November 14, 2016

Ms. Patricia Beaumont  
Director, Facilities Support Operations  
University of Rochester  
271 East River Road  
Rochester, New York 14627

RE: Greenhouse Gas Inventory  
FILE: 10490/63347

Dear Ms. Beaumont:

O’Brien & Gere (OBG) is pleased to provide the University of Rochester with this greenhouse gas (GHG) inventory. This letter report and the enclosed information were prepared in accordance with the scope of services outlined in our March 16, 2016 proposal.

BACKGROUND

University of Rochester is not a signatory of the American College & University Presidents’ Climate Commitment (ACUPCC). However, the school is actively evaluating and implementing energy efficiency and sustainability measures across the campus. In support of evaluating the effects of implemented measures and setting its own GHG reduction goals, the University of Rochester requested OBG’s assistance with completing a GHG inventory for its campus.

The GHG inventory was completed using Version 8.0 of Clean Air Cool Planet’s Campus Carbon Calculator (Calculator). This following sections describe the methodologies used to compile the data required by the Calculator to complete this inventory and also provide a discussion of the results.

DATA COMPILATION

OBG attended a project kickoff meeting at the University of Rochester campus on June 28, 2016. The purpose of this meeting was to review the GHG emission sources with campus personnel and discuss the data that was required to complete the GHG inventory. The review of GHG emission sources was conducted within the context of the requirements for use of the Calculator to complete the GHG inventory. Prior to this meeting, OBG provided University of Rochester with a scorecard for distribution to appropriate staff to identify activities that result in the emissions of GHGs, metrics that quantify the emissions from these activities during the identified baseline year and the information required for each activity.
Data was provided by the University of Rochester for the following GHG emission sources:

- **Scope 1 Emission Sources**
  - Stationary sources (*e.g.*, on-campus boilers and cogeneration)
  - Mobile sources (*e.g.*, university vehicle fleet including light trucks, heavy trucks, other non-passenger mobile sources including the on-campus bus system)
  - Refrigerants and chemicals (*e.g.*, laboratory operations)
  - Agriculture sources

- **Scope 2 Emission Sources**
  - Purchased electricity

- **Scope 3 Emission Sources**
  - Faculty/staff commuting
  - Student commuting
  - Solid waste

The University of Rochester indicated that the following campus buildings should be included as part of the GHG inventory since they are considered to be part of the contiguous campus:

- **Central Utilities**
  - Middle Campus Chiller Plant (MCCP)
  - Central Utilities (CU)

- **Medical Center**
  - Medical Center (MC) including School of Medicine & Dentistry (SMD) and Strong Memorial Hospital (SMH)
  - Parking Garage
  - Eastman Dental Center
  - Helenwood Hall (HWH)
  - Children’s School at URMC (Child Care)

- **River Campus**
  - River Campus Buildings (Div 18 & 20)
  - Alumni Advancement Center (AAC)
  - University Facilities Building (UFC)
  - Laboratory for Laser Energetics (LLE)
  - Graduate Housing
  - Fraternity and Sorority Housing
  - Grounds
  - Danforth Dining (DANF)
  - University Health Service (UHS)
  - Residential Life
The following campus buildings are not considered a part of the University of Rochester's contiguous campus but are under the University of Rochester's control and operations and are also included in the GHG inventory:

- Mount Hope Campus, located at 1305 Mt. Hope Avenue
- Memorial Art Gallery (MAG)
- Eastman School of Music (ESM)
- River Campus (RC) Properties
- Cardiovascular Research Institute (CVRI), located at 211 Bailey Road
- Telecom (including Townhouse ACS)
- Science Parkway

The following paragraphs provide discussion of the methodologies that were used to compile the required data for the aforementioned GHG emission sources.

**SCOPE 1 EMISSION SOURCES**

The data compiled for the Scope 1 GHG emission sources is summarized below:

1. **On-campus cogeneration:** University of Rochester provided OBG with the Central Utilities (CU) Cogen Hot Water Production and Power Production data for FY2010 through FY2016. The annual natural gas consumption for the CU facility for these years was used for the purpose of estimating total natural gas consumption for the cogeneration facility for FY2010 through FY2016. The electricity output for the cogeneration facility was provided by the University, which derived its exported electrical production from monthly meter readings. The steam output for the cogeneration facility was estimated from the heat Million British thermal unit (MMBtu) recovery data for the University’s records for River Campus and the Medical Center.

2. **Boilers:** University of Rochester provided OBG with the annual natural gas consumption data for the boilers that serve the campus buildings that are under the University’s control, as previously discussed.

3. **Mobile sources:** University of Rochester provided OBG with the gasoline, diesel and propane consumption for mobile sources, including the on-campus bus system, for FY2010 through FY2016.

4. **Fugitive Sources:** University of Rochester provided OBG with refrigerant & chemical usage for chillers and facility operations. Leak rates and losses were provided for a portion of the refrigeration units. For those units that the University of Rochester does not track losses for, it was conservatively assumed that 1% of the total charge is released on an annual basis.

5. **Agriculture Sources:** University of Rochester provided OBG with the total pounds of synthetic fertilizer used annually for FY2010 through FY2016. The percent nitrogen content for the fertilizer was also provided.

**SCOPE 2 EMISSION SOURCES**

The Scope 2 GHG emission sources operated at the campus include purchased electricity. University of Rochester provided the annual purchased electricity consumption for each of the aforementioned buildings for FY2010 through FY2016.

**SCOPE 3 EMISSION SOURCES**

University of Rochester provided OBG with the following data for FY2010 through FY2016:

- The number of faculty/staff and student parking permits
- The zip codes associated with the faculty/staff and student parking permits
- The number of students living on on-campus dorms/housing
- Mass of solid waste shipped offsite for landfill disposal that was generated by the campus buildings. It was indicated that the solid waste that is generated by the University of Rochester is shipped to a landfill that provides methane recovery with electricity generation.
- Mass of solid waste incinerated. The waste sent for incineration is not used for electricity generation
- Mass of recycled material consisting of plastic, metal, glass and scrap metal
- Mass of recycled paper

The faculty/staff and student commuting miles were estimated based on the following assumptions:
- Each member of the faculty and staff makes an average of 10 one-way trips per week to the campus
- 80% of the faculty and staff travel to campus 48 weeks per year
- 20% of the faculty and staff travel to campus 42 weeks per year
- The average distance for each one-way trip for each member of the faculty or staff is 9 miles. This distance was estimated based on an evaluation of the zip code data provided for the issued parking permits for faculty/staff.
- 65% of the faculty/staff commute via personal automobile and 35% of the faculty/staff commute via public bus.

University of Rochester has indicated that students who commute to the campus use personal automobile, public bus, ride bikes and walk. University of Rochester provided the number of parking permits that were issued for each zip code from which students commute using personal automobiles. The total commuting miles for student commuting via personal automobile and public bus were estimated based on the following assumptions:
- The number of students that commute was assumed to be the difference between the total number of students and the number of students living in on-campus dorms.
- 75% of the students that commute do so via person automobile
- 25% of the students who commute do so via public bus, bicycle and walking
- Equal numbers of students commute via public bus, bicycle and walking
- Students who commute via personal automobile or public bus make 8 one-way trips to the campus per week for 30 weeks per year.
- The average distance per one-way trip for students who commute via personal automobile or public bus is 6 miles. This distance was estimated by dividing the total, combined one-way distance for 80% of the students who have parking permits.

**GHG INVENTORY RESULTS**

Table 1 provides the GHG emissions, in units of metric tons of carbon dioxide equivalent (MTCO₂e), which were estimated by the Calculator for FY2010 through FY2016 for the contiguous campus plus the additional buildings that are under the University of Rochester’s control. Figure 1 provides a graphical representation of the estimated GHG emission intensity in units of metric tons of CO₂e per thousand gross square foot (MTCO₂e/1000GSF). Figure 2 provides the relative contributions of the various GHG emission sources to the total campus-wide GHG emissions. Figure 3 provides a summary of the absolute GHG emissions for FY2010 through FY2016, along with a depiction of the GSF for this same time period.
As shown in Table 1, the total GHG emissions for the University of Rochester have increased by approximately 19% from FY2010 emissions. It is noted that the GHG emissions estimated to be released from the landfilling of solid waste are now estimated to be negative. Version 8.0 of the Calculator utilizes an updated emission factor for the landfilling of solid waste at a facility which provides methane recovery and electricity generation. This updated emission factor reflects the avoidance of GHG emissions from the generation of electricity such that the net GHG emission factor is negative. As shown in Figure 2, the GHG emissions resulting from the operation of stationary combustion sources represent 60% of the total campus-wide emissions. The GHG emissions resulting from consumption of purchased electricity represent 23% of the total campus-wide emissions. The GHG emissions resulting from faculty/staff commuting represent 16% of the total campus-wide emissions.

The GHG emissions from Scope 1 stationary combustion have increased by approximately 21%. This increase may be attributed to the following:

- An increase in natural gas consumption for on-campus cogeneration facility of approximately 24% from the FY2010 natural gas consumption.
- An increase in total GSF for the University of Rochester of approximately 7% from the FY2010.

It is also noted that the GHG emissions from faculty/staff commuting increased 21% since FY2010. These increases may be attributed to a 21% increase in the total number of faculty and staff since FY2010. The total number of students increased by 14% since FY2010.

In general, the GHG emissions from the Scope 1, Scope 2 and Scope 3 emission sources at the University of Rochester have increased since FY2010. As shown in Figure 1, the GHG emission intensity has increased from 17.5 MTCO$_2$e/1000GSF to 19.3 MTCO$_2$e/1000GSF since FY2010. However, it is noted that, while the emission intensity was initially increasing from FY2010 to FY2014, it has since decreased from 20.2 MTCO$_2$e/1000GSF to 19.3 MTCO$_2$e/1000GSF.

Should you have questions regarding this letter or the enclosed information, please do not hesitate to Tricia D’Agostino at (315) 956-6774.

Very truly yours,
O’BRIEN & GERE ENGINEERS, INC.

Jamie D. Newtown
Senior Managing Scientist

Attachments: Table 1 – Summary of GHG Emissions
Figure 1 – Greenhouse Gas Emission Intensity
Figure 2 – GHG Emission Source Contributions
Figure 3 – Absolute GHG Emissions and Gross Square Footage

cc: Tricia M. D’Agostino, P.E. - OBG
Tables
# Table 1 - Summary of GHG Emissions

University of Rochester  
Rochester, New York

<table>
<thead>
<tr>
<th>GHG Emission Source</th>
<th>FY2010 (MTCO\textsubscript{2}e)</th>
<th>FY2011 (MTCO\textsubscript{2}e)</th>
<th>FY2012 (MTCO\textsubscript{2}e)</th>
<th>FY2013 (MTCO\textsubscript{2}e)</th>
<th>FY2014 (MTCO\textsubscript{2}e)</th>
<th>FY2015 (MTCO\textsubscript{2}e)</th>
<th>FY2016 (MTCO\textsubscript{2}e)</th>
<th>% Change\textsuperscript{(a)}</th>
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<tr>
<td><strong>Scope 1</strong></td>
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<tr>
<td>Total Stationary Source Combustion</td>
<td>112,152</td>
<td>120,452</td>
<td>126,438</td>
<td>140,269</td>
<td>142,340</td>
<td>141,992</td>
<td>136,067</td>
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<td>Contiguous Campus</td>
<td>106,817</td>
<td>114,726</td>
<td>121,475</td>
<td>135,207</td>
<td>136,701</td>
<td>136,277</td>
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<td>Stationary combustion - Central Utilities</td>
<td>101,804</td>
<td>109,082</td>
<td>116,446</td>
<td>129,955</td>
<td>130,887</td>
<td>130,520</td>
<td>125,906</td>
<td>23.7</td>
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<td>Stationary combustion - River Campus</td>
<td>4,726</td>
<td>5,374</td>
<td>4,766</td>
<td>5,042</td>
<td>5,610</td>
<td>5,578</td>
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<td>4,963</td>
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<td>2,002</td>
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<td>Refrigerants and Chemicals</td>
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<td>630</td>
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<td>586</td>
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<td>Agriculture Sources</td>
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<td>129,144</td>
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<td>Purchased Electricity</td>
<td>46,261</td>
<td>51,509</td>
<td>52,372</td>
<td>50,964</td>
<td>50,565</td>
<td>51,880</td>
<td>52,941</td>
<td>14.4</td>
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<tr>
<td>Contiguous Campus</td>
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<tr>
<td>Purchased electricity - Central Utilities</td>
<td>4,710</td>
<td>4,998</td>
<td>5,607</td>
<td>5,121</td>
<td>4,640</td>
<td>6,095</td>
<td>6,866</td>
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<td>Purchased electricity - River Campus</td>
<td>14,650</td>
<td>16,332</td>
<td>16,415</td>
<td>16,509</td>
<td>16,719</td>
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<td>Purchased electricity - Medical Center</td>
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<td>25,349</td>
<td>25,654</td>
<td>25,389</td>
<td>25,381</td>
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<td>Non-contiguous Campus</td>
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<tr>
<td><strong>Total Scope 2</strong></td>
<td>46,261</td>
<td>51,509</td>
<td>52,372</td>
<td>50,964</td>
<td>50,565</td>
<td>51,880</td>
<td>52,941</td>
<td>14.4</td>
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<td><strong>Scope 3</strong></td>
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<td>Total Commuting</td>
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<td>30,865</td>
<td>31,207</td>
<td>33,738</td>
<td>34,572</td>
<td>36,514</td>
<td>36,528</td>
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<td>Faculty/staff commuting</td>
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<td>30,028</td>
<td>30,363</td>
<td>32,864</td>
<td>33,640</td>
<td>35,573</td>
<td>35,573</td>
<td>21.3</td>
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<td>Student commuting</td>
<td>795</td>
<td>836</td>
<td>843</td>
<td>873</td>
<td>931</td>
<td>941</td>
<td>955</td>
<td>20.1</td>
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<td>Solid Waste</td>
<td>-212</td>
<td>-234</td>
<td>-241</td>
<td>-244</td>
<td>-246</td>
<td>-244</td>
<td>-253</td>
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<td><strong>Total Scope 3</strong></td>
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<td>30,631</td>
<td>30,966</td>
<td>33,494</td>
<td>34,326</td>
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<td><strong>Total (Scope 1, 2 and 3)</strong></td>
<td>190,958</td>
<td>205,269</td>
<td>212,482</td>
<td>227,301</td>
<td>230,080</td>
<td>233,179</td>
<td>228,341</td>
<td>19.6</td>
</tr>
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</table>

**Notes:**

(a) Represents change in GHG emissions from FY2010 to FY2016.
Revised Air Dispersion Model

Figures
Figure 1 - Greenhouse Gas Emission Intensity

GHG Emissions Intensity (MTCO$_2$/1000GSF)

Year

Figure 2 - GHG Emission Source Contributions

- Total Stationary Source Combustion: 60%
- Mobile Source Combustion: 16%
- Purchased Electricity: 23%
- Faculty/Staff Commuting: 1%
- Student Commuting: 0.4%
Figure 3 - Absolute GHG Emissions and Gross Square Footage

- Refrigerants and Chemicals
- Mobile Source Combustion
- Agriculture Sources
- Total Commuting
- Purchased Electricity
- Total Stationary Source Combustion
- GSF