



MUNICIPAL
PROPERTY
ASSESSMENT
CORPORATION

**IMPACT OF
INDUSTRIAL WIND TURBINES ON
RESIDENTIAL PROPERTY
ASSESSMENT IN ONTARIO**
2016 ASSESSMENT BASE YEAR STUDY

Table of Contents

ABSTRACT	3
AUTHORS OF THIS REPORT	4
JASON MOORE, MRICS, MBA, UBC CERTIFICATE OF REAL PROPERTY ASSESSMENT	4
JAMIE STATA, BA, UBC CERTIFICATE OF REAL PROPERTY ASSESSMENT	4
SCOTT BRADFIELD, BSc (HON), A.I.M.A.....	4
EXECUTIVE SUMMARY	6
BACKGROUND.....	6
2008 BASE YEAR STUDY.....	6
2012 BASE YEAR STUDY.....	7
2016 BASE YEAR STUDY.....	7
CONCLUSIONS.....	7
INTRODUCTION.....	9
2008 BASE YEAR STUDY.....	9
2012 BASE YEAR STUDY.....	9
PURPOSE OF THIS REPORT	12
LEGISLATION	13
VALUATION OF RESIDENTIAL PROPERTIES	14
MULTIPLE REGRESSION ANALYSIS	14
MARKET AREAS.....	14
KEY FACTORS AFFECTING VALUE.....	14
LEGISLATED VALUATION DATE.....	15
ASSESSMENT-TO-SALE RATIO STUDY	15
APPLICATION OF VALUATION MODEL	15
INDUSTRIAL WIND TURBINES.....	16
©Municipal Property Assessment Corporation	1

2016 BASE YEAR ANALYSIS..... 16

DATA COLLECTION 16

EQUITY OF RESIDENTIAL ASSESSMENTS IN PROXIMITY TO INDUSTRIAL WIND TURBINES20

 COMPARISON TO THE 2012 BASE YEAR STUDY 20

 2016 BASE YEAR STUDY..... 21

 COUNTY RESULTS 33

 SUMMARY OF FINDINGS..... 34

LIST OF REPORT APPENDICES37

GLOSSARY OF TERMS38

Abstract

The Municipal Property Assessment Corporation (MPAC) undertook a study to ensure that the assessments of properties in proximity to industrial wind turbines (IWTs) are fair and accurate. Over the last few years, the subject of IWTs has been the subject of numerous reports and studies – both in Canada and worldwide. Past and current studies undertaken by academics, real estate and health professionals have focused on the potential impacts of IWTs on property value and the health of those residing on the property. Given MPAC’s legislated mandate, this report studies whether properties within five kilometres of an IWT are assessed at current value, and whether their assessment is equitable to those situated more than five kilometres from an IWT.

MPAC’s study concludes that 2016 Current Value Assessments (CVAs) of properties located within proximity to an IWT are assessed at their current value and are equitably assessed in relation to homes at greater distances. This finding is consistent with MPAC’s 2008 and 2012 CVA reports. The study underwent a rigorous independent third-party peer review (conducted by Robert J. Gloude-mans) and includes appendices describing the study parameters and documenting the analyses.

Authors of This Report

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Executive Summary

This report provides the results of the Municipal Property Assessment Corporation's study of the impact of industrial wind turbines (IWTs) on residential property assessment in Ontario (2016 Assessment Base Year Study).

Background

MPAC is responsible for accurately assessing and classifying property in Ontario in compliance with the *Assessment Act* and regulations set by the Government of Ontario. Our assessors are trained experts in the field of valuation and apply appraisal industry standards and best practices. Every four years, we conduct a province-wide Assessment Update and mail Property Assessment Notices to every property owner in Ontario. The most recent Assessment Update was in 2016 when we updated the assessed values of every property in Ontario. All properties were assessed as of the legislated valuation date of January 1, 2016. These updated values and classifications are used by municipalities and taxing authorities to calculate property taxes and are in effect for the 2017-2020 tax years.

When assessing any property, MPAC relies on the real estate market to indicate what influence a factor, such as IWTs, may have on a property's value. MPAC does this through the ongoing study and analysis of the market including the investigation of sales transactions.

Over the last few years, IWTs have been the subject of a number of reports and studies – both in Canada and worldwide. Studies undertaken by academics, real estate and health professionals have focused on the potential impacts of IWTs on property value and the health of those residing on the property. Given MPAC's legislative mandate, this report studies whether properties within five kilometres of an IWT are accurately assessed at their current value, and whether those properties are assessed equitably with properties that are further than five kilometres from an IWT.

To date, MPAC has completed three reviews of the impact of IWTs: 2008, 2012 and 2016 base year studies.

2008 Base Year Study

MPAC undertook a study looking at the impact of IWTs on residential assessments using the 2008 base year CVAs. The 2008 study concluded that the presence of IWTs that are either abutting or in proximity to a property had neither a positive nor negative impact on assessed values.

2012 Base Year Study

With much more sales data available, MPAC was able to conduct a more thorough review using 2012 assessment base year information. The study considered proximity and whether the wind turbine was visible (full, partial or not visible at all). A statistically significant difference was found between homes within one kilometre of an IWT and those farther away but the difference was well within international standards for equity between groups of property. All other tests showed equity between property groups. For more information about the 2012 base year review, see the introduction section of this report (which includes a link to the full report).

2016 Base Year Study

MPAC has continued to monitor the influence of proximity to IWTs over the current values of residential properties and has completed an analysis similar in scope to the 2012 Base Year Study.

To conduct this study, MPAC considered 25 market areas with sufficient sales to allow for analysis and applied industry standard mass appraisal techniques and internationally accepted ratio study standards to current value assessments for these market areas.

MPAC conducted an assessment-to-sale ratio study to determine whether assessments are equitable regardless of whether a property is within close proximity to an IWT. An individual assessment-to-sale ratio study is calculated by dividing the assessed value of each property by its time adjusted sale price. A ratio study is conducted to first establish the level of appraisal for a group of properties and equity is determined by comparing the level of appraisal with other groups of properties. If a group of properties is assessed at market value, the median assessment-to-sale ratio will lie between 0.90-1.10. By definition, equity is said to exist if the difference between the property categories is five per cent or less. This definition follows the International Association of Assessing Officers (IAAO) ratio study standards.

MPAC found that the level of appraisal for properties within one kilometre of an IWT is 1.007. The level of appraisal for properties within one to two kilometres of an IWT is 0.995. These numbers are within 3.3% and 2.1% of the level of assessment of properties more than five kilometres from an IWT (0.974) and are below the 5% noted above.

Conclusions

Following its review, MPAC concluded that 2016 Current Value Assessments of properties located within proximity of an IWT are assessed at their current value and are equitably assessed when compared to the assessments of properties that are not in proximity to IWTs.

Therefore, no adjustments are required for 2016 CVAs. This finding is consistent with MPAC's 2008 and 2012 base year IWT reports.

In addition to the results shared in this report, MPAC also commissioned an internationally recognized expert in the field of mass appraisal and ratio studies to review the report and its findings. This expert has confirmed the findings in this report (Appendix A – Independent Review of Report – Industrial Wind Turbine Ratio Study - R.J. Gloudemans, November 22, 2016).

Introduction

The topic of wind energy has been front and centre in the minds of many Ontarians, particularly those living in rural areas. Much has been written about how industrial wind turbines impact those who live in proximity to them. There has been extensive reporting on the numerous aspects of this subject, including reports of health effects, the approval process for siting IWTs and the potential for property devaluation due to the perceived stigma attached to these developments.

Several studies, based on both scientific and non-empirical methods, have been completed by academics and real estate professionals to determine whether or not the presence of an IWT has an effect on the sale price of a property. A study released by the Berkeley National Laboratory and prepared for the U.S. Department of Energy¹, found minimal impact on property values as a result of being in close proximity to IWTs. A study by the University of Guelph using Ontario data reached a similar conclusion². However, one Ontario case study³ released in 2013, argues that properties in Ontario in proximity to an IWT are devalued by as much as 30 to 35 per cent.

Also, Health Canada produced a study on the health effects of living near IWTs.⁴

2008 Base Year Study

MPAC conducted a study using 2008 base year Current Value Assessments, to determine whether residential properties located near IWTs were equitably assessed when compared to properties at a greater distance. The study was based on very limited sales information as there were few IWTs in the province at that time. As a result, it was difficult to draw meaningful conclusions with the 2008 study. Based on the available sale information, no adjustment to value was required for the 2008 Current Value Assessments.

2012 Base Year Study

In response to the growing presence of IWTs in Ontario as well as requests for information from stakeholders, MPAC undertook a new study using the 2012 base year CVAs to provide a thorough examination of the impact of IWTs on residential property assessment.

¹ Ben Hoen et al, "A Spatial Hedonic Analysis of the Effects of Wind Energy Facilities on Surrounding Property Values in the United States", Berkeley National Laboratory, August 2013

² Vyn, R. J., and R. M. McCullough. (2014). The effects of wind turbines on property values in Ontario: Does public perception match empirical evidence? *Canadian Journal of Agricultural Economics* 62 (3): 365-392.

³ Ben Lansink, "Case Studies: Diminution / Change in Price Melancthon and Clear Creek Wind Turbine Analyses, Municipal Property Assessment Corporation (MPAC) Current Value Changes," Lansink Appraisals and Consulting, February 2013

⁴ <http://www.hc-sc.gc.ca/ewh-semt/noise-bruit/turbine-eoliennes/summary-resume-eng.php>

Specifically, the study sought to examine the following two statements:

1. Determine if residential properties in close proximity to IWTs are assessed equitably in relation to residential properties located at a greater distance. This was referred to as *Study 1 – Equity of Residential Assessments in Proximity to Industrial Wind Turbines*.
2. Determine if sale prices of residential properties are affected by the presence of an IWT in close proximity. This was referred to as *Study 2 – Effect of Industrial Wind Turbines on Residential Sale Prices*.

Study 2 was added to the original scope of the review to respond to enquiries MPAC received from stakeholders and interested parties.

To conduct these studies, MPAC considered 15 market areas with sufficient sales to allow for analysis and applied industry standard mass appraisal techniques and internationally accepted ratio study standards.

To determine the equity of assessments of properties within close proximity to an IWT, MPAC conducted an assessment-to-sale ratio (ASR) study. An individual ASR is calculated by dividing the assessed value of each property by its time-adjusted sale price. A ratio study is conducted to first establish the level of appraisal for a group of properties and equity is determined by comparing the level of appraisal with other groups of properties. If a group of properties is assessed at market value, the median ASR will lie between 0.90-1.10⁵. By definition, equity is said to exist if there is 5% or less difference between property categories (or groups of properties) as per International Association of Assessing Officers (IAAO) ratio study standards.

The level of appraisal for properties within one kilometre of an IWT was 1.034. The level of appraisal for properties at greater distance (one to two kilometres, two to five kilometres and over five kilometres) ranged from 0.989 to 0.992, a 4.2 to 4.5% differential, which is below the 5% noted above.

Following its review, MPAC concluded that 2012 CVAs of properties located within proximity of an IWT were assessed at their current value and were equitably assessed in relation to homes at greater distances from the IWTs. No adjustments were required for 2012 CVAs. This finding is consistent with MPAC's 2008 CVA report.

MPAC's findings also concluded that there was no statistically significant impact on sale prices of

⁵ MPAC adopted the IAAO Ratio Study standards for the 2016 assessment update. Therefore, the Target Level of Assessment (LOA) changed between 2012 and 2016 from 0.95 – 1.05 to 0.90 – 1.10. See International Association of Assessing Officers, *Standard on Ratio Studies*, April 2013, pp. 17-19

residential properties in these market areas resulting from proximity to an IWT, when including distance to an IWT in its regression analysis for areas with adequate sales.

In addition to the results shared in this report, MPAC also commissioned an internationally recognized expert in the field of mass appraisal and ratio studies to review the report and its findings. This expert confirmed MPAC's findings in his report.

To see the full 2012 base year study [click here](#).

Purpose of This Report

This 2016 base year report has been undertaken to ensure that the assessments on residential properties in proximity to IWTs are accurate and equitable. Specifically, the report examines whether residential properties in close proximity to IWTs are assessed equitably in relation to residential properties located at a greater distance.

Legislation

Sections of the *Assessment Act* relevant to this study include the following:

Section 1 (1): “current value” means, in relation to land, the amount of money the fee simple, if unencumbered, would realize if sold at arm’s length by a willing seller to a willing buyer; (“valeur actuelle”).

Section 19 (1): The assessment of land shall be based on its current value.

Section 44 (3): For 2009 and subsequent taxation years, in determining the value at which any land shall be assessed, the Board shall,

- determine the current value of the land; and
- have reference to the value at which similar lands in the vicinity are assessed and adjust the assessment of the land to make it equitable with that of similar lands in the vicinity if such an adjustment would result in a reduction of the assessment of the land. 2008, c. 7, Sched. A, s. 13.

Under the *Assessment Act* and associated regulations, (Ontario Regulation 282/98, Section 42.5), IWTs are valued at a prescribed rate per taxation year (Table 1). The value of the IWT, plus the value of the associated land, is placed in the industrial tax class.

Table 1 - IWT Valuation

Property Tax Year	IWT Value Per MW
2013 and earlier	\$40,000
2014	\$42,658
2015	\$43,542
2016	\$43,986
2017	\$50,460
2018	\$50,460
2019	\$50,460
2020	\$50,460

Valuation of Residential Properties

To estimate value of residential properties, MPAC applies the direct comparison approach through mass appraisals. The direct comparison approach estimates the current value of a subject property by comparing it to similar properties and adjusting the result to account for differences between the two properties. Mass appraisal uses standardized processes and common data to allow for the valuation of a group of properties and the statistical testing of the results. For more information on how residential properties are assessed, go to mpac.ca.

Multiple Regression Analysis

MPAC uses industry standard computer-assisted mass appraisal techniques to apply the direct comparison approach to value through a statistical tool known as multiple regression analysis.

Regression analysis is a statistical technique used to analyze data in order to predict the value of one variable, such as market value, based on known data (e.g., living area, lot size, quality, location, etc.). If only one variable is used, such as living area, the procedure is called simple regression analysis. When two or more variables are used in the analysis, the procedure is called multiple regression analysis.

Multiple regression analysis estimates the value of one variable (i.e., the dependent variable) based on the information from the available data (i.e., the independent variables). Assessing authorities, such as MPAC, develop an equation that estimates current value based on the sale prices and property characteristics of sold properties. The equation, or valuation model, provides the best estimate of current value in statistical terms since it reduces the overall error between sale price and predicted value (estimated current value) to the lowest possible amount in dollar terms.

Market Areas

In Ontario, MPAC has approximately 130 residential market areas. Market areas are geographic areas subject to the same economic influences. One valuation model is built for each market area. A market area could be a section of a large city, like Toronto, a medium sized city like Niagara Falls or a cluster of smaller towns. Also, it could be the rural residential properties within a county or a group of lakes in a recreational waterfront area such as Muskoka or Kawartha Lakes.

Key Factors Affecting Value

Approximately 85% of the current value of a property can be attributed to the following five property characteristics: location, building area, construction quality, lot size and age of the home adjusted for renovations and additions. Other features that may be adjusted for include;

water frontage, building amenities (e.g., basement area, basement finish, bathrooms, fireplaces, heating, air conditioning), secondary structures (e.g., garages, in-ground pools), site features (e.g., abutting green space, abutting a ravine, abutting a commercial property, topography, corner lot, traffic pattern). Value influences differ across the province and therefore will not have the same impact on every market model.

Legislated Valuation Date

All estimates of current value represent market conditions as of January 1, 2016, which is the legislated valuation date for the 2017-2020 property tax years. As a result, part of MPAC's analysis is to determine the amount of inflation or deflation in each market area and adjust sale prices for time in relation to the legislated valuation date.

Assessment-to-Sale Ratio Study

Once each valuation model has been developed, it is tested to ensure it is producing accurate and uniform estimates of value using a sale ratio study, which compares value estimates to actual sale prices. This study ensures that the overall level of assessment for the market area is within international standards for accuracy and uniformity. The second aspect of the ratio study is to ensure that equity has been achieved across all major property characteristics.

Application of Valuation Model

Once the statistical testing has been completed and the valuation model for each market area has been deemed appropriate, it is applied to all the applicable properties in the market area and qualified valuation staff commence individual value review. The purpose of this exercise is to reconcile the value estimates to ensure that an accurate and equitable assessment has been placed on each property. These efforts tend to focus on areas with few sales and properties with features that cannot be captured within mass appraisal models. This review work continues up until the Assessment Roll is provided to each municipality and will include sales before and after the valuation date.

Industrial Wind Turbines

2016 Base Year Analysis

Between 2008 and 2016, Ontario has seen a proliferation of wind turbine projects with the introduction of the *Green Energy Act* in 2009 and the Feed-in-Tariff (FIT) program. This has resulted in a large set of available sales data for properties in proximity to these projects.

For the purposes of the 2016 base year study, MPAC has adopted a definition of an IWT to be one with a capacity of at least 1.5 megawatts. MPAC analyzed sales located within five kilometres of any IWT with this generating capacity. This is consistent with the definition currently being used by Health Canada⁶ and was used for the 2008 and 2012 MPAC studies.

Data Collection

To ensure MPAC's inventory of IWTs was as complete as possible, MPAC obtained NAV Canada's entire flight obstacle inventory, which included the geographic coordinates of every self-reported IWT in Ontario. NAV Canada's inventory is subject to voluntary reporting compliance and thus does not include every IWT/flight obstacle. Any IWTs identified by NAV Canada that had not yet been field inspected by MPAC, were inspected by local staff and all relevant data was keyed into MPAC's database. Any IWTs identified in MPAC's database that were not included on NAV Canada's database were either inspected by local MPAC staff and the geographic coordinates were collected, or determined through the use of satellite digital imagery. To track the inventory, MPAC assigns a structure code of 567 to represent IWTs.

To ensure the database inventory was accurate, MPAC staff then conducted quality checks of all IWT data, including its generating capacity and geographic coordinates to ensure accuracy (e.g., co-ordinates not placing the IWTs on the correct property). Of the 2,321 IWTs in MPAC's database after this exercise, 48 were removed for having a capacity below 1.5 MW and two were removed for other reasons, leaving 2,271 IWTs for review. The distribution across MPAC's market areas is as follows:

⁶ http://www.hc-sc.gc.ca/ewh-semt/consult/_2013/wind_turbine-eoliennes/comments_part1-commentaires_partie1-eng.php#a16

Table 2 – Count of IWTs by MPAC Region

MPAC Region	Region Description	IWT Count	Property Count
01 - Cornwall	Prescott & Russell County, Stormont Dundas & Glengarry County	10	9
05 – Kingston	Frontenac County, Lennox & Addington County	91	68
18 – St. Catharines	The Region of Niagara	10	7
20 – Brantford	Brantford City, Brant, Haldimand and Norfolk Counties	234	192
22 – Kitchener	Regional Municipality of Waterloo, Dufferin and Wellington County, City of Guelph	220	153
23 – London	Elgin, Middlesex & Oxford Counties	137	123
24 – Goderich	Huron & Perth Counties	284	217
25 – Owen Sound	Grey & Bruce Counties	280	222
26 – Chatham	Chatham-Kent, Lambton County	602	510
27 – Windsor	Windsor/Essex	173	148
30 - Sudbury	Regional Municipality of Sudbury, Territorial District of Sudbury, Territorial District of Manitoulin	25	24
31 – Sault Ste. Marie	Territorial District of Algoma	162	46
32 – Thunder Bay	Territorial District of Kenora, Territorial District of Rainy River, Territorial District of Thunder Bay	43	43
Overall		2,271	1,762

As some properties had more than one IWT erected on them, the property count does not match the count of IWTs.

Virtually all IWTs are erected on vacant lots or farm properties, with almost 95% located on farms and most of the remainder on vacant lots.

The year of construction of IWTs in the database ranges from 2002 to 2016, with a breakdown as follows:

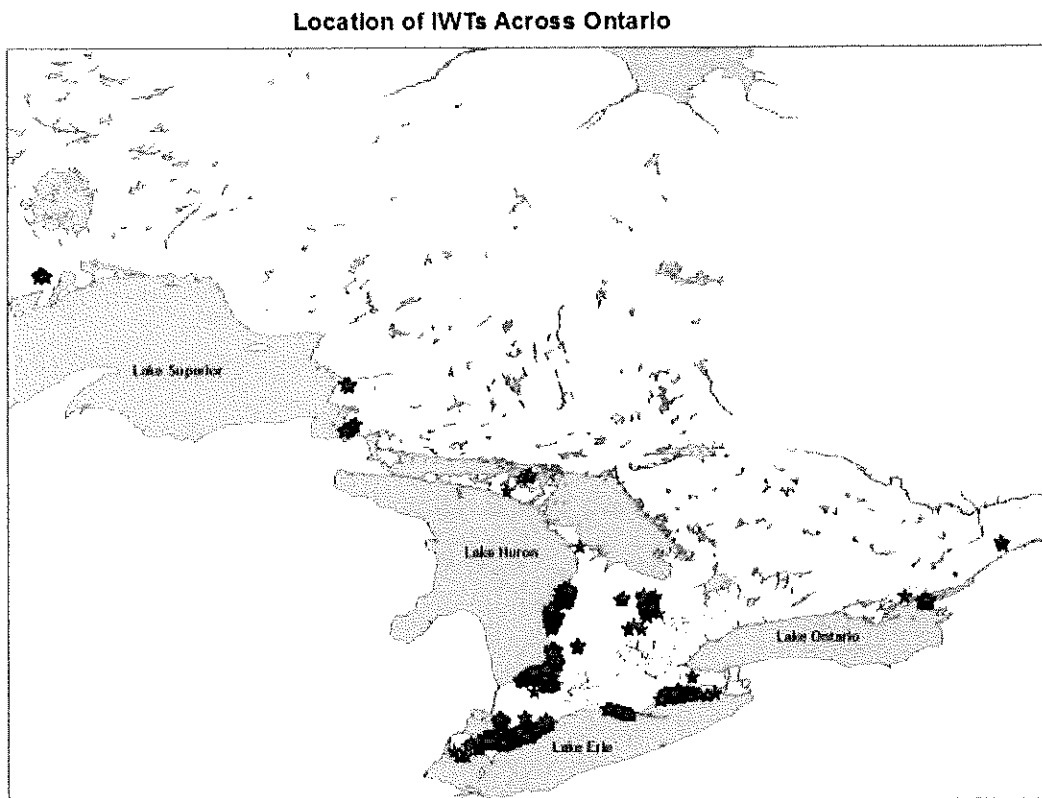
Table 3 - Typical Physical Characteristics of IWTs Across Ontario

MPAC Region	Median Year of Construction	Earliest Year of Construction	Latest Year of Construction	Median Generating Capacity	Minimum Generating Capacity	Maximum Generating Capacity
01 - Cornwall	2014	2014	2014	3.00	3.00	3.00
05 - Kingston	2008	2008	2014	2.30	1.65	2.30
18 - St. Catharines	2014	2014	2014	1.80	1.80	1.80
20 - Brantford	2013	2007	2014	2.20	1.50	2.30
22 - Kitchener	2008	2006	2014	1.50	1.50	2.75
23 - London	2014	2006	2015	1.62	1.50	2.22
24 - Goderich	2015	2006	2016	1.80	1.50	2.30
25 - Owen Sound	2008	2002	2015	1.80	1.60	2.30
26 - Chatham	2012	2008	2015	2.03	1.50	2.50

27 – Windsor	2010	2010	2013	2.30	1.65	2.30
30 – Sudbury	2014	2004	2014	2.50	1.80	2.50
31 – Sault Ste. Marie	2006	2006	2015	1.50	1.50	1.62
32 – Thunder Bay	2010	2010	2010	2.30	2.30	2.30
Overall	2012	2002	2016	1.80	1.50	3.00

The following map shows the locations of the IWTs used in the analysis.

Figure 1



Equity of Residential Assessments in Proximity to Industrial Wind Turbines

For this study, MPAC analyzed open market sales of improved residential properties from January 2012 through October 2016 in the market areas surrounding IWTs. A market area is defined as a geographic area, usually contiguous, subject to the same economic influences, where properties tend to increase or decrease in value together. Improved residential properties would include single detached houses, semi-detached houses, townhouses, and multiplex properties with up to six self-contained units. Farms, commercial and industrial properties were not included in this analysis.

Comparison to the 2012 Base Year Study

This study is similar to the one conducted for the 2012 base year. To provide clarity to readers who are familiar with the 2012 study, a summary of similarities and differences is provided below.

Similarities

The methodology is the same. Both reports contain a sale ratio study which compares the median level of assessment between different groups of properties. The details of the sale ratio study are provided below. The number of sales in proximity to an IWT has increased due to the increase in IWT construction over the past four years (1157 in 2012 vs. 2271 in 2016).

IWTs with a capacity less than 1.5MW have been removed when measuring distance to an IWT: 28 were removed in 2012 vs. 48 in 2016 (note one IWT was removed in 2016 that was situated on a nuclear power plant property).

Differences

For the 2012 study distance from an IWT to a property was measured from the corner of the dwelling to the closest IWT. For 2016, distance was measured from the property boundary nearest the IWT. It was found to be too time-consuming to collect data from the corner of the dwelling as this required a field inspection to obtain the coordinates for the corner of the dwelling, and would require field visits as new IWTs are constructed in the future. As mapping information becomes more sophisticated, MPAC will look for ways to collect this information electronically.

In 2012, MPAC collected data on how much of an IWT was in view (full, partial or none) for all residences within two kilometres of an IWT. This data was not collected for 2016 because it didn't impact the assessment in 2012 and this data was too time-consuming to collect. It

required a physical inspection and photos taken at each property whenever a new IWT was constructed and required significant resources to keep the database up to date. MPAC will look to published research and studies and if an efficient method surfaces, we will consider implementing it.

A new measure for the 2016 study is the concentration of IWTs around residential properties. This was measured using Geographical Information Systems (GIS) to determine the number of IWTs within the distance grouping for each sale (i.e. number of IWTs within one kilometre, two kilometres or five kilometres of a sale). This allows MPAC to test if the number of IWTs in proximity to a residence affects the level of assessment.

2016 Base Year Study

Sales

For this study, sales in proximity to IWTs were found in 25 market areas.

Table 4 – MPAC Market Area Descriptions

Market Area	MPAC Region	Description
01RR010	01 - Cornwall	City of Cornwall and the Counties of Prescott & Russell, Stormont, Dundas and Glengarry
05RR030	05 – Kingston	Napanee, Loyalist Township, Frontenac/Lennox & Addington Counties South Rural/Waterfront
16RR030	16 - Barrie	Simcoe West
18RR010	18 – St. Catharines	Niagara Rural
18WF010	18 – St. Catharines	Niagara/Lake Erie Waterfront
19RR010	19 – Hamilton	Hamilton Rural
20RR010	20 – Brantford	Brant, Haldimand, Norfolk Counties - Rural/Waterfront
22RR010	22 – Kitchener	Dufferin & Wellington Counties - Rural
22UR020	22 – Kitchener	Dufferin County Villages

22UR030	22 – Kitchener	Wellington County Villages
23RR010	23 – London	Elgin, Middlesex & Oxford Counties - Rural
23UR030	23 – London	Towns of Tillsonburg, Ingersoll, Woodstock, Aylmer, St. Thomas and Strathroy
24RR010	24 – Goderich	Huron & Perth Counties - Rural
25RR010	25 – Owen Sound	Grey & Bruce Counties - Rural and Inland Lakes
25UR010	25 – Owen Sound	Grey & Bruce Counties - Urban
26RR010	26 – Chatham	Chatham-Kent - Rural/Wallaceburg
26RR030	26 – Chatham	Lambton County - Rural/Waterfront
26UR010	26 – Chatham	City of Chatham
27RR010	27 – Windsor	Essex County Rural and Towns
27UR070	27 – Windsor	Lasalle, Tecumseh, Lakeshore Urban & Essex Urban
30RR010	30 - Sudbury	District of Sudbury
31RR010	31 – Sault Ste Marie	District of Algoma
31UR010	31 – Sault Ste Marie	Sault Ste. Marie/Prince Township
45WF050	24 – Goderich	Lake Huron
	25 – Owen Sound 26 - Chatham	
78WF040	16 – Barrie	Georgian Bay
	17 – Bracebridge	
	25 – Owen Sound	
	28 – North Bay	

Adjustments for being in proximity to IWTs were not included when establishing CVAs for the 2008, 2012 or 2016 base years in any of these market areas.

Sales Filters

To account for typical minimum sale amounts, any sale below \$10,000 was removed in Southwestern or Eastern Ontario, and any sale below \$5,000 was removed in Northern Ontario. Any sale of a property on which an IWT sits was removed from analysis to avoid the potential influence that the income stream associated with such properties may exert. As concerns about noise and vibration have been raised by IWT opponents, sales of vacant land were removed (i.e. only properties with a residence were included). There were two market areas with five or fewer sales and these were excluded from the analysis (Goderich urban area and Kingston urban area). Sales that were not open market transactions or suspected to not be arms-length open market transactions were removed from the analysis. Finally, those with extreme ratios of CVA to sale price as defined by the International Association of Assessing Officers (IAAO) Standard on Ratio Studies⁷ were also removed from analysis.

Assessment-to-Sale Ratio Study

To establish the level of assessment and test for equity, MPAC conducts an assessment-to-sale ratio study. The assessment-to-sale ratio study is determined for each sold property by dividing the assessed value by its sale price or time adjusted sale price.

International standards state that a group of properties is assessed at current value if the level of assessment lies between 0.90 – 1.10. The preferred measurement of the level of assessment is the median ASR for the group of properties being studied.⁸

The level of assessment (LoA) for different categories of properties can be compared against one another to ensure that they align and if so, the properties between each group are said to be equitably assessed. Groups of properties would be said to be inequitably assessed if there was a statistically significant difference between their respective levels of assessment (at least 5%).

Median ASRs and their 95% confidence intervals were calculated for groups of distance variables. The median always divides the data into two equal parts and is less affected by extreme ratios than other measures of central tendency. Because of these characteristics, the median is generally the preferred measure of central tendency and is used to determine LoA in this report.

⁷ International Association of Assessing Officers, *Standard on Ratio Studies*, April 2013, pp. 53-54

⁸ International Association of Assessing Officers, *Standard on Ratio Studies*, April 2013, pp. 13

When the calculated median is based on sample data, the result is called a point estimate, which is accurate for the sample but is only one indicator of the level of assessment in the population. Confidence intervals around the point estimate provide indicators of the reliability of the sample statistics as predictors of the overall level of appraisal of the population. Note that noncompliance with appraisal level standards cannot be determined without the use of confidence intervals or hypothesis tests⁹. A confidence interval consists of two numbers (upper and lower limits) that bracket a calculated measure of central tendency for the sample; there is a specified degree of confidence that the calculated upper and lower limits bracket the true measure of central tendency for the population.

MPAC looked at three different data elements in determining if equity exists:

1. Abutting a property with an IWT
2. Distance to closest IWT
3. Number of IWTs within each distance range

1. Abutting a Property with an IWT

Table 5 – Abutting an IWT Sale Ratio Study

Assessment Update Year	Sales Count	LoA	95% LCL	95% UCL	Target LoA ¹⁰	LoA within Target LoA	Confidence Intervals Overlap Target LoA	Corrective Action Required
2012	32	1.002	0.929	1.121	0.95 – 1.05	Yes	Yes	No
2016	166	0.997	0.970	1.025	0.90 – 1.10	Yes	Yes	No

There are 166 sales of properties that abut an IWT. The level of assessment is 0.997. There is no inequity with regard to properties that abut an IWT.

2. Distance to Closest IWT

A breakdown of the 110,338 sales used in the analysis, by distance, follows:

⁹ International Association of Assessing Officers, *Standard on Ratio Studies*, April 2013, p. 13

¹⁰ MPAC adopted the IAAO Ratio Study standards for the 2016 assessment update, hence why the Target Level of Assessment (LOA) changed between 2012 and 2016

Table 6 – Distance Grouping by Market Area

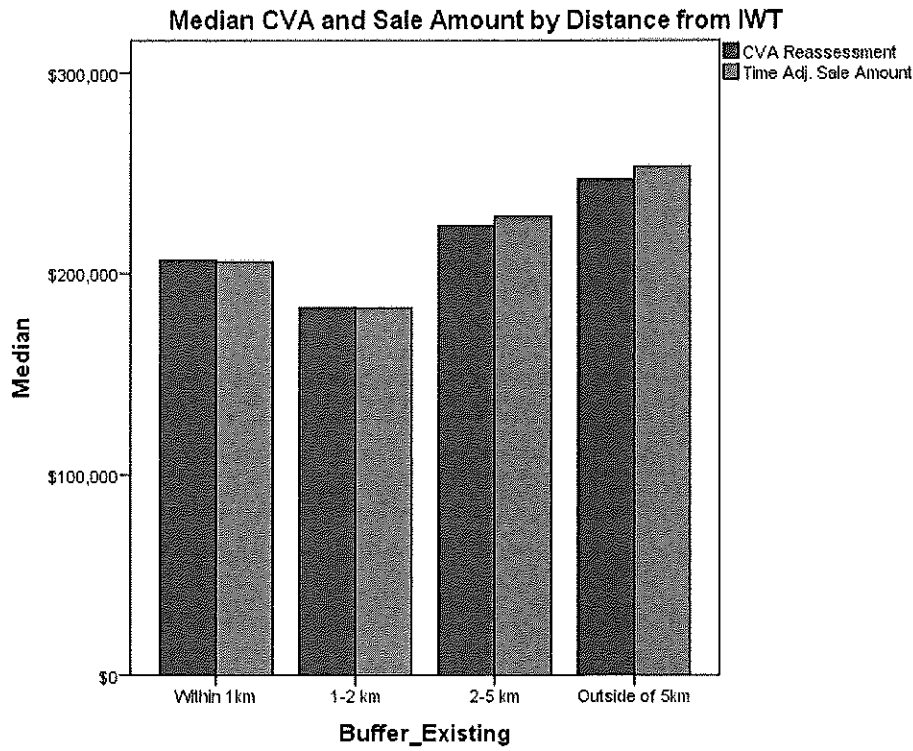
Market Area	MPAC Region	< 1 km	1-2 km	2-5 km	> 5 km	Total
01RR010	01 - Cornwall	9	4	36	11,914	11,963
05RR030	05 – Kingston	30	13	335	3,748	4,126
16RR030	16 - Barrie	0	0	6	6,482	6,488
18RR010	18 – St. Catharines	11	45	95	2,262	2,413
18WF010	18 – St. Catharines	0	18	31	186	235
19RR010	19 – Hamilton	0	8	38	1,742	1,788
20RR010	20 – Brantford	247	351	1,230	6,961	8,789
22RR010	22 – Kitchener	83	67	217	2,570	2,937
22UR020	22 – Kitchener	0	0	689	3,149	3,838
22UR030	22 – Kitchener	0	135	38	3,610	3,783
23RR010	23 – London	13	89	284	7,156	7,542
23UR030	23 – London	0	0	353	9,567	9,920
24RR010	24 – Goderich	23	55	268	3,731	4,077
25RR010	25 – Owen Sound	32	37	250	3,473	3,792
25UR010	25 – Owen Sound	0	24	279	6,130	6,433
26RR010	26 – Chatham	298	920	1,109	847	3,174
26RR030	26 – Chatham	18	152	557	2,530	3,257
26UR010	26 – Chatham	0	0	559	2,125	2,684
27RR010	27 – Windsor	216	483	1,436	3,915	6,050

27UR070	27 – Windsor	4	265	250	4,762	5,281
30RR010	30 – Sudbury	0	4	17	1,883	1,904
31RR010	31 – Sault Ste Marie	0	7	25	2,527	2,559
31UR010	31 – Sault Ste Marie	0	12	31	4,180	4,223
45WF050	24 – Goderich 25 – Owen Sound 26 – Chatham	0	2	596	1,162	1,760
78WF040	16 – Barrie 17 – Bracebridge 25 – Owen Sound 28 – North Bay	0	0	22	1,300	1,322
TOTAL		984	2,691	8,751	97,912	110,338

Refer to Table 1 for market area descriptions.

Comparing the median assessed value to the median time adjusted sale amount by the distance categories shows that the figures are very similar. Consider Figure 2 below. To make this comparison, one must consider the height of the blue and green bars for each of the distance groupings. Similar heights indicate that the median sale price (adjusted to January 1, 2016) and the median assessed value are similar. Comparisons between the different distance groupings should not be made because this chart does not control for differences in the housing stock of each grouping. These differences could be physical (building size or age) or differences due to location (e.g., homes further than 5km from an IWT being closer to urban centers). The results for all sales are provided in Figure 2.

Figure 2 – Comparison of CVA and Time Adjusted Sale Price by Distance Groupings



Appendix B – Current Value Assessment and Sale Amount Bar Charts contains a similar bar chart for each market area.

The following tables compare the 2012 results to the 2016 results.

2. Distance to Closest IWT All Sales

2012 Assessment Update

Table 7 – Distance Grouping Sale Ratio Study 2012 Current Value Assessment

Distance Grouping	Sales Count	LoA	95% LCL	95% UCL	Target LoA	LoA within Target LoA	Confidence Intervals Overlap Target LoA	Corrective Action Required
Within 1 km	279	1.034	1.011	1.057	0.95 – 1.05	Yes	Yes	No
1 km to 2 km	989	0.989	0.979	1.000	0.95 – 1.05	Yes	Yes	No

2 km to 5 km	3,063	0.992	0.988	0.997	0.95 – 1.05	Yes	Yes	No
Outside 5 km	37,093	0.992	0.991	0.993	0.95 – 1.05	Yes	Yes	No
OVERALL	41,424	0.992	0.991	0.994	0.95 – 1.05	Yes	Yes	No

2016 Assessment Update

Table 8 – Distance Grouping Sale Ratio Study 2016 Current Value Assessment

Distance Grouping	Sales Count	LoA	95% LCL	95% UCL	Target LoA	LoA within Target LoA	Confidence Intervals Overlap Target LoA	Corrective Action Required
Within 1 km	984	1.007	0.993	1.019	0.90 – 1.10	Yes	Yes	No
1 km to 2 km	2,691	0.995	0.989	1.003	0.90 – 1.10	Yes	Yes	No
2 km to 5 km	8,751	0.977	0.974	0.980	0.90 – 1.10	Yes	Yes	No
Outside 5 km	97,912	0.974	0.973	0.974	0.90 – 1.10	Yes	Yes	No
OVERALL	110,338	0.974	0.974	0.975	0.90 – 1.10	Yes	Yes	No

The level of appraisal for properties within one kilometre of an IWT has fallen while it has increased slightly for properties with IWTs one to two kilometres away. The difference between both groups and properties outside five kilometres of an IWT is statistically significant (the confidence intervals don't overlap). The difference between sales within one kilometre and sales outside five kilometres is 3.3% (the confidence intervals are 1.9% apart). The difference between sales one to two kilometres from an IWT and outside five kilometres is 2.1% (the confidence intervals are 1.5% apart). Both these differences are well within IAAO standards for equity between groups of properties.

Appendix C – Distance Grouping 2016 Sale Ratio Study by Market Area contains assessment-to-sale ratio data for each Market Area.

Distance to Closest IWT - Rural Properties Only

2012 Assessment Update

Table 9 – Distance Groupings – Rural Market Sale Ratio Study 2012 Current Value Assessment

Distance Grouping	Sales Count	LoA	95% LCL	95% UCL	Target LoA	LoA within Target LoA	Confidence Intervals Overlap Target LoA	Corrective Action Required
Within 1 km	278	1.034	1.011	1.055	0.95 – 1.05	Yes	Yes	No
1 km to 2 km	715	0.996	0.982	1.008	0.95 – 1.05	Yes	Yes	No
2 km to 5 km	2,284	0.999	0.993	1.005	0.95 – 1.05	Yes	Yes	No
Outside 5 km	23,135	0.995	0.993	0.997	0.95 – 1.05	Yes	Yes	No
OVERALL	26,412	0.996	0.994	0.997	0.95 – 1.05	Yes	Yes	No

2016 Assessment Update

Table 10 – Distance Grouping – Rural Market Sale Ratio Study 2016 Current Value Assessment

Distance Grouping	Sales Count	LoA	95% LCL	95% UCL	Target LoA	LoA Within Target LoA	Confidence Intervals Overlap Target LoA	Corrective Action Required
Within 1 km	980	1.007	0.992	1.019	0.90 – 1.10	Yes	Yes	No
1 km to 2 km	2,235	0.999	0.992	1.007	0.90 – 1.10	Yes	Yes	No
2 km to 5 km	5,903	0.986	0.982	0.990	0.90 – 1.10	Yes	Yes	No
Outside 5 km	61,741	0.976	0.974	0.977	0.90 – 1.10	Yes	Yes	No
OVERALL	70,859	0.977	0.976	0.978	0.90 – 1.10	Yes	Yes	No

The 2016 results for rural properties are similar to the results using all sales. The statistics are virtually unchanged.

3. Number of IWTs within each Distance Range

For the 2016 study, MPAC examined how the level of assessment changed when the number of IWTs within each grouping changed to determine whether the concentration of IWTs around a residence impacts the level of assessment. The results are provided below.

Table 11 – Number of IWTs within 1 km Sale Ratio Study 2016 Current Value Assessment

IWT Count	Sales Count	LoA	95% LCL	95% UCL	Target LoA	LoA within Target LoA	Confidence Intervals Overlap Target LoA	Corrective Action Required
1-3 IWTs	900	1.003	0.990	1.016	0.90 – 1.10	Yes	Yes	No
4-6 IWTs	80	1.022	0.990	1.053	0.90 – 1.10	Yes	Yes	No
7-9 IWTs	4	1.002	0.934	1.034	0.90 – 1.10	Yes	Yes	No
OVERALL	984	1.007	0.993	1.019	0.90 – 1.10	Yes	Yes	No

The level of assessment is fairly consistent within one kilometre of an IWT. For properties with four to six IWTs within one kilometre, the ASR is 1.022. There are 80 sales in this grouping.

- a. Number of IWTs within one to two kilometres of a Residence (properties within one kilometre of an IWT filtered)

Table 12 – Number of IWTs within 1 km to 2 km Range Sale Ratio Study 2016 Current Value Assessment

IWT Count	Sales Count	LoA	95% LCL	95% UCL	Target LoA	LoA within Target LoA	Confidence Intervals Overlap Target LoA	Corrective Action Required
1-3 IWTs	2,062	0.997	0.990	1.005	0.90 – 1.10	Yes	Yes	No
4-6 IWTs	529	0.983	0.968	1.011	0.90 – 1.10	Yes	Yes	No
7-9 IWTs	54	1.020	0.957	1.111	0.90 – 1.10	Yes	Yes	No
10-15 IWTs	39	0.971	0.937	1.057	0.90 – 1.10	Yes	Yes	No

16-20 IWTs	4	0.907	N/A ¹¹	N/A	0.90 – 1.10	Yes	Yes	No
21-30 IWTs	3	1.172	N/A	N/A	0.90 – 1.10	Yes	Yes	No
OVERALL	2,691	0.995	0.989	1.003	0.90 – 1.10	Yes	Yes	No

Any properties with IWTs within one kilometer are filtered for this table. There appears to be no pattern for properties that have IWTs within one to two kilometres. The median for properties with seven to nine IWTs is 1.020 but the lower confident limit is 0.957. There are a very small number of observations beyond 15 IWTs which has resulted in median levels of assessment diverging from 1.00. There are too few sales to calculate confidence intervals for these two groups of turbine counts.

- b. Number of IWTs within two to five kilometres of a Residence (properties within two kilometres of an IWT filtered)

Table 13 – Number of IWTs within 2 km to 5 km Sale Ratio Study 2016 Current Value Assessment

IWT Count	Sales Count	LoA	95% LCL	95% UCL	Target LoA	LoA Within Target LoA	Confidence Intervals Overlap Target LoA	Corrective Action Required
1-3 IWTs	3,317	0.976	0.971	0.980	0.90 – 1.10	Yes	Yes	No
4-6 IWTs	2,264	0.975	0.969	0.980	0.90 – 1.10	Yes	Yes	No
7-9 IWTs	997	0.988	0.977	0.998	0.90 – 1.10	Yes	Yes	No
10-15 IWTs	1,795	0.976	0.969	0.983	0.90 – 1.10	Yes	Yes	No
16-20 IWTs	204	0.989	0.957	1.017	0.90 – 1.10	Yes	Yes	No
21-30 IWTs	145	0.992	0.961	1.040	0.90 – 1.10	Yes	Yes	No

¹¹ “When the sample size is five or fewer, the 95 percent confidence interval is nonexistent. When there are six to eight ratios, the lower and upper 95 percent confidence limits equal the lowest and highest ratios in the sample, and caution is advised.” Gloudemans, Robert and Richard Almy, *Fundamentals of Mass Appraisal*, International Association of Assessing Officers, Kansas City, Missouri, 2011, p. 366.

31-40 IWTs	13	0.998	0.886	1.112	0.90 – 1.10	Yes	Yes	No
41+ IWTs	16	1.034	0.982	1.103	0.90 – 1.10	Yes	Yes	No
OVERALL	8,751	0.977	0.974	0.980	0.90 – 1.10	Yes	Yes	No

Any properties with IWTs within two kilometres are filtered for this table. The median for properties with more than 40 IWTs within five kilometres is 1.034 with 16 observations. All the lower confidence intervals are below 1.00.

c. Properties more than five kilometres from an IWT (Control Group)

Table 14 – Sale Ratio Study for Properties with no IWTs within 5km (Control Group) 2016 Current Value Assessment

IWT Count	Sales Count	LoA	95% LCL	95% UCL	Target LoA	LoA Within Target LoA	Confidence Intervals Overlap Target LoA	Corrective Action Required
No IWTs within 5km	97,912	0.974	0.973	0.974	0.90 – 1.10	Yes	Yes	No

These are the properties with no IWTs within five kilometres. They are being shown for comparison purposes.

Appendix D –Number of IWTs by Distance Grouping 2016 Sale Ratio Study by Market Area contains assessment-to-sale ratio data for each market area.

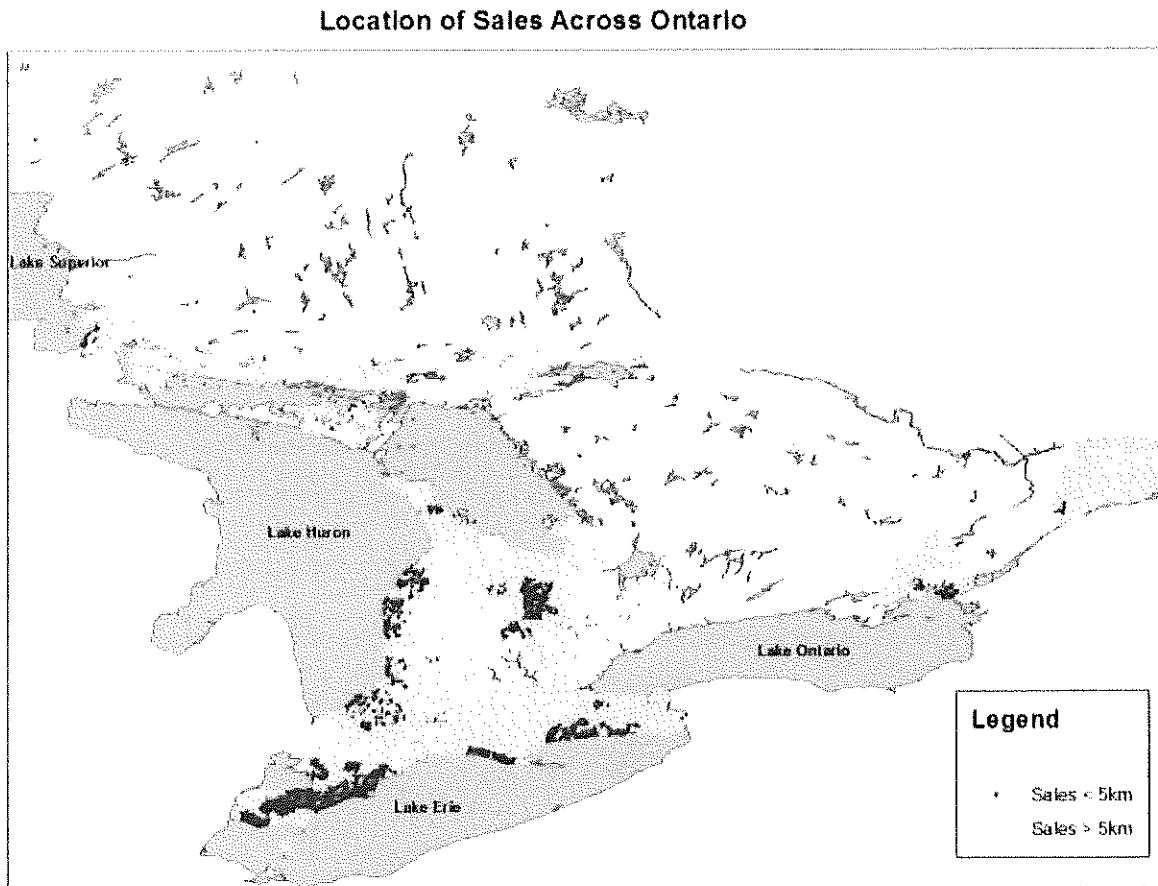
County Results

The statistics below were run at the county level to determine whether there were any patterns across the province. Overall, the results were very consistent with two exceptions: rural areas of Huron and Perth Counties and Grey and Bruce Counties. For properties in Huron/Perth within one kilometre of one or more IWTs the median sale ratio was low at 0.844. For properties in Grey/Bruce within one kilometre of one or more IWTs the median was high at 1.03. This was consistent regardless of the number of IWTs in both cases. Given the close geographical proximity of these counties, the results seem unusual and will require further review.

**Table 15 – Sale Ratio Study for Properties within 1 km of IWTs - Regions 24 and 25 2016
 Current Value Assessment**

County	Sales Count	LoA	95% LCL	95% UCL	Target LoA	LoA within Target LoA	Confidence Intervals Overlap Target LoA	Corrective Action Required
Huron/Perth	23	0.844	0.768	0.949	0.90 – 1.10	No	Yes	No
Grey/ Bruce	32	1.030	0.929	1.081	0.90 – 1.10	Yes	Yes	No

Figure 3 – Location of Sales Used in the Analysis (Red within 5 km of an IWT, Green outside 5 km of an IWT)



Summary of Findings

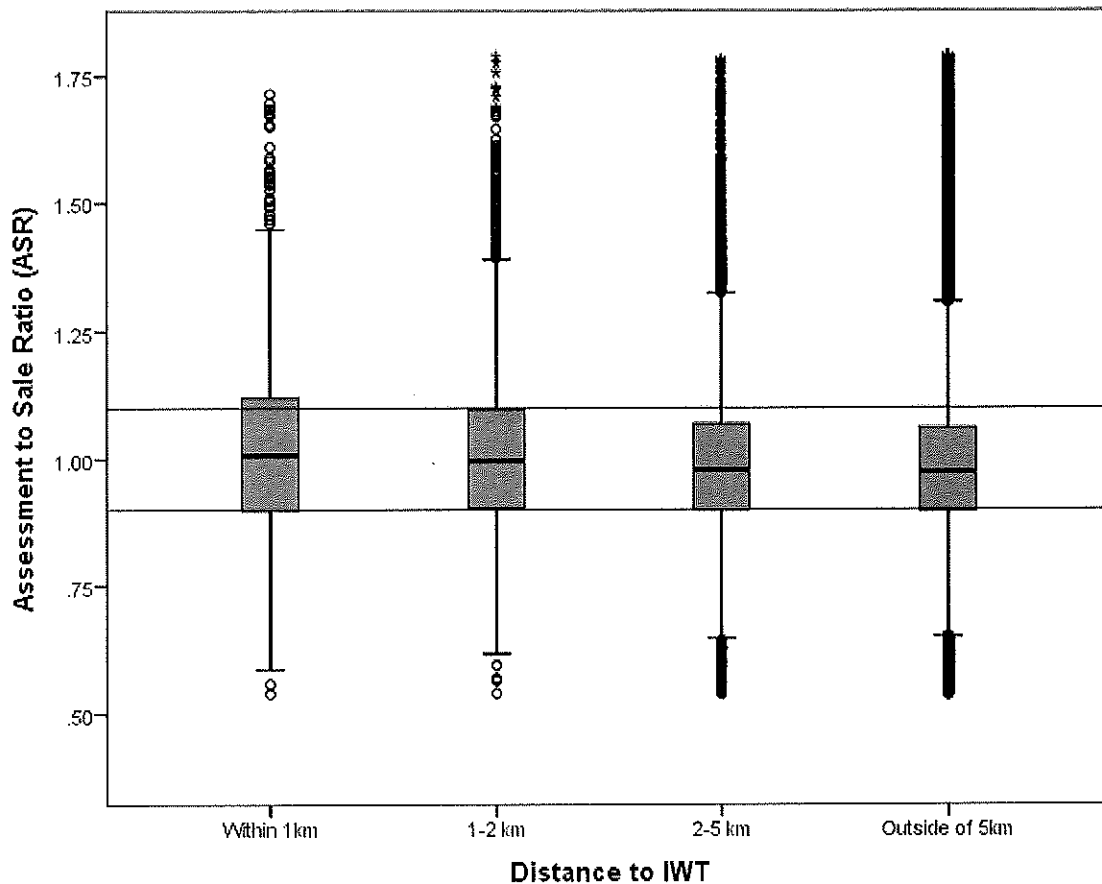
Section 9.2.1 of the International Association of Assessing Officers (IAAO) Standard on Ratio Studies states:

“The level of appraisal of each stratum (class, neighborhood, age group, market areas, and the like) should be within 5 percent of the overall level of appraisal of the jurisdiction. For example, if the overall level of appraisal of the jurisdiction is 1.00, but the appraisal level for residential property is 0.93 and the appraisal level for commercial property is 1.06, the jurisdiction is not in compliance with this requirement. This test should be applied only to strata subject to compliance testing. It can be concluded that this standard has been met if 95 percent (two-tailed) confidence intervals about the chosen measures of central tendency for each of the strata fall within 5 percent of the overall level of appraisal calculated for the jurisdiction. Using the above example, if

the upper confidence limit for the level of residential property is 0.97 and the lower confidence limit for commercial property is 1.01, the two strata are within the acceptable range."

Sales within one kilometre of an IWT showed a level of appraisal that was higher than the median assessment-to-sale ratio of sales further away (median assessment-to-sale ratio of 1.007). The lower confidence level of sales within one kilometre of an IWT is 0.993. This is well within 5% of the overall level of appraisal ($0.993 - 0.974 = 1.9\%$). Sales within one to two kilometres of an IWT showed a level of appraisal that was also higher than the median assessment-to-sale ratio of sales further away (median assessment-to-sale ratio of 0.995). The lower confidence level of sales within one to two kilometres of an IWT is 0.989. This is also well within 5% of the overall level of appraisal ($0.989 - 0.974 = 1.5\%$). So, although sales within two kilometres of an IWT do have a level of assessment above the overall level, the difference is not great enough to require value adjustment according to IAAO guidelines. These findings are illustrated in the following box plot.

Figure 4 – Assessment-to-Sale Ratio by Distance Grouping



The dark line within each box represents the median ASR. The lower and upper ends of the box represent the 25th and 75th percentiles, respectively. This box plot illustrates that the median assessment-to-sale ratio for sales within one kilometre of an IWT is slightly higher than the other groups, but the boxes for all the groups overlap.

In the IAAO Standard on ratio studies from 2013¹², an equity decision-making matrix is provided to allow a jurisdiction to determine if equity exists between groups of properties. This matrix has been populated for the two scenarios described above. The performance standard range is 0.90 to 1.10. Note that if the point estimate is outside of the performance standard range but the confidence interval does overlap the range, action is not required.

Table 16 – Decision Making Matrix

Scenario	Point Estimate	Confidence Interval (CI) Width	CI Overlaps Performance Standard Range	Point Estimate in Performance Standard Range	Action Required
<1 km to IWT	1.007	0.993 to 1.019	Yes	Yes	No
1 km - 2 km to an IWT	0.995	0.989 to 1.003	Yes	Yes	No

Therefore, based on the results of this analysis, there is no inequity with regards to distance to the nearest IWT.

This finding is consistent with MPAC’s 2008 and 2012 studies.

MPAC’s findings are also consistent with a third party review of this study conduct by Robert J. Gloude-mans. Mr. Gloude-mans is an independent internationally-recognized mass appraisal consultant. MPAC provided Mr. Gloude-mans with a dataset of all sales less than five kilometres from the nearest IWT to conduct his analysis. *Mr. Gloude-mans’ report is included as Appendix A – Independent Review of Report – Industrial Wind Turbine Ratio Study - R.J. Gloude-mans, November 22, 2016.*

¹² International Association of Assessing Officers, *Standard on Ratio Studies*, April 2013, p. 35

List of Report Appendices

Appendix A – Independent Review of Report – Industrial Wind Turbine Ratio Study - R.J. Gludemans, November 22, 2016

Appendix B – Current Value Assessment and Sale Amount Bar Charts

Appendix C – Distance Grouping 2016 Sale Ratio Study by Market Area

Appendix D – Number of industrial wind turbines by Distance Grouping 2016 Sale Ratio Study by Market Area

Glossary of Terms

assessment roll – An annual listing provided to each taxing authority in the Province of Ontario containing, among other things, the current value and tax classification of each property within the jurisdiction.

assessment-to-sale ratio (ASR) – The ratio obtained by dividing the assessed value of a property by the time-adjusted sale price of a property.

base year – The year that an estimate of a property's value is based on.

Current Value Assessment (CVA) – The estimated value of a property based on a specific date.

direct comparison approach (also known as Sales Comparison Approach) – An approach to valuing a property that estimates the current value of a subject property by adjusting the sale price of comparable properties for differences between the comparable properties and the subject property.

industrial wind turbine (IWT) – A wind turbine used to generate at least 1.5 MW of electricity.

geographic coordinates – A set of two numbers that reference the latitude and longitude of a point on the Earth.

market area – A market area is defined as a geographic area, usually contiguous, subject to the same economic influences, where properties tend to increase or decrease in value together.

market model – Geographic areas subject to the same economic influences.

mass appraisal – The valuation of a group of properties as of a given date using standardized processes, employing common data, and allowing for statistical testing.

median – The median of a group of numbers is the middle number after they have been sorted from lowest to highest. If you have an odd number of cases, the median is the middle value. If you have an even number of cases, the median is the value midway between the two middle values. The median, in comparison to the mean, is less sensitive to extreme values.

megawatt (MW) – A unit of measure in energy generation or consumption.

Municipal Property Assessment Corporation (MPAC) – A body responsible for determining the correct market value and tax classification for all properties in the Province of Ontario, based on current value assessment.

regression analysis – A statistical technique used to analyze data in order to predict the value of one variable, such as market value, based on known data (e.g., living area, lot size, quality, location, etc.).

For more information about MPAC and how MPAC assesses properties, visit mpac.ca.