Nottawasaga Valley Conservation Authority

Field-based Agricultural Resource Inventory of the Innisfil Creek Subwatershed, 2015

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1.0 INTRODUCTION
Agricultural field-based mapping at the subwatershed level provides an opportunity to determine the spatial distribution and occurrence of crops and other field features at a specific point in time to complement integrated water resource management. Developed by the Ministry of Agriculture and Rural Affairs (OMAFRA), the Agricultural Resource Inventory (AgRI) is a database of farming practices and land management systems based on farm field-specific information within southern Ontario (OMAFRA, 2013). The objective of the AgRI is to understand crop production, crop rotation patterns, tillage practices, distribution of crop-specific nutrient application, pest-management practice, and water management (OMAFRA, 2010).

The predominant land use in the Innisfil Creek Subwatershed is agriculture including highly productive speciality crop areas of potato and sod production situated on the Tioga loam and Alliston sandy loam soils, and carrots and onions located in the muck-organic soils. This 49,100 ha (491 km\(^2\)) subwatershed located in south Simcoe County is prone to drought conditions related to meteorological-agricultural droughts (Figure 1).

The Innisfil Creek Subwatershed field-based AgRI mapping was completed in 2010, 2011, 2012, 2014, and 2015 by Nottawasaga Valley Conservation Authority (NVCA) staff. The 2013 AgRI mapping was completed by OMAFRA and is presently not publicly available. Consistent with previous years, the objective of this project is to complete 2015 AgRI mapping of the Innisfil Creek Subwatershed and determine crop distribution, crop rotation patterns, and crop-specific irrigation characteristics at the subwatershed level through the integration of the previous AgRI mapping exercises.*

*Alternative Format - If you require this document in an alternative format, please contact NVCA by phone at 705-424-1479, Ext. 228 or send an email to admin@nvca.on.ca
Figure 1: Innisfil Creek Subwatershed study area.
2.0 METHODOLOGY

The 2015 Innisfil Creek Subwatershed, road-based, windshield, farm-field survey was completed from July 6 to July 13, 2015, similar to previous years to ensure consistency in recognition of the crop cycle. The following methodology was used to complete this exercise:

1. Maps were generated using ArcGIS and imported to an iPad. The PDF Maps application, created by Avenza Systems Inc., was used during the in-field mapping process. The application is available for Apple iOS and Android systems. The application for Apple can be downloaded from iTunes: https://itunes.apple.com/ca/app/avenza-pdf-maps/id388424049?mt=8

2. Where visible from the roadside, individual fields were surveyed for the below attributes. The mapping exercise was completed on all roads within the study area except for Highway 400 due to safety concerns.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Description</td>
<td>Bailed, cultivated, harvested, patchy, ploughed, rolled, or weedy</td>
</tr>
<tr>
<td>Crop</td>
<td>Crop type: alfalfa, apples, barley, beets, cabbage, canola, carrot, corn, edible beans, fallow, hay, field-based nursery and landscape, oats, onion, parsnips, pasture, potato, radish, rye, soybeans, squash, strawberries, turf, unknown*, and wheat</td>
</tr>
<tr>
<td>Land Use</td>
<td>Field, farmstead or rough land</td>
</tr>
<tr>
<td>Irrigation System</td>
<td>Centre pivot, drip irrigation, stationary gun, traveling boom, or traveling gun</td>
</tr>
<tr>
<td>Livestock</td>
<td>Cattle, donkey, goat, etc.</td>
</tr>
<tr>
<td>Residue</td>
<td>Last season(s) crop residue</td>
</tr>
<tr>
<td>Row Direction</td>
<td>East, southeast, southwest, or south</td>
</tr>
<tr>
<td>Tillage</td>
<td>Tillage practices: conventional, conservation, or no-till</td>
</tr>
</tbody>
</table>

*Unknown: Unknown was selected if the farm fields were ploughed or harvested and unable to identify the residue.

3. The data from the iPad was transferred to ArcGIS for quality assurance and control and data analysis. Some AgRI polygons from the 2012 AgRI framework, courtesy of OMAFRA, were modified to fit the 2015 survey data, for instance where two crops are grown in one AgRI polygon.
3.0 RESULTS

3.1 Subwatershed agriculture land use

This project focused on farm-field specific information. 18,215 ha of managed fields and approximately 403 ha of rough land were surveyed (Figures 2 and 3). Rough land is defined as a non-agricultural land that is overgrown with native plants and grasses. Non-mapped fields correspond to fields that were not visible from the roadside and consist of approximately 9,475 ha of managed fields and 5,346 ha of non-mapped rough land (Table 1). This was determined by overlaying 2012 orthophotography on the AgRI polygon framework to determine if the field was managed or not.

Roughly 27,690 ha (57%) of the total area of the subwatershed corresponds to managed agricultural field. Woodlands represent 19% of the subwatershed. Other land use includes water, ditches, fencerows, railways, roads, and quarries.

Table 1: Mapped and non-mapped areas (ha).

<table>
<thead>
<tr>
<th>Land Uses</th>
<th>Mapped Areas</th>
<th>Non-Mapped Areas</th>
<th>Total</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmstead</td>
<td>80.36</td>
<td>1,963.05</td>
<td>20,43.41</td>
<td>4.18</td>
</tr>
<tr>
<td>Fields</td>
<td>18,214.57</td>
<td>9,474.99</td>
<td>27,689.56</td>
<td>56.70</td>
</tr>
<tr>
<td>Rough Land</td>
<td>403.01</td>
<td>5,345.58</td>
<td>5,748.59</td>
<td>11.77</td>
</tr>
<tr>
<td>Woodland</td>
<td>9,102.16</td>
<td>9,102.16</td>
<td>18.64</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>227.68</td>
<td>227.68</td>
<td>0.47</td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>1,700.30</td>
<td>1,700.30</td>
<td>3.48</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>2,326.80</td>
<td>2,326.80</td>
<td>4.76</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>18,697.94</strong></td>
<td><strong>30,140.56</strong></td>
<td><strong>48,838.49</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

*Non-mapped areas are based on the 2012 orthoimagery layer.*
Figure 2: Mapped and non-mapped farm-fields and rough land, Innisfil Creek Subwatershed.
Figure 3: Mapped and non-mapped farm-fields, Innisfil Creek Subwatershed.
3.2 Mapped and non-mapped fields per subcatchment

The AgRI polygons were analyzed to determine the percent completeness of mapped and non-mapped farm-fields per subcatchments within the Innisfil Creek Subwatershed (Table 2; Figure 4). Approximately 66% of fields in the Innisfil Creek Subwatershed were surveyed in 2015. Although, the Cookstown subcatchment has the highest mapped area (49%), the Bailey subcatchment has the highest percent completeness of farm-fields (69%; Table 3).

Table 2: Mapped and non-mapped areas per subcatchment (ha).

<table>
<thead>
<tr>
<th>Subcatchment</th>
<th>Subcatchment Area</th>
<th>Mapped Areas</th>
<th>Non-Mapped Areas</th>
<th>Percent Completeness (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Farmstead</td>
<td>Farm-Fields</td>
<td>Rough Land</td>
</tr>
<tr>
<td>Bailey</td>
<td>12,633.57</td>
<td>13.61</td>
<td>4,421.30</td>
<td>104.52</td>
</tr>
<tr>
<td>Beeton</td>
<td>9,035.74</td>
<td>26.27</td>
<td>2,057.28</td>
<td>103.98</td>
</tr>
<tr>
<td>Cookstown</td>
<td>3,282.61</td>
<td>13.59</td>
<td>1,576.59</td>
<td>6.39</td>
</tr>
<tr>
<td>Innisfil</td>
<td>18,126.76</td>
<td>22.04</td>
<td>7,405.46</td>
<td>167.58</td>
</tr>
<tr>
<td>Penville</td>
<td>6,022.09</td>
<td>4.87</td>
<td>2,743.05</td>
<td>16.65</td>
</tr>
</tbody>
</table>

*Other areas include ditches, fencerows, roads, urban areas, water, and woodlands

Table 3: Mapped and non-mapped farm fields per subcatchment.

<table>
<thead>
<tr>
<th></th>
<th>Mapped</th>
<th>Non-Mapped</th>
<th>Total</th>
<th>% Mapped</th>
<th>% Non-Mapped</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bailey</td>
<td>4,421.30</td>
<td>1,945.50</td>
<td>6,366.80</td>
<td>69.44</td>
<td>30.56</td>
</tr>
<tr>
<td>Beeton</td>
<td>2,057.28</td>
<td>1,897.74</td>
<td>3,955.02</td>
<td>52.02</td>
<td>47.98</td>
</tr>
<tr>
<td>Cookstown</td>
<td>1,576.59</td>
<td>788.05</td>
<td>2,364.65</td>
<td>66.67</td>
<td>33.33</td>
</tr>
<tr>
<td>Innisfil</td>
<td>7,405.46</td>
<td>3,370.45</td>
<td>10,775.91</td>
<td>68.72</td>
<td>31.28</td>
</tr>
<tr>
<td>Penville</td>
<td>2,743.05</td>
<td>1,464.21</td>
<td>4,207.26</td>
<td>65.20</td>
<td>34.80</td>
</tr>
<tr>
<td>Total</td>
<td>18,203.67</td>
<td>9,465.96</td>
<td>27,669.63</td>
<td>65.79</td>
<td>34.21</td>
</tr>
</tbody>
</table>
Figure 4: Mapped and non-mapped farm-fields per Subcatchment.
3.3 Crop distribution

Table 4 and Figure 5 outline the variety of crops grown and the corresponding area in the Innisfil Creek Subwatershed in 2015. The main crops grown in this subwatershed are alfalfa, corn, hay, potato, soybean, turf, and wheat (Figure 6); covering approximately 15,738 ha (86% of the total mapped farm-fields). Main crops were arbitrarily defined as crops with a percentage of 3% or higher, with the exception of pasture which is not a cultivated or harvested crop. Soybean is the predominant crop, corresponding to 39% of the total mapped area. Wheat and corn are the second most abundant crop per area (53% of total mapped farm-fields). The average field size is approximately 8 ha.

Spatially, potato and turf fields are mainly found in the Simcoe Lowlands whereas soybean, corn and wheat are found throughout the subwatershed. Also, carrots and onions are generally located in the headwater areas of the Innisfil Creek in the Cookstown Marsh area.

Table 4: Crops grown in the Innisfil Creek Subwatershed.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Number of Fields</th>
<th>Area Cover (ha)</th>
<th>Percentage (%)</th>
<th>Area per Field (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>96</td>
<td>670.99</td>
<td>3.67</td>
<td>6.99</td>
</tr>
<tr>
<td>Asparagus</td>
<td>1</td>
<td>0.41</td>
<td>0.00</td>
<td>0.41</td>
</tr>
<tr>
<td>Barley</td>
<td>19</td>
<td>85.70</td>
<td>0.47</td>
<td>4.51</td>
</tr>
<tr>
<td>Cabbage</td>
<td>1</td>
<td>16.27</td>
<td>0.09</td>
<td>16.27</td>
</tr>
<tr>
<td>Canola</td>
<td>16</td>
<td>128.83</td>
<td>0.70</td>
<td>8.05</td>
</tr>
<tr>
<td>Carrot</td>
<td>13</td>
<td>116.19</td>
<td>0.63</td>
<td>8.94</td>
</tr>
<tr>
<td>Corn</td>
<td>270</td>
<td>2,488.72</td>
<td>13.60</td>
<td>9.22</td>
</tr>
<tr>
<td>Fallow</td>
<td>87</td>
<td>361.74</td>
<td>1.98</td>
<td>4.16</td>
</tr>
<tr>
<td>Hay</td>
<td>197</td>
<td>1,175.09</td>
<td>6.42</td>
<td>5.96</td>
</tr>
<tr>
<td>Nursery and Landscape</td>
<td>17</td>
<td>46.40</td>
<td>0.25</td>
<td>2.73</td>
</tr>
<tr>
<td>Oats</td>
<td>19</td>
<td>177.53</td>
<td>0.97</td>
<td>9.34</td>
</tr>
<tr>
<td>Onion</td>
<td>19</td>
<td>231.97</td>
<td>1.27</td>
<td>12.21</td>
</tr>
<tr>
<td>Pasture</td>
<td>189</td>
<td>839.77</td>
<td>4.59</td>
<td>4.44</td>
</tr>
<tr>
<td>Potato</td>
<td>47</td>
<td>792.57</td>
<td>4.33</td>
<td>16.86</td>
</tr>
<tr>
<td>Rye</td>
<td>12</td>
<td>150.91</td>
<td>0.82</td>
<td>12.58</td>
</tr>
<tr>
<td>Soybeans</td>
<td>758</td>
<td>7,024.01</td>
<td>38.56</td>
<td>9.27</td>
</tr>
<tr>
<td>Squash</td>
<td>1</td>
<td>1.02</td>
<td>0.01</td>
<td>1.02</td>
</tr>
<tr>
<td>Strawberries</td>
<td>1</td>
<td>7.05</td>
<td>0.04</td>
<td>7.05</td>
</tr>
<tr>
<td>Sunflower</td>
<td>1</td>
<td>1.36</td>
<td>0.01</td>
<td>1.36</td>
</tr>
<tr>
<td>Turf</td>
<td>53</td>
<td>957.29</td>
<td>5.23</td>
<td>18.06</td>
</tr>
<tr>
<td>Turnip</td>
<td>1</td>
<td>1.30</td>
<td>0.01</td>
<td>1.30</td>
</tr>
<tr>
<td>Unknown – Ploughed Field</td>
<td>37</td>
<td>310.71</td>
<td>1.70</td>
<td>8.40</td>
</tr>
<tr>
<td>Wheat</td>
<td>268</td>
<td>2,628.73</td>
<td>14.36</td>
<td>9.81</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,123</strong></td>
<td><strong>18,214.57</strong></td>
<td><strong>100</strong></td>
<td></td>
</tr>
</tbody>
</table>
Figure 5: 2015 Crop distribution, Innisfil Creek Subwatershed.
Figure 6: 2015 Main crop distribution, Innisfil Creek Subwatershed.
3.4 Hydrologic soil groups and crop distribution

Soils are classified into one of four hydrologic soil groups according to the rate of water infiltration when soils are bare, not frozen, and receive precipitation from long-duration storms (Table 5; Natural Resources Conservation Service, 2007). The crop distribution overlain with the hydrologic soil units is used to determine if there is a broad correlation between crops and the hydrological soil group, notwithstanding other field variables.

Table 5: Hydrologic Soil Group.

<table>
<thead>
<tr>
<th>Hydrologic Soil Group</th>
<th>Runoff Potential</th>
<th>Infiltration Rate (cm/hr)</th>
<th>Soil Textures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>Soils have low runoff potential and high infiltration rates even when thoroughly wetted</td>
<td>&gt;0.76</td>
<td>Sand, loamy sand, or sandy loam</td>
</tr>
<tr>
<td>Group B</td>
<td>Soils have moderately low runoff potential and moderate infiltration rates when thoroughly wetted</td>
<td>0.38 – 0.76</td>
<td>Silt loam or loam</td>
</tr>
<tr>
<td>Group C</td>
<td>Soils have moderately high runoff potential and low infiltration rates when thoroughly wetted</td>
<td>0.13 – 0.38</td>
<td>Sandy clay loam</td>
</tr>
<tr>
<td>Group D</td>
<td>Soils have high runoff potential and very low infiltration rates when thoroughly wetted</td>
<td>0 – 0.13</td>
<td>Clay loam, silty clay loam, sandy clay or clay</td>
</tr>
</tbody>
</table>

In the Innisfil Creek Subwatershed, 76% of the main crops (defined as alfalfa, corn, hay, potato, soybeans, turf and wheat) are grown in soils classified as Group B (33.5%) and Group C (42.6%; Table 6). Specific to potato, 42% of the total field area corresponds to Group B and 26% in Group A. Similarly, turf is mainly grown in soils classified as Group B with a total area of 57% (Figure 7). It is noted that Group B is the most prominent soil type in the Innisfil Creek Subwatershed.

Table 6: Area (ha) of main crops per Hydrologic Soil Groups.

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>Group C</th>
<th>Group D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>71.14</td>
<td>297.62</td>
<td>263.83</td>
<td>38.39</td>
</tr>
<tr>
<td>Corn</td>
<td>197.73</td>
<td>918.97</td>
<td>1,141.38</td>
<td>224.51</td>
</tr>
<tr>
<td>Hay</td>
<td>282.13</td>
<td>415.42</td>
<td>433.86</td>
<td>43.68</td>
</tr>
<tr>
<td>Potato</td>
<td>200.73</td>
<td>323.97</td>
<td>137.88</td>
<td>101.47</td>
</tr>
<tr>
<td>Soybeans</td>
<td>708.85</td>
<td>2,445.89</td>
<td>3,337.80</td>
<td>496.42</td>
</tr>
<tr>
<td>Turf</td>
<td>76.09</td>
<td>552.51</td>
<td>197.93</td>
<td>130.77</td>
</tr>
<tr>
<td>Wheat</td>
<td>166.75</td>
<td>1,005.88</td>
<td>1,349.85</td>
<td>104.39</td>
</tr>
<tr>
<td><strong>Subwatershed total</strong></td>
<td><strong>1,110.35</strong></td>
<td><strong>17,774.77</strong></td>
<td><strong>16,085.60</strong></td>
<td><strong>3,929.70</strong></td>
</tr>
<tr>
<td>% Subwatershed total</td>
<td>22.72</td>
<td>36.35</td>
<td>32.89</td>
<td>8.04</td>
</tr>
</tbody>
</table>
Figure 7: Hydrologic Soil Groups in the Innisfil Creek Subwatershed.
3.5 Irrigation

Agricultural irrigation in the Innisfil Creek Subwatershed was mapped through the 2015 AgRI exercise based on the presence of field-based irrigation equipment (centre pivot, traveler, etc.). Irrigated fields are concentrated in the Simcoe Lowlands, notably in the downstream reach before coalescing with the Nottawasaga River and secondly in the muck soils at the headwaters of Innisfil Creek in the Cookstown Marsh area. These two areas strongly correlate with slopes of less than 1%, making it ideal for irrigation (Figure 8).

Only 3% of the mapped fields were observed with irrigation equipment deployed at the time of the survey. The predominant type of irrigation found in the Innisfil Creek Subwatershed is the centre-pivot irrigation system, covering the largest area (Table 7). Other irrigation systems found are the travelling-gun and wheel line irrigation systems. Centre pivot irrigation systems are self-propelled systems in which the system rotates around a pivot in a circular pattern (Verhallen, 2002). Travelling-gun systems consist of a wheeled cart with a large sprinkler. These systems are expensive, require higher labour costs compared to centre pivot systems, and the uniformity of water distribution can be affected by wind (Verhallen, 2002). Similar to the centre pivot system, the wheel line irrigation system moves in a linear pattern and contains rotator sprinklers, if they are not properly spaced they can provide poor coverage.

<table>
<thead>
<tr>
<th>Irrigation System</th>
<th>Number of Systems</th>
<th>Area Covered (ha)</th>
<th>Percentage of Total Mapped irrigation equipment (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centre Pivot</td>
<td>24</td>
<td>546.08</td>
<td>2.91</td>
</tr>
<tr>
<td>Traveling Gun</td>
<td>3</td>
<td>38.62</td>
<td>0.21</td>
</tr>
<tr>
<td>Wheel Line Irrigation</td>
<td>1</td>
<td>15.48</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Table 8 and Figure 9 outline all fields that were mapped with an irrigation system present at the time of the survey. Potato crop represents roughly 45% of the total irrigated crop area with soybean the other observed crop with significant number of irrigation systems deployed. Irrigation systems were also present on fields with corn, soybean and grains (rye, wheat, etc.) which are typically not considered crops that are locally irrigated, and are assumed to be rotation crops.

Potato and turf are dominated by centre pivot irrigation technology. Travelling guns and stationary guns were observed in specialty crops (cabbage), potato, and turf fields (Figure 8). Interestingly, no carrot fields (n=13) were observed to have irrigation equipment deployed in the field irrigated; however, this may be an artifact of the easy transportability of travelers from field to field typically used to irrigate carrots.

The top three irrigated crops grown in the Innisfil Creek Subwatershed, in descending order of total area of both irrigated and non-irrigated cropland, consists of potato, soybean, and turf. It appears that less than 35% of the total area of potato crop is irrigated (Table 9). This figure is also representative of the ratio of irrigated versus non-irrigated land/number.
of fields for the onion crop which is situated in a different soil class. It is noted that the AgRI field mapping represents a point in time of field conditions and irrigation systems, yet irrigation equipment may be moved from field to field.

Figure 9 outlines the distribution of the irrigation systems and the corresponding crops in addition to all agriculture-based Permit to Take Water (PTTW) locations. Not all PTTW locations are directly associated with a field that contains an irrigation system. This may be reflective of the movement of the equipment to other fields that are undergoing irrigation.

Table 8: Location of irrigation systems.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Location of Irrigation Systems (Area ha)</th>
<th>Number of Fields</th>
<th>Irrigated Crop</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Centre Pivot</td>
<td>Traveling Gun</td>
<td>Wheel Line Irrigation</td>
</tr>
<tr>
<td>Cabbage</td>
<td></td>
<td>16.27</td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td></td>
<td>49.39</td>
<td></td>
</tr>
<tr>
<td>Potato</td>
<td></td>
<td>274.54</td>
<td></td>
</tr>
<tr>
<td>Rye</td>
<td></td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>Soybeans</td>
<td></td>
<td>114.52</td>
<td></td>
</tr>
<tr>
<td>Turf</td>
<td></td>
<td>90.77</td>
<td>22.35</td>
</tr>
<tr>
<td>Wheat</td>
<td></td>
<td>16.26</td>
<td></td>
</tr>
<tr>
<td>Total Area</td>
<td></td>
<td>546.08</td>
<td>38.62</td>
</tr>
</tbody>
</table>

Table 9: Irrigated crops grown in the Innisfil Creek Subwatershed.

<table>
<thead>
<tr>
<th>Irrigated Crops</th>
<th>Total Area (ha)</th>
<th>Number of Fields</th>
<th>Irrigated Area (ha)</th>
<th>Number of Fields</th>
<th>% Irrigated Area vs Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabbage</td>
<td>16.27</td>
<td>1</td>
<td>16.27</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>Potato</td>
<td>792.57</td>
<td>47</td>
<td>272.54</td>
<td>11</td>
<td>34.39</td>
</tr>
<tr>
<td>Turf</td>
<td>957.29</td>
<td>53</td>
<td>128.60</td>
<td>7</td>
<td>13.43</td>
</tr>
</tbody>
</table>


Figure 8: Distribution of crops that are typically irrigated and the distribution of irrigation systems, Innisfil Creek Subwatershed. It is noted that not all irrigated crops have an irrigation system on the field.
Figure 9: Distribution of irrigation systems and corresponding fields.

The Innisfil Creek Subwatershed AgRI mapping was completed in 2010, 2011, 2012 and 2014 by NVCA staff using the same methodology (Table 10). The 2013 AgRI mapping was completed by OMAFRA and is presently not publicly available.

The 2010 AgRI mapping was completed as a pilot endeavor and covered a relatively small sampling area of the subwatershed using a different parcel layer and covering a total farm-field area of 10991 ha. It is noted that all grains were combined in 2010.

In 2011, the AgRI mapping area increased, focusing on the northern aspect of the subwatershed with a total mapped farm field area of 11,745 ha (Figure 10). The AgRI map for 2012 and 2014 include the entire subwatershed. In 2012, the total mapped farm fields were 16,216 ha whereas the total area mapped in 2014 was comparable at 16,933 ha. It is noted that in 2012 fields that were partially in/out of the subwatershed were excluded from the final mapped area whereas in 2014 the fields were clipped to the subwatershed boundary. The 2011, 2012, 2014 and 2015 AgRI results are herein used for comparing crop rotations.

Table 10: Number of fields surveyed and area covered (ha) per year.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area</th>
<th>N. of Fields</th>
<th>Area</th>
<th>N. of Fields</th>
<th>Area</th>
<th>N. of Fields</th>
<th>Area</th>
<th>N. of Fields</th>
<th>Area</th>
<th>N. of Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>205.50</td>
<td>24</td>
<td>741.03</td>
<td>110</td>
<td>806.20</td>
<td>114</td>
<td>670.99</td>
<td>96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>2,125.68</td>
<td>75</td>
<td>1,254.67</td>
<td>127</td>
<td>1,254.67</td>
<td>127</td>
<td>2,638.85</td>
<td>234</td>
<td>2,488.72</td>
<td>270</td>
</tr>
<tr>
<td>Hay</td>
<td>806.36</td>
<td>128</td>
<td>399.85</td>
<td>63</td>
<td>700.76</td>
<td>126</td>
<td>1,175.09</td>
<td>197</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potato</td>
<td>1,150.57</td>
<td>26</td>
<td>769.45</td>
<td>48</td>
<td>611.34</td>
<td>39</td>
<td>811.34</td>
<td>53</td>
<td>792.57</td>
<td>47</td>
</tr>
<tr>
<td>Soybean</td>
<td>3691.37</td>
<td>113</td>
<td>2,459.48</td>
<td>242</td>
<td>5,889.69</td>
<td>611</td>
<td>7,011.03</td>
<td>723</td>
<td>7,024.01</td>
<td>758</td>
</tr>
<tr>
<td>Turf</td>
<td>1201.21</td>
<td>25</td>
<td>769.22</td>
<td>41</td>
<td>720.84</td>
<td>50</td>
<td>756.65</td>
<td>47</td>
<td>957.29</td>
<td>53</td>
</tr>
<tr>
<td>Wheat</td>
<td>2,537.22</td>
<td>245</td>
<td>3,282.85</td>
<td>315</td>
<td>2,123.87</td>
<td>229</td>
<td>2,628.73</td>
<td>268</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8,168.83</td>
<td>239</td>
<td>8,801.90</td>
<td>855</td>
<td>12900.26</td>
<td>1,315</td>
<td>14,848.70</td>
<td>1,526</td>
<td>15,737.40</td>
<td>1,689</td>
</tr>
<tr>
<td>Total Mapped Farm-Fields</td>
<td>10,990.90</td>
<td>324</td>
<td>10,666.99</td>
<td>1,191</td>
<td>16,215.89</td>
<td>1,762</td>
<td>16,933.30</td>
<td>1,883</td>
<td>18,214.57</td>
<td>2,123</td>
</tr>
</tbody>
</table>
Figure 10: 2011 – 2012, 2014 and 2015 AgRI results, main crops.
4.1 2014 and 2015 AgRI results

The same methodology and study area as the 2014 AgRI survey was used to complete the 2015 AgRI survey. The mapped 2015 covers a slightly larger area in comparison with the 2014 AgRI survey (Table 11). In 2014, 1,883 fields were surveyed, compared to 2,122 fields in 2015. During the 2015 field survey it was noted that crops were cultivated later than 2014; specifically soybean, corn, and grain crops. A total of 37 fields (310.71 ha) were ploughed. However, the 26 ploughed fields in 2014 have a greater area coverage (380.42 ha) than 2015.

The 2014 Field Based Agricultural Resource Inventory of the Innisfil Creek Subwatershed can be found on the NVCA website under Groundwater management, Special Projects (http://www.nvca.on.ca/watershed-science/groundwater).

Table 12 and Figure 11 outline the crops grown in 2014 and 2015.

Table 11: 2014 and 2015 Mapped and Non-mapped areas (ha).

<table>
<thead>
<tr>
<th>Land Uses</th>
<th>Mapped Areas</th>
<th>Non-Mapped Areas*</th>
<th>Total</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmstead</td>
<td>80.36</td>
<td>192.47</td>
<td>1,963.05</td>
<td>1,912.56</td>
</tr>
<tr>
<td>Farm-Fields</td>
<td>18,214.57</td>
<td>16,933.30</td>
<td>9,474.99</td>
<td>10,378.88</td>
</tr>
<tr>
<td>Rough Land</td>
<td>403.01</td>
<td>987.48</td>
<td>5,345.58</td>
<td>5,009.90</td>
</tr>
<tr>
<td>Woodland</td>
<td>9102.16</td>
<td>8,949.87</td>
<td>9,102.12</td>
<td>8,949.87</td>
</tr>
<tr>
<td>Water</td>
<td>227.68</td>
<td>208.45</td>
<td>227.68</td>
<td>208.45</td>
</tr>
<tr>
<td>Urban</td>
<td>1,700.30</td>
<td>1,689.75</td>
<td>1,700.30</td>
<td>1,689.75</td>
</tr>
<tr>
<td>Other</td>
<td>2,326.80</td>
<td>1,417.35</td>
<td>2,326.80</td>
<td>1,417.35</td>
</tr>
<tr>
<td>Total</td>
<td>18,697.94</td>
<td>18,113.25</td>
<td>30,140.56</td>
<td>29,566.76</td>
</tr>
</tbody>
</table>

* The 2015 AgRI polygons were modified to have higher area coverage of the Innisfil Creek Subwatershed (99.7% in 2015 and 97.3% in 2014).
Table 12: 2014 and 2015 crops grown in the Innisfil Creek Subwatershed.

<table>
<thead>
<tr>
<th>Crop</th>
<th>2015 Number of Fields</th>
<th>2015 Area Cover (ha)</th>
<th>2014 Number of Fields</th>
<th>2014 Area Cover (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>96</td>
<td>670.99</td>
<td>114</td>
<td>806.20</td>
</tr>
<tr>
<td>Apples</td>
<td></td>
<td></td>
<td>2</td>
<td>2.54</td>
</tr>
<tr>
<td>Asparagus</td>
<td>1</td>
<td>0.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barley</td>
<td>19</td>
<td>85.70</td>
<td>19</td>
<td>145.92</td>
</tr>
<tr>
<td>Beets</td>
<td></td>
<td></td>
<td>1</td>
<td>5.34</td>
</tr>
<tr>
<td>Cabbage</td>
<td>1</td>
<td>16.27</td>
<td>4</td>
<td>71.90</td>
</tr>
<tr>
<td>Canola</td>
<td>16</td>
<td>128.83</td>
<td>3</td>
<td>5.47</td>
</tr>
<tr>
<td>Carrot</td>
<td>13</td>
<td>116.19</td>
<td>12</td>
<td>78.67</td>
</tr>
<tr>
<td>Corn</td>
<td>270</td>
<td>2,488.72</td>
<td>234</td>
<td>2,638.85</td>
</tr>
<tr>
<td>Edible Beans</td>
<td></td>
<td></td>
<td>4</td>
<td>19.50</td>
</tr>
<tr>
<td>Fallow</td>
<td>87</td>
<td>361.74</td>
<td>64</td>
<td>282.90</td>
</tr>
<tr>
<td>Hay</td>
<td>197</td>
<td>1,175.09</td>
<td>126</td>
<td>700.76</td>
</tr>
<tr>
<td>Nursery and Landscape</td>
<td>17</td>
<td>46.40</td>
<td>11</td>
<td>34.14</td>
</tr>
<tr>
<td>Oats</td>
<td>19</td>
<td>177.53</td>
<td>16</td>
<td>85.49</td>
</tr>
<tr>
<td>Onion</td>
<td>19</td>
<td>231.97</td>
<td>16</td>
<td>225.99</td>
</tr>
<tr>
<td>Pasture</td>
<td>189</td>
<td>839.77</td>
<td>169</td>
<td>634.80</td>
</tr>
<tr>
<td>Parsnips</td>
<td></td>
<td></td>
<td>2</td>
<td>9.25</td>
</tr>
<tr>
<td>Potato</td>
<td>47</td>
<td>792.57</td>
<td>53</td>
<td>811.34</td>
</tr>
<tr>
<td>Radish</td>
<td></td>
<td></td>
<td>1</td>
<td>19.56</td>
</tr>
<tr>
<td>Rye</td>
<td>12</td>
<td>150.91</td>
<td>4</td>
<td>72.35</td>
</tr>
<tr>
<td>Soybeans</td>
<td>758</td>
<td>7,024.01</td>
<td>723</td>
<td>7,011.03</td>
</tr>
<tr>
<td>Strawberries</td>
<td>1</td>
<td>7.05</td>
<td>1</td>
<td>7.06</td>
</tr>
<tr>
<td>Squash</td>
<td>1</td>
<td>1.02</td>
<td>2</td>
<td>3.28</td>
</tr>
<tr>
<td>Sunflower</td>
<td>1</td>
<td>1.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turf</td>
<td>53</td>
<td>957.29</td>
<td>47</td>
<td>756.65</td>
</tr>
<tr>
<td>Turnip</td>
<td>1</td>
<td>1.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unknown – Ploughed Field</td>
<td>37</td>
<td>310.71</td>
<td>26</td>
<td>380.42</td>
</tr>
<tr>
<td>Wheat</td>
<td>268</td>
<td>2,628.73</td>
<td>229</td>
<td>2,123.87</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,122</strong></td>
<td><strong>18,214.57</strong></td>
<td><strong>1,883</strong></td>
<td><strong>16,933.28</strong></td>
</tr>
</tbody>
</table>
Figure 11: 2014 and 2015 AgRI results.

The centre pivot system is the main irrigation system used in the subwatershed. In 2015, 35% of the potato fields were found with an irrigation system, 33% in 2014 and 22% in 2012. In 2014, a total of 43 irrigation systems were found during the survey (Table 13, Figure 12). In 2014, 32 centre pivots found during the survey were within the subwatershed. A total of 24 centre pivots were found in 2015. It is noted by the location of the irrigated systems that not all systems are in used as some systems were found in non-irrigated fields. In 2014, 6 out of the 8 travelling guns found were located in the same cabbage field (42 ha).

Table 13: Number of irrigation systems and area covered (ha) in 2015, 2014 and 2012.

<table>
<thead>
<tr>
<th>Irrigation System</th>
<th>2015</th>
<th>2014</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of</td>
<td>Number of</td>
<td>Number of</td>
</tr>
<tr>
<td></td>
<td>Systems</td>
<td>Systems</td>
<td>Systems</td>
</tr>
<tr>
<td>Centre Pivot</td>
<td>24</td>
<td>32</td>
<td>10</td>
</tr>
<tr>
<td>Stationary Gun</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Traveling Boom</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Traveling Gun</td>
<td>3</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Wheel Line Irrigation</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>43</td>
<td>18</td>
</tr>
</tbody>
</table>
Figure 12: Irrigation systems in 2015, 2014 and 2012.
4.3 Potato crop rotation

Crop rotation refers to the practice of growing a sequence of differing crops in a field in successive seasons. An effective crop rotation can provide growers with numerous benefits ranging from improved soil productivity to decreasing soil runoff. Crop rotations will differ from field to field, soil type to soil type, and climate region to climate region. Crop rotation also influences the sustainability of agricultural systems and is typically three to five years.

Potatoes, the predominantly irrigated crop grown in the subwatershed, are typically rotated every three years. Therefore, it is assumed that the 2015 potato fields should also be in potatoes in 2012 with a rotation crop (wheat, corn and soybean) in 2013 and 2014. (As previously stated 2013 AgRI results are not available for the Innisfil Creek Subwatershed).

The number of fields mapped in potato crop in 2015 was 47, covering 793 ha (Table 14; Figure 13). In 2014, 44 fields were mapped which corresponded to the 2015 potato fields. 5 of the 44 fields in 2014 were in potato, representing 266.22 ha or 32% of the corresponding crop area. Reference to the 2015 potato fields, 57 ha in 2014 did not undergo a three year rotation. Similarly, 11 fields (185 ha) were in potatoes in 2012. Through a visual estimate, it appears that a few fields did not undergo a rotational crop during 2011-2015, notwithstanding 2013. Therefore, it is concluded that not all potato fields in the subwatershed are undergoing a three-year rotation, which potentially may be exhausting the soil.

Table 14: Total area (ha) of farm-fields based on 2015 mapped potato fields.

<table>
<thead>
<tr>
<th>Crop</th>
<th>2015 Area (ha)</th>
<th>2015 Number of Fields</th>
<th>2014 Area (ha)</th>
<th>2014 Number of Fields</th>
<th>2012 Area (ha)</th>
<th>2012 Number of Fields</th>
<th>2011 Area (ha)</th>
<th>2011 Number of Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potato</td>
<td>792.57</td>
<td>47</td>
<td>56.54</td>
<td>5</td>
<td>184.52</td>
<td>11</td>
<td>234.47</td>
<td>15</td>
</tr>
<tr>
<td>Barley</td>
<td>28.76</td>
<td>1</td>
<td>28.76</td>
<td>1</td>
<td>28.76</td>
<td>1</td>
<td>28.76</td>
<td>1</td>
</tr>
<tr>
<td>Corn</td>
<td>216.94</td>
<td>10</td>
<td>128.93</td>
<td>3</td>
<td>128.93</td>
<td>3</td>
<td>54.38</td>
<td>4</td>
</tr>
<tr>
<td>Rye</td>
<td>72.35</td>
<td>4</td>
<td>72.35</td>
<td>4</td>
<td>72.35</td>
<td>4</td>
<td>72.35</td>
<td>4</td>
</tr>
<tr>
<td>Soybeans</td>
<td>171.14</td>
<td>11</td>
<td>120.79</td>
<td>7</td>
<td>120.79</td>
<td>7</td>
<td>58.56</td>
<td>2</td>
</tr>
<tr>
<td>Turf</td>
<td>14.42</td>
<td>1</td>
<td>11.33</td>
<td>1</td>
<td>11.33</td>
<td>1</td>
<td>11.33</td>
<td>1</td>
</tr>
<tr>
<td>Unknown - Ploughed field</td>
<td>10.46</td>
<td>1</td>
<td>10.46</td>
<td>1</td>
<td>10.46</td>
<td>1</td>
<td>10.46</td>
<td>1</td>
</tr>
<tr>
<td>Wheat</td>
<td>154.52</td>
<td>10</td>
<td>133.19</td>
<td>7</td>
<td>133.19</td>
<td>7</td>
<td>139.14</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>792.57</strong></td>
<td><strong>47</strong></td>
<td><strong>711.20</strong></td>
<td><strong>44</strong></td>
<td><strong>619.66</strong></td>
<td><strong>31</strong></td>
<td><strong>516.12</strong></td>
<td><strong>33</strong></td>
</tr>
</tbody>
</table>
Figure 13: 2015 Potato field distribution.
4.4 Turf crop rotation

From seed to harvest, turf is considered a two-year crop, rotating with another crop in the third year. It is assumed that 50% of the 2015 turf crop will be harvested in 2016 and 50% was seeded in 2014. The number of fields mapped with turf in 2015 was 53, covering 957.29 ha (Table 15). In 2014, 36 of the 53 fields mapped in 2015 were in turf, representing 595 ha or 62% suggesting good best management practices with respect to crop rotation. Rotational crops (soybeans and wheat) in 2014 correspond to 94.78 ha or 10% of the total area (Figure 14). The area that changed from potato (2014) to turf (2015) corresponds to 6.87 ha or 0.7% of the total area.

<table>
<thead>
<tr>
<th>Crop to:</th>
<th>2015</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Area (ha)</td>
<td>Number of Fields</td>
</tr>
<tr>
<td>Turf</td>
<td>957.29</td>
<td>53</td>
</tr>
<tr>
<td>Fallow</td>
<td>9.58</td>
<td>1</td>
</tr>
<tr>
<td>Potato</td>
<td>6.87</td>
<td>1</td>
</tr>
<tr>
<td>Soybeans</td>
<td>74.75</td>
<td>4</td>
</tr>
<tr>
<td>Unknown</td>
<td>248.68</td>
<td>9</td>
</tr>
<tr>
<td>Wheat</td>
<td>20.02</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>957.29</strong></td>
<td><strong>53</strong></td>
</tr>
</tbody>
</table>
Figure 14: 2015 turf fields compared against the 2014 AgRI mapping to identify rotation patterns.
5.0 SUMMARY

Based on the 2015 AgRI mapping, the Innisfil Creek Subwatershed agricultural characteristics consists of:

- Approximately 18,215 ha of managed fields and approximately 403 ha of rough land were surveyed in 2015. Non-mapped fields consist of approximately 9475 ha of managed fields and 5,346 ha of non-mapped rough land. Roughly 27,690 ha (57%) of the total area of the subwatershed corresponds to managed agricultural field.

- The main crops grown in the Innisfil Creek Subwatershed are soybeans, wheat, corn, hay, turf, potato and alfalfa covering approximately 86% of the total mapped farm-fields. Soybean is the predominant crop, corresponding to 39% of the total mapped area.

- 76% of the main crops are grown in soils classified as Group B (33.5%) and Group C (42.6%).

- The overwhelming type of irrigation system found in the Innisfil Creek Subwatershed is the centre-pivot irrigation system (24 of the 28 systems mapped).

- The top three irrigated crops grown in the Innisfil Creek Subwatershed, in descending order of total area of both irrigated and non-irrigated cropland, consists of potato, soybeans, and turf. From the 2015 results, it appears that approximately 35% of the total area of potato crop is irrigated.

- Regarding crop rotation, 53 turf fields were mapped in 2015. Thirty six of the 53 fields were also turf in 2014, representing 595 ha or 62%. Rotational crops (potato, soybeans, and wheat) in 2014 correspond to 102 ha or 11% of the total area.

5.1 Recommendations

The field-based mapping at the subwatershed level provides an opportunity to determine the spatial distribution and occurrence of the crops at a specific point in time (e.g., the month of July, 2015 for the Innisfil Creek Subwatershed). This foundational, agriculture-focused, land use dataset allows for integrated analysis related to crop distribution and total area grown, spatial distribution of irrigation systems for specific crop and slope, correlating crops to the hydrologic characteristics of the soil, etc. In addition, crop rotation patterns or the lack thereof can be determined using historical field mapping exercises. Application of the GIS-based field data dataset can be collectively utilized for a variety of program areas, e.g., the determination of broad nutrient application rates, crop-specific targeted stewardship/BMP outreach, potential for soil erosion, etc.

The following recommendations are offered for consideration:

- Comprehensive subwatershed AgRI mapping is available for the Innisfil Creek Subwatershed for 2012, 2014 and 2015. It is recommended that the 2013 AgRI mapping be obtained from OMAFRA. Also carry out the subwatershed scale AgRI
mapping annually in order to provide a comprehensive data set and a five-year crop rotation cycle for 2016 and 2017.

- Possible expansion of the AgRI mapping to capture farmstead and tillage characteristics to gain the holistic snapshot of agricultural practices at the subwatershed scale.

- Continued use of the iPad for mapping and exploration of opportunities to map fields that are not visible, e.g. drones and other applicable precision agriculture opportunities.

- Complete statistical trend analysis to forecast future crop production (number of fields and area grown). Also, a comparative analysis with the last available Census Agricultural data is encouraged to determine the accuracy against the AgRI mapping.

- Complete an economic analysis of crop valuation for the subwatershed and the individual crop, percentage of crop grown in the subwatershed vs the county level and the associated overall value.

- Evaluate how the Agriculture and Agri-Food Canada (AAFC) annual crop inventory aligns with the NVCA AgRi data for soybean and corn to determine the degree of correlation between the two datasets.
6.0 REFERENCES


