wetland Science, Design and Engineering Work in Alberta. Alberta Government. Available: https://open.alberta.ca/dataset/c86572a8-560d-4f2e-a751-2467021b074a/resource/48dd8c05-fb55-4893-9769-7159770229c6/download/practicestandardwetland-may01-2017.pdf.

GOA (Government of Alberta). 2019. Alberta Wetland Replacement Fact Sheet. Available: https://open.alberta.ca/dataset/434aa433-8836-4637-9386-c67844b41b9d/resource/9e455832-f97b-4905-9575-e772dccd9338/download/wetland-replacement-factsheet-201812.pdf

Hobbs, R.J. and D.A. Norton. 1996. Towards a Conceptual Framework for Restoration Ecology. Restoration Ecology 4(2): 93-110.

ILUI (Institute for Land Use Innovation) and LSC (Land Stewardship Centre). 2012. Review of Past and Present Funding and Stewardship Programs in Alberta. Final Report. Pp. 39.

IPBES, 2018. Summary for policymakers of the thematic assessment report on land degradation and restoration of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES Secretariat, Bonn, Germany.

Kauffman, A. 2018. Investigating the use of Reverse Auctions for Restorable Wetlands on the Prairies. MSc Thesis, Department of Resource Economics and Environmental Sociology, University of Alberta. Pp. 73. Available: https://era.library.ualberta.ca/items/c61e7ab4-7b3f-4228-acfc-5f5b006ba114/view/1cd2987c-3b2f-487e-b116-2088b5e3fc36/Kauffman_Anna_M_201809_MSc.pdf.

Novak, L. 2017. A reverse auction for Wetland Restoration in Southern Alberta. MSc Thesis, Department of Resource Economics and Environmental Sociology, University of Alberta. Pp. 57. Available: https://era.library.ualberta.ca/items/3e53c5d0-fc75-4ef3-9b02-32fca3b268a0/view/37537f4f-187c-422d-998a-3dce63b338f5/Novak_Lucas_L_201707_MSc.pdf.

SER, 2004. The SER International Primer on Ecological Restoration. Society for Ecological Restoration International.

Strathcona County. 2009. Wetland Conservation. Policy SER-009-036, Strathcona County Municipal Policy Handbook. Strathcona County, Alberta. Available: https://www.strathcona.ca/files/files/at-lls-mph-ser-009-036-wetland-conservation.pdf.

UNESCO 2017. Ecological Sciences for Sustainable Development. Webpage. Available: http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/biosphere-reserves/.

Van Asselen, S., Verburg, P. H., Vermaat, J. E., & Janse, J. H. 2013. Drivers of wetland conversion: a global meta-analysis. PloS one, 8(11): e81292.

Weber M, Krogman N, Foote L, Rooney R. 2017. Natural capital and the political economy of wetland governance in Alberta. Journal of Environmental Policy & Planning 19:279–292.