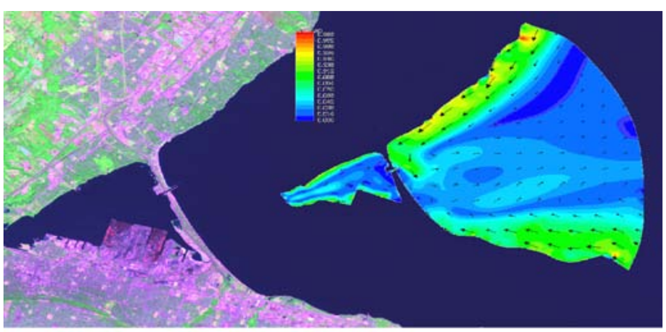
SOURCE WATER PROTECTION

Collaborative Study to Protect Lake Ontario Drinking Water

Addendum to Final Phase 1 Report
(MOE Module 4)
for the
Regional Municipality of Halton



June 2008

This report was developed for the Regional Municipality of Halton by Stantec Consulting Ltd. with the following contributors:

Lake Ontario Collaborative Source Protection Technical Study

Module 4 Addendum for the Regional Municipality of Halton: Burlington Water Purification Plant, Burloak Water Purification Plant, and Oakville Water Purification Plant

June 2008

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APPENDIX

1.0 Introduction

1.1 REPORT PURPOSE

This report is an addendum to the final Regional Municipality of Halton *Intake Protection Zone Delineation and Vulnerability Assessment Study for the Burlington, Burloak, and Oakville Water Purification Plants* Module 4 report submitted on March 14, 2008. This report addendum is intended to:

1. Provide information on additional hydrodynamic modeling work undertaken by Stantec at the request of the Lake Ontario Collaborative (LOC);
2. Revise upland delineations based upon the hydrodynamic modeling; and
3. Revise the vulnerability scores.

1.2 SCOPE OF WORK

Stantec has been retained by the Region of Peel in conjunction with various Conservation Authorities and Municipalities to undertake the work required by the Ministry of the Environment Source Water Protection Guidance Modules as well as fulfill requirements of the LOC. Client Project Management is provided by the Ontario Clean Water Agency (OCWA). Work to date that has been authorized as part of the Module 4 study involving the Regional Municipality of Halton is as follows:

1. Phase 1 - Guidance Module 4 – Surface Water Vulnerability Analysis (Module 4) - Completed; and
2. Additional Phase 1 Module 4 model refinement to the water treatment plant intakes located in the Western Lake Ontario region- Completed.

The additional Phase 1 Module 4 refinement work was granted by OCWA to Stantec based upon the proposal dated September 12, 2007 (refer to Appendix 1.1).

2.0 Phase 1 Module 4 – Surface Water Vulnerability Analysis and Additional Model Refinement

2.1 BACKGROUND

The intention of the Module 4 extension work was to refine initial modeling efforts and meet the needs of the Collaborative. HCCL was retained as the modeling subconsultant responsible for undertaking the hydrodynamic analysis portion of the work. General features of this refinement involves the reduction of wind return period from 100-yr to 10-yr and the inclusion of 3-D components. The modeling work was completed by HCCL on March 20, 2008 and submitted to Stantec. The complete HCCL modeling report is provided in Appendix 2.1. Based on the results of HCCL's analysis, the updated land-based delineation methodology and results are presented herein, along with a reassessment of vulnerability scores and associated uncertainty.

2.2 METHODOLOGY

2.2.1 Overview

The IPZ-1, the zone closest to the intake, represents the area that is considered to be most vulnerable to contamination. Methodology to delineate this zone was provided by the Ministry of the Environment (MOE) in the Draft October 2006 Module 4 Guidance. IPZ-1 requires a minimum circular radius of 1km for Great Lakes intakes unless local conditions warrant expansion of this zone. Additional methodology to Module 4 provided by the MOE restricts the onshore extent of the IPZ-1 to the Conservation Authority Regulated Area (Regulated Limit) or 120m, whichever is greater (refer to Appendix 2.2).

Module 4 IPZ-2 delineation methodology requires the inclusion of both shoreline areas and watercourses that may impact the WTP source water within the designated time of travel (TOT). The landfall points of the modeled in-water zone represent the extremes of the alongshore extents of the IPZ-2. Between these points, the IPZ-2 extends 120m landward, or to the Regulated Limit, whichever is greater. The upstream extent of each watercourse that outlet within the modeled area is determined using a function of velocity at full-bank flow and the residual TOT. A similar setback of 120m or the Regulated Limit, whichever is greater, is applied to each bank. Modifications to these setbacks may be applied where local topography indicates that an area does not drain to the watercourse in question and/or where preferential pathways concentrate flow to the water body.

2.2.2 Residual TOT

It was decided earlier in the study through consultation with operations staff and the Regional Municipality of Halton that a 2-hour TOT be used for the IPZ-2 analysis. As the alongshore extents of IPZ-2 produced through HCCL's modeling analysis represent the boundaries of the delineation, the watercourses that outfall within this extent were analyzed further as they contribute to the source water of this intake. A residual TOT was interpolated at each of the watercourse outlets by taking the proportion of the radial arm from the intake crib to the IPZ-2 extents and the radial arm from the intake crib to the watercourse outlet. Residual TOTs are calculated in Tables 2.1, 2.4 and 2.7 below. Given a residual TOT for each watercourse, the IPZ-2 can be delineated an appropriate distance upstream where the velocity of flow can be determined.

2.2.3 Watercourse Velocity

Velocities for seven (7) Halton watercourses were obtained from Conservation Halton (CH) at a number of flow points under two-year and ten-year flow conditions. For this analysis, two-year flows were used to approximate bank-full flows. Between flow points, the velocity of the watercourse was assumed to be equal to the velocity at the closest known point, creating a series of reaches with constant flow speeds. Upstream distances for these creeks were calculated piecewise based on the velocity for each reach until the entire residual TOT was achieved. These calculations are presented in Tables 2.2, 2.5 and 2.8.

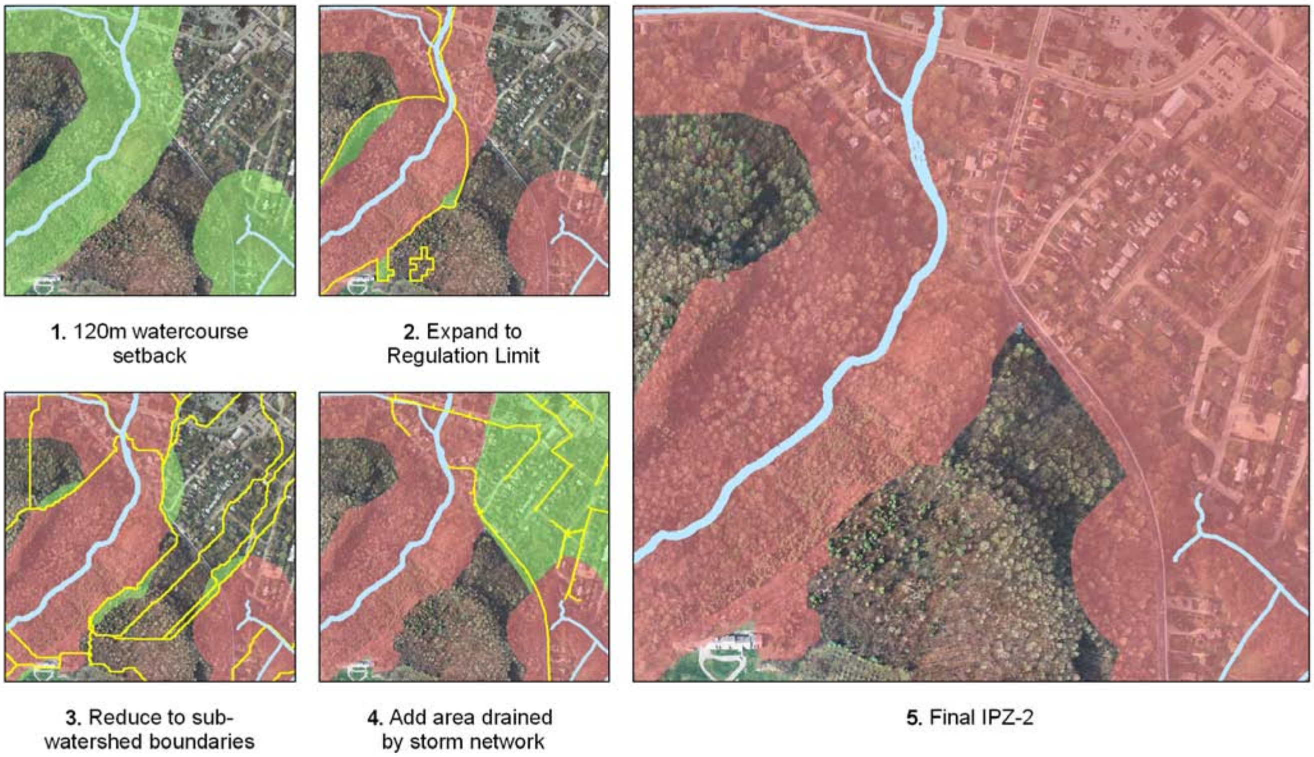
For watercourses where velocity information was unknown, a regional velocity of 1.42m/s was applied. This value is the mean of the average velocities found for the seven Halton creeks for which data was available. Upstream distances for these creeks were calculated by multiplying each residual TOT by 1.42m/s. Up-stream distances for all watercourses in the IPZ-2 are calculated in Tables 2.3, 2.6 and 2.9.

2.2.4 Setbacks and Adjustments

A 120m setback was applied to each watercourse for the up-stream distances calculated above, with the CH 2002 Waterflow dataset defining watercourse paths and tributaries. A circular cap of radius 120m was applied at each endpoint. This delineation was then compared to the April 2006 CH Approximated Regulation Limit and watercourse setbacks were increased as appropriate. Finally, the delineation was compared to CH Watershed Boundaries data and land that drains away from a given watercourse was excluded from the setback.

Mapping of the Burlington and Oakville stormwater networks was used to include developed areas that discharge stormwater into Lake Ontario or watercourses within the modeled zone. Additional areas were included where overland flow or tile drainage may quickly convey potential contaminants to the WTP intake. Figure 2.1 illustrates the application of these steps.

Figure 2.1: IPZ-2 Delineation Example



2.3 BURLINGTON WTP

2.3.1 Calculations

Table 2.1 shows calculations for residual TOT values given an updated modeled in-water zone using the methodology outlined in section 2.2.1.

Table 2.1: Burlington WTP Residual Times-of-Travel

Watercourse[1]	Direction from Intake	Distance from Intake (km)	Mouth-to-Intake TOT (min)	Residual TOT (min)
West Modeled Boundary	*W*	*3.50*	*120.0*	*0.0*
Lower Rambo Creek	W	2.38	81.6	38.4
Roseland Creek	W	0.07	2.3	117.7
East Modeled Boundary	*E*	*6.19*	*120.0*	*0.0*
Tuck Creek	E	0.99	19.2	100.8
Shoreacres Creek	E	2.11	40.9	79.1
Appleby Creek	E	3.31	64.2	55.8

Flow velocity data was provided for two (2) of these creeks, namely Appleby Creek and Shoreacres Creek. The calculations of their upstream distances and average velocities are outlined in Table 2.2 below.

Table 2.2: Burlington WTP Upstream Distance Calculations for Appleby Creek and Shoreacres Creek

Reach	Reach Length (m)	Velocity (m/s)	Residual TOT (min)	Distance (m)	Remaining TOT (min)
Appleby Creek					
1943	1702	1.01	55.8	1702	27.7
1895	2217	1.99	27.7	2217	9.1
1856	2837	1.48	9.1	812	0
			Total Distance (m):	4731	
			Average Velocity (m/s):	1.41	
Shoreacres Creek					
1697	1571	2.79	79.1	1571	69.7
1679	2850	2.19	69.7	2850	48.0
1578	5400	1.54	48.0	4438	0
			Total Distance (m):	8859	
			Average Velocity (m/s):	1.87	

Upstream distances for all creeks within the modeled zone are provided in Table 2.3. Lower Rambo Creek, Roseland Creek, and Tuck Creek have adopted the Regional Velocity described in Section 2.2.2.

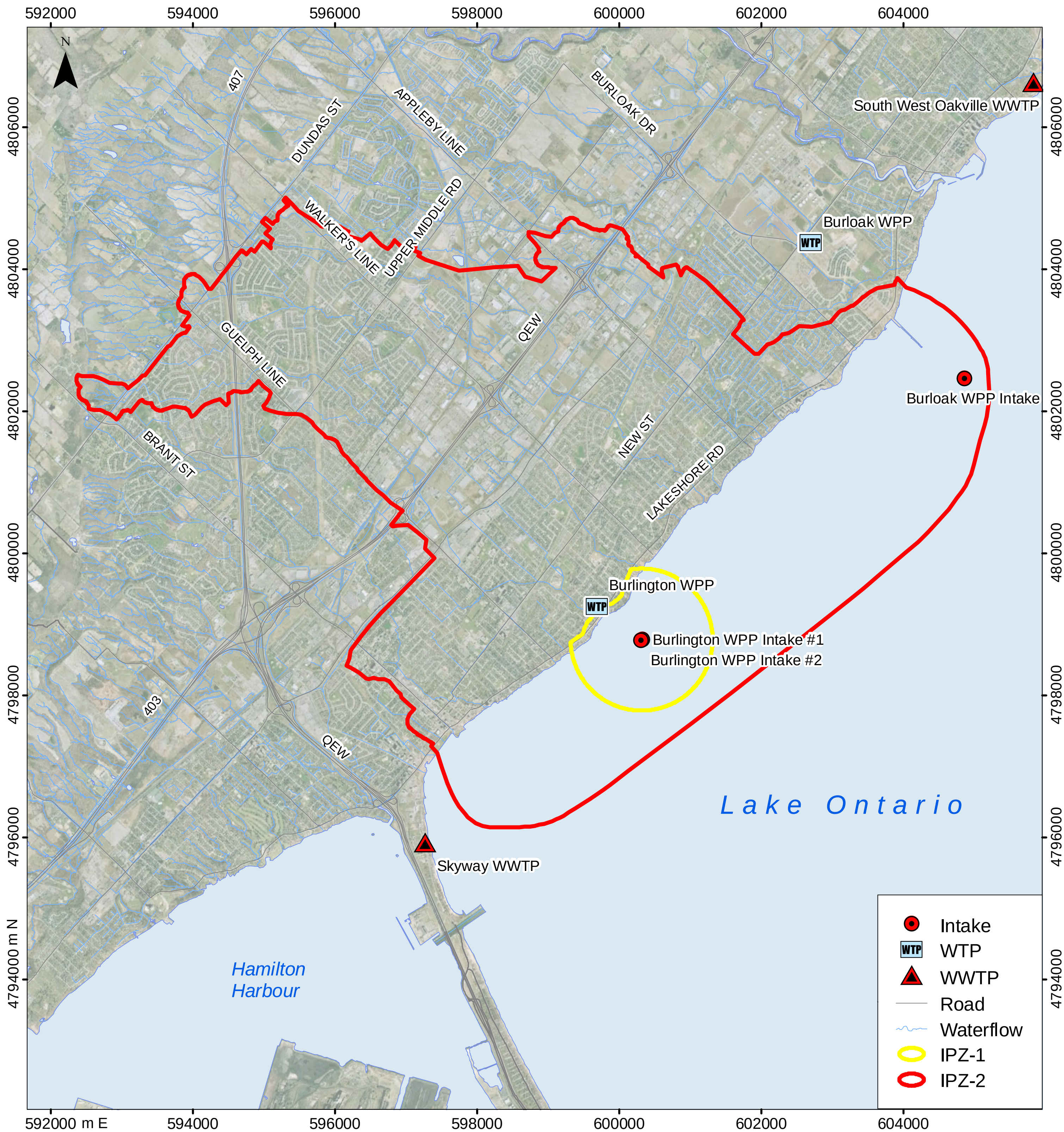
Table 2.3: Upstream Distances for All Watercourses

Watercourse	Residual TOT (min)	Velocity (m/s)	Upstream Distance[1] (m)
Lower Rambo Creek	38.4	1.42	3272
Roseland Creek	117.7	1.42	10025
Tuck Creek	100.8	1.42	8589
Shoreacres Creek	79.1	1.87 [2]	8859
Appleby Creek	55.8	1.41 [2]	4731

[1] May be greater than the total length of the given watercourse.
[2] Average velocity, see Table 2.2.

2.3.2 Results

The resulting IPZ-1 is reduced slightly from 3.14km² to 2.86km² due to the limits imposed on onshore extents. The IPZ-2, however, is increased in size from 33.2km² to 56.9km²; including more than 25km² of additional developed upland area. The upland area now extends to Dundas Street in the northwest, and narrows with increasing distance from shore. The alongshore extent of the zone did not change significantly at approximately 9.3 km. Two major expressways, the Queen Elizabeth Way (QEW) and Highway 407, are now included in the zone, as well as two rail corridors. The resulting IPZs are shown in Figure 2.2.



Imagery © Google Earth.
Waterflow courtesy of Conservation Halton.
Topographic data © Natural Resources Canada.
Bathymetry courtesy of NOAA.
Projection: UTM Zone 17N, NAD 1983

1 0 1 2 Km

Project

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Figure No.	Revision No.	Date
2.2	**2**	**June 3, 2008**

Title

Burlington WPP Intake Protection Zones

DRINKING WATER SOURCE PROTECTION

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2.4 BURLOAK WPP

2.4.1 Calculations

Table 2.4 shows calculations of residual TOT values given an updated modeled in-water zone using the methodology outlined in section 2.2.1.

Table 2.4: Residual Times-of-Travel

Watercourse[1]	Direction from Intake	Distance from Intake (km)	Mouth-to-Intake TOT (min)	Residual TOT (min)
West Modeled Boundary	*W*	*6.48*	*120.0*	*0.0*
Roseland Creek	W	6.09	112.8	7.2
Tuck Creek	W	5.28	97.8	22.2
Shoreacres Creek	W	4.08	75.6	44.4
Appleby Creek	W	2.97	55.0	65.0
East Modeled Boundary	*E*	*5.37*	*120.0*	*0.0*
Sheldon Creek	E	1.77	39.6	80.4
Bronte Creek	E	2.82	63.0	57.0

Flow velocity data was provided for four (4) of these creeks, namely Appleby Creek, Shoreacres Creek, Sheldon Creek and Bronte Creek. The calculations of their upstream distances and average velocities are outlined in Table 2.5 below.

Table 2.5: Upstream Distance Calculations for Appleby Creek, Shoreacres Creek, Sheldon Creek and Bronte Creek

Reach	Reach Length (m)	Velocity (m/s)	Residual TOT (min)	Distance (m)	Remaining TOT (min)
Appleby Creek					
1943	1702	1.01	65.0	1702	36.9
1895	2217	1.99	36.9	2217	18.3
1856	2837	1.48	18.3	1629	0
			Total Distance (m):	5548	
			Average Velocity (m/s):	1.42	
Shoreacres Creek					
1697	1571	2.79	44.4	1571	35.0
1679	2850	2.19	35.0	2850	13.3
1578	5400	1.54	13.3	1231	0
			Total Distance (m):	5652	
			Average Velocity (m/s):	2.12	
Sheldon Creek					
2092	2300	1.08	80.4	2300	44.9

Reach	Reach Length (m)	Velocity (m/s)	Residual TOT (min)	Distance (m)	Remaining TOT (min)
2083	3048	1.61	44.9	3048	13.4
2123	3199	2.34	13.4	1875	0
			Total Distance (m):	7223	
			Average Velocity (m/s):	1.50	
Bronte Creek					
2201	1878	0.30	57.0	1026	0
			Total Distance (m):	1026	
			Average Velocity (m/s):	0.30	

Upstream distances for all creeks within the modeled zone are outlined in Table 2.6 below, with Roseland Creek and Tuck Creek adopting the Regional Velocity described in Section 2.2.2.

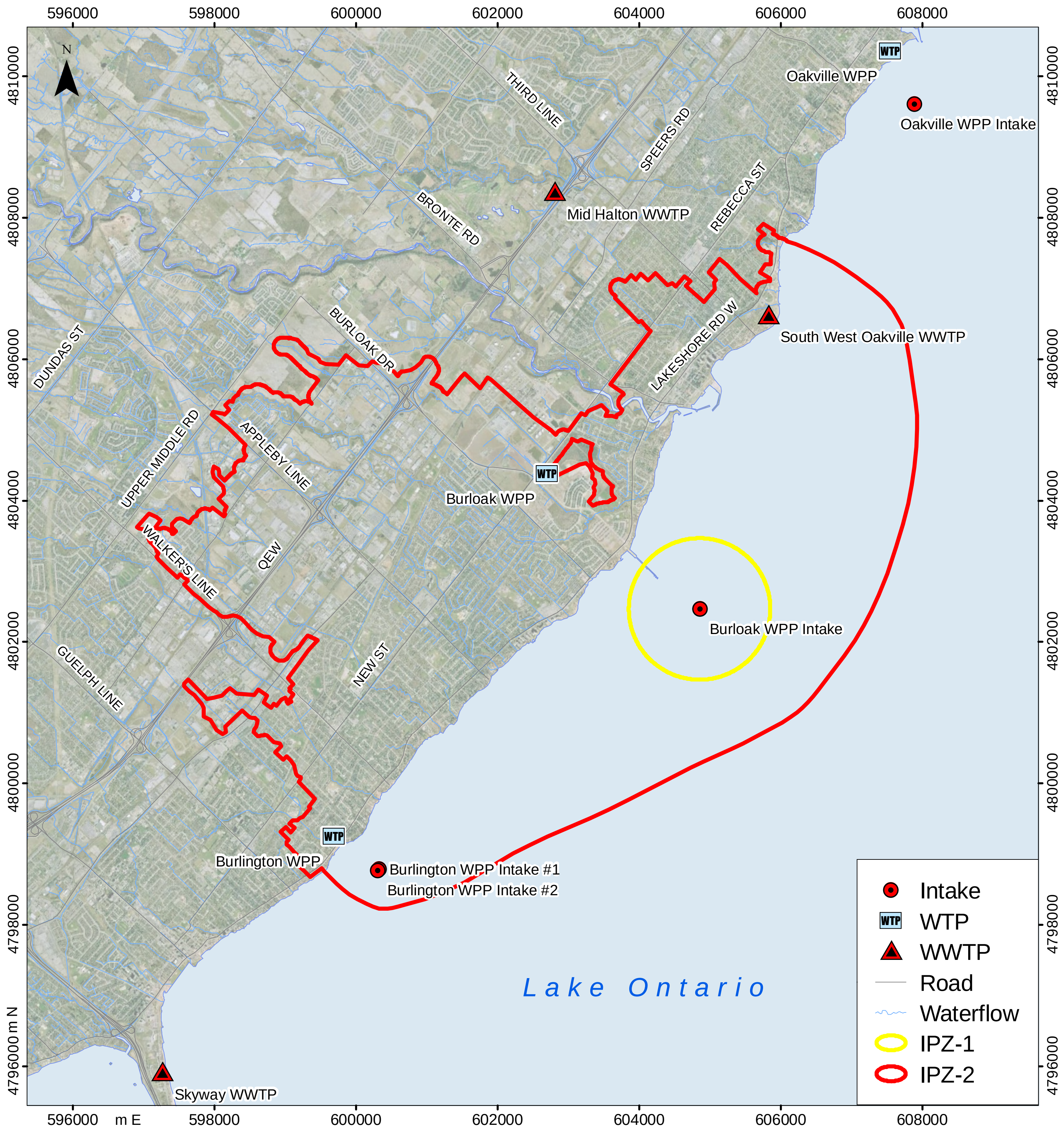
Table 2.6: Upstream Distances for All Watercourses

Watercourse	Residual TOT (min)	Velocity (m/s)	Upstream Distance[1] (m)
Roseland Creek	7.2	1.42	615
Tuck Creek	22.2	1.42	1893
Shoreacres Creek	44.4	1.87 [2]	5652
Appleby Creek	65.0	1.41 [2]	5548
Sheldon Creek	80.4	1.50 [2]	7223
Bronte Creek	57.0	0.30 [2]	1026

[1] May be greater than the total length of the given watercourse.
[2] Average velocity, see Table 2.

2.4.2 Results

The IPZ-1 did not change, remaining a circle of 1km radius centred on the intake. The IPZ-1 is entirely contained within Lake Ontario, except for the presence of the Petro-Canada dock in the northwest quadrant of the zone. The IPZ-2, however, increased in size from 44.9km^2 to 61.0km^2, and included approximately 20km^2 of additional developed upland area mostly west of Bronte Creek. The upland area now extends nearly to Upper Middle Road in the northwest, and narrows with increasing distance from shore. The alongshore extent of the zone has increased to approximately 11 km. A major expressway, the QEW, is now included in the zone, as well as two rail corridors. The resulting IPZs are shown in Figure 2.3.



Project

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Figure No.	Revision No.	Date
2.3	**2**	**June 3, 2008**

Title

Burloak WPP Intake Protection Zones

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Projection: UTM Zone 17N, NAD 1983

1 0 1 2 Km

2.5 OAKVILLE WPP

2.5.1 Calculations

Table 2.7 shows calculations of residual TOT values given an updated modeled in-water zone using the methodology outlined in section 2.2.1.

Table 2.7: Residual Times-of-Travel

Watercourse[1]	Direction from Intake	Distance from Intake (km)	Mouth-to-Intake TOT (min)	Residual TOT (min)
West Modeled Boundary	*W*	*6.27*	*120.0*	*0.0*
Bronte Creek	W	5.43	103.9	16.1
Fourteen Mile Creek	W	2.28	43.6	76.4
McCraney Creek	W	1.61	30.8	89.2
East Modeled Boundary	*E*	*7.53*	*120.0*	*0.0*
Sixteen Mile Creek	E	0.91	14.5	105.5
Morrison Creek	E	3.54	56.4	63.6
Wedgewood Creek	E	4.24	67.5	52.5
Joshua's Creek	E	6.58	104.9	15.1
Clearview Creek	E	7.11	113.3	6.7

Flow velocity data was provided for four (4) of these creeks, namely Bronte Creek, Fourteen Mile Creek, Sixteen Mile Creek and Joshua's Creek. The calculations of their upstream distances and average velocities are outlined in Table 2.8 below.

Table 2.8: Upstream Distance Calculations for Bronte Creek, Fourteen Mile Creek, Sixteen Mile Creek and Joshua's Creek

Reach	Reach Length (m)	Velocity (m/s)	Residual TOT (min)	Distance (m)	Remaining TOT (min)
Bronte Creek					
2201	1878	0.30	16.1	289	0
			Total Distance (m):	289	
			Average Velocity (m/s):	0.30	
Fourteen Mile Creek					
2618	1701	2.84	76.4	1701	66.4
2602	2978	1.32	66.4	2978	28.8
2642	8823	1.54	28.8	2663	0
			Total Distance (m):	7342	
			Average Velocity (m/s):	1.60	
Sixteen Mile Creek					
2728	2492	1.62	105.5	2492	79.9

Reach	Reach Length (m)	Velocity (m/s)	Residual TOT (min)	Distance (m)	Remaining TOT (min)
2716	3167	2.20	79.9	3167	55.9
2774	3433	2.38	55.9	3433	31.8
2742	6540	2.00	31.8	3819	0
			Total Distance (m):	12911	
			Average Velocity (m/s):	2.04	
Joshua's Creek					
438	2500	1.09	15.1	988	0
			Total Distance (m):	988	
			Average Velocity (m/s):	1.09	

Upstream distances for all creeks within the modeled zone are outlined in Table 2.9 below, with McCraney Creek, Morrison Creek, Wedgewood Creek and Clearview Creek adopting the Regional Velocity described in Section 2.2.2.

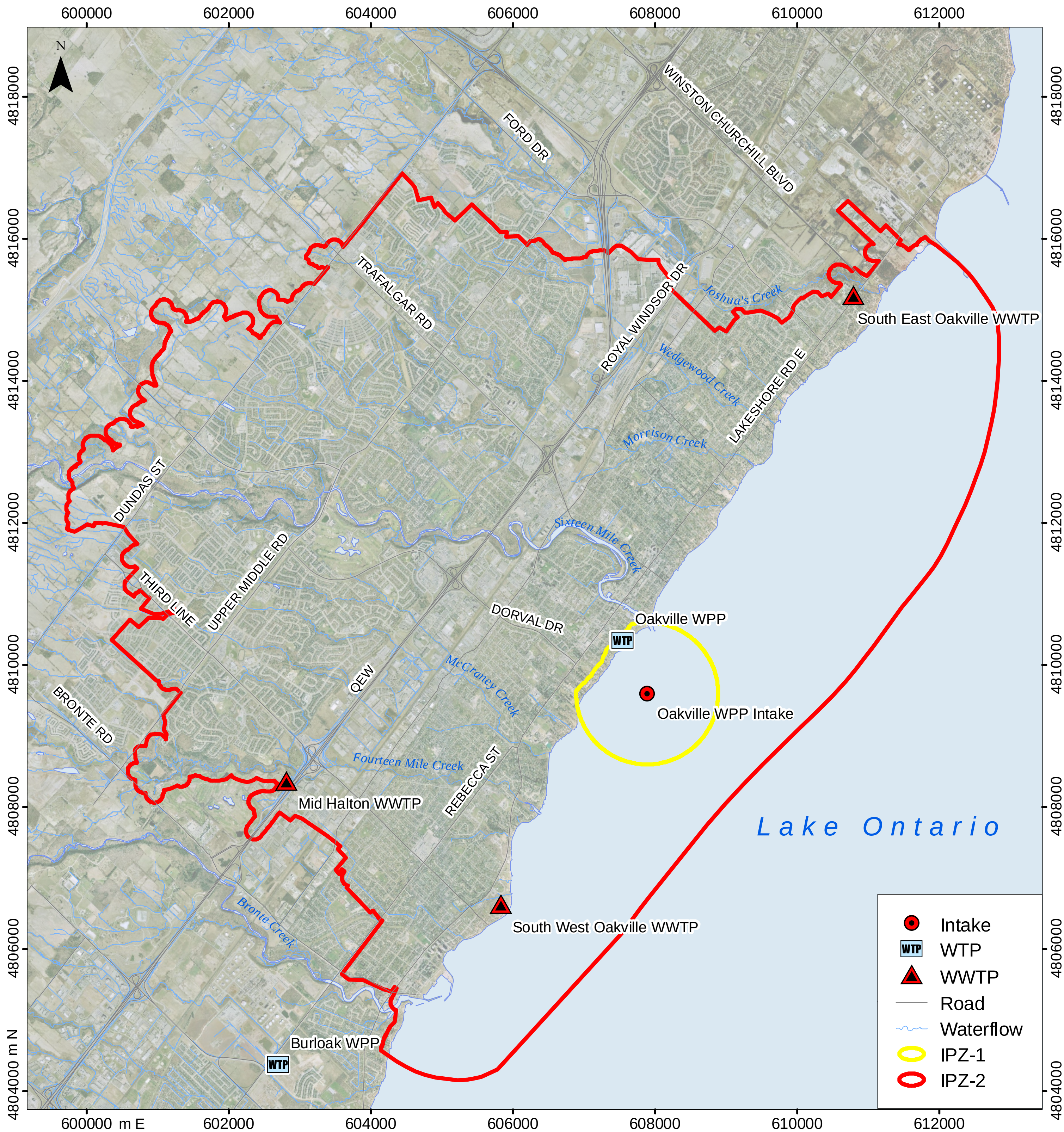
Table 2.9: Upstream Distances for All Watercourses

Watercourse	Residual TOT (min)	Velocity (m/s)	Upstream Distance[1] (m)
Bronte Creek	16.1	0.30 [2]	289
Fourteen Mile Creek	76.4	1.60 [2]	7342
McCraney Creek	89.2	1.42	7597
Sixteen Mile Creek	105.5	2.04 [2]	12911
Morrison Creek	63.6	1.42	5421
Wedgewood Creek	52.5	1.42	4470
Joshua's Creek	15.1	1.09 [2]	988
Clearview Creek	6.7	1.42	571

[1] May be greater than the total length of the given watercourse.
[2] Average velocity, see Table 2.

2.5.2 Results

The resulting IPZ-1 is reduced slightly from 3.14km^2 to 2.96km^2 due to the limits imposed on onshore extents. The IPZ-2, however, has increased in size from 39.0km^2 to 97.1km^2, and included approximately 45km^2 of additional developed upland area. The upland area now extends nearly to Burnhamthorpe Rd in the northwest, and narrows with increasing distance from shore. The alongshore extent of the zone has increased to approximately 13.8 km. A major expressway, the QEW, is now included in the zone, as well as a rail corridor. The resulting IPZs are shown in Figure 2.4.



Project

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Figure No.	Revision No.	Date
2.4	**2**	**June 3, 2008**

Imagery © Google Earth.
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Topographic data © Natural Resources Canada.
Bathymetry courtesy of NOAA.
Projection: UTM Zone 17N, NAD 1983

1 0 1 2 Km

Title

Oakville WPP
Intake Protection Zones

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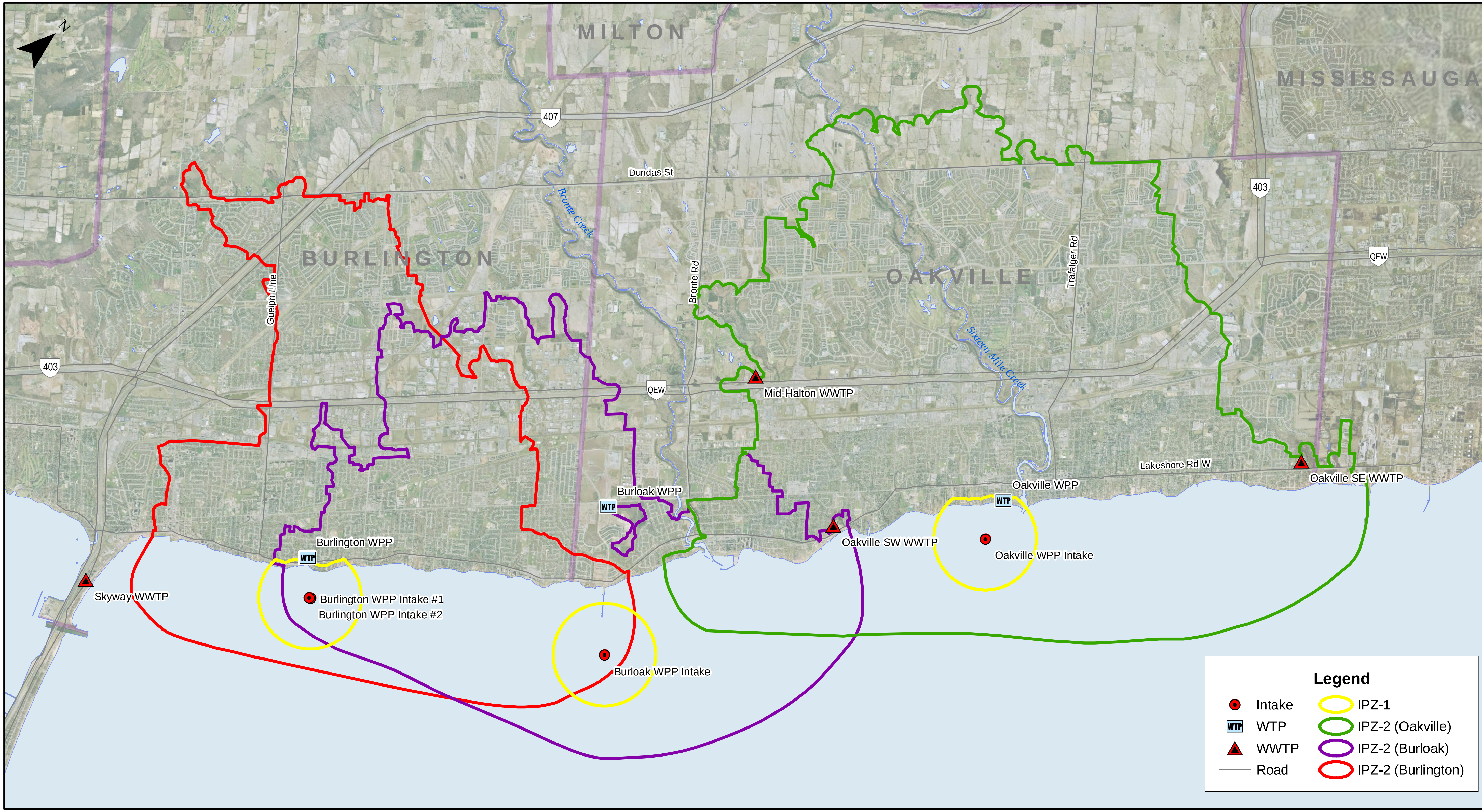
2.6 COMBINED HALTON DELINEATIONS

The individual delineations for the three (3) Halton WPPs presented in previous sections of this report depict the resulting IPZ1 and IPZ2 for each facility. A combined image is provided in Figure 2.5 that depicts the overall Halton study area and the interaction of each of the IPZs.



DRINKING WATER SOURCE PROTECTION
ACT FOR CLEAN WATER

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Bathymetry courtesy of NOAA.
Projection: UTM Zone 17N, NAD 1983

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Project
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Figure No.	Revision No.	Date
2.5	**2**	**June 3, 2008**

Title
Halton Region Intake Protection Zones

3.0 Vulnerability Assessment

3.1 INTRODUCTION

Each IPZ was assigned a vulnerability score (V) based on a number of factors, including, but not limited to, runoff generation potential, transport pathways, intake characteristics, and historical water quality records.

The two components that combine to create the V score are the zone vulnerability factor (Vf_z) and the source vulnerability modifying factor (Vf_s). The Vf_s can range from 0.5 to 0.7, with higher values indicating higher vulnerability, and is based on intake depth, distance from shore, and historical water quality. The Vf_z is based on the potential for runoff generation and the number and density of transport pathways. The IPZ-1 receives an MOE prescribed value of 10 because of its proximity to the intake, while the IPZ-2 can range from 7 to 9.

3.2 BURLINGTON WPP

The value assigned to the Vf_s is based on the intake depth, distance from shore, and historical water quality. Since none of these characteristics changed with updates to the IPZ delineation, the Vf_s remained the same. A value of 0.7 was assigned because of the combination of a relatively shallow intake depth of 5m, a moderate distance from shore of 750m, and satisfactory raw water quality records.

The revised Burlington WTP IPZ-2 delineation incorporated new, mostly urban areas to the zone, including residential areas in the north and south portions of Burlington and employment lands adjacent to the QEW. Storm drainage networks are extensive in these areas.

Two major expressways and two railways were also introduced to the zone with accompanying drainage ditches and variety of potentially hazardous transported goods.

The upper reaches of Rambo Creek and parts of Roseland Creek are diverted at Fairview St and drain to Hamilton Harbour via Indian Creek reducing the potential size of the zone. The overall slope within the zone remains unchanged at between 1% and 1.5%.

Given this combination of factors that both generate and mitigate runoff, the Vf_z remained unchanged at 8. The overall V scores for the IPZ-1 and IPZ-2 remained unchanged at 7 and 6 respectively.

3.3 BURLOAK WPP

The value assigned to the Vf_s is based on the intake depth, distance from shore, and historical water quality. Since none of these characteristics changed with updates to the IPZ delineation, the Vf_s remained the same. A value of 0.5 was assigned due to the relatively deep intake depth of 17m and sizable distance from shore of 1350m. As the intake was not yet operational at the time of writing, historical water quality records could not be considered.

The revised Burloak WTP IPZ-2 delineation added new, mostly urban areas to the zone, including residential areas in the south portions of Burlington and Oakville and employment lands adjacent to the QEW. Storm drainage networks are extensive in these areas, facilitating urban runoff. In addition, four new watercourses in Appleby Creek, Shoreacres Creek, Tuck Creek and Roseland Creek were added to the zone; each conveys water from a number of storm outfalls to the Lake Ontario source water.

A major expressway and two railways were also introduced to the zone with accompanying drainage ditches and variety of potentially hazardous transported goods.

A nearshore water movement study to site the Burloak intake indicates a limited impact is experienced from shoreline influences at the intake (Baird, 2002).

Given the additional potential for transportation of urban runoff to the intake, while considering the water movement study, the Vf_z increased to the middle of the allowable range, from 7 to 8. The overall V scores for the IPZ-1 and IPZ-2 remained 5 and 4 respectively. (As the product of the Vf_s and Vf_z is rounded to the next highest whole number for the purposes of this study, no change was experienced in the V score for the IPZ-2 despite a change in the Vf_z.)

3.4 OAKVILLE WPP

The value assigned to the Vf_s is based on the intake depth, distance from shore, and historical water quality. Since none of these characteristics change with updates to the IPZ delineation, the Vf_s remains the same. A value of 0.6 is assigned due to the moderate intake depth of 8.7m and distance from shore of 860m, and satisfactory water quality records.

The revised Oakville WTP IPZ-2 delineation now incorporates new, mostly urban areas to the zone, including residential areas in the north and south portions of Burlington and employment lands adjacent to the QEW. Storm drainage networks are extensive in these areas, but additional runoff effects are mitigated by stormwater management ponds common north of the QEW.

Bronte Creek and Joshua’s Creek were added to the zone. The up-tributary distances for these creeks, however, are minimal. A major expressway and a railway were also introduced to the zone with accompanying drainage ditches and variety of potentially hazardous transported goods.

The overall slope within the zone remained unchanged at between 1% and 1.5%.

Given this combination of factors that both increase and mitigate runoff, the Vf_z remained unchanged at 8. The overall V scores for the IPZ-1 and IPZ-2 remained unchanged at 6 and 5 respectively.

4.0 Uncertainty Assessment

Each IPZ was assigned an uncertainty level of either “low” or “high” based on the confidence in both the delineation itself and the assigned vulnerability scoring. Factors influencing this process can include the distribution and quality of data, the assumptions and effectiveness of modeling, the variety of approaches used, and validation of results with real-world data.

For all Halton intakes, the IPZ-1 achieved low overall uncertainty because of high confidence in both the delineation and scoring outlined above. The delineation follows the prescribed 1km radius with minor alterations due to revisions to Ministry guidance, resulting in low uncertainty. The vulnerability scoring also carries a low uncertainty given the quality and frequency of data used to characterize the vulnerability of the source water (Vf_s) and the MOE prescribed value of 10 for the Vf_z. Where both the delineation and scoring exhibit low uncertainty, overall IPZ uncertainty can be described as “low”.

The IPZ-2 uncertainty was high for all Halton intakes due to uncertainty remaining in the delineation itself. While in-water modeling was improved to consider wind and wave events from a number of different directions, the model has not been calibrated with field data. The length of the upstream portions of the IPZ-2 were based on the extent of this modeling, as well as a limited number of stream-flow points, and in a few cases, a regional average stream velocity. While the overall quality of modeling and availability of data significantly improved the delineation, the outstanding assumptions identified in this addendum necessitate a high level of delineation-related uncertainty. The uncertainty associated with the vulnerability assessment is low due to the density, frequency and quality of data available. In this case, where either the delineation or scoring component of uncertainty is high, the overall IPZ uncertainty defaults to “high”.

5.0 Conclusion

Revised modeling, additional data, and updated Ministry guidance have facilitated a redelineation of the Halton IPZs and a re-examination of associated vulnerability scores and uncertainty levels. In-lake modeling now accounts for 10-year wind events from eight (8) compass directions and 10-year wave and wind events from three (3) critical directions. This modeling was combined with flow velocities for points in a number of creeks to better determine upstream distances for the IPZ-2 in each watercourse. The additional effects of storm runoff were considered with the inclusion of storm sewer network and watershed boundary data. The resulting IPZ-1 was truncated for the Burlington WPP and Oakville WPP, but remained unchanged for the Burloak WPP. The IPZ-2 now extends landward to Dundas St. for the Burlington WPP, to Upper Middle Rd. for the Burloak WPP, and nearly to Burnhamthorpe Rd. for the Oakville WPP. The alongshore extent of the IPZ-2 did not change significantly for the Burlington WPP, but increased significantly for the Burloak and Oakville WPPs. The overall V scores did not change for any plant despite an increase in the IPZ-2 Vfz at the Burloak WPP. Uncertainty levels remained unchanged and all scores are summarized in Table 5.1 below.

Table 5.1: Vulnerability Score and Uncertainty Level Summary

Component	**Burlington WPP**		**Burloak WPP**		**Oakville WPP**	
	IPZ-1	**IPZ-2**	**IPZ-1**	**IPZ-2**	**IPZ-1**	**IPZ-2**
Zone Vulnerability Factor (Vf_Z)	*10*	*8*	*10*	*8*	*10*	*8*
Source Vulnerability Modifying Factor (Vf_S)	*0.7*		*0.5*		*0.6*	
Vulnerability Score (V)	7	6	5	4	6	5
Vulnerability Score Uncertainty	*LOW*	*LOW*	*LOW*	*LOW*	*LOW*	*LOW*
IPZ Delineation Uncertainty	*LOW*	*HIGH*	*LOW*	*HIGH*	*LOW*	*HIGH*
Overall Uncertainty	LOW	HIGH	LOW	HIGH	LOW	HIGH

Appendix 1.0:
Scope of Work

Appendix 1.1
Additional Phase 1 Module 4 Refinement Notice to Proceed

Deonarine, Gary

From: Holly Wirth [HWirth@ocwa.com]
Sent: Thursday, September 20, 2007 2:09 PM
To: Langan, John
Cc: Andrew Valickis; LMoore@ocwa.com; Greg.Aickele@peelregion.ca; Deonarine, Gary; Tyrrell, John
Subject: FW: Memo 3-D Proposal-
Attachments: Memo 3-D Proposal-12Sep07.pdf

John,

We have reviewed Stantec's Memo: 3-D Modeling and Re-definition of In-Water and Upland IPZ-2 for Western Lake Ontario Intakes (attached) and discussed it with the Sub and Steering committees. Approval has been granted for the additional work outlined in the memo. Please proceed with the work.

Sincerely,

Holly

From: Langan, John [mailto:john.langan@stantec.com]
Sent: Wednesday, September 12, 2007 4:16 PM
To: Andrew Valickis
Cc: Holly Wirth
Subject: Memo 3-D Proposal-

Draft memo outlining Western Lake Ontario 3-D re-modelling and costs with supporting images.

It's in pdf to attach the images.

Your comments will be appreciated for finalization.

Best regards,

John S. Langan
Project Manager Environmental
Stantec Consulting Ltd.
800 - 171 Queens Avenue
London ON N6A 5J7
Ph: (519) 645-2007 Ext. 259
Fx: (519) 645-6575
Cell: (519) 668-4861
john.langan@stantec.com
stantec.com

Memo

Stantec

To:	Andy Valickis OCWA Toronto	From:	John Langan Stantec London
File:	165500512	Date:	September 12, 2007

Reference: 3-D Modeling and Re-definition of In-Water and Upland IPZ-2 for Western Lake Ontario Intakes

Two dimensional ADCIRC modelling has been undertaken to delineate the in-water vulnerability zones for both 10-year and 100-year wind events and a 2-hour time of travel (TOT) by HCCL at five Western Lake Ontario intakes; Grimsby, Hamilton, Burlington, Burloak, and Oakville. ADCIRC 2-D has been applied with good confidence for many other Great Lakes intakes by HCCL at Port Stanley, Grand Bend, Thunder Bay, Fort Erie, Northumberland County and Prince Edward County.

Concerned that the 2-D results may not fully conceptualize water movement for intakes in Western Lake Ontario due to unique lake configuration and susceptibility to long fetch winds from the east, especially in nearshore shallow areas, HCCL applied a 3-D variant of the model with inputs of 2-hour TOT and 100-yr winds and waves from multiple directions for the whole area. The uncertainty in the results from this modeling is much lower since waves have been considered and the return rip currents at depth resulting from easterly winds are considered. While the model applies to the whole of Western Lake Ontario, intake-specific runs using the 100-year event inputs were made for Hamilton, only but included the western extremities of overlapping zones for nearby Grimsby and Burlington intakes. Results of the 2-D and 3-D modelling are depicted in the attached figures.

The Lake Ontario Collaborative (Collaborative) Sub-committee has asked Stantec to have HCCL run this 3-D western Lake Ontario model with 10-year wind and wave events and a 2-hour TOT for the in-water and alongshore IPZ-2 component at five western Lake Ontario intakes. With re-definition of this component, the upland and watershed IPZ-2 components will also have to be re-drawn and vulnerability scores re-evaluated for the Module 4 Report.

The HCCL cost for this extra work is $19,250 (including mark-up) and will include revised figures and supporting text changes to report and/or addendum report. The Stantec cost is $10,000 for text and figure changes, reports production, travel and meetings for presentation of new results and project management for the additional work. Total extra cost is $29,250 exclusive of applicable taxes.

Reference: 3-D Modeling and Re-definition of In-Water and Upland IPZ-2 for Western Lake Ontario Intakes

STANTEC CONSULTING LTD.

J. Langan

John S. Langan
Project Manager Environmental
john.langan@stantec.com

Attachment:

c. G Deonarine
H. Wirth

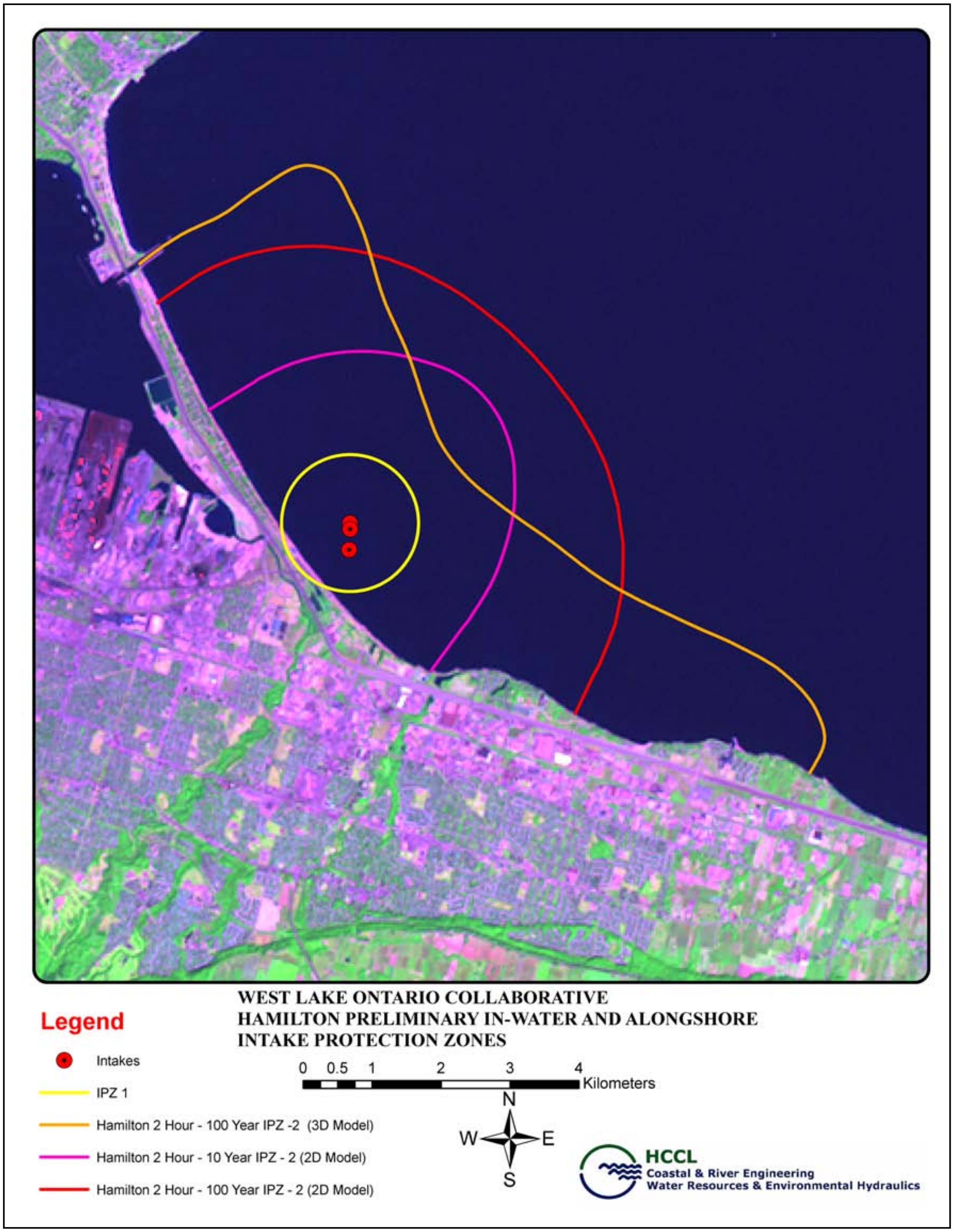
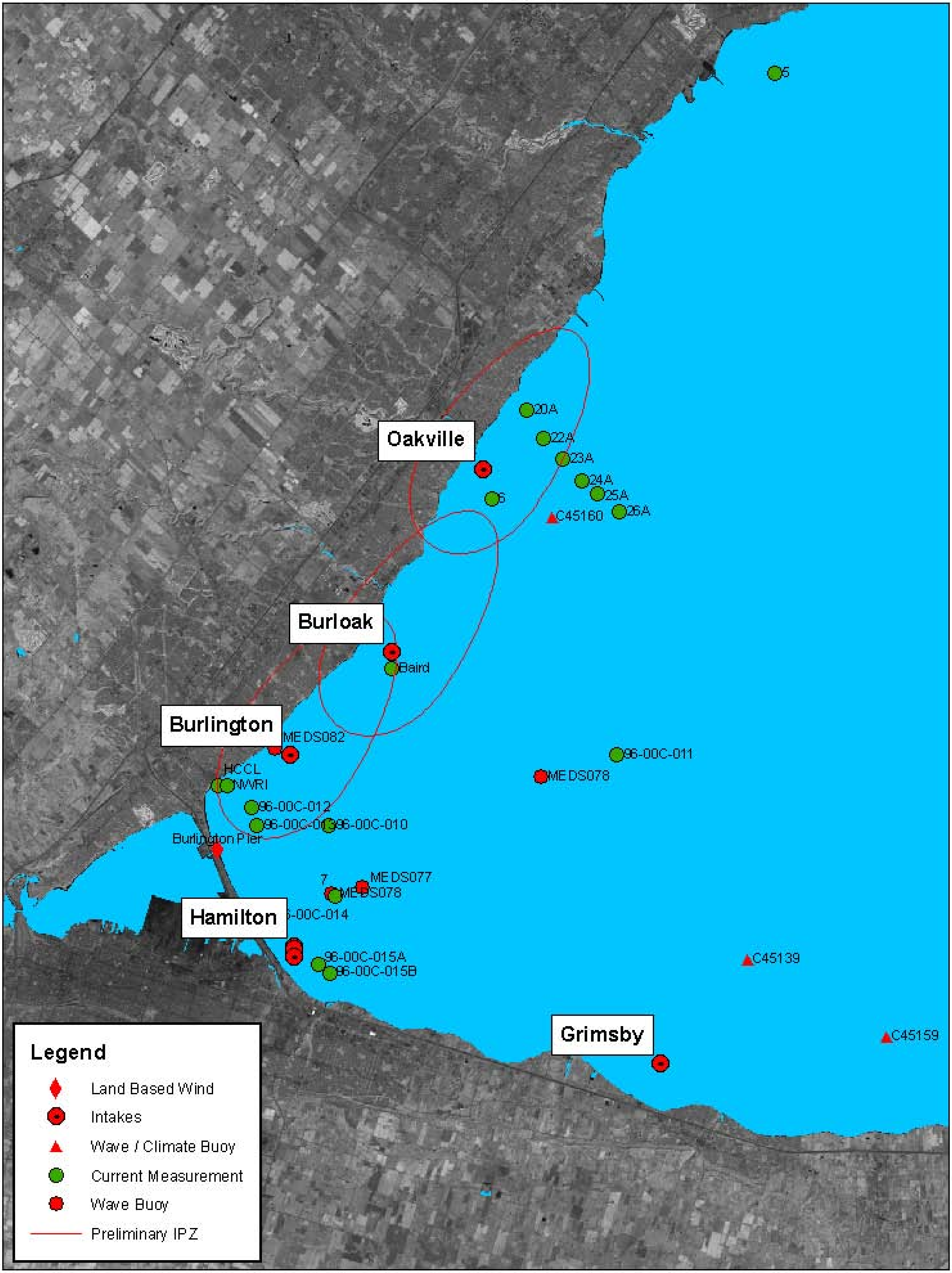
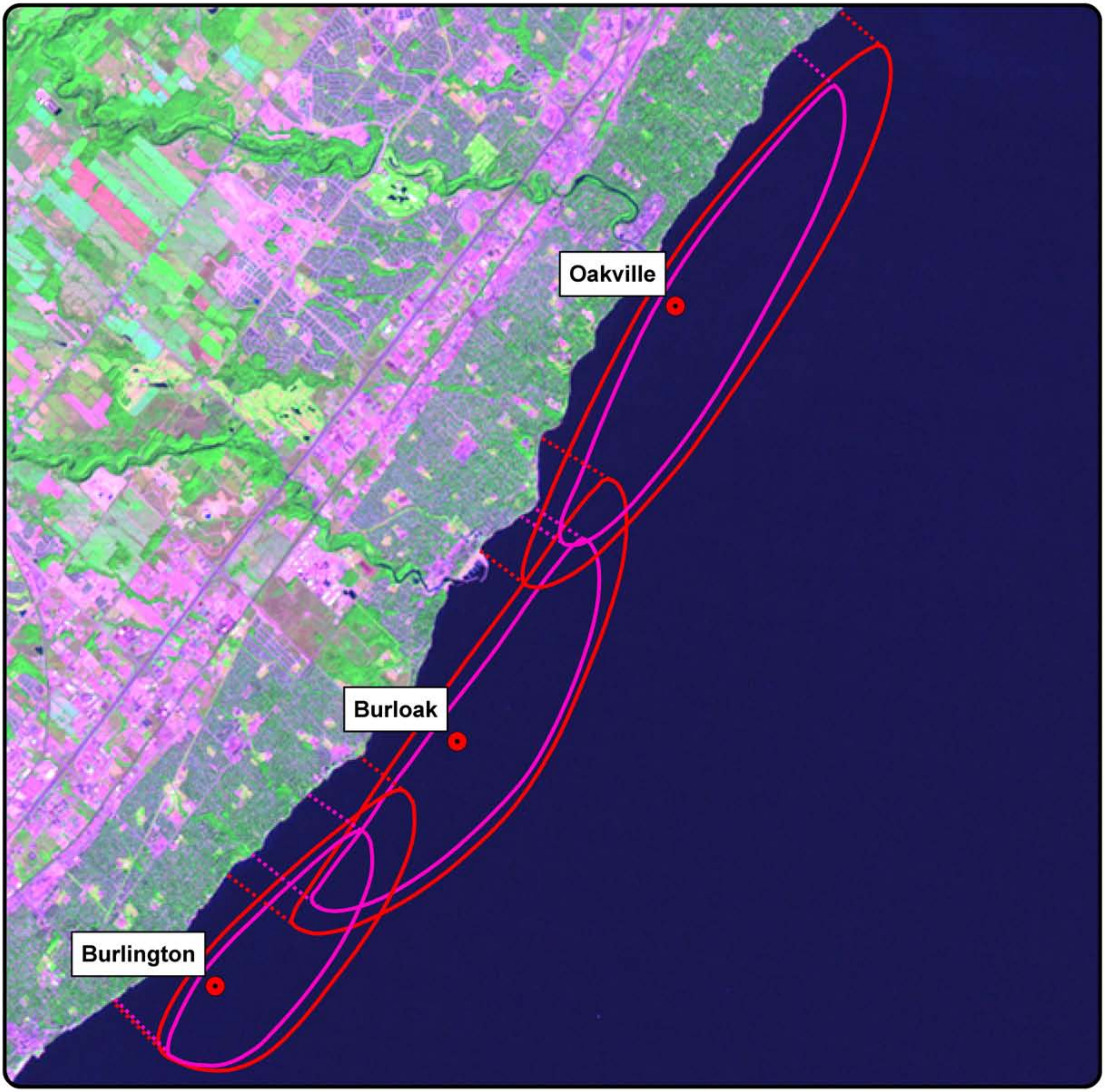


Figure: Hamilton – Preliminary In-Water and Alongshore IPZ-2



Oakville
Burloak
Burlington
Hamilton
Grimsby
5
20A
22A
23A
24A
25A
26A
6
C45160
Baird
MEDS082
HCCL
NWRI
96-00C-011
MEDS078
96-00C-012
96-00C-010
Burlington Pier
7
MEDS077
MEDS078
96-00C-015A
96-00C-015B
C45139
C45159
Legend
Land Based Wind
Intakes
Wave / Climate Buoy
Current Measurement
Wave Buoy
Preliminary IPZ



HALTON REGION - INTAKE PROTECTION ZONES

Legend

- 2 Hour -10 Year
- 2 hour - 100 year
- Recommended Shoreline Intersect (2 Hour - 10 Year)
- Recommended Shoreline Intersect (2 Hour - 100 Year)

N W E S

0 0.5 1 2 3 4 Kilometers

HCCL
Coastal & River Engineering
Water Resources & Environmental Hydraulics

Grimsby Intake Protection Zones

N
W E
S

0 0.5 1 2 3 4 Kilometers

Legend

- 2 hour - 10 year
- 2 Hour - 100 year
- Intakes
- Recommended Shoreline Intersect (2 Hour -10 year)
- Recommended Shoreline Intersect (2 Hour - 100 Year)

HCCL
Coastal & River Engineering
Water Resources & Environmental Hydraulics

Appendix 2.0:
Additional Model Refinement

Appendix 2.1

Lake Ontario Collaborative Module 4 Extension Technical Brief – HCCL

Western Lake Ontario Collaborative- Module 4 Extension
Technical Brief

10 Year In-Water and Alongshore IPZ-2 Delineations for:

Halton Region

- Oakville Intake
- Burloak Intake
- Burlington Intake

City of Hamilton

- Hamilton Intakes

Region of Niagara

- Grimsby Intake

Submitted to Stantec Consulting
March 20, 2008

HCCL
Coastal & River Engineering
Water Resources & Environmental Hydraulics

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1 Purpose

The purpose of this exercise has been to provide refinement to the Phase 1 preliminary "In-Water and Alongshore Extent of the Intake Protection Zones" (IPZ) delineation for the Western Lake Ontario Collaborative sites at Oakville, Burloak, Burlington, Hamilton and Grimsby. Preliminary delineations were presented in August, 2007 based on the results of 2-D hydrodynamic modelling for relevant boundary conditions, and extended 3-D modelling with limited boundary conditions for 10 and 100 year return periods. The present refinement of the delineations, based on direction from the Lake Ontario Collaborative Technical Steering Committee provides for finalization of the Phase 1, 3-D modelling with 10 year boundary conditions for relevant wind and wave forcing conditions.

2 Background

The preliminary IPZ delineations were initiated in December, 2006, with initial guidance from the Ministry of Environment via the October 2006 Revisions to the "Assessment Report:Draft Guidance Module 4" documentation. The guidelines are not specific with regard to the level of risk to be associated with the events defining the IPZ, and simply suggested that for the Zone 2 delineation within a Great Lakes setting, "the travel time can be calculated in the lakes using average longshore current velocity during high wind and current period".

Ideally, the IPZ would be defined on the basis of:

a) sufficient time series measurements of currents (measured locally and regionally in order to define the spatial variations over the area of the IPZ) for a period of sufficient length to capture the probabilistic nature of the current magnitudes and directions over the broad range of potential environmental input conditions, or
b) detailed hydrodynamic modelling (3-D) including the influence of winds, waves and hydrologic inputs, and run using a sufficiently long historic input time series to capture the probabilistic nature of the current magnitudes and directions over the broad range of potential environmental input conditions.

Although there is certainly information available with regard to historic winds, waves and hydrologic inputs for potential use in numerical modelling, there are limited periods where concurrent data exists to provide reliable time series inputs, for verification of a model that might be developed. Furthermore, current numerical modelling capabilities cannot effectively provide for detailed process modelling using extended periods of combined wind and wave time series. Typically, where detailed nearshore process modelling is required, relatively short periods of time are simulated over relatively small domains, and where extended modelling periods are required, processes are lumped or approximated through empirical approximation techniques. Neither is ideal for defining an IPZ based on wind and wave conditions, associated with a 10 to 100 year return period.

HCCL's initial approach to the assessment was based on hydrodynamic conditions associated with 10 year and 100 year wind, wave and hydrologic input conditions. This approach ultimately assumes that model inputs associated with a 10% chance of excedence in any given year (10 year return period input) will provide a 10 year return period current velocity in the model. Initial modelling was performed using a 2-dimensional (vertically averaged) hydrodynamic modelling approach (ADCIRC) including waves, with progression to 3-D modelling using the Princeton Ocean Model (POM). The purpose of the 2-D analysis was to provide preliminary IPZ estimates, and to guide the development of the 3-D modelling with regard to sensitivities in parameters.

The 3-D modelling was performed with the Princeton Ocean Model, with additional stresses imposed on the model domain to reflect the effects of the local wave climate. The model domain was developed such that all intakes were included within one domain, with increased resolution in the vicinity of the intakes and shoreline. This modelling is discussed in the relevant technical modelling reports. A limited number of 100 year scenarios were possible with the 3-D approach due to budget limitations. The purpose of the 3-D modelling was to provide for an assessment of the improved ability of the 3-D approach to reflect the hydrodynamics at the end of the Lake where shoreline geometry results in an increase in the relevance of the 3-dimensional nature of flow. The technical aspects of the modelling to this point are provided in the relevant sections of the Hydrotechnical Analyses reports for the various intakes.

Following a meeting of Western Lake Ontario consultants, Collaborative Steering Committee members and Representatives of the Ontario Ministry of Environment on August 8, 2007, the Collaborative authorized an extension of the HCCL Module 4 modelling to provide for refinements to boundary conditions to finalize IPZ-2 delineations for 10 year events only, accounting for relevant wave conditions at each site. The modelling refinements and results of that modelling are the subject of this brief.

3 Modelling Refinements

3.1 General

The 100 year conditions were not considered in the finalization of the Phase 1 IPZ-2 delineations. The modelling of 10 year design conditions was completed assuming critical wind/wave approach directions, with wind and wave magnitudes determined for such directions through statistical analysis of the relevant historical data.

Wind conditions were specified over the entire model domain for the 8 primary compass directions. Wave conditions were computed separately for local domains for critical directions of interest, and the associated stresses were interpolated to the POM grid cells within those local domains and imposed as an additional stress to the model.

Hydrologic inputs were not included in the 3-D modelling domain due to the relative coarseness of the grid and the relatively small influence of hydrologic inputs in the establishment of the alongshore currents. The minimum grid resolution of approximately

80 m is roughly double the width of the larger river mouths, whereas reasonable modelling of the hydrologic inputs would include multiple grid nodes across any given input. This is not considered to adversely impact the assessment of the lateral (alongshore) extents of the IPZ-2 given that the extreme hydrologic inputs are generally an order of magnitude smaller than the typical alongshore flows generated through winds and waves. The hydrologic inputs were included in the 2-D modelling, and found to be insignificant in the definition of the zone.

This is not to say that the hydrologic inputs are not important for delivery of contaminants to an intake under certain environmental conditions. It is simply noted that the extreme conditions that define the maximum in-water and alongshore extent of IPZ-2 for intakes in moderate to shallow water depths appear to be primarily defined by the local wind and wave stresses. There may be numerous combinations of wind and wave conditions which would permit a watercourse within the IPZ-2 boundary to influence water quality at a given intake within 2 hours. The shortest travel time from a shoreline source to a given intake is however a much more complex problem, with potential local and possibly seasonal considerations required in the definition of the associated driving forces. Because the Phase 1 analyses is not intended to be source-specific, an evaluation of specific conditions which would maximize the potential for transport from a given watercourse source has not yet been undertaken.

Modelling to date has also indicated that the lakewide boundary conditions have a minimal influence on the local currents generated under high wind conditions. Furthermore, the specification of the lakewide boundary conditions for significant events is subject to considerable interpretation, as real measurements for extreme events are generally not available, and would be dependent to some degree on antecedent conditions. The specification of 3-D boundary conditions would be further constraining to the solution, should they be prescribed in an inappropriate manner. Due to these limitations, the 3-D modelling has been completed assuming an open boundary, which permits transfer of energy into and out of the domain. The boundary has been developed a significant distance from the areas of interest in order to permit the development of relevant hydrodynamic conditions within the area of the intakes under the local forcing functions.

Specific combinations of wind and wave boundary conditions imposed on the domain for each of the areas of interest are noted in the following sections. As previously noted, modelling was also conducted for wind-only conditions from the 8 primary compass points, with 10 year design wind speeds. A discussion of the results of the finalized 10 year event modelling is provided in Section 4.

3.2 Halton Intakes

The Halton shoreline is aligned in a southwest to northeast orientation, with the intakes located in close proximity to the western end of Lake Ontario. As a result, wave fetches from the east / northeast are very large, while those from the southwest and west are significantly smaller. Efforts to define the combination of 10 year wind and wave conditions which maximizes the alongshore extent of the IPZ-2 and potential shoreline connections have resulted in the definition of boundary conditions as presented in Table 3.1.

Table 3.1 : 10 Year Wind + Wave Conditions – 3-D POM at Halton Intakes

IPZ-2 Orientation	10 Year Waves (From)	10 Year Winds (From)
Alongshore	H_s = 4.5 m, T_p = 9s (E)	18.8 m/s (NE)
Onshore/Offshore	H_s = 2.2 m: T_p = 6s (S)	20.8 m/s (SW)
Alongshore	H_s = 1.7 m: T_p = 5s (SE)	13.7 m/s (SE)

3.3 Hamilton Intakes

The Hamilton shoreline is aligned in a northwest to southeast local orientation, with the intakes located at the extreme westerly end of Lake Ontario. As a result, wave fetches from the easterly quadrants are very large, while those from the westerly quadrants are virtually non-existent. Due to the regional shoreline orientation and associated circulations, and because the shoreline-normal (onshore/offshore) direction is generally consistent with the axis of the lake, the distinction between predominant alongshore driving forces and predominant cross-shore driving forces is less evident. Efforts to define the combination of 10 year wind and wave conditions which maximizes the alongshore extent of the IPZ-2 and potential shoreline connections have resulted in the definition of boundary conditions as presented in Table 3.2.

Table 3.2 : 10 Year Wind + Wave Conditions – 3-D POM at Hamilton Intakes

IPZ-2 Orientation	10 Year Waves (From)	10 Year Winds (From)
Alongshore	H_s = 4.2 m, T_p = 8s (E)	19.2 m/s (E),
Onshore/Offshore	H_s = 1.7 m: T_p = 5s (N)	18.7 m/s (NW)
Alongshore	H_s = 3.2 m: T_p = 7.5s (NE)	18.8 m/s (NE)

3.4 Grimsby Intake

The Grimsby shoreline is aligned in a west-northwest to east-southeast local orientation. Although Grimsby is subject to larger westerly exposure than Hamilton, this intake is also located at the westerly end of Lake Ontario within a regional context. Wave fetches from the northeasterly quadrants are very large, while those from the westerly quadrants are limited. Efforts to define the combination of 10 year wind and wave conditions which maximizes the alongshore extent of the IPZ-2 and potential shoreline connections have resulted in the definition of boundary conditions as presented in Table 3.3.

Table 3.3 : 10 Year Wind + Wave Conditions – 3-D POM at Grimsby Intakes

IPZ-2 Orientation	10 Year Waves (From)	10 Year Winds (From)
Alongshore	H_s = 3.2 m, T_p = 7.5 (NE)	19.2 m/s (E)
Onshore/Offshore	H_s = 1.6 m: T_p = 5s (NW)	22.3 m/s (W)
Alongshore	H_s = 1.7 m: T_p = 5s (N)	17.6 m/s (N)

4 Discussion and Interpretation of results

4.1 General

The results of 2-hour particle tracking for the various Lake Ontario Collaborative intakes are shown within the context of the nearshore bathymetry in the following sections. These figures present the results of the 2 hour back-tracking for all boundary conditions (events) discussed in Section 3. Back-tracking has been performed at various depths, extending from the bed to the surface.

The definition of a shoreline connect is complex. At a given depth, the back-tracking may intersect the local bed, which from a plan-view perspective would appear to be some distance from the perceived shoreline as defined by the static water level. Therefore, the termination of some of the back-tracking paths are not necessarily due to a time-limited transport condition, but rather the particle track encountering the model boundary at the bed, and stopping due to the boundary influence on the numerical simulation.

Furthermore, there is significant turbulence within the wave breaking zone which would be expected to make contaminants released within the wave breaking zone available across the zone in a relatively short period of time. This process is influenced by numerous local parameters, and is not well resolved by existing numerical modelling tools.

Given the complexities of the nearshore hydrodynamics, especially within the wave breaking zone, the wave breaking zone has been assumed to represent the effective shoreline for IPZ-2 connection purposes. Therefore, where the particle tracking reaches the expected wave breaking region, the IPZ-2 boundary is connected to the shoreline. This shoreline connection point and associated nearshore delineation has been adjusted as necessary in order to provide for a geometrically smoothed boundary. Because marginal changes in boundary conditions would be expected to generate variations in the particle tracking alignments, it is considered prudent interpret the tracking plots accordingly, avoiding overly complex boundaries based on the discrete number of boundary combinations modeled.

The bathymetric contours presented in the back-tracking images represent depths of 8 m and less. Given design wave heights in the order of 1.7 to 4.5 m, wave breaking would be expected to be initiated in depths of approximately 2 to 6 m. Breaker depth may vary with local bathymetry, wave characteristics and local currents as well, and therefore this boundary definition is also subject to some variation.

4.2 Halton Intakes

The results of 2-hour particle tracking for the Halton Intakes for the boundary conditions noted above, is shown within the context of the nearshore bathymetry in Figure 4.1. This figure presents the results of the 2 hour back-tracking for the 8 compass wind directions as well as wind + wave events presented in Table 3.1, with tracking performed at various depths, from the bed to the surface.

Generally, events driven by winds and waves with a strong alongshore sense result in more consistent (narrow) bands of back-tracking, while events with more cross shore wind and wave forcing produce a wider band of back-tracking. Under these conditions, the potential transport from the offshore areas (particle tracking originating offshore) is predominantly associated with surface waters, whereas the tracking extending along the shoreline and to the nearshore regions is more often associated with currents at depth. This is in part due to the tendency for offshore transport at depth to originate from wave action in the nearshore region, where alongshore currents are also relatively strong

Significant watercourses within the defined IPZ-2 delineations include Sixteen Mile Creek, which discharges to Lake Ontario less than a kilometer from the Oakville Intake and Bronte Creek which is within both the Oakville Intake and Burloak Intake IPZ-2 boundaries, discharging to Lake Ontario approximately 2.5 kilometers east of the Burloak Intake.

As previously noted, the hydrologic inputs from these sources are not significant factors in defining the maximum 10 year IPZ limits within the lake. Although these watercourses may be significant general sources of contaminants to the nearshore region, the determination of the shortest travel time from a given watercourse to an intake would require evaluation of numerous potential combinations of antecedent wind and wave conditions under high discharge conditions, possibly considering thermal influences, and is beyond the scope of the present modelling exercises. For the purpose of upland delineations, an approximate time of travel from the two major watercourses noted above, to the respective intakes of potential influence, has been estimated based on the ratio of the alongshore distance between intake and watercourse to distance between intake and alongshore extent of the IPZ-2 zone. This is not necessarily considered to be a conservative estimate, but without analysis specifically directed towards defining the optimum pathway between the intake and watercourse, a more sophisticated approach is not justified.

On this basis, the approximated time of travel from watercourse discharge points to intakes of interest are estimated (to the nearest 15 minutes) as follows:

- 16 Mile Creek to Oakville Intake ≈ 0.5 Hrs
- Bronte Creek to Oakville Intake ≈ 1.75 hrs
- Bronte Creek to Burloak Intake ≈ 1.0 hrs

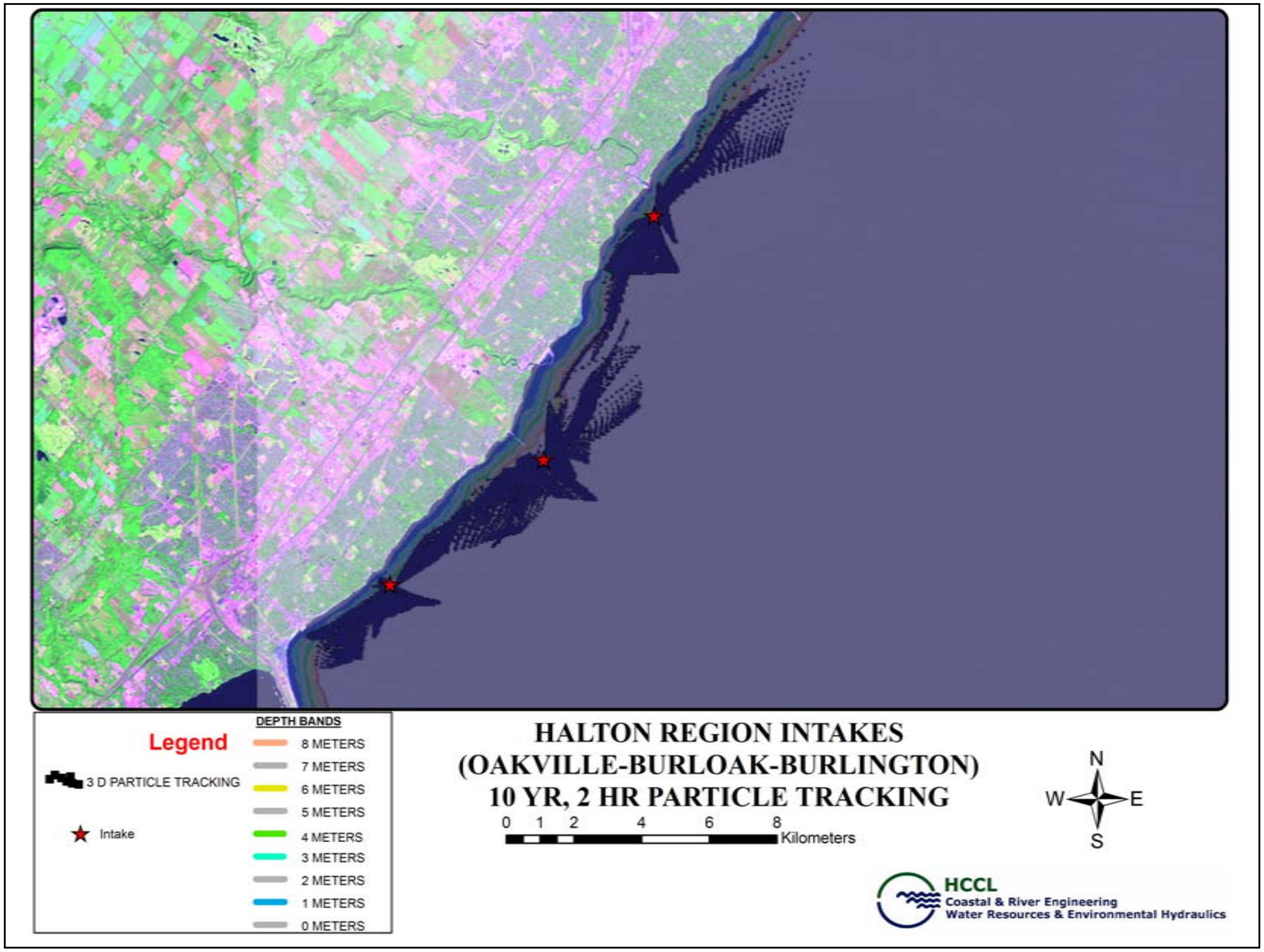

Figure 4.1: Halton Intakes – 10 Year, 2 Hour Back-tracking Results

4.3 Hamilton Intakes

The results of 2-hour particle tracking for the Hamilton Intakes for the boundary conditions noted above, is shown within the context of the nearshore bathymetry in Figure 4.2. This figure presents the results of the 2 hour back-tracking for the 8 compass wind directions as well as wind + wave events presented in Table 3.2, with tracking performed at various depths, from the bed to the surface.

The IPZ-2 region for the Hamilton intakes appears to be influenced by the shoal area to the southeast of the intakes. The increased width of the surf zone in this area and the general orientation of the shoal with respect to the local shoreline at the intake results in a higher potential for back-tracking particles to be picked up by the relatively strong alongshore current in this region.

The extent of the zone to the northeast is not as significant, largely due to the reduced exposure under the local shoreline geometry, and the resulting smaller region over which the boundary forces are applied in the alongshore sense. The bathymetry to the northwest is more regular and although particle tracking extends into the breaking zone, it is not shown to reach the Hamilton Harbour shipping canal within the 2 hour time of travel. This does not suggest that contaminants from the harbour would not influence water quality at the intakes. Extrapolation of the 2 hour back-tracking would suggest that the harbour mouth is within about 2.5 hours travel time of the intakes. Given the known water quality issues within the harbour, and the potential for currents (thermally induced, hydraulically induced or vessel induced) to provide for exchange of harbour waters with the nearshore lake waters, the relative proximity of the source should be given due consideration.

4.4 Grimsby Intake

The results of 2-hour particle tracking for the Grimsby Intake for the boundary conditions noted above, is shown within the context of the nearshore bathymetry in Figure 4.3. This figure presents the results of the 2 hour back tracking for the 8 compass wind directions as well as wind + wave events presented in Table 3.3, with tracking performed at various depths, from the bed to the surface.

Particle back-tracking from the Grimsby intake for the modeled boundary conditions generally travels within the nearshore region, often within the 6 m depth contour region. All events modeled tend to generate a predominant alongshore current, expected to be due to the regional shoreline orientation. The undulating shoreline is also expected to generate localized focusing of offshore currents, which may not be fully reflected in the current model resolution. The effect of the shoreline undulations is evidenced to some degree by the bow-tie shape of the tracking plot.

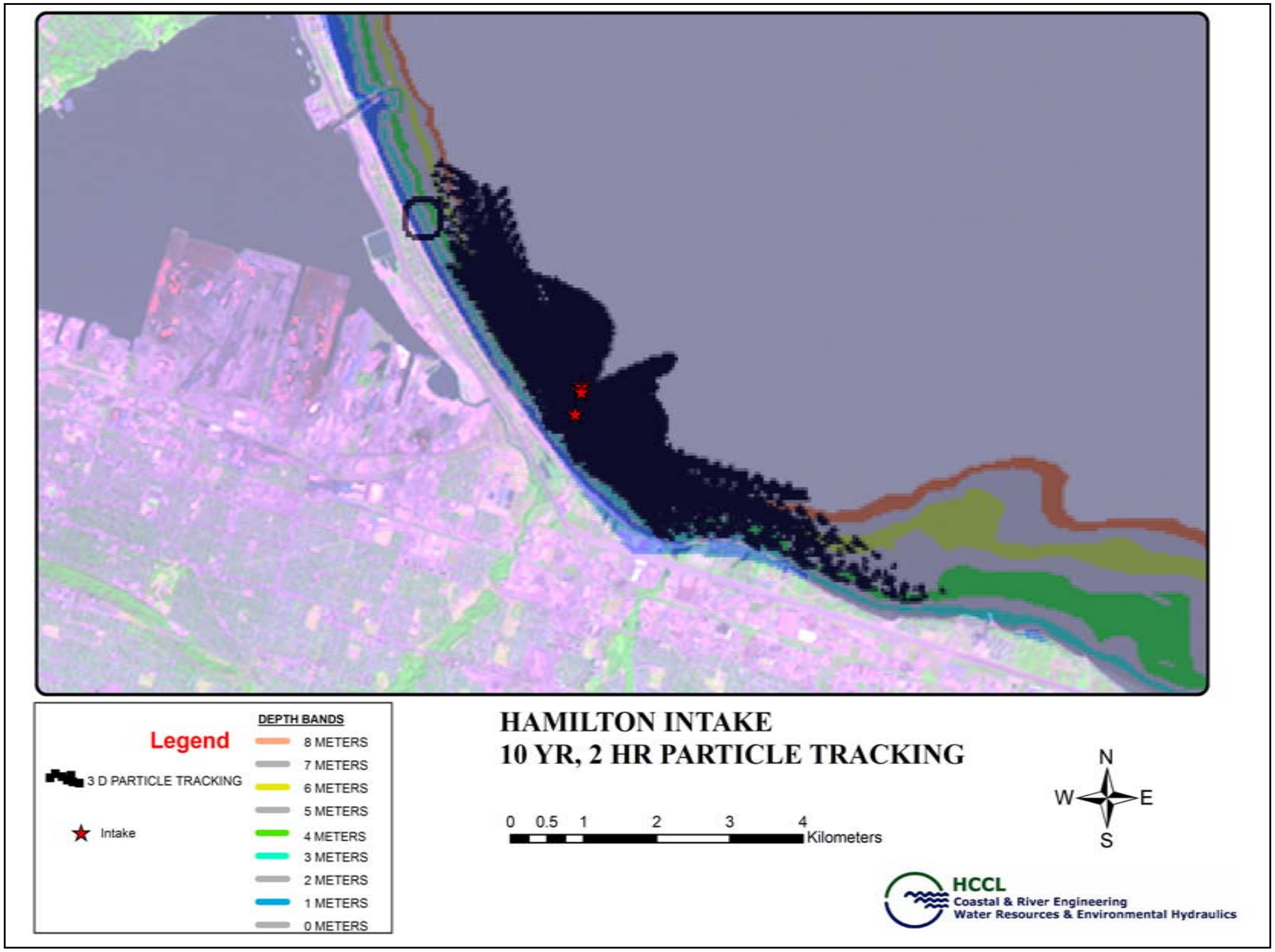

Figure 4.2: Hamilton Intakes – 10 Year, 2 Hour Back-tracking Results

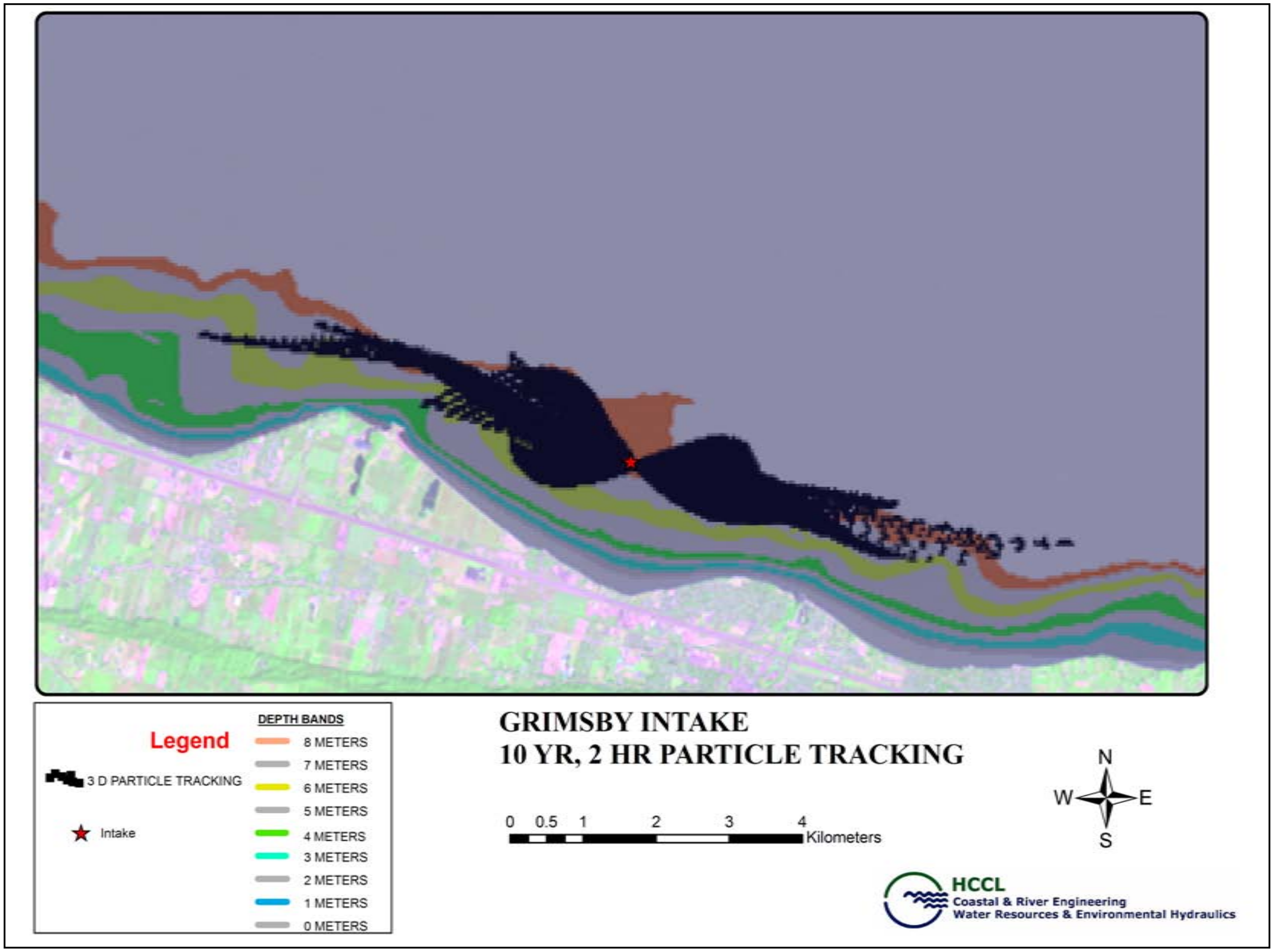

Figure 4.1: Grimsby Intake – 10 Year, 2 Hour Back-tracking Results

5 Revised In-Water and Alongshore Extent of IPZ-2

The IPZ-2 boundaries were adjusted based on the modelling refinement discussed herein. Backward particle tracking results for the 3-D POM modelling forced by winds and interpreted wave stresses.

As previously noted, these boundaries have been interpreted such that shoreline connection is assumed where particle back-tracking reaches the estimated effective wave breaking zone. These zones are defined on the basis of a relatively comprehensive hydrotechnical modelling effort. The analysis would benefit to some degree from further refinement of the modelling grid and consideration of additional possible combinations of extreme wind, wave and hydrologic input conditions. It is noted, however, that current scientific methods cannot fully account for the complexities of the nearshore hydrodynamic environment, and therefore, some level of interpretation of the results will always be necessary

The IPZ-2 boundaries resulting from the finalized Phase 1 analyses are presented in Figure 5.1.

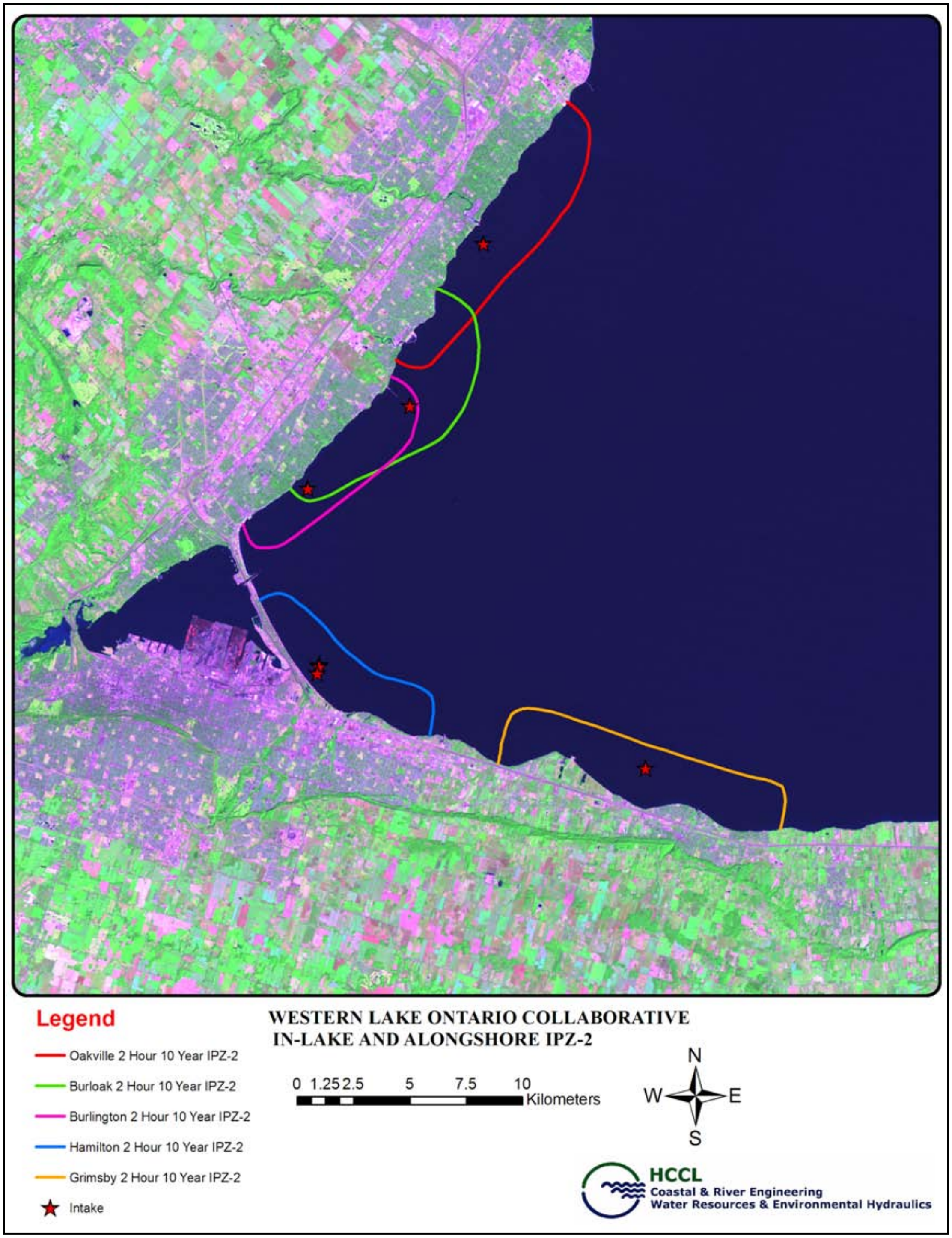

Figure 5.1: Western Lake Ontario Collaborative
10 Year, 2 Hour, In-Water and Alongshore IPZ-2

Appendix 2.2

Additional Delineation Methodology from MOE

From: Keller, Martin(ENE) [mailto:Martin.Keller@ontario.ca]
Sent: Thursday, January 24, 2008 4:27 PM
To: Laurence Moore
Cc: Andrew Valickis; Deonarine, Gary; Langan, John; Tucker, Clara (ENE)
Subject: Planning and Coordination Meeting Jan 25

Hi Larry,

You indicated to me that you would like some guidance on the proposed updates to the technical study components, specifically related to IPZ-3 for your planning and coordination meeting tomorrow. I won't be able attend tomorrow's meeting, however, Stantec is aware of these updates through the Technical Discussion Sessions held in December 2007 and I will summaries the proposed updates that are relevant to the work the Collaborative is doing on Lake Ontario Intakes in this email. Anything that is not mentioned here is not proposed to change.

Please note that my advice is provided in absence of regulations and rules, and might not be applicable once these have been developed.

IPZ-1

Where IPZ-1 intersects with land, the zone is proposed to extend on to land to the limit of the Regulatory Area plus 15m or 120m, measured from the shoreline, whichever is greater. It is suggested that this applies to both Great Lakes and Great Lakes Connecting Channel intakes. It would also apply to Inland Lakes, although you don't have any in your study area.

IPZ-2

Where IPZ-2 intersects with land, a setback of 15 m from the limit of the Regulated Area or 120m (whichever is greater) is proposed to be used from the shoreline. We suggest that the setback can be modified in the following circumstances:

- The local topography is such that portions of the drainage area in the setback do not drain towards the water body whereby the setback would be reduced; or
- There is presence of natural and constructed preferential pathways which concentrate the flow to the water body. In this case we suggest that the setback can be extended to include those preferential pathways where a supporting rationale exists.

In reference to the October 2006 draft guidance (Module 4 page 11) the up-current extension of IPZ-2 for Great Lakes Connecting Channels is proposed to be based on current flows that represent average normal condition, not maximum flows. This would then be in line with using average longshore current velocity during high wind and current period for Great Lakes, and bankfull flow velocities (roughly equivalent to a 2yr storm event) in river settings.

IPZ-3

For Great Lakes and Great Lakes Connecting Channels (as well as for rivers and inland lakes), it is proposed to have an issues driven delineation of IPZ-3. That is, for Great Lakes and Connecting Channels, it is proposed to not have an IPZ-3 for the purpose of undertaking a threats inventory.

The IPZ-3 for issues is proposed to be delineated once an issue has been identified at an intake; that is the issue IPZ-3 is specific to a contaminant. For example, if a WTP in the past had a situation where they had to shut down the plant because of elevated benzene levels (such has happened in Wallaceburg as I undestand), benzene could be identified as an issue for this WTP. In this case, it is proposed that a benzene issue IPZ-3 would be delineated, if the probable sources of benzene are not confined to IPZ-1 and IPZ-2. In other words, an IPZ-3 for a specific issue would be delineated if the issue can not be fully explained by the threats that have been inventoried in IPZ-1 and IP-2. We suggest that issues IPZ-3s are contaminant specific; that is if there are multiple issues, there could be multiple issues IPZ-3, one for each issue.

IPZ-3 for an issue is proposed to extend upstream from IPZ-2 to include a setback of 15m plus the limit of the Regulated Area or 120m (whichever is greater), and may include areas beyond this setback (e.g., seepage areas) where a supporting rationale exists. This means that preferential pathways are proposed to be included in the issues IPZ-3. It is proposed that the issues IPZ-3 be scoped to the level of a subwatershed at a minimum to focus on those areas that are contributing to the issue.

On Great Lakes and Great Lakes Connecting Channels (as well as on inland lakes), it is proposed that an issues IPZ-3 does not necessarily have to be connected to the IPZ-2. So it is proposed that a tributary that is known to contribute to the issue at the intake that is situated further along the shoreline, this tributary can also delineated as an issue IPZ-3.

It is important to note that the proposed approach is to only delineate an IPZ-3 once an issue has been defined, and where it can not be accounted for in IPZ-1 and IPZ-2.

I've attached a few graphics to help with interpretation.

Regards

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