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October 31, 2019
File: 193804820

**Attention: Chris Norgaard**
*Tioga Area Economic Development Corp*oration
PO Box 63
Tioga, ND 58852

Dear Mr. Norgaard,

**Reference: City of Tioga Air Quality Study Results**

The city of Tioga, North Dakota (the City) is interested in the potential ambient air impacts to the community should a new petrochemical facility and a natural gas power plant be added to the region. The contents of this letter describe the ambient air modeling procedures implemented by Stantec Consulting Services (Stantec) to project ambient air quality impacts surrounding the City. Hess Refinery is currently permitted through the North Dakota Department of Environmental Quality (NDDEQ)and operational to the east of town. Information provided by Hess and the NDDEQ was utilized to establish a baseline condition. Stantec utilized air modeling data from two state agencies to represent the new petrochemical facility and the power plant to determine the net impact from their operation. Stantec located the new operations in areas near the City that would maximize the overall net impact by nesting the facilities relatively near each other.

As described in subsequent sections of this memorandum, data was obtained that was determined to be representative of a natural gas power plant and a petrochemical facility. However, the input values implemented for this analysis, the stack parameters used, the designated locations of each facility, and the receptor grid selection should not be interpreted as final. Therefore, the results should also not be viewed as absolute. Rather, all information provided is a guide for potential outcomes, and either facility will be required to go through a full permitting process whereby several assumptions made here may be different than a true proposed project.

**Model Selection**

The EPA approved air dispersion model, BEEST AERMOD (version 11.14) using the 18081 AERMOD executable, was utilized for the Air quality Impact Analysis. AERMOD is the recommended model for short range analysis up to 50 kilometers in Appendix W of the USEPA's Code of Federal Regulations, Title 40, Part 51 (EPA 2005). AERMOD is an enhanced steady state Gaussian plume model that incorporates air dispersion based on planetary boundary layer turbulence, structure, scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain (EPA 2004a).

Elevated terrain was imported using a geo-referenced tagged 1/3-arc second image file format GeoTIFF downloaded from the United States Geological Survey (USGS) EROS Data Center (Landfire) website. The 18081 AERMAP executable program embedded in BEEST AERMOD 11.14 was used to process elevation and terrain data and to assign heights to all buildings, sources, and receptors within the project boundary. The GeoTIFF file was imported in the Universal Transverse Mercator (UTM) NAD 83 coordinate system.

**Reference: City of Tioga Air Quality Study Results**

BEEST AERMOD 11.14 includes rural and urban algorithm options. These options affect the wind speed profile, dispersion rates, and mixing-height formula used in calculating ground-level pollutant concentrations. A protocol was developed by the EPA to classify an area as either rural or urban for dispersion modeling purposes. The classification is based on average heat flux, land use, or population density within a three-kilometer radius from the plant site. The EPA has specified that land use is the most definitive criterion. A land use analysis showed a lack of development in the remote area of the project and within the vicinity to produce urban wind channeling and affect the surface roughness setting. Therefore, the rural dispersion option was used for this modeling analysis.

**Building Downwash Parameters**

BEEST AERMOD 11.14 includes a downwash analysis for use when there are buildings included in the model. The Building Profile Input Program with Plume Rise Model Enhancement (BPIP-PRIME) was used to determine downwash effects from buildings and building-sized tanks on all sources. These sources were included for the petrochemical plant, natural gas power plant, and the Hess Refinery.

**Receptor Grid**

This modeling analysis was performed using a two distinct receptor patterns. The first pattern located receptors at 50-meter (m) spacing along the property boundaries of the three operational facilities. The second pattern was centered at the middle of the City, where a polar grid was added at each 10 degrees (36 receptors around each ring). A ring was added at a 100-m and 250-m radius. The third ring was a 500-m radius, with all subsequent rings at 500-m radius segments out to 6,000-m (3.7 miles). All model receptors were preprocessed using the AERMAP software associated with AERMOD. The AERMAP software (version 18081) establishes a base elevation and a height scale for each receptor location. The height scale is a measure of the receptor's location and base elevation and its relation to the terrain feature that has the greatest influence in dispersion for that receptor. See Figure 1 for further details.

**Reference: City of Tioga Air Quality Study Results**

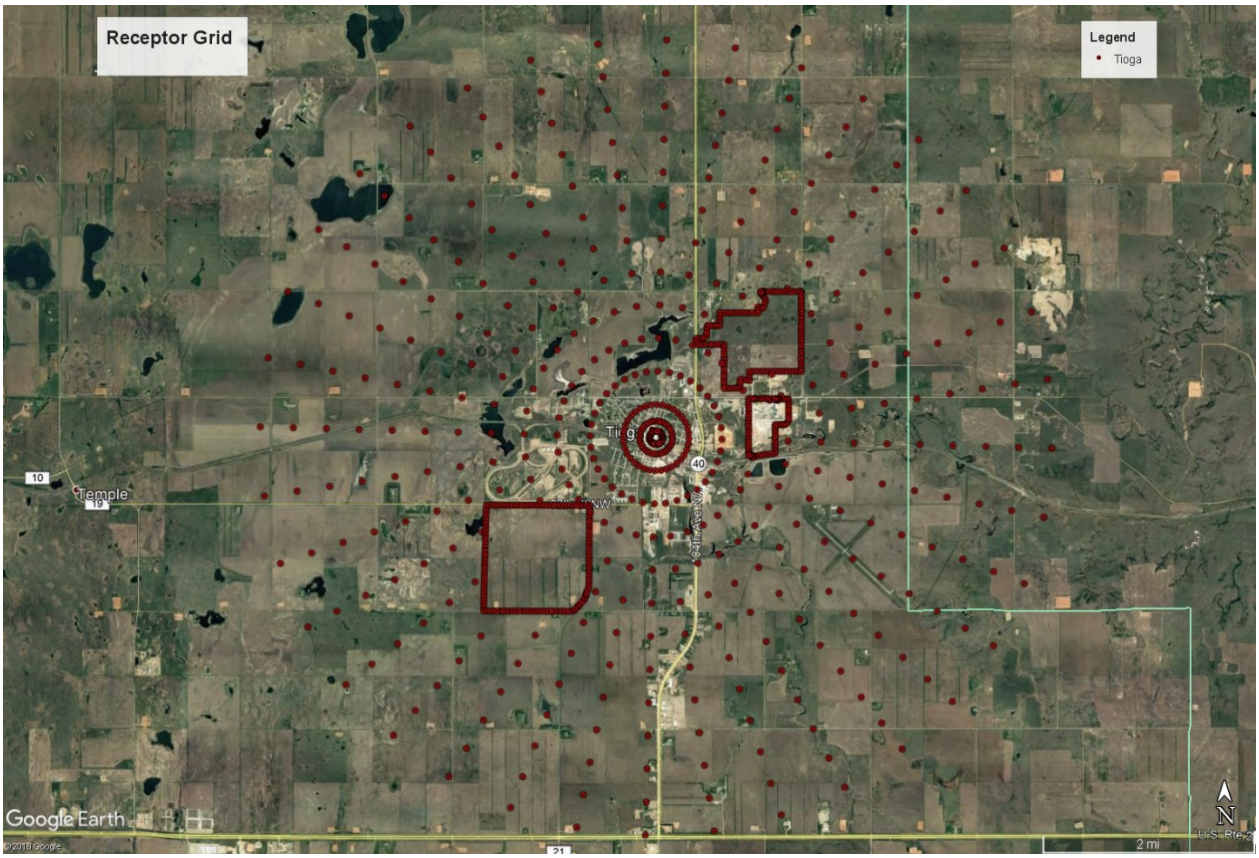



**Figure 1: Receptor Grid Layout**

## Meteorological Data

Meteorological data inputs of hourly data are required in AERMOD to estimate pollution concentrations. Bismarck meteorological data were obtained. 2011-2015 data files were used because surface data for more recent years were missing or incomplete. 1-hour ISHD and fsl files were applied to AERMET. Seasonal surface characteristics and twelve wind sectors were assumed. These factors along with average moisture, snow cover in the winter months and arid climate were applied to obtain albedo, bowen ratio and surface roughness. These were then concatenated into representative surface and profile files. The Bismarck meteorological wind rose plot from 2011-2015 is shown in Figure 2, which indicates that the primary wind direction is from the northwest and secondarily from the east or southeast.

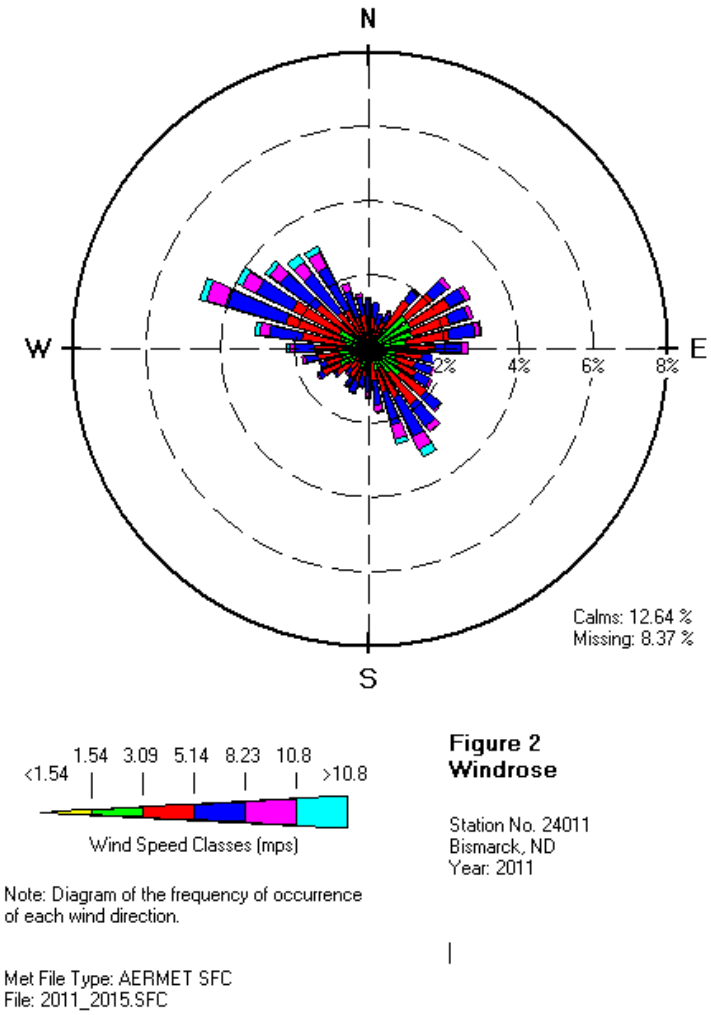



**Figure 2 – Bismarck Airport Windrose**

**Ambient Air Quality Standards**

The Ambient Air Quality Standards (AAQS) for compliance demonstration for federal and North Dakota standards are shown in Table 1. The EPA is required under the Clean Air Act (CAA) to promulgate National Ambient Air Quality Standards or NAAQS, for protection of human health and the environment. The EPA delegates implementation and enforcement of the AAQS to the states. The standards represent criteria pollutants of concern for impacts to human health and are measured in parts per million (ppm) or micrograms per cubic meter (μg/m$^3$).

Regulated particulate criteria pollutants of concern include $PM_{10}$, and Particulate Matter less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$). Additionally, gaseous pollutants (CO, $NO_x$ $SO_2$) and the emissions for the regulated pollutants are modeled and background pollutant concentrations added for comparison to the NAAQS for compliance demonstration.

## Table 1 Ambient Air Quality Standards for Compliance Demonstration

| Pollutant | Averaging Time | National Standard | North Dakota Standard | Form |
|---|---|---|---|---|
| $PM_{2.5}$ | Annual | 12 µg/m³ | 12 µg/m³ | Annual mean, averaged over 3 years; 1st high |
| | 24-hour | 35 µg/m³ | 35 µg/m³ | 98th percentile, averaged over 3 years; 8th high |
| $PM_{10}$ | 24-hour | 150 µg/m³ | 150 µg/m3 | Not to be exceeded more than once per year on average over 3 years; 6th high |
| CO | 1-hour | 35 ppm | 35 ppm | Not to be exceeded more than once per year; 2nd high |
| | 8-hour | 9 ppm | 9 ppm | |
| $NO_2$ | 1-hour | 188 µg/m³ | 188 µg/m³ | 98th percentile, averaged over 3 years; 8th high |
| | Annual | 100 µg/m³ | 100 µg/m³ | Annual mean; 1st high |
| $SO_2$ | 1-hour | 196 µg/m³ | 196 µg/m³ | 99th percentile, averaged over 3 years; 4th high |
| | 3-hour | 0.5 ppm | 0.5 ppm | Not to be exceeded more than once per year; 2nd high |

**Background Pollutant Concentrations**

The NDDEQ Modeling Guidance document outlines fixed background concentrations to be used for permit analyses for all of the state criteria ambient air quality standards, which and are summarized in Table 2.

## Table 2 Background Concentration for North Dakota (µg/m3)

| Pollutant | Averaging Period | | | | |
|---|---|---|---|---|---|
| | 1-hour | 3-hour | 8-hour | 24-hour | Annual |
| $SO_2$ | 13 | 11 | -- | -- | -- |
| $NO_2$ | 35 | -- | -- | -- | 5 |
| $PM_{10}$ | -- | -- | -- | 30 | -- |
| $PM_{2.5}$ | -- | -- | -- | 13.7 | 4.75 |
| CO | 1149 | -- | 1149 | -- | -- |

## Modeled Air Pollutants

BEEST AERMOD 11.14 was run to estimate impacts for the following criteria air pollutants and averaging periods:

- $PM_{10}$: 24-hour;
- $PM_{2.5}$: 24-hour & Annual;
- CO: 1-hr & 8-hr;
- $NO_2$: 1-hr & Annual;
- $SO_2$: 1-hr, 3-hr;
- $NH_3$: 1-hr & 8-hr (NDDEQ Standards; Guideline concentrations)

## $NO_2$ Methodology

The Tier 2, ARM2 methodology with default maximum 0.9 and minimum 0.5 ratios were applied.

## AERMOD Input Parameters and Emission Rate Development

The intent of this analysis was to establish the potential net ambient air impact from the introduction of a petrochemical facility and a natural gas power plant. Therefore, it was assumed that the current baseline includes the Hess Refinery. While the Hess emissions were not included as part of the net change analysis, buildings, tanks and the property boundary were incorporated. Those sources were added to ensure the potential building downwash is accorded as accurately as possible. All building and tank locations were established via Google Earth imagery and onsite confirmation by Stantec personnel. Heights were also established by onsite measurements made by Stantec. The property boundary was estimated from NDDEQ documentation provided to Stantec.

A theoretical location for the power plant was added to the southwest of the City. The property boundary was assumed to be 67th Street NW to the north, 105th Ave NW to the east, 66th Street NW to the south and the western boundary lies east of a water body and parallels 105th Ave. The width of this area is approximately 1.57 kilometers. For the purposes of this report, the property was identified as being of sufficient size to support the operation, while being located near Hess to maximize the projected air impacts. No information was provided relative to an actual or potential location of the power plant.

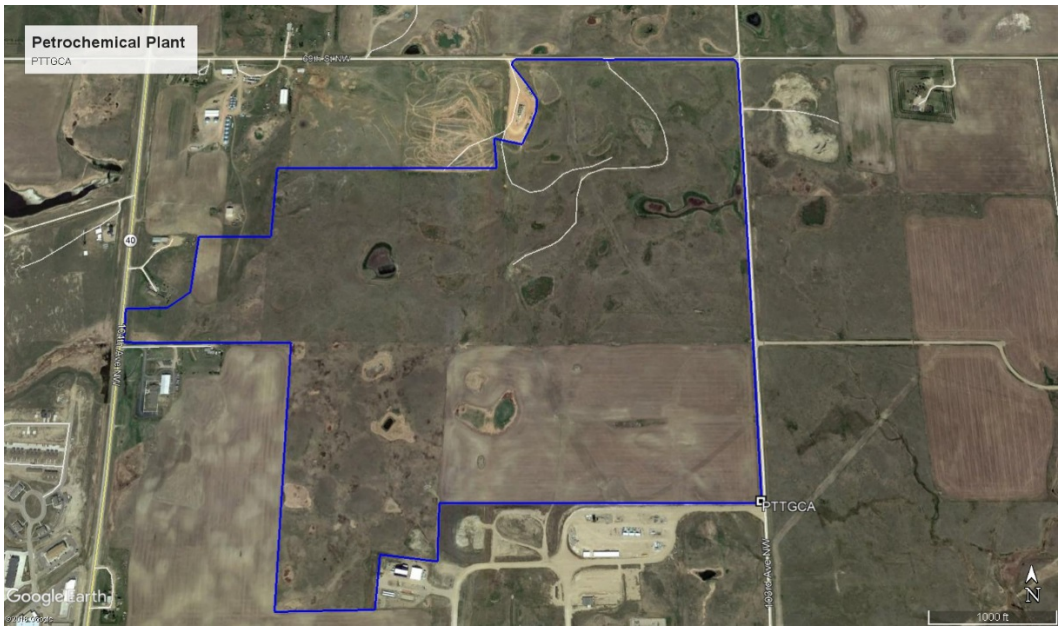
Stantec identified a 660 Megawatt combined-cycle, natural gas combustion turbine power plant with a heat recovery boiler to represent the potential power plant. Data was obtained from a power plant currently under construction in Beloit County, Wisconsin that was permitted in March 2016. All emission rates, stack parameters and the building configuration was obtained from the Wisconsin Department of Natural Resources dispersion modeling personnel. The site layout and sizing were added without alteration, other than shifting a few buildings to ensure all sources fit within the theoretical property boundary.

The petrochemical plant was added to the north of the Hess facility across from 68 Street NW. The property was located along 103rd Ave NW to the east and 69th Street NW to the north. The other boundaries attempted to exclude other residential and industrial zones as much as possible. Please see Figure 3 that identifies the assumed boundary for each facility.

**Reference: City of Tioga Air Quality Study Results**

Stantec identified a 1,500 kiloton per year polyethylene manufacturing facility, which was recently permitted in December 2018 for construction in Belmont County, Ohio to be the representative petrochemical facility for addition to the area. All emission rates, stack parameters, and the building configuration was obtained from the Ohio Environmental Protection Agency dispersion modeling personnel. Each was added without alteration, other than shifting a few buildings to ensure all sources fit within the theoretical boundary.

It should be noted that, while each facility was deemed to be representative, neither facility location, emission rates, nor stack parameters should be considered absolute. If a facility were to propose locating near Tioga, it will be necessary to go through all permitting steps and modeling requirements. The approach applied and findings of this analysis are meant to be for informational purposes only and should be used as a guide for potential ambient air impacts should these facilities be located in the Tioga area.



**Reference: City of Tioga Air Quality Study Results**


**Figure 3 – Petrochemical/Power Plant Location**

**Dispersion Modeling Results – Change of Impact**

As discussed above, it was assumed that the Hess Refinery is incorporated into the baseline impact of the region around Tioga. Therefore, the results described in this section are the net ambient air impact attributable to the addition of the petrochemical and natural gas power plant. The modeled maximum concentrations for each pollutant averaging period are shown in Table 3. The table provides the location in UTMs of the highest concentration at a point accessible to the public.

## Table 3 Highest Modeled Air Pollutant Concentrations Delta

| Pollutant | Averaging Time | Dispersion Modeling Result | | | Applicable Ambient Standard (µg/m³) |
|---|---|---|---|---|---|
| | | Receptor Location[1] | | Maximum Δ Concentration (µg/m³)[2] | |
| | | UTM Easting (m) | UTM Northing (m) | | |
| $PM_{10}$ | 24-Hour | 651,275.10 | 5,359,729.00 | 37.41 | 150 |
| $PM_{2.5}$ | 24-Hour | 651,225.80 | 5,359,727.90 | 19.11 | 35 |
| | Annual | 651,225.80 | 5,359,727.90 | 5.87 | 12 |
| CO | 1-hour | 651,127.10 | 5,359,725.50 | 5,239 | 40,000 |
| | 8-hour | 651,594.40 | 5,359,835.80 | 3,393 | 10,000 |
| $NO_2$ | 1-hour | 654,846.00 | 5,363,887.30 | 360.01 | 188 |
| | Annual | 651,225.80 | 5,359,727.90 | 16.62 | 100 |

**Reference: City of Tioga Air Quality Study Results**

| Pollutant | Averaging Time | Dispersion Modeling Result | | | Applicable Ambient Standard (µg/m³) |
|---|---|---|---|---|---|
| | | Receptor Location[1] | | Maximum Δ Concentration (µg/m³)[2] | |
| | | UTM Easting (m) | UTM Northing (m) | | |
| $SO_2$ | 1-hour | 654,219.10 | 5,363,430.10 | 86.96 | 196 |
| | 3-hour | 654,846.00 | 5,363,887.30 | 51.71 | 1,300 |
| $NH_3$ | 1-hour | 651,225.80 | 5,359,727.90 | 0.043 | 0.488 |
| | 8-hour | 651,594.40 | 5,359,835.80 | 0.024 | 0.348 |

[1] All coordinates in UTM projection, NAD 1983.
[2] Background values included. $NH_3$ is based on milligrams per cubic meter

There is potential for an exceedance of the 1-hr $NO_2$ standard. However, all exceedances are either along the petrochemical boundary or just east of the facility. There are no net increases within the city limits of Tioga (see Figure 4). Additionally, under a more site-specific modeling analysis that would be performed during permitting, there are other methods that can be conducted to reduce the implied $NO_2$ contribution.

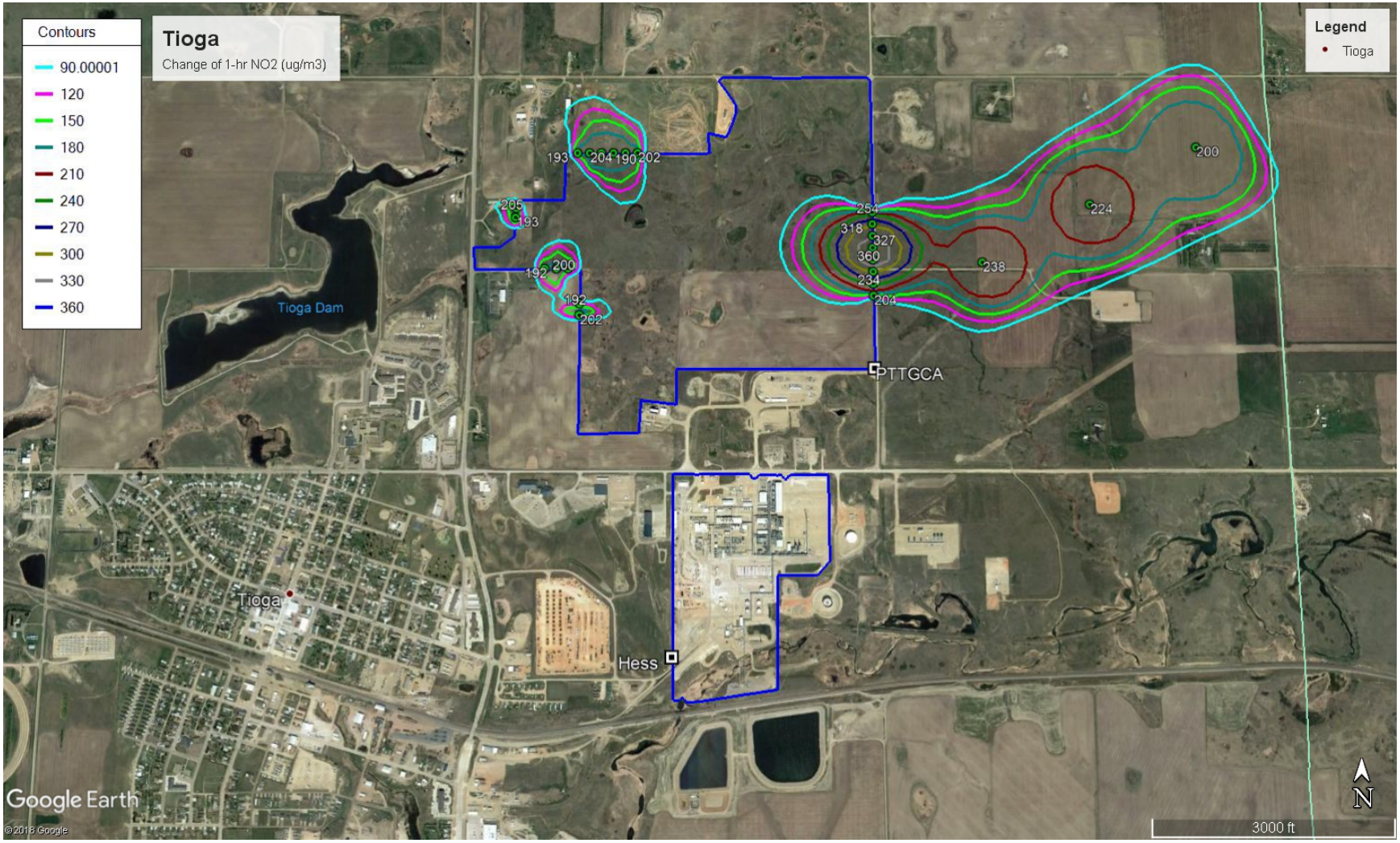



**Figure 4 – 1-hr $NO_2$ Results**

**Reference: City of Tioga Air Quality Study Results**

All other net criteria pollutant impacts were less than the applicable air quality standard. Based on the assumptions made in this analysis, it is likely that the net air quality impact from the inclusion of a petrochemical facility and natural gas power plant to the Tioga region would be limited, if the facilities are properly designed and permitted. The facilities may need to address short-term air quality impacts within their design, but it is unlikely that the city of Tioga, itself, would see an adverse net change of air quality impacts from the current baseline. Please see the attached figures for graphical representation of the maximum net changes for each criteria pollutant.

Regards,

**STANTEC CONSULTING SERVICES INC.**

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