The Holland Marsh Drainage System: A Case Study

Town of Bradford West Gwillimbury
King Township

Presented by Kenn Smart P. Eng.
Brief Summary of Presentation

- The Setting
- The original Engineering Report
- History highlights of the Marsh from construction to 1997
- The Holland Marsh lands and drainage system as they exist today
- Problems with the Holland Marsh Drainage System
- Initial engineering work. Findings and conclusions.
- Main events in Engineering Studies to date
- Alternate designs considered
- Current recommended work for improvements
- Cost estimate
- Construction timing
- Future maintenance
Original Engineers Report

- Plans for reclamation of the Holland Marsh Swamp were promoted by Professor Day, University of Guelph


- Report date June 19, 1924

- Construction started in 1925 and was completed by 1930
• **Components;**
  - 27.8 km of canal and dyke
  - Main Drain (Central River)
  - Pumping station (40,000 gpm)

• **Notes;**
  - No structures included
  - Only one foot of fall in each canal
  - 7 feet of depth in each canal
  - Only assessed internal marsh lands (approx 7,000 acres)
  - Cost estimate $130,770
Events Between Original Construction and 1997

• 1930 Periodical slump and tree removal to 1997

• 1945 Holland Marsh Road Act. Gave legal status to the dykes being used as roads

• 1949 Additional pumping station built (V. Bardawill Pump House)

• 1954 Hurricane Hazel – October 15, 1954 (dykes breached, up to 7 ft of water within marsh)
Events Between Original Construction and 1997

- 1954 to 1955  Reconstruction of Canals and Dykes
Events Between Original Construction and 1997

- 1955  Further pumping station built (Charlie Davis Pump House)

- 1970’s  Numerous studies by LSRCA to 1980’s

- 1979  Pile wall constructed at North Branch Junction

- Minimal cleanout activities since 1956 due to;
  - No room to level spoil or to work
  - Development along widened dykes
  - Cannot apply original bylaw

- 1993  KSAL reconstruct main pumping station (Art Janse Pumping Station, 67,000 gpm capacity)

- 1995  KSAL requested to do a study of structures including new hydrology study (estimation of flood flows)

- 1997  KSAL appointed to do Preliminary Report for improvements
Holland Marsh Lands and the Holland Marsh Drainage System as it Exists Today
Holland Marsh Lands and the Holland Marsh Drainage System as it Exists Today

• Marsh lands themselves are fully drained and irrigated. They are recognized as one of the most fertile productive agricultural areas in the province

• Numerous small municipal drains have been constructed on interior marsh lands

• The Central River is cleaned annually by barge using auger excavation techniques (Art Janse developed and undertook such for years)

• Art Janse Pumping Station maintains Central River elevations (with assistance as needed from Victor Bardawill or Charlie Davis Pump Houses) to a small variation of levels throughout the year

• Highway 400 passes north and south through the centre portion of the marsh

• Highway 9 constitutes part of the south canal dyke from Highway 400 westerly
Holland Marsh Lands and the Holland Marsh Drainage System as it Exists Today

- Canals are fully to partially filled in with sediment
- Majority of dykes are used as roads, are subject to continuous subsidence and are very uneven
- Minimal to no separation between traveled dykes and canal
Holland Marsh Lands and the Holland Marsh Drainage System as it Exists Today

- Willow trees grow along interface of canal and dyke

- Provincially Significant Wetlands exist on much of the outside lands of the canal with protected flood plain throughout

- Almost continuous building development on inside of dykes where used as roads (residential, agricultural, agricultural-commercial)
Interval 1    Pottageville Swamp in background

Interval 3    Day Street, Highway 400 in background
Interval 2  North Branch Holland River, Fraser Creek Swamp, Charlie Davis and Victor Bardawill Pump Houses

Interval 1  Springdale Church, Five Sideroad Bridge, Pottageville Swamp
Interval 18  Highway 9, Pottageville Swamp

Intervals 14 & 15  Wood Choppers Lane, Golf Course, Ansnorveldt Wetland
Summary of Problems with the HMDS Canals and Dykes

**Drainage**
- Original design of system 2.1 m (7 ft) depth and 11.5 to 21.5 m (38 to 70 ft) top width existed
- After Hurricane Hazel, 3 m (10 ft) depth and 16.5 to 21.5 m (54 to 70 ft) top width were provided
- Past 48 yrs canals have retained top width but depths have been reduced due to accumulation of sediment
- Slow movement of water contributes to build up of sediment

**Flood Protection**
- Dykes should provide protection for the 100 year storm level but are too low in numerous locations
- Studies also assessed the potential impacts of spring ice melts and are of concern
- Peat causes the dyke to be constantly subsiding and occasionally slumping
- Dykes were raised as early as the 1930’s and as late as the 1990’s

**Life Safety**
- Within 10 years of emergency work done on canals and dykes after Hurricane Hazel, 11 fatalities associated with existence of canals occurred. Fatalities are continuing
- Dyke roads are very narrow, are uneven and ponding of water occurs that add to the danger
- A potential major tragedy could result if a school bus were to enter the canal
- Initiating Municipality (BWG) and the HMDC stated, at project startup, that any engineering report on channel repair, maintenance or improvements is also to provide for life safety

**Maintenance**
- Modification of canals and dykes following Hurricane Hazel and development on land adjacent to the dyke have rendered the intended maintenance impossible
- Cleaning out canals would involve equipment working along paved roads and hauling material away to a disposal site
- Costs would be excessive
- This type of maintenance is not provided for by original engineers report and could be proven to be illegal and municipality would have to absorb costs

**Rodents**
- With dyke adjacent to the canal, on-going problems with burrowing rodents into dyke has occurred
- This has caused additional slumping and settlement to date but could cause/contribute to breaching to occur during high waters
Structures

• Since the construction of the canals, eleven municipal structures have been constructed across the system. Four have been constructed by the province for Hwy 9 and Hwy 400, five structures have been constructed by the two municipalities and two structures have been constructed privately.

• An analysis by KSA determine that improvements should occur to three of the municipal structures on the South canal and to two on the North canal

• Increased capacity should be provided through the two Hwy 400 structures.

• Two private structures were found to be undersized

• A primary concern at bridges is the obstruction and sizing of the opening area to handle ice conditions

Use of Canals for Discharge of Drains & Inlets for Irrigation

• No policy at present for construction of pipes through the dyke

• Total of 240± pipes exist through the dyke, mostly for irrigation purposes

• Many pipes have no protection (backwater valves) and should water rise in the canals flooding would be aggravated. They could create locations of dyke weakening in high flood levels.

Uncontrolled Field Cultivation/Excavation Adjacent to the Canal and Top of the Dyke

• Abuses of the top of the dyke, including using it as a dump site, encroachment up to the canal by cultivation and in some instances excavation of the dyke for fill

• Need to provide policies and guidelines for working adjacent to dykes and dyke stability

Tributary Streams

• Tributary streams are depositing substantial sediment into the canal

• Development in upstream areas has dramatically increased flow into streams during runoff events

• Need to provide recommendations and guidelines for improved watershed management along tributaries

Potential Environmental Hazard

• With increased traffic along the roads and increased hauling of oil and gasoline products, the potential exists for an environmental disaster should a spill occur
Initial Engineering Work

- Prepare ownership plans
- Updated profiles/sounding
- Surveyed new cross sections
- Reviewed external watershed
- Reviewed studies by LSRCA
- Reviewed files of Art Janse, Drainage Superintendent
- Reviewed past soils data
- Walked dykes and boated canals with Art Janse (had to portage in parts)
- Obtained structure drawings
- Retention of environmental sub consultant
- Meetings with Municipal, County and MTO personnel
- Initial meetings with LSRCA, MNR and DFO
- Completed hydrology/hydraulics study
- Completed ice study
- Obtained aerial photography
- Obtained accident data
Initial Findings/Conclusions

• There are many problems as per previous slides

• Original watershed assessed should be expanded

• Decision re assessing riparian owners should be questioned

• Disposal of excavated materials would be an issue (350,000 m³ just clean out and 1,250,000 m³± or relocation part)

• Costs to be assessed out would be high and additional funding should be sought

• Could be significant fishery, wildlife and wetland concerns to be addressed

• Would be significant impacts on a number of structures
Main Events Summarized

March 1997  Preliminary Report Appointment

1997- 1998  Initial Engineering

- Detailed surveys, cross sections, soundings
- Ownership drawings
- Perimeter watershed
- Initial discussions with Municipalities, MNR, LSRCA, DFO, MTO, Simcoe County
- Retention of Environmental Sub Consultant
- Review of past reports and soil surveys
- Many meetings with Art Janse, Drainage Superintendent
- Preparation of Preliminary Report costing and drawings
1998 - 2002  **Efforts to Verify Upstream Watershed including Riparian Owners Could be Assessed Through Section 76 Report Approach**

- Retention of P. Courey as solicitor
- Many meetings/discussions with seven municipalities and their solicitors
- 3 appearances before Drainage Referee
- 1 appearance before Drainage Tribunal
- 3 Public Meetings and Open Houses
- 28 appeals out of 7,831 notices sent out
- favourable decision on October 2002

1999 - 2000  **Search for Additional Funding**

Town of Bradford West Gwillimbury (especially Art Janse) made many approaches to MP’s and MPP’s with little or no success
1999 – 2000  **Joint Provincial Effort to Secure Funding Through MNR and LSRCA Due to Flood Protection**

- Joint committee headed by Bill Mungal OMAFRA with reps from MNR, LSRCA, Town of BWG and King Township to attempt to secure a separate source of funding

- Committee decision was for KSAL to prepare updated cost estimate, plans and profiles, with cost benefit analysis, future maintenance provisions and have such reviewed through Peer Review process

- Substantial document was completed in May 2000 and ultimately accepted by B. Plezak, P. Eng. engineer for LSRCA and by LSRCA July 2002

- However, no funding resulted. Only a commitment to support a Super Build application

2002 – 2003  **Joint Committee Established by Town of BWG and King Township to Review Results of Drainage Referee Decision and Peer Review and Determine Further Direction**

- Decision made to appoint Engineer to do Final Report on May 2003
2003 Engineering on Final Report Commenced
  ▪ Two site meetings
  ▪ Updated surveys as necessary
  ▪ Commence full geotechnical study
  ▪ New meetings with MNR, LSRCA and DFO
  ▪ Recontact Simcoe County and MTO

2003 – 2004 DFO Determine Project is Subject To Canadian Environmental Assessment Act (CEAA)

2004 – 2006 Reports Prepared Pursuant to CEAA Study
  ▪ Two further Landowner meetings/open houses
  ▪ Scope of Project Report
  ▪ Project Description Report
  ▪ 3 Volume CEAA Study Report
  ▪ Michalski Nielsen Associates Ltd. are environmental sub consultant. Prepared Toxicity Report
2006 – 2007

Review of CEAA Reports by DFO, Health Canada and Environment Canada

- Involved joint meetings, many e-mails and telephone calls
- Culminated in an Addendum Report (called a Memorandum of Understanding)

Currently

- The HADD application is being prepared for the first construction year
- MOU is being reviewed and it appears only remaining concern may involve around mapping of Waterfowl Species at Risk
- Hopefully CEAA Study Report will be completed and the HADD authorized yet this year

2008

- Complete Engineering Report and Drainage Act procedures
Alternate Designs Considered

- Bottom cleanout with leveling
- Bottom cleanout with hauling
- Bottom cleanout with suction dredging
- Partial relocation
- Full relocation
- Imported berms
- Raise dyke roads
- Construct floodwall
- Costing guardrails
- Consolidating two canals into one
Current Recommended Work

• 27.8 km of canal work;
  – 8.8 km to have relocated canal with imported berm
  – 8.9 km to have relocated canal with no berm
  – 0.9 km to have partially relocated canal
    (in areas of bridges and buildings close to canal)
  – 7.3 km to have bottom cleanout with leveling on adjacent lands
  – 1.9 km to have bottom cleanout with partial leveling, hauling of balance
Cross Section of Cleanout with Leveling
Cross Section of Partial Relocation
Other Current Recommended Work

- 2 Highway 400 structures to have enlarged channel sections between piers
- 5 Township structures to be enlarged or replaced
- 214 irrigation inlets to be improved
- Continuous fish and wildlife reconstruction/enhancement, sediment curtains and fences, siltation and supernatent ponds to be implemented (see next slides)
1. **Sediment/Soil Sampling Strategy**

a) **Sediment Sampling in Canal Bottoms Being Removed**
   - Collect samples at 500 to 1000m intervals.
   - Collect one sample of sediment. If sediment depth is greater than 1.5m, collect two samples.
   - Analyze for the OC pesticides DDT, DDE, DDD and Toxaphene plus for F3 and F4 PHC’s.

b) **Sampling Canal Bottom After Removal of Sediments**
   - Collect sample at 500 to 1000m intervals.
   - Collect at 150mm to 300mm below bottom.
   - Analyze for the OC pesticides DDT, DDE, DDD and Toxaphene plus for F3 and F4 PHC’s.

c) **Sampling Soils Where Excavated Sediments to be Levelled**
   - Collect sample at 500 to 1000m intervals.
   - Collect at 150mm to 300mm below surface.
   - Analyze for the OC pesticides DDT, DDE, DDD and Toxaphene plus for F3 and F4 PHC’s.

d) **Sampling Native Soils to be Used as Fill in Backfilled Canals**
   - Collect sample at 500 to 1000m intervals.
   - Collect one sample from each 1m of depth.
   - Analyze for the OC pesticides DDT, DDE, DDD and Toxaphene plus for F3 and F4 PHC’s.
   - Consider MOE Fill Quality Guidelines for Lake Fill.

e) **Exceedences**
   - Where canal sediment pesticide levels exceed comparable levels of pesticides in fields to be used for levelling, canal sediments to be stockpiled and then hauled to and used as fill in sections of canal being backfilled.

f) **Adaptive Management**
   - The extent of sampling may be altered after experience is gained with the first construction reach(es).
2. Turbidity Sampling Strategy

a) **Background Sampling**
   - Obtain background turbidity samples within the year leading up to construction during spring runoff period, during midsummer, during fall period and after one significant runoff event.
   - Collect three samples at each sample period and space the samples uniformly through the length to be excavated in the following year.
   - Sample for other selected water quality parameters (suspended solids, phosphorous, nitrogen) twice before construction.

b) **Sampling During Construction**
   - Initially collect turbidity samples daily during first week and then collect samples at 2 week frequencies and after any significant runoff event.
   - Collect one sample upstream and one sample downstream of the work interval at each sampling time.
   - Conduct visual observations for turbidity plumes daily.
   - Sample for other selected water quality parameters (suspended solids, phosphorous, nitrogen) twice during construction.

c) **Post Construction Sampling**
   - Sample turbidity over the two following years in any construction reach.
   - Samples to be obtained in spring, summer and fall and after any significant runoff event.
   - Sample for other selected water quality parameters (suspended solids, phosphorous, nitrogen) once per year.

d) **Exceedences**
   - Exceedence is related to samples outside of the construction zone.
   - Exceedence is defined as twice the standard error of the background.
   - If exceedence occurs re sample, repair mitigation measures where required, create new measures as required and/or alter or suspend work where justified.
   - Apply adaptive management techniques as required.
   - CWQO will be utilized as part of the monitoring and reporting protocol as well as for establishing compliance thresholds for mitigative actions.
   - Supernatant pond conditions and usage to be reviewed.

e) **Adaptive Management**
   - The extent of sampling may be altered after experience is gained with the first construction reach(es).
3. Commitments re Fish Habitat Reconstruction

- Existing habitat found in the canal is quite uniform with essentially one habitat type dominating the canals. The new canals are proposed to have a diversity of habitats which are expected to offer variety in habitat depth and substrate type as well as function for spawning, nursery and feeding habitat for various species. The proposed features (in addition to the native substrates) are as follows:

  - littoral shelf;
  - log bundles;
  - macrophyte transplants;
  - gravel substrates; and
  - deep pool excavations.

- As an example, the density of the enhancements for the first construction reach (Intervals 13 through 16) will be;

  - Littoral shelf – 1 m in depth – 9,328 m² (3,731 m total length x 2.5 m width – specialized features described below, located in littoral shelf);

  - Log bundles, large woody debris along littoral shelf – 157.5 m² (21 locations x 3 m in width x 2.5 m of littoral shelf – placed every 200 m);

  - Macrophyte transplants, native aquatic vegetation in 1 m depth – 125 m² (5 locations x 10 m reach x 2.5 m width of littoral shelf);

  - Gravel substrates along littoral shelf – 225 m² (3 locations x 30 m reach x 2.5 m width of littoral shelf);

  - Deep pool habitat approximately 1 m below new typical canal depth – 2,400 m² (3 locations x 200 m in length x 4 m in width); and

  - Native substrates following excavation, 3 m in depth – 69,235 m² (3,731 m length x 19.2 m width – 2,400 m² deep pool habitat).

- Through adaptive management these densities/frequencies may be modified to maximize the net benefit.
Other Recommended Work

• Guard Rails

• Well Head Reconstruction

• Temporary Cleanout at Structures

• Buffer Strips adjacent to worked fields
Cost Estimate
(as per estimate done Jan 2006)

- Allowances (Section 29 & 30) 200,000
- Construction:
  - Ditch work and berms 6,500,000
  - Structures 4,000,000
  - Environmental 500,000
- Engineering (including legal geotechnical, environmental) 1,300,000
- Administration 1,500,000

TOTAL $14,000,000
Approximate Proposed Assessment
(2006 Dollars)

- Landowners $6,200,000
- Municipalities $3,850,000
- County $2,150,000
- MTO $1,800,000

TOTAL $14,000,000
Construction Timing

- Work to be spread out over 7 years
- Approximately 4,000 metres per year
- Construction technique
PLAN VIEW
NOT TO SCALE
(N.T.S.)

SECTION B-B
N.T.S.

SCHMATIC FOR: SEDIMENT CONTROL DURING PARTIAL RELOCATION

NOTE: CANAL IS PARTIALLY DEWATERED IN PARTIAL RELOCATION
Construction Timing

- Work to possibly start 2009±
- Work to finish 2015±
- Structure work could involve two further years
Future Maintenance

- Frequency will vary, 20 to 50 years
- In areas of full relocation maintenance to be done from surface of backfilled canal
- Material to be stockpiled and leveled or hauled when dry
- Leveling only possible in areas of consolidated backfill
- Disposal site to be determined/acquired for hauling
- Other repair and maintenance to be done – beaver dams, fallen trees, slumped berms, slumped slopes etc. to be done as required
- The maintenance costs for the recommended option would involve annual gross assessments of $75,000 (as per 2000 estimates – would be more now) if costs are billed annually