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Illinois Association of Wastewater Agencies Carbon Footprint Report Urbana, Illinois

Symbiont
Project No. W09145

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EXECUTIVE SUMMARY

The Illinois Association of Wastewater Agencies (IAWA) is an organization of wastewater treatment agencies that, among other activities, examines and educates members with respect to issues affecting its membership. The United States Environmental Protection Agency (U.S. EPA) has directed states to develop numeric in-stream nutrient criteria for phosphorus and nitrogen. Numeric criteria can be established to assist in protecting the water quality immediately affected by permitted wastewater discharges. In addition, the Natural Resource Defense Council has petitioned the United States Environmental Protection Agency (U.S. EPA) to limit all Publicly-Owned Treatment Works to a discharge of 0.3 mg/L of total phosphorus and 3.0 mg/L of total nitrogen. A previous report (Zenz, 2003) prepared for the Illinois Association of Wastewater Agencies (IAWA) identified the facilities that would need to be added to Illinois wastewater treatment plants (WWTPs) to meet these proposed nutrient limits. This report was prepared to evaluate the impact additional nutrient removal processes would have on the carbon footprint of Illinois WWTPs.

For purposes of this study, the term carbon footprint was defined as the sum of all greenhouse gas emissions associated with the collection, treatment, and ultimate disposal of wastewater. The greenhouse gases applicable to wastewater treatment are primarily carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). This report identifies the primary sources of these emissions at a WWTP: direct emissions from the waste treatment process and indirect emissions from the consumption of electricity.

A survey of IAWA membership was conducted to obtain plant and power data. Reponses were received from 18 out of the 55 members contacted. This resulted in data from 28 conventional treatment plants and 1 BNR plant. The majority of respondents listed coal burning, nuclear, and/or natural gas burning as power production sources. A few cited wind and other power sources. Data from this survey was used to determine a relationship between annual average flow rate and population which was later used to relate plant emissions to flow rate.

Direct emissions from the wastewater treatment plant process were calculated by comparing the N_2O emissions from a conventional treatment process without intentional nitrification/ denitrification to an advanced treatment process with intentional nitrification/denitrification. According to EPA's US Greenhouse Gas Inventory (2006), plants with conventional treatment processes that do not include intentional nitrification/denitrification generate 3.2 grams N_2O per capita per year. This is compared to 7 grams N_2O per capita per year for plants with intentional nitrification/denitrification. The difference in these emission factors (3.8 grams N_2O per capita per year). In was determined that process changes would contribute an additional 45 lbs CO_2 equivalents/day per MGD.

Indirect emissions were computed by comparing energy requirements of conventional and advanced treatment. Data published by the Electrical Power Research Institute (EPRI) was used. It was determined that advanced treatment required additional electrical energy. A relationship was developed for the additional energy consumption associated with advanced treatment as a function of flow rate. Emission factors from EPA eGRID data were used to quantify the greenhouse gases emissions associated with this power increase. The result was an estimated average of 1000 lbs of CO_2 equivalent/day per MGD increase based on a typical power generation resource mix in the state of Illinois.

This report also discussed the impact of several miscellaneous site specific sources of greenhouse gases that may further contribute to a change in a WWTP's carbon footprint. These sources include sludge production and disposal, chemical needs and transportation, the de-regulated energy market, and construction related emissions.

This report demonstrates the affects that lower nutrient effluent limits will have on the carbon footprint of Illinois municipal WWTPs. The lower nutrient limits will lead to plant upgrades and process treatment modifications that will result in significant increases in greenhouse gas emissions. The single largest emission source would come from electrical energy increases. A second source for increased emissions would come from the biological processes. A third source could come from emissions associated with trucking of sludge and chemicals.

At a minimum using current power generation figures for Illinois, a typical conventional treatment plant will experience an increase of 1,045 lbs of CO_2 equivalent for every million gallons per day of flow. Actual values will be dependent on the details of each treatment plant and should be determined on a case by case basis. For a treatment plant with a flow of 10 MGD, the annual greenhouse gas emissions increase is equal to the annual emissions from about 300 automobiles. If all municipal waste flows in the state were considered, the increase in greenhouse gas emissions would be more than 470,000 tons of CO_2 equivalent per year which equals 12% to 15% of the annual emissions of a 600 MW electrical power plant operating with an average annual capacity factor of 75% in the State of Illinois.

Section 1.0
INTRODUCTION

1.1 PURPOSE OF STUDY

The Illinois Association of Wastewater Agencies (IAWA) is an organization of wastewater treatment agencies that, among other activities, examines and educates members with respect to issues affecting its membership. The United States Environmental Protection Agency (U.S. EPA) has directed states to develop numeric in-stream nutrient criteria for phosphorus and nitrogen. Numeric criteria can be established to assist in protecting the water quality immediately affected by permitted wastewater discharges. Limitations on allowable nutrient loadings to receiving streams may also be imposed to reduce the Gulf of Mexico hypoxia. Gulf hypoxia is caused by an excess of nutrients delivered from the Mississippi River water shed to the Gulf of Mexico, stimulating excess algae growth. When the algae die, bacterial degradation utilizes available oxygen in the water column, resulting in large areas with anoxic conditions. Reduction of the nutrient load to the Gulf from all sources will likely be necessary to reverse this condition.

Additionally, the Natural Resource Defense Council has petitioned the U.S. EPA to include nutrient removal in the definition of secondary treatment. The petition asks that all Publicly-Owned Treatment Works be limited to a discharge of 0.3 mg/L total phosphorus and 3.0 mg/L total nitrogen.

IAWA members and other municipal wastewater dischargers would need to add facilities to meet the proposed nutrient reduction requirements, as documented in a previous report (Zenz, 2003) prepared for IAWA. Additional facility operations will impact energy and chemical usage, which could result in an indirect and possibly direct increase in greenhouse gas emissions. The potential implications are significant on a local level for IAWA members and their customers, as well as on a national level. Illinois is the fifth most populous state in the country, and the sixth greatest producer of CO_2 emissions (2007). This report has been prepared to summarize the carbon footprint implications associated with implementation of nutrient removal processes for Illinois municipal wastewater dischargers.

1.2 DEFINITION OF CARBON FOOTPRINT

There are many interpretations as to the definition of “Carbon Footprint”. It is necessary for the purposes of this report to settle on a working definition for IAWA.

The term “Carbon Footprint” is generally defined as a measure of the impact human activities have on the environment in terms of the amount of greenhouse gases produced, measured in units of carbon dioxide. For the IAWA this translates to the sum of all emissions associated with the collection, treatment, and ultimate disposal of wastewater. Significant sources of these emissions include the indirect emissions from the purchase of electricity, direct emissions resulting from the treatment process, fugitive emissions from the waste itself, and transportation related emissions.

This report will focus on the change in the carbon footprint of IAWA members that would result from the changes in treatment methods required to meet the proposed nutrient reduction requirements in the NRDC petition. Therefore, only the emissions sources that would be impacted by a change from conventional to advanced treatment were evaluated in this study. For the purposes of this report, the treatment processes required to achieve low total nitrogen and total phosphorous effluent discharge limits will be referred to as "advanced treatment".

Section 2.0
BACKGROUND

2.1 GREENHOUSE GASES AND CARBON FOOTPRINT

Scientists inform us that some of the gases that are released into the atmosphere have the ability to trap heat. A list of naturally occurring greenhouse gases (GHG) include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ozone (O_3). Several classes of halogenated substances that contain fluorine, chlorine, or bromine are also greenhouse gases, but they are, for the most part, solely a product of industrial activities. Even though some greenhouse gases are naturally occurring, scientists believe that an excess amount of these gases can have negative impacts on the environment. They believe that these increases in the concentrations of heat-trapping greenhouse gases can be linked to the increase in the Earth's average surface temperature. These discussions of a link between greenhouse gases and climate change have led some companies and organizations to assess their carbon footprint.

The purpose of this study was to assess the impact of proposed nutrient reduction requirements on the carbon footprint of wastewater treatment plants in the state of Illinois. As defined above, a carbon footprint is determined by examining greenhouse gas emissions. The greenhouse gases applicable to wastewater treatment are primarily carbon dioxide, methane, and nitrous oxide.

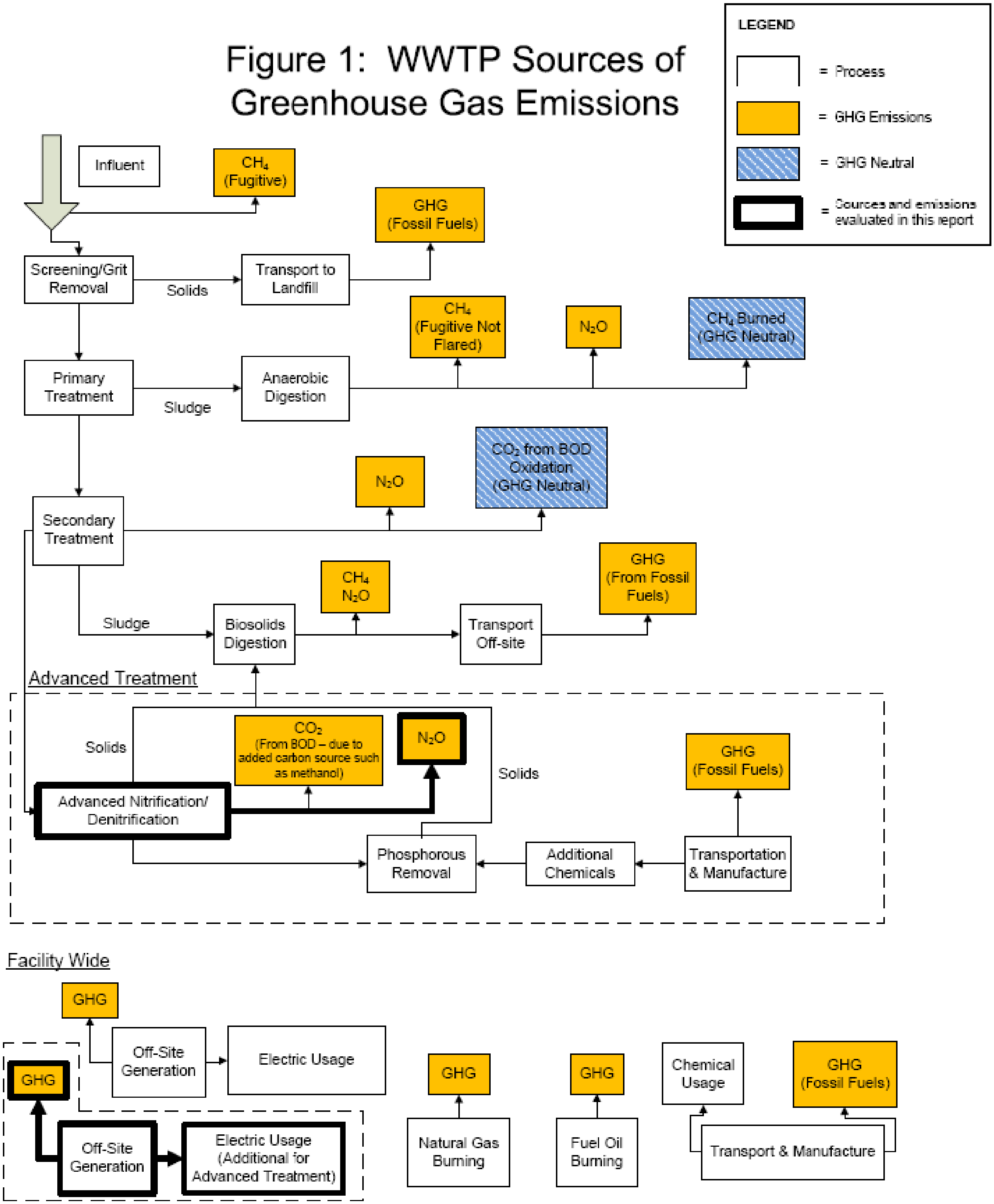
When describing greenhouse gases related to the carbon footprint of a plant or process, the units of pounds or tons of CO_2 equivalents or carbon equivalents are most often used. For this report, units of CO_2 equivalents will be used. Gases other than CO_2 can be converted to CO_2 equivalents using Global Warming Potentials (GWP). The Intergovernmental Panel on Climate Change (IPCC) developed the GWP concept to compare the ability of each greenhouse gas to trap heat in the atmosphere relative to another gas. The GWP of a greenhouse gas is defined as the ratio of the time-integrated radiative forcing from the instantaneous release of 1 kilogram (kg) of a trace substance relative to that of 1 kg of a reference gas (IPCC 2001). In this case, the reference gas used is CO_2. According to the IPCC Fourth Assessment Repot (2007), the GWP for methane is 25 and nitrous oxide is 298.

2.2 SOURCES OF GREENHOUSE GAS EMISSIONS IN WASTEWATER TREATMENT

The overall carbon footprint of a wastewater treatment plant includes both direct and indirect emissions of greenhouse gases resulting from the collection, treatment, and disposal of wastewater. Specific sources of these emissions were identified consistent with published references. The various sources are depicted in Figure 1 and described below starting with the collection system.

Methane (CH_4) can be generated throughout the collection system if anaerobic conditions exist. The amount of fugitive methane released under these conditions is dependent on the amount of degradable organic material in the wastewater.

Figure 1: WWTP Sources of Greenhouse Gas Emissions



The first step of the wastewater treatment process typically begins with primary treatment consisting of screening, grit removal, and primary settling. These unit processes result in the generation of waste solids that must be transported to a landfill or other means of disposal. The transportation of waste causes the release of greenhouse gases associated with the combustion of fossil fuels. The amount released is dependent on the fuel efficiency of the hauling truck, fuel type used, and distance traveled.

Secondary treatment biological treatment process release carbon dioxide (CO_2) and nitrous oxide (N_2O). Carbon dioxide is generated from the oxidation of the biochemical oxygen demand (BOD) in the wastewater. This source of carbon dioxide emissions is typically omitted from Greenhouse Gas Inventories according to the IPCC Guidelines because they are of biogenic origin. An exception to this is when organics are added to the wastewater from an imported fossil fuel origin, e.g., methanol produced from natural gas. N_2O can be an intermediate product of both nitrification and denitrification; however it is most often associated with denitrification. The amount of N_2O released depends on whether or not the plant is operating with intentional nitrification/denitrification. According to the U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2006, plants that incorporate intentional nitrification/denitrification generate 3.8 grams N_2O per capita per year more than plants without intentional nitrification/denitrification.

Additional emissions result from the handling and treatment of the biosolids that are generated throughout the wastewater treatment process. Many plants utilize anaerobic digestion for solids treatment. This digestion process results in the release of CH_4 and N_2O. Most of the CH_4 released can be neutralized if burned (flared or other forms of combustion). Inefficiencies in the gas collection system combined with the presences of small amounts of dissolved GHG can result in CH_4 and N_2O being released. As with the screenings/grit removal, the transportation of waste solids is also a source of emissions due to fossil fuel combustion. Finally, the ultimate disposal of the biosolids results in fugitive N_2O and CH_4 emissions, particularly if waste is placed in landfills or used for composting or agriculture application.

Throughout the wastewater treatment process, chemicals may be used to facilitate nutrient removal. There are greenhouse gases emissions associated with the manufacturing and transport of these chemicals. The quantity of these emissions is dependent on the type of chemical and delivery distance traveled.

In addition to the treatment process itself, there are greenhouse gas emissions associated with a wastewater treatment plant's power consumption. These may be direct emissions from burning of natural gas or fuel oil or indirect emissions from purchased electricity. The quantity of emissions resulting from purchase of electricity depends on a plant's energy use and source of energy production.

2.3 SOURCES OF GREENHOUSE GAS EMISSIONS ASSOCIATED WITH CHANGE TO ADVANCED TREATMENT

As mentioned previously, this study focused on the change in greenhouse gas emissions that would result from the installation and operation of the advanced treatment that would be required to achieve low total phosphorous total nitrogen discharge limits. The focus of this study is indicated by the dashed lines in Figure 1.

Each of the sources of greenhouse gases discussed above were evaluated in terms of a change from conventional to advanced treatment starting with the collection system. The move to advanced treatment should not affect the collection system therefore any fugitive methane emissions from the collection need not be included in the final analysis. The same would be true of screening, grit removal, or primary treatment processes.

The move to advance treatment would significantly alter secondary treatment. The addition of an intentional nitrification/denitrification process would result in an increase in N_2O emissions. The addition of process equipment combined with higher oxygen demands will lead to an increase in indirect emissions as a result of higher electrical demands. An increase in the addition of chemicals needed for advanced treatment combined with any higher sludge disposal requirements would lead to increased in emissions due to fossil fuel consumption.

In summary, it was determined that the sources that would be impacted most significantly by moving from conventional to advanced treatment would include direct emissions of N_2O released during nitrification/denitrification and the indirect emissions associated with the purchase of electricity. The incremental carbon footprint associated with these sources can be calculated and is discussed in the following sections. The potential impacts of other minor sources, such as biosolids digestion, transportation, chemicals and related fossil fuel consumption are discussed later in this report.

Therefore, for purposes of quantifying these additional greenhouse gas emissions, this study focused on the following:

1. Direct Source: Additional N_2O from intentional nitrification/denitrification

2. Indirect Source: Additional greenhouse gas emissions from off-site generation of additional electricity needed for advanced treatment.

These two sources of greenhouse gases are highlighted in bold in Figure 1.

2.4 PREVIOUS IAWA WORK

IAWA commissioned Consoer Townsend to study the process needs associated with low nitrogen and phosphorous effluent discharge limits. This study was completed by Dr. David Zenz in March 2003 and concluded: (Note: TN refers to total nitrogen and TP refers to total phosphorous.)

- "…monthly average effluent TP of 0.5 mg/L and monthly average TN levels of 3.0 mg/L can be achieved using currently available chemical and biological processes."

- "For retrofitting existing suspended growth systems:
    - TN removal – Dual anoxic and aeration zones
    - TP removal – Biological phosphorous removal using anaerobic/anoxic selection."

- "For retrofitting existing fixed film systems:
    - TP removal – chemical phosphorous removal at multiple dose points
    - TN removal – separate stage denitrification with methanol addition"

Dr. Zenz considered many different processes for both nitrogen and phosphorous treatment along with analyzing the needs of small, medium and large treatment plants. The conclusions highlighted above indicate that new biological, chemical and mechanical steps must added to existing treatment processes in order to achieve low effluent targets. The result of these additional steps will be an increase in the amount of energy needed by the treatment plant. Increases in energy will directly affect the carbon footprint associated with waste treatment.

Section 3.0
SURVEY

3.1 PURPOSE OF SURVEY

A survey was conducted in order to obtain plant and power information from the IAWA membership. Survey questions included plant flow rate, permit limits and plant performance, types of treatment processes utilized, and types and quantities of chemicals used. Data was also requested, if available, on power usage and sources of power production. A sample of the survey can be found in Appendix A.

3.2 SUMMARY OF SURVEY RESULTS

Out of the 55 agency members contacted, 18 respondents provided data on total of 29 wastewater treatment plants. These plants ranged in size from an average a flow of 1.35 MGD up to 732 MGD. Most of the plants that responded currently have permit limits for BOD, TSS, and ammonia. None of these plants currently have total nitrogen limits and only two have limits on total phosphorus.

Of particular interest are the responses from the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC). MWRDGC provided data from seven plants: Egan, Hanover Park, Kirie, Calumet, Northside, Stickney and Lemont. Of these treatment plants:

Six of the plants could be classified as nitrifying (Egan, Hanover Park, Kirie, Calumet, Northside, & Stickney)

The Lemont plant would be classified as non-nitrifying.

Four of the treatment plants have average flow rates that fall within the range of other survey respondents (Egan, Hanover Park, Kirie, and Lemont)

Three of the plants have average flow rates well beyond the range of other survey respondents (Calumet, Northside, and Stickney).

Twenty five of the wastewater treatment plants that responded to the survey, provided data on their electric utility's power production sources. Almost all of the plants listed coal burning and nuclear as power production sources. Most plants also listed natural gas burning as a source. Only two plants responding use any wind energy and none of the plants currently use solar power. Several plants also marked "other" as one of the power sources in their response.

All responses have been summarized in Appendix B.

Section 4.0
DISCUSSION AND ANALYSIS

4.1 ANALYSIS OF SURVEY RESULTS

As was stated previously, data was collected from 29 treatment plants throughout the IAWA members. The data was first organized by process type. Any plant that reported a non-nitrifying activated sludge system was considered non-nitrifying. Any treatment plant that reported low ammonia effluent concentrations independent of process types, was considered nitrifying. There was one plant from the survey that indicated it is using an advanced (BNR) treatment process. The remaining 28 plants that responded to the survey were considered to have conventional treatment processes for the purposes of this study.

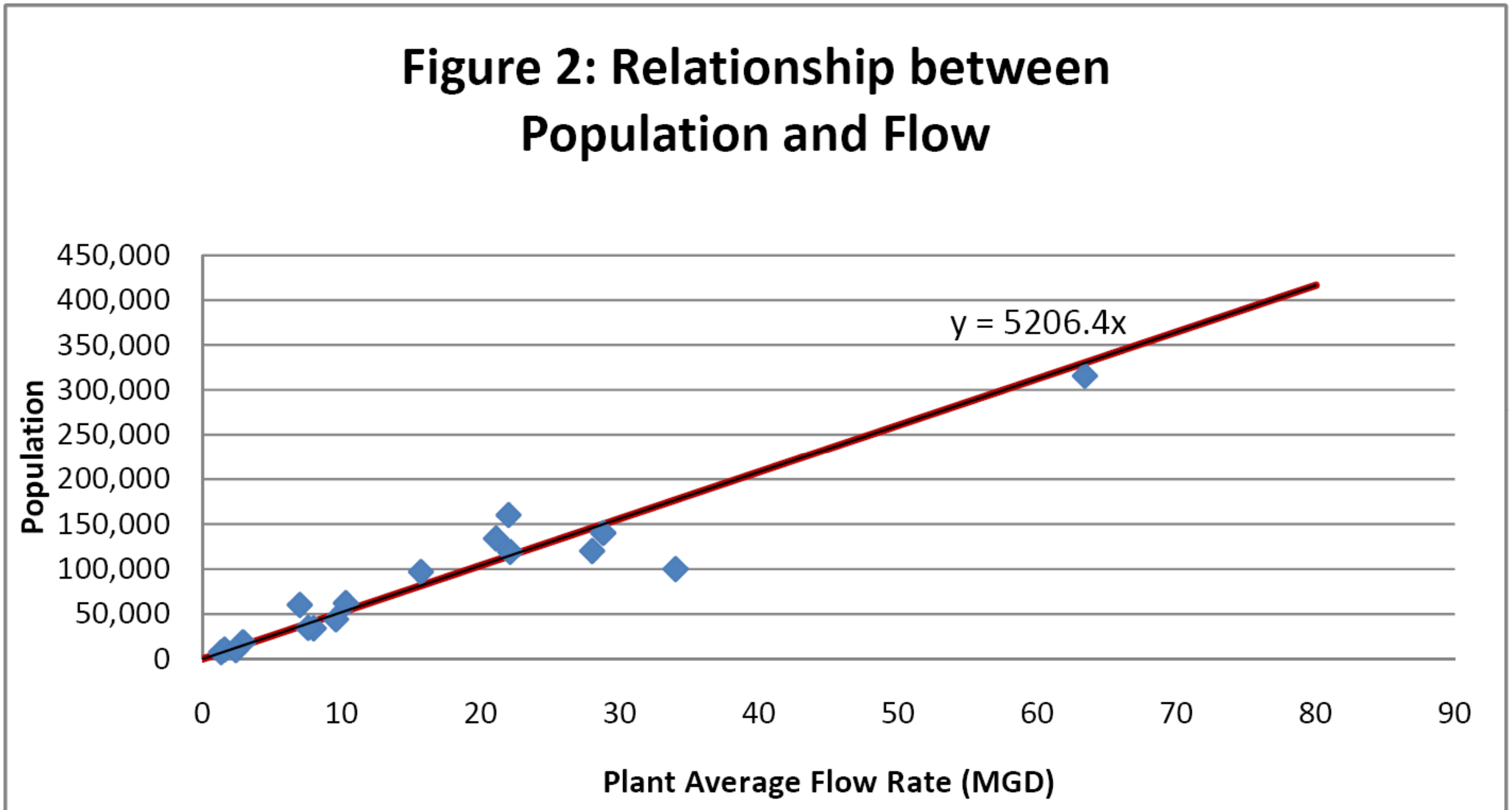
Once the data was organized into these three groups, the data was adjusted to develop relationships all based on average flow rate. Flow rate was chosen as the basis for analyzing the data because it would allow IAWA members to relate the results to their individual plants. Please see the discussion of the results found later in this report for more information.

4.2 CALCULATION OF APPLICABLE DIRECT EMISSIONS FROM TREATMENT PROCESS

As has been mentioned before, there are direct emissions of greenhouse gases that result from the treatment process itself. Of particular concern for this study is the N_2O associated with the nitrification/denitrification process. According to EPA's US Greenhouse Gas Inventory (2006), plants with conventional treatment processes that do not include intentional nitrification/ denitrification generate 3.2 grams N_2O per capita per year. This is compared to 7 grams N_2O per capita per year for plants with intentional nitrification/denitrification. The difference in these emission factors (3.8 grams N_2O per capita per year) was used to determine the net increase in N_2O emissions associated with a change to advanced treatment. Based on the average plant flow rates from the survey and population data from the IAWA membership directory, a relationship was developed for flow rate and population (see Figure 2). This relationship was used along with the per capita emissions factors to calculate the net increase in N_2O process emissions as a function of annual average flow. The N_2O emissions associated with the conversion to advanced treatment processes were converted to equivalent CO_2 emissions by using a GWP of 298 and are shown in Figure 3.

4.3 CALCULATION OF APPLICABLE INDIRECT EMISSIONS

The consumption of purchased electricity is the main source of indirect emissions for wastewater treatment plants. As described in previous sections, there is an increase in power consumption associated with a plant changing from conventional to advanced treatment. In order to estimate the magnitude of this impact, it was necessary to estimate the amount of



MWRDGC data not shown on this figure.

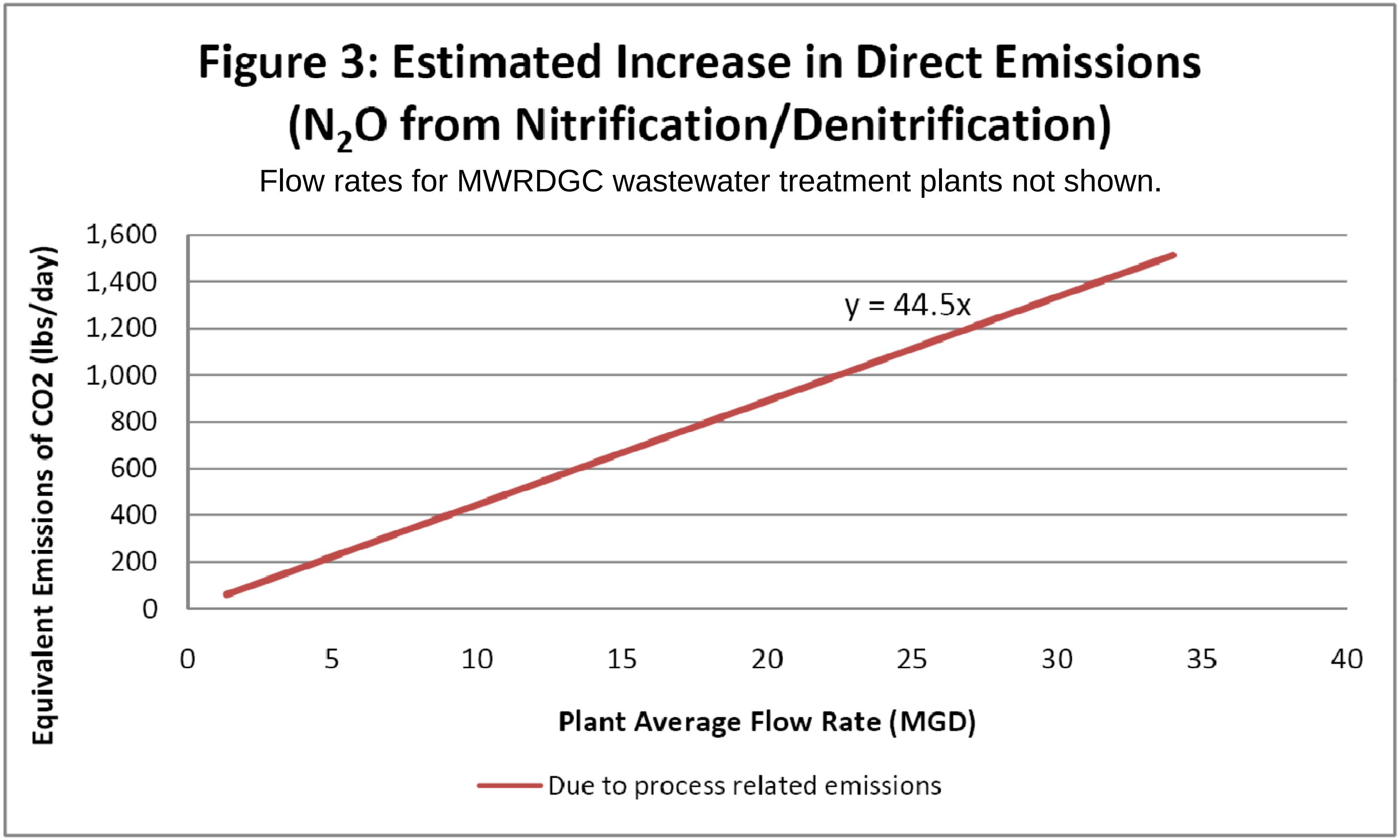


Figure 3: Estimated Increase in Direct Emissions
(N_2O from Nitrification/Denitrification)
Flow rates for MWRDGC wastewater treatment plants not shown.
Equivalent Emissions of CO2 (lbs/day)
1,600
1,400
1,200
1,000
800
600
400
200
0
y = 44.5x
0
5
10
15
20
25
30
35
40
Plant Average Flow Rate (MGD)
Due to process related emissions

additional energy needed. Sources are available to assist with this analysis. For the purposes of this report, one primary source along with 3 supporting sources were considered. The primary source of information was published by the Electrical Power Research Institute (EPRI) in the technical report titled “Water & Sustainability (Volume 4): U.S. Electricity Consumption for Water Supply & Treatment – The next Half Century”. Supporting references include estimates found in Dr. Zenz report; the technical paper written by Hugh Monteith and others titled “Achieving Stringent Effluent Limits Takes A Lot Of Energy” presented during WEFTEC 2007; and data obtained as part of the membership survey described earlier in this report. The following provides a summary of the energy information:

- Table 3-1 of the EPRI technical report illustrates the electrical consumption at various treatment plant flow rates for different treatment processes.

- Dr. Zenz reported that increases in plant operating costs for biological nutrient removal would be in the range of 50 percent.

- Mr. Monteith reports energy values for different treatment processes. Using this data, it is possible to demonstrate energy increases ranging from 70 to 80 percent depending on plant size.

- Data taken from the survey results for the Urbana-Champaign area suggest an energy increase of about 44 percent as a result of BNR treatment. Urbana-Champaign Sanitation District was the only district to report energy information for a nitrification plant and an advanced treatment (BNR) plant. It should be noted that this BNR plant is not designed to meet the proposed nutrient limits and that solids treatment for both the BNR plant and the nitrification plant is done at the nitrification plant.

For the purposes of this report, EPRI data was used to derive a relationship between additional energy consumption as a function of flow rate. This data shows about a 40% increase in electrical energy consumption per million gallons treated at small treatment plant flow rates rising to near 50% at higher flow rates. The EPRI data is supported by estimates reported by Dr. Zenz along with the data reported by Urbana-Champaign. The EPRI data is slightly lower than the information found in the Monteith report. Figure 4 is a graphical depiction of the data from the EPRI report. A best fit formula was derived for each data set. The formulas were then combined in order to generate a flow based relationship for the difference between conventional and advanced treatment. This new relationship would then be combined with the survey data results to develop an estimate for advanced treatment energy estimates.

Data from the survey results was used to obtain an estimate for the energy requirement per million gallons of daily flow for plants using conventional treatment. The electrical energy use information for each plant was divided by the corresponding average plant flow rate. The result was graphed in order to determine if a trend could be observed. Figures 5 and 5a depict this data from the non-nitrifying and nitrifying treatment plants in our data set. From this analysis, a function was developed. This function served as the basis for determining the relationship between energy needs and plant average flow rate. The function was based primarily on data from the nitrifying plants.

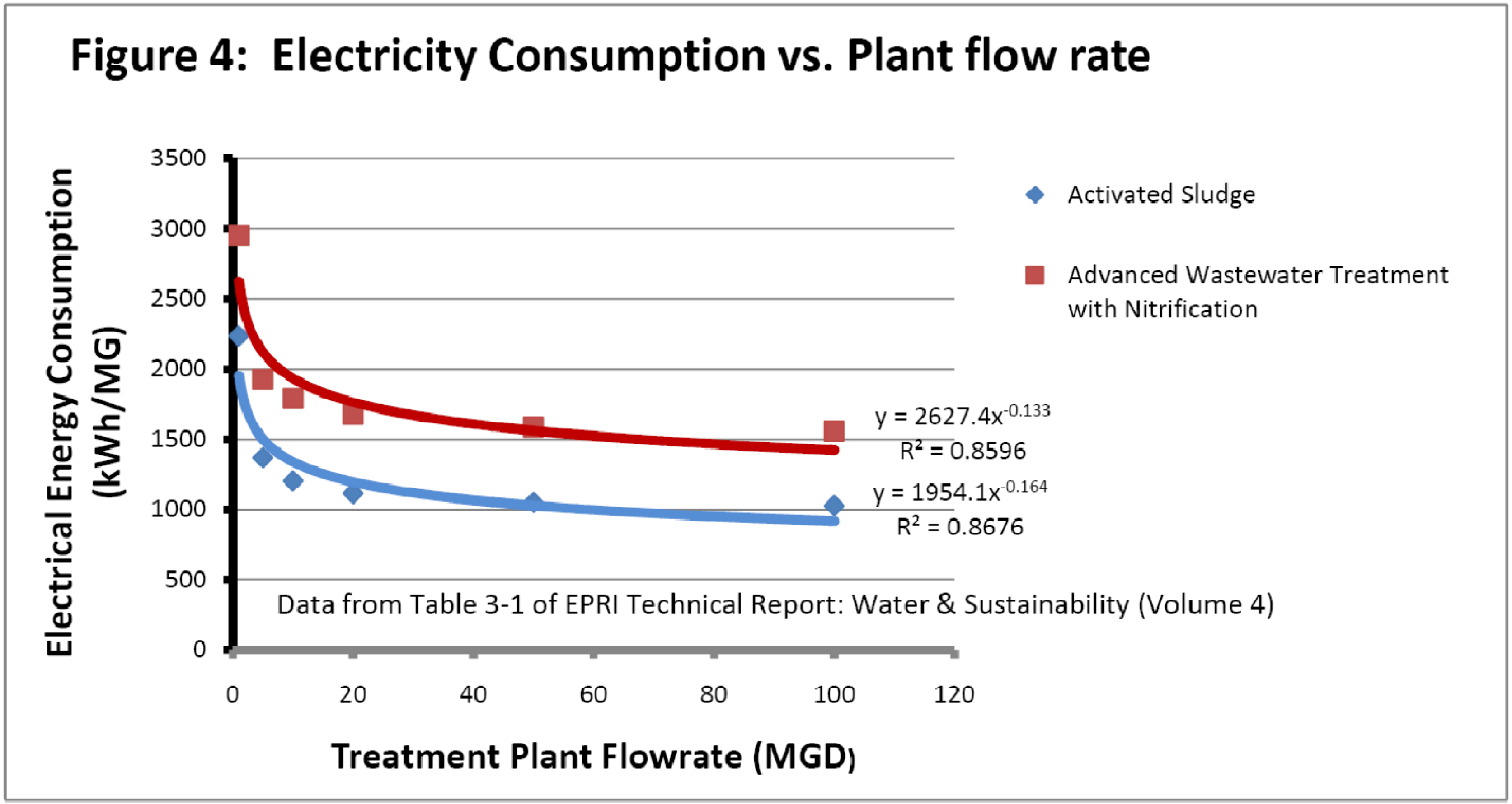


Figure 4: Electricity Consumption vs. Plant flow rate
Electrical Energy Consumption (kWh/MG)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
Treatment Plant Flowrate (MGD)
Activated Sludge
Advanced Wastewater Treatment with Nitrification
y = 2627.4x^-0.133
R² = 0.8596
y = 1954.1x^-0.164
R² = 0.8676
Data from Table 3-1 of EPRI Technical Report: Water & Sustainability (Volume 4)

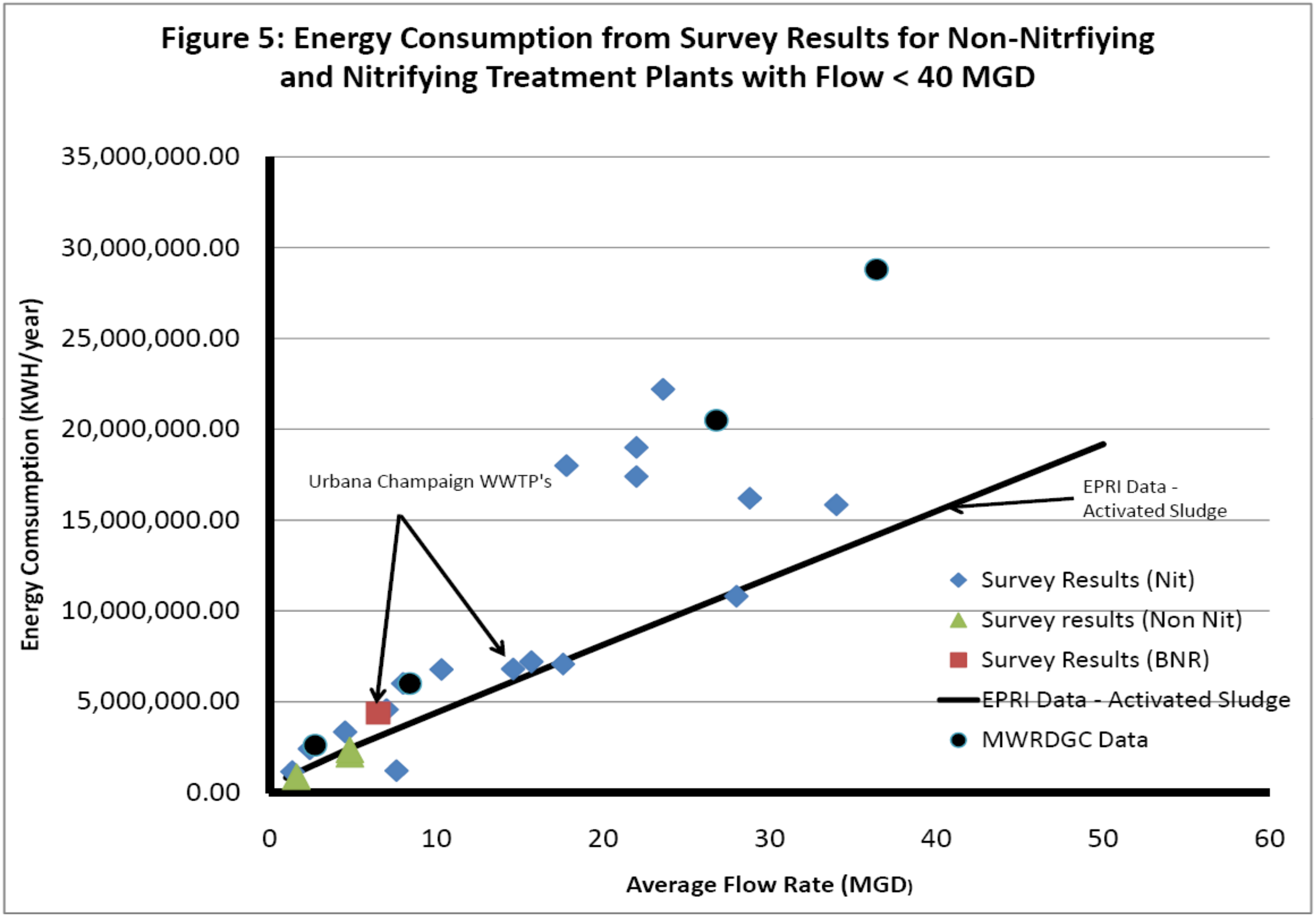


Figure 5: Energy Consumption from Survey Results for Non-Nitrfiying and Nitrifying Treatment Plants with Flow < 40 MGD
35,000,000.00
30,000,000.00
25,000,000.00
20,000,000.00
15,000,000.00
10,000,000.00
5,000,000.00
0.00
Energy Comsumption (KWH/year)
0
10
20
30
40
50
60
Average Flow Rate (MGD)
Urbana Champaign WWTP's
EPRI Data - Activated Sludge
Survey Results (Nit)
Survey results (Non Nit)
Survey Results (BNR)
EPRI Data - Activated Sludge
MWRDGC Data

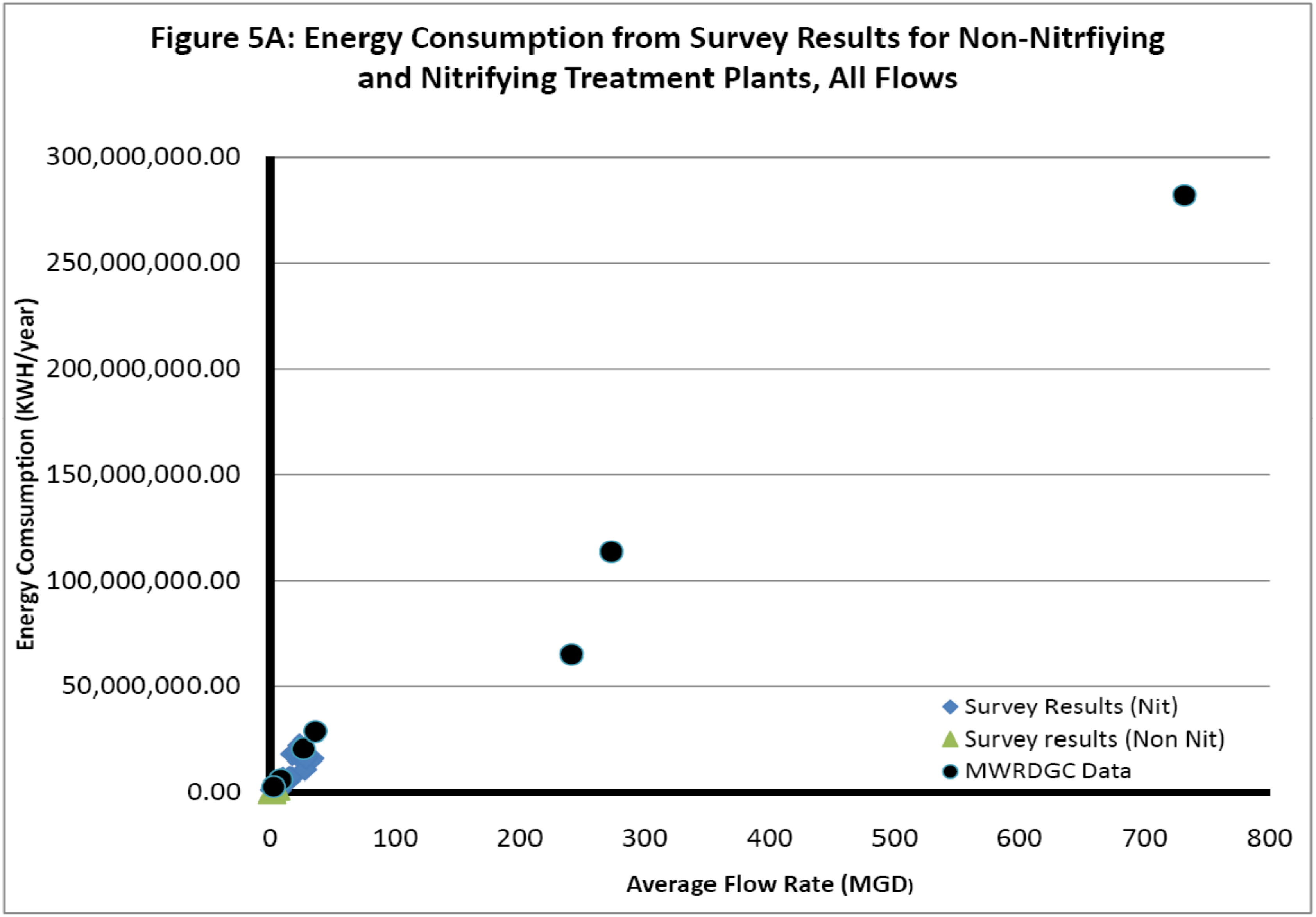


Figure 5A: Energy Consumption from Survey Results for Non-Nitrfiying and Nitrifying Treatment Plants, All Flows
300,000,000.00
250,000,000.00
200,000,000.00
150,000,000.00
100,000,000.00
50,000,000.00
0.00
Energy Comsumption (KWH/year)
0
100
200
300
400
500
600
700
800
Average Flow Rate (MGD)
Survey Results (Nit)
Survey results (Non Nit)
MWRDGC Data

Figures 6 and 6a depict both the flow based energy consumption as reported by IAWA treatment facilities along with a second flow based relationship for advanced flow energy requirements using the EPRI data. The equation for the IAWA treatment plant data has an r-squared value of 0.9826 indicating that the equation can explain the data set over 98% of the time. The equation shown on Figures 6 and 6a serves as the basis for determining increase power demands as a function of flow rate.

The indirect emissions from this net increase in power usage were then calculated using the emissions factors published in EPA's Emission & Generation Resource Integrated Database (eGRID). The applicable subregions for IAWA members are Reliability First Corporation West (RFCW) and SERC Reliability Corporation Midwest (SRMW). The RFCW subregion includes the northernmost areas along Lake Michigan and the Wisconsin/Illinois border, and the SRMW includes the rest of the state. A copy of eGRID subregion map is included in Appendix C.

According to eGRID data, the generation resource mix for these subregions is primarily coal, followed by nuclear, and some natural gas and other miscellaneous sources. This is consistent with the data Symbiont collected on power sources from the survey results and the large utility companies serving the Illinois area.

Since there are IAWA members located in both subregions, separate computations of the net increase in emissions were made for each group. The eGRID emission factors for CO_2, CH_4, and N_2O were applied to the power consumption data described in earlier in this section. The results in terms of equivalent CO_2 emissions are depicted in Figures 7 and 8 for the RFCW and SRWM subregions, respectively.

4.4 OTHER SOURCES OF EMISSIONS

There are several smaller sources of carbon emissions associated with advanced treatment that are more difficult to quantify in terms of the IAWA membership as a whole. These smaller sources are affected to a large degree on the unique aspects associated with each individual treatment plant. These smaller sources have not been included in the analysis but examples have been prepared to demonstrate the contribution of these other sources on the overall carbon footprint.

Chemical Treatment – In most cases, additional chemicals will be needed for advanced treatment. These chemicals may include coagulants such as Ferric Chloride or Alum, polymers and additional sources of BOD such as methanol. Transportation and production of these chemicals will result in an increased consumption of fossil fuels and therefore an increase in carbon footprint. The amount of the increase will be dependent on trucking distance and chemical consumption. In the case of supplemental BOD chemicals, the actual chemical itself could result in additional CO_2 emissions. If the BOD source is considered non-biogenic, then any CO_2 emissions associated with biological respiration should be included as greenhouse gas emissions. An example of this would be methanol manufactured from natural gas. However, if the BOD source is biogenic, then the CO_2 emissions associated with biological respirations can be excluded. An example of this might be the use of molasses as a BOD source.

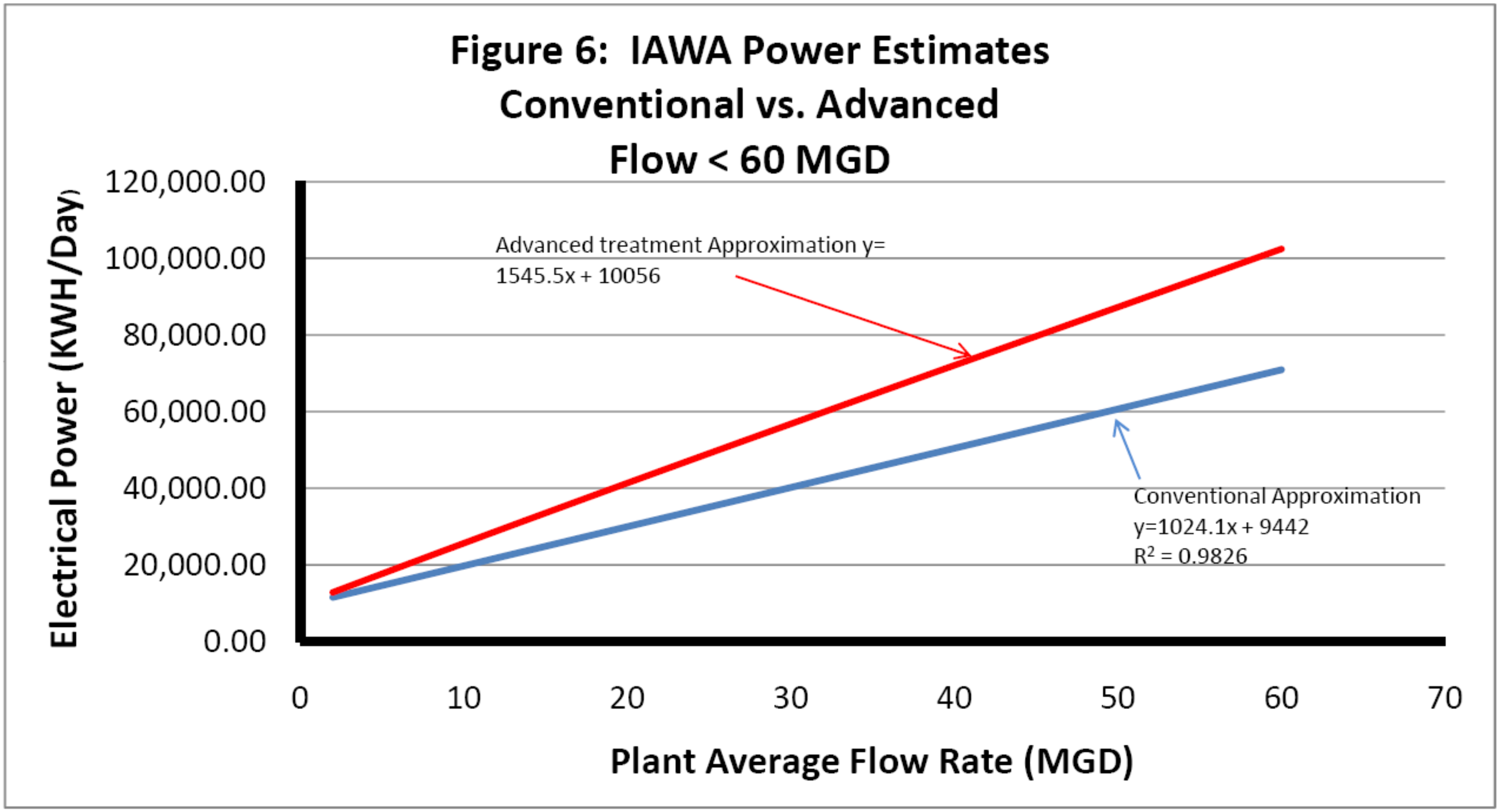


Figure 6: IAWA Power Estimates
Conventional vs. Advanced
Flow < 60 MGD
Electrical Power (KWH/Day)
120,000.00
100,000.00
80,000.00
60,000.00
40,000.00
20,000.00
0.00
0
10
20
30
40
50
60
70
Plant Average Flow Rate (MGD)
Advanced treatment Approximation y=
1545.5x + 10056
Conventional Approximation
y=1024.1x + 9442
R2 = 0.9826

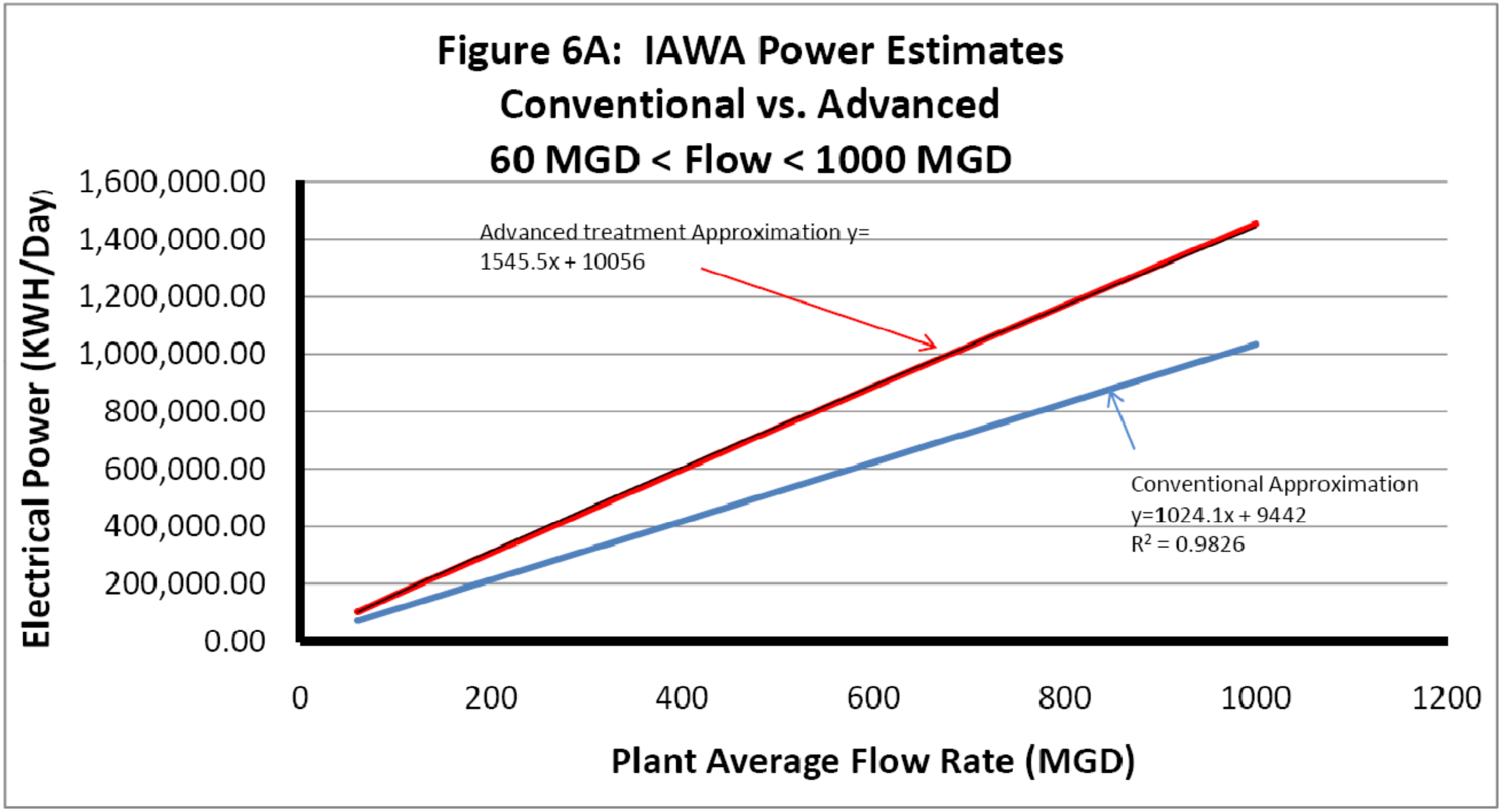


Figure 6A: IAWA Power Estimates
Conventional vs. Advanced
60 MGD < Flow < 1000 MGD
Electrical Power (KWH/Day)
1,600,000.00
1,400,000.00
1,200,000.00
1,000,000.00
800,000.00
600,000.00
400,000.00
200,000.00
0.00
Advanced treatment Approximation y=
1545.5x + 10056
Conventional Approximation
y=1024.1x + 9442
R² = 0.9826
0
200
400
600
800
1000
1200
Plant Average Flow Rate (MGD)

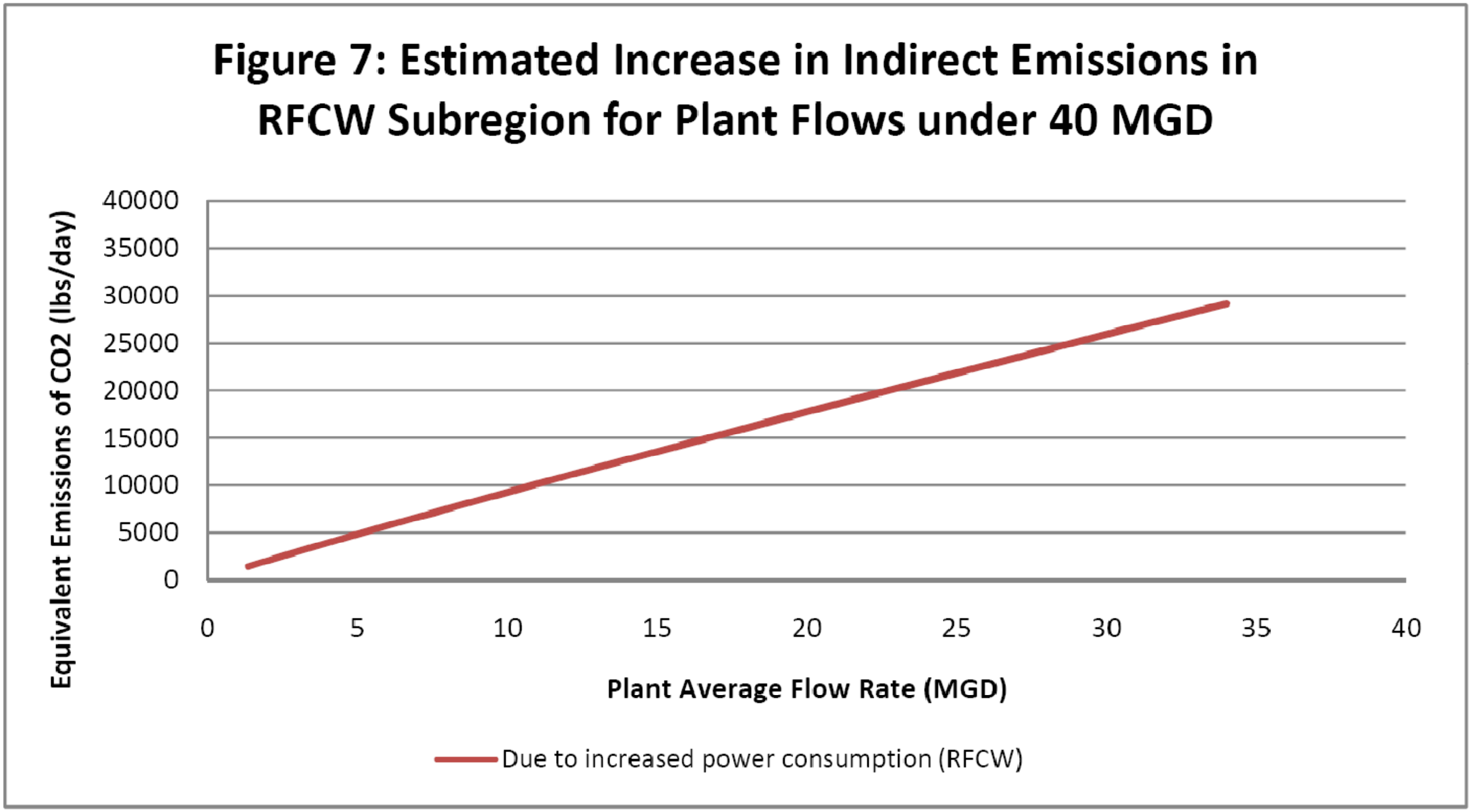


Figure 7: Estimated Increase in Indirect Emissions in RFCW Subregion for Plant Flows under 40 MGD
Equivalent Emissions of CO2 (lbs/day)
40000
35000
30000
25000
20000
15000
10000
5000
0
0
5
10
15
20
25
30
35
40
Plant Average Flow Rate (MGD)
Due to increased power consumption (RFCW)

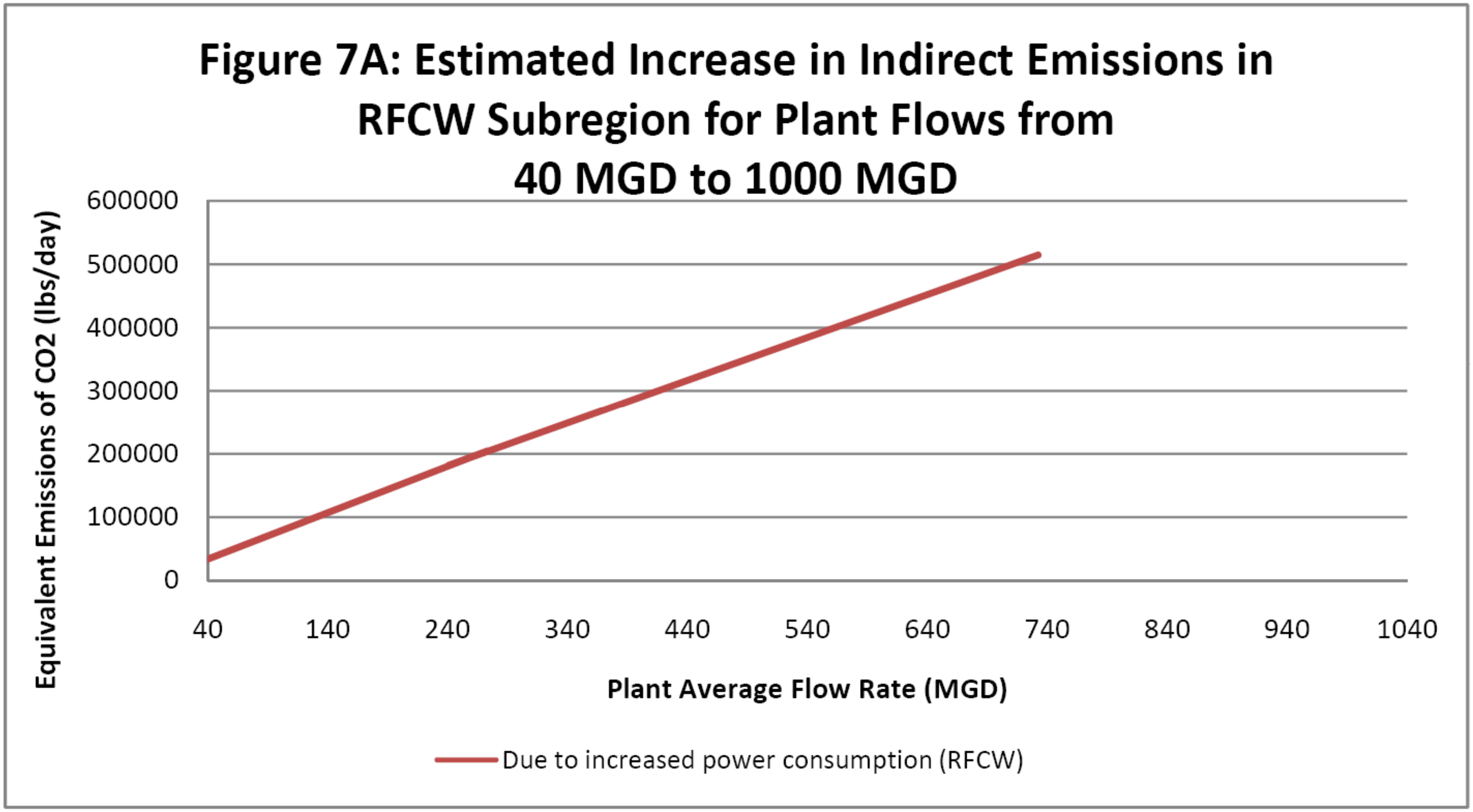
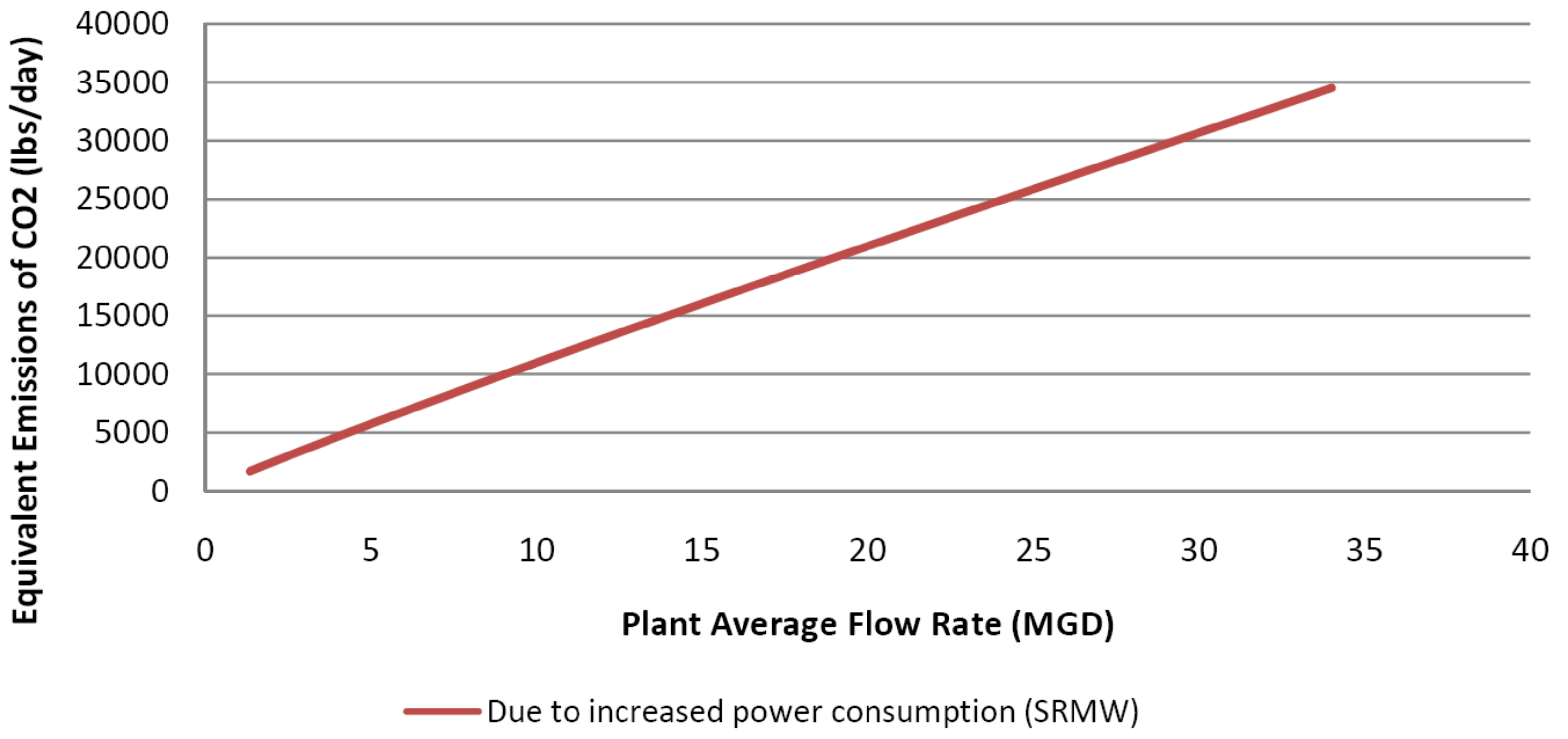


Figure 7A: Estimated Increase in Indirect Emissions in RFCW Subregion for Plant Flows from 40 MGD to 1000 MGD
Equivalent Emissions of CO2 (lbs/day)
600000
500000
400000
300000
200000
100000
0
40
140
240
340
440
540
640
740
840
940
1040
Plant Average Flow Rate (MGD)
Due to increased power consumption (RFCW)

Figure 8: Estimated Increase in Indirect Emissions in SRMW Subregion



To demonstrate the impact chemicals might have on carbon footprint assume that additional biogenic chemicals are needed and that the trucking distance traveled per year to transport these chemicals is 12,000 miles. The increase in GHG emissions associated with this amount of trucking would amount to approximately 23 tons of CO_2 equivalent per year.

Solids Production – Advanced treatment systems may have increased solids disposal requirements. The Zenz report indicated that biological sludge production associated with advance treatment could decrease by as much as 10 percent. However, chemical sludge production could increase by 35 to 45 percent. Any increases in sludge production would result in an increase in trucking leading to an increase in carbon footprint. Complicating this analysis could be the method of sludge disposal. It has been shown, for example, that some treatment plant waste disposed of in a landfill will decompose and release methane gas. If the landfill does not have a methane capture system, the methane being released will dissipate into the atmosphere further increasing the carbon footprint. On the other hand, some treatment plants can decrease sludge production by using on site anaerobic digestion. Methane gas produced through this process can be captured and in some cases used as fuel for electricity generation. Where feasible, this on-site electricity generation can be used to offset some of the increase in energy, and corresponding carbon footprint, associated with a switch to advanced treatment . It has been estimated that greenhouse gas emissions can be reduced by 20 to 40 percent (Haas and others, 2008) if this generated electricity can be used.

To demonstrate the impact solids production may have on carbon footprint, assume that additional sludge is produced requiring 3,000 extra miles of trucking per month. The impact increased trucking alone would have on the plant's GHG emissions would be approximately 69 tons of CO_2 equivalent per year.

Deregulated Energy Market in Illinois – The electrical market in Illinois is not regulated. Districts can purchase their power from a pre-selected group of utilities provided by the Illinois Commerce Commission. As a result, for some IAWA members, there could be additional power requirements associated with transmitting electrical energy over long distances depending on the source of the electrical energy. If the plant's electricity is transmitted over a long distance, the increase in emissions associated with energy consumption could be even greater that the values calculated in Section 4.3 due to this power loss.

Construction Phase – Little has been written on the subject of the physical changes that would be necessary to convert a conventional treatment plant to an advanced treatment plant. It is reasonable to assume that a significant amount of civil and mechanical work may be needed. There would be greenhouse gas emissions associated with this work. These emissions would include those associated with powering construction equipment (fossil fuel consumption) and with producing construction materials.

Section 5.0
SUMMARY OF RESULTS

The increase in direct and indirect emissions described above can be added together to determine the overall change in carbon footprint resulting from the changes in treatment methods required to meet the proposed nutrient reduction requirements. These results in terms of equivalent CO_2 emissions per MGD of flow are shown in Figures 9 and 10 for the RFCW and SRWM subregions respectively. The total emissions were also calculated for sample plant sizes of 1, 10, 30, and 100 MGD as shown in the tables below.

RFCW Subregion				
Plant Name	Annual Average Daily Flow (MGD)	Equivalent Emissions of CO_2 (lbs/day)		
		Direct Emissions	Indirect Emissions	Total Increase
Small Plant	1	45	1,073	1,118
Medium Plant	10	445	9,269	9,714
Large Plant	30	1,335	25,916	27,251
Extra Large Plant	100	4,451	79,947	84,398

SRMW Subregion				
Plant Name	Annual Average Daily Flow (MGD)	Equivalent Emissions of CO_2 (lbs/day)		
		Direct Emissions	Indirect Emissions	Total Increase
Small Plant	1	45	1,272	1,316
Medium Plant	10	445	10,983	11,428
Large Plant	30	1,335	30,709	32,045
Extra Large Plant	100	4,451	94,734	99,185

There are many different ways to demonstrate the impact of the increased carbon footprint associated with the change from conventional to advanced treatment. Some examples include:

1) Over the course of a year, the increase in emissions for a 10 MGD plant in the RFCW subregion would be over 1,770 tons of CO_2 equivalent. This is equal to the:
   a. Annual greenhouse gas emissions from almost 300 passenger vehicles
   b. Or CO_2 emissions from the annual electricity use of over 200 homes

2) The total increase in annual emissions from the 21 conventional treatment plants in the survey would be over 50,000 tons of CO_2 equivalent. This is equal to the:
   a. Annual greenhouse gas emissions from almost 8,500 passenger vehicles
   b. Or CO_2 emissions from the annual electricity use of over 6,100 homes
   c. Or over 1 percent of the annual CO_2 emissions of a 600 MW power plant operating with an average annual capacity factor of 75% in the State of Illinois.

3) The State of Illinois has roughly 1200 municipal WWTPs with over 3700 MG of permitted flow per day. Converting all of them to advanced treatment would potentially increase the state's emissions by more than 470,000 tons of CO_2 equivalent per year. This is equal to:
   a. Annual greenhouse gas emissions from almost 78,000 passenger vehicles
   b. Or CO_2 emissions from the annual electricity use of over 56,000 homes
   c. Or 12% to 15% percent of the annual CO_2 emissions of a 600 MW coal fired power plant with a operating with an average annual capacity factor of 75% in the State of Illinois

The three largest treatment facilities of MWRDGC deserve special consideration. These three facilities alone represent almost 50% of the total permitted municipal flow capacity in the State. The following table indicates the estimated impact on the carbon footprint of these treatment plants as a result of converting to advanced treatment.

Predicted Carbon Footprint Increase

Treatment Plant:	Calumet	Northside	Stickney
Flow Rate (MGD):	273	241	732
Carbon Footprint Increase: :Lbs CO_2 Eq/Day			
Direct (Process)	12,152	10,728	32,583
Indirect (Energy)	204,544	182,031	514,470
Total (rounded)	216,700	192,760	547,000

The flow rates of these are well above typical treatment plant flow rates. Caution is recommended when applying these values. A more thorough review of the data and details associated with each plant is advised in order to provide more accurate estimates of the carbon footprint impact.

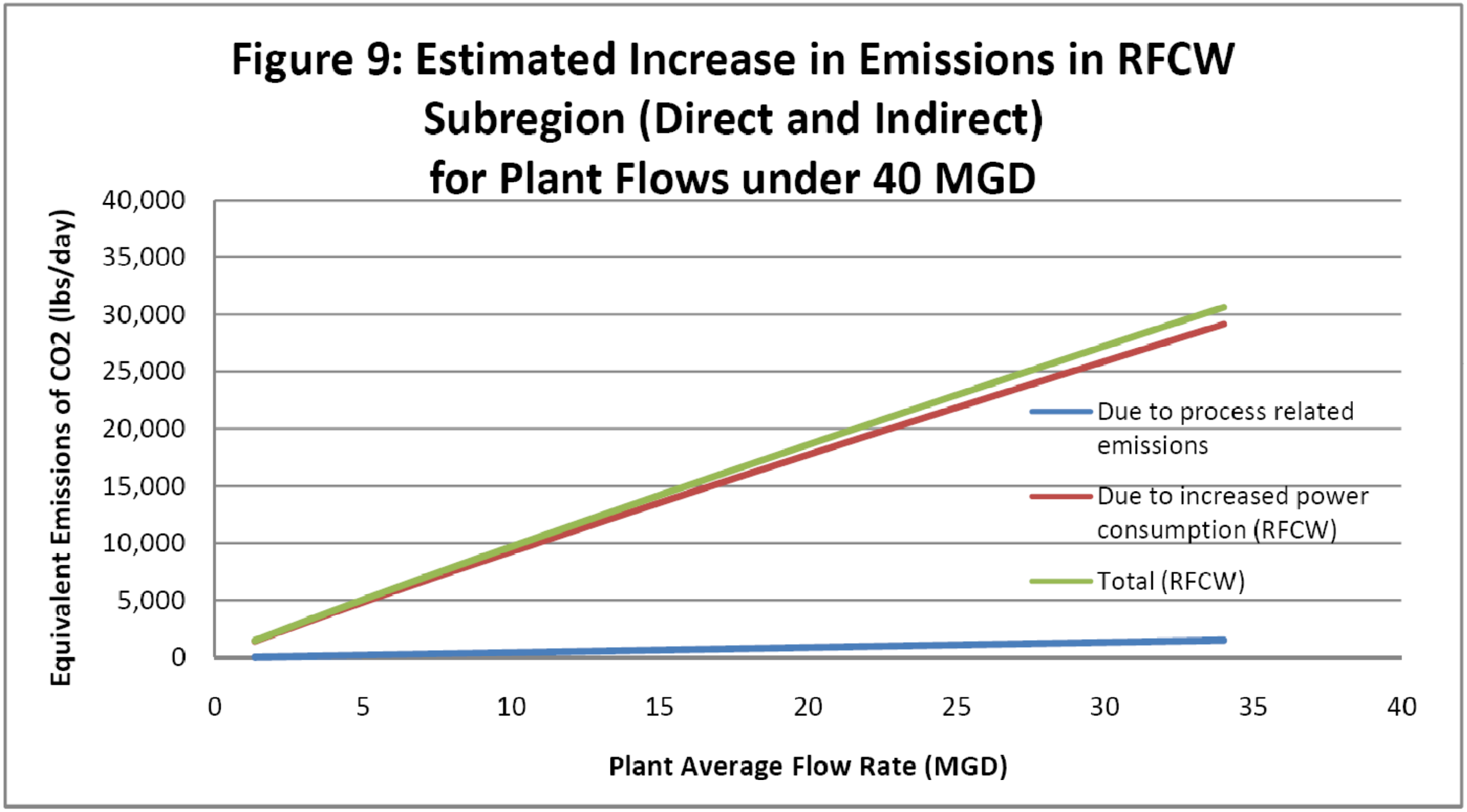


Figure 9: Estimated Increase in Emissions in RFCW Subregion (Direct and Indirect) for Plant Flows under 40 MGD
Equivalent Emissions of CO2 (lbs/day)
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
0
5
10
15
20
25
30
35
40
Plant Average Flow Rate (MGD)
Due to process related emissions
Due to increased power consumption (RFCW)
Total (RFCW)

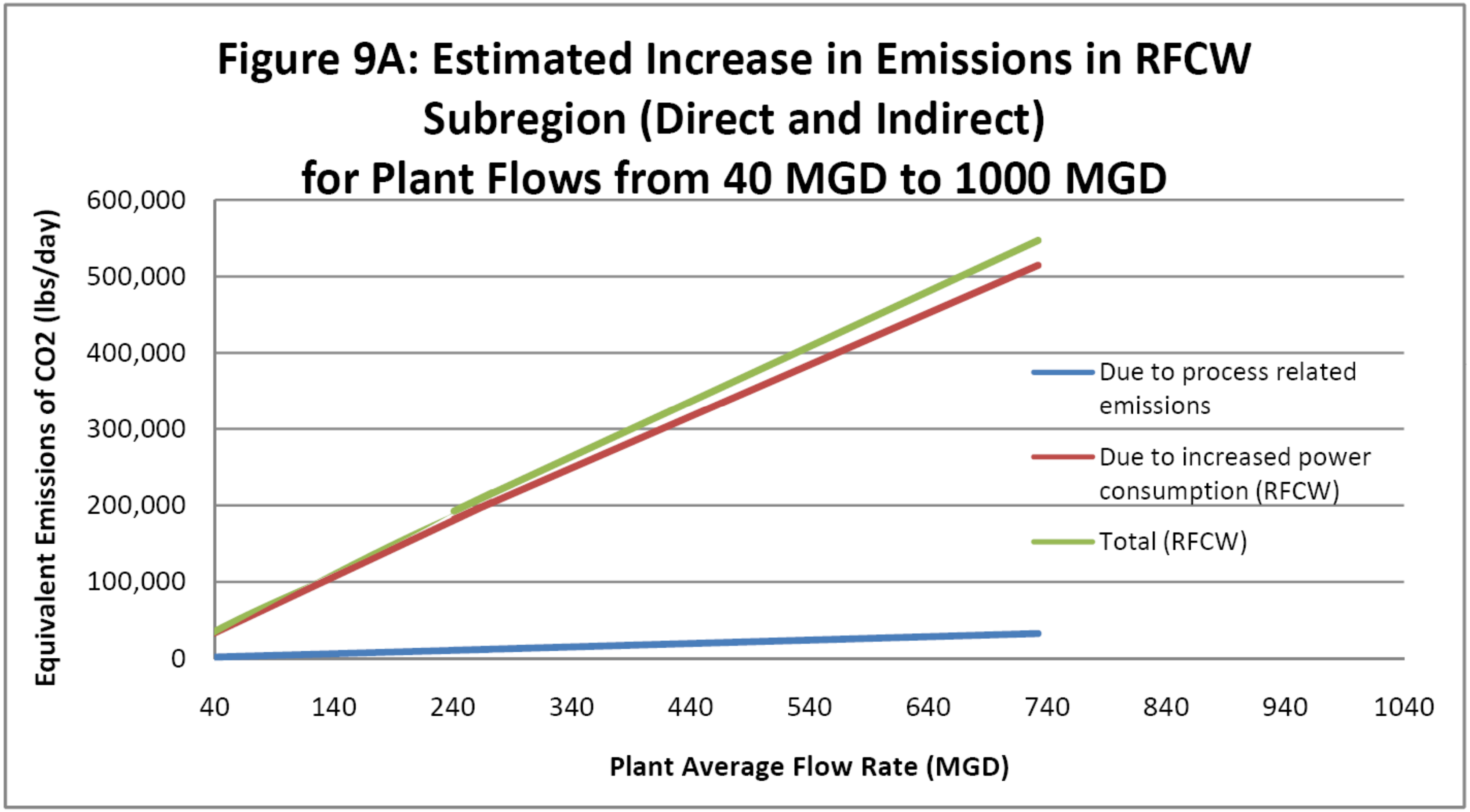


Figure 9A: Estimated Increase in Emissions in RFCW
Subregion (Direct and Indirect)
for Plant Flows from 40 MGD to 1000 MGD
Equivalent Emissions of CO2 (lbs/day)
600,000
500,000
400,000
300,000
200,000
100,000
0
40
140
240
340
440
540
640
740
840
940
1040
Plant Average Flow Rate (MGD)
Due to process related emissions
Due to increased power consumption (RFCW)
Total (RFCW)

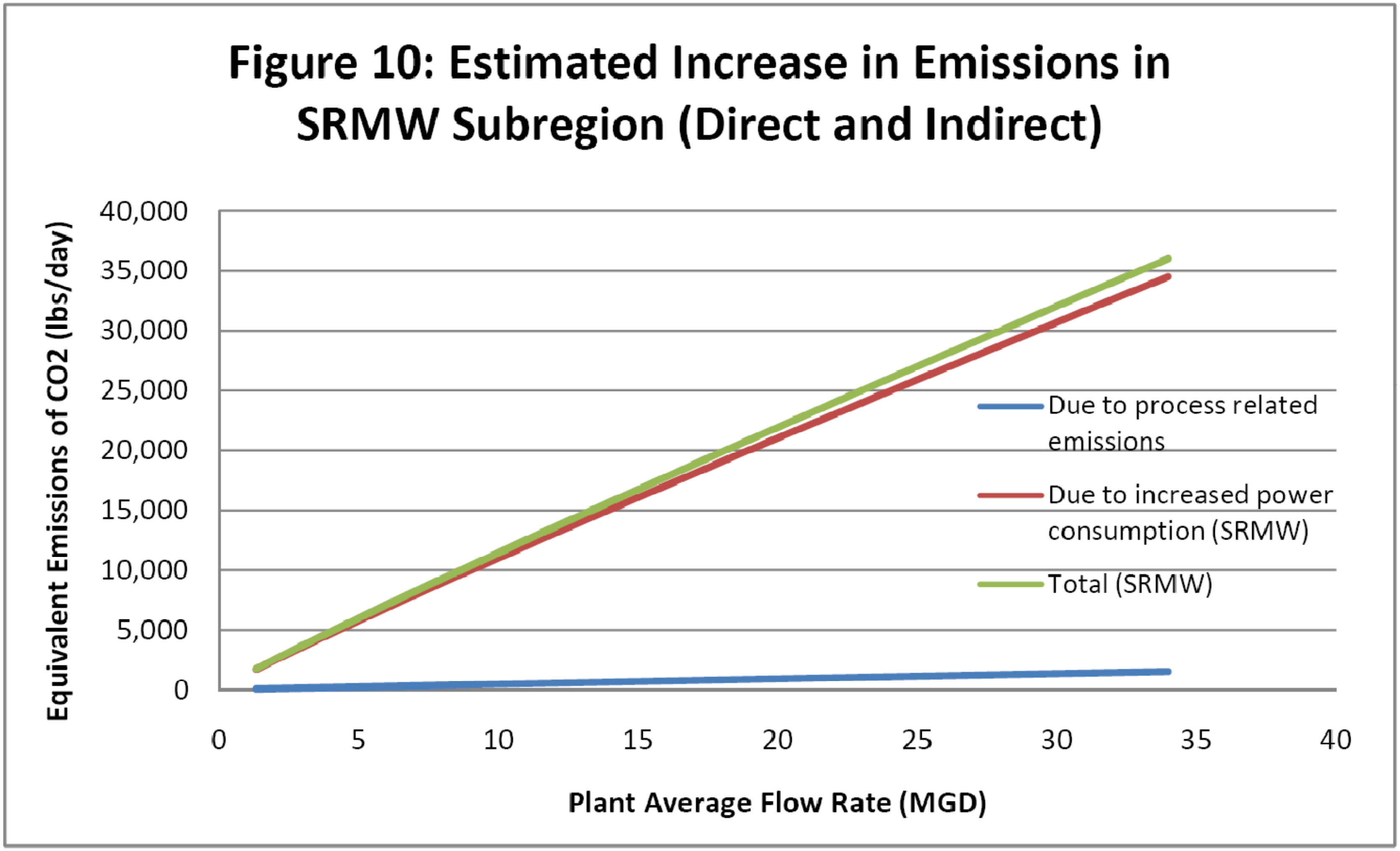


Figure 10: Estimated Increase in Emissions in SRMW Subregion (Direct and Indirect)
Equivalent Emissions of CO2 (lbs/day)
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
0
5
10
15
20
25
30
35
40
Plant Average Flow Rate (MGD)
Due to process related emissions
Due to increased power consumption (SRMW)
Total (SRMW)

Section 6.0
CONCLUSIONS

This report demonstrates the effects that lower nutrient effluent limits will have on the carbon footprint of Illinois municipal WWTPs. The lower nutrient limits will lead to plant upgrades and process treatment modifications that will result in significant increases in greenhouse gas emissions. The single largest emission source would come from electrical energy increases. A second source for increased emissions would come from the biological processes. A third source could come from emissions associated with trucking of sludges and chemicals.

At a minimum using current power generation figures for Illinois, a typical conventional treatment plant will experience an increase of 1,045 lbs of CO_2 equivalent for every million gallons per day of flow. Actual values will be dependent on the details of each treatment plant and should be determined on a case by case basis. For a treatment plant with a flow of 10 MGD, the annual greenhouse gas emissions increase is equal to the annual emissions from about 300 automobiles. If all municipal waste flows in the state were considered, the increase in greenhouse gas emissions would be more than 470,000 tons of CO_2 equivalent per year which is equal 12% to 15% of the annual emissions of a 600 MW electrical power plant operating with an average annual capacity factor of 75% in the State of Illinois.

Section 7.0
REFERENCES

de Haas, David, and others, “Greenhouse Gas Inventories from WWTPs – The Trade-off with Nutrient Removal”, 2008 Water Environment Federation Sustainability Conference.

Doorn, Michiel R. J., and others, Intergovernmental Panel on Climate Change IPCC), “Guidelines for National Greenhouse Gas Inventories”, Chapter 6: Wastewater Treatment and Discharge, 2006; Report available at: http://www.ipcc.ch/ipccreports/methodology-reports.htm.

Environmental Protection Agency (EPA), “Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2006”, Chapter 8: Waste; Complete report available at: http://www.epa.gov/climatechange/emissions/usinventoryreport.html.

Forster, Piers, and others, Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Repot (2007), Working Group I Report "The Physical Science Basis", Chapter 2: Changes in Atmospheric Constituents and in Radiative Forcing, 2007; Report available at: http://www.ipcc.ch/ipccreports/assessments-reports.htm.

Intergovernmental Panel on Climate Change (IPCC), “Climate Change 2001: The Scientific Basis”; Report available at: http://www.ipcc.ch/ipccreports/assessments-reports.htm.

Monteith, Hugh and others, “Achieving Stringent Effluent Limits Takes A Lot of Energy”, WEFTEC 2007.

Zenz, David R., Ph. D., P.E., Consoer Townsend Envirodyne Engineers, Inc., “Technical Feasibility and Cost to Meet Nutrient Standards in the State of Illinois”, 2003.

APPENDIX A

SURVEY FORM

SYMBIONT

6737 West Washington Street
Suite 3440
West Allis, Wisconsin 53214

414 291 8840
Fax 414 291 8841
www.symbiontonline.com

IAWA Carbon Footprint Report
Survey

IAWA has contracted with Symbiont to help determine the potential carbon footprint implications associated with advanced wastewater treatment. The purpose of this survey is to gather information from the IAWA membership that would be helpful to this study. Your assistance with completing this survey is greatly appreciated. It is not our intent to overburden you with gathering this data. Please only provide the data that is readily available. If you do not have some of the data, please complete what you can and return as soon as possible but no later than August 19, 2008.

If you have any questions, please contact either Brandon Koltz or Jon Butt of Symbiont (414-291-8840).

Plant Name/Location: ___________________________

Contact Name/Phone Number: ___________________

Plant Information

Average Flow Rate (MGD): _______________
Design Flow Rate (MDG): _______________

	Permit (indicate units)	Average Plant Performance (indicate units)
BOD		
TSS		
Ammonia		
TN		
TP		

Process: Please check all that apply

Activated Sludge Non-nitrifying ________
Single Stage Nitrification ________
2-Stage Nitrification ________
BNR ________
Trickling Filter ________
Oxidation Ditch ________
SBR ________
Filtration (Sand or cloth) ________
Other ________

(If other is selected, please write the process(es) used):

Approximate Annual Amounts of Chemical Used (Please indicate units):

Ferric Chloride	_______/year
Other Ferric or Ferrous Salt	_______/year
Alum	_______/year
Polymer	_______/year

Solids Treatment (check all that apply)

Aerobic Digestion	_________
Anaerobic Digestion	_________
Centrifuge Dewatering	_________
Belt Filter Press Dewatering	_________
Other Means of Watering	_________
Compost	_________
Landfill Disposal	_________
Land Application	_________
Mine Site Reclamation	_________
Commercial Distribution	_________
Advanced Solids Disposal	_________

If using an advanced procedure, please indicate procedure being used:

<u>Power Information</u>

(Note: As a result of the deregulated electric market in The State of Illinois, which allows you to purchase power from any of the non-residential Electric Suppliers listed by the Illinois Commerce Commission, it is important that you identify the utility that provides your energy).

Name of Electric Utility: ______________________________

Approximate Power Cost
($/KwH or other): ______________________________

Average Electric usage (per year): __________/year

Average Natural gas usage
(therms/yr or mmcf/yr): __________/year

Average Fuel (diesel or fuel oil) (gallons/year): __________/year

Source of Utility Power Production: Check all that apply, if known

Coal Burning	________
Natural Gas Burning	________
Nuclear	________
Wind	________
Solar	________
Other	________

APPENDIX B

SURVEY RESULTS

Plant Information			Plant 1	Plant 2	Plant 3	Plant 4
Plant Name			Southeast WWTP -- Bloomington Normal Water Reclamation District	West WWTP -- Bloomington Normal Water Reclamation District	Fox River water Reclamation District	Danville Sanitary District
Plant Location			Heyworth, Illinois	Bloomington, IL	Elgin, IL	Danville, IL
Contact Name			Adam Lanning	Adam Lanning	Rick Manner or Jack Russell	Jerry Connolly
Phone Number			(309) 827-4396	(309) 827-4396	(847) 742-2068	(217) 442-3193
Parameter		**Units**				
Average Flow Rate		MGD	4.52	17.6	28	8.0
Design Flow Rate		MGD	7.5	21.5	37.75	16.0
BOD	Permit	mg/L	10	10	13	10
	Average Plant Performance	mg/L	2.65	4.3	2.5	3
TSS	Permit	mg/L	12	12	16	12
	Average Plant Performance	mg/L	1.49	3.7	4.5	3
Ammonia	Permit	mg/L	1.6	1.5	1.5	1.5
	Average Plant Performance	mg/L	0.14	0.42	0.14	0.08
TN	Permit	mg/L	N/A	N/A	N/A	N/A
	Average Plant Performance	mg/L	N/A	N/A	22.5	N/A
TP	Permit	mg/L	N/A	N/A	N/A	N/A
	Average Plant Performance	mg/L	N/A	N/A	3.6	3.6
Process (Check all that apply)						
Activated Sludge Non-nitrifying						
Single Stage Nitrification			X	X	X	X
2-Stage Nitrification						
BNR						
Trickling Filter				X		
Oxidation Ditch						
SBR						
Filtration (Sand or Cloth)			X	X		
Other			X	X		X
Annual Chemical Usage		**Units**				
Ferric Chloride		lbs				
Other Ferric or Ferrous Salt		lbs			320,000	
Alum						
Polymer		lbs		13,200	100,000	
Polymer		gal				
Solids Treatment (Check all that apply)						
Aerobic Digestion						
Anaerobic Digestion			X	X	X	X
Centrifuge Dewatering						
Belt Filter Press Dewatering			X	X	X	
Other Means of Dewatering			X	X	X	X
Compost						
Landfill Disposal					X	
Land Application			X	X	X	X
Mine Site Reclamation						
Commercial Distribution						
Advance Solids Disposal						
Other						

Plant Information		Plant 1	Plant 2	Plant 3	Plant 4
Plant Name		Southeast WWTP -- Bloomington Normal Water Reclamation District	West WWTP -- Bloomington Normal Water Reclamation District	Fox River water Reclamation District	Danville Sanitary District
Plant Location		Heyworth, Illinois	Bloomington, IL	Elgin, IL	Danville, IL
Power Information	**Units**				
Electric Utility		Corn Belt Energy	Constellation New Energy	Exelon	Ameren
Power Cost	$/kwh	$0.08315	$0.06848	$0.08	$0.10
Average Electric Usage	kwh/year	3,335,000	7,068,000	10,800,000	6,000,000
Average Natural Gas Usage	therms/yr	72,464	42,910	130,000	62,000
Avg Fuel Use (Diesel/FuelOil)	gallons/year		12,300		
Average Fuel Use (Gasoline)	gallons/year				
Power Production (Check all that apply)					
Coal Burning		X	X		X
Natural Gas Burning		X			X
Nuclear		X	X	X	X
Wind		X			
Solar					
Other		X			
Notes:		Reported multiple values for ammonia; Other Proces = UV Disinfection; Other Dewatering = GBT; Power Breakdown: Coal 58%, Natural Gas 2%, Nuclear 5%, Wind 3%, Petroleum Coke 12%, Purchased 28%	Permit limits for CBOD, not BOD; Reported multiple values for ammonia; Other Process = UV Disinfection; Other Dewatering = GBT, Sand drying beds, Concrete drying pads	Numbers are blended or totaled value for 3 plants; Other Ferric = Ferric Sulfate; Other Dewatering = Gravity Belts, Gravity Belt Thickeners (before Ana. Digestion); Landfill disposal is for grit only	Reported multiple values for ammonia; TP reported as PO4 as P; Other Process = Multimedia filter; Other Dewatering = Lagoon decanting

Plant Information			Plant 5	Plant 6	Plant 7	Plant 8
Plant Name			Downers Grove WWTC	Galesburg Sanitary District	Southwest Treatment Plant-- Urbana Champaign	Northeast Treatment Plant -- Urbana Champaign
Plant Location				Galesburg, IL	Champaign, IL	Urbana, IL
Contact Name			Nick Menninga	Harold Saline	Mike Little	Mike Little
Phone Number			(630) 969-0664	(309) 343-9087	(217) 367-3409 ext. 224	(217) 367-3409 ext. 224
Parameter		**Units**				
Average Flow Rate		MGD	10.3	7.6	6.5	14.6
Design Flow Rate		MGD	11	11.0	8.0	17.3
BOD	Permit	mg/L	10	17	10	10
	Average Plant Performance	mg/L	1.4	6.0	1.4	1.8
TSS	Permit	mg/L	12	15	12	12
	Average Plant Performance	mg/L	1	4.7	1.0	4.3
Ammonia	Permit	mg/L	1.5	1.4	1.5	1.5
	Average Plant Performance	mg/L	0.3	1.0	0.20	0.21
TN	Permit	mg/L	N/A	N/A	N/A	N/A
	Average Plant Performance	mg/L	N/A	N/A	10.5	16.11
TP	Permit	mg/L	N/A	N/A	1.0	N/A
	Average Plant Performance	mg/L	N/A	N/A	0.41	3.42
Process (Check all that apply)						
Activated Sludge Non-nitrifying					X	X
Single Stage Nitrification			X		X	X
2-Stage Nitrification						
BNR					X	
Trickling Filter				X	X	X
Oxidation Ditch						
SBR				X		
Filtration (Sand or Cloth)			X	X	X	X
Other						
Annual Chemical Usage		**Units**				
Ferric Chloride		lbs				
Other Ferric or Ferrous Salt		lbs				
Alum						
Polymer		lbs	13,500			
Polymer		gal			21,716	29,100
Solids Treatment (Check all that apply)						
Aerobic Digestion						
Anaerobic Digestion			X	X		X
Centrifuge Dewatering						X
Belt Filter Press Dewatering			X			
Other Means of Dewatering			X	X		
Compost						
Landfill Disposal				X		
Land Application			X	X		X
Mine Site Reclamation						X
Commercial Distribution						
Advance Solids Disposal						
Other					X	

Plant Information		Plant 5	Plant 6	Plant 7	Plant 8
Plant Name		Downers Grove WWTC	Galesburg Sanitary District	Southwest Treatment Plant-- Urbana Champaign	Northeast Treatment Plant -- Urbana Champaign
Plant Location			Galesburg, IL	Champaign, IL	Urbana, IL
Power Information	**Units**				
Electric Utility		ComEd	Ameren IP (Energy Provider - Constellation New Energy)	Integrys Energy Services	Integrys Energy Services
Power Cost	$/kwh	$0.08	$0.1178	$0.071	$0.072
Average Electric Usage	kwh/year	6,770,460	1,200,000	4,370,000	6,800,000
Average Natural Gas Usage	therms/yr	33,255	24,000	6,400	12,000
Avg Fuel Use (Diesel/FuelOil)	gallons/year				
Average Fuel Use (Gasoline)	gallons/year				
Power Production (Check all that apply)					
Coal Burning				X	X
Natural Gas Burning				X	X
Nuclear				X	X
Wind					
Solar					
Other				X	X
Notes:			Reported multiple values for BOD, TSS, and ammonia permit limits	Reported multiple values for ammonia; Reported polymer in gallons; All solids treatment is done at the Northeast Plant (TWAS trucked there daily)	Reported multiple values for ammonia; Reported polymer in gallons

Plant Information			Plant 9	Plant 10	Plant 11	Plant 12
Plant Name			Wheaton Sanitary District	Thorn Creek Basin Sanitary District	Princeton Municipal Wastewater Plant	North Shore Sanitary District – Clavey Road STP
Plant Location			Wheaton, IL			
Contact Name			Stephen R. Maney, Exec Dir	Jennifer Hindel	H. Scott Wallis	Sharon Thieszen
Phone Number			(630) 668-1515	(708) 754-0525 ext. 16	(815) 879-3961	(847) 623-6060
Parameter		**Units**				
Average Flow Rate		MGD	7.0	15.7	1.351	17.8
Design Flow Rate		MGD	8.9	16.0	2.150	28
BOD	Permit	mg/L	20	10	10	10
	Average Plant Performance	mg/L	1.1	3	3	2
TSS	Permit	mg/L	24	12	12	12
	Average Plant Performance	mg/L	2.5	3	6	1
Ammonia	Permit	mg/L	8.1	1.8	0.7	1.5
	Average Plant Performance	mg/L	0.79	0.4	0.425	0.05
TN	Permit	mg/L	N/A	N/A	N/A	N/A
	Average Plant Performance	mg/L	N/A	21	N/A	N/A
TP	Permit	mg/L	N/A	N/A	N/A	N/A
	Average Plant Performance	mg/L	N/A	N/A	N/A	N/A
Process (Check all that apply)						
Activated Sludge Non-nitrifying						
Single Stage Nitrification			X	X		
2-Stage Nitrification						X
BNR						
Trickling Filter			X			
Oxidation Ditch					X	
SBR						
Filtration (Sand or Cloth)			X	X		X
Other						X
Annual Chemical Usage		**Units**				
Ferric Chloride		lbs				
Other Ferric or Ferrous Salt		lbs				
Alum						
Polymer		lbs	16,000			52,000
Polymer		gal		350		
Solids Treatment (Check all that apply)						
Aerobic Digestion					X	
Anaerobic Digestion			X	X		X
Centrifuge Dewatering			X			
Belt Filter Press Dewatering						X
Other Means of Dewatering						X
Compost						
Landfill Disposal						X
Land Application			X	X	X	
Mine Site Reclamation						
Commercial Distribution						
Advance Solids Disposal						X
Other						

Plant Information		Plant 9	Plant 10	Plant 11	Plant 12
Plant Name		Wheaton Sanitary District	Thorn Creek Basin Sanitary District	Princeton Municipal Wastewater Plant	North Shore Sanitary District – Clavey Road STP
Plant Location		Wheaton, IL			
Power Information	**Units**				
Electric Utility		Midwest	MidAmerican Energy	Princeton Municipal Electric	ComEd (Sempra supplies generation)
Power Cost	$/kwh	$0.048	$0.08	$0.0820	$0.0767
Average Electric Usage	kwh/year	4,560,000	7,200,000	1,149,000	18,000,000
Average Natural Gas Usage	therms/yr	30,000	8,400		394,000
Avg Fuel Use (Diesel/FuelOil)	gallons/year	3,080	300	650	
Average Fuel Use (Gasoline)	gallons/year				
Power Production (Check all that apply)					
Coal Burning		X	X	X	X
Natural Gas Burning					X
Nuclear		X	X		X
Wind					
Solar					
Other					X
Notes:		Did not indicate fuel type (diesel or fuel oil)	Reported multiple values for ammonia; Did not indicate fuel type (diesel or fuel oil); Reported polymer in gallons	Power Cost $0.082 June-Oct, $0.076 Oct-June; Did not indicate fuel type (diesel or fuel oil)	Permit has monthly avg and daily max limits for BOD and TSS (monthly avg listed in this table); Ammonia has seasonal limits (lowest monthly average listed); Other process = UV Disinfection; Advanced Solids = Sludge drying followed by vitrification process to produce glass aggregate for beneficial reuse

Plant Information			Plant 13	Plant 14	Plant 15	Plant 16
Plant Name			North Shore Sanitary District -- Gurnee STP	North Shore Sanitary District -- Waukegan STP	Sanitary District of Decatur	Village of Deerfield, Wastewater Reclamation Facility
Plant Location			Gurnee, IL		Decatur, IL	Deerfield, IL
Contact Name			Sharon Thieszen	Sharon Thieszen	Tim Kluge	Frank Cisek, Superintendent
Phone Number			(847) 623-6060	(847) 623-6060	(217) 422-6931 ext. 214	(847) 719-7447
Parameter		**Units**				
Average Flow Rate		MGD	23.6	22.0	34	2.92
Design Flow Rate		MGD	47.2	44.0	41	3.5
BOD	Permit	mg/L	10	10	20	10
	Average Plant Performance	mg/L	2	2	2.8	2.3
TSS	Permit	mg/L	12	12	25	12
	Average Plant Performance	mg/L	1	2	5.5	5.48
Ammonia	Permit	mg/L	1.7	1.5	1.3	1.5
	Average Plant Performance	mg/L	0.05	0.05	0.21	0.33
TN	Permit	mg/L	N/A	N/A	N/A	N/A
	Average Plant Performance	mg/L	N/A	N/A	19.6	N/A
TP	Permit	mg/L	N/A	1	N/A	N/A
	Average Plant Performance	mg/L	N/A	N/A	12.8	N/A
Process (Check all that apply)						
Activated Sludge Non-nitrifying						
Single Stage Nitrification					X	X
2-Stage Nitrification			X	X		
BNR						
Trickling Filter						X
Oxidation Ditch						
SBR						
Filtration (Sand or Cloth)			X	X		
Other			X	X		
Annual Chemical Usage		**Units**				
Ferric Chloride		lbs		46,000		
Other Ferric or Ferrous Salt		lbs			400,000	
Alum						
Polymer		lbs	93,000	31,000	25,000	
Polymer		gal				
Solids Treatment (Check all that apply)						
Aerobic Digestion						X
Anaerobic Digestion					X	X
Centrifuge Dewatering						
Belt Filter Press Dewatering			X	X		
Other Means of Dewatering			X	X	X	X
Compost						
Landfill Disposal			X	X		
Land Application					X	X
Mine Site Reclamation						
Commercial Distribution						
Advance Solids Disposal			X	X		
Other						

Plant Information		Plant 13	Plant 14	Plant 15	Plant 16
Plant Name		North Shore Sanitary District -- Gurnee STP	North Shore Sanitary District -- Waukegan STP	Sanitary District of Decatur	Village of Deerfield, Wastewater Reclamation Facility
Plant Location		Gurnee, IL		Decatur, IL	Deerfield, IL
Power Information	**Units**				
Electric Utility		ComEd (Sempra supplies generation)	ComEd (Sempra supplies generation)	Constellation New Energy	
Power Cost	$/kwh	$0.0714	$0.0787	$0.066	
Average Electric Usage	kwh/year	22,200,000	17,400,000	1,320,000	
Average Natural Gas Usage	therms/yr	259,000	220,000	negligible	
Avg Fuel Use (Diesel/FuelOil)	gallons/year			50,000	
Average Fuel Use (Gasoline)	gallons/year				
Power Production (Check all that apply)					
Coal Burning		X	X		
Natural Gas Burning		X	X		
Nuclear		X	X		
Wind					
Solar					
Other		X	X		
Notes:		Permit has monthly avg and daily max limits for BOD and TSS (monthly avg listed in this table); Ammonia has seasonal limits (lowest monthly average listed); Other process = UV Disinfection; Advanced Solids = Sludge drying followed by vitrification process to produce glass aggregate for beneficial reuse	Permit has monthly avg and daily max limits for BOD and TSS (monthly avg listed in this table); Ammonia has seasonal limits (lowest monthly average listed); TP limit is daily max for excess flow to Lake MI; Other process = UV Disinfection; Advanced Solids = Sludge drying followed by vitrification process to produce glass aggregate for beneficial reuse	Permit limits for CBOD, not BOD; Reported multiple (seasonal) values for ammonia; Use Ferrous chloride; Other Dewatering = Lagoon dewatering; Did not indicate fuel type (diesel or fuel oil)	Permit has monthly avg and daily max limits for BOD and TSS (monthly avg listed in this table); Reported multiple values for ammonia; Other Dewatering = beds

Plant Information			Plant 17	Plant 18	Plant 19	Plant 20
Plant Name			Greater Peoria Sanitary District WWTP	North WWTP, Moline	South WWTP, Moline	City of LaSalle WWTP
Plant Location			Peoria, IL	Moline, IL	Moline, IL	LaSalle, IL
Contact Name			Stan Browning	Rob Barnard	Rob Barnard	Sam McNeilly
Phone Number			(309) 272-4800	(309) 736-5779	(309) 736-5779	(815) 228-3753
Parameter		**Units**				
Average Flow Rate		MGD	28.8	4.8	4.8	1.6
Design Flow Rate		MGD	37	5.5	9.0	3.33
BOD	Permit	mg/L	20	20	20	20
	Average Plant Performance	mg/L	9	5	11	4.0
TSS	Permit	mg/L	25	25	25	25
	Average Plant Performance	mg/L	8	6	12	6.4
Ammonia	Permit	mg/L	2.5	N/A	N/A	N/A
	Average Plant Performance	mg/L	1.1	N/A	7	N/A
TN	Permit	mg/L	N/A	N/A	N/A	N/A
	Average Plant Performance	mg/L	N/A	N/A	N/A	0.21
TP	Permit	mg/L	N/A	N/A	N/A	N/A
	Average Plant Performance	mg/L	N/A	N/A	N/A	1.52
Process (Check all that apply)						
Activated Sludge Non-nitrifying			X	X	X	X
Single Stage Nitrification			X			
2-Stage Nitrification						
BNR						
Trickling Filter						
Oxidation Ditch						
SBR						
Filtration (Sand or Cloth)						
Other					X	
Annual Chemical Usage		**Units**				
Ferric Chloride		lbs	92,400			
Other Ferric or Ferrous Salt		lbs				
Alum						
Polymer		lbs	366,600			
Polymer		gal				
Solids Treatment (Check all that apply)						
Aerobic Digestion						X
Anaerobic Digestion			X		X	X
Centrifuge Dewatering			X			
Belt Filter Press Dewatering				X	X	
Other Means of Dewatering			X			X
Compost						
Landfill Disposal			X	X	X	
Land Application			X			
Mine Site Reclamation						
Commercial Distribution						
Advance Solids Disposal						
Other						

Plant Information		Plant 17	Plant 18	Plant 19	Plant 20
Plant Name		Greater Peoria Sanitary District WWTP	North WWTP, Moline	South WWTP, Moline	City of LaSalle WWTP
Plant Location		Peoria, IL	Moline, IL	Moline, IL	LaSalle, IL
Power Information	**Units**				
Electric Utility		Ameren Energy Marketing/Ameren CILCO Dist.	Mid American Energy	Mid American Energy	Ameren
Power Cost	$/kwh	$0.063	$0.053	$0.053	$0.09
Average Electric Usage	kwh/year	16,200,000	2,098,113	2,345,283	868,800
Average Natural Gas Usage	therms/yr	141,000	50,150	15,150	14,392
Avg Fuel Use (Diesel/FuelOil)	gallons/year				
Average Fuel Use (Gasoline)	gallons/year				
Power Production (Check all that apply)					
Coal Burning		X	X	X	X
Natural Gas Burning		X	X	X	
Nuclear			X	X	X
Wind					
Solar					
Other		X			
Notes:		Permit limits for CBOD, not BOD; Reported multiple values for ammonia; Use Ferrous chloride; Other Dewatering = drying lagoons; Power Breakdown: Coal 64%, Natural Gas 29%, Other 7%	Reported multiple values for BOD and TSS	Reported multiple values for BOD and TSS; Other Process = RBC	Reported multiple values for BOD and TSS; Other Dewatering = Sludge drying beds and sludge storage lagoons

Plant Information			Plant 21	Plant 22	Plant 23	Plant 24
Plant Name			Springbrook Water Reclamation Center	Rochelle	Stickney WRP	North Side WRP
Plant Location			Naperville, IL	Rochelle, IL	Cicero, IL	Skokie, IL
Contact Name			Allan Poole, Director of Public Utilities	Kathy Cooper	Reed Dring	Sergio Serafino
Phone Number			(630) 420-6131	(815) 561-2061	(708) 588-4003	(847) 568-8312
Parameter		**Units**				
Average Flow Rate		MGD	22.00	2.40	732	241
Design Flow Rate		MGD	26.25	4.87	1200	333
BOD	Permit	mg/L	10	10	10	10
	Average Plant Performance	mg/L	2.0	2.4	3	2
TSS	Permit	mg/L	12	12	12	12
	Average Plant Performance	mg/L	2	1.4	6	6
Ammonia	Permit	mg/L	1.4	1.2	2.5	2.5
	Average Plant Performance	mg/L	0.4	0.3	0.62	0.49
TN	Permit	mg/L	N/A	N/A	N/A	N/A
	Average Plant Performance	mg/L	12.5	N/A	N/A	N/A
TP	Permit	mg/L	N/A	N/A	N/A	N/A
	Average Plant Performance	mg/L	3.4	N/A	N/A	N/A
Process (Check all that apply)						
Activated Sludge Non-nitrifying						
Single Stage Nitrification			X	X	X	X
2-Stage Nitrification						
BNR						
Trickling Filter						
Oxidation Ditch						
SBR						
Filtration (Sand or Cloth)			X			
Other						
Annual Chemical Usage		**Units**				
Ferric Chloride		lbs				
Other Ferric or Ferrous Salt		lbs				
Alum						
Polymer		lbs	180,000	40,000		
Polymer		gal			7,000,000	
Solids Treatment (Check all that apply)						
Aerobic Digestion			X			
Anaerobic Digestion					X	
Centrifuge Dewatering			X	X	X	
Belt Filter Press Dewatering						
Other Means of Dewatering					X	
Compost						
Landfill Disposal				X	X	
Land Application			X		X	
Mine Site Reclamation						
Commercial Distribution					X	
Advance Solids Disposal						
Other						

Plant Information		Plant 21	Plant 22	Plant 23	Plant 24
Plant Name		Springbrook Water Reclamation Center	Rochelle	Stickney WRP	North Side WRP
Plant Location		Naperville, IL	Rochelle, IL	Cicero, IL	Skokie, IL
Power Information	**Units**				
Electric Utility		City of Naperville, Department of Public Utilities - Electric	Rochelle Utility	Peoples Energy	Peoples Energy
Power Cost	$/kwh	$0.0728	$0.06	$0.065	$0.070
Average Electric Usage	kwh/year	19,000,000	2,400,000	282,000,000	65,100,000
Average Natural Gas Usage	therms/yr			707,000	383,200
Avg Fuel Use (Diesel/FuelOil)	gallons/year			20,500	300
Average Fuel Use (Gasoline)	gallons/year				
Power Production (Check all that apply)					
Coal Burning		X	X	X	X
Natural Gas Burning		X	X		
Nuclear		X	X	X	X
Wind		X			
Solar					
Other					
Notes:			Reported multiple values for BOD and TSS	Reported seasonal limits for Ammonia (2.5/4.0 mg/L); Polymer = Mannic; Solids Treatment includes: Sludge Concentration Tanks, Off Site Sludge Lagoons, Off Site Sludge Drying Cells; Did not specificy whether fuel use was diesel or fuel oil	Reported seasonal limits for Ammonia (2.5/4.0 mg/L); Did not specificy whether fuel use was diesel or fuel oil

Plant Information			Plant 25	Plant 26	Plant 27	Plant 28
Plant Name			Calumet WRP	Kirie WRP	Hanover Park WRP	Egan WRP
Plant Location			Chicago, IL	Des Plaines, IL	Hanover Park, IL	Schaumburg, IL
Contact Name			Brian Perkovich	Mary Moscinski	John Lazicki	Sanjay Patel
Phone Number			(773) 256-3509	(847) 375-2501	(630) 736-4210	(847) 584-5401
Parameter		**Units**				
Average Flow Rate		MGD	273	36.38	8.40	26.8
Design Flow Rate		MGD	354	52	12	30
BOD	Permit	mg/L	10	4	10	10
	Average Plant Performance	mg/L	2	2	2	2
TSS	Permit	mg/L	15	5	12	12
	Average Plant Performance	mg/L	5	3	2	2
Ammonia	Permit	mg/L	2.5	1.6	1.5	1.5
	Average Plant Performance	mg/L	0.15	0.35	0.23	0.07
TN	Permit	mg/L	N/A	N/A	N/A	N/A
	Average Plant Performance	mg/L	N/A	N/A	N/A	N/A
TP	Permit	mg/L	N/A	N/A	N/A	N/A
	Average Plant Performance	mg/L	N/A	N/A	N/A	N/A
Process (Check all that apply)						
Activated Sludge Non-nitrifying						
Single Stage Nitrification			X	X	X	X
2-Stage Nitrification				X		
BNR						
Trickling Filter						
Oxidation Ditch						
SBR						
Filtration (Sand or Cloth)				X	X	X
Other						
Annual Chemical Usage		**Units**				
Ferric Chloride		lbs	1,000,000			3,260,000
Other Ferric or Ferrous Salt		lbs				
Alum						
Polymer		lbs				4,050,000
Polymer		gal	5,200,000		1,300	
Solids Treatment (Check all that apply)						
Aerobic Digestion						
Anaerobic Digestion			X		X	X
Centrifuge Dewatering			X			X
Belt Filter Press Dewatering					X	X
Other Means of Dewatering			X		X	
Compost						
Landfill Disposal			X			X
Land Application			X		X	X
Mine Site Reclamation						
Commercial Distribution			X			
Advance Solids Disposal						
Other						

Plant Information		Plant 25	Plant 26	Plant 27	Plant 28
Plant Name		Calumet WRP	Kirie WRP	Hanover Park WRP	Egan WRP
Plant Location		Chicago, IL	Des Plaines, IL	Hanover Park, IL	Schaumburg, IL
Power Information	**Units**				
Electric Utility		Peoples Energy	Peoples Energy	Peoples Energy	Peoples Energy
Power Cost	$/kwh	$0.075	$0.074	$0.077	$0.074
Average Electric Usage	kwh/year	113,700,000	28,800,000	6,000,000	20,500,000
Average Natural Gas Usage	therms/yr	170,000	176,000	130,000	409,000
Avg Fuel Use (Diesel/FuelOil)	gallons/year	23,000			
Average Fuel Use (Gasoline)	gallons/year	40,000			
Power Production (Check all that apply)					
Coal Burning		X	X	X	X
Natural Gas Burning					
Nuclear		X	X	X	X
Wind					
Solar					
Other					
Notes:		Reported seasonal limits for Ammonia (2.5/4.0 mg/L); Ferric Chloride = 500 DT/year; Solids Treatment includes: Sludge Concentration Tanks, Sludge Lagoons, Drying Cells	Reported seasonal limits for Ammonia (2.1/1.6/4.0 mg/L)	Reported seasonal limits for Ammonia (1.5/3.9/2.9 mg/L); Sand Filtration; more than 1300 gallons of emulsion polymer; Solids Treatment includes: Sludge Lagoons	Reported seasonal limits for Ammonia (1.5/3.6/2.3 mg/L); Ferric Chloride = 440 DT/year for dewatering plus 1,190 Dt/year for phosphorus removal study

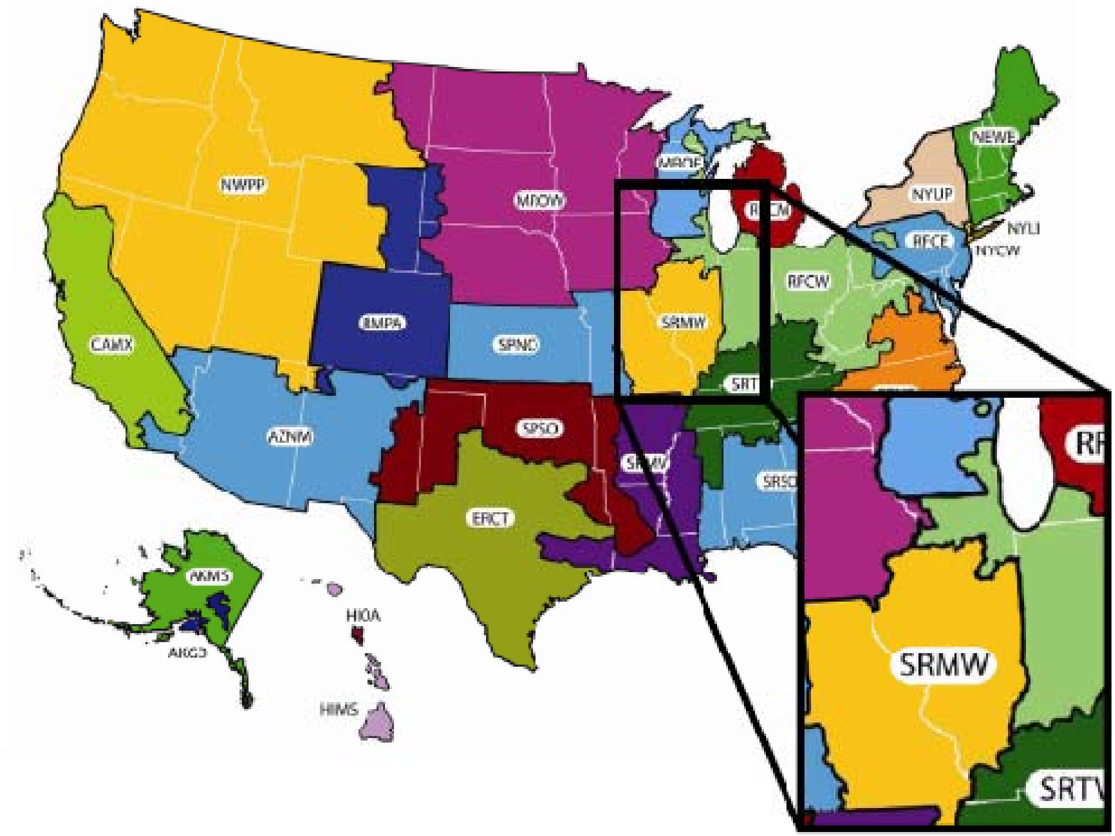
Plant Information			Plant 29	Summary		
Plant Name			Lemont WRP			
Plant Location			Lemont, IL			
Contact Name			Brian Perkovich	Total Number of Plants Responding		Total Number of Respondents
Phone Number			(773) 256-3509	29		18
Parameter		**Units**		**Average**	**Units**	**Total Number of Plants**
Average Flow Rate		MGD	2.72	55.4	MGD	**w/ permit requirement**
Design Flow Rate		MGD	2.3	82.4	MGD	
BOD	Permit	mg/L	20	12.6	mg/L	29
	Average Plant Performance	mg/L	4	3.2	mg/L	
TSS	Permit	mg/L	25	15.2	mg/L	29
	Average Plant Performance	mg/L	7	4.0	mg/L	
Ammonia	Permit	mg/L	N/A	1.9	mg/L	25
	Average Plant Performance	mg/L	N/A	0.6	mg/L	
TN	Permit	mg/L	N/A	N/A	mg/L	0
	Average Plant Performance	mg/L	N/A	14.6	mg/L	
TP	Permit	mg/L	N/A	1.0	mg/L	2
	Average Plant Performance	mg/L	N/A	4.1	mg/L	
Process (Check all that apply)				**Total Number of Plants**		
Activated Sludge Non-nitrifying			X	7		
Single Stage Nitrification				20		
2-Stage Nitrification				4		
BNR				1		
Trickling Filter				6		
Oxidation Ditch				1		
SBR				1		
Filtration (Sand or Cloth)				15		**Total Number of Plants**
Other				7		**Reporting Chemical**
Annual Chemical Usage		**Units**		**Average**	**Units**	**Usage by Type**
Ferric Chloride		lbs		1,099,600	lbs	4
Other Ferric or Ferrous Salt		lbs		360,000	lbs	2
Alum				N/A		0
Polymer		lbs		415,025	lbs	12
Polymer		gal		2,042,078	gal	6
Solids Treatment (Check all that apply)				**Total Number of Plants**		
Aerobic Digestion				4		
Anaerobic Digestion				19		
Centrifuge Dewatering				8		
Belt Filter Press Dewatering				11		
Other Means of Dewatering				16		
Compost				0		
Landfill Disposal				12		
Land Application				18		
Mine Site Reclamation				1		
Commercial Distribution				2		
Advance Solids Disposal				3		
Other				1		

Plant Information		Plant 29	Summary		
Plant Name		Lemont WRP			
Plant Location		Lemont, IL			
Power Information	**Units**		**Average**	**Units**	**Total Number of Plants Reporting Power Usage by Type**
Electric Utility		Peoples Energy			
Power Cost	$/kwh	$0.073	0.074	$/kwh	
Average Electric Usage	kwh/year	2,600,000	24,278,023	kwh/year	28
Average Natural Gas Usage	therms/yr	23,968	146,429	therms/yr	24
Avg Fuel Use (Diesel/FuelOil)	gallons/year		13,766	gallons/year	8
Average Fuel Use (Gasoline)	gallons/year		40,000	gallons/year	1
Power Production (Check all that apply)			**Total Number of Plants**		**Total Number of Plants Listing Production**
Coal Burning		X	24		
Natural Gas Burning			12		25
Nuclear		X	23		
Wind			2		
Solar			0		
Other			7		
Notes:					

APPENDIX C

eGRID SUBREGION MAP

EPA's eGRID Subregion Map



Subregion Name	Abbreviation	Year 2004 Emission Rates		
		lbs CO_2/MWh	lbs CH_4/MWh	lbs N_2O/MWh
RFC West	RFCW	1,556.39	0.0196	0.0244
SERC Midwest	SRMW	1,844.34	0.0214	0.0288

Source: EPA Climate Leaders Greenhouse Gas Inventory Protocol Core Module Guidance: Indirect Emissions from Purchases/Sales of Electricity and Steam, June 2008.