Wetland and Stream Restoration Design
Somenos Marsh, North Cowichan, British Columbia

Wood Ducks

Trumpeter Swans

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Introduction

This report describes how wetlands modified years ago at Somenos Marsh can be restored to clean runoff, reduce flooding, and increase wildlife viewing opportunities. A saturated field North of Beverly Street may be transformed into a beautiful series of wetlands to be enjoyed by thousands annually.

Somenos Marsh is located on Vancouver Island in the Duncan and North Cowichan urban areas. Huge numbers of waterfowl travelling the Pacific Flyway use Somenos Marsh during migration. In 1988 the British Columbia Ministry of Environment identified Somenos as *one of the best places to view wildlife close to an urban centre*. In 2000 Bird Life International recognized Somenos Marsh as a *globally significant* Important Bird Area.[1]

The restored wetlands would be used by the many Trumpeter Swans now flying over the site.

Most of the wetlands in Somenos Marsh were greatly modified for agriculture beginning in the 1800s. Deep ditches were dug to move streams, dry standing water, and lower the elevation of groundwater. Extensive networks of drainage structures made from wood, rock, clay pipes, and concrete pipes were buried in the ground to dry the shallow wetlands for farming. Wetlands were filled and leveled with soil to create smooth landscapes that could be plowed and harvested.

[1] Somenos Marsh Wildlife Society Website; January 29, 2015: http://www.somenosmarsh.com/

Wetland and stream restoration projects were identified on a 6-acre parcel of land owned by the community of North Cowichan off Beverly Street (see Map 1: Somenos Wetland Project). This land will be referred to as the *North Cowichan Property*. A design team consisting of Robin Annschild (Wetland Restoration Project Manager), Elizabeth Bailey (Somenos Marsh Wildlife Society), Thomas R. Biebighauser (Wetland Restoration and Training LLC) and Tony MacLeod (Geologist & GIS mapper) examined the North Cowichan Property on January 5 and 9, 2015.

The team determined it is possible to restore wetlands and streams on the North Cowichan Property that would clean water, reduce flooding, and fill naturally from rainfall and snowmelt. The project would appear natural, not affect the new dike and trail system, nor affect adjoining properties and roads. No pumps, pipes, or diversions would be needed to maintain the wetlands. The improvements would be attractive and function like natural ecosystems.

Wetlands like this one would be restored

Here Kyle Rasmussen digs a test hole at the North Cowichan Property. Kyle prepared a detailed report describing the restoration of Somenos Marsh. His findings were used in this report[2].

Project Objectives

Wetland and stream restoration projects were designed on the North Cowichan Property to accomplish the following objectives:

1. Clean runoff from urban areas
2. Reduce flooding
3. Increase biodiversity of animals and plants
4. Improve habitat for waterfowl, wading birds, and shorebirds
5. Increase wildlife viewing opportunities
6. Improve the beauty of the landscape
7. Increase opportunities for tourism
8. Provide an outdoor classroom for students
9. Replenish groundwater
10. Improve habitat for pollinators such as butterflies and bees
11. Strengthen partnerships with agencies and volunteers

[2] Kyle Rasmussen, *Restoring Wetlands in the Somenos Basin*. Report prepared for the Somenos Marsh Wildlife Society, August 27, 2012, 61pp.

Background

The property contains fields that were farmed, but are now too wet to farm. The elevation of groundwater is at or near the surface of the fields. Trees and shrubs grow on the few drier portions of the fields.

A ditched stream flows from South to North along the eastern edge of the property. This stream was historically moved, channeled, and placed in a ditch to create the farm fields. Deep and shallow drainage ditches are common on the property. Some of these ditches are visible on aerial photographs. The ditches still carry water, even if they are no longer maintained. The ditches prevent water from standing on the soil surface, and lower the elevation of groundwater.

The property was initially examined by Tom Biebighauser and Kyle Rasmussen (Somenos Marsh Wildlife Society) on July 21, 2012. The area was found to be wet with a high water table when visited. Test holes that were dug revealed soil textures that varied from organic, silt loam, and sandy loam.

The property was at one time leveled and sloped so that water would flow into the constructed ditches. The shallow basins that are now dry on the land show where wetlands were filled and drained. The long term effectiveness of actions taken to drain wetlands in the US and Canada are described in the book by Thomas R. Biebighauser *Wetland Drainage, Restoration and Repair.*[3].

[3] Biebighauser, Thomas R., 2007. Wetland Drainage, Restoration, and Repair, Lexington, KY, University Press of Kentucky, 241pp.

The Somenos Marsh historically contained wetlands like this one

Deep and shallow ditches are common on the property. The straight ditches were once natural streams. Historically, the streams flowing in the valley were sinuous with braided channels.

Garry Oak Swamp Restoration

Garry oak can be found growing in wetlands with skunk cabbage in the Cowichan Valley. A single Garry oak is growing on the edge of an old field near two drainage ditches at the Cowichan Garry Oak Preserve on Quamichan Lake. The Garry oak is growing on a mound of soil surrounded by saturated soil. Garry oak is in the white oak family that grows well in the moist soils of wetlands. Other Garry oaks can be found growing in the nearby swamps on the Somenos Marsh Conservation Area.

It is very possible that Garry oak swamp was once more common in the Cowichan Valley, but that the trees growing in wetlands were removed, and the land drained and leveled for farming.

This Garry oak is growing on a mound of soil surrounded by wetland containing skunk cabbage near Quamichan Lake

The actions taken to drain the North Cowichan Property created ideal growing conditions for reed canary grass-after commercial farming operations ceased. Reed canary grass grows best in sunlight, on seasonally saturated soils, where the ground has been leveled for farming. Garry oak seedlings do not appear to compete with reed canary grass. They will not germinate and grow in the saturated soils in the old fields where the drainage systems are no longer maintained. Fortunately, it is possible to restore a series of ridges and mounds in the reed canary grass, and plant Garry oak seedlings to restore the Garry oak-skunk cabbage ecosystem.

These Garry oaks are growing along the edge of a wetland on the Somenos Marsh Conservation Area

Drainage Legacy

Problems associated with historic drainage activities continue today in Somenos Marsh. Soil erosion along stream banks is common. Large trees growing in riparian areas are falling into the streams as banks collapse. Because the wetlands normally associated with floodplains have been filled with soil, water rushes downstream after each rain, carrying soil from fields. The modifications made to the landscape cannot be expected to heal without help from implementing the practices identified in this report.

Many of the drainage ditches are eroding because of the head-cuts that have formed in them. These head-cuts are causing a deepening and widening of the ditches, resulting in significant erosion. As the ditches erode they cut deeper and wider, causing the elevation of groundwater to drop further below the surface, resulting in the drainage of surrounding wetlands.

The streams on the Somenos Marsh naturally would have low banks and flow across the floodplain during storms. Instead, the streams today are flowing in deep ditches without access to the floodplain. The ditches are located on higher ground, not in the center of the valley at lower elevations like natural streams. One would expect natural streams on level ground to be sinuous, winding across the valley like a snake, not straight like an arrow. The water flowing in natural streams should also be connected to groundwater. Natural streams support high biodiversity, while ditches do not.

Natural streams often contain deep pools of water and riffles supporting a diversity of aquatic organisms. The floodplains of natural streams flowing over gentle ground are generally wide and saturated, containing a diversity of wetlands. Historically, beaver would have dammed natural streams on level ground, forming a diversity of wet-meadow, ephemeral, and emergent wetlands. Unfortunately, beaver are generally not able to dam streams that were moved.

Techniques developed for restoring wetlands and streams by the Center for Wetlands and Stream Restoration may be used to complete wetland and stream restoration projects at the Somenos Marsh.[4] The restored wetlands would appear natural, and require little, if any maintenance. Heavy equipment could be used to control erosion, loosen compacted soil, reduce reed canary grass, restore wetland basins, and recharge groundwater.

Site Selection

Areas where wetlands and streams once occurred were identified on and near the North Cowichan Property. The sites were located where drainage ditches and possible buried drainage structures could be disabled. The wetlands were located in open areas of reed canary grass, between patches of trees and shrubs. The size, depth, and shape of each area was chosen so that the wetland would appear natural, develop its intended hydrologic regime, and be feasible to construct.

Actions needed to restore the wetlands were identified by using hand-held sampling tools. Tests for groundwater were completed by using a 48-inch long tile probe and a 48-inch long soil auger. Soil texture was identified by using maps, a soil auger, and by using the ribbon test. A laser level was used to measure slope. The location of each recommended wetland restoration site was marked so that it had no more than a 1-percent slope, and changed 20cm or less from upper to lower edge.

[4] Biebighauser, Thomas R., 2011. Wetland Restoration and Construction – A Technical Guide. The Wetland Trust, New York, 186pp.

The soils on the site are saturated, with groundwater quickly filling each test hole

A GPS was used to record the location of each possible wetland and stream project. Photographs were taken of work areas. Plastic ribbons were used to mark possible perimeters of wetland projects. A construction cost estimate was prepared for each wetland that could be restored. Maps were prepared by Tony MacLeod showing the dike, urban drains, water-control structures, ditches, and proposed wetland and stream restoration areas.

Wetlands would be restored in the old fields on the North Cowichan Property. The wet fields are dominated by reed canary grass.

The restored wetlands and stream would clean the dirty runoff found in the ditches on site.

Wetlands would be restored like this one near Cranbrook, BC. Notice the gradual slopes and varied edges, with no dam

Project design

Ten-wetlands and a section of the N-S ditch were identified for restoration on the North Cowichan Property. The wetlands were designed to clean water from four ditches entering the property. The wetlands and stream would be built to remove contaminants from urban runoff, and provide habitat for wildlife and plants.

Map 2: Somenos Wetland Project Detail shows a conceptual design completed based on 1 day in the field on January 5th, 2015. If this project is approved, additional design work would be completed prior to construction to mark location of wetlands and spillways on the ground based on field elevations.

A diversity of wetland types may be restored by the project, including emergent, ephemeral, shrub, forested, and wet-meadow types. Wetlands may be restored so they appear and function like natural wetlands, requiring little, if any maintenance. The finished habitats would appear natural, and increase biodiversity. The following factors would be used to guide the restoration of the wetlands:

1. The wetlands would be built not to impact nearby roads, trails, and private property.
2. Streams would not be blocked or dammed. The risk of wetland failure is high when streams are dammed. One must armor with rock or uses concrete to reinforce spillways of wetlands built by damming streams. Dams that cross streams are expensive to design and build. They can also require extensive review and permitting, along with regular inspection and maintenance. Wetlands that are built by damming a stream are often short lived and soon fill with sediment.
3. Above ground dams would not be built. High dams with steep slopes require maintenance by regular mowing to prevent trees and shrubs from taking root and causing damage. High dams must be inspected regularly for breaches and for damage caused by animal burrowing. In addition, building high dams can require extensive review and permitting.
4. Water control structures would not be used. Instead, the wetlands would be designed and built to naturally obtain desired hydro-periods. Water control structures often become points of failure in wetland projects. They can be blocked by animals and vandalized. In addition, water control structure will leak over time.
5. The restored wetlands would be supplied naturally with surface water and ground water. No pumps or wells would be used to supply the wetlands with water.
6. The slopes within the restored wetlands would be made gradual. This would promote plant diversity and use by waterfowl, wading birds, and shorebirds.

7. The spillways for the restored wetlands would be made to become wet-meadow wetlands. Buried vertical grade control structures made from logs would be added to the spillways as needed to prevent erosional head-cuts from forming.
8. The soil removed from building the wetlands would be spread on site and not hauled away. The size and shape of each wetland designed takes into consideration the disposition of soil to be removed to build the wetland. The soil would be placed in naturally appearing ridges and mounds so that it would not cause flooding of neighboring lands.
9. Some of the soil that is removed to build the wetlands would be placed so that it would become saturated and form wet-meadow wetlands or wet-prairies with a diversity of wildflowers. This soil would not be compacted. The hydrology of the wet-meadows would be maintained by water flowing from the restored wetlands.
10. Some of the soil removed would be used to fill sections of drainage ditches between the wetlands being restored.
11. A portion of the soil removed to build the wetlands would be placed in naturally appearing ridges and mounds of various elevations and sizes. The soil would be piled loosely and not compacted so it would support trees such as Garry oak, Oregon ash, cottonwood, and red cedar. This soil would provide sites for planting wildflowers, trees and shrubs. The wildflowers would provide great benefits to pollinators such as bees and butterflies. The loosened soil would not erode, but rather absorb runoff.
12. Required permits would be obtained prior to construction.
13. Heavy equipment would be cleaned prior to construction to avoid introducing non-native plants to the wetland restoration locations.
14. The heavy equipment would be “walked” carefully between trees and shrubs to each construction area. The machines would not disturb the ground with blades or buckets while accessing the work sites. It would be difficult to see where the heavy equipment has traveled after the projects are completed.
15. Desirable plants growing on the work sites would be carefully removed and, saved, and replanted following restoration activities. Heavy equipment would be generally used to accomplish this task.
16. Below surface-groundwater dams would be constructed as needed to increase wetland success. The groundwater dams would not be visible and would help disable subsurface water flow in ditches, buried drainage structures, and thru permeable layers of sand and gravel.
17. Naturally appearing pit and mound topography would be formed in and around the wetlands being restored to increase plant and animal diversity.
18. Large and small woody debris would be added to the wetlands to improve habitat for plants and animals.
19. Nonnative plants would be removed as part of wetland restoration. These plants would be buried deep in the wetlands being restored to control growth, and to sequester their carbon.

The wetlands may be restored all at once, or one at a time. It is recommended that the wetland sites most visible from Beverly Street and trail be built last, after the contractor has gained skills building the first ones. Sections of stream channel and associated floodplain should be built between each wetlands to serve as a spillway. However, the stream should not be directed to flow into the wetlands until all the wetlands have been built and are vegetated.

Stream Restoration for North-South Ditch: Wetlands 1 through 7

Action may be taken to re-naturalize the North-South ditch where it flows onto the North Cowichan Property. The stream may be restored to improve water quality, reduce flooding, increase biodiversity, and provide wildlife habitat. The stream was historically placed in a straight ditch where no water treatment is taking place.

The stream was moved and channeled for farming operations. It was once likely a ribbon of wetlands flowing downslope. The wetlands may have been swamps containing Garry oak, Oregon ash, red cedar, and cottonwood. Beaver ponds and wet-meadow wetlands were probably common along its length.

The stream would be moved out of the N-S ditch onto a restored floodplain, flowing through restored wetlands along its path.

Moving and channeling streams to dry land for agriculture was common across British Columbia in the 1800s and 1900s. The deep and channeled streams drained wetlands and provided critical outlets for extensive networks of buried drainage structures.

The stream flowing in the N-S ditch may be restored to appear similar to this stream with pools and wetlands along the floodplain

The stream flowing in the N-S ditch may be restored to contain pools like this one.

Natural streams on level ground are sinuous and can be expected to flow across a floodplain containing wetlands. Unaltered streams generally contain deep pools of water and riffles supporting a diversity of fish and other aquatic organisms. The floodplains associated with

natural streams flowing over a gentle slope are generally wide and saturated, forming ribbons of wet-meadow, shrub, and forested wetlands. Natural streams have low banks and can be expected to flow across the floodplain after storm events. The waters in a natural stream are generally connected to groundwater in the valley.

The stream flowing in the N-S ditch was once sinuous, containing a diversity of ephemeral, wet-meadow, shrub, and forested wetlands on its floodplain. The stream is now straight, has steep banks, and lacks pools, riffles, and wetlands.

Wetlands 1 through 5

A section of the North-South ditch would be restored by building a sinuous floodplain and stream channel. Survey work was completed to identify a proposed path of the stream, as shown on Map 2: Somenos Wetland Project Detail. The restored stream would flow over a gradual slope, into and out of wetlands 1 through 5. The restored stream would have a wide floodplain with low banks so it would not erode. Ephemeral, wet-meadow, forested, and shrub wetlands would be restored along the floodplain of the restored stream. The floodplain would become a long ribbon of restored wet meadow wetland that would clean runoff.

The restored stream would be supplied naturally with groundwater and surface water. The stream would contain deep pools and a diversity of wetlands. The stream restoration would be implemented using the techniques described in the book by Thomas R. Biebighauser *Wetland Restoration and Construction - A Technical Guide*. The techniques to be used are highly successful, low cost, and would require little, if any maintenance.

A short section of the North-South ditch would be plugged to turn water currently flowing in the ditch into wetlands 1 through 5. The remainder of the ditch would be maintained. This could help dry neighboring private land to the East of the North Cowichan Property.

Wetland 6

Wetland 6 may be constructed as shown on Map 2: Somenos Wetland Project Detail, or added to the stream restoration after wetland 4 and before wetland 5. Building it as a separate wetland may benefit amphibians by providing breeding habitat with warmer, cleaner water. Adding this extra wetland to stream restoration will add sinuosity and increase treatment time for storm water currently flowing in the North-South ditch. Adding wetland #6 to the stream restoration would add an estimated $4500 to the cost estimate (see Budget for Wetland and Stream Restoration).

Wetland 7

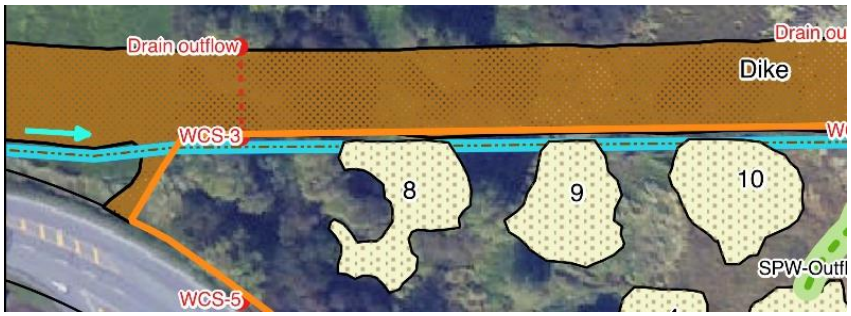
A berm from North-South ditch construction or dredging runs along the west bank of the ditch, raising the elevation of the West bank relative to the East bank. This prevents water from flooding into the North Cowichan Property at high flows. Wetland #7 would be constructed to both widen the ditch and lower the elevation of the West bank of the ditch.

Here is a summary of the steps that would be taken to restore the stream flowing in the North-South ditch:

1) The area would be examined to make certain that rare species of plants or animals are not negatively affected by restoration activities.
2) Required permits would be obtained.
3) Heavy equipment would be cleaned to avoid introducing non-native plants.
4) Desirable plants would be carefully removed, saved, and replanted following restoration activities.
5) Heavy equipment would be used to remove non-native vegetation, topsoil, and organics from each work site. The topsoil and organics would be saved for later spreading in and around the completed stream and floodplain to further improve habitat for plants and animals.
6) Heavy equipment would be used to dig a wide floodplain and shallow depressions for wetlands on the floodplain. Excess soil would be spread near each work site and blended into the surroundings. All soil would be loosened and planted to native trees, shrubs and wildflowers for pollinators.
7) Large diameter trees would be buried in the restored floodplain to control erosion. These materials would serve as vertical grade control, preventing head-cuts from forming. The trees would be kept saturated so they would not decompose.
8) Naturally appearing pit and mound topography would be formed on the floodplain and in the wetlands. These features would greatly improve plant and animal diversity.

9) Large and small woody debris would be added to the stream and wetlands to improve habitat for plants and animals.

East-West Ditch Restoration Design: Wetlands 8 through 10



Wetlands 8, 9 and 10 would be constructed by widening the East-West ditch at 3 locations along the base of the dike. This will be done without impairing flow in the ditch or impacting the dike structure. The wetlands will provide storm water treatment to water flowing in the East-West ditch by allowing water to flow in and out of the wetlands.

The wetlands to be restored would not affect the flood control dike and trail north of the East-West ditch show here.

Emergent wetlands with forested edges like this one would be restored. This wetland is only one-year old

Wetlands would be restored similar to this one on the Lake Ranch near Argenta

Biodiversity would be increased by changing fields of dense reed canary grass to wetlands like this one

Desirable native plants such as skunk cabbage would be removed, saved, and replanted in the restored wetlands. This skunk cabbage was growing along the edge of a drainage ditch.

Nonnative plants such as English hawthorn would be removed as part of wetland restoration

Logs and snags

Large woody debris and vertical snags may be placed in and near wetlands to improve habitat for animals and plants. Large diameter logs placed in and near wetlands can be expected to be used by birds and insects for perches, and turtles for basking. Snags are also used by bats for roosting.

Logs that can be used to support the excavator and to place in the wetlands may be ordered. This load of 45-logs costs $2,500 at Meadow Creek, BC

The excavator can move logs to the worksites

This emergent wetland was built in less than one day at Meadow Creek. Note how the soil was piled to provide planting sites for trees and shrubs. Logs were placed in the wetland for woody debris, and set for snags

These logs were placed in a restored wetland to provide roosts for birds, and basking sites for turtles. Note how the ends of the log were broken off and covered with soil to appear natural

Wildlife features

Waterfowl and Amphibian habitat needs

These actions may be taken to restore wetlands so they provide habitat for trumpeter swans, waterfowl, and for breeding amphibians:

1. Wetlands of various shapes, sizes, and depths should be restored.
2. Some of the wetlands should be made shallow so they dry under drought conditions. This would prevent non-native fish from becoming established that would prey on amphibians and their eggs. The periodic drying of the wetlands would also reduce possible colonization by the American bullfrog that also preys on amphibians.Invertebrate populations would be highest in the ephemeral wetlands, providing food for waterfowl.
3. Hibernation sites for amphibians may be created by making mounds of vegetation and woody debris in the wetlands. These mounds can be built from root masses and clumps of vegetation.
4. Hiding and nesting cover can be improved around the restored wetlands by scattering logs, large woody debris, and piles of rock.

Western painted turtle

These actions may be taken to improve habitat for the western painted turtle:

1. Nesting sites can be created by shaping ridges and mounds of sandy-loam texture soil. These should be placed in sunlit areas, near wetlands, and above the water level. The sand found when excavating wetlands can be used to make these features.

2. Basking logs can be placed in wetlands. These can be any length and diameter. These should be anchored with a pile of soil on floodplains so they do not wash away.
3. Mounds of soil can be placed in restored wetlands to provide loafing sites for turtles. These mounds can range from 1 – 10 meters in diameter and be from 10 to 100cm above the elevation of water in the wetland. The mounds should not be compacted.
4. Hibernation sites can be made where waters from a spring are found entering a wetland under construction. The emergence of the spring should be excavated and shaped into a deep depression. The depression should be filled partially with loose soil so turtles can burrow into the spring to avoid detection by predators such as the otter.
5. Wetlands of various shapes, sizes, and depth can be restored in each area to provide for juvenile and adult habitat needs in each season.

Western toad

These actions may be taken when building wetlands to improve habitat for the western toad:

1. The wetlands can be made shallow so it dries by the end of September. This will prevent fish from living in the wetland that prey on western toad eggs, larvae, and adults.
2. Hibernation sites can be created by making mounds of vegetation and woody debris. These mounds can be placed within and around the wetland and contain root masses and clumps of vegetation.
3. Hiding cover can be improved around the wetlands by scattering logs, large woody debris, and piles of rock.
4. Wetlands of various shapes, sizes, and depth can be restored in each area to provide for western toad habitat needs in each season.

Native Frogs

These actions may be taken to restore wetlands that would benefit the northern red-legged frog and other native species of frogs and salamanders:

1. The wetlands should be made shallow so they dry by the end of September. This will prevent fish from living in the wetlands that prey on frog eggs, larvae, and adults. The periodic drying of the wetlands would reduce possible colonization by the American bullfrog, a non-native species that preys on the northern red-legged frog.
2. Hibernation sites can be created by making mounds of vegetation and woody debris in the wetland. These mounds can be built from root masses and clumps of vegetation.
3. Hiding cover can be improved around the restored wetlands by scattering logs, large woody debris, and piles of rock.
4. Wetlands of various shapes, sizes, and depth can be restored in each area to provide for frog habitat needs in each season.

Mosquitoes

The restored wetlands can be expected to lower mosquito numbers. The dragonfly larvae, damselfly larvae, salamander larvae, and invertebrates that thrive in the restored wetlands can be expected to control mosquitoes. Swallows, bats, and dragonflies will consume adult mosquitos. The wetlands should become a population "sinks" for mosquitoes.

Reed Canary Grass

Techniques would be used to prevent reed canary grass from dominating the restored wetlands. These practices have been developed by Tom Biebighauser and are described in the PowerPoint Presentation he has prepared; *Reed Canary Grass and Wetland Restoration*. The PowerPoint is in a Dropbox File, the link for the file is:
https://www.dropbox.com/sh/uzhftga0mlel47c/AAC4r2NeF2Cjgzf0Kx11tocIa?dl=0
Please contact tombiebighauser@gmail.com is you are not able to open this presentation.

Skunk cabbage would grow in wetlands restored from old fields growing reed canary grass

The soil removed to restore the wetlands can be planted to shrubs like salmonberry. The spillways may be planted with skunk cabbage.

Wet meadow wetlands similar to this one shown would be restored from the old fields

Project Construction

Equipment & Access

The use of heavy equipment is necessary to restore the wetlands described in this report. The route that heavy equipment would use to access the worksites would be planned in advance, and marked using brightly colored plastic ribbons. A skilled individual would be on site monitoring heavy equipment use. An excavator with low ground pressure would be used to access the worksites. The machine would not leave ruts like a rubber tired vehicle.

The wetlands were designed to be built by a large 100 Series Excavator, or a smaller 200-Series Excavator with an operator skilled at working on saturated soils. The operator would be directed by Tom Biebighauser or Robin Annschild.

It would be necessary to plan how the excavator moves around each worksite so it does not become stuck. The author has built numerous wetlands on saturated soils across British Columbia with success. The key is hiring a contractor with experience working in wet areas, and providing them with the supplies needed to stay afloat.

At a minimum, the heavy equipment should meet the following specifications:

Excavator: 160 Series (or a CAT 315, not a mini-excavator, these machines are built on a 200 Series carriage but have the lighter, 100-Series weight)
80HP or larger
22,500lbs minimum
Bucket that is 48-inches or wider with thumb attachment
On tracks, not wheels

Or

Excavator: 200-Series (or a CAT 320)
148 HP minimum
38,000lbs minimum
Bucket that is 60-inches wide with thumb attachment
On tracks, not wheels

Here are some of the advantages of using a 160 or 200-Series excavator for the wetland and stream restoration:

1. The excavator can stay in one place and reach a large portion of each work area. This saves destroying surrounding vegetation because the machine does not have to move over the entire work area to remove soil.
2. The larger excavator does not have to move the soil a number of times, greatly speeding progress. A smaller excavator must swing the soil a number of times across the work area. The longer reach means less moving, which is especially important when using swamp pads or logs to stay afloat on saturated soils.
3. The unit cost of moving soil is less for a large excavator compared to a small excavator

Swamp pads and/or logs will be needed to keep the excavator afloat during construction of the wetlands dominated by reed canary grass. Swamp pads (excavator pads, crane mats, tundra mats, dragline mats) may be used to support heavy equipment on any kind of surface.

One set (4) commercial swamp pads

Here are the dimensions of swamp pads that can be rented from Riverside Rental in British Columbia:

1. 48-inches wide x 20-feet long x 12-inches thick
2. All pads are constructed with four 12-inch x 12-inch hemlock or fir beams
3. The pads are cross bolted with four 1 ¼-inch bolts, each countersunk with proper timber washers
4. Each swamp pad has two 7/8-inch lifting cables

Riverside Rental in Abbotsford, BC advertises rental rates for a set of four swamp pads at $800 per week, or $2800 per month.[5]

[5] Riverside Equipment Rental: http://www.riversideequipment.com/Swamp-Pads-Equipment-Mats.aspx (1-800-566-0557)

Here are the dimensions of swamp pads sold by Gienow Log Services[6] in British Columbia:

1. 45-inches wide x 20-feet long x 15-inches thick
2. All pads are constructed with three 15-inch x 15-inch timbers, cross-bolted with four 1-inch bolts, each countersunk with proper timber washers.
3. Each swamp pad has a 7/8-inch cable loop at each end for handling
4. Only top-quality timbers are used for extended lifetime and durability

Excavator on one set of commercial swamp pads (at left). Large diameter logs can also be used to keep the excavator from sinking on saturated soils (at right).

Logs can also be used to keep the excavator from sinking. At least 15-logs are needed to build one set of wetlands. More are needed if you want to place them in the wetlands during construction. Logs that are too long are difficult to move and get in the way of piling soil. Logs too small in diameter will break. Species that work well include fir and larch. Cedar and hemlock are too soft and are likely to break. The logs should be at least 20-inches in diameter, and 21-feet long. The logs can easily be moved by an excavator using a thumb attachment. They can be placed in the wetland as snags after the project is completed. The logs should be ordered in advance and piled where the excavator will access the area. The contractor should have a chainsaw on site to trim the logs if needed.

[6] Gienow Log Services: http://swamppads.shawwebspace.ca/ (1-604-644-3322)

Logs would be used to keep the excavator from sinking when building the wetland. The logs should be of similar diameter and length to prevent the excavator from rocking and slipping. Wetlands can also be built when the ground is frozen, with snow on the ground.

Contracting

A Service contract should be used to hire the heavy equipment and operators to complete the wetland and stream projects. Under a Service Contract, the heavy equipment and operators are hired by the hour for completing the work. The award of the service contract may be based on a combination of factors that include: ability to provide the required heavy equipment, performance operating heavy equipment, experience restoring wetlands, and price. The price for building each wetland would be greatly reduced if the contractor are paid by the hour, not by the job for building each wetland. Copies of requisitions and contracts that include an experience questionnaire, equipment questionnaire, and specifications are available from Tom Biebighauser.

Buried utilities

For safety a check for buried utilities must be conducted prior to building the wetlands and streams described in this report. All buried utilities that are in the area should be marked so they can be avoided. The wetlands should not be built unless this critical step is completed. It is the law that one calls before digging, and it can take 3-days or more for the utility companies to respond and check for buried utilities.

Permits

Permits may be required before proceeding with the restoration of the wetlands described in this report. Robin Annschild is available to help with permitting needs.

Robin Annschild or Tom Biebighauser would work closely with the operator to restore wetlands at Somenos Marsh.

Construction Monitoring

Tom Biebighauser and Robin Annschild are available to assist with implementing the restoration projects identified in this report. One would be on site full time during construction to direct heavy equipment operations and to respond to concerns from the public.

Planting

It is recommended that the soil exposed from restoring the wetlands be seeded to wheat, coastal BC native grasses and wildflowers for erosion control. The wheat will germinate and grow within 3-days of rain, giving the exposed soil a pleasing green appearance.

A diversity of native shrubs and trees may be planted on the ridges and mounds of soil removed from the wetlands. Seeds from local sedges and rushes may be harvested and used to seed the spillways and wetlands.

Black cottonwood trees can be planted on soil removed to restore the wetlands. The restored wetlands would provide habitat for a diversity of plants.

Restoration Practices

The restoration projects may be implemented using the techniques described in the books by Thomas R. Biebighauser *Wetland Restoration and Construction - A Technical Guide,* and *Wetland Drainage, Restoration and Repair*. Tom Biebighauser has restored over 1,500 wetlands in the United States, and over 200-wetlands in British Columbia.

Wetland Restoration Photos

Photographs showing restored wetlands and streams are available for viewing at:

Arizona Wetland Construction
https://picasaweb.google.com/105985116543820569589/ArizonaWetlandConstruction

School Wetlands: https://picasaweb.google.com/105985116543820569589/SchoolWetlands#

Tulaberry Farm Wetland Restoration Project:
https://plus.google.com/photos/105985116543820569589/albums/5916157203616332017?authkey=CN-Lh8qpxr6mQg

Dix River Stream and Wetland Restoration Project:
https://picasaweb.google.com/105985116543820569589/DixRiverStreamAndWetlandRestorationProject#

Queens Wetland Restoration Project:
https://picasaweb.google.com/105985116543820569589/QueensWetlandRestorationProject#

Slabcamp Creek and Stonecoal Branch Stream and Wetland Restoration Project:
https://picasaweb.google.com/105985116543820569589/SlabcampCreekStonecoalBranchStreamAndWetlandRestorationProject#

Wetlands Built Using Liners:
https://picasaweb.google.com/105985116543820569589/WetlandsBuiltUsingLiners#

Wetland Construction from Deep Ponds:
https://picasaweb.google.com/105985116543820569589/WetlandConstructionFromDeepPonds#

Wetlands Restored in Autumn:
https://picasaweb.google.com/105985116543820569589/WetlandsRestoredInAutumn#

Wetlands Restored and Created:
https://picasaweb.google.com/105985116543820569589/WetlandsRestoredAndCreated#

Volunteer Involvement

Volunteers may help implement the wetland and stream restoration projects. Volunteers can take an active role in the construction, planting, and monitoring of the restoration projects. Volunteers can help monitor construction, control erosion, establish native plants, and control non-native species. They may also work to measure project success by completing plant and animal surveys and water quality monitoring.

Training

The actual restoration of the wetlands and streams may be accomplished as part of a *Hands-on Wetland Restoration Workshops* instructed by Tom Biebighauser. Tom works in partnership with agencies and organizations to instruct practical training sessions where participants learn about wetlands and how to restore them by becoming actively involved in the construction and planting of wetlands. Tom has instructed Hands-on Wetland

Restoration Workshops across North America for over 12-years. The training program has been effective at encouraging individuals to initiate wetland and stream restoration programs in their communities.

Tom Biebighauser works with students at the SLV Charter School in Ben Lomond, California to build a wetland on school grounds.

Budget for Wetland and Stream Restoration[12]

Wetland Number	Size (m^2) estimate[17]	Excavator Hours[18]	Excavator Cost Estimate[19]	Wheat[20]	Wheat Cost Estimate	Construction Monitoring Days[21]	Construction Monitoring Estimate
1	461	12	$1,959	1.0	$30	1.4	$1,439
2	324	8	$1,377	1.0	$30	1.0	$1,011
3	531	13	$2,257	1	$30	1.7	$1,658
4	416	10	$1,768	1	$30	1.3	$1,299
5	580	15	$2,465	2	$60	1.8	$1,811
6	638	16	$2,712	2	$60	2.0	$1,992
7	222	6	$944	1	$30	0.7	$693
8	597	15	$2,537	2	$60	1.9	$1,864
9	543	14	$2,308	1	$30	1.7	$1,695
10	636	16	$2,703	2	$60	2.0	$1,986
SPW1	161	8	$1,369	0.5	$15	1.0	$1,005
SPW2	140	7	$1,190	0.5	$15	0.9	$874
SPW3	190	10	$1,615	0.5	$15	1.2	$1,186
SPW4	131	7	$1,114	0.5	$15	0.8	$818
SPW5	200	10	$1,700	1	$30	1.3	$1,249
SPW-Outflow	380	19	$3,230	1	$30	2.4	$2,373
TOTAL	**6150**	**184**	**$31,246**	**18**	**$540**	**23.0**	**$22,952**

Total costs for each category	Rate	# of hrs/bags/days	Estimated Cost
Excavator	$170/hr	184 hrs	$31,246
Wheat	$30/bag	18 bags	$540
Construction Monitoring	$999/day	23 days	$22,952
Total estimated construction costs (excluding logs, native plants and seeds)			**$54,738**

[12] Does not include cost of logs and planting

[17] Area of soil available for planting after construction is about 130% larger than the wetland area restored.

[18] The estimated number of excavator hours needed to build each wetland is based on the progress rate for the similar Meadow Creek Wetland Restoration Project completed in January 2015. Progress rate for this site is estimated at 30m²/hour for wetland construction, and 15m²/hour for spillway construction.

[19] Excavator estimated at $170/hour (includes mobilization and taxes).

[20] Wheat: (1-50lb bag/500m² wetland) x ($30/bag)

[21] Construction Design & Monitoring: Tom Biebighauser or Robin Annschild, ($999/day), cost includes all salary, travel, and taxes.

Summary

Naturally appearing and functioning wetlands and streams may be restored on the North Cowichan Property to clean runoff and increase biodiversity. Implementing the projects would improve wildlife habitat and viewing opportunities for thousands of people each year. The wetlands may be restored at a low cost and would require little, if any maintenance. The projects may be completed in combination with the instruction of Hands-on Wetland Restoration Workshops, where individuals receive practical training in wetland restoration techniques. Restoring these habitats would clean water, reduce flooding, restore ecosystems, and involve many volunteers, strengthening relationships between agencies, nonprofit organizations, and the public.

This report was prepared for Elizabeth Bailey, Program Coordinator at the Somenos Marsh Wildlife Society.

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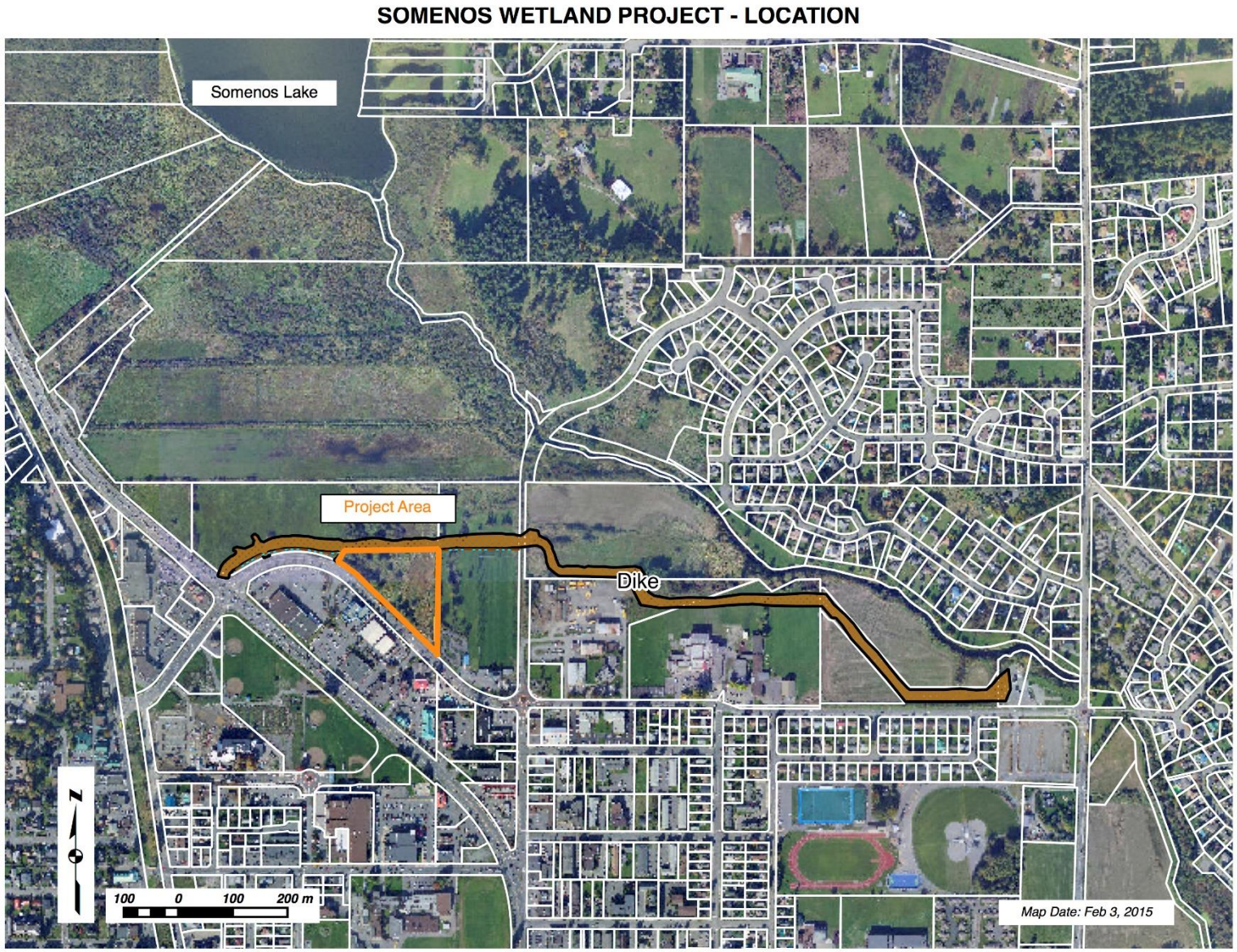
Map 1: Somenos Wetland Project, North Cowichan Property Location



Map 2: Somenos Wetland Project Detail

Wetland	Area SqM
1	461
2	324
3	531
4	416
5	595
6	579
7	295
8	670
9	596
10	671