City of Edmonton

Wetland Monitoring

Edmonton Wetlands Workshop
December 4-5, 2013

Presentation Outline

- **Kennedale Wetland**
  - Water Quality
  - Sediment removal
  - Vegetation management
- **Biological Monitoring**
- **Operational Issues**

City of Edmonton

Kennedale Wetland

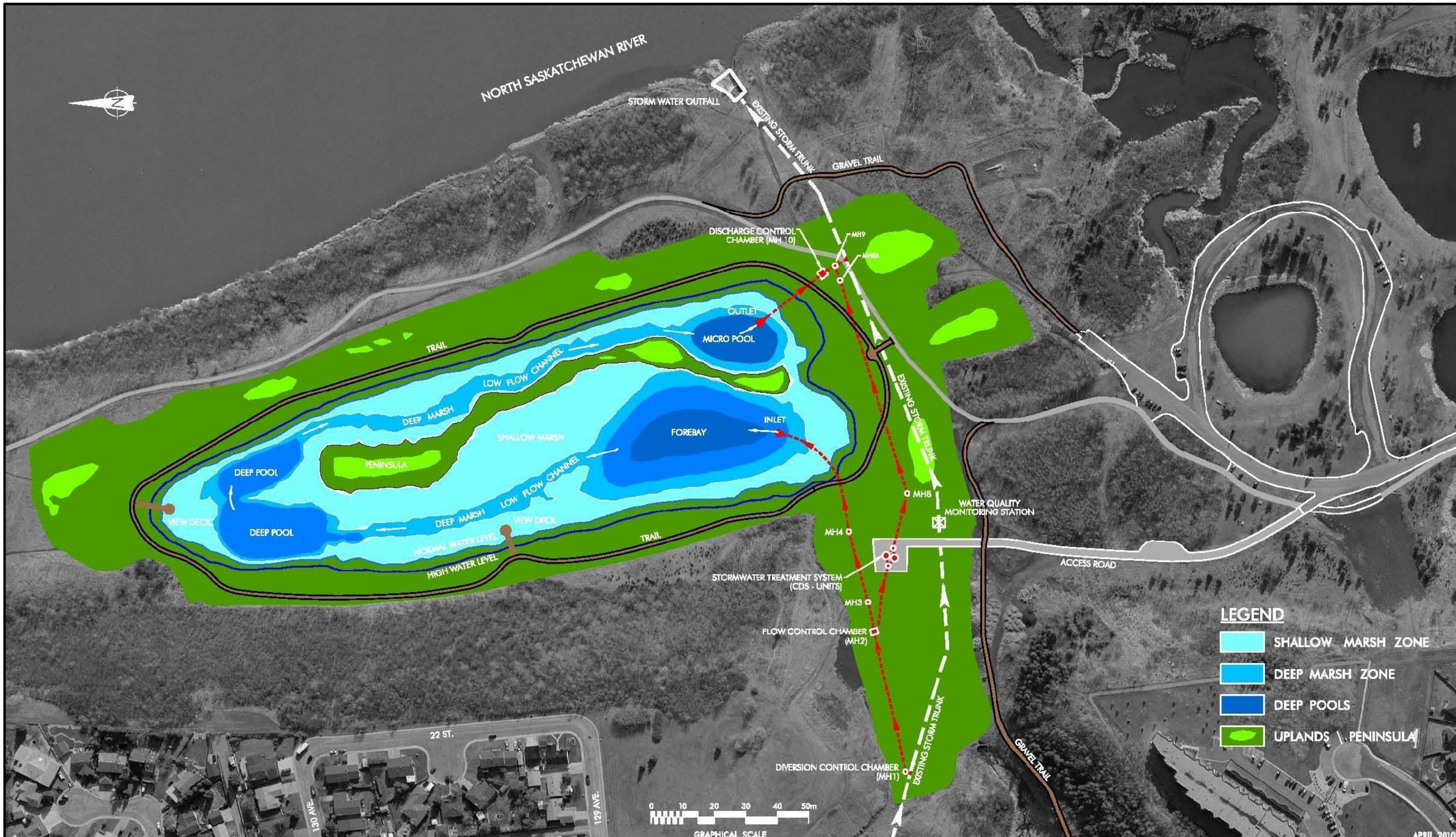
Hermitage Park.

Constructed: 2009

Watershed: 7,250 ha

Wetland: 5 ha

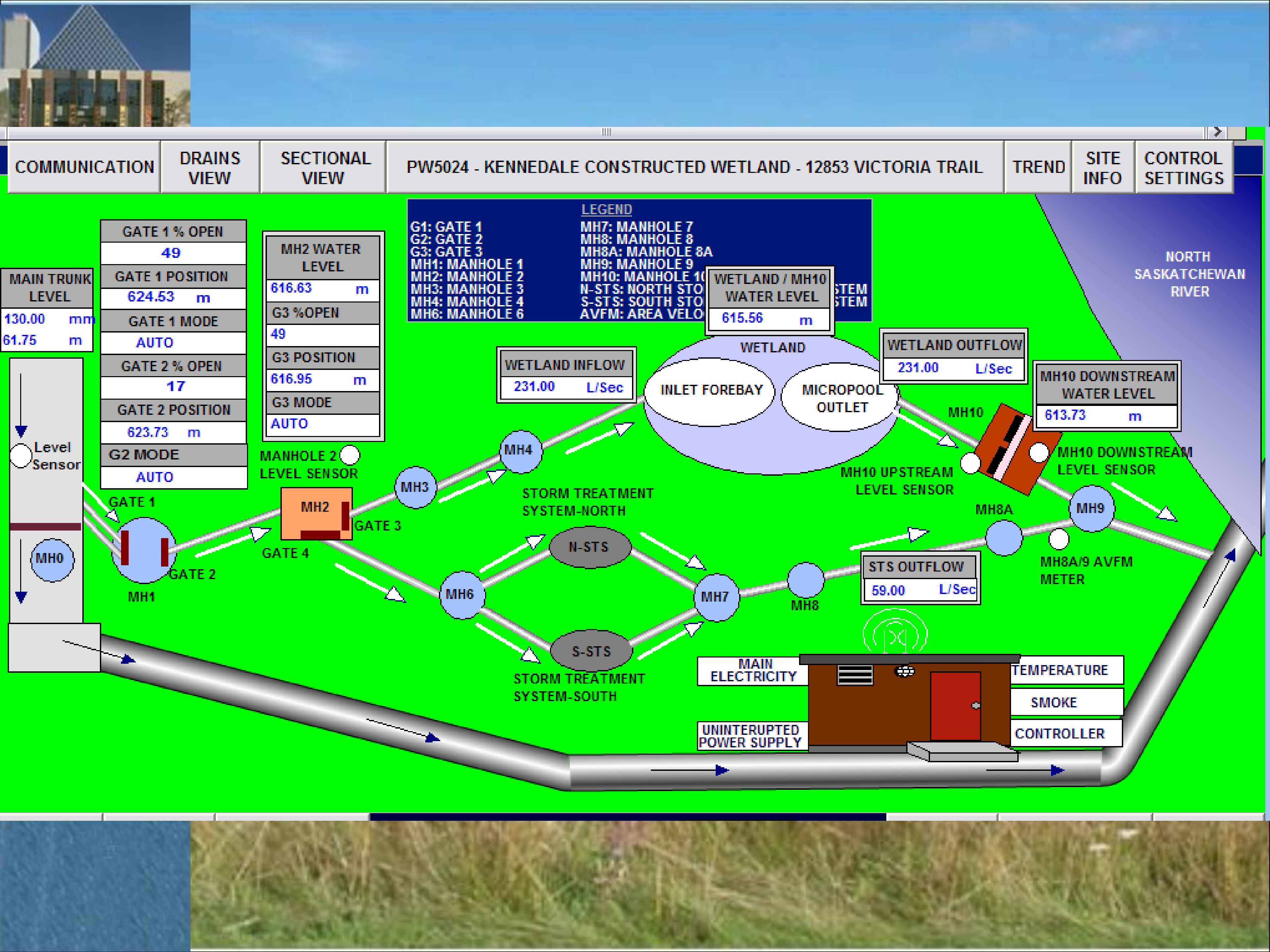
Storage: 50,400 m^3



KENNEDALE CONSTRUCTED WETLAND

THE CITY OF Edmonton

ASSET MANAGEMENT AND PUBLIC WORKS
DRAINAGE SERVICES



COMMUNICATION
DRAINS VIEW
SECTIONAL VIEW
PW5024 - KENNEDALE CONSTRUCTED WETLAND - 12853 VICTORIA TRAIL
TREND
SITE INFO
CONTROL SETTINGS
LEGEND
G1: GATE 1
G2: GATE 2
G3: GATE 3
MH1: MANHOLE 1
MH2: MANHOLE 2
MH3: MANHOLE 3
MH4: MANHOLE 4
MH6: MANHOLE 6
MH7: MANHOLE 7
MH8: MANHOLE 8
MH8A: MANHOLE 8A
MH9: MANHOLE 9
MH10: MANHOLE 10
N-STS: NORTH STO
S-STS: SOUTH STO
AVFM: AREA VELO
STEM
STEM
NORTH SASKATCHEWAN RIVER
MAIN TRUNK LEVEL
130.00 mm
61.75 m
GATE 1 % OPEN
49
GATE 1 POSITION
624.53 m
GATE 1 MODE
AUTO
GATE 2 % OPEN
17
GATE 2 POSITION
623.73 m
G2 MODE
AUTO
MH2 WATER LEVEL
616.63 m
G3 %OPEN
49
G3 POSITION
616.95 m
G3 MODE
AUTO
WETLAND / MH10 WATER LEVEL
615.56 m
WETLAND
INLET FOREBAY
MICROPOOL OUTLET
WETLAND INFLOW
231.00 L/Sec
WETLAND OUTFLOW
231.00 L/Sec
MH10 DOWNSTREAM WATER LEVEL
613.73 m
MH10
MH10 DOWNSTREAM LEVEL SENSOR
MH10 UPSTREAM LEVEL SENSOR
Level Sensor
MH0
GATE 1
MH1
GATE 2
MANHOLE 2 LEVEL SENSOR
MH2
GATE 3
GATE 4
MH3
MH4
STORM TREATMENT SYSTEM-NORTH
N-STS
MH6
MH7
S-STS
STORM TREATMENT SYSTEM-SOUTH
MH8
STS OUTFLOW
59.00 L/Sec
MH8A
MH9
MH8A/9 AVFM METER
MAIN ELECTRICITY
UNINTERUPTED POWER SUPPLY
TEMPERATURE
SMOKE
CONTROLLER


6712
ISCO


KCWL - OVERVIEW
MH1
MH2
52 cm
MH3
MH4
WETLAND INFLOW 154 L/Sec
WETLAND
MH10
G1
G2
G3
29 %
OPEN
49 %
OPEN
US LEVEL 276 cm
DS LEVEL 92 cm
N-STS
S-STS
MH6
MH7
MH8
MH8A
MH9
MAIN TRUNK TO NBR
STS FLOW 59 L/Sec
167 mm
RESET KCWL
ALL ALARMS
ALARM
MANAGEMENT
MAIN MENU

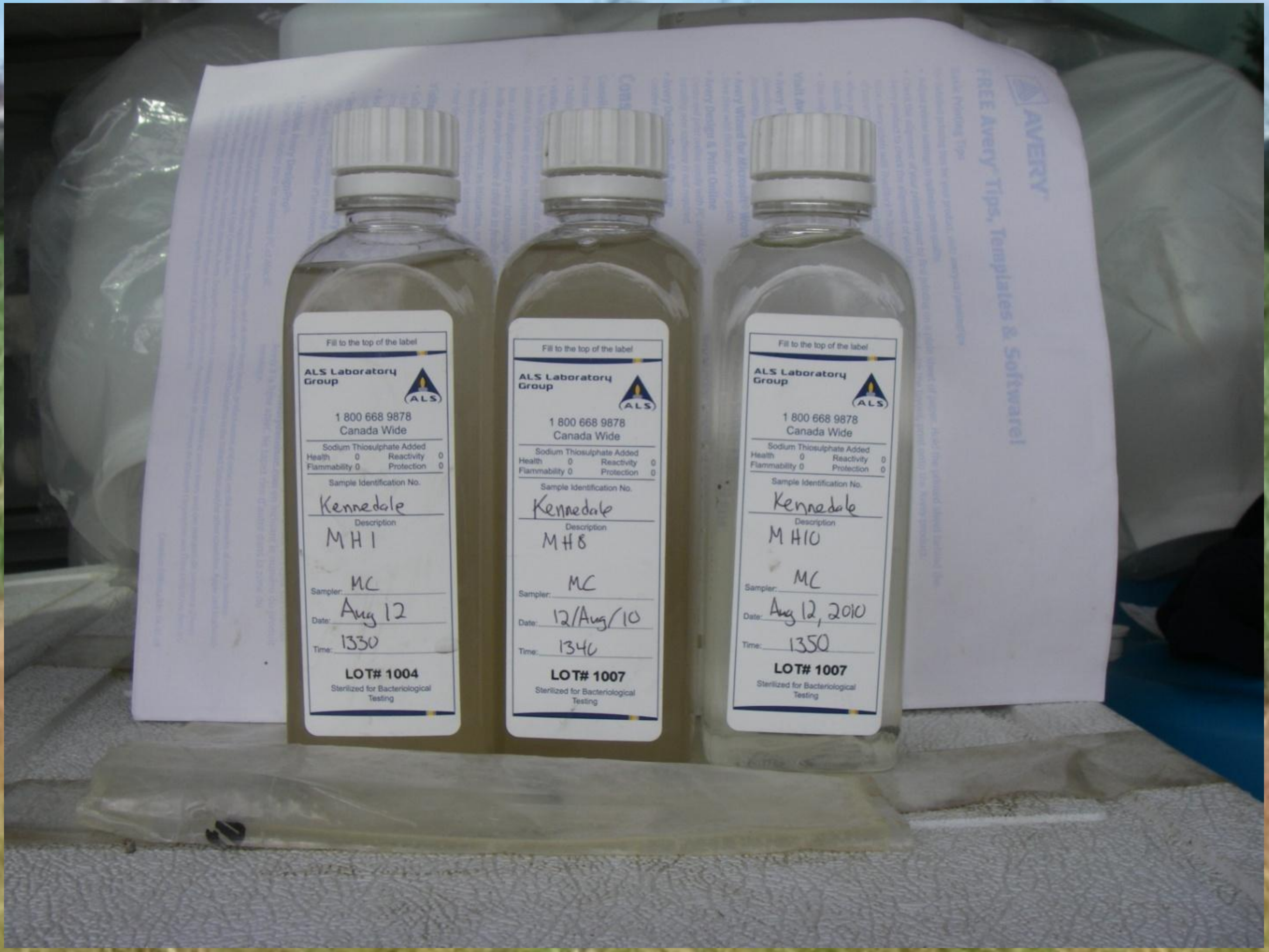
Monitoring Objectives

- Comparison of inflow and outflow volumes (water budget of the wetland) – gave up on this.
- Comparison of inflow and outflow water quality.
- Statistical validation of results (removal efficiency statistically different then zero).
- How does efficiency vary from pollutant to pollutant (TSS, nutrients, bacteria)?
- Does efficiency improve, decay, or remain stable over time (ongoing monitoring and results)?
- Constructed wetland's efficiency vs. STS units efficiency?
- Sediment accumulation

Monitoring Scope

- Baseflow weekly at inlet MH1, outlet MH10 and wetland – reduced to monthly and in 2011 dropped completely (low concentrations).
- Rain event – collect FW composite at MH1 and MH10
- Rain event – collect grab sample at MH8 D/S from STS units
- Forebay sediment accumulation - bathymetric survey
- Parameters included: TSS, TP, TKN, ammonia, Nitrate+Nitrite, Cl, E.Coli.
- Metals and pesticides (one baseflow and two storm events).

Kennedale Wetland Samples



Results and Efficiency

- Efficiency calculated:

$$\text{Individual Event Efficiency} = \frac{\text{Concentration}_{in} - \text{Concentration}_{out}}{\text{Concentration}_{in}} \text{ x } 100$$

- Calculated for each event, overall (baseflow and wet weather) and for each parameter.

$$\text{Mean Concentration Efficiency} = 1 - \frac{\text{Average outlet concentration}}{\text{Average inlet concentration}} \text{ x } 100$$

Results and Efficiency

- Removal Efficiency highly dependant upon the parameter and flow conditions (baseflow or wet weather)
- TSS and E.Coli high removal rate and TKN had moderate removal rate during the storm
- TP had low and negative removal
- Ammonia and NO2+NO3 had negative removal efficiencies however the concentrations entering and leaving wetland were not significantly different.

Table 4.1: Summary of Average Removal Efficiencies from the Kennedale Wetland

Parameter	**Average Removal Efficiency**
TSS	++
Chloride	--
TKN	-- *
Ammonia	++
$NO_3 + NO_2$	- *
TP	+
E. coli	+++
Chlorophyll *a*	---

Note: + = < 30%, ++ = 31 to 90%, +++ = >91%
- = <-30%, -- = -31 to -90%, --- = >-91%
* denotes that concentrations in the inflow (MH1) and outflow (MH10) were not statistically different

Sediment Monitoring

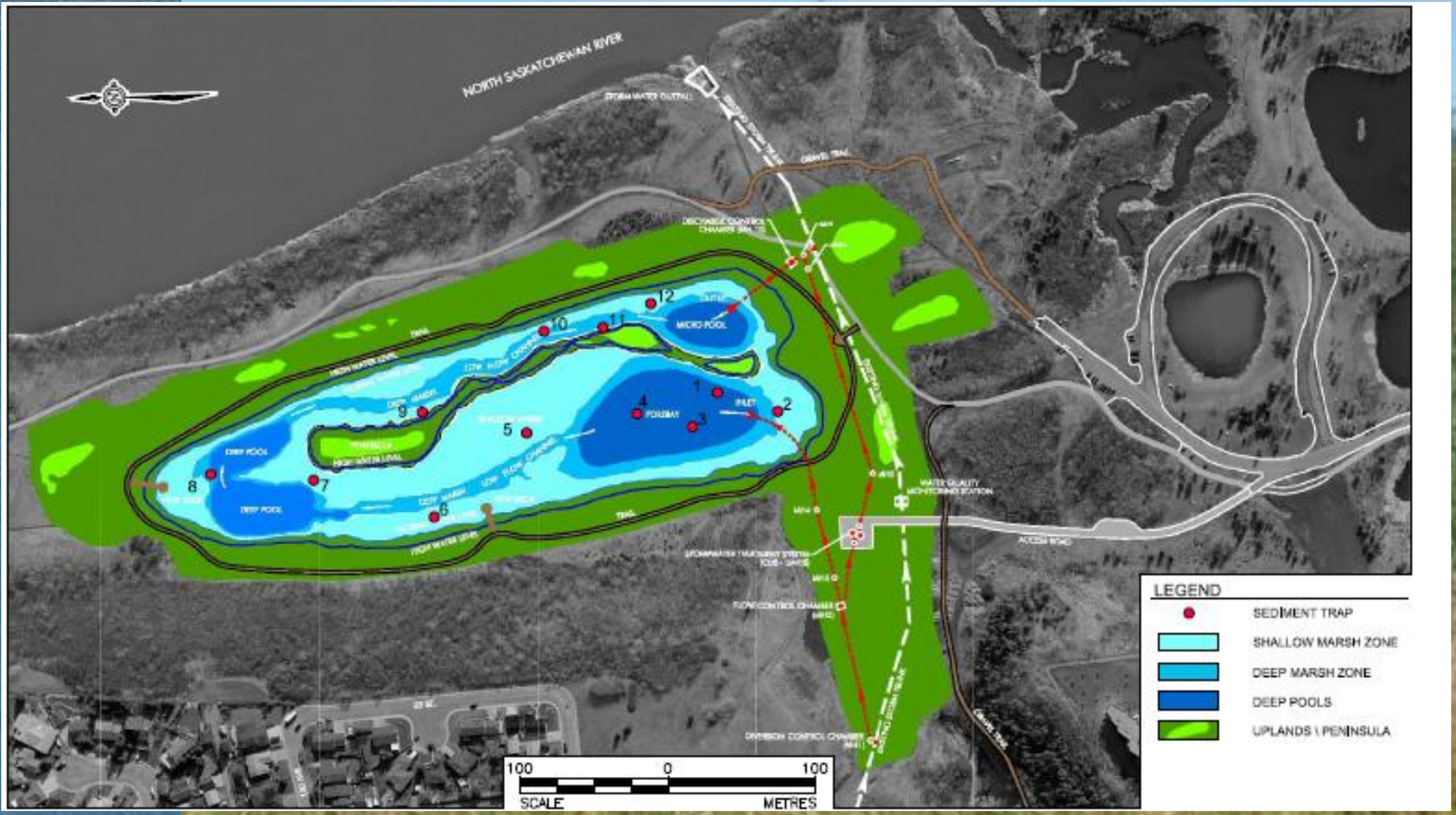


Table 2.4: Sediment Accumulation within Sediment Traps Deployed between July 11, 2011 and October 8, 2011

Sediment Pail #	Water Depth on July 11 (m)	Sediment Accumulation (cm)
1	4.5	6
2	0.9	-[a]
3	7.2	> 15 [b]
4	8.0	> 15 [b]
5	1.0	1
6	1.0	-[a]
7	1.2	2
8	1.1	4
9	1.1	1
10	1.0	-[a]
11	1.7	3
12	1.0	4

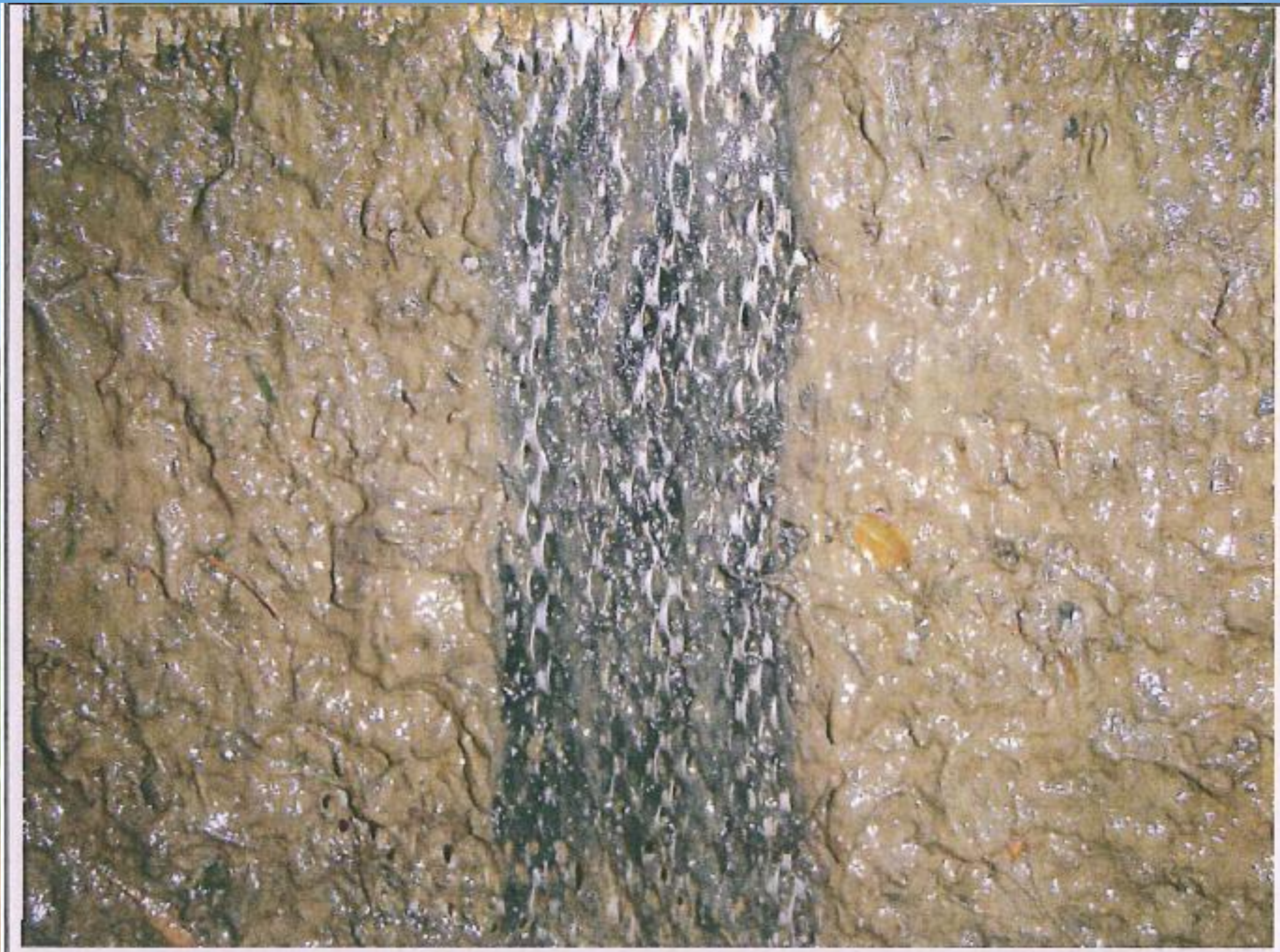
Note: a = sediment trap was not located on October 8, 2011, and therefore no accumulation could be measured
b = sediment traps could only hold 15 cm of sediment, and these traps were full.

Figure F.4: Sediment traps consisting of plastic pails lined on the bottom with concrete during deployment. Pails were filled with water from the forebay and outlet pool to show the difference in turbidity during a prolonged rain event July 11, 2011

Forebay

Outlet Pool

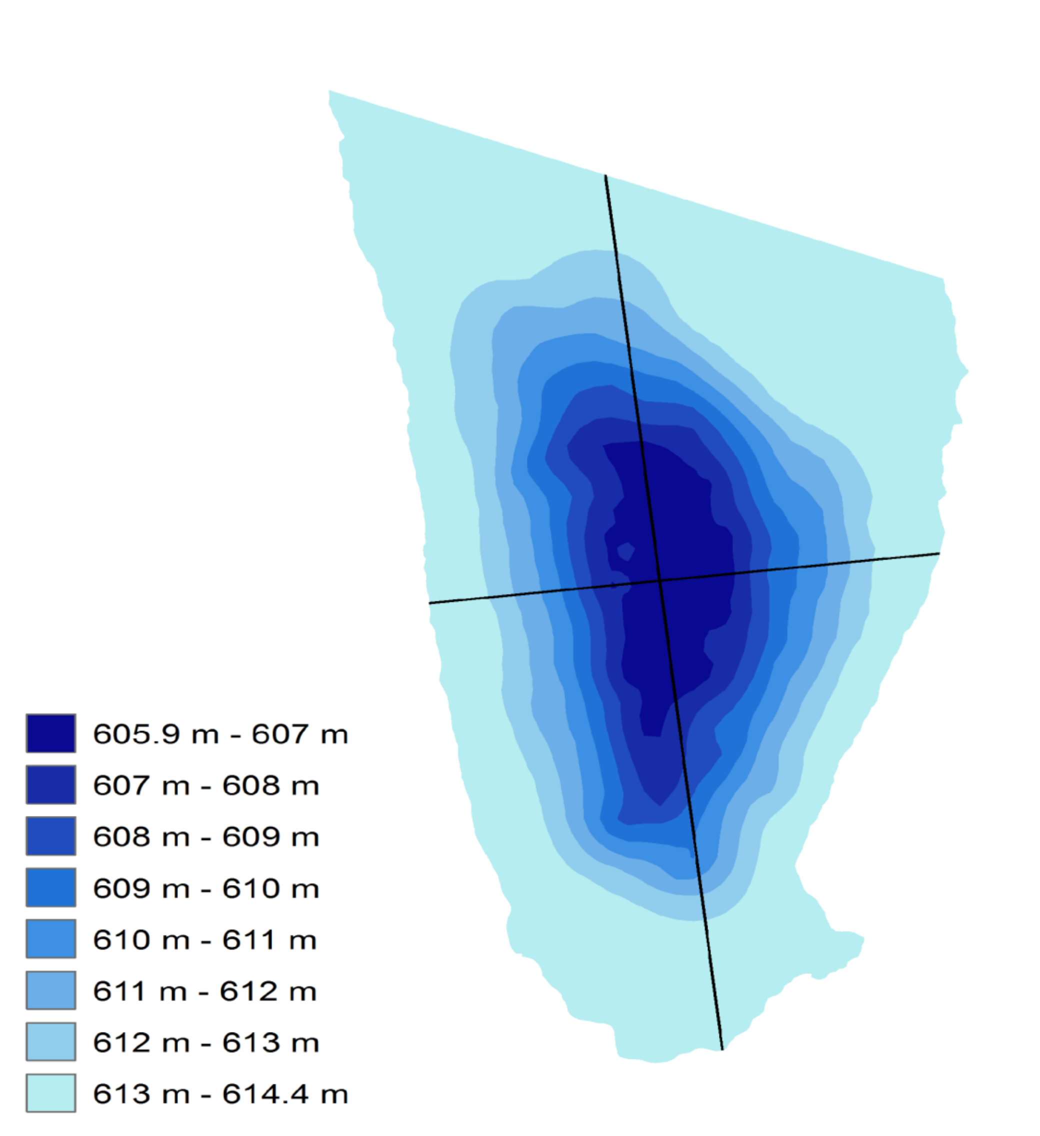
Sediment trap No. 4 retrieved from forebay – note clay/silt sediment and that pale is overfilled



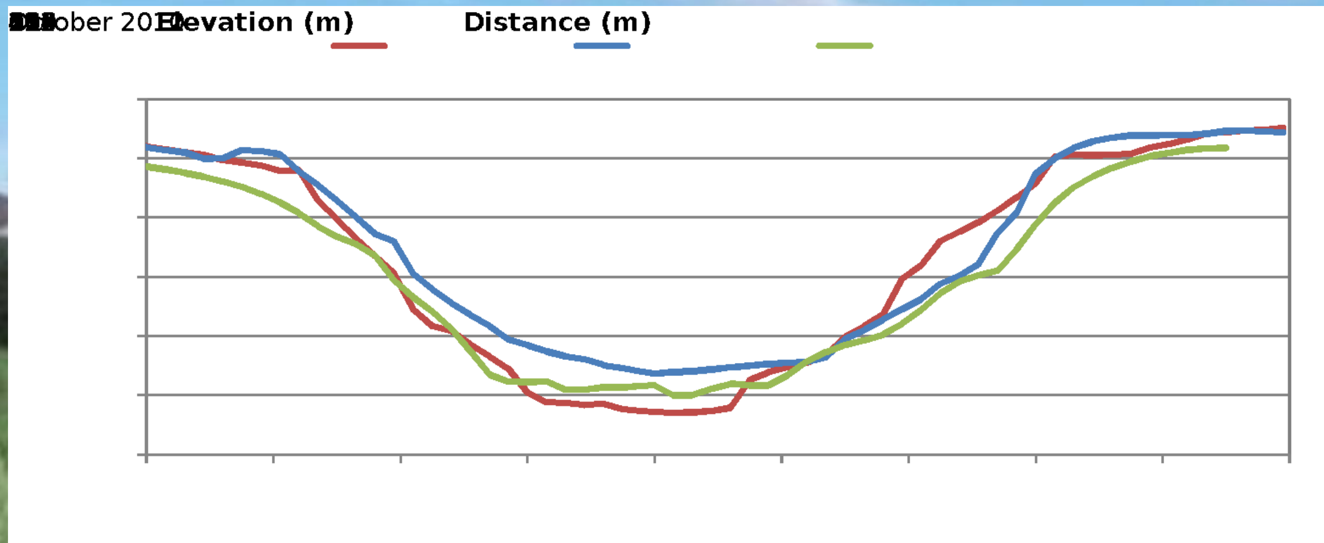
PIC.# 1

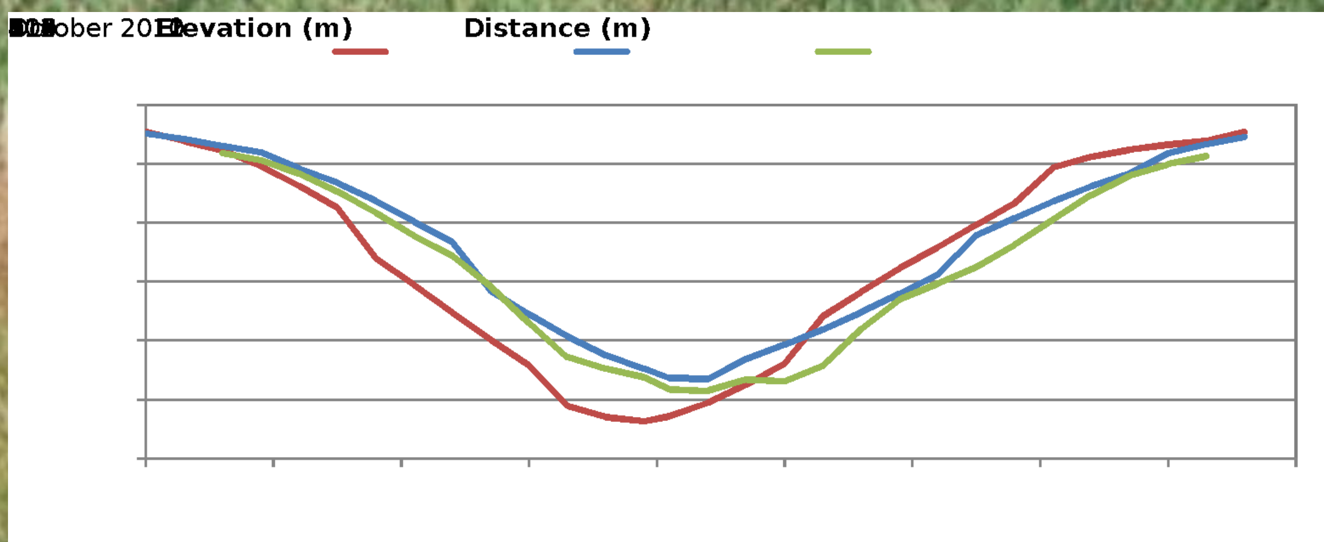
CDS unit screen July 13, 2011 (releases from Snow Storage).

Forebay Bathymetric Profile

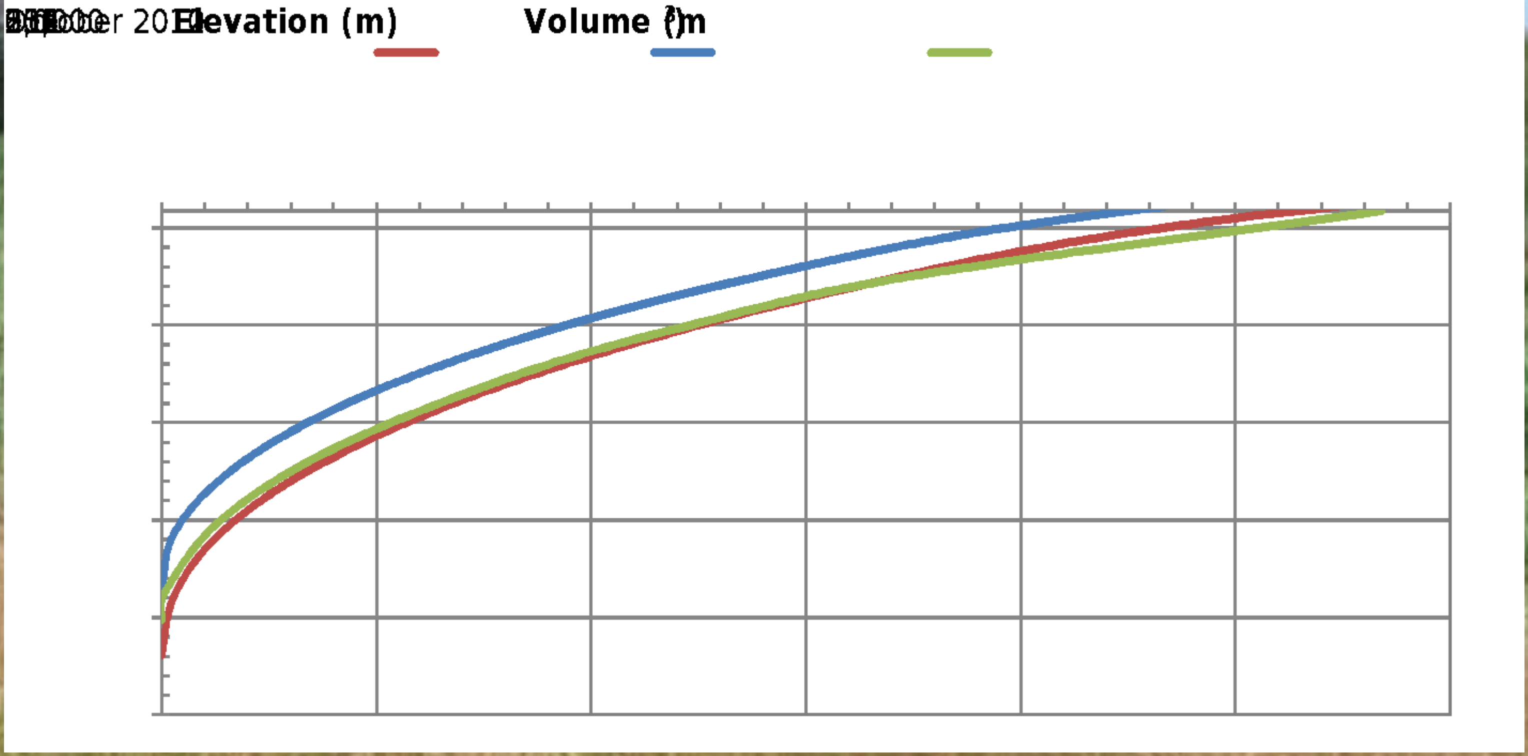


North and South transect





Cumulative volume at various depths



Vegetation Management

- Wetland plant communities not established as desired (2011)
- Mapping of current plants, water level monitoring and recommendations for remedial measures.
- Monitoring in 2012 to access the success of the remedial measures.

- High water level restricts establishment of plants
- High precipitation immediately after construction completion
- Record wetland plant species and abundance
- Record and map emergent plants at site
- Provide recommendations for vegetation management within the site.
- Performance monitoring (established quadrants, counted plants, assess initial survival)

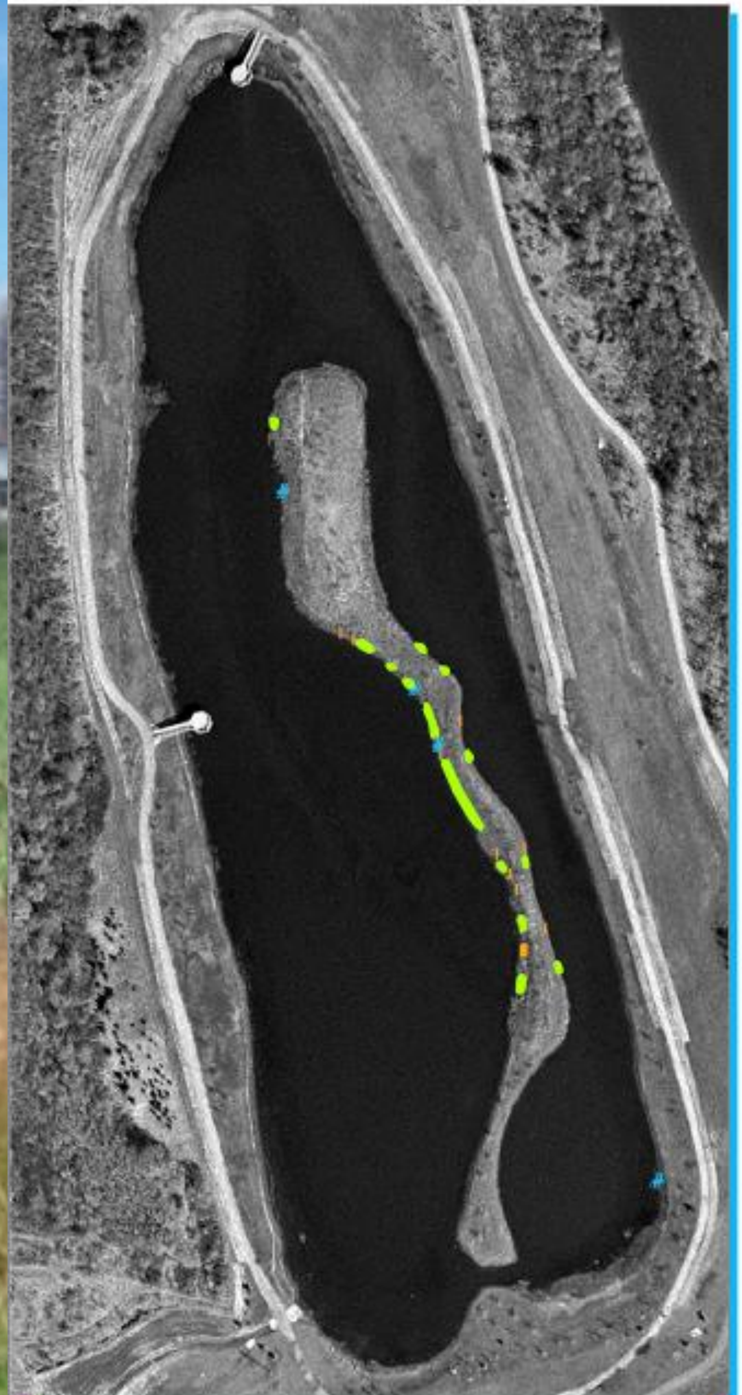


Figure 1. Emergent Plant Locations

Aerial Photograph Date: May 2010
Date Map Created: 08 December 2011

Legend

Mappable Emergent Plant Communities

- Common cattail
- Sedge

Emergent Plant Patches

- Sedge
- Bulrush

0 20 40 80 Meters

1:1,800

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD

Recommendations

- Lower the water level in late summer, fall and winter below NWL (0.40m below)
- Install additional wetland plants (plugs of common cattail and soft stem bulrush).
- Use snow fencing to protect the new plant installation
- Bring in wetland soil (organic soil and remnant plant material) from other wetland site in the City.

Plate 2. An area of new emergent plant installations along the shoreline on 17 August 2011.

Plate 3. Typical shoreline showing abrupt transition from grass to exposed soils (25 August 2011; water level at the time of approximately 614.83)

Plate 4. A small, na

Plate 5. Submersed aquatic vegetation, duckweed and algae occur together along the shallow bench of the facility. The open water to the right is a result of deeper water (25 August 2011).

Plate 6. Sharp-leaved
the trees and shrul

Plate 7. Extensive weeds established near the north end of the island (25 August 2011).

Plate 8. Original extent of wetland soils along the west shoreline on 13 October 2011.

Recommendations

- Winter 2011/2012 water level back to NWL
- Allow for spring water level to rise but only for a few days and lower it again to allow the growth of rhizomes.
- Gradual drawdown to below NWL by June 2012
- Allow only for partial and occasional flooding and lower water level by fall

Biological Monitoring of City of Edmonton Wetlands and Stormwater Facilities 2007-2011

City of Edmonton

Program Objectives

To assess if and how well constructed wetlands are fulfilling biological wetland functions and providing related wetland values.

- **By examining biological parameters**
- **Using a comparative approach - examine different site types- wet ponds, constructed wetlands, natural wetlands**
- **By selecting sites with varying physical features**
  - **Size, age, location and surrounding land use**

Year	Focus	Wet Pond	Naturalized Wet Pond	Constructed Wetland	Natural Wetland	Stormwater-influenced	Total Sites
2007	▪ Pilot year ▪ All site types	1	_	3	1	1	6
2008	▪ Less site variability ▪ Natural wetlands only	–	–	–	2	3	5
2009	▪ Upland areas/ connectivity	_	3	0	1	_	4
2010	▪ Constructed wetlands only	–	–	4	_	_	4
2011	▪ Constructed and natural wetlands ▪ Resample 2 sites	_	_	**4**	_	**1**	**5**
TOTAL SITES		**1**	**3**	**11**	**4**	**5**	**24**

Biological Parameters Examined

Year	Plants	Benthic Invertebrates	Amphibians	Fish	Birds	Mammals (Tracking)
2007	√	√	√	√	√	√
2008	√	√	-	-	√	√
2009	√	√	√	-	√	√
2010	√	√	√	-	√	√
2011	√	√ (1 site only)	√	-	√	√

Five Year Summary

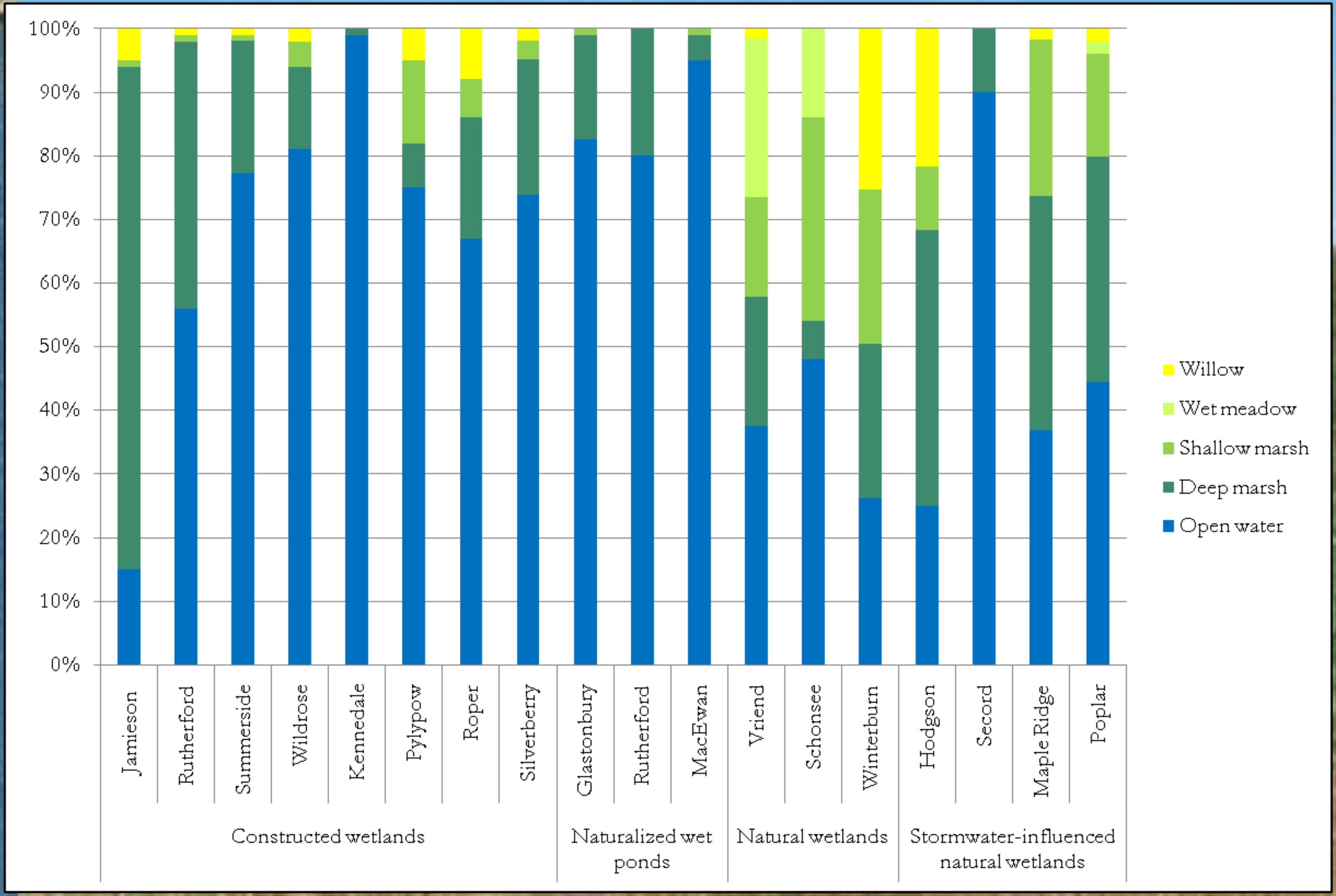
Biologically-meaningful metrics selected for inclusion.

- Native upland and wetland plant richness, exotic species richness
- Percent of uplands manicured
- Proportional representation of wetland communities
- Richness and diversity of breeding waterbirds and landbirds
- Maximum calling code for amphibians
- Weighted wetland-dependent and wetland-independent habitat value.
- Relationship between site habitat value and area of woody communities.
- Presence of bird and mammal species that indicate connectivity.

Five Year Summary

Results: Vegetation

- Constructed wetlands and naturalized wet ponds had greatest number of native upland species.
- Natural wetlands had greatest number of native wetland plants, but stormwater-influenced wetlands had fewest.
- Constructed wetland types had more exotics and manicured upland than natural types.


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Jamieson
Rutherford
Summerside
Wildrose
Kennedale
Pylypow
Roper
Silverberry
Glastonbury
Rutherford
MacEwan
Vriend
Schonsee
Winterburn
Hodgson
Secord
Maple Ridge
Poplar
Constructed wetlands
Naturalized wet ponds
Natural wetlands
Stormwater-influenced natural wetlands
Willow
Wet meadow
Shallow marsh
Deep marsh
Open water

Five Year Summary

Results: Birds

- Natural wetland types had greater richness and diversity of breeding waterbirds than constructed types.
- Natural wetlands types also had greater richness and diversity of breeding landbirds.
- Natural wetlands scored higher than stormwater-influenced wetlands on bird metrics.
- Naturalized wet ponds scored higher on landbird metrics than constructed wetlands, waterbirds showed the opposite trend.

Five Year Summary

Results: Ecological Connectivity

- Natural wetlands scored highest: outside/fringe of developed urban areas.
- All other types (wet pond excluded) scored similarly.

Five Year Summary

Results: Amphibians

- Natural wetlands scored higher than constructed wetland types.
- However, amphibians were present at all site types.

Five Year Summary

Results: Habitat Value

- Natural wetlands scored highest.
- Other three types scored considerably lower. Constructed wetlands had second-highest score.
- Greater area of woody communities was positively associated with greater site habitat value.
  - ✓ Woody habitats contribute to greater wetland function.

Five Year Summary

Results: Facility Age

- Most metrics were not significantly influenced by age.
- Age is positively correlated with:
  - ✓Wetland-dependent habitat value
  - ✓Upland plant species richness
- But negatively correlated with:
  - ✓Abundance of amphibians

Five Year Summary

Conclusions

- Un-integrated wetlands performed better than integrated ones. Stormwater-integrated wetlands and constructed wetlands performed equally well in many respects.
- Weed management is an issue for upland communities at constructed wetland types. Natural types appear somewhat resilient.
- Development of shallow marsh and wet meadow communities is poor at constructed wetland types.

Five Year Summary

Conclusions

- It is unclear whether amphibians are able to successfully reproduce in urban wetlands.
- Facility age was a weak predictor of performance, suggesting other factors (hydrology?) may be more influential.
- Woody habitats contribute positively to site habitat value and wetland function.

Five Year Summary

Recommendations

- Planted Beds - Explore installing and management options for encouraging development of diverse, native-dominated understorey communities.
- Establish nest box maintenance programs.
- Continue to monitor water level manipulation at Kennedale and its benefits (include additional sites)?
- Continue to research/monitor success of aquatic plantings.

Five Year Summary

Recommendations

- Continue to monitor Poplar Lake to determine long-term sustainability of stormwater-influenced wetlands.
- At future constructed wetlands, strive to establish expansive riparian shrub communities.
- Address dense concentrations of weeds as part of regular maintenance.

Design/Maintenance

Recommendations

- **Wetland Components**
  - ✓ Ensure that largest open water patch is >0.5 ha.
  - ✓ Establish an expansive emergent zone.
  - ✓ **Do not create hard-surface shorelines.**
  - ✓ **Create the shallowest slopes possible.**
  - ✓ Create an undulating shoreline to increase waterbird density.
  - ✓ Ensure that much of the shoreline is bordered by shrubby communities.

Design/Maintenance

Recommendations

- **Upland Components**
  - ✓ **Establish a minimum 30m wide upland buffer comprising natural or naturalized plant communities.**
  - ✓ **Establish a significant proportion of unmanicured herbaceous vegetation.**
  - ✓ Do not use exotic species in landscaping.
  - ✓ Implement stringent weed management during the first five years of facility operation.

Design/Maintenance

Recommendations

- **Upland Components**
  - ✓ Consider seeding native forbs and grasses in planted beds to encourage the development of native-dominated understorey communities.
  - ✓ Reconsider the use of mulch as a ground cover, and its potential role in limiting native understorey development.
  - ✓ Integrate retained natural areas and/or create/retain structural connectivity.

Operation Issues

Depth of facility

- ✓ Shallow prevents easy access (multiple launch points required).
- ✓ Shallow promotes algae and weed growth (light and heath penetration), depletion of oxygen and reduces effectiveness of algaecide.
- ✓ Shallow warm anaerobic areas are source of odours and main reason for complaints.

Operation Issues

Shape and other features

- ✓ Narrow areas easily overgrown (dense vegetation prevents water flow).
- ✓ Stream/creek like features through NBH – limited access and residential constraints.
- ✓ Weirs underdesigned (not holding the water during spring melt or big events) causing erosion.
- ✓ Gates and control structures need to be standardized.
- ✓ Underdesigned settling ponds (overloaded during the construction).
- ✓ Bridges and viewing platforms are prone to erosion (multiple departments involvement).

Operation Issues

Citizen's Expactations

- ✓ High and unrealistic expectation.
- ✓ Facilities are specifically designed to prevent downstream flooding (due to development), remove the pollutants from the surface runoff and provide ecological balance (lost due to development).

Operation Issues

Other Issues

- ✓ Landscaped close to NWL – trees, shrubs and other vegetation not suitable for high water table, having problems to establish and maintain this vegetation.
- ✓ Live soil vs. non-live soil – live soil improves establishment of aquatic plants (water treatment, erosion control and other benefits).
- ✓ Lack of erosion control in surrounding areas (during construction) resulting in increased sediment deposits in newer facilities.

Operation Issues

Other Issues

- ✓ Boatlaunch and access ramps are not constructed for long term usage.
  - o Interlocking brick quickly becomes overgrown with vegetation making them slippery under wet conditions. Erosion along edges of the brick leads to damage of side-slopes and base layer
  - o Unrelated (to SWMF) planters, flower beds, park benches, garbage receptacles, mail boxes,…, limit access to boat launches and the facility (equipment).


Questions?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