2022 UPDATE
Greenhouse Gas Action Plan

Prepared for
Washington Suburban Sanitary Commission

Prepared by
Jacobs

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Executive Summary

Background

Washington Suburban Sanitary Commission (WSSC) Water provides water and wastewater service to an estimated 1.9 million residents in Maryland's Montgomery and Prince George's counties. WSSC owns and operates two water filtration plants (WFPs), five water resource recovery facilities (WRRFs), more than 5,800 miles of freshwater pipeline, and more than 5,600 miles of sewer pipeline.

In 2010, the State of Maryland and the Metropolitan Washington Council of Governments (which includes both Montgomery and Prince George's counties) have adopted a greenhouse gas (GHG) emission reduction goal to achieve a 10 percent reduction in emissions every 5 years through 2050, for a total reduction of 80 percent below the baseline year of 2005. Starting in 2011, WSSC has adopted this same goal, in alignment with the jurisdictions it serves.

WSSC has developed inventories of annual GHG emissions for all Commission operations for the calendar years (CY) 2005 through 2022. The inventories quantify the GHG emissions that result from the energy-intensive processes required to treat and distribute potable water for public use and to collect and treat wastewater before discharge. Accounting protocols published by The Climate Registry, the Intergovernmental Panel on Climate Change (IPCC), and the International Council for Local Environmental Initiatives, are used to complete the inventory with the most recently updated methodology and emissions factors. Methodologies are described in detail in WSSC's GHG Inventory Development and Management Plan (2021). Based on the inventory results, a 40-year plan of action was developed with strategies to reduce future GHG emissions at WSSC by 10 percent every 5 years through the year 2050 (80 percent reduction by 2050), using demonstrated technologies and practices available at the present time. In November 2012, CH2M HILL, Inc., now Jacobs, and Shah & Associates prepared the *Greenhouse Gas Action Plan*, which summarized the findings of the inventory and outlined the proposed GHG emission reduction strategies to meet an initial reduction goal by 2030. The report also provided future considerations for additional strategies to meet the ultimate goal by 2050.

The 2012 report and supporting information have been evaluated and updated annually since 2012 to reflect current operations, projects, inventory data and to track progress against the plan and updated the action strategies. The previous updates include the following:

- *2013 Update to the Greenhouse Gas Action Plan*, dated December 2014, included the inventory data from CY2012 and CY2013.
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- *2020 Update to the Greenhouse Gas Action Plan*, dated June 2021, included the inventory data from CY2020.
- *2021 Update to the Greenhouse Gas Action Plan*, dated June 2022, included the inventory data from CY2021.

This report (dated June 2023) constitutes the 2022 update to the GHG Action Plan and includes the following:

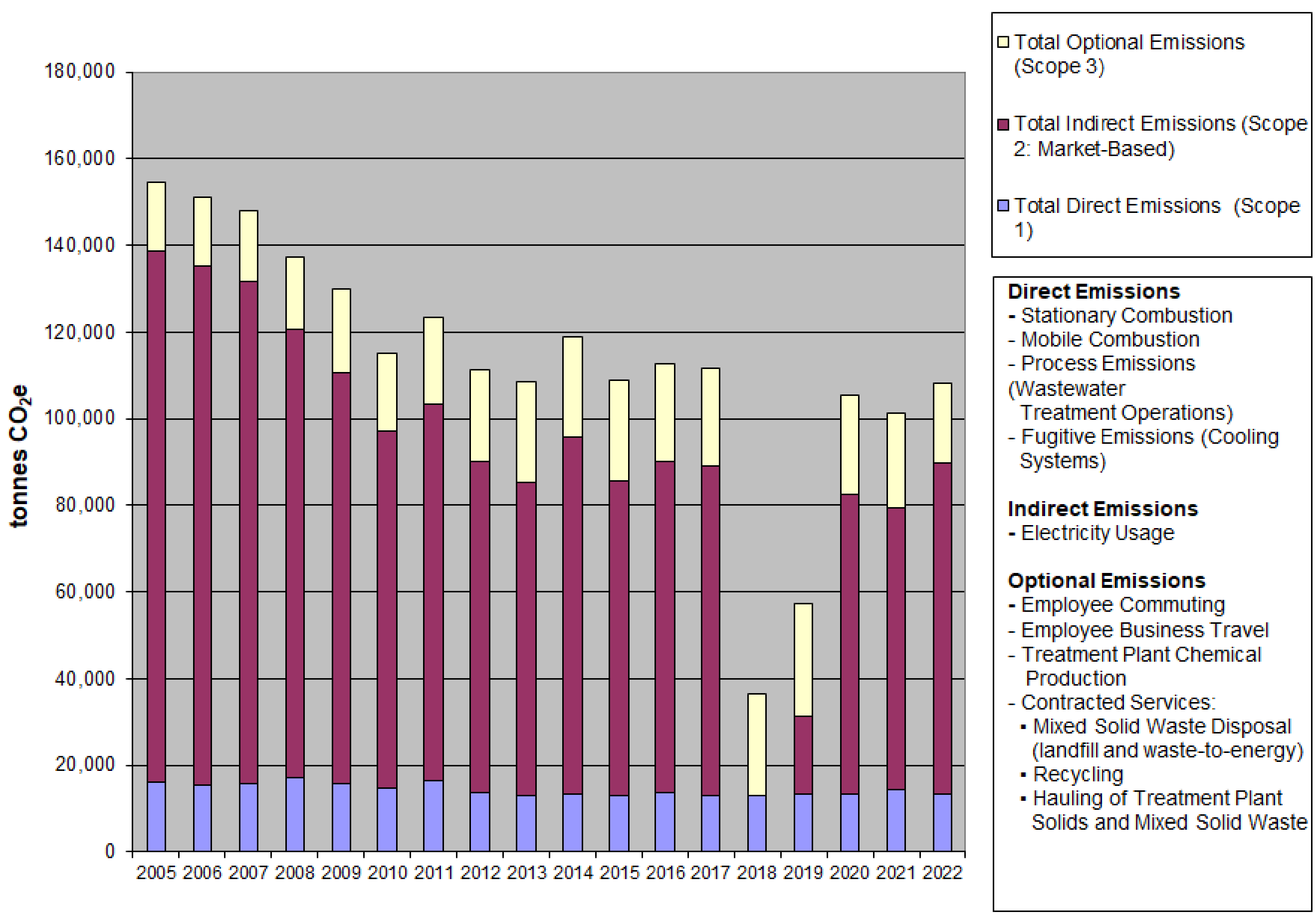
- Revised GHG inventory summary that includes CY2022 and adjusted Scope 1 emissions for all inventory years per the latest revisions to the IPCC (2019) and Global Protocol for Community Scale GHG Inventories from GHG Protocol (2021) protocols, which included updated methodologies for estimating GHG emissions from wastewater treatment processes. See Appendix A for further information.
- Summary of completed, in-progress, and new planned projects at WSSC that will impact the GHG inventory.
- Projected annual emissions through the year 2035, which are compared to the original WSSC GHG reduction goal (10 percent reduction every 5 years).
- Validation of the emission reduction strategies listed in the 2012 GHG Action Plan and annual updates through 2022 in terms of practicality, timing, GHG reduction potential and cost.

GHG Inventory Summary

The inventories include emissions from Scope 1, Scope 2, and Scope 3 sources. Scope 1 emissions, or **direct emissions**, result from sources or processes owned and/or controlled by WSSC. Scope 2, ***indirect*** emissions, result from electricity purchases. Scope 3, ***other indirect*** emissions are from relevant outsourced or non-owned/controlled activities (for example, biosolids hauling, chemical manufacturing, and business travel). A graphical representation of the annual GHG emission totals (including Scope 1, Scope 2, and Scope 3 emissions) is presented on Figure ES-1.

In 2008, WSSC began a direct purchase of wind-generated electrical power. This resulted in an avoidance of Scope 2 emissions (resulting from electricity purchases) and a net reduction in GHG emissions. In 2018, WSSC purchased Renewable Energy Credits (RECs) to offset all the Scope 2 indirect emissions.

FIGURE ES-1
Summary of Annual GHG Net Emissions by Source Category and Calendar Year



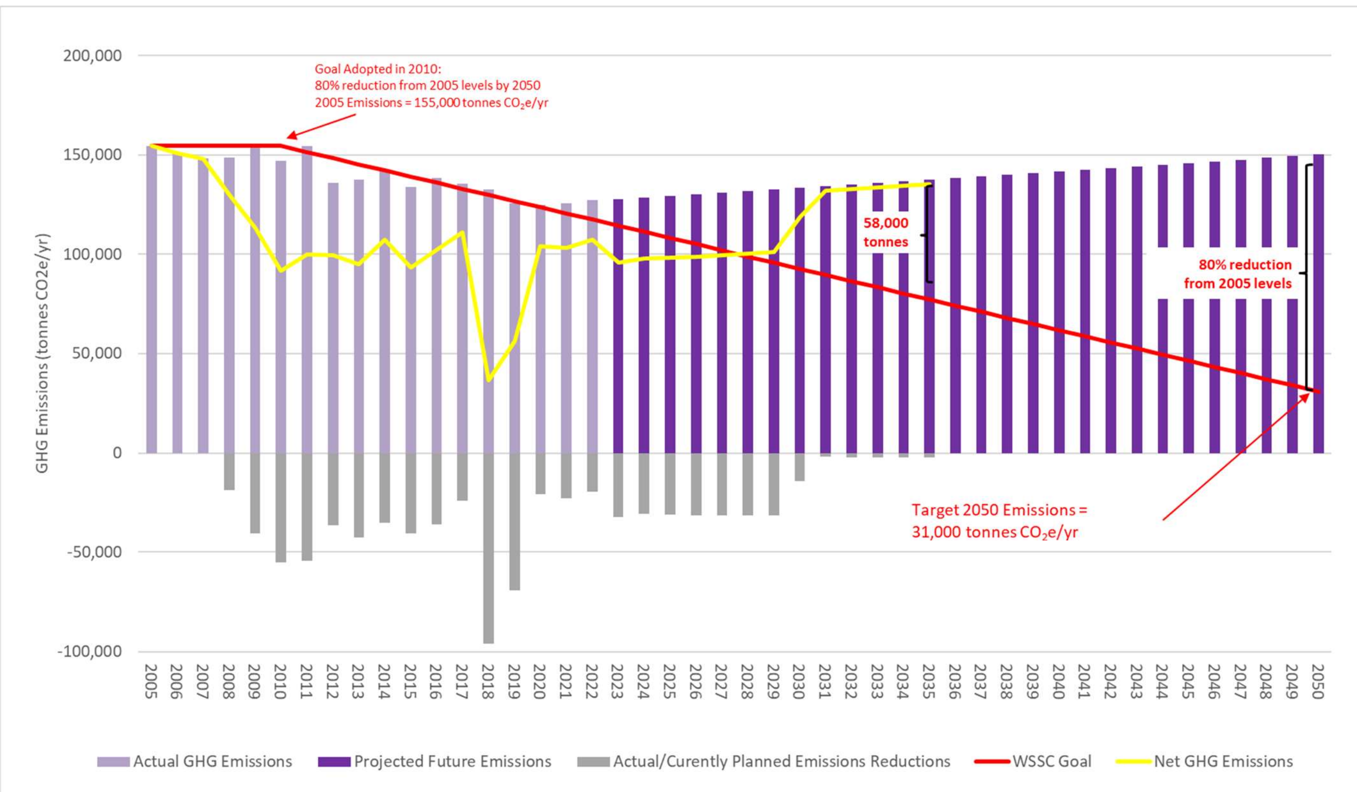
GHG Emissions Projections

Based on the results of the GHG inventory and the completed, in-progress, and planned projects at WSSC, projected annual emissions were developed and compared to the 2035 GHG reduction goal. The inventory results were used as the baseline from which the future GHG emissions could be projected. Future GHG emissions at WSSC will be mainly affected by the following factors:

- Population growth in the service area that will increase the demand for potable water and the resulting wastewater flows.
- Regulatory drivers that require process upgrades in order to meet more advanced levels of treatment.
- Implementation of renewable energy programs such as wind, solar, and biogas (anaerobic digestion and combined heat and power).

Figure ES-2 illustrates how the projected growth of GHG emissions compares to WSSC's current goal of 10 percent reduction every 5 years after 2010, and the impact of projects currently under implementation. The projection includes the purchase of RECs for 2022 and the 10-year wind contract that began June 1, 2020. The red line represents a reduction of 10 percent every 5 years (starting in 2010) based on the 2005 GHG emissions. The projection indicates that by 2035 WSSC would need to reduce annual emissions by 54,000 tonnes carbon dioxide equivalent (CO_2e), or 43 percent of the projected 2035 annual emissions, in order to meet the goal.

FIGURE ES-2
Projected Future Emissions due to Growth and Current Projects Compared Against GHG Reduction Goal



Emission Reduction Strategies

The GHG inventory results and the future emissions projections were used to develop strategies to reduce the GHG emissions and meet the reduction goal.

The following are the main focus areas of the GHG reduction strategies:

- Optimizing the efficiency of the water distribution system.
- Improving equipment efficiency for water and wastewater.

- Reducing residuals and optimizing processes.
- Reducing GHGs associated with vehicles and transportation.
- Optimizing building services (lighting and heating, ventilating, and air conditioning [HVAC]).
- Implementing renewable energy.

Table ES-1 summarizes the strategies developed, the projected GHG emissions reduction impact, and the estimated capital, annual, and life-cycle costs.

In 2022, the impact of the strategies was re-evaluated based on the latest emissions factors and updated information about each project. The changes are noted in the description of the strategies. Strategies that were removed from consideration or moved into implementation phase (actual projects) were removed from this table. New strategies were added due to a recent energy audit conducted at some of the WRRFs that resulted in proposed energy-reduction projects.

The annual cost and life-cycle cost for the strategies were updated to reflect the new implementation year. The unit cost of electricity used was $0.090 per kilowatt hour per the latest cost information from WSSC.

TABLE ES-1
Proposed Greenhouse Gas Reduction Strategies

No.	Strategy Name	Description	2035 GHG Reduction (tonnes CO_2e/yr)	Year Impl.	Capital Cost	Annual Cost (+) or Savings (-)	Life-cycle Cost[a] (through 2035)
Group 1 - System Efficiency – all strategies either implemented or removed from consideration							
Group 2 - Equipment Efficiency							
2.9	Potomac Main Zone Pump #1	Replace existing Pump #1 in the Main Zone pump station at Potomac WFP.	-410	2024	$795,000	-$87,500	-15,000
2.13	Aeration Efficiency at Parkway WRRF	Replace the existing process aeration blowers with more efficient units and implement electrical upgrades.	-280	2024	$1,000,000	-$54,000	$500,000
Group 3 - Residuals/Process							
3.3	Phosphorus Recovery at the Bioenergy Plant	Implement phosphorus recovery from the digested sludge flow stream. The process converts the phosphate to a commercial-grade fertilizer which then reduces WSSC's GHG footprint because it offsets GHGs produced in industrial fertilizer manufacture.	-1,500	2028	$2,100,000	-$15,000	$2,007,000
3.4	Green Carbon Sources for Denitrification	Replace methanol at WB and Piscataway with "green" sources of carbon such as MicroC-3000 for the denitrification process. Reduce GHGs in the production of methanol (Scope 3) and in the consumption of methanol in the process (Scope 1).	-3,900	Ongoing	$0	-$102,000	-$1,100,000
3.5	Recycling	Uniform recycling strategy (paper, cans, bottles, light bulbs). Assume a 10% reduction in GHGs associated with garbage landfilling and incineration.	-10	Ongoing	$0	$0	$0
3.6A	Increased Nutrient Removal Process Efficiency	Implement innovative ammonia-based aeration control to promote innovative nutrient removal processes (Nite/Denite) at Seneca and WB that can potentially reduce aeration by 20%.	-1,700	2023	$2,000,000	-$320,000	-$1,200,000
3.6B	Mainstream Anammox at Piscataway	Implement innovative biological nutrient removal process (mainstream Anammox or Nite/Denite) at Piscataway that can potentially reduce aeration by 20%.	-660	2028	$5,000,000	-$154,000	$4,200,000

TABLE ES-1
Proposed Greenhouse Gas Reduction Strategies

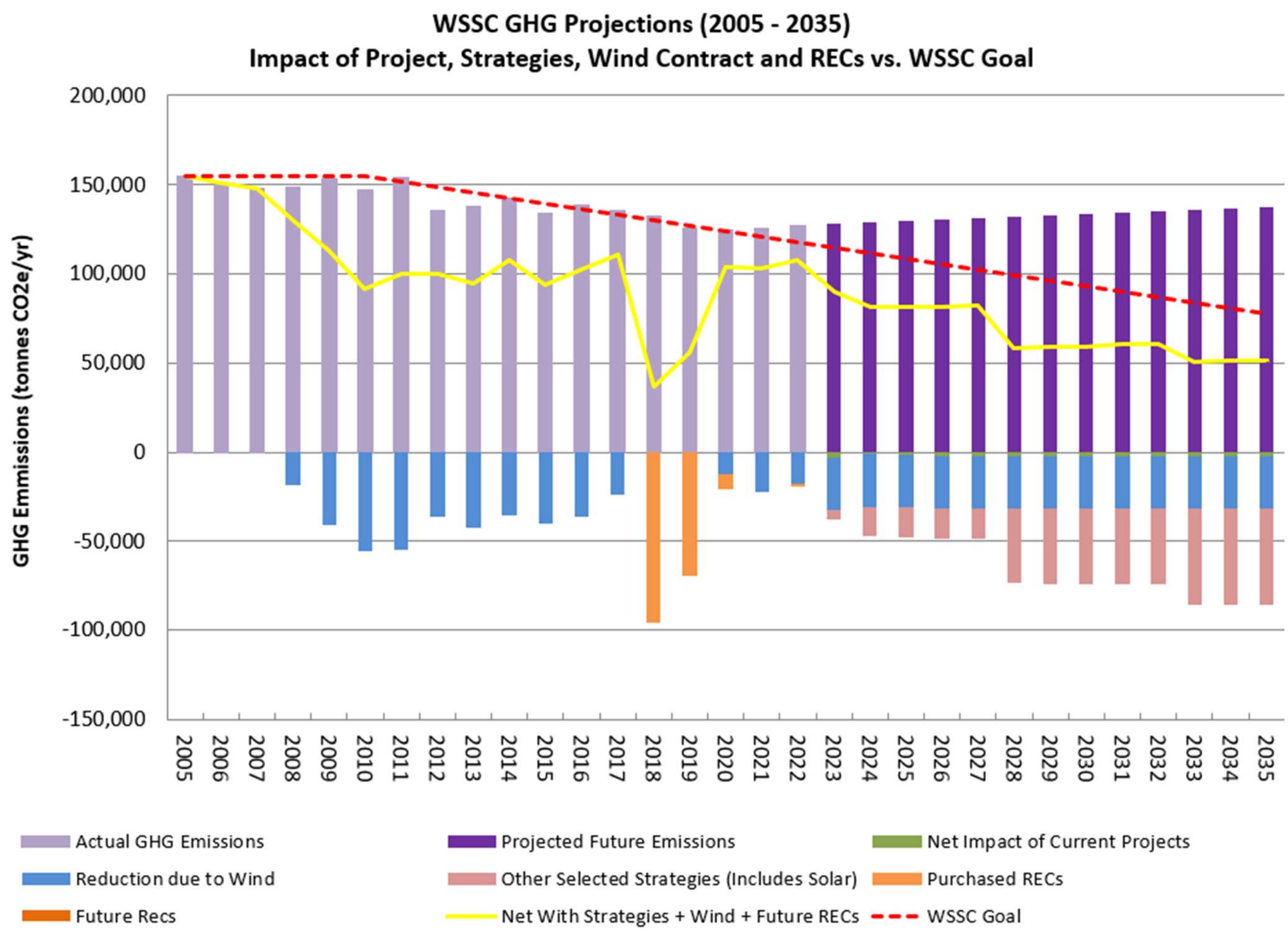
No.	Strategy Name	Description	2035 GHG Reduction (tonnes CO_2e/yr)	Year Impl.	Capital Cost	Annual Cost (+) or Savings (-)	Life-cycle Cost[a] (through 2035)
Group 4 – Transportation							
4.1	Electric Fuel Vehicle Purchase	Replacement of 5 fleet vehicles per year for a 4-year period (2025-2028) with electric fuel vehicles.	-30	2025	$280,000	-$10,900	$180,000
Group 5 - Lighting/HVAC							
5.7	Anacostia Depot Sewer Thermal	Implement sewer thermal technology to replace natural gas use for heating and electricity use for cooling at three building at Anacostia Depot: the Admin Building, Heavy Equipment Shop, and Warehouse.	-60	2026	$4,200,000	-$15,900[b]	Not available for all indicated projects.
Group 6 - Renewable Resources							
6.2	Additional Solar Installation (11.8 MW)	Construction of 11.8 MW solar facility. WSSC will own 100% of the environmental attributes (carbon offset) derived from projected generation of approximately 25,000 MWh/year.	-10,400	2024	$0	$0	$0
6.3	Wind Energy	Develop new 10-year electricity supply contract beyond June 1, 2030. Assumed 70,000 MWh/yr.	-29,000	2030	$0	$0	$0
6.4	Renewable Energy Purchase (WSSC Goal)	Purchase renewable energy (with RECs) to achieve WSSC reduction goal by 2035. Based on the projected completed for the CY2022 update, no REC purchases are projected to be necessary to meet the WSSC goal.	0	NA	$0	$0	$0
6.5	Potomac Carbon Recovery	Onsite carbon capture at Potomac WTP for future Microgrid system with offsite sequestration	-23,000	2028	$0	$700,000	$4,400,000
6.6	Piscataway Bioenergy Carbon Recovery	Convert CO_2 to methanol using electro catalytic process	-11,500	2033	$10,000,000	To be determined following planned pilot study.	

[a] Life-cycle cost calculated using a discount rate of 3%.
[b] Annual savings are based on estimated annual avoided fuel purchase. Potential income from RECs is not included.
MW = megawatt(s)
MWh = megawatt hour
TBD = to be determined
WB = Western Branch
WTP = Water Treatment Plant
yr = year

Impact of Selected Strategies

The strategies selected, in conjunction with renewed wind contract for roughly one-third of WSSC's electricity consumption, will result in a reduction of 83,000 tonnes of CO_2e in annual GHG emissions by the year 2035. Only a reduction of 58,000 tonnes CO2e is required to meet WSSC's goals in 2035. Thus, WSSC will be exceeding the reduction goal in all future years. Figure ES-3 identifies, in different categories, the impact of the renewed wind contract and the REC purchases (Strategies 6.3 and 6.4 listed in Table ES-1). All the other strategies combined are shown under the "Other Selected Strategies" category.

FIGURE ES-3
Projected Future Greenhouse Gas Emissions and Impact of Selected Strategies on WSSC Goal Attainment



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SECTION 1

Introduction

Washington Suburban Sanitary Commission (WSSC) Water provides water and wastewater service to an estimated 1.9 million residents in Maryland’s Montgomery and Prince George’s counties. WSSC owns and operates two water filtration plants (WFPs), five water resource recovery facilities (WRRFs), more than 5,800 miles of freshwater pipeline, and more than 5,600 miles of sewer pipeline.

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SECTION 2

GHG Inventory Summary

This section updates the GHG inventory summary that was included in Section 2 of the November 2012 *Greenhouse Gas Action Plan* (CH2M and Shah & Associates 2012).

The table and figure numbers in this document have been kept identical to those in Section 2 of the November 2012 GHG Action Plan document for ease of reference. They have been updated with the inventory results from 2012 through 2022. The annual inventories are available on the Energy Information System.

GHG Inventory Summary (2005 to 2022)

For the baseline year, 2005, WSSC operations produced a total of 154,528 tonnes carbon dioxide equivalent (CO_2e) in GHG emissions. Subsequent years (2006 through 2022) have seen a slight decrease in the GHG emissions at WSSC despite an increase in several aspects of operations, including wastewater treatment chemical use, energy use, and number of employees. To aid in achieving emissions reduction targets, in 2008, WSSC began a direct purchase of wind-generated electrical power. These purchases resulted in a net reduction in total GHG emissions in the inventories since the baseline year. In 2018, WSSC purchased Renewable Energy Credits (RECs) to offset all of their Scope 2 indirect emissions. A graphical representation of the annual GHG emission totals (including Scope 1, Scope 2, and Scope 3 emissions) is presented on Figure 2-1. Table 2-1 summarizes the net emissions totals by scope.

FIGURE 2-1
Summary of Annual GHG Net Emissions by Source Category and Calendar Year

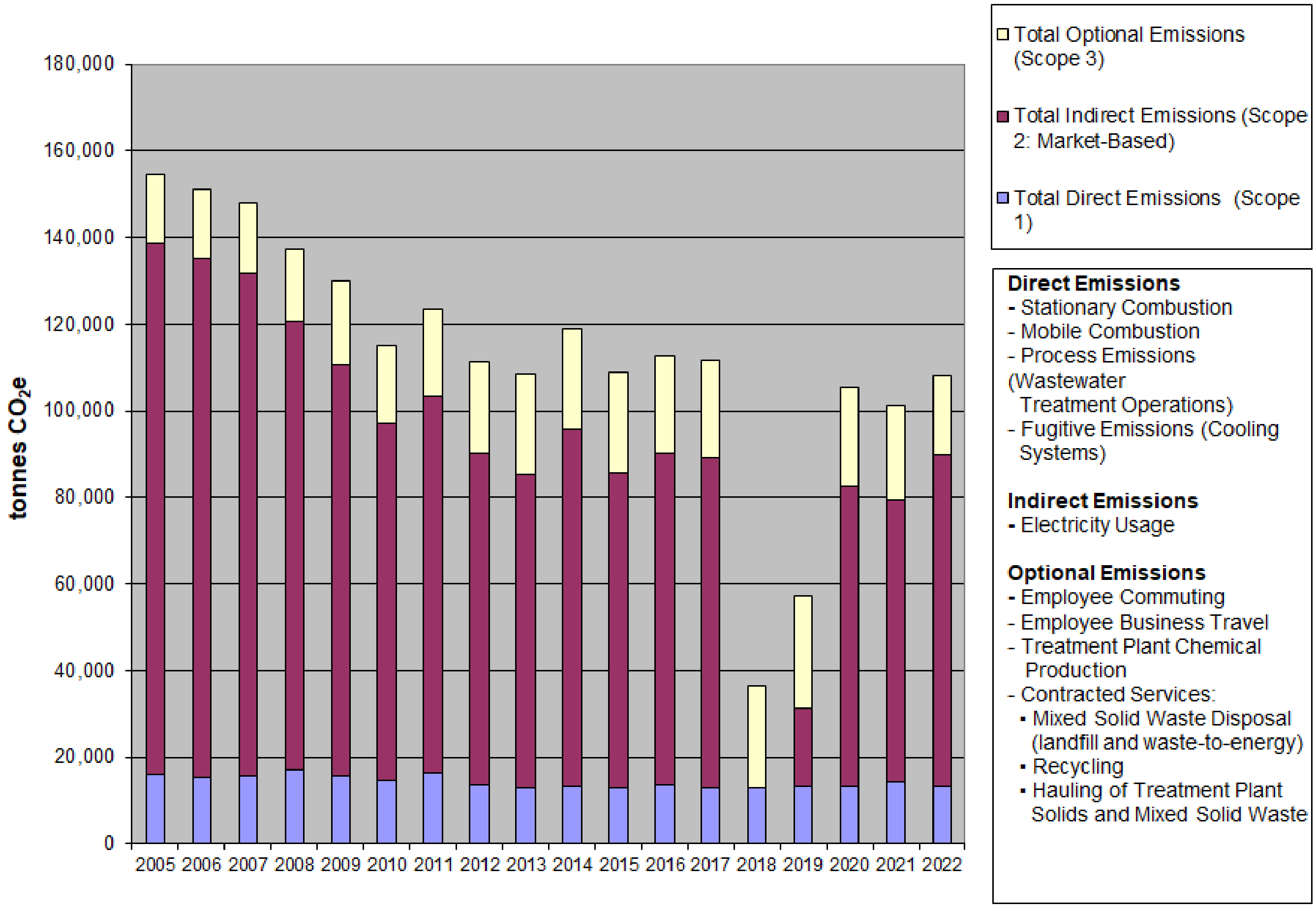


TABLE 2-1
Summary of Annual Greenhouse Gas Emissions by Scope and Calendar Year

Source	2005 (Baseline)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Direct Emissions - Scope 1 (tonnes CO_2e)	15,887	13,659	12,760	13,206	13,044	13,628	12,957	13,081	13,181	13,411	14,474	13,149
Indirect Emissions – Market-based Scope 2 (tonnes CO_2e)	122,673	100,870	101,572	106,364	97,534	102,029	100,413	96,003	86,212	88,381	89,481	98,801
Optional Emissions – Scope 3 (tonnes CO_2e)	17,506	22,864	24,866	24,703	25,009	24,327	23,886	25,195	28,007	24,798	23,274	20,233
Avoided Emissions (tonnes CO_2e) [a]	(1,538)	(26,056)	(30,533)	(25,434)	(26,643)	(27,139)	(25,737)	(97,747)	(70,103)	(19,293)	(26,124)	(23,860)
Total Net Entity-Wide GHG Emissions (tonnes CO_2e)	154,527	111,336	108,665	118,839	108,944	112,845	111,519	36,534	57,297	105,532	101,105	108,322

Source	2005 (Baseline)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Increase/Decrease from the Baseline (2005)	--	-28.0%	-29.7%	-23.1%	-29.5%	-27.0%	-27.8%	-76.4%	-62.9%	-31.7%	-34.6%	-29.9%
Reduction Goal	--	-14%	-16%	-18%	-20%	-22%	-24%	-26%	-28%	-30%	-32%	-34%

[a] Avoided emissions include inorganic fertilizer emissions avoidance due to land application of biosolids (Scope 3) and purchased RECs (Market-based Scope 2)

The annual results of each emissions category are detailed in the sections that follow.

Direct Emissions (Scope 1)

Scope 1 emissions, or direct emissions, result from sources, processes, or facilities owned and/or controlled by WSSC. The WSSC GHG inventory contains the following source categories for direct emissions: stationary combustion, mobile combustion, process-related, and fugitive (refrigerant usage).

Stationary Combustion Sources

Stationary source emissions result from combustion of fossil fuels in equipment such as boilers, heaters, generators, pumps, and incinerators in a fixed location. Table 2-2 summarizes the annual use of each fuel by type and the corresponding GHG emissions.

TABLE 2-2
Stationary Source Fuel Usage and Greenhouse Gas Emissions by Calendar Year

Fuel Type	2005 (Baseline)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Natural Gas (therms)	742,413	415,040	344,350	284,255	319,918	249,773	246,761	387,128	364,976	338,372	364,424	345,593
Propane (gal)	4,670	3,282	2,985	3,065	7,303	7,303[a]	10,000[b]	2,355	14,000[b]	3,650	3,609	3,361
Fuel oil (gal)	23,133	3,841	11,574	12,640	14,925	14,925[a]	10,000[b]	12,016	26,000[b]	11,167	11,684	14,901
Diesel (gal)	15,847	25,147	23,806	7,477	13,974	13,974[a]	22,746	15,258	16,000[b]	74,612	53,244	52,408
WRRF Sludge (dry tons)	4,520	1,710	0	0	0	0	0	0	0	0	0	0
Total Stationary Source Emissions (tonnes CO_2e)	**6,168**	**3,238**	**2,277**	**1,787**	**2,146**	**1,717**	**1,766**	**2,429**	**2,528**	**2,821**	**2,586**	**2,509**

[a] Data not available for CY2016. Assumed same usage as in CY2015.

[b] Data not available for CY2017 or CY2019. Estimated by WSSC.

Natural gas is used for heating in most WSSC facilities. Fuel use for stationary combustion did not change significantly from 2021 to 2022; WSSC decreased natural gas use from 2021 to 2022 by 5 percent, propane use by 3%, and diesel use by 2%. Fuel oil use increased from 2021 to 2022 by 28%, but it should be noted that fuel oil use has fluctuated significantly from 2012 to 2022.

Mobile Combustion Sources

A summary of annual fuel usage in the WSSC vehicle fleet and the related GHG emissions are shown in Table 2-3.

TABLE 2-3
Mobile Source Fuel Usage and GHG Emissions by Calendar Year

Fuel Type	2005 (Baseline)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Diesel (gal)	262,035	281,526	266,213	302,930	282,890	320,963	304,058	304,567	283,842	246,176	269,138	248,516
Gasoline (gal)	377,680	339,680	295,625	351,877	322,983	352,376	382,154	384,731	333,077	307,142	320,275	337,416
Total Mobile Source Emissions (tonnes CO_2e)	**6,082**	**5,889**	**5,385**	**6,220**	**5,737**	**6,391**	**6,477**	**6,513**	**5,868**	**5,229**	**5,601**	**5,518**

Diesel and gasoline use for equipment and vehicles did not see a significant change from 2021 to 2022. The GHG emissions generated by mobile combustion sources decreased 10 percent in 2022 compared to the baseline year 2005.

The size of the fleet has been inconsistent from 2020 to 2022. In 2020, the size of the fleet was 1,147 assets; this includes gasoline and diesel vehicles and equipment. The fleet size increased to 1,505 in 2021 and decreased to 1,338 in 2022.

Wastewater Treatment Process Emissions

Table 2-4 summarizes process parameters for each WRRF and the overall process related GHG emissions by CY.

TABLE 2-4
Annual Wastewater Treatment Process Parameters and Greenhouse Gas Emissions by Calendar Year

Facility	2005 (Baseline)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Western Branch (MGD)	19.02	18.92	19.22	22.10	20.05	19.89	23.64	24.12	23.92	24.88	23.60	21.81
Piscataway (MGD)	21.66	19.32	22.01	23.75	22.29	25.14	21.84	30.80	28.71	29.53	24.53	24.49
Parkway (MGD)	5.90	6.45	6.23	6.57	6.54	6.11	6.27	7.66	6.59	7.15	6.33	6.24
Seneca (MGD)	14.34	14.85	13.09	15.42	14.37	14.53	13.61	14.61	14.90	15.29	14.70	13.73
Damascus (MGD)	0.82	0.80	0.85	0.88	0.81	0.78	0.71	0.84	0.80	0.85	0.82	0.78
Hyattstown (MGD)	0.0042	0.0047	0.0042	0.0055	0.0043	0.0041	.0049	0.0059	0.0050	0.0060	0.0054	0.0056
Total AADF Treated (MGD)	**62**	**60**	**61**	**69**	**64**	**66**	**66**	**78**	**75**	**78**	**70**	**67**
Average Effluent TN Conc. (mg/L)	3.33	3.54	2.99	2.61	2.06	2.07	1.93	2.37	2.55	2.19	3.25	1.35
Total Methanol Use (gal)	404,732	597,390	763,865	801,648	849,195	901,483	629,630	513,302	682,978	838,551	1,017,358	846,140
Total MicroC-3000 Use (gal)	0	0	0	0	0	0	126,533	341,623	402,469	177,099	136,662	390,437
Total Wastewater Process Emissions (tonnes CO_2e)	3,637	4,451	5,026	5,164	5,199	5,431	4,650	4,076	4,720	5,285	6,205	5,046

[a] Total wastewater process emissions do not include biogenic emissions.
AADF = Annual Average Day Flow
TN = Total Nitrogen

Table 2-4 shows that while the total AADF treated in WSSC wastewater facilities had remained more-or-less constant from 2005 to 2017 (averaging about 64 MGD), AADF increased approximately 18 percent in 2018, 2019, and 2020, to about 78 MGD reflecting two of the wettest years on record (2018 and 2020) and lingering infiltration and inflow (I&I) impacts at Piscataway WRRF. In 2022, the annual average daily flow was 67 MGD across all wastewater plants, a decrease in 4.2 percent from 2021.

In 2017, WSSC began to substitute MicroC-3000 for methanol at several facilities. MicroC-3000 is an entire agriculturally derived alternative carbon source that is composed of approximately 70 percent methanol. Because it is 100 percent agriculturally derived, carbon dioxide (CO_2) emissions from the use of the product are considered biogenic in nature. Using MicroC-3000 in CY2022 reduced the CO_2 emissions due to external carbon use in wastewater treatment by approximately 32 percent compared to what they would have been if only methanol had been used.

Refrigerant Fugitive Emissions

Table 2-5 summarizes the GHG emissions attributed to hydrofluorocarbon (HFC) refrigerant use in each CY.

TABLE 2-5
Refrigerant Usage and Greenhouse Gas Emissions by Calendar Year

Material Type	2005 (Baseline)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total HFC Refrigerant Use (lb)	0	94	74	41	9	96	74	74	74	99	113	67
Total Fugitive Emissions (tonnes CO_2e)	**0**	**73.6**	**57.5**	**34.8**	**6.5**	**88.7**	**64.6**	**63.2**	**63.2**	**35.5**	**83.0**	**76.0**

WSSC is currently phasing out all use of HCFC/chlorofluorocarbons (CFC) refrigerants (R-22) because of their ozone-depleting qualities. New equipment will be phased in that uses HFC/perfluorocarbon (PFC) refrigerants, which are reportable GHG emissions. This change may result in increased refrigerant-related emissions for the year or years in which new equipment is charged and set up.

Indirect Emissions (Scope 2)

Scope 2 emissions, or indirect emissions, result from energy-related activities owned and/or controlled by another entity that are being completed on behalf of the reporting entity. For the WSSC inventory, only indirect emissions from purchased electricity are included. Other sources of Scope 2 emissions, such as purchased heating, cooling, or steam, do not exist at WSSC.

Scope 2 Emissions

A summary of annual electricity usage for all facilities within the WSSC operations and the associated GHG emissions are shown in Table 2-6, alongside both the location-based and market-based Scope 2 emissions from purchased electricity. The market-based method is used to track WSSC's progress towards its target and is therefore used throughout this report in the tables and associated figures.

TABLE 2-6
Purchased Electricity Use and Greenhouse Gas Emissions by Calendar Year

	2005 (Baseline)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Entity-wide Electricity Use (MWh)	205,645	209,256	210,261	220,471	221,495	225,794	223,685	218,796	208,328	218,860	213,171	214,706
RECs (MWh)	0	(50,819)	(59,953)	(49,356)	(56,816)	(56,451)	(53,831)	(220,000)	(145,000)	(48,970)	(58,812)	(46,706)
Net Total Electricity Use (MWh)	205,645	158,436	150,308	171,115	164,680	169,343	169,854	(1,204)	63,328	169,890	154,359	168,000
Total Indirect Emissions (tonnes CO_2e) Location-Based [a]	**102,741**	**95,585**	**96,044**	**100,708**	**101,176**	**87,881**	**77,318**	**75,629**	**68,015**	**71,054**	**64.794**	**76,793**
Total Indirect Emissions (tonnes CO_2e) Market-based	**122,673**	**76,374**	**72,611**	**82,553**	**72,516**	**76,521**	**76,249**	**0**	**26,207**	**69,088**	**63,360**	**69,636**

[a] RECs cannot be deducted if the location-based method is used.

In 2021, WSSC signed a new 10-year contract to purchase 70,000 MWh per year of wind-generated power. The contract became effective on June 1, 2020 and generated 54,038 MWh in 2021. In 2022, WSSC purchased RECs totaling 46,706 MWh. This renewable energy source provides a net reduction in the amount of fossil-fuel generated power that is used by WSSC operations.

Since 2005 (the baseline year), electricity use at WSSC has been variable, going up and down by approximately 4 to 6 percent from year-to-year. Throughout this period, the electricity consumption at the WRRFs and the buildings and facilities remained relatively consistent. However, the water treatment plants (WTPs) and the pump stations show more variable power consumption. In 2022, the overall electricity use at WSSC increased by 4 percent over the baseline year of 2005.

Table 2-6A illustrates the electricity use for wastewater treatment and total treated flow since 2016.

TABLE 2-6A
Electricity Use at Water Resource Recovery Facilities

	2016	2017	2018	2019	2020	2021	2022
Damascus (MWh/yr)	2,390	2,292	2,299	2,517	2,515	2,316	2,186
Parkway (MWh/yr)	5,519	6,103	6,907	6,046	5,550	6,724	6,742
Piscataway (MWh/yr)	16,626	16,796	19,492	18,846	19,897	18,414	19,036
Seneca[a] (MWh/yr)	16,227	17,353	17,570	18,030	18,621	16,506	19,154
Western Branch[a] (MWh/yr)	26,572	27,706	21,235	23,810	20,172	22,862	27,901
Hyattstown (MWh/yr)	87	89	93	86	89	68	61
Total MWh WRRFs	**66,707**	**70,155**	**74,219**	**72,548**	**66,844**	**66,890**	**75,080**
Total Flow Treated (MGD)	66	66	78	75	78	70	67
kWh per MG Treated	2,750	2,909	2,606	2,653	2,357	2,384	3,068

[a] Seneca and Western Branch facilities have solar installations. The electricity use includes solar MWh generated at those facilities.
MG = million gallons

Table 2-6B presents the electricity use for drinking water treatment and total treated flow since 2016.

TABLE 2-6B
Electricity Use at Water Treatment Plants

	2016	2017	2018	2019	2020	2021	2022
Patuxent (MWh/yr)	8,563	8,359	9,962	9,306	9,645	9,665	10,530
Rocky Gorge (MWh/yr)	12,577	12,119	10,034	10,894	17,795	14,467	14,787
Potomac (MWh/yr)	88,103	83,659	77,934	69,249	75,968	75,305	72,158
Total MWh WTPs	**109,242**	**104,137**	**97,930**	**89,448**	**103,408**	**99,437**	**97,475**
Flow Treated Patuxent (MGD)	53.0	39.3	51.2	47.5	59.9	57.8	50.54
Flow Treated Potomac (MGD)	111.7	123.4	111.7	115.3	112.9	116.3	119.01
Total Flow Treated (MGD)	**165**	**163**	**163**	**163**	**173**	**174**	170
kWh per MG Treated	1,817	1,754	1,646	1,505	1,639	1,565	**1,575**

Table 2-6C presents the electricity use at WSSC buildings and facilities since 2016.

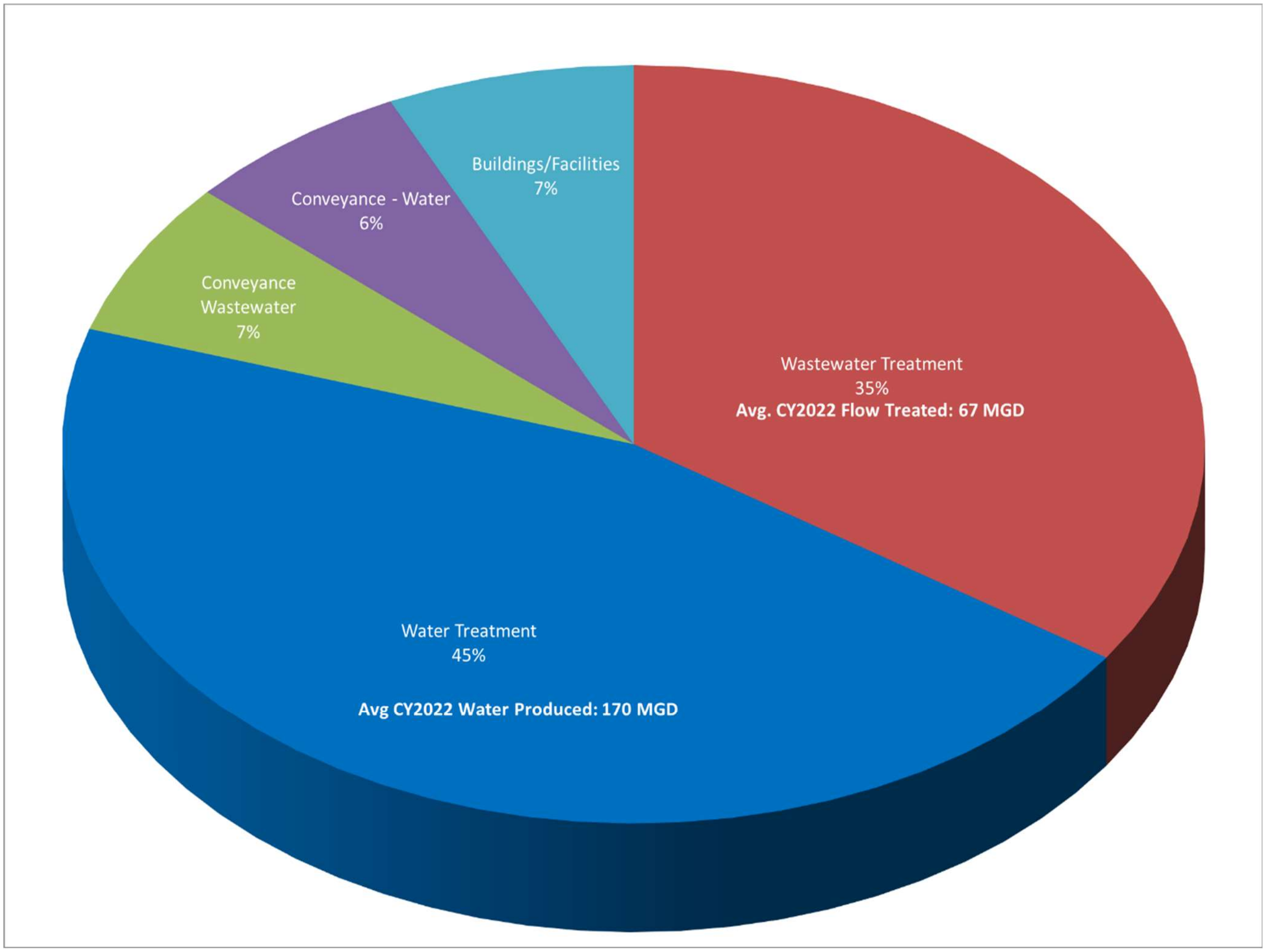
TABLE 2-6C
Electricity Use at Buildings and Facilities

	2016	2017	2018	2019	2020	2021	2022
Richard G. Hocevar Building (MWh/yr)	9,658	10,905	9,668	9,852	8,987	9,617	9,892
Consolidated Lab (MWh/yr)	1,584	1,632	1,595	1,614	1,764	1,892	1,786
Anacostia FMD (MWh/yr)	1,171	1,189	999	953	817	910	1,418
Gaithersburg Depot (MWh/yr)	559	574	559	485	429	424	398
Lyttonsville Depot (MWh/yr)	686	635	652	631	599	641	610
Temple Hills Depot (MWh/yr)	873	859	847	849	943	968	872
Total MWh Buildings	**14,531**	**15,793**	**14,321**	**14,383**	**13,540**	**14,451**	**14,975**

FMD = Facilities Maintenance Division

The CO_2e output emission rates associated with the electricity use have been reduced because of changes in the resource mix in the electric grid, with shifts away from high-emitting combustion resources (such as coal) lowering the emission rates. The market-based CO_2e emission rate (tonne CO_2e per MWh of electricity) for Pennsylvania-New Jersey-Maryland Interconnection has decreased by 29 percent from 1,309 lb CO_2/MWh in 2005 to 927 lb CO_2/MWh in 2022. Figure 2-2 shows the relative use of electricity for water treatment, wastewater treatment, conveyance (both water and wastewater), and facility operations at WSSC in CY2022.

FIGURE 2-2
Comparison of 2022 Electricity Usage by Category



Optional Indirect Emissions (Scope 3)

Scope 3 emissions, or other indirect emissions, include those generated by activities over which WSSC has influence and that occur within WSSC's operational boundaries but are not owned or controlled by WSSC. The major sources of Scope 3 emissions are contracted services (such as treatment plant solids transport, mixed solid wastes transport and disposal), chemical manufacture, and employee travel. Mobile source emissions are generated from equipment and vehicles operated by contracted businesses and from employee commuting and business travel in personal vehicles. Fugitive emissions from landfill disposal of solid waste and the land application of biosolids are also included as part of this scope.

Employee Commuting and Business Travel

Table 2-7 lists the total mileage used by employees to commute to work and to complete business travel in personal vehicles.

TABLE 2-7
Employee Travel Mileage and Greenhouse Gas Emissions by Calendar Year

	2005 (Baseline)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total Number of Employees	1396	1573[a]	1573[a]	1540	1611	1610	1622	1637	1657	1681	1612	1,594
Employee Commuting (million miles)	14.50	20.97	20.97	20.47	21.53	21.32	21.61	21.72	22.87	14.17[b]	12.49	17.81
Employee Business Travel (million miles)	0.130	0.132	0.161	0.106	0.116	0.124	0.118	0.180	0.113	0.053	0.062	0.073
Total Travel (million miles)	14.63	21.10	21.13	20.58	21.65	21.45	21.73	21.90	22.98	14.22[b]	12.55	17.88
Total Optional Mobile Source Emissions (tonnes CO_2e)	**6,755**	**9,755**	**9,757**	**9,467**	**9,093**	**9,009**	**9,125**	**8,094**	**8,607**	**5,300[b]**	**4,505**	**4,378**

[a] Based upon Fiscal Year 2013 data.
[b] Revised from June 2022 Action Plan Update.

Business travel miles increased in 2022 due to stay-at-home orders being lifted but remained at about half of pre-pandemic levels. Employee commuting increased in 2022 because of decreased teleworking. It was assumed in 2020 and 2021 that 50 percent of employees were working from home 85 percent of the week. For 2022, the analysis estimated that about 50 percent of the total employees at WSSC work at WSSC's headquarters, the Richard G. Hocevar Building (RGH) and about 40 percent were telecommuting per week (2 days a week).

Employee commuting increased in 2022 by 5 million miles, but the CO_2e emissions actually decreased compared to last year. The emissions factor for tonnes CO_2e emissions per mile commuted was updated in the 2022 inventory, and this resulted in the decrease in overall emissions due to commuting.

Contracted Services

Biosolids and Solid Waste Hauling

Mobile emissions associated with contracted services include the use of contractor-owned trucks for transporting biosolids from the treatment plants to a landfill or agricultural land application area and transporting mixed solid wastes to a landfill or material recycling facility.

The total miles traveled by contractors to transport biosolids generated at WSSC facilities increased considerably after 2011 because incinerators at the Western Branch were removed from service in August 2012. Therefore, all solids generated at this facility were hauled to various landfills in Virginia, with an average round-trip distance of 290 miles. In addition, regulations restrict the amount of biosolids that can be land-applied in Maryland as well as the time of year when they may be applied. These regulations have resulted in the majority of the biosolids from WSSC being transported to Virginia for land application, resulting in greater travel distances.

In 2019, the solids-handling facility at the Patuxent WTP started operations and the solids hauled were added to the inventory. The solids from Patuxent WTP used to be drained via the sewer to the Parkway WRRF, and therefore the solids production at Parkway were reduced in 2019.

No biosolids hauling data were provided in 2020; therefore, the data from 2019 was used. 2021 biosolids data were obtained for all WRRFs except for Western Branch, which has 2019 data. Complete biosolids data for all plants were provided in 2022.

Table 2-8 details the total miles traveled for the transportation of solids and mixed solid wastes to their final disposal destination and the corresponding GHG emissions.

TABLE 2-8
Contractor Biosolids Transport Annual Mileage and Greenhouse Gas Emissions by Calendar Year

Originating Facility	2005 (Baseline)	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Damascus (miles)	7,800	14,383	14,525	10,634	10,864	11,077	7,049	10,539	10,539	12,307	12,038
Parkway (miles)	149,656	144,716	131,693	107,441	109,433	90,231	94,814	71,160	71,160	61,347	65,431
Piscataway (miles)	180,271	318,410	370,646	413,113	317,693	320,241	294,837	562,732	562,732	245,980	192,486
Potomac (miles)	32,860	33,625	36,439	42,101	40,193	53,604	68,694	51,635	13,444	37,784	35,848
Patuxent (miles)	0	0	0	0	0	0	0	19,035	23,052	17,723	16,295
Seneca (miles)	168,873	199,027	134,166	184,512	177,405	177,695	148,918	134,236	134,236	166,723	172,296
W. Branch (miles)	0	344,092	344,137	321,138	327,508	352,490	317,220	391,586	391,586	391,586	186,531
Mixed Solid Waste (miles)[a]	51,972	51,972	51,972	51,972	51,972	51,972	62,819	86,582	53,956	55,366	72,734
Total Transport (miles)	**591,431**	**1,106,225**	**1,083,578**	**1,130,911**	**1,035,068**	**1,057,310**	**994,351**	**1,327,504**	**1,260,704**	**988,816**	**753,658**
Total Optional Mobile Source Emissions (tonnes CO_2e)	**1,262**	**2,309**	**2,269**	**2,311**	**2,115**	**2,161**	**2,032**	**2,713**	**2,576**	**2,033**	**1,549**

[a] Based on contracted annual number of total pick-ups.

Solid Waste Management

WSSC facilities generate mixed solid wastes (including trash and recyclables), which are collected and disposed in either a landfill or an incinerator depending on the county where they are collected. Landfill disposal of mixed solid wastes results in GHG emissions because of CH_4 released at the landfill. Incineration results in N_2O emissions. For the GHG inventory, purchasing contracts were used to estimate the amount of solid waste disposed by WSSC across all operations. In 2012, 2013, 2014, 2015, 2016, and 2017, the same value for mixed solid waste disposed was used as in previous years. Annual data for solid waste disposal were available for the 2018, 2019, 2020, 2021, and 2022 inventories. This data indicated the amount of waste, cardboard, and comingled recyclables collected. The hauling distance (miles) for collection of all materials (including recyclables) was calculated for the optional mobile source emissions. Only the tons of waste (not recyclables) were used to calculate the emissions from landfill or incineration. Cardboard and recyclables were assumed to be repurposed and those emissions were not included in the scope of this inventory.

Biosolids Management

The biosolids resulting from the wastewater treatment processes are applied on agricultural lands or transported to a landfill. Land application of biosolids results in GHG emissions because of the release of N_2O into the environment. Biosolids disposal in a landfill results in CH_4 and N_2O emissions. CO_2 is also sequestered in the soil during the land application or landfill disposal of biosolids. This CO_2 is considered biogenic. Land application of biosolids for agricultural use provides an offset of CO_2 emissions that would have resulted from the use of inorganic fertilizer. This offset is included in the inventory in the indirect emissions category as these reductions occur outside of WSSC's organizational boundary.

Table 2-9 summarizes the amount of biosolids generated and the corresponding GHG emissions (that is, biogenic, nonbiogenic, and avoided) released and/or sequestered as a result of the disposal method (for example, landfill and land application).

TABLE 2-9
Biosolids Production and Greenhouse Gas Emissions by Calendar Year

Facility	2005 (Baseline)	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Western Branch											
Land Applied	0	0	0	0	0	0	0	0	0	0	15,529
Landfilled	1,684	28,283	28,864	28,898	29,379	29,238	28,533	30,172	32,313	33,860	19,274
Piscataway											
Land Applied	28,020	31,504	34,182	36,380	33,901	33,055	36,214	47,053	44,364	32,549	31,014
Landfilled	0	0	0	0	0	0	0	0	0	5,441	0
Parkway – Land Applied	15,542	13,153	14,386	13,635	14,813	13,056	16,873	9,621	9,133	6,486	9,379
Seneca											
Land Applied	22,921	23,209	21,690	20,336	21,897	21,989	22,543	22,343	22,945	22,840	24,233
Landfilled	0	0	0	0	0	0	0	0	0	32	0
Damascus											
Land Applied	1,344	1,442	1,301	1,288	1,315	1,246	1,272	1,353	1,379	1,516	1,540
Landfilled	0	0	0	0	0	0	0	0	0	33	0
Marlboro Meadows – Land Applied	0	0	0	0	0	0	0	0	0	0	0
Total Wet Tons	**69,511**	**97,591**	**100,423**	**100,537**	**101,305**	**98,584**	**105,434**	**110,541**	**110,133**	**102,731**	**100,969**
Total Biosolids Emissions (tonnes CO_2e)	4,165	6,465	6,354	6,537	6,428	6,113	6,782	7,438	8,262	8,008	5,680
Biogenic CO_2 Sequestered (tonnes CO_2e)	(2,873)	(4,172)	(4,078)	(4,179)	(4,112)	(3,874)	(4,307)	(4,748)	(4,981)	(4,215)	(3,944)
Inorganic Fertilizer Use Offset (tonnes CO_2e)	(1,538)	(1,571)	(1,622)	(1,624)	(1,631)	(1,572)	(1,743)	(1,822)	(1,764)	(1,437)	(1,852)
Net Emissions (tonnes CO_2e)	**(246)**	**722**	**654**	**733**	**685**	**667**	**731**	**868**	**1,517**	**2,356**	**(116)**

Total biosolids produced and managed from WSSC facilities in 2021 decreased significantly compared to previous years. This decrease is due to decreased landfilling, especially at Western Branch.

Chemical Use

WSSC's seven WRRFs and two WFPs use various chemicals in the treatment process. GHGs may be emitted during the manufacture and/or use of these chemicals. The emissions associated with the manufacture of methanol are included as Scope 3 emissions, while emissions resulting from use in the process are included in the Scope 1 category, direct process emissions, as previously presented. Calcium carbonate ($CaCO_3$), or lime, also releases process-related emissions of CO_2 when manufactured. These emissions are included as Scope 3 emissions within the inventory. Table 2-10 summarizes lime and methanol usage by plant each year and the corresponding GHG emissions.

Table 2-10 shows that lime usage decreased, most significantly at Western Branch and Piscataway. In 2017, WSSC wastewater treatment facilities started substituting MicroC-3000, a 100 percent agriculturally derived alternative carbon source for methanol. Using MicroC-3000 in CY2022 reduced the CO_2 emissions due to alternative carbon use in wastewater treatment by approximately 32 percent compared to what they would have been if only methanol had been used. Note that there was an overall increase of external carbon use observed in 2022. Methanol use actually decreased from previous years, but MicroC usage increased so much that all external carbon use increased compared to last year. Overall, the GHG emissions associated with manufacture of lime and methanol increased by 44 percent over the 2005 baseline.

TABLE 2-10
Chemical Usage at Treatment Facilities and Associated Greenhouse Gas Emissions by Calendar Year

Facility	2005 (Baseline)	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Western Branch (Lime, tons)	0	0	0	0	0	0	0	1,506	2,200	2,746	1,516
Piscataway (Lime, tons)	2,032	2,356	2,637	3,068	2,415	2,598	3,328	5,261	3,506	2,817	1,687
Parkway (Lime, tons)	1,003	849	986	874	1,053	909	1,353	605	621	637	627
Seneca (Lime, tons)	1,408	988	645	809	860	1,540	1,958	806	858	923	917
Damascus (Lime, tons)	23	53	51	48	52	48	49	51	52	49	24
Hyattstown (Lime, tons)	0	0	0	0	0	0	0	0	0	0	0
Patuxent (Lime, tons)	543	514	476	522	527	366	543	521	516	501	472
Potomac (Lime, tons)	1,127	1,833	1,667	2,133	1,875	1,711	2,762	2,193	2,300	2,551	2,229
Total Lime Usage (tons)	**6,136**	**6,593**	**6,461**	**7,454**	**6,782**	**7,172**	**9,993**	**10,943**	**10,053**	**10,225**	**7,472**
Western Branch (Methanol, gal)	404,732	551,542	551,542	504,505	642,752	412,057	275,124	166,625	420,173	528,188	357,418
Piscataway (Methanol, gal)	0	212,323	239,369	238,446	174,957	178,269	238,178	516,353	334,761	407,311	488,722
Parkway (Methanol, gal)	0	0	11,907	78,088	53,566	0	0	0	0	0	0
Seneca (Methanol, gal)	0	0	0	28,156	30,208	39,304	0	0	83,617	81,859	0
Total Methanol Use (gal)	**404,732**	**763,865**	**801,648**	**821,039**	**901,483**	**634,876**	**513,302**	**682,978**	**838,551**	**1,017,358**	**846,140**
Western Branch (MicroC-3000, gal)	0	0	0	0	0	62,890	185,784	267,381	116,380	71,373	252,753
Parkway (MicroC-3000, gal)	0	0	0	0	0	63,643	73,447	67,474	60,719	58,483	63,975
Seneca (MicroC-3000, gal)	0	0	0	0	0	0	83,392	67,614	0	6,806	73,709
Total MicroC-3000 Use (gal)	**0**	**0**	**0**	**0**	**0**	**126,533**	**342,623**	**402,469**	**177,099**	**136,662**	**390,437**
Total Chemical Usage Emissions (tonnes CO_2e)	5,000	6,043	6,030	6,745	6,452	6,164	8,272	9,041	8,499	8,884	7,206

SECTION 3

WSSC's Projected Future Emissions

Inventory Conclusions

Overall, total gross GHG emissions, (including Scope 1, Scope 2, and Scope 3 emissions, before accounting for avoided emissions from RECs or fertilizer avoidance) having decreased 11 percent from the 2005 baseline. Gross emissions totaled 174,788 tonnes CO_2e in 2005 and 155,802 tonnes in 2022.

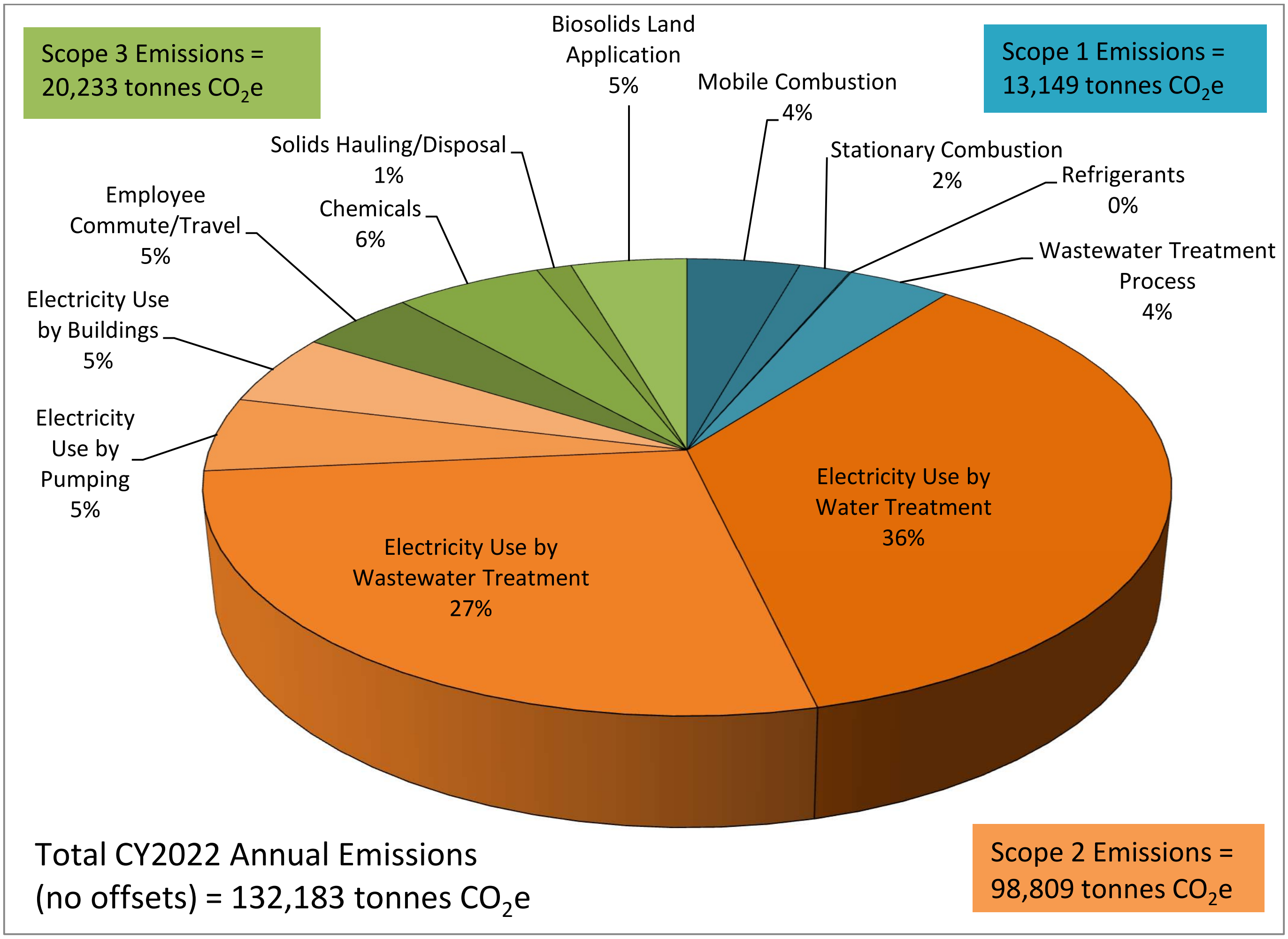
Fuel consumption (stationary) has reduced each year since 2005, mainly due to an overall decrease in natural gas therms and diesel usage. Wastewater treatment plant sludge as fuel was phased out in 2013, leading to further decreases in emissions due to fuel consumption.

Electricity use has increased, but this increase has been offset by the lower emissions rate per MWh consumed (due to cleaner electricity generation in the grid), resulting in a net reduction in the tonnes of CO_2e emitted compared to the base year.

MicroC usage must continue to keep up with the increase in methanol use every year. Emissions associated with the management of biosolids have decreased because of the avoidance of landfilling of biosolids.

Figure 3-1 illustrates the impact of the various operations conducted at WSSC on the average total entity wide GHG emissions in 2022. The areas shaded in blue represent Scope 1 GHG emissions. The areas shaded in orange represent Scope 2 emissions. The areas shaded in green represent Scope 3 emissions. Gross emissions are shown (with no avoided emissions) to better illustrate the contributions from the various elements to the overall total.

FIGURE 3-1
Comparison of CY2022 Gross Greenhouse Gas Emissions by Category



Emissions Conversion Factors for Project Planning

To aid WSSC's future project planning, emissions conversion factors for gallons of methanol used and saved and kWhs used and saved are presented in Table 3-1. These conversion factors can be used to estimate the GHG emissions impact of a potential capital project or operational strategy and are updated annually based on the results of the inventory calculations. Methanol emissions per gallon accounts for both Scope 1 (process emissions) and Scope 3 (manufacturer emissions).

TABLE 3-1
Emissions Conversion Factor

Emissions Conversion Factor	Value	Unit
Methanol (Scope 1 and 3)	0.00602	Tonne CO_2e/gal
Electricity (Scope 2)	0.00046	Tonnes CO_2e/kWh

GHG Emissions Projections (2022 to 2035)

The next step in the process of updating the GHG Action Plan was to determine how the GHG emissions would change in the future and how the projected future emissions compared to the stated GHG reduction goal by 2035. The inventory results were used as the baseline from which the future GHG emissions could be projected. Future GHG emissions at WSSC will be mainly affected by the following factors:

1. Population growth in the service area that will increase the demand for potable water and the resulting wastewater flows.
2. Regulatory drivers that require process upgrades, to meet more advanced levels of treatment.
3. Implementation of renewable energy programs such as wind, solar, and biogas (anaerobic digestion [AD] and combined heat and power [CHP]).

Data were collected from current planning, design, and construction documents to estimate the impact of these factors on future GHG emissions, and the results are summarized in this section.

Note that the table and figure numbers in this document have been kept identical to those in Section 2 of the November 2012 GHG Action Plan for ease of reference but they have been updated with the latest data.

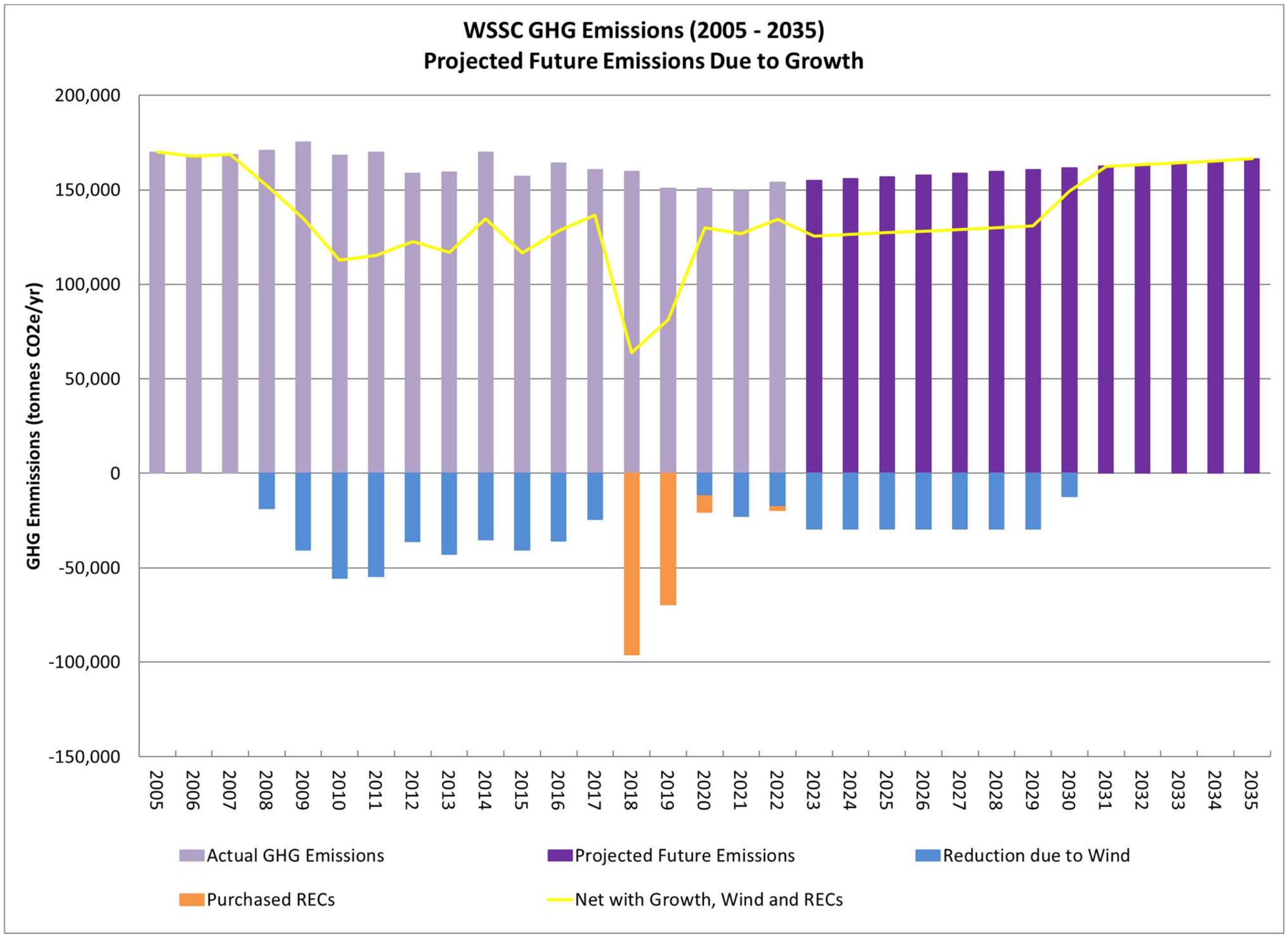
GHG Emissions Increase due to Growth

Current planning projections at WSSC predict zero growth in drinking water demand through 2022. For the purposes of this update, the growth rate in water production was also assumed to be zero through 2035. The wastewater treatment demand was assumed to grow at about 1 percent per year through 2035. The 1 percent per year increase was also applied to other aspects of WSSC operations (such as, personnel and fleet vehicles).

Figure 3-2 shows the historical GHG emissions through CY2022 and the projected future GHG emissions associated with the estimated growth in wastewater treatment demand.

Figure 3-2 also shows the net GHG inventory for WSSC including the effect of the 10-year wind contract from 2020 to 2030, and the purchase of RECs in CY2018, CY2019, CY2020, and CY2022. Note that market-based Scope 2 methodology is being used for planning purposes.

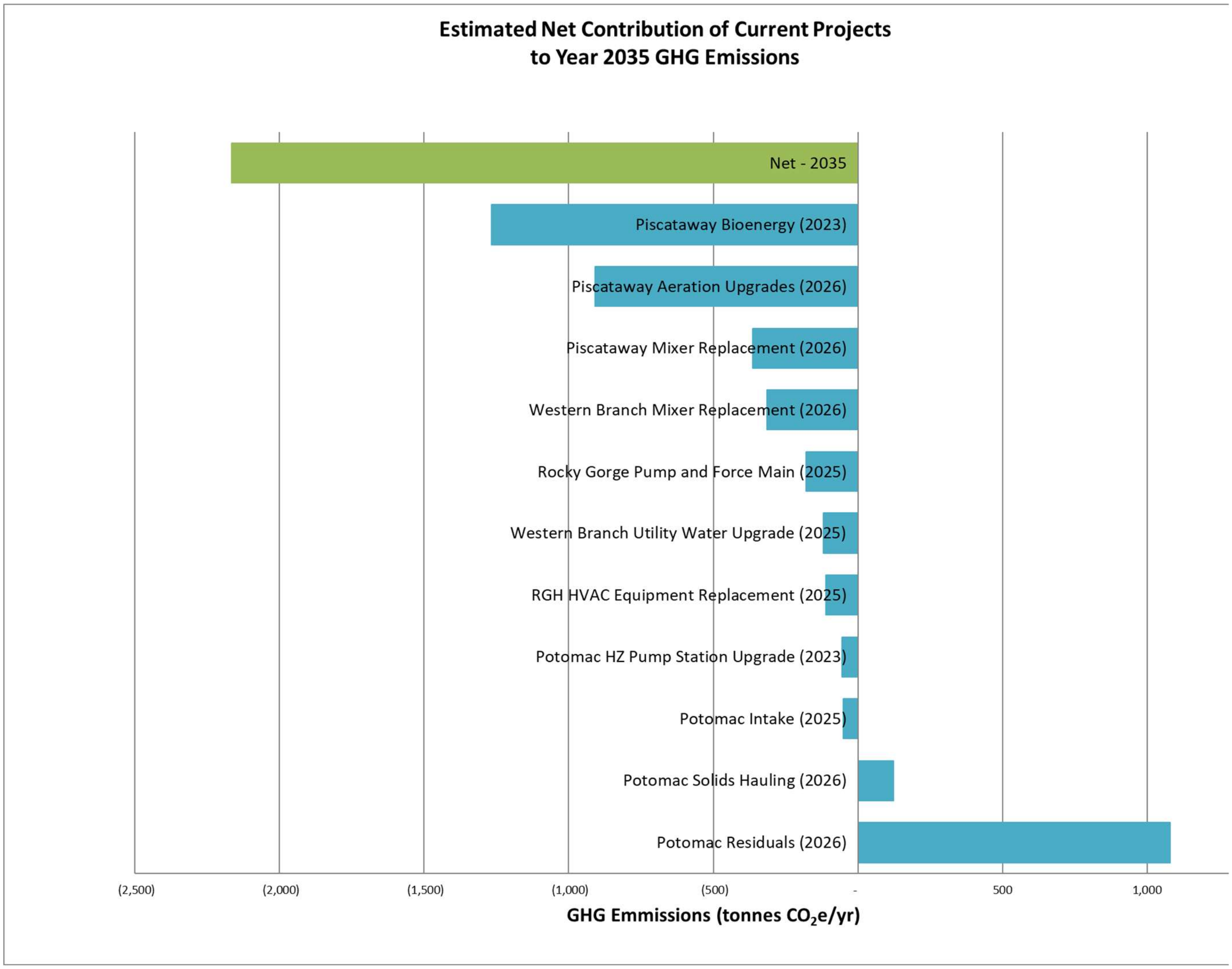
FIGURE 3-2
Projected Future Emissions due to Growth



GHG Emissions Increase due to Major Capital Improvement Projects

The next step in updating the projection of future GHG emissions at WSSC was to update the estimated impact of current major capital improvement projects on GHG emissions. WSSC is currently in the process of upgrading and/or expanding several facilities to meet future demand and treatment requirements. Specific information was collected about each major project, and future energy use was estimated. Figure 3-3 illustrates the relative contributions of the major projects currently underway to the projected 2035 annual GHG emissions. This updated figure only includes projects that are currently in development (planning, design, or construction phases) and indicates the year in which it is expected to be completed and operational. The capital improvement projects account for a total reduction of 8,235 tonnes CO_2e from the 2035 annual GHG emissions.

FIGURE 3-3
Estimated Net Contribution of Current Water and Wastewater Capital Improvement Projects to 2035 Annual Greenhouse Gas Emissions



As Figure 3-3 illustrates, the main sources of estimated **increases** to the GHG emissions are:

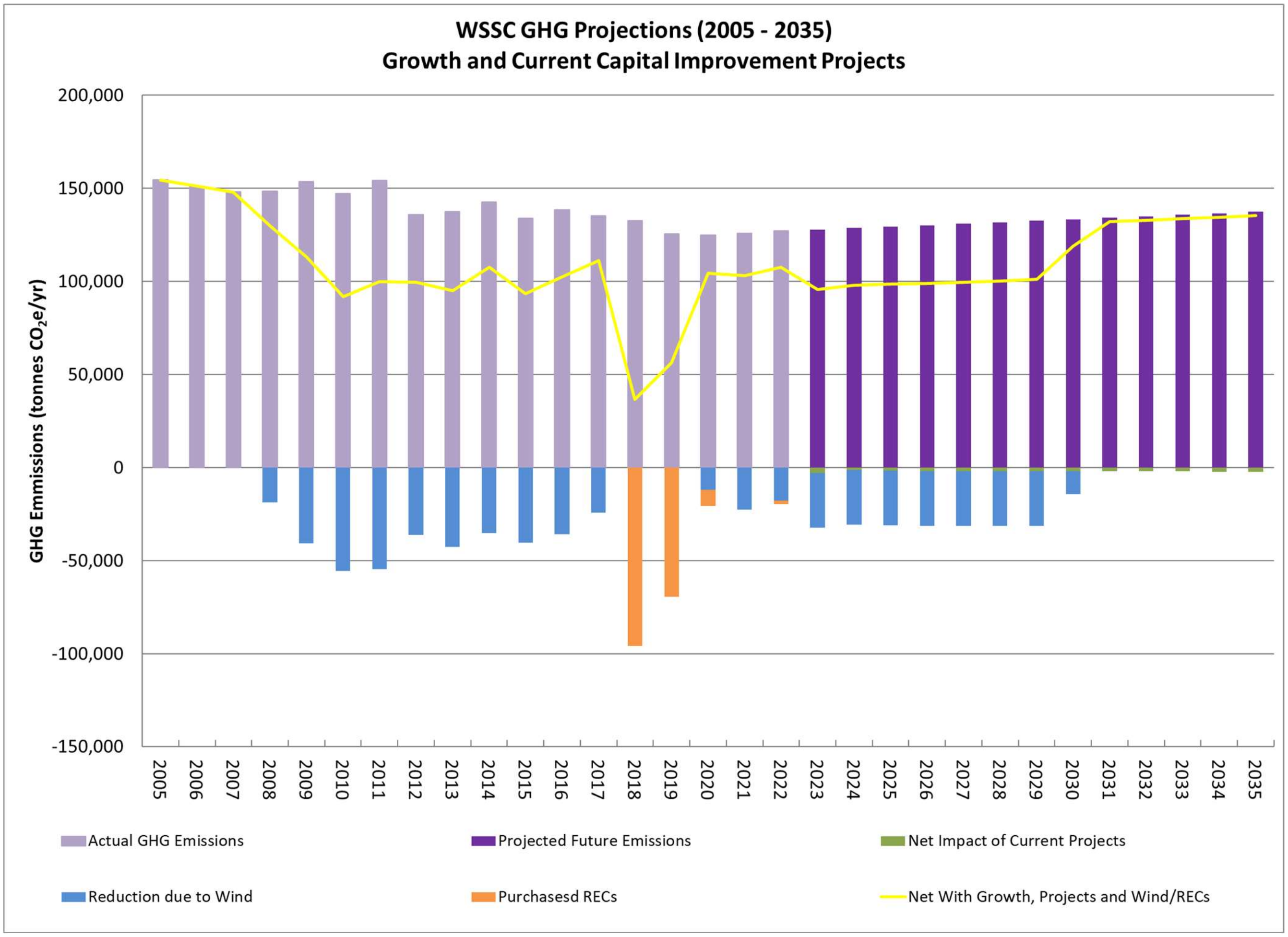
1. Solids Treatment at Potomac WFP: The Potomac WFP is currently planning for improvements to the existing facility to increase the number of solids that are treated and to reduce/eliminate discharges to the Potomac River. The project will be implemented in two phases: Phase 1, an increase in solids capture of 25 percent over current levels (by 2022), and Phase 2, an increase in solids capture of 250 percent over current levels (by 2025).

The main sources of estimated GHG emission **reductions** are:

1. Implementation of a Bioenergy System at Piscataway WRRF: The system will consist of thermal hydrolysis followed by AD to treat sludge from all WSSC wastewater treatment facilities. The biogas produced will be cleaned, re-introduced to the natural gas pipeline, and WSSC will sell the gas as a renewable resource. WSSC would then purchase natural gas and use it in CHP units to generate electricity at the plant. The Bioenergy project will also reduce GHGs caused by biosolids hauling and lime use (Scope 3). This project is expected to be completed in 2023.
2. Piscataway Aeration Upgrades: This project consists of blower replacements at Piscataway that will result in in a decrease in required energy usage. This project is expected to be completed in 2026.

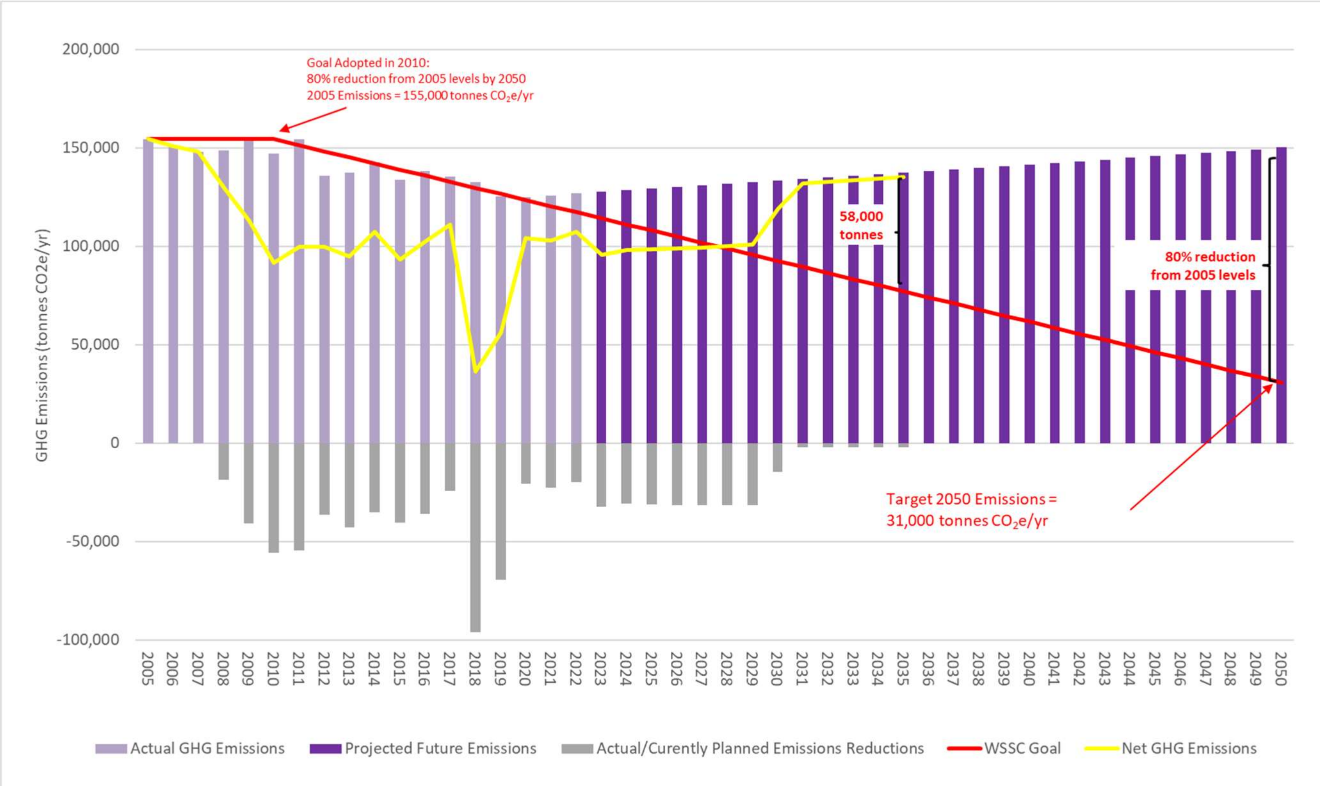
Figure 3-4 shows the cumulative effect of growth and the projects currently underway. This figure indicates that by 2035, the GHG emissions will be about 12 percent lower than 2005 levels if no additional measures are taken to reduce GHG emissions. The projection includes the effect of the new 10-year wind-generated electricity contract from 2020 to 2030, and the purchase of RECs for annually 2018 through 2022.

FIGURE 3-4
Projected Future Emissions due to Growth and Current Capital Improvement Projects



WSSC's goal is to reduce GHGs by 10 percent every 5 years based on the 2005 GHG emissions. Figure 3-5 illustrates how the projected growth of GHG emissions compares to the goal. The projection indicates that by 2035 WSSC would need to reduce annual emissions 58,000 tonnes CO_2e, or 43 percent of the projected 2035 annual emissions, to meet WSSC's current goal of 10 percent reduction every 5 years.

FIGURE 3-5
Projected Future Emissions due to Growth and Current Projects Compared Against WSSC GHG Reduction Goal



SECTION 4

Emission Reduction Strategies

GHG Emissions Reduction Strategies

Table 4-1 summarizes the strategies developed, the projected GHG emissions reduction impact, and the estimated capital, annual, and life-cycle costs.

The following are the main focus areas of the GHG reduction strategies:

- Optimizing the efficiency of the water distribution system.
- Improving equipment efficiency for water and wastewater.
- Reducing residuals and optimizing processes.
- Reducing GHGs associated with vehicles and transportation.
- Optimizing building services (lighting and heating, ventilating, and air conditioning [HVAC]).
- Implementing renewable energy.

In 2022, the impact of the strategies was re-evaluated based on the latest emissions factors and updated information about each project. The changes are noted in the description of the strategies in Table 4-1. Strategies that were removed from consideration or moved into implementation phase (actual projects) were removed from this table. New strategies were added due to a recent energy audit conducted at some of the WRRFs that resulted in proposed energy-reduction projects.

The annual cost and life-cycle cost for the strategies were updated to reflect the new implementation year and extended out to 2035. Life-cycle cost was calculated based on the capital cost, the annual operations and maintenance (O&M) cost, and the number of years between the proposed strategy's implementation year, and 2035. All strategies except for REC purchases have a negative O&M cost because they result in annual savings. O&M costs for electricity related strategies were calculated based on the number of kWhs saved annually by the strategy and the cost of electricity (assumed $0.09 per kWh). Annual O&M for other projects, such as using green carbon sources for denitrification, are based on annual savings in chemical costs.

Note that the table and figure numbers in this document have been kept identical to those in Section 3 of the November 2012 GHG Action Plan for ease of reference but they have been updated with new data collected in this GHG Action Plan update.

TABLE 4-1
Proposed Greenhouse Gas Reduction Strategies

No.	Strategy Name	Description	2035 GHG Reduction (tonnes CO_2e/yr)	Year Impl.	Capital Cost	Annual Cost (+) or Savings (-)	Life-cycle Cost[a] (through 2035)
Group 1 – System Efficiency – all strategies either implemented or removed from consideration							
Group 2 – Equipment Efficiency							
2.9	Potomac Main Zone Pump #1	Replace existing Pump #1 in the Main Zone pump station at Potomac WFP.	-410	2024	$795,000	-$87,500	-15,000
2.13	Aeration Efficiency at Parkway WRRF	Replace the existing process aeration blowers with more efficient units and implement electrical upgrades.	-280	2024	$1,000,000	-$54,000	$500,000
Group 3 – Residuals/Process							
3.3	Phosphorus Recovery at the Bioenergy Plant	Implement phosphorus recovery from the digested sludge flow stream. The process converts the phosphate to a commercial-grade fertilizer which then reduces WSSC's GHG footprint because it offsets GHGs produced in industrial fertilizer manufacture.	-1,500	2028	$2,100,000	-$15,000	$2,007,000
3.4	Green Carbon Sources for Denitrification	Replace methanol at WB and Piscataway with "green" sources of carbon such as MicroC-3000 for the denitrification process. Reduce GHGs in the production of methanol (Scope 3) and in the consumption of methanol in the process (Scope 1).	-3,900	Ongoing	$0	-$102,000	-$1,100,000
3.5	Recycling	Uniform recycling strategy (paper, cans, bottles, light bulbs). Assume a 10% reduction in GHGs associated with garbage landfilling and incineration.	-10	Ongoing	$0	$0	$0
3.6A	Increased Nutrient Removal Process Efficiency	Implement innovative ammonia-based aeration control to promote innovative nutrient removal processes (Nite/Denite) at Seneca and WB that can potentially reduce aeration by 20%.	-1,700	2023	$2,000,000	-$320,000	-$1,200,000
3.6B	Mainstream Anammox at Piscataway	Implement innovative biological nutrient removal process (mainstream Anammox or Nite/Denite) at Piscataway that can potentially reduce aeration by 20%.	-660	2028	$5,000,000	-$154,000	$4,200,000

TABLE 4-1
Proposed Greenhouse Gas Reduction Strategies

No.	Strategy Name	Description	2035 GHG Reduction (tonnes CO_2e/yr)	Year Impl.	Capital Cost	Annual Cost (+) or Savings (-)	Life-cycle Cost[a] (through 2035)
Group 4 – Transportation							
4.1	Electric Fuel Vehicle Purchase	Replacement of 5 fleet vehicles per year for a 4-year period (2025-2028) with electric fuel vehicles.	-30	2025	$280,000	-$10,900	$180,000
Group 5 – Lighting/HVAC							
5.7	Anacostia Depot Sewer Thermal	Implement sewer thermal technology to replace natural gas use for heating and electricity use for cooling at three building at Anacostia Depot: the Admin Building, Heavy Equipment Shop, and Warehouse	-60	2026	$4,200,000	-$15,900[b]	Not available for all indicated projects.
Group 6 – Renewable Resources							
6.2	Additional Solar Installation (11.8 MW)	Construction of 11.8 MW solar facility. WSSC will own 100% of the environmental attributes (carbon offset) derived from projected generation of approximately 25,000 MWh/year.	-10,400	2024	$0	$0	$0
6.3	Wind Energy	Develop new 10-year electricity supply contract beyond June 1, 2030. Assumed 70,000 MWh/yr.	-29,000	2030	$0	$0	$0
6.4	Renewable Energy Purchase (WSSC Goal)	Purchase renewable energy (with RECs) to achieve WSSC reduction goal by 2035. Based on the projected completed for the CY2022 update, no REC purchases are projected to be necessary to meet the WSSC goal.	0	NA	$0	$0	$0
6.5	Potomac Carbon Recovery	Onsite carbon capture at Potomac WTP for future Microgrid system with offsite sequestration	-23,000	2028	$0	$700,000	$4,400,000
6.6	Piscataway Bioenergy Carbon Recovery	Convert CO_2 to methanol using electro catalytic process	-11,500	2033	$10,000,000	To be determined following planned pilot study.	

[a] Life-cycle cost calculated using a discount rate of 3%.
[b] Annual savings are based on estimated annual avoided fuel purchase. Potential income from RECs is not included.
MW = megawatt(s)
MWh = megawatt hour
WB = Western Branch
yr = year

Selected Emissions Reduction Strategies

The evaluation conducted in the November 2012 GHG Action Plan resulted in 20 selected strategies that would be needed, in addition to the implementation of a new wind energy contract, to meet the 2030 GHG reduction goal.

In the subsequent GHG Action Plan updates, these strategies were reviewed and revised, as needed, to reflect the current projects underway at WSSC, as well as some strategies that have already been implemented. As a result of these investigations, the list was narrowed down as follows:

1. ~~Office Equipment –~~ This strategy is being implemented.
2. ~~Reduce Water Pressure~~ – Removed from consideration in 2016 GHG Action Plan update.
3. ~~Patuxent Reclaim Pumps –~~ Removed from consideration in 2014 GHG Action Plan update.
4. ~~Optimize Water Pumping Efficiency –~~Removed from consideration in 2016 GHG Action Plan update.
5. ~~Solar Water Heating at RGH –~~Removed from consideration in 2014 GHG Action Plan update.
6. ~~Track Water Distribution System Valves~~ Removed from consideration in 2022 GHG Action Plan update.
7. ~~Rentricity℠ Flow-to-Wire –~~ Removed from consideration in 2016 GHG Action Plan update.
8. ~~Replace Mixers at Piscataway –~~Moved to Actual Projects in 2019 GHG Action Plan update.
9. ~~Business Trip Reductions –~~Removed from consideration in 2013 GHG Action Plan update.
10. ~~Anacostia Wastewater Pumps –~~Removed from consideration in 2015 GHG Action Plan update.
11. Aeration Efficiency at Parkway ~~and Piscataway WRRFs –~~Piscataway moved to Actual Projects in 2019 GHG Action Plan update.
12. ~~Solar PV at Seneca and Western Branch (4 MW) –~~This project was completed in 2012.
13. Additional Solar Installation (11.8 MW). – Updated from 6 MW installation to 11.8 MW installation for 2022 GHG Action Plan Update
14. ~~Potomac High Zone Pumps –~~Moved to Actual Projects in 2019 GHG Action Plan update.
15. Recycling
16. ~~Telecommuting –~~ WSSC has instituted a telecommuting policy and therefore this strategy has been implemented. Note that in future inventories, data may need to be collected on the number of miles avoided in order to account for the benefit of this strategy.
17. ~~HVAC/Lighting Upgrades~~ This project is under implementation and no longer a future strategy.
18. Ostara Pearl Process–WSSC is currently evaluating the AirPrex System for phosphorus recovery.
19. ~~Optimize Wastewater Pumping Efficiency –~~Removed from consideration in 2016 GHG Action Plan update.
20. ~~Digestion/CHP –~~This project (Bioenergy at Piscataway WRRF) is under implementation.
21. Green carbon sources for denitrification.
22. Use of hybrid/alternative fuel vehicles in WSSC’s fleet.
23. Mainstream Anammox at Piscataway.
24. Replace Potomac Main Zone Pump #1.
25. Replace Aeration Blowers at Parkway.
26. Aeration Improvements at Seneca and Western Branch.
27. Carbon Recovery at Potomac

28. Carbon Recovery at Piscataway
29. Sewer Thermal at Anacostia Depot

In the 2013 GHG Action Plan update, the impact of the strategies was re-evaluated based on the latest emissions factors and updated information about each project as summarized in Table 3-1. The cumulative reduction of the remaining selected strategies by 2035 was not enough to meet the 2035 reduction goal. For this reason, two of the strategies that had previously not been selected were added back into consideration: (1) using hybrid/alternative fuel vehicles in WSSC's fleet, and (2) using green carbon sources for denitrification. In addition, a new strategy was developed: increasing the efficiency of the nutrient removal process at Piscataway, Seneca, and Western Branch WRRFs.

The 2014 GHG Action Plan update includes two additional energy-saving strategies that were identified by the Phase F EPC contract: (1) replacing the existing biological process reactor mixers at Parkway WRRF, and (2) replacing the Potomac WFP Main Zone Pump #1.

The 2015 GHG Action Plan update reflects the decision by WSSC to allow the solar developer to retain the RECs for any additional solar photovoltaic installations on WSSC facilities. These projects therefore will not impact WSSC's GHG inventory.

The 2016 GHG Action Plan update removed several strategies to reduce energy use in the drinking water distribution system and the wastewater pumping stations as these strategies have not been feasible to implement as originally envisioned. In the future, as improved pumping and control technologies come on the market, WSSC should continue to investigate, evaluate, and potentially pilot new monitoring and control systems that can lower electricity use for pumping and reduce non-revenue water.

The 2017 GHG Action Plan update obtained new data on the potential to recover phosphorus from the digested sludge at Piscataway as part of implementation of the Bioenergy project. WSSC is considering implementing the AirPrex technology instead of Ostara. AirPrex results in reduced struvite production compared to Ostara.

The 2018 GHG Action Plan update removed some strategies that have been or are being implemented, such as replacing the mixers at Parkway WRRF and implementation of the telecommuting policy and the office equipment upgrades. Four new equipment efficiency strategies were added as a result of the Energy Audit conducted at several wastewater treatment facilities.

The 2019 GHG Action Plan update removed some equipment efficiency strategies that are being implemented. The update also added a future 6-MW solar installation. The RECs will go to the solar developer but WSSC may buy them back if an economic analysis deems it feasible.

The 2020 GHG Action Plan update revised the fleet replacement strategy to account for the use of electric vehicles instead of hybrids as the fleet is replaced in future years.

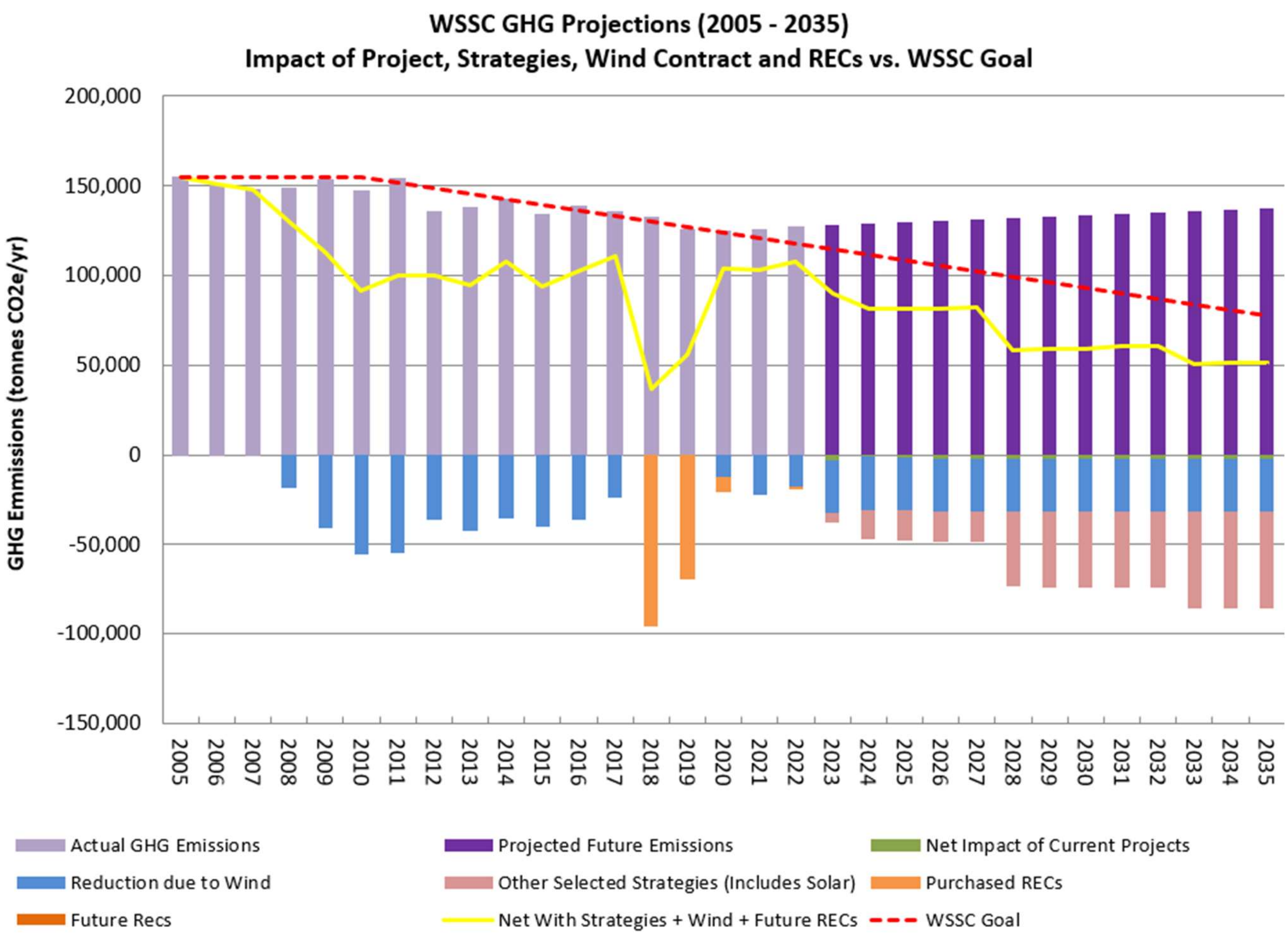
The 2021 GHG Action Plan update removed tracking water distribution valves from the strategy list.

This 2022 GHG Action Plan Update incorporates updated calculations into Strategy 3.6A - Increased Nutrient Removal Process Efficiency. The updated calculations now include aeration savings if the blowers at Seneca are replaced. The 2022 GHG Action Plan Update also added three new strategies: 5.7 (Sewer Thermal at Anacostia Depot), 6.5 (Potomac Microgrid and Carbon Recovery), and 6.6 (Piscataway Carbon Recovery).

Impact of Selected Strategies

The strategies selected, in conjunction with renewed wind contract for roughly one-third of WSSC's electricity consumption, will result in a reduction of 83,000 tonnes of CO_2e in annual GHG emissions by the year 2035. Only a reduction of 58,000 tonnes CO2e is required to meet WSSC's goals in 2035. Thus, WSSC will be exceeding their reduction goals in all future years. Figure 4-1 shows the GHG projections with the proposed strategy reductions. Figure 4-1 identifies in different categories the impact of the renewed wind contract and the REC purchases (Strategies 6.3 and 6.4 listed in Table 4-1). All the other strategies combined are shown under the "Other Selected Strategies" category.

FIGURE 4-1
Projected Future Greenhouse Gas Emissions and Impact of Selected Strategies on WSSC Goal Attainment



SECTION 5

Future Considerations

This section summarizes and updates factors identified during the November 2012 GHG Action Plan that will affect the energy use in the service district beyond the next 20 years, as well as further opportunities that WSSC should continue to monitor, assess, and pursue, if warranted, to achieve the emissions reduction goal.

Future Treatment Requirements

Wastewater Treatment

The main areas of future regulations for wastewater treatment include:

1. Reductions in the Nutrient Discharge Limits: Nitrogen and phosphorus effluent concentrations as low as 1 mg/L TN and 0.1 mg/L total phosphorus could be envisioned. Meeting these levels of treatment would require additional treatment processes such as carbon adsorption (to reduce inorganic total Kjeldahl nitrogen) and additional flocculation and filtration (to meet very low total phosphorus limits). Although these processes themselves are not overly energy-intensive, they could considerably increase the energy requirement in the facility if additional pumping of the entire plant flow is needed to meet the hydraulic requirements of the new processes.
2. Micro-constituents (polychlorinated biphenyls [PCBs], per- and polyfluoroalkyl substances [PFAS], personal-care products, pharmaceuticals): Removal of some of these micro-constituents could require energy-intensive processes such as reverse osmosis, which could increase the energy use per MG treated by about 1,500 kWh, or about a 54 percent increase from WSSC’s current average use of 2,700 kWh per MG.
3. Limits on land application of biosolids: Recent changes in biosolids management as outlined by the Maryland Department of Agriculture have restricted land application practices in Maryland. Beginning in mid-2016, 6-month bans on land applications have been enforced. In addition, the Virginia Legislature is considering regulations like those implemented in Maryland. The majority of the biosolids generated in WSSC facilities are currently land-applied in Virginia. As a result of the new regulations, management practices will force entities to manage their residuals onsite and/or transport stabilized biosolids greater distances to other states, which will increase trucking emissions. Emerging contaminants of concern, such as PFAS, could also result in restrictions or bans on land application. At WSSC, the planned Bioenergy system at the Piscataway WRRF will reduce the overall volume of biosolids to be managed offsite, which will help alleviate the impact of these new restrictions.

Water Treatment

In 2015, the U.S. Environmental Protection Agency (EPA) began its mandatory 6-year review of the National Primary Drinking Water Regulation (NPDWRs) as part of the Safe Drinking Water Act. In that effort, the EPA will assess all existing NPDWRs and will also evaluate the Contaminated Candidate List to determine which contaminants of major or immediate concern should be added to the regulations.

Contaminants that could lead to further regulations include:

1. Chemical contaminants such as estrogen-based hormones from pharmaceutical manufacturing, insecticides, and fungicides used in agricultural applications and manufacturing contaminants such as perchlorates.
2. Microbiological contaminates such as cryptosporidium, which can cause gastrointestinal and respiratory illnesses.
3. Disinfection by-products such as trihalomethanes, bromates, chlorites, and haloacetic acids.

4. PCBs that are found in landfill runoff, chemical leaching, and waste chemical discharges.
5. Algal toxins produced in algal blooms that develop when nutrients flow into waterways via agricultural runoff. These toxins can threaten humans, as is the case with microcystin, which is linked to potentially serious health effects.
6. EPA announced a proposed NPDWR for six PFAS compounds in March 2023 and the regulation is anticipated to be finalized by the end of 2023.

Most of these contaminants will require additional treatment for removal. To meet advanced treatment goals, emerging or new technologies would need to be applied that require higher consumption of energy or additional chemicals and consumables. Technologies such as ozone, ultraviolet (UV) disinfection, advanced oxidation processes, and Mixed Ion Exchange could increase electricity usage at the WFPs by 20 percent or more. Additional chemicals such as hydrogen peroxide to achieve advanced oxidation or ion exchange media for removal additional disinfection by-product precursor compounds would also increase the GHG footprint of operating these advanced systems.

Future Technological Developments

Future technological developments that may help reduce the GHG emissions at WSSC include:

- More efficient aeration systems, including high-efficiency blowers and high-efficiency diffusers (flat panel-type). WSSC is currently moving forward with projects to enhance the efficiency of the aeration blowers at the major WRRFs. In addition, new membrane-based aeration systems are being piloted that could considerably reduce the energy required to transfer oxygen to water for biological treatment.
- Advances in biological wastewater treatment, such as the deammonification process. This process reduces the aeration and supplemental carbon requirements per pound of nitrogen removed compared to the conventional nitrification-denitrification system currently used. The process also significantly reduces the amount of waste sludge produced. The deammonification process is currently being implemented in several WRRFs in the U.S. to treat side streams such as digested sludge centrate. Hampton Roads Sanitation District and Alexandria Renew Enterprises are currently in the process of implementing this technology in the mainstream. The sidestream process is part of the Piscataway WRRF Bioenergy project. If an Anammox-based system is selected for the Piscataway project, the Anammox bacteria could then be used to seed the mainstream reactors and mainstream deammonification could be implemented. This is currently a GHG reducing strategy in this GHG Action Plan.
- Advances in lamp and ballast technology to reduce energy use in UV disinfection systems. These include using light-emitting diodes to emit the UV light. The technology continues to evolve but there are no commercial applications to-date.
- Microbial fuel cells, which convert chemical energy to electrical energy by the catalytic reaction of microorganisms, could be used to generate electricity directly from the wastewater. This technology continues to evolve but is not ready for full-scale implementation.
- Installation of microturbines at pressure reducing valves (PRVs) may produce some electricity for use in distribution system facilities. This technology is typically installed in high-head PRVs. However, based on discussion with WSSC, it is not anticipated that this strategy would produce a significant amount of energy savings simply due to network PRVs being for relatively low reductions in pressure.
- Improved control technologies, neural network systems, and smart models could revolutionize how complex systems such as water distribution networks are controlled in the future. In 10 years, it is expected that new technologies will emerge that will enable systems to be optimized for energy efficiency and water quality. In addition, these advanced control systems can also be deployed at WRRFs and WFPs to optimize the facilities' operations for energy efficiency.

- Expanding implementation of micro-grids and/or energy storage systems that would allow WSSC to use and develop local renewable power more efficiently.

Reduction in Volume of Water and Wastewater Treated

To reduce the emissions associated with water treatment and pumping, WSSC could develop strategies to effectively reduce the volume of water treated at the WFPs and WRRFs. These strategies include:

- Reduction in non-revenue water: WSSC estimated in 2015 that approximately 17 to 18 percent of the water produced in the WFPs is “lost” in the system. This percentage represents inefficiency in the system and is currently caused mainly by ruptures in water mains that WSSC is working to address. As the existing water mains are replaced and better monitoring takes place, non-revenue water will be reduced. Water loss reduction is an area where there are many current technological developments, as many utilities around the world are grappling with water supply and energy-shortage problems. These technologies include development of district metering areas, where water delivery in sections of the service area is measured and compared to water delivered to the customer. A system the size of WSSC’s should have a few hundred district metering areas that could be used to identify and repair leaks and other sources of non-revenue water. New improvements in customer-level metering would also provide more-accurate and real-time data to help identify anomalies that may indicate a water leak. Also, new “software as service” products are currently coming on the market, such as a new service offered by TaKaDu to use existing system data and scan it for deviations from patterns that indicate leaks, faulty meters, or other sources of water loss.
- Reduction in I&I: The rapid increase in wastewater flows at the WSSC WRRFs can be largely attributed to I&I. WSSC is continuing to invest in sewage collection infrastructure to reduce I&I. Green infrastructure is also currently being encouraged and championed in Montgomery and Prince George’s counties to keep stormwater out of the sewage collection system.
- Water conservation: New technological advances in appliances such as washing machines, dishwashers, toilets, fixtures, and faucets continue to reduce the water used per person. In addition, WSSC could introduce water conservation incentives and education to its customers, including funding to upgrade old appliances and fixtures. Finally, if energy costs increase dramatically in the future, WSSC will have to increase water and sewer rates which will encourage reduction in water use.
- Water reuse: Reuse of treated WRRF effluent for non-potable uses (such as irrigation or cooling) continues to be a concept that is becoming more widespread in the industry as more utilities search for ways to reduce treatment costs and increase the water supply sources. In the case of WSSC, reuse of WRRF effluent is an attractive strategy because it reduces the volume of water and therefore the nutrient load released to the Chesapeake Bay. For example, the Cox Creek Water Reclamation Facility effluent currently is used for cooling at the Brandon Shores Plant in Anne Arundel County. As the population grows and the health of the Bay continues to be a concern in the region, reuse measures are likely to gain public and regulatory acceptance. Opportunities for reuse need to be identified but could include water for irrigation of golf-courses or other large landscaping users, cooling water for power plants or other industrial uses, and “purple pipe” applications such as toilet flushing in new commercial developments where a dual distribution system is installed.

Future Changes in Emissions Protocols

In 2021, both the Greenhouse Gas Protocol and The Climate Registry released updates to relevant protocols to align with the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and Global Protocol for Community Scale GHG Inventories from GHG Protocol (2021) protocols. These updates include new guidance and standards for how GHG emissions resulting from wastewater treatment processes, part of WSSC’s Scope 1 emissions, are quantified and reported.

The WSSC GHG inventory for 2023 will incorporate this updated protocol concerning CH_4 and N_2O emissions; CH_4 and N_2O especially now have a much higher impact on process emissions. This protocol change will increase overall emissions by approximately 20% each year since 2005.

Methane emissions from wastewater collection systems have historically not been included in greenhouse gas emissions inventories despite the growing evidence that this infrastructure can be a potentially significant source of such emissions. A key challenge of including sewer methane in GHG inventories is the lack of an accepted protocol to estimate these emissions as well as the extent and widespread nature of sewer networks to embark on a monitoring campaign. A preliminary estimation of GHG emissions from WSSC's collection system, methane in specific, was developed using a published methodology[1] that relies on the physical characteristics of the assets in such system. The methodology used in these estimates was empirically generated based on a limited pool of data. For this reason, the is uncertainty regarding how the specific site conditions where the data were gathered may impact the resulting equations used for this estimate.

Preliminary estimates of collection system emission (Table 5-1) using the proposed methodology and available data are between 14,600 to 34,700 tonnes CO_2e, which is approximately 14 to 34 percent of the CY2022 inventory (101,100 tonnes CO_2e). There are 13,200 to 32,00 tonnes (13 to 32 percent) of emissions from the gravity network. There are 1,400 to 2,700 tonnes (1 to 3 percent) of emissions from the pressure network and force mains. Preliminary estimates are based purely on pipe size, once average flow information and wastewater temperature become available, this estimate can be further refined using the same methodology.

TABLE 5-1
Collection System GHGs

Pipe Type	Estimated Tonnes GHGs	Percentage of Total GHGs
Force Main	1,400 to 2,700	1 to 3
Gravity Main	13,200 to 32,000	13 to 32

Increasing the accuracy of these estimates would require a deeper analysis of the collection system characteristics (for example, hydraulic behavior, ventilation regime, and wastewater quality). As with any other protocol for estimating GHG emissions, direct measurement by monitoring actual sewer methane levels at strategic locations could also increase the understanding of the extent of these emissions within the context of the overall WSSC GHG inventory.

[1] Willis, J., B. Brower, C. Peot, S. Murthy, P. Regmi, W. Graf, K. Sharma, and Z. Yuan, Z. 2018. *New GHG Methodology to Estimate/Quantify Sewer Methane*. WEF 2018 Odors and Air Quality, Portland, OR, United States. March 28.

WSSC WATER
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