Gila River Indian Community Greenhouse Gas Emissions Inventory
2007 Baseline Year

For Submittal To:

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EXECUTIVE SUMMARY

This report contains a baseline greenhouse gas (GHG) emissions inventory (EI) for the Gila River Indian Community (GRIC or Community). The boundaries for this EI are the Community boundaries, and where possible, the boundaries of the districts within the Community. The GRIC Department of Environmental Quality (DEQ) received funding for this project through the Climate Showcase grant from the United States Environmental Protection Agency (EPA).

The baseline GHG EI includes emissions from mobile sources, electricity generation based on usage, natural gas usage, propane usage, and other sources of GHG emissions. The calculations for emissions related to electricity usage are based on the reported GHG emissions at the site where the electricity was generated, and are therefore considered indirect emissions. The data collection was accomplished by requesting data from electricity, natural gas and propane providers; using vehicle miles traveled (VMT) data from the 2007 GRIC criteria pollutant EI; and using available data for agricultural acreage in production, electricity transmission lines within the Community, wastewater treatment plants, and recycling.

When possible, data for calendar years 2007 – 2009 were used, with the focus on 2007 as a baseline year since it is the baseline year for the GRIC's most recent criteria pollutant EI. Emissions calculations are focused on carbon dioxide (CO_2) emissions, but when possible included other GHGs (methane [CH_4], nitrous oxide [N_2O], and sulfur hexafluoride [SF_6]) reported as carbon dioxide equivalent (CO_2e). Each GHG has a different global warming potential (GWP) effect on the atmosphere, with CO_2 serving as the reference gas (see Table 1.1). Emissions were calculated using several methods, including EPA GHG Equivalency Calculators, AP-42 emissions factors, US Department of Energy (DOE) fuel economy estimates, and EPA Technical Support Documents.

Table E.1 Global Warming Potentials for GHG Emissions (EPA values based on Intergovernmental Panel on Climate Change [IPCC] Third Assessment Report, 2001)

Gas	GWP
CO_2	1
CH_4	23
N_2O	296
SF_6	22,200

The results of this GHG EI will be used to determine the major sources of GHG emissions on the Community, including indirect emissions based on usage, and to understand trends in emissions (e.g. electricity usage per household) over time. Since the Community experiences relatively slow growth when compared with the growth of areas like Metropolitan Phoenix, some of these baseline emissions values are expected to remain relatively constant over time.

Mobile sources represented the largest category of emissions sources for the criteria pollutant EI in 2007, and also for this GHG EI. Electricity generation based on usage was the second largest category of GHG emissions on the Community.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 Background

The Gila River Indian Community (GRIC or Community), a federally-recognized tribe, is a rural community located on approximately 374,000 acres in south-central Arizona, adjacent to the southern border of Phoenix, Chandler, and Gilbert, with an on-reservation population of approximately 12,000 people (Figure 1). The reservation was established in 1859 by Executive Order with Congressional approval. Members of the Community are Akimel O'odham (Pima) and Pee Posh (Maricopa) and form the fourth most populous Indian Reservation in the United States. On the northern boundary, the Community is adjacent to the rapidly growing Phoenix metropolitan area. A portion of the Community (92,000 acres) lies within Maricopa County. This portion of GRIC is located within the Federal Non-Attainment Area for particulate matter less than 10 microns (PM10), which has been classified as "serious" by the Environmental Protection Agency (EPA). It is currently undetermined to what extent air pollution from the Phoenix metropolitan area affects air quality within GRIC boundaries.

The Community has three industrial parks containing approximately 50 industrial plants along with several industrial facilities located in outlying areas. The Lone Butte Industrial Park, the largest of the three industrial parks, lies within the Maricopa County non-attainment area and includes one Federally-regulated major source (Pimalco). The remaining two industrial parks are much smaller and contain only minor sources of air pollution. These industrial facilities are not required to submit any greenhouse gas (GHG) emissions reports to GRIC Department of Environmental Quality (DEQ) or to the EPA. There is no previous GHG emissions inventory (EI) report for the Community.

Agricultural production throughout the Community includes cotton, alfalfa, wheat/barley, citrus and vegetables. There were approximately 35,065 acres in agricultural production in 2007 throughout the Community. Approximately 6,700 agricultural acres are located within the Maricopa County non-attainment area.

The largest source of both criteria air pollution and GHG emissions within the Community is vehicle emissions. Interstate 10 is the single largest source of criteria pollution with approximately 1,400,000 vehicle miles traveled (VMT) within the Community daily. The second largest source of GHG emissions is electricity generation (indirect) based on usage within the Community.

1.2 Study Area

The Community extends from the towns of Phoenix and Chandler on the north, south to near Casa Grande, and from the Estrella Mountains on the west to Coolidge on the east (Figure 1). The Community lies in Sonoran Desert terrain that is primarily light scrub and cactus with an elevation of approximately 1,200 to 1,400 feet above sea level. The temperature varies from approximately 20°F in the winter to >115°F in the summer. Annual precipitation is light with approximately 36 days per year with >0.01 inches. Wind speed and direction can vary, but

generally the wind blows from the southwest to the northeast in the morning and reverses direction in the afternoon. Wind speed can vary from a slight breeze to 70 mile per hour winds during the summer monsoon season.

2.0 METHODOLOGIES

To prepare this GHG baseline EI, the GRIC DEQ assessed mobile source emissions, electricity usage, natural gas usage, propane usage, and other emission source categories. The calculations were used to report consistent units of GHG emissions as tons of carbon dioxide equivalent (CO_2e). Emissions were calculated using several methods, including EPA GHG Equivalencies Calculator, AP-42 emissions factors, EPA and Department of Energy (DOE) fuel economy estimates, and EPA Technical Support Documents. These methodologies were presented to and approved by EPA at the beginning of the project for approval, since there are no existing guidelines for preparation of a GHG EI for Indian Reservations.

2.1 Mobile Source Emissions

To estimate GHG emissions from mobile sources, DEQ used VMT data from the 2007 criteria pollutant EI (originally collected from Maricopa Association of Governments [MAG], Maricopa County Department of Transportation [MCDOT], Arizona Department of Transportation [ADOT] and GRIC Department of Transportation [DOT]) and the calculation from the EPA GHG Equivalencies Calculator. In addition, average fuel economy for both gasoline and diesel fueled vehicles was used (EPA and DOE). The calculation provided by EPA accounts for CO_2, CH_4, and N_2O emissions and reports all of those as tons of CO_2e.

2.2 Electricity Usage

To calculate indirect GHG emissions based on electricity usage (not actual emissions at the source of generation), the regional Emissions & Generation Resource Integrated Database (eGRID) default emissions factor was used for customers of Gila River Indian Community Utility Authority (GRICUA), Arizona Public Service (APS) and the San Carlos Irrigation Project (SCIP). The Power Profiler equation was used for Salt River Project (SRP) customers within the community. These calculations only include CO_2 emissions. A separate calculation for sulfur hexafluoride (SF_6) emissions related to electricity transmission lines is included in section 7.2.

2.3 Natural Gas Usage

The EPA GHG Equivalencies Calculator includes a calculation for CO_2 emissions from the burning of natural gas for heating. This does not include natural gas (methane or CH_4) released to the atmosphere.

2.4 Propane Usage

The EPA GHG Equivalencies Calculator includes a calculation for CO_2 emissions from the burning of propane for heating or cooking.

2.5 Other Sources

Emissions related to agricultural production were calculated using the AP-42 emissions factor for nitrous oxide (N_2O) based on tons of fertilizer applied. The amount of fertilizer applied in 2007 was obtained from the GRIC 2007 criteria pollutant EI.

To calculate SF_6 emissions related to electricity transmission, the miles of transmission lines within the Community were obtained from GRICUA, and emissions were calculated based on equations in the EPA Technical Support Document for Process Emissions of Sulfur Hexafluoride (SF_6) and Perfluorinated Compounds (PFCs) from Electric Power Systems: Proposed Rule for Mandatory Reporting of Greenhouse Gases.

Published GHG emissions estimates from municipal wastewater treatment processes (Hicks 2010) were used to estimate the emissions from the Chandler Wastewater Treatment Plant and 14 other plants which are located on the Community.

Cardboard recycling figures for 2007 were used to estimate reductions in GHG emissions, compared to a life-cycle assessment methodology to estimate a baseline of emissions from landfilled waste, using the EPA Waste Reduction Model (WARM).

3.0 MOBILE SOURCE EMISSIONS

The calculation of GHG emissions from mobile sources was based on the EPA GHG Equivalencies Calculator and applied to 2007 GRIC EI data. The calculation for mobile source GHG emissions uses an average value for gasoline powered vehicles of 19.67 pounds CO_2 / gallon of gasoline (0.00892 metric tons CO_2 / gallon of gasoline), and average fuel efficiency of 20.4 miles per gallon (EPA fuel economy). The 2007 total vehicle miles traveled (VMT) on the Community of 895,337,335 was distributed as 90 percent gasoline and 10 percent diesel vehicles. The ratio of CO_2 emissions to total emissions (including CO_2, CH_4 and N_2O) as CO_2e was 0.977 for 2007 (1 metric ton = 1.10231 tons).

To calculate emissions from diesel powered vehicles, the same equation was applied to 10 percent of the VMT with the EPA emission factor of 22.2 pounds CO_2 / gallon of diesel (0.01007 metric tons CO_2 / gallon of diesel) and average fuel efficiency for diesel heavy duty trucks of 6.6 mpg (DOE fuel economy). Table 3.1 includes a summary of calculated mobile source GHG emissions.

Table 3.1 Mobile Source Emissions 2007 Baseline Tons CO_2e for GRIC

Mobile Source	VMT 2007	Metric Tons CO_2/gal	CO_2:GHG ratio	Tons CO_2e
Gasoline Vehicle	805,803,601.5	0.00892	0.977	379,456.68
Diesel Vehicle	89,533,733.5	0.01007	0.977	147,116.00
Total 2007	895,337,335.0			**526,572.68**

4.0 ELECTRICITY USAGE

Electricity usage in kilowatt-hours (kWh) on the Community for calendar years 2007 – 2009 was requested from SRP, GRICUA, SCIP, and APS. APS could not provide data specific to the Community since only 10 homes in District 7 have APS service; therefore, the SRP average household usage data (2007 annual kWh) was used to estimate total usage for APS customers on the Community for this GHG EI. GRICUA data were provided as total energy sales for Federal fiscal years (FY 2008 is October 2007 – September 2008). SCIP data was provided as total energy sales for FY2010.

SRP provided calendar year 2007 – 2009 data separated into commercial and residential customer categories. This allowed DEQ to calculate additional comparisons including changes in usage per household and per commercial customer for SRP customers (Tables 4.1 & 4.2). SRP serves customers in Districts 6 and 7.

Table 4.1: SRP Residential Annual Electricity Usage on GRIC

Calendar Year	kWh Used	# Households	Usage/Household	% change from 2007
2007	2,830,178	195	14,514	0%
2008	2,872,259	206	13,943	-4%
2009	3,427,362	268	12,789	-12%

Table 4.2: SRP Commercial Annual Electricity Usage on GRIC

Calendar Year	kWh Used	# Customers	Usage/Customer	% change from 2007
2007	15,596,170	100	155,962	0%
2008	16,257,068	119	136,614	-12%
2009	16,274,665	106	153,534	-2%

Note that the trend in annual electricity usage per household and customer was lower in 2008 and 2009 compared to the 2007 baseline. The national average for single-family home electricity consumption was 12,773 kWh (EPA GHG Equivalencies Calculator). It is not surprising that the SRP average electricity usage per household on GRIC is slightly higher than the national average, considering the hot summer temperatures and need for air conditioning.

The Power Profiler equation (EPA Clean Energy) was used for SRP GHG emissions (Tables 4.3 & 4.4). The SRP specific emissions factor = 6.5667×10^{-4} tons CO_2 / kWh.

Table 4.3: SRP CO_2 Emissions from Residential Electricity Usage on GRIC

Calendar Year	kWh Used	SRP CO_2 Emission Factor	Tons of CO_2 Emitted
2007	2,830,178	6.5667×10^{-4} tons CO_2 / kWh	1,858.49
2008	2,872,259	6.5667×10^{-4} tons CO_2 / kWh	1,886.13
2009	3,427,362	6.5667×10^{-4} tons CO_2 / kWh	2,250.65

Table 4.4: SRP CO_2 Emissions from Commercial Electricity Usage on GRIC

Calendar Year	kWh Used	SRP CO_2 Emission Factor	Tons of CO_2 Emitted
2007	15,596,170	6.5667 x 10^{-4} tons CO_2 / kWh	10,241.54
2008	16,257,068	6.5667 x 10^{-4} tons CO_2 / kWh	10,675.53
2009	16,274,665	6.5667 x 10^{-4} tons CO_2 / kWh	10,687.08

Note that the trend in annual CO_2 emissions for SRP customers was higher in 2008 and 2009 compared to the 2007 baseline. Although the usage per household and customer was lower, the number of households and customers increased from 2007 levels. These calculations only include CO_2 emissions; other GHGs emitted from electricity generation are considered negligible.

For GRICUA, SCIP, and APS the general emissions factor was used (from: eGRID2010 Version 1.1, U.S. annual non-baseload CO_2 output emission rate, year 2007 data):

Emissions factor = 6.8956 x 10^{-4} metric tons CO_2 / kWh

Tables 4.5, 4.6 and 4.7 include calculations and estimates for GRICUA, APS and SCIP based on available data supplied to GRIC DEQ and emissions factor for electricity usage in 2007. Table 4.8 is a summary of all electricity usage GHG emissions for GRIC.

Table 4.5: GRICUA CO_2 Emissions on GRIC

Fiscal Year	kWh Sold	CO_2 Emission Factor	Tons of CO_2 Emitted
2008	85,068,620	6.8956 x 10^{-4} tons CO_2 / kWh	64,661.41
2009	117,104,110	6.8956 x 10^{-4} tons CO_2 / kWh	89,011.87
2010	126,119,573	6.8956 x 10^{-4} tons CO_2 / kWh	95,864.61

Table 4.6: APS CO_2 Emissions on GRIC (estimated for 10 households)

Calendar Year	kWh Used	CO_2 Emission Factor	Tons of CO_2 Emitted
2007	145,140	6.8956 x 10^{-4} tons CO_2 / kWh	110.32

Table 4.7: SCIP CO_2 Emissions on GRIC

Fiscal Year	kWh Sold	CO_2 Emission Factor	Tons of CO_2 Emitted
2010	97,565,000	6.8956 x 10^{-4} tons CO_2 / kWh	74,160.02

Table 4.8: 2007 Baseline Summaries of CO_2 Emissions on GRIC from Electricity Usage

Supplier	kWh	CO_2 Emission Factor	Tons of CO_2 Emitted
SRP residential	2,830,178	6.5667 x 10^{-4} tons CO_2 / kWh	1,858.49
SRP commercial	15,596,170	6.5667 x 10^{-4} tons CO_2 / kWh	10,241.54
GRICUA	85,068,620	6.8956 x 10^{-4} tons CO_2 / kWh	64,661.41
APS	145,140	6.8956 x 10^{-4} tons CO_2 / kWh	110.32
SCIP	97,565,000	6.8956 x 10^{-4} tons CO_2 / kWh	74,160.02
Total	201,205,108		**151,031.80**

5.0 NATURAL GAS USAGE

Carbon dioxide emissions per therm of natural gas burned were determined by multiplying heat content (average is 0.1 million British Thermal Units [mmbtu]), times the carbon coefficient (14.47 kilograms [kg] carbon per mmbtu), times the fraction oxidized (assumes 100%), times the ratio of the molecular weight of carbon dioxide to carbon (44/12). (1 metric ton = 1.10231 tons)

0.1 mmbtu/1 therm * 14.47 kg C/mmbtu * 44 g CO_2/12 g C * 1 metric ton/1000 kg =
0.0053 metric tons CO_2/therm or 0.0058 tons CO_2/therm.

Southwest Gas provided natural gas usage data for 2009 of 1,493,739 therms for 8,116 customers in District 4. The total calculated emissions are **8,736.12 tons** of CO_2.

6.0 PROPANE USAGE

The EPA GHG equivalencies calculator estimates 0.024 metric tons of CO_2 are emitted from burning each 18 pound (lb) propane cylinder (0.0265 tons CO_2 per cylinder). Propane usage for Gila River Farms and residential customers throughout the Community was reported to be 253,971 gallons in 2007. This is equivalent to 59,260 cylinders or **1,567.75 tons** of CO_2.

7.0 OTHER SOURCES

GRIC DEQ collected available data for agricultural acreage in production, electricity transmission lines within the Community, wastewater treatment plants, and recycling.

7.1 Agricultural Soil Management

Nitrous oxide is produced naturally in soils through the microbial processes of denitrification and nitrification. These natural emissions of N_2O can be increased by a variety of agricultural practices and activities, including the use of synthetic and organic fertilizers, production of nitrogen-fixing crops, cultivation of high organic content soils, and the application of livestock manure to croplands and pasture. All of these practices directly add additional nitrogen to soils, which can then be converted to N_2O. Indirect additions of nitrogen to soils can also result in N_2O emissions. Indirect additions include those processes by which applied fertilizer or manure nitrogen volatilizes into ammonia and oxides of nitrogen and then is ultimately re-deposited onto the soil in the form of particulate ammonium, nitric acid, and oxides of nitrogen. Surface run-off and leaching of applied nitrogen into ground water and surface waters can also result in indirect additions of nitrogen to the soil.

The Compilation of Air Pollution Emissions Factors AP-42 Fifth Edition, Section 14.1 addresses nitrous oxide (N_2O) emissions from soils. Emission factors are presented for N_2O emitted from agricultural and non-agricultural soils. The N_2O emission factor for agricultural soils is presented as an equation, and was taken directly from the U.S. EPA (1995) State Workbook and the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 1993. For agricultural soils, emissions of N_2O are affected by the use of nitrogen-containing fertilizers. The equation to estimate N_2O emissions associated with fertilizer application is:

N_2O Emissions = FC * EC * (44/28)

Where: FC = Fertilizer consumption (tons N-applied);
EC = Emission coefficient (0.0117 tons N_2O - N/ton N-applied); and
44/28 = Molecular weight ratio of N_2O to N_2O as N (N_2O/N_2O-N).

Based on the 2007 GRIC EI with 35,065 acres in agricultural production (cotton, alfalfa, wheat/barley, citrus and vegetables) and 2,689 tons of fertilizer used, the resulting N_2O emissions are 49.44 tons, which is **14,634.07 tons** of CO_2e emissions (using GWP of 296).

7.2 Electricity Transmission

To calculate SF_6 emissions related to electricity transmission, the miles of transmission lines within the Community were obtained from GRICUA, and emissions were calculated based on equations in the EPA Technical Support Document for Process Emissions of Sulfur Hexafluoride (SF_6) and PFCs from Electric Power Systems: Proposed Rule for Mandatory Reporting of Greenhouse Gases.

For this GHG EI, DEQ used the estimate of 25,000 metric tons of CO_2e per 1,186 miles of transmission. GRICUA provided the estimate of 110 miles of transmission lines within the Community.

25,000 metric tons CO_2e/1,186 miles * 110 miles * 1.1023 ton/metric ton =
2,555.95 tons CO_2e

Based on the conversion of 713 lbs of SF_6 = 1000 metric tons of CO_2e, 1 metric ton = 1.10231 tons or 2204.622 lbs, this is equivalent to 1,653.24 lbs of SF_6.

7.3 Wastewater Treatment

Published GHG emission factors from municipal wastewater treatment processes were used to estimate the emissions from the Chandler Wastewater Treatment Plant and 14 other plants which are located on the Community. While emissions from plants can vary greatly depending on the processes employed, the published estimate of 0.410 grams of CO_2e per Liter of wastewater treated was used to calculate emissions based on 10 million gallons per day of wastewater treatment at the Chandler plant, and a combined 4.4 million gallons per day at the other 14 plants (Glenn Stark, GRIC DEQ, personal communication). This includes CO_2, CH_4, and N_2O emissions based on monitoring data.

The resulting annual emissions calculated = **8,991.06 tons** CO_2e

7.4 Recycling

The EPA GHG equivalencies calculator uses emission factors from EPA's Waste Reduction Model (WARM), which estimates that 2.87 metric tons of CO_2e are avoided for each ton of mixed waste recycled instead of landfilled.

Cardboard recycling on GRIC totaled 28.89 tons in 2007, which is **91.40 tons CO_2e avoided**.

8.0 SUMMARY

Mobile sources represented the largest category of emissions sources for the criteria pollutant EI in 2007, and also for this GHG EI. Electricity generation based on usage was the second largest category of GHG emissions on the Community. The third largest category was emissions resulting from fertilizer usage on agricultural land. Cardboard recycling on GRIC in 2007 resulted in 91.40 tons CO_2e emissions avoided.

Table 8.1: 2007 Baseline Summary of Calculated CO_2e Emissions on GRIC

Source	Year of Data Used	Tons of CO_2e Emitted
Mobile Sources	2007	526,572.68
Electricity Usage	2007 - 2010	151,031.80
Natural Gas Usage	2009	8,736.12
Propane Usage	2007	1,567.75
Agricultural	2007	14,634.07
Electricity Transmission	2007	2,555.95
Wastewater Treatment	2007	8,991.06
Total		**714,089.43**

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