APPENDIX B

TERRESTRIAL ENVIRONMENT SUPPORTING DOCUMENTATION

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1.0 TECHNICAL APPENDIX - BATS

1.1 Study Area

As part of the Ontario Ministry of the Environment's (MOE) Environmental Screening Process (ESP) for electricity projects (Ontario Regulation 116/01), Golder undertook a review of background information and conducted autumn bat surveys to assess the presence and relative activity of bats within the Site Study Area (SSA) (Figure 7.3-1). These surveys were carried out to help establish the environmental baseline conditions within the SSA prior to Project implementation.

This report, in part, also presents information relevant to item 4.4 of the MOE's environmental screening checklist, which asks: Will the project have negative effects on wildlife habitat, populations, corridors or movement?

1.2 Background

1.2.1 Mortality Risk for Bats

Bat mortality in relation to wind turbines varies considerably by geographic location and species (United States Government Accountability Office (GAO 2005)). For example, wind turbines in forested landscapes, particularly those on forested ridges, such as high-profile sites in the Appalachian Mountains of West Virginia, tend to have significantly higher bat mortality rates than turbines placed in open areas.

Arnett et al. (2007) estimated that "*…bat fatality from 21 studies located at 19 different facilities from five different regions in the United States and one province in Canada ranged from 0.9-53.3 bats/MW…*". Similarly, Johnson (2004, cited in Ontario Ministry of Natural Resources [MNR] 2006) reported an average of 3.4 bat fatalities per turbine per year throughout the United States, which ranged from 0 to 4.3 bats per turbine per year in western states and up to 38 bats per turbine in six weeks in the Appalachians (MNR 2006). Experts agreed that this research has not shown "alarming" numbers of bat kills at most facilities (GAO 2005). However, habitat, and specifically forested ridges such as those present at the Appalachian facilities, appear to be an important factor in elevated bat mortality risk (Arnett et al. 2005). It also appears that size and height of the turbine are important factors contributing to the risk of collision. In southern Alberta, Barclay et al. (2007) found that bat mortalities generally increase with the height of wind turbines, suggesting that newer, taller turbines may be reaching the airspace of migratory bats.

Based on a review of completed studies, most of the bat fatalities occur during the migratory season of the long distance, tree roosting migrant bats (GAO 2005; MNR 2006). Johnson (2004, as cited by MNR 2006) indicated that over 90% of bat fatalities occur between mid-July and the end of September across the United States. Therefore, bat species that display migratory behaviour are likely at higher risk than resident species. A review of bat mortality at wind farms in the United States found that over 80% of fatalities were of long distance, tree-roosting migratory species, specifically silver-haired bat (*Lasionycteris noctivagans*), hoary bat (*Lasiurus cinereus*), and eastern red bat (*Lasiurus borealis*) (Johnson 2005). Arnett *et al.* (2008) also indicated that the tricolored bat (*Perimyotis subflavus*) (formerly the eastern pipistrelle (*Pipistrellus subflavus)* may also be at a slightly higher risk of turbine mortality. Other bat species that migrate shorter distances to hibernaculae (including eastern small-footed bat (*Myotis leibii*), little brown bat (*Myotis lucifugus*), northern long-eared bat (*Myotis septentrionalis*), and the big brown bat (*Eptesicus fuscus*), which may hibernate locally in buildings, had lower risk of turbine related mortality. Recent research, however, suggests that, more than colliding with turbine blades, bats may be at a higher risk of succumbing to the effects of barotrauma (Baerwald *et al.* 2008). Low air pressure is created on one side of turbine blades as they move through the air and when bats fly through this low pressure, the air in their lungs rapidly expands causing immediate hemorrhaging and subsequently death.

At one wind power park near Long Point, Ontario, along the north shore of Lake Erie in southwestern Ontario, the actual number of bats killed per year per turbine varied between 4.5 and 5.5 (James 2008). Interestingly, most of the mortality happened on only a few nights each year. For example, in the autumn of 2007, one-third of all bat collisions occurred over two nights and most of these occurred at turbines located within 250 m of the lakeshore.

1.2.2 Bat Activity

Natural Resources Canada (NRCan), along with four independent wind plant operators, supported a research initiative (EchoTrack 2005) to study nighttime bird and bat activity during the autumn of 2004 at six existing wind plants in Alberta. The study included evaluations at six control sites that were similar in topography and land-use to the plant sites, but without wind turbines. Using radar and sound recording technology, the study identified and tracked the movement of birds and bats at these sites, identifying the species of some individuals. Three nights of monitoring were undertaken at each of the twelve sites, yielding more than one million identified flight tracks. The most frequent flight times (primarily attributable to bird activity) were between one and two hours after dusk, gradually tapering off through the remainder of the night. At some, but not all sites, a second peak of activity (primarily attributable to bird activity) was observed at dawn. This research indicated that bats were noted during the radar and sound monitoring mainly near ridges, especially near treed areas or buildings that would provide roosting and foraging habitat. The research showed that most of the activity noted during the middle of the night (i.e., four and six hours after dusk) were bats and most of the activity at or just after dusk and again at dawn were birds. The number of birds or bats observed at sites did not differ between those with turbines and those without, but birds were heard to call more frequently at turbine sites compared to sites without turbines.

The nightly pattern indicates that birds and bats may be at greatest risk of colliding with turbines at dusk for two hours, in the middle of the night (four to six hours after dusk), and for the two hours just before dawn. However, for there to be a risk, birds and bats must fly at turbine height (i.e., within the rotor swept area) and many do not. Nearly 96% of recorded flights at sites with turbines and 86% of recorded flights at control sites were higher than 100 m (Echotrack 2005). These values are considerably different from the 76% of recorded flights above and 23% within the rotor swept area during pre-construction monitoring at Wolfe Island, Ontario using the Echotrack system (Echotrack 2008). Such differences may be attributable to the standing water, woodlots, hedgerows, and buildings that acted as attractants to bats.

Over the study in Alberta (Echotrack 2005), a total of 49 collisions with the turbines were considered to have occurred, representing 0.02% of the total flights recorded. Of the 49 collisions, 45 were assumed to be bats and four appeared to be birds. The most common casualty was the little brown bat, while others included the northern long-eared bat, hoary bat, and silver-haired bat. The collisions occurred an hour after dusk, six hours after dusk, and at dawn.

A significant finding of this Echotrack (2005) research was the observation that birds and bats appear to detect wind farms at night and take action to avoid the wind turbines, resulting in a low proportion of collisions relative to the number of individuals flying through the study area (i.e., 0.02% collision rate). The radar studies showed many birds and bats increased their flight height and slowed their flight speed when they approached the wind turbines. As no such behaviour was observed at the control sites, the research suggests that it was the presence of the turbines that led to this behaviour. By increasing altitude and flying well above the turbine blades, most birds and bats avoided the wind turbines and effectively reduced the risk of collision. Despite this, bats are still being killed at wind turbine sites. As Kunz *et al*. (2007) suggests, it is possible that bats are being attracted to the wind turbines or the turbine sites. In a forested area, the modification of the site landscape for the installation of wind turbines, such as the creation of open areas by the removal of trees, may result in favourable conditions for aerial insects. This increased abundance of a primary food source may attract bats to the site while foraging. It is also possible that, as dawn approaches and they seek out roost sites, the tree roosting bats may be mistaking the turbine towers for large trees and either collide with the turbines or succumb to barotrauma if they fly through the low pressure created by the turbine blades. Such effects could potentially occur at forested and non-forested sites.

1.2.3 Site Features Potentially Affecting Bat Activity

Under the authority of the *Fish and Wildlife Conservation Act* (1997), the MNR is responsible for the protection of bat species, which are listed as "specially protected mammals" (MNR 2006). The MNR has recently prepared a Developmental Working Draft titled *Guideline to Assist in the Review of Wind Power Proposals – Potential Impacts to Bats and Bat Habitat* (MNR August 2007) regarding data requirements and survey protocols for bats at proposed wind plant locations.

As discussed in Section 1.2.1, bats appear to have a higher risk of mortality at wind turbines in areas such as the forested Appalachian ridges, but little is known about the factors that may contribute to mortality risk in other landscapes such as the more open and agricultural spaces of southern Ontario or the rolling forested landscape of eastern Ontario. Generally, site features that are expected to be related to increased bat use include significant hibernaculae, significant maternity roosts, and proximity to large, linear, landscape features (e.g., ridges, escarpments, and shorelines). The MNR's Significant Wildlife Habitat Technical Guide (MNR 2000) defines significant hibernaculae and maternity roosts relative to the species and the number of individuals present and relate to resident bats. Large linear landscape features are relevant for migratory bats, which research indicates may be at greater risk of mortality from wind turbines.

1.3 Methods

1.3.1 Background Data Review

1.3.1.1 Bat Status in Ontario

Little is known regarding the pathways and behaviour of migratory bats (GAO 2005; MNR 2007). Bat longevity is relatively high and reproduction rates are relatively low compared (Arnett 2007; GAO 2005; MNR 2006). None of the bat species potentially found in the SSA are designated as species at risk by the Committee on the Status of Wildlife in Canada (COSEWIC) or the Committee on the Status of Species at Risk in Ontario (COSSARO). One species, the small-footed bat, is considered vulnerable to imperilled in Ontario (S2S3) by the Natural Heritage Information Centre ("NHIC"), and two species, northern long-eared bat and tricolored bat, are considered vulnerable (S3?, where the question mark indicates uncertainty as to their rank).

The big brown bat is sedentary and overwinters locally. The eastern small-footed bat, little brown bat, northern long-eared bat and tricolored bat are resident species that migrate, sometimes over many kilometres, to hibernaculae (MNR 2006). Three species, the silver-haired, red and hoary bats migrate longer distances and it is thought that they leave Ontario in the winter (MNR 2006). Autumn migration periods for these species in Canada are generally from mid- to late August through October (van Zyll de Jong 1985), although other studies have found that the peak of migration can start as early as mid-July (Johnson 2005; MNR 2006).

1.3.1.2 Potential Bat Use of the Adelaide Wind Farm

No known significant hibernaculae or roosts in the vicinity of the SSA were identified in correspondence from the MNR (Holly Simpson, pers. comm. 2008). Most species that hibernate in Ontario rely on caves and mines, which are relatively warm and humid, for overwintering (MNR 2006). The big brown bat may also overwinter in buildings or rock crevices (MNR 2006). Other species may use buildings, rock slabs, tree cavities, loose bark, foliage and snags for roosting.

The potential for bat hibernaculae within the SSA was assessed by examining geological mapping to determine if karst caves or fissures in the bedrock are likely to occur. Habitat types and abundance were also reviewed to determine potential locations, if any, of hibernaculae and swarming sites. These were subsequently verified in the field.

1.3.2 Survey Methods

Bat surveys were conducted in the fall of 2008 (late July and September). The purpose of the surveys was to assess the presence, species and observed level of activity of bats throughout the SSA. The timing of the surveys was intended to capture both migratory and resident bat species, based on the migratory periods outlined by van Zyll de Jong (1985) and Ontario Ministry of Natural Resources (2007).

Surveys were conducted between 30 July and 15 September, 2008. The surveys focused on areas of potential bat feeding habitat such as forest edges, clearings, ridges, and wetlands to gauge diversity and activity of bats using the SSA. A total of seven bat stations were established throughout the SSA (Figure 7.3-1).

Four Binary Acoustic Technology (BAT) bat detectors/recorders were initially deployed at heights of approximately 3 m using a ground-based stand, whereas the fifth bat detector/recorder was placed on the meteorological tower at a height of approximately 25 m (Figure 7.3-1). After the initial deployment of the five bat detectors on 30 July 2008, detectors were left in the field, and data downloaded on a seven to fourteen consecutive nights (sunset to sunrise) rotation. The four ground-based bat detectors were rotated between six stations throughout the SSA. The meteorological tower station was left in place for the duration of the study. The redeployment of bat detectors among the six stations continued until 15 September, 2008 when two consecutive nights had elapsed without recording any bat activity at any of the detectors.

To determine whether the number of bat passes recorded within the SSA represented high bat activity, three regional reference sites where bat activity was expected to be high based on habitat, biology and professional judgement. Each site was surveyed for one night each during the study period (August to mid September).

The digital recordings collected by each BAT detector were analyzed and quality assurance and control was conducted by an expert in bat identification using sonograms. The data were summarized by species groups and total number of bat passes.

Using ultra-sonic detection, seven species and two species groups of bats can be distinguished with some confidence (Government of Alberta 2005). The seven identifiable groups and two species groups, each of which are common to eastern Ontario are:

- Big brown bat;
- Silver-haired bat (migratory);
- Big brown bat (non-migratory) / silver-haired bat (migratory);
- Hoary bat (migratory);
- Tricolored bat (migratory);
- Northern long-eared bat;
- Little brown bat;
- Eastern small-footed bat;
- Eastern red bat (migratory); and
- The Myotis genus: small-footed bat, little brown bat, and northern long-eared bat (resident).

The rationale for identifying the above species/groups was to assist in determining the relative abundance of the migratory species. Recorded call frequencies were compared to the known frequency ranges of Ontario bat species and assigned to one of the species groups above.

1.4 Results

1.4.1 Hibernaculae

No known hibernaculae in the SSA were identified in correspondence from the MNR and none were found during field surveys. No natural caves or abandoned mines are known to occur on the SSA, and there is limited potential for caves or fissures given the flat topography and deep soils.

1.4.2 Roosting Habitat

No known roosts within the SSA were identified in correspondence from the MNR and none were identified through field surveys. The primarily agricultural land of the SSA, with small deciduous woodlots, provides limited roosting or hibernating habitat. Additional habitat for resident bats may be present in the barns and machine sheds as well as the attic of an older farmhouse, but these tend to be well lit, which may deter bats from roosting. No rock outcroppings are known to occur within the SSA.

1.4.3 Landscape-Scale Features

The SSA is not located within or adjacent to major linear landscape features that may concentrate migrating bats.

1.4.4 Fall Migration

BAT detectors were deployed during fall migration between 30 July and 15 September, 2008. In total, 117 detector-nights of data were collected, although bats were not necessarily detected every night. A total of 4,989 separate bat passes were recorded during surveys (Table III-1). Across the SSA, and including all detectors, there was an average of 42.6 bat passes per night, per detector. Of the individuals that could be assigned to species groups, the most common species throughout the monitoring period was the big brown bat. Of the seven bat stations established in the SSA, the highest number of bat passes per night (102.8) was recorded at station five (ADEL-5), which was located adjacent to Adelaide Creek. Three regional reference sites in southern Ontario where bat activity was suspected to be high, based on MNR criteria and professional judgment, were surveyed periodically during the study period using Anabat SD1 detectors to compare relative bat activity in the SSA. It is generally accepted that the detection probability will be similar between Anabat SD1 and BAT detectors, since no scientific literature has been published to suggest otherwise. In addition, although analysis of the reference sites was completed by the same person as the data collected within the SSA, greater species classification is possible using BAT detectors, thus resulting in more detailed species differentiation. For all bat species combined, the maximum number of bat passes per night recorded in the SSA (221) was substantially lower than the maximum number of bat passes per night recorded at any of the reference stations (range 1542 – 2160 maximum passes per night), within the migration and swarming period. These qualitative comparisons suggest that bat activity in the SSA is generally low compared to the southwestern Ontario reference sites.

If the survey was only conducted over a short period, MNR requires that monitoring be compelted during favourable weather conditions. Since bat activity was surveyed throughout the migration and swarming period, our analysis does not compare individual survey nights to daily weather or weather trends. However it was noted that average temperatures from the London CS meteorological station, were generally consistent with Environment Canada average temperatures for the period. The general area, using the London CS meteorological data was, recorded to be 11-16% drier than average (Environment Canada 2009).

Table III-1 Bat Groups and Number of Passes Recorded in the SSA

Station	Active Detector Nights	Mean Passes Per Night - All Species	Mean Passes Per Night by Species[1]									
			Hoary bat	Silver-haired bat	Silver-haired/Big brown bat	Big brown bat	Eastern red bat	Little brown bat	Northern long-eared bat	Eastern small-footed bat	Myotis Unknown	Tricolored bat
ADEL-01	14	17.9	0.9	1.9	0.4	9.7	0.3	4.4	0.0	0.0	0.3	0.1
ADEL-02	3	10.7	0.3	0.0	0.0	1.7	5.0	3.0	0.0	0.0	0.7	0.0
ADEL-03	13	91.9	3.6	8.9	1.6	64.9	2.2	10.1	0.2	0.1	0.5	0.0
ADEL-04m	43	4.7	0.7	0.4	0.6	2.3	0.1	0.6	0.0	0.0	0.1	0.0
ADEL-05	9	102.8	0.7	0.7	0.4	30.2	3.6	65.9	0.0	0.3	0.6	0.4
ADEL-06	21	95.3	0.1	2.1	3.7	45.1	1.3	41.1	0.0	1.3	0.7	0.0
ADEL-07	14	27.3	0.1	1.1	1.1	18.9	1.4	3.8	0.0	0.2	0.6	0.0
Total Detector Nights	117											
Total Passes - All Stations Combined	-	4989.0	101.0	220.0	148.0	2569.0	131.0	1737.0	2.0	35.0	41.0	5.0
Mean Passes Per Night - All Stations Combined	-	42.6	0.9	1.9	1.3	22.0	1.1	14.8	0.0	0.3	0.4	0.0

[1] Species interpreted based on acoustic analysis of the recorded bat sonograms

1.5 Discussion

1.5.1 Bat Use of the Study Area

The 2008 surveys suggest that most bat species commonly found in southern Ontario are found within or passing through the SSA. The majority of observations within the SSA were of the big brown bat and myotis group. The presence of big brown bats, especially in August, would most likely represent a resident population, which would be expected to roost and overwinter in the municipality of Strathroy-Caradoc, possibly within buildings. The relatively low number of individual observations, when compared to reference sites, suggest that the SSA does not experience high levels of bat activity during the fall. Deciduous swamps, as well as streams, which provide foraging habitat, are located within the SSA, but these waterbodies are unlikely to function as migratory corridors given their small size.

Recently released published and unpublished information as cited in Section 1.2.1, as well as the results of this study, reveal that the sampling design was adequate to collect information on bat activity at the SSA during the migration period. Based on the timing of mortality at eastern US wind farms, it is possible that some species' peak migration in Ontario may occur in August or even the latter part of July. Surveys during the end of July, through to the third week of September should have captured all migratory events. Additionally, although the methods did not sample through the entire height of blade sweep, some 35-125 m above the ground, one bat detector was elevated an average of 25 m above the ground and captured bat echolocation up to an estimated height of 30-45 m, depending on species and weather conditions.

1.5.2 Potential Effects on Bats

Although little is known about bat populations and distribution, particularly through the migration period, studies at existing wind turbine facilities show that mortality is relatively low in the absence of specific conditions (e.g., forested ridges). In some regions, where forested ridges are present, bat mortality may be higher. For example, at the Mountaineer Wind Energy Center in West Virginia, USA, an estimated 1,400-4,000 bats were killed in 2003 (Kerns and Kerlinger 2004). In southwestern Alberta, 532 bat fatalities were reported at the Summerview facility in 2005 and 2006 (Brown and Hamilton 2006).

Turbines in the SSA will generally be sited away from the buildings to address noise requirements, and away from watercourses, thereby reducing the potential for bat-turbine interaction. Studies conducted on wind plants in the United States suggest that the big brown bat would be at low risk for collisions (Johnson 2005). Although there is little information in existing literature as to the behaviour of bats during migration, it appears that, in general, many bats do not travel through the height of the blade sweep (EchoTrack 2005).

Few bat fatalities occur in the spring and summer, suggesting that resident bats are unlikely to collide with wind turbines during regular foraging (MNR 2006). These same studies suggest that eastern red bats, hoary bats and silver-haired bats would be at higher risk during their fall migration (Johnson 2005; MNR 2006), perhaps because the migratory individuals are not familiar with the local conditions or because their migratory flight behaviour can put them at risk of collision with wind turbine blades or barotrauma. The SSA, however, is not located along a major linear landscape feature (the topography is similar to that found throughout most of southern Ontario) and relatively few silver-haired, hoary and eastern red bats were recorded in the SSA. It is, therefore, not unexpected that the number of migrating individual bats detected during the fall migration was low.

1.6 Conclusion

Given the lack of any known or found hibernaculae, coupled with the relatively small number of bats observed during monitoring, bat activity in the SSA is considered to be low. Limited suitable roosting and foraging habitat is present, so bats would not be expected to concentrate in the SSA. Based upon data collected during the field surveys and the information presented in background sources, it is unlikely that bats are present in large numbers within the SSA or adjacent areas and, therefore, the Project is not expected to have significant negative effects on bat habitat or populations.

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2.0 TECHNICAL APPENDIX – BIRDS

2.1 Introduction

Golder undertook avian use surveys (AUS) to assess the distribution, abundance, and flight behaviour of the avifauna in the SSA. The surveys were conducted to establish the environmental baseline conditions for the SSA. Specifically, the avian field program was designed to collect data on the birds that use or fly through the SSA throughout the seasons.

Studies to establish baseline conditions in the SSA included spring migration, breeding, fall migration, and winter use surveys for birds. These studies were implemented in January 2008, with the understanding that the results would later be used in an environmental assessment of the proposed Project within the Project boundaries at the time the study was initiated. As a result, a protocol for collecting these data was developed to meet the expectations of Environment Canada (EC) and MNR, based on previous discussions with these agencies and a review of draft guidelines (e.g., Kingsley and Whittam 2007; MNR 2007).

2.2 Background

Observed effects of wind energy projects on birds are either direct, as in the case of mortality arising from collisions with wind turbines, or indirect, as in the case of habitat loss for infrastructure or disturbance of habitat through changes in existing activity levels or sensory disturbance. In fact, indirect effects in some situations may be more substantive than direct mortality. In general, public perception tends to considerably inflate the actual avian mortality attributable to wind energy projects (EC 2005). The actual avian mortality depends on a number of site-specific factors, including bird densities and the types of species and habitats present, as well as the wind farm design features that may either individually, or in combination with each other, influence avian mortality rates. Some of these factors include:

- Topography;
- Scale of the facility;
- Tower dimension and design;
- Turbine lighting;
- Blade speed;
- Habitat type;
- Transmission line design and location; and
- Facility configuration.

A large number of studies have been undertaken to investigate concerns related to avian mortality resulting from wind farms (e.g., Osborn *et al.* 2000; Johnson *et al.* 2003; Barrios and Rodríguez 2004; Echotrack 2005; Drewitt and Langston 2006). The findings indicate that overall, bird deaths due to wind turbines are low, especially when compared to other anthropogenic structures. In one particular study of avian mortality (Erickson *et al*. 2005), an extensive literature review was conducted and a comparison of annual avian mortality in the U.S. was presented (Table III-2). This same study indicated that the annual average number of birds killed in the USA is estimated at 2.19 birds per turbine per year.

Table III-2 Predicted Annual Avian Mortality Rates, USA

Anthropogenic Structure	Bird Deaths/Year
Vehicles	80 million
Buildings and Windows	550 million
Cats	100 million
Power Lines	130 million
Communication Towers	4.5 million
Wind Power Parks	28,500

Source: Erickson *et al*. 2005

An Ontario study of the Canadian National Exhibition turbine in Toronto determined that total annual mortality was unlikely to exceed three birds, corrected for predator removal (James and Coady 2003). This study concluded that local birds appeared to have adapted to the presence of the turbine and avoided it, and that the mortality rate at the turbine was “absolutely insignificant” when compared to mortality from other causes.

A research study by EchoTrack (2005) used radar technology to study nighttime bird and bat activity during the autumn of 2004 at six wind power parks and six control sites in Alberta. Results of this study indicated that 0.02% of total flights recorded ended in assumed collisions with the turbines; 8% of these were birds, while 92% were bat collisions. The radar studies showed many birds and bats appear to detect wind farms at night and take evasive action to avoid the wind turbines; many birds increased their flight height and slowed their flight speed when they approached the wind turbines. Since no such behaviour was observed at the control sites, the research suggests that it was the presence of the turbines that led to this behaviour. By increasing altitude and flying above the turbine blades, birds apparently avoided the wind turbines and effectively reduced the risk of collision.

Although avian mortality due to wind turbines is reported to be low in comparison to other anthropogenic structures, when selecting and assessing a turbine site(s) during the environmental screening process, it is important to identify bird breeding, staging, and foraging areas, as well as migration routes, to minimize any potentially adverse environmental effects. This technical report documents the avian community characteristics and the habitat conditions of the SSA to assess and mitigate where required, any potentially adverse environmental effects of the proposed Project. We consider the field program to be appropriate for examining the dynamics of seasonal bird movements and habitat use for the SSA. The surveys represent snapshots in the area, providing a representative cross-section of the diversity, abundance and behaviour of birds migrating through and/or using the SSA.

2.3 Methods

2.3.1 Literature Review

A variety of documents and information sources were reviewed to develop the monitoring protocol, determine important bird-related issues, and to identify site-specific records of natural features, habitats, or species occurrences that were relevant to the proposed Project. Guidance regarding monitoring protocols and report contents was obtained from the following:

- Wind Turbines and Birds: A Guidance Document for Environmental Assessment. Final Report (EC, April 2007);
- Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds. Prepared by the Canadian Wildlife Service. Final Report, February 2007; and
- Kingsley, A. and B. Whittam. (2007). Wind Turbines and Birds: A Background Review for Environmental Assessment. Prepared for the Canadian Wildlife Service. Draft April 2, 2007.

The EC (2007) report contains an up-to-date, comprehensive literature review of studies involving avian mortality and wind turbines and provides an outline for conducting bird-related surveys for wind turbine projects. Although this remains a draft document, EC is using it to assess project proposals.

Technical information regarding residential and migrant birds, national, provincial, and regional bird status, and site-specific features and species occurrences were collected from the following sources:

- Natural Heritage Information Centre database (www.mnr.gov.on.ca/MNR/nhic/nhic.cfm), accessed April 1, 2007); and
- Ontario Breeding Bird Atlas (www.birdsontario.org/atlas/atlasmain.html).

2.3.2 Avian Use Surveys

Avian use surveys were conducted throughout 2008 (Table III-3). Surveys included roadside counts as well as covering the entire SSA on foot, inspecting all natural habitats, and recording presence of each species detected visually and/or by call or sound. Surveys began at, or within half an hour of sunrise and were generally completed by late morning. During spring and fall migration, a second round of surveys was conducted in the afternoon to record migrating raptors. Surveys were only conducted when weather conditions (i.e., precipitation and wind) were within the parameters required by monitoring programs such as the Breeding Bird Survey (Droege 1990) or the Ontario Forest Bird Monitoring Program (Welsh 1995). Although wind conditions were always suitable during the early mornings, wind speeds typically increased through the morning and exceeded recommended guidelines on approximately 10% of the visits for the last 1 -1.5 hours of the survey. Winds in the afternoon, often exceeded recommended guidelines, but these surveys focussed on raptors. As a result of increased wind speeds, the ability to detect birds by calls or sounds was diminished. Given the location of the SSA and nature of the proposed undertaking, this was not surprising. To accommodate these conditions, the order of sampling plots was changed with each successive visit so that plot visits were temporally distributed throughout the morning.

As shown in Figure 5, a total of fifteen (15) AUS plots were established to provide adequate coverage throughout the SSA. AUS counts were ten minutes in duration and all species heard or observed within an unlimited radius were recorded. Information recorded for each observation included the number of birds in the flock (if the observation was of a flock), species (or at least bird group, e.g., sparrow), behaviour (either perched, soaring, or in flight, or flying with a specific direction), relative flight height and flight direction, and distance to individuals or flocks.

Point counts are not suitable for detecting some bird groups such as waterfowl (the method works best for passerines). Therefore, an area-search was conducted to document the occurrence of species that are typically not detected during point count surveys. Approximately, one hour of area-searching was conducted for every three square kilometres of the SSA.

Table III-3 Survey Dates for Avian Surveys

Season	Date
Spring	21 April 2008
	22 April 2008
	05 May 2008
Summer	06 Jun 2008
	30 June 2008
Fall	31 August 2008
	15 September 2008
Winter	25 January 2008
	21 February 2008

Table III-4 Bird Groups Detected in the SSA

Bird Group	Fall			Spring			Summer			Winter			Overall		
	Individuals	Mean use	Percent Composition	Individuals	Mean Use	Percent Composition	Individuals	Mean Use	Percent Composition	Individuals	Mean Use	Percent Composition	Individuals	Mean Use	Percent Composition
Grouse	nd	nd	nd	1	0.05	0.18	nd	nd	nd	nd	nd	nd	1	0.04	0.02
Passerines	1612	45.87	78.52	473	21.50	87.75	891	28.00	96.22	657	32.85	98.50	3647	131.22	86.81
Raptors	18	0.60	0.88	22	1.00	3.96	5	0.17	0.54	8	0.40	1.20	53	2.08	1.26
Shorebirds	5	0.17	0.24	25	1.14	4.50	18	0.60	1.94	nd	nd	nd	48	1.88	1.14
Waterbirds	15	0.50	0.73	4	0.18	0.72	9	0.30	0.97	nd	nd	nd	28	1.10	0.67
Waterfowl	397	13.23	19.34	10	0.45	1.80	nd	nd		nd	nd	nd	407	15.96	9.69
Woodpeckers	6	0.20	0.29	6	0.27	1.08	3	0.10	0.32	2	0.10	0.30	17	0.67	0.40
Total	**2053**	**68.43**		**555**	**25.23**		**926**	**30.87**		**667**	**33.35**		**4201**	**164.75**	

nd = no data

2.3.3 Species At Risk

Species of conservation concern are defined as native species listed under the federal *Species at Risk Act* or provincial *Endangered Species Act* or with a provincial ranking (S-rank) below S4. Review of the NHIC, OBBA, and other databases and correspondence with the MNR (Holly Simpson, pers. comm. 2008) was conducted to evaluate the occurrence of species at risk within the SSA.

2.4 Results

2.4.1 Study Area

An Ecological Land Classification (ELC) mapping exercise was conducted to confirm and assess the character of existing habitat conditions. Vegetation communities were delineated on aerial photographs and checked in the field; community characterizations (i.e., ecosites and ecotypes) were then based on the ELC system (Lee *et al*. 1998).

Ninety percent of the 8,299 ha SSA is agricultural lands, with the remainder comprised of wetlands and watercourses (1%), roads (1%), and deciduous forests (8%). Most of the land had been cleared and wetlands drained during the early twentieth century for timber and agriculture. Very little of this land has since regenerated through natural second growth forest succession because of the intense agricultural practices.

2.4.2 Species Present

A total of 4,201 individuals of 77 bird species were recorded within the SSA. A complete list is provided in Appendix B.1 with season-specific results presented in the following subsections. The species identified were ranked S5 (i.e., very common and demonstrably secure in Ontario), or S4 (i.e., common and apparently secure). The majority of species observed during field surveys were associated with open or agricultural habitat and forest edges.

Urban and agricultural birds common in Ontario, such as the rock pigeon (*Columba livia*), house sparrow (*Passer domesticus*), and European starling (*Sturnus vulgaris*) which are ranked SE (i.e., exotic and not a native component of Ontario’s fauna) were frequently recorded within the SSA; a result that was expected in predominately agricultural landscapes. Similarly, waterfowl, and in particular Canada geese (*Branta canadensis*) during the fall, were common in the agricultural fields of the SSA, representing approximately 9% of all individuals detected. In contrast, raptors and waterbirds were a minor component of the avifauna within the SSA, each representing <1.5% of the individuals recorded. For example, only two raptor species and a single waterbird species were observed during the 2008 study period in the SSA. The red-tailed hawk (*Buteo jamaicensis*), the most common buteo in Ontario, was observed soaring over the agricultural fields of the SSA during field surveys on less than ten occasions.

2.4.2.1 Spring Migration Surveys

A total of 555 individuals of 42 species were recorded on three separate dates during spring migration surveys in late April and early May, 2008 (Appendix B-1). The most common species observed in the SSA during spring migration were red-winged blackbird (*Agelaius phoeniceus*), horned lark (*Eremophila alpestris)*, and common grackle (*Quisculus quiscula*). Due to potential differences in risk of collision with turbines of different bird groups (Kingsley and Whittam 2005), data are summarized according to seven bird groups: gamebirds (including turkeys, partridges and grouse); waterfowl (including ducks, geese and swans); waterbirds (including herons, rails, and cormorants); shorebirds (including gulls, plovers and sandpipers); raptors (including hawks, falcons and eagles, and for the purposes of this summary, vultures); songbirds (including passerines and near passerine landbirds); and woodpeckers. Of these groups, songbirds and shorebirds comprised 87.8% and 4.5% of all individuals, respectively (Table III-4).

Table III-5 summarizes the mean observed flying height of the bird groups (excluding non-flying and perched individuals) recorded during the spring migration surveys. Birds observed within 40 m of the ground were considered to be below the sweep of the rotor blades, those flying from 40 to 120 m were considered to be within the sweep of the rotor blades, and those birds observed flying above 120 m were described as being above the rotor sweep.

Most bird groups flew at an average height of less than 40 m during spring migration surveys. Two bird groups, raptors and waterbirds, flew at an average height that was within the sweep of the rotor blades during the spring. However, the sample size for waterbirds was small, representing two individuals and <1% of all birds observed in flight during the spring migration surveys (Table III-6).

Table III-5 Mean Height of Bird Groups Observed During Avian Use Surveys

Bird Group	**Mean Flight Height (m)**				
	Spring	**Summer**	**Fall**	**Winter**	**Four Seasons Combined**
Grouse	nd	nd	nd	nd	nd
Songbirds	21.78	14.25	18.02	25.19	18.52
Raptors	66.56	27.56	23.15	15.00	46.20
Shorebirds	26.73	13.10	22.22	nd	21.28
Waterbirds	94.17	42.00	36.90	nd	52.81
Waterfowl	19.50	nd	87.71	nd	70.66
Woodpeckers	20.00	13.33	nd	15.00	15.83
All Bird Groups	**41.46**	**22.05**	**37.60**	**18.40**	**37.55**

Table III-6 Number and Percent of All Flying Individuals Observed During Avian Use Surveys

Bird Group	Spring						Summer				Fall						Winter			
	Under 40 m		40-120 m		Over 120 m		Under 40 m		40-120 m		Under 40 m		40-120 m		Over 120 m		Under 40 m		Within 40-120 m	
	Number of Individuals	Percent	Number of Individuals	Percent	Number of Individuals	Percent	Number of Individuals	Percent	Number of Individuals	Percent	Number of Individuals	Percent	Number of Individuals	Percent	Number of Individuals	Percent	Number of Individuals	Percent	Number of Individuals	Percent
Songbirds	197	61.37	4	1.25	64	19.94	511	86.61	5	0.92	1078	64.71	202	12.12		0.00	228	93.83	11	4.53
Raptors	7	2.18	14	4.36	1	0.31	4	0.73	1	0.18	10	0.60	7	0.42		0.00	2	0.82		0.00
Shorebirds	16	4.98	1	0.31		0.00	14	2.57		0.00	4	0.24		0.00		0.00		0.00		0.00
Waterbirds	1	0.31	2	0.62	1	0.31	1	0.18	8	1.47	10	0.60	5	0.30		0.00		0.00		0.00
Waterfowl	8	2.49	1	0.31		0.00		0.00		0.00	25	1.50	240	14.41	85	5.10		0.00		0.00
Woodpeckers	4	1.25		0.00		0.00	1	0.18		0.00		0.00		0.00		0.00	2	0.82		0.00
Total	**233**	**72.59**	**22**	**6.85**	**66**	**20.56**	**531**	**97.43**	**14**	**2.57**	**1127**	**67.65**	**454**	**27.25**	**85**	**5.10**	**232**	**95.47**	**11**	**4.53**

2.4.2.2 Breeding Bird Surveys

A total of 926 individuals of 38 species were recorded during the breeding bird surveys (Appendix B-1). The most common species recorded in the SSA during the breeding season were European starling (*Sturnus vulgaris)*, red-winged blackbird, and house sparrow (*Passer domesticus*). Of the bird groups previously identified, songbirds comprised 96.2% of all individuals (Table III-4). Overall, the species recorded during these surveys are typical of southern Ontario agricultural landscapes. The SSA supports a good representation of species found in the LSA.

Table III-5 summarizes the overall mean observed (excluding non-flying/perched individuals) flying height of the bird groups during the breeding bird surveys. Waterbirds were the only bird group that flew within the sweep of the rotor blades during the breeding season, representing eight individuals and <2% of all flying individuals (Table III-6).

2.4.2.3 Fall Migration Surveys

A total of 2053 individuals of 44 species were recorded on three separate dates during fall migration surveys between late August and October, 2007 (Appendix B-1). The most common species in the SSA during fall surveys were European starling, Canada goose (*Branta canadensis*) and mourning dove (*Zenaida macroura)*. Of the bird taxa groups previously described, songbirds and waterfowl comprised 78.5% and 19.3% of all individuals, respectively (Table III-4).

Table III-5 summarizes the overall mean observed flying height of the bird groups recorded during the fall migration surveys. Waterfowl were the only bird group that flew within the sweep of the rotor blades during the fall season, representing 240 individuals and 14.4% of all flying individuals (Table III-6).

2.4.2.4 Winter Surveys

A total of 667 individuals of 12 species were recorded during the winter surveys in January and February, 2008 (Appendix B-1). The most common species within the SSA during winter surveys were American crow (*Corvus brachyrhynchos)*, European starling and horned lark. Of the bird taxa groups previously described, songbirds comprised 98.5% of all individuals (Table III-4).

Table III-5 summarizes the overall mean observed flying height of the bird groups recorded during winter surveys. The mean flight height of all bird groups observed was < 40 m during winter surveys.

2.4.3 Species at Risk

No species at risk were observed during the 2007/2008 bird monitoring program. Review of the NHIC indicated that there were historic records (1995) of loggerhead shrike (*Lanius ludovicianus*; listed as Endangered provincially and federally) within the SSA. There have been no observations of this species in the SSA or LSA since 1995. According to the OBBA (2008), there was also a single record of a red-headed woodpecker (*Melanerpes erythrocephalus;* listed as special concern provincially and federally*)* within the SSA.

2.4.4 Summary

The SSA supports a diverse community of birds that are typical of agricultural habitat types. The SSA also supports a small bird community that prefers mature deciduous forests and forest edge habitats. The low relative abundance of migratory species within the SSA, particularly during spring and fall seasons, suggests that the SSA does not function as a migratory corridor. All bird species noted during the surveys are relatively common in Ontario and are not dissimilar from bird inventories reported elsewhere in similar habitat types in southern Ontario.

2.5 Discussion

2.5.1 Direct Effects

The main direct effect of the proposed Project on birds is mortality due to collision with the wind turbines. Background information reviewed and field studies undertaken have demonstrated that the SSA does not lie within a prominent migration corridor, nor would it be characterized as a significant breeding or wintering area for birds. These factors lead to the conclusion that the potential for direct avian mortality during operation of the Project is limited.

2.5.2 Indirect Effects

The indirect effects arising from the loss, fragmentation, or disturbance of habitat during the construction, operation, and maintenance of the wind energy facility have a larger potential to negatively affect birds than the direct mortality discussed above. An effective tool in minimizing potential indirect effects, especially to wetlands and woodlands, is to avoid, wherever possible, construction of turbines and ancillary facilities in or across any remaining natural habitats.

Sensory disturbance (visual and auditory), as a result of site preparation and construction activities may result in, under exceptional circumstances, habitat alienation, displacement, or nest desertion. Studies in the Netherlands suggest that, landbird, and in particular woodland songbird population densities begin to decline at an average noise level of 42 dB (Reijnen *et al.* 1996). Forman and Hersperger (1996) further suggest that noise associated with traffic can affect bird populations by disrupting vocal communication required for mate selection, mate location, foraging communication, predator detection and avoidance and parent-nestling communication.

Species that are thought to be the most sensitive to disturbance, as a result of fragmentation, include area-sensitive species (e.g., brown creeper (*Certhia americana*), red-breasted nuthatch (*Sitta canadensis*), and bay-breasted warbler (*Dendroica castanea*)), but none of these species were recorded within the SSA. Installation of wind turbines in existing agricultural lands is expected to have a limited effect on bird habitat, as no natural vegetation (trees and understory) is expected to be removed in the SSA.

2.6 Conclusions and Recommendations

The Project meets the general and specific siting guidelines for onshore facilities suggested by Bird Studies Canada (BSC 2003). BSC (2003, p. ii) note that "the greatest adverse effect that wind energy facilities have on birds is disturbance to breeding and wintering birds (except in areas where poor habitat quality exists, such as agricultural and industrial areas)" and that "in areas where sufficient information…indicates or predicts a low risk to birds (generally urbanized areas and intensive agricultural sites where there are no other features present that would increase collision risk or disturbance), the project can proceed with little or no pre-construction monitoring" (p. iii).

The SSA was judged to not provide high quality bird habitat. Field surveys, which found relatively low abundances of most bird species, support this conclusion. In fact, all species found within the SSA are common throughout much of southern Ontario.

This document is intended to provide baseline information for an environmental assessment and any post-construction monitoring that may be undertaken by AET. As appropriate, it is recommended that a plan for post-construction monitoring be prepared, using suggestions from BSC (2003) for guidance.

2.7 References

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Appendix B-1. Number of individuals (Num.) and percent composition (%) by season for birds observed during field surveys in the SSA.

Species Common Name	Fall		Spring		Summer		Winter		Four Season Total	
	Num.	%	Num.	%	Num.	%	Num	%	Num	%
American crow	27	1.32	21	3.78	29	3.13	469	70.31	546	13.00
American goldfinch	44	2.14	7	1.26	23	2.48			74	1.76
American kestrel	1	0.05							1	0.02
American pipit			33	5.95					33	0.79
American redstart	1	0.05							1	0.02
American robin	7	0.34	18	3.24	30	3.24			55	1.31
Baltimore oriole					1	0.11			1	0.02
barn swallow	11	0.54	4	0.72	6	0.65			21	0.50
blackbirds	160	7.79							160	3.81
black-capped chickadee	1	0.05	3	0.54			2	0.30	6	0.14
blue jay	6	0.29	8	1.44	8	0.86			22	0.52
bobolink			34	6.13	6	0.65			40	0.95
brown thrasher			2	0.36					2	0.05
brown-headed cowbird	32	1.56	23	4.14	16	1.73			71	1.69
Canada goose	388	18.90	4	0.72					392	9.33
cedar waxwing	1	0.05							1	0.02
chipping sparrow	13	0.63	6	1.08	16	1.73			35	0.83
common grackle	60	2.92	38	6.85	55	5.94			153	3.64
common loon			1	0.18					1	0.02
common raven							2	0.30	2	0.05
downy woodpecker	1	0.05					1	0.15	2	0.05
duck species	4	0.19							4	0.10
eastern meadowlark	2	0.10	1	0.18	6	0.65			9	0.21
eastern wood-pewee					2	0.22			2	0.05
European starling	712	34.68	19	3.42	269	29.05	111	16.64	1111	26.45
field sparrow	3	0.15							3	0.07
gray catbird	1	0.05			2	0.22			3	0.07
great blue heron	2	0.10	2	0.36	1	0.11			5	0.12
great crested flycatcher			1	0.18	2	0.22			3	0.07
greater yellowlegs	2	0.10							2	0.05
gull species	1	0.05							1	0.02
hairy woodpecker							1	0.15	1	0.02

Appendix B-1. Number of individuals (Num.) and percent composition (%) by season for birds observed during field surveys in the SSA.

Species Common Name	Fall		Spring		Summer		Winter		Four Season Total	
	Num.	%	Num.	%	Num.	%	Num	%	Num	%
horned lark	32	1.56	64	11.53	43	4.64	59	8.85	198	4.71
house finch	2	0.10	1	0.18					3	0.07
house sparrow	50	2.44	39	7.03	82	8.86	4	0.60	175	4.16
house wren			2	0.36	5	0.54			7	0.17
indigo bunting					2	0.22			2	0.05
killdeer	3	0.15	25	4.50	18	1.94			46	1.09
magnolia warbler	2	0.10							2	0.05
mallard	5	0.24	6	1.08					11	0.26
mourning dove	214	10.42	2	0.36	24	2.59			240	5.71
northern cardinal	6	0.29	4	0.72	2	0.22			12	0.29
northern flicker	4	0.19	4	0.72	1	0.11			9	0.21
northern harrier	1	0.05			1	0.11			2	0.05
pileated woodpecker	1	0.05							1	0.02
red-bellied Woodpecker			1	0.18	2	0.22			3	0.07
red-eyed Vireo					7	0.76			7	0.17
red-tailed Hawk	2	0.10	1	0.18			7	1.05	10	0.24
red-winged Blackbird	170	8.28	78	14.05	141	15.23	1	0.15	390	9.28
ring-billed Gull	12	0.58	1	0.18	8	0.86			21	0.50
rock pigeon	22	1.07	12	2.16	27	2.92			61	1.45
rose-breasted grosbeak	1	0.05	3	0.54	5	0.54			9	0.21
rough-legged hawk							1	0.15	1	0.02
savannah sparrow	14	0.68	36	6.49	43	4.64			93	2.21
sharp-shinned hawk	2	0.10							2	0.05
snow bunting							9	1.35	9	0.21
song sparrow	16	0.78	18	3.24	22	2.38			56	1.33
tree swallow			7	1.26	8	0.86			15	0.36
turkey vulture	12	0.58	21	3.78	4	0.43			37	0.88
vesper sparrow	2	0.10			2	0.22			4	0.10
white-crowned sparrow			2	0.36					2	0.05
wild turkey			1	0.18					1	0.02
wood thrush			1	0.18	4	0.43			5	0.12

Appendix B-1. Number of individuals (Num.) and percent composition (%) by season for birds observed during field surveys in the SSA.

Species Common Name	Fall		Spring		Summer		Winter		Four Season Total	
	Num.	%	Num.	%	Num.	%	Num	%	Num	%
yellow warbler					3	0.32			3	0.07
yellow-bellied sapsucker			1	0.18					1	0.02
Total	**2053**		**555**		**926**		**667**		**4201**	

APPENDIX C

NOISE IMPACT ASSESSMENT

Golder Associates

FINAL
REPORT ON

NOISE IMPACT ASSESSMENT
ADELAIDE WIND FARM
TOWNSHIP OF ADELAIDE METCALFE, ONTARIO

Submitted to:

Air Energy TCI Inc
381 Rue Notre-Dame (Ouest)
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H2Y 1V2

June 2009

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1.0 INTRODUCTION

This Noise Impact Assessment has been prepared by Golder Associates Ltd. (Golder) in support of the Environmental Screening Report/Environmental Impact Statement (ESR/EIS) for the Adelaide Wind Farm Project.

Air Energy TCI Inc (AET) proposes to develop (construct, operate and eventually decommission) a 72 megawatt (MW) wind power generating facility. Wind developments greater than 2 MW are classified as Category B projects under the Electricity Project Regulation (Ontario Regulation 116/01). Accordingly, the proposed project is subject to Ontario's *Environmental Assessment Act*, requiring the completion of an Environmental Screening Report (ESR). AET has also registered the Adelaide Wind Farm Project under the federal ecoENERGY for Renewable Power Program on March 11, 2008 (Registration Number 5911-A17-1). Once a Contribution Agreement has been signed with Natural Resources Canada (NRCan), the Project will have officially received federal funding, and the Project will trigger the need for an Environmental Impact Statement (EIS) under the *Canadian Environmental Assessment Act* (CEAA) (NRCan, 2008). Although the CEAA was not officially triggered prior to the completion of this report, it is foreseeable that this trigger may occur in the future and AET has made the decision to also draft this document to meet the requirements of CEAA.

Golder was retained by AET to carry out a Noise Impact Assessment (NIA) of the proposed wind farm located in the Township of Adelaide-Metcalfe, Ontario. The purpose of this study was to determine the noise impact of the stationary noise sources at the proposed wind farm on the most sensitive points of reception.

The Project consists of 40 x Vestas V90 - 1.8 MW wind turbines with a total rated capacity of 72 MW. The turbines will each have a nameplate capacity of 1.8 MW. This represents the maximum generating capacity in Megawatts (MW) of each wind turbine. However, it is recognized that wind levels are not constant, and therefore a "capacity factor" is used to forecast how much energy will actually be produced by the combined installed capacity of all of the wind turbines. Based on experience in Ontario, in the period between March 2006 and December 2008, the average capacity for wind power Projects located in the province was 27% (IESO, 2008). Wind measurements on site have indicated an estimated capacity factor of 32%, which equates to 201 Gigawatt hours (GWh), or enough to supply over 18,000 average homes (Ontario Ministry of Energy and Infrastructure, 2008).

A site location plan is provided in Figure 1. A site layout plan showing the source locations is provided in Figures 2a through 2c. A zoning map is provided in Appendix A.

2.0 SITE OPERATIONS

The wind farm will consist of forty (40), Vestas V90 1.8 MW WTGs that will be in full operation year-round, 24-hours per day. These noise sources will be situated within the property boundary as shown in Figures 2a through 2c. Table 1 summarizes the wind turbine locations. The WTGs will each have a nameplate capacity of 1.8 MW. The manufacturer's specifications are outlined below in Table 2.

From the base of each turbine, power is transferred through 34.5 kV underground cables to either an adjacent wind turbine (wired in series) or to a junction box connected to several other turbines. The power is then transferred either directly to the Project substation or via a 34.5 kV overhead cable before connecting to the Project substation. The 34.5 kV overhead collection system will be designed to use standard utility equipment and cables. Connection between the individual turbines and the substation will be achieved through a combination underground and overhead transmission lines across the site. Overhead transmission will occur through stringing and installation of new overhead lines or upgrading of existing lines. A Part 1 System Impact Assessment has been completed and AET is currently in discussions with IESO to finalize the system connection arrangements. After power is "stepped up" to 115 kV at the substation, power will be fed into the existing 115kV transmission spur (Circuit W2S), which runs parallel to the east shoulder of Kerwood Drive, where it will normally feed the Buchanan 11kkV Bus.

The substation components include: an isolation switch, circuit breaker, step-up power transformer, distribution switch-gear, instrument transformers, grounding, revenue metering, reactive power compensation, and a substation control and operations building. The substation design may allow for future expansion of the Project. Substation grounding will follow Canadian Electrical Code (CEC) standards. The substation will be fenced and secured based on standard utility practices and will include an oil containment system to prevent soil contamination in the event of a leak. Table 3 summarizes the transformer location.

Table 1: Wind Turbine Locations

Project Name: Air Energy TCI Inc, Adelaide Wind Power Project					
Type of Coordinates: UTM 17 NAD 83					
Equipment Make & Model: Vestas V90-1.8, 95m hub height					
Identifier	Location Coordinates		Identifier	Location Coordinates	
	X	Y		X	Y
WTG-1	441693	4762865	WTG-21	440587	4759274
WTG-2	441963	4763325	WTG-22	440261	4759935
WTG-3	442240	4762859	WTG-23	440365	4758006

Table 1: Wind Turbine Locations (continued)

Project Name: Air Energy TCI Inc, Adelaide Wind Power Project					
Type of Coordinates: UTM 17 NAD 83					
Equipment Make & Model: Vestas V90-1.8, 95m hub height					
Identifier	Location Coordinates		Identifier	Location Coordinates	
	X	Y		X	Y
WTG-4	442610	4762657	WTG-24	440616	4759846
WTG-5	444245	4762845	WTG-25	440629	4757751
WTG-6	445115	4762836	WTG-26	440941	4757571
WTG-7	445631	4763125	WTG-27	441625	4759702
WTG-8	445546	4762665	WTG-28	441641	4757570
WTG-9	445939	4762693	WTG-29	441992	4759773
WTG-10	446360	4762314	WTG-30	442062	4757616
WTG-11	446370	4762735	WTG-31	442430	4759661
WTG-12	437710	4759955	WTG-32	444335	4758300
WTG-13	438055	4759832	WTG-33	444699	4758283
WTG-14	438237	4758255	WTG-34	445175	4759905
WTG-15	438165	4759414	WTG-35	445215	4759484
WTG-16	438465	4759952	WTG-36	445687	4759898
WTG-17	438593	4758143	WTG-37	446031	4759766
WTG-18	438837	4759917	WTG-38	445411	4763431
WTG-19	439187	4759817	WTG-39	438101	4757738
WTG-20	439847	4759939	WTG-40	444717	4759896

Table 2: Vestas V90-1.8Turbine Technical Specifications

Component	Specification
Rated capacity	1.8 MW
Cut-in wind speed	3.5 m/s
Cut-out wind speed	25 m/s
Rated wind speed	12 m/s
Number of blades	3
Rotor Diameter	90 m
Swept area	6362 m^2
Rotor speed (variable)	9.0 – 14.5 rpm

Table 2: Vestas V90-1.8Turbine Technical Specifications (continued)

Component	Specification
Rotor speed regulation	Pitch regulated
Tower (hub) height	95 m
Gearbox	1 planetary stage / 2 helical stages
Generator	3-phase asynchronous generator
Converter	Double conversion online
Braking system (fail-safe)	Mechanical disc brake
Yaw system	Plain bearing system with built in friction
Control system	VMP 5000 multiprocessor control system comprised of 4 main processors
Noise reduction	VMP 5000 multiprocessor control system (noise emission control)
Lightning protection system	Lightning receptors, down conducting system and earthing System consistent with International Electrochemical Commission (IEC) Design Codes.
Tower design	Tapered tubular steel

Source: Vestas, 2008

Table 3: Substation Transformer Locations

Identifier	Location Coordinates	
	X	Y
Transformer	439534	4759743

3.0 DESCRIPTION OF TECHNICAL TERMS

To help understand the analysis and recommendations made in this report, the following is a brief discussion of technical noise terms.

Sound pressure level is expressed on a logarithmic scale in units of decibels (dB). Since the scale is logarithmic, a sound that is twice the sound pressure level as another will be three decibels (3 dB) higher.

The noise data and analysis in this report have been given in terms of frequency distribution. The levels are grouped into octave bands. Typically, the centre frequencies for each octave band are 31.5, 63, 125, 250, 500, 1000, 2000, 4000 and 8000 Hertz (Hz.). The human ear responds to the pressure variations in the atmosphere that reach the ear drum. These pressure variations are composed of different frequencies that give each sound we hear its unique character.

It is common practice to sum sound levels over the entire audible spectrum (i.e., 20 Hz to 20 kHz) to give an overall sound level. However, to approximate the hearing response of humans, each octave band measured has a weighting applied to it. The resulting “A-weighted” sound level is often used as a criterion to indicate a maximum allowable sound level. In general, low frequencies are weighted higher, as human hearing is less sensitive to low frequency sound.

Environmental noise levels vary over time, and are described using an overall sound level known as the L_{eq}, or energy averaged sound level. The L_{eq} is the equivalent continuous sound level, which in a stated time, and at a stated location, has the same energy as the time varying noise level. It is common practice to measure L_{eq} sound levels in order to obtain a representative average sound level. The L_{90} is defined as the sound level exceeded for 90% of the time and is used as an indicator of the “ambient” noise level.

4.0 CRITERIA AND GUIDELINES

The proposed wind farm site location can be best defined as Class 3 rural, as per MOE Publications NPC-232 and NPC-233 (MOE 1995a and 1995b). The performance limits for Class 3 areas are listed in MOE publication NPC-232 (MOE 1995a). The noise level limits are also provided in reference to wind induced background sound level in MOE publications PIBS 4709e "*Noise Guidelines for Wind Farms: Interpretation for Applying MOE NPC Publications to Wind Power Generation Facilities (October 2008)*" (MOE 2008).

The sound level limit for the residential receptors in a Class 3 area can be described as follows:

- For wind speeds at or below 6 m/s

  The sound level limit at a Point of Reception, expressed in terms of the hourly equivalent energy sound level (L_{eq}) is 40.0 dBA or the minimum hourly background sound level established in accordance with requirements un Publication NPC-232/NPC-233, whichever is higher.

- For wind speeds above 6m/s

  The sound level limit at a Point of Reception in a Class 3 Area (Rural), under conditions of average wind speed above 6 m/s respectively, expressed in terms of the hourly equivalent energy sound level (L_{eq}), is the wind induced background sound level, expressed in terms of ninetieth percentile sound level (L_{90}) plus 7 dB, or the minimum hourly background sound level established in accordance with requirements in Publications NPC-232/NPC-233, whichever is higher.

These limits are summarized in Table 4.

Table 4: Noise Level Limits Based on Average Wind Speed at 10 m Height

Wind Speed (m/s)	≤ 6	7	8	9	10
Class 3 Criteria (dBA)	40.0	43.0	45.0	49.0	51.0

5.0 RECEPTORS

5.1 Points of Reception

Two hundred and nineteen (219) residential receptors have been identified as being the most sensitive Points of Reception (PORs) in the vicinity of the proposed wind farm as shown on the site location plan in Figure 1. Figure 2a through 2c illustrates PORs within 2 km of the proposed turbines or transformers but specifically identifies PORs within 1.5 km of any proposed turbines or transformer. These receptors have been modelled at a height of 4.5 m and located at the centre of the dwelling. Eighty-Two (82) vacant lots have also been modelled with PORs located within a building envelope typical to the area. More specifically, the PORs have been placed at the point within the building envelope closest to the nearest turbine. These receptors have also been modelled at a height of 4.5m above grade. A letter from the local planner indicating the lots for which a future building permit may become available is provided in Appendix B. Vacant lot receptor locations were determined based on this letter. Table 5 summarizes these locations.

Table 5: Points of Reception Location Summary

Receptor ID	Description	Location Coordinates	
		X	Y
POR1	Refer to attached CD for Table 5.		
POR2			
POR3			

5.2 Participating Receptor Locations

In accordance with MOE guidelines, a receptor is a Participating Receptor (PR) and is not considered as a POR if the property of the receptor is associated with the Project. Therefore, the sound level limits stated in Section 4 of this report do not apply.

Forty-Five (45) receptors have been identified as PRs in accordance with MOE guidelines. These receptors have been modelled at a height of 4.5 m and located at the centre of the dwelling. Twenty-Nine (29) signed vacant lots have also been modelled with PRs located within a building envelope typical to the area. These PRs have been placed at the point within the building envelope closest to the nearest turbine. These receptors have also been modelled at a height of 4.5m above grade. PR locations are summarized in Table 6.

Table 6: Participating Receptor Locations Summary

Receptor ID	Description	Location Coordinates	
		X	Y
PR1	Refer to attached CD for Table 6.		
PR2			
PR3			

A zoning map is included in Appendix A.

6.0 METHODOLOGY

6.1 Predicted Noise Impact Assessment

Noise impact predictions were carried out using the commercially available software package CadnaA V 3.7.124. The predicted levels take into consideration that the sound from a stationary point noise source spreads spherically and attenuates at a rate of 6 dB per doubling of distance. Further, attenuation from barriers, ground effect and air absorption may be included in the analysis as determined from ISO 9613 (Parts 2) (International Organization for Standardization 1996), which is the current standard used for outdoor sound propagation predictions. It should be noted that this standard makes provisions to include a correction to address for downwind or temperature inversion conditions, whereby levels would increase for a downwind receptor and similarly levels would also decrease for an upwind receptor. Noise predictions have been made for downwind or moderate temperature inversion conditions, a design condition consistent with the accepted practice of the MOE.

6.2 Turbine Noise Emission Rating

Wind Shear

Sound power levels emitted by wind turbine generators are dependent on wind speeds at the hub. In contrast, the background noise levels specified by the MOE are based on wind speeds at receptor locations. Therefore, the site-specific wind shear has been used to account for the difference in wind speed between winds at 10 m versus wind speed at hub height. Table 7 summarizes the difference in wind speed for the Project based on a site-specific summer night-time average wind shear value of 0.465.

Table 7: Predicted Hub-height Wind Speed

Wind Speed (m/s) at 10m height	≤ 6	7	8	9	10
Wind Speed (m/s) at Hub height	≤ 17.26	20.13	23.01	25.89	28.76

Turbine Noise Emission Rating

Currently, there is no spectral sound power data available for the 60 Hz version of the V90-1.8 WTGs. However, based on the data provided to Golder, the overall sound power level at various wind speeds for the 60 Hz wind turbines are lower than the overall sound power level of the 50 Hz wind turbines. Therefore, the 50 Hz sound power spectrum for the WTGs was used as this would likely yield conservative predictions at the identified receptor locations. Table 8 provides the sound power spectrum of the 50 Hz wind turbines.

As required by the MOE, the sound power data for the Vestas WTGs was acquired in accordance with IEC 61400-11 (IEC 2002) procedures as identified in the manufacturer's noise data provided in Appendix C.

Table 8: Noise Source Sound Power Level Summary Table at Standard Operation

	Octave Band Sound Power Level (dB)									
	Manufacturer's Emission Levels [1]					Adjusted Emission Levels [2]				
Wind Speed (m/s) at 10m height	**≤ 6**	**7**	**8**	**9**	**10**	**≤ 6**	**7**	**8**	**9**	**10**
Frequency (Hz)										
63	110.7	112.4	112.3	111.3	112.0	112.0	112.0	112.0	112.0	112.0
125	105.1	106.9	106.8	106.8	106.6	106.6	106.6	106.6	106.6	106.6
250	100.9	102.1	101.9	101.0	101.4	101.4	101.4	101.4	101.4	101.4
500	97.9	98.4	98.9	98.3	98.4	98.4	98.4	98.4	98.4	98.4
1000	97.4	98.3	98.6	97.3	98.3	98.3	98.3	98.3	98.3	98.3
2000	94.6	95.6	96.3	95.3	96.3	96.3	96.3	96.3	96.3	96.3
4000	92.8	94.3	95.0	97.8	95.5	95.5	95.5	95.5	95.5	95.5
8000	86.0	89.7	90.4	91.2	93.0	93.0	93.0	93.0	93.0	93.0
A-Weighted	**102.5**	**103.6**	**104.0**	**104.0**	**104.0**	**104.0**	**104.0**	**104.0**	**104.0**	**104.0**

[1] Tested based on Measurement standard IEC 61400-11 ed. 2 2002.

[2] Using the site specific summer night-time average wind shear of 0.465 resulted in the use of the maximum sound power (i.e., 104.0 dBA) at all wind speeds

6.3 Cumulative Effects Assessment

In order to assess potential cumulative effects associated with the Project, all other planned projects within a 10 km buffer around the site were considered (Figure 3).

As per published MOE guidelines (MOE, 2008) AET completed research to identify any approved adjacent projects. It was concluded that no approved projects existed within or nearby the project area as of April 2009.

Further research was completed as requested by MOE guidance to, “assess the impacts of adjacent wind farms in the process of being planned” (MOE, 2008). AET gathered project information that was available through the Environmental Screening Process and also contacted neighbouring planning authorities to acquire any additional available information. AET prepared a memo identifying the results of their research. The following summarizes the memo, which is included in Appendix D.

Five (5) planned wind farms within a 10 km radius of the Adelaide Wind Farm were identified. At the time that this research was carried out there were no Environmental Screening Reports available in the public domain. Information was limited to the various project Notices of Commencement and discussions with planning authorities and Canadian Hydro Developers. These projects are summarised below:

- **Canadian Hydro Developers Inc (CHD) Parkhill Project** – AET contacted CHD and were advised that the project being developed is a 35MW capacity project with a proposed transmission interconnection point that does not compete for transmission capacity with that proposed for the Adelaide Wind Farm. Therefore, it is considered that both the Adelaide Wind Farm and Parkhill project could co-exist from a transmission connection capacity perspective. Cumulative effects were assessed for the Canadian Hydro-Parkhill Wind Project (CHPWP) and the Adelaide Wind Farm. CHD provided AET with 152 receptor locations within CHPWP project area and predicted worst case noise levels from the CHPWP operations at these receptors as of the April 2009 project design. In order to assess the cumulative effects, noise predictions from the Adelaide Wind Farm were completed for the identified receptors within the CHPWP area and added to the provided CHPWP modelling results.
- **Florida Power and Light Electric Canadian Wind (FPLE)** – the following Notices of Commencement have been issued:
    - Strathroy A+B (2 x Standard Offer Contract (SOC) Projects – 18MW)
    - Strathroy C (1 x SOC Project - 9MW)

- Bornish (Larger project - 85MW)

It is understood that the Adelaide Wind Farm and the FPLE projects are competing for limited transmission capacity. Therefore, the Adelaide Wind Farm and the identified FPLE projects are considered to be mutually exclusive, (i.e., if the 72MW Adelaide Wind Farm is built, there would not be sufficient capacity for these other projects to proceed).

6.4 Transformer Noise Emission Rating

The Project substation will include a step up power transformer. Table 9 provides the transformer noise specification that will be used to procure the substation transformer. The specification is based a sound pressure level of 74 dBA at a distance of 2 m from any surface on the transformer. This results in an overall sound power level of 100 dBA for the transformer.

Table 9: Substation Transformer Sound Power Noise Specification

Octave Band Centre Frequency (Hz)								
Source	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Transformer[1,2]	103.4	106.9	105.0	97.8	90.9	87.7	79.4	70.5

[1] Transformers will be designed in accordance with all applicable standards including CSA-C88-M90 and the above octave band sound power levels.

[2] A 5 dB penalty has been added to the transformers overall sound pressure levels at each POR in accordance with MOE requirements.

6.5 Atmospheric Absorption

As required by the MOE, the attenuation due to atmospheric absorption is based on the atmospheric attenuation coefficients for a temperature of 10ºC and a relative humidity of 70%. Table 10 summarizes the atmospheric attenuation coefficients used in this assessment.

Table 10: Summary of Atmospheric Absorption Coefficients

Octave Band Centre Frequency (Hz)	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Atmospheric Absorption Coefficients (dB/km)	0.1	0.4	1.0	1.9	3.7	9.7	32.8	117.0

6.6 Ground Absorption

In accordance with MOE procedures, ground absorption at the source(s), receiver(s) and all areas between have been set as follows:

- $G_{(source)}$ = 1;
- $G_{(receiver)}$ = 0.5; and
- $G_{(middle)}$ = 0.8.

7.0 RESULTS

7.1 Noise Impact Assessment

Using noise data provided by the WTG manufacturer and the noise specification for the substation transformer, Golder has carried out noise predictions for the operation of the wind farm. Based on the site specific wind shear of 0.465, predictions were only required for a wind speed of 6m/s at a height of 10m, as the adjusted sound power level for each of the WTGs was 104.0 dBA (i.e., maximum sound power level). The results of the predictions are summarized in Table 11 and Table 12. Figure 4 shows the resulting noise level contours. Please refer to the attached CD for sample calculations as well as a Cadna-A model file. As required by the MOE, sample calculations include noise predictions for a single WTG at one receptor location and all WTGs at a single receptor location.

7.2 Cumulative Effects Assessment

As discussed in Section 6.3 the cumulative effects assessment was completed by preparing noise predictions from the Adelaide Wind Farm for the identified receptors within the CHPWP area and adding the results to the provided CHPWP modelling results.

CHD provided results for One-Hundred and fifty two (152) receptors with noise levels ranging between 15.7 and 39.8 dBA. These receptors are identified in Figure 3.

Among the CHD assessed receptors, the maximum overall sound level was at 39.8 dBA for two receptors (R90 and R96 as identified by CHD). The predicted noise levels from the Adelaide Wind Farm at these receptor locations were 15.9 and 16.8 dBA respectively, resulting in a cumulative effect of 39.8 dBA (i.e., 0.0 dB increase due to the Adelaide Wind Farm).

The maximum increase resulting from the cumulative effects due to both wind farms operating is 2.0 dB and occurs at R28. The resulting cumulative overall noise level for this receptor is 17.7 dBA which is well below the MOE limit of 40.0 dBA and generally below typical existing noise levels present in a rural environment.

The highest predicted noise level, due to the Adelaide Wind Farm, for a receptor located within the CHPWP project site is 19.9 dBA at R114. The overall cumulative noise level at R114 is predicted to be 32.1 dBA which is also well below the MOE noise level limit. The results for the receptors that were considered in the cumulative effects assessment are summarized in Table 13.

Table 11: Combined Noise Impact Assessment Summary – Points of Reception

Point of Reception ID	Distance to Nearest Wind Turbine (m)	Nearest Turbine ID	Calculated Overall SPL (dBA) at Receptor Locations at Selected Wind Speeds (m/s)					Sound Level Limit at Selected Wind Speeds (dBA)					Compliance with MOE Limits?
			≤ 6	7	8	9	10	≤ 6	7	8	9	10	
POR001	Refer to attached CD for Table 11.												
POR002													
POR003													

Table 12: Combined Noise Impact Assessment Summary – Participating Receptors

Participating Receptor ID	Distance to Nearest Wind Turbine (m)	Nearest Turbine ID	Calculated Sound Level at Selected Wind Speeds (dBA)				
			≤ 6	7	8	9	10
PR001	Refer to attached CD for Table 12.						
PR002							
PR003							

Table 13: Cumulative Effects at Receptors

Receptor ID	Location Coordinates		Noise levels resulting from Canadian Hydro – Parkhill Wind Project (dBA)	Calculated Overall SPL (dBA) at Receptor Locations (6m/s wind speed at 10m height) (dBA)	Cumulative Effects (dBA)
	X	Y			
R1	Refer to attached CD for Table 13.				
R2					
R3					

8.0 CONCLUSION

Golder was retained by Air Energy TCI Inc, to prepare a Noise Impact Assessment for the proposed 72 MW wind farm, located in Adelaide, Ontario. Using manufacturer's noise specifications, Golder has predicted noise impact levels that are at or below the MOE noise level limits at specified wind speeds. Based on these results, the proposed wind farm will operate within compliance limits as set out by the MOE.

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SI/JT/Dd/wlm

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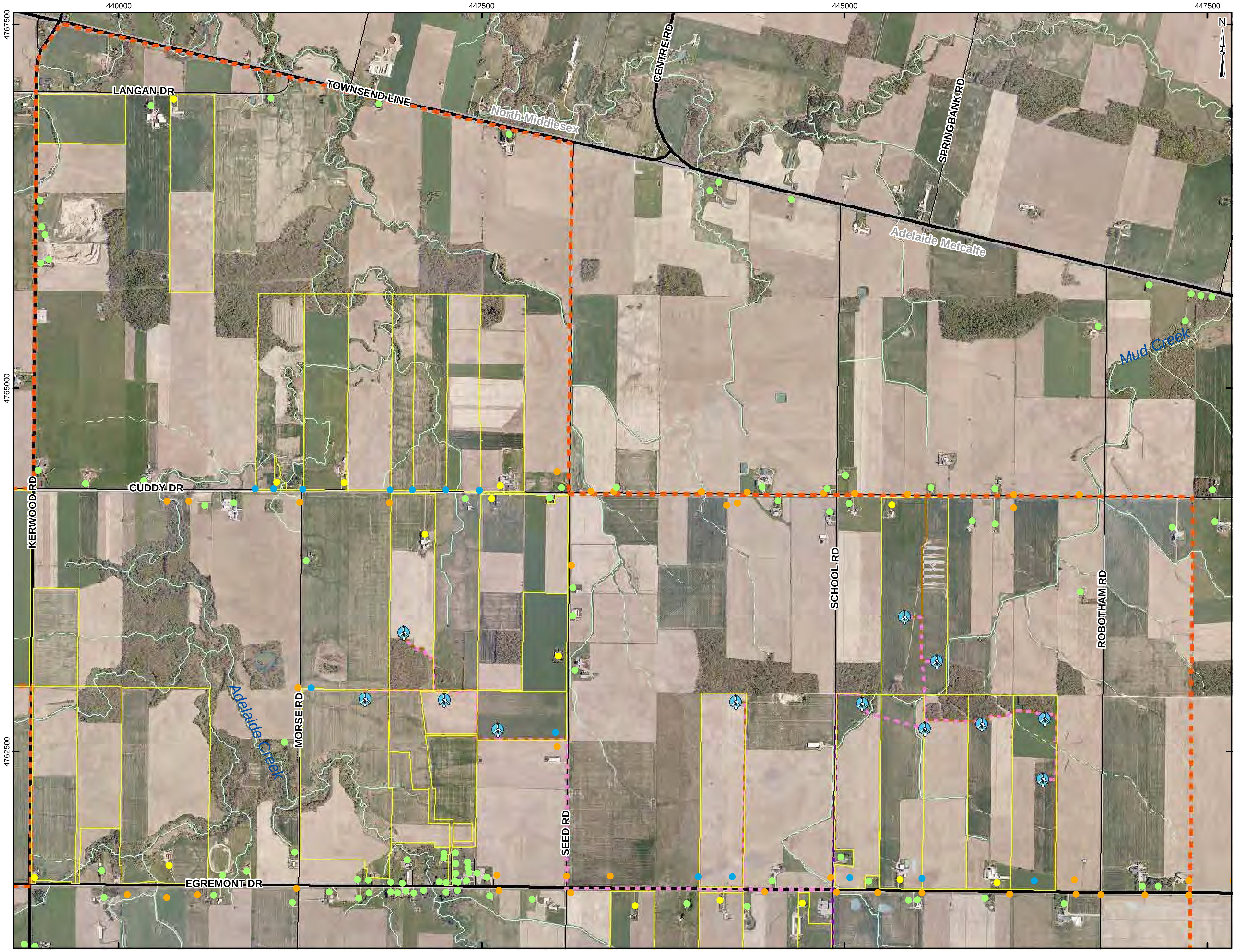
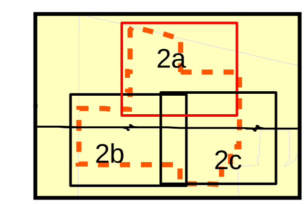
FIGURES

LEGEND
Layout 27 Turbine - March 5, 2009
Substation
Overhead Cable
Underground Cable
Access Road
Expressway
Major Road
Local Road
Watercourse, Permanent
Watercourse, Intermittent
Site Study Area
Optioned Lots - March 5, 2009
Municipal Boundary
Waterbody, Permanent
Wetland, Permanent
435000
437500
440000
442500
445000
447500
450000
4767500
4765000
4762500
4760000
4757500
Warwick
TOWNSEND LINE
Keyser
Springbank
GLASGOW ST
PETTY ST
MCCUBBIN RD
SPRINGBANK RD
WYATT RD
North Middlesex
Adelaide Metcalfe
BIRNAM LINE
LANGAN DR
WISBEACH RD
SEXTON RD
BRICK YARD LINE
CUDDY DR
Crathie
CRATHIE DR
Mud Creek
Adelaide Creek
SCHOOL RD
ROBOTHAM RD
Wisbeach
Dejong
EGREMONT DR
Adelaide
Wrightmans Corners
NEWELL RD
WILSON RD
MORSE RD
CENTRE RD
HIGHWAY 402
SEED RD
KERWOOD RD
ZION LINE
MULLIFARRY DR
Mullifarry
BROWN RD
PIKE RD
THORN DR
Strathroy-Caradoc
Strathroy
CONFEDERATION LINE
NAPPERTON DR
Napperton
Lake Huron
Sarnia
Study Area
London
Kitchener
HIGHWAY 401
Lake Erie
Index Map
REFERENCE
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2009
Air Photo - Spring 2006 First Base Solutions.
Datum: NAD 83 Projection: UTM Zone 17N
0 0.5 1 2 3
Kilometres
PROJECT
ADELAIDE WIND FARM PROJECT
tci renewables
TITLE
SITE LAYOUT
Golder Associates
Mississauga, Ontario
PROJECT NO. 07-1112-0151
SCALE AS SHOWN
REV. 0
DESIGN PP 05 Mar. 2008
GIS PP 3 Apr. 2009
CHECK BC 6 Apr. 2009
REVIEW
FIGURE: 1
G:\Projects\2007\07-1112-0151 TCI\AdelaideWindFarm\GIS\MXDs\Draft\Febuary2009Edits\Report\NoiseSiteLayout.mxd



LEGEND

- Point Of Reception
- Participating Receptor
- Vacant Point Of Reception
- Vacant Participating Receptor
- Layout 27 Turbine - March 5, 2009
- Substation
- Overhead Cable
- Underground Cable
- Access Road
- Expressway
- Major Road
- Local Road
- Watercourse, Permanent
- Watercourse, Intermittent
- Site Study Area
- Optioned Lots - April 24, 2009
- Municipal Boundary
- Waterbody, Permanent
- Wetland, Permanent



REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2009
Air Photo - Spring 2006 First Base Solutions.
Datum: NAD 83 Projection: UTM Zone 17N

0 250 500 1,000 1,500
Metres

PROJECT

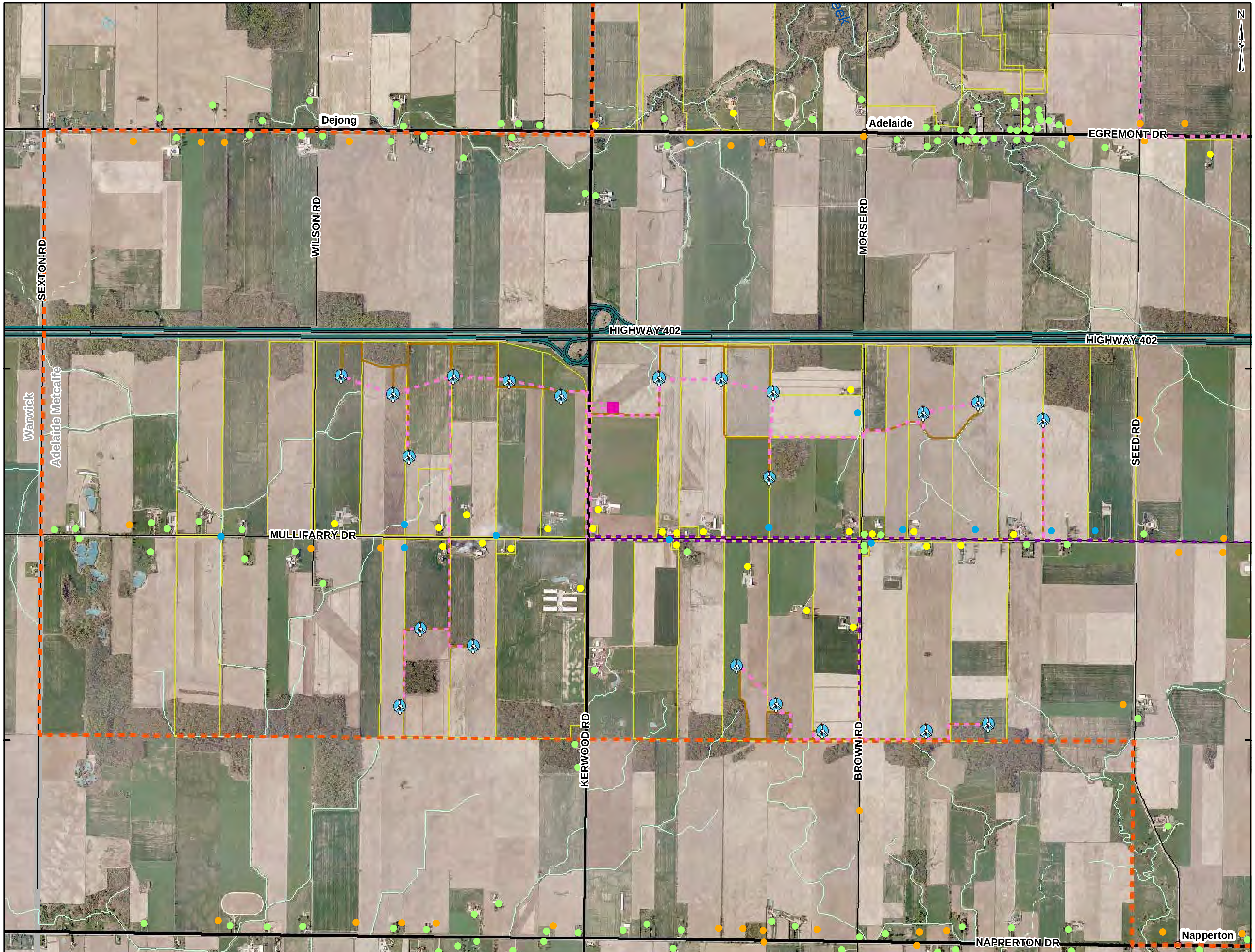
ADELAIDE WIND FARM PROJECT

TITLE

SITE LAYOUT A

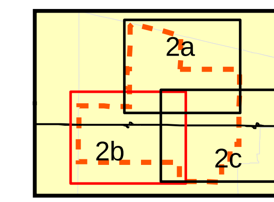
Golder Associates
Mississauga, Ontario

PROJECT NO. 07-1112-0151			SCALE AS SHOWN	REV. 0
DESIGN	PP	05 Mar. 2008	FIGURE: 2a	
GIS	PP	3 Apr. 2009		
CHECK	BC	6 Apr. 2009		
REVIEW				



LEGEND

- Point Of Reception
- Participating Receptor
- Vacant Point Of Reception
- Vacant Participating Receptor
- Layout 27 Turbine - March 5, 2009
- Substation
- Overhead Cable
- Underground Cable
- Access Road
- Expressway
- Major Road
- Local Road
- Watercourse, Permanent
- Watercourse, Intermittent
- Site Study Area
- Optioned Lots - April 24, 2009
- Municipal Boundary
- Waterbody, Permanent
- Wetland, Permanent



REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2009
Air Photo - Spring 2006 First Base Solutions.
Datum: NAD 83 Projection: UTM Zone 17N

0 250 500 1,000 1,500
Metres

PROJECT

ADELAIDE WIND FARM PROJECT

tci renewables

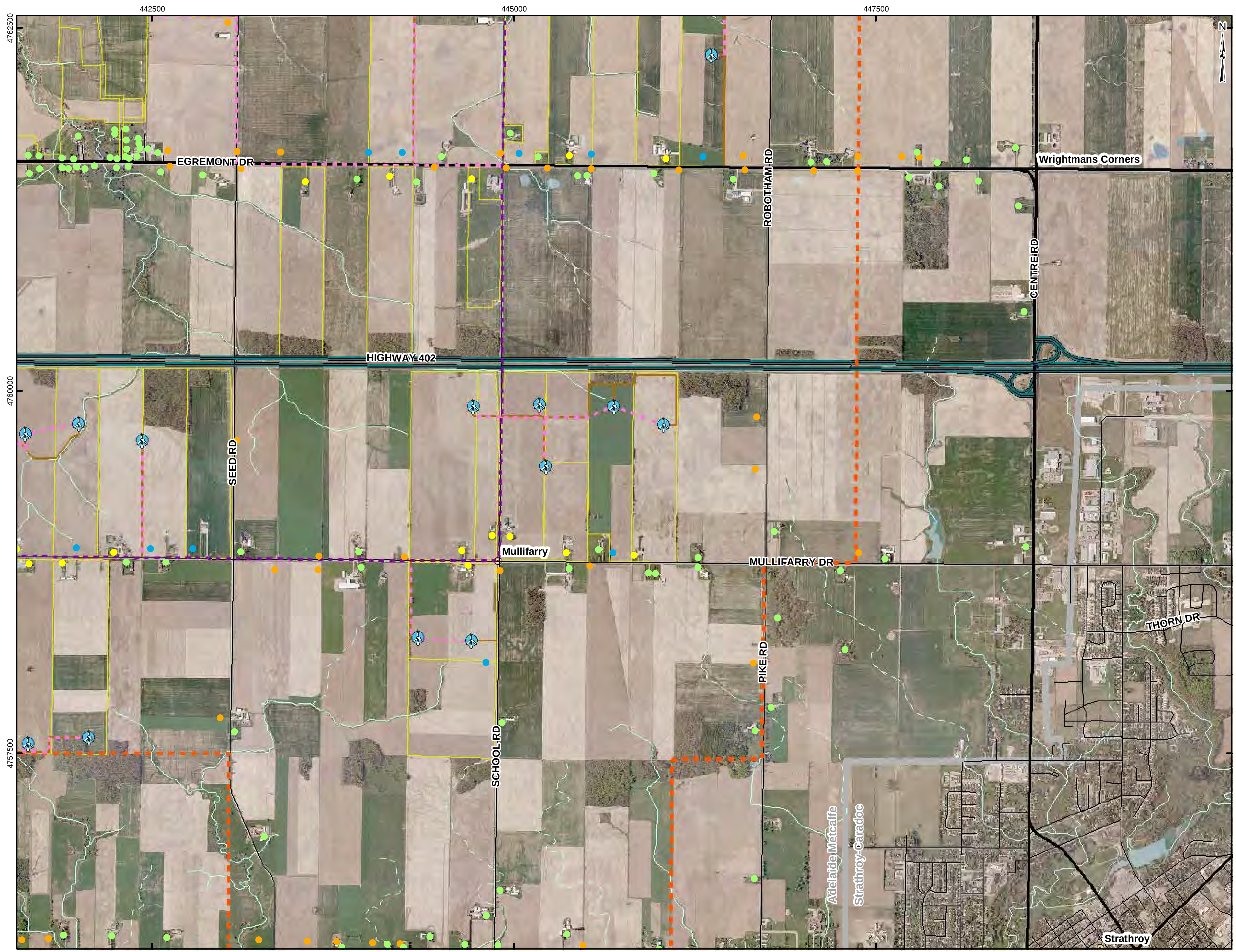
TITLE

SITE LAYOUT B

Golder Associates
Mississauga, Ontario

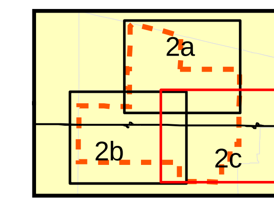
PROJECT NO. 07-1112-0151			SCALE AS SHOWN	REV. 0
DESIGN	PP	05 Mar. 2008	FIGURE: 2b	
GIS	PP	3 Apr. 2009		
CHECK	BC	6 Apr. 2009		
REVIEW				

G:\Projects\2007\07-1112-0151 TCI\AdelaideWindFarm\GIS\MXDs\Draft\Febuary2009EditsReport\2b_SiteLayout.mxd



LEGEND

- Point Of Reception
- Participating Receptor
- Vacant Point Of Reception
- Vacant Participating Receptor
- Layout 27 Turbine - March 5, 2009
- Substation
- Overhead Cable
- Underground Cable
- Access Road
- Expressway
- Major Road
- Local Road
- Watercourse, Permanent
- Watercourse, Intermittent
- Site Study Area
- Optioned Lots - April 24, 2009
- Municipal Boundary
- Waterbody, Permanent
- Wetland, Permanent



REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
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Air Photo - Spring 2006 First Base Solutions.
Datum: NAD 83 Projection: UTM Zone 17N

0 250 500 1,000 1,500
Metres

PROJECT
ADELAIDE WIND FARM PROJECT
tci renewables

TITLE
SITE LAYOUT C

Golder Associates
Mississauga, Ontario

PROJECT NO. 07-1112-0151			SCALE AS SHOWN	REV. 0
DESIGN	PP	05 Mar. 2008		
GIS	PP	3 Apr. 2009		
CHECK	BC	6 Apr. 2009		
REVIEW				

FIGURE: 2c

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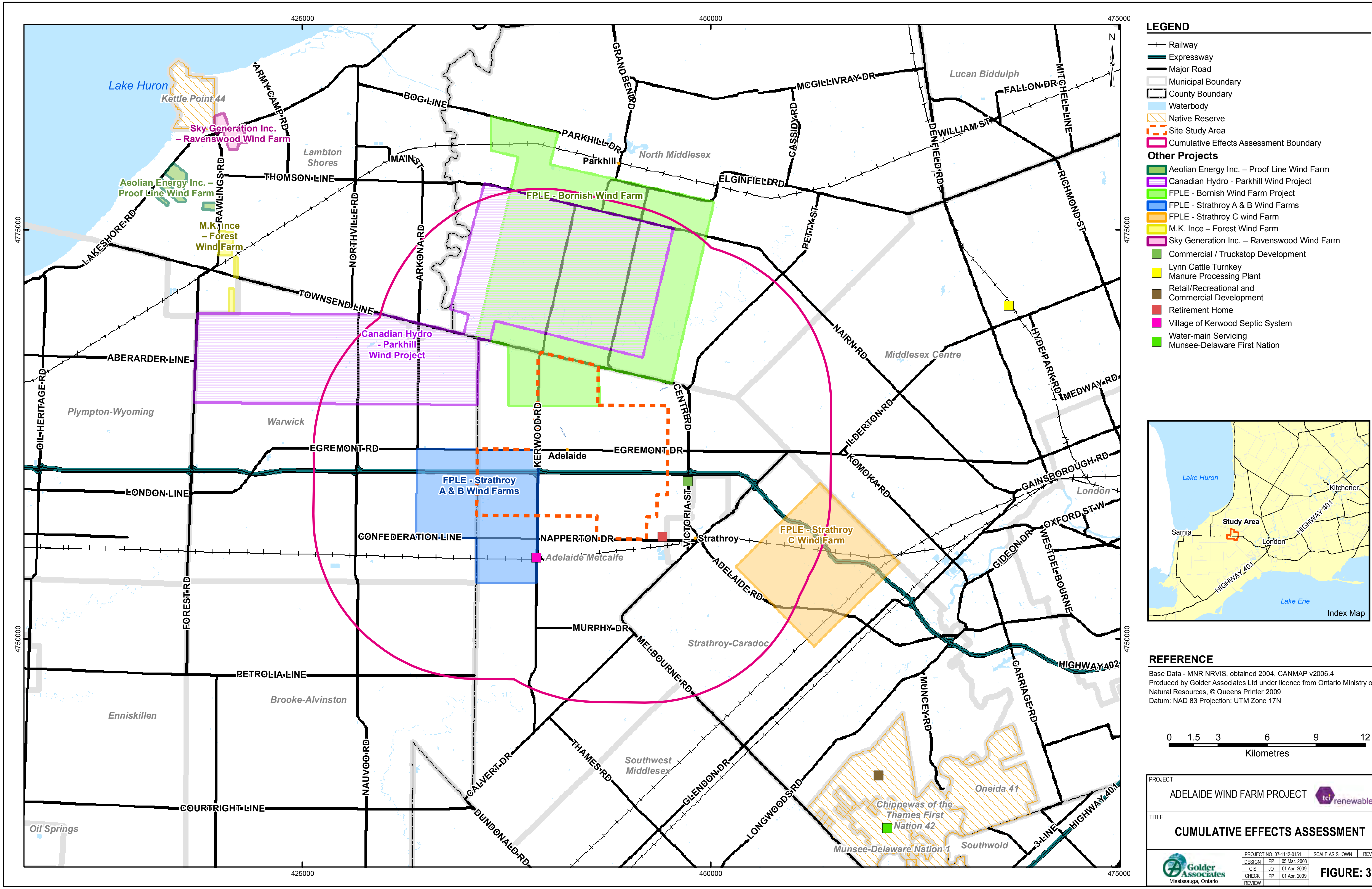
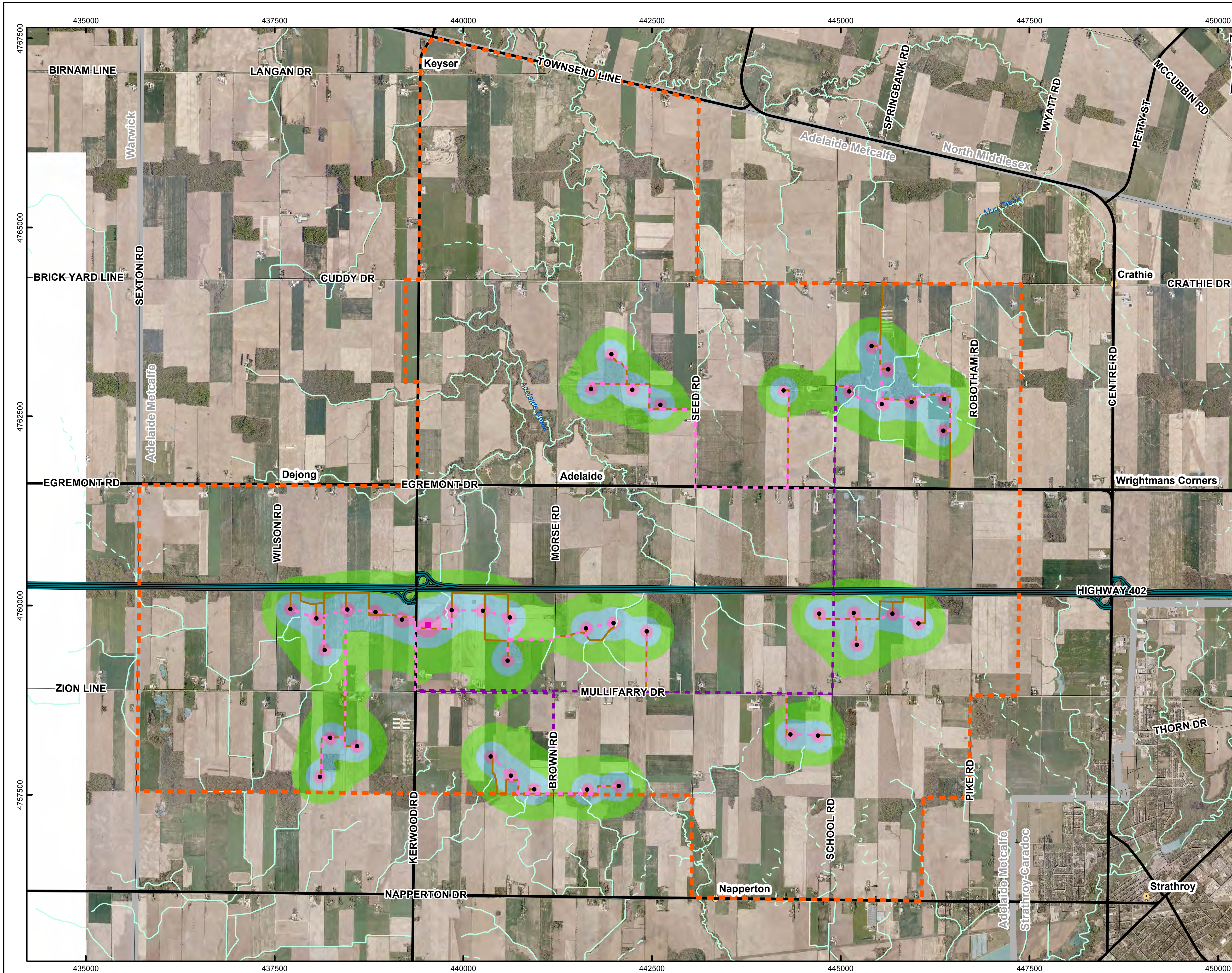

LEGEND
Railway
Expressway
Major Road
Municipal Boundary
County Boundary
Waterbody
Native Reserve
Site Study Area
Cumulative Effects Assessment Boundary
Other Projects
Aeolian Energy Inc. – Proof Line Wind Farm
Canadian Hydro - Parkhill Wind Project
FPLE - Bornish Wind Farm Project
FPLE - Strathroy A & B Wind Farms
FPLE - Strathroy C wind Farm
M.K. Ince – Forest Wind Farm
Sky Generation Inc. – Ravenswood Wind Farm
Commercial / Truckstop Development
Lynn Cattle Turnkey Manure Processing Plant
Retail/Recreational and Commercial Development
Retirement Home
Village of Kerwood Septic System
Water-main Servicing Munsee-Delaware First Nation
Lake Huron
Kettle Point 44
Sky Generation Inc. – Ravenswood Wind Farm
Aeolian Energy Inc. – Proof Line Wind Farm
M.K.Ince – Forest Wind Farm
Lambton Shores
North Middlesex
Lucan Biddulph
FPLE - Bornish Wind Farm
Canadian Hydro - Parkhill Wind Project
FPLE - Strathroy A & B Wind Farms
FPLE - Strathroy C Wind Farm
Plympton-Wyoming
Warwick
Middlesex Centre
Adelaide
Adelaide Metcalfe
Strathroy
Parkhill
London
Strathroy-Caradoc
Brooke-Alvinston
Enniskillen
Southwest Middlesex
Oil Springs
Oneida 41
Chippewas of the Thames First Nation 42
Munsee-Delaware Nation 1
Southwold
BOG LINE
PARKHILL DR
MCGILLIVRAY DR
FALLON DR
WILLIAM ST
ELGINFIELD RD
THOMSON LINE
MAIN ST
TOWNSEND LINE
ABERARDER LINE
EGREMONT RD
EGREMONT DR
LONDON LINE
CONFEDERATION LINE
NAPPERTON DR
MURPHY DR
PETROLIA LINE
COURTRIGHT LINE
HIGHWAY 402
HIGHWAY 401
OIL HERITAGE RD
LAKESHORE RD
ARMY CAMP RD
RAWLINGS RD
NORTHVILLE RD
ARKONA RD
KERWOOD RD
GRAND BEND RD
CASSIDY RD
DENFIELD RD
MITCHELL LINE
RICHMOND ST
PETTY ST
CENTRE RD
VICTORIA ST
NAIRN RD
ILDERTON RD
KOMOKA RD
HYDE PARK RD
MEDWAY RD
GAINSBOROUGH RD
OXFORD ST W
GIDEON DR
WESTDEL BOURNE
ADELAIDE RD
MELBOURNE RD
FOREST RD
NAUVOO RD
CALVERT DR
DUNDONALD RD
THAMES RD
GLENDON DR
LONGWOODS RD
MUNCEY RD
CARRIAGE RD
3 LINE
425000
450000
475000
4775000
4750000
N
Lake Huron
Kitchener
Sarnia
Study Area
London
HIGHWAY 401
Lake Erie
Index Map
REFERENCE
Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2009
Datum: NAD 83 Projection: UTM Zone 17N
0 1.5 3 6 9 12
Kilometres
PROJECT
ADELAIDE WIND FARM PROJECT
tci renewables
TITLE
CUMULATIVE EFFECTS ASSESSMENT
Golder Associates
Mississauga, Ontario
PROJECT NO. 07-1112-0151
SCALE AS SHOWN
REV. 0
DESIGN PP 05 Mar. 2008
GIS JO 01 Apr. 2009
CHECK PP 01 Apr. 2009
REVIEW
FIGURE: 3



LEGEND

- • Layout 27 Turbine - March 5, 2009
- Substation
- Overhead Cable
- Underground Cable
- Access Road
- Expressway
- Major Road
- Local Road
- Watercourse, Permanent
- Watercourse, Intermittent
- Site Study Area
- Municipal Boundary
- Waterbody, Permanent
- Wetland, Permanent

6m/s Noise (dB)

- 40-45
- 45-50
- >50

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2009
Air Photo - Spring 2006 First Base Solutions.
Datum: NAD 83 Projection: UTM Zone 17N

0 0.5 1 2 3
Kilometres

PROJECT
ADELAIDE WIND FARM PROJECT

tci renewables

TITLE
NOISE RESULTS FROM 6 M/S WIND SPEED

Golder Associates
Mississauga, Ontario

PROJECT NO. 07-1112-0151			SCALE AS SHOWN REV. 0
DESIGN	PP	05 Mar. 2008	
GIS	PP	28 Apr. 2009	FIGURE: 4
CHECK			
REVIEW			

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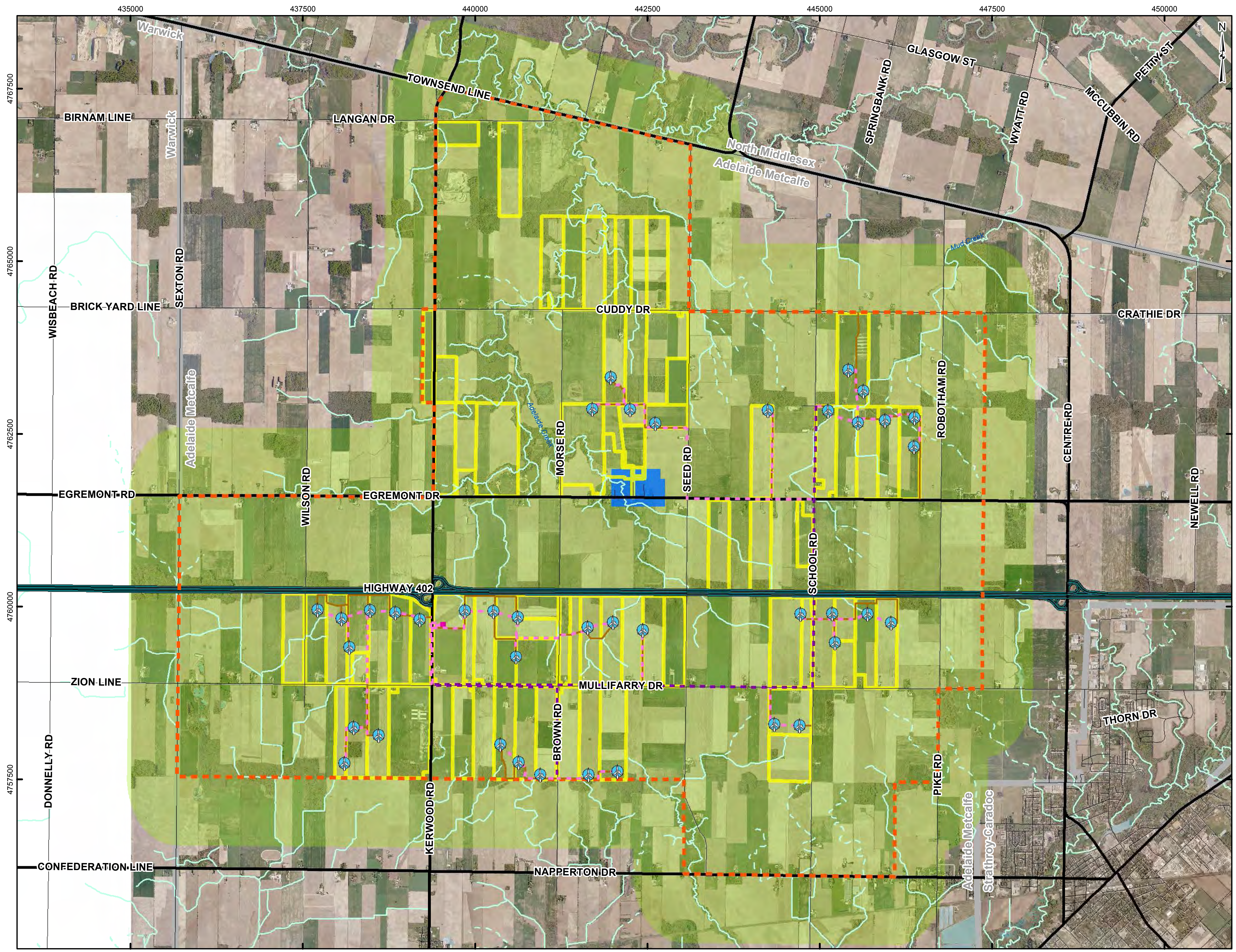
APPENDIX A

ZONING MAP



LEGEND

- Layout 27 Turbine - March 5, 2009
- Overhead Cable
- Underground Cable
- Access Road
- Substation
- Site Study Area
- Expressway
- Major Road
- Local Road
- Watercourse, Permanent
- Watercourse, Intermittent
- Optioned Lots - March 5, 2009
- Residential
- Agriculture
- Municipal Boundary
- Waterbody, Permanent
- Wetland, Permanent

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2009
Air Photo - Spring 2006 First Base Solutions.
Land Use - Middlesex County Official Plan.
Datum: NAD 83 Projection: UTM Zone 17N

0 0.5 1 2 3
Kilometres

PROJECT

ADELAIDE WIND FARM PROJECT

tci renewables

TITLE

ZONING

Golder Associates
Mississauga, Ontario

PROJECT NO. 07-1112-0151			SCALE AS SHOWN	REV. 0
DESIGN	PP	05 Mar. 2008	**APPENDIX A**	
GIS	JO	13 Feb. 2009		
CHECK	PP	1 Apr. 2009		
REVIEW				

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APPENDIX B

LETTER FROM PLANNER

GSP group
SHAPING GREAT COMMUNITIES

PLANNERS
URBAN DESIGNERS
LANDSCAPE ARCHITECTS

April 22, 2009
Project No. 09001.301

Mark Gallagher
Development Manager
TCI Renewables, Suite 102,
381 Notre Dame Ouest
Montreal, Quebec H2Y 1V2

Re: Noise Mapping and Eligibility for a Building Permit
Township of Adelaide Metcalfe
Adelaide Wind Farm Project

In our previous memo we had indicated that a building permit for single detached dwelling would typically be permitted on a property with a minimum 150 metres of frontage and 40 hectares of lot area. While this holds true, there are properties that do not meet these requirements that would be permitted to have a building permit for a single detached dwelling. A building permit would be permitted on these properties as they are existing lots of record that would have been of a size and shape that was permitted in the previous 3-97 Zoning By-law for the Township of Adelaide.

In Zoning By-law 3-97 a single detached dwelling was permitted on a lot with a minimum lot area of 20.6 ha (50.9 acres) along with 145 metres (475 feet) of frontage.

Section 5.7 of the current Zoning By-law (34-2007) states that:

> *5.7 Existing Lots and Uses*
>
> *Existing lots with less than the required lot area or lot width may be used, and buildings erected or altered thereon, for the purposes permitted in the zone in which they are situated, subject to compliance with all other regulations of this By-law. For the purposes of this section, an existing lot which has been increased in lot area or lot width through consent approval under the Planning Act shall be deemed to be an existing lot.*

Therefore, based on the above information there are a number of properties that are eligible for a building permit for a single detached dwelling that do not meet the current minimum lot sizes.

GSP Group Inc.
72 Victoria Street S., Suite 201
Kitchener, ON N2G 4Y9
P 519.569.8883
F 519.569.8643

www.gspgroup.ca

However, mapping provide by TCI (*Adelaide Wind Farm Project Ontario – Vacant Lot & Noise Contour Map Layout 027, CA-ADE-M111 CG Apr 2009)* that identifies the noise contours and "signed" parcels within the wind farm indicates that there will not be any parcels that are "not signed" that will be precluded from obtaining a building due to noise constraints.

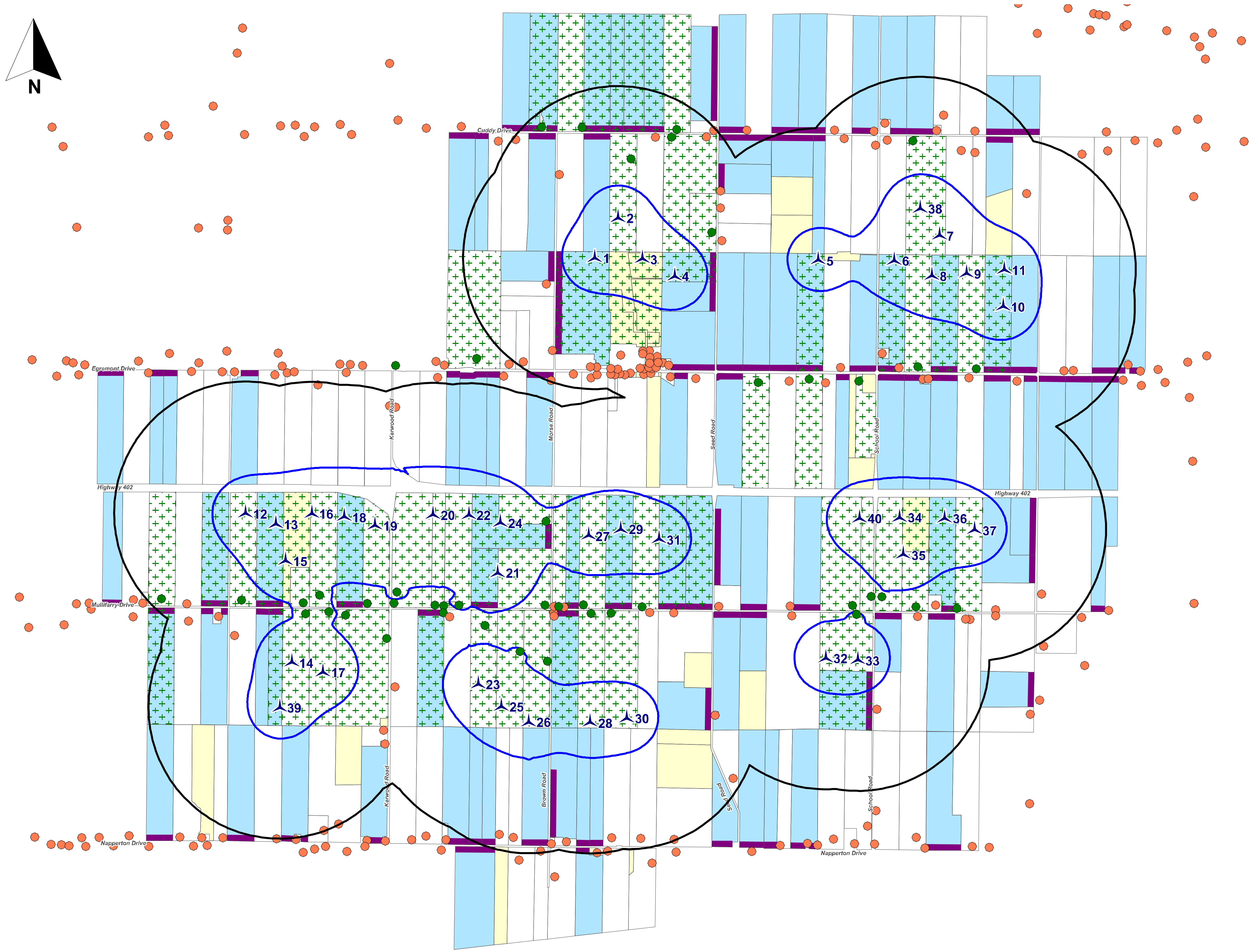
Furthermore, vacant parcels that are eligible for a building permit have been identified on the mapping with a "building envelope" that is consistent with the typical building pattern in the area as per Policy 6.3.3 of the MOE Noise Guidelines dated October 2008.

Based on the comments above and the mapping provided, all of the building permit eligible parcels have sufficient area and identified building envelopes (typical of the building patter of the area) which fall outside of the 40dBa noise contours . This does not take into account other potential constraints on the property.

I trust this is satisfactory for your needs. Should you have any questions or require clarification to the forgoing please do not hesitate to contact me.

Yours Truly,
GSP GROUP INC.

Brandon Flewwelling, MCIP, RPP



tci renewables

Overview Map

Adelaide Wind Farm Project Ontario

Legend

- Turbine
- Non Signed Dwelling
- Signed Dwelling
- Turbine Buffer (1500m)
- Noise Modelling Results 40db Noise Contour
- Signed Lot
- Vacant Lot Deemed to be Eligible for a Building Permit for a Single Detached Dwelling (See Note 1)
- Vacant Lot Deemed to be Ineligible for a Building Permit for a Single Detached Dwelling (See Note 1)
- Building Envelope (See Note 2)

Notes

1. Eligible lots are those that comply with Zoning By-Law 3-97 having a minimum lot area of 20.6 ha (50.9 acres) along with a minimum of 145m (475 feet) frontage

2. A "Building Envelope", that is consistent with the typical building pattern in the area as per Policy 6.33 of the MOE Noise Guidelines dated October 2008, has been identified within each vacant lot eligible for a building permit

0 km 2.7 km

Scale 1:45,000 @ 11x17

Vacant Lot & Noise Contour Map Layout 027

Map Centre
442,030 4,760,350
UTM (NAD 83) Zone 17

CA-ADE-M114 CG Apr 2009

GSP group

SHAPING GREAT COMMUNITIES

PLANNERS
URBAN DESIGNERS
LANDSCAPE ARCHITECTS

April 6, 2009
Project No. 09001.301

Mark Gallagher
Development Manager
TCI Renewables, Suite 102,
381 Notre Dame Ouest
Montreal, Quebec H2Y 1V2

Re: Noise Mapping and Eligibility for a Building Permit
Township of Adelaide Metcalfe
Adelaide Wind Farm Project

In our previous memo we had indicated that a building permit for single detached dwelling would typically be permitted on a property with a minimum 150 metres of frontage and 40 hectares of lot area. While this holds true, there are properties that do not meet these requirements that would be permitted to have a building permit for a single detached dwelling. A building permit would be permitted on these properties as they are existing lots of record that would have been of a size and shape that was permitted in the previous 3-97 Zoning By-law for the Township of Adelaide.

In Zoning By-law 3-97 a single detached dwelling was permitted on a lot with a minimum lot area of 20.6 ha (50.9 acres) along with 145 metres (475 feet) of frontage.

Section 5.7 of the current Zoning By-law (34-2007) states that:

> *5.7 Existing Lots and Uses*
>
> *Existing lots with less than the required lot area or lot width may be used, and buildings erected or altered thereon, for the purposes permitted in the zone in which they are situated, subject to compliance with all other regulations of this By-law. For the purposes of this section, an existing lot which has been increased in lot area or lot width through consent approval under the Planning Act shall be deemed to be an existing lot.*

Therefore, based on the above information there are a number of properties that are eligible for a building permit for a single detached dwelling that do not meet the current minimum lot sizes.

GSP Group Inc.
72 Victoria Street S., Suite 201
Kitchener, ON N2G 4Y9
P 519.569.8883
F 519.569.8643

www.gspgroup.ca

However, mapping provide by TCI that identifies the noise contours and "signed" parcels within the wind farm indicates that there will not be any parcels that are "not signed" that will be precluded from obtaining a building due to noise constraints. Based on the mapping provided, all of the building permit eligible parcels have sufficient area outside of the 40dBa noise contours. This does not take into account other potential constraints on the property.

I trust this is satisfactory for your needs. Should you have any questions or require clarification to the forgoing please do not hesitate to contact me.

Yours Truly,
GSP GROUP INC.

Brandon Flewwelling, MCIP, RPP

GSP group
SHAPING GREAT COMMUNITIES

PLANNERS
URBAN DESIGNERS
LANDSCAPE ARCHITECTS

Project No. 09001.301
March 11, 2009

To whom it may concern:

RE: Proposed Adelaide Wind Farm
Air Energy TCI

Air Energy TCI (AET) has been in contact with the Township of Adelaide Metcalfe and this office from early in the development process of their proposed Adelaide Wind Farm (March 2007). Air Energy TCI has been in contact with us continuously throughout the design process (by email, telephone and through several scheduled meetings), seeking guidance on various procedural and development issues. Recently AET have contacted us to provide some direction for inclusion in the noise study on evaluating building location and availability of building permits on vacant lots.

In light of this inquiry we provided the following logic in determining when a building permit would be permitted on a vacant lot and where a dwelling would typically be situated on a vacant parcel.

Availability of Building Permit:
A building permit would typically be permitted on any of the vacant agricultural parcels that meet the minimum lot sizes for an agricultural parcel of:

- Minimum Lot Area – 40 ha
- Minimum Lot Width – 150 m

Typical Building Location:
The Zoning By-law for the Township of Adelaide Metcalfe states that the Minimum Front Yard required is 30 m. Therefore, an assumption of the dwellings location would be a minimum of 30 m from the front lot line. Typical of this area of Adelaide Metcalfe most of the dwellings are located approximately within the front 1/5th of the agricultural parcel.

GSP Group Inc.
72 Victoria Street S., Suite 201
Kitchener, ON N2G 4Y9
P 519.569.8883
F 519.569.8643

www.gspgroup.ca

Building Set back
With the understanding of the information we provided above, AET further studied the project area and established that the upper quartile building setback along Mullifarry Drive (the main road bisecting the proposed wind farm) is 70 m. AET then provided a potential building envelope location across the frontage of vacant parcels eligible for a building permit using the width of the frontage of the site and up to 70 m from the front lot line. This approach represents a suitable building envelope location and satisfies the requirements of Section 6.3.3 of the MOE Noise Guidelines which requires a building envelop area of up to 1 hectare for potential building location on vacant parcels.

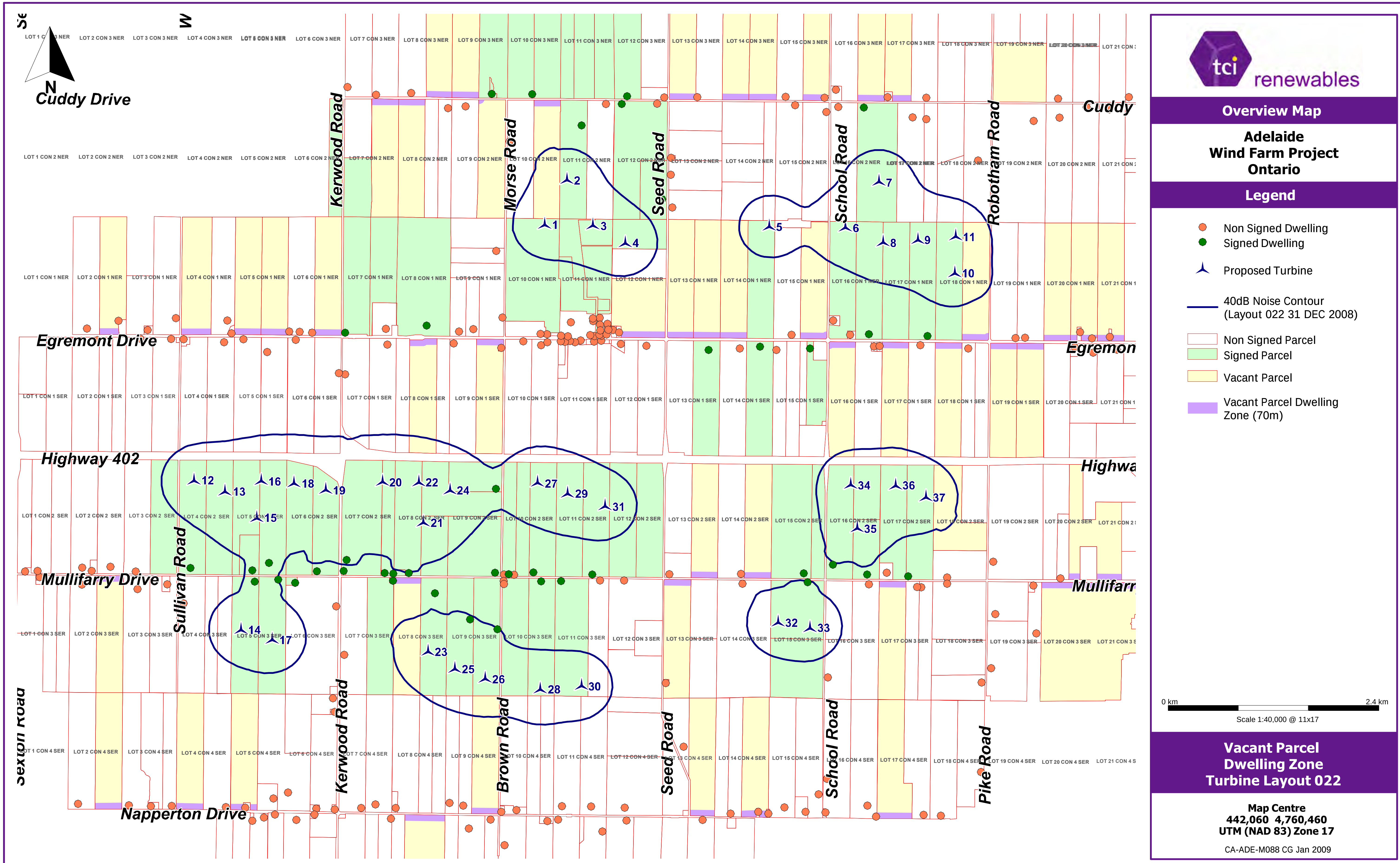
Noise Contour Modeling
AET utilized all of the information provided above to create a Noise Contour Map for the basis of the noise study.

AET provided us with the map entitled: Vacant Parcel Dwelling Zone Turbine Layout 022 – CA-ADE-M088 CG Jan 2009. This map indicates that the assumed location of a future dwelling on all vacant parcels is outside of the 40 dB noise contour.

Based on the information and mapping provided by AET we are satisfied that a suitable rationale for studying the impacts of noise from the proposed Adelaide Wind Farm has been provided.

Yours Truly,
GSP Group Inc.

Brandon Flewwelling, MCIP, RPP



tci renewables
Overview Map
Adelaide
Wind Farm Project
Ontario
Legend
Non Signed Dwelling
Signed Dwelling
Proposed Turbine
40dB Noise Contour
(Layout 022 31 DEC 2008)
Non Signed Parcel
Signed Parcel
Vacant Parcel
Vacant Parcel Dwelling
Zone (70m)
0 km
2.4 km
Scale 1:40,000 @ 11x17
Vacant Parcel
Dwelling Zone
Turbine Layout 022
Map Centre
442,060 4,760,460
UTM (NAD 83) Zone 17
CA-ADE-M088 CG Jan 2009
N
Cuddy Drive
Egremont Drive
Highway 402
Mullifarry Drive
Napperton Drive
Kerwood Road
Morse Road
Seed Road
School Road
Robotham Road
Sullivan Road
Brown Road
Pike Road
Sexton Road
Cuddy
Egremon
Highwa
Mullifarr

APPENDIX C

MANUFACTURER'S NOISE DATA

Isono, Samuel

From: Mark Gallagher [mark.gallagher@tcir.net]
Sent: Thursday, December 11, 2008 12:32 PM
To: Tomaselli, Joe
Cc: Wright, Jeff (Mississauga); Holt, Leigh; Isono, Samuel
Subject: FW: Noise Data

Hi Joe,

Please review detail below and give me a call to discuss. Is this sufficient to perform assessment to the relevant standards?

Mark

tci renewables

www.tcirenewables.com

From: Brett O'Connor
Sent: 11 December 2008 11:58
To: Mark Gallagher
Subject: FW: Noise Data

Mark
Please see noise characteristics from Vestas, these are at 10m above ground level for an 80m tower. As we're working with a 95m I guess Golders would have to work backwards from the figures below to establish noise emissions from nacelle and then predict from there for the 95m in accordance with the relevant Ontario noise guidelines. I believe that the data below was measured at 10m height for a 80m hub height.

I suggested to Tom that if Golderrs have any queries it would be best to get a conference call arranged for all three parties.

Regards
Brett
T: +1 514 842 1923
C: +1 514 805 6474

From: Thomas Mills [mailto:thmi@vestas.com]
Sent: 10 December 2008 14:27
To: Brett O'Connor; Charles Gagnon
Subject: RE: Noise Data

Hi Brett,

As discussed, please see below. Unfortunately at this stage values are only available for the 50Hz model, however the 60Hz machine is expected to be very similar, or slightly reduced emissions due to a lower tip speed. 60Hz values will not be available until we have test results late next summer.

10 m wind speed related sound power values for modeling purposes

Turbine: V90/1800, Mode 0
Hub height: 80

v10	LwA	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
3 m/s	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4 m/s	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5 m/s	99.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6 m/s	102.5	84.5	89.0	92.3	94.7	97.4	95.8	93.8	84.9
7 m/s	103.6	86.2	90.8	93.5	95.2	98.3	96.8	95.3	88.6
8 m/s	104.0	86.1	90.7	93.3	95.7	98.6	97.5	96.0	89.3
9 m/s	104.0	85.1	90.7	92.4	95.1	97.3	96.5	98.8	90.1
10 m/s	104.0	85.8	90.5	92.8	95.2	98.3	97.5	96.5	91.9
11 m/s	104.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12 m/s	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13 m/s	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14 m/s	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

The values are valid for the following conditions
Meas. Standard: IEC 61400-11:2002, using amendment procedure above 95% RP
Wind shear: 0.1592
Max turbulence at 10 m height: 0.16
Inflow angle: 0 +/-2 deg
Air density: 1,225 kg/m3

The values are valid for the A-weighted sound power levels. Octave band values must be regarded as informative.
Site specific values are not warranted

Regards,

Thomas Mills

Vestas Americas
Wind & Site Engineer
Tel: +1 503 327 2166
Mobile: +1 503 805 7956
Fax: +1 503 327 2001
Email: thmi@vestas.com

From: Brett O'Connor [mailto:brett.oconnor@tcir.net]
Sent: Friday, November 21, 2008 12:52 PM
To: Charles Gagnon
Subject: RE: Noise Data

Charles
We've checked with the consultants, all we need is the noise emissions at the nacelle for varying wind speeds, our consultants will translate that via the windshear to measure the compliance of our site against the requirements I sent previously. Unless this is a service Vestas provide free for clients?? We have the shear profile.

Can you please let me know asap, we are close to submitting our ESR and this is one of the last outstanding items.

Regards
Brett

T: +1 514 842 1923
C: +1 514 805 6474

tci renewables
www.tcirenewables.com
TCI Renewables Ltd No:5360262 Registered in England & Wales; 7 West Way, Oxford, OX2 0JB VAT No:GB867303806

From: Charles Gagnon [mailto:chgag@vestas.com]
Sent: 11 November 2008 14:04
To: Brett O'Connor
Subject: RE: Noise Data

Hi Brett,

I've only had a partial response from our site folks regarding your noise inquiry. They have asked that you send the average summer night time shear value and the turbine type (in this case the V90 1.8MW on an 80m tower).

I would presume that once we receive this information, we can proceed with the calculations and provide you with the required data.

Yours sincerely,

Charles Gagnon

Vestas-Canadian Wind Technology, Inc.
chgag@vestas.com

From: Brett O'Connor [mailto:brett.oconnor@tcir.net]
Sent: November 11, 2008 11:43
To: Charles Gagnon
Subject: FW: Noise Data

Charles

Any joy with the noise data?
Please also see below some queries from Consumers Energy in Ohio related to a grid application we are looking to submit for a circa 80MW wind farm with V90 turbines.

1. Default parameters and instructions/whitepaper for setting parameters for the V80 dynamic model in PTI PSS/E.
2. The General Specification Document no.: 0000-6153 V00 indicates that the machine operates at unity power factor. Consumers Energy wants to know how this is accomplished, either through converter switching or switched capacitors?
3. What is the short circuit contribution and equivalent circuit of the machine as seen by the 34.5 kV system?
4. Please provide a reactive power capability curve
5. PTI dynamics.

Regards
Brett
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please consider the environment - do you really need to print this email?

From: Brett O'Connor
Sent: 04 November 2008 14:24
To: 'Charles Gagnon'
Cc: Mark Gallagher
Subject: Noise Data

Charles

Trust all is well.

As we're aiming to deposit our Environmental Screening Report in the next 1-2 months we need to conclude our noise studies. Would it be possible for Vestas to provide the information required in accordance with the Ontario Governments Noise Guidelines, as attached and extracted below to enable us to complete the required studies. The main issue is that we require the noise levels across the power curve to enable the required noise profile to be established.

Can you please let me know any queries.

6.2.2
Wind Turbines
The acoustic emissions of the wind turbine must be specified by the manufacturer for the full range of rated operation and wind speeds. As a minimum, the information must include the sound power levels, frequency spectra in octave bands (63 to 8000 Hz), and tonality at integer wind speeds from 6 to 10 m/s. The acoustic emission information must be determined and reported in accordance with the international standard CAN/CSA-C61400-11-07, Reference [5].
6.2.3
Adjustment to Wind Turbine Generator Acoustic Emissions for Wind Speed Profile
The wind speed profile on site of the Wind Farm may have an effect on the manufacturer's wind turbine acoustic emission data and, consequently, on the sound levels predicted at a Point of Reception. Therefore, the wind turbine generator acoustic emission levels must be consistent with the wind speed profile of the project area.
To address this issue, the assessment must use manufacturer's acoustic emission data adjusted for the average summer night time wind speed profile, representative of the site.
The adjusted acoustic emissions data must be used in the noise impact assessment at each receptor. The manufacturer's acoustic emissions data and the adjusted acoustic emission data used in the noise impact assessment must be tabulated in Table 3.

Regards
Brett

Brett O'Connor
Operations Director
TCI Renewables (Registered in Canada as Air Energy TCI Inc)

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Class I
Item no.: 950019 V07
2008-05-05

General Specification

V90 – 1.8/2.0 MW

50 Hz OptiSpeed^{TM} – Wind Turbine
Controller 5000.02 VCS

Table of Contents

1 Wind Turbine Description

The VESTAS V90-1.8/2.0 MW is a pitch regulated upwind turbine with active yaw and a rotor with three blades.

The VESTAS V90–1.8/2.0 MW has a rotor diameter of 90 m and operates using the OptiSpeed^{TM} concept. This feature enables the rotor to operate with variable speed (RPM) and hereby optimize the aerodynamic efficiency of the rotor.

The V90-1.8/2.0 MW 50Hz is available in 3 noise modes:

Mode 0	Power optimized (no damping)
Mode 1	Semi-damped
Mode 2	Full damped

The 1.8 MW version is available for IEC IIA wind conditions and the 2.0 MW version is available for IEC IIIA and DIBt II wind conditions.

All V90-1.8/2.0 MW turbines are equipped with OptiTip®, the special VESTAS pitch regulating system. With OptiTip®, the angles of the blades are constantly regulated to the optimum position under the relevant wind situation. The purpose is to optimize the power production and noise levels.

The blades are made of glass fibre reinforced epoxy and carbon fibres. Each blade consists of two blade shells, bonded to a supporting beam. Special steel root inserts connect the blades to the blade bearing. The blade bearing is a 4-point contact ball bearing, which is bolted to the blade hub.

The forged main shaft transmits the power to the generator through the gearbox. The gearbox is a combined planetary and helical gearbox. From the gearbox, the power is transmitted via a composite high speed coupling to the generator. The generator is a special asynchronous 4-pole generator with wound rotor.

The high voltage step up transformer is located to the rear of the nacelle in a separate compartment. The transformer is of a dry resin design, specially designed for operation in wind turbines.

At all wind speeds, the OptiTip® and the OptiSpeedTM systems will maximize the power output regardless of the air temperature and air density. At high wind speeds, the energy production is maintained at nominal output.

The turbine is equipped with an aerodynamic braking system, which will stop the rotation when such action is required. The system will perform a full feathering of the blades thus bringing the rotor rotation to a controlled level. A parking disc brake is mounted on the high-speed shaft of the gearbox. This brake is only manually activated by pressing an Emergency Stop Button inside the wind turbine.

All functions and operations of the wind turbine are monitored and controlled by a microprocessor-based control unit. The control system is equipped with a number of sensors to ensure a safe and optimal operation of the wind turbine.

Operation of the pitch system (blade rotation) is performed by 3 hydraulic cylinders, one for each blade. The hydraulic unit is installed in the nacelle and supplies hydraulic pressure to both the pitch- and braking systems. The systems are equipped with hydraulic accumulators to ensure a controlled and safe shutdown during grid outages.

Four electrical yaw gears rotate the nacelle on the top of the tower. The yaw bearing system is a plain-bearing system with built-in friction.

The glass fibre reinforced nacelle cover protects all the components inside the nacelle against rain, snow, dust, sun, etc. A central bottom opening provides access to the nacelle from the tower. An 800 kg service crane system is installed inside the nacelle. The crane can be upgraded to hoist up to 7500 kilograms.

The steel tubular tower is delivered painted and is available in various tower heights (for details see 1.2).

As an option, VESTAS offers a service lift in the tubular tower.

1.1 OptiSpeed^{TM} Description

OptiSpeed^{TM} ensures a steady and stable electric power production from the turbine.

The OptiSpeed system consists of an asynchronous generator with wound rotor and slip rings. A power converter with IGBT switches, contactors and protection enables the turbine to operate with variable speed.

The OptiSpeed and the OptiTip systems ensure energy optimization, low noise operation and reduction of loads on the gearbox and other vital components.

The system controls the current in the rotor circuit of the generator. This gives precise control of the reactive power, and gives smooth connection sequence to the grid.

The reactive power control is as default set to 0 KVAr export/import.

1.2 Type Approvals

The V90-1.8/2.0 MW wind turbine is approved according to the following standards:

Country:	Design criteria:	Conditions:	Hub heights:	Turbine ratings:
IEC	WT01	IIA / IIIA	80 m	1.8 MW / 2.0 MW
	WT01	IIA	95 m	1.8 MW
	WT01	IIIA	105 m	2.0 MW
Germany	DIBt	Zone II	95 m / 105 m / 125 m	2.0 MW

Table 1-1

1.3 Terrain Conditions

If the terrain is outside the below listed rules or the terrain otherwise seems complex, particular considerations may be necessary and Vestas must be contacted.

- Within a radius of 100 meters from the turbine, maximum slope of 10°.
- Within a radius of 100 to 500 meters from the turbine, maximum slope of 15°.
- Outside a 500 meters radius from the turbine, maximum slope of 20°.

1.4 Climatic Conditions

A standard wind turbine is designed for operating at ambient temperatures ranging from -20°C to +30°C. Thus, it stops operation at -20°C and +30°C.

The restart temperatures after stop on lower/upper ambient temperature limit are -19°C to +29°C respectively. Special precautions must be taken outside the standard operating temperatures (see 1.6 General Reservations, p. 5).

The wind turbines can be placed in wind turbine parks with a distance of at least 5 rotor diameters (450 m) between the wind turbines. If the wind turbines are placed in one row, perpendicular of the predominant wind direction, the distance between the wind turbines must be at least 4 rotor diameters (360 m).

The relative humidity can be 100% (max. 10% of lifetime). Corrosion protection according to ISO 12944-2 for corrosion class: C5-M outside (see special differentiation on tower in 3.11 Tower (Steel)), C4 in spinner / hub and trafo room, and C3 inside the nacelle. Corrosion protection is designed for long lifetime.

1.5 Grid Connection

The wind turbine must be connected to high voltage grid at 6-33 kV (50 Hz), where 36 kV (U_m) is the highest equipment voltage. The cable connection is made in the bottom of the tower.

The step up transformer output voltage is customised to fit the local interconnection grid voltage.

The voltage of the high voltage grid must be within +5/-5%. Steady frequency variations within +1/-3 Hz (50 Hz) are acceptable. Intermittent or rapid grid frequency fluctuations may cause serious damage to the turbine.

Over the turbine lifetime, grid drop-outs are to occur at an average of no more than 20 times a year.

The earthing system for the turbine and electrical grid must be made according to the Vestas Earthing System concept.

For more general information on the Vestas Earthing system, see Vestas document, item no.: 0000-3388.

1.6 General Reservations

Vestas OptiSpeed™ technology is not available in United States of America and Canada.

Operation during icy conditions can result in operation stops.

In certain combinations of high wind, high temperature, low air density and/or low voltage, power de-rating may happen to ensure that the thermal conditions of the main components such as gearbox, generator, transformer etc. are kept within limits.

It is generally recommended that the grid voltage is as close to nominal as possible. In case of grid dropout and very low temperatures, a certain time for warming up must be expected, before the wind turbine can start to operate.

If the wind turbine is placed more than 1000 m above sea level, the cooling efficiency of the turbine could be decreased. A temperature rise might occur in the generator, the transformer and in other electrical components. Under such circumstances, a periodic reduction of rated power might occur, even if the ambient temperature is within the specified limits.

At sites placed more than 1000 m above sea level, there will be an increased risk of ice build up. All start/stop parameters within the controller has a control hysteresis incorporated which can affect the operation during start, stop and restart of the turbine.

Lightning strikes are considered force majeure, i.e. damage caused by lightning strikes is not warranted by Vestas.

Due to continuous development and updating of our products, VESTAS reserves the right to change the specifications.

2 Main Data

2.1 Wind Climate

Turbulence is a factor to describe short-term wind variations/fluctuations. Below, the design conditions for the VESTAS V90-1.8/2.0 MW wind turbine are listed.

IEC class	Hub height [m]	A-parameter [m/s]	Mean wind [m/s]	C-parameter	Turbulence [%]	Wind gust Max. acc. [m/s^2]
IIA	80	9.59	8.5	2.0	18	10
IIIA	80	8.46	7.5	2.0	18	10
IIA	95	9.59	8.5	2.0	18	10
IIIA	105	8.46	7.5	2.0	18	10

The wind speed and turbulence listed are with reference to the hub height.

DIBt zone	Hub height [m]	A-parameter [m/s]	Mean wind [m/s]	C-parameter	Turbulence [%]	Wind gust Max. acc. [m/s^2]
II	95	7.17	6.35	2.0	20	10
II	105	7.28	6.46	2.0	20	10
II	125	8.40	7.43	2.0	18	10

The maximum allowable extreme wind speeds are listed below.

IEC Class	Max.10 min. mean [m/s] 50 year	Max. 3 sec. mean [m/s] 50 year	Max.10 min. mean [m/s] 1 year	Max. 3 sec. mean [m/s] 1 year	Stop Wind Speed/ Restart Wind Speed [m/s]
IIA	42.5	59.5	31.9	44.6	25/20
IIIA	37.5	52.5	28.2	39.4	25/20

DIBt zone	Max.10 min. mean [m/s] 50 year	Max. 3 sec. mean [m/s] 50 year	Max.10 min. mean [m/s] 1 year	Max. 3 sec. mean [m/s] 1 year	Stop Wind Speed/ Restart Wind Speed [m/s]
II 95m	39.6	50.7	31.7	40.6	21/20
II 105m	40.2	51.3	32.2	41.0	23/20
II 125m	41.3	52.3	33.1	41.8	25/20

2.2 Power Curves – Calculated

Power curves are calculated for the 2 nominal power versions (1.8 and 2.0 MW). 12 different air densities and 3 noise modes are calculated for each nominal power version. The power is calculated on the low voltage side of the transformer. Therefore, losses in transformer and high voltage cables are not included. Wind speed and power are related to hub height.

2.2.1 Power Curve [kW] V90-1.8 MW Star/Delta, Mode 0

P (10min) [kW] V90-1.8 MW Star/Delta, Mode 0												
Wind [m/s]	**Air density [kg/m^3]**											
	1.225	**0.97**	**1**	**1.03**	**1.06**	**1.09**	**1.12**	**1.15**	**1.18**	**1.21**	**1.24**	**1.27**
4	**88**	64	67	70	72	75	78	81	84	87	90	92
5	**204**	157	162	168	174	179	185	190	196	202	207	213
6	**371**	288	297	307	317	327	337	346	356	366	376	385
7	**602**	471	486	502	517	532	548	563	579	594	609	625
8	**901**	711	733	756	778	801	824	846	868	890	912	934
9	**1243**	985	1015	1045	1076	1106	1136	1167	1197	1228	1258	1289
10	**1570**	1262	1300	1338	1376	1414	1452	1486	1520	1554	1584	1611
11	**1759**	1527	1562	1597	1632	1667	1702	1719	1735	1751	1763	1770
12	**1793**	1722	1735	1747	1760	1773	1785	1788	1790	1792	1794	1795
13	**1800**	1788	1790	1792	1795	1797	1799	1800	1800	1800	1800	1800
14	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
15	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
16	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
17	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
18	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
19	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
20	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
21	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
22	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800

P (10min) [kW] V90-1.8 MW Star/Delta, Mode 0												
23	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
24	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
25	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800

2.2.2 Power Curve [kW] V90-1.8 MW Star/Delta, Mode 1

P (10min) [kW] V90-1.8 MW Star/Delta, Mode 1												
Wind [m/s]	**Air density [kg/m^3]**											
	1.225	**0.97**	**1**	**1.03**	**1.06**	**1.09**	**1.12**	**1.15**	**1.18**	**1.21**	**1.24**	**1.27**
4	**88**	64	66	69	72	75	78	81	84	87	90	92
5	**204**	157	162	168	174	179	185	190	196	202	207	213
6	**371**	288	297	307	317	327	336	346	356	366	376	385
7	**602**	471	486	502	517	533	548	563	579	594	609	625
8	**900**	710	732	755	777	800	822	844	867	889	911	933
9	**1229**	964	996	1028	1060	1092	1124	1154	1184	1214	1245	1275
10	**1541**	1190	1236	1282	1327	1373	1419	1454	1489	1524	1556	1587
11	**1742**	1437	1484	1530	1576	1622	1668	1689	1710	1731	1748	1760
12	**1790**	1650	1675	1700	1725	1749	1774	1779	1783	1788	1791	1793
13	**1800**	1762	1769	1776	1784	1791	1798	1799	1799	1800	1800	1800
14	**1800**	1795	1796	1797	1798	1799	1800	1800	1800	1800	1800	1800
15	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
16	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
17	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
18	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
19	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
20	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
21	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
22	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
23	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
24	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
25	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800

2.2.3 Power Curve [kW] V90-1.8 MW Star/Delta, Mode 2

P (10min) [kW] V90-1.8 MW Star/Delta, Mode 2												
Wind [m/s]	**Air density [kg/m^3]**											
	1.225	**0.97**	**1**	**1.03**	**1.06**	**1.09**	**1.12**	**1.15**	**1.18**	**1.21**	**1.24**	**1.27**
4	**88**	64	67	69	72	75	78	81	84	87	90	92
5	**204**	157	162	168	174	179	185	190	196	202	207	213
6	**371**	288	297	307	317	327	337	346	356	366	376	385
7	**602**	471	486	502	517	533	548	563	579	594	609	625
8	**880**	694	716	738	760	782	804	826	848	869	891	912
9	**1147**	911	939	966	994	1022	1050	1078	1106	1133	1161	1189
10	**1405**	1114	1148	1183	1217	1252	1286	1320	1354	1388	1421	1453
11	**1623**	1315	1354	1394	1434	1473	1513	1545	1576	1607	1635	1659
12	**1729**	1515	1548	1581	1614	1647	1680	1694	1708	1722	1732	1739
13	**1761**	1672	1688	1703	1718	1734	1749	1753	1756	1759	1762	1763
14	**1774**	1751	1755	1759	1764	1768	1772	1773	1773	1773	1773	1773
15	**1786**	1782	1782	1783	1784	1785	1786	1786	1786	1786	1786	1786
16	**1795**	1792	1792	1793	1794	1794	1795	1795	1795	1795	1795	1795
17	**1799**	1798	1798	1798	1798	1798	1798	1798	1798	1799	1799	1799
18	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
19	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
20	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
21	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
22	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
23	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
24	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
25	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800

2.2.4 Power Curve [kW] V90-2.0 MW Star/Delta, Mode 0

P (10min) [kW] V90-2.0 MW Star/Delta, Mode 0												
Wind [m/s]	**Air density [kg/m^3]**											
	1.225	**0.97**	**1**	**1.03**	**1.06**	**1.09**	**1.12**	**1.15**	**1.18**	**1.21**	**1.24**	**1.27**
4	**88**	64	67	70	72	75	78	81	84	87	90	93
5	**205**	157	163	169	174	180	185	191	197	202	208	213
6	**371**	288	297	307	317	327	337	346	356	366	375	385
7	**601**	470	486	501	517	532	548	563	578	594	609	624
8	**901**	711	734	756	779	801	824	846	868	890	912	934
9	**1243**	985	1015	1045	1075	1106	1136	1166	1197	1227	1258	1289
10	**1591**	1262	1301	1341	1380	1419	1458	1496	1534	1572	1609	1646
11	**1876**	1531	1577	1622	1667	1712	1757	1791	1825	1859	1887	1910
12	**1979**	1782	1814	1846	1879	1911	1943	1953	1963	1974	1981	1986
13	**1999**	1943	1953	1962	1972	1982	1992	1994	1996	1998	1999	2000
14	**2000**	1991	1993	1995	1996	1998	2000	2000	2000	2000	2000	2000
15	**2000**	1999	1999	2000	2000	2000	2000	2000	2000	2000	2000	2000
16	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
17	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
18	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
19	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
20	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
21	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
22	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
23	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
24	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
25	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000

2.2.5 Power Curve [kW] V90-2.0 MW Star/Delta, Mode 1

P (10min) [kW] V90-2.0 MW Star/Delta, Mode 1												
Wind [m/s]	**Air density [kg/m^3]**											
	1.225	**0.97**	**1**	**1.03**	**1.06**	**1.09**	**1.12**	**1.15**	**1.18**	**1.21**	**1.24**	**1.27**
4	**88**	64	66	69	72	75	78	81	84	87	90	92
5	**204**	157	162	168	174	179	185	190	196	202	207	213
6	**371**	288	297	307	317	327	336	346	356	366	376	385
7	**602**	471	486	502	517	533	548	563	579	594	609	625
8	**900**	710	732	755	777	800	822	844	867	889	911	933
9	**1229**	975	1005	1034	1064	1094	1124	1154	1184	1214	1245	1275
10	**1555**	1231	1269	1308	1346	1385	1423	1460	1498	1536	1573	1609
11	**1835**	1482	1527	1572	1617	1661	1706	1743	1780	1816	1849	1877
12	**1967**	1726	1763	1800	1837	1874	1911	1927	1943	1959	1970	1977
13	**1997**	1906	1921	1937	1953	1968	1984	1988	1991	1995	1997	1999
14	**2000**	1979	1983	1987	1991	1995	1999	1999	2000	2000	2000	2000
15	**2000**	1997	1998	1998	1999	1999	2000	2000	2000	2000	2000	2000
16	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
17	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
18	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
19	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
20	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
21	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
22	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
23	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
24	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
25	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000

2.2.6 Power Curve [kW] V90-2.0 MW Star/Delta, Mode 2

P (10min) [kW] V90-2.0 MW Star/Delta, Mode 2												
Wind [m/s]	**Air density [kg/m^3]**											
	1.225	**0.97**	**1**	**1.03**	**1.06**	**1.09**	**1.12**	**1.15**	**1.18**	**1.21**	**1.24**	**1.27**
4	**88**	64	67	69	72	75	78	81	84	87	90	92
5	**204**	157	162	168	174	179	185	190	196	202	207	213
6	**371**	288	297	307	317	327	337	346	356	366	376	385
7	**602**	471	486	502	517	533	548	563	579	594	609	625
8	**880**	694	716	738	760	782	804	826	848	869	891	912
9	**1147**	911	939	966	994	1022	1050	1078	1106	1133	1161	1189
10	**1408**	1114	1148	1183	1217	1252	1286	1321	1356	1390	1425	1459
11	**1657**	1315	1356	1398	1439	1480	1521	1560	1599	1637	1674	1709
12	**1846**	1520	1564	1607	1651	1694	1738	1769	1799	1830	1855	1875
13	**1927**	1717	1751	1784	1817	1851	1884	1896	1909	1921	1929	1934
14	**1956**	1868	1884	1899	1915	1931	1946	1949	1952	1954	1956	1957
15	**1975**	1945	1950	1956	1962	1967	1973	1973	1974	1974	1975	1975
16	**1989**	1972	1975	1978	1981	1984	1988	1988	1989	1989	1989	1990
17	**1996**	1982	1984	1986	1987	1989	1991	1992	1994	1995	1996	1996
18	**1999**	1989	1990	1991	1991	1992	1993	1995	1996	1998	1999	1999
19	**2000**	1994	1995	1996	1996	1997	1998	1999	1999	2000	2000	2000
20	**2000**	1998	1999	1999	1999	2000	2000	2000	2000	2000	2000	2000
21	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
22	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
23	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
24	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
25	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000

2.3 Annual Output Estimate

Below, annual output for different wind distributions is listed. Calculations are based on wind conditions with 10% turbulence, an air density of 1.225 kg/m3, wind shear of 0.15, terrain angle of 0 degrees and A- and C-data from 2.1 Wind Climate, p. 6.

Annual production [MWh]		
	V90-1.8 MW	**V90-2.0 MW**
DIBt II (95m)		5487
DIBt II (105m)		5673
DIBt II (125m)		7233
IEC IIA (80m and 95m)	8249	
IEC IIIA (80m and 105m)		7339

Table 2-1: Annual production [MWh]

2.4 Noise Curves, Calculated

	Sound Power Level at Hub Height, V90-1.8MW “Mode 0”				
	Conditions for Sound Power Level	Verification standard: IEC 61400-11 Ed. 2 Wind shear as described in table below. Max turbulence at 10 meter height: 16% Inflow angle (vertical): 0 ± 2° Air density: 1.225 kg/m^3			
	Hub height	HH 80 m	HH 95 m		
	Wind shear	0.1592	0.1592		
	Verification Report:				
		dB(A) re 1pW	dB(A) re 1pW		
	L_{WA} @ 4m/s (10 meter above ground)	94.4	95.0		
	L_{WA} @ 5m/s (10 meter above ground)	99.4	100.0		
	L_{WA} @ 6m/s (10 meter above ground)	102.5	102.8		
	L_{WA} @ 7m/s (10 meter above ground)	103.6	103.7		
	L_{WA} @ 8m/s (10 meter above ground)	104.0	104.0		
	L_{WA} @ 9m/s (10 meter above ground)	104.0	104.0		
	L_{WA} @ 10m/s (10 meter above ground)	104.0	104.0		
	L_{WA} @ 11m/s (10 meter above ground)	104.0	104.0		

	Sound Power Level at Hub Height, V90-1.8MW "Mode 0"				
	L_{WA} @ 12m/s (10 meter above ground)	104.0	104.0		

	Sound Power Level at Hub Height, V90-1.8MW "Mode 1"				
	Conditions for Sound Power Level	Verification standard: IEC 61400-11 Ed. 2 Wind shear as described in table below. Max turbulence at 10 meter height: 16% Inflow angle (vertical): 0 ± 2° Air density: 1.225 kg/m³			
	Hub height	HH 80 m	HH 95 m		
	Wind shear	0.1592	0.1592		
	Verification Report:				
		dB(A) re 1pW	dB(A) re 1pW		
	L_{WA} @ 4m/s (10 meter above ground)	94.4	95.0		
	L_{WA} @ 5m/s (10 meter above ground)	99.4	100.0		
	L_{WA} @ 6m/s (10 meter above ground)	102.5	102.6		
	L_{WA} @ 7m/s (10 meter above ground)	103.0	103.0		
	L_{WA} @ 8m/s (10 meter above ground)	103.0	103.0		
	L_{WA} @ 9m/s (10 meter above ground)	103.0	103.0		
	L_{WA} @ 10m/s (10 meter above ground)	103.0	103.0		
	L_{WA} @ 11m/s (10 meter above ground)	103.0	103.0		
	L_{WA} @ 12m/s (10 meter above ground)	103.0	103.0		

	Sound Power Level at Hub Height, V90-1.8MW "Mode 2"				
	Conditions for Sound Power Level	Verification standard: IEC 61400-11 Ed. 2 Wind shear as described in table below. Max turbulence at 10 meter height: 16% Inflow angle (vertical): 0 ± 2° Air density: 1.225 kg/m3			
	Hub height	HH 80 m	HH 95 m		
	Wind shear	0.1592	0.1592		
	Verification Report:				
		dB(A) re 1pW	dB(A) re 1pW		
	L_{WA} @ 4m/s (10 meter above ground)	94.4	95.0		
	L_{WA} @ 5m/s (10 meter above ground)	99.4	100.0		
	L_{WA} @ 6m/s (10 meter above ground)	100.9	101.0		
	L_{WA} @ 7m/s (10 meter above ground)	101.0	101.0		
	L_{WA} @ 8m/s (10 meter above ground)	101.0	101.0		
	L_{WA} @ 9m/s (10 meter above ground)	101.0	101.0		
	L_{WA} @ 10m/s (10 meter above ground)	101.0	101.0		
	L_{WA} @ 11m/s (10 meter above ground)	101.0	101.0		
	L_{WA} @ 12m/s (10 meter above ground)	101.0	101.0		

	Sound Power Level at Hub Height, V90-2.0MW "Mode 0"				
	Conditions for Sound Power Level	Verification standard: IEC 61400-11 Ed. 2 Wind shear as described in table below. Max turbulence at 10 meter height: 16% Inflow angle (vertical): 0 ± 2° Air density: 1.225 kg/m^3			
	Hub height	HH 80m	HH 95m	HH 105m	HH 125m
	Wind shear	0.1592	0.1573	0.1562	0.1543
	Verification Report:				
		dB(A) re 1pW	dB(A) re 1pW	dB(A) re 1pW	dB(A) re 1pW
	L_{WA} @ 4m/s (10 meter above ground)	94.4	95.0	95.5	96.1
	L_{WA} @ 5m/s (10 meter above ground)	99.4	100.0	100.3	100.8
	L_{WA} @ 6m/s (10 meter above ground)	102.5	102.8	103.0	103.3
	L_{WA} @ 7m/s (10 meter above ground)	103.6	103.7	103.8	103.9
	L_{WA} @ 8m/s (10 meter above ground)	104.0	104.0	104.0	104.0
	L_{WA} @ 9m/s (10 meter above ground)	104.0	104.0	104.0	104.0
	L_{WA} @ 10m/s (10 meter above ground)	104.0	104.0	104.0	104.0
	L_{WA} @ 11m/s (10 meter above ground)	104.0	104.0	104.0	104.0
	L_{WA} @ 12m/s (10 meter above ground)	104.0	104.0	104.0	104.0

	Sound Power Level at Hub Height, V90-2.0MW “Mode 1”				
	Conditions for Sound Power Level	Verification standard: IEC 61400-11 Ed. 2 Wind shear as described in table below. Max turbulence at 10 meter height: 16% Inflow angle (vertical): 0 ± 2° Air density: 1.225 kg/m^3			
	Hub height	HH 80 m	HH 95 m	HH 105 m	HH 125 m
	Wind shear	0.1592	0.1573	0.1562	0.1543
	Verification Report:				
		dB(A) re 1pW	dB(A) re 1pW	dB(A) re 1pW	dB(A) re 1pW
	L_{WA} @ 4m/s (10 meter above ground)	94.4	95.0	95.5	96.1
	L_{WA} @ 5m/s (10 meter above ground)	99.4	100.0	100.3	100.8
	L_{WA} @ 6m/s (10 meter above ground)	102.4	102.7	102.8	103.0
	L_{WA} @ 7m/s (10 meter above ground)	103.0	103.0	103.0	103.0
	L_{WA} @ 8m/s (10 meter above ground)	103.0	103.0	103.0	103.0
	L_{WA} @ 9m/s (10 meter above ground)	103.0	103.0	103.0	103.0
	L_{WA} @ 10m/s (10 meter above ground)	103.0	103.0	103.0	103.0
	L_{WA} @ 11m/s (10 meter above ground)	103.0	103.0	103.0	103.0
	L_{WA} @ 12m/s (10 meter above ground)	103.0	103.0	103.0	103.0

	Sound Power Level at Hub Height, V90-2.0MW “Mode 2”				
	Conditions for Sound Power Level	Verification standard: IEC 61400-11 Ed. 2 Wind shear as described in table below. Max turbulence at 10 meter height: 16% Inflow angle (vertical): 0 ± 2° Air density: 1.225 kg/m^3			
	Hub height	HH 80m	HH 95m	HH 105m	HH 125m
	Wind shear	0.1592	0.1573	0.1562	0.1543
	Verification Report:				
		dB(A) re 1pW	dB(A) re 1pW	dB(A) re 1pW	dB(A) re 1pW
	L_{WA} @ 4m/s (10 meter above ground)	94.4	95.0	95.5	96.1
	L_{WA} @ 5m/s (10 meter above ground)	99.4	100.0	100.0	100.2
	L_{WA} @ 6m/s (10 meter above ground)	100.9	101.0	101.0	101.0
	L_{WA} @ 7m/s (10 meter above ground)	101.0	101.0	101.0	101.0
	L_{WA} @ 8m/s (10 meter above ground)	101.0	101.0	101.0	101.0
	L_{WA} @ 9m/s (10 meter above ground)	101.0	101.0	101.0	101.0
	L_{WA} @ 10m/s (10 meter above ground)	101.0	101.0	101.0	101.0
	L_{WA} @ 11m/s (10 meter above ground)	101.0	101.0	101.0	101.0
	L_{WA} @ 12m/s (10 meter above ground)	101.0	101.0	101.0	101.0

3 Technical Specifications

3.1 Rotor

Diameter:	90 m
Swept area:	6362 m^2
Rotational speed static, rotor:	14.9 rpm
Rotor speed, operation interval rotor:	9.0 - 14.9 rpm
Rotational direction:	Clockwise (front view)
Orientation:	Upwind
Tilt:	6°
Blade coning:	-2°
Number of blades:	3
Aerodynamic brakes:	Full feathering

3.2 Blade

Principle:	Airfoil shells bonded to supporting beam
Material:	Fibreglass reinforced epoxy and carbon fibres
Blade connection:	Steel root inserts
Air foils:	RISØ P + FFA-W3
Length:	44 m
Chord:	
Blade root:	3.512 m
Blade tip:	0.391 m
Twist (blade root / blade tip):	17.5°
Weight:	Approx. 6,660 kg

3.3 Blade Bearing

Type:	2 row 4-point contact ball bearing

3.4 Blade Hub

Type:	Cast ball shell hub
Material:	EN-GJS-400-18U-LT

3.5 Main Shaft

Type:	Forged, trumpet shaft
Material:	42 CrMo4 QT / EN 10083

3.6 Bearing Housing

Type:	Cast foot housing with lowered centre
Material:	EN-GJS-400-18U-LT

3.7 Main Bearings

Type:	Spherical roller bearings from recognized suppliers

3.8 Machine Foundation

Type:	Cast EN-GJS-400-18U-LT

3.9 Yaw System

Type:	Plain bearing system with built-in friction
Material:	Forged yaw ring heat-treated. Plain bearings PETP.
Yawing speed:	< 0.5°/sec

3.10 Yaw Gears

Type:	Non-locking combined worm gear and planetary gearbox Electrical motor brake
Motor:	2.2 kW, 6 pole, asynchronous

3.11 Tower (Steel)

Type:	Conical tubular
Material:	S 355
Surface treatment:	Painted
Corrosion class, outside:	C5-I (ISO 12944)
Corrosion class, inside:	C3 (ISO 12944)
Top diameter for all towers:	2.3 m

Bottom mean diameter for all towers:	4.15 m
	Hub Height
3-parted, modular tower	80 m IEC IIA / IIIA
4-parted, modular tower	95 m IEC IIA
4-parted, modular tower	105 m IEC IIIA
4-parted, modular tower	95 m DIBt II
5-parted, modular tower	105 m DIBt II
5-parted, modular tower	125 m DIBt II
The hub height is measured from ground level, and the distance from tower top flange to blade hub centre is included (1.7 m)	
Service lift:	As an option, VESTAS offers a service lift

3.12 Gearbox

Type:	1 planetary stage / 2 helical stages
Ratio:	50 Hz: 1:113.1 $\pm$ 0.2%
Cooling:	Oil pump with oil cooler
Oil heater:	2 kW
Oil filtration:	25 μm inline / 3 μm offline
Manufacturer:	Vestas has more sub-suppliers of gearboxes. All gearboxes comply with Vestas' specifications.

3.13 Couplings

Main shaft - gearbox:	
Type:	Shrink disc, conical
Gearbox – generator:	
Type:	Composite shaft

3.14 Generator with VCS

Rated power:	2.0 MW
Type:	Asynchronous with wound rotor, slip rings and VCS
Voltage:	Stator: 690 V Rotor: 480 V
Frequency:	50 Hz
No. of poles:	4
Class of protection:	IP54

Rated speed:	1680 RPM / 2016 RPM
Rated power factor, default:	1.0
Power factor range:	0.98_{CAP} - 0.96_{IND} (default set at 1.00).
Manufacturer:	Vestas has more sub-suppliers of generators. All generators comply with Vestas' specifications.

3.15 Manually Activated Parking Brake

Type:	Disc Brake
Diameter:	600 mm
Disc material:	EN-GJV-300

3.16 Hydraulic Unit

Pump capacity:	44 l/min
Working pressure:	180 - 200 bar
Oil quantity:	160 l
Motor:	18.5 kW

3.17 Anemometer and Wind Direction Sensor

Type:	1 ultrasonic sensor

3.18 Control Unit

Power supply:	
Voltage:	690 V, 480 V
Frequency:	50 Hz
Power supply for light:	230 VAC / 110V VAC
Computer:	
Communication:	ArcNet
Program memory:	EPROM (flash)
Programming language:	C / C++
Configuration:	Modules
Operation:	Numeric keyboard + function keys
Display:	4 x 40 characters
Supervision/control:	

	Active power
	Reactive power
	Yawing
	Hydraulics
	Environment (wind, temperature)
	Rotation
	Generator
	Pitch system
	Grid
	Remote monitoring: Possibility of connection of serial communication
Information:	Operating data
	Production
	Operation log
	Warning log
	Alarm log
Commands:	Run / Pause
	Man. Yaw start / stop
	Maintenance routine

3.19 Transformer

Type:	Cast resin
Rated Power:	2100 kVA
High voltage:	6 - 33 kV (50 Hz) (36 kV (U_m) equipment voltage)
Frequency	50 Hz
Vector group:	Dyn
HV – Tappings:	±2 x 2.5%
Low voltage:	690 V
Power at 690 V	1902 kVA
Low voltage:	480 V
Power at 480 V	205 kVA

3.20 Weights (tolerance ± 3%)

Type	**IEC IIA/IIIA 80m**	**IEC IIA 95m**	**IEC IIIA 105m**	**DIBt II 95m**	**DIBt II 105m**	**DIBt II 125m**
Tower	147,000 kg	197,000 kg	233,000 kg	200,000 kg	224,000 kg	310,000 kg
Nacelle	68,000 kg	68,000 kg	68,000 kg	68,000 kg	68,000 kg	68,000 kg
Rotor	38,000 kg	38,000 kg	38,000 kg	38,000 kg	38,000 kg	38,000 kg
Total	**253,000 kg**	**303,000 kg**	**339,000 kg**	**306,000 kg**	**330,000 kg**	**416,000 kg**

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General Specification

V90 – 1.8 MW VCUS

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See section 11 'General Reservations, Notes and Disclaimers', p. 34 for general reservations, notes, and disclaimers applicable to these general specifications.

1 General Description

The Vestas V90-1.8 MW wind turbine is a pitch regulated upwind turbine with active yaw and a three-blade rotor. The Vestas V90-1.8 MW turbine has a rotor diameter of 90 m with a generator rated at 1.8 MW. The turbine utilizes a microprocessor pitch control system called OptiTip® and the Variable Speed concepts (VCUS: Vestas Converter Unity System). With these features the wind turbine is able to operate the rotor at variable speed (RPM), helping to maintain the output at or near rated power.

2 Mechanical Design

2.1 Rotor

The V90-1.8 MW is equipped with a 90 meter rotor consisting of three blades and the hub. Based on the prevailing wind conditions, the blades are continuously positioned to help optimise the pitch angle.

Rotor	
Diameter	90 m
Swept Area	6362 m^2
Rotational Speed Static, Rotor	14.5 rpm
Speed, Dynamic Operation Range	9.0 – 14.5 rpm
Rotational Direction	Clockwise (front view)
Orientation	Upwind
Tilt	6°
Blade Coning	2°
Number of Blades	3
Aerodynamic Brakes	Full feathering

Table 2-1: Rotor data

2.2 Blades

The 44 m Prepreg (PP) blades are made of carbon and glass fibre and consist of two airfoil shells bonded to a supporting beam.

PP Blades	
Type Description	Airfoil shells bonded to supporting beam
Blade Length	44 m
Material	Fibreglass reinforced epoxy and carbon fibres
Blade Connection	Steel roots inserted
Air Foils	RISØ P + FFA –WA
Chord:	
Blade root	3.512 m
Blade tip	0.391 m
Twist (blade root/blade tip)	17.5°
Weight	6,700 kg

Table 2-2: PP blades data

2.3 Blade Bearing

The blade bearings are double row 4-point contact ball bearings.

Blade Bearing	
Type	2 row 4-point contact ball bearing
Lubrication	Grease lubrication, manually re-greased

Table 2-3: Blade bearing data

2.4 Pitch System

The energy input from the wind to the turbine is adjusted by pitching the blades according to the control strategy. The pitch system also works as the primary brake system by pitching the blades out of the wind. This causes the rotor to idle.

Double row 4-point contact ball bearings are used to connect the blades to the hub. The pitch system relies on hydraulics and uses a cylinder to pitch each blade. Hydraulic power is supplied to the cylinder from the hydraulic power unit in the nacelle through the main gearbox and the main shaft via a rotating transfer.

Hydraulic accumulators inside the rotor hub ensure sufficient power to stop the turbine in case of grid failure.

Pitch System	
Type	Hydraulic
Cylinder	Ø125/80 – 760
Number	1 pcs./ blade
Range	-5º to 90º

Table 2-4: Pitch system data

Hydraulic System	
Pump capacity:	44 l/min
Working pressure:	180 - 200 bar
Oil quantity:	160 l
Motor:	18.5 kW

Table 2-5: Hydraulic system data

2.5 Hub

The hub supports the 3 blades and transfers the reaction forces to the main bearing. The hub structure also supports blade bearings and pitch cylinder.

Hub	
Type	Cast ball shell hub
Material	Cast iron EN GJS 400-18U-LT / EN1560
Weight	8,400 kg.

Table 2-6: Hub Data

2.6 Main Shaft

Type:	Forged, trumpet shaft
Material:	42 CrMo4 QT / EN 10083

2.7 Bearing Housing

Type:	Cast foot housing with lowered centre
Material:	EN-GJS-400-18U-LT

2.8 Main Bearings

Type:	Spherical roller bearings
Lubrication	Grease lubrication, manually re-greased

2.9 Machine Foundation

Type:	Cast EN-GJS-400-18U-LT

2.10 Gearbox

The main gearbox transmits torque and revolutions from the rotor to the generator.

The main gearbox consists of a planetary stage combined with a two-stage parallel gearbox, torque arms and vibration dampers.

Torque is transmitted from the high-speed shaft to the generator via a flexible composite coupling, located behind the disc brake. The disc brake is mounted directly on the high-speed shaft.

Gearbox	
Type:	1 planetary stage / 2 helical stages
Ratio:	60 Hz: 1:92.6 nominal
Cooling:	Oil pump with oil cooler
Oil heater:	2 kW
Max gear oil temp:	80°c
Oil cleanliness:	-/15/12 ISO 4406

Table 2-7: Gearbox data

2.11 Generator Bearings

The bearings are greased and grease is supplied continuously from an automatic lubrication unit when the nacelle temperature is above -10°C. The yearly grease flow is approximately 2,400 cm^3/year.

2.12 High Speed Shaft Coupling

The flexible coupling transmits the torque from the gearbox high speed output shaft to the generator input shaft. The flexible coupling is designed to minimize misalignments between gearbox and generator. The coupling consists of two composite discs and an intermediate tube with two aluminium flanges and a glass fibre tube. The coupling is fitted to 3-armed hubs on the brake disc and the generator hub.

High Speed Shaft Coupling	
Type Description	VK 420

Table 2-8: High speed shaft coupling data

2.13 Yaw System

The yaw system is designed to keep the turbine upwind when the operating mode is RUN or PAUSE. The nacelle is mounted on the yaw plate, which is bolted to the turbine tower. The yaw bearing system is a plain bearing system with built-in friction. Asynchronous yaw motors with brakes enable the nacelle to rotate on top of the tower.

The VMP controller receives information of the wind direction from the wind sensor. Automatic yawing is deactivated when the mean wind speed is below 3 m/s.

Yaw System	
Type	Plain bearing system with built in friction
Material	Forged yaw ring heat-treated. Plain bearings PETP
Yawing Speed	< 0.5˚/sec.

Table 2-9: Yaw system data

Yaw Gear	
Type	Non-locking combined worm gear and planetary gearbox Electrical motor brake
Motor	1.5 kW, 6 pole, asynchronous
Number of yaw gears	6
Ratio Total (4 planetary stages)	1,120 : 1
Rotational Speed at Full Load	Approx. 1 rpm at output shaft

Table 2-10: Yaw gear data

2.14 Crane

The nacelle houses the service crane. The crane is a single system chain hoist.

Crane	
Lifting Capacity	Max. 800 kg

Table 2-11: Crane data

2.15 Tower Structure (Onshore)

Tubular towers with flange connections, certified according to relevant type approvals, are available in different standard heights. Magnets provide load support in a horizontal direction and internals, such as platforms, ladders, etc., are supported vertically (i.e. in the gravitational direction) by a mechanical connection.

The hub heights listed include a distance from the foundation section to the ground level of approximately 0.6 m depending on the thickness of the bottom flange and a distance from the tower top flange to the centre of the hub of 1.95 m.

Tower Structure	
Type Description	Conical tubular
Hub Heights	80 m/105 m
Material	S355 (A709/A572-50)
Weight	80 m IEC 2A 160 metric tons* 105 m IEC 2A 245 metric tons**

Table 2-12: Tower structure (Onshore) data

NOTE */** Typical values. Dependant on wind class, and can vary with site / project conditions.

2.16 Nacelle Base-Frame and Cover

The nacelle cover is made of fibreglass. Hatches are positioned in the floor for lowering or hoisting equipment to the nacelle and evacuation of personnel.

The roof section is equipped with wind sensors and skylights which can be opened from inside the nacelle to access the roof and from outside to access the nacelle. The nacelle cover is mounted on the girder structure. Access from the tower to the nacelle is through the yaw system.

The nacelle bedplate is in two parts and consists of a cast iron front part and a girder structure rear part. The front of the nacelle bedplate is the foundation for the drive train, which transmits forces from the rotor to the tower, through the yaw system. The bottom surface is machined and connected to the yaw bearing and the yaw-gears are bolted to the front nacelle bedplate.

The nacelle bedplate carries the crane beams through vertical beams positioned along the site of the nacelle. Lower beams of the girder structure are connected at the rear end.

The rear part of the bedplate serves as foundation for controller panels, cooling system and transformer.

Type Description	Material
Nacelle Cover	GRP
Base Frame Front	SG cast iron
Base Frame Rear	Welded Grid Structure

Table 2-13: Nacelle base-frame and cover data

2.17 Cooling

The cooling systems for the main components in the turbine shown below are all placed inside the nacelle and therefore conditioned by nacelle air. The transformer is conditioned by ambient air as it is placed in the air intake. The mass flow of air through the nacelle is mainly driven by the generator external fan and the gear oil cooler fans which lead the heated air out of the nacelle.

Component	Cooler type	Internal heating at low temperature
Nacelle	Forced air	No (yes LT/off shore)
Hub/nose cone	Natural air	No (yes LT/off shore)
Gear	Forced oil/air	Yes
Generator	Forced air/air	Yes
Slip rings	Forced air/air	Yes
Transformer	Forced air	No (heat source)
VCS	Forced water/air	No (heat source)
VRUS	Forced water/air	No (heat source)
VMP section	Forced air/air	Yes
Hydraulics	Forced air	Yes

All other heat generating systems are also equipped with fans and or coolers but are considered as minor contributors to nacelle thermodynamics.

2.18 Generator Cooling

The generator cooling system consists of an air to air cooler mounted on the top of the generator and two internal fans and one external fan. All the fans can run at high or low speed (1800/3600 rpm.).

Generator Cooling	
Air Inlet Temp. – External:	35°
Nominal Air Flow – Internal:	2.2 m^3/s
Nominal Air Flow – External:	1.95 m^3/s
Cooling Capacity	75 kW

Table 2-14: Cooling, generator data

2.19 Converter Cooling

The converter cooling system consists of a water pump that circulates the cooling water through the converter modules and a water cooler with a two-speed fan.

Converter Cooling	
Nominal Water Flow	Approx. 45 l/min (50% glycol)
Water Inlet Pressure	Max 2.0 bar
Water Inlet Temperature	Max. 56 ºC
Cooling Capacity	10 kW

Table 2-15: Cooling, converter data

2.19.1 Gearbox- and Hydraulic Cooling

The gearbox cooling system consists of two oil circuits and two oil coolers. The first circuit is equipped with a mechanically driven oil pump and oil cooler with built-in thermo bypass valve and the second circuit is equipped with an electrically driven oil pump and oil cooler.

Gearbox Cooling	
Gear Oil Cooler 1 (Mechanically driven oil pump)	
Nominal Oil Flow	72 l/min
Oil Inlet Pressure	80 °C
Air Inlet Temperature	45 °C
Nominal Air Flow	1.5 m^3/s
Cooling Capacity	32 kW
Gear Oil Cooler 2 (Electrically driven oil pump)	
Nominal Oil Flow	105 l/min
Oil Inlet Temp.	80 °C
Air Inlet Temp.	45 °C
Nominal Air Flow	3.2 m^3/s
Cooling Capacity	60 kW

Table 2-16: Cooling, gearbox data

The combined lubrication/cooling system is driven by a mechanical pump, mounted on the gear. This pumps oil, whenever gear is rotating. The cooling pump circuit is electric, and only activated when the mechanical circuit cannot meet the cooling demand.

Hydraulic Cooling	
Nominal Water Flow	Approx. 50 l/min (50% glycol)
Water Inlet Pressure	Max 2.0 bar
Water Inlet Temperature	Max. 53 ºC
Cooling Capacity	12 kW

Table 2-17: Cooling, hydraulic data

2.19.2 Transformer Cooling

The transformer is equipped with forced air cooling. The ventilator consists of six fans, located below the transformer leading the cooling air to locations beneath and between the HV and LV windings of the transformer.

Transformer Cooling	
Nominal Air Flow	1470 m^3/h
Air Inlet Temperature	Max. 30°C

Table 2-18: Cooling, transformer data

2.19.3 Nacelle Cooling

Heated air generated by mechanical and electrical equipment is removed from the nacelle by the 3 oil cooler fans and the generator cooling fan. The airflow enters the nacelle through louver dampers in the weather shield underneath the nacelle. The fans can run at low or high speed depending on the temperature in the nacelle, gear and generator.

Nacelle Cooling	
Nominal Airflow	7.3 m^3/s
Air Inlet Temperature	Max. 40°C

Table 2-19: Cooling, nacelle data

3 Electrical Design

3.1 Generator (VCUS – 60 Hz)

The generator is a 3-phase asynchronous generator with wound rotor, which is connected to the Vestas Converter Unity System (VCUS) via a slip ring system. The generator is an air-to-air cooled generator with an internal and external cooling circuit. The external circuit uses air from the nacelle and exhausts it out through the rear end of the nacelle.

The generator has six poles. The generator is wound with form windings in both rotor and stator. The stator is connected in star at low power and delta at high power. The rotor is connected in star and is insulated from the shaft. A slip ring unit is mounted to the rotor for the purpose of the VCUS control.

Generator	
Type Description	Asynchronous with wound rotor, slip rings and VCUS
Rated Power (PN)	1.86 MW
Rated Apparent Power	1.86 MVA (Cosφ = 1.00)
Frequency	60 Hz
Voltage, Generator	690 Vac
Voltage, Converter	480 Vac
Number of Poles	6
Winding Type (Stator/Rotor)	Form/Form
Winding Connection, Stator	Star/Delta
Rated Efficiency (generator only)	> 96.5 %
Power Factor (cos)	1.0
Over Speed Limit acc. to IEC (2 min.)	2,900 rpm
Vibration Level	≤ 1.8 mm/s
Weight	Approx. 8,100 kg
Generator Bearing - Temperature	2 Pt100 sensors
Generator Stator Windings - Temperature	3 Pt100 sensors placed at hot spots and 3 as back-up

Table 3-1: Generator data

3.2 HV Cables

HV cable runs from the transformer in the nacelle down the tower to the switchgear (switchgear not included). The cable is a 4-conductor rubber insulated halogen free cable.

HV Cables	
Type	NTSCGEHXOEU
Cross Section	3x70/70 mm^2
Rated Voltage	12/20 kV and 20/35 kV depending on the transformer voltage.

Table 3-2: HV cables data

3.3 Transformer

The transformer is located in a separate locked room in the nacelle with surge arresters mounted on the high voltage side of the transformer. The transformer is a two winding, three-phase dry-type transformer, which is self-extinguishing. The windings are delta-connected on the high voltage side unless otherwise specified.

The low voltage windings have a voltage of 690 V and a tapping at 480 V and are star-connected. The 690 V and 480 V systems in the nacelle are a TN-system, which means the star point is connected to earth.

Transformer	
Type Description	Dry-type cast resin
Primary Voltage	10-33 kV
Rated Apparent Power	2,100 kVA
Secondary Voltage 1	690 V
Rated Power 1 at 1000 V	1,900 kVA
Secondary Voltage 2	480 V
Rated Power 2 at 400 V	200 kVA
Vector Group	Dyn5 (option YNyn0)
Frequency	60 Hz
HV-tappings	± 2 x 2.5 % offload
Inrush Current	6-10 x $\hat{I}_n$ depending on type.
Short-circuit Impedance	7.8 % ±10% @ 690V, 1,900 kVA, 120°C
Insulation Class	F
Climate Class	C2
Environmental Class	E2
Fire behaviour Class	F1

Table 3-3: Transformer data

3.4 Converter

The converter controls the energy conversion in the generator. The VCUS converter feeds power from the grid into the generator rotor at sub sync speed and feeds power from the generator rotor to the grid at super sync speed.

Converter	
Rated Slip	12%
Rated RPM	1,344 RPM
Rated Rotor Power (slip=12%, 400V)	185 kW
Rated Grid Current (slip = 12%)	210 A
Rated Rotor Current	101 A
Rated Rotor Current (cos φ= 1.0, slip = 12%)	576 A

Table 3-4: Converter data

3.5 AUX System

The AUX System is supplied from the 690/480 V outlet from the HV transformer. All motors, pumps, fans and heaters are supplied from this system.

All 110 V power sockets are supplied from a 690/110 V transformer.

Power Sockets	
Single Phase	110 V (20 A)
Three Phase	690 V (16 A)

Table 3-5: AUX system data

3.6 Wind Sensors

The turbine is equipped with 2 ultrasonic wind sensors with built in heaters.

Wind Sensors	
Type	FT702LT
Principle	Acoustic Resonance
Built in Heat	99 W

Table 3-6: Wind sensor data

3.7 VMP (Vestas Multi Processor) Controller

The turbine is controlled and monitored by the VMP5000 control system.

VMP5000 is a multiprocessor control system comprised of 4 main processors (Ground, Nacelle, Hub and Converter) interconnected by an optical-based 2.5 Mbit ArcNet network.

I/O modules are connected to CAN interface modules by a serial digital bus, CTBus.

The VMP5000 controller serves the following main functions:

- Monitoring and supervision of overall operation
- Synchronizing of the generator to the grid during connection sequence in order to limit the inrush current
- Operating the wind turbine during various fault situations
- Automatic yawing of the nacelle
- OptiTip® - blade pitch control
- Noise emission control
- Monitoring of ambient conditions
- Monitoring of the grid
- Monitoring of the smoke detection system

VMP5000 is built from the following main modules:

Module	Function	Network
CT3601	Main processor. Control and monitoring (ground, nacelle and hub)	ArcNet, CAN
CT318	Main processor. Converter control and monitoring	ArcNet
CT3218	Counter/encoder module. RPM and Azimuth measurement	CTBus
CT3134 Digital in CT3153 Digital out	24 VDC digital input/output. 4 channels configurable for either input or output.	CTBus
CT3215	2 Ch. RS 422/485 port. Serial interface for e.g. wind sensors.	CTBus
CT3220 Pigiback C	2 Ch. Analogue input 0.24 mA (Configurable).	CTBus
CT3220 Pigiback F	3 Ch. PT100 interface module. 4 wire pt100 measurement technology	CTBus
CT218	Operator Panel. RS422 interface	-----

Table 3-7: VMP controller data

3.8 Uninterruptible Power Supply (UPS)

The UPS is equipped with AC/DC DC/AC converter (double conversions), which receives power from battery cells in the same cabinet as the UPS. During grid outage, the UPS will supply the specified component with 230V AC.

The back-up time for the UPS system is proportional to the power consumption. Actual back-up time may vary.

UPS		
Battery Type	Valve-Regulated Lead Acid (VRLA)	
Rated Battery Voltage	2 x 8 x 12 V (192 V)	
Converter Type	Double conversion online	
Rated Output Voltage	230 V AC	
Rated Output Voltage	230 V AC	
Converter Input	230 V +/-20%	
Back-up Time*	Controller system	30 seconds
	Safety Systems	35 minutes
Re-charging Time	Typical	Approx. 2.5 hours

Table 3-8: UPS data

NOTE * For alternative back-up times, please consult Vestas!

4 Turbine Protection Systems

4.1 Braking Concept

The main brake on the turbine is aerodynamic. Braking the turbine is done by feathering the three blades. Each blade can be feathered individually to slow the turbine in an emergency stop.

In addition there is a mechanical disc brake on the high speed shaft of the gearbox. The mechanical brake is only used as a parking brake, and when activating the emergency stop push buttons.

4.2 Short Circuit Protections

Breakers	**Generator / Q8 ABB S7H 1600 690 V**	**Controller / Q15 ABB S3X 690 V**	**VCS-VCUS / Q7 ABB S5H 400 480 V**
Breaking Capacity I_{cu}, I_{cs}	25, 20 KA	75, 75 KA	40, 40 KA
Making Capacity I_{cm} (415V Data)	143 KA	440 KA	143 KA
Thermo Release I_{th}	1600 A	100 A	400 A
Magnetic Release I_m	9.6 KA	1.0 KA	1600 A

Table 4-1: Short circuit protection data

4.3 Overspeed Protection

The generator RPM and the main shaft RPM are registered by inductive sensors and calculated by the wind turbine controller in order to protect against overspeed and rotating errors.

The turbine is also equipped with a VOG (Vestas Overspeed Guard), which is an independent computer module measuring the rotor RPM, and in case of an overspeed situation the VOG activates full feathering of the three blades independently of the turbine controller in the turbine.

Overspeed Protection	
VOG Sensors Type	Inductive
Trip Levels	19.36 (Rotor RPM)/2,110 (Generator RPM)

Table 4-2: Overspeed protection data

4.4 Lightning System

The Lightning System (LS) consists of three main parts.

- Lightning receptors
- Down conducting system
- Earthing System

Lightning Protection Design Parameters			**Protection Level I**
Current Peak Value	i_{max}	[kA]	200
Total Charge	Q_{total}	[C]	300
Specific Energy	W/R	[MJ/Ω]	10
Average Steepness	di/dt	[kA/μs]	200

Table 4-3: Lightning design parameters

NOTE Lightning system is designed according to IEC (see 7.7). Lightning strikes are considered force majeure, i.e. damage caused by lightning strikes is not warranted by Vestas.

4.5 Earthing (also known as grounding)

A separate set of documents describe the earthing system in detail, depending on the type of foundation the turbine has been installed on.

Requirements in the Vestas Earthing System specifications and work descriptions are minimum requirements from Vestas and IEC. Local and national requirements, as well as project requirements, may require additional measures.

4.6 Corrosion Protection

Classification of corrosion categories for atmospheric corrosion is according to ISO 9223:1992

Corrosion Protection	External Areas	Internal Areas
Nacelle	C5	C3 and C4 Climate strategy: Heating the air inside the nacelle compared to the outside air temperature lowers the relative humidity and helps ensure a controlled corrosion level.
Hub	C5	C3
Tower	C5-I	C3

Table 4-4: Corrosion protection data for nacelle, hub and tower

5 Safety

The safety specifications in Section 5 provide limited general information about the safety features of the turbine and are not a substitute for Buyer and its agents taking all appropriate safety precautions, including but not limited to (a) complying with all applicable safety, operation, maintenance, and service agreements, instructions, and requirements, (b) complying with all safety-related laws, regulations, and ordinances, (c) conducting all appropriate safety training and education and (d) reading and understanding all safety-related manuals and instructions. See section 5.14 Manuals and Warnings, p. 22 for additional guidance.

5.1 Access

Access to the turbine from the outside is through the bottom of the tower. The door is equipped with a lock. Access to the top platform in the tower is by a ladder or lift (optional). Access to the nacelle from the top platform is by ladder. Access to the transformer room in the nacelle is equipped with a lock. Unauthorized access to electrical switch boards and power panels in the turbine is prohibited according to IEC 60204-1 2006.

5.2 Escape

In addition to the normal access routes, alternative escape routes from the nacelle are through the crane hatch or from the roof of the nacelle.

The hatch in the roof can be opened from both the inside and outside.

Escape from the tower lift is by ladder.

5.3 Rooms/Working Areas

The tower and nacelle are equipped with connection points for electrical tools for service and maintenance of the turbine.

5.4 Floors, Platforms, Standing and Working Places

There is one floor per tower section.

There are places to stand at various locations along the ladder.

The floors have anti-slip surfaces.

Foot supports are placed in the turbine for maintenance and service purposes.

5.5 Climbing Facilities

A ladder with a fall arrest system (rigid rail or wire system) is mounted through the tower.

Rest platforms are provided at intervals of 9 metres along the tower ladder between platforms.

There are anchorage points in the tower, nacelle, hub and on the roof for attaching a fall arrest harness.

Over the crane hatch there is an anchorage point for the emergency descent equipment.

Anchorage points are coloured yellow and are calculated and tested to 22.2 kN

5.6 Moving Parts, Guards and Blocking Devices

Moving parts in the nacelle are shielded.

The turbine is equipped with a rotor lock to block the rotor and drive train.

It is possible to block the pitch of the cylinder with mechanical tools in the hub.

5.7 Lighting

The turbine is equipped with light in the tower, nacelle, transformer room and in the hub.

There is emergency light in case of loss of electrical power.

5.8 Noise

When the turbine is out of operation for maintenance, the sound level in the nacelle is below 80 dB(A). In operation mode ear protection is required.

5.9 Emergency Stop

There are emergency stops in the nacelle, hub and in the bottom of the tower.

5.10 Power Disconnection

The turbine is designed to allow for disconnection from all its power sources during inspection or maintenance. The switches are marked with signs and are located in the nacelle and in the bottom of the tower.

5.11 Fire Protection/First Aid

A 5 kg CO_2 fire extinguisher must be located in the nacelle at the left yaw gear. The location of the fire extinguisher, and how to use it, must be confirmed before operating the turbine.

A first aid kit must be placed by the wall at the back end of the nacelle. The location of the first aid kit, and how to use it, must be confirmed before operating the turbine.

Above the generator there is a fire blanket which can be used to put out small fires.

5.12 Warning Signs

Additional warning signs inside or on the turbine must be reviewed before operating or servicing of the turbine.

5.13 Offshore Installation

In addition to the safety equipment mentioned above, offshore turbines are provided with a fire extinguisher and first aid box at the bottom of the tower, and a survival kit on the second platform in the tower.

5.14 Manuals and Warnings

Vestas OH&S manual and manuals for operation, maintenance and service of the turbine provide additional safety rules and information for operating, servicing or maintaining the turbine.

6 Environment

6.1 Chemicals

Chemicals used in the turbine are evaluated according to Vestas Wind Systems A/S Environmental system certified according to ISO 14001:2004.

- Anti-freeze liquid to help prevent the cooling system from freezing.
- Gear oil for lubricating the gearbox.
- Hydraulic oil to pitch the blades and operate the brake.
- Grease to lubricate bearings.
- Various cleaning agents and chemicals for maintenance of the turbine.

7 Approvals, Certificates and Design Codes

7.1 Type Approvals

The turbine is type certified according to the certification standards listed below:

Standard	Conditions	Hub Height
IEC SoC	IEC Class 2A	80 m
	IEC Class 2A	105 m

Table 7-1: Type approvals data

7.2 Design Codes – Structural Design

The structural design has been developed and tested with regard to, but not limited to, the following main standards.

Design Codes - Structural Design	
Nacelle and Hub	IEC 61400-1:2005 EN 50308
Tower	IEC 61400-1:2005 Eurocode 3

Table 7-2: Structural design codes

7.3 Design Codes - Mechanical Equipment

The mechanical equipment has been developed and tested with regard to, but not limited to, the following main standards:

Design Codes – Mechanical Equipment	
Gear	Designed in accordance to rules in ISO 81400-4
Blades	DNV-OS-J102 IEC 1024-1 IEC 60721-2-4 IEC 61400 (Part 1, 12 and 23) IEC WT 01 IEC DEFU R25 ISO 2813 DS/EN ISO 12944-2

Table 7-3: Mechanical equipment design codes

7.4 Design Codes - Electrical Equipment

The electrical equipment has been developed and tested with regard to, but not limited to, the following main standards:

Design Codes – Electrical Equipment	
High Voltage ac circuit breakers	IEC 60056
High Voltage testing techniques	IEC 60060
Power Capacitors	IEC 60831
Insulating bushings for ac voltage above 1kV	IEC 60137
Insulation co-ordination	BS EN 60071
AC Disconnectors and earth switches	BS EN 60129
Current Transformers	IEC 60185
Voltage Transformers	IEC 60186
High Voltage switches	IEC 60265
Disconnectors and Fuses	IEC 60269
Flame Retardant Standard for MV Cables	IEC 60332
Transformer	IEC 60076-11
Generator	IEC 60034
Specification for sulphur hexafluoride for electrical equipment	IEC 60376
Rotating electrical machines	IEC 34
Dimensions and output ratings for rotating electrical machines	IEC 72 & IEC 72A
Classification of insulation, materials for electrical machinery	IEC 85
Safety of machinery – Electrical equipment of machines	IEC 60204-1

Table 7-4: Electrical equipment design codes

7.5 Design Codes - I/O Network System

The distributed I/O network system has been developed and tested with regard to, but not limited to, the following main standards:

Design Codes – I/O Network System	
Salt Mist Test	IEC 60068-2-52
Damp Head, Cyclic	IEC 60068-2-30
Vibration Sinus	IEC 60068-2-6
Cold	IEC 60068-2-1
Enclosure	IEC 60529
Damp Head, Steady State	IEC 60068-2-56
Vibration Random	IEC 60068-2-64
Dry Heat	IEC 60068-2-2
Temperature Shock	IEC 60068-2-14
Free Fall	IEC 60068-2-32

Table 7-5: I/O Network system design codes

7.6 Design Codes - Lightning Protection

The LPS is designed according to Lightning Protection Level (LPL) I:

Design Codes – Lightning Protection	
Designed according to	IEC 62305-1: 2006 IEC 62305-3: 2006 IEC 62305-4: 2006
Non Harmonized Standard and Technically Normative Documents	IEC/TR 61400-24:2002

Table 7-6: Lightning protection design codes

7.7 Design Codes – Earthing

The Vestas Earthing System design is based on and complies with the following international standards and guidelines:

- IEC 62305-1 Ed. 1.0: Protection against lightning – Part 1: General principles.
- IEC 62305-3 Ed. 1.0: Protection against lightning – Part 3: Physical damage to structures and life hazard.
- IEC 62305-4 Ed. 1.0: Protection against lightning – Part 4: Electrical and electronic systems within structures.

- IEC/TR 61400-24. First edition. 2002-07. Wind turbine generator systems - Part 24: Lightning protection.
- IEC 60364-5-54. Second edition 2002-06. Electrical installations of buildings - Part 5-54: Selection and erection of electrical equipment – Earthing arrangements, protective conductors and protective bonding conductors.
- IEC 61936-1. First edition. 2002-10. Power installations exceeding 1kV a.c.- Part 1: Common rules.

8 Colour and Surface Treatment

8.1 Nacelle Colour and Surface Treatment

Surface Treatment of Vestas Nacelles	
Standard Nacelle Colours	RAL 7035 (light grey) RAL 9010 (pure white)
Gloss	According to ISO 2813

Table 8-1: Surface treatment, nacelle

8.2 Tower Colour and Surface Treatment

Surface Treatment of Vestas Tower Section		
	External:	**Internal:**
Tower Colour Variants	RAL 7035 (light grey) RAL 9010 (pure white) – only Onshore	RAL 9001 (cream white)
Gloss	50-75% UV resistant	Maximum 50%

Table 8-2: Surface treatment, tower

8.3 Blades Colour

There is a range of available blade colours depending on country specific requirements.

Blades Colour	
Blade Colour Variants	RAL 7035 (Light Grey), RAL 9010 (White), RAL 7038 (Agate Grey)
Tip-End Colour Variants	RAL 2009 (Traffic Orange), RAL 3000 (Flame Red), RAL 3020 (Traffic Red)
Gloss	< 20%

Table 8-3: Colours, blades

9 Operational Envelope and Performance Guidelines

Actual climatic and site conditions have many variables and must be considered in evaluating actual turbine performance. The design and operating parameters set forth in this section do not constitute warranties, guarantees, or representations as to turbine performance at actual sites.

NOTE As evaluation of climate and site conditions is complex, it is needed to consult Vestas for every project.

9.1 Climate and Site Conditions

Values refer to hub height:

Extreme Design Parameters		
Wind Climate	**IEC 2A**	**IEC 3A**
Ambient Temperature Interval (Normal Temperature Turbine)	-30° to +50 °C	
Extreme Wind Speed (10 min. average)	42.5 m/s	37.5 m/s
Survival Wind Speed (3 sec. gust)	59.5 m/s	52.5 m/s

Table 9-1: Extreme design parameters

Average Design Parameters		
Wind Climate	**IEC 2A**	**IEC 3A**
Wind Speed	8.5 m/s	7.5 m/s
A-factor	9.59 m/s	8.46 m/s
Form Factor, c	2.0	2.0
Turbulence Intensity acc. to IEC 61400-1, including Wind Farm Turbulence (@15 m/s – 90% quantile)	18%	
Wind Shear	0.20	
Inflow Angle (vertical)	8°	

Table 9-2: Average design parameters

9.1.1 Complex Terrain

Classification of complex terrain acc. to IEC 61400-1:2005 Chapter 11.2.

For sites classified as complex appropriate measures are to be included in site assessment.

9.1.2 Altitude

The turbine is designed for use at altitudes up to 1000 m above sea level as standard.

Above 1000 m special considerations must be taken regarding e.g. HV installations and cooling performance. Consult Vestas for further information.

9.1.3 Wind Farm Layout

Turbine spacing to be evaluated site-specifically. Spacing in any case not below three rotor diameters (3D).

DISCLAIMER

As evaluation of climate and site conditions is complex, consult Vestas for every project. If conditions exceed the above parameters Vestas must be consulted!

9.2 Operational Envelope – Temperature and Wind

Values refer to hub height and as determined by the sensors and control system of the turbine.

Operational Envelope – Temperature and Wind	
Ambient Temperature Interval (Normal Temperature Turbine)	-20° to +40° C
Cut-in (10 min. average)	3.5 m/s
Cut-out (100 sec. exponential average)	25 m/s
Re-cut in (100 sec. exponential average)	20 m/s

Table 9-3: Operational envelope - temperature and wind

9.3 Operational Envelope - Grid Connection *

Values refer to hub height and as determined by the sensors and control system of the turbine.

Operational Envelope - Grid Connection		
Nominal Phase Voltage	$U_{P, nom}$	400 V
Nominal Frequency	f_{nom}	60 Hz

Table 9-4: Operational envelope - grid connection

The Generator and the converter will be disconnected if:

	U_P	U_N
Voltage above 110 % of nominal for 60 sec.	440 V	759 V
Voltage above 113.5 % of nominal for 0.2 sec.	454 V	783 V
Voltage above 120 % of nominal for 0.08 sec.	480 V	828 V
Voltage below 90 % of nominal for 60 sec.	360 V	621 V
Voltage below 85 % of nominal for 0.4 sec.	340 V	586 V
Voltage below 75 % of nominal for 0.08 sec.	300 V	517 V
Frequency is above [Hz] for 0.2 sec.	62 Hz	
Frequency is below [Hz] for 0.2 sec.	57 Hz	

Table 9-5: Generator and converter disconnecting values

NOTE * Over the lifetime of the turbine, grid dropouts are to be limited to no more than once a month on average as calculated over one year.

9.4 Performance – Own Consumption

The consumption of electrical power by the wind turbine is defined as consumption when the wind turbine is not producing energy (generator is not connected to the grid). This is defined in the control system as Production Generator (zero).

The following components have the largest influence on the power consumption of the wind turbine:

Own Consumption	
Hydraulic Motor	18.6 kW
Yaw Motors 6 x 1.75 kW	10.5 kW
Oil Heating 3 x 0.76 kW	2.3 kW
Air Heaters 3 x 3.4 kW	10.2 kW
Oil Pump for Gearbox Lubrication	3.5 kW
HV Transformer located in the nacelle has a no-load loss of	Max. 3.9 kW

Table 9-6: Own consumption data

9.5 Operational Envelope - Conditions for Power Curve, Noise Levels, C_p & C_t Values (at Hub Height)

See Appendix 1 for C_p & C_t values, Appendix 2 for power curve and Appendix 3 for noise level.

Conditions for Power Curve, Noise Levels, C_p & C_t Values (at Hub Height)	
Wind Shear	0.10 - 0.16 (10 min. average)
Turbulence Intensity	8 - 12% (10 min. average)
Blades	Clean
Rain	No
Ice/Snow on Blades	No
Leading Edge	No damage
Terrain	IEC 61400-12-1
Inflow Angle (Vertical)	0 ± 2 °
Grid Frequency	60 ± 0.5 Hz

Table 9-7: Conditions for power curve, noise levels, C_p & C_t values

10 Drawings

10.1 Structural Design - Illustration of Outer Dimensions

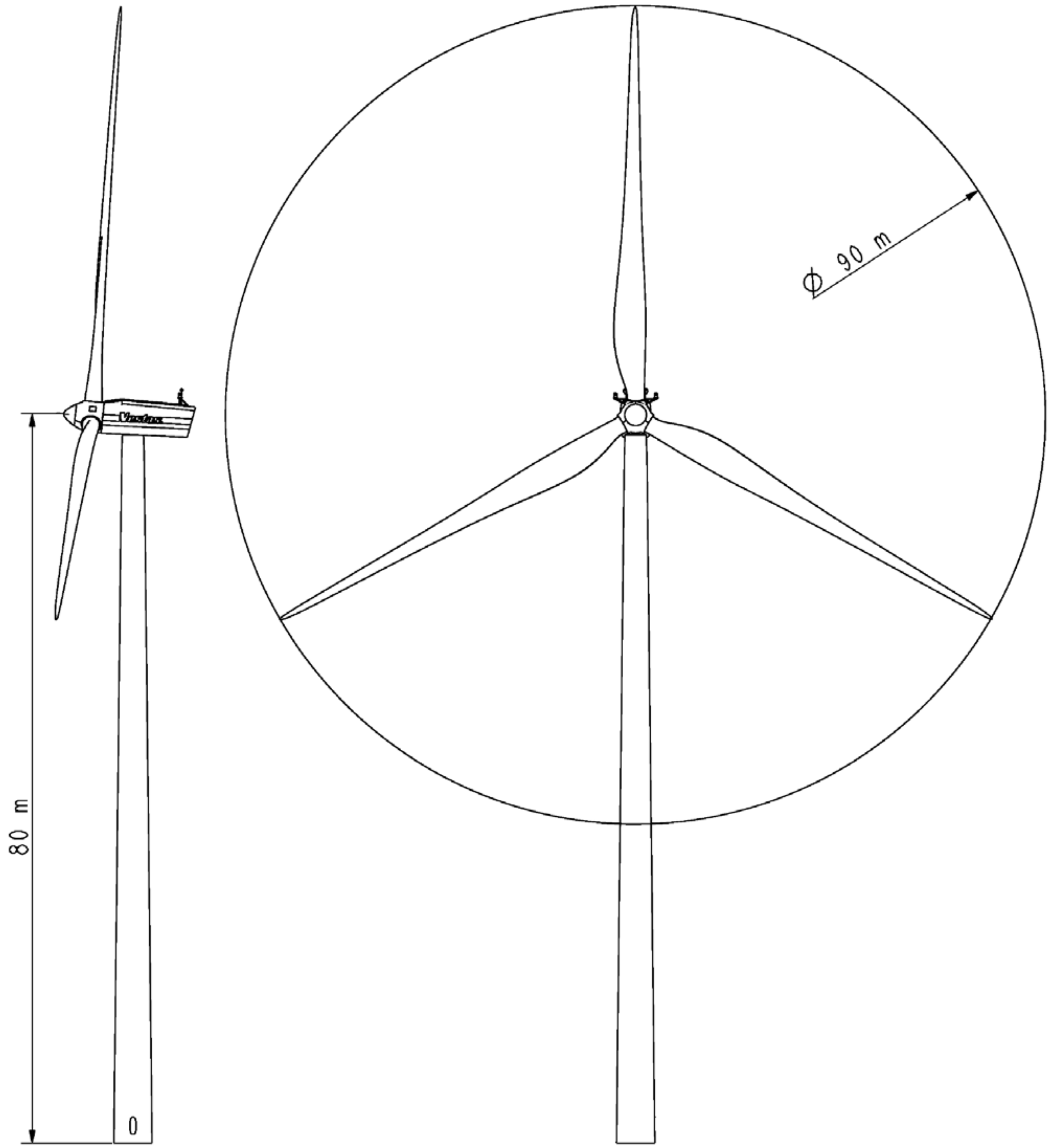

Figure 10-1: Illustration of outer dimensions – structure (Drawing no. 956042)

10.2 Structural Design - Side View Drawing

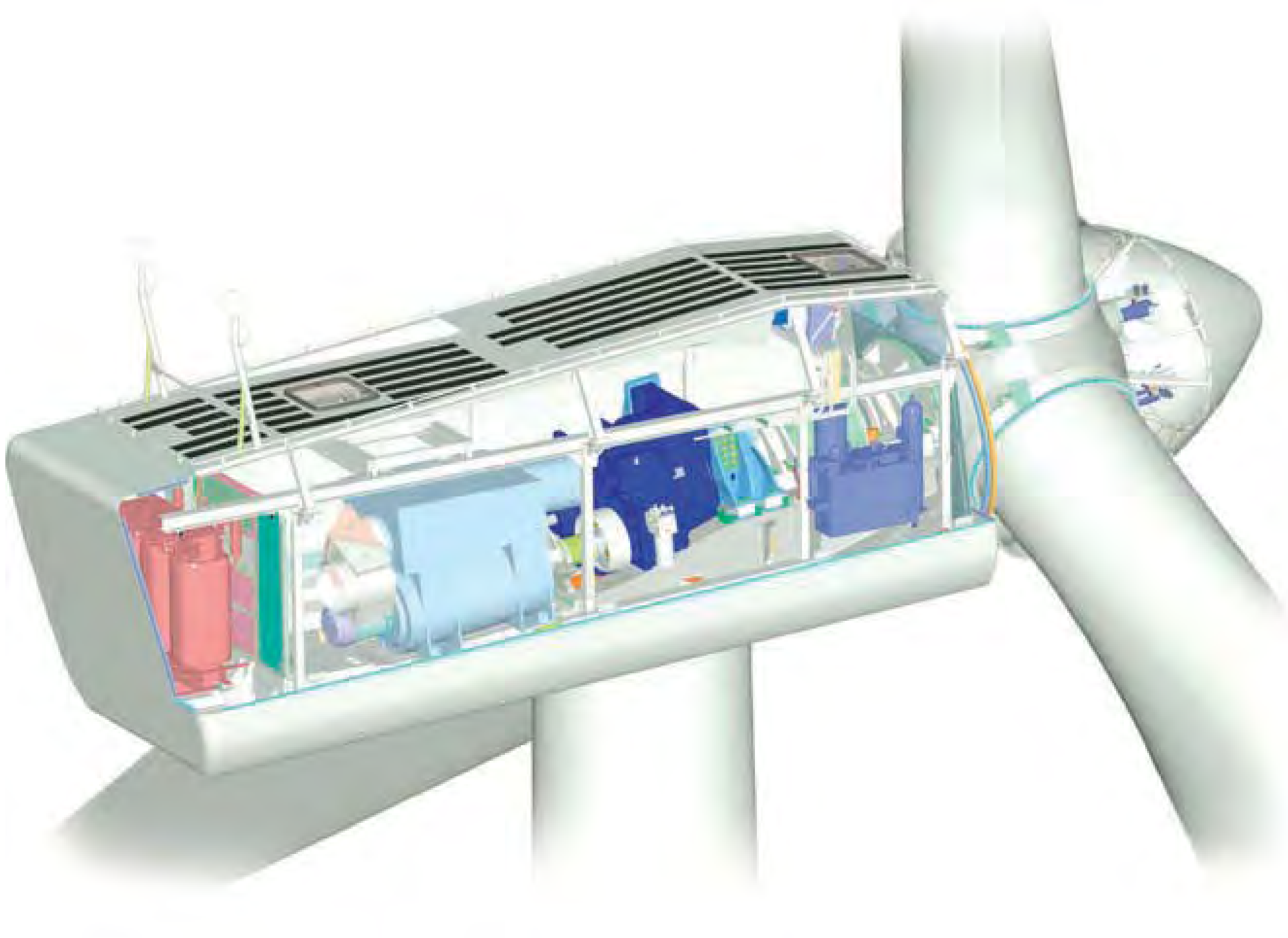

Figure 10-2: Side view drawing

10.3 Electrical Design – Main Wiring 60 Hz

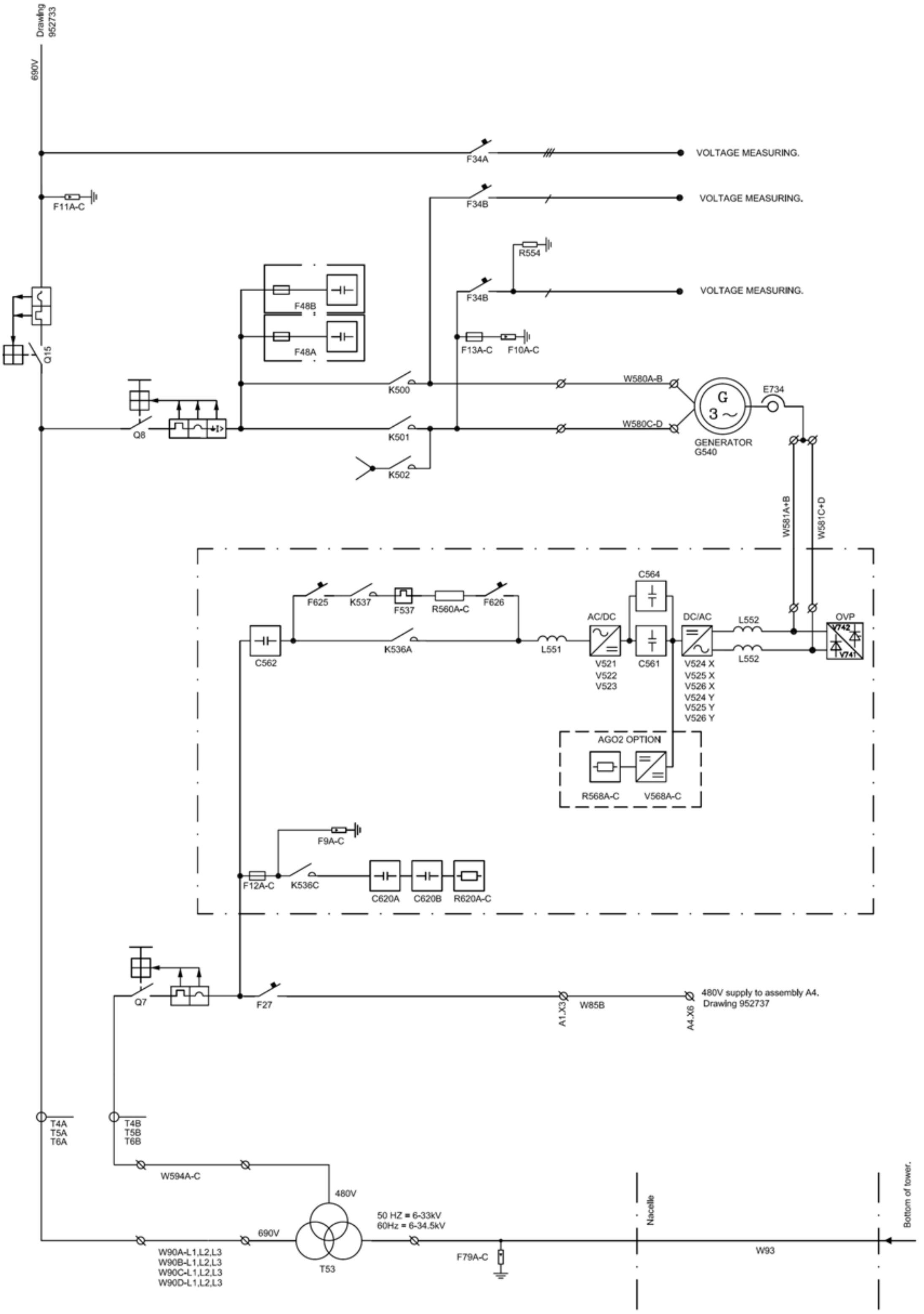

Figure 10-3: Main wiring 60 Hz

11 General Reservations, Notes and Disclaimers

- These general specifications apply to the current version of the V90 wind turbine. Updated versions of the V90 wind turbine, which may be manufactured in the future, may have general specifications that differ from these general specifications. In the event that Vestas supplies an updated version of the V90 wind turbine, Vestas will provide updated general specifications applicable to the updated version.
- Periodic operational disturbances and generator power de-rating may be caused by combination of high winds, low voltage or high temperature.
- Vestas recommends that the electrical grid be as close to nominal as possible with little variation in frequency.
- A certain time allowance for turbine warm-up must be expected following grid dropout and/or periods of very low ambient temperature.
- The estimated power curve for the different estimated noise levels (sound power levels) is for wind speeds at 10 minute average value at hub height and perpendicular to the rotor plane.
- All listed start/stop parameters (e. g. wind speeds and temperatures) are equipped with hysteresis control. This can, in certain borderline situations, result in turbine stops even though the ambient conditions are within the listed operation parameters.
- The earthing system must comply with the minimum requirements from Vestas, and be in accordance with local and national requirements, and codes of standards.
- Lightning strikes are considered force majeure, i.e. damage caused by lightning strikes is not warranted by Vestas.
- For the avoidance of doubt, this document 'General Specifications' is not, and does not contain, any guarantee, warranty and/or verification of the power curve and noise (including, without limitation, the power curve and noise verification method). Any guarantee, warranty and/or verification of the power curve and noise (including, without limitation, the power curve and noise verification method) must be agreed to separately in writing.

12 Appendices

12.1 Performance – C_p & C_t Values

Performance – C_p & C_t Values – Air Density 1.225 kg/m^3		
Wind Speed	**Cp (Mode 0)**	**Ct (Mode 0)**
m/s	[-]	[-]
3	0.4246	0.8470
4	0.4836	0.7962
5	0.4841	0.8007
6	0.4841	0.8008
7	0.4841	0.8009
8	0.4839	0.7805
9	0.4696	0.6990
10	0.4343	0.6047
11	0.3775	0.4915
12	0.2907	0.3556
13	0.2287	0.2725
14	0.1831	0.2153
15	0.1489	0.1740
16	0.1227	0.1432
17	0.1023	0.1196
18	0.0861	0.1012
19	0.0732	0.0866
20	0.0628	0.0748
21	0.0542	0.0652
22	0.0472	0.0572
23	0.0413	0.0506
24	0.0363	0.0450
25	0.0322	0.0403

Table 12-1: C_p & C_t values

12.2 Performance - Estimated Power Curves

At 1000V / 400V, low voltage side of the high voltage transformer.

Wind speed at hub height, 10 min average.

12.2.1 Power Curve, Mode 0

Wind speed [m/s]	1.225	0.97	1	1.03	1.06	1.09	1.12	1.15	1.18	1.21	1.24	1.27
3	18	12	12	13	13	14	15	16	16	17	18	19
4	88	63	66	69	72	75	78	81	84	87	90	93
5	202	153	159	165	171	176	182	188	194	199	205	211
6	363	280	289	299	309	319	328	338	348	358	367	377
7	589	459	474	490	505	520	536	551	566	582	597	612
8	888	695	718	741	764	786	809	831	854	877	899	922
9	1226	965	995	1026	1057	1088	1119	1149	1180	1211	1241	1271
10	1548	1235	1273	1311	1349	1387	1426	1461	1496	1531	1564	1594
11	1758	1492	1531	1569	1607	1645	1684	1705	1726	1747	1764	1775
12	1808	1700	1719	1737	1755	1773	1791	1796	1801	1805	1809	1811
13	1815	1789	1793	1798	1803	1807	1812	1813	1814	1815	1815	1815
14	1815	1812	1813	1813	1814	1814	1815	1815	1815	1815	1815	1815
15	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
16	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
17	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
18	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
19	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
20	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
21	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
22	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
23	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
24	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
25	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815

Figure 12-1: Power curve, mode 0

12.3 Noise Levels

12.3.1 Noise Curve V90 – 1.8 MW, 60 Hz, Mode 0

Sound Power Level at Hub Height: Noise mode 0		
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 2 2002** **Wind shear: 0.16** **Max. turbulence at 10 meter height: 16%** **Inflow angle (vertical): 0 ± 2°** **Air density: 1.225 kg/m³**	
Hub Height	80 m	105 m
L_{wA} @ 4 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	94.6 5.6	95.5 5.8
L_{wA} @ 5 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	99.4 7.0	100.3 7.3
L_{wA} @ 6 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	102.3 8.4	102.6 8.7
L_{wA} @ 7 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	103.1 9.8	103.3 10.2
L_{wA} @ 8 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	103.5 11.2	103.5 11.7
L_{wA} @ 9 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	103.5 12.6	103.5 13.1
L_{wA} @ 10 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	103.5 14.0	103.5 14.6
L_{wA} @ 11 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	103.5 15.3	103.5 16.0
L_{wA} @ 12 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	103.5 16.7	103.5 17.5
L_{wA} @ 13 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	103.5 18.1	103.5 18.9

Figure 12-2: Noise curve, mode 0

APPENDIX D

CUMULATIVE EFFECTS MEMO FROM AET

tci renewables

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Joe Tomaseli
Acoustics Noise & Vibration
Golder Associates Ltd.#
2390 Argentia Rd, Mississauga,
ON, L5N 5Z7

29th April 2009

Dear Joe,

RE: Cumulative Assessment Memo

Through research of publicly available information and discussions with local planning authorities, other developers and landowners in the area, it is our understanding that there are 5 planned wind farms within 10km of the Adelaide wind farm project.

1) Parkhill Wind Farm (35MW), Canadian Hydro Developers (CHD)
2) Bornish Wind Farm (85MW) Florida Power & Light Energy (FPLE)
3,4) Strathroy A & B (18MW) 2 Standard Offer Contract Projects (FPLE)
5) Strathroy C (9MW) 1 x Standard Offer Contract Project (FPLE)

The Parkhill Wind Farm is planning to connect to a different IESO controlled electrical transmission circuit than that planned for the Adelaide Wind Farm and therefore it is possible that both projects could proceed and co-exist. In light of this we feel it should be considered as part of a cumulative assessment.

The Bornish Wind Farm is planning to connect to the same transmission circuit (W2S) as the Adelaide Wind Farm and given that this circuit limit was shown to be 75MW (see enclosed extract from RES III RFP document) the two projects would therefore be mutually exclusive and a cumulative assessment is not considered necessary.

Strathroy A,B & C projects are Standard Offer Projects whereby the contracts were executed in June 2008 (OPA's SOC Progress Report June 2008). The Standard Offer Programme underwent some proposed changes in May 2008 and all contracts awarded after May 13 2008 are subject to these new programme rules. One of the key ones was that only 10MW of capacity would be available to a developer per Transformer Station. We believe that Strathroy A-C are all planned to connect to Strathroy TS and therefore only one could proceed under the new programme rules.

tci renewables

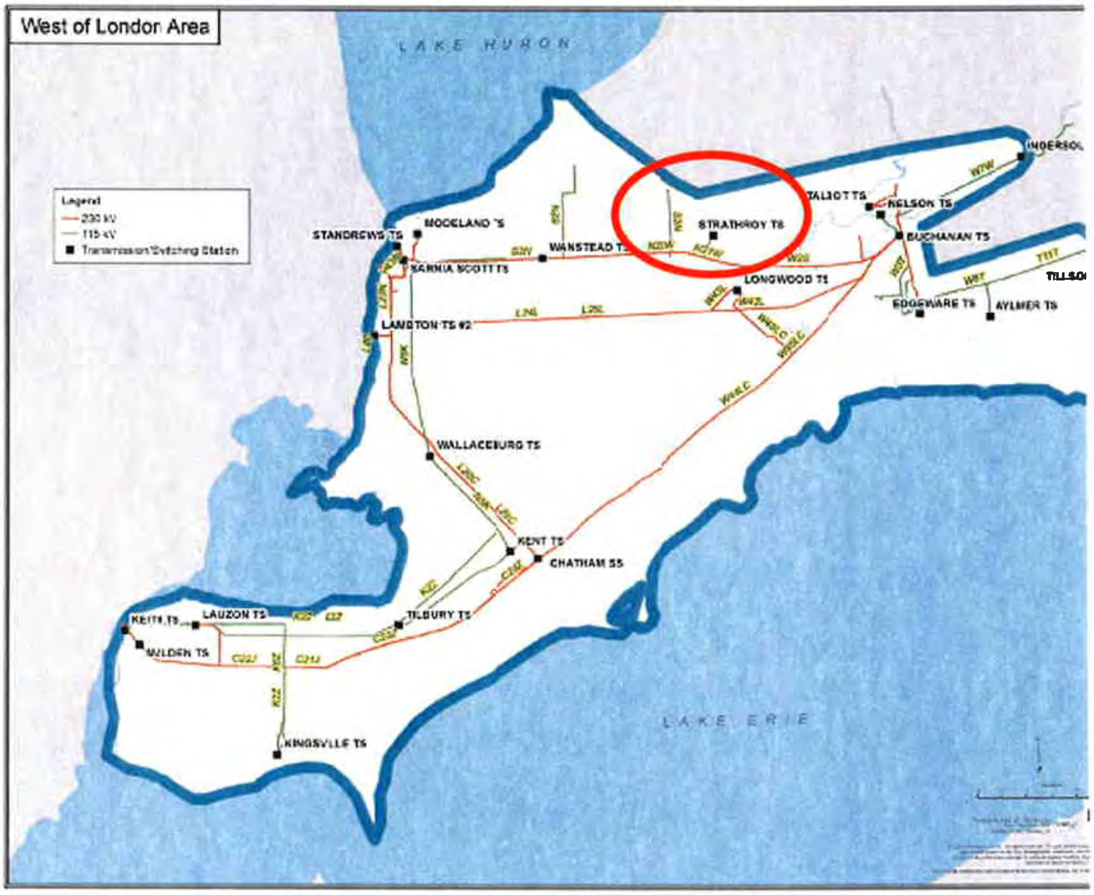
It is important to note that wind projects under the Standard Offer Programme have become stagnated with no contracts being signed in 2009 as per most recent update report (Feb 2009). It is also worthy to note that despite the remarkable uptake of contracts in 2007-08; the conversion rate has been extremely low. As of the latest published SOC progress report (Feb 2009) 746MW of wind projects had been awarded contracts since the launch of the Programme but less than 10% had actually been built with only 67MW in operation. It is generally understood within the industry that the remaining contracted projects are unlikely to proceed to construction under the terms of the SOC programme and that executed SOC contracts (as these three are) are not currently eligible for award of the new higher Feed in Tariff being proposed under the Green Energy Act.

In addition, the transmission constraints matrix that was issued as part of the RES III RFP (Appendix Q) shows that there is only 75MW of capacity available on either circuits W2S or S2N (Adelaide Junction to Strathroy TS). We believe this is the same transmission station proposed for the three SOC projects and is also the same transmission circuit named in the Notice of Commencement as the connection point for the Bornish Wind Project. Given that AET is proposing to develop a 72MW wind farm connecting to circuit W2S, it has been concluded that the Adelaide Wind Farm and the other identified projects (Strathroy A,B & C and Bornish) would be mutually exclusive i.e. If AET builds a 72MW wind farm then the capacity would be taken and none of the other projects proposed by FPLE would be able to proceed and vice versa until such time that there is a transmission upgrade. No such upgrade is planned for the area and therefore a cumulative assessment is not viewed as necessary at this time.

If you have any questions please do not hesitate to contact me.

Yours Sincerely,

Mark Gallagher
Development Manager



Transmission Constraints Map Appendix P RES III RFP Document (Source : OPA)

The diagram above shows the transmission lines for the area called "west of London" the highlighted area shows the circuit area where Adelaide wind farm would connect.

W9L		W6NL
115 kV circuits: W3T, W4T	120	Yes
115 kV circuits: W2S [redacted]	75	
115 kV circuits: W12W, W7W	130	Yes
115 kV circuits: W3T, T11T	120 (sum of both circuits)	Yes: W3T & W4T
115 kV circuits: W4T, T11T	120 (sum of both circuits)	

Extract from OPA RES III Appendix Q – Transmission Matrix (source: OPA)

The transmission matrix extract above shows the 75MW limit on the proposed circuit.

Strathroy TS		
Acceptable generation = 39.6 MW		
Station Queue	M1 - (A)	M3 - (%)
1	1042 (9 MW)	
2	1043 (9 MW)	
3		1044 (9 MW)
4	892 (2 MW)	
CIA pending	1296 (10 MW)	
CIA pending	1297 (10 MW)	
CIA pending	1298 (10 MW)	
5		1282 (10 MW)
CIA pending		1283 (10 MW)
CIA pending	920 (10 MW)	
CIA pending	921 (10 MW)	
CIA pending		922 (10 MW)

Extract from Hydro One Distribution Generation Connections Application List (March 2009)

The applications highlighted above are believed to be FPLE's Strathroy A,B, & C projects given that the capacity matches the proposals i.e. 9MW and the sequential numbering of the applications (which usually indicates that the same developer submitted all applications).

Source:(http://www.hydroonenetworks.com/en/customers/generators/generation_connections/distribution/queue_process/Application_List_FINAL.pdf)

APPENDIX D

STAGE 1 ARCHAEOLOGY ASSESSMENT

April 2009

STAGE 1 ARCHAEOLOGICAL ASSESSMENT

Air Energy TCI Adelaide Wind Farm Various Lots, Concession 1 to 5 N.E.R. and 1 to 4 S.E.R. Geographic Township of Adelaide Middlesex County, Ontario

Submitted to:
Air Energy TCI Inc.
381 Rue Notre-Dame (Ouest)
Montreal, QC H2Y 1V2
Tel: 1-888-842-1923 Fax: 514-842-7904

REPORT

PIF Number: P001-422-2008

Report Number: 07-1112-0151-1800-R01

Distribution:

3 Copies - Ontario Ministry of Culture
2 Copies - Golder Associates Ltd.

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Golder Associates

Executive Summary

A Stage 1 archaeological background study was conducted for a parcel of approximately 8275 hectares in the Township of Adelaide-Metcalfe, Middlesex County, Ontario. The parcel consists of Lots 7 to 19, Concession 1 North of Egremont Road; part of Lot 6 and Lots 7 to 19, Concession 2 North of Egremont Road; Lots 7 to 12, Concessions 3 to 4 North of Egremont Road; part of Lot 7 and Lots 8 to 10, Concession 5 North of Egremont Road; Lots 1 to 19, Concessions 1 to 2 South of Egremont Road; Lots 1 to 18, Concession 3 South of Egremont Road; and Lots 13 to 17, Concession 4 South of Egremont Road. This area will eventually be the site of 40 wind turbines. This Stage 1 archaeological assessment was conducted as part of an Environmental Assessment for Electricity Projects coordinated by Golder Associates Limited, Mississauga office.

The objective of the Stage 1 assessment was to compile all available information about the known and potential cultural heritage resources within the study area and to provide specific direction for the protection, management and/or recovery of these resources, consistent with Ministry of Culture guidelines (Government of Ontario 1993).

Archaeological potential criteria commonly used by the Ontario Ministry of Culture were applied to determine areas of archaeological potential within the study area. The archaeological potential for pre-contact Aboriginal and Euro-Canadian sites was deemed to be moderate to high on these properties. As a result, Stage 2 archaeological assessment will be required for all areas to be disturbed during turbine or access road construction.

As further archaeological assessment is recommended, the Ontario Ministry of Culture is asked to review the results in this report and issue a letter of concurrence with the findings herein. A letter of clearance is not requested at this time.

Table of Contents

TABLES

FIGURES

Acknowledgments

Acknowledgements	Jeff Wright, RP Bio., CCEP, Dip.T., Leigh Holt, M.A.Sc.
Project Manager	James A. Wilson, M.A.
Licensed Project Director(s)	Jeffrey Muir, B.A.
Report Production	Jeffrey Muir, B.A.
Field/Office Assistants	Irena Jurakic, M.A.
Senior Review	James A. Wilson, M.A., Rebecca Balcom, M.A., Principal
Proponent Contact	Mark Gallagher, Air Energy TCI Incorporated
Ministry of Natural Resources	Barbara Dickson
Ministry of Culture	Robert von Bitter, Shari Prowse, M.A.

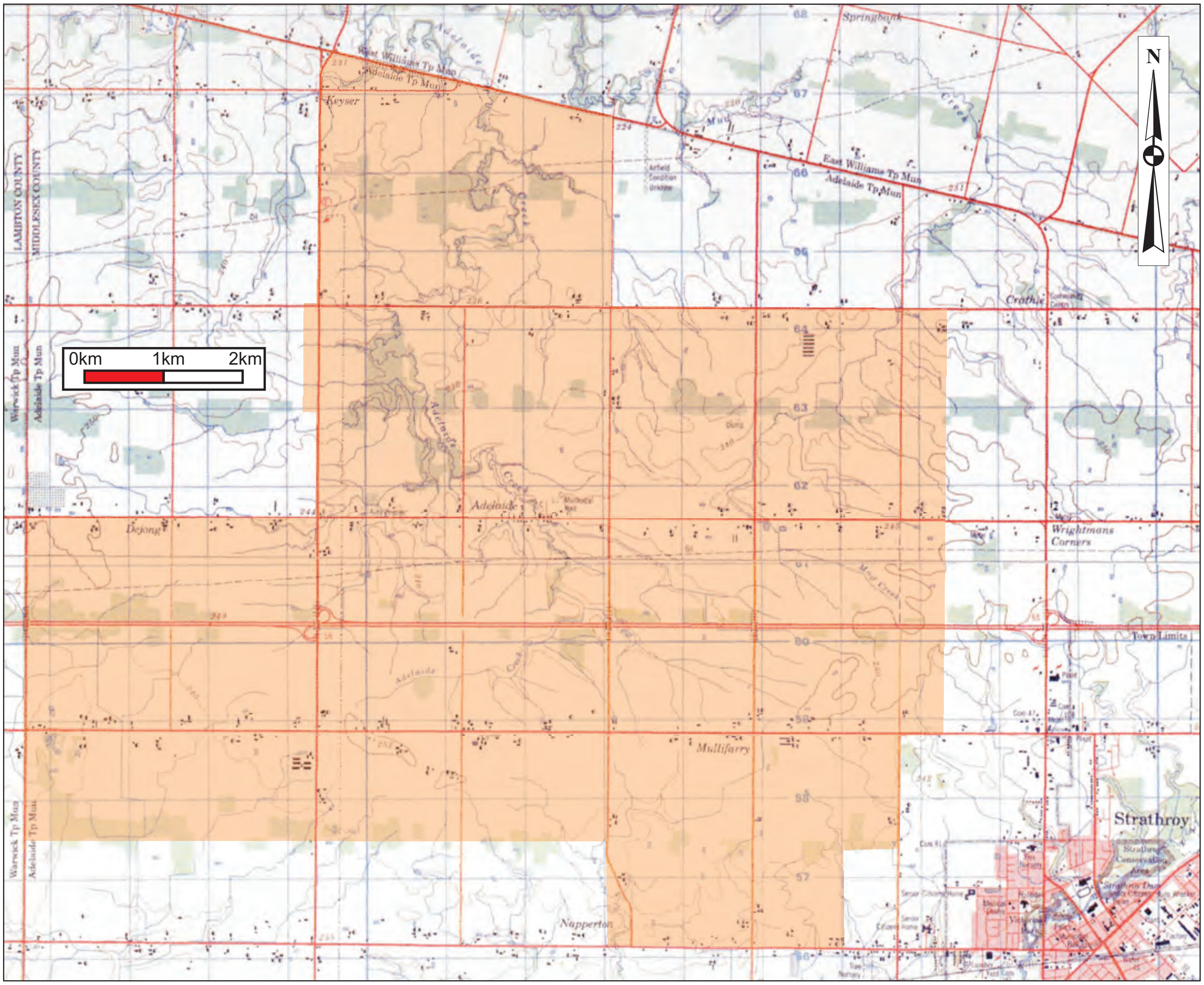
1.0 PURPOSE

A Stage 1 archaeological background study was conducted for a parcel of approximately 8275 hectares in the Township of Adelaide-Metcalfe, Middlesex County, Ontario (Figure 1). The parcel consists of Lots 7 to 19, Concession 1 North of Egremont Road; part of Lot 6 and Lots 7 to 19, Concession 2 North of Egremont Road; Lots 7 to 12, Concessions 3 to 4 North of Egremont Road; part of Lot 7 and Lots 8 to 10, Concession 5 North of Egremont Road; Lots 1 to 19, Concessions 1 to 2 South of Egremont Road; Lots 1 to 18, Concession 3 South of Egremont Road; and Lots 13 to 17, Concession 4 South of Egremont Road. This area will eventually be the site of 40 wind turbines. This Stage 1 archaeological assessment was conducted as part of an Environmental Assessment for Electricity Projects coordinated by Golder Associates Limited, Mississauga office.

The objective of the Stage 1 assessment was to compile all available information about the known and potential cultural heritage resources within the study area and to provide specific direction for the protection, management and/or recovery of these resources, consistent with Ministry of Culture guidelines (Government of Ontario 1993).

The Stage 1 assessment was conducted on September 4th, 2008 under archaeological consulting licence P001, issued to Jim Wilson by the Ontario Ministry of Culture. Archaeological potential criteria commonly used by the Ontario Ministry of Culture were applied to determine areas of archaeological potential within the study area. The archaeological potential for pre-contact Aboriginal and Euro-Canadian sites was deemed to be moderate to high on these properties. For pre-contact Aboriginal sites this determination is made on account of the presence of nearby water sources, level topography, and suitable soils for pre-contact agricultural practices. The historic Euro-Canadian potential was on account of documentation indicating early 19th century occupation, abandoned villages, plus the continued existence of historic transportation routes such as Egremont Road. As a result, Stage 2 archaeological assessment will be required for all areas to be disturbed during turbine or access road construction.

As further archaeological assessment is recommended, the Ontario Ministry of Culture is asked to review the results in this report and issue a letter of concurrence with the findings herein. A letter of clearance is not requested at this time.



LEGEND

Study Area

REFERENCE

DRAWING BASED ON
Government of Canada
1994a *Topographic Map Sheet 40 I/13: Strathroy* (Edition 6). Surveys and Mapping Branch, Department of Energy, Mines and Resources, Ottawa.
1994b *Topographic Map Sheet 40 P/4: Parkhill* (Edition 7). Surveys and Mapping Branch, Department of Energy, Mines and Resources, Ottawa.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

Stage 1 Archaeological Assessment
Air Energy TCI Adelaide Wind Farm
Geo. Twp. of Adelaide, Middlesex County, Ontario

TITLE

Location of the Study Area

Golder Associates

PROJECT No.		07-1112-0151-1800	FILE No.	0711120151-1800-R01001
			SCALE AS SHOWN	REV.
CADD	JM	FEB 26/09	**FIGURE 1**	
CHECK				

2.0 STUDY METHODS

In compliance with the provincial regulations and standards set out in the "*Archaeological Assessment Technical Guidelines*" (Government of Ontario 1993), the Stage 1 Archaeological Overview/Background Study included:

- a review of the land use history, including pertinent historical, environmental, and archaeological data, to determine areas of archaeological potential within the corridor;
- an examination of the National Site Registration Database to determine the presence of known archaeological sites in and around the project area; and
- a visual evaluation of the study corridor.

In addition to the visual evaluation of the subject property, background research was conducted at the Ministry of Culture Office in Toronto, the University of Western Ontario Map Library, and the archaeological firm's corporate library.

3.0 BACKGROUND RESEARCH

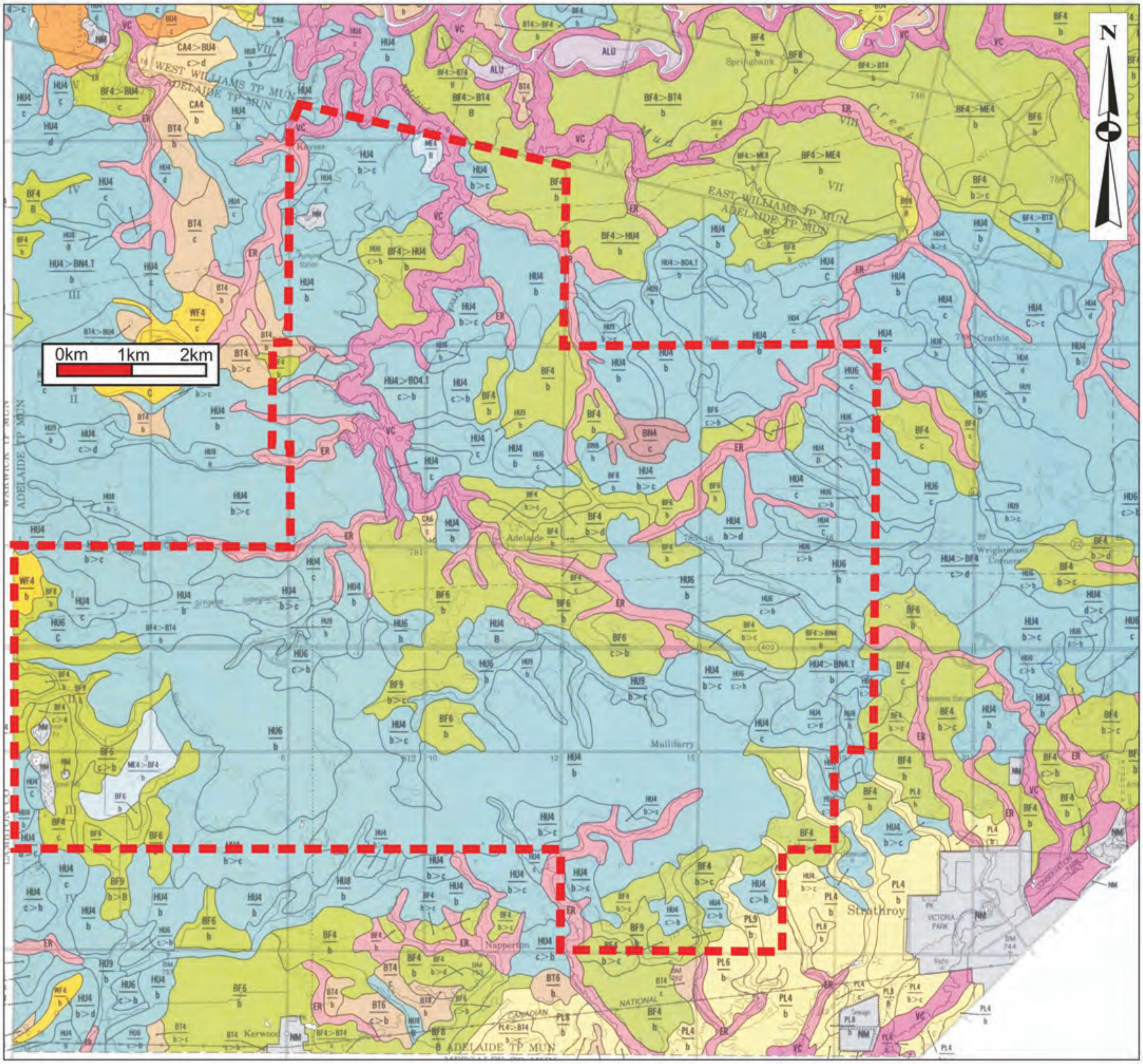
3.1 The Natural Environment

The study area is located in Middlesex County, the Geographic Township of Adelaide, now part of the Township of Adelaide-Metcalfe. The study area covers various lots ranging between Concessions 1 to 5 North of Egremont Road and Concessions 1 to 4 South of Egremont Road. The study area is part of the southwestern end of the Horseshoe Moraines (Chapman and Putnam 1984: 127-129), specifically the tail end of the Seaforth Moraine (Hagerty and Kingston 1992: 11). This physiographic region:

> has a fairly simple landscape. Structurally it consists of two, and in some places three morainic ridges composed of pale brown, calcareous, fine-textured till, with a moderated degree of stoniness. … Huron clay loam … is the most representative soil type on the morainic ridges and it occurs quite widely in other well-drained areas as well.
>
> (Chapman and Putnam 1984: 127)

The study area has two major soil types present: the Huron series and the Brantford series Figure 2. Both soil series are silty clay loams and range from moderately well drained to imperfectly drained in the study area. Six other minor concentrations of identifiable soil series include the well to imperfectly drained Bennington silt loam, the well to imperfectly drained Brant silty loam, the rapid to imperfectly drained Caledon sand loam, the moderately well to imperfectly drained Melbourne silty clay loam, the poorly drained Waterin loamy fine sand, and the well to imperfectly drained Wattford fine sandy loam. The area's topography is nearly level with only some areas of gentle sloping which can contribute to the soils' drainage characteristics as noted here. Most of the soil classes mentioned here would have been suitable for pre-contact Aboriginal agriculture given their modern agricultural capability ratings (Hagerty and Kingston 1992: 74-96) although they would not be the highest yielding soil types available in Middlesex County.

The original surveyor's notes and maps from the Adelaide Township survey of 1831 by Peter Carroll give an overview of the vegetation present in the area prior to the Euro-Canadian occupation of the area (Carroll 1831a). The forest cover noted in the study area along Egremont Road and along the side roads travelling north from it includes mostly basswood, beech, birch, black ash, elm, ironwood, maple, white ash, and white oak. There are also some isolated instances of cherry and poplar. The few marshy areas recorded also had willow trees and rose bushes noted, while one relatively treeless clearing housed plum trees and thorn bushes. In Lot 19, Concession 1 N.E.R. a ridge with "limestones" was noted. Also along Egremont Road but outside of the study area hickory trees were identified.



LEGEND

- Limits of Study Area

Soil Series

BN4 - Bennington
BT4 - Brant
BF4 - Brantford
CA4 - Caledon
HU4 - Huron
ME4 - Melbourne
PL9 - Plainfield
WF4 - Wattford

Miscellaneous

ER - Eroded Channel
NM - Not Mapped
VC - Valley Complex

REFERENCE

DRAWING BASED ON
Hagerty, T.P. and M.S. Kingston
1992 *The Soils of Middlesex County*. Report Number 56 of the Ontario Centre for Soil Resource Evaluation. 2 volumes. Resources Management Branch, Ontario Ministry of Agriculture and Food, Ontario.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

Stage 1 Archaeological Assessment
Air Energy TCI Adelaide Wind Farm
Geo. Twp. of Adelaide, Middlesex County, Ontario

TITLE

Soils of the Study Area

Golder Associates

PROJECT No.		07-1112-0151-1800
CADD	JM	FEB 26/09
CHECK		

FILE No. 0711120151-1800-R01002
SCALE AS SHOWN REV.

FIGURE 2

3.2 Previously Known Archaeological Resources and Surveys

Previous archaeological assessments and research surveys in Middlesex County have demonstrated that the area was intensively utilized by pre-contact Aboriginal peoples. Table 1 summarizes the culture history of Middlesex County, based on Ellis and Ferris (1990). However, only one site has been discovered within the study area, in the southeast corner (Government of Ontario n.d.). The Armbro site (AfHj-107) was a 10 by 15 metre lithic scatter found by Jacqueline Fisher in 2000. It contained a drill and a lithic debitage scatter but no diagnostic artifacts and therefore can only be interpreted as an undateable pre-contact Aboriginal site. Further archaeological assessment would be required if a wind turbine was to be placed in the immediate area.

Table 1: Cultural Chronology for the Middlesex County Area

Period	Characteristics	Time Period	Comments
Early Palaeo-Indian	Fluted Projectiles	9000 - 8400 B.C.	spruce parkland/caribou hunters
Late Palaeo-Indian	Hi-Lo Projectiles	8400 - 8000B.C.	smaller but more numerous sites
Early Archaic	Kirk and Bifurcate Base Points	8000 - 6000 B.C.	slow population growth
Middle Archaic	Brewerton-like points	6000 - 2500 B.C.	environment similar to present
Late Archaic	Lamoka (narrow points)	2000 - 1800 B.C.	increasing site size
	Broadpoints	1800 - 1500 B.C.	large chipped lithic tools
	Small Points	1500 - 1100B.C.	introduction of bow hunting
Terminal Archaic	Hind Points	1100 - 950 B.C.	emergence of true cemeteries
Early Woodland	Meadowood Points	950 - 400 B.C.	introduction of pottery
Middle Woodland	Dentate/Pseudo-Scallop Pottery	400 B.C. - A.D.500	increased sedentism
	Princess Point	A.D. 550 - 900	introduction of corn
Late Woodland	Early Ontario Iroquoian	A.D. 900 - 1300	emergence of agricultural villages

Period	Characteristics	Time Period	Comments
	Middle Ontario Iroquoian	A.D. 1300 - 1400	long longhouses (100m +)
	Late Ontario Iroquoian	A.D. 1400 - 1650	tribal warfare and displacement
Contact Aboriginal	Various Algonkian Groups	A.D. 1700 - 1875	early written records and treaties
Late Historic	Euro-Canadian	A.D. 1796 - present	European settlement

3.3 Historic Site Research

The Euro-Canadian sites discussed here cover the entire study area (Figure 1). This section addresses a previous site assessment report prepared by TCI Renewables (TCI Renewables 2007), discussing previously mentioned historic sites while excluding those that are no longer part of the study area. A general discussion of Adelaide Township will be followed by an examination of four existing and former communities, established in the 19th century, within the study area: the village of Adelaide and the former post offices of Keyser, Mullifarry, and Napperton.

3.3.1 Adelaide Township

The potential wind turbine tower sites are situated within the Geographic Township of Adelaide in Middlesex County, on properties that have been occupied by settlers since the late eighteenth century. The area first enters the Euro-Canadian historic record as part of Treaty Numbers 21 and 27½ made between the First Nation inhabitants of the area and the British. Treaty Number 21

> was a provisional agreement, entered into on the 9th day of March, 1819, between John Aiken, Esquire, on behalf of His Majesty, and the Principal Men of the Chippewa Nation of Indians, inhabiting a tract of land, whereas the said John Aikens for His Majesty was to pay the said Indians 600 pounds yearly for the said tract described as follows:
>
> "Commencing at the northerly side of the River Thames at the south west angle of the Township of London; thence along the western boundary of the Township of London, in a course north 21 degrees, 30 minutes west, twelve miles to the north west angle of the said Township; then on a course about south 62 degrees and 30 minutes west forty-eight miles more or less until it intersects a line on a course produced north two miles from the north east angle of the Shawnee [Sombra] Township; then along the eastern boundary line of the said Township, twelve miles and a half more or less to the northern boundary line of the Township of Chatham; then east twenty-four miles more or less to the River Thames; then along the waters edge of the River Thames against the stream to the place of beginning, reserving a tract of land situate[d] on the northerly side of the River Thames nearly opposite to the northerly angle of the Township of Southwold and south west angle of the Del[a]ware Township containing 15,360 acres; also reserving two miles square distant about four miles above the rapids where the Indians have their improvements and nearly parallel to the Moravian Village containing 5,120 acres."
>
> (Morris 1943: 24-25)

Treaty Number 21 was further modified in Treaty Number 280½ (Canada 1891b: 281-282) and finally confirmed in Treaty Number 25 which modified the method of quantity of payment to the First Nation Groups concerned and some minor variation in the description of the land surrender (Morris 1943: 25).

A small portion of the northwest corner of the Geographic Township of Adelaide was later surrendered in Treaty Number 27½,

> being an agreement made at Amherstburg in the Western District of the Province of Upper Canada on the 26th of April, 1825, between James Givens, Esquire, Superintendent of Indian Affairs, on behalf of His Majesty King George the Fourth and the Chiefs and Principal Men of the part of the Chippewa Nation of Indians, inhabiting and claiming the tract of land …. Wawanosh Township in the County of Huron was named after Way-way-nosh the principal Chief of the Band making this Treaty.
>
> (Morris 1943: 26-27)

Treaty Number 27½ was subsequently confirmed on July 10th, 1827 as Treaty Number 29 with only a minor change in the legal description of the boundaries of the land surrender (Morris 1943: 27).

Although it is difficult to exactly delineate treaty boundaries today, Figure 3 gives an approximate outline of the limits of Treaty Numbers 21 and 27½ (noted as “R” and “T’ respectively on the map). Figure 4 shows the approximate location of the current study area on the undated treaty map for Treaty Number 21 and Figure 5 shows the approximate location of the current area on the 1827 treaty map for Treaty Number 27½ (Canada 1891a).

LEGEND

- Treaty Boundary
- Approximate Location of Study Area

Treaty No. 381, Volume 3 (May 9th, 1781): Mississauga and Chippewa
Crawford's Purchase (Oct. 9th, 1783): Algonquin and Iroquois
Crawford's Purchase (Oct. 9th, 1783): Mississauga
Crawford's Purchases (1784, 1787, 1788): Mississauga
John Collins' Purchase (1785): Chippewa
Treaty No. 2 (May 19th, 1790): Odawa, Chippewa, Pottawatomi, and Huron
Treaty No. 3 (Dec. 2nd, 1792): Mississauga
Haldimand Tract: from the Crown to the Mohawk (1793)
Tyendinaga: from the Crown to the Mohawk (1793)
Treaty No. 3¾ (Oct. 24th, 1795): from the Crown to Joseph Brant
Treaty No. 5 (May 22nd, 1798): Chippewa
Treaty No. 6 (Sep. 7th, 1796): Chippewa
Treaty No. 7 (Sep. 7th, 1796): Chippewa
Treaty No. 13 (Aug. 1st, 1805): Mississauga
Treaty No. 13A (Aug. 2nd, 1805): Mississauga
Treaty No. 16 (Nov. 18th, 1815): Chippewa
Treaty No. 18 (Oct. 17th, 1818): Chippewa
Treaty No. 19 (Oct. 28th, 1818): Chippewa
Treaty No. 20 (Nov. 5th, 1818): Chippewa
Treaty No. 21 (Mar. 9th, 1819): Chippewa
Treaty No. 27 (May 31st, 1819): Mississauga
Treaty No. 27½ (Apr. 25th, 1825): Ojibwa and Chippewa
Treaty No. 35 (Aug. 13th, 1833): Wyandot or Huron
Treaty No. 45 (Aug. 9th, 1836): Chippewa and Odawa
Treaty No. 45½ (Aug. 9th, 1836): Saugeen
Treaty No. 57 (Jun. 1st, 1847): Iroquois of St. Regis
Treaty No. 61, Robinson Treaty (Sep. 9th, 1850): Ojibwa
Treaty No. 72 (Oct. 30th, 1854): Chippewa
Treaty No. 82 (Feb. 9th, 1857): Chippewa
Williams Treaty (Oct. 31st and Nov. 15th, 1923): Chippewa and Mississauga
Williams Treaty (Oct. 31st, 1923): Chippewa

NOTES

This drawing is schematic only and is to be read in conjuction with accompanying text. All locations are approximate.

REFERENCE

1. Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
2. Treaty Boundary - Approximate Treaty Boundary was created by Golder Associates Ltd. Jan. 2009.

MORRIS, J.L. 1943. Indians Of Ontario. Reprinted 1964. Department Of Lands And Forests, Toronto.

Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2008

Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17

0 25 50
Kilometres

PROJECT

Stage 1 Archaeological Assessment
Air Energy TCI Adelaide Wind Farm
Geo. Twp. of Adelaide, Middlesex County, Ontario

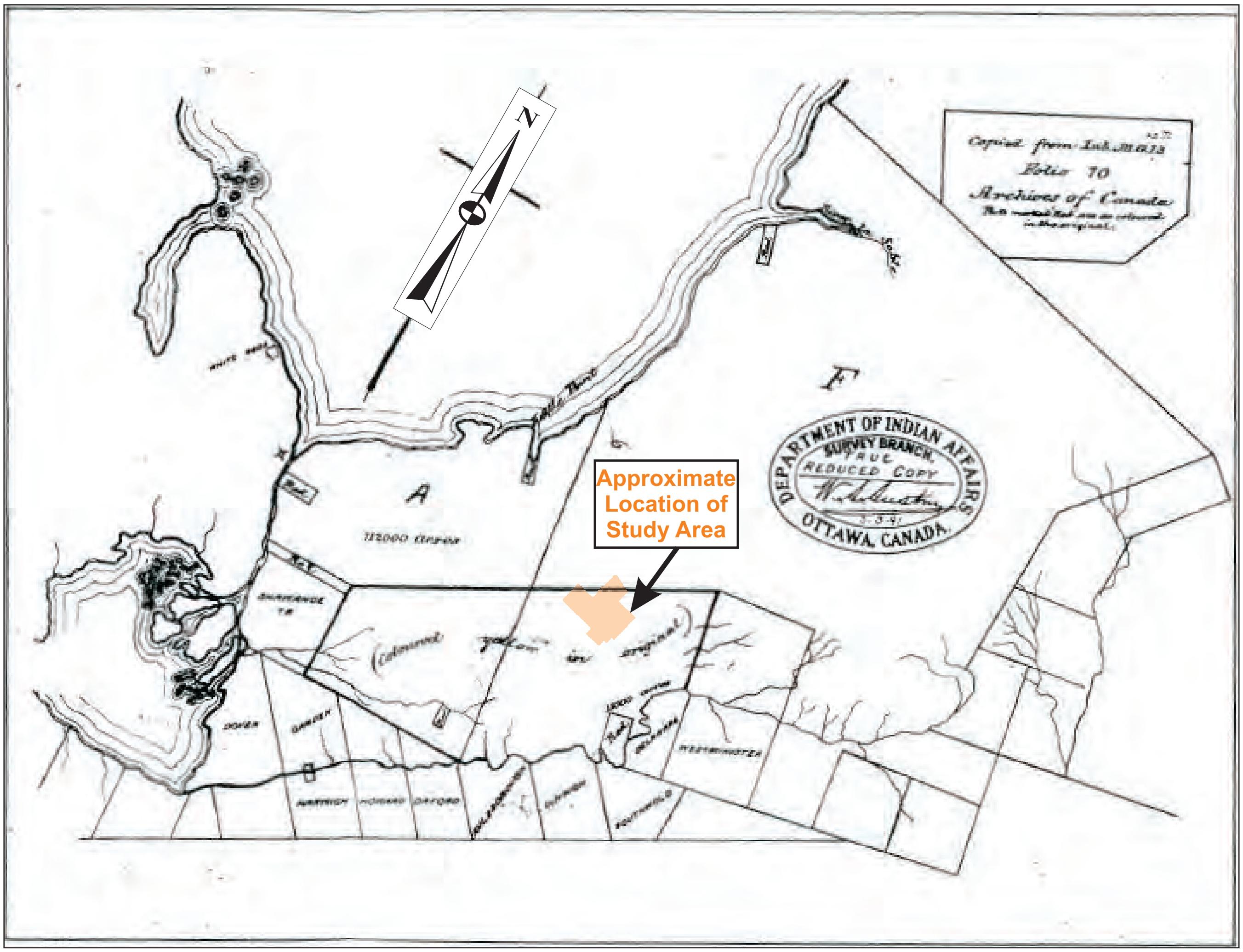
TITLE

Treaty Boundaries Based on Morris 1943

Golder Associates
Mississauga, Ontario

PROJECT No. 07-1112-0151			1:2,500,000	REV. 0.0
DESIGN	JMC	15 Dec. 2008	FIGURE 3	
GIS	JMC	23 Jan. 2009		
CHECK	JM	23 Jan. 2009		
REVIEW	JM	23 Jan. 2009		

G:\Projects\2008\08-1136-0180 Bruce to Milton Transmission Line Reinforcement\GIS\MXDs\Draft\OBM\Treaty_Area.mxd



REFERENCE

DRAWING BASED ON
Canada
1891 *Indian Treaties and Surrenders. From 1680 to 1890.* Volume I. Brown Chamberlin, Ottawa. Unpaginated map.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

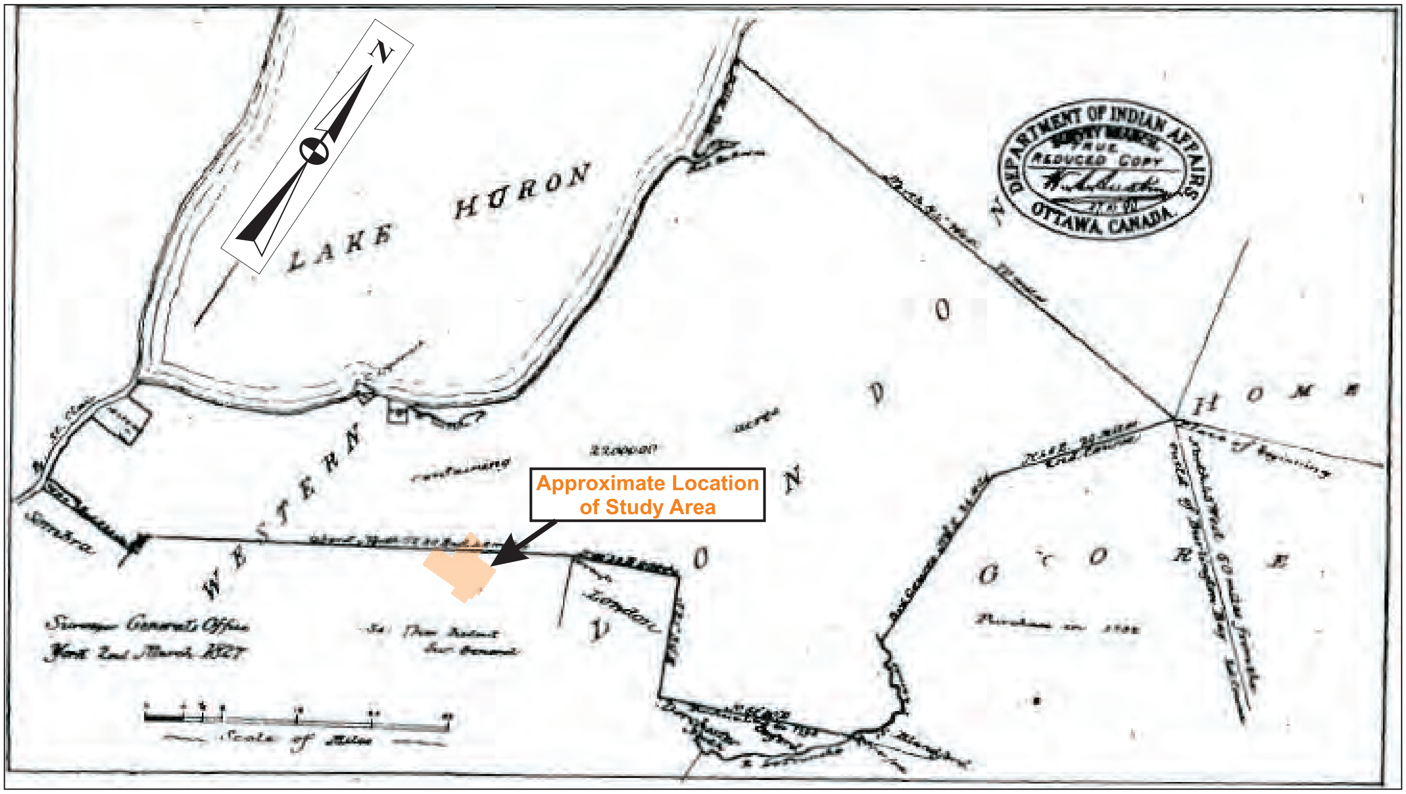
Stage 1 Archaeological Assessment
Air Energy TCI Adelaide Wind Farm
Geo. Twp. of Adelaide, Middlesex County, Ontario

TITLE

Undated Map of Treaty Number 21, Approximately Illustrating Study Area

Golder Associates

PROJECT No.		07-1112-0151-1800	FILE No.	0711120151-1800-R01004
			SCALE	NOT TO SCALE REV.
CADD	JM	FEB 26/09		
CHECK			**FIGURE 4**	



REFERENCE

DRAWING BASED ON
Canada
1891 *Indian Treaties and Surrenders. From 1680 to 1890.* Volume I. Brown Chamberlin, Ottawa. Unpaginated map.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

Stage 1 Archaeological Assessment
Air Energy TCI Adelaide Wind Farm
Geo. Twp. of Adelaide, Middlesex County, Ontario

TITLE

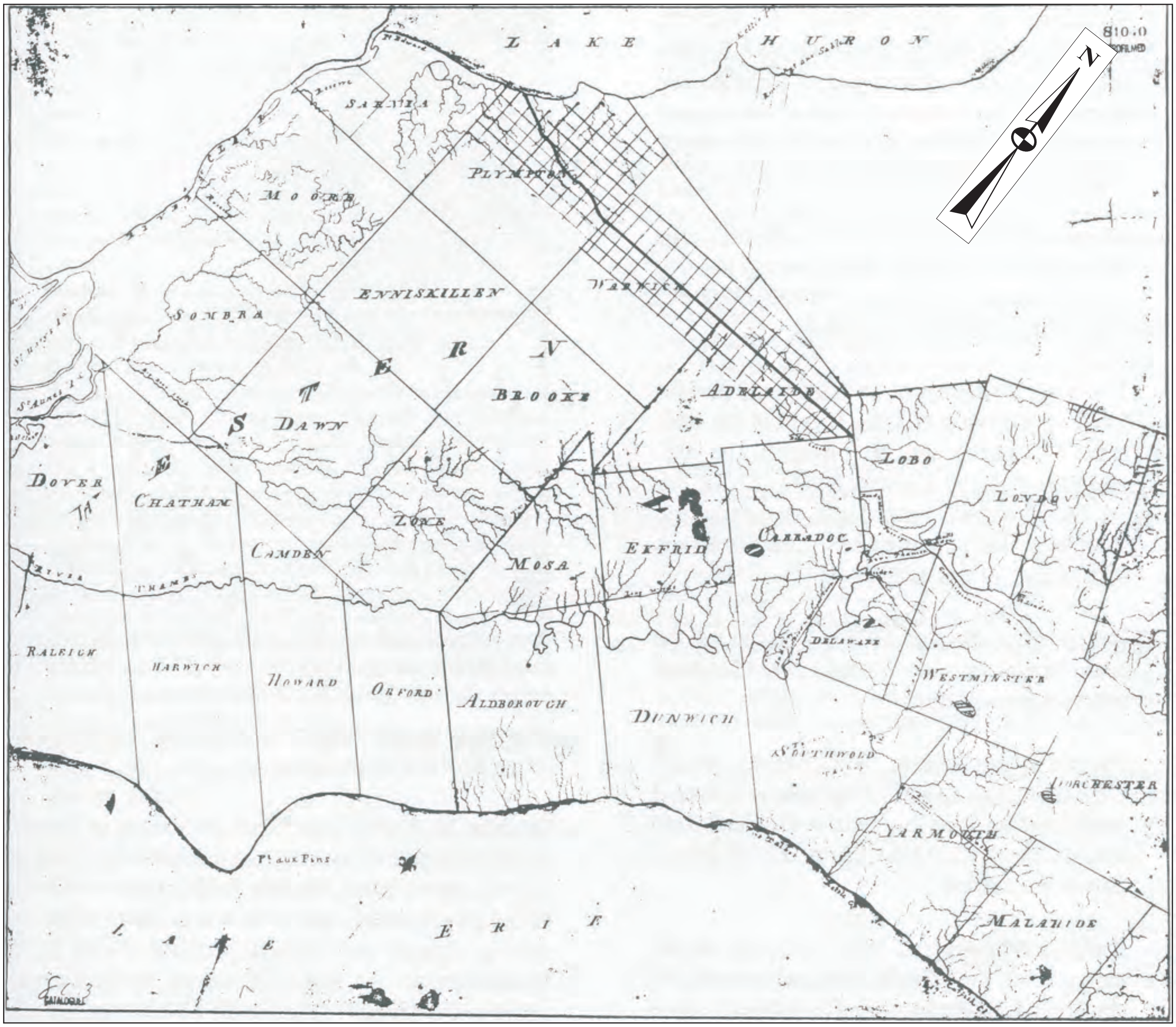
1827 Map of Treaty Number 27½,
Approximately Illustrating Study Area

Golder Associates

PROJECT No.		07-1112-0151-1800	FILE No.	0711120151-1800-R01005
			SCALE AS SHOWN	REV.
CADD	JM	FEB 26/09	**FIGURE 5**	
CHECK				

The first Euro-Canadian settlement of the area began in the 1830's after Egremont Road was laid through the study area (Figure 6) in 1831 by the Deputy Surveyor Peter Carroll (Carroll 1831a, Carroll 1831b). Egremont Road was surveyed at the request of the Lieutenant Governor of Canada, Sir John Colborne. He recognized that the contemporary road network of Longwoods Road and Talbot Road spanning the western part of the London District and of the Western District in what is now southwestern Ontario was insufficient to allow European settlers into the area and did not provide a sufficient military transportation route should any defensive concerns arise (Nielsen 1993: 3). Peter Carroll was engaged by Peter Robinson, Commissioner of Crown Lands and Surveyor General of Woods, to survey a road extending from the northeast corner of Caradoc Township to the shores of Lake Huron. Peter Carroll completed the initial survey of Adelaide Township (along with Warwick and Plympton Townships that are now part of Lambton County) in 1831. This survey lay in the route of Egremont Road along with "three tiers of lots on either side" (Nielsen 1993: 6). He then finished the remainder of the survey of the township in 1832 (Nielsen 1993: 8).

The original township map made by Peter Carroll (Figure 7), while dated in Oxford County on December 29th, 1831, had numerous additions made to it over the following years. The most obvious addition is the complete survey of the entire township which was not actually completed until July of 1832 (Nielsen 1993: 8). The names of lot occupants given on the maps appear to have been added once settlers moved into the area after 1832. For example, the first recorded settlers in the area are the Radcliff brothers, William and Thomas, who settled in the township in 1832, as well as Dr. Thomas Phillips who erected the first house in the township (Nielsen 1993: 10). Other names are conspicuous later additions. For example, Thomas Pennington is written into the west half of Lot 15, Concession 2 N.E.R. (Figure 8) but he is recorded as having only purchased the land from the Crown in 1856 (ATHG 2001: 329). His name also overwrites a now illegible inscription reading "W½ specification for […]" which might be related to the land's designation as a clergy reserve. In fact, all lands that were marked with a blue watercolour oval were designated as Clergy Reserves. This meant that all proceeds from the Crown Patent went in support of the Protestant clergy, usually the Anglican Church (ATHG 2001: 439). However, by the time of Thomas Pennington's purchase in 1856 the land had been secularized (Fahey 2008). Incidentally, the lots marked with a red watercolour oval were designated as Crown Lands. In any case, close examination of the study area as depicted on the original township map does not reveal any squatters recorded from before 1831 or any notable First Nations activity in the area.



LEGEND

Approximate Location of Study Area

REFERENCE

DRAWING BASED ON
Nielsen, Eleanor
1993 *The Egremont Road: Historic Route from Lobo to Lake Huron*. Lambton Historical Society, Sarnia. p. 7.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

Stage 1 Archaeological Assessment
Air Energy TCI Adelaide Wind Farm
Geo. Twp. of Adelaide, Middlesex County, Ontario

TITLE

Map Showing Peter Carroll's Original 1831 Egremont Road Survey

Golder Associates

PROJECT No.	07-1112-0151-1800	FILE No.	0711120151-1800-R01006
		SCALE	NOT TO SCALE REV.
CADD	JM	FEB 26/09	
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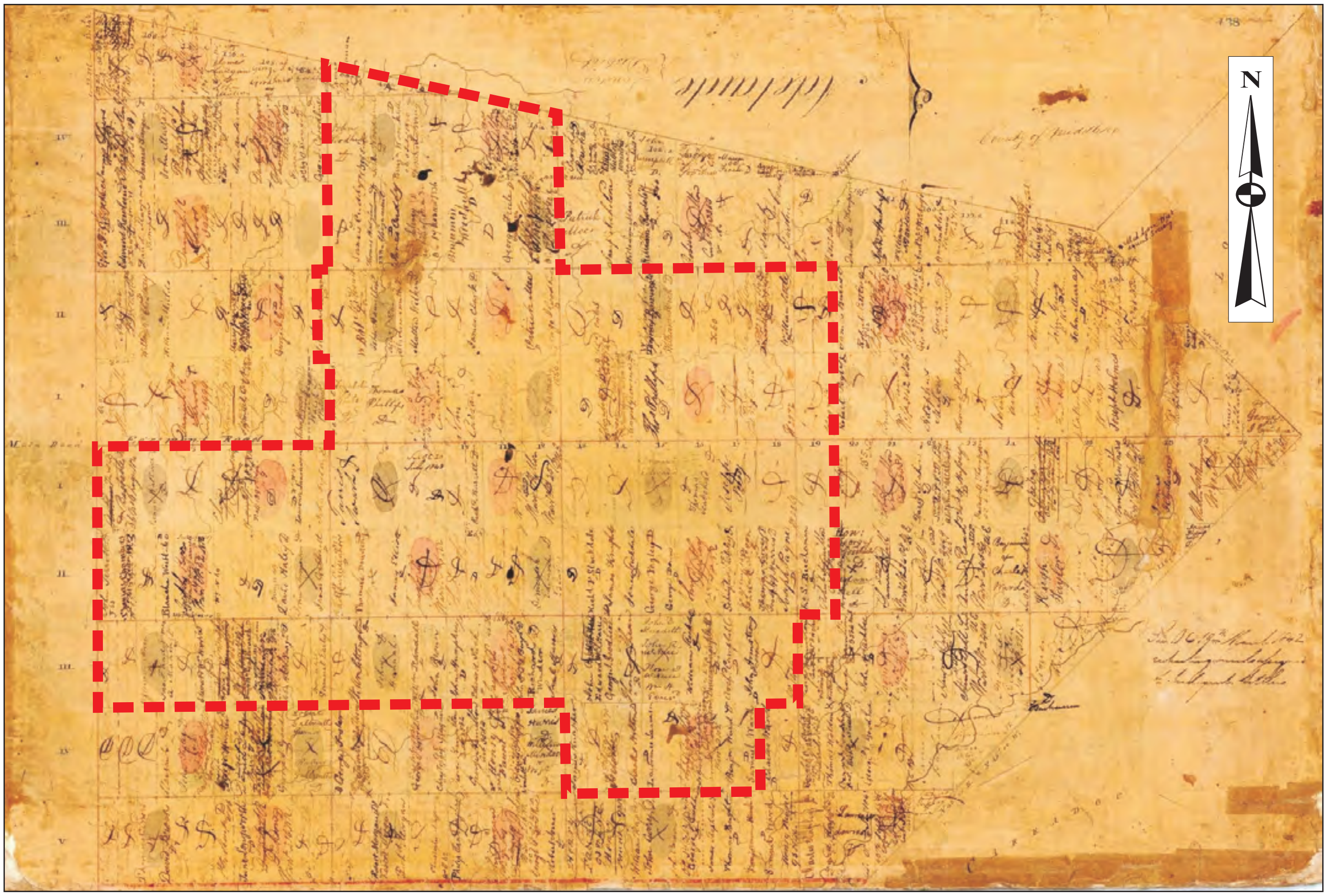
FIGURE 6



LEGEND

Study Area

REFERENCE

DRAWING BASED ON
Caroll, Peter
1831 *Plan of the Township of Adelaide. By Peter Carroll, Deputy Surveyor, 29th December 1831*. Map No. 438. On file with the Ministry of Natural Resources Crown Land Survey Records Office, Peterborough, Ontario.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT
Stage 1 Archaeological Assessment
Air Energy TCI Adelaide Wind Farm
Geo. Twp. of Adelaide, Middlesex County, Ontario

TITLE
A Portion of Peter Carroll's
1831 Map of the Township of Adelaide

Golder Associates

PROJECT No.	07-1112-0151-1800		FILE No.	0711120151-1800-R01007
			SCALE NOT TO SCALE	REV.
CADD	JM	FEB 26/09	**FIGURE 7**	
CHECK				

REFERENCE

DRAWING BASED ON
Caroll, Peter
1831 *Plan of the Township of Adelaide. By Peter Carroll, Deputy Surveyor, 29th December 1831.* Map No. 438. On file with the Ministry of Natural Resources Crown Land Survey Records Office, Peterborough, Ontario.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

Stage 1 Archaeological Assessment
Air Energy TCI Adelaide Wind Farm
Geo. Twp. of Adelaide, Middlesex County, Ontario

TITLE

Detail from Peter Carroll's
1831 Map of the Township of Adelaide

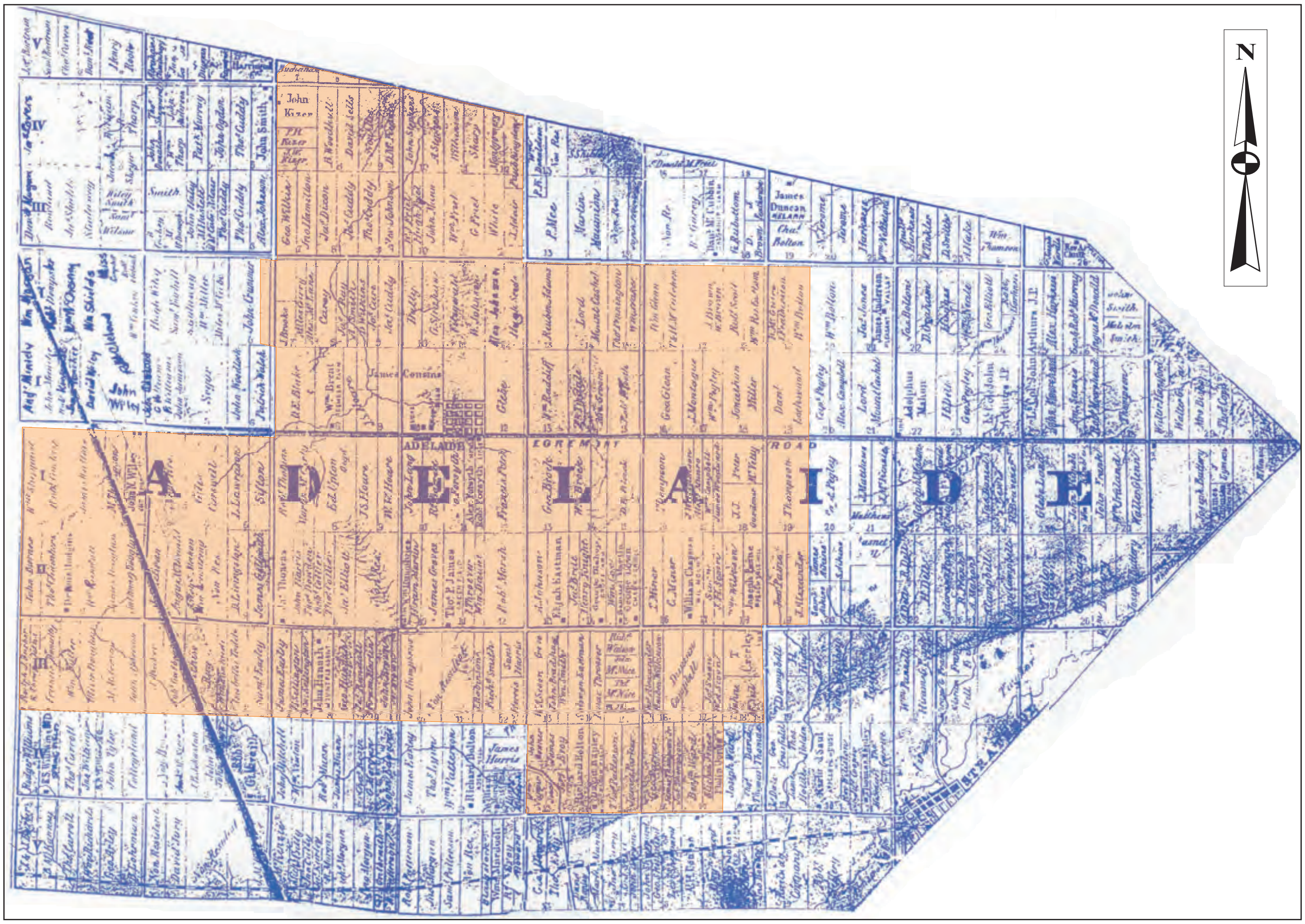
Golder Associates

PROJECT No.		07-1112-0151-1800	FILE No.	0711120151-1800-R01008
			SCALE NOT TO SCALE	REV.
CADD	JM	FEB 26/09		
CHECK			**FIGURE 8**	

Two later maps from the 19th century record the Euro-Canadian settlers and illustrate the growth in the study area: the 1862 Tremaine Map (Tremaine 1862) and the 1878 H.R. Page and Company Historical Atlas Map (H.R. Page 1878). The Tremaine Map (Figure 9) provides the names of all of the landowners but only illustrates a select number of structures on the properties. However, the later Historical Atlas Map (Figure 10) not only provides the names of the landowners but also the structures on the majority of the properties. Besides houses, the structures noted include brickyards, cemeteries, churches, hotels, manufactories, mills, and schools. Table 2 lists those lots that hold a structure other than a house, along with the name of the occupant. Even though locations are only approximate on these maps, they do give an idea of potential for significant archaeological historic remains that could be impacted within the study area. Typically these locations no longer exhibit any visible evidence of their former structure and if they are to be impacted by a wind turbine placement the location would need to be archaeologically assessed to see if there are any archaeological remains (Figure 11). Outside of any of the communities discussed in Sections 3.3.2 to 3.3.5, two notable structures within the study area are:

- **The West Adelaide Presbyterian Cairn** is located on the east half of Lot 3, Concession 1 S.E.R. The original cemetery was used from 1853 to 1881 and subsequently abandoned. It was not until the 1950's that the present cairn was constructed from the remaining tombstones. Although some of the bodies might have been moved, documentation for this cemetery is insufficient to determine this (ATHG 2001: 466-467) and the only information known about the burials is recorded on the cairn itself (Robb and McLeod 1982). Archaeological concerns undoubtedly exist for this insufficiently recorded Euro-Canadian pioneer cemetery.

- **The Victoria Cheese Company** was established in 1871 in a large wooden frame building by Lawrence Cleverdon and his business partner John Carrothers on Lot 2, Concession 2 S.E.R. The cheese factory was sold to John Clark in 1882. The building was sold again in 1925 and was used as a drive shed until it was blown down and demolished by a tornado in 1953. Now an open field, if a turbine is to be slated for construction nearby, possible archaeological traces of the cheese factory could be impacted (ATHG 2001: 95-97; Grainger 2002: 15).



LEGEND

Study Area

REFERENCE

DRAWING BASED ON
Tremaine, George R.
1862 *Tremaine's Map - London and Middlesex County*.
George C. Tremaine, Toronto.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

Stage 1 Archaeological Assessment
Air Energy TCI Adelaide Wind Farm
Geo. Twp. of Adelaide, Middlesex County, Ontario

TITLE

A Portion of the 1862 Map of the Township of Adelaide on *Tremaine's Map - London and Middlesex County*

Golder Associates

PROJECT No.		07-1112-0151-1800	FILE No.	0711120151-1800-R01009
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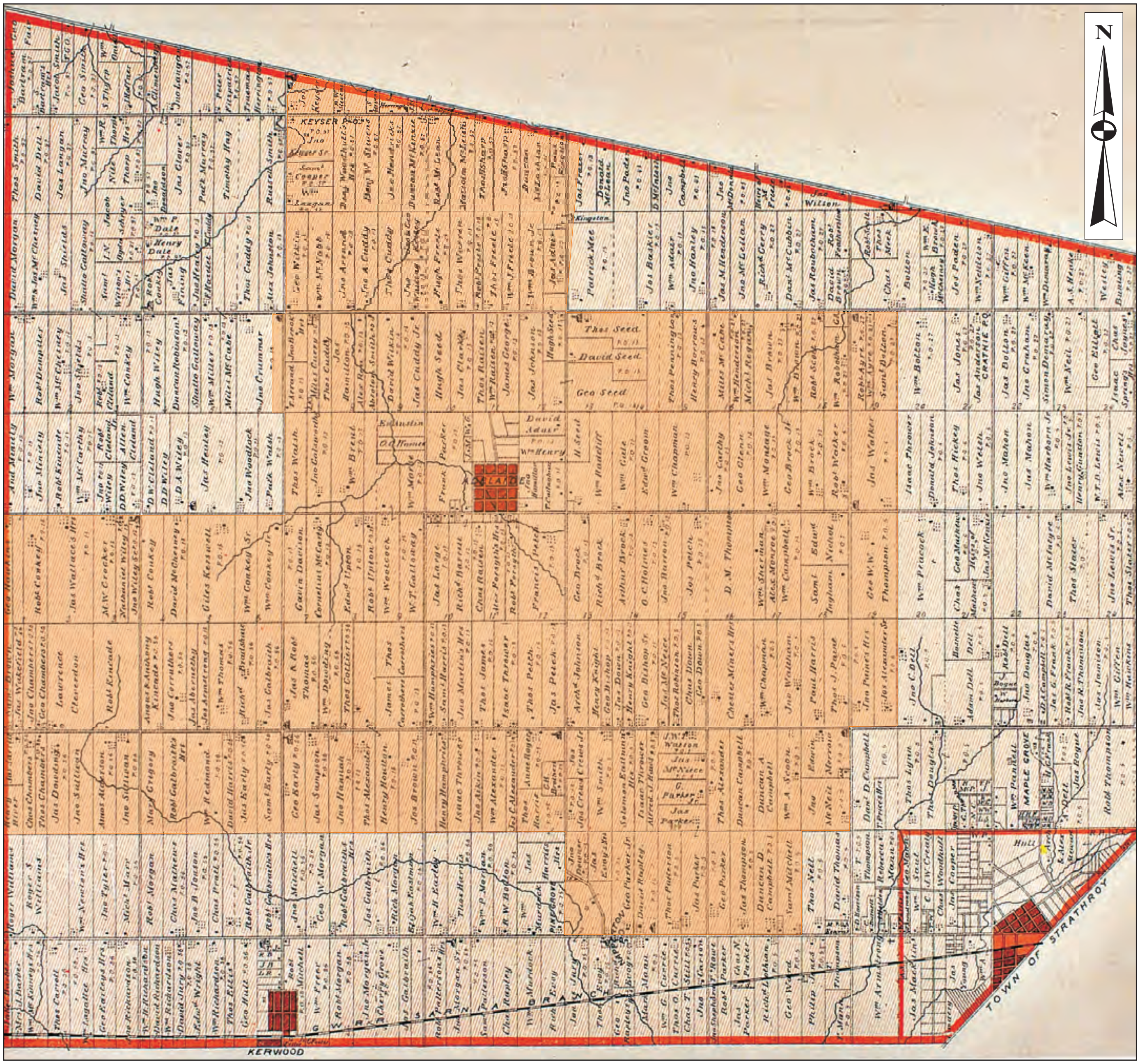
CADD	JM	FEB 26/09		
CHECK			**FIGURE 9**	



LEGEND

Study Area

REFERENCE

DRAWING BASED ON
H.R. Page and Company
1878 *Illustrated Historical Atlas of the County of Middlesex*.
1972 reprint. Edward Phelps, Sarnia.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

Stage 1 Archaeological Assessment
Air Energy TCI Adelaide Wind Farm
Geo. Twp. of Adelaide, Middlesex County, Ontario

TITLE

A Portion of the Historic Map of the Township of Adelaide in the 1878 *Illustrated Historical Atlas of the County of Middlesex*

PROJECT No.	07-1112-0151-1800	FILE No.	0711120151-1800-R01010
		SCALE	NOT TO SCALE REV.
CADD	JM	FEB 26/09	
CHECK			

Golder Associates

FIGURE 10

Figure 11: Probable Site of Former Schoolhouse on Part of Lot 18, Concession 3 S.E.R. of the Geographic Township of Adelaide

Table 2: Historic Properties with Potentially Significant Structures According to the 1878 *Illustrated Historical Atlas of the County of Middlesex*

Lot	Concession	Owner	Structure
11	1 N.E.R.	Village of Adelaide	Town Plot
19	1 N.E.R.	James Walker	Schoolhouse
8	2 N.E.R.	John Crummer	Schoolhouse
Part of 13	2 N.E.R.	Thomas Seed	Church
Part of 19	2 N.E.R.	Robert Ayre	Schoolhouse
Part of 7	4 N.E.R.	John Keyser Senior	Post Office, Brickyard
Part of 3	1 S.E.R.	John Wiley Senior	Church, Cemetery
2	2 S.E.R.	Lawrence Cleverdon	Factory
Part of 7	2 S.E.R.	James and Robert Thomas	Schoolhouse

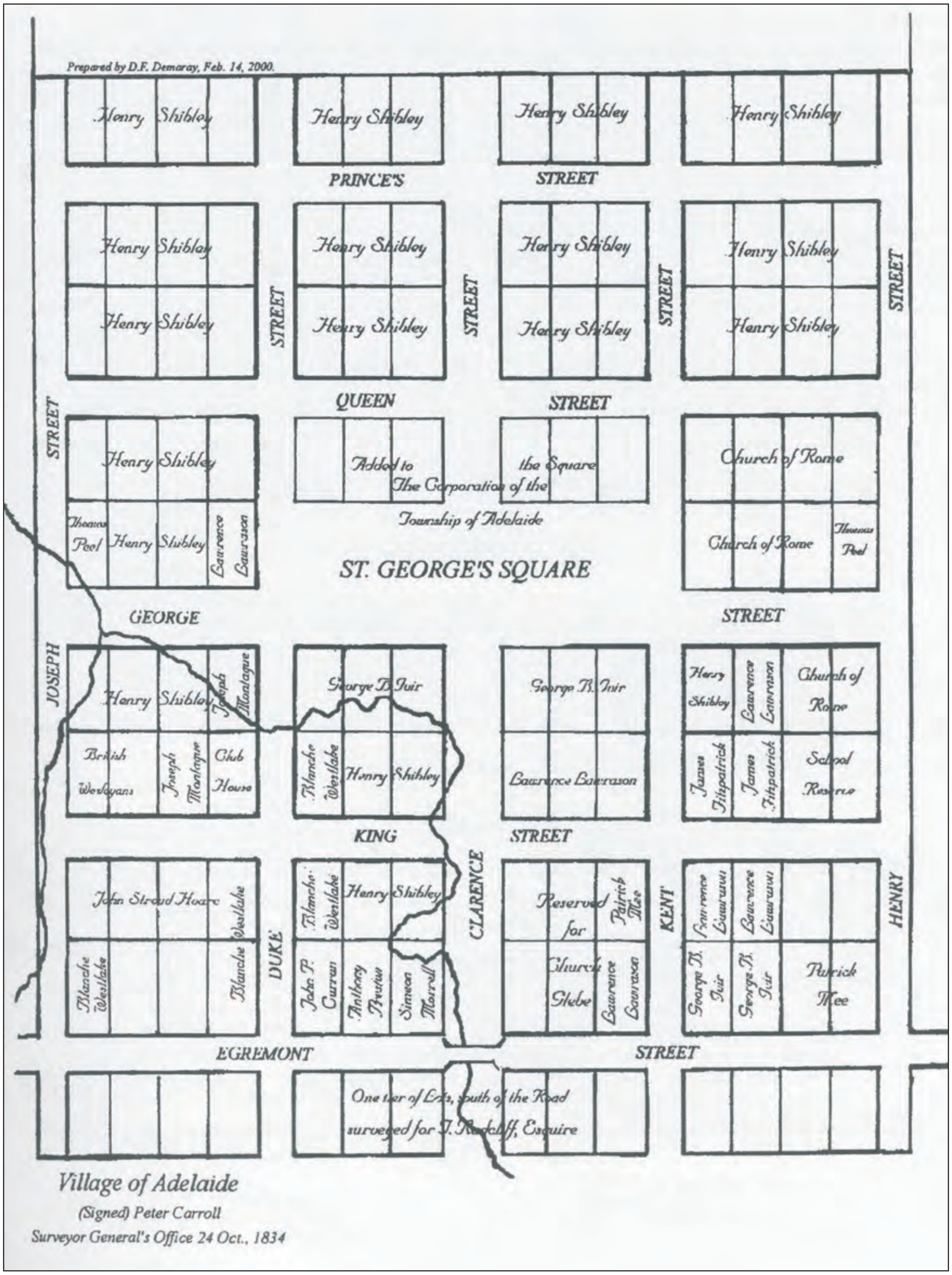
Lot	Concession	Owner	Structure
Part of 7	3 S.E.R.	George Early	Church
Part of 12	3 S.E.R.	Anne Rogers	Church
Part of 18	3 S.E.R.	Edwin Morrow	Schoolhouse
13	4 S.E.R.	Jonas Jury	Lime Kiln
Part of 14	4 S.E.R.	David Rapley	Schoolhouse

Concerning the other structures in Table 2, documentary records do exist for the former schools and churches (which are summarized in ATHG 2001) and if those former structures are to be impacted by turbine construction additional historical research can be undertaken alongside any further Stage 2 or Stage 3 archaeological assessment. However, not all significant structures survived long enough to be depicted on the surviving maps of Adelaide Township; two examples will suffice. On the west half of Lot 10, Concession 2 S.E.R. the Humphries' Wesleyan Methodist Church existed from 1855 to 1861. The land was purchased from William Humphries on September 28, 1855. The small log house built there was also used as a schoolhouse. Few records exist and there is no further trace of the church after 1861. This area could be archaeologically significant if it is to be impacted by a wind turbine (ATHG 2001: 453). Then, on Lot 5, Concession 1 S.E.R., the first log schoolhouse for S.S. #6 Adelaide was built in 1865 and was used until a new frame schoolhouse was built across the road on Lot 5, Concession 1 N.E.R. Although local tradition says the frame schoolhouse was built "[s]ometime before 1884" (ATHG 2001: 477), it already existed by the time of the 1878 Historical Atlas where this later structure (just outside of the study area) is clearly visible. Like the Humphries' Wesleyan Methodist Church, the former log schoolhouse location now comprises an area of archaeological significance.

3.3.2 Adelaide

Adelaide was laid out by Peter Carroll in 1833. Four structures already existed on the town plot prior to its survey, including two houses and two stores, one containing government offices (Nielsen 1993: 28). After the town plot was surveyed (Figure 12) the community continued to expand but it never occupied the entire surveyed area. The village had reached a maximum population of 200 in 1857 but ceased to grow when the Grand Trunk Railway Line between London and Sarnia passed through Strathroy to the south (ATHG 2001: 505-506). The village plan in the 1878 historical atlas shows the town plot was still in use but very few buildings had been laid out on the theoretical allotments available (Figure 13). Today, the surveyed road grid no longer survives although some of the road allowances still exist legally (Figure 14). A portion of Kent Street is still used while Barrett Street to the west was a portion of Duke Street and Feasey Street to the east used to be a portion of Henry Street. Further archaeological investigation in the area would be necessary if turbines are to be placed in the area given the abandonment and destruction of former village buildings over time. However, given that wind turbines are generally not placed so close to inhabited areas, the need for archaeological mitigation is unlikely. Nevertheless, a list of past sites of note in Adelaide that could be archaeologically significant includes:

- **St. Ann's Anglican Church** was a frame church with a rectory built in 1833 and destroyed by a windstorm in 1868 (ATHG 2001: 442-443). It was replaced by the current church that still stands.



REFERENCE

DRAWING BASED ON
Adelaide Township Heritage Group
2001 *Adelaide Township… a history*. Adelaide Township Heritage Group, Strathroy. p. 25.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

Stage 1 Archaeological Assessment
Air Energy TCI Adelaide Wind Farm
Geo. Twp. of Adelaide, Middlesex County, Ontario

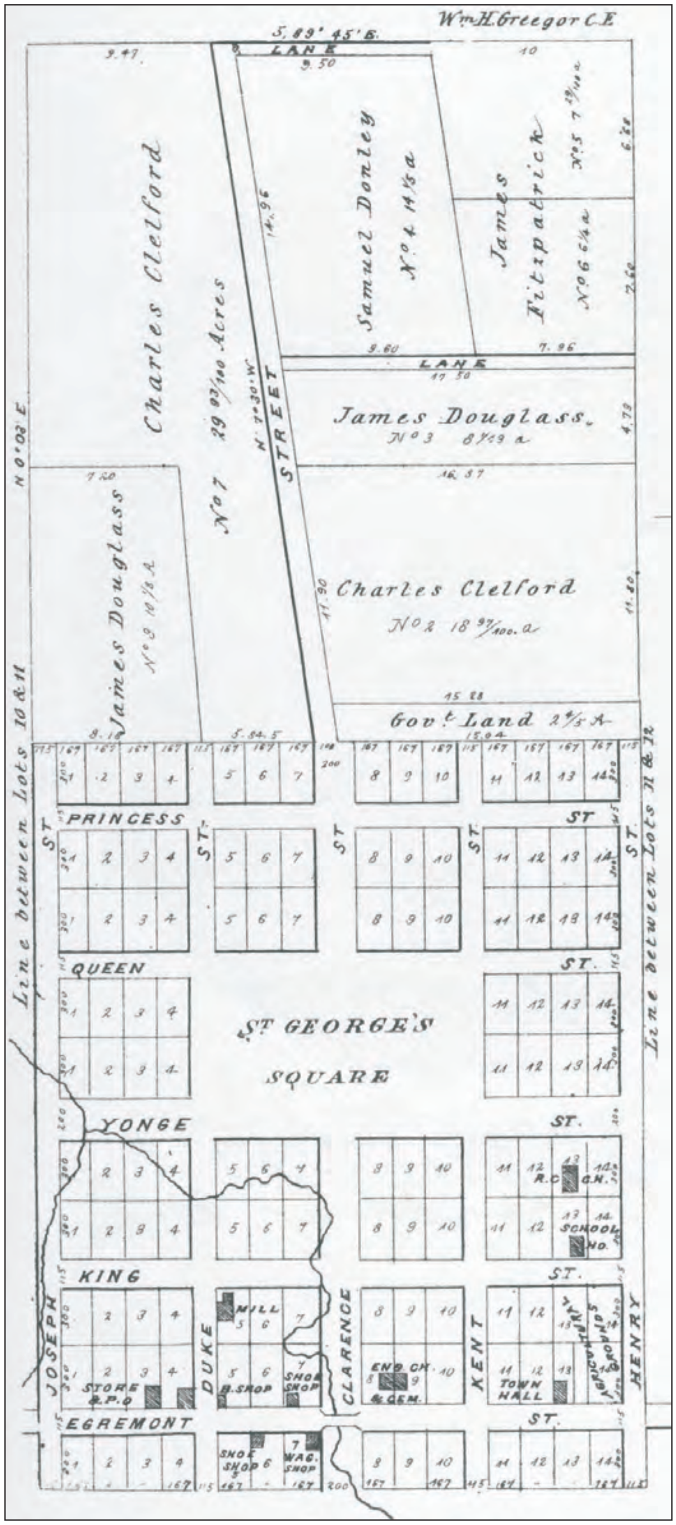
TITLE

Original 1833 Town Plot for the
Village of Adelaide (Redrawn)

PROJECT No.		07-1112-0151-1800
CADD	JM	FEB 26/09
CHECK		

FILE No. 0711120151-1800-R01012
SCALE NOT TO SCALE REV.

FIGURE 12



REFERENCE

DRAWING BASED ON
H.R. Page and Company
1878 *Illustrated Historical Atlas of the County of Middlesex*.
1972 reprint. Edward Phelps, Sarnia. p. 51.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

Stage 1 Archaeological Assessment
Air Energy TCI Adelaide Wind Farm
Geo. Twp. of Adelaide, Middlesex County, Ontario

TITLE

1878 Town Plot for the
Village of Adelaide in the *Illustrated*
Historical Atlas of the County of Middlesex

Golder Associates

PROJECT No.	07-1112-0151-1800	FILE No.	0711120151-1800-R01013
		SCALE	NOT TO SCALE REV.
CADD	JM	FEB 26/09	
CHECK			

FIGURE 13

REFERENCE

DRAWING BASED ON

Mapping provided by client.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

Stage 1 Archaeological Assessment
Air Energy TCI Adelaide Wind Farm
Geo. Twp. of Adelaide, Middlesex County, Ontario

TITLE

The Village of Adelaide Today

Golder Associates

PROJECT No.		07-1112-0151-1800	FILE No.	0711120151-1800-R01014
			SCALE	AS SHOWN REV.
CADD	JM	FEB 26/09		
CHECK			**FIGURE 14**	

- **St. Ann's Anglican Church Cemetery** is associated with the destroyed St. Ann's Anglican Church and its still standing successor. The cemetery was formally established in 1833 but it has a headstone dating to 1828 (ATHG 2001: 463). The site is marked by a Heritage Trail sign and is located at 2276 Egremont Drive (Figure 15).

- **St. Patrick's Roman Catholic Church** was a white frame chapel beside the associated cemetery built in 1849. It was torn down in 1904 and replaced by a brick church that year. The original church was located in Lot 13 south of Yonge Street (Figure 13); the later brick church located at Egremont Road. The church was abandoned after 1962 and was razed to the ground in 1984 (ATHG 2001: 459-460).

- **St. Patrick's Roman Catholic Cemetery** covered 0.4 hectares of land and was part of the original 1848 Crown Patent of 1.6 hectares for the associated church and residence too. It was in use between 1849 and 1933 and eventually fell into disrepair. The oldest remaining stone dates to 1864 (ATHG 2001: 464). Although the cemetery has been marked off, on account of its poor upkeep and the incomplete burial records from the cemetery (ATHG 2001: 460-462), burial remains could easily fall outside of the cemetery area and would need a precautionary archaeological assessment. The site is marked by a Heritage Trail sign in an unnumbered lot northwest of the north end of Feasey Street (Figure 16).

- **S.S. #12 Adelaide Village School** was located on Lots 13 and 14 on the north side of King Street (for a total of 0.4 hectare). It stood from 1850 to 1890 and was subsequently torn down (ATHG 2001: 501-502). It is noted on the 1878 Village of Adelaide Map (Figure 13) and most likely any archaeological remains lie near or under currently standing buildings at 29105 Feasey Street (Figure 17).

Figure 15: The Present Day St. Ann's Anglican Church and Its Associated Cemetery; Facing Northwest from Egremont Road

Figure 16: The St. Patrick's Roman Catholic Cemetery As It Stands Today; Facing Northwest from Feasey Street

Figure 17: Current House and Playground Structure at 29105 Feasey Street, Former Site of the Adelaide Village School; Facing Southwest from Feasey Street

3.3.3 Keyser

A late 19th century post office was the Keyser Post Office, named after the Keyser family that held the property. The Keyser family occupied Lot 7, Concession 4 N.E.R. at the intersection of present day Langan Drive and Kerwood Road (County Road 8) from the 1830's onwards. The intersection was known locally from that time as "Keyser Corner" or "Keyser's Corner" (ATHG 2001: 226, 514). While the intersection is not marked with a distinct name on the 1862 Tremaine Map (Figure 9), the family does own the properties on the southeast corner (here spelled "Kizer").

The Keyser Post Office opened in 1864 and closed in 1891 and then reopened from 1901 to 1913. The post office is noted in the 1878 historical atlas (Figure 10). The community had an average population of between 30 to 60 people although it had 200 people at its height in 1871 (ATHG 2001: 514). At its height, Keyser spanned the intersection both inside and outside of the study area. By 1913 when the post office closed the village had dwindled and now only the name remains on maps. The local brick and tile yard operated by John Philip Keyser from the 1860's onwards was located behind his house on part of Lot 7, Concession 4 N.E.R. (ATHG 2001: 515, Grainger 2002: 9-10). The clay from his property was used to make the bricks stamped with the "KEYSER" label. This activity has probably left behind both archaeological traces and landscape disturbance in the forest area and the adjacent field that remains (Figure 18). Another significant building on the same lot was the S.S. #1 and #2 – Adelaide and West Williams, Keyser School, which was in use from 1858 until the school was abandoned for the new schoolhouse in 1877 (ATHG 2001: 469). Like the brickyard, this building may have left behind archaeological traces. Other poorly documented structures associated with Keyser might have existed in the study area at one time too. Just outside of the study in the northwest corner of Lot 7, Concession 5 N.E.R. stood a church and the schoolhouse replacing the S.S. #1 and #2.

Figure 18: Probable Location of Keyser Brickworks in Forested Area With Creek Running Through It; Facing North Along East Side of Kerwood Road

3.3.4 Mullifarry

The community of Mullifarry is still noted on maps (Figure 1) although it was only a post office from 1880 until 1913 (Grainger 2002: 12). A farm in the area retains the name "Mullifarry Landing" but is a later construction named in honour of the post office (Figure 19). The post office had been moved in 1900; the original building housing the post office no longer stands. The torn down house might have left behind archaeological remains that could be significant.

Figure 19: Barn Labelled "Mullifarry Landing" at 3003 Mullifarry Drive; Facing South from Mulifarry Drive

3.3.5 Napperton

Another late 19th century post office was the Napperton Post Office. The community is well known for one of its turn of the century inhabitants, Arthur Currie, who later led the Canadian Armed Forces in France during World War I (Grainger 2002: 13). However, his family actually lived south of Napperton Drive just outside of the study area. Besides various farmsteads, most special use structures associated with this community were also located south of Napperton Drive outside of the study area (for example, a church, a log schoolhouse, and the post office after which the community was named). Within the study area, the last frame schoolhouse in the community, S.S. #5 Napperton, was located on the east half of Lot 14, Concession 4 N.E.R. and no longer stands today, having closed down in 1960 (Grainger 2002: 13-14). This structure might have left archaeological traces although it was replaced by a ranch house in 1961 (ATHG 2001: 475-476).

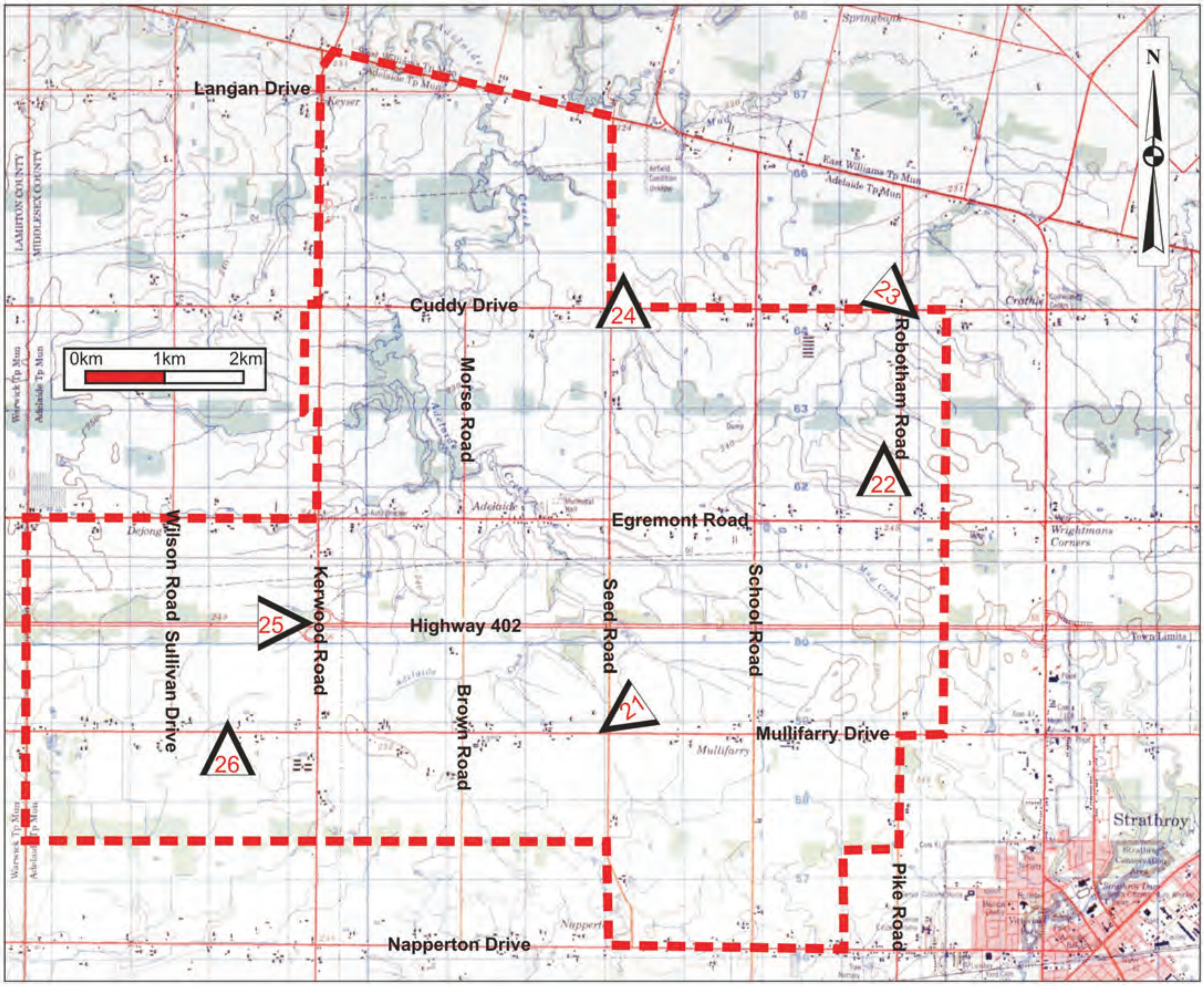
The Napperton Post Office opened in 1870 and closed in 1915, located outside of the study area on Lot 14 Concession 5 S.E.R. until 1905 when it moved across the street into the study area in a still existing house on Lot 12, Concession 4 S.E.R. (ATHG 2001: 539). The post office is noted in the 1878 historical atlas, although its exact location is difficult to discern on that map (Figure 10). At its height, Napperton spanned the intersection both inside and outside of the study area but eventually the local church closed down and for indeterminate reasons the community did not respond to economic opportunities such as the nearby placement of the Sarnia Branch of the Great Western Railway (Grainger 2002: 14). Other businesses and structures disappeared, such as the lime kiln noted on Lot 13, Concession 4 S.E.R. owned by Jonas Jury according to the 1878 Historical Atlas (Figure 10). By 1915 when the post office closed the village had declined and now only the name remains on maps. Given the area is still actively farmed and documented structures are no longer standing, there may be archaeologically significant sites in the area associated with Napperton.

3.3.6 Summary

Given evidence for Euro-Canadian settlement in the Geographic Township of Adelaide since the early 19th century plus evidence of abandoned village sites, the study area exhibits definite archaeological potential for historic Euro-Canadian occupation and the study area needs to be examined for such evidence accordingly.

3.4 Visual Evaluation

The study corridor was visually on evaluated September 4th, 2008. Figure 20 illustrates where each photo was taken along the study corridor. As can be seen in the photographs, visibility was excellent and the weather cloudy but bright when the photographs were taken. The figures illustrate the relatively flat topography of the area (Figure 21) with the occasional slope (Figure 22), the nature of the creeks that cross the study area (Figure 23), the tree lots that stand in some of the fields (Figure 24), how Highway 402 intersects the study area (Figure 25), and the landscape of a typical area where turbines are probably to be located (Figure 26).



LEGEND

Study Area

Direction of Photographic Figure

REFERENCE

DRAWING BASED ON
Government of Canada
1994a *Topographic Map Sheet 40 I/13: Strathroy* (Edition 6). Surveys and Mapping Branch, Department of Energy, Mines and Resources, Ottawa.
1994b *Topographic Map Sheet 40 P/4: Parkhill* (Edition 7). Surveys and Mapping Branch, Department of Energy, Mines and Resources, Ottawa.

NOTES

THIS DRAWING IS SCHEMATIC ONLY AND IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

ALL LOCATIONS ARE APPROXIMATE.

PROJECT
Stage 1 Archaeological Assessment
Air Energy TCI Adelaide Wind Farm
Geo. Twp. of Adelaide, Middlesex County, Ontario

TITLE
Map of the Study Area Showing
Location of Photographic Figures

Golder Associates

PROJECT No.	07-1112-0151-1800	FILE No.	0711120151-1800-R01020
		SCALE	AS SHOWN REV.
CADD	JM	FEB 26/09	**FIGURE 20**
CHECK			

Figure 21: Flat Topography of the Study Area; Facing Southwest from the Corner of Mullifarry Drive and Seed Road

Figure 22: A Portion of the Study Area Exhibiting Some Moderate Topography; Facing North Along Robotham Road

Figure 23: A Typical Creek (Flowing into Mud Creek) Crossing the Study Area; Facing Southeast from Robotham Road

Figure 24: A Small Tree Lot in a Larger Agricultural Field; Facing North from Cuddy Drive

Figure 25: A View of Highway 402 Intersecting the Study Area; Facing East from Kerwood Road

Figure 26: Landscape of a Typical Probable Turbine Location; Facing North from Mullifarry Drive Between Sullivan Road and Kerwood Road

4.0 RESULTS

4.1 Potential for Pre-contact Aboriginal Archaeological Sites

Archaeological potential is established by determining the likelihood that archaeological resources may be present on a subject property. Archaeological potential criteria commonly used by the Ministry of Culture (Government of Ontario 1997) were applied to determine areas of archaeological potential along the study corridor. These variables include: distance to various types of water sources, soil texture and drainage, glacial geomorphology, and the general topographic variability of the area.

Distance to modern or ancient water sources is generally accepted as the most important determinant of past human settlement patterns and, considered alone, may result in a determination of archaeological potential. However, any combination of two or more other criteria, such as well-drained soils, or topographic variability, may also indicate archaeological potential. Finally, extensive land disturbance can eradicate archaeological potential (Wilson and Horne 1995).

In archaeological potential modeling, a distance to water criterion of 300 metres is generally employed for primary water courses, including lakeshores, rivers and large creeks, while a criterion of 200 metres is applied to secondary water sources, including swamps and small creeks. For the present project, there are numerous small streams within the study area especially Adelaide Creek in the western portion and Mud Creek in the Eastern portion (Figure 1). The original survey of Egremont Road (Carroll 1831a) also noted areas of swamp along its route (see Section 3.1).

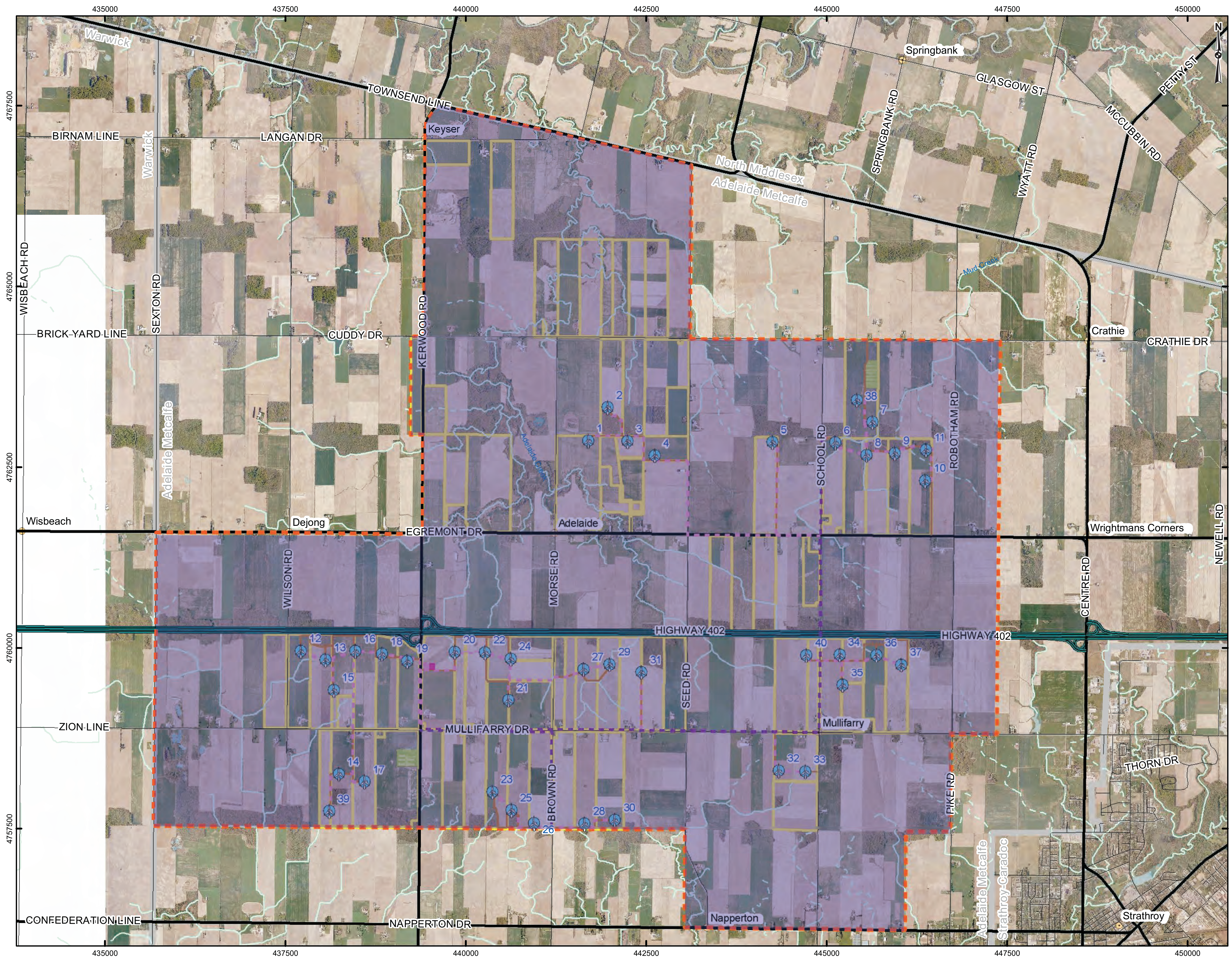
Soil texture can be an important determinant of past settlement, usually in combination with other factors such as topography. The study area is fairly level with no areas of steep slope that would not be suitable for settlement. With respect to soil texture, Aboriginal groups preferred well drained lighter (sandy) soils to heavier soils. The soils of the study area are imperfectly drained soils that are mostly silty clay loam. Although some areas might have been swampy in the past due to the imperfect drainage and relatively level topography, the rest of the study area would have been suitable for pre-contact aboriginal agriculture, although not ideal. Therefore, these soils provide further archaeological potential for aboriginal sites within the study area.

When the above noted archaeological potential criteria are applied to the study area, the archaeological potential for pre-contact Aboriginal sites is deemed to be moderate to high (Figure 27). This assessment is due to the presence of water sources, the level land without areas of steep slope and the moderately drained silty clay loam soils.

4.2 Potential for Historic Archaeological Sites

The criteria used by the Ontario Ministry of Culture to determine potential for historic archaeological sites include the presence of: 1) particular, resource-specific features that would have attracted past subsistence or extractive uses; 2) areas of initial, non-Aboriginal settlement; 3) early historic transportation routes; and 4) properties designated under the Ontario Heritage Act (Government of Ontario 1997:14).

The area has been the location of generalized farming in the past and is still used in that fashion today. There is evidence of Euro-Canadian settlement extending back to the early 19th century during the initial settlement of Adelaide Township. The 19th century road grid is still in use which includes a major transportation route of Egremont Road. In addition, four small communities that have decreased in size since the 19th century might have left behind significant archaeological remains. On account of these factors the archaeological potential for the study area is judged to be moderate to high (Figure 27).



LEGEND

- Layout 27 Turbine - March 5, 2009
- Substation
- Overhead Cable
- Underground Cable
- Access Road
- Expressway
- Major Road
- Local Road
- Watercourse, Permanent
- Watercourse, Intermittent
- Site Study Area
- Proposed Laydown / Staging Area
- Optioned Lots - March 5, 2009
- Municipal Boundary
- Waterbody, Permanent
- Wetland, Permanent
- Area of Archaeological Potential

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2009
Air Photo - Spring 2006 First Base Solutions.
Datum: NAD 83 Projection: UTM Zone 17N

0 0.5 1 2 3
Kilometres

PROJECT
Stage 1 Archaeological Assessment
Air Energy TCI Adelaide Wind Farm
Geo. Twp. of Adelaide, Middlesex County, Ontario

TITLE
Archaeological Potential of Study Area

Golder Associates
Mississauga, Ontario

PROJECT NO. 07-1112-0151			SCALE AS SHOWN	REV. 0
DESIGN	PP	5 Mar. 2009	**FIGURE 27**	
GIS	PP	3 Apr. 2009		
CHECK	BC	6 Apr. 2009		
REVIEW				

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5.0 SUMMARY AND RECOMMENDATIONS

A Stage 1 archaeological background study was conducted for a parcel of approximately 8275 hectares in the Township of Adelaide-Metcalfe, Middlesex County, Ontario. The parcel consists of Lots 7 to 19, Concession 1 North of Egremont Road; part of Lot 6 and Lots 7 to 19, Concession 2 North of Egremont Road; Lots 7 to 12, Concessions 3 to 4 North of Egremont Road; part of Lot 7 and Lots 8 to 10, Concession 5 North of Egremont Road; Lots 1 to 19, Concessions 1 to 2 South of Egremont Road; Lots 1 to 18, Concession 3 South of Egremont Road; and Lots 13 to 17, Concession 4 South of Egremont Road. This area will eventually be the site of 40 wind turbines. This Stage 1 archaeological assessment was conducted as part of an Environmental Assessment for Electricity Projects coordinated by Golder Associates Limited, Mississauga office.

The objective of the Stage 1 assessment was to compile all available information about the known and potential cultural heritage resources within the study area and to provide specific direction for the protection, management and/or recovery of these resources, consistent with Ministry of Culture guidelines (Government of Ontario 1993).

Archaeological potential criteria commonly used by the Ontario Ministry of Culture were applied to determine areas of archaeological potential within the study area. The archaeological potential for pre-contact Aboriginal and Euro-Canadian sites was deemed to be moderate to high on these properties. For pre-contact Aboriginal sites this determination is made on account of the presence of nearby water sources, level topography, and suitable soils for pre-contact agricultural practices. The historic Euro-Canadian potential was on account of documentation indicating early 19th century occupation, abandoned villages, plus the continued existence of historic transportation routes such as Egremont Road. As a result, Stage 2 archaeological assessment will be required for all areas to be disturbed during turbine or access road construction (Figure 27).

As further archaeological assessment is recommended, the Ontario Ministry of Culture is asked to review the results in this report and issue a letter of concurrence with the findings herein. A letter of clearance is not requested at this time.

Should deeply buried archaeological material be found during construction activities, the Ministry of Culture should be notified immediately (416) 314-7174. In the event that human remains are encountered during construction, the proponent should immediately contact both the Ministry of Culture and the Registrar or Deputy Registrar of the Cemeteries Regulation Unit of the Ministry of Consumer and Commercial Relations, (416) 326-8404.

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7.0 IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Golder Associates Ltd. has prepared this report in a manner consistent with that level of care and skill ordinary exercised by members of the archaeological profession currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

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Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project.

Special risks occur whenever archaeological investigations are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain archaeological resources. The sampling strategies incorporated in this study comply with those identified in the Ministry of Culture's Archaeological Assessment Technical Guidelines (1993) (Stages 1-3 and Reporting Format).

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Senior Archaeologist	Principal, Director of Cultural Sciences

JAW/RJB/jm/wlm

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