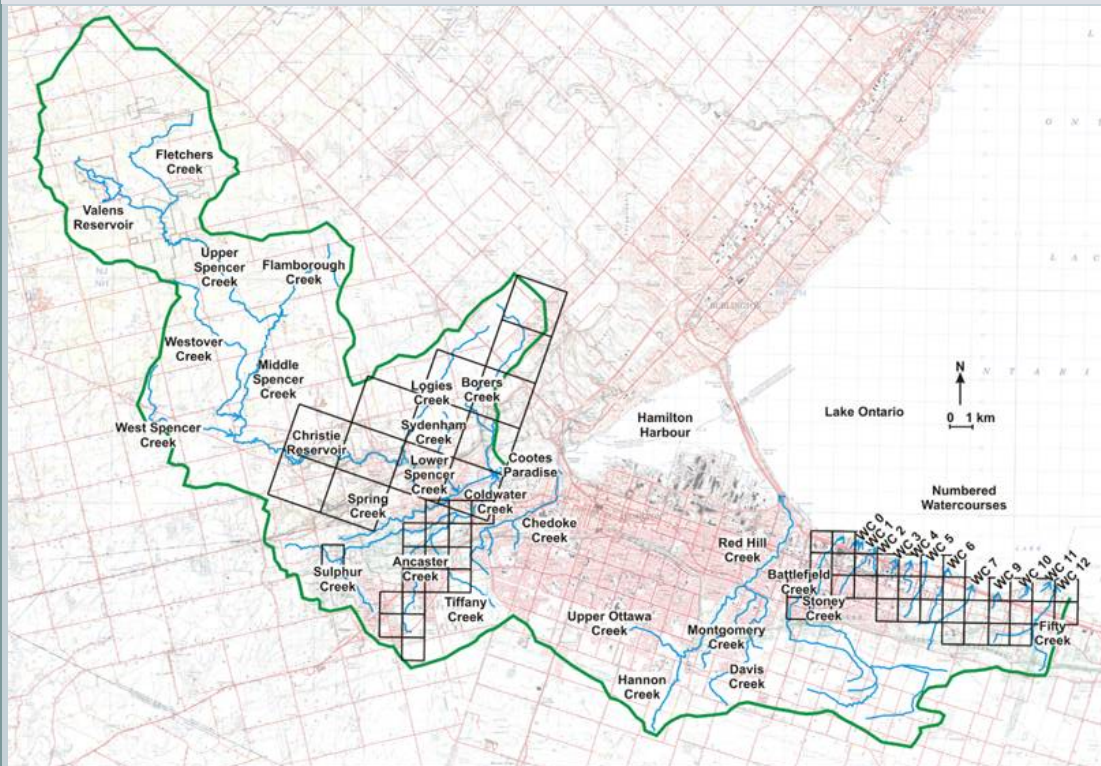
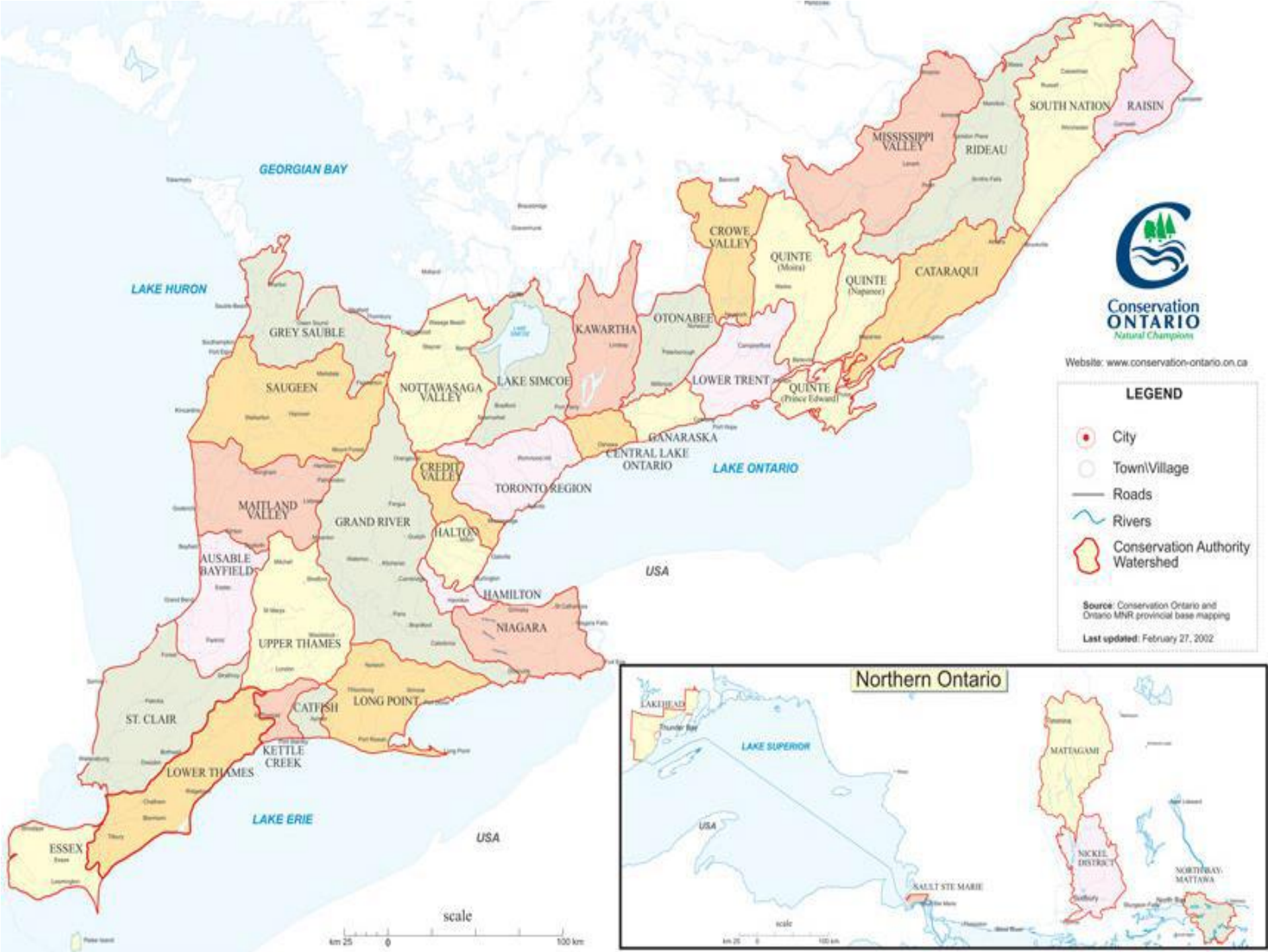


RECENT UPDATES TO FLOODPLAIN MAPPING AT HAMILTON CA - IMPROVING OUR IDENTIFICATION OF FLOOD VULNERABLE AREAS



By Jonathan Bastien
Water Resource Engineering





HAMILTON CONSERVATION AUTHORITY

HELLO

MY NAME IS



**Hamilton
Conservation
Authority**

A Healthy Watershed for Everyone

HAMILTON CA PROGRAMS –

“And I Say, Hey Yeah Yeah, Hey Yeah Yeah. I Said Hey, What’s Going On?”



- Flooding and erosion protection
- Watershed/Sub-watershed Planning
- Water quality and quantity monitoring and management
- Planning & Regulations
- Environmental land use planning
- Protection of sensitive wetlands, flood plains and valley lands

HAMILTON CA PROGRAMS



- Habitat protection
- Ecosystem regeneration
- Reforestation and sustainable woodlot management
- Environmental education and information programming
- Outdoor recreation
- Stewardship activities that include agricultural and rural landowner assistance

WATER RESOURCES ENGINEERING ROLES



- Flood Plain Mapping
- Flood Monitoring & Warning
- Drought Monitoring & Warning
- Dam Operation
- HCA Plan & Regulations Reviews
- Watershed Characterization
- Flood & Drought Emergency Preparedness

FLOOD MANAGEMENT –

“Making it Work, Takes a Little Longer. Making it Work, Takes a Little Time”



Prevention

Protection

Monitoring & Emergency Preparedness

FLOOD MANAGEMENT



Protection

- Operation of HCA's two dams (Valens and Christie Lake) to provide flood attenuation
- Undertaking special projects to enhance flood protection infrastructure
- Provide technical advice to municipalities as to additional flood mitigation actions during the emergency response process

FLOOD MANAGEMENT



Monitoring & Emergency Preparedness

- Flood forecasting and warning
- Preparation of flood contingency plans

FLOOD MANAGEMENT



Prevention

- **Floodplain mapping updates**
- Land use planning
- Regulation of development
- Assessing existing and future conditions
 - Integrated subwatershed studies
 - Watershed water budgets

FPM 101 –



- For most of the HCA watershed, FPM are based on the expected flooding if Hurricane Hazel had occurred directly over Hamilton.
- Actual storm event, which occurred over Toronto area in Oct 1954. (285mm of rain in 48 hours; with 212mm of that falling in the last 12 hours)
- Provincial standard storm (MNRF)

FPM 101



- For the Stoney Creek Numbered Watercourse areas, FPMs are based on the expected flooding from a 100 year design storm (Based on a probability calculation using local area precipitation data)

FPM 101 –

“Humidity is Rising, Barometer’s Getting Low. According to All Sources,
the Street’s the Place to Go”



- 1:100 year storm event – 1 % chance of occurring in any given year
- 1:50 year storm event – 2 % chance of occurring in any given year
- 1:5 year storm event – 20 % chance of occurring in any given year
- 1:2 year storm event – 50 % chance of occurring in any given year

FPM 101

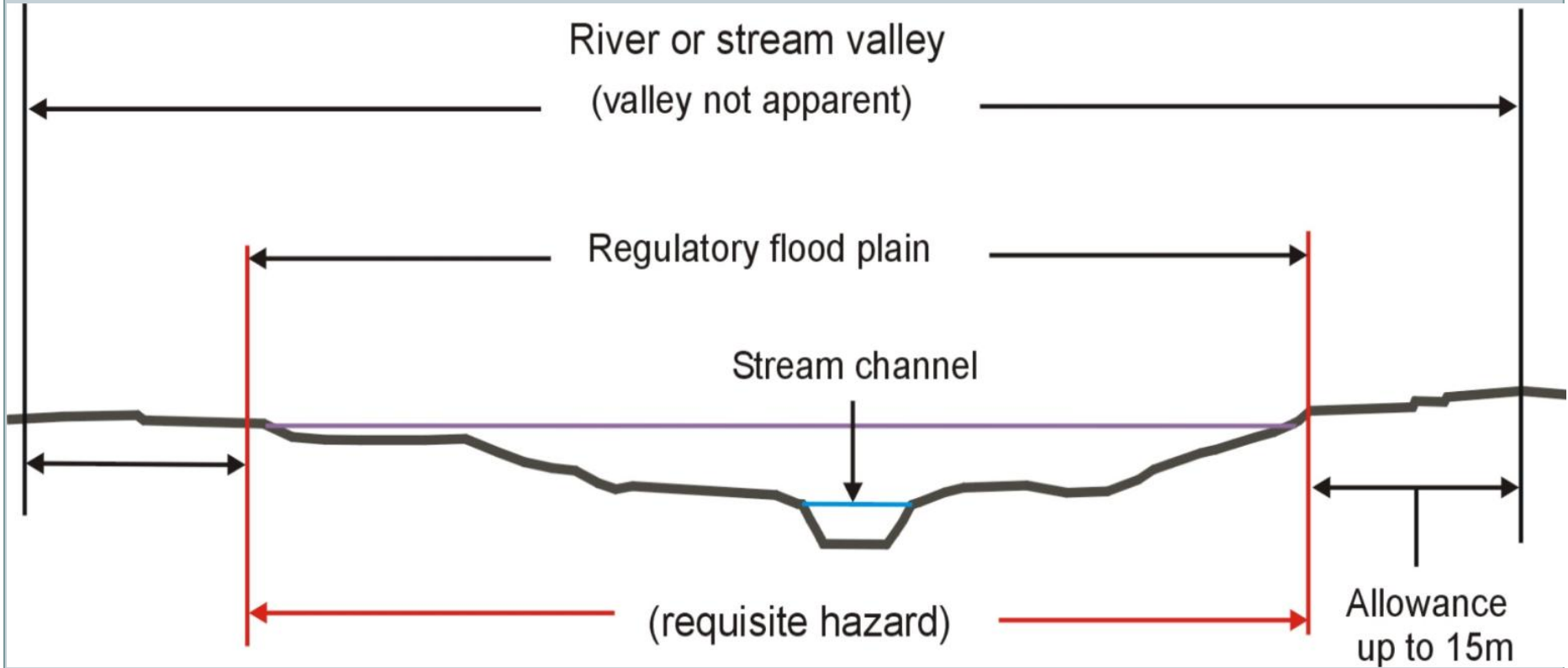
Location of Interest	Lower Spencer Creek Approximate Peak Flows (cms)						
	Hurricane Hazel	100 Year	50 Year	20 Year	10 Year	5 Year	2 Year
Downstream of Coldwater Creek Confluence	750	90	85	75	70	60	40
Upstream of Coldwater Creek Confluence	525	75	70	60	55	45	35
Downstream of Spring Creek Confluence	500	75	70	60	55	45	30
Upstream of Spring Creek Confluence & Downstream of No Name Creek Confluence	375	60	55	50	45	40	30
Upstream of No Name Creek Confluence & Downstream of Logie's Creek Confluence	350	55	50	45	40	35	25
Upstream of Logies Creek Confluence	300	50	45	40	35	30	25
Downstream of Christie Reservoir	300	45	45	40	35	30	25

FPM 101

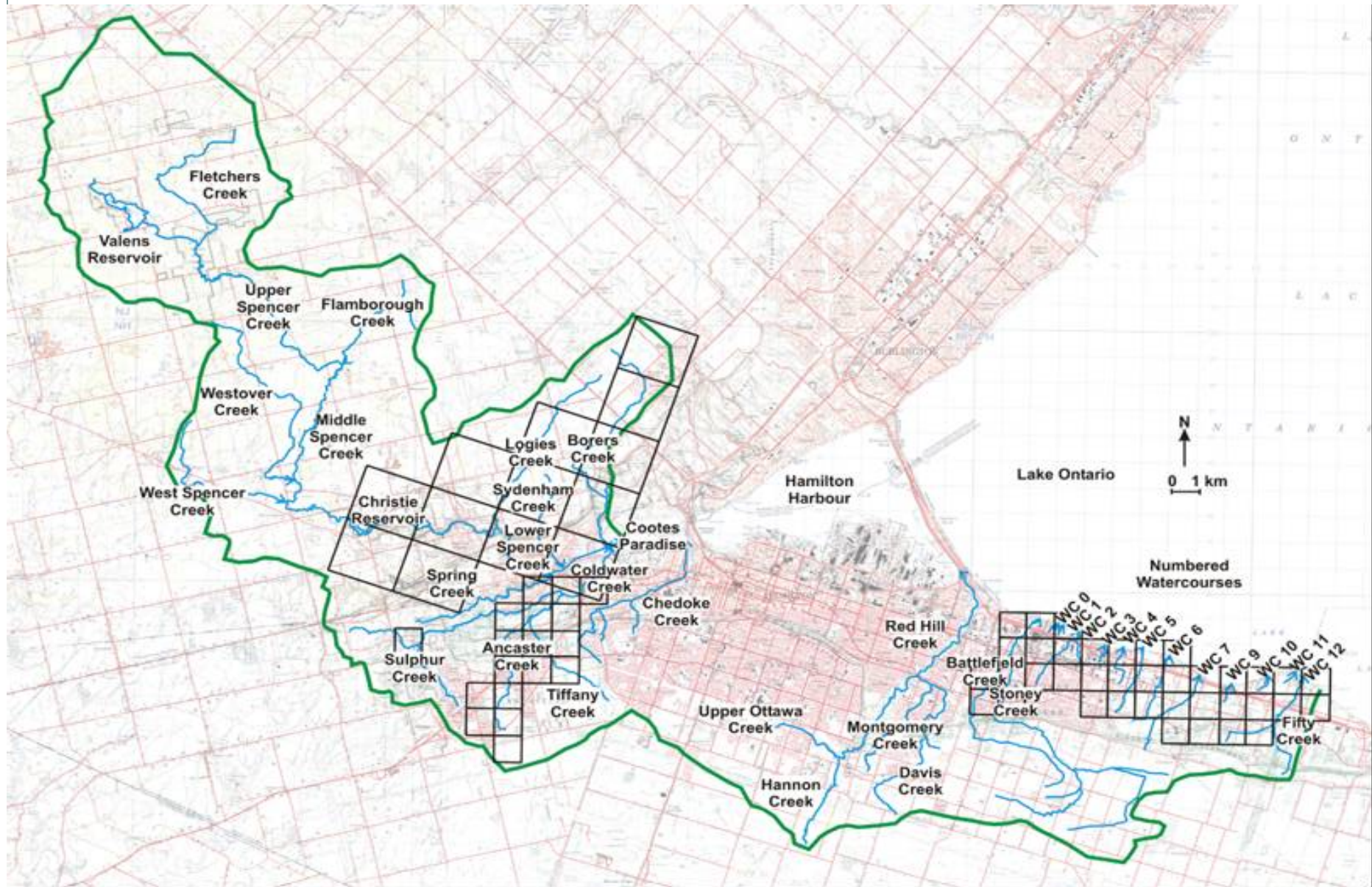


- Regardless of storm event used, FPM is based on (continued):
 - Future land use projections (Official Plan)
 - Does NOT account for flow-reduction due to flood control / SWM / storage in the storm sewer system
 - Does NOT account for flooding effects of debris / ice jams during a storm

FPM 101



CURRENT HCA FLOOD PLAIN MAPPING



CURRENT HCA FLOOD PLAIN MAPPING



- In 2010, a review was completed of the current extent and state of FPM in the HCA watershed:
 - Hydrology
 - Hydraulics
 - Mapping

Reviewed the:

- Coverage
- Reproducibility and Defend Ability
- Up-to-date-ness
- Standards adhered to

CURRENT HCA FLOOD PLAIN MAPPING –

“Right Here, Right Now, There is No Other Place I Want to Be. Right Here, Right Now, Watching the World Wake Up From History”



- Official FPM:
 - Meets FDRP / HCA guidelines
- Best Available / Estimated Flood Levels:
 - Does NOT satisfy ALL aspects of FDRP / HCA FPM guidelines
 - Based on review, confidence / accuracy is expected to be similar to Official FPM
- No FPM Available:
 - No available FPM or Flood Levels OR
 - Available data expected to have low confidence / accuracy

CURRENT HCA FLOOD PLAIN MAPPING



- Official FPM is currently available for:
 - Lower Spencer Creek
 - Upper & Middle Ancaster Creek
 - Upper Borers Creek
 - Lower Tiffany Creek
 - Lower Stoney Creek
 - Lower Battlefield Creek
 - Stoney Creek Numbered Watercourses & Fifty Crk

CURRENT HCA FLOOD PLAIN MAPPING-

“You're the Best! Around! Nothing's Gonna Ever Keep You Down”



- Best Available / Estimated Flood Levels is currently available for:
 - Upper & Middle Spencer Creek
 - Fletcher's Creek
 - Flamborough Creek
 - Westover Creek
 - West Spencer Creek
 - Logie's Creek

CURRENT HCA FLOOD PLAIN MAPPING



- Best Available / Estimated Flood Levels is currently available for (Continued):
 - Spring Creek
 - Sulphur Creek
 - Upper & Middle Tiffany Creek
 - Hannon Creek
 - Lower Davis Creek
 - Upper Battlefield Creek & Upper Stoney Creek

CURRENT HCA FLOOD PLAIN MAPPING –

“Nothing Really Matters, Anyone Can See. Nothing Really Matters,
Nothing Really Matters to Me”



- No FPM currently available for:
 - Sydenham Creek
 - Lower Ancaster Creek
 - Lower Borers Creek
 - Chedoke Creek
 - Redhill Creek
 - Upper Davis Creek
 - Montgomery Creek

RATIONALE FOR FPM UPDATES



- Extend coverage to additional reaches of watercourses OR Watercourses without FPM
- Update topographic mapping, hydraulic analysis, and hydrologic analysis (including use of more recent land use and climate data) to represent current and future conditions
 - Current HCA FPM – 1976 – 1990 (majority); 2011 for Stoney Creek & Battlefield Creek
- Enhance reproducibility and defensibility of FPM
 - Sometimes FPM study reports are not sufficient to reproduce the hydrologic and the hydraulic analysis

RATIONALE FOR FPM UPDATES



- Update FPM to adhere to a consistent Standard
 - Lower Spencer Creek and tribs. – 1985 FDRP / 1976 Industry Standards
 - Ancaster Creek – 1985 FDRP
 - Borers Creek - 1976 Industry Standards
 - Stoney Creek – 1985 FDRP
 - Battlefield Creek – 1985 FDRP
 - Stoney Creek Num. Watercourses – 1985 FDRP

In 2010, HCA FPM Standards developed, based on the 1985 FDRP Terms of Reference

PRIORITIZATION OF FPM UPDATES –

“Yo, I’ll Tell You What I Want, What I Really, Really Want.
So Tell Me What You Want, What You Really, Really Want”



- The priority of FPM Updates is based on:
 - 2010 FPM Review recommendations
 - HCA Planning and Regulation staff recommendations
 - Recent and future development and growth
 - Consultation with partners

CURRENT HCA FPM GUIDELINES



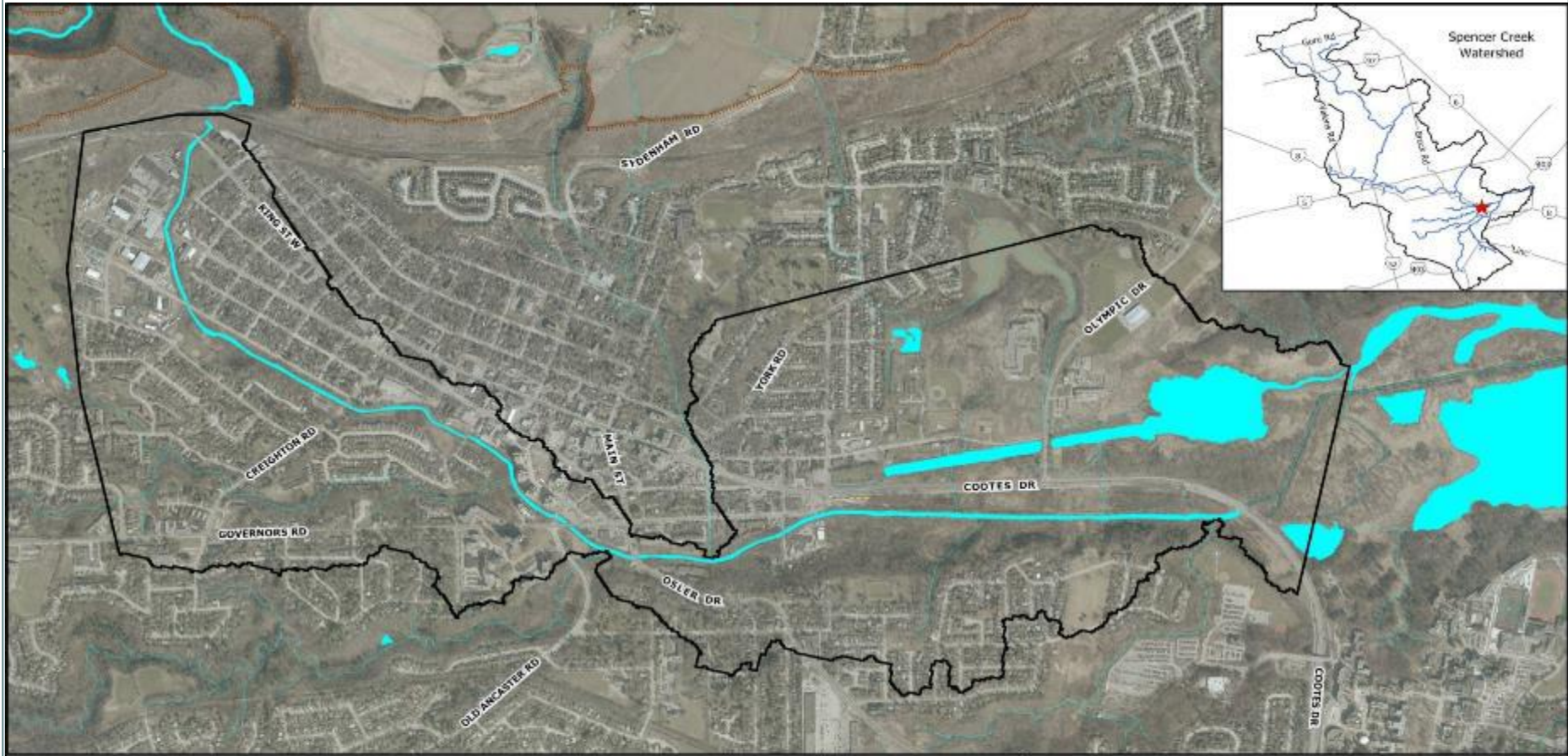
- Detailed standards are stipulated regarding:
 - Background Information Report
 - Mapping Check / Survey Work
 - Hydrology (approach, QA/QC, documentation, preferred parameter values, calibration / verification, etc.)
 - Hydraulics (approach, QA/QC, documentation, preferred parameter values, calibration / verification, etc.)
 - Flood Plain Maps

RECENT UPDATES TO FPM AT HCA



- Lower Spencer Creek
- Stoney Creek Numbered Watercourses
- Battlefield Creek & Stoney Creek

FLOOD PLAIN MAPPING UPDATES FOR LOWER SPENCER CREEK



 Project Focus Area
  Watercourse
  Water Body
  Niagara Escarpment

0 1 km




SPENCER CREEK PROJECT FOCUS AREA

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LOWER SPENCER CREEK PREVIOUSLY ADOPTED FPM



- Based on a combination of various previous Hydrologic, Hydraulic and Flood Plain Mapping studies, each for a relatively small section or reach
- Studies completed between 1977 – 2009

LOWER SPENCER CREEK RATIONALE FOR FPM UPDATES



- A consistent approach to hydrology, hydraulics and flood plain mapping for all reaches
- A consistent parameterization
- Updated topographic mapping, hydraulic analysis, and hydrologic analysis (including account for current land use and recent climate data)

LOWER SPENCER CREEK RATIONALE FOR FPM UPDATES



- Enhanced reproducibility and defensibility of FPM
 - Some of the available FPM study reports were not sufficient to reproduce the hydrologic and the hydraulic analyses
- Utilize advances in modeling technology

LSC - DETAILS OF FPM UPDATES – “Rain Drops Keep Falling on My Head”



Hydrology

- MIKE 11 NAM continuous modeling (1950-2005)
- Calibration (peak flows, peak timing, hydrograph shape) to 5 separate storm events based on available WSC gauge data
- Verification (peak flows, peak timing, hydrograph shape) to longer periods based on available WSC gauge data

LOWER SPENCER CREEK DETAILS OF FPM UPDATES



Hydrology

- Validation (peak flows) to previous adopted hydrology studies
- FFA at key points of interest to obtain return period peak flow rates (2 to 100 yr)
- Snowmelt, regional storm and thunderstorms
- Hydrology did not account for Climate Change

LOWER SPENCER CREEK DETAILS OF FPM UPDATES

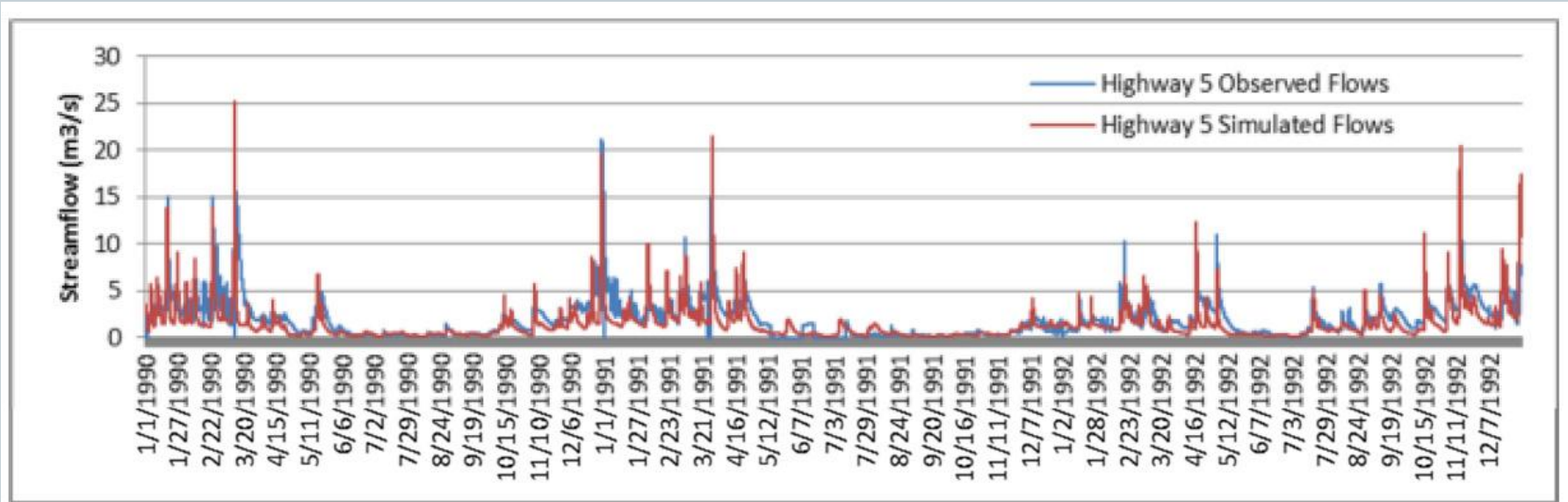


Figure 14 Highway 5 Verification Plot, 1990

LSC -DETAILS OF FPM UPDATES –

“Even Flow, Thoughts Arrive Like Butterflies”



Hydraulics

- HEC-RAS steady state modeling
- Peak flow rates provided from hydrology modeling
- Cross-sections determined from newly-obtained DEM that meets FDRP / HCA FPM horizontal & vertical accuracy standards
- Watercourse structure inventory developed and accounted for in HEC-RAS model

LSC-FINDINGS / CHALLENGES /SUCSESSES–

“Risin’ Up to the Challenge of Our Rival”

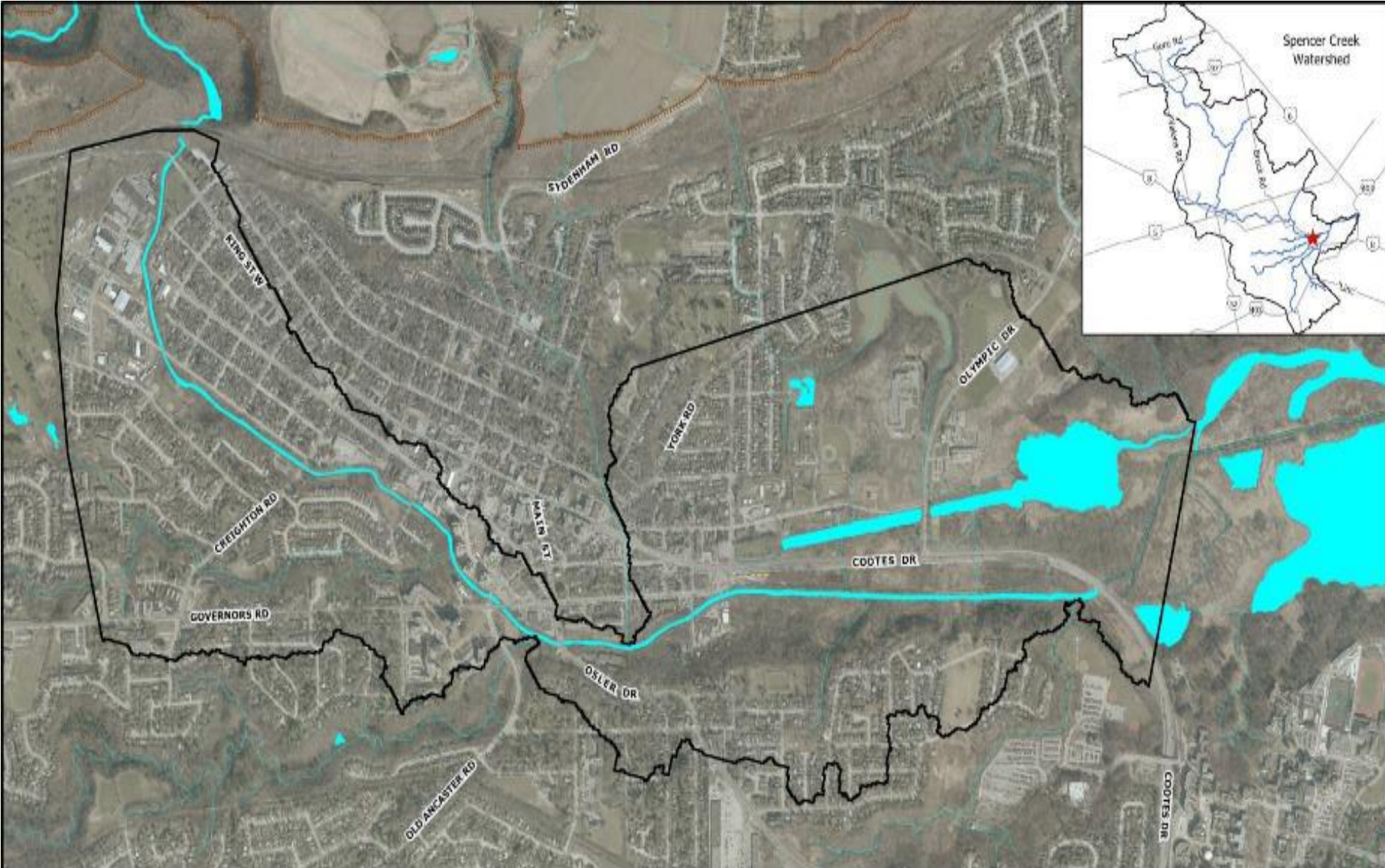


- Study Area for FPM versus much larger Hydrology Catchment Area
- For majority of locations, Lower Spencer Creek expected to contain the 100 year peak flows
- Updated Regulatory FPM compared to previously adopted FPM (small reach for each previously adopted study, high slope - comparison issues) – But no significant, large scale, unjustifiable differences found

LOWER SPENCER CREEK FINDINGS / CHALLENGES / SUCCESSES



- TWO flooding mechanisms accounted for:
 - Watercourse flooding (using above modeling)
 - Backwater flooding from Cootes Paradise
 - ✦ Attempted to account for Cootes Paradise in hydrology using cross-section storage
 - ✦ Decided to use previous Cootes Paradise Hydraulic Assessment to define backwater flooding levels
 - ✦ Backwater flooding from Cootes Paradise produced higher flood levels for lower reaches



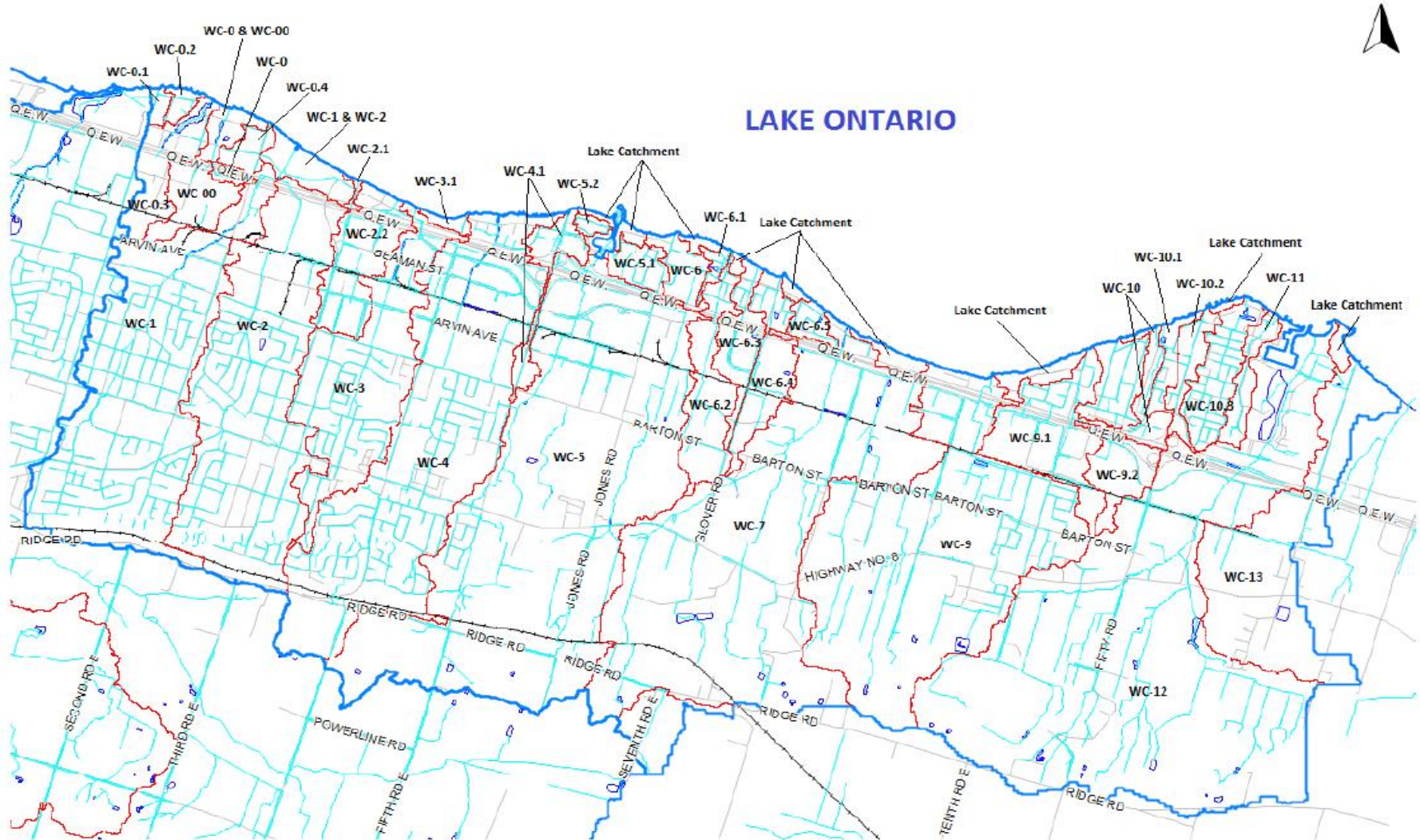
 Project Focus Area
  Watercourse
  Water Body
  Niagara Escarpment



SPENCER CREEK PROJECT FOCUS AREA

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FLOOD PLAIN MAPPING UPDATES FOR STONEY CK NUMBERED WATERCOURSES



STONE CREEK NUM. WC'S CURRENTLY ADOPTED FPM



- Official FPM based on 1989 Flood Damage Reduction Study (Hydrologic, Hydraulic and Flood Plain Mapping)
- Best Available modeling based on various more recent Sub-watershed, Block Servicing, and development application studies

STONE CREEK NUM. WC'S RATIONALE FOR FPM UPDATES



- Updated topographic mapping, hydraulic analysis, and hydrologic analysis (including account for current land use and recent climate data)
- Enhanced reproducibility and defensibility of FPM
 - Some of the available FDRP study reports were not sufficient to reproduce the hydrologic and the hydraulic analyses
- Utilize advances in modeling technology

DETAILS OF FPM UPDATES –

“I Want to Know. Have You Ever Seen the Rain. Comin’ Down on a Sunny Day?”



Hydrology

- GAWSER continuous modeling (1960-1992) and design event modeling
- Calibration (peak flows, peak timing, hydrograph shape) to separate storm events based on previous temporary streamflow gauge data

STONE CREEK NUM. WC'S DETAILS OF FPM UPDATES



Hydrology

- Validation (peak flows) to various recent & previous hydrology studies
- FFA at key points of interest to obtain return period peak flow rates (2 to 100 yr)
- Snowmelt, regional storm and thunderstorms
- Hydrology did not account for Climate Change

DETAILS OF FPM UPDATES –

“Islands in the Stream. That is What We Are”



Hydraulics

- HEC-RAS steady state modeling
- Peak flow rates provided from hydrology modeling
- Cross-sections determined from newly-obtained DEM that meets FDRP / HCA FPM horizontal & vertical accuracy standards
- Watercourse structure inventory developed and accounted for in HEC-RAS model

NEXT STEPS



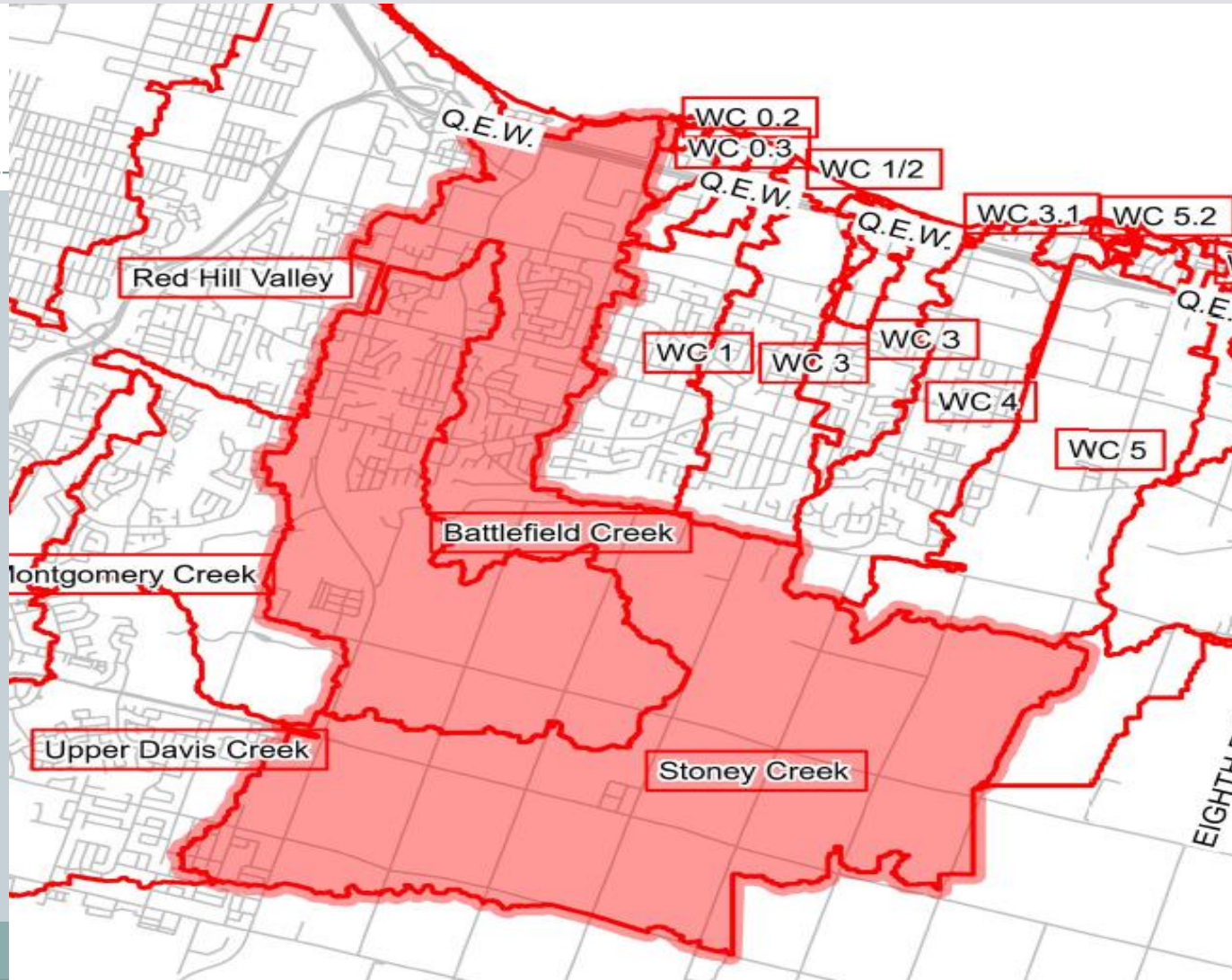
- Hydrology and Hydraulic assessments (ongoing)
- Complete Hydrology & Hydraulic modeling
- FPM
- Vigorous internal review of FPM

STONE CREEK NUM. WC'S ONGOING CHALLENGES



- 100 year is the Regulatory storm
- Small watercourse flow capacity and spills between watercourses
- Flat terrain and natural floodplain flow attenuation

FLOOD PLAIN MAPPING UPDATES FOR BATTLEFIELD CK & STONEY CK



CURRENTLY ADOPTED FPM –

“Cause You’re Hot Then You’re Cold. You’re Yes Then You’re No. You’re In Then You’re Out. You’re Up Then You’re Down”



- Official FPM based on 1976 FPM study (Hydrologic, Hydraulic and Flood Plain Mapping) – Above Escarpment
- Official FPM based on 1989 Flood Damage Reduction Study (Hydrologic, Hydraulic and Flood Plain Mapping) – Below Escarpment
- Best Available modeling based on 2011 Flood Control CEA & 2018 Wetland Storage Conceptual Design study

BATTLEFIELD CREEK & STONEY CREEK RATIONALE FOR FPM UPDATES



- A consistent approach to hydrology, hydraulics and flood plain mapping for all reaches
- A consistent parameterization
- Updated topographic mapping

BATTLEFIELD CREEK & STONEY CREEK RATIONALE FOR FPM UPDATES



- Enhanced reproducibility and defensibility of FPM
 - Some of the available FPM study reports were not sufficient to reproduce the hydrologic and the hydraulic analyses

DETAILS OF FPM UPDATES –



Hydrology

- HEC HMS continuous modeling (1962-1995)
- Calibration (peak flows, peak timing, hydrograph shape) to separate storm events based on temporary streamflow gauge data

BATTLEFIELD CREEK & STONEY CREEK DETAILS OF FPM UPDATES



Hydrology

- Validation (peak flows) to various recent & previous hydrology studies
- FFA at key points of interest to obtain return period peak flow rates (2 to 100 yr)
- Snowmelt, regional storm and thunderstorms
- Hydrology did not account for Climate Change

BATTLEFIELD CREEK & STONEY CREEK DETAILS OF FPM UPDATES



Hydraulics

- HEC-RAS steady state modeling
- Peak flow rates provided from hydrology modeling
- Cross-sections determined from newly-obtained DEM that meets FDRP / HCA FPM horizontal & vertical accuracy standards
- Watercourse structure inventory developed and accounted for in HEC-RAS model

NEXT STEPS –

“Step One! We Can Have Lots of Fun. Step Two! There’s So Much We Can Do”



- Hydrology and Hydraulic assessments (ongoing)
- Complete Hydrology & Hydraulic modeling
- FPM
- Vigorous internal review of FPM

ONGOING CHALLENGES –

“Tell Me. Why’d You Have to Go and Make Things So Complicated?”



- Possible Regulatory storm event spill from Stoney Creek to Battlefield Creek
- Flat terrain and natural floodplain flow attenuation
- Snowmelt representation

THANK YOU –

“ ... for Lettin Me Be Myself, Again”



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Hamilton Conservation Authority*

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