Final Report for 2020 Southern Ute Indian Tribe Comprehensive Emissions Inventory for Criteria Pollutants, Hazardous Air Pollutants, and Greenhouse Gases

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List of Acronyms

AP-42	EPA Compilation of Air Pollutant Emission Factors
API	American Petroleum Institute
AQP	Air Quality Program
BIA	United States Bureau of Indian Affairs
BSFC	Brake Specific Fuel Consumption
BTEX	Benzene, Toluene Ethyl-Benzene, Xylene
bbl	Barrel (42 U.S. Gallons)
CAA	Clean Air Act
CARMMS	Colorado Air Resource Management Modeling Study
CDPHE	Colorado Department of Health and Environment
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO2*e*	Carbon Dioxide Equivalent
COGCC	Colorado Oil and Gas Conservation Commission
CY	Calendar Year
CFR	Code of Federal Regulations
DRMS	Colorado Division of Reclamation Mining and Safety
EI	Emissions Inventory
EIA	Environmental Impact Assessment
EPA	United States Environmental Protection Agency
FAA	Federal Aviation Administration
GHG	Greenhouse gas
GSJB	Greater San Juan Basin
HAP	Hazardous Air Pollutants
hp	Horse Power
H_2S	Hydrogen Sulfide
ICR	Information Collection Request
ITEP	Institute for Tribal Environmental Professionals
Kdf	Cretaceous Fruitland Formation
Kpcl	Cretaceous Picture Cliffs Sandstone
LFG	Landfill Gas

LP	Liquid Petroleum
LTO	Landing and Take-off Cycles
MMscf	Million Standard Cubic Feet
MSW	Municipal Solid Waste
NEI	National Emissions Inventory
NMHC	Non-methane Hydrocarbons
NMOC	Non-methane Organic Compounds
NO_x	Oxides of Nitrogen
NPS	National Park Service
O_3	Ozone
Pb	Lead
PM_{10}	Particulate Matter 10 microns and smaller
$PM_{2.5}$	Particulate Matter 2.5 microns and smaller
PSD	Prevention of Significant Deterioration
PTE	Potential to Emit
QA	Quality Assurance
RICE	Reciprocating internal combustion engine
scf	Standard Cubic Feet
SO_2	Sulfur Dioxide
SUIT	Southern Ute Indian Tribe
TEG	Tri-ethylene Glycol
TEISS	Tribal Emissions Inventory Software Solutions
THC	Total Hydrocarbons
TMNSR	Tribal Minor New Source Review Program
TOC	Total Organic Compounds
tpy	Tons per Year
USFS	United States Forest Service
VOC	Volatile Organic Compounds
WRAP	Western Regional Air Partnership
4SLB	Four stroke lean burn
4SRB	Four stroke rich burn
2SLB	Two stroke lean burn

I. Executive Summary

The Southern Ute Indian Tribe (Tribe) Air Quality Program (AQP) has prepared an emissions inventory of quantifiable point and non-point sources on the Southern Ute Indian Reservation (Reservation) for calendar year 2020 (CY2020). The emissions inventory was prepared according to the Environmental Protection Agency Class II emission inventory guidelines of using measured data when available or data and emissions factors from reputable sources when measured data were not available.

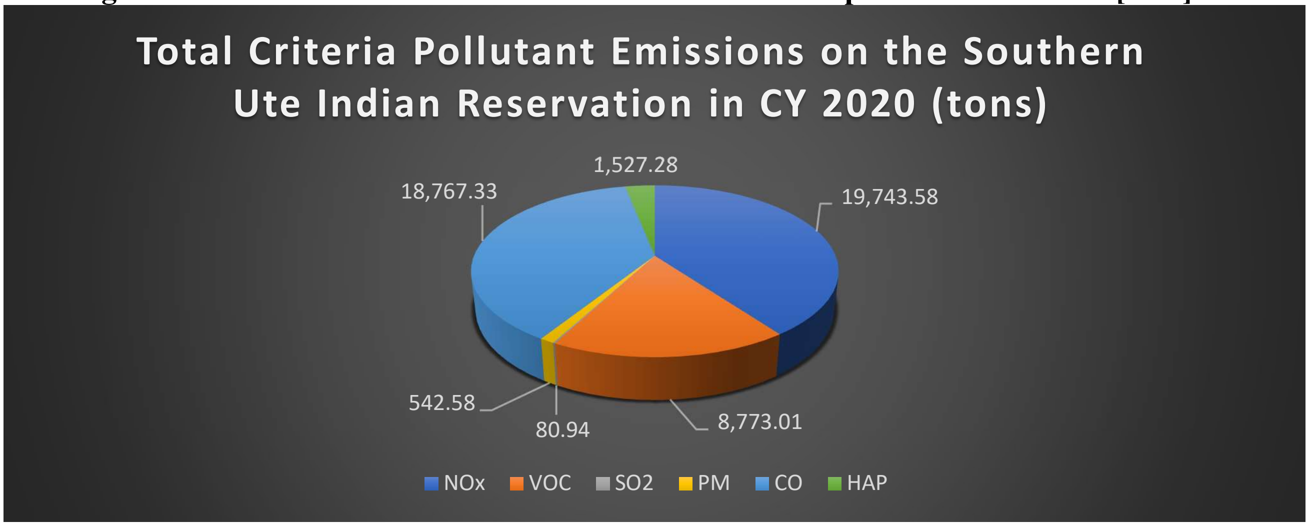
Oil and natural gas production is the predominant industry on the Reservation and emissions data for these sources were collected directly from source operators through annual emission inventories, registrations from sources under the Tribal Minor New Source Review (TMNSR) program (true minor sources), and a Clean Air Act (CAA) Section 114 information collection request issued by the Tribe in June 2021. Data for other sources were collected from various reputable state, local, and federal data sources.

This report also covers emissions from landfills, nonpoint sources, mobile sources, wildfires, biogenic sources, and the Fruitland outcrop. Nonpoint sources include agricultural burning, residential heating, gravel pits. gas stations, and airports.

Reservation emission totals for CY 2020 were 19,743.58 tons of oxides of Nitrogen (NOx), 8,773.01 tons of Volatile Organic Compounds (VOC), 80.94 tons of Sulfur Dioxide (SO_2), 396.57 tons of Particulate Matter 10 micrometers or less in diameter (PM_{10}), 146.02 tons of Particulate Matter 2.5 micrometers or less in diameter ($PM_{2.5}$), 18,767.33 tons of Carbon Monoxide (CO), 1,527.28 tons of total Hazardous Air Pollutants (HAP), and 11,342,510.62 metric tonnes of Greenhouse Gas (GHG) emissions measured in Carbon Dioxide Equivalent (CO2*e*).

Total criteria pollutant (NOx, VOC, SO_2, PM_{10}, $PM_{2.5}$, CO) and HAP emissions on the Reservation for 2020 are presented below in Figure 1.

Figure 1: Southern Ute Indian Reservation total criteria pollutant emissions [tons]



II. Overview

1. Purpose of Inventory

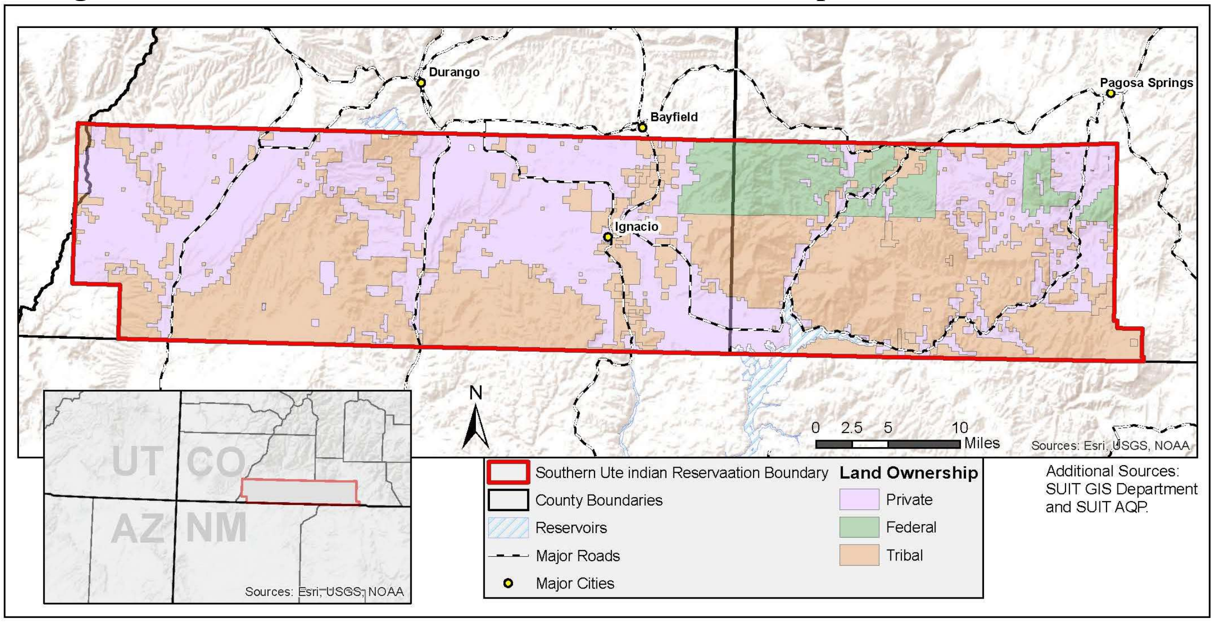
The purpose of this Emissions Inventory (EI) was to establish baseline emissions estimates for the 2020 calendar year for all quantifiable air emission sources located within the exterior boundaries of Reservation. The emissions data for the Reservation presented in this EI has been organized by source category and pollutant. The EI will be used for future air quality planning purposes, such as development of air quality regulations targeted at ozone precursors for maintaining attainment with the National Ambient Air Quality Standards, emissions modeling, and Title V permitting fee analysis.

The primary air pollutants included in this EI are NOx, CO, PM_{10}, $PM_{2.5}$, VOC, HAP, and GHG.

2. Geographic Location of Southern Ute Indian Reservation

The Reservation is located in southwestern Colorado. The Reservation land area covers 1,066 square miles in three counties (La Plata, Archuleta, and Montezuma) and borders New Mexico to the south (Figure 2). The total area covered by this inventory is approximately 682,590 acres, which encompasses all land within the external boundaries of the Reservation. The Southern Ute Indian Tribe (Tribe) and/or its members own approximately 320,000 acres, while the remaining land mass is comprised of non-Indian and government land in a checkerboard fashion. The primary land use is agricultural, and the predominant industry is oil and natural gas production.

Figure 2: Southern Ute Indian Reservation total criteria pollutant emissions [tons]



3. Climate

The Reservation remains generally semi-arid throughout the year. Located north of northern New Mexico desert land and south of the Colorado alpines, the average temperature range during the winter months average temperatures are between 20 and 40 degrees Fahrenheit. Freezing temperatures are common throughout the winter and during the 2020 calendar year the coldest month was February with a low of 3.4 degrees Fahrenheit and a monthly average of 32.4 degrees Fahrenheit. During the summer months the average high temperatures were in the high eighties and nineties. The warmest month of 2020 was July with a high of 99.6 degrees Fahrenheit, and a monthly average of 73.6 degrees Fahrenheit. Rain was the dominant form of precipitation on the Reservation and total precipitation for calendar year 2020 was 4.0 inches. The driest month was June with 0.3 inches of precipitation and the wettest month was August with 2.2 inches of precipitation.[1]

4. Geology

The Reservation is situated in the northern portion of the San Juan Basin, a geologic structural basin underlying southwestern Colorado and northwestern New Mexico. The basin is composed of Cambrian to Holocene aged sedimentary rocks and contains one of the

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[1] Southern Ute Indian Tribe: Ambient Monitoring. (2020). *2020 AQS Ute 3 Humidity and Temperature Hourly Data.* Retrieved from: http://www.southernute-nsn.gov/environmental-programs/air-quality/ambient-monitoring/.

largest coal-bed methane natural gas fields in the world within the Cretaceous aged Fruitland Formation.[2] The majority of the natural gas production on the Reservation is coalbed methane from the Fruitland Formation, but conventional natural gas is also produced from Cretaceous aged sandstone reservoirs of the Pictured Cliffs Formation, Mesa Verde Group, and the Dakota Sandstone. Tight gas reservoirs of the Cretaceous aged Mancos Shale have also been drilled, however, no significant exploration and production has occurred within the Reservation as of 2020.

5. Sources

The sources included in this emissions inventory were organized according to source type and size. These sources are as follows:

A. Point Sources

1) Title V permitted oil and natural gas sources
2) TMNSR minor oil and natural gas sources, including:
    a. Permitted minor TMNSR sources,
    b. Registered minor TMNSR sources,
3) Municipal solid waste landfills, and
4) Airports.

B. Non-point Sources

1) Small oil and gas sources,
2) Fruitland Formation Outcrop natural gas seeps,
3) Gasoline stations,
4) Aviation gasoline dispensing,
5) Gravel pits,
6) Residential heating, and
7) Agricultural burning.

C. Mobile Sources

1) On-road vehicles, and
2) Non-road equipment.

D. Events

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[2] Fasset, J. E., & Hinds, J. S. (1971). Geology and Fuel Resources of the Fruitland Formation and Kirtland Shale of the San Juan Basin, New Mexico and Colorado. Geological Survey Professional Paper 676. United States Government Printing Office. Retrieved from https://pubs.usgs.gov/pp/0676/report.pdf.

1) Fire events (wildland fires and prescribed burns).

E. Biogenic Sources

III. Data Quality Objectives

Data objectives for this inventory are as follows:

1. Accuracy

- Data for this EI were collected according to EPA level II EI guidelines using measured data when available or data from reputable sources such as EPA, the Colorado Oil and Gas Conservation Commission (COGCC) and professional organizations when measured data were not available.
- Emission factors were developed using measured data or commonly accepted emissions factors and assumptions from EPA and professional organizations.
- All data sources, emission factors, assumptions, and emission calculation methodologies were documented.
- Emission calculation models were utilized when available (GRI-GLYCalc 4.0, Tanks 4.09d, etc.) and all inputs are provided in annual emission reports or 2020 CAA Section 114 Information Collection Request (ICR) worksheets.
- Results of the 2020 SUIT EI were compared with results from the 2017 SUIT EI.
- Quality Assurance review of emission totals, assumptions, emission factors, and calculation methodologies was conducted by a third-party contractor.

2. Uncertainty

- Reported emissions may be inaccurate.
- The number of unreported oil and gas sources is unknown and can only be estimated based on sources reported to COGCC.
- Emissions differences between CY2020 SUIT EI, CY2017 SUIT EI, and CY2015 SUIT EI may occur due to different preparation methodologies and assumptions.

3. Completeness

- Capture 100% of point source emissions reported in the annual emission fees for CY2020.
- Capture 95% of non-point oil and gas sources in the 2020 CAA 114 ICR.
- Reported information will be used to extrapolate emissions to 100% to fill data gaps.
- Capture 80% of area sources (gas stations, etc.).

4. Comparability

- EI results will be compared with results from the 2017 SUIT EI and 2015 SUIT EI.
- Emission factors and assumptions will be compared with methodologies used in similar emission calculation applications.

IV. Point Sources

As of 2020, there were a total of 2,860 oil and gas production sources operating on the Reservation. These sources consisted of 35 sources operating under Title V operating permits, 11 sources operating under TMNSR permits (synthetic minor sources), 238 true minor sources, and 2,582 non-point sources with emissions below the TMNSR program thresholds, referred to in this emissions inventory as “small oil and gas sources”.

1. Title V Permitted Oil and Gas Sources

Description of Sources

Thirty-five oil and gas Title V sources operated on the Reservation during calendar year 2020. Sources include natural gas compressor stations, central delivery points, treating plants, and processing plants.

Title V sources are defined as sources with the potential to emit (PTE) 100 tons per year (tpy) of a single criteria pollutant, 25 tpy of HAP in aggregate, or ten tpy of an individual HAP. The Tribe has full delegation of a Title V operating permit program under 40 CFR Part 70 and during calendar year 2020, 35 oil and gas sources operated under Tribally-issued Title V permits.

Data Collection

Title V sources are required to report emissions annually and pay a per-ton emission fee for pollutants emitted. Emissions data for Title V sources were collected directly from the calendar year 2020 fee calculation worksheets submitted by each source to the Tribe. Actual emissions data were available for all 35 Title V oil and gas sources. GHG emissions, reported as carbon dioxide equivalent ($CO2e$) were obtained from fee calculation worksheets (if provided) and if not, the PTE listed in their most recent Title V permit renewal was used and cross checked with EPA Facility Level Information on GreenHouse Gases Tool (FLIGHT) at https://ghgdata.epa.gov/ghgp/main.do. This data collection methodology adheres to the EPA level II EI guidelines for utilizing measured data when available.

Emissions

Total criteria pollutant, HAP, and GHG emissions estimated from Title V sources for the 2020 calendar year are displayed below in Table 1.

Table 1: Title V criteria pollutant, HAP, and GHG emissions estimations [tons]*

Pollutant	NOx	VOC	SO2	PM	CO	Total HAP	GHG
Emissions	2,359.8	1,032.9	46.9	101.9	1,872.9	306.1	2,124,765.3

*CO2*e* emissions for all Title V sources are reported values obtained from annual Title V fee forms and EPA GHG data and are reported in metric tonnes

Total criteria pollutant and HAP emissions by equipment type from Title V sources for the 2020 calendar year are displayed below in Figures 3 through 5.

Figure 3: Criteria pollutant and HAP emissions at Title V sources [tons]

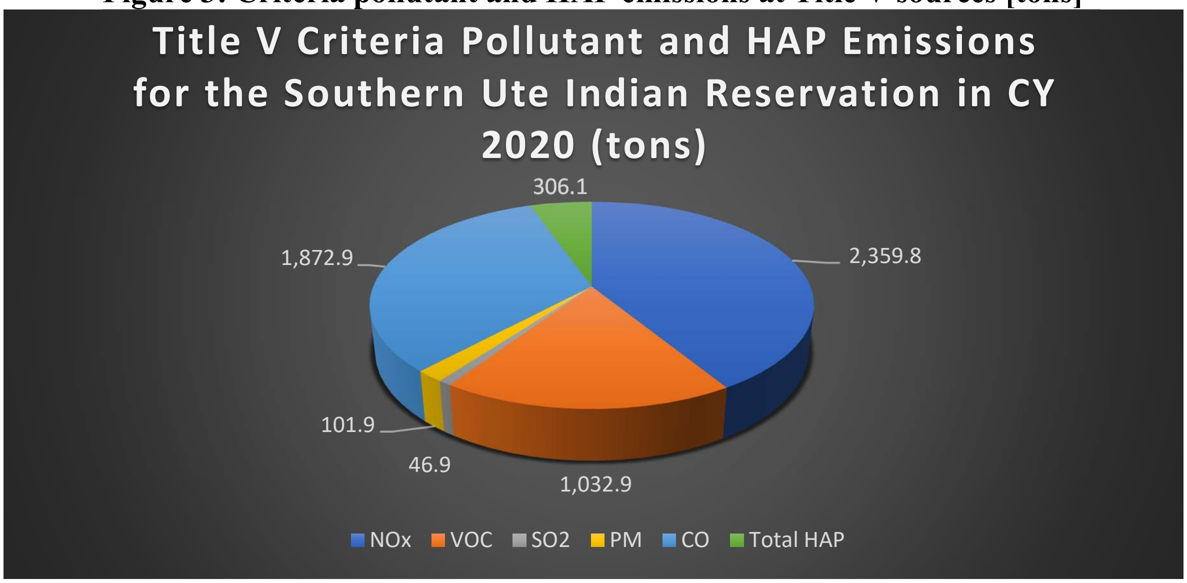
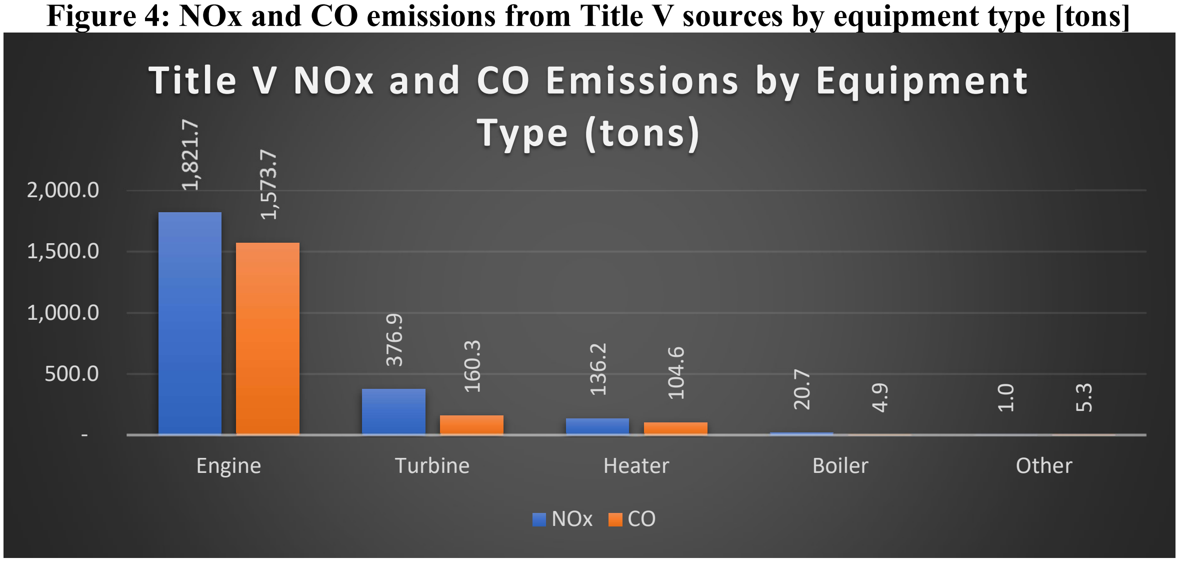
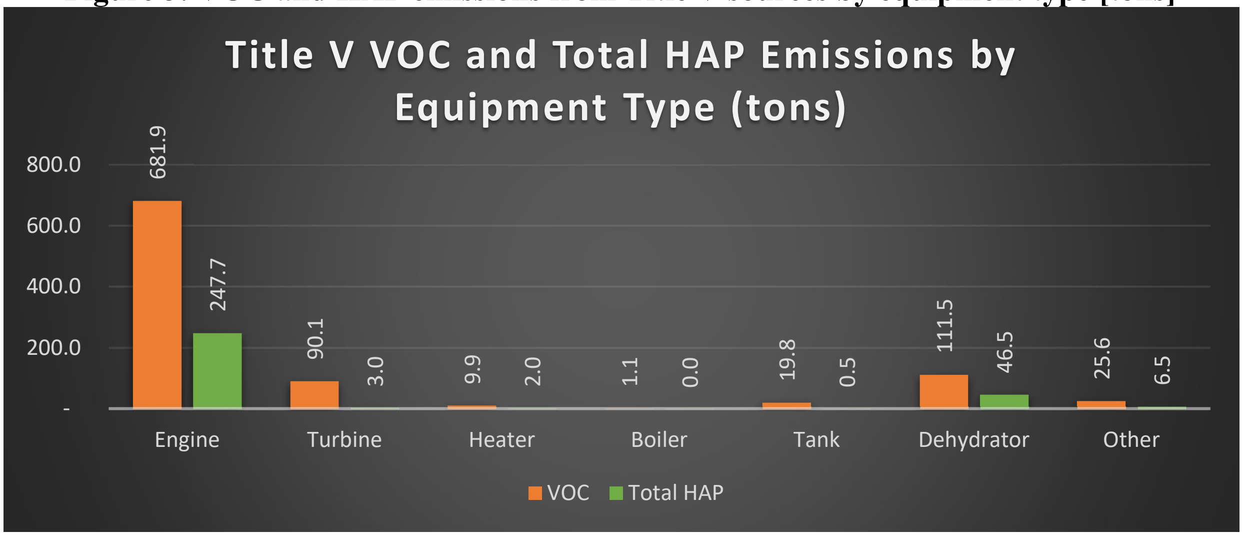


Figure 4: NOx and CO emissions from Title V sources by equipment type [tons]



*"Other" includes emissions from amine units, excess emission events, blowdowns, maintenance, and fugitive emission sources

Figure 5: VOC and HAP emissions from Title V sources by equipment type [tons]



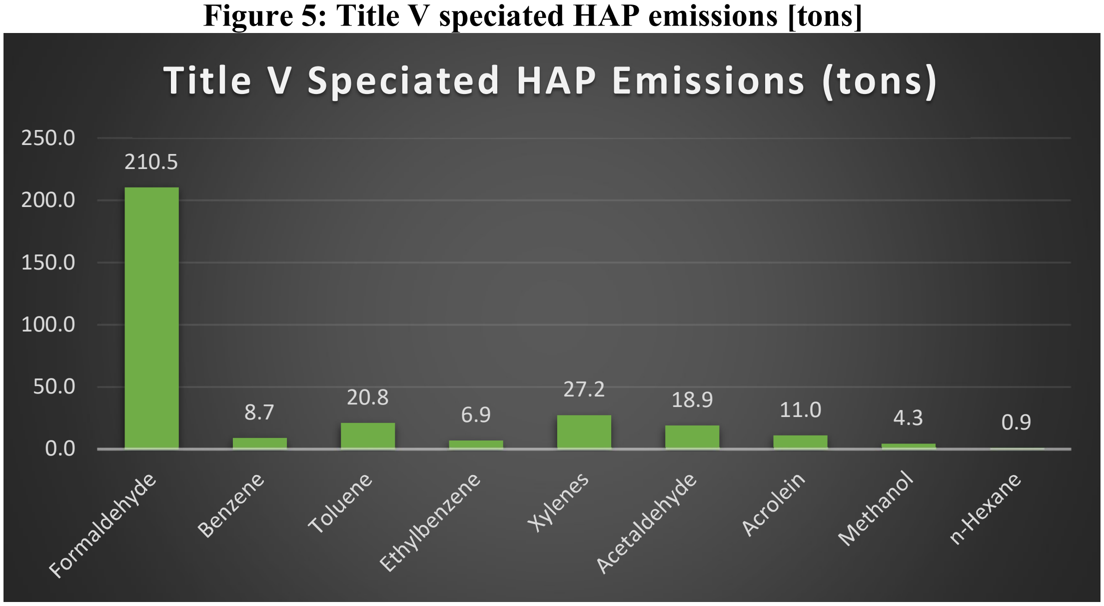
*"Other" includes emissions from amine units, excess emission events, blowdowns, maintenance, and fugitive emission sources

Speciated HAP emissions from Title V sources are displayed below in Table 2 and Figure 5.

Table 2: Title V HAP emissions [tons]

Pollutant	Formaldehyde	Benzene	Toluene	Ethylbenzene	Xylenes	Acetaldehyde	Acrolein	Methanol	n-Hexane
Emissions	210.5	8.7	20.8	6.9	27.2	18.9	11.0	4.3	0.9

Figure 5: Title V speciated HAP emissions [tons]



2. Minor Oil and Gas Point Sources

The Tribal Minor New Source Review (TMNSR) permitting program is found at 40 CFR Part §49.151 through §49.164.[3] The TMNSR permitting program includes new or modified source permitting, permits by rule, and a registration program. For the purposes of this inventory, two main categories of emission sources under this program were considered: a.) Permitted TMNSR oil and gas sources, and b.) Registered TMNSR Oil and Gas Sources.

The emission thresholds for the TMNSR permitting program are located at 40 CFR Part §49.153. Minor sources with emissions less than the levels displayed in Table 3 below are not required to obtain a permit or register under the program.

The emission thresholds from 40 CFR Part §49.153 are displayed below in Table 3.

Table 3: 40 CFR Part 49 Minor New Source Review Program Emissions Thresholds

Regulated NSR Pollutant	Minor NSR Thresholds for Attainment/ Unclassifiable [tpy]
Carbon Monoxide (CO)	10
Nitrogen Oxides (NO_x)	10
Sulfur Dioxide (SO_2)	10
Volatile Organic Compounds (VOC)	5
PM Total	10
PM_{10}	5
$PM_{2.5}$	3
Lead	0.1
Fluorides	1
Sulfuric Acid Mist	2
Hydrogen Sulfide (H_2S)	2
Total Reduced Sulfur (including H_2S)	2
Reduced Sulfur Compounds (including H_2S)	2
Municipal Waste Combustor Emissions	2
Municipal Solid Waste Landfill Emissions (measured as non-methane organic compounds)	10

A. Synthetic minor Oil and Gas Sources

Description of Sources

This category reflects larger emission sources that would be subject to either the Prevention of Significant Deterioration (PSD), Title V operating permit program, or both programs absent enforceable emission limitations to reduce the source's PTE. These types of permits are often referred to as "synthetic minor permits".

[3] 40 CFR Part 49 - Indian Country: Air Quality Planning and Management. (2020). U.S. Government Publishing Office. Retrieved from http://www.ecfr.gov/cgi-bin/text-idx?SID=bc4187dbf0b08beb092efe4251fe4493&mc=true&tpl=/ecfrbrowse/Title40/40cfr49_main_02.tpl

During calendar year 2020, eleven sources on the Reservation operated under TMNSR permits. Of the eleven sources in this category, nine sources are natural gas compressor stations, and one source is a natural gas processing plant. Five sources have permits to reduce emissions below Title V permitting thresholds and six sources have permits for various other reasons.

Data Collection

Only the five oil and gas sources with TMNSR permitted emissions below the Title V permitting thresholds were included in this category to avoid double counting emissions. Emissions from the remaining six oil and gas sources, which also hold Title V operating permits issued by the Tribe, were already accounted for under the Title V Oil and Gas Sources category of this inventory.

Synthetic minor sources are required to submit annual emissions inventories to EPA Region 8 for the pollutants regulated under each permit and emissions data was collected directly from the annual emissions inventories submitted for calendar year 2020[4]. For the pollutants and emission units that were not reported to EPA Region 8, AQP calculated emissions or utilized data that was submitted for its 2017 emission inventory. If actual operating hours were not available, maximum operating hours were used. This data collection methodology adheres to the EPA level II EI guidelines for using measured data when available.

Emissions

Total 2020 criteria pollutant, HAP, and GHG emissions from permitted TMNSR oil and gas sources on the Southern Ute Indian Reservation are presented below in Table 4.

Table 4: Criteria Pollutant, HAP, and GHG emissions for synthetic minor sources [tons]*

Pollutant	NOx	CO	VOC	PM	SO2	Total HAP	GHG (CO2e)
Emissions	253.9	137.5	126.2	3.8	5.9	29.7	69931.4

*GHG emissions reported in tonnes.

Total criteria pollutant and HAP emissions from synthetic minor sources on the Southern Ute Indian Reservation by equipment type are presented below in Figure 6, Figure 7, and Figure 8.

Figure 6: Criteria pollutant and HAP emissions from synthetic minor sources [tons]

[4] Emissions from Southern Ute Indian Tribe (2021). CY 2020 EPA TMNSR Fee Forms.

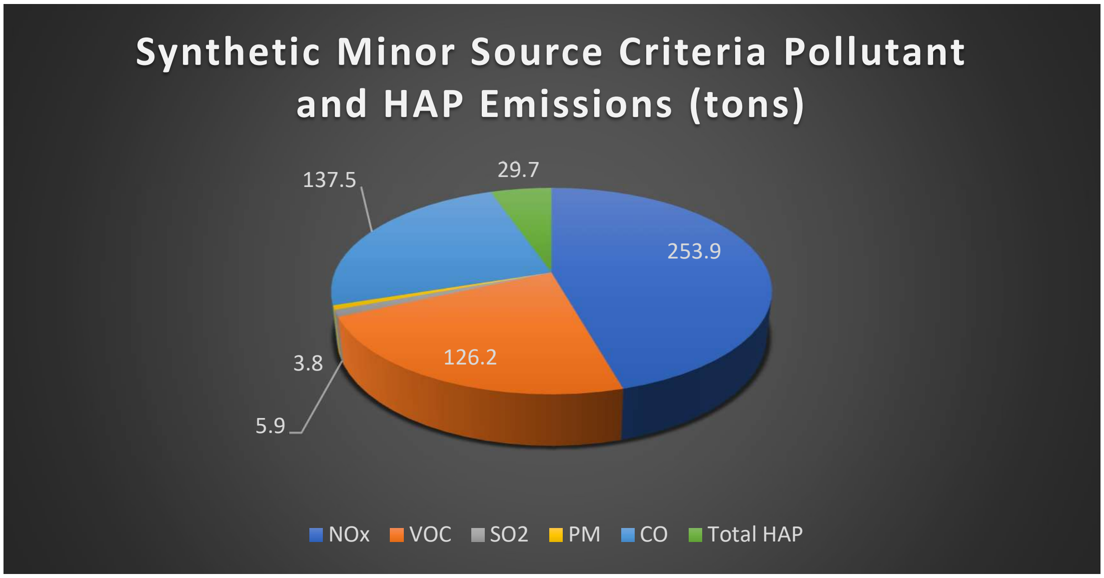
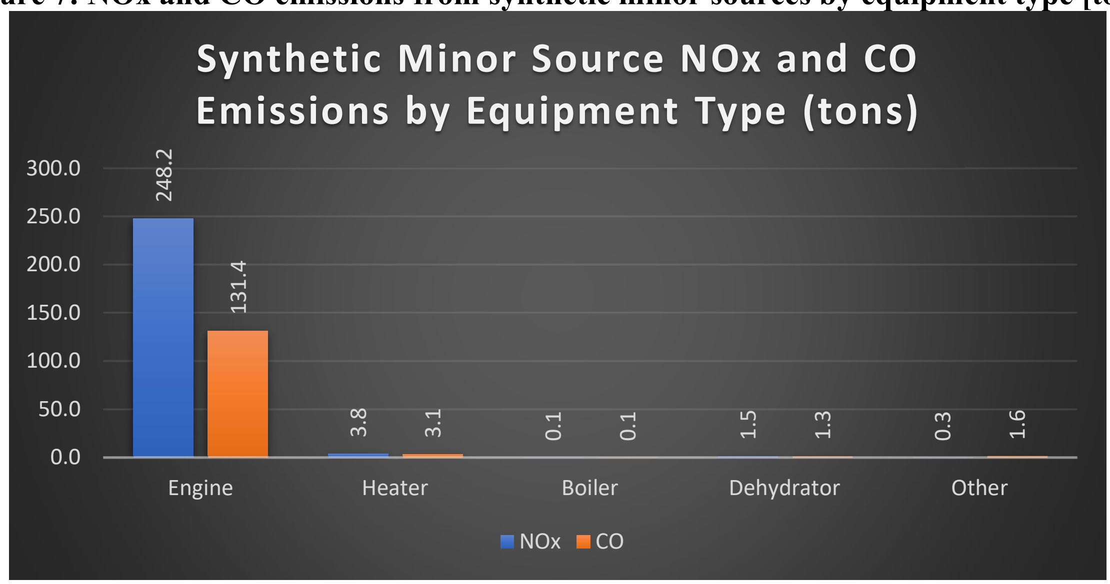
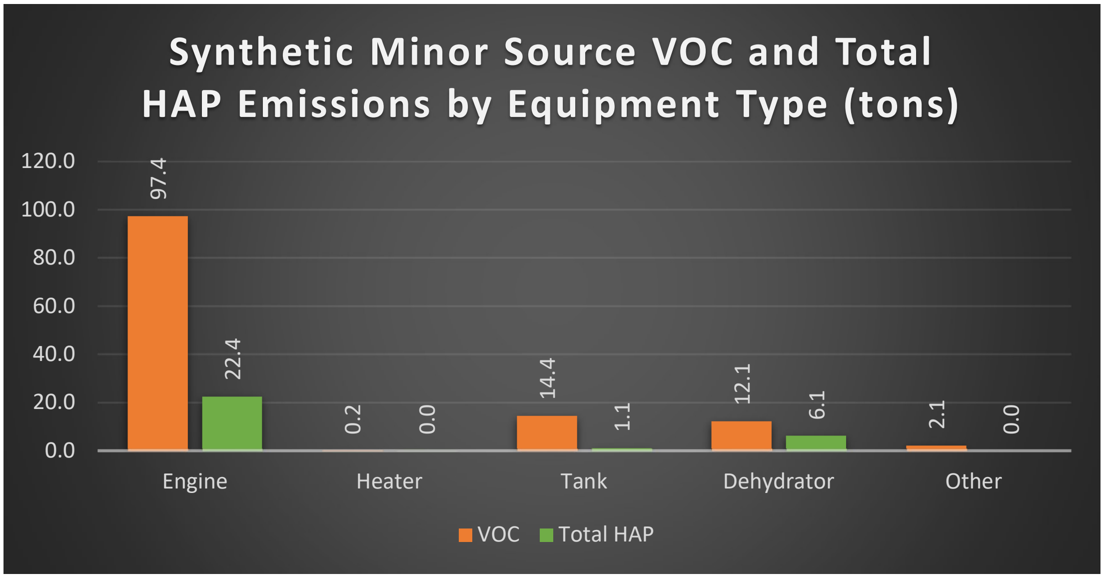


Figure 7: NOx and CO emissions from synthetic minor sources by equipment type [tons]



*"Other" includes emissions from insignificant emission units

Figure 8: VOC and HAP emissions from synthetic minor sources by equipment type [tons]



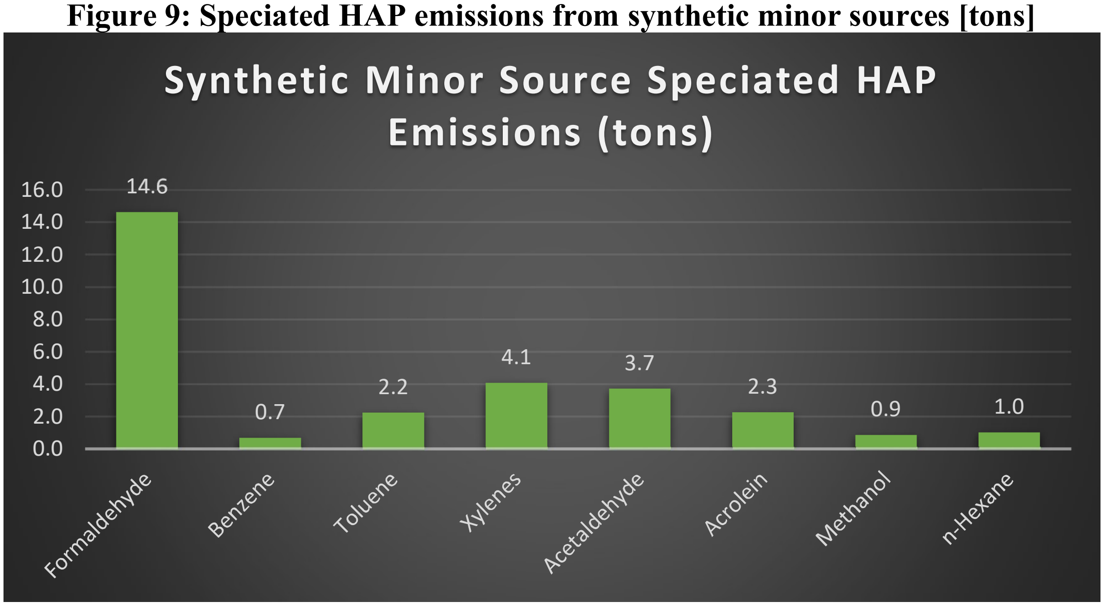
*"Other" includes emissions from insignificant emission units

Total 2020 speciated HAP emissions from synthetic minor sources on the Southern Ute Indian Reservation are displayed below in Table 5 and Figure 9.

Table 5: Speciated HAP emissions from synthetic minor sources [tons]

Pollutant	Formaldehyde	Benzene	Toluene	Xylenes	Acetaldehyde	Acrolein	Methanol	n-Hexane
Emissions	14.6	0.7	2.2	4.1	3.7	2.3	0.9	1.0

Figure 9: Speciated HAP emissions from synthetic minor sources [tons]



B. Registered Tribal Minor New Source Review Oil and Gas Sources Description of Sources

The TMNSR program required operators of true minor sources, as defined in §49.152, to register each oil and gas source with EPA Region 8 by no later than March 1, 2013. Existing oil and gas sources constructed or modified after March 1, 2013, but before October 3, 2016 were also required to register. All oil and gas sources constructed after March 1, 2013 are required to apply for a site-specific TMSNR permit or comply with the Oil and Gas Federal Implementation Plan for Indian Country at 40 CFR Part 49, Subpart C.

For CY 2020, the AQP had record of 238 active oil and gas source registrations for the Reservation.[5] The registrations included source locations, emission unit descriptions, and actual emissions calculations. All of the registered sources are natural gas production sources, primarily well-sites. Certain non-oil and gas sources, such as hot mix asphalt plants and stone quarrying, crushing and screening operations, also required registration with the EPA under the TMNSR program, but to date, no such sources have been registered. Presumably, non-oil and gas sources that did not register with the EPA may exist on the Reservation, and this issue will be addressed below in the data collection section.

Data Collection

For the purposes of this emission inventory section, only emissions from true minor sources were included. Sources with Title V operating permits or synthetic minor permits were not required to register under 40 CFR Part 49; therefore, there is little risk of double counting emissions from these sources. Emissions from Title V sources and synthetic minor sources were assessed separately, as discussed in Chapter IV Section 1 and 2A of this report.

Due to the potential for registration information to be stale or out of date, the AQP issued a mandatory Clean Air Act Section 114 ICR in June 2021 to obtain updated and reconciled registration data for true minor sources from each facility operator. The ICR included data for registered oil and gas sources. Specifically, the ICR requested reconciliation of the operational status of each previously registered true minor source, equipment located at each source, and the actual emissions for calendar year 2020.

The ICR also requested information that was exempted from TMNSR registration including emissions estimates for engines less than or equal to 50-hp and facility-wide emissions of HAP and GHG. It was anticipated that the ICR could also result in emissions reporting by sources that had never registered with the EPA. This data collection methodology adheres to the EPA level II EI guidelines for utilizing measured data when available.

Emissions

[5] Southern Ute Indian Tribe. (2021). Information Collection Request.

Total 2020 emissions of criteria pollutants, HAP, and GHG from true minor sources on the Reservation are displayed below in Table 6.

Table 6: Criteria pollutant and HAP emissions from true minor sources [tons]*

Pollutant	NOx	CO	VOC	PM	SO2	Total HAP	GHG (CO2e)
Emissions	4,575.2	3,248.1	834.5	42.8	16.1	291.0	1,568,843.6

*GHG emissions reported in metric tonnes.

Total 2020 criteria pollutant and HAP emissions from true minor sources on the Reservation by equipment type are displayed below in Figures 10 through 12. GHG emissions from true minor sources are displayed below in Figure 13.

Figure 10: Criteria pollutant and HAP emissions from true minor oil and gas sources [tons]

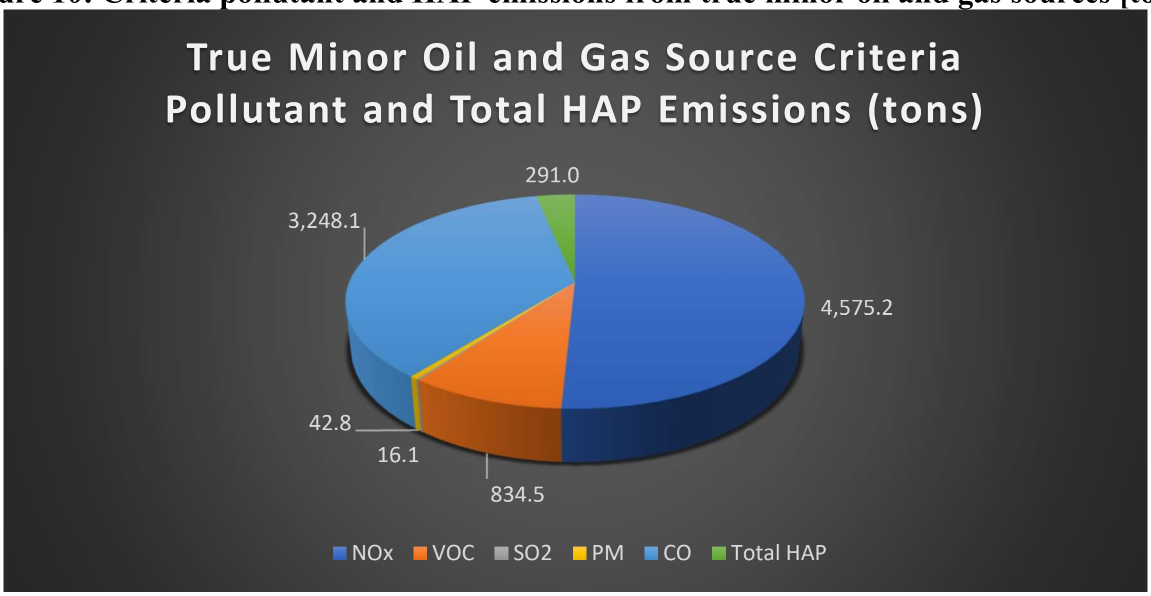
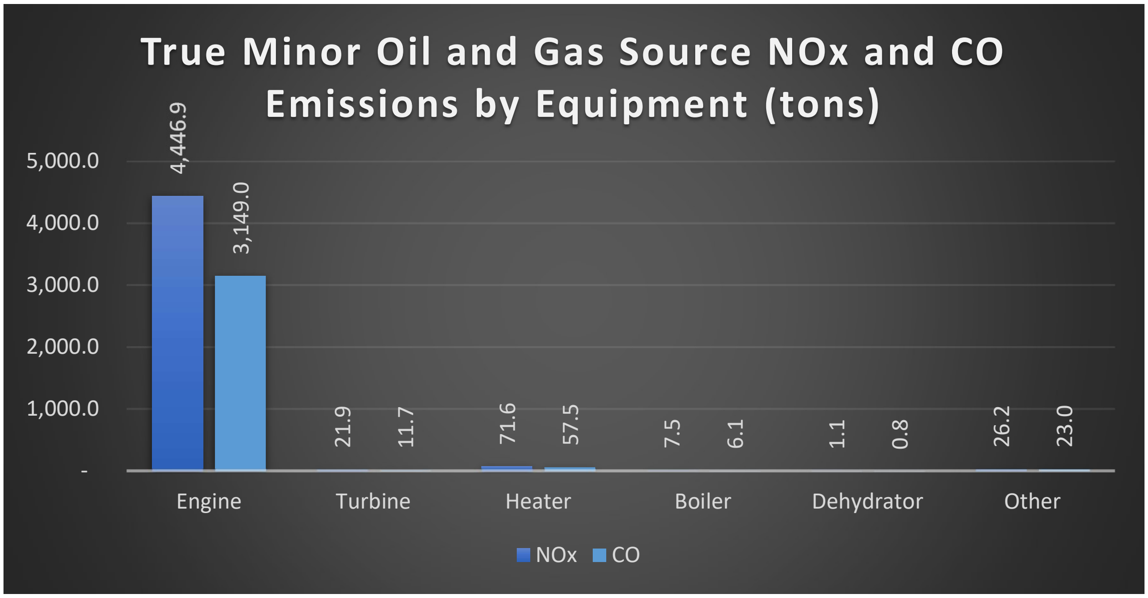
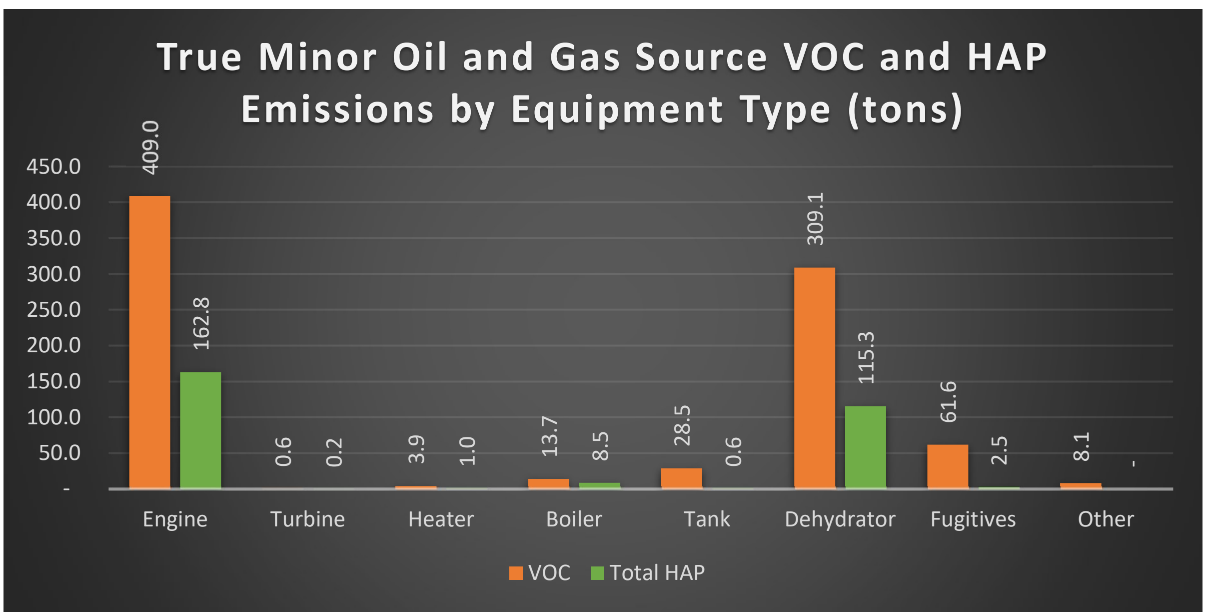


Figure 11: NOx and CO emissions from true minor oil and gas sources by equipment type [tons]



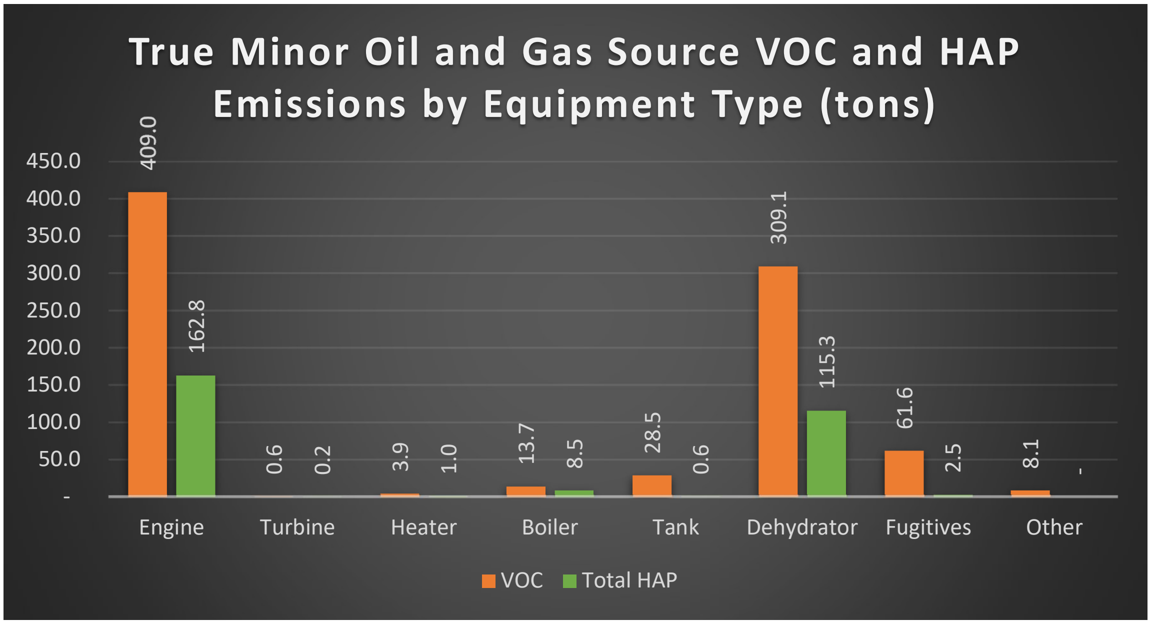
*"Other" consists of combustors, flares, and undefined equipment

Figure 12: VOC and HAP emissions from true minor oil and gas sources by equipment type [tons]



*"Other" consists of combustors, flares, and undefined equipment

Figure 13: GHG emissions from true minor oil and gas sources by equipment type [tonnes]



*"Other" consists of combustors, flares, and undefined equipment

3. Permitted Point Sources

In 2020, the one non-oil and gas point source operating under a TMNSR permit on the Reservation is a gravel pit. The operator reported the facility did not operate in 2020 and therefore, no emissions were reported for the source.

Table 7: Criteria pollutant and HAP emissions from permitted non-oil and gas point sources [tons]

Pollutant	NOx	CO	VOC	PM_{10}	$PM_{2.5}$	PM	SO_2	Total HAP	CO_2e
Emissions	0	0	0	0	0	0	0	0	0

4. Landfill Gas

The Southern Ute Indian Tribe has two Class II municipal solid waste (MSW) landfills within the Reservation boundaries. The first one is the Bondad Recycling Center and Depository (Bondad Landfill) located in Bondad, Colorado and the second one is the Archuleta County Landfill, located south of Pagosa Springs, Colorado. Both MSW disposal sites accept non-hazardous residential, commercial, and industrial waste. The Bondad Landfill is owned and operated by Transit Waste, LLC and has been in operation since 1997. The Archuleta County Landfill is owned and operated by Archuleta County and began operation in 1985. The Bondad Landfill operates under a tribally issued Title V operating permit and the Archuleta County Landfill reports annual landfill gas emissions to the Colorado Department of Public Health and Environment (CDPHE).

Data Collection

The Archuleta County Landfill submitted acceptance volumes for 2018, 2019, and 2020 for input in LandGEM 3.02 with a density 0.79 Megagram/cubic yard. The density was estimated from the reported Megagrams per cubic yard for the years 2013 through 2015. All reports were previously submitted by Archuleta County to the CDPHE. Emissions data for the Bondad Landfill were directly obtained from the CY 2020 Title V emissions fee form submitted to the Tribe.

Emission Calculation Methodology

Emissions for the Archuleta County landfill were estimated using the EPA's MSW landfill emissions model, LandGEM version 3.02 (LandGEM).[6] Emissions data for the Bondad Landfill were obtained from the CY 2020 Title V emissions fee form submitted to the Tribe by Transit Waste, LLC, who ran LandGEM to estimate emissions from this facility. The LandGEM model estimates total landfill gas, non-methane organic compounds (NMOC), and hazardous air pollutants (HAP).

The LandGEM model is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of landfilled waste in MSW landfills.

$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} k L_0 \left(\frac{M_i}{10} \right) e^{-k t_{ij}}$$

Where:

Q_{CH4} = annual methane generation in the year of calculation (m^3/year)
i = 1 year time increment
n = (year of the calculation) – (initial year of waste acceptance)
j = 0.1 year time increment
k = methane generation rate (year-1)
Lo = potential methane generation capacity (m^3/Mg)
M_i = mass of waste accepted in the i^{th} year (Mg)
t_{ij} = age of the j^{th} section of waste mass M_i accepted the i^{th} year (decimal years, e.g., 3.2 years)

LandGEM Inputs and Assumptions

Complex microbial and biochemical reactions occur within the landfill's interior after the waste has been deposited. The two primary constituents of landfill gas (LFG) are methane (CH_4) and carbon dioxide (CO_2). LFG also contains small amounts of non-methane organic

[6] U.S. EPA - Landfill Gas Emissions Model. (2021). Retrieved from https://www.epa.gov/catc/clean-air-technology-center-products#software.

compounds, which includes VOC, HAP, and GHG. LandGEM estimates the LFG from anaerobic decomposition of the waste with CH_4 and CO_2 content between 40 and 60 percent. The LandGEM default used for methane is 50 percent by volume (the model default value). The production of LFG is a continuous process until microbial reactions are limited by substrate or moisture. Other factors include climate, moisture conditions, and types of solid waste accepted (degradable vs. inert).

Parameters for climatic conditions used in the LandGEM model were a k-value of 0.02 $year^{-1}$ (an arid area that receives less than 25 inches of rain annually) and a L_o-value of 170 cubic meter per megagram. The VOC concentrations are assumed to be 39 percent of NMOC concentrations, consistent with the footnote C Table 2.4-2 of the EPA's publication titled *AP-42, Fifth Edition Compilation of Air Emission Factors* (EPA AP-42).[7] HAP emissions for the Archuleta County Landfill are from the LandGEM report using default emissions factors from EPA AP-42. The total estimated emissions of LFG were estimated using the flow rate and molecular weights.

Emissions

The estimated LandGEM emissions for Bondad Landfill were provided to the Tribe in a Title V emissions fee form package submitted by Transit Waste for calendar year 2020. Emissions estimates for Archuleta County Landfill were calculated by the Tribe using LandGEM and the waste acceptance rates and waste-in-place data values for 2018-2020 along with the historical data submitted

To avoid double counting emissions from the Bondad Landfill, emissions from Bondad Landfill were only included in the Landfill gas emission totals and not included in the Title V emission totals presented in Section IV.1 of this report.

Total refuse in place in tons and total emissions of GHG, VOC and HAP from MSW landfills on the Reservation for 2020 are displayed below in Table 8 and Figure 14.

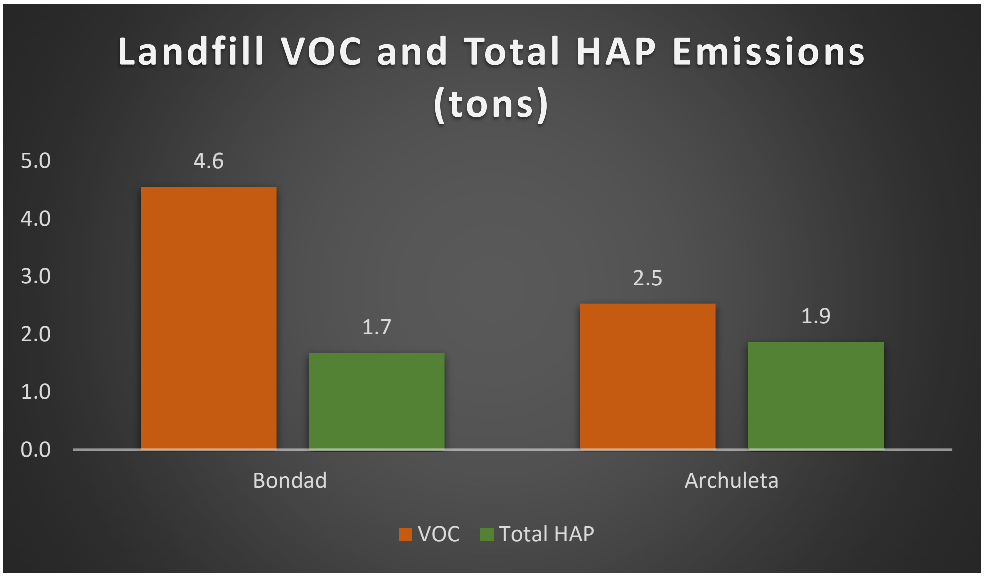
Table 8: Municipal solid waste landfill refuse in place [tons] and emissions [tons]*

	Refuse in Place	GHG	VOC	HAPs[1]
Bondad Landfill	1,667,802	4,846.5	4.6	1.7
Archuleta County Landfill	548,775	18,380.2	2.5	1.9
Totals	**2,216,577**	**23,226.7**	**7.1**	**3.6**

*An insignificant quantity of double counting of VOCs occurs because many reported HAPs are also considered VOCs.

Figure 14: Municipal solid waste landfill emissions [tons]

[7] U.S. Environmental Protection Agency. (2020). *AP-42: Compilation of Air Emission Factors*. Retrieved from https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors.



5. Airports

There are three airports located within the Reservation: the Durango-La Plata County Airport, the Animas Air Park, and the Animas Air Park Helipark.

Data Collection

The AQP obtained CY 2018 data from EPA's National Emissions Inventory database (NEI), which includes total landing and take-off cycles (LTOs) and piston and turbine engine emission estimates for the heliport, taxi, and general aviation at the Animas Air Park.[8] The LTOs were from the Federal Aviation Administration (FAA). The methodologies used by EPA to calculate airport emissions are detailed in the Eastern Research Group's document titled *Documentation for Aircraft Component of the National Emissions Inventory Methodology.*[9]

Emissions data for the Animas Air Park and Animas Air Park Heliport were submitted to the NEI by EPA. Emissions data for the Durango-La Plata airport were reported to the NEI by the CDPHE.

Assumptions

[8] U.S. EPA National Emission Inventory Emissions Inventory System. (2020). Retrieved from https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei.

[9] Eastern Research Group. (2001, January). Documentation for Aircraft Component of the National Emissions Inventory Methodology. (ERG No. 0245.03402.011).

Calendar year 2020 airport emissions are assumed to be similar to emissions from the airports during CY 2018.

Emissions

Total criteria pollutant and HAP emissions from airports on the Reservation for 2020 are displayed in Table 9 and Figure 15 and Figure 16 below.

Table 9: Criteria pollutant and HAP emission from airports [tons]*

	NOx	VOC	SO_2	$PM_{2.5}$	PM_{10}	Lead	CO	Total HAP
Animas Air Park Heliport	0.01	0.01	0.00	0.01	0.01	0.00	0.27	0.00
Animas Air Park	0.40	0.84	0.08	0.51	0.66	0.03	30.93	0.31
Durango-La Plata County	36.07	13.09	4.94	3.29	3.83	0.1	185.91	3.59
Totals	**36.47**	**13.94**	**5.02**	**3.81**	**4.50**	**0.13**	**217.11**	**3.90**

*Emissions estimations for airports are from the 2018 EPA National Emission Inventory Database and assumed to be realistic estimations of airport emissions for 2020.

Figure 15: CO and NOx emissions from airports [tons]

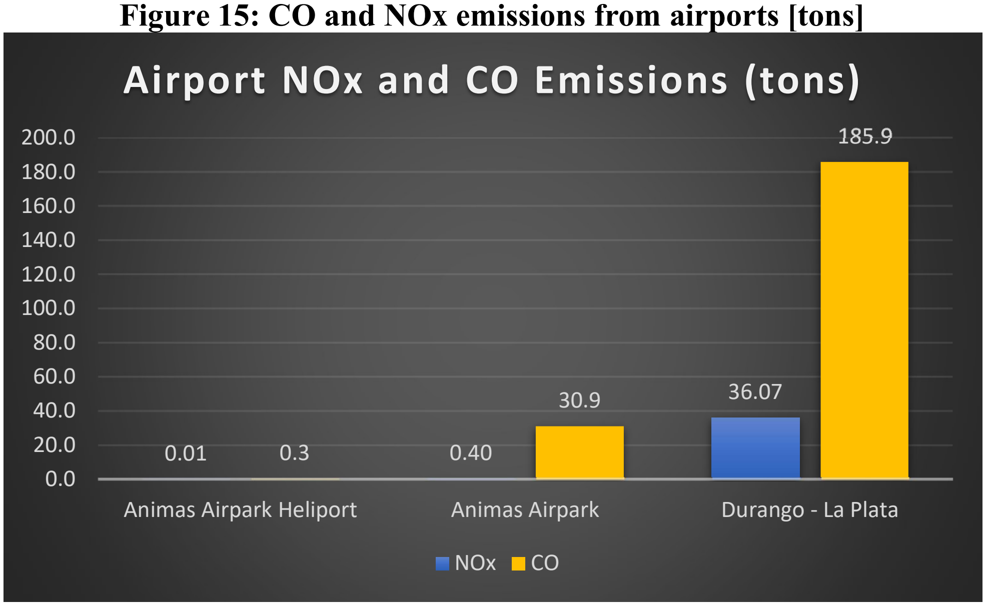
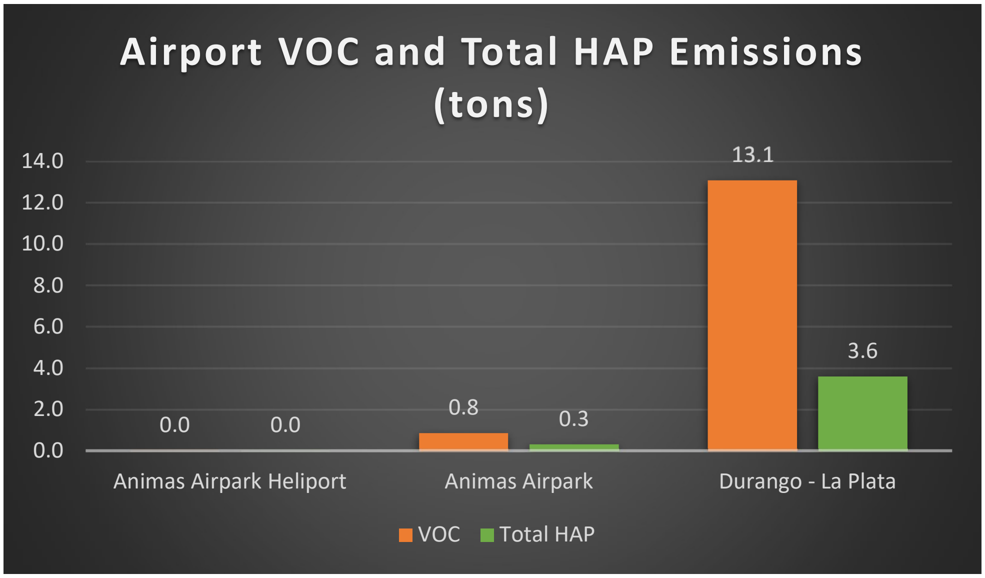


Figure 16: VOC and Total HAP emissions from airports [tons]



V. Non-Point Sources

1. Small Oil and Gas Sources

Description of Sources

For the purpose of this EI small oil and gas sources are defined as: *oil and gas sources with emissions below the thresholds that require registration under the EPA Tribal Minor New Source Review (TMNSR) Program at 40 CFR Part 49*. The majority of these sources are natural gas well sites, which are comprised of artificial lift engines, separators, filter coalescers, compressor engines, reciprocating compressors, lube oil tanks, tank heaters, dehydration units, and produced water, condensate, and oil tanks.

Data Collection

Source information for small oil and gas sources was obtained through a mandatory Clean Air Act Section 114 ICR issued by the AQP in June of 2021 to each known operator with sources operating on the Reservation. To identify the operators within the Reservation and estimate the total number of small oil and gas sources on the Reservation, the AQP compiled site and ownership data from the COGCC and Drilling Edge databases.[10,11]

The ICR was the basis for collecting the information necessary to calculate emissions from small oil and gas sources and required each recipient to provide actual equipment counts

[10] COGCC. (2020). Production Data. La Plata. Retrieved from http://cogcc.state.co.us/data2.html#/downloads.

[11] Drilling Edge Database (2016). Retrieved from http://www.drillingedge.com/colorado.

and production information. Data was requested for each company's operations on the Reservation in its entirety and not specific to any single source location.

Completed ICRs were submitted by 27 of the 32 (84%) companies that reported production on the Reservation in CY 2020 to the COGCC database. The completed ICRs accounted for 2,570 of the 2,582 (99.5%) known small oil and gas sources on the Reservation. The AQP used 2017 ICR submitted information for the remaining unreported sources.

Calculation Methodology

The AQP calculated emissions for small oil and gas sources on an equipment basis using measured data, widely accepted emission factors and emission calculation methodologies, the equipment counts reported in the ICR, and CY 2020 production data from the COGCC. Descriptions of how emissions were calculated for each equipment type are included later in this section.

Emissions

Criteria pollutant, HAP, and GHG emission estimations from small oil and gas sources on the Reservation in 2020 are displayed below in Table 10.

Table 10: Emissions from small oil and gas sources [tons]*

Pollutant	NOx	VOC	SO2	PM	CO	Total HAP	GHG
Emissions	11,664.0	798.8	5.6	183.8	9,716.6	233.9	1,575,054.1

*GHG emissions reported in metric tonnes.

Criteria pollutant, HAP, and GHG emissions from small oil and gas sources on the Reservation by equipment type are displayed below in Figures 17 through 20.

Figure 17: Criteria pollutant and HAP emissions from small oil and gas sources [tons]

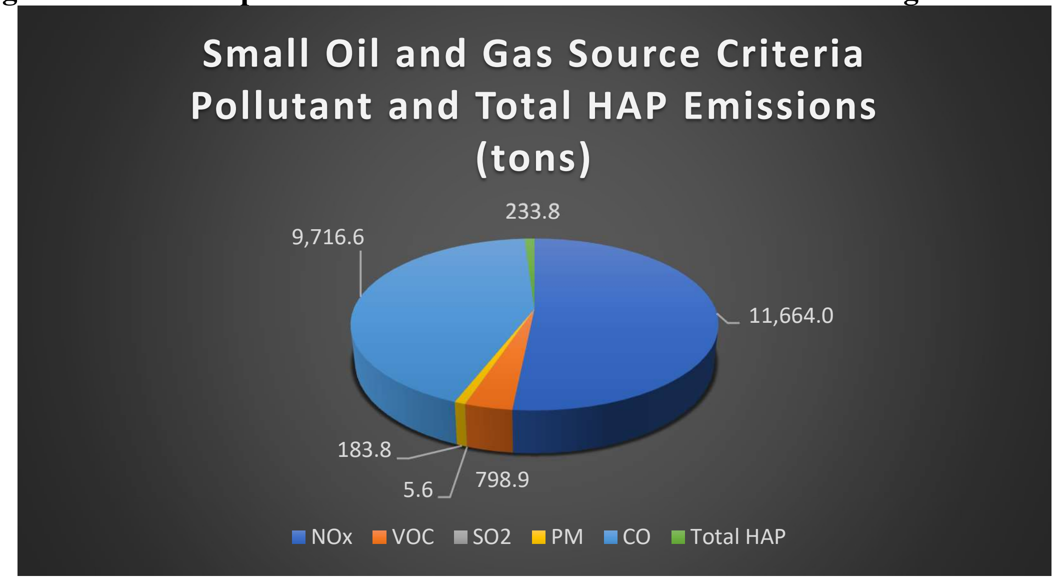


Figure 18: NOx and CO emissions from small oil and gas sources by equipment type [tons]

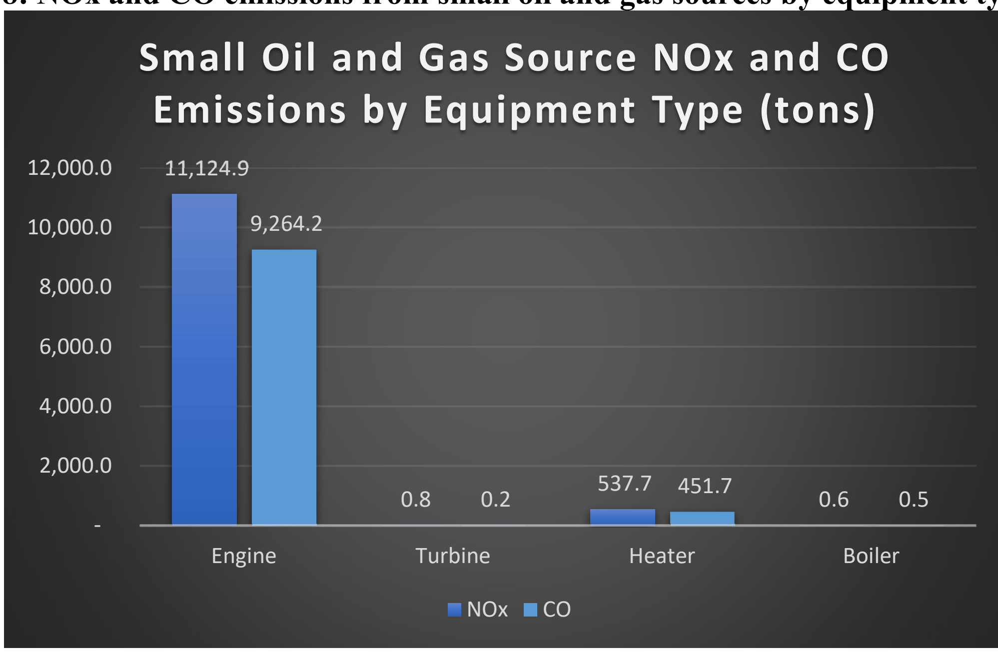


Figure 19: VOC and HAP emissions from small oil and gas sources by equipment type [tons]

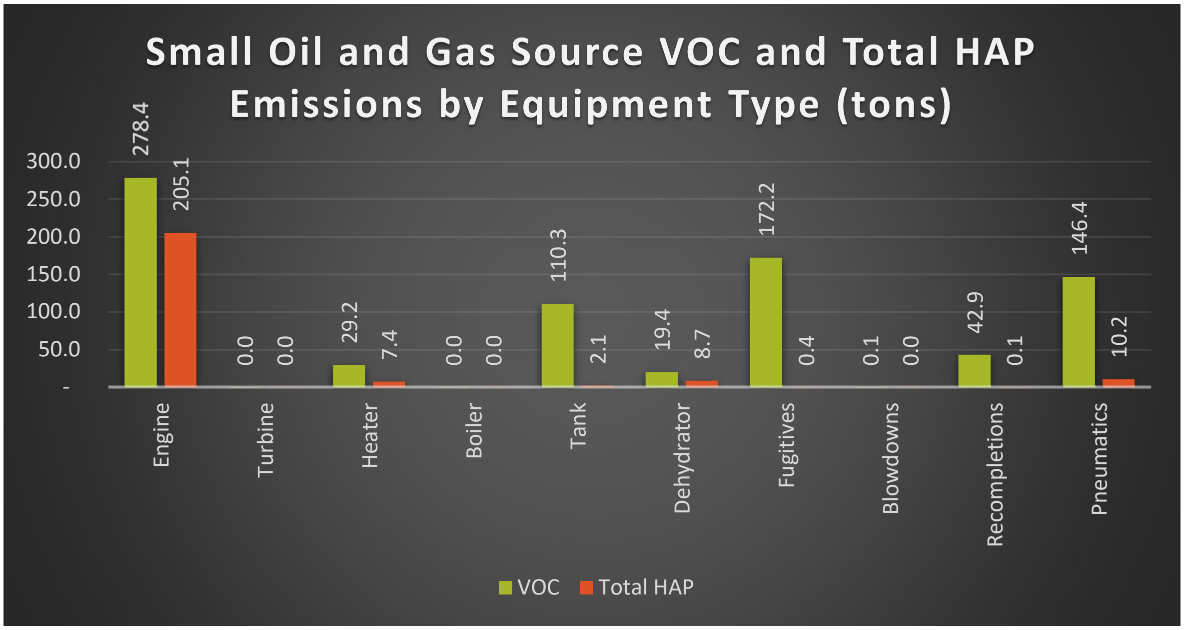
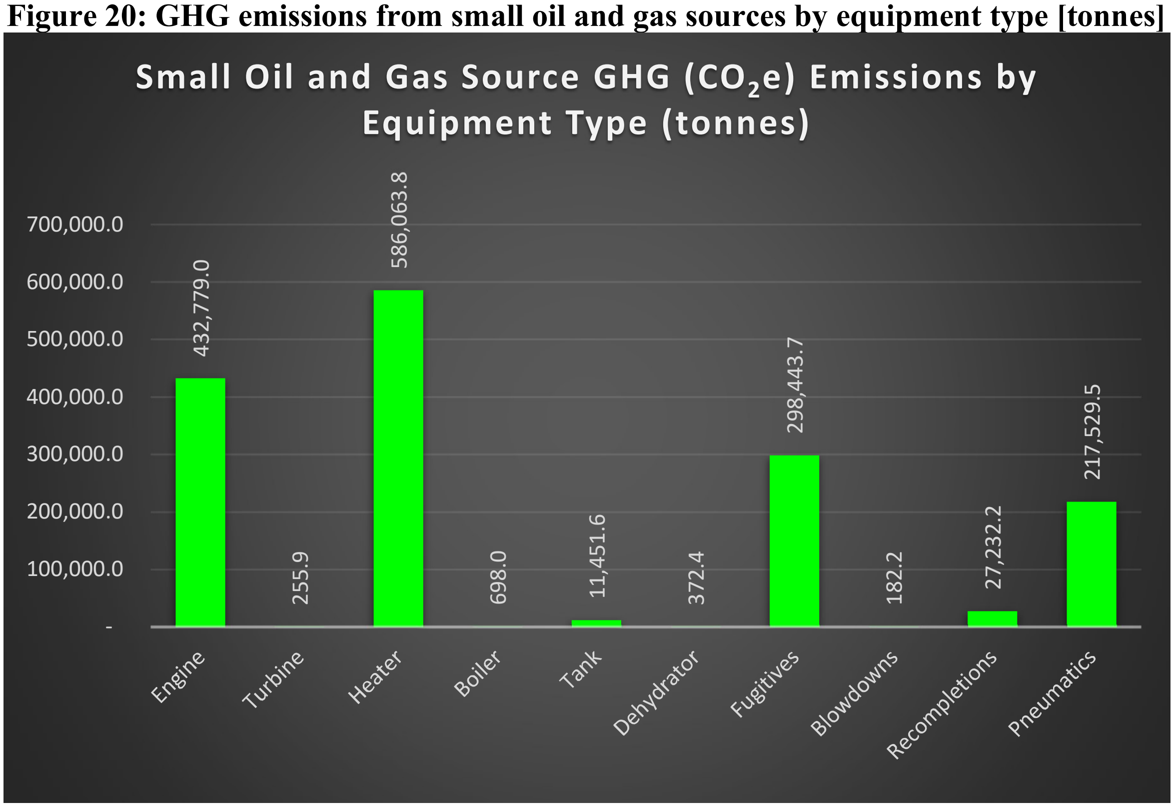


Figure 20: GHG emissions from small oil and gas sources by equipment type [tonnes]

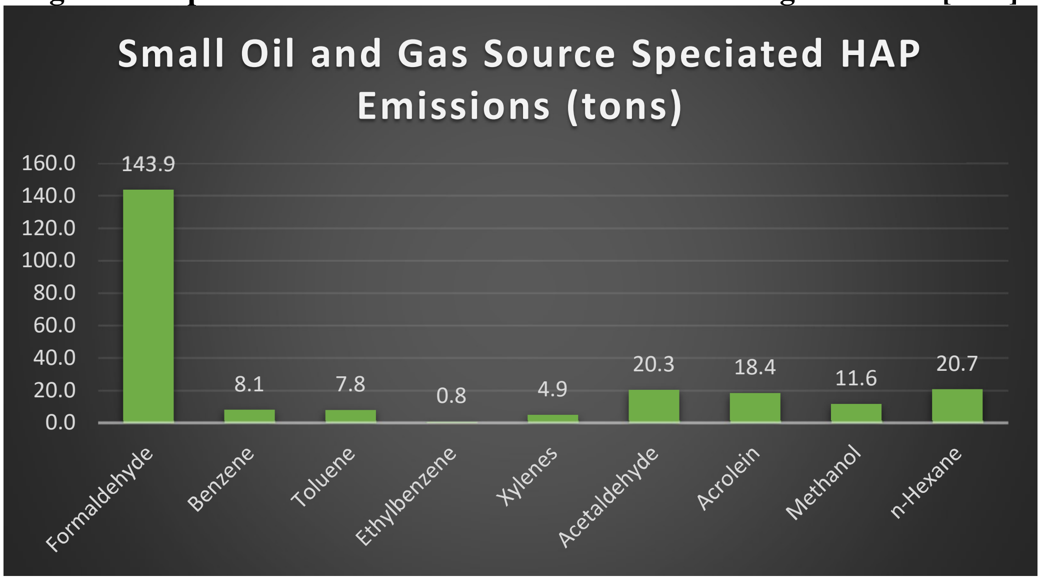


2020 Speciated HAP emissions are displayed below in Table 11 and Figure 21.

Table 11: Speciated HAP emissions from small oil and gas sources [tons]

Pollutant	Formaldehyde	Benzene	Toluene	Ethylbenzene	Xylenes	Acetaldehyde	Acrolein	Methanol	n-Hexane
Emissions	143.9	8.1	7.8	0.8	4.9	20.3	18.4	11.6	20.7

Figure 21: Speciated HAP emissions from small oil and gas sources [tons]



A. Natural Gas-Fired Reciprocating Internal Combustion Engines

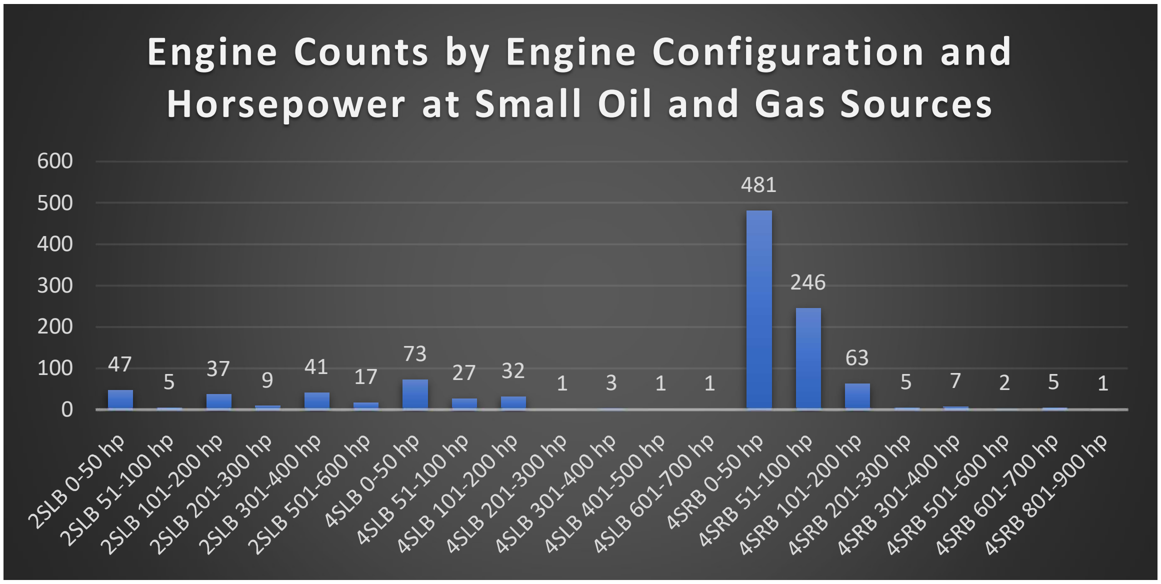
Description of Units

Natural gas-fired spark-ignited reciprocating internal combustion engines (RICE) are used by the oil and gas industry to compress natural gas, pump liquids, generate electricity, and to provide artificial lift. The most prevalent pollutants emitted from natural gas-fired RICE are NOx, CO, VOC, and HAP.

Data Collection

The ICR required recipients to list the total number of natural gas-fired spark-ignition and compression ignition RICE operated by their company on the Reservation. Engines were reported according to horsepower range, and engine configuration. Engine configurations included two-stroke lean-burn (2SLB), four-stroke lean-burn (4SLB), four-stroke rich-burn (4SRB), and diesel. The ICR included assumed values for engine operating hours and average brake specific fuel consumption (BSFC) and provided recipients the option to provide values more representative of their operations. A summary of reported engines at small oil and gas sources on the Reservation in 2020 are displayed below in Figure 22.

Figure 22: Engine counts by engine configuration and horsepower at small oil and gas sources



Emission Calculation Methodology

Criteria Pollutant and HAP Emissions:

Criteria pollutant and HAP emissions were calculated for each engine configuration and horsepower rating category reported in the ICR. Emission calculations were based on the maximum horsepower of each reported horsepower range, the appropriate emission factors for stationary internal combustion sources from Chapter 3 of EPA AP-42, an assumed BSFC of 7,500 Btu/hp-hr (if the operator did not input anything more representative of their operating conditions), an assumed 100% engine operating load, and assumed operating schedule of 8,760 hours per year (if the operator did not input a different number of annual operating hours). The assumed BSFC value was derived by averaging the BSCF from all natural gas-fired engines in the Caterpillar Gas Engine Rating Pro software.[12] All emissions were calculated for uncontrolled operation. The natural gas on the Reservation contains negligible amounts of sulfur, therefore SO_2 emissions from engines are minimal.

GHG Emissions:

Greenhouse gas emissions were calculated using the default values from Tables C-1 and C-2 of 40 CFR Part 98, Subpart C and the same methodology as used for criteria pollutants and HAP.[13]

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[12] Caterpillar, Inc. (2015). Gas Engine Rating Pro Emissions Estimation Software. Retrieved from http://www.cat.com/en_US/articles/solutions/oil-gas/gas_engine_rating_pro.html.

[13] 40 CFR Part 98 - Mandatory Greenhouse Gas Reporting. (2021). U.S. Government Publishing Office. Retrieved from http://www.ecfr.gov/cgi-bin/text-idx?SID=32c4baa0d0aff54fa651d1cdb1cd7934&mc=true&tpl=/ecfrbrowse/Title40/40cfr98_main_02.tpl.

Example Calculation

Calculation of engine heat rate (MMBtu/hr) using AQP's assumed brake specific fuel consumption (Btu/hp-hr):

HR (MMBtu/hr) = BSFC (7500 Btu/hp-hr)/10^6 x hp

Where:

HR = heat rating (MMBtu/hr)
BSFC = brake-specific fuel consumption
hp = engine horsepower

Engine emission calculation:

tpy = (EF) x HR x OH/2000 pounds/ton

Where:

tpy = tons per year
EF = emission factor (lb/MMBtu)
HR = heat rate
OH = annual operating hours

Example Nox emissions calculation for a 200 hp four-stroke rich-burn engine operating 8,760 hours per year:

tpy = (2.21 lb/MMBtu) x (1.5 MMBtu/hr) x (8760 hr)/2000 lb/ton = 14.52 tpy Nox

Emissions

Total criteria pollutant, HAP, and GHG emissions from natural gas-fired RICE at small oil and gas sources are displayed below in Table 12 and Figures 23 and 24.

Table 12: Natural gas-fired reciprocating internal combustion engine counts and criteria pollutant, HAP, and GHG emissions for small oil and gas sources [tons]*

Engine Configuration and Horsepower (hp)	Number of Engines	NOx	VOC	SO2	PM	CO	Total HAP	GHG
2SLB 0-50 hp	47	170.8	6.5	0.0	4.1	20.8	4.2	5,722.5
2SLB 51-100 hp	5	61.3	2.3	0.0	1.5	7.5	1.5	2,055.0
2SLB 101-200 hp	37	774.3	29.3	0.1	18.8	94.3	18.8	25,948.5
2SLB 201-300 hp	9	270.0	10.2	0.1	6.5	32.9	6.7	9,046.7

2SLB 301-400 hp	41	1,707.8	64.6	0.3	41.4	208.0	41.5	57,232.6
2SLB 501-600 hp	17	1,062.2	40.2	0.2	25.7	129.3	25.8	35,595.9
4SLB 0-50 hp	73	472.4	13.7	0.1	0.0	36.7	8.4	12,301.5
4SLB 51-100 hp	27	361.9	10.5	0.1	0.0	28.1	6.3	9,422.4
4SLB 101-200 hp	32	788.1	22.8	0.1	0.0	61.2	13.7	20,520.4
4SLB 201-300 hp	1	35.7	1.0	0.0	0.0	2.8	0.6	928.6
4SLB 301-400 hp	3	148.7	4.3	0.0	0.0	11.6	2.4	3,872.2
4SLB 401-500 hp	1	59.4	1.7	0.0	0.0	4.6	1.0	1,547.7
4SLB 601-700 hp	1	93.8	2.7	0.0	0.0	7.3	1.6	2,442.9
4SRB 0-50 hp	481	1,715.2	23.0	0.5	14.8	2,887.2	24.3	82,450.5
4SRB 51-100 hp	246	1,785.7	23.9	0.5	15.4	3,005.7	25.3	85,836.0
4SRB 101-200 hp	63	900.9	12.1	0.2	7.7	1,516.5	12.8	43,306.7
4SRB 201-300 hp	5	106.9	1.5	0.0	0.9	183.3	1.5	5,234.7
4SRB 301-400 hp	7	203.3	2.7	0.1	1.7	342.2	2.9	9,771.4
4SRB 501-600 hp	2	87.1	1.2	0.0	0.6	146.6	1.2	4,187.7
4SRB 601-700 hp	5	254.1	3.4	0.1	2.2	427.7	3.6	12,214.3
4SRB 801-900 hp	1	65.3	0.9	0.0	0.6	110.0	0.9	3,140.8
Totals:	**1104**	**11,059.6**	**277.6**	**2.4**	**141.5**	**9,154.2**	**204.2**	**429,638.2**

*GHG reported in metric tonnes.

Figure 23: CO and NOx emission from small oil and gas sources by engine type [tons]

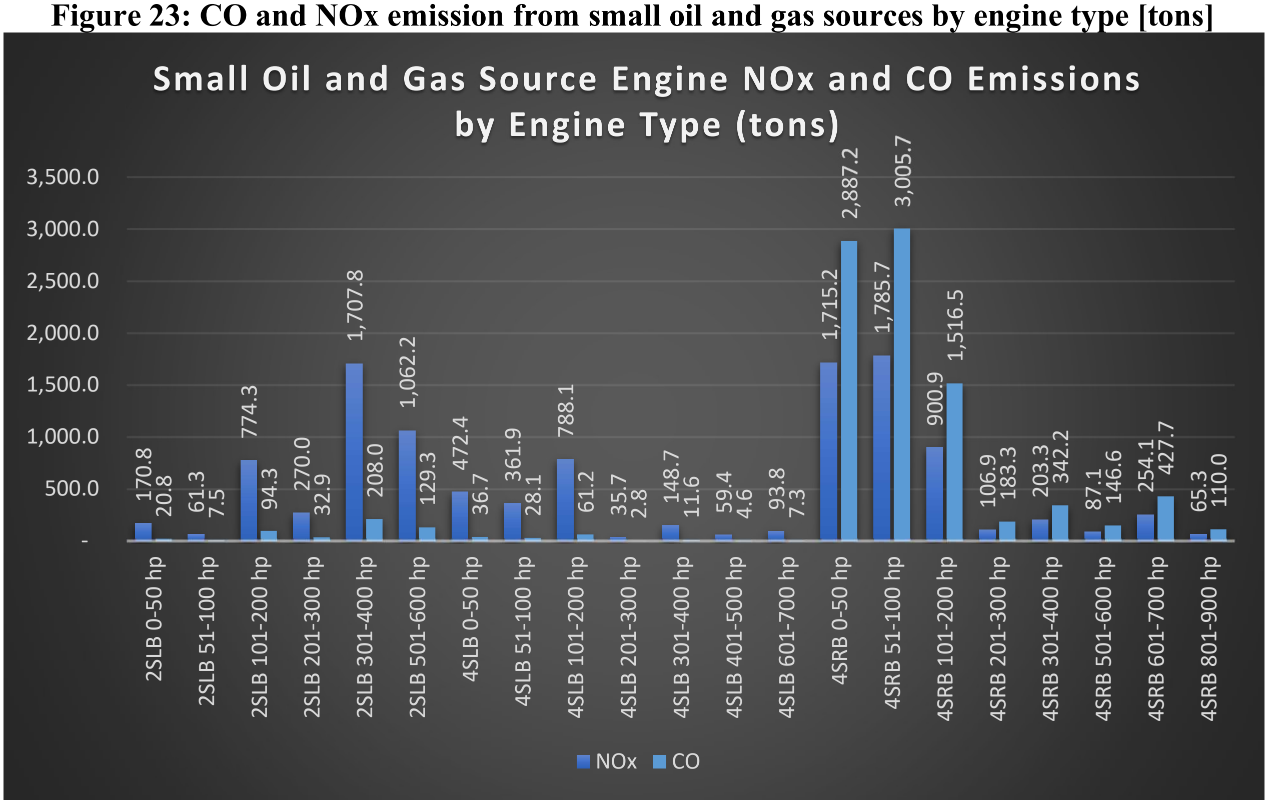
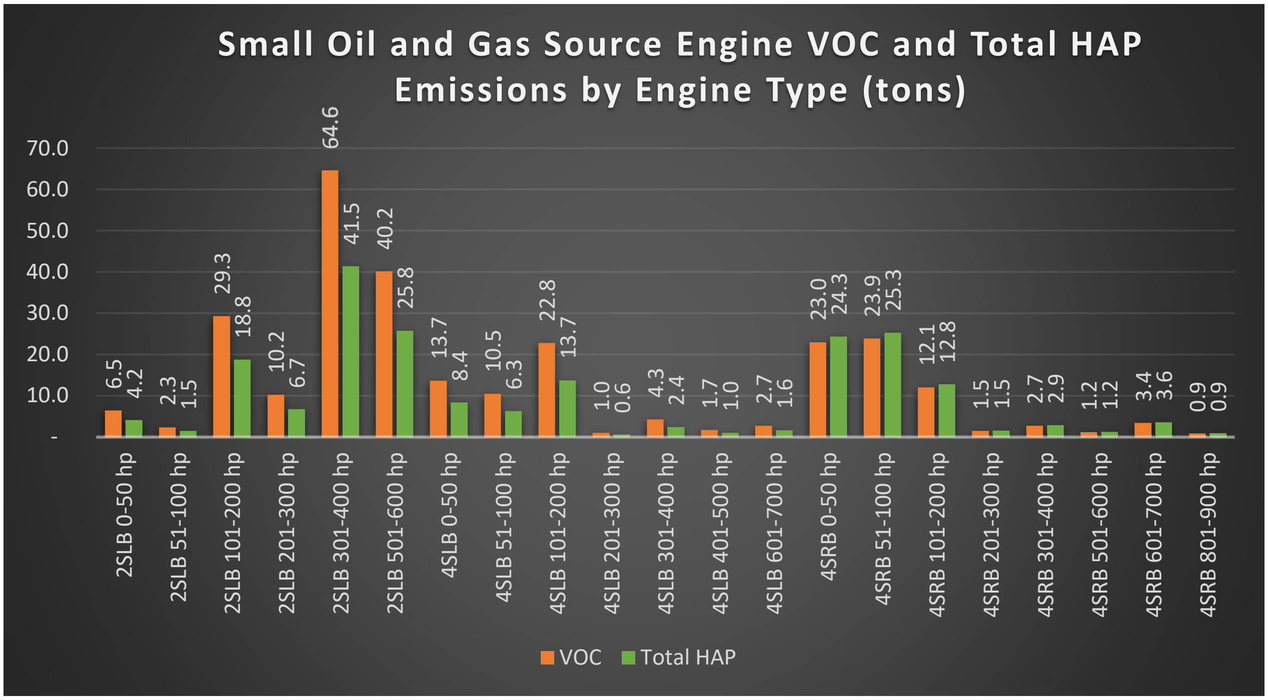


Figure 24: VOC and Total HAP emissions from small oil and gas sources by engine type [tons]



B. Stationary Natural Gas Turbines:

Description of Units

Natural gas-fired stationary turbines are a type of rotary internal combustion engine used by the natural gas industry for natural gas transmission and for electric generation. Turbines operate by introducing compressed air and fuel into a combustion chamber to generate hot gases, which are expanded into the power turbine to rotate the power shaft and create work. Two types of combustion processes are used in turbines, the first being lean-premix staged combustion in which a lean air and fuel mixture is introduced into the combustion chamber, and the second type being diffusion flame combustion where the air and fuel mixing occurs within the combustion chamber. The power shaft is used to run a centrifugal compressor for gas transmission, or to rotate an alternator when used for electric generation.

Data Collection

The ICR required recipients to list the total number of natural gas-fired turbines operated by their company on the Reservation. Turbines were reported according to horsepower or kilowatt range and, turbine configuration. Turbine configurations included uncontrolled, water-steam injection, and lean-premix. The AQP assumed turbines to operate for 8,760 hours per year. Average brake specific fuel consumption (BSFC) was assumed to be 11,000 Btu/hp-hr, as established in the document titled *Stationary*

Combustion Turbines in the United States.[14] If an operator specific BSFC was reported in the ICR, this value was used in place of the assumed BSFC value.

Only one turbine was reported at a small oil and gas source in the ICR. The turbine was a 0-50 hp, lean pre-mix unit, operated 8,760 hours per year, with a BSFC of 11,000 Btu/hp-hr.

Emission Calculation Methodology

Criteria Pollutant and HAP Emissions:

Criteria pollutant and HAP emissions were calculated based on the maximum reported horsepower, emission factors for stationary gas turbines from Chapter 3.1 of EPA AP-42, 100% engine operating load, an operating schedule of 8,760 hours per year and a reported BSFC of 11,000 Btu/hp-hr. The calculation methodology for natural gas turbines is the same methodology used for reciprocating internal combustion engines and displayed in an example calculation earlier in this section. The natural gas on the Reservation contains negligible amounts of sulfur, therefore SO_2 emissions from turbines are minimal.

GHG Emissions:

Greenhouse gas emissions were calculated using the default values from Tables C-1 and C-2 of 40 CFR Part 98, Subpart C and the same methodology as used for criteria pollutants and HAP.

Emissions

Criteria pollutant, HAP, and GHG emissions from natural gas turbines on the Southern Ute Reservation for 2020 are displayed in Table 13.

Table 13: Turbine count and criteria pollutant, HAP, and GHG emissions at small oil and gas sources [tons]*

Turbine configuration and horsepower	Number of turbines	NOx	CO	PM10	VOC	Total HAP	GHG (CO2e)
Lean-Premix 0-50 hp	1	0.77	0.20	0.02	0.01	0.00	255.92

*GHG reported in metric tonnes.

C. Tri-Ethylene Glycol Dehydration Units

Description of Units

[14] McGowin (1973) Stationary Combustion Turbines in the United States.

Tri-ethylene glycol (TEG) dehydration units are commonly used in the natural gas industry to remove entrained water from the natural gas stream to meet pipeline contract water specifications. The dehydration process begins with routing the natural gas stream through TEG in an absorber (or contactor tower) where the entrained water is absorbed by the TEG. During this step, hydrocarbons present in the natural gas stream are also absorbed in the glycol. Following the absorption step, the water saturated (rich) glycol is then distilled to drive off absorbed water before being re-circulated to the absorber. The distillation step results in emissions of VOC and HAP from the reboiler still-vent. The common still-vent HAP emissions are benzene, toluene, ethyl-benzene, and xylene.

Data Collection

The AQP collected dehydration unit counts from the ICR, which required operators to enter the total number of dehydration units operated by their company at small oil and gas sources on the Reservation during calendar year 2020. The ICR included assumed dehydration unit operating parameters and a theoretical extended natural gas analysis, as described later in this section, which could be accepted or overridden with values more representative of the operators' operations. The theoretical extended gas analysis is displayed below in Table 14.

Fifty dehydration units were reported in the ICR submittals and all submittals accepted the AQP's assumed operation and natural gas composition values.

Emissions Calculation Methodology

Emissions for glycol dehydration units were calculated using the GRI-GLYCalc 4.0 model (GLYCalc), the AQP's theoretical values for dehydration unit operating parameters and natural gas composition, and the methodology outlined in the GLYCalc user's manual.[15] GLYCalc is the EPA's preferred method of quantifying emissions from glycol dehydration units for the development of tribal/state/local emissions inventories.[16]

Product of combustion emissions from dehydration unit reboilers were included in the emission totals for heaters and boilers presented in Section V.1.E. of this report to avoid double counting.

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[15] Gas Research Institute. (2000). GLYCalc Version 4.0. Retrieved from http://sales.gastechnology.org/000102.html.

[16] U.S. EPA. (1995). Glycol Dehydrator Emissions Test Report and Emissions Estimation Methodology. Retrieved from https://www3.epa.gov/ttn/chief/old/efdocs/glycoldehydratortestreport.pdf.

Table 14: Theoretical extended natural gas analysis – average of 31 natural gas analyses from the Southern Ute Indian Reservation

Component	Average
Methane	92.3814%
Ethane	0.9867%
Propane	0.2291%
Isobutane	0.0349%
n-Butane	0.0468%
Isopentane	0.0107%
n-Pentane	0.0070%
n-Hexane	0.0028%
Carbon Dioxide	6.1663%
Nitrogen	0.1134%
Hydrogen Sulfide	0.0000%
2,2 Dimethylbutane	0.0000%
2,3 Dimethylbutane	0.0000%
Cyclopentane	0.0003%
2-Methylpentane	0.0004%
3-Methylpentane	0.0029%
2,2 Dimethylpentane	0.0012%
Methylcyclopentane	0.0000%
2,4-Dimethylpentane	0.0012%
2,2,3-Trimethylbutane	0.0000%
Benzene	0.0000%
3,3-Dimethylpentane	0.0005%
Cyclohexane	0.0000%
2-Methylhexane	0.0008%
2,3-Dimethylpentane	0.0002%
1,1-Dimethylcyclopentane	0.0000%
3-Methylhexane	0.0000%
1,t-3-Dimethylcyclopentane	0.0002%
1,c-3-Dimethylcyclopentane	0.0000%
3-Ethylpentane	0.0000%
1,t-2-Dimethylcyclopentane	0.0000%
2,2,4 Trimethylpentane	0.0000%
n-Heptane	0.0002%
Methylcyclohexane	0.0028%
Toluene	0.0021%
n-Octane	0.0010%
Ethylbenzene	0.0017%
2,3-Dimethylheptane	0.0001%
m-Xylene	0.0000%
p-Xylene	0.0002%
o-Xylene	0.0003%
n-Nonane	0.0001%
n-Decane	0.0008%
n-Undecane	0.0006%
Total:	100.00%
Total VOC:	0.35%

GRI-GLYCalc Model Input Parameters

The AQP developed assumed dehydration unit operational values for natural gas temperature, pressure, and flowrate by averaging operational information from dehydration units at small oil and gas sources provided by two of the largest operators on the Reservation. An assumed extended natural gas analysis was prepared by averaging 31 individual extended gas analyses from natural gas production sector compressor stations that were reported to the AQP in Title V operating permit applications between 2017 and 2020.

The AQP's assumed values were input into the GLYCalc emissions model using a pipeline water content specification of seven pounds of water per MMscf of natural gas, 1.5% H_2O lean glycol, and assuming uncontrolled operation with no flash tank.
The assumed GLYCalc input parameter values are provided below in Table 15.

Table 15: GRI-GLYCalc Model input parameters for TEG Dehydration units at small oil and gas sources

Wet Gas Temperature [°F]	68.5
Wet Gas Pressure [psig]	353.5
Dry Gas Flowrate/ Throughput [MMscf/day]	0.9
Lean Glycol Water Content [weight % H2O]	1.5
Glycol Pump Type	Electric/ Pneumatic
Pipeline Water Content Specification [lb H2O/MMscf]	7.0

GRI-GLYCalc Model Emissions Output:

Fifty dehydration units were reported for small oil and gas sources in the ICR submittals and all dehydration unit emissions were calculated using the AQP's default GRI-GLYCalc emissions report. The GRI-GLYCalc report was applied once to each of the 50 dehydration units reported in the ICR, and then summed to derive a reservation-wide emissions estimate for glycol dehydration units located at small oil and gas sources.

No operator specific GLYCalc reports or dehydration unit emission estimations were provided in the ICR submittals.

Modeled GRI-GLYCalc emissions for a single TEG dehydration unit and using the AQP's assumed model inputs are provided in Table 16.

Table 16: GRI-GLYCalc Model emissions output for TEG Dehydration units [tons]

Pollutant	Uncontrolled Emissions
Methane	0.2341
Ethane	0.0226
Propane	0.0211
Isobutane	0.0076
n-Butane	0.0156
Isopentane	0.0057
n-Pentane	0.0050
Cyclopentane	0.0000
n-Hexane	0.0080
Cyclohexane	0.0048
Other Hexanes	0.0000
Heptanes	0.0000
Methylcyclohexane	0.0097
2,2,4-Trimethylpentane	0.0002
Benzene	0.0237
Toluene	0.0796
Ethylbenzene	0.0122
Xylenes	0.0998
C8+ Heavies	0.1469
Total HC Emissions	**0.6966**
Total VOC Emissions	**0.4399**
Total HAP Emissions	**0.3849**
Total BTEX Emissions	**0.2153**

Example Calculation

Example calculation for VOC emissions from ICR Reported dehydration units:

VOC Emissions (tpy) = AQP Generated GRI-GLYCalc Emissions Output x Number of 2020 ICR Reported Dehydration Units

Example:

24.2 tpy annual VOC emissions = 0.4399 tpy VOC x 50 reported dehydration units

Emissions

VOC and HAP emissions from 50 TEG Dehydration Units at small oil and gas sources on the Reservation are provided in Table 17.

Table 17: VOC and HAP Emissions from TEG Dehydration Units from small oil and gas sources [tons]

	Number of Dehydration Units	VOC	Total HAP	Benzene	Toluene	Ethylbenzene	Xylenes
Totals	50	19.4	8.7	1.0	3.4	0.5	3.6

D. Liquid Storage Tanks

Description of Equipment and Emissions Categories

The oil and gas industry utilize liquid storage tanks for the storage of produced water, condensate, oil, coolants, and lubricants. The primary emissions from liquid storage tanks are methane, VOC and HAPs. Emission categories include breathing and working losses, flash emissions, and tank loadout.

Breathing and Working Losses:

Breathing losses occur when vapor expansion generated during temperature fluctuations increases the vapor pressure within a tank and cause fugitive emissions to escape from the roof vent. Light colored tanks and tank heaters can help maintain more consistent tank temperatures and reduce breathing losses by reducing vapor pressure variations. Full tanks also produce lower breathing losses due to less space for vapors to expand and escape from roof vents. Working losses occur when liquids are pumped into and out of storage tanks. The displacement of vapors within the tank and the turbulence caused by the movement of the liquid create airborne vapors. Submerged fill tanks can be effective for reducing turbulence and the creation of airborne vapors.

Flash Emissions:

Flash emissions are emissions that occur when liquid dumped from the separator into the liquid storage tank goes from higher pressure to lower pressure, resulting in the entrained gas being released as a vapor from the liquid. The gas to liquid ratio, pressure and temperature of the liquids in the separator, and the temperature and pressure of the liquid storage tank influence the amount of flashing losses.

Tank Loadout Emissions:

Tank loadout emissions are vapor loss from transport tanks that occur during the transfer of liquids from a storage tank to a transport tank. Loadout emissions occur due to the generation of vapors in transport tanks during liquid loading, the transfer of vapors from the liquid storage tank to the transport tank, and the displacement of vapors trapped in transport tanks from previous loads during loading.

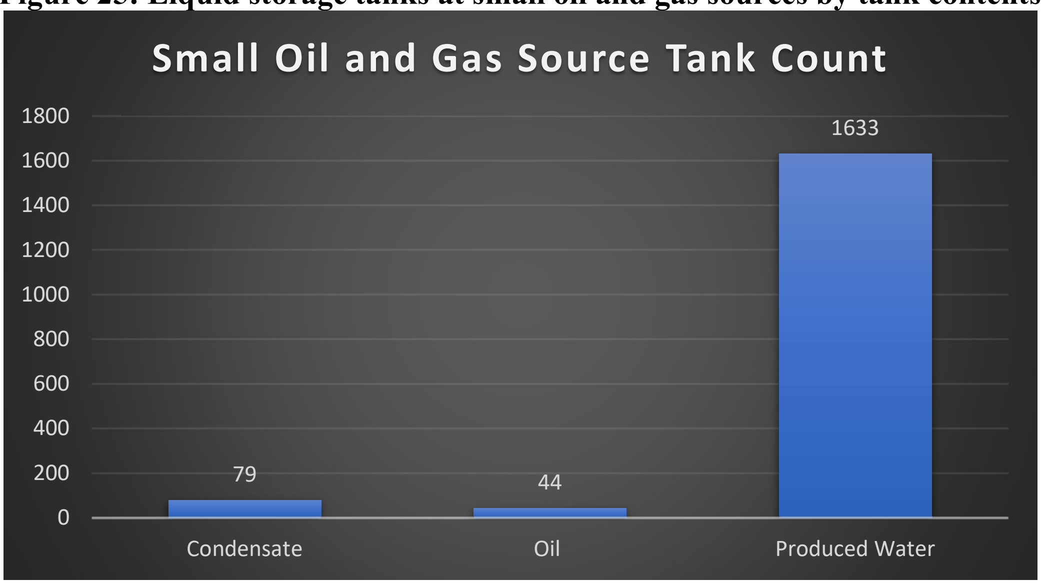
Data Collection

Tank Counts and Data for Calculating Breathing and Working Losses:

The ICR required each operator to provide the total number of produced water, condensate, and oil tanks located at their small oil and gas sources on the Reservation. Reported tank counts were based on tank capacity and contents.

A summary of tanks reported in the ICR, by tank contents, is displayed below in Figure 25.

Figure 25: Liquid storage tanks at small oil and gas sources by tank contents



The ICR also provided operators with the opportunity to override assumed data values for annual liquid throughput, Reid Vapor Pressure, and general tank characteristics with values more representative of their operations. Tank characteristics include roof type, color, condition, and presence of a tank heater. Development of liquid throughput values is discussed later in this section. Emissions from lubricant oil and glycol storage tanks were assumed to be negligible and no data was requested for these sources.

Methodology for Deriving Average Liquid Throughput Values:

The AQP developed two types of annual liquid throughput values, based on the availability of data in the COGCC database for sources in La Plata County, Colorado for CY 2020. If data were available from COGCC, the AQP used operator-specific throughput values and if the data were not available, the AQP developed assumed annual average liquid throughput values. The operator-specific annual average liquid throughput values were derived by dividing their total reported produced water and condensate/oil production numbers by the total number of sources that reported production for CY 2020.

Assumed average annual liquid throughput values were developed for operators that reported active sources to the COGCC in 2020 but did not report production. The assumed annual throughput value for produced water was derived by dividing the total CY 2020 produced water production values reported to the COGCC database by the total number of reported sources. A combined condensate and oil assumed annual average tank throughput value was derived by dividing the total CY 2020 combined condensate and oil production value reported to the COGCC database by the number of small oil and gas sources that reported condensate or oil production. Not all companies reported condensate or oil production to COGCC, and four companies reported much larger condensate and oil production numbers than other companies producing condensate and oil. Companies that did not produce any condensate or oil and the few companies with large production numbers were dropped from the calculations to avoid skewed production numbers. Assumed annual average liquid throughput values for the produced water, oil, and condensate at small oil and gas sources on the Reservation are displayed below in Table 18.

Table 18: Assumed annual average liquid throughput values for produced water, oil, and condensate tanks at small oil and gas sources*

Number of Sources Operating in 2020	2,903
2020 Oil/Condensate Produced [bbl]	13,933
2020 Water Produced [bbl]	9,018,787
Average Oil/Condensate per source per year [bbl]	0.12
Average Water per source per year [bbl]	1,361

*Throughput numbers were derived from averaging production numbers from COGCC (2020). Production Data. Retrieved from http://cogcc.state.co.us/data2.html#/downloads.

Emission Calculation Methodology

Liquid storage tank emissions are calculated based on three separate emission event categories that occur during normal tank operation at atmospheric pressures, as described earlier in this section. The emissions categories include: breathing and working losses, flash emissions, and loadout emissions. Discussions are provided below the methodologies used to calculate emissions for each tank emissions category.

<u>Breathing and Working Losses</u>

Data Collection and Assumptions:

Emission totals for the Reservation were developed for each individual operator by running the EPA TANKS 4.09d Emissions Estimation Software (TANKS) model once for each tank size and production type category reported in the ICR and then multiplying each modeled emissions total by the number of corresponding tanks reported.[17] Reported liquid throughput values were used when provided and assumed throughput values were used when data was not provided.

Emission Calculations:

Standing, and working losses were calculated using the TANKS model and reported or assumed input data values for liquid throughput, Reid vapor pressure, and tank characteristics. An equal distribution through all tanks was assumed by dividing the total production by the total number of tanks in a given category. Produced water was assumed to consist of a mixture of 99% water and 1% condensate. Condensate was assumed to have a Reid Vapor Pressure of 10 in the TANKS model. The default values for crude oil were used for oil tank calculations. The model was run for tanks operating at atmospheric pressure and the TANKS model meteorological conditions for Albuquerque, New Mexico. Emission estimates using this geographic location may be biased slightly higher, as average temperatures in Albuquerque are warmer than within the Reservation. All tanks were assumed to have a cone shaped roof, to be gray in color, and equipped with a tank heater.

Liquid Storage Tanks Flash Emissions

Data Collection and Assumptions:

The ICR requested flash gas liberation data from produced water, condensate, and oil, to aid in calculating flash emissions. No ICR submittals were returned with flash liberation data, as this type of sampling is not common practice on the Reservation.

In September 2016, the AQP contracted a third-party vendor to perform flash liberation sampling at well-site locations operated by two different companies on the Reservation. Sampling was performed on the separator at each well-site in order to obtain a pressurized sample. In total, seven produced water samples were obtained from coal-bed methane wells of the Fruitland Coal Formation on the east and west sides of the Reservation. Two produced water samples and one condensate sample were obtained from conventional natural gas wells of the Picture Cliffs Sandstone Formation in the south central portion of the Reservation.[18] Due to the very low oil production numbers reported to the COGCC database for La Plata County Colorado in CY2020 and the absence of viable sampling locations, the AQP elected to not obtain oil flash gas samples, but to use the condensate flash sampling results to estimate oil flash emissions

[17] U.S. EPA. (2006). TANKS 4.09d Emissions Estimation Software. Retrieved from https://www3.epa.gov/ttnchie1/software/tanks.

[18] Air Pollution Testing, Inc. (2016). Southern Ute Indian Tribe Flash Liberation Analyses.

Two additional condensate flash samples were provided by an operator that performed sampling in August 2016 from liquid knockout locations on a well-site gathering pipeline containing natural gas from conventional wells in the southern portion of the Reservation.

All sampling reports included an extended gas analysis, gas to water ratio, gas specific gravity, separator temperature and pressure, and ambient temperature and pressure.

Results from the six valid produced water samples were averaged to obtain assumed gas composition, gas to water ratio values, gas molecular weight, and gas component weight percent to be used in the development of emission factors for estimating storage tank flash emissions. The same methodology was applied for deriving average composition values from the three valid condensate samples.

Averaged extended gas analysis values for produced water and condensate are displayed below in Table 19 and Table 20, respectively. Averaged gas to water and gas to condensate values are displayed below in Table 21.

Table 19: Produced water flash gas analysis from small oil and gas sources on the Southern Ute Indian Reservation [Mol %]*

Flash Gas Component	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Average
Hydrogen Sulfide	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Nitrogen	0.0373%	0.0000%	1.0883%	1.0464%	2.6862%	0.5921%	0.9084%
Carbon Dioxide	72.3236%	68.4996%	36.5680%	29.7757%	5.8668%	16.3515%	38.2309%
Methane	26.6076%	31.0289%	62.2021%	67.0612%	91.4075%	76.3697%	59.1128%
Ethane	0.3200%	0.0271%	0.1155%	0.0138%	0.0119%	4.0640%	0.7587%
Propane	0.0359%	0.0231%	0.0124%	0.037%	0.0079%	1.0078%	0.1874%
Isobutane	0.0036%	0.0035%	0.0012%	0.0049%	0.0007%	0.1582%	0.0287%
N-Butane	0.0100%	0.0160%	0.0015%	0.0163%	0.0029%	0.1689%	0.0359%
2,2 Dimethylpropane	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Isopentane	0.0028%	0.0037%	0.0003%	0.0071%	0.0005%	0.1027%	0.0195%
N-Pentane	0.0039%	0.0078%	0.0005%	0.0117%	0.0012%	0.0612%	0.0144%
2,2 Dimethylbutane	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Cyclopentane	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0108%	0.0018%
2,3 Dimethylbutane	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
2 Methylpentane	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
3 Methylpentane	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
N-Hexane	0.4360%	0.1881%	0.0005%	1.8678%	0.0035%	0.2114%	0.4512%
Methylcyclopentane	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Benzene	0.0085%	0.0000%	0.0000%	0.0227%	0.0000%	0.1056%	0.0228%
Cyclohexane	0.0084%	0.0000%	0.0000%	0.0418%	0.0021%	0.0481%	0.0167%
2-Methylhexane	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
3-Methylhexane	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
2,2,4 Trimethylpentane	0.0000%	0.0000%	0.0000%	0.0000%	0.0003%	0.0088%	0.0015%
Other C7's	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
N-Heptane	0.0000%	0.0000%	0.0006%	0.0000%	0.0026%	0.2092%	0.0354%
Methylcyclohexane	0.0037%	0.0000%	0.0000%	0.0081%	0.0029%	0.0865%	0.0169%
Toluene	0.0108%	0.0000%	0.0000%	0.0514%	0.0016%	0.1397%	0.0339%
Other C'8s	0.1872%	0.0000%	0.0091%	0.0196%	0.0011%	0.2745%	0.0819%
N-Octane	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Ethylbenzene	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0049%	0.0008%
M&P Xylenes	0.0008%	0.0000%	0.0000%	0.0141%	0.0000%	0.0242%	0.0065%
O-Xylene	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Other C9's	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
N-Nonane	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Other C10's	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
N-Decane	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Undecanes(11)	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Totals:	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Total VOC:	**0.7116%**	**0.2422%**	**0.0261%**	**2.1029%**	**0.0273%**	**2.6225%**	**0.9554%**
Total HAP:	**0.4561%**	**0.1881%**	**0.0005%**	**1.9560%**	**0.0054%**	**0.4946%**	**0.5168%**

*Air Pollution Testing, Inc. (2016, September). Southern Ute Indian Reservation Flash Liberation Analyses.

Table 20: Condensate flash gas analysis from small oil and gas sources on the Southern Ute Indian Reservation [Mol %]*

Flash Gas Component	Sample 1	Sample 2	Sample 3	Average
Hydrogen Sulfide	0.000%	0.000%	0.0000%	0.000%

Nitrogen	6.633%	5.170%	0.5871%	4.130%
Carbon Dioxide	3.053%	2.564%	2.8208%	2.813%
Methane	62.466%	62.678%	50.2222%	58.455%
Ethane	14.918%	16.162%	20.4293%	17.170%
Propane	6.279%	7.028%	12.0540%	8.454%
Isobutane	1.371%	1.353%	3.2488%	1.991%
N-Butane	1.738%	1.840%	3.6206%	2.400%
2,2 Dimethylpropane	0.000%	0.000%	0.0000%	0.000%
Isopentane	0.794%	0.769%	1.7594%	1.107%
N-Pentane	0.551%	0.560%	1.0198%	0.710%
2,2 Dimethylbutane	0.000%	0.000%	0.0000%	0.000%
Cyclopentane	0.000%	0.000%	0.1844%	0.061%
2,3 Dimethylbutane	0.000%	0.000%	0.0000%	0.000%
2 Methylpentane	0.000%	0.000%	0.0000%	0.000%
3 Methylpentane	0.000%	0.000%	0.0000%	0.000%
N-Hexane	0.869%	0.748%	1.4232%	1.013%
Methylcyclopentane	0.000%	0.000%	0.0000%	0.000%
Benzene	0.105%	0.076%	0.1128%	0.098%
Cyclohexane	0.000%	0.000%	0.0000%	0.000%
2-Methylhexane	0.000%	0.000%	0.0000%	0.000%
3-Methylhexane	0.000%	0.000%	0.0000%	0.000%
2,2,4 Trimethylpentane	0.003%	0.003%	0.0291%	0.012%
Other C7's	0.000%	0.000%	0.0000%	0.000%
N-Heptane	0.557%	0.461%	0.7371%	0.585%
Methylcyclohexane	0.000%	0.000%	0.2793%	0.093%
Toluene	0.166%	0.126%	0.1768%	0.156%
Other C'8s	0.000%	0.000%	0.8700%	0.290%
N-Octane	0.304%	0.247%	0.0000%	0.184%
Ethylbenzene	0.008%	0.007%	0.0076%	0.008%
M&P Xylenes	0.071%	0.074%	0.1086%	0.085%
O-Xylene	0.000%	0.000%	0.0000%	0.000%
Other C9's	0.000%	0.000%	0.0000%	0.000%
N-Nonane	0.088%	0.088%	0.0000%	0.059%
Other C10's	0.000%	0.000%	0.0000%	0.000%
N-Decane	0.027%	0.048%	0.0000%	0.025%
Undecanes(11)	0.000%	0.000%	0.0000%	0.000%
Totals:	**100%**	**100%**	**100%**	**100%**
Total VOC:	**12.9310%**	**13.4280%**	**25.6315%**	**17.3302%**
Total HAP:	**1.2220%**	**1.0340%**	**1.8581%**	**1.3714%**

*Air Pollution Testing, Inc. (2016, September). Southern Ute Indian Reservation Flash Liberation Analyses.

Table 21: Average gas to water and gas to condensate ratios for small oil and gas sources*

Gas/Water [scf/bbl]	Gas/Condensate [scf/bbl]
3.3	16.5

*Air Pollution Testing, Inc. (2016, September). Southern Ute Indian Reservation Flash Liberation Analyses.

Flash Emission Calculation Methodology:

Flash emission factors in pounds per barrel (lb/bbl) were developed for VOC, BTEX, methane, and carbon dioxide. The measured gas oil/gas water ratio (scf/bbl) was divided by the ideal gas law conversion factor (scf/lb-mol) and then multiplied by the molecular weight of the flash gas (lb/lb-mol) and then multiplied by the weight percent of each specific component to derive the emission factors. The total emissions were calculated by multiplying the emission factors for each component by the total reported production in barrels. Tank throughput values in barrels per day were either reported values or the assumed values developed by AQP, as described previously in this section. Flash emission totals for the Reservation were developed for each individual operator using either reported or assumed liquid throughput values.

Example Emission Factor Development for Flash Emissions:

*Emission Factor (lb/bbl) = GOR/R*MW*Wt%*

Where:

GOR = measured gas oil/gas water ratio (scf/bbl)
R = ideal gas law conversion factor (scf/lb-mol)
MW = molecular weight of flash gas (lb/lb-mol)
Wt% = weight percent of desired component in flash gas

Example Emission Calculation:

*Emissions (ton/year) = EF*P/2000*

Where:

EF = emission factor (lb/bbl)
P = annual production (bbl/year)
2000 = conversion factor (lb/ton)

Liquid Storage Tank Loadout Emissions

Data Collection and Assumptions:

Tank loadout emissions were calculated by conservatively assuming that all liquid storage tanks are unloaded manually by truck, and not sent through pipeline. Emission factors and emission calculations were derived from Section 5.2 of EPA AP-42 for Transportation and Marketing of Petroleum Liquids. Loading was assumed to be submerged fill and the saturation emission factor for submerged dedicated normal service was selected for calculating loading losses. Truck tank capacity was assumed to be 100 bbl per loadout event and reported or assumed liquid production numbers were used for calculating the number or loadout events per year. Each loadout event was assumed to be one-hour in duration and the assumed annual hours of unloading operations for each operator were directly correlated to the reported or assumed annual liquid production. Molecular weight and true vapor pressure values were derived from TANKS model runs for produced water and condensate.

Example Tank Loadout Emissions Calculation Methodology:

Tank loadout emissions are calculated using two separate calculations. The first equation is used to estimate the total molecular weight of loading emissions losses and a second equation is used to estimate the total emission rate on a pollutant basis. Both calculations are displayed below:

Loading Losses Calculation:

$$L = 12.46 \times (S) \times (P) \times ((MW)/T) \times (1\text{-}eff)$$

Where:

L=Loading Losses (lb/1000 gallons)
S = Saturation Factor
P = True Vapor Pressure (Pva @ T)
MW = Molecular Weight (lb/lb-mol)
T = Temperature
E = Control Efficiency of Loading

Total Emission Rate Calculation:

$$\text{Tons Per Year} = L * \text{Annual Throughput}/2000 * \text{Wt\%}$$

Where:

L = Loading Losses (lb/1000 gallons)
Annual Throughput = annual throughput (1000 gallons)
2000 = conversion factor (lb/ton)
Wt% = Component Weight Percentage from Flash Gas Analysis

Liquid Storage Tank GHG Emissions

Tank Flash Greenhouse Gas Emissions:

Flash greenhouse gas (GHG) emissions for storage tanks were calculated using the measured data from the flash liberation sampling completed in 2016 from well-sites on the Reservation. Emission factors for Methane and Carbon Dioxide were developed as cited in the *Flash Emission Calculation Methodology* section of this report. These emission factors were multiplied by the total production and divided by a conversion factor to provide an output in tons per year. This was then multiplied by a conversion factor to convert to metric tonnes and then multiplied by the global warming potential of each component, found in Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) Table 7.15, to provide an output total in metric tonnes of carbon dioxide equivalent.

Example Calculation for Tank Flash GHG Emission:

$$CH4\ (CO2e) = (EF*P/CF1)*CF2*GWP$$

Where:

EF = emission factor (lb/bbl)
P = annual production (bbl/year)
CF1 = conversion factor (2000lb/ton)
CF2 = conversion factor (0.907185 metric tonnes/ton)
GWP = global warming potential (29.8 for Methane, 273 for N_2O*)*

Tank Loadout GHG Emissions

GHG emissions from tank loadout were calculated using the same methodology found in the *Liquid Storage Tank Loadout Emissions* section of this report. Once the loadout emissions, in tons per year, are determined for a GHG, it is multiplied by a conversion factor to convert it to metric tonnes. This metric tonnes number is then multiplied by the global warming potential of the individual component to provide an output in metric tonnes of carbon dioxide equivalent.

Example Tank Loadout GHG Calculations:

$$CO2e = tpy*CF*GWP$$

Where:

CO2e = carbon dioxide equivalent (metric tonnes)
tpy = emissions (tons per year)
CF = conversion factor (0.907185 metric tonnes/ton)
GWP = global warming potential of individual pollutant

Total Liquid Storage Tank Emissions

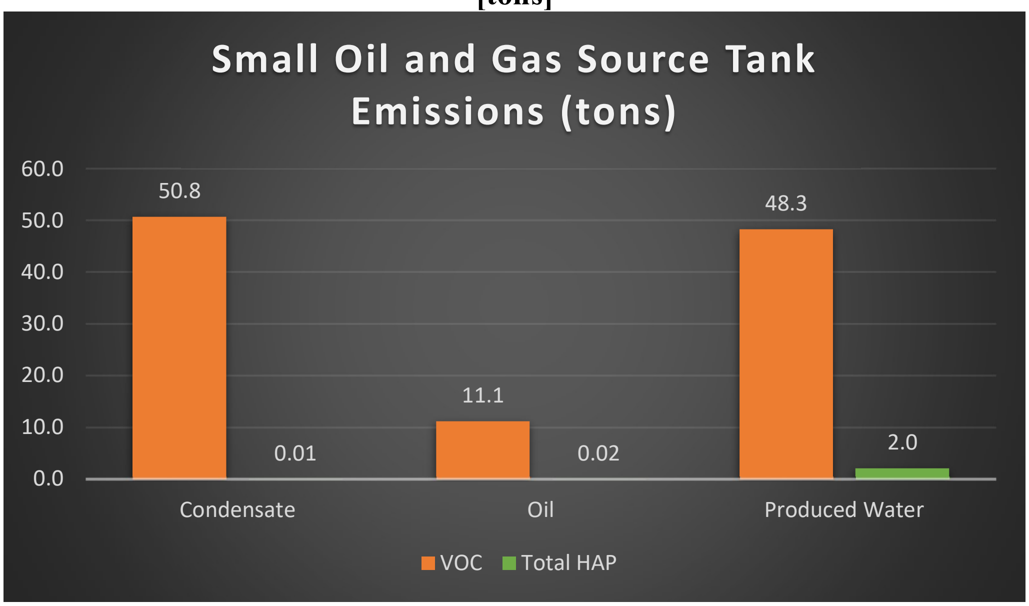
Total liquid storage tank emissions at small oil and gas sources from working and breathing losses, flash emissions, tank loadout, and GHG emissions on the Reservation are displayed in below in Table 22 and Figure 26. Emissions are displayed by tank contents.

Table 22: VOC, HAP, and GHG Emissions from liquid storage tanks at small oil and gas sources [tons]*

Tank Contents	Tank Count	VOC	Total HAP	GHG
Condensate	79	50.8	0.01	5.3
Oil	44	11.1	0.02	14.8
Produced Water	1633	48.3	2.0	11,477.4
Totals	**1756**	**110.2**	**2.1**	**11,497.5**

*GHG emissions reported in metric tonnes

Figure 26: VOC and HAP emissions from liquid storage tanks at small oil and gas sources [tons]



E. External Combustion Sources

Description of Sources

Natural gas-fired external combustion sources are widely used by the natural gas industry as tank heaters, heated separators, reboilers, and boilers.

Data Collection

The ICR required each operator to report the total number of heaters and boilers operated by their company on the Reservation. Heater and boiler counts were reported according to heat rate range in MMBTU/hr. Operators were also given the option to report average heater and boiler operating hours to override the AQP's assumed operating hours. A description of the AQP's assumed values is included in the emission calculation discussion.

Assumptions

If no hours of operation were reported in the ICR, AQP assumed heaters to operate 24 hours per day for half of the year (183 days per year) which equates to 4,392 hours per year. Boilers were assumed to operate for 24 hours per day, 365 days a year, which equates to 8,760 hours per year.

Emission Calculation Methodology

Criteria pollutant and HAP emissions for external combustion sources were calculated using the emission factors from EPA AP-42 Chapter 1.4 for uncontrolled natural gas-fired external combustion sources, the maximum heat rating from each heat rating category reported in the ICR, a default natural gas heating value of 1,026 Btu/scf and assumed or reported operating hours.

The AQP used the default natural gas heating value of 1,026 Btu/scf from 40 CFR Part 98 to convert the EPA emission factors from lbs/MMscf to lbs/MMBtu.

GHG emissions were calculated using the Tier 1 calculation methodology, the natural gas emission factors from Tables C-1 and C-2 of 40 CFR Part 98 and assumed or reported operating hours.

Example Calculations

Criteria and HAP Example Calculations:

$$lb/hr = (EF/HV) \times (HR)$$

Where:

EF = Emission Factor (lb/MMscf)
HV = Default Heat Value of Natural Gas fuel (Btu/scf)
HR = Heat Rate of Boiler/Heater (MMBtu/hr)

Example NOx lb/hr calculation for 0.5 MMBtu/hr natural gas-fired boiler/heater:

lb/hr = (100/1,026) x 0.5 = 0.05

tpy = (lb/hr) x OH/2000

Where:

(lb/hr) = Emission Rate
OH = Annual Operating Hours
2000 = Pounds per ton

Example NOx tpy calculation for 0.5 MMBtu/hr natural gas-fired boiler/heater operating 4392 hours per year:

tpy = (0.05) x 4392/2000= 0.1098

GHG Example Calculation:

GHG Calculation Methodology:

= EF x HR x CF x GWP

Where:

EF = fuel specific default emission factor, from tables C-1 and C-2 of Part 98 (kg/MMBtu)
HR = heat rate (MMBtu/hr)
CF = conversion factor (lb/kg)
GWP = global warming potential

Emissions

Criteria pollutant, HAP, and GHG emissions from external combustion sources located at small oil and gas sources on the Reservation for calendar year 2020 are displayed below in Table 23. Emissions are displayed by unit count and heat rating in MMBtu/hr.

Table 23: Criteria pollutant, HAP, and GHG emissions from heaters and boilers at small oil and gas sources [tons]*

Equipment Type and Heat Rating	Unit Count	NOx	VOC	SO_2	PM	CO	HAP	GHG (CO_2e)
Heaters								
0.25 MMBtu/hr	1798	95.8	4.9	0.6	7.8	80.5	1.7	104,417.2
0.5 MMBtu/hr	328	35.0	1.9	0.2	2.9	29.4	0.6	38,162.0
1.0 MMBtu/hr	1001	214.2	11.8	1.3	16.3	180.0	1.5	233,523.4
100 MMBtu/hr	9	92.6	10.6	1.2	14.6	161.8	3.6	209,961.1
Heaters Total	3136	537.7	29.2	3.2	41.6	451.7	7.4	586,063.8
Boilers								
0.25 MMBtu/hr	6	0.6	0.0	0.0	0.1	0.5	0.0	698.0
Boilers Total	6	0.6	0.0	0.0	0.1	0.5	0.0	698.0

Total	**3142**	**538.3**	**29.3**	**3.2**	**41.7**	**452.2**	**7.4**	**586,761.7**

*GHG reported in metric tonnes.

F. Equipment Leaks and Fugitive Emissions

Description of Sources

Natural gas leaks from components commonly used in the natural gas industry result in emissions of methane, CO_2, VOC, and HAP. Components include: valves, pumps, pressure relief valves, connectors, flanges, and, open-ended lines. These components are ancillary equipment to many larger equipment source types including: headers, separators, heaters, filters, engines, compressors, dehydration units, and storage tanks.

Data Collection

The ICR provided operators with the option to report average fugitive component counts for single and co-located well-sites. In the absence of ICR provided component counts, the AQP relied on assumed component counts, as detailed below.

Assumptions

Fugitive component counts were assumed based on component counts for natural gas production contained in the Canadian Association of Petroleum Producers (CAPP) document titled *Guide to Calculating Greenhouse Gas Emissions*.[19] Component counts for single and co-located well-site locations are displayed below in Table 24.

Table 24: Assumed fugitive emission component counts at single and co-located natural gas well-sites

Component Type-Service	Component count for a Single well	Component count for Two co-located wells	Component count for Three Co-located wells	Component count for Four Co-located wells
Valves-Gas/Vapor	16	32	48	64
Connectors-Gas/Vapor	60	120	180	240
Open-Ended Lines-Gas/Vapor	3	6	9	12

Emission Calculation Methodology

GHG, VOC, and HAP Emission Calculations:

GHG, VOC, and HAP emissions from equipment leaks and fugitive emissions were calculated using the average emission factor approach and the gas/vapor total organic compound (TOC) emission factors for oil and gas production from Table 2-4 of EPA's

[19] Canadian Association of Petroleum Producers. (2003). *Guide to Calculating Greenhouse Gas Emissions.* Retrieved from http://www.capp.ca/publications-and-statistics/publications/241974.

OAQPS document titled *Protocol for Equipment Leak Emission Estimates.* The TOC emission factor for gas/vapor was chosen as the most representative of production on the Reservation in CY2020 and is the most conservative emission factor available. TOC emissions were calculated by multiplying the gas/vapor emission factor by component counts calculated using the *CAPP* generic fugitive component count and the number of sources entered in the ICR. Each source was assumed to operate for 8,760 hours annually. GHG, VOC, and HAP emissions were then derived by multiplying the TOC emissions by the GHG, VOC, and HAP molecular weight fraction percentages of an assumed extended natural gas analysis for the Reservation. If component counts were provided by operators in the ICR, emissions for their company's productions were calculated using their reported counts in place of the CAPP component counts.

Example Calculations

GHG, *VOC, and HAP Emission Calculation Methodology:*

GHG, VOC, or HAP Emissions = EPA OAQPS Average Emission Factor for Gas Valves x CAPP Generic Valve Count x Annual Operating Hours x (Ton/2000lb0 x weight percent (GHG, VOC, or HAP) = tpy GHG, VOC, or HAP emissions

Valves VOC Emissions (tpy) = (0.00992 lb/hr/valve) x 1000 valves x (8760 hr/yr) x (Ton/2000 lb) x (1.51%) = 0.66 tons/year

Emissions

Volatile organic compound, HAP, and GHG emissions from equipment leak and fugitive emission sources located at small oil and gas sources on the Reservation for calendar year 2020 are displayed below in Table 25.

Table 25: Emissions of VOC, HAP, and GHG from equipment leaks and fugitive emission sources at small oil and gas sources [tons]*

	VOC	Total HAP	GHG
Fugitives	172.2	0.4	298,443.7

*GHG reported in metric tonnes.

G. Natural Gas Driven Pneumatic Devices

Description of Sources

Natural gas-driven pneumatic controllers and pumps are used in the oil and natural gas industry for maintaining liquid levels, pressures, pressure differentials, and temperature. Many devices are designed to leak, or "bleed", natural gas and in doing so emit natural gas containing methane, CO_2, VOC, and HAP. Pneumatic devices are classified as high or low continuous bleed controllers, intermittent bleed controllers, or zero bleed controllers.

Data Collection

The AQP assigned an assumed value for the average number of pneumatic devices located at a single wellsite from the 2014 Environmental Science and Technology report titled *Methane Emissions from Process Equipment at Natural Gas Production Sites in the United States*.[20] The assumed pneumatic device count value was provided in the ICR and operators were provided the opportunity to override the assumed value with values more representative of their operations.

Emission Calculation Methodology

Pneumatic device emissions were calculated by applying the generic natural gas emission factors found in EPA's April 2014 Report for Oil and Natural Gas Sector Pneumatic Devices to the AQP's assumed average device count or average device counts reported in the ICR.

Example Emission Calculation:

$$lb/hr = Count \times Bleed\ Rate \times R \times MW \times Y$$

Where:

Count = total number of devices
Bleed Rate = bleed rate from device (scf/hr/device)
R = Universal gas constant (lb-mol/379.4scf)
MW = molecular weight of the component (lb/lb-mol)
Y = volume fraction of component in the vented gas

Example for Methane:

$$lb/hr = 2695 \times 5.5 \times 1/379.4 \times 16.01 \times 92\% = 575.4\ lb/hr$$

$$tpy = lb/hr \times OH/2000$$

Where:
lb/hr = emission rate in pounds per hour
OH = annual operating hours

[20] Allen, D. (2014). Methane Emissions from Process Equipment at Natural Gas Production Sites in the United States: Pneumatic Controllers. *Environmental Science & Technology, 49*, 633-640. Retrieved from http://pubs.acs.org/doi/pdf/10.1021/es5040156.

2000 = pounds per ton

tpy methane = 575.4 x 8760/2000 = 2520.3 tpy

Emissions

VOC, HAP, and GHG emissions from natural gas driven pneumatic devices on the Reservation during 2020 are displayed below in Table 26.

Table 26: VOC, HAP, and GHG emissions from natural gas driven pneumatic devices at small oil and gas sources [tons]*

	VOC	Total HAP	GHG
Pneumatics	146.4	10.2	217,529.5

*GHG reported in metric tonnes.

H. Natural Gas Blowdowns

Description of Sources

Natural gas blowdowns are intentional and unintentional gas releases during maintenance, routine operations, and emergencies. Blowdowns occur from gas compressors, compressor startups, gas wellbores, vessels, pipelines, and various equipment.

Data Collection

The ICR requested emissions resultant from maintenance and emergency natural gas blowdowns from compressors. Due to the burden of capturing actual emissions for each blown down event at a large number of small oil and gas sources, emissions from such events are based on assumptions on the amount of gas released, the AQP's assumed extended gas analysis, and an assumed number of events anticipated during a calendar year. The ICR provided operators with the opportunity to override the AQP's assumed values with values more representative of their operations.

Assumptions

The AQP developed assumed values for the number and time duration of annual compressor blowdowns that occur per year and the volume of natural gas vented per event. Assumed values were based on the 2015 Colorado Air Resources Management Modeling Study (CARMMS)[21]. The values assumed for 2020 are displayed below in Table 27.

[21] ENVIRON International Corp.; Carter Lake Consulting; Environmental Management and Planning Solutions. (2015). *Colorado Air Resources Management Modeling Study.* Retrieved from

Table 27: Assumed values for annual natural gas compressor blowdown events occurring at small oil and gas sources in 2017

Compressors	
Annual compressor blowdowns per compressor	2
Estimated amount of gas lost per blowdown [Mscf/event]	10

Emissions Calculation Methodology

Emissions from natural gas blowdowns were calculated using either the AQP's assumed extended gas analysis or reported natural gas analysis, and assumed or reported event frequencies, duration, and gas loss values.

Example Calculations:

tpy = Total vented x Ideal Gas Density/2000

Where:

Total vented = total volume of gas vented (for specific component) (scf/yr)

= (volume vented per blowdown (Mscf/event) x frequency (events/yr) x 1000scf/Mscf) x %vol of component

*Ideal Gas Density (lb/scf) = MW/(R*T)*
MW = molecular weight of the component
R = universal gas constant (0.730235 scf.atm/°R.lb-mol)
T = temperature (60 °F converted to 519.67 °R)
2000 = pounds per ton

Emissions

Emissions from natural gas blowdown activities occurring on the Reservation during 2020 are displayed below in Table 28.

Table 28: VOC, HAP, and GHG emissions from natural gas blowdowns at small oil and gas sources [tons]*

Pollutant	VOC	Total HAP	GHG
Blowdowns	0.1	0.0	182.2

*GHG reported in metric tonnes.

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https://www.blm.gov/sites/blm.gov/files/documents/files/program_natural%20resources_soil%20air%20water_air co_quicklins_CARMMS2.0.pdf.

I. Well Completion and Re-completion Venting

Description of Sources

Well completions and recompletions, when not employing closed vent system techniques, also known as "green completions", release natural gas during the "flow back" stage of the process. Flow back is the stage in which drilling fluid and hydrocarbon reservoir fluids return to the surface prior to well production. Green completion techniques capture flow back materials, including natural gas.

Data Collection

The number of well completions that occurred in calendar year 2020 were obtained from the COGCC database. Zero well completions occurred on the Reservation in calendar year 2020. No data were available for well recompletions in the COGCC database and an assumed recompletion value of 1% of all operating wells per year was obtained from the 2015 CARMMS.

The ICR also provided the opportunity for operators to report the number of well completion and recompletion events that occurred in calendar year 2020, including natural gas lost per event, and completion by type (conventional or green completion).

Assumptions

Fifty percent of all well completions and recompletions were assumed to utilize green completion technology with no natural gas vented to atmosphere. Conventional well completions and recompletions were assumed to vent 1,000 Mscf of natural gas per event. These assumptions were derived from the 2015 CARMMS.

For well recompletions, the assumed well recompletion value of 1% of all operating wells per year was obtained from the CARMMS study and assumed to be accurate and representative of operations on the Reservation.

All completion and recompletion activities were assumed to be either conventional or green completions, based on information provided by two large natural gas operators on the Reservation. Therefore, the AQP did not estimate emissions from flaring events that may occur during well completion or re-completion activities. Assumed well completion and recompletion values for 2020 are displayed below in Table 29.

Table 29: Assumed values for well completion and recompletion activities at small oil and gas sources*

Completion Type	Conventional	Green Technology
Percent of completions by type:	50%	50%

Estimated amount of gas vented to atmosphere per event [Mscf/event]:	1000	0
Estimated amount of gas controlled via closed loop system per event [Mscf/event]:	0	1000

*Assumed values are based on the 2015 CARMMS.

Emission Calculation Methodology

Emissions from well completion and recompletions were calculated using an assumed extended gas analysis and reported or assumed event frequencies and gas loss values. Emissions from drilling engines that are employed during well completion and re-completion activities were not calculated.

Emissions

Emissions from well completion and recompletion venting on the Reservation in calendar year 2020 are displayed below in Table 30.

Table 30: VOC, HAP, and GHG emissions from well recompletion activities at small oil and gas sources [tons]*

	VOC	Total HAP	GHG
Recompletions	42.9	0.1	27,232.2

*GHG reported in metric tonnes.

VOC, HAP, and GHG emissions from Fugitives, Blowdowns, Recompletions, and Pneumatics are displayed below in Figure 27 and Figure 28.

Figure 27: VOC and HAP emissions from Fugitives, Blowdowns, Recompletions, and Pneumatics [tons]

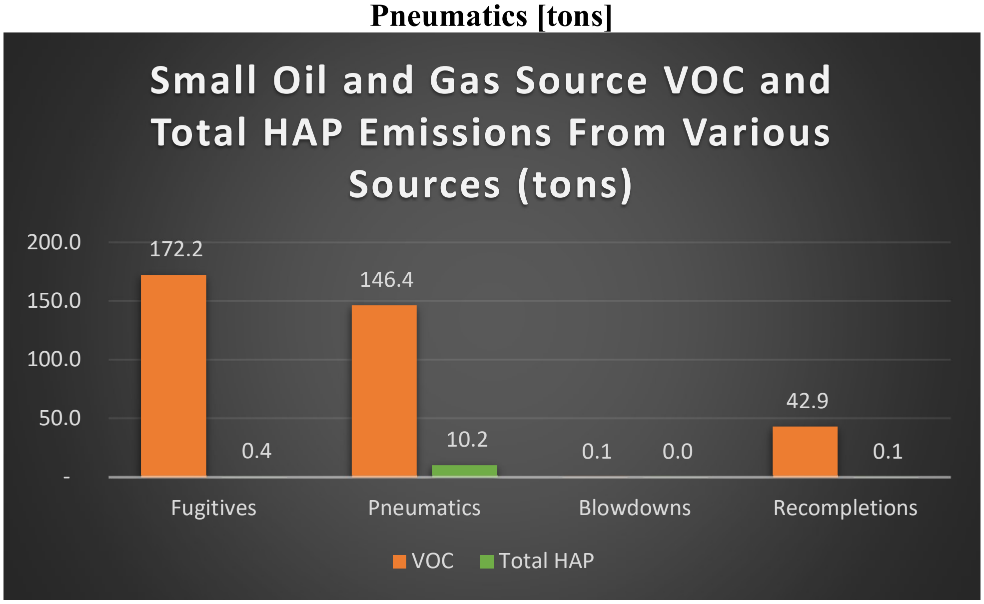
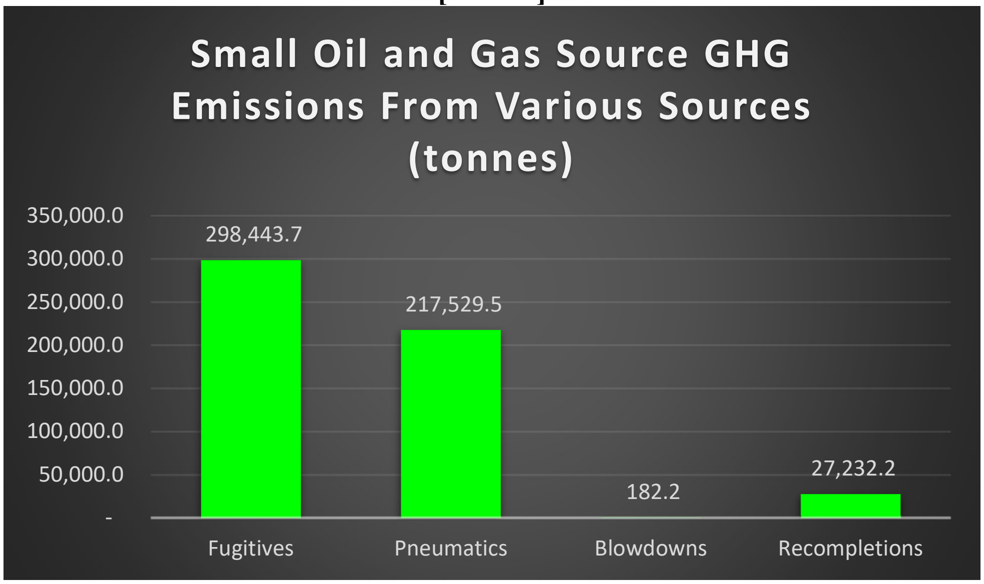


Figure 28: GHG emissions from Fugitives, Blowdowns, Recompletions, and Pneumatics [tonnes]



J. Typical Well-Site Configuration

Description

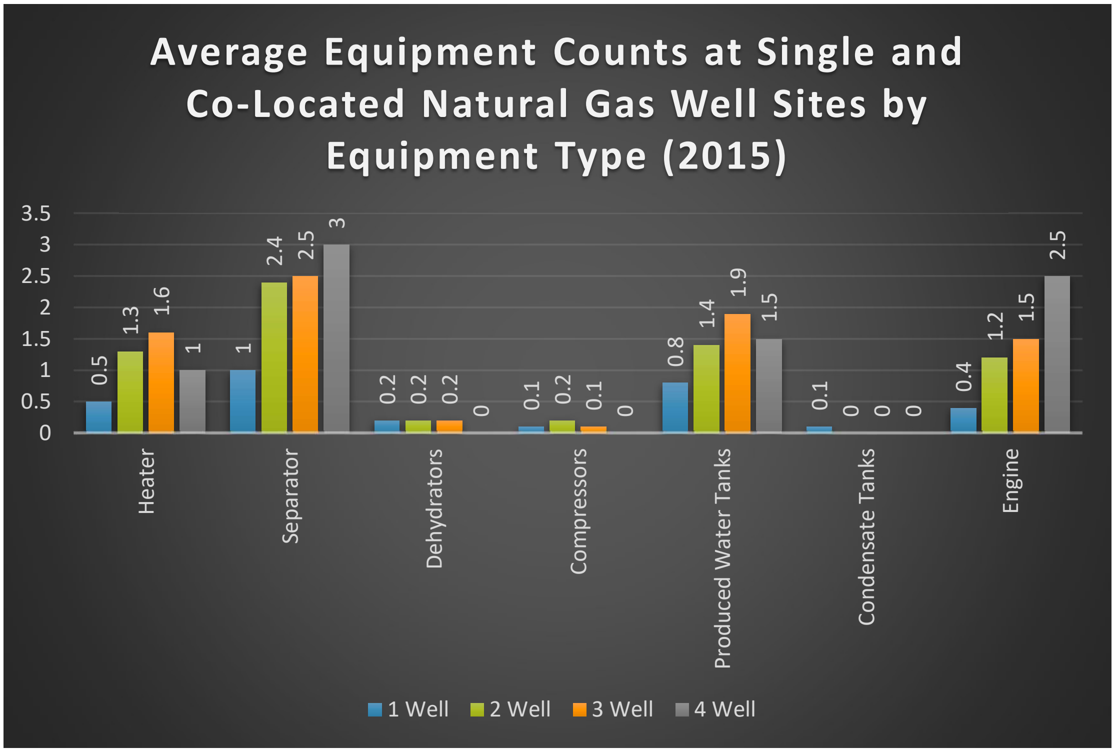
The AQP compiled equipment count information collected in the previous comprehensive emission inventory ICRs in CY 2015 to prepare average equipment type counts based on the number of natural gas wells located on a single well-pad. This information can be used to gain a better understanding of typical well-site configurations on the Reservation and to assist with estimating emissions from any proposed natural gas development schedules.

Average equipment counts at small oil and gas sources on the Reservation are displayed below in Table 31 and Figure 29.

Table 31: Average equipment counts at single and co-located well-sites at small oil and gas sources

Number of Wells per Pad	Heater	Separator	Dehydrators	Compressors	Produced Water Tanks	Condensate Tanks	Engine
1	0.5	1.0	0.2	0.1	0.8	0.1	0.4
2	1.3	2.4	0.2	0.2	1.4	0.0	1.2
3	1.6	2.5	0.2	0.1	1.9	0.0	1.5
4	1.0	3.0	0.0	0.0	1.5	0.0	2.5

Figure 29: Average equipment counts at small oil and gas sources by equipment type



2. Fruitland Formation Outcrop Natural Gas Seeps

Description of Sources

Naturally occurring methane and CO_2 seepage from outcrops of the Cretaceous Fruitland Formation (Fruitland Outcrop) contribute a significant quantity of the GHG emissions on the Reservation.

Data Collection

The data used to quantify emissions from the Fruitland Outcrop were provided to the AQP from the SUIT Department of Energy (SUIT DOE). SUIT DOE has collected outcrop seepage data on an annual basis since 2007 using an independent contractor between 2007 and 2020. The goal of the study is identification, mapping, and quantification of methane seeps on the Fruitland Outcrop. A backpack mounted, hand-held gas flux meter manufactured by WEST Systems is used to measure methane and CO_2 soil gas flux concentrations in moles per meters squared per day [mol/m² day] at thirty-five seep areas, totaling 51,667,675 square feet (1.9 miles) of ground. The flux concentrations were then used by the contractor to calculate volumetric methane and CO_2 concentrations for 2020 in MCFD.

Emission Calculation Methodology

The AQP calculated ton per year emission rates for methane and CO_2 by converting the volumetric methane and CO_2 flux concentrations from MSCF to SCFD and then dividing the flux concentrations by the ideal gas law constant and multiplying the constants by the molecular weight of each gas. GHG emissions in CO_2 equivalence (CO_2e) were calculated by multiplying methane emissions by the IPCC's global warming potential factor of 29.8 for methane.

Example Calculations

Calculation to Convert Flux Rate in SCFD to lb/day

*lb/day = Flux/Ideal Gas Law Conversion Factor*molar mass*

Where:

Flux = Volumetric gas flux in SCFD
Ideal Gas Law Conversion Factor = 379.3 SCF/mol
Molar Mass = $g*Mol^{-1}$ (CH4 = 16.04; CO2 = 44.01)

*lb/day Methane = 27,574,000/379.3*16.04 = 1,166,061 lb/day Methane*

Calculation to convert lb/day to tpy:

*tpy = lb/day/2000(lb/ton)*365 (days/year)*

Emissions

Emission calculations for methane, CO_2, and total GHG in CO_2e are displayed below in Table 32:

Table 32: Emissions of methane, CO_2, and total GHG in CO_2 Equivalent [tonnes]

Methane	5,753,025.33
CO_2	170,315.82
Total GHG (CO_2e)	5,923,341.15

3. Gas Stations

Description of Sources

There are five road and one marina gasoline service station that operated on the Reservation during calendar year 2020.

Data Collection

2020 gasoline throughput values were provided to the AQP by representatives of each gas station, and the total throughput is displayed below in Table 33.

Table 33: Annual gasoline throughput at gasoline stations located on the Southern Ute Indian Reservation [gal/yr]*

Total Gasoline Throughput:	**1,650,141.75**

Assumptions

AQP assumed that gasoline throughput values reported by gas station representatives are valid.

Due to the absence of emission factors for diesel fuel dispensing in EPA AP-42 Section 5.22, the AQP assumed emissions from diesel fuel dispensing to be negligible and did not calculate emissions for this activity. EPA AP-42 Section 5.2.2, also assumes a negligible methane content from gasoline evaporative emissions; therefore, AQP did not calculate GHG emissions for gas stations.

Emission Calculation Methodology

Gas station emissions were calculated using the Tribal Emissions Inventory Software Solutions (TEISS) emissions calculator for gasoline service stations.[22] The calculator employs emission factors from EPA AP-42 Section 5.2.2. Total reported fuel throughputs were input into the TEISS emissions calculator for two stages of gasoline service station emissions. Stage 1 includes underground tank filling and submerged filling. Stage 2 includes underground tank breathing and emptying, vehicle refueling displacement losses (uncontrolled), and spillage.

Emissions

Total VOC emissions from gas stations on the Reservation during 2020 are displayed below in Table 34.

Table 34: VOC emissions from gasoline dispensing stations [tons]

Pollutant	Emissions
VOC	16.83

4. Aviation Gasoline

[22] Institute for Tribal Environmental Professionals. (2021). Tribal Emissions Inventory Software Solution Version 3.6. Retrieved from http://www7.nau.edu/itep/main/air/air_aqt_teiss.

Description of Sources

Emission estimates for aviation gasoline and the amount of lead in the leaded gasoline for counties were last developed by EPA for calendar year 2014. Lead is an additive in aviation gasoline used for piston-engine aircrafts (either general aviation or air taxi) to increase the fuel octane and prevent valve seat decline, which is a safety concern.

Data Collection

Data was obtained from the EPA NEI for calendar year 2017. EPA's data collection methodology is described in EPA's 2008 Technical Support Document titled *Lead Emissions from the Use of Leaded Aviation Gasoline in the United States*.[23]

Assumptions

The AQP assumed EPA's calendar year 2017 EPA's aviation gasoline emission estimates for La Plata County and Animas Air Parks would be the most representative emission estimates available for calendar year 2020.

Emissions

VOC and HAP emissions from aviation gasoline usage on the Reservation in 2020 is displayed below in Table 35.

Table 35: VOC and HAP emissions from aviation gasoline [tons]*

Total VOC Emissions	**6.28**
Total HAP Emissions	**0.33**

*Emissions for aviation gasoline fueling are estimated from data sourced from the 2017 EPA National Emission Inventory Database and assumed to be realistic estimations of aviation gasoline fueling emissions for 2020.

5. Gravel Pits

Description of Sources

Twelve sand and gravel pits operated within the exterior boundaries of the Reservation during calendar year 2020. Data was collected from the Colorado Division of Reclamation

[23] U.S. EPA. (2008, October). Lead Emissions from the use of Leaded Aviation Gasoline in the United States. Retrieved from: https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P1004MXJ.TXT.

Mining and Safety (DRMS) database[24]. The emissions from pits on the Reservation were estimated by scaling down the emissions estimates reported to the 2017 EPA NEI for La Plata and Archuleta counties for calendar year 2017.

Data Collection

The AQP identified active gravel pits located within the exterior boundaries of the Reservation through the DRMS ArcGIS data set. AQP identified the gravel, sand, and combined sand and gravel permits located within the exterior boundaries of the Reservation in La Plata and Archuleta counties. Permits with an active status for 2020 were then cross-referenced with the DRMS Imaged Document data to determine if there was production in 2020. This methodology determined nineteen active gravel pits in La Plata County and three active gravel pits in Archuleta County during 2020.

Emissions

Gravel pit emissions for La Plata County were obtained from the EPA's calendar year 2017 Nonpoint Emission Inventory for gravel pits. Emission totals were reported to NEI for La Plata and Archuleta counties and not for individual gravel pits. To derive emission estimates for the Reservation, the reported emission totals for La Plata County were downscaled by the percentage of the affected acreage of active gravel pits that are located within the exterior boundaries of the Reservation. For example, 30.71% of the affected acreage of active gravel pits in La Plata County are within the Reservation boundaries, therefore, gravel pits on the Reservation account for 30.71% percent of emissions in La Plata County. Emission totals for 2020 are displayed below in Table 36.

Table 36: Emissions of PM_{10} and $PM_{2.5}$ from active gravel pits

County	Pollutant	County emissions [tpy]	Percent of active permitted pits within SUIR	Reservation Emissions [tpy]
La Plata	**PM_{10}**	176.38	30.71%	54.16
La Plata	**$PM_{2.5}$**	22.05	30.71%	6.77
Archuleta	**PM_{10}**	29.40	10.88%	3.20
Archuleta	**$PM_{2.5}$**	3.67	10.88%	0.40

6. Residential Heating

A. Description of Sources: Fireplaces and Wood Burning Stoves

[24] Colorado Division of Reclamation Mining and Safety. (2021). *Active Hardrock Permits.* Department of Natural Resources. Retrieved from https://maps.dnrgis.state.co.us/drms/Index.html?viewer=drms.

Fireplaces and wood burning stoves are a significant source of residential heating within the exterior boundaries of the Reservation. The predominant types of solid fuel available are pinyon-juniper, pine, and aspen.

Data Collection

The U.S. Census 2015-2019 American Community Survey 5-Year Estimate (survey) was used to determine the number of households on the Reservation that use fireplaces or wood burning stoves for residential heating.[25] The survey estimates the total number of households on the Reservation that used wood as a heating source during the five-year survey period.

The U.S. Energy Information Administration, Office of Energy Consumption and Efficiency Statistics' 2015 Residential Energy Consumption Survey (EIA) was used to obtain the average number of cords used within a year at an average household.[26] Table CE7.2 of the EIA lists the household wood consumption as 35.2 million BTU . Utah State University Forestry Extension lists the Heating Value per Cord in million BTU from which an average heating value for the predominant types of solid fuel available of pinyon-juniper, pine, and aspen was calculated. The average heating value per cord of 22.4 million BTU was used to calculate an average household usage of 1.6 cords per year. The U.S. Census reported 925 households on the Reservation use fireplaces or woodstoves as the primary heating source.

Fireplace and wood burning residential heating data for the Southern Ute Indian Reservation in 2020 is displayed below in Table 37.

Table 37: Fireplace and wood burning residential heating data

Homes heated with wood	Average fuel use per household/year	Unit of measurement	Total number of cords used in 2020
815	1.6	Cords	1304

Emission Calculation Methodology

Emissions for residential fireplace and wood burning stoves were calculated using the Tribal Emissions Inventory Software Solutions (TEISS) emission calculator. The calculator employed emission factors from EPA AP-42 Section 1.10.2, which may be adjusted based on the units of data input.

Example Calculations

[25] U.S. Census Bureau. (2019). 2015-2019 American Community Survey 5-Year Estimates. Retrieved from https://data.census.gov/cedsci/

[26] U.S. Energy Information Administration. (2021) Table CE7.2 Household wood consumption in the U.S. – totals and averages, 2015. Retrieved from: https://www.eia.gov/consumption/residential/data/2015/c&e/pdf/ce7.2.pdf.

Wood Type	Heating Value Mm BTU/cord
Western Juniper	21.8
Pinyon	27.1
Quaking Aspen	18.2
Average	**22.4**

$$\frac{35.2 \text{ mmBTU} \times 1 \text{ cord}}{22.4 \text{ mm BTU}} = 1.6 \text{ cords (input into TEISS)}$$

$$\frac{815 \text{ households} \times 1.6 \text{ cord}}{\text{household}} = 1{,}304 \text{ cords (input into TEISS)}$$

Assumptions

The U.S. Census surveyed 5,102 households and reported 815 with an estimated uncertainty of ± 206 households on the Reservation use fireplaces or woodstoves for home heating. The TEISS variables chosen were conventional pre-phase I wood stove, Rocky Mountain and Pacific Coast region with Ponderosa Pine Hardwood Forest.

Emissions

Total criteria pollutant and GHG emissions from residential fireplace and wood-burning stoves on the Reservation in 2020 are displayed below in Table 38.

Table 38: Criteria pollutant and GHG emissions from fireplaces and wood burning stoves [tons]*

Pollutant	NOx	SO_2	PM_{10}	CO	VOC	GHG (CO_2e)
Total	1.87	0.27	20.49	154.54	35.49	5629.94

*GHG reported in metric tonnes.

B. Description of Sources: Propane Heating

Liquid propane (LP) is the dominant source of residential heating on the Reservation and in Southwest Colorado.

Data Collection

The U.S. Census 2015 -2019 American Community Survey 5-Year Estimate was used to determine the number of households on the Reservation that use LP gas as a source of heating.

The U.S. Energy Information Administration, Office of Energy Consumption and Efficiency Statistics' 2015 Residential Energy Consumption Survey (EIA) was used to obtain the average of LP used per household. The survey estimated the average number of gallons of LP used within a year for an average household.[27] The U.S. Census surveyed 5,102 households and reported 2,555 with an estimated uncertainty of ± 331 households on the Reservation use LP gas as the primary heat source and the EIA estimated 278 gallons of LP gas are burned per year in households in Colorado.

Liquid Propane residential heating data for the Southern Ute Indian Reservation in 2020 is displayed below in Table 39.

Table 39: Liquid propane residential heating data

Homes Heated with Liquid Propane	Average Fuel Use per Household/Year	Unit of Measurement	Total Gallons used in 2020
2,555	278	Gallons	710,290

Emission Calculation Methodology

Emissions for residential LP gas heating were calculated using the TEISS emission calculator. The calculator employed emission factors from EPA AP-42 Section 1.5.

Example Calculation

$$\frac{2{,}555 \text{ households} \times 278 \text{ gallons}}{\text{household}} = 710{,}290 \text{ gallons *(input into TEISS)}$$

Assumptions

The U.S. Census surveyed 5102 households and reported 2,555 with an estimated uncertainty of ± 331 households on the Reservation use LP gas for home heating. The actual sulfur content of LP gas on the Reservation is unknown and the default sulfur content of 0.54 grains/100 ft^3 was used in the TEISS emission calculator.

Emissions

Total criteria pollutant and GHG emissions from residential LP gas usage on the Reservation in 2020 is displayed below in Table 40.

[27] U.S. Energy Information Administration. (2021). Table CE2.5 Household Site Fuel Consumption in the West Region, Totals and Average, 2015 Physical Units. Retrieved from https://www.eia.gov/consumption/.

Table 40: Criteria pollutant and GHG emissions from liquid propane gas heating at residential sources [tons]*

Pollutant	NOx	SO_2	PM_{10}	CO	VOC	GHG (CO_2e)
Total	4.76	0.02	0.01	1.35	0.19	4080.06

*GHG reported in metric tonnes.

C. Description of Sources: Natural Gas Heating

Natural gas is a prevalent residential heating fuel on the Reservation.

Data Collection

The U.S. Census 2015-2019 American Community Survey 5-Year Estimate (survey) was used to determine the number of households on the Reservation that use natural gas for residential heating. The survey estimates the total number of households on the Reservation that used natural gas as a heating source during the five-year survey period.

The U.S. Energy Information Administration, Office of Energy Consumption and Efficiency Statistics' 2015 Residential Energy Consumption Survey (EIA) was used to obtain the average of natural gas used per household. The survey estimated the average cubic feet of natural gas used within a year for an average household. The U.S. Census reported 1017 or 20% of households on the Reservation use natural gas as the primary heat source and the EIA estimated 48.3 thousand cubic feet (48.3 Mcf) of natural gas are burned per year in households in Colorado.

Natural Gas residential heating data for the Southern Ute Indian Reservation in 2020 is displayed below in Table 41.

Table 41: Natural gas residential heating data

Homes Heated with Natural Gas	Average Fuel Use per Household/Year	Unit of Measurement	Total MMcf used in 2017
1017	0.0483	MMcf	49.12

Emission Calculation Methodology

Emissions for residential natural gas heating were calculated using the TEISS emission calculator. The calculator employed emission factors from EPA AP-42.

Example Calculation

$$\frac{1017 \text{ household} \times 0.0483 \text{ MMcf gas}}{\text{household}} = 49.12 \text{ MMcf gas (input into TEISS)}$$

Assumptions

The U.S. Census surveyed 1,017 households with an estimated uncertainty of ± 208 households that use natural gas for home heating. TEISS input variables were the EPA AP-42 default heating value of 1020 Btu/ft^3 and sulfur content of 2000 grains/ MMft^3.

Emissions

Total criteria pollutant and GHG emissions from residential natural gas heating sources on the Reservation in 2020 are displayed below in Table 42.

Table 42: Criteria pollutant and GHG emissions from natural gas heating at residential sources [tons]*

Pollutant	NOx	SO_2	PM_{10}	CO	VOC	GHG (CO_2e)
Total	2.31	.01	.05	0.98	0.14	2661.35

*GHG reported in metric tonnes.

7. Agricultural Burning

Description of Activity

Agricultural burning is performed on the Reservation to clear irrigation ditches of vegetation and to clear pastures of weeds and vegetation prior to crop cultivation.

Data Collection

Emissions from agricultural burning on the Reservation were obtained from the 2017 NEI for La Plata County and 2014 NEI Archuleta County as the 2017 NEI contained no data for Archuleta. EPA reported two types of agricultural burning: Agricultural Burning Grasses, and Agricultural Burning Unspecified Crop Type. EPA did not report emissions for Agricultural Burning Unspecified Crop Type for Archuleta County. Emissions were not included in this emissions inventory for Montezuma County due to only 0.2% of the county falling within the Reservation boundaries.

Emission Calculation Methodology

Emissions obtained from the NEI for La Plata and Archuleta County were scaled down proportionally to the percentage of land in La Plata and Archuleta counties that fall within the exterior boundaries of the Reservation. 38.9% and 29.5 % respectively.

Assumptions

AQP assumes the methods and calculations used to develop emissions from agricultural burning are valid and acknowledges that the process used to reduce emissions for the Reservation could result in a slight under or overestimation of emissions. It is also assumed that emissions from agricultural burning from the 2014 and 2017 NEI are realistic estimations that occurred in 2020.

Emissions

Criteria pollutants, NH_3, and HAP emission estimates from agricultural burning that occurred within the exterior boundaries of the Reservation in 2020 are displayed below in Table 43.

Table 43: Criteria pollutant, NH_3, and HAP emissions from agricultural burning [tons]*

Pollutant	PM_{10}	$PM_{2.5}$	CO	NOx	NH_3	SO_2	VOC
Total	1.40	1.03	8.05	0.19	0.55	0.07	0.67

*Emissions for agricultural burning were estimated from data retrieved from the 2014 and 2017 EPA National Emission Inventory Database and are assumed to be realistic estimations of agricultural burning emissions that occurred in 2020.

VI. Mobile Sources

Description of Sources

Mobile source emissions are generated from on-road vehicles and non-road engines including lawn equipment, recreational vehicles, agricultural equipment, construction equipment, etc.

1. On-Road Mobile Sources

AQP estimated emissions for on-road mobile sources using EPA's 2017 NEI county level mobile emissions data to estimate Reservation specific mobile emissions. On-road mobile sources in 2017 NEI county level data include emissions from motorized vehicles that are normally operated on public roadways. This includes diesel and non-diesel (gasoline, compressed natural gas (CNG), and ethanol, etc.) fueled on-road mobile sources such as passenger cars, motorcycles, minivans, sport-utility vehicles, light-duty trucks, heavy duty trucks, and buses. The sector includes emissions generated from parking areas as well as emissions while the vehicles are moving.

Data Collection

Data were collected from EPA's 2017 NEI county level mobile emissions.

Emission Calculation Methodology

The 2017 NEI is comprised of mobile emission estimates calculated based on the MOVES model run with S/L/T submitted activity data when provided, except for California and tribes, for which the NEI includes submitted emissions. In cases where S/L/T submitted data is not provided, EPA-developed default activity based on data from the Federal Highway Administration.

Data values were derived from 2017 NEI for both La Plata and Archuleta counties. Data adjustments were made to the emission totals for each county based on the percentage of road miles in La Plata and Archuleta County that fall within the exterior boundaries of the Reservation, as determined from GIS shapefiles obtained from the La Plata and Archuleta County GIS departments.[28,29] The data adjustment resulted in a reduction of the emissions to 35% and 17% for La Plata and Archuleta Counties, respectively. No significant roads on the Reservation are located in Montezuma County, and therefore AQP assumed on-road emissions for Montezuma County to be negligible. The AQP determined that 947.3 miles of roads are within the Reservation boundaries. The AQP later combined the two adjusted county level datasets to obtain Reservation emission totals. Data outputs were organized by criteria pollutants emissions.

Assumptions

AQP assumed that data from the 2017 NEI to be the best available data for estimating 2020 on-road mobile emissions on the Reservation.

Emissions

Criteria pollutant emissions from on-road mobile sources on the Reservation in 2017 are displayed below in Table 44.

Table 44: Criteria pollutant emissions from on-road mobile sources [tons]

Pollutant	CO	NOx	VOC	PM_{10}	$PM_{2.5}$
Emissions	1590.27	383.96	216.13	16.99	10.63

2. Non-Road Mobile Sources

Non-road mobile sources contribute a significant portion of the NOx and CO emissions from mobile sources. Non-road mobile sources on the Reservation include agricultural equipment, construction and mining equipment, lawn and garden equipment, and

[28] La Plata County. (2018). *Roads.* GIS/Mapping. Retrieved from ftp://ftp.laplata.co.us/shapefiles/.

[29] Archuleta County. (2018). *Roads - Archuleta County.* GIS. Retrieved from http://www.archuletacounty.org/504/Download-GIS-Data.

recreational equipment fueled by gasoline, diesel, other sources (CNG and liquified petroleum gas (LPG), etc.).

Data Collection

Data were collected from EPA's 2017 NEI county level mobile emissions.

Assumptions

AQP assumed that data from the 2017 NEI to be the best available data for estimating 2020.

Emission Calculation Methodology

The 2017 NEI used MOVES2014b version of EPA's Motor Vehicle Emissions Simulator (MOVES) Model, to estimate non-road emissions. All the input and activity data required to run the non-road component of MOVES model (MOVES-Nonroad) are contained within the MOVES default database, which is distributed with the model. State- and county-specific data can be used by creating a supplemental database known as a county database (CDB) and specifying it in the MOVES run specification (runspec). State, local and tribal (S/L/T) agencies can update the data within the CDBs to produce emissions estimates that accurately reflect local conditions and equipment usage. MOVES first uses the data in the CDBs and fills in any missing data from the MOVES default database.

Data values for non-road emissions were derived from 2017 NEI for both La Plata and Archuleta counties. The emissions for La Plata and Archuleta County were reduced to 38.9% and 29.5% respectively based on the portion of these counties within the exterior boundaries of the Reservation. The AQP later combined the adjusted emissions data sets from La Plata and Archuleta counties to obtain Reservation emission totals.

Emissions

Criteria pollutant emissions from non-road mobile sources on the Reservation in 2017 are displayed below in Table 45.

Table 45: Criteria pollutant emissions from non-road mobile sources [tons]

Pollutant	CO	NOx	VOC	PM_{10}	$PM_{2.5}$
Emissions	816.51	50.67	90.10	6.58	6.23

VII. Events

1. Wildland Fires and Prescribed Burns

Description of Activity

The forest on the Reservation is predominantly comprised of pinyon-juniper woodlands with ponderosa, gambel oak, aspen and sub-alpine forest at higher elevation areas. The forest is prone to wildfire and prescribed burns are utilized as a forest management strategy to help prevent catastrophic fires, improve wildlife habitat, and improve overall forest health. Wildfires and prescribed burns can be significant sources of air pollution on the Reservation and the Four Corners area.

Data Collection

Wildland and prescribed burn fire (forest fire) data for calendar year 2020 were obtained from the Bureau of Indian Affairs (BIA) and the Southern Ute Agency Fire Management Division.[30] The initial data identified 32 fires (31 wildfires and 1 prescribed fires). Data sets included type of fire, latitude and longitude of fire perimeter, and acres burned.

Emission Calculation Methodology

Forest fire emission estimates were calculated using the USFS BlueSky Playground web tool (BlueSky).[31] BlueSky is comprised of several internal USFS datasets and modeling programs, including the Fuels Characteristic Classification System fuel information dataset (FCCS), the CONSUME3 fuel consumption model, and the FEPS emission factors model.

Forest fire data including latitude and longitude and acres burned are input into BlueSky and BlueSky selects the correct default model input values based on the fire location. Input values include available fuel load, fuel consumed, emission factors, and meteorological forecast data. “Dry” was selected for the fuel moisture value. Forest fire event by FCCS fuel bed type are displayed below in Table 46.

Table 46: Forest fire occurrence by fuels characteristic classification system, fuel bed type, and acres burned

FCCS Fuel Bed Description	Number of Fires	Acres Burned
Ponderosa Pine Savanna	3	3.5
Tobosa-Grama Grassland	1	6
Pinyon-Utah Juniper Woodland	25	234.85
Low Sagebrush Shrubland	2	1.1
Totals	**31**	**245.45**

[30] Bureau of Indian Affairs Fire Management. (2020). *Southern Ute 2020 Fire Occurrence*

[31] U.S. Forest Service AirFire Research Team. (2020). *BlueSky Playground (Version 2.0 beta)*. Retrieved from https://playground.airfire.org/ .

Emission Equations

Emissions = (Area burned) x (Fuel Load Available) x (Fuel Consumed (Burn Efficiency)) x (Emission Factors)

Mass of Emissions =
Area burned (input from AQP datasets)
Fuel Load Available (updated FCCS map) *Bluesky Playground Framework*
Fuel Consumed (CONSUME3)
Emission Factors (FEPS plus HAPs)

Assumptions

Collected and reported fire related data is assumed to be accurate and to be the best data available. BlueSky is assumed to function as intended and to select the proper fuel characteristics from the USFS FCCS map when latitude and longitude coordinates are input into the model.

Emissions

Total criteria pollutant, NH_3 and GHG from prescribed burns and wildland fires that occurred within the exterior boundaries of Reservation boundaries in 2020 are displayed below in Table 47.

Table 47: Criteria pollutant, NH_3, and GHG emissions from prescribed burns and wildland fires [tons]*

Pollutant	PM_{10}	$PM_{2.5}$	CO	NOx	NH_3	SO_2	VOC	GHG (CO_2e)
Total	13.34	11.19	123.71	2.41	2.02	1.14	29.35	1873.41

*GHG reported in metric tonnes.

VIII. Biogenic

Biogenic processes of trees, vegetation, soil, and microbial activities generate VOC, NOx, CO, and HAP emissions. EPA estimates biogenic emissions for triennial inventory years, with the last estimation performed for calendar year 2017.

Assumptions

The AQP assumed the emission estimations prepared by EPA to be performed correctly and to be the best available emissions estimates for 2020.

Emission Calculation Methodology

Biogenic emissions estimated for La Plata and Archuleta County were prepared by EPA using the EPA's Biogenic Emission Inventory System and Biogenic Emissions Land Use Database.[32] AQP obtained the 2017 emission estimates for La Plata and Archuleta counties from the 2017 NEI. Emissions estimates for Montezuma County were not included in this emissions inventory due to only 0.2% of the county falling within the Reservation boundaries.

County wide emissions were reduced for La Plata and Archuleta County to 38.9% and 29.5% respectively, based on the area of each county that is located within the exterior boundaries of the Reservation.

Emissions

Criteria pollutant and HAP emissions from biogenic sources on the Reservation in 2020 are displayed below in Table 48.

Table 48: Criteria pollutant and HAP emissions from biogenic sources [tons]*

Pollutant	CO	NOx	VOC	HAP
Emissions	879.43	408.03	5,483.95	662.79

*Emissions for biogenic sources were estimated from data retrieved from the 2017 EPA National Emission Inventory data and are assumed to be realistic estimations of biogenic source emissions for 2020.

IX. Summary

1. Emissions Sources

Reservation emissions presented in this inventory are distributed between point, non-point, mobile, and biogenic sources.

A. Point Sources

There are four categories of point sources including:

1) Title V permitted oil and gas sources,
2) TMNSR permitted and true minor oil and gas sources,
3) Municipal solid waste landfills, and
4) Airports.

B. Non-Point Sources

There are eight categories of non-point sources including:

[32] U.S. Environmental Protection Agency. (2021). Biogenic Emission Inventory System. Retrieved from https://www.epa.gov/air-emissions-modeling/biogenic-emission-inventory-system-beis.

1) Small oil and natural gas sources,
2) Fruitland Formation Outcrop natural gas seeps
3) Gasoline stations,
4) Aviation gasoline dispensing,
5) Gravel pits,
6) Residential heating,
7) Fire events (wildland fires and prescribed burns), and
8) Agricultural burning.

C. Mobile Sources

Mobile sources are divided into two categories:

1) On-road, and
2) Non-road.

D. Biogenic Emissions

Biogenic emissions encompass all non-man-made emission sources.

2. Emission Inventory Findings

A summary of 2020 criteria pollutant, HAP, and GHG emissions by source category is displayed below in Table 49.

Table 49: Criteria pollutant, HAP, and GHG emissions on the Southern Ute Indian Reservation [tons][*]

Source Category	NOx	VOC	SO2	PM10	CO	Total HAP	GHG (CO2e)
Point Sources							
Title V Oil and Gas	2,359.76	1,032.92	46.85	101.94	1,872.89	306.09	2,124,765.29
Synthetic Minor Oil and Gas	253.89	126.22	5.86	3.75	137.54	29.68	69,931.40
True Minor Oil and Gas	4,575.24	834.57	16.07	42.81	3,248.08	290.97	1,568,843.62
Municipal Solid Waste Landfills	-	7.09	-	15.21	0.30	3.55	23,226.65
Airports	36.47	13.94	5.02	4.50	217.11	0.31	-
Total Point Source Emissions	7,225.37	2,014.75	73.80	168.20	5,475.92	630.61	3,786,766.97
Non-Point Sources							
Small Oil and Gas Sources	11,664.00	879.10	5.63	112.01	9,716.55	233.90	1,618,203.64
Fruitland Formation Outcrop	-	-	-	-	-	-	5,923,341.15
Gas Stations	-	16.84	-	-	-	-	-
Aviation Gasoline	-	6.27	-	-	-	-	-
Gravel Pits	-	-	-	57.36	-	-	-
Residential Heating	8.94	35.81	0.30	20.68	156.88	-	12,371.35
Fire Events	2.41	29.35	1.14	13.34	123.71	-	1,873.41
Agricultural Burning	0.19	0.67	0.07	1.39	8.05	-	-
Total Non-Point Source Emissions	11,675.54	968.04	7.14	204.79	10,005.19	233.90	7,555,789.54
Mobile Sources							
Mobile Sources	434.64	306.23	-	23.57	2,406.78	-	-
Biogenic Sources							
Biogenic	408.03	5,483.95	-	-	879.43	662.79	-
Total Emissions							
Total:	19,743.58	8,772.97	80.94	396.57	18,767.33	1,527.29	11,342,556.51

[*]GHG gas emissions reported in metric tonnes.

Oil and natural gas production and mid-stream transmission are the predominant industries on the Reservation. Of all the quantified emission categories, oil and gas contributed the most significant quantities of NOx, CO, SO_2 and PM_{10} to the airshed during 2020. Oil and gas related activities accounted for 18,852.9 tons, or 95% of the total NOx emissions quantified in the emission inventory; CO emissions accounted for 80% of the total quantified CO emissions, 14,975.1; SO_2 accounted for 92% of the total quantified SO_2 emissions, 74.4 tons; PM_{10} accounted for 77% of the total quantified PM_{10} emissions, 260.5 tons; and HAP emissions accounted for 56% of the total quantified HAP emissions, 860.6 tons.

Biogenic sources are the most significant source of VOC emissions to the airshed. VOC emissions from this category account for 63% of the total VOC emissions to the airshed at 5,483.9 tons.

The Fruitland Outcrop is the most significant source of GHG emissions, calculated to be 5,923,341.1 metric tons, or 52% of total Reservation emissions.

NOx, CO, VOC, and HAP emissions by source category on the Reservation in 2020 are displayed below in Figures 30 and 31.

Figure 30: NOx and CO emissions by source category [tons]

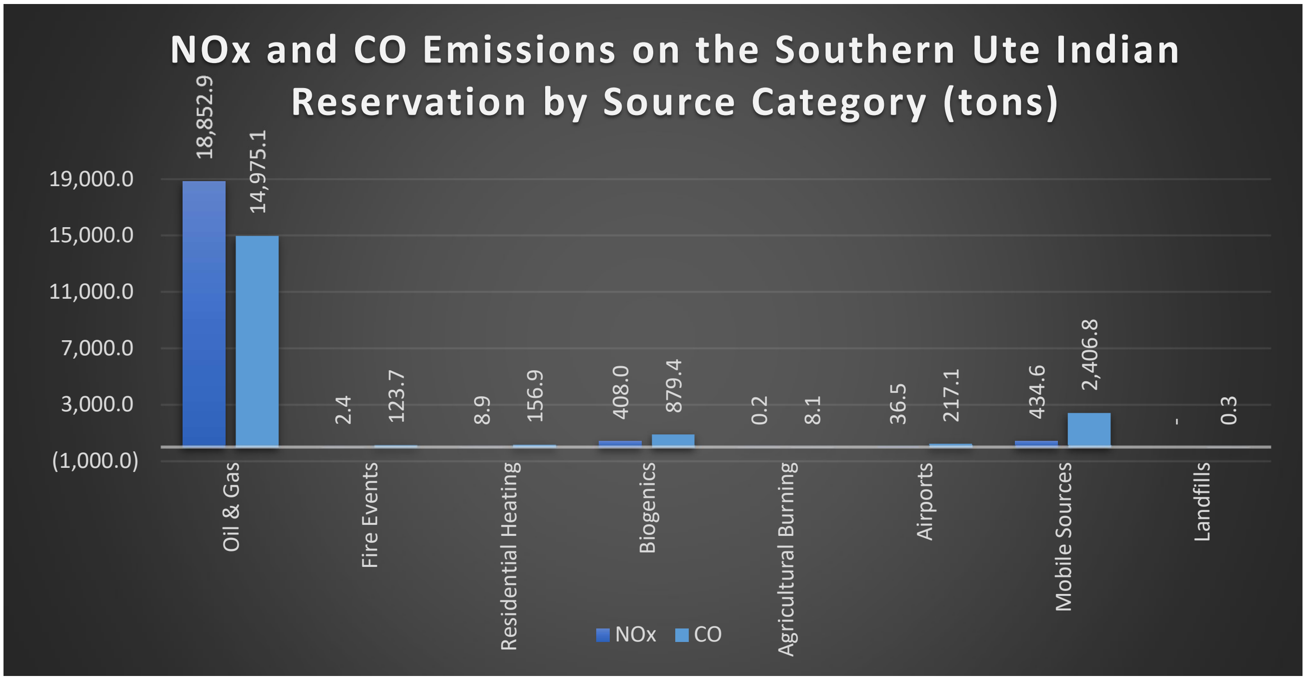
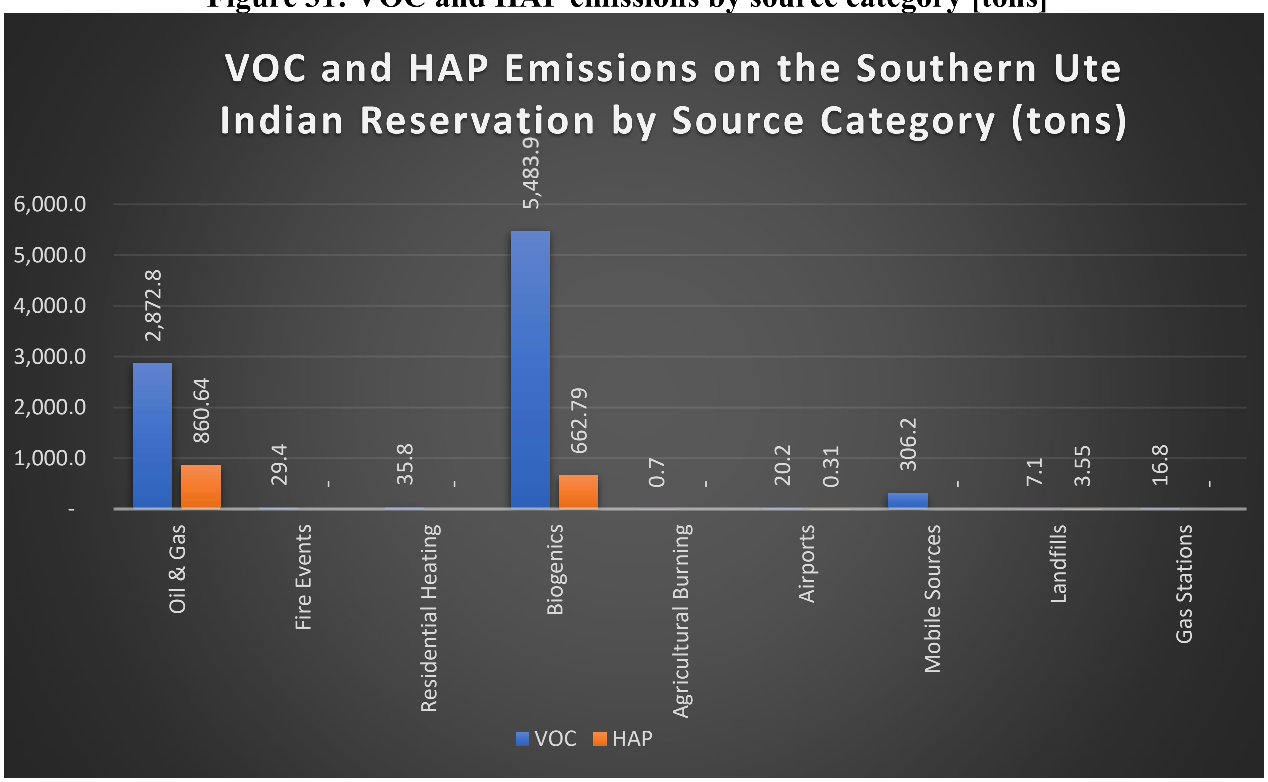


Figure 31: VOC and HAP emissions by source category [tons]*



*Airport emissions include the point airport emissions as well as the non-point aviation gasoline emissions.

Due to the lack of accurate emission factors and reliable data, GHG emissions were not estimated for every category presented in this inventory. Several categories that were not evaluated or quantified, such as mobile sources and biogenic sources, would be expected to contribute significant emissions of GHG.

3. Oil and Gas Emissions Summary

The bulk of the emission sources within the point source category are larger emission sources such as natural gas compressor stations, central delivery points, treating plants, and processing plants. Combined, the Title V, permitted TMNSR, and true minor sources represent the bulk of NOx, CO, PM10, SO_2, and non-biogenic VOC and HAP emissions.

Within the oil and gas sector, non-point source, small oil and gas sources such as production well sites, contribute the most NOx, CO, and PM_{10} emissions to the airshed in contrast to the larger Title V, permitted TMNSR, and true minor sources. This is due to the large number of small oil and gas sources, 2,582 sites, operating within the exterior boundaries of the Reservation. This category alone accounts for 62% of the total airshed NOx emissions at 11,664.0 tons and 65% of the total CO emissions at 9,716.6 tons. Emissions of particulate matter 10 micrometers or less in diameter were 112.0 tons, or about 43% of the total airshed emissions. Emissions totals from oil and gas sector sources are displayed below in Table 50 and Figures 32 through Figures 34.

Table 50: Emissions from oil and gas sector sources [tons]*

Pollutant	NOx	VOC	SO2	PM10	PM2.5	CO	GHG (CO2e)	Total HAP
Title V	2,359.8	1,032.9	46.9	101.9	-	1,872.9	2,124,765.3	306.1
Synthetic Minor	253.9	126.2	5.9	3.8	-	137.5	69,931.4	29.7
True Minor	4,575.2	834.6	16.1	42.8	-	3,248.1	1,568,843.6	291.0
Small Oil & Gas Sources	11,664.0	879.1	5.6	112.0	71.8	9,716.6	1,618,203.6	233.9
Totals:	**18,852.9**	**2,872.8**	**74.4**	**260.5**	**71.8**	**14,975.1**	**5,381,744.0**	**860.6**

*GHG emissions reported in metric tonnes.

Figure 32: NOx and CO emissions from oil and gas sources [tons]

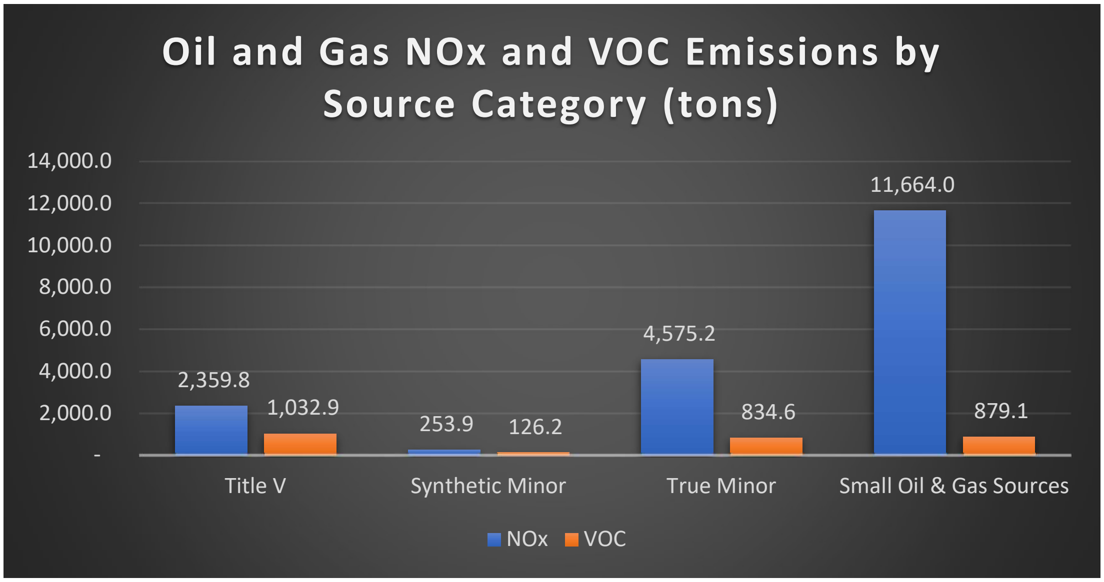


Figure 33: VOC and HAP emissions from oil and gas sources [tons]

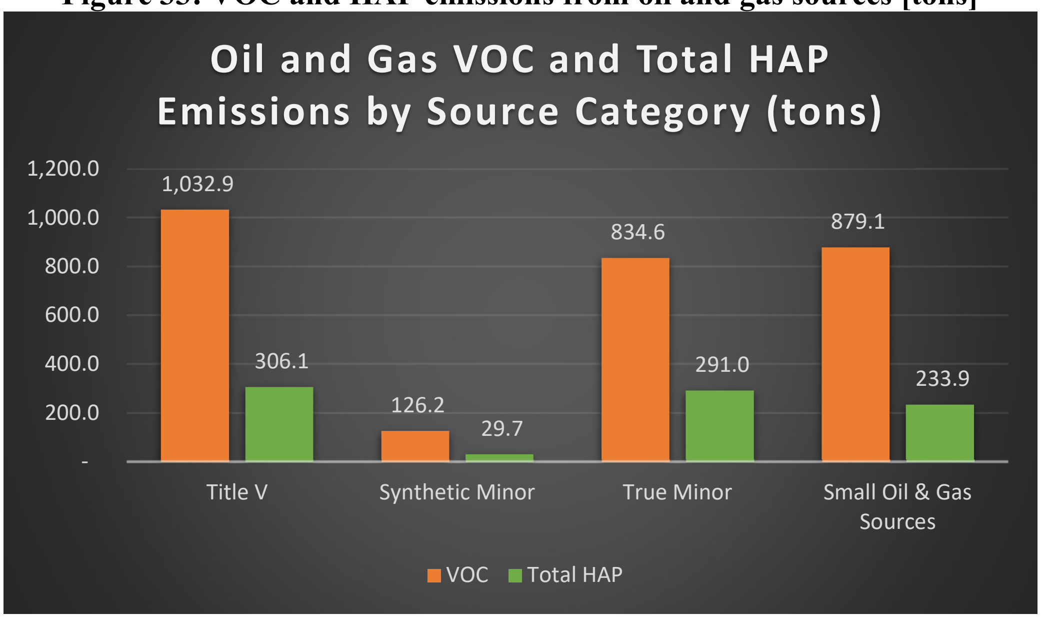
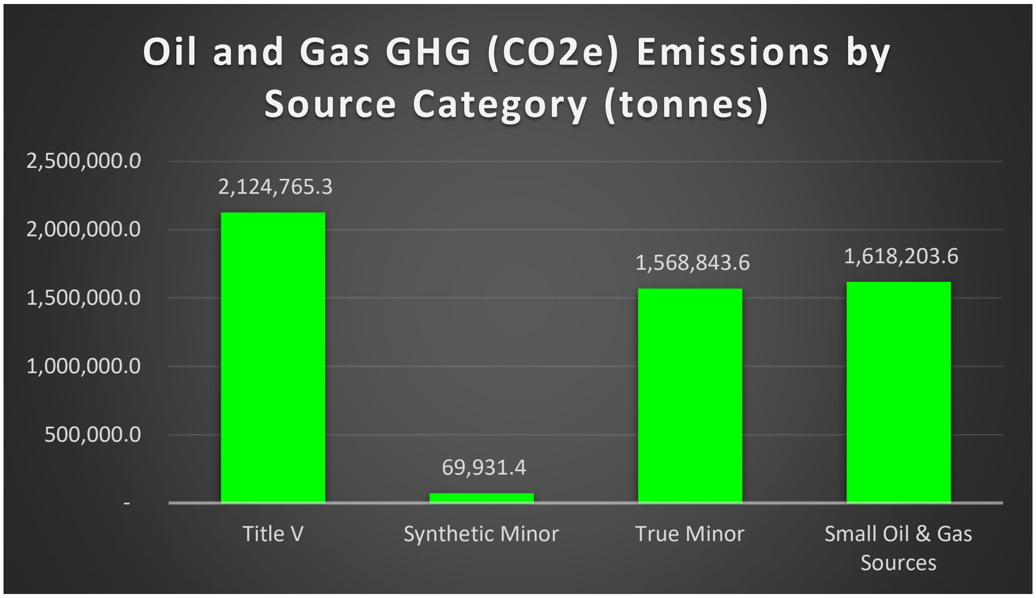


Figure 34: GHG (CO_2e) emissions from oil and gas sources [tonnes]

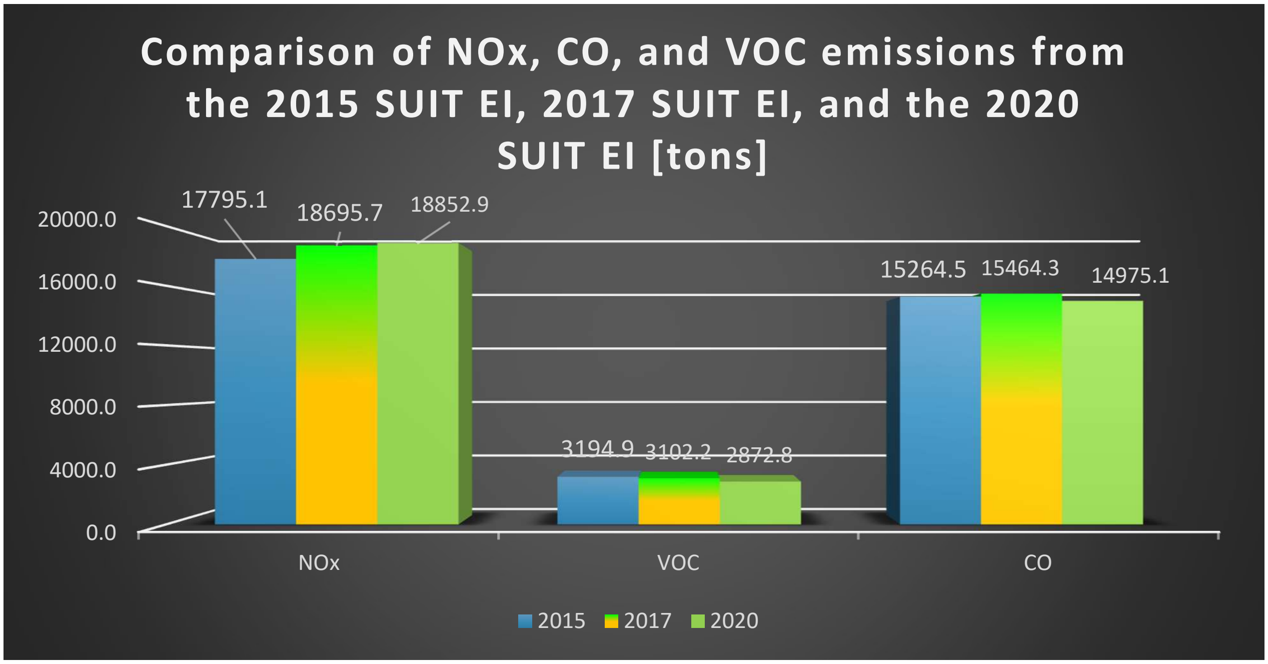


Within the small oil and gas sources, the emission unit type that contributed the most NOx and CO emissions were natural gas-fired reciprocating internal combustion engines (RICE). Four-stroke rich burn (4SRB) engines between 0-50 hp and 4SRB engines between 51-100 hp were the largest emitting subcategories.

4. Comparison of the 2020 SUIT EI to Previous Emissions Inventories

To evaluate the representativeness of oil and gas emission estimations from this 2020 SUIT emissions inventory, the AQP has compared the results with oil and gas emission estimates for the Reservation from the *2015 Southern Ute Indian Reservation Emission Inventory* (2015 SUIT EI) and the *2017 Southern Ute Indian Reservation Emission Inventory* (2017 SUIT EI)

Figure 35: Comparison of NOx, CO, and VOC emissions from the 2015 SUIT EI, 2017 SUIT EI, and the 2017 SUIT EI [tons]

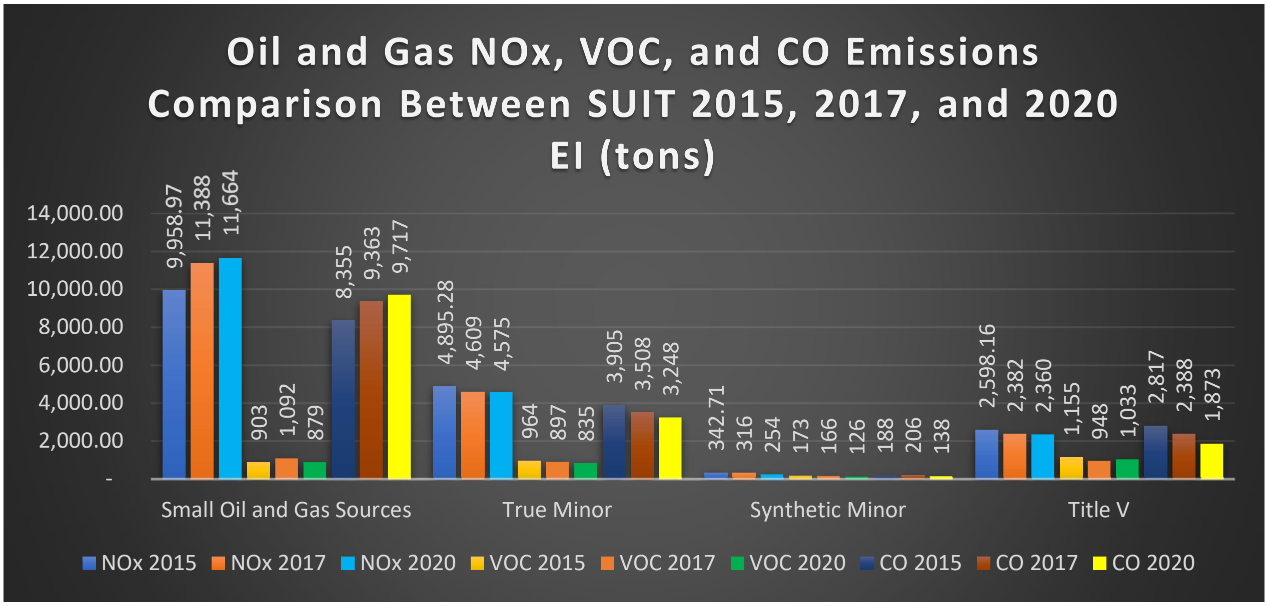


A comparison of the 2015 SUIT EI, 2017 SUIT EI, and 2020 SUIT EI shows a 1,057.8 ton increase in NOx emissions and a 289.4 ton decrease in CO emissions between 2015 and 2020 at oil and gas point sources and non-point sources. AQP attributes the increased NOx emissions and decrease in CO emissions to 91 more lean burn engines being reported in 2020 than in 2015 and 46 less rich burn engines at the non-point oil and gas sources.

Between the 2015 and 2020 SUIT EIs, emissions decrease trends were observed at oil and gas point sources. True minor sources, synthetic minor, and Title V sources showed a decrease in NOx, CO, and VOC emissions. AQP attributes the decreases in NOx and VOC emissions to decreased oil and gas production on the Reservation between 2017 and 2020.

A comparison of NOx, CO and VOC emissions at oil and gas sources on the Reservation from the 2020 SUIT EI and the 2017 SUIT EI is displayed below in Figure 36.

Figure 36: Comparison of oil and gas NOx, CO, and VOC emission estimations for the Southern Ute Indian Reservation from the 2015, 2017, and 2020 SUIT EIs [tons]


Oil and Gas NOx, VOC, and CO Emissions Comparison Between SUIT 2015, 2017, and 2020 EI (tons)
14,000.00
12,000.00
10,000.00
8,000.00
6,000.00
4,000.00
2,000.00
-
9,958.97
11,388
11,664
903
1,092
879
8,355
9,363
9,717
4,895.28
4,609
4,575
964
897
835
3,905
3,508
3,248
342.71
316
254
173
166
126
188
206
138
2,598.16
2,382
2,360
1,155
948
1,033
2,817
2,388
1,873
Small Oil and Gas Sources
True Minor
Synthetic Minor
Title V
NOx 2015
NOx 2017
NOx 2020
VOC 2015
VOC 2017
VOC 2020
CO 2015
CO 2017
CO 2020

X. Bibliography

40 CFR Part 49 - Indian Country: Air Quality Planning and Management. (2020). U.S. Government Publishing Office. Retrieved from http://www.ecfr.gov/cgi-bin/text-idx?SID=bc4187dbf0b08beb092efe4251fe4493&mc=true&tpl=/ecfrbrowse/Title40/40cfr49_main_02.tpl.

40 CFR Part 98 - Mandatory Greenhouse Gas Reporting. (2020). U.S. Government Publishing Office. Retrieved from http://www.ecfr.gov/cgi-bin/text-idx?SID=32c4baa0d0aff54fa651d1cdb1cd7934&mc=true&tpl=/ecfrbrowse/Title40/40cfr98_main_02.tpl

7-2-11 Gas Station Throughput Data. (2020). (M. Wampler, Compiler)

Air Pollution Testing, I. (2016, September). Southern Ute Indian Reservation Flash Liberation Analyses.

Allen, D. (2014). Methane Emissions from Process Equipment at Natural Gas Production Sites in the United States: Pneumatic Controllers. *Environmental Science & Technology, 49*, 633-640. Retrieved from http://pubs.acs.org/doi/pdf/10.1021/es5040156

American Petroleum Institute. (2009). *Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry*. Retrieved from htp://www.api.org/~media/files/ehs/climate-change/2009_ghg_compendium.ashx.

Archuleta County. (2018). *Roads - Archuleta County.* GIS. Retrieved from http://www.archuletacounty.org/504/Download-GIS-Data

Bar-Ilan A., J. G. (2009, September 1). Development of Baseline 2006 and Midterm 2012 Emisions from Oil and Gas Activity in the North San Juan Basin. Prepared by Environ for Western Regional Air Partnership. Retrieved from https://www.wrapair.org//forums/ogwg/documents/NSanJuanBasin/2009-09_06_Baseline_and_12_Midterm_Emissions_N_San_Juan_Basin_Technical_Memo_09-01.pdf

Bureau of Indian Affairs Fire Management. (2020). *Southern Ute 2020 Fire Occurrence.*

Canadian Association of Petroleum Producers. (2003). *Guide to Calculating Greenhouse Gas Emissions.*

Caterpillar, Inc. (2015). Gas Engine Rating Pro Emissions Estimation Software. Retrieved from http://www.cat.com/en_US/articles/solutions/oil-gas/gas_engine_rating_pro.html

COGCC. (2020). Production Data. La Plata. Retrieved from http://cogcc.state.co.us/data2.html#/downloads

Colorado Division of Reclamation Mining and Safety. (2021). *Active Hardrock Permits.* Department of Natural Resources. Retrieved from http://mining.state.co.us/Reports/Pages/GISData.aspx.

(2020). *CY 2020 EPA TMNSR Emissions Reports.*

Drilling Edge. (2015). Electronic Database. Retrieved from http://www.drillingedge.com/colorado

Eastern Research Group. (2001, January). Documentation for Aircraft Component of the National Emissions Inventory Methodology. (ERG No. 0245.03402.011).

ENVIRON International Corp.; Carter Lake Consulting; Environmental Management and Planning Solutions. (2015). *Colorado Air Resources Management Modeling Study.*

Fasset, J. E., & Hinds, J. S. (1971). Geology and Fuel Resources of the Fruitland Formation and Kirtland Shale of the San Juan Basin, New Mexico and Colorado. *Geological Survey Professional Paper 676*. United States Government Printing Office. Retrieved from https://pubs.usgs.gov/pp/0676/report.pdf

Gas Research Institute. (2000). GLYCalc Version 4.0. Retrieved from http://sales.gastechnology.org/000102.html

Institute for Tribal Environmental Professionals. (2021). Tribal Emissions Inventory Software Solution Version 3.6. Retrieved from http://www7.nau.edu/itep/main/air/air_aqt_teiss.

La Plata County. (2018). *Roads.* GIS/Mapping. Retrieved from ftp://ftp.laplata.co.us/shapefiles/

McGowin, C. (1973). *Stationary Internal Combustion Engines in the United States.* Washington D.C.: U.S. Environmental Protection Agency. Retrieved from https://nepis.epa.gov/Exe/ZyNET.exe/9101AO45.txt?ZyActionD=ZyDocument&Client=EPA&Index=Prior%20to%201976&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&UseQField=&IntQFieldOp=0&ExtQField

Sky Ute Thriftway Throughput Data. (2020). (M. Wampler, Compiler)

Southern Ute Indian Tribe. (2009, August). *Programmatic Environmental Assesment for 80 Acre Infill Oil and Gas Development on the Southern Ute Indian Reservation.*

Southern Ute Indian Tribe. (2020). *Information Collection Request.*

(2020). *Southern Ute Indian Tribe Calendar Year 2020 Part 70 FEE Forms.*

Southern Ute Indian Tribe Motor Pool Throughput Data. (2020). (M. Wampler, Compiler)

Southern Ute Indian Tribe: Ambient Monitoring. (2020). *2020 AQS Ute 3 Humidity Hourly Data.* Retrieved from http://www.southernute-nsn.gov/environmental-programs/air-quality/ambient-monitoring/

Southern Ute Indian Tribe: Ambient Monitoring. (2020). *2020 AQS Ute 3 Temp Hourly Data.* Retrieved from http://www.southernute-nsn.gov/environmental-programs/air-quality/ambient-monitoring/

Turning Beyond Service Throughput Data. (2020). (M. Wampler, Compiler)

U. S. Energy Information Administration. (2021). Table CE7.2 Household wood consumpoion in the I.S. - totals and averages, 2015.

U.S. Census Bureau. (2019). 2015-2019 American Community Survey: ACS 5-Year Estimates Detailed Tables.

U.S. Department of Interior and U.S. Department of Agriculture. (2016). *Federal Wildland Fire Occurrence Data*. Retrieved from Federal Fire Occurrence: http://wildfire.cr.usgs.gov/firehistory/index.html.

U.S. Energy Information Administration. (2021). Table CE2.5 Household Site Fuel Consumption in the West Region, Totals and Average, 2015 Physical Units. Retrieved from https://www.eia.gov/consumption/

U.S. Environmental Protection Agency. (2020). *AP-42: Compilation of Air Emission Factors*. Retrieved from https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emission-factors

U.S. Environmental Protection Agency. (2021). Biogenic Emission Inventory System. Retrieved from https://www.epa.gov/air-emissions-modeling/biogenic-emission-inventory-system-beis

U.S. EPA - Landfill Gas Emissions Model. (2021). Retrieved from https://www.epa.gov/catc/clean-air-technology-center-products#software.

U.S. EPA. (1995). Glycol Dehydrator Emissions Test Report and Emissions Estimation Methodology. Retrieved from https:www3.epa.gov/ttn/chief/old/efdocs/glycoldehydratortestreport.pdf

U.S. EPA. (2006). TANKS 4.09d Emissions Estimation Software. Retrieved from https://www3.epa.gov/ttnchie1/software/tanks

U.S. EPA. (2008, October). Lead Emissions from the Use of Leaded Aviation Gasoline in the United States.

U.S. EPA Moves 2014. (2016). Retrieved from https://www.epa.gov/catc/clean-air-technology-center-products#software

U.S. EPA National Emissions Inventory Emissions Inventory System. (2020). Retrieved from https://eis.epa.gov/eis-system-web/welcome.html

U.S. Forest Service AirFire Research Team. (2020). *BlueSky Playground (Version 2.0 beta)*. Retrieved from http://playground.airfire.org/home.php

Waste Industry Coalition. (2001, January). Comparison of Recent Landfill Gas Analysis with Historic AP-42 Values.

XI. Appendix – Quality Assurance Review

Description of Quality Assurance Review

To meet the EPA emissions inventory level II data quality objective of conducting a third party quality assurance (QA) review, the AQP contracted with Ramboll. The QA review included the review of the data collection methodology, data, assumptions, emission factors, calculation methodologies, and emission totals. An abridged version of the final QA report is attached as an Appendix. A full version of the QA report, which contains all of the QA review forms can be requested from the AQP.