Natural Gas Gathering & Boosting Updates Under Consideration for 2019 GHGI

EPA Workshop

October 17, 2018

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G&B Stations

G&B Stations: Current GHGI Methodology

- Methodology relies on Marchese et al. 2015 study
- Station counts in each year are calculated as marketed onshore gas production in the given year (obtained from EIA) divided by the year 2012 throughput per station from the Marchese et al. 2015 study
- Station-level EFs for normal and episodic vented and fugitive emissions were calculated using data from the Marchese et al. 2015 study
- CO_2 emissions are based on CO_2 EFs developed by applying a default production segment ratio of CO_2-to-CH_4 gas content

G&B Stations: Available Data

- GHGRP Subpart W
  - G&B segment newly reported under subpart W as of RY2016
  - G&B facilities defined as a unique combination of operator and basin of operation
  - Subpart W does not delineate data for G&B stations versus pipelines
  - However, the data are reported on an emission source level, so each source can be assigned as likely occurring at either G&B stations or pipelines

G&B Station Emissions Data, Year 2016

Data Source	Total CH_4 Emissions (mt)	Total CO_2 Emissions (mt)
Subpart W (as reported)	796,868	5,930,105
2018 GHGI (national total)	2,149,065	233,502

G&B Stations: Available Data (cont.)

- Recent Studies
  - Vaughn et al. (2017). *Comparing facility-level methane emission rate estimates at natural gas gathering and boosting stations*
  - Yacovitch et al. (2017). *Natural gas facility methane emissions: measurements by tracer flux ratio in two US natural gas producing basins*
  - Zimmerle et al. (2017). *Gathering pipeline methane emissions in Fayetteville shale pipelines and scoping guidelines for future pipeline measurement campaigns*
  - Alvarez et al. (2018). *Assessment of methane emissions from the U.S. oil and gas supply chain*.

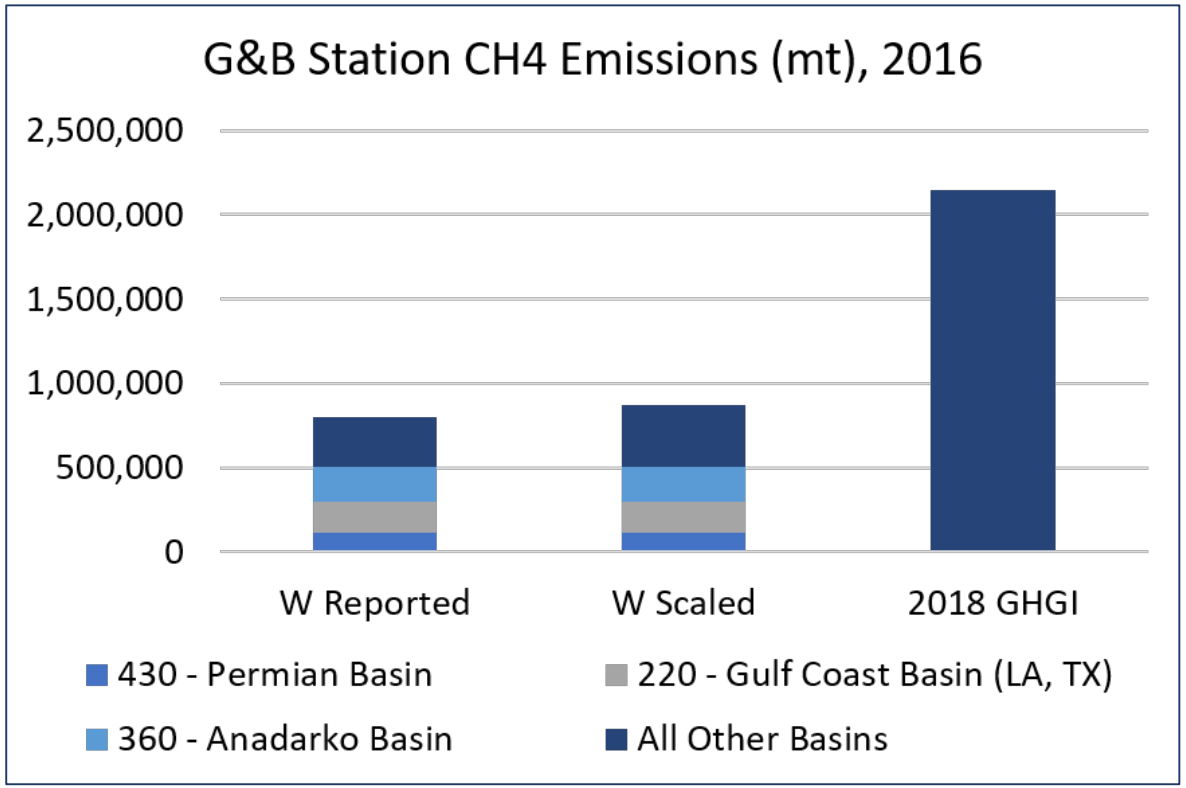
Data Source	CH_4 Emission Rate (kg/h)
Current GHGI (excl. episodic)	43
Current GHGI (incl. episodic)	47
Vaughn (Fayetteville) (excl. tank venting)	50.4
Vaughn (Fayetteville) (incl. tank venting)	74.5
Yacovitch (Fayetteville)	40
Yacovitch (DJ)	11
Alvarez (excl. episodic)	47
Alvarez (incl. episodic)	52

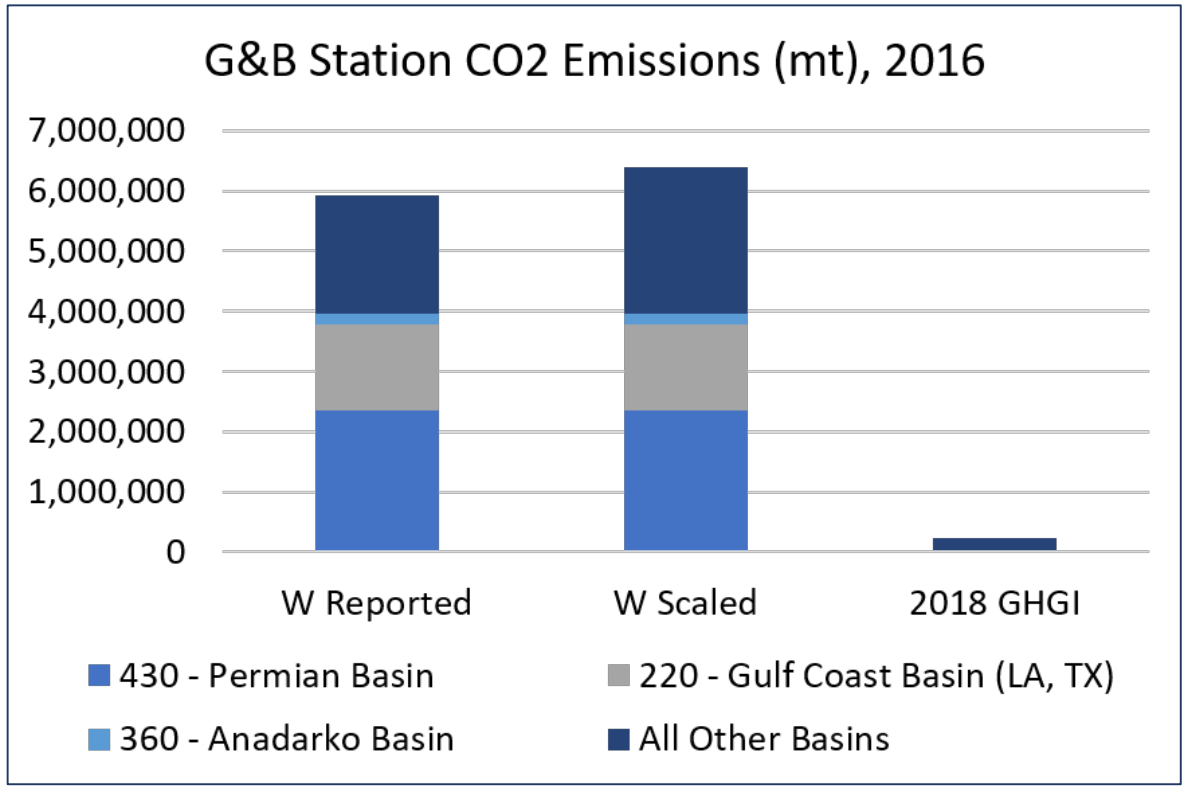
G&B Stations: Subpart W Basin-Level, Throughput-Based Scaling Approach

1. Compare the quantity of gas received (reported by subpart W G&B facilities) to the total amount of gas produced from wells (estimated from DrillingInfo)
2. For the top-emitting basins and the group of all other basins, calculate a scaling factor equal to the gas produced divided by the gas received
3. For each basin or basin group, apply the scaling factor to reported emissions

Basin	Subpart W Reported Station Emissions (MMT)		Subpart W: Quantity Gas Received (bscf)	Adjusted Quantity Gas Received (bscf)	DrillingInfo: Gas Produced (bscf)	Basin Scaling Factor
	CH_4	CO_2				
430 - Permian Basin	0.1	2.4	9,378	2,547	2,547	1.0
220 - Gulf Coast Basin (LA, TX)	0.2	1.4	4,671	3,062	3,062	1.0
360 - Anadarko Basin	0.2	0.2	2,378	1,712	1,712	1.0
All Other Basins	0.4	2.4	25,273	18,033	22,354	1.24

G&B Stations: Comparison of Subpart W Basin-Level Scaling vs Current GHGI





G&B Stations: Reciprocating Compressor Seal and Valve Leaks

- The majority of compressors in the G&B segment are reciprocating, accounting for 99% of compressors reported to subpart W
- The subpart W EF for reciprocating compressors (which is from the 1996 GRI/EPA study) was developed for small compressors, reflects rod packing emissions only, and does not include blowdown or isolation valve emissions
- The 1996 GRI/EPA study estimated that large compressor stations in the production segment were best represented by EFs for reciprocating compressors in the transmission segment

G&B Stations: Reciprocating Compressor Seal and Valve Leaks (cont.)

- EPA reviewed available data and is considering whether the current GHGI EFs for gas processing or transmission reciprocating compressors are more representative of G&B reciprocating compressors, because:
  - Compressor sizes (hp) are likely more comparable
  - The EFs include blowdown valve and isolation valve leak emissions

Segment	Data Source for Current GHGI EF	Current GHGI EF (scfd CH_4/ compr.)	# hp Data Points	Median hp/compr. [Average]
Production (well sites)	GRI/EPA 1996	26	61	No data
G&B stations	Marchese et al. 2015 study	n/a	328	1,300 [1,400]
Gas processing	RY2016 GHGRP	2,189	2,738	1,650 [2,164]
Gas transmission	Zimmerle et al. 2015 study	9,246	3,284	2,000 [2,718]

G&B Stations: Reciprocating Compressor Seal and Valve Leaks (cont.)

- Emissions comparison for each of the EFs under consideration

Approach for Reciprocating Compressors	EF (scfd CH_4/compr.)	CH_4 Emissions from Recip. Compressors (mt)
Subpart W as-reported	26	2,654
Subpart W scaled-up (basin-level approach)	26	2,970
Subpart W scaled-up, applying GHGI Processing segment EF	2,189	250,345
Subpart W scaled-up, applying GHGI Transmission segment EF	9,246	1,057,316

G&B Stations: Compressor Engine Exhaust

- G&B facilities calculate exhaust emissions using 1 of 2 methodologies:
  1. If pipeline quality natural gas is combusted → subpart C applied, which relies on a CH_4 EF
  2. If field gas, process vent gas, or natural gas that is not pipeline quality is combusted → subpart W mass balance equation applied
- G&B reporters do not report information on which method was applied, but assumptions can be made based on reported fuel type

G&B Stations: Compressor Engine Exhaust (cont.)

- In the 2017 GHGI, for gas processing segment revisions, EPA determined the GRI/EPA EF (the basis of the GHGI EF) best represented national CH_4 emissions, versus using the subpart C EF
- The GRI/EPA EF is similar to the EF developed in a Zimmerle et al. 2015 study, which measured transmission segment engine emissions
- The GRI/EPA EF may be more appropriate for reciprocating engines in the GHGI for the natural gas industry (including G&B)

Data Source	Combustion Type	CH_4 EF (kg/mmBtu)	CH_4 EF (scf/hp-hr)
GHGRP (subpart C)	Generic combustion, including engines and turbines	0.001	0.00037
2018 GHGI (basis is 1996 GRI/EPA study)	Reciprocating engine compressor drivers in the natural gas industry	0.65	0.24

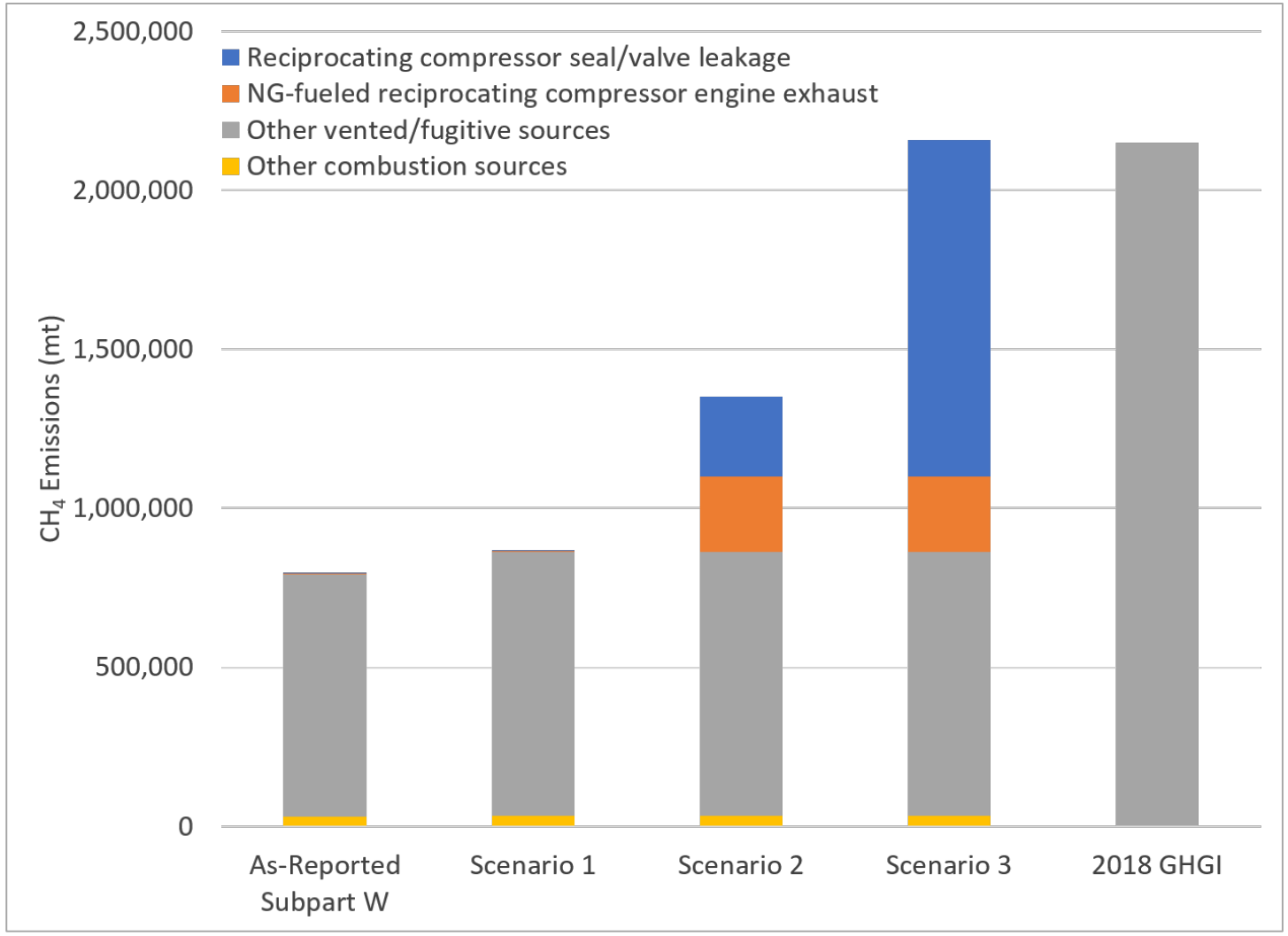
G&B Stations: Compressor Engine Exhaust (cont.)

- EPA is considering recalculating the G&B compressor engine exhaust emissions that relied on the subpart C EF methodology
  - EPA would use reported volume of natural gas combusted in compressor drivers from subpart W, paired with the current GHGI EF
  - For compressors using the subpart W equation, no adjustment to the exhaust emissions would be made
- Impact of applying GHGI EF to natural gas compressor drivers instead of the subpart C EF:

Approach	CH_4 EF (kg/mmBtu)	CH_4 Emissions (mt)
Subpart W as-reported	0.001	414
Subpart W scaled-up	0.001	492
Subpart W scaled-up, applying GHGI EF	0.65	236,897

G&B Stations: Overview of Updates Under Consideration

- Scenario 1: Basin-level, throughput-based scaling approach
- Scenario 2: Basin-level, throughput-based scaling approach PLUS the GHGI gas processing reciprocating compressor EF and the GHGI engine exhaust EF
- Scenario 3: Basin-level, throughput-based scaling approach PLUS the GHGI gas transmission reciprocating compressor EF and the GHGI engine exhaust EF



G&B Stations: Stakeholder Feedback Topics

1. Data sources and methodologies to consider in updating GHGI
2. Reciprocating compressor seal and valve leakage emissions analysis
3. Compressor engine exhaust analysis
4. Other emission sources that EPA should examine to assess the difference between subpart W-based estimates and the current GHGI estimates
5. How to assess GHGRP reporting coverage
6. How to consider regional and temporal variability in GHGRP data
7. Level of detail to present in the GHGI

Refer to EPA memo posted online for additional detail

G&B PIPELINES

G&B Pipelines: Current GHGI Methodology

- Methodology relies on 1996 GRI/EPA study
- Pipeline miles in each year are calculated using an AF (pipeline miles per well) from the 1996 GRI/EPA study times the total count of gas wells (DrillingInfo) in that year, plus a correction factor from the GRI/EPA study
- Pipeline CH_4 EF (emissions per mile) representing leaks and blowdowns developed from 1996 GRI/EPA study
- CO_2 emissions based on CO_2 EFs developed by applying a default production segment ratio of CO_2-to-CH_4 gas content

G&B Pipelines: Available Data

- GHGRP Subpart W
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G&B Pipeline Emissions and Mileage Data, Year 2016

Data Source	Total CH_4 Emissions (mt)	Total CO_2 Emissions (mt)	Pipeline Miles
Subpart W	152,011	8,967	405,174
2018 GHGI	157,798	18,820	398,554

G&B Pipelines: Subpart W Scaling Approaches

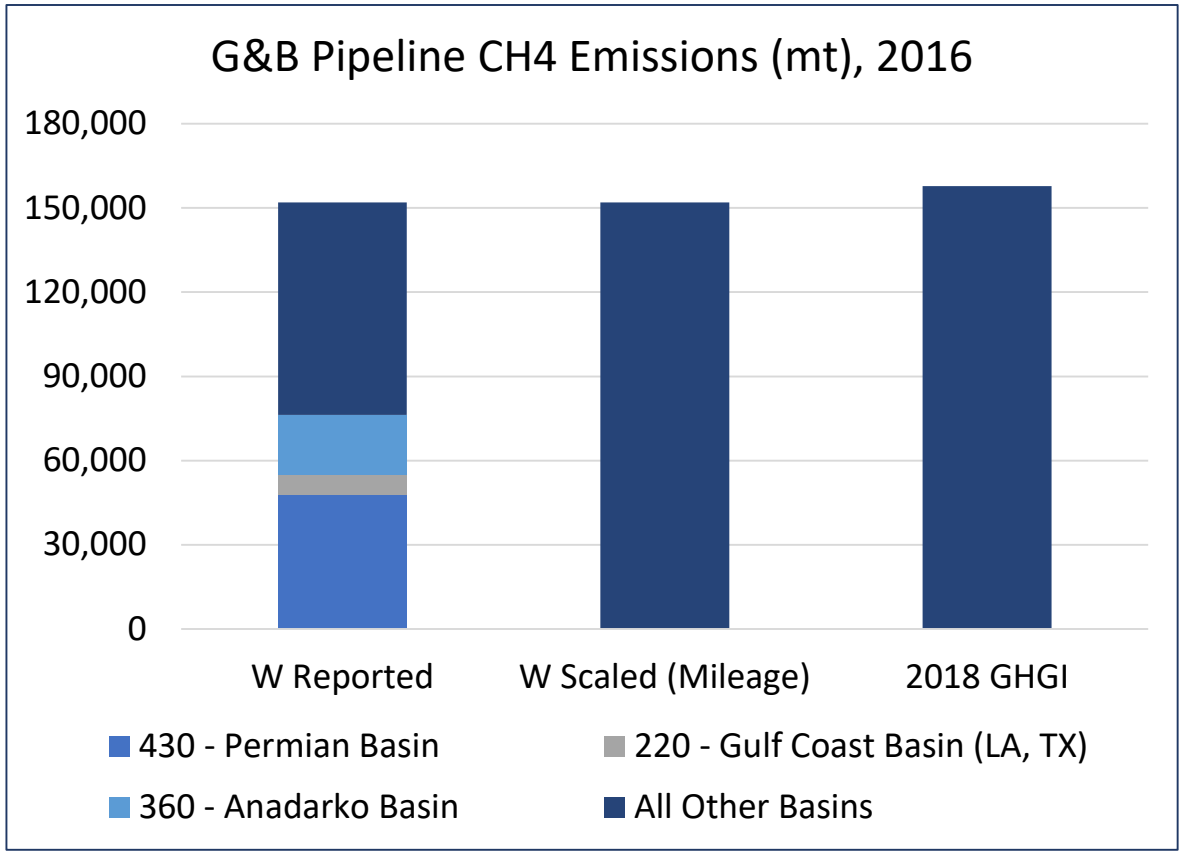
Basin-Level, Throughput-Based Scaling (Identical to G&B stations)

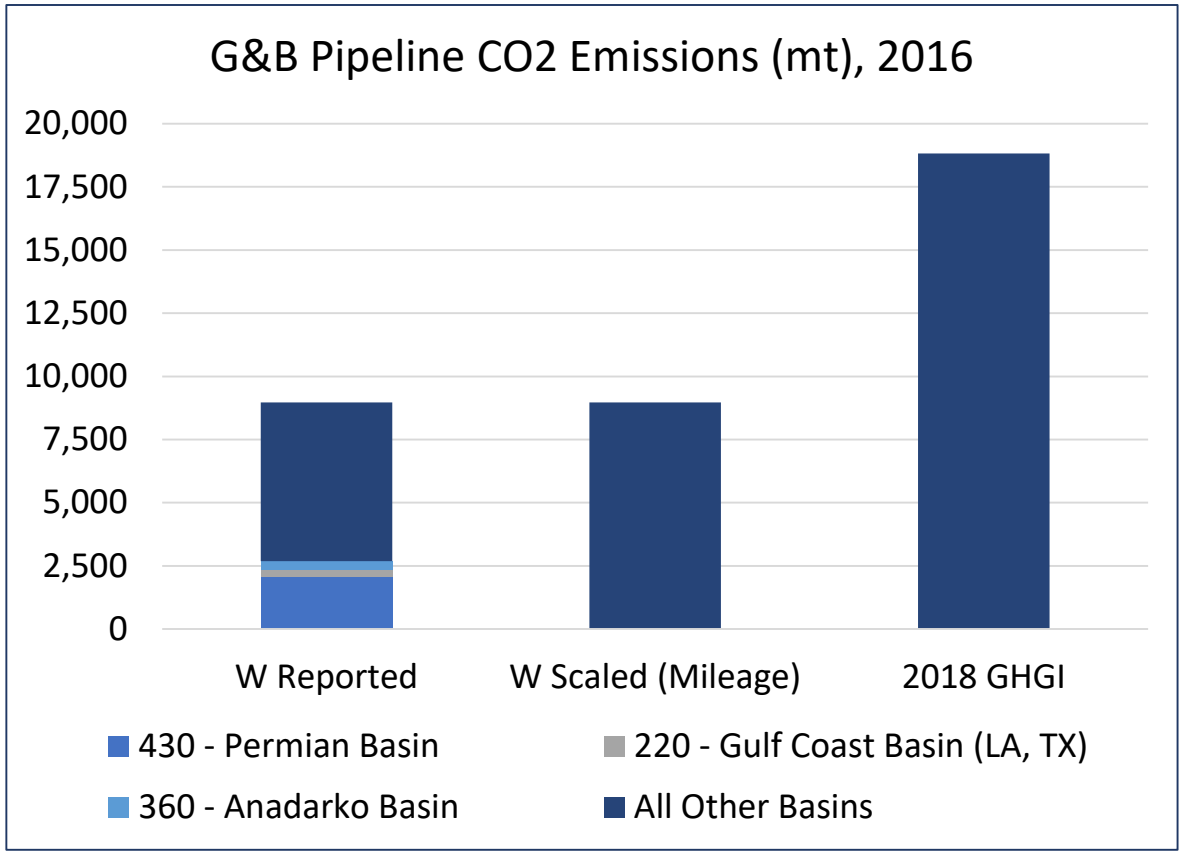
1. For each basin or basin group, apply the calculated scaling factor to reported emissions

Pipeline Mileage Scaling

1. Assume subpart W covers 100% of G&B pipelines, based on comparison to current GHGI and other available gathering pipeline mileage data
2. Use subpart W data as-reported in GHGI
3. Initial stakeholder feedback supports the pipeline mileage scaling approach

G&B Pipelines: Comparison of Subpart W Scaling vs Current GHGI





G&B Pipelines: Stakeholder Feedback Topics

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2. How to assess GHGRP reporting coverage
3. How to consider regional and temporal variability in GHGRP data
4. Level of detail to present in the GHGI

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