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National Disaster Mitigation Program (NDMP)

Flood Risk Assessment Study

June-6-18

Outline

- Today's Objectives
- Study Origin
- Study Objectives
- RAIT Criteria
- Climate Change
- NDMP Study Methodology
- Example (Sackville Rivers)
- Council Recommendations & Next Steps

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Today's Objectives

- Present the findings of the NDMP study to the Board.

- Receive RWAB Feedback.

Study Origin

- In 2015, HRM and Halifax Water compiled a compendium of known areas prone to flooding within the service boundary.
- Initially, over 5700 drainage issue sites were identified.
- This list was refined down to 916 sites.

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Study Origin

- The criteria used to refine the list included:
  - Work was undertaken to address the issue.
  - Duplicate sites were removed.
  - Private property issues were excluded.
  - Sites considered nuisance only were dropped.

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Study Origin

- The list of 916 sites was further refined by HRM and Halifax Water staff to 30 key sites.

- The criteria used to develop the 30 key sites did consider risk but did not attempt to quantify or measure it.

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Study Objectives

- Using the 30 key sites as a starting point, develop a top 10 highest priority areas using the NDMP Risk Assessment Information Template (RAIT) developed by Public Safety Canada.

- Develop a preliminary mitigation strategy complete with order of magnitude costs estimates.

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RAIT Criteria

- Infrastructure
- Public Safety
- Society
- Economic
- Environment
- Return Period Likelihood

RAIT Criteria

- The assessment considers the impacts of Climate Change in terms of the frequency, duration, and volume of extreme events, and its impact on municipal stormwater systems.

Climate Change

Flooding Scenarios

- Flash Flood
  - High intensity & short duration (summer thunderstorms)
- Heavy Rainfall
  - >50mm in 24 hours (nor'easters/tropical storms)
- Multi-day Accumulation
  - Rainfall during thaw cycle (run-off along frozen ground)
- Storm Surge (Costal high water)
  - Storm events with high tides (HRM)

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Climate Databases

- Environment Canada Climate Change (ECCC)
  - National Data Archive
    - Basic level of Q&A
- Community Collaborative Rain Hail & Snow (CoCoRaHS)
  - Volunteer network producing 10-15 year of precipitation data

Rainfall Normals 1981-2010			
	Halifax Intl Airport	Shearwater Airport	Halifax Citadel
Spring (MAM)	294.9	321.1	331.0
Summer (JJA)	285.2	313.1	318.5
Fall (SON)	365.7	363.5	376.6
Winter (DJF)	250.3	263.7	287.6
Annual	1196.1	1261.2	1313.9
3-day Max Accumulation	153.9	153.8	115.9
Extreme 24hr Aug 15 1971	218.1	184.9	118.1

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Intensity, Duration & Frequency (IDF)

- Produced from an extreme value statistical analysis of at least 10 years of rate-of-rainfall;
- Include frequency and amounts or extreme rainfall rates;
- Annual maximum durations are complied each year;
- Return Periods of 2,5,10, 25, 50 and 100 years.

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IDF Variances

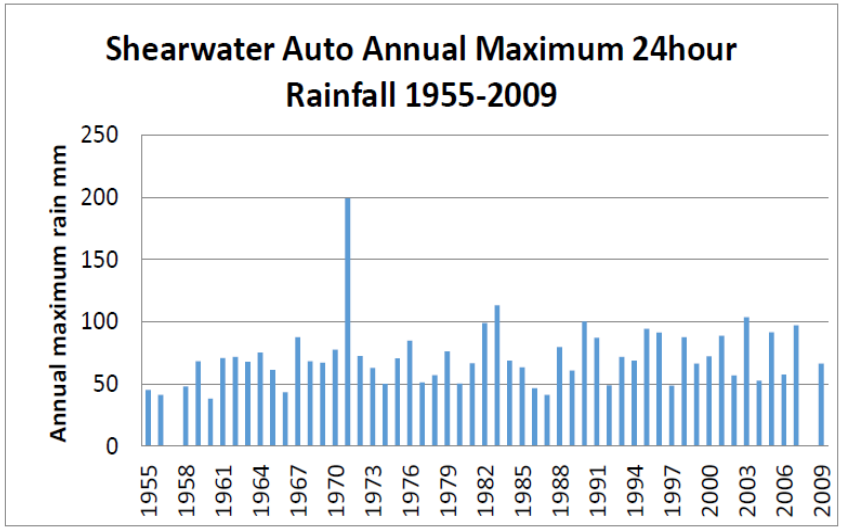

Figure 1. Shearwater Airport Auto Site Annual Maximum 24hour Rainfall.

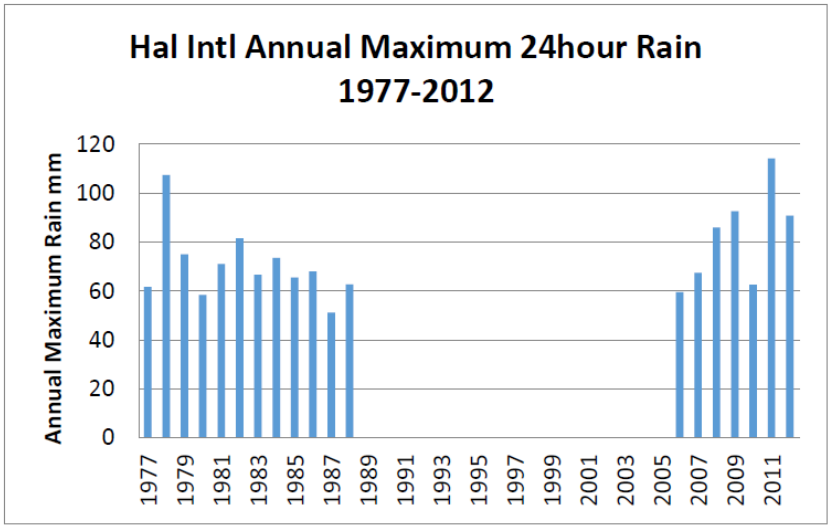

Figure 2. Halifax International Airport Annual Maximum 24hour Rainfall.

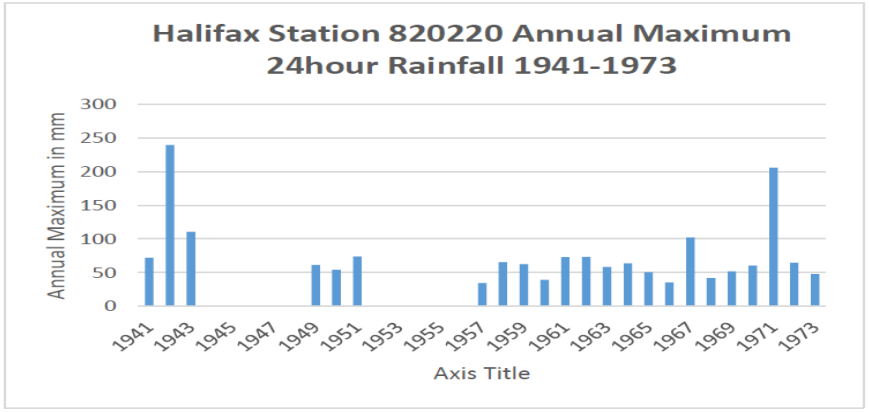

Figure 3. Halifax Station 8202200 Annual Maximum 24hour Rainfall.

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IDF Variances Cont.

100 year return period	Halifax Intl Airport (20 yrs)	Shearwater Airport (53 yrs)	Halifax (8202200) (23 yrs)
5 min	12.1	12.8	13.5
10 min	18.1	18.0	16.6
15 min	22.0	21.6	18.5
30 min	30.2	29.7	26.8
1h	47.2	40.1	39.0
2h	61.9	60.2	60.6
6h	85.5	99.5	109.2
12h	114.2	118.2	146.7
24h	126.5	151.1	232.9

Comparison of 100year Return Period amounts for 3 Halifax stations, extracted from IDF Curves valid 2014

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Sea Level Rise & High Water

- Combination of
  - Sea level rise
  - Increasing storm surge
  - Crustal subsidence (Sinking land)

Extreme Total Sea Level (High Water) (metres CD) – Halifax

Return Period	2000	2025	2055	2085	2100
10-Year	2.87 ± 0.10	3.02 ± 0.13	3.30 ± 0.25	3.70 ± 0.46	3.93 ± 0.58
25-Year	2.97 ± 0.10	3.12 ± 0.13	3.40 ± 0.25	3.80 ± 0.46	4.03 ± 0.58
50-Year	3.04 ± 0.10	3.19 ± 0.13	3.47 ± 0.25	3.87± 0.46	4.10 ± 0.58
100-Year	3.11 ± 0.10	3.26 ± 0.13	3.54 ± 0.25	3.94 ± 0.46	4.17 ± 0.58

High Water Projected Values Based on Halifax NS (from Richards & Daigle, 2011)

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HRM Extreme Precipitation

HRM Site	Avg. Ann. Rain 1981-2010	2020s	2050s	2080s
HFX Citadel	1314	1380	1432	1511
Shearwater Airport	1262	1324	1375	1463
Halifax Intl.	1196	1256	1304	1388

Average annual Rainfall (mm)

Halifax 24r	2014	2020s	2050s	2080s
2yr	68	89	106	124
5yr	112	137	159	176
10yr	141	170	192	213
25yr	178	210	232	259
50yr	206	239	262	294
100yr	233	268	291	328

24hr projections (mm) @ Station 8202200

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Climate Change Summary

- Extreme events, especially heavy precipitation events, will continue to increase in frequency and intensity;
- Extreme event >200mm in 24hr;
- HRM receives 1200-1300 mm of rain annually
- Analyzed sites to experience 16% annual precipitation increase by 2100
- Projections indicate that the current 100yr event will:
  - 50yr event by 2020
  - 25yr event by 2050
  - 15yr event by 2080

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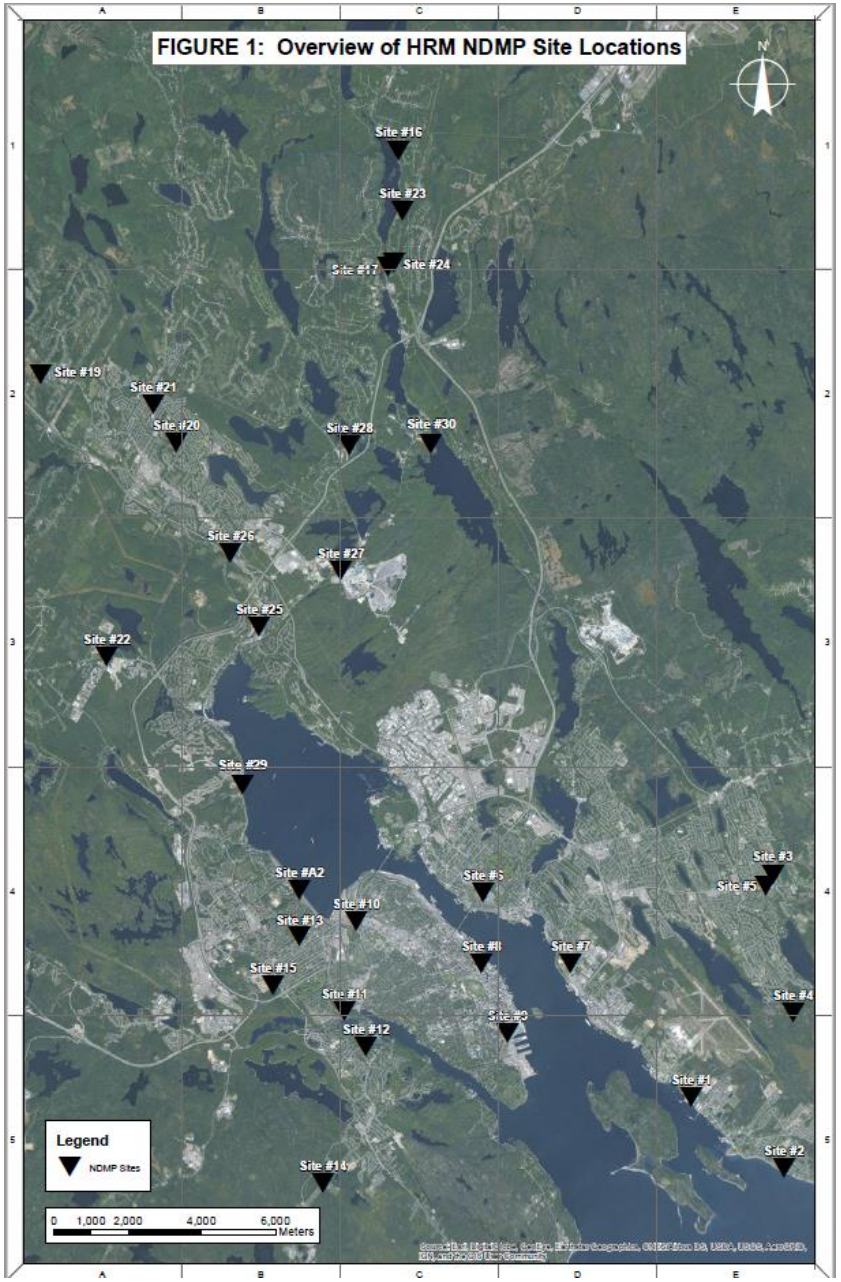
FIGURE 1: Overview of HRM NDMP Site Locations
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Site #16
Site #23
Site #17
Site #24
Site #19
Site #21
Site #20
Site #28
Site #30
Site #26
Site #27
Site #25
Site #22
Site #29
Site #A2
Site #6
Site #3
Site #5
Site #10
Site #13
Site #8
Site #7
Site #15
Site #11
Site #4
Site #9
Site #12
Site #1
Site #2
Site #14
Legend
NDMP Sites
0 1,000 2,000 4,000 6,000
Meters

Methodology

- Desktop Research
- Climate Change Analysis
- Site Visits
- Operation Staff Workshops
- RAIT

10 Sites

Ranking	Site Name
1	Sackville Rivers
2	Shubenacadie Lakes
3	Karlson's Wharf @ Upper Water Street - Halifax
4	Inglis Street @ Barrington Street - Halifax
5	Highway 2, from Holland Road to Miller Lake Road - Fall River
6	Pleasant Street, near Dartmouth General Hospital - Dartmouth
7	Cole Harbour Road @ Perron Drive - Cole Harbour
8	Shore Road - Eastern Passage
9	Hammonds Plains Road @ Bluewater Road - Bedford
10	Mount Saint Vincent at Bedford Highway

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Final Outcome Groupings

- Large Natural Watershed Systems
  - Sackville River Systems
  - Shubenacadie Lakes System
  - Cole Harbour/Bisset Lake Watershed
- Localized Drainage Infrastructure
  - Highway 2
  - Pleasant Street
  - Hammonds Plains Road at Bluewater
  - Bedford Highway at Mount Saint Vincent
- Tidal Influenced Systems
  - Karlsons Wharf
  - Inglis at Barrington
  - Shore Road – Eastern Passage

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Example – Sackville Rivers

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Sackville Rivers
Risks

- Risk Statement:
  - Riverine flooding of the Sackville & Little Sackville River system.

- Risk Event:
  - Little Sackville River: Flooding following a 1:100 year, 24hr rainfall event
  - Sackville River: Flooding following a 1:100 year, 48hr rainfall event.

Sackville Rivers
Key Site Characteristics

Vulnerabilities	Discussion
Key Local Infrastructure	Refer to Key Assets Inventory for further discussion.
Population Density & Urbanization	— Primarily Medium-density residential and high-density commercial. — Tributary watershed includes various land uses and population densities, including undeveloped forest, residential, mixed-use, parks, and commercial. — Increasing development within the tributary watershed.
Vulnerable Populations	— Long-term care facilities. — Residential. — Some properties were reported to require evacuation during flood events.
Economic Considerations	— Commercial centres of Bedford and Lower Sackville are located within the identified floodplain. — Bedford Highway, Highway 101 and 102 are within potential floodplain: Major transportation, shipping, and commuter routes.
Political/Societal Considerations	— System has been studied in detail by the Municipality. — Identified in Provincial Statement of Interest for Flood Risk Management. — High Profile for the widespread community; Media/Political Attention. — Private residential property damage. — Commercial property damage. — Major transportation and commuter routes. — Public spaces/Parks/Trails.
Environmental Considerations	— Potential contamination of the natural riverine system. — Fish Hatchery Park: Impacts to fish habitat. — Eventually discharges to the Bedford Basin: Potential contaminant release to the marine environment. — Flooding of transportation routes can also collect excess debris and roadway contaminants. — Erosion & sedimentation in the river system.

Sackville Rivers
Key Asset Inventory

Asset	Discussion
Transportation Routes	— Provincial Highways 101 & 102, Bedford Highway. — Emergency Evacuation Routes for the Municipality. — Public transit, commuter, shipping routes. — Other local transportation routes.
Watercourse Crossing Structures	— Bridge Structures (Highway 101 and 102), Bedford Highway, Sackville Drive, Bedford Place Mall etc.). — Various Bridges, Culverts, roadway crossings.
Commercial Centre	— Commercial centres of Bedford and Lower Sackville Communities. — Bedford Place Mall, Sunnyside Mall.
Private Property (Residential)	— Private residential buildings.
Utilities	— Water transmission & distribution system (incl. Siphon located at Bedford Place Mall). — Sewer collection system.
Long-Term Care Facility	— Cobequid Regional Rehabilitation Centre.
Cultural/Historical Assets	— Gate of Heaven Cemetery. — Range Park (HRM Parks). — Fultz House Museum. — Sackville Rivers Association Trail System.
Future Development	— Future Fire Station Planned near Range Park. — HRM Planned Growth Centre (Bedford) is located within the floodplain.

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Sackville Rivers
Mitigation Strategy

1. Engineering Feasibility Study of Potential Flood Remediation Measures.

2. Update Planning & Development Policy within Floodplain.

Council Recommendations

- Methodology endorsement
- Develop a joint flood risk implementation plan

Next Steps

- Report to Council – July 2018
- Flood Risk Implementation Plan – Fall 2018

Questions?