

Task Summary Report
(Baird Phase II Tasks 3.2 and 5.1)
**Bluff Distance Mapping – Lake Ontario Detailed
Site Studies**



**Coastal Task Working Group
International Joint Commission
Lake Ontario – St. Lawrence River Regulation Study**

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Prepared By



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BLUFF DISTANCE MAPPING – LAKE ONTARIO DETAILED SITE STUDIES

1.0 INTRODUCTION

This task forms part of a series of tasks being conducted for the Coastal Task Working Group (CWG) of the IJC Lake Ontario – St. Lawrence River Study by Christian J. Stewart Consulting (CJS) and W.F. Baird and Associates (Baird). Specifically this task comprises a portion of “Task 3.2 – Evaluate Development Density Classification” and “Task 5.1 - Number of Buildings and Average Distance (per reach)” in the June 14, 2002 Phase II proposal submitted to the CWG by Baird and CJS.

2.0 BACKGROUND AND PURPOSE

As part of their efforts within the Coastal Task Group, Baird is developing a Flood and Erosion Prediction System (FEPS) that will be used to make evaluations of potential flood and erosion impacts due to changes in water level regulation that might occur on the Lake and River. In order to assist in the calibration of the model, as well as to conduct levels of analyses that would not be possible over the entire Lake and River system, Baird has established a series of site study areas where the FEPS model will be used to conduct a series of detailed analyses.

One key component of the FEPS model is to determine, based on best available historic, as well as modeled and newly determined recession rates, the amount of time before an existing property may be negatively influenced or threatened by an erosion hazard. A key data input then, was the present distance of existing buildings from the bluff edge.

To gather this data, Baird, in Phase I of the Study, developed simple kilometer-by-kilometer estimates of the number of buildings per shoreline reach and the average distance of those buildings from the bluff crest for a number of the detailed site study areas. These were rough estimates based on observation of air photos, videos and DOPs (i.e., no precise measuring was conducted).

In order to gauge the accuracy of these initial estimates (and this technique) for lakewide application, as well as to develop more precise data of this type for use in the detailed FEPS analysis that Baird is conducting in the Site Study areas, detailed mapping and collection of bluff distances for each structure was required. This was conducted in four of the Site Study areas including the CND1 (Niagara), CND7 (Whitby-Oshawa-Newcastle), US4 (Chimney Bluffs area) and US7 (Eastern Lake Ontario Sand Dunes) “Shore Unit” areas (Figure 1).



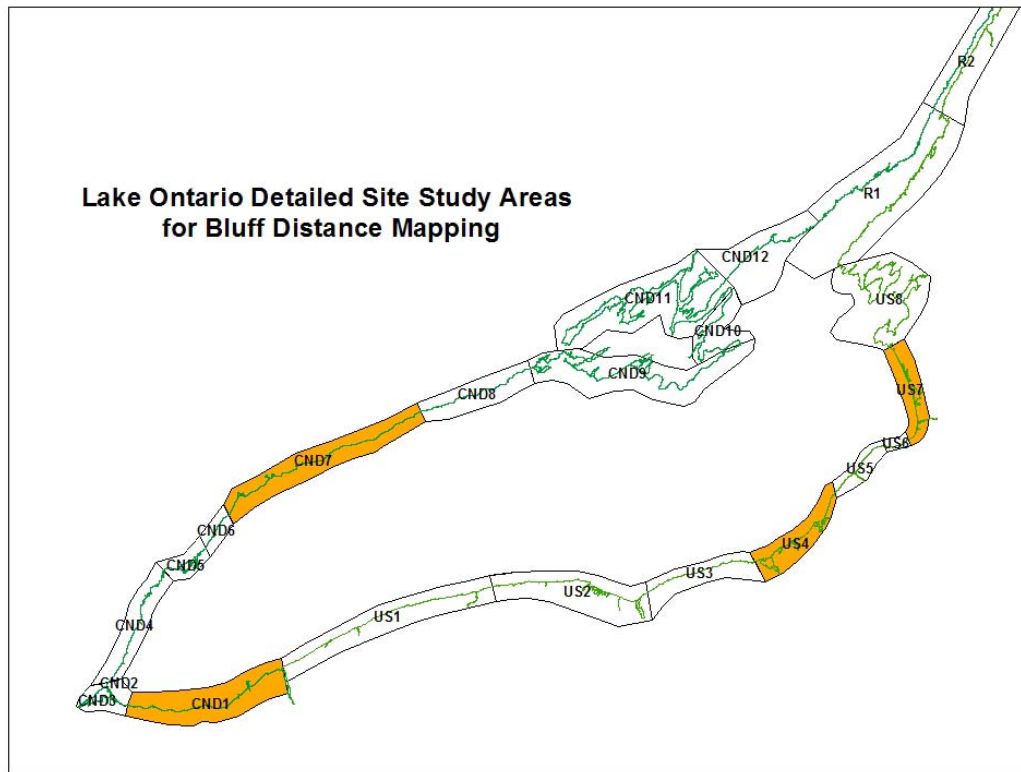


Figure 1 – Location of Detailed Site Study Areas Where Bluff Distance Mapping was Completed.

Using detailed planimetric information that was available from other activities within the Study as well as available DOPs, the distance of all “first-tier” structures in each shore unit from the bluff crest was mapped. Summary statistics were then prepared for each Study Area and are presented later in this report. These include the number of structures (bluff distance lines) per reach, and the average, maximum and minimum, bluff distance per reach. The specific length of each line segment is retained in the attribute table of the mapped segment.

3.0 METHODS

3.1 Digital Orthophotography

The primary data source used in mapping bluff distances in the 4 site study areas was new digital orthophotography that was flown in these areas for the IJC Study.



On the Canadian side, 2000 black and white (CND7) and 2002 color (CND1) photography was provided by Environment Canada (prepared by JD Barnes and Associates). On the U.S. side, 2002 color photography was provided by the U.S. Army Corps of Engineers (prepared by EarthData International Inc.).

In using the DOPs, a number of limitations were encountered. These included:

- 1) The CND1, US4 and US7 photography were all flown during “leaf-on” conditions. As such, in many cases, vegetation and vegetation shadows obscured either the bluff crest, or the closest edge of the structure and as such defining the precise start and end point of the bluff distance line segment may have been difficult. Where they were available, Digital Elevation models (DEMs) and spot elevation data were used to assist in determining the bluff crest, but these were also sometimes not very reliable, or were at a scale that was not feasible to use. In these instances, classification was done through field knowledge of the shoreline, or reasonable assumption, based on surrounding protection types.
- 2) The CND1 photography had a number of instances where the image was “blurred” (as if the print had been slightly moved in the middle of the scanning process). Unfortunately, this blur tended to happen right at the land water interface. Again, this made it difficult to interpret bluff crest position. Similarly, these photos were often very dark in places, again resulting in difficult interpretation of bluff crest and structure edges;
- 3) On all photography, in low lying dune / beach environments, it was difficult to discern what should be defined as the bluff crest. In most cases, a vegetation line was used where present. Again DEMs and spot elevation data were used in some areas to assist in determining the most appropriate position.

Additional minor issues are identified in the metadata that was prepared for each of the ArcMap coverages that were developed.

3.2 Bluff Distance Mapping

The mapping of bluff distances was completed directly in ArcMap for each detailed site study area. First, the digital shoreline for the study area and the associated digital orthophotos were brought in to use for mapping and reference purposes. Where available (US4, US7), bluff crest mapping that was developed within the Study was also loaded. Individual line segments were then created for each structure. Segments initiated at the edge of the building and were extended



toward the shoreline and ended at the bluff crest position. In creating the bluff distance line segments, a number of “rules” were developed and followed:

- 1) In general, only “first-tier” structures within 300m - 400m of existing shoreline / bluff line were captured. Some “second tier” structures were mapped where there were gaps in first tier;
- 2) Line segments were generally drawn so that they were perpendicular to the overall “trend” of the shoreline. As such, the line is NOT always the shortest distance between the structure and the bluff crest;
- 3) Patios / pools / decks / walkways associated with a structure were not used as building edges, only the closest edge or corner of the major structure itself;
- 4) Where shore protection (SP) was present and there was no discernable sign of a bluff crest, the top of bluff was considered to be top/crest of the shore protection;
- 5) Where wetland vegetation was present, the “bluff crest” was defined where the non-wetland / wetland vegetation interface was noted;
- 6) Townhouse and other multi-family residential structures were considered as one building;
- 7) Where boathouses were on / adjacent to water, they were not captured. For any analysis they would be considered a “zero” distance from bluff crest. Any attempt to draw a line for these would result in assigning a value greater than 0. Also, these structures are not typically in a bluff environment or a low bank environment; and
- 8) Bluff distance measurements were generally only measured for “open-coast” shorelines only. This included the shorelines of large embayments located in US4 (e.g., Sodus Bay, Port Bay) and US7 (e.g., North Pond), but did not include such things as the shorelines of marina basins (e.g., Newport Yacht Club – CDN1) or the Welland Canal (CND1), which were included as part of the digital shoreline. Islands were not captured in this analysis.

Additional minor issues are identified in the metadata that was prepared for each of the ArcMap coverages that were developed.

Examples of the bluff distance mapping can be found in Figure 2.





Figure 2 - Example of Bluff Distance Mapping, CND7 (Top) and US4 (Bottom)



4.0 DATA PRESENTATION AND ANALYSIS

4.1 ArcMap Files

ArcMap shape (.SHP) files were created for each study area. These include:

- **cnd1_bluff_dist.shp** – Perpendicular shore protection, CND1 Study Area
- **cnd7_bluff_dist.shp** – Perpendicular shore protection, CND7 Study Area
- **us4_bluff_dist.shp** – Perpendicular shore protection, US4 Study Area
- **us7_bluff_dist.shp** – Perpendicular shore protection, US7 Study Area

4.2 Data Attributes

The attribute tables within ArcMap contain the following key information (exact field names may vary slightly by file):

Length - This provided the length of the bluff distance line segment in meters based on the start and end points that were mapped.

Reach – The particular 1 kilometer IJC Study reach segment that the line segment was within. This was recorded for analysis purposes.

Comments - Any relevant additional information regarding the bluff distance line segment.

4.3 Data Analysis

For analysis purposes, data was exported from the ArcMap program into MS-Excel in order to compute overall statistics on the total number of bluff distance line segments mapped in each study area. Data was also presented on a reach-by-reach basis and included the number of segments (structures) per reach as well as the maximum, minimum and average bluff distance. Summaries for each Study Area are presented below.

4.3.1 CND1 - Niagara

Summary statistics for bluff distance mapping in the CND1 Shore Unit are presented in Table 1. For the entire Shore Unit, 1,503 structures were mapped. Average distance to the bluff for all structures was 39.8 m, with an average



Table 1
"Distance to Crest of Bluff" Statistics by Reach
on Lake Ontario Within Shoreline Segment CND1

Reach	Count of Lines within Reach	Minimum Length	Maximum Length	Average Length
1223	17	30.9	135.8	62.6
1224	10	7.8	136.2	68.5
1225	3	150.2	185.1	173.3
1226	1	72.7	72.7	72.7
1227	9	7.0	25.7	14.7
1228	29	1.7	52.1	18.8
1229	7	8.8	44.2	26.6
1230	12	5.1	89.2	28.2
1231	20	16.3	63.4	36.3
1236	13	26.2	82.6	56.9
1237	18	1.7	35.2	17.1
1238	11	6.8	110.8	43.3
1239	18	1.5	133.0	28.4
1240	21	4.6	49.3	19.1
1241	31	6.9	41.3	17.1
1242	23	9.4	170.2	49.9
1243	23	8.1	76.6	26.1
1246	23	6.7	78.1	25.0
1247	3	8.7	40.7	23.9
1261	47	11.3	157.3	77.7
1262	35	15.1	138.3	64.4
1263	41	6.8	150.0	50.6
1264	28	15.8	96.4	36.6
1265	24	20.8	97.3	49.8
1266	1	88.4	88.4	88.4
1270	14	5.2	64.8	25.4
1271	49	3.2	70.0	27.7
1272	35	5.9	113.8	28.8
1273	9	6.5	31.7	16.6
1274	28	0.8	129.3	37.0
1275	20	7.6	81.2	39.0
1276	13	15.4	87.8	32.2
1277	6	5.6	27.4	14.4
1278	26	1.5	45.9	24.6
1279	7	27.6	63.4	48.0
1280	1	21.0	21.0	21.0



1281	8	7.3	113.2	29.8
1282	9	10.1	138.1	59.5
1283	14	12.0	187.7	56.5
1284	19	3.2	118.9	47.4
1285	12	30.3	173.0	61.3
1286	27	17.4	118.3	51.6
1287	25	20.4	108.7	53.4
1288	21	12.0	132.7	60.6
1289	26	1.3	121.3	60.1
1290	14	9.5	172.7	49.5
1291	17	32.5	181.1	91.9
1292	16	2.3	99.2	33.7
1293	27	14.6	177.4	76.8
1294	38	7.6	82.5	31.7
1295	52	3.3	65.4	23.9
1296	40	6.8	158.5	73.9
1297	10	1.4	73.8	20.7
1299	20	2.2	80.1	38.8
1300	44	10.2	144.5	44.3
1301	36	9.6	143.4	45.4
1302	27	11.9	127.9	33.8
1303	10	15.1	159.3	45.1
1306	1	26.5	26.5	26.5
1308	14	1.7	64.9	30.1
1309	16	9.0	49.0	27.4
1310	30	4.1	95.6	29.7
1311	36	3.5	52.6	18.7
1312	37	11.1	75.2	34.1
1313	32	2.5	72.6	29.2
1314	19	2.4	74.3	23.1
1315	7	4.1	22.8	11.3
1316	23	9.9	38.4	30.6
1317	33	7.4	61.5	22.4
1318	30	0.8	103.1	32.2
1319	3	10.8	166.0	65.9
1320	34	9.0	64.1	26.3
TOTAL:	1,503			

GENERAL STATISTICS:

Reaches with at least 1 Bluffline within CND1:	72
Percentage of Reaches with at least 1 Bluffline:	86.0%
Average Length of Blufflines within CND1:	39.8
Average Minimum Length:	13.7
Average Maximum Length:	96.3

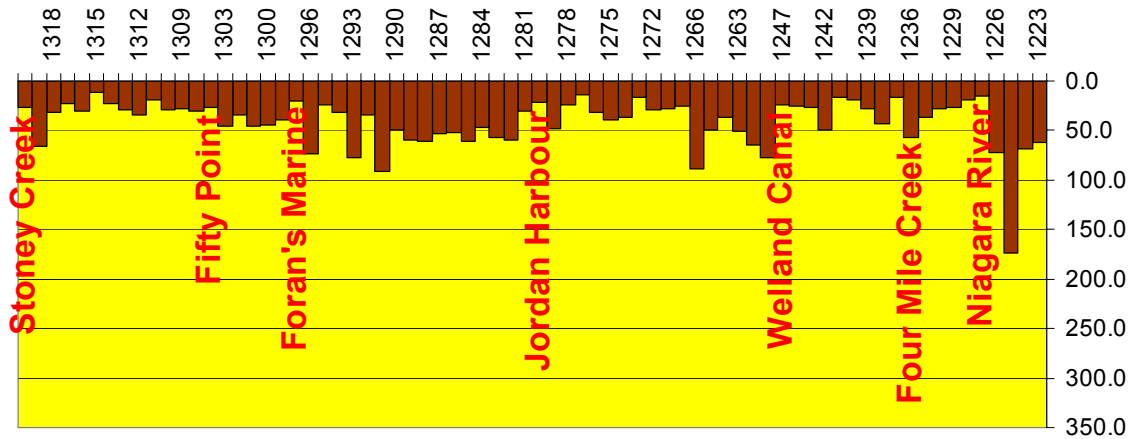


maximum of 96.3 m and an average minimum of 13.7 m. On a reach-by reach basis, Reach 1225 had the highest average bluff distance (173.3 m, 7 structures) and Reach 1315 had the lowest average bluff distance (11.3 m, 7 structures). The highest single bluff distance measurement was found in Reach 1283 (187.7 m) and the lowest was found in Reaches 1274 and 1318 (0.8 m). Reach 1295 had the highest number of structures present (52), with an average bluff distance of 23.9 m.

In order to observe general trends within the entire CND1 Shore Unit, the average bluff distance for each kilometer reach was plotted and is presented below in Figure 3. From this it can be seen that structures tend to be closer to the bluff crest in the areas between Stoney Creek and Fifty Point, to the east of Jordan Harbour and between the Welland Canal and Four Mile Creek. Structures tend to be furthest away from the bluff crest between Foran's Marine (Grimsby) and Jordan Harbour and to the west of the Welland Canal entrance (Port Weller).

Figure 3

Average Bluff Distance by Reach - CND1 Shore Unit



Note: Graph is oriented geographically such that North is at the top. Place names have been added for reference purposes. Reaches without any bluff distance line segments are not included in the graph.

4.3.2 CND7 – Oshawa / Whitby / Newcastle

Summary statistics for bluff distance mapping in the CND7 Shore Unit are presented in Table 2. For the entire Shore Unit, 850 structures were mapped. Average distance to the bluff for all structures was 58.4 m, with an average maximum of 111.2 m and an average minimum of 42.8 m. On a reach-by reach



basis, Reach 1605 had the highest average bluff distance (335.7 m, 5 structures) and Reach 1614 had the lowest average bluff distance (5.2 m, only 1 structure). The highest single bluff distance measurement was found in Reach 1605 (503.4 m) and the lowest was found in Reaches 1665 and 1685 (0.9 m). Reach 1685 had the highest number of structures present (52), with an average bluff distance of 14.6 m.

Table 2
"Distance to Crest of Bluff" Statistics by Reach
on Lake Ontario Within Shoreline Segment CND7

REACH	Count of Lines within Reach	Minimum Length	Maximum Length	Average Length
1605	5	124.0	503.4	335.7
1606	2	122.2	150.2	136.2
1607	6	69.6	262.8	142.7
1608	18	40.3	156.5	96.1
1609	14	1.8	155.6	76.0
1610	31	55.3	173.3	123.1
1611	21	6.9	156.1	60.7
1612	9	68.9	202.3	122.1
1613	22	6.8	97.0	47.1
1614	1	5.2	5.2	5.2
1615	1	7.4	7.4	7.4
1616	37	3.2	85.5	52.0
1620	3	8.6	14.2	11.2
1621	27	2.4	65.5	31.7
1622	1	14.3	14.3	14.3
1623	24	13.0	89.6	46.9
1624	24	16.4	64.6	33.7
1627	1	13.1	13.1	13.1
1628	6	13.1	87.8	39.9
1629	17	2.4	64.3	31.3
1631	11	2.3	107.2	54.4
1632	2	117.2	179.3	148.3
1633	6	21.2	185.4	97.8
1634	1	28.5	28.5	28.5
1635	1	67.2	67.2	67.2
1636	9	44.1	129.6	109.5
1637	27	8.8	141.0	88.3
1638	5	3.7	79.3	48.1
1639	17	6.3	76.7	24.9
1640	1	21.1	21.1	21.1
1641	6	67.4	82.6	70.5
1648	27	62.1	133.4	94.1



1649	1	113.1	113.1	113.1
1650	1	71.4	71.4	71.4
1651	1	24.8	24.8	24.8
1653	4	5.5	24.4	17.5
1654	1	44.2	44.2	44.2
1655	1	64.4	64.4	64.4
1656	6	11.6	124.8	33.6
1658	3	13.9	22.8	17.9
1659	16	18.5	76.9	37.6
1660	2	162.3	167.1	164.7
1661	2	217.5	221.8	219.7
1662	26	15.2	209.5	75.8
1663	33	5.2	72.9	43.8
1664	10	1.7	49.4	16.3
1665	11	0.9	94.0	44.9
1666	4	9.8	84.2	57.8
1667	2	5.9	8.8	7.4
1668	4	6.4	48.0	21.0
1672	1	232.3	232.3	232.3
1673	4	13.3	42.5	26.8
1674	4	5.8	91.9	53.1
1675	2	100.7	136.1	118.4
1679	16	6.0	101.7	49.3
1680	17	4.5	119.0	44.9
1681	1	156.2	156.2	156.2
1682	1	27.2	27.2	27.2
1683	1	37.5	37.5	37.5
1684	6	6.9	123.9	37.9
1685	46	0.9	42.3	14.6
1686	43	6.8	48.8	25.9
1687	14	2.4	133.6	23.2
1688	2	65.2	241.5	153.4
1689	21	60.6	184.0	74.3
1690	43	22.3	89.3	39.0
1691	44	23.0	70.7	42.9
1692	1	157.7	157.7	157.7
1693	1	136.5	136.5	136.5
1694	18	1.8	156.0	41.3
1695	15	16.2	74.7	46.7
1696	8	7.0	128.8	56.2
1699	1	36.9	36.9	36.9
1700	4	262.6	306.6	288.5
1701	1	21.1	21.1	21.1
1702	10	4.4	177.6	76.0
1703	3	71.7	286.9	212.4
1704	11	10.7	188.8	100.8



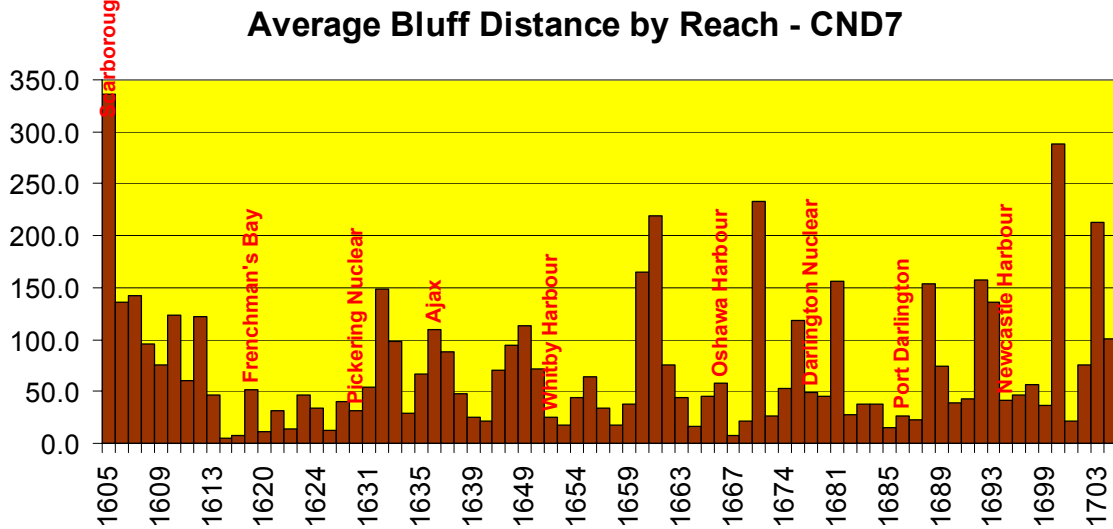
Total: 850

GENERAL STATISTICS:

Reaches with at least 1 Bluffline within CDN7:	78
Percentage of Reaches with at least 1 Bluffline:	77.2%
Average Length of Blufflines within CDN7:	58.4
Average Minimum Length:	42.8
Average Maximum Length:	111.2

In order to observe general trends within the entire CND7 Shore Unit, the average bluff distance for each kilometer reach was plotted and is presented below in Figure 4. From this it can be seen that bluff distances for this Shore Unit are extremely variable. Bluff distances tend to be shorter in some of the embayments and harbour areas (e.g., Frenchman’s Bay, Whitby Harbour, Oshawa Harbour, Port Darlington) and longer in many of the open coast reaches.

Figure 4



Note: Graph is oriented geographically such that North is at the top. Place names have been added for reference purposes. Reaches without any line segments have not been included in the graph.

4.3.3 US4 – Chimney Bluffs

Summary statistics for bluff distance mapping in the US4 Shore Unit are presented in Table 3. For the entire Shore Unit, 1,850 structures were mapped.



Average distance to the bluff for all structures was 19.1 m, with an average maximum of 56.9 m and an average minimum of 8.7 m. On a reach-by reach basis, Reach 787 had the highest average bluff distance (139.6 m, 2 structures) and Reach 823 had the lowest average bluff distance (2.9 m, 8 structures). The highest single bluff distance measurement was found in Reach 831 (181.9 m) and the lowest was found in Reach 842 (0.1 m). Reach 893 had the highest number of structures present (57), with an average bluff distance of 10.7 m.

Table 3
"Distance to Crest of Bluff" Statistics by Reach
on Lake Ontario Within Shoreline Segment US4

Reach	Count of Lines within Reach	Minimum Length	Maximum Length	Average Length
780	6	13.7	125.5	62.7
781	3	12.1	41.2	21.9
783	1	29.1	29.1	29.1
784	28	0.2	37.4	17.7
785	6	3.8	33.7	17.3
787	2	114.0	165.1	139.6
788	10	8.6	116.0	41.9
789	1	3.4	3.4	3.4
791	2	39.3	40.6	40.0
792	2	6.5	21.1	13.8
793	4	10.0	82.0	29.2
794	9	7.5	42.0	22.7
805	7	40.1	116.6	78.2
806	6	26.0	75.3	53.3
807	46	0.7	31.8	9.0
808	27	1.6	27.5	11.8
809	41	1.0	29.2	9.7
810	17	1.3	62.0	19.2
811	24	1.1	65.2	19.4
812	25	4.8	63.1	24.4
813	13	19.9	49.4	31.4
814	24	5.7	66.5	14.6
815	35	10.1	55.5	23.9
816	30	1.9	35.5	14.6
817	3	16.7	46.4	28.3
818	22	10.4	33.2	16.2
819	4	22.4	41.5	31.7



820	14	6.9	37.8	20.6
821	34	1.7	59.9	16.5
822	26	1.2	60.5	18.9
823	8	1.1	4.9	2.9
824	17	3.5	64.9	23.9
825	3	42.4	97.5	64.7
827	9	7.3	58.0	26.2
828	1	9.4	9.4	9.4
831	6	20.0	181.9	93.5
833	4	7.4	34.7	21.0
834	14	3.8	49.2	17.1
835	46	0.9	40.0	12.0
836	33	1.9	28.2	10.6
837	50	0.9	53.9	12.5
838	9	8.2	49.5	23.2
840	32	10.2	70.3	20.8
841	26	5.1	40.1	16.0
842	35	0.1	55.2	22.0
843	34	2.6	56.8	19.2
844	48	3.0	50.0	13.3
845	42	6.1	41.0	15.1
846	1	12.9	12.9	12.9
847	8	19.4	113.7	52.4
849	3	21.9	97.3	61.6
850	17	6.0	66.8	20.3
851	6	11.4	92.4	34.0
852	13	7.1	65.2	29.4
857	1	15.1	15.1	15.1
858	36	0.7	72.7	26.3
859	26	3.7	99.1	20.3
860	30	0.9	68.8	27.6
861	3	7.2	58.7	31.2
864	11	2.3	87.7	16.6
865	23	1.2	7.8	3.1
866	16	1.7	9.4	3.5
867	14	3.9	12.0	8.3
868	1	7.6	7.6	7.6
869	14	1.5	60.0	19.5
870	34	2.7	95.8	13.1
871	10	4.4	34.6	22.1
872	54	2.6	68.7	18.9
873	28	2.2	31.8	17.9
874	39	2.2	96.0	25.9
875	15	2.2	23.3	14.3
876	15	3.2	77.9	25.8
877	28	2.3	94.5	21.3
879	5	18.6	70.4	41.1



880	27	4.7	45.5	19.0
881	36	2.5	54.3	14.7
882	37	2.5	51.7	21.3
883	26	1.7	34.7	17.6
884	18	5.6	25.1	14.7
885	8	3.1	38.6	14.4
886	4	2.8	61.6	23.0
887	4	26.7	45.7	36.8
888	17	3.0	50.8	21.1
889	40	1.3	35.1	10.5
890	33	3.1	78.7	17.2
891	31	0.4	127.8	21.8
892	46	2.5	33.8	12.2
893	57	2.8	19.3	10.7
894	44	3.6	113.4	36.3
895	34	2.3	72.6	14.5
896	19	10.4	60.1	23.8
897	29	4.0	69.9	20.9
TOTAL:				
		1850		

GENERAL STATISTICS:

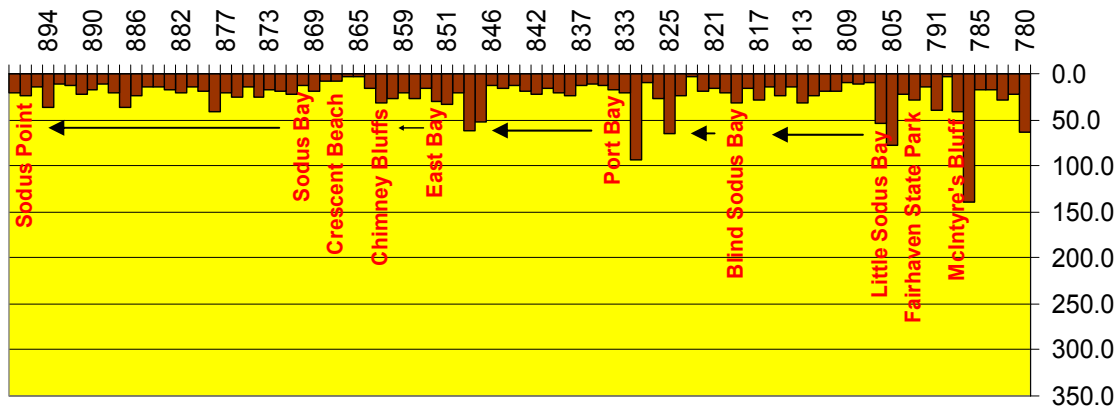
Reaches with at least 1 Bluffline within US4:	92
Percentage of Reaches with at least 1 Bluffline:	77.3%
Average Length of Blufflines within US4:	19.1
Average Minimum Length:	8.7
Average Maximum Length:	56.9

In order to observe general trends within the entire US4 Shore Unit, the average bluff distance for each kilometer reach was plotted and is presented below in Figure 5. From this it can be seen that bluff distances for this Shore Unit are somewhat shorter (by well more than half) than those in CDN1 and CDN7 indicating that development is generally closer to the shoreline here. However, the majority of this development takes place in the various embayments (Port Bay, East Bay, Sodus Bay, etc.) and as such this would be expected, given the sheltered conditions in these areas. Where there is open coast shoreline, bluff distances are higher, most exceeding 50 meters (the exception being the Lake Bluff shoreline, just east of Crescent Beach (Reach 865)).



Figure 5

Average Bluff Distance by Reach - US4



Note: Graph is oriented geographically such that North is at the top. Place names have been added for reference purposes. Reaches without any line segments have not been included in the graph.

4.3.4 US7 – Eastern Lake Ontario Sand Dunes

Summary statistics for bluff distance mapping in the US7 Shore Unit are presented in Table 4. For the entire Shore Unit, 1,276 structures were mapped. Average distance to the bluff for all structures was 14.5 m, with an average maximum of 40.7 m and an average minimum of 5.0 m. On a reach-by reach basis, Reach 674 had the highest average bluff distance (50.2 m, only 1 structures) and Reach 667 had the lowest average bluff distance (1.8 m, 2 structures). The highest single bluff distance measurement was found in Reach 674 (149.8 m) and the lowest was found in Reach 699 (0.3 m). Reach 699 also had the highest number of structures present (67), with an average bluff distance of 6.7 m.

Table 4
"Distance to Crest of Bluff" Statistics by Reach
on Lake Ontario Within Shoreline Segment US7

Reach	Count of Lines within Reach	Minimum Length	Maximum Length	Average Length
618	21	1.3	106.2	22.7
623	22	6.1	74.0	31.7
624	42	4.9	44.4	16.4



625	37	4.4	25.3	14.6
626	26	4.9	23.2	12.7
627	1	50.2	50.2	50.2
661	19	1.5	50.8	14.9
662	32	0.8	20.6	9.9
663	2	10.8	41.2	26.0
665	1	11.3	11.3	11.3
666	4	7.4	49.3	20.5
667	2	0.7	2.9	1.8
668	15	1.9	41.3	20.1
669	59	2.0	7.4	4.6
670	16	1.8	8.9	4.5
671	64	0.5	22.1	8.0
672	48	0.5	17.3	4.9
673	29	11.6	51.0	31.0
674	23	1.2	149.8	32.7
675	61	1.2	21.7	9.5
676	9	0.7	110.2	45.5
677	23	5.6	95.3	18.9
678	35	1.9	42.7	17.6
679	35	1.2	47.4	18.4
680	44	2.5	37.7	14.9
681	28	1.5	28.8	11.1
682	36	1.6	50.4	18.0
683	18	5.4	26.7	14.4
684	27	7.9	107.0	29.5
686	9	6.5	25.1	12.5
687	6	1.6	22.8	8.8
688	11	7.8	42.0	19.7
689	6	8.3	20.2	14.3
690	11	9.6	77.9	34.3
692	14	4.9	85.6	29.7
693	9	2.9	19.7	9.5
694	23	4.9	26.7	13.1
695	23	3.2	18.5	9.1
696	12	4.7	23.9	14.7
697	6	11.5	48.9	23.7
698	2	3.5	8.1	5.8
699	67	0.3	25.6	6.7
700	36	1.0	36.2	11.7
701	15	1.2	16.9	7.8
702	17	0.7	17.6	10.7
703	4	10.6	31.0	22.0
717	6	2.7	39.6	19.6
718	9	1.2	25.7	12.6
719	4	1.9	8.4	3.6



720	23	1.0	30.8	10.0
721	35	1.6	44.3	10.8
722	1	18.1	18.1	18.1
723	3	8.9	90.0	40.3
728	33	5.2	64.7	23.5
729	40	2.7	29.8	11.1
730	28	5.3	26.2	14.5
731	19	0.7	24.8	9.1
732	23	0.7	76.5	13.2
733	2	6.3	7.8	7.1
TOTAL:	1276			

GENERAL STATISTICS:

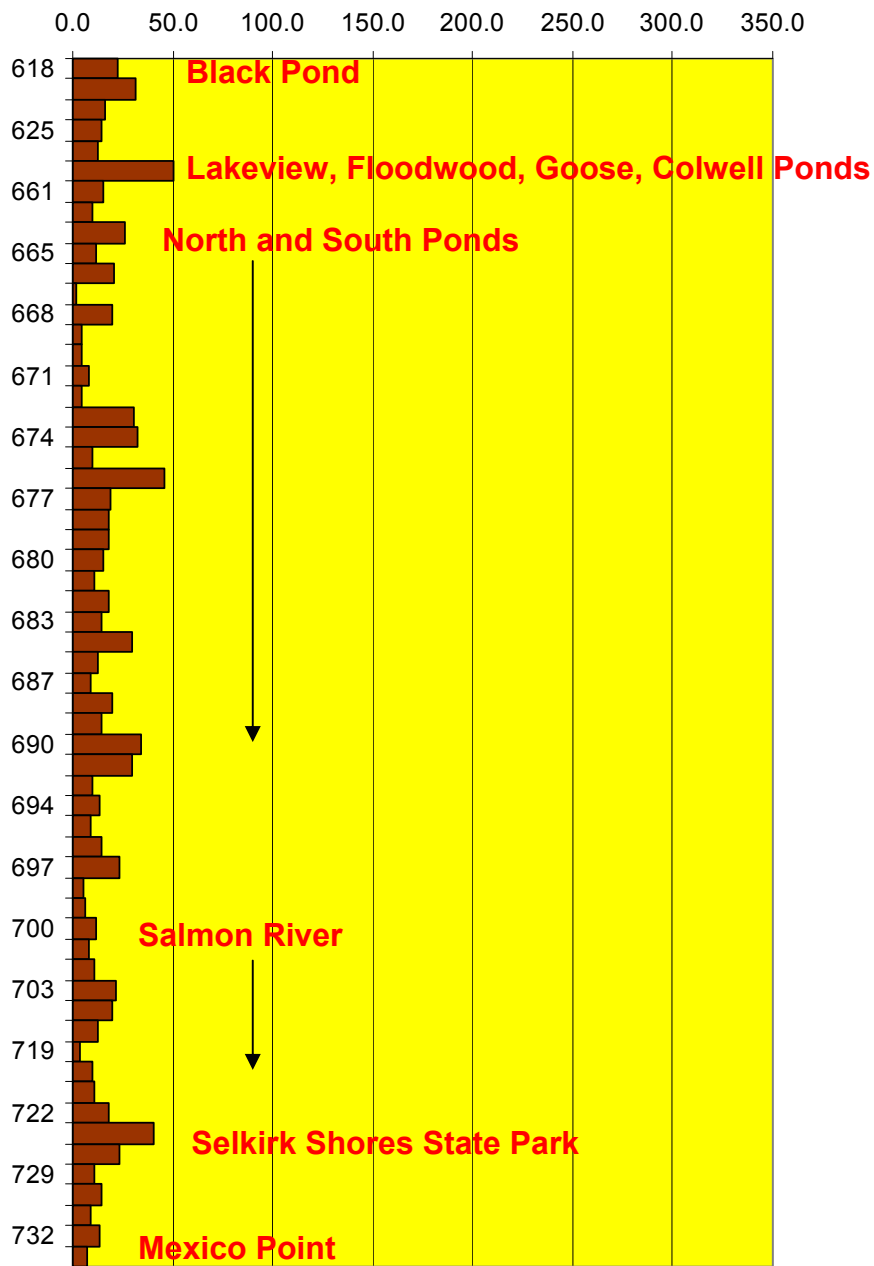
Reaches with at least 1 Bluffline within US7:	59
Percentage of Reaches with at least 1 Bluffline:	50.9%
Average Length of Blufflines within US7:	14.5
Average Minimum Length:	5.0
Average Maximum Length:	40.7

In order to observe general trends within the entire US7 Shore Unit, the average bluff distance for each kilometer reach was plotted and is presented below in Figure 6. From this it can be seen that bluff distances for this Shore Unit are the shortest of any of the 4 areas examined so far, with only one of the reach averages being over 50 meters in length (Reach 627). Much of the development in this Shore Unit takes place in the North and South Pond areas, where a sheltered environment can lead to development closer to the water. On the open coast, development tends to be in low lying dune or beach areas and on the narrow barriers protecting the ponds. As such, there is not a great deal of room for development and bluff distance measurements as a result will be shorter.



Figure 6

Average Bluff Distance by Reach - US7



Note: Graph is oriented geographically such that North is at the top. Place names have been added for reference purposes. Reaches without any line segments have not been included in the graph.

