Therriault, John

From:	Ted Tiberi <ttiberi@aridtech.com>
Sent:	Monday, September 09, 2013 12:15 PM
To:	Therriault, John
Subject:	R2013-018
Attachments:	OTC_Presentation 4-4-13 for IL EPA submittal.pptx; spreadsheet showing derivation of the refueling and storage tank emissions OTC phone conf 22 may 2013.xlsx; Stage II, ORVR and Emissions Reduction Options 20 DEC 2012 with Executive Summary.pdf; Analysis Results[1] copy.pdf; CT_CF_Drop_13.txt

PC#4

Dear Mr. Therriault,

As per our phone conversation (and my subsequent call with Mr. Richard McGill), I am pleased to attach ARID's comments in the matter of Case R2013-018 currently before the Illinois Pollution Control Board (IPCB). I have attached 3 files; a powerpoint presentation previously provided to the OTC (Ozone Transport Commission), an excel spreadsheet showing the derivation of the charts found in the powerpoint, and a White Paper, where ARID's rationale is more fully explained. Also, I have attached a non-road emissions study compiled by Meszler Engineering Services at the request of the Maryland Department of Environment (MDE). The non-road emissions are generated from the refueling of gas cans, motorcycles, boats, snowmobiles, etc.. The non road fuel tanks do not have ORVR technology....nor will they ever have ORVR technology in the future. I have also attached a video taken with a special camera which shows the emissions from a non-ORVR vehicle being refueled at a non-Stage II GDF.

Please note that we respectively request that our filing be accepted late into the record as we recently became aware of this matter before the IPCB.

As part of our submittal, I would also like to say that the State of PA is in the process of considering field-testing to accurately quantify the storage tank emissions from GDF (Gasoline Dispensing Facilities) under various scenarios (with and without Stage II, and with and without the use of vapor processors, for example). The results of such field measurements will comprise key inputs into future rule making in this matter.

In addition, our attachments include GDF emissions data from the state of Connecticut and the state of Massachusetts as we were provided with detailed metrics for these states. For example, for MA data in our spreadsheet calculations, we used:

- Emission Factor : 7.01 lbs/1,000 gallons (dKC report)
- ORVR Throughput: .8487 in year 2013 (penetration values per dKC report)
- ORVR Efficiency: 98% (USEPA)
- Stage II Efficiency:
75% (dKC, MA, USEPA)
- Gasoline Throughput:
2.9 billion gallons per year (final results normallized to lb/1,000 gallon)

The calculation methods and dynamics for the state of Illinois would be the same; if IL EPA would like to provide ARID with the above metrics (along with GDF population data as a function of throughput), ARID would be pleased to work up the Illinois-specific data)

As seen in the attached materials, ARID clearly shows that the removal of Stage II vapor recovery systems from GDF with sole reliance on vehicle based ORVR technology will increase refueling emissions. It is our understanding that the MOVES model is designed primarily for complex vehicle emissions calculations related to tailpipe exhaust as a function of engine acceleration rates, and the use of the MOVES model for GDF storage tank emissions based on ORVR population is not applicable to this matter. ARID uses a simple spreadsheet which clearly shows that the combination of non-ORVR vehicle refueling at a non-Stage II GDF will result in very large refueling emissions.When these non-Stage II refueling emissions are summed from the period of 2013 - 2022 (ORVR population of 99.63% in 2022); they exceed the refueling emissions over the same period from the "status-quo" (the combination of Stage II with and without ORVR vehicles). To make matters worse, when the storage tank emissions are added to the total emissions, the gap for the non-Stage II case becomes even wider. To further exacerbate the gap, the non-road refueling emissions are added to the total, which shows that the decision to decommission Stage II does in fact result in a large net increase in emissions, and therefore such a decision will have a negative impact on the environment and human health. The attached White Paper discusses the particular impact on Environmental Justice (EJ) areas; where a disproportionate share of older vehicles are in use, and therefore a lower proportion of such vehicles will have ORVR technology installed. In this manner, the refueling emissions will be much higher in the EJ areas, and individuals who do now own newer model vehicles will earn the right to ingest toxic and carcinogenic vapors such as benzene. (Please refer to the attached video).

We urge IL EPA to re-consider their plans to decommission Stage II vapor recovery. We feel that the option of **enhancing Stage II** has béen largely overlooked, and that such an option provides the best solution for cost-effective, state-of-the-art technology for minimizing emissions while at the same time yielding a favorable economic payback for the GDF owner. As a second option, even if the flawed decision to remove Stage II is approved, the control of storage tank emissions with a vapor processor is a viable means for limiting the emissions to the environment. We strongly urge IL EPA (and the IL PCB) to either make direct measurements of storage tank emissions or seek to participate with the measurement efforts underway in the state of PA. After the real-world field data are collected and analyzed, then the state of IL Pollution Control Board can be in a position to make a science-based, objective decision on the matter at hand.

I am pleased to visit with the IL EPA and/or the IL PCB to further clarify any of the information contained in my submittal.

We have been involved in GDF vapor recovery technology for the past 20 years, and we appreciate the opportunity to contribute technical data and information on this issue.

Respectfully submitted,

Ted Tiberi, President & Founder

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Vapor Recovery Emissions Reductions

Stage II and ORVR

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Topics of Discussion

- Refueling Emissions
  - Status Quo vs Non Stage II (MA DEP example)
- Storage Tank Emissions
  - IEE (Incompatibility Excess Emissions) for Status Quo
  - STBL (Storage Tank Breathing Losses) for MA DEP
- Enhancement of Status Quo and MA DEP
  - Processor on Combined Storage Tank Ullage
- Rhode Island Shared Savings Example

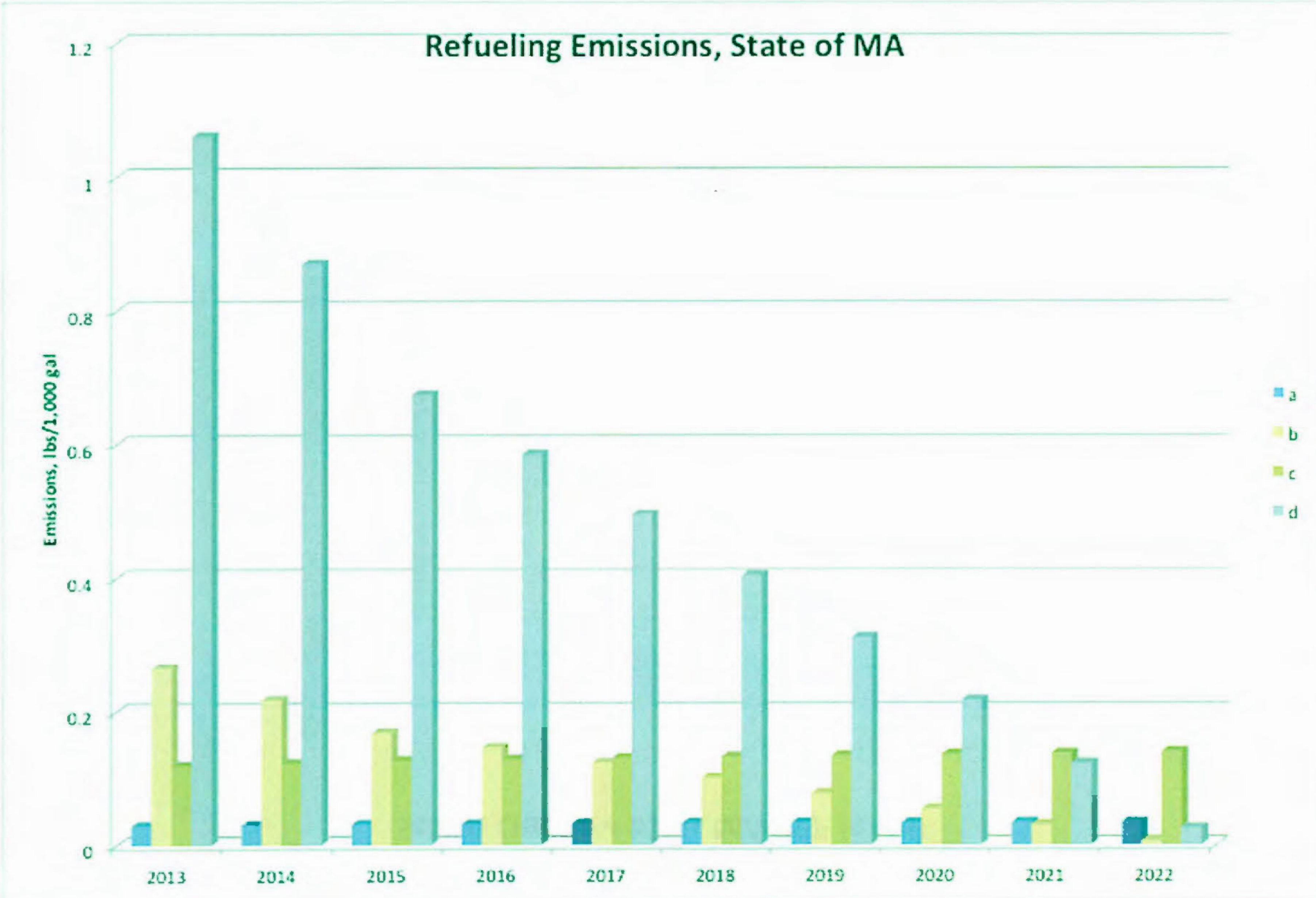
Refueling Emissions Assumptions

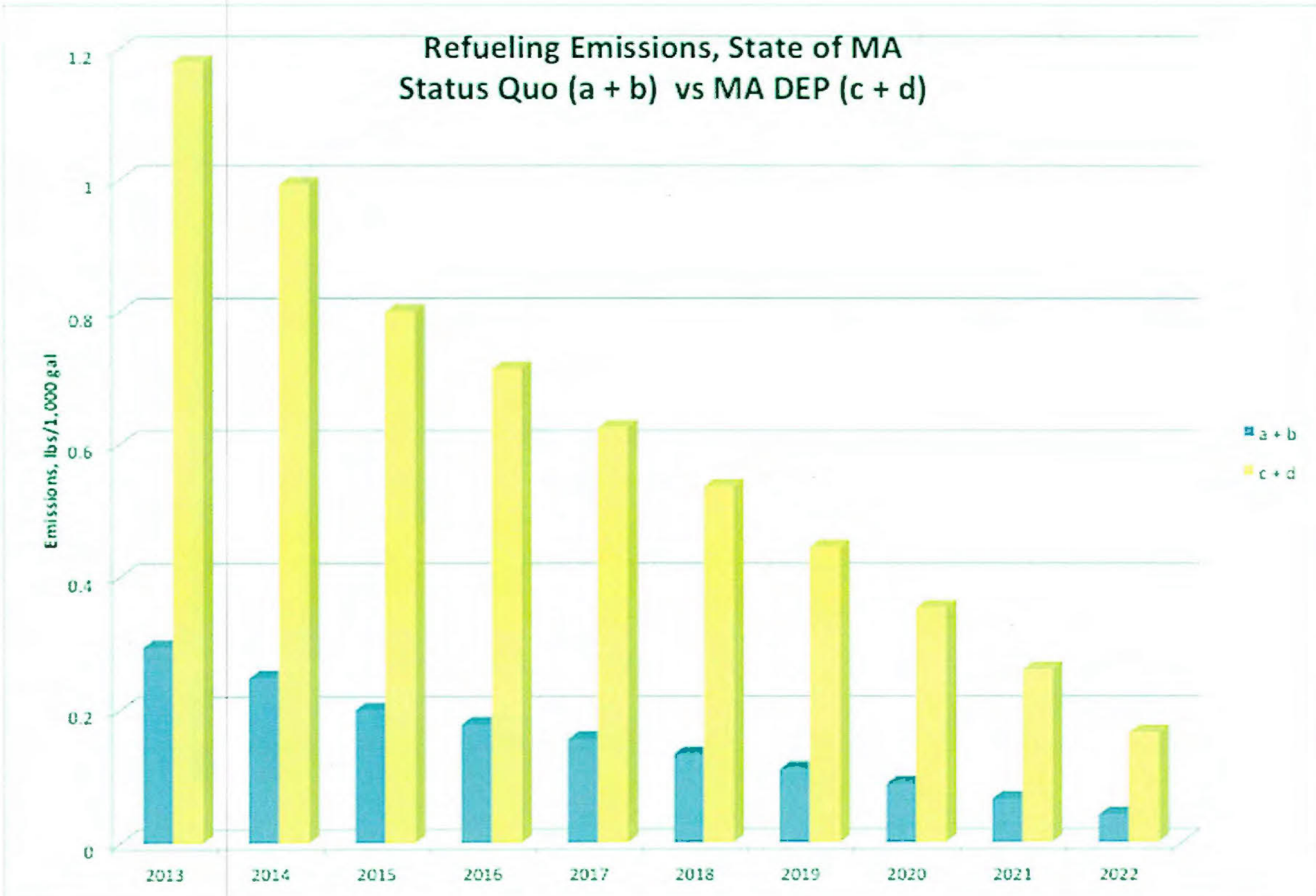
The MA DEP Study was used as an example

- Uncontrolled refueling emissions = 7.01 lbs/1000 gal
- ORVR Efficiency = 98%
- ORVR Penetration = 85% for 2013
- Stage 2 Efficiency = 75%
- TOTAL EMISSONS = Refueling Emissions + Storage Tank Emissions

Refueling Emissions (lbs/1000 gal) 2013

	ORVR	No ORVR
Stage II	**A** 7.01 (0.85) (1- 0.98) (1- 0.75) 0.029	**B** 7.01 (1-0.85) (1-0.75) 0.263
No Stage II	**C** 7.01 (0.85) (1-0.98) 0.119	**D** 7.01 (1-0.85) 1.05


Refueling Emissions, State of MA
Emissions, lbs/1,000 gal
1.2
1
0.8
0.6
0.4
0.2
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
a
b
c
d



Refueling Emissions, State of MA
Status Quo (a + b) vs MA DEP (c + d)
Emissions, lbs/1,000 gal
1.2
1
0.8
0.6
0.4
0.2
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
a + b
c + d

Storage Tank Emissions

Vent and Fugitive Emissions (lbs/1000 gal)

Assumptions

IEE = 0.86 lbs/1000gal at 100% ORVR penetration

STBL = 1.0 lbs/1000 gal

Non Road = 0.223 lbs/1000 gal

TOTAL EMISSIONS (lbs/1000 gal)

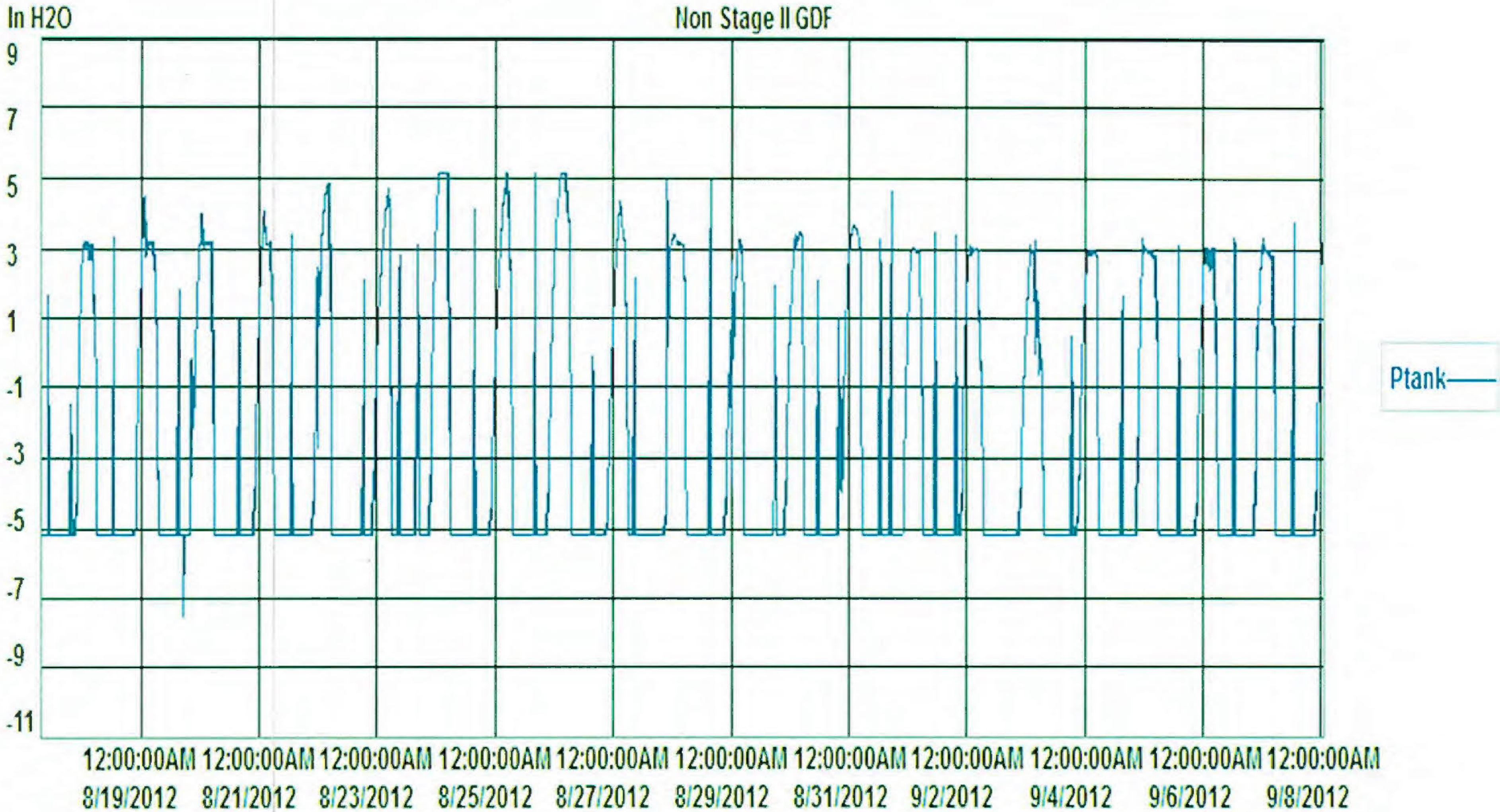
2013

	Refueling	Vent + Fugitives	Non Road	TOTAL
STATUS QUO	0.289	1.126	0	1.415
MASS DEP	1.169	1.0	0.236	2.405

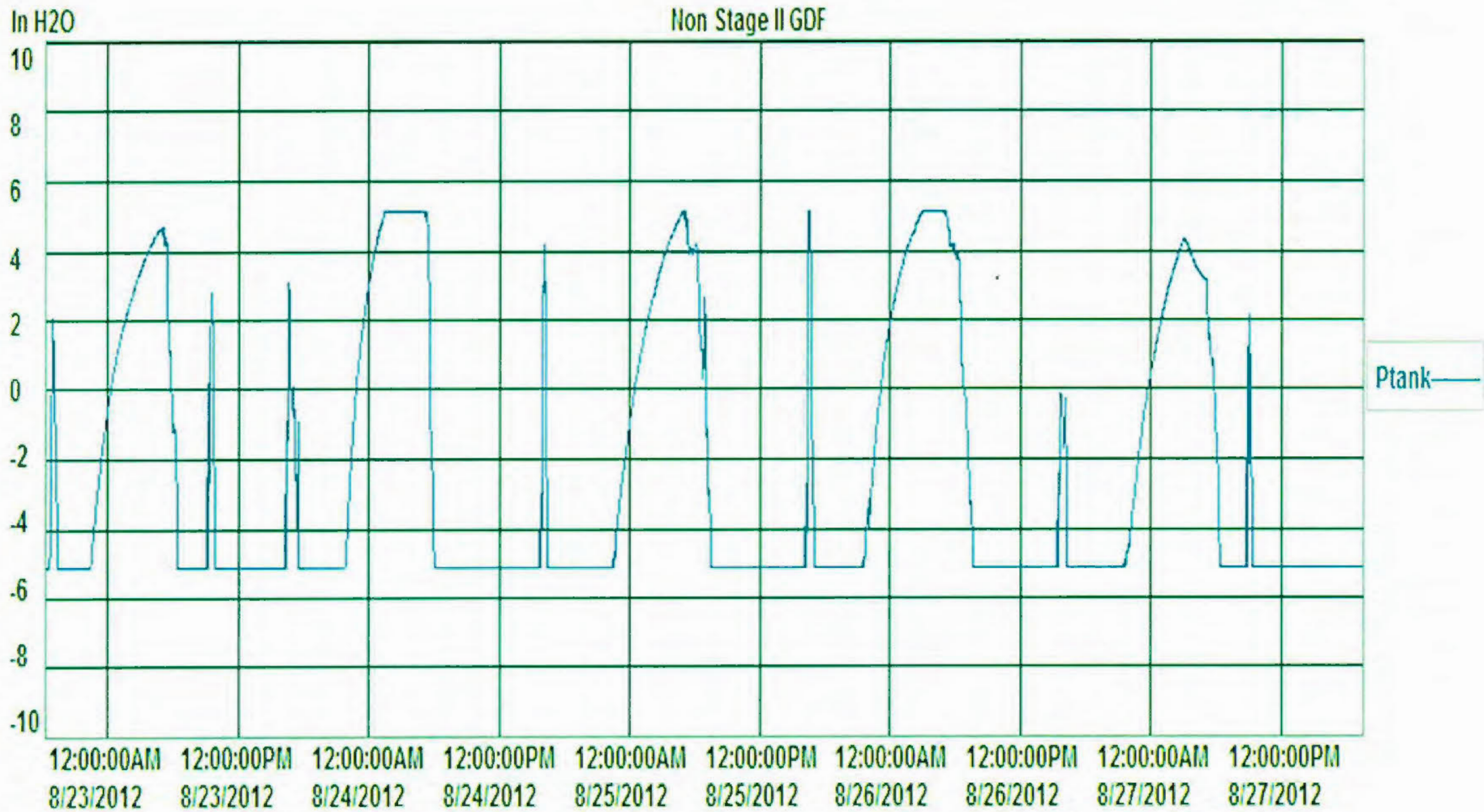
Misconceptions About Non Stage II

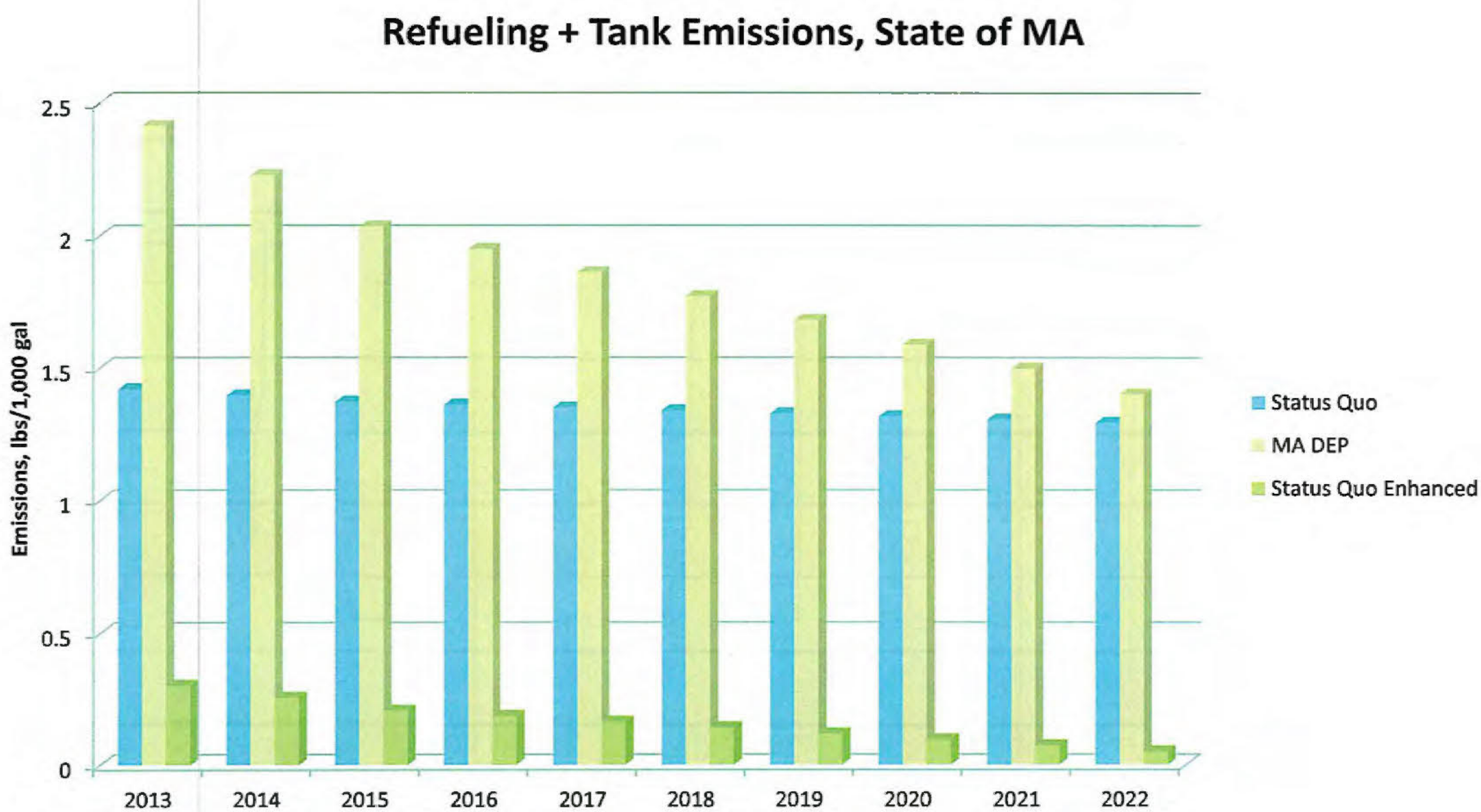
- Most Stakeholders believe that Storage Tank is under vacuum 100% of the time
- This assumption leads to view of no Storage Tank Emissions in absence of Stage II
- Reality shows this is not the case, air ingested during busy pumping periods will attempt to re-saturate the vapor space; evaporation of liquid gasoline to vapor phase will increase pressure and lead to vent and fugitive emissions
- This scenario repeats on a daily cycle

Non-Stage II Site Pressure Profile

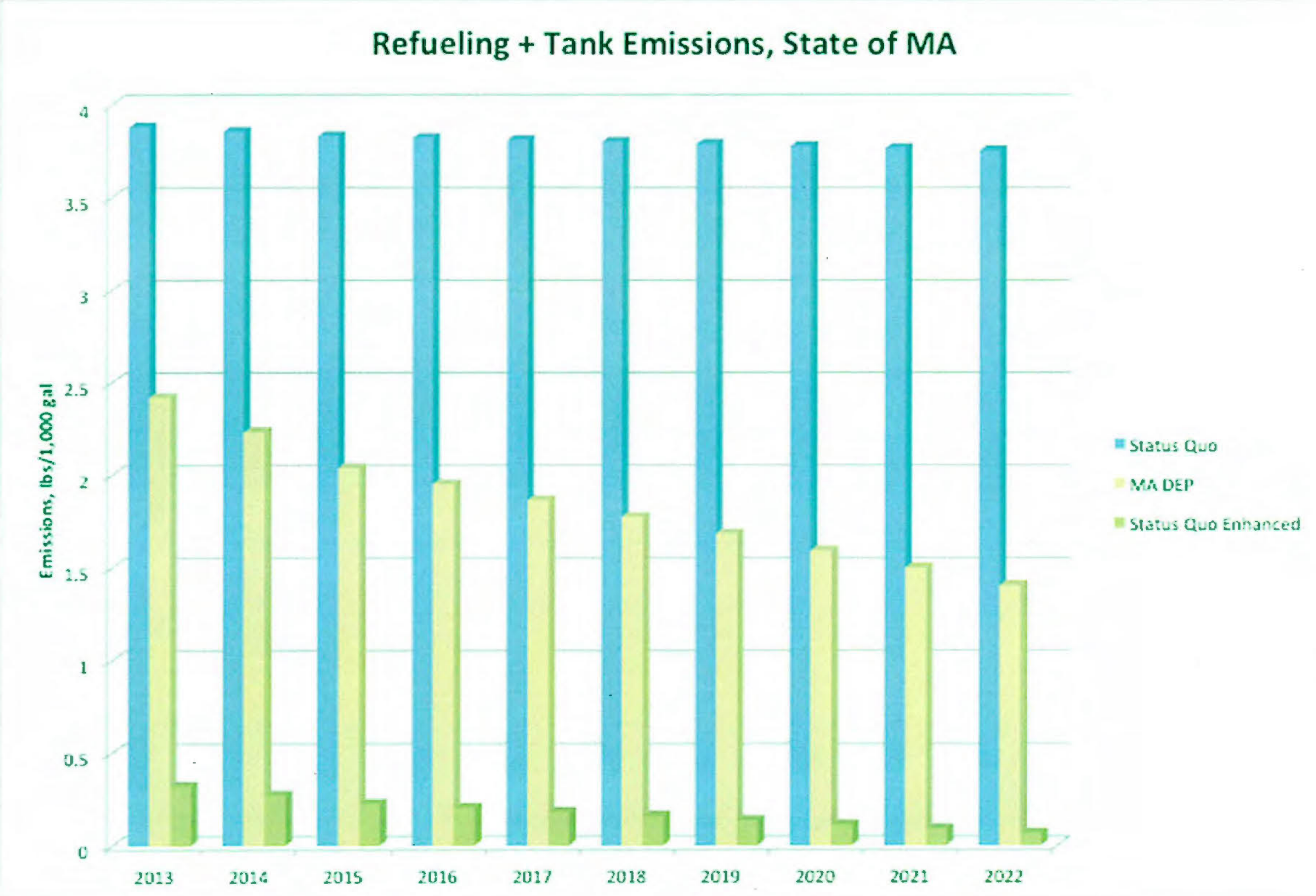


Non-Stage II Site Pressure Profile
Expanded Scale

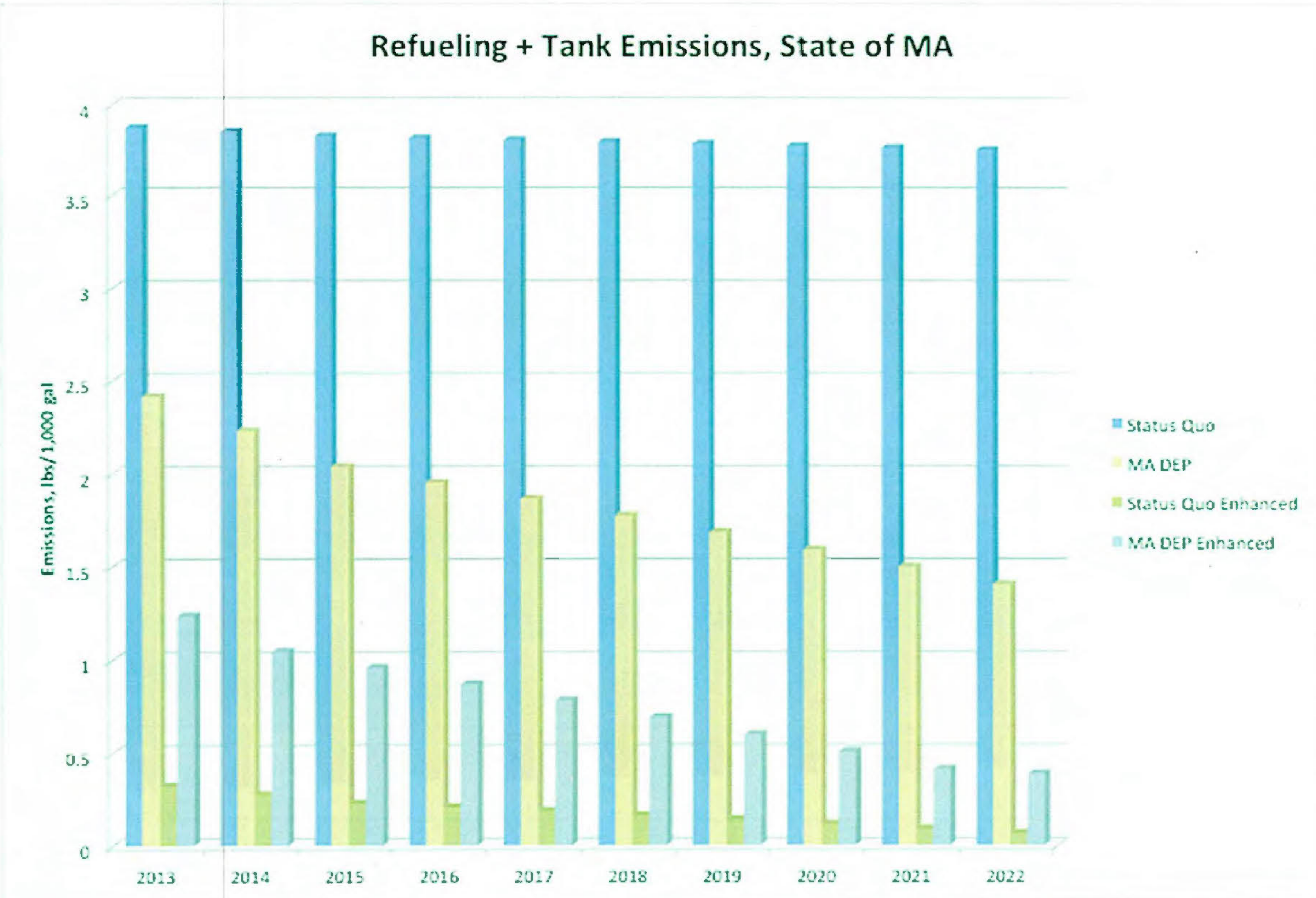



Refueling + Tank Emissions, State of MA
Emissions, lbs/1,000 gal
2.5
2
1.5
1
0.5
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Status Quo
MA DEP
Status Quo Enhanced

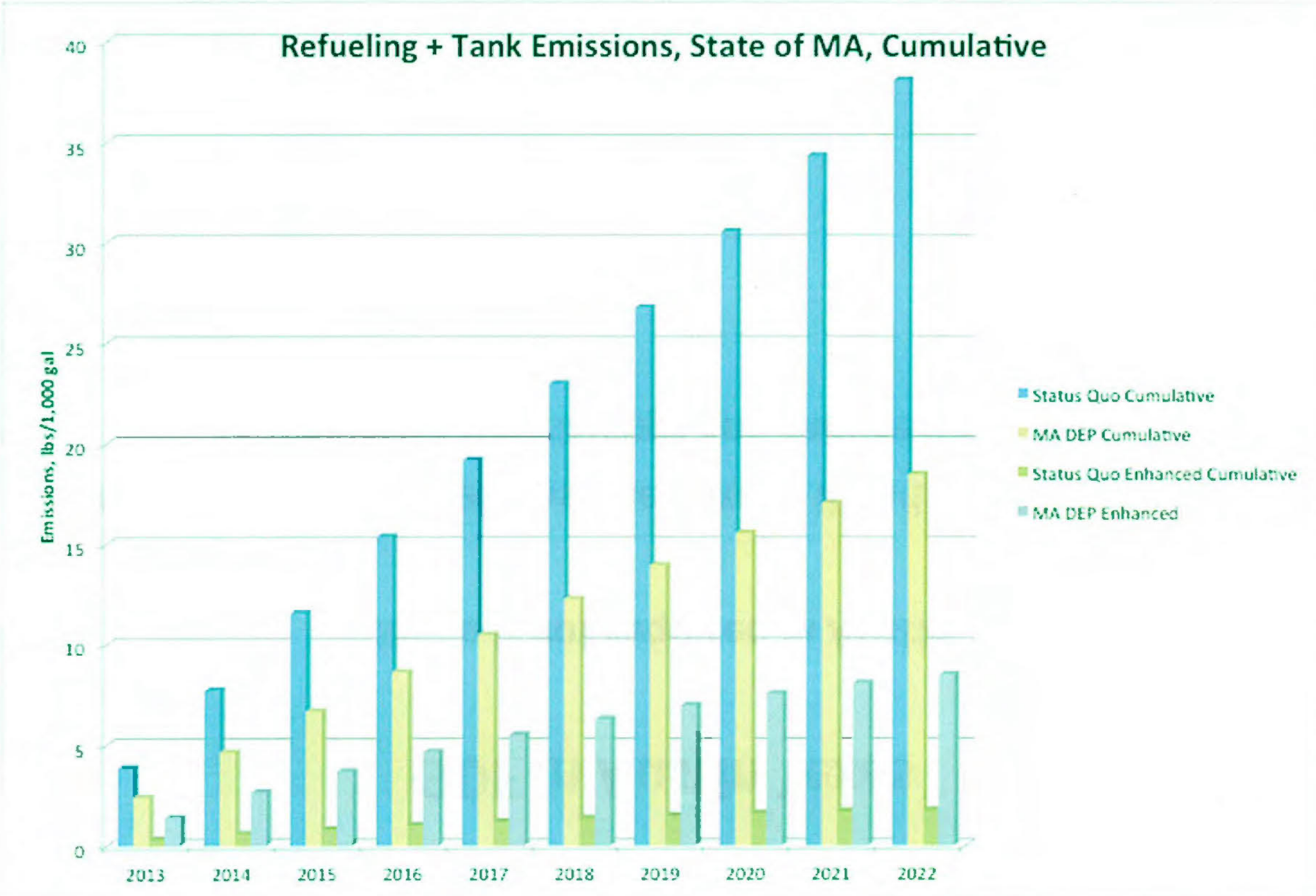
Realistic IEE, 2013 =3.58 lbs/1000gal



Realistic IEE, 2013 =3.58



Realistic IEE, 2013 =3.58



GDF in Austin Texas

Stage II not required in Austin

Customer proactively installed Stage II and ARID Processor
To maximize fuel savings and reduce emissions

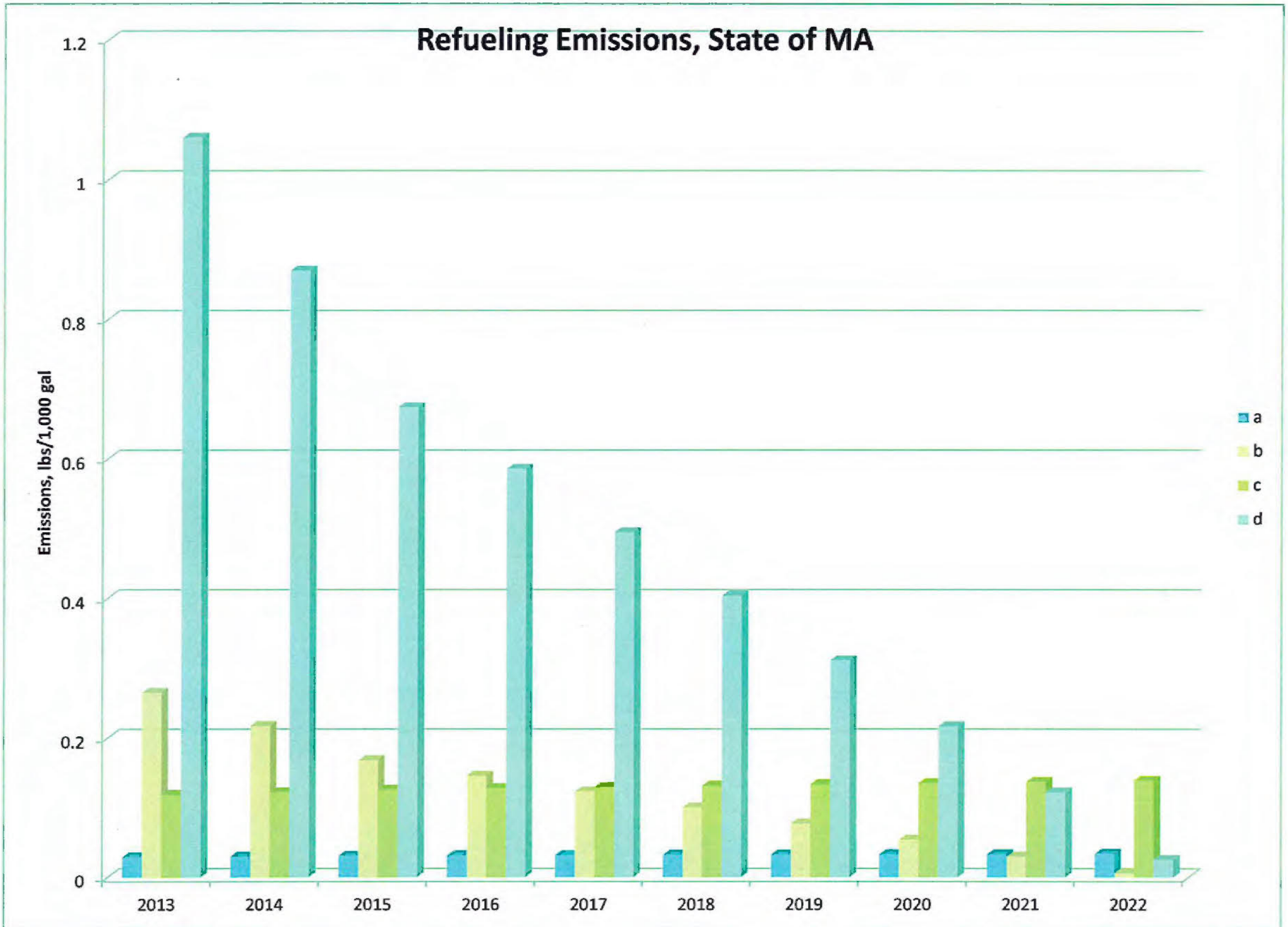
Why a Processor?

- Actively Controls Pressure
- Eliminates almost all Vent and Fugitive Emissions
- Reports Anomalies Immediately (vapor leakage)
- Returns Saleable Product to the storage tank
- Cost neutral (or cash flow positive) to GDF using shared savings program

Energy, Emissions & Fuel Savings Example

Rhode Island, GDF Throughput Data Supplied by Barbara Morin
For 70% of RI throughput

- Net Energy Savings = 15,592,072,799 Btu/yr (16 Billion Btu/yr)
- Tons/yr of emissions Reduced = 353.12
- Gallons/yr of saved fuel = 141,250
- No Net Cost
  - Under a Shared Savings Program, the GDF owner/operator generates positive cash flow and pays nothing for the processor
- Where else in pollution control applications can the above savings be generated for a positive cash flow ?



Refueling Emissions, State of MA
Emissions, lbs/1,000 gal
1.2
1
0.8
0.6
0.4
0.2
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
a
b
c
d

Stage II & ORVR and Associated Emissions of Gasoline Vapor State of Connecticut Gasoline Dispensing Facilities

Ted Tiberi, Luke Howard, Mike Heffernan, ARID Technologies, Inc.

18 December 2012
www.ARIDtech.com

Executive Summary

Gas stations; also called gasoline dispensing facilities (GDF) typically store fuel in underground tanks (called UST's). The gasoline is dispensed through nozzles to the motorist's vehicle tank. When the vehicle tank is refilled, the liquid gasoline entering the tank will displace a volume of vapor phase gasoline; for example, if 10 gallons of fuel are pumped into the vehicle tank, approximately 10 gallons of vapor will be displaced. This displaced vapor is comprised of air and hydrocarbons. Some of the hydrocarbons (also called VOC's - Volatile Organic Compounds) contain HAP's (Hazardous Air Pollutants), and direct exposure to some HAP's is known to increase risks for cancer; for example benzene. In addition, the emissions of VOC's to the atmosphere are ozone precursors; where ozone formation in the lower atmosphere is detrimental to human health.

To reduce emissions of VOC's and HAP's to humans and the environment, Stage II vapor recovery systems were put in place. The Stage II systems use a small vacuum pump located in the fuel dispenser along with a coaxial hose (hose within a hose) arrangement to allow liquid gasoline to flow from the UST's to the vehicle and at the same time to collect displaced vapors from the vehicle tank and then direct these collected vapors back to the UST's.

The operation of Stage II vapor recovery provides three key benefits:

- Reduced health risks to motorists as direct exposure to benzene and other HAP's is avoided
- Reduced impact of hydrocarbon emissions to the environment as the displaced vapors are captured and directed back to the UST's
- Operational savings to the GDF owner/operator since the recovered vapors from the motorist's vehicle tank are used to blanket the liquid gasoline stored in the UST's. By keeping the hydrocarbon vapor concentration at elevated levels in the vapor space of the UST's, the natural phenomena of evaporation of liquid gasoline to vapor phase gasoline is avoided. In this manner, there is a kind of linked or interdependency between the Stage II system and the UST's
    - The vapor space above the liquid gasoline has a hydrocarbon vapor concentration that attains some "equilibrium level",

where the rate of liquid evaporating to vapor equals the rate of vapor condensing to liquid. When the equilibrium hydrocarbon concentration is altered by ingestion of atmospheric air, liquid fuel will evaporate to increase the hydrocarbon concentration back up to the original equilibrium level. During this process of "re-saturation" of the UST vapor space, the storage tank pressure will increase and excess volume of hydrocarbon vapors will be exhausted from the UST vapor space (One gallon of liquid gasoline evaporates into 520 gallons of vapor phase gasoline, at 40% hydrocarbon concentration). This storage tank breathing loss is the primary reason that very large above ground storage tanks at bulk gasoline terminals, refineries and distribution facilities use so-called "floating roof tanks"; these tanks use a roof that literally floats on the surface of the gasoline, therefore eliminating any vapor space above the liquid, to subsequently eliminate the breathing loss dynamics.

A debate emerged between the Auto and Oil Industries as to what party should be responsible for controlling the refueling losses. The Oil Industry prevailed and the Auto industry was forced to equip new vehicles with the so-called ORVR (On Board Refueling Vapor Recovery) system. The ORVR system is primarily comprised of an activated carbon canister, which captures the displaced vapor during refueling. As the motorist drives down the highway, the carbon canister is regenerated by a portion of engine intake air "back flushing" through the carbon canister, where the hydrocarbons are desorbed and burned as fuel in the engine. Since the ORVR systems are not retrofit to vehicles, but rather incorporated into new vehicle production, the population of ORVR equipped vehicles has been slowly increasing throughout the United States. Passenger vehicles were first equipped in 1998, with 40%, 80%, and 100% of new vehicle production having ORVR systems in 1998, 1999 and 2000, respectively.

At the time of the Oil Industry "victory", the oil industry wanted to remove the Stage II hardware from GDF. Since only a low proportion of vehicles had ORVR systems in 1998, immediate removal of the Stage II systems was not possible. However, the oil industry negotiated for a timed "phase-out" of the Stage II hardware in conjunction with a greater proportion of ORVR equipped vehicles in the fleet. The notion of widespread use (WSU) was discussed between USEPA and the Oil Industry; whereby a certain population of ORVR equipped vehicles would trigger the removal of Stage II vapor recovery controls. The rough idea formulated at that time (without in-depth study or understanding) was that after a threshold population of ORVR vehicles was attained in the fleet, the use of overlapping controls (Stage II at the GDF and ORVR within the vehicles) would be counterproductive since the emissions controlled by ORVR Alone would exceed the emissions controlled by either Stage II Alone or Stage II in conjunction with ORVR. However, in practice, these fundamental assumptions are not accurate or true. For the first assumption regarding the refueling emissions controlled by ORVR Alone in comparison to Stage II Alone; we show in our CHART1 of this report, that there is a cross-over for the ORVR Alone curve with the Stage II Alone curves; however, in practice Stage II is never able to be used "Alone" as there will always now be some proportion of ORVR equipped vehicles in the fleet. Thus, our CHART2 shows that the combination of Stage II + ORVR provides the lowest emissions in comparison to ORVR Alone over the entire interval presented; which incorporates increased proportion of ORVR vehicles in the fleet. Basically, the presence of the Stage II system acts as a "backstop" to provide a chance to capture the refueling emissions from non-ORVR vehicles. Therefore the combined Stage II + ORVR efficiency will always be higher than ORVR Alone.

For the second assumption from above, regarding the total emissions controlled by ORVR Alone in comparison to Stage II in conjunction with ORVR; we show in CHART3 that there is a cross-over for the ORVR Alone curve with the Stage II + ORVR curves; however, this ORVR Alone curve is generated without including any storage tank breathing losses. These storage tank-breathing losses are the category of emissions described above under the "Operational Savings" section of this Executive Summary. Since Stage II is removed under the ORVR Alone option, the UST's are not able to use any of the hydrocarbon vapors displaced from the motorist's vehicle tank; as these vapors are now adsorbed on the activated carbon used in the ORVR system. As such, the UST's will ingest atmospheric air to offset the vacuum developed as product is withdrawn and directed to vehicles. The interdependency of Stage II and the UST's is now interrupted, and the ingested air will cause storage tank breathing losses to occur. The dynamics of this situation have been overlooked or ignored by the Regulatory Community, Lawmakers, and other Stakeholders. When the storage tank breathing losses are properly accounted for and added back to the emissions inventory, the ORVR Alone curve never crosses over the ORVR +Stage II curves, and therefore the ORVR Alone case never provides for the maximum amount of emissions reductions. The fact that Stage II systems "solve two problems simultaneously" by recovering displaced vapors from the vehicle tank AND using these recovered vapors to blanket the UST vapor space and thereby avoid subsequent evaporation of fuel and storage tank breathing losses has not been understood.

A quick word about IEE, Incompatibility Excess Emissions. IEE have been recognized by various Stakeholders'; whereby the higher proportion of ORVR equipped vehicles will cause higher amounts of ambient air to be ingested by the Stage II systems. This greater quantity of air will dilute the hydrocarbon vapor space, and cause liquid fuel to evaporate and eventually be exhausted from the UST combined vapor spaces. When the IEE are properly quantified, there is a crossover with the ORVR Alone case with the Stage II + ORVR Case (Please see CHART5c); when a vapor processor is not used to actively manage the UST pressure. When a vapor processor such as the ARID Permeator is employed, the IEE emissions are reduced by 99.3%, and this is clearly the optimum configuration. For clarity, ORVR Alone storage tank breathing losses and Stage II + ORVR IEE are generated by a similar mechanism. Storage tank breathing losses are caused by pure air ingested through the vent line, and IEE emissions are generated by a combination of air and hydrocarbons pumped back into the UST by the Stage II system, while refueling an ORVR equipped vehicle.

Widespread Use and General Overview

In general, vapor emissions at gasoline dispensing facilities (GDF) are comprised of **refueling emissions** and **storage tank emissions**. In turn, refueling emissions are generated at the nozzle/vehicle interface and at the outlet from the carbon canister used on the ORVR systems. The storage tank emissions are comprised of vent line emissions through the pressure/vacuum valve (p/v valve) and fugitive emissions through various point sources within the vapor containing hardware; where the vent & fugitive emissions are a function of storage tank pressure.

At a GDF using a combination of Stage II and ORVR, the storage tank vent and fugitive emissions comprise the so-called "IEE" or incompatibility excess emissions. The IEE emissions are generated from the combined storage tanks due to air ingestion, dilution of the hydrocarbon concentration within the vapor spaces of the tanks, and subsequent evaporation of liquid gasoline to increase the vapor space concentration back to the original "equilibrium" value. As ORVR penetration increases with time, the IEE will increase due to leaner vapors (more air) being returned to the storage tank vapor space, which in-turn triggers the evaporative process described above.

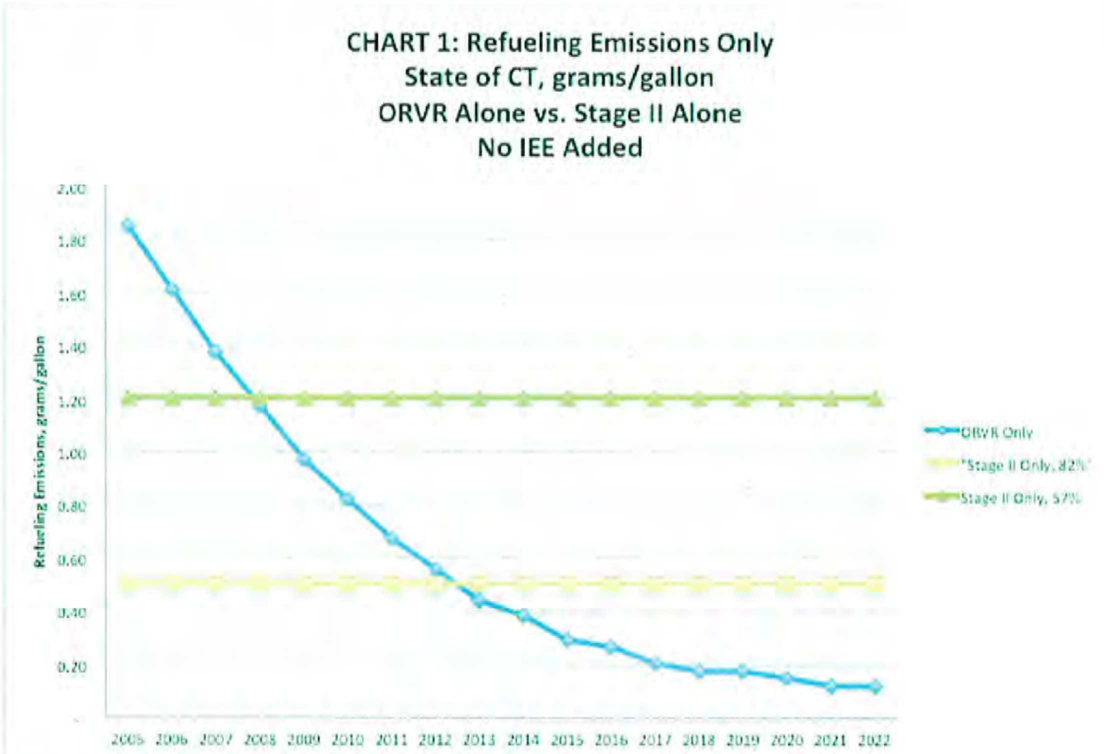
With non-Stage II and ORVR alone, air ingestion via Stage II vacuum pumps located in the fuel dispensers is eliminated, however ***air will still be ingested into the storage tanks through the vent line.*** During busy refueling periods, the negative cracking pressure of the p/v valve is quickly reached since the volume of fuel removed from the tank will draw down the level of fuel and this "piston effect" will create a vacuum in the tank vapor space. Typically, the air ingestion will occur when a negative pressure of -6 to -8 inches of water column is reached. The ambient air entering the system will cause the liquid fuel in the tank to evaporate (similar to IEE mechanism), and when the GDF experiences slower pumping periods or when the GDF is closed for business, the combined storage tank pressure will quickly increase. Let's refer to these emissions as "*Storage Tank Breathing Losses*".

To summarize, when Stage II and ORVR are used together at a GDF, the storage tank emissions are called IEE (Incompatibility Excess Emissions). When Stage II is not present at the GDF, and only ORVR is employed, the storage tank emissions are called Storage Tank Breathing Losses (STBL).

ORVR and Stage II Emissions

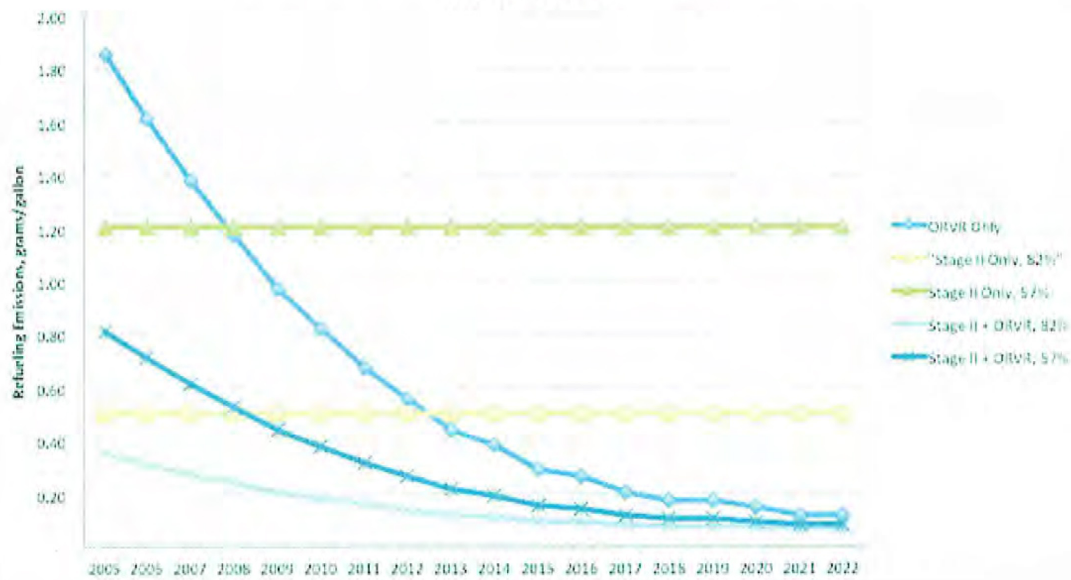
In our view, the concept of ORVR WSU "widespread use" has been misunderstood and misinterpreted. The primary flaw centers on the "breakeven" or "cross over point"; where (1) the refueling emissions from ORVR alone are said to equal the refueling emissions from Stage II alone; or (2) when refueling emissions from ORVR alone are said to equal the refueling emissions from Stage II plus ORVR.

It is best to illustrate these points by charts. Chart 1, represents the data from the dKC Report shown as Figure 3 on page 48. Here ARID recreates the dkC data by using a simple spreadsheet instead of MOVES. Our spreadsheet uses all the same assumptions as dKC. First, we plot the ORVR Alone vs. Stage II Alone refueling emissions from 2005 through 2022; we show ORVR only and two control efficiencies for Stage II only, 82% and 57%. This Chart 1, is essentially the same as Figure 3.



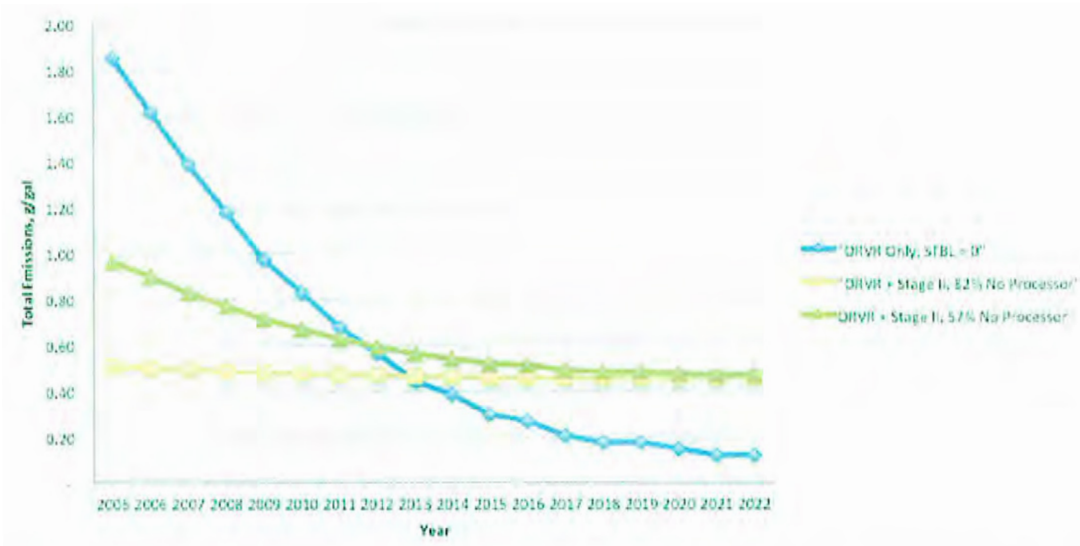
Next, we show Chart 2, which incorporates Stage II + ORVR refueling emissions, using the same Stage II efficiencies of 82% and 57%. The refueling emissions with the combined use of Stage II and ORVR are always lower than the emissions with ORVR only; and there is no "crossover" point with ORVR only and the Stage II + ORVR curves. Thus definition (1) from above on WSU is negated, and there is no benefit to using ORVR Alone in comparison to Stage II + ORVR over the entire interval shown.

CHART 2: Refueling Emissions Only
State of CT, grams/gallon
ORVR Alone vs. Stage II Alone & Stage II + ORVR
No IEE Added



Next, we move to Chart 3, which represents the data from the dKC Report shown as Figure 4 on page 49. Here ARID recreates the dKC data by again using our simple spreadsheet instead of MOVES; incorporating the relevant dKC assumptions. First we plot ORVR Alone vs. Stage II plus ORVR, at the two Stage II efficiency levels. Even though ARID has directly measured values for IEE which far exceed the value of 0.86 lbs. VOC / 1,000 gal figure used by dKC for their Figure 4 plot; ARID uses the low figure in our Chart 3. Chart 3, if realistic, would show a benefit to using ORVR Alone beyond 2012 to 2013 (depending on Stage II efficiency).

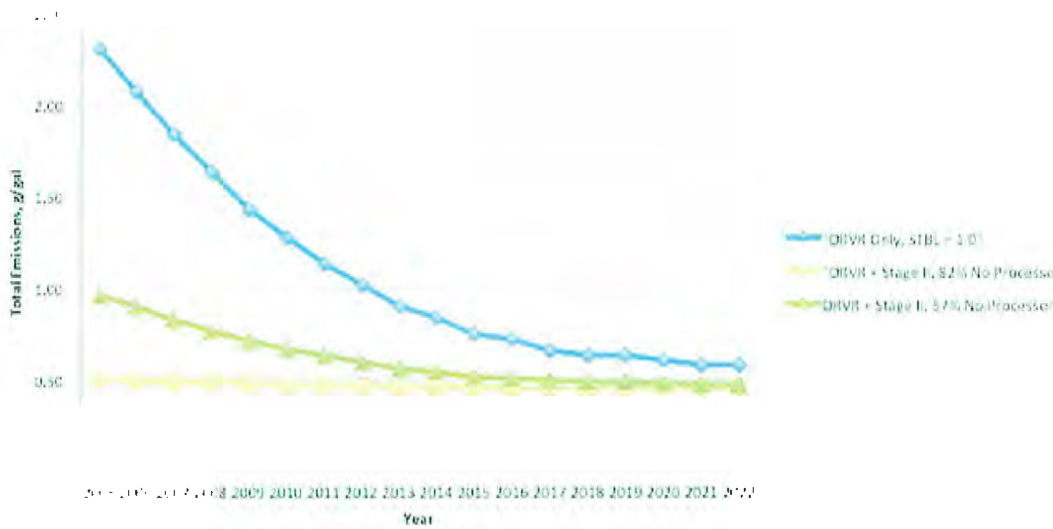
CHART 3: State of CT: Refueling Emissions + IEE
ORVR Alone vs. Stage II plus ORVR (No Processor)
0.86 lbs VOC / 1,000 gal IEE
STBL = 0.0 lbs VOC / 1,000 gal



However, the major problem with Chart 3 (and Figure 4) is that the Storage Tank Breathing Losses (STBL) for the ORVR Alone plot is **set to zero**. The assumption of zero STBL is totally unrealistic and not supportable by actual measured data. The STBL are a very important contribution to the total vapor losses, and the dKC Report (and US EPA rationale) have totally neglected this category of emissions. For decades, the USEPA has ignored this category of important emissions in their analysis of Stage II and ORVR interactions.

It is this very same category of emissions which dKC recommends the use of a vapor processor for mitigating; however, the magnitude of these emissions is strangely assigned a zero in this part of the dKC analysis.

CHART 4: State of CT: Refueling Emissions + IEE
ORVR Alone vs. Stage II plus ORVR (No Processor)
0.86 lbs VOC / 1,000 gal IEE
STBL = 1.0 lbs VOC / 1,000 gal



We incorporate a very conservative figure of 1.0 lbs./1,000 gal STBL in our Chart 4. Please note a gap between the ORVR Only emissions and the ORVR + Stage II emissions; there is no intersection of the curves and therefore no emissions reduction advantage to using ORVR Alone in comparison to ORVR + Stage II. Please also note that the emissions gap is relatively modest in future years. As a fair comparison, our Chart 5 now incorporates emissions curves for ORVR + Stage II + Vapor Processor; where an active vapor processor is used to control storage tank pressure and to reduce IEE by 99.3%, as confirmed by objective, third-party field testing.

In Chart 4a, below; we incorporate a still conservative figure of 2.5 lbs./1,000 gal STBL. Please note that further "upward shift" in the ORVR only emissions curve.

CHART 4a: State of CT: Refueling Emissions + IEE
ORVR Alone vs. Stage II plus ORVR (No Processor)
0.86 lbs VOC / 1,000 gal IEE
STBL = 2.5 lbs VOC / 1,000 gal

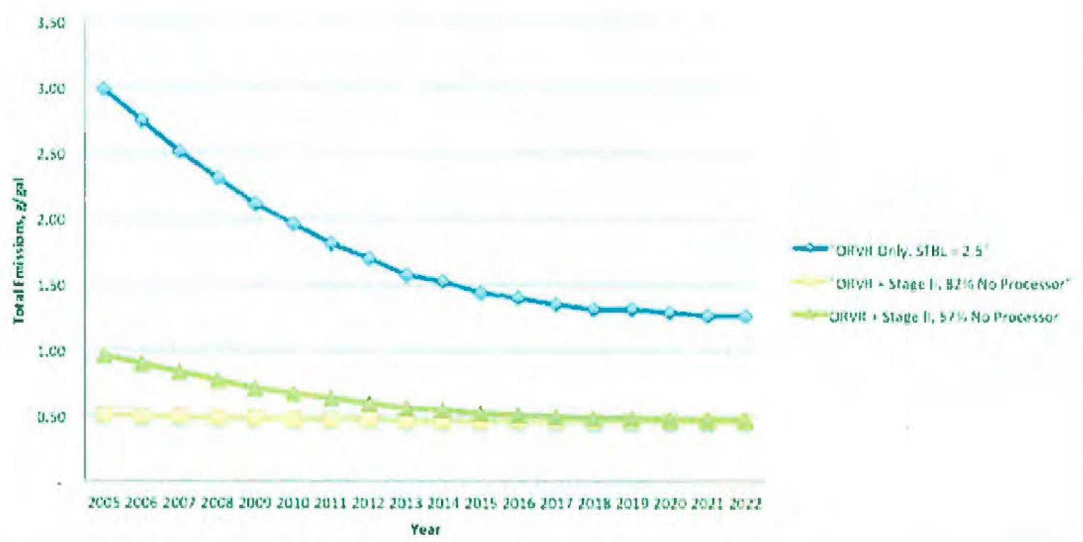
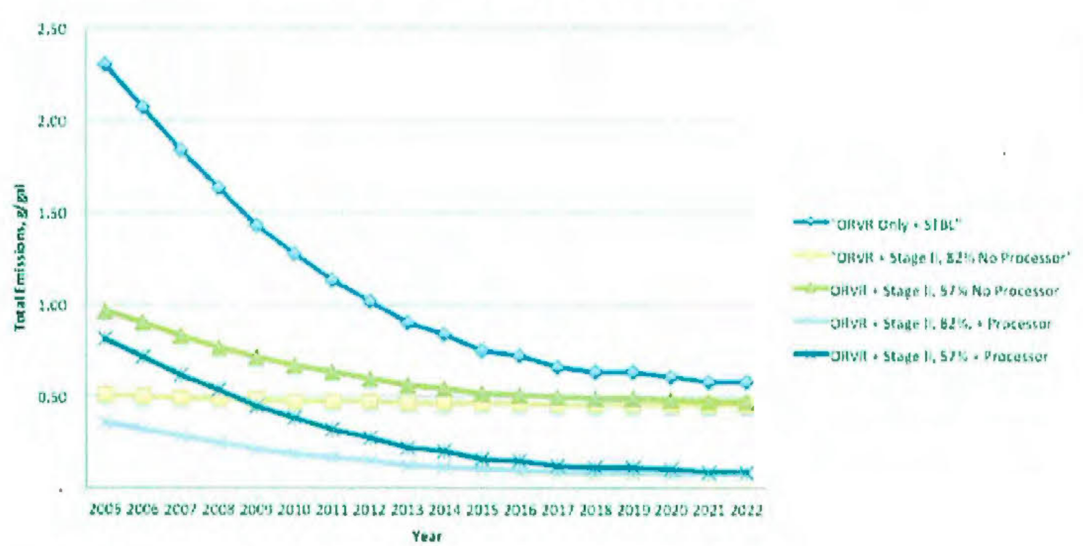


CHART 5: State of CT: Refueling Emissions + IEE
ORVR Alone vs. Stage II plus ORVR (With and Without Processor)
0.86 lbs VOC / 1,000 gal IEE
STBL = 1.0 lbs VOC / 1,000 gal



As seen in Chart 5, the ORVR + Stage II + Processor curves show a large reduction in total emissions from the ORVR Alone case, when STBL emissions are properly accounted for in the emissions inventory. We use a very conservative figure of 1.0 lbs. VOC / 1,000 gal for STBL; in practice ARID has measured values nearly five times higher than this figure, or about 5 lbs. of VOC per 1,000 gallons of fuel dispensed.

Chart 5b, below, shows the same curves but with STBL incremented to 2.5 lbs./1,000 gallons; still in our view a conservative figure.

Ironically, as mentioned previously, the dKC Report (and USEPA rationale) seems to recommend the elimination of Stage II (without considering enhancement via vapor processors); but then the report recommends the use of vapor processors to mitigate ***the new problem*** caused by STBL, in an ORVR only environment.

Especially bothersome is that STBL are not included in the dKC report to CT DEEP, Figure 4, page 49. The omission of these important storage tank emissions results in dramatically different (and incorrect) conclusions drawn from this study.

Thus far, we have explained a fundamental flaw in the dKC Report and USEPA treatment of storage tank emissions in an ORVR Alone environment. In addition, we have shown a large emissions gap between the CT DEEP proposal and the simple enhancement of Stage II vapor recovery. In the section to follow, we will quantify the costs per ton of VOC reduced under the CT DEEP proposal and compare these to the costs per ton of VOC reduced for a state-of-the-art approach using the ARID processor. For our economic analysis, we will incorporate the most conservative assumptions from our perspective (in other words; even though ARID has directly measured higher parameters for IEE and STBL; we will use lower figures referenced in the dKC Report and by USEPA)

CHART 5b: State of CT: Refueling Emissions + IEE
ORVR Alone vs. Stage II plus ORVR (With and Without Processor)
0.86 lbs VOC / 1,000 gal IEE
STBL = 2.5 lbs VOC / 1,000 gal

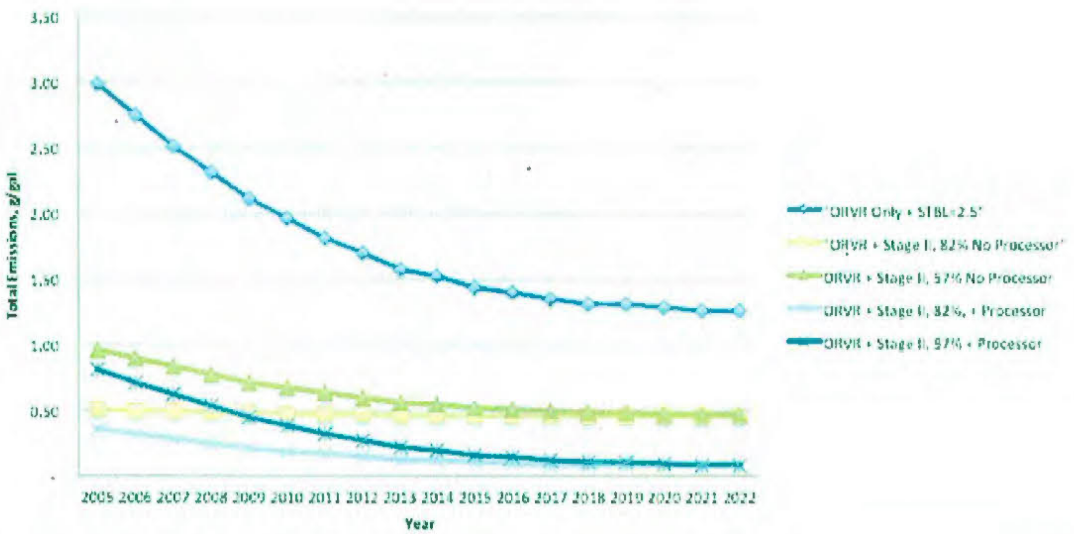
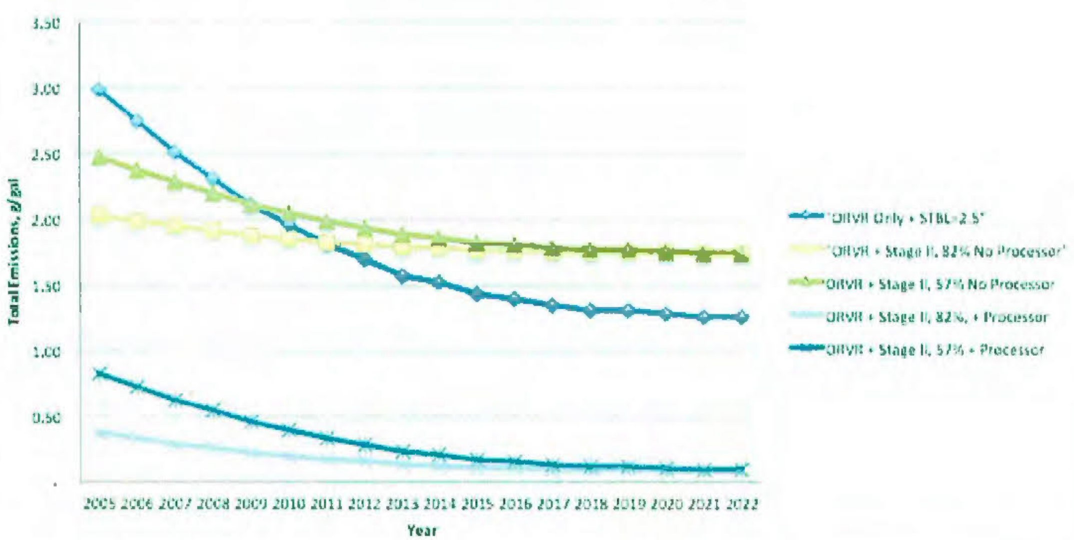


CHART 5c: State of CT: Refueling Emissions + IEE
ORVR Alone vs. Stage II plus ORVR (With and Without Processor)
3.67 lbs VOC / 1,000 gal IEE
STBL = 2.5 lbs VOC / 1,000 gal



Economic Analysis

Assumptions used in the Cost Effectiveness calculations:

- Fuel Savings: $4/gallon
- Stage II Operating Expenses: $3,277/site-year
- Stage II Removal Expenses: $7,000 / site (33% allocated in 2013, 33% allocated in 2015, and 33% allocated in year 2018)
- State of CT Gasoline Throughput: 1,514,621,565 gallons per year; constant over period 2013 – 2022
- Uncontrolled Refueling Emissions: 6.601 lbs. / 1,000 gallons
- Stage II Overall Vapor Recovery Efficiency: 69% (82% + 57%)/2
- ORVR Vapor Recovery Efficiency: 98%, constant with no degradation
- 93.5 % of fuel dispensed to GDF equipped with Stage II Vacuum Assisted systems
- IEE = 0.86 lbs. / 1,000 gallons
- STBL: 0, 1.0 and 2.5 lbs. / 1,000 gallons

Table 1: Cost Effectiveness: IEE = 0.86 lbs. VOC/1,000 gal, STBL = 1.0 lbs./1,000 gal

ORVR Alone vs. Stage II + ORVR + Processor

Column1	Column2	Column3	Column4	Column5	Column6	Column7
	2013	2013	2015	2015	2018	2018
Throughput Category	Fuel Savings	Net $/Ton	Fuel Savings	Net $/Ton	Fuel Savings	Net $/Ton
Less than 300,000	$53,378	($117,954)	$45,708	($138,018)	$39,571	($157,396)
300,000 to 700,000	$185,606	($12,953)	$158,934	($15,401)	$137,597	($17,761)
700,001 to 1,100,000	$311,185	($6,623)	$266,467	($8,003)	$230,693	($9,336)
1,100,001 to 1,500,000	$266,012	($4,256)	$227,785	($5,238)	$197,204	($6,187)
1,500,001 to 1,900,000	$206,887	($2,741)	$177,157	($3,469)	$153,373	($4,173)
1,900,001 to 2,700,000	$298,885	($1,644)	$255,935	($2,188)	$221,575	($2,714)
2,700,001 to 3,900,000	$283,986	($667)	$243,177	($1,047)	$210,530	($1,415)
> 3,900,001	$316,870	$145	$271,336	($99)	$234,908	($335)

If we exclude the first two throughput categories from above (< 700,000 gallons per year); The cost effectiveness for the six subsequent throughput categories show viable measures; where approximately 87.5% of CT gasoline throughput is controlled with the combination of Stage II + ORVR + Processor. Of particular note, the maximum cost per ton is show to be $9,336, with a revenue stream of $145 per ton for the best case. These figures are for very conservative IEE and STBL; please note that these cost effectiveness figures vary greatly from the dKC reported range of $21,000 to $32,000 per ton for Stage II enhancement, Table 30; page 34.

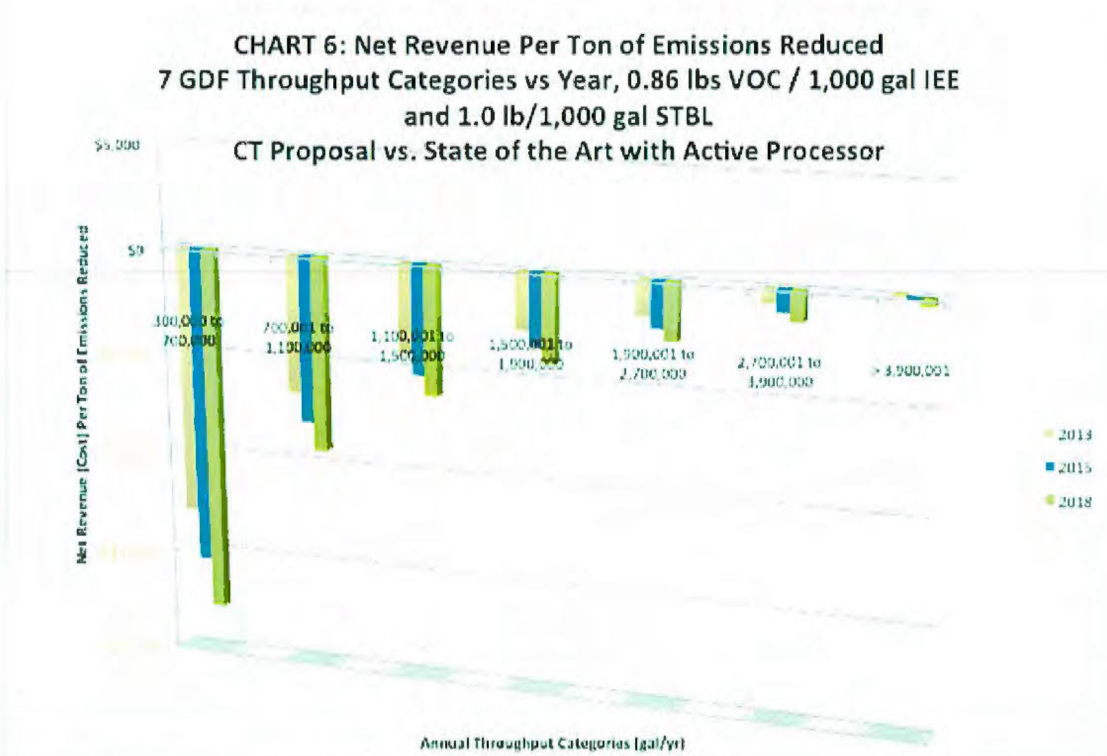
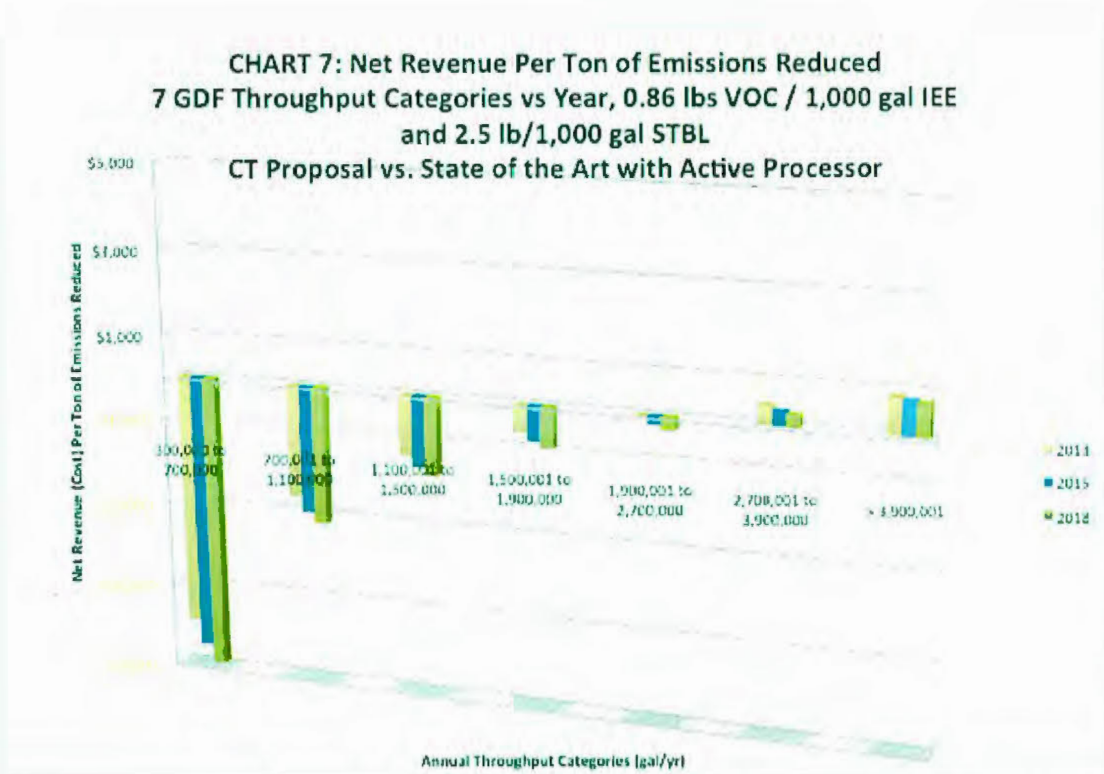


Table 2: Cost Effectiveness: IEE = 0.86 lbs. VOC/1,000 gal, STBL = 2.5 lbs./1,000 gal

ORVR Alone vs. Stage II + ORVR + Processor

Column1	Column2	Column3	Column4	Column5	Column6	Column7
	2013	2013	2015	2015	2018	2018
Throughput Category	Fuel Savings	Net $/Ton	Fuel Savings	Net $/Ton	Fuel Savings	Net $/Ton
Less than 300,000	$103,834	($59,859)	$96,164	($64,762)	$90,027	($68,286)
300,000 to 700,000	$361,051	($5,884)	$334,379	($6,481)	$313,041	($6,910)
700,001 to 1,100,000	$605,334	($2,627)	$560,617	($2,965)	$524,842	($3,207)
1,100,001 to 1,500,000	$517,461	($1,410)	$479,234	($1,650)	$448,653	($1,823)
1,500,001 to 1,900,000	$402,449	($631)	$372,719	($809)	$348,935	($937)
1,900,001 to 2,700,000	$581,407	($68)	$538,457	($201)	$504,097	($296)
2,700,001 to 3,900,000	$552,425	$435	$511,616	$342	$478,969	$275
> 3,900,001	$616,394	$852	$570,859	$793	$534,431	$750

If we exclude the first throughput category from above (< 300,000 gallons per year); The cost effectiveness for the seven subsequent throughput categories show viable measures; where approximately 97.2% of CT gasoline throughput is controlled with the combination of Stage II + ORVR + Processor. Of particular note, the maximum cost per ton is show to be $6,910, with a revenue stream of $852 per ton for the best case. These figures are for conservative IEE and STBL; please note that these cost effectiveness figures vary greatly from the dKC reported range of $21,000 to $32,000 per ton for Stage II enhancement, Table 30; page 34. Also the ARID costs are far below the upper cost range shown in Table 26, page 26, where a figure of $42,257 per ton is listed.



Negative Health Impacts

At a non-Stage II GDF, in addition to the problem of Storage Tank Breathing Losses, STBL, non-ORVR vehicle refueling will directly expose the motorist (and nearby people) to carcinogenic vapors, increasing toxic exposure risk factors. Please reference this link for video of a refueling event with a non-ORVR vehicle refueling at a non-Stage II GDF: http://www.youtube.com/watch?v=E8Hoj-_v0W4&feature=related

- This problem will be more prevalent at GDF refueling a higher proportion of non-ORVR vehicles. Such GDF are typically located in so-called Environmental Justice (or "EJ") areas.
- Motorists who refuel non-ORVR equipped vehicles at non-Stage II GDF will be directly exposed to carcinogenic vapors, thus creating unnecessary and unreasonable risks to public health, welfare and safety

In Connecticut, the population of automobiles is approximately 2 million (1,999,809, US Dept. of Transportation, Federal Highway Administration, Highway Statistics, 2006). Thus, if ORVR penetration is 87% in year 2013; then 13% or 260,000 vehicles do not have ORVR. Using an ORVR vapor recovery efficiency of 98%; upon refueling each "batch of 260,000 cars", the raw emissions will be equivalent to 50 x 260,000 or 13,000,000 vehicles. This far exceeds the total vehicle population by a factor of 6.5 times. In another context, the motorist refueling a non-ORVR vehicle at a non-Stage II GDF will be exposed to ***50 times the pollutants*** as a motorist refueling an ORVR vehicle.

Conclusion

In conclusion, the elimination of Stage II and sole reliance on ORVR technology does not provide the State of Connecticut with optimal emissions reductions; in terms of both refueling and storage tank emissions. This action will increase emissions of VOC's and HAPS, increase health risks to motorists, GDF employees and members of the Community, where the brunt of the emissions and negative health impacts will be borne by EJ Communities.

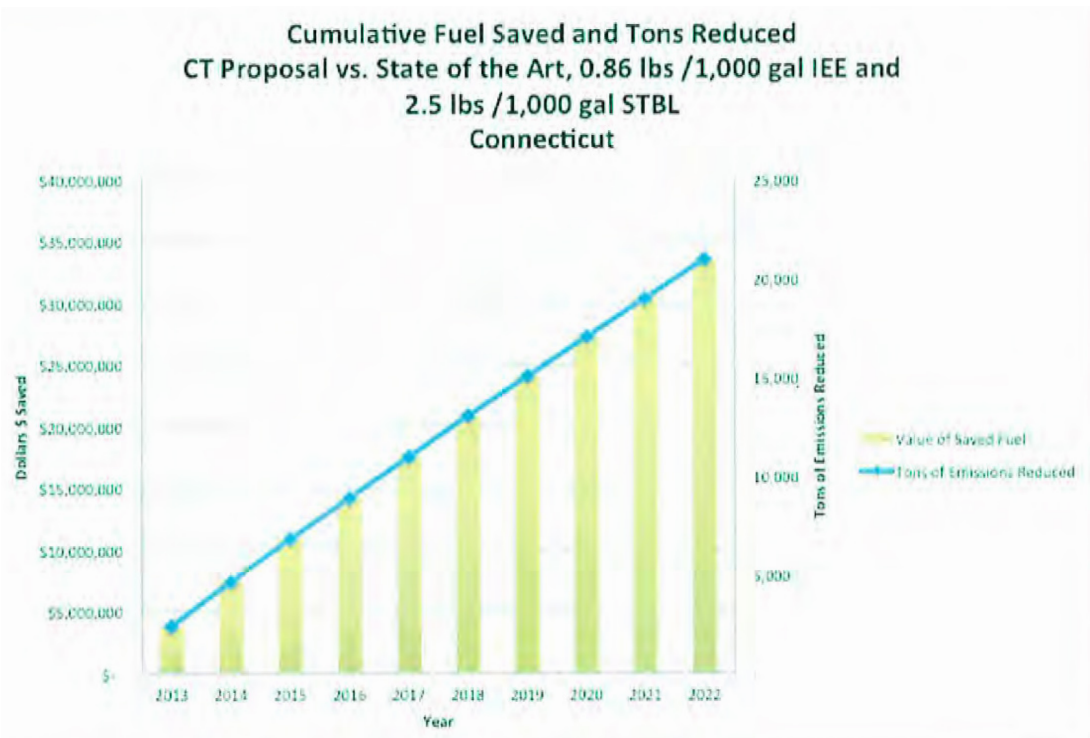
Overlooked in past studies and analyses on this topic are three key elements: 1.) The proper quantification and accounting for the IEE and the STBL from the Storage Tanks, 2.) The adverse health impacts from raw, uncontrolled emissions from non-ORVR vehicles; especially the disproportionate share of this burden being borne by EJ Communities, and 3.) The positive impact of using active processors to enhance Stage II by managing storage tank pressure and significantly reducing IEE and STBL.

The optimal course of action is for CT DEEP to require Enhanced Stage II via vapor processors with continuous pressure monitoring and remote data acquisition.

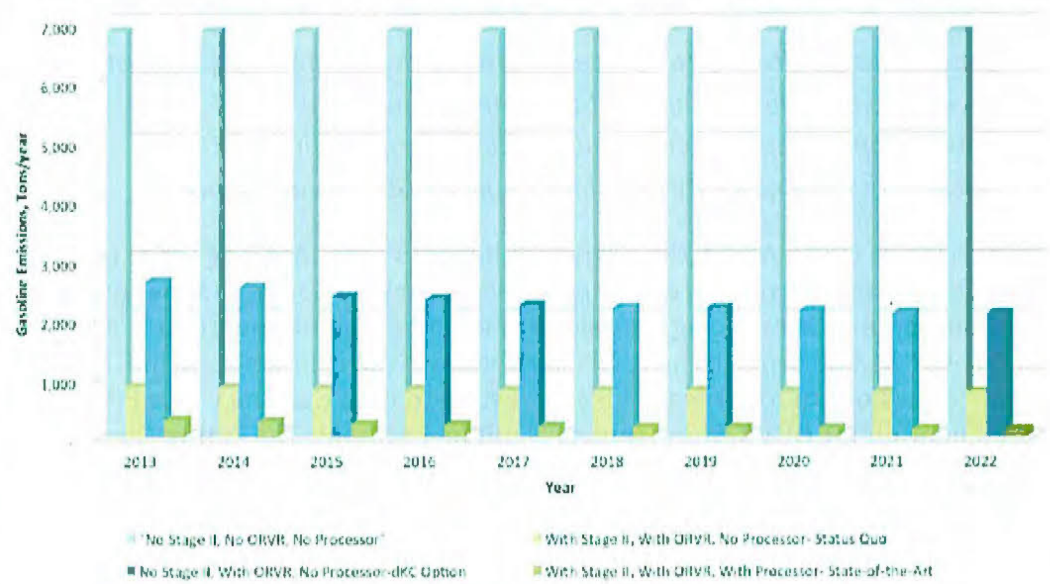
The detailed analysis above shows that the use of an active processor provides the following benefits to a GDF:

- *Control of VOC's and HAP's*
- *Reduction of Toxic Exposure Risk to motorists, GDF employees and members of Community*
- *Energy Recovery from saved gasoline*
- *Automatic monitoring and inspection through data logging and remote data acquisition system*
- *Continuous monitoring to reduce leaks in UST and Stage II piping system*
- *Leverage valuable existing hardware already installed at GDF*
- *Improve operating efficiency and associated profitability for GDF*
- *Allow both large capacity and small capacity GDF to earn benefits*

In comparison to ORVR Alone, the aggregate benefits for enhancing Stage II for the State of CT GDF operators with a vapor processor include $33 million in fuel savings while at the same time reducing emissions of volatile organic compounds and air toxics by over 21,000 tons. In the final chart below which shows State of CT aggregate emissions in tons/year; it is interesting to note that the CT DEEP recommendation for ORVR Alone ranks 3rd out of 4 options; the Status-Quo case is a better alternative and the ARID processor case is the far superior option.



Gasoline Emissions Under Various Scenarios
Connecticut - Statewide
(Includes Refueling Emissions, 0.86 lbs / 1,000 gal IEE with Stage II + ORVR and 2.5 lbs / 1,000 gal STBL with ORVR Alone):



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Engineering Services
engineering
906 Hamburg Drive, Abingdon, Maryland 21009

To: Marcia Ways, MDE

From: Dan Meszler

Subject: Stage II Emission Reduction Benefits

Date: August 22, 2012

As requested by MDE, MES has performed an analysis of the potential impacts associated with the elimination of Stage II requirements in Maryland. In conducting this analysis, MES has evaluated potential gasoline refueling emissions trends related to both onboard refueling vapor recovery (ORVR) and Stage II control technology over the period 2011 through 2020. MES has also evaluated the potential impact of indirect excess emissions (IEE), caused by a negative interaction between ORVR and some Stage II controls, on gasoline refueling emissions and quantified the potential timeframe in which IEE emissions may lead to a crossover point, following which Stage II emissions controls might actually result in an increase in refueling emissions above levels that would result if Stage II controls were eliminated.[1] As requested, all analysis has been performed at the county level of detail for each of the 12 counties that currently require Stage II controls. Emission estimates are available for each county individually as well as the aggregate Baltimore and Washington, D.C. metropolitan areas and the 12 county Stage II area as a whole.

Before presenting a synopsis of analysis results, it is important to recognize that despite the fact that Stage II control technology has been in use in the U.S. for four decades, there is surprisingly little consensus on the actual in-use effectiveness of such technology, even with regard to reducing vapor displacement emissions. Greater uncertainty exists with regard to whether Stage II offers any spillage-related emission reduction benefit; and there is virtually no information available with regard to the effectiveness of Stage II controls during the refueling of either nonroad equipment and vehicles or portable refueling containers. In fact, most SIP-related Stage II estimates continue to rely on information originally published in EPA guidance documents in the early 1990s, and developed from rather sparse databases.[2] There are some data available for more recent issues such as IEE, but even those data exhibit significant uncertainty – indicating potential emission rates that vary approximately over an order of magnitude. For these reasons, it is not possible to present a single set of conclusive results regarding the impact of eliminating Stage II vapor recovery requirements. Instead, analysis results are presented on in a four-step

[1] In reviewing the impacts of IEE, it is important to recognize that there are methods to eliminate such emissions, including the installation of ORVR-compatible Stage II equipment and bulk storage tank vent line vapor recovery and processing equipment. *While it is beyond the scope of this analysis, it is important to evaluate the cost effectiveness of IEE reduction technology before any decision-making based on IEE impacts is implemented*.

[2] U.S. EPA, “Technical Guidance - Stage II Vapor Recovery Systems for Control of Vehicle Refueling Emissions at Gasoline Dispensing Facilities,” EPA-450/3-91-022a, November 1991.

fashion so that the potential impact (and associated uncertainty) of specific analysis assumptions can be accurately gauged.

The first set of analysis results apply solely to gasoline vapor displacement emissions associated with onroad vehicle refueling. These results indicate the interaction between ORVR and Stage II controls assuming no gasoline spillage benefits (for either technology) and no Stage II control associated with nonroad equipment and vehicles or portable refueling containers. In the context of analysis design, this set of results is consistent with similar analyses that MES has encountered from the EPA and others. A second set of analysis results extends the first set to include potential gasoline spillage impacts for onroad vehicles. Potential impacts related to nonroad equipment and vehicles and portable refueling containers continue to be ignored. A third set of results adds the potential vapor displacement impacts associated with nonroad equipment and vehicles and portable refueling containers to the onroad vehicle vapor displacement (only) estimates (potential spillage impacts on both onroad and nonroad equipment and vehicle emissions are not considered). Finally, a fourth set of analysis results adds the potential spillage impacts for nonroad equipment and vehicles and portable refueling containers to the vapor displacement impacts estimated in the third set of analysis results. Table 1 summarizes this approach and provides a brief description of how each set of results allows for the effects of effectiveness uncertainty to be evaluated.

Each set of analysis results includes estimates for three evaluation scenarios, allowing for a range of control effectiveness values to be investigated (within each results set). In addition, each analysis set also includes impacts with and without IEE, so that the impacts of IEE reductions can also be isolated. Together, the resulting analysis estimates define a wide range of potential impacts and it is, unfortunately, not possible to narrow this range to a single value given the existing state of Stage II (and ORVR) effectiveness data.[3] Ideally existing uncertainty over Stage II effectiveness would be narrowed through the conduct of detailed (and comprehensive)

Table 1. Impacts Included in Analysis Results

Emissions Impact Type	Results Set 1	Results Set 2	Results Set 3	Results Set 4
Onroad Displacement Emissions	Included	Included	Included	Included
Onroad Spillage Emissions	Not Included	Included	Not Included	Included
Nonroad Displacement Emissions	Not Included	Not Included	Included	Included
Nonroad Spillage Emissions	Not Included	Not Included	Not Included	Included
Benefit of Results Set	Isolates onroad displacement effects, allowing effects of spillage uncertainty to be understood.	Isolates onroad effects, allowing nonroad influence on combined effects to be understood.	Isolates combined onroad and nonroad effects of Stage II removal, without spillage effects uncertainty.	Isolates potential maximum onroad and nonroad effects of Stage II removal.

[3] Note that although MES did not alter the ORVR effectiveness assumptions employed by the U.S. EPA, it should be recognized that these assumptions are quite aggressive – assigning a 98 percent in-use effectiveness to ORVR vapor displacement control. Should this level of effectiveness ultimately prove to be overly optimistic, the level of Stage II reductions (relative to those of ORVR) presented in this analysis will be correspondingly underestimated.

in-use field studies, but given the four decade history of such controls and the ever increasing penetration of ORVR technology, it seems unlikely that such studies will be undertaken in the imminent future, if ever. There are valuable information being developed and published by organizations such as the California Air Resources Board and independent developers and marketers of Stage II and IEE control equipment, but those data provide little information with regard to specific conditions in Maryland.

To conduct the requested analysis, MES has constructed a spreadsheet that allows the potential gasoline vapor displacement and spillage impacts for onroad vehicles and nonroad vehicles and equipment to be quantified for any given set of ORVR and Stage II effectiveness assumptions. While readers interested in the specific methodology employed to develop the onroad and nonroad portions of this spreadsheet will find significant additional detail in the sections of this memorandum that follow, fundamental uncontrolled refueling emissions are derived from the EPA's MOVES and NONROAD emissions models for onroad vehicle and nonroad equipment and vehicles respectively.[4,5] ORVR effectiveness data developed by the EPA and Stage II effectiveness data provided by MDE form the backbone of the implemented analysis.

Table 2 presents the various system effectiveness assumptions used to evaluate the impacts of Stage II controls. ORVR spillage and vapor displacement effectiveness estimates are taken (without change) from the databases underlying the EPA MOVES model. For onroad vehicles, Stage II effectiveness assumptions for "nominal" scenario 1 are set at values provided by MDE. Scenarios 2 and 3 reflect a 20 percentage point increase and decrease in vapor displacement effectiveness respectively – with these shifts intended to isolate the effect of in-use effectiveness uncertainty. The magnitude of the MDE-estimated Stage II spillage reduction effectiveness for onroad vehicles is held constant across all three scenarios, but the spreadsheets corrects scenarios 2 and 3 for what MES believes is a flaw in the MOVES emissions estimation algorithm for Stage II spillage impacts. The interested reader is referred to the detailed discussion on onroad vehicle emissions processing below for more information on this perceived flaw, but its net impact is manifested in MOVES as an overestimation of Stage II spillage reduction benefits. The spreadsheet developed by MES for this analysis allows this potential flaw to be eliminated, and that option is selected for scenarios 2 and 3. Conversely, scenario 1 is constructed to produce onroad vehicle impact estimates identical to those estimated by MOVES (and so includes no adjustment for this perceived flaw).

MES has elected to maintain all spillage-related effectiveness assumptions unchanged across all three scenarios in an effort to minimize the influence of alternative spillage assumptions on analysis results. This is exclusively due to the fact that MES does not believe that Stage II provides any reliably demonstrated spillage reduction benefits. The effect of Stage II on spillage is subject to significant uncertainty, with some EPA documents indicating a reduction benefit and others indicating no reduction. Vacuum assist Stage II systems are the overwhelmingly

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[4] The MOVES model and associated supporting documentation can be downloaded from www.epa.gov/otaq/models/moves/index.htm.

[5] The NONROAD model and associated supporting documentation can be downloaded from www.epa.gov/otaq/nonrdmdl.htm.

Table 2. Emissions Impact Effectiveness Assumptions

Analysis Parameter	Scenario 1	Scenario 2	Scenario 3
Onroad Vehicle Emissions Impact Parameters			
ORVR Spillage Reduction Factor	50%	50%	50%
ORVR Vapor Displacement Reduction Factor	98%	98%	98%
Stage II Spillage Reduction Factor	70%	70%	70%
Stage II Vapor Displacement Reduction Factor	70%	90%	50%
Use MOVES Stage II Spillage Assumptions	Yes	No	No
Incompatibility Excess Emissions Rate (1)	0.3901 [0.00086]	0.3901 [0.00086]	0.3901 [0.00086]
Nonroad Equipment and Vehicle Emissions Impact Parameters			
Spillage Reduction Factor at a Balance System Pump	70%	70%	70%
Spillage Reduction Factor at a Vacuum Assist Pump	70%	70%	70%
Vapor Displacement Reduction Factor at a Balance System Pump	0%	0%	0%
Vapor Displacement Reduction Factor at a Vacuum Assist Pump	70%	90%	50%
Portable Refueling Container (Pump Refilling) Emissions Impact Parameters			
Spillage Reduction Factor at a Balance System Pump	70%	70%	70%
Spillage Reduction Factor at a Vacuum Assist Pump	70%	70%	70%
Vapor Displacement Reduction Factor at a Balance System Pump	0%	0%	0%
Vapor Displacement Reduction Factor at a Vacuum Assist Pump	56%	72%	40%

Notes: (1) grams [pounds] per gallon dispensed to ORVR-equipped vehicles.

predominant – in fact, nearly universal – Stage II system in Maryland. It is difficult to envision an engineering rationale for spillage emissions control with such systems. Vacuum assist systems are virtually indistinguishable from non-Stage II gasoline delivery systems in both style and function – as perceived by the user. While booted balance-type systems might engender some behavioral caution on the part of users – leading to possible decreases or increases spillage depending on user response thereto – balance systems are associated with far less than one percent of Stage II gasoline throughput in Maryland. This uncertainty is seemingly confirmed by available field studies where some researchers find decreases in spillage with Stage II systems, while others find the opposite.[6]

Nevertheless, even as recently as the 2012 release of the MOVES2010b model, supporting documentation claims that "Stage II controls reduce the amount of fuel spilled due to "spitback"."[7] Based in EPA emission rate calculations, spitback is responsible for approximately 50 percent of uncontrolled spillage emissions, with the remainder due to nozzle drips – both pre and post fill (at about 7 and 10 percent of total spillage respectively) – and overfill (at about 33

[6] See for example, Section 3.4.2 of U.S. EPA, "Technical Guidance - Stage II Vapor Recovery Systems for Control of Vehicle Refueling Emissions at Gasoline Dispensing Facilities," EPA-450/3-91-022a, November 1991.

[7] See for example, Appendix F of U.S. EPA, "Motor Vehicle Emission Simulator (MOVES), User Guide Version, MOVES2010b," EPA-420-B-12-001, March 2012.

percent of total spillage).[8],[9] As mentioned previously, while booted balance-type Stage II systems might indeed reduce spitback emissions, such systems are exceedingly rare in Maryland. Moreover, the introduction of enhanced evaporative emissions testing requirements, beginning in the mid-1990s, was responsible for the virtual elimination of spitback due to the inclusion of an actual vehicle refueling event as an integral component of vehicle evaporative testing – leading to the redesign of vehicle fill pipes and a limit on the delivery rate of gasoline. Whether spitback emission reduction is credited to enhanced evaporative testing, ORVR, or Stage II controls, it is difficult to envision a scenario where one program is more effective than the other. Once spitback is "not spilled," it can't be "not spilled" again. Of course, some residual impact may accrue to Stage II for vehicles without ORVR, but even that requires an assumption that vacuum assist systems somehow control spitback, nozzle leakage, or overfilling (relative to a conventional non-Stage II delivery system). Given our skepticism in this regard, MES has elected to utilize the MDE-provided Stage II spillage reduction credit of 70 percent without change on the premise that the derivation of this level of effectiveness is documented and supported in existing MDE Stage II materials.

Two IEE rates have been assumed in this analysis. Each scenario is evaluated at both a zero IEE rate and a rate of 0.86 pounds per thousand gasoline gallons dispensed to ORVR-equipped vehicles (by definition, the IEE rate is always zero for vehicles without ORVR and for balance-type Stage II systems regardless of ORVR presence). As mentioned above, there are a rather wide range of published IEE rates – and the actual rate in Maryland is dependent on the mix of balance, low V/L vacuum assist, and high V/L vacuum assist systems.[10]

MDE provided data for Stage II system types in Maryland. These data, which are summarized in Table 3, indicate a near negligible fraction of balance-type systems. Healy vacuum assist systems are identified as distinct from other vacuum assist systems, but MES does not believe that one can assume that all existing Healy systems are ORVR compatible, so this analysis treats all vacuum assist systems as a group (of unknown V/L performance). As indicated in Table 3, the identified Healy systems account for less than five percent of all gasoline throughput, so any error associated with this aggregation is small. Nevertheless, the assumed 0.86 pounds per thousand gallon IEE rate is representative of high V/L Stage II systems, and it is virtually certain that some fraction of existing Stage II systems are low V/L (ORVR compatible) systems.[11] Thus the IEE impacts presented in the analysis results should be viewed as "high end" estimates almost certain to overstate the impact of IEE in Maryland. However, the impact of alternative assumptions regarding IEE (e.g., a 50/50 split of ORVR and non-ORVR compatible vacuum

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[8] See for example, Table 4 of U.S. EPA, memorandum from Glenn W. Passavant with subject "Onboard Refueling Vapor Recovery Widespread Use Assessment," June 9, 2011.

[9] Elimination of the 50 percent spitback emissions contribution is undoubtedly the source of EPA's ORVR spillage emissions reduction credit of 50 percent (as shown in Table 2 and encoded in the databases underlying the EPA MOVES model).

[10] V/L is the volumetric ratio of vapor returned to liquid dispensed from the refueling storage tank. Vacuum assist systems with V/L ratios of 1 (±10 percent) exhibit IEE rates that are about an order of magnitude lower than those with V/L ratios of 1.2.

[11] The 0.86 pounds per thousand gallon emission rate is based on California Air Resources Board testing and is representative of a high V/L system emission rate. See U.S. EPA, "Stage II Vapor Recovery Systems, Issues Paper," August 12, 2004.

Table 3. Stage II System Distribution (fraction of Stage II gasoline throughput)

County	Balance System	Vacuum Assist	Healy Vacuum Assist
Anne Arundel	0.3%	94.3%	5.4%
Baltimore	0.5%	95.2%	4.3%
Calvert	0.0%	94.2%	5.8%
Carroll	0.2%	98.4%	1.4%
Cecil	0.3%	96.8%	2.9%
Charles	0.1%	83.8%	16.1%
Frederick	0.3%	96.3%	3.4%
Harford	0.1%	97.8%	2.0%
Howard	0.3%	98.4%	1.4%
Montgomery	0.3%	97.0%	2.8%
Prince George's	0.1%	92.2%	7.7%
Baltimore City	0.3%	98.4%	1.3%
Stage II Area Total	0.3%	95.0%	4.7%

assist systems) can be easily evaluated by interpolating between the zero and non-zero IEE emissions curves in the presented results. Alternatively, MES would be happy to evaluate one or more scenarios with alternative IEE rate assumptions should MDE develop data on the distribution of high and low V/L vacuum assist systems.

Finally MES has estimated the potential Stage II impact on nonroad vehicles and equipment refueled at gasoline dispensing pumps, as well as portable refueling containers refilled at gasoline dispensing pumps. Although the latter are not included in the EPA's NONROAD model, MES has developed a methodology to estimate portable refueling container emissions from other data included with, and estimates produced by, the model. The interested reader will find detailed information on this methodology in the extended nonroad processing discussion that follows.

For nonroad equipment and vehicles refueled at a gasoline dispensing pump, MES has applied the same Stage II spillage effectiveness assumptions provided by MDE for onroad vehicles. Although we have concerns regarding the accuracy of this estimate (as described above), we see no reason that spillage impacts (should such exist) would differ (on a relative basis) across the onroad and nonroad sectors. The relative contributions of onroad vehicle fill pipe redesign and mandated dispensing flow rate caps to spitback emissions reduction is unclear, but the latter certainly influence any equipment subjected to pump refueling, be that equipment used in onroad or nonroad applications. Of course, the primary concern of MES is that neither ORVR nor Stage II controls are the primary drivers of spitback emission reduction. For vapor displacement control, we assume zero effectiveness for balance-type Stage II systems (due to a perceived lack of fill pipe standardization that would allow for a proper balance-type system seal) and vacuum assist system effectiveness identical to that for onroad vehicles (due to the negative pressure operational nature of such systems that should compensate for differing fill pipe characteristics).

For portable refueling containers refilled at a gasoline dispensing pump, MES has also applied the same Stage II spillage effectiveness provided by MDE for onroad vehicles, for the same reasons described in the preceding paragraph. For vapor displacement control, we again assume zero effectiveness for balance-type Stage II systems (due to a perceived lack of a proper balance-type system seal). For vacuum assist systems, we discount the effectiveness values for onroad vehicles by 20 percent, under the assumption that the negative pressure operational nature of such systems will still provide control, but that control will be reduced due to the lack of a defined fill pipe and the likelihood that some vapor will escape above the nozzle intake openings. Given the lack of available data, this discount is not robust and should be subjected to refinement should additional information become available. As described in detail in the extended nonroad processing discussion that follows, there are assumptions associated with portable container refilling emission estimates that should be understood; primarily that (1) such refilling is performed on containers that are properly sealed (before refilling) and thus contain saturated gasoline vapor, and (2) no post-refilling losses are assumed, so that the volume of gasoline dispensed into such containers is the *minimum* required to refuel associated nonroad equipment. Clearly alternative assumptions are possible and MES would be happy to adjust the portable refueling container estimates should MDE wish to investigate alternative assumptions.

Given these assumptions, Figures 1 through 4 present the derived emission impact estimates for results sets 1 through 4. For results set 1 (Figure 1), which addresses onroad vehicle vapor displacement emissions only, the zero impact point for Stage II is mid-2013 for "nominal" input scenario 1. If the IEE rate is altered to reflect a 50 percent ORVR compatible system penetration, the point of zero impact would be extended to 2017. If potential onroad spillage impacts are considered (Figure 2), the "maximum IEE" zero impact point is mid-2015 for "nominal" input scenario 1 – extended to beyond 2020 for a 50 percent ORVR compatible system penetration.[12] Adding nonroad vehicles and equipment to a displacement only evaluation (Figure 3) indicates a "maximum IEE" zero impact point of early 2015 for "nominal" input scenario 1 – extended to beyond 2020 for a 50 percent ORVR compatible system penetration. Finally, including both onroad and nonroad vehicles and equipment and both potential displacement and spillage impacts (Figure 4) indicates a "maximum IEE" zero impact point of beyond 2020 for "nominal" input scenario 1.

Of course, the specific level of emissions "above" or "below" the zero impact point for any given evaluation scenario varies with time, so it is not possible to define a required emissions offset should Stage II control requirements be eliminated – without first specifying an associated time parameter. The specific time-dependent nature of such an offset can be easily viewed in Figures 1 through 4 as the distance between each emissions impact curve and the horizontal zero impact line. Tables 9 through 56, included at the end of this memorandum, present the specific emission impact estimates for each year from 2011 through 2020 by county, metropolitan area, and Stage II region (Tables 9 through 32), as well as hazardous air pollutant emission impact estimates for those same years for the aggregate Stage II region (Tables 33 through 56). The remainder of this memorandum provides additional detail on the methodologies employed to estimate onroad and nonroad equipment and vehicle emissions.

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[12] The analysis conducted by MES includes all years from 2011 through 2020, so it is not possible to precisely indicate transition points beyond 2020 without additional analysis beyond the scope of this work.

Figure 1. Results Set 1 – Onroad Only, Displacement Impacts Only (VOC, metric tonnes per day)

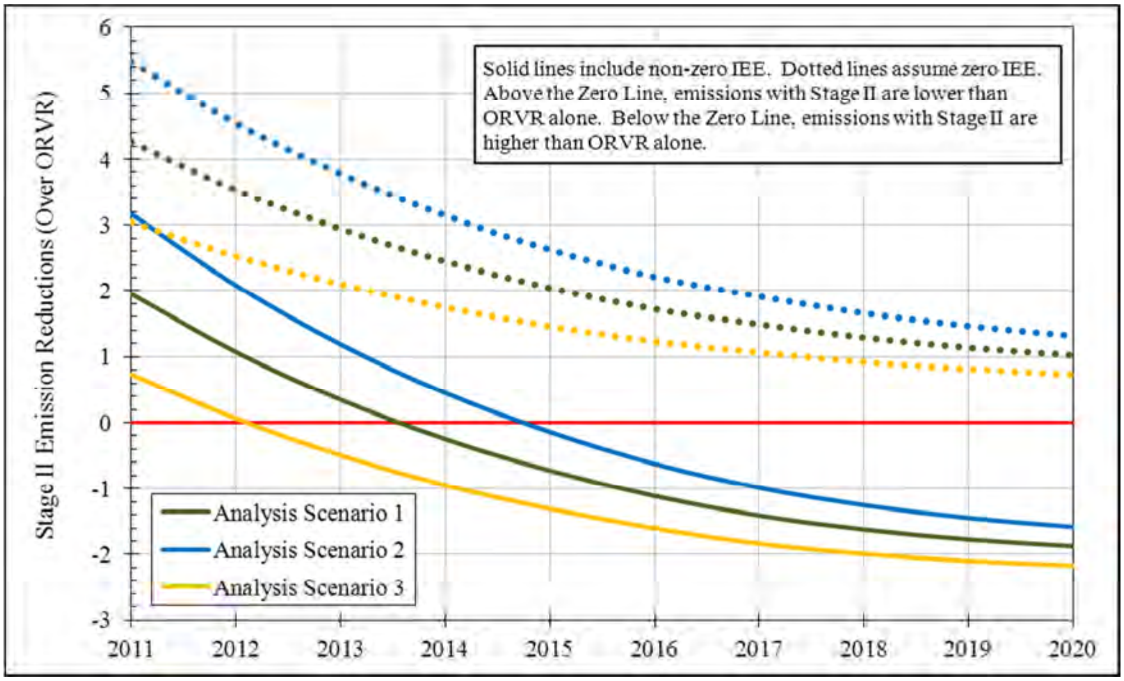


Figure 2. Results Set 2 – Onroad Only, Displacement and Spillage Impacts (VOC, metric tonnes per day)

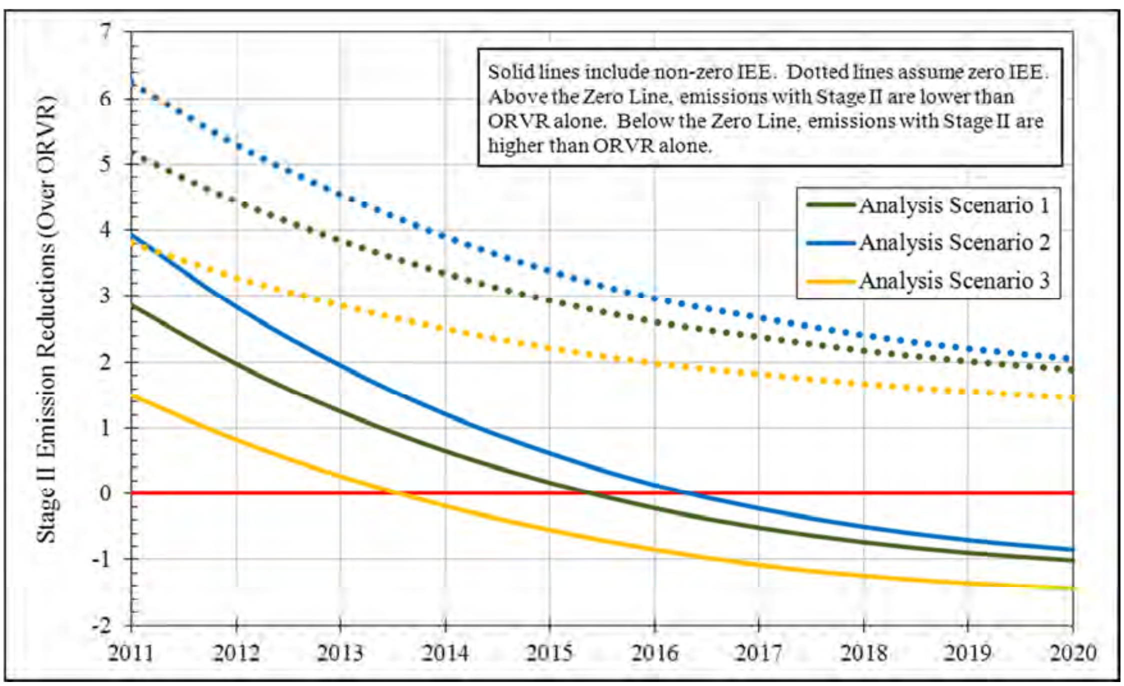


Figure 3. Results Set 3 – Onroad+Nonroad, Displacement Impacts Only (VOC, metric tonnes per day)

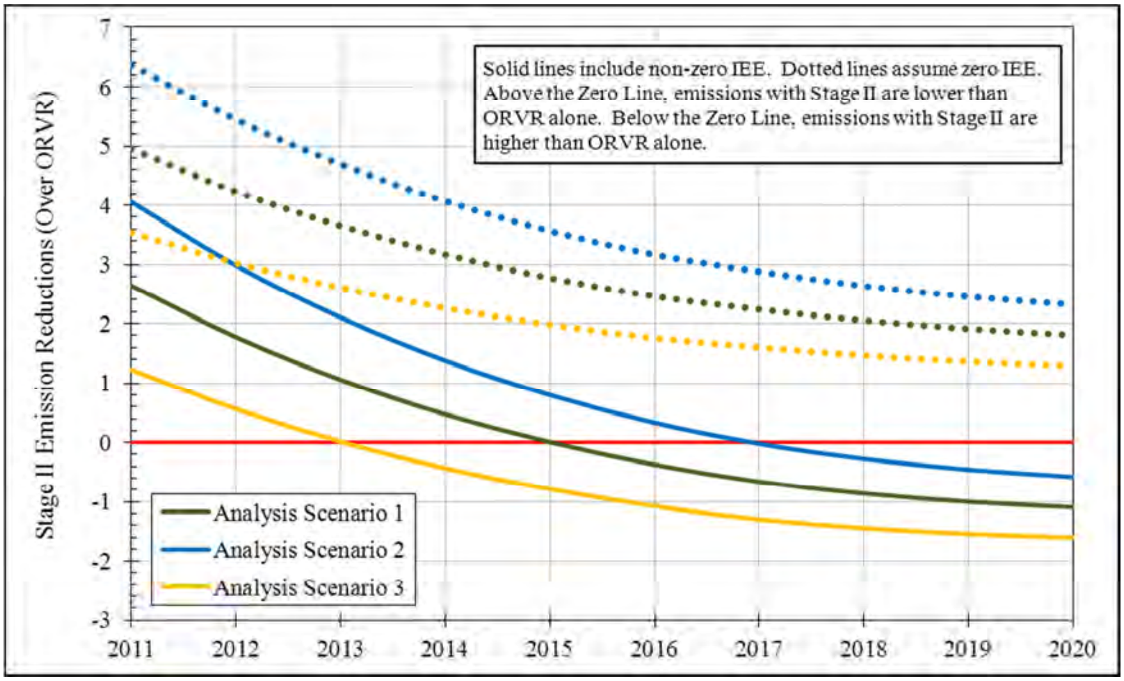
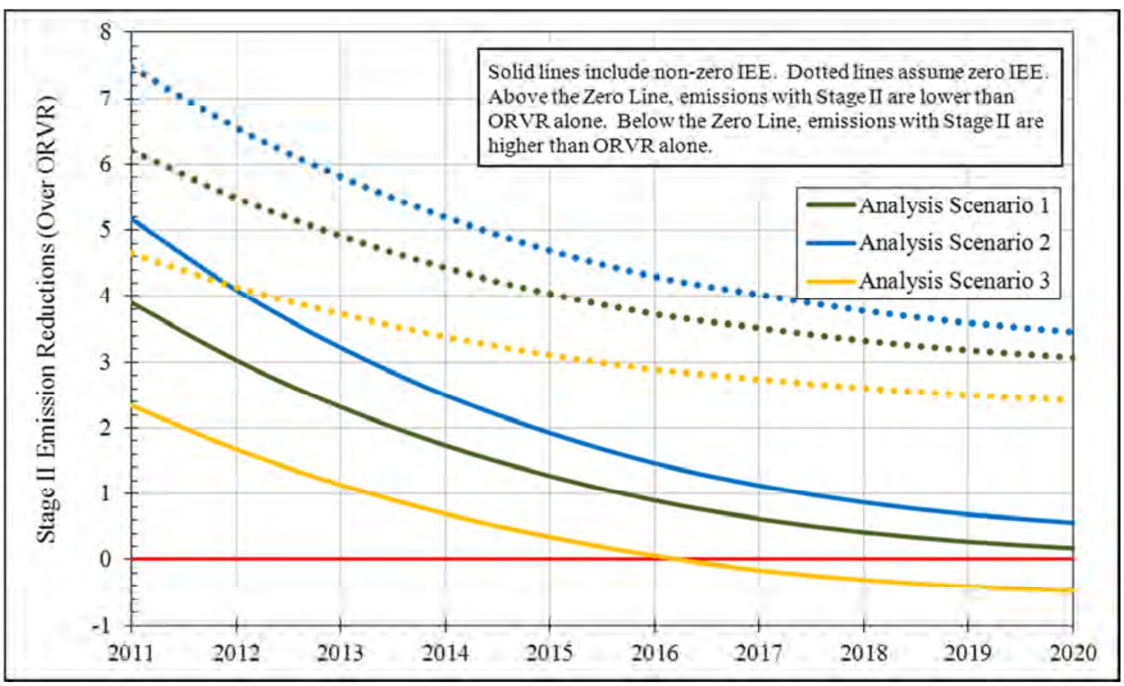


Figure 4. Results Set 4 – Onroad+Nonroad, Displacement and Spillage Impacts (VOC, metric tonnes per day)



Onroad Processing: Generally, all emission estimates for onroad vehicles are based on modeling performed using the U.S. EPA's MOVES2010b model.[13] The MOVES model includes the capability of estimating the impact of Stage II vapor recovery on both displacement and spillage emissions. However, based on an analysis of how MOVES handles the interaction between ORVR and Stage II controls with regard to spillage emissions, MES believes that while the MOVES algorithms are not flawed per se, there are nuances in their implementation that are not discussed in any of the available MOVES-related documentation, and which result in a significant likelihood that users will not properly quantify Stage II modeling inputs. For this reason, as well as to facilitate alternative scenario evaluation, MES developed a stand-alone routine that allows both the ORVR and Stage II emission estimates that would be produced through the execution of detailed MOVES modeling scenarios to be produced quickly and efficiently in a spreadsheet environment (in effect, MES has moved MOVES uncontrolled emissions data and MOVES assumptions and algorithms related to ORVR and Stage II into an independent spreadsheet).

There are several parameters required to implement MOVES ORVR and Stage II algorithms that are not available from MOVES output data. These parameters include: (1) the penetration of ORVR-equipped vehicles into the fleet, which varies both with geography (due to differences in fleet turnover rates) and time, (2) the volume of fuel consumed by vehicles, and (3) the EPA-assumed effectiveness of ORVR controls on vapor displacement and spillage emissions. The first two sets of parameters were *precisely* calculated using other MOVES data as described below. The third set of parameters is reported in supporting documentation associated with MOVES, but also confirmable via examination of the default database underlying the model. Specifically, MOVES assumes that ORVR controls reduce displacement and spillage emissions by 98 and 50 percent respectively.[14]

It is worth noting that while MOVES "assigns" the 50 percent spillage emissions reduction to ORVR controls, the driving force in this reduction is not ORVR per se, but the introduction of enhanced evaporative emissions testing requirements in the mid-1990s. These enhanced requirements include a vehicle refueling event as an integral part of the evaporative emissions testing process, which prompted vehicle manufacturers to redesign fuel tank fill pipes to eliminate gasoline "spitback."[15,16] For reasons that are not clear, EPA assigns the benefit of this emission reduction to ORVR controls. This "mis-assignment" can be easily confirmed through examination of the MOVES default database, wherein "ORVR-induced" spillage reductions begin in model year 1996 (prior to the introduction of ORVR), while ORVR-induced vapor displacement reductions "properly" begin in model year 1998.[17] Although this "accounting discrepancy" is of no real practical importance in this analysis from an emission reduction

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[13] The MOVES model and associated supporting documentation can be downloaded from www.epa.gov/otaq/models/moves/index.htm.

[14] See MOVES database table "sourcetypetechadjustment."

[15] In addition, these same requirements limited the maximum flow rate from gasoline dispensing pumps to 10 gallons per minute, which assisted manufacturers in fill pipe redesign.

[16] "Spitback" occurs when gasoline is dispensed into a fuel tank at a rate that exceeds the rate at which evacuating vapor is released, forcing liquid to accumulate in and overflow the fill pipe.

[17] See MOVES database table "sourcetypetechadjustment."

standpoint, it is critical in assessing the fraction of ORVR-equipped vehicles in the fleet at any given point in time (as that assessment cannot be reliably based on spillage emissions changes).

To calculate the fraction of *gasoline use* associated with ORVR-equipped vehicles in the fleet at any given point in time (as assumed by MOVES), one needs to compare MOVES-estimated vapor displacement emissions with ORVR in place to MOVES-estimated vapor displacement emissions in the absence of ORVR.[18],[19] Since MOVES assumes a fixed 98 percent reduction in vapor displacement from ORVR-equipped vehicles, the fraction of fuel consumed by ORVR-equipped vehicles (as assumed within MOVES) can be calculated as follows:

$$\text{FA Emis} = [\text{UC Emis}(1 - \text{ORVRf})] + [\text{UC Emis}(1 - 0.98)(\text{ORVRf})], \text{ or}$$

$$\text{ORVRf} = \frac{\text{FA Emis} - \text{UC Emis}}{[\text{UC Emis } (1 - 0.98)] - \text{UC Emis}}$$

where: FA Emis = fleet average emissions
UC Emis = uncontrolled emissions (i.e., emissions with no ORVR)
ORVRf = fraction of emissions generated by ORVR-equipped vehicles[20]

While this calculation is conceptually trivial, it must be performed for each year and each county evaluated (since ORVR penetration changes over time and since the age and relative populations of vehicles across vehicle types will generally vary with geography). Table 4 depicts the calculated ORVR fuel consumption fractions for the 12 counties included in this analysis. These fractions are used in the spreadsheet developed for this analysis to both calculate ORVR emissions impacts as well as distinguish Stage II impacts on vehicles without ORVR from corresponding impacts on vehicles with ORVR.

In order to estimate the impact of IEE, it is necessary to know the absolute volume of gasoline that is associated with *both* ORVR and Stage II controls.[21] The ORVR fuel consumption fraction

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[18] A non-ORVR MOVES scenario is run by providing an alternative "sourcetypetechadjustment" database table that replaces all default adjustments with a value of zero.

[19] Note that *all* MOVES runs described in this document (and used for the associated Stage II analysis) include *only* emissions from gasoline vehicles (by instructing MOVES to estimate emissions from all gasoline vehicle types and no others). This is critical for many of the described calculations since parameters such as emission rates, ORVR requirements, and Stage II applicability differ across fueling types. To derive accurate data, calculations must either be limited to gasoline vehicles (as in this analysis) or include appropriate corrections for fuel-related influences.

[20] Since vapor displacement emission factors are expressed in mass per unit volume of fuel dispensed, the fraction of emissions also equals the fraction of gasoline consumed by ORVR-equipped vehicles – which, due to the fact that mileage accumulation rates vary by age and vehicle type, is not the same as the population fraction of ORVR-equipped vehicles.

[21] IEE (incompatibility excess emissions) is the name assigned to incremental refueling station bulk tank losses that result when vacuum assisted Stage II vapor recovery systems deliver ambient air to the refueling tank instead of saturated gasoline vapor. This occurs because the vast majority of saturated vapor displaced during ORVR-equipped vehicle refueling is captured by the ORVR system. There are methods to eliminate these losses, but in the absence of these system "upgrades," the combination of an ORVR-equipped vehicle and a vacuum assist Stage II system has been shown to lead to IEE.

Table 4. Fuel Consumption Fractions of ORVR-Equipped Vehicles

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	77.3%	81.7%	85.2%	88.1%	90.3%	92.2%	93.5%	94.6%	95.4%	96.0%
Baltimore	77.7%	82.0%	85.5%	88.3%	90.5%	92.3%	93.6%	94.6%	95.4%	95.9%
Calvert	74.4%	79.3%	83.4%	86.7%	89.3%	91.5%	93.1%	94.4%	95.3%	96.0%
Carroll	76.5%	81.0%	84.7%	87.7%	90.1%	92.0%	93.5%	94.6%	95.4%	96.1%
Cecil	71.4%	76.5%	80.6%	84.0%	86.8%	89.0%	90.8%	92.1%	93.2%	94.0%
Charles	75.0%	79.8%	83.8%	87.0%	89.6%	91.7%	93.3%	94.5%	95.4%	96.1%
Frederick	75.0%	79.8%	83.7%	87.0%	89.6%	91.6%	93.2%	94.4%	95.3%	96.0%
Harford	76.9%	81.4%	85.0%	87.9%	90.2%	92.0%	93.4%	94.5%	95.3%	95.9%
Howard	77.8%	82.1%	85.6%	88.3%	90.5%	92.3%	93.6%	94.6%	95.4%	96.0%
Montgomery	76.4%	81.0%	84.7%	87.7%	90.2%	92.1%	93.6%	94.7%	95.5%	96.1%
Prince George's	76.1%	80.7%	84.5%	87.6%	90.0%	92.0%	93.5%	94.6%	95.5%	96.1%
Baltimore City	78.5%	82.6%	86.0%	88.7%	90.8%	92.5%	93.8%	94.8%	95.5%	96.1%
Baltimore Region Total	77.6%	81.9%	85.4%	88.2%	90.5%	92.2%	93.6%	94.6%	95.4%	96.0%
Washington Region Total	76.0%	80.6%	84.4%	87.5%	90.0%	92.0%	93.5%	94.6%	95.5%	96.1%
Stage II Area Total	76.7%	81.2%	84.8%	87.8%	90.1%	92.0%	93.5%	94.5%	95.4%	96.0%

provides the fraction of total fuel subject to both controls, but MOVES does not output the actual gasoline consumption estimate calculated within the model. Nevertheless, this gasoline volume can be precisely estimated from other MOVES output and assumptions. For this analysis, the parameters selected for this calculation are the MOVES-estimated uncontrolled (i.e., no ORVR and no Stage II) spillage emissions and the MOVES-assumed uncontrolled spillage emission rate of 0.31 grams per dispensed gallon.[22] Using these parameters, gasoline use in gallons is equal to emissions mass in grams divided by the spillage emissions rate (0.31 grams per dispensed gallon). Table 5 depicts the calculated fuel consumption volumes for a July weekday in the 12 counties included in this analysis. These volumes are used in the spreadsheet developed for this analysis to estimate IEE.[23]

[22] The emission rate is from MOVES database table "refuelingfactors." This combination of parameters results in precise estimates since the spillage emission factor is constant for all gasoline vehicles and all uncontrolled modeling scenarios (unless, of course, the scenario itself involves explicitly altering the factor).

[23] The tabulated volumes are, by definition, consistent with the vehicle miles of travel data provided by MDE as input into MOVES, the MOVES-assumed fuel economy data for modeled vehicles, and the resulting emission estimates upon which this analysis is based. As a result, they are used in this analysis without change. Nevertheless, it is possible to make a *general* assessment of the accuracy of these MOVES-derived estimates though comparisons with reported Maryland fuel use data. The average annual onroad gasoline usage for Maryland between 2007 and 2010 (no data is currently available for 2011), as reported by the Federal Highway Administration (see www.fhwa.dot.gov/policyinformation/statistics.cfm, table MF-21 for each of the four included years) is 2,677,554,500 gallons, which equates to an average daily consumption of 7.34 million gallons. According to Maryland State Highway Administration statistics (see sha.md.gov/index.aspx?pageid=681, Annual Vehicle Miles of Travel Report) for 2011, the 12 county Stage II area is responsible for about 85 percent of statewide miles of travel, so that reported fuel use for the 12 county Stage II area should be on the order of 6.24 million gallons per average annual day (7.34 × 0.85). MOVES data exceed this consumption rate by 24 percent, but there is a summer weekday seasonal factor that must be considered. While MES is uncertain of the aggregate seasonality factor for the 12 county Stage II area, typical factors are in the range of 1.1-1.15, so that the summer

Table 5. Stage II Area Fuel Consumption (million gallons per summer weekday)

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.93865	0.94224	0.94905	0.95099	0.94922	0.96174	0.97973	0.96800	0.95589	0.94230
Baltimore	1.32527	1.32405	1.32757	1.32435	1.31606	1.31851	1.32822	1.30927	1.28994	1.26861
Calvert	0.11760	0.12032	0.12324	0.12553	0.12731	0.12823	0.12971	0.13050	0.13116	0.13153
Carroll	0.21650	0.21885	0.22189	0.22380	0.22482	0.23151	0.23968	0.23755	0.23531	0.23271
Cecil	0.19541	0.20031	0.20584	0.21001	0.21337	0.21537	0.21836	0.22005	0.22155	0.22264
Charles	0.20133	0.20595	0.21093	0.21486	0.21793	0.21950	0.22204	0.22342	0.22460	0.22525
Frederick	0.45177	0.46051	0.46998	0.47705	0.48222	0.48406	0.48803	0.48971	0.49095	0.49104
Harford	0.38133	0.38576	0.39142	0.39511	0.39728	0.40977	0.42494	0.42139	0.41764	0.41323
Howard	0.63166	0.63404	0.63862	0.63996	0.63884	0.64694	0.65873	0.65095	0.64294	0.63388
Montgomery	1.25379	1.26384	1.27593	1.28165	1.28262	1.27445	1.27221	1.26580	1.25854	1.24833
Prince George's	1.42185	1.42844	1.43729	1.43885	1.43500	1.42112	1.41394	1.40251	1.39019	1.37474
Baltimore City	0.60671	0.60561	0.60676	0.60488	0.60074	0.60064	0.60388	0.59512	0.58623	0.57638
Baltimore Region Total	4.10012	4.11054	4.13531	4.13910	4.12697	4.16911	4.23518	4.18228	4.12795	4.06710
Washington Region Total	3.44633	3.47907	3.51738	3.53794	3.54509	3.52737	3.52592	3.51194	3.49544	3.47089
Stage II Area Total	7.74186	7.78992	7.85853	7.88704	7.88542	7.91185	7.97946	7.91427	7.84494	7.76063

Finally, as indicated above, the treatment of spillage emission reductions as attributable to ORVR controls is somewhat misleading in MOVES (since these reductions are driven by enhanced evaporative emissions testing requirements rather than ORVR). Nevertheless, since MOVES assumes a 50 percent spillage emissions reduction for such vehicles, it is possible to estimate the fraction of *gasoline use* associated with reduced spillage vehicles in the fleet at any given point in time (as assumed by MOVES). Since both the uncontrolled and controlled spillage emission rates are fixed (at 0.31 and 0.31×(1-0.5) grams per dispensed gallon respectively), the gasoline usage fraction of reduced spillage vehicles (as assumed within MOVES) can be calculated as follows:

$$\frac{\text{FA Emis}}{\text{GC}} = [0.31(1 - \text{RSf})] + [0.31(1 - 0.5)(\text{RSf})], \text{ or}$$

$$\text{RSf} = \frac{\left[\frac{\text{FA Emis}}{\text{GC}}\right] - 0.31}{[0.31\ (1 - 0.5)] - 0.31}$$

where: FA Emis = fleet average spillage emissions (in grams)
GC = fleetwide gasoline consumption (in gallons)
RSf = fraction of emissions generated by reduced spillage vehicles[24]

weekday equivalent of the reported annual average day gasoline consumption rate should be on the order of 7.02 million gallons (6.24 × 1.125). MOVES data exceed this consumption rate by about 10 percent. A more refined comparison may yield even closer agreement, but such analysis is beyond the scope of this work.

[24] Since spillage emission rates are expressed in mass per unit volume of fuel dispensed, the fraction of emissions also equals the fraction of gasoline consumed by reduced spillage vehicles – which, due to the fact that mileage

While this calculation is conceptually trivial, it must be performed for each year and each county evaluated (since reduced spillage vehicle penetration changes over time and since the age and relative populations of vehicles across vehicle types will generally vary with geography). Table 6 depicts the calculated reduced spillage vehicle fuel consumption fractions for the 12 counties included in this analysis. These fractions are not used in the spreadsheet developed for this analysis, but provide a quantitative indication of why spillage emission reduction is not an ORVR-driven phenomena (since the derived fuel consumption fractions are greater than the corresponding ORVR fuel consumption fractions presented in Table 4 above).

Table 6. Fuel Consumption Fractions of Reduced Spillage Vehicles

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	91.6%	93.3%	94.4%	95.2%	95.8%	96.3%	96.7%	97.0%	97.3%	97.5%
Baltimore	91.6%	93.2%	94.4%	95.2%	95.7%	96.3%	96.6%	97.0%	97.2%	97.4%
Calvert	91.0%	92.8%	94.2%	95.1%	95.8%	96.4%	96.8%	97.2%	97.5%	97.7%
Carroll	91.7%	93.3%	94.5%	95.3%	95.9%	96.4%	96.8%	97.2%	97.4%	97.6%
Cecil	88.8%	90.9%	92.2%	93.2%	93.9%	94.6%	95.1%	95.5%	95.8%	96.1%
Charles	91.0%	92.9%	94.2%	95.2%	95.8%	96.4%	96.9%	97.2%	97.5%	97.7%
Frederick	91.0%	92.8%	94.2%	95.1%	95.8%	96.4%	96.8%	97.1%	97.4%	97.6%
Harford	91.6%	93.2%	94.4%	95.2%	95.8%	96.3%	96.7%	97.0%	97.2%	97.4%
Howard	91.6%	93.3%	94.4%	95.2%	95.8%	96.3%	96.7%	97.0%	97.2%	97.4%
Montgomery	91.0%	92.9%	94.2%	95.1%	95.8%	96.4%	96.8%	97.2%	97.4%	97.6%
Prince George's	91.0%	92.9%	94.2%	95.1%	95.8%	96.4%	96.8%	97.2%	97.4%	97.6%
Baltimore City	91.7%	93.3%	94.4%	95.2%	95.8%	96.3%	96.7%	97.0%	97.3%	97.5%
Baltimore Region Total	91.6%	93.3%	94.4%	95.2%	95.8%	96.3%	96.7%	97.0%	97.2%	97.4%
Washington Region Total	91.0%	92.9%	94.2%	95.1%	95.8%	96.4%	96.8%	97.2%	97.4%	97.6%
Stage II Area Total	91.3%	93.0%	94.2%	95.1%	95.7%	96.3%	96.7%	97.0%	97.3%	97.5%

As discussed above, MOVES assumes reduced spillage emissions beginning with the introduction of enhanced evaporative emissions testing in model year 1996 (for 100 percent of all light duty vehicles). MOVES (properly) assumes ORVR-driven vapor displacement reductions track ORVR introduction beginning in model year 1998 (for less than 100 percent of passenger cars due to an associated multi-year phase-in, and with even more extended delays for light duty trucks). Thus, the vapor displacement-derived fuel consumption fractions accurately track ORVR deployment (and lag the spillage-derived fractions by about five years).

MOVES model emission estimates with no ORVR controls, no reduced spillage controls, and no Stage II controls have been incorporated into an analysis spreadsheet for the 12 Maryland counties with Stage II requirements. These emission estimates were developed by executing the

accumulation rates vary by age and vehicle type, is not the same as the population fraction of reduced spillage vehicles.

MOVES model for each county using appropriate input data for each calendar year from 2011 through 2020.[25],[26] The analysis spreadsheet includes ORVR, reduced spillage, and Stage II emission impact algorithms identical to those of the MOVES model. These algorithms can be evaluated by the user for any specified set of ORVR and Stage II effectiveness assumptions (without need to rerun the MOVES model).

In evaluating the MOVES algorithms for Stage II controls, it became apparent that there are nuances in the implementation of spillage-related calculations that result in a significant likelihood that users will not properly quantify Stage II modeling inputs. For this reason, the spreadsheet developed for this analysis includes an option to perform Stage II spillage-related calculations in exactly the same manner as MOVES, or in a slightly modified manner that serves to diminish the likelihood of inaccurate emissions estimation.

The fundamental "problem" is that MOVES assumes that Stage II spillage benefits (if any) accrue "on top of" any ORVR (or more accurately, any enhanced evaporative test-driven) spillage benefits. In principle this is a valid approach and associated emission estimates will be accurate *if the associated input data are properly quantified*, but MOVES guidance documents provide little explanation related to algorithm function and input quantification, and EPA's default effectiveness assumption (specifically, a 50 percent spillage reduction due to Stage II) itself seems to be improperly quantified given the MOVES algorithm design. Basically, MOVES applies an additional reduction to any remaining spillage emissions that are left after (ORVR, or enhanced evaporative test, driven) spillage reductions. This reduction accrues to both ORVR and non-ORVR equipped vehicles, reducing any remaining emissions by the same specified percentage (in the case of the EPA default data, by 50 percent).

Unfortunately, this approach does not seem to recognize that once something is "not spilled," it can't be "not spilled" again. For example, if ORVR (or more accurately enhanced evaporative testing) leads to a 50 percent reduction in spillage due to fill pipe redesign and a flow rate cap that eliminate spitback emissions, then Stage II controls cannot reduce spitback emissions any further on affected vehicles (since the spitback mode of spillage is eliminated). Yet, if both ORVR and Stage II are assigned 50 percent reduction effectiveness values (as they are in the EPA default data), then ORVR-equipped vehicles will actually have spillage emissions reduced by 75 percent when both programs are modeled together (50 percent from ORVR and 50 percent of the remainder from Stage II, or $[1-((1-0.5)\times(1-0.5))]$), while vehicles without ORVR will have emissions reduced by "only" 50 percent. Of course, if Stage II targeted entirely different

25 The input data used for the MOVES modeling scenarios were provided by MDE to ensure that the estimates generated in this analysis are consistent with other onroad vehicle modeling performed by MDE.

26 In total, 360 scenarios were processed through the MOVES model, each applicable to one of the 12 Stage II counties. At 12 counties and 10 evaluation years per county, there are 120 MOVES scenarios per scenario "group." A total of three scenario "groups" were modeled. One group of 120 MOVES runs estimated emissions in the absence of ORVR, spillage, and Stage II controls. This group forms the basis of the onroad vehicle portion of the spreadsheet developed for this analysis. A second group of 120 MOVES runs estimated emissions with ORVR and spillage controls in place, as defined by default EPA database tables. A third group of 120 MOVES runs estimated emissions with ORVR and spillage controls in place, as defined by default EPA database tables, and Stage II controls in place as defined by MDE. These latter two groups were analyzed to ensure that the algorithms implemented in the spreadsheet developed for this analysis were identical to those implemented in MOVES (in effect, to ensure that spreadsheet predicted Stage II impacts would exactly match the same impacts that would be estimated by additional tailored MOVES runs).

components of spillage (e.g., nozzle drip or overfilling), it is possible for the dual reductions to be accurate, but it does not appear that this is the intention of the EPA default data. Certainly, no specific guidance is provided to ensure that Stage II spillage impacts are estimated properly given MOVES algorithms.

If both ORVR and Stage II are credited with reducing spitback, then the net Stage II reduction for ORVR-equipped vehicles should be zero (since ORVR has already been credited with the associated spillage reduction). Under MDE's default Stage II assumptions, which ascribe a 70 percent spillage reduction to Stage II, the net spillage reduction due to ORVR and Stage II combined is 85 percent [1-((1-0.5)×(1-0.7))]. If instead, the overall spillage reduction is intended to be 70 percent with Stage II, then non-ORVR vehicles should have a 70 percent reduction applied and ORVR vehicles should be subject to an *additional* spillage reduction of "only" 40 percent [(0.7-0.5)/0.5]. This would produce the desired net 70 percent reduction [1-((1-0.5)×(1-0.4))]. Similarly, if the EPA default Stage II spillage reduction of 50 percent is intended to signify (as expected) that ORVR and Stage II have the same spillage impacts, then the net Stage II reduction for ORVR-equipped vehicles should be zero [(0.5-0.5)/0.5]. This, however, is *not* the way the Stage II algorithms are implemented in MOVES.

As an option, the spreadsheet developed for this analysis allows the user to select a Stage II spillage algorithm that is either: (1) identical to that implemented in MOVES, or (2) implemented as a "net" (ORVR plus Stage II) reduction for ORVR-equipped vehicles and a "full" reduction for non-ORVR vehicles. Under the second option, Stage II is only credited with spillage emission reduction for ORVR-equipped vehicles at a rate based on the extent to which the Stage II spillage reduction effectiveness exceeds that of ORVR alone. Non-ORVR vehicles are always credited with the full Stage II spillage reduction.

Finally, MOVES emissions estimates were also used to develop both hydrocarbon adjustment and speciation factors, the former allowing hydrocarbons to be expressed as either total organic gases (TOG), total hydrocarbons (THC), volatile organic compounds (VOC), non-methane organic gases (NMOG), or non-methane hydrocarbons (NMHC) – the latter allowing for estimation of methane, methyl tertiary butyl ether (MTBE), ethanol, benzene, xylene, toluene, ethyl benzene, hexane, 2,2,4-trimethylpentane, and naphthalene. Table 7 presents the derived factors, which are built into the spreadsheet developed for this analysis and used to estimate hazardous air pollutant emissions as well as tailor hydrocarbon emissions estimates to the basis desired by the user. It is perhaps worth noting that while one would expect the components of evaporated gasoline to be identical whether that evaporation occurs inside or outside of a fueling tank, MOVES estimates slightly different hydrocarbon fractions for displacement and spillage emissions. While the source of this difference is not clear, it has been retained in this analysis to ensure consistency with MOVES emissions estimates. It should also be noted that the factors depicted in Table 7 are used for both onroad and nonroad emission estimates in the spreadsheet developed for this analysis.[27]

[27] The U.S. EPA NONROAD model that was used for nonroad vehicle and equipment emissions estimation in this analysis does not include speciation factors for hazardous air pollutants. It does, however, include hydrocarbon adjustment factors for refueling emissions and these are set to unity (i.e., TOG=THC=VOC=NMOG=NMHC). Since this is not consistent with MOVES adjustment factors and since the same gasoline is assumed for both onroad and nonroad vehicles and equipment, it makes no sense to assume different hydrocarbon adjustment factors for onroad and nonroad vehicles and equipment. Since gasoline in the Stage II counties contains ethanol

Table 7. Emissions Adjustment and Speciation Factors

Emission Species	Vapor Displacement Emissions	Spillage Emissions
Total Organic Gases (TOG)	1.00000	
Total Hydrocarbons (THC)	0.88934	0.91090
Volatile Organic Compounds (VOC)	1.00000	
Methane (CH_4)	0.00000	
Non-Methane Organic Gasses (NMOG)	1.00000	
Non-Methane Hydrocarbons (NMHC)	0.88934	0.91090
Methyl Tertiary Butyl Ether (MTBE)	0.00000	
Ethanol	0.13345	
Benzene	0.00333	
Xylene	0.06423	
Toluene	0.14336	
Ethyl Benzene	0.01721	
Hexane	0.02536	
2,2,4-Trimethylpentane	0.03354	
Naphthalene	0.00040	

All factors are relative to VOC emissions.

Nonroad Processing: Generally, all emission estimates for nonroad vehicles and equipment are based on modeling performed using the U.S. EPA's NONROAD2008a model.[28] While the NONROAD model does include the capability of estimating the impact of Stage II vapor recovery on vapor displacement emissions from gasoline equipment refueled at a gasoline dispensing pump, there are two limitations associated with the way in which Stage II impacts are estimated in the model – limitations that require model emission estimates to be augmented in order to fully gauge the potential impacts of Stage II system removal.

The primary limitation is that the NONROAD model makes no estimate of the emissions associated with filling portable refueling containers. This is a critical issue in evaluating the potential benefits of Stage II on nonroad equipment and vehicle emissions since the overwhelming majority of nonroad gasoline usage in urban areas is associated with portable container refueling.[29] Emission estimates for nonroad equipment refueled from a portable container are generated by the model, but emissions associated with filling up those portable containers are not considered. Since these containers are filled at gasoline dispensing pumps,

in significant volumes, it is believed that the MOVES assumptions are superior to those of the NONROAD model, so the latter have been replaced with the former in this analysis.

[28] The NONROAD model and associated supporting documentation can be downloaded from www.epa.gov/otaq/nonrdmdl.htm.

[29] Although it is not possible to assign a specific value to this majority as it depends on equipment population and usage rates that are dependent on both geography and time (even at the county level), typical urban area portable container refueling fractions in this analysis range from 70-90 percent – but are as low as 40 percent in the more rural affected counties and as high as 95 percent in some urban counties.

emissions associated with the refilling of portable containers can be affected by Stage II systems. A methodology to estimate the emissions associated with the refilling of portable containers was developed, as described below, from data produced by the NONROAD model.

The second limitation associated with the way in which the NONROAD model estimates Stage II impacts is that there is no consideration of potential Stage II impacts on gasoline spillage emissions. Unlike the EPA MOVES model, which considers both displacement and spillage impacts, the NONROAD model includes impact estimates for displacement emissions only. Thus, a methodology was developed, as described below, to estimate potential Stage II spillage emission impacts.[30]

The NONROAD model does not provide an output that describes which equipment are assumed to be refueled at a gasoline dispensing pump and which equipment are assumed to be refueled via portable fuel containers. However, this distinction can be inferred by comparing the model output for a scenario without Stage II vapor recovery to an otherwise identical scenario with Stage II vapor recovery. The specific Stage II effectiveness assumptions are not important to the comparison; any non-zero effectiveness assumption will produce the same results.[31] Equipment for which NONROAD model emission estimates do not vary across the two scenarios must be assumed (in the NONROAD model) to be refueled via a portable fuel container (since the alternative would result in lower emissions under the Stage II non-zero effectiveness scenario). Equipment for which NONROAD model emission estimates do vary across the two scenarios must be assumed (in the NONROAD model) to be refueled at a gasoline dispensing pump.[32]

Since the NONROAD model estimates fuel consumption by equipment type, the fuel consumption associated with the identified gasoline dispensing pump and portable refueling container equipment fractions can be readily calculated from model output. The total fuel consumption supplied through portable refueling containers indicates exactly the volume of fuel that must initially be placed into such containers at gasoline dispensing pumps, and thus exactly that volume of fuel that would be associated with: (1) the displacement of gasoline vapor during the filling of portable containers, (2) potential fuel spillage during those filling events, and (3) potentially affected by Stage II vapor recovery equipment.

To estimate vapor displacement emissions associated with the filling of portable refueling containers at gasoline dispensing pumps, MES applied the same vapor displacement algorithm that NONROAD applies to equipment refueling.[33] This algorithm estimates displacement

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[30] While MES is skeptical of Stage II (and ORVR) spillage emissions benefits, the inclusion of possible benefits in the onroad vehicle sector (as is the case in the EPA MOVES model algorithms) dictates the inclusion of those same possible benefits in the nonroad vehicle and equipment sector.

[31] For this comparison, MES assumed an effectiveness of 100 percent for Stage II in order to maximize comparative emission differentials (which can be helpful for equipment with very low population, and thus emissions, estimates).

[32] The magnitude of the emissions differential in conjunction with the scenario Stage II effectiveness assumption was used to confirm the function of the Stage II impact algorithm coded within the NONROAD model. This serves as an important quality assurance check since these same computations are ultimately reproduced by MES in an external spreadsheet that allows the impacts of alternative Stage II effectiveness assumptions to be evaluated without rerunning the NONROAD model.

[33] U.S. EPA, "Refueling Emissions for Nonroad Engine Modeling, NR-013b," EPA420-P-04-013, April 2004.

emissions mass as a function of dispensed fuel temperature, ambient temperature, and gasoline RVP as follows:

$$\text{gpdg} = e^{[-1.2798 - (0.0049 \times (T_d - T_a)) + (0.0203 \times T_d) + (0.1315 \times \text{RVP})]}$$

where: gpdg = grams (of gasoline vapor) per dispensed gallon
T_a = ambient temperature (degrees F)
T_d = dispensed gasoline temperature (degrees F) = $62 + (0.6 \times (T_a - 62))$
RVP = Reid Vapor Pressure (psi)

Ambient temperature and RVP were set at the values provided by MDE as part of the MOVES modeling data for the 12 Stage II counties. For ambient temperature, a daily average temperature was calculated as the arithmetic average of the 24 hourly average temperatures provided by MDE. These data as well as the resulting vapor displacement emission rates are presented in Table 8.

Table 8. Displacement Data for Filling of Portable Refueling Containers

Vapor Displacement Parameter	Baltimore Area Counties	Washington D.C. Area Counties	Cecil County
Average Ambient Temperature (ºF)	81.55	84.12	82.09
RVP (psi)	6.74	6.74	6.74
Dispensed Fuel Temperature (ºF)	73.73	75.272	74.054
Displacement Emission Rate (gpdg)	3.132	3.248	3.156

While there is no question that portable containers must be minimally filled with the same volume of gasoline required to refuel associated nonroad equipment,[34] there is uncertainty related to the vapor saturation status of the empty portable containers at the time of refueling. It is assumed in this analysis that such containers are properly sealed between their last use to refuel nonroad equipment and their subsequent refilling, such that they contain saturated vapor at the time that gasoline is dispensed into the portable container. In cases where the portable container is not properly sealed between the time of last use and subsequent refilling, the actual vapor displacement rate could be substantially lower than assumed in this analysis. Without a detailed analysis of consumer behavior with regard to portable container handling, it is impossible to know the fraction of containers that are not properly sealed with precision (although one might reasonably expect consumers to minimize fugitive vapor loss to avoid inhalation of escaping vapors).

[34] Ignoring post-fill spillage and evaporative losses related to storage, which for conservative estimation purposes are ignored in this analysis.

In addition to vapor displacement, there will also be spillage emissions associated with the refilling of portable fuel containers. As with displacement emissions, MES applied the same spillage algorithm that NONROAD applies to equipment refueling – which assumes that spillage emissions from a gasoline dispensing pump equal 3.6 grams per refueling event.[35] By estimating the average number of gallons dispensed per refueling event, this spillage mass can be converted into an emission rate per gallon of dispensed fuel. Based on data collected by the California Air Resources Board, MES estimated an average portable refueling container size of 2.364 gallons.[36] This results in an average spillage emission rate of 1.523 grams per dispensed gallon (3.6/2.364), which was used in this analysis to estimate spillage emissions during the filling of portable refueling containers.[37]

Using the derived vapor displacement and spillage emission rates, emissions associated with the filling of portable refueling containers can be estimated in a fashion that is entirely consistent with the methodologies employed in the NONROAD model for nonroad equipment refueling. These estimates can then be adjusted in accordance with assumed Stage II effectiveness rates to derive Stage II induced emission reduction estimates. It is important to note that while the NONROAD model calculates Stage II emission impacts solely for displacement emissions, MES extended this calculation to cover both displacement and spillage emissions (based on independent effectiveness inputs for displacement and spillage) for consistency with the Stage II modeling approach employed in both the MOVES and MOBILE6 onroad vehicle emissions models.

As with the onroad emissions analysis approach described above, NONROAD model emission estimates with no Stage II controls have been incorporated into an analysis spreadsheet for the 12 Maryland counties with Stage II requirements. These emission estimates were developed by executing the NONROAD model for each county using appropriate input data for each calendar year from 2011 through 2020.[38,39] The analysis spreadsheet includes Stage II emission impact

[35] U.S. EPA, "Refueling Emissions for Nonroad Engine Modeling, NR-013b," EPA420-P-04-013, April 2004.

[36] Nguyen, M., "Source Inventory Category # 1434, Portable Fuel Container Spillage," undated. The document, which indicates the fraction of 1, 2, and 5 gallon containers to be 39.2, 35.6, and 25.2 percent respectively, can be downloaded from www.arb.ca.gov/ei/areasrc/districtmeth/BayArea/C1434.pdf.

[37] Note that this assumes that all portable containers are empty when refilled. Since it is likely that some containers will not be empty, this approach almost certainly underestimates the actual volume of gasoline spillage. However, there are no data available to estimate the average liquid volume present at the time of portable container refilling, and since the NONROAD model employs a similar assumption for spillage emissions associated with nonroad equipment, the empty container approach is entirely consistent with other NONROAD model emission estimates.

[38] Generally, the input data are derived from MOVES (onroad vehicle) meteorologic and fuel-related input data provided by MDE.

[39] In total, 90 scenarios were processed through the NONROAD model, each applicable to one of three geographic areas of common meteorology and fuel characteristics as defined by MDE (these areas represent the six county Baltimore area, the five county Washington D.C. area, and Cecil County). Fifty scenarios were evaluated for the Baltimore area: 10 reflecting no Stage II controls, 10 reflecting a 25 percent effective Stage II control efficiency, 10 reflecting a 50 percent effective Stage II control efficiency, 10 reflecting a 75 percent effective Stage II control efficiency, and 10 reflecting a 100 percent effective Stage II control efficiency. Only the 10 "no Stage II" scenarios are used in the final analysis spreadsheet, the remainder were used to identify which equipment were refueled with portable containers and to confirm the methodology through which NONROAD estimates Stage II impacts so that that methodology could be replicated without deviation in the analysis spreadsheet. Twenty

algorithms identical to those of the NONROAD model as well as supplemental equivalent algorithms to estimate Stage II impacts on portable fueling container and spillage emissions. These algorithms can be evaluated by the user for any specified set of Stage II effectiveness assumptions (without need to rerun the NONROAD model).

Potential Impact Tables. Tables 9 through 32 that follow present specific emission impact estimates for each year from 2011 through 2020 by county, metropolitan area, and the aggregate Stage II region. Tables 33 through 56 present associated hazardous air pollutant emission impact estimates for those same years for the aggregate Stage II region.

scenarios were evaluated for each of the Washington D.C. and Cecil County areas: 10 reflecting no Stage II controls and 10 reflecting a 100 percent effective Stage II control efficiency. As with the Baltimore area, only the 10 "no Stage II" scenarios are used in the analysis spreadsheet.

Table 9. Stage II Reductions with Zero IEE
Onroad Only, Displacement Impacts Only, Scenario 1
(VOC, metric tonnes per day)

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.50	0.41	0.34	0.28	0.24	0.20	0.18	0.15	0.14	0.12
Baltimore	0.69	0.57	0.47	0.39	0.33	0.28	0.24	0.21	0.18	0.17
Calvert	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02
Carroll	0.12	0.10	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03
Cecil	0.13	0.11	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.04
Charles	0.12	0.10	0.09	0.07	0.06	0.05	0.04	0.04	0.03	0.03
Frederick	0.27	0.23	0.19	0.16	0.13	0.11	0.10	0.08	0.07	0.07
Harford	0.21	0.17	0.14	0.12	0.10	0.09	0.08	0.07	0.06	0.05
Howard	0.33	0.27	0.23	0.19	0.16	0.13	0.12	0.10	0.09	0.08
Montgomery	0.71	0.59	0.49	0.41	0.34	0.28	0.24	0.21	0.18	0.16
Prince George's	0.81	0.67	0.56	0.46	0.38	0.31	0.27	0.23	0.20	0.18
Baltimore City	0.31	0.25	0.21	0.17	0.14	0.12	0.11	0.09	0.08	0.07
Baltimore Region Total	2.15	1.77	1.47	1.23	1.03	0.88	0.77	0.67	0.59	0.53
Washington Region Total	1.98	1.65	1.37	1.14	0.95	0.78	0.67	0.58	0.51	0.46
Stage II Area Total	4.26	3.53	2.94	2.44	2.04	1.72	1.49	1.29	1.14	1.02

Table 10. Stage II Reductions with Non-Zero IEE
Onroad Only, Displacement Impacts Only, Scenario 1
(VOC, metric tonnes per day)

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.22	0.11	0.03	-0.04	-0.10	-0.14	-0.18	-0.20	-0.22	-0.23
Baltimore	0.29	0.15	0.03	-0.06	-0.14	-0.20	-0.24	-0.27	-0.29	-0.31
Calvert	0.04	0.02	0.01	0.00	-0.01	-0.02	-0.02	-0.03	-0.03	-0.03
Carroll	0.05	0.03	0.01	-0.01	-0.02	-0.03	-0.04	-0.05	-0.05	-0.06
Cecil	0.07	0.05	0.03	0.01	0.00	-0.01	-0.02	-0.03	-0.04	-0.04
Charles	0.06	0.04	0.02	0.00	-0.02	-0.03	-0.04	-0.05	-0.05	-0.05
Frederick	0.14	0.08	0.04	0.00	-0.03	-0.06	-0.08	-0.10	-0.11	-0.12
Harford	0.09	0.05	0.01	-0.02	-0.04	-0.06	-0.08	-0.09	-0.09	-0.10
Howard	0.14	0.07	0.01	-0.03	-0.07	-0.10	-0.12	-0.14	-0.15	-0.15
Montgomery	0.34	0.19	0.07	-0.03	-0.11	-0.18	-0.23	-0.26	-0.29	-0.30
Prince George's	0.39	0.22	0.08	-0.03	-0.12	-0.20	-0.25	-0.29	-0.32	-0.33
Baltimore City	0.12	0.06	0.01	-0.04	-0.07	-0.09	-0.11	-0.13	-0.14	-0.14
Baltimore Region Total	0.91	0.46	0.10	-0.19	-0.43	-0.62	-0.77	-0.87	-0.94	-0.99
Washington Region Total	0.97	0.56	0.22	-0.07	-0.30	-0.48	-0.62	-0.72	-0.79	-0.84
Stage II Area Total	1.95	1.07	0.35	-0.25	-0.72	-1.11	-1.41	-1.62	-1.77	-1.88

**Table 11. Stage II Reductions with Zero IEE
Onroad Only, Displacement Impacts Only, Scenario 2
(VOC, metric tonnes per day)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.64	0.53	0.44	0.37	0.31	0.26	0.23	0.20	0.18	0.16
Baltimore	0.89	0.73	0.61	0.50	0.42	0.36	0.31	0.27	0.24	0.21
Calvert	0.09	0.08	0.07	0.05	0.05	0.04	0.03	0.03	0.03	0.02
Carroll	0.15	0.13	0.11	0.09	0.07	0.06	0.06	0.05	0.04	0.04
Cecil	0.16	0.14	0.12	0.10	0.09	0.08	0.07	0.06	0.05	0.05
Charles	0.15	0.13	0.11	0.09	0.08	0.06	0.06	0.05	0.04	0.04
Frederick	0.35	0.29	0.24	0.20	0.17	0.14	0.12	0.11	0.09	0.08
Harford	0.26	0.22	0.18	0.15	0.13	0.11	0.10	0.09	0.08	0.07
Howard	0.42	0.35	0.29	0.24	0.20	0.17	0.15	0.13	0.12	0.11
Montgomery	0.91	0.76	0.63	0.52	0.43	0.36	0.31	0.26	0.23	0.21
Prince George's	1.05	0.86	0.72	0.59	0.49	0.40	0.34	0.29	0.26	0.23
Baltimore City	0.39	0.32	0.27	0.22	0.19	0.16	0.14	0.12	0.11	0.09
Baltimore Region Total	2.76	2.28	1.89	1.58	1.32	1.13	0.99	0.86	0.76	0.68
Washington Region Total	2.55	2.12	1.76	1.46	1.22	1.01	0.86	0.74	0.65	0.59
Stage II Area Total	5.48	4.54	3.78	3.14	2.62	2.21	1.91	1.66	1.46	1.31

**Table 12. Stage II Reductions with Non-Zero IEE
Onroad Only, Displacement Impacts Only, Scenario 2
(VOC, metric tonnes per day)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.36	0.23	0.13	0.04	-0.03	-0.08	-0.13	-0.16	-0.18	-0.19
Baltimore	0.49	0.31	0.17	0.05	-0.04	-0.12	-0.17	-0.21	-0.24	-0.26
Calvert	0.06	0.04	0.03	0.01	0.00	-0.01	-0.01	-0.02	-0.02	-0.03
Carroll	0.09	0.06	0.03	0.01	0.00	-0.02	-0.03	-0.04	-0.04	-0.05
Cecil	0.11	0.08	0.06	0.04	0.02	0.00	-0.01	-0.02	-0.03	-0.03
Charles	0.10	0.07	0.04	0.02	0.00	-0.01	-0.03	-0.03	-0.04	-0.05
Frederick	0.22	0.15	0.09	0.04	0.00	-0.03	-0.05	-0.07	-0.09	-0.10
Harford	0.15	0.10	0.05	0.02	-0.01	-0.03	-0.05	-0.07	-0.08	-0.08
Howard	0.23	0.15	0.08	0.02	-0.02	-0.06	-0.09	-0.11	-0.12	-0.13
Montgomery	0.54	0.36	0.21	0.08	-0.02	-0.10	-0.16	-0.20	-0.23	-0.26
Prince George's	0.62	0.41	0.24	0.10	-0.01	-0.11	-0.17	-0.22	-0.26	-0.28
Baltimore City	0.21	0.13	0.07	0.01	-0.03	-0.06	-0.08	-0.10	-0.11	-0.12
Baltimore Region Total	1.52	0.97	0.52	0.16	-0.13	-0.37	-0.55	-0.68	-0.77	-0.84
Washington Region Total	1.53	1.03	0.61	0.26	-0.03	-0.25	-0.42	-0.55	-0.65	-0.71
Stage II Area Total	3.16	2.08	1.19	0.45	-0.14	-0.62	-0.99	-1.25	-1.45	-1.58

**Table 13. Stage II Reductions with Zero IEE
Onroad Only, Displacement Impacts Only, Scenario 3
(VOC, metric tonnes per day)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.36	0.29	0.24	0.20	0.17	0.15	0.13	0.11	0.10	0.09
Baltimore	0.49	0.41	0.34	0.28	0.23	0.20	0.17	0.15	0.13	0.12
Calvert	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01
Carroll	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02
Cecil	0.09	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.03
Charles	0.09	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.02
Frederick	0.19	0.16	0.14	0.11	0.09	0.08	0.07	0.06	0.05	0.05
Harford	0.15	0.12	0.10	0.09	0.07	0.06	0.06	0.05	0.04	0.04
Howard	0.23	0.19	0.16	0.13	0.11	0.10	0.08	0.07	0.07	0.06
Montgomery	0.51	0.42	0.35	0.29	0.24	0.20	0.17	0.15	0.13	0.12
Prince George's	0.58	0.48	0.40	0.33	0.27	0.22	0.19	0.16	0.14	0.13
Baltimore City	0.22	0.18	0.15	0.12	0.10	0.09	0.08	0.07	0.06	0.05
Baltimore Region Total	1.53	1.27	1.05	0.88	0.73	0.63	0.55	0.48	0.42	0.38
Washington Region Total	1.42	1.18	0.98	0.81	0.68	0.56	0.48	0.41	0.36	0.33
Stage II Area Total	3.04	2.52	2.10	1.75	1.46	1.23	1.06	0.92	0.81	0.73

**Table 14. Stage II Reductions with Non-Zero IEE
Onroad Only, Displacement Impacts Only, Scenario 3
(VOC, metric tonnes per day)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.07	-0.01	-0.07	-0.12	-0.16	-0.20	-0.23	-0.25	-0.26	-0.26
Baltimore	0.09	-0.02	-0.10	-0.17	-0.23	-0.27	-0.31	-0.33	-0.35	-0.35
Calvert	0.02	0.01	0.00	-0.01	-0.02	-0.02	-0.03	-0.03	-0.03	-0.04
Carroll	0.02	0.00	-0.01	-0.03	-0.04	-0.05	-0.06	-0.06	-0.06	-0.07
Cecil	0.04	0.02	0.00	-0.01	-0.02	-0.03	-0.04	-0.05	-0.05	-0.05
Charles	0.03	0.01	-0.01	-0.02	-0.03	-0.04	-0.05	-0.06	-0.06	-0.06
Frederick	0.06	0.02	-0.02	-0.05	-0.07	-0.09	-0.11	-0.12	-0.13	-0.14
Harford	0.03	0.00	-0.03	-0.05	-0.07	-0.08	-0.10	-0.11	-0.11	-0.12
Howard	0.04	-0.01	-0.05	-0.09	-0.11	-0.14	-0.16	-0.17	-0.17	-0.18
Montgomery	0.13	0.02	-0.07	-0.15	-0.21	-0.26	-0.29	-0.32	-0.34	-0.35
Prince George's	0.16	0.03	-0.08	-0.16	-0.23	-0.29	-0.32	-0.35	-0.37	-0.39
Baltimore City	0.03	-0.01	-0.05	-0.08	-0.11	-0.13	-0.14	-0.15	-0.16	-0.16
Baltimore Region Total	0.30	-0.04	-0.32	-0.54	-0.72	-0.87	-0.99	-1.06	-1.11	-1.14
Washington Region Total	0.40	0.09	-0.18	-0.39	-0.57	-0.70	-0.81	-0.88	-0.94	-0.97
Stage II Area Total	0.73	0.06	-0.49	-0.95	-1.31	-1.60	-1.84	-1.99	-2.10	-2.17

Table 15. Stage II Reductions with Zero IEE
Onroad Only, Displacement Plus Spillage Impacts, Scenario 1
(VOC, metric tonnes per day)

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.61	0.52	0.45	0.39	0.35	0.31	0.29	0.26	0.24	0.23
Baltimore	0.85	0.72	0.62	0.54	0.48	0.42	0.39	0.36	0.33	0.31
Calvert	0.09	0.07	0.07	0.06	0.05	0.04	0.04	0.04	0.03	0.03
Carroll	0.14	0.12	0.11	0.09	0.08	0.08	0.07	0.06	0.06	0.06
Cecil	0.15	0.13	0.12	0.11	0.09	0.08	0.08	0.07	0.07	0.06
Charles	0.14	0.13	0.11	0.10	0.08	0.07	0.07	0.06	0.06	0.05
Frederick	0.32	0.28	0.24	0.21	0.19	0.17	0.15	0.14	0.13	0.12
Harford	0.25	0.22	0.19	0.16	0.15	0.13	0.13	0.12	0.11	0.10
Howard	0.40	0.34	0.30	0.26	0.23	0.21	0.19	0.18	0.16	0.15
Montgomery	0.86	0.73	0.64	0.55	0.48	0.42	0.38	0.35	0.32	0.30
Prince George's	0.98	0.84	0.72	0.62	0.54	0.47	0.42	0.39	0.36	0.33
Baltimore City	0.38	0.32	0.28	0.24	0.21	0.19	0.17	0.16	0.15	0.14
Baltimore Region Total	2.63	2.25	1.95	1.70	1.49	1.34	1.24	1.13	1.05	0.98
Washington Region Total	2.39	2.05	1.78	1.54	1.35	1.18	1.06	0.97	0.90	0.84
Stage II Area Total	5.17	4.43	3.84	3.34	2.93	2.61	2.38	2.17	2.01	1.89

Table 16. Stage II Reductions with Non-Zero IEE
Onroad Only, Displacement Plus Spillage Impacts, Scenario 1
(VOC, metric tonnes per day)

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.33	0.22	0.14	0.07	0.01	-0.03	-0.07	-0.09	-0.11	-0.12
Baltimore	0.45	0.30	0.18	0.09	0.01	-0.05	-0.09	-0.13	-0.15	-0.17
Calvert	0.05	0.04	0.02	0.01	0.01	0.00	-0.01	-0.01	-0.01	-0.02
Carroll	0.08	0.05	0.03	0.02	0.00	-0.01	-0.02	-0.02	-0.03	-0.03
Cecil	0.10	0.07	0.05	0.04	0.02	0.01	0.00	-0.01	-0.01	-0.02
Charles	0.09	0.06	0.04	0.02	0.01	0.00	-0.01	-0.02	-0.03	-0.03
Frederick	0.19	0.14	0.09	0.05	0.02	-0.01	-0.03	-0.04	-0.05	-0.06
Harford	0.14	0.09	0.06	0.03	0.01	-0.01	-0.03	-0.04	-0.05	-0.05
Howard	0.21	0.14	0.09	0.04	0.00	-0.02	-0.05	-0.06	-0.08	-0.08
Montgomery	0.48	0.34	0.21	0.11	0.03	-0.03	-0.08	-0.12	-0.15	-0.17
Prince George's	0.56	0.39	0.25	0.13	0.04	-0.04	-0.09	-0.13	-0.16	-0.18
Baltimore City	0.19	0.13	0.08	0.03	0.00	-0.03	-0.05	-0.06	-0.07	-0.08
Baltimore Region Total	1.39	0.94	0.57	0.28	0.04	-0.15	-0.30	-0.41	-0.48	-0.54
Washington Region Total	1.37	0.96	0.62	0.33	0.10	-0.08	-0.22	-0.33	-0.40	-0.46
Stage II Area Total	2.86	1.97	1.25	0.65	0.17	-0.22	-0.52	-0.74	-0.90	-1.01

Table 17. Stage II Reductions with Zero IEE
Onroad Only, Displacement Plus Spillage Impacts, Scenario 2
(VOC, metric tonnes per day)

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.73	0.62	0.53	0.46	0.40	0.35	0.32	0.29	0.27	0.25
Baltimore	1.02	0.86	0.73	0.63	0.55	0.48	0.44	0.39	0.36	0.33
Calvert	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.04
Carroll	0.17	0.15	0.13	0.11	0.10	0.09	0.08	0.07	0.07	0.06
Cecil	0.18	0.16	0.14	0.12	0.11	0.10	0.09	0.08	0.08	0.07
Charles	0.17	0.15	0.13	0.11	0.10	0.09	0.08	0.07	0.06	0.06
Frederick	0.39	0.34	0.29	0.25	0.22	0.19	0.17	0.15	0.14	0.13
Harford	0.30	0.26	0.22	0.19	0.17	0.15	0.14	0.13	0.12	0.11
Howard	0.48	0.41	0.35	0.30	0.26	0.24	0.22	0.19	0.18	0.17
Montgomery	1.04	0.88	0.75	0.64	0.56	0.48	0.43	0.38	0.35	0.33
Prince George's	1.19	1.00	0.85	0.73	0.63	0.54	0.48	0.43	0.39	0.36
Baltimore City	0.45	0.38	0.33	0.28	0.24	0.21	0.19	0.18	0.16	0.15
Baltimore Region Total	3.16	2.68	2.29	1.97	1.71	1.52	1.39	1.25	1.15	1.06
Washington Region Total	2.89	2.46	2.10	1.80	1.55	1.34	1.19	1.07	0.98	0.91
Stage II Area Total	6.24	5.30	4.54	3.90	3.38	2.97	2.67	2.41	2.21	2.05

Table 18. Stage II Reductions with Non-Zero IEE
Onroad Only, Displacement Plus Spillage Impacts, Scenario 2
(VOC, metric tonnes per day)

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.45	0.32	0.22	0.13	0.06	0.01	-0.03	-0.07	-0.09	-0.11
Baltimore	0.62	0.44	0.29	0.18	0.08	0.01	-0.05	-0.09	-0.12	-0.14
Calvert	0.07	0.05	0.04	0.02	0.01	0.00	0.00	-0.01	-0.01	-0.01
Carroll	0.11	0.08	0.05	0.03	0.02	0.00	-0.01	-0.02	-0.02	-0.03
Cecil	0.13	0.10	0.08	0.06	0.04	0.02	0.01	0.00	-0.01	-0.01
Charles	0.12	0.09	0.06	0.04	0.02	0.01	0.00	-0.01	-0.02	-0.02
Frederick	0.26	0.19	0.14	0.09	0.05	0.02	-0.01	-0.03	-0.04	-0.05
Harford	0.19	0.14	0.09	0.06	0.03	0.01	-0.01	-0.03	-0.04	-0.05
Howard	0.29	0.21	0.14	0.08	0.04	0.00	-0.02	-0.05	-0.06	-0.07
Montgomery	0.66	0.48	0.33	0.21	0.11	0.02	-0.04	-0.08	-0.12	-0.14
Prince George's	0.76	0.55	0.38	0.24	0.12	0.03	-0.04	-0.09	-0.13	-0.15
Baltimore City	0.27	0.19	0.12	0.07	0.03	0.00	-0.03	-0.04	-0.06	-0.07
Baltimore Region Total	1.93	1.37	0.92	0.55	0.26	0.03	-0.15	-0.29	-0.38	-0.45
Washington Region Total	1.87	1.37	0.95	0.60	0.31	0.08	-0.09	-0.22	-0.32	-0.38
Stage II Area Total	3.93	2.84	1.95	1.21	0.61	0.13	-0.23	-0.50	-0.70	-0.85

Table 19. Stage II Reductions with Zero IEE
Onroad Only, Displacement Plus Spillage Impacts, Scenario 3
(VOC, metric tonnes per day)

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.45	0.39	0.34	0.29	0.26	0.24	0.22	0.20	0.19	0.18
Baltimore	0.62	0.53	0.46	0.41	0.36	0.32	0.30	0.27	0.25	0.24
Calvert	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.03	0.02
Carroll	0.11	0.09	0.08	0.07	0.06	0.06	0.05	0.05	0.05	0.04
Cecil	0.11	0.10	0.09	0.08	0.07	0.06	0.06	0.05	0.05	0.05
Charles	0.11	0.09	0.08	0.07	0.06	0.06	0.05	0.05	0.04	0.04
Frederick	0.24	0.21	0.18	0.16	0.14	0.13	0.11	0.11	0.10	0.09
Harford	0.18	0.16	0.14	0.12	0.11	0.10	0.10	0.09	0.08	0.08
Howard	0.30	0.26	0.22	0.20	0.17	0.16	0.15	0.14	0.13	0.12
Montgomery	0.63	0.54	0.47	0.41	0.36	0.32	0.29	0.27	0.25	0.23
Prince George's	0.72	0.62	0.54	0.47	0.41	0.36	0.32	0.30	0.28	0.26
Baltimore City	0.28	0.24	0.21	0.18	0.16	0.14	0.13	0.12	0.11	0.11
Baltimore Region Total	1.94	1.67	1.45	1.27	1.13	1.02	0.95	0.87	0.81	0.76
Washington Region Total	1.76	1.52	1.32	1.15	1.01	0.90	0.81	0.74	0.69	0.65
Stage II Area Total	3.81	3.28	2.86	2.50	2.21	1.98	1.82	1.67	1.56	1.46

Table 20. Stage II Reductions with Non-Zero IEE
Onroad Only, Displacement Plus Spillage Impacts, Scenario 3
(VOC, metric tonnes per day)

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.17	0.09	0.02	-0.03	-0.07	-0.11	-0.14	-0.15	-0.17	-0.18
Baltimore	0.22	0.11	0.02	-0.05	-0.10	-0.15	-0.18	-0.21	-0.22	-0.23
Calvert	0.03	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02
Carroll	0.04	0.02	0.01	-0.01	-0.02	-0.03	-0.03	-0.04	-0.04	-0.04
Cecil	0.06	0.04	0.02	0.01	0.00	-0.01	-0.02	-0.02	-0.03	-0.03
Charles	0.05	0.03	0.01	0.00	-0.01	-0.02	-0.03	-0.03	-0.04	-0.04
Frederick	0.11	0.06	0.03	0.00	-0.03	-0.05	-0.06	-0.07	-0.08	-0.09
Harford	0.07	0.04	0.01	-0.01	-0.03	-0.04	-0.06	-0.07	-0.07	-0.08
Howard	0.11	0.05	0.01	-0.02	-0.05	-0.07	-0.09	-0.10	-0.11	-0.12
Montgomery	0.26	0.15	0.05	-0.02	-0.09	-0.14	-0.17	-0.20	-0.22	-0.23
Prince George's	0.30	0.17	0.06	-0.02	-0.09	-0.15	-0.19	-0.22	-0.24	-0.26
Baltimore City	0.09	0.04	0.01	-0.03	-0.05	-0.07	-0.09	-0.10	-0.10	-0.11
Baltimore Region Total	0.70	0.36	0.08	-0.15	-0.32	-0.47	-0.59	-0.67	-0.72	-0.76
Washington Region Total	0.74	0.43	0.16	-0.05	-0.23	-0.37	-0.47	-0.55	-0.61	-0.65
Stage II Area Total	1.50	0.82	0.27	-0.19	-0.55	-0.85	-1.08	-1.24	-1.35	-1.43

**Table 21. Stage II Reductions with Zero IEE
Onroad Plus Nonroad, Displacement Only Impacts, Scenario 1
(VOC, metric tonnes per day)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.58	0.50	0.43	0.37	0.33	0.29	0.27	0.25	0.23	0.22
Baltimore	0.79	0.67	0.58	0.50	0.44	0.39	0.35	0.32	0.30	0.28
Calvert	0.09	0.08	0.07	0.06	0.05	0.04	0.04	0.04	0.03	0.03
Carroll	0.15	0.13	0.11	0.10	0.09	0.08	0.07	0.07	0.06	0.06
Cecil	0.15	0.13	0.12	0.10	0.09	0.08	0.07	0.07	0.06	0.06
Charles	0.14	0.12	0.11	0.09	0.08	0.07	0.07	0.06	0.06	0.05
Frederick	0.31	0.27	0.23	0.20	0.18	0.16	0.14	0.13	0.12	0.11
Harford	0.24	0.20	0.18	0.15	0.14	0.12	0.11	0.10	0.10	0.09
Howard	0.38	0.33	0.28	0.24	0.21	0.19	0.18	0.16	0.15	0.14
Montgomery	0.87	0.75	0.65	0.57	0.51	0.45	0.41	0.38	0.36	0.35
Prince George's	0.91	0.77	0.65	0.56	0.48	0.41	0.37	0.33	0.31	0.29
Baltimore City	0.34	0.29	0.25	0.21	0.18	0.16	0.15	0.13	0.12	0.11
Baltimore Region Total	2.48	2.11	1.82	1.58	1.38	1.24	1.13	1.04	0.96	0.91
Washington Region Total	2.32	1.99	1.71	1.49	1.30	1.14	1.03	0.95	0.88	0.83
Stage II Area Total	4.95	4.23	3.65	3.17	2.77	2.46	2.24	2.05	1.91	1.81

**Table 22. Stage II Reductions with Non-Zero IEE
Onroad Plus Nonroad, Displacement Only Impacts, Scenario 1
(VOC, metric tonnes per day)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.30	0.20	0.12	0.05	-0.01	-0.05	-0.09	-0.11	-0.12	-0.13
Baltimore	0.39	0.25	0.14	0.04	-0.03	-0.08	-0.13	-0.16	-0.18	-0.19
Calvert	0.05	0.04	0.03	0.01	0.01	0.00	-0.01	-0.01	-0.01	-0.02
Carroll	0.08	0.06	0.04	0.02	0.01	0.00	-0.01	-0.02	-0.02	-0.03
Cecil	0.09	0.07	0.05	0.03	0.02	0.01	0.00	-0.01	-0.02	-0.02
Charles	0.08	0.06	0.04	0.02	0.01	0.00	-0.01	-0.02	-0.03	-0.03
Frederick	0.18	0.13	0.08	0.04	0.01	-0.01	-0.03	-0.05	-0.06	-0.07
Harford	0.12	0.08	0.05	0.02	0.00	-0.02	-0.04	-0.05	-0.06	-0.06
Howard	0.19	0.12	0.07	0.02	-0.01	-0.04	-0.06	-0.08	-0.09	-0.09
Montgomery	0.50	0.35	0.23	0.14	0.06	0.00	-0.05	-0.08	-0.11	-0.12
Prince George's	0.48	0.32	0.18	0.07	-0.02	-0.09	-0.15	-0.18	-0.21	-0.23
Baltimore City	0.16	0.09	0.04	0.00	-0.03	-0.06	-0.08	-0.09	-0.10	-0.10
Baltimore Region Total	1.25	0.81	0.45	0.16	-0.07	-0.26	-0.41	-0.50	-0.57	-0.61
Washington Region Total	1.30	0.89	0.56	0.28	0.06	-0.12	-0.25	-0.35	-0.42	-0.46
Stage II Area Total	2.64	1.77	1.06	0.47	0.01	-0.37	-0.66	-0.86	-1.00	-1.09

**Table 23. Stage II Reductions with Zero IEE
Onroad Plus Nonroad, Displacement Only Impacts, Scenario 2
(VOC, metric tonnes per day)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.75	0.64	0.55	0.48	0.42	0.38	0.35	0.32	0.30	0.28
Baltimore	1.02	0.87	0.74	0.64	0.56	0.50	0.45	0.41	0.39	0.36
Calvert	0.11	0.10	0.08	0.07	0.06	0.06	0.05	0.05	0.04	0.04
Carroll	0.19	0.16	0.14	0.12	0.11	0.10	0.09	0.09	0.08	0.08
Cecil	0.19	0.17	0.15	0.13	0.12	0.10	0.10	0.09	0.08	0.08
Charles	0.18	0.16	0.14	0.12	0.11	0.09	0.09	0.08	0.07	0.07
Frederick	0.40	0.35	0.30	0.26	0.23	0.20	0.18	0.17	0.16	0.15
Harford	0.31	0.26	0.23	0.20	0.17	0.16	0.15	0.13	0.12	0.12
Howard	0.49	0.42	0.36	0.31	0.28	0.25	0.23	0.21	0.20	0.19
Montgomery	1.12	0.97	0.84	0.74	0.65	0.58	0.53	0.49	0.47	0.45
Prince George's	1.17	0.99	0.84	0.72	0.62	0.53	0.47	0.43	0.39	0.37
Baltimore City	0.44	0.37	0.32	0.27	0.23	0.21	0.19	0.17	0.16	0.15
Baltimore Region Total	3.19	2.72	2.34	2.03	1.78	1.59	1.46	1.33	1.24	1.17
Washington Region Total	2.98	2.55	2.20	1.91	1.67	1.47	1.33	1.22	1.13	1.07
Stage II Area Total	6.37	5.44	4.69	4.07	3.56	3.16	2.88	2.64	2.46	2.32

**Table 24. Stage II Reductions with Non-Zero IEE
Onroad Plus Nonroad, Displacement Only Impacts, Scenario 2
(VOC, metric tonnes per day)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.47	0.34	0.24	0.15	0.09	0.03	-0.01	-0.04	-0.06	-0.07
Baltimore	0.62	0.44	0.30	0.19	0.10	0.03	-0.03	-0.07	-0.09	-0.11
Calvert	0.08	0.06	0.04	0.03	0.02	0.01	0.01	0.00	0.00	-0.01
Carroll	0.12	0.09	0.07	0.05	0.03	0.02	0.01	0.00	-0.01	-0.01
Cecil	0.14	0.11	0.08	0.06	0.05	0.03	0.02	0.01	0.00	0.00
Charles	0.13	0.10	0.07	0.05	0.03	0.02	0.00	0.00	-0.01	-0.02
Frederick	0.27	0.20	0.15	0.10	0.06	0.03	0.01	-0.01	-0.03	-0.04
Harford	0.19	0.14	0.10	0.06	0.04	0.01	-0.01	-0.02	-0.03	-0.04
Howard	0.30	0.22	0.15	0.09	0.05	0.02	-0.01	-0.03	-0.04	-0.05
Montgomery	0.74	0.57	0.42	0.30	0.20	0.12	0.07	0.03	0.00	-0.02
Prince George's	0.74	0.54	0.37	0.23	0.11	0.02	-0.04	-0.09	-0.12	-0.15
Baltimore City	0.25	0.18	0.11	0.06	0.02	-0.01	-0.03	-0.05	-0.06	-0.07
Baltimore Region Total	1.96	1.41	0.97	0.61	0.33	0.09	-0.08	-0.20	-0.29	-0.35
Washington Region Total	1.96	1.46	1.05	0.71	0.43	0.21	0.04	-0.08	-0.17	-0.23
Stage II Area Total	4.05	2.98	2.10	1.38	0.80	0.33	-0.02	-0.27	-0.45	-0.58

**Table 25. Stage II Reductions with Zero IEE
Onroad Plus Nonroad, Displacement Only Impacts, Scenario 3
(VOC, metric tonnes per day)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.42	0.36	0.31	0.27	0.23	0.21	0.19	0.18	0.16	0.16
Baltimore	0.57	0.48	0.41	0.36	0.31	0.28	0.25	0.23	0.21	0.20
Calvert	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02
Carroll	0.10	0.09	0.08	0.07	0.06	0.06	0.05	0.05	0.05	0.04
Cecil	0.11	0.09	0.08	0.07	0.07	0.06	0.05	0.05	0.05	0.04
Charles	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.04
Frederick	0.22	0.19	0.17	0.15	0.13	0.11	0.10	0.09	0.09	0.08
Harford	0.17	0.15	0.13	0.11	0.10	0.09	0.08	0.07	0.07	0.06
Howard	0.27	0.23	0.20	0.17	0.15	0.14	0.13	0.12	0.11	0.10
Montgomery	0.62	0.54	0.47	0.41	0.36	0.32	0.30	0.27	0.26	0.25
Prince George's	0.65	0.55	0.47	0.40	0.34	0.30	0.26	0.24	0.22	0.20
Baltimore City	0.24	0.21	0.18	0.15	0.13	0.11	0.10	0.09	0.09	0.08
Baltimore Region Total	1.77	1.51	1.30	1.13	0.99	0.88	0.81	0.74	0.69	0.65
Washington Region Total	1.66	1.42	1.22	1.06	0.93	0.82	0.74	0.68	0.63	0.60
Stage II Area Total	3.54	3.02	2.61	2.26	1.98	1.76	1.60	1.47	1.36	1.29

**Table 26. Stage II Reductions with Non-Zero IEE
Onroad Plus Nonroad, Displacement Only Impacts, Scenario 3
(VOC, metric tonnes per day)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.13	0.06	-0.01	-0.06	-0.10	-0.13	-0.16	-0.18	-0.19	-0.20
Baltimore	0.17	0.06	-0.03	-0.10	-0.15	-0.20	-0.23	-0.25	-0.26	-0.27
Calvert	0.03	0.02	0.01	0.00	-0.01	-0.01	-0.02	-0.02	-0.02	-0.03
Carroll	0.04	0.02	0.01	-0.01	-0.02	-0.03	-0.03	-0.04	-0.04	-0.04
Cecil	0.05	0.03	0.02	0.00	-0.01	-0.02	-0.02	-0.03	-0.03	-0.04
Charles	0.04	0.02	0.01	-0.01	-0.02	-0.03	-0.03	-0.04	-0.04	-0.05
Frederick	0.09	0.05	0.01	-0.02	-0.04	-0.06	-0.08	-0.09	-0.10	-0.10
Harford	0.06	0.02	0.00	-0.02	-0.04	-0.06	-0.07	-0.08	-0.09	-0.09
Howard	0.08	0.03	-0.01	-0.05	-0.07	-0.09	-0.11	-0.12	-0.13	-0.13
Montgomery	0.25	0.14	0.05	-0.03	-0.09	-0.13	-0.17	-0.19	-0.21	-0.22
Prince George's	0.23	0.10	-0.01	-0.09	-0.16	-0.21	-0.25	-0.28	-0.30	-0.31
Baltimore City	0.06	0.01	-0.03	-0.06	-0.08	-0.10	-0.12	-0.13	-0.13	-0.13
Baltimore Region Total	0.54	0.20	-0.07	-0.29	-0.46	-0.61	-0.73	-0.80	-0.84	-0.87
Washington Region Total	0.64	0.33	0.07	-0.14	-0.31	-0.45	-0.55	-0.62	-0.67	-0.70
Stage II Area Total	1.23	0.56	0.01	-0.43	-0.79	-1.08	-1.30	-1.45	-1.55	-1.61

Table 27. Stage II Reductions with Zero IEE
Onroad Plus Nonroad, Displacement Plus Spillage Impacts, Scenario 1
(VOC, metric tonnes per day)

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.73	0.65	0.58	0.52	0.48	0.45	0.43	0.40	0.38	0.37
Baltimore	1.00	0.88	0.78	0.70	0.64	0.59	0.56	0.53	0.50	0.48
Calvert	0.10	0.09	0.08	0.08	0.07	0.06	0.06	0.06	0.05	0.05
Carroll	0.19	0.17	0.15	0.14	0.13	0.12	0.12	0.11	0.11	0.10
Cecil	0.18	0.16	0.15	0.13	0.12	0.11	0.11	0.10	0.10	0.09
Charles	0.17	0.15	0.14	0.13	0.11	0.11	0.10	0.09	0.09	0.09
Frederick	0.39	0.35	0.31	0.28	0.26	0.24	0.22	0.21	0.20	0.20
Harford	0.30	0.26	0.24	0.21	0.20	0.19	0.18	0.17	0.16	0.15
Howard	0.49	0.43	0.39	0.35	0.32	0.30	0.28	0.27	0.26	0.25
Montgomery	1.10	0.99	0.89	0.81	0.75	0.69	0.65	0.62	0.60	0.59
Prince George's	1.12	0.98	0.87	0.77	0.69	0.63	0.58	0.54	0.52	0.50
Baltimore City	0.43	0.38	0.33	0.30	0.27	0.25	0.23	0.22	0.21	0.20
Baltimore Region Total	3.14	2.76	2.47	2.23	2.03	1.89	1.80	1.70	1.62	1.56
Washington Region Total	2.90	2.56	2.29	2.07	1.88	1.72	1.61	1.53	1.46	1.42
Stage II Area Total	6.21	5.49	4.91	4.43	4.04	3.73	3.52	3.32	3.18	3.07

Table 28. Stage II Reductions with Non-Zero IEE
Onroad Plus Nonroad, Displacement Plus Spillage Impacts, Scenario 1
(VOC, metric tonnes per day)

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.45	0.35	0.27	0.20	0.15	0.10	0.07	0.05	0.03	0.02
Baltimore	0.60	0.46	0.34	0.25	0.18	0.12	0.08	0.05	0.03	0.01
Calvert	0.07	0.06	0.04	0.03	0.02	0.02	0.01	0.01	0.00	0.00
Carroll	0.12	0.10	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.02
Cecil	0.13	0.10	0.08	0.07	0.05	0.04	0.03	0.02	0.02	0.01
Charles	0.11	0.09	0.07	0.05	0.04	0.03	0.02	0.01	0.01	0.00
Frederick	0.26	0.20	0.16	0.12	0.09	0.06	0.05	0.03	0.02	0.01
Harford	0.18	0.14	0.11	0.08	0.06	0.04	0.02	0.01	0.00	0.00
Howard	0.29	0.23	0.17	0.13	0.09	0.07	0.04	0.03	0.02	0.01
Montgomery	0.73	0.59	0.47	0.37	0.30	0.23	0.19	0.16	0.13	0.12
Prince George's	0.70	0.53	0.40	0.28	0.19	0.12	0.07	0.03	0.00	-0.02
Baltimore City	0.25	0.18	0.13	0.09	0.06	0.03	0.01	0.00	-0.01	-0.02
Baltimore Region Total	1.90	1.46	1.10	0.81	0.58	0.40	0.26	0.16	0.09	0.04
Washington Region Total	1.88	1.47	1.14	0.86	0.64	0.46	0.33	0.23	0.16	0.12
Stage II Area Total	3.90	3.03	2.32	1.74	1.27	0.90	0.62	0.41	0.27	0.17

**Table 29. Stage II Reductions with Zero IEE
Onroad Plus Nonroad, Displacement Plus Spillage Impacts, Scenario 2
(VOC, metric tonnes per day)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.88	0.77	0.69	0.61	0.56	0.51	0.49	0.46	0.43	0.42
Baltimore	1.20	1.05	0.93	0.82	0.74	0.68	0.64	0.60	0.57	0.54
Calvert	0.13	0.11	0.10	0.09	0.08	0.07	0.07	0.06	0.06	0.06
Carroll	0.22	0.20	0.18	0.16	0.15	0.14	0.13	0.13	0.12	0.12
Cecil	0.22	0.20	0.18	0.16	0.15	0.13	0.12	0.12	0.11	0.11
Charles	0.21	0.19	0.17	0.15	0.13	0.12	0.11	0.11	0.10	0.10
Frederick	0.47	0.42	0.37	0.33	0.30	0.27	0.25	0.24	0.23	0.22
Harford	0.36	0.32	0.28	0.25	0.23	0.21	0.20	0.19	0.18	0.17
Howard	0.58	0.51	0.45	0.41	0.37	0.34	0.32	0.31	0.29	0.28
Montgomery	1.33	1.18	1.05	0.95	0.87	0.80	0.75	0.71	0.68	0.66
Prince George's	1.36	1.18	1.03	0.91	0.81	0.72	0.66	0.62	0.58	0.56
Baltimore City	0.52	0.45	0.39	0.35	0.31	0.28	0.26	0.25	0.23	0.22
Baltimore Region Total	3.77	3.29	2.92	2.61	2.35	2.17	2.05	1.92	1.83	1.75
Washington Region Total	3.49	3.07	2.72	2.43	2.19	1.99	1.85	1.74	1.66	1.60
Stage II Area Total	7.48	6.56	5.81	5.19	4.69	4.30	4.02	3.78	3.59	3.46

**Table 30. Stage II Reductions with Non-Zero IEE
Onroad Plus Nonroad, Displacement Plus Spillage Impacts, Scenario 2
(VOC, metric tonnes per day)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.60	0.47	0.37	0.29	0.22	0.17	0.13	0.10	0.08	0.07
Baltimore	0.80	0.63	0.48	0.37	0.28	0.21	0.16	0.12	0.09	0.07
Calvert	0.09	0.07	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.01
Carroll	0.16	0.13	0.11	0.09	0.07	0.06	0.05	0.04	0.03	0.03
Cecil	0.16	0.14	0.11	0.09	0.07	0.06	0.05	0.04	0.03	0.03
Charles	0.15	0.12	0.10	0.08	0.06	0.04	0.03	0.02	0.02	0.01
Frederick	0.34	0.27	0.22	0.17	0.13	0.10	0.08	0.06	0.05	0.04
Harford	0.24	0.19	0.15	0.12	0.09	0.07	0.05	0.04	0.03	0.02
Howard	0.39	0.31	0.24	0.19	0.14	0.11	0.08	0.07	0.05	0.04
Montgomery	0.96	0.78	0.63	0.51	0.42	0.34	0.29	0.25	0.22	0.20
Prince George's	0.93	0.73	0.56	0.42	0.30	0.21	0.15	0.10	0.06	0.04
Baltimore City	0.33	0.25	0.19	0.14	0.10	0.07	0.04	0.03	0.01	0.01
Baltimore Region Total	2.53	1.98	1.54	1.19	0.90	0.68	0.51	0.38	0.30	0.24
Washington Region Total	2.47	1.98	1.57	1.22	0.95	0.73	0.57	0.44	0.36	0.30
Stage II Area Total	5.17	4.10	3.22	2.50	1.93	1.46	1.12	0.87	0.68	0.56

**Table 31. Stage II Reductions with Zero IEE
Onroad Plus Nonroad, Displacement Plus Spillage Impacts, Scenario 3
(VOC, metric tonnes per day)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.55	0.49	0.44	0.40	0.37	0.35	0.33	0.31	0.30	0.29
Baltimore	0.75	0.66	0.60	0.54	0.49	0.46	0.44	0.41	0.40	0.38
Calvert	0.08	0.07	0.06	0.06	0.05	0.05	0.05	0.04	0.04	0.04
Carroll	0.14	0.13	0.12	0.11	0.10	0.09	0.09	0.09	0.08	0.08
Cecil	0.13	0.12	0.11	0.10	0.09	0.09	0.08	0.08	0.07	0.07
Charles	0.13	0.12	0.10	0.10	0.09	0.08	0.08	0.07	0.07	0.07
Frederick	0.29	0.26	0.24	0.22	0.20	0.18	0.17	0.17	0.16	0.15
Harford	0.22	0.20	0.18	0.16	0.15	0.14	0.14	0.13	0.13	0.12
Howard	0.36	0.32	0.29	0.27	0.25	0.23	0.22	0.21	0.20	0.20
Montgomery	0.83	0.75	0.68	0.62	0.58	0.54	0.51	0.49	0.48	0.47
Prince George's	0.84	0.74	0.66	0.59	0.53	0.49	0.45	0.43	0.41	0.39
Baltimore City	0.32	0.28	0.25	0.23	0.21	0.19	0.18	0.17	0.16	0.16
Baltimore Region Total	2.35	2.09	1.88	1.70	1.56	1.47	1.40	1.33	1.27	1.23
Washington Region Total	2.17	1.93	1.74	1.58	1.45	1.34	1.26	1.20	1.15	1.12
Stage II Area Total	4.65	4.14	3.73	3.39	3.11	2.89	2.74	2.61	2.50	2.42

**Table 32. Stage II Reductions with Non-Zero IEE
Onroad Plus Nonroad, Displacement Plus Spillage Impacts, Scenario 3
(VOC, metric tonnes per day)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Anne Arundel	0.27	0.19	0.13	0.08	0.04	0.00	-0.02	-0.04	-0.05	-0.06
Baltimore	0.35	0.24	0.15	0.09	0.03	-0.01	-0.05	-0.07	-0.08	-0.09
Calvert	0.04	0.03	0.02	0.01	0.01	0.00	0.00	-0.01	-0.01	-0.01
Carroll	0.08	0.06	0.04	0.03	0.02	0.01	0.00	0.00	0.00	0.00
Cecil	0.08	0.06	0.05	0.03	0.02	0.01	0.00	0.00	-0.01	-0.01
Charles	0.07	0.05	0.04	0.02	0.01	0.00	0.00	-0.01	-0.01	-0.02
Frederick	0.16	0.12	0.08	0.05	0.03	0.01	0.00	-0.01	-0.02	-0.03
Harford	0.11	0.08	0.05	0.03	0.01	0.00	-0.02	-0.02	-0.03	-0.03
Howard	0.17	0.12	0.08	0.05	0.02	0.00	-0.02	-0.03	-0.03	-0.04
Montgomery	0.46	0.35	0.26	0.19	0.13	0.08	0.05	0.03	0.01	0.00
Prince George's	0.42	0.29	0.18	0.10	0.03	-0.02	-0.06	-0.09	-0.11	-0.12
Baltimore City	0.14	0.09	0.05	0.02	-0.01	-0.03	-0.04	-0.05	-0.06	-0.06
Baltimore Region Total	1.11	0.78	0.50	0.28	0.11	-0.03	-0.14	-0.21	-0.26	-0.28
Washington Region Total	1.15	0.84	0.59	0.37	0.21	0.07	-0.02	-0.10	-0.15	-0.18
Stage II Area Total	2.34	1.68	1.13	0.69	0.34	0.06	-0.16	-0.31	-0.41	-0.47

**Table 33. Stage II HAPs Reductions with Zero IEE
Onroad Only, Displacement Impacts Only, Scenario 1
(kilograms per day, entire 12 county Stage II area)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	568.34	471.10	392.28	326.18	272.31	229.49	198.68	172.04	151.81	136.44
Benzene	14.17	11.75	9.78	8.13	6.79	5.72	4.95	4.29	3.79	3.40
Xylene	273.55	226.75	188.81	156.99	131.06	110.45	95.62	82.80	73.07	65.67
Toluene	610.55	506.09	421.42	350.40	292.53	246.53	213.43	184.81	163.08	146.58
Ethyl Benzene	73.29	60.75	50.59	42.06	35.12	29.60	25.62	22.19	19.58	17.60
Hexane	108.00	89.53	74.55	61.98	51.75	43.61	37.76	32.69	28.85	25.93
2,2,4-Trimethylpentane	142.84	118.40	98.59	81.98	68.44	57.68	49.93	43.24	38.15	34.29
Naphthalene	1.70	1.41	1.18	0.98	0.82	0.69	0.60	0.52	0.46	0.41
Speciated Emissions Total	1792.45	1485.78	1237.20	1028.71	858.82	723.76	626.60	542.58	478.78	430.32
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

**Table 34. Stage II HAPs Reductions with Non-Zero IEE
Onroad Only, Displacement Impacts Only, Scenario 1
(kilograms per day, entire 12 county Stage II area)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	259.95	142.76	46.20	-33.25	-96.67	-148.54	-188.44	-216.40	-236.58	-250.23
Benzene	6.48	3.56	1.15	-0.83	-2.41	-3.70	-4.70	-5.40	-5.90	-6.24
Xylene	125.12	68.71	22.24	-16.00	-46.53	-71.50	-90.70	-104.16	-113.87	-120.44
Toluene	279.26	153.37	49.64	-35.71	-103.85	-159.58	-202.44	-232.47	-254.15	-268.81
Ethyl Benzene	33.52	18.41	5.96	-4.29	-12.47	-19.16	-24.30	-27.91	-30.51	-32.27
Hexane	49.40	27.13	8.78	-6.32	-18.37	-28.23	-35.81	-41.12	-44.96	-47.55
2,2,4-Trimethylpentane	65.33	35.88	11.61	-8.36	-24.30	-37.33	-47.36	-54.39	-59.46	-62.89
Naphthalene	0.78	0.43	0.14	-0.10	-0.29	-0.45	-0.56	-0.65	-0.71	-0.75
Speciated Emissions Total	819.84	450.26	145.72	-104.85	-304.87	-468.49	-594.32	-682.49	-746.14	-789.19
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

**Table 35. Stage II HAPs Reductions with Zero IEE
Onroad Only, Displacement Impacts Only, Scenario 2
(kilograms per day, entire 12 county Stage II area)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	730.72	605.70	504.36	419.37	350.11	295.05	255.44	221.19	195.18	175.43
Benzene	18.22	15.11	12.58	10.46	8.73	7.36	6.37	5.52	4.87	4.38
Xylene	351.70	291.53	242.76	201.85	168.51	142.01	122.95	106.46	93.94	84.44
Toluene	784.99	650.69	541.82	450.52	376.11	316.97	274.41	237.62	209.68	188.46
Ethyl Benzene	94.24	78.11	65.04	54.08	45.15	38.05	32.94	28.53	25.17	22.62
Hexane	138.86	115.11	95.85	79.69	66.53	56.07	48.54	42.03	37.09	33.34
2,2,4-Trimethylpentane	183.65	152.23	126.76	105.40	87.99	74.16	64.20	55.59	49.06	44.09
Naphthalene	2.19	1.82	1.51	1.26	1.05	0.88	0.77	0.66	0.59	0.53
Speciated Emissions Total	2304.58	1910.29	1590.69	1322.62	1104.19	930.55	805.62	697.60	615.57	553.27
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

**Table 36. Stage II HAPs Reductions with Non-Zero IEE
Onroad Only, Displacement Impacts Only, Scenario 2
(kilograms per day, entire 12 county Stage II area)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	422.33	277.36	158.29	59.95	-18.87	-82.98	-131.68	-167.25	-193.21	-211.25
Benzene	10.53	6.92	3.95	1.50	-0.47	-2.07	-3.28	-4.17	-4.82	-5.27
Xylene	203.27	133.50	76.18	28.85	-9.08	-39.94	-63.38	-80.50	-92.99	-101.67
Toluene	453.70	297.96	170.04	64.40	-20.27	-89.14	-141.46	-179.67	-207.56	-226.93
Ethyl Benzene	54.47	35.77	20.41	7.73	-2.43	-10.70	-16.98	-21.57	-24.92	-27.24
Hexane	80.26	52.71	30.08	11.39	-3.59	-15.77	-25.02	-31.78	-36.72	-40.14
2,2,4-Trimethylpentane	106.15	69.71	39.78	15.07	-4.74	-20.85	-33.09	-42.03	-48.56	-53.09
Naphthalene	1.27	0.83	0.47	0.18	-0.06	-0.25	-0.39	-0.50	-0.58	-0.63
Speciated Emissions Total	1331.97	874.77	499.21	189.07	-59.50	-261.70	-415.29	-527.47	-609.35	-666.24
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

**Table 37. Stage II HAPs Reductions with Zero IEE
Onroad Only, Displacement Impacts Only, Scenario 3
(kilograms per day, entire 12 county Stage II area)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	405.95	336.50	280.20	232.98	194.51	163.92	141.91	122.88	108.43	97.46
Benzene	10.12	8.39	6.99	5.81	4.85	4.09	3.54	3.06	2.70	2.43
Xylene	195.39	161.96	134.86	112.14	93.62	78.90	68.30	59.15	52.19	46.91
Toluene	436.11	361.49	301.01	250.29	208.95	176.09	152.45	132.01	116.49	104.70
Ethyl Benzene	52.35	43.40	36.14	30.05	25.08	21.14	18.30	15.85	13.98	12.57
Hexane	77.15	63.95	53.25	44.27	36.96	31.15	26.97	23.35	20.61	18.52
2,2,4-Trimethylpentane	102.03	84.57	70.42	58.56	48.89	41.20	35.67	30.88	27.25	24.49
Naphthalene	1.22	1.01	0.84	0.70	0.58	0.49	0.43	0.37	0.33	0.29
Speciated Emissions Total	1280.32	1061.27	883.72	734.79	613.44	516.97	447.57	387.56	341.98	307.37
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

**Table 38. Stage II HAPs Reductions with Non-Zero IEE
Onroad Only, Displacement Impacts Only, Scenario 3
(kilograms per day, entire 12 county Stage II area)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	97.57	8.16	-65.88	-126.44	-174.47	-214.11	-245.21	-265.55	-279.95	-289.21
Benzene	2.43	0.20	-1.64	-3.15	-4.35	-5.34	-6.12	-6.62	-6.98	-7.21
Xylene	46.96	3.93	-31.71	-60.86	-83.97	-103.05	-118.02	-127.81	-134.74	-139.20
Toluene	104.82	8.77	-70.77	-135.83	-187.43	-230.01	-263.42	-285.28	-300.75	-310.69
Ethyl Benzene	12.58	1.05	-8.50	-16.31	-22.50	-27.61	-31.62	-34.25	-36.10	-37.30
Hexane	18.54	1.55	-12.52	-24.03	-33.16	-40.69	-46.60	-50.46	-53.20	-54.96
2,2,4-Trimethylpentane	24.52	2.05	-16.56	-31.78	-43.85	-53.81	-61.63	-66.74	-70.36	-72.69
Naphthalene	0.29	0.02	-0.20	-0.38	-0.52	-0.64	-0.73	-0.80	-0.84	-0.87
Speciated Emissions Total	307.72	25.75	-207.77	-398.77	-550.25	-675.28	-773.35	-837.51	-882.93	-912.14
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

**Table 39. Stage II HAPs Reductions with Zero IEE
Onroad Only, Displacement Plus Spillage Impacts, Scenario 1
(kilograms per day, entire 12 county Stage II area)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	690.22	591.75	512.61	445.95	391.34	348.29	318.03	290.03	268.48	251.63
Benzene	17.21	14.76	12.78	11.12	9.76	8.69	7.93	7.23	6.70	6.28
Xylene	332.21	284.82	246.72	214.64	188.36	167.64	153.07	139.60	129.22	121.11
Toluene	741.48	635.71	550.68	479.07	420.41	374.16	341.65	311.57	288.42	270.32
Ethyl Benzene	89.01	76.31	66.11	57.51	50.47	44.92	41.01	37.40	34.62	32.45
Hexane	131.17	112.45	97.41	84.75	74.37	66.19	60.44	55.12	51.02	47.82
2,2,4-Trimethylpentane	173.47	148.73	128.84	112.08	98.36	87.54	79.93	72.89	67.48	63.24
Naphthalene	2.07	1.77	1.54	1.34	1.17	1.04	0.95	0.87	0.80	0.75
Speciated Emissions Total	2176.84	1866.30	1616.70	1406.45	1234.23	1098.47	1003.01	914.72	846.73	793.61
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

**Table 40. Stage II HAPs Reductions with Non-Zero IEE
Onroad Only, Displacement Plus Spillage Impacts, Scenario 1
(kilograms per day, entire 12 county Stage II area)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	381.83	263.42	166.53	86.52	22.37	-29.74	-69.09	-98.40	-119.91	-135.04
Benzene	9.52	6.57	4.15	2.16	0.56	-0.74	-1.72	-2.45	-2.99	-3.37
Xylene	183.78	126.78	80.15	41.65	10.77	-14.31	-33.25	-47.36	-57.71	-65.00
Toluene	410.19	282.98	178.90	92.95	24.03	-31.95	-74.22	-105.71	-128.82	-145.07
Ethyl Benzene	49.24	33.97	21.48	11.16	2.88	-3.83	-8.91	-12.69	-15.46	-17.42
Hexane	72.56	50.06	31.65	16.44	4.25	-5.65	-13.13	-18.70	-22.79	-25.66
2,2,4-Trimethylpentane	95.97	66.21	41.85	21.75	5.62	-7.47	-17.37	-24.73	-30.14	-33.94
Naphthalene	1.14	0.79	0.50	0.26	0.07	-0.09	-0.21	-0.29	-0.36	-0.40
Speciated Emissions Total	1204.23	830.78	525.22	272.89	70.54	-93.78	-217.91	-310.35	-378.18	-425.90
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

**Table 41. Stage II HAPs Reductions with Zero IEE
Onroad Only, Displacement Plus Spillage Impacts, Scenario 2
(kilograms per day, entire 12 county Stage II area)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	832.88	707.19	605.85	520.59	450.87	395.76	356.72	321.42	294.35	273.39
Benzene	20.77	17.64	15.11	12.98	11.24	9.87	8.90	8.02	7.34	6.82
Xylene	400.87	340.38	291.60	250.57	217.01	190.49	171.69	154.70	141.67	131.59
Toluene	894.74	759.71	650.85	559.26	484.36	425.16	383.22	345.29	316.21	293.70
Ethyl Benzene	107.41	91.20	78.13	67.14	58.15	51.04	46.00	41.45	37.96	35.26
Hexane	158.28	134.39	115.13	98.93	85.68	75.21	67.79	61.08	55.94	51.95
2,2,4-Trimethylpentane	209.33	177.74	152.27	130.84	113.32	99.47	89.66	80.78	73.98	68.71
Naphthalene	2.50	2.12	1.82	1.56	1.35	1.19	1.07	0.96	0.88	0.82
Speciated Emissions Total	2626.78	2230.36	1910.76	1641.87	1421.97	1248.18	1125.06	1013.70	928.34	862.25
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

**Table 42. Stage II HAPs Reductions with Non-Zero IEE
Onroad Only, Displacement Plus Spillage Impacts, Scenario 2
(kilograms per day, entire 12 county Stage II area)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	524.49	378.85	259.77	161.17	81.89	17.73	-30.39	-67.02	-94.04	-113.28
Benzene	13.08	9.45	6.48	4.02	2.04	0.44	-0.76	-1.67	-2.35	-2.83
Xylene	252.44	182.34	125.03	77.57	39.42	8.54	-14.63	-32.26	-45.26	-54.52
Toluene	563.45	406.99	279.06	173.14	87.98	19.05	-32.65	-72.00	-101.02	-121.69
Ethyl Benzene	67.64	48.86	33.50	20.79	10.56	2.29	-3.92	-8.64	-12.13	-14.61
Hexane	99.67	71.99	49.37	30.63	15.56	3.37	-5.78	-12.74	-17.87	-21.53
2,2,4-Trimethylpentane	131.82	95.22	65.29	40.51	20.58	4.46	-7.64	-16.84	-23.63	-28.47
Naphthalene	1.57	1.14	0.78	0.48	0.25	0.05	-0.09	-0.20	-0.28	-0.34
Speciated Emissions Total	1654.18	1194.83	819.27	508.31	258.28	55.93	-95.86	-211.37	-296.58	-357.26
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

**Table 43. Stage II HAPs Reductions with Zero IEE
Onroad Only, Displacement Plus Spillage Impacts, Scenario 3
(kilograms per day, entire 12 county Stage II area)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	508.12	437.99	381.69	334.21	295.26	264.63	243.19	223.11	207.60	195.43
Benzene	12.67	10.92	9.52	8.34	7.36	6.60	6.07	5.56	5.18	4.87
Xylene	244.56	210.81	183.71	160.86	142.11	127.37	117.05	107.38	99.92	94.06
Toluene	545.86	470.52	410.04	359.03	317.19	284.28	261.26	239.68	223.02	209.94
Ethyl Benzene	65.53	56.48	49.22	43.10	38.08	34.13	31.36	28.77	26.77	25.20
Hexane	96.56	83.23	72.53	63.51	56.11	50.29	46.22	42.40	39.45	37.14
2,2,4-Trimethylpentane	127.71	110.08	95.93	84.00	74.21	66.51	61.12	56.07	52.18	49.12
Naphthalene	1.52	1.31	1.14	1.00	0.89	0.79	0.73	0.67	0.62	0.59
Speciated Emissions Total	1602.52	1381.34	1203.78	1054.04	931.22	834.60	767.00	703.65	654.75	616.35
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

**Table 44. Stage II HAPs Reductions with Non-Zero IEE
Onroad Only, Displacement Plus Spillage Impacts, Scenario 3
(kilograms per day, entire 12 county Stage II area)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	199.73	109.65	35.61	-25.21	-73.71	-113.40	-143.92	-165.33	-180.78	-191.25
Benzene	4.98	2.73	0.89	-0.63	-1.84	-2.83	-3.59	-4.12	-4.51	-4.77
Xylene	96.13	52.77	17.14	-12.14	-35.48	-54.58	-69.27	-79.57	-87.01	-92.05
Toluene	214.56	117.79	38.25	-27.09	-79.18	-121.82	-154.61	-177.61	-194.21	-205.45
Ethyl Benzene	25.76	14.14	4.59	-3.25	-9.51	-14.62	-18.56	-21.32	-23.31	-24.66
Hexane	37.96	20.84	6.77	-4.79	-14.01	-21.55	-27.35	-31.42	-34.36	-36.34
2,2,4-Trimethylpentane	50.20	27.56	8.95	-6.34	-18.53	-28.50	-36.17	-41.55	-45.44	-48.07
Naphthalene	0.60	0.33	0.11	-0.08	-0.22	-0.34	-0.43	-0.50	-0.54	-0.57
Speciated Emissions Total	629.92	345.81	112.30	-79.52	-232.47	-357.65	-453.92	-521.42	-570.16	-603.16
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

Table 45. Stage II HAPs Reductions with Zero IEE
Onroad Plus Nonroad, Displacement Impacts Only, Scenario 1
(kilograms per day, entire 12 county Stage II area)

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	660.69	564.70	487.16	422.37	369.84	328.38	298.95	273.71	254.88	240.93
Benzene	16.48	14.08	12.15	10.53	9.22	8.19	7.46	6.83	6.36	6.01
Xylene	318.00	271.80	234.48	203.29	178.01	158.05	143.89	131.74	122.67	115.96
Toluene	709.76	606.65	523.34	453.74	397.30	352.77	321.16	294.03	273.81	258.82
Ethyl Benzene	85.20	72.83	62.83	54.47	47.70	42.35	38.55	35.30	32.87	31.07
Hexane	125.55	107.31	92.58	80.27	70.28	62.40	56.81	52.01	48.44	45.78
2,2,4-Trimethylpentane	166.05	141.93	122.44	106.16	92.95	82.53	75.14	68.79	64.06	60.55
Naphthalene	1.98	1.69	1.46	1.27	1.11	0.98	0.90	0.82	0.76	0.72
Speciated Emissions Total	2083.71	1780.99	1536.43	1332.10	1166.41	1035.67	942.85	863.23	803.84	759.85
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

Table 46. Stage II HAPs Reductions with Non-Zero IEE
Onroad Plus Nonroad, Displacement Impacts Only, Scenario 1
(kilograms per day, entire 12 county Stage II area)

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	352.30	236.37	141.08	62.95	0.86	-49.65	-88.17	-114.73	-133.51	-145.75
Benzene	8.79	5.89	3.52	1.57	0.02	-1.24	-2.20	-2.86	-3.33	-3.63
Xylene	169.57	113.77	67.90	30.30	0.41	-23.90	-42.44	-55.22	-64.26	-70.15
Toluene	378.47	253.92	151.56	67.63	0.93	-53.33	-94.71	-123.25	-143.43	-156.57
Ethyl Benzene	45.43	30.48	18.19	8.12	0.11	-6.40	-11.37	-14.80	-17.22	-18.80
Hexane	66.95	44.92	26.81	11.96	0.16	-9.43	-16.75	-21.80	-25.37	-27.70
2,2,4-Trimethylpentane	88.55	59.41	35.46	15.82	0.22	-12.48	-22.16	-28.84	-33.56	-36.63
Naphthalene	1.06	0.71	0.42	0.19	0.00	-0.15	-0.26	-0.34	-0.40	-0.44
Speciated Emissions Total	1111.11	745.47	444.95	198.54	2.72	-156.58	-278.06	-361.85	-421.07	-459.66
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

**Table 47. Stage II HAPs Reductions with Zero IEE
Onroad Plus Nonroad, Displacement Impacts Only, Scenario 2
(kilograms per day, entire 12 county Stage II area)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	849.46	726.05	626.35	543.05	475.50	422.21	384.37	351.91	327.70	309.76
Benzene	21.19	18.11	15.62	13.54	11.86	10.53	9.59	8.78	8.17	7.73
Xylene	408.85	349.45	301.47	261.37	228.86	203.21	185.00	169.38	157.72	149.09
Toluene	912.55	779.97	672.87	583.38	510.82	453.56	412.92	378.04	352.04	332.77
Ethyl Benzene	109.55	93.63	80.78	70.03	61.32	54.45	49.57	45.38	42.26	39.95
Hexane	161.43	137.98	119.03	103.20	90.36	80.23	73.04	66.87	62.27	58.87
2,2,4-Trimethylpentane	213.50	182.48	157.42	136.49	119.51	106.11	96.60	88.45	82.36	77.85
Naphthalene	2.55	2.18	1.88	1.63	1.43	1.27	1.15	1.05	0.98	0.93
Speciated Emissions Total	2679.06	2289.85	1975.41	1712.70	1499.67	1331.57	1212.24	1109.86	1033.51	976.94
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

**Table 48. Stage II HAPs Reductions with Non-Zero IEE
Onroad Plus Nonroad, Displacement Impacts Only, Scenario 2
(kilograms per day, entire 12 county Stage II area)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	541.07	397.71	280.27	183.63	106.53	44.18	-2.75	-36.53	-60.69	-76.91
Benzene	13.49	9.92	6.99	4.58	2.66	1.10	-0.07	-0.91	-1.51	-1.92
Xylene	260.42	191.42	134.90	88.38	51.27	21.26	-1.32	-17.58	-29.21	-37.02
Toluene	581.26	427.25	301.09	197.27	114.44	47.46	-2.96	-39.24	-65.20	-82.62
Ethyl Benzene	69.78	51.29	36.14	23.68	13.74	5.70	-0.35	-4.71	-7.83	-9.92
Hexane	102.82	75.58	53.26	34.90	20.24	8.40	-0.52	-6.94	-11.53	-14.62
2,2,4-Trimethylpentane	135.99	99.96	70.44	46.15	26.77	11.10	-0.69	-9.18	-15.25	-19.33
Naphthalene	1.62	1.19	0.84	0.55	0.32	0.13	-0.01	-0.11	-0.18	-0.23
Speciated Emissions Total	1706.45	1254.32	883.93	579.14	335.98	139.33	-8.68	-115.21	-191.41	-242.57
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

**Table 49. Stage II HAPs Reductions with Zero IEE
Onroad Plus Nonroad, Displacement Impacts Only, Scenario 3
(kilograms per day, entire 12 county Stage II area)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	471.92	403.36	347.97	301.69	264.17	234.56	213.54	195.50	182.05	172.09
Benzene	11.77	10.06	8.68	7.52	6.59	5.85	5.33	4.88	4.54	4.29
Xylene	227.14	194.14	167.48	145.21	127.15	112.90	102.78	94.10	87.62	82.83
Toluene	506.97	433.32	373.82	324.10	283.79	251.98	229.40	210.02	195.58	184.87
Ethyl Benzene	60.86	52.02	44.88	38.91	34.07	30.25	27.54	25.21	23.48	22.19
Hexane	89.68	76.65	66.13	57.33	50.20	44.57	40.58	37.15	34.60	32.70
2,2,4-Trimethylpentane	118.61	101.38	87.46	75.83	66.39	58.95	53.67	49.14	45.76	43.25
Naphthalene	1.41	1.21	1.04	0.90	0.79	0.70	0.64	0.59	0.55	0.52
Speciated Emissions Total	1488.37	1272.14	1097.45	951.50	833.15	739.76	673.47	616.59	574.17	542.75
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

**Table 50. Stage II HAPs Reductions with Non-Zero IEE
Onroad Plus Nonroad, Displacement Impacts Only, Scenario 3
(kilograms per day, entire 12 county Stage II area)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	163.53	75.02	1.89	-57.73	-104.81	-143.47	-173.58	-192.93	-206.33	-214.58
Benzene	4.08	1.87	0.05	-1.44	-2.61	-3.58	-4.33	-4.81	-5.15	-5.35
Xylene	78.71	36.11	0.91	-27.78	-50.44	-69.05	-83.55	-92.86	-99.31	-103.28
Toluene	175.68	80.59	2.03	-62.01	-112.59	-154.13	-186.47	-207.26	-221.66	-230.52
Ethyl Benzene	21.09	9.68	0.24	-7.44	-13.52	-18.50	-22.39	-24.88	-26.61	-27.67
Hexane	31.08	14.26	0.36	-10.97	-19.92	-27.26	-32.99	-36.66	-39.21	-40.78
2,2,4-Trimethylpentane	41.10	18.86	0.48	-14.51	-26.34	-36.06	-43.63	-48.49	-51.86	-53.93
Naphthalene	0.49	0.22	0.01	-0.17	-0.31	-0.43	-0.52	-0.58	-0.62	-0.64
Speciated Emissions Total	515.76	236.61	5.97	-182.06	-330.54	-452.49	-547.45	-608.48	-650.74	-676.76
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

Table 51. Stage II HAPs Reductions with Zero IEE
Onroad Plus Nonroad, Displacement Plus Spillage Impacts, Scenario 1
(kilograms per day, entire 12 county Stage II area)

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	829.10	732.65	655.54	590.97	538.48	497.58	469.48	443.66	424.30	409.65
Benzene	20.68	18.27	16.35	14.74	13.43	12.41	11.71	11.06	10.58	10.22
Xylene	399.05	352.63	315.52	284.44	259.17	239.49	225.96	213.54	204.22	197.17
Toluene	890.68	787.06	704.23	634.86	578.47	534.54	504.35	476.61	455.81	440.08
Ethyl Benzene	106.92	94.48	84.54	76.21	69.44	64.17	60.55	57.22	54.72	52.83
Hexane	157.56	139.23	124.58	112.31	102.33	94.56	89.22	84.31	80.63	77.85
2,2,4-Trimethylpentane	208.38	184.14	164.76	148.53	135.34	125.06	118.00	111.51	106.64	102.96
Naphthalene	2.49	2.20	1.96	1.77	1.61	1.49	1.41	1.33	1.27	1.23
Speciated Emissions Total	2614.85	2310.66	2067.47	1863.84	1698.27	1569.29	1480.67	1399.25	1338.17	1291.99
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

Table 52. Stage II HAPs Reductions with Non-Zero IEE
Onroad Plus Nonroad, Displacement Plus Spillage Impacts, Scenario 1
(kilograms per day, entire 12 county Stage II area)

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	520.71	404.31	309.46	231.55	169.50	119.55	82.36	55.23	35.91	22.98
Benzene	12.99	10.08	7.72	5.77	4.23	2.98	2.05	1.38	0.90	0.57
Xylene	250.62	194.60	148.95	111.45	81.58	57.54	39.64	26.58	17.28	11.06
Toluene	559.39	434.34	332.44	248.75	182.09	128.43	88.48	59.33	38.58	24.69
Ethyl Benzene	67.15	52.14	39.91	29.86	21.86	15.42	10.62	7.12	4.63	2.96
Hexane	98.95	76.83	58.81	44.00	32.21	22.72	15.65	10.49	6.82	4.37
2,2,4-Trimethylpentane	130.87	101.62	77.78	58.20	42.60	30.05	20.70	13.88	9.03	5.78
Naphthalene	1.56	1.21	0.93	0.69	0.51	0.36	0.25	0.17	0.11	0.07
Speciated Emissions Total	1642.25	1275.13	975.99	730.28	534.58	377.04	259.75	174.17	113.25	72.48
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

**Table 53. Stage II HAPs Reductions with Zero IEE
Onroad Plus Nonroad, Displacement Plus Spillage Impacts, Scenario 2
(kilograms per day, entire 12 county Stage II area)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	998.15	874.82	775.89	693.10	625.87	573.31	536.83	504.09	479.62	461.27
Benzene	24.89	21.82	19.35	17.29	15.61	14.30	13.39	12.57	11.96	11.50
Xylene	480.42	421.06	373.44	333.60	301.24	275.94	258.38	242.62	230.84	222.01
Toluene	1072.28	939.80	833.51	744.58	672.35	615.89	576.70	541.53	515.24	495.53
Ethyl Benzene	128.72	112.82	100.06	89.39	80.71	73.94	69.23	65.01	61.85	59.49
Hexane	189.68	166.25	147.45	131.71	118.94	108.95	102.02	95.80	91.14	87.66
2,2,4-Trimethylpentane	250.87	219.87	195.01	174.20	157.30	144.09	134.92	126.70	120.54	115.93
Naphthalene	2.99	2.62	2.33	2.08	1.88	1.72	1.61	1.51	1.44	1.38
Speciated Emissions Total	3148.02	2759.07	2447.03	2185.94	1973.90	1808.12	1693.07	1589.84	1512.65	1454.78
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

**Table 54. Stage II HAPs Reductions with Non-Zero IEE
Onroad Plus Nonroad, Displacement Plus Spillage Impacts, Scenario 2
(kilograms per day, entire 12 county Stage II area)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	689.76	546.49	429.81	333.68	256.89	195.28	149.71	115.66	91.23	74.60
Benzene	17.20	13.63	10.72	8.32	6.41	4.87	3.73	2.88	2.28	1.86
Xylene	331.99	263.03	206.87	160.60	123.65	93.99	72.06	55.67	43.91	35.90
Toluene	740.99	587.08	461.73	358.47	275.97	209.78	160.83	124.25	98.01	80.14
Ethyl Benzene	88.95	70.48	55.43	43.03	33.13	25.18	19.31	14.92	11.77	9.62
Hexane	131.08	103.85	81.68	63.41	48.82	37.11	28.45	21.98	17.34	14.18
2,2,4-Trimethylpentane	173.36	137.35	108.02	83.87	64.57	49.08	37.63	29.07	22.93	18.75
Naphthalene	2.07	1.64	1.29	1.00	0.77	0.59	0.45	0.35	0.27	0.22
Speciated Emissions Total	2175.41	1723.54	1355.54	1052.38	810.21	615.88	472.15	364.76	287.73	235.27
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

**Table 55. Stage II HAPs Reductions with Zero IEE
Onroad Plus Nonroad, Displacement Plus Spillage Impacts, Scenario 3
(kilograms per day, entire 12 county Stage II area)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	620.61	552.14	497.51	451.75	414.53	385.66	366.00	347.69	333.98	323.60
Benzene	15.48	13.77	12.41	11.27	10.34	9.62	9.13	8.67	8.33	8.07
Xylene	298.71	265.75	239.45	217.43	199.52	185.62	176.16	167.35	160.75	155.75
Toluene	666.71	593.14	534.46	485.30	445.32	414.30	393.18	373.51	358.78	347.63
Ethyl Benzene	80.04	71.21	64.16	58.26	53.46	49.74	47.20	44.84	43.07	41.73
Hexane	117.94	104.93	94.54	85.85	78.78	73.29	69.55	66.07	63.47	61.50
2,2,4-Trimethylpentane	155.98	138.77	125.04	113.54	104.19	96.93	91.99	87.39	83.94	81.33
Naphthalene	1.86	1.65	1.49	1.35	1.24	1.16	1.10	1.04	1.00	0.97
Speciated Emissions Total	1957.32	1741.35	1569.06	1424.74	1307.38	1216.31	1154.30	1096.56	1053.31	1020.58
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%

**Table 56. Stage II HAPs Reductions with Non-Zero IEE
Onroad Plus Nonroad, Displacement Plus Spillage Impacts, Scenario 3
(kilograms per day, entire 12 county Stage II area)**

County	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
MTBE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethanol	312.23	223.80	151.43	92.33	45.56	7.63	-21.12	-40.75	-54.41	-63.08
Benzene	7.79	5.58	3.78	2.30	1.14	0.19	-0.53	-1.02	-1.36	-1.57
Xylene	150.28	107.72	72.88	44.44	21.93	3.67	-10.17	-19.61	-26.19	-30.36
Toluene	335.42	240.42	162.68	99.18	48.94	8.20	-22.69	-43.77	-58.45	-67.76
Ethyl Benzene	40.27	28.86	19.53	11.91	5.88	0.98	-2.72	-5.25	-7.02	-8.13
Hexane	59.33	42.53	28.78	17.55	8.66	1.45	-4.01	-7.74	-10.34	-11.99
2,2,4-Trimethylpentane	78.47	56.25	38.06	23.20	11.45	1.92	-5.31	-10.24	-13.68	-15.85
Naphthalene	0.94	0.67	0.45	0.28	0.14	0.02	-0.06	-0.12	-0.16	-0.19
Speciated Emissions Total	984.72	705.83	477.58	291.19	143.69	24.06	-66.62	-128.51	-171.61	-198.93
Fraction of Total VOC	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%	42.1%