Section 2:

LIDAR Land Cover Classification Methodology

Methodology Employed for Identifying, Mapping, and Measuring Specific Land Cover Classifications (Woodlands, Grassland/Shrub, Developed, Beach, and Bare Ground) using Remote Sensing within the Niagara River Area of Concern Inland Boundary

The land cover classification data set produced as a result of this project employed remote sensing techniques consisting of three types of image classification, and a thorough manual quality control comparison to classify all areas within the proposed Niagara River AOC inland boundary into five main categories of: woodland, grassland/shrub, developed areas, beach, and bare earth.

Land Cover Classification Methodology

The base imagery used for this project was open source 4-band digital ortho-imagery at a resolution of 1-ft ground sampling distance (GSD). This data originates from the NYS Division of Homeland Security and Emergency Services – Office of Cyber Security. The publication date of this imagery is November 30, 2011; however, the flight date that produced the imagery is actually Spring 2001 (source here would be good).

Classification steps:

Step 1 - ***NDVI (Normalized Difference Vegetation Index).*** Aan NDVI is derived by generating a ratio between the Red and Near Infrared bands of the imagery. This layer is a measure of vegetation vigor.

Step 2 – ***Unsupervised Classification.*** This step is performed where natural groupings are generated automatically using a programmed algorithm. The user determines the number of groupings to be generated. The algorithm then generates the natural groupings based on the spectral values of the 4-band imagery and the value of NDVI derived layer. The number of natural groupings created varies throughout the Niagara River Area of Concern (AOC) inland boundary study area due to spectral variability. This study area is broken up into 35 tiles.

Step 3 – ***Supervised Classification.*** The final classification method used is an interactive method of assigning training sites to the unsupervised groupings. Various known locations are assigned a value such as “woodland” or “shrub”. Based on the output of the unsupervised classification, the NDVI, and the original 4-band imagery an algorithm performs a decision rule across the entire study area and creates a continuous output of the land covers in question.

Step 4 – ***Manual Checks for Quality Assurance and Quality Control.*** All 35 tiles underwent controls to account for final deliverable quality. Technicians manually reviewed each tile for comparison with the underlying aerial imagery to determine where areas may have been assigned to incorrect classes (provide an example as an e.g.,). If an error was found, the technician manually reassigned the area in question to its correct class.

Wetlands

While the steps outlined above provided good results relative to land cover identification and accuracy for the major land cover classifications, the wetlands classes were determined to be too ambiguous to produce meaningful results using the steps described above. Therefore, trained wetland biologists with experience in photointerpretation of wetlands manually determined the locations and areas of all wetlands.

The manual wetland determinations are based on conditions as visible from:

1. ***4-band 2011 aerial photos*** (as described above).
2. ***Bare earth LiDAR data*** (FEMA 2007) High accurate elevation data provide a visual of topographic conditions and hydrologic sinks providing a greater detail to wetland boundaries.
3. ***Hydric soils*** (NRCS 2010) Hydric soils provide sancillary data to support wetland location determinations.
4. ***Personal Knowledge*** Although this portion of the project did not include field verification, the biologists were able to use a wealth of knowledge from past visits to support mapping.
5. ***NYSDEC Wetlands*** Some state regulated wetlands exist within the study area.
6. ***National Wetland Inventory (USFW)*** NWI provides the most extensive available dataset. These data provided the starting point for the interpretation. All areas of the study area were reviewed, with improvements and corrections to create the final wetlands dataset.

Sources of Error

The largest source of error was caused by the land cover algorithm's misclassification of areas due to confusion caused by shadow areas. The algorithm confused shadow areas with impervious surface, or at other times would inaccurately identify shadow areas with woodlands. Another source of confusion occurred in differentiation of woodland and scrub land covers. Quality controls found these errors and technicians reassigned the areas in question. Targeted field verification is expected during Phase 2 of the project, and further discussion will accompany that effort.

BNRK LIDAR- WETLAND RESULTS COMPARED TO NOAA (in acres)

	BNRK			NOAA			BNRK-NOAA		
Tributary Name	Emergent	Shrub	Forested	Emergent	Shrub	Forested	Emergent	Shrub	Forested
BERGHOLTZ CREEK	42.8	4.0	112.1	1.56	6.19	80.00	41.2	-2.20	32.1
BLACK CREEK	64.9	16.7	92.5	6.28	16.10	68.99	58.6	0.57	23.5
BUFFALO RIVER	0.4	0.0	1.8	28.96	17.89	10.23	-28.5	-17.89	-8.4
BULL CREEK	13.7	23.5	222.5	1.57	2.46	184.56	12.1	21.05	37.9
CAYUGA CREEK	177.9	18.4	105.7	2.00	2.89	69.80	175.9	15.51	35.9
CAZENOVIA CREEK	0.0	0.0	0.0	12.95	1.33	10.30	-12.9	-1.33	-10.3
ELLICOTT CREEK	8.4	6.6	12.4	14.45	2.71	5.38	-6.0	3.93	7.0
FISH CREEK	21.4	4.1	192.8	2.49	7.92	94.89	18.9	-3.84	97.9
GILL CREEK	148.4	21.7	178.1	65.90	86.72	96.41	82.5	-64.97	81.7
NIAGARA RIVER	276.5	115.3	851.5	322.02	241.78	592.66	-45.5	-126.51	258.9
POWER VISTA	0.0	0.0	0.0	2.03	0.74	0.07	-2.0	-0.74	-0.1
SAWYER CREEK	22.9	3.0	37.7	1.45	4.04	4.97	21.5	-1.08	32.7
SCAJAQUADA CREEK	0.0	0.0	0.0	0.00	0.00	0.89	0.0	0.00	-0.9
TONAWANDA CREEK	0.1	0.7	33.5	11.37	6.99	36.84	-11.3	-6.25	-3.4
TWO MILE CREEK	10.8	3.6	9.6	0.94	7.74	8.14	9.9	-4.09	1.5
UNAMED TRIB S. OF ELLICOTT C.	16.4	0.0	0.0	0.0	0.7	0.0	16.4	-0.70	0.0
TOTAL	804.6	217.6	1850.2	474.0	406.2	1264.1	330.6	-188.6	586.1

	BNRK			NOAA			BNRK-NOAA		
Municipality	Emergent	Shrub	Forested	Emergent	Shrub	Forested	Emergent	Shrub	Forested
BUFFALO	40.3	16.0	12.1	71.44	29.98	29.15	-31.1	-14.0	-17.1
GRAND ISLAND	163.9	80.0	699.0	94.57	141.47	415.75	69.3	-61.4	283.3
HAMBURG	0.0	0.0	0.0	1.67	0.22	0.06	-1.7	-0.2	-0.1
LACKAWANNA	12.7	0.0	4.8	10.57	2.27	10.52	2.1	-2.3	-5.7
LEWISTON (TOWN)	43.1	18.6	174.7	61.13	32.20	75.22	-18.0	-13.6	99.5
LEWISTON (VILLAGE)	0.2	0.0	1.0	5.67	2.67	13.64	-5.4	-2.7	-12.6
NIAGARA (TOWN)	84.1	9.5	39.4	1.33	5.67	22.96	82.8	3.8	16.4
NIAGARA FALLS	2.7	0.4	20.4	66.19	38.59	36.00	-63.5	-38.2	-15.6
NORTH TONAWANDA	4.6	5.4	43.3	14.47	10.87	30.51	-9.8	-5.4	12.8
PORTER	0.0	0.0	0.0	16.98	2.00	22.93	-17.0	-2.0	-22.9
TONAWANDA (CITY)	7.0	4.4	22.0	5.16	7.34	9.07	1.8	-2.9	12.9
TONAWANDA (TOWN)	65.4	7.6	47.0	38.69	17.28	35.49	26.7	-9.7	11.5
TUSCARORA	133.3	16.9	254.0	57.09	73.59	187.57	76.2	-56.7	66.5
WHEATFIELD	249.2	58.7	533.2	22.85	40.89	356.94	226.4	17.8	176.2
YOUNGSTOWN	0.0	0.0	0.0	5.31	1.11	18.89	-5.3	-1.1	-18.9