Emerging Stormwater Issues and Challenges: Urban Spills Management

James Li
Department of Civil Engineering
Ryerson University
Toronto, Ontario
March 27, 2012

Acknowledgement

- MOE Spill Action Centre
- City of Toronto
- Toronto and Regions Conservation Authority
- Great Lakes Sustainability Fund
- National Water Research Institute
- Natural Science and Engineering Research Council

Presentation Outline

- What is spills and their impacts?
- Spills management strategy
- Spill database
- Statistical and spatial analyses
- Preventive and control plans
- Conclusions
- Recent research

Introduction

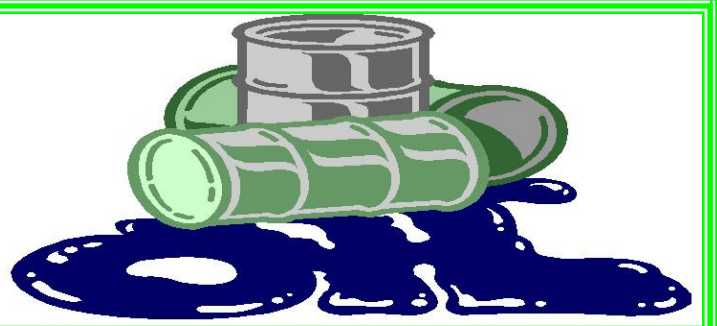
What is a spill incident ? ? ?

" . . . a discharge into the natural environment, from or out of a structure, vehicle or other container, and that is abnormal in quantity in light of all the circumstances of the discharge"

S.A.C. 1992

Wet spills – during rain

Dry spills – no rain



Toronto Star: March 18, 2003

A Mississauga company will pay **$35,000** in fines for an oil spill that contaminated water quality in a nearby creek and was not reported to authorities, an Ontario Court Judge ruled Friday. XXX Ltd. was fined $15,000 for discharging materials that impaired water quality in Little Etobicoke Creek, as well as $5,000 for failing to inform the MOE of the spill. An additional $15,000 will be paid to the Toronto Wildlife Centre because of charges laid by Environment Canada under the Migratory Birds Act.

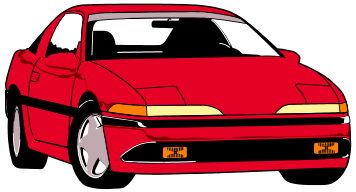
Gasoline Spill Incident

Underground Storage Tank

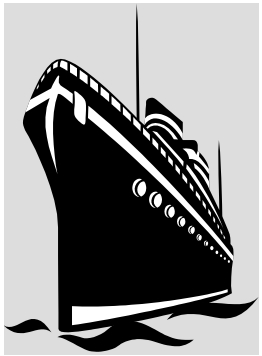
Residential Heating Oil Spill

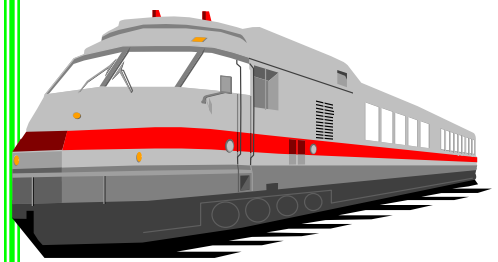
Other Sources of Possible Spill Events

- Aviation
- Petroleum Refinery
- Marine Vessels
- Motor Vehicles



- Service Station
- Transport Truck
- Train / Rail
- Residential areas

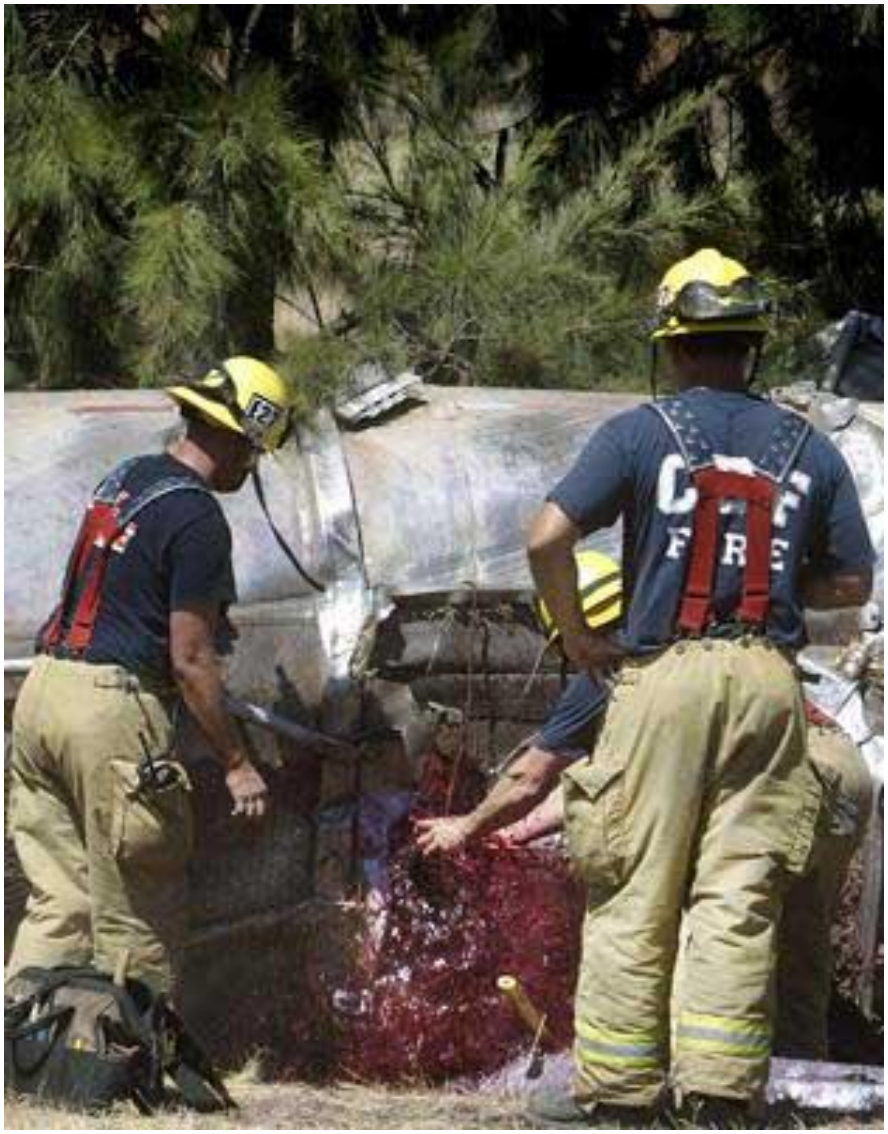




Other interesting spills

California Tar Spill

California Red Wine Spill



Other interesting spills

Beer Spill

MD Flour Spill

Other interesting spills

Las Vegas Pig Spill

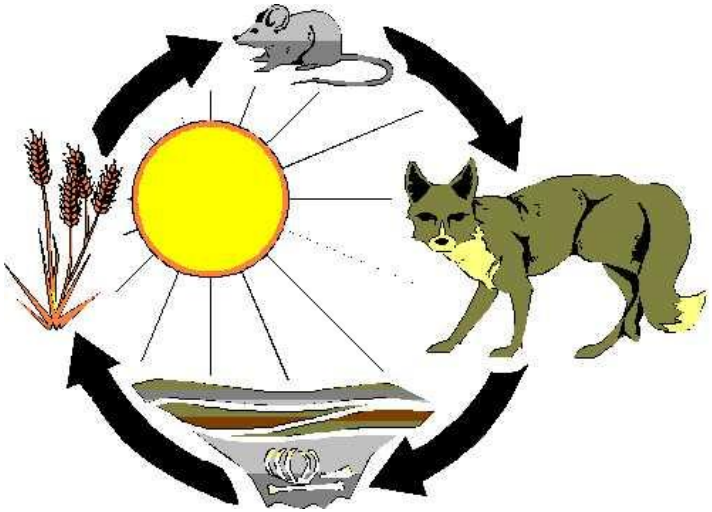
Las Vegas Pig Spill

Environmental Impacts

Deaths of Wildlife

Mutation of aquatic species

Part of food chain/web



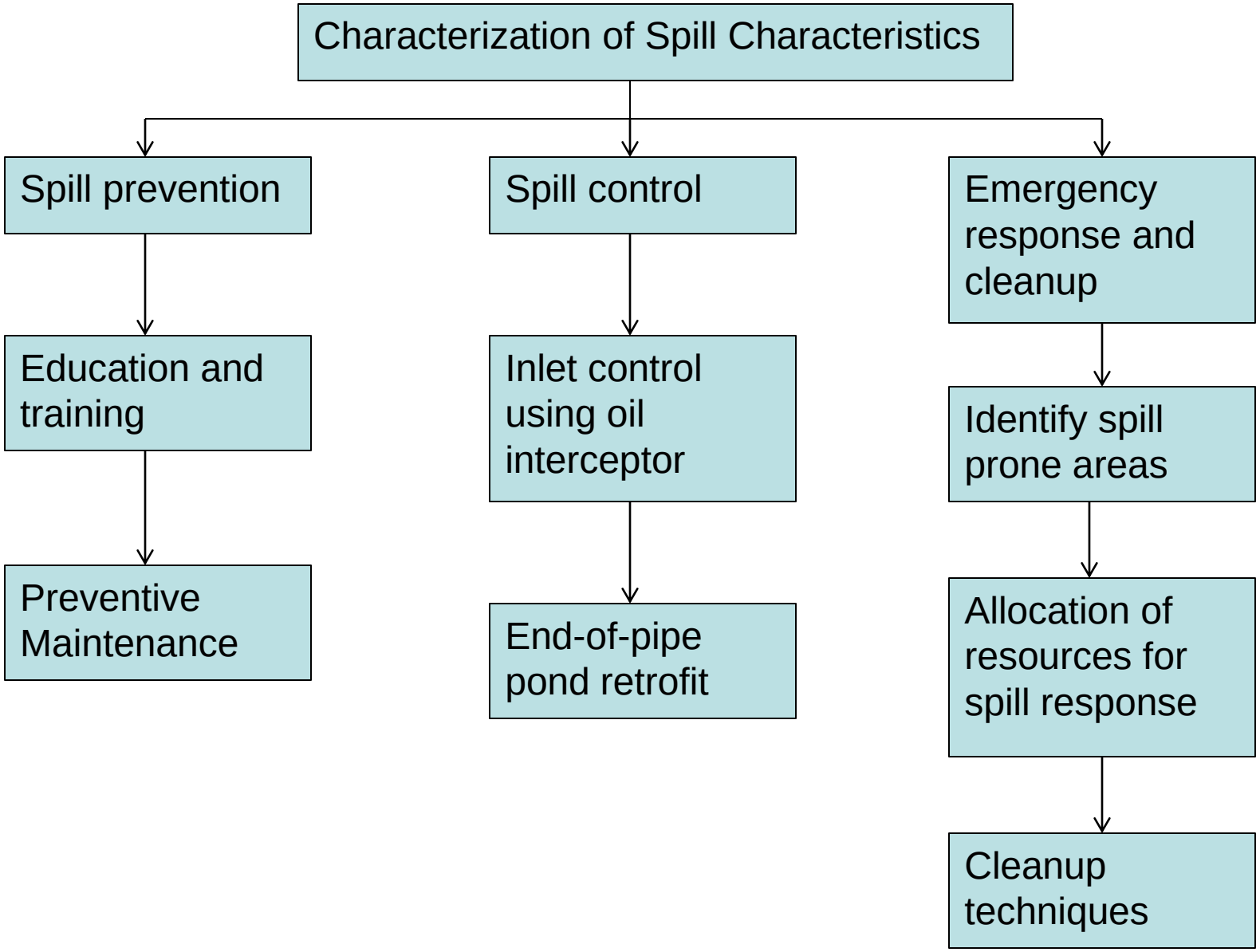
Spill Management Approach

- Compilation of spill database and other related data
- Spatial analysis of spills
- Statistical analysis of spills
- Identification of spill prone sewersheds and spill characteristics
- Development of comprehensive spill management plans.

City	Sewer Use By-law	Spill Management Plan	Spill Response Team
Victoria	×	√	×
Edmonton	√	√	√
Whitehorse	√	×	×
Yellowknife	√	×	×
Regina	√	×	×
Winnipeg	×	×	×
Ottawa	√	×	×
Toronto	√	√	√
Charlottetown	√	×	×
Fredericton	√	×	×
Halifax	√	×	√
St. John's	×	×	×
Quebec	×	×	×
Montreal	√	×	×
Iqaluit	√	×	×

Municipal Oil Spill Management Survey Results (Han 2006)

Comprehensive Spill Management Framework



Spill Records

- Ministry of the Environment's Spill Action Centre.
- Records started in 1988
- 14,000 oil spills (1988-2000)
- 9,000 chemical spills (1988-2000)
- 2,700 hydro spills (1993-1999)
- CN spills

Spill Database

- Microsoft ACCESS database with geocoded data.
- Link to Geographic Information System for spatial analysis
- Enable data update and statistical analysis

Statistical Analysis of Spill Characteristics

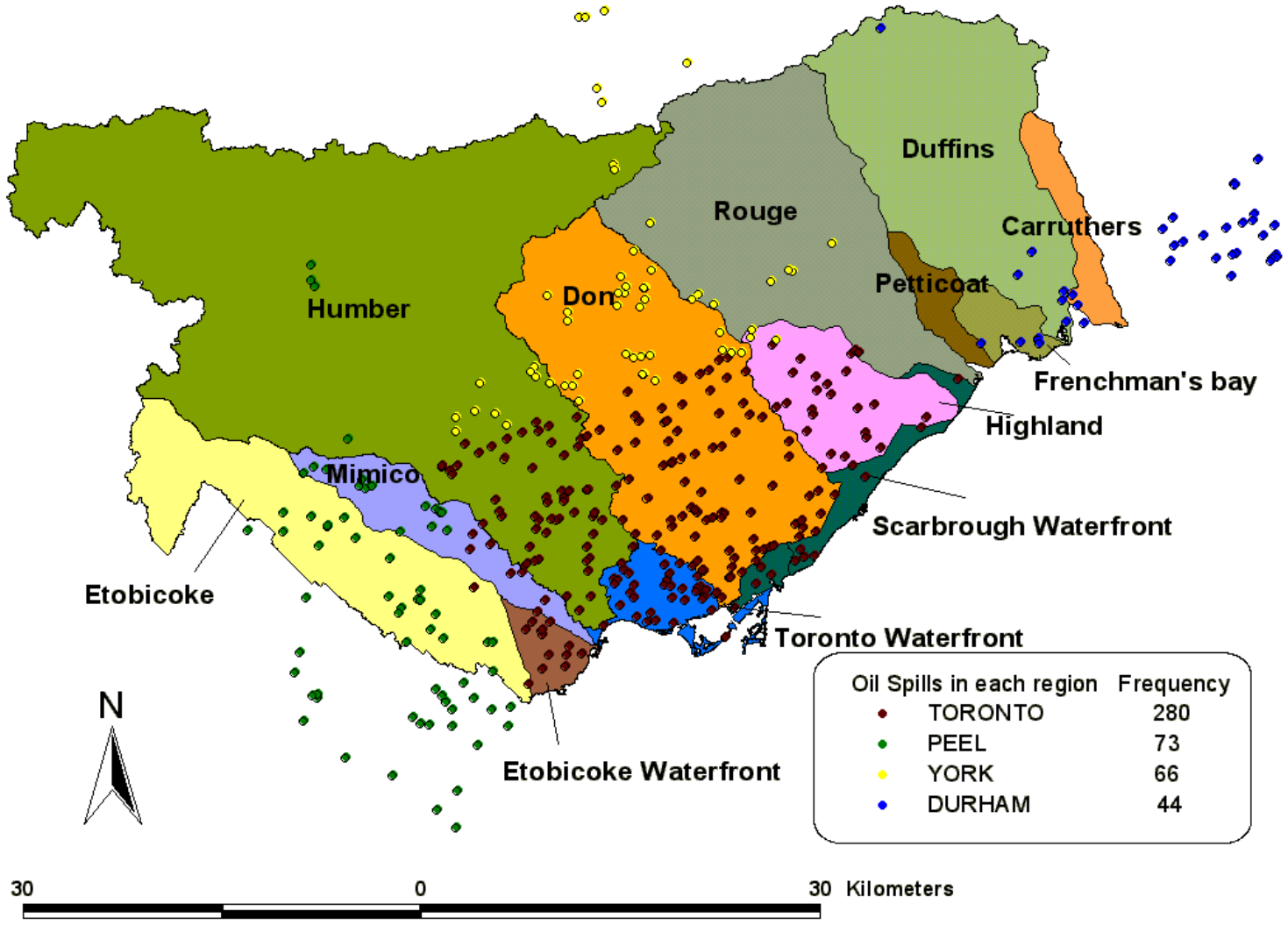
Percentile oil spill event volume in the City of Toronto

Location	**Event Volume (L)**				
	95%	90%	85%	80%	75%
Gas Station	300	105	100	50	45
Parking	800	450	250	200	160
Road	450	350	225	180	110
Storage Depot	2200	1000	600	450	300

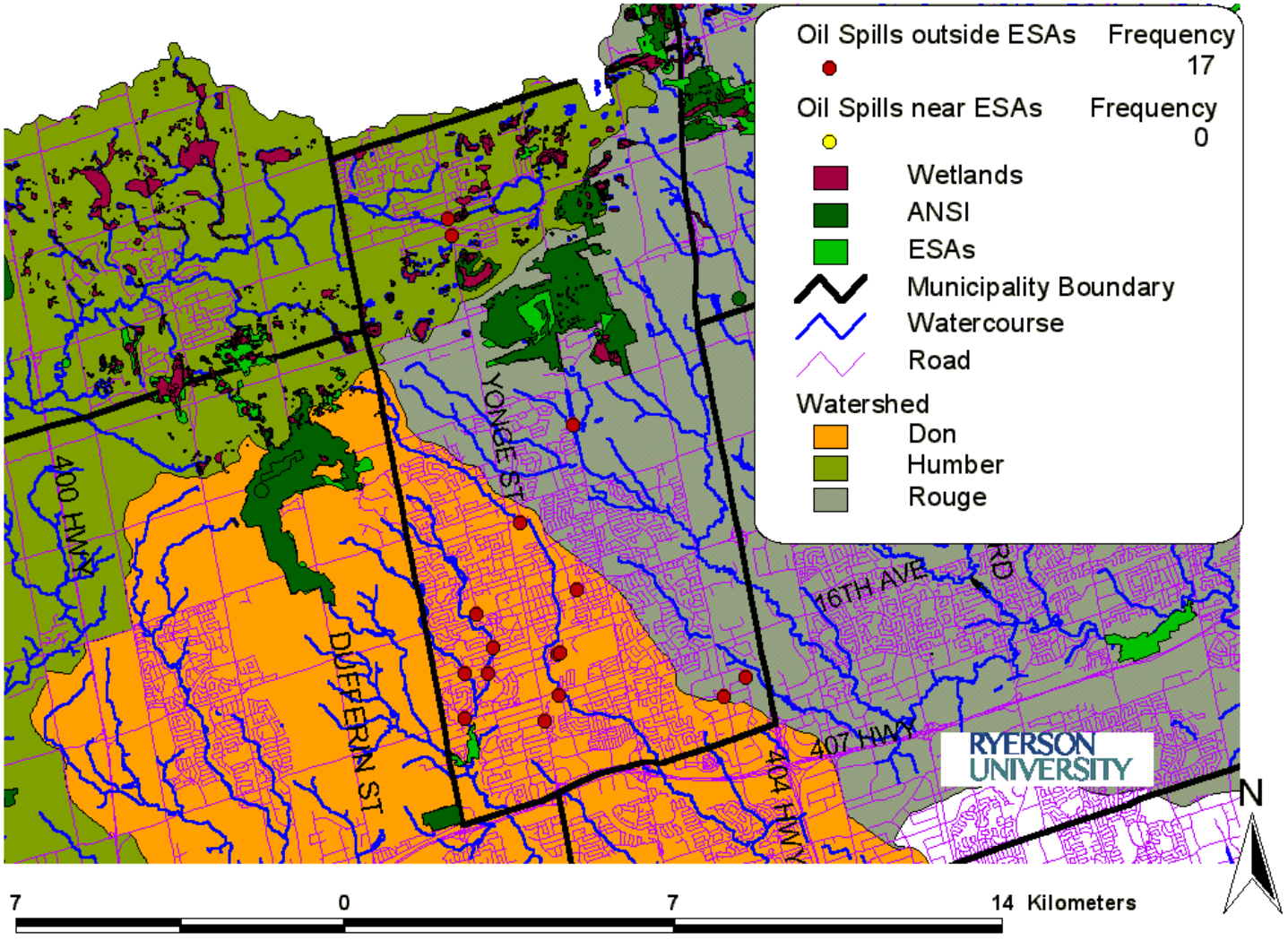
Oil Spill Control Devices

- Oil grease separator (for sanitary)
- Oil water separator (for storm)
- Oil grit separator (for storm)

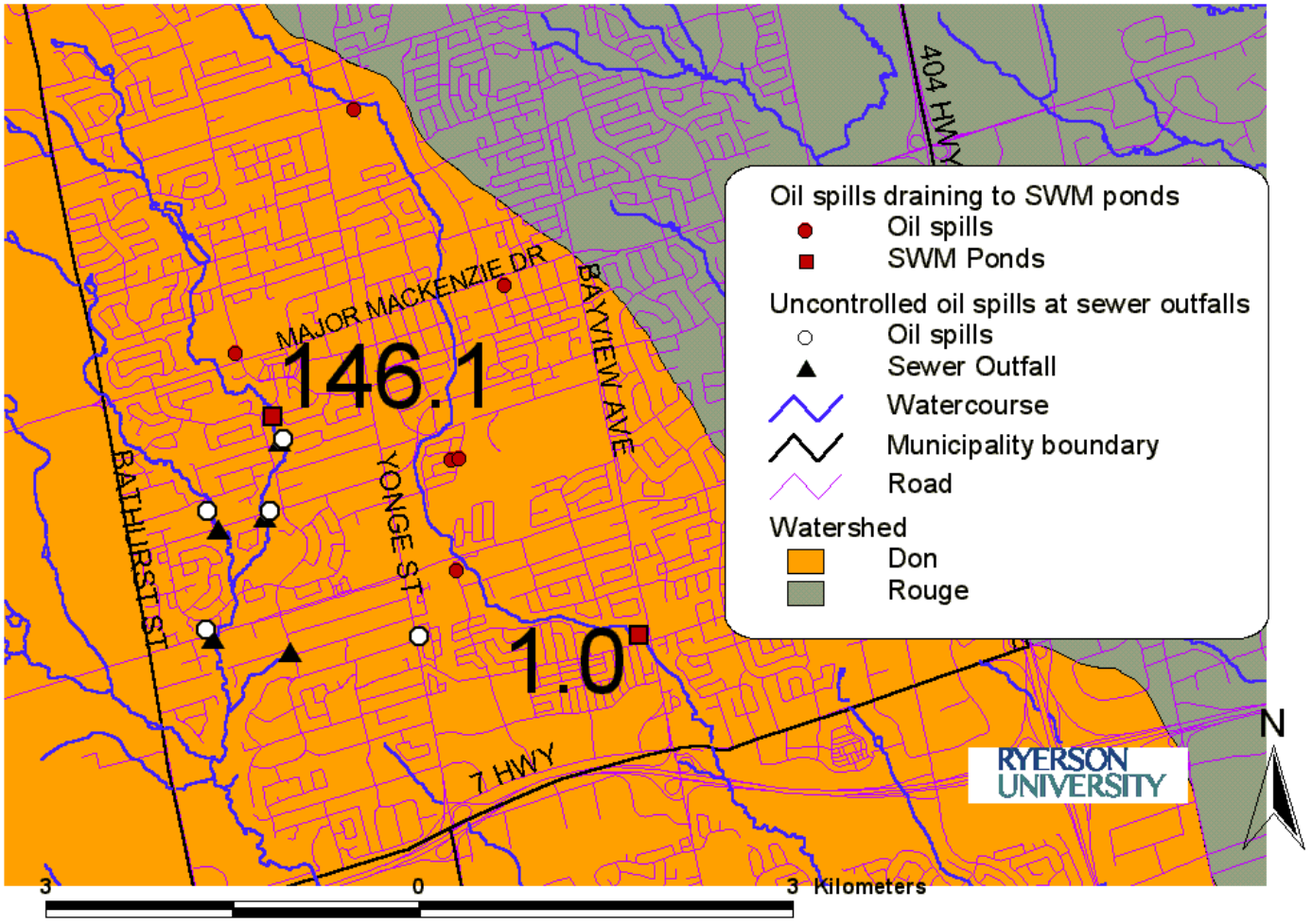
Spatial Analysis of Spill Characteristics



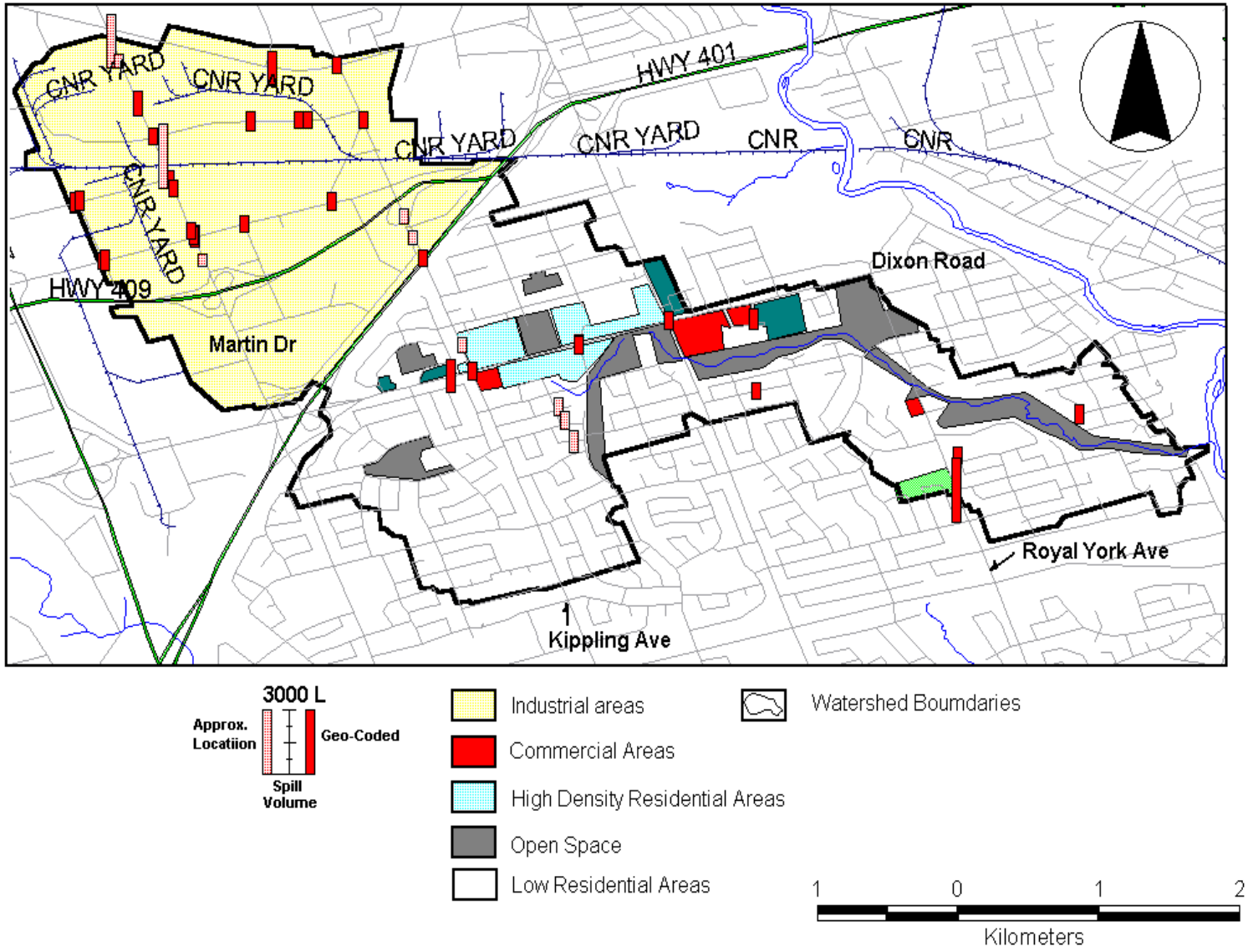
Spatial Analysis of Spill Characteristics



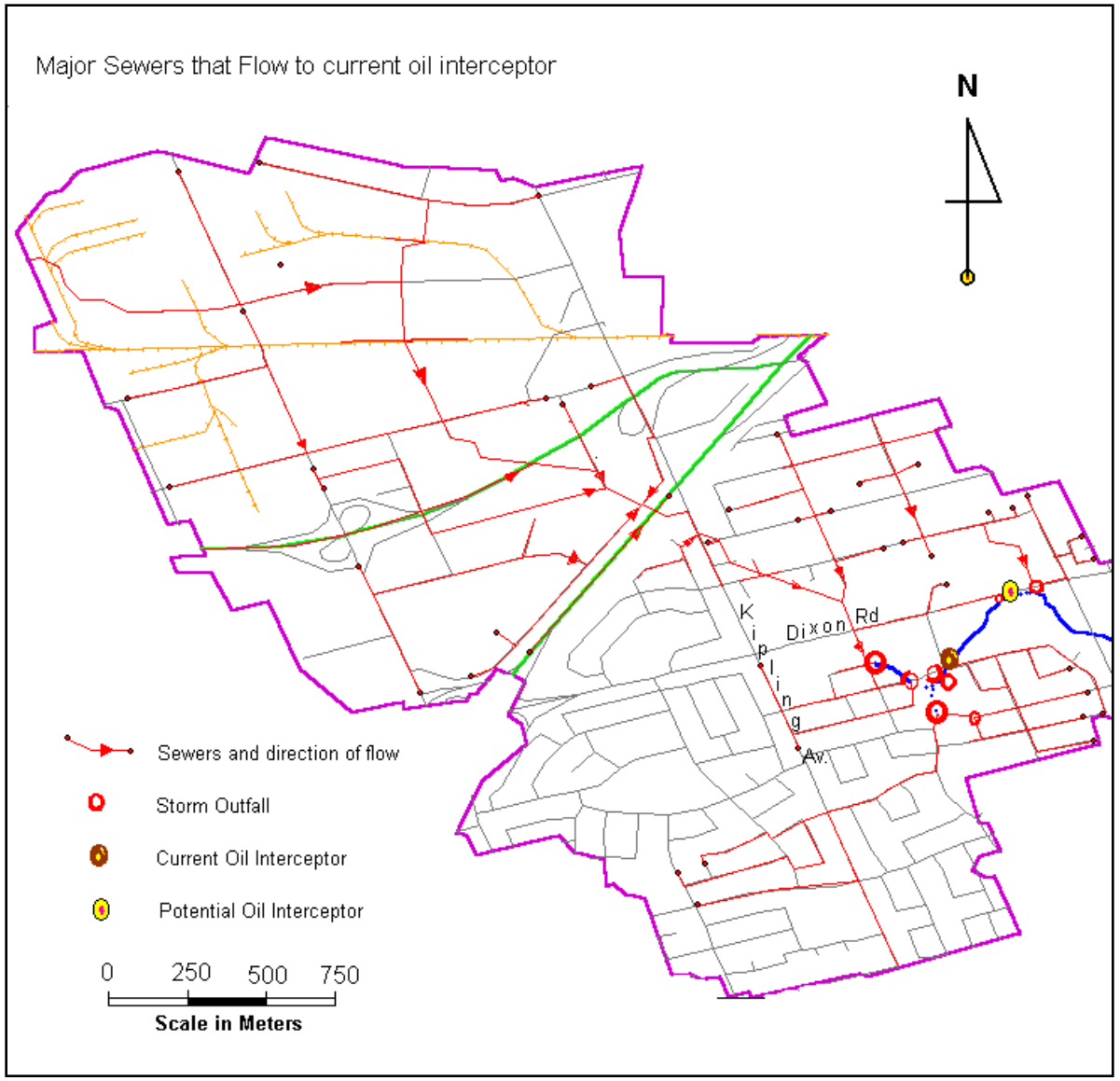
Stormwater Pond Retrofit for Oil Containment



Spatial Analysis of Spill Characteristics



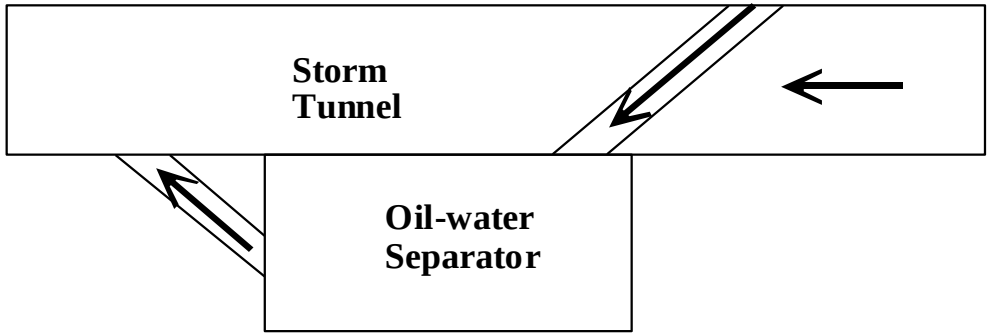
Proposed Spill Control Location



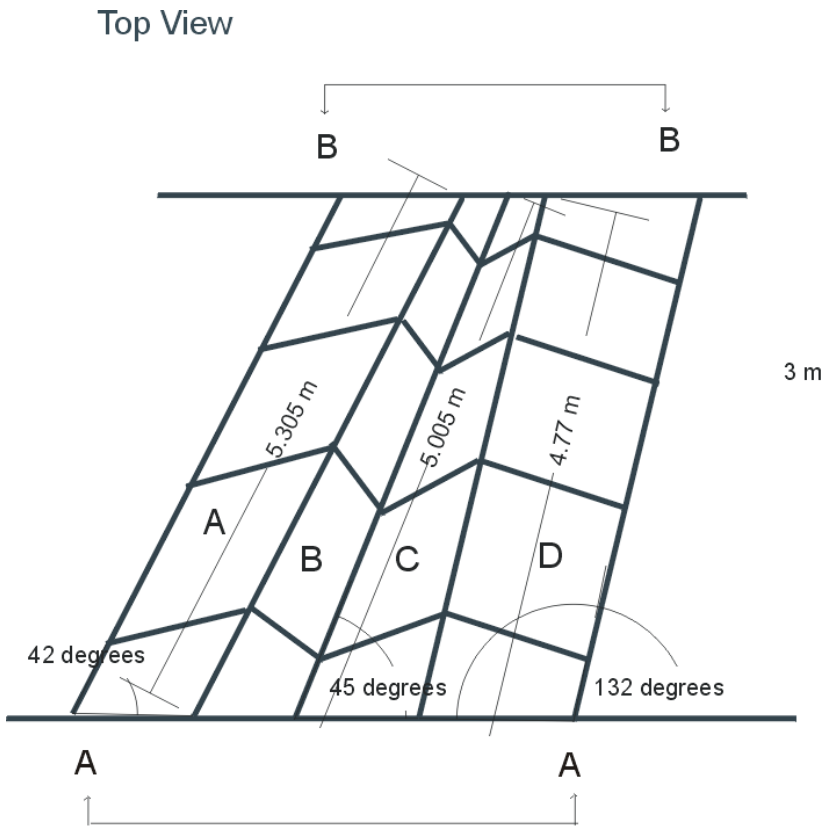
Humber Creek Outfall

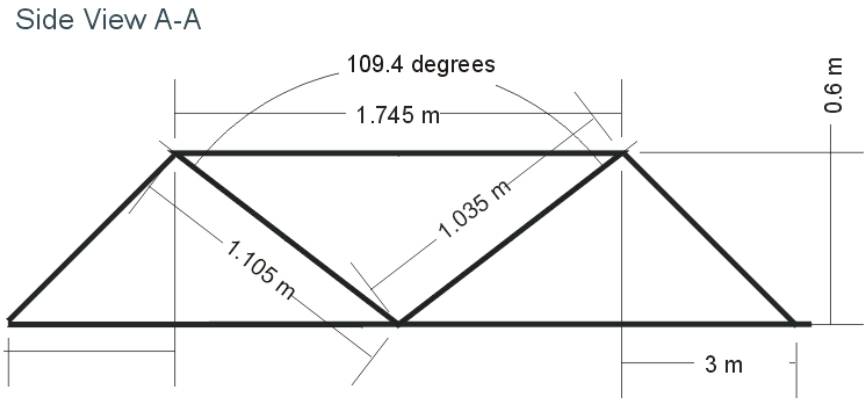
Design Criteria for Spill Control

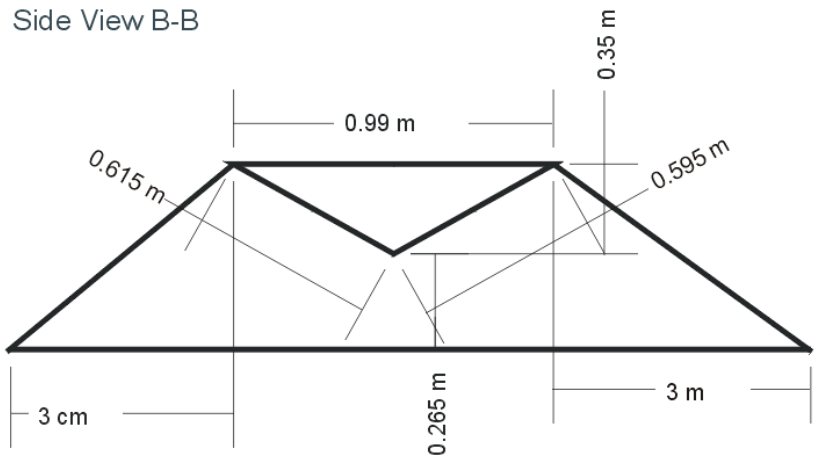
- Design baseflow = 120 L/s
- Target gasoline
- Design temperature = 10 C
- Floatables and sediments should be captured inside the device



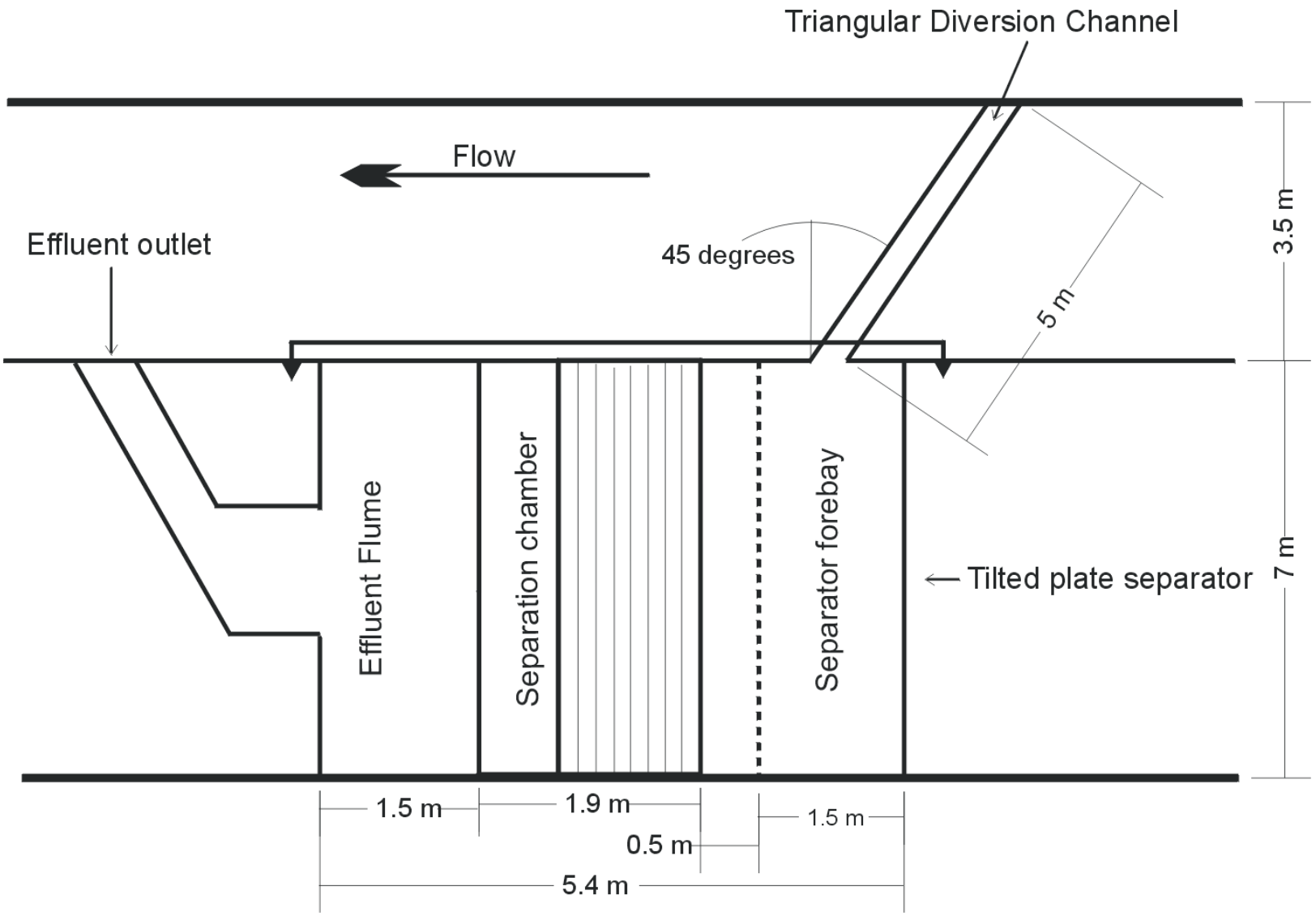
Triangular Lateral Spillway Channel



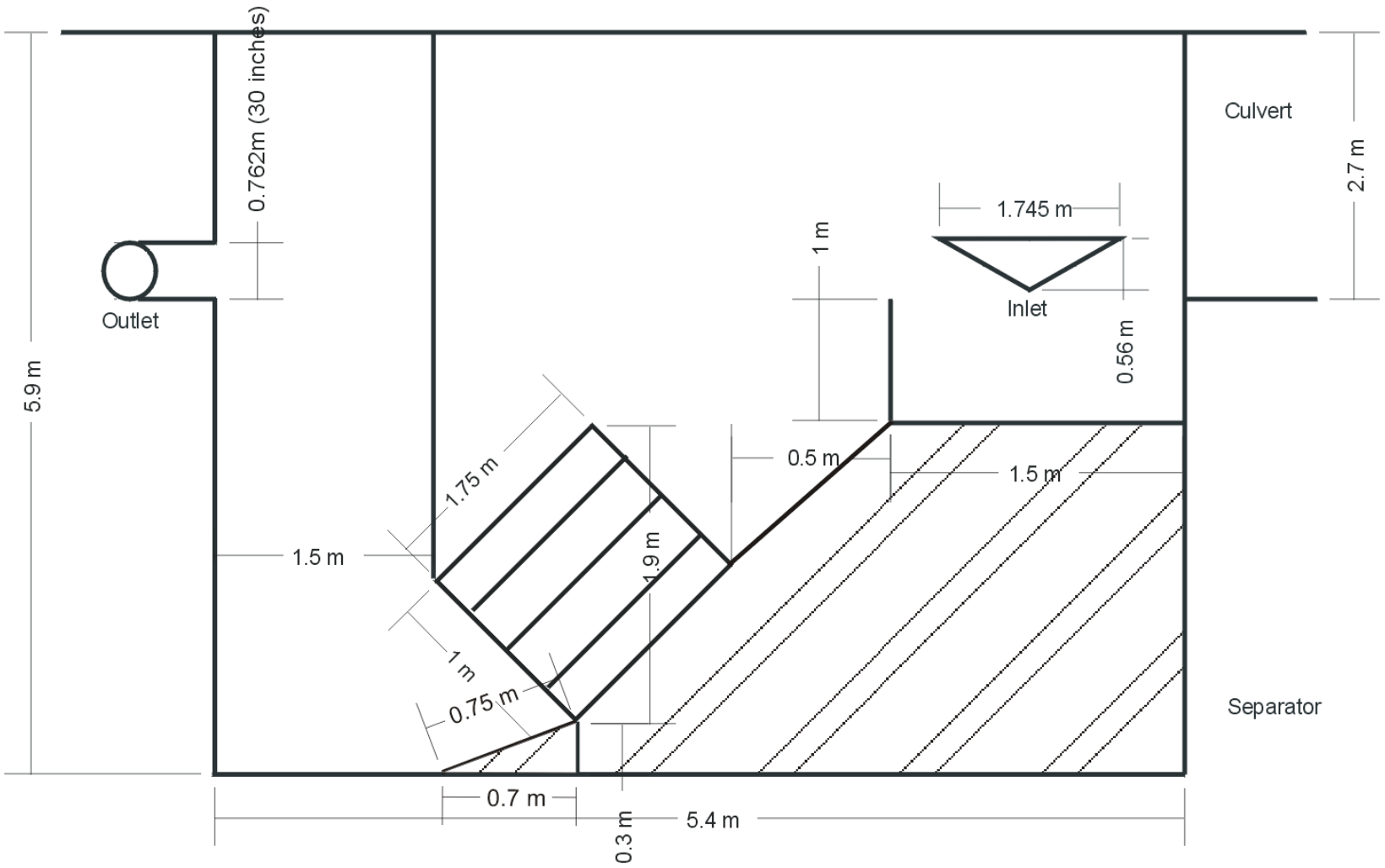




Modified Tilted-Plate Separator



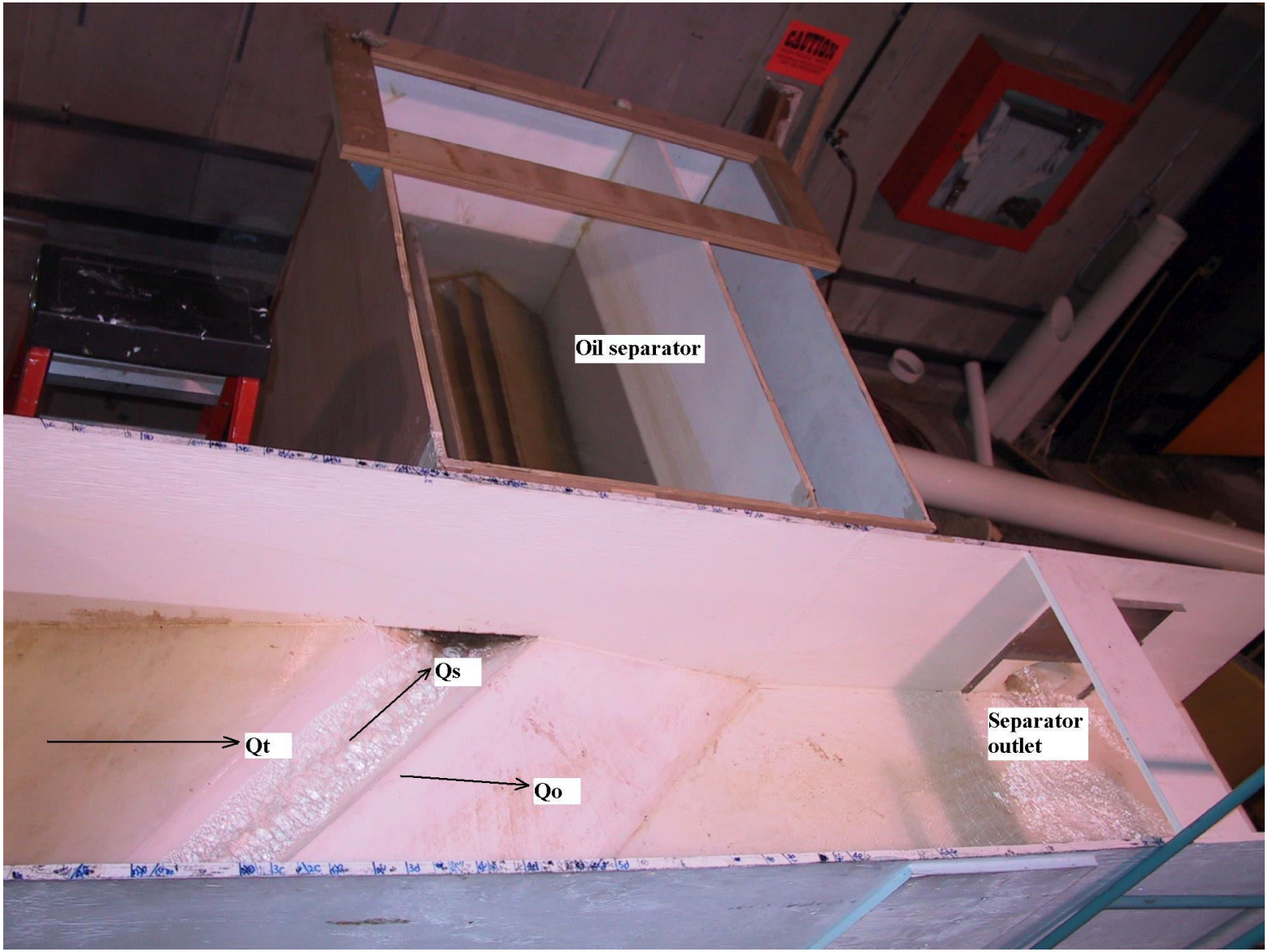
Modified Tilted-Plate Separator



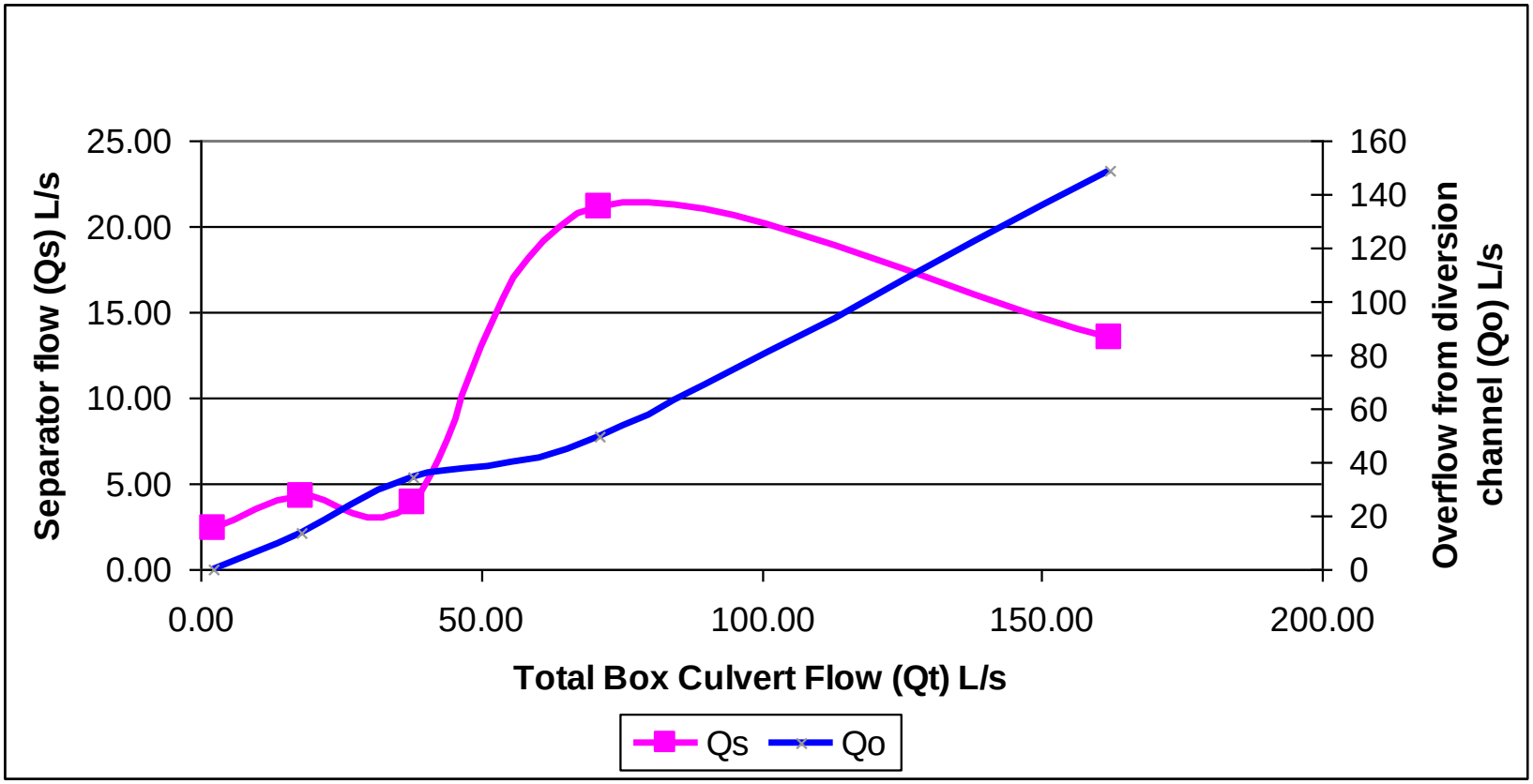
Physical Model Study

- What is the maximum flow through the separator?
- What is the effect of backwater effect on the hydraulics of the separator?
- Can light and heavy objects be trapped inside the separator under all flow conditions?

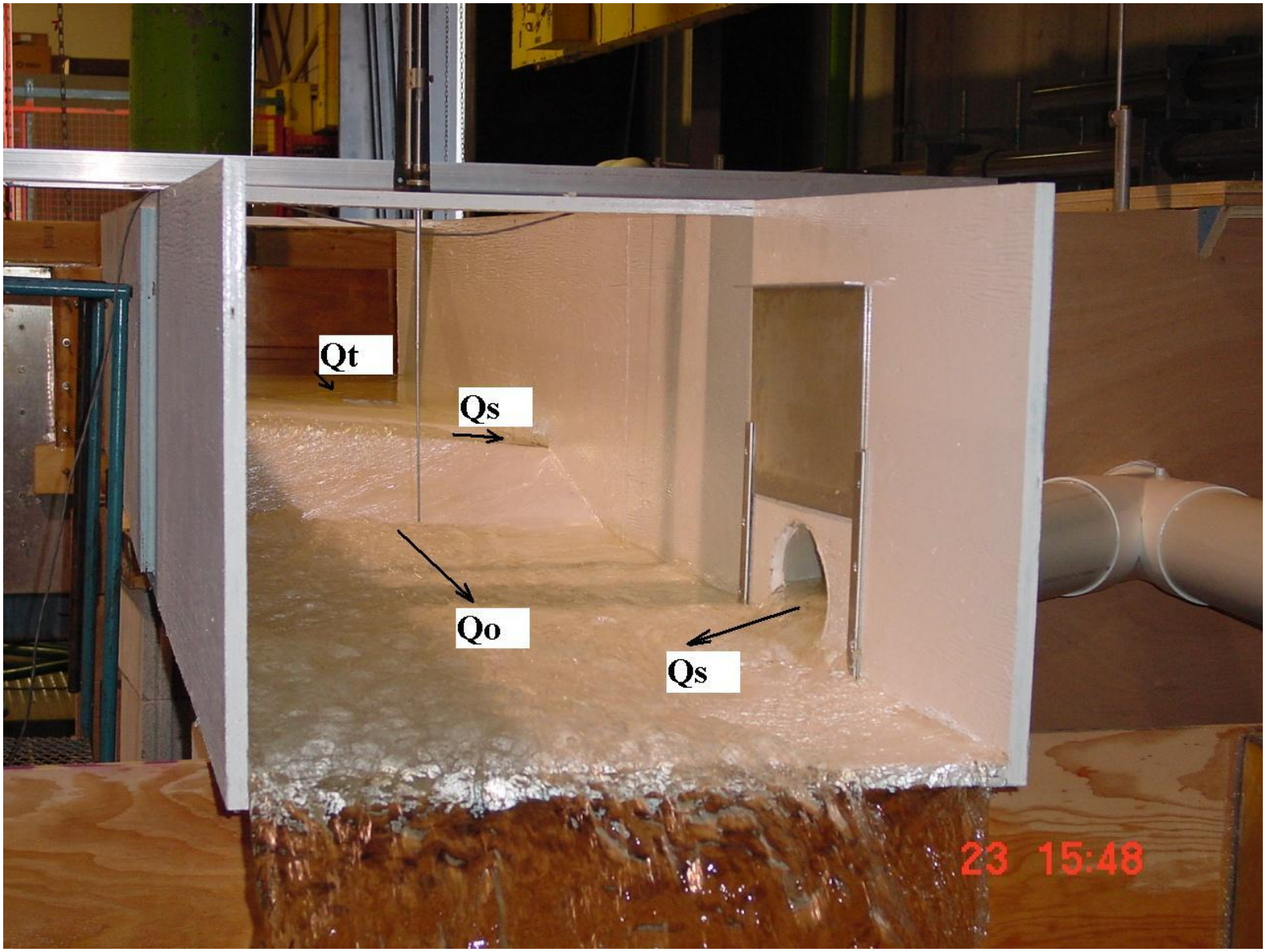
An Outfall Oil/Water Separator



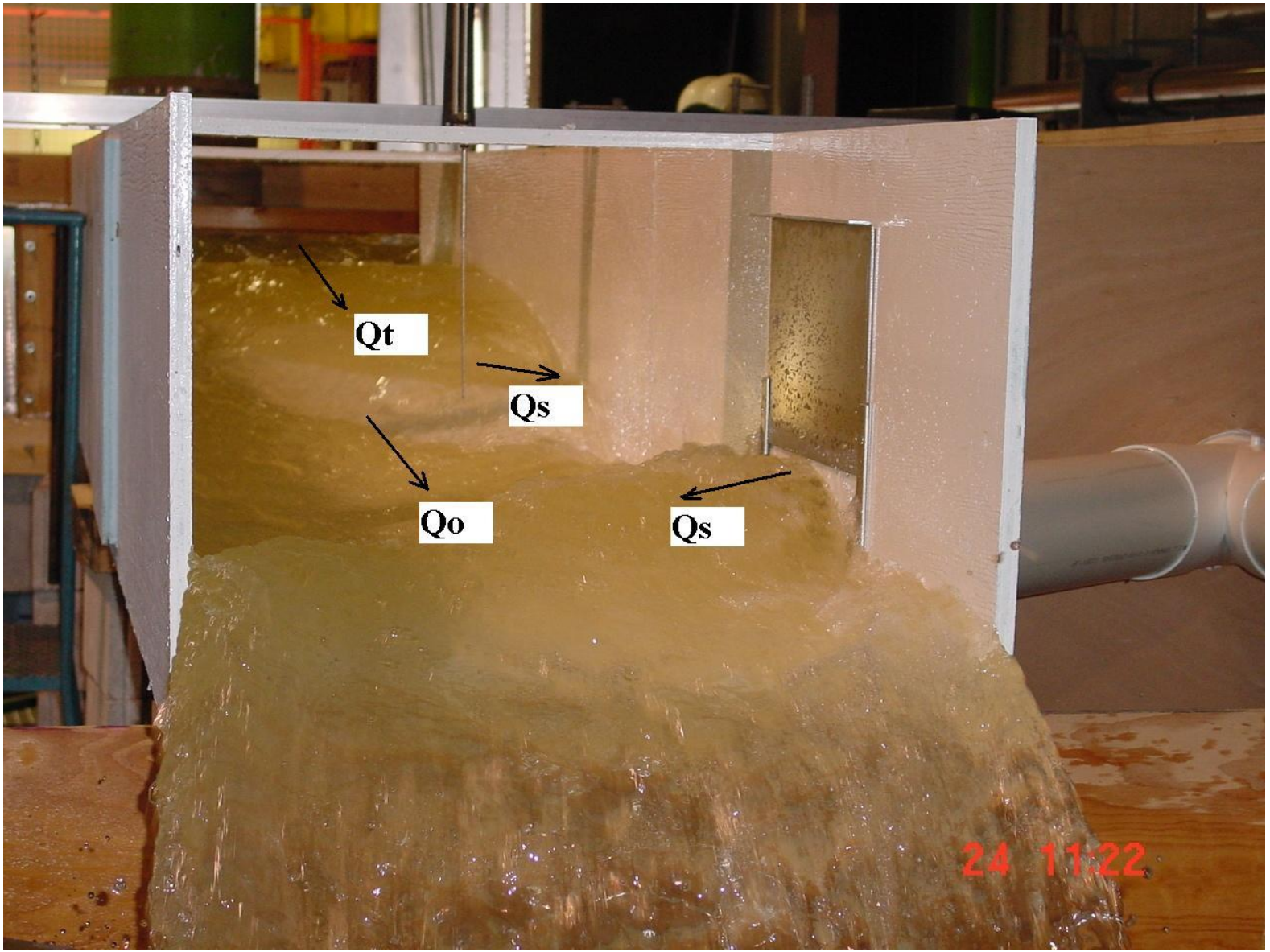
Maximum Flow through the Separator



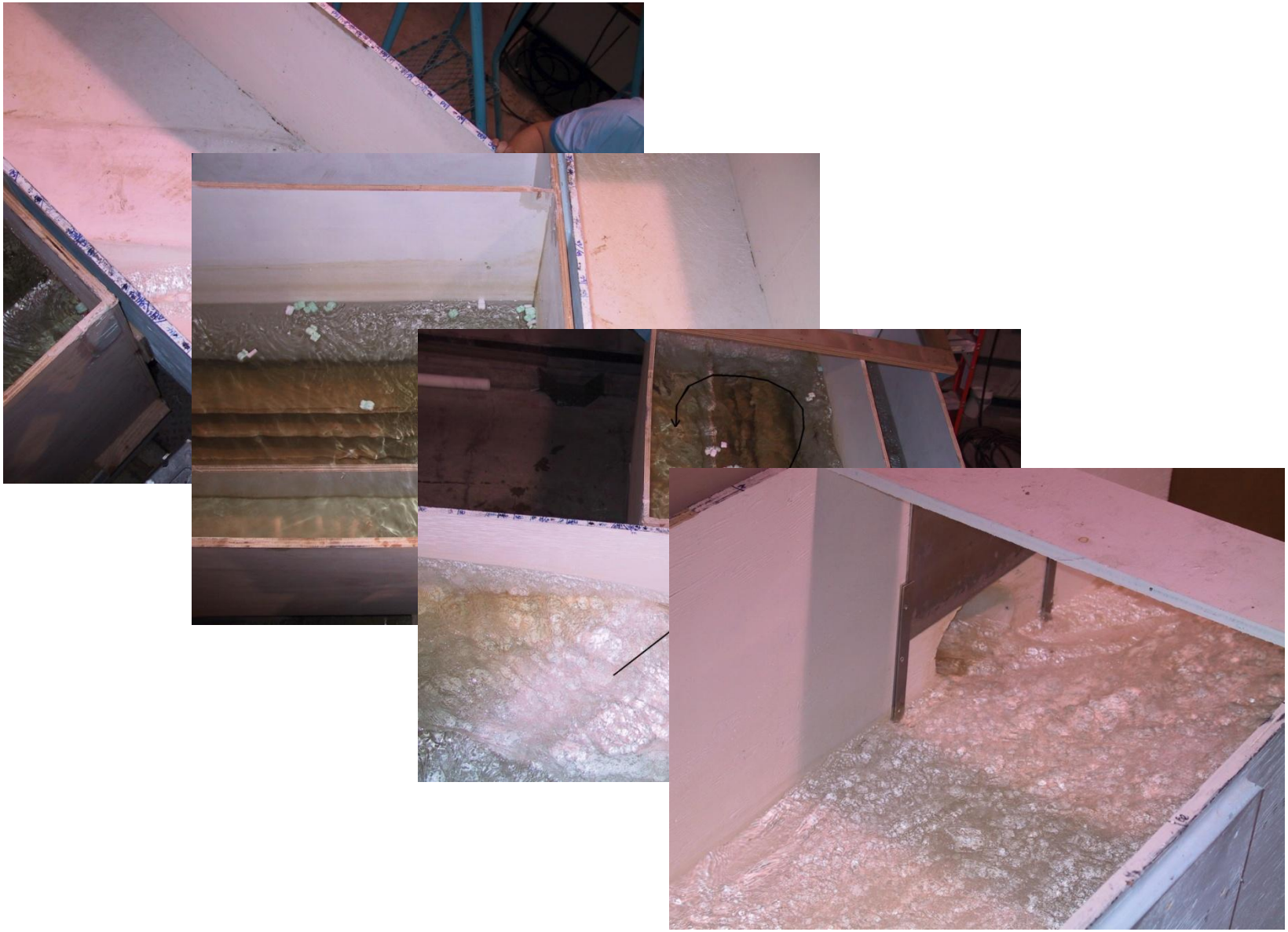
Flow profiles at the model



Flow profiles at the model



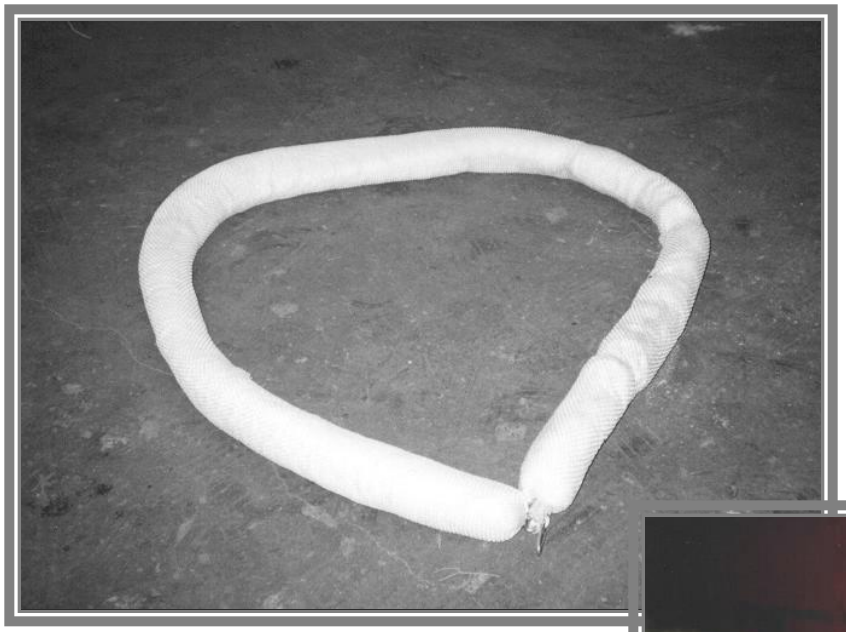
Light Particles



Pollution Prevention

Storage Tank With Surrounding Concrete Dike

Containment Equipment

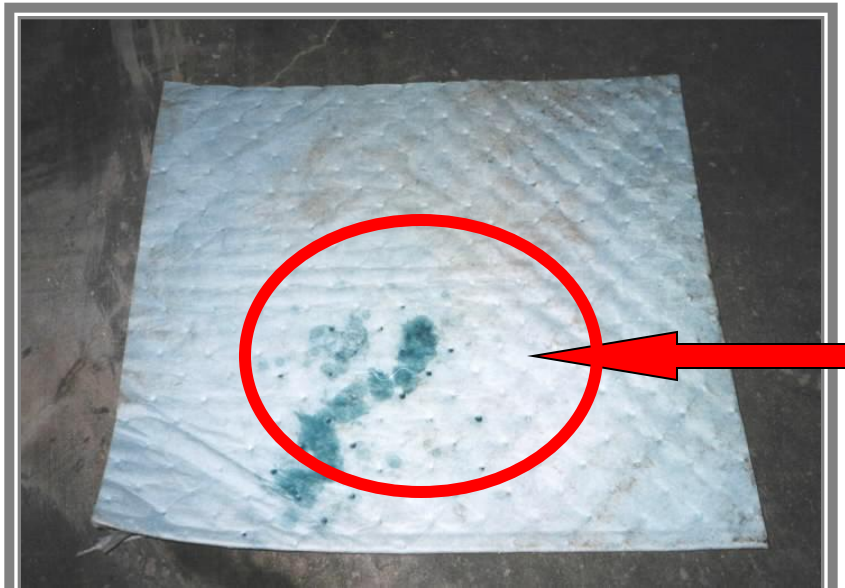


Sock

Water Booms

Clean Up Materials

Absorbent Material

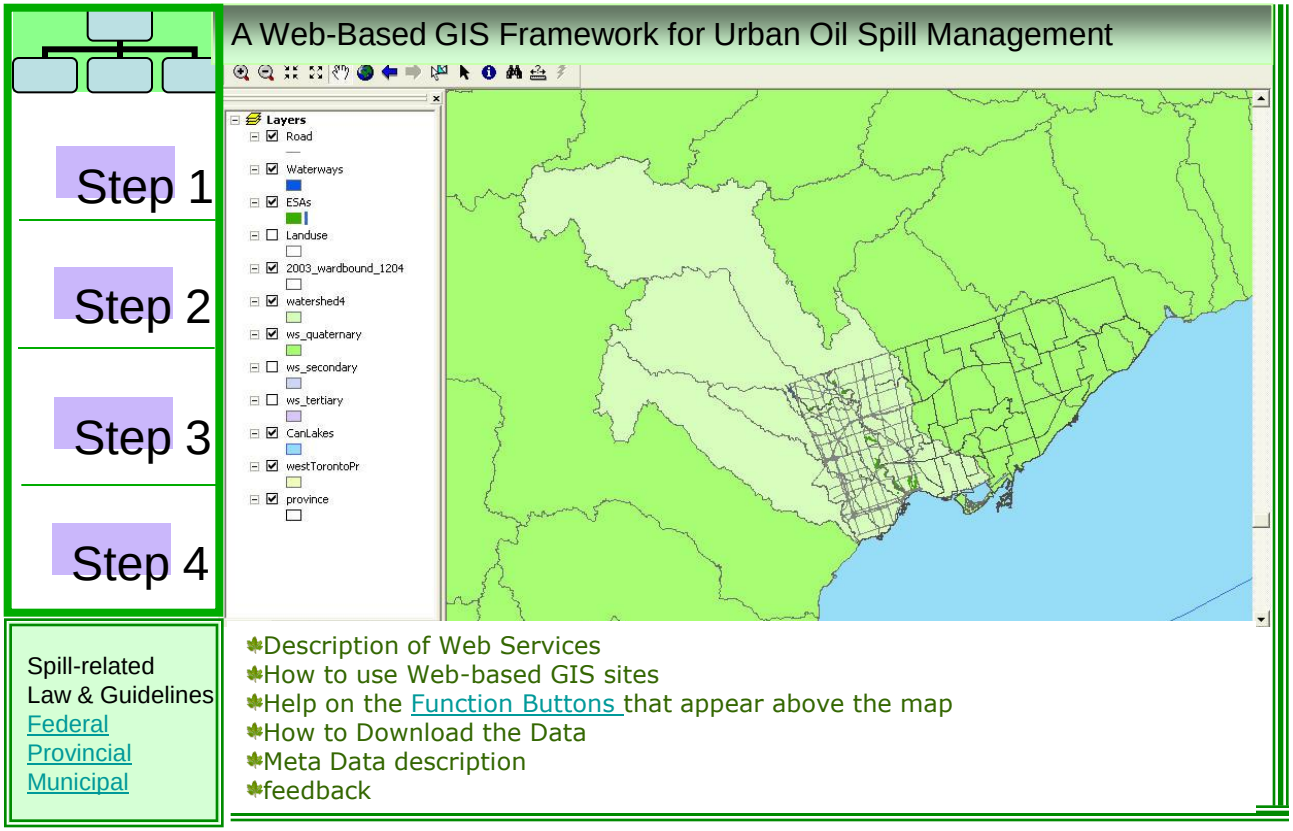


Absorbent Pad

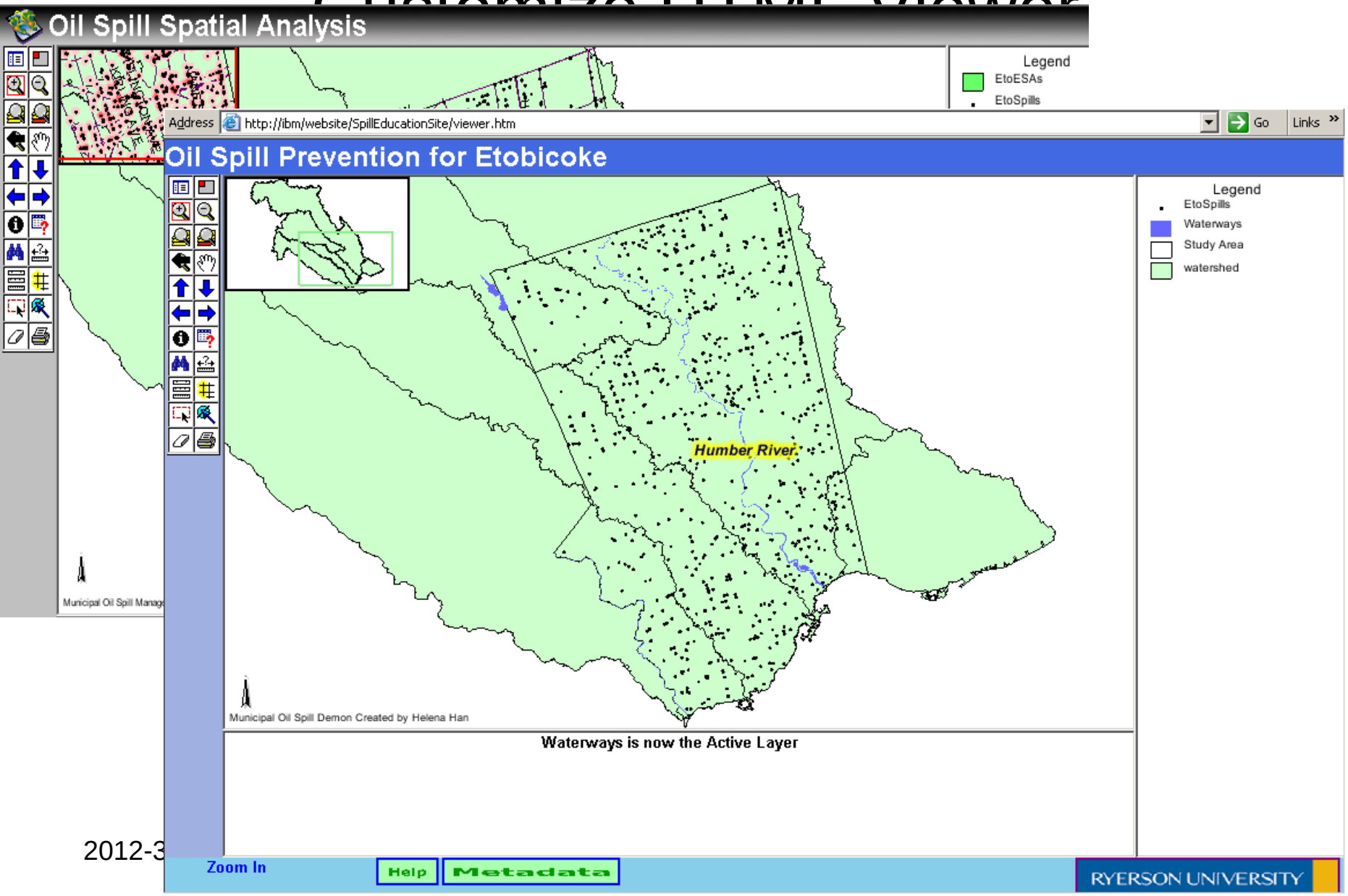
Summary and Conclusion

- Spills management is important in urban areas.
- A spills management approach should focus on compilation of database, analysis of spill event characteristics, development of pollution prevention and control plans, development of spill response systems.

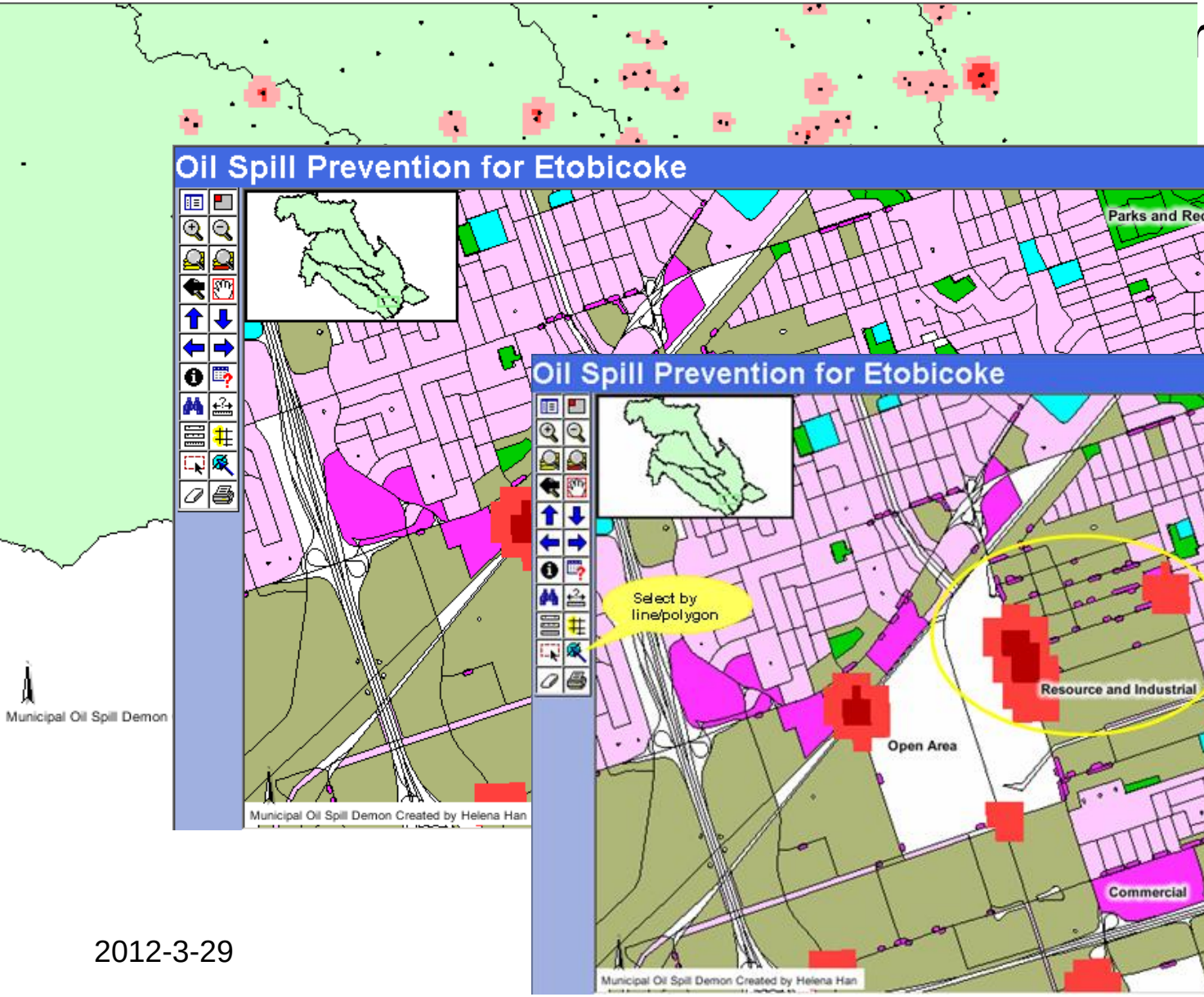
Recent Research



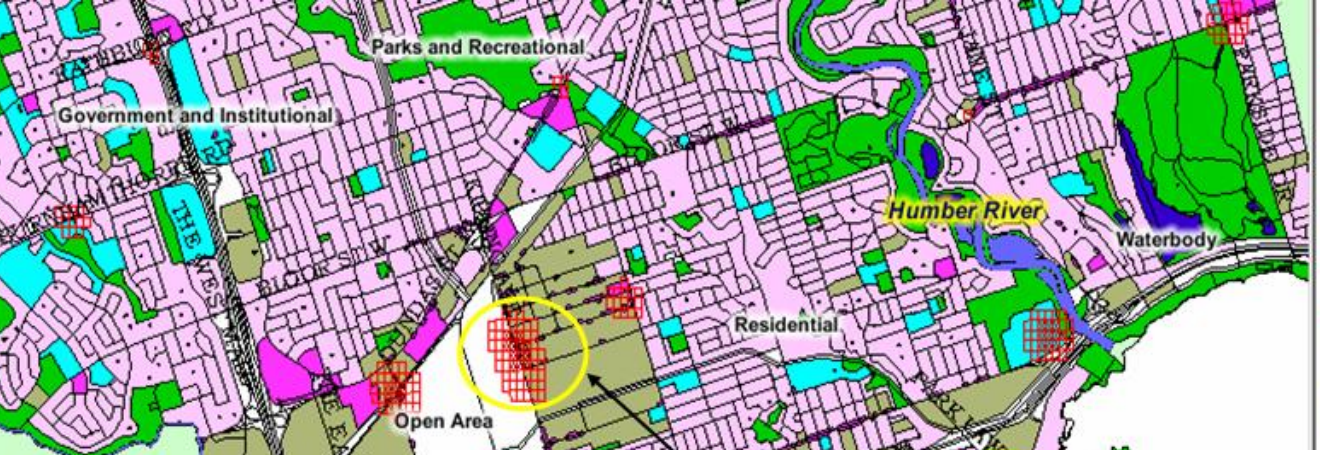
Customize HTML Viewer

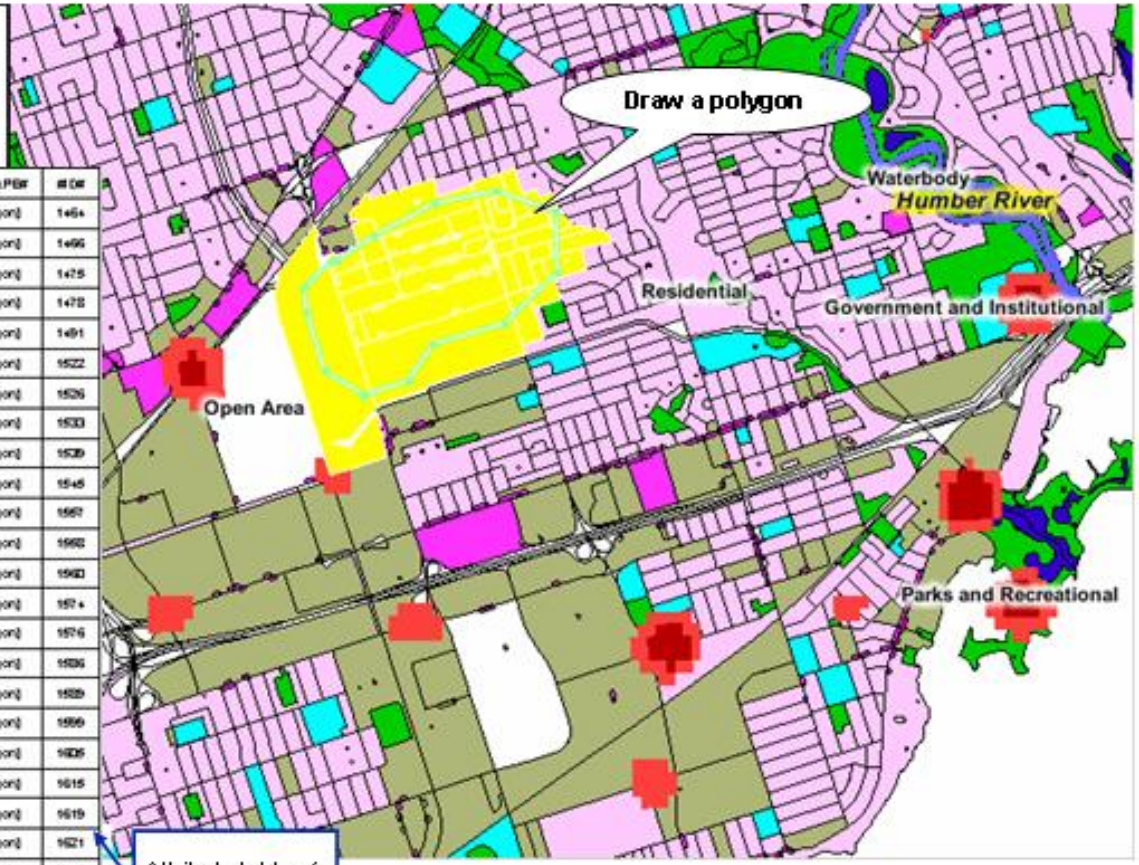


Web-based GIS Assist Urban Spill Management



2012-3-29

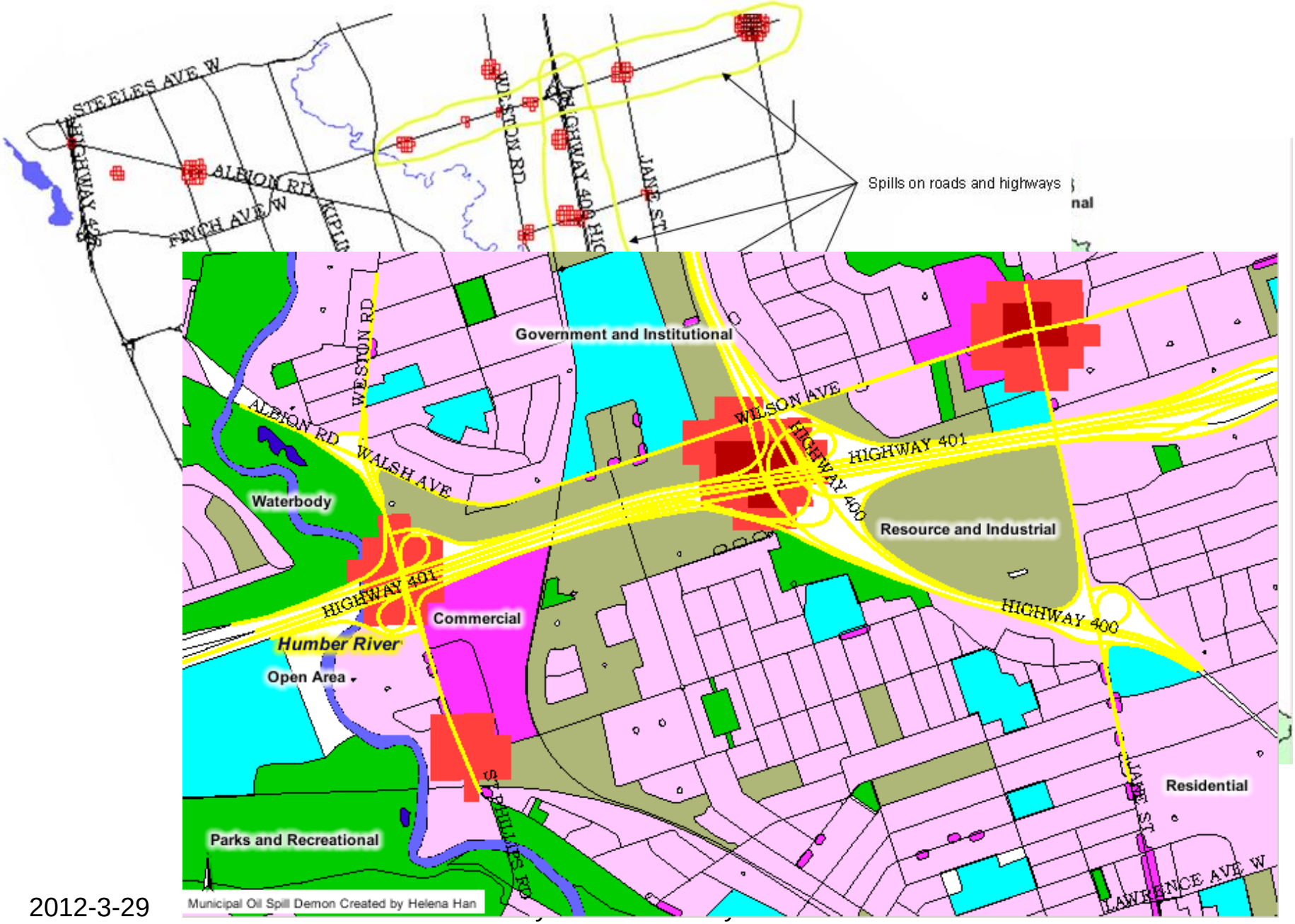




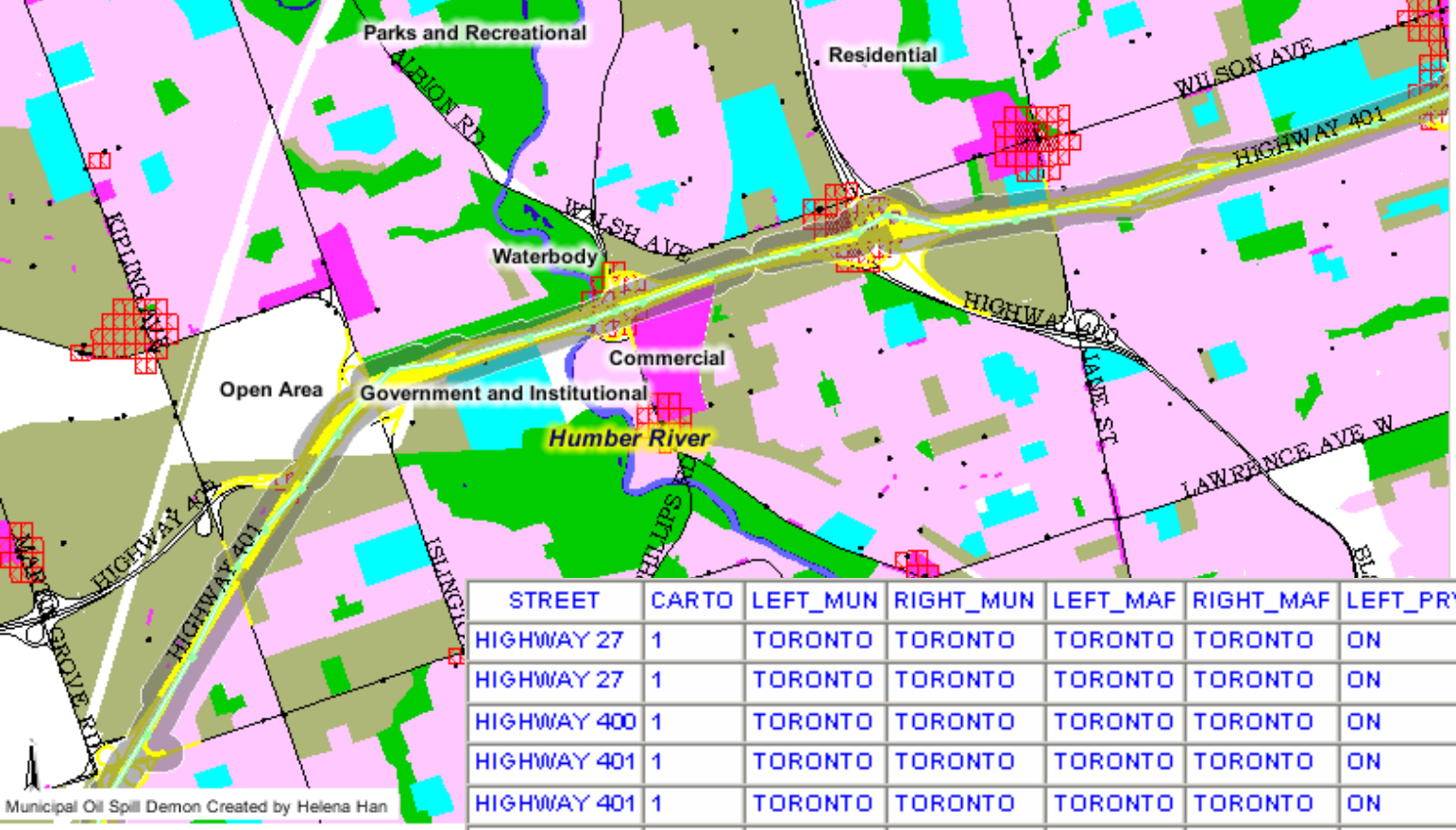
fea	CATEGORY	#FEATURE	#OID
1	Resource and Industrial	[polygon]	1464
2	Commercial	[polygon]	1466
3	Commercial	[polygon]	1475
4	Commercial	[polygon]	1478
5	Commercial	[polygon]	1491
6	Commercial	[polygon]	1522
7	Commercial	[polygon]	1526
8	Commercial	[polygon]	1533
9	Resource and Industrial	[polygon]	1539
10	Commercial	[polygon]	1545
11	Residential	[polygon]	1567
12	Commercial	[polygon]	1568
13	Commercial	[polygon]	1580
14	Commercial	[polygon]	1574
15	Resource and Industrial	[polygon]	1576
16	Commercial	[polygon]	1586
17	Commercial	[polygon]	1589
18	Residential	[polygon]	1599
19	Commercial	[polygon]	1605
20	Commercial	[polygon]	1615
21	Commercial	[polygon]	1619
22	Commercial	[polygon]	1621
23	Residential	[polygon]	1624
24	Government and Institutional	[polygon]	1625
25	Commercial	[polygon]	1637

Attribute table of selected area

2012-3-29


STEELES AVE W
HIGHWAY 400
ALBION RD
FINCH AVE W
WESTON RD
JANE ST
Spills on roads and highways
Government and Institutional
WESTON RD
ALBION RD
WALSH AVE
WILSON AVE
HIGHWAY 401
HIGHWAY 400
Waterbody
Resource and Industrial
HIGHWAY 401
Commercial
HIGHWAY 400
Humber River
Open Area
Residential
Parks and Recreational
JANE ST
LAWRENCE AVE W
Municipal Oil Spill Demon Created by Helena Han

2012-3-29

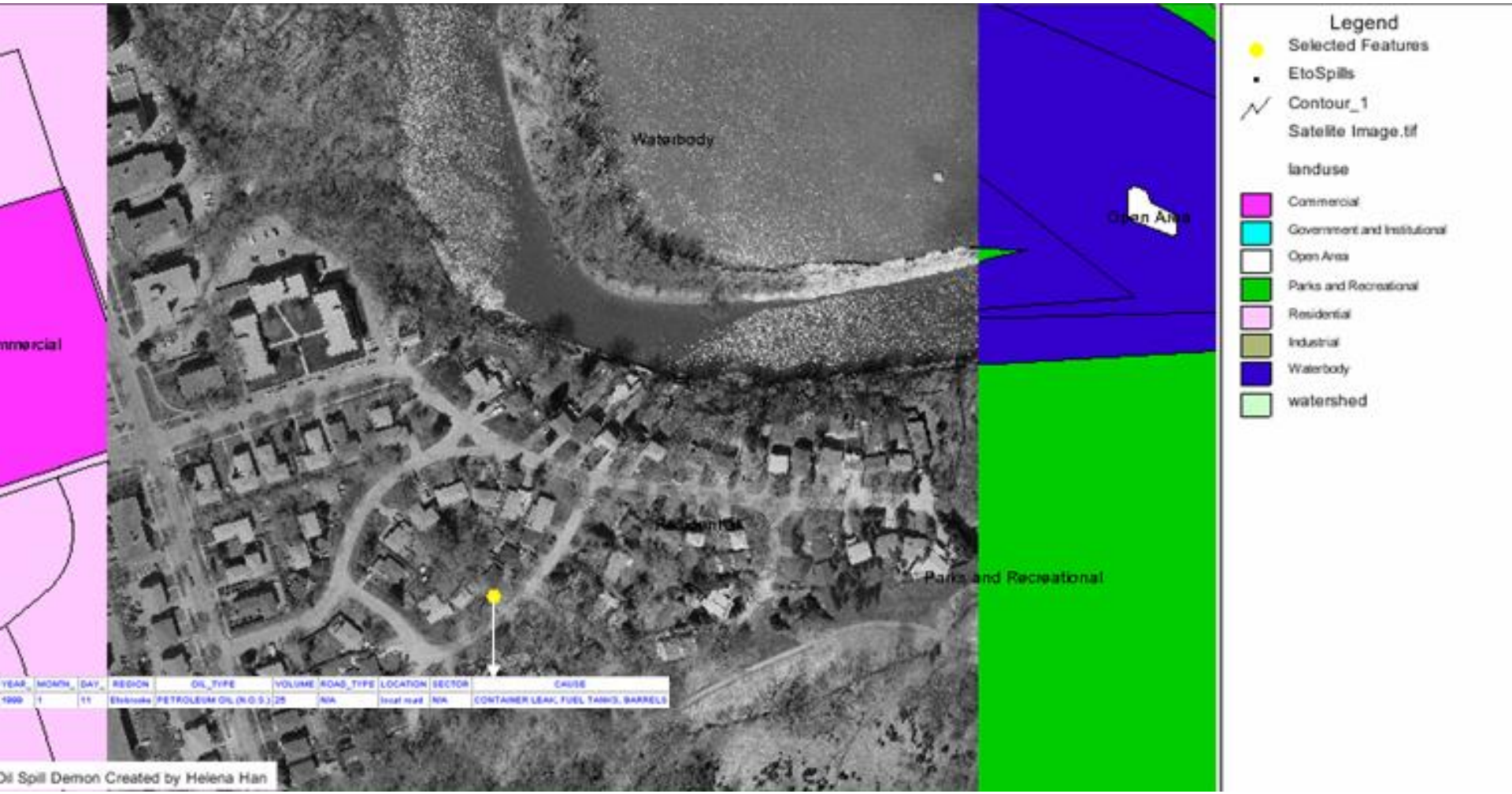


STREET	CARTO	LEFT_MUN	RIGHT_MUN	LEFT_MAF	RIGHT_MAF	LEFT_PRV	RIGHT_PRV	SHAPE_LENG
HIGHWAY 27	1	TORONTO	TORONTO	TORONTO	TORONTO	ON	ON	0.00036917742
HIGHWAY 27	1	TORONTO	TORONTO	TORONTO	TORONTO	ON	ON	0.00033252176
HIGHWAY 400	1	TORONTO	TORONTO	TORONTO	TORONTO	ON	ON	0.00018293715
HIGHWAY 401	1	TORONTO	TORONTO	TORONTO	TORONTO	ON	ON	0.00460969319
HIGHWAY 401	1	TORONTO	TORONTO	TORONTO	TORONTO	ON	ON	0.00642728619
HIGHWAY 401	1	TORONTO	TORONTO	TORONTO	TORONTO	ON	ON	0.00548485367
HIGHWAY 401	1	TORONTO	TORONTO	TORONTO	TORONTO	ON	ON	0.0015647064
HIGHWAY 401	1	TORONTO	TORONTO	TORONTO	TORONTO	ON	ON	0.00101841357
HIGHWAY 401	1	TORONTO	TORONTO	TORONTO	TORONTO	ON	ON	0.00259936398
HIGHWAY 401	1	TORONTO	TORONTO	TORONTO	TORONTO	ON	ON	0.01031711737
HIGHWAY 401	1	TORONTO	TORONTO	TORONTO	TORONTO	ON	ON	0.01390827209
HIGHWAY 401	1	TORONTO	TORONTO	TORONTO	TORONTO	ON	ON	0.00601814043
HIGHWAY 401	1	TORONTO	TORONTO	TORONTO	TORONTO	ON	ON	0.01018044435
HIGHWAY 401	1	TORONTO	TORONTO	TORONTO	TORONTO	ON	ON	0.00704984995
HIGHWAY 401	1	TORONTO	TORONTO	TORONTO	TORONTO	ON	ON	0.00584922127
HIGHWAY 409	1	TORONTO	TORONTO	TORONTO	TORONTO	ON	ON	0.00046949188
KIPLING AVE	4	TORONTO	TORONTO	TORONTO	TORONTO	ON	ON	0.00184220148
WESTON RD	4	TORONTO	TORONTO	TORONTO	TORONTO	ON	ON	0.00021339184

2012-3-29

Rec	DESCR	ID	FMF_OBJECT	OFFICIAL_N	EFFECTIVE_	EXT_EFFEST	#SHAPE#
1	Environmentally Sensitive Area	202	1200808797	Yes	2004-01-08-15:48:35	1998-11-23-12:45:34	[polygon]
2	Environmentally Sensitive Area	200	1200808795	Yes	2004-01-08-15:48:35	1998-11-23-12:45:33	[polygon]
3	Environmentally Sensitive Area	201	1200808796	Yes	2004-01-08-15:48:35	1998-11-23-12:45:33	[polygon]
4	Environmentally Sensitive Area	198	1200808793	Yes	2004-01-08-15:48:35	1998-11-23-12:45:32	[polygon]
5	Environmentally Sensitive Area	199	1200808794	Yes	2004-01-08-15:48:35	1998-11-23-12:45:33	[polygon]
6	Environmentally Sensitive Area	197	1200808792	Yes	2004-01-08-15:48:35	1998-11-23-12:45:32	[polygon]
7	Environmentally Sensitive Area	196	1200808791	Yes	2004-01-08-15:48:35	1998-11-23-12:45:32	[polygon]
8	Environmentally Sensitive Area	195	1200808790	Yes	2004-01-08-15:48:35	1998-11-23-12:45:31	[polygon]
9	Environmentally Sensitive Area	194	1200808789	Yes	2004-01-08-15:48:35	1998-11-23-12:45:31	[polygon]
10	Environmentally Sensitive Area	193	1200808788	Yes	2004-01-08-15:48:35	1998-11-23-12:45:30	[polygon]
11	Environmentally Sensitive Area	296	1200808891	Yes	2004-01-08-15:48:35	1998-11-23-12:46:12	[polygon]
12	Environmentally Sensitive Area	192	1200808787	Yes	2004-01-08-15:48:35	1998-11-23-12:45:30	[polygon]

2012-3-29


Legend
Selected Features
EtoSpills
Contour_1
Satellite Image.tif
landuse
Commercial
Government and Institutional
Open Area
Parks and Recreational
Residential
Industrial
Waterbody
watershed
Waterbody
Open Area
Parks and Recreational
YEAR_ MONTH_ DAY_ REGION OIL_TYPE VOLUME ROAD_TYPE LOCATION SECTOR CAUSE
1999 1 11 Etobicoke PETROLEUM OIL (N.O.S.) 25 N/A local road N/A CONTAINER LEAK, FUEL TANKS, BARRELS
Oil Spill Demon Created by Helena Han