February 1, 2012

Dear Open House participant,

Thank-you for downloading a copy of the draft, updated management plan for the Serpentine Wildlife Mangement Area. The current draft incorporates three major changes that the Ministry of Forests, Lands and Natural Resource Operations would like to make to the management plan: (i) increasing the priority for providing habitat for Species at Risk, (ii) increasing efforts to control invasive species and (iii) strengthening the regulatory tools available to manage human activities within the WMA. The project team is still engaged in the process of consulting with many stakeholders, consequently, some of these details are still in development.

The purpose of the open house is to provide an opportunity for the general public to provide comments on the vision and goals proposed in the management plan for the Wildlife Management Area. By holding the open house in the middle of the updating process, this will allow the project team to weigh public comments with those of the other stakeholders.

Thank-you again for contributing to the management plan update. We look forward to discussing your comments with you at the Open House.

Sincerely,
The Project Team
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Serpentine Wildlife Management Area
Management Plan

April 2012

Serpentine

Wildlife Management Area

Draft 31 January 2012

BRITISH COLUMBIA
Ministry of
Forests, Lands and
Natural Resource Operations

Photo Credit: *North Pen (K. Summers)*

This document replaces the previous Serpentine Wildlife Management Area management plan (2000).

Serpentine

Wildlife Management Area

Management Plan

Approved by:

_____ _____

[name] Date

Director, Resource Management
Ministry of Forests, Lands and Natural Resource Operations
South Coast Region

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1.0 Introduction

British Columbia is the most biologically diverse province in Canada. A wide range of ecosystems supports some 142 mammals, 488 birds, 22 amphibians, 18 reptiles and 468 fish species along with an estimated 2790 native vascular plant species (BC Conservation Data Centre, 2001). The British Columbia Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) aims to maintain and restore the province's ecological diversity of fish and wildlife species and their habitats, and to provide and enhance fish and wildlife services to British Columbians and others.

One way the MFLNRO meets these goals is through the management of the province's protected areas system and various types of conservation lands. The MFLNRO has acquired conservation lands for fish and wildlife in a number of ways including purchase, long-term lease, and legislative designation. All conservation lands are intended to give priority to the conservation of specific wildlife and/or fish species and their habitats, while often providing for other resource uses. These sites are established where the wildlife, fish and/or related habitat values are of regional, provincial, or national significance. They may be used for a variety of purposes including the conservation and management of:

- Habitat for endangered, threatened, sensitive, or vulnerable species
- Habitat required for a critical life-cycle phase of a species, such as spawning, rearing, nesting, or winter feeding
- Migration routes or other movement corridors
- Areas of very high productivity or species richness

Some conservation lands are designated as Wildlife Management Areas (WMA) under the Wildlife Act. The WMA designation provides the MFLNRO with tools to assist in managing important fish and wildlife habitats.

The Serpentine Wildlife Management Area contributes to all of the conservation land purposes described above, and is an important freshwater and agricultural ecosystem in the Fraser River delta—Boundary Bay area. This management plan will set appropriate management objectives and strategies for maintaining wildlife and their supporting habitats in the WMA.

1.1 WMA Planning Purpose

The MFNLRO prepares management plans to guide the management of WMAs over the next 20 years. These plans set forth objectives and strategies to manage fish and wildlife species and their habitats, along with various human uses. A management plan relies on current information relating to such subjects as natural and cultural attributes and human uses of the WMA, together with land management activities occurring on

surrounding lands. It is recommended that a management plan be reviewed every five to ten years as environmental, social, and economic conditions change.

The process for preparing a management plan involves a careful analysis of the overall goals of the WMA, use patterns, and possible sources of conflict with fish, wildlife and their habitats. The intent is to ensure management decisions maintain and restore fish and wildlife habitats, and that human use within the WMA does not have negative impacts. Identifying potential impacts from adjacent land uses is also an important aspect of the planning process.

A management plan not only establishes long-term management direction for a WMA, it also identifies immediate issues. Because the MFLNRO is unable to address all issues simultaneously, the management plan prioritizes the numerous management strategies it identifies.

A management plan is prepared after thorough stakeholder input into the resolution of major issues. A public process is then undertaken to provide comments on a draft plan. Once all comments have been assessed, the Regional Manager of the Ministry of Forests, Lands, and Natural Resource Operations approves the final document.

For the Serpentine Wildlife Management Area, the management planning process has relied on consultation with a variety of stakeholders and a number of information sources, including:

- BC Ministry of Forests, Lands, and Natural Resource Operations
- Ducks Unlimited Canada
- Katzie First Nation; Kwantlen First Nation; Semiahmoo First Nation; Sto:lo Nation; Sto:lo Tribal Council; Tsawwassen First Nation; Tsleil-Waututh Nation
- Environment Canada
- City of Surrey
- Mud Bay Dyking District
- BC Ministry of Transportation and Infrastructure
- BC Ministry of Environment
- Local property owners and tenure holders
- Serpentine Management Plan 2000
- BC Wildlife Act
- Federal Migratory Birds Convention Act

Public input into the management plan to be obtained during an open house scheduled for February 8th, 2012.

1.2 Background Summary

The 71.3 ha Serpentine Wildlife Management Area is located in the City of Surrey. It is bounded by the Serpentine River on the north side, King George Boulevard on the east, Highway 99 on the west and 44th Avenue on the south.

The substrates within this region are of fluvial and glaciofluvial origin. The diked farmlands and adjacent tidal flats of the Mud Bay lowlands are part of an alluvial plain with a maximum elevation of 15 m. The area is drained by the Nicomekl and Serpentine Rivers, the estuaries of which meet in Mud Bay, which is part of the intertidal Boundary Bay Wildlife Management Area. Before the area was diked in the 19th century, the surrounding area formed part of the tidal salt-marsh of Mud Bay (Leach 1983).

Before settlement in the area, the floral communities of the lower Serpentine River floodplain-Mud Bay area were probably a heterogenous mix of grassland with salt marsh vegetation in low-lying areas and hardhack (Spirea douglasii) thickets wherever heights of land existed. North and Teversham (1979) have classified the pre 1880 (before diking) habitat of the Serpentine WMA as grassland, with nearby salt marsh and mixed grassland-shrub vegetation types. Native vegetation communities no longer exist in their historical form since the area has been both diked and farmed. The history of the land use between diking and the establishment of the current Wildlife Management Area is found in Appendix 1.

Currently a complex of permanent wetland, farmed upland, managed and unmanaged non-permanent moist soil areas, old-field, and hedgerow/woodlot characterize the site. Waterfowl species are characteristic of this site, predominantly dabbling ducks and Canada Geese. Beginning in the 1960s the area was recognized as an important area for migrating and wintering waterfowl, which led to its establishment first as a conservation area, then as a 'Wildlife Sanctuary' under the *Wildlife Act* on July 5, 1973, and then on April 12, 2009, as a Wildlife Management Area. The site has been managed under a partnership with Ducks Unlimited Canada since 1969.

Waterfowl use the WMA as an extension of their other nearby habitats, including the intertidal mudflats of the Boundary Bay WMA, and adjacent farmlands. An objective of management is to attract birds, especially American Wigeon and Canada Geese, away from local crops at critical times.

Other waterfowl and waterbirds occurring regularly within the WMA include mergansers, breeding Mallards, teal, and Gadwalls, breeding and nonbreeding American Coots and Pied-billed Grebes, and foraging Great Blue Herons. American Bitterns occur regularly and breeding is suspected. Songbirds use the many hedgerows and thickets at all times of the year, and Northern Shrikes occur regularly during the winter. Townsend's voles and other small mammals inhabit the fields, providing food for herons, Red-tailed Hawks, Northern Harriers, Barn Owls, and coyotes.

The area has also been used for educational pursuits since the 1970s when Douglas College had an Environmental Studies Centre at the WMA. Ducks Unlimited currently conducts programs on the site for grade 3 and 4 students. Biological studies have also been carried out here by students from BCIT, UBC, and SFU.

The first management plan for the site was written in 1992 and updated in 2000. It was to be used for 30 years from the date of establishment of the WMA, which did not occur until 2009. The plan called for updates at five-year intervals. This plan updates and replaces the 2000 plan.

1.3 Management Issues

The history and context of the Serpentine Wildlife Management Area require that several other interests be addressed.

Lease Holder and Other Third-Party Access

- BC Hydro hydroelectric towers and right-of-way
- Rogers Cellular infrastructure
- Telus Cellular infrastructure (re Clearnet)

Annex Lands

- East Marsh east dike: Surrey right-of-way beside King George Blvd
- Fields: Highways Ministry (BC Transportation Finance Authority) south of 44th Ave.
- Fields: Highways Ministry (BCTFA) between Highway 99 and the WMA

Recreation

- Trails
- Parking
- Signs
- Conflicts
    - Ice skating
    - Dog walking
    - Garbage/litter
    - Other potential conflicts

Serpentine River Dike

- Mud Bay Improvement District
- Recreational Use and effects on dike, WMA, and private land

Invasive Species

- Introductions by public (drop-offs)

- Management Issues and priorities (vegetation and animals)

Agriculture and Waterfowl

- Waterfowl in the WMA and their use of adjacent lands

This management plan will address all of the stated issues and provide management direction for each.

1.4 Annex Lands and Management Units

The Serpentine WMA consists of two zones, the actual WMA and the Annex lands (Figure 2). The Annex is an area contiguous with the WMA boundaries that is owned by other agencies. The Annex consists of three separate parcels, two owned by the BC Transportation Financing Authority (BCTFA), and a portion along the King George Boulevard transferred from the BCTFA to the City of Surrey in 1999. Prior to 1999 both parcels were managed as habitat for fish and wildlife through an agreement between the MFLNRO and the BCTFA.

Management units were established within the WMA to identify areas with similar objectives. The WMA has been subdivided into 15 management units (Section 5.2) based on historical land divisions, habitat type, and management objectives.

2.0 Role of the Wildlife Management Area

The Serpentine WMA is significant because it is land that provides agricultural opportunities while managing habitat for a variety of wildlife species, in particular waterfowl that move freely between alternate habitats occurring on adjacent farmlands and the Mud Bay/Boundary Bay intertidal mudflats.

2.1 Context Setting

The Serpentine Wildlife Management Area is found in the Serpentine and Nicomekl River lowlands that empty westward into Mud Bay at the east side of Boundary Bay, in Surrey, British Columbia (Figure 1). Its legal description is as follows:

> Lot 3, Plan LMP 23121, except Statutory Right of Way Plan 77180, and 207 m2 of unsurveyed Crown land northeast of Lot 3 as described on Plan LMP 23121.

It lies about 6 km north of the City of White Rock and 2 km east of Mud Bay. The site is bounded by the Serpentine River on the north side, the King George Highway on the east, Highway 99 on the west and 44th Avenue on the south. It's approximately 71-

hectare area provides alternate habitat to local farmlands, and contributes increased biodiversity of the surrounding lowland areas.

Provincially, wetlands account for only 5.6% percent of British Columbia's land base and are one of the most rare and biologically productive ecosystem types on the British Columbia coast. As such, the Serpentine WMA is an important addition to protected wetland areas in the province. The Serpentine WMA is also unique in being the only non-tidal WMA in the Fraser River delta.

The Serpentine WMA is part of a network of protected areas including Boundary Bay WMA, South Arm Marshes WMA, Roberts Bank WMA, Sturgeon Bank WMA, Alaksen National Wildlife Area and Burn's Bog Ecological Conservancy Area. Due to their location on the Fraser River delta, this network is of international importance as habitat for migratory and wintering birds. The Fraser River estuary is listed as an Important Bird Area of global significance by BirdLife International because of the large (>20,000 individuals) congregations of: (i) waterfowl; (ii) shorebirds; (iii) and colonial waterbirds and seabirds. It is continentally significant because it holds 1% or more of the North American population of some species. It also holds 1% or more of the Canadian population of some species, making it nationally significant as well. The estuary supports over 500,000 shorebirds during spring migration, ranking it as a site of hemispheric importance within the Western Hemisphere Shorebird Reserve Network.

An application is also being prepared by a partnership between all three levels of government to nominate the network of protected areas (excluding Alaksen NWA, which is already a RAMSAR site) as a 'Wetland of International Importance' under the 1971 International Convention on Wetlands, signed in Ramsar Iran. The Convention is an intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of their 'Wetlands of International Importance' and to plan for the 'wise use' or sustainable use, of all of the wetlands in their territories.

All agencies with environment strategies and plans are encouraged to work closely with the Ministry of Forests, Lands, and Natural Resource Operations in the management of Serpentine WMA.

2.2 Vision, Goals and Principles

Management action within the Serpentine WMA will be guided by the over-all vision for the WMA, strive to reach the goals of the management plan and be based on the principles.

Vision

The vision of the Serpentine Wildlife Management Area will be to maintain and enhance the productivity of the fish and wildlife habitats it contains.

Goals

In order to support the vision for the Serpentine WMA, the management plan has five goals:

1. Provide habitat for wintering and migrating birds.
2. Provide habitat for species at risk.
3. Provide wildlife oriented public recreational opportunities that are compatible with the WMA vision.
4. Promote conservation awareness, education, enhancement and research.
5. Prohibit human activities that are incompatible with the WMA vision.

Principles

The following principles are to guide management actions and prescriptions taking place within the Serpentine Wildlife Management Area:

a. unless stated otherwise, the term “wildlife” is to be used in the broadest sense to include birds, mammals, fish, herptiles, invertebrates, microorganisms, plants, and their habitats;
b. management prescriptions are to be cost effective;
c. management prescriptions will be reviewed regarding their impact on agricultural, commercial, and industrial lands near the WMA;
d. management prescriptions are to emphasize natural features and processes or compatible agricultural practices;
e. any vegetation plantings are to use only native species, or species deemed to benefit fish and wildlife;
f. management prescriptions are to benefit waterfowl, Species at Risk and over-all biodiversity; special management for one group will be accommodated only when impacts on other groups are low;
g. species having a negative or undesirable impact on management objectives may be controlled (e.g., purple loosestrife, blackberry);
h. user amenities and facilities will be minimal, low-impact, low maintenance, and compatible with management objectives;
i. the public is to have an opportunity to provide input into broad management decisions;

j. the WMA will be managed in a manner that is compatible with adjacent agricultural activities (e.g. controlling noxious weeds, attracting waterfowl away from nearby private and leased agricultural land by providing quality foraging opportunities);
k. FLNRO and Ducks Unlimited will develop partnerships to improve expertise and expand resources that will improve wildlife habitat; and
l. management will not unjustifiably infringe upon traditional aboriginal rights in the WMA.

3.0 Community Context

Land and resources used in and adjacent to the WMA include the agricultural industry, commercial uses, and public use. It is also within the overlapping land claims areas of five First Nations.

3.1 First Nations

Seven First Nations have land claims that overlap with the WMA: Tsawwassen First Nation, Katzie First Nation, Kwantlen First Nation, Tsleil-Waututh First Nation, Sto:lo First Nation, Sto:lo Tribal Council, and Semiahmoo First Nation.

The area encompassed by the Tsawwassen First Nation Treaty (8 December 2006) includes the WMA. That treaty maps the TFN's interest in harvesting natural resources, including fish, wildlife, migratory birds, and plants.

Management Strategies

No specific strategies have been identified yet with respect to First Nation's direct input into the management goals of the WMA.

3.2 Agriculture

The WMA is managed to avoid conflicts with nearby agriculture. In particular forage is produced for grazing waterfowl such as Canada Geese and American Wigeon to attract them away from crops on adjacent agricultural land.

4.0 Land Uses, Tenures, Interests, and Jurisdictions

Several government and business entities have legal interest or jurisdiction, either over the land managed as part of the Serpentine WMA, or over WMA activities that might affect their jurisdictional interests (Figure 2).

4.1 BC Hydro

BC Hydro maintains a 500 kV transmission line within an associated right-of-way between Highway 99 and the west side of the Serpentine WMA. B.C. Hydro requires unencumbered access from 44th Avenue to maintain its towers and lines. The 108 m wide right-of-way is part of the BCTFA Annex managed by the WMA.

4.2 Communications Towers

Three sets of cellular communications infrastructure located on BC Hydro's transmission towers are operated by two companies. The companies require access to maintain their facilities.

4.1 Mud Bay Diking Commission

The Mud Bay Diking Commission manages the dikes of the Mud Bay Diking (improvement) District, which includes the dike along the south side of the Serpentine River, below the sea dam. The dike is part of the Wildlife Management Area, the northern border of which is the normal high water mark on the north side of the dike. As a landowner, MFLNRO is a member of the Diking District and is taxed annually to assist with the dike maintenance.

The Diking District requires that the management area's interior water management dikes be set back from the river dike to prevent water from being impounded against the toe of the main river dike.

4.1 BC Transportation Financing Authority and Ministry of Highways and Infrastructure

The Serpentine Annex property held by the BCTFA continues to be managed for wildlife and agricultural purposes under a 5-year renewable agreement negotiated in 1998, which can be cancelled on 90 days notice if the land is required for highway purposes. BCTFA will be contacted to update and renew the agreement in 2012.

4.2 City of Surrey

The WMA lies within the City of Surrey. The City has legal interests in two parts of the area managed by the WMA. To the east, parallel King George Blvd, it owns a right-of-way (Pl 77180) transferred to it from the Highways ministry when the King George Highway Arterial Classification was rescinded on April 1, 1999. The east dike of the Serpentine WMA East Marsh and the Serpentine River pump are on this land.

In 2006, Surrey obtained a right-of-way (BCP 10665, Pl 6251) over the Serpentine River dike for "Multiple Purposes," which included dike management and recreational access. The dike is within the WMA. To facilitate public access to the dike, Surrey has built a parking lot on its property alongside King George Blvd and adjacent to the dike.

4.3 Navigable Waters Protection – Transport Canada

Transport Canada administers the federal Navigable Waters Protection Act (NWPA). The NWPA is a federal government statue designed to protect the public right and safety of navigation by prohibiting the building or replacement of any work that interferes with navigation.

If a proposed project has the potential to interact with or affect navigation, the proponent must submit an application to Transport Canada for approval under the NWPA. FLNRO, which administers the Serpentine WMA, has no authority to interfere with, or impose regulations on, the public right to navigation in waters defined as navigable under the NWPA.

4.4 Fisheries and Oceans Canada

Fisheries and Oceans Canada (DFO) is responsible for administering the federal Fisheries Act, which provides for the protection of fish habitat and protection of water quality for fish and fish habitats. DFO has jurisdiction over any land/water use proposals on the WMA that could affect fish habitat in the river.

4.5 Environment Canada

The Canadian Wildlife Service administers the federal Migratory Birds Convention Act the federal Canada Wildlife Act, and the federal Species At Risk Act. They address wildlife matters that are the responsibility of the federal government. These include protection and management of migratory birds and their habitats, nationally significant and endangered species, and other wildlife issues of national and international importance.

Through its management of federal compensation money for the expansion of the third runway at YVR (Vancouver International Airport), CWS provided funds in 1997 and 1998 for the establishment of hedgerows within the WMA, and perhaps in the 1980s for the hedgerows planted along 44th avenue and in the Annex.

4.6 Agricultural Land Reserve

The Agricultural Land Commission Act, S.B.C. 2002, c. 36, was brought into force on November 1, 2002. This Act repealed the Agricultural Land Reserve Act, the Land Reserve Commission Act and the Soil Conservation Act, and replaced them with a new Act that incorporates some of the provisions from the repealed Acts, and established the Provincial Agricultural Land Commission.

In addition to the ALCA, the Agricultural Land Reserve Use, Subdivision and Procedure Regulation, B.C. Reg. 171/2002, replaced all existing regulations under the (repealed) Agricultural Land Reserve Act and Soil Conservation Act. This Regulation identifies farm activities and other, non-farm uses permitted in the ALR, notification requirements for soil removal and placement of fill, procedures for submitting applications and identifies filing requirements.

Any habitat enhancements other than vegetation management, and construction of facilities for public access, must comply with these acts and regulations.

4.7 Ducks Unlimited Canada

Ducks Unlimited Canada (DUC) has done most of the habitat creation and management of the WMA, beginning in 1969. The provincial government (currently through FLNRO) has a 30-year legal agreement with DUC, dated 5 July, 1985. Under this agreement DUC is required to construct and maintain all dams and other works to improve and preserve the lands as suitable habitat for waterfowl and other wildlife. This activity is to include all design, surveys, licensing, etc.

Vegetation management within the WMA and the Annex is also the responsibility of DUC, as laid-out in the 10-year Farming and Vegetation Management Agreement between DUC, MFLNRO and BCTFA. This agreement outlines the goals and prescribes the practices required to manage upland areas for grazing waterfowl and maintain identified set asides and depressions for other wildlife-related functions. This agreement expires in 2012. DUC and BCTFA will be contacted to update and renew this agreement.

5.0 Natural Values Management

The management plan considers the natural values of the Wildlife Management Area, addresses any potential resource conflicts, and outlines management objectives and strategies.

5.1 Natural Features

The physical features and organisms of management interest occurring at the Serpentine WMA are discussed here.

5.1.1 Soils

The substrates within the WMA are of fluvial and glaciofluvial origin. The diked farmlands and adjacent tidal flats of the Mud Bay lowlands are part of an alluvial plain with a maximum elevation of 15 m. This plain was formed by post-glacial tidal action between the 100 m high morainal deposits of Panorama Ridge to the north and the 45 m high morainal deposits of the Sunnyside Uplands to the south. The area is drained by the Nicomekl and Serpentine Rivers, the estuaries of which meet in Mud Bay. Before the area was diked in the 19th century, the surrounding area formed part of the tidal salt-marsh of Mud Bay (Leach 1983).

The landform is flat to slightly undulating and is characterized by a variety of soils. The soils are described as poorly drained, medium to moderately fine textured deltaic deposit, often overlain with 10 to 160 cm of peaty to well-decomposed organic soil (Luttmerding 1980). Usually, the alluvial soils consist of silty fluvial deposits on top of a sandy layer. The organic soils are acidic, with a typical range of pH 4.2 - 4.5. Its origin is from the build-up of organic matter caused by retarded oxidation, and from several "veins" of peaty material that bisect the northern soils in the area. The soils are classified as combinations of Rego, Orthic and Humic Gleysols where mineral soil is at the surface, or of Teric Humisols and Teric Mesisols in areas where deep organics occur (Luttmerding 1980).

5.1.2 Water

Water on the Serpentine Wildlife Management Area comes from three sources: rainfall (130 cm/yr); pumping from the nutrient rich Serpentine River (water licence for 1000 ac/ft/yr); and a small artesian spring in the northwest corner producing 36 litres per minute (Figure 3). One or two smaller springs in the administration area are inconsequential for management purposes.

The water quality characteristics vary seasonally. Due to lack of depth and circulation, the water temperature fluctuates with the ambient air temperature. The pH in the East Marsh (6.0 - 6.2) reflects that of the water pumped in from the Serpentine River. Other

interior areas (North and South Pens) had spring pH levels of 6.3 and 6.4 and a summer level of 7.0 when measured in 1981. The Triangle Marsh is more alkaline (pH 6.9 - 8.0), possibly due to minimal circulation and the influence of water from the artesian spring that had pH measurements between 8.0 - 8.5 during January through August 1976.

The water conductivity throughout the area is usually less than 0.6 mmhos year round (a conductivity of 2 mmhos is deleterious to freshwater plants); however, it is higher where salt water leakage occurs through culverts connecting with the river below the dam.

Organic soils stain the water yellow to brown. Suspended particulate matter, mostly organic, combines with the staining to cause a high turbidity, resulting in a light penetration of only 4 to 17 cm. Probable origins of the suspended particulate matter include bottom substrates stirred up by wind action or disturbed by dabbling ducks, and faecal material from waterbirds. The high nutrient level of this suspended material contributes to algal blooms which further increase the turbidity. With some exceptions, the high turbidity, combined with low pH has hindered the development of rooted aquatic vegetation.

Water within the WMA is managed through impoundments and pumping (Figure 3).

5.1.3 Vegetation

The Serpentine WMA is managed to create or maintain six basic habitat types: permanent or semi-permanent freshwater marsh, moist-soil seasonally-flooded sites, agricultural fields, old-field, hedgerow/woodlot, and salt marsh (Figure 4). A former seventh habitat type, referred to as transitional, is now largely characterized by woody vegetation (hedgerow/woodlot) interspersed with areas of old-field.

Permanent and Semi-permanent Open Water

The major ditches, East Marsh, Triangle Marsh, and North and South Pens are flooded to varying degrees for much of the year. In the late summer, they are drawn down through evaporation and drainage for management purposes. Formerly, water evaporated from those areas during the summer, frequently leaving them dry. When dry, they exhibited iron concentrations on the surface and polygonal cracking as the organic soils contracted. In wet years, however, the flats produced crops of annuals, including smartweed (*Polygonum* spp.) and a small *Juncus* sp. Works to create agricultural uplands in the South Pen in 1992, and in the South and North Pens and Triangle Marsh in 1997, deepened these areas. Since then, drawdowns to expose mudflats for migrating shorebirds can be more controlled. After drawdown some permanent water remains, particularly in the deeper parts of the East Marsh and South Pen.

Due to the low pH and high turbidity, submergent vegetation has been slow to establish, although some widgeongrass (*Ruppia* sp.) occurs in the East Marsh. Emergent vegetation has similarly been slow to develop, but after initial transplanting, cattail (*Typha latifolia*) established around the perimeter of the East Marsh in the summer drawdown area. Round-stem bulrush (*Scirpus validus*) planted in the East Marsh in 1981 was not successful. However, patches of bulrush became established voluntarily in the Triangle Marsh and North Pen by 1998.

Moist Soil Fields

This managed habitat is found only in the Long Meadow. The preferred management for these fields is to till (plough, disc or harrow) every three or four years to encourage the growth of moist soil annuals, primarily smartweed (*Polygonum* spp.) A small *Juncus* sp. is also common. Around the perimeter, bentgrass (*Agrostis* sp.) and reed canarygrass (*Phalaris arundinacea*) grow in dense stands. The precise species mix depends on the frequency of tillage and the timing and duration of flooding.

Agricultural fields

The main biological purpose of agricultural management is to provide forage for grazing waterfowl, in particular Canada geese and American wigeon. The agricultural fields have been managed in three ways in recent years:

a) regular mowing of grass areas (eg dikes and peninsulas) throughout the spring and summer to provide both breeding and nonbreeding Canada geese a source of forage.
b) forage production in the South Pen, Barn Meadow, North Pen, and Triangle Marsh under arrangements with various local farmers. These fields provide grazing for Canada geese and wigeon, particularly during the fall and winter. During the winter, ponding resulting from precipitation also attracts other waterfowl. These pastures were renovated in 1978 and again during 1989-92.
c) occasional planting of cereal crops (corn, winter wheat, oats, and barley) which is left unharvested to provide feed for waterfowl and other wildlife.

Old-field

Old-field is a component of passively managed areas, such as infrequently mowed dike slopes. The Rough Meadow has characteristics similar to old-field, except that flooding precludes the soil fauna and small mammals usually found in this habitat type. In 1998, portions of the Triangle Marsh in the Serpentine Annex were seeded and left to develop as old-field.

Hedgerow/Woodlot

Fence lines, field perimeters, dike toes and other unmanaged areas have developed woody vegetation. They are characterized by shrubs, either alone or in combination with grasses. Characteristic woody species include elderberry (*Sambucus racemosa*), snowberry (*Symphoricarpus albus*), salmonberry (*Rubus spectabilis*), blackberry (*Rubus* spp.), and trees such as black hawthorn (*Crataegus douglasii*), alder (*Alnus rubra)*, and cottonwood (*Populus tricocarpa*). In 1997 and 1998, the widened south side of the Serpentine dike and areas along the North-South road were planted with coniferous and deciduous trees and shrubs. During the 1980's, field perimeters of the Serpentine Annex south of 44th Avenue were also planted with a variety of trees and shrubs.

Salt Marsh

The formerly diked land inside the oxbow on the Serpentine River now lies outside the river dike. Breaches in the old dike allow brackish water to flood the area on high tides. The area supports grasses, sedge, and halophytic plants such as salt grass (*Distichlis spicata*), arrow grass (*Triglochin maritimum*) and glasswort (*Salicornia virginica*). Similar vegetation grows in patches along the river bank outside the WMA. The surrounding dike is overgrown with shrubs and small trees.

5.1.4 Fish

Chum and coho salmon, rainbow trout, steelhead, cutthroat trout and carp are among the fish that occur in the adjacent Serpentine River. Species captured in minnow traps in the WMA ponds, presumably pumped into the WMA from the Serpentine River, include prickly sculpin, pumpkinseed sunfish, brown bullhead catfish, flat-head minnow, an unidentified minnow species, three-spined stickleback, and a shiner species. No formal inventory has been done.

During the early 1980's, a salmon-rearing box was maintained by a local fish and game club for the Department of Fisheries and Oceans, using the artesian water in the Triangle Marsh. When the alevins hatched, they were removed immediately to a suitable rearing stream. The program was discontinued due to insufficient numbers of volunteers to maintain it (K. Summers, pers comm.).

5.1.5 Wildlife

Wildlife objectives and management strategies will encompass a diversity of species, but with a focus on waterfowl and raptors.

5.1.5.1 Birds

Notwithstanding any biodiversity objectives, the ultimate purpose of most of the habitat management of the Serpentine WMA is to provide food for waterfowl and raptors.

Waterfowl

The Serpentine WMA is on a major regional flyway for birds commuting between Boundary Bay and the agricultural lands of the Serpentine and Nicomekl River flood plains. From late summer through early spring thousands of Mallards, Wigeon, Pintails, and Green-winged Teal use the area. Waterfowl occurring in smaller numbers include Shovelers, Blue-winged and Cinnamon Teal, Ring-necked Ducks, Greater and Lesser Scaup, Buffleheads, and Common and Hooded Mergansers. During previous years, as many as 10,000 ducks (mostly wigeon and mallards) and 500 Canada geese have used the WMA during peak periods.

Mallards and Canada Geese are the main breeding waterfowl, although some Gadwall, Blue-winged Teal, Cinnamon Teal, and Wood Duck broods have been observed, and Blue-winged Teal may also breed. Since the cessation of the Canada Goose introduction program, the numbers of breeding geese have declined. Currently, DUC staff estimates, and recent breeding records, show that in the spring only three to six breeding pairs of Canada geese use the Wildlife Management Area, while in the fall the population is about 100 geese.

Raptors

Twenty-two species of raptors have been recorded in the Fraser River Delta (Butler, et al 1987). Of these, the short-eared owl, northern harrier, rough-legged hawk, red-tailed hawk and bald eagle are the most common. Raptors occur in the largest numbers during the winter months.

Red-tailed Hawks and Northern Harriers are frequently observed over the Serpentine area when waterfowl and shorebirds are most abundant (during migration and winter). Visits are occasionally made by Bald eagles, rough-legged hawks, ospreys, and short-eared owls. During winter, Cooper's and sharp-shinned hawks frequently hunt for passerines in the hedgerows. Barn owls resided and nested in two barns that once existed on the site and likely still forage there.

Other Birds

Great blue herons occur regularly in the marshes and ditches around the Wildlife Management Area. Shorebirds use the exposed mudflats of the North and South Pens, Triangle Marsh, Long Meadow, and East Marsh during the late summer and fall drawdown; however, shorebird use has diminished since drawdown management has become minimal. Western Sandpipers, Long-billed Dowitchers, Spotted Sandpipers, Wilson Snipe and other species occur. Dunlin, once among the most abundant species, are now uncommon. The area also occasionally attracts species rare for this area; most noteworthy was the occurrence of two breeding pairs of American Avocets during the spring and summer of 1988 and 1989.

Hedgerows of shrubs and small trees along fence lines, road perimeters, and dikes provide habitat for numerous passerine species. The most abundant species resident in hedgerows include black-capped chickadees, spotted towhees, and song sparrows. Other common passerines include northwestern crows, American robins, European starlings, and house finches. Common breeders in and around the marshes are marsh wrens, and red-winged blackbirds. When nest boxes were maintained, tree swallows were common nesters.

5.1.5.2 Mammals

The Townsend's vole (*Microtus townsendi*) is probably the most abundant mammal on the Wildlife Management Area and is an important food resource for raptorial birds, herons, and coyotes. Several other small (shrews and mice) and medium sized (mustelids, raccoon, muskrat) mammals occur. Beaver rarely enter from the Serpentine River (or are dropped off by people who have trapped them elsewhere).

5.1.5.3 Herptiles

Little information exists on amphibians and reptiles; however, northwestern salamanders (Ambystoma gracila), green frogs (*Rana clamitans*), bull frogs (*R. catesbeiana*), red-legged frogs (*Rana aurora*), Pacific chorus frogs (*Pseudacris regilla*), and garter snakes (*Thamnophis* spp.) are common and a rubber boa (*Charina bottae*) was once observed. In recent years people have introduced turtles. Red-eared sliders are most common, and there is limited evidence that western painted turtles are present and may be breeding.

5.1.5.4 Invertebrates

A random assortment of aquatic invertebrates have been found by DU while pond-dipping during educational programs: giant water bug, water scorpion, species of predacious diving beetle, backswimmers, water boatman, damselflies, mayflies, caddisflies, dragonflies, dobsonflies, mosquitoes, bloodworm midges, rat-tailed maggot (hoverfly), whirligig beetles, water striders, water beetles, and snail-predating leeches (Glossiphonidae).

Further investigation would be required to understand what species and groups of invertebrates are present in the SWMA ecosystems.

5.1.6 Species at Risk

Species at risk are identified and classified both provincially and federally. British Columbia has pledged to conserve the province's species at risk under the National Accord for the Protection of Species at Risk (1996). The BC Conservation Data Centre

tracks the province's species at risk and assesses the conservation risk for each species. Species are given a rank based on their risk of extinction, and these ranks are compiled into three lists. The two lists with management priority are Red-list and Blue-list species.

The red list includes species that have been legally designated as endangered, are extirpated, or are considered candidates for such designation. The blue list includes species not immediately threatened or endangered, but of special concern due to characteristics that make them particularly sensitive to human activities or natural events.

Federally, COSEWIC classifies species into several risk categories, while the Species At Risk act officially recognized certain species as being at risk by including them on Schedule 1. Schedule 1 species generally have the highest COSEWIC risk categories of Endangered, Threatened, or Species of Concern. The first two categories are roughly equivalent to the provincial Red List, while the third is similar to the provincial Blue List. A given species may or may not be given the same recognition provincially and federally.

While some species at risk, according to the above criteria, are known to occur on the Serpentine WMA, management activities have not targeted these species in the past. Several Blue-listed species known or suspected to occur include Great Blue Heron, American Bittern, Barn Owl, Barn Swallow, and possibly western painted turtle (though introduced). Other species are possible, including Pacific water shrew (Red List), Short-eared owl (Blue List), some invertebrates and plants.

Management action may be taken to enhance habitat with the WMA to benefit Species at Risk, as long as these actions have low impact on other WMA values. Management action may be directed at Species at Risk that currently occur within the WMA, or may involve introductions or re-introductions of species that require populations expansions for recovery.

5.1.7 Biodiversity

Biodiversity simply means the variety of all living things. The concept refers to the structure, function and composition of ecosystems and the interactions between abiotic and biotic components. Preserving biodiversity is a conservation priority for governments worldwide. Canada is a signatory nation to the United Nations Convention on Biological Diversity. British Columbia has responded to the Convention of Biological Diversity by adding to its vast network of protected lands, including parks, protected areas and conservation lands such as Wildlife Management Areas, strengthening the species at risk provisions in the *Wildlife Act*, and improving resource management programs throughout government.

At a local level, agencies use a multitude of approaches to preserve biological diversity. This management plan has identified that wintering and migratory birds and species at risk will receive the highest management priority within the Serpentine WMA. A species approach contributes to biodiversity, however, an ecosystem approach is also required to achieve biodiversity objectives. Both approaches are required in different parts of the WMA to achieve its goals.

Evaluations of Environmentally Sensitive Areas was done within the City of Surrey (Abs *et al.*, 1990 and Coast River Env. Serv. Ltd. et al. 1997). Rural areas were classed as having high, medium or low sensitivity and importance. The Serpentine Wildlife Management Area falls within an area rated as "high." This designation also includes the Serpentine River and all nearby farmlands. This designation was in keeping with the rating given to this area by Benn et al (1977) in a report done for the GVRD.

Some aspects of ecosystem management in the Serpentine WMA include maintaining clean water, maintaining and enhancing nutrient cycling, minimizing human use impacts, and allowing some modified landscapes to undergo natural vegetation succession. The succession being allowed in the Pool area, planting hedgerows, and mimicking historical grasslands by maintaining old-field conditions all contribute to preserving biodiversity within the Serpentine WMA.

5.1.8 Detrimental Species

Species that are detrimental to the goals and vision of the WMA can be divided into two classes: (i) alien (non-native) species and (ii) native species. Alien species typically are introduced to an area outside of their normal range by the intentional or unintentional action of humans. Aliens are of great concern because they often become invasive, spreading to the detriment of native species, following introduction. Most invasive species are from other parts of North America, Europe and Asia.
Several invasive, mostly alien species have been identified in the WMA. Some of the plant species are also considered to be agricultural pests and provincial measures and programs exist to help combat their spread (e.g., FLNRO's Invasive Alien Plant Program: http://www.for.gov.bc.ca/hra/Plants/raw.htm). The following list identifies how each may affect the habitat and wildlife management goals of the WMA:

INVASIVE SPECIES	CHARACTERISTICS	GOALS POTENTIALLY IMPACTED
Blackberry	Aggressive pioneer capable of invading open uplands and wetland edges and displacing native vegetation. Also provide some habitat and food for birds and small mammals.	WMA Goals Vegetation Wildlife Biodiversity
Japanese Knotweed	Aggressive pioneer capable of displacing native vegetation, particularly in hedgerows and old-fields. Has little wildlife food value.	WMA Goals Vegetation Wildlife Biodiversity

INVASIVE SPECIES	CHARACTERISTICS	GOALS POTENTIALLY IMPACTED
Purple Loosestrife	Aggressive wetland pioneer capable of displacing native wetland vegetation. Has little food or structural value.	WMA Goals Vegetation Wildlife Biodiversity
Yellow Flag Iris	Wetland plant capable of displacing native wetland vegetation.	Vegetation Wildlife Biodiversity
Small-seeded Bulrush	Native moist soil invasive capable of displacing other wetland vegetation and reducing diversity.	Vegetation Wildlife Biodiversity
Reed Canarygrass	Moist soil invasive capable of displacing all other vegetation. Has little food or structural value.	WMA Goals Vegetation Wildlife Biodiversity
American bullfrog	Voracious predator on any living thing smaller than it is.	Biodiversity Species at Risk
American Green Frog	Competition with and predation on smaller amphibians.	Biodiversity
Red-eared Sliders	May compete with other aquatic species for food. Competition with introduced native western painted turtles (Blue List).	Species at Risk
Eastern Grey Squirrel	Sometimes dropped off here by people who have trapped them elsewhere. Prey on bird's nests.	Biodiversity
European Rabbit	Sometimes dropped off here as unwanted pets. Browse shrubs and herbaceous vegetation. Can inhibit success of newly planted shrubs.	Vegetation
Feral cats	Predators on ground-nesting birds	Wildlife
Pumpkin Seed (Sunfish)	Compete with native species; food source for piscivorous birds.	Unknown
Brown Bullhead	Compete with native species; food source for piscivorous birds.	Unknown
Carp	Uproot vegetation and increase water turbidity. Presence unknown, but occur in Serpentine R from which water is pumped.	Vegetation Wildlife

Some native species, although they are not invasive, may need to be controlled because of their negative impacts on infrastructure or because their requirements for resources exceed the supply within the WMA. Two common examples are beavers and muskrats. Both species can weaken dikes by burrowing into them. Beavers also can compromise water management within the WMA by building dams and can damage habitat by removing trees faster than they can replace themselves.

5.1.9 Inventory, Monitoring, and Research

The WMA is a suitable location for research and education programs related to wetland ecology, agricultural and wildlife interactions and integration, waterfowl management, old-field development, and other subjects. Douglas College and UBC conducted studies of this nature in the 1970's. More recently, students from the B.C. Institute of Technology's wildlife program and SFU have also used the Serpentine Wildlife Management Area as a site for studies on subjects related to waterfowl, vegetation, wetlands, and rodents.

Such studies have the potential of helping understand the ecology of the WMA and informing its management. Similarly, inventory and monitoring would increase the knowledge and awareness of natural features and processes and effects of management practices within the WMA, and provide essential information that will allow the goals and objectives of the Serpentine WMA to be accomplished.

5.2 Management Units

The Serpentine WMA and its Annex have been subdivided into 15 management units (MUs), each representing either different management objectives or physical separation from adjacent MUs (Figure 5).

Operation and maintenance of the internal dikes and water control structures are done jointly by FLNRO and DUC according to an operations plan reviewed and adjusted annually. Habitat management is carried out by DUC under a 10-year farming and vegetation management agreement with FLNRO.

Habitat management involves a variety of activities including water management, periodic renovation of agricultural fields, renovation and/or flood rotation of moist soil fields, mowing/haying, tree and shrub planting, and brush control. Ditches, water control structures, pumps, and water movement used in the habitat management activities are shown on Figure 3. These activities are addressed below in relation to each Management Unit and Sub Unit.

5.2.1 Salt Marsh MU 1

This 3.9 ha area was formerly diked, but an intentional breach in the dike on the east side has opened it to the Serpentine River, creating a salt-marsh. The grasses, sedge and halophytic vegetation (salt grass, glasswort, arrow grass, sedges, etc.) provide feeding and loafing areas for waterfowl and shorebirds. Surrounding low trees on the dikes provide habitat for passerines and raptors.

No active management is anticipated for this compartment, which is reminiscent of former salt marshes lost to diking.

5.2.2 Serpentine River Dike MU2

The Serpentine River Dike was upgraded to between 1992 and 1998 by the Mud Bay Diking District to meet the current standards. This MU is managed for the developing old-field and hedgerow/woodlot habitats. The approximately 3.5 ha area was seeded with a grass-legume seed mix, and planted with about 3500 shrubs and trees following the dike upgrade. Many of the plants did not survive, but those that did are doing well.

The dike is a popular walking trail and use is encouraged by the City of Surrey, who obtained a right-of-way over this WMA land in 2006 and built a parking lot to access it from King George Boulevard. The dike is also used by people fishing in the Serpentine River, which is outside the WMA. Some erosion exists on the river side of the dike from people and/or dogs accessing the river edge.

5.2.3 Pool Area MU 3

The 5.8 ha Pool Area MU, formerly an old-field community, is undergoing natural succession and is now dominated by trees and shrubs, primarily by black hawthorn. Excess water from other compartments is diverted through this MU where it is temporarily impounded until it can drain through gravity-operated flap gates into the Serpentine River at low tide.

To date, the habitat has been allowed to follow a natural succession from its former agricultural state. Though this MU is currently unmanaged, future management could involve the creation of old-field habitat.

5.2.4 Triangle Marsh MU 4

In 1997, the 9.4 ha Triangle Marsh MU was reconstructed to create uplands on the west side and a deeper wetland on the east. Most of the western uplands are in the Annex (Figure 2) and managed as part of the WMA under an agreement with MOTH. MSUs 4-A and 4-B (0.9 ha and 0.7 ha respectively) are seeded with a Delta Farmland and Wildlife Trust (DFWT) seed mix and have been left to develop into old-field. The larger central portion (2.2 ha) was planted with the Serpentine Hay Mix and is managed for forage production by a local farmer. The 10:1 slopes between the water and upland were intended to facilitate farm equipment operation on the slopes to better manage the vegetation between the wetland and upland.

A management option identified for this slope was to plant annual cereals such as winter to provide forage for Canada geese, wigeon, and other waterfowl. In recent years, the slopes have been mowed along with the upland field.

A continually-flowing artesian well provides some water. The balance of the water is provided by rainwater and through controlling levels with stoplogs to enable water flow

through structure No. 35 from the South Pen. A flapgate was installed on this control structure in 1999.

One of the original objectives for this MU was to manage the wetland to benefit shorebirds and waterfowl by promoting mudflat and moist soil crops such as smartweed, which would also help control purple loosestrife. Because of the limitation of water control, vegetation succession has resulted in the development of wetland marsh vegetation, which provides much less food for wintering and migrating waterfowl and shorebirds.

5.2.5 North Pen MU 5

In 1997, the 8.7 ha North Pen MU was reconstructed to create two central upland ponds totalling 2.3 ha and 4.3 of ha semi-permanent water. The upland was seeded with Serpentine Hay Mix and is managed for forage production as part of a five-year farming agreement. The 10:1 slopes between the water and upland were designed to facilitate farm equipment operation on the slopes to better manage the vegetation between the wetland and upland. The north slope was renovated recently and is receives periodic maintenance mowing. Purple loosestrife is annually controlled by hand pulling.

A management option identified for slopes between the agricultural areas and the ponds was planting annual cereals such as winter wheat to provide forage for Canada geese, wigeon, and other waterfowl. In recent years, the slopes have been mowed periodically to control cattail, reed canarygrass and other plants to improve waterfowl access between the ponds and fields.

The water source is rainfall and seepage through the dike from the South Pen. Water control structures No. 7 (replaced in 1994) were designed for maintaining water levels in this MU, but operation has not been required because of seepage into the MU from the South Pen. Natural drawdown occurs over the summer.

5.2.6 South Pen MU 6

The 18.7 ha South Pen MU was reconstructed in 1992 as an agricultural forage field with three perimeter ponds, and three peninsulas in MU 6-A. In 1997, the three peninsulas in MU 6-A were modified to create 10:1 slopes, and a fourth peninsula was constructed. The 10:1 slopes between the water and upland was designed to facilitate farm equipment operation on the slopes to better manage the vegetation between the wetland and upland. The 2.5 ha area of the four peninsulas is contiguous with the 11.5 ha field, creating a total agricultural area of 14 ha.

In recent years the peninsulas have been managed with the field for forage production, with a final cut in the fall to provide food for grazing waterfowl. Another management option identified is to plant crops to be left for grazing migratory and wintering waterfowl. The moats surrounding the peninsulas, and the smaller perimeter ponds,

provide localized staging habitat for waterfowl that subsequently graze on the adjacent field and peninsulas.

The water source is a combination of rainfall and water from the East Marsh. Water levels are managed through the operation of control Nos. 8, 16, and 19 to keep water levels as high as possible, with natural drawdown occurring over the summer. These three controls were upgraded in the 1990s (Figure 3).

5.2.7 Long Meadow MU 7

The 9.6 ha Long Meadow MU is a seasonally flooded field, except for approximately 1.0 ha of the higher central and southern portions. In the past, the low areas were managed on a three- or four-year rotation to promote the growth of moist soil annuals (primarily *Polygonum* spp.) as fall waterfowl food. This rotation involved ploughing once every three or four years to retard perennial plants and stimulate the growth of annual moist soil plants. The water regime in the field was then managed annually to control purple loosestrife and promote smartweed germination. Since the mid 1990s, suitable farm equipment (a large breaking plow) has not been available to manage the area. In recent years, there has been no management of the low-lying area and it has become overgrown with reed canarygrass , with a subsequent reduction in use by waterfowl and possibly other wildlife.

Prior to September 1999, the higher central and southern portions had become overgrown with a variety of moist soil perennials, such as reed canarygrass, *Agrostis* sp., *Juncus* spp. and forbs. In 1999, these areas were rototilled and disced, and then seeded with winter wheat to provide forage for Canada geese and wigeon, but no management has occurred since then.

The only management in recent years has been annual hand control of purple loosestrife.

5.2.8 Rough Meadow MU 8

The 4.6 ha Rough Meadow MU is separated from the Long Meadow MU by a ditch, but both MUs are at a similar elevation. Both MUs flood and drain together. However, MU 8 has not been ploughed and is characterized by perennial grasses and shrubs. Potential exists to manage low areas with the Long Meadow to promote the growth of moist soil annuals. The higher areas provide old-field habitat.

5.2.9 East Marsh MU 9

The 17.4 ha East Marsh is largely open water, with peripheral shallows vegetated with widgeongrass and cattail. The compartment serves as a brood rearing site for waterfowl produced on the WMA and adjacent farmlands, and provides loafing and feeding habitat for migrating and wintering waterfowl.

Two central peninsula systems and some small islands in the southwest provide nest sites for dabblers and Canada geese. The peninsulas are mowed once in June after waterfowl nesting has finished and once in September to provide grazing and loafing for wintering waterfowl. About 30 loafing logs have initially been placed in open water areas for use by waterfowl; they are also used by introduced turtles.

This MU serves as the reservoir from which water can be directed to other Management Units. The water level is kept filled (full supply level) for most of the year, either from rainwater or, during July and August, through pumping from the Serpentine River. Water from this MU can be diverted into MU's 7 and 8 or through the ditch south and west of the Long Meadow to supply water for MUs 4, 5, and 6.

5.2.10 Barn Meadow MU 10

The 1.3 ha forage field in this 2.8 ha MU is harvested annually under a five-year farming agreement. It is presently hayed by a different contractor than the one farming the agricultural areas of the rest of the Serpentine WMA and adjacent Serpentine Annex. A hay barn is also located in this MU. The remainder of the unit contains administrative buildings (office trailer and a storage barn). A small artesian spring occurs in this area.

5.2.11 Clover Meadow MU 11

This MU is part of the Annex. It is planted with about 3.6 ha of corn, which is harvested to provide winter habitat for waterfowl. An unmanaged 1.1 ha subunit (MU 11-A) is largely old-field with a small pond.

5.2.12 Parking – Day Use Area MU 12

The parking and day-use area occupy 0.5 ha of the Annex. Vehicle access to the public parking lot is via 44th Avenue off King George Boulevard. Picnic tables and a shelter are located on a rough lawn area by the parking lot. No additional access or day use facilities are proposed. Trails and three viewing towers can be accessed from the parking lot.

5.2.13 House Meadow MU 13

This MU is part of the Annex. Most of it (4.2 ha) is managed for forage for waterfowl grazing. The 1.7 ha subunit, MU 13-A, has a caretakers house and the surrounding area is left as old-field. The main MU has two low area totalling 0.6 ha characterized by open water and *Juncus*.

5.2.14 Highway Meadow MU 14

The 4.1 ha Highway Meadow is part of the Annex. It consists of a 2 ha forage field and an area of old-field, pond, and shrubs.

5.2.15 South Meadow MU 15

This 6 ha unit is part of the Annex. All but 0.5 ha is managed as forage for wintering waterfowl.

6.0 Human Use Management

Wildlife Management Areas are created with the primary purpose of maintaining and restoring fish and wildlife species and their habitats. These areas are also popular recreational spots for local residents and tourists alike. This section identifies some of the human uses within the WMA and which of these uses is compatible with WMA objectives. Management strategies are geared toward minimizing impacts to fish and wildlife.

6.1 Outdoor Recreation & Tourism

Walking (including walking dogs if they are on a leash) and wildlife viewing are the primary recreational activities permitted on the WMA. A parking lot, roads, dikes, and three observation towers form the basis of the wildlife viewing facilities. Picnic tables are provided near the parking lot (Figure 6). Anglers fish from the Serpentine River dike.

Because of urban pressures, many visitors come to the WMA for reasons unrelated to its wildlife management objectives.

6.1.1 Walking Trails and Interior Activities

Trails follow the interior dike between the East Marsh and Long and Rough Meadows, Serpentine River dike, the North-South Road, and 44th Avenue. Three viewing towers were built along this route in 1981, 1991 and 1992 (Figure 6). These are accessed from a parking lot on 44th Ave. (Annex MU 12), and more recently from a Surrey parking lot by King George Blvd near the Serpentine River.

The use of some dikes for trails and the construction of the towers were done to facilitate wildlife appreciation and education. Without monitoring, other secondary uses easily become established, including those not compatible with wildlife use. Potentially incompatible uses include dogs off leash, cycling, jogging, and ice skating in the East Marsh.

Although weather suitable for ice skating is limited and unpredictable, the number of people present during cold weather has increased from dozens to several hundred per day. While this use occurs when ponds cannot support waterbirds, there is concern

about potential displacement of raptors and other wildlife, damage to riparian vegetation and garbage that is left behind.

6.1.2 Fishing

No fishing occurs within the Serpentine WMA, but up to 30 anglers have been recorded on the dike when coho salmon and trout are running in the Serpentine River; the river is not part of the WMA. This use is compatible with the WMA, although trails down the dike side, thought to be created by anglers and dogs accessing the river, require monitoring to ensure they do not become foci for erosion.

6.2 Motor Vehicle Access, Parking, and Foot Access to Towers

Motor vehicle access in the WMA is along 44th Ave. from King George Blvd to the Annex parking lot and day use area. The size of this 15-car lot is appropriate for the level of public use the WMA can accommodate and still fulfil its wildlife management objective. The extension of 44th Ave through the WMA is a service road and walking trail only and is not open to vehicular traffic.

The City of Surrey has provided access to the Serpentine River dike from a parking lot by King George Blvd at the dike (see Section 4.5). The parking lot and gate are on Surrey owned property. Surrey has an easement over the provincially owned dike, which is part of the WMA. Vehicles are not permitted on the dike.

6.3 Interpretation and Nature Appreciation

It is important that people appreciate the natural values associated with the Serpentine WMA; however, care must be taken so people do not detrimentally impact those values. All interpretation and nature appreciation activities must follow the Ministry of Environment's wildlife viewing ethics guidelines. These guidelines, which can be found on the ministry's website at http://www.env.gov.bc.ca/bcparks/explore/wild_gen.html are as follows:

Wildlife Viewing Code of Ethics

As wildlife viewers, our goal is to watch animals behaving in natural ways in their natural habitats. We respect the needs of wild animals for space, natural vegetation, and ecological community. We recognize our responsibility to know the consequences of wildlife viewing.

As guiding principles we agree:

Wildlife Viewing Code of Ethics

- To view or photograph from a distance that respects the needs of wildlife, using proper equipment such as binoculars, spotting scopes and telephoto lenses. Before approaching wildlife we will first learn the spatial needs of each species and to recognize their alarm signals and behaviours.
- To avoid noises or actions that might stress wildlife or cause animals to waste energy in unnecessary flight.
- To be patient, remembering that we are guests in wildlife habitat.
- To avoid approaching animals that are breeding, nesting, brooding or raising young, because parents and young are especially vulnerable at these times. We will learn the places and times to avoid these situations. We will not approach young or baby animals.
- To avoid feeding wildlife outside the back yard, recognizing that feeding usually leads to problems such as unnatural food dependency, habituation to humans, disease or even death.
- To keep pets on a leash around any wildlife, and avoid bringing pets into sensitive wildlife habitat.
- To avoid trampling or damaging vegetation.
- To respect the rules and regulations of protected areas. Trails, roads, closure areas and other management features are designed for safety and welfare of visitors, natural vegetation and wildlife.
- To be respectful of other wildlife watchers and property owners.

6.4 Regional Manager's Orders and Regulations

Section 7 (4) of the British Columbia Wildlife Act allows a Regional Manager to prohibit certain uses and activities within a Wildlife Management Area. Regulations respecting use and occupation of a WMA may also be made via an OIC under Section 108(2)(b) of the Wildlife Act. The following are the Regional Manager's Orders or Regulations recommended for the Serpentine WMA:

Regional Manager's Orders
• Dogs must be on leashes at all times;
• The use of all vehicles is prohibited;
• Visitor activities are to be restricted to designated trails and facilities;

Regulations
• Camping is prohibited.
• Fires are prohibited.

Objective

Enact a Regional Manager's Order and Regulations prohibiting uses and activities that threaten WMA values.

Activities	Compatible	Comments
Hiking/Walking	Y	Restricted to trails
Wildlife Viewing	Y	Restricted to trails and viewing platforms
Camping	N	
Boating	N	
Mechanized Off-Road Activity (e.g., cycling)	N	
Motorized Off-Road Activity (e.g., quads, 4x4s, dirt bikes)	N	
Low-level ultralight or other aerial flights	N	
Horse Use	N	
Hunting	N	
Recreational Fishing	Y1	Fishing permitted in Serpentine R from WMA-owned dike
Commercial Fishing (Saltwater)	The appropriateness of this activity is determined by DFO	
Trapping	M	Only as required to control nuisance wildlife and introduced species
Invasive/Noxious Weed Control	Y	Ongoing for some species; may also be required for other species
Invasive Wildlife Species Control	M	As required
Scientific Research Activities requiring collecting or habitat modification	M	By educational institutions or government: under permit from FLNRO
Scientific Research Activities (non-manipulative)	Y	By educational institutions or government
Facilities/Infrastructure	**Compatible**	**Comments**
Information and Interpretation Buildings/Centres	Y1	Existing or upgraded facilities permissible in administrative area MU 10 only
Administrative Buildings and Compounds	Y1	As above
Shelters (picnic)	Y	As provided in MU 12 only
Picnic Areas (vehicle accessed and serviced)	Y	As provided in MU 12 only
Interpretive Signage	Y	As needed
Roads	Y1	Along 44th Ave. to access parking and day use area

Activities	Compatible	Comments
Parking Lots	Y	As provided in MU 12 only
Trails	Y1	As provided only; other dikes are not open to the public
Utility Corridors	N	Allowed on Annex lands only
Water Control Structures	Y	Pump from Serpentine R and interior water management structures and ditches
Fish Rearing Infrastructure	M	Limited suitability using water from aquifers
Commercial Aquaculture Facilities	N	
Communication Sites/Towers	N	Allowed on Annex lands ony

Y = Compatible activity or use.
Y1 = Compatible with restrictions.
M = May be compatible under certain conditions.
N = Not compatible.

7.0 Plan Implementation

Introduction

This section compiles all of the actions listed throughout this management plan and lists them in order of priority. Implementation of these actions is dependent upon the availability of the Ministry of Forests, Lands, and Natural Resource Operations' financial and staff resources. They will also be affected by the needs of other WMAs and protected areas in the Lower Mainland Region and in the rest of the province. Approval of this management plan does not constitute automatic approval of funding for implementation. In addition, the Ministry may have to seek corporate, community or interagency partnerships to implement many of the actions in this management plan.

Prioritizing the main resources is necessary to effectively implement this management plan. The following outline lists the proposed actions in three sections: Highest Priority Actions; Task or Project Oriented Actions; and On-going and Monitoring Actions. The first list, Highest Priority Actions, highlights actions that are of the highest priority and require attention within the near future.

The second list, Task or Project Oriented Actions, highlights actions that require a specific task or project. Implementation of this list depends on budgets and available resources either within the Ministry or within the community and stakeholders. The third list, Ongoing Monitoring Actions, describes actions that require ongoing or monitoring types of tasks or projects.

8.0 References

TO DO

Appendix 1: Site History Prior to the WMA

TO DO

Appendix 2: Species Inventory

TO DO

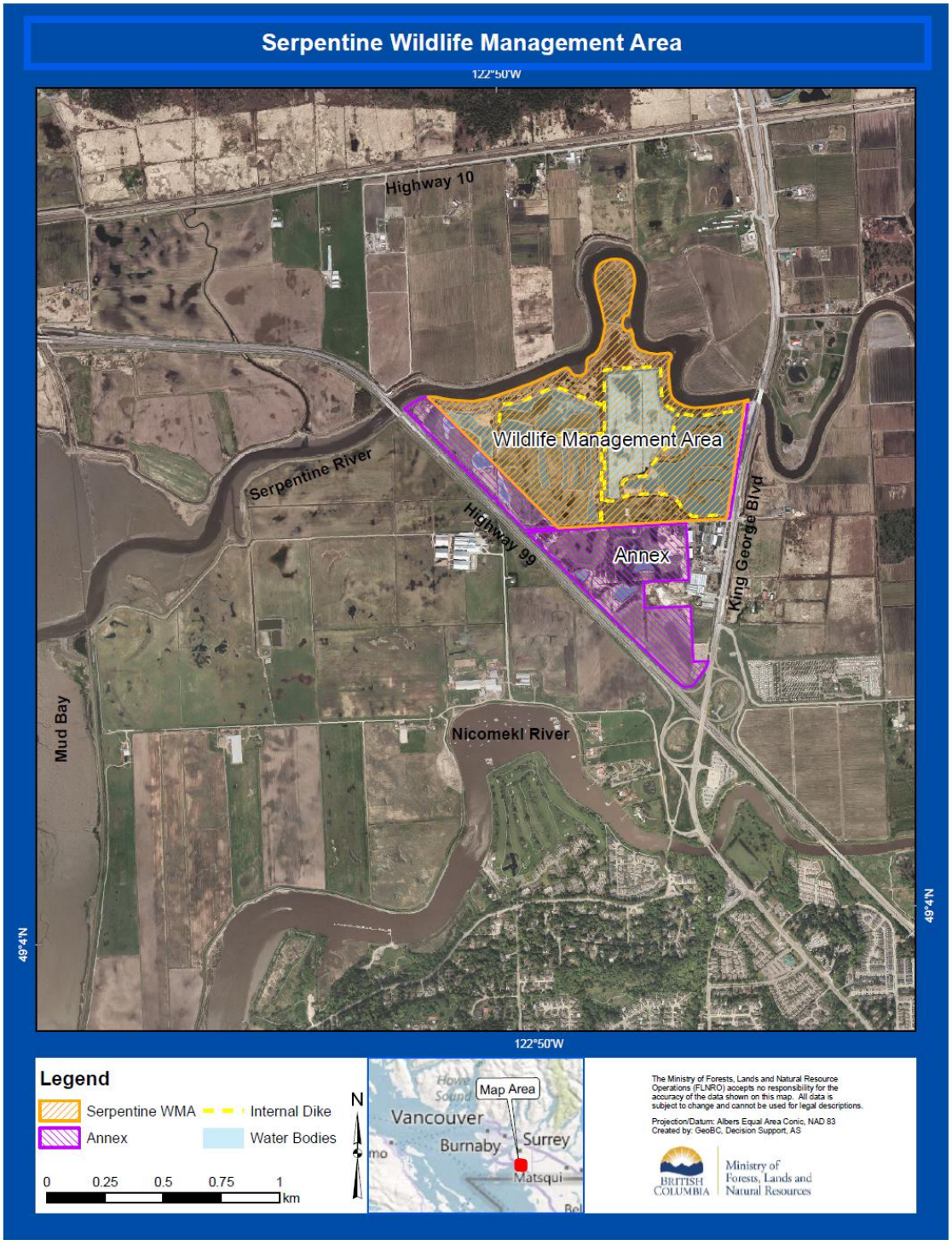

Figure 1 Serpentine WMA overview.

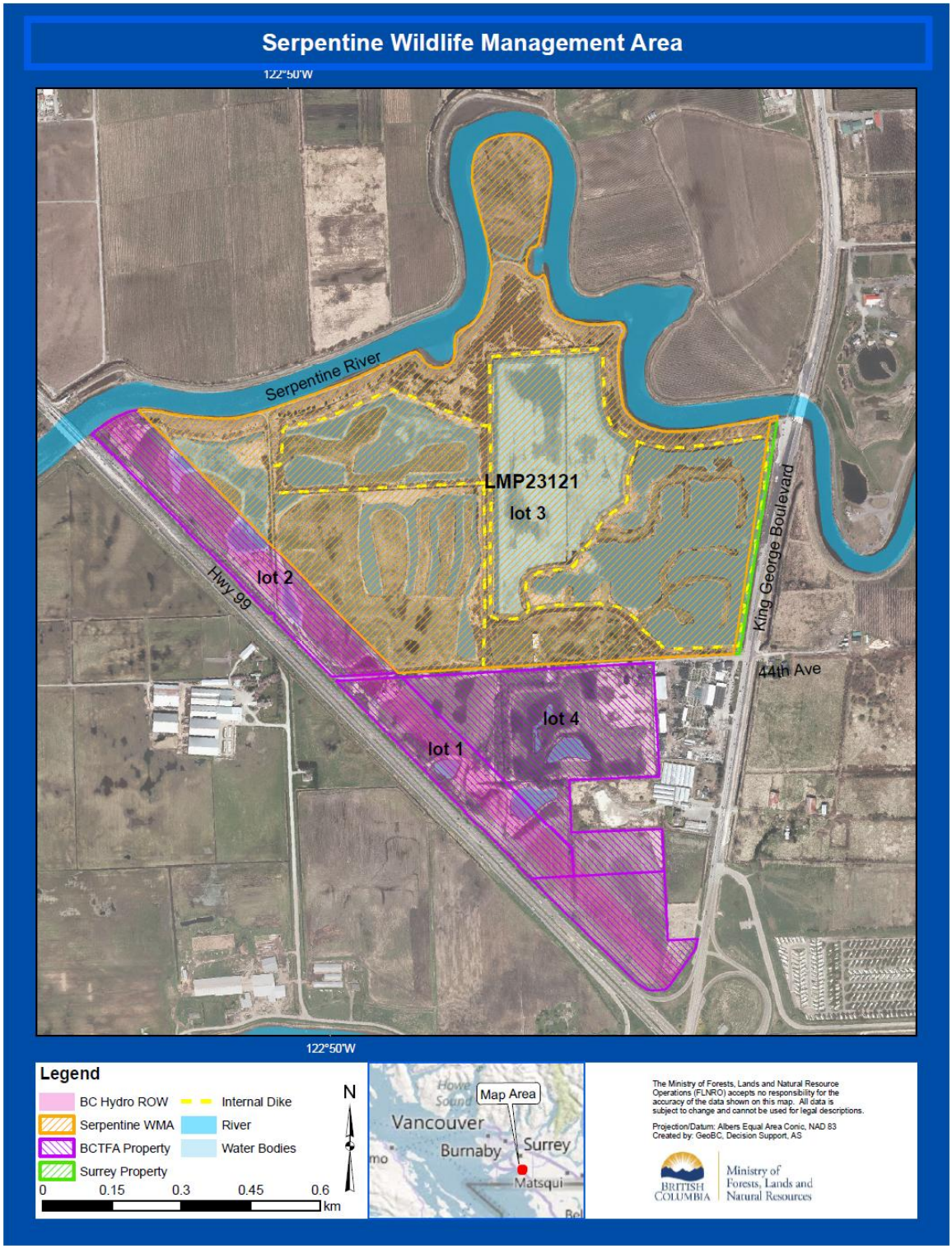

Figure 2 Land Tenure

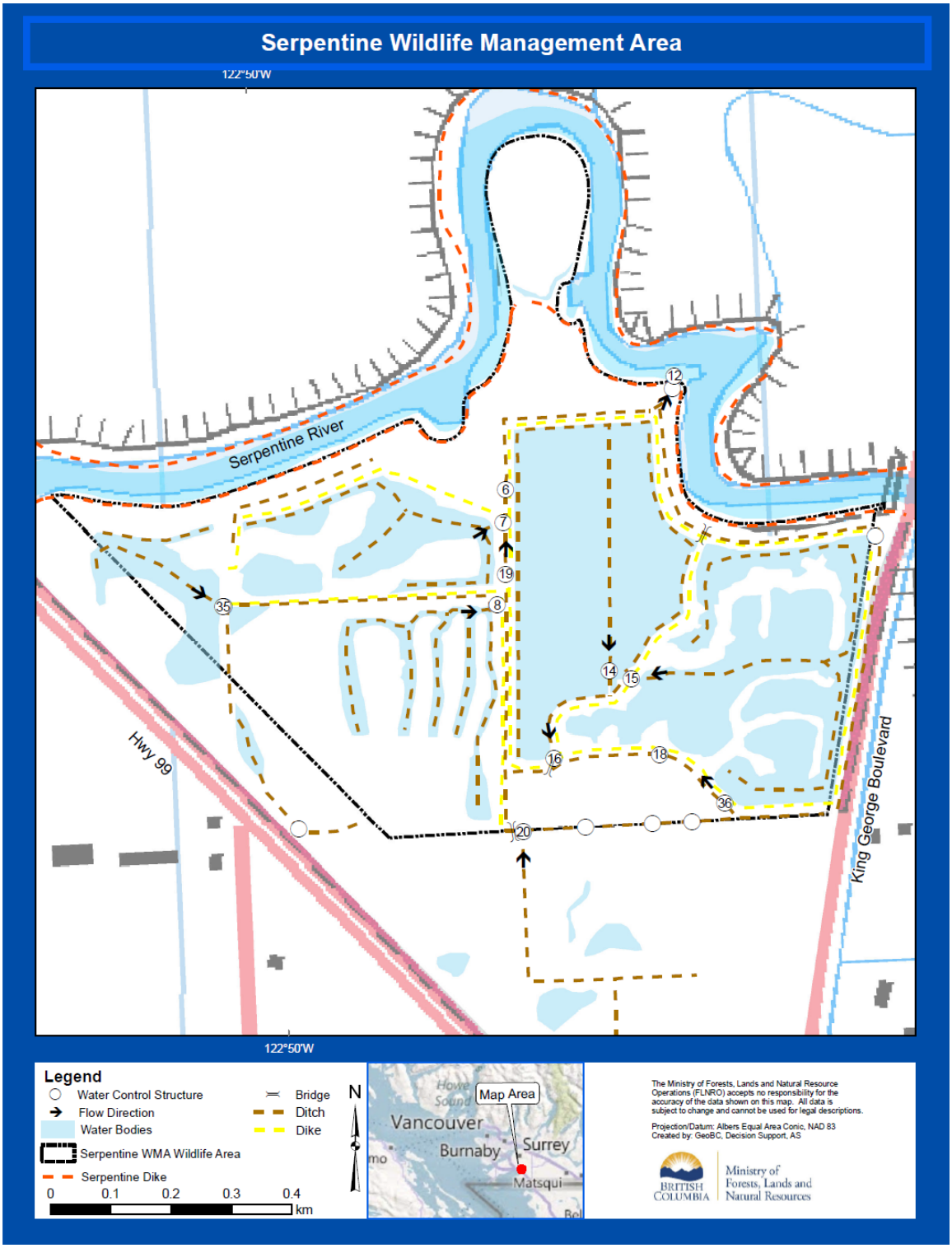

Figure 3 Water Management.

Figure 4 Habitat Types.

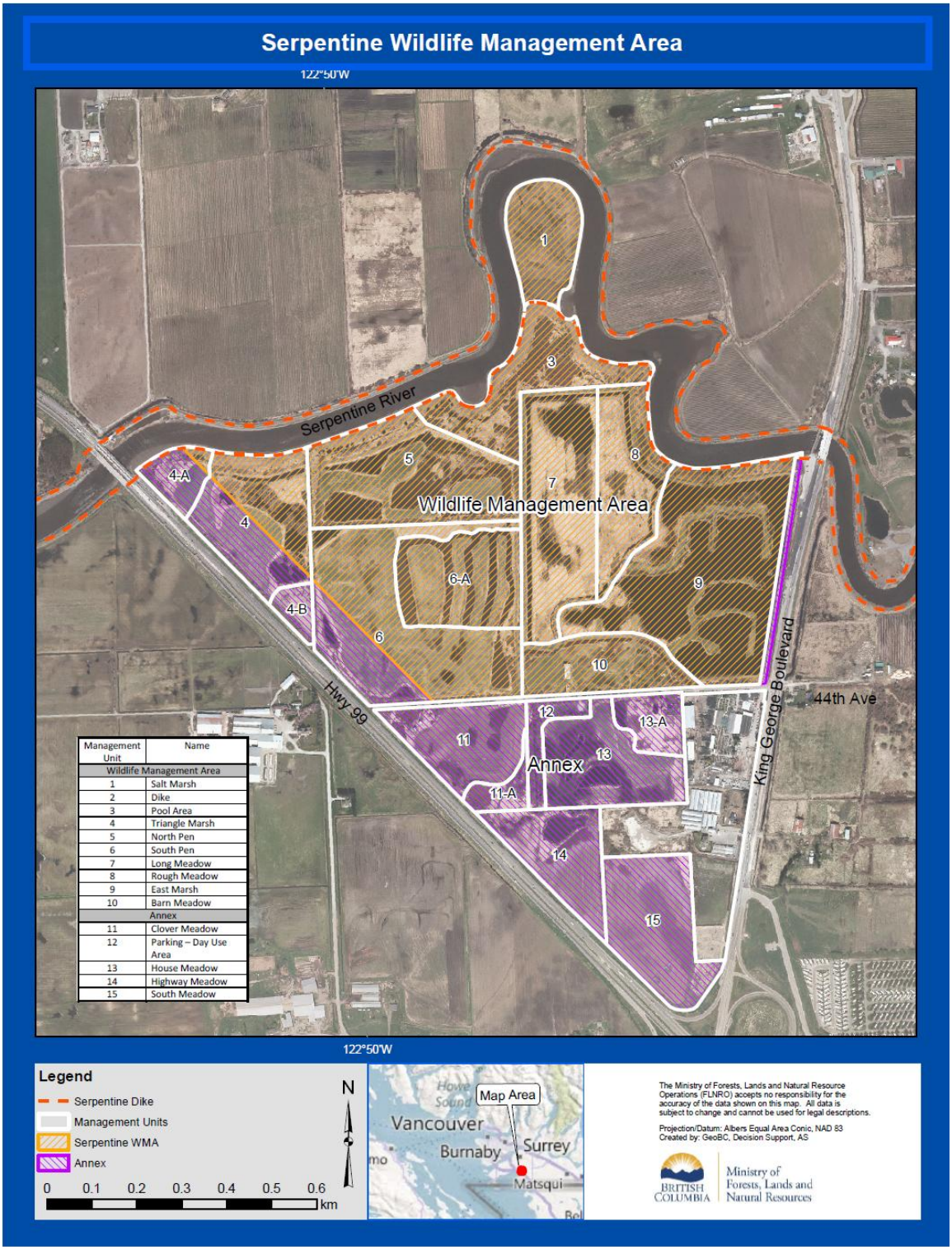

Figure 5 Management Units.

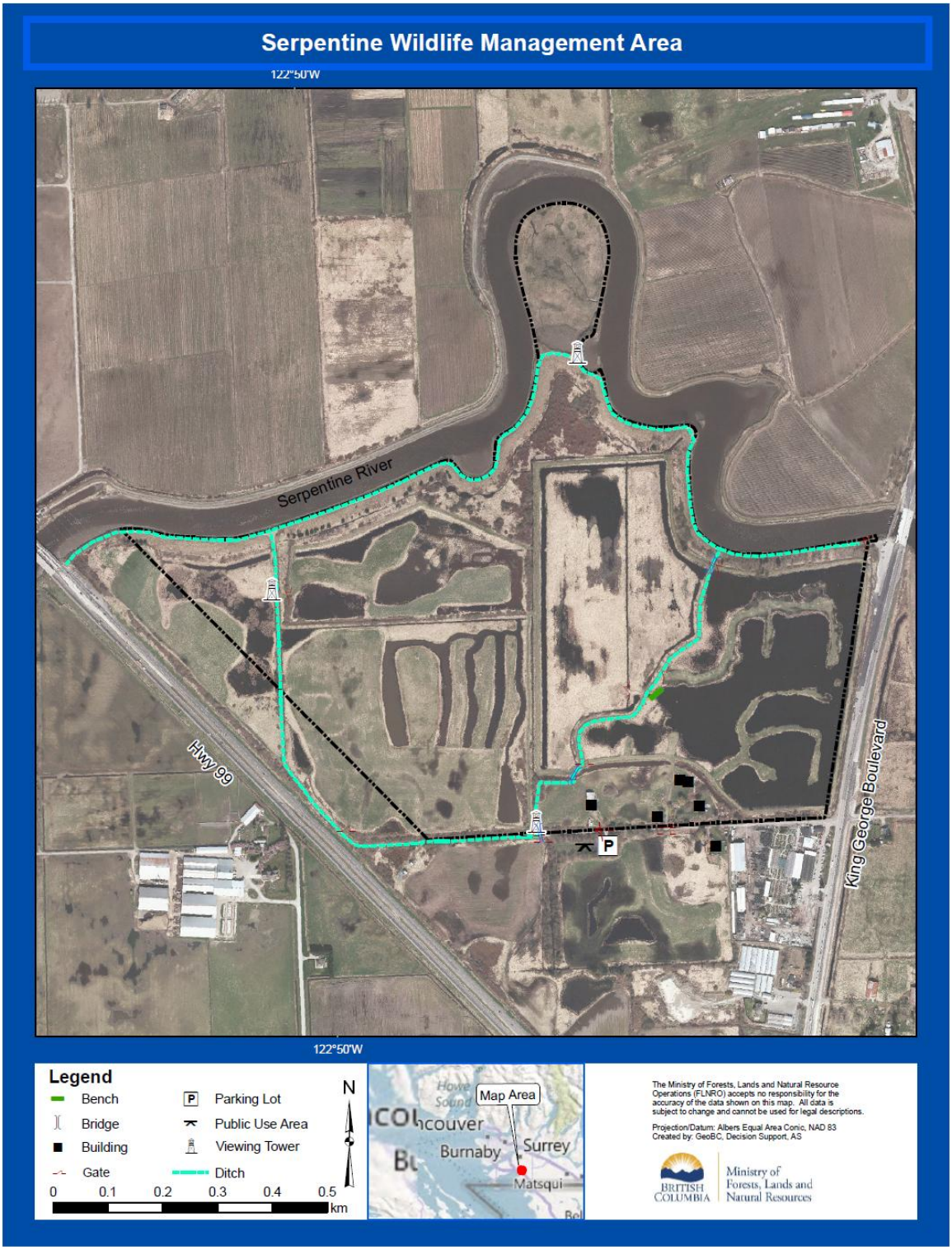

Figure 6 Existing Trails and Facilities.