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AGRICULTURAL ASSESSMENT REVIEW FOR THE NORTH WEST SECONDARY PLAN STUDY AREA LOCATED IN THE CITY OF WELLAND, NIAGARA REGION

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TABLE OF CONTENTS

List of Appendices

List of Tables

List of Figures

List of Maps

1.0 STUDY OBJECTIVES

1.1 Introduction

This report has been prepared as an Agricultural Impact Assessment related to a secondary plan study in northwest Welland as shown on Maps 1 and 2. The study's general objective is outlined in the Request for Proposal (RFP) as follows:

> *The focus of the secondary plan and associated studies is to create a vision for the subject lands and related policies/directions that will ensure its successful implementation. The process will identify opportunities and constraints for development of the subject lands and the location, extent and sensitivity of the existing natural, social, cultural and economic environment in the study area. Mitigation measures for any impacts to the environment will also be determined.*

With respect to agriculture, the RFP specifies two requirements for a:

- *Minimum Distance Separation I Study to determine whether the Northwest expansion lands are impacted by active or potential livestock facilities. If the study finds that the Northwest lands are within 300 metres of an active or potential livestock facility then mitigation measures will need to be provided; and an,*
- *Agricultural Impact Assessment to assess the impact of future development on prime agricultural areas and how to minimize and mitigate any impacts on the agricultural system; and, where necessary, how an urban area expansion is in compliance with the Minimum Distance Separation formulae.*

Therefore, following the RFP, the content of this report is framed by policy as well as guidelines and addresses several agricultural characteristics of the study area, Welland, and Niagara Region, given the agricultural context of southern Ontario. As a result, this agricultural assessment is based on current conditions as well as on an estimate of future conditions and was completed to answer three questions as follows:

- What are the characteristics of the agricultural environment within and adjacent to the Northwest Welland Secondary Plan Study Area?
- How have the agricultural characteristics within Welland, Thorold and Niagara Region changed over the past 35 years?
- Are mitigation measures required with respect to the proposed non-agricultural development in the Northwest Welland Secondary Plan Study Area and what mitigation measures are available for the reduction of impacts to agriculture *to the extent feasible*?

The use of past conditions to project/estimate future conditions is subject to the extrapolation of existing measurements and therefore to the general limitations associated with extrapolation (as outlined in many statistics texts and described within Wikipedia). The phrase "The Northwest Welland Secondary Plan Study Area" is used synonymously with the words "study area" and "site" within this report.

The Northwest Secondary Plan planning process includes reports from several different disciplines. Therefore, this agricultural assessment information should be supplemented with information provided within other reports prepared for the The Northwest Secondary Plan Study Area (with specific reference and importance attached to the planning analysis prepared by SGL Planning & Design Inc.). As well, the contents of this agricultural report may be changed by the author as a result of information and questions provided within external reviews.

The report uses four phrases which are defined as follows:

- **Soil Capability Class** - This term is the one most often used in rating agricultural soils and is defined as part of the *Canada Land Inventory Soil Capability Classification for Agriculture* - Soil Capability for Common Field Crops. It is an interpretive classification of the soils maps produced within Canada where soils are identified by texture, drainage class, layers (diagnostic horizons) etc. following the Canadian System of Soil Classification (1978, third edition 1989 http://sis.agr.gc.ca/cansis/references/1998sc_a.html). The soil capability rating is a seven-class system consisting of a class number (1 (best) – 7 (poorest)) and a subclass limitation such as stoniness, slope, or erosion (represented by an alphabetic code P, T, E, etc.). The best soils with no limitations for production of common field crops are ranked as class I and soils unsuitable for agriculture are rated as class 7. This information concerning capability classes and subclass limitations is provided as part of the relational database included with the soil mapping digitized by OMAFRA and provided by LIO/MNR (Land Information Ontario/Ministry of Natural Resources).
- **Soil Productivity Index** - The original soil capability classification classes one through seven have been converted from an ordinal to a ratio scale on the basis of crop yields. For common field crops, such as grain corn, oats and barley, a relationship was measured to demonstrate that if class I land was assigned the soil productivity index value 1.00, then class 2 would be 0.80 and class 3 would be 0.64 etc. The use of the ratio scale allows for a mathematically acceptable measurement of mean value. Therefore, a given study area can have a single average value of a soil productivity index. When comparing different site alternatives, the use of the soil productivity index allows comparison of the alternatives using a single value. The use of the soil productivity index also provides a way to deal with soil complexes - where a soil complex is represented by a single polygon (in the past this was called a map unit) where there are two or more soil series/types present and mapped and where there is some likelihood to be a combination of soil capability classes such as 60% class I and 40% class 2T, for example.
- **Soil Potential Index** - Like the aforementioned Soil Productivity Index, the Soil Potential Index provides an “average” (single value) soil potential for agricultural production for a given area when that area contains more than one soil potential rank or rating. The Soil Potential Index is based on ranks which are part of an ordinal scale and provide a potential rating for the production of fruit and vegetable crops.
- **Agricultural Performance** - Agricultural performance is a single relative comparative measure that combines many agricultural characteristics of a given area in comparison to another given area (for example, one Region or County relative to another Region or County). The scoring, ranking or relative difference

is quantitative. Agricultural performance includes economic, socio-cultural and physical variables and is described in more detail in in the method section following.

1.2 Methods

Several different sources and methods have been used to characterize agriculture presently as well as trends over time to distinguish whether the study area is relatively better or poorer. Poorer sites have lower impacts and require less mitigation. Direct observation in the field have been supplemented with indirect observations provided by aerial photo interpretation, as well as third-party quantitative data that have been analysed statistically. The viewpoint has been taken that information from several different sources provides a more powerful tool when assessing agriculture.

Therefore, the findings described in the following section are based on published literature, which is listed in the references section, quantitative statistics, fieldwork, and aerial photo interpretation. Much of the information relates to the use of data from Statistics Canada and the Ontario Ministry of Agriculture, Food and Rural Affairs and is subject to the limitations of the surveys completed by these government groups. The use of published information, fieldwork, and aerial photo interpretation is intended to provide quantitative as well as qualitative evidence in support of the opinions on agricultural impacts outlined within this report. This agricultural assessment presents data graphs as well as mapped information together at the end of the report to allow the reader to review the information used to provide the descriptions and opinions within this report.

Single factor analysis as well as the use of multi-attribute data analysis was used to compare the agricultural performance of Niagara and Welland relative to other sub-tier municipalities in Niagara Region. The multi-attribute data analyses were completed using two methods; linear weighted combination, and concordance which are described in more detail in Appendix 4.

Agricultural census data for Welland (and the other sub-tier municipalities in Niagara Region) are sometimes subject to suppression for reasons of confidentiality. However, the data can be imputed. Several different methods are available to impute missing information. In this report, the imputed value, for example, an area or total number of animals reported in Niagara Region not accounted for in the data supplied for the sub-tier municipalities, was assigned to the sub-tier municipalities having suppressed information, based on the number of farms reporting the agricultural information and lacking the area or animal number data. The formula used to calculate the imputed value was:

$$((A - B)/(F))*S$$

Where:

A= the total value reported for the Niagara Census District).

B= the values reported for the sub-tier municipalities (Census Consolidated Subdivision) where data was <u>not</u> suppressed.

F= the total number of farms associated with all of the sub-tier municipalities having suppressed data.

S= the number of farms associated with the sub-tier municipality having the suppressed data and for which the value is being imputed.

The amount of suppression of agricultural data is relatively high for Welland because it does not contain a large amount of agricultural land. For example, for the Census years from 1981 to 2016, no agricultural data are presented for Welland in the years 1986, 1991, 2011 and 2016. Agricultural data for Welland have been combined with that of Thorold for the Census years 2011 and 2016. Therefore, for several analyses looking at trends from 1981 to 2016, data have been combined for Welland and Thorold

Additional information related to methods is included as part of subsections addressing findings on the following pages.

2.0 FINDINGS

2.1 Planning Context

The information gathered and analysed is informed generally by five planning documents:

1. Government of Ontario. 2014. *Provincial Policy Statement*. Queen's Printer for Ontario; which indicates the need for minimizing land use conflict and the application of Minimum Distance Separation (MDS).
2. Ministry of Municipal Affairs. 2017. *Growth Plan for the Greater Golden Horseshoe (2017)*. Queen's Printer for Ontario; which introduces and defines the *Agricultural System* and the *Agri-Food Network*.
3. Ontario Ministry of Agriculture, Food and Rural Affairs. 2018. *Draft Agricultural Impact Assessment (AIA) Guidance Document;* which refers to agricultural assessments at the secondary plan stage.
4. Ontario Ministry of Agriculture, Food and Rural Affairs. 2018. *Implementation Procedures for the Agricultural System in Ontario's Greater Golden Horseshoe*; which provides additional detail with respect to the *Agricultural System* and the *Agri-Food Network*.
5. Ontario Ministry of Agriculture, Food and Rural Affairs. 2017. *The Minimum Distance Separation (MDS) Document, Formulae and Guidelines for Livestock Facility and Anaerobic Digester Odour Setbacks*. Publication 853, implemented March 1, 2017; which documents the process and calculation method for MDS.

Much of what is referred to in these five documents has little relevance to the Northwest Welland Secondary Plan Study Area because this area has already been affected by non-agricultural development within and adjacent to the study area (as will be described later within this report). The study area and current official plan designations for Niagara Region are shown on Map 1. Current and proposed official plan designations for Welland, Thorold and Pelham have also been reviewed and are presented on Map 2 which is a single map combining land-use designations for all three sub- tier municipalities.

The impacts to agriculture are informed specifically by reference to these Official Plans. The Welland Northwest Secondary Plan Study Area is designated as Good General

Agriculture and Rural in the Niagara Region Official Plan (Map 1). The study area includes designations for Agriculture, Institutional, Residential Open Space and Recreation as well as Core Natural Heritage System in the Welland Official Plan (Map 2). Maps 1 and 2 also indicate that the study area is almost entirely surrounded by non-agricultural uses or designations and that the proposed non-agricultural development of the Welland Northwest Secondary Plan Study Area is a logical extension of existing or planned urban development within Pelham, Thorold and Welland. The Northwest Welland Secondary Plan Study Area is a small residual area of agriculture, a "hole in the donut" where the doughnut is the non-agricultural development in Pelham, Thorold and Welland.

2.2 Agricultural Context, Trends and Evaluation

A comprehensive examination of agricultural single factors as well as multi-attribute analysis has been completed and the results summarized graphically in Appendix 1. The single factor evaluations are based directly on information gathered as part of the Agricultural Census for Canada over a 35-year timeframe from 1981 to 2016. In some cases, the analyses required a calculation. For example, graphing trends/changes in nutrient unit production (formerly animal units) from 1981 to 2016 required converting livestock numbers for several different species to nutrient units following tables in *The MDS Document* (2017). Observations on the combination of nutrient units with odour factor also required reference to *The MDS Document* (2017).

Multi-attribute analysis can be completed using different methods, databases and importance ranking (weighting) as described previously. Several different databases were used which have been identified using a single descriptor such as "fruits and vegetables", "yield", "economic" and "food production". All the multi-attribute analyses presented graphically in Appendix 1 have each database variable given the same weight (unit weight). Additionally, none of the database variables were inverted values of the original census information. The results of several different multi-attribute analyses have been included to demonstrate that the highest scored 5 Counties/Regions and the lowest scored 5 Counties/Regions tend to be similar irrespective of the database. This does not mean that there are not some exceptions.

<u>Agricultural Performance</u>

Niagara Region generally has a very high-performance rating relative to other Regions/Counties in southern Ontario. Niagara has the highest score when crop and livestock data are compared using the 2016 census information (Figure 1). When the dataset is restricted to economics, Niagara ranks sixth out of 35 Regions/Counties (Figure 2). When the economics information is restricted to gross and net income Niagara ranks second (Figure 3). Niagara does relatively poorly with the rank of 30th out of 35 when 12 field crop yields (grain corn, barley, canola, coloured beans, fodder corn, hay, mixed grain, oats, soybeans, spring wheat, dry white beans, and winter wheat) are compared (Figure 4) but improves to a rank of 19th when the predominantly grown five field crops yields of grain corn, fodder corn, hay, soybeans and winter wheat are used in the multi-attribute analysis.

The agricultural performance of Niagara indicates that Niagara is very important in the context of southern Ontario and that agricultural lands proposed for non-agricultural development need to be studied and chosen carefully. Findings described in the following pages will indicate that the choice of the Northwest Welland Secondary Plan Study Area is a good one which minimizes agricultural impacts.

Census Farm Number and Area

Figures 5 through 8 indicate that from 1981 to 2016:

- Census farm number and census farm area have been decreasing in Welland.
- Welland's proportion of Niagara Region's total census farm area has decreased.
- Welland's proportion of Niagara's total census farm area has varied but is approximately 1%.

Area in Greenhouses

Figures 9 and 10 indicate that:

- In 2016 Niagara ranked 2nd in total square metres of area under glass, plastic or other protection relative to other Counties/Regions in southern Ontario.
- Area under glass, plastic or other protection data are skewed with a very high percentage being found in Essex County.
- Niagara's total area under glass, plastic or protection is mostly found in Lincoln and Niagara-on-the-Lake and there is a very small amount of area under glass, plastic or other protection in Thorold + Welland.

Economics and Financial

Figures 11 to 20 provide context for several economic and financial indicators as follows:

- On-farm net operating average income in Ontario does not surpass off-farm income until the revenue category $100,000-$249,999 is reached.
- Over 80% of farm operators have more off-farm income than on-farm operating income in Ontario.
- Ontario average farm value (dollars gross per hectare) is greater for a cross-section of fruits and vegetables (apples, grapes, sweet corn, pumpkins and squash; grapes are the fruit crop predominantly grown in Niagara Region) than for common field crops such as soybeans, winter wheat and hay.
- Average farm value for crops has increased from 1981 to 2016,
- gross income per hectare for greenhouse products is much higher (up to $1.5 million per hectare).
- The proportion of farms in each total farm capital class varies from Niagara Region relative to Welland + Thorold. Welland + Thorold has a higher proportion of farms with total farm capital of less than $1 million relative to Niagara.
- The proportion of farms in each total gross receipts class varies from Niagara Region relative to Welland + Thorold. Welland + Thorold has a higher proportion of farms, has more farms with lower total gross receipts than does Niagara Region.
- Analysing trends in gross farm receipts minus total business expenses to calculate net on-farm income is limited because the farm expense categories

have changed over time. However, farm expense categories have been the same for 2001, 2006 and 2011 as summarized in Table 1. Separate farm expense categories are not provided in the 2016 agricultural census.

TABLE 1

STATISTICS CANADA CENSUS FARM EXPENSE CATEGORIES (2001, 2006, 2011)
Fertilizer and lime purchases
Purchases of herbicides, insecticides, fungicides, etc.
Seed and plant purchases (excluding materials purchased for resale)
Total feed, supplements and hay purchases
Total feed, supplements and hay purchases
Livestock and poultry purchases
Veterinary services, drugs, semen, breeding fees, etc.
Custom work, contract work and hired trucking
Total wages and salaries $
Wages and salaries paid to family members $
Wages and salaries paid to all other persons $
All fuel expenses (diesel, gasoline, oil, wood, natural gas, propane, etc.)
Repairs and maintenance to farm machinery, equipment and vehicles
Repairs and maintenance to farm buildings and fences
Rental and leasing of land and buildings
Rental and leasing of farm machinery, equipment and vehicles
Electricity, telephone and all other telecommunication services
Farm interest expenses
All other expenses (excluding depreciation and capital cost allowance)

- When 2016 total farm capital, total value of land and buildings, the value of all farm machinery and equipment, total gross farm receipts, total farm operating expenses, and net on farm income (gross receipts minus operating expenses) are calculated proportionate to area and also to number of farms (per unit area in hectares and per farm, respectively) and subject to multi-attribute analysis, Welland + Thorold is poorer than the value for Niagara Region and ranks ninth on a per farm basis and 10th out of 12 on a per hectare basis.

<u>Agricultural Land Use</u>

Agricultural as well as non-agricultural land use within the study area is graphed in Figures 21 through 28.

- Agriculture and Agri-Food Canada (AAFC) prepares agricultural land use maps yearly which are based on the interpretation of aerial photography. The 2017 map (Maps 4 and 5) has been generalized into broad categories such as "cultivated, fallow, small grains, oilseeds, pulses, beans, hay, pasture, corn, potatoes, other crops"; fruits and vegetables"; "urban, built up" etc. and demonstrates that less than half of the Northwest Welland Secondary Plan Study Area is in agricultural use and that no fruits and vegetables are present.

- The Statistics Canada information of 2016 supports that of AAFC and indicates that where agricultural land is present in Thorold + Welland, 87% of that is in common field crops, hay, forage or pasture with less than 1% reported production of fruits and vegetables. In Niagara Region, 73% is in common field crops, hay, forage or pasture and fruit berries and nuts are at 11% with vegetables at 1%.
- Trends in fruit production over time show a reduction in the number of farms reporting as well as the number of hectares of fruit reported in Thorold + Welland from 1981 to 2016.
- Trends and vegetable production show a reduction in the number of hectares of vegetables reported in Thorold + Welland with fluctuating levels of farms reporting. However, farms reporting vegetable production in Thorold + Welland are low ranging from 1 to 8 farms.
- Thorold + Welland and Niagara Region show declining areas of fruit and vegetable production proportionate to total farm area between 1981 to 2016.
- Balance of trade data demonstrate that more money is being spent on imported fruits and vegetables that is being earned via exporting Ontario's fruit and vegetables.

Livestock and Manure Production

Figures 29 and 30 compare the relative number of nutrient units as well as those nutrient units per unit area in Niagara Region, Thorold + Welland and Welland as follows:

- Where data are available, the total number of nutrient units has declined from 1981 to 2006 in Welland.
- In Niagara Region and Thorold + Welland, the total nutrient units per Census Farm hectare has declined from 1981 to 2016.
- In 2016, Niagara Region and Thorold + Welland had less than one animal nutrient unit per hectare.

2.3 Agricultural Soil Capability and Soil Potential

The predominant soils within the Northwest Welland Secondary Plan Study Area include the soil series Beverly, Toledo, Tuscola, Berrien, Colwood and alluvium which are imperfectly and poorly drained. These soils are predominantly prime lands in soil capability classes 1 through 3 as shown on Map 6. Additional description for soil classification and soil capability are outlined in Appendix 3.

Soils and soil capability information could be used at the secondary plan stage to:

- identify soils that provide a better base for parks and playing fields and/or
- provide a rationale for the timing at the such that the better agricultural lands are developed last.

However, the application/utility of the soils and soil capability information will depend on the rate at which urban development needs or does occur and the relative aerial extent of different kinds of urban use. Neither the rate or extent of proposed urban use are currently known.

Soils within the study area have some soil potential for the production of fruit and vegetable crops. The soil capability classification is for common field crops and does not include fruit and vegetable crops. Thus, various classifications on the potential of various soils to produce fruits and vegetables have been published more recently for some Regions/Counties in southern Ontario. Specialty crop classification systems are described more fully and summarized in tabular form in Appendix 2. Niagara Region does have soil potential ratings for fruits and vegetables and these have been adapted within this report. There are 20 crop groupings in this specialty crop rating system as shown in Table 2 (9 groups for fruits and 11 groups for vegetables). The crop groups A, B, C and E are rated as unsuitable (rank 7) due to climate and/or are not grown commercially in Welland.

Table 2 summarizes soil potential ratings for the predominant soils within the study area. The soil potential rating assumes that tile drainage and irrigation are applied as required. Only two soil series, Berrien and Tuscola with a slope ranging between 0.5 and 5%, have an average soil potential rating of 3. The remaining soils, which are predominant, have an average rating of 4 and 5. Notwithstanding the average rating, the smaller areas of Berrien and Tuscola soils have relatively good potential for the production of labrusca grapes, apples, pears, plums, raspberries, strawberries, currants, gooseberries, as well as a broad cross-section of vegetables including cole crops (broccoli, Brussels sprouts, cauliflower), eggplant, peppers, cucumbers, tomatoes, sweet corn, pumpkins and squash.

Soil potential for the production of fruits and vegetables does not mean that the lands are being used for that kind of production. Neither does soil potential for fruit and vegetables indicate that the lands are a *Specialty Crop Area* as defined in the PPS. The Northwest Welland Secondary Plan Study Area is not, nor is it adjacent to a *Specialty Crop Area.* As already described, the study area is not being used for fruit and vegetable production and, at the broader scale of Thorold + Welland and Niagara, area of fruit and vegetable production is declining.

The fruit and vegetable crops that can be grown in Welland and the study area are not unique in the context of the Province or of the Greater Toronto Area. The amounts of different specialty crops and trends and their relative area of production have been described previously and will be addressed again in the following section.

TABLE 2 SOIL POTENTIAL RATINGS

				FRUITS									VEGETABLES											Total Score	Average Soil Potential Rating
SOIL_NAME1	SLOPE1	CLASS1	DRAINAGE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T		
Alluvium	1.0	B/C	Poor	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	140	7
Berrien	1.0	B	Imperfect	7	7	7	2	7	2	2	1	3	2	2	1	2	2	2	2	2	2	2	1	58	3
Beverly loamy	1.0	B	Imperfect	7	7	7	3	7	3	2	4	3	1	4	5	3	2	3	5	1	2	2	3	74	4
Beverly	1.0	B	Imperfect	7	7	7	3	7	3	2	4	3	2	5	5	3	3	4	5	2	3	3	3	81	4
Beverly	3.5	C,c	Imperfect	7	7	7	3	7	3	2	4	3	2	5	5	3	3	4	5	2	3	3	3	81	4
Colwood	1.0	B	Poor	7	7	7	4	7	3	3	3	3	2	3	2	3	2	4	3	2	3	3	3	74	4
Toledo loamy	1.0	B	Imperfect	7	7	7	4	7	4	4	5	5	2	4	5	3	3	4	5	2	2	2	4	86	4
Toledo	1.0	B	Imperfect	7	7	7	4	7	4	4	5	5	3	5	5	3	4	5	5	3	3	3	4	93	5
Toledo	3.5	C,c	Imperfect	7	7	7	4	7	4	4	5	5	3	5	5	3	4	5	5	3	3	3	4	93	5
Tuscola	3.5	B	Imperfect	7	7	7	1	7	2	2	1	1	1	2	1	2	1	2	2	1	1	2	2	52	3

Crops Used:	
Tree Fruits, Grapes and Small Fruits:	
A	Peaches, Apricots, Nectarines
B	Sweet Cherries
C	Sour Cherries
D	Labrusca Grapes
E	Vinifera Grapes
F	Apples
G	Pears, Plums
H	Strawberries, Raspberries
I	Currants, Gooseberries
Vegetable Crops:	
J	Broccoli, Brussel Sprouts, Cauliflower
K	Bulb Onions, Garlic
L	Green (Bunching) Onions
M	Eggplant, Peppers
N	Cucumbers
O	Muskmelon
P	Potatoes
Q	Tomatoes
R	Sweet Corn
S	Celery, Lettuce
T	Pumpkins, Squash

2.3 Agricultural Land Use

Agricultural land use within the study area was ascertained based on field work (roadside reconnaissance), area photo interpretation as well as by reference to the published literature. The Northwest Welland Secondary Plan Study Area lands are predominantly used for common field crop production as can be seen by interpreting the aerial photo base on Map 2. Woodland (including wetlands) areas are the 2nd most predominant land use (based on areal measurement). The study area includes a significant amount of non-agricultural development including strip development adjacent to roads. These observations are supported by AAFC and Statistics Canada census information which was described previously.

2.5 Climate

There are no readily available regional maps that integrate the various components of climate such as crop heat units, precipitation during the growing season, depth to water table, availability of water for irrigation, sunshine days and other climate risk factors into a single potential rating similar to soil capability. However, several broad scale, recent as well as historical climate information maps, are available from Agriculture and Agri-Food Canada at the national and provincial levels. These maps are at broad scale and appropriate for application at the Provincial and regional scales such as for southern Ontario. These maps are not sufficiently precise for application in the Northwest Welland Secondary Plan Study Area. Regardless, the climate information provides the evidence that Niagara is relatively unique within the context of Ontario. Hence, the mapping of a significant proportion of Niagara as *Specialty Crop Area*. As already discussed the Northwest Welland Secondary Plan Study Area is not within the *Specialty Crop Area*.

Niagara Region is unique in that it has more specific mapping for grape site selection (Fisher and Slingerland, 2002). This mapping provides information indicating that the Northwest Secondary Plan Study Area is in areas classified as “F” and “G” which are the poorer areas for grape production. Niagara Region also has done studies related to irrigation water (Stantec, 2005, 2007). Given the current agricultural land use and lack of fruits and vegetables within the Northwest Welland Secondary Plan Study Area, irrigation requirements are minimal.

2.6 Livestock and Manure Production

Several data sources have been used at various scales to characterize livestock use. For example, impediments to the construction of new livestock buildings are to be found in government regulation such as the Nutrient Management Act (NMA, 2002) and the Act’s associated Regulation (2005), in addition to the costs associated with the livestock business.

These costs include:

- The requirements of compliance with the NMA. Costs are significant and vary with agricultural industry and are outlined in the paper by Brethour et al. (2004). The poultry business is in a relatively good position to expense those costs.
- Costs for entering supply controlled agricultural industry such as dairy or poultry (which are the livestock industries with a good expectation of high net returns) is high. Combe (2000) estimated that the capital investment (excluding land costs) related to 30,000 units of chicken broiler quota was $1.609 million. Therefore, the capital investment (excluding land) for the 30,000 units of chicken broiler quota would be in excess of $1.6 million at current prices.

Given the level of liability, costs of compliance, hard work and uncertainty associated with livestock production, that production may become a less desirable farming option. For example, livestock farming may not be the favoured choice for an agricultural operation because of externally imposed requirements related to nutrient management, animal welfare, diseases such as BSE and avian influenza in addition to the cost of quota associated with supply-controlled industries (chicken, eggs and dairy). This perspective is supported by information that indicates that less livestock and manure is being produced within Niagara Region over time (as discussed previously).

The trends provided by the published literature support field observations and aerial photo interpretation that indicate no barns within and adjacent to the Northwest Welland Secondary Plan Study Area. Therefore, there is no need to calculate Minimum Distance Separation (MDS). If there were barns within a 1.5 km radius of the study area, the need for MDS calculations would be diminished because of the application of Guideline 12 in the MDS Document (2017) which states that MDS does not need to be applied when four or more existing non-agricultural uses are in close proximity to a barn. The specific circumstances related to the application of guideline 12 are outlined in the MDS Document.

2.7 Agricultural Infrastructure

Agricultural Systems in the *Agri-Food Network* are related to infrastructure that supports and/or is integral to agricultural production and processing. Fieldwork and aerial photo interpretation did not reveal the presence of agricultural infrastructure serving the needs of farmers in the area. The lack of livestock barns correlates with the lack of other agricultural infrastructure within the Northwest Welland Secondary Plan Study Area.

2.8 Mitigation

There is much qualitative literature describing possible conflict between agriculture and urban uses where that conflict is related to dust, pesticides, noise, light, transportation, odour, trespass, vandalism, farm management, animal care and other matters related to life in, and expectations associated with, agricultural versus urban areas. Is not the intent of this report to review that literature extensively. OMAFRA does not have documents that describe mitigation measures and their efficacy but have provided information prepared by some municipalities within southern Ontario (London, Mississippi Mills) and to government papers available for British Columbia (OMAFRA, 2016). The literature from British Columbia is more extensive. Published literature generally provides information with respect to subdivision design and other recommendations intended to reduce urban/rural conflict.

- Roads at the boundary between agricultural and urban areas should be designed to accommodate large, wide, slow-moving farm machinery (by use of wider road surfaces including paved shoulders; by placement of road markers, signage, mail boxes, away from the road edge, for example).
- Visual barriers provided by tree plantings within the agricultural and urban areas would potentially reduce some impacts related to light and noise.
- Choose areas of lower agricultural importance/priority for non-agricultural development where that proposed non-agricultural development has a boundary adjacent to relatively lower priority agricultural lands.

The literature shows that mitigation can take the form of:

- physical separation (buffer strips),
- berms,
- fencing,
- screening through use of vegetation,
- insertion of low-density uses between high-density urban uses and farm land,
- specialized zoning of buffer strips to prevent structures, storage, and removal of vegetation,
- clauses attached to land title which warn that adjacent uses include farm land where normal farm practices are protected and where those practices include the production of dust, vibration, odours, light, noise etc. and the use of fertilizers and pesticides,
- any combination of the aforementioned.

The need for, as well as the form or characteristics of, that mitigation can depend on several factors such as:

- the relative importance of the farmland as defined by planning policy;
- the kind and scale/size of agricultural operations (livestock versus fruit production, for example) probably affected by new urban development;
- the probability of impacts to agriculture and the severity of those impacts if they should occur;
- the probability that mitigation in any, or of specific form, can significantly reduce probable impacts;
- the relative positive impacts of residential development adjacent to farm land compared to negative impacts associated with the juxtaposition of residential and agricultural development.

The literature tends to emphasize the negative interactions at the urban/agricultural interface. However, there are some positive impacts and these are outlined by Sokolow (Chapter 12, no date).

> *The common generalization from several studies is that urban proximity can provide profit-making opportunities as well as problems for farmers, considering the potential for direct marketing, other forms of access to urban consumers, and off-farm income for operators. (Edelman, et al., 1999). But only certain kinds of intensely-cultivated farms, including vegetable producers, seem to benefit from such locations (Larson, et al., 2001). A USDA review of the available information on farms in metropolitan areas characterizes them as smaller, producing more per acre, more diverse, and more focused on high-value production than farms in non-metropolitan areas (U.S. Department of Agriculture, 2001).*

Given that the Northwest Welland Secondary Plan Study Area is of relatively lower importance in the context of Welland and Niagara, the lack of agricultural infrastructure, no need for Minimum Distance Separation, the lack of high-value fruit and vegetable crops and greenhouses, the size and juxtaposition of the study area relative to nonagricultural uses, the mitigation discussed in the literature is not necessary related to the study area.

3.0 SUMMARY/CONCLUSIONS/RECOMMENDATIONS

The findings of the AgPlan analyses and mitigation review are summarized as follows;

- The study area does not meet the requirements for a *Specialty Crop Area* as defined within the PPS.
- The area does not have a high average potential for the production of specialty crops (fruits and vegetables) unlike lands in the *Specialty Crops Area* delineated in the northern parts of Niagara Region.
- Lands in the study area are predominantly in soil capability classes 1 through 3 (prime lands) as is much of Niagara Region.
- Soils have different drainage classes and textures.
- Common field crops are predominantly grown in areas of current agricultural use. Non-agricultural uses are actually predominant within the Northwest Welland Secondary Plan Study Area.
- Census farm number and area is diminishing over time and will likely continue as non-agricultural development occurs in Niagara and Welland.
- The majority of farms have more off-farm income than non-farm income.
- There are significant differences in gross and net incomes associated with common field crops versus fruits and vegetables versus greenhouse crops. High gross and net income crops are not present in the Northwest Welland Secondary Plan Study Area.
- Niagara has a relatively high total farm capital in the context of Ontario whereas Thorold + Welland does not. Farm capital in Thorold + Welland is relatively lower in the context of Niagara.
- Niagara's gross income and net income are relatively high in the context of other Counties/Regions in southern Ontario. Gross and net income in Thorold + Welland is relatively lower in the context of Niagara.
- At a Regional/County scale, multi-attribute analyses rate Niagara's performance as high except in the instance of field crop yields.
- Common field crop production predominates in Niagara region as a whole and Welland.
- Farms producing fruits and vegetables and the area in fruits and vegetables have diminished between 1981 and 2016. No fruit and vegetable production was observed in the Northwest Welland Secondary Plan Study Area.
- Nutrient (formerly animal) units are diminishing within Welland and Niagara.
- Nutrient units times odour factor is also diminishing within Welland and Niagara.
- No MDS measurements are required related to the Northwest Welland Secondary Plan Study Area because livestock barns were not observed in the 1.5 km MDS study area around the site.
- No observable farm infrastructure such as seed drying and sales facilities were observed within or adjacent to the Northwest Welland Secondary Plan Study Area.
- The Northwest Welland Secondary Plan Study Area is a small area which is almost entirely surrounded by planned or existing non-agricultural uses. The study area also contains a relatively high amount of strip development and non-agricultural uses

In conclusion, the Northwest Welland Secondary Plan Study Area is relatively poorer agriculturally and is isolated from other agricultural uses. The study area's lack of agricultural infrastructure and compliance with MDS minimize impacts to the remaining agricultural lands which are currently in common field crop production. The Northwest Welland Secondary Plan Study Area is a logical extension of Welland.

Given the characteristics of the Northwest Welland Secondary Plan Study Area, no recommendations, including mitigation, are made.

AgPlan Limited

Michael K. Hoffman
Agricultural Analyst

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APPENDIX 1
FINDINGS - DATA GRAPHS AND MAPS

FIGURE 1

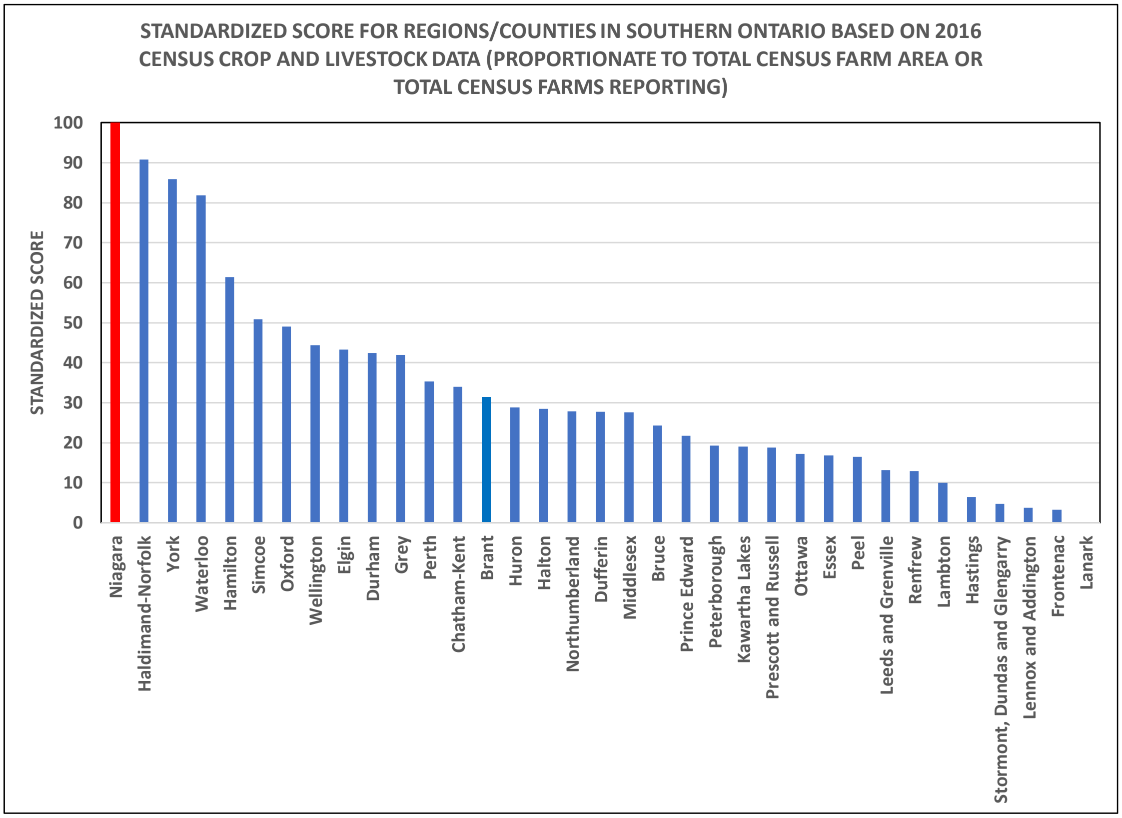


FIGURE 2

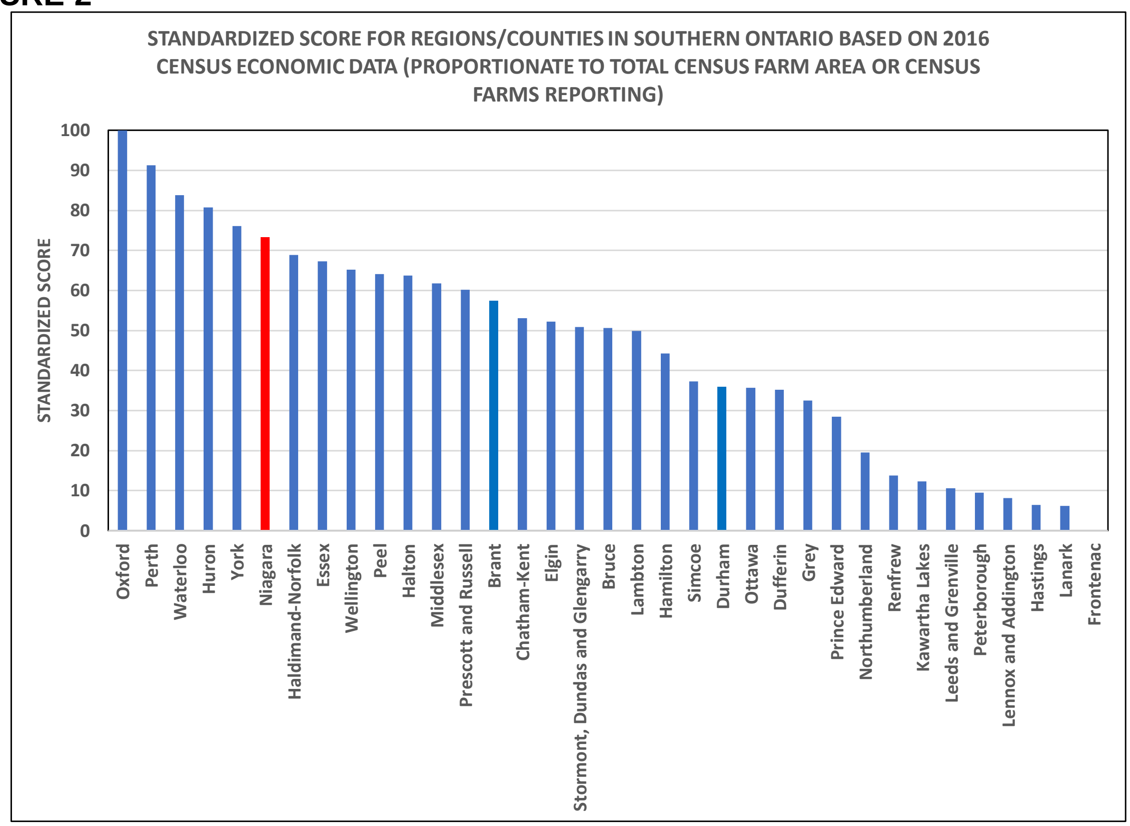
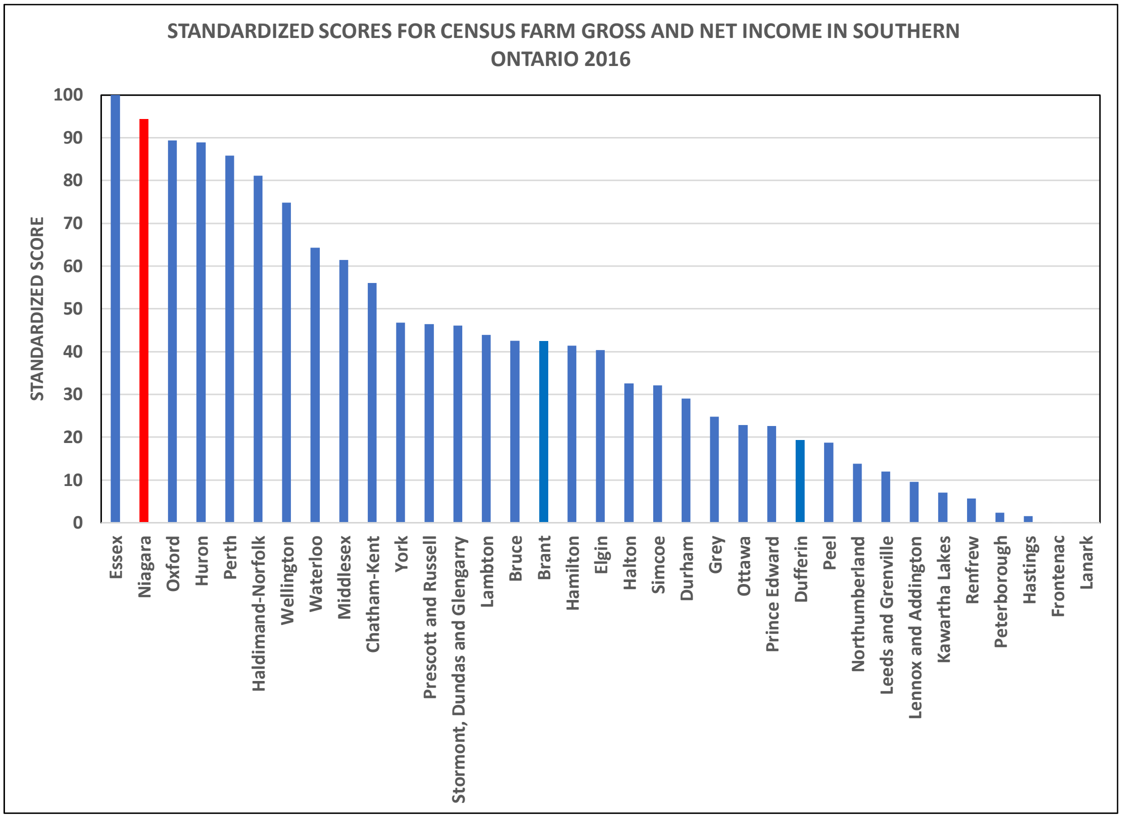


FIGURE 3



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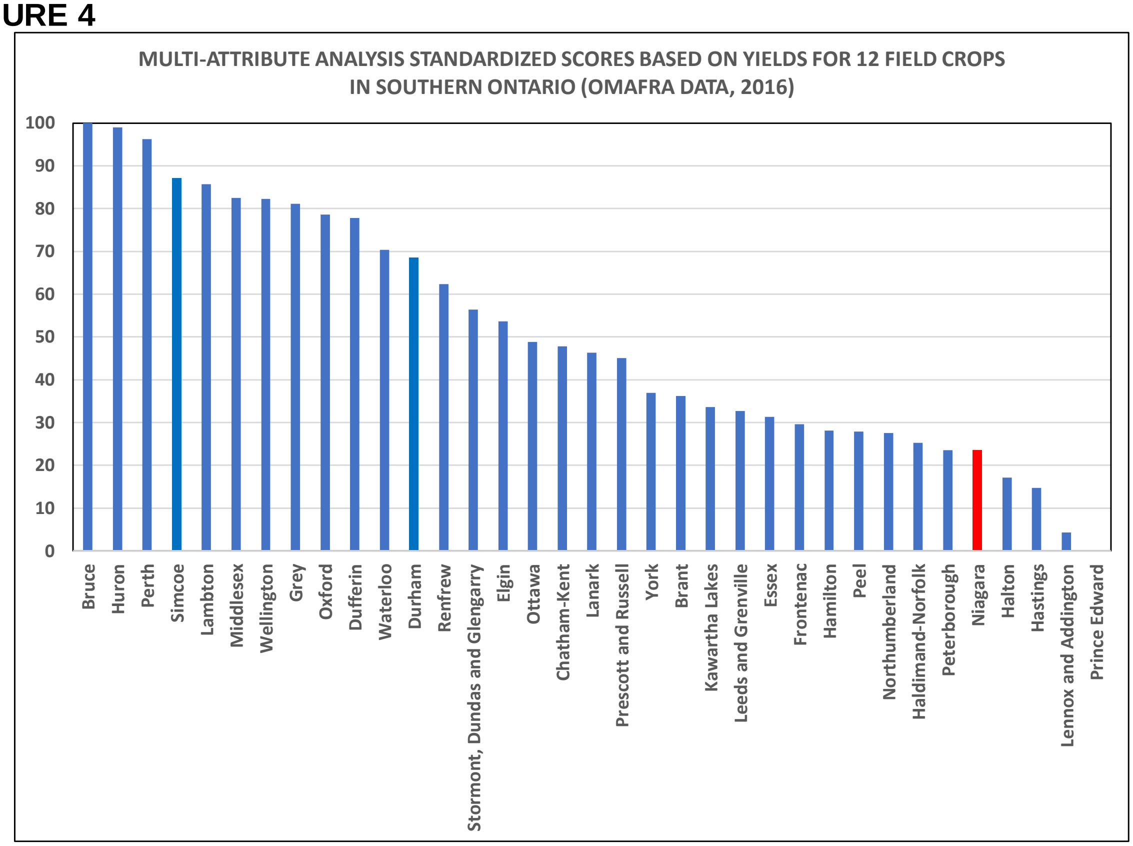

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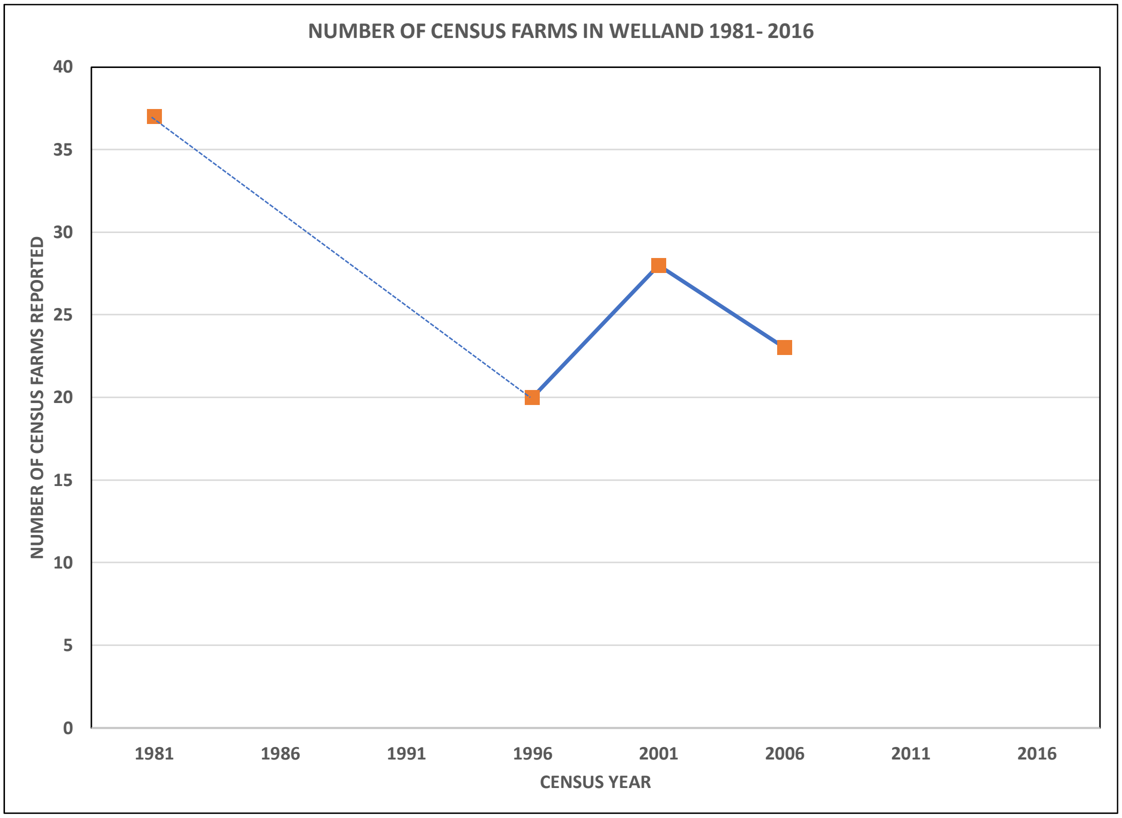

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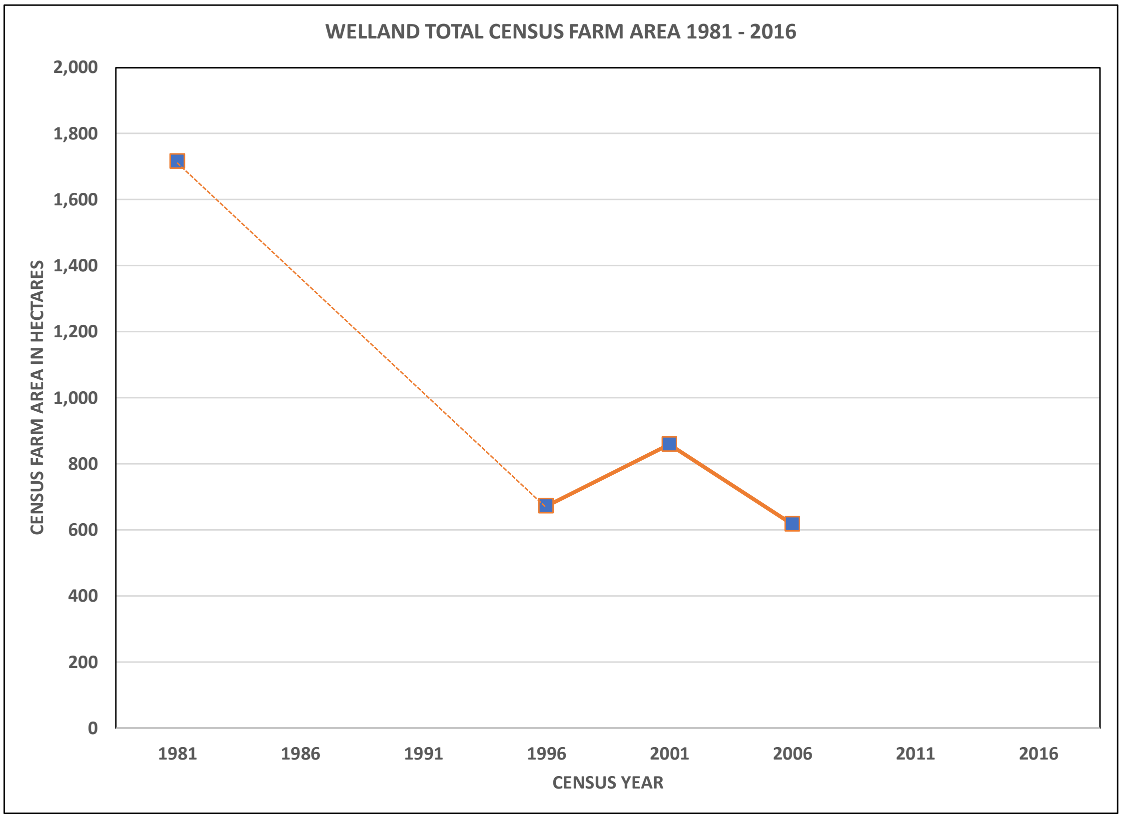

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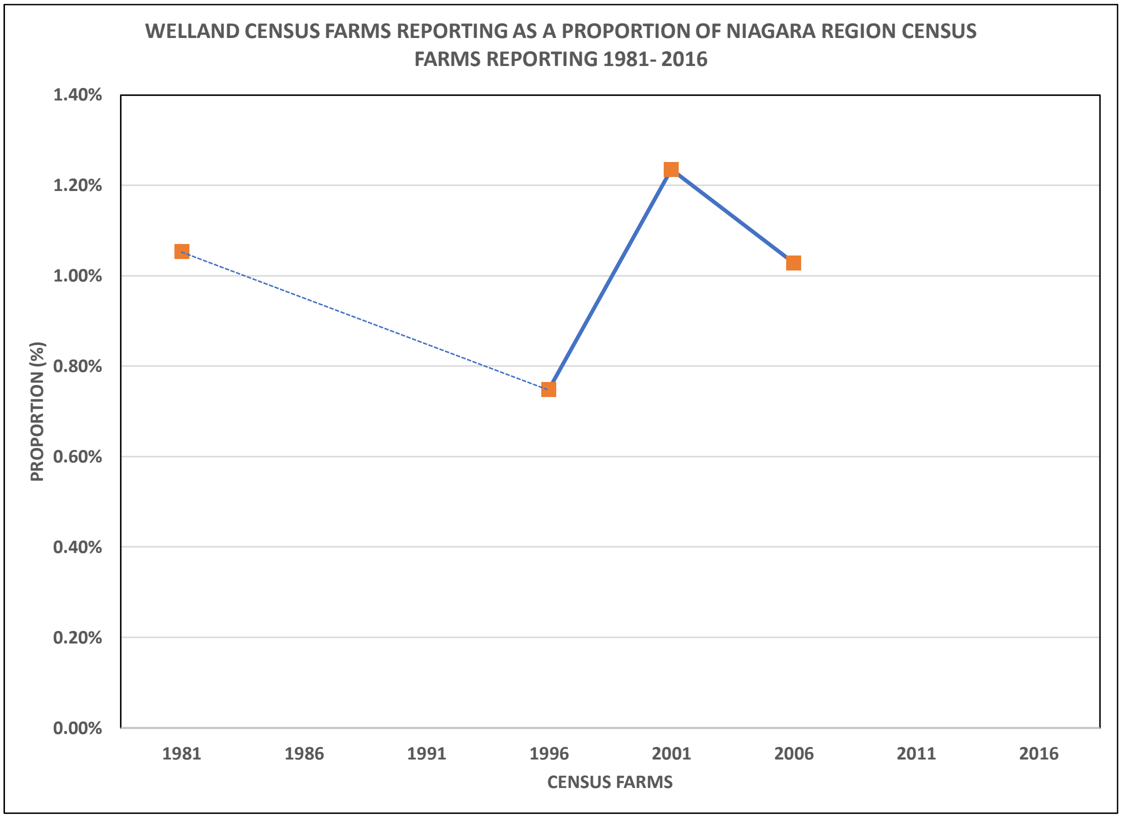

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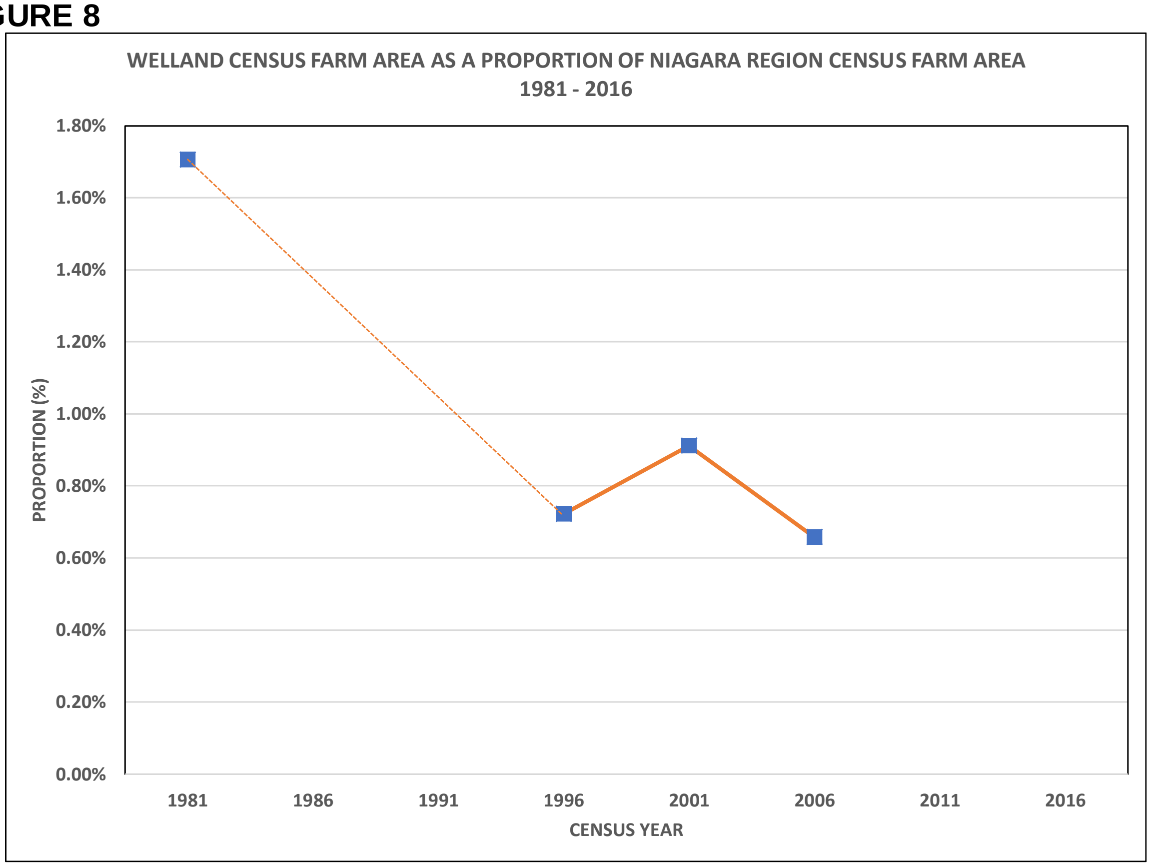

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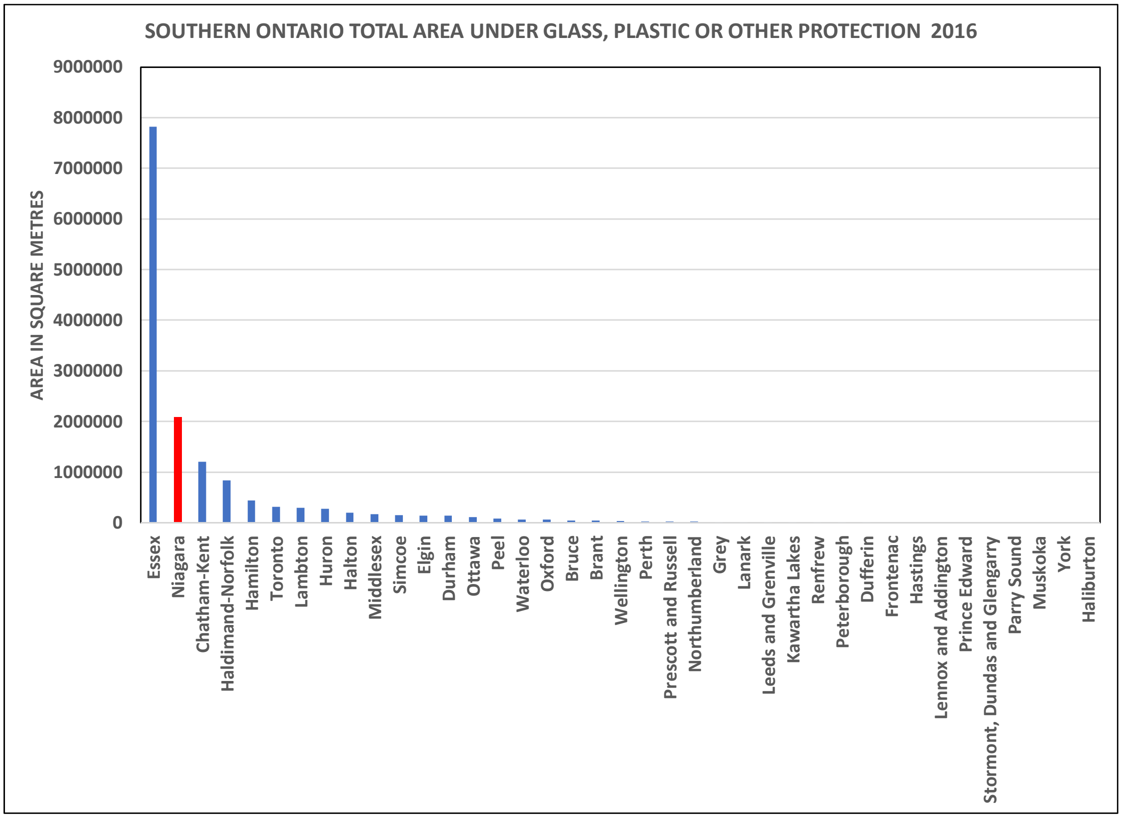

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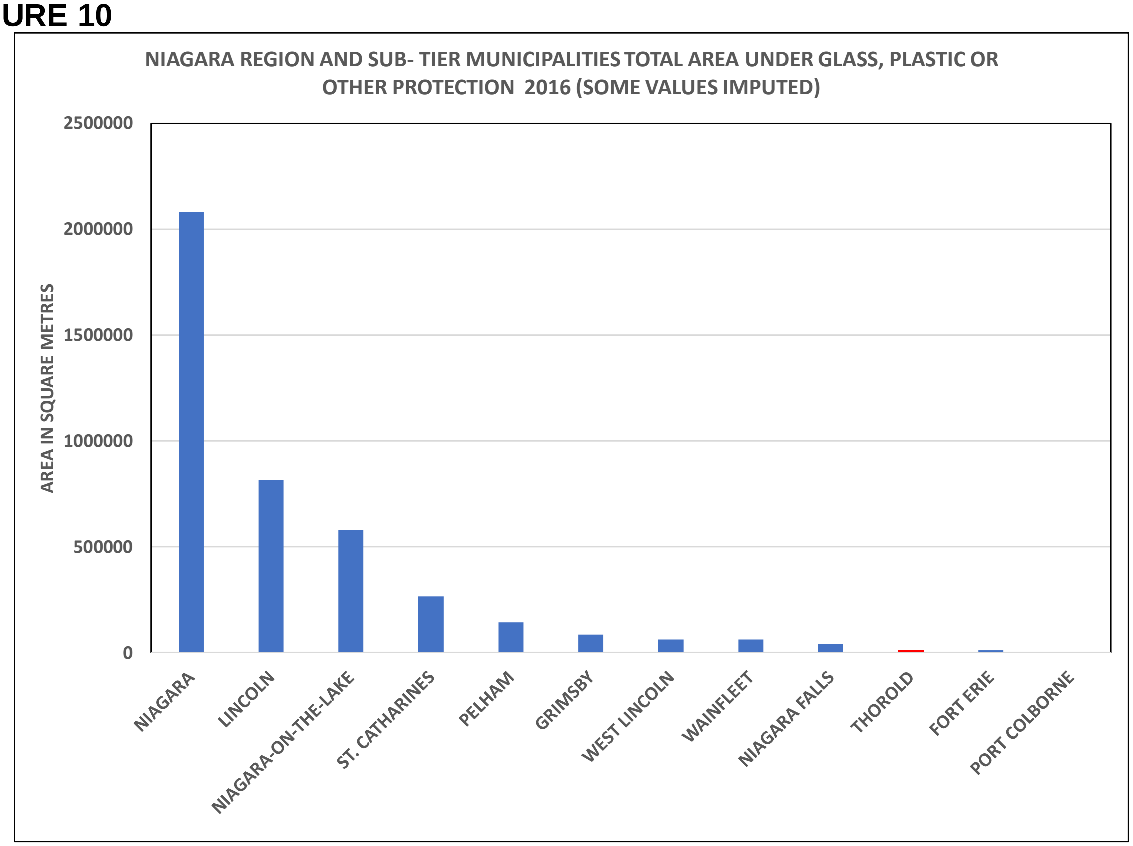
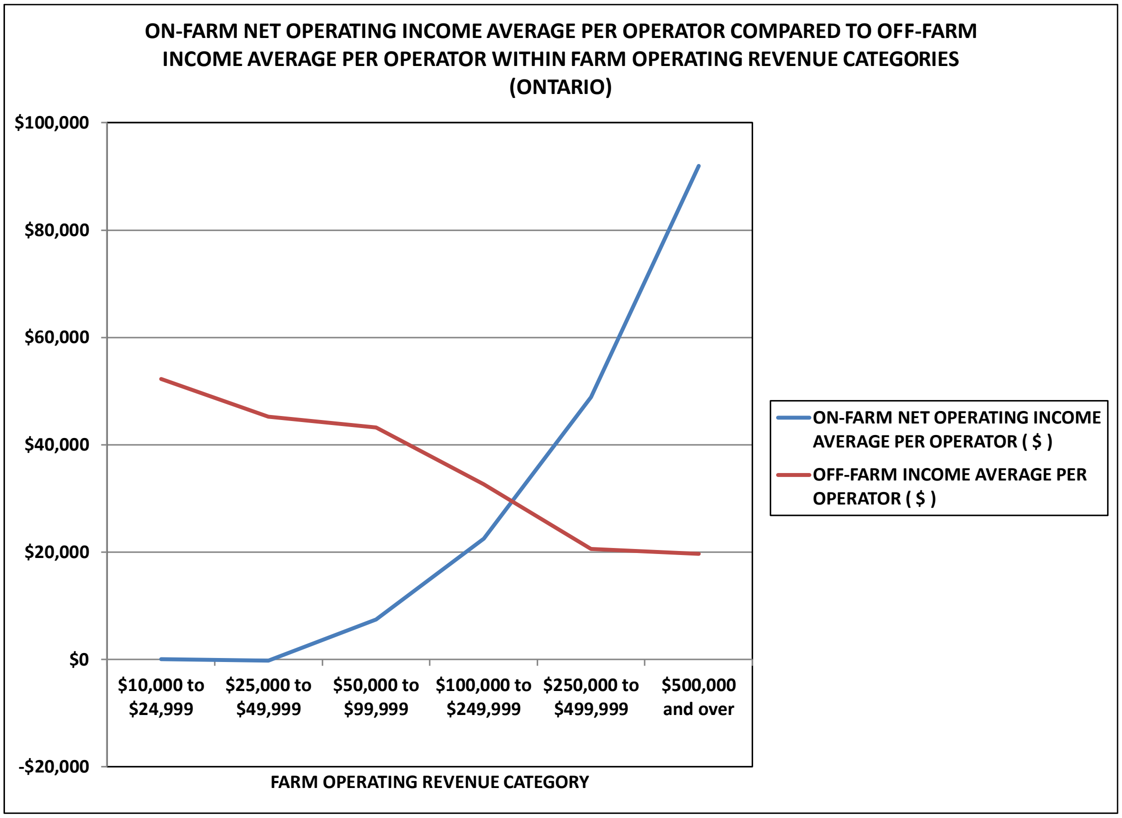


FIGURE 11



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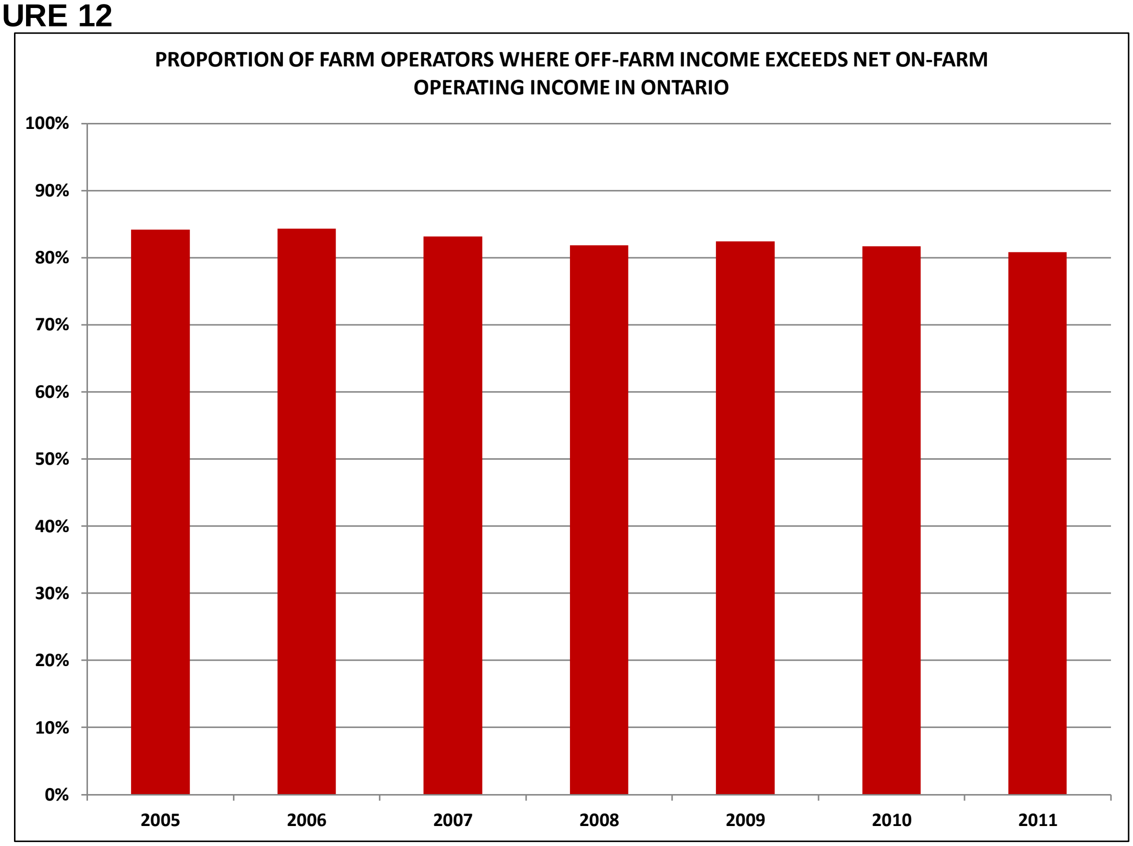

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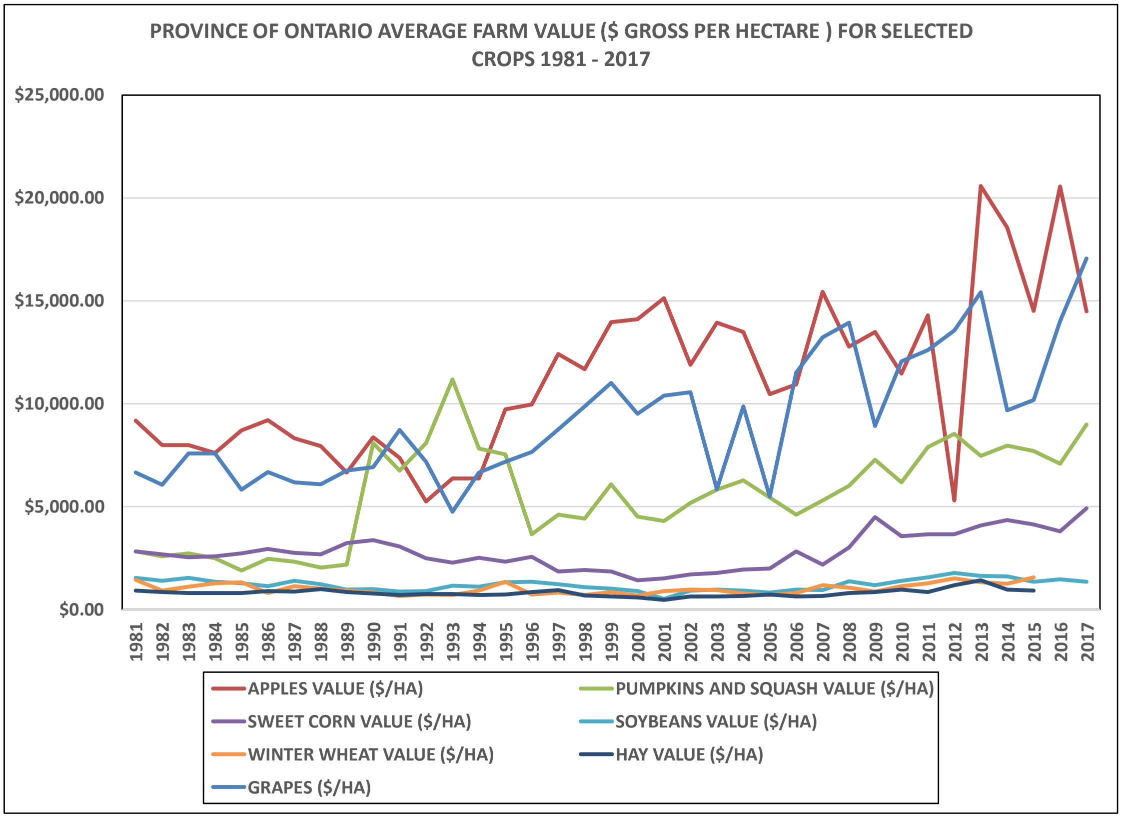

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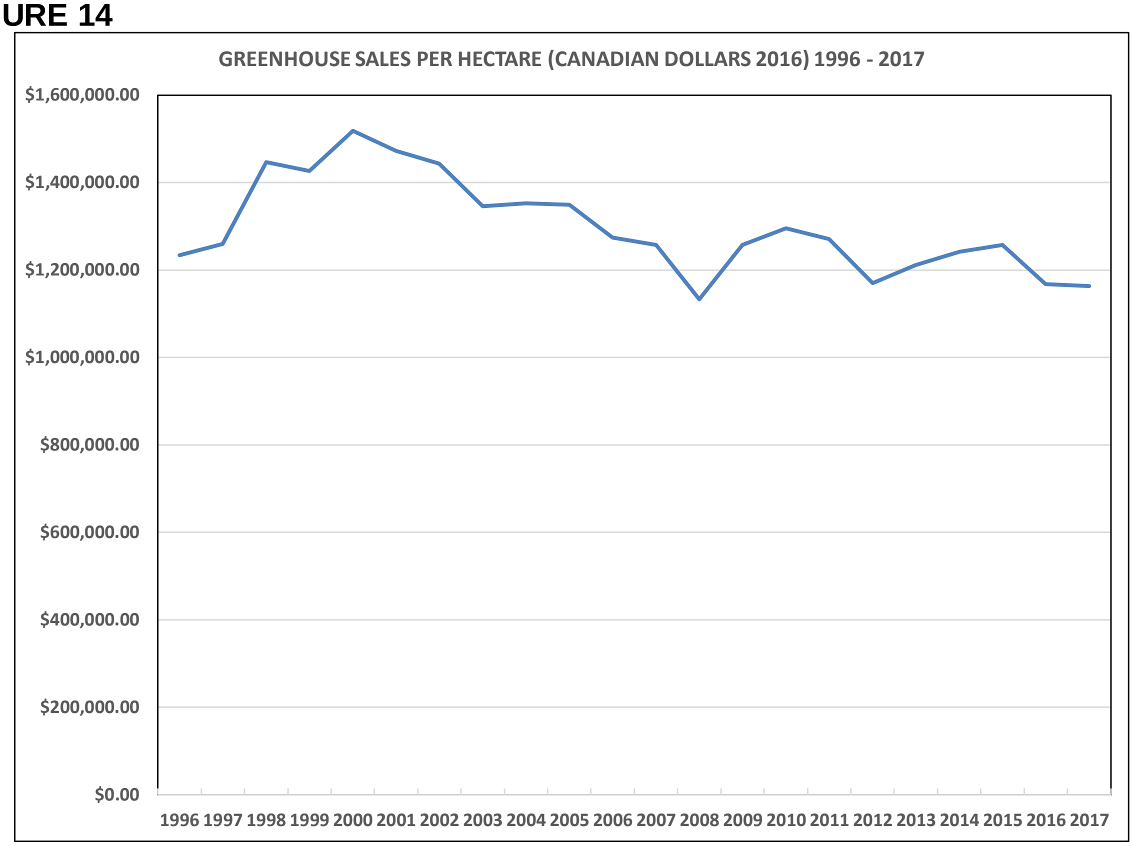

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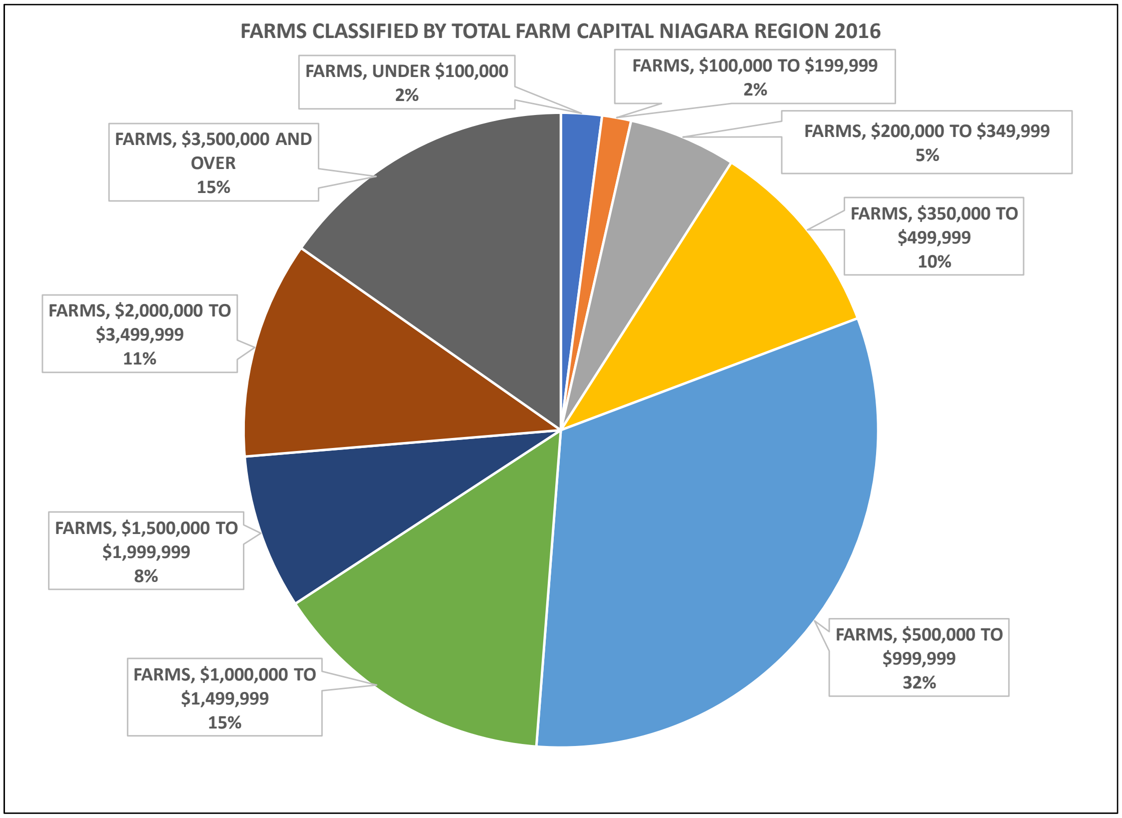

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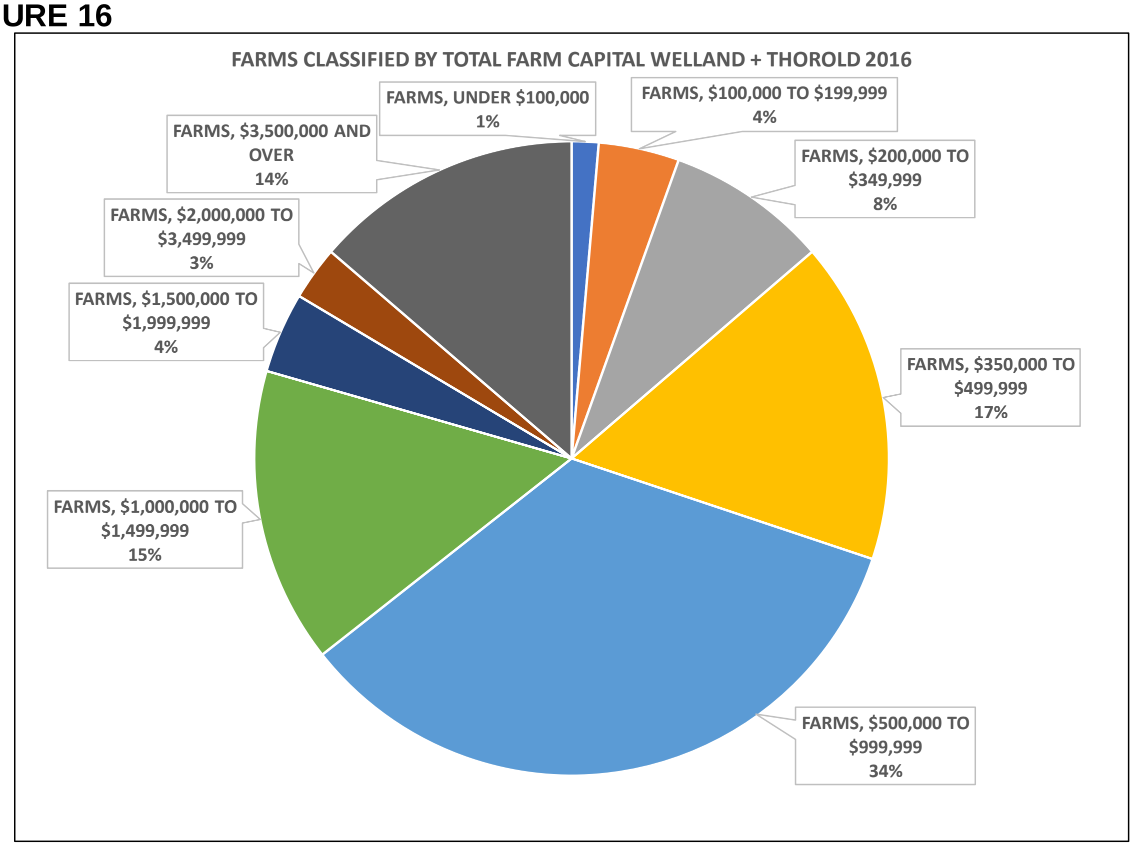

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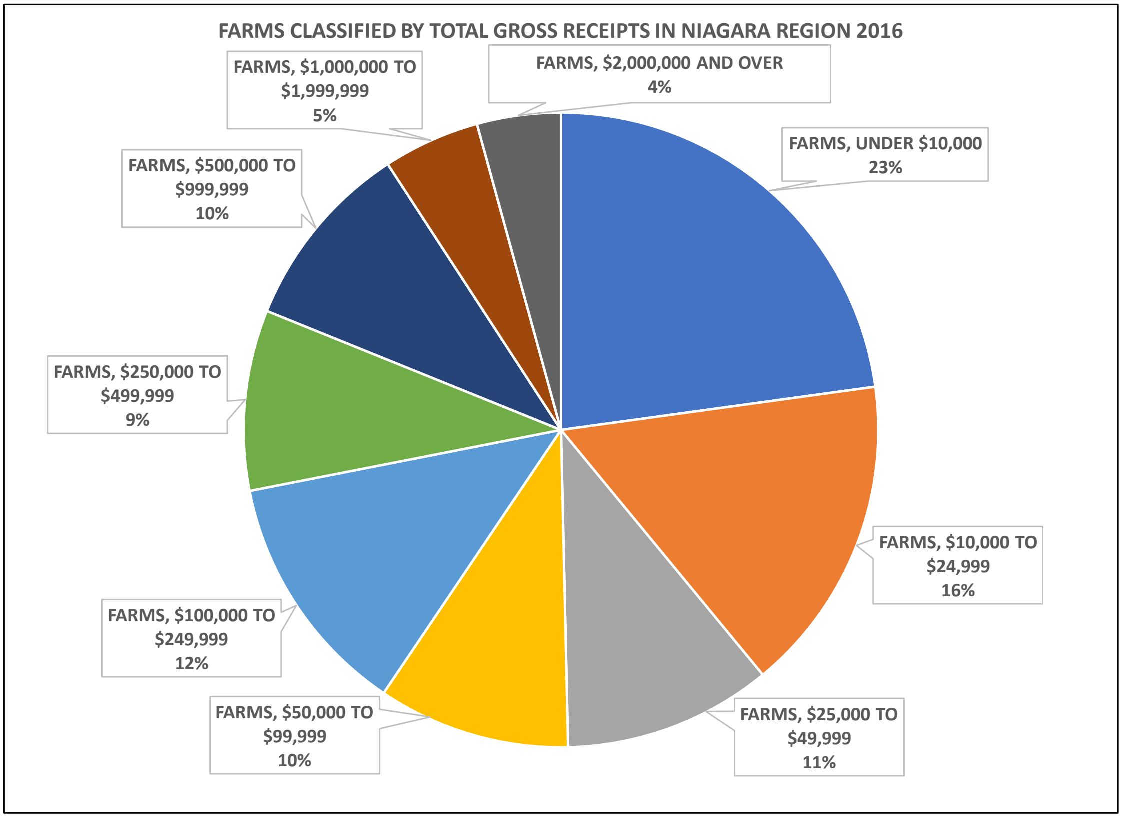

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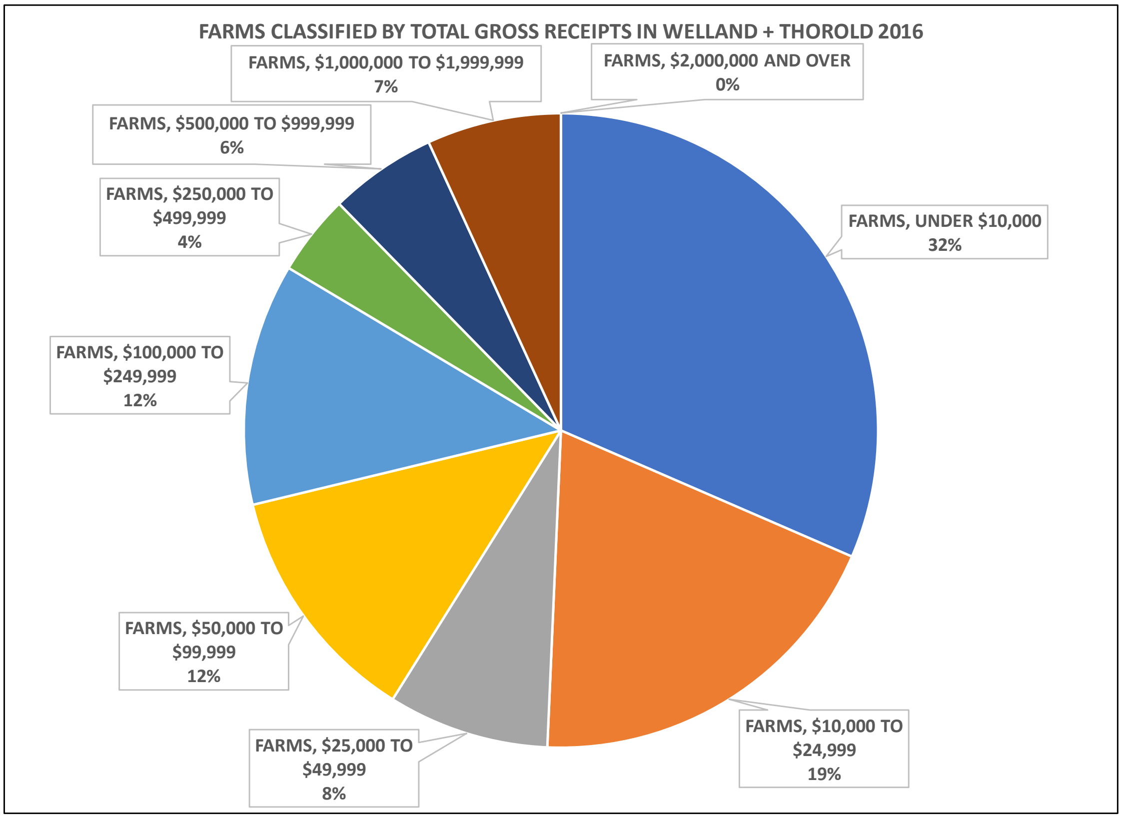

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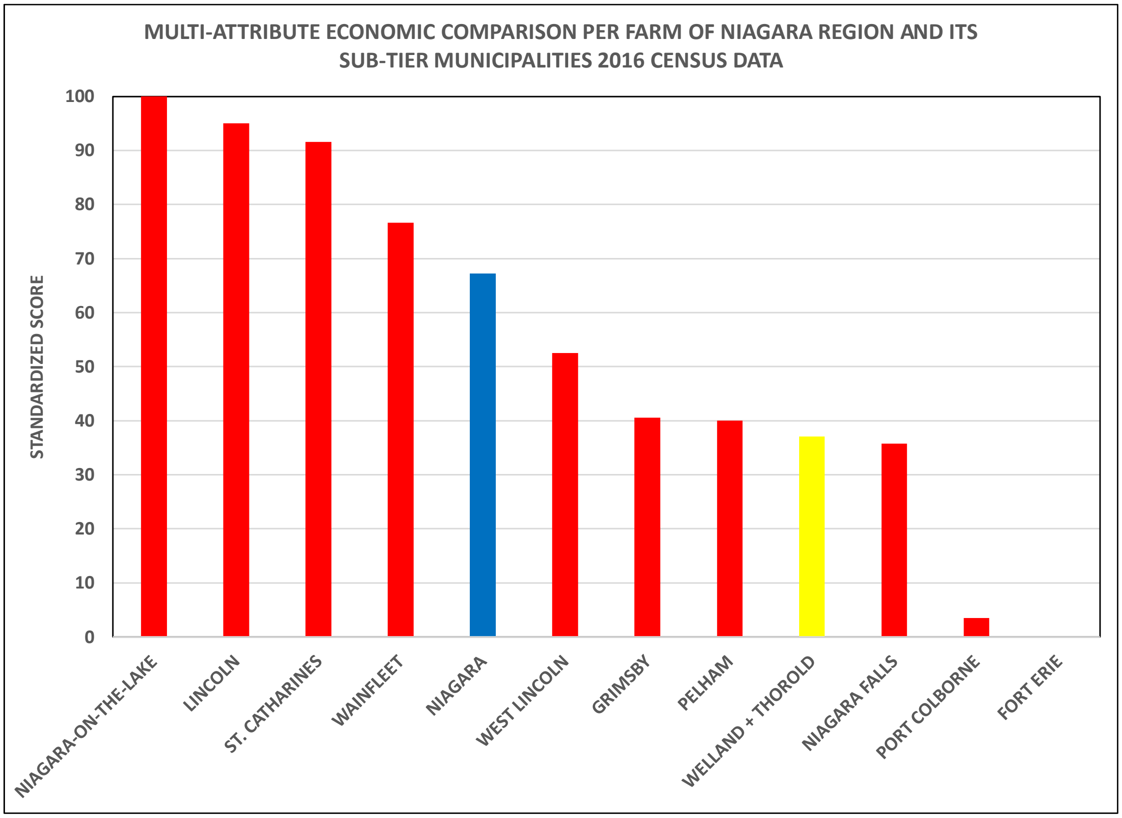

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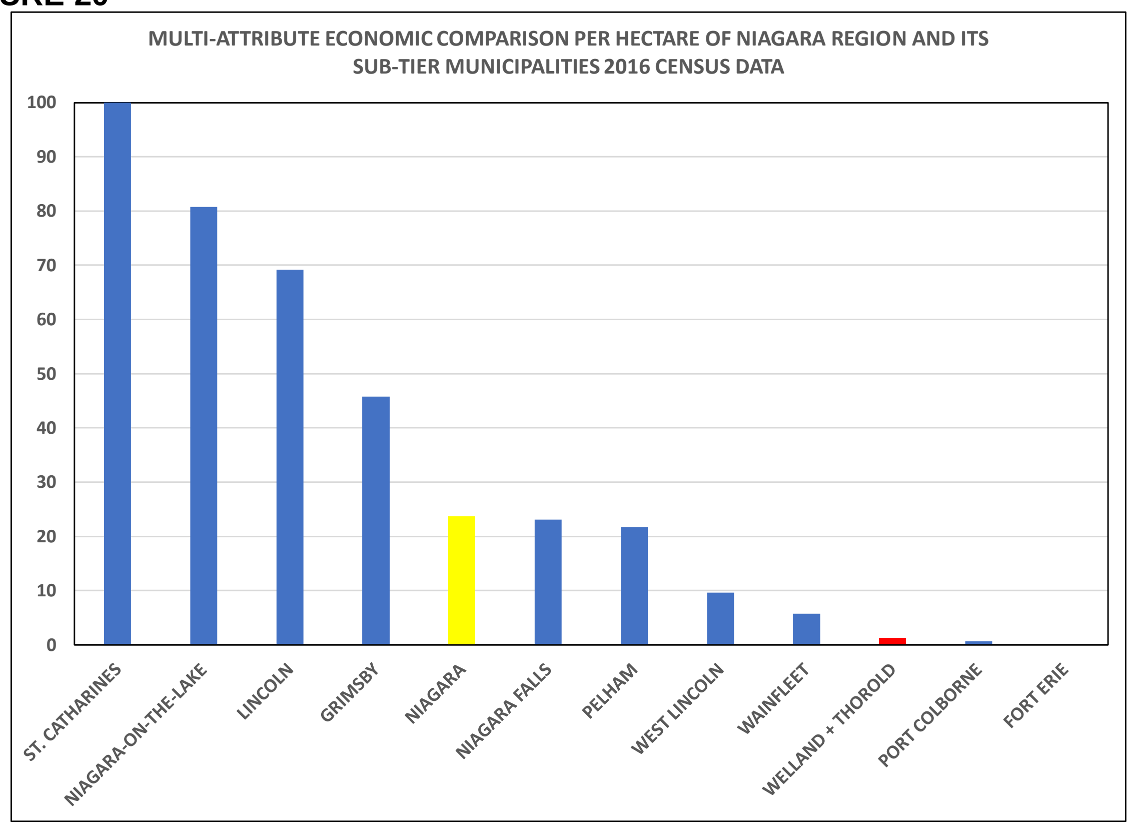

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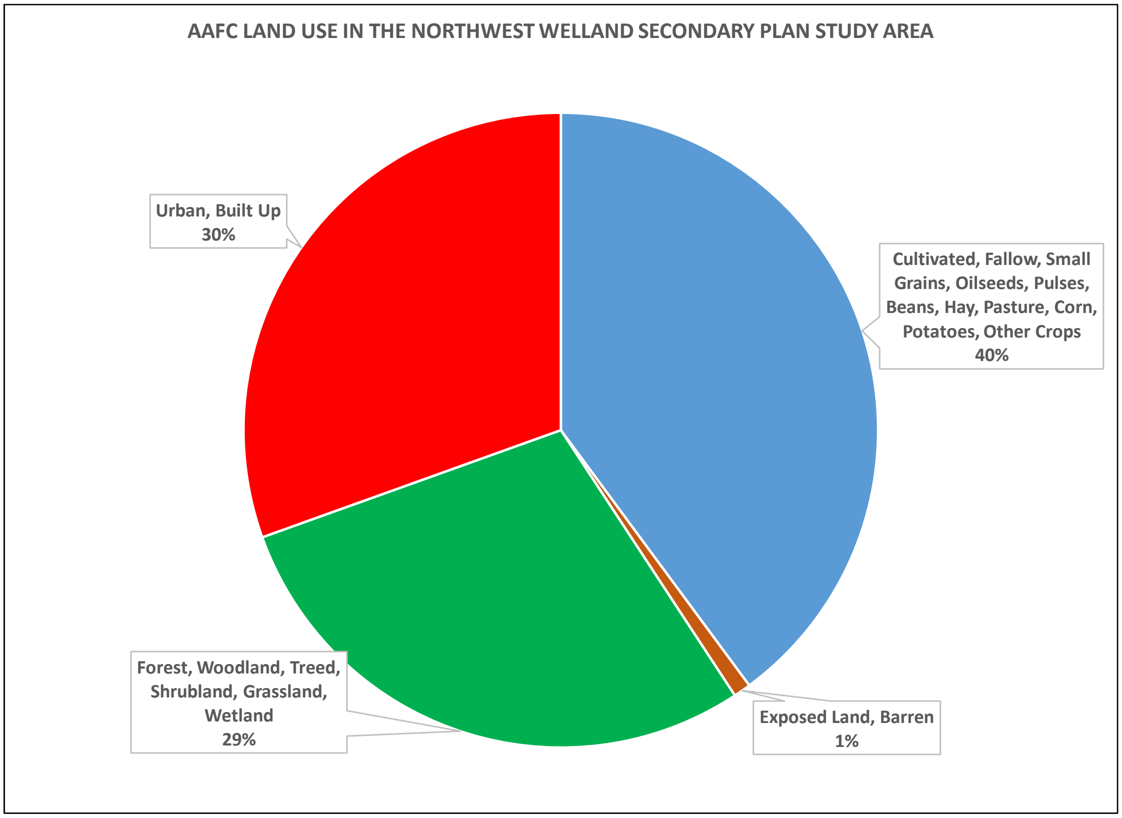

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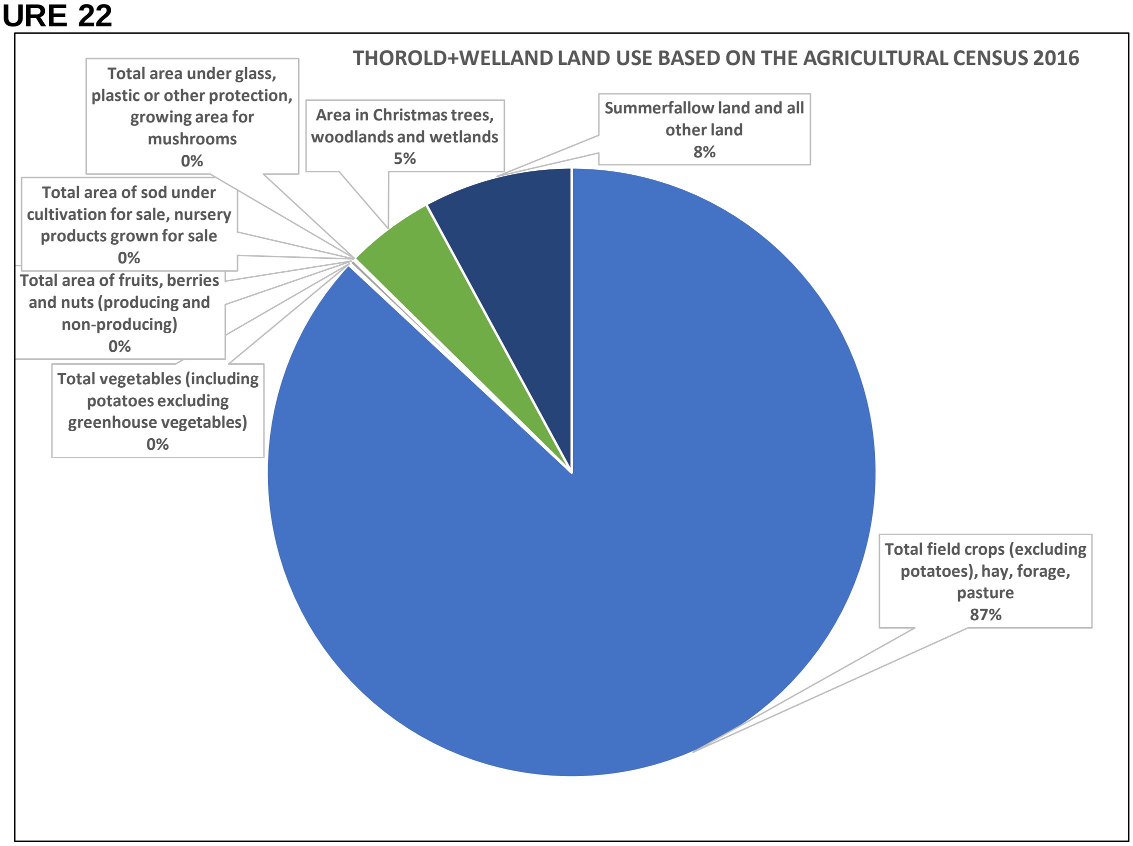

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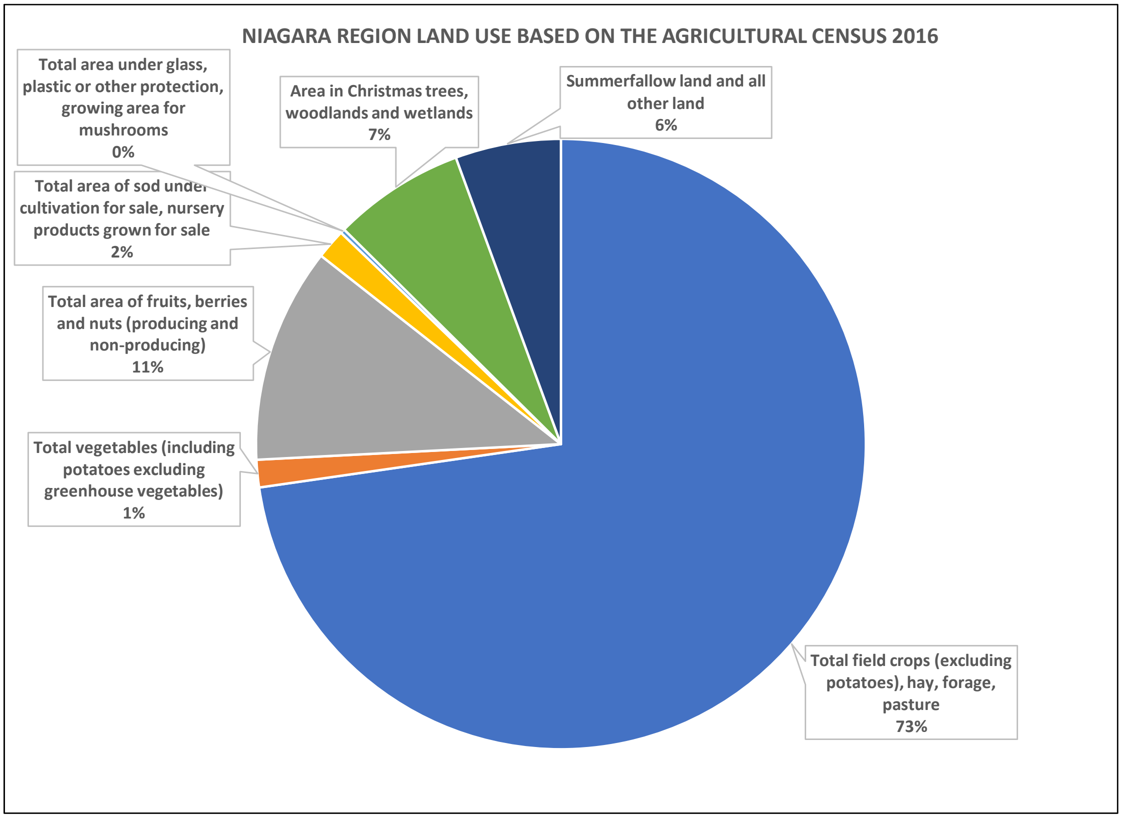

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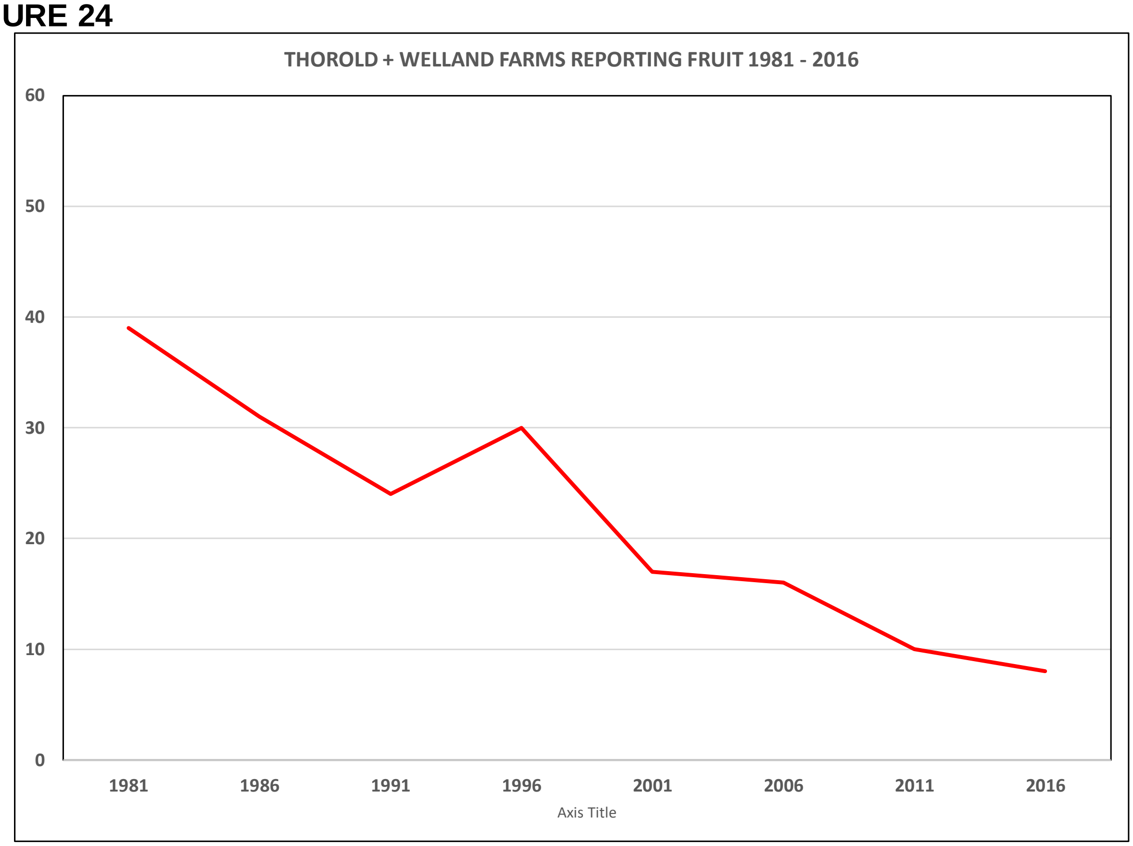

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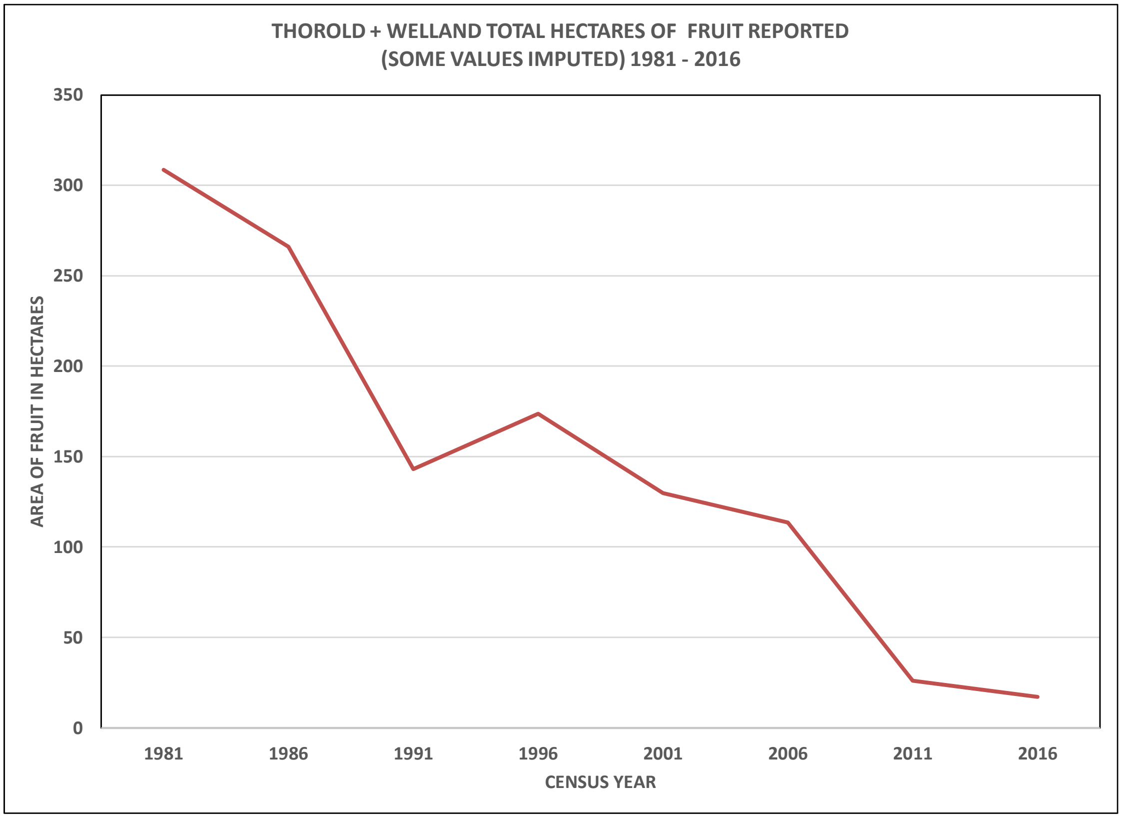

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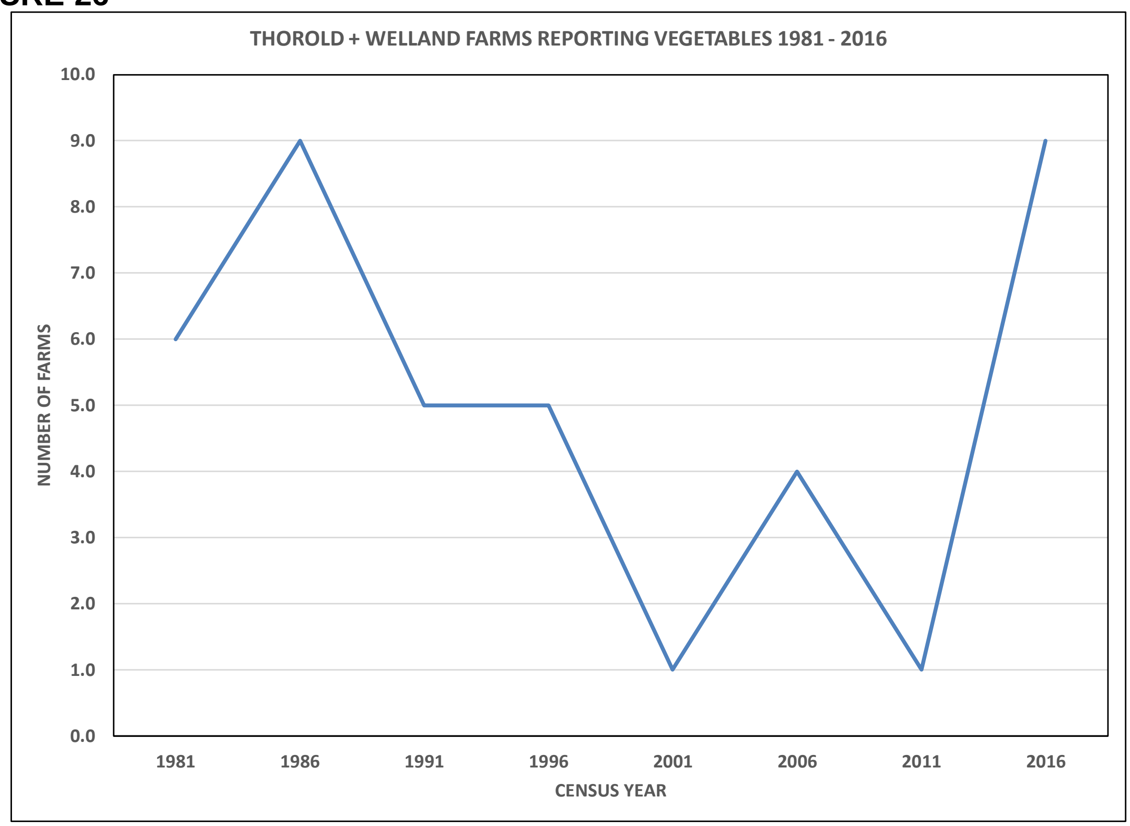

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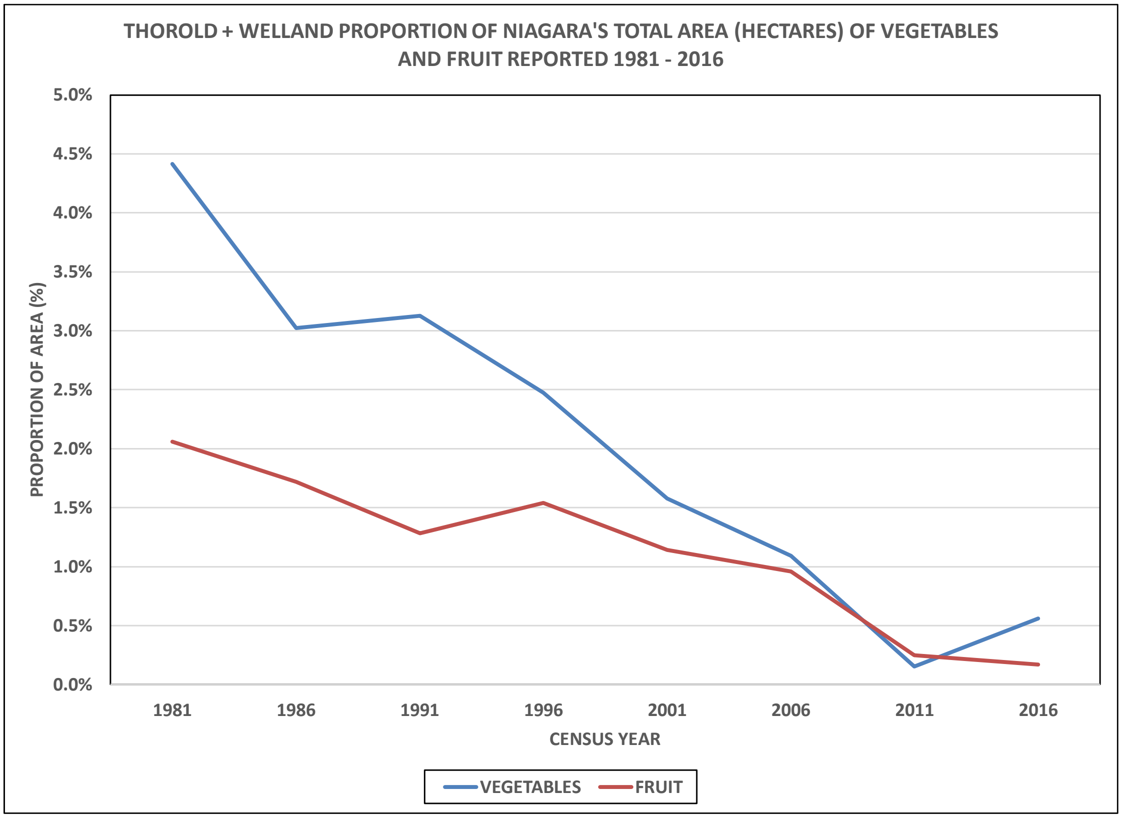

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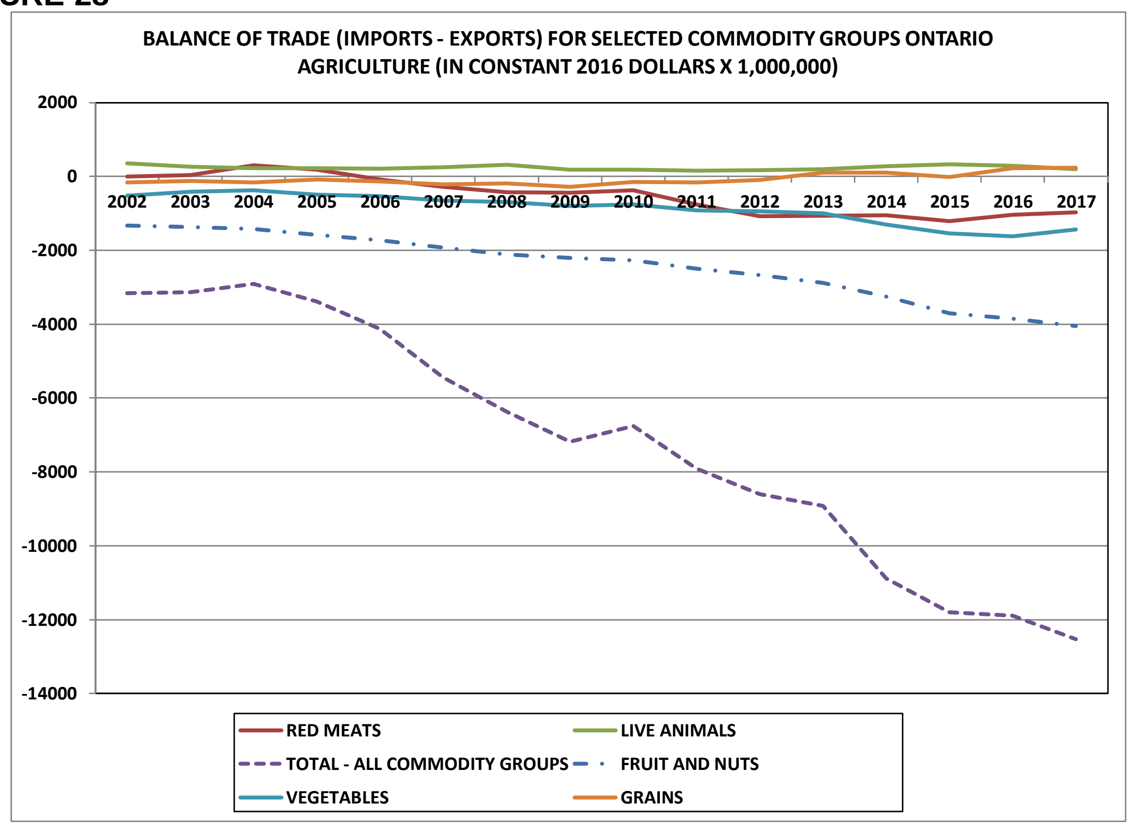

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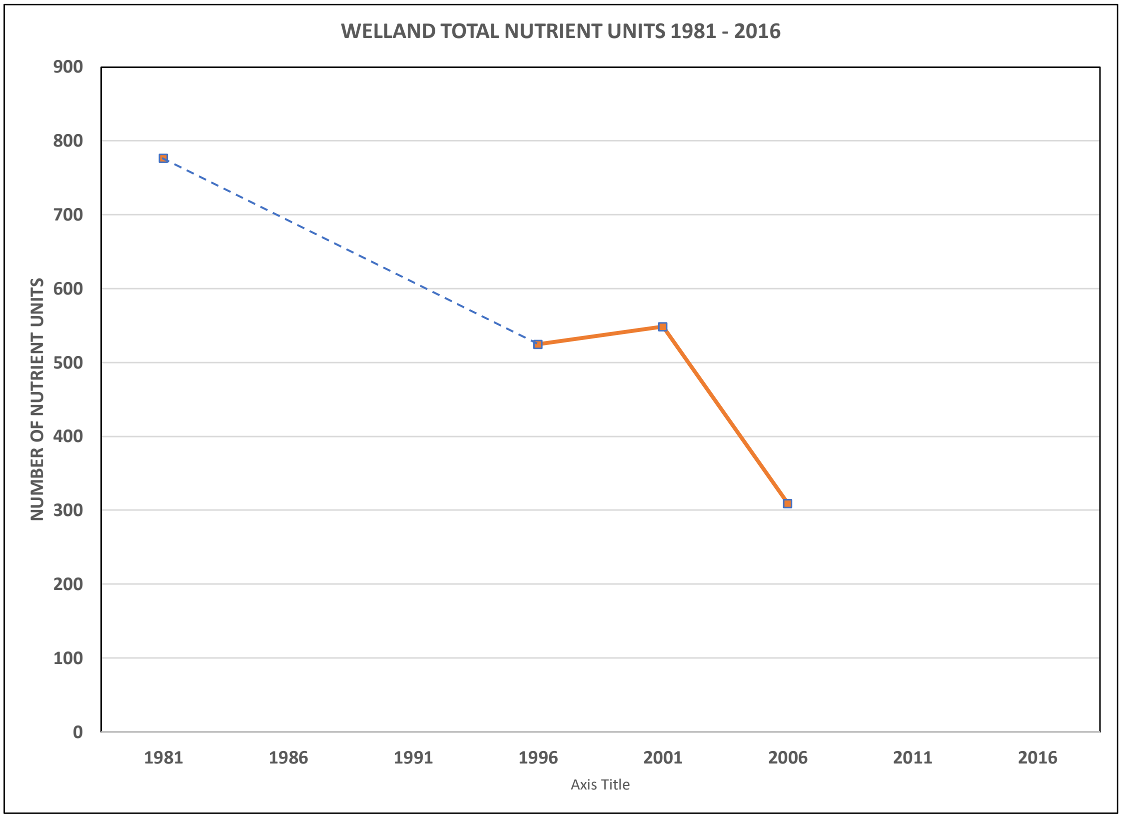

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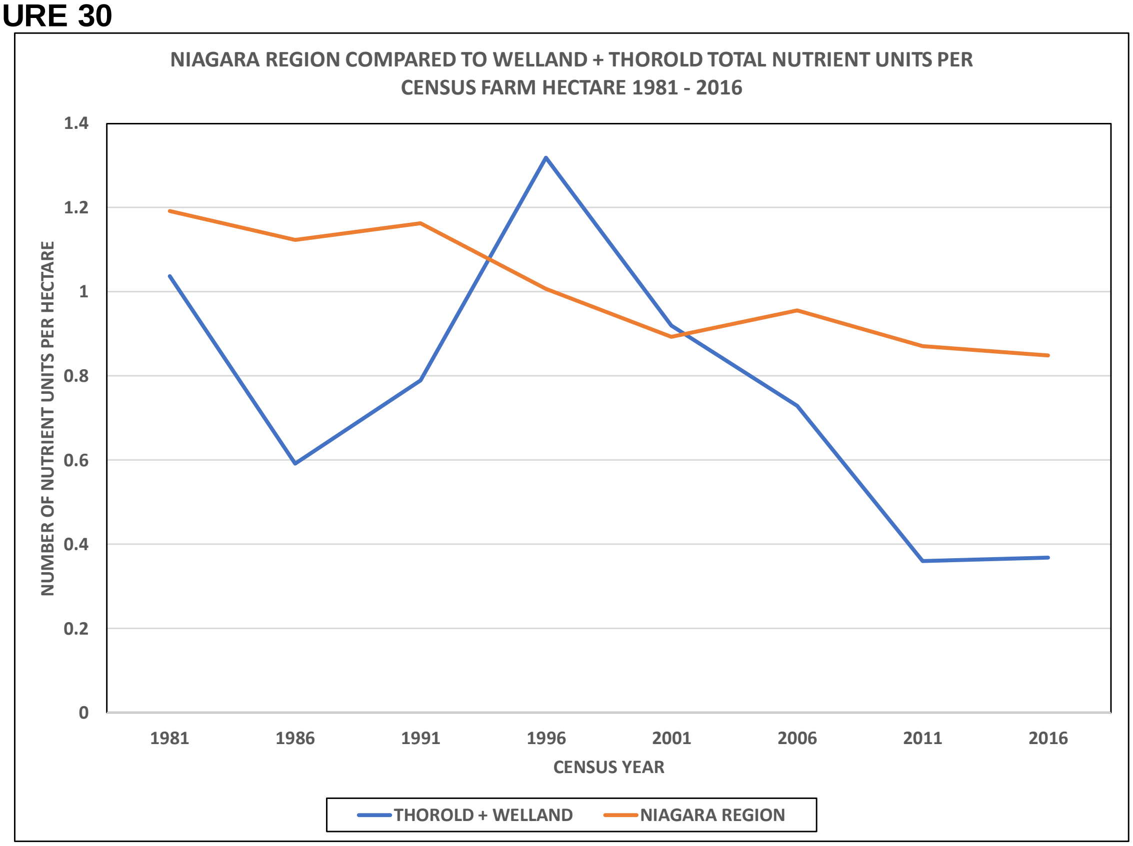
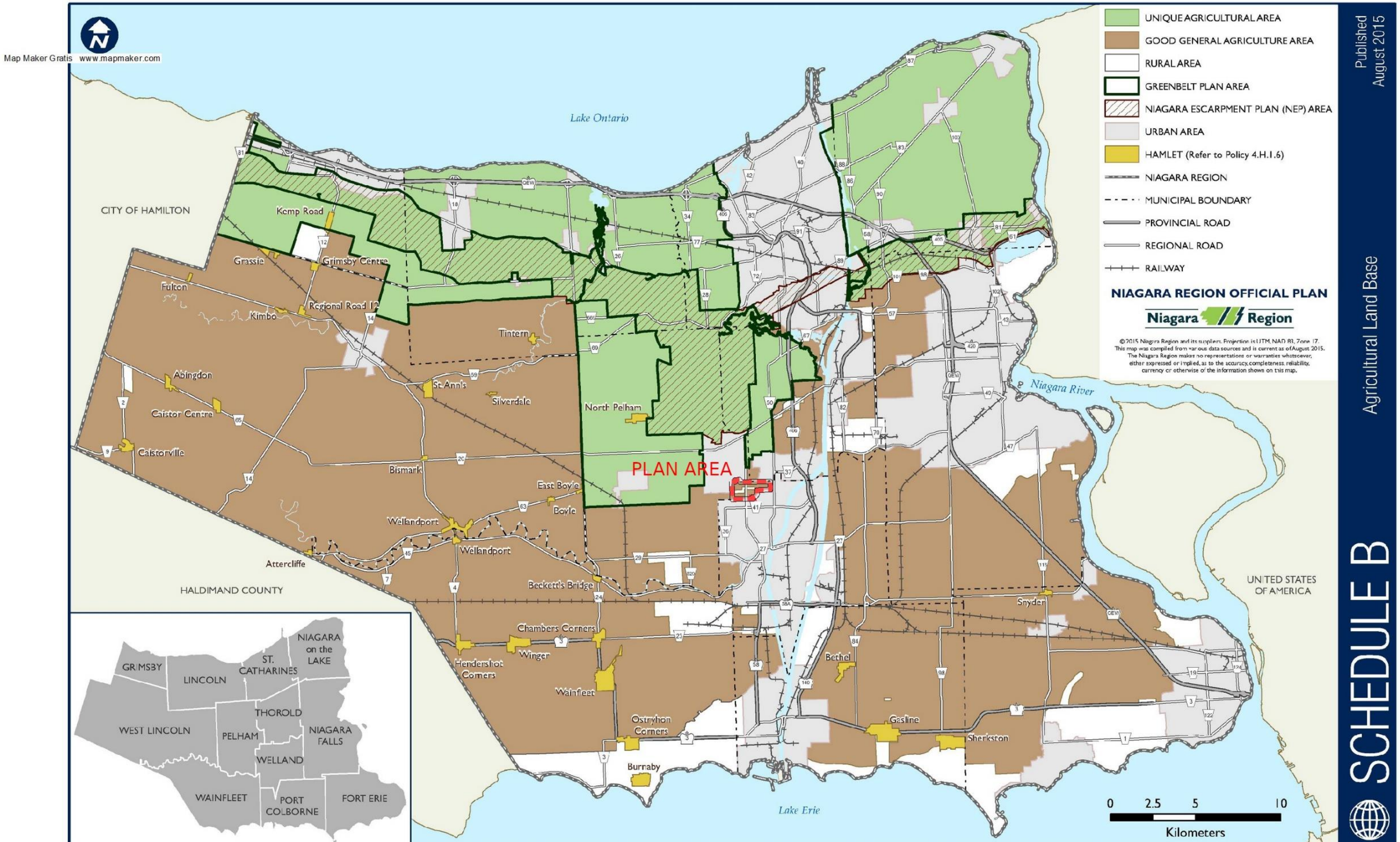
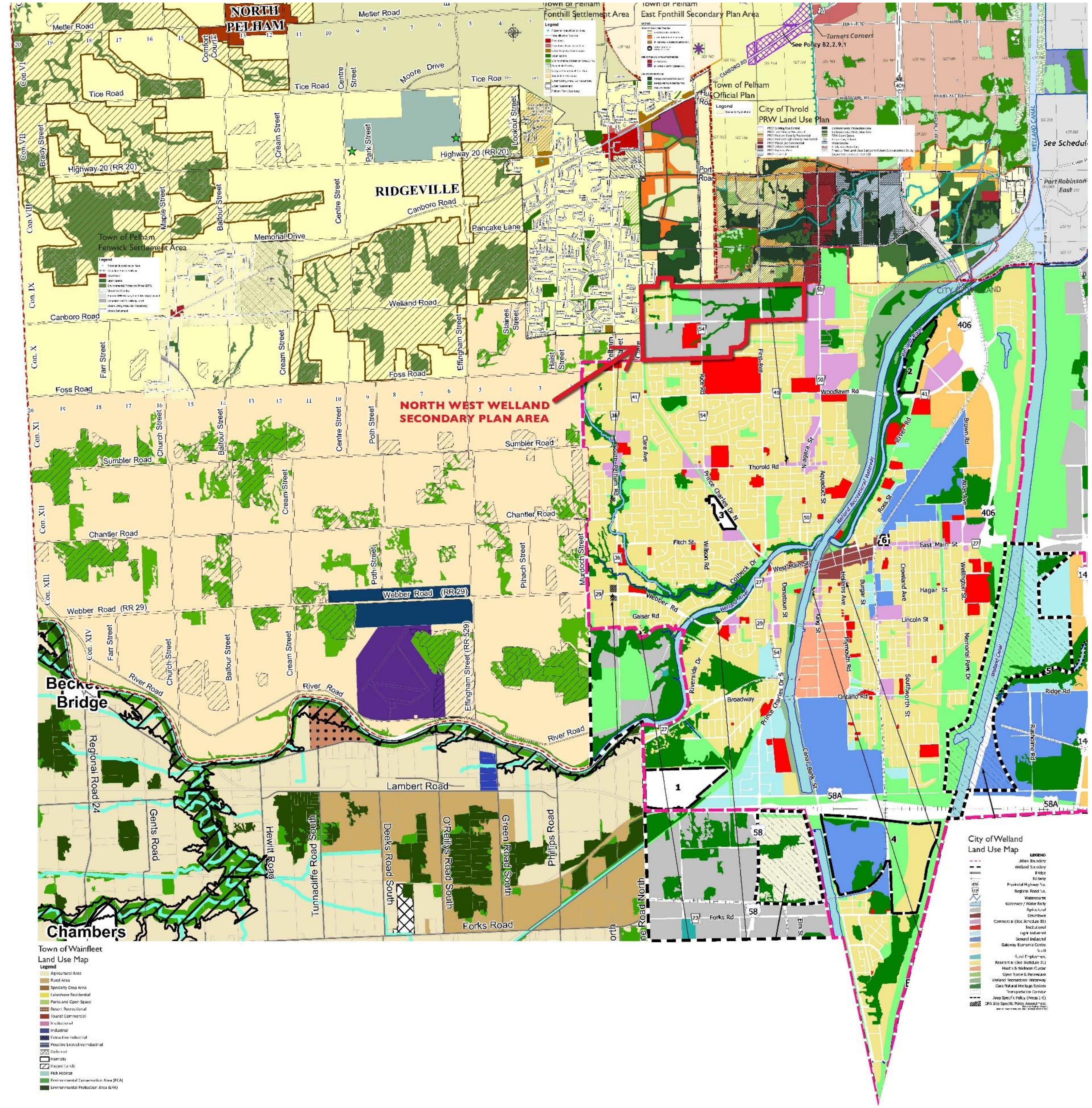
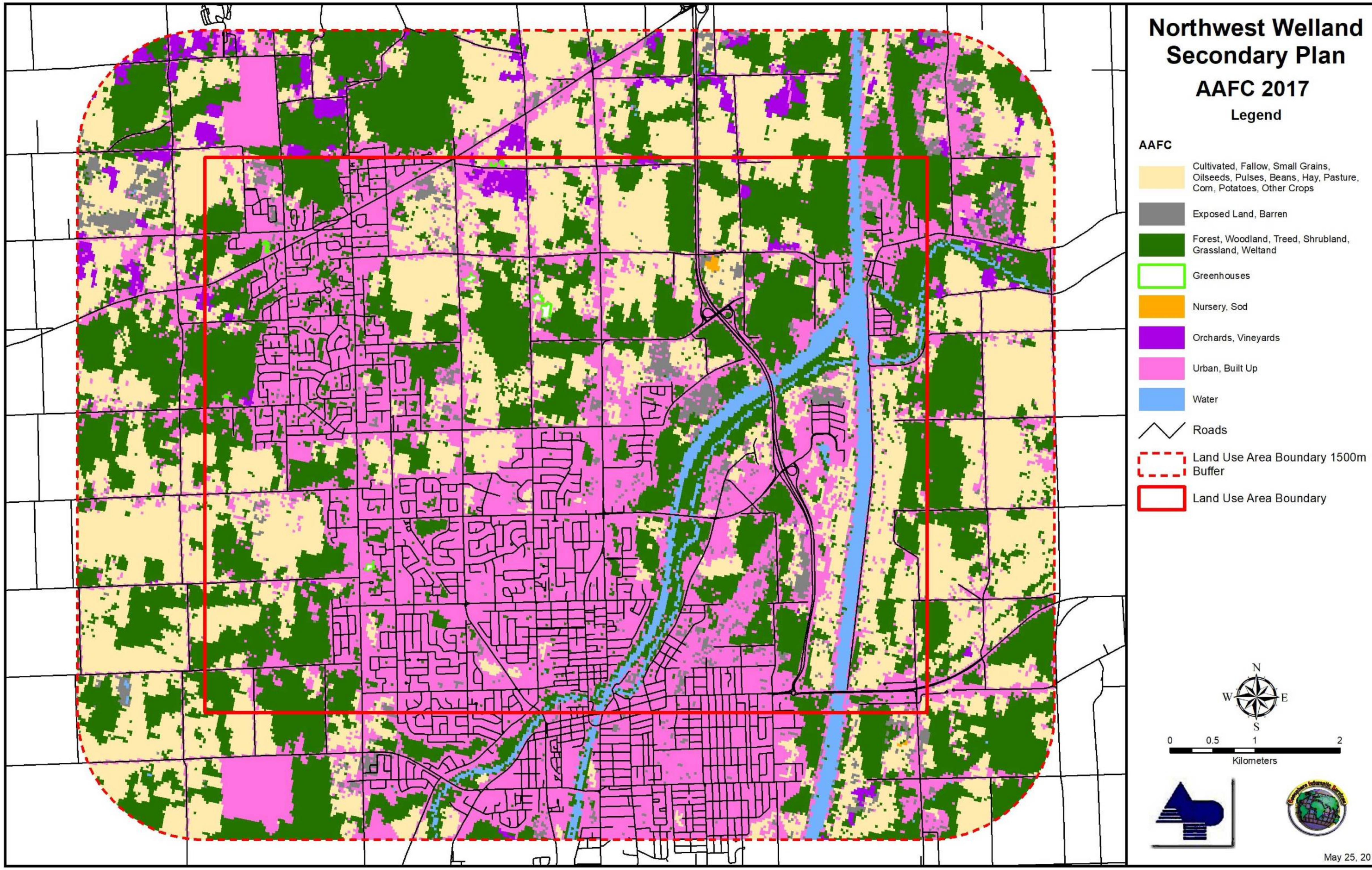


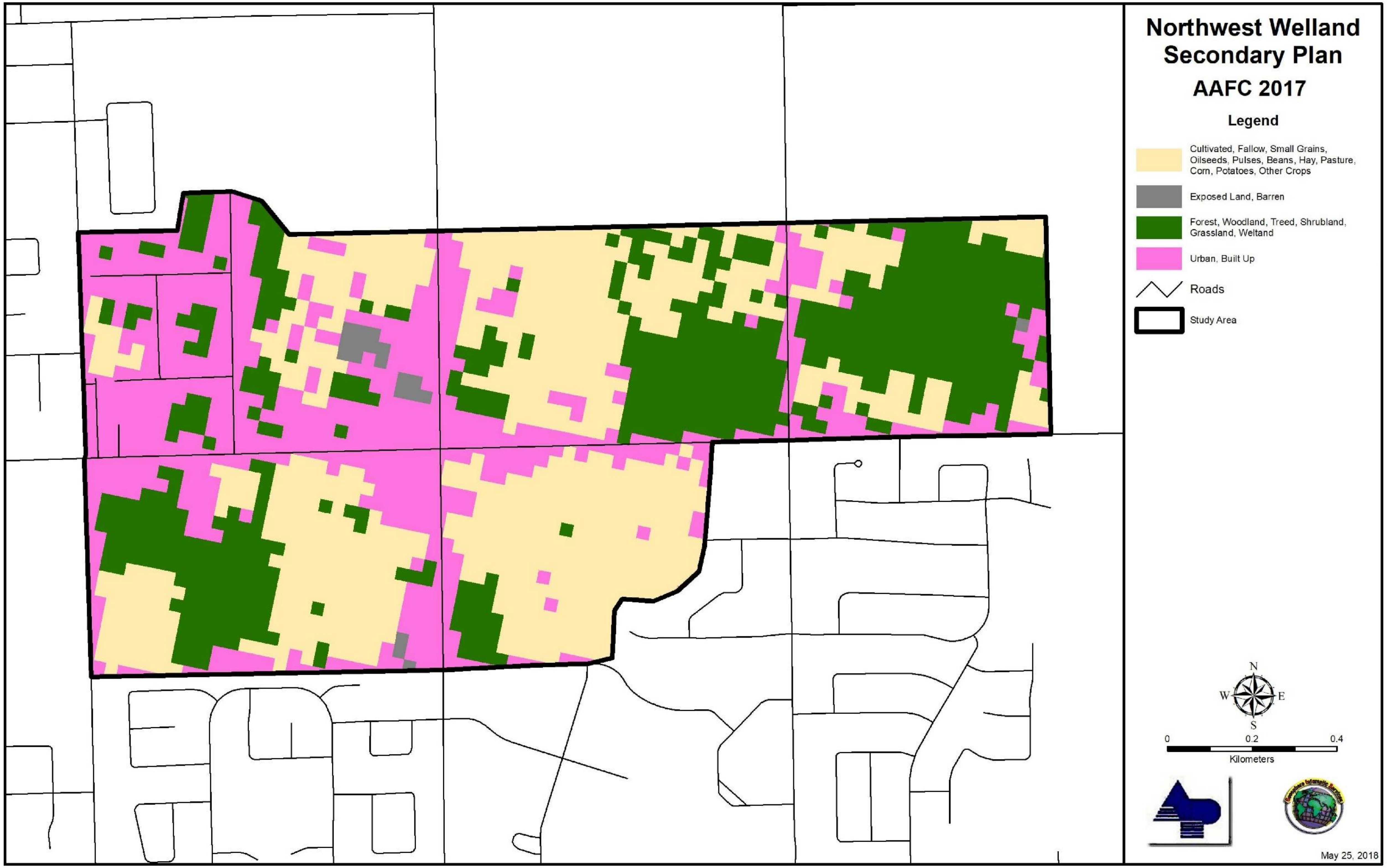

Map Maker Gratis www.mapmaker.com
UNIQUE AGRICULTURAL AREA
GOOD GENERAL AGRICULTURE AREA
RURAL AREA
GREENBELT PLAN AREA
NIAGARA ESCARPMENT PLAN (NEP) AREA
URBAN AREA
HAMLET (Refer to Policy 4.H.1.6)
NIAGARA REGION
MUNICIPAL BOUNDARY
PROVINCIAL ROAD
REGIONAL ROAD
RAILWAY
NIAGARA REGION OFFICIAL PLAN
Niagara Region
Published August 2015
Agricultural Land Base
SCHEDULE B
Lake Ontario
Lake Erie
Niagara River
CITY OF HAMILTON
HALDIMAND COUNTY
UNITED STATES OF AMERICA
PLAN AREA
Kemp Road
Grassie
Grimsby Centre
Fulton
Kimbo
Regional Road 12
Tintern
Abingdon
St. Ann's
Silverdale
North Pelham
Caistor Centre
Caistorville
Bismark
East Boyle
Boyle
Wellandport
Attercliffe
Beckett's Bridge
Chambers Corners
Winger
Hendershot Corners
Wainfleet
Ostryhon Corners
Burraby
Bethel
Gasline
Sherkston
Snyder
GRIMSBY
LINCOLN
ST. CATHARINES
NIAGARA on the LAKE
WEST LINCOLN
PELHAM
THOROLD
NIAGARA FALLS
WELLAND
WAINFLEET
PORT COLBORNE
FORT ERIE
0 2.5 5 10
Kilometers


NORTH PELHAM
RIDGEVILLE
NORTH WEST WELLAND SECONDARY PLAN AREA
Town of Pelham Fenwick Settlement Area
Town of Pelham Fonthill Settlement Area
Town of Pelham East Fonthill Secondary Plan Area
Town of Pelham Official Plan
City of Throld PRW Land Use Plan
Town of Wainfleet Land Use Map
City of Welland Land Use Map
Becketts Bridge
Chambers
Meter Road
Tice Road
Highway 20 (RR 20)
Canboro Road
Memorial Drive
Welland Road
Foss Road
Sumbler Road
Chantler Road
Webber Road (RR 29)
River Road
Lambert Road
Forks Road
Regional Road 24
Gents Road
Hewitt Road
Tunnacliffe Road South
Deeks Road South
O'Reilly's Road South
Green Road South
Phillips Road
Cream Street
Centre Street
Balfour Street
Church Street
Farr Street
Poth Street
Effingham Street
Pinach Street
Murdoch Street
See Schedule
Port Robinson East
Turners Corners
See Policy B2.2.9.1
Broadway
East Main St
Lincoln St
Thorold Rd
Woodlawn Rd
Ontario Rd

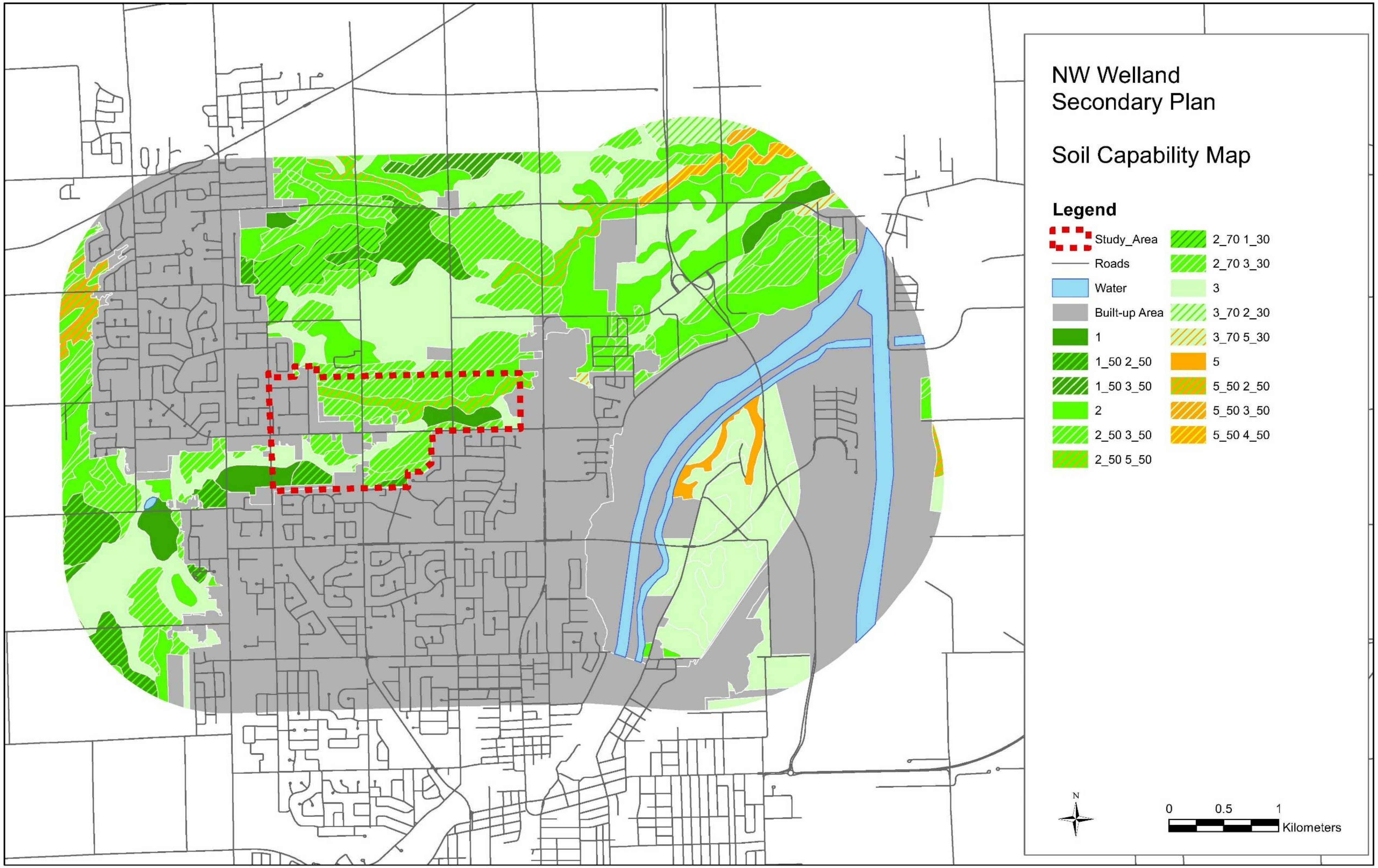
MAP 3 AERIAL PHOTOGRAPH OF THE NORTHWEST SECONDARY PLAN STUDY AREA


Northwest Welland Secondary Plan
AAFC 2017
Legend
AAFC
Cultivated, Fallow, Small Grains, Oilseeds, Pulses, Beans, Hay, Pasture, Corn, Potatoes, Other Crops
Exposed Land, Barren
Forest, Woodland, Treed, Shrubland, Grassland, Weltand
Greenhouses
Nursery, Sod
Orchards, Vineyards
Urban, Built Up
Water
Roads
Land Use Area Boundary 1500m Buffer
Land Use Area Boundary
N
W
E
S
0
0.5
1
2
Kilometers
May 25, 2018

MAP 5
AAFC LAND USE FOR THE STUDY AREA



MAP 6
SOIL
CAPABILITY



APPENDIX 2

SOIL PRODUCTIVITY INDEX and SOIL POTENTIAL INDEX CALCULATION

Soil potential ratings for fruits and vegetables have data limitations associated with soil rating systems and climate as described in the following paragraphs. All the databases evaluated have limitations associated with scale, data availability or alternatively, data suppression. For example, a soil rating system for specialty crops was developed by Hoffman and Cressman in 1984 for Ontario Hydro (Ecologistics and Smith, Hoffman, 1984). This is a three-class system – good, fair or poor which uses crop groupings but has not been applied on a broad scale to the Province. The Ontario Institute of Pedology and subsequently the Ontario Center for Soil Resource Evaluation has compiled specialty crop capability systems for some areas within Ontario. However, the Province has not a single specialty crop soil potential rating for all of Ontario. Given this lack of comprehensive soil potential information for specialty crops, it is not possible to reasonably differentiate which soils are most unique for specialty crop production within the Province.

However, some soil potential ratings for fruit and vegetables have been produced for Haldimand-Norfolk, Niagara, Elgin, Middlesex and Brant. Unfortunately, the fruit and vegetable crop groupings used in different soil surveys are dissimilar in number as well as in the kinds of fruits or vegetables included in each group. For example, Niagara has 20 crop groupings (9 for fruits and 11 for vegetables) whereas Haldimand-Norfolk has 15 groups that do not always separate fruit and vegetables into separate categories. More details about the soil potential ratings for specialty crops are outlined in a summary in the table following in this Appendix. In addition, both five as well as seven class soil potential rating systems have been used in published soil survey reports in Ontario.

As a second example of information limitations, climate data is limited due to scale and a lack of integration. Several single factor maps produced on a broad scale are available for crop heat units, plant hardiness zones, temperature minima and maxima as well as precipitation. More specific maps such as the map for *Site Selection for Grapes in the Niagara Peninsula* (Fisher and Slingerland, 2002) are not available for the province of Ontario. Additionally, specific studies on irrigation such as that done for Niagara Region (Stantec, 2007) are not available for southern Ontario.

ONTARIO SPECIALTY CROP SOIL CLASSIFICATIONS SUMMARY

Crop Grouping Description 1	Niagara Crop Grouping	Crop Grouping Description 2	Haldimand-Norfolk Crop Grouping	Crop Grouping Description 3	Middlesex and Elgin Crop Grouping	Crop Grouping Description 4	Brant Crop Grouping
	Seven Class System		Seven Class System		Five Class System		Seven Class System
Tree Fruits, Grapes and Small Fruits:	**Tree Fruits, Grapes and Small Fruits:**	**Tree Fruits, Grapes and Small Fruits:**	**Tree Fruits, Grapes and Small Fruits:**	**Tree Fruits, Grapes and Small Fruits:**	**Tree Fruits, Grapes and Small Fruits:**	**Tree Fruits, Grapes and Small Fruits:**	**Tree Fruits, Grapes and Small Fruits:**
Peaches, Apricots, Nectarines	A	Apricots, Sour Cherries, Sweet Cherries,	D1				

Crop Grouping Description 1	Niagara Crop Grouping	Crop Grouping Description 2	Haldimand-Norfolk Crop Grouping	Crop Grouping Description 3	Middlesex and Elgin Crop Grouping	Crop Grouping Description 4	Brant Crop Grouping
		Peaches					
Sweet Cherries	B						
Sour Cherries	C						
Labrusca Grapes	D	Hybrid and Vinifera Grapes, Labrusca Grapes	D3				
Vinifera Grapes	E						
Apples	F	Apples	D4	Apples	2	Apples	D1
Pears, Plums	G	Pears, Plums	D2	Pears, Plums	3		
Strawberries, Raspberries	H	Peppers, Raspberries, Rhubarb, Strawberries	B3	Raspberries, Strawberries	1	Strawberries	B3
Currants, Gooseberries	I						
				Rutabagas	3		
		Peanuts	A2	Peanuts	2		
				Heart Nuts, Filbert Nuts	3		
				Walnuts	2		
Vegetable Crops:	**Vegetable Crops:**	**Vegetable Crops:**	**Vegetable Crops:**	**Vegetable Crops:**	**Vegetable Crops:**	**Vegetable Crops:**	**Vegetable Crops:**
Crop Grouping Description 1	Niagara Crop Grouping	Crop Grouping Description 2	Haldimand-Norfolk Crop Grouping	Crop Grouping Description 3	Middlesex and Elgin Crop Grouping	Crop Grouping Description 4	Brant Crop Grouping
Broccoli, Brussels Sprouts, Cauliflower	J	Cabbage, Cauliflower, Canola, Sweet Corn, Tomatoes, Turnips	C3	Brussels Sprouts, Cauliflower, Cabbage	8	Cabbage, Cauliflower	C2
Bulb Onions, Garlic	K	Onions, Beets, Carrots	B1				
Green (Bunching) Onions	L						
Eggplant, Peppers	M	Peppers, Raspberries, Rhubarb, Strawberries	B3	Peppers	6	Peppers	B2
Cucumbers	N			Cucumbers	4		
Muskmelon	O	Ginseng, Muskmelon, Watermelon	B2			Ginseng	B1
Potatoes	P	Potatoes	A3	Irish Potatoes	3	Potatoes	A1
Tomatoes	Q					Tomatoes	C2
Sweet Corn	R			Sweet corn	7	Sweet Corn	C2
Celery, Lettuce	S	Cucumber, Lettuce, Radish	C4				
Pumpkins, Squash	T	Green Beans, Peas, Pumpkins, Squash	C2				
		Asparagus	A1	Asparagus	1		
		Fava Beans, Soybeans, White Beans	C1	Soybeans	4	Beans	C1
				Sweet Potatoes	2		
				White beans	5		

SOIL PRODUCTIVITY INDEX CALCULATION

The soil productivity index is an arithmetic mean that expresses the relative occurrence of soil capability classes 1 to 7 on selected properties or within specified boundaries. The index is most often based on soil productivity ratings (Hoffman, 1973). Areas with the highest soil capability index will have mainly class 1 land. Areas with a low index will consist of lower soil capabilities. The productivity index method has been used because it provides a single number derived from a listing, by proportion, of the soil capability classes 1 through 7 which allows for direct comparison among different areas or sites. Impacts on soil capability will generally be greatest on an area with a high soil capability index; that is, impacts will be highest when good (higher capability land) is lost to development.

Method

Soil Productivity Index = *(proportion of area of class 1 soils x 1.0) + (proportion of area of class 2 soils x 0.8) + (proportion of area of class 3 soils x 0.64) + (proportion of area of class 4 soils x 0.49) + (proportion of area of class 5 soils x 0.33) + (proportion of area of class 6 soils x 0.17) + (proportion of area of class 7 soils x 0.02)*

The area of each soil map unit was measured and areas of similar soil capability were summed for CLI classes 1 to 7 lands. The area was calculated for each CLI class and subsequently multiplied by a productivity index corresponding to each soil class. The productivity index is specific to each capability class. The proportion of each area occupied by each soil capability class was multiplied by the corresponding soil productivity value (following Hoffman, 1973) and products were subsequently summed to obtain a soil productivity index for lands affected by or potentially affected by development.

SOIL POTENTIAL RATING FOR FRUITS AND VEGETABLES

Soil potential ratings are based on crop groupings and classes described for Brant County by Acton (1989) and for Niagara Region by Kingston and Presant (1989). Crop suitability class descriptors in the original Kingston and Presant's report have been placed in an ordinal scale for soil potential as outlined in the following:

- Good (G) – 1
- Fair to Good (F-G) – 2
- Fair (F) – 3
- Poor to Fair (P-F) – 4
- Poor (P) – 5
- Very Poor (VP) – 6
- Unsuitable (U) - 7

A matrix is created having rows which are the different soils found within a given area in the columns are for the crop groupings. The highest or best rating is class 1 and those soils that are unsuitable rated lowest as class 7. Climate has been assumed to limit the production of peaches, nectarines, apricots, cherries and vinifera grapes within some Counties/Regions and the soil potential rating has been modified to class 7 (unsuitable) based on that climate limitation. An average specialty crop soil potential rating was calculated by adding the classes for the separate crops or crop groupings and dividing it by the total number of those crop groups (8 crop groupings following Acton and 20 crop groupings following Kingston and Presant).

The application of this average soil potential rating is limited to comparisons at a provincial and regional/county scale at its broadest extent but depending on variations in climate may only be suitable as a relative rating at the municipal or Cityship level.
It should also be noted that the soil potential rating is an average and that there may be individual crops that will grow very well on a particular soil. In other words, a soil with an average specialty crop potential class 4 rating may actually contain one or two crop groupings with soil potential ratings at a higher level - that is, soil potential subclass 2, for example.

Soil Potential Index
The average soil potential index is an arithmetic mean that expresses the relative occurrence of soil potential ratings 1 to 7 on selected properties or within specified boundaries. Areas with the highest soil potential index will have mainly rating 1 land. Areas with a low index will consist of lower soil potential (5-7) for specialty crops. The potential index method has been used because it provides a single number derived from a listing, by proportion, of the soil potential ratings 1 through 7 in a given area which allows for direct comparison among different areas or sites.

Method
Soil Potential Index = *(proportion of area of rating 1 soils x 1) + (proportion of area of rating 2 soils x 2) + (proportion of area of rating 3 soils x 3) + (proportion of area of rating 4 soils x 4) + (proportion of area of reading 5 soils x 5) + (proportion of area of rating 6 soils x 6) + (proportion of area of class 7 soils x 7)*

The area of each soil map unit was measured using GIS and areas of similar soil potential were summed for potential ratings 1 to 7 lands. The soil productivity index and the soil potential index both tend to correlate with soil capability class.

APPENDIX 3
SOIL CLASSIFICATION AND SOIL SURVEY

Ontario's published soil surveys follow a hierarchical system of soil classification to represent a three-dimensional area called a pedon (see http://www.pedosphere.ca/resources/CSSC3rd/chapter02.cfm). This three-dimensional area is intended to be represented as a two-dimensional map polygon usually shown as the soil series on soil maps in Ontario. Soil characteristics such as texture and particle size are a part of a continuum and the soil map also must present a landscape continuum as part of a discrete map polygon. In short, soils are represented as discrete units on a map even though the soils themselves are not discrete. As a result, there can be, and there have been, different ways of representing changes in soils that have been mapped within Ontario and within parts of the rest of the world. Not surprisingly, the opportunity to represent soils in different ways has resulted in significant changes in the approach to mapping soils over the time within which soil surveys have been published in Ontario. The older soil surveys tend to lump large areas into soil map polygons, whereas newer soil surveys have smaller more detailed polygons. Newer soil surveys also tend to have complexes (which are soil map polygons containing 2 or more soil series and/or two a more soil capability classes and subclass limitations). Examples of more recent soil surveys include Niagara, Haldimand-Norfolk, Brant, Kent, Middlesex, Ottawa urban fringe, Ottawa-Carlton and the soils component within the report titled *State of the Resources for the Duffin-Rouge Agricultural Preserve*. A review of older as well as newer Ontario soil reports indicates the following:

- soil series with the same name may not have the same characteristics between Counties and/or Regions,
- some soil series identified in detailed field studies are not always represented in the County/Regional published soil survey within which the detailed work is being completed; and,
- not all the soil capabilities assigned to a particular soil series are consistent from one soil report to another soil report.

The significance of the difference between old mapping styles and newer ones can be illustrated by using an old soil report and comparing the old soil map to a newer map. Both maps were produced by government staff. Within Durham Region, as well as a part of York Region, an area identified as an Agricultural Preserve was remapped (Schut *et al*) at a scale of 1: 20,000 in 1994 relative to two maps produced in 1956 (Olding et al.) and 1955 (Hoffman and Richards) both at a scale of 1: 63,360. A review of these older and newer maps shows that:

- there are differences in the number and size of soil polygons and the differences in the soil polygons represent differences in soil series and soil phases, and
- soil capability values assigned to each of the soil polygons are different from older map to newer map.

When the soil capability information is calculated as a productivity index, the old map assigned a productivity index of 0.91 (equivalent to capability class 1 soils) to that part of the Agricultural Preserve located within Durham Region whereas the new map has a productivity index of 0.66 that is relatively equivalent to capability class 3 (0.64). This information demonstrates that the soil productivity within the Preserve is significantly lower than the original mapping by Olding *et al.* (1956) would indicate. Given that some of the soils mapped in the Preserve by Schut et al. (1994, OMAF) require tile drainage, this tile drainage would need to be in place to reach the average productivity index value of 0.66.

RATING FOR COMMON FIELD CROPS

The original soil capability classification is part of the Canada Land Inventory (CLI) and used an ordinal scale having the numbers 1 through 7. (A discussion of the definition of different scales is available in many mathematics texts. Siegel (1956) outlines a good summary matrix of the definitions for different scales that can be related to statistical tests). Alternatively, Velleman and Wilkinson (1993) describe mathematical scales as part of a continuum and argue that the use of specific statistical tests for specific scales is inappropriate. Irrespective of scale, the CLI capability interpretation was derived based on "*research data, recorded observations, and experience*" and was not intended for use as an indicator of the "*most profitable use of land*".

The class, the broadest category in the capability classification, is a grouping of subclasses that have the same relative degree of limitation or hazard. The limitation or hazard becomes progressively greater from class 1 to class 7. The class indicates the general suitability of the soils for agricultural use.

Class 1 - Soils in this class have no significant limitations in use for crops.

Class 2 - Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices.

Class 3 - Soils in this class have moderately severe limitations that restrict the range of crops or require special conservation practices or both.

Class 4 - Soils in this class have severe limitations that restrict the range of crops or require special conservation practices or both.

Class 5 - Soils in this class have very severe limitations that restrict their capability of producing perennial forage crops, and improvement practices are feasible.

Class 6 - Soils in this class are capable only of producing perennial forage crops and improvement practices are not feasible.

Class 7 - Soils in this class have no capability for arable agriculture or permanent pasture.

Agricultural soils information is currently available in old-style printed format as well as in digital format. The original information with all presented as soil survey reports with accompanying soil maps. Some more recent soil survey publications include a separate interpretive map for soil capability following the rules outlined in the Canada Land Inventory Soil Capability Classification for Agriculture. However, most reports contain a section that has a matrix summarizing soil capability classes for different soil series and phases relative to slope class. The very early soil reports prior to the 1960s tend to have a descriptive summary of the relative merits of different soil series for common field crop production - a precursor to the CLI soil capability classification. When the CLI soil capability classification work was started, a list of all the soil series was compiled and a soil capability class assigned to each soil series having a given set of limitation such as slope class and stoniness class. This information served as a base and blueprint maps, produced by projecting soil polygon/map unit boundaries on to topographic maps at a scale of 1 to 50,000, summarized capability on a County basis. When the County work was being done, additional detailed soil surveys were completed in several smaller sample areas to assist in assigning soil capability classes to the soils/soil polygons found within the County. The blueprint maps served (without edit) as the base for the production of generalized 1: 250,000 scale soil capability maps by the Federal Government in Ottawa. The same blueprint maps were also used as a data source when the soil surveys for Ontario were digitized by OMAFRA. The digitizing included matching soil polygon series and soil capability information at the boundaries between Counties/Regions. Additionally, several more detailed soil surveys have been completed and the soil capabilities outlined in these published reports do not always match the soil capability values assigned on the blueprint maps. Thus, soil capability values can come from several different sources as follows:

- the unpublished summary of capability classes assigned to all of the soil series present as a result of mapping up to the 1960s;
- the blueprint map soil capability classes;
- the separate County summary data prepared as the base for the blueprint maps;
- the soil capability classes assigned within published soil reports after the 1960s some of which result because of published scientific information about the effects of soil characteristics such as density on soil capability.

Other soil capabilities have been derived because of the identification of new soil series, new soil phases and differing opinions about the capability of different soils

Subsequently, research by Hoffman (1973) indicated that soil capability class was an indicator of common field crop yields and productivity (yield) indices could be derived based on those yields. The indices, described more specifically in Appendix 1, are used as an “average” for three crops: oats, barley, and corn.

The soil capability class ordinal scale could then be converted into an interval scale using Hoffman’s (1973) data. The data used to create the interval scale are based on older soil surveys and the soil capability class summaries associated with the older surveys are summarized by Hoffman and Noble (1975). New surveys have been completed for Regions such as Middlesex, Elgin and Niagara. In these new surveys, because of work by McBride (1983), the soil capability classes for some soils have been changed to a lower class, particularly for soils with a high clay content. While McBride’s work has been related to average yield data, on a County or Regional basis, no site-specific yield data has been used to confirm that the newer changes to soil capability class is supported by specific yields as was completed in Hoffman’s (1973) research. Therefore, the capability classes used in the newer soil surveys, such as the one for Niagara, might better be described as being part of an ordinal scale.

Regardless of the difference of opinion concerning arithmetic scale, yield data, and productivity indices, both data sources and methods have been investigated as part of the work described in this report.

The original soil capability rating report (Environment Canada, 1972) has assumptions which have been applied to the interpretation of soil capability. Two of these assumptions (Environment Canada, 1972) are germane to a discussion on the capability of the subject lands and are as follows:

- *Good soil management practices that are feasible and practical under a largely mechanized system of agriculture are assumed.*
- *Soils considered feasible for improvement by draining, by irrigating, by removing stones, by altering soil structure, or by protecting from overflow, are classified*

according to their continuing limitations or hazards in use after the improvements have been made. The term "feasible" implies that it is within present day economic possibility for the farmer to make such improvements and it does not require a major reclamation project to do so. Where such major projects have been installed, the soils are grouped according to the soil and climatic limitations that continue to exist. A general guide as to what is considered a major reclamation project is that such projects require co-operative action among farmers or between farmers and governments. (Minor dams, small dykes, or field conservation measures are not included).

Therefore, these assumptions have been considered in the evaluation of soils in this specialty crop study. Soil capability mapping has been based on the original soil map which is now available in digital format from LIO based on information originally supplied by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA).

As discussed previously, the Canada Land Inventory (CLI) originally assumed that soil management that could be applied by a farmer would occur. Therefore, improvements such as irrigation and adequate drainage (both surface and subsurface) were already assumed to be applied in the rating of soils into capability classes.

Tile Drainage

As noted previously, soil capability and therefore productivity makes assumptions about tile drainage (that is, that tile drainage is applied where it is needed and that capability class ratings reflect the fact that the drainage is already assumed to be in place). There are some differences of opinion about which soil drainage classes would benefit from tile drainage. However, it is likely that imperfectly and poorly drained soils would show improved yields when tiles had been installed. There is no doubt that poorly drained soils have better yields when tile drained. As well, it is likely that the imperfectly drained soils would benefit from tile drainage. Unfortunately, the newer soil surveys do not indicate how soil capability class levels would change if imperfectly drained soils are not tiled.

Some information is available to assist in estimating how productivity is diminished in areas requiring tile drainage. For example, yield data collected over 20 years and that were summarized and evaluated by Irwin (1999) indicate that, because of tile drainage, average yields have improved within a range where the least improvement was a 10 percent increase for coloured beans in contrast to a high increase of 38 percent for wheat. The summary by Irwin (1999) did not differentiate by soil series, soil drainage class, or by location in the Province. Based on a general interpretation of the data from Irwin (1999), it can be estimated that imperfectly drained soils in an undrained state could be poorer by a single capability class. However, the installation of tile drainage on the imperfectly drained soils is less likely than installation on poorly and very poorly drained soils.

APPENDIX 4
MULTI-ATTRIBUTE ANALYSIS AND AGRICULTURAL PERFORMANCE

MULTI-ATTRIBUTE ANALYSIS

There are several different methods available to rank agricultural areas given provincial agricultural policy. In all cases, more than one agricultural attribute is used to differentiate the better from the poorer agricultural lands to designate the better lands as prime. Hence, all agricultural land evaluation related to the PPS must be multi-attribute analysis. Any multi-attribute analysis may have different results based on:

- the number and kind of variables considered,
- the scale and therefore precision at which the agricultural information is available,
- the accuracy of the information,
- the analysis method,
- the weights applied to the variables,
- the number of evaluation and area units evaluated and therefore the geographic extent of the evaluation,
- whether the data was standardized, and
- whether all of the data was presented consistently to mean that a high number is intended to indicate a high importance value.

A review of the literature did not present information suggesting that a particular single multi-attribute analysis method is the best method. Even the wording employed for the quantitative methods used to combine information varies. The University of Redlands and the Spatial Decision Support Consortium (2012) have prepared a summary of the language and definitions associated with Multi-Criteria Decision Analysis (MCDA). Some of the work described by the University of Redlands is based on work by Malczewski (2006). Multi-attribute Combination Methods is a subset of MCDA having subcategories of Analytical Hierarchy Process, Concordance Methods, Fuzzy Aggregation Operation, Ideal/Reference Point Method, Value/Utility Function Method and Weighted Linear Combination. Therefore, there is a need to consider more than one agricultural metric and more than one analysis method when evaluating agricultural land.

The Ontario Ministry of Agriculture, Food and Rural Affairs suggests using a Land Evaluation and Area Review (LEAR) method to evaluate agricultural lands. The rationale for this recommendation is not available. A Lear analysis fits in to the subcategory of Weighted Linear Combination which is described on the Redlands website as "the most often used technique for tackling spatial multi-attribute decision making".

There are several other methods that could be used to show similarity/dissimilarity amongst the combined variables defining agricultural value of the lands within Ontario. The Lear analysis is linear and other methods available to differentiate the better from the poorer agricultural lands can be used to emphasize differences by squaring those differences - thus, looking at differences based on an exponential relationship. A cluster analysis is based on a sum of squares technique and has been used to measure similarity/dissimilarity. Alternatively, Massam (1993) has used Concordance to complete spatial analyses rating different land areas. Concordance is an additive method which emphasizes the weights assigned to variables more so than the actual range of numerical difference when comparing those variables.

Regardless, there are several decisions that must be made when evaluating agricultural land given the guidance provided by the PPS and these decisions include, but are not limited to, the:

- multi-attribute analysis method(s),
- agricultural indicators/variables used in the analysis,
- evaluation unit size,
- weighting/importance rating,
- minimum area designated, and,
- point at which differences are sufficient to place lands in specialty crop, agricultural or rural designations.

The agricultural multi-attribute analyses results presented within this report are the "weighted linear combination" method such as the LEAR described by OMAFRA.

Any multi-attribute analysis, including a LEAR analysis, may have different results based on:

- the number and kind of variables considered,
- the analysis method,
- the weights applied to the variables,
- whether the data was standardized, and
- whether all the data was presented consistently to mean that a high number is intended to indicate a high importance value.

A review of the literature did not present information suggesting that a single multi-attribute analysis method is the best method. Even the wording employed for the quantitative methods used to combine information varies. The University of Redlands and the Spatial Decision Support Consortium (2012) have prepared a summary of the language and definitions associated with Multi-Criteria Decision Analysis (MCDA). Some of the work described by the University of Redlands is based on work by Malczewski (2006). Multi-attribute Combination Methods is a subset of MCDA having subcategories of Analytical Hierarchy Process, Concordance Methods, Fuzzy Aggregation Operation, Ideal/Reference Point Method, Value/Utility Function Method and Weighted Linear Combination. A LEAR analysis fits in to the subcategory of Weighted Linear Combination which is described on the Redlands website as "the most often used technique for tackling spatial multi-attribute decision making".

AgPlan Limited and Michael Hoffman have carried out various multi-criteria decision analyses at different scales throughout the Province of Ontario. The following paragraphs briefly describe the methods used to evaluate agricultural performance within different Regions or Counties in central to southwestern Ontario. Most of the variables used in the regional scale analyses are outlined in the Agricultural Census for Ontario. Additional variables for soil productivity and crop yields are available through OMAF(RA) for the years used in the analyses. The early census years had relatively few variables (in the order of 30) while later census years used many variables (in the range of hundreds). Some environmental variables used in the later analyses first appeared in 1996. There is the potential for an infinite number of ways to modify the data using the three ways described. Therefore, individual databases were designed to include some relatively different measures of agricultural performance/achievement.

Regional Comparison
At the regional scale for example, environmental, economic, and production viewpoints were separated for some databases. In other instances, a modified characterization within a single category such as production was completed. For example, production was characterized as using total production values (volumetric or gravimetric) for some data sets and as production per unit area (yield) in other data sets. Multiple characterisations were used to represent different perspectives as well as different values associated with the agricultural indicators/metrics. Therefore, for example, total production values were included because they give a relative indication of a County's contribution to the total food production that occurred within a given year within southern to central Ontario. However, this production indicator tends to be correlated with the area of the County. Therefore, yield data was included and/or emphasized to minimize any effect associated with a Region/County's size on that Region/County's performance rating. As well, each of the data sets was modified using different weighting schemes to represent disparate views about which indicators are better predictors of agricultural performance.

Different agricultural variables were grouped into databases to emphasize different parts of each year's agricultural indicators. In general terms, one database was prepared for fruits and vegetables and the second database produced so that the area and farm number data from the first a database was proportional to the total census farm area or total number of census farms.

Methods and Standardization
The combination of different variables to produce a single value has traditionally presented problems and colloquially is known as the "combining apples and oranges" problem. The problem of combination has been reduced by choosing methods that compare indicators using a standardized quantitative scale. As described previously, each data set could be analysed using two different methods as follows:

(1) Simple additive weighting (SAW);
(2) Concordance (CCD); and

For the simple additive weighting and concordance methods, the data were standardized based on the maximum and minimum indicator values for each variable. Standardization used the following formula:

$$\text{Standardized Score} = 100 \times \frac{(\text{Raw Data Value}) - (\text{Minimum Raw Data Value})}{(\text{Maximum Raw Data Value}) - (\text{Minimum Raw Data Value})}$$

Therefore, all scores range between the values 0 and 100.

In addition to different data sets, and different agglomeration analysis methods, different weights were considered. However, in this instance all variables were given equal/unit weight. The agricultural analysis methods were also set up to allow for the calculation of the inverse of any variable.